ArcFlux - Determing Arctic Freshwater Fluxes with CryoSat-2

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Introduction.

Rapid changes occurring in the Earth's climate system. Through both atmospheric and oceanic circulation, heat is transferred from the equator to the poles. The effects of climate change are most pronounced in the Arctic. Possible ways in which Arctic (eco) systems can be affected by warmer temperatures include: changes in amount and duration of snow and ice cover; frequency and extent of spring floods; changes in the ratio of P-E (precipitation minus evapotranspiration); amounts of water transport to lakes and rivers from snow and permafrost melting; and a decrease in frozen precipitation.

The Arctic Ocean is sensitive to freshwater fluxes (FWF) in terms of ocean stratification, circulations and the nutrient balance. The main input to the freshwater budget is river discharge, ice and snow discharge, net precipitation, and inflow of low-salinity water through Bering Strait The transport of freshwater out of the Arctic Ocean is dominated by outflow of liquid water through the Canadian Arctic Archipelago (CAA) and outflow of liquid water and sea ice through Fram Strait

The main objective of this work is to determine the freshwater budget of the Arctic Ocean.

To solve this task we propose to focus on the freshwater fluxes where **Earth observation** data together with In-situ data is expected to improve the estimation of the Arctic Ocean freshwater budget.

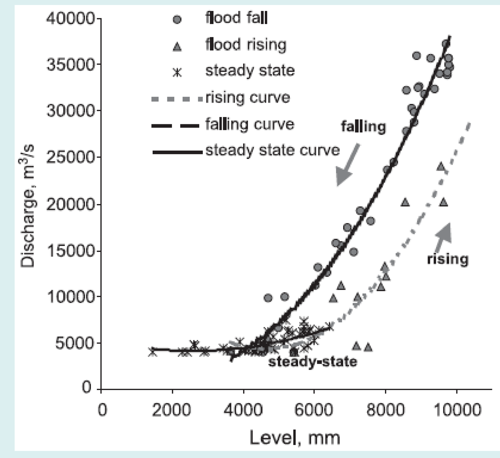
These are;

Discharge from rivers.
Inflow of ice and melt run off
Outflow of sea ice.
Outflow of freshwater in the ocean.

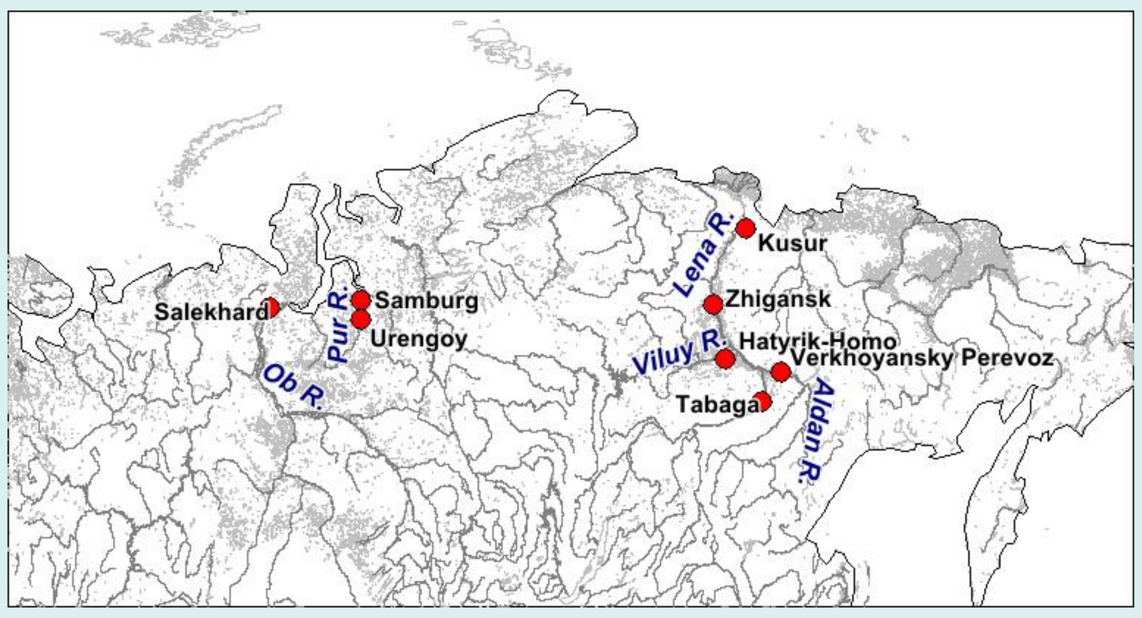
River Discharge / Flux

River discharge will be estimated from the classical rating curve approach, where the water height, retrieved from altimetric satellites, will be functionally related to the discharge on the gauge stations. Three test areas were selected for this study : large Ob and Lena rivers with the width enough to produce the clear altimetric signal, and medium-size river Pur selected for feasibility study.

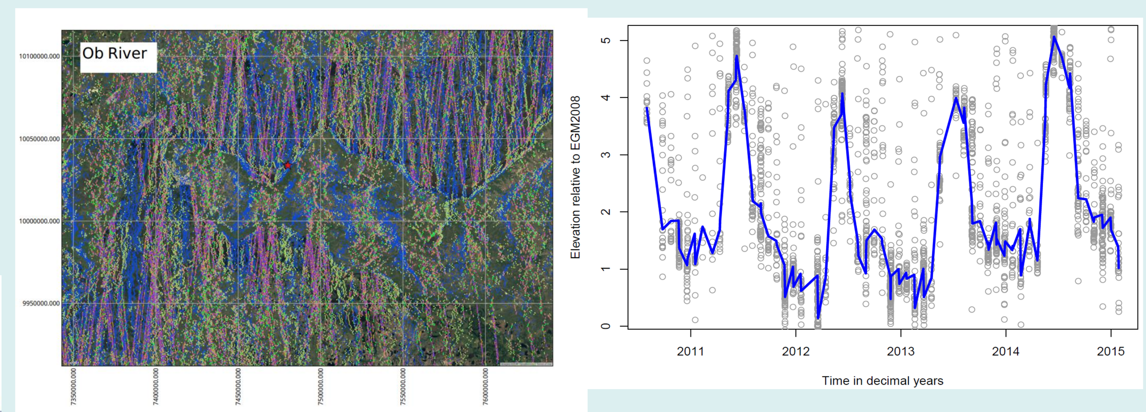
TOPEX/Poseidon water level relation with in situ discharge for Ob River Salekhard gauge

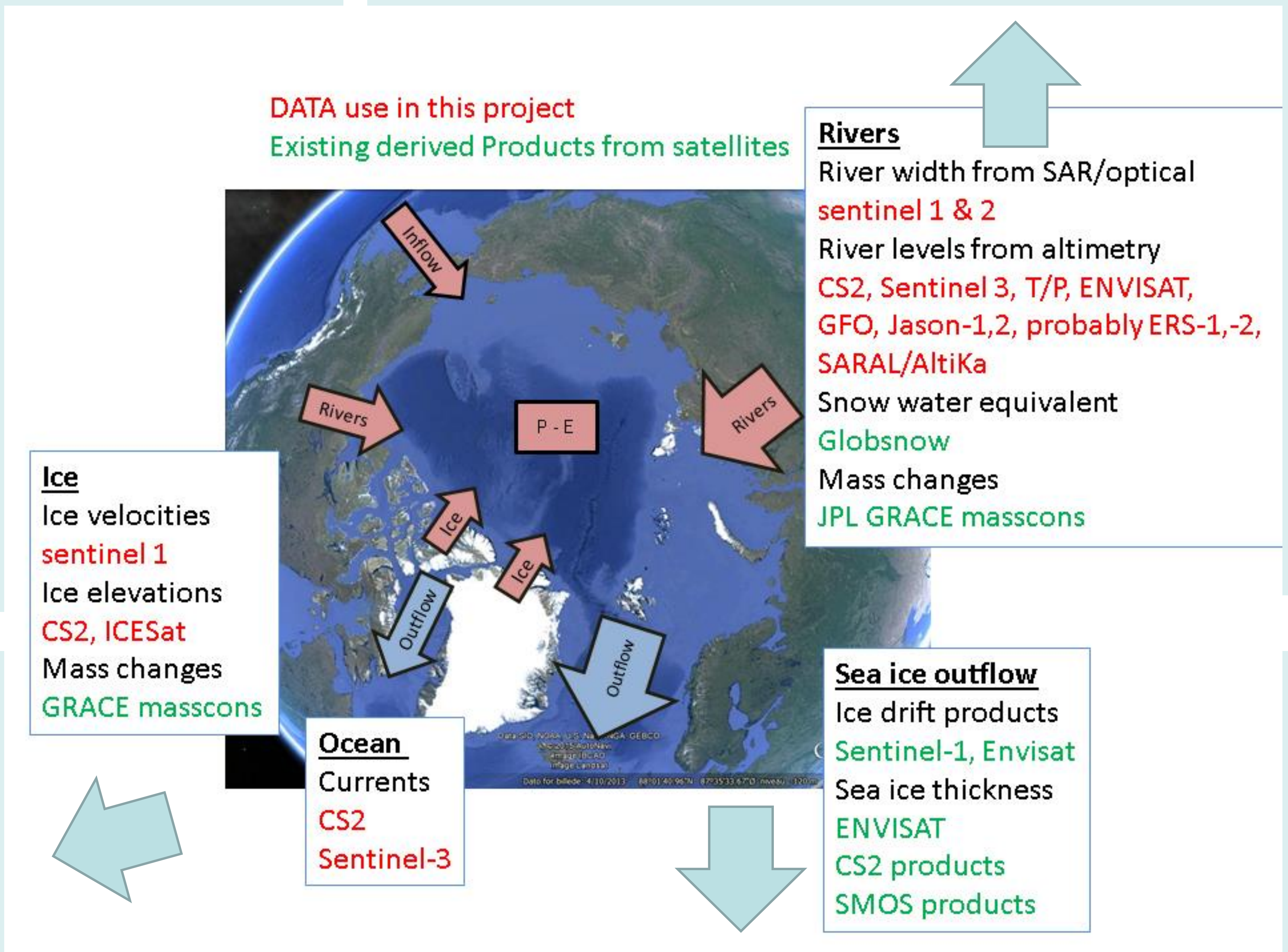


Test area map with the positions of gauge stations that will be used for EO estimation of the river input

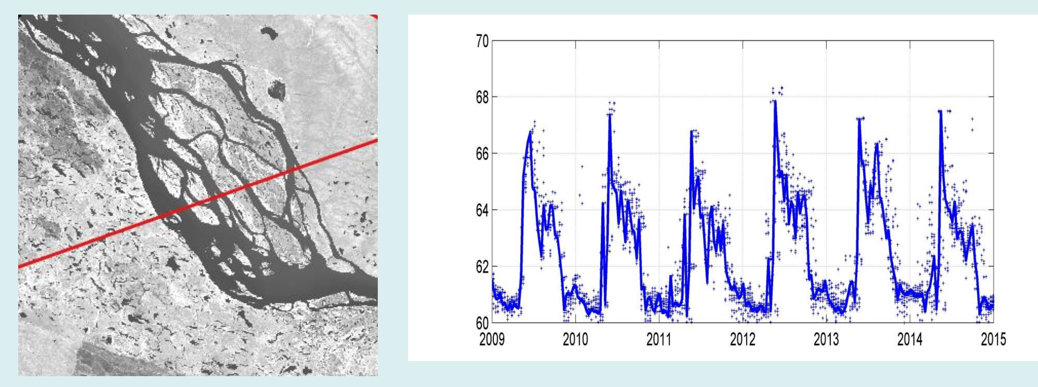


Cryosat-2 Ob River coverage (left) and water level time series (right) near the Salekhard gauge station





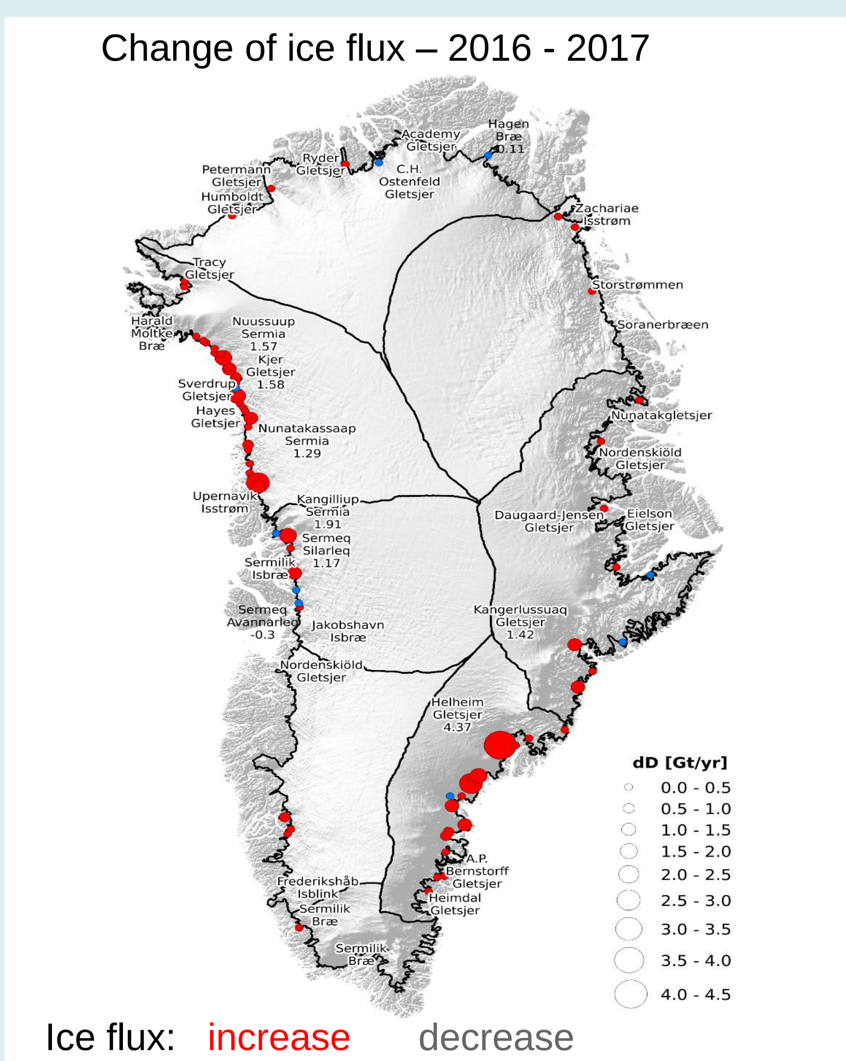
Jason-2 Lena River virtual station (left) and water level time series (right) after the confluence of three major tributaries with gauge stations

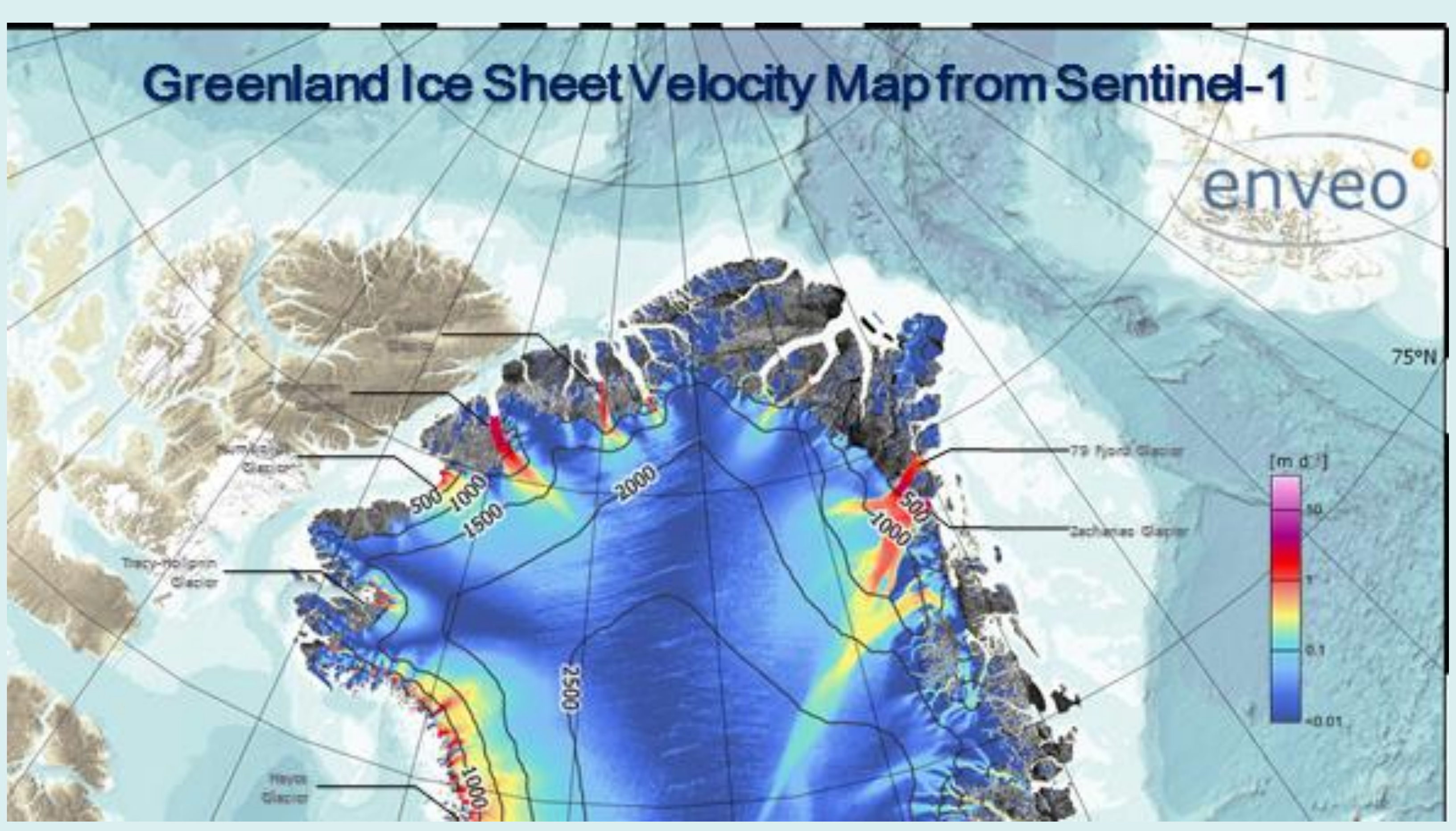


Ice Cap Fluxes

The fresh water flux from the ice sheet and ice caps includes two major processes, (i) the calving flux from marine terminating glaciers and (ii) melt water flux (run-off). (i) The calving flux is the ice discharge through a defined gate which is defined in general near the grounding line of the outlet glaciers.

To calculate the calving flux ice velocity data and the ice thickness at the gate is needed. Ice velocity data can be derived from repeat pass SAR data (i.e. Sentinel-1), while the ice thickness is derived from the difference between ice surface and bedrock elevations. Ice surface DEM will come (and be continuously updated) using satellite/airborne altimetry from i.e. Cryosat.2 while the bedrock topography will have to come from models

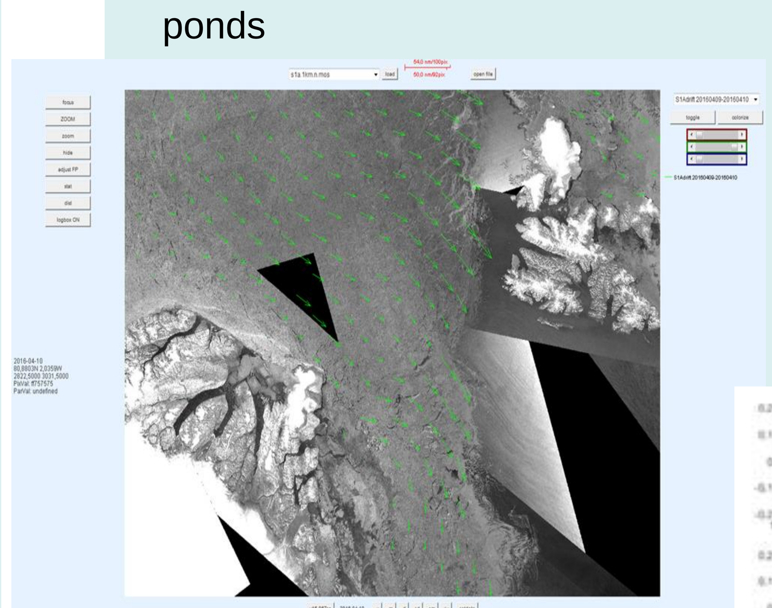


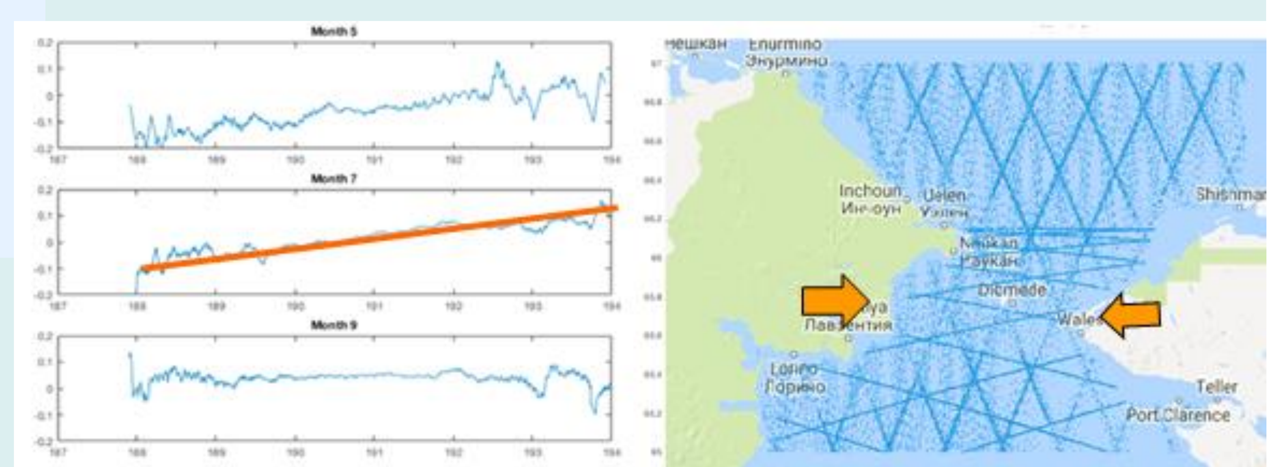


Sea ice FW outflow / Ocean currents

Due to the recent availability of sea ice thickness estimates from satellite radar altimeters and drift from repeated SAR imagery, this study will use a combination of these satellite based observations to estimate the present FWF across the largest outflow fluxgate crossing the Fram Strait.

We will use a combination of CryoSat-2 and ENVISAT monthly sea ice thickness profiles from existing products. Observations of sea ice thicknesses of thickness less than 0.5 m from SMOS mission will primarily be used to estimate the overall storage of freshwater contained in Arctic Ocean, as the sea ice in Fram Strait are primarily older thicker ice types. As the sea ice thicknesses measured by radar altimetry do not include the snow layer on top of the sea ice Sea ice thickness derived satellite altimetry, are not available in Arctic summer months June-September, due to contaminated signals from meltwater ponds





Satellite altimetry has for many years been applied to derive ocean currents under the geostrophic assumption through deriving an accurate mean dynamic topography. Until the launch of CryoSat-2, this has been an impossible task in the Arctic Ocean since it is partly ice covered. Hence the new satellites are far less prone to be corrupted by sea ice and far better to capture sea level in leads of the sea ice.

General information

ArcFlux was initiated in 2016 and is funded by ESA STSE ITT Arctic+, ArcFlux is a response to Theme 3: Freshwater fluxes)

The project homepage is **arcflux.eu**