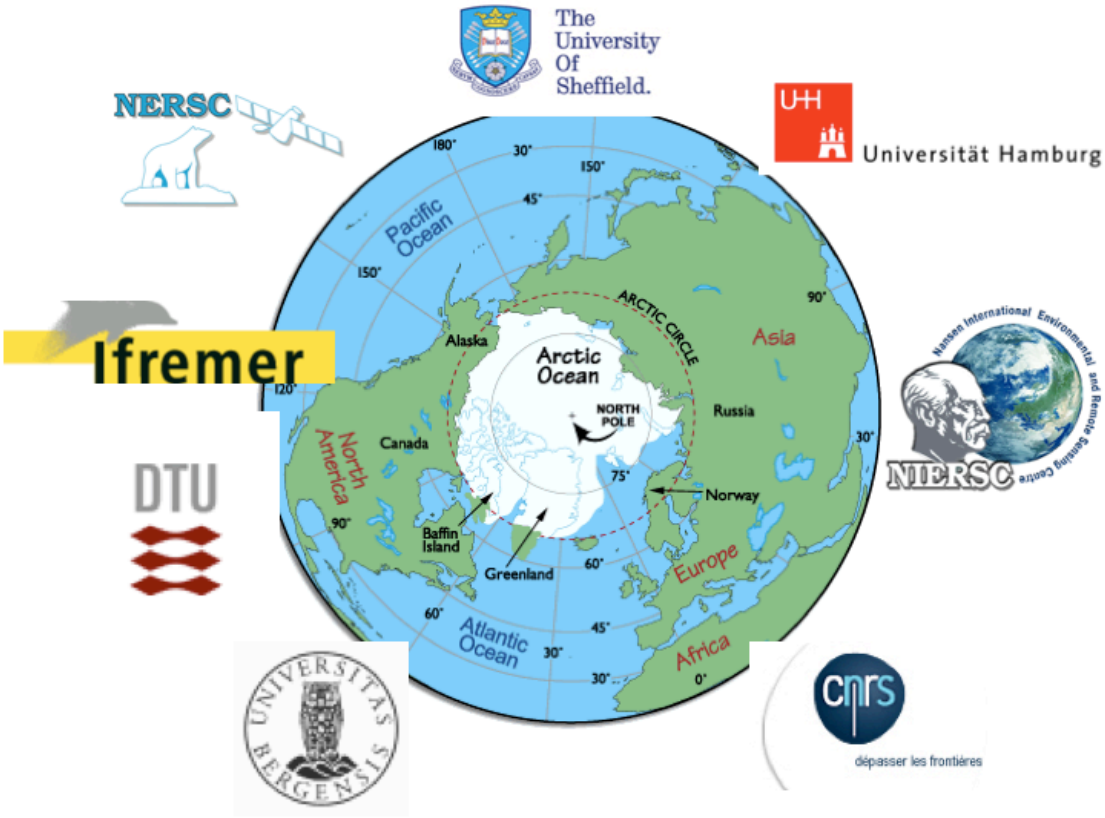

MONARCH-A

Collaborative Project

Deliverable 2.4.2 - Assessment of shortcomings that need to be improved through an Arctic Reanalysis.

Grant Agreement Number 242446

SEVENTH FRAMEWORK PROGRAMME

7th Framework Programme

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1. Deliverable in framework of MONARCH-A project

1.1 Main objectives of MONARCH-A project

The Arctic and northern hemisphere high latitude regions experience significant changes during past few decades, associated with climate change. Arctic itself is an important part of the climate system, and changes that occur in this region, in turn, influence the rest of the Planet.

Due to harsh environmental conditions and inaccessibility of some of the Arctic areas, especially during the winter, there is a lack of consistent historical and modern observational data. As a result, our understanding of Arctic climate related processes and ability to predict consequences of changes in this region for Europe is limited.

The ultimate objective of the MONARCH-A project is to provide the scientific community with subset of multidisciplinary Essential Climate Variables for the Arctic region. The information package will be based on generation of time series of observation datasets and reanalyses of past observational data enabling adequate descriptions of the status and evolution of the high latitude and Arctic region Earth system components.

1.2 WP 2.4 Assessing uncertainty of existing reanalyses and simulations over the Arctic

Despite its importance for processes related to global thermohaline circulation, Arctic Basin remains one of the most under-sampled regions of the World Ocean. Sea ice coverage limits access of research vessels and make it hard for satellites to measure characteristics of the upper ocean layers.

Moreover, available observations of ocean parameters are very sparse both spatially and temporally. On this basis it is hard to make solid conclusions about details of the large-scale circulation in the Arctic Ocean, and especially about its interannual and decadal variability.

One of the main goals of WP 2 (Changes in Sea Level and Ocean Circulation) is to provide dynamically consistent reanalysis of the Arctic Ocean over the last 50 years, allowing better understanding of water mass formation, circulation, sea level, sea ice extent and sea ice thickness changes in this region. It will also allow for detailed examination of the consistency between the steric height (vertical temperature and salinity effect), the mean sea surface height and the mean dynamic topography. In particular it is recognized that estimates of the mean sea surface change in the Arctic is challenging due to the presence of sea ice that limit the direct use of altimetry, while the mean dynamic topography is associated with significant uncertainties due to lack of data and adequate validation of models. However, the recent launches of the GOCE and Cryosat 2 satellite missions are very favourable for improving these conditions. As such, new observations of the marine geoid and sea ice freeboard height will allow for proper validations. In turn, more reliable estimation of the mean dynamic topography and mean sea surface height will be derived. Moreover, long time period of the reanalysis will also connect long-term Arctic Ocean variability with the IPY era, in particular when more observations are available.

1.3 D2.4.2 - Assessment of shortcomings that need to be improved through an Arctic Reanalysis

Over the last decade significant progress has been achieved in ocean data assimilation and data synthesis approaches in the ocean (sometimes also referred to as "reanalysis"). As a result, routine ocean synthesis are now feasible on a regular basis and are being performed over up to several decades for the global ocean, e.g., covering the period of the NCEP/NCAR and ECMWF/ERA/ERA Interim reanalysis since the early 50th. However, the high-latitude regions, especially the Arctic Ocean, are not well represented in these global ocean reanalyses. This is the target of the MONARCH-A WP 2.4 reanalyses.

Most of the data available over Arctic region do not have the same quality as is usual for other regions of the World Ocean. As emphasized above, the quality and availability of satellite altimetry is hampered by sea ice, and not available at all above 82°N for radar altimetry. Furthermore, variability in the storm track causes variations both in the local marine and terrestrial climates and is a major cause of variability in Arctic marine ecosystems at seasonal to decadal time scales. However, the atmospheric wind forcing models are not fully manifesting this. Satellite wind field retrievals for the high latitude and Arctic regions from the last 15-20 years is therefore potentially a very valuable source of information for looking at the role of extremes on seasonal-to-interannual scales.

Assessing a high-quality in situ data base for the Arctic is also a major challenge. A second important objective is, therefore, to assess the quality of all available historical data in the Arctic region during the last 30-50 years. Since, most of the data will be incomplete in both spatial and temporal coverage and often are not overlapping it will be important to use models for their interpretation, such as carried out and reported in D2.4.1.

2. Conclusion

The results of the exploitation and analyses of several existing long-term simulations of the Arctic Ocean delivered in D2.4.1 will allow us to evaluate the quality of recent simulation products provided by a range of ocean models forced only by atmospheric forcing, without data assimilation. This will furthermore be combined with important new input from D2.2.1, D2.2.2 and D2.2.3 on the improved estimates of the mean sea surface and its annual to decadal variability together with improved determination of the mean dynamic topography. In turn, the main challenges and specific need for further advances can adequately be identified (at month 18). Moreover, this will ease the choice of model setup for the data assimilation during the reanalysis to estimate the state of the Arctic Ocean over the last 50+ years, such as:

- model domain;
- resolution of eddy and boundary current processes;
- choice of covariances in assimilating observations;
- critical levels of data availability and density (e.g. Argo); relative value of different satellite and in-situ data sources in constraining the ocean circulation estimates;
- relative value of availability of reliable freshwater runoff data from the major rivers around the Arctic rim.

Finally, whenever possible, we will compare and validate the results with the best available observations not used in the reanalyses.