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.

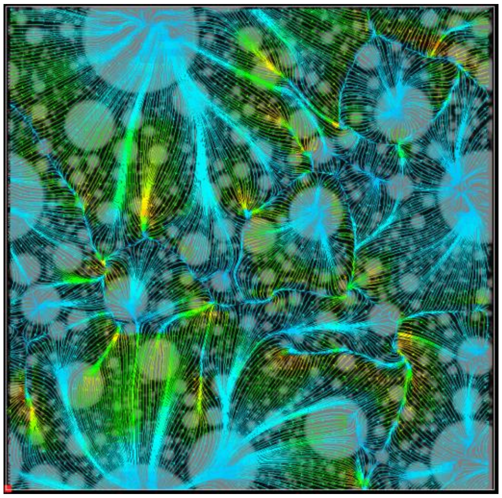

Fig. 1. Convective motion in the atmosphere over a set of round sea ice floes (seen in the background). Lines show trajectories of air motion at the surface, with color indicating wind speed. Note narrow air streams originating from the centers of large floes. (Results of a high-resolution numerical weather model)

Fig. 2. Frazil streaks in the Terra Nova Bay, Antarctica. Note different appearance (and roughness) of the sea surface within and between areas of high ice concentration (Photo courtesy Stephen Ackley, PIPERS Programme)

The goal of this project is to improve our understanding of sea ice interactions with the ocean and atmosphere at the level of individual ice floes. We are going to study how the lower atmosphere responses to local heating and moistening that takes place over cracks and other open water areas in sea ice (even though the water is close to freezing, it is warm compared to the surrounding ice surface, leading to convective motion in the overlying air; see Fig. 1). To achieve this, we are going to measure air temperature, humidity and motion with drones (or UAVs, Unmanned Aerial Vehicles), as well as to use high-resolution numerical weather modelling to understand relationships between the relevant variables. Another aspect of interest in our project are interactions of sea ice with waves. Again, they have mutual character: on the one hand, waves bend and, if they are sufficiently steep, break the ice, on the other hand, the sizes of ice floes influence the dissipation of wave energy, and thus decide how far into the ice cover the waves can propagate. Yet another example of ocean–sea ice–atmosphere interactions takes place during initial phases of ice formation, when small ice crystals gradually accumulate on the sea surface, forming very characteristic, elongated streaks (Fig. 2) with high apparent viscosity and surface roughness. They are formed by turbulent motion in the ocean, but at the same time change properties of that motion, as well as that of the overlying atmosphere.

All in all, identifying effects of floe-scale processes that are significant at larger scales and including them in climate models will allow us to produce better, more reliable climate predictions, both global and regional. The results of this project should bring us a few steps closer to achieving this goal.