Validation of JASON-1 ALTIMETER WIND and WAVE MEASUREMENTS

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Colocation procedures and analysis developed at IFREMER LOS-CERSAT are applied to validate JASON-1 significant wave height (SWH), sigma0 and wind speed measurements, using buoy, GEOSAT FO and ERS-2 altimeter data. The JASON data set consists of cycles 2 to 66, i.e. from January 2002 to October 2003. JASON Ku SWH measurements are shown to be in close agreement with buoy data. Nevertheless comparisons with GFO and ERS-2 indicate that JASON altimeter underestimates high SWH, as observed for all other altimeters. For sigma0, in the past, because of the lack of absolute calibration, the practice was to calibrate sigma0 in order to get similar wind speeds when using an operational algorithm. Present Ku sigma0 comparisons show 0.72 dB and 0.61 dB biases of JASON-1 relative to GFO and ERS-2, respectively. For wind speed, about 1 m/s negative bias is observed for JASON relative to buoy measurements. Comparisons with GFO and ERS-2 indicate also negative biases (-0.9 m/s and -0.6 m/s, respectively), but with non linear differences as a function of wind speed. Observed scatter is relatively low (standard deviation of differences with buoy measurements is less than 1.3 m/s) showing that the new wind speed algorithm, swh and sigma0 dependent, might be more accurate.

1 - ALTIMETER DATA

JASON-1 IGDR cycles 2 to 66 (January 2002 to October 2003)
GEOSAT Follow-On IGDR provided by J. Lillibridge (NOAA/NESDIS/ORA)
ERS-2 OPR from CERSAT

2 - BUOY DATA

From European, NDBC US and Canadian MEDS networks.
Buoy wind speed measurement is corrected to equivalent 10 m altitude using stability conditions (Liu et al, J. Atm. Sci., 36,1722 - 1735, 1979).

3 - METHOD

For buoy comparisons colocated data are selected when the closest approach of the altimeter ground track is less than 50 km, within a 30 minute time window.
Altimeter colocated data is estimated as the closest along-track 1 second elementary altimeter measurement, and/or as the 50 km along-track average.

For altimeter cross comparisons, ground-track crossing points are selected when the time difference between the two altimeter measurements is less than one hour. Comparisons are performed over 1 second elementary altimeter measurements, and/or over 100 km along-track averages, in order to filter time and space variability effects.
For 100 km averaging, data are selected when the number of individual 1-second valid measurements, to be averaged, is larger than or equal to:
14 for GFO (15 maxi)
16 for JASON (17 maxi)
15 for ERS-2 (15 maxi)

4 – CORRECTIONS TO ALTIMER SWH & SIGMA0

Some corrections can be applied to altimeter measurements. These corrections were estimated from previous long-term cross altimeter comparisons and buoy comparisons (Queffeulou P., ISOPE-2003 conference Proc.):

GFO SWH_cor = 1.0802 SWH + 0.0392
SIGMA0_cor = SIGMA0 – 0.66 dB
ERS-2 SWH_cor = 1.0740 SWH – 0.0079
SIGMA0_cor = SIGMA0 + 0.20 dB (since January 2000)

5 - STATISTICAL PARAMETERS

Comparisons are presented using scatter-plots. Mean value and standard deviation of differences (dif = X-Y) are given, with the percentage of data for which the difference is within the mean(dif) +- 2 std(dif). Slope and intercept of the orthogonal distance regression line are also given, with the rms of the fit.

FLAGS

JASON igdr
Qual_1hz_alt Alt_echo-type 1hz_num_val >= 19
Alt_surface_type
off_nadir_angle_wvform < 0.1deg² rms_swh_ku

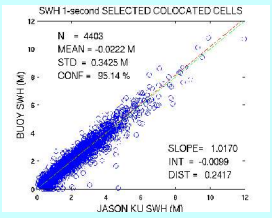
GFO igdr
qual_1hz_data
1hz_num_val = 10

ERS-2 opr
measurement confidence data
ocean_flag 1hz_swh_num_val >= 17

JASON – BUOY comparison

SIGNIFICANT WAVE HEIGHT

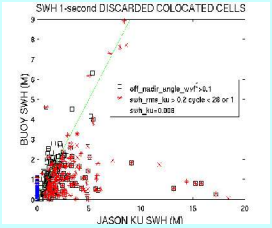
BUOY		N	mean	std	slope	intercept	fit_rms
	1 s	4403	-0.02	0.34	1.0170	-0.0089	0.21
	50 km	3078	-0.05	0.30	1.0113	-0.0054	0.21
GFO	1 s	6879	-0.13	0.35	1.0701	-0.0764	0.16
	100 km	6260	0.10	0.17	1.0752	0.0981	0.09
ERS-2	1 s	6520	-0.13	0.35	1.0761	-0.0772	0.21
	100 km	6177	-0.16	0.17	1.0584	0.0022	0.11

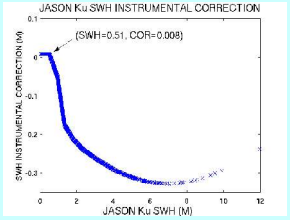


Scatter plot of 1-second selected colocated cells shows that JASON Ku SWH is in close agreement with buoy data, bias can be considered as 0, and slope coefficient as 1.

Bottom left graph shows the data set discarded from the above analysis (9.2%): black square symbols correspond to large (> 0.1 deg²) JASON off nadir angle waveform; red stars to large 1 Hz SWH rms (>0.2 m before cycle 28, and > 1.0 m after); blue squares to JASON swh value of 0.008 m. The instrumental correction to swh (bottom right) is equal to 0.008 m for swh less than 0.51 m, indicating that blue squares correspond to swh equal to zero, if the instrumental correction is not applied.

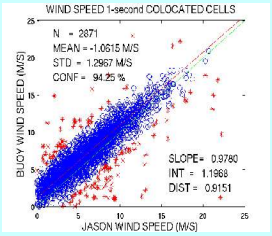
Note that some non erroneous data are discarded and that a test on the ratio of swh rms to swh might be more efficient.





WIND SPEED

		N	mean	std	slope	intercept	fit_rms
BUOY	1 s	2871	-1.06	1.30	0.9780	1.1968	0.92
	50 km	1854	-0.95	1.17	0.9930	0.9989	0.84
GFO	1 s	6914	-0.90	0.90	0.9999	0.9019	0.64
	100 km	6260	-0.91	0.78	0.9921	0.9817	0.55
ERS-2	1 s	6717	-0.58	1.11	1.0560	0.1175	0.77
	100 km	6169	-0.57	0.96	1.0576	0.0923	0.66

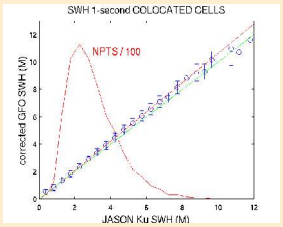


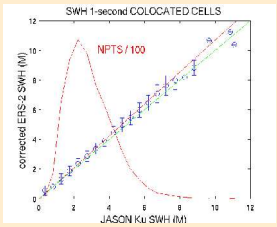
At the opposite of the observation for SWH, the impact on wind speed estimate of the off nadir angle waveform or of the 1 Hz SWH rms is not significant. For buoy comparison, some data (4.7%), outside the mean plus or minus twice the standard deviation are discarded for statistics estimate (red stars).

A negative bias about 1.0 m/s is observed., with a larger underestimate of JASON for light winds. The scatter is low, less than 1.3 m/s.

JASON, GEOSAT FO and ERS 2 comparison

SIGNIFICANT WAVE HEIGHT

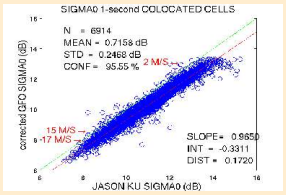


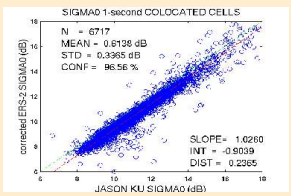


Surprisingly both comparisons with GFO and ERS-2 show larger slope coefficients, about 1.07, than for the buoy comparison (cf in the table) : the low number of buoy SWH measurements over 5 m (relative to GFO and ERS comparisons) could have a significant impact on the slope estimate.

BACKSCATTER COEFFICIENT

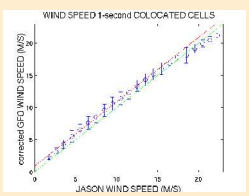
		N	mean	std	slope	intercept	fit_rms
GFO	1s	6914	0.72	0.25	0.9650	-0.3311	0.17
ERS-2	1s	6717	0.61	0.34	1.0260	-0.9039	0.24

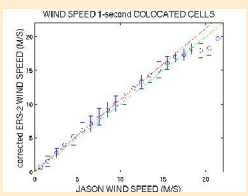




JASON Ku sigma0 bias is about 0.72 dB relative to GFO and 0.61 dB relative to ERS-2. This means that this bias has to be removed before applying the wind speed algorithm used for GFO and ERS-2. Note that the useful sigma0 range for wind speed estimate is about from 5 dB to 15 dB.

WIND SPEED





As observed with the buoy data, JASON wind speed is biased low relative to GFO and ERS-2, and the difference is not linearly dependent on wind speed (at high winds). Nevertheless standard deviations are low.