

Comparisons of Jason-3 and Sentinel-3A and tide gauges

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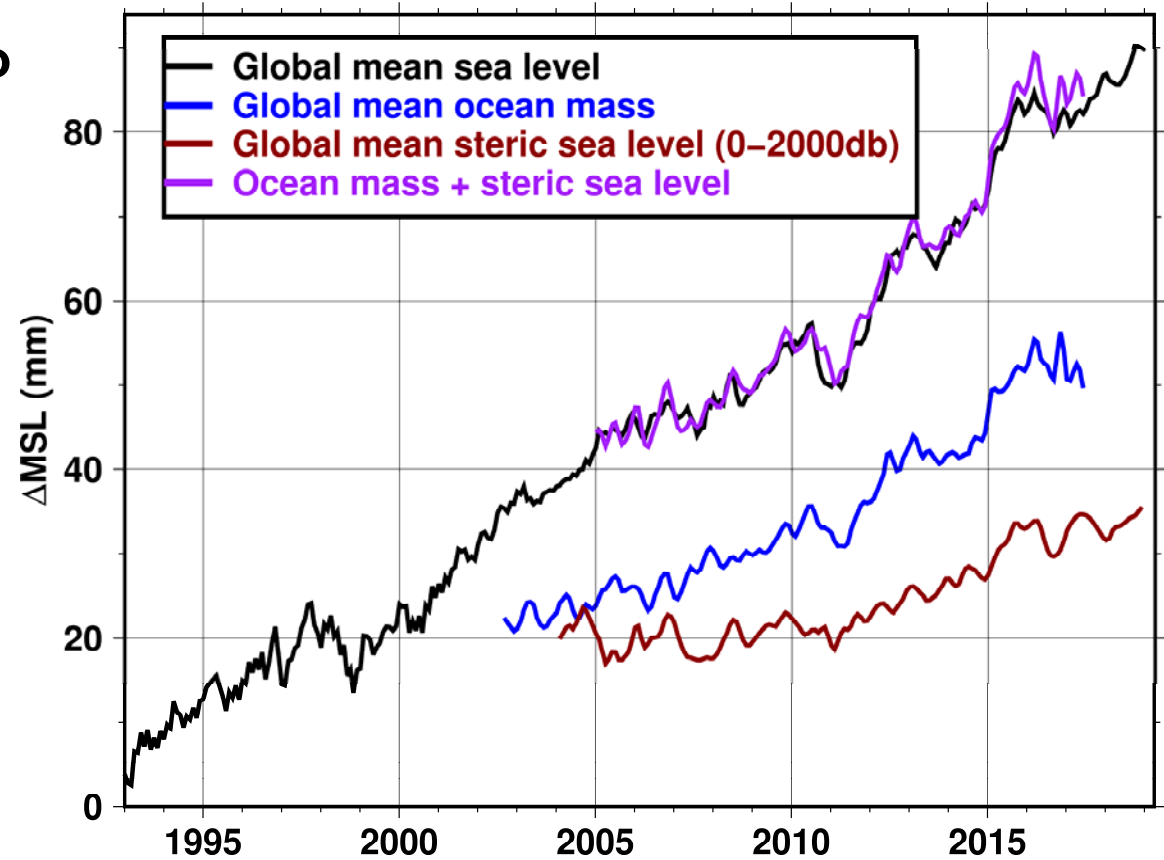




Sea level budget

Sea level budget closure Jason-2/3 vs. GRACE+Argo

~1 year gap between
GRACE and GRACE-FO



2018 State of the Climate Report

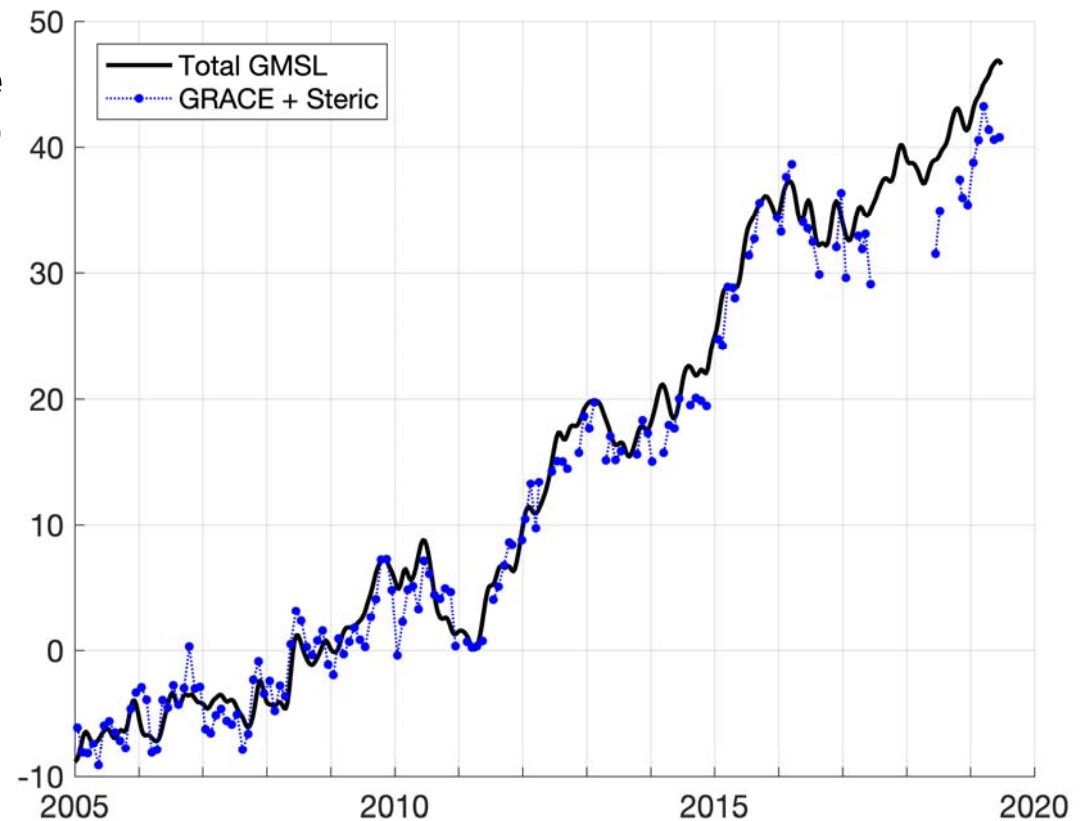


Sea level budget with GRACE-FO

A bias difference between global mean sea level from altimetry and from GRACE+Argo after the transition GRACE to GRACE-FO has been observed.

Sea level budget closures have several possible sources of error:

- **Salinity errors in Argo**
- **Accounting for deep ocean warming**
- **Elastic response of the solid Earth**
- **Drifts in altimeters and biases between missions**

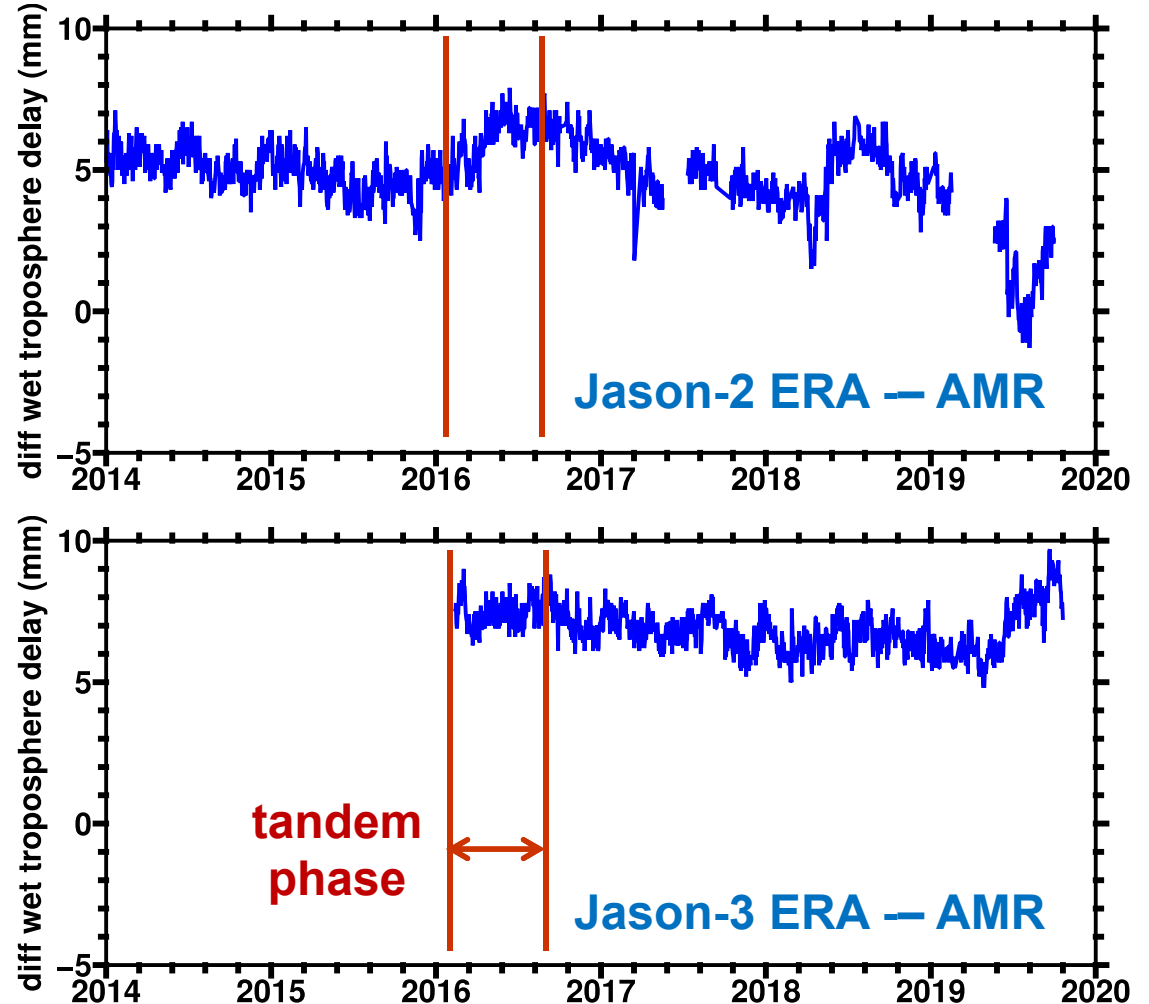


Beckley and Loomis



Wet troposphere differences

During the Jason-2/Jason-3 tandem phase, the radiometer (AMR) wet troposphere path delays is stable for Jason-3, but drifts for Jason-2.





Intermission comparisons

RADS used to estimate intermission biases among Jason-2/-3, Sentinel-3A/-3B, CryoSat-2, and AltiKa

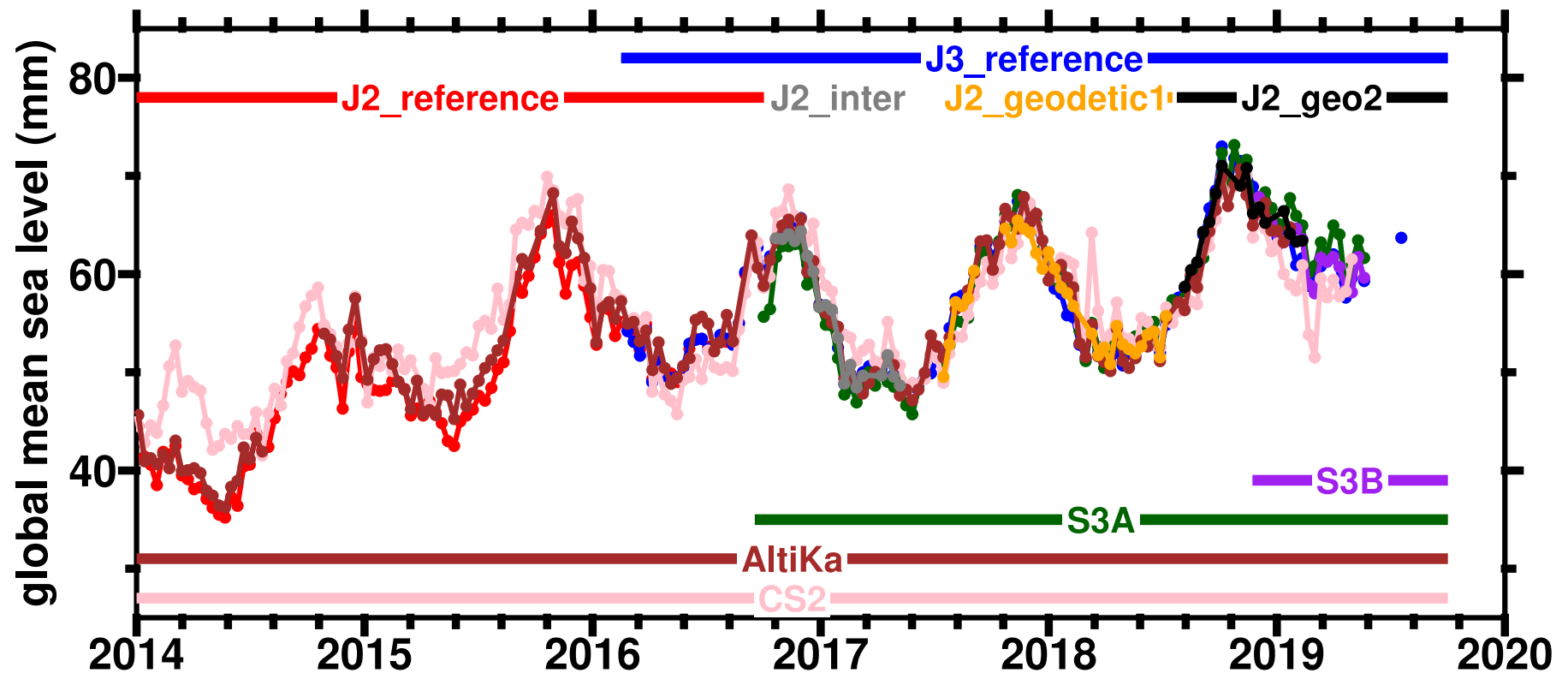
- 2014 to present
- Global ($< 66^\circ$ latitude)
- 9.91-day mean sea level for all missions
- DTU18 mean sea surface
- ERA model wet troposphere path delay
- Adjust intermission biases





Intermission global mean comparison

- Excellent agreement among all altimeters
- RADS CryoSat-2 shows significant drift compared other missions





Intermission differences (DTU15 MSS; AMR)

Number of overlapping ~10 day “cycles”

	J2ref	J2int	J2geo1	J2geo2	S3A	S3B	CS2	AltiKa
Jason-3	22	18	28	28	104	26	102	99
AltiKa	101	18	28	13	80	6	176	
CryoSat2	175	18	28	14	86	14		
S3A		19	29	16		16		

Standard deviation of GMSL differences (mm)

	J2ref	J2int	J2geo1	J2geo2	S3A	S3B	CS2	AltiKa
Jason-3	1.01	1.29	1.79	4.00	1.73	1.05	2.92	1.99
AltiKa	1.52	1.45	1.98	1.51	1.70	1.34	2.95	
CryoSat2	8.51	1.37	2.79	1.94	3.27	2.10		
S3A		1.26	1.95	3.04		1.09		



Intermission differences (DTU18 MSS; ERA)

Number of overlapping ~10 day “cycles”

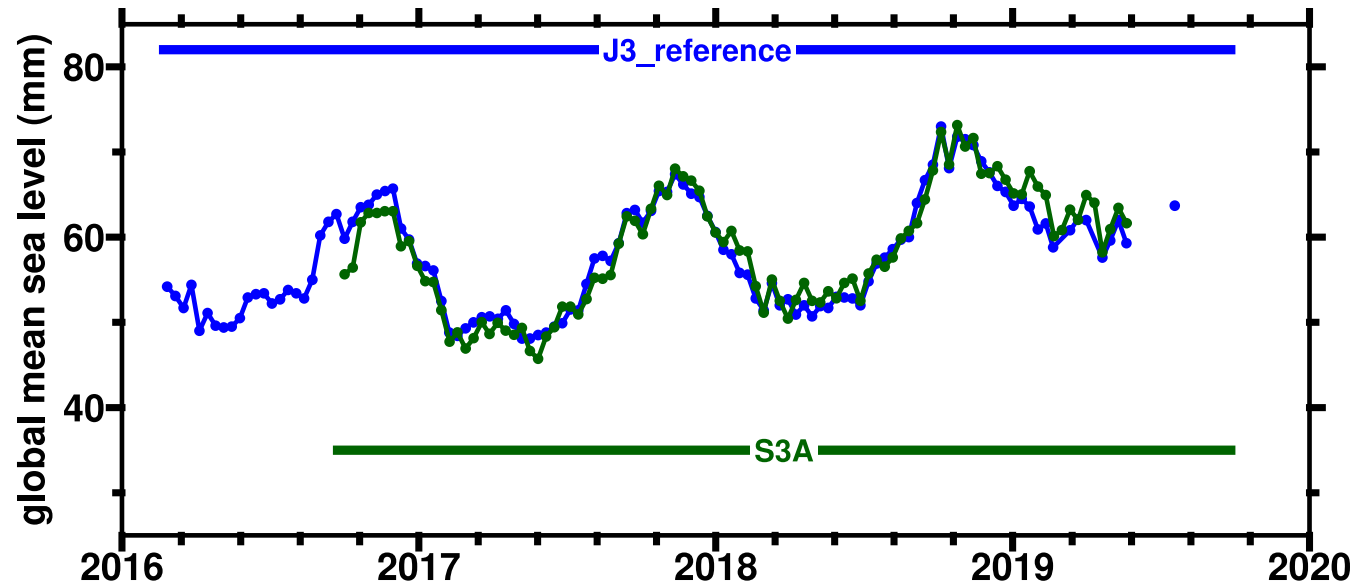
	J2ref	J2int	J2geo1	J2geo2	S3A	S3B	CS2	AltiKa
Jason-3	22	18	28	16	90	14	101	99
AltiKa	84	18	28	13	80	6	162	
CryoSat2	90	18	28	13	85	13		
S3A		19	29	16		16		

Standard deviation of GMSL differences (mm)

	J2ref	J2int	J2geo1	J2geo2	S3A	S3B	CS2	AltiKa
Jason-3	0.68	0.97	1.42	1.54	1.86	0.94	2.89	1.51
AltiKa	1.44	1.07	1.60	1.63	1.71	1.24	3.18	
CryoSat2	3.50	1.26	2.94	1.91	3.32	2.03		
S3A		0.95	1.54	1.74		1.05		



Sentinel-3A and Jason-3



Trend in between Jason-3 minus Sentinel-3A residuals: -1.45 mm/year. (ERA wet troposphere model)

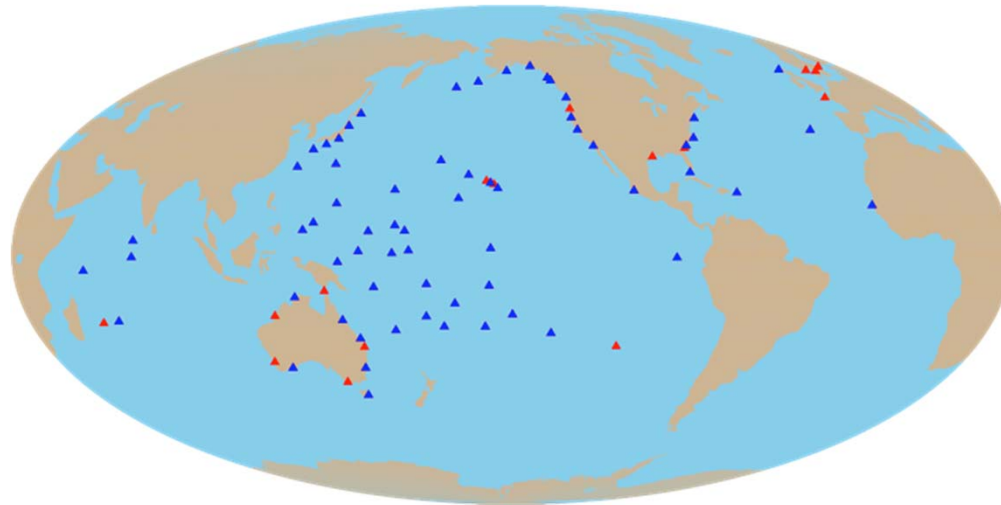
Processor changes in early 2019 introduce a shift in the sea state bias.



Tide gauge network

Tide gauge (TG) data from the University of Hawaii Sea Level Center (UHSLC)

- Fast-delivery data
- Some TG records extended with research quality data
 - Estimate datum level shifts from overlaps





Methodology

Mitchum 2000 Criteria [64 gauges]

- Mitchum [2000] applied a quality control to the UHSLC time series and eliminated gauges based on these criteria:
- No reliable land motion estimates
 - No "internal" estimate from a long time series; no GNSS
- Overlap period with altimetry is too short
- Possible tide gauge level shift
- Apparent nonlinear land motion
- Poor ocean signal agreement

Modifications to Mitchum

- Additional gauges chosen primarily from those used in Watson et al 2015 after controlling for data availability
- Vertical land motion based on Nevada Geodetic Laboratory GNSS rates + GIA model

Added to Mitchum

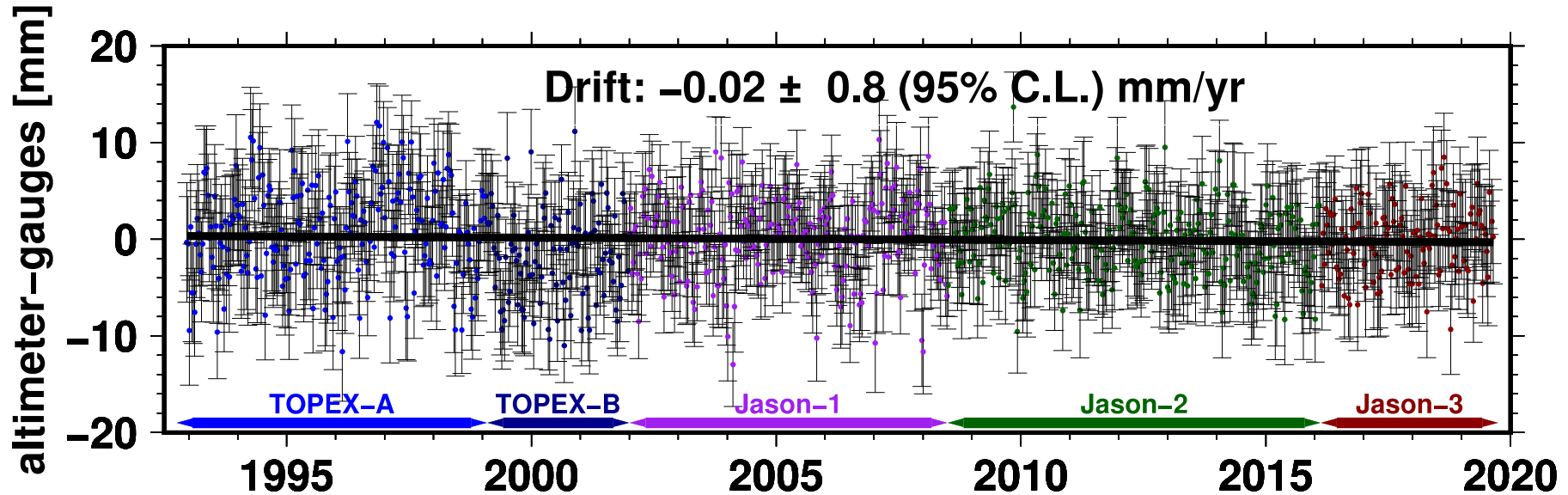
Easter Island	Fremantle
Nawiliwili	Brisbane
Kahului	Booby Island
Port Louis	South Beach, Oregon
Portland, Aus.	Fort Pulaski, Georgia
Broome	Goteborgorsh
Brest	

Removed from Mitchum

Suva
Kushiro
Pago Pago
Adak



Altimeter/tide gauge comparison



- Altimeter minus tide gauge residuals for Jason-3 are the lowest of any altimeter.
- May reflect the stability of the AMR

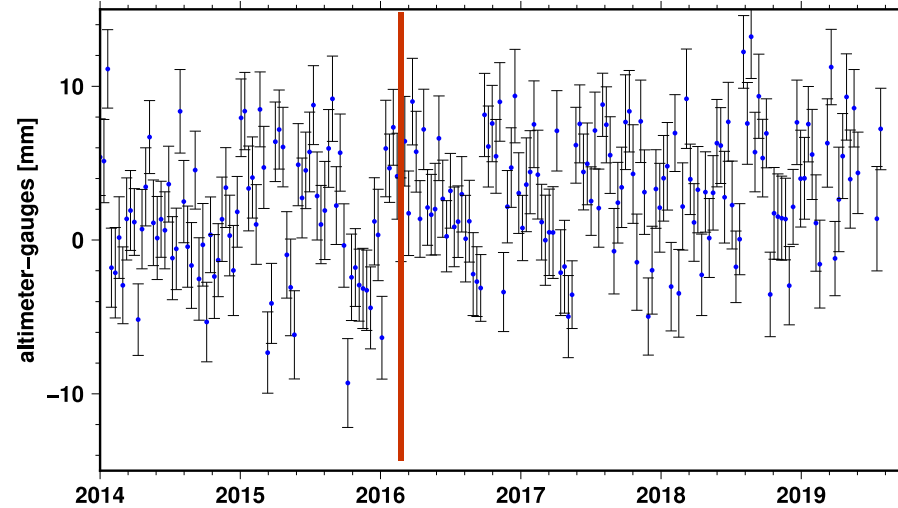
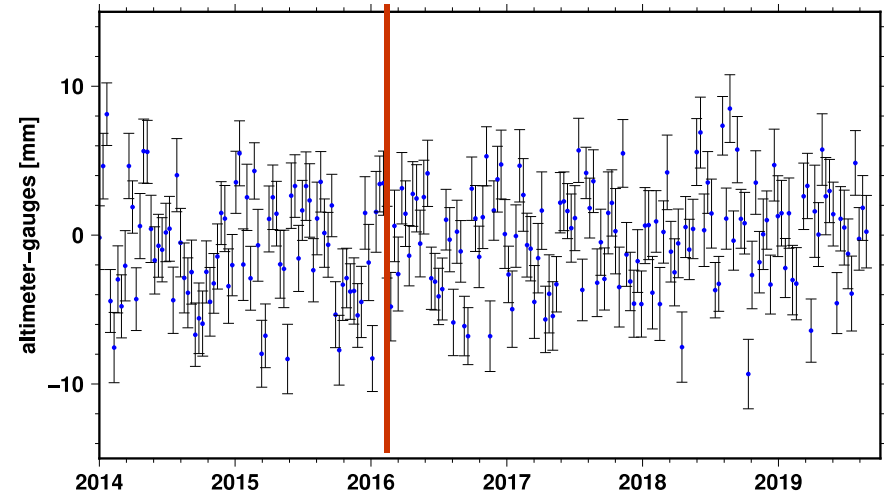
Altimeter	St. dev. of residuals
TOPEX side-A	4.82
TOPEX side-B	4.61
Jason-1 reference	4.14
Jason-2 reference	3.64
Jason-3 reference	3.45



Intermission bias // Wet troposphere path delay

ERA	Jason-2 2014–2016	Jason-3 2016–2018
St dev. residuals	4.30	3.73
Bias ± 0.8 mm (95% C.L.)	1.50	3.04

AMR	Jason-2 2014–2016	Jason-3 2016–2018
St dev. residuals	3.76	3.27
Bias ± 0.8 mm (95% C.L.)	-0.94	-0.48

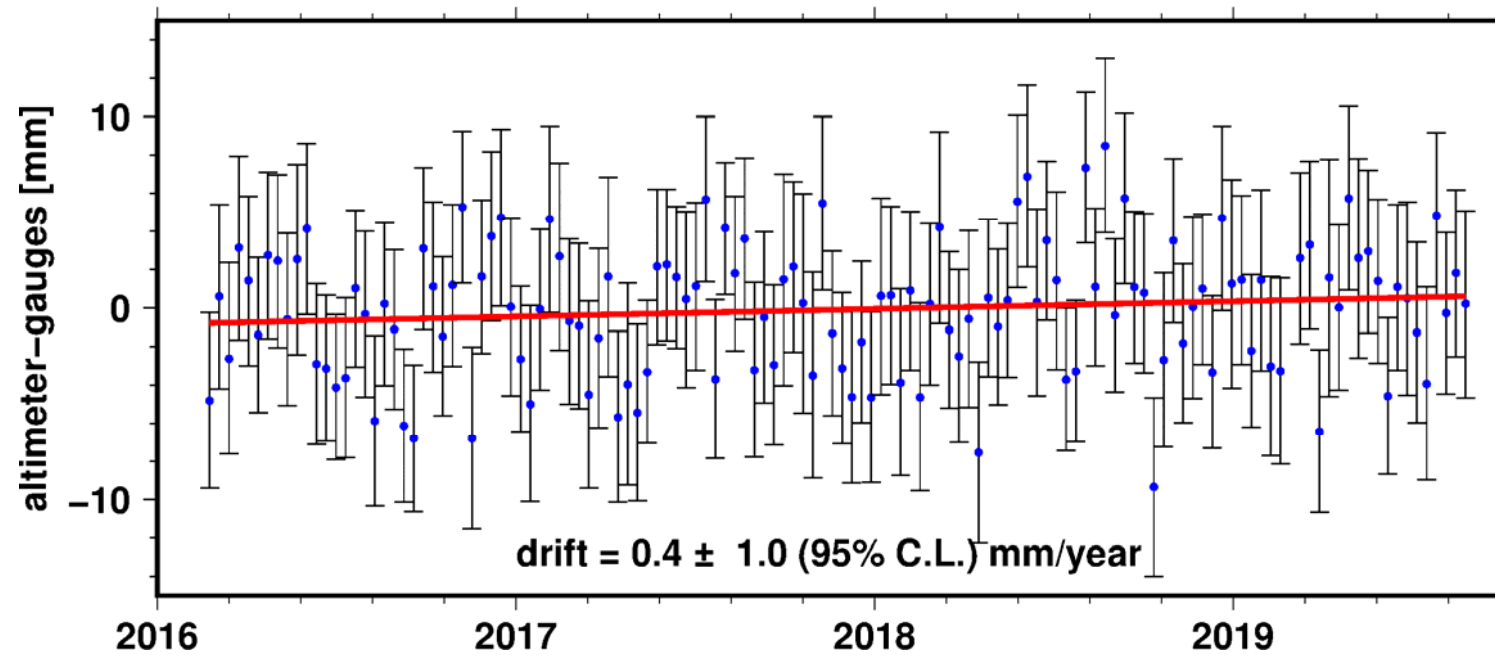




Jason-3/tide gauge comparison

Jason-3 tide gauge comparison

No significant drift

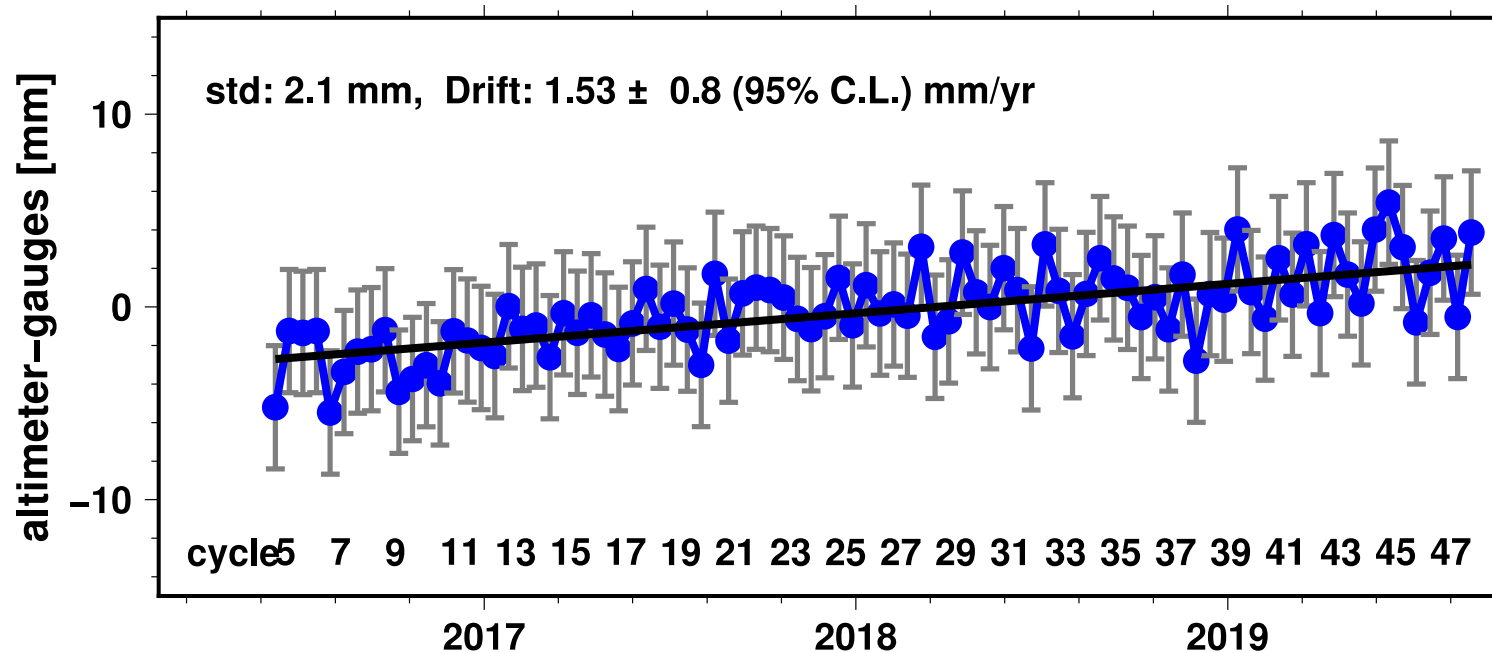




Sentinel-3A/tide gauge comparison

Sentinel-3A tide gauge comparison

- 13.5 day time steps
- MWR wet troposphere
- Reduces the length of the time series needed to detect a significant drift





Conclusions

- **Intermission comparisons suggest that the ERA wet troposphere and DTU2018 mean sea surface produce smaller residual differences than the AMR and DTU2015**
- **The Jason-3 tide gauge comparison shows smaller residuals with the AMR wet troposphere difference**
- **The tide gauge comparison indicates a Sentinel-3A SAR mode drift, in part from the processor change in early 2019**
 - **Will need to reassess the S3A drifts after the next full-mission reprocessing**
 - **No significant Jason-3 drift**