

**External Review**

**of the**

**Joint Institute for the Study of the  
Atmosphere and Ocean (JISAO)  
University of Washington**

**Review Panel Members**

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**Submitted to the  
National Oceanic and Atmospheric Administration  
Science Advisory Board  
on  
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## Summary

An external review of the research, education, and outreach programs of the Joint Institute for the Study of the Atmosphere and Ocean (JISAO) at the University of Washington (UW) was conducted on 6-7 March, 2014 on the UW campus in Seattle, WA. The NOAA Science Advisory Board (SAB) approved guidelines for conducting the review were provided by the Office of Oceanic and Atmospheric Research (OAR) within the National Oceanic and Atmospheric Administration (NOAA). The review was conducted under the auspices of the NOAA SAB and, therefore, is subject to the requirements of the Federal Advisory Committee Act (FACA). A list of review panel members is provided in Appendix I. The review panel's on-site agenda is provided in Appendix II. The mission, goals, and primary research themes of JISAO are provided in Appendix III.

JISAO is a single university cooperative institute (CI), but involves several departments and programs at the University of Washington, including: the Department of Atmospheric Sciences; the School of Aquatic and Fishery Sciences; the School of Oceanography; Washington Sea Grant and Friday Harbor Laboratories within the University's College of the Environment; and several other academic departments and research units. NOAA collaboration includes the Pacific Marine Environmental Laboratory (PMEL), Northwest Fisheries Science Center (NWFS), and Alaska Fisheries Science Center (AFSC).

JISAO's seven research themes are: (1) climate research and impacts; (2) environmental chemistry; (3) marine ecosystems; (4) ocean and coastal observations; (5) protection and restoration of marine resources; (6) seafloor processes; and (7) tsunami observations and modeling. The review panel found that scientific research activities associated with each of JISAO's seven research goals range from satisfactory to outstanding.

Prior to the re-competition in 2010, JISAO had four themes: (1) marine ecosystems; (2) climate (including tropical ocean and atmosphere, Arctic, and the Pacific Northwest); (3) coastal oceanography (including tsunamis); and (4) environmental chemistry (including ocean carbon, atmospheric aerosols and trace gases, and hydrothermal vents). The JISAO review in 2005 suggested that regional marine ecosystems, hydrothermal vents, and tsunami research should be expanded. The re-competition in 2010 expanded the JISAO themes to the seven as stated previously, and represented a re-organization of existing research rather than the addition of new areas. One new theme was added: Protection and Restoration of Marine Resources.

The re-competition re-shuffled the level of interest and support for research themes. Growth has been mostly in multi-disciplinary areas across themes, such as studies of

marine ecosystems and the effect of climate variability and climate change on those ecosystems, as well as carbon cycle research and ocean acidification. Tsunami research continues, but at a decreased level to the past because of the completion and implementation of an initial phase of tsunami models. Observational research and development support for *in situ* ocean systems continues to decline across NOAA.

JISAO research activities are well aligned with NOAA's Vision of the Future stated in NOAA's Next Generation Strategic Plan, and more specifically with all four of NOAA's Long-term Goals of Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans, and Resilient Coastal Communities and Economies. Not all research themes are equally strong, and JISAO should consider possible amalgamation or downsizing to have more flexibility to focus on emerging important scientific challenges. This will require greater flexibility in NOAA management.

Based upon these findings, the Panel issued 9 recommendations for JISAO and 3 for NOAA. The Review Panel concluded that JISAO is a valuable member of the NOAA CI community and assigned an overall rating of Outstanding.

## **I. Overview of JISAO**

JISAO's vision is to be the leading NOAA Cooperative Institute engaged in environmental research for the northwest Pacific and Arctic Oceans, as well as the Pacific Northwest from Oregon to Alaska. JISAO research is fundamentally interdisciplinary and multidisciplinary with the overarching goal of achieving an integrated understanding of the regional climate system including atmosphere, ocean, and ecosystem interactions. To this effect, JISAO's mission is centered upon the seven scientific themes mentioned above that correspond well with all of the components of NOAA's Next Generation Strategic Plan.

## **II. Strategic Plan**

### **Findings**

A. JISAO has a well-developed strategic plan that encompasses a remarkably broad research portfolio made possible by its setting within the multifaceted activities of the UW College of the Environment and interactions with PMEL, NWFSC, and AFSC. The strong research portfolio also encompasses exceptional support for training of the next generation of NOAA scientists and engagement with the public about important environmental issues.

B. JISAO research is highly productive and influential in several of the themes defined in their strategic plan. Scholarship is excellent. There are nevertheless considerable

differences in the level of capability and effort among the seven research themes that merit reevaluation.

C. Too rigid adherence to the original structure of the themes based upon the original JISAO award appears to reduce flexibility and the opportunity to modify JISAO's focus to take advantage of important research opportunities.

D. Partnerships between JISAO and the three NOAA labs vary in extent and effectiveness and should be evaluated in relation to reductions in discretionary funding.

## **Recommendations**

A. NOAA should encourage and support JISAO to review its research themes with regard to concentrating on its major research activities and consider amalgamating or reducing some others.

B. JISAO should develop a system to keep track of productivity within the different themes as a tool for reevaluation of their comparative strengths. It would have been useful for the panel to receive a list of publications broken down by research theme as a basis for more objective evaluation of their differential scientific impact.

C. JISAO needs to capture more discretionary funds to exploit new opportunities and developments.

## **III. Science Review**

### **Findings**

A. JISAO science is excellent, productive, and collaborative. Publication output is high with 236 publications over the past year. Recent examples of the many outstanding research achievements that particularly impressed the Review Panel include tsunami modeling, regional ecosystem forecasting, black carbon production, and dynamics of Arctic ice.

Tsunami modeling: JISAO scientists have developed a tsunami modeling and warning system that is being implemented in operational warning centers in the U.S. The system includes three primary elements: (1) a method for determining the initial deformation of the sea floor based on real-time observations from the Deep-Ocean Assessment and Reporting of Tsunami (DART) buoy array, (2) an efficient deep-ocean propagation model, and (3) a set of very-high resolution coastal modules for selected locations along US and other coastlines. The coastal modules allow prediction of tsunami impacts at high spatial and temporal resolution in low-lying coastal areas. The three elements are knitted together such that seamless model simulations are possible in near real-time for

individual harbors and coastal towns. This effort has led to a substantial improvement in the capabilities of the Tsunami Warning Centers to provide timely and reliable information on the potential threats of tsunamis. In addition, results of the deep-ocean propagation model are available to forecasters in other countries around the Pacific to use for their own tsunami warning efforts.

Seasonal coastal ocean ecosystem prediction (J-SCOPE): Seasonal forecasts of ocean conditions for the coastal waters from central California to Vancouver Island are being made in support of NOAA's California Current Integrated Ecosystem Assessment Program (CCIEA) with a focus on sardines and salmon. The work is being conducted by JISAO in collaboration with NOAA's Northwest Fisheries Science Center. Seasonal ocean predictions for the Pacific Northwest are being made using a high-resolution Regional Ocean Model System (ROMS). Boundary conditions for the regional model are obtained from operational simulations by NOAA's Climate Forecast System (CFS) model. The predictions feature specific oceanic properties crucial to the nearshore and coastal marine ecosystems such as upwelling of ocean water, pH (a measure of ocean acidity), mixed layer depth, oxygen concentration and plankton distributions. These quantities can be related to the abundance and location of forage fish such as sardines. Initial results are very promising, and have attracted not just the interest of a variety of local stakeholders, but also the attention of scientists, managers and fishers for its adaptation to other regions.

Black carbon: Sometimes referred to as soot, black carbon is the product of fossil fuel combustion and dispersed through the atmosphere as fine particles that are, per mass, the most absorbing substance among all particles. JISAO scientists and their partners are providing new quantitative evaluation of the role of black carbon in climate. A large group of scientists, led by a group of four scientists including Sarah Doherty from JISAO, published an intensive review of all measurements of black carbon in recent years and an evaluation of its role on climate. They conclude that the warming impact of black carbon on climate during the industrial age is likely to be twice as high as previous estimates. This conclusion implies that the warming due to increases in carbon dioxide may be somewhat less than previous estimates conclude. In addition to its direct atmospheric effect, black carbon, when deposited on snow and ice surfaces, contributes to an accelerated melting of snow and ice. Global climate models indicate that this is a potentially large warming effect for the planet (by melting bright, reflective surfaces), but little is known about the actual concentration of black carbon in snow. University of Washington scientists from JISAO and the Atmospheric Sciences Department in collaboration with scientists at Lanzhou University in China are rectifying this situation by carrying out an extensive snow data collection in the Arctic, China and Mongolia, and North America. Snow samples are collected, melted, and filtered to measure the actual amount of black carbon in the snow. Early results suggest that black soot is present in snow in substantial amounts and may be contributing to enhanced snowmelt in the northern hemisphere.

Arctic meteorology and extent of summer sea ice: Loss of summer sea ice is proceeding much more rapidly than projected rates of decline based upon current-generation climate models. JISAO is playing a leading role in understanding this discrepancy based upon an extensive array of direct measurements of temperatures and pressure as well as movements of floes.

B. JISAO excels in its sustained, long-term measurements of environmental parameters that are essential for basic understanding of process.

C. Quality of postdoctoral and research scientists is uniformly high. In our meetings, young researchers eloquently explained what they are doing and why in terms of fundamental scientific understanding.

## **Recommendations**

A. Theme leaders and JISAO science administrators should work to expand, consolidate, or phase out efforts in less productive themes (e.g., marine resources).

B. JISAO and NOAA need to maintain, enhance, and ensure the continuation of long-term observational capabilities that are at the core of JISAO's research mission for improved modeling and predictive tools.

## **IV. Education and Outreach**

### **Findings**

A. JISAO provides a strongly supportive and nurturing environment for young scientists. Programs for postdoctoral fellows and research opportunities for undergraduates (REUs) are excellent with a strong record of job placement and acceptance to graduate schools. Morale and enthusiasm appeared consistently high.

B. JISAO has a strong commitment to diversity.

C. Public outreach is also remarkably impressive, especially given that it is underfunded and dependent upon opportunism and volunteer participation. One exceptional example is the regular climate scientist program on local National Public Radio (NPR).

### **Recommendations**

A. JISAO needs to reach out more to people based at PMEL to bring them onto the UW campus and better facilitate interactions for collaboration and brainstorming of new projects. This could be greatly facilitated by a weekly seminar and provision of office space and/or a meeting area for visiting PMEL people on the UW campus.

B. JISAO needs to continue to press for more Task I funding from NOAA.

## **V. Science Management**

### **Findings**

A. Partnership between JISAO and PMEL has developed into a strong, stable, and productive relationship, but this was somewhat less apparent with the two fisheries laboratories (NWFSC and AFSC). Moreover, communication among Center leaders did not appear to be as strong as it could be to better foster collaboration.

B. JISAO Council meetings improve communications among stakeholders. The Council is composed of representatives from each of the collaborating partners: UW School of Oceanography, UW School of Aquatic and Fishery Sciences, and PMEL, among others. Because of the diverse partnerships across the larger JISAO community, regular meetings of the principals are quite valuable. Updates on research and outreach projects as well as funding initiatives and agency priorities can be transparently discussed at these meetings to avoid conflicts and enhance collaborations.

C. JISAO fosters a lively intellectual environment exemplified by the enthusiasm of young scientists. There is a clear sense of grass roots creativity. This is nurtured by good use of returned overhead.

D. JISAO programs suffer from a lack of discretionary funds to support new projects and proposals.

### **Recommendations**

A. JISAO should further encourage and enable partnerships and side projects among postdocs and researchers. To this end, JISAO should provide more seed monies to pursue new project ideas and proposal writing. PMEL will need to buy into this effort, which is important for postdoctoral career development.

B. JISAO needs to improve its relationships with the NOAA Fisheries Centers (NWFSC and AFSC) to identify opportunities

## **VI. Comments and Recommendations for NOAA**

A. The relationships among Cooperative Institutes are byzantine, obscure, and defined by historical relations between the CI and NOAA that are effectively impenetrable without enormous unnecessary effort by the review team. NOAA should provide reviewers with a concise document outlining NOAA's vision of the role of the CI within



NOAA's research program. This should be done well in advance of the on-site meeting, preferably in a face-to-face meeting with the SAB Chair of the review.

B. The strict formats of the reports inhibit the CI Director from providing information in ways that would be valuable to the review process. For example, we had to push for additional information about JISAO's most outstanding achievements because the review format does not call for it. The review format also inhibits flexibility for the future by locking the process into a checking off of boxes rather than standing back to ask more generally what has been achieved, what has been more or less profitable, and how could the Strategic Plan and basic science be improved to do an even better job in future. *In essence, the present review format discourages input for adaptive management.*

C. Task I funding for education and outreach is absurdly underfunded. There is a basic disconnect and hypocrisy in setting standards that have been consistently underfunded in relation to NOAA expectations. JISAO has done exceptionally well in spite of this, but doing so has taken a heavy toll on morale of senior administration who shoulder the unnecessary burden.

## **Appendix I - JISAO Review Panel Members**

### **[1] Jeremy Jackson, Ph.D., Chair [Member of NOAA's Science Advisory Board]**

Senior Scientist Emeritus  
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Jeremy Jackson is Senior Scientist Emeritus at the Smithsonian Institution and Professor of Oceanography Emeritus at the Scripps Institution of Oceanography in La Jolla, California. He is also the Science Director of the Global Coral Reef Monitoring Network at the International Union for the Conservation of Nature. Professor Jackson studied at the George Washington University and Yale. He is the author of more than 150 scientific publications and author or editor of eight books. He studies human impacts on the oceans and the ecology and paleoecology of tropical marine ecosystems. Dr. Jackson is a Fellow of the American Academy of Arts and Sciences and the American Association for the Advancement of Science and recipient of numerous international prizes and awards including most recently the Roger Torrey Peterson Medal from Harvard University, the Paleontological Medal, and the Society for Conservation Biology LaRoe Award for Outstanding Contributions to Conservation Biology. Jackson's work on historical overfishing and the recent collapse of coastal ecosystems was chosen by Discover magazine as the outstanding scientific achievement of 2001. Island Press recently published his latest book, *Shifting Baselines: The Past and Future of Ocean Fisheries*.

### **[2] Arthur J. Miller, Ph.D.**

Research Oceanographer  
Senior Lecturer in Climate Sciences  
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Arthur J. Miller is currently a Research Oceanographer (equivalent to Full Professor) and a Senior Lecturer in Climate Sciences at Scripps Institution of Oceanography (UCSD). He is also Director of the Climate, Atmospheric Science, and Physical Oceanography (CASPO) Division. He is a physical oceanographer who studies oceanic influences on climate variability using a combination of computer simulation models and observational analysis. His research extends from basic issues in physical oceanography to a variety of topics in climate dynamics, atmospheric dynamics, data assimilation,

regional impacts of global climate change, and oceanic ecosystem response to physical forcing. He currently is an Associate Editor for *Journal of Geophysical Research-Oceans* and *Atmospheric Science Letters*. He also serves on the U.S. CLIVAR Phenomena Observations and Synthesis (POS) Panel, and has served on the U.S. GLOBEC Scientific Steering Committee, the PICES Evaluations of Climate Change Working Group, the Bering Ecosystem Study (BEST) Scientific Steering Committee, and the U.S. CLIVAR Pacific Sector Implementation Panel. He is the author or co-author of more than 80 refereed publications and currently has or has had funding from NSF, NOAA, NASA, ONR, DOE, and the CA Dept of Boating and Waterways. He received his B.S. in physical oceanography from the Florida Institute of Technology and his Ph.D. from the University of California, San Diego.

**[3] Selina Heppell, Ph.D.**

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Dr. Heppell received her PhD in Zoology from Duke University in 1998, specializing in population ecology of vertebrates and marine biology. As a conservation biologist-turned-fisheries scientist, she has served on a number of advisory and review panels for NOAA and the Pacific Fisheries Management Council, providing advice on protected species management, population responses to fishing and climate change, and development of tools for ecosystem-based fisheries management. She is currently an Associate Professor and Associate Department Head in the Department of Fisheries and Wildlife at Oregon State University, where she teaches population ecology and directs a growing online program in fisheries and wildlife science.

**[4] Peter Lamb, Ph.D. (Ex-Officio, cooperative institute representative)**

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Peter J. Lamb received B.A. (1969) and M. A. (1971, with Honours) degrees in Geography from the University of Canterbury (New Zealand), the Ph.D. in Meteorology from the

University of Wisconsin in 1976, and a D.Sc. for published research in Climate Science from the University of Canterbury in 2002. In 1991, Dr. Lamb joined The University of Oklahoma as a tenured full Professor in its School of Meteorology, and Director of the NOAA Cooperative Institute for Mesoscale Meteorological Studies (CIMMS). He received a George Lynn Cross Research Professorship in 2001, which is The University of Oklahoma's highest research honor. Dr. Lamb's primary research interests are in the physical and dynamical processes responsible for climate and its short-term fluctuations (intraseasonal, interannual, decadal). Recently, Dr. Lamb was elected to the Council (2011-2014) and Executive Committee (2012-2014) of the American Meteorological Society.

## Appendix II - JISAO Science Review Agenda



**JISAO Science Review Agenda  
March 5 and 6, 2014  
Wallace Hall, Room 120  
University of Washington**

**March 5**

<u>Time</u>	<u>Topic</u>	<u>Presenter</u>	<u>Location</u>
8:00 – 8:45 am	Science Review Panel Executive Session (Continental Breakfast)	Closed session	Wallace Hall 120
8:45 – 9:00 am	Welcome	Dean Lisa Graumlich	Wallace Hall 120
9:00 – 9:45 am	JISAO Introduction and Overview	Tom Ackerman	"
9:45 – 10:00 am	Coffee Break		"
10:00 – 12:00 pm	Science Presentations <ul style="list-style-type: none"> <li>• Arctic climate and observations – Ignatius Rigor</li> <li>• Ocean chemistry – Rolf Sonnerup</li> <li>• Ocean modeling and forecasting – Al Hermann</li> <li>• Ocean floor vents – Dave Butterfield</li> </ul>		"
12:00 – 1:15 pm	Lunch	Review Panel and JISAO Council	CoENV Dean's Conference Room OCN 203
1:15 – 2:45 pm	Science Presentations <ul style="list-style-type: none"> <li>• Marine ecosystems – Nick Bond</li> <li>• Fisheries – John Horne</li> <li>• Tsunami modeling – Diego Arcas</li> </ul>		Wallace Hall 120
2:45 – 3:00 pm	Coffee Break		"
3:00 – 3:45 pm	NOAA Sponsors and Stakeholders	Closed Session	"
3:45 – 4:30 pm	Review panel meeting	Closed Session	"
4:30 – 6:00 pm	Poster Session and Reception		School of Aquatic and Fishery Sciences FSH Lobby
6:00 pm	Return to Watertown Hotel		
7:00 pm	Dinner at Ivar's Salmon House		Walk or transport provided

## Appendix II - JISAO Science Review Agenda (continued)



JISAO Science Review Agenda  
 March 5 and 6, 2014  
 Wallace Hall, Room 120  
 University of Washington

<b>March 6</b> <b><u>Time</u></b>	<b><u>Topic</u></b>	<b><u>Presenter</u></b>	<b><u>Location</u></b>
8:00 – 9:00 am	Science Review Panel Executive Session (Continental Breakfast)	Closed session	Wallace Hall 120
9:00 – 10:15 am	Education and Outreach	Tom Ackerman	"
10:15 – 10:30 am	<i>Coffee Break</i>		"
10:30 – 11:00 am	Facilities Overview	Nick Bond	"
11:00 – 12:00 pm	JISAO Executive Director, Deputy Director and Assistant Director	Closed Session	"
12:00 – 1:00 pm	<i>Lunch with Post-docs and Early Career Scientists</i>		"
1:00 – 3:00 pm	Science Review Panel Executive Session	Closed Session	"
3:00 – 3:15 pm	<i>Coffee Break</i>		"
3:15 – 4:00 pm	Science Review Panel Executive Session	Closed Session	"
4:00 – 5:00 pm	Initial report back to JISAO Preliminary Findings and Tentative Recommendations	Ackerman, Bond, Smith	"
5:00 pm	Adjourn		

## Appendix III - JISAO Mission, Goals, and Primary Research Themes

The Joint Institute for the Study of the Atmosphere and Ocean (JISAO) has existed since 1977 for the purpose of fostering research collaboration between the University of Washington (UW) and the National Oceanic and Atmospheric Administration (NOAA). JISAO's research is at the forefront of investigations on climate change, ocean acidification, fisheries assessments, and tsunami forecasting. The [JISAO Council and Senior Fellows](#) provide recommendations to the Institute management. The Institute's mission and goals, as outlined in its last recompetition proposal, are:

### Mission

The CI mission is two-fold:

- *To conduct multi- and interdisciplinary research in atmospheric, oceanic, and fishery sciences and on impacts and policy that provides understanding of climate and ecosystem interactions, the way in which these interactions are affected by natural variability and anthropogenic perturbations, and the consequences for natural systems and human society*
- *To participate in the education both of a new generation of students who are environmentally literate, understand the interlocking complexity of environmental problems, and are trained in solution methods, and of the citizenry of the Pacific Northwest and the nation to enable them to understand the competing demands of environmental and societal health and resource and economic sustainability.*

Thus, the vision of the CI is to be one of the principal research arms that enable NOAA to achieve its vision of an informed society. The mission of the CI is to conduct research that underpins and guides NOAA's mission of understanding and predicting environmental changes and managing resources and to participate broadly in the education of citizens, particular students, about environmental issues, problems and solutions. The CI's mission is directly relevant to the first three of NOAA's mission goals on managing resources, understanding climate variability and change, and meeting needs for weather and water information. Furthermore, the educational mission of the CI is directly aligned with the goals of increasing environmental literacy and technical competence in an increasingly diversified workforce.

### Goals

The proposed CI flows naturally from our existing Joint Institute. Thus, our goals in part seek to maintain and advance the current position of JISAO. Our list of goals is long, but reflects the diversity and breadth of activities already existing within JISAO and proposed for the new Cooperative Institute.

Our five-year research goals are to:

- Maintain national and international leadership in research on global atmospheric and oceanic circulations and atmosphere-ocean interactions from the tropics to the poles, with a focus on understanding processes that determine climate sensitivity.
- Continue to develop national and international leadership in research on regional climate modeling, particularly focusing on the Pacific Northwest and the Arctic.
- Maintain national and international leadership in climate impact assessment and climate policy analysis.
- Develop an internationally recognized research program in ocean acidification that encompasses the global carbon cycle, ocean chemistry, and organism and ecosystem responses.
- Continue to develop national and international leadership in the understanding and modeling of marine ecosystems, particularly in Puget Sound, the Gulf of Alaska, and the Bering Sea.
- Maintain national and international leadership in research on tsunami modeling and forecasting along with a special emphasis on educating a user community for these tools in developing countries around the Pacific and Indian Oceans.
- Provide leadership and technical expertise in the development and deployment of ocean observing systems and systems at the atmosphere-ocean interface and in the management and analysis of environmental data sets, particularly the integration of these data sets in space and time.

Our five-year education, outreach and management goals are to:

- Influence, in partnership with the College of the Environment and the units within it, the development of new curricula and degree-granting programs at the undergraduate and graduate level that will raise environmental literacy in the university and the community and educate NOAA's workforce of the future in ocean and atmospheric sciences, marine organism and ecosystem research, and impacts and policy.
- Enhance existing and develop additional programs that bring underrepresented groups into atmospheric, oceanic, and fisheries academic programs and research laboratories, retain them through to successful completion of these programs and help find employment in the NOAA and academic workforce.
- Partner with university organizations such as Washington Sea Grant and community organizations such as Pacific Science Center to promote NOAA research activities and educate the regional and national community about NOAA accomplishments.
- Modify the existing organization to improve the management structure and create a more ordered long-term career path for JISAO research and administration staff.



## Primary Research Themes

1. Climate research and impacts
2. Environmental chemistry
3. [Marine ecosystems](#)
4. Ocean and coastal observations
5. [Protection and restoration of marine resources](#)
6. Seafloor processes
7. [Tsunami observations and modeling](#)

## JISAO global and regional topics of concern and interest to the public include:

- **enhancing** research capabilities of UW and NOAA scientists, utilizing the diverse array of scientific and technical expertise and specialized research facilities within both institutions;
- **facilitating** the training of the next generation of NOAA's scientists by capitalizing on the UW's extraordinary strength in the geosciences and its degree granting authority;
- **providing** UW students the opportunity to participate in NOAA research, thereby enriching their educational experience;
- **offering** educational and outreach activities to our local and regional communities through K-12 programs, student internships, training and recruitment programs, through media contacts and publications; and,
- **developing** relationships with government agencies and industries in the state of Washington and throughout the Pacific Northwest with a view toward assisting NOAA in tailoring its climate forecasts and assessments to meet the needs of stakeholders.