Evaluation of the numerical wave model (WaveWatch III) for wave simulation in the Antarctic marginal ice zone

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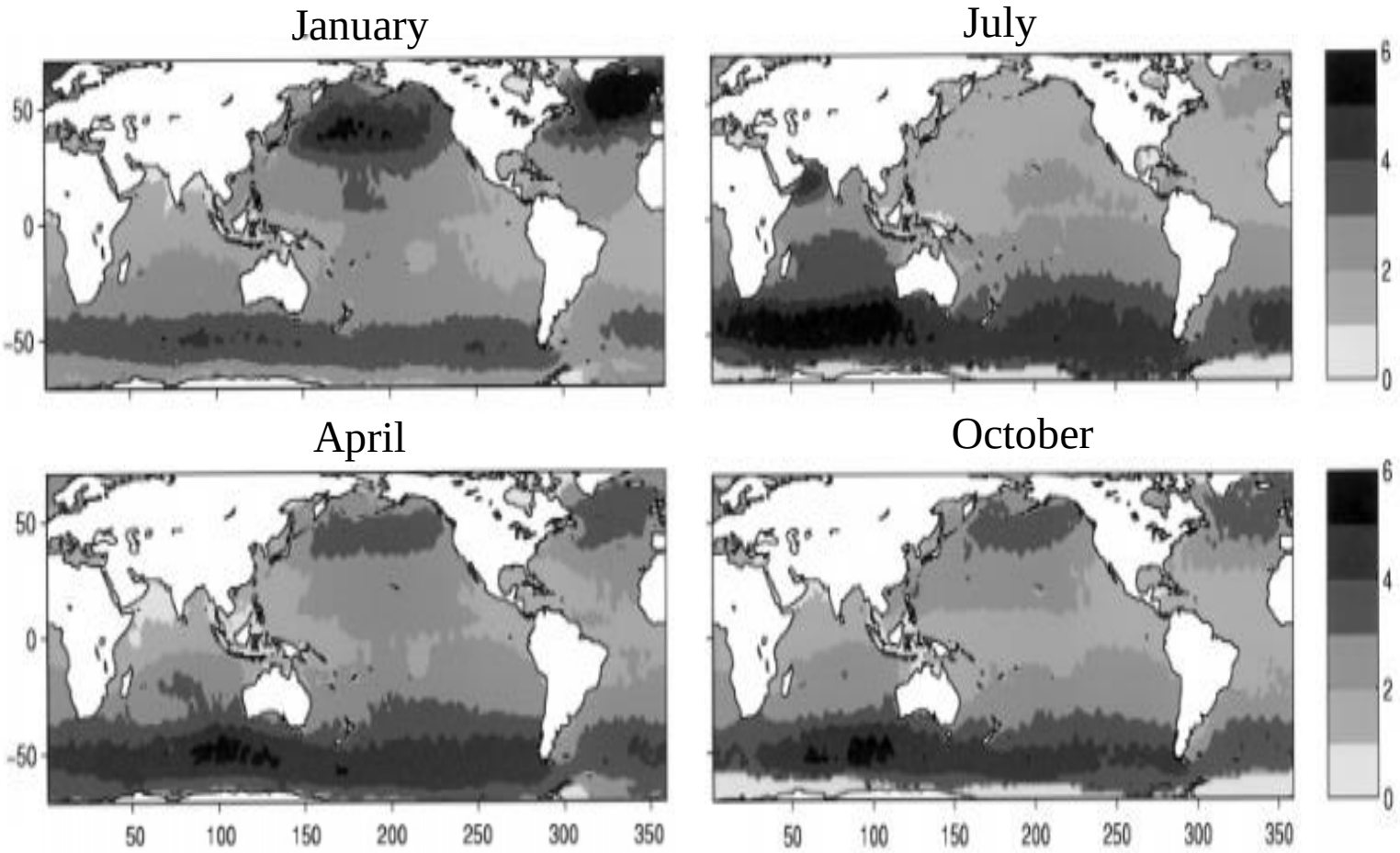
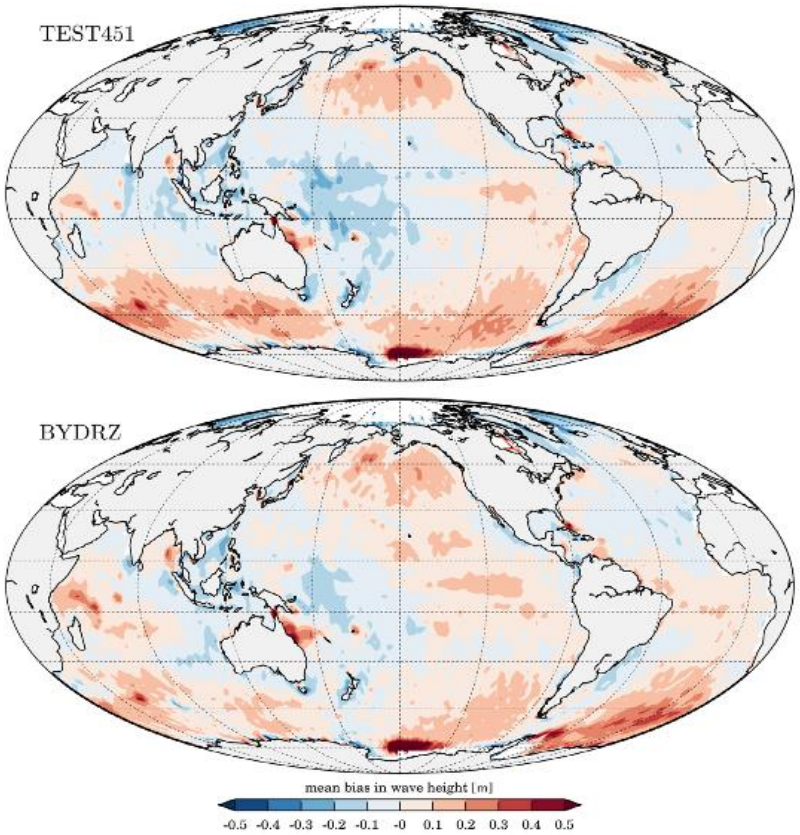
Global distributions of mean monthly values of significant wave height (I.R. Young, 1999):



Mean spatial bias in wave height for the 2006 global hindcast (Zieger et al., 2015):



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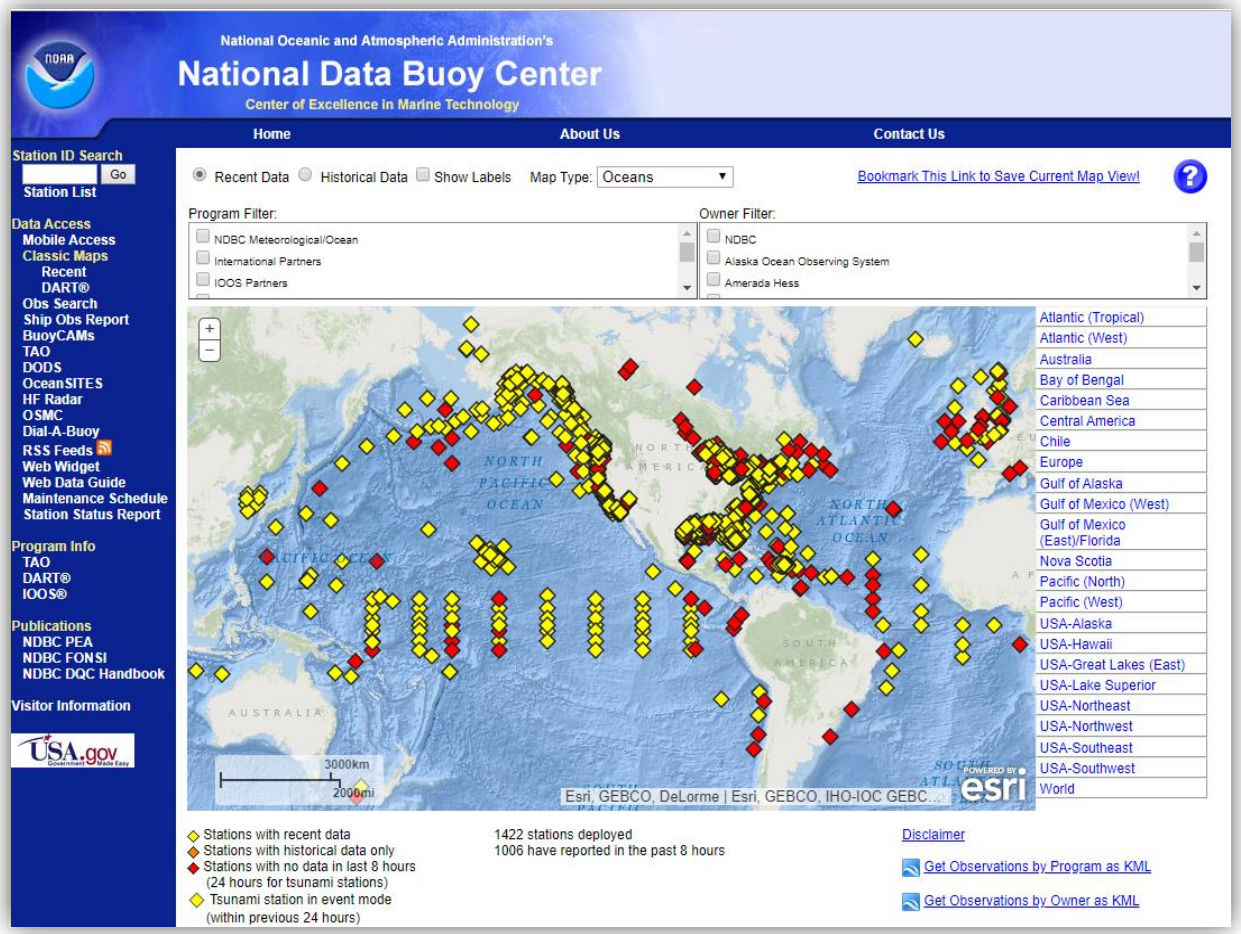
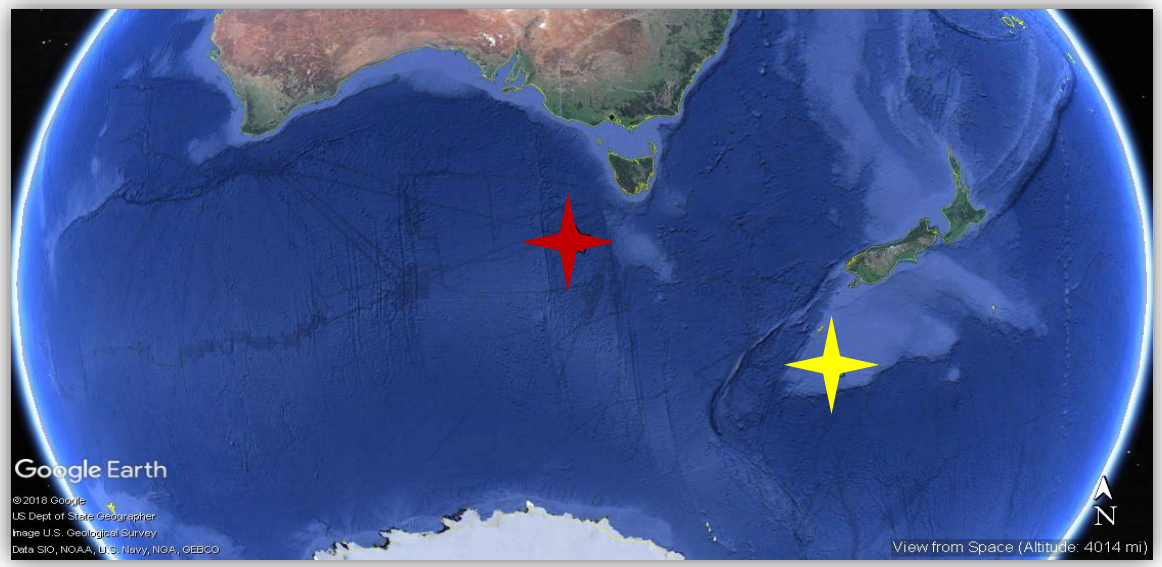
Location of NDBC Buoys



Operational buoys in the Southern Ocean



Southern Ocean WRB (**SOWRB**) & Campbell Island WRB (**CIWRB**) Since 2017

Southern Ocean Flux Station (**SOFS**) Since 2010

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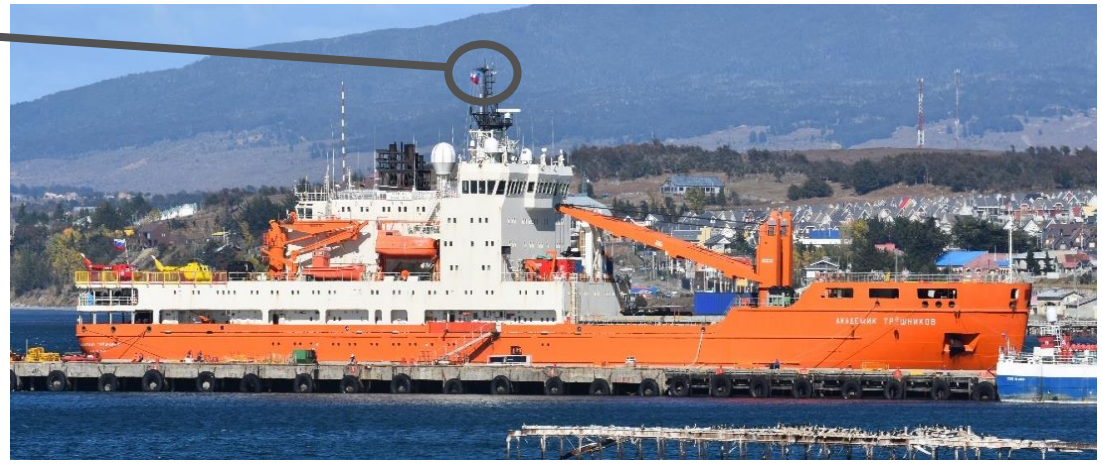
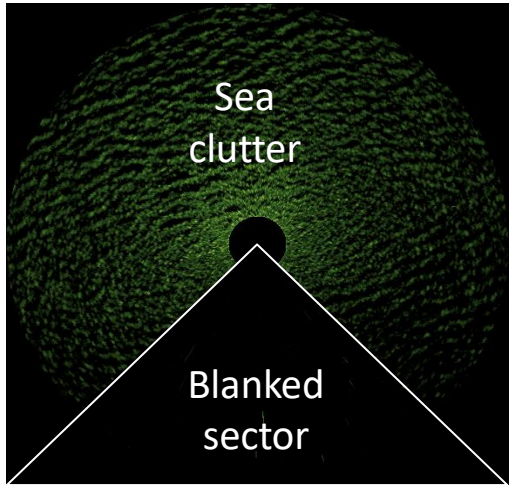
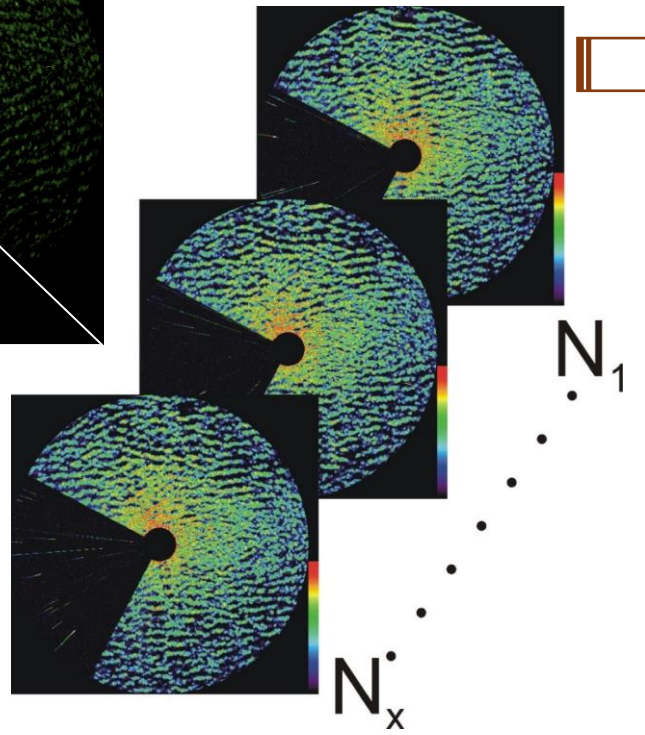
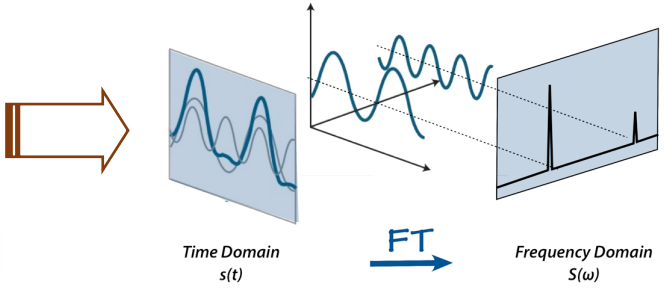
Antarctic Circumnavigation Expedition (ACE)

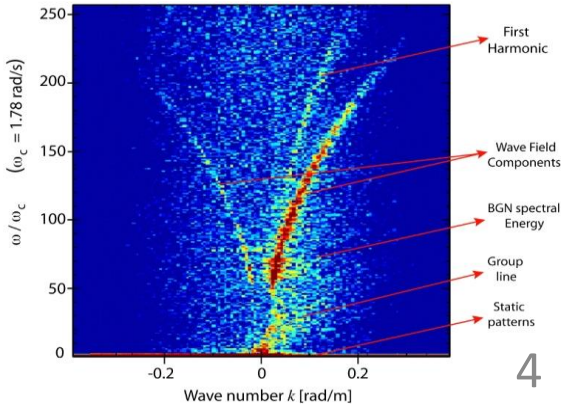
Dec. 2016 – Mar. 2017





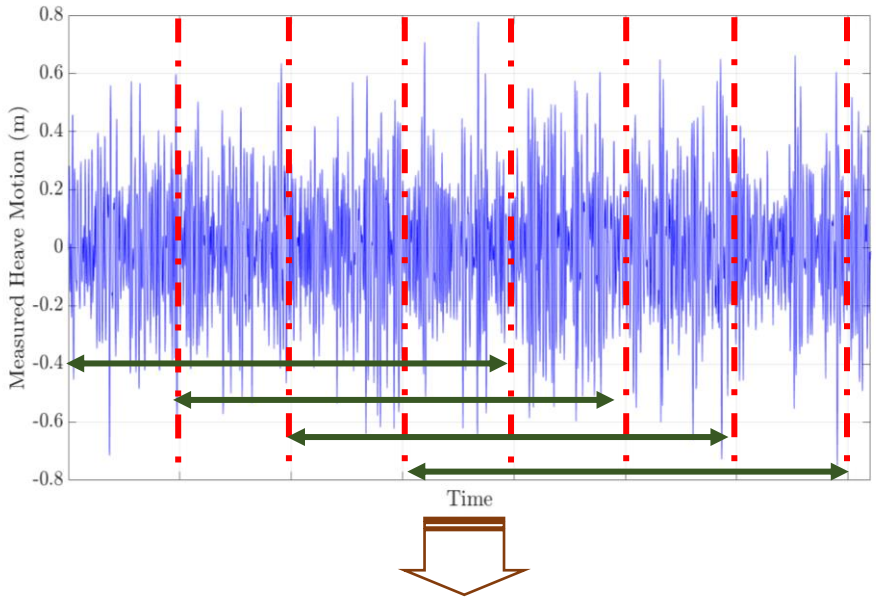


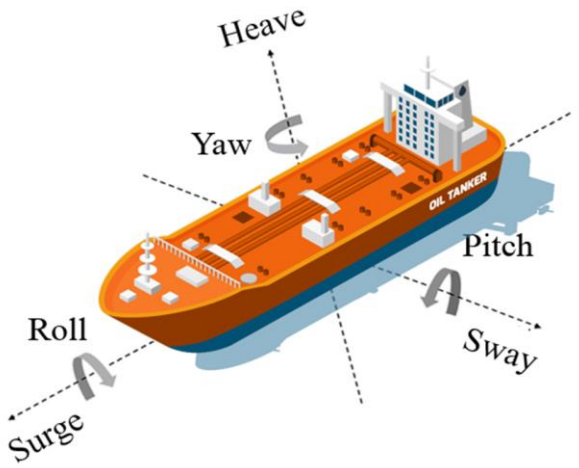




- ✓ Wave, wind and surface current are measured using a radar-based wave and surface current monitoring system (WaMoS-II) built on board of the research icebreaker Akademik Tryoshnikov both in the open ocean and Antarctic marginal ice zone.

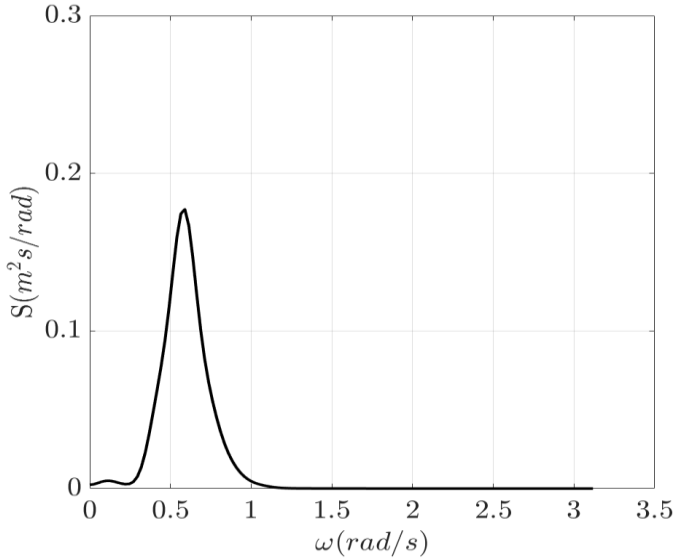
Wave observations are calibrated against reconstructed sea state based on ship motion response

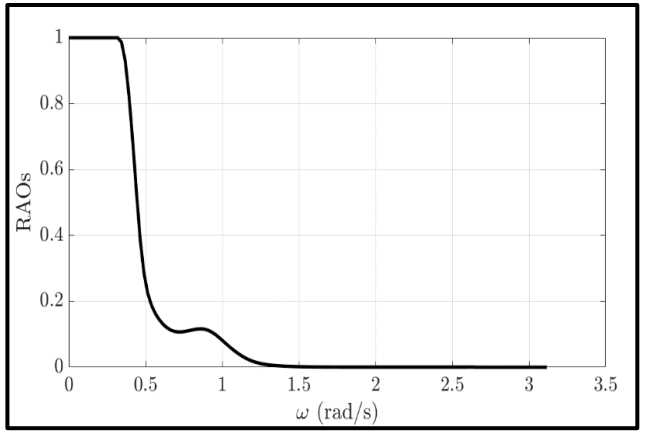




✓ Wave spectrum is estimated assuming ship as a big buoy.

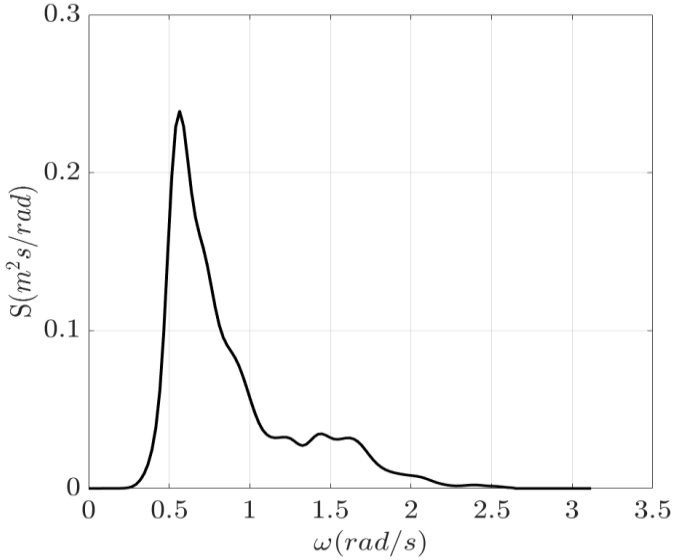
Measured Response Spectrum



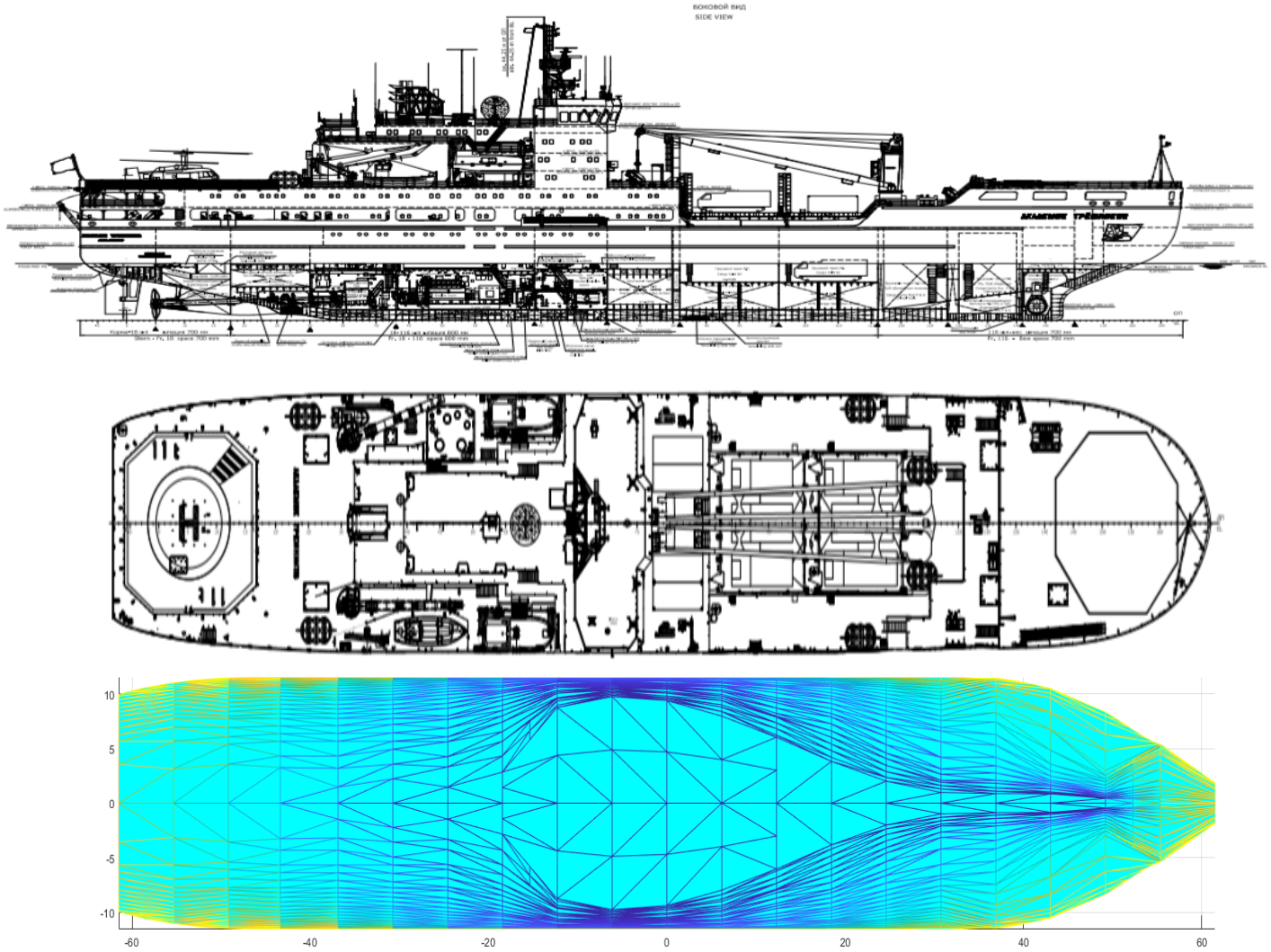


÷ Transfer Function (RAO²)

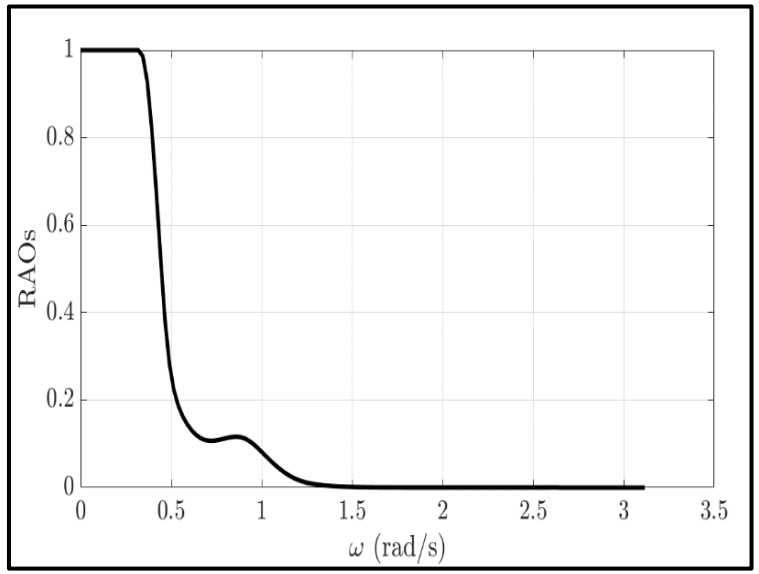
Reconstructed Sea State



Vessel's transfer function is modeled using a model based on boundary element method



- ✓ **NEMOH**, developed at Ecole Centrale de Nantes, is an open source boundary element method solver, used to model the RAO.



- ✓ The sea state is reconstructed providing wave data both in the Southern Ocean and Antarctic marginal ice zone and then evaluated against satellite data-sets.

Mass and Restoring Matrices → Freq., Dir. & Depth → **NEMOH** → Added Mass, Exciting Forces and Damping Matrices → ***Transfer Function*** **RAO**

- ✓ WaMoS-II observations are calibrated based on the reconstructed sea state.
- ✓ Calibrated significant wave height is compared with satellite data-sets from SAR and Altimeter.

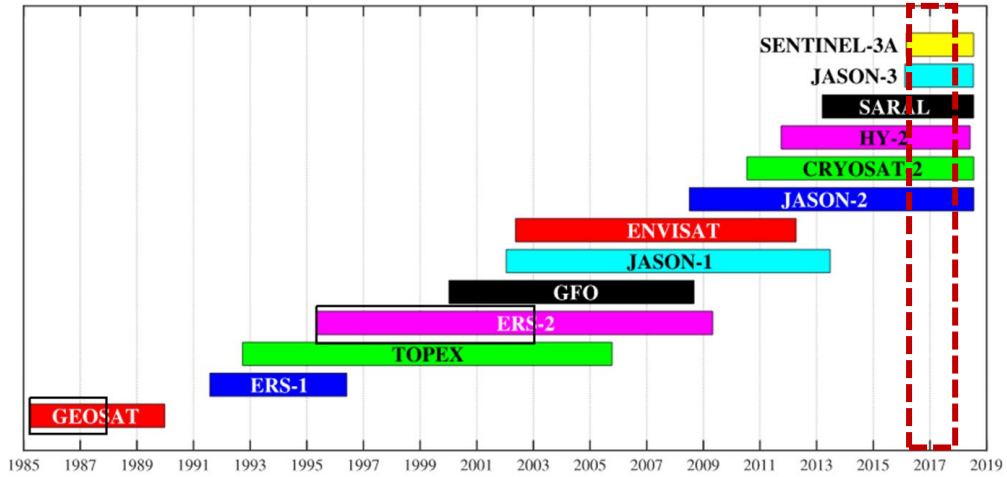


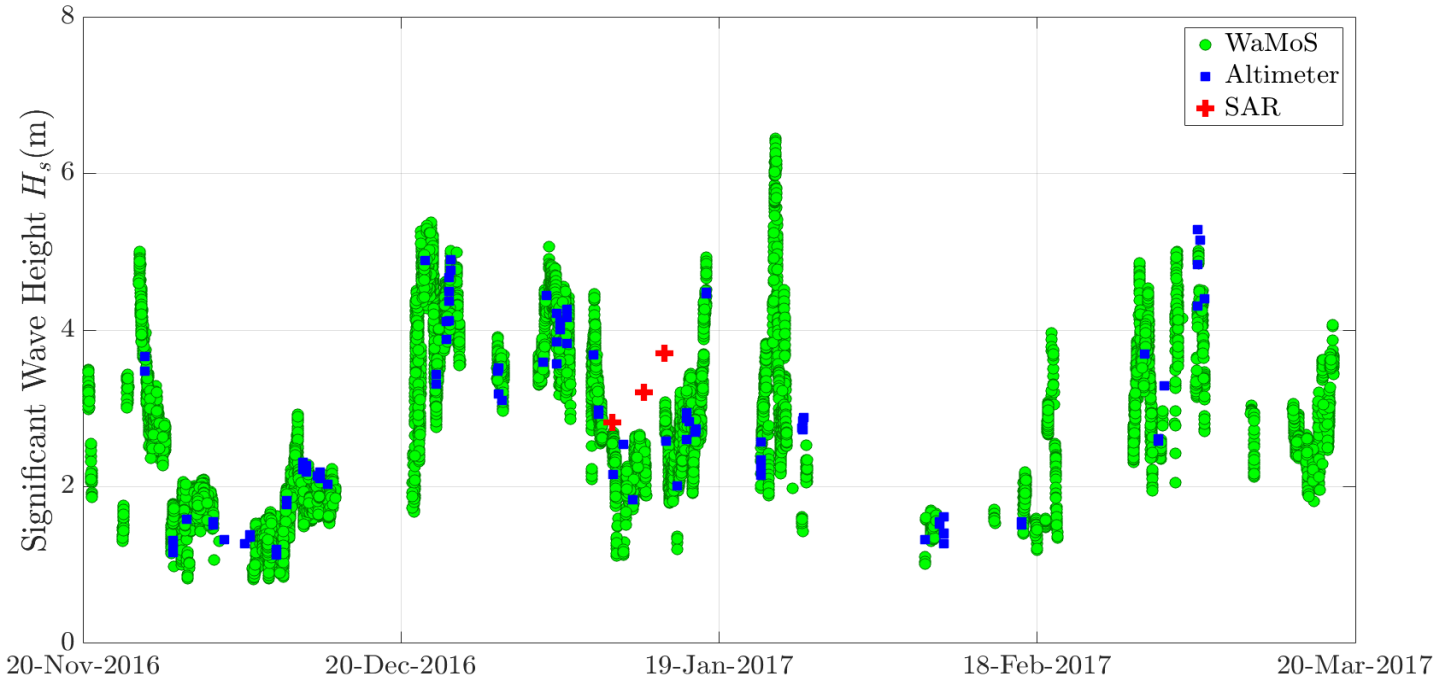
Image from: Ribel & Young (2019)

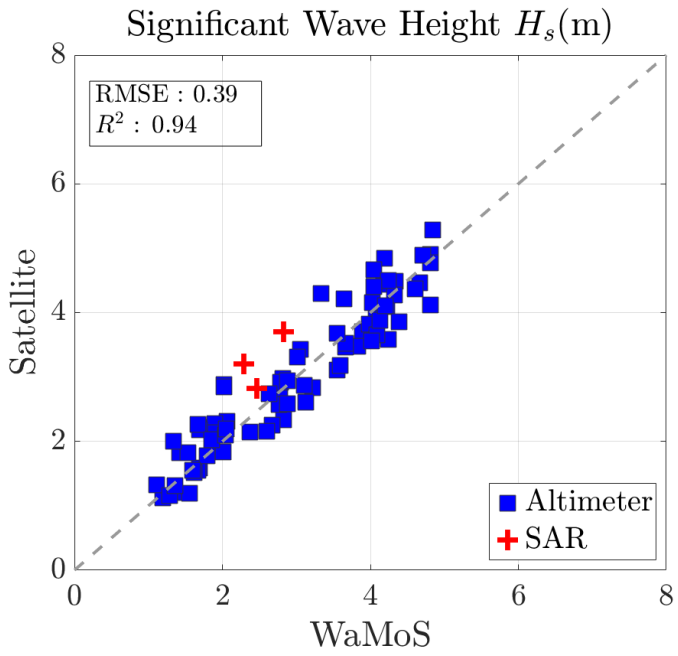
Altimeter data from satellites:

- SENTINEL-3A,
- JASON-3,
- SARAL,
- HY-2,
- CRYOSAT, and
- JASON-2

SAR data from satellites:

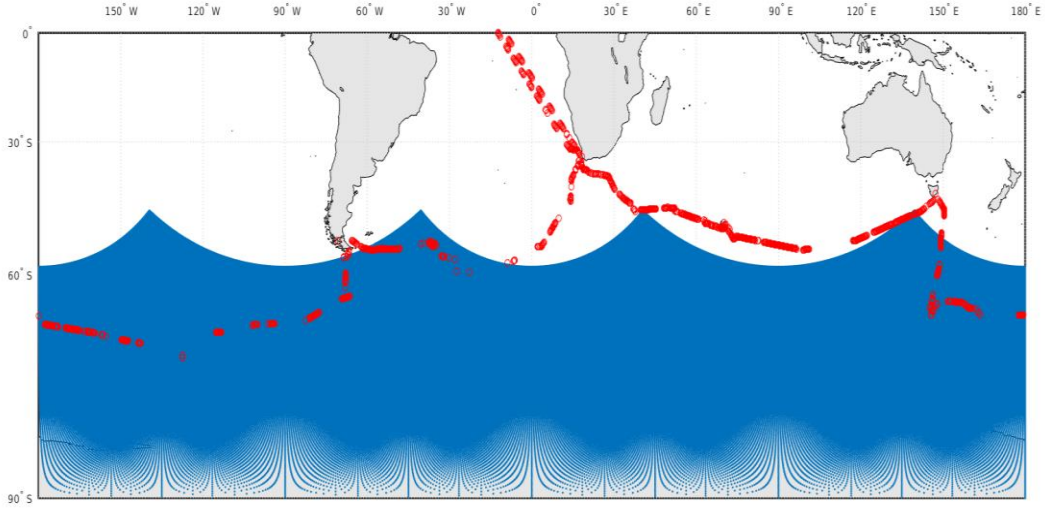
- Sentinel-1A, and
- Sentinel-1B

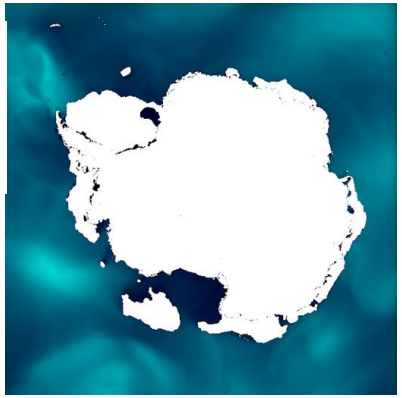




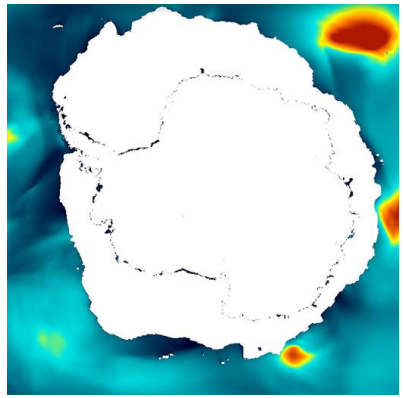
A WaveWatch III wave model is developed based on the wave observations

- ✓ The presented observations during ACE underpin the set up, calibration and validation of a WaveWatch III wave model over a domain covering the Southern Hemisphere.

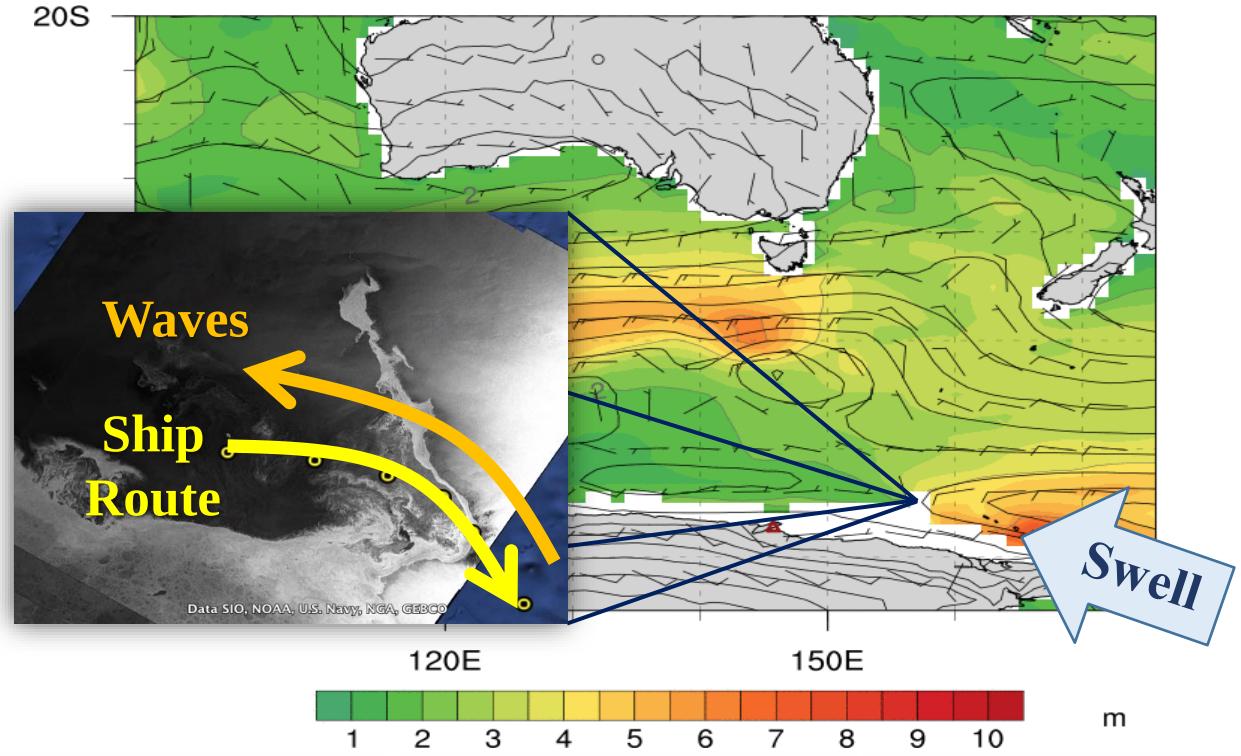




January



July



- ✓ The model is used to investigate test cases of waves-in-ice observations during Antarctic Circumnavigation Expedition.