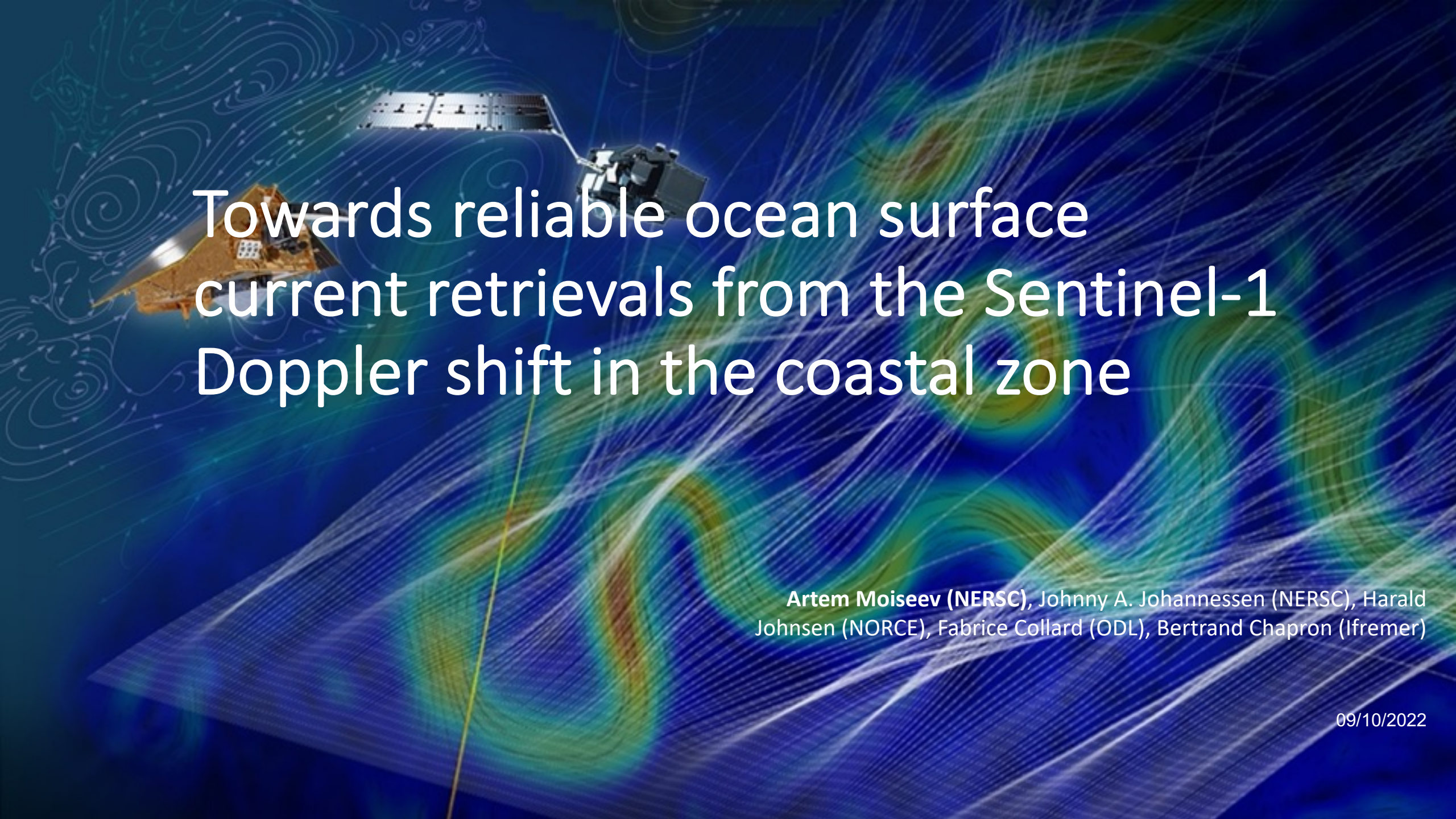

Towards reliable ocean surface current retrievals from the Sentinel-1 Doppler shift in the coastal zone

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09/10/2022

Motivation

- Reliable direct observations of the ocean surface current to support emergency marine operations, energy sector, and climate research.
- Existing ocean observing system do not always provide systematic observations with required resolution and/or coverage
- SAR Doppler shift provides high-resolution all-weather day and night measurements of the surface current radial velocity.

SAR Doppler

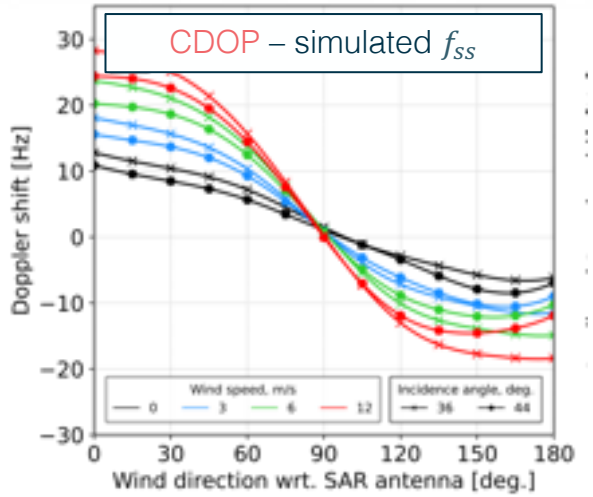
$$f_{dca} = \underbrace{(f_{ss} + f_{osc})}_{\text{Geophysical}} + \overbrace{f_{elec} + f_{att} + f_{sca} + \Delta f}^{\text{Non-geophysical}}$$

- Challenge #1: Remove all non-geophysical contributions and derive reliable geophysical
- Challenge #2: Accurately estimate and remove the sea state induced signal
- Challenge #3: Validation

Geophysical Model Function for the sea state

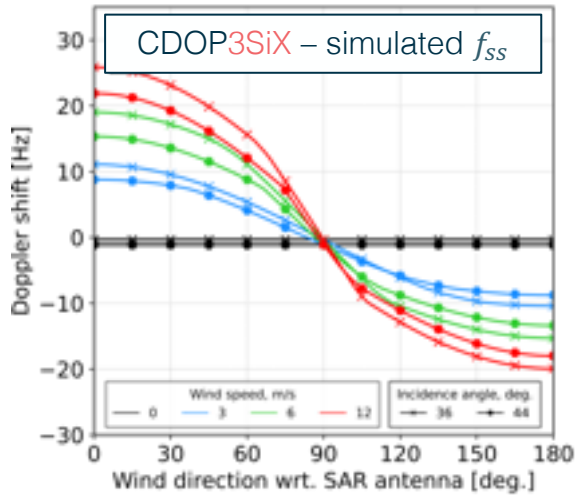
Original idea: Use an empirical GMF to predict the wind-wave-induced Doppler shift for the given wind field and radar configuration:

$$f_{ss} \approx f_{ww} = \mathrm{CDOP}(\underbrace{u_{10}, \phi}_{\text{Wind model (ECMWF)}}, \theta, p)$$



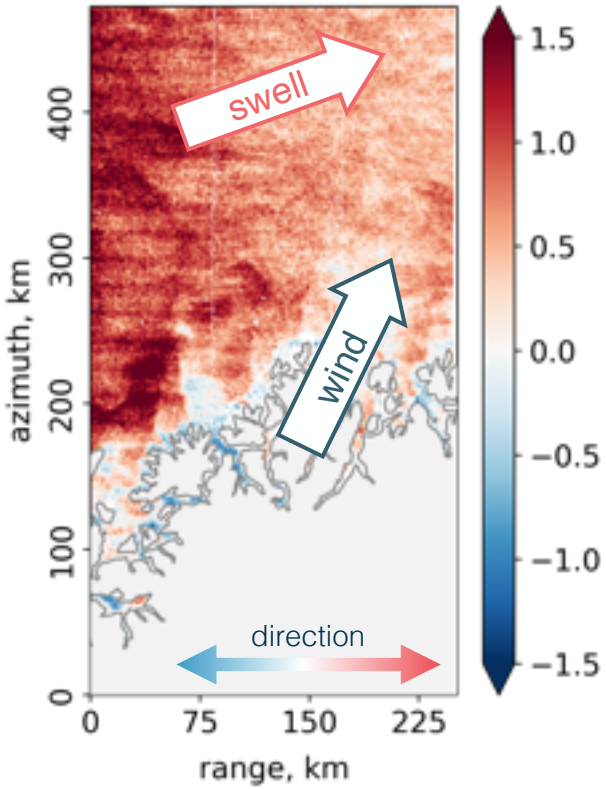
New idea: Add range directed the wind sea (x_{ws}) and swell (x_{sw}) orbital velocity to provide more realistic representation of the sea state:

$$f_{ss} = \mathrm{CDOP3SiX}(x_{10}, \underbrace{x_{ws}, x_{sw}}_{\text{Wave model}}, \theta, p)$$

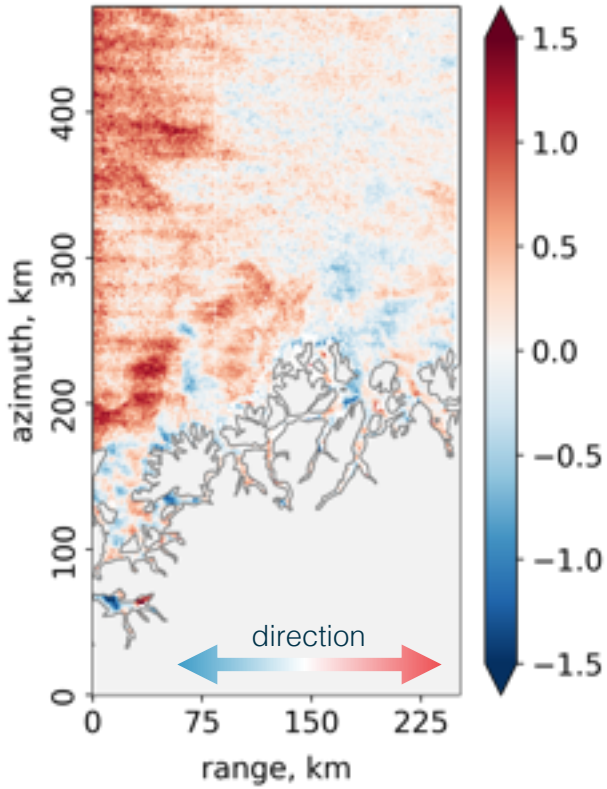


Sentinel-1B IW VV scene from 15 January 2018

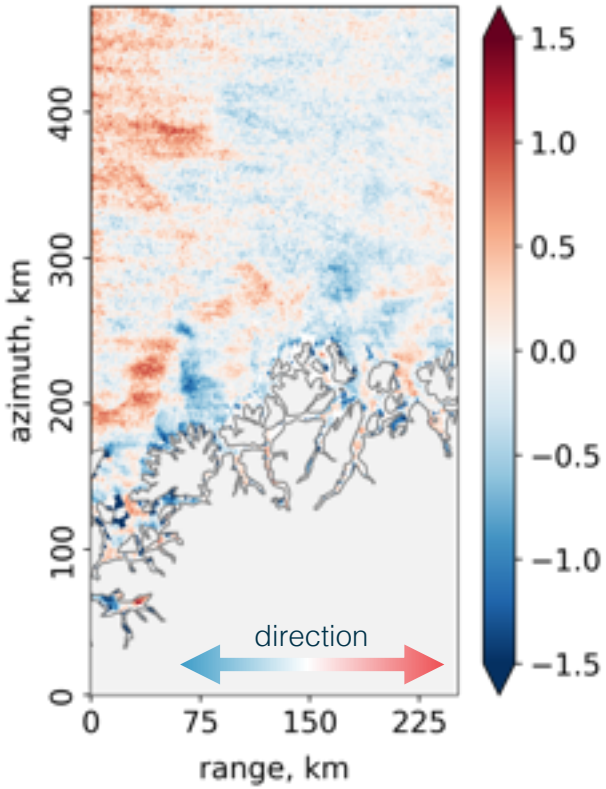
Total Surface Motion
(sea state + current)



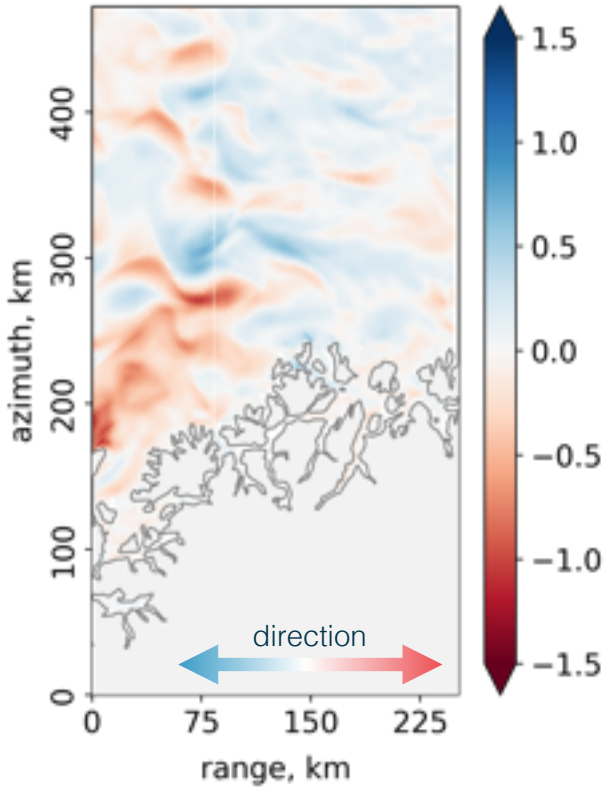
Surface Current - old
(total - CDOP)



Surface Current - new
(total – CDOP3SiX)



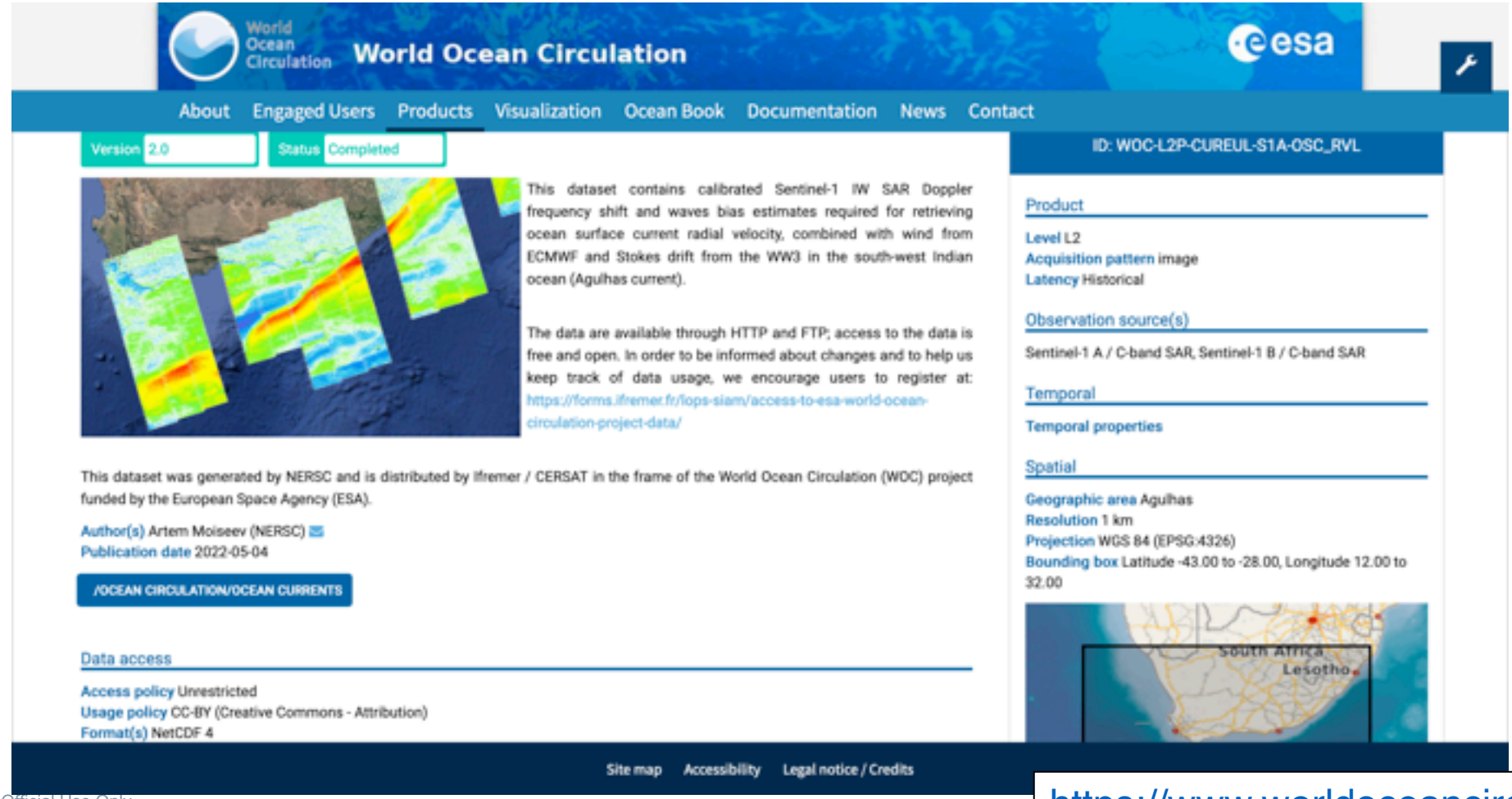
Surface Current - model
(ROMS NorShelf)



Northern Norway

Sentinel-1 IW A/B OSC RVL product

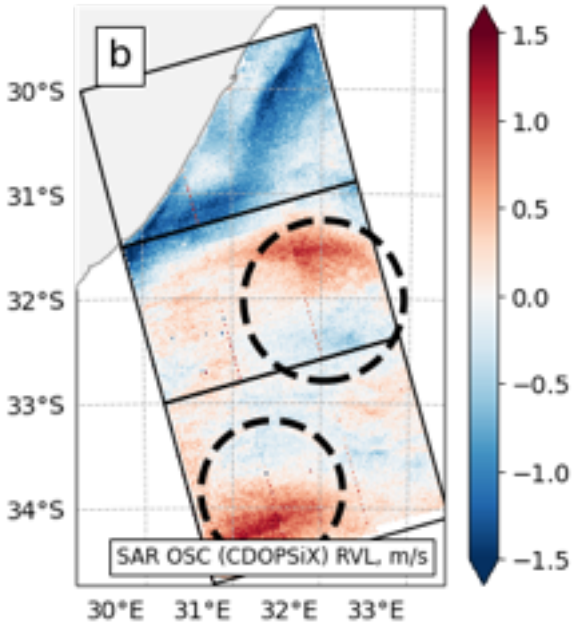
– ESA World Ocean Circulation Project: Sentinel-1A/B IW OSC RVL product (1 year - Agulhas)



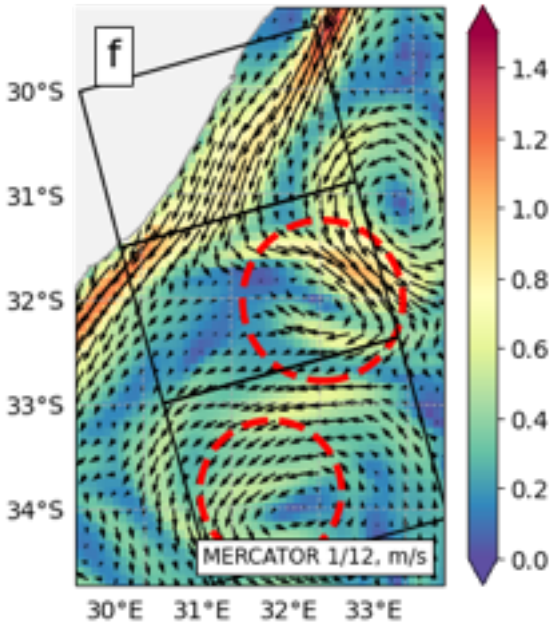
https://www.worldoceancirculation.org

Validation of the Sentinel-1 OSC retrievals

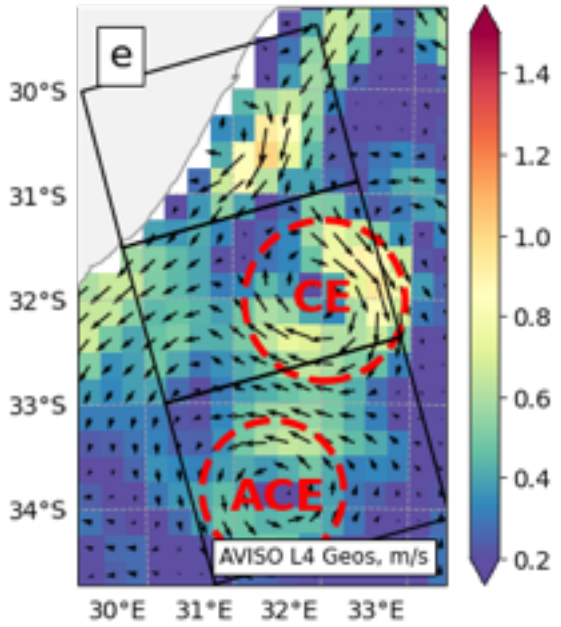
Sentniel-1
Surface Current RVL



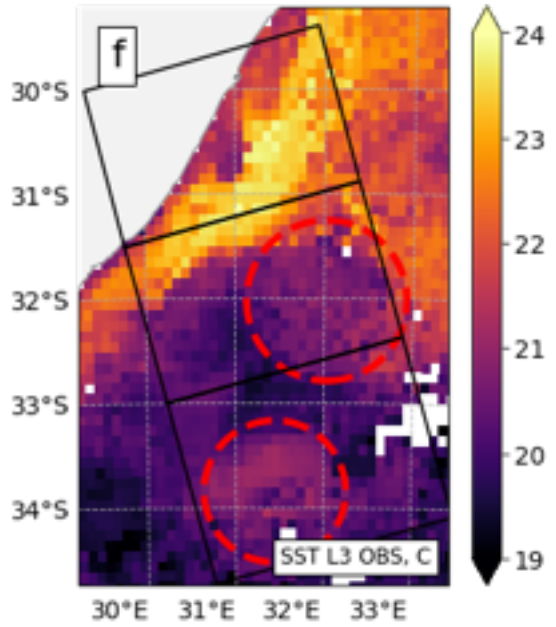
Mercator 1/12
Surface current



AVISO
Geostrophic current

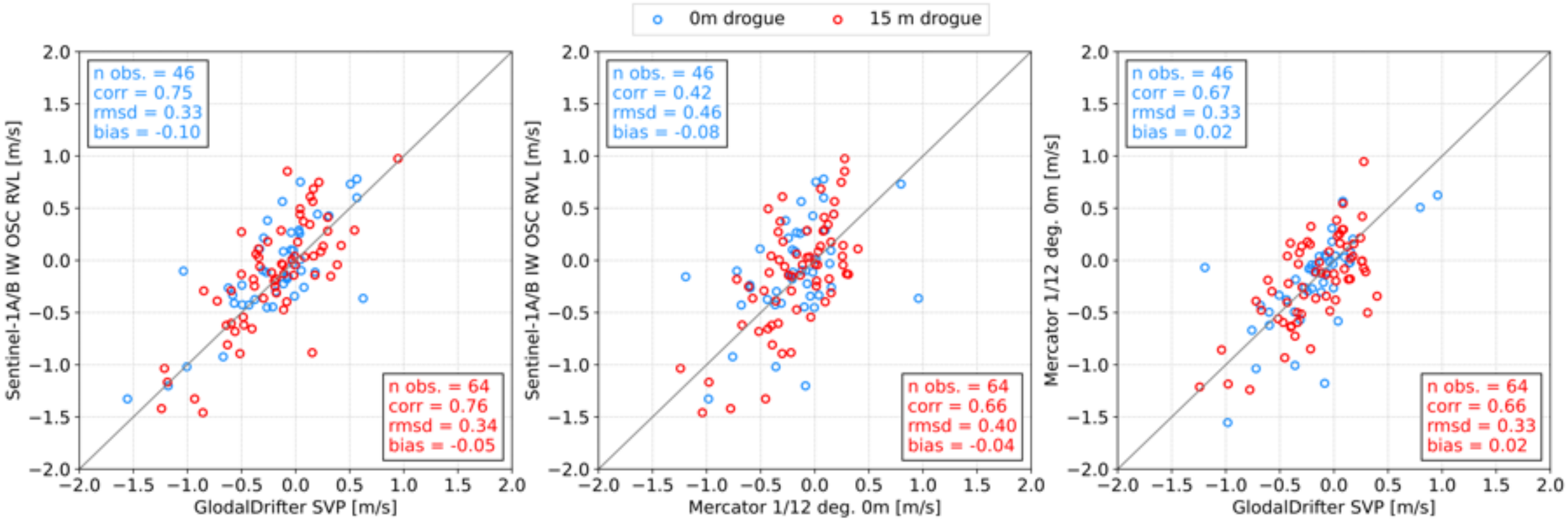


Infrared
Sea Surface Temperature



Sentinel-1A IW VV ascending pass on 14 July 2019

Sentinel-1B IW VV scene from 15 January 2018



Conclusions and outlook

New algorithm for estimating sea state induced Doppler

- Improved accuracy of surface current retrievals
- Relevant for other missions
- Simulation studies
- SAR-derived sea state?

Sentinel-1 derived RVLs are consistent with independent data

- Framework for systematic collocation and validation
- Compared with altimetry, drifters, SST, models, etc.
- Large amount of data
- Validation campaign?

SAR-derived surface currents for monitoring and marine operations

- Emergency response
- Operational oceanography and Climate
- Data assimilation?
- Reprocessing of Sentinel-1 archive?