# SBIR

# Small Business Innovation Research

## FY 2012

NOAA Program Solicitation: **NOAA 2012-1**

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U.S. DEPARTMENT OF COMMERCE
http://www.oar.noaa.gov/ORTA

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**DEPARTMENT OF COMMERCE**
**NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION**

# PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH (SBIR)

## 1.0 PROGRAM DESCRIPTION

### 1.1 Introduction

The Department of Commerce (DOC) National Oceanic and Atmospheric Administration (NOAA) invites small businesses to submit research proposals under this solicitation. Firms with strong research capabilities in any of the areas listed in Section 8 of this solicitation are encouraged to participate. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. **Unsolicited proposals are not accepted under the Small Business Innovation Research (SBIR) program.**

Objectives of this program include stimulating technological innovation in the private sector and strengthening the role of small business in meeting Federal research and development (R&D) needs. This program also seeks to increase the commercial application of innovations derived from Federal research and to foster and encourage participation by socially and economically disadvantaged and woman-owned small businesses.

### 1.2 Three-Phase Program

The "Small Business Innovation Research Program Reauthorization Act of 2000" requires the Department of Commerce to establish a three-phase SBIR program by reserving a percentage of its extramural R&D budget to be awarded to small business concerns for innovation research.

The funding vehicles for NOAA's SBIR program in both Phase I and Phase II are contracts. This document solicits Phase I proposals only.

**NOAA has the unilateral right to select SBIR research topics and awardees in both Phase I and Phase II, and to award several or no contracts under a given subtopic.**

#### 1.2.1 Phase I – Feasibility Research

The purpose of Phase I is to determine the technical feasibility of the proposed research and the quality of performance of the small business concern receiving an award. Therefore, the proposal should concentrate on research that will significantly contribute to proving the feasibility of the proposed research, a prerequisite to further support in Phase II.

### 1.2.2 Phase II – Research and Development

Only firms that are awarded Phase I contracts under this solicitation will be given the opportunity to submit a Phase II proposal immediately following completion of Phase I. Phase II is the R&D or prototype development phase. It will require a comprehensive proposal outlining the research in detail, plan to commercialize the final product, and a company presentation to the panel (more information concerning company presentations will be sent to all Phase I contract awardees). NOAA may require delivery of the prototype. Each Phase II applicant will be required to provide information for the SBA Tech-Net Database System (http://tech-net.sba.gov) when advised this system can accept their input.

Further information regarding Phase II proposals and Tech-Net requirements will be provided to all firms receiving Phase I contracts.

### 1.2.3 Phase III – Commercialization

In Phase III, it is intended that non-SBIR capital be used by the small business to pursue commercial applications of Phase II.

## 1.3 Manufacturing-related Priority

Executive Order (EO) 13329 "Encouraging Innovation in Manufacturing" requires SBIR agencies, to the extent permitted by law and in a manner consistent with the mission of that department or agency, to give high priority within the SBIR programs to manufacturing-related research and development (R&D). "Manufacturing-related" is defined as "relating to manufacturing processes, equipment and systems; or manufacturing workforce skills and protection."

The NOAA SBIR Program solicits manufacturing-related projects through many of the subtopics described in this Solicitation. Further, NOAA encourages innovation in manufacturing by giving high priority, where feasible, to projects that can help the manufacturing sector through technological innovation in a manner consistent with NOAA's mission. This prioritization will not interfere with the core project selection criteria: scientific and technical merit, and the potential for commercial success.

## 1.4 Energy Efficiency and Renewable Energy Priority

The Energy Independence and Security Act of 2007 (P.L. 110-140) directs SBIR Programs to give high priority to small business concerns that participate in or conduct energy efficiency or renewable energy system R&D projects.

The NOAA SBIR Program solicits energy efficiency or renewable energy system R&D projects through many of the subtopics described in this Solicitation. Further, NOAA encourages

innovation in energy efficiency or renewable energy system R&D by giving high priority, where feasible, to projects that conduct energy efficiency or renewable energy system R&D through technological innovation in a manner consistent with NOAA's mission. This prioritization will not interfere with the core project selection criteria: scientific and technical merit and the potential for commercial success.

### 1.5 Eligibility

Each organization submitting a proposal for both Phase I and Phase II **must** qualify as a small business (Section 2.1) for research or R&D purposes (Section 2.2) at the time of the award. In addition, the primary employment of the principal investigator must be with the small business at the time of the award and during the conduct of the research. More than one-half of the principal investigator's time must be spent with the small business for the period covered by the award. **Primary employment with a small business precludes full-time employment with another organization. The NOAA program manager in consultation with the contracting officer must approve deviation from these requirements.**

For both Phase I and Phase II, the work must be performed in the United States. "United States" means the fifty states, the territories and possessions of the United States, the Commonwealth of Puerto Rico, the District of Columbia, the Republic of the Marshall Islands, the Federated States of Micronesia, and the Republic of Palau. **The NOAA program Manager in consultation with the contracting officer may approve exceptions to this requirement.**

Joint ventures and limited partnerships are eligible, provided the entity created qualifies as a small business as defined in this Solicitation. **Consultative arrangements between firms and universities or other non-profit organizations are encouraged, with the small business serving as the prime contractor.**

For Phase I, a minimum of two-thirds of the research and/or analytical effort must be performed by the awardee. For Phase II, a minimum of one-half of the research and/or analytical effort must be performed by the awardee.

**Unsolicited proposals or proposals not responding to subtopics listed herein are not eligible for SBIR awards. Only proposals that are directly responsive to the subtopics as described in Section 8 will be considered.**

### 1.6 Contact with NOAA

In the interest of competitive fairness, oral or written communication with NOAA or any of its components concerning additional information on the technical topics described in Section 8 of this solicitation **is strictly prohibited**.

**Requests for additional general SBIR information on the NOAA SBIR program may be addressed to:**

Kelly Wright, SBIR Program Manager
1315 East West Highway, Room 106
Silver Spring, MD 20910
Email: Kelly.Wright@noaa.gov
Telephone: (301) 713-3565 Fax: (301) 713-4100

**For Information on contractual issues contact:**

Joan Clarkston, Contract Specialist
601 E. 12th Street, Rm 1756
Kansas City, MO 64106
E-mail: joan.e.clarkston@noaa.gov
Telephone: (816) 426-7469

Additional scientific and technical information sources are listed in Section 7.

## 2.0 DEFINITIONS

Definitions are from "Small Business Innovation Research Policy Directive; Notice of final Policy Directive," Federal Register, September 24, 2002 (Vol. 67, Number 185) unless specifically noted.

### 2.1 Commercialization

The process of developing marketable products or services and producing and delivering products or services for sale (whether by the originating party or by others) to Government or commercial markets.

***As used here, commercialization includes both Government and private sector markets.***

### 2.2 Essentially Equivalent Work

This occurs when (1) substantially the same research is proposed for funding in more than one contract proposal or grant application submitted to the same Federal agency;
(2) substantially the same research is submitted to two or more different Federal agencies for review and funding consideration; or (3) a specific research objective and the research design for accomplishing an objective are the same or closely related in two or more proposals or awards, regardless of the funding source.

## 2.3 Feasibility

The practical extent to which a project can be performed successfully.

## 2.4 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any Federal agency and any small business concern (SBC) for the performance of experimental, developmental, or research work, including products or services, funded in whole or in part by the Federal Government.

***For purposes of this Solicitation, NOAA intends to award contracts in accordance with the Federal Acquisition Regulation.***

## 2.5 Historically Underutilized Business Zone (HUBZone) Small Business Concern

(See 13 CFR Part 126 for additional details)

Status as a qualified HUBZone Small Business Concern is determined by the Small Business Administration.

## 2.6 Joint Venture

An association of concerns with interests in any degree or proportion by way of contract, express or implied, consorting to engage in and carry out a single specific business venture for joint profit, for which purpose they combine their efforts, property, money, skill, or knowledge, but not on a continuing or permanent basis for conducting business generally. A joint venture is viewed as a business entity in determining power to control its management.

## 2.7 Primary Employment

Primary employment means that more than one half of the principal investor's time is spent in the employ of the small business concern. This requirement extends also to "leased" employees (workers who are employed by a third-party leasing company) serving as the principal investigator. Primary employment with a small business concern precludes full time employment at another organization.

## 2.8 Research or Research and Development

Any activity that is (a) a systematic, intensive study directed toward greater knowledge or understanding of the subject studied; (b) a systematic study directed specifically toward applying new knowledge to meet a recognized need; or (c) a systematic application of knowledge toward the production of useful materials, devices, systems, or methods, and includes design, development, and improvement of prototypes and new processes to meet specific requirements.

In general, the NOAA SBIR program will fund Phase I and Phase II proposals with objectives that can be defined by (b) and (c) in the above paragraph.

## 2.9 SBIR Technical Data

All data generated during the performance of a SBIR award.

## 2.10 SBIR Technical Data Rights

The rights an SBC obtains in data generated during the performance of any SBIR Phase I, Phase II, or Phase III award that an awardee delivers to the Government during or upon completion of a Federally-funded project, and to which the Government receives a license.

## 2.11 Small Business Concern

A Small Business Concern is one that, at the time of award for both Phase I and Phase II funding agreements:

(a) is organized for profit, with a place of business located in the United States, which operates primarily within the United States or which makes a significant contribution to the United States economy through payment of taxes or use of American products, materials or labor;

(b) is in the legal form of an individual proprietorship, partnership, limited liability company, corporation, joint venture, association, trust or cooperative, except that where the form is a joint venture, there can be no more than 49 percent participation by foreign business entities in the joint venture;

(c) is at least 51 percent owned and controlled by one or more individuals who are citizens of, or permanent resident aliens in, the United States, except in the case of a joint venture, where each entity to the venture must be 51 percent owned and controlled by one or more individuals who are citizens of, or permanent resident aliens in, the United States; and

(d) has, including its affiliates, not more than 500 employees.

Control can be exercised through common ownership, common management, and contractual relationships. The term “affiliates” is defined in greater detail in 13 CFR 121.103. The term “number of employees” is defined in 13 CFR 121.106.

A business concern may be in the form of an individual proprietorship, partnership, limited liability company, corporation, joint venture, association, trust, or cooperative. Further information may be obtained at http://www.sba.gov/size, or by contacting the Small Business Administration’s Government Contracting Area Office or Office of Size Standards.

### 2.12 Socially and Economically Disadvantaged Small Business Concern

(See 13 CFR 124 Parts 103 and 104 for additional information)

Is one that is:

(a) at least 51 percent owned by (1) an American Indian tribe or a native Hawaiian organization, or (2) one or more socially and economically disadvantaged individuals, and

(b) controlled by one or more such individuals in its management and daily business operations.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent Asian Americans, or any other individual found to be socially and economically disadvantaged by the Small Business Administration (SBA) pursuant to Section 8(a) of the Small Business Act, 15 U.S. Code (U.S.C.) 637(a).

### 2.13 Subcontract

Any agreement, other than one involving an employer-employee relationship, entered into by an awardee of a funding agreement calling for supplies or services for the performance of the original funding agreement.

### 2.14 Women-Owned Small Business

An SBC that is at least 51 percent owned by one or more women, or in the case of any publicly owned business, at least 51 percent of the stock is owned by women, and women control the management and daily business operations

## 3.0 PROPOSAL PREPARATION GUIDELINES

### 3.1 Proposal Requirements

The objective is to provide sufficient information to demonstrate that the proposed work represents a sound approach to the investigation of an important scientific or engineering innovation. **The proposal must meet all the requirements of the subtopic in Section 8 to which it applies.** A proposal must be self-contained and written with all the care and thoroughness of a scientific paper submitted for publication. It should indicate a thorough knowledge of the current status of research in the subtopic area addressed by the proposal. Each proposal should be checked carefully by the offeror to ensure inclusion of all essential material needed for a complete evaluation. The proposal will be peer reviewed as a scientific paper. All units of measurement should be in the metric system.

NOAA reserves the right not to submit to technical review any proposal which it determines has insufficient scientific and technical information, or one which fails to comply with the administrative procedures as outlined in the NOAA/SBIR Checklist in Section 10. Proposals that do not pass the screening criteria (outlined in Section 4.2) will be rejected without further consideration.

The proposal must not only be responsive to the specific NOAA program interests described in Section 8 of the solicitation, but also serve as the basis for technological innovation leading to **new commercial products, processes, or services.** An organization may submit different proposals on different subtopics or different proposals on the same subtopic under this Solicitation. When the proposed innovation applies to more than one subtopic, the offeror must choose that subtopic which is most relevant to the offeror's technical concept.

**Proposals principally for the commercialization of proven concepts or for market research must not be submitted for Phase I funding, since such efforts are considered the responsibility of the private sector.**

The proposal should be direct, concise, and informative. Promotional and other material not related to the project shall be omitted.

### 3.2 Phase I Proposal Limitations

- Page Length - **no more than 25 pages**, consecutively numbered, including the cover page, project summary, main text, references, resumes, any other enclosures or attachments, and the proposal summary budget. **Any pages included after the 25th will not be reviewed.** The only exception to the page count limitation are those pages necessary to comply with the itemization of prior SBIR Phase II awards, per Section 3.5.

- Paper Size - must be 21.6 cm X 27.9 cm (8 ½" X 11").

- Print Size - **must be easy to read with a fixed pitch font of 12 or fewer characters per inch or proportionally spaced font of point size 10 or larger with no more than six lines per inch. Margins should be at least 2.5cm.**

Supplementary material, revisions, substitutions, audio or videotapes, or other electronic media will **not** be accepted.

**Proposals not meeting these requirements will be rejected without review.**

### 3.3 Phase I Proposal Submission Forms and Technical Content

This section includes instructions for completing required forms and writing the Technical Content section. A complete proposal application must include six (6) copies of each of the following:

(a) Cover Page (required form, see Section 9)

(b) Project Summary (required form, see Section 9)

(c) Technical Content (up to 22 pages)

(d) Proposed Budget (required form, see Section 9)

Proposals received missing any of these required items will be rejected without review.

#### 3.3.1 Cover Sheet

Complete all items in the "Cover Page" required form and use as page 1 of the proposal. Please ensure that required signatures are included. **NO OTHER COVER WILL BE ACCEPTED.** Photocopies are permitted.

Before NOAA can award a contract to a successful offeror under this solicitation, the offeror must be registered in the Central Contractor Registration (CCR) database and complete their Online Representations and Certifications (ORCA). In order to complete these registrations, the offeror shall:

1. The offeror must have a Dun and Bradstreet number (DUNS). If the offeror does not have a DUNS Number, obtain a Dun and Bradstreet Number by contacting the organization directly at 1-866-705-5711 (within the United States) or going to http://fedgov.dnb.com/webform. There is no cost associated with obtaining a DUNS number.
2. Upon obtaining a DUNS number, proceed with registration of the CCR database at http://www.bpn.gov/ccr/defalt.aspx or call 1-866-606-8220 or 334-206-7828 (Federal Service Desk). Additional information about the CCR database can be located on their

Frequently Asked Questions web link or going to the User's Guide at https://www.bpn.gov/ccr/doc/CCRUsersGuide.pdf.

3. When registering in CCR, the offeror shall ensure that North American Industrial Classification Standard (NAICS) code 541712 for Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology) is included for this procurement.
4. Upon activation of your CCR record, ORCA registration can be completed at https://orca.bpn.gov. You will need your MPIN number from your CCR registration in order to login.

Additional help on CCR and ORCA registration may also be obtained from your local Procurement Technical Assistance Center (PTAC). To find more information about the PTAC or locate a local office visit http://www.aptac-us.org/new/.

No award shall be made under this solicitation to a small business concern **without** a completed registration in CCR and ORCA under NAICS code 541712.

Offerors are cautioned to identify proposal page numbers that contain their confidential information in the Proprietary Notice section at the end of the Cover Page.

### 3.3.2 Project Summary

Complete all section of the "Project Summary" form and use as page 2 of your proposal. The technical abstract should include a brief description of the problem or opportunity, the innovation, project objective, and technical approach.

In summarizing anticipated results, include technical implications of the approach (for both Phase I and II) and the potential commercial applications of the research. **Each awardee's Project Summary will be published by NOAA and, therefore, must not contain proprietary information.**

### 3.3.3 Technical Content

Beginning on page 3 of the proposal, include the following items with headings as shown: **(All headings must be included. If a particular section does not apply, please include the heading, followed by N/A)**

(a) **Identification and Significance of the Problem or Opportunity.** Make a clear statement of the specific research problem or opportunity addressed, its innovativeness, commercial potential, and why it is important. Show how it applies to a specific subtopic in Section 8.

(b) **Phase I Technical Objectives.** State the specific objectives of the Phase I effort, including the technical questions it will try to answer to determine the feasibility of the proposed approach.

(c) **Phase I Work Plan.** Include a detailed description of the Phase I Research or Research Development plan. The plan should indicate not only what will be done, but also where it will be done, and how the Research will be carried out. The method(s) planned to achieve each objective or task, mentioned in item (b) above, should be discussed in detail. **This section should be at least one-third of the proposal.**

(d) **Related Research or R&D.** Describe research or R&D that is directly related to the proposal, including any conducted by the principal investigator or by the proposer's firm. Describe how it relates to the proposed effort, and describe any planned coordination with outside sources. **The purpose of this section is to persuade reviewers of the proposer's awareness of recent development in the specific topic area and assure them that the proposed research represents technology presently not available in the marketplace.**

(e) **Key Personnel and Bibliography of Related Work.** Identify key personnel involved in Phase I, including their directly related education, experience, and publications. Where resumes are extensive, summaries that focus on the most relevant experience and publications are suggested. List all other commitments that key personnel have during the proposed period of contract performance.

(f) **Relationship with Future R&D.** Discuss the significance of the Phase I effort in providing a foundation for the Phase II R&D effort. Also state the anticipated results of the proposed approach, if Phases I and II of the project are successful.

(g) **Facilities and Equipment.** The conduct of advanced research may require the use of sophisticated instrumentation or computer facilities. The proposer should provide a detailed description of the availability and location of the facilities and equipment necessary to carry out Phase I.

(h) **Consultants and Subcontracts.** The purpose of this section is to convince NOAA that: (1) research assistance from outside the firm materially benefits the proposed effort, and (2) arrangements for such assistance are in place at the time the proposal is submitted.

**Outside involvement in the project is encouraged where it strengthens the conduct of the research; such involvement is not a requirement of this solicitation.**

**1.** Consultant – A person outside the firm, named in the proposal as contributing to the research, must provide a signed statement

confirming his/her availability, role in the project, and agreed consulting rate for participation in the project. **This statement is part of the page count.**

**2.** Subcontract – Similarly, where a subcontract is involved in the research, the subcontracting institution must furnish a letter signed by an appropriate official describing the programmatic arrangements and confirming its agreed participation in the research, with its proposed budget for this participation. **This letter is part of the page count.**

(i) **Potential Commercial Applications and Follow-on Funding Commitment.** Describe in detail the commercial potential of the proposed research, how commercialization would be pursued, benefits over present products on the market, and potential use by the Federal Government.

(j) **Cooperative Research and Development Agreements (CRADA).** State if the applicant is a current CRADA partner with NOAA, or with any other Federal agency, naming the agency title of the CRADA, and any relationship with the proposed work.

(k) **Guest Researcher.** State if the applicant is a guest researcher at NOAA, naming the sponsoring laboratory.

(l) **Cost Sharing.** Offerors may propose cost sharing. Cost participation could serve the mutual interest of NOAA and certain SBIR contractors by helping to assure the efficient use of available resources. Except where required by other statutes, NOAA does not encourage or require cost sharing on Phase I projects, nor will cost sharing be a consideration in evaluation of Phase I proposals.

### 3.4 Equivalent Proposals or Awards

A firm may have received other SBIR awards or elected to submit essentially equivalent proposals under other SBIR program solicitations. In these cases, a statement **must** follow the Technical Content section in the proposal indicating:

(a) the name and address of all agencies to which a proposal was submitted or from which an SBIR award was received;

(b) the date of proposal submission or date of award;

(c) the title, number, and date of the SBIR program solicitation under which a proposal was submitted or award received;

(d) the specific applicable research topic for each proposal submitted or award received;

(e) the title of the research project; and

(f) the name and title of the principal investigator for each proposal submitted or award received.

If no equivalent proposal is under consideration or equivalent award received, a statement to that effect **must** be included in this section of the technical content area of the proposal and certified within the Cover Page.

### 3.5 Prior SBIR Phase II Awards

If a small business concern has received more than 15 SBIR Phase II awards from any of the Federal agencies in the preceding five fiscal years, it must submit on a separate page, the names of awarding agencies, dates of awards, funding agreement numbers, amounts, topic or subtopic titles, follow-on agreement amounts, sources and dates of commitments, and current commercialization status for each Phase II. The offeror shall document the extent to which it was able to secure Phase III funding to develop concepts resulting from previous Phase II SBIR Awards. **This required information shall not be part of the page count limitation.**

### 3.6 Proposed Budget

Complete the "NOAA/SBIR Proposal Summary Budget" (Section 9.3) for the Phase I effort, and include it as the last page of the proposal. Some items on this form may not apply. Enough information should be provided to allow NOAA to understand how the offeror plans to perform if the contract is awarded. A complete cost breakdown should be provided giving labor rates, proposed number of hours, overhead, G&A, and profit. A reasonable profit will be allowed. When proposing travel, identify the number of trips, people involved, labor categories, destination of travel, duration of trip, commercial airfare or mileage rate, per diem expenses, and purpose of travel. Proposed travel costs cannot exceed the rates and amount specified in the Joint Travel Regulations. Budgets for travel funds must be justified and related to the needs of the project. Where equipment is to be purchased, list each individual item with the corresponding cost. The inclusion of equipment will be carefully reviewed relative to need and appropriateness for the research proposed. Equipment is defined as an article of nonexpendable, tangible property having a useful life of more than one year and an acquisition cost of $5,000 or more per unit.

Kick-off Meetings and/or Final Phase I Presentation/Demonstration is not required unless specifically mentioned in the specific research subtopic in section 8. If the offeror would like to propose a Kick-Off Meeting and/or Final Phase I Presentation/Demonstration, it must be included in the proposal and reference the costs in the budget in order to be considered by the government.

**SBA Policy requires that NOAA not issue SBIR awards that include provisions for subcontracting any portion of the contract back to the originating agency or any other Federal Government agency or to other units of the Federal Government. Requests for waivers from this requirement must be sent to the contracting officer. Upon receipt, the government shall review the request and make a determination whether to forward the request to SBA for review. SBA may issue a waiver on a case-by-case basis.**

**For Phase I, the proposing firm must perform a minimum of two-thirds of the research and/or analytical effort. The total cost for all consultant fees, facility leases, usage fees, and other subcontract or purchase agreements may not exceed one-third of the total contract price. For Phase II, the proposing firm must perform one-half of the research and/or analytical effort.**

### 3.7 Multiple Proposals

Offerors may submit multiple proposals to this solicitation. Offerors should submit separate proposal packages for each topic area they wish to be considered. If offerors have multiple proposals with different method or deliverables that they wish to propose on the same topic area, a separate proposal package should be provided for each method or deliverable.

## 4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

### 4.1 Introduction

All Phase I and II proposals will be evaluated and judged on a competitive basis. **A proposal will not be deemed acceptable if it represents presently available technology.** Proposals will be initially screened to determine responsiveness. Proposals passing this initial screening will be technically evaluated through by engineers or scientists (reviewers may be NOAA employees or outside of NOAA) to determine the most promising technical and scientific approaches. Each proposal will be judged on its own merit. NOAA is under no obligation to fund any proposal or any specific number or proposals in a given topic. It also may elect to fund several or none of the proposed approaches to the same topic or subtopic.

### 4.2 Phase I Screening Criteria

Phase I proposals that do not satisfy all of the screening criteria shall be rejected without further review and will be eliminated from consideration for award. Proposals may not be resubmitted (with or without revision) under this solicitation. The screening criteria are:

(a) The proposing firm must qualify as a small business, in accordance with Section 2.11.

(b) The Phase I proposal must meet **all** of the requirements stated in Section 3.

(c) The Phase I proposal must be limited to one subtopic and clearly address research for that subtopic.

(d) **Phase I proposal budgets must not exceed $95,000.**

(e) **The project duration for the Phase I research must not exceed six months.**

(f) The proposing firm must carry out a minimum of two-thirds of expenditures under each Phase I project.

(g) The proposal must include all essential material needed in accordance with Section 3 for a complete evaluation in accordance with the criteria in paragraph 4.3.

Screening Criteria for Phase II Proposals shall be provided at a later date for all Phase I awardees.

### 4.3 Phase I Evaluation and Selection Criteria

Phase I proposals that comply with the screening criteria will be rated by NOAA and/or external scientists or engineers in accordance with the following criteria:

(a) The technical approach and the anticipated agency and commercial benefits that may be derived from the research (25 points)

(b) The adequacy of the proposed effort and its relationship to the fulfillment of requirements of the research topic or subtopics (20 points)

(c) The soundness and technical merit of the proposed approach and its incremental progress towards topic or subtopic solution (20 points)

(d) Qualifications of the proposed principal/key investigators, supporting staff, and consultants (15 points)

(e) Evaluations of proposals require, among other things, consideration of a proposal's commercial potential as evidenced by (20 points):

(1) The SBC's record of commercializing SBIR or other research
(2) The existence of second phase funding commit from private sector or non-SBIR funding sources,
(3) The existence of third phase follow-on commitments for the subject of the research, and,
(4) The presence of other indicators of the commercial potential of the idea.

Reviewers will base their ratings on information contained in the proposal. It cannot be assumed that reviewers are acquainted with any experiments referred to, key individuals or the firm. No technical clarifications may be made after proposal submission.

Final award decisions will be made by NOAA based upon ratings assigned by reviewers and consideration of additional factors, **including possible duplication of other research**, the importance of the proposed research as it relates to NOAA needs, and the availability of funding. NOAA may elect to fund several or none of the proposals received on a given subtopic. Approximately one-third of subtopic areas are generally funded. Upon selection of a proposal for a Phase I award, NOAA reserves the right to negotiate the amount of the award.

### 4.4 Phase II Evaluation and Selection Criteria

During the feasibility study project performance period, Phase I awardees will be provided instructions for preparation and submission of Phase II proposals. Phase II proposals that comply with the screening criteria as stated in those instructions will be rated by NOAA and external scientists and engineers in accordance with the following criteria:

(a) The scientific and technical merit of the proposed research, including innovation, originality and feasibility (25 points)

(b) Degree to which the Phase I objectives were met (25 points)

(c) Quality of the proposal's commercial potential as evidenced by either the offerors record of commercializing other research products, existence of outside, non-SBIR funding or partnering commitments, or the presence of other indicators of commercial potential of the idea (25 points)

(d) Quality and/or adequacy of facilities, equipment, personnel described in the proposal (25 points)

Upon selection of a proposal for Phase II award, NOAA reserves the right to negotiate the amount of the award. NOAA is not obligated to fund any specific Phase II proposal.

### 4.5 Release of Proposal Review Information

After final award decisions have been announced, the technical evaluations of a proposal will be provided to the proposer only upon written request within 30 days after awards are announced. The identity of the reviewers will not be disclosed.

## 5.0 CONSIDERATIONS

### 5.1 Awards

NOAA will award firm-fixed price contracts to successful offerors. A firm-fixed price contract identifies a price that is not subject to any adjustment on the basis of the contractor's cost expenditure in performing the effort. This agreement type places upon the contractor the risk and full responsibility for all costs and resulting profit or loss. It provides maximum incentive for the contractor to control costs and perform effectively and imposes a minimum administrative burden upon both parties. NOAA also does not allow any advance payments to be made on its awards. The firm-fixed price shall be inclusive of all transportation/shipping/insurance costs for government furnished property (if requested in the proposal and accepted by the government) made available for use by awardee and all deliverables/prototypes to be furnished to NOAA.

Contingent upon availability of funds, NOAA anticipates making approximately **15** Phase I firm-fixed price contracts of no more than **$95,000** each. Total performance period shall be no more than six (6) months. Historically, NOAA has funded about ten percent of the Phase I proposals submitted which is approximately one-third of the subtopic areas.

Phase II awards shall be for no more than $400,000 (except for subtopics with the suffix "SG", which are limited to $300,000). The period of performance to complete Phase II effort will depend upon the scope of the research, but the final report due date should not exceed 24 months. One year after completing the R&D activity, the awardee shall be expected to report on their commercialization activities. The total period of performance for Phase II is anticipated to be approximately 36 months.

It is anticipated that **approximately half of the Phase I awardees will receive Phase II awards**, depending upon the availability of funds. To provide for an in-depth review of the Phase I final report and the Phase II proposal and commercialization plan, Phase II awards will be made approximately five months after the completion of Phase I.

For planning purposes, proposers should understand that Phase I awards are tentatively issued in July 2012, Phase II proposals are due approximately February 2013, and Phase II awards are issued tentatively June 2013.

**This Solicitation does not obligate NOAA to make any awards under either Phase I or Phase II. Furthermore, NOAA is not responsible for any monies expended by the proposer before award of any contract resulting from this Solicitation.**

### 5.2 Reports

Progress reports scheduled periodically during the Phase I and Phase II periods of performance will include all technical details regarding the research conducted up to that point in the project and will provide detailed plans for the next stages of the project. The acceptance

of each progress report will be contingent upon appropriate alignment with the solicited and proposed milestones. Consideration will be given to changes from the solicited and proposed milestones if results from experimentation warrant a deviation from plan. Inclusion of proprietary information within the progress reports and final report may be necessary in order to effectively communicate progress and gain appropriate consultation from NOAA experts regarding next steps. All such proprietary information will be marked according to instructions provided in section 5.5.

Final reports submitted under Phase I and Phase II shall include a single-page project summary as the first page, identifying the purpose of the research, and giving a brief description of the research carried out, the research findings or results, and the commercial applications of the research in a final paragraph. The remainder of the report should indicate in detail the research objectives, research work carried out, results obtained, and estimates of technical feasibility.

All final reports must carry an acknowledgement on the cover page such as: "This material is based upon work supported by the National Oceanic and Atmospheric Administration (NOAA) under contract number _____. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the NOAA."

The commercialization update report will include the target markets and customers that have been identified for the technology developed under the SBIR project. The report shall include details about additional activities that have been planned and executed along with future plans to derive revenues from the technology; these may include but are not limited to: pricing, partners, licensing, production plans, manufacturing partners, follow-on R&D funding. Resources committed by the awardee to effectively commercialize technologies developed under the SBIR project will be clearly demonstrated as well as projections for further commercialization. Further details regarding the exact requirements for the commercialization update report will be provided with the Phase II Award.

### 5.3 Payment Schedule

The specific payment schedule (including payment amounts) for each award will be incorporated into the resultant contract. Typically Phase I has approximately three progress reports with invoices submitted which includes the final report. The final report shall be due six months from contract award. Phase II progress reports and invoices are typically due every two to four months with the final report due 24 months from the date of award.

No advance payments will be allowed.

NOAA will negotiate the Phase II award payments and progress reports prior to award. It is anticipated that an amount of $10,000 shall be withheld until submission of the commercialization update report due twelve (12) months after the submission of the final report

on Phase II. If this report is not received, the remaining funds may be unilaterally deobligated by the government from the contract.

### 5.4 Deliverables

Offers submitted in response to subtopics that require delivery of a prototype should state in the proposal, the plan to develop and deliver the specified prototype. Notwithstanding the absence of such an explicit statement in the offeror's proposal, delivery of the developed prototype as called for by the Solicitation subtopic is required.

### 5.5 Proprietary Information, Inventions, and Patents

#### 5.5.1 Limited Rights in Information and Data

Information contained in unsuccessful proposals will remain the property of the proposer. Any proposal, which is funded, will not be made available to the public, except for the "Project Summary" page.

The inclusion of proprietary information is discouraged unless it is absolutely necessary for the proper evaluation of the proposal. Information contained in unsuccessful proposals will remain the property of the offeror. The Government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements. If proprietary information is provided by an offeror in a proposal, which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law. This information must be clearly marked by the offeror with the term "confidential proprietary information" and the following legend must appear on the first page of the technical section of the proposal:

> "These data shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part for any purpose other than evaluation of this proposal. If a funding agreement is awarded to this offeror as a result of or in connection with the submission of these data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement and pursuant to applicable law. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction are contained on pages _____ of this proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the proposal from further consideration, without assuming any liability for inadvertent disclosure. The Government will limit dissemination of such information to its employees and, where necessary for evaluation, to outside reviewers on a confidential basis.

Examples of laws that restrict the government to protect confidential/proprietary information about business operations and trade secrets possessed by any company or participant

include: Freedom of Information Act (FOIA) – 5. U.S.C. § 552(b); Economic Espionage Act – 18 U.S.C. § 1832; and Trade Secrets Act – 18 U.S. C. § 1905.

In view of the above, proposers are cautioned that proposals are likely to be less competitive if significant details are omitted due to the proposer's reluctance to reveal confidential/proprietary information.

### 5.5.2 Copyrights

The contractor may normally establish claim to copyright any written material first produced in the performance of an SBIR contract. If a claim to copyright is made, the contractor shall affix the applicable copyright notice of 17 U.S.C. 401 or 402 an acknowledgment of Government sponsorship (including contract number) to the material when delivered to the Government, as well as when the written material or data are published or deposited for registration as a published work in the U.S. Copyright Office. For other than computer software, the contractor gives to the Government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable, worldwide license to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government.

For computer software, the contractor gives to the Government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable, worldwide license for all such computer software to reproduce, prepare derivative works, and perform publicly and display publicly, by or on behalf of the Government.

### 5.5.3 Rights in Data Developed under SBIR Contracts

Except for copyrighted data, the Government shall normally have unlimited rights to data in Phase I, II, or III awards, such as:

(a) data specifically identified in the SBIR contract to be delivered without restriction;

(b) form, fit, and function data delivered under the contract;

(c) data delivered under the contract that constitute manuals or instructions and training material for installation, operation, or routine maintenance and repair of items, components, or processes delivered or furnished for use under the contract; and

(d) all other data delivered under the contract.

The contractor is authorized to affix the following "SBIR Rights Notice" to SBIR data delivered under the contract:

**SBIR RIGHTS NOTICE**

These SBIR data are furnished with SBIR rights under Contract No. _____ (and subcontract _____, if appropriate). For a period of four years after acceptance of all items to be delivered under this contract, the Government agrees to use these data for Government purposes only, and they shall not be disclosed outside the Government (including disclosure for procurement purposes) during such period without permission of the contractor, except that, subject to the forgoing use and use by support contractors. After the aforesaid four-year period, the Government has a royalty-free license to use, and to authorize others to use on its behalf, these data for Government purposes, but is relieved of all disclosure prohibitions and assumes no liability for unauthorized use.

**(END OF NOTICE)**

The Government's sole obligation with respect to any properly identified SBIR data shall be as set forth in the paragraph above. The four-year period of protection applies for Phases I, II, and III.

### 5.5.4 Patents

Small business firms normally may retain the worldwide patent rights to any invention made with Government support. The Government receives a royalty-free license for Federal Government use, reserves the right to require the patent holder to license others in certain circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must substantially manufacture it domestically. To the extent authorized by 35 U.S.C. 205, the government will not make public any information disclosing a government-supported invention for a minimum 4-year period (that may be extended by subsequent SBIR funding agreements) to allow the awardee a reasonable time to pursue a patent.

SBIR awardees must report inventions to the NOAA SBIR Program within two months of the inventor's report to the awardee. The reporting of patents and other patent obligations shall be completed through the iEdison System unless noted in resulting contract. For additional information on the iEdison System go to https://s-edison.info.nih.gov/iEdison/.

## 5.6 Awardee Commitments

Upon the award of a contract, the contractor will be required to make certain legal commitments. The outline that follows illustrates the types of clauses to which the contractor would be committed. This list is not a complete list of clauses to be included in Phase I funding agreements, and is not the specific wording of such clauses. Copies of complete terms and conditions are available upon request.

(a) Standards of Work. Work performed under the contract must conform to high professional standards.

(b) Inspection of Work. Work performed under the contract is subject to Government inspection and evaluation at all reasonable times.

(c) Examination of Records. The Comptroller General (or a duly authorized representative) shall have the right to examine pertinent records of the contractor involving transactions related to this contract.

(d) Default. The Government may terminate the agreement if the contractor fails to perform the work contracted.

(e) Termination for Convenience. The Government may terminate the contract at any time if it deems termination to be in the best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

(f) Disputes. Any dispute about the contract, which cannot be resolved by agreement, shall be decided by the Contracting Officer with right to appeal.

(g) Contract Work Hours. The contractor cannot require an employee to work more than eight hours a day or 40 hours a week, unless the employee is compensated accordingly (i.e., received overtime pay).

(h) Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

(i) Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

(j) Affirmative Action for the Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

(k) Officials Not to Benefit. No Government official shall benefit personally from any SBIR contract.

(l) Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation, except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

(m) Gratuities. The Government may terminate the contract if any gratuity has been offered to any representative of the Government to secure the contract.

(n) Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

(o) American-Made Equipment and Products. When purchasing either equipment or a product with funds provided through the contract, purchase only American-made equipment and products to the extent possible, in keeping with the overall research needs of the project.

## 5.7 Additional Information

(a) Projects. The responsibility for the performance of the principal investigator, and other employees or consultants, who carry out the proposed work, lies with the management of the organization receiving an award.

(b) Organizational Information. Before award of an SBIR contract, the Government may request the proposer to submit certain organizational, management, personnel, and financial information to assure responsibility of the proposer.

(c) **Duplicate Awards. If an award is made under this solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by any agency of the Federal Government. Severe penalties may result from such actions.**

(d) **Your firm is required to obtain a Dunn and Bradstreet Number (DUNS) and register in the Central Contractor Registration (CCR) database and the Online Representations and Certifications (ORCA) database in order to be eligible to receive a contract award.**

(e) If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

(f) The Government is not responsible for any monies expended by the offeror before award of any contract.

## 5.8 Research Projects with Human Subjects, Human Tissue, Data or Recordings Involving Human Subjects

### 1352.235-70 Protection of Human Subjects (APR 2010)

(a) Research involving human subjects is not permitted under this award unless expressly authorized in writing by the Contracting Officer. Such authorization will specify the details of

the approved research involving human subjects and will be incorporated by reference into this contract.

(b) The Federal Policy for the Protection of Human Subjects (the “Common Rule”), adopted by the Department of Commerce at 15 CFR Part 27, requires contractors to maintain appropriate policies and procedures for the protection of human subjects in research. The Common Rule defines a “human subject” as a living individual about whom an investigator conducting research obtains data through intervention or interaction with the individual, or identifiable private information. The term “research” means a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge. The Common Rule also sets forth categories of research that may be considered exempt from 15 CFR Part 27. These categories may be found at 15 CFR 27.101(b).

(c) In the event the human subjects research involves pregnant women, prisoners, or children, the contractor is also required to follow the guidelines set forth at 45 CFR Part 46 Subpart B, C and D, as appropriate, for the protection of members of a protected class.

(d) Should research involving human subjects be included in the proposal, prior to issuance of an award, the contractor shall submit the following documentation to the Contracting Officer:

(1) Documentation to verify that contractor has established a relationship with an appropriate Institutional Review Board (“cognizant IRB”). An appropriate IRB is one that is located within the United States and within the community in which the human subjects research will be conducted;

(2) Documentation to verify that the cognizant IRB possesses a valid registration with the United States Department of Health and Human Services' Office for Human Research Protections (“OHRP”);

(3) Documentation to verify that contractor has a valid Federal-wide Assurance (FWA) issued by OHRP.

(e) Prior to starting any research involving human subjects, the contractor shall submit appropriate documentation to the Contracting Officer for institutional review and approval. This documentation may include:

(1) Copies of the human subjects research protocol, all questionnaires, surveys, advertisements, and informed consent forms approved by the cognizant IRB;

(2) Documentation of approval for the human subjects research protocol, questionnaires, surveys, advertisements, and informed consent forms by the cognizant IRB;

(3) Documentation of continuing IRB approval by the cognizant IRB at appropriate intervals as designated by the IRB, but not less than annually; and/or

(4) Documentation to support an exemption for the project from the Common Rule [ *Note:* this option is not available for activities that fall under 45 CFR Part 46 Subpart C].

(f) In addition, if the contractor modifies a human subjects research protocol, questionnaire, survey, advertisement, or informed consent form approved by the cognizant IRB, the contractor shall submit a copy of all modified material along with documentation of approval for said modification by the cognizant IRB to the Contracting Officer for institutional review and approval. The contractor shall not implement any IRB approved-modification without written approval by the Contracting Officer.

(g) No work involving human subjects may be undertaken, conducted, or costs incurred and/or charged to the project, until the Contracting Officer approves the required appropriate documentation in writing.

### 5.9 Research Projects Involving Vertebrate Animals

Any proposal that includes research involving vertebrate animals (including fish) must be in compliance with the National Research Council's "Guide for the Care and Use of Laboratory Animals" which can be obtained from National Academy Press, 2101 Constitution Avenue, NW, Washington, D.C. 20055. In addition, such proposals must meet the requirements of the Animal Welfare Act (7 U.S.C. 2131 et seq.), 9 CFR Parts 1, 2, and 3, and if appropriate, 21 CFR Part 58. These regulations do not apply to proposed research using pre-existing images of animals or to research plants that **do not** include live animals that are being cared for, euthanized, or used by the project participants to accomplish research goals, teaching, or testing. These regulations also do not apply to obtaining animal materials from commercial processors of animal products or to animal cell lines or tissues from tissue banks.

### 5.10 Technical Assistance for Proposal Preparation and Project Conduct

Proposers may wish to contact the NIST Hollings Manufacturing Extension Partnership (MEP), a nationwide network of locally managed extension centers whose sole purpose is to provide small- and medium-sized manufacturers with the help they need to succeed. The centers provide guidance to high-technology companies seeking resources and teaming relationships. To contact a MEP center, call 1-800-MEP-4-MFG (1-800-637-4634) or visit MEP's website at www.mep.nist.gov.

Proposers may also contact independent state, regional, or area specific resources, for example, economic development agencies for additional assistance and resources.

## 6.0 SUBMISSION OF PROPOSALS

### 6.1 Deadline for Proposals and Modifications

**Deadline for Phase I proposal receipt (six copies) at the NOAA Eastern Region Acquisition Division is 4:00 p.m. (CST) on February 1, 2012.**

**NOAA does not accept electronic submission of proposals.**

**All offerors should expect delay in delivery due to added security at NOAA. It is the responsibility of the offeror to make sure delivery is made on time.**

Offerors are responsible for submitting proposals that adhere to the requirements of the solicitation (see 10.0 NOAA SBIR Checklist) so as to reach the government office by the time specified in the solicitation. Any proposal that is received after the exact time specified for receipt of proposals is "late" and will not be considered unless there is acceptable evidence to establish that it was received at the Government installation designated for receipt of proposals and was under the Government's control prior to the time set for receipt of proposals or it was the only proposal received.

Modifications to proposals may be submitted at any time before the solicitation closing date and time, and the offeror may submit modifications in response to an amendment, or to correct a mistake at any time prior to award. A late modification of an otherwise successful proposal that makes its terms more favorable to the Government will be considered at any time it is received and may be accepted. Revised proposals may only be submitted when requested or allowed by the Contracting Officer. Proposals may be withdrawn at any time before award. Withdrawals are effective upon receipt of notice by the Contracting Officer.

**Letters of instruction will be sent to those eligible to submit Phase II proposals. The Phase II proposals are due after receipt of the Phase I Final Report, approximately seven months after commencement of the Phase I contract.**

Offerors are cautioned of unforeseen delays that can cause late arrival of proposals at NOAA, resulting in them not being included in the evaluation procedures. No information on the status of proposals under scientific/technical evaluation will be available until formal notification is made.

### 6.2 Proposal Submission

Six hardcopies of each proposal must be received no later than 4:00 pm (CST) on February 1, 2012. Proposals are to be mailed to:

**U.S. Department of Commerce, NOAA**
**ATTN: SBIR Proposals/Joan Clarkston**
**Eastern Region Acquisition Division - KC**
**601 E. 12th Street, Room 1756**
**Kansas City, Missouri 64106**

**Telephone: 816-426-7469**

Proposals may be sent to the above address via US Mail, other commercial carriers, or hand delivered. All deliveries must be made no later than the due date and time stipulated in the solicitation. If proposals are going to be hand carried, please note that we are located in a Federal Building, which has increased security requirements for entering the facility. Offerors that hand carry their proposals should take into consideration these additional security requirements and provide themselves adequate time to enter through security so that proposals are not submitted after the required date and time. Acknowledgment of receipt of a proposal by NOAA will be made. All correspondence relating to proposals must cite the specific **proposal number** identified in the acknowledgment.

(a) **Packaging: Secure packaging is mandatory. NOAA cannot process proposals damaged in transit. All six copies of the proposal must be sent in the same package. Do not send separate "information copies," or several packages containing parts of a single proposal, or two packages of six copies of the same proposal. The top copy must be signed as an original by the principal investigator and the corporate official. Other copies may be photocopies.**

(b) **Bindings: <u>Do not use special bindings or covers</u>**. Staple the pages in the upper left hand corner of each proposal. Separation or loss of proposal pages cannot be the responsibility of NOAA.

Proposals in response to this solicitation shall be valid for a period of 240 calendar days after the closing date of the solicitation.

### 6.3 Warning

**While it is permissible, with proper notification to NOAA, to submit identical or essentially equivalent proposals for consideration under numerous Federal program solicitations, it is unlawful to enter into contracts requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the soliciting agency or agencies before award.**

## 7.0 SCIENTIFIC AND TECHNICAL INFORMATION SOURCES

### 7.1 General Information

The following web pages may be sources for additional technical information:

http://www.noaa.gov http://www.lib.noaa.gov

### 7.2 Oceanography and Marine Science

Scientific information in the areas of oceanography and marine science may be obtained from organizations shown in the website http://www.nsgo.seagrant.org/SGDirectors.html

## 8.0 RESEARCH TOPICS

### 8.1 TOPIC: Resilient Coastal Communities and Economies

### 8.1.1R SUBTOPIC: Unmanned Aerial System-Borne Gravimeter

**Summary:** The National Geodetic Survey (NGS) within NOS has a federal mandate to provide accurate positioning, including heights, to all federal non-military mapping activities in the USA. The NOAA NGS leads the GRAV-D Project (Gravity for the Redefinition of the American Vertical Datum) with a specific goal to model and monitor Earth's geoid (a surface of the gravity field, very closely related to global mean sea level) to serve as a zero reference surface for all heights in the nation. Accurate heights are critical information needed for better understanding of threats to low-lying communities and coastal ecosystems from inundation by storms, flooding, and/or sea level rise. The GRAV-D Project has successfully utilized airborne gravimetry observations to collect highly precise gravity measurements throughout CONUS, Alaska, and their littoral regions. However, more than 85% of the targeted surface area still needs to be economically surveyed, including portions of Alaska, the Aleutian Islands, Hawaii, the US Pacific Island holdings, and most of interior CONUS.

**Project Goals:** As Unmanned Aircraft Systems (UAS) mature in flight capabilities and operational readiness, UAS provide a feasible alternative to manned airborne gravimetry missions. Gravity data collection by manned aircraft can typically be categorized as very dull due to long, repetitive flight paths as the aircraft "mows the lawn" over a given data collection region. These missions pose a safety challenge for pilots who must maintain concentration and focus during the mundane flight patterns. UAS can also offer fuel savings over comparable manned aircraft, leading to more energy efficient data collection, and quicker survey completion because of the long endurance of the platform.

The NOAA UAS Program is partnering with the GRAV-D Project to explore cost and operationally feasible UAS observing strategies for gravity data collection. We request a Phase I study to demonstrate the design feasibility of an airborne gravimeter suitable for autonomous data collection onboard a low or medium altitude long endurance UAS operating in turbulent environments. The design of the system must describe the detailed system interface between the UAS and gravimeter payload, including power, navigation, and data communication systems.

**Phase I Activities and Expected Deliverables:** The purpose of this Phase I is to determine the technical feasibility of the proposed research and the quality of performance of the small business concern receiving an award. We request a Phase I study to demonstrate the design feasibility of an airborne gravimeter suitable for autonomous data collection onboard a low or medium altitude long endurance UAS operating in turbulent environments. The design of the system must:

Identify a UAS platform (Predator B and IKHANA are promising candidates),

1. Identify a gravimeter payload suitable for gravimetric geoid modeling,
2. Describe the detailed system interface between the UAS and gravimeter payload,
3. Describe the power, navigation, and data communication sub-systems,
4. Provide a cost analysis for Phase II and future operational system.

**Phase II Activities and Expected Deliverables:** Phase II will be the Research & Development (R&D) and prototype development phase which will require:

1. Comprehensive proposal outlining the research in detail,
2. New technology flight demonstration of proposed UAS/GRAV-D system (small business may request government owned equipment in this phase),
3. Delivery of the prototype design including drawings,
4. Plan to commercialize the final product,
5. A company presentation to the SBIR panel.

### 8.1.2SG SUBTOPIC: Development of Ocean and Coastal Renewable Energy Related Technologies

**Summary:** The ocean and coastal zones of the United States contain reserves of potential energy that have not yet been tapped to meet the increasing demands of an energy-hungry nation. Successfully tapping this energy will rely on more than just new energy harvest technologies – it will rely on the ability to site such projects in an environmentally sound way, and to assess the environmental impacts of such emplacements in a logical, efficient manner.

**Project Goals:** Projects should involve the development of innovative observing technologies that support siting decisions and/or evaluation of environmental impacts of renewable ocean energy technologies such as a) biofuels developed from microalgae or macroalgae, b) wave, c) tidal/current, d) geothermal, e) offshore/coastal wind, or f) ocean-thermal energy conversion.

**Phase I Activities and Expected Deliverables**:

1. Clearly identify need
2. Develop proof of concept

**Phase II Activities and Expected Deliverables:**

1. Develop prototype
2. Test prototype

### 8.1.3SG SUBTOPIC: Innovative Approaches to Facilitating Coastal and Marine Spatial Planning Processes

**Summary:** The ocean and coastal zones of the United States are called upon to serve a variety of human purposes. As the number and complexity of human uses grows, conflicts arise. The Ocean Policy Task Force defines coastal and marine spatial planning as a comprehensive, adaptive, integrated, ecosystem-based, and transparent spatial planning process, based on sound science, for analyzing current and anticipated uses of ocean, coastal, and Great Lakes areas. Coastal and marine spatial planning identifies areas most suitable for various types or classes of activities in order to reduce conflicts among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives.

**Project Goals:** Projects should involve research and development of innovative tools, technologies, and information services that facilitate coastal and marine spatial planning processes by a) allowing multiple stakeholders to understand and resolve competing uses, b) integrating data sets in a user friendly fashion, or c) creating easy-to-use simulation and scenario processes.

**Phase I Activities and Expected Deliverables:**

- Clearly identify need
- Develop proof of concept

**Phase II Activities and Expected Deliverables:**

- Develop prototype
- Test prototype

### 8.1.4F SUBTOPIC: Quantification of Green House Gas Fluxes in Coastal Ecosystems

**Summary:** Coastal wetlands, mangroves, and sea grasses sequester vast amounts of carbon in their plant material and sediments. These carbon sequestration and storage capabilities are important ecosystem services that if incorporated into management and planning can increase the protection and restoration of these habitats and allow for their inclusion in carbon markets. Key first steps to leverage carbon services to increase habitat conservation are to have a better understanding of exactly how much carbon is being sequestered or emitted from these ecosystems as well as how much is stored in the sediments from historical accumulation. Accurate data on these carbon services (and areal extent of habitats) are critical to support the development of carbon sequestration/storage protocols for coastal wetlands and to support efforts to incorporate carbon services of these habitats into Federal decision-making. The collection of more accurate data on carbon services will be facilitated by the development of an easy-to-use in-the-field, instrument or software that can quantify net carbon flux. In addition there are potential beneficiaries of the development of this instrument or software, including

agricultural industry, the energy sector, private capital investment firms and developing countries. Accurate and rapid measurements of carbon sequestration, emissions, and storage, will provide the science support for federal and state habitat conservation, consultations and possible regulatory efforts. Improving the science behind quantifying carbon services can also facilitate the development of voluntary carbon markets which in turn can provide private sector funding that support habitat conservation goals. The costs of monitoring carbon are currently a hurdle for coastal carbon projects. Development of a cost effective, rapid measurement instrumentation or technology can help drive down cost and increase feasibility of incorporating coastal carbon into planning and conservation. A tool that could be easily used in the field, or a remote sensing tool, would be particularly useful.

**Project Goals:**
The short term goal of this initiative is the development of easy-to-use in-the-field, instrumentation or software, or a simple remote sensing technique, that will improve carbon or greenhouse gas (GHG) quantification, particularly measuring fluxes (i.e. emission and sequestration rates) for different coastal types. Quantification of rates of flux will potentially provide data to address various long term needs. Advancements in improved measurements of carbon fluxes will generate more accurate information that can eventually be incorporated into the development of a GHG protocol. The development of such a protocol will facilitate channeling private investment into coastal habitat protection and restoration by bringing these projects into a voluntary carbon market or promoting the carbon services provided by these habitats. Although research has found that coastal ecosystems are very effective at sequestering carbon, there is a need for additional research on comparative rates of carbon sequestration and carbon emissions, as well as total carbon storage in sediment, in different regions, different types of habitats, and under varying environmental conditions. The development of instrumentation and/or software that advances the measurement of flux (emission and sequestration) rates as well as total carbon storage for different coastal habitats will meet the need for improved quantification. More scientific information is needed on the carbon sequestration potential of saline coastal habitats.

**Phase I Activities and Expected Deliverables:**
Activity
The Phase I should focus on developing the proposed methodological approach and required instrumentation and software that would be necessary to develop the product. This should also include descriptions of laboratory and field testing and potential test sites where applicable. The expected deliverables from this phase would be:

- A documented Research and Development Plan (R&D) for instrumentation and/or software development
- Examples of potential modeling or simulation that may be used for verification and prediction of carbon flux
- Demonstration of the ability to use the product to compare carbon flux across different coastal environments including tidal settings

**Phase II Activities and Expected Deliverables:**

Activity

Phase II will involve the assembly of the instrumentation that will be used to quantify coastal GHG flux. The output of this phase will be a prototype instrument/software package that can be further developed for commercial end users such as research institutions, federal and state agencies as well as the private sector.

The expected deliverables would be;

- Instrumentation and or software that can be easily used in the field or via remote sensing, to measure carbon fluxes or storage
- Production of relevant documentation and software needed to operate the tool.
- Where applicable, additional computer modeling and instructions for calculated estimates of carbon sequestration and emissions in different coastal habitat environments

## 8.1.5N SUBTOPIC: Self Reporting GPS Tracked Bench Mark for Sensor Vertical Position

**Summary:** At some point, with the advancements in GPS technology – accuracy, power, and unit size - the concept of a self-reporting bench mark could provide extreme cost savings and other efficiencies related to vertical stability. The bench mark could be stand-alone or incorporated into a sensor. One would think with proper timing, acquired knowledge of its surroundings (proximity to buildings, bridges, towers, obstructions, etc.), and lots of time (relatively), it would be possible to approach a GPS manual leveling survey that used accepted receivers and procedures. Shifts following earthquakes, hurricanes could be tracked without dispatching a field crew. This information could support decisions to shut-off or continue dissemination of critical data at the site of a disaster (e.g., 2011 Pacific Tsunami that hit Japan and affected much of the Pacific including West Coast U.S.). One of the big benefits would be the direct incorporation of this bench mark into sensors that monitor various vertical movements such as water level. To produce meaningful data, these sensors have to be leveled-in and routinely checked. While some of the accuracy levels required might take hours or maybe even days to accumulate, it would eliminate or greatly reduce the expense of deploying a field crew.

**Project Goals**: Development of a low-power system that can achieve sub-centimeter accuracy, with a possibly obstructed view of the sky, and transmit the data effectively.

**Phase I Activities and Expected Deliverables:**

- Can the expected accuracy be achieved given a range of obstructions?
- If the unit is truly stand alone, how would it be powered?
- How would the data be prefiltered?
- What data transmission systems might be applicable?

**Phase II Activities and Expected Deliverables:**

- Develop both stand-alone and integrated unit.
- Test the units in various situations.
- Demonstrate an acceptable data transfer and required external processing.

## 8.1.6N SUBTOPIC: Enhanced Electrochemical Detection of Toxins in Water, Shellfish and Fish Samples

**Summary:** Toxins found in water, shellfish and fish threaten human health and result in significant economic losses. This is particularly true of the toxins produced by harmful algal blooms which are becoming more frequent. Consequently, there is a need for rapid, easy to use and inexpensive detection methodologies which allow resource managers, public health officials, aquaculturists, and commercial and recreational fishers to detect toxins. Of particular concern are toxins from harmful algae. One approach to developing such technologies which has shown great promise is the use of electrochemical detection. A major advantage of these technologies is that they provide an unambiguous digital readout. This contrasts with current field test technologies which depend largely on interpretation of color change in order to estimate toxin concentrations. The primary impediment to broadly employing this technology to water, fish and shellfish toxin analysis is that the typical electrode design depends on incubating a small amount of sample on top of a fixed electrode surface. Having to use a small volume of sample often limits the sensitivity of the assay such that only toxin levels at or above the regulatory limit can be reliably measured. To overcome these limitations, we are seeking proposals for the development of a flow through membrane-based electrode technology which can concentrate the toxin and which allows interfering compounds to be rapidly rinsed away prior to detecting the toxin.

**Project Goals:** The short-term goal of this project is the development of a membrane based electrochemical detection technology that is widely applicable to toxin detection in water, shellfish and fish. Our particular interest is in the toxins produced by harmful algal bloom species (HABs), but we have written the project description more broadly so that a variety of toxins may be used to validate the technology. The intent was to make technology as widely applicable as possible so as to enhance its commercialization potential. The subtopic call further requires that the toxin used in developing the method be of direct concern to key NOAA user groups. This was partially included as way of helping identifying a potential consumer group for the final product.
The long-term goal is to commercialize the technology for use in producing cost effective hand held devices with unambiguous digital readouts for detecting key toxins of concern in the marine environment with little training. The key target audiences for these devices are resource managers, public health officials, NGOs, aquaculture facilities, and commercial and recreation fishers. The technology may also have application for veterinary testing as well.

Phase I Activities and Expected Deliverables: We are seeking proposals for the development of a novel membrane-based, flow through, electrode technology for detection of harmful algal bloom toxins which can meet the following criteria:

- Develop a disposable electrode which eliminates the need to regenerate or clean the electrode and prevents cross-contamination (1 month).
- Demonstrate quantitative toxin capture with up to 1 ml of sample flowing through the membrane in 10 to 20 seconds (2 months).
- Produce a reliable signal which can be read using a hand held device with a digital readout (3 months).
- Produces a linear standard curve over a range of concentrations that are appropriate for making regulatory decisions (20%-200% of the regulatory limit for the toxin being used to test the assay; 4 months).
- Demonstrate the toxin can be quantitatively detected in when processing a water, fish or shellfish sample containing that toxin (5 months).
- Deliver electrode costing <$2.00 when produce in quantity (6 months)

Phase II Activities and Expected Deliverables: This sensor technology has application to a wide variety of chemicals which are present at low concentration in water. It will have wide applications in both industry and environmental monitoring.

Deliverables

- Develop robust, hand held tool (meter) that converts membrane electrode signal to a digital read out
- Demonstrate proof of concept (alpha testing) using an algal toxin
- Develop and implement a test plan, including beta testing by potential users
- Modify and adjust membrane electrode and meter based on beta testing results
- Deliver fully functional tool with user instructions and documentation on accuracy and precision of algal toxin
- Provide preliminary results with other analyses such as PCBs, Hg and melamine to prove that the membranes will have wide commercial applicability
- Deliver instruction manual and plan for commercialization
- Work in collaboration with NOAA to promote the product for use in assays for detecting substances of concern such as algal toxins, steroids, antibiotics, human hormones, bromates, trihalomethanes, and vinyl chlorides

**Phase II Activities and Expected Deliverables:** Not applicable and at this point.

### 8.1.7N SUBTOPIC: Robust HF Radar Tsunami Detection Software Development

**Summary:** Although predicted 32 years ago, actual observations of the unique tsunami signature expected in HF radar data has only recently been confirmed for the first time with the March 2011 Japanese event. This was observed by several radars, both in Japan and on the U.S. West Coast. First-generation detection software based on highly idealized assumptions and simulations had been developed and offered commercially before the Japan event. With

the advent of actual data, this should be improved and optimized, leading to a more useful, robust, and reliable product. Detecting the pattern of the tsunami in HF radar radial velocity data in a timely fashion depends on many tradeoffs. Foremost is a good representation of this radial pattern as influenced entirely by the local bathymetry offshore from the radar.

**Project Goals:** Rather than employ idealized bathymetry to represent the radar-observed radial velocity signature in HF radar current data (e.g., constant-depth strips parallel to shore), the actual complex bathymetry should be employed to define the tsunami-induced pattern. This remains to be done. One approach is to solve the second-order partial differential equation set representing radar-observable velocity fields for an approaching tsunami, including its period and the water depth vs. position. Several alternative solution methods are possible. A stored set of radial velocity patterns can then be fitted to the radar data to detect the tsunami and characterize its local intensity before arrival at the coast. Then, methods should be tested (via simulation and available data sets from the Japanese tsunami) to isolate the expected signature from background currents and noise (non-tsunami related), so as to optimize the pattern recognition process. Software should be developed, optimized, and debugged that will become the heart of a commercial product that could run on the hundreds of HF radars deployed worldwide, and rapidly growing in number each year.

**Phase I Activities and Expected Deliverables:**
The first phase should focus on deriving the methodology for representing the radar's radial current patterns as influenced by local bathymetry. Two or three coastal locations should be identified and used as examples. Also, approaches to removing or mitigating background current patterns (e.g., predictable tides and statistical turbulence) should be examined and evaluated. Simulation techniques should be developed and debugged for use in optimization studies. Deliverables would be:

- An algorithmic methodology documented and programmed in MATLAB or a similar language, that expressed radar-observed radial velocity patterns produced by the tsunami, depending on on the local bathymetry.
- A simulation code and documentation that will allow the evaluation and optimization of tsunami-detection codes based on a pattern recognition scheme.
- Description of the algorithmic methodology that was developed for background current removal methods. Background includes non-tsunami current patterns such as tides, constant flow over some prior period, and noise-like fluctuations always seen in radar-observed surface flows.

**Phase II Activities and Expected Deliverables:**
Phase 2 will exercise methodologies of Phase 1 at a variety of coastal locations where tsunamis are expected (from historical evidence) to impact strongly and most frequently. Simulations should reveal how the tsunami observables (its local intensity and time before reaching shore) depend on the approaching amplitude and bathymetry. These, along with background current/noise removal, should be used to optimize pattern recognition algorithms. The software and simulations should then be exercised and compared against the tsunami signatures collected by the HF radars that observed the 2011 Japan event, which will be made available to winners of this investigation. The output of this phase should be a prototype

software package that can be considered for refinement and commercial offering to HF radar operators (presently exceeding 300 worldwide), to be run in parallel with other real-time current mapping, wave monitoring, and vessel surveillance software on the expanding worldwide networks. Deliverables would be:

- A software tool programmed in a language suitable to run in real time on HF radar systems in present use (e.g., C++ language).
- Documentation that explains the methodology behind and use of the software tool produced above.
- A tabulation of which of the hundreds of coastal HF radars worldwide might be suitable for inclusion of such software, based on their tsunami-observation potential.
- A technical document or journal paper that presents the algorithmic methodology, along with the evidence for its effectiveness. This would be based on optimization studies using the simulation codes derived under Phase I and exercised against tsunami signatures collected after the Japan March 2011 event.

**References:**

Barrick, D.E. (1979), A coastal radar system for tsunami warning, Remote Sensing of Environ., vol. 8, pp. 353-358.

Lipa, B.J., D.E. Barrick, J. Bourg, and B.B. Nyden (2006), HF Radar Detection of Tsunamis, Journal of Oceanography, vol. 62, pp. 705-716.

## 8.2 TOPIC: Healthy Oceans

### 8.2.1R SUBTOPIC: Zero-Reaction Manipulator-Handled Submersible Drill Rig

**Summary:** A recurring request from principal investigators using human occupied (HOV) and remotely operated (ROV) submersible vehicles is the ability to take a number of short core samples from rock outcrops. These cores would then be subjected to a number of analyses. Currently awarded projects researching drowned fossil coral reefs would benefit by taking core samples for dating and related analyses to determine the subsidence and sea level history of the Hawaiian Ridge. This has application to paleoceanography and global climate change studies. Some additional applications and benefits include the ability to expand support for studies of paleomagnetism, radiometric dating, petrology, paleontology, archeology, and engineering/corrosion assessments of submerged cultural resources along with renewable energy installations and ocean observatory components.

Submersible hydraulic drills are not the issue, as there are several commercial ones available that are small enough to handle with a manipulator. Several issues make this difficult and require some innovation: 1) be able to eject the drill bit or the entire drill (probably both), 2) take multiple cores during one dive, 3) keep the torque of the drill from disorienting an essentially neutrally buoyant vehicle.

Size-weight limitations: <100 lbs dry. Fit in and be operable by the claw hand of a standard manipulator (*e.g.*, Schilling Titan 4). Hydraulically powered and operate off a system producing ~3 gal/min at ~2000 psi. Core diameter of ~one inch and length to ~six inches, and the ability to take 6-8 cores during one dive. Higher RPMs and/or a counter-rotating mechanism may reduce the need for employing drastic operational techniques to maintain vehicle orientation and advance the bit.

**Project Goals:** The short-term goal is to acquire a drill system capable of coring into material such as fossil coral reefs composed of carbonate. A coring device will allow users to take stratigraphically controlled samples from a vertical rock outcrop and have that sample come from deeper in the substrate where it is more protected from post-formation alteration, recrystallization, and biogenic borings over time. Analyses with cores will reduce the effects of open-system perturbations and improve the radiometric age date results. The overarching purpose of these studies is to unravel the competing processes of sea level change and subsidence/tectonic events to better constrain the variations in the sea level record over recent geologic time, along with predictions for the future. The objective of one funded project is to find and sample Last Glacial Maximum (LGM) sites in the main Hawaiian Islands; a mid-ocean locale far removed from the influence of plate boundaries and continental hydroisostatic and glacioisostatic processes, and having relatively mild and well understood tectonic influences on elevation relative to sea level. A second funded project that could benefit from this technology is taking place in the Papahānaumokuākea Marine National Monument in the Northwestern Hawaiian Islands. Its main objective is to determine the vertical history and climatic fluctuations that formed a series of (now drowned) reef terraces during the initial period of rapid subsidence following volcano growth, and during the subsequent period of slow subsidence as the underlying plate aged and cooled.

In both of these cases, a core is better than a cobble or a broken piece of material because of the:

- Ability to selectively sample a larger quantity of indurated carbonate substrate. Opportunistic grab samples usually represent a layer of bio-eroded and chemically altered material not suitable for further testing.
- Better preservation of internal structure of the rocky substrate to show relationships between fossils, cements and boring organisms.
- Potential to sample and date multiple specimens from the same core for high spatial resolution geochronology.
- Orientation being maintained, thus samples are usable in paleocean/paleoclimate reconstructions.
- Ability to allow high resolution annual sampling of biogeochemical proxies for paleoceanographic conditions

A longer-term goal is the capacity to core igneous substrates including lava flows, pyroclastics, exposed intrusive volcanic bodies, and sedimentary rocks; along with man-made materials including, but not limited to, concrete, hardened plastics, and metal objects (hulls, casings, etc). This capability will greatly expand the scientific and engineering support which can be offered to users.

**Phase I Activities and Expected Deliverables:** Assess the feasibility of overcoming issues 1-3.

- Determine if modification to a commercial off the shelf (COTS) drill is possible or if an entirely new tool must be designed.
- Assess whether an electrically powered drill has more merit. We believe hydraulic is more versatile and applicable to both HOVs and ROVs and thus may have more commercial application.
- Decide on the optimum core sample length and diameter based on available power, commercially available bits, payload weight and size limits, etc.
- Ascertain the best method to employ multi-core capability: It is desirable to offload each core from the drill after completion to reduce tool weight, bulk, and potential loss of samples if ejection becomes necessary.

**Phase II Activities and Expected Deliverables:** Final discussion with user group on the methods to overcome issues 1-3.

- Detailed design and power management plans prepared and reviewed by user group prior to prototyping.
- Quick-disconnect COTS connectors to be used (or specially designed and fabricated ones) tested by user group.
- Final plans and operational instructions delivered.
- Prototype built, tested, and eventually delivered to NOAA or user group following proper certifications and other SBIR program requirements.

**Links:**

http://coral.aoml.noaa.gov/pipermail/coral-list/2007-February/004080.html

http://www.whoi.edu/sbl/liteSite.do?litesiteid=3912&articleId=6218

http://www.dockbuildersupplies.com/catalog/item/7578377/8006643.htm

http://www.rentaltoolsonline.com/CS-Unitec-Hand-Held-Underwater-Hydraulic-Core-D-p/101149.htm

### 8.2.2R SUBTOPIC: High-Sensitivity/High-Precision Measurements of Calcium Concentrates in Seawater

**Summary:** The decrease in seawater pH (ocean acidification) caused by absorption of anthropogenic atmospheric CO2 leads to a reduction in the aragonite saturation state (ΩAR). Studies indicate that calcifying marine organisms respond to reduced ΩAR with decreased calcification rates. In particular, calcification rates in reef-building corals may have slowed by 10% over the last 150 years, with predictions to slow another 15-30% by the end of century. We cannot fully evaluate or address this threat to ocean biota without a highly precise, sensitive and direct method for measuring calcification rates. Existing methods for measuring

calcification rates are not ideal. The most common measures changes in total alkalinity by titration followed by using assumptions and equations to calculate the change in [$Ca^{+2}$]. Measuring skeletal incorporation of radioactive $Ca^{+2}$ is hazardous and difficult to use for field/community studies. Direct measurement of [$Ca^{+2}$] is possible with ion selective electrodes (ISE). Calcium ISEs are common in clinical applications, but are not widely used in seawater because of calibration difficulties, drift, and low sensitivity. Measurements of [$Ca^{+2}$] by complexometric titrations are laborious and lack the sensitivity or precision needed. To advance, the field needs a quick and simple method to measure [$Ca^{+2}$] with a precision of ±5 µM. Major issues to address are: high background [$Ca^{+2}$] in seawater (~10.2 mM); interference from other ions (e.g. Mg); and relatively small [$Ca^{+2}$] changes during laboratory incubations or diel cycles due to calcification (~0.050 mM). It will take a novel new technology or analytical method to achieve this goal.

**Project Goals:** This project will provide the field with a quick and simple method to measure with precision and accuracy [$Ca^{+2}$] to allow the measurement of calcification rates of marine organisms. The new Method will be useful to a wide range of users (e.g., coral reef specialists, aquaculture, fisheries, etc) and would help in assessing the impact of climate change and ocean acidification on the health of the marine ecosystem in general and of calcifying organisms in particular.

**Phase I Activities and Expected Deliverables:**

- Demonstrate technical feasibility of the proposed new technique
- Provide theoretical proof or/and practical testing results
- Demonstrate that the new method works in seawater
- Demonstrate that the proposed new technique will provide high sensitivity and high precision measurements of calcium concentrations
- Comprehensive and detailed proposal outlining the research tackled in Phase II
- Provide a coast analysis for Phase II and future operational systems

**Phase II Activities and Expected Deliverables:**

- Test and provide test results proving the success of the new technique.
- Design and deliver a prototype using the new technology
- Demonstration of the proposed technology
- Comprehensive report outlining the research in detail
- Plan to commercialize the final product
- A Company presentation to the SBIR Panel

## 8.2.3F SUBTOPIC: Improving environmental Sustainability and Competitiveness of US Marine Aquaculture.

**Summary:** The purpose of this subtopic is to develop innovative products and services to support the development of an environmentally, socially, and economically sustainable marine

aquaculture industry in the US in a way that is compatible with healthy marine ecosystems and other users of coastal and ocean resources. As marine aquaculture technology moves from research to operations, aquaculture producers need affordable and reliable techniques, products, and services to support growth and economic viability of sustainable aquaculture operations. There is also a need for reliable and affordable equipment, instruments, tools and techniques to assess the potential risks and benefits of marine aquaculture facilities and to monitor any impacts of marine aquaculture operations on marine ecosystems. NOAA's 2011 Annual guiding memorandum states that "*Eliminating overfishing, rebuilding overfished stocks, and enabling sustainable marine aquaculture are essential for achieving fish populations that can produce maximum sustainable yields, ensuring the long-term sustainability of commercial and recreational harvests, and maximizing the economic and social benefits of sustainable fisheries and safe seafood".* Enabling the development of sustainable marine aquaculture figures prominently in NOAA's Next Generation Strategic Plan and in NOAA's recent new Policy for Marine Aquaculture (currently in draft form and awaiting final release after public comment). The three areas of focus for SBIR grants in aquaculture this year closely align with these guiding principles. They are:

1. Alternative feeds
2. Improved health management
3. Novel production technologies and techniques

## 1. Alternative feeds

**Summary:** Currently available aquafeeds are highly dependent on fish meal and fish oils. These cost of fish meal and fish oil has increased dramatically in recent years, reducing profit margins in finfish aquaculture operations. In addition, some question whether the forage fish from which fish oil and meal are derived can continue to be sustainably managed as demand for aquafeeds continues to increase. New diets and ingredients are needed which successfully replace these marine components with non-traditional sources of protein and oils that result in sustainable and economical feeds. There is a need to meet the nutritional requirements of marine species in all life stages (from hatchery to market size), including use of diets that rely less on fish oil and fish meal without sacrificing the human health benefits of seafood consumption.

**Project Goals:** Develop aquafeeds that successfully replace fish meal and fish oils with novel ingredients from sustainable sources, including biological or chemical methods for de novo production of long chain n-3 fatty acids and/or high value nutritional products from marine algae. Reduce the "fish in, fish out" ratio for cultured species

**Phase I Activities and Expected Deliverables:**
Research and development geared towards the development of sustainable replacements for fish meal and fish oils in aquafeeds, or the development means to produce fish meal and oil from seafood byproducts (e.g. fish trimmings). Deliverables include reports from trials of the proposed diets showing biological and economic feasibility of the new feeds.

**Phase II Activities and Expected Deliverables:**
Prototype pilot-scale trials of the products developed in phase I showing biological and economic feasibility of the feeds under commercial conditions.

## 2. Improved health management

**Summary:** Disease is one of the main causes of losses in aquaculture operations. Transmission of disease from wild to farmed animals and vice versa is also is a concern in aquaculture operations. Better therapeutants and techniques are needed to prevent, diagnose, and manage diseases in aquaculture operations.

**Project Goals:** Develop improved products and tools for preventing, diagnosing, and controlling disease in marine aquaculture operations.

**Phase I Activities and Expected Deliverables:**
Execute research and development of preventive measures, vaccines, diagnostic tools, and other management techniques for marine aquatic diseases that impact aquaculture operations. Report to show promise for commercial application of such techniques.

**Phase II Activities and Expected Deliverables:**
Prototype trials of the techniques and products developed in phase I showing biological and economic feasibility under commercial conditions.

## 3. Novel production technologies and techniques

**Summary:** As US aquaculture develops to fill the gap between domestic demand and supply new technologies and techniques are needed to help the industry develop in a sustainable way. Sustainable production and management technologies and techniques complement the improved feeds and health management focus areas.

**Project Goals:** Development of improved aquaculture technologies and techniques and management measures for raising marine organisms to market size in land-based, coastal, and in open-ocean grow-out facilities with careful monitoring, minimizing, and mitigating of environmental impacts. Examples of projects considered under this focus area include projects to develop technologies and techniques related to: production of fish, shellfish, and marine algae in hatcheries; evaluation and selection of appropriate sites for marine aquaculture operations and prevent or reduce effluents and escapes from facilities; and engineering technologies (e.g. cage designs, moorings, cleaning and feeding systems).

**Phase I Activities and Expected Deliverables:**
Research and develop improved aquaculture techniques and management measures for raising marine organisms in a sustainable way. Report to show promise for commercial application of such techniques.

**Phase II Activities and Expected Deliverables:**
Prototype trials of the techniques and products developed in phase I showing biological and economic feasibility under commercial conditions.

**References:**

Nash, C.E., 2004. Achieving Policy Objectives to Increase the Value of the Seafood Industry in the United States: The Technical Feasibility and Associated Constraints. Food Policy 29, 621-641.

National Marine Fisheries Service, 2007. Summary of the National Marine Aquaculture Summit. Available at http://aquaculture.noaa.gov/pdf/summit/summitsum_web_1_08.pdf

NOAA 10 Year Plan for Marine Aquaculture Available at http://aquaculture.noaa.gov/pdf/finalnoaa10yrrweb.pdf

The Future of Aquafeeds. Michael B. Rust, Fredric T. Barrows, Ronald W. Hardy, Andrew Lazur, Kate Naughten, and Jeffrey Silverstein (2010). NOAA/USDA Alternative Feeds Initiative. http://aquaculture.noaa.gov/pdf/feeds/aquafeedsrept_nov2010.pdf

**8.2.4F SUBTOPIC: Automated Image Analysis for Fisheries Applications**

**Summary:** Video and Image recording systems are increasingly being used by NMFS for a multitude of applications. Underwater systems are deployed on or near the seafloor or towed above the seafloor to record images of fish that are later analyzed to estimate numbers, sizes, and species composition in an area. Underwater systems are also installed in trawls to collect images that can be used to determine numbers, sizes, and species of fish caught in the trawl with the end goal of developing non-destructive trawls that collect all necessary information without actually catching the fish. Other systems are installed on commercial fishing vessels to monitor what fish are caught, kept, and discarded during fishing operations. The effort required to analyze data from these systems is time consuming and expensive. Computer automated analysis to identify fish species contained in an image sequence or video segment has been moderately successful in very controlled photographic conditions when the potential number of species in the images is limited to just a few. Fish lengths are successfully measured using stereo camera systems but require significant manual input by an analyst. There is a need for innovative approaches to automated recognition and counting of fish species and estimation of length of fish in the images collected by various systems.

**Project Goals:** The long term goal is to automate analysis of video and/or image sequences for two focal areas [(1) live fish underwater and (2) captured fish on vessels] to reduce the labor required to produce numerical data from the video or image sequences. Each focal area presents a number of technical challenges. Underwater images are frequently required to make use of ambient light to avoid influencing fish behavior and the resulting images are usually low contrast. Fish in these images may be viewed from any aspect and distance from the camera. Accurate counting of these fish requires tracking each individual during the time it

is in the camera view to avoid counting one fish multiple times. In contrast, captured fish could be imaged using artificial light at a fixed range but may (on a conveyor belt, for example) be positioned in any orientation in close proximity to, or partially obscured by, other fish. Some fish species exhibit multiple color phases underwater and most fish change color and appearance with time after capture. Successful projects will produce either software or hardware/software systems, applicable to one or more of these scenarios, that accept or collect sequences of images and count the number and sizes of each fish species present in the images.

**Phase I Activities and Expected Deliverables:**
For focal areas 1 (live fish underwater) and/or 2 (captured fish on vessels):

- Identify potentially quantifiable features of commercially important and frequently encountered fish species occurring in the southeast US Atlantic Ocean, Caribbean Sea, and Gulf of Mexico that can be used for automated classification such as shape and color patterns.
- Develop and demonstrate capability to automate data collection, potentially including but not necessarily limited to:
    - Identification of images or segments of video when fish are present
    - Species classification
    - Species-specific metrics of abundance and individual sizes
    - Habitat characteristics
- Quantify error associated with data generated (e.g., proportion of fish correctly identified to species; degree of error about abundance or size estimates). Demonstrate level of repeatability of results across multiple users
- Deliverable: a detailed report documenting methods and results, with discussion of results and identification of successes and remaining challenges

**Phase II Activities and Expected Deliverables:**
For focal areas 1 (live fish underwater) and/or 2 (captured fish on vessels):

- Develop one or more transferable software packages / platforms with user-friendly interface to accomplish data processing capabilities developed during Phase I activities
- Products should allow improvement in species classification performance through incorporation of new training data and information on additional species.
- Products should allow analyst intervention/correction in instances where confidence in species identification is low.
- Desired analysis results include:
    - Individual fish length measurements and species identifications
    - Summary information on species composition and length distributions collected over multiple image sequences
    - Confidence intervals associated with individual species identifications and length measurements within a sequence and summary statistics for analysis of multiple sequences.
- Deliverable: software package(s) / platform(s)

## 8.2.5F SUBTOPIC: ME70 MULTIBEAM PROCESSING EFFICIENCY IMPROVEMENTS

**Summary:** The NOAA Northeast Fisheries Science Center (NEFSC) conducts annual spring and autumn bottom trawl surveys from Cape Hatteras, North Carolina into Canadian waters. The surveys are a stratified random design where the trawl locations are selected *a priori* and based on stratification and allocation of effort. Approximately 360-400 bottom trawl hauls are done during each survey. During a survey, the majority of trawls are damaged, often beyond repair. The damages occur primarily in the northern half of the survey area, but also occur in other rocky areas as well. Currently, a single-beam echo sounder is used to "scout" an area for a trawl path that will not damage the trawl. In short, this method is time consuming and has not been effective given the propensity for damaging the bottom trawls.

In addition to the need for bathymetry, there is also a need for detecting and enumerating many living marine resources residing above the seabed and in the water column. Acoustic hardware (e.g., multi- or single-beam sonars) and software are now able to collect bathymetry and water-column data, but are often specialized for mapping the seafloor or detecting targets in the water column, not both. A need clearly exists for a more efficient and effective method to evaluate bathymetry for towing a bottom trawl, while simultaneously collecting water column data.

**Project Goals:** The goal of submitted proposals should be to develop an automated hardware and software system that can process multibeam data in "real" time for bathymetry and the water column. While the long-term goal is to develop a generic system that can accept data from a variety of vendors, we propose to use the Simrad ME70 to initiate this project. The Simrad ME70 is a state-of-the-art multibeam system that was designed to collect water column and seafloor data. Each of the new NOAA FSVs has an ME70 and there are developments within NMFS and internationally to develop software to process these data. Simrad also has a "bathymetry" module that has been tested on the FSV Henry Bigelow during the last portion of the NEFSC spring bottom trawl, with apparent success at delivering real-time bathymetry for scouting trawlable habitat. Unfortunately, the bathymetry module does not easily allow for collecting simultaneous water column data.

Project objectives are:

1) Develop new and/or improve existing hardware and software to process multibeam data to deliver bathymetry in real time to a display on a vessel's bridge;
2) Develop new and/or improve existing hardware and software to process multibeam data to deliver seafloor hardness (or some similar measurement) in real time to a vessel's bridge;
3) Develop new and/or improve existing hardware and software to process multibeam data for water column information simultaneous with bathymetry and seafloor hardness.

### Phase I Activities and Expected Deliverables:

Phase I should focus on

- a comprehensive assessment of existing methods;

- developing the methodological approach, instrumentation, and software necessary to achieve one or more of the objectives;
- demonstrating capabilities for real-time acquisition and display of water column and/or bathymetric information; and
- data simulations involving real bathymetry and features that are likely to affect bottom sampling.

Deliverables include
- a detailed report documenting the project, including methods, preliminary results (e.g., theoretical and/or empirical), and a discussion of the strengths and limitations (e.g., ME70-specific or generalized to other multibeam systems), and remaining challenges.
- a proof-of-concept demonstrating the capability to achieve one or more of the objectives.

**Phase II Activities and Expected Deliverables:**
Based on the results from Phase I, Phase II will involve
- fabricating components for a prototype system;
- developing software algorithms;
- integrating the prototype with the ME70; and
- collecting test sets of data with a prototype system in areas where bathymetric features will affect bottom sampling.

Deliverables include
- fully functional pre-production prototype(s); and
- a detailed report documenting the project, prototype, and integration with the ME70, results of analyzing field data, strengths and limitations of the prototype, and remaining challenges.

## 8.2.6N SUBTOPIC: Development of Sustainable Coral Cell and Tissue-Culture Lines

**Summary:** This solicitation seeks a technology that successfully produces sustainable culturing and cryopreservation of scleractinian coral cell and/or tissue lines for *in vitro* propagation and experimentation. Generating immortalized vertebrate cell lines has revolutionized the fields of medicine, agriculture and toxicology; however there are no permanent marine invertebrate cell lines in existence. To date, the availability of coral cell cultures are limited to isolation of cells from wild-caught specimens as primary cultures that stop dividing within 24-72 hrs and are only viable for weeks. Marine invertebrates have been recalcitrant to *in vitro* cell culture, illustrating the need for innovative solutions. Overcoming this barrier will address identifying risk factors for threatened coral species by providing a toxicological tool for screening environmental toxicants in marine waters. Coral cell lines will open research in cell biology, virology, genetics, biochemistry and physiology for clearer understanding of natural processes and pathologies. Providing an alternative to wild-harvested corals is a significant contribution to conservation and management of these marine resources.

Industry can also benefit from the ability to screen, select and produce novel compounds. Clearly with the need to identify causes of global coral reef decline, such a technological breakthrough would provide an invaluable tool to elucidate causes and devise interventions. Because coral are basal metazoans with genes more closely related to humans than other invertebrate model organisms (e.g., *Drosophila* and *C. elegans*) having genetically distinct immortalized coral cell lines would broaden the commercial market, providing an alternative to the classical invertebrate models.

**Project Goals:** The short-term goals of the project are to 1) develop the technology in at least one scleractinian coral species to produce lines of scleractinian cells or tissues viable in culture for a minimum of 3 months, and 2) produce clones from genetically distinct parental material thus enabling the production of individuals lines that are each genetically distinct. It is expected that the successful applicant will be able to provide multiple genetic lineages.

For the long-term, the methodology must also be amenable to mass propagation of the individual products (i.e., cell lines, tissues) for distribution and sale preferably including cryopreservation and the addition of coral genera from Indo-Pacific and Atlantic/Caribbean corals. Candidate species of interest are included among genera *Porites, Montastraea, Acropora, Stylophora, Pocillopora or Fungia.* The development of this technology would provide a vital resource to academia, government and industry as an alternative marine invertebrate model system and a critical tool for identifying risk factors for threatened and endangered species for improved management strategies. The products from this innovation would serve as alternative laboratory research models, and the availability of genetically distinct cell lines would assist in elucidating the underlying mechanisms governing biological processes and pathologies. The development of coral cell lines would be a 'green biotechnology' that would provide an alternative to wild-captured specimens in support of conservation and restoration efforts for healthy oceans.

**Phase I Activities and Expected Deliverables:**

*Activities*

- Separate coral cells and differentiate cell types based on identifiable and reproducible criteria from one scleractinian coral species
- Establish tissue culture media and conditions (e.g., temperature, pH, and media additives) to sustain primary cell cultures and determine passage number for a minimum of 5 cell types for the species
- Immortalize at least 2 cell types and demonstrate their stability in culture

*Deliverables*

- Acceptable cell cultures may consist of undifferentiated or differentiated cell types able to be maintained under defined *in vitro* tissue culture conditions and have defined characteristics of scleractinian corals and specific cell type(s).
- Provide characteristics used to type coral cells and the validation method used for assigning the character ( i.e., special cell-surface marker or morphological feature)
- Provide data to support long-term culture of established cell lines

**Phase II Activities and Expected Deliverables:**

*Activities*

- Apply methods devised in Phase I to a minimum of 6 additional scleractinian corals, representing species from the Atlantic/Caribbean and the Indo-Pacific.
- Establish tissue culture conditions to sustain primary cell cultures from additional species and determine passage number for a minimum of 10 cell types for the species
- Immortalize at least 10 cell types and demonstrate their stability in culture
- Determine cryopreservation conditions for freezing down coral cells and their resuscitation for at least 10 passages
- Conduct collaborative trials with at least another laboratory as a means to validate methodology (i.e., the ability of end users to maintain the immortalized cells in culture).

*Deliverables*

- Acceptable cell cultures may consist of undifferentiated or differentiated cell types able to be maintained under defined *in vitro* tissue culture conditions and have defined characteristics of scleractinian corals.
- Provide characteristics used to type coral cells and validation for assigning the character ( i.e., special cell-surface marker or morphological feature)
- Provide data to support long-term culture of established cell lines and cross-lab validation
- Provide data for cryopreservation and resuscitation of cell lines

## 8.3 TOPIC: Climate Adaptation and Mitigation

### 8.3.1C SUBTOPIC: Development of a Long-Term Lagrangian pH and $pCO_2$ Drifter

**Summary:** The oceans are a major sink for atmospheric $CO_2$ and have served to mitigate a large fraction of anthropogenic emissions since the industrial revolution. Despite the large amount of ocean $CO_2$ data, there are still, however, significant uncertainty in estimating the uptake of anthropogenic $CO_2$ by the oceans. For example, measurement-based estimates of air-sea $CO_2$ fluxes still have >50% uncertainty (Takahashi et al., 2009). Much of this uncertainty can be attributed to the difficulty in sampling the global ocean with sufficient spatial and temporal coverage. To further the understanding of air-sea $CO_2$ fluxes, ocean acidification, and inorganic carbon dynamics, intensive, year-round monitoring is required.

Autonomous sensors for pH and pCO2 have been developed over the past decade and are becoming more widely used for oceanographic research. However, an integrated autonomous pH and $pCO_2$ platform is not currently commercially available. The most important and immediate need is to obtain sea surface $pCO_2$ and pH measurements in the surface ocean. The surface float technology for integration of these sensors is well advanced. Availability of a surface pH-pCO2 float will make possible the development of an Argo-like $CO_2$ monitoring network, which does not currently exist.

**Project Goals:** The short-term goal of this project is to design a cost-effective Lagrangian drifter that can monitor $pCO_2$ and/or pH in the surface ocean continuously over long periods of time. The long-term goal is the incorporation of drifters measuring $pCO_2$ and pH into larger observation schemes which will be of great importance, as they will provide the continuous, long-term, in situ measurements of sea surface $pCO_2$ and calcium carbonate saturation states that are needed to quantify changes in air-sea $CO_2$ fluxes and carbon transport in the global oceans over the last decade.

**Phase I Activities and Expected Deliverables:**

- Develop conceptual methodology
- Verify methodology
- Investigate and Identify appropriate components
- Design bench-level prototype

**Phase II Activities and Expected Deliverables**:

- Purchase components
- Integrate components
- Construct working bench-level prototype
- Perform initial bench testing
- Iteratively test and refine the original design as necessary
- Integrate the prototype into a drogued surface float with satellite telemetry
- Conduct field tests
- Provide verification of data quality

### 8.3.2C SUBTOPIC: Assessing the Economic Value of Climate Predictions

**Summary:** In order to measure the economic value of the use of climate information, a methodology is under development to estimate the use of climate information by the Southeast agricultural sector. If and when completed, this methodology may be transferable to other sectors, or it may be necessary to develop other sector-specific methods of assessing the use of climate information and the value of the information to that sector. Methodologies, whether the existing development or those to be developed, should also be able to assess the economic value of improved predictive capability given that the information provided will be incorporated into sectors' decision making processes. For new methodologies, the measures need to be specific for different sectors of the national economy, but general in transfer of applications from one sector to another. Key sectors of the national economy may include, but are not limited to, agriculture, management of water resources, health, conventional and renewable energy, and transportation. An assessment of sectoral needs for climate information and sensitivity to the quality of the information should be achieved as part of this project. Project outcomes include a measure of the economic value of climate predictions, which will provide an assessment of:

- Dollars saved by a sector of the economy as a result of use of climate predictions; or
- Loss avoidance in the economic sector as a result of use of climate predictions; and
- Projected savings with percentage improvement in skill of climate predictions.

**Project Goals:** This section should include the short-term and long-term goals of the project. It should expand on the unmet need identified in the summary section, and it should provide a general description of how funded projects will address this need.
Proposals will use existing or methodologies under development or develop new techniques to measure the economic value of climate predictions to targeted sectors and/or regions. Projects will identify target sectors through a priority/feasibility list, such as agriculture by region, conventional energy, renewable wind or solar energy, or water resource management, and develop a strategy to determine the use and value of predictions to the sector and/or region. The project will identify the current use of climate forecasts by the sector, and by gaining insights into the use of climate predictions, link seasonal forecasts to an economic model specific to the sector to determine the dollars saved by the sector through use of climate information versus not using any product, or determine the loss avoidance over time. The forecast skill will have to be taken into consideration as this may or may not increase the value depending on use of the product, as well as usage over time, which may equate to more dollars saved by a stakeholder. As part of the project, the impact and sensitivity of climate variability to the sector and/or region will have to be assessed. Projects will also apply methodologies to estimate future economic benefit based on improvement in prediction skill.

The specific goals of this project are:

1. Measure the current marginal effect of climate variability on an identified sector;
2. Perform a sensitivity analysis to evaluate the economic impact of alternative climatic scenarios;
3. Measure the impact of climate variability and information and predictions on the technical efficiency of the identified sector/region; and
4. Evaluate regional and temporal disparities on the impact of climate variability of the sector/region.

Expected outcomes of this project will complete the statements:

- The provider's climate predictions save the [blank to fill] sector **$**[blank to fill] M vs. not using any prediction product; or
- The provider's climate predictions help the [blank to fill] sector avoid **$**[blank to fill] M in losses vs. not using any prediction product; and
- With a [blank to fill]% improvement in skill, the [blank to fill] sector could save an additional $[blank to fill].

**Phase I Activities and Expected Deliverables**:

- Evaluate existing methodologies for assessing economic value of climate information and its use

- Outline methodology, including new technique development if necessary, to assess the value of climate information and its use
- Identify sector or economy or region for study
- Assess the effect of climate variability and prediction on the sector or economy or the region
- Prepare a tangible work plan for executing the assessment of the economic value of climate predictions

**Phase II Activities and Expected Deliverables:**

- Measure current effect of climate variability on sector
- Assess use of climate predictions in decision making and value from use
- Conduct sensitivity analysis to evaluate economic impact of various climate patterns on productivity and economic value
- Assess potential value of further improvements to predictive capability
- Expand metrics to multiple sectors (energy, financial markets; tourism; insurance, etc.)

Option 2: If no methodology exists, then develop and test new methodology

- Measure current effect of climate variability on sector
- Assess use of climate predictions in decision making and value from use
- Conduct sensitivity analysis to evaluate economic impact of various climate patterns on productivity and economic value
- Assess potential value of further improvements to predictive capability

### 8.3.3C SUBTOPIC: The Local Three Month Temperature and Precipitation Outlooks (L3MTO and L3MPO)

**Summary:** NOAA climate data and forecast products respond to decision needs at national to local scales. Few products, however, convey both a view of the future and a picture of the past. Putting projections into the user's context of institutional and operational memory allows them to better respond to changing climate conditions. One product that does so, the Local 3-Month Temperature Outlooks (L3MTO), introduced in 2007, facilitates decision-making at a local scale. The 2009 Customer Satisfaction Survey of NOAA NWS Climate Products indicated that 86% of respondents, after viewing L3MTO, wanted NOAA to issue a similar product for precipitation, a Local 3 Month Precipitation Outlooks (L3MPO). Since then the periodic customer satisfaction surveys indicated a need for L3MTO product improvements, especially critical for the way the information is communicated to the wide range of NOAA climate users.

This proposal would improve the L3MTO product, develop a L3MPO, and deliver decision support tools that include visualizations of the forecast products and concurrent past weather conditions. The benefit of this work will allow more users to better respond to changing climate conditions by putting the projected 3-month forecasts into context of past local climate

conditions. The present users of national temperature and precipitation outlook products include agriculture, construction, energy, reclamation, recreation and tourism, retail, water resources and wild life management. Future use of L3MTO and L3MPO would expand beyond the technically-literate to many other sectors. Decision-makers, business and industry will benefit most by improved communication methods of this highly-technical forecast information.

**Project Goals:** The project goals include improvements in L3MTO (http://www.weather.gov/climate/l3mto.php), development of L3MPO, and delivery of decision support tools based on integration of these two forecast products with past weather conditions. The products' methods employ downscaling techniques to extend NOAA's 3 Month Temperature and Precipitation Outlooks to local levels. The local product, as well as the source of the downscaling products, show the expected shift in probability of temperature and precipitation categories, which are defined by historical reference periods.

Several pilot studies have been attempted for developing a L3MPO; concentrating on the main need of identifying a comprehensive downscaling technique that could extend the NOAA 3-Month Precipitation Outlook to site-specific locations around the country. Special consideration should be made for Alaska and Pacific Islands due to climatic specificities and 3MPO forecasting process that that different from continental US. The developed methodology should be tested and verified using L3MPO reforecast from 1994 to present time. Challenges for developing L3MPO methodology include selection of a parsimonious mathematical model for highly skewed hydrologic variables, limited prediction skills of the L3MPO downscaling source, and diversity of hydro-climatic zones of US. The project will address all the challenges through rigorous testing of various methodological approaches and verification of reforecast. Development of L3MPO visual design will utilize findings of L3MTO studies.

Delivery of information contained within these highly-technical scientific products should aid their consumption and use. To make these products responsive to more sectors, the delivery mechanisms should included value added products that foster interpretation tools; that allow data extraction, visualization, and comparison of forecast conditions to those of past conditions in periods of record of interest to the user.

The products should be made accessible and applicable to a wide range of NOAA climate users in many sectors; agriculture, air quality, construction, education, energy, engineering, forestry, health, insurance, landscape ecology, livestock management, manufacturing, recreation, reclamation, tourism, retail, transportation, water resources, and wild life management.

Products should be integrated into the NOAA suite of weather and climate toolkits at the Climate Portal (http://www.climate.gov ), be consistent with the look and content of other products and also technical requirements of the portal. The integration should include testing the product design with the portal user groups and addressing their comments and preferences

**Phase I Activities and Expected Deliverables**:

During the first phase, the project activities should include:

- Analyze the L3MTO scores of customer satisfaction surveys and relevant comments
- Design test of alternative approaches for communication of probabilistic forecast information
- Compare and contrast available downscaling methods potentially useful for applications to L3MPO methodology
- Develop tools for inter-comparisons of L3MTO and L3MPO products with past climate conditions for the time period of interest of the user.

**The Phase I Deliverables should be:**

- Assessment of value or uses of L3MTO and L3MPO by the range of NOAA climate users
- Proposal for L3MTO improvements
- Proposal for L3MPO methodology based on pilot tests of several alternative models
- Proposal for the product integration into the Climate Portal
- Statement of work for phase II

**Phase II Activities and Expected Deliverables**:

During the phase II, the project activities should include:

- Develop alternative approaches for communication of probabilistic forecast information
- Develop a prototype for L3MTO improvements
- Prove the prototype appeal to wide range of NOAA user groups
- Develop methodology for L3MPO and prove its potential skill
- Develop proposal for L3MPO efficient deployment into the NOAA climate services operations
- Prepare manuscripts for scientific and popular publications

Deliverables:

- Best approach for L3MTO redesign
- Publication of L3MPO methodology
- Proposal for efficient integration of the product into the Climate Portal
- Visualization toolkit for integration of past weather with forecast products

### 8.3.4C SUBTOPIC: Integrated Water Resources Adaptation and Mitigation Approaches in the Coastal Zone

**Summary**: In recent years, water resource managers have become increasingly concerned about the amount of energy used, and therefore greenhouse gas (GHG) emissions generated, to provide water services (i.e., drinking water and waste water) to their consumers. At the

same time, many utilities are faced with the potential for long-term climate change impacts on water quality, availability, and built infrastructure for water delivery and management. Potential water quality and quantity impacts include saline intrusion into coastal aquifers and loss of freshwater flows due to inland droughts and increasing demand. Infrastructure threats arise from potential damage due to sea level rise and increased frequency and severity of storms and flooding. Finally, an important issue to consider is the possibility that collection, distribution, and treatment systems located along the coast will be constantly flooded, or would be completely under the new water table and would have to be re-located. Increasing climate-related risk is forcing adaptation discussions and action.

Given new public awareness; a desire to reduce GHG by local, state and federal entities; a need to develop new tools/approaches to adapting to a changing sea level and climate; and the reality of the cost of adaptation and mitigation to utilities, the results of this project would benefit a number of utilities, particularly in coastal areas who are already (or soon will be) addressing these pressing issues. The primary objective of this project would be to provide utilities with the tools and technologies they need to effectively and economically adopt adaptation strategies that reduce energy use, protect the quality and quantity of water supplies (especially from saline intrusion into coastal drinking water aquifers), and reduce the potential damage to infrastructure from climate-related risks.

While a limited number of existing tools address individual aspects of adaptation or mitigation, decision makers are seeking tools and technologies to help them make optimal decisions to meet multiple goals, including how to build resilience to the multiple threats without increasing energy use. This need was articulated at a recent workshop hosted by NOAA, EPA, NASA, the Water Research Foundation, and the Water Environmental Research Foundation titled "The Future of Research on Climate Change Impacts on Water: A Workshop Focusing on Adaptation Strategies and Information Needs" held in August 2010. For more information see: www.waterrf.org/projectsreports/publicreportlibrary/4340.pdf.

The research products should seek to address some combination of water quality and quantity or mitigation and adaptation simultaneously, and could include methods and technologies to: optimize carbon and water footprinting of adaptation approaches, reduce energy intensity of water treatment and movement, generate energy at the treatment facility and develop means of becoming net-zero energy users, create an ecological/environmental footprint metric, and/or develop and use non-conventional water sources.

**Project Goals**: The goal of this joint, inter-agency project would be the development of a tool(s) or technology (ies) that water utilities (both water supply and wastewater) in the coastal zone could use in utility adaptation/mitigation design and operations for water and wastewater management and infrastructure. It would be important that small and medium utilities are kept in mind as this is being developed and that there are sufficient tools and/or guidance included so that they will be able to use the new tool or technology.

**Phase I Activities and Expected Deliverables:**
Phase 1 would include: (1) discussions and feedback from utility stakeholders, (2) a list of the requirements needed by water managers in the coastal zone for a technology or tool to

adequately address integrated water resources adaptation and mitigation approaches, (3) development of specific approaches for different types (drinking water, wastewater) and size (small, large service area) utilities that could be taken in Phase 2 of this project to address those needs, including options that would be incorporated into a potential final product.

**Phase II Activities and Expected Deliverables:**
At the conclusion of Phase II, the SBIR recipient will have developed a technology or tool that coastal water managers could use to support and guide them in their decision making and adaptation planning and implementation to make economically sound and practical adaptation measures. Finally, the tool or technology should be able to be integrated into a utility's long term capital planning program.

## 8.3.5D SUBTOPIC: Environmental Baselines for Coral Reefs: SST, PAR And UV

**Summary:** Coral reef ecosystems provide a number of essential ecological services that underpin industries such as tourism and fisheries, and are important for stabilizing and protecting coastlines and human infrastructure from wave energy. In the U.S., reefs generate over $18 billion in tourism and fishing. Climate change represents the gravest threat to coral reefs. Increasing stress arising from rapidly warming seas is increasing the frequency and severity of coral bleaching, and mortality. Since 1997, NOAA Coral Reef Watch (CRW) have been producing coral bleaching forecast products using specialized SST climatologies. Currently these are based on AVHRR Pathfinder data, however with the increased spatial resolution of operational SSTs and a need for longer, more accurate data sets that include PAR and UV, the Pathfinder methodology is unable to provide the required data. This project seeks to provide CRW with the necessary data to derive climatologies suitable for use with current and future operational SST, PAR and UV satellite products. This requires the development of methodologies and processing systems that utilize relevant polar and geostationary data to produce 0.05 degree resolution SST data from 1981 that is compatible with current operational NOAA GOES/POES blended SST products. Methodologies and processing systems are also needed to provide PAR and UV products that match the 0.05 degree resolution SST product and that are also compatible with current operational NOAA PAR and UV products. The SST, PAR and UV products need to be of high accuracy and should be internally consistent through space and time.

**Project Goals:** CRW require highly accurate long term data sets with which to create specialized climatologies that are used to predict the effects of environmental stress on coral reefs. Their current operational products suffer from inaccurate climatologies that were derived from short SST data sets with largely unknown errors due to large amounts of gap filling. As CRW seek to derive new high spatial and temporal resolution bleaching predictions, there is a need for the development of improved SST data sets and for the creation of long term solar radiation products such as PAR and UV. This will be the first attempt at the production of long term global solar radiation data sets.

The SST goals of this project are to produce a global GOES/POES blended SST product that stretches from 1981 to the present. The product should be at 0.05 degree resolution and should be gap filled in an accurate manner. The SST error should be better than 0.5oC and consistent in space and time. The product should also be compatible with the current NOAA GOES/POES blended SST operational product.

The short term goal is to produce the SST data set for the Caribbean/Gulf region over the period 1995 to present. CRW currently use AVHRR Pathfinder data to produce the climatologies for SST over coral reefs, however there are a number of problems with the Pathfinder methodology that necessitate the development of a new more useful data set:

- The Pathfinder methodology relies heavily on the existence of *in* situ buoy SST data. This means that Pathfinder becomes less accurate in earlier years due to a lack of buoy data in early years. CRW would benefit from a data set with more consistent errors through time.

- So as to ensure good quality data, the Pathfinder methodology is forced to reject many pixels other than just those that are clouded. The result is that only 15% of SST pixels are flagged as being flag 4 or above, which is deemed to be the threshold for good quality data. Since CRW require gap filled data to produce good quality climatologies and to hindcast their anomaly products, this would require that as much as 85% of the pixels be gap filled. Clearly this is a significant source of error for CRW.

The solar radiation goals of this project are to produce global PAR (Photosynthetically Active Radiation) and UV products from 1995 to present. These products need to be produced on the exact same 0.05 degree grid as the blended SST product. Like the blended SST product, these products will require the use of data from GOES, MTSAT, ELEKTRO-L, MSG and METEOSAT, and should be compatible with the operational NOAA PAR and UV products. There is no Pathfinder equivalent for PAR and UV products.

The long-term goal for this project is therefore to produce global SST, PAR and UV data sets that stretch as far back in time as possible (1981 for SST and 1995 for PAR and UV).

**Phase I Activities and Expected Deliverables:**
Using GOES East and POES data:

- Derive a 0.05 degree GOES/POES blended SST data set for the greater Caribbean/Gulf of Mexico region that covers 1995 to present:
    - Obtain all necessary data
    - Develop processing system
    - Produce blended SST gap-filled data set
- Demonstrate that the SST product is equivalent to the operational blended SST product

**Phase II Activities and Expected Deliverables:**

- Derive a global 0.05 degree GOES/POES blended SST data set that covers 1981 to present:
    - Obtain all necessary data

    - Develop processing systems
    - Produce blended SST gap-filled data set
- Demonstrate that the SST data are equivalent to the operational NOAA blended SST product
- Derive a global 0.05 degree geostationary PAR and UV data set that covers 1995 to present (where possible, or less where appropriate satellite data are not available):
    - Obtain all necessary data
    - Develop processing systems
    - Produce PAR and UV data sets

• Demonstrate that the PAR and UV data are equivalent to the operational NOAA PAR and UV products.

## 8.4 TOPIC: Weather-Ready Nation

### 8.4.1W SUBTOPIC: Comprehensive Analysis of Lower Atmosphere for Support to Firefighting

**Summary:** Wildfire-suppression costs are estimated at $3B per year, with additional costs for damage to property, infrastructure, health, and natural resources. More importantly, many firefighters and homeowners lose their lives during evacuations and when fires make unpredictable movements. Many researchers have focused on the surface conditions that affect fires, but there is increasing recognition that the three-dimensional atmosphere, especially in the planetary boundary layer, plays a key role. Lack of data in the lower atmosphere, assimilation of that data into analysis schemes and high resolution models, and the forecasts themselves all result in a very poor diagnosis and prediction of the fire environment. The 2008 NOAA SAB report, “Fire Weather Research: A Burning Agenda for NOAA,” strongly advocates that “high spatial and temporal resolution (surface) observations and (upper air) soundings…are needed in the immediate vicinity of the wildland fire for both nowcasting and initialization of numerical models…data passed with minimal latency to the forecaster…”. The National Research Council’s Board on Atmospheric Sciences and Climate led the 2010 publication of “When Weather Matters,” which states, “temperature, humidity, and dry lightning can play a role in wildfire initiation, development and spread, while winds and terrain typically play key roles in spreading major wildfires.”

Many researchers are examining the potential use of Unmanned Aircraft Systems (UAS) in the prediction of conditions that can dramatically impact fire behavior, but UAS at this point are considered cost-prohibitive. Conventional aerial surveys are costly and difficult to arrange, pibals and balloonsondes do not provide adequate spatial coverage and cannot be guided, and aerostats are not mobile and cannot follow the evolution of the fire. What is needed is a comprehensive examination of deployable profilers, UAS, and even dropsondes from aircraft which could improve the spatial and temporal resolution of atmospheric conditions that impact the dynamics of volatile fire lines, fires in rough topography, and areas where fuels can change fire behavior as impacted by weather conditions.

**Project Goals**: Develop means for comprehensive analysis and near-term prediction of wind, humidity and temperature for lowest 2-3 km of atmosphere that will meet the requirements of firefighting agencies. This framework should emphasize inclusion of high resolution terrain data as well as an infrastructure to allow minimal data latency and immediate processing and interpretation of data for decision support.

**Phase I Activities and Expected Deliverables:**
Develop concept of architecture to meet project goals above. This concept should address the most efficient and cost-effective means for observing and forecasting weather in and around fires, how data can be best processed, and how data can be best packaged for customers.

Activities:

- Concept Development
- Proof of Concept Testing
- Validation and Verification of Results
- Feasibility Assessment Development

Deliverables:

- Feasibility Assessment

**Phase II Activities and Expected Deliverables:** Formalize architecture for optimal sensing of the atmosphere near fire activity. This should be a fully-fleshed out product from results in Phase I.

Activities:

- Concept Implementation and Product Development
- Product Expansion
- Forecasting Feasibility Studies

Deliverables:

- Prototype Lower Atmospheric Architecture for Support to Firefighting
- Feasibility Assessment for Architecture.
- Feasibility Assessment for Putting New Architecture into Operations

**References:**

Fire Weather Research: A Burning Agenda for NOAA. A Report from the NOAA Science Advisory Board. Oct. 2008, 92 pp.

J. Mandel, J.D. Beezley, and A.K. Kochanski, 2011. Coupled atmosphere-wildland fire modeling with WRF-Fire version 3.3. Geosci. Model Dev. Discuss., 4, 497-545 (describes complications with integrating weather information into a coupled model system)

Sher Schranz, 2009. Use of Unmanned Aircraft Systems for the NOAA Fire Weather Research Program. 2009 NOAA Unmanned Aircraft Systems Conference, Washington DC.

When Weather Matters: Science and Services to Meet Critical Societal Needs. Committee on Progress and Priorities of U.S. Weather Research and Research-to-Operations Activities, BASC. National Academies Press, 2010, 181 pp.

URLs:
http://www.weather.gov/ost/S&TRoadmap - Provides info on NWS S&T Roadmap, to include Fire Weather S&T Plan

http://radar.srh.noaa.gov/fire - NWS Fire Weather page showing capabilities for observations and situational awareness

http://raws.wrh.noaa.gov/roman/index.html - Main web page for Real-time Observation Monitor and Analysis Network showing Geographic Coordinating Areas (GCAs)

### 8.4.2W SUBTOPIC: Probabilistic Tool for Improving Weather Decision Services

**Summary:** Goal #1 presented in the NWS Strategic Plan (2011) is to "Improve weather decision services for events that threaten lives and livelihoods." This will involve an effective application of probabilistic forecast information to greatly benefit many areas of government and industry, to include firefighting, emergency management, commerce, energy planning, and agriculture (NRC 2006). One key to meeting this goal is the introduction of the necessary tools to get the job done, as described in the NWS Strategic Plan:

- Forecaster Tools: Develop and implement, with research community and other partners, forecaster tools that support data mining, enhance visualization, smart decision assistance, and forecaster coordination and collaboration.

- Decision Support Tools: Develop and implement, with users and partners, tools to apply weather, water, and climate information, including forecast uncertainty, into user decision processes and systems.

- Social Science: Integrate social science research, methods, and capabilities into science service areas, forecaster tools, and decision support systems.

The objective of this subtopic is to fulfill this visionary advancement with a focus on the "forecast tool" that enables the forecaster to support optimal decision making by primary customers (e.g., emergency managers, FAA, etc.). The tool will fully incorporate probabilistic weather information and principles of risk analysis and decision theory. Part of that functionality must include the ability to objectively define the customer's risk tolerance, particularly for sequential and dynamic decision contexts. To address aspects of social sciences and human cognition (NWS 2010), the tool will also promote effective communication of the optimal decision (e.g., reasoning on forecast uncertainty and the decision

recommendation) to the customer in an interactive forum. Lastly, the tool must be able to validate the benefit(s) to the customer who follows the optimized decision recommendations.

While the main focus is on the "forecaster tool", consideration will also be given to constructing a user-specific "decision support tool." Tailoring the application of probabilistic weather forecasts to the often complex aspects of a user's decision context is critical to fully realizing optimal performance, as demonstrated in studies such as Small et al. (2011).

**Project Goals**: Construction of a tool that enables forecasters to support optimal decisions for primary customers by incorporating probabilistic weather forecasts, risk analysis, and social sciences.

**Phase I Activities and Expected Deliverables:** Phase I needs to concentrate on proof-of-concept of the proposed tool with respect to how it fits into the NWS forecast process and interaction with NWS customers. It is also important to target use of available, well-calibrated probabilistic weather forecasts.

Activities:

- Concept Development
- Proof of Concept Testing
- Validation and Verification of Results
- Feasibility Assessment Development

Deliverables:

- Feasibility Assessment

**Phase II Activities and Expected Deliverables:** Phase II will deliver the prototype tool to be used by forecasters. This tool will meet the specifications outlined above, be prepared for integration into NWS operations, and be prepared for commercial use.

Activities:

- Concept Implementation and Product Development
- Product Expansion
- Forecasting Feasibility Studies

Deliverables:

- Prototype Probabilistic Tool
- Feasibility Assessment for New Tool
- Feasibility Assessment for Integrating New Tool into Operations

**References:**

National Research Council (NRC), 2006: *Completing the Forecast: Characterizing and Communicating Uncertainty for Better Decisions Using Weather and Climate Forecasts*. Washington, DC: National Academies Press.

National Weather Service, 2010: *National Mesoscale Probabilistic Prediction: Status and the Way Forward*. A white paper, available at [http://www.weather.gov/ost]

National Weather Service, 2011: *NOAA'S National Weather Service Strategic plan. 2011 – 2020*. Final Copy for NEP Review, available at [www.weather.gov/com/stratplan]

Small A.A., J.B. Stefiky, J. Verlinde, N.C. Johnson, 2011: The Cloud Hunter's Problem: An Automated Decision Algorithm to Improve the Productivity of Scientic Data Collection in Stochastic Environments. *Monthly Weather Review,* in press.

When Weather Matters: Science and Services to Meet Critical Societal Needs. Committee on Progress and Priorities of U.S. Weather Research and Research-to-Operations Activities, BASC. National Academies Press, 2010, 181 pp.

## 8.4.3W SUBTOPIC: Standardized Rip Current Forecasting and Dissemination

**Summary:** According to the U.S. Lifeguard Association, rip currents cause approximately 100 fatalities per year in the U.S. The NWS has enhanced its rip current program over the last several years by:

- including rip current science and forecasting into training
- developing a rip current awareness website (http://www.ripcurrents.noaa.gov)
- designating a yearly rip current awareness week (first week of June)
- having outlooks highlighted on the watch, warning, advisory page (http://www.weather.gov)
- developing a rip current monitoring program where lifeguards are trained to observe and report surf zone conditions conducive to rip current development
- increasing its rip current education and outreach program
- providing more detailed rip current risk outlooks via surf zone forecasts and other coastal statements
- investigating the value of rip current watches, warnings, or advisories.

Despite these enhancements, there are no standard national rip current forecasting methods used across NWS coastal offices. As a result, NWS rip current outlooks vary in product issuance format and threshold, terminology, and dissemination and are often not clearly understood by users; especially visitors or tourists. A disproportionate number of rip current fatalities tend to be visitors or tourists.

Most rip current fatalities are males (80-85%) and the majority of those males are young, between the ages of 10-29. There are various social reasons for this gender bias and the NWS is beginning to target this gender and age group but much more effort is necessary.

**Project Goals**: Develop standard national rip current forecasting methods, dissemination, and terminology.

**Phase I Activities and Expected Deliverables:**

Development of concept for prototype or architecture for riptide forecasts and warnings. Formation of schematic that captures process from prediction to forecasts to dissemination, in a way that the end product is completely understandable to all customers.

Activities:

- Concept Development
- Proof of Concept Testing
- Validation and Verification of Results
- Feasibility Assessment Development

Deliverables:

- Feasibility Assessment

**Phase II Activities and Expected Deliverables:**

Standardized forecasting algorithm and dissemination process for decision support regarding riptides. This should be a tool ready for integration into NWS operations and ready for commercialism here and abroad.

Activities:

- Concept Implementation and Product Development
- Product Expansion
- Forecasting Feasibility Studies

Deliverables:

- Prototype Process for Riptide Forecasting
- Feasibility Assessment for New Riptide Forecasting and Dissemination Process.
- Feasibility Assessment for Putting New Architecture into Operations

### 8.4.4W SUBTOPIC: Reducing Impact of Severe Space Weather on Global Positioning Satellite (GPS) Satellite Signal Users

**Summary:** The Nation's critical infrastructure and economy are increasingly dependent on high accuracy GPS positioning, navigation, and timing services. Severe space weather can result in degradation or disruption of the GPS signal which in turn can prevent dual-frequency GPS receivers from locking onto the GPS satellite signal and from determining position at all (denial of service). High latitudes such as the Alaska Region are especially susceptible. As our Nation's dependence on reliable satellite navigation (GPS) increases, any denial of service will have significant life, safety, and economic impacts.

Specification and forecast products are needed to support the broad GPS user community. Precision GPS systems are now integral to many commercial enterprises including air transportation, oil exploration, road building, agriculture, surveying, shipping and

transportation. Many new applications of GPS have been deployed in the last five years during which time, there were few major space weather storms due to the fact that the sun was at the lowest point in its eleven year solar cycle. Thus, there are numerous customers for GPS products who do not yet know they are customers. The NOAA Space Weather Prediction Center currently has no operational product for specifying or forecasting ionospheric scintillation and the resulting denial of service.

A network of ground-based GPS receivers in North America make it possible to characterize ionospheric scintillation and potential denial of service in real-time. These new data could be assimilated into an empirical or even a physics-based model to provide specification and forecast capabilities for GPS denial of service.

**Project Goals:** The ultimate goal of this activity is to develop specification and forecast capabilities and prototype products for ionosphere-induced denial of service for GPS customers. The initial outcome of this project is a feasibility assessment on the best method of specifying, or now-casting, scintillation over the United States. Later phases of this project should include development of prototype GPS denial of service products and explore the practicality of extending this proof-of-concept beyond the US to other regions of the world. In addition it is anticipated that an assessment of a capability to provide forecasts of GPS denial of service with hours to days of lead time. To insure that any product or service would be advantageous to prospective customers, a rigorous verification and validation of the proof-of-concept should be addressed. In addition to specifying and forecasting scintillation, work will need to be done to develop means of effectively disseminating this information to a diverse customer base with disparate levels of understanding.

**Phase I Activities and Expected Deliverables:**
Activities:

- Concept Development
- Proof of Concept Testing
- Validation and Verification of Results
- Feasibility Assessment Development

Deliverables:

- Feasibility Assessment

**Phase II Activities and Expected Deliverables:**
Activities:

- Concept Implementation and Product Development
- Product Expansion (Regional and then Global)
- Forecasting Feasibility Studies

Deliverables:

- Prototype Ionospheric Scintillation and GPS Denial of Service Product for US (including Alaska)
- Feasibility Assessment for Expansion to Other Regions Where Data are Available.
- Feasibility Assessment for Developing Forecasts of Ionospheric Scintillation and GPS Denial of Service

### 8.4.5D SUBTOPIC: Development of a Prototype Hyperspectral Microwave Sensor

**Summary:** Modern passive microwave space-borne sensors have only a limited number of channels available, totaling anywhere between 5 and 30 channels. This limited number of channels has been shown to be insufficient to solve for the ill-posed nature of the inversion of the geophysical state from space-borne measurements. This is especially true for cases where cloud, rain and/or ice are present in the atmosphere. In this case indeed, a large uncertainty exists due the lack of knowledge about the particle density, shape, size, distribution, vertical structure, temperature dependence, etc. A larger number of channels will help solve for the inherent ambiguities in these cases. It will also allow to provide a higher vertical resolution for the temperature and humidity sounding, a better distinction between the surface and the atmospheric signals, a better surface typing due to the different spectral signatures of the different surface parameters mixtures, etc. While sensors operating in the infrared and near-infrared have experienced an ever increasing number of channels and bands with the new hyperspectral sensors (such as IASI, CrIS, AIRS), microwave sensors despite their large benefits to weather prediction and their ability to penetrate cloud and sense within and below the cloudy and rainy layers, have not seen their number of channels increase. This type of sensors would be expected to have significant positive impacts on the forecast skills of numerical weather prediction models, especially if deployed in space with large spatial and temporal coverages (for hurricanes conditions especially). Besides the large of number of channels (between hundreds and thousands) sought, in the range between 3 GHz and 300 GHz, possibly going up to 600 GHz and potentially higher (sub-millimeter spectral region), it is emphasized that the noise level should be as low as possible and at least as low as the current state of the art sensors.

**Project Goals:** The short term goal of the project is to build a prototype hyperspectral microwave sensor. This prototype sensor could be ground-based. It should however be kept in mind that the long term of the project is to build an airborne sensor and later a space-borne hyperspectral microwave sensor. This will allow testing gradually the benefits of having such a sensor, first in remote sensing environment and then in numerical weather prediction environment.

**Phase I Activities and Expected Deliverables:** Phase I will concentrate on studying the most optimal design (scientifically and technologically) of the hyper spectral microwave sensor. The deliverable will be a design that could serve as a basis for building a prototype hyperspectral microwave sensor.

**Phase II Activities and Expected Deliverables:** Phase II will aim at building the prototype hyperspectral microwave sensor, based on the optimal design developed in Phase I. The phase II project would be expected to take advantage of the most recent technological advances made in the microwave sensors technology, related among others, reduced noise levels, local oscillators, wave guides, antenna designs, etc.

### 8.4.6D SUBTOPIC: Low-Cost High Frequency Passive Microwave

## Radiometer for Ground Measurements

**SUMMARY:** Passive microwave sensors are key sensor payloads on many operational satellites, including those operated by NOAA and EUMETSAT – the Advanced Microwave Sounding Unit (AMSU) and the Microwave Humidity Sounder (MHS). Over the past decade, satellite-based high frequency measurements at and above 150 GHz (including those near the 183 GHz water vapor absorption band) have become extremely useful for the retrieval of several parameters, including precipitation rate and snowpack properties. In order to advance our understanding of the relationship between these parameters and the emitting microwave energy (and to advance radiative transfer model development), a sensor that can be used on the ground (either pointing upward or downward) which takes measurements at these high frequencies needs to be developed – presently, such sensors typically make measurements at 90 GHz or lower.

**Project Goals:**
It is envisioned that the prototype sensor would work off of the design of an existing instrument and potentially have a full complement of measurements spanning the range of 10 – 190 GHz (i.e., have channels that are comparable to existing or future planned microwave sensors such as the Advanced Technology Microwave Sounder (ATMS) and the GPM Microwave Imager (GMI)). As such, a prototype sensor is envisioned for Phase I whereas a fully operational instrument with the following attributes would be produced during Phase II:

(1) Dual Polarization: Ice crystals scatter and depolarize microwave radiation depending on particle size and observation frequency (Matzler, 1984; Hewison et al., 1999). Emission and scattering of snow depends on depth, density, morphology and liquid water content. Polarized microwave observations can provide these important information.
(2) Upward- and downward-looking Mobility: upward for liquid cloud water path retrieval (for cloud and precipitation, downward for simultaneous cloud liquid water path and surface emissivity retrievals.
(3) Scanning ability: Cross-track sensors such as AMSU, MHS and ATMS view the earth at varying angles.

**Phase I Activities and Expected Deliverables:**
- Prototype radiometer design and test data
- Deliverable – working model with at least some of the requested attributes

**Phase II Activities and Expected Deliverables:**
- Development of full working radiometer with required measurement bands, polarizations, scanning geometry
- Test data sets documenting instrument performance under a variety of meteorological and surface conditions
- Deliverable – fully functional instrument

**References**

Hewison, T. J., and English, S. J.,1999: Airborne retrievals of snow and ice surface emissivity at millimeter wavelengths, , *IEEE Trans. Geosci. Rem. Sens.*, **37**, 1871-1879.

Matzler, C., 1994: Passive microwave signatures of landscapes in winter. *Meteor. Atmos. Phys.,* **54,** 241-260.

### 8.4.7D SUBTOPIC: Enhanced Geospatial Query Support for Oceanic Data Discovery

**Summary**: This subtopic focuses on development of a web service to transform a rich textual description of a geographic area into a geospatial object such as a polygon or set of polygons. This new capability will greatly enhance ease of use as well as improve people's success in locating geospatial data. The initial domain is oceanic geospatial data at the NOAA National Data Centers (Oceanographic, Geophysical and Climatic centers). The new techniques are expected to have broader applicability to terrestrial data as well as to other federal (NASA Distributed Active Archive Centers, USGS, and others) and commercial geospatial data archives and portals.

The nation's volume of geospatial data is rapidly increasing. For the nation to receive the full benefits of this data through widespread usage in research and decision support, it is essential to develop state-of-the-art data discovery systems. Current geospatial search systems are far from ideal, especially for novice users encountering a steep learning curve. A simple, easy to use interface is characteristic of popular Internet search engines. But, these open domain search engines are created primarily for largely unstructured data (web pages) and rely primarily on keyword matching. This frequently results in low precision even for well posed questions. The geospatial data is largely structured data. Significant effort is spent standardizing data formats and developing rich metadata suitable for the designated user community. With the recent developments in natural language query processing and semantic web technologies, high precision natural language query processing systems could be developed on such largely structured data.

**Project Goals**: A web-based service is envisioned that converts complex geospatial queries, specified in natural language, to geospatial objects. The service could be used as a component of the data discovery systems employed by the data centers and/or portals. Most of the current metadata search engines do not extend beyond simple geographic bounding box searches and do not accept regions of arbitrary shape as input. But new generation of data discovery software like Geoportal have the capability.

Popular internet-based map services like Google Maps and Bing Maps, have elementary natural language query processing capabilities for geospatial data. For example, typing "Pizza near Union Station" produces a map of suitable nearby restaurants. The search engines only use nearest neighbor queries and do not handle more complicated natural language queries. For example, a query like "States adjacent to the Gulf of Mexico" will not return proper results. For oceanographic data discovery, the ability to answer more complicated queries is required,

especially those involving topological queries or a combination of spatial and attribute queries. Some example queries are: “Regions within 50 miles of Florida coast in the Gulf of Mexico”, “area within 10 miles of an oil spill event”, “James Cook’s route across the Pacific”, “Coastal state with highest population density”. It is possible to create domain dependent (Geospatial in this case) natural language question answering systems to pose and respond to such queries.

While natural language query systems for structured data in relational databases already exist (e.g. ChartSearch), interfaces to geospatial data are more challenging. Recent developments in geospatial semantic web and natural language processing are paving the way for a solution to this problem (See GeoSPARQL , W3C Geo XG, Power Set, Wolfram Alpha, IBM Watson). The solution to the geospatial data discovery problem involves transforming the natural language query to one which could be interpreted by a geospatial database containing Ocean features in a well defined schema. The database could be continuously updated with new event-defined locations. A web service to use such natural language interface would enable data archives and portals to call the service remotely from within their metadata search interfaces, avoiding the need to maintain redundant geospatial query translation databases. But unlike Google Maps which accepts simple bounding box queries and return maps as images, the queries to the web service would be more complicated geospatial queries posed in natural language that return geometric objects.

The short term goal of the project is to show that natural language interfaces to metadata search engines are feasible for geospatial queries. The long term goal is to develop data discovery systems which would make it easier to search, query and explore data at geospatial data repositories, in particular the NOAA data centers.

Longer-term broader impact of the subtopic is application well beyond data discovery to cover all geospatial query interfaces. The system can be extended to allow users to include additional geospatial data layers with the queries involving a combination of existing layers with custom layers. For example, a resource manager could include a habitat layer and query for “coral habitat within 50 miles of the Florida coast in the Gulf of Mexico.”

**Phase I Activities and Expected Deliverables**:
1) The immediate goal of the project is to develop an early prototype system which would respond accurately to well-posed geospatial queries in English in a proof of concept geospatial datasets. A novice would pose the query in simple and plain English and the system would return accurate results. If the system could not uniquely interpret the natural language query, it should suggest alternate probable matches to the initial query or prompt for rephrasing by the user.

**Phase II Activities and Expected Deliverables**:
1) A comprehensive geospatial database of all the natural and artificial features and historical events that occurred in the World Oceans (e.g., ocean features like trenches, underwater volcanoes, the boundaries of all the water bodies in the world, or historical sea routes).
2) The prototype developed in Phase I should be extended to create a natural language interface to this Knowledge base of Geospatial features belonging to oceans. The system should respond accurately to the queries mentioned before. The output to the query should be

in a format which is understood by GIS software. For example, the result for “Regions within 50 miles of Florida Coast in the Gulf of Mexico” would return the correct polygon.
3) A web service API should be created for the query interface so that users anywhere can programmatically use this service. The API is similar to geocoding or a map locator API, but is more complex and differs in many ways. A client API will be created to integrate the service into metadata search engines.

**Additional References**:

OGC Geospatial Semantic Web Interoperability Experiment:
http://www.opengeospatial.org/projects/initiatives/gswie, Accessed on 05/19/2011.

Egenhofer, M.J. (2002) Toward the Semantic Geospatial Web. In Proceedings of the Tenth ACM International Symposium on Advances in Geographic Information Systems, McLean, Virginia.

# 9.0 SUBMISSION FORMS

## 9.1 NOAA/SBIR Coverpage

| NOAA/SBIR<br>SMALL BUSINESS INNOVATION RESEARCH | This firm and/or Principal Investigator ___ has ___ has not submitted proposals for essentially equivalent work under other federal program solicitations, or ___ has ___ has not received other federal awards for essentially equivalent work |
|---|---|

| SOLICITATION NO.: NOAA 2012-1 | CLOSING DATE: February 1, 2012 |
|---|---|
| NAME OF SUBMITTING FIRM | |
| TAXPAYER IDENTIFICATION NUMBER | |
| DUNS NUMBER | |
| ADDRESS OF FIRM (INCLUDING ZIP CODE + 4) | |
| | |
| TITLE OF PROPOSED PROJECT | |
| REQUESTED AMOUNT: $ | PROPOSED DURATION: Six (6) Months |
| SOLICITATION SUBTOPIC NO. | SOLICITATION SUBTOPIC TITLE |

| THE ABOVE ORGANIZATION CERTIFIES THAT: | YES | NO |
|---|---|---|
| 1. It is a small business firm as defined on page 6. | | |
| 2. The primary employment of the principal investigator will be with the firm at the time of award and during the conduct of the research. | | |
| 3. A minimum of two-thirds of the research will be performed by this firm in Phase I. | | |
| 4. It qualifies as a socially and economically disadvantaged small business as defined on page 7. | | |
| 5. It qualifies as a woman-owned small business as defined on page 7. | | |
| 6. It will permit the government to disclose the title and technical abstract page, plus the name, address and telephone number of the corporate official if the proposal does not result in an award to parties that may be interested in contacting you for further information or possible investment. | | |
| 7. Is your business in a HUB Zone? (See: http://map0.sba.gov:82/gis/esri/hubzone/index.html) | | |

| PRINCIPAL INVESTIGATOR/<br>PROJECT DIRECTOR | CORPORATE OFFICIAL<br>(BUSINESS) | OTHER INFORMATION |
|---|---|---|
| NAME (Printed) | NAME (Printed) | YEAR FIRM FOUNDED |
| | | |
| SIGNATURE | SIGNATURE | NUMBER OF EMPLOYEES |
| DATE | DATE | Average Previous 12 months _____<br>Currently _____ |
| TITLE | TITLE | HAS THIS PROPOSAL BEEN SUBMITTED TO ANOTHER AGENCY?<br>Yes ☐ No ☐ |
| TELEPHONE NO. + AREA CODE | TELEPHONE NO. + AREA CODE | IF YES, WHAT AGENCY?<br>_____ |
| | | |
| E-MAIL (Printed) | E-MAIL (Printed) | FAX # |

PROPRIETARY NOTICE

For any purpose other than to evaluate the proposal, this data shall not be disclosed outside of the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a funding agreement is awarded to this proposer as a result of or in connection with this submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data source without restriction. The data in this proposal subject to this restriction is contained on separate proprietary page(s).

## 9.2 NOAA/SBIR Project Summary Form

| | |
|---|---|
| NAME OF FIRM: | |
| AMOUNT REQUESTED: | |
| ADDRESS: | PHONE #:<br>FAX #:<br>E-MAIL: |
| PRINCIPAL INVESTIGATOR (NAME AND TITLE) | |
| TITLE OF PROJECT | |
| SOLICITATION SUBTOPIC NUMBER | SOLICITATION SUBTOPIC TITLE |
| TECHNICAL ABSTRACT (LIMIT 200 WORDS) | |
| SUMMARY OF ANTICIPATED RESULTS | |

## 9.3 NOAA/SBIR Proposal Summary Budget

| FIRM: | PROPOSAL NUMBER:<br>(Leave Blank) |
|---|---|
| PRINCIPAL INVESTIGATOR: | |
| | |
| | PRICE |
| DIRECT LABOR: | $ |
| OVERHEAD RATE: | $ |
| OTHER DIRECT COSTS: | $ |
| MATERIALS: | $ |
| GENERAL AND ADMINISTRATIVE (G&A): | $ |
| PROFIT: | $ |
| TOTAL PRICE PROPOSED: | $ |
| | |
| THIS PROPOSAL IS SUBMITTED IN RESPONSE TO NOAA SBIR PROGRAM SOLICITATION 2012-1 AND REFLECTS OUR BEST ESTIMATES AS OF THIS DATE. | |
| _____<br>TYPED NAME AND TITLE | _____ _____<br>SIGNATURE DATE |

## 9.4 NOAA/SBIR BUDGET INSTRUCTIONS

The offeror is to submit a cost estimate with detailed information for each element, consistent with the offeror's cost accounting system. This does not eliminate the need to fully document and justify the amounts requested in each category. Such documentation should be contained, as appropriate, on a budget explanation page immediately preceding the budget in the proposal.

### 1. Principal Investigator (PI)

The PI must be with the small business concern at the time of contract award and during the period of performance of the research effort. Additionally, more than half of the PI's time must be spent with the small business firm during the contract performance.

### 2. Direct Labor

All personnel (including PI) must be listed individually, with the projected number of hours and hourly wage.

### 3. Overhead Rate

Specify current rate and base. Use current rate already negotiated with a Federal agency, if available. If no rate has been negotiated, a reasonable overhead rate (10-15% is average) may be requested, which will be subject to approval by NOAA. Overhead includes fixed costs not directly related to the research effort, e.g., rent, heat, light, facilities, telephones, maintenance, insurance, etc.

### 4. Other Direct Costs

List all other direct costs which are not described above (i.e. consultants, subcontractor, travel, and equipment purchases). Each of the above needs a detailed explanation and elaboration of its relation to the project. (Up to $4,000 may be allocated for technical and commercial assistance.)

### 5. Materials

The materials and supplies required for the project must be identified. There is also a need to specify type, quantity, unit cost, and total estimated cost of these materials and supplies.

### 6. General & Administration (G&A)

Specify current rate and base. Use current rate already negotiated with a Federal agency, if available. If no rate has been negotiated, a reasonable G&A rate may be requested, subject to approval by NOAA. G&A includes costs associated with managing and running the small business, e.g. computers, copier, marketing, charitable contributions, loans, gifts, entertainment, dues, etc.

### 7. Profit

The small business may request a reasonable profit. About seven percent of the cost is the average proposed.

## 10.0 NOAA/SBIR CHECKLIST

Please review this checklist carefully to assure that your proposal meets the NOAA requirements. Failure to meet these requirements will result in your proposal being rejected without consideration.

**Six copies of the proposal must be received by 4:00 p.m. (CST) February 1, 2012.**

_____ 1. The **COVER PAGE** has been completed and is page 1 of the proposal. Required signatures are included.

_____ 2. The **PROJECT SUMMARY** has been completed and is page 2 of the proposal. The abstract contains no proprietary information.

_____ 3. The **TECHICAL CONTENT** of the proposal begins on **PAGE 3** and includes the items identified in **SECTION 3.3.3** of the solicitation. The technical content section of the proposal is limited to 22 pages in length.

_____ 4. The **PROPOSED BUDGET** has been completed, including signature, and is the **last page** of the proposal. The proposal budget is for $95,000 or less. No more than one-third of the budget is allocated to consultants and/or subcontractors.

_____ 5. The entire proposal, including forms and technical content, is **25 pages or less in length**.

_____ 6. The proposal, Cover Page and Project Summary contains an easy-to-read font (fixed pitch of 12 or fewer characters per inch or proportional font of point size 10 or larger) with no more than six lines per inch, except as a legend on reduced drawings, but not tables.

_____ 7. The proposal contains only pages of 21.6cm x 27.9cm size (8 ½ " x 11").

_____ 8. The proposal is limited to only one of the subtopics in Section 8.

_____ 9. The P.I. will be employed by the company at least 51% of the time during the award period.

NOTE: Proposers are cautioned of unforeseen delays that can cause late arrival of proposals, with the result that they may be rejected without evaluation.

Potential offerors are advised to sign up within https://www.fedbizopps.gov to receive notification of any amendment to the solicitation that may be released after opening date.

## 11.0 SBIR NATIONAL CONFERENCES

FEDERAL R&D OPPORTUNITIES
FOR
TECHNOLOGY INTENSIVE FIRMS

Marketing Opportunities for R&D and Technology Projects with Federal Agencies and Major Corporations.

Techniques and Strategies for Commercializing R&D through Venture Capital, Joint Ventures, Partnering, Subcontracts, Licensing, and International Markets.

Management Seminars in Marketing and Business Planning.

Working with Academia and the States.

Agency and company exhibits and/or One-on-One tables will be open for networking opportunities for all attendees!

Louisville, Kentucky May 30- June 1, 2012

For further information on this conference and upcoming conferences see the SBIR Homepage: www.sbir.gov