Using numerical models to design the future Arctic observing system: insights from the APPLICATE project

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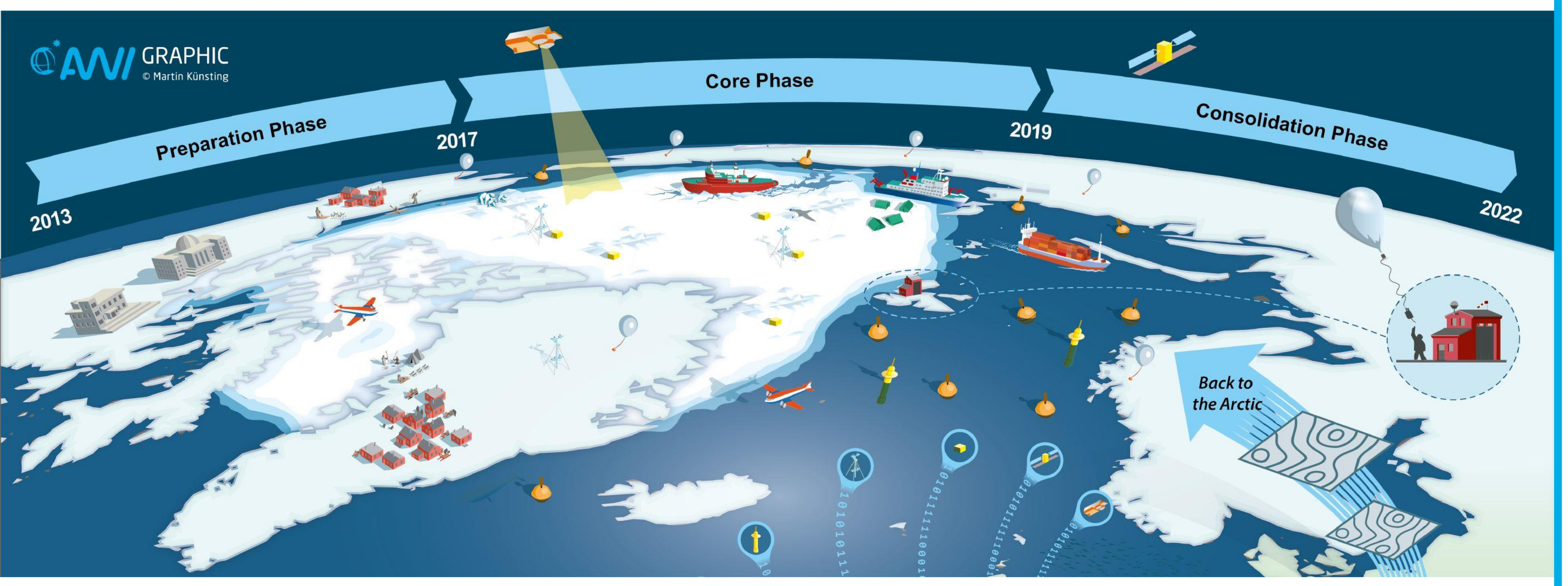
Context



Arctic observations are key to understand the fundamental nature of high-latitude climate variability, to initialize sub-seasonal to interannual environmental predictions and to evaluate weather and climate models. One of the grand objectives of APPLICATE is to **guide the development of future Arctic observing systems**. Specific scientific questions are:

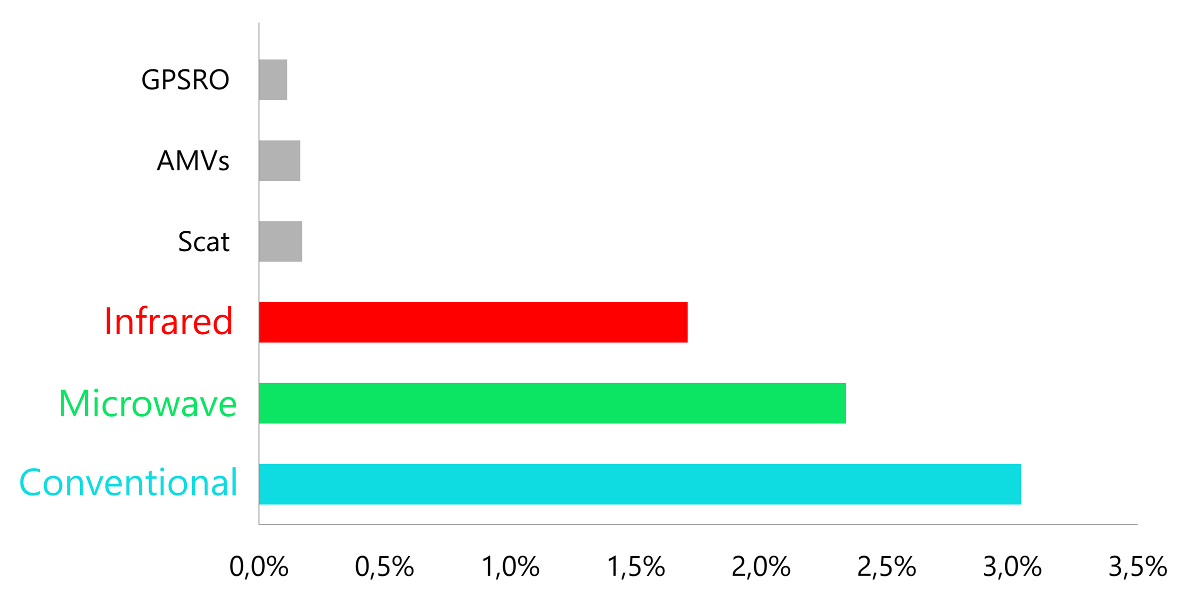
WHAT type of Arctic observations contribute to prediction skill in the Arctic and beyond? (sensitivity analyses)

WHERE should these observations **WHEN** be conducted? (network optimization)

HOW should these observations be used in weather and climate models? (data assimilation)

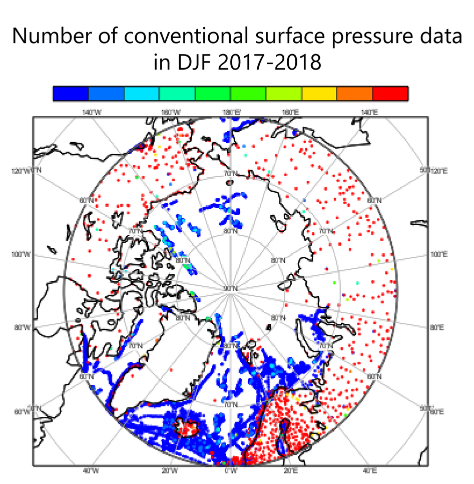
Here, we highlight with three examples how these questions can be addressed using state-of-the-art global weather and climate models.

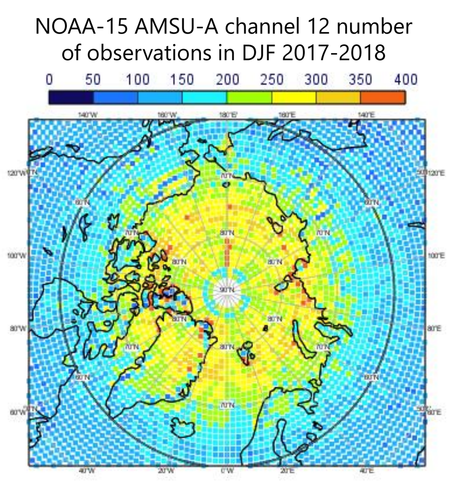
Example 1. Investigating the importance of specific types of observations for initializing Numerical Weather Prediction systems.



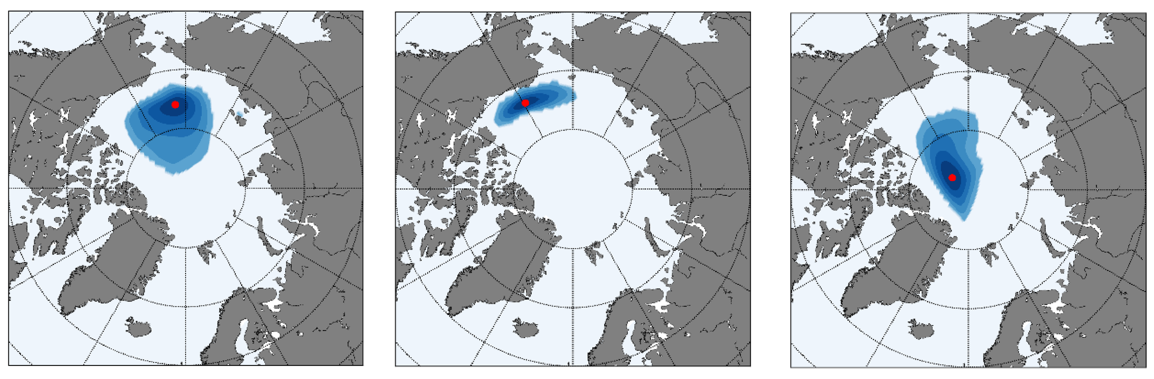
The Forecast Sensitivity Observation Impact (FSO: Cardinali, *Q. J. R. Meteorol. Soc.*, 2009; doi:10.1002/qj.366) estimates the individual contribution of a given type of Arctic (>60N) observation to the reduction of global short-range (24-hr, Z500) forecast error.

Conventional (synoptic, buoy, aircraft, …) data are key for weather prediction in winter. Despite a very good spatial and temporal coverage, satellite observations suffer from large errors due e.g. to the presence of mixed-phase clouds.



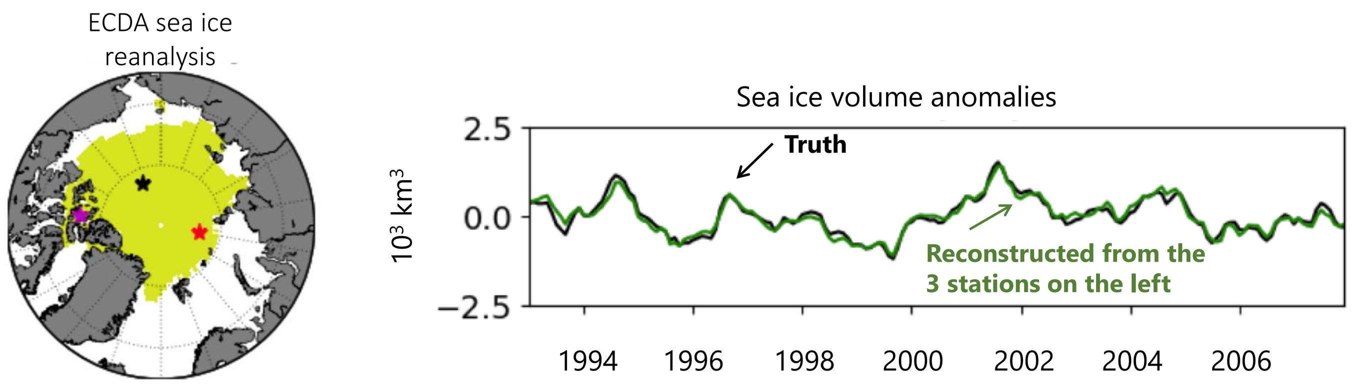


Example 2. Optimizing the sea ice thickness monitoring network



Area of influence for three selected points in the Arctic Basin, as estimated from the CESM-LE long pre-industrial control run (Kay et al., *Bull. Amer. Meteor. Soc.*, 2015; doi:10.1175/BAMS-D-13-00255.1). The area of influence is defined as the set of grid points for which sea ice thickness anomalies correlate at more than 1/e with the thickness anomalies at the red dot.

MSc thesis of G. Van Achter (2018)

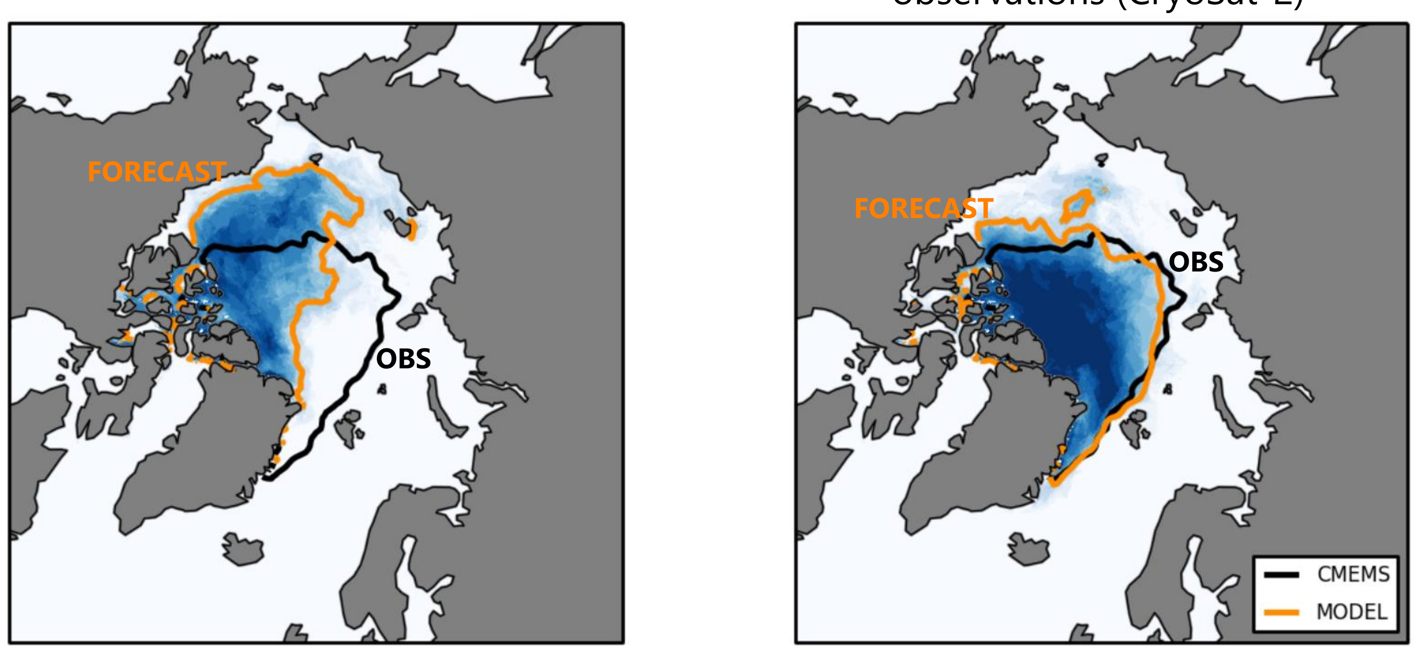


In a model world, it takes only a limited number of stations to reconstruct Arctic sea ice volume anomalies

Example 3. Assimilating sea ice thickness data for improved seasonal sea ice predictions

Summer Arctic sea ice prediction has been an area of intense research since 10 years, given the recent records of September sea ice extent and the growing interest for sea ice information a few months in advance. Early studies have suggested that the areal coverage of sea ice in September is largely determined by the late-spring sea ice thickness distribution. Initializing sea ice thickness has remained a challenge so far.

September 2012 sea ice concentration from the MetOffice GloSea forecast system, as forecasted from May 1st, 2012



Blockley and Peterson., *Cryosphere*, 2018 (doi:10.5194/tc-12-3419-2018)

About APPLICATE

APPLICATE (**A**dvanced **P**rediction in **P**olar regions and beyond: modelling, observing system design and **LI**nkages associated with a **C**hanging **A**rctic clima**TE**; www.applicate.eu) is an €8 million project financed by the EU HORIZON 2020 Research and Innovation programme. It involves **16 partners from nine countries** (Belgium, France, Germany, Iceland, Norway, Russia, Spain, Sweden and the United Kingdom) and is carried out over a period of four years (Nov 2016-Oct 2020). It has the goal to **enhance predictive capacity for weather and climate in the Arctic and beyond** and to determine the influence of Arctic climate change on **Northern Hemisphere mid-latitudes** for the benefit of policy makers, businesses and society.

You can follow the project evolution and achievements on www.applicate.eu and follow the Twitter account @applicate_eu.