SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2020
Project Title:	Towards a coupled atmosphere-wave-seaice-ocean high resolution Arctic forecasting system
Computer Project Account:	spnomuel
Principal Investigator(s):	Dr. Malte Müller
Affiliation:	Norwegian Meteorological Institute
Name of ECMWF scientist(s) collaborating to the project (if applicable)	n/a
Start date of the project:	1/1/2020
Expected end date:	31/12/2022

Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	n/a	n/a	7000000	2246487
Data storage capacity	(Gbytes)	n/a	n/a	20000	80000

Summary of project objectives (10 lines max)

The main objective of the project is to advance short-range forecast capabilities of weather, waves, ocean, and sea-ice, by coupling model components in an physically consistent and operationally efficient way. The (stand-alone) forecasting systems for weather (AROME-Arctic), waves (WAVEWATCH III), ocean and sea-ice (CICE-ROMS) are utilized in a configuratiion for the European Arctic domain. The model system components will be coupled by utilizing the OASIS-MCT coupler (*Voldoire et al. 2017)*. Verification methods based on in-situ and satellite observations for all model components are developed (*Müller et al. 2017, Melsom et al. 2019, Bohlinger et al. 2019*).

Summary of problems encountered (10 lines max)

n/a

Summary of plans for the continuation of the project (10 lines max)

Further developments and model experiments are planed in order to simulate the complex intereactions between the waves, sea-ice, and atmosphere within the Marginal Ice Zone.

List of publications/reports from the project with complete references

Løken, T.K., J. Rabault, E.E. Thomas, M. Müller, K.H. Christensen, G. Sutherland, and A. Jensen (2020) A comparison of wave observations in the Arctic marginal ice zone with spectral models. *submitted to 25th IAHR Symposium on Ice Conference Proceedings.* https://arxiv.org/abs/2003.09472

Summary of results

1. Evaluation of the impact of sea-ice leads on weather forecast uncertainities.

A 10-member ensemble simulation with the operational weather model setup AROME-Arctic (*Müller et al. 2017*) has been performed for a 3 week period in March 2018. These ensemble forecasts have been utilized to force the sea-ice lead resolving model nexSIM. The high-resolution sea-ice fields are then, in turn, used as boundary condition to the AROME-Arctic model system (weakly coupling). The ensemble simulations have been produce on the ECMWF HPC and are currently transferred to the local cluster of MET Norway. In the second half of 2020 these simulations will be analysed with a focus on the impact of sea-ice leads on weather forecast uncertainties.

2. Towards full coupling of atmosphere, waves, and sea-ice.

A. A fully coupled AROME-Arctic – WAVEWATCH III simulation has been produce for September 2018 to compare against waves-in-ice field observations. In this model setup the sea-ice concentration is not simulated by a numerical model, instead intialized by the sea-ice fields from ECMWF IFS. The first results show that the waves are realistically damped within the sea-ice (*Løken et al. 2020*). The goal is to tune the attenuation of waves in the coupled model system.

B. A fully coupled AROME-Arctic – WAVEWATCH III simulation has been started for Jan/Feb, 2020 to perform a statistical assessment of the skill of weather and wave prediction in the coupled model framework. It is the first longer simulation performed by this coupled model setup. The goal ist to qualify the model setup as an operational model system at MET Norway.

References

Bohlinger, P., T. Economous, Ø. Breivik, M. Müller (2019) A novel approach to computing super observations for probabilistic wave model validation. Ocean Dynamics, accepted

Løken, T.K., J. Rabault, E.E. Thomas, M. Müller, K.H. Christensen, G. Sutherland, and A. Jensen (2020) A comparison of wave observations in the Arctic marginal ice zone with spectral models. *submitted to 25th IAHR Symposium on Ice Conference Proceedings.* https://arxiv.org/abs/2003.09472

Melsom, A., C. Palerme, M. Müller (2019) Validation metrics for ice edge position forecasts. Ocean Sci. Discussions, 15, 615-630,

Müller M., Y. Batrak, J. Kristiansen, M.Ø. Køltzow, G. Noer, A. Korosov (2017b) Characteristics of a convective-scale weather forecasting system in the Arctic, Mon. Wea. Rev., 145, 4771–4787. Seity et al. (2011) The AROME-France convective-scale operational model, Mon. Wea. Rev., 139, 976-991. Süld, J.K, A. Rasheed, J. Kristiansen, Ø. Sætra, A. Carrasco and T. Kvamsdal, (2015): Mesoscale numerical modeling of ocean-atmospheric interactions. Energy Procedia, 80, 433-441.

Voldoire et al. (2017) SURFEX v8.0 interface with OASIS3-MCT to couple atmosphere with hydrology, ocean, waves and sea-ice models, from coastal to global scales. Geosci. Model Dev., 10, 4207-4227.