Norwegian Meteorological Institute

WP 4
Testing Arctic sea ice predictability in NorESM

Jens Boldingh Debernard

SSPARSE Kick-off meeting

08.11.2016

Background

- Inherent coupled problem
- Time-frame relevant for a global feedbacks.
- Possible teleconnections from autumn sea ice minimum to Eurasia winter circulation.

- Goal: To study in detail the possibility for teleconnections and feedbacks associated with the changes in the sea ice cover that we loose in the regional ice-ocean model.

Norwegian Meteorological Institute

NorESM

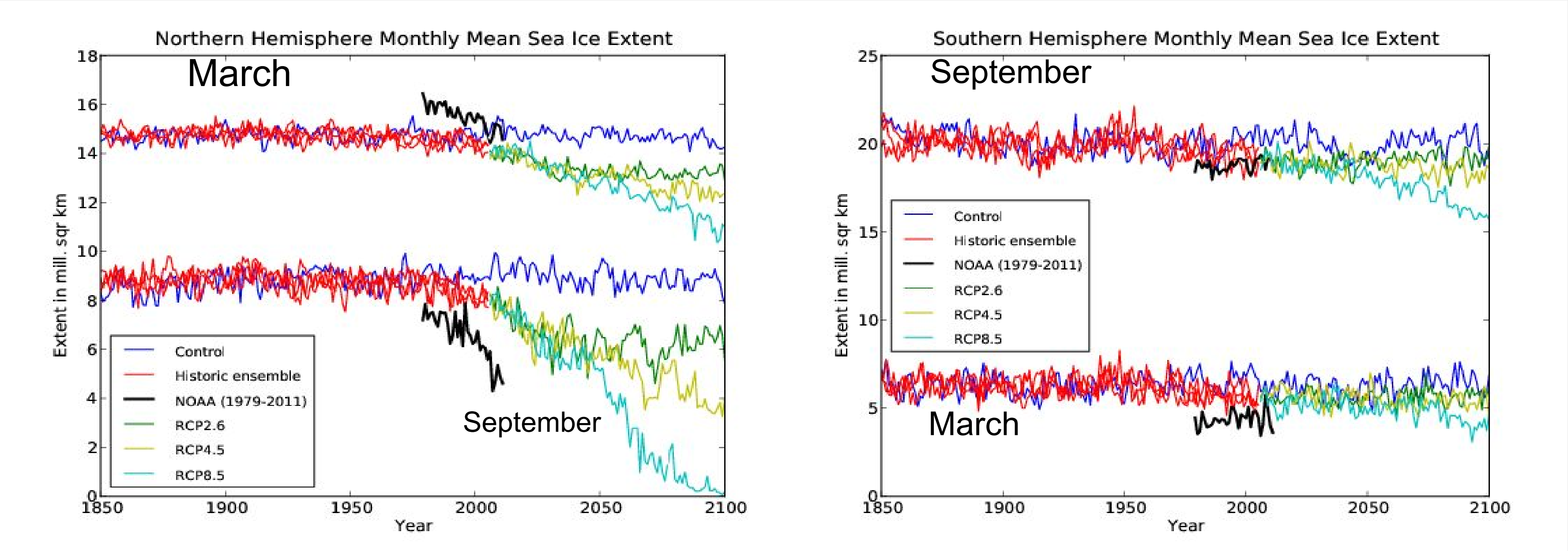
- State of the art CMIP-type climate model.
- Based on the CESM family of models from NCAR with changes.
    - Ocean component replaced with an isopycnic-coordinate model based on MICOM.
    - HAMOCC ocean carbon cycle model.
    - CAM-Oslo life-cycle scheme for aerosols.
    - Different tuning and possible different configuration options than used in CESM.

Present and planned NorESM-versions

- NorESM1-M (2deg atm, 1deg ocean-ice, CMIP5 version with bug-fixes)
- NorESM-Happi (version used in HAPPI-MIP; NorESM1-M with refinements from different EU-projects like ACCESS; 1deg atm, 1 deg ocean-ice)
- NorESM2-LM (CMIP6 version, not ready …)
- NorCMP (NorESM1-M based climate prediction model equipped with the Ensemble Kalman Filter (EnKF) system assimilation techniques

- NorESM1 versions are based on CICE4, NorESM2 will use CICE5

Sea ice extent from NorESM1-M CMIP5 runs and observations

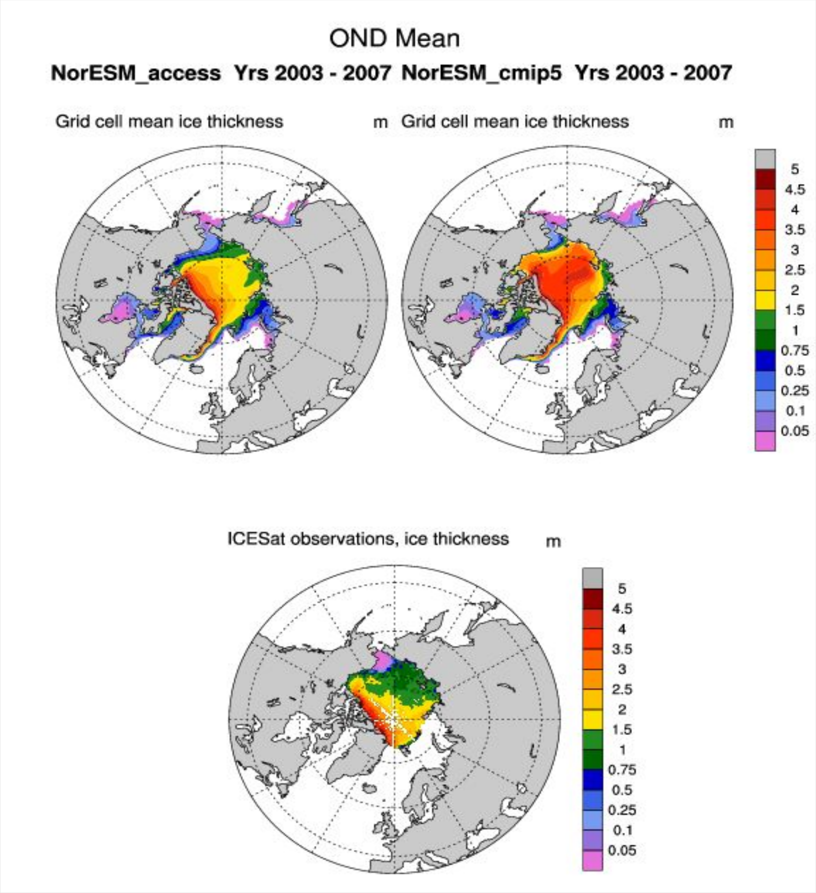


- A little too small extent in HN winter (due to too warm Labrador Sea).
- Too large extent in NH summer, and too slow decline compared with observations.
- Too thick and extensive summer ice extent in SH (too much multi year ice).

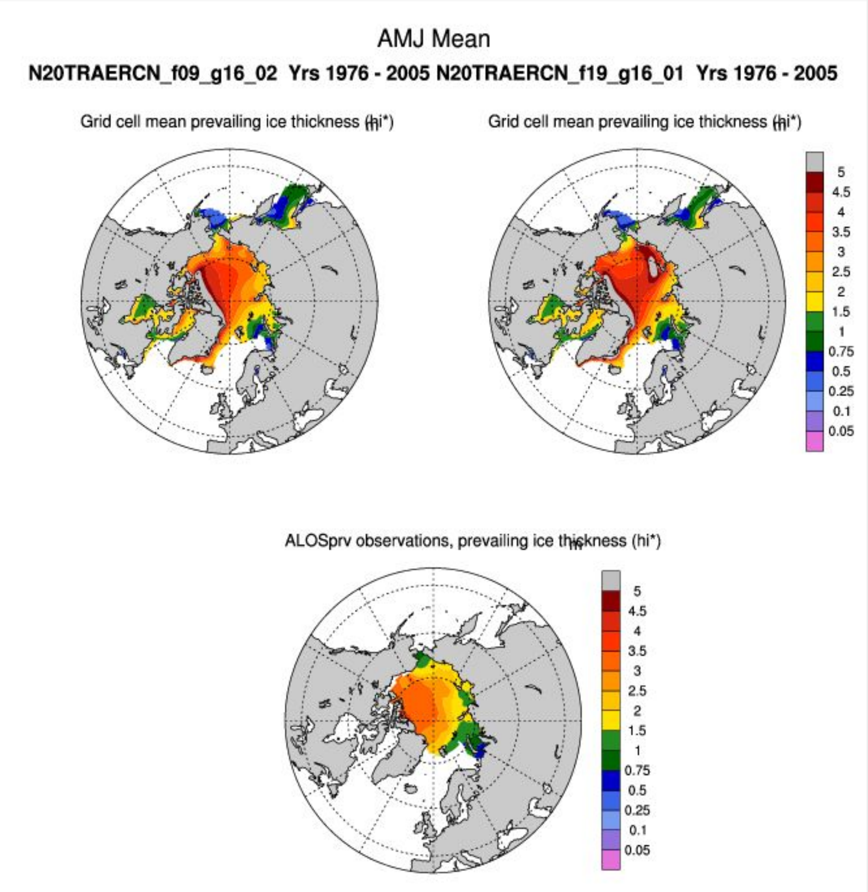
- NorESM is one of the models with slow decline in NH sea ice extent.
- SH simulation is quite good!

Compared with observations of SIT

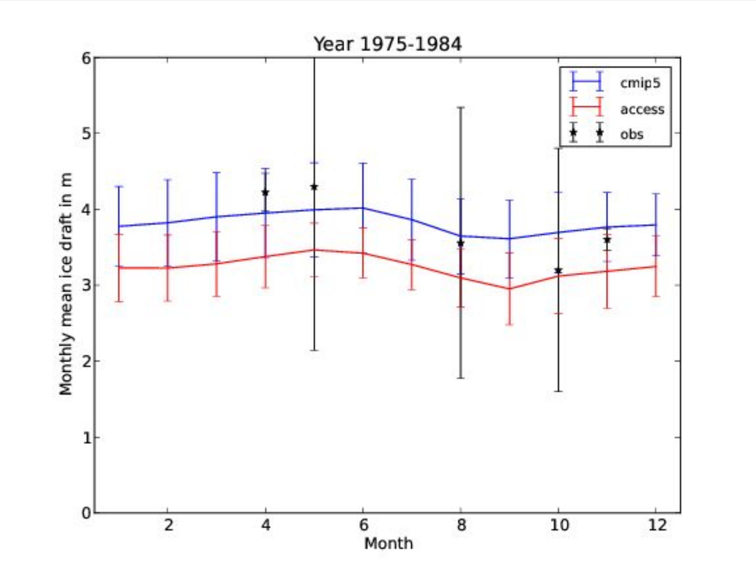
ICESat (2003-2007), Oct-Nov

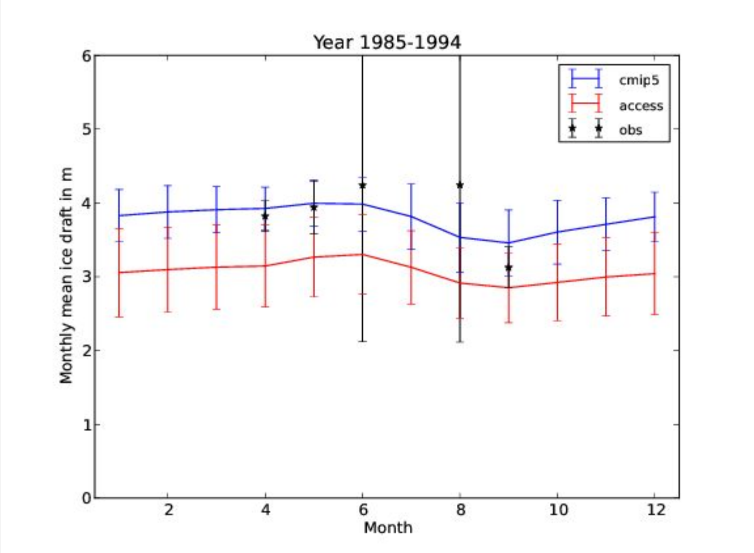


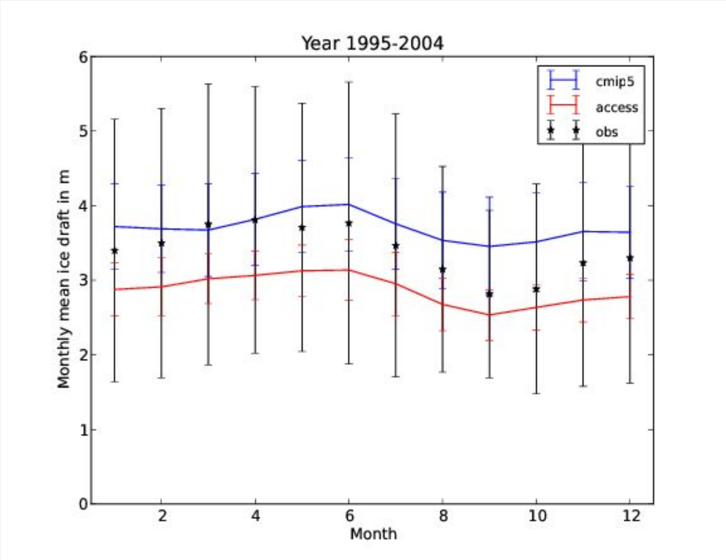
Russian landing sites
1950-1989

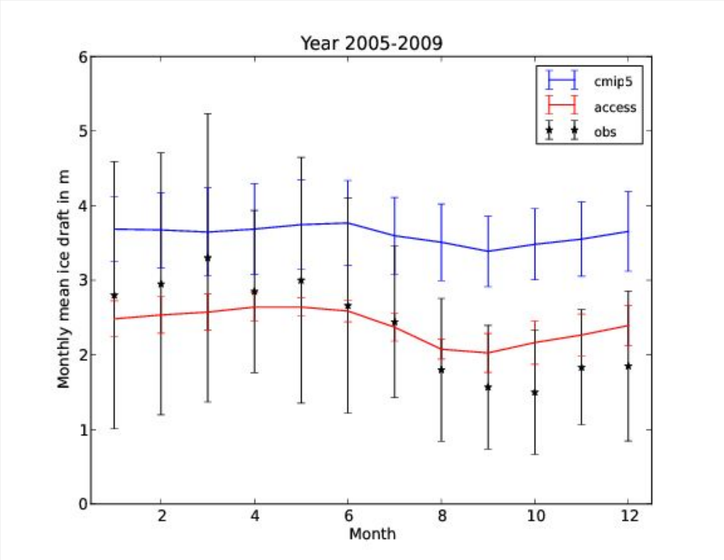


Sesonal cycle of SIT near NP

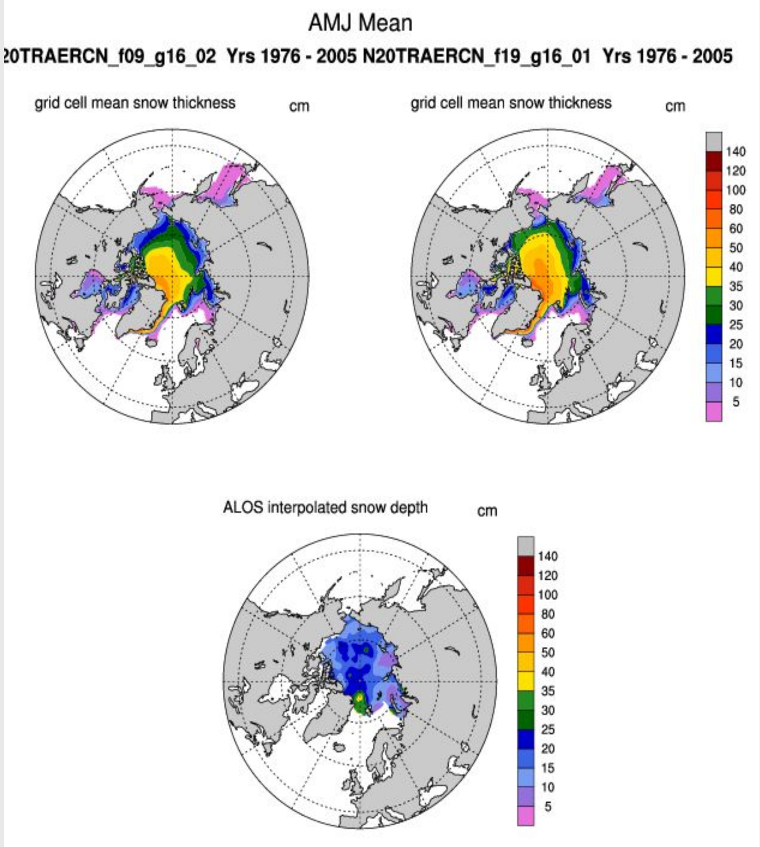








Snow, too much, but observations are very sparse ...

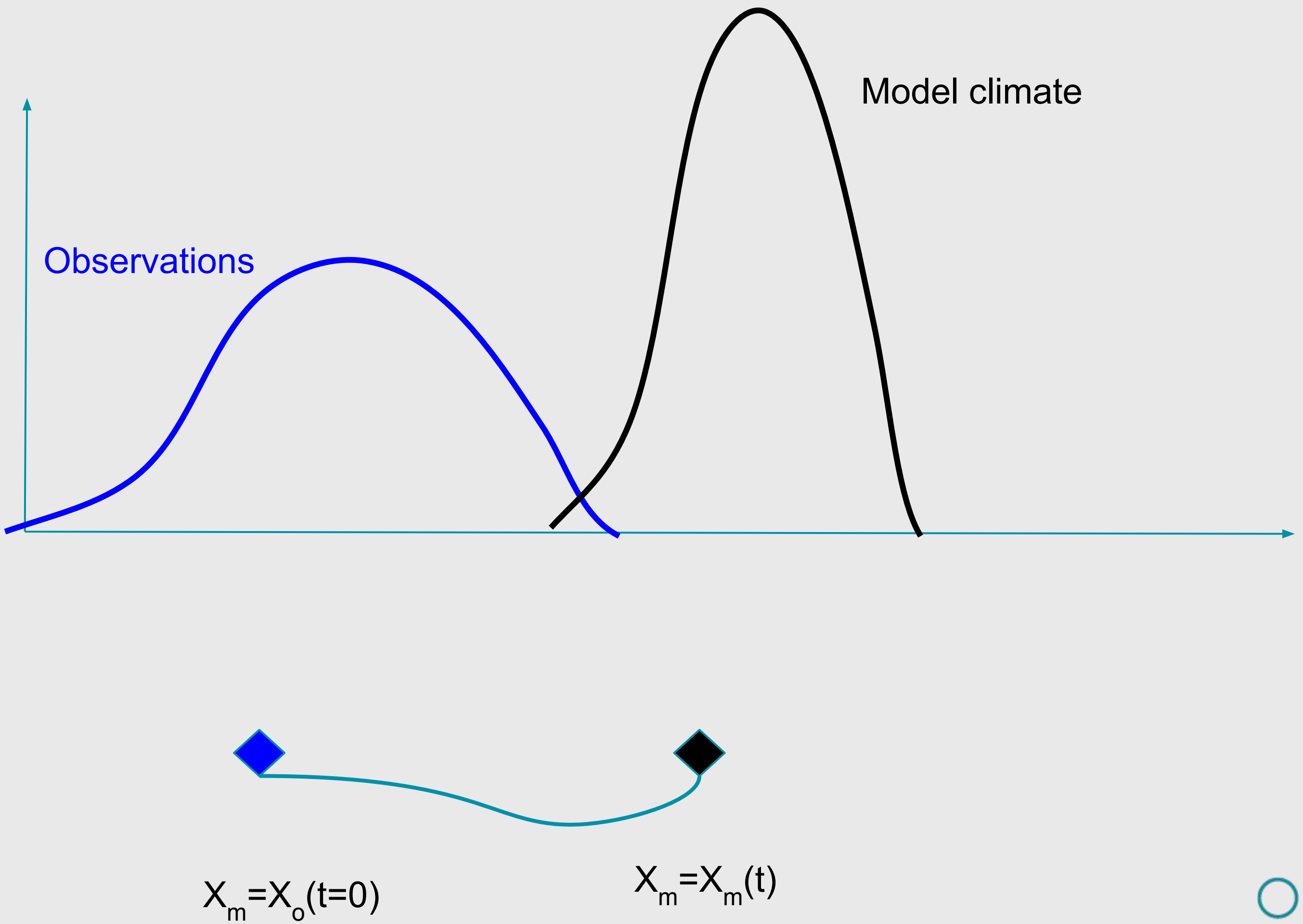


The Warner et al 1999 climatology estimates around 25-30 cm snow in Central Arctic during spring.

Newer estimates find typical less snow than this.

Russian landing sites 1950-1989

“All models drift”



Norwegian Meteorological Institute

The drift occurs over different time-scales

Spin-up time for typical components of the climate system (based on typical figures from NorESM).

- Atmosphere: 1-2 years
- Ocean mixed layer - atmosphere: ~20 years
- Arctic sea ice: ~10 years (depending on amount of ice).
- Deep ocean: ~1000 years.
- Land: ~1000 years.

For seasonal forecasts the drift and the predicted anomalies are often of the same size.

Initialization strategies in seasonal and decadal prediction systems

- "full field initialization": Toward observed state.
  - Results are detrended afterwards based on historical model drift.

- "anomaly initialization": Assimilate anomalies from climatology.
  - The forecasted anomalies are mapped back into observed space.

- In SPARSE we do not have full seasonal forecasts with NorESM as a goal. We would like to use NorESM as a tool to understand predictability of Arctic sea ice, and also to understand the limitation of the other approaches (statistical and regional ice-ocean model).

Experiment types with NorESM

- Task 4.2: Idealized, similar perturbations of sea ice within the seasonal ensembles. How to isolate the effects of the global model compared with the regional response?
  - Perturbations in a control climate
  - Perturbations in a strongly trending climate (present day).

- Task 4.3: Perturbations using assimilation technique in CICE?
  - Use similar assimilation method for the ice to what we use in WP2.

- Task 4.4: Influence of new sea ice physics on predictability.
  - Repeat the experiments from 4.2 and 4.3 with new sea ice physics to investigate possible changes in the sea ice predictability.
  - How to control model drift due to the new physics?

Norwegian Meteorological Institute

?

- What version of NorESM should be used?
- What assimilation strategy to be used in CICE?
- How to isolate the similarities and differences in response and results between the regional model and NorESM (regional model near observed state and forced with forecast versus almost free NorESM runs)?
- Should other parts of the climate system be constrained (SST?)


Norwegian
Meteorological
Institute