Regional Arctic sea ice predictability and prediction on seasonal to interannual timescales

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Abstract- *The fast depletion of the Arctic sea ice extent observed during the last three decades has awakened concerns about the consequences of such changes at hemispheric scales, and opened socio-economic opportunities such as maritime transport. This PhD project aims at investigating the sources of predictability and prediction skill of Arctic sea ice conditions at the regional scale. The first months have been dedicated to the investigation of the mechanisms behind the development of model systematic errors in seasonal regional predictions.*

I. Introduction

Over the last three decades (since the advent of satellite imagery), the Arctic sea ice extent has experienced a steady depletion by about 3% per decade [1]. Whereas the average September sea ice extent over the period 1979-2000 was estimated to be 7.04 million km^2, a record low of 3.41 million km^2 was reached on 18 September 2012 as reported by the National Snow and Ice Data Center (NSIDC).

Such a rapid sea ice decline is projected to accelerate in the coming decades, with a summer Arctic ice-free expected within the next 50 years [2]. Advanced knowledge about the potential opening of maritime routes such as the Northern Sea route (north of Russia) and the Northwest Passage (through northern Canada) could offer faster and cheaper shipping between the Atlantic and Pacific [3, 4].

Information on the marine accessibility of Arctic seas and the duration of the ice-free season in the marginal ice zone (MIZ) would allow planning of the exploitation of resources, ship supplies and fishing and hunting activities, which are of particular interest for the Inuit populations. The growing polar ecotourism industry could also benefit from sea-ice predictions.

II. Objectives

This project has mainly two objectives:

1. Investigating the sources and mechanisms of predictability of the Arctic sea ice at regional scale, including in some case studies. This objective could be divided into three different sub-objectives:
   A. Attribution of mechanisms leading to successful predictions of the regional Arctic sea ice conditions, which goes beyond most current studies focused on the global scale.
   B. Diagnosing potential causes for failures in predicting the Arctic sea ice conditions in some regions.
   C. Improving the representation of processes, as the sea ice deformation, by increasing the horizontal resolution for example.

2. Investigating the mechanisms for the development of model biases during the predictions.

This project will rely on two state-of-the-art forecast systems, EC-Earth and CNRM-CM.

III. First Results

Within the second objective, we have obtained initial results.

The PredEC2.3 is a retrospective seasonal prediction experiment which climate predictions have been initialized on 1st May and 1st November every year from 1979 to 2012. 5 members were run with the EC-Earth2.3 model for each startdate. We estimated the drift, i.e. the evolution of the prediction bias as a function of the forecast time, compared to the NSIDC observational data.

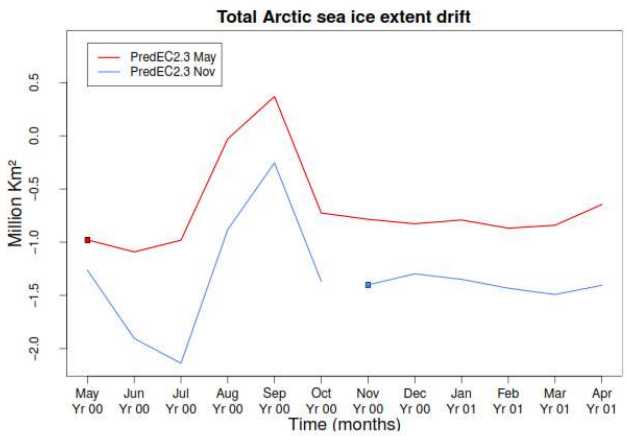

Fig. 1. Total Arctic sea ice extent prediction drift for the PredEC2.3 [illegible]) compared with the PredEC2.3 experiment initialized in November (in blue).

The evolution of the bias from one month to the following throughout the year is similar whether we initialize the forecast in May or November (Fig. 1). Looking at the total

Arctic sea ice extent drift for the November initialized experiment, we can note that there is an underestimation of 1.5 million km from November to May with respect to the observational data, which makes a larger bias by 0.5 million km compared to the May initialized forecast. Note also the higher underestimation during the summer.

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