Assessment of recent revisions to the TOPEX/Poseidon/Jason Sea Surface Height Climate Data Record: Impact on global and regional sea level estimates

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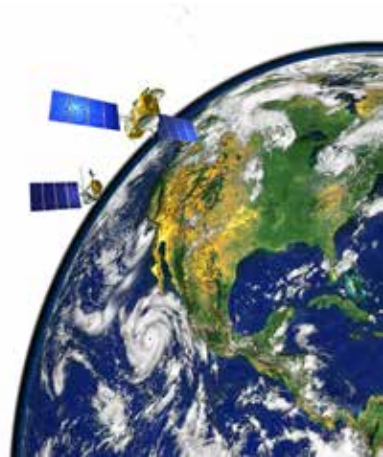
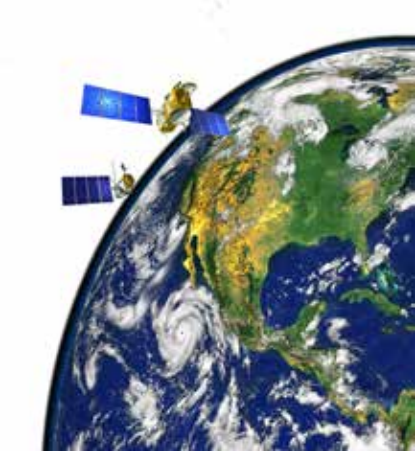


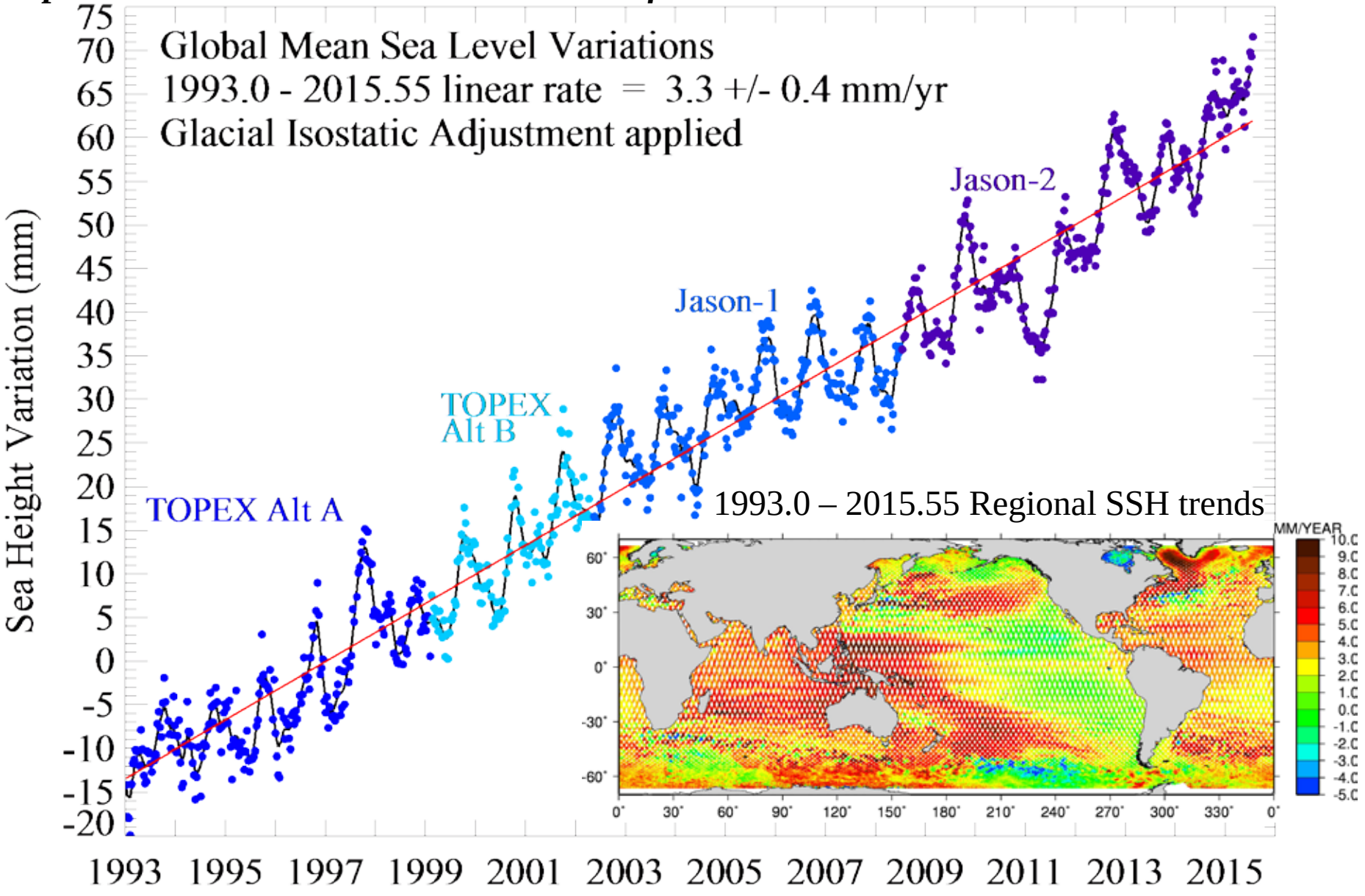
2015 OSTST Meeting, Oct. 21, 2015, Reston, VA

Preview

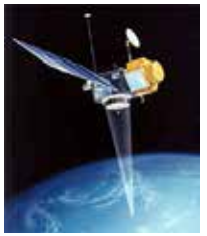
- Revisions to MEaSURE's Sea Surface Height (SSH) product
  TOPEX/Poseidon, Jason-1&2 primary mission data (Sep. 1992 – Aug. 2015)
  http://podaac.jpl.nasa.gov/Integrated_Multi-Mission_Ocean_AltimeterData
  EOSDIS doi: 10.5067/ALTTS-TJ122
- Current global and regional sea level estimates
- Geodetic issues – POD, reference frame, time varying gravity modeling
- Monitoring instrument stability – tide gauge verification analyses, error budget
- Monitoring of observed changes in recent regional SSH trends

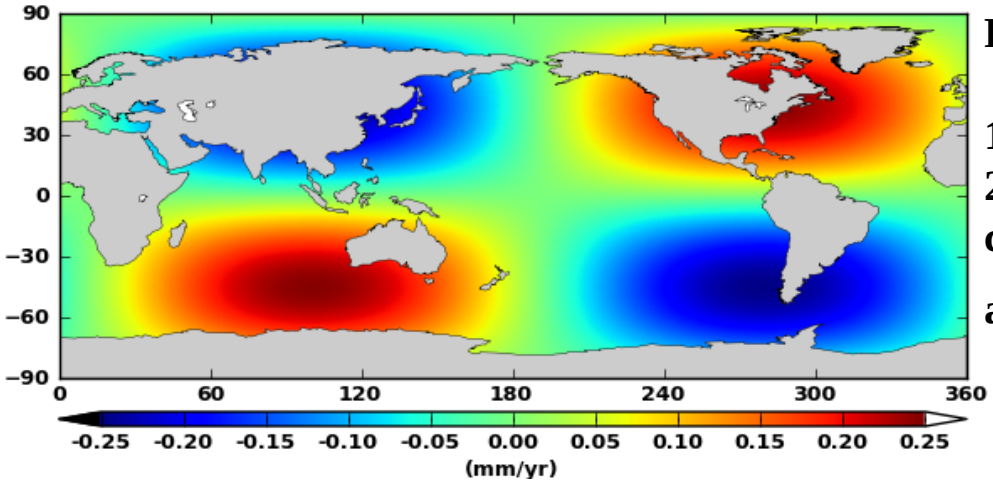


Objective: ***Develop a coherent and consistent time series of sea surface height from multi-mission altimeter data that meets the most stringent accuracy requirements demanded to provide credible mean sea level estimates for climate research.***



Revised Pole tide correction-impact on regional sea level estimates



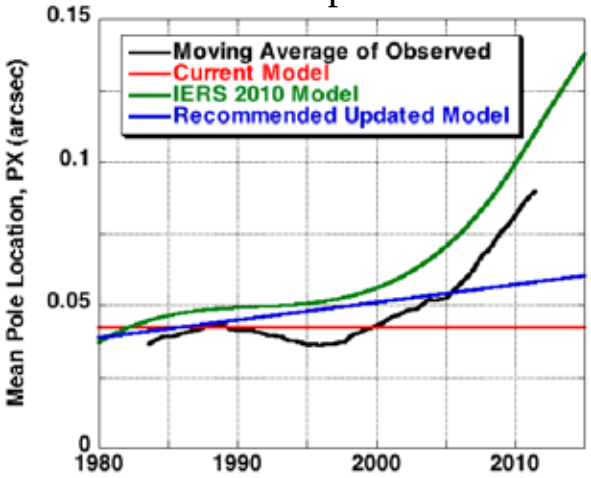


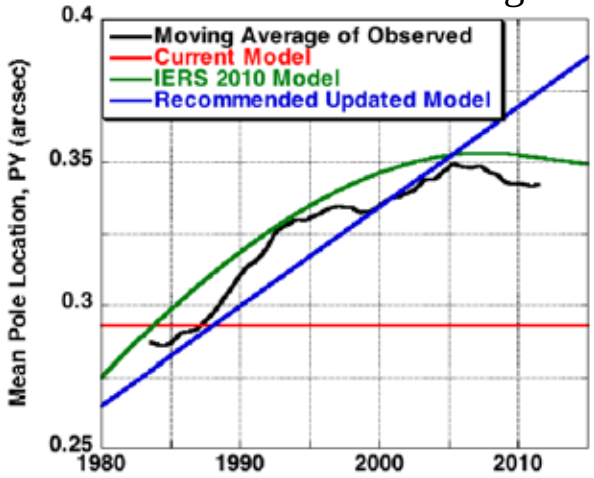
Prior model has two deficiencies:

1. **Not valid for long-term drift in polar motion.**
2. **Ignores effects of self-gravitation, loading, conservation of mass, and geocenter motion arising from redistribution of mass of oceans.**

- **Error of +/- 0.25 mm/year.**

- Recommended updated model of “Mean Pole” includes bias and long-term drift.

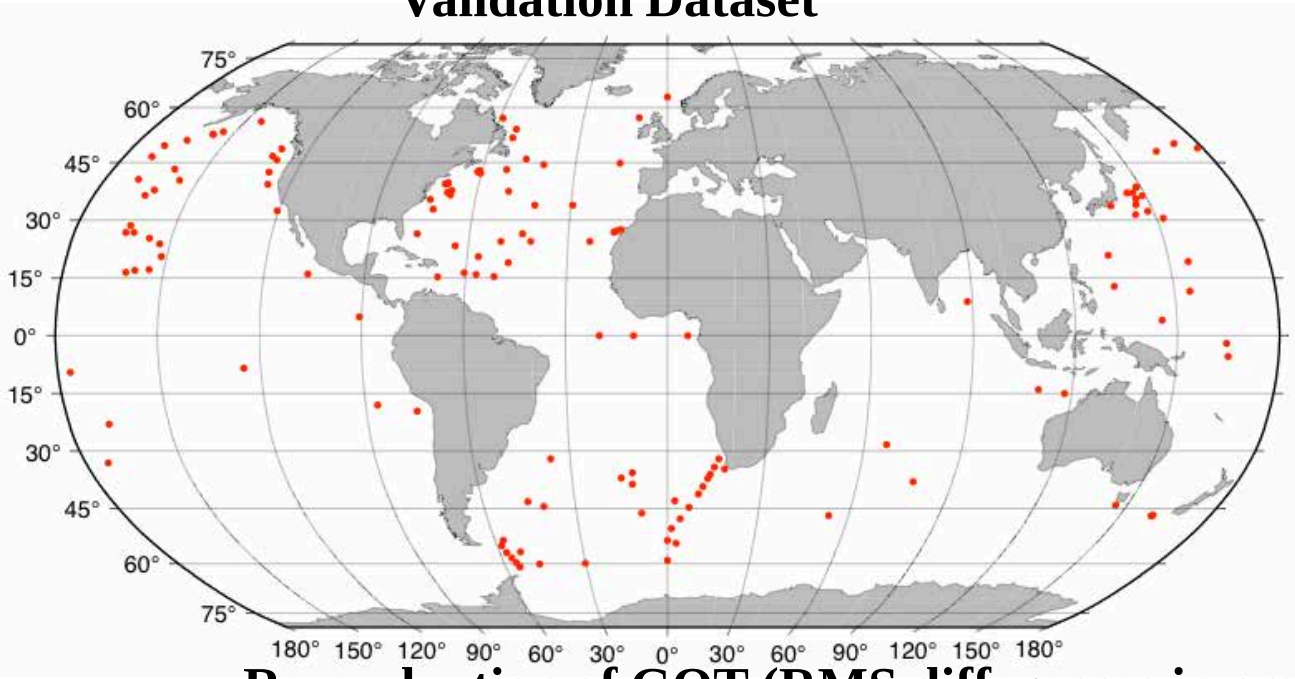




Poster TID_004 Updating the Pole Tide Model for Satellite Altimetry, Desai et al.

High-Precision Comparisons of Bottom-Pressure & Altimetric Tides

137-station Bottom Pressure Tidal Validation Dataset

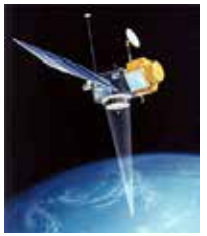


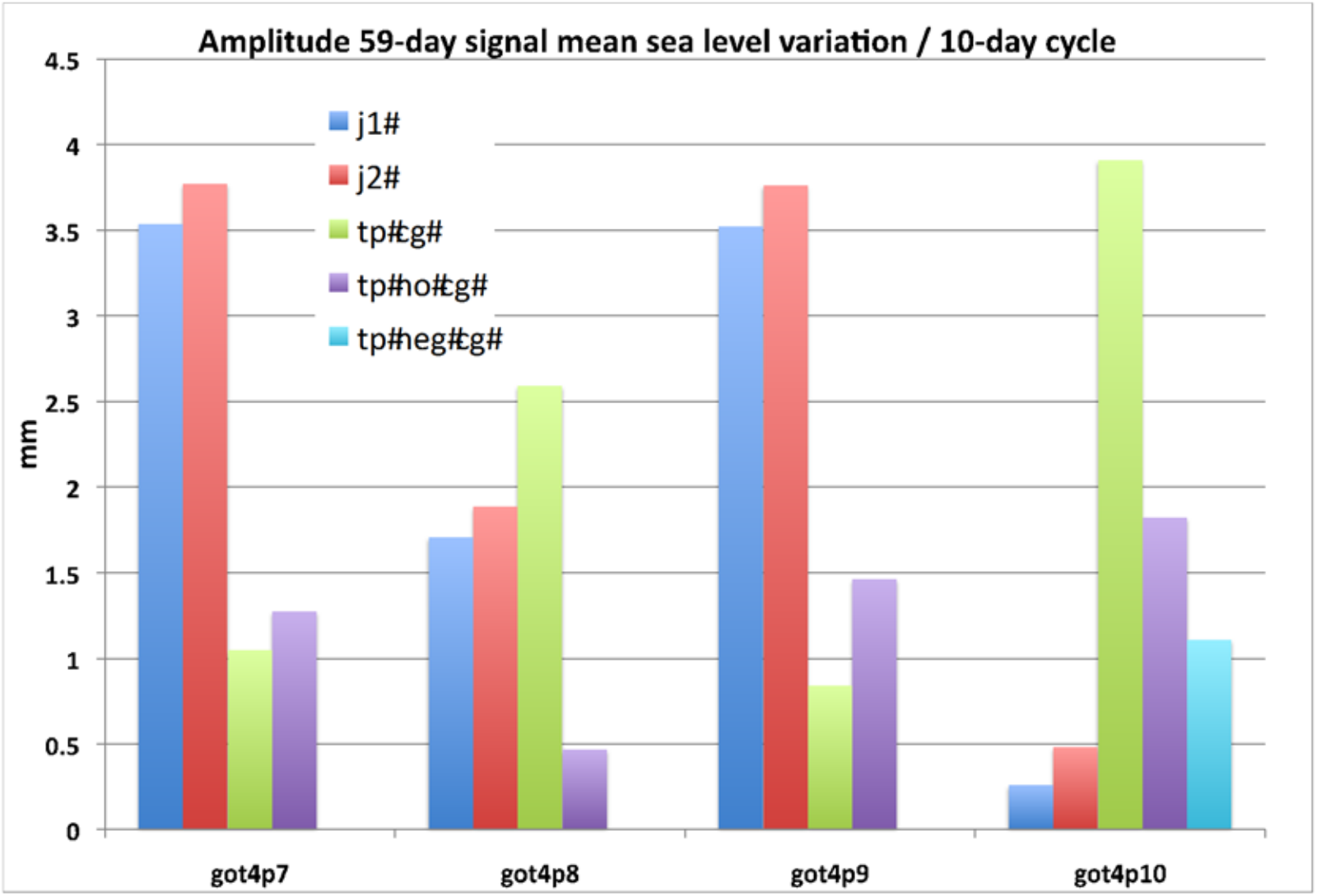
Re-evaluation of GOT (RMS differences in cm.)

	Q1	O1	P1	K1	N2	M2	S2	K2
GOT4.8	0.17	0.30	0.23	0.42	0.25	0.51	0.37	0.21
GOT4.10	0.15	0.23	0.19	0.30	0.24	0.47	0.32	0.18

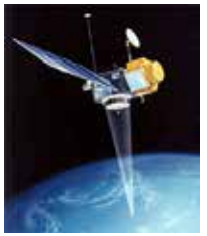
Note: GOT4.10 derived from Jason-1 & 2 altimetry only.
GOT4.8 derived from T/P altimetry only.

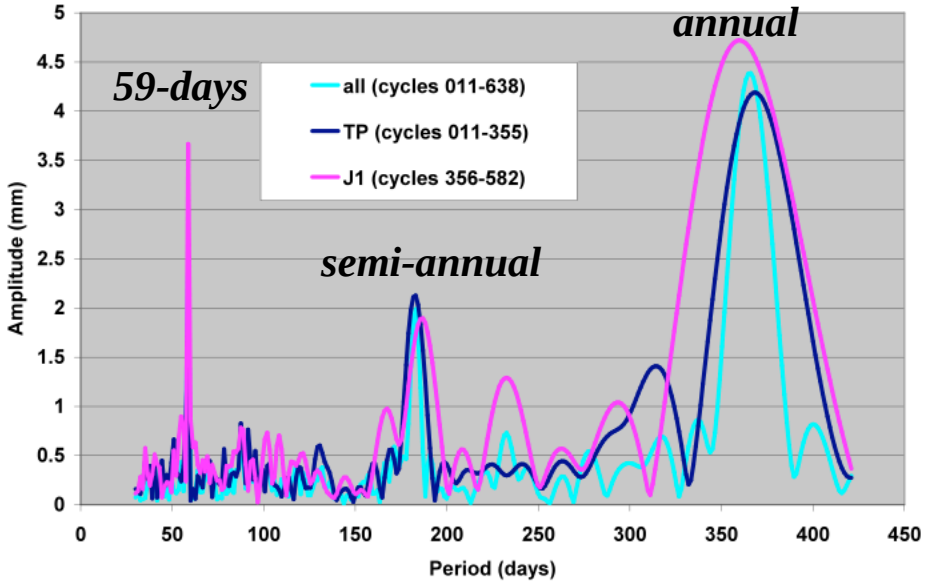
Ocean Tide Model Development
reduction of the 59-day signal

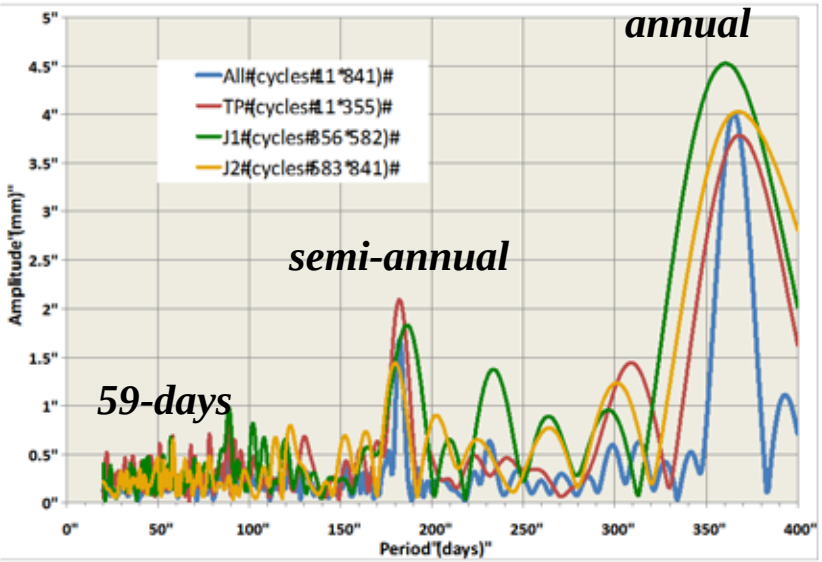




Periodic variations in GMSL Estimates
Reduction of Error at 59-days





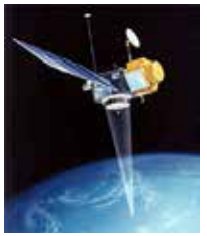


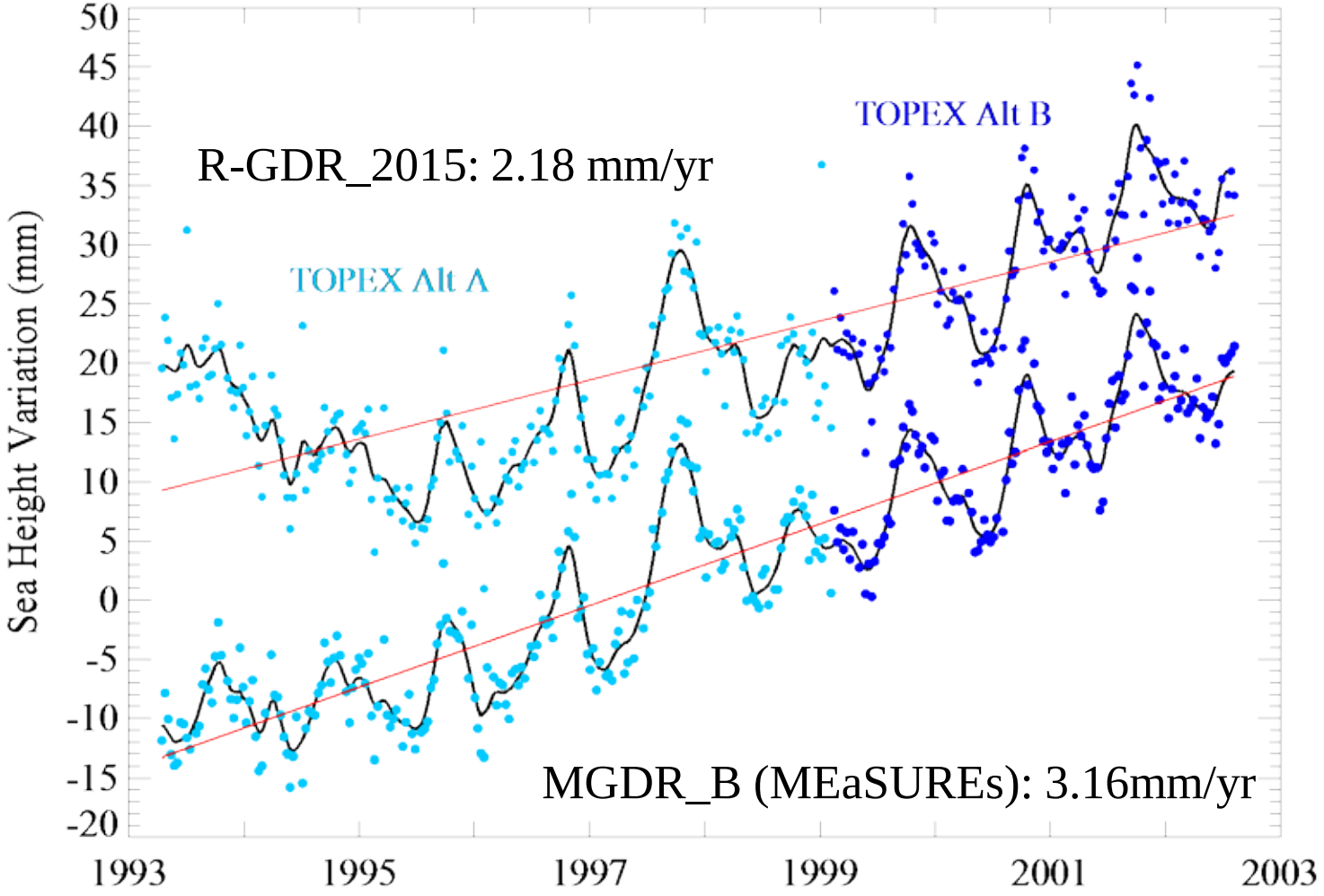
T/P: GOT4.7, Cg applied, S_2 air-tide error in dry troposphere correction
Jason-1: GOT4.7
Jason-2: GOT4.7

T/P: GOT4.8, Cg not applied, Dry tropo corrected for S_2 air-tide error
Jason-1: GOT4.10
Jason-2: GOT4.10

See also Zawadzki et al., Reduction of the 58.77-day Signal in the Mean Sea Level derived from TOPEX/Poseidon, Jason-1 and Jason-2 data with the latest FES and GOT ocean tide models

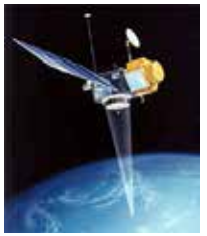
TOPEX Global Mean Sea Level
Cycles 21 – 364
MGDR_B vs R-GDR_2015

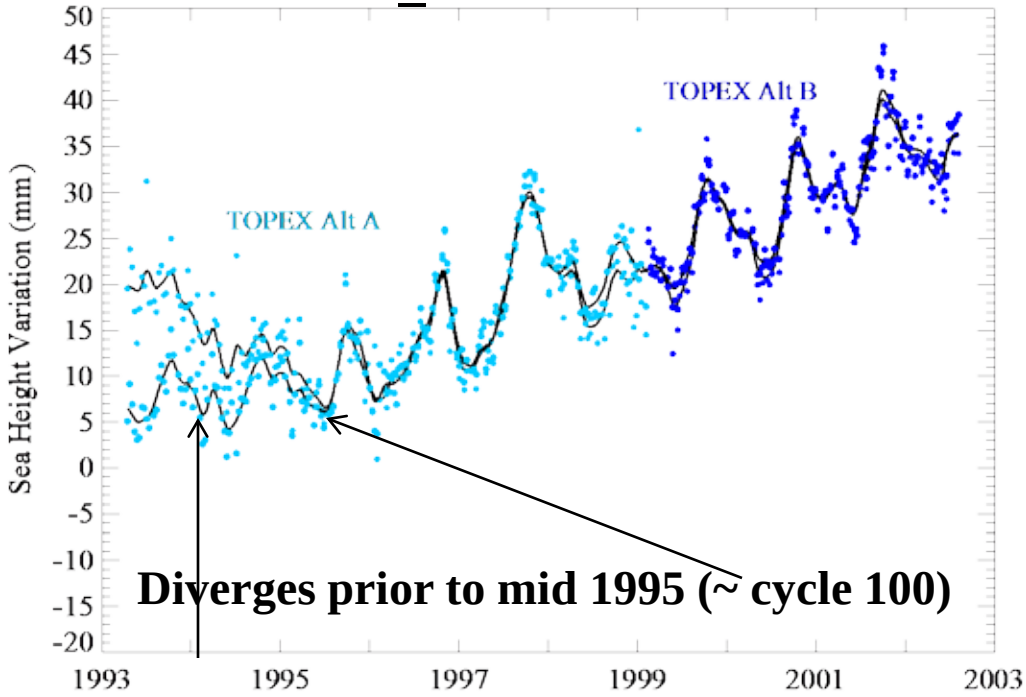




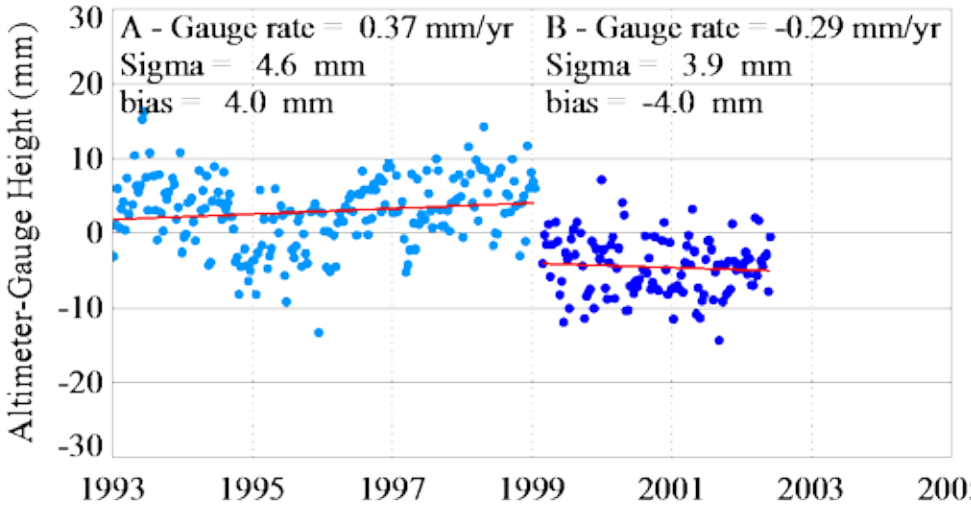
see Poster: Feng et al., Revised sea state bias models for retracked TOPEX altimeter data

TOPEX Global Mean Sea Level
MGDR_B versus R-GDR

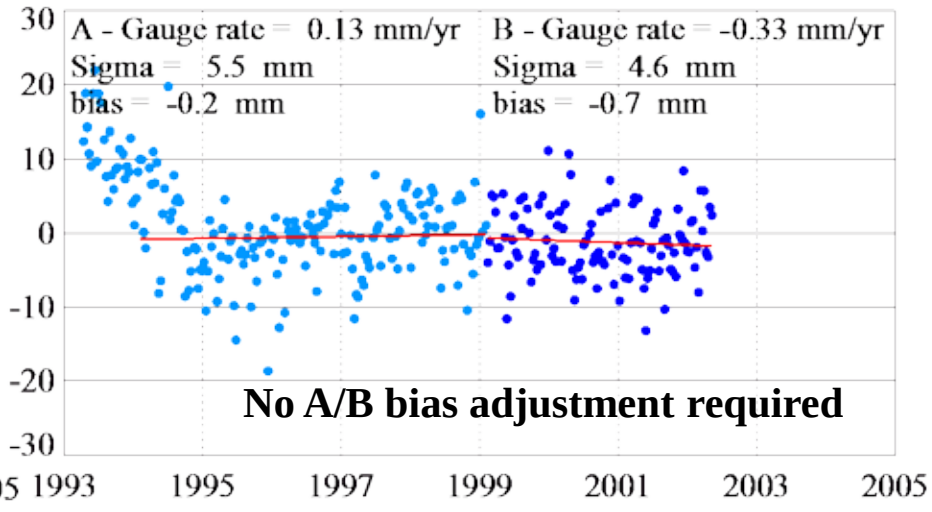




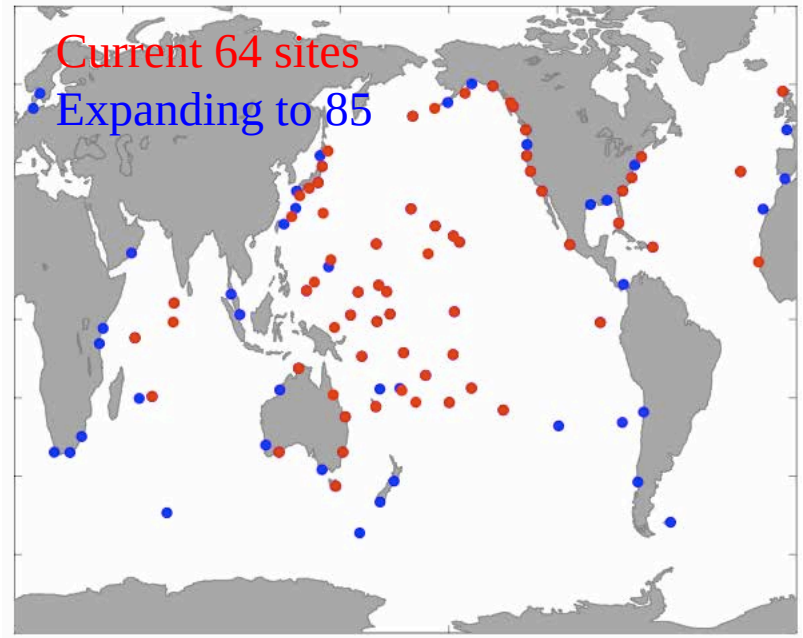
MGDR_B



R-GDR_2015



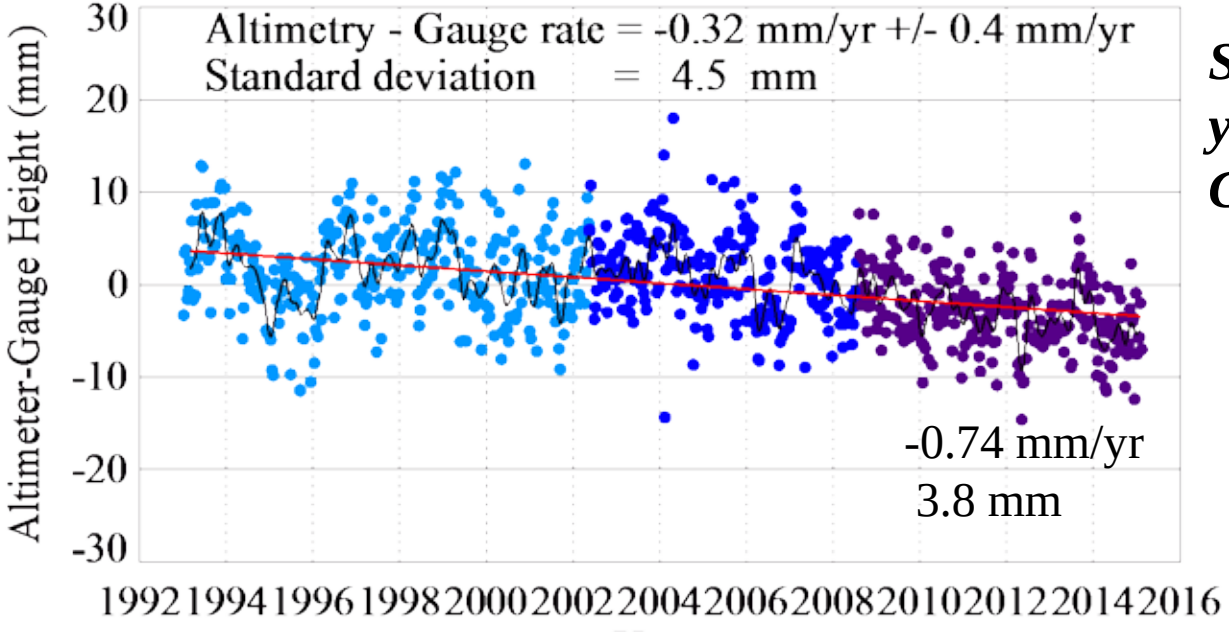
Tide Gauge "ground truth" Network



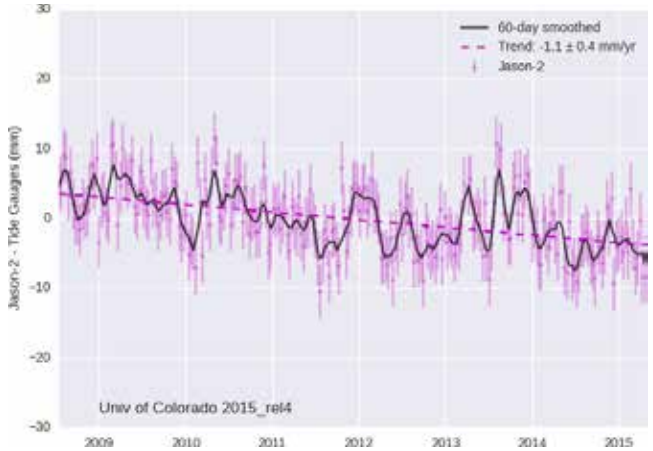
- *Prof. Gary Mitchum provides independent assessments of SSH time series for GSFC, NOAA, and U. of Colorado.*

- *Largest uncertainty in estimated rates arises from land motion at gauges.*

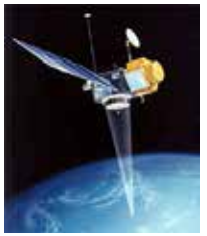
- **Vertical land motion corrections based on GPS ULR5 series** ***(Santamaría-Gómez, 2012).***



Stability estimate of the 23 year record based on GSFC std1204 orbit.

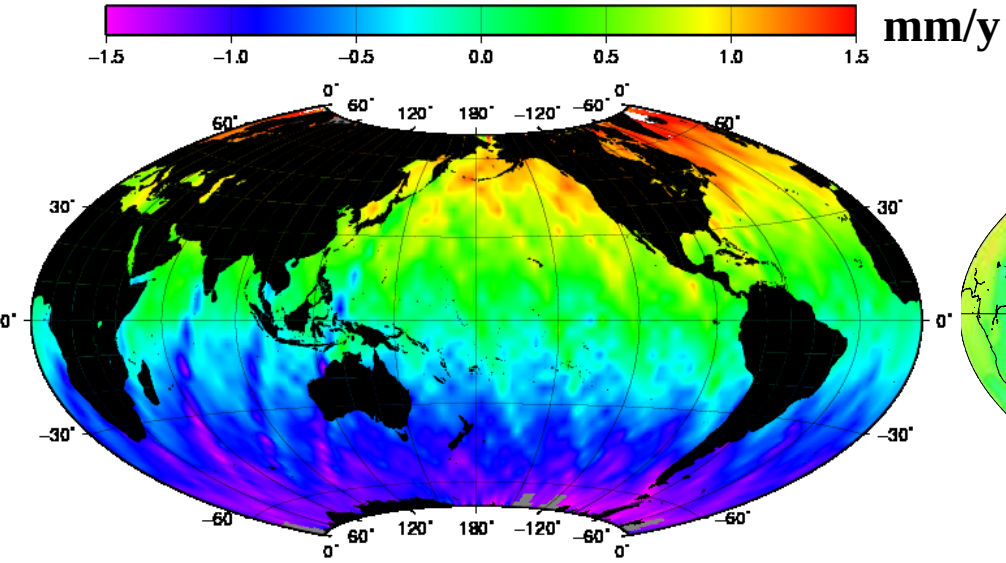


Compounded TVG + TRF induced-errors in regional sea level trend estimates



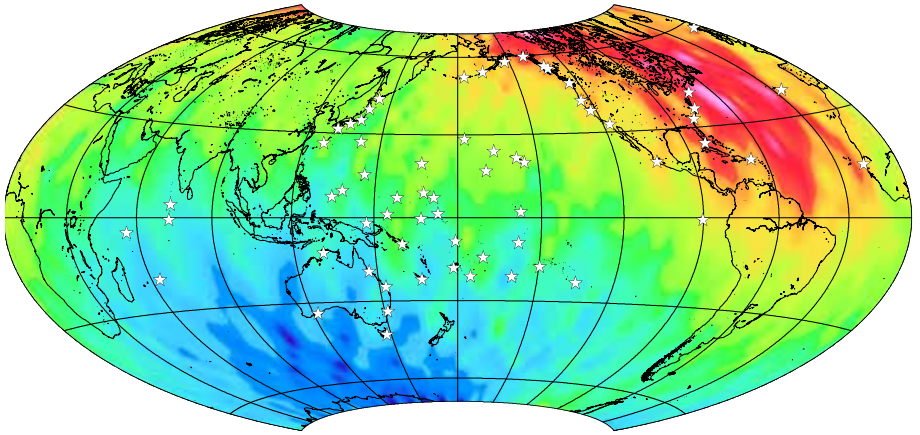
Impact of outdated TRF

T/P: ITRF2008 – CSR95



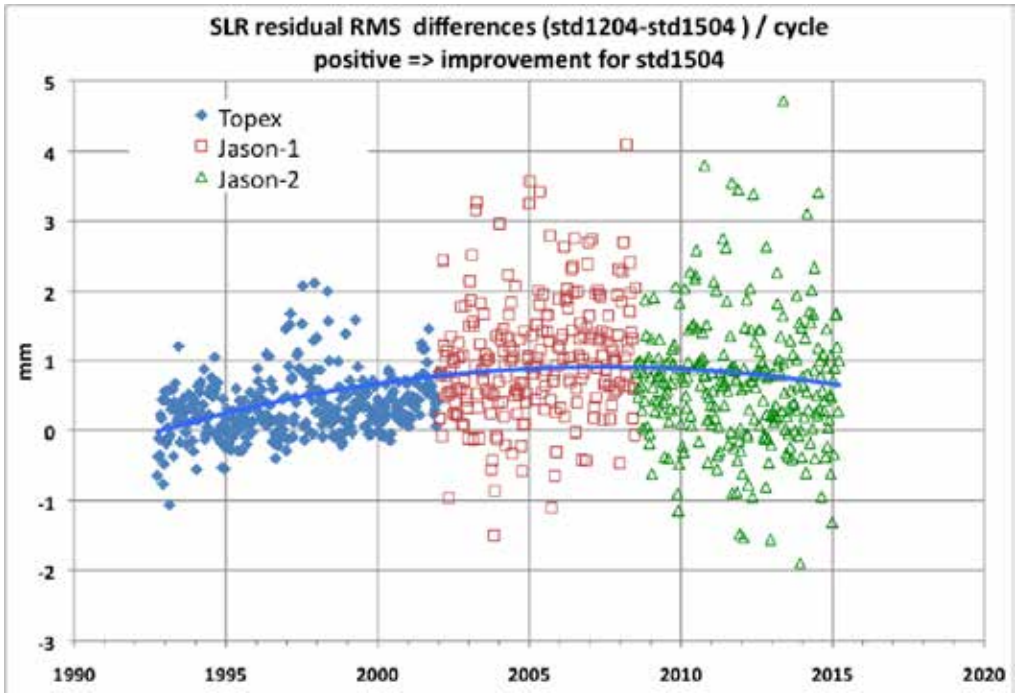
Impact of TVG models

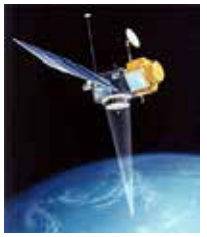
Jason-2: GSFC 1204 – GDR_T



Geographically correlated errors will impact verification results depending on the chosen validation tide gauge network geometry.

GSFC revised orbit standard std1504





Std1504 radial orbit accuracy relative to std1204 using SLR data.

GSFC std1504 principal updates to the previous std1204 standard:

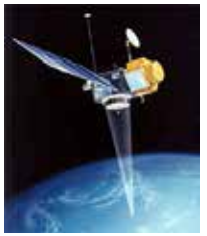
Ø **gravity field:** offset, rate, annual and semi-annual terms to deg/order 5x5 from SLR/DORIS tracking to 21 satellites, estimated over two spans: 1993-2002, 2003-2014; GOCO2S (from 6x6).

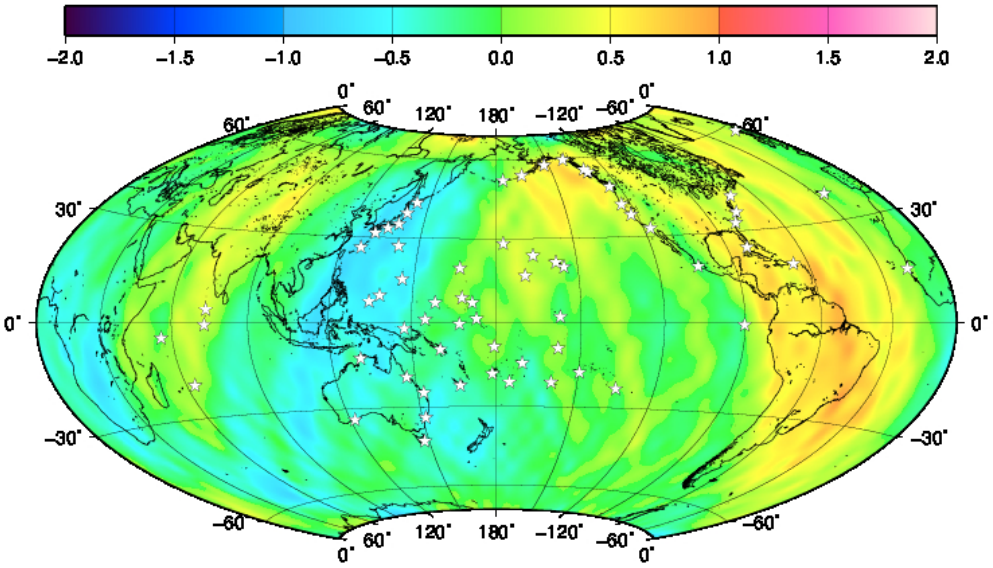
Ø measured **solar array pointing angles** for Jason1 and Jason2

Ø improved Jason-1/2 satellite **center of mass (CM_s)** to SLR/DORIS antenna phase center modeling

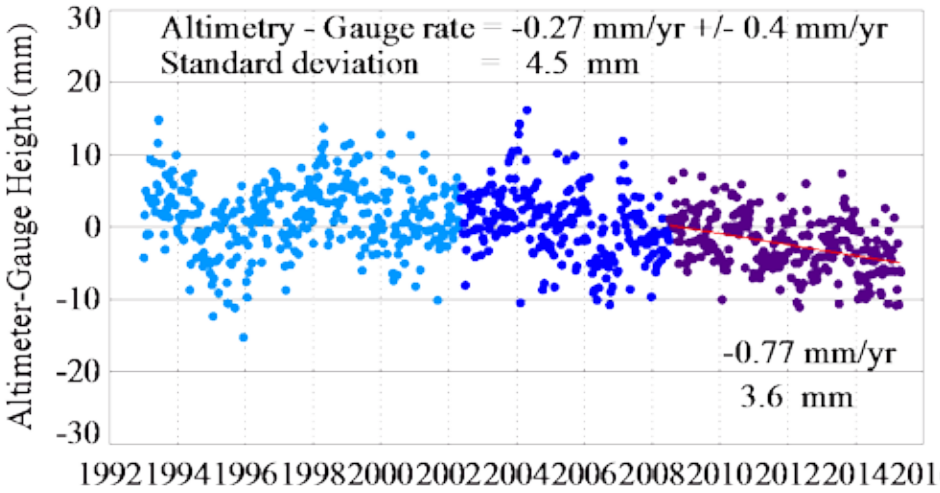
Ø forward modeling of station displacements due to annual **geocenter variation (CM_E)**

Jason-2 regional orbit difference trends
GSFC std1504 minus JPL14a

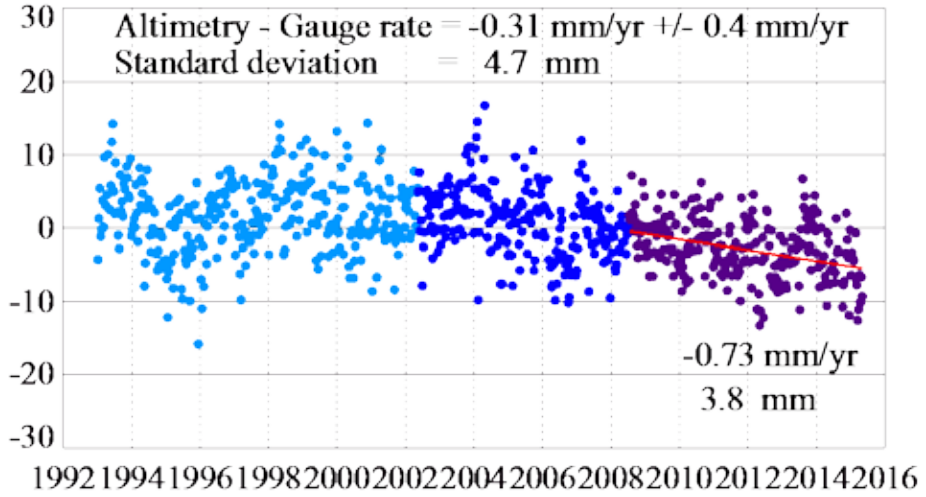




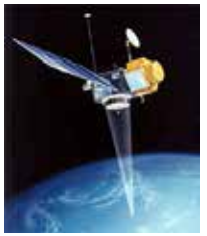
GSFC std1504



JPL14a

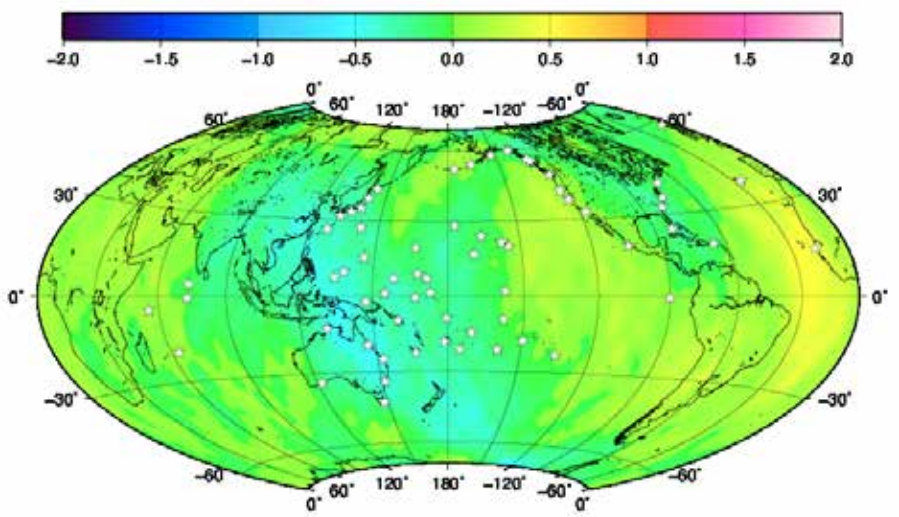


Jason-2 GDR_D and GDR_E POD Comparison

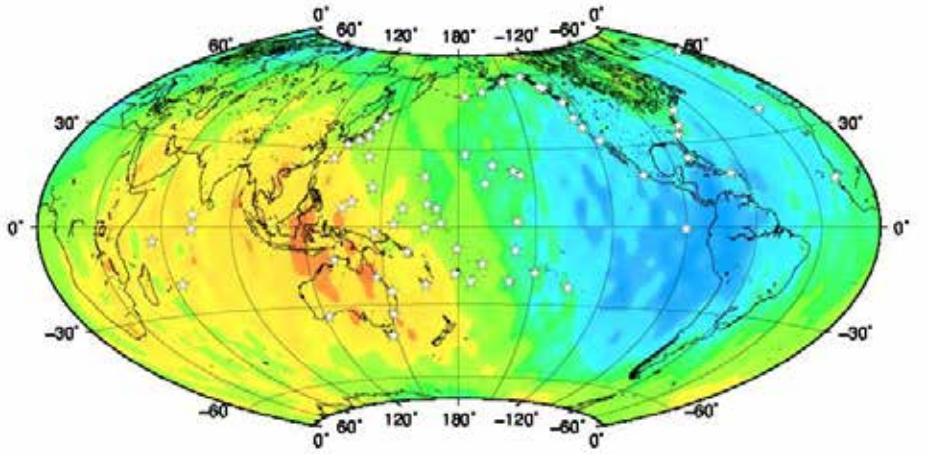


Jason-2 regional orbit difference trends

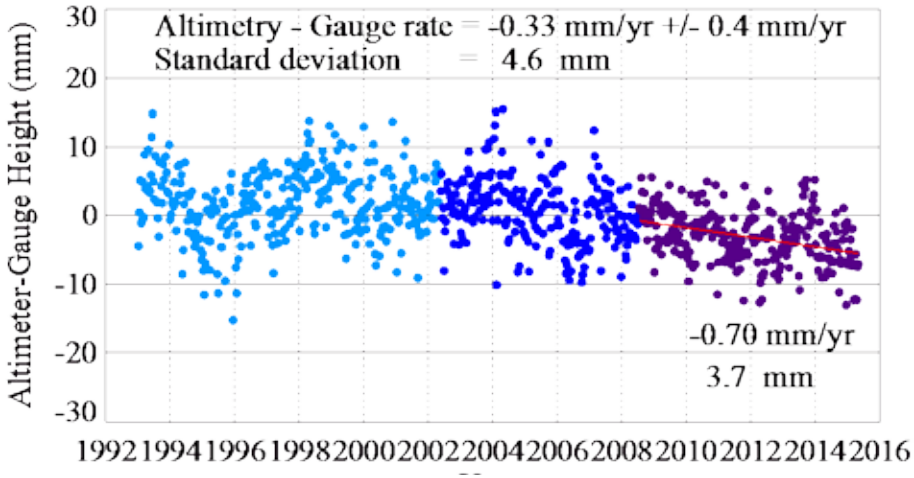
CNES GDR_E minus JPL14a



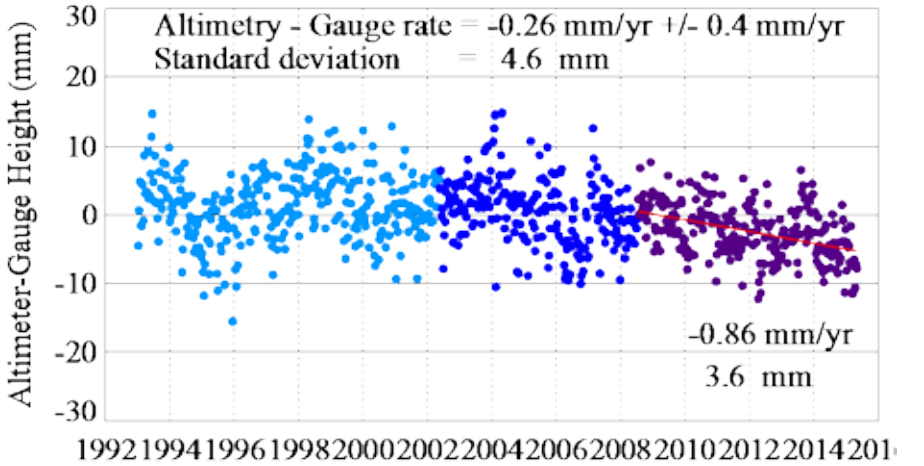
CNES GDR_D minus JPL14a



GDR_E



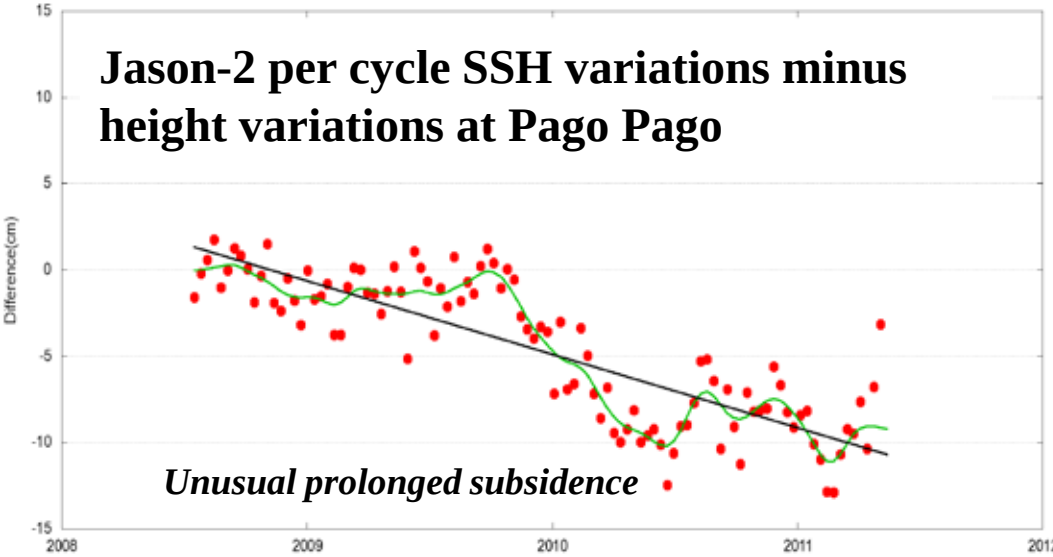
GDR_D



Tide Gauge Vertical Motion Estimation

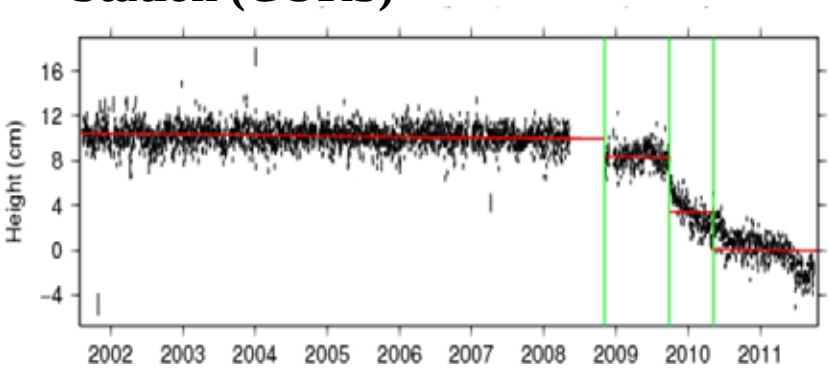
Mis-modeling at Pago Pago

Jason-2 per cycle SSH variations minus height variations at Pago Pago

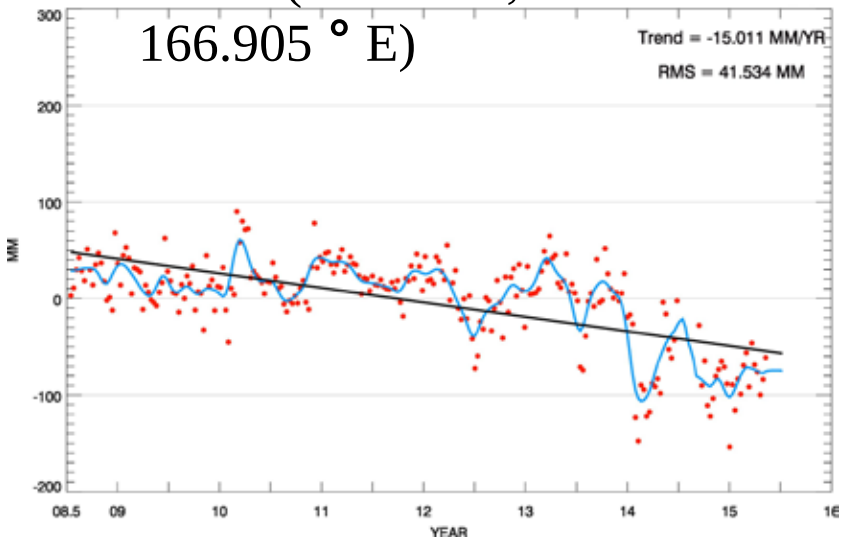


Unusual prolonged subsidence

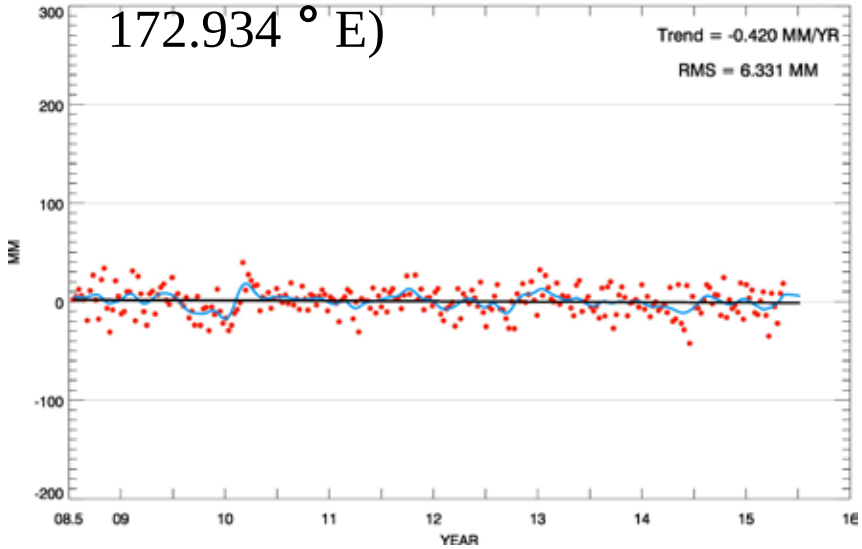
GPS time series from NGS Continuously Operating Reference Station (CORS)



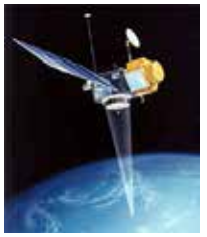
Nauru (0.528 ° S, 166.905 ° E)

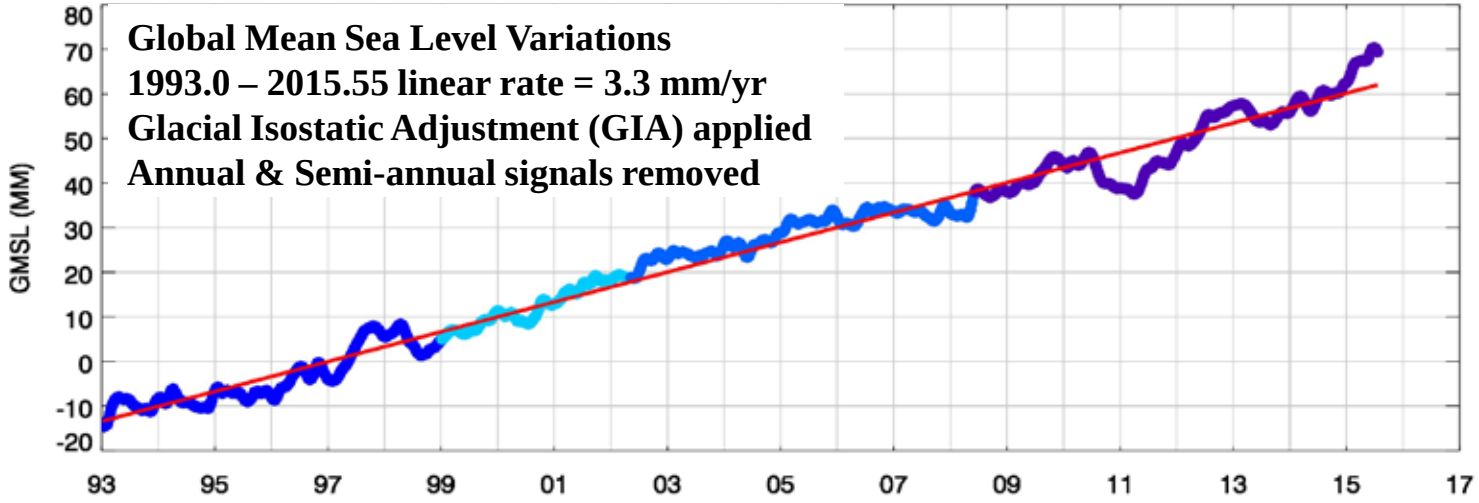


Betio (1.358 ° N, 172.934 ° E)

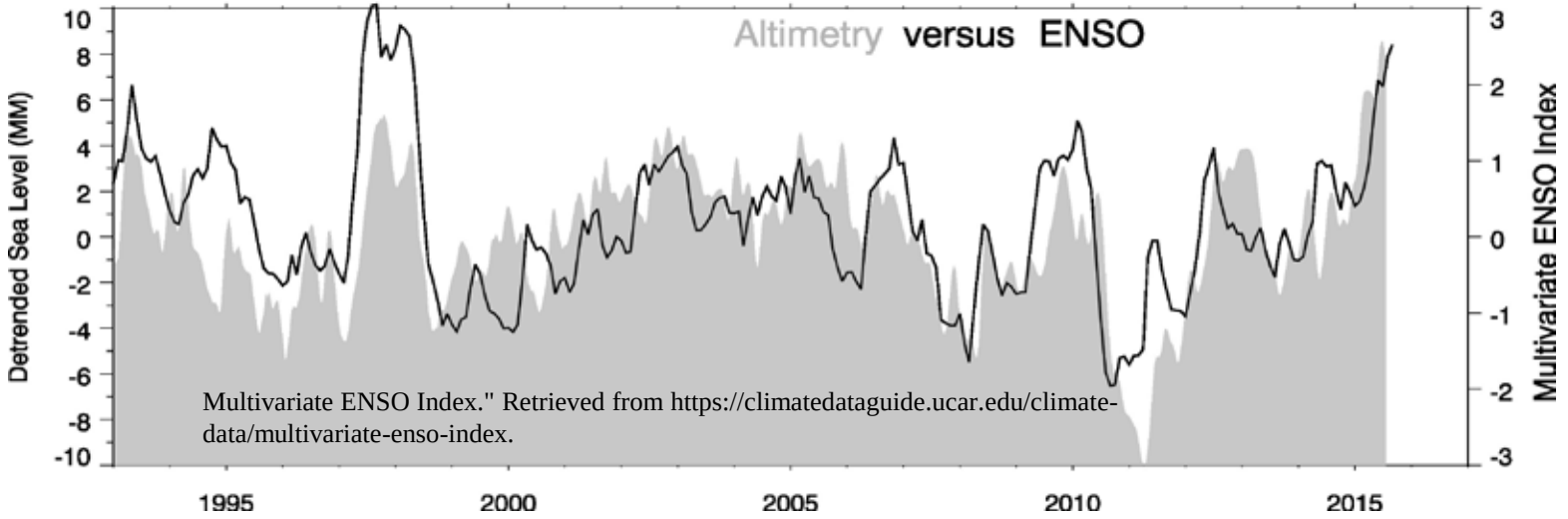


Impact of ENSO on Global Mean Sea Level





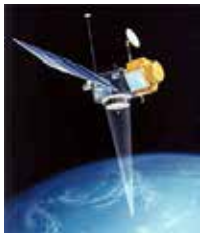
De-trended GMSL versus Multivariate ENSO index



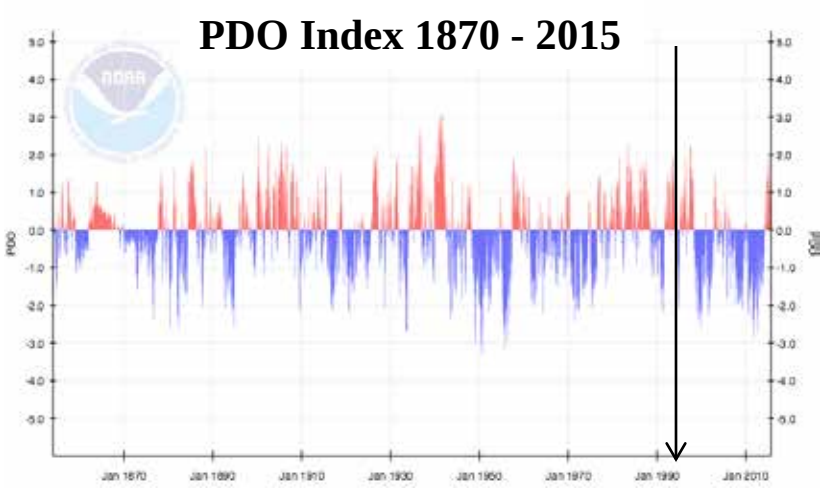
Multivariate ENSO Index." Retrieved from https://climatedataguide.ucar.edu/climate-data/multivariate-enso-index.

Regional SSH Trends Reflecting Climate Indices

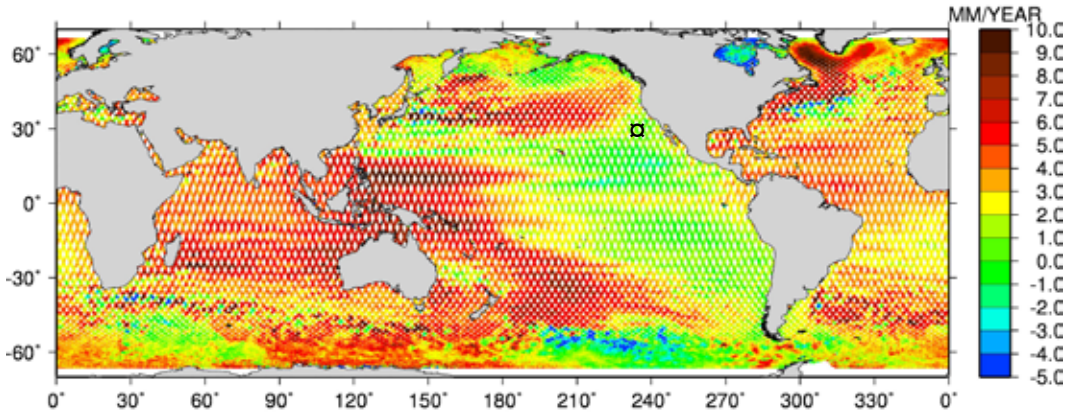
Pacific Decadal Oscillation (PDO) Case Study

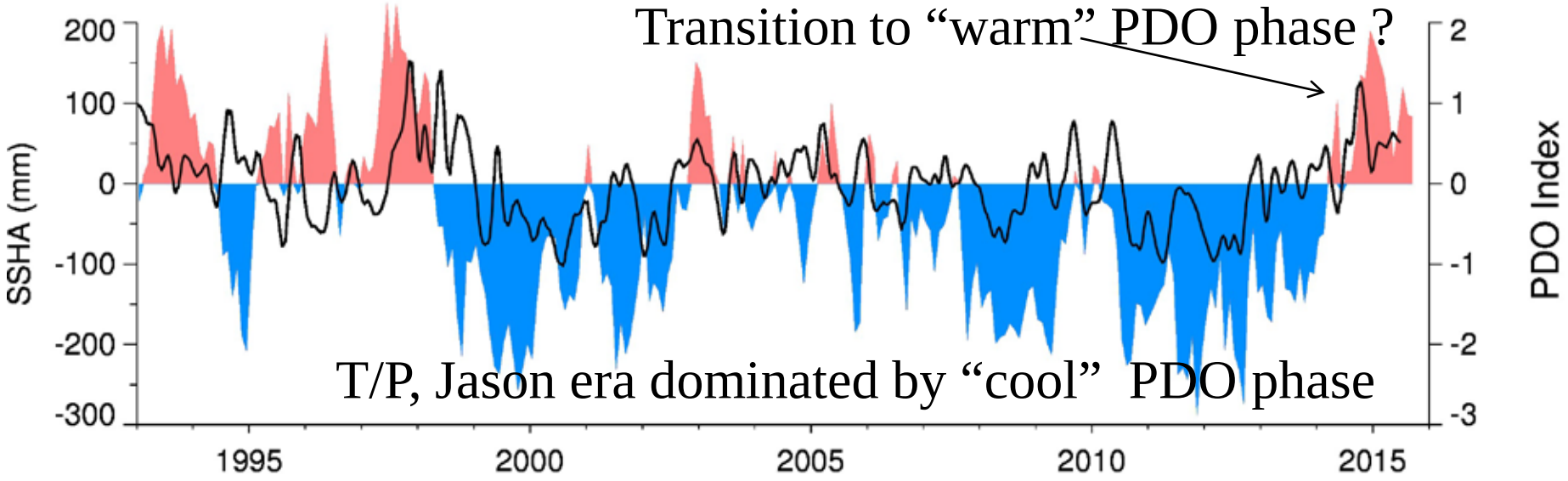


PDO Index 1870 - 2015

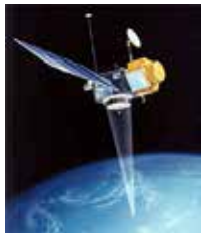


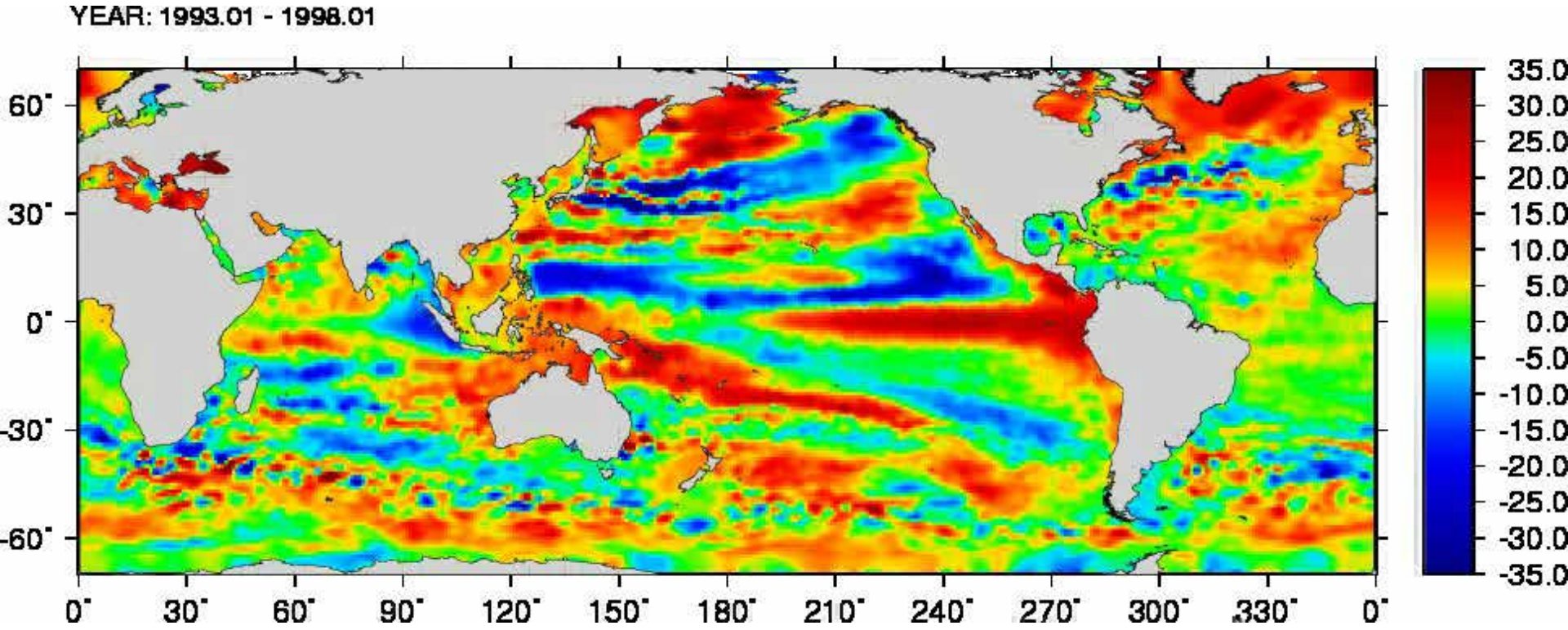
SSH trends 1993.0 -2015.5

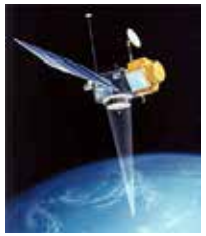




Regional 5-yr Sea Surface Height Trends
1993.0 – 2015.5







YEAR: 2010.50 - 2015.49