A mechanism for winter sea ice opening to the north of Svalbard

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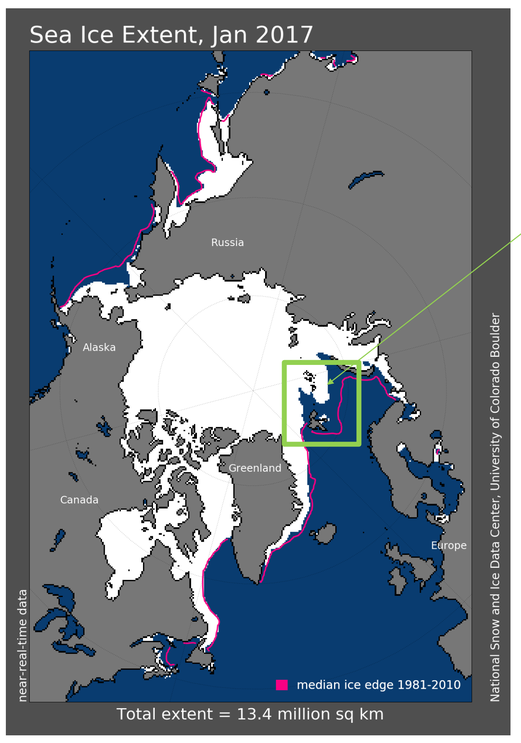
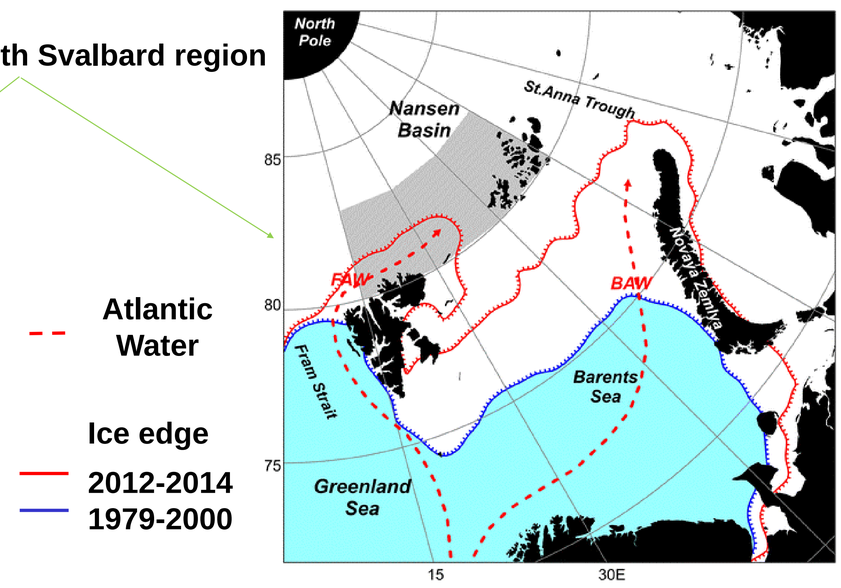
Abstract: Large negative trends and interannual variability in the winter sea ice cover have been documented in the region located to the north of Svalbard over the last decades which have been partly attributed to sea ice-ocean interactions. It is shown that low sea ice coverage in this region is often associated with short-term, large amplitude events of ice edge retreat. In order to document the occurrence of such events and their causes, we analyzed sea ice concentration data in remote sensing microwave observations and outputs from a 1/24° regional ice-ocean model simulations. The present analysis focuses on an outstanding event which occurred in winter 2006 and led to a large sea ice opening lasting more than a month. We estimate the different contributions to the sea ice volume budget and highlight the importance of both atmosphere and ocean forcing in the observed retreat. It is shown in particular that enhanced sea ice melt in relation to the Atlantic Water heat reservoir plays a critical role.

1 North of Svalbard : a region of large sea ice extent variability during the last decades



Long-term retreat of February ice edge

North Svalbard region

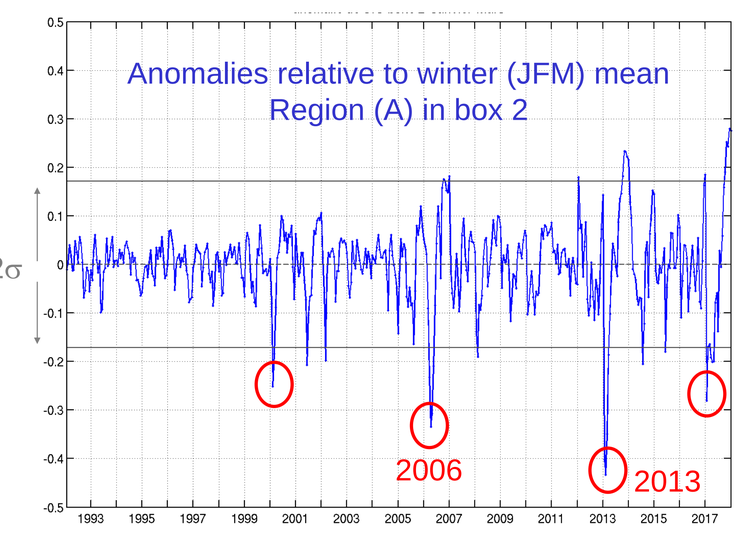


Atlantic Water

Ice edge
2012-2014
1979-2000

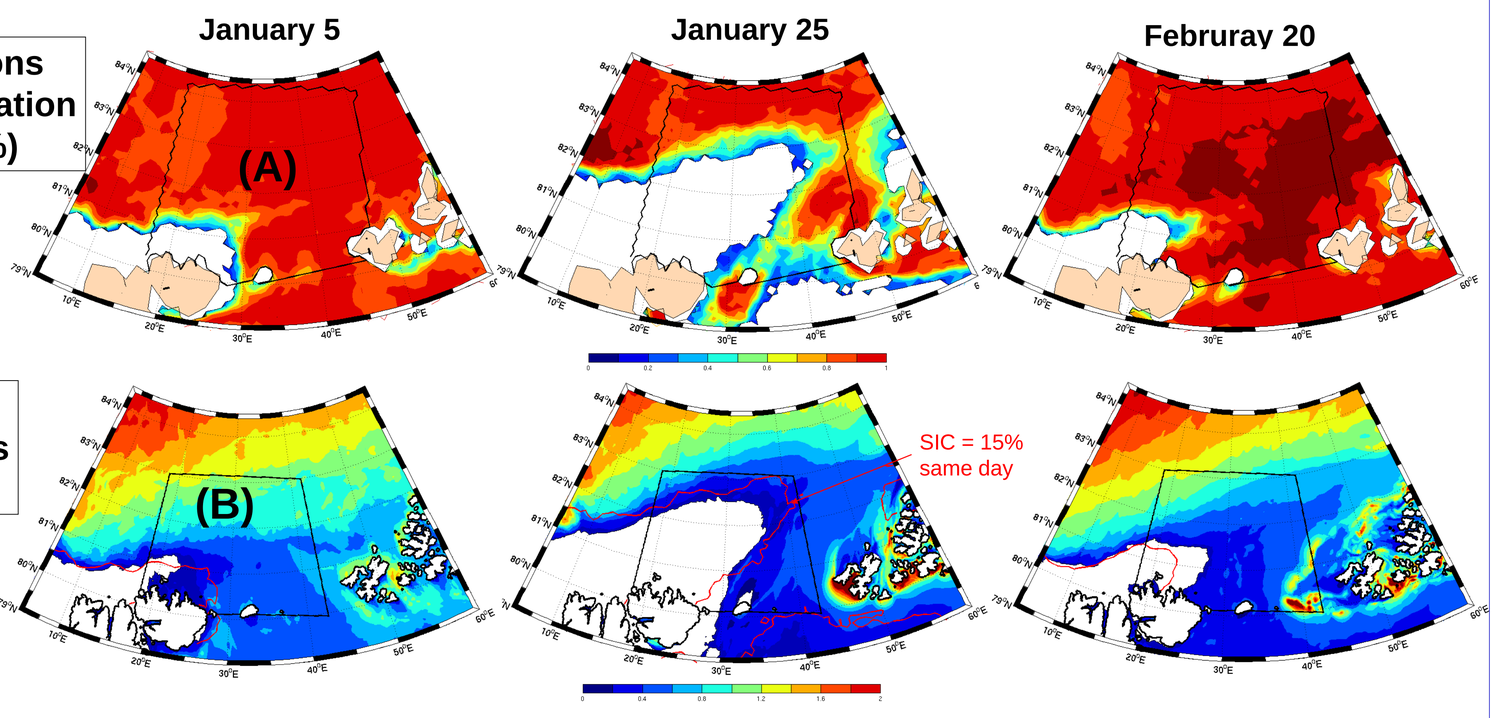
Ivanov et al., 2016

SSM/I sea ice concentration 1992-2017
North Svalbard region (A) (see box 2)



2 Winter 2006 : A one-month duration opening event in January

Observations
Ice concentration
(SIC>15%)

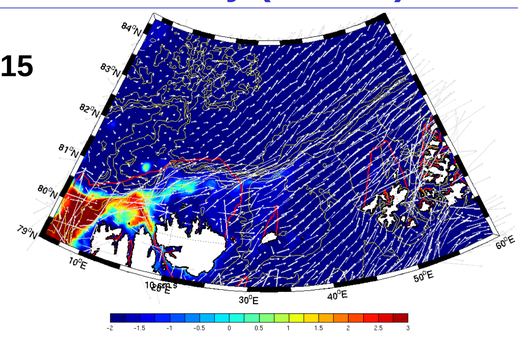


Model
ice thickness
(h>0.1 m)

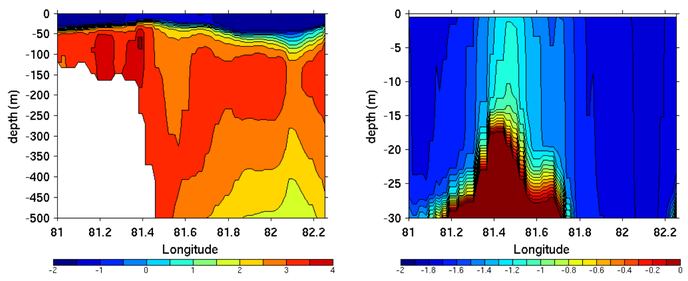
- **Area of low ice concentration is maximum on January 25. Evolution of model ice thickness shows similar scenario**
- **Concomitant thinning of the sea ice extends northeastward well beyond the ice edge**

3 Upper ocean temperature and velocity (0-10 m)

January 15



Temperature distribution along 30.6°E



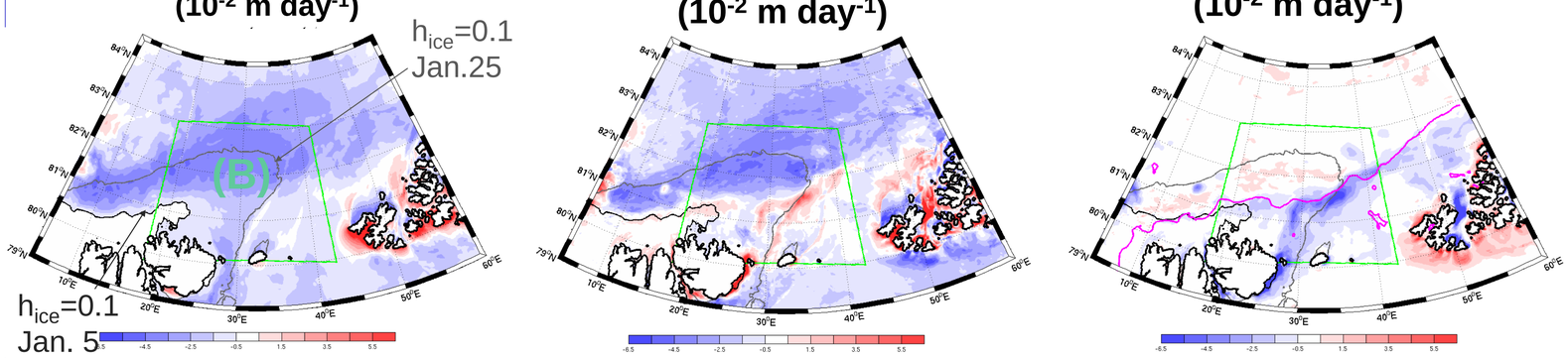
- **A tongue of warm SSTs develops under the ice**
- **The feature coincides with outcropping of warm Atlantic Water at the shelf break**

4 Sea ice budget : transport versus thermodynamics (January 5 - 25)

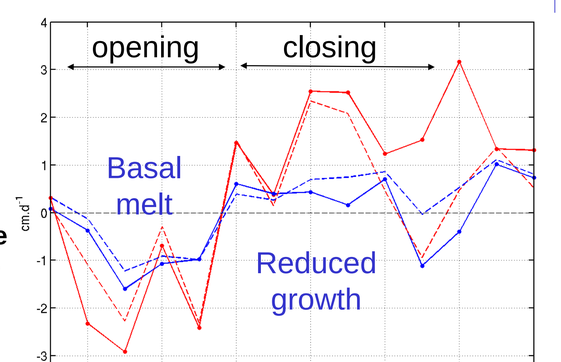
Ice thickness change
(10^{-2} m day^{-1})

Convergence
(10^{-2} m day^{-1})

Thermodynamic growth
(10^{-2} m day^{-1})



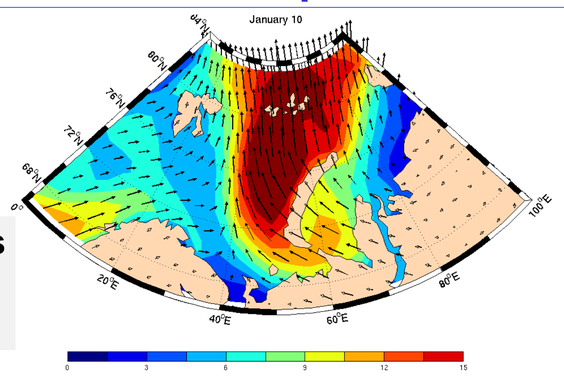
Sea ice volume budget evolution
region (B) (see box 2)



- **Ice divergence and ice melt altogether contribute to the sea ice cover opening between Jan.5 and Jan. 25**
- **Ice divergence dominates and contributes to the northward opening. Melting operates along the AW pathway**
- **Closing of the low sea ice concentration area after Jan. 25 is delayed by ocean heat flux as the ice moves over warmer water (reduced ice growth)**

5 Respective role of the atmosphere and ocean forcings

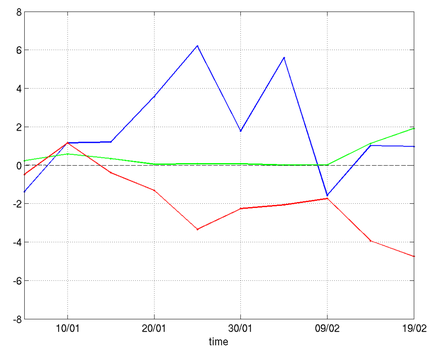
Surface wind (m s^{-1})
January 15



Strong southerly winds trigger northward sea ice drift

Ocean surface warming, as a result of stronger westward current and shoaling of the Atlantic water drive basal sea ice melt, in the inner pack ice during opening and at the ice edge during closing

Surface layer (0-10 m) heat budget



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