Arctic sea ice conditions in seasonal re-forecasts with the CNRM-CM6-1 model

Ilona Välisuo [1], Lauriane Batté [1], David Salas Y Mélia [1], Constantin Ardilouze [1] and Matthieu Chevallier [2]

1 CNRM UMR 3589, Université de Toulouse, Météo-France, CNRS, Toulouse, France
2 DIROP/MAR, Météo-France, Toulouse, France

Divers sea ice conditions in the Arctic

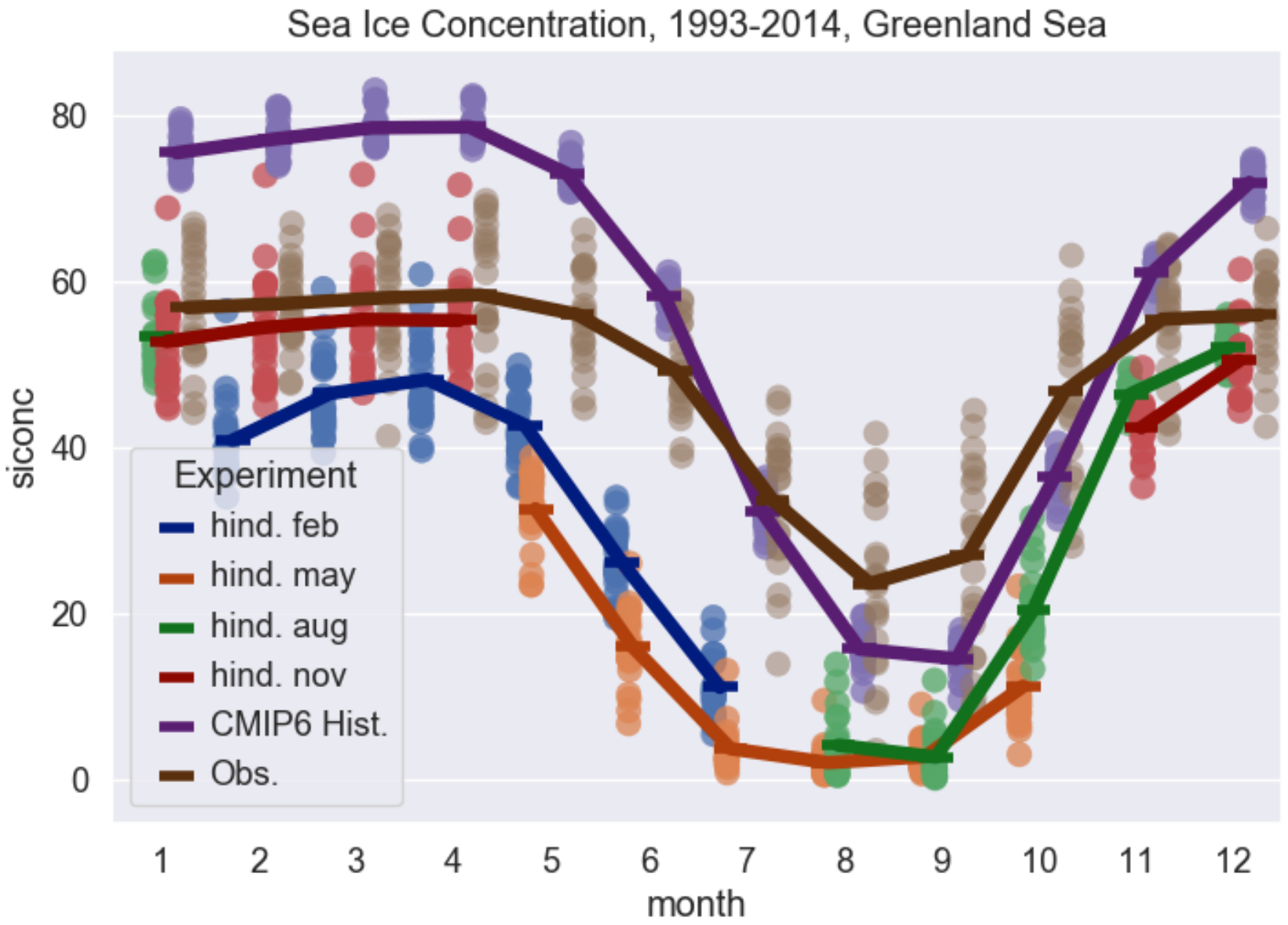
- Sea ice conditions in the Arctic are not uniform, but affected by:
  - Latitude, temperature, atmospheric conditions
  - Ocean currents, Atlantic inflow (Greenland sea, Barents Sea)
  - Export of ice, transpolar drift (Fram strait, Greenland Sea)
  - Fresh water input (Kara, Laptev, East Siberian Seas)
- Purpose of the presentation:
  - Present modeled sea-ice conditions in Greenland Sea and Chukchi Sea to highlight the differences in the sea ice conditions

METEO FRANCE

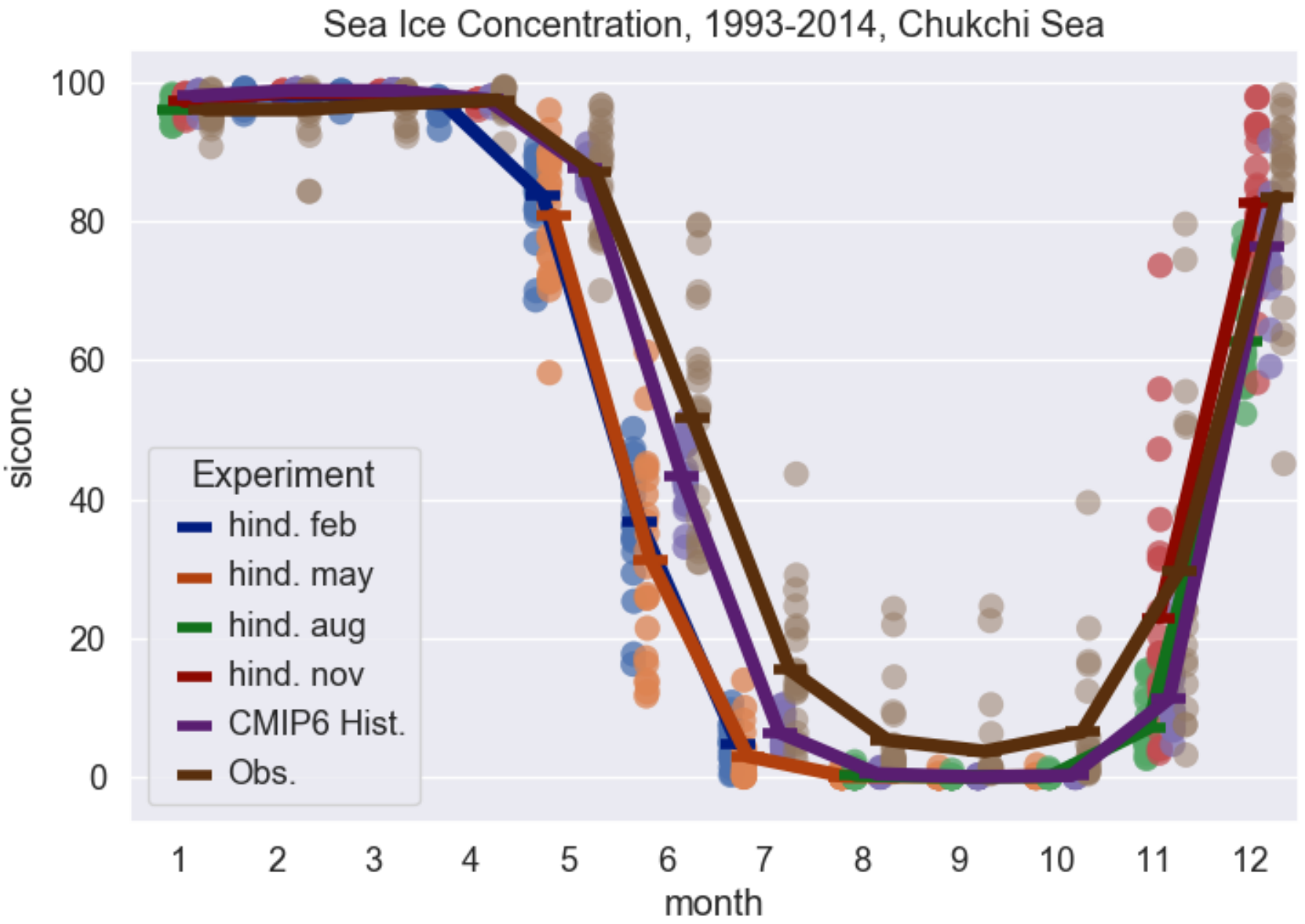
Model data and observations

- Study period: 1993-2014
- Model: CNRM-CM6-1 (French coupled climate model)
- Sea ice model: GELATO
- Experiments :
  - Seasonal hindcasts
    - Initialized in February, May, August and November
    - Forecast times of 6 months
  - Climate simulation:
    - CNRM-CMIP6 historical experiment
- Observations:
  - Sea ice concentration, National Snow and Ice Data Center

Results: Sea ice concentration, varying result in Greenland Sea



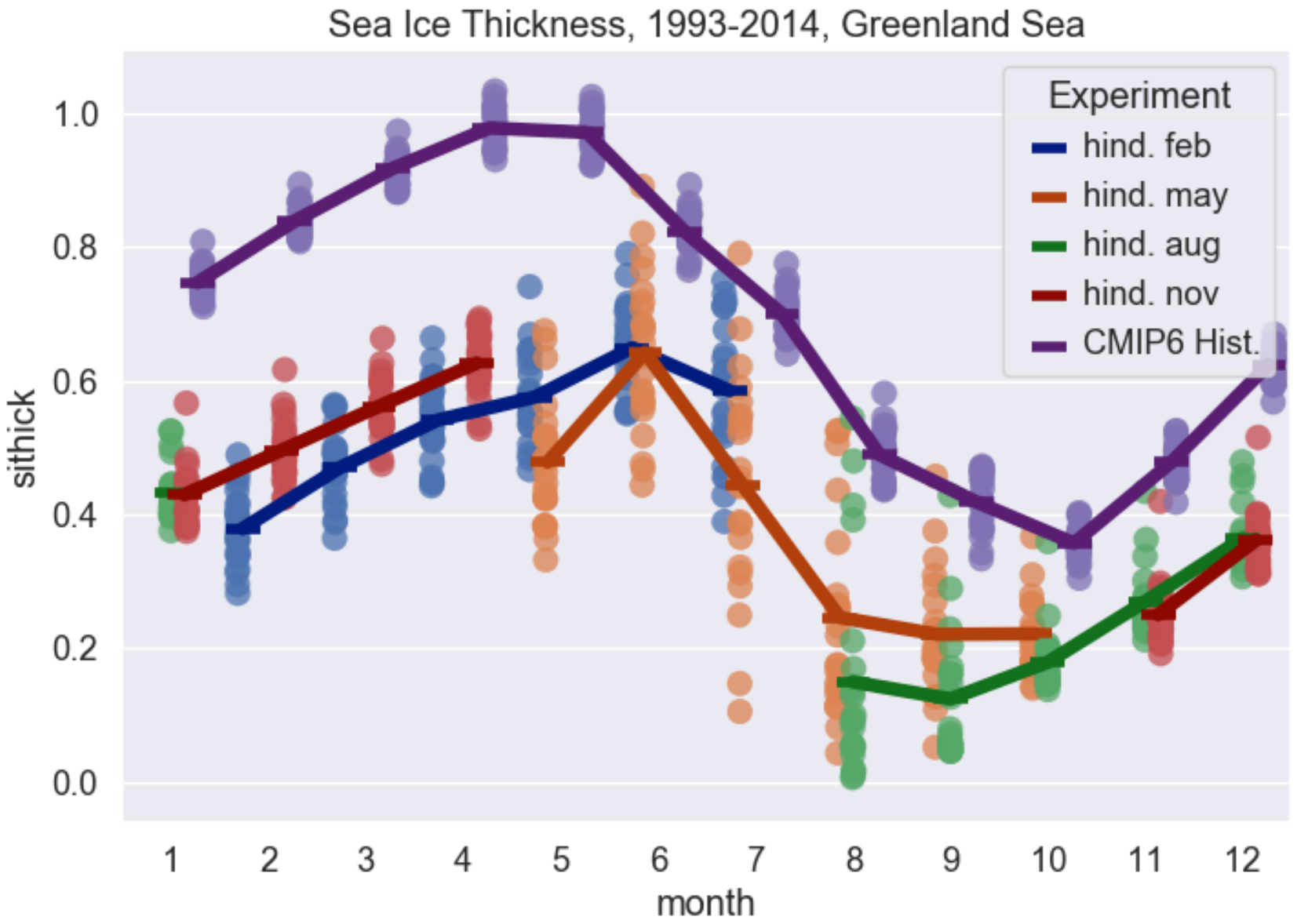
Results: Sea ice concentration, more uniform results in Chukchi Sea



Result : Sea Ice concentration

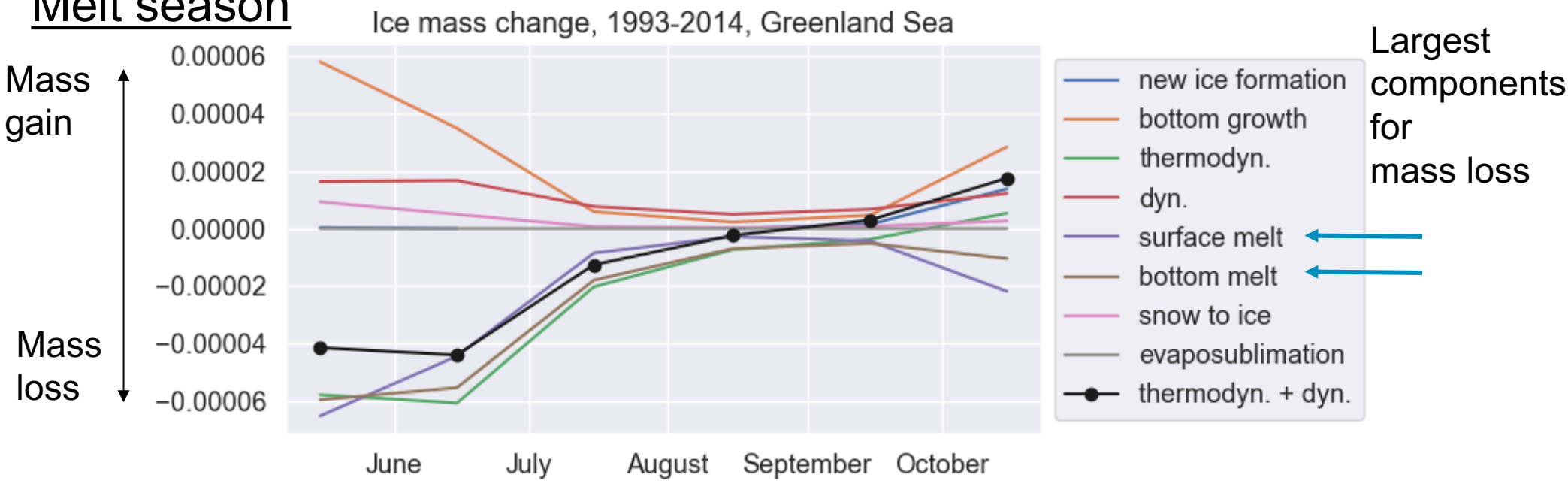
- Greenland Sea
  - Large interannual variability during all seasons
  - Large differences in the hindcasts according to initial date
- Chukchi Sea
  - Winters fully ice covered and summers mostly ice free
  - Largest differences between the simulations occur in the melt season
- In general in both regions
  - Models catch well the sea ice concentrations when the seas are fully ice covered or fully ice free
  - Seasonal hindcasts produce in general lower sea ice concentrations than observed
  - CMIP6 simulation has smaller interannual variability
  - The observed seasonal cycle is less pronounced than the modelled

Results : Sea ice thickness in Greenland Sea dependent on initial conditions



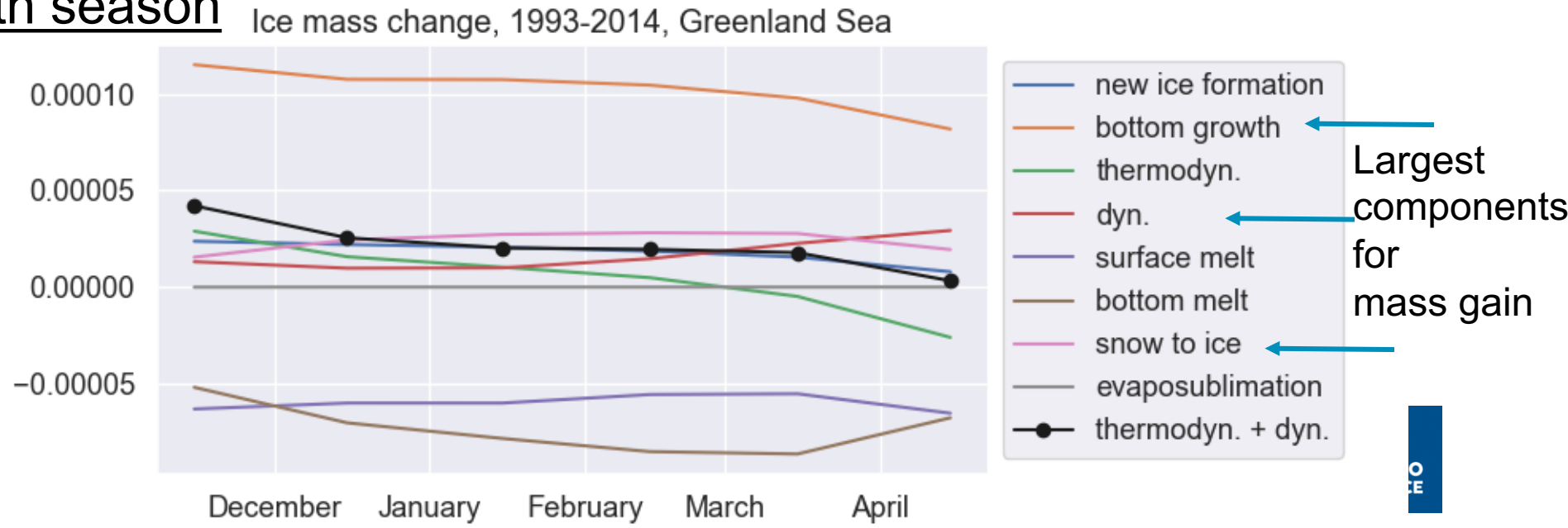
Results : Mass balance, Greenland sea

Melt season



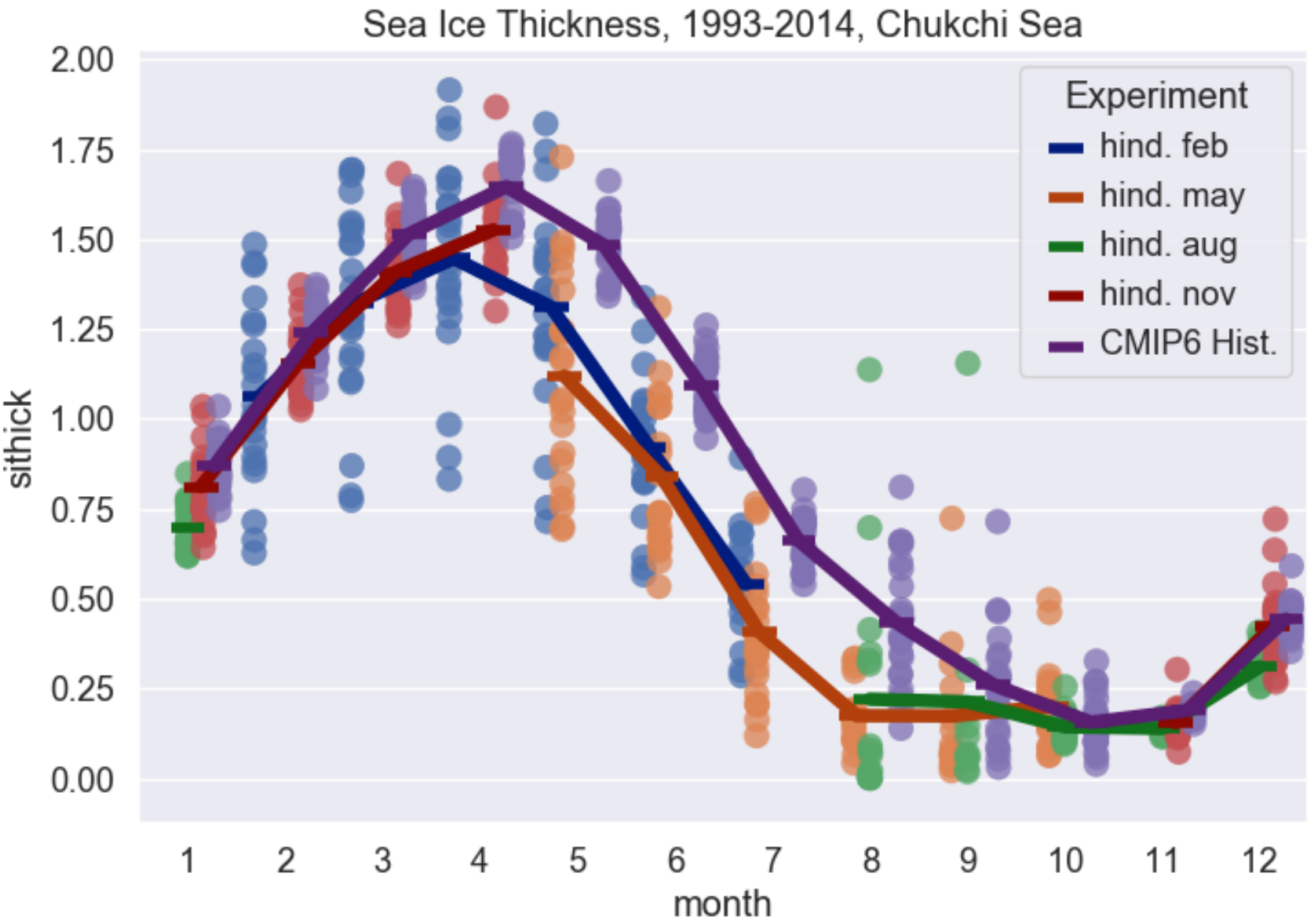
Largest components for mass loss

Growth season



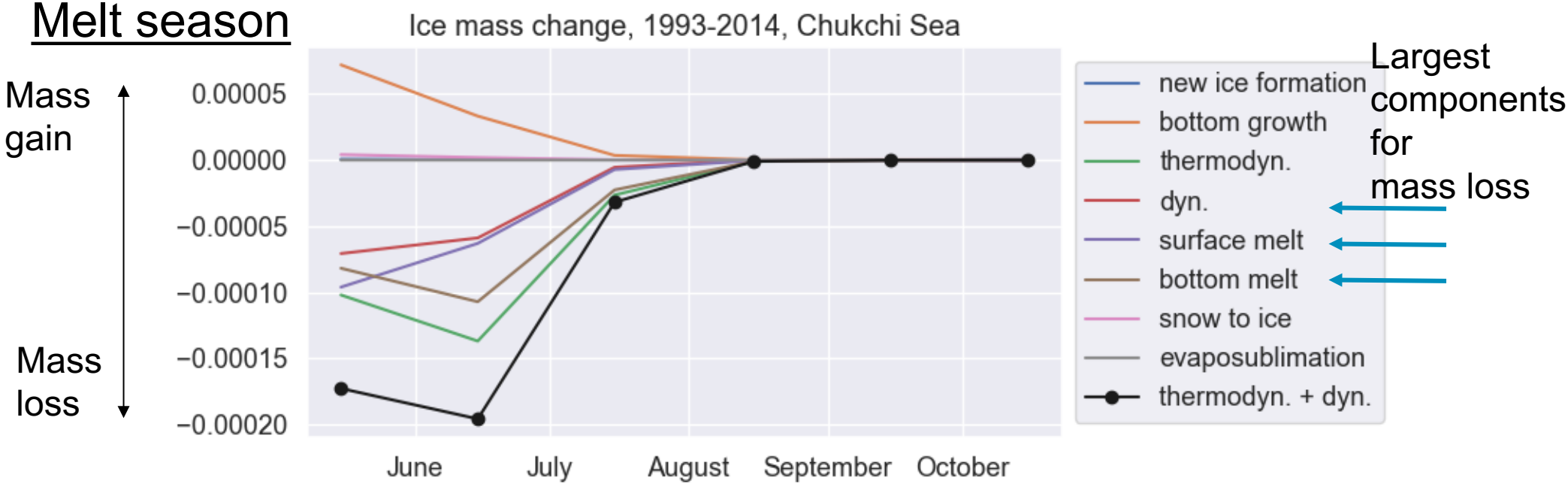
Largest components for mass gain

Results : Sea ice thickness, Chukchi Sea

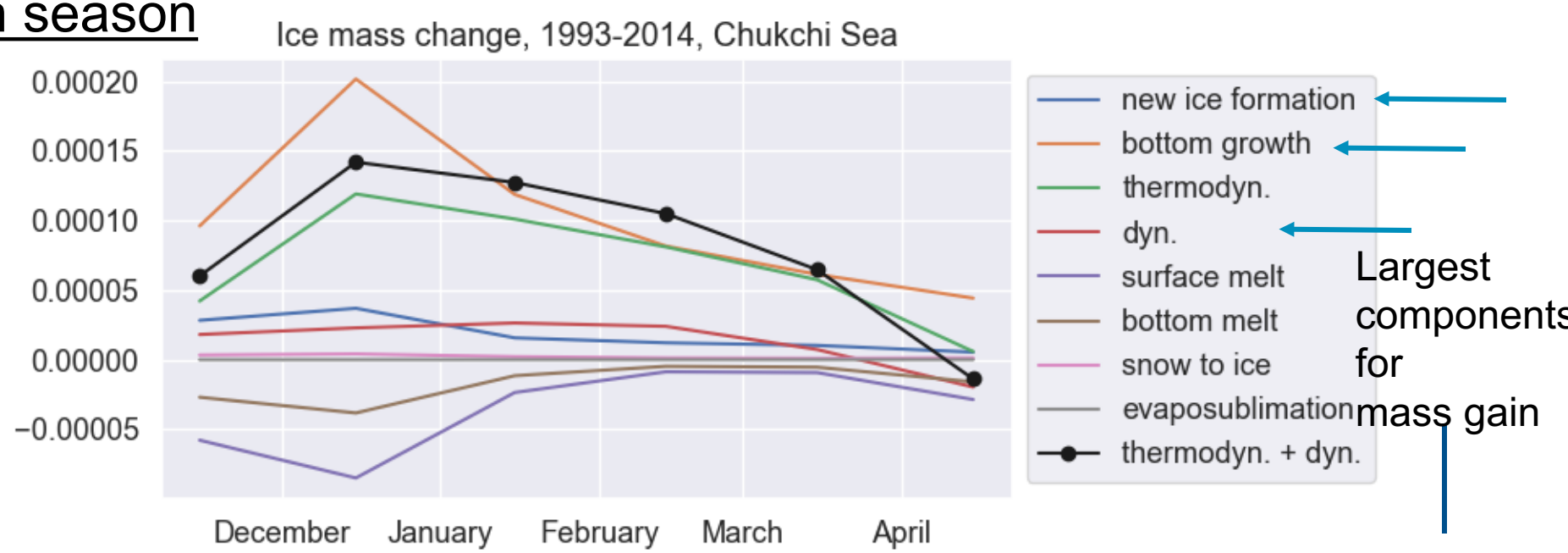


Results : Mass balance, Chukchi Sea

Melt season



Growth season

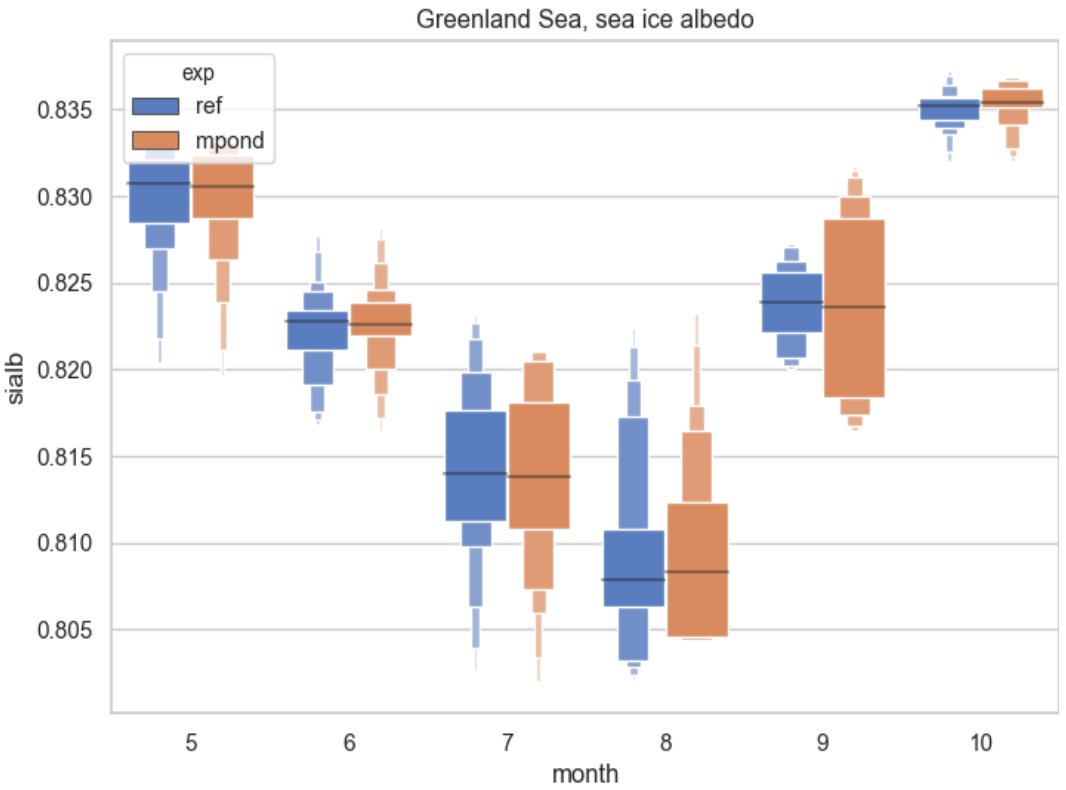


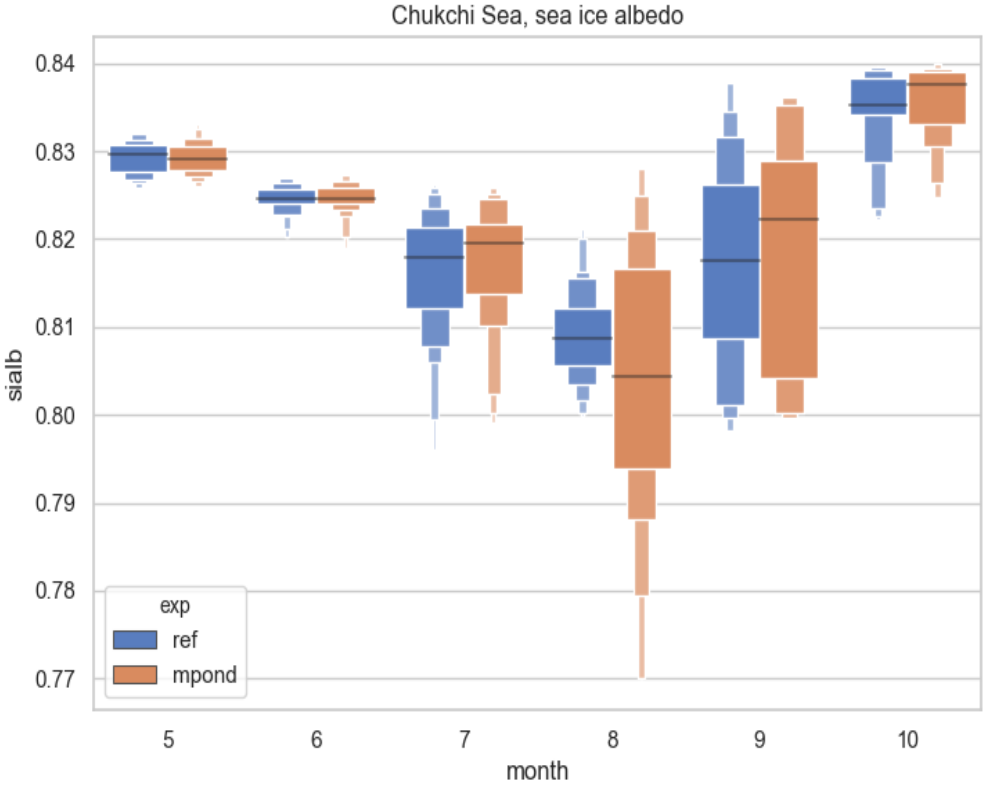
Mass budget overview

- **Greenland Sea**
  - Mass growth due to :
    - Thermodynamic growth at the bottom
    - Snow to ice transformation
    - Ice dynamics
  - Mass loss due to :
    - Melt at the surface and the bottom
- **Chukchi Sea**
  - Mass growth due to :
    - Thermodynamic growth at the bottom
    - New ice formation in open water
    - Ice dynamics
  - Mass loss due to :
    - Melt at the surface and the bottom
    - Ice dynamics

Model improvements: does the surface albedo change, if melt pond formation is turned on?

- Melt ponds form when melt water at the surface of the ice doesn't drain, but is collected in ponds at the surface of the ice
- Melt ponds decrease the albedo of the ice and have potential to increase melting due to albedo feedback
- We did a seasonal hindcast experiment where melt pond formation was activated in the sea ice model





Conclusions

- Seasonal hindcasts face different challenges in the different Arctic seas. For example:
  - In Chukchi Sea models catch well the sea ice concentrations when the sea is fully ice covered
  - During the melt season large difference between model experiments in both Greenland and Chukchi sea
- The difference between seasonal hindcasts and CMIP6 historical climate simulation is larger in Greenland Sea than Chukchi Sea
- The interannual varibility of sea ice concentration and thickness is larger in the seasonal hindcasts than the CMIP6 simulation
- Including melt ponds in the sea ice model has potential to improve the seasonal sea ice predictions
  - however, the first look at result doesn’t reveal instant improvements

APPLICATE.eu

Advanced prediction in polar regions and beyond

This project (APPLICATE) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727862.

Contact:

Ilona Välisuo,
postdoctoral researcher

ilona.valisuo@meteo.fr

CNRM UMR 3589, Université de Toulouse, Météo-France, CNRS

Toulouse, France