DESCRIPTION FOR THE GENERAL PUBLIC

The global climate is changing. These changes involve all components of the Earth's system and all parts of the world, but through a number of feedback loops they are particularly strong in the polar regions of both Hemispheres. One of their symptoms are recently observed trends in the sea ice extent, hotly debated among scientists and the general public alike.

Whereas sea ice plays a crucial role in shaping the weather and climate of the polar and subpolar regions, our understanding of its physics and dynamics is still far from satisfactory. Sea ice is extremely complex and heterogeneous and may take several different forms depending on its age, formation conditions and history – from a slushy mixture of crystals with water, through collections of separate ice floes, up to a thick, continuous layer delineated by narrow deformation zones. Moreover, sea ice is constantly interacting with the upper layer of the ocean and the lower layer of the atmosphere, both modifying and being modified by processes taking place there. An extremely wide range of scales is involved, from sub-meter up to hundreds of kilometers. An important – and very hard to answer – question is if, and how, small-scale processes affect those at regional or even global scale.

Fig. 1. Fragment of a satellite image showing the marginal ice zone east of Greenland, with eddies of various sizes, revealing complex ocean dynamics.

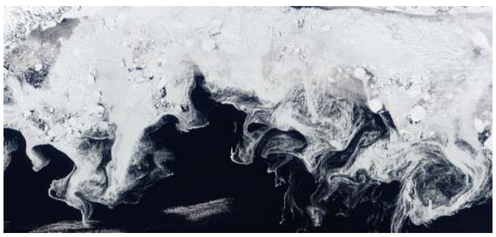
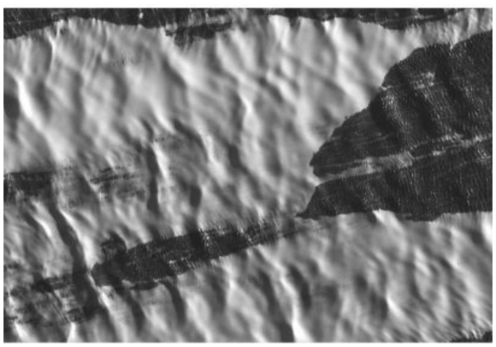


Fig. 2. A very-high resolution (pixel size: 60 cm) image of the sea surface in Terra Nova Bay polynya (Ross Sea) during sea ice formation. Note very different properties of waves in ice-covered and ice-free regions.



The goal of this project is to improve our understanding of selected aspects of sea ice interactions with the ocean and atmosphere. We are going to focus on processes that are related to turbulence in the surface layer of the ocean. Two situations are particularly interesting from this perspective: the so-called marginal ice zone (MIZ; Fig. 1), a highly dynamic part of the ice cover neighboring the open ocean; and coastal polynyas (Fig. 2), open-water regions created by very strong and cold offshore winds around the continent of Antarctica (and, less frequently, in the Arctic). These two situations, and locations where they occur, are very different – and yet they share several common features, one of which is the importance of turbulent mixing. In the MIZ, turbulence under the rough lower surface of the ice leads to dissipation and thus attenuation of waves entering from the open ocean. In polynyas, turbulence mixes the newly forming ice crystals deep into the water column, prohibiting it from accumulating at the surface and from isolating that surface from the atmosphere – thus increasing the total sea ice production.

In our project, we are going to study those (poorly known) processes in the lab, as well as with numerical models. The core of the project are experiments at the Scripps Ocean–Atmosphere Research Simulator (SOARS), an innovative, unique research facility at the Scripps Institution of Oceanography (San Diego, California, USA). It combines a wave tank wind a wind tunnel, and, crucially, allows generating turbulent conditions with steep, breaking waves, wind speeds up to 25 m/s and air temperatures as low as –20°C. We will use SOARS to collect data on sea ice formation, water–atmosphere heat exchange, turbulence, wave propagation, and several other quantities, and use that data to formulate better models of the processes of interest.

All in all, in a wider perspective, the new insights into ocean–sea ice–atmosphere interactions gained in this project will contribute to more reliable models of polar and subpolar regions, and thus also to better weather and climate predictions, both global and regional.