ALTIMETER WAVE HEIGHT VALIDATION - AN UPDATE

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Colocation procedures and analysis developed at IFREMER LOS-CERSAT allow long term monitoring of altimeter significant wave height (SWH). Trends and biases, up to several tens of centimeters, between the Geophysical Data Records issued from the various altimeter missions, were identified and corrections were proposed (Queffeulou 2004). Since that time data from new buoy networks were acquired, increasing the size of the data set, particularly for JASON and ENVISAT. Updated validation results differ, slightly, from the previous ones and improve the cross-altimeter SWH measurement consistency. But significant differences are observed, at high SWH, within the various buoy networks, which could raise the question of the choice for a reference SWH measurement.

ALTIMETER DATA

TOPEX M-GDR cycle 1 to 481 - ERS OPR cycle 1 to 85
JASON-1 GDR cycle 1 to 143 - ENVISAT IMAR cycle 9 to 43
GEOSAT Follow-On GDR cycle 37 to 164

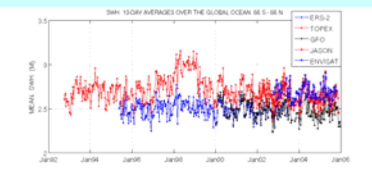
BUOY DATA

EUROPE : European network (Ireland, UK Met Office, Météo France)
NDBC : US National Data Buoy Center network
MEDS : Canadian Marine Environmental Data Services
EPPE : Spanish Ente Publico Puertos del Estado network
NORUT : Norwegian buoy network

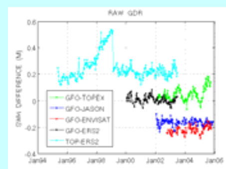
METHOD

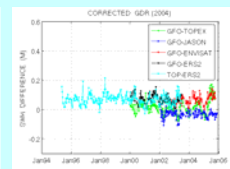
For buoy comparisons, colocated data are selected when the closest approach of the altimeter ground track is less than 50 km of the buoy location, within a 30 minute time window. Altimeter colocated data are averaged, along-track , over 50 km.

For altimeter cross comparisons, ground-track crossing points are selected when the time difference between the two altimeter measurements is less than one hour. A one hour time window is chosen, instead of 30 minutes for the buoy comparisons, in order to increase the size of the resulting colocated data set. Altimeter data are then averaged, along-track , over 100 km, in order to filter time and space variability effects. For 100 km averaging, data are selected only when all the individual along-track 1-second measurements are valid: 15 for ERS and GFO, 17 for TOPEX and Jason, and 13 for ENVISAT.

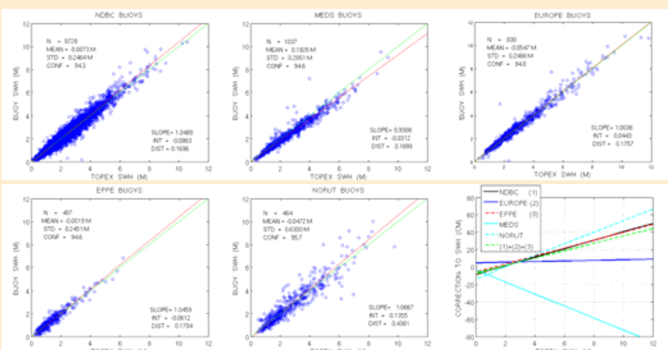


Times series (left figure) of 10-day averages of SWH over the global ocean show significant differences among the altimeters (first figure on the right).
Using the swh altimeter data correction (Queffeulou 2004) allows to reduce the differences to less than about 15 cm (second figure on the right).
Could this residual be reduced, with improved corrections, or does it result from the different time and geographical samples of the global ocean by the various altimeters?





TOPEX (side-B) – BUOYS comparison



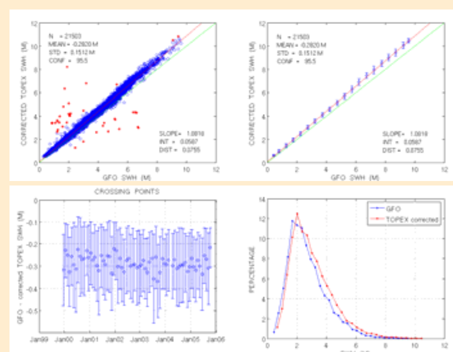
TOPEX SWH corrections deduced from the five different buoy networks

Results from the 5 buoy networks: as previously observed TOPEX side-B swh agrees with buoy data, needing only a few percent correction, but, here, the results differ according to the buoy network, as also shown in Table below, giving data number, mean value and standard deviation of TOPEX - buoy swh differences, slope and intercept coefficients of the orthogonal distance regression lines. NDBC and EPPE networks give almost the same results, not far from the EUROPE ones. The MEDS network "seems" to underestimate high swh, while NORUT is very noisy.

BUOY	n	mean	std	slope	intercept
NDBC (1)	9728	-0.01	0.25	1.0489	-0.0863
EUROPE (2)	830	-0.05	0.25	1.0036	0.0443
EPPE (3)	407	-0.00	0.24	1.0459	-0.0612
NORUT	464	-0.05	0.63	1.0667	-0.1355
MEDS	1037	0.19	0.29	0.9308	-0.0312
(1)+(2)+(3)	10966	-0.01	0.25	1.0428	-0.0733

Such differences (for EUROPE and NDBC) were already observed by Cotton et al. (2004). The origin of the differences might be rather in the way buoy swh is estimated from the measurements, in sensor types and calibrations, and in buoy transfer function, than in the geographical location of the buoys.

GEOSAT FO - TOPEX comparison



SWH measurements from GFO (raw) and TOPEX (corrected) at crossing points are strongly correlated. Mean value of differences is about 28 cm, with a 15 cm standard deviation. The slope (1.0818) and intercept (0.0587) of the orthogonal regression line can be used to correct the GFO SWH data.

JASON – BUOYS comparison

BUOY	n	Mean	std	slope	intercept
NDBC (1)	3487	-0.12	0.24	1.0680	-0.0125
EUROPE (2)	992	-0.12	0.23	1.0101	0.0919
EPPE (3)	306	-0.07	0.33	1.0122	0.0463
NORUT	473	-0.17	0.61	1.0765	-0.0422
MEDS	1354	0.09	0.26	0.9638	-0.0026
(1)+(2)+(3)	4783	-0.12	0.24	1.0429	0.0266

ENVISAT – BUOYS comparison

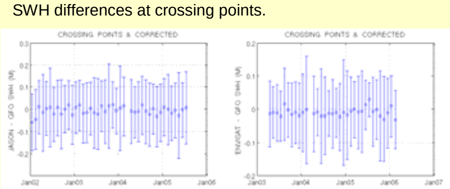
BUOY	n	mean	std	slope	intercept
NDBC (1)	2757	0.07	0.24	1.0750	-0.2191
EUROP (2)	718	0.03	0.24	1.0228	-0.0935
EPPE (3)	295	0.16	0.28	1.0239	-0.2034
NORUT	341	0.13	0.41	1.0571	-0.2726
MEDS	999	0.24	0.28	0.9578	-0.1449
(1)+(2)+(3)	3770	0.07	0.24	1.0585	-0.1935

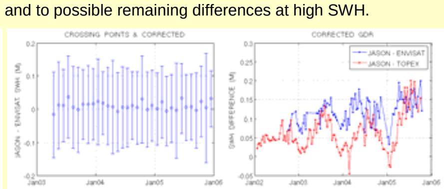
The tables give results of JASON and ENVISAT comparisons with buoys. The relative behaviour of the buoy networks is the same as observed with TOPEX.

Corrections to SWH are estimated (green values) using the slope and intercept coefficients from NDBC, EUROPE and EPPE buoy comparisons.

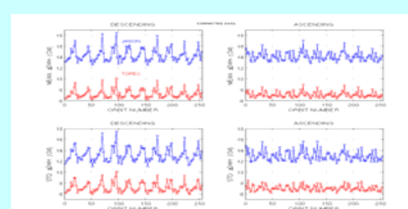
Once corrected JASON and ENVISAT SWH are very close to GFO, as shown on the time series of monthly mean SWH differences at crossing points.

Monthly mean SWH differences between JASON and ENVISAT, at crossing points, are close to zero (left). Nevertheless, the 10-day mean value differences for global ocean (right) are larger and fluctuate due to different time and geographical samplings and to possible remaining differences at high SWH.





TOPEX & JASON SWH noise



For testing, TOPEX and Jason collinear data (over 21 cycles) are compared. Results show the positive impact of the proposed corrections, but, curiously, indicate a significant difference between ascending and descending tracks, so as a dependence on orbit number. A further analysis of the along track SWH noise is conducted. Data noise is estimated, for each individual pass, as the mean value and standard deviation of swh differences between pair of successive data. Above figures show,that the noise of Jason SWH is almost twice the TOPEX one, and that the noise level is depending on the orbit number, particularly for descending tracks, with a periodic variation about 26 orbits. The reason for this behaviour is questionned.

Cotton, P.D., P.G. Challenor and J-.M Lefevre, Calibration of ENVISAT and ERS-2 wind and wave data through comparison with in situ data and wave model analysis fields, *Proc.* ENVISAT ERS Symposium, ESA SP572, 6-10Sept. 2004, Salzburg, Austria.

Queffeulou, P., Long term validation of wave height measurements from altimeters, *Marine Geodesy*, 27:495-510,2004.

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