ARCTIC 2022 – IMPLEMENTED PROJECTS

Drone Experiment for Sear Ice Retrieval (DESIR)

PI, LEAD INSTITUTION

Dr Sara Fleury, LEGOS/OMP, FR

ABSTRACT

The Arctic ice pack is a major witness and actor of global warming. In fact, since the end of the 1970s, space imagery has measured the dramatic decrease in its surface area. This decrease, which is particularly marked in summer, has resulted in an increase in the absorption of solar energy by the ice-free ocean. Indeed, while the ice, because of its albedo, reflects nearly 80% of the energy back into space, the ocean absorbs most of the solar energy (about 90%), thus accelerating the melting of the ice pack. This positive feedback, or vicious circle, explains most of the Arctic Amplification, i.e. the 2 to 3 times faster warming of the Arctic compared to the rest of the globe.

Thus, weather and climate models must include a model of the pack ice for their short- and long-range forecasts. These models are fed by atmospheric, oceanic and pack ice observations. It is now possible to observe the extent of the ice pack on a daily basis by means of satellites. But unfortunately this extension does not allow us to characterise the state of the ice pack and its future. For this, it is essential to know its thickness. Indeed, thin ice will not be able to withstand heat waves or storms, unlike thick pack ice. It has been demonstrated in various recent publications (Blockley 2018, Allar 2019, ...) that thickness observations can extend the prediction of pack ice extension from a few days to a few months.

Thanks to the launch of the CryoSat-2 space altimeter in 2010, we can now measure the thickness of the ice pack. The method consists of measuring the height of the ice and the height of the surrounding water in the ice fractures. The difference between these two heights gives us the freeboard of the ice (the part above the surface). From the relative densities of the water and ice and the law of hydrostatic equilibrium we can deduce the thickness of the ice pack.

Unfortunately the operational implementation is still delicate because of various sources of uncertainties, in particular the effects of ice roughness on the measurements and the effects due to the presence of snow on the ice.

The development of this method requires numerous observations in the field, in particular of thickness, in order to calibrate the spatial measurements. Unfortunately, these measurements are very difficult to obtain and to date

they are not sufficiently representative of the different types of ice that can be encountered over the entire Arctic basin all over the seasons.

Indeed, the means required to carry out this type of observation are extremely heavy. They require airborne deployments or heavy instrumentation such as the installation of moorings under the ice or the placing of buoys on the ice. Moreover, these techniques only allow point measurements in time (e.g. airborne) or space (e.g. moorings).

This is even more obvious in Antarctica. This is why the ASPECT project was set up in 1996. This project consists of asking any scientist who has the opportunity to sail in the southern pack ice to visually estimate the thickness of the pack ice from the deck of the boat and to transmit these observations to the project. While these measurements, for lack of better, are very useful, they lack precision.

However, thanks to the popularisation of drones and the miniaturisation of instruments, we are now able to make altimetric measurements using lidars carried by drones.

The aim of this project is to demonstrate the feasibility of this approach for measuring the thickness of the ice pack from ships.

The equipment required is relatively light, as the sensor weighs only a few hundred grams.

It can therefore be carried by a quad-rotor drone of relatively modest size and weight. On the other hand, the conditions of measurements being delicate, they require for this experimental phase the presence of an experienced pilot at the scientist's side.

This experimental phase also requires the ability to validate the measurements made by the drone. We therefore hope, thanks to this cruise, to be able to carry out alternative measurements, in particular thanks to the EM and Acoustic doppler Ice thickness measurement (SIMS, developed by C. Haas - whom we know well) and other Ice Load Monitoring System that could be available. We would also be very interested in snow depth measurements if possible. And of course by all the meteorological and oceanographic parameters (including salinity) which allow us to better characterise the ice and its possible snow cover.

In order to cover a maximum of pack ice types off the coast (the most difficult to observe and where space altimetry works best) we would like to embark on a North Pole expedition as early as possible in the summer season. This is why we have chosen the cruise of 08/07/2022. But other options can be considered depending on availability as we are interested in all types of ice floes.