OSTST09   Seattle

Instrument Processing Splinter

Shannon Brown
Phil Callahan
Juliette Lambin
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<td>Jason-2 instrumental and processing status</td>
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<td>14:12</td>
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<td>Singular value decomposition applied on altimeter waveforms</td>
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<td>Jean-Damien DESJONQUERES</td>
<td>POSEIDON3 instrument investigations, corrections and upgrades</td>
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<td>Analysis of TOPEX retracted GDR data</td>
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<td>Walter Smith (Eric Leuliette)</td>
<td>Difference in J-1 and J-2 retracker-induced biases</td>
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<td>Ngan Tran</td>
<td>Sea state bias on the Jason-1/2 missions</td>
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<td>Praphun Naenna</td>
<td>An analytical model of the electromagnetic bias using the physical optics scattering theory</td>
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<td>15:24</td>
<td>Estelle Obligis</td>
<td>SLOOP: Potential of new retrieval algorithms for the wet tropospheric correction of the Jason1/Jason2 Radiometers</td>
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<td>Shannon Brown</td>
<td>Performance Assessment of the Advanced Microwave Radiometer after 1-year in Orbit</td>
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<td>All</td>
<td>Discussion</td>
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<td>Adjourn to coffee break</td>
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**Additional Topics**

- Graham Quartly: What's the point of mispointing?
- BOY Francois: Scalable processor for altimetry (SPA): New CNES processing center for altimetry missions
Obligis – New Wet Retrieval Algorithms

- Retrieval algorithms formulated over learning database (dh, TB1, TB2, TB3) ... possible new parameters Lapse Rate, SST
- Formulation based on the minimization of both **global bias** and the standard deviation
  - Loglinear algorithms \( dh= c_0 + [c_1 \ln (280-TB18.7)] + c_2 \ln(280-TB23.8) + c_3 \ln(280-TB34) \) \([2 \text{ vs } 3 \text{ freq}]\)
  - Neural algorithms \( dh = \text{NN}(TB18.7, TB23.8, TB34) \)
- This minimization of global bias and standard deviation ignores seasonal or regional specificities \(\Rightarrow\) geographically correlated errors
- Next 2 slides show performance based on simulation from ECMWF fields of 2, 3 TB algorithms and then a new algorithm incorporating Lapse Rate to 800mb and SST
Residuals = Differences between retrieved and reference dh

LIN 23.8 34 => σ=8.4 mm

NN 23.8 34 => σ=5.6 mm

LIN 18.7 23.8 34 => σ=4.1 mm

NN 18.7 23.8 34 => σ=2.2 mm

Lapse rates very different from normal, often positive
Performances of a new algorithm on simulated database

dh=NN(TB18.7, TB23.8, TB34, γ800, SST)
Brown – AMR Performance Assessment

• New AMR data products (available on PO.DAAC – restricted access)
  – AMR sea ice flag – Tb34 – T18 < 10K, |Lat| > 47; reflects NSIDC ice masks
  – AMR rain flag – TB18 > 200K, Liquid > 0.75 kg/m^2; statistically reflects TRMM rain climatology
  – AMR coastal path delay – works both open ocean and coast; provides 1.2cm accuracy to within 5km of coast

• AMR Autonomous Radiometer Calibration System (ARCS)
  – Used to operationally monitor calibration and detect and correct changes prior to GDR production. GDR will be different from IGDR if calibration is performed

• AMR performance to date

• JMR replacement product
  – Periodic 5mm shifts in JMR PDs after August 2008 safehold
  – JMR replacement product shows negligible residual bias from AMR and lower variance compared to JMR on GDR-C
GPS Validation of New Coastal PDs

- Coastal GPS sites used to validate new coastal PD algorithm
- Coastal PD algorithm shows little excess variance from GPS up to coastline

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“"A Novel Near-Land Radiometer Wet Path Delay Retrieval Algorithm: Application to the Jason-2/OSTM Advanced Microwave Radiometer” in review TGARS
AMR PD Stability Assessment

- AMR TBs appear to be stable compared to cold reference
- No residual dependence on instrument temperature (e.g. yaw state bias)
- Re-calibration for GDR only performed on 34 GHz channel
  - 0.5 K jump – September 19, 2008
  - 1 K jump – November 28, 200
Naenna – Analytical EMB Model using Physical Optics

• The EM bias is caused by nonlinear behavior of sea waves, i.e. smooth and shallow wave troughs are stronger reflectors than wave crests. Include different wave scales in model.
  - Jackson (1979) used geometrical optics to describe the cross section as proportional to the height pdf of specular surface points
    \[ \beta_{EM} = \frac{\langle z \sigma^0 \rangle}{\langle \sigma^0 \rangle} \]
    \[ \beta_{EM} = -\frac{1}{8} \lambda_{12} H_{1/3} \]

• The final expression for EMB

\[
\beta_{EM} = \int_{-\infty}^{\infty} dx \ A(x) \left[ S_{\Sigma}(x) - S(0) \right] \exp \left\{ -\frac{4k_0^2 \sigma^2 (1 - C(x))}{1 + 2 \left( \frac{\sigma}{c \alpha} \right)^2 (1 - C'(x))} \right\}
\]

- leftover term, slowly varying
- the reduced bicorrelation fn (3rd order statistic)

\[ S'(x) = \frac{1}{\sigma^3} \langle f^2(x_0) f(x_0 + x) \rangle \]

Under simplifying assumptions, this will reproduce Jackson result
Tran – Jason-1/2 Sea State Bias, Alternative Models

• Differences of J1 – J2 do not have any obvious SWH dependence
  – SSB solutions for J1, J2 are consistent at the 1-2 cm level throughout the SWH-U domain

• A discrepancy in the J2 wind speed has been found that can be corrected with linear adjustment of sigma0
  – Depending on the final correction of the sigma0, a small difference in SSB may exist

• Alternative SSB with an additional parameter(s) from wave models – swell, wave period – and classification to separate sea states into classes representing varied wave age and steepness regimes, i.e. swell-dominated, young seas and intermediate mixed seas
  – Classification parameters wind_SWH/SWH, mss_long/mss_tot
Performance as function of latitude
data from 2002, 2003 & 2004
Smith – Waveform Simulation Investigation of Retracking

- MLE3 and MLE4 seek the waveform model parameters by iterative refinement of an initial guess.
- The refinement is driven by Gauss-Newton steps solved with a QR algorithm.
- The "driving force" that changes the model parameters at each step is $\nabla \chi^2$.
- Since $\chi^2$ is asymmetric around the desired range solution, the driving forces are asymmetric. This causes random errors in the waveform to give biased random errors in the fitted parameters.
- These can induce an apparent SSB, as shown previously at OSTST 2008 in Nice.
Desjonqueres – Jason 2 Instrument Investigations

- **Range Bias** – 2 corrections bring Jason 1-2 bias to <~ 1.5 cm
  - PRF truncation
  - Calibration value from ground test corrected

- Occasional tracking of low amplitude but distorted WF corrected by adjusting thresholds (only really affects land)

- Current operational mode = DIODE Acquisition with Median tracking
  - DIODE reduces acquisition time to <~0.5 sec giving more coastal/ocean data

- DIODE/DDEM mode recently had DEM updated

- Onboard software updated to improve stability of waveform in window
Thibaut – Jason Tracking

In Nice OSTST, very good results about Jason-2 performance were presented by various speakers. Since then, we have got confirmation of these very good results.

• However, some studies were decided to investigate (and close) some specific points:
  
  • J2 colored spectra and impact of Wfs compression – not compression effect, but small error in analysis
  
  • Mispointing and antenna beamwidth – estimated off nadir angle depends on BW used. Recommend 1.28 deg (instead of 1.26)
  
  • Retracking diagram for C band – because Jason-2 is well pointed, it is no longer necessary to use K band off nadir angle (MLE4) in C band (MLE3); improves C band sigma0
  
  • Skewness coefficient – Jason-1, Jason-2 agree on skewness value = -0.1
  
  • Rain flag – develop Jason rain flag based on MLE3 retracking to get stable K/C relation; build this into processing (requires analysis of 1 yr of data). Also, new wind speed based on new sigma0 ➔ new SSB with new WS
  
  • Impact of filter variability on altimetric parameters – no significant changes in filter (« weights »), PTR
Thibaut – Singular Value Decomposition + Retracking (1 of 2)

- **SLOOP project** (funded by CNES) to improve altimeter open ocean products
- The idea is also to try to reduce the noise level of the estimations without introducing artificial along-track spatial correlation ➔ **Reduction of the noise level of the WFs before estimation**
- SVD is a classical technique in signal processing (developed in 1940) sometimes used to « denoise » signals.

\[ S = S + B \]

Taking the S matrix representing the noisy signal (Wfs matrix)

\[ S = U \Sigma V^* \]

Computing the Singular Value Decomposition

- \( S \) \((m,n)\): WF matrix \((m= 104; n=300)\)
- \( U \) \((m,m)\), \( V^*\)(n,n): unit matrices
- \( \Sigma \) \((m,n)\): diagonal matrix

Discarding small singular values of \( S \) (which mainly represent the additive noise)

The rank-k matrix \( A_k \) represents a filtered signal

Reduction of the noise level of the WFs before estimation
Thibaut – Singular Value Decomposition + Retracking (2 of 2)

**Impact on range**

- SVD allows a strong noise reduction on SWH and range, in rms by a factor between 1.2 (weak waves) to 2 (strong waves).
- SVD allows to pass from a 7 km resolution (1 Hz) to a 1.2 km resolution (6 Hz) with an equivalent noise (precision of the SLA).

**Impact on SWH**

- SVD spectrum – Ku band
  - 54 cm at 20 Hz
  - 12 cm at 20 Hz
  - 8 cm at 20 Hz
  - 5 cm at 20 Hz

- ML4 spectrum – Ku band
  - 54 cm at 20 Hz
  - 12 cm at 20 Hz
  - 8 cm at 20 Hz
  - 5 cm at 20 Hz
Callahan – TOPEX Retracking

• Data Product Overview
  – Retracked all TOPEX cycles 021 - 480, except for a few for which either GDRs or SDRs could not be obtained from PODAAC
  – RGDRs include new GSFC orbits, GOT4.7 tides, TMR corrections
  – RGDR format same as 2007 (new orbit in different slot)

• Result Highlights
  – Retracking appears to correct SWH change from Alt-A PTR change
  – Results not very sensitive to selection/variation of weights
  – Results fairly sensitive to PTR variations
  – Skewness continues to absorb waveform leakages and shows N/S, Asc/Des (Toward/Away from equator, +/- Range rate) feature
  – 2009 RGDRs different from 2007 RGDRs with a bias of about 1 cm and in variation with SWH, but similar in most other ways
  – New results appear to be more symmetric in variations, errors
TOPEX RGDR Time Variations

Corrects Alt-A SWH change

Retracking Correction to Range
**TOPEX  RGDR  Time Variations – Labroue et als Analysis**

- Alt-A Sea Level trend is radically changed
  - Ask other groups to check
  - Likely source of problem is solving for skewness
- Things to check:
  - PTR fitting, changes
  - Retracking without solving for skewness