Five-member ensemble wave forecast for the R/V Mirai 2023 Arctic Ocean expedition using different sea ice forcing

Takehiko Nose[1], Takuji Waseda[1], Tsubasa Kodaira[1], and Xingkun Xu[1]
[1]*Graduate School of Frontier Sciences, The University of Tokyo*

We have delivered wave forecasts for annual R/V Mirai Arctic Ocean expeditions since 2019 to support the onboard observation scheduling and to ensure safe working conditions for crew members. For example, major deck operations are prohibited when wave height and wind speed exceed 2 m and 10 ms^{-1}, respectively. The wave predictability, however, is strongly affected by the sea ice forcing representation, which has considerable uncertainty (Nose et al., 2020, 2023). As a result, the interpretation of wave forecasts has not been straightforward (especially based on the feedback from the R/V Mirai 2022 Arctic Ocean expedition).

To evaluate the uncertainty of the wave forecasts, we developed an ensemble wave forecast system for the R/V Mirai 2023 Arctic Ocean expedition (MR23). The ensemble system uses 5 members to produce the prediction spreading, and the spreading is produced simply by changing the sea ice concentration and thickness forcing in the wave model that simulates wave attenuation due to sea ice. The sea ice forcing used are as follows:

1. AMSR2 JAXA data set (thickness is set at a constant thickness of 0.5 m and the sea ice conditions are unchanged for the 5-day forecast)
2. IcePOM sea ice forecast produced by the Arctic Sea Ice Information Center and shown in VENUS (2023).
3. RIOPS sea ice forecast produced by The Canadian Centre for Meteorological and Environmental Prediction.
4. neXtSIM sea ice forecst produced by the Nansen Environmental and Remote Sensing Center (NERSC).
5. TOPAZ4 sea ice forecast produced by the NERSC and Norwegian Meteorological Institute.

Despite the small number of ensemble members, the large difference in the sea ice field representations among the sea ice observation and models produces large wave height forecast uncertainty. Since the difficulty of data assimilation is identifying the uncertainty, the analysis of the MR23 ensemble forecast system may lead us to implement a simple assimilation scheme. By implementing the data assimilation scheme, we can learn how the ice field should be corrected (e.g., which parameters can be corrected to improve the wave model predictions, ice edge location, 0.5 sea ice concentration contours?). What we need now is the true wave field, which is usually obtained using the altimeter wave height, SAR data, and the buoy data. We present the overview of the ensemble forecast system and update the MR23 wave buoy observations for possible benchmarking of the wave forecast.

References

Nose T., Rabault J., Waseda T., Kodaira T., Fujiwara Y., Katsuno T., Kanna N., Tateyama K., Voermans J., and Alekseeva T. 2023. A comparison of an operational wave-ice model product and drifting wave buoy observation in the central Arctic Ocean: investigating the effect of sea ice forcing in thin ice cover, Polar Research, 42, 8874, http://dx.doi.org/10.33265/polar.v42.8874

Nose T., Waseda T., Kodaira T., and Inoue J. 2020. Satellite retrieved sea ice concentration uncertainty and its effect on modelling wave evolution in marginal ice zones. The Cryosphere, 14, 2029–2052, https://doi.org/10.5194/tc-14-2029-2020

VENUS 2023, https://ads.nipr.ac.jp/venus.mirai/#/mirai

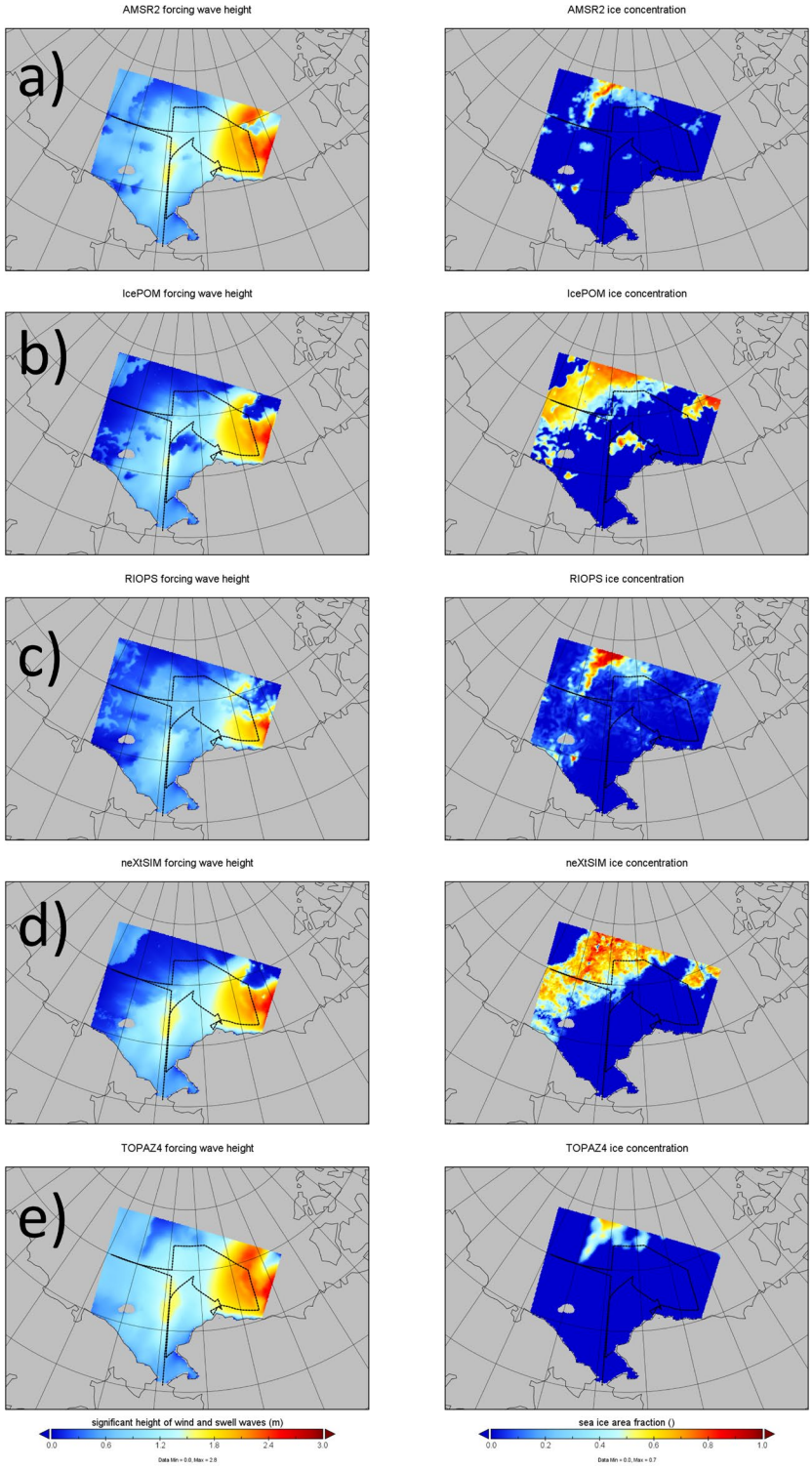

Figure 1. Wave height (left column) and sea ice concentration (right column) distribution for 29 Aug 2023 for a) AMSR2 b) IcePOM, c) RIOPS, d) neXtSIM, and e) TOPAZ4. The black dotted line is the planned MR23 track.