Regional Calibration/Validation

Wednesday, October 29, 2014

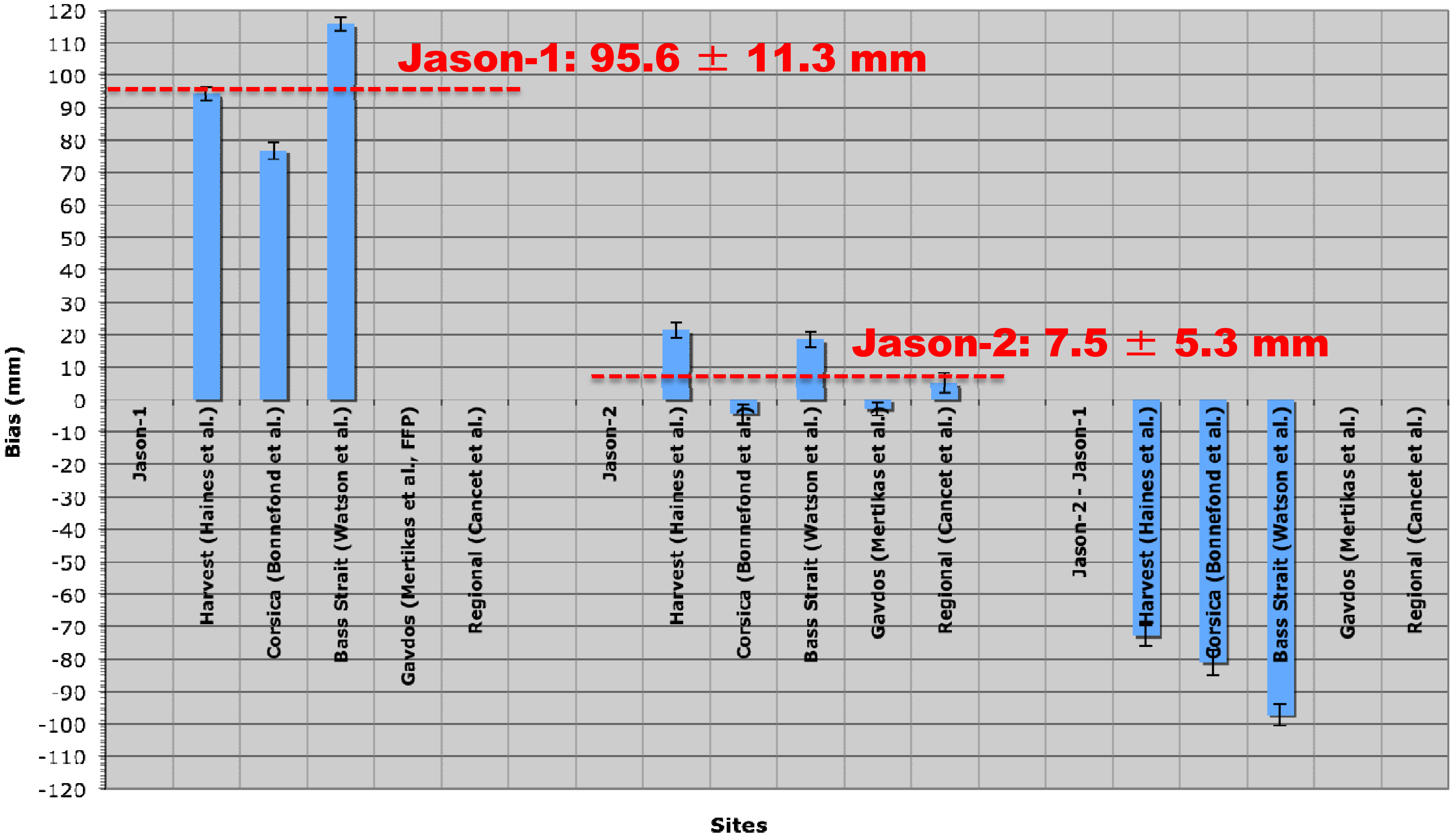
7 oral presentations.

15 posters (for both sessions).

Local Cal/Val summary report

- **Ensemble results from dedicated sites and regional campaigns indicate**:
  - Current Jason-2 (GDR-D) SSH unbiased or slightly biased (questionable significance).
  - Current Jason-1 (GDR-C) SSH bias high by ~10 cm, but upcoming Poseidon-2 range (internal path delay) corrections and other updates (e.g., SSB) expected to reduce bias to near zero. Preliminary GDR-E results significantly improve consistency between the Harvest and Corsica calibration sites (from ±9 to ±2 mm).
  - Legacy (T/P) systems unbiased.
  - First SARAL/AltiKa results support that altimeter measures slightly long (-50 ±5 mm). Very good agreement with Issyk-kul lake estimates.
- **Unusual estimates of Jason-2 drift from dedicated sites warrant investigation**
  - Significant but smaller drift (~3 mm/yr current vs. 5 mm/yr last year) with opposing signs at different sites.
  - Raises questions on regional stability of altimetric measurements, but also on the stability of the in-situ observations (of water level and vertical land motion).

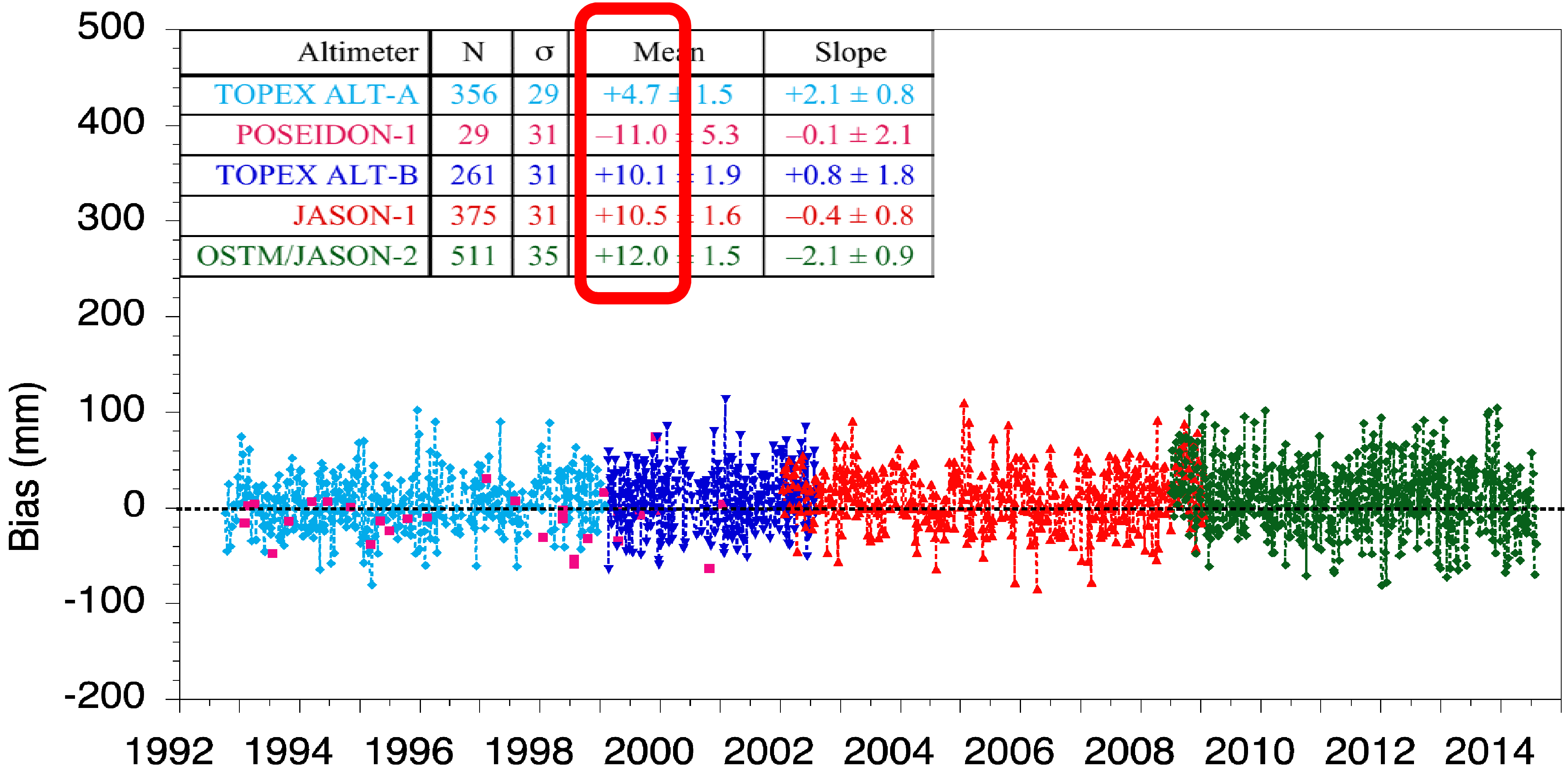
In-Situ Bias Estimates for Jason-1 and Jason-2



Combined Long-Term Calibration Record

Enhanced Time Series *(1532 overflights; Jason-1 @ Bass Strait pending)*

Altimeter	N	σ	Mean	Slope
TOPEX ALT-A	356	29	+4.7 ± 1.5	+2.1 ± 0.8
POSEIDON-1	29	31	–11.0 ± 5.3	–0.1 ± 2.1
TOPEX ALT-B	261	31	+10.1 ± 1.9	+0.8 ± 1.8
JASON-1	375	31	+10.5 ± 1.6	–0.4 ± 0.8
OSTM/JASON-2	511	35	+12.0 ± 1.5	–2.1 ± 0.9



Regional Cal/Val summary report

- **Regional calibration methods (Cancet et al.)**
  - **employed for the first time at all three historical calibration sites (Corsica, Harvest and Bass Strait). This technique shows great promise for reducing errors (though increasing numbers of overflights), expanding the calibration footprint of each site and better link in-situ and global calval results**
- **Evolution of tide gauge/altimeter comparisons has led to new insights**
  - **Leads to lower estimate for GMSL in one study, due principally to TOPEX Side A.**
  - **Highlights importance of accurate land motion estimates.**
  - **Underscores importance of developing rigorous error budgets for competing solutions.**
  - **Different approaches also desirable to expose errors.**
  - **Questions on the Jason-2 drift have been largely resolved (close agreement between all teams).**
- **Comparisons to ARGO and GRACE providing valuable new insights on stability - A good 'closing budget' is available for 2004-2014 period but still open questions on :**
  - **Impact of the deep layer thermal content – future ARGO network will improve the sampling of the deep layers content.**
  - **Sensitivity to the GRACE geoid solution has been emphasized**

Global Calibration/Validation
Wednesday, October 29, 2014

7 oral presentations.

15 posters (for both sessions).

Global Cal/Val summary report

- **Jason Missions**
  - Jason-1:
    - **Some analysis presented**, waiting for the updated Jason-1 GDR-E data set to resume the work (in particular the hemispheric bias between JA2&JA1 during the tandem phase).
  - Jason-2 **data coverage and quality remains excellent.**
    - Sea surface height error < 4 cm for temporal scales less than 10 days.
    - GMSL comparisons to tide gauges < 0.4 mm/yr
    - Semi-diurnal errors aliased at 58.77 days were analyzed again with new tide models and also CY2 data
    - CNES GDR-E orbit much closer to JPL GPS-based reduced dynamic soln.

Global Cal/Val summary report

- **SARAL Mission**
  - Excellent data coverage and quality, even slightly better than Jason-2.
    - Missing measurements due to rain are significantly fewer than anticipated.
  - Range bias of ~-5 cm still remains to be explained.
  - Residual wind-dependent inconsistency in SARAL radiometer wet troposphere correction in current product version.
  - Improvements to current product standard foreseen in 2015.
    - Sea state bias, wind LUT, radiometer wet troposphere correction, sigma0 atmospheric attenuation, orbit, ice2 retracking, … .

- **Crysosat**
  - Excellent data quality in both LRM and SAR modes (NOAA and CNES processing).
  - New techniques have been proposed to screen spurious data impacted by sea ice and close to the coast.

- **HY2A**
  - Routinely processed on CNES side to allow data use in SALP/DUACS but …
  - Not a stable mission on the long-term basis

Cal/Val round-table discussion

1. Jason-2/Jason-3 transition:

- DIODE/DEM mode for J-2 &/or J-3 during formation phase
  - **Proposal from the project is approved** (median tracking for Jason-2 and change to DEM mode every other cycle for Jason-3), recalling that JA3 offers the required flexibility (on-board commanding enabled by the so-called ‘bit mode’, implying easy updates to the tracking mode without mission impacts)
  - **More information on this mode is required** … Action on the project side to provide to OSTST a technical note describing the DIODE/DEM mode.
  - **Review of the product flag values is required** (not linked to the Diode/DEM mode)

Cal/Val round-table discussion

1. **Other topics:**
   - LRM/SAR
     - CP4O project results provides **good confidence of SAR data quality over ocean**. PLRM mode also provides valuable inputs.
     - **Additional studies required** on SSB, swell, sigma naught events, … Also on other surfaces (inland water, sea-ice, land ice)
     - S3 : **proposal to implement a SAR/LRM geographical box** like the one implemented on CY2. Duration to be assessed.
   - Jason-3 Numerical Retracker
     - **Prototype implementation is approved**, tentatively with additional algorithms (DCOre retracking, 3parameter SSB, …) if feasible.

Cal/Val round-table discussion

- **Venice 2012**: how to develop/promote a high accuracy/stability tide gauge network to be able to monitor altimetry?
  - are we able to define such a subnetwork?
    - **No** … let the different groups define their own criteria to select the reliable network
    - For the monitoring of the altimeter system **additional networks (in land water)** should also be used
  - which kind of instrumentation (radar, pressure, CGPS, …)
    - A lot of evolutions have been performed on the instrumentation since 1850 without impacts on the long term monitoring.
    - Recommend that OSTST endorse the 2012 The Global Sea Level Observing System Implementation Plan
  - which accuracy/stability is needed?
    - Better **vertical land motion monitoring** (long lasting open point …) is required – GPS and/or other means should be implemented (we cannot rely on 'close GPS' sites). This would also provide additional GPS information in coastal areas for radiometer correction analysis
    - PIs to provide the expected impacts on the long-term monitoring accuracy.

Seed questions

- **How to better insure external monitoring of the radiometer behavior (coastal contamination, long-term stability, …)?**
  - GPS? Ground radiometers?...
  - Radiometer remains a large source of uncertainty (refer to Shannon presentation) – use of model reanalysis (ERA Interim, others …) is very valuable.
  - GPS @ tide gauges coastal network would be valuable
  - JA3 will improve the long term stability – JCS will be even better

- **Bathymetry** : key information for SWOT mission
  - Resume the work on the computation of bathymetry on European side

- **Long term stability of the wind/waves retrieval:** current status? can it be improved? what is the system limitation?
  - Wind is an essential variable : project to analyze the system capability on this variable

Introduction:

1. **Proposed New Models**
   (CNES/GDR-E, NASA GSFC/std1404)
   → **Evaluation of proposed changes.**

2. **Tracking System Systems Status (Jason2)**

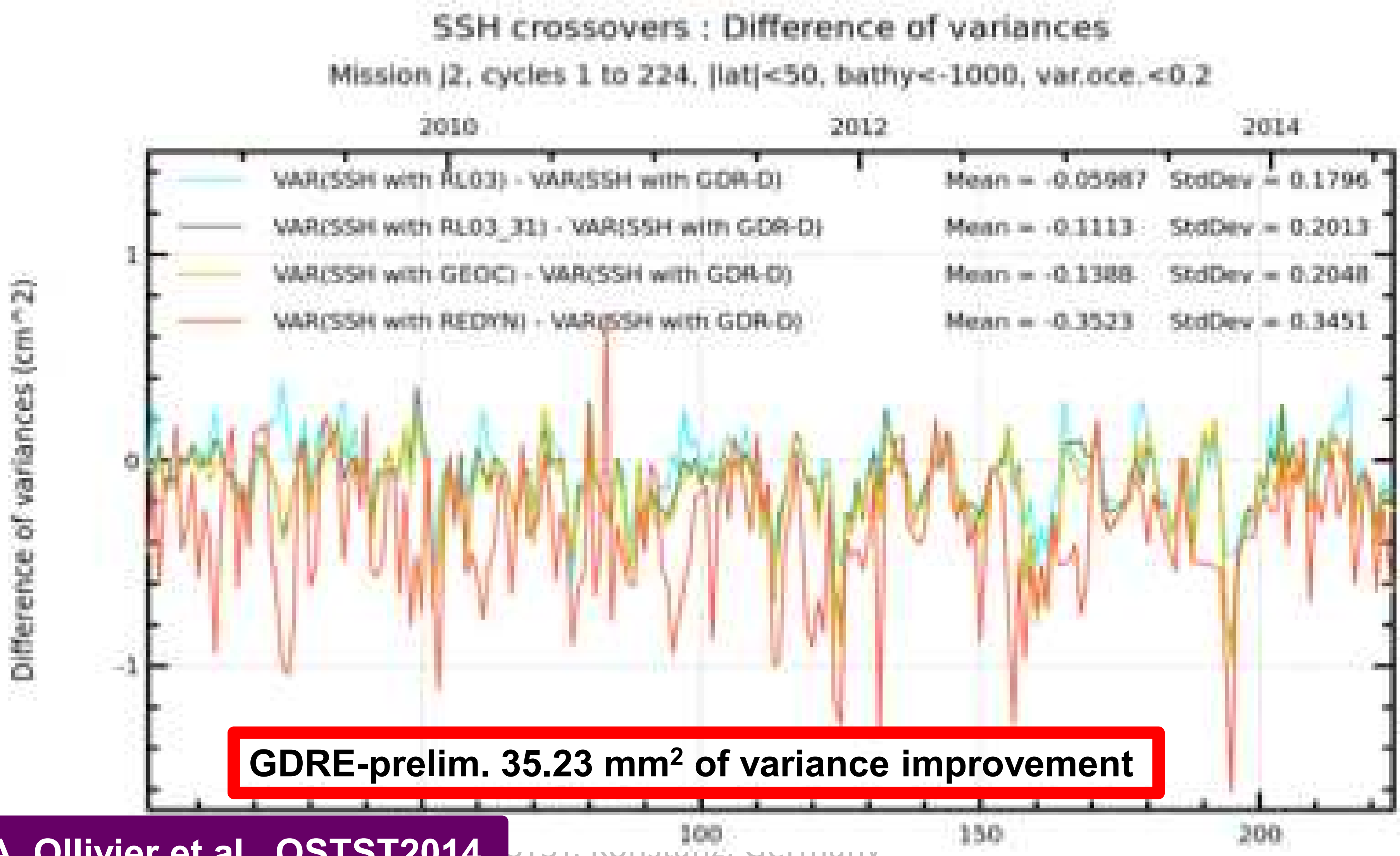
3. **Significant Results**

4. **Issues**
   • ITRF2013 availability and impact on new standards; modeling changes.
   • Time-variable gravity modeling.

Proposed New Models

	CNES (GDRD -> GDRE)	NASA GSFC (std1204 → -std1404)
	GDRE prelim	std1404 prelim
Gravity	**New Model. GRGS RL03 piece-wise continuous field w. C31/S31 estimation by arc**	**New Model: GOCO2s + harmonic fit, w C31/S31 estimation by arc; from SLR_DORIS TVG time series**
Earth-COM variations (geocenter)	**Apply J. Ries model (*from Lageos1/Lageos2*)**	**Apply J. Ries model (*from Lageos1/Lageos2*)**
Troposphere Refraction (for DORIS)	No change	**Vienna Mapping Function (VMF1)**
Solar Radiation Pressure	**Jason1-2. Updated** – from Flavien Mercier et al.	No change
Tides/Ocean Loading	**FES2012 (**FES2014 if available**)**	**GOT4.10**
DORIS antenna ph.	**Apply**	**Apply**
Parameterization	**Improved stochastic solutions**	No change
Satellites	**Jason-1, Jason-2, Jason-3**	**TP, Jason-1, Jason-2, Jason-3**

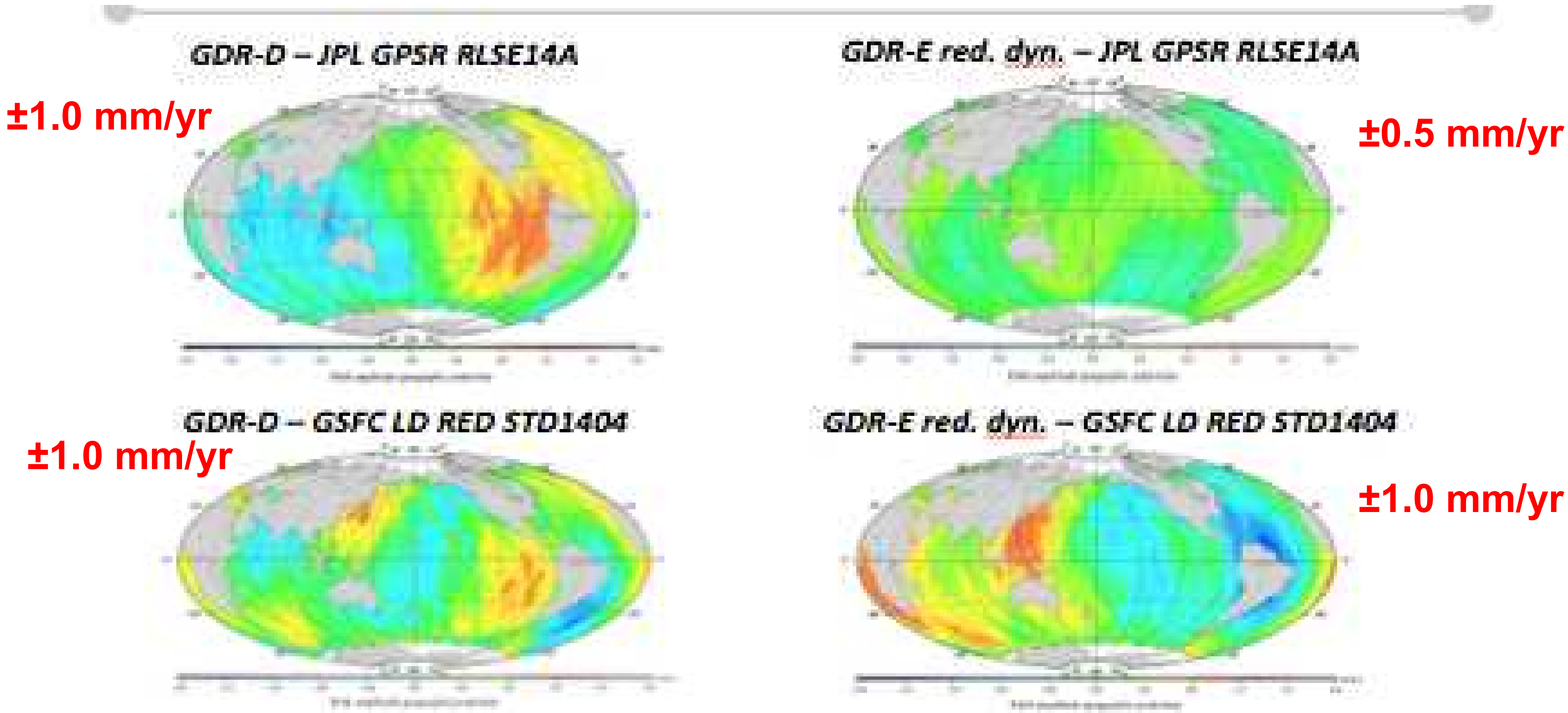
Evaluation of Model Improvements wrt GDR-D with Crossovers



GDRE-prelim. 35.23 mm² of variance improvement

A. Ollivier et al., OSTST2014

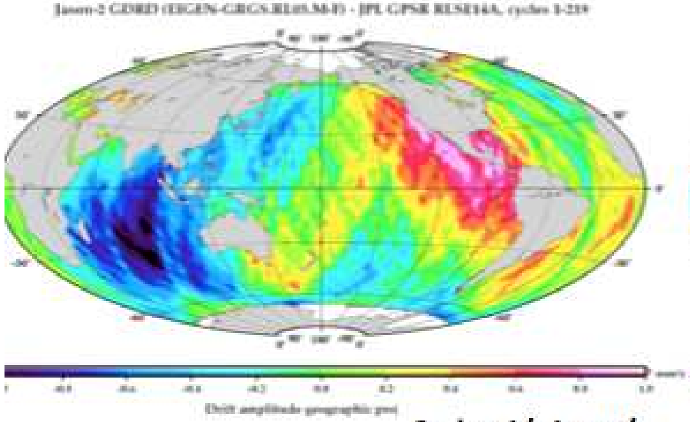
Geographically Correlated Radial Orbit Error: Radial Orbit Drift: (Reduced-dynamic vs. dynamic orbits)

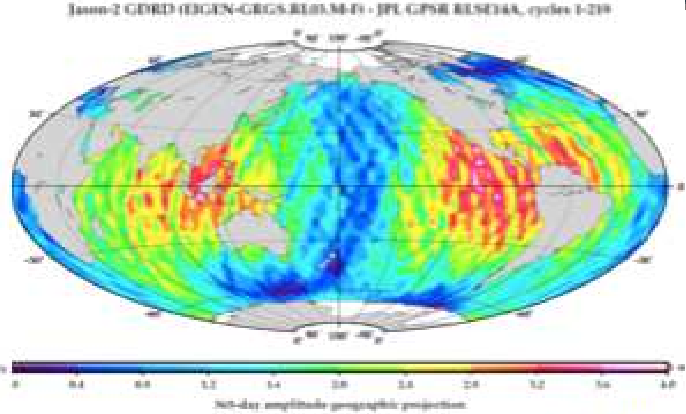


J. Moyard et al., OSTST2014

Jason2 GDR-D (model EIGEN-GRGS.RL03.MEAN-FIELD) vs. JPL reduced dynamic orbit (cycles 1-219)

No C_{31}/S_{31} estimation



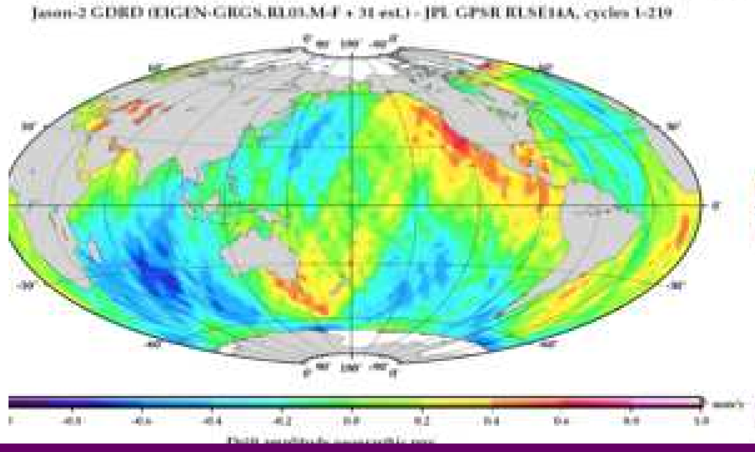


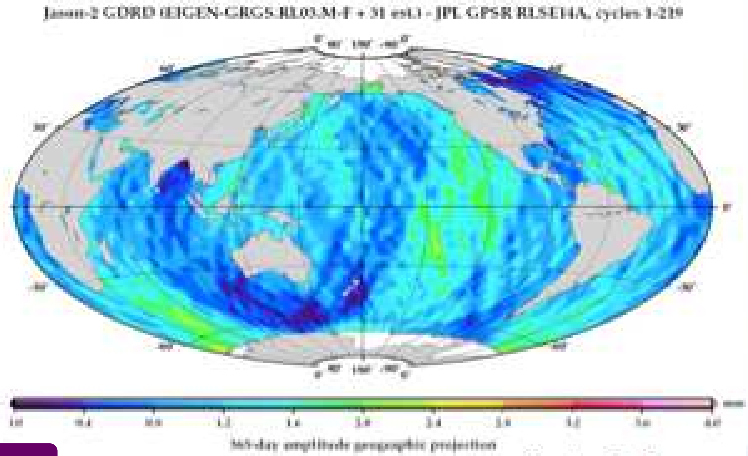
DRIFT term

ANNUAL term

(cycles 1-219)

With C_{31}/S_{31} estimation



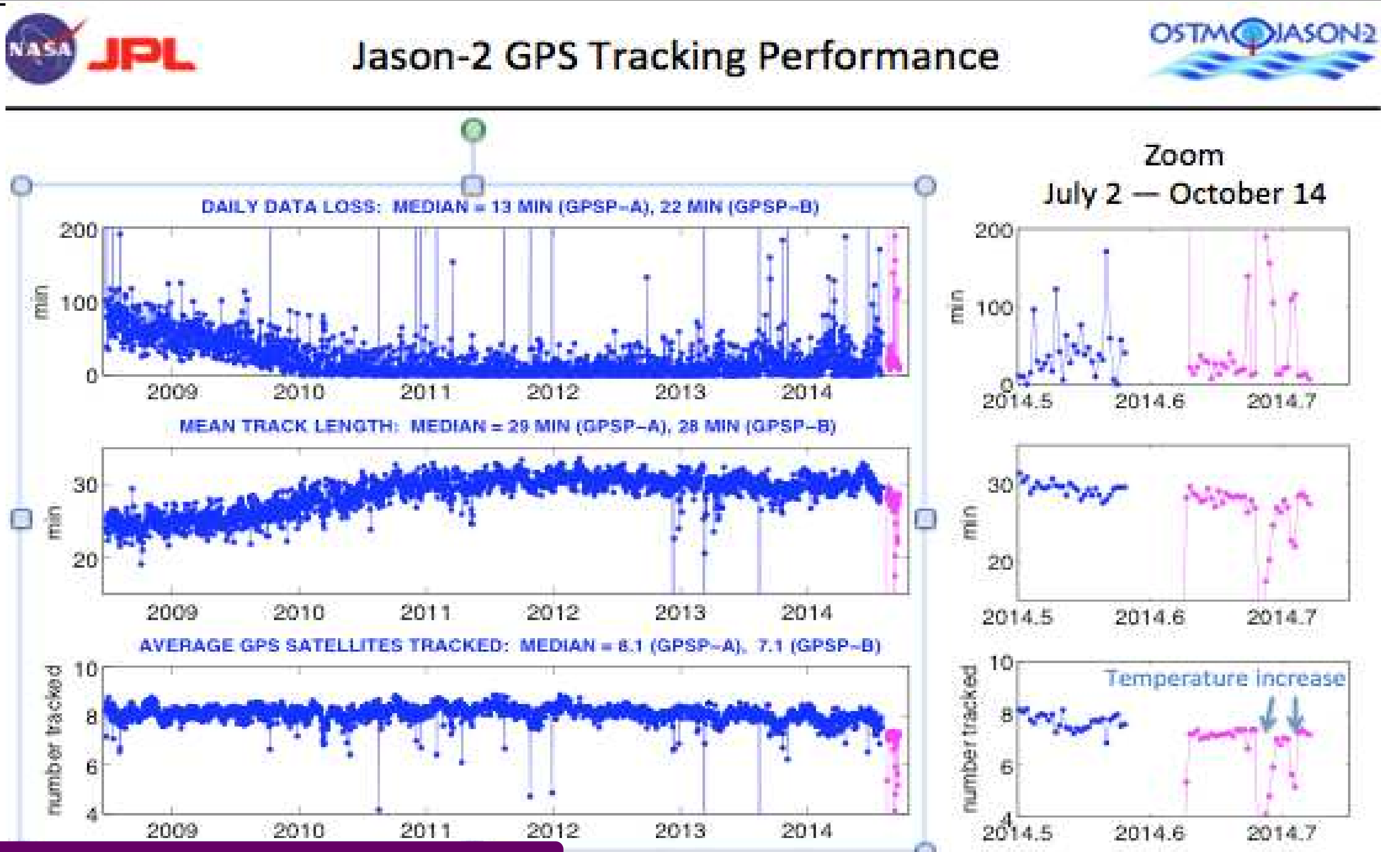


JM Lemoine & R. Biancale et al., OSTST2014

many

Tracking System Status.

1. SLR --- Nominal performance.
2. DORIS – Nominal performance.
3. GNSS – Switch to GPS Receiver B. Under evaluation.



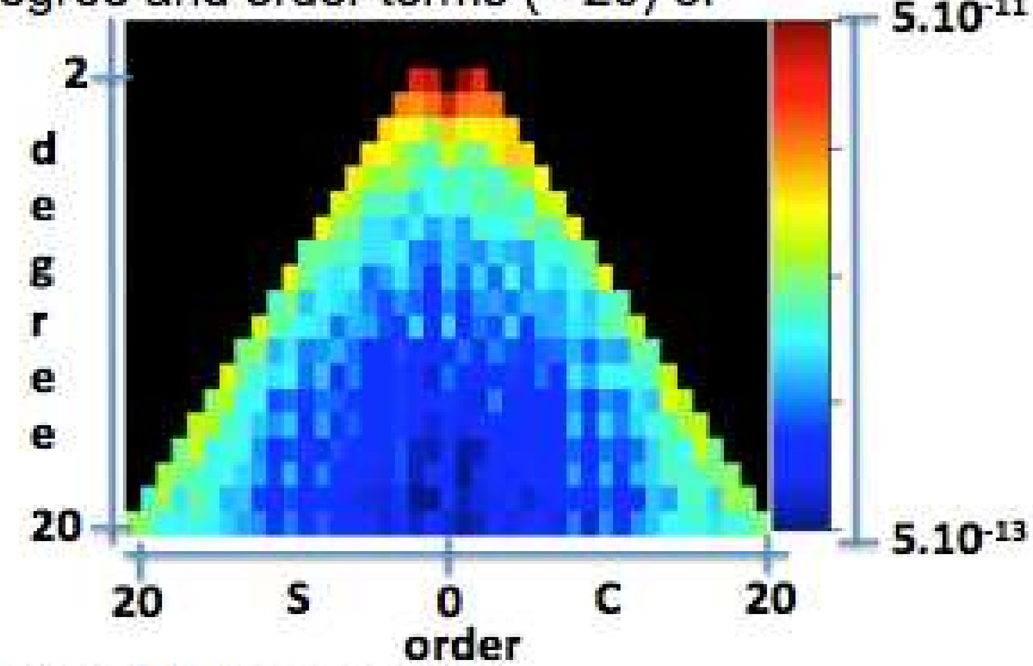
W. Bertiger et al., OSTST2014

GPSP-B max sats = 8; GPSP-A max sats = 12

Altimeter Satellite Sensitivity to Time-Variable Gravity (I)

Goal

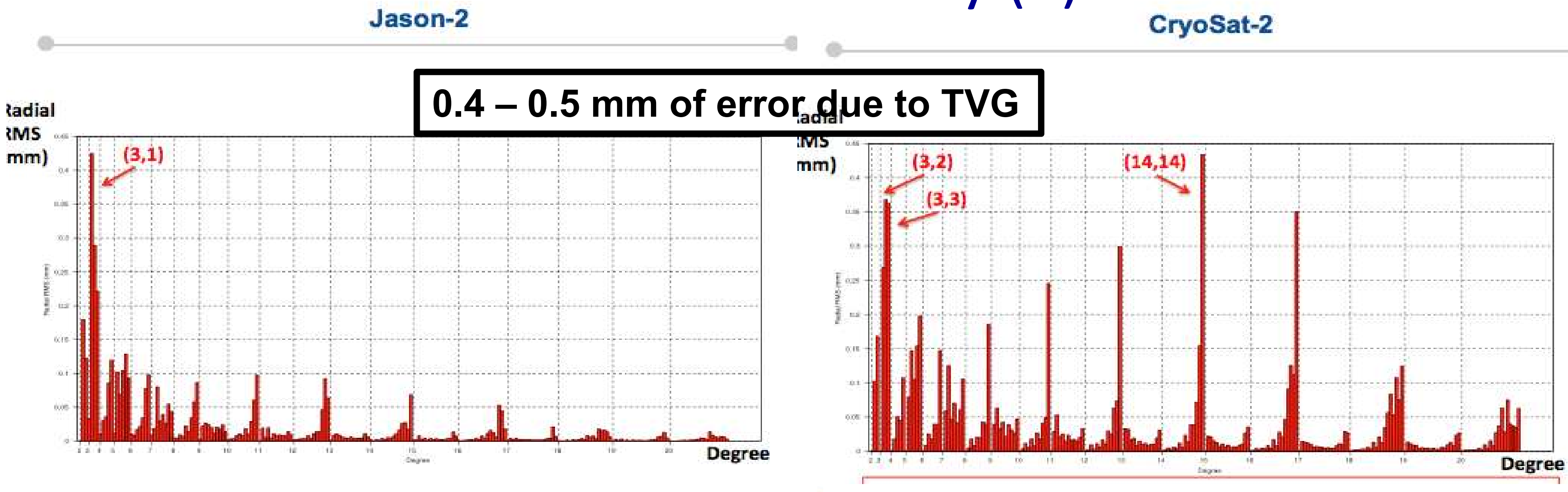
- The differences between the low degree and order terms (< 20) of GRACE monthly gravity field solutions from the four processing centers (CSR, GFZ, JPL and GRGS) was analyzed to gauge their "internal" error.



- The radial orbit sensitivity of the four currently flying altimeter missions to individual variations in spherical harmonics corresponding to the standard deviation values previously obtained was then computed.

A. Couhert et al., OSTST2014

Altimeter Satellite Sensitivity to Time-Variable Gravity (II)

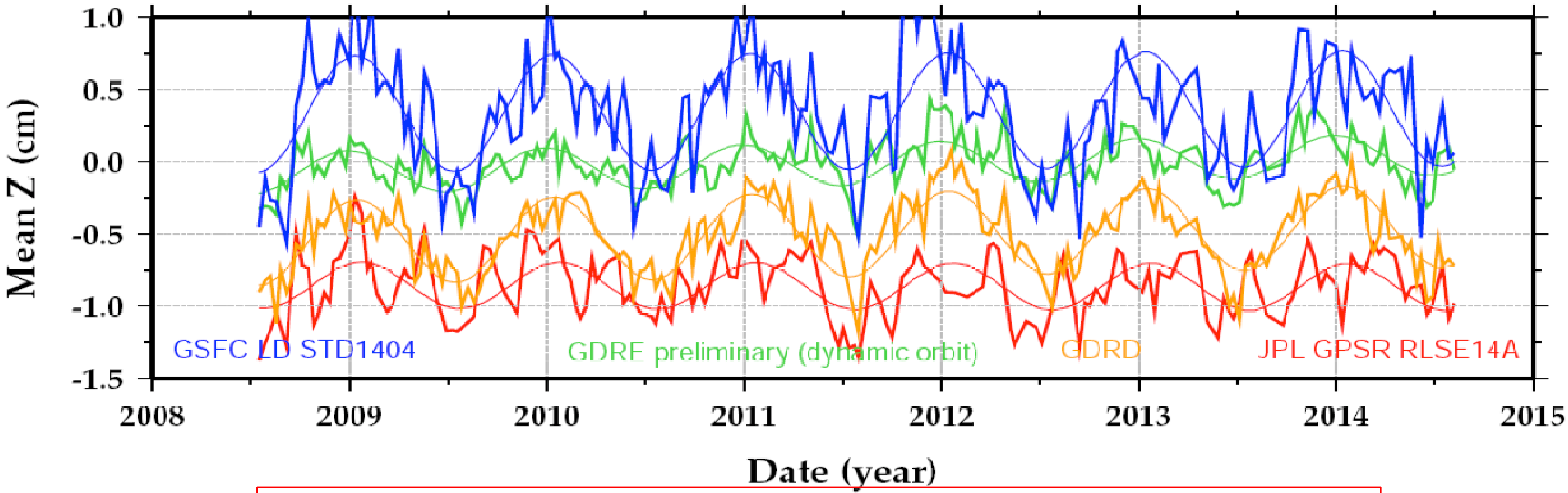


Projected Error on Jason-1/Jason-2 and Cryosat-2 from Dispersion in GRACE TVG solutions affects altimeter satellites at specific orders and sets of coefficients. Can Affect MSL rate significantly, especially regionally.

A. Couhert et al., OSTST2014

Relative Orbit Centering Stability Between POD Centers

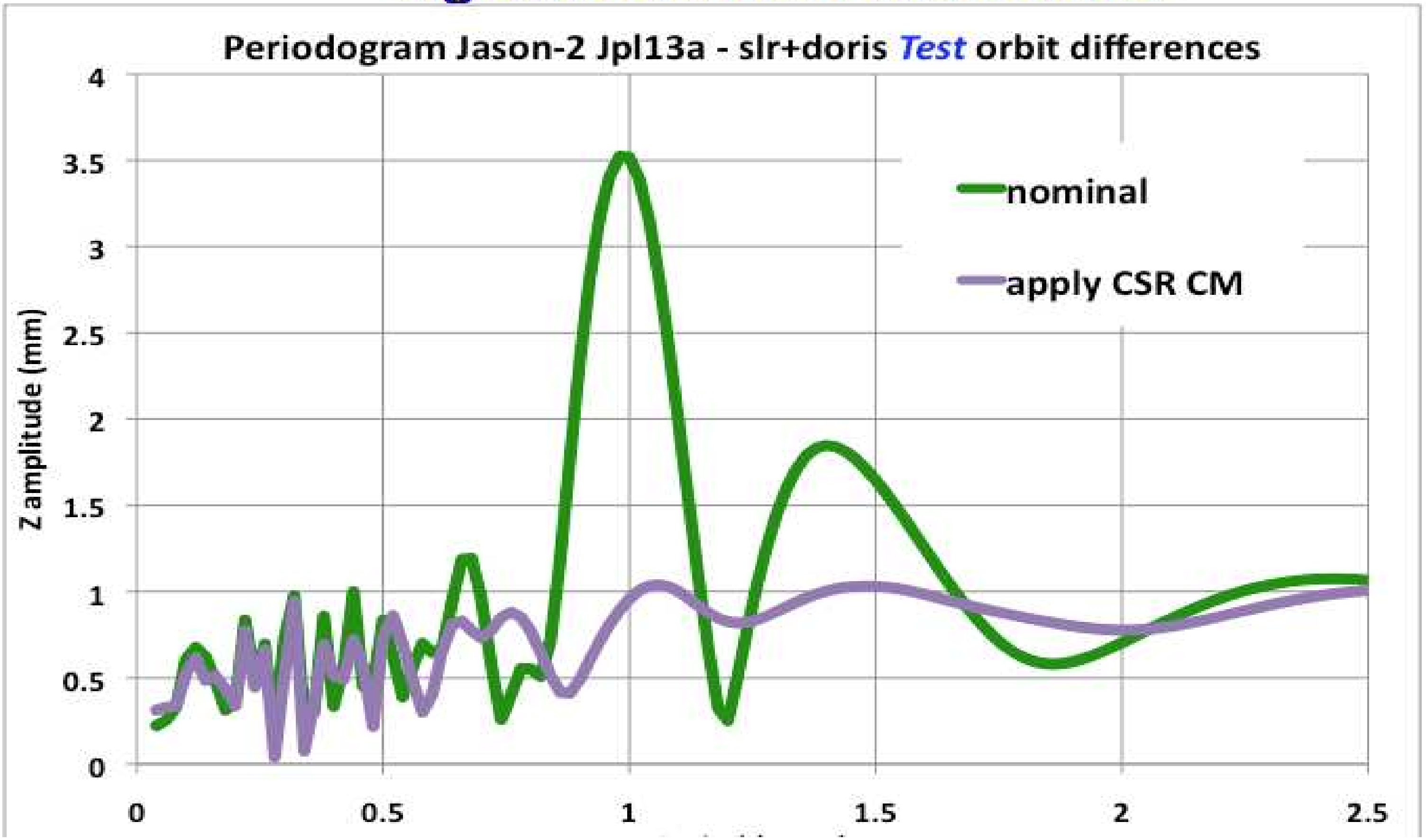
Mean Z orbit differences with respect to the GDR-E preliminary reduced-dynamic solution



Z bias of 1-2 mm (opposite sign) w.r.t. GSFC and JPL,
Z annual signal from 1 to 4 mm between all orbits

A. Couhert et al., OSTST2014

CSR CM largely removes annual Z difference signature with JPL13a orbits



N. Zelensky et al., OSTST2014

Caveat: (1) Geocenter variations have complex transfer function to orbit, and is not a pure harmonic function (non-stationary, secular trends)**; (2) Other effects may produce Z differences.**

TOPEX, Jason-1, Jason-2: Improvements foreseen across all missions

satellite	test – NASA GSFC orbits	mean RMS residuals		
		DORIS (mm/s)	SLR (cm)	Xover * (cm)
TOPEX cyc 1-446	std1204	0.4962	1.597	5.605
	std1404 (prelim)	**0.4960**	**1.579**	**5.610**
Jason-1 cyc 1-374	std1204	0.3697	0.853	5.458
	std1404 (prelim)	**0.3673**	**0.795**	**5.445**
Jason-2 cyc 1-226 (xover 1-216)	std1204	0.3778	0.934	5.345
	std1404 (prelim)	**0.3779**	**0.907**	**5.332**

F. Lemoine et al., OSTST2014

Other

• **M. Otten et al. (ESA)** processing of Jason2 (GNSS, SLR, DORIS) under development using ambiguity fixing. Results are promising (< 1 cm rad diff RMS with JPL comparable orbit) ... more work will be done.

• **H. Capdeville et al. (LCA)**. Presented ITRF2013 orbits - differenced with GDRD – good agreement for all altimeter satellites. Augurs well for ITRF2013.

• **F. Lemoine et al. (GSFC)** Summarized ITRF2013 processing; 1 -1.5 cm RMS SLR fits for other altimeter satellites (Envisat, Cryosat2, Saral, HY2A). Unknown outgassing on HY2A seen in POD; Saral. CNES-GSFC differences of order 1 cm radial RMS.

• **S. Rudenko et al**.. (GFZ). Test of ITRF2013 Gravity field, VMF1 and GFZ AOD1B dealiasing models on Envisat.

Very encouraging other POD groups (GFZ, ESA, LCA) are producing altimeter satellite orbits – aids the validation of orbit quality.

Outstanding Issues.

1. ITRF2013 (new realization of terrestrial reference frame)

- Delivery of final solution sometime in 2015. (date uncertain).
- IMPACT. ➔New time series of orbits must be planned when the new ITRF2013 is validated. ➔ 3 to 5 months to validate & re-compute orbits.
- ISSUES. The new ITRF will feature new nonlinear models for station motion – not part of current POD software.
- DECISION. Proceed with re-computations (new standards) early in 2015 without ITRF2013.

2. Time-variable gravity modelling for altimeter satellites.

- If new validated static+TVG model by early 2015, we can consider it – other wise use GRGS RL03 piecewise continuous model with estimation of C31/S31 per J1/J2 arc.
- Altimetry satellites are operationally dependent on GRACE data to properly model TVG variations. Models must be updated periodically. Alternatives using SLR+DORIS (+GNSS), a possible partial solution.

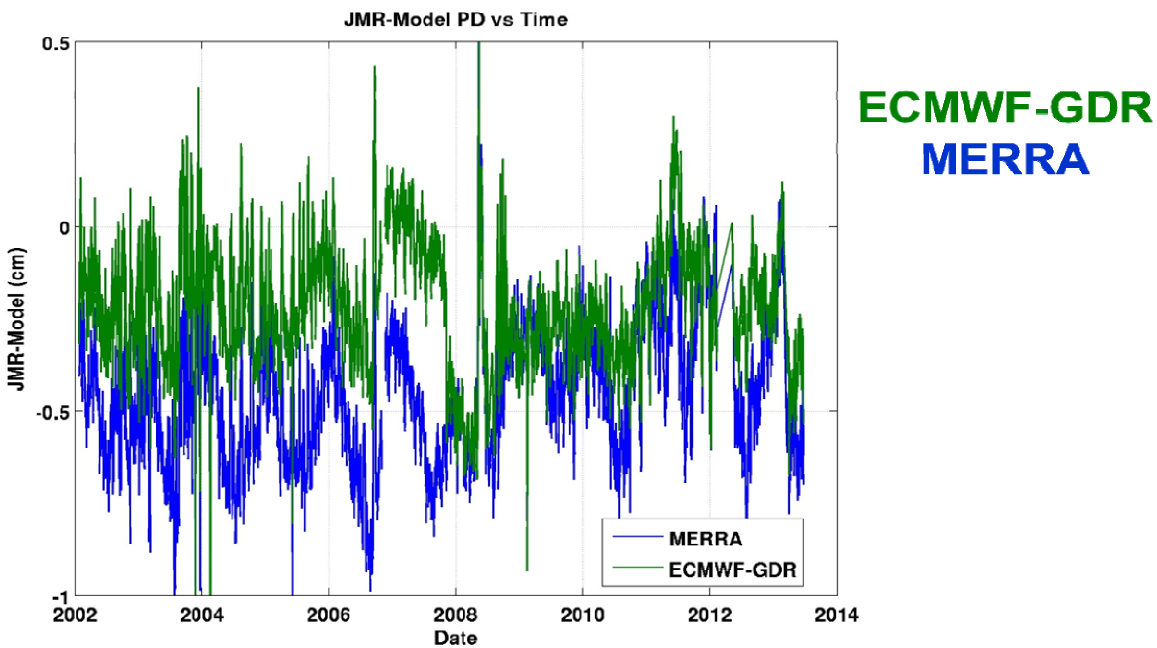
Instrument Processing Corrections Summary

S. Brown

E. Obligis

- JMR end-of-mission re-calibration effort is complete
  - 2 mm/yr uncertainty for any 1 year
  - << 1 mm/yr for mission
  - Algorithms updated to Jason-2 GDR-D standard

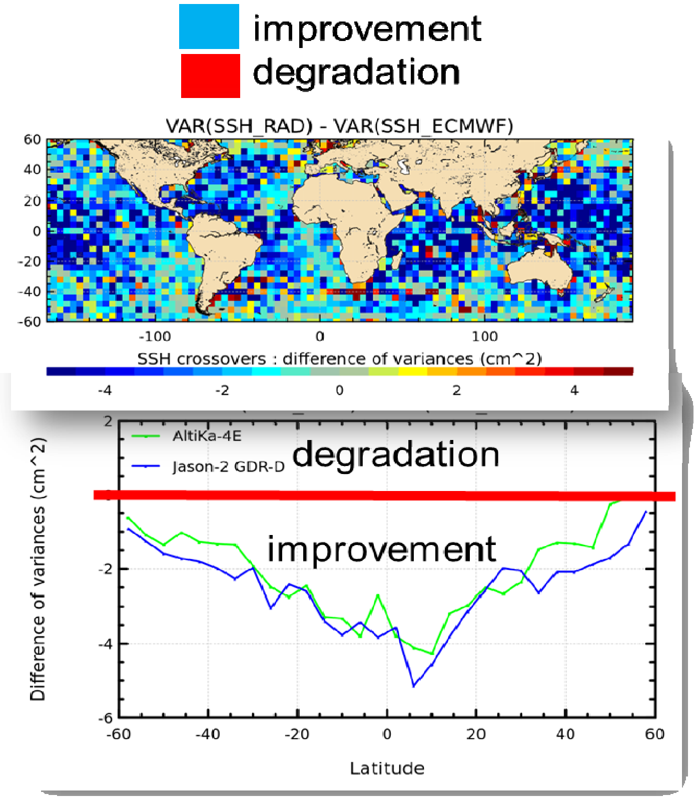
- **The need for this type of *a posteriori* calibration will be reduced for Jason-3 (cold sky calibration) and eliminated for Jason-CS (complete 2-point external calibration)**



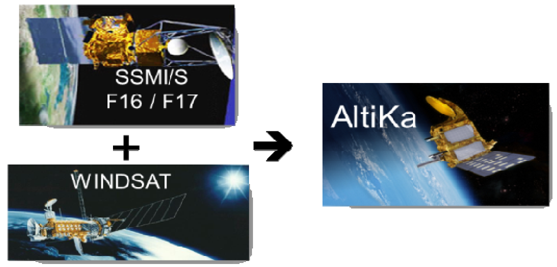
- Instrumental performances of SARAL/AltiKa radiometer are excellent
  - Very good agreement with other instruments (AMSU-A/J2) on Amazon forest
  - Cold vicarious calibration and double difference shows a good agreement between AL and AMSU (|Δ|~1K) for both channels
  - At crossover points, the results show a dependency of the difference of BT between AL/AMSU/EN wrt J2 for the 23.8GHz.

- Empirical '4E' retrieval performances are close to Jason-2; further improvements are foreseen adding temperature lapse rate
  - Instrumental performances of SARAL/AltiKa radiometer are excellent and we are now in position to provide even better geophysical products.
  - same approach should be applied to atm. Attenuation

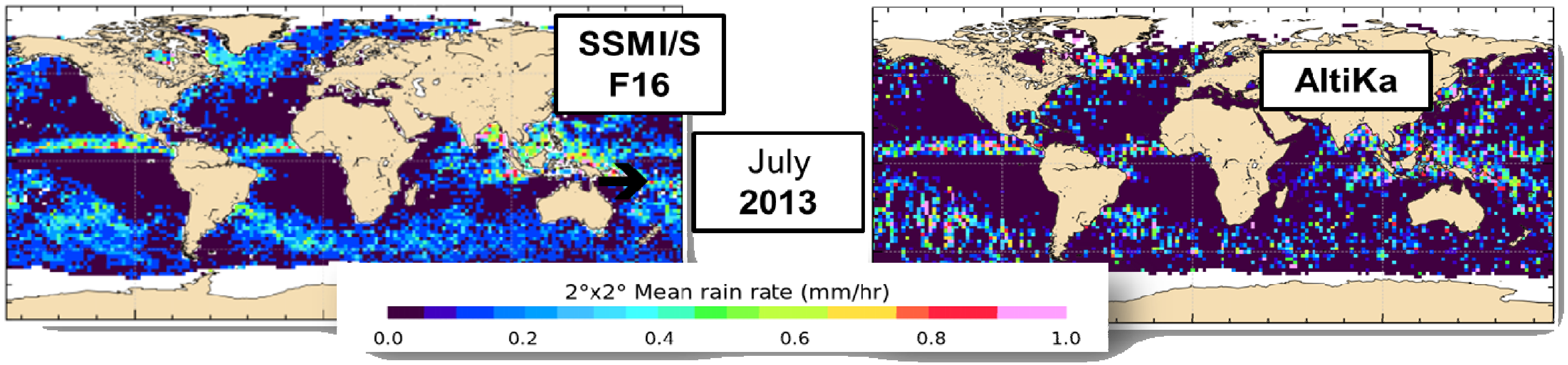
- An effort should be put on the simulation of the backscattering coefficient in Ka band in order to:
  - improve our knowledge on atmospheric & surface interaction at this frequency
  - continue to improve our understanding of the statistics of the Sigma0 in Ka band in the perspective of the SWOT mission



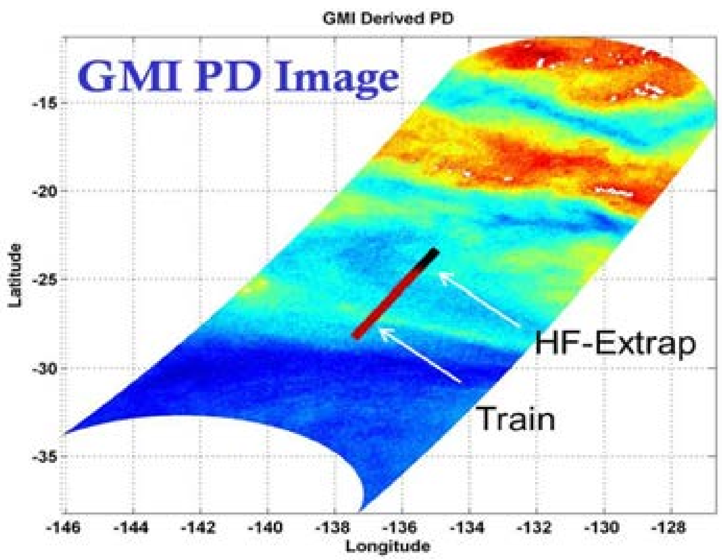
- A ‘closest’ rain rate product is available for AltiKa together with
  - the time lag between the external source and AltiKa measurements
  - a confidence flag
- Can be used for the validation of rain flag development or assessment of the impact of rain on Ka-band altimetry measurement
- Estimating the rain rate from AliKa measurements would be a real improvement

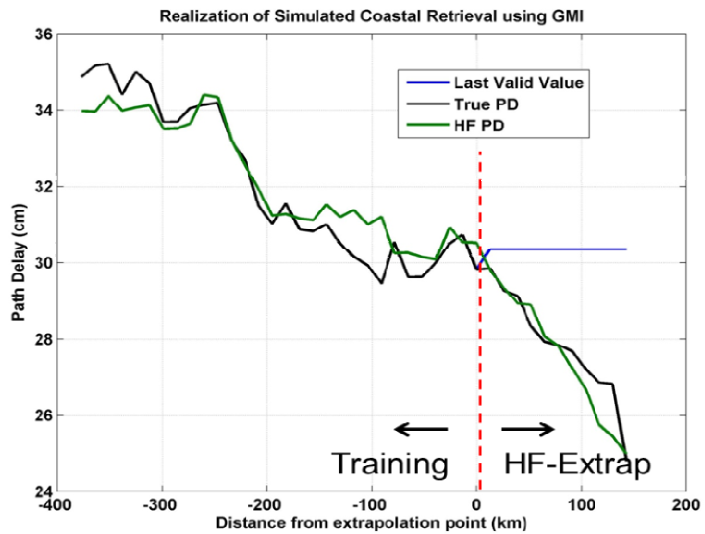


- ‘closest’ rain rate will be available on PEACHI dataset on
  http://odes.altimetry.cnes.fr



- High frequency radiometer channels if integrated into future high resolution altimetry missions will improve observations in the coastal regions and potentially improve observations over land
  - It is demonstrated that these channels can be used to keep the PD errors below 8mm up to the coastline
  - Overland, 183 GHz sounding channels can be used along with model data to reach 2-3 cm level accuracy
  - Missions such as Jason-CS and SWOT will benefit from these systems
  - An airborne high-frequency radiometer for wet PD has been built by CSU/JPL and first flights are taking place in early November





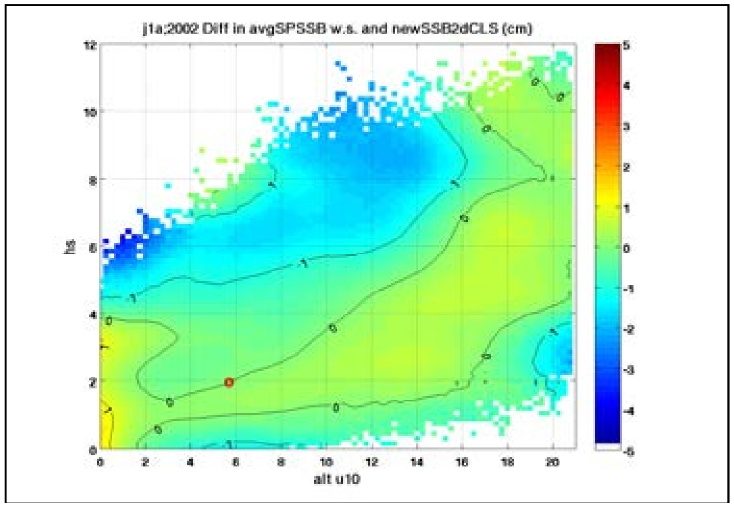
Low-frequency PD
High Frequency PD fit
Extrapolate Last valid value

- **Metrics for sea state bias (SSB) correction evaluated for inter-comparing models**

- **Direct SLA data evaluation** shows that in terms of variance reduction the 3D SSB outperforms 2D SSB in the range of **0.5-1.5cm^2.** This evaluation test may be not related only to SSB model performance (spurious correlation with SLA)

- **Collinear difference data evaluation** shows the largest absolute variance reduction measures for 3D, with 3D SSB outperforming 2D SSB in the range of **1-2.5cm^2**, very stable from year to year and in zonal evaluation. We view this as the best evaluation test even though a 10 day difference may yet be sub-optimal (see crossovers below)

- **Crossover difference data evaluation** shows much less variance reduction gain in the 3D vs. 2D evaluation. This test is sub-optimal for evaluating SSB performance.. The crossover test might be useful for many geophysical corrections, but it is a relative measure at best for sea state dependent SSB performance testing.



- DComb product available which optimally combines all sources of wet PD information
- Important for missions like Cryosat that do not include a radiometer

Recommendations

- Recommendation that radiometer products be provided at native sampling rate (e.g. 16 Hz for the AMR, 5Hz Altika) to better exploit the data
  - Improve coastal processing or retrievals over large inland water bodies for example
- Compare L2 algorithms on common training dataset
  - Consideration for baseline algorithms in future missions (SWOT, Jason-CS)
- Need to ensure climate requirements are maintained for Jason-CS to ensure that the radiometer is designed with stable external calibration targets

Splinter Summary – LRM Retracking (1)

- **TOPEX Retracking** *(Phil Callahan, JPL)***:**

Covered in plenary – 12:20 today

- **Numerical Retracking for Jason-3** *(F. Boy, CNES)***:**

Even if the Jason-3 altimeter POS3B perfectly **fulfils all its requirements** , the “numerical retracking” has been considered as a **very performing solution** to prevent **any degradations** on altimetry products due to a potential ageing of components.

  – Available as additional data product.
  – Need feedback from experts

Splinter Summary – LRM Retracking (2)

- **DECORE Retracking:** *(L. Amarouche, CLS)*

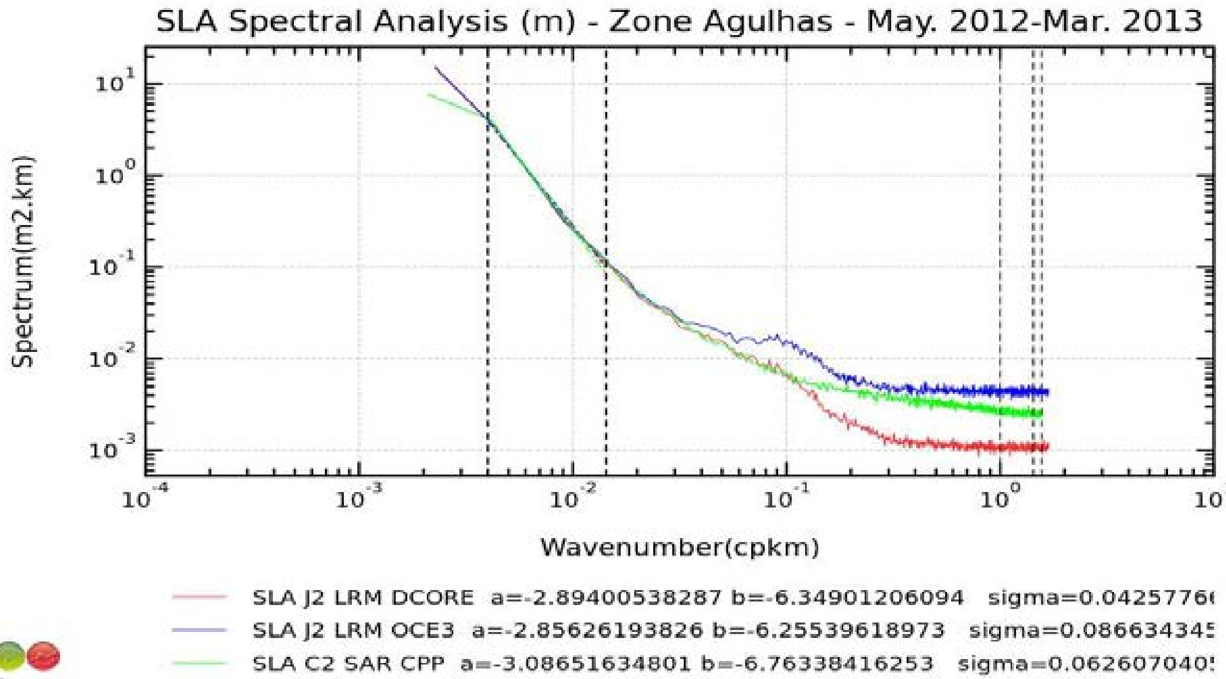
A new retracker has been developed:

DCORE for parameters **DeCOrrelation REtracker.**

DCORE is using a modified waveform analytical model that mitigates the impact of the trailing edge deformations on the range and SWH.

SWH and Gamma are smoothed and then injested in a second pass MLE2 to estimate epoch and sigma0

This retracking significantly reduces the spectral hump but also the noise on the estimated parameters.



Splinter Summary – SAR Mode (1)

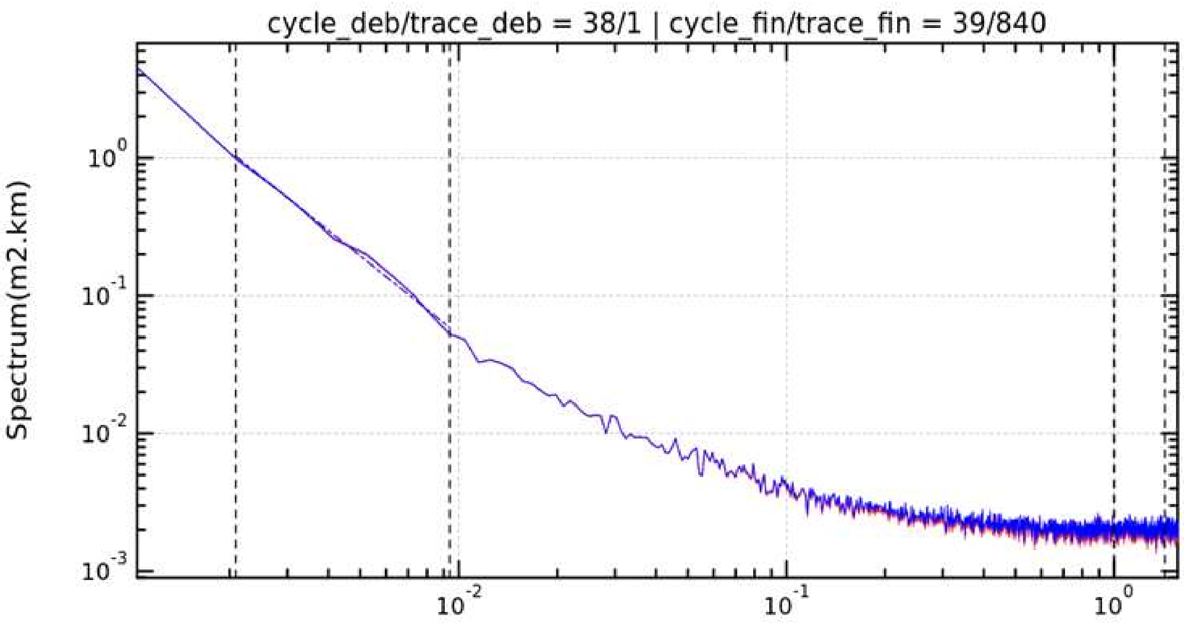
- **CryoSat Plus For Oceans:** *(D. Cotton)*

Full assessment and comparison between different PLRM and SARM processing methods:

- For SAR processing : Numerical (CPP) vs Analytical (SAMOSA).
- For PLRM processing: RADS vs CPP

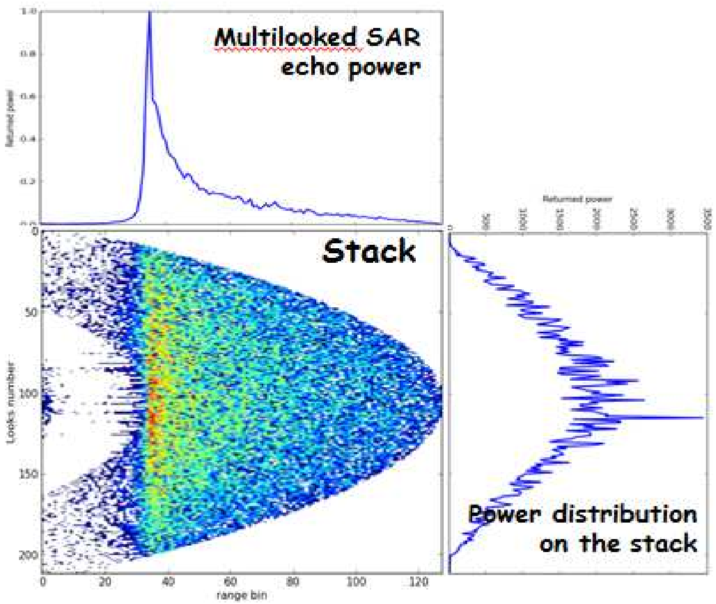
Relationship of methods now understood and in good agreement

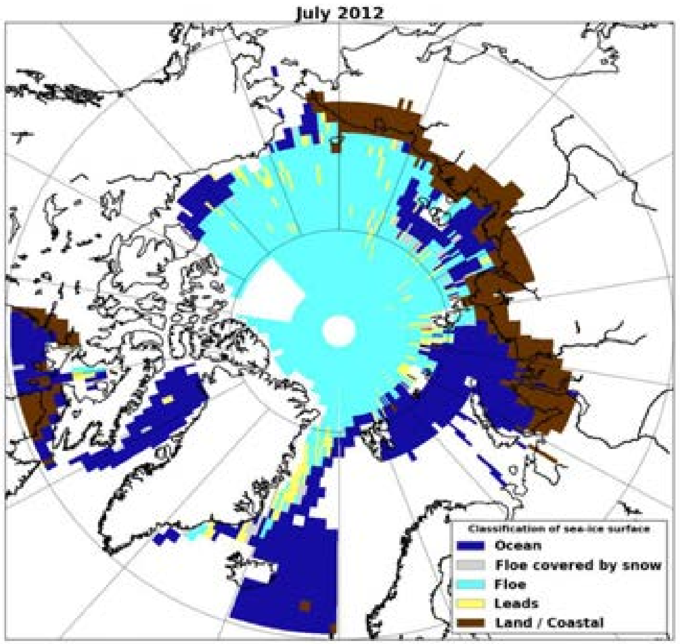
➔ **Both SAR retrackers allows 1-Hz product users to recover smaller wavelengths (10-80 km) of interest for oceanography**



Splinter Summary – SAR Mode (2)

- **Exploiting the power distribution in the stack:** *(T. Moreau, CLS)* To extract more information such as:
  - Surface Roughness
  - Surface Type (ice, land, etc.)
  - Mispointing Angle





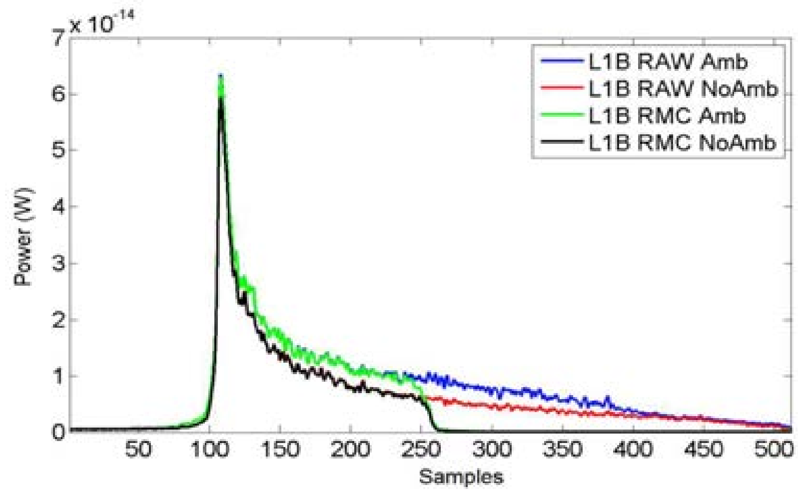
Splinter Summary –Sentinel 6/J-CS

- **Ground Prototype Processor (GPP) has been developed for Sentinel 6** *(M. Roca &C/ Martin-Puig, iSardSat)*
  - Presentation of the different GPP functionalities and processing
  - Outputs Level 1A, L1BS, L1B (LRM, SAR) data
  - Data available from ftp://ftp.eopp.esa.int

GPP accounts for many new onboard processing features.
Results have been shown with different configurations.

- **A new Retracker developed** to validate GPP outputs (Level 1B)
- Results on CryoSat2 data were shown to validate the new Retracker against CNES CPP
  - **Good agreement in general**

Retracker should be aligned with L1 processor

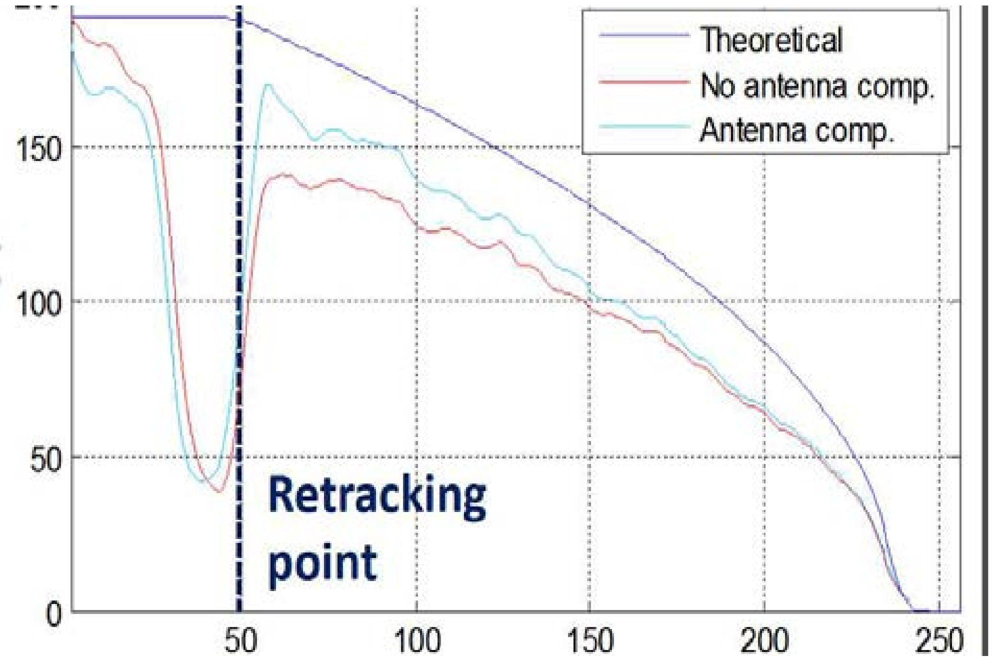


Splinter Summary – SAR Stacking (1)

- **SAR Speckle Reduction by compensating the stack with the antenna pattern** *(M. Scagliola, ARESIS)*

Conclusion: Increases the number of equivalent looks (ENL) by ~30% for CryoSat2 → **SAR Speckle reduction**

Results need to be validated at Level 2 to confirm that SLA variance is also reduced



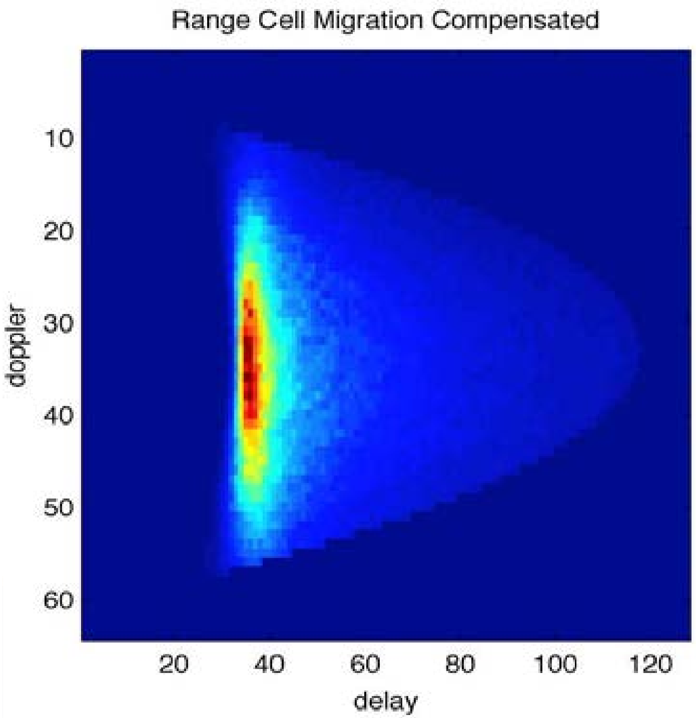
Splinter Summary – SAR Stacking (2)

- **Across-track dilation Compensation** *(C. Ray, ISardSat)*

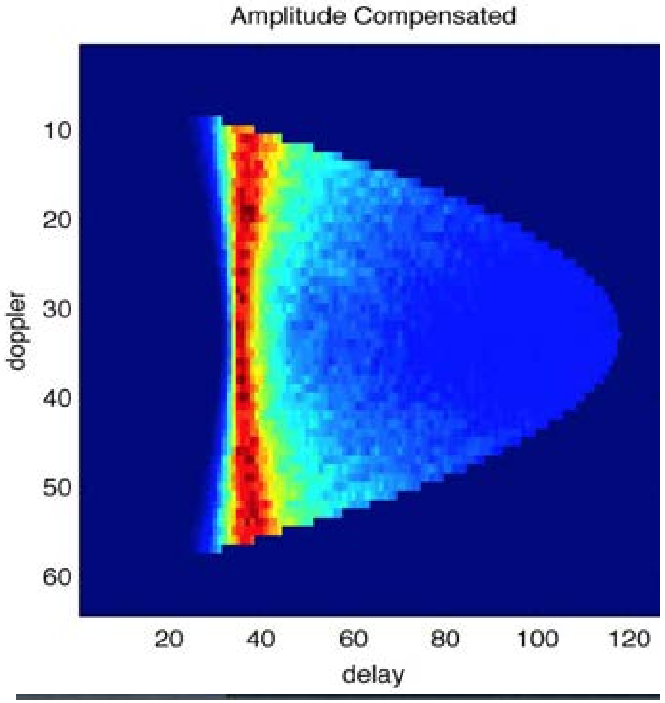
A new SAR multilooking methodology has been proposed by Ray (TGRS 2015) including beam reshaping

  – Reduces noise, increases precision

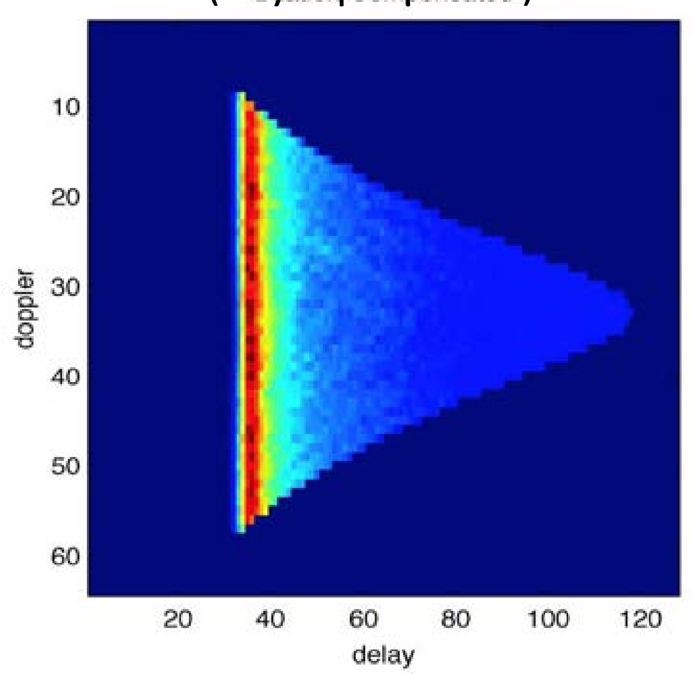
"Classical" Stack
Range Compensation



Antenna Pattern Compensation
(similar to Scagliola)



Across-track Dilation
Compensation
(Ray – proposed)



Round Table

- **Jason-2/Jason-3 tandem phase:**
  - Recommendation to not shorten the tandem phase from initial plan (6 months).

- **Numerical Retracker for Jason-3:**
  - Available later as a “delta product” for experts on demand
  - Will be delivered separately from operational products
  - <u>Objectives:</u>
    - Assess the numerical retracker performances
    - Decide by the end of assessment period which one to use for operational products
  - Several iterations may be needed
  - Input/validation from OSTST members welcome (notably from Instrument Processing splinter)

Round Table

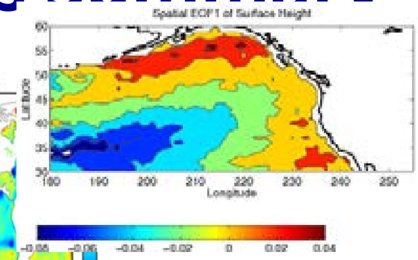
- **TOPEX Processing:**
  - Recommendation to deliver the TOPEX waveforms to the users

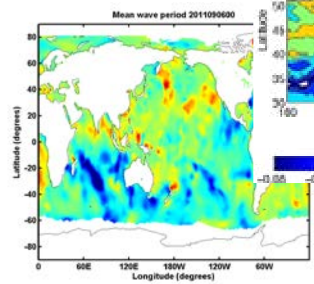
- **SAR-LRM continuity:**
  - Current status: SAR and LRM continuity has been assessed on CY2 data:
    - PLRM-LRM within 1 cm
    - SAR-PLRM differences about 0,5%SWH
  - DECORE Retracking could be used on PLRM wvfs to reduce the noise level and make easier SAR-LRM-PLRM comparison
  - For Sentinel-3, SAR-LRM continuity will be assessed during commissioning phase by switching modes over oceans
  - Sea State Bias for Doppler Altimetry: Need to be addressed
    - ITT from EUMETSAT
    - Current studies from ESA and CNES

Application Development for Operations Summary

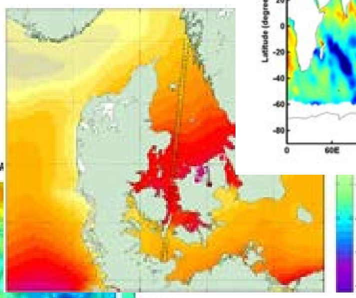
(6 Oral; 12 Poster)

Wave forecasts



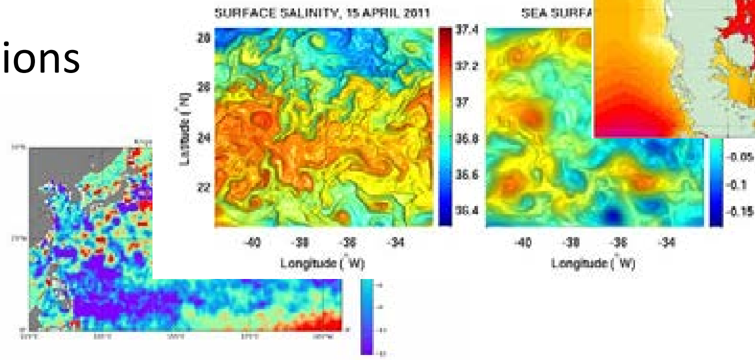


Storm surge forecasts

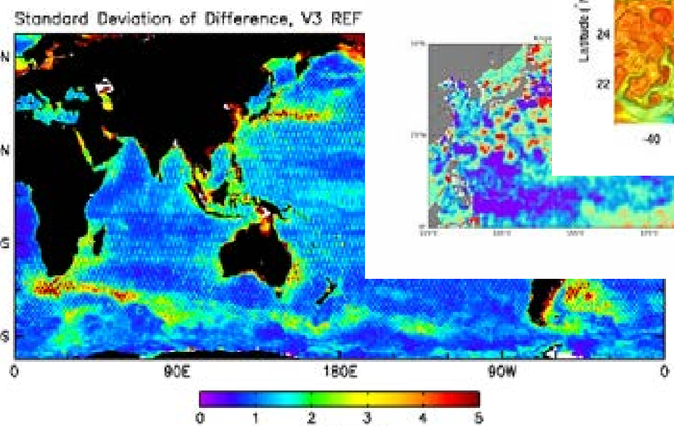


Climate Indices

Numerical model assimilation

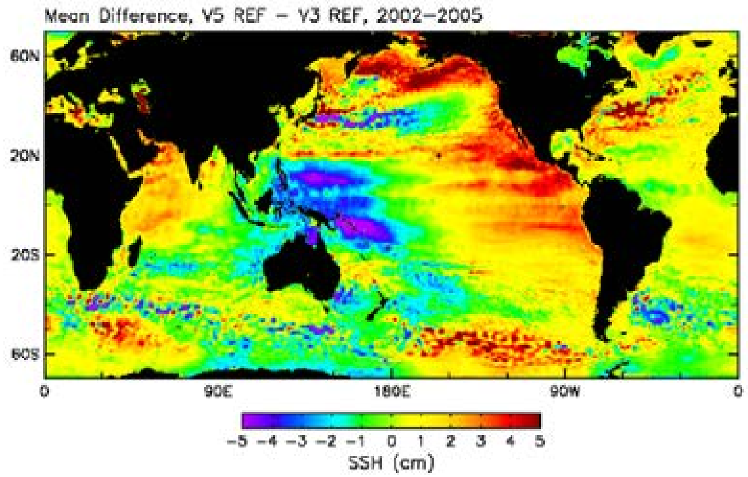


Advanced gridded multisensor applications

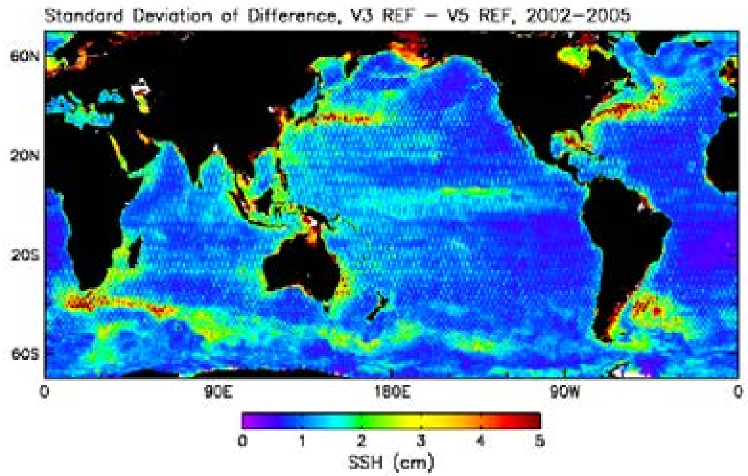


Advancements in AVISO Grids

Mean and Standard Deviation of the Differences
DT-2014 REF minus DT-2010 REF, Oct 2002-Sept 2005



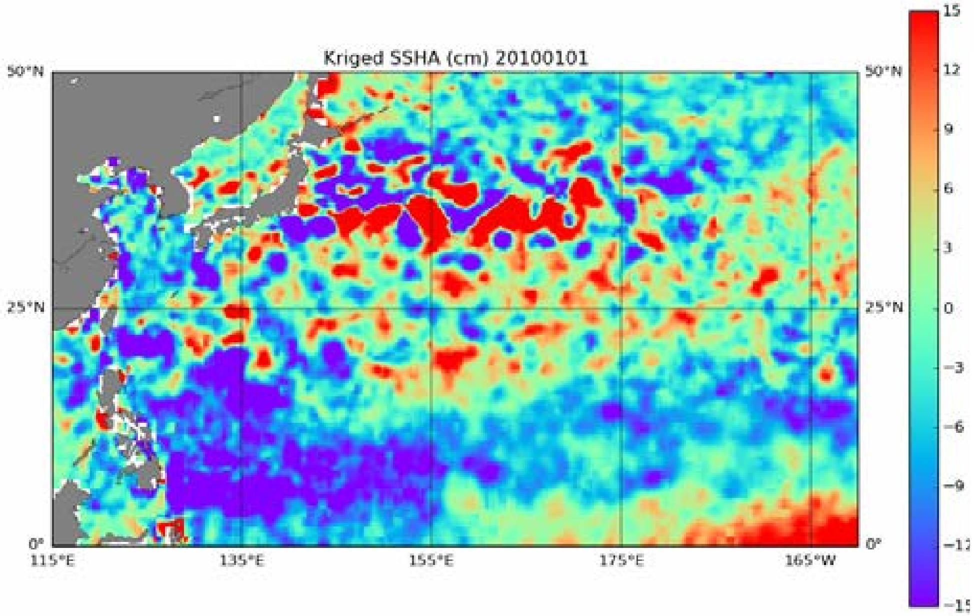
- Differences exceed 5 cm in the eastern and western Pacific and at high latitudes of the North Pacific.
- Patchy differences in the regions of strong currents are indicative of different mean flow conditions over the 20-yr averaging period compared with the previous 7-yr average.

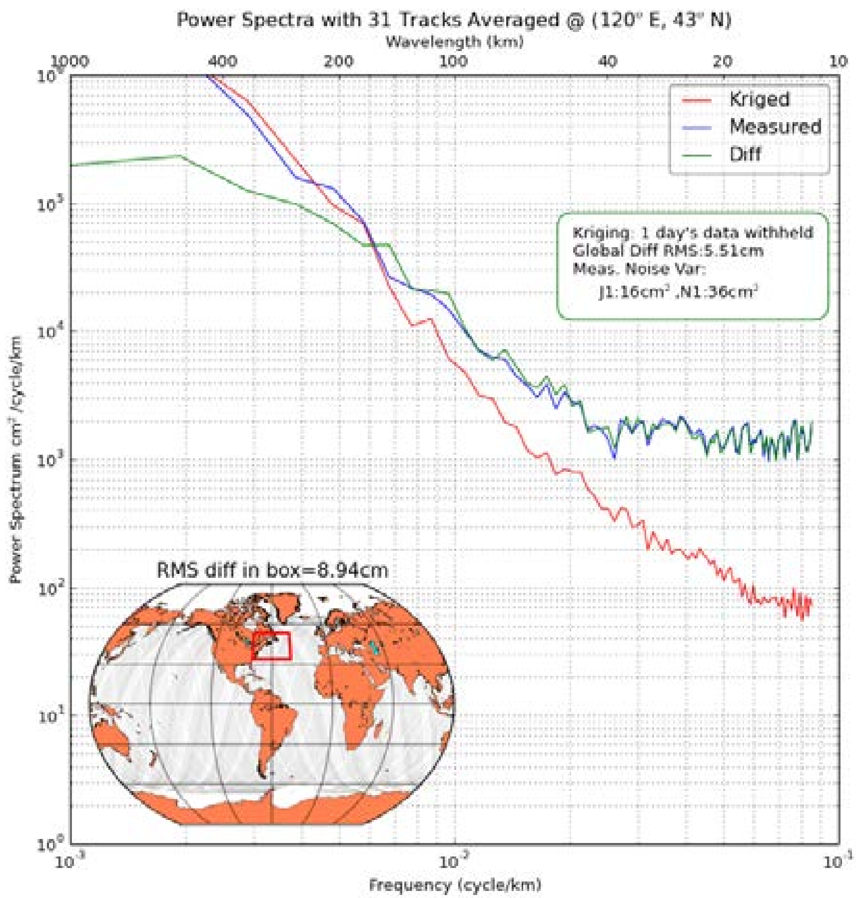


- Differences are typically 1-4 cm and exceed 10 cm in energetic regions.
- An underlying "checkerboard" pattern is correlated with the ground track of the 10-day repeat orbit (see regional figures).

(Chelton [*Pujol*])

JPL Gridding Performance Relative to Along-track Observations



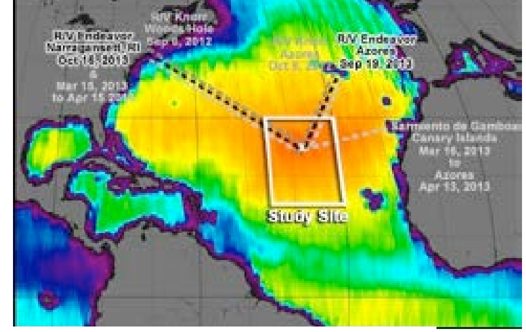


Spectra of the alongtrack data, the map interpolated alongtrack, and their difference. The data were NOT used to generate the map.

For this region wavelengths longer than ~ 180km are resolved. RMS diff 8.9cm

(Willis [*Zlotnicki*])

NASA SPURS Experiment



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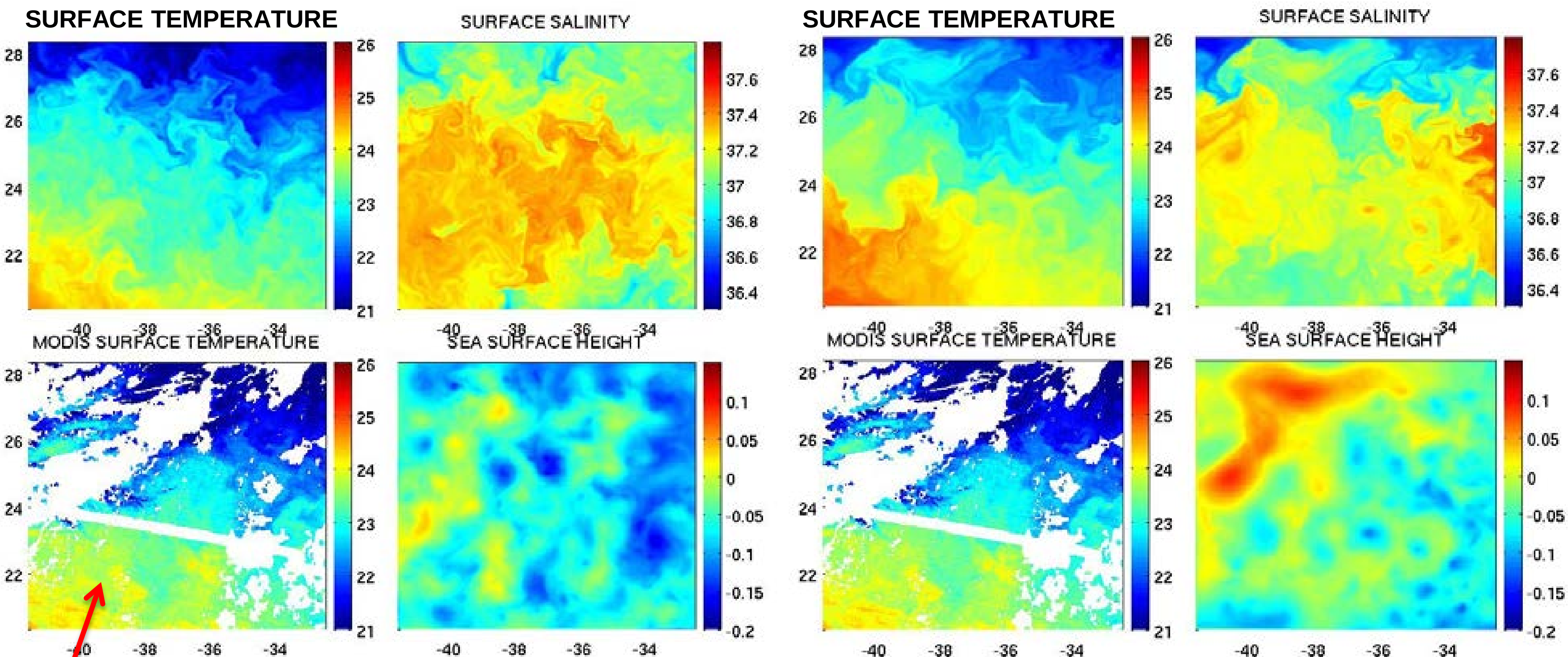
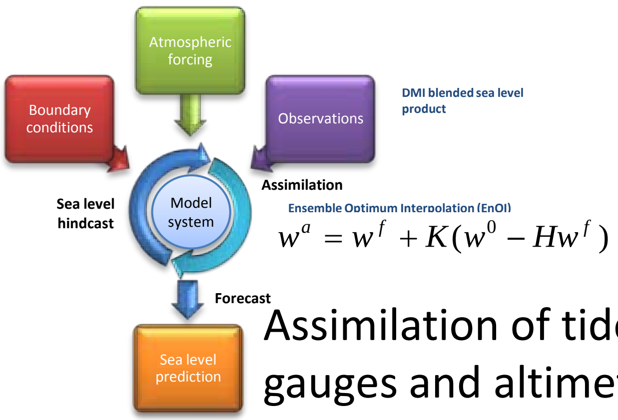


1-km MODIS SST

24h Forecast, Valid at UTC 03, March 25, 2013

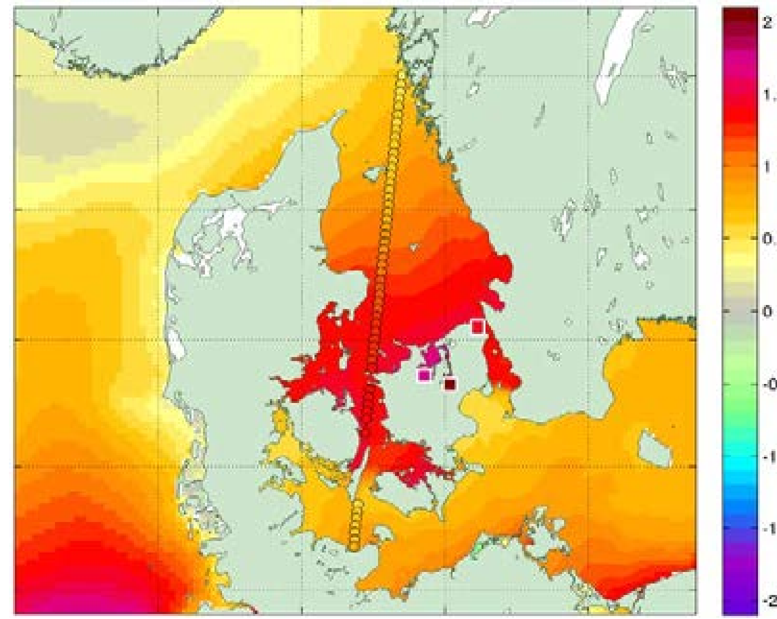
(Li)

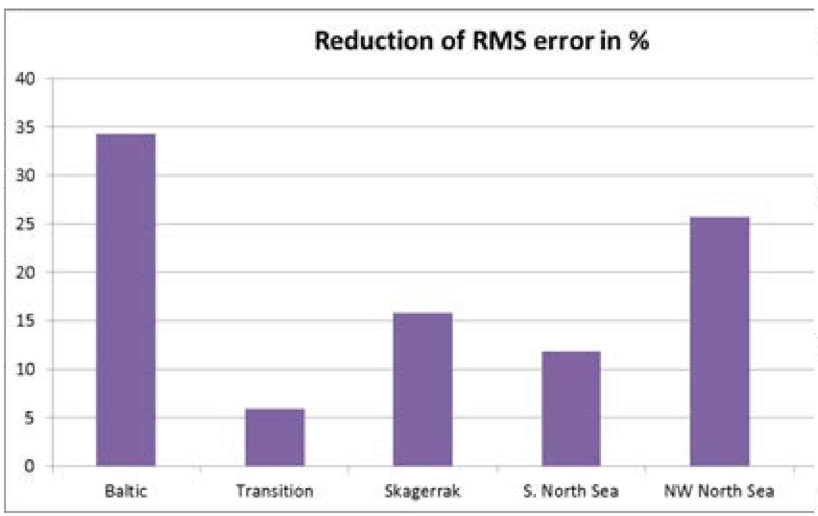
Storm Surge during Bodil, Denmark



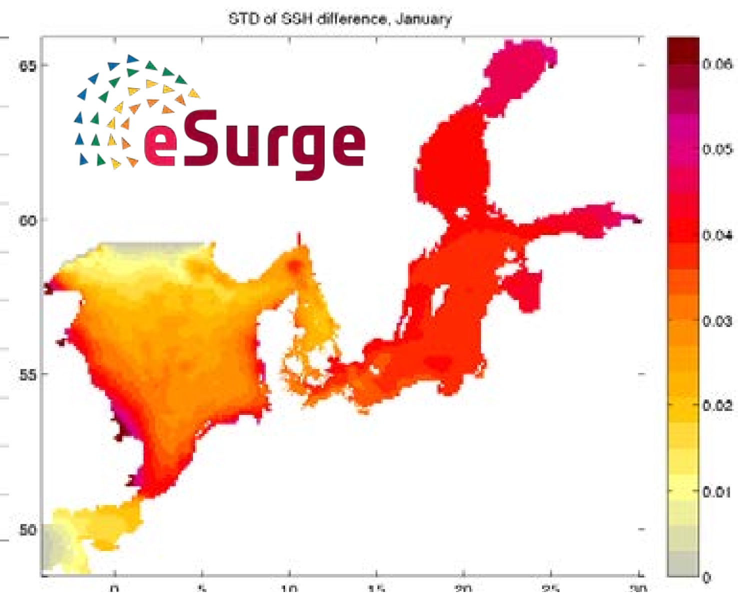
Assimilation of tide gauges and altimetry

Bodil storm surge forecast compared to CryoSat-2 observations





Root mean square error reduction at independent validation stations, averaged by area and over 2 years.



Standard deviation of change made by assimilation, January 2003 and 2004.

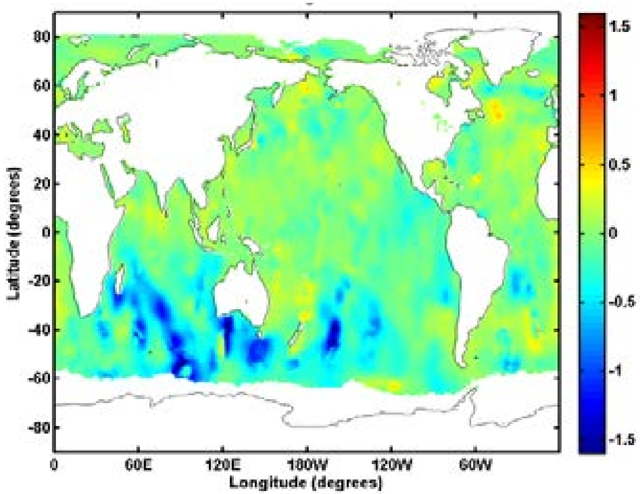
(Madsen)

Altimeter + SAR assimilation

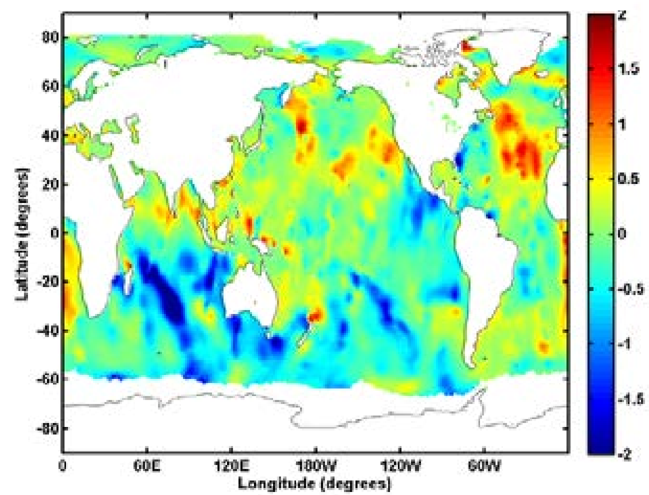
METEO FRANCE
Toujours un temps d'avance

Jason-2 + Saral Improvement ~6% on SWH compared to the operational MFWAM

Swell wave height



Mean Wave Period



Altimeter and ASAR Impact
Difference between MFWAM-UP with and without assimilation

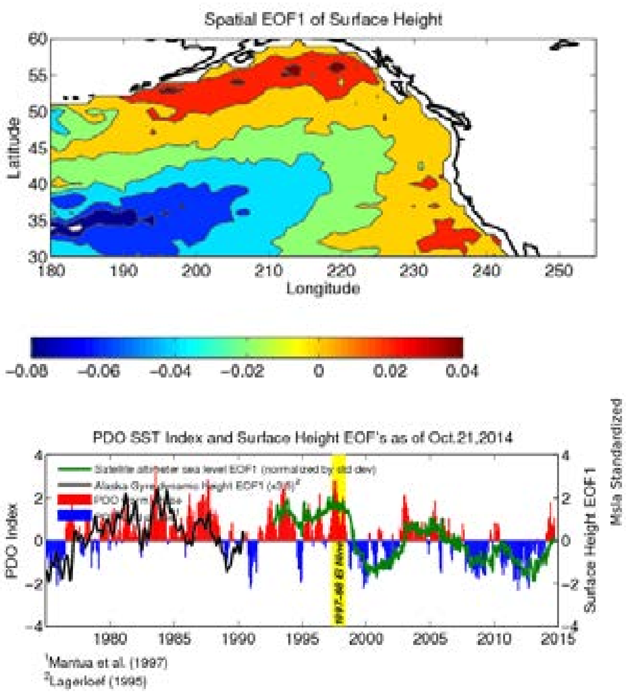
(Aouf)

Climate Indices

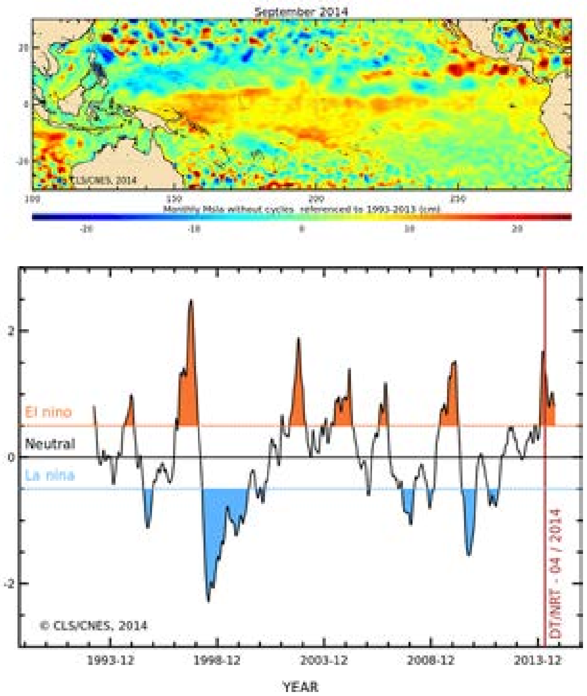
(Leben [*Hamlington*])

Produce a consistent set of near real-time (NRT) and historical ocean climate indices based on satellite altimetry and sea level reconstructions.

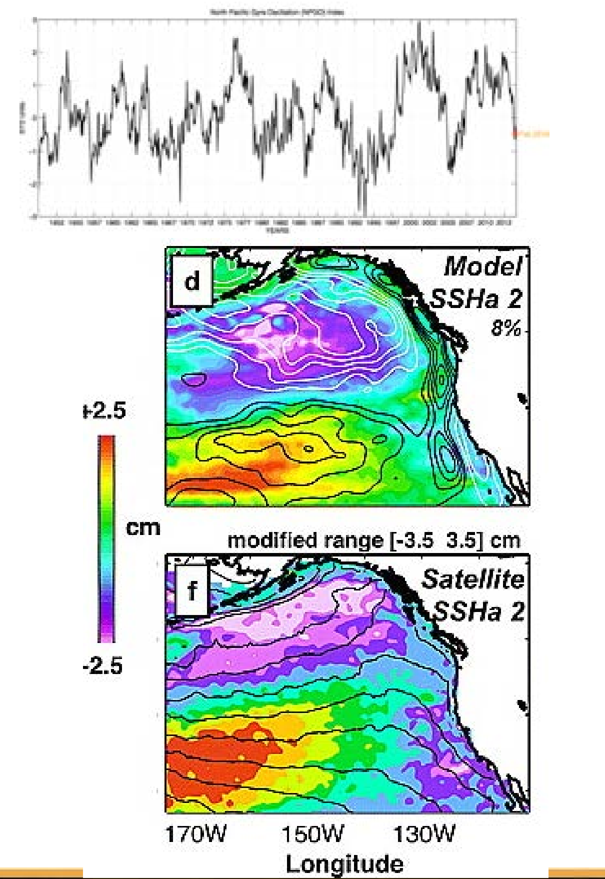
PDO

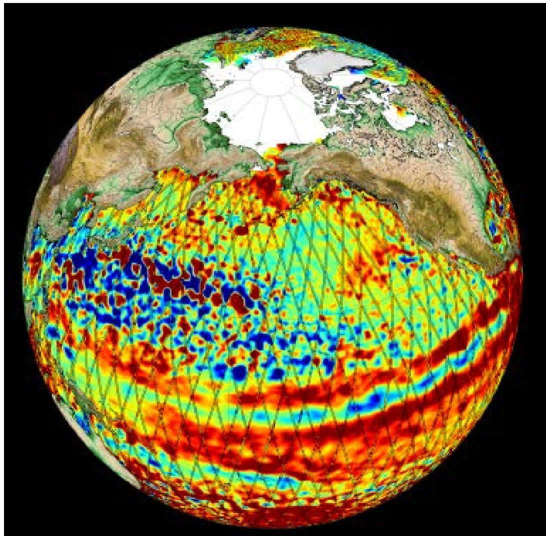


ENSO

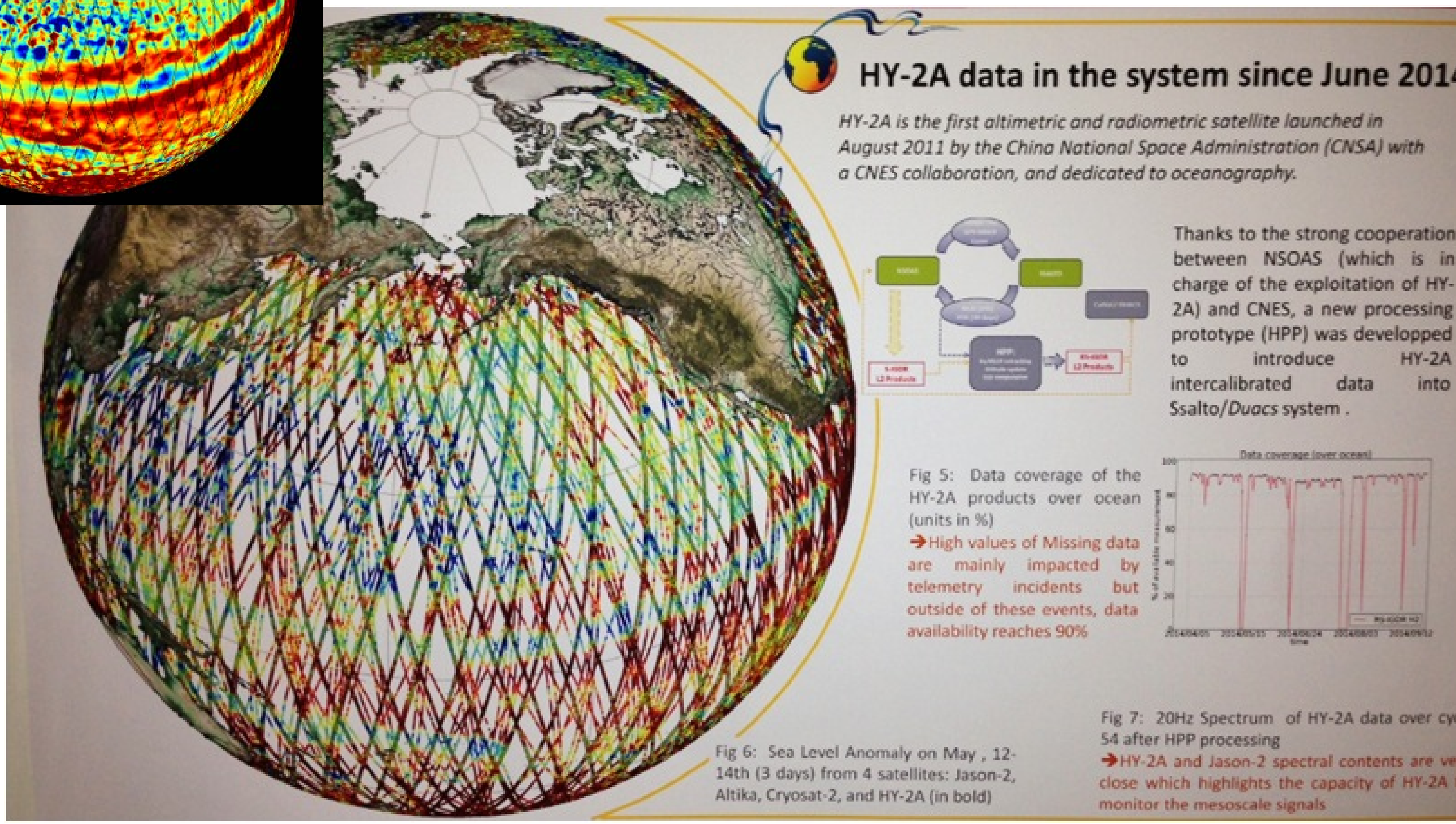


NPGO





DUACS 2014 & HY-2A



(Faugere)

Key Conclusions

- **New NRT AVISO products demonstrated in DT-2014 relative to DT-2010 (Chelton [*Pujol*])**
  - Advancements in sensor specific corrections, along track treatment, covariances
  - Eddy amplitudes, propagation speed, nonlinearity increase
  - Added data sources increases energy
- **New interpolation processes based on Krigging (Willis [*Zlotnicki*])**
  - Evaluation against withheld altimeter data shows noise levels decrease
- **Assimilation in dynamical models during NASA SPURS experiment (Li)**
  - Model dynamics produces submesoscale salinity anomaly similar to observed
  - Energetics increase dramatically relative to data-only analyses
- **Application and assimilation in storm surge forecasting (Madsen)**
  - Forecast errors reduced 5-35%
  - STD of SSH differences over 6 cm
- **Wave forecasts extended with assimilation of altimeter observed SWH and SAR (Aouf)**
  - Jason-2 as a reference, significant improvement using altimeter +SAR at high latitudes
  - Tropics improve when using altimeter and SAR together
- **Climate monitoring (Leben [*Hamlington*])**
  - Climate indices based on altimeter data: El Niño, PDO, NPGO
  - Developing methodology to build climate indices prior to 1993

NRT Round Table Summary

Jason-2/Jason-3 transition:

- DIODE/DEM mode for J-2 &/or J-3 during formation phase
  - OK; Alternating J-3 Median/DEM cycles may impact inland water users…
- Jason-2 interleaved orbit at end of formation flight
  - OK; any reason to reconsider 3-day vs. 5-day interleaved lag?

Jason-2 Extension of Life:

- Needs for geodesy vs. operational oceanography
  - Improvement of MSS benefits coastal/shelf operational oceanography
  - Consideration of exact repeat/subycles. No move till we must…
- Protection of reference & interleaved orbits - OK

Other topics:

- LRM/SAR continuity
  - Sentinel-3 SAR/LRM asc/desc (or alternating cycles) and data available ASAP…
- Jason-1 GDR-E updates
  - Provide J-2/J-3 OGDR-E with NRT MOG2D DAC as an additional field
- Jason-3 Numerical Retracker
  - Consider adding Dcorr retracker too, but beware of product “bloat”

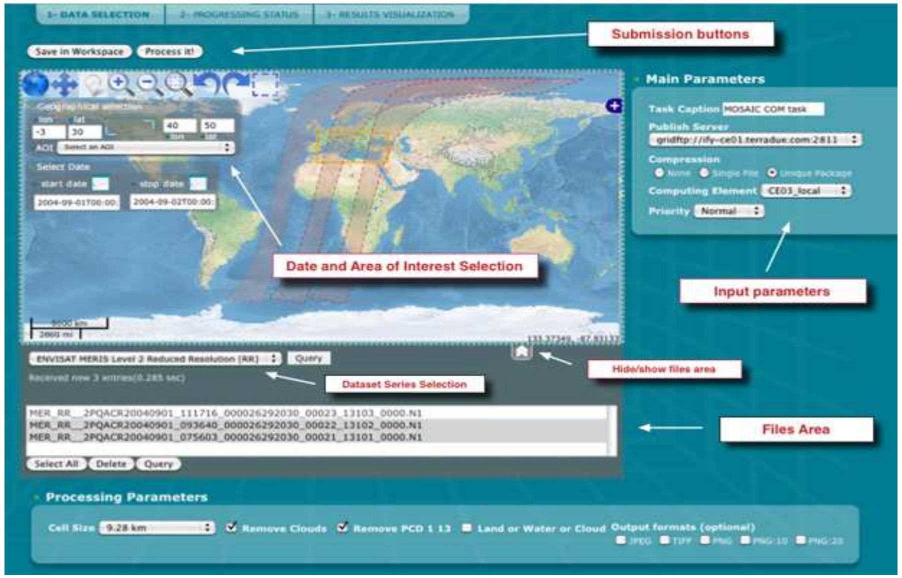
Outreach &
Data services

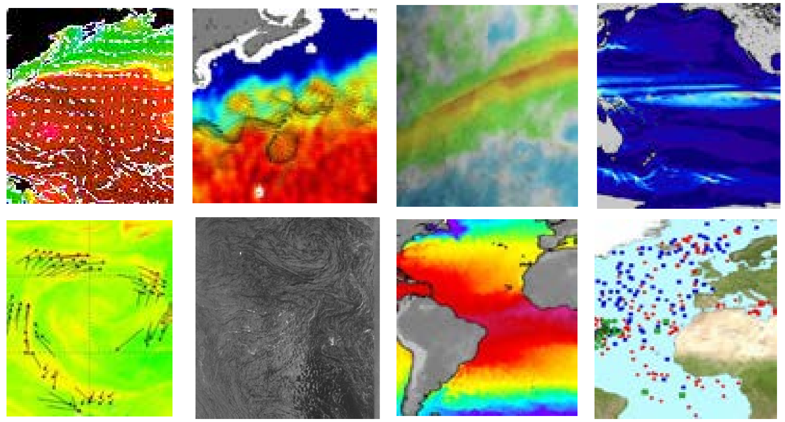
In summary

- Data Services: 4 presentations, 1 showcase, 4 Posters
- Outreach: 2 presentations, 7 showcases, 1 feedback, 3 Posters

- The short format of the "outreach showcases" a great success

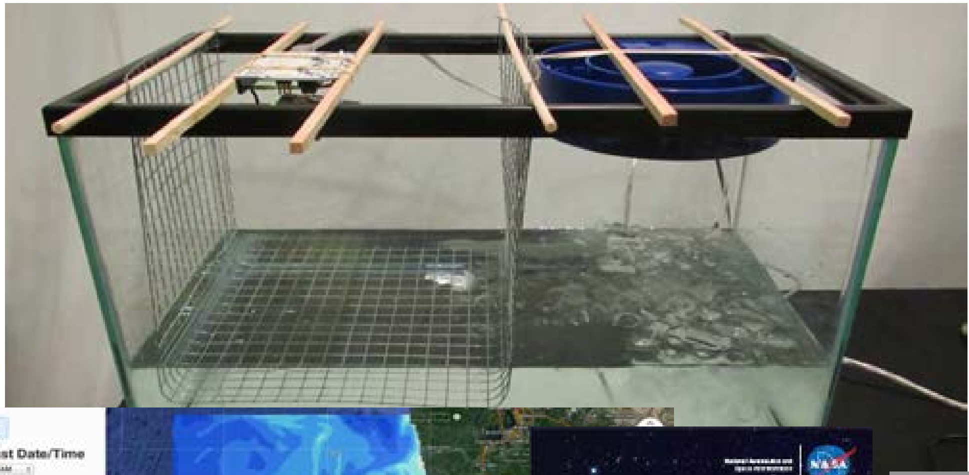
GLOBCURRENT

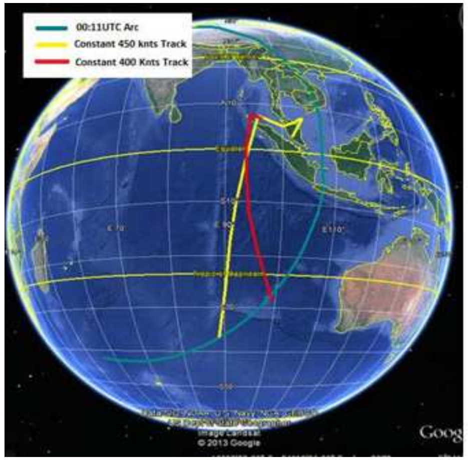


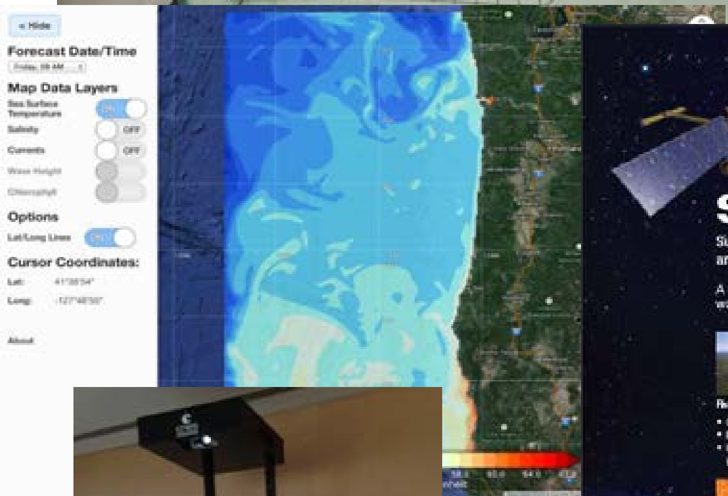


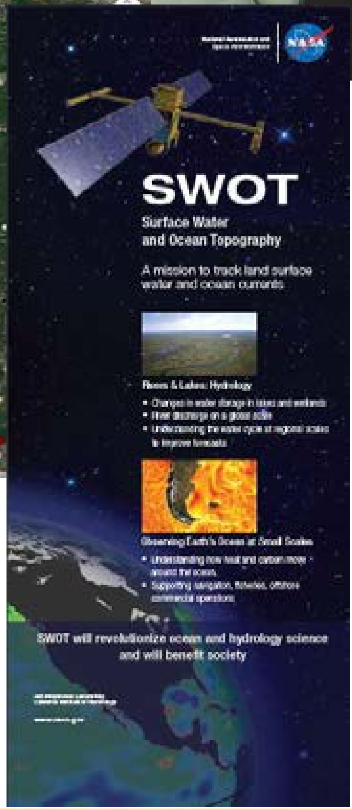
Data services

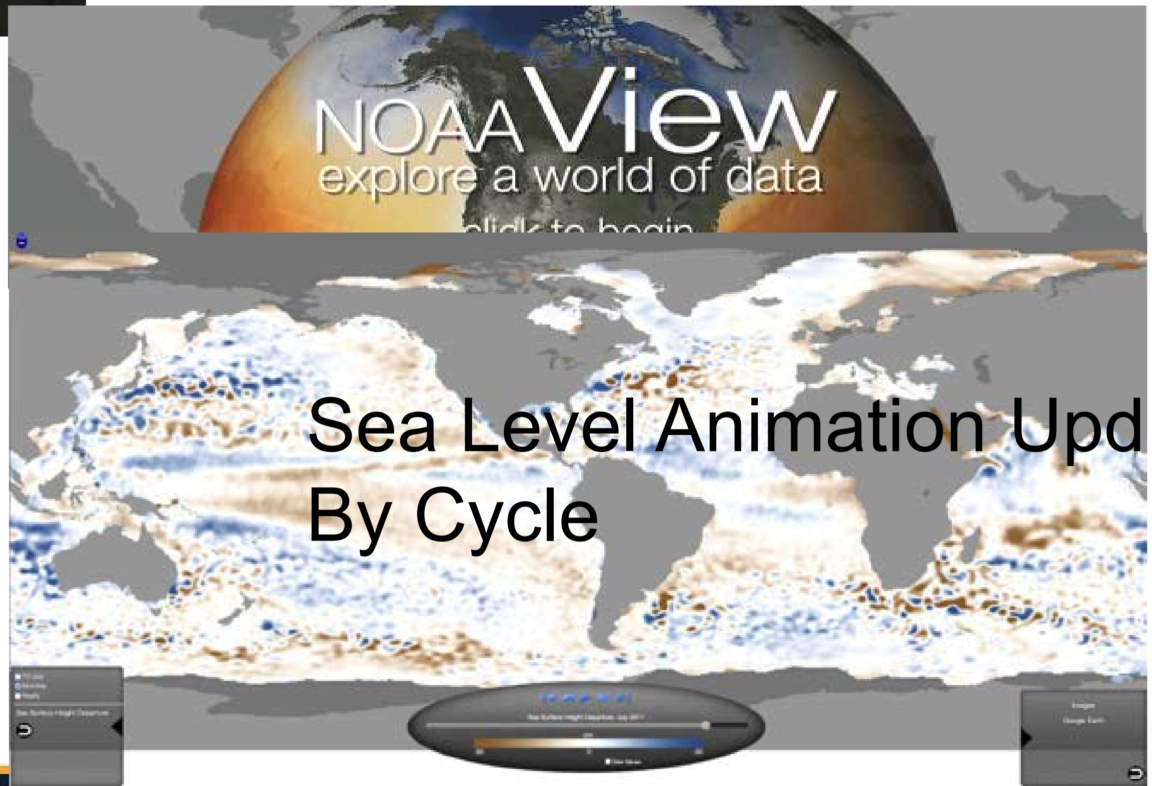
- New products distributed, from grids to SAR altimetry-specific processing outputs
- New services (online, interactive including web services) to distribute them
- Discussion about « open and free access » vs registration-based access.
  - Given the choice, most users chose not to register
  - But registration is a mean to know them better, and better serve them









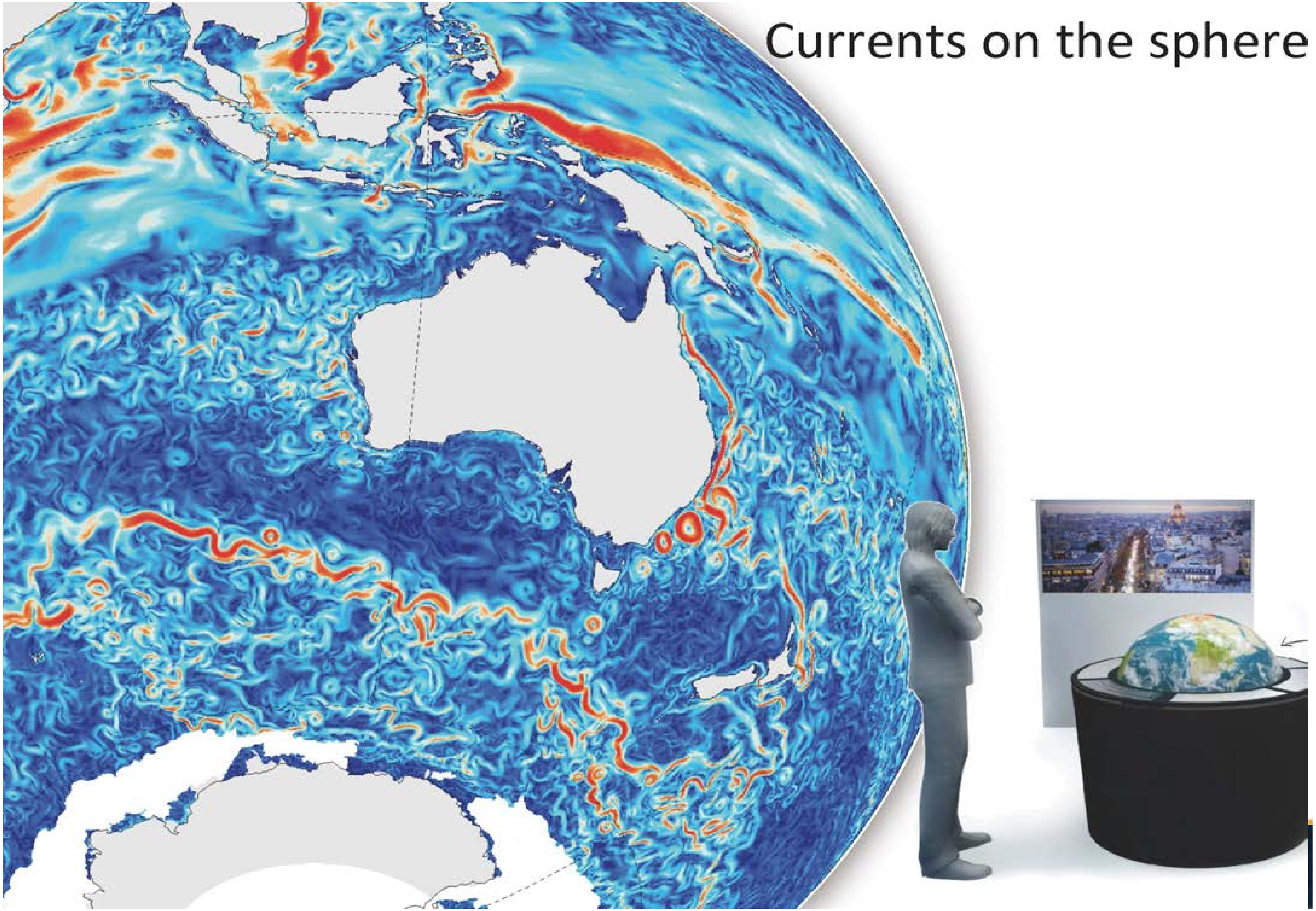


Sea Level Animation Upd By Cycle

Recommendations / perspectives

- A number of resources (figures, maps, movies, animations, schemes…) available
  - On the web
  - On our computers / databases
- don't hesitate to ask for general material or a specific theme / figure
  (at worst, we can think about having it made for future uses)
- If you have "hands-on" activities, try to write a rough description to share it

Currents on the sphere



Recommendations / perspectives

- Jason-3 / Sentinel-3 launch planned next year
- COP21 Climate conference in Dec. 2015

→ preparing for those launches AND the climate conference

OSTST posters on the web

- A complete overview of what was shown during this meeting
- An archive of past meetings (from 1998)

- **UPLOAD** them in pdf on http://meetings.aviso.altimetry.fr using the account used to submit abstracts.
  (you can also upload your presentations)
- Your posters available online at this address

- ❑ **Objectives:** Establish the link between altimetry experts and applications (MSL, mesoscale, etc)
- • New insights about errors in the altimeter system

$\Rightarrow$ From experts to applications

- • End-user needs and requirements in terms of errors, including formalism of errors

$\Rightarrow$ From applications to experts

- ❑ Splinter divided into 3 parts :

1) Mean Sea Level applications : 2 talks / 2 posters
2) Ocean circulation & mesoscale : 2 talks / 2 posters
3) Analysis and formalism of errors : 2 talks / 2 posters

Mean Sea Level Applications

- **E. Leuliette et al** . Global and regional biases in sea level can be determined with a 6 month tandem cal/val phase:

➔ Jason-2/CryoSat global biases are well determined after 6 months without tandem data;

➔ The radiometer calibration doesn't benefit significantly from an extended tandem phase;

➔ The seasonal, geographic variations of sea state make the SSB vulnerable to geographically-correlated errors;

➔ If the geographically-correlated errors between J3 and S6/JCS were sufficiently small, 6 months would be sufficient to determine the SSB;

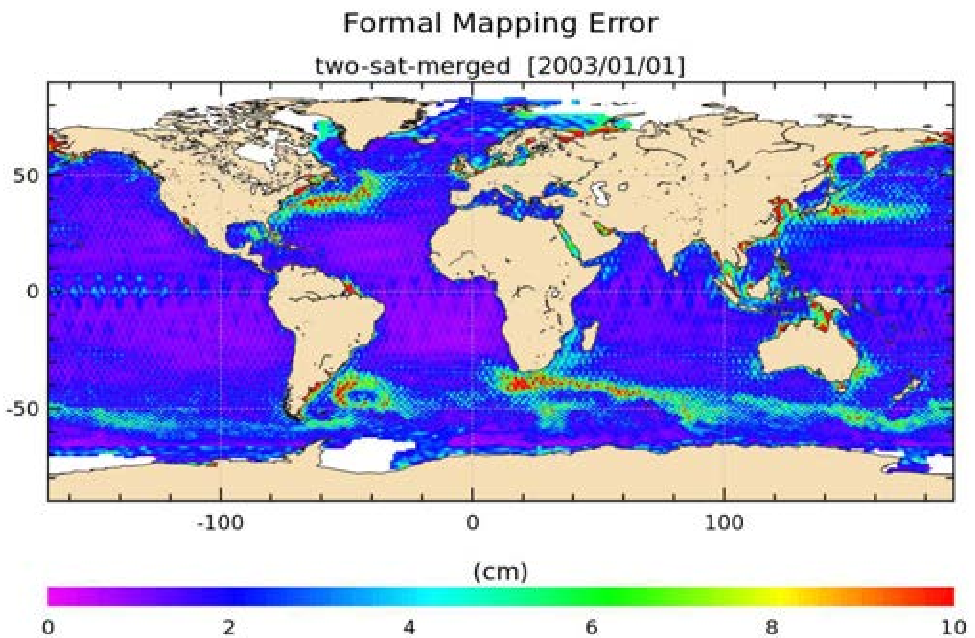
➔ The Jason-2/Jason-3 cal/val (as scheduled) will poorly sample high waves in the Northern Hemisphere, as they would be sparse at the time

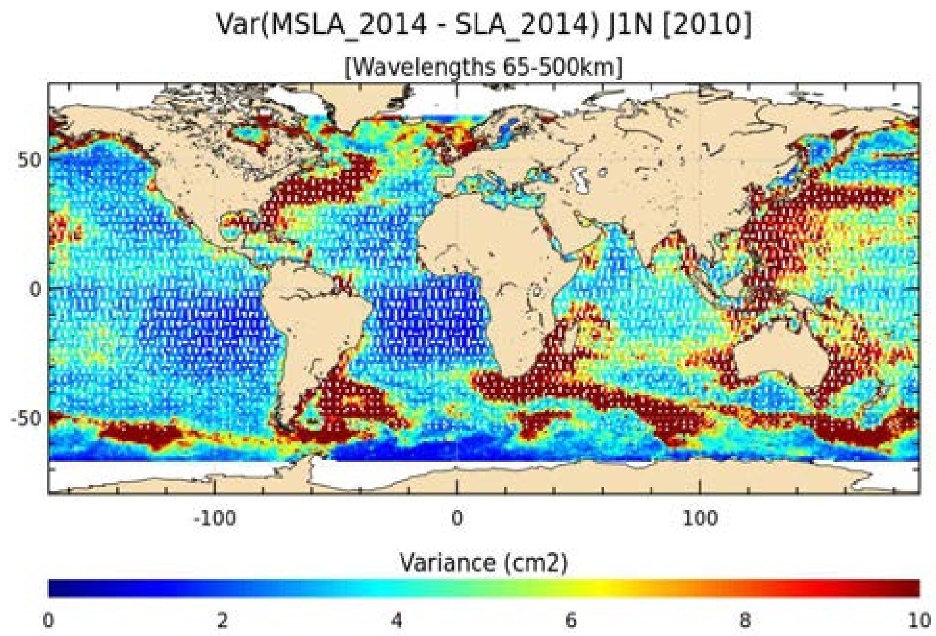
- **M. Scharffenberg et al. :** Sea Level ECV quality assessment via global Ocean model assimilation
➔ currently errors of the model are larger than altimetry errors but the description of altimetry errors (at climate scale) is very useful for the validation of model outputs.

- **L. Zawadzki & M. Ablain et al.** calculate the envelope errors of the global MSL time series for jason-1 and Jason-2 missions: work on-going

Ocean circulation & mesoscale

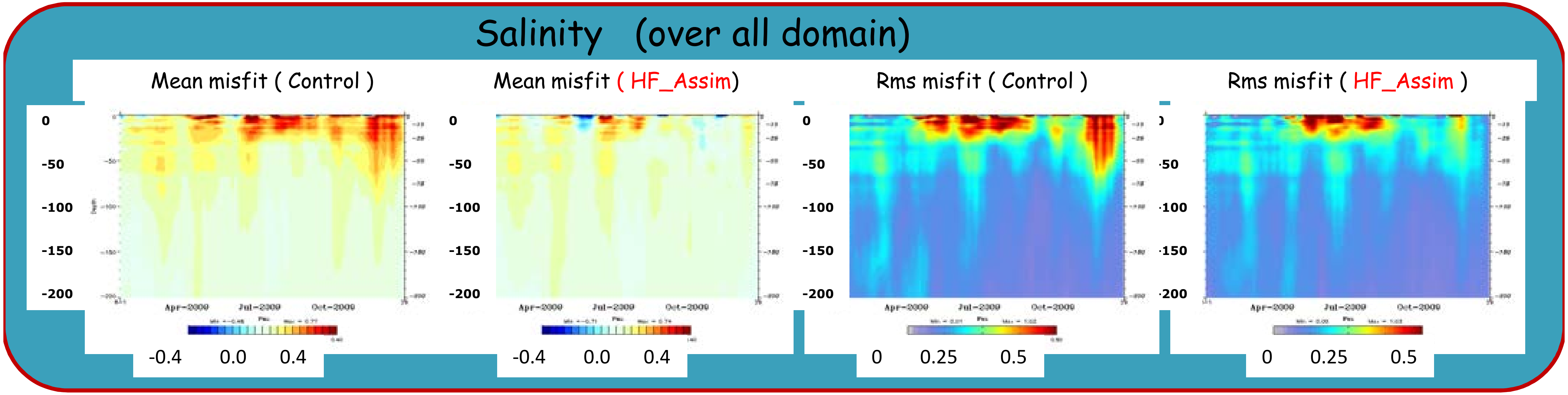
- **I. Pujol et al.** provide a better evaluation of errors in merged DUACS/AVISO Sea Level products at mesoscale: Formal mapping error e.g. instantaneous error associated with a map (already available); Upper bound error estimation at mesoscale (based on comparison between maps and independant along-track)





Ocean circulation & mesoscale

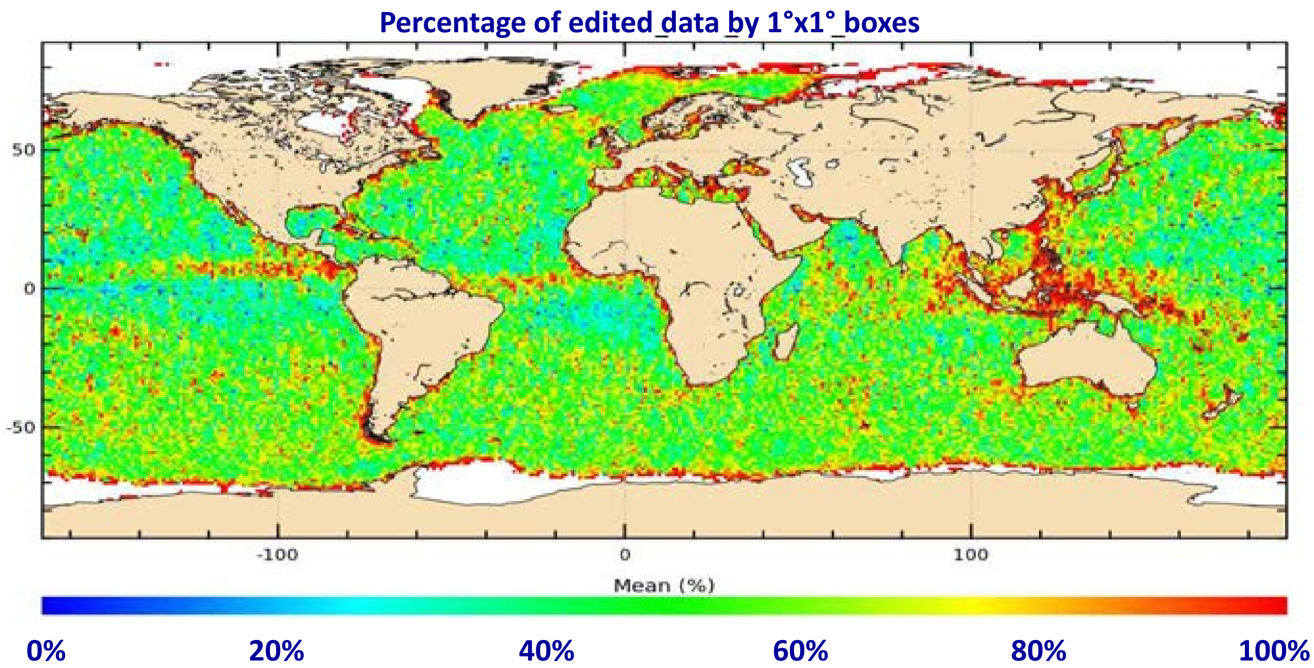
- **M. Benkiran & I. Pujol et al.** Model errors are reduced when assimilating data consistent with the model resolution & physical content ➔ need to develop specific products (and budget error associated) for assimilation purpose



- **Simon Verrier et al. (Poster)** test the impact of present and future altimetric missions on ocean forecasts ➔ changing the budget error from LRM to SAR measurements do not impact the model assimilation since errors of the model are larger

Analysis and formalism of errors

- **J.C. Poisson et al.:** Wavelet analysis of AltiKa measurements strongly improves the detection of ocean surface heterogeneities: this information could be provided to users via ODES



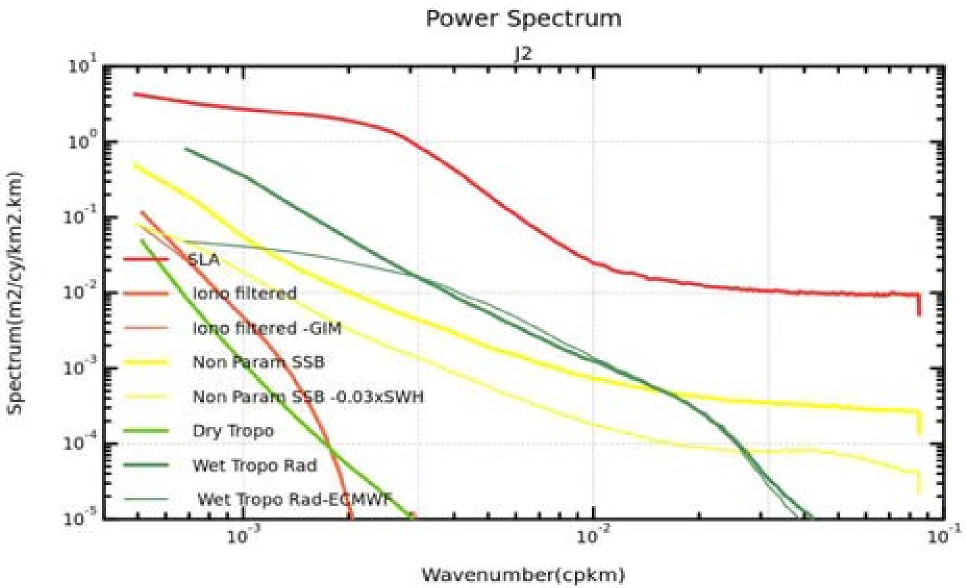
- **G. Quartly et al.** (Poster): Improving the sea-level estimates in the Arctic by filtering out better the waveforms impacted by sea ice

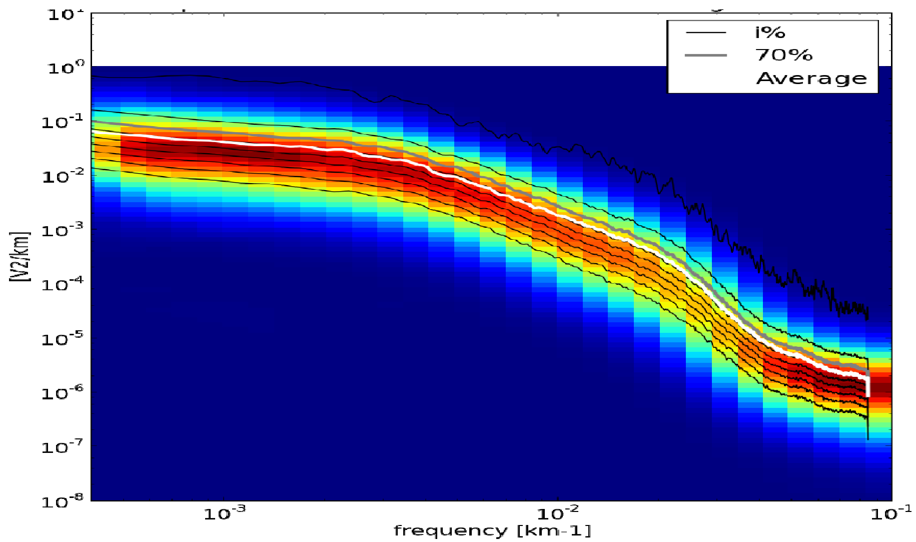
Analysis and formalism of errors

- **A. Olivier et al. :** Improvement on the characterization of the error by performing a spectral analysis of altimetric signal and errors for Jason-2 measurements:

- work is on-going and the objective is to provide a spectral error budget of sea-level

SSH = Orbit - Range - Iono - Sea State Bias - Dry tropo - Wet tropo





Number of individual spectra averaged per box

- **G. *Dibarboure et al.*** *(Poster) point out the interest of a new approach based on the Radon transform to detect anisotropic error sources*

Conclusions

- from last OSTST :
  - better interaction between end-users and altimeter groups
  - new insights allowing a better description of the altimeter errors
  - new method to characterize the errors

- Recommendation for the next OSTST:

  - Encourage feedbacks from end-users to better characterize the error for their studies are very encouraged !

  - The errors should not only be in the form of a static table; instead they should consist of errors as function of wavelength and conditions (e.g. Sea State)

  - We need to characterize the errors on regional sea level trends and to provide these errors (e.g in peer review papers, inclusion into products)

  - The propagation of measurements errors into the final products should be further studied.

Tide Splinter: A too-short summary

Carrère & Lyard: FES2014 atlas to be released by end of 2014.

Zhao, Girton, Alford: First-cut global maps of coherent internal tides
M2, O1, K1, and (maybe) S2

Desai & Ray: Geocenter adjustment needed for all
altimeter-based ocean-tide models

See program for other talks and posters!

Tides Round Table Points

1. No input to DIODE/DEM decision.
   – except we do not want to lose data from inaccurate DEM.

2. We look forward to more years of J-2 data on the interlaced tracks.
   – will improve mapping both internal & coastal tides

3. Proposed Jason-2 "internal tide campaign"

Purpose: Explore temporal coherence of internal tides – possibly critical for SWOT

Proposal: Keep J-2 on J-3 ground-track (for ~6 cycles) but delayed by ~3 hours (or even 6 hours). J-2 and J-3 then see out-of-phase internal tides.

Problem: Requires either
(a) moving J-2 ascending node by 45° or more
(b) launching J-3 into different orbit plane which eliminates J-3 tandem verification campaign.

And anyway: study needed to establish signal:noise.

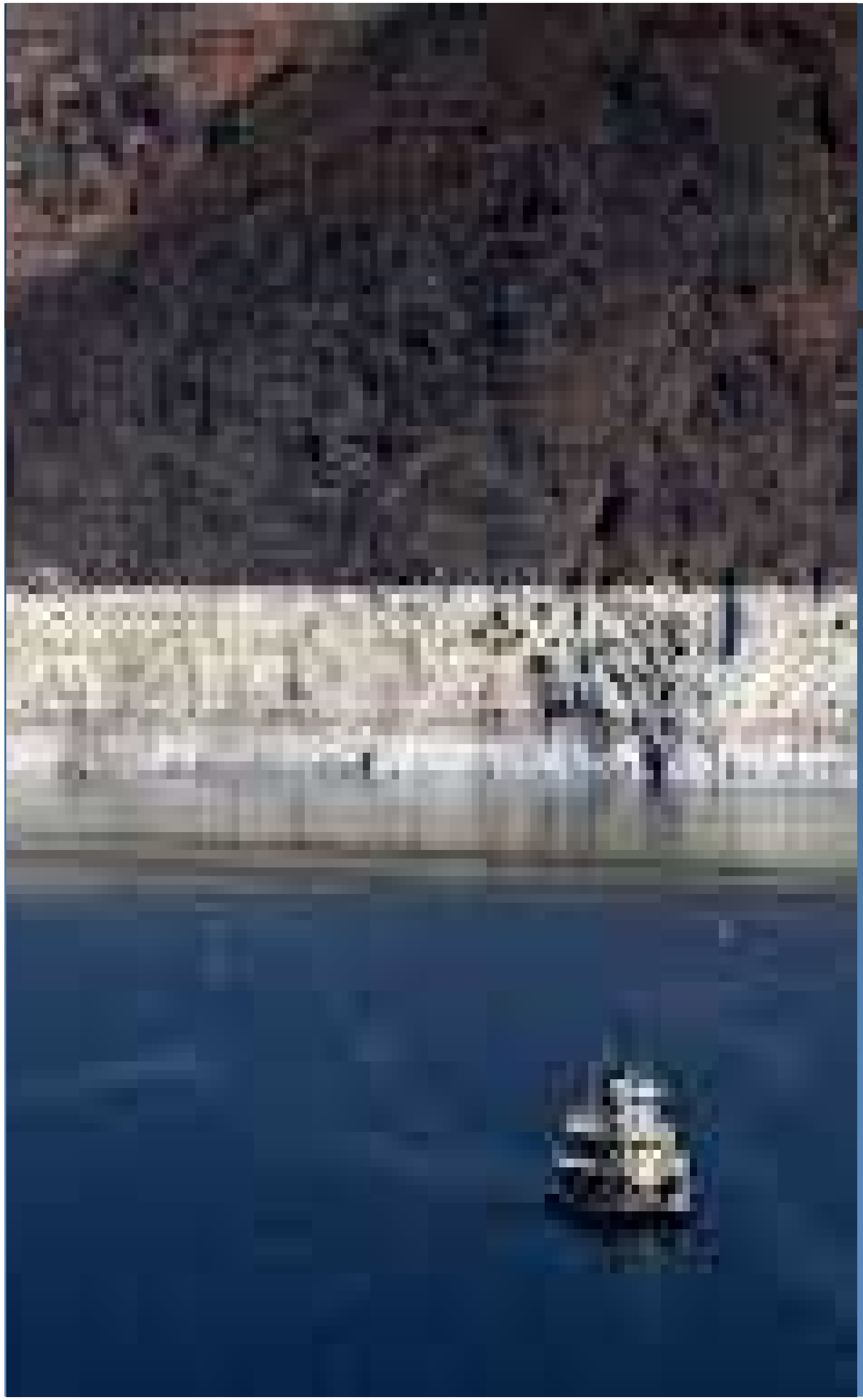
Science Results from Satellite Altimetry
Inland Waters
Multi-mission and Long-term monitoring

21+8 Abstracts OSTM+SARAL
Far larger International community

Focus on Lakes, Reservoirs, Wetlands and Rivers

Radar (and Laser) altimetry
Jason2/OSTM, SARAL, Envisat, Cryosat-2, ICESat-1, and Ka-band Interferometry

Study Regions:, Po, Ganges, Brahmaputra, Congo, Amazon basins, Madagascar, and
Danish, Turkish, Brazilian, African and Iranian lakes



Data Bases – ***for accessing altimetric parameters.***

Data processing/retracking – ***for improving target size and land/water boundary limitations, and improving elevation accuracy. Including many cross-comparisons between different retrackers and atmospheric corrections.***

Verification and Validation Schemes – ***for checking future near real time data.***

Online Product Databases – ***for lake, reservoir, wetland and river channel variations. Application orientated aimed at stakeholders.***

General Instrument Performance – assessing the new SARAL data set.

Forward look to SAR techniques – Cryosat-2 and SWOT.

Acquiring discharge and river morphology

Modeling River Surface Slope – Envisat good
Deriving River Rating Curves (databases)
Characterization of River Surface Roughness – use of pressure sensors/stereo photogrametry
Improving temporal resolution – treating the basin as one "dynamic" system.

Climate change and Hydrological Zones

Defining zonation via correlation between multiple virtual stations.
Modeling Lake/Reservoir water levels – aiming at a truly global perspective.

Hazards Applications

(MODIS/SAR/SSMI/GRACE/TRMM)
Floods and Drought - Variability in fresh water supply, or loss of infrastructure and damages.

Much focus on new missions such as Cryosat-2 (LRM, SAR, SARIn), and SARAL, validation and retracking tests still ongoing.

Cryosat-2 - LRM good accuracy cf contemporary instruments
- good use for bridging ENV/SARAL time gap

SARAL – good performance (e.g., rms on 40Hz 3-5cm, 5-30cm rms with gauge)
- breaking through existing water body size limitations<100km2, <50km2
- improved accuracy, closer proximity to coastlines, expected seasonality (bias/striping some further investigation of tracking/data processing)

Retracking – Many systems, many new retrackers and techniques, emphasis on subwaveform retrackers (variable cm improvements on cm-decimeter RMS).

Continuity and tandem missions required to resolve inter-mission bias.

Question of the use of Jason2-/Jason-3 DIODE/DEM mode not been answered here across the entire community.

Clear demonstration of the usefulness of RA data in un-gauged basins.
Good expectations from Sentinel-3, Jason-3, Jason-CS, SWOT – especially for wetland studies with improved spatial coverage/resolution.

Science Results from Satellite Altimetry: Finer scale ocean processes (mesoscale and coastal)

Wed, Oct 29 2014, 14:00 - 15:45

Session chairs:

David Griffin, Jacques Verron and Rosemary Morrow

7 Oral presentations
35 poster presentations !

Mesoscale capability of along-track altimeter data

Claire Dufau (CLS), Marion Orsztynowicz (LEGOS), Gérald Dibarboure (CLS), Rosemary Morrow (LEGOS), Pierre-Yves Le Traon (MERCATOR)

Wavenumber Spectra in Drake Passage from models, altimetry, and ADCP: Connecting theory to observations

Sarah Gille (Scripps Institution of Oceanography, UC San Diego), Teresa Chereskin (Scripps Institution of Oceanography, UC San Diego), Bruce Cornuelle (Scripps Institution of Oceanography, UC San Diego), Matthew Mazloff (Scripps Institution of Oceanography, UC San Diego), Cesar Rocha (Scripps Institution of Oceanography, UC San Diego), Jinbo Wang (Scripps Institution of Oceanography, UC San Diego)

Seasonal Mesoscale and Submesoscale Eddy Variability along the North Pacific Subtropical Countercurrent

Bo Qiu (University of Hawaii), Shuiming Chen (University of Hawaii), Patrice Klein (Ifremer), Hideharu Sasaki (JAMSTEC), Yoshikazu Sasai (JAMSTEC)

Frontogenesis Predictability in the Gulf Stream

Gregg Jacobs (Naval Research Laboratory), James Richman (Naval Research Laboratory)

Spatial variability of the annual cycle in coastal sea level: a regional study

Marcello Passaro (GSNOCS University of Southampton / European Space Agency - ESRIN), Paolo Cipollini (Marine Physics and Ocean Climate Group, National Oceanography Centre, Southampton), Jérôme Benveniste (European Space Agency - ESRIN)

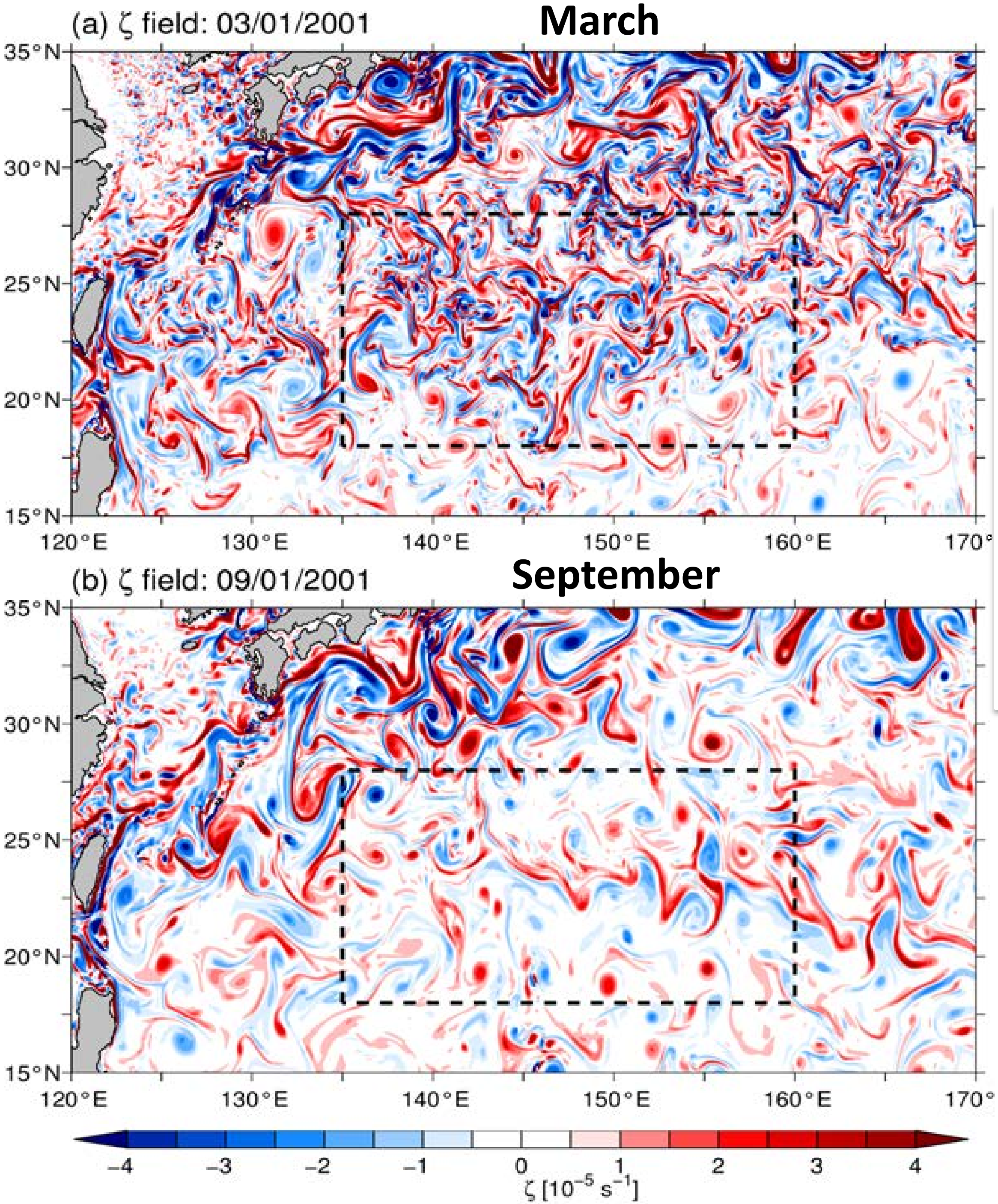
Exploring the mesoscale activity in the Solomon Sea: a complementary approach with a numerical model and altimetric data

Lionel Gourdeau (LEGOS/IRD), Jacques Verron (LGGE/CNRS), Jacques Melet (LEGOS), William Kessler (NOAA/PMEL), Frédéric Marin (LEGOS/IRD), Bughsin Djath (LEGOS)

Behaviour of oceanic mesoscale eddies over the Bay of Bengal in contrasting monsoon years

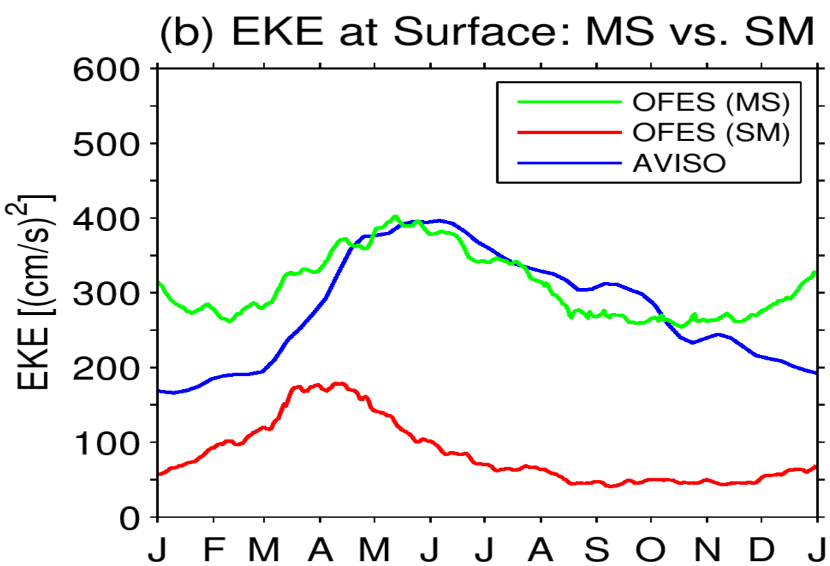
Subhra Prakash Dey (IIT Kharagpur, India), Mihir K. Dash (IIT Kharagpur), P. C. Pandey (IIT Bhubaneswar)

Example – observability in HR models

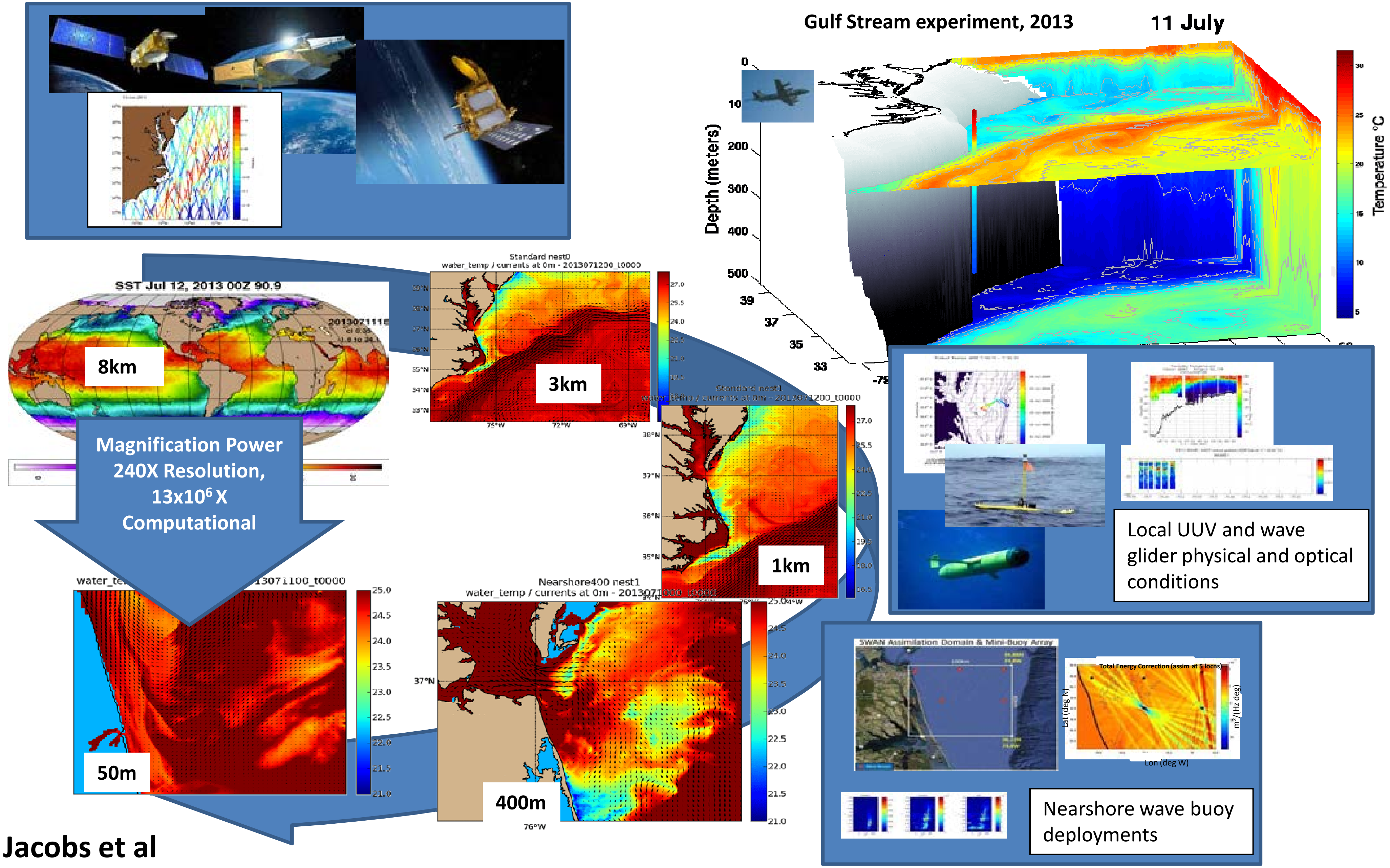


Qiu et al.

Small ML instabilities occur rapidly in late winter, larger mesoscale instabilities develop slowly due to inverse cascade: AVISO maps only detect the larger eddies in NP STCC

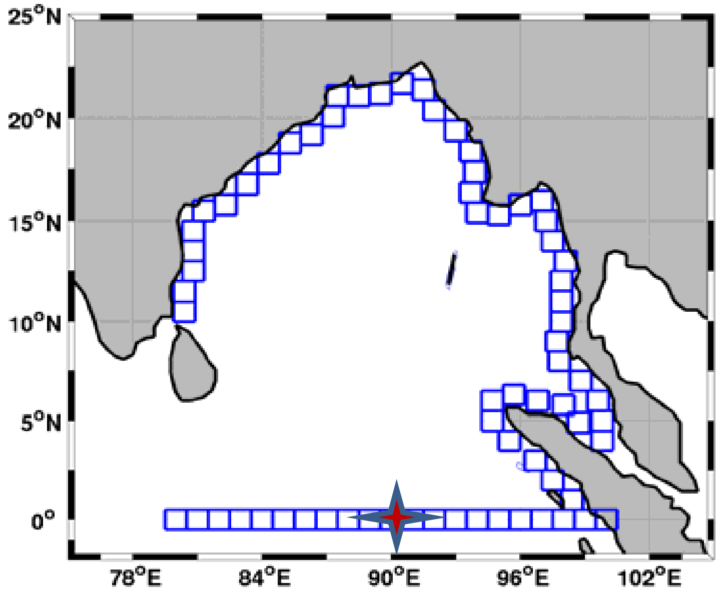


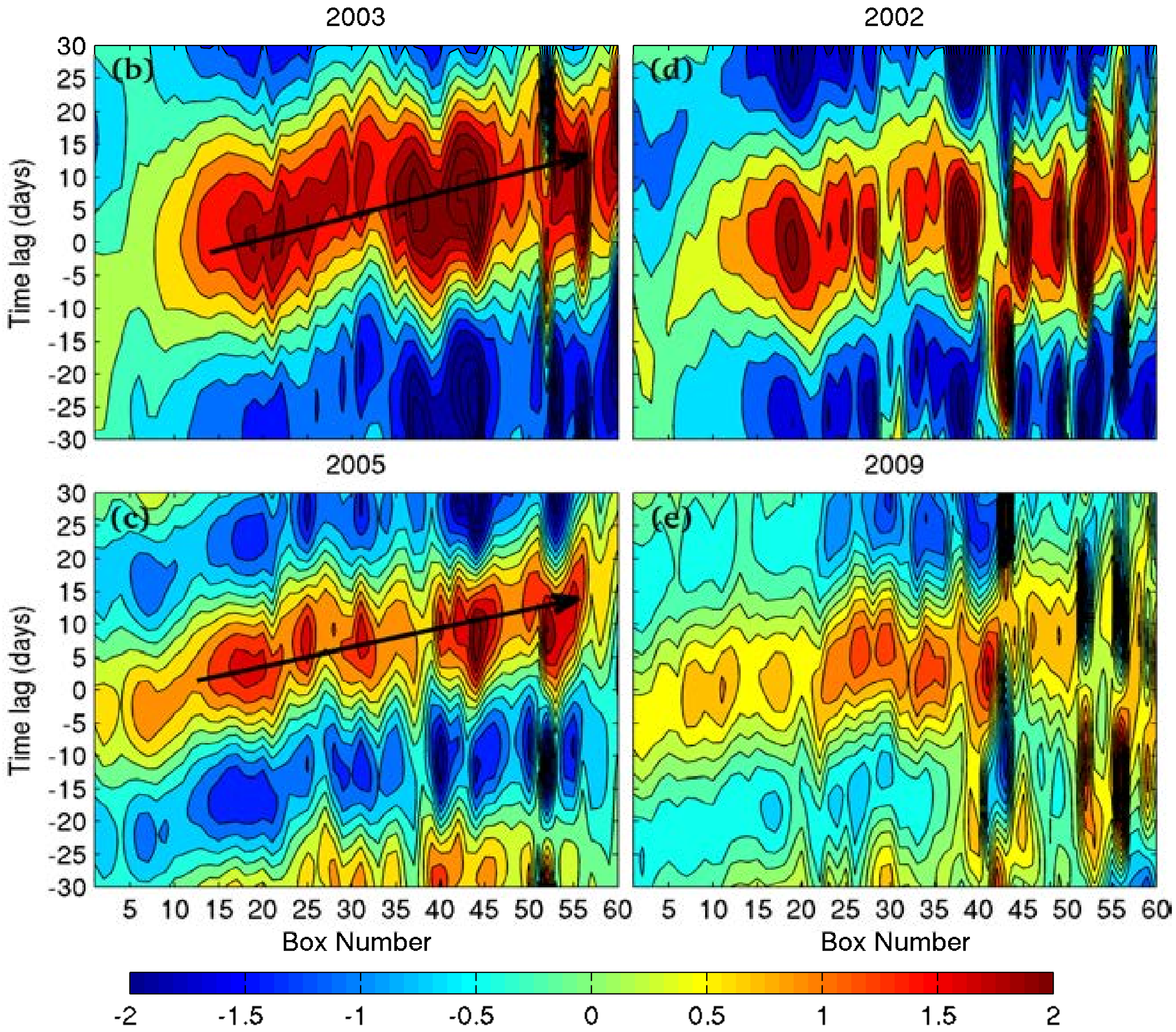
Challenge of frontogenesis prediction is the precise positioning of mesoscale structures



Jacobs et al

Coastal Kelvin waves in the Bay of Bengal : regression of observed intra-seasonal MSLA w.r.t MSLA at 90° E





The SLA is filtered using Lanczos band pass filter with 30 – 100 days periodicity

Science results from satellite altimetry

Global:

- Long-term in-situ based observations are underestimating the Southern Hemisphere contribution to global ocean heat content (OHC) change. Observed and modeled estimates of SSH suggest ocean steric changes and hence OHC changes have occurred at equivalent rates in each hemisphere. If Southern Hemisphere observed estimates are subsequently corrected, this yields a global OHC increase of 20-60% (Landerer).

- Over the last decade, Argo estimates of the OHC down to 2000m depth shows that the thermal expansion of the ocean explains 32% (0.9 mm/yr) of the observed GMSL trend of 2.8 mm/yr. Over the same period the closure of the sea level budget suggest that the deep Ocean warming (below 2000m) is too small to be detectable yet (Llovel).

- A joint inversion using GRACE and Jason-1/2 data and various sea level fingerprints was used to assess regional sea level change in Bangledesh (Uebbing).

Science results from satellite altimetry

- **Pacific:** Sea level reconstructions suggest that the PDO explains a large part of the sea level trends observed by satellite altimetry in the Pacific ocean. When this contribution from the PDO is removed, significant residual trends remain in the Pacific. Ocean models and climate models show that this residual is due to the rapid recent Indian ocean warming which is suspected to be of anthropogenic origin (Hamlington).

- **Arctic:** Estimates of Artic ocean sea level from satellite altimetry shows that the Arctic Ocean sea level rise agrees with global MSL rise but with large regional and temporal variations. Temporal variations of the Arctic ocean SL are essentially due to mass changes at non-seasonal time scales driven by net flow variations between the Nordic Seas and the North Atlantic in response to zonal winds over the northeastern Atlantic (Armitage and Volkov).

- **Coastal sea level**: At monthly to interannual time scales, satellite altimetry suggests that the sea level variability is higher close to the coast than in the open ocean. In term of trends, results are not conclusive yet. More work is needed to refine trends close to the coast (Melet).

Take home messages from the 8th Coastal Altimetry Workshop

Paolo Cipollini, National Oceanography Centre, UK

Organizing committee: J. Benveniste (ESA), P. Cipollini (NOC), L. Miller (NOAA), N. Picot (CNES), H. Bonekamp (EUMETSAT), T. Strub (OSU), D. Vandemark (UNH), S. Vignudelli (CNR)

Session Chairs: O.B. Andersen (DTU), L. Bao (Chinese Acad. Sci), M. Cancet (Noveltis), J. Fernandes (U Porto), L.-L. Fu (JPL), J. Gómez-Enri (U Cadiz), J. Hausman (JPL), K. Ichikawa (Kyushu U), L. Fenoglio (TUD), A. Pascual (IMEDEA), R. Scharroo (EUMETSAT), T. Strub (OSU), P. Thibaut (CLS) J. Wilkin (Rutgers U), A. Uematsu (JAXA), D. Vandemark (UNH), S. Vignudelli (CNR)

plus the many scientists who contributed papers, posters & animated discussions

The quality of coastal altimetry continues to improve

This challenges our understanding of the ocean at short scales

Technical advances

- Knowledge on how to handle SAR altimetry is rapidly expanding
  - stacking, improved waveform models
- CryoSat-2 SARM working very well and ideal precursor to Sentinel-3
- AltiKa also extremely good in coastal zone
- Envisat Individual Echoes great testbed for new and future missions

SAR Altimetry Training Course, 21-22 Oct

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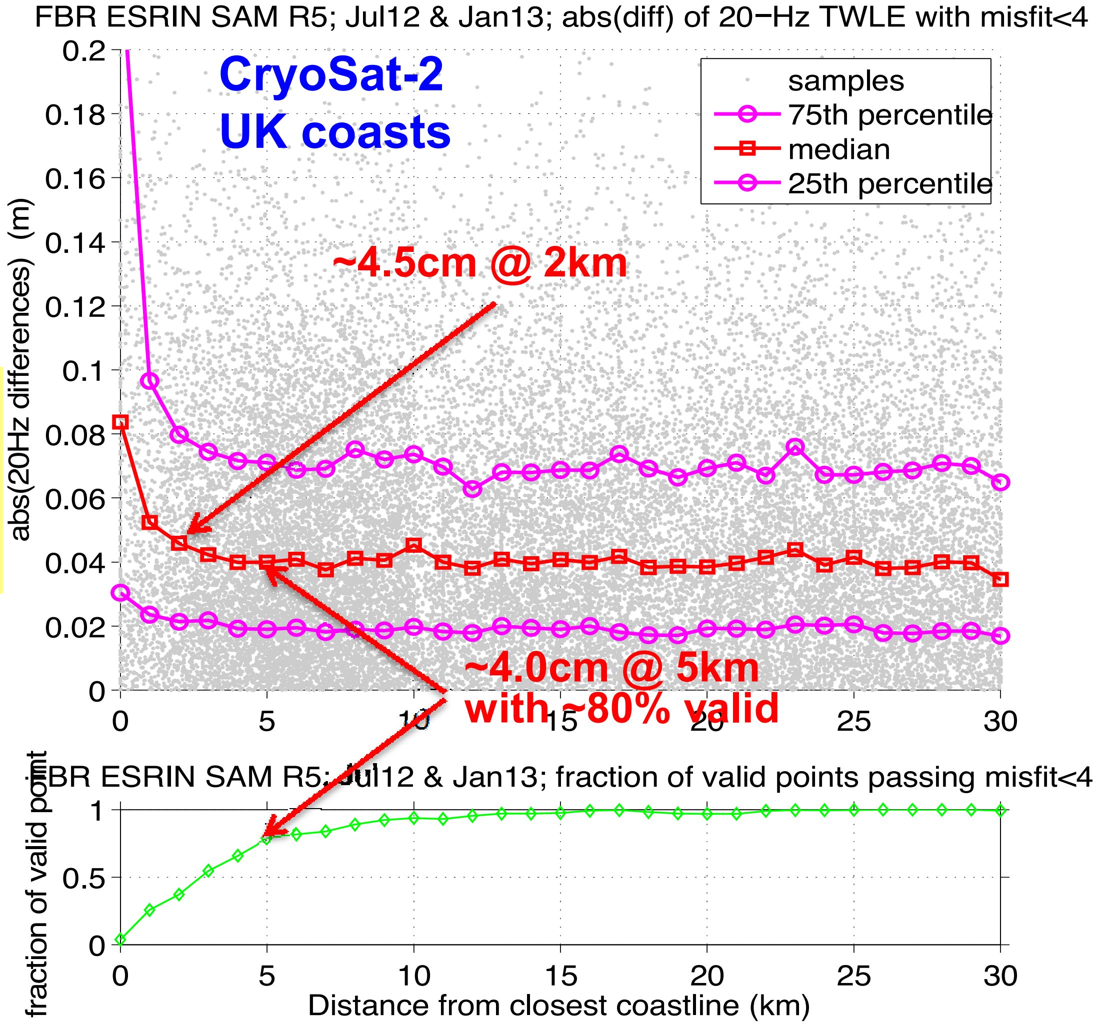

CP4O Team

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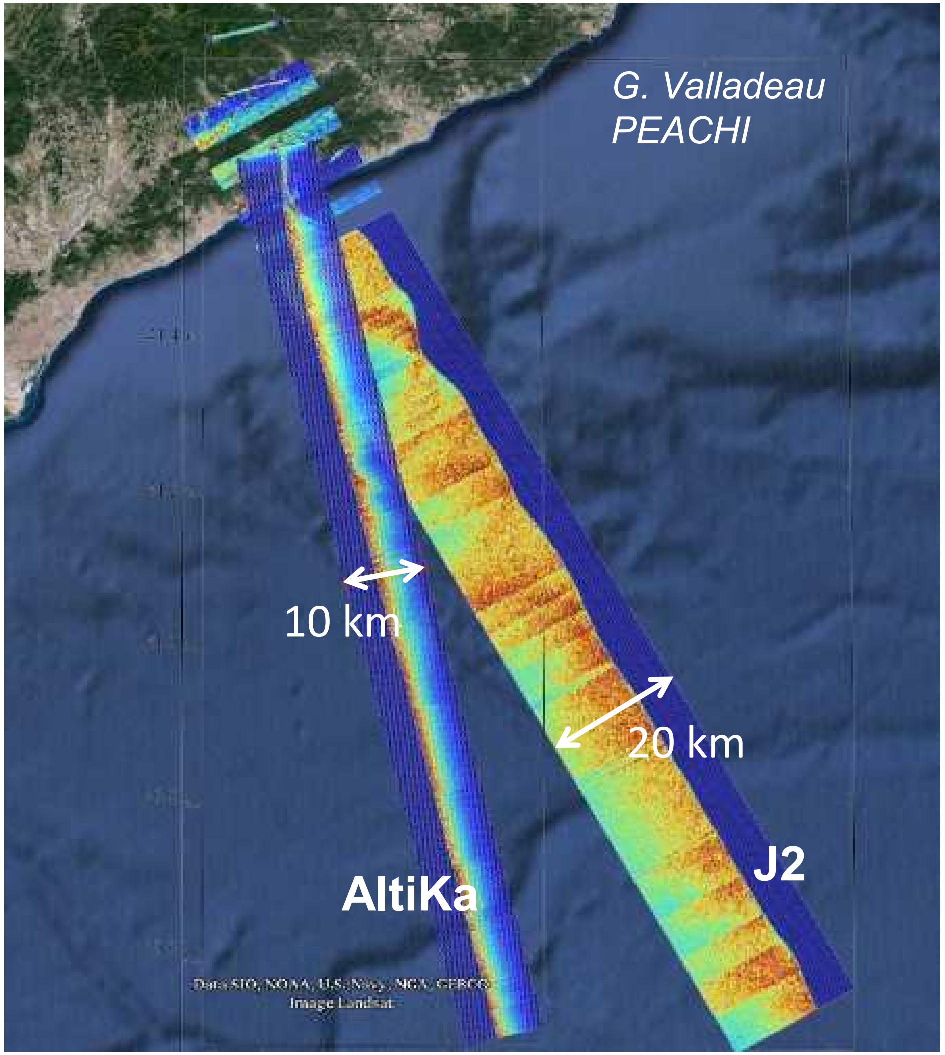
AltiKa / Jason-2 West Mediterranean Sea



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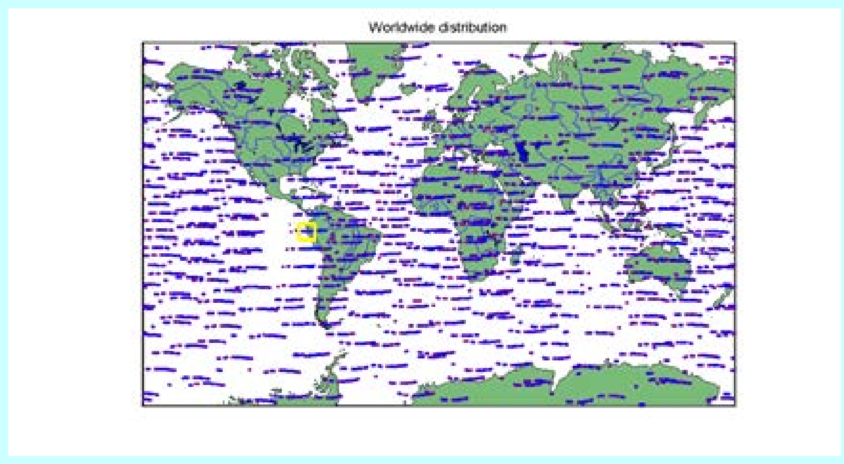
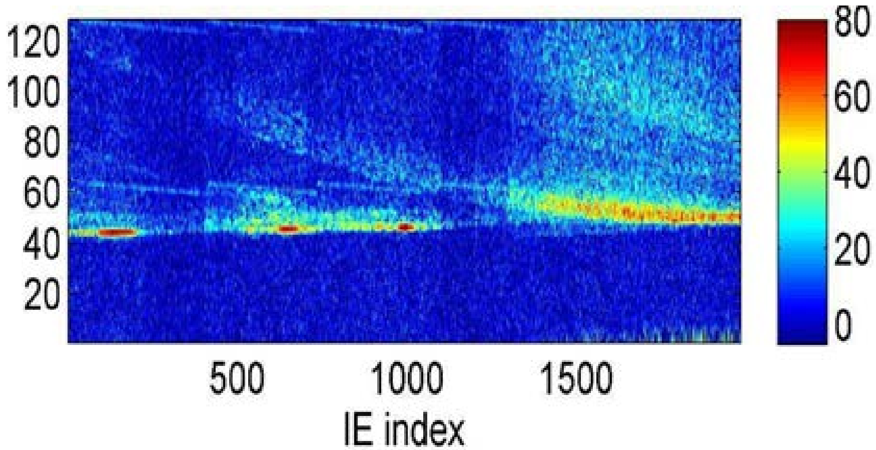


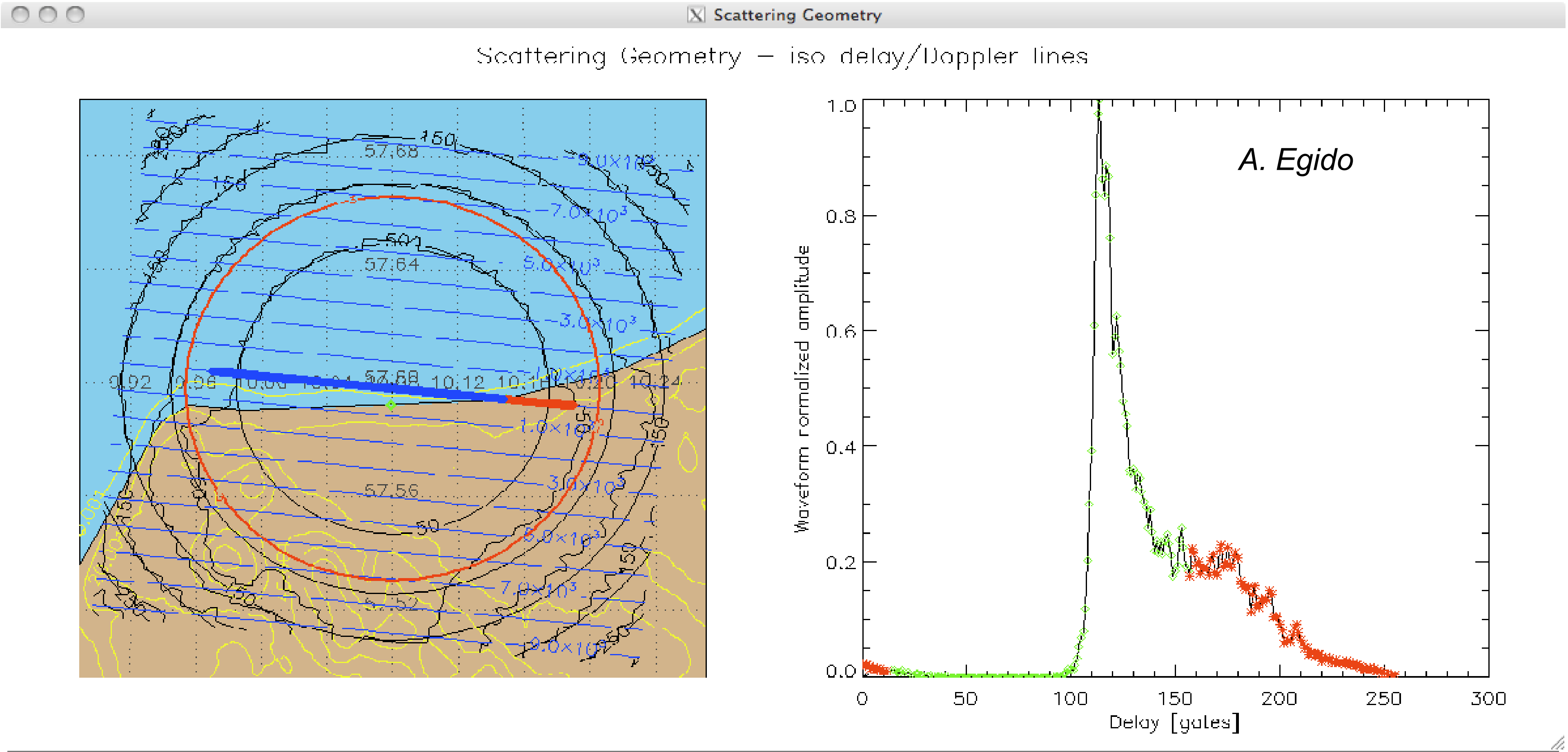


1-second of of 1800 Hz echoes in vicinity of Rio Tigre, Peru; Amplitude in dB re noise

R. Abileah

Technical advances

- Avoiding land effects with range gate selection



Technical advances

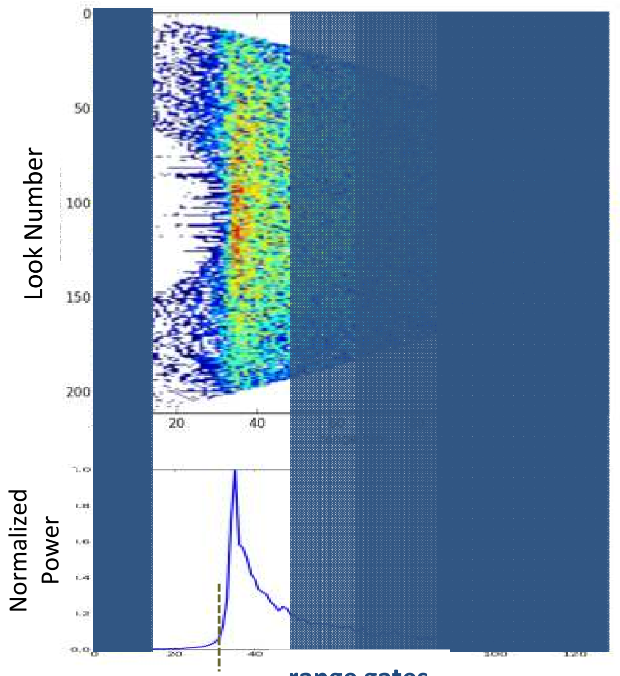
- Avoiding land effects with range gate selection
- Improvement in retrackers
  - windowing/subwaveforms
- Work on inland waters remains very relevant and promotes better understanding

SAR Mode

Stack of echos (after migration)

Multilooked echo

P. Thibaut



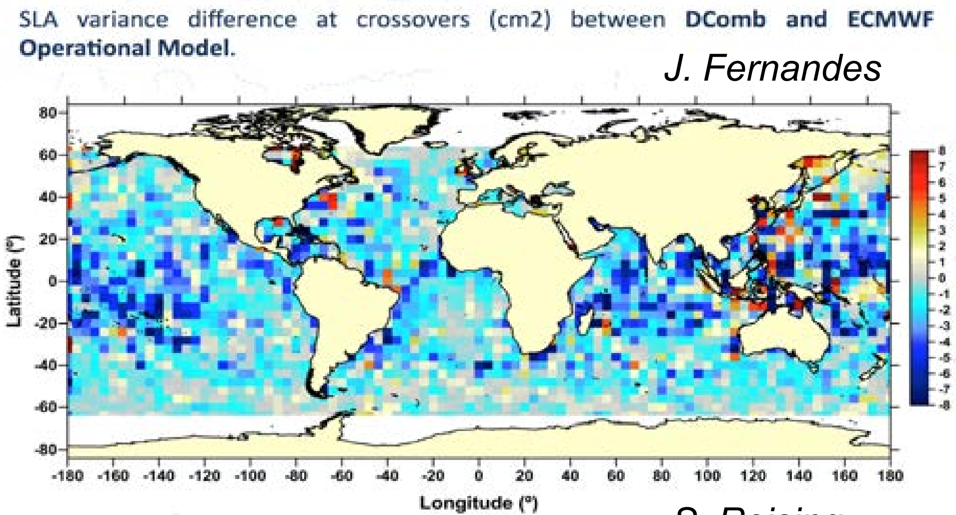
12 . 33 . 48

Window Truncation	12-115	12-83	12-63	12-48
Radius of the WF footprint	7488 m	5848 m	4530 m	3203 m

Continuing improvement in corrections

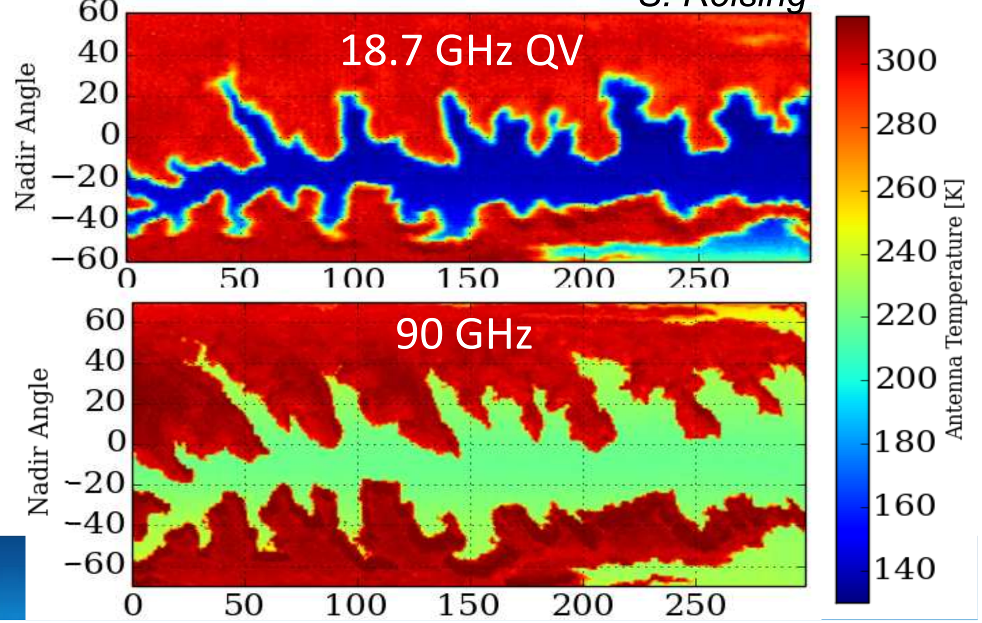
- DComb Wet Tropo
- High-res MWR on the horizon
- MSS – and tides!!
  - in coastal regions data editing for MSS determination is critical
  - SarIN! Example
- Significant differences shown between the GDR-Global DAC prediction and local models within several regions.
  - do not apply the global DAC to the altimeter SSHA, or do so after evaluation against wind-forced HF signals along your coastline.

Variance difference at Xovers: DComb-ECMWF



J. Fernandes

S. Reising



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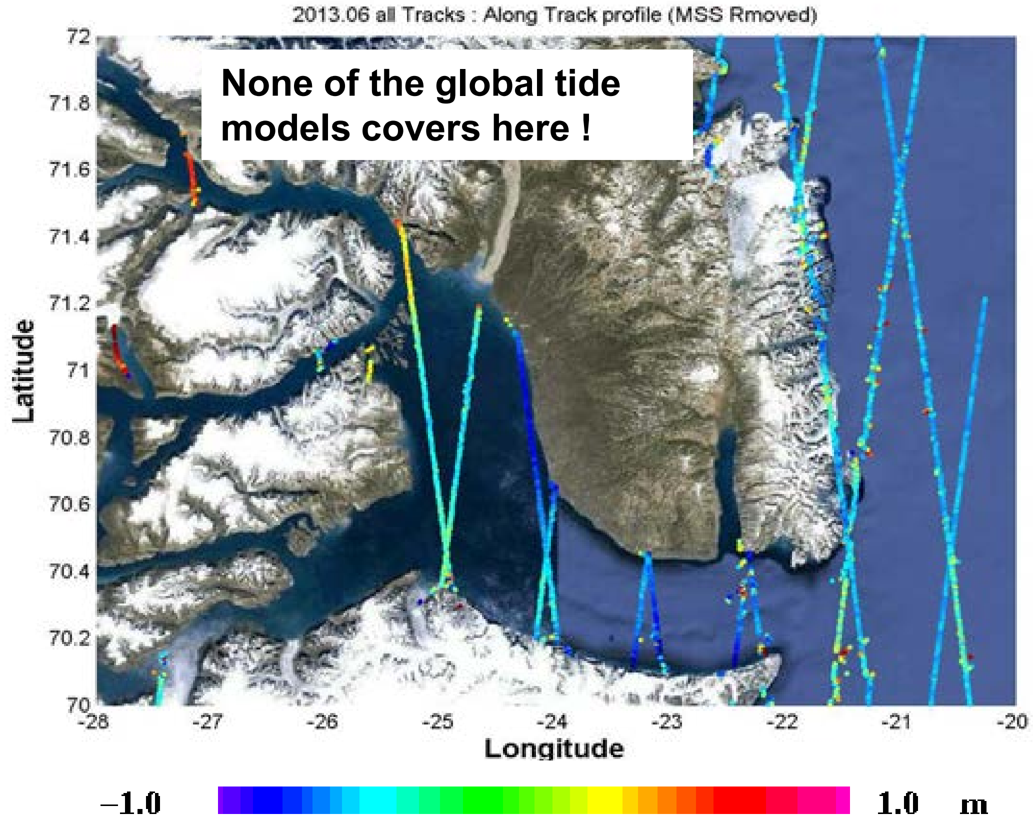

O. Andersen

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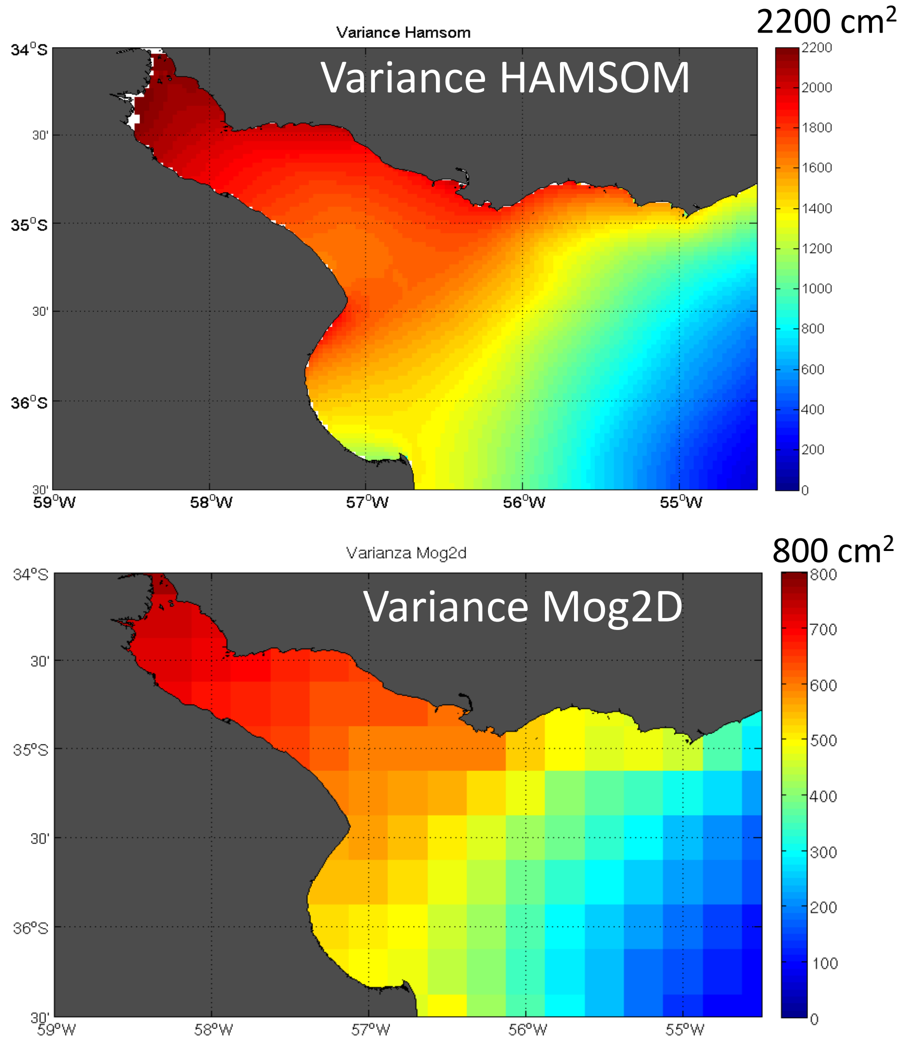


L Ruiz-Etcheverry

CAW-8 Recommendations

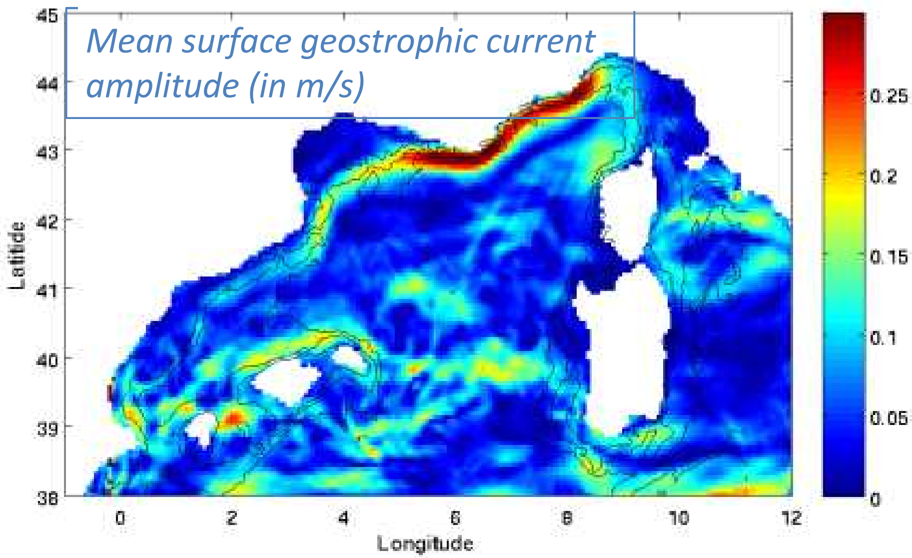
To Agencies and data providers

- [CAW8-REC1] **Unfiltered along-track high-resolution SSH** should be open to public in both delayed and NRT products
  - Best filtering scales may differ regionally and seasonally
- [CAW8-REC2] A **Coastal MSS and MDT** recomputed with high-resolution SSH would be a useful thing
  - For understanding dynamics
  - For cal/val with non-repeating tracks (although less accurate than in repeating orbits)
- [CAW8-REC3] support R&D in development of **more accurate tidal models in the coast** (including merging regional models with global ones)

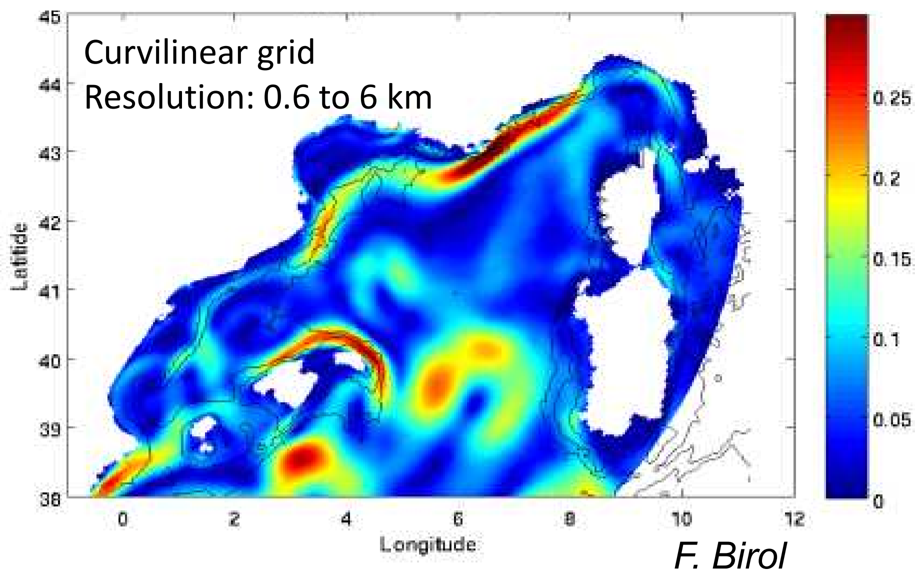
Cal/Val and Applications

- 30+ contributions
- from broad shelf to the coast
- strong complementarity with models

Observations (MDT Rio 2014)

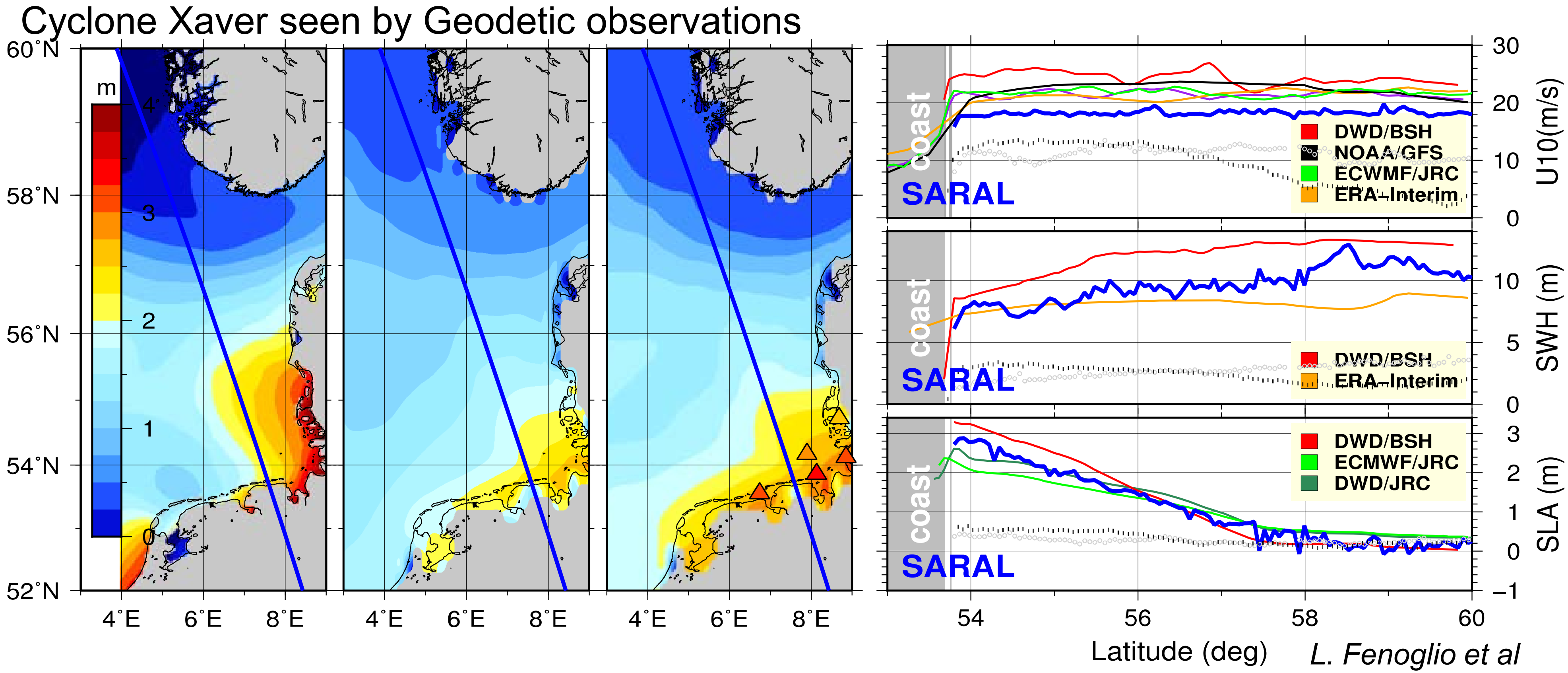


Symphonie model (regional config in 2014)



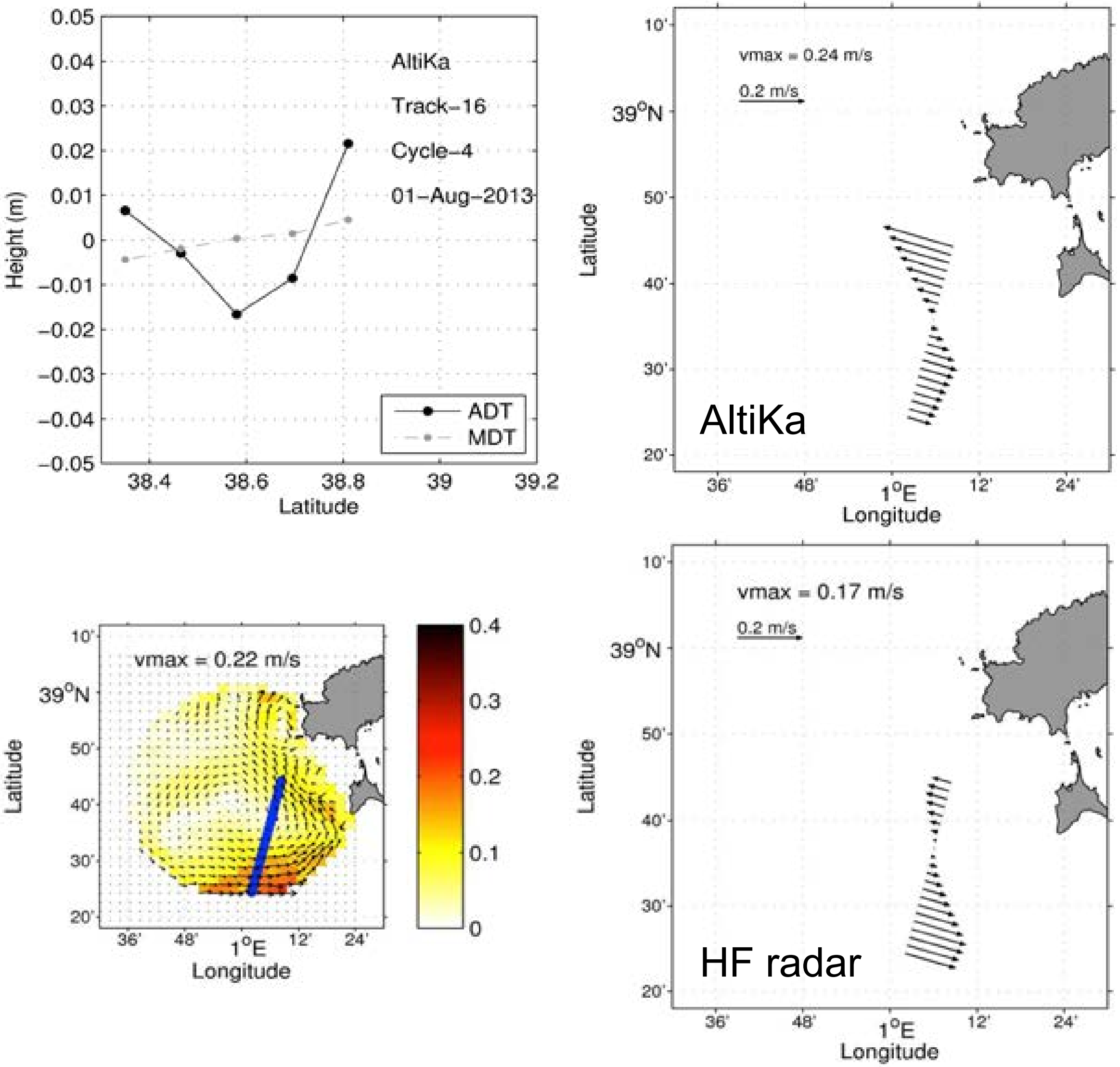
F. Birol

Application example 1: storm surges



Present constellation insufficient to reliably capturing all surges, but the time/space information content can be extended using model dynamics (example: statistically altimetry/tide gauge blending by DMI)

Application example 2: coastal dynamics



Example at Ibiza, W Med: SARAL/AltiKa derived velocities reveal coherent mesoscale features with general good agreement with HF radar fields

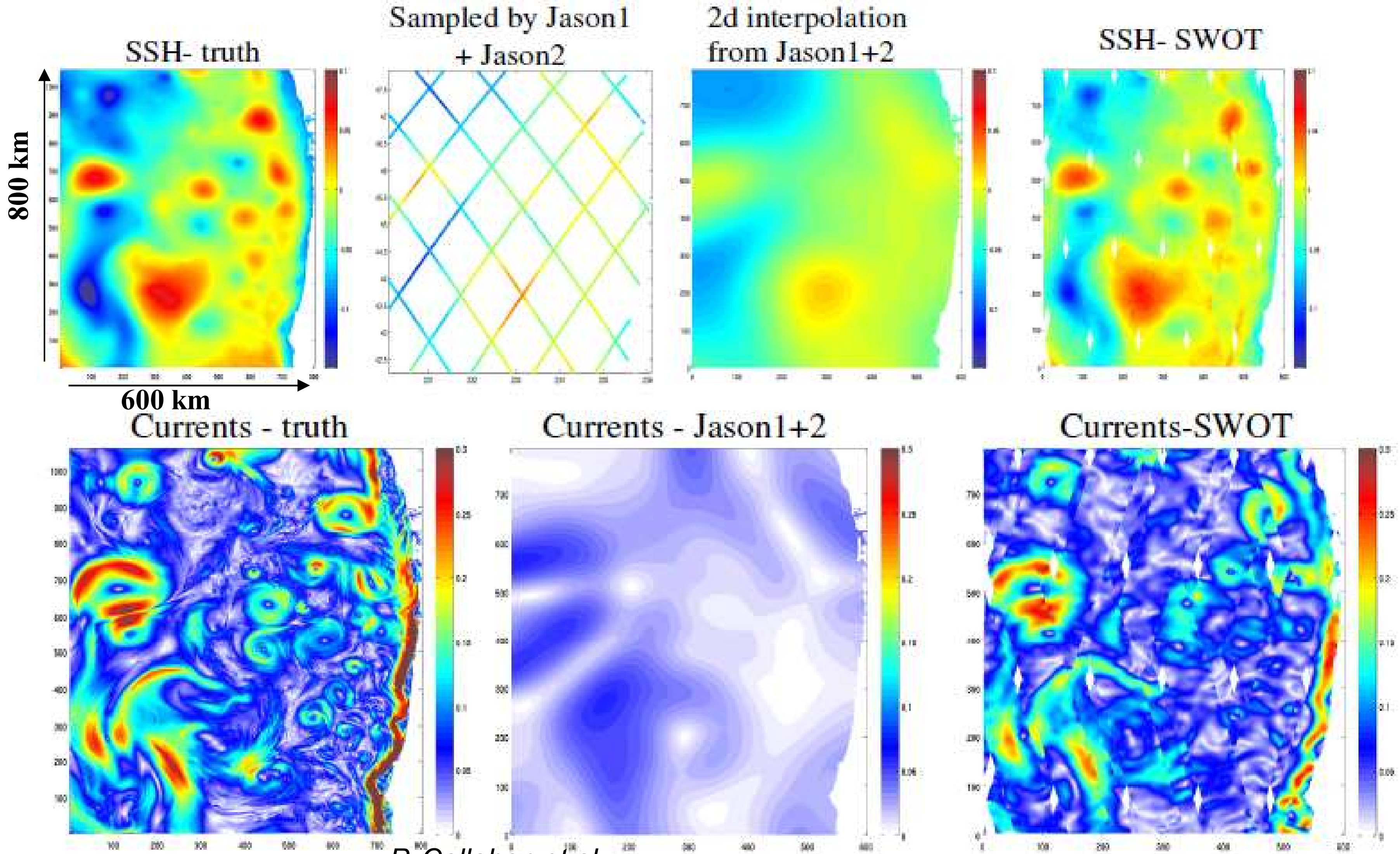
A. Pascual et al

The Challenge, again

- The quality of coastal altimetry – **precision and resolution** – continues to improve, challenging our understanding of the ocean at short scales
- how do we manage the extra resolution?
  - recognize that these features are not geostrophic
  - links to submesoscale features are responsible for much of the ocean energy; and mixing
  - The high resolution will help to derive high resolution bathymetry
  - River outflows, estuary circulation and ocean-estuary interactions will be better mapped

Relevance to SWOT

US
West
Coast



P. Callahan et al

*Proposed Mission – Pre-decisional – for planning & discussion purposes only

Relevance to GODAE OceanView

- GOV COSS-TT (Coastal and Shelf Seas Task Team)
    - John Wilkin representing CAW
- Need **COSS-TT/CAW joint meeting** to promote uptake of Coastal Altimetry and expose issues for SWOT etc.
- Need **COSS-TT/CAW/OST-hydrology joint meeting** to target river discharge & coastal wetlands for land-estuary ocean interaction


600 years ago…..
Council of Constance, 1414-1418

National Oceanography Centre · cnes · NOAA · EUMETSAT · NASA · OSU Oregon State · University of New Hampshire · esa

60 Abstracts, 29 Posters, 26 Talks + 1 Keynote by K. Raney
7 dedicated sessions, 80 participants from 19 countries
All material available on www.coastalt.eu/community

Yet another successful
'Council' of Coastal Altimetry

› SARAL/Altika workshop

The **Ka-kid** in the playground of the big **Ku-guys…**

Reminder

- An ISRO-CNES (+ EUMETSAT) mission
- The first Ka-band altimetric mission for oceanography
  - Also ARGOS: SARAL stands for Satellite with ARgos and ALtika

« necessity »: Gap filler between ENVISAT and Jason-3 / Sentinel-3
  - Same orbit/ground-track than ENVISAT: 35 days, high inclination 98.55°, …

« continuity »: Maturity of altimeter technology

« innovation »: Ka-band

Status

- Launch on 25 Feb. 2013 from SriHarikota on PSLV20
- First waveforms provided on Feb. 26, early morning, just a few hours after launch
- First IGDR processed by CNES on March 6
- GDR delivered to everyone early Sept. 2013
- Instrument characteristics are very stable in orbit
- Instrument performances are as measured during ground tests

Data

Data coverage:

- Greater than 99% over ocean

Data editing:

- Excellent, less than 3% of ocean data are edited
- Much lesser impact of rain than expected

Data latency

- Very quick availability of the data
- Operational products (OGDR, IGDR) generated and distributed in a timely manner with a comfortable margin

SARAL vs. Jason-2:

Crossovers:

- SARAL slightly better than Jason-2: 5.2 cm vs. 5.4 cm for RMS of SSH differences (Envisat : 5.6 cm)

Drift:

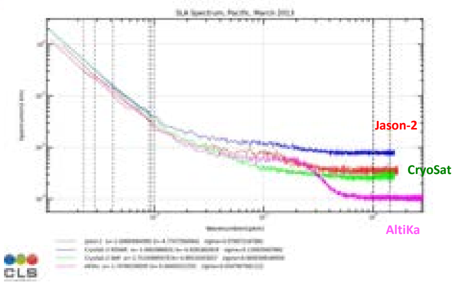
- No significant global SSH drift is detected w.r.t. Jason-2

Bias:

- SSH bias w.r.t. Jason-2 is about -4.8 cm (or Jason-2 is about +4.8 cm w.r.t. SARAL ☺)

Noise:

- SSH @1Hz: SARAL better than Jason-2: 0.9 cm vs. 1.6 cm
- SWH @2m: SARAL better than Jason-2: 5 cm vs. 7 cm



Applications

SSH

- **Open ocean:** significant gain in resolution/accuracy
- **Coastal ocean:** more reliable near the coast than Jason-2 (twice closer)
- **Ice:** large backscatter sensitivity in space over ice and snow
- **Inland waters:** better accuracy w.r.t. ENVISAT, continuity ERS/ENVISAT/SARAL on the same track
- **Operational:** straightforward to use

SWH

- **Operational:** straightforward to use

Publications, conference

Marine Geodesy SARAL/AltiKa Special Issue

- On going
- Good success: ≈ 50 papers
- Publication: Spring 2015 ?

A next Marine Geodesy Special Issue next year ?

- Under discussion
- Call for papers: July 2015 ?

EGU General Assembly 2015:

- “The SARAL/AltiKa satellite mission for Oceanography, Glaciology and Hydrology”
- Vienna: 12-17 April 2015

Conclusions

in sankrit सरल SARAL means EASY

System and operations

- Excellent cooperation ISRO-CNES
- All components of the SARAL/AltiKa system are working properly (but SHM early Oct.)
- Excellent stability of instruments so far

Data

- **Availability**
  - Easy !
  - High availability of data despite the feared effects of rain
  - Products made available to users very quickly
- **Quality**
  - All products data inline with mission requirements
  - Similar to JASON-2 and often better
- **On going actions**
  - To further improve processing algorithms

First look from science PI’s

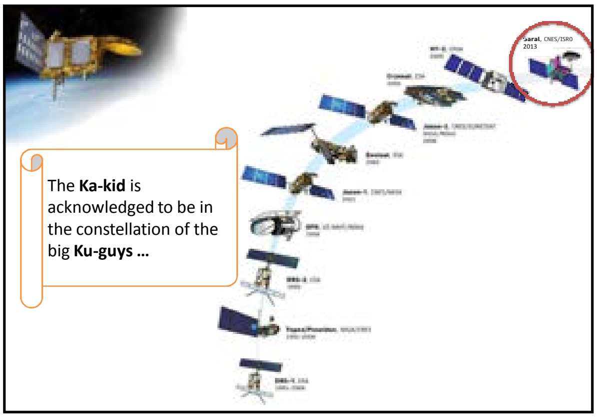
- Enthousiasm for these new+good data …
- Easy to fit in operational systems
- New opportunities seen with the Improved (mesoscale) resolution in the open ocean
- Improved access to the coastal ocean
- New openings for ice sheet and continental waters

AltiKa and future directions

- Ka-band innovations may bring some opportunities to understand Ku better
- A step towards improved resolution … and preparation for SWOT
- **The new frontiers of altimetry are going to be open even more widely: coastal oceanography, cryosphere, hydrology, …**

Future ?

- AltiKa-Follow-On (with emphasize on Ice) under consideration by CNES for phase 0


Saral, CNES/ISRO
2013
The **Ka-kid** is acknowledged to be in the constellation of the big **Ku-guys** …