Validation of the temporal ocean mass variations from GRACE with in-situ observations

Hiroshi Munekane* (Center for Space Research, University of Texas at Austin)
munekane@csr.itexas.edu
* On leave from Geographical Survey Institute, Japan

Outline of this study

We validated the GRACE-derived temporal ocean mass variations with the two independent sets of in-situ observations, namely, the altimetric sea level changes in combination with continuous steric height changes at moored buoys, and continuous Bottom Pressure Recorders (BPR's) observations.

Dataset

GRACE

* Variations of Stokes' coefficients converted to the mass variation on the surface of the Earth
* Ocean Pole Tide corrected (Wahr, 1985)
* ΔC_{20} replaced by the SLR-derived values (Cheng, personal comm.)
* Spatial Gaussian filter with 1000km radius applied

In-situ mass variations

1. Altimeter in combination with continuous steric height observations

* Mass vatiation=sea level height (altimetry)-steric height changes
* Sea level changes from Mean Sea Level Anomaly by ERS-1/2, JASON-1 (AVISO)
* Steric height changes from temperature profile observations at the TAO-TRITON buoys by NOAA/JAMSTEC (Figure 1).
* Gridded mass variations are first embedded in the ECCO2 (kf049f) bottom pressure fields, and are applied the same spatial filter.

2. Bottom Pressure Recorder (BPR) measurements

* Pressure changes at the seafloor converted to the mass variations
* Data from the DART system by NOAA (Figure 1)
* Ocean tide (Matsumoto et al., 2000), Ocean Pole tide (Wahr, 1985) removed

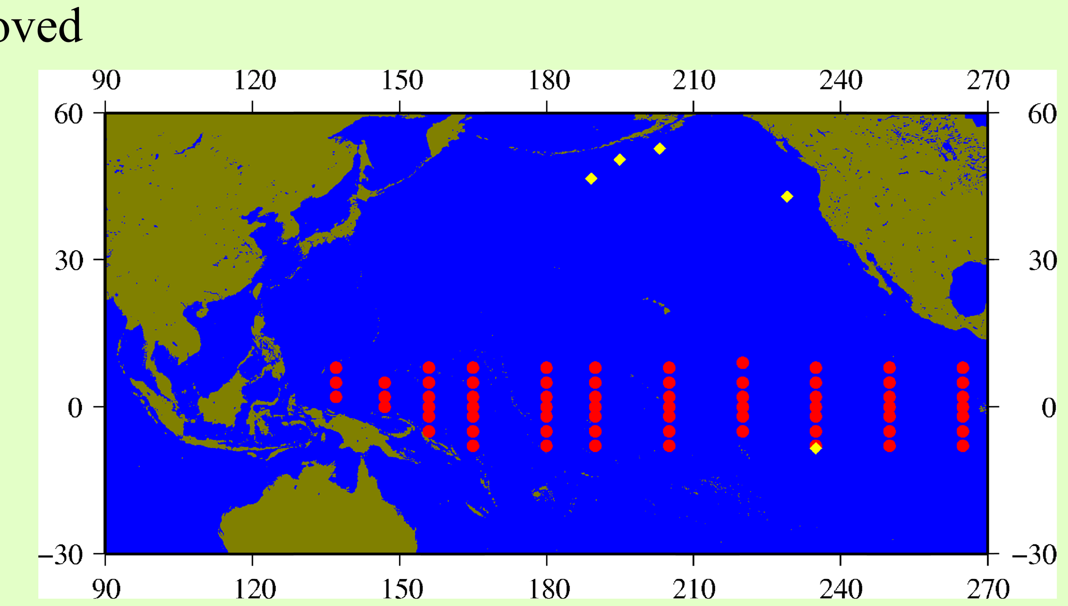

Fig. 1 Locations of TAO-TRITON buoys (red circles) and DART BPRs (yellow circles)

Procedures

1. Both timeseries are detrended.
2. Degree-1 Stokes' coefficients are estimated with the least-squares
3. GRACE timeseries are corrected for degree-1 Stokes' coefficients and both timeseries are compared.

Results

1. UTCSR Level-2 product (0K20)

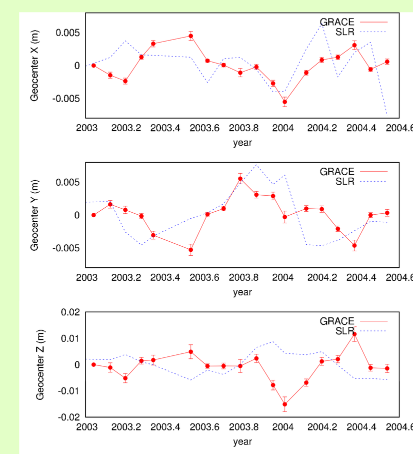

Fig. 2a Geocenter motion

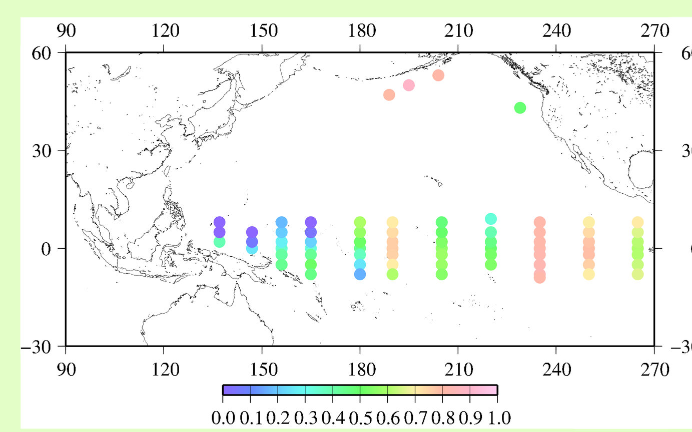

Fig. 2b Spatial correlation

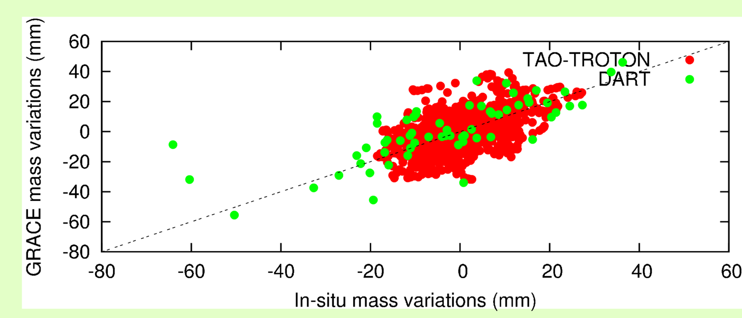

Fig. 2c Scatter plot.

2. EIGEN Level-2 product (0002)

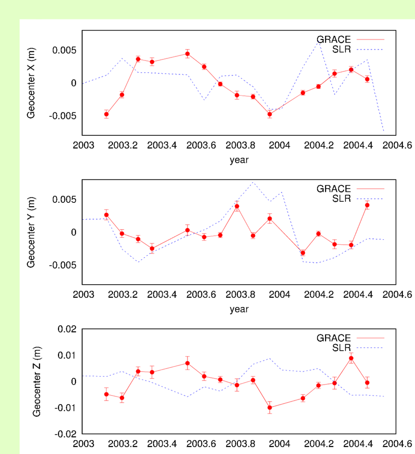

Fig. 3a Geocenter motion

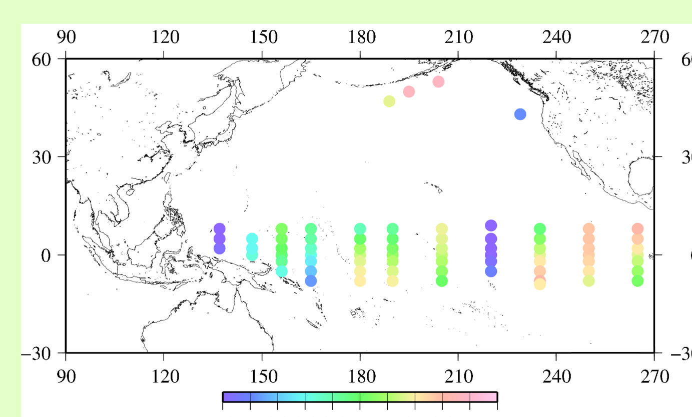

Fig. 3b Spatial correlation

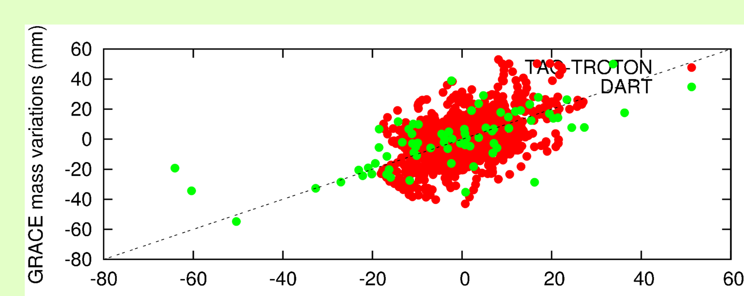

Fig. 3c Scatter plot.

3. UTCSR Level-2 product+SLR degree-1 terms*

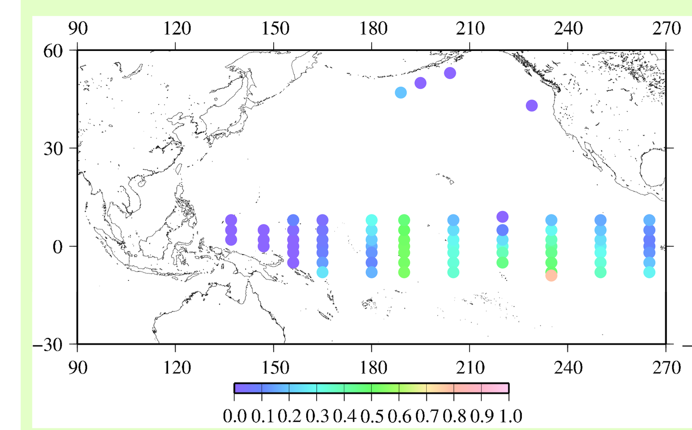

Fig. 4a Spatial correlation

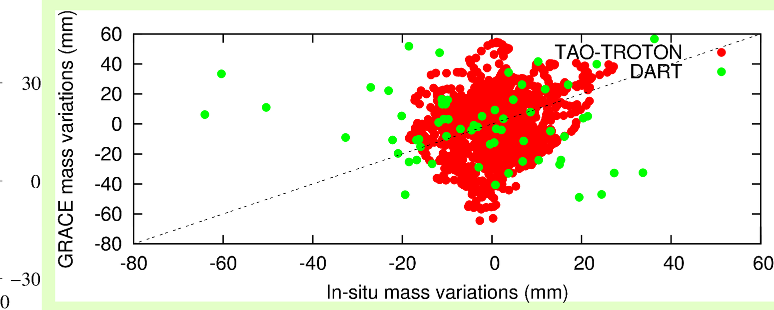

Fig. 4b Scatter plot.

*From International Laser Ranging Service joint solution A

4. UTCSR Level-2 product+ no degree-1 terms

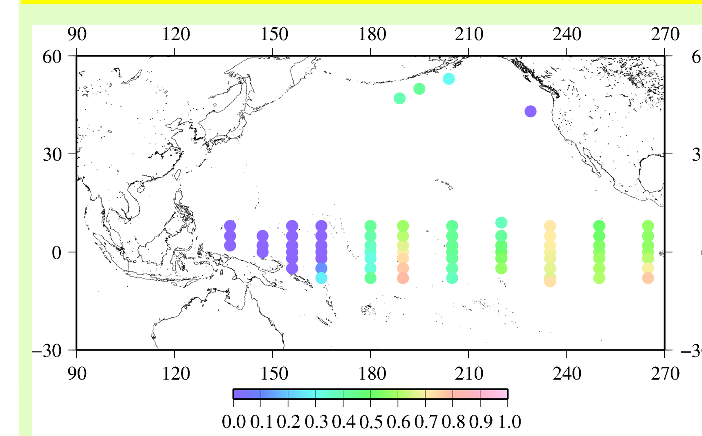

Fig. 5a Spatial correlation

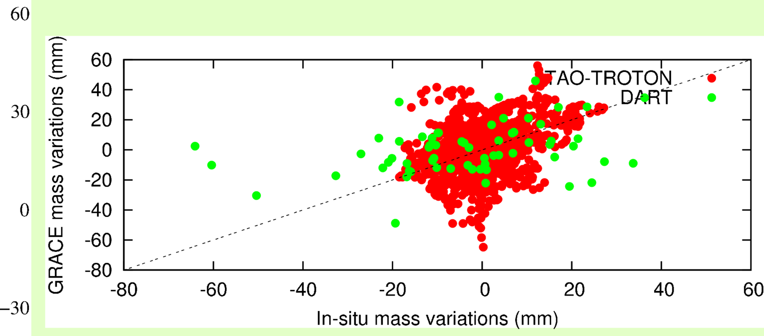

Fig. 5b Scatter plot.

Statistics

Type of solutions	TAO_admittance(coh)	DART_admittance(coh)	ALL_admittance(coh)	RMS_IS(mm)	RMS_ORG(mm)	RMS1(mm)	RMS2(mm)
UTCSR	0.85+-0.05(0.55)	0.76+-0.13(0.75)	0.82+-0.04(0.57)	9.4	13.5	11.2	11.1
EIGEN	0.90+-0.06(0.51)	0.69+-0.12(0.69)	0.85+-0.05(0.53)	9.4	15.9	13.6	13.5
UTCSR+SLR_DEGREE1	0.51+-0.07(0.21)	-0.16+-0.16(0.13)	0.35+-0.06(0.16)	9.4	20.9	21.5	20.7
UTCSR+NO_GEOCENTER	0.73+-0.06(0.36)	0.28+-0.11(0.33)	0.62+-0.05(0.34)	9.4	17.2	16.6	16.2

*RMS_IS=RMS of in situ mass variability
*RMS_ORG=RMS of GRACE-derived mass variability
*RMS1=RMS of (GRACE-in situ) mass variability
*RMS2=RMS of (GRACE-in situ) mass variability (admittance considered)

Conclusions

* GRACE-derived and in-situ mass variabilities correlate well
* GRACE predicts slightly larger variabilities
* Geocenter motions should be inverted
* z component of inverted Geocenter motion is errornous (due to poor geometry of observation sites?)

References

* Wahr, 1985. JGR, 90, 9363-9368.
* Matsumoto et al.,2000. J. Oceanogr., 56, 567-581.