
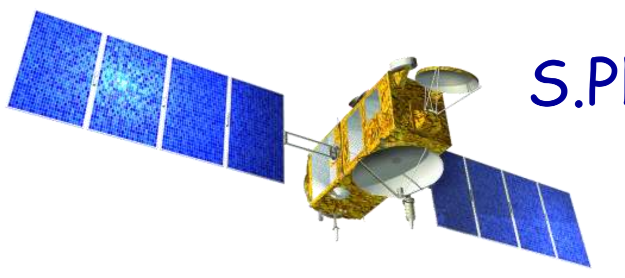

Orbit quality assessment through SSH calculation

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Overview

Quality of precise orbit ephemerides is crucial for quality of altimeter data products and the studies based upon these data. Inversely, studies using Sea Surface Height (SSH) calculation from altimeter data or insitu data give insight in orbit quality for the different missions, help to compare different orbit solutions for one mission, and help to give hints which mission is impacted by suspicious behavior, when comparing several missions.

Hereafter, we present the main results from analyses concerning:

- the impact of using different orbit solutions on the Jason-2 SSH performances
- the detection of a strong East/West MSL drift between the Jason-1 and Envisat
- the significant improvement on SSH calculation of using recent orbit solutions for T/P and GFO
- impact of ITRF 2005/2008 on Jason-2 SSH performances

Method

Orbit performance can be accessed via SSH (orbit – range – geophysical corrections) computation at mono- or dual-satellite crossover points, but also comparing to independent in-situ data sets, such as tide gauges or temperature/ salinity profiles.

Mono- or dual satellite crossovers: Choosing ascending/descending crossovers within a 10 days period, allows to limit influence of geophysical evolution of the ocean (except for regions with high oceanic variability).

Cartography of mean SSH asc/desc differences at crossovers should only show noise, and no geographically correlated patterns (indicating systematic differences between ascending and descending passes). Cyclic mean and standard deviation of asc/desc SSH differences are computed in order to perform long-term monitoring.

Along-track Sea Level Anomaly (SLA) analysis: Along-track SLA is used to compute global and local Mean Sea Level (MSL) trends, which are compared between the different altimeter missions and insitu data.

Comparison with insitu data: Tide gauges (mostly near coasts) and temperature/ salinity profils (almost global coverage) are an independent source of data. From them, an insitu SSH can be computed and compared to altimetry data.

Impact of several Jason-2 orbit solutions on performances at SSH crossovers

POE orbit solution from several productions centers (CNES, JPL, GSFC), using different technics, are tested for Jason-2 data. Figure 1 shows maps of SSH differences at crossovers for different orbit solutions.

Orbit	Type	Cycles used for maps
Gdr Jason-2 product (Cerri et al.)	Tri-technic	1-40
Cnes_gps_std040 (Cerri et al.)	Gps standard dyn.	1-40
Cnes_gps_dynred (Cerri et al.)	Gps reduced dyn.	1-32
Jpl_rlse09a (Bertiger et al.)	gps	1-40
Cnes_dor_niv0 (Cerri et al.)	Doris purs	1-40
GSFC_ld_std0905 (Beckley et al.)	Doris + Laser	1-20

All orbits show similar results, but a geo-graphically correlated pattern (positiv in North-Atlantic, negativ in South-Atlantic) is visible for most orbit solutions. Only GPS reduced dynamic orbit solutions show less patterns. For JPL 09a solution only a small hemi-spheric bias of about +/- 1 cm is left, which disapears when correcting for pseudo datation bias.

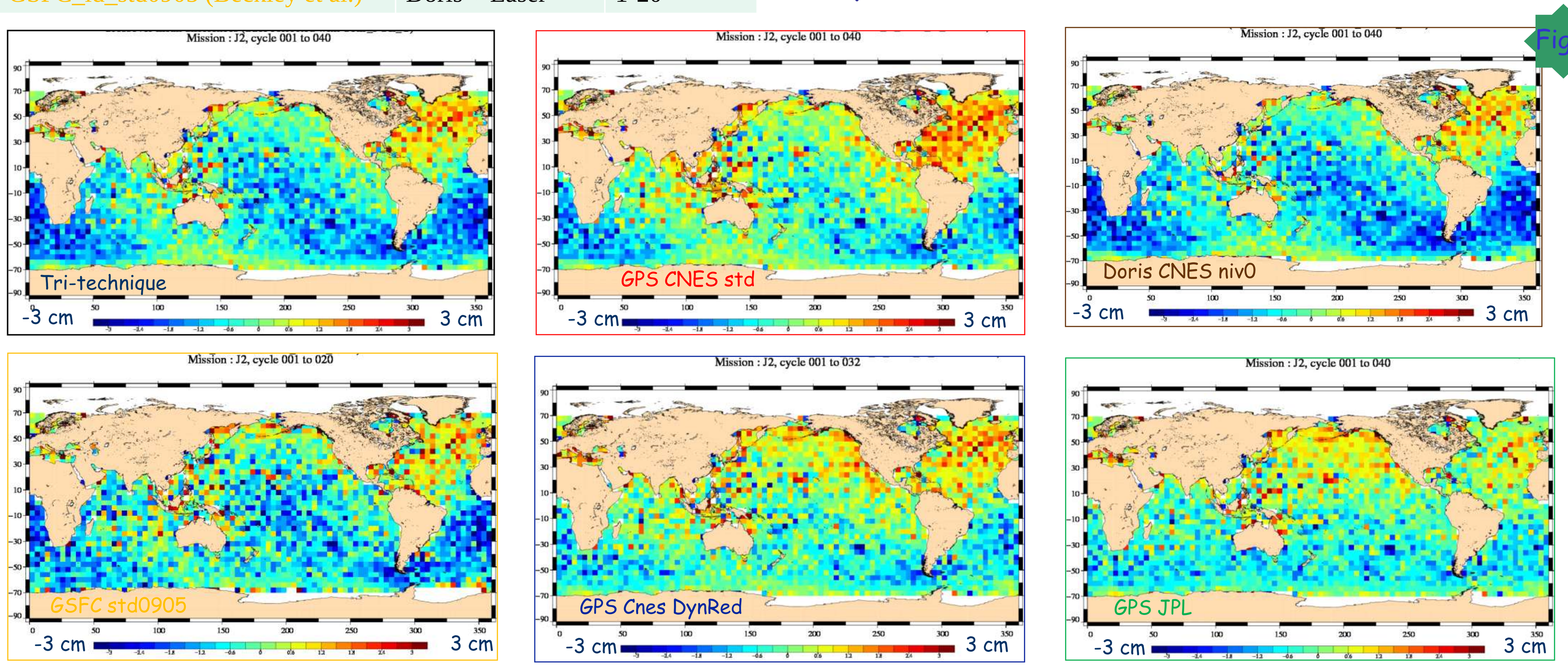


Fig. 1: Maps of SSH differences at crossovers for several orbit solutions.

Official POE solution from GDR shows an 120 day signal (related to β' angle), which is increased for CNES GPS orbits, and strongly reduced for JPL09a. Reduced dynamic solutions reduce generally variance at crossovers.

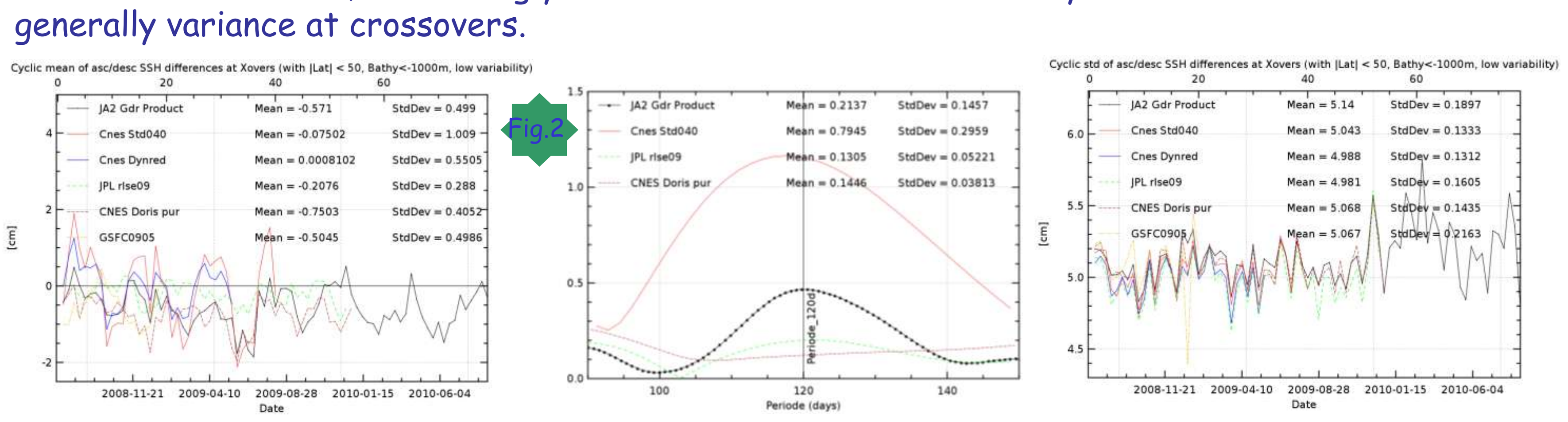


Fig. 2: Monitoring of cyclic mean Maps of SSH differences at crossovers for several orbit solutions.

Orbit solutions show similar performances, but GPS JPL09a is the best one: geographically more homogeneous (at crossovers), less impacted by 120 days signal, and has less rms at crossovers.

Improvement on SSH calculation using last orbit solutions for Topex/Poseidon and Geosat Follow-On

Historical altimeter missions, like Topex/Poseidon or Geosat-Follow-On (GFO) are not yet reprocessed and their level-2 altimeter products contain still orbit solutions based on JGM3 gravity model. Cartography of SSH ascending/descending crossover differences show trackiness and large signatures of +/- 3 cm amplitude (fig. 3). Using orbit solutions with gravity fields based on GRACE measurements, such as GSFC Std0809 orbit (Lemoine et al., 2008), reduces significantly trackiness (fig. 4) and reveals geographical correlated signal on GFO.

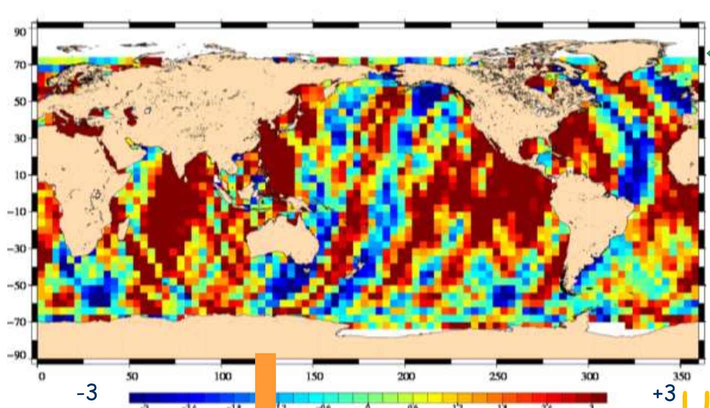
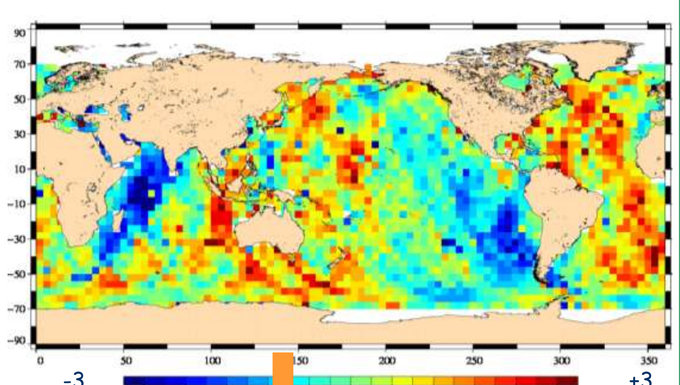


Fig. 3: Cross-over mean differences using original orbit solutions for GFO cycles 045 to 114 (left) and Topex/Poseidon cycles 11 to 446 (right).



Using GSFC std0809 orbits

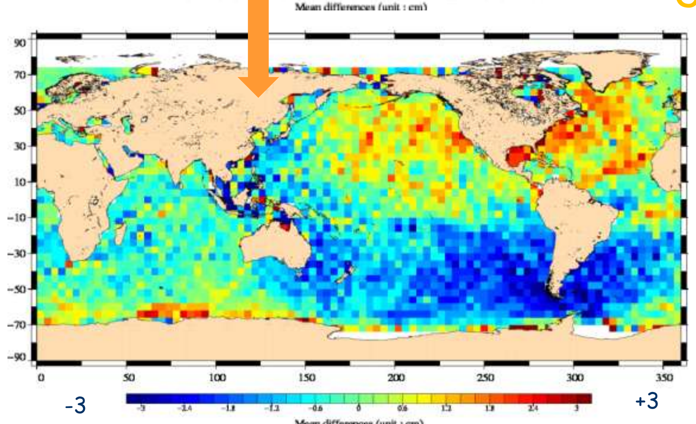
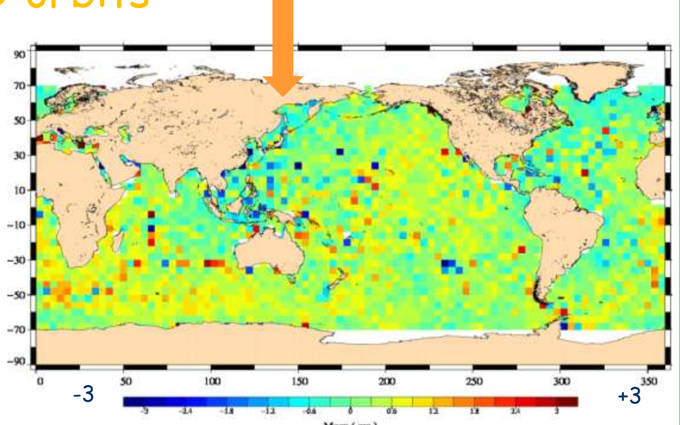


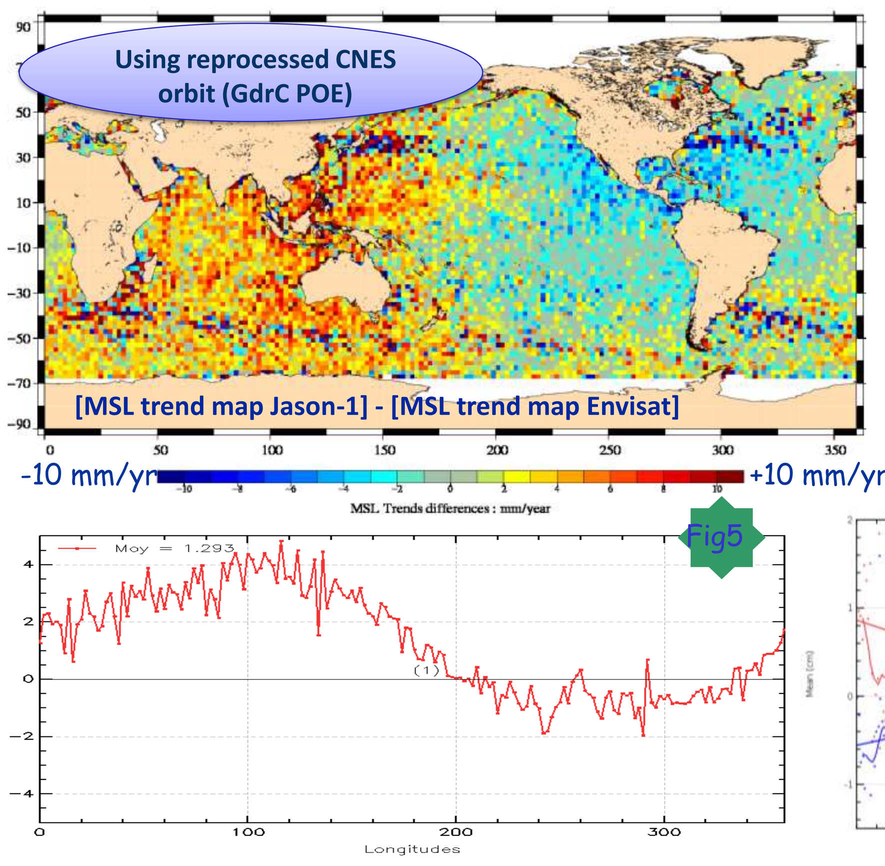
Fig. 4: Cross-over mean differences using GSFC STD0809 orbit for GFO cycles 045 to 114 (left) and Topex/Poseidon cycles 11 to 446 (right).



Recent orbit solutions based on Eigen4 gravity model improve significantly SSH performances, remaining geographically correlated patterns need to be analysed, especially on GFO.

Detection of Est-West drift in local MSL maps between Jason-1 and Envisat

Computing local Mean Sea Level (MSL) trend maps for Jason-1 and Envisat and substucting one map from the other reveals a strong east-west signal. Its amplitude is dependant on longitude.



Yearly dual-crossover maps between Jason-1 and Envisat show an increase of East/West bias, especially since 2007 (cf. talk Y. Faugere). Can this be related to gravity field ?

Comparing SLA from altimeter and T/S profils separated in eastern and western hemisphere (fig. 6) confirm a drift between East and West for Envisat, whereas it is much less pronounced for Jason-1 (inside errors of the method).

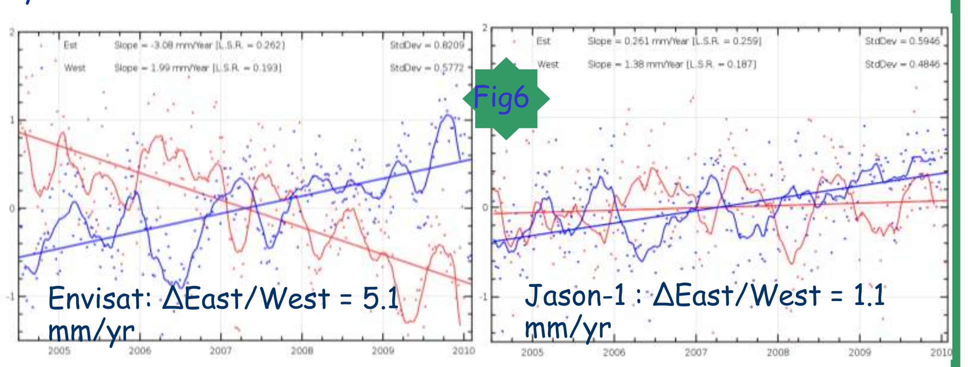


Fig. 5: Difference of MSL trend (Jason-1 - Envisat). Top: map, bottom: as function of longitude.

Fig. 6: Difference between altimeter data and T/S profils, separated in eastern and western hemisphere. Left: Envisat, right:Jason-1.

East/West signal is likely due to the Envisat orbit calculation.

Assessing impact of ITRF 2005/2008

In the frame of ITRF2008 analysis, CNES has produced two series of Doris/Laser orbits for Jason-1 and Jason-2: one with ITRF2005 and one with ITRF2008. Altimeter data are used in order to assess impact of ITRF version change.

Mission	Type	ITRF	Cycles
Jason-2	Doris/SLR	2005 and 2008	1-70
Jason-1	Doris/SLR	2005 and 2008	1-20,100-120,200-220,300-310

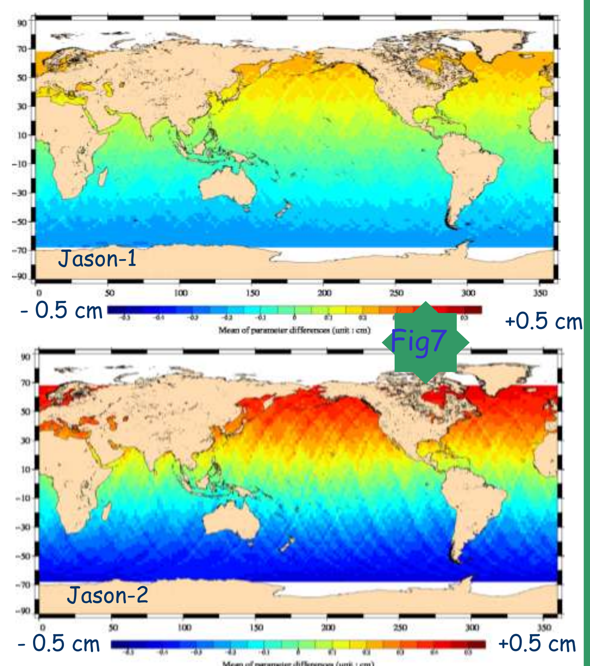


Fig. 7: Maps of orbit differences (ITRF2008 – ITRF2005) averaged over 70 cycles Jason-1 (top) and Jason-2 (bottom).

Mean of differences over ~70 cycles (fig. 7) shows typical hemispheric bias, which is more pronounced for Jason-2. Both ITRF versions show similar performances of SSH asc/desc differences at crossovers (variance of SSH difference is almost the same for ITRF2008 and ITRF2005, fig. 8). Difference (ITRF2008-ITRF2005) of along-track SLA variance shows an annual signal of +/-1 cm2 amplitude.

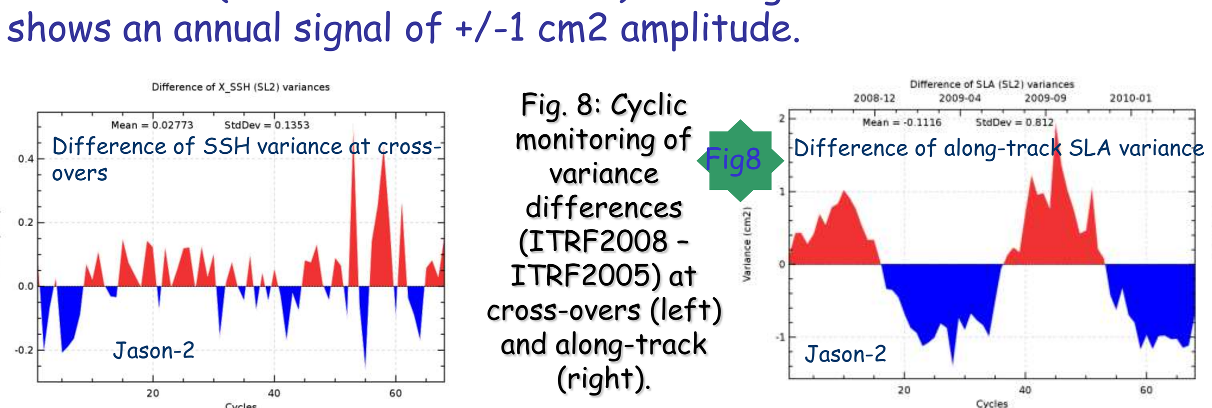
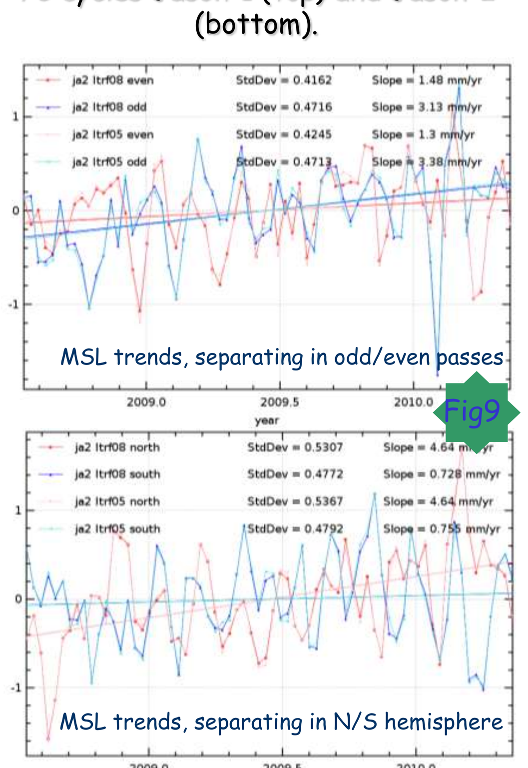


Fig. 8: Cyclic monitoring of variance differences (ITRF2008 – ITRF2005) at cross-overs (left) and along-track (right).



Using ITRF2008 orbit solution, instead of ITRF2005, has neither impact on global MSL trend, nor when separating in North/South hemisphere (fig. 9, bottom).

Fig. 9: MSL trends for Jason-2 using D/L orbits with ITRF2005 or 2008. Separating in odd and even passes (top) or north and south hemisphere (bottom). Annual and semi-annual signals are adjusted.

Over the studied period, changing to ITRF2008 solution, will only have a limited impact on SSH performances and global MSL trends

Conclusion

Using altimeter and insitu data, allows to analyze orbit solutions and to detect potential problems as the east/west drift detected in Envisat MSL, assess quality of orbit solutions, and study impact of modifications in orbit solutions

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Lisbon, October 2010

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