Proposed Splinter Sessions

- Regional and Global CAL/VAL for Assembling a Climate Data Record
- Precision Orbit Determination
- Instrument Processing
- Near Real Time Products and Applications and Multi-Mission, Multi-Sensor Observations
- Outreach, Education and Altimetric Data Services
- The Geoid, Mean Sea Surfaces and Mean Dynamic Topography
- Quantifying Errors and Uncertainties in Altimetry data
- Science Results from Satellite Altimetry

Regional and Global CAL/VAL for Assembling a Climate Data Record

Pascal Bonnefond, Shailen Desai, Bruce Haines, Eric Leuliette, Nicolas Picot

Determining the random and systematic errors in the fundamental instrument observations and in the Level-2 geophysical data products is a continuing process that involves participation of both the project teams and the OSTST investigators. The principal objectives of joint verification are to: 1) assess the performance of the measurement system, including the altimeter and orbit-determination subsystems; 2) improve ground and on-board processing; and 3) enable a seamless and accurate connection between the current (OSTM/Jason-2) and legacy (TOPEX/Poseidon and Jason-1) time series. To succeed in these objectives, the general approach is to pool the talents and resources of the project and science teams. Engaging the science team in the continuous CALVAL effort has been one of the hallmarks of success for the TOPEX/Poseidon and Jason altimeter programs. The CNES and NASA research announcements have consistently emphasized CALVAL, recognizing that the science investigators conducting research in some of the most demanding applications (e.g., mean sea level) are often positioned to offer the most innovative CALVAL solutions.

During the first 6 months of each new mission, an intensive verification effort is conducted by all members of the Verification Team in order to verify the integrity of the system—and to make adjustments where necessary—before starting the routine GDR production. However, the verification effort continues afterwards on a routine and permanent basis. These ongoing efforts are essential to ensure the integrity of the long-term climate record at the 1-mm/yr level.

CALVAL activities are conducted based on dedicated in-situ observations, statistics, cross comparisons between models, different algorithms and external satellite data. The studies go well beyond validation of the overarching error budget underlying the mission requirements. They focus in particular on the temporal and geographically correlated characteristics of the errors. Reduction of this class of errors is critical, since they are conspicuously damaging to estimates of ocean circulation and sea level.
Because of the usual huge number of contributions it has been decided to separate the CALVAL splinter into two parts and this should be maintained: Local calibration/validation

(focusing on bias) and Global calibration/validation (focusing on corrections quality assessment and error budget assessment)

Precision Orbit Determination

Luca Cerri, Frank Lemoine

Precision orbit determination underpins the accuracy and quality of the data for all altimeter missions.

With a twenty-year long altimeter record from three missions on the reference orbit (TOPEX/Poseidon, Jason-1 and Jason-2/OSTM) and from several others on lower orbits (ERS, Envisat, Cryosat, HY2A, Saral/AltiKa), the focus is now on the long term stability of the orbit solutions and on the impact of geographically correlated errors on both the global and regional Mean Sea Level estimates.

The most critical issues concern the stability of the reference frame for computing the orbits, the accuracy and fidelity of the force models that underpin the POD computations and the overall quality of the available tracking data.

The stability of the orbit in the North/South direction is estimated to be better than 1 mm/yr by comparison of orbits obtained using different tracking techniques and the ITRF2008 reference frame. Orbit quality is affected by the performance of the individual tracking systems (SLR, DORIS, GPS), and issues that are of a particular concern include the proper modeling of coordinates and biases for the SLR stations, the SAA effect on the Jason-1 DORIS receiver, and the performance of the GPS receiver on Jason-2 OSTM. While great strides have been made in the modeling of the static gravity and through other updates of the IERS standards, the fidelity with which time-variable gravity is modeled has emerged as an important limiting error source. Also, a precise orbit solution is the result of an estimation process involving some extent of arbitrariness in the parameterization: for instance, it is left to the POD analyst to decide how much weight should be given to tracking data with respect to dynamic models, and to one tracking technique with respect to the others. The comparison of different solutions obtained using a different parameterization (dynamic vs reduced dynamic) remains a fundamental tool to quantify the accuracy of the models and the tracking data on the long term. This type of comparison is typically achieved during the POD splinter, and raises issues that altimeter analysts should be aware of.

In addition, the accurate modeling of radiation-pressure related forces is essential to avoid the introduction of spurious beta-prime related signals into the orbits and thus into the long-term altimetric data records.

The POD splinter brings together POD specialists with altimetry users so that the two communities can interact. POD specialists gather during the splinter to discuss their latest results but they are also there to answer questions from the community. A well-known example is the MSL inconsistency between Envisat and Jason which was highlighted by the CalVal team in Lisbon and explained by the POD team with insufficient TVG models. Indeed, multi-satellites combinations are also a major interest to users, orbit error differences

between missions is thus a welcomed topic and has been addressed by the latest splinter meetings.

Instrument Processing

François Boy, Emilie Bronner, Shannon Brown, Phil Callahan, Robert Cullen, Estelle Obligis, Walter Smith

The Instrument Processing splinter addresses the key algorithms and processing steps that transform the raw instrument data from the altimeter system into science products with instrument calibrations. Because of the large interest in SAR processing, the Instrument Processing splinter has been given an extra session on Tuesday morning, so there will now be three. We will be taking a somewhat more structured approach to the splinter sessions this year in order to try to answer some of the key questions of SAR processing and the determination of spectral signatures in the observations. The Tuesday morning session will focus on SAR processing and the comparison of those results to conventional altimetry mode data. We will carefully review the abstracts and may ask some authors to adjust their presentations to have the most complete presentation and discussion.

Other topics of particular interest for altimeter processing are first results from SARAL/AltiKa and full understanding of the spectral "hump" noted last year as the SSH spectrum was pushed to the highest frequencies.

For radiometer studies, contributions on higher frequencies as recommended last year for Jason-CS and on spatial variability are of particular interest.

Other instrument processing issues will be discussed as time allows or will be asked to do a poster.

Particular issues discussed recently include:

1. Radiometer:

- High frequency radiometer studies: is there anything further following the recommendation from 2012 OSTST that a Jason-CS radiometer should operate at higher frequency?
- Any impacts of new J-CS drift requirement on processing?

2. Altimeter:

- Impacts of low SWH on:
    - Waveform aliasing and its magnitude
    - Impacts for conventional ("LRM" or pulse-width-limited echoes) on current and future missions
    - Impacts for SAR mode on current and future missions
- How should non-Brown echoes be handled in processing (LRM and SAR), for example, those returned over a so-called Sigma 0 bloom?
- Characterizing differences between LRM and SAR for retrieved geophysical parameters (range, SWH, backscatter).

- Sensitivity of SAR altimetry retrievals as a function of platform mispointing and associated uncertainties.
- Improvements to SAR processing algorithms such as multi-look stack weighting, etc.
- Surface characterization from SAR stack data
- Impacts of swell on SAR retrievals
- SSB differences between "LRM" and SAR.
- Improvement in algorithms for on-board tracking echo used in SAR mode of future instruments

Near Real Time Products and Applications and Multi-Mission, Multi-Sensor Observations

Emilie Bronner, Gregg Jacobs, John Lillibridge, Julia Figa Saldana

Near Real-Time Ocean Surface Topography products, and their incorporation into meteorology and oceanography forecast systems, have seen extensive development with the availability of NRT altimeter data, which includes sea surface height, wave height and wind speed. This session calls for abstracts that examine developments and future challenges at all the steps along this chain from the satellite sensor, through the computation of NRT products, and incorporation into numerical forecast models to the final delivery of forecast information.

Jason-2, CryoSat-2 and AltiKa are all providing data reliably and in near real time, although there is some degradation in data coverage and quality from the recent years. Each of these missions bring particular challenges to maintaining accuracy and precision for a wide range of applications. Quantitative examinations of data coverage and accuracy impact are invited to help define future requirements. Other data sets certainly have complementary roles, and we invite participants to show how these additional data sets extend the observations from the altimeter satellites. These include in situ observations such as from ARGO, WOCE drifters, TOGA/TAU and Pirata. Other existing and new satellite sensors provide additional information, from sea surface temperature, surface winds, to salinity from Aquarius.

Outreach, Education and Altimetric Data Services

Margaret Srinivasan, Vinca Rosmorduc

The international collaborations in outreach, education, and applications have celebrated over 20 years of cooperation over the multi-mission lifetimes. A fruitful partnership has developed, and includes participation by NASA, CNES, Eumetsat, NOAA, and ESA. Joint products and activities have been fostered, and continue to be developed. In this session we wish to share our collective story and ideas, and to involve the scientists in the process of reaching educational and general public audiences. Our outreach team, reflecting the international science collaborations we represent, see the Outreach session as our opportunity to collaborate with each other, share our respective and joint activities and outcomes, and to involve the scientists in the education and public outreach (EPO) process.

Our overarching goal is to enhance understanding in the general population and across scientific disciplines of the value of ocean science research and, ultimately, public funding of space agencies. In order to maximize the 'reach' of altimetry outreach, a closer collaboration with the science teams, scientists from other disciplines, and other outreach professionals is necessary. The Outreach session at our annual OSTST is a key steppingstone on the path to achieving this goal as we meet and interact with scientists in the time leading up to and during the meeting.

The 'Showcase' element of our Outreach session has become a popular forum for members of the OSTST to share their outreach activities. It also provides a means to demonstrate the breadth of outreach being done to the larger OSTST, and perhaps spur ideas for more participation by team members.

Altimetric Data Services is an important element of this splinter. It provides a way for exchanging information and linking projects and users together so users can benefit from the wide variety of altimetry-derived data available. Exchanges between science team members are highly valuable, as experiences and solutions are shared in this splinter.

For the 2013 OSTST meeting we will focus the relevance of altimetric science to climate issues, support of training new users on the use of altimetry data, sharing resources and outreach products with a wide audience (and in multiple languages), focus on existing and potential collaborations between data centers to better serve users, and addressing long-term data management scenarios outside of project funds (and within data centers).

The Geoid, Mean Sea Surfaces and Mean Dynamic Topography

Chairs: Ole B. Andersen, Marie-Helene Rio

Geoid / MSS / MDT are key products for referencing altimetry. The quality of the altimetric sea level products (Sea Level anomaly, Absolute Dynamic topography) and the derived ocean surface currents, directly depends on the quality of these surfaces. With the successful launch and availability of data from new satellites (Cryosat-2, AltiKa and Hy-2) both SAR and Ka-band altimetry are becoming available for updated geoid, MSS and MDT products. This is a challenge for operational oceanographic application having to investigate and ingest both new types of altimetry but also altimetry away from the "well revisited" ground tracks.

Both Cryosat-2 and Jason-1 have successfully provided new geodetic mission data to improve the resolution and accuracy of both geoid and MSS. At the same time the availability of SAR and Ka-band altimetry opens for new challenges. At the same time GOCE is continuing to provide very high quality geoid data and the combination of longer time-series with lowering of the orbit will increase the resolution and accuracy of the geoid in the future.

In this splinter, we will am to highlight the last progress on Geoid, MSS and MDT surfaces and these new and exciting perspectives. We therefore invite presentation in these various fields, both on developing new geoid/MSS/MDT, but also on the use of the latest versions of these for oceanographic purposes.

Quantifying Errors and Uncertainties in Altimetry Data

Chairs: Michaël Ablain, Joël Dorandeu, Remko Scharoo

Although altimeter data provide an accurate estimation of sea-level over the last 20 years, they are impacted by errors at different time and spatial scales as any measurement system. Some are known to exist but have not been resolved, some are not even known to exist. This is the bane of our constantly expanding knowledge about a complex measurement system that does not only depend on the altimeter instrument, but also on radiometer data for the wet tropospheric delay correction, orbit determination and its associated reference frame, model data for atmospheric pressure, dynamic atmospheric correction, tides and alike. With a measurement system this complex it is often very difficult to identify even the cause of an error, like the 59-day signal observed between sea levels determined by Jason-1/2 and TOPEX.

Obviously, the identification and determination of new errors in altimeter data is an activity of crucial importance to improve and correct the whole altimeter datasets. This also allows us to provide users the error budget of altimeter data for a dedicated altimeter mission or for applications. However this activity makes sense only if the need of those applications is well defined. This means that the formulation of errors is as relevant as their identification. Thus the way of the error budget is presented (standards, classification of errors, wavelength, frequency, etc.) has to continue to be formalized better.

In this session we invite presentations and posters dealing with the two main following topics:

- new insights about errors in the altimeter system as a whole (all contributions are to be taken into account in a systemic approach). This is from altimeter specialists towards applications. Contributions on improvements and resolutions to long-lasting uncertainties, errors, and data anomalies are particularly encouraged. One topic of particular interest is the "spectral bump" at short wavelengths in the sea level spectrum.
- the needs from applications in terms of error formulation: what is lacking in the current situation? This is from applications towards altimeter specialists. Contributions from climate change experts, oceanographers, assimilators, etc., are encouraged.

Science Results from Satellite Altimetry

Chairs: Hans Bonekamp, Pascal Bonnefond, Lee-Lueng Fu, Rosemary Morrow, John Lillibridge, Josh Willis

General science results based on data from satellite altimetry will be included in this session. Studies that focus on climate change, sea level rise, mesoscale and sub-mesoscale oceanography, and large-scale oceanography are particularly welcome. Although this

session will primarily focus on ocean surface topography observations, we also welcome science contributions that make use of the ancillary observations such as wet path delay, significant wave height, wind speed, or any results that do not fit into any of the other splinter sessions.