Satellite Data for Wave Model Validation

Satellite Oceanography Users Workshop, Melbourne, Australia 9-11 Nov 2015

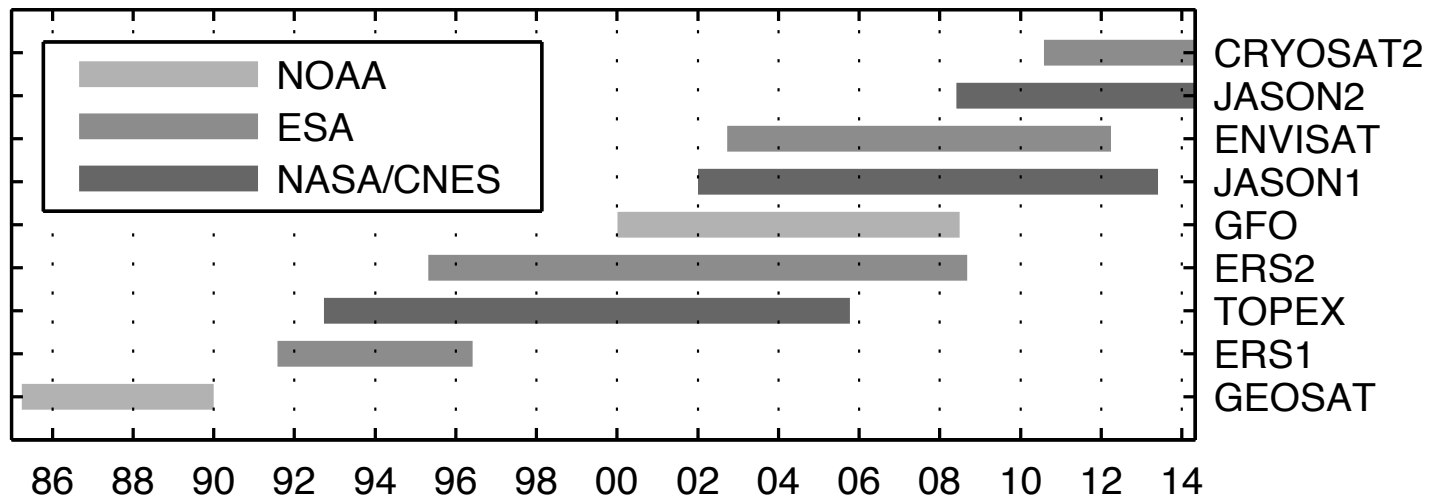Stefan Zieger

Outline

- Satellite data

    - Altimeters

    - Radiometers (and Scatterometers)

- Wave model validation

    - Operational model

    - Reanalysis

    - Tropical Cyclones

- Data sources

Altimeters

- Altimeters operational since 1985

- Since 1991 parallel operating satellites

- Near global coverage (depending on orbit configuration)

- Active satellites:

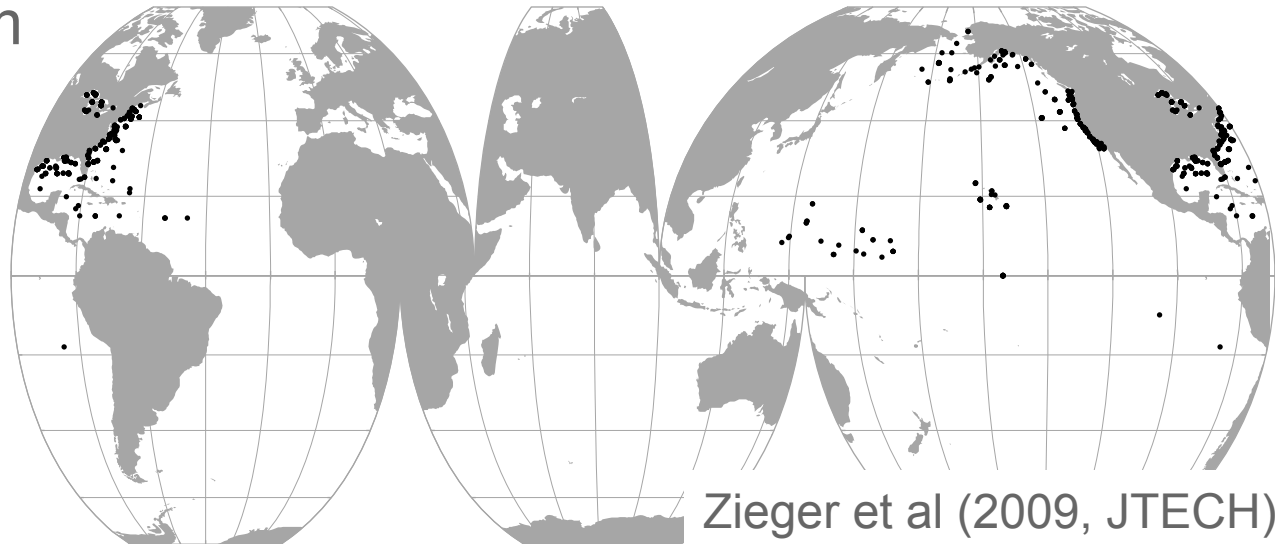 - JASON2

  - CS2

  - ALTIKA

  - HY2

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Altimeters

validation and quality control

• Altimeter wave height routinely validated against marine observations from the U.S National Buoy Data Center (NDBC)

• Wave height in excellent quality available in near-real time (hours)

• RMS error <0.20m

• High accuracy for

  • ENVISAT

  • JASON1/2

  • CY2

  • ALTIKA
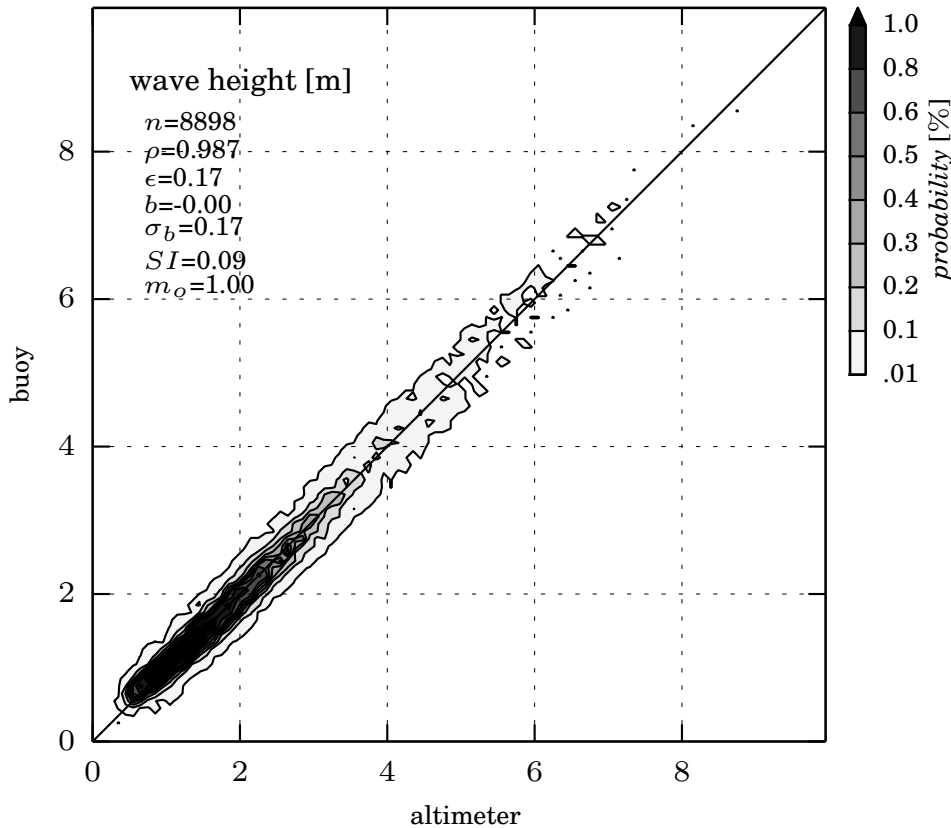
Zieger et al (2009, JTECH)

Altimeters

validation and quality control

Altimeters
validation and quality control

• Altimeter wind speed is based on various transfer functions (empirical fit to different ranges of observations)

• Scatter in wind speed is higher in buoy comparison

• Highest quality in geophysical data record (GDR) available ~30 days after data acquisition

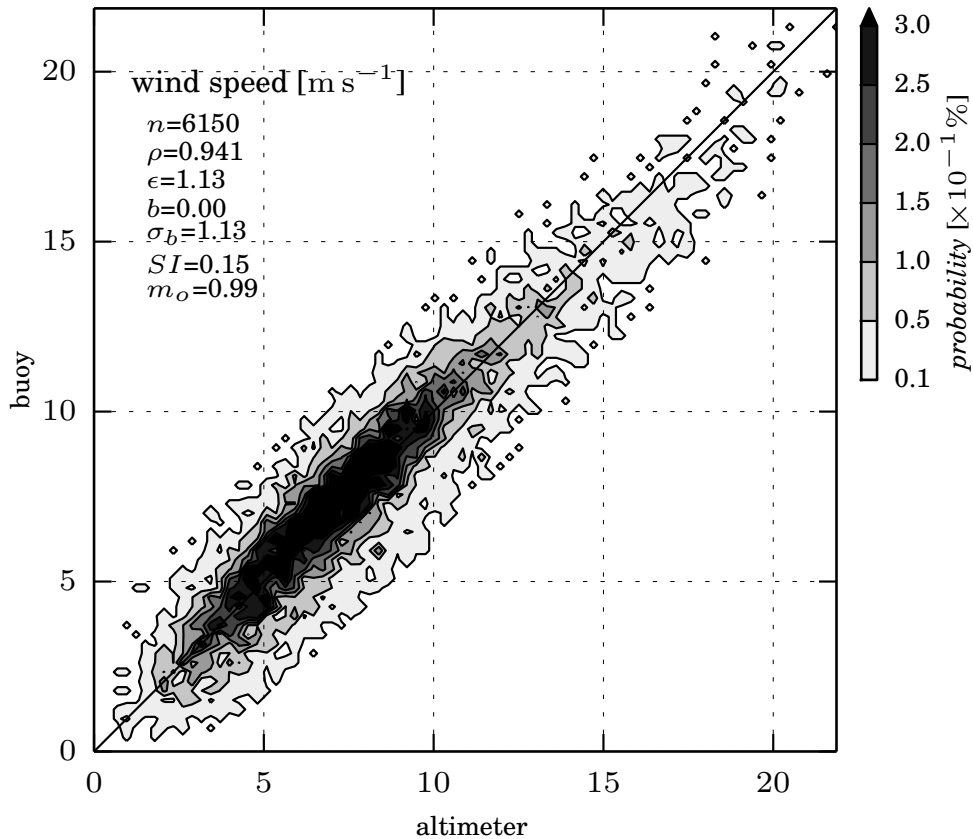• RMS error in wind speed in order of 1.10 - 1.30 m s^{-1} when unified model function is applied

Zieger et al (2009, JTECH)

Satellite Oceanogra...

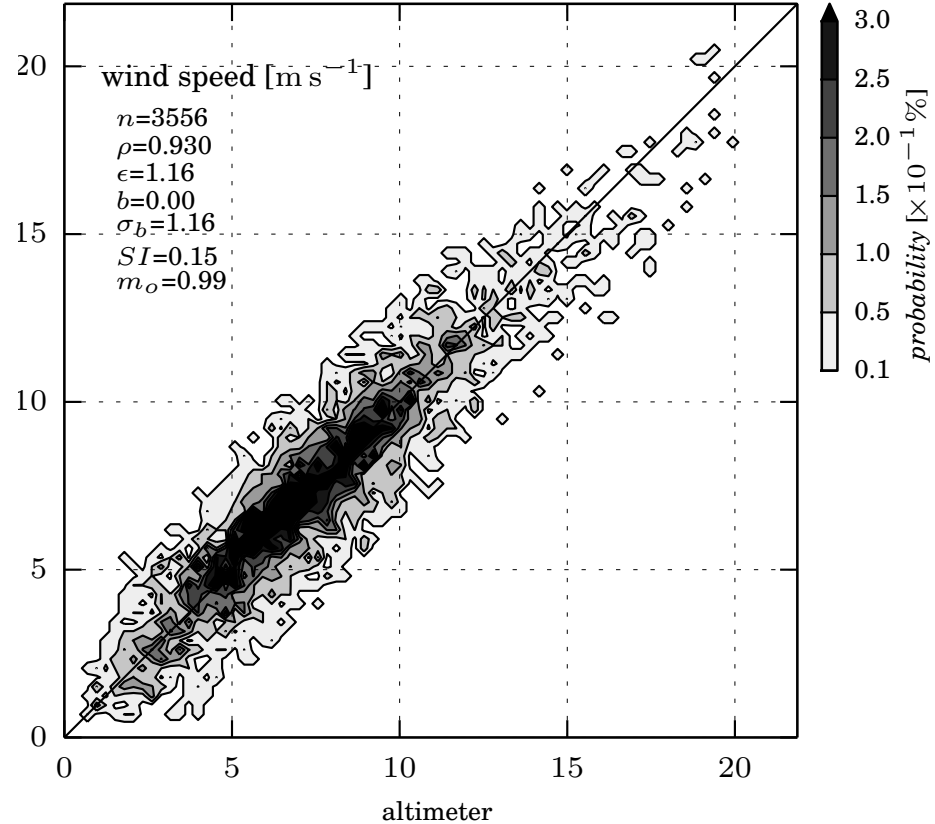# Altimeters

validation and quality control

Altimeters

validation and quality control

- Calibration studies and bias correction (Zieger et al 2009)

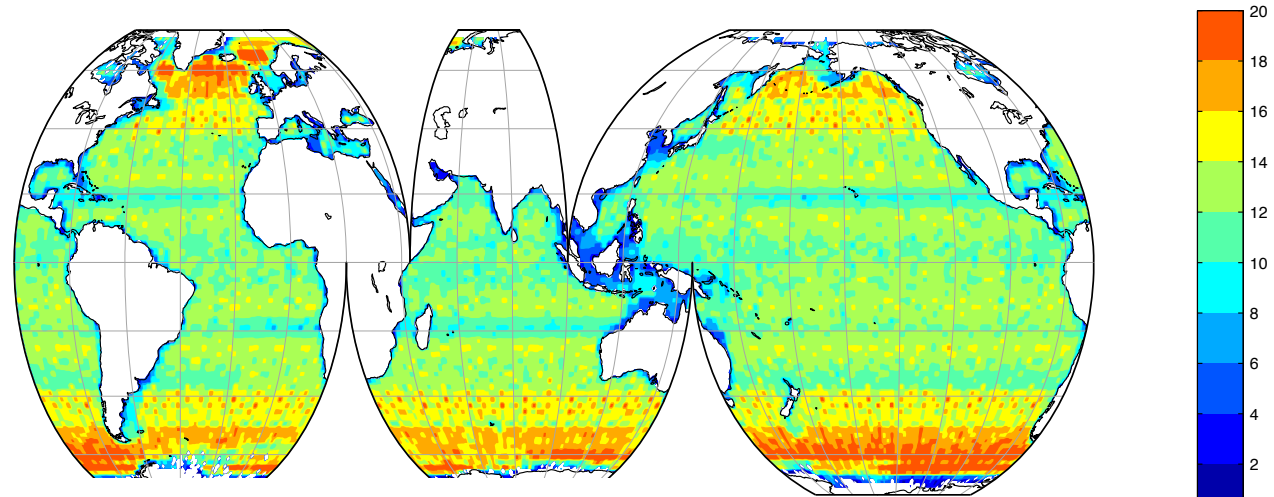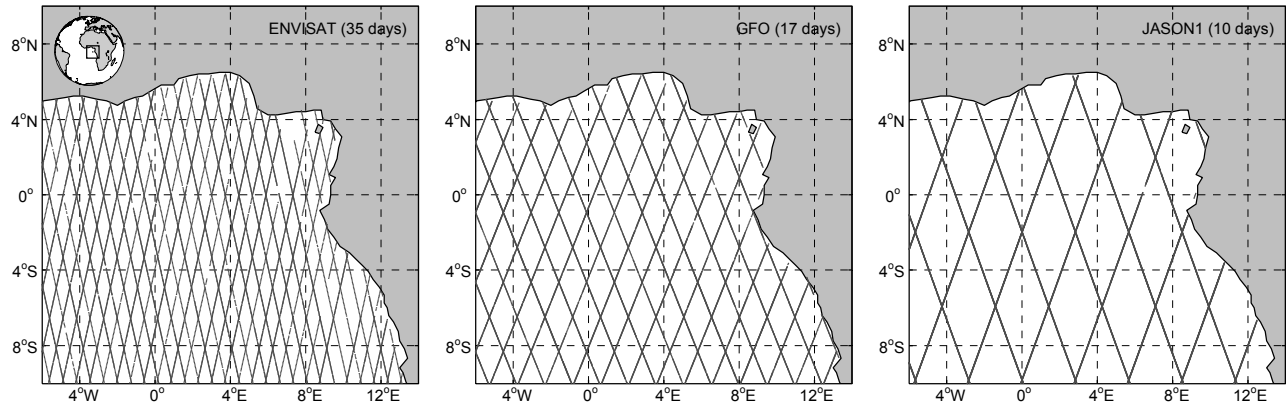|	Altimeter	Slope	Offset	ε	e	ρ	n	Slope	Offset	ε	n	Slope	Offset	n
				Present study and Zieger et al (2009)				**Queffeulou et al. (2004) for H_s Queffeulou (2003) for U_{10}**				**Young (1999a)**		
H_s	ENVISAT	1.069	-0.198	0.15 m	0.12 m	0.990	4390	1.033	-0.183	0.19 m	1280			
	ERS1	1.127	+0.280	0.20 m	0.16 m	0.984	2079					1.243	+0.040	192
	ERS2	1.076	+0.042	0.17 m	0.13 m	0.989	7885	1.064	+0.001	0.19 m	12070			
	GEOSAT	1.076	+0.122	0.21 m	0.17 m	0.982	1600					1.144	-0.148	203
	GFO	1.068	+0.102	0.15 m	0.12 m	0.991	6179	1.080	+0.039		21228			
	JASON1	1.036	+0.026	0.16 m	0.13 m	0.990	4420	1.007	+0.039	0.19 m	2853			
	TOPEX	1.049	-0.098	0.17 m	0.13 m	0.990	3428	1.024	-0.048	0.17 m	7826	1.067	-0.079	192
U_{10} (A07)	ENVISAT	1.010	-0.110	1.11 m s^{-1}	0.86 m s^{-1}	0.941	2926	0.964	+0.599	1.52 m s^{-1}	292			
	ERS1	1.047	-0.293	1.07 m s^{-1}	0.83 m s^{-1}	0.984	1333					0.849	+1.217	192
	ERS2	1.005	-0.024	1.20 m s^{-1}	0.93 m s^{-1}	0.931	5093							
	GEOSAT	1.015	-0.087	1.76 m s^{-1}	1.31 m s^{-1}	0.857	1113					0.874	+0.337	196
	GFO	0.986	-0.059	1.31 m s^{-1}	1.02 m s^{-1}	0.925	4136							
	JASON1	0.999	+0.070	1.28 m s^{-1}	0.99 m s^{-1}	0.936	2865	0.986	+0.887	0.85 m s^{-1}	1236			
	TOPEX	1.010	-0.062	1.11 m s^{-1}	0.87 m s^{-1}	0.948	2486					0.943	+1.847	190

Altimeters

sampling and availability

Australian Government
Bureau of Meteorology

- Altimeters sample over a small foot print (8-16km)

- Global coverage within 10-35 days depending on orbit geometry.

- The number of altimeter pass in a 2 degree bin is limited along the equator and increases at high latitudes.
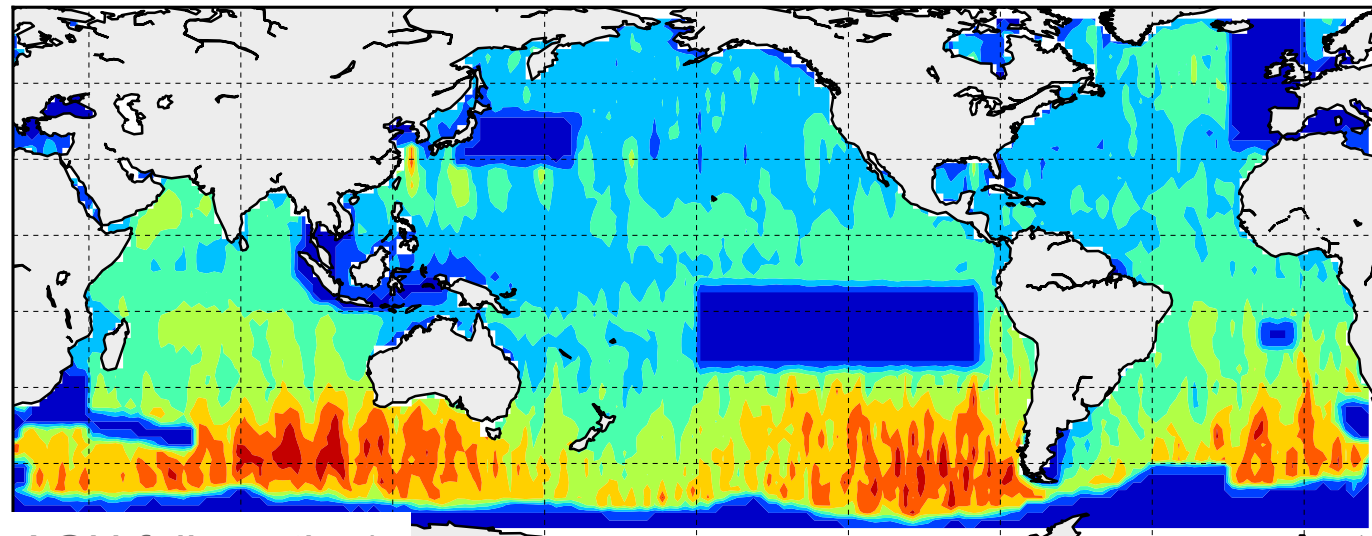

Zieger et al (2014, Deep Sea Res.)

Altimeters

sampling and availability

- CRYOSAT2 operates in different modes

- Waveform retracking from fast delivery products can fill gaps
  (available from NOAA/NESDIS)

Climatology - Aug 2012

mean wave height in [m]

0   1   2   3   4   5   6

Zieger et al (2013, AGU fallmeeting)
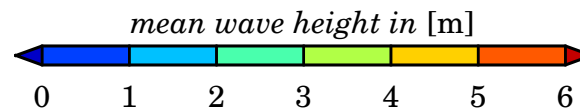
Radiometers (and Scatterometers)

- Microwave radiometers measure brightness temperature of the winds roughened surface.

- Wind can be retrieved with an accuracy of 0.9 m s^{-1} (SSM/I, Wentz 1997, Wentz et al 2007).

- SSM/I data is limited to near no-rain condition and conditions of greater than 2 mm hr^{-1} are excluded ("fair-weather bias"?) (Wentz and Spencer 1998).

- Daily global coverage.

Radiometers (and Scatterometers)

Australian Government
Bureau of Meteorology

- Sampling pattern of SSM/I radio-meter F14 on 16 August 2004.

- Black areas are masked due to ice, missing data or rain.

Zieger et al (2014, Deep Sea Res.)

Wave Model Validation

operational atmospheric model

- BNOC wind speed ACCESS-G (APS2 ¼ degree)

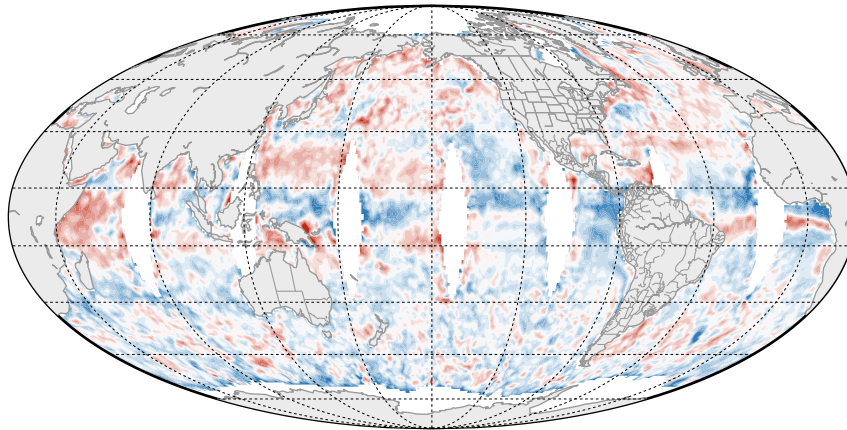- Example: June 2015

- RMSE ~1.5m s^{-1}

- BIAS ~0.1m s^{-1}
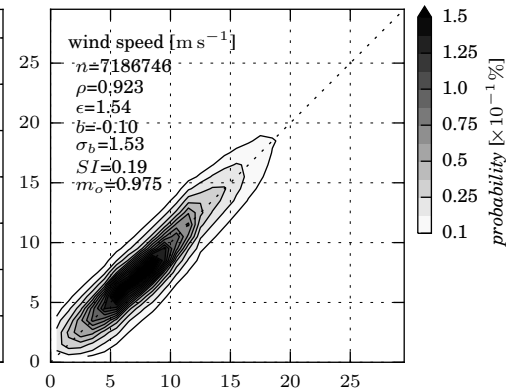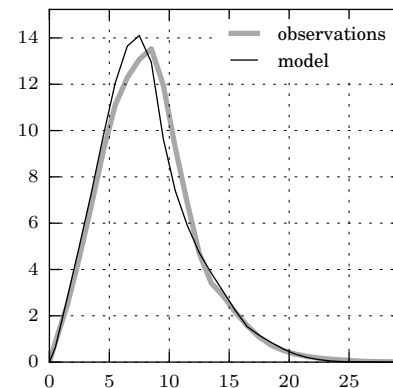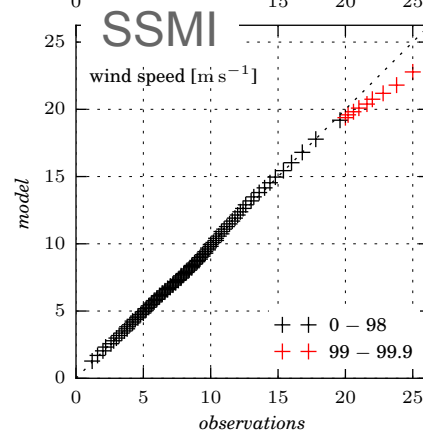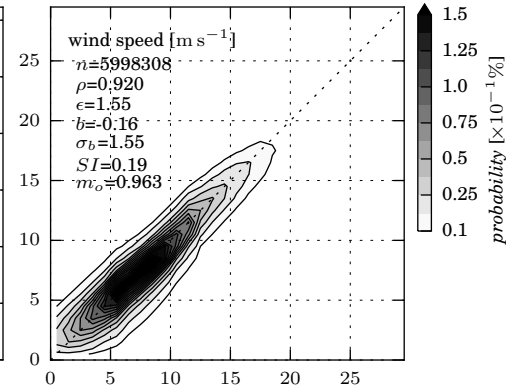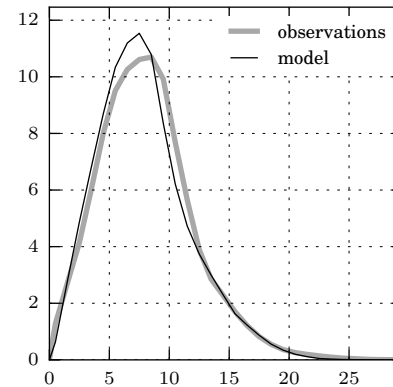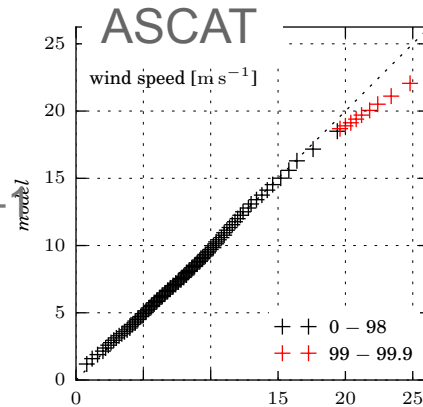
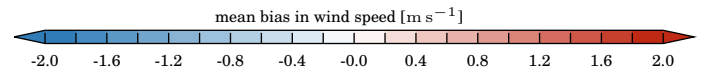# Wave Model Validation

operational atmospheric model

ASCAT
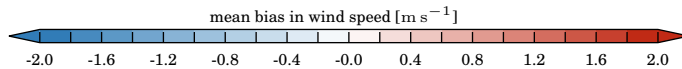
- Example: June 2015

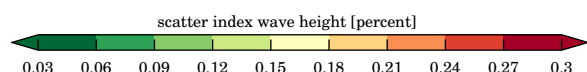- ACCESS-G (APS2 ¼ deg.)

- 3 hourly field output (±30min.)
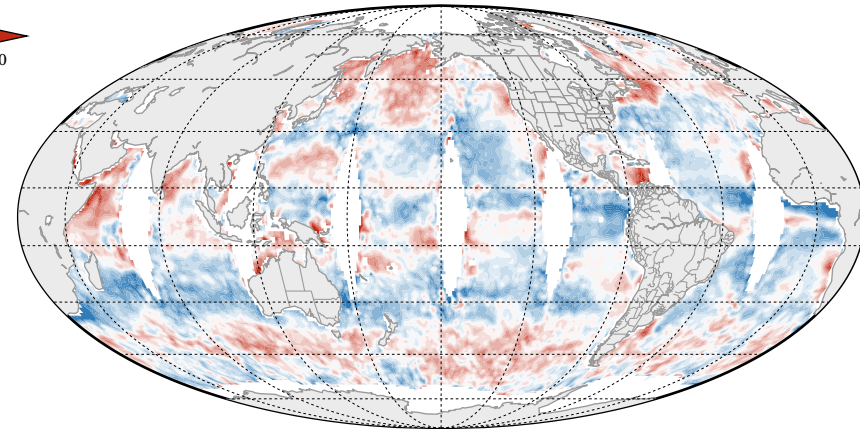
SSMI

Wave Model Validation
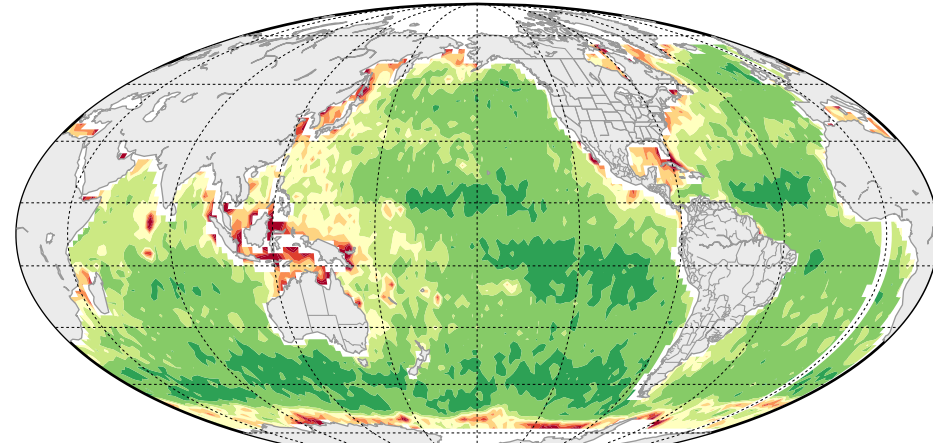## operational wave model
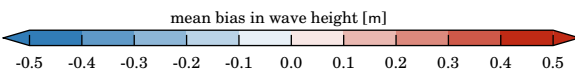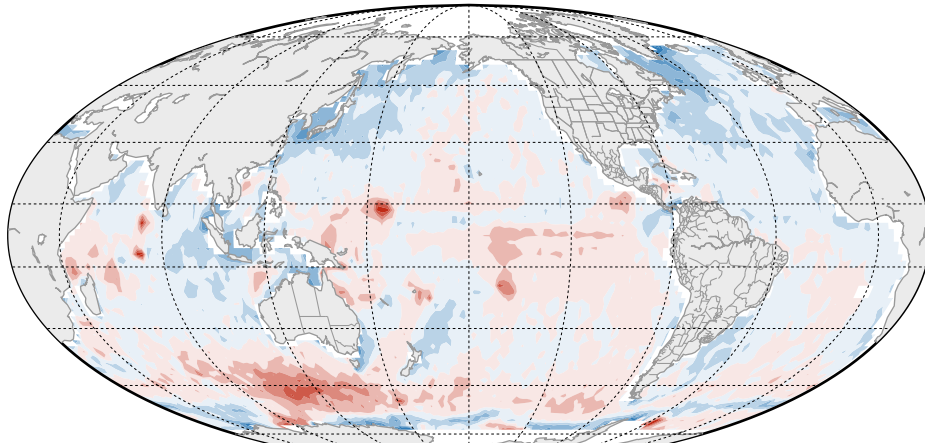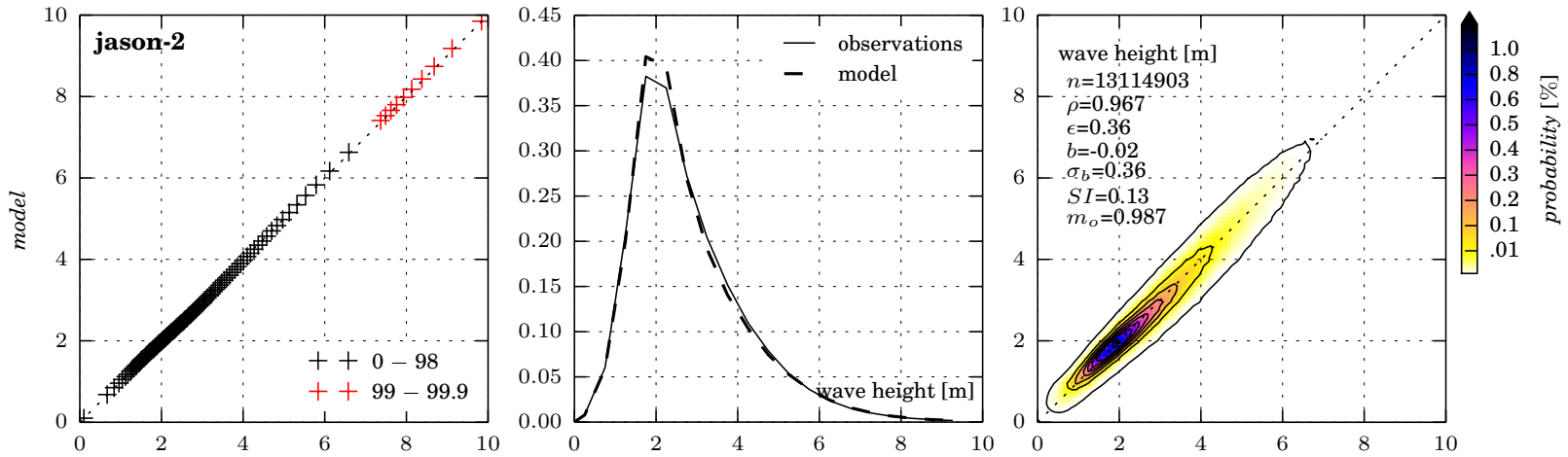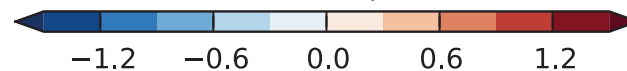
Wave Model Validation
PACCSAP hindcast

- CFSR/CFS2 ocean surface wind (Saha et al. 2010, 2014, JCLIM) validation

- Low bias in wind speed disappeared in CFS2 (Saha et al 2014)
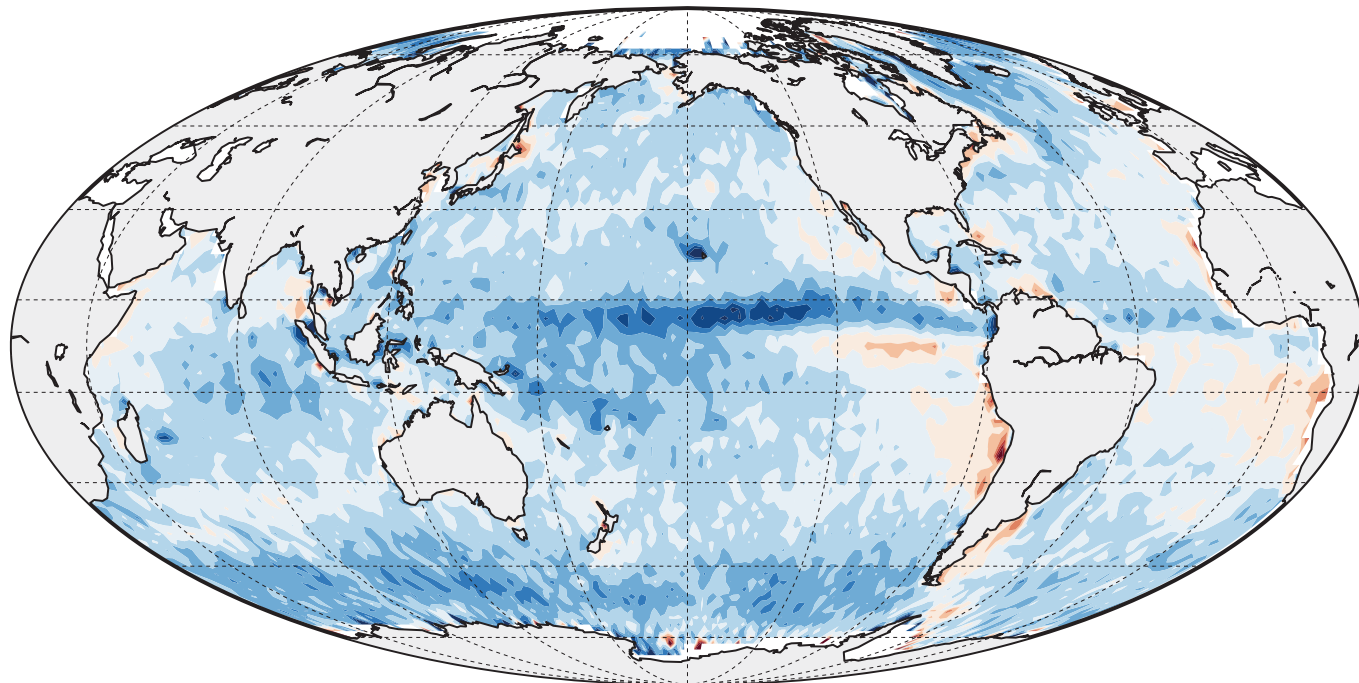
mean bias in wind speed [m s^{-1}]

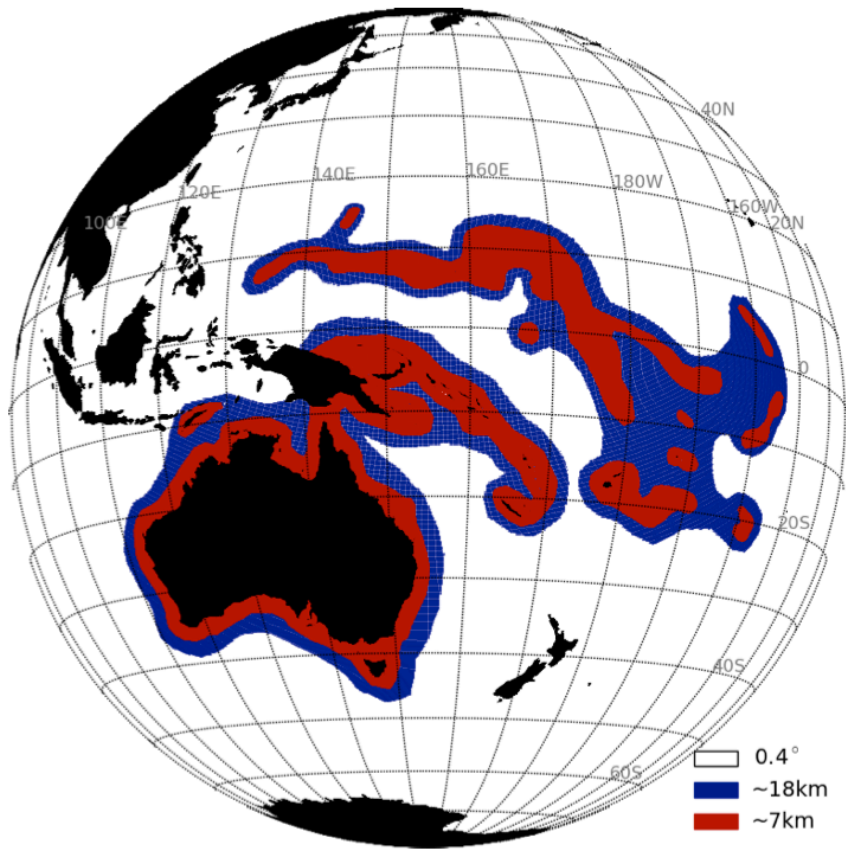−1.2   −0.6   0.0   0.6   1.2

CFSR 2006

Wave Model Validation

• Validation of the 7km grid around Australia and Pacific Islands

Legend:
- 0.4°
- ~18km
- ~7km

Durrant et al (2014, CAWCR Rpt. 070)

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Wave Model Validation

PACCSAP hindcast
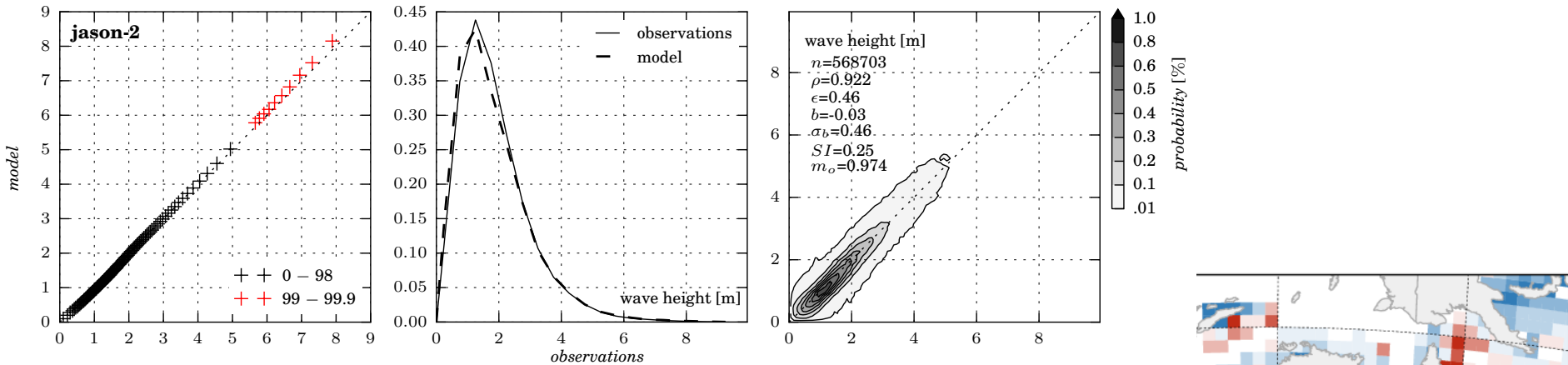
- wave model - JASON2 comparison

- RMS error: 0.46m

- Bias: -0.03m
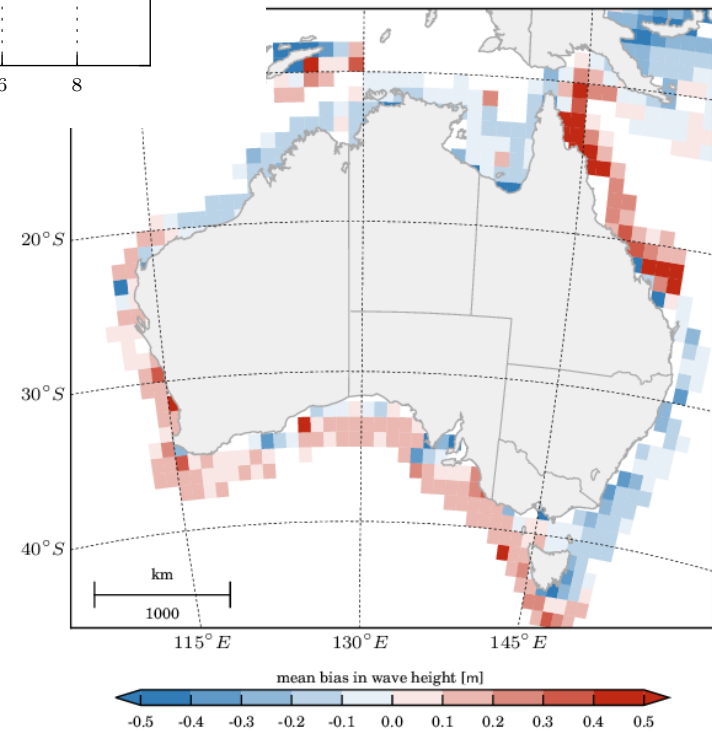
Wave Model Validation
Tropical Cyclone YASI 2011

- ENVISAT altimeter track 1 February 2011 23:36 UTC
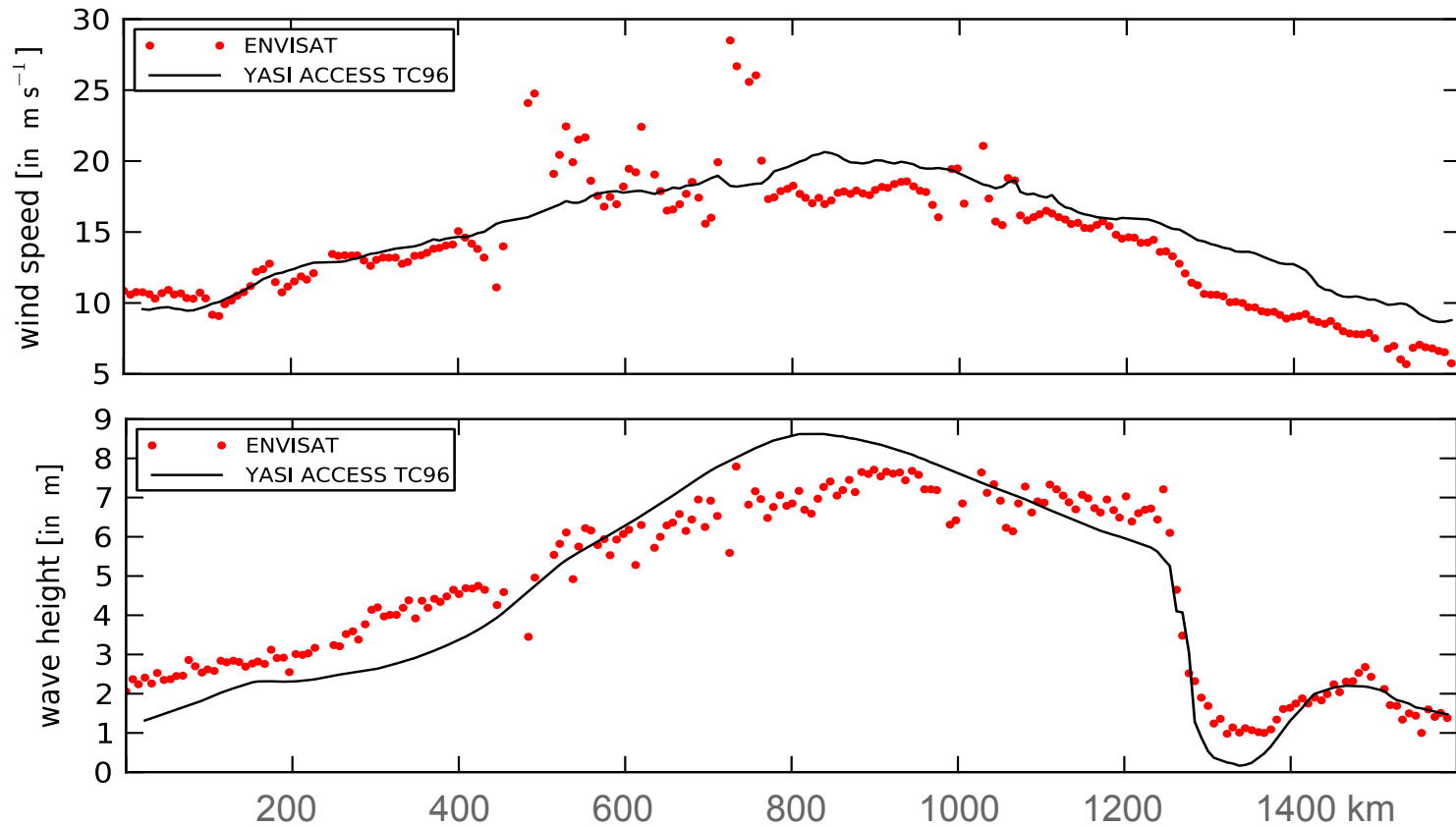
Data Sources

- Altimeter data

    - RADS (http://rads.tudelft.nl/rads/rads.shtml)

    - GLOBWAVE database (http://globwave.ifremer.fr/)

    - NOAA/NESDIS LSA interim geophysical data record (http://www.star.nesdis.noaa.gov/sod/lsa/NearRealTime/)

- Radiometer data (SSMI, GMI, AMSRE, TMI, WindSat)

    - Remote sensing systems (http://www.remss.com/missions)

- Scatterometer data (ASCAT, QuickScat, SeaWinds, RapidScat)

    - Remote sensing systems (http://www.remss.com/missions)

Thank you.

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