MEMORANDUM FOR: Scott B. Gudes
Acting Under Secretary for
Oceans and Atmosphere/Administrator
and Deputy Under Secretary

FROM: Al Beeton
Chairman

SUBJECT: NESDIS Office of Research and Applications Science Review

The federal charter for the NOAA Science Advisory Board (SAB) states that the Board will provide the Under Secretary of Commerce for Oceans and Atmosphere advice and recommendations on all aspects of NOAA's science programs and activities. At the request of the Assistant Administrator for Satellite and Information Services (NESDIS), the SAB convened a working group to conduct an external science review of the NESDIS Office of Research and Applications. The review was conducted in September 2000. The review panel's draft report was presented to the Board at its March 2001 meeting for discussion and disposition. The draft report was accepted as is, with no additional comments or recommendations. The NOAA Science Advisory Board "Final Report: External Science Review of the Office of Research and Applications" is hereby being transmitted to you for your consideration. The Board has expressed an interest in receiving a report in writing or at some future meeting describing what NOAA has done to address the recommendations in the Report.

Attachment

cc: NOAA SAB members
G. Withee E
M. Uhart R/SAB

# FINAL REPORT

# EXTERNAL SCIENCE REVIEW

## Of the
## Office of Research and Applications (ORA)
## National Environmental Satellite, Data, and Information Service (NESDIS)
## National Oceanic and Atmospheric Administration (NOAA)

September 2000

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## EXECUTIVE SUMMARY


The National Environmental Satellite, Data, and Information Service (NESDIS) of the National Oceanic and Atmospheric Administration (NOAA) convened an external team to conduct a review of the Office of Research and Applications (ORA). The review, held on September 14-15, 2000, was conducted in response to a NOAA Science Advisory Board (SAB) call for information regarding the quality and use of science in support of the mission of NOAA. The SAB provided a suggested framework for such science reviews. This framework includes the following eight (8) themes: (1) quality, creativity, and credibility; (2) timeliness and scale; (3) science connected to the application and operational implementation of policy; (4) capacity-building; (5) education; (6) efficiency; (7) social science integration; and (8) diversity.

The External Science Team (EST) found the ORA to be a vital and productive organization that contributes well and serves as a valuable source of accomplishments and contributions to the NOAA/NESDIS and the entire Earth science and applications communities. The staff is motivated, productive, and responsive to the mission and goals of NOAA and NESDIS. The ongoing endeavors reflect valuable efforts that respond to customer needs and further reflect substantial investments in planning for the future. The management is to be praised for fostering an environment where vigorous activity is clearly taking place.

This report, recognizing the significant accomplishments within the ORA, will focus and comment on the plans of the ORA for its future and the adequacy of its defined roadmap to accomplish this prescribed future. The EST has made recommendations to NESDIS/ORA in the areas of (1) strategic, operational and tactical planning; (2) science priorities; (3) partnerships; (4) technology transfer; and (5) capacity building, diversity and education. Highlights of these recommendations include the need for:

- A strategic plan that is further informed by internal and external science and applications communities;
- Added emphasis on (i) the calibration and validation of satellite data, (ii) oceanographic research, and (iii) social science research;
- ORA prioritization of research initiatives; and
- Development and implementation of plans that address capacity-building and diversity.

## OVERVIEW

On September 14-15, 2000, an external team conducted a science review of the Office of Research and Applications (ORA) within the National Environmental Satellite, Data, and Information Service (NESDIS) of the National Oceanic and Atmospheric Administration (NOAA). The review was convened at the request of the Assistant Administrator of NESDIS, Mr. Greg Withee, in response to a NOAA Science Advisory Board (SAB) call for information regarding the quality and use of science in support of the mission of NOAA. The SAB provided a suggested framework for NOAA science reviews. This framework includes the following eight (8) themes deemed to be important parameters relative to a strategic review of NOAA science projects and programs. The themes are (1) quality, creativity, and credibility; (2) timeliness and scale; (3) science connected to the application and operational implementation of policy; (4) capacity-building; (5) education; (6) efficiency; (7) social science integration; and (8) diversity. The ORA science review and the contents of this report were informed by an ORA overview document entitled, *Office of Research and Applications ... in the Year 2000* (September, 2000), and a series of presentations with supporting documentation provided by the management team of the ORA.

This report, recognizing the significant accomplishments within the ORA, will focus and comment on the plans of the ORA for its future and the adequacy of its defined roadmap to accomplish this prescribed future. Also provided in this report is a summary of the (1) goals, objectives and accomplishments of ORA, (2) status of strategic and operational planning initiatives and their implementation within ORA, and (3) existing and future challenges and opportunities for ORA as perceived by the External Science Team (EST). Provided, as an attachment, is a listing of EST members and their affiliations.

## ORA MISSION AND OBJECTIVES

Overviews of the mission, goals, objectives, planning strategies and accomplishments of the ORA were provided by the Director of the ORA, Dr. James F. W. Purdom, the Deputy Director, Dr. Marie Colton, and the Chief Scientist, Dr. W. Paul Menzel. These overviews were then expanded upon in detail by each of the three Division Chiefs of the ORA. Provided are highlights of each.

The **Office of Research and Applications (ORA)** supports the mission of NOAA and NESDIS by providing observations and information from environmental satellites to describe and predict changes in the Earth's environment, and conserve and manage wisely the Nation's coastal and marine resources to ensure sustainable economic opportunities. The ORA is the science arm of NESDIS and provides leadership, guidance, and direction for NESDIS research, development, and applications activities with respect to satellites and satellite data. Its primary objectives are to:

- Ensure that satellite remote sensing data and information products are of the highest quality possible;
- Enhance the utilization of satellite remote sensing data and information products so that the NOAA missions of environmental assessment, prediction, and stewardship are met both today, and in the future; and,

- Conduct basic and applied oceanographic, land surface and atmospheric research on the use of satellite data for monitoring environmental characteristics and their changes.

The ORA objectives, as delineated, support the implementation of the strategic vision and plan of NOAA. Activity within the ORA focuses on NOAA's strategic themes of (1) environmental assessment and prediction and (2) environmental stewardship. In the area of **environmental assessment and prediction,** ORA scientists focus on ensuring that current satellite data utilization is maximized as part of NOAA's integrated environmental observation, assessment, and forecast services. These services are directed toward enhancing public safety and the Nation's economic and environmental security. ORA scientists are actively engaged in three areas within that theme: (1a) Advance Short-Term Warning and Forecast Services where science is focused on achieving the goals of the U.S. Weather Research Program and on improving the utilization of satellite data for Numerical Weather Prediction (NWP); (1b) Implement Seasonal to Interannual Climate Forecasts, where ORA science focuses on developing satellite-based global data and information products to provide the initial conditions needed to predict seasonal to interannual climate variations, verify seasonal to interannual predictions, and better characterize and understand these short-term climate variations; and (1c) Predict and Assess Decadal to Centennial Change where considerable energies are devoted to calibration and validation of long-term satellite data sets useful for studying climate trends and natural variability. Within the **environmental stewardship** theme, which concentrates on maintaining U.S. ocean and coastal areas with healthy ecosystems and encouraging wise human use and development of ocean, coastal and living marine resources, ORA scientists are active in two of the main focus areas which are: (2a) Build Sustainable Fisheries; and (2b) Sustain Healthy Coasts.

The **Climate Research and Applications Division (CRAD)** provided an overview of data sets used for climate assessments and satellite products developed for climate prediction. There is a laudable and significant overall effort to demonstrate the applications of satellite data to climate. The Division is also quite active in performing and developing satellite calibration procedures and planning for new satellite instruments. The special challenges and opportunities described by the CRAD include developing improved methodologies for assimilating satellite data into global atmospheric models. In particular, the rate at which existing volumes of data are utilized by global models of the atmosphere does not keep pace with the generation of these volumes of data (i.e., a smaller fraction of data over time is being effectively utilized by global models of the atmosphere). The problem may grow given that much more data intensive, higher output multispectral/ hyperspectral instruments are being planned or developed for the near and far future.

The CRAD is encouraged and excited about the progress being made to develop a joint NOAA/NASA Center for data assimilation in which the ORA will play a major role. The thinking communicated suggests that the proposed Center should assist in meeting the challenges and goals delineated by CRAD. The Division also recognizes the special challenges associated with the growing climate monitoring and trends assessment thrusts of NOAA including the opportunities and challenges accompanying the National Polar Orbiting Environmental Satellite Series (NPOESS). Because NPOESS is a multi-agency (NOAA, DOD/Air Force/NASA) organization requiring new collaborations and interactions, organizational challenges are anticipated; however, the benefits to science of these partnerships are far-reaching.

The **Atmospheric Research and Applications Division (ARAD)** described its focus on the use of satellite data in support of the strategic goal of NOAA to perform environmental monitoring and prediction. The Division primarily targets applied research and technology transfer in support of this goal. This involves developing new techniques and products, transferring the technology to the user community through effective applications efforts, and from those efforts also assisting in the definition of improved future satellite instrumentation and operations. The priorities and requirements identified, given the existence of the Internet/World Wide Web, included performance of rapid prototyping and evaluation of products and developing new methodologies to perform technology transfer through web-based products. These efforts are directed toward maximum utilization of satellite data and products through better training and education of the User Community. The efforts of the ARAD also strive to better utilize new data from non-NOAA (e.g., NASA and international satellite programs) satellite data sources.

The **Oceanic Research and Applications Division (ORAD)** described how its personnel seek to effectively develop and apply satellite data for coastal and ocean applications. Major activities include involvement in and support of the Coastwatch program and demonstrating the use of ocean surface winds, topography, sea surface temperature, rainfall, ice cover, ocean biology/chlorophyll estimates, etc., as determined from satellite data. The ORAD seeks to prepare for the future by assessing initiatives that include the NPOESS, an "Ocean Observer" satellite, a U. S. Synthetic Aperture Radar (SAR), and international efforts (e.g., EUMETSAT, ESA, and ventures with Japan, China, India, etc.) for coastal and ocean monitoring and attendant applications. A key element to the advancement of these activities is the proposed Cooperative Institute for Ocean Remote Sensing. This Institute would serve to further strengthen the partnership between NESDIS and the university research community. The ORAD is focused on strengthening the emerging coastal constituency and developing a leadership reputation for such efforts. The organizational goal is to be effective in facilitating the transfer of knowledge from a research status to an operational status of initiatives that include active microwave determination of ocean surface winds, satellite altimetry over oceans, observations of ocean color, synthetic aperture radar (SAR), sea surface temperature and the assimilation of satellite data for use in ocean models.

## EXTERNAL SCIENCE TEAM (EST) REVIEW

This report summarizes the science review of the ORA by the External Science Team (EST)) and is organized into five sections. The sections are (1) strategic, operational and tactical planning; (2) science priorities; (3) partnerships; (4) technology transfer; and (5) capacity building, education and diversity. Incorporated into each section are aspects of the framework for science reviews as suggested by the NOAA Science Advisory Board.

### Strategic, Operational and Tactical Planning

**Strategic Planning** During its review, the EST found an organization displaying considerable vitality and accomplishment. Overall the efforts within each of the divisions of the ORA appeared focused on their specific mission, objectives and purpose, which were aligned with and cognizant of the goals and objectives of NESDIS and NOAA. These efforts were organized to create a

complementary and mutually supportive research environment across ORA divisions. The ORA has developed what appears to be regarded by NESDIS and NOAA as a very valuable service to them and to the external science community. Currently, formalized approaches are not in place within the ORA to obtain information regarding the value-added by ORA science to the internal/external community. **Recommendation:** It is recommended that the ORA define and implement approaches to document the value-added by ORA science to the internal/external user community.

Minimal evidence was presented to the EST regarding customer input, customer satisfaction and the use of this information. **Recommendation:** A strategic plan for the ORA is needed which incorporates customer input. This plan will not only serve as an important element in the ORA roadmap to the future, it will further serve to integrate the vision, mission and objectives of the ORA with other divisions within NESDIS and NOAA. This integration is needed to maximize the contributions of the ORA to the broader community of internal and external stakeholders.

**Recommendation:** The EST recommends that the ORA work more closely with the management of NOAA, other elements of NOAA (e.g. the National Weather Service), and NASA to provide a stronger emphasis on the development of improved systems and observations from geostationary orbit. Enhanced collaborations with NASA regarding such efforts are encouraged.

**Operational Planning** The description of the process of prioritization of product development by the ORA was sketchy and there seemed to be confusion as to who had control of the decision making in this regard. In addition, there were instances where product requests had been on "lists" for several years with no apparent action or strategy to address these requests. **Recommendation:** The EST is of the view that a stronger effort needs to be made to ensure that product development is connected with the prime customers (who we expect to be within NOAA and in particular the NWS).

**Recommendation:** The EST believes that it would be wise and prudent for the ORA to develop metrics that permit management to have a more quantitative view of its relative effort in the areas of development and transition, a view that can be communicated to others. Publications are a good measure of the scientific development activity but there did not seem to be any demonstrable measure of the value-added to other organizations by the transition and operational product activities. **Recommendation:** It is recommended that ORA routinely survey organizations internal and external to NOAA to determine the value-added to the activities of their organizations by the ORA transition and operational product activities.

The ORA has clearly adopted internet-based communications, which can, and do, lead to greater efficiencies both in the delivery and assimilation of data. However, there is the risk that focusing on the immediacy of web-based demands will compromise the longer-term organizational vision. **Recommendation:** It is important that management foster a view towards distant research horizons and not allow pre-occupation with instant results for the web pages to dominate the agenda.

**Tactical Planning** While the mission and objectives of the ORA are clearly stated, they are very broad. The reality of finite human, fiscal and operational resources necessitates that the ORA have a plan that aligns its research, development and applications activities with the constraints of the

resources available. The ORA is in a situation in which approximately 50% of its budget is base and the remainder derives from other internal and external programs. The existing match between base funding from NOAA and expenditure for salaries is an unhealthy situation as it gives managers very little flexibility, particularly in initiating new projects. Clearly this is a situation that is ripe for mission drift. The Director was adamant in his position that he controls mission drift and that this was not an issue. However, in discussions with some members of the staff, work was being performed for non-NOAA agencies that did not connect at all with the NOAA strategic directions. **Recommendation:** The ORA must distinguish between work that is relevant and work that is a priority. Given that part of the ORA mission is the validation of satellite products, it is unfortunate that ORA scientists must seek external funding for needed instrumentation and to support field programs. Does NOAA/NESDIS/ORA consider the inherent, if not the immediately apparent costs of obtaining external funds? The constraints of inadequate base funds warrant vigilance by the ORA to avoid mission drift and to prioritize its objectives.

To accomplish the ORA objectives, as described during the review, warrants an increased budget for the ORA. The EST would support such an augmentation given the importance and logic of the directions noted above. However, in the face of budget constraints throughout NOAA, and even the entire federal government, at minimal, sustaining the existing budget is mandatory. Given the possibility of flat or declining budgets, and even in the case of an increased budget, the importance of partnering, working and collaborating with other agencies (e.g., NASA, DOE, etc.) cannot be overemphasized. Budget constraints further highlight the need for the clear prioritization of work within the ORA.

The wide range of scientific activities described throughout the review suggests that each division is spread thinly, i.e., too much breadth without adequate depth. This means that the continuity of research efforts is dependent upon staff turnover. **Recommendation:** It is recommended that the ORA determine an optimal breadth of research as part of its strategic planning process.

An ORA operational planning process (OPTORA – Operating Plans and Tasks for ORA) has been initiated which has the promise of providing the guidance needed by the ORA to prioritize work and to ensure that this work is used by other areas within NESDIS and NOAA to make informed decisions regarding operational and data needs. **Recommendation:** The EST applauds the institution of the OPTORA process and recommends that the ORA strategic plans and operational tasks are aligned with the ORA and NESDIS budgets and that all are used to prioritize the work of ORA.

The EST, in evaluating the ORA presentations and reports, recognizes that the ORA has a special set of challenges associated with new instruments being planned for the future and the attendant complexity and volume of observations from these instruments. The data will be complex albeit the clear advantage and utility of the data are assured, therefore, the challenges of developing the applications and performing the technology transfer to NOAA, other agencies, and the science community are real and very large. In particular, the challenges inherent in the acquisition and exploitation of new information technologies (computers, data storage, communications and networks, the use of the internet, etc.) and the staging of transitions from old to new technology are formidable. It was clear that the entire staff of the ORA recognized these challenges and envisions the use of collaborations and partnerships to move in appropriate directions. The pathway to

allocating or obtaining the resources to do this, however, remains worrisome and a bit "murky". **Recommendation:** Given the very necessity and worthiness of addressing the advent of new instruments and their ensuing data sets, obtaining the necessary resources and recruiting, retaining, and rewarding the requisite personnel, the EST recommends that NESDIS and NOAA management should be cognizant of the resource needs and support the ORA insofar as possible.

## Science Priorities

The growing climate emphasis in NOAA, which the EST supports strongly, suggests that the ORA should plan and encourage stronger and deeper efforts in calibration and validation of satellite data for climate purposes. As new sensors become operational, their attendant data require careful characterization of the sensor performance including the calibration of the instruments and attendant error budget analyses relative to requirements, etc. **Recommendation**: The EST recommends that the ORA plan and strengthen its efforts in the calibration and validation of satellite data for climate purposes. This effort not only should involve joint efforts with NASA and the Department of Defense (DOD), but also with academia, particularly the inclusion of graduate students and faculty. These types of efforts are very good for the training of students and the acquisition of an appropriate depth of understanding of how satellite instruments perform and how their measurements can be applied.

The ORA and the ORAD are correctly planning and vectoring their efforts to include more emphasis on oceanography. Given the important role of the oceans in weather and climate, this is a necessary and laudable direction for the future and the EST supports that emphasis. However, again the specifics of how this emphasis will be developed were not displayed in detail and, perhaps, it is premature or not possible to do so. **Recommendation:** The EST supports the ORA in its efforts to engage in a more deliberate ocean and coastal remote sensing direction and recommends that the OPTORA process be applied to the ocean efforts and that NESDIS and NOAA subsequently encourage and support this as deemed appropriate and possible. The approach employed by the ORAD to identify the needs of the "customer base" as guidance to selecting tasks within the NOAA guidelines is key to the success of this effort.

The primary mission of NOAA/NESDIS/ORA is one of stewardship of the environment; however, only anecdotal information was provided to the EST throughout the review regarding the societal impact/benefits of the ORA research underway. **Recommendation:** The EST recommends that the ORA and its divisions include in its planning and programs explicit social science objectives and associated research. Social science research is needed to clearly demonstrate the value-added of satellite data and products to the public-at-large. Congressional budgets are increased and decreased because of the strength of such arguments.

## Partnerships

The future of ORA is likely going to be somewhat different from its past in that convergence of intellectual and operational capital is taking place among producers of satellite data. **Recommendation:** The ORA will need to be much more sensitive to its potential customers and to form new partnerships with research and development laboratories that are external to its existing base of partners. Clearly, senior management recognizes this imperative with respect to the use of

satellite data in Numerical Weather Prediction (NWP), however, strong partnerships must be established with other application domains.

The ORA explicitly indicates that one of the keys to their future effectiveness is the use of the Cooperative Institutes. **Recommendation:** The EST also views the use of cooperative institutes as an effective strategy to advance the work of the ORA and supports the addition of more oceanographic efforts in these Institutes and the addition of a new Cooperative Institute for Ocean Remote Sensing as proposed by ORAD during this review.

The ORA has a vision of expanded collaboration with others but it appeared to the EST that the vision was limited to the Cooperative Institutes that ORA has or will create. Centers/Cooperative Institutes at various universities (e.g., Wisconsin and Colorado) provide valuable collaborations with academia. These collaborations foster new ideas and heighten the probability and success of educating and motivating scientists who can complement and extend the existing and future base of research and applied scientists within ORA. Currently, there are three (3) existing cooperative institutes with a fourth proposed. **Recommendation:** It is recommended that a broader outreach be established to engage the inventiveness and energy and resources of universities other than those represented by the Cooperative Institutes and of other agencies that have interests similar to ORA. The ORA recognizes that continuing to foster close alliances with academic/research/development groups will maximize future development.

The ORA is presently housed in a building that is not compatible with, nor constructed to be efficient or effective for use in a high technology, data intensive, networked environment as required by the strategic vision of the ORA. The EST, in particular, believes that adequate facilities are highly important from a strategic planning point-of-view. The recruitment and retention of highly trained and motivated personnel is aided by a state-of-the-art facility. Positioning such facilities near or on a university campus may represent the more cost-effective mechanism to ensure the availability of the needed workforce of the future. It is true that communications technologies can facilitate more distant connections than in the past, but because of the importance of student involvement and training, it is suggested that the ORA would be significantly more effective in meeting its needs, goals, and priorities if the close associations attendant with being near or on a college campus were captured. **Recommendation:** The EST clearly notes that the existing infrastructure is a major challenge as it relates to the effectiveness of the ORA and encourages the ORA, working with the management of the NESDIS and NOAA, to be alert to opportunities to obtain housing facilities that adequately allow the mission, intent, and purpose of the ORA to be sustained as described in previous sections.

**Recommendation:** It is imperative that close relations be maintained between the NWP model development group of the National Center for Environmental Prediction (NCEP) and ORA if the goal of improving the use of satellite data in NWP models is to be realized. In addition, if ORA and NCEP were collocated with NASA and university associates, then their synergy would most probably result in significant payoffs.

## Technology Transfer

The leadership of the ORA by the Director, Dr. James F. W. Purdom, is commendable and deliberate in demonstrating a sense a vision and purpose to the organization. The EST found that quality research was being performed and significant effort aimed towards addressing the needs of a broad customer base. There is anecdotal evidence that suggests that the ORA has made continual, substantive efforts in strengthening its overall science output. Much less in evidence were new products designed to enhance the tangible outputs that can result from the use of satellite data. **Recommendation:** The EST must re-emphasize the ORA's unique and important role as a transition laboratory and that it must be more deliberate in its work to maintain a healthy balance between development and transitions. Other NOAA laboratories have budgetary lines that clearly define the relative effort between development and transitions, the ORA does not.

The ORA has clearly adopted internet-based communications, which can, and do, lead to greater efficiencies both in the delivery and assimilation of data. However, there is the risk that focusing on the immediacy of web-based demands will compromise the longer-term organizational vision. **Recommendation:** It is important that management foster a view towards distant research horizons and not allow pre-occupation with instant results for the web pages to dominate the agenda.

## Capacity Building, Education, and Diversity

The recruitment of personnel through Cooperative Institutes and other venues is very important and needed to obtain the scientific talent required to analyze and exploit the new data sources on the horizon, and assimilate these data into coupled numerical models of the atmosphere, ocean and land processes. **Recommendation:** The ORA, NESDIS, and NOAA should explore new approaches to attract, educate, retain, and reward personnel that have the talents and potential needed to advance their goals. Special emphasis within that broad objective should be placed on identifying, encouraging, and recruiting underrepresented minorities.

Programs should exist within the ORA to educate, encourage and promote minorities and women into management. The statistics provided to the EST by the ORA management on the status of women and minorities within the organization were not representative of an organization that encourages diversity. **Recommendation:** It is recommended that the statistics regarding the status of women and minorities within ORA be reviewed by NESDIS and, in turn, NESDIS should formulate a plan to address diversity. The importance and attractiveness of the NOAA mission and the attendant contributions that a properly trained individual can provide for the benefit of mankind should be emphasized within this plan.

The management of ORA recognizes the need to increase the visibility of its research as a strategy to achieve increases in funding from NESDIS and NOAA. **Recommendation:** The EST applauds the recognition given to ORA researchers for their outstanding achievements. The EST believes that the ORA should continue to promote and encourage individuals and groups to seek NOAA-wide and other special awards in recognition of their outstanding achievements. This is a sound approach to increasing NESDIS/ORA visibility to the internal and external community.

## SUMMARY

The EST has found the ORA to be a vital and productive organization that contributes well and is a valuable source of accomplishments and contributions to the NOAA/NESDIS and the entire Earth science and applications communities. The staff is motivated, productive, and responsive to the mission and goals of NOAA and NESDIS. The ongoing endeavors reflect good efforts that respond to customer needs and further reflect substantial investments in planning for the future. The management is to be praised for fostering an environment where vigorous activity is clearly taking place.

There are challenges and needs for the future, which include responding to opportunities such as the data-rich, highly multispectral or hyperspectral instruments being developed or planned for the future. These efforts require careful planning and allocation of resources (dollars, personnel, infrastructure, and equipment). The EST sees explicit recognition of these challenges by the ORA personnel, but more definition of the roadmap to that future needs to be developed. The ORA collaborations with academia in the form of existing and planned cooperative institutes (e.g., an institute devoted to or increasingly emphasizing oceanography) are key to the future of ORA and should be encouraged. The cooperative institutes also provide a venue of training of new personnel that will contribute to the NOAA/NESDIS/ORA missions and goals and the identification, recruitment and promotion of properly trained individuals for the future including underrepresented minorities and women. The budget of the ORA ideally should be increased given the essential and leveraging role that the ORA provide in the NOAA/NESDIS organization.

Special challenges have been identified by the EST including the advocacy and development of increased observational capabilities from geosynchronous orbit that may involve a better "balance" between the scope of geosynchronous (GEO) activities versus low, earth-orbit (LEO) activities in NOAA; the need for a strategy to ensure the existence of the needed scientific capacity and a more diverse workforce; and, increased efforts in examining the social science drivers and implications of ORA research. The correct and important emphasis on climate monitoring and assessment in NOAA indicates careful attention and allocations of resources should be directed towards the characterization, calibration and error budget analyses relative to satellite data requirements and applications. The infrastructure needs of the ORA include obtaining information technologies and a facility that is compatible with the information technology environment. The EST strongly suggests building facilities that engender strong collaborations with academia by being located on or near a university campus.

The future of the ORA appears bright, and the challenges stimulating though formidable. The EST is pleased to have had the opportunity to review the ORA efforts and considers it an opportunity that has benefited all the participants of the EST.

October 15, 2002

MEMORANDUM FOR: Gregory W. Withee
Assistant Administrator, NESDIS

FROM: Marie Colton
Director, ORA

SUBJECT: Response for the Science Advisory Board regarding ORA External Science Review Report follow-up

The NESDIS Office of Research and Application would like to thank the External Science Team (EST) Panelists from the NOAA Science Advisory Board (SAB) for their thorough review held September 14-15, 2000. We appreciated the opportunity to discuss NESDIS science and applications with the group and to get suggestions and recommendations on how to improve our programs.

We will take this opportunity to demonstrate how we have responded to the EST suggestions over the past two years. For convenience, each recommendation in the EST reporth has been numbered sequentially (see numbered copy) and used in our response. Following the report outline, our response is organized in five sections: 1) Strategic, Operational and Tactical Planning; 2) Science Priorities; 3) Partnerships; 4) Technology Transfer; and 5) Capacity Building, Education and Diversity.

## 1. Strategic, Operational and Tactical Planning

### A Strategic Planning

*a) EST Recommendations*

*Recommendation #2*: A strategic plan for the ORA is needed which incorporates customer input. This plan will not only serve as an important element in the ORA roadmap to the future, it will further serve to integrate the vision, mission and objectives of the ORA with other divisions within NESDIS and NOAA. This integration is needed to maximize the contributions of the ORA to the broader community of internal and external stakeholders.

*Recommendation #7*: It is important that management foster a view to distant research horizons and not allow pre-occupation with instant results for the web pages to dominate the agenda.

*Recommendation #8*: The ORA must distinguish between work that is relevant and work that is a priority. Given that part of the ORA mission is the validation of satellite products, it is unfortunate that ORA scientists

must seek external funding for needed instrumentation and to support field programs. Does NOAA/NESDIS/ORA consider the inherent, if not the immediately apparent costs of obtaining external funds? The constraints of inadequate base funds warrant vigilance by the ORA to avoid mission drift and to prioritize its objectives.

*Recommendation #9*: It is recommended that the ORA determine an optimal breadth of research as part of its strategic planning process.

*b) ORA Interpretation*

ORA should continue to focus activity using the Operating Plans and Tasks for ORA (OPTORA) process, taking into account the concerns expressed by the SAB. In instituting the OPTORA process, ORA should develop a "roadmap" that links emerging and required remote sensing science, future instruments, and user requirements into a consolidated view for the future. Input should be obtained from other NESDIS and NOAA offices and reviewed by our customers. The vision should be cognizant of relevance, mission priorities, and resources such that substantive progress can be made in relevant scientific areas that can be adequately supported, and irresolvable goals identified.

c) *ORA Actions*

Over the past two years and most recently with the Program Review instituted by the new NOAA administrator, NOAA as a whole and NESDIS have developed or are in the process of developing new strategic plans. From these plans, NESDIS has prepared a 5-year Implementation plan and each Office is linked to this plan by an Annual Management Contract, which identifies applications milestones to be completed each year. ORA has been contributing and participating in all these activities. Also because of the program review, NESDIS has been designated to work with other NOAA line Offices to establish NOAA-wide observational requirements. Results for NWS, NMFS and NOS are almost completed. This process will guide NOAA in its systems development and priorities which will lead to improved specifications for ORA in future program development.

## B Performance Measures

*a) EST Recommendations*

*Recommendation #1*: It is recommended that the ORA define and implement approaches to document the value-added by ORA science to the internal/external user community.

*Recommendation #5:* The EST believes that it would be wise and prudent for the ORA to develop metrics that permit management to have a more

quantitative view of its relative effort in the areas of development and transition, a view that can be communicated to others.

*Recommendation #6*: It is recommended that ORA routinely survey organizations internal and external to NOAA to determine the value-added to the activities of their organizations by the ORA transition and operational product activities.

*Recommendation #10*: The EST applauds the institution of the OPTORA process and recommends that the ORA strategic plans and operational tasks are aligned with the ORA and NESDIS budgets and that all are used to prioritize the work of ORA.

b) ***ORA Interpretation:*** ORA should better describe and promote understanding of the "business" of applications science by characterizing the investment costs and return rates for new products in terms of economic or other quantitative measures that can be used to explain, inform, justify, prioritize or focus new science investment.

c) ***ORA Actions***

In the NESDIS Annual Management Contracts mentioned above, offices are required to set milestones and report quarterly on their accomplishments in accordance with the Government Performance Review Act. ORA has accomplished all its goals for the past two years. Furthermore, because of the President's Management Agenda that requires performance measures to be instituted, NESDIS and ORA have received extensive training in specifying measures appropriate to desired outcomes of science programs. Recently, ORA management attended a three-day workshop on "Peformance Measures for R&D Organizations" which brought together all of the R&D branches of government agencies to address common approaches for measuring"user-inspired" science performance within federal science programs. ORA intends to adopt such a "values-oriented" framework to specify measures appropriate in each of the categories of long-term, sustaining, improved, and technologically innovative work.

ORA has participated in two GOES Users Conferences where users' requirement in terms of hardware, software, and products where discussed and where constituents where able to voice their needs. This is a very important source of feedback for the Office activities. Finally, a products review was conducted between NESDIS and the NWS, which reviewed nearly 400 satellites products for relevance and quality.

## 2. Science Priorities

### *a) EST Recommendations*

*Recommendation #3:* The EST recommends that the ORA work more closely with the management of NOAA, other elements of NOAA (e.g. the National Weather Service), and NASA to provide a stronger emphasis on the development of improved systems and observations from geostationary orbit. Enhanced collaborations with NASA regarding such efforts are encouraged.

*Recommendation #12*: The EST recommends that the ORA plan and strengthen its efforts in the calibration and validation of satellite data for climate purposes. This effort not only should involve joint efforts with NASA and the Department of Defense (DOD), but also with academia, particularly the inclusion of graduate students and faculty. These types of efforts are very good for the training of students and the acquisition of an appropriate depth of understanding of how satellite instruments perform and how their measurements can be applied.

*Recommendation #13*: The EST supports the ORA in its efforts to engage in a more deliberate ocean and coastal remote sensing direction and recommends that the OPTORA process be applied to the ocean efforts and that NESDIS and NOAA subsequently encourage and support this as deemed appropriate and possible. The approach employed by the ORAD to identify the needs of the "customer base" as guidance to selecting tasks within the NOAA guidelines is key to the success of this effort.

*Recommendation #14:* The EST encourages the ORA and its divisions to include in its planning and programs explicit social science objectives and associated research.

b) ***ORA Interpretation:***

The National Polar-orbiting Environmental Satellite System (NPOESS) has established a risk-reduction effort called NPOESS Preparatory Program (NPP) with NASA and other elements of NOAA to launch and evaluate new sensors on experimental polar satellites prior to their implementation on NPOESS operational platforms. The recommendation seems to suggest that ORA should explore a geostationary counterpart to NPP, a "GPP", within the NESDIS, NASA, and GOES user community. The opportunity afforded by NASA's GIFTS program should be fully exploited, with full encouragement and support by NESDIS and NOAA management.

Special attention should be given to delivery of well-calibrated satellite data via calibration/validation efforts that include ORA working with other instrument and remote sensing specialists, as well as academia. Satellite data from instruments with known characteristics are essential to both basic algorithm performance and the development of long-term climate records.

Long term coordinated programs with other satellite data providers and users should be developed with the support of NESDIS management ORA initiatives to mainstream satellite oceanography and coastal remote sensing are timely and relevant, and should be encouraged and supported by NESDIS.

ORA should include relevant social science objectives in its research portfolio. Since social science is not its primary mission, ORA should at the least address how satellite data can be provided to users so that the data are amenable to social science studies. ORA should then engage in collaborative research partnerships with social scientists. The outcomes of such studies would also help ORA quantify the value of satellite data and products as well as support societal research. ORA should support and exploit social science aspects being undertaken by programs with which it is involved, such as USWRP.

c) ***ORA Actions***

In 2002, the NASA/NOAA Joint Center for Satellite Data Assimilation (JCSDA) was created. This center physically co-located employees from NESDIS/ORA, NWS/NCEP, NASA and DOD and is exploiting satellite data for improving weather prediction. Data assimilation from advanced sounders such as GIFTS is a science priority and is currently being studied using the NASA Advanced IR Sounder (AIRS). Launched in May, 2002, these data are already being used in parallel-runs at NCEP and other major weather centers, marking a record time for research data to reach the operational centers. With respect to GIFTS, a product and application development plan has been developed and approved that outlines NOAA participation in this geostationary "risk-reduction" effort.

Long-term data analyses, calibration and validation of operational and research systems has taken on special importance in the intervening two years since the SAB review. Attention on "climate services" has resulted in major participation in "climate observational systems" panels, the CEOS Working Group on calibration and validation, a review and formal response to the NRC study on long-term satellite data, establishment of formal science teams between ORA and our sister organization, the National Climatic Data Center, direct connections with NCEP Climate Prediction Center, and the NPOESS Preparatory Program, which has the charter of defining operational "Climate Data Records". ORA's role is to maintain in-depth knowledge of instruments and their pre-launch and post-launch characteristics to ultimately reduce system errors that contribute to the overall variance in the climate signals deduced from satellite data. Further, we are working to identify the highest priority data that should be reprocessed for climate, especially to include the AVHRR and microwave data.

In order to reinforce the Oceanography side of its activities, ORA will award a new Cooperative Institute for Satellite Ocean Oceanography in the first quarter, FY03. This is the first competitively awarded NOAA Cooperative Institute and marks a milestone for "satellite oceanography" by formally recognizing remote sensing as a specialty within a major oceanographic academic institute. Within ORA, we have a new ocean division chief who is enthusiastically leading the charge to "operationalize" satellite oceanography. He has formed inter-office and agency science teams around each of the major observables (sea temperature, color, wind, ice, and height) in order to produce a suite of validated products for input into forecast systems and use by coastal managers for real-time applications.

The inclusion of social sciences is done through the Cooperative Institutes and in particular will be an essential part of the Coop Inst for Climate Studies (CICS) at the Univ. of Maryland through the collaboration of ORA scientists with the geography and social science departments. In addition, ORA recently acquired GIS technology and is hiring a contractor to establish and teach the connections between space and demographic data so that ORA researchers can learn to prepare science products that are of relevance and utility to social scientists. Finally, all of our major appropriated programs have been organized around five essential elements: Internal (directed) research, External (competitive) research, education, outreach, and infrastructure. Collaborative work in social sciences will be achieved through the external and outreach components of these programs.

## 3. Partnerships

### *a) EST Recommendations*

*Recommendation 15*: The ORA will need to be much more sensitive to its potential customers and to form new partnerships with research and development laboratories that are external to its existing base of partners. Clearly, senior management recognizes this imperative with respect to the use of satellite data in Numerical Weather Prediction (NWP); however, strong partnerships must be established with other application domains.

*Recommendation #16*: The EST also views the use of cooperative institutes as an effective strategy to advance the work of the ORA and supports the addition of more oceanographic efforts in these Institutes and the addition of a new Cooperative Institute for Ocean Remote Sensing as proposed by ORAD during this review.

*Recommendation #17*: It is recommended that a broader outreach be established to engage the inventiveness and energy and resources of

universities other than those represented by the Cooperative Institutes and of other agencies that have interests similar to ORA.

*Recommendation #19*: It is imperative that close relations be maintained between the NWP model development group of the National Center for Environmental Prediction (NCEP) and ORA if the goal of improving the use of satellite data in NWP models is to be realized. In addition, if ORA and NCEP were collocated with NASA and university associates, then their synergy would most probably result in significant payoffs.

c) *ORA Interpretation:* ORA research and development activities and data products have value to an increasingly large audience. ORA must partner with a global network of informed users and developers, as well as the R&D components of other satellite operators, to achieve full utilization of our data, to increase our understanding of user needs, to identify critical, new science issues, and to leverage our own and external talent.

d) ***ORA Actions***

ORA by the creation of Joint Centers and Cooperative Institutes, has successfully collaborated with other parts of NOAA, the Federal Government and Academia. ORA is committed to maintain and expand these collaborations. ORA also has public announcements of opportunity via its appropriated programs in which work of other academic institutions is solicited.

In addition, with the creation of the Coastal Remote Sensing Program established in close collaboration with NOAA/NOS, ORA is reaching out to state and local agencies as well as the private sector.

ORA has a strong program for Post-doctoral Fellows and Visiting Scientists that brings both new ideas and potential new employees.

The Office recently received NESDIS' approval to reorganize into divisions that will facilitate partnerships and explicit connections to strategic areas: satellite climatology and meteorology, satellite oceanography, and Cooperative Research Programs, which manages all of the cooperative institutes in a division for better coordination of research and activities.

## 4. Technology Transfer

***a) EST Recommendations***

*Recommendation #4*: The EST is of the view that a stronger effort needs to be made to ensure that product development is connected with the prime customers (who we expect to be within NOAA and in particular the NWS).

*Recommendation #20*: The EST must re-emphasize the ORA's unique and important role as a transition laboratory and that it must be more deliberate in its work to maintain a healthy balance between development and transitions. Other NOAA laboratories have budgetary lines that clearly define the relative effort between development and transitions. The ORA does not.

*Recommendation #21*: It is important that management foster a view to distant research horizons and not allow pre-occupation with instant results for the web pages to dominate the agenda (identical to #7).

b) ***ORA Interpretation***

ORA occupies a critical, transition link between remote sensing science and the operational remote sensing services that NESDIS has the mission to provide. ORA scientists study and contribute to the scientific body of knowledge pertaining to remote sensing physics, but are distinct from pure academicians, in that they specialize in the application of that knowledge to solving current, real-world problems, which often exist in non-scientific constituencies. Those individuals who are successful in the bridging role between research and operations need appropriate levels of management support to initiate and follow transitions from the research domain all the way into an operational product. ORA must track and quantify its scientific success not only in conventional terms of publications and scientific reputations, but also in terms of the operational value of new services that ORA's scientific activities help bring on-line. Similarly, ORA, with its customers' involvement, should develop initiation, traceability, funding and quantifiable success measures pertinent to the successful implementation and appraisal of a new product. NESDIS should identify methods to support and reward successful, timely transitions.

c) ***ORA Action***

ORA is taking full advantage of the Mission Development Requirements list established for various NOAA Line Offices and is using those to guide the development of its programs. The Director is a member of the newly established NOAA Research Council that has the aim of developing a corporate science strategy and programmatic balance for NOAA.

ORA has been actively involved in an extensive analysis of the research-to-operations process at NESDIS, with an eye both to improving the timeliness of real-time product transitions and also using the process to address "climate"

and "archive" products. This work is being coordinated with the activities associated with the NOAA Program Review so as to incorporate as much of the new strategies, requirements, architecture, and science directions as possible.

ORA has also participated as an "expert witness" in two NRC studies on technology transfer of remotely sensed data into applications.

## 5. Capacity Building, Education and Diversity

*a) EST Recommendations*

*Recommendation #11*: Given the very necessity and worthiness of addressing the advent of new instruments and their ensuing data sets, obtaining the necessary resources and recruiting, retaining, and rewarding the requisite personnel, the EST recommends that NESDIS and NOAA management should be cognizant of the resource needs and support the ORA insofar as possible.

*Recommendation #18*: The EST clearly notes that the existing infrastructure is a major challenge as it relates to the effectiveness of the ORA and encourages the ORA, working with the management of the NESDIS and NOAA, to be alert to opportunities to obtain housing facilities that adequately allow the mission, intent, and purpose of the ORA to be sustained as described in previous sections.

*Recommendation #22*: The ORA, NESDIS, and NOAA should explore new approaches to attract, educate, retain, and reward personnel that have the talents and potential needed to advance their goals. Special emphasis within that broad objective should be placed on identifying, encouraging, and recruiting underrepresented minorities. Programs should exist within the ORA to educate, encourage and promote minorities and women into management. The statistics provided to the EST by the ORA management on the status of women and minorities within the organization were not representative of an organization that encourages diversity.

*Recommendation #23:* It is recommended that the statistics regarding the status of women and minorities within ORA be reviewed by NESDIS and, in turn, NESDIS should formulate a plan to address diversity. The importance and attractiveness of the NOAA mission and the attendant contributions that a properly trained individual can provide for the benefit of mankind should be emphasized within this plan.

*Recommendation #24:* The EST applauds the recognition given to ORA researchers for their outstanding achievements. The EST believes that the

ORA should continue to promote and encourage individuals and groups to seek NOAA-wide and other special awards in recognition of their outstanding achievements. This is a sound approach to increasing NESDIS/ORA visibility to the internal and external community.

*b) ORA Interpretation*

ORA's science mission can only be accomplished by employing the best human talent available. ORA's population demographics should be examined to determine how to take advantage of the diversity that the nation's scientific community offers in order to fully tap the available talent pool. The educational activities underway at ORA's Institutes and at MSIs should be encouraged and strongly supported by management. ORA must be more deliberate in its recruitment efforts to reach the widest possible candidate audience. Once the employees are at ORA, a continued supportive environment, with opportunity to grow and be recognized, as well as modern facilities are necessary to retain the special talent needed. It is recognized that the ORA needs to be housed in a superior science environment facility, and to that end ORA should act with other elements in NOAA to relocate to an up-to-date scientific environment.

*c) ORA Actions*

ORA was a full participant in the NOAA-wide SFA process and has identified several actions that should improve the quality of its workforce and quality of life for the workforce.

In addition, exploration of the relocation of ORA on the University of Maryland College Park Campus is being actively pursued. However, the construction of the building as well as the move is not expected before 2007-2009 and is subject to receiving adequate funding from Congress. Meanwhile, ORA is currently renovating all of its spaces within the World Weather Building to provide better use of space and windows, provide new furniture, and improve safety.

In 2001, under a new program, a Cooperative Institute for Remote Sensing Science and Technology was created at the City University of New York, New York Campus, with a consortium of five other minority serving institutes. This program has the express purpose of matriculating minority students in environmental sciences.