Near real time altimeter sea state products for NOAA/NCEP

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I. Abstract

Maritime sea state guidance and forecasting offices at the National Centers for Environmental Prediction (NCEP) in NOAA are now operationally incorporating satellite ocean significant wave height (SWH) data into daily products. We will report on a new project designed to enhance and optimize use of altimeter wave and wind data at NCEP. The project is supported by the NASA Science Mission Directorate's program to accelerate the operational use of research data. We are working with NOAA operational and research programs to review and refine the use of altimeter-derived sea state, wave period, and wind speed within the NCEP offices of Ocean Prediction Center (OPC) and Environmental Modeling Center (EMC). Near real time data from Jason-1, Jason-2, Envisat, and GFO are being employed in these centers in different respects. Data flow, latency, quality, and multi-mission capabilities are all being addressed to assure the best use of altimetric products. A NASA-funded project has been initiated recently to accelerate the use of altimeter wave products . This poster discusses the overall project objectives , the use of altimeter data within OPC and EMC, and provide some first results addressing SWH data quality within the near real-time data streams.

II. Objectives

1. Provide consistent NRT significant wave height products for all satellite altimeters by developing operationally robust software 1) to generate automatic assessment of systematic, instrumental differences among Jason-1, Envisat, GFO, and Jason-2, including patches for possible degradation of any wave products, and 2) to edit data for spurious values without removing improbable but physically correct data related to extreme events.

2. Provide altimetric wave period data within well understood limitations, and consistent data across the available instruments
   a. Verify TOPEX-derived wave period for Jason-1, Envisat and GFO. Derive or fine-tune wave period algorithms for Envisat, GFO and Jason-2.
   b. Establish operationally-useful limits on the applicability of altimetric wave period (this quantity's accuracy depends on local wind strength and the ratio of shorter-scale sea to longer-scale swell).

3. Provide a robust software tool that
   a. takes as inputs the operational data streams from Jason, OSTM, Envisat and GFO produced by the ground segments of these missions
   b. implements the data editing, quality assessments, and computation of wave period
   c. outputs results in a format used by the N-AWIPS/GEMPAC data display software at OPC
   d. generates further statistics that can be used to track possible instrument anomalies

III.1. Near real time altimeter data and data flow at NCEP/NOAA, Sept. 2008

Altimeter file information	Jason-1 GTS	Jason-1 NAVO	Jason-2 interim	Envisat NAVO	GFO NAVO	Envisat GTS[1]
Input NRT altimeter wind/wave BUFR	OSDR[2]	SNAPS jogb*.bufr	OGDR-BUFR[3] (prelim.)	SNAPS efgb*.bufr	SNAPS gogb*.bufr	TBD
Data source for NCEP_Native file and native source	CNES	NAVO, OSDR, JPL pull	ESPC/DDS, GTS[2], OGDR-BUFR	NAVO, FIMAR, ESA pull	NAVO, NGDR-O, NOAA pull	ESA
NCEP Transfer method	GTS	ftp push	GTS	ftp push	ftp push	N/A
NCEP/NCO decoder[4]	dcigdr IGDR decoder	dcgfld GFO-FD wind/wave decoder	none	dcgfld GFO-FD wind/wave decoder	dcgfld GFO-FD wind/wave decoder	N/A
NCEP tank filenames[5]	xx106 cajosww	xx110 ajosww	none	xx108 envosww	xx107 gfofww	N/A
Absolute latency[6] (hrs) min. / avg. / max.	0.75 / 2.20 / 4.20	0.84-1.1 / 3.3-24. / 5.4-48	92%< 3 hr in Aug2008[7]	1.7 / 3.2 / 5.0	1.2-4.2 / 6.2-9.8 / 15.0	N/A
Possible latency improvements	unlikely	N/A	Increase # of ground stations?	GTS soon? 20097	low priority	N/A
Hourly ASCII NAWIPS files[10]	jason_yyyymmddhh.sgwh	N/A	jason2* sgwh	envi* sgwh	gfo* sgwh	N/A

[1] Email between S. Wilson & H. Laure 20080911 indicates this GTS injection may occur soon.
[2] The EMC table for BUFR types has this listed at IGDR but this is not true. It is OSDR.
[3] These files are renamed at NCEP/NCO as jao_*.bf.glo_*.bf , or enf_*.bf, directory= /oceano/
[4] OGDR-BUFR = OGDR-SSHA except the latter is in netCDF
[5] Trial period data flow method - see "ostm_ncep_brief_20080917.ppt", J. Lillibridge.
[6] Decoder name and description taken from "decoderlist.doc" of 14 Sep. 2008, Mainelli and Ator
[7] See Bufr Type 31: Oceanographic Data at — http://www.emc.ncep.noaa.gov/mmb/data_processing/data_dumping.doc/table_1.htm
[8] Defined as time between receipt into tank and actual observation. Values provided for the period 20080910-20080914 by Jeff Whiting in email of 15 Sep 2008.
[9] From data shown in "ostm_ncep_brief_20080917.ppt", J. Lillibridge. Time is measured to the DDS receipt and is NOT a "tank" receipt time.
[10] Produced by Greg McFadden, hourly files for use in the NAWIPS display. Jason-2 is treated specially but the others are read using WMO tank decoders obtained from Vera Gerald.

III.2. Issues on significant wave height data quality

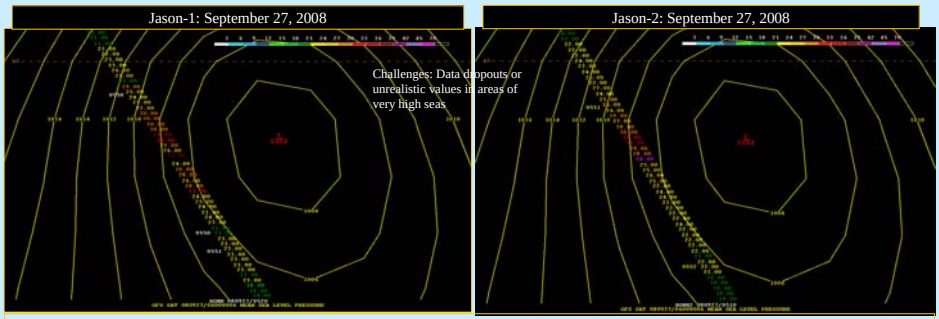

Figure 1: Real time NAWIPS altimeter SWH maps (values (in units of feet) along the altimeter tracks) on September 27, 2008. The example shows how the data can be useful for maritime sea state nowcasting at the NCEP Ocean Prediction Center. However, in high seas and even clear air, the altimeter data do at times dropout and/or present unrealistic values - particularly in very high sea areas. (Left: for Jason-1; Right : OSTM (Jason2))

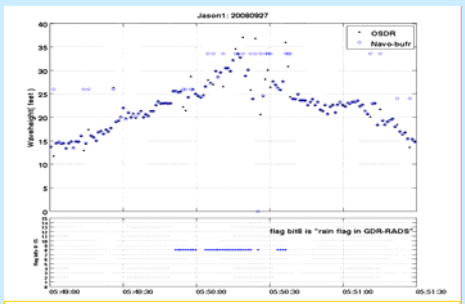

Figure 2a
Top: Along track Jason1 Hs from NAVO-BUFR files (blue circles) and OSDR (black dots) for September 27, 2008. **Bottom:** the GDR flags that show flag 8 (i.e. rain flag) is occurring in the high sea areas.

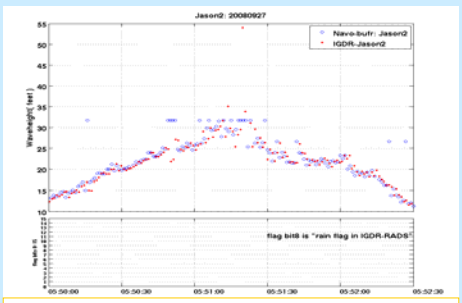

Figure 2b
Top: Along track Jason-2 Hs from NAVO-BUFR files (blue circles) and ISDR (black dots) for September 27, 2008. **Bottom:** the IGDR flags show that no flags were ON for the same high sea area (cal/val phase period for Jason2).

III.3 Missing Hs data and possible remedies

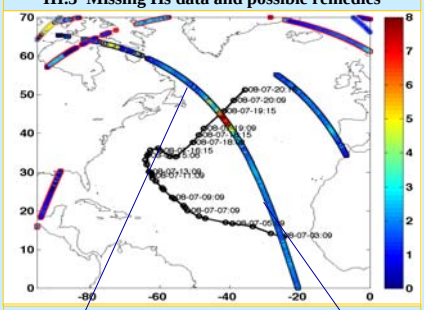

Figure 3 North Atlantic altimeter significant wave height data for Tropical Storm Bertha collected near 2000 UTC, July 19 2008 (Black, red and gray background: Jason1, GFO, and ENVISAT, respectively within +-6 hr window)

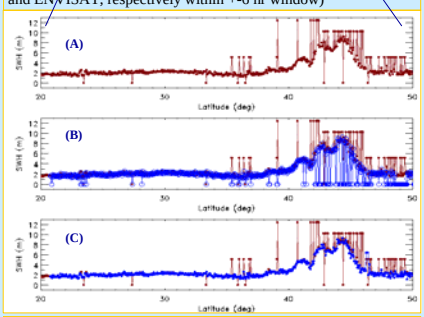

Figure 4
Panel A: NCEP BUFR SWH data for Storm Bertha event, July 19 2230 UTC Jason-1 data in the North Atlantic: **Panel B :** NCEP BUFR SWH data (dark red), Jason-1 OSDR SWH data (blue) after flagging to zero data outside editing limits. **Panel C :**BUFR SWH data (dark red), filtered OSDR data (blue) where any flagged OSDR data are replaced by a 7 second (~45km) running median filter.

III.4. Altimeter-based wind speed (u10)

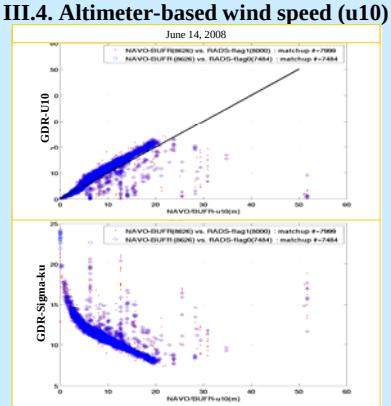

Figure 5
Top : Scatter plot of Jason-1 GDR vs. NAVO wind speed U10, **Bottom:** Scatter plot of Jason-1 GDR Sigma-Ku vs. NAVO wind speed U10. GDR data from RADS database during a 3-hour period on June 14, 2008; RADS editing flag1 (red) and flag0 (blue) stand for no editing and RADS default editing, respectively.

IV. Ongoing work

The initial project team kick-off meeting was held at NCEP in Sept. 2008. Key tasks identified for near-term progress:

- document data flow from the satelllites to the forecast NAWIPs screen and identify feasible data latency and data quality improvements (see III.1 - III.3 above).
- develop/obtain an altimeter orbit prediction software tool to identify where the satellites will be in the next several hours to alert the forecasters of incoming data useful in their analyses. This tool has been developed at JPL and provided to G. McFadden at NCEP.
- provision of long term quality-controlled SWH and altimeter wind speed data sets for the Wavewatch 3 forecasting group

In addition we are evaluating:

- the relation of altimeter U10 to Sigma- Ku and C, and propose a wave period algorithm using altimeter-measured Sigma and wave height. (For NRT products one needs to retreive σ^0_{Ku} from U10 , see **Figure 5**)

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