EPICA

Eddy Properties and Impacts in the Changing Arctic

Principal investigator

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Areas of contribution

Oceanic processes
Modelling and forecasting
Observations
Outreach

Summary

Mesoscale and submesoscale eddies are important features of the climate system that contribute to shaping the hydrography of the Arctic Ocean and influencing other components of the climate system. However, their properties and precise roles in different regions of the Arctic Ocean are still poorly understood, with serious implications for our understanding of the Arctic Ocean dynamics and the realism of eddy parameterizations in climate models. It can be argued that our current knowledge is limited by the shortness and incompleteness of the observational record; and by computational challenges in carrying out eddy-resolving simulations. The proposed project will combine the high-resolution modelling capabilities offered by the multiresolution Finite volumE Sea ice-Ocean Model (FESOM) with the unique year-round data collected during the MOSAiC campaign. The combination will significantly advance our understanding of the dynamics and role of mesoscale and submesoscale eddies. The resolution of the global model will be increased to 1 km in the whole Arctic Ocean to resolve mesoscale eddies in the main Arctic basins, and further refined to sub-kilometer scales at the MOSAiC sites to capture submesoscale features. The evaluated eddy-resolving configuration is a preparation for the next generation of kilometre-scale climate-model projection and coupled-model prediction; in addition, effective eddy diffusivities will also be derived from the eddy-resolution simulations, which can be used to
improve the fidelity of current coarse climate models.

**Description**

Mesoscale and submesoscale eddies are important features of the climate system that contribute to shaping the hydrography of the Arctic Ocean and influencing other components of the climate system. However, their properties and precise roles in different regions of the Arctic Ocean are still poorly understood, with serious implications for our understanding of the Arctic Ocean dynamics and the realism of eddy parameterizations in climate models. It can be argued that our current knowledge is limited by the shortness and incompleteness of the observational record; and by computational challenges in carrying out eddy-resolving simulations. The proposed project will combine the high-resolution modelling capabilities offered by the multiresolution Finite volumE Sea ice-Ocean Model (FESOM) with the unique year-round data collected during the MOSAiC campaign. The combination will significantly advance our understanding of the dynamics and role of mesoscale and submesoscale eddies. The resolution of the global model will be increased to 1 km in the whole Arctic Ocean to resolve mesoscale eddies in the main Arctic basins, and further refined to sub-kilometer scales at the MOSAiC sites to capture submesoscale features. The MOSAiC data will be used to determine whether at these model resolutions we are able to reliably simulate the observed eddy properties and variability; the model results will be used to synthesize the rich MOSAiC observations. We will study processes forming (sub)mesoscale eddies, quantify eddy-induced fluxes of salt, heat and momentum, and distinguish ocean internal variability from forced variability. We will also explore processes of eddy generation in the vicinity of sea ice leads, which emerge in high-resolution simulations at the km-scale, along with their effects on ocean restratification and air-sea exchange. The evaluated eddy-resolving configuration is a preparation for the next generation of kilometre-scale climate-model projection and coupled-model prediction; in addition, effective eddy diffusivities will also be derived from the eddy-resolution simulations, which can be used to improve the fidelity of current coarse climate models.

**Timeline**

2021-01-01 - 2023-12-31

**Regional emphasis**

Northern hemisphere: Yes

Southern hemisphere: No

**Key project deliverables**

Filling the gap in the understanding of the role of Arctic Ocean eddies for the ocean and air-sea exchange in the changing Arctic;
A unique model data set from a 1-km Arctic;
An evaluated global ocean model with 1-km Arctic that can be used in new-generation coupled models for Arctic prediction and climate projection;
Improved eddy parameterization with diffusivity derived from the eddy-resolving simulations

Data management

DKRZ

Is data provided to WMO Global Telecommunication System

No