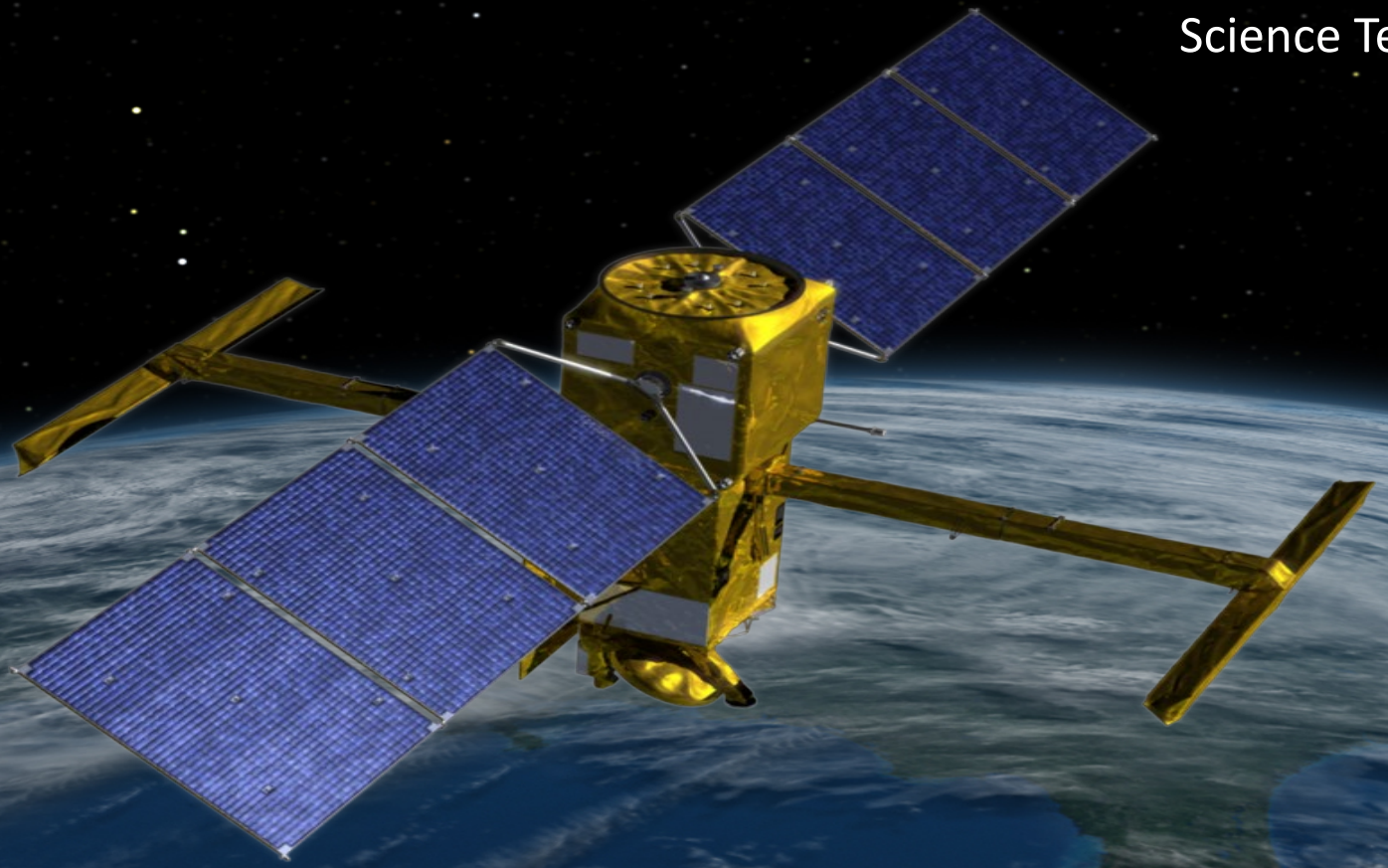
Surface Water and Ocean Topography (SWOT) Mission

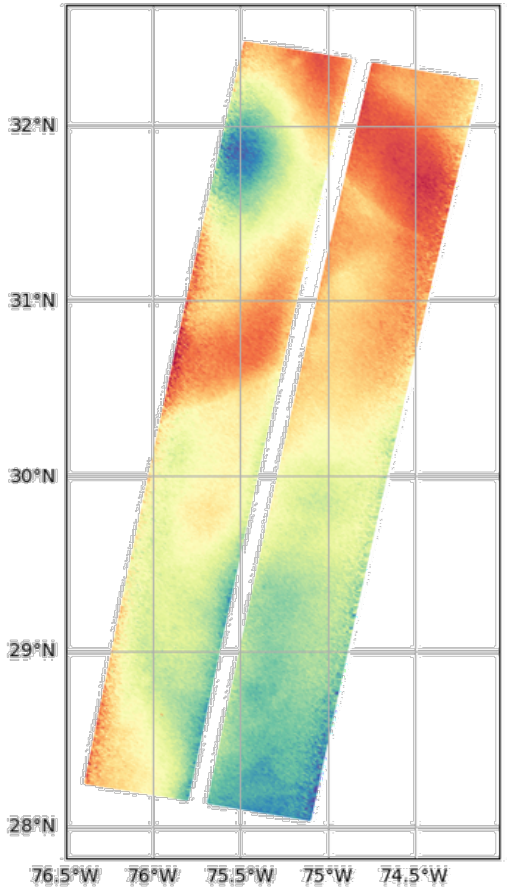
Science Team, September 2023, Toulouse

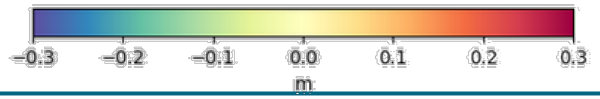


A –very– first glimpse in Sigma0 signatures.

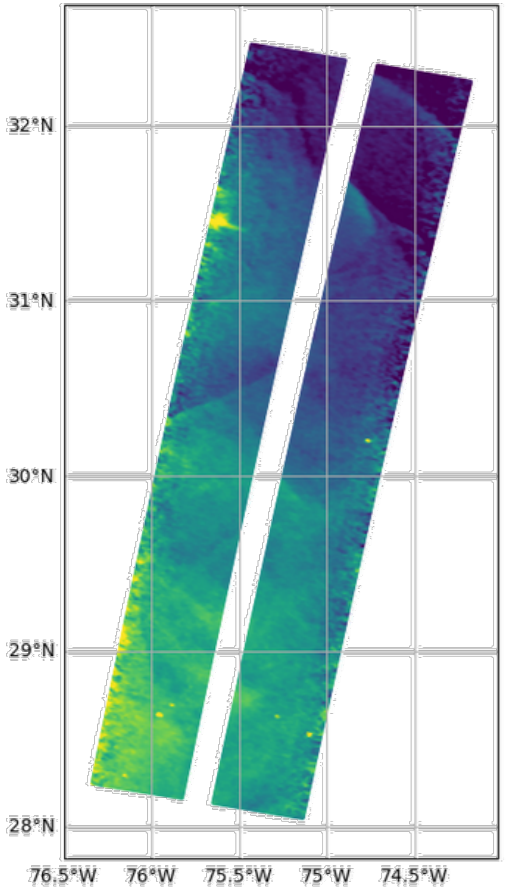
SWOT/SAR: sigma 0, and much more.

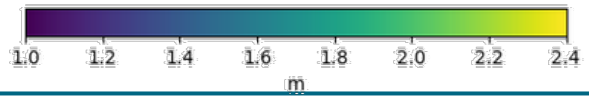
Topography



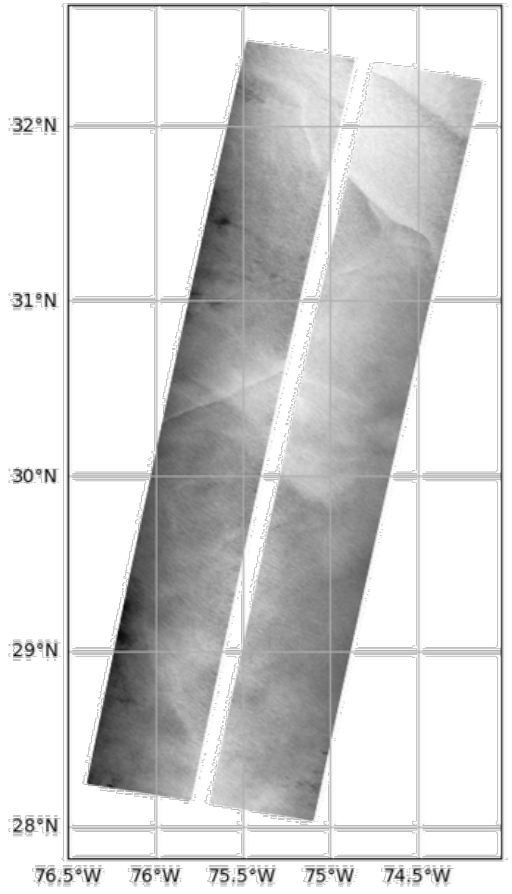


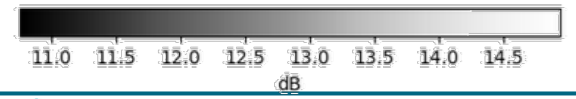
Waves





sigma0

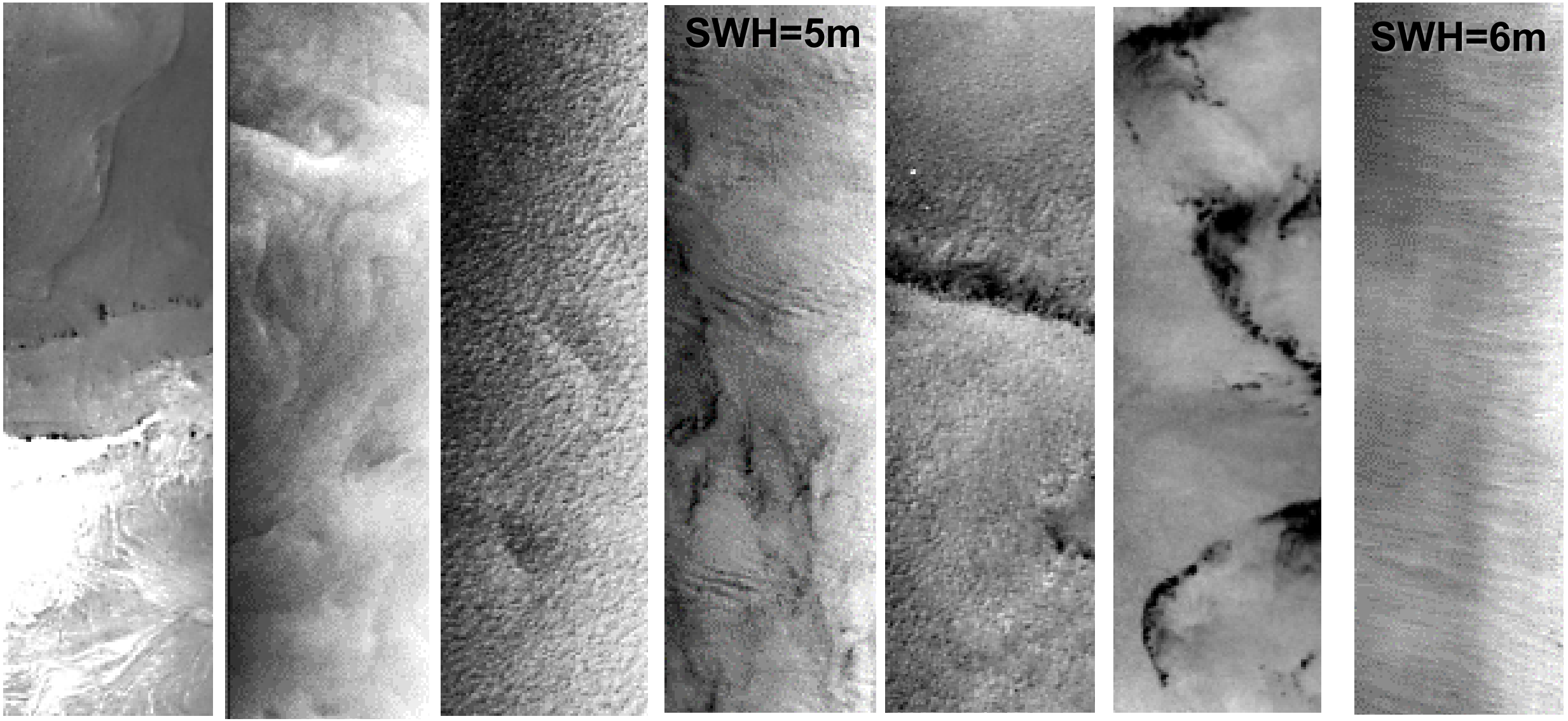




New opportunities to interpert the topography the light of sig0 (and waves) maps.

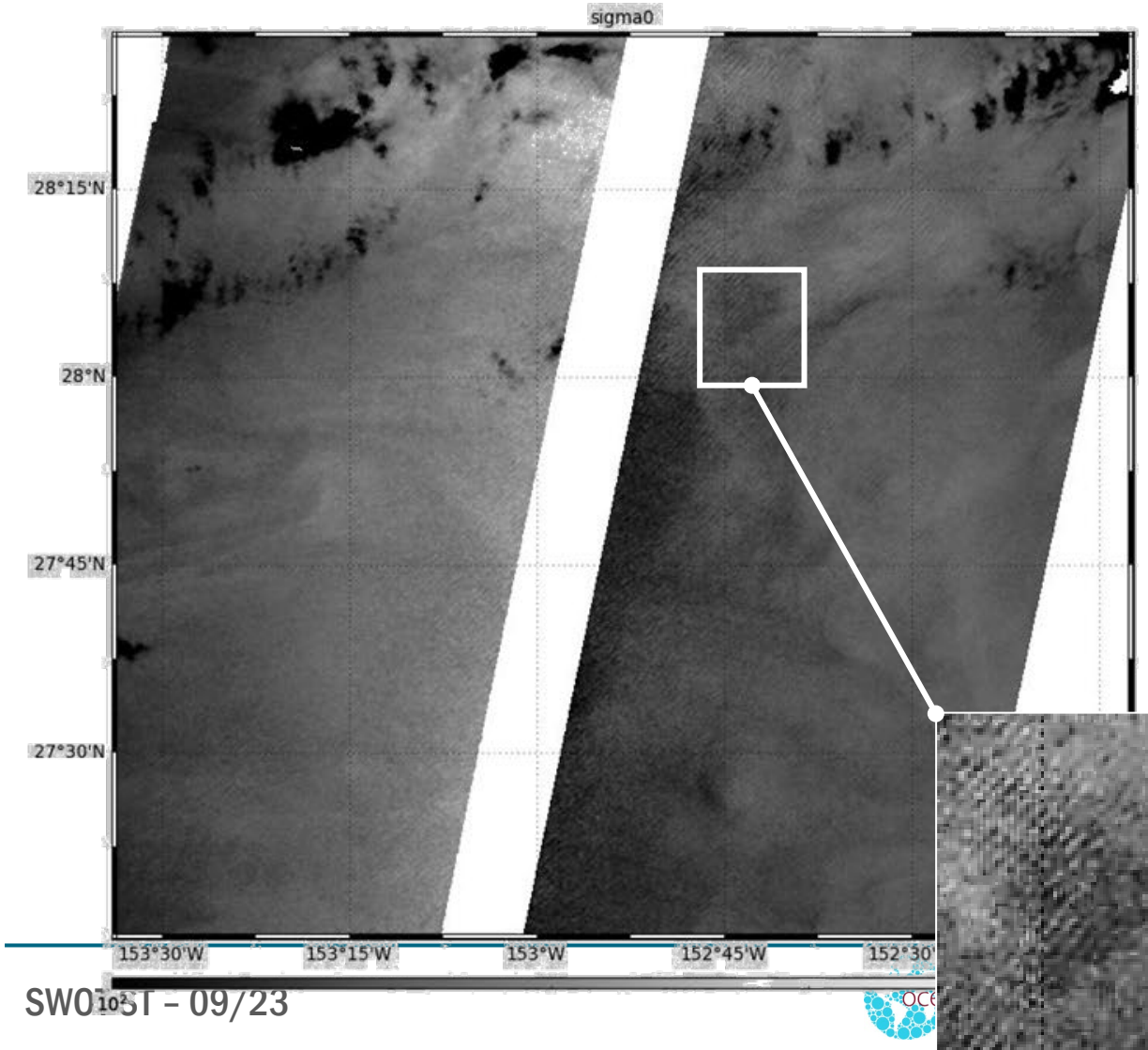
- and vice-versa.

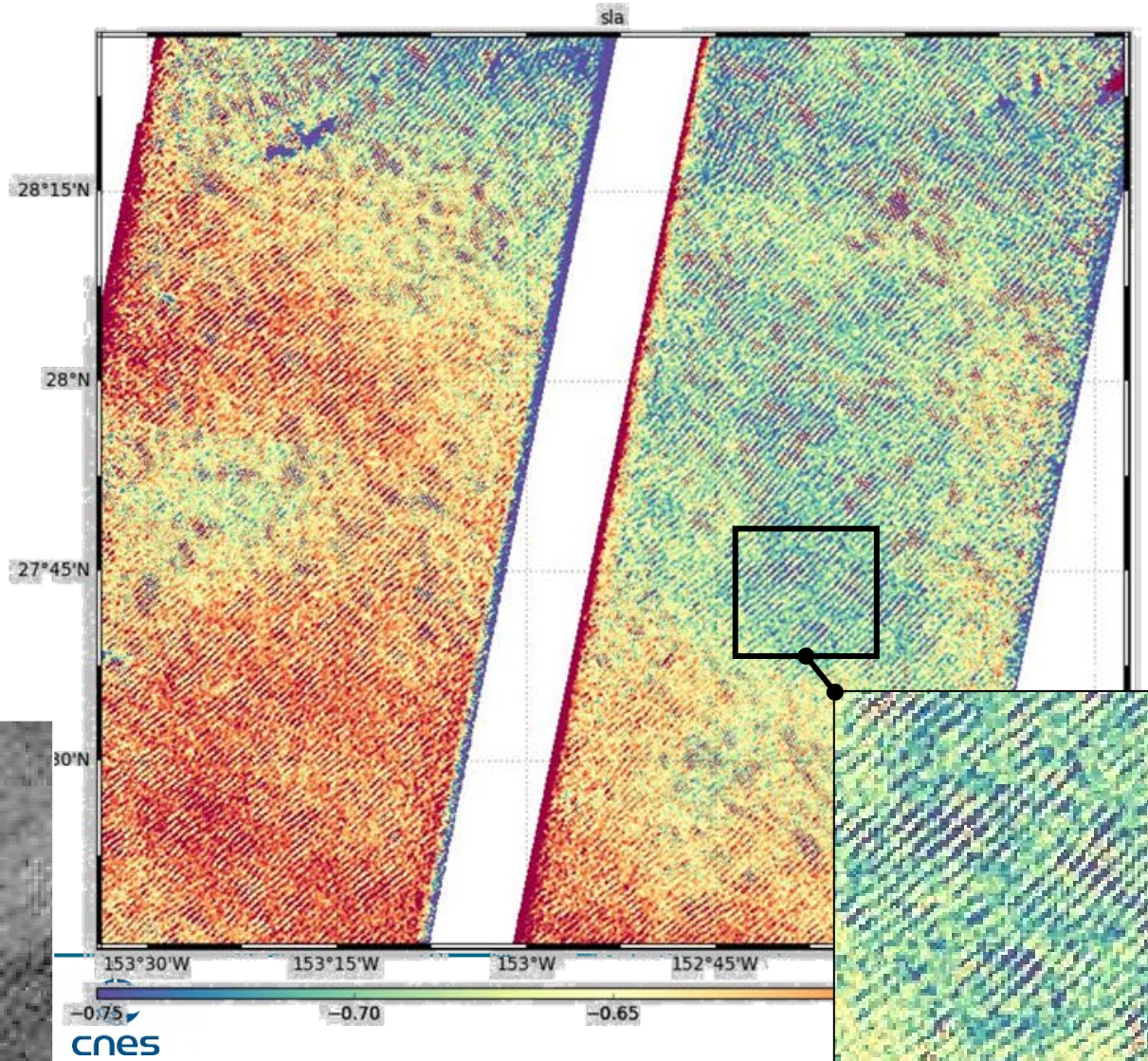
Surface/atmosphere conditions portfolio



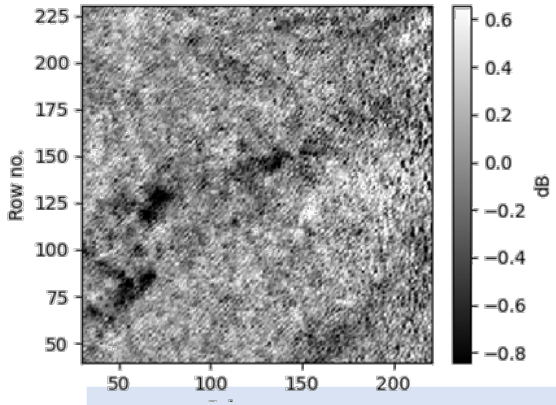
Swell signature in 250m product: stripes and wave groups

→ The signature of (very) long swells is expected in KaRIn's 250m product
→ Rare occurrence because swells are attenuated by the OBP smoothing and further smoothing from 250-m to 2-km
→ Advantage of 2D image: KaRIn data can be used to characterize the properties of swells (and to process data accordingly)



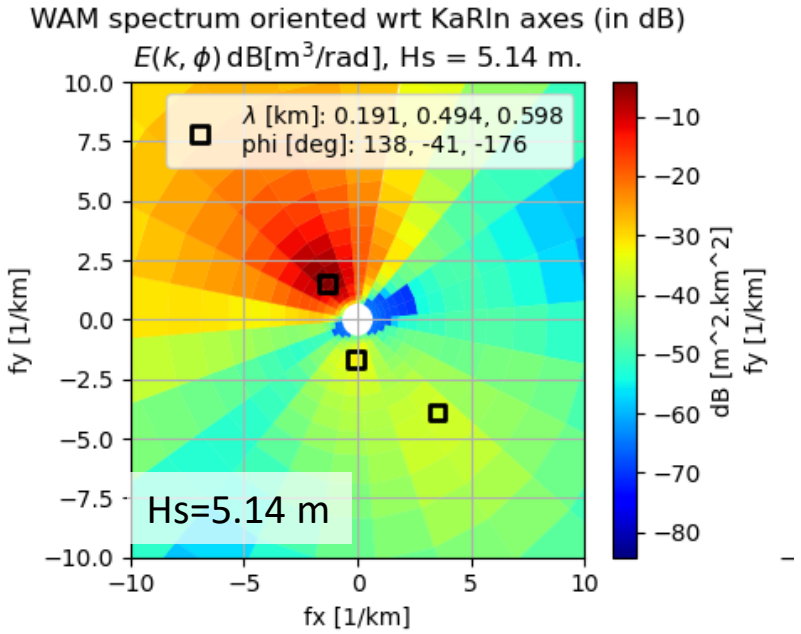


Swells: transformation of wave spectra

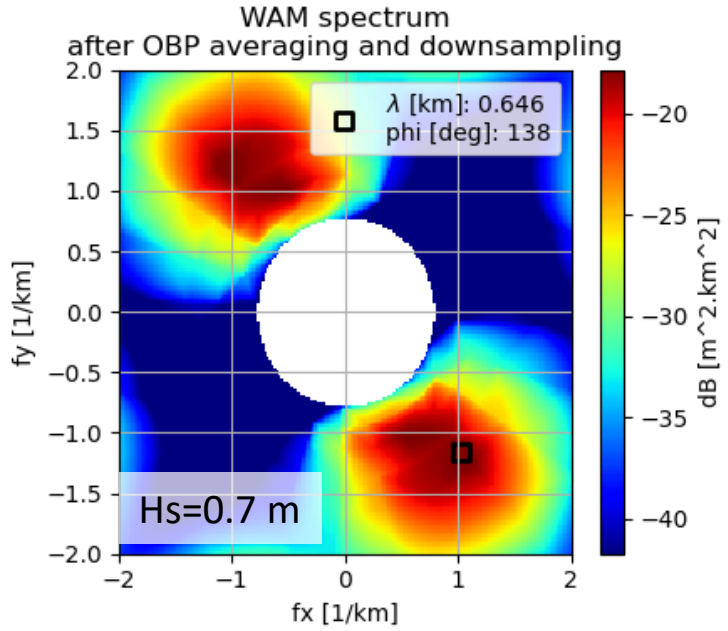


The instrument system and On-Board processor transform the observed wave spectra, once for all.

Processing of MFWAM

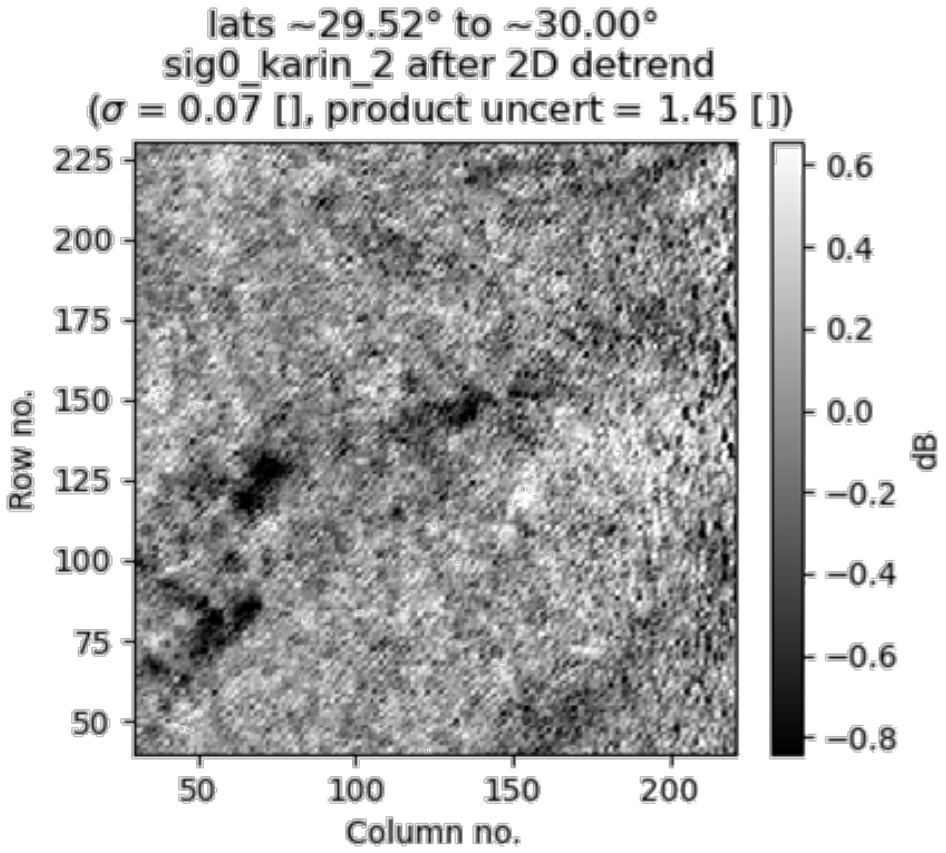


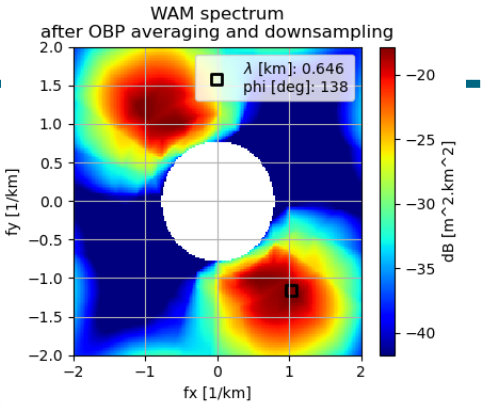
MFWAM as seen by KaRIN

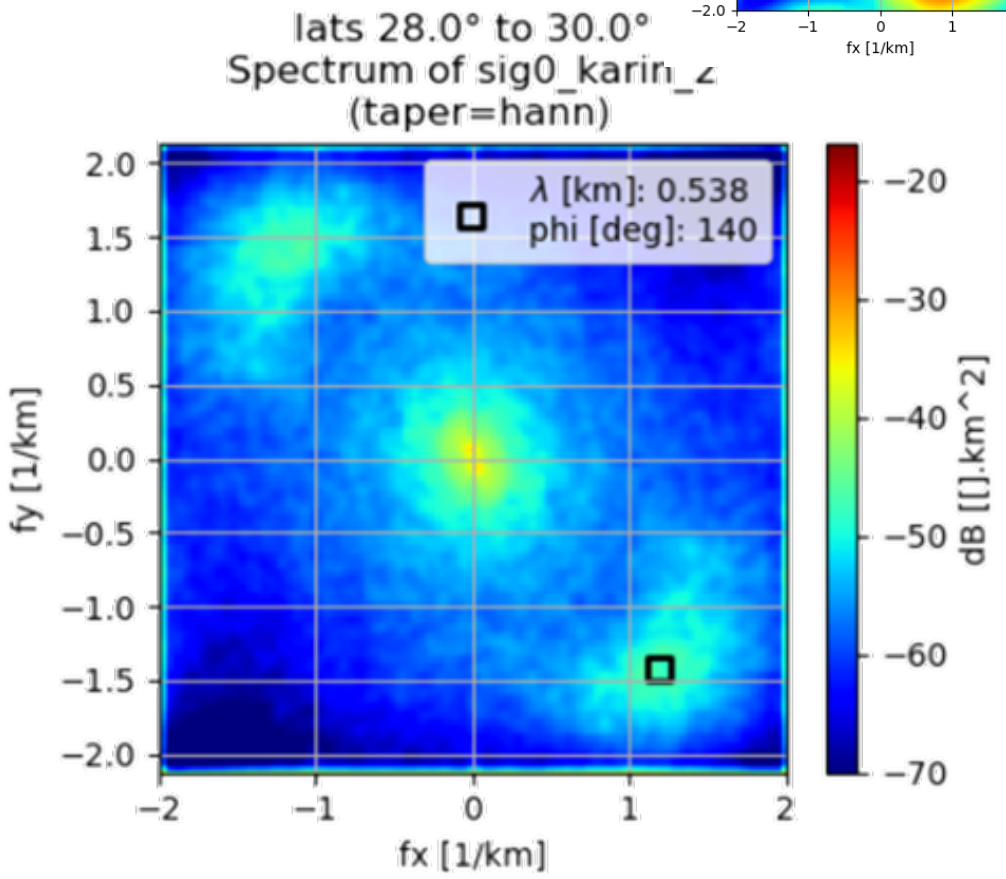


The observed of hundreds of meters features cannot be interpreted straightforwardly.

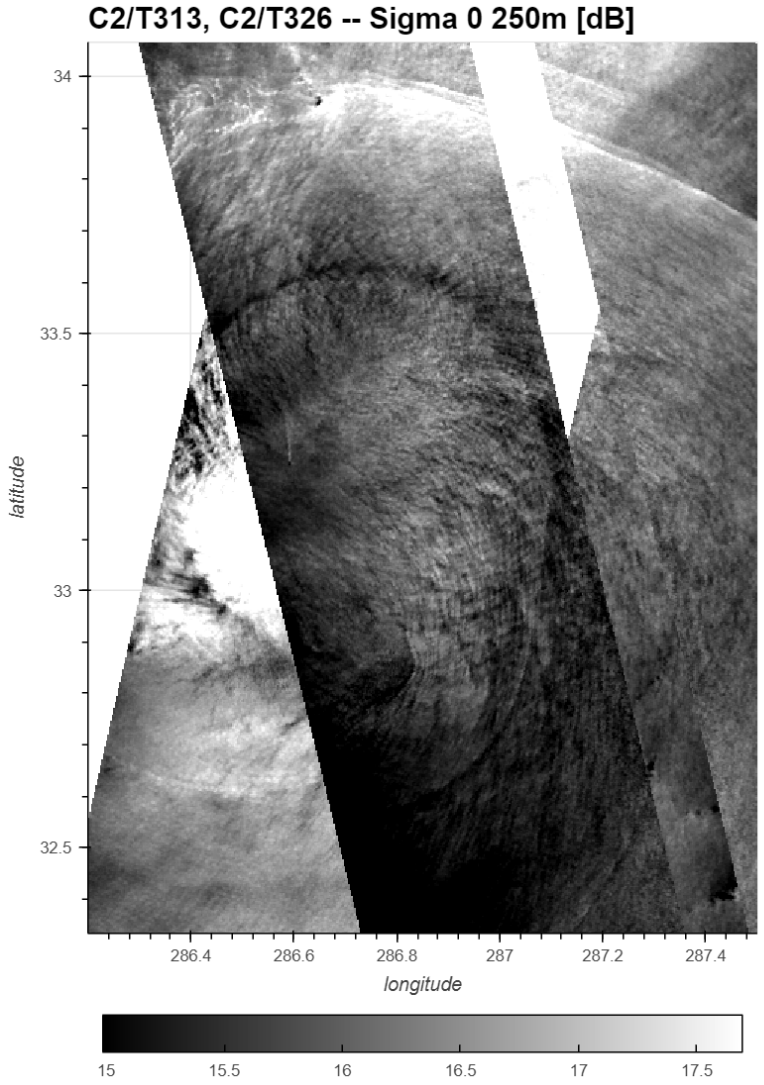
Swell signature spectrum





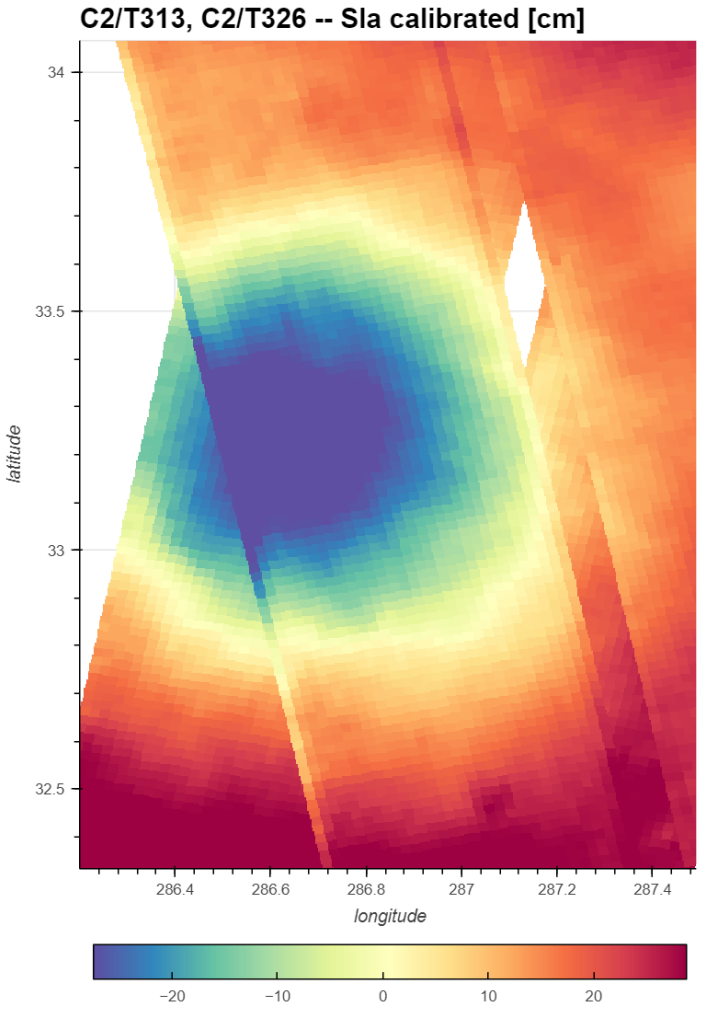


Cycle 2- Track 313+326

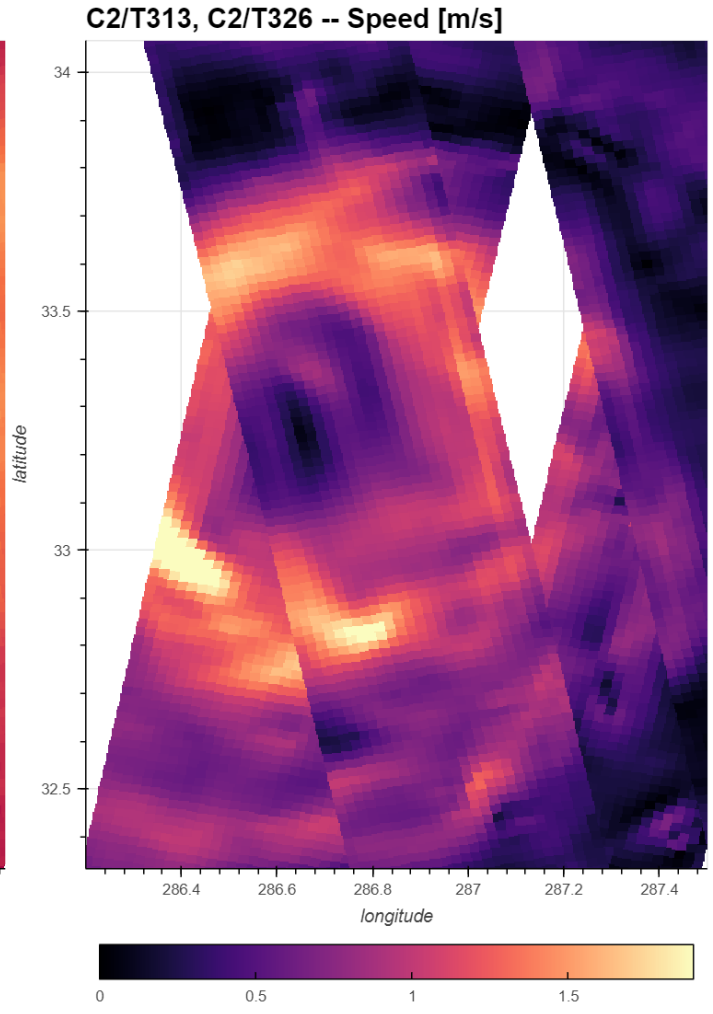


50-km Eddy

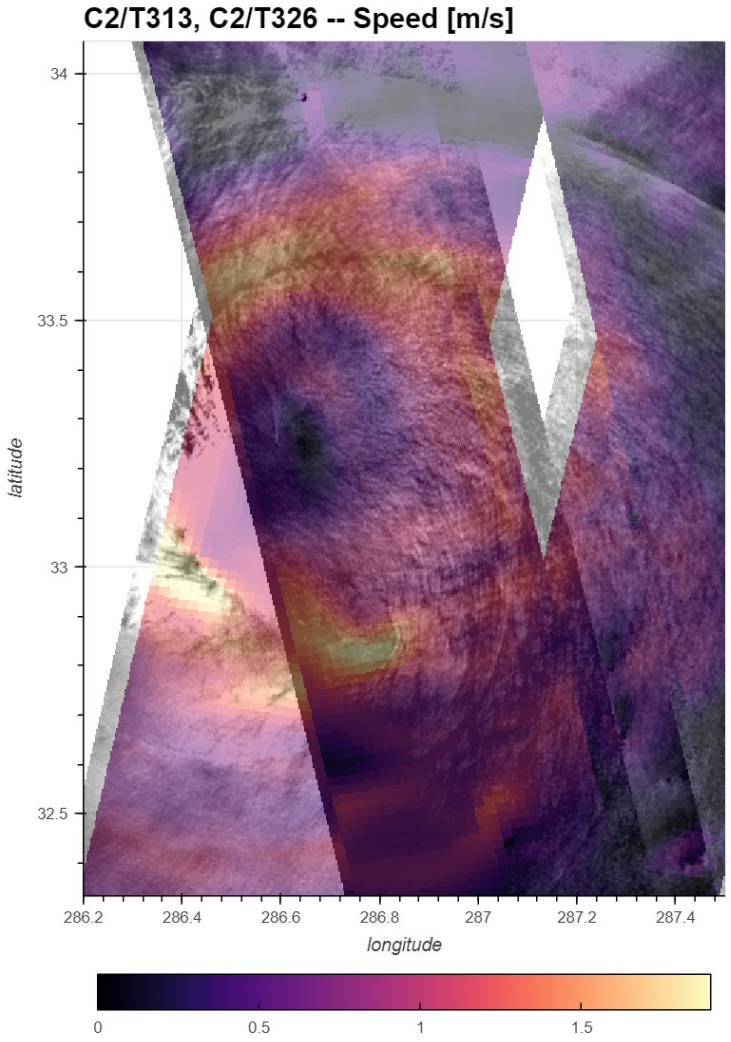
SLA



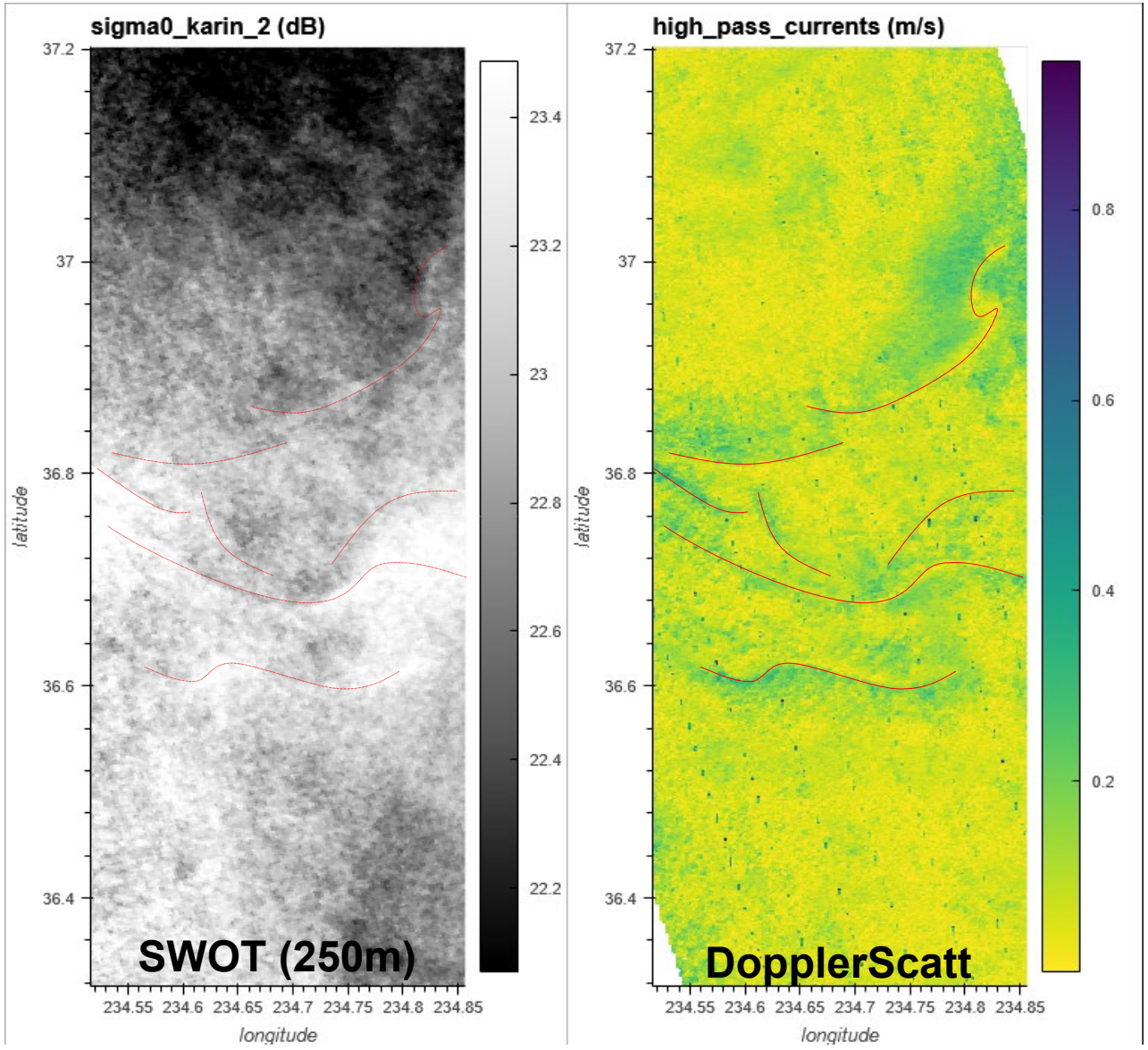
Geostrophic velocities (from SLA)



With sig0 in transparency

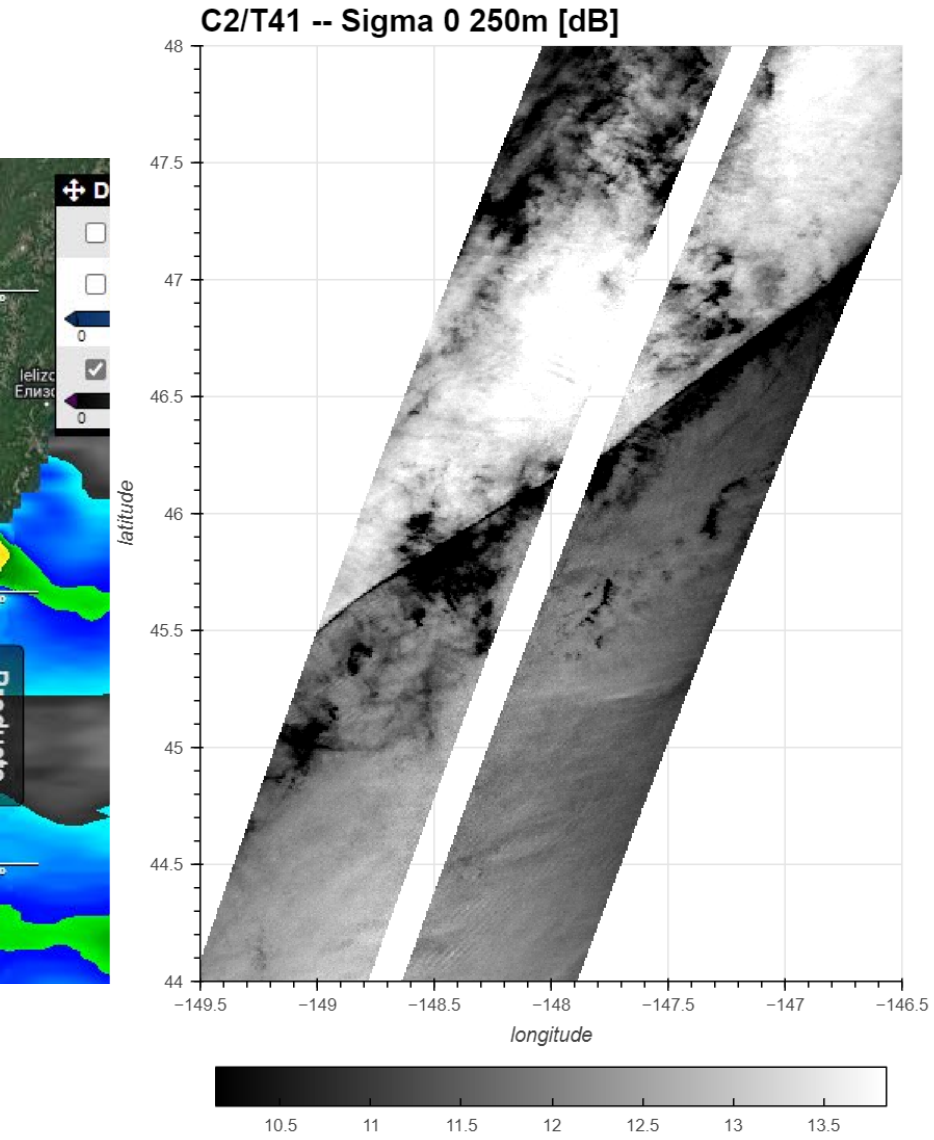


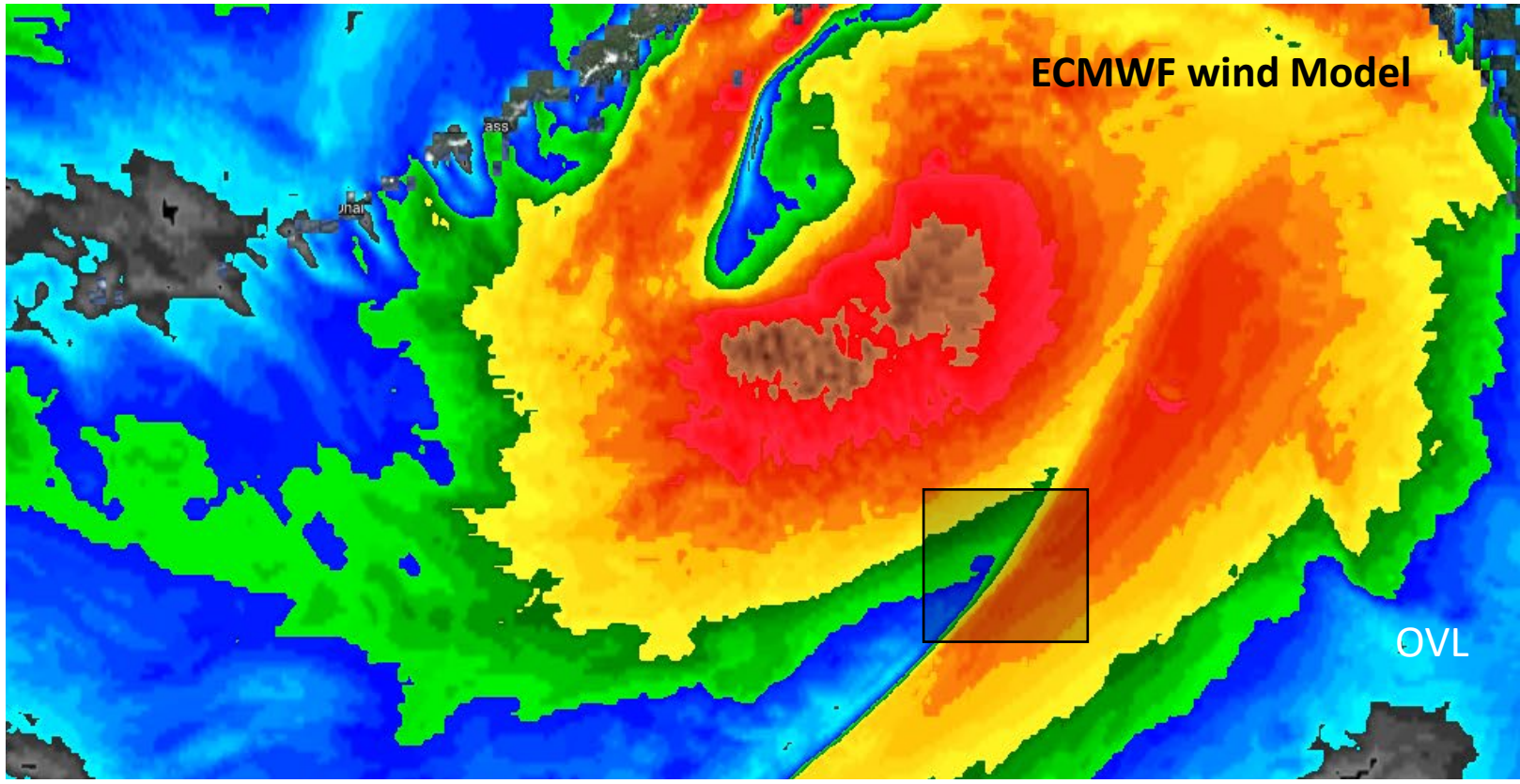
Sig0 and currents: Dopplerscatt overflight



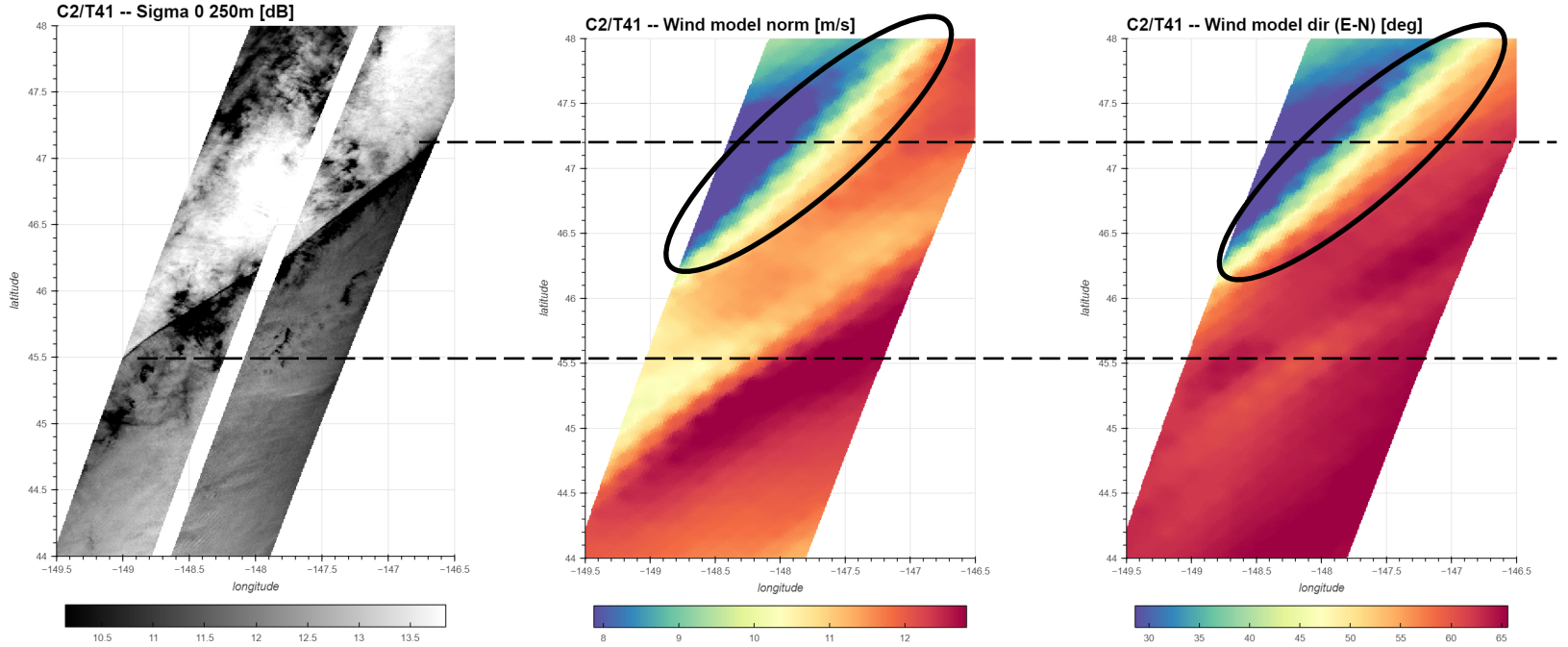
S-MODE / DopplerScatt (courtesy of E.Rodriguez)

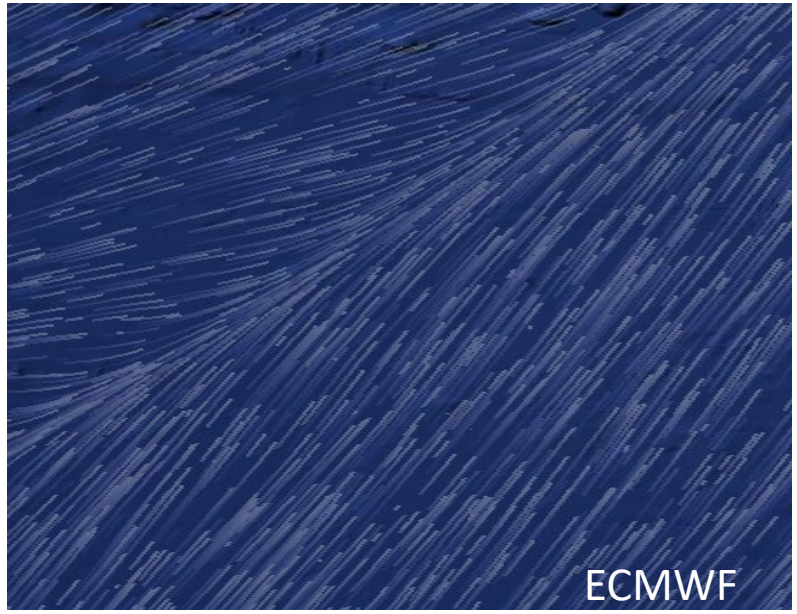
Cycle 2 Track 41





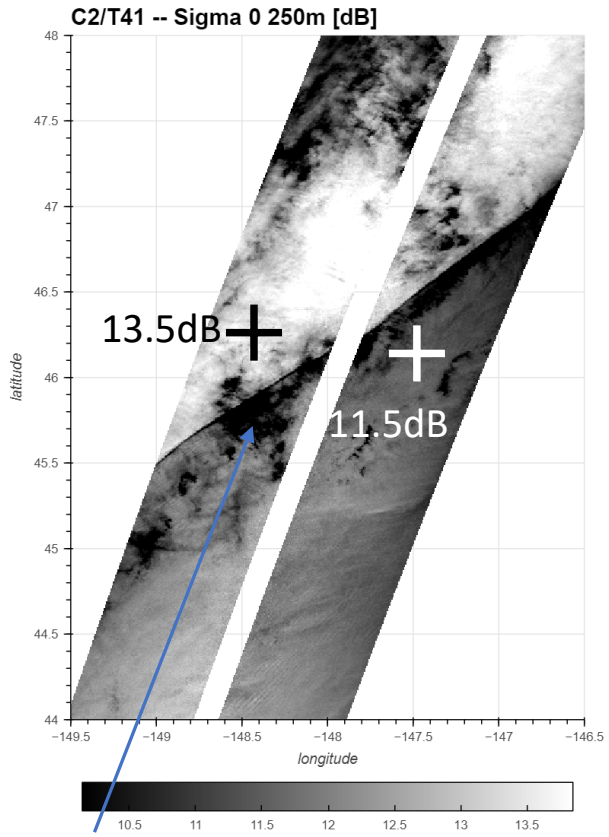
Wind front ?

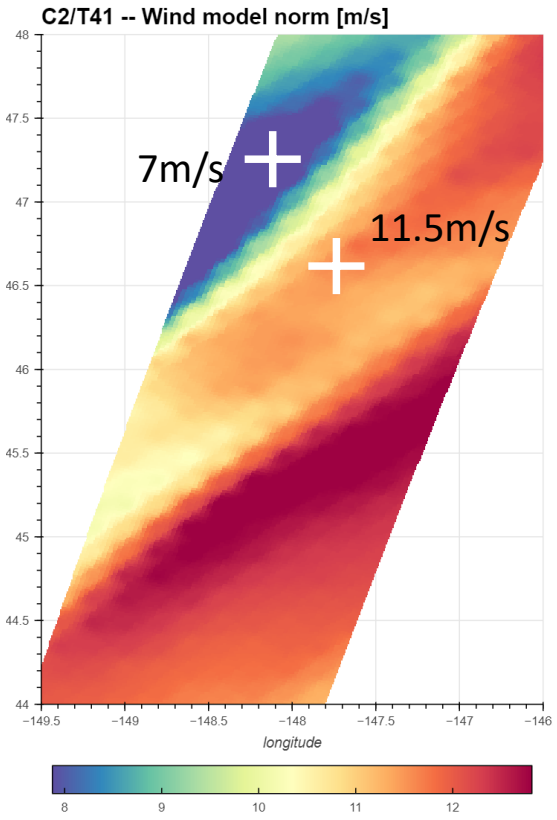


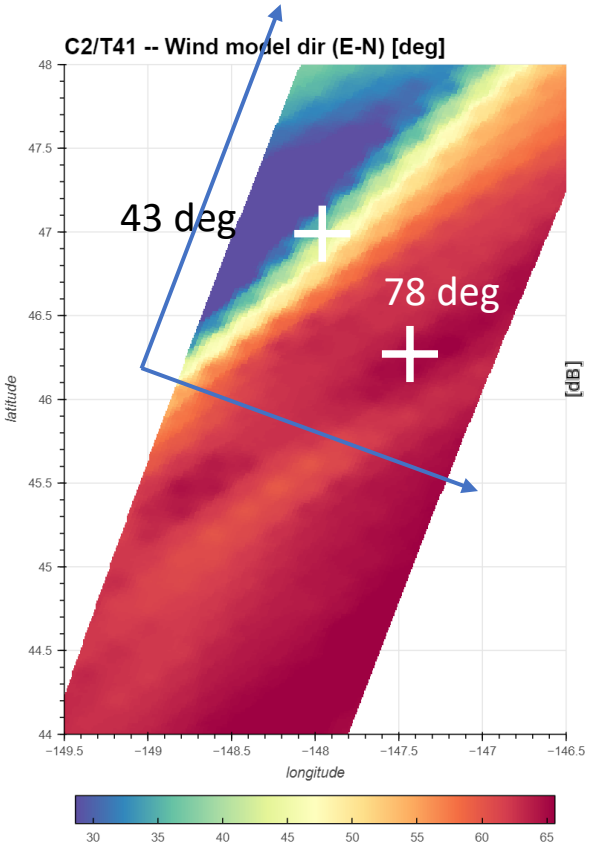


ECMWF Model actualy sees a wind front – But location does not match.
The dynamic in the model seems loosy.

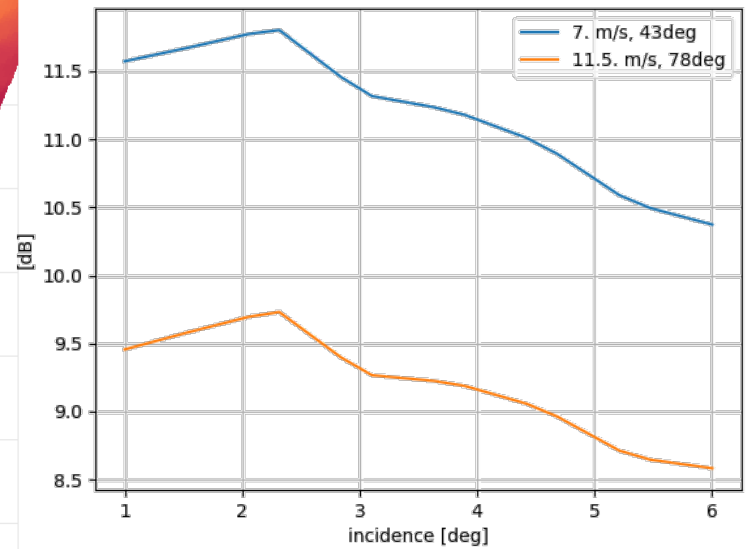
Wind front !







Note: Karin winds should show that directly, after “Fall” reprocessing



NRCS theory from GPM data (Hossan et al., 2021), parametrized with wind model

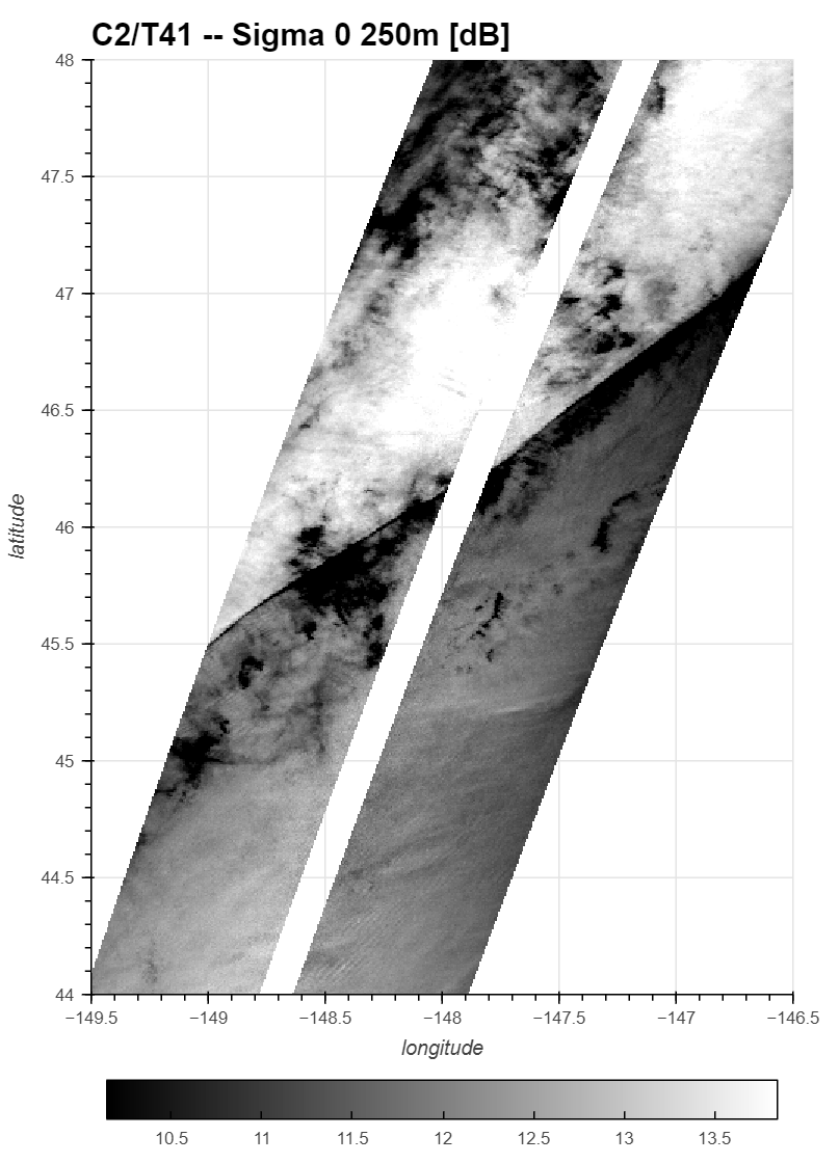
Clouds ?

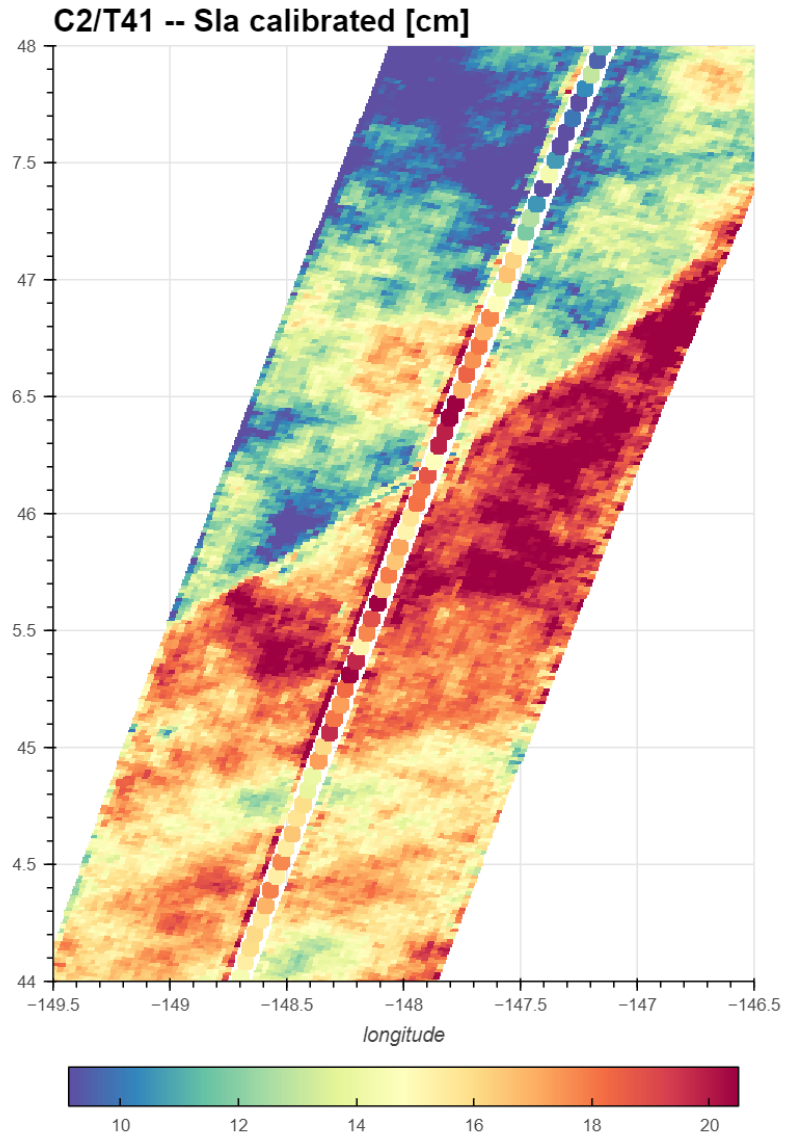
2dB of difference

The 2dB of difference in the sig0 image can be explained with the wind front

Hossan, A., & Jones, W. L. (2021). Ku- and Ka-Band Ocean Surface Radar Backscatter Model Functions at Low-Incidence Angles Using Full-Swath GPM DPR Data. *Remote Sensing*

Wind front





→ Apparent intense SSHA offset: 10 cm over a few kilometers

→ For context, this would be like a tsunami propagating in the Pacific (none here, we double-checked)

→ Can it be true SSHA ?

→ SSB correction is here using the wind model. (see next slide)

A step aside to talk about SSB and its correction.

First comment: Operationnal SSB correction is correct at least at 0-th order, (checked with SWOT NADIR).
We discuss here of what can happen in snapshots with fancy patterns.

SSB modeling
SSB(SWH, wind)

True SSB is only partially correlated with sig0

Sig0 modeling
sig0(wind, atmosphere, geostrophic currents, other currents)

KaRIN winds from sig0

If pixels with atmosphere and currents are kept

Winds are biased

SSB correction using wind model

SSB Correction miss the fine scales and can mislocate fetaures.

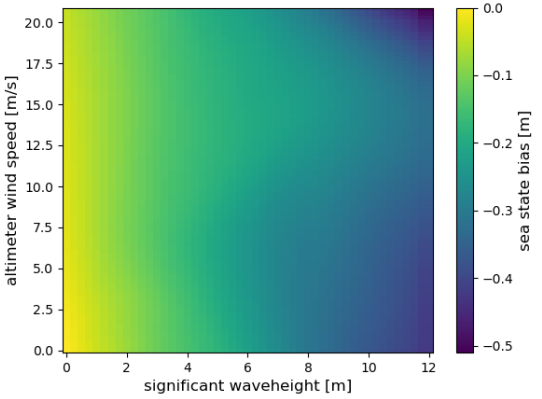
Actual correction used in images for this presentation

SSB correction using KaRin winds

SSB Correction is biased*

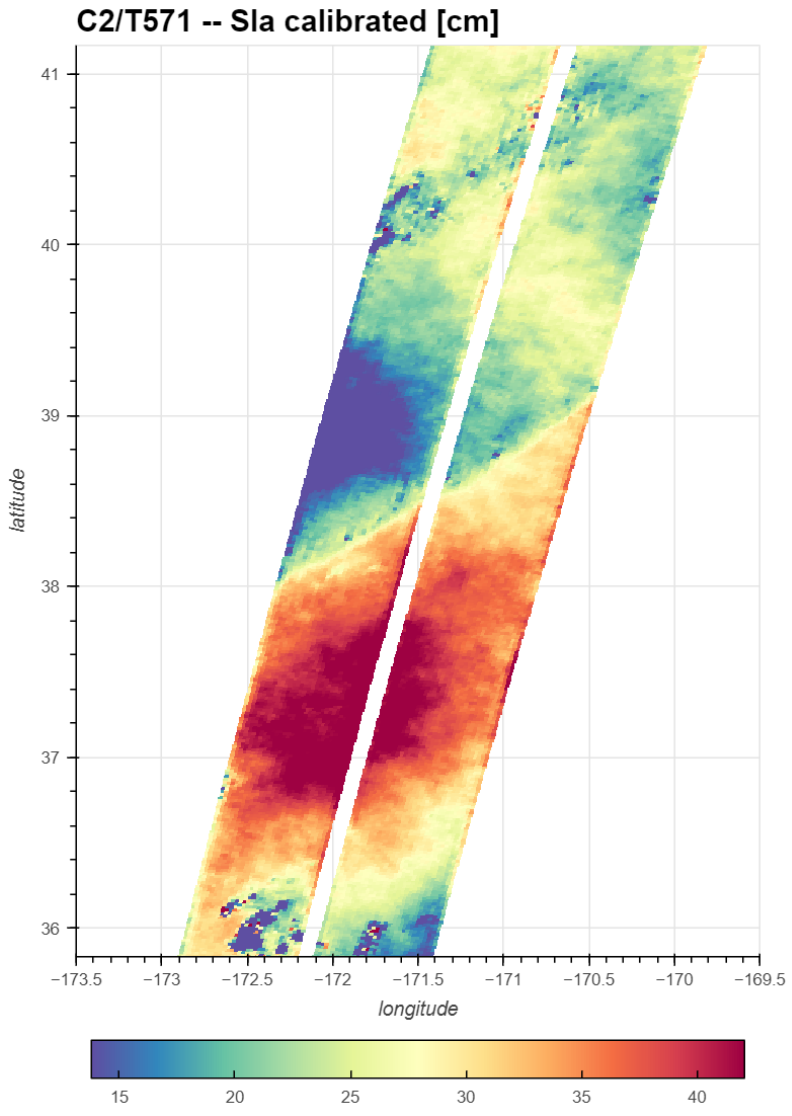
Biases can be correlated to SSHa

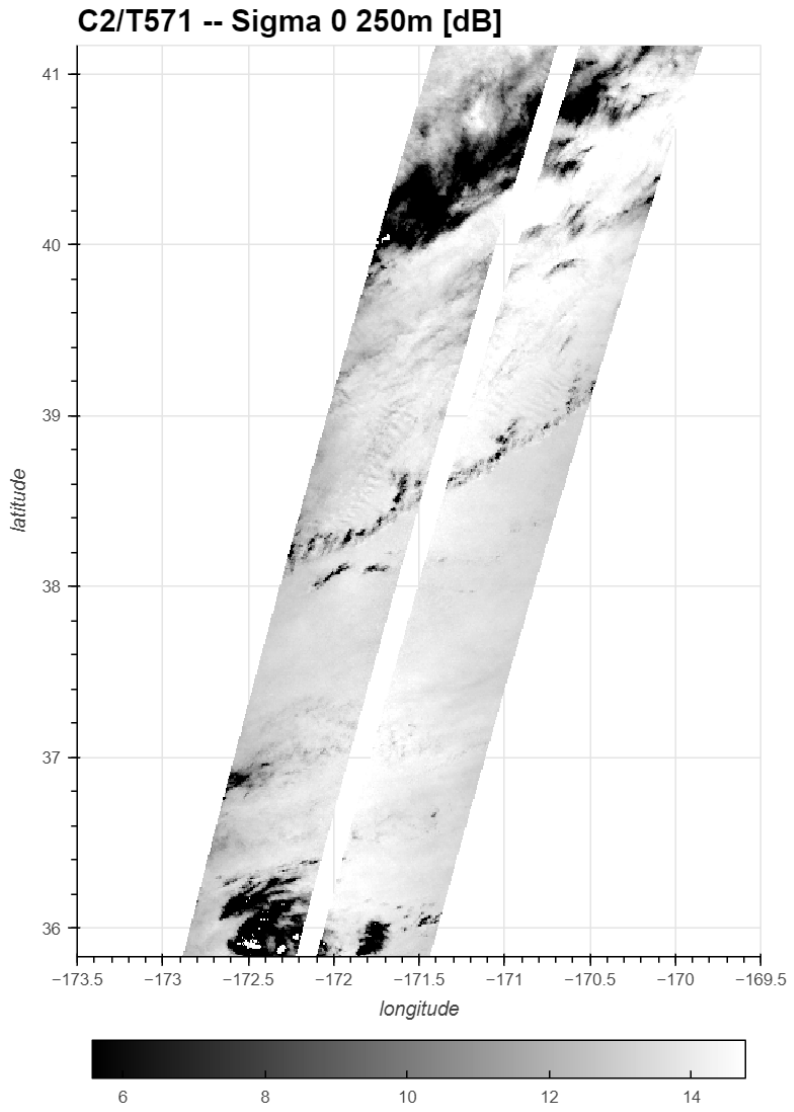
* With current (AltiKA based) SSB correction table, **the sensitivity to wind is low.**

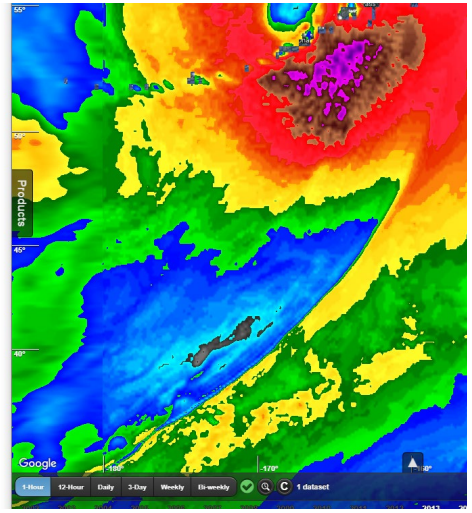


Identifying all SSB sources is important to refine this very simple rationale.

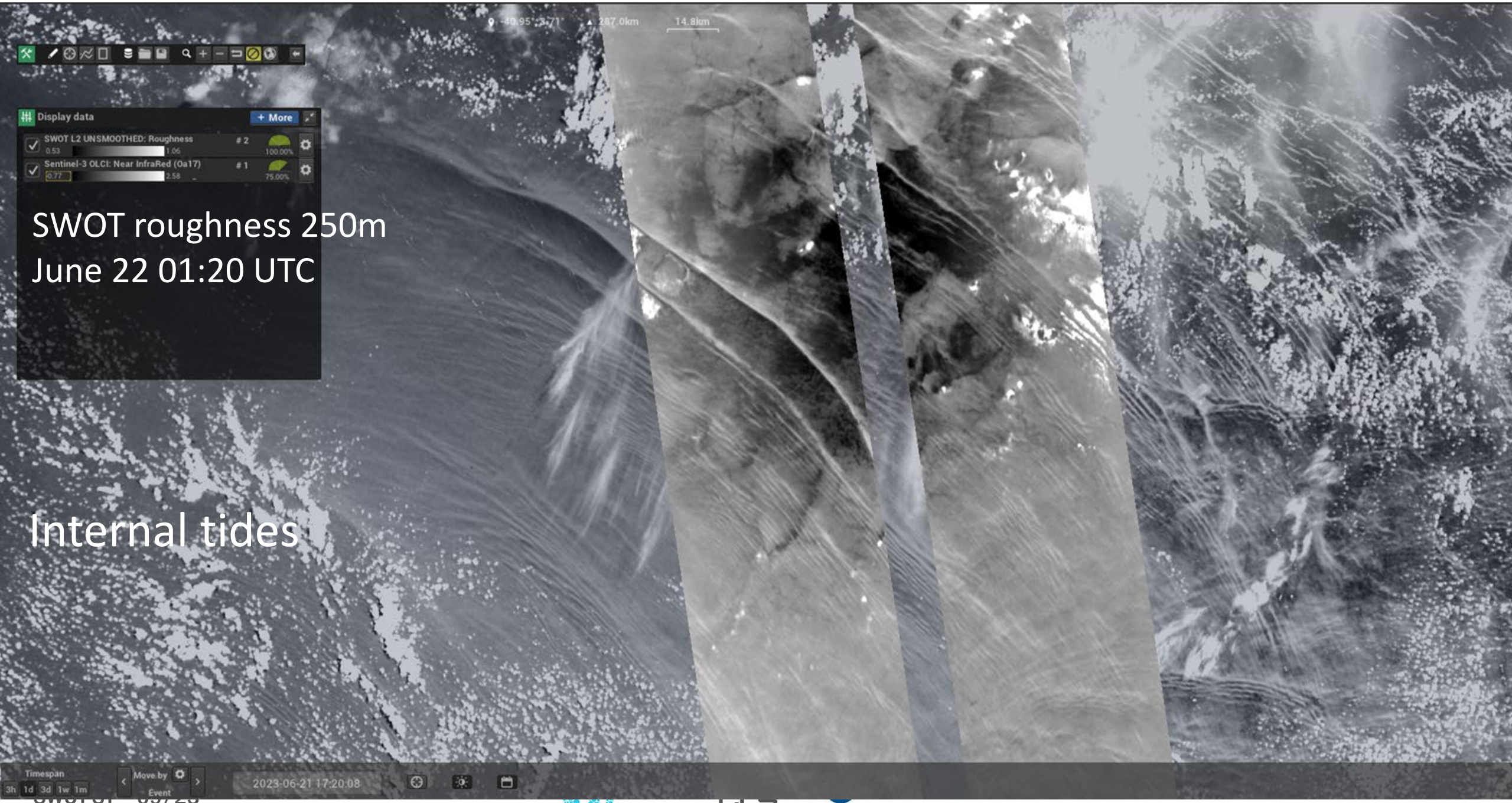
Same SSHa feature, no sig0 front

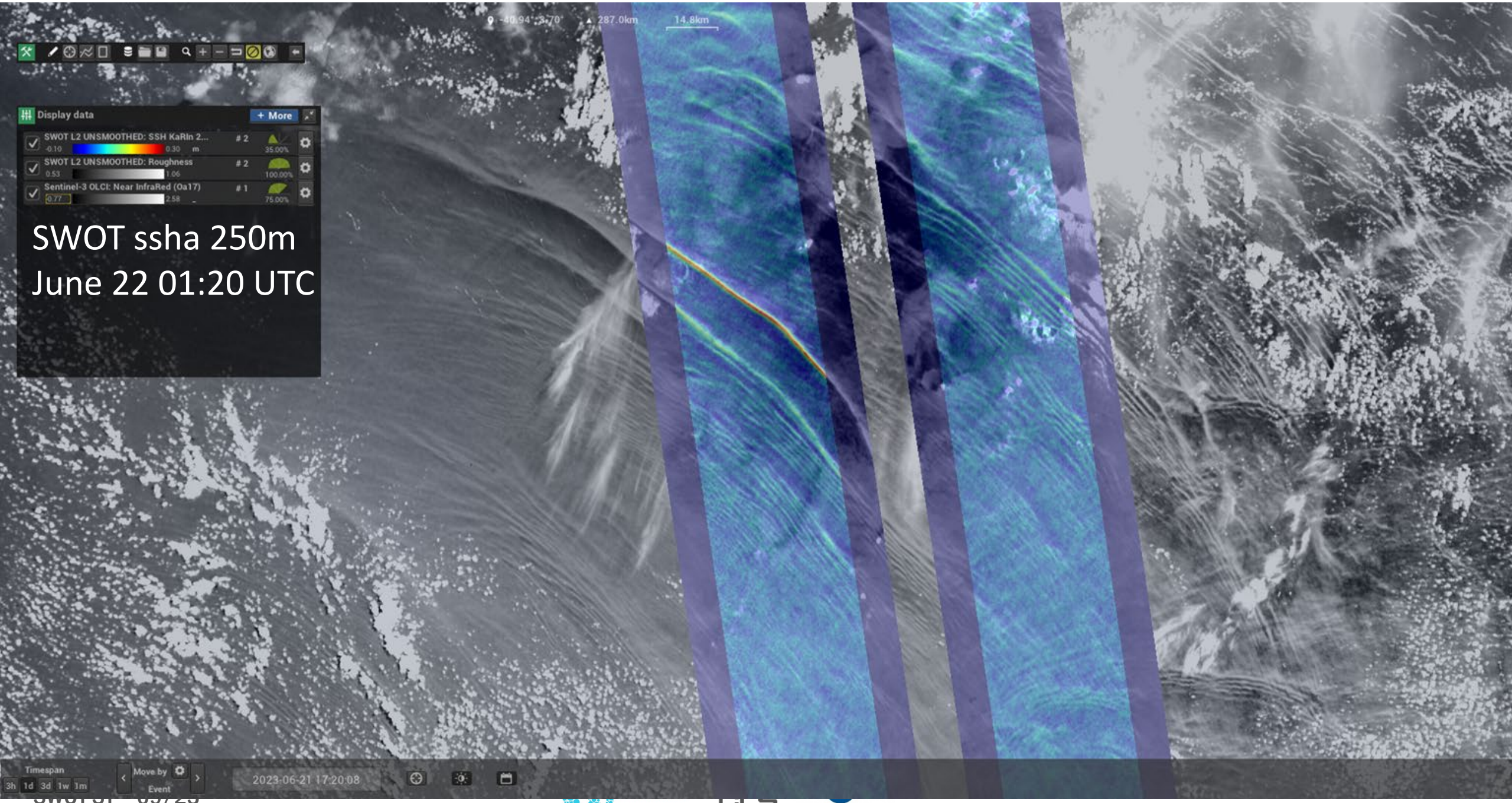


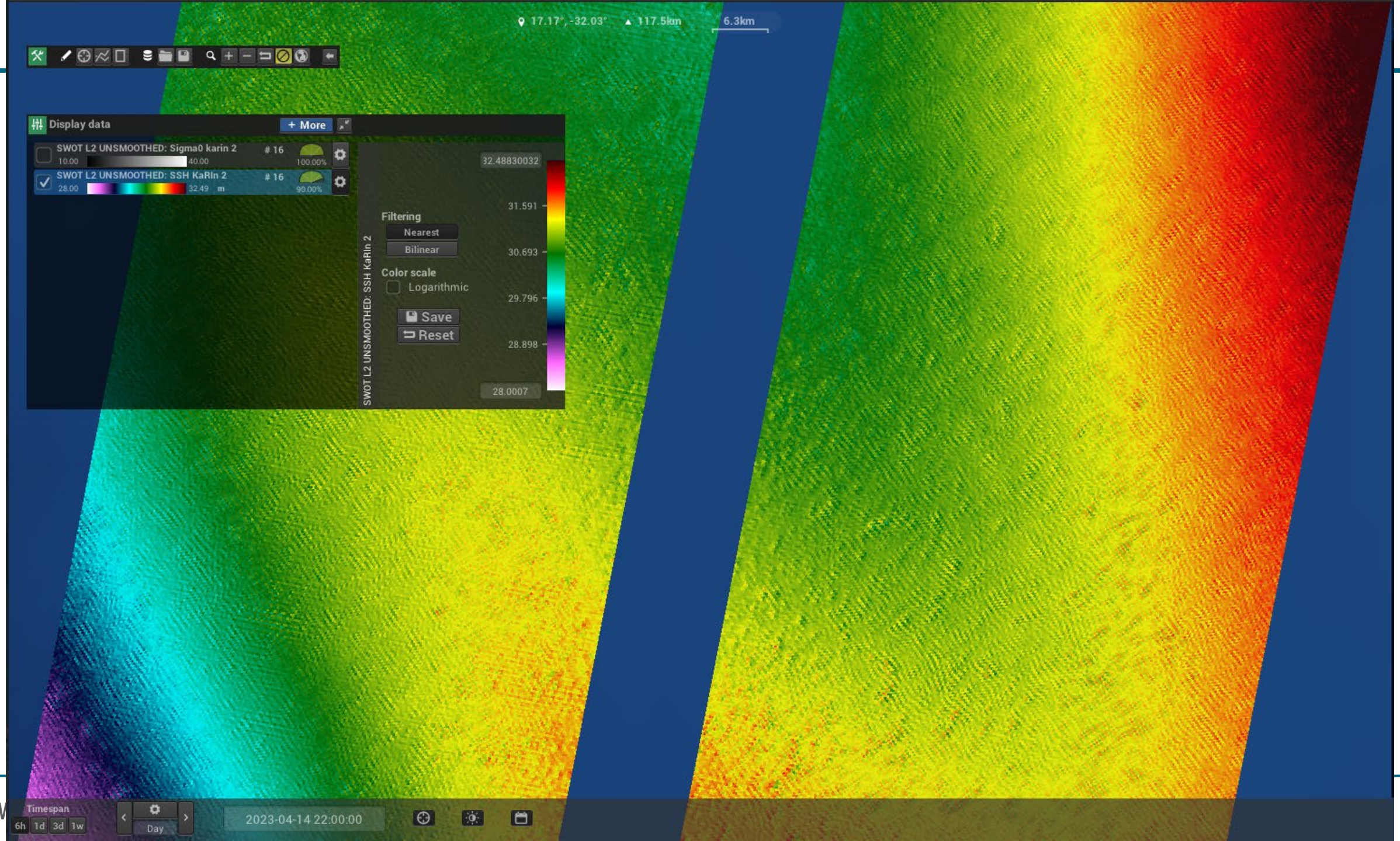


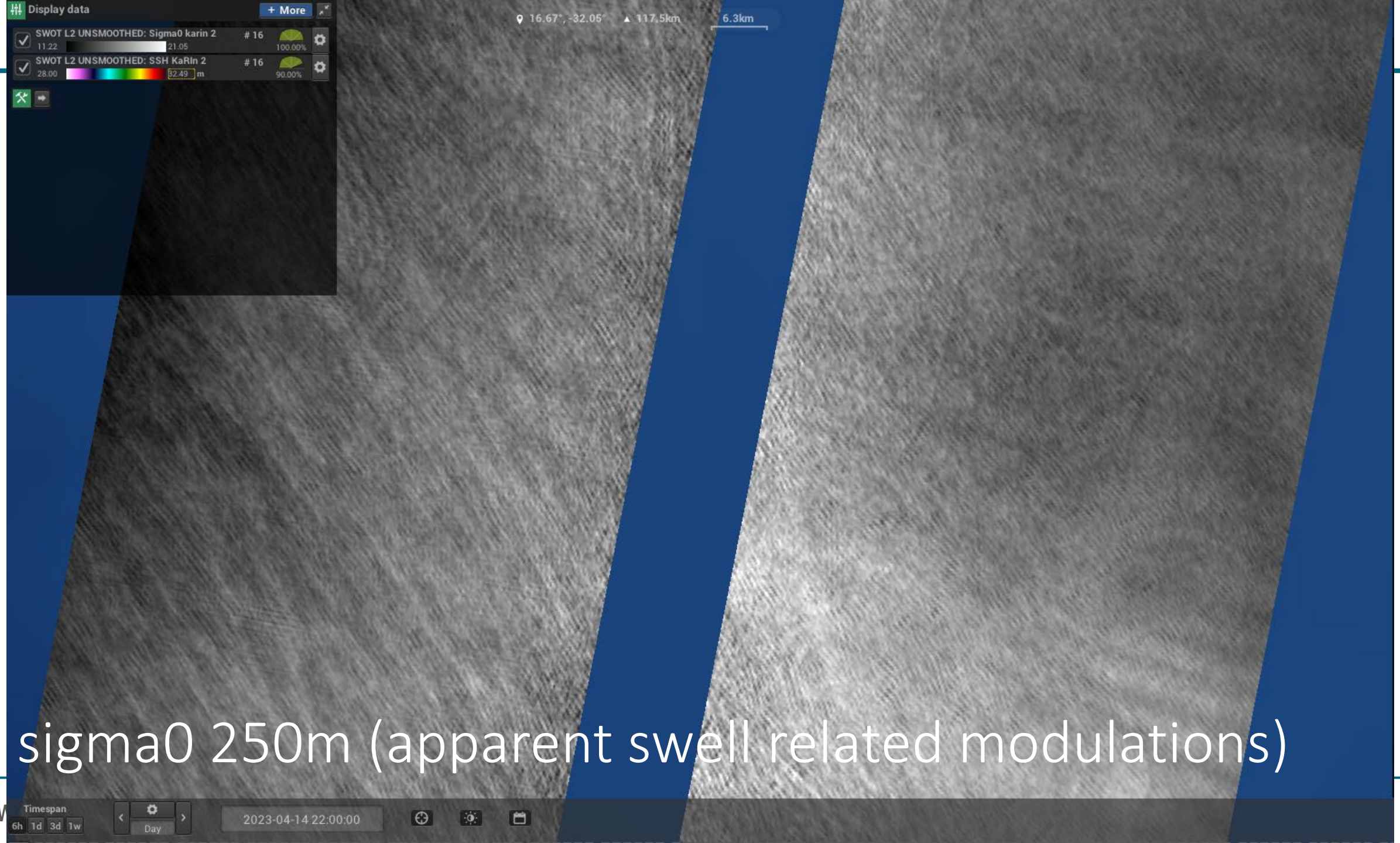


→ Can it be true SSHA ?
Here, SSHa step correlate with a sig0 step

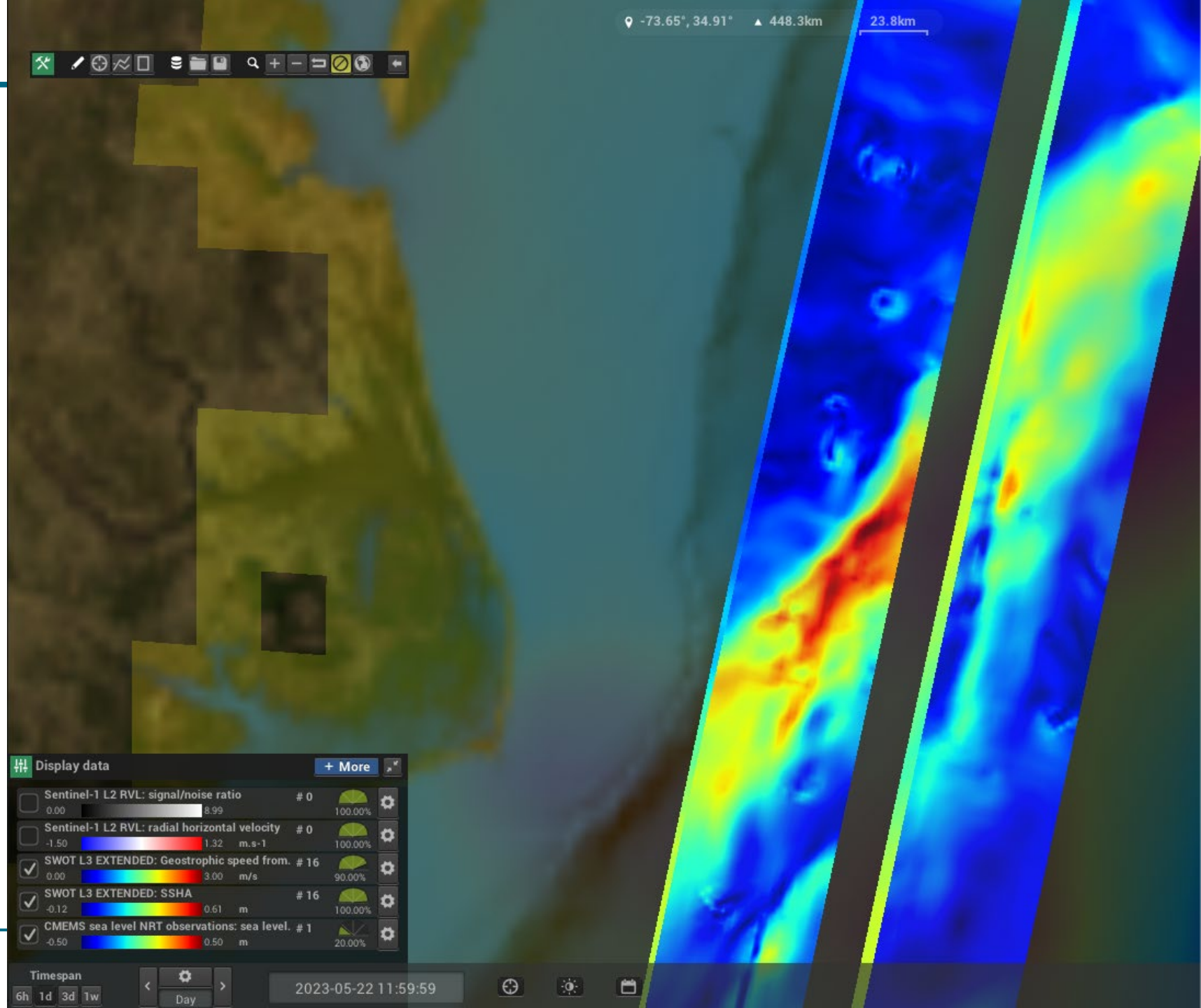

Display data
+ More
SWOT L2 UNSMOOTHED: Roughness
0.53
1.06
2
100.00%
Sentinel-3 OLCI: Near InfraRed (Oa17)
0.77
2.58
1
75.00%
SWOT roughness 250m
June 22 01:20 UTC
Internal tides
Timespan
3h 1d 3d 1w 1m
Move by
Event
2023-06-21 17:20:08

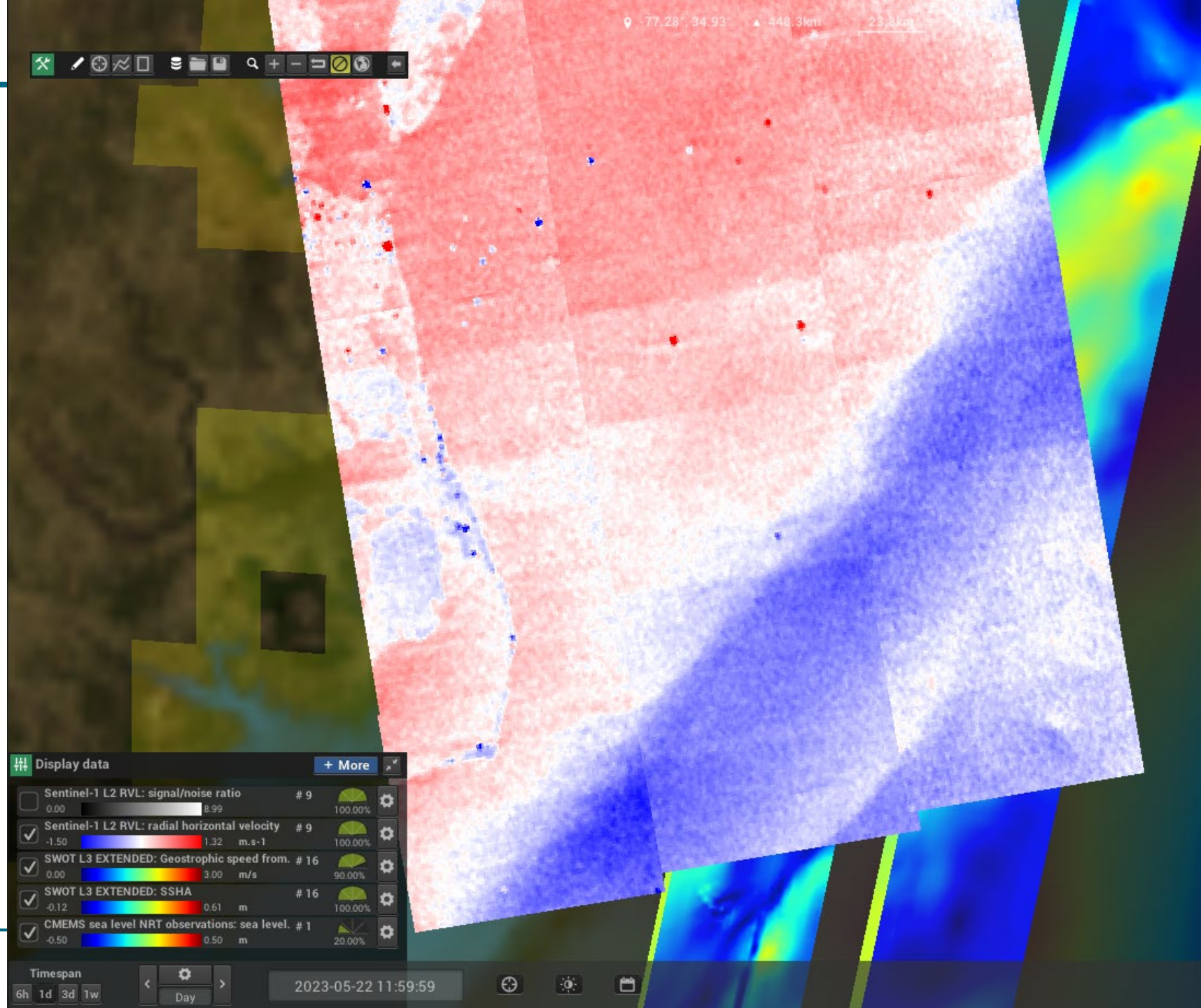

Display data
+ More
SWOT L2 UNSMOOTHED: SSH KaRIn 2...
SWOT L2 UNSMOOTHED: Roughness
Sentinel-3 OLCI: Near InfraRed (Oa17)
SWOT ssha 250m
June 22 01:20 UTC
Timespan
Move by
Event
2023-06-21 17:20:08


17.17°, -32.03°
117.5km
6.3km
Display data
+ More
SWOT L2 UNSMOOTHED: Sigma0 karin 2
16
10.00
40.00
100.00%
SWOT L2 UNSMOOTHED: SSH KaRIn 2
16
28.00
32.49
m
90.00%
32.48830032
31.591
30.693
29.796
28.898
28.0007
SWOT L2 UNSMOOTHED: SSH KaRIn 2
Filtering
Nearest
Bilinear
Color scale
Logarithmic
Save
Reset
Timespan
6h
1d
3d
1w
Day
2023-04-14 22:00:00



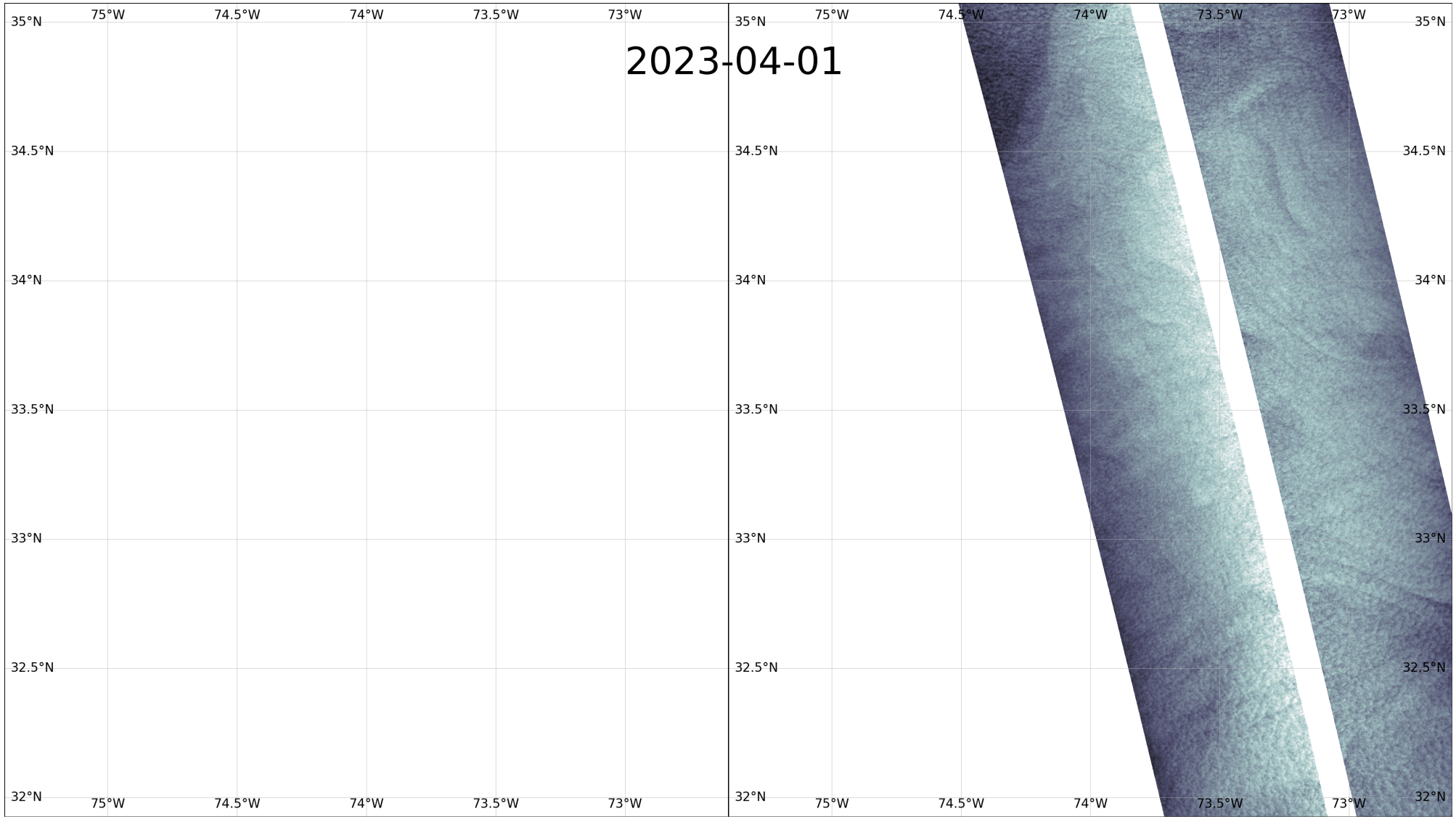
sigma0 250m (apparent swell related modulations)


-73.65°, 34.91°
448.3km
23.8km
Display data
+ More
Sentinel-1 L2 RVL: signal/noise ratio
0.00
8.99
0
100.00%
Sentinel-1 L2 RVL: radial horizontal velocity
-1.50
1.32
m.s-1
0
100.00%
SWOT L3 EXTENDED: Geostrophic speed from.
0.00
3.00
m/s
16
90.00%
SWOT L3 EXTENDED: SSHA
-0.12
0.61
m
16
100.00%
CMEMS sea level NRT observations: sea level.
-0.50
0.50
m
1
20.00%
Timespan
6h
1d
3d
1w
Day
2023-05-22 11:59:59


77.28° 34.93°
448.3km
23.8km
Display data
+ More
Sentinel-1 L2 RVL: signal/noise ratio # 9
0.00 8.99 100.00%
Sentinel-1 L2 RVL: radial horizontal velocity # 9
-1.50 1.32 m.s-1 100.00%
SWOT L3 EXTENDED: Geostrophic speed from. # 16
0.00 3.00 m/s 90.00%
SWOT L3 EXTENDED: SSHA # 16
-0.12 0.61 m 100.00%
CMEMS sea level NRT observations: sea level. # 1
-0.50 0.50 m 20.00%
Timespan
6h 1d 3d 1w
Day
2023-05-22 11:59:59

BACKUP

Gulf stream animated



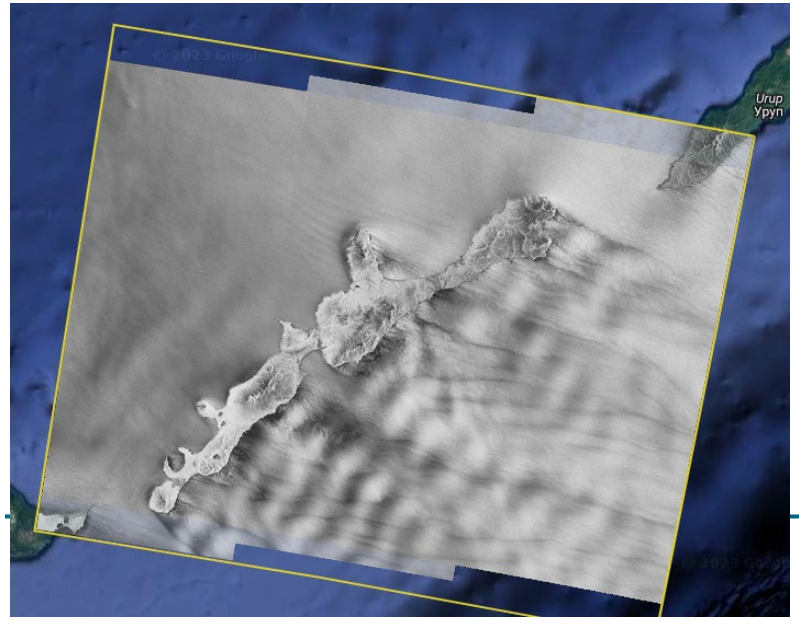
Atmospheric lee waves seen by KaRIn

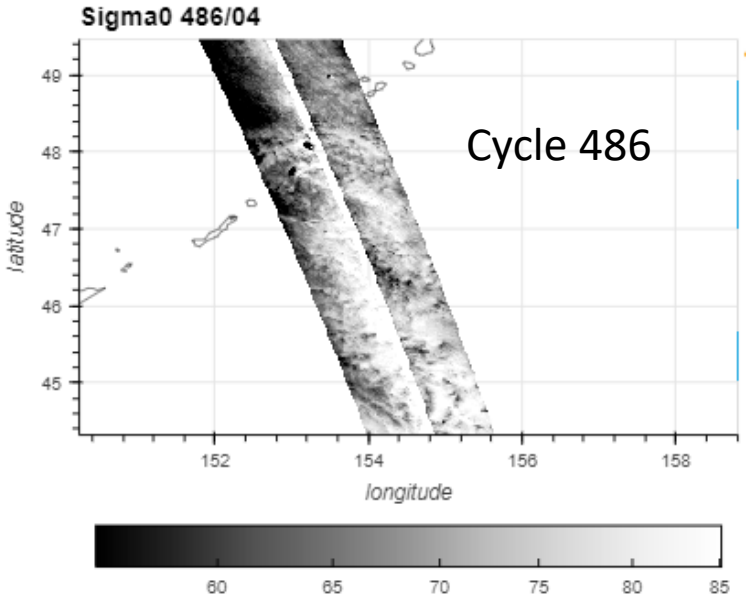
Gravity waves generated in particular atmospheric stability conditions behind strong topographic variations.
Frequently seen in SAR images (S1)

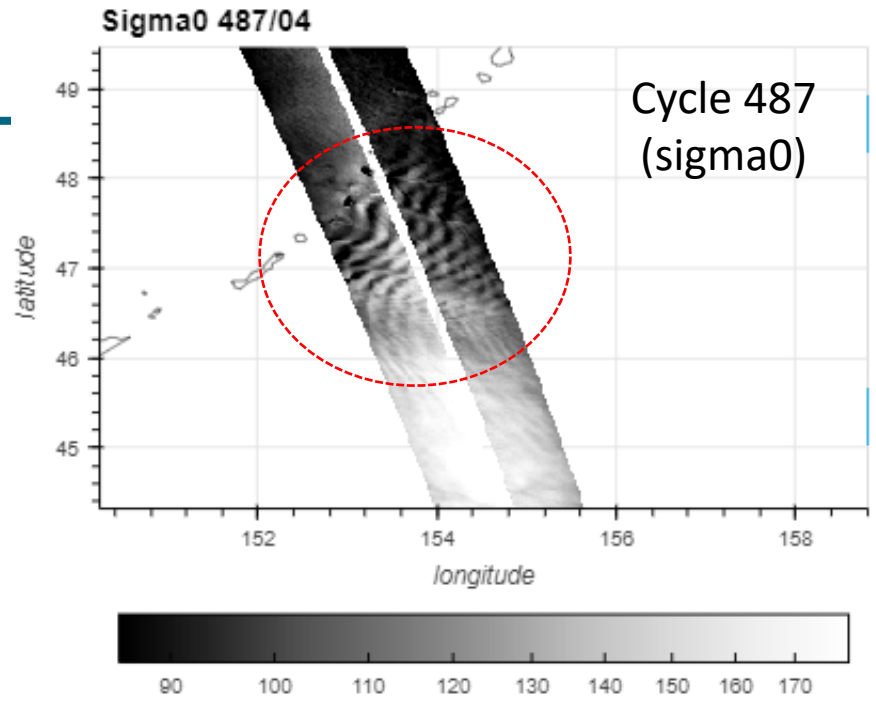
Note sure if the SWOT signature in SSHA is

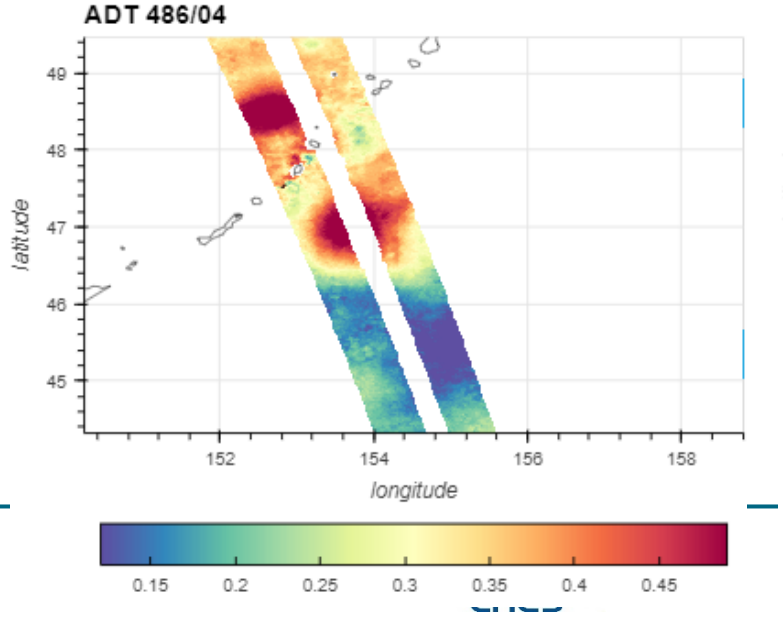
- A deficiency in the DAC correction (not enough resolution in model inputs or MOG2D/TUGO model)
  ➔ most likely scenario (uncorrected inverse barometer)
- A measurement artifact (SSB insufficient resolution of nadir SWH and/or model wind)
- Actual topography waves trigged by the atmosphere

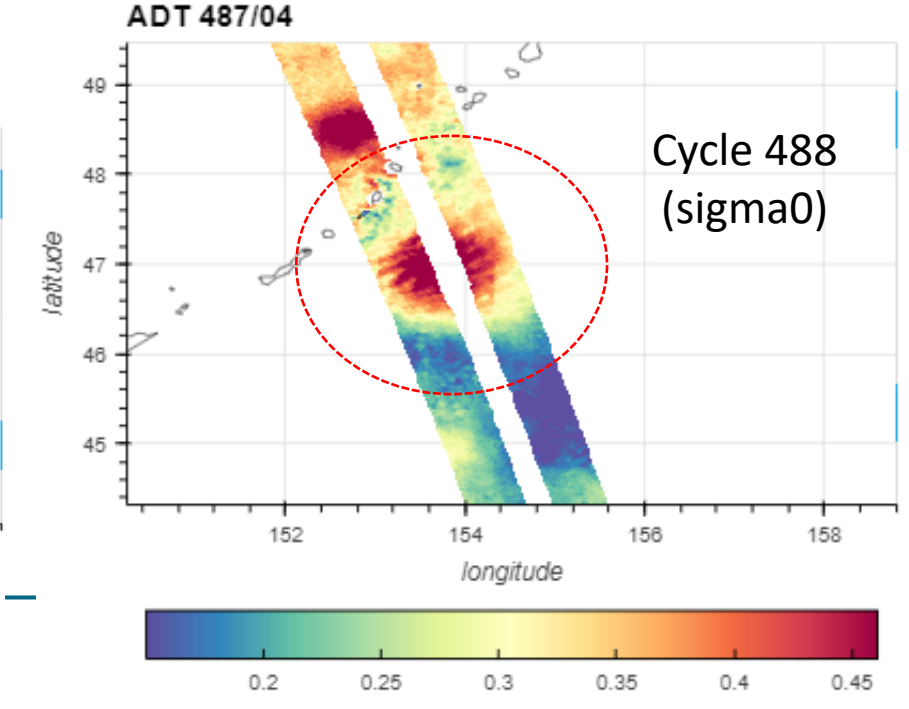
Sentinel-1 for reference

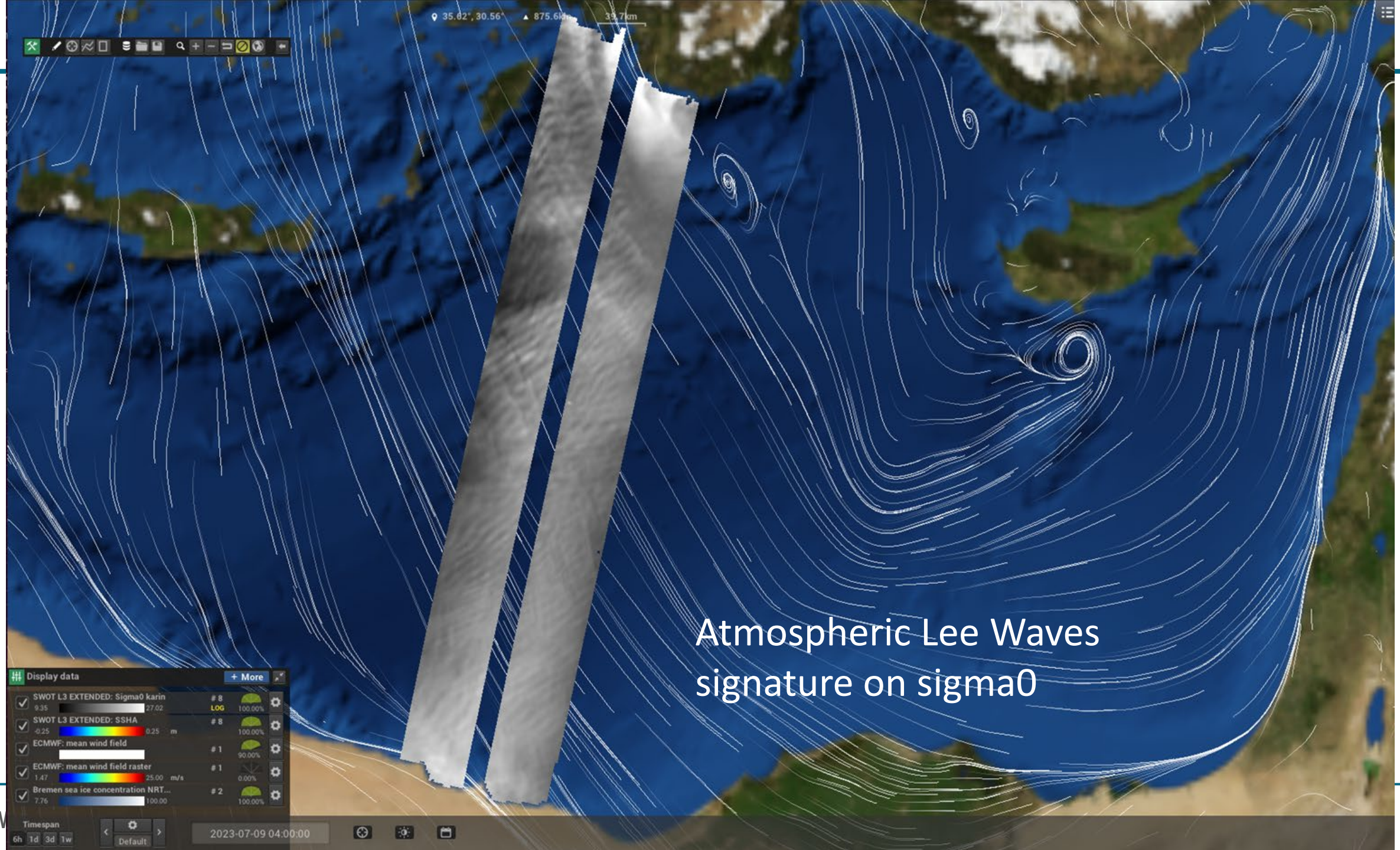




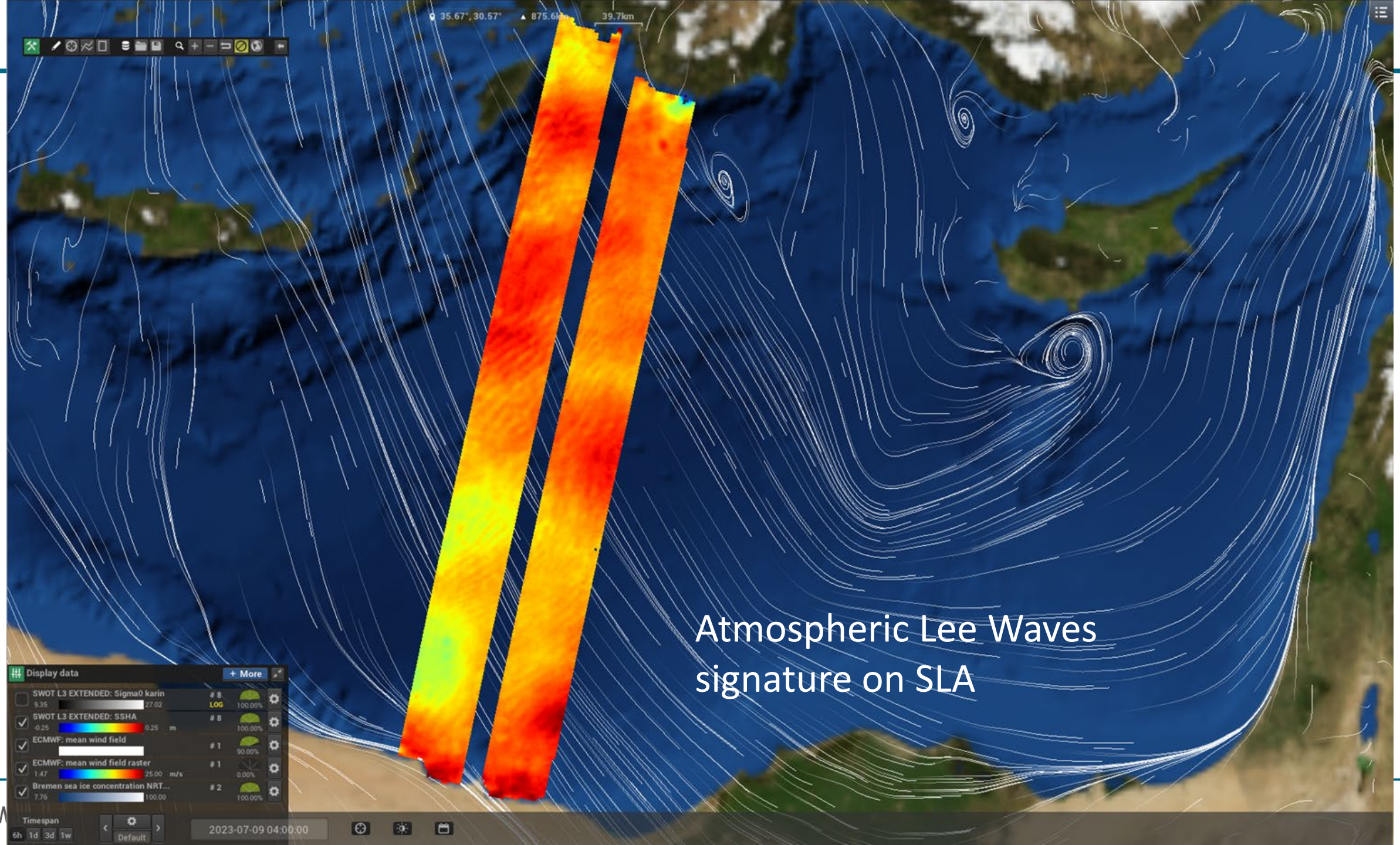




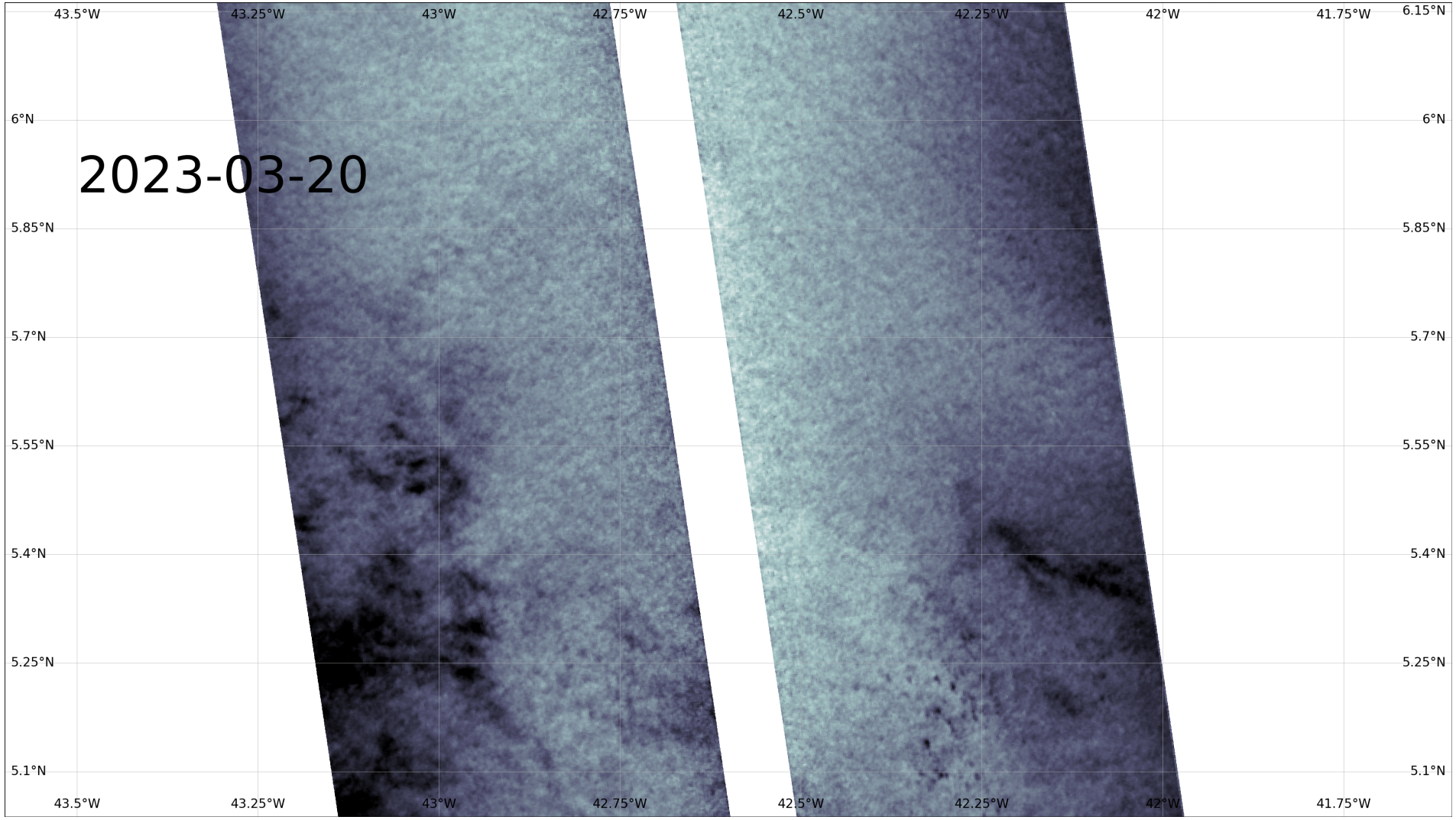




Atmospheric Lee Waves
signature on sigma0


35.67°, 30.57°
875.6km
39.7km
Display data
+ More
SWOT L3 EXTENDED: Sigma0 karin
9.35
27.02
LOG
SWOT L3 EXTENDED: SSHA
-0.25
0.25
m
ECMWF: mean wind field
ECMWF: mean wind field raster
1.47
25.00
m/s
Bremen sea ice concentration NRT...
7.76
100.00
Timespan
6h 1d 3d 1w
Default
2023-07-09 04:00:00
Atmospheric Lee Waves
signature on SLA

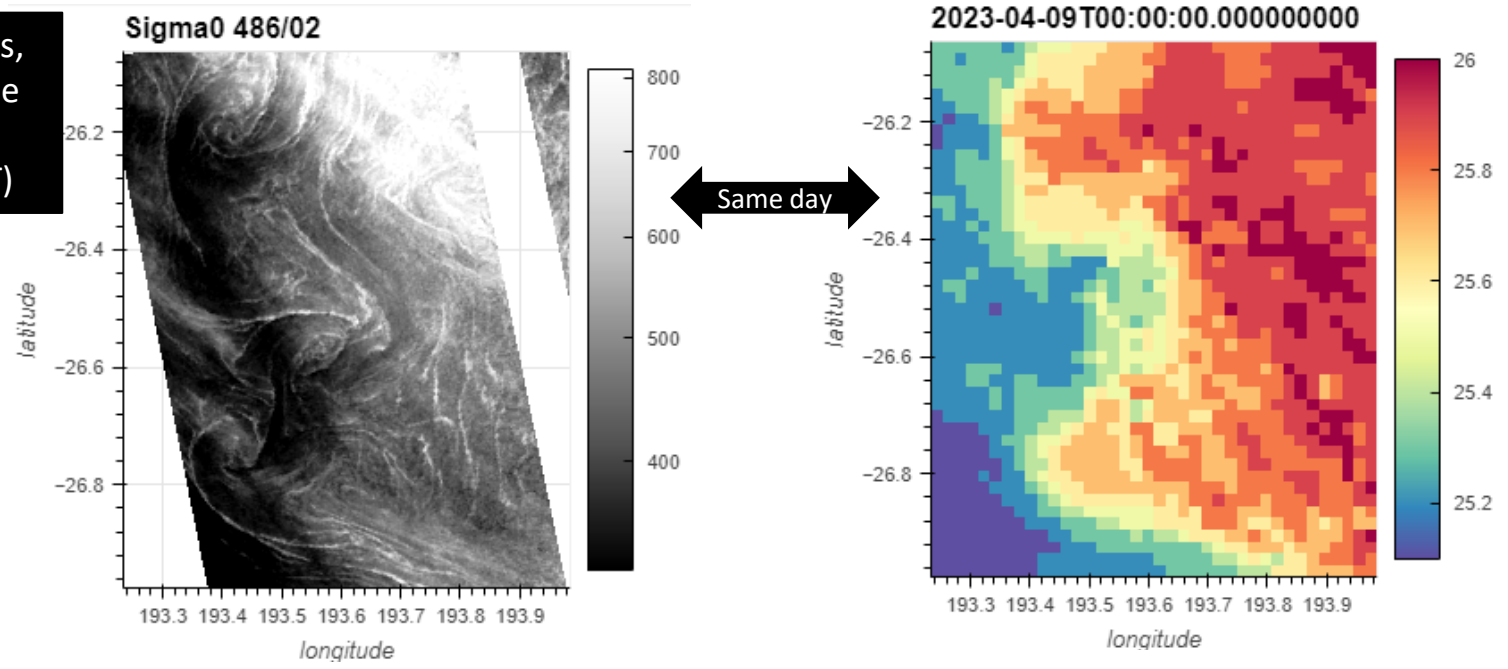
Sargassum travelling



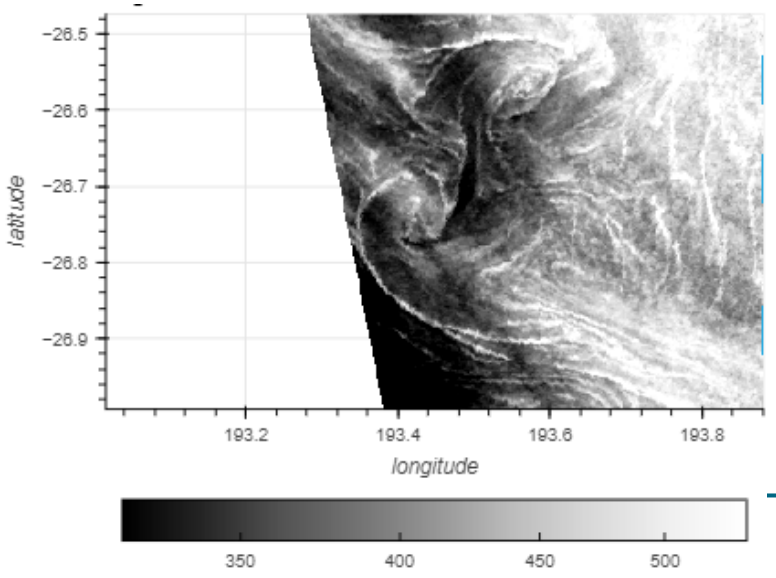
Examples of submesoscale seen by KaRIN σ0

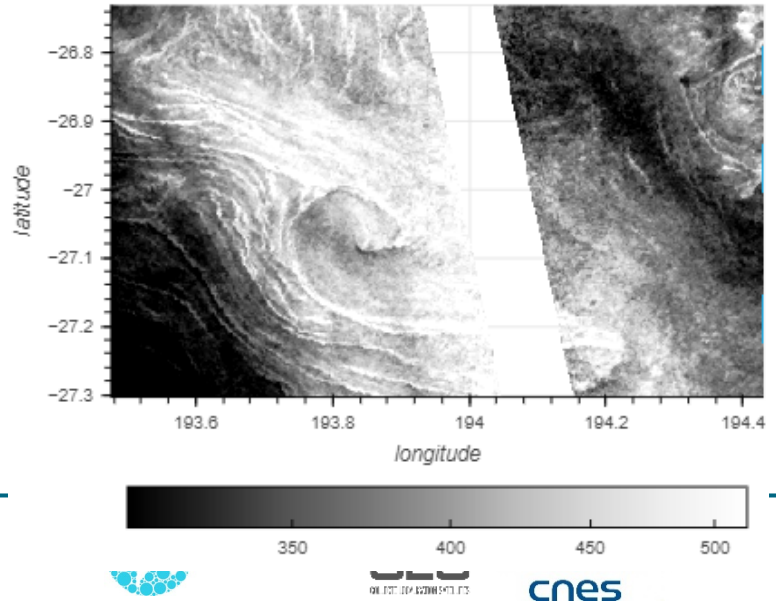
In low wind & wave conditions, the KaRIn σ0 captures thin the filaments from small/sub mesoscale (confirmed by SST)

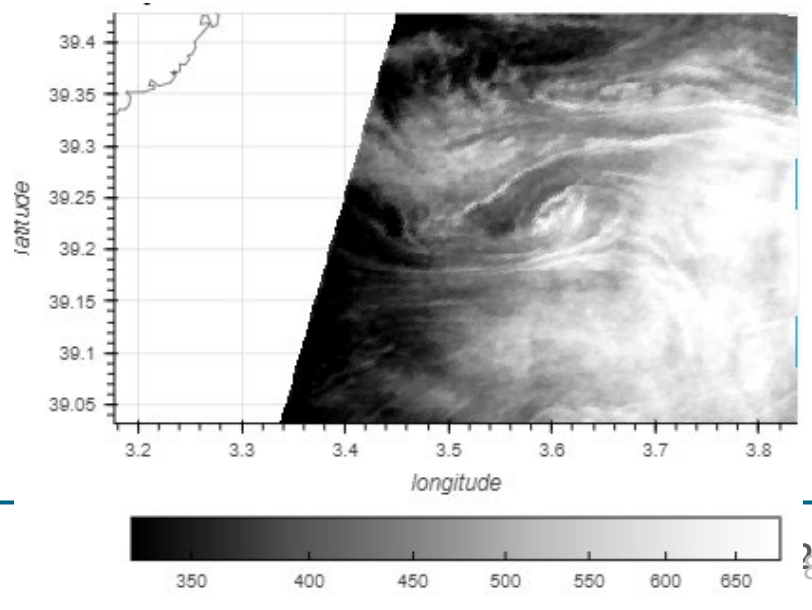
KaRIn σ0 (250m)



SST for reference







From large to submesoscale