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The increase of the length of the ice-free season in the Arctic

J. Rodrigues

Department of Applied Mathematics and Theoretical Physics, University of Cambridge (jmr64@cam.ac.uk/+441223765900)

A study of the sea ice concentrations obtained by passive microwave satellite imagery during the 1979-2007 period reveals remarkable changes in the sea ice cover of the Arctic Ocean and almost all Arctic seas, notably the unprecedented depletion of sea ice that occurred in the summer of 2007.

While the total sea ice extent and area and their changes in the past few decades have been extensively discussed in the literature, much less attention has been devoted to the length of the ice-free season. Yet, it can be argued that the latter is a more convenient variable to quantify the evolution of the sea ice cover. Firstly, the sea ice extent and area are global variables while the length of the ice-free season is a local one, and thus more appropriated to study locally the variation of the ice cover e.g. in a small region such as narrow strait (which occupies one or only a few pixels in the usual 12.5 or 25km grids). Secondly, while the ice extent or area must be calculated, say, for each month of the year (for instance by averaging the daily ice extents or areas over one month), the length of the ice-free season has one single value for each year for each point, thus being more representative of the ice situation in a certain year than the usually quoted Summer minimum or Winter maximum.

After giving the rigorous definition of length of the ice free season, and explaining how it can be extracted from the sea ice concentration files archived and distributed by the NSIDC, we proceed to calculate this quantiy for each point of the Northern Hemisphere for each year between 1979 and 2007. We consider 84 subregions of the Arctic and discuss the evolution of the length of the ice-free season in each of them.

We show, for instance, that 2007 was the longest ice-free season in many parts of the Arctic Ocean, in all sectors of the Russian Arctic, in the Beaufort Sea, in most of the channels of the Canadian Archipelago that form variants of the Northwest Passage, in the Baltic Sea and in the Gulf of Bothnia. We identify the regions of the Canadian Arctic that until recently were ice-covered essentially all year round, and now enjoy considerable ice-free periods, examples of which are Viscount Melville Sound and McClure Strait.

We compute the average increase in the number of ice-free days in each region in the past 29 years. We find, for example, that the length of the ice-free season in the Russian Arctic increased, on average, at a rate of 1.7 days per year between 1979 and 2006; in 2007, however, the average ice-free season was 18 days longer than in 2005 and 2006.

In conclusion, we believe that our work not only provides an alternative description (to the one based on ice extent that is usually presented) of the evolution of the Arctic sea ice cover in the recent decades but that it can be used in future assessments of the navigational conditions in shipping routes such as the Northern Sea Route and the Northwest Passage, and of the access to natural resources in the Arctic.