Sea-ice cover in Isfjorden and Hornsund

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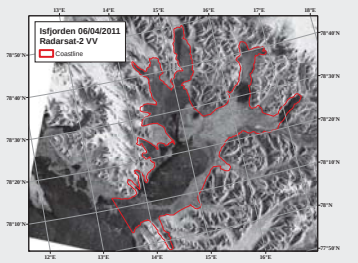
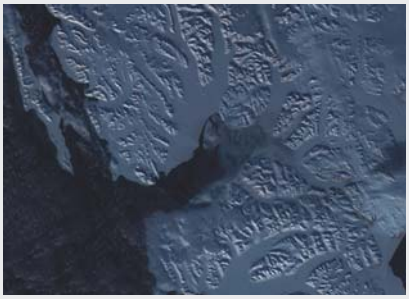
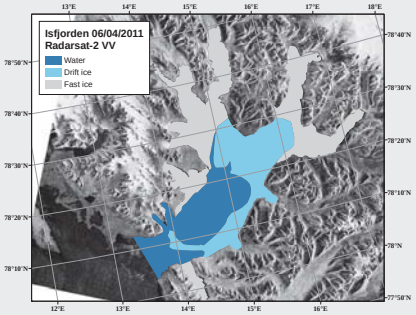
Abstract As part of the AWAKE-2 project, a sea-ice database was built up for two fjords in Svalbard (Isfjorden and Hornsund) using in-situ observations and high-resolution satellite images from SAR and optical sensors. Almost 20 000 satellite images have been collected so far and used for manual interpretation to analyse sea-ice coverage in Isfjorden and Hornsund during the last decade. The result is a time series with an almost daily resolution defining the fjord area into fast ice, open water and drifting ice. The error estimation of the daily results vary between several 1 % up to more than 10 % depending on sun light, cloud cover, availability and quality of the satellite data. To quantify an ice season in a fjord and for comparison with atmosphere and ocean data, a new index called 'days of fast ice coverage' (DFI) has been developed. The DFI represent the sum of the fast ice area relative to the entire fjord area from all days during a certain period of time (e.g. one season). The results show a major shift in fast ice coverage between the period 2000-2005 and 2005-2013 with a decreasing mean value from 50 to 23 DFI in Isfjorden and from 56 to 39 DFI in Hornsund.

Method



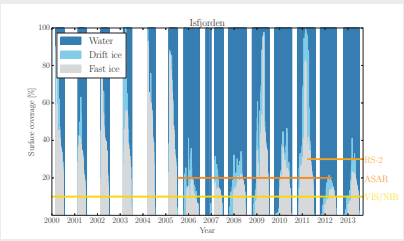


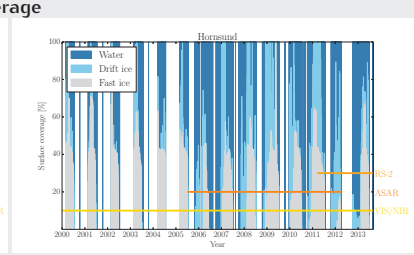
The raw Level-1 SAR images are pre-processed with the Nansen Center python toolbox 'nansat' (open-source at https://github.com/nansencenter). The created .tif files are imported into ArcGIS to adjust the symbology and define the areas of open water, fast ice and drift ice by cutting a polygon covering the fjord area. In an ideal case, a VIS/NIR image is available for validation.



Results

Sea-ice cover time series and satellite coverage

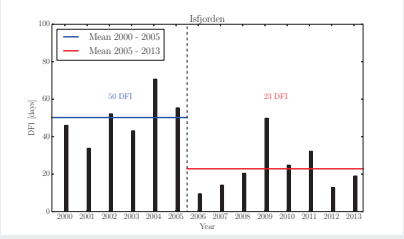


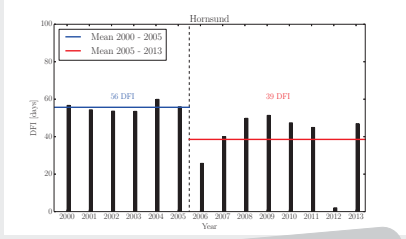


DFI - days of fast ice coverage

- Index for quantifying fast ice season in fjord
- Includes temporal and spatial extent
- Intercomparable between different fjords

$$DFI = \sum_{days} \frac{fast\ ice\ area}{fjord\ area}$$

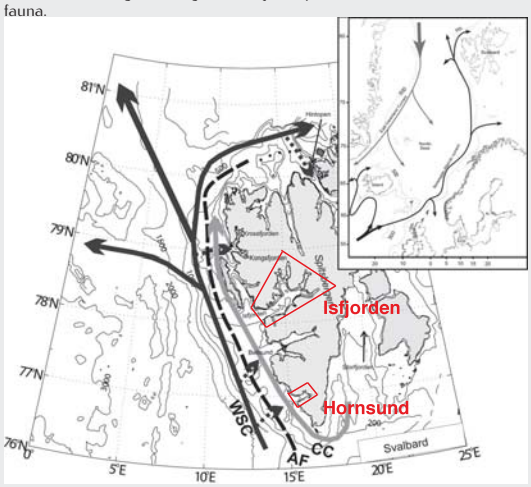




Arctic fjords are highly vulnerable to warming and are expected to exhibit the earliest environmental changes resulting from anthropogenic impacts on climate.

Study area

Svalbard's climate is strongly affected by the West Spitzbergen Current (WSC), which transports warm and salty Atlantic Water northwards and causes eastern Fram Strait containing the northernmost permanently ice free ocean. The Coastal Current, separated to the WSC by the Arctic Front (AF), transports colder, fresher water along the shelf and favours the seasonal sea-ice growth in Isfjorden and Hornsund. Atlantic water inflows into the fjords can alter the sea-ice conditions during the following winter season significantly with major impacts on the local climate and fauna.

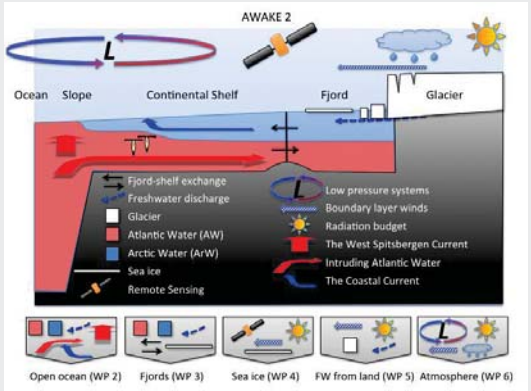


AWAKE-2

The aim of AWAKE-2 is to understand the interactions between the main components of the climate system in the Svalbard area: ocean, atmosphere and ice to identify mechanisms of interannual climate variability and long-term trends.

Hypothesis

Atlantic Water inflows over the Svalbard shelf and into the fjords have become more frequent during the last decades due to changes in the ocean and atmosphere. The integrated effect of these events results in new regimes and changes in atmosphere, ocean, sea-ice and glaciers in Svalbard.



Outlook

- The sea-ice cover time series will be updated every year until 2016 and published in a paper.
- A fjord-polynya model, using sea-ice coverage and meteorological data as input, will be used to estimate the production of brine-enriched shelf water that can control the water mass exchange rate and the circulation dynamics between the fjord and the shelf region.
- The DFI values will be used for comparison with atmosphere and oceanic data, collected in Isfjorden and Hornsund by different AWAKE-2 partners (UNIS, IOPAS etc.), to provide new and improved knowledge of the critical interconnections between atmosphere, hydrosphere and cryosphere.

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