# 5. Technology Transfer
# 10-11-06

## A. How are research results from the Institute shared with NOAA as well as the broader scientific community?

This depends on the project and the nature of the collaboration. As an example, the collaboration between Richard Reynolds and Dudley Chelton resulted in an improvement to the standard "Reynolds SST" product that is disseminated by NCDC. The reprocessed data set (1985-present) will be made available by NCDC through its normal data distribution methods.

Other products that are new need to be transferred to a NOAA office. For oceanographic data sets, the most operational channel is the CoastWatch program and associated NOAA labs that archive data more permanently than CoastWatch. Our primary contact in this regard is the West Coast CoastWatch node in Monterey (Pacific Grove), California. The CoastWatch program does not usually archive research-quality data, being meant to serve more operational products. However, the West Coast CoastWatch node is co-located with the NOAA/NMFS Environmental Research Division Laboratory (ERD), which has a mandate to archive and analyze long time series for relation to fisheries time series. Thus, Dave Foley works within both the operational CoastWatch system and the archival ERD lab. The division between operational (and short-lived) data sets and archival data sets is a problem that NOAA needs to address, with a systematic reprocessing of satellite data that will convert operational data into climate data records.

As an example of a new product that is being transitioned to CoastWatch/ERD, the graphical windrose wind climatology of Chelton and Risien is being transferred to David Foley at the Monterey CoastWatch/ERD site. This climatology is also served from a CIOSS web site. At CoastWatch/ERD, the product is not simply taken from CIOSS. It is reproduced, possibly with modifications determined by NOAA. This is because the code used at CIOSS is not necessarily "scalable" to the Monterey systems. The cumbersome nature of this transfer reflects the relatively immature state of oceanographic operational systems. A second form of the wind climatology is being developed by Chelton and Risien, in the form of a digital climatology (compared to the graphical format of the first product) that can be used to drive numerical models, analyzed for surface wind dynamics or subtracted from real-time fields to produce anomalies from the normal seasonal cycle.

In addition to the transfer of "products" to NOAA centers such as NCDC and CoastWatch, the normal method of scientific communication is the publication of results in peer-reviewed papers. Improvements to the Reynolds SST fields will be documented in a peer-reviewed paper, as will the wind climatologies of Chelton and Risien. The same is true of the results of the evaluations of WindSat OVW products (Freilich), surface radiation estimates (Coakley), etc.

## B. How are NOAA's research interests conveyed to the Cooperative Institute?

This is similar to the question covered in Section 3-B, the formal mechanisms for joint planning between NOAA and CIOSS. The answer is the list of mechanisms found there and modified somewhat below.

- Our annual review process for new and continuing projects supported by our annual core funding involves both a local review by the Council of Fellows and a review by our program manager and his colleagues in NOAA/NESDIS/STAR. Prior to the local review, the program manager has sometimes provided a prioritized set of topics for the annual omnibus proposal.
- There are periodic discussions between CIOSS personnel and NOAA managers at CI Directors' meetings and other meetings with more focused themes. Al Powell (NOAA/NESDIS/STAR) has initiated periodic conference calls with the NESDIS CI Directors to discuss future plans.
- Informal discussions between academic and NOAA CIOSS Fellows occur on a regular basis. These become more frequent as collaborations develop over time. For instance, there are presently more frequent discussions between Freilich and Chang; Chelton and Reynolds; Strub and Foley; etc. than before the existence of CIOSS. These type of interactions would be greatly enhanced if there were NOAA personnel physically present at CIOSS.
- Members of CIOSS participate on teams assembled by NOAA to plan specific types of activities, such as the "Research and Operations" teams. NASA Science Working Teams for ocean color, OVW and Ocean Surface Topography (OST) have also included NOAA team members and these teams have been a venue for NOAA personnel to make the needs of NOAA known.
- Within the GOES-R Risk Reduction program, NOAA holds annual meetings in which the various Risk Reduction efforts are presented and discussed. Suggestions from NOAA program managers for modifications to those efforts are made at that time.
- As described above, during Year-3, we held a joint meeting of four "working groups" (WGs) within CIOSS: COAST/Ecosystems, Dynamics, Ocean Vector Winds and Product Development. Our Program Manager (Eric Bayler) brought members of his staff to CIOSS and the working groups to discuss NOAA research interests and possible future projects. The Ecosystems WG is identical to the COAST project members. The Dynamics group includes the modelers and those using altimeter data for analysis of ocean dynamics. The Wind WG consists of the organizers of the OVW workshops from CIOSS and NOAA. The Product Development WG was lead by Strub and Dave Foley and discussed the kinds of products presently available through CoastWatch and products that the group thought could be developed that would be useful.
- The COAST project has held four workshops, during which it has made general plans for field studies off the West, East and Gulf Coasts (workshops 2 and 3) and specific plans for the field work off the West Coast (workshop 4).
- A number of CIOSS research scientists from Corvallis have visited NESDIS and NCEP in Camp Springs. Strub made an initial visit in March 2003 to discuss plans with Eric Bayler, at the very beginning of CIOSS activities. Strub, Chelton, Allen and Egbert visited during Year-2 to discuss the relation of satellite data and ocean modeling, both basin-scale and coastal. Chelton gave a seminar at NCEP at that time. Chelton made a

repeat visit, with another seminar, this time also meeting with John LeMarshall at the JCSDA. In Year-4 (September 2006), Jim Richman spent 10 days at NCEP and the JCSDA to establish further contacts with the modelers there (see the report for Miller and Richman in Section 4).

- The planned workshops on coastal modeling and on climate effects on California Current ecosystems will discuss plans for future projects. We have specifically invited Frank Aikman from NOS to present the NOAA plans for IOOS modeling efforts in the coastal ocean.

## C. What has been the most important research or development result that has been transferred to customers during the last four years?

There are a number of "product" improvements that could vie for the category of "most important" result, but most of those are still in development. The product that is most widely used, has been the most improved and is nearly ready for distribution, to date, is the Reynolds global SST analyses. The new versions of these fields have spatial resolution that is improved by an order of magnitude and temporal resolution improved from weekly to daily. The figure on the back cover of the Briefing Book makes this dramatic improvement clear. This product is not only valuable for the analyses it allows by itself; its improvement is amplified by its use as the bottom boundary condition for atmospheric models, both real-time forecasts and re-analyses. By extending the improvements back in time to 1985, it allows re-analyses of the atmospheric models to incorporate the improved spatial resolution and produce more realistic surface winds, which can be used to drive re-analyses of the ocean circulation. The long-range impacts of the improvements in this product are enormous.

Other products also have the potential for great impact. The graphical wind climatologies of Chelton and Risien were developed in consultation with the NOAA HazMat center in Seattle. They can only improve estimates of trajectories of oil spills and other surface materials that are based on climatologies. The digital climatology of the scatterometer winds will substitute for other wind climatologies used to drive ocean models. Improvements of the scatterometer climatologies will allow real-time estimates of wind anomalies, much more accurate than those from previous model or ship estimates of the climatological seasonal cycles in surface winds. These will improve in the future with the new, higher-resolution data sets that will be made available by the work of Freilich and Chang.

Looking to the future, the entire COAST project is designed to produce data sets from aircraft and in water optical measurements that will allow the development of algorithms for any future satellite color sensor. In the long run, the data collected by the COAST project may be the most revolutionary of the products produced by CIOSS.

Considering NOAA personnel to be the "customers", workshops and short courses for NOAA personnel represent a transfer of technology. These include the training for NWS forecasters in the use of satellite OVW products (Freilich), the short course in the use of satellite data for NOAA/NMFS personnel (Strub, Wilson and Foley), the OVW workshops that brought together both research and operational users of OVW products (Chang, Chelton and Freilich), etc. See Section 6 for a more complete list of these workshops, training exercises and short courses.

Eventually, efforts to develop coastal ocean model prediction systems will produce products (surface ocean velocity and wind fields) that will be critical to the IOOS system. Remote sensing

will never provide the continuous coverage of surface ocean conditions requested by State and Federal Resource managers. Only the combinations of remotely sensed and in situ data, along with data assimilating models, will give that coverage.

## D. What is planned for the next 1-2 years?

We expect the present, productive research and science outreach activities to continue into the fifth year of the present CIOSS funding. The Reynolds SST fields will become public, the wind climatologies will be available from both CIOSS and CoastWatch/ERD, the next COAST field experiments will take place off the East and Gulf Coasts, and training sessions will be continued for NWS and NMFS personnel. Funds for a second workshop on ocean color climate data records (CDRs) are also still in hand. Discussions on the exact format and subject material for that workshop are evolving and it is likely to combine a definition of the complete end-to-end ocean color CDR process with discussions for the MOBY-2 platform. The hope is to bring NASA and NOAA together and coordinate their future plans regarding CDRs and vicarious calibration of ocean color sensors. If CIOSS is extended for a second five-year period, the research directions of CIOSS will continue to evolve, in respond to both internal interests and capabilities and external programmatic directions. The directions that we expect CIOSS to move, in response to external pressures, are described at the end of Section 2. The CIOSS Council of Fellows will determine the priorities for new or continuing directions, given these considerations.