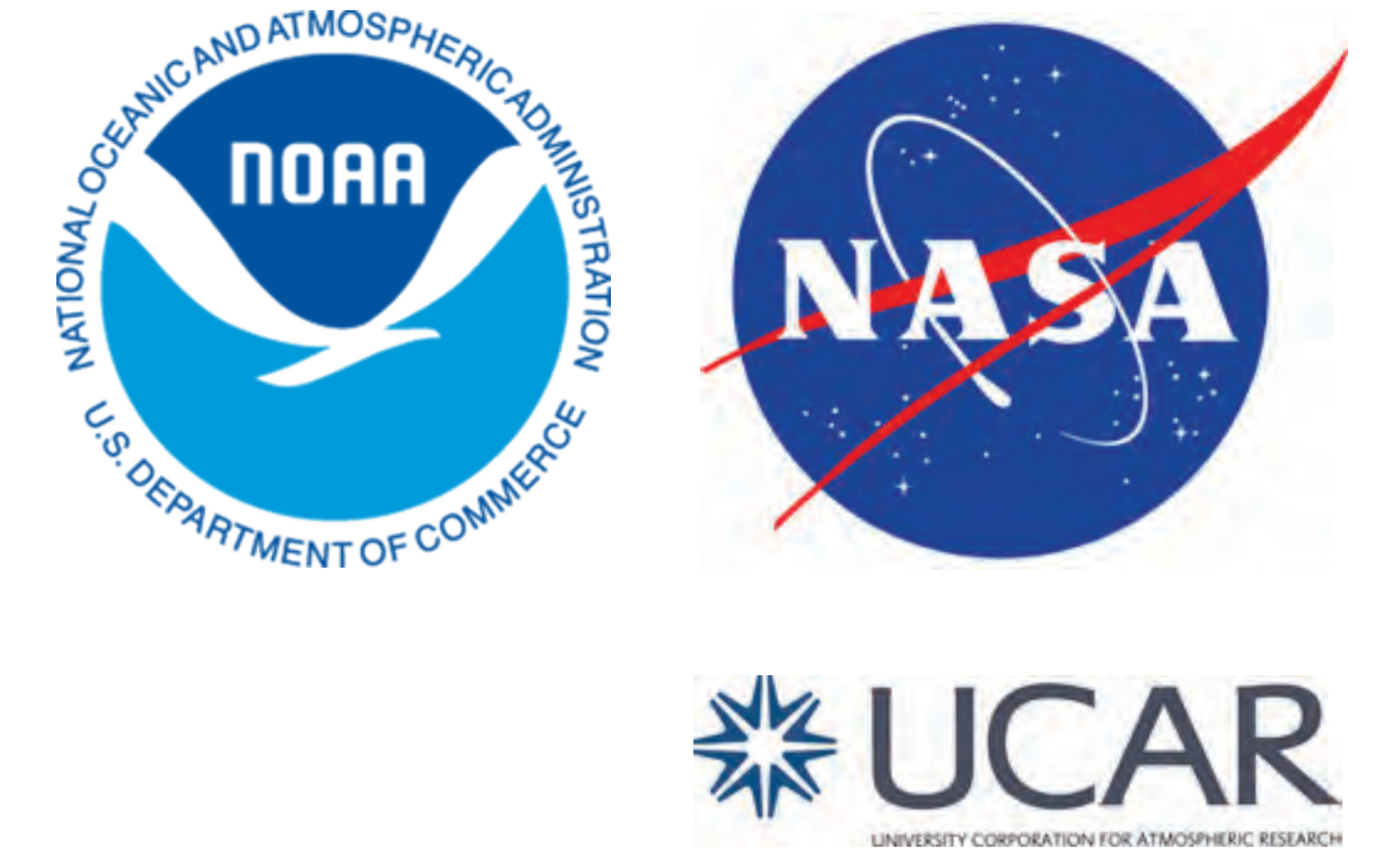




# Marine Training Workshop on the Use of Satellite Wind & Wave Products in South American Waters

May 14-19, 2012

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Hosted by the Center for Weather Forecasting and Climate Research (CPTEC), Brazilian Space Agency (INPE), Cachoeira Paulista, Brazil

**Issue.** Some National Meteorological Services (NMS) – NOAA, US Navy, UK Met Office, ECMWF, Météo-France, Australian Bureau of Meteorology and Japanese Meteorological Agency – routinely use satellite-derived Ocean Vector Wind (OVW) and Significant Wave Height (SWH) in operational marine analyses, warnings and forecasts. However, most NMS do not!

As specific examples, Bulgaria, Estonia, Greece, Iceland, Italy, Latvia, Slovenia, Turkey, Fiji, India, Mauritius, South Africa, and all of the countries in South America do not.

**Potential Importance.** We have had satellite scatterometers and altimeters flying since 1992, and two of the most easily understood satellite observations of the ocean surface are OVW and SWH. Given that two of the most important observations required in marine forecasting are OVW and SWH, one would think that their routine operational use would be wide spread, but that is not the case.

**Why is this?** In order to routinely use satellite OVW and SWH in operational forecasts, a forecaster needs to be able to answer four questions:

- (1) How do I know what OVW and SWH observations are available?
- (2) How do I access those observations?
- (3) How do I integrate OVW and SWH with complementary observations?
- (4) How do I use those (accessed and integrated) observations to improve operational analyses and forecasts?

Forecasters in most NMS cannot answer these four questions; they lack the supporting scientific and technical infrastructure enjoyed by the larger developed countries, most of which have a companion space agency and the support it provides both to an associated university community and the NMS.

- For (1), an operational forecaster needs to be aware of the multiple satellite scatterometers and altimeters that are currently flying, as well as the multiple procedures to access the data which themselves are in multiple formats.
- For (2), the forecaster needs timely access to data from each of those sources (typically within three hours of collection); the forecaster also needs timely access to complementary satellite imagery (clouds and SST), in-situ (ship, buoy, coastal stations) observations, and NWP output; no one route provides all data needed; access is via multiple routes, such as the Global Telecommunications System, direct satellite downlinks, EUMETCAST/GeoNetCast Americas, FTP, etc.
- For (3), the forecaster needs an analysis and display system to provide a capability to ingest and combine data from the various sources accessed via different routes; NOAA's system utilizes a version of GEMPAK known as AWIPS or N-AWIPS (soon to be upgraded to AWIPS-2); most NMS do not have an analysis and display system.
- For (4), the forecaster needs to understand the capabilities and limitations of satellite scatterometers and altimeters, as well as how and under what circumstances these data can be used to contribute to improved analyses and forecasts; this expertise is typically resident in an associated space agency or university community.

**Their Alternative?** Forecasters in operational centers where OVW and SWH are not used typically rely on FTP access to global NWP forecasts from centers such as NOAA/NCEP, U.S. Navy, and U.K. Met Office; they combine those forecasts with whatever observations are available from ships and coastal met stations and tailor them to their particular region of interest. What they are unable to do, however, is assess how accurate or inaccurate these NWP-based forecasts actually are.

**Marine Training Workshops.** NOAA and EUMETSAT have established a series of Training Workshops promoting the use of wind and wave products in marine forecasting and research. The first two were hosted by IOC/IODE in Oostende, Belgium with financial support from the Flanders Government. The third focused on South America and was hosted by INPE/CPTEC with financial support from NASA provided through UCAR.

#### Objectives of the Third Workshop.

Primary Objectives:

- To improve the use of satellite wind (scatterometer) and wave (altimeter) data products in marine forecast ing and research in South America
- This will be accomplished via:
  - An introduction to scatterometry and altimetry
  - Case studies drawn from South American waters utilizing actual satellite, in-situ and model data prod- ucts in the GEMPAK environment

Secondary Objectives:

- Introduction to the utilization of GEMPAK as an analysis and display tool to handle these data products
- Overview of how to access these products
- Introduction to INPE/CPTEC as a potential source of guidance and advice for South American colleagues following the Workshop

**Local Host for the Third Workshop.** Being focused on South America waters, a local host in South America was needed in order to maximize student participation by minimizing student travel costs. CPTEC was selected for a number of reasons.

- CPTEC is the leading weather forecast and climate center in South America; it is the only organization on that continent capable of running integrated atmospheric, oceanic and terrestrial models, and it has the latest model Cray supercomputer;
- CPTEC uses GEMPAK in its research and has a classroom equipped with 15 computers all running GEMPAK;
- CPTEC is developing a single-point-of-access to the multiple sources of satellite and in-situ data, as well as NWP output, needed for marine forecasting, and it is willing to serve this data stream to other South American NMS via FTP;
- CPTEC is willing to provide scientific and technical guidance and advice to those NMS that would like to adopt GEMPAK for use in their operational marine forecast centers, just as it has done so for the Brazilian Navy.

#### Instructors for the Third Workshop.

- Waldenio Almeida, INPE/CPTEC
- Rosio Camayo, INPE/CPTEC
- Paul Chang, NOAA/NESDIS
- Zorana Jelenak, NOAA/NESDIS
- Milton Kampel, INPE/HQ
- Jean-Michel Lefevre, Météo-France
- Stephane Lirola, Météo-France
- Cesar Mello, INPE/CPTEC
- Joe Sienkiewicz, NOAA/NWS
- Ad Stoffelen, KNMI

#### Workshop Organizers.

- Facilitators
  - Luiz Machado, INPE/HQ
  - Mark Higgins, EUMETSAT
  - Stan Wilson, UCAR
- Administrative/Logistical Support
  - Cacilda Aravequia, INPE/CPTEC
  - Meg Austin & Susan Baltuch, UCAR
  - Claudia Lucaccioni, INPE/CPTEC

**Students.** Both operational marine forecasters and associated researchers were invited to participate. 28 students from seven South American countries participated. These countries are Argentina, Brazil, Chile, Colombia, Ecuador, Peru, and Uruguay.

The operational marine forecast services in each of these countries were represented. About half of the students were operational forecasters and half were associated researchers. Researchers from two universities where complementary marine research programs exist – the Universidad de Concepcion and Universidad de Valparaiso, both in Chile – were represented. The other researchers were in-house scientific and technical support people.

With the exception of Argentina, operational marine forecasting in each of these countries is the responsibility of its Navy; moreover, operational marine forecasting is separate and distinct from forecasting in support of aviation (typically done by its Air Force) and forecasting in support of agriculture (typically done by a counterpart civilian organization). Argentina is the only country in South America that is actively working to integrate operational forecasting across the three sectors; it has recently combined the three previously separate organizations and placed the resulting organization under its Defense Department. While operational forecasting in Brazil is the responsibility of three (or more) separate organizations, CPTEC is the only organization that has integrated forecasting spanning these three sectors.

While there appear to be reasonably effective relationships between supportive academic departments in Universities and operational marine forecast centers in Argentina, Brazil and Chile, similar linkages do not appear to exist in the other four countries. While there are universities in these other countries, the civilians in the universities and the Navies have each tended to go their own way, with the result of no apparent collaboration.

**Student Feedback from the Third Workshop.** 23 of the 28 students responded to a questionnaire evaluating the Third Training Workshop. With the exception of one who apparently had difficulty with English (and with whom an English/Spanish translator was able to sit for most of the workshop), they all felt that the workshop met their objectives. Regarding what they might like to change, 7 operational forecasters said that they would like to have had more time working with GEMPAK on case studies; the others said that they liked the workshop as it was. Here are examples of responses to three key questions.

1. What is the most important thing you learned in the course?
  - 14 - How to use altimeter and scatterometer data with GEMPAK for improved forecasts
  - 12 - Understanding the capabilities and limitations of scatterometer and altimeter data
  - 5 - How to use those data to verify NWP model forecasts
2. What did you like most about this course?
  - 11 - Being able to display all data in a single tool, GEMPAK
  - 7 - Being able to meet and work with experts in remote sensing and marine forecasting
  - 6 - Being able to meet and work with our colleagues in different South American countries
  - 4 - Interest on the part of the instructors interacting with South American colleagues and discussing shared problems
  - 2 - Balanced mix of a theoretical view to understand the how the instruments work and their limitations, and a practical view to learn how to use all data together to make better decisions
3. What challenges will you face in using this data in your work?
  - 6 - Installing GEMPAK and accessing the required data in real time
  - 6 - Training colleagues back home in the use of altimeter and scatterometer data in GEMPAK
  - 4 - How to produce significantly improved forecasts and warnings on a routine basis by knowledgeable forecasters through the use of GEMPAK with timely access to the required data
  - 3 - How to convince the authorities of the potential improvements that can be made in marine forecasting, so that the resources can be made available to purchase the equipment required to host GEMPAK, as well as the associated IT (information technology) expertise to implement and maintain it
  - 2 - Firewall issues that concern the maintaining security, while at the same time providing operational forecast systems with timely access to high-bandwidth data from the internet

**Next Steps?** The three Training Workshops have helped develop the motivation for marine forecast centers to use satellite OVW and SWH to improve their operational forecasting. They have demonstrated how, and under what circumstances, OVW and SWH can be used to make significant improvements. This Third Workshop has taken an additional step. It is showing the South American marine forecast centers how they can help themselves; it is helping facilitate the implementation in interested centers of a capability to access, integrate and use OVW and SWH for improved forecasts. CPTEC will play a key role in this implementation; it has agreed to help the other countries in South America address challenges, as stated in the student feedback, by providing at no cost:

- A single-point-of-access via FTP to all observations and NWP output needed for marine forecasting,
- Assistance in how to install and use GEMPAK, and
- The scientific and technical guidance and advice to make the overall system play together.

This has the potential for each South American country to establish and maintain an improved capability for operational marine forecasting. And assuming that forecast centers adopt the same GEMPAK analysis and display system, they will be able to call on CPTEC for continued scientific and technical guidance and advice on an as-needed basis; additionally, they will also be more easily be able to share experiences with their neighbors and help each other.

**Why care?** We need to ensure that important satellite observations – like OVW and SWH with a demonstrated capability to improve services in support of the marine community – are made available and are easy to use by responsible operational organizations. In so doing, we will be able to maximize the potential advocacy base of users, who in turn can help justify continued support of expensive satellite programs in an increasingly competitive economic climate.

**Acknowledgments.** Funding for the organization of the Third Training Workshop, the travel and per diem for non-Brazilian students, and some instructor travel was provided by NASA through a grant to UCAR's Visiting Scientist Program. NOAA and EUMETSAT provided additional instructor travel support. INPE and the Brazilian Navy provided travel support for their own students. CPTEC served as the local host providing classroom space, IT support, and assistance with a myriad of local arrangements. All of this support is gratefully acknowledged.

