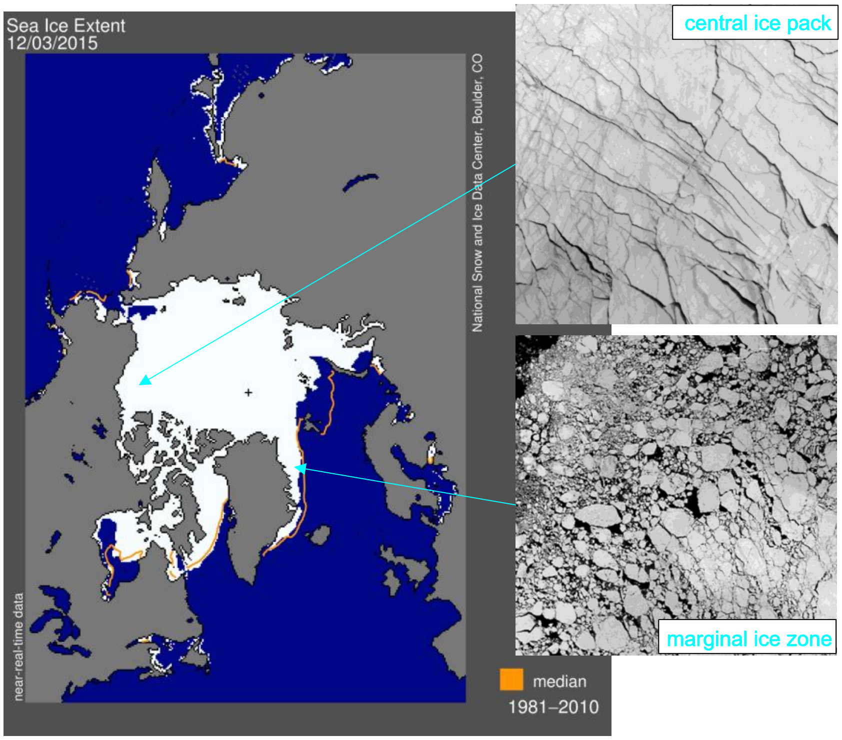
## DESCRIPTION FOR THE GENERAL PUBLIC

The global climate is changing. These changes involve all components of the Earth system and all parts of the world, but through a number of feedback loops they manifest themselves particularly strong in the polar regions of both Hemispheres. One of their symptoms are recently observed trends in the sea ice extent (negative in the Arctic, positive in the Antarctic) which are 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. Severe environment, making direct observations challenging, definitely is one of the reasons, but more importantly, 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 (see figure to the left). An extremely wide range of scales is involved, from sub-meter up to hundreds of kilometers. The large scale properties of sea ice, relevant for climate models, emerge as a complex result of processes and interactions taking place at smaller scales. The goal of this project is to improve our understanding of sea ice dynamics at the level of individual ice floes. As wind, waves and currents act on sea ice, the floes interact with each other and new floes are formed by breaking or freezing. In particular, close to the ice edge, in a region called the marginal ice zone (MIZ), sea ice is broken by waves, which in turn are affected by the ice. Many aspects of these processes have been only basically studied. One of the main goals of this project is to develop theoretical models of sea ice–waves interactions and to implement them in a numerical model of sea ice. This model – called DESIgn (for *Discrete-Element bonded-particle Sea Ice model*) – has been developed in recent years by the Principal Investigator of this project to enable simulations of very large numbers of individual ice floes and it already proved useful in explaining some of the phenomena commonly observed in MIZ, like for example `herding' of ice floes on the sea surface, or intermittent character of stress in the ice. Implementing new features in the model will extend its range of applicability. In particular, the goal is to apply DESIgn to study the details and reveal the causes of one of the most spectacular sea ice fracturing events in the recent years, which happened in the Beaufort Sea in winter 2013 (see http://earthobservatory.nasa.gov/IOTD/view.php?id=80752 for images and animations). Finally, a whole group of tasks in the project is related to the analysis of how the degree of fragmentation of the sea ice cover influences the processes in the upper ocean and the lower atmosphere.




*Sea ice extent in the Arctic on 3 Dec 2015 and satellite images showing typical forms of sea ice in the central ice pack and in the marginal ice zone. (Sea ice extent map: National Snow and Ice Data Center, nsidc.org; upper image: AVHRR; lower image: Landsat.)*

All in all, identifying those emergent 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.