OSTST09   Seattle

Instrument Processing Splinter

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June 24, 2009

Agenda

14:00	THIBAUT	Jason-2 instrumental and processing status
14:12	THIBAUT	Singular value decomposition applied on altimeter waveforms
14:24	Jean-Damien DESJONQUERES	POSEIDON3 instrument investigations, corrections and upgrades
14:36	Philip Callahan	Analysis of TOPEX retracked GDR data
14:48	Walter Smith (Eric Leuliette)	Difference in J-1 and J-2 retracker-induced biases
15:00	Ngan Tran	Sea state bias on the Jason-1/2 missions
15:12	Praphun Naenna	An analytical model of the electromagnetic bias using the physical optics scattering theory
15:24	Estelle Obligis	SLOOP: Potential of new retrieval algorithms for the wet tropospheric correction of the Jason1/Jason2 Radiometers
15:36	Shannon Brown	Performance Assessment of the Advanced Microwave Radiometer after 1-year in Orbit
15:48	All	Discussion
16:00		Adjourn to coffee break

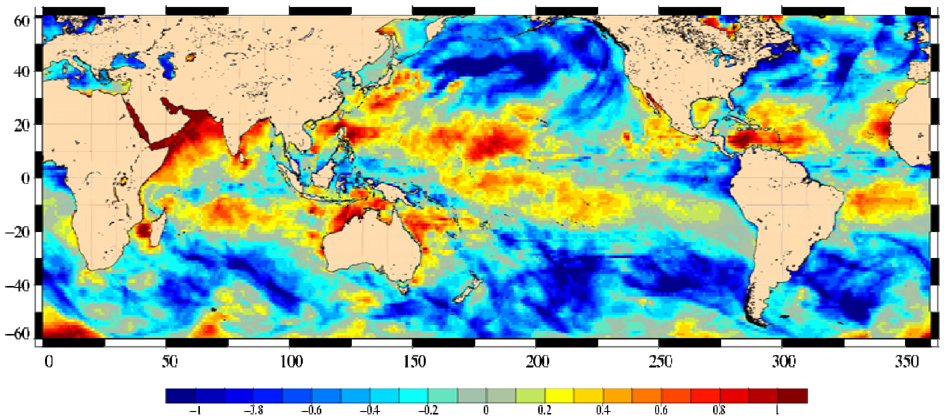
Graham Quartly	What's the point of mispointing?
BOY Francois	Scalable processor for altimetry (SPA): New CNES processing center for altimetry missions

Obligis – New Wet Retrieval Algorithms

- Retrieval algorithms formulated over learning database (dh, TB1, TB2,TB3) … possible new parameters Lapse Rate, SST
- Formualtion based on the minimization of both **global bias and the standard deviation**
  - Loglinear algorithms dh= c0 + [c1 ln (280-TB18.7)] + c2 ln(280-TB23.8) + c3 ln(280-TB34) [2 vs 3 freq]
  - Neural algorithms dh =NN([TB18.7,] TB23.8,TB34)
- This minimization of global bias and standard deviation ignores seasonal or regional specificities = > 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

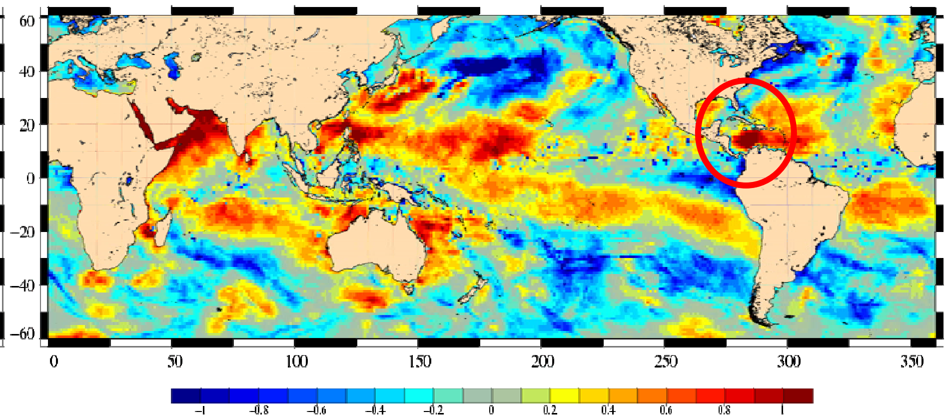
Residuals = Differences between retrieved and reference dh

LIN 23.8 34 => σ=8.4 mm



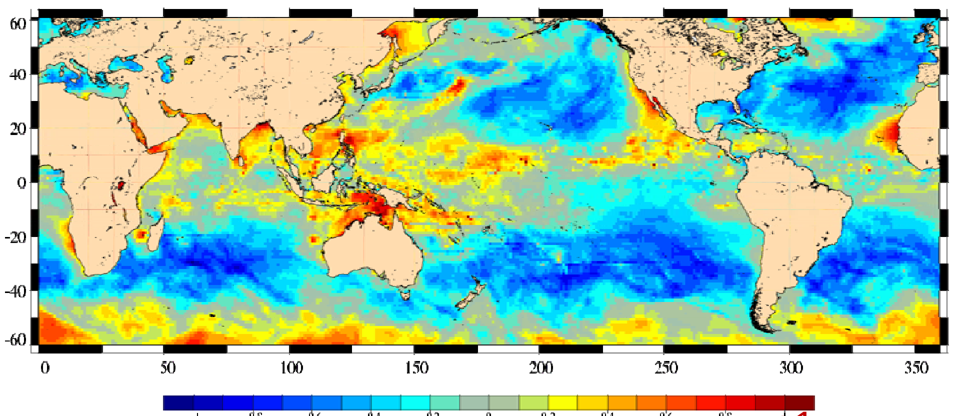
-1cm +1cm

NN 23.8 34 => σ=5.6 mm



-1cm +1cm

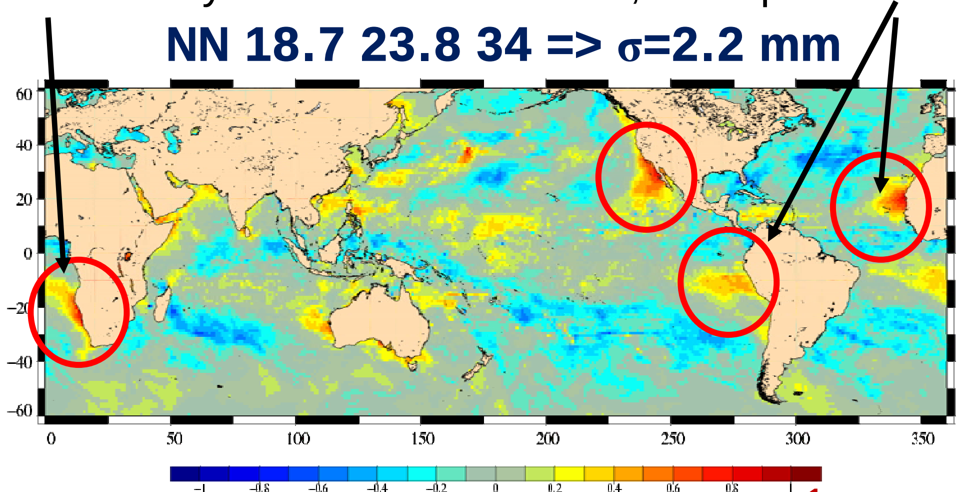
LIN 18.7 23.8 34 => σ=4.1 mm



-1cm +1cm

Lapse rates very different from normal, often positive

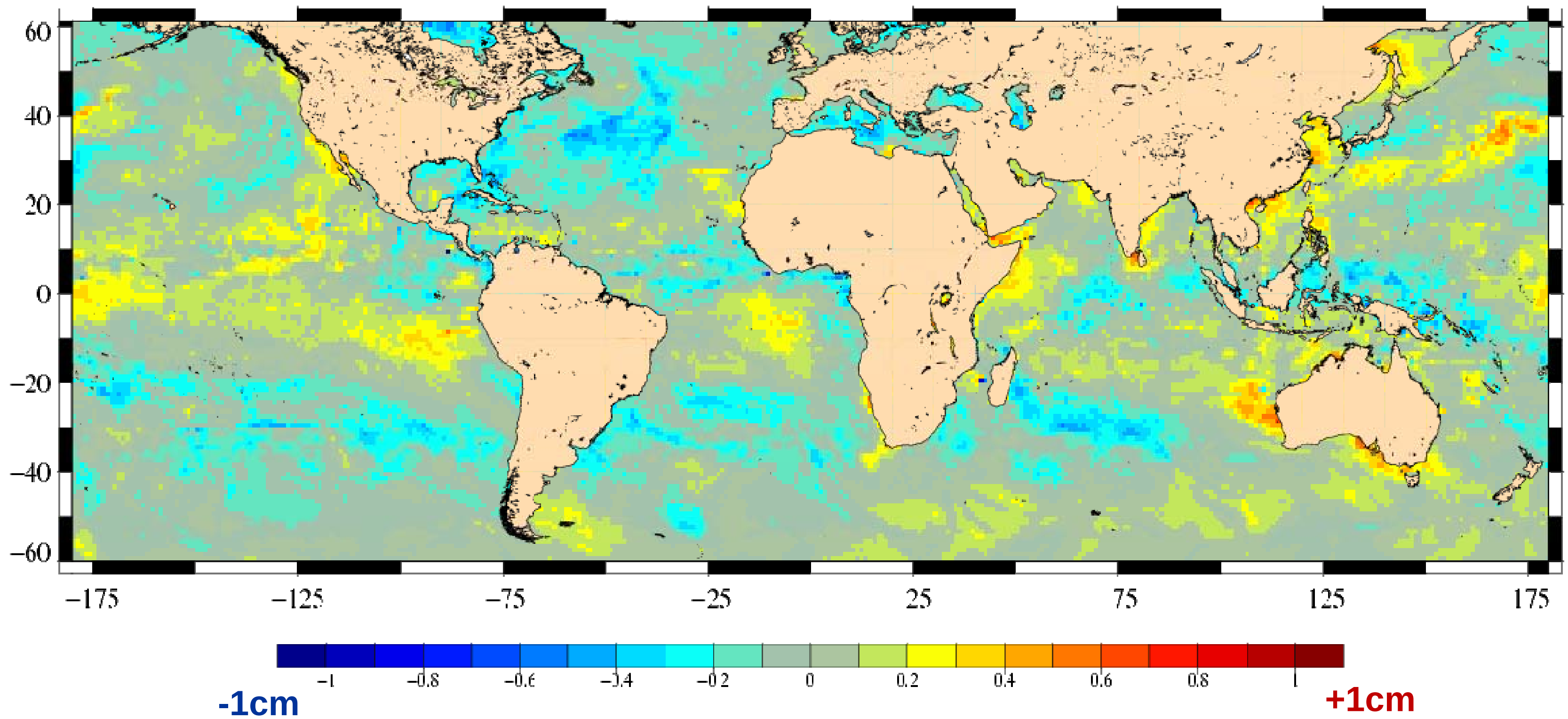
NN 18.7 23.8 34 => σ=2.2 mm



-1cm +1cm

Performances of a new algorithm on simulated database

dh=NN(TB18.7,TB23.8, TB34,γ800,SST)



Nb of data	:	43039	St. Dev	:	0.1658328	Skewness	:	0.2591651	Minimum	:	−1.1421746
Mean	:	−0.0002088	Rms	:	0.1658329	Kurtosis	:	1.5086549	Maximum	:	1.3581051

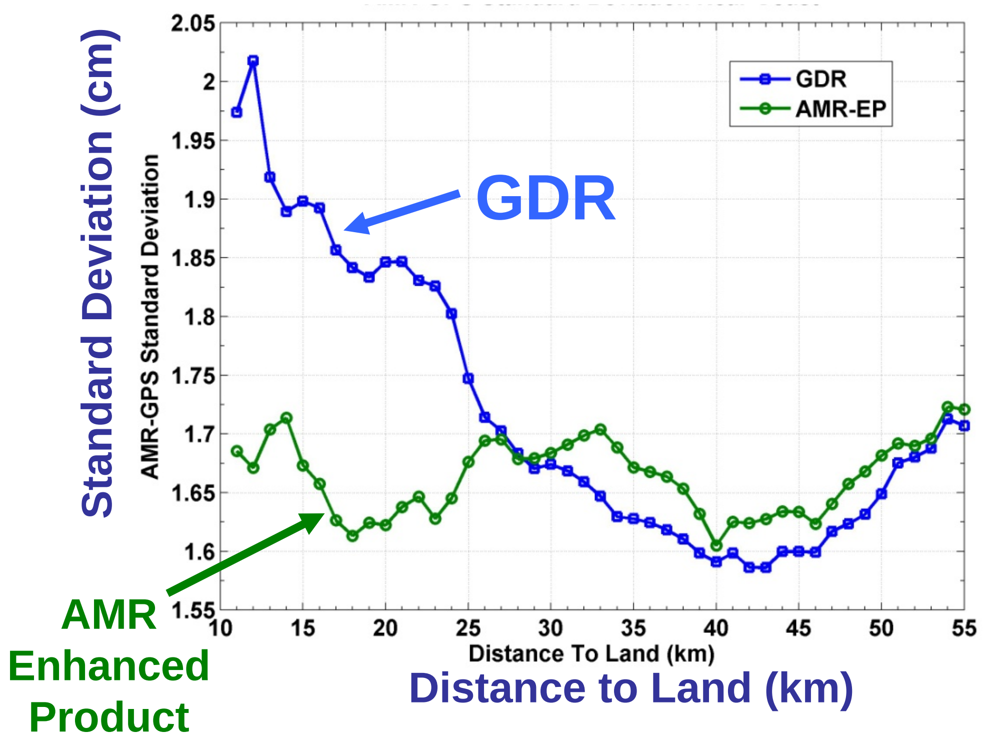
Brown – AMR Performance Assessment

- 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

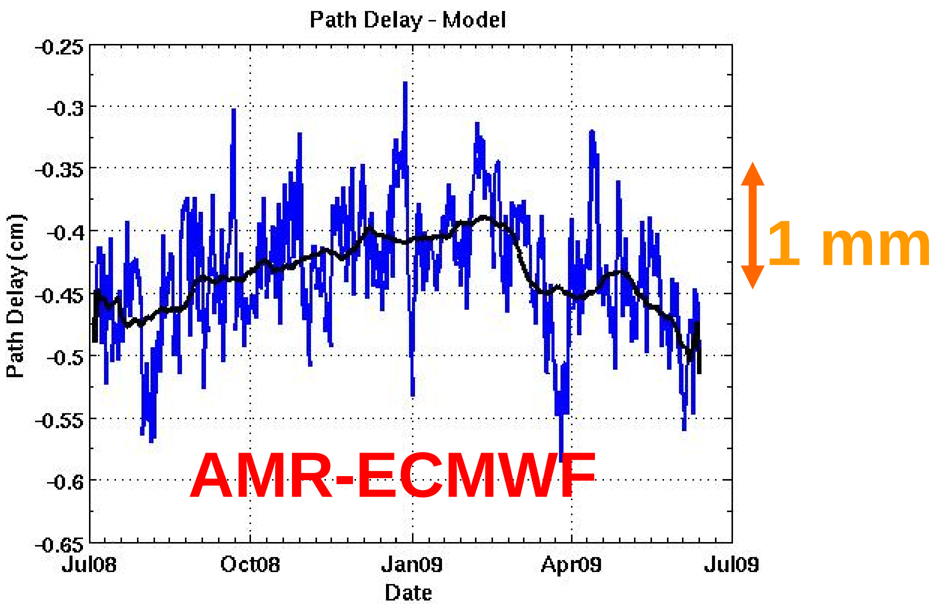
- Coastal GPS sites used to validate new coastal PD algorithm
- Coastal PD algorithm shows little excess variance from GPS up to coastline

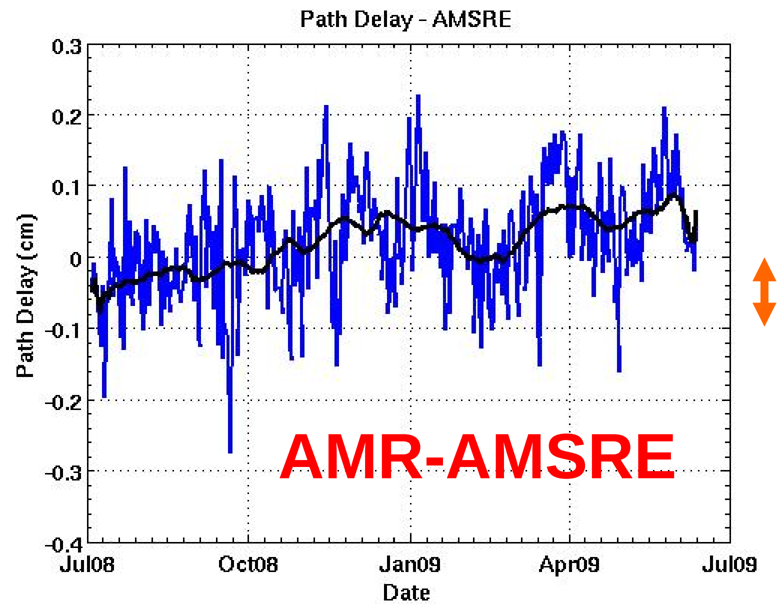
GPS-AMR Standard Deviation Approaching Coast

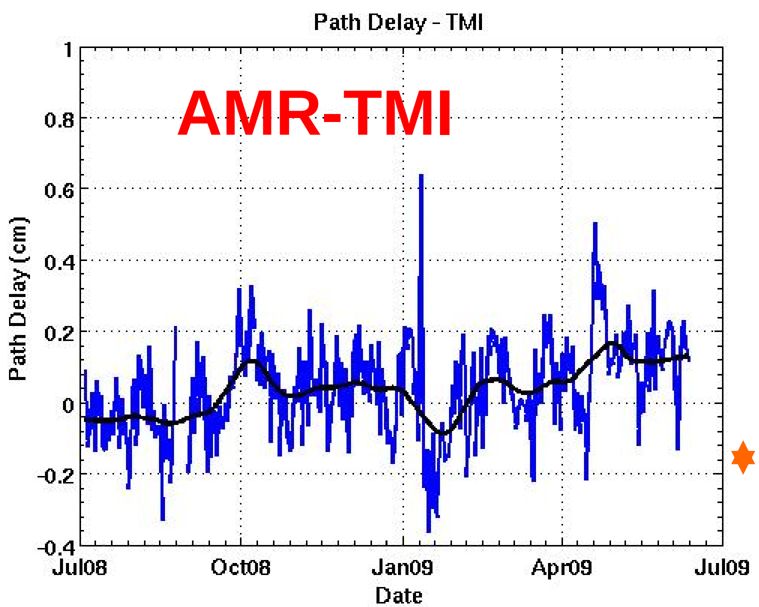


–*"A Novel Near-Land Radiometer Wet Path Delay Retrieval Algorithm: Application to the Jason-2/OSTM Advanced Microwave Radiometer" in review TGARS*

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

$$\beta_{\mathrm{EM}} = \frac{\langle z\sigma^0\rangle}{\langle \sigma^0\rangle} \qquad \beta_{\mathrm{EM}} = -\frac{1}{8}\lambda_{12}H_{1/3}$$

- The final expression for EMB

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

leftover term, slowly varying

the reduced bicorrelation fn (3rd order statistic)

$$S(x) = \frac{1}{\sigma^3}\left\langle f^2(x_0)f(x_0+x)\right\rangle$$

similar to standard PO term

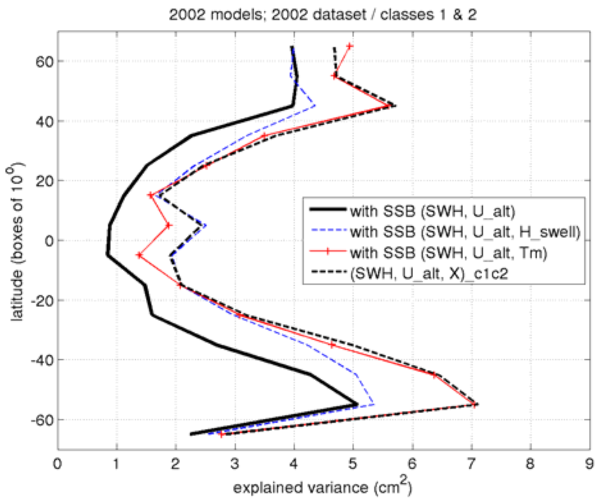
Under simplifying assumptions, this will reporduce Jackson result

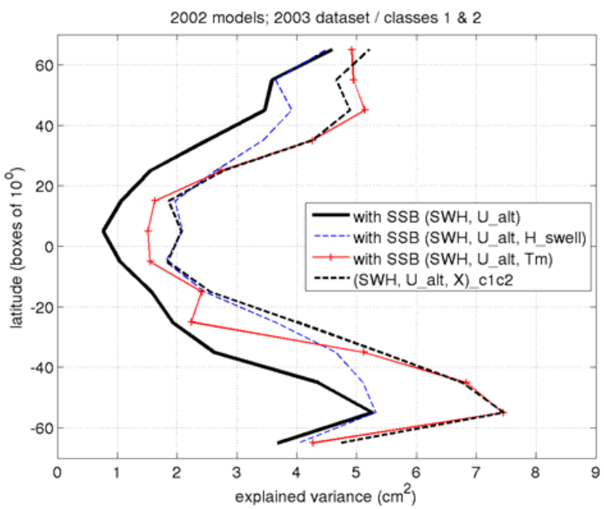
Tran – Jason-1/2 Sea State Bias, Alternative Models

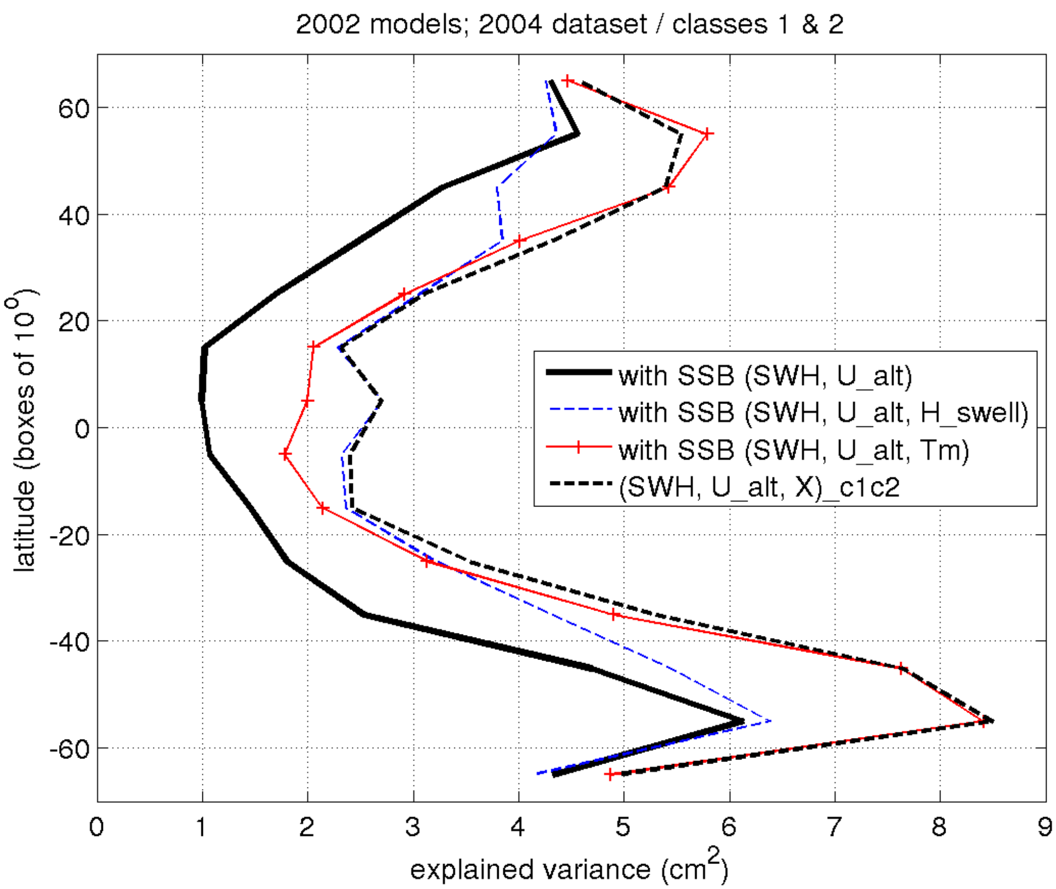
- Differences of J1 – J2 do not have any obvious SWH dependence
  - SSB solutions for J1, J2 are consistent at the 1-2 cm level throughout the SWH-U domain
- A discrepancy in the J2 wind speed has been found that can be corrected with linear adjustment of sigma0
  - Depending on the final correction 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

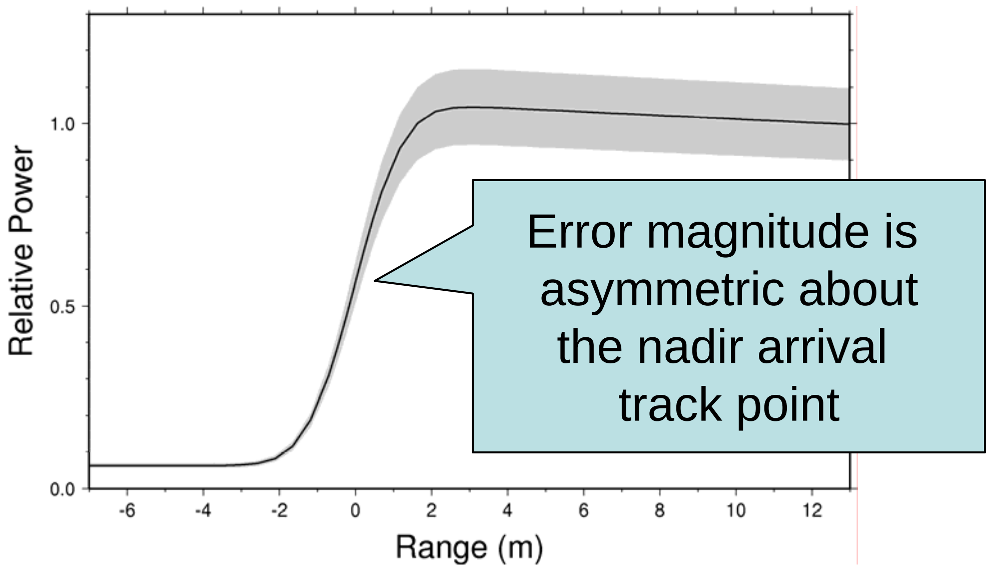
Performance as function of latitude
data from 2002, 2003 & 2004







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/DEM 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 (developped in 1940) sometimes used to « denoise » signals.

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

$$S = \bar{S} + B$$

Computing the Singular Value Decomposition

$$S = U\Sigma V^*$$

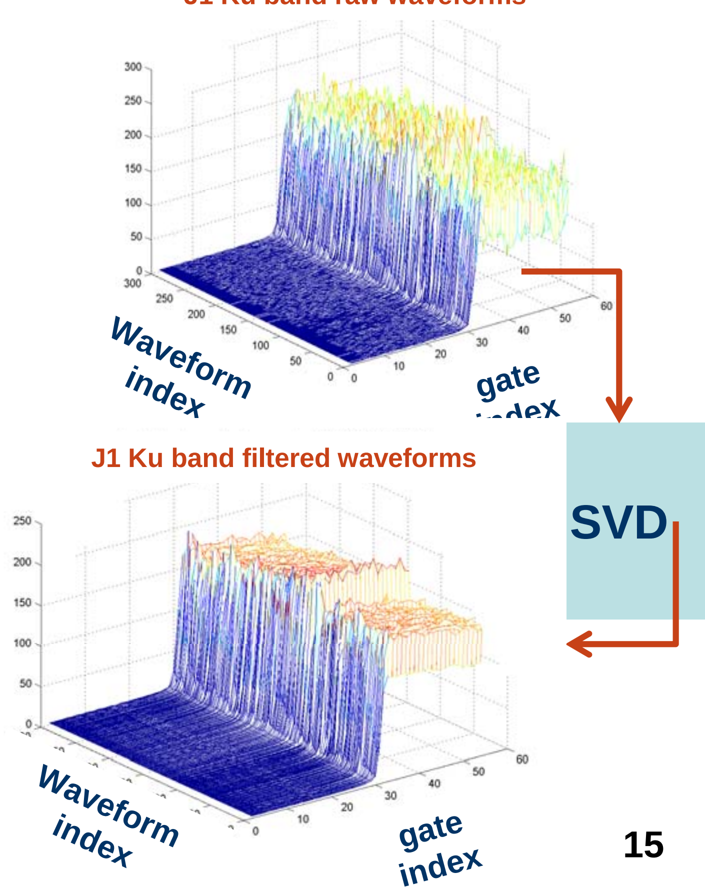
S (m,n) : WF matrix (m= 104; n=300)
U (m,m), V(n,n): unit matrices*
Σ (m,n) : diagonal matrix

$$S = \lambda_1 VS_1 + \ldots + \lambda_k VS_k + \ldots \lambda_r VS_r$$

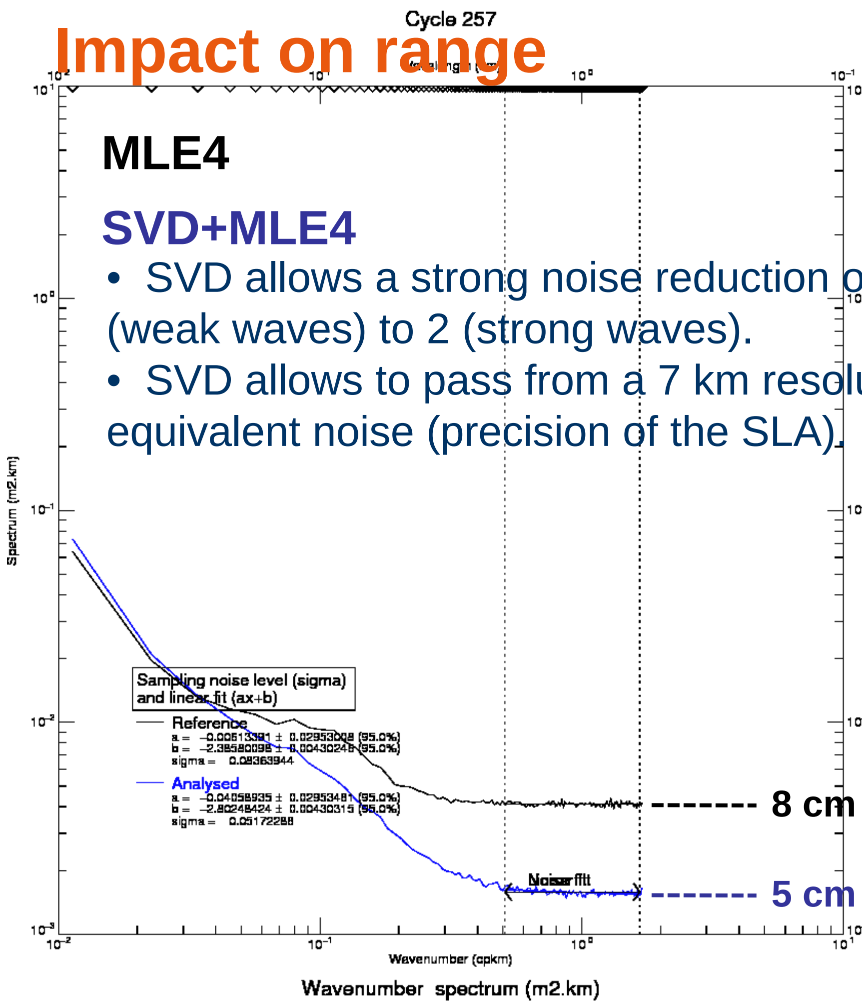
signal + noise — noise

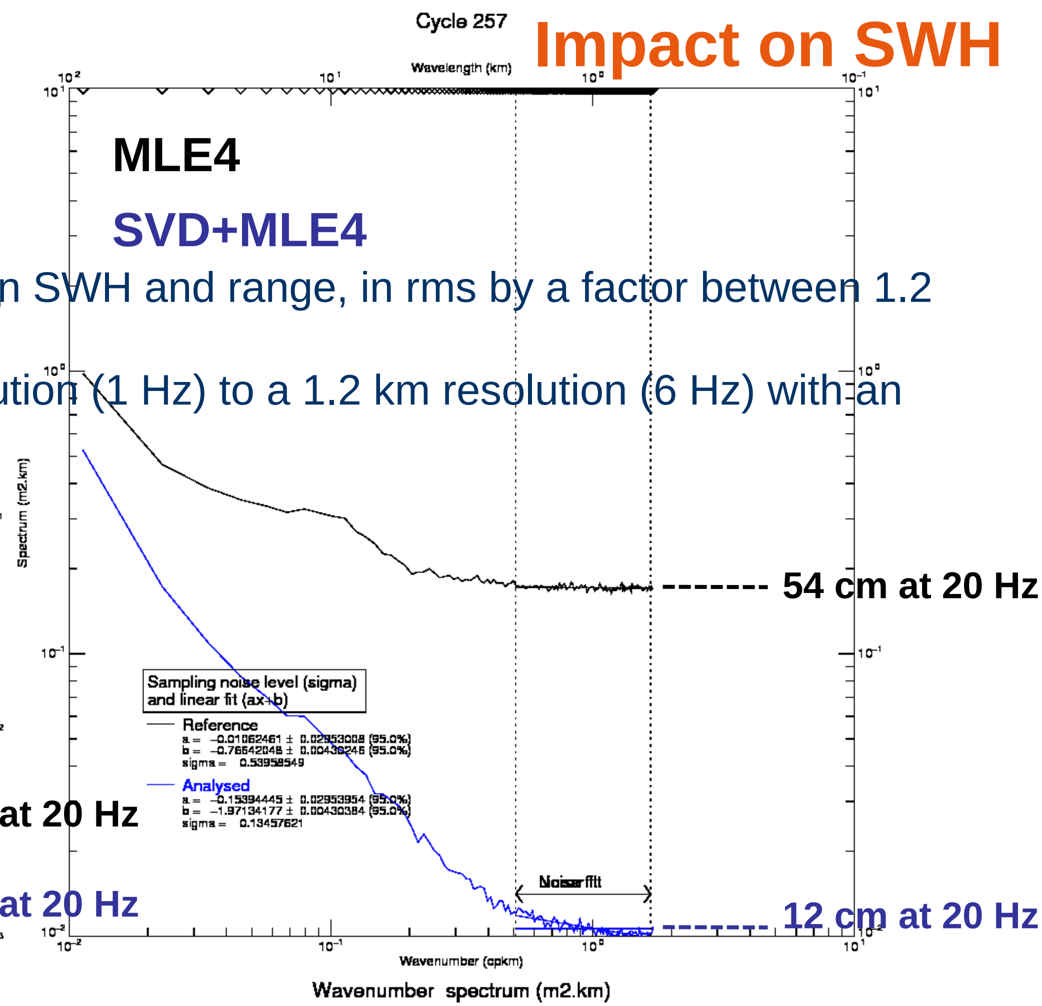
Discarding small singular values of S (which mainly represent the additive noise)

The rank-k matrix Ak represents a filtered signal



Thibaut – Singular Value Decomposition +Retracking (2 of 2)





- 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).

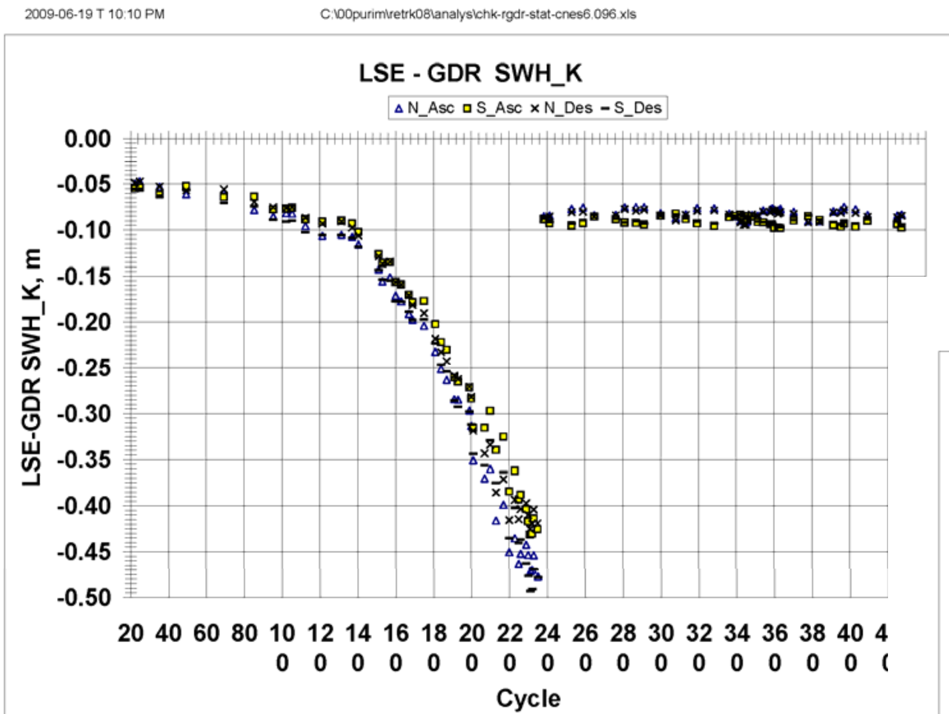
Callahan – TOPEX Retracking

- 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)

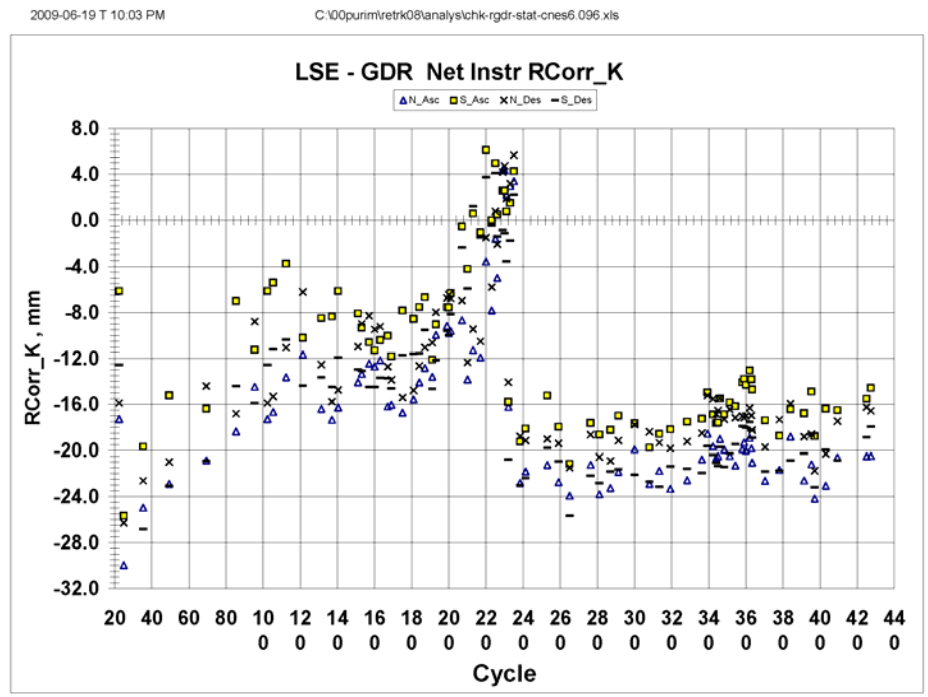
- Result Highlights
  - Retracking appears to correct SWH change from Alt-A PTR change
  - Results not very sensitive to selection/variation of weights
  - Results fairly sensitive to PTR variations
  - Skewness continues to absorb waveform leakages and shows N/S, Asc/Des (Toward/Away from equator, +/- 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

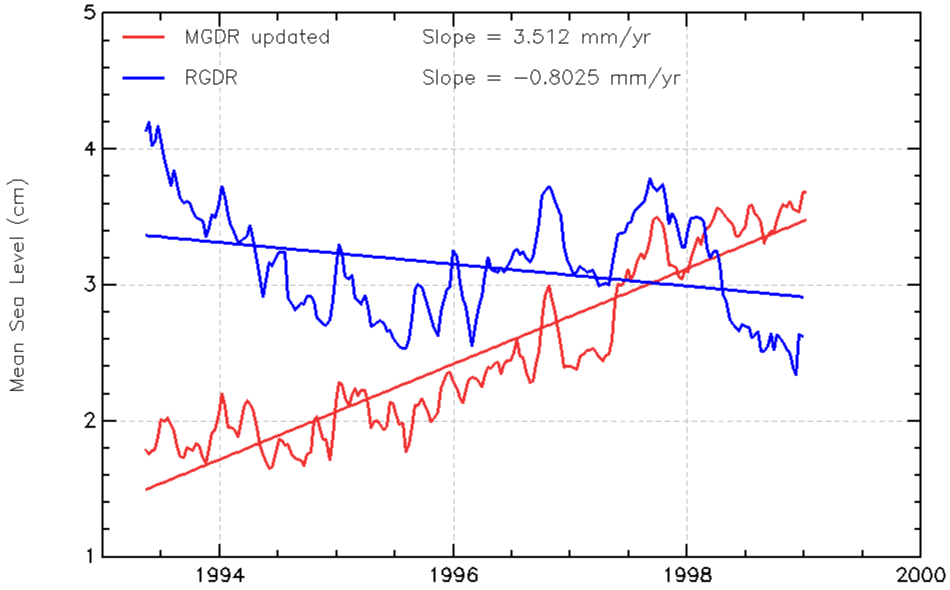


Retracking Correction to Range

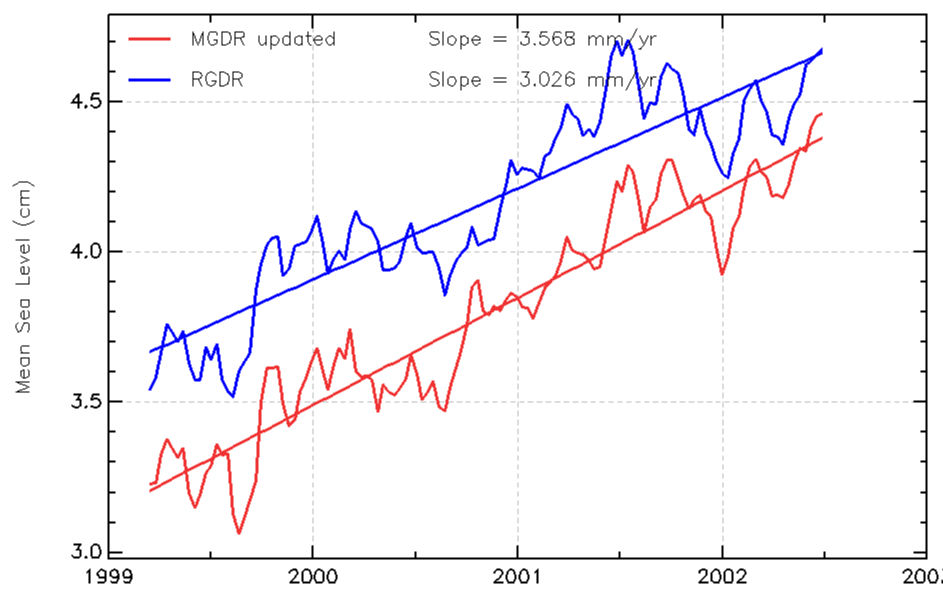


TOPEX RGDR Time Variations – Labroue et als Analysis

Side A MSL



Side B MSL



- 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