Presentation of Results of the Ice Classification with EisKlass31 Algorithm Due to Endurance22

Christine König and Thomas König

Dr. Thomas König & Partner, Fernerkundung GbR
Dießen am Ammersee, Germany

Endurance22 Science Workshop
Jan. 18, 2023

Dr. Thomas König & Partner, Fernerkundung GbR

D-82234 Dießen am Ammersee

founded:	Jan. 2018
shareholder:	Dr. Christine König Dr. Thomas König

Endurance22 Science Workshop, Jan. 18, 2023

Project EisKlass31

Improving sea ice position information for navigation in polar waters through combined sea ice classification with optical data from the Sentinel-3 and SAR data from the Sentinel-1 satellite series.
(Funded by German Federal Ministery of Digital and Transport)

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Major Results

- Method developed for classification of sea ice types / properties from Sentinel-3 SLSTR satellite data, starting from a method for NOAA-AVHRR data,
  - using measurements of reflected solar radiation and emitted radiation in the infrared spectral region,
  - with continuous color spectrum used for resulting images,
  - with extended portfolio of distinguishable ice/snow classes and
  - applicability to Arctic and subarctic seas, demonstrated using about 2500 scenes.
- Extensive research on the validation of the method
- First trials of combining with sea ice classifications from DLR's Sentinel-1 SAR data.
- Elaboration of the proposal for combined ice classification from SLSTR and SAR, which is going to be realized in project EisKlass2.

Instruments on board Copernicus Satellites

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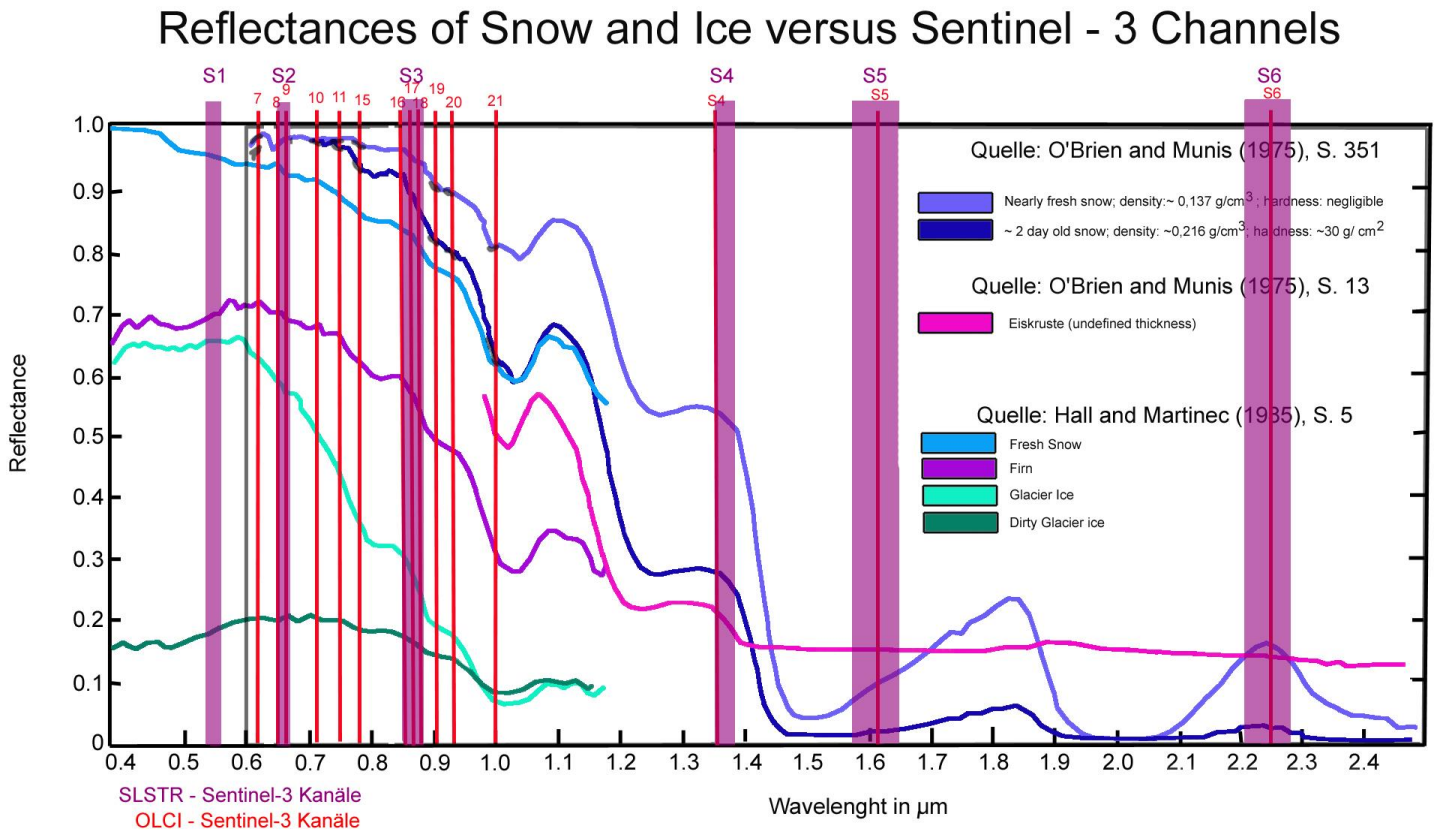
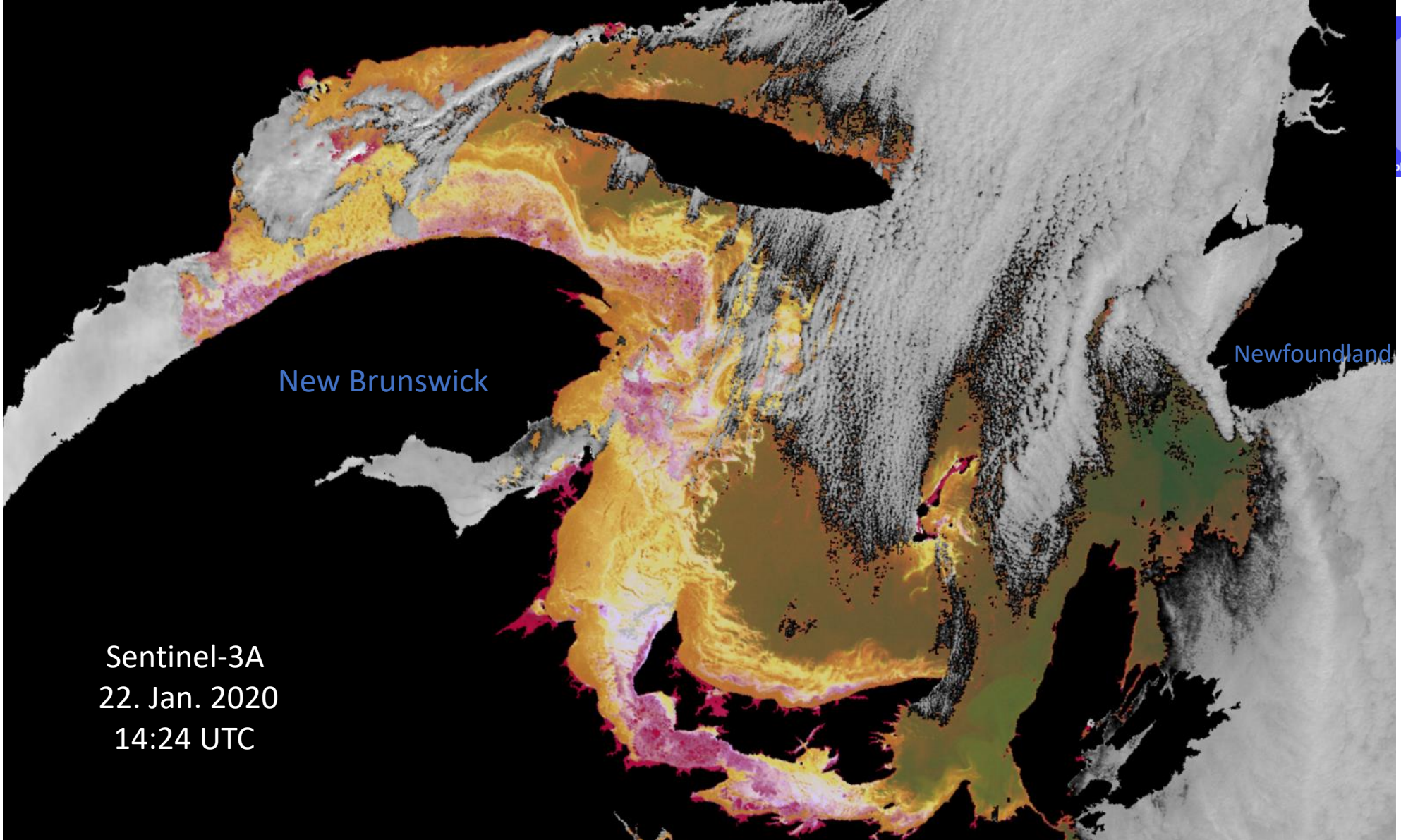
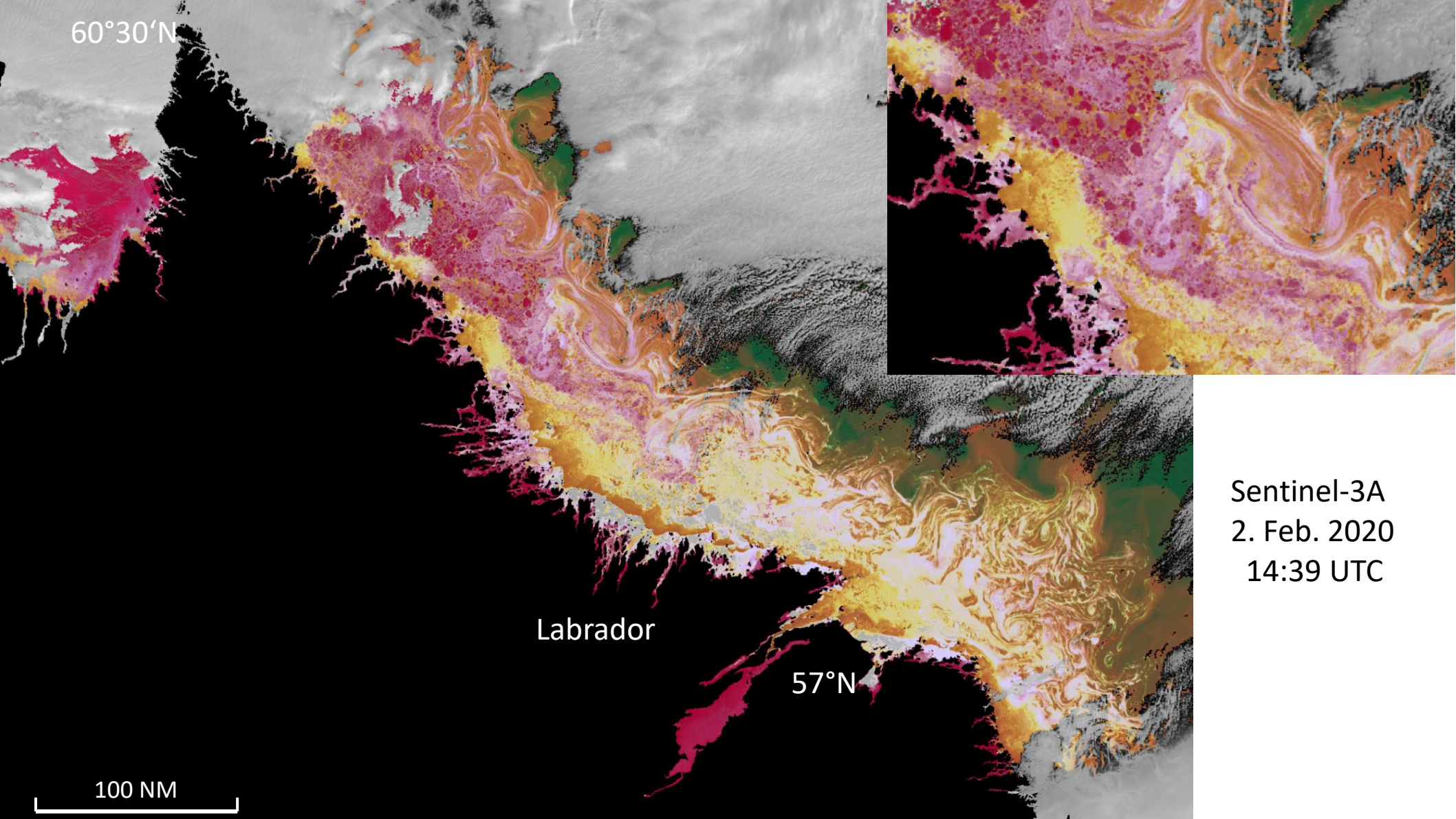
Satellit	Launch Dates	Instrumente	Swath Width [km]	Geometric resolution [m]	Radiometric resolution
Sentinel-1A **Sentinel-1B**	Apr. 3, 2014 Apr. 25, 2016	**C-Band SAR**, VV+VH / HH+HV	80 (SM)/ 250 (IW)/ 400 (EW) Wave Mode	5x5 (SM)/ 5x20 (IW)/ 20x40 (EW)	
Sentinel-2A **Sentinel-2B**	Jun. 23, 2015 Mar. 7, 2017	**MSI**, 13 spectral channels, optic, solar	290 km	10/20/60	12 Bit
Sentinel-3A **Sentinel-3B**	Feb. 16, 2016 Apr. 25, 2018	**SLSTR**, 9 spectral channels, optic, solar + TIR **OLCI**, 21 Spektralkanäle optic, solar	1400 (NadirView) 700 (RearView) 1270	500/1000 300	14 Bit

Spectral channels S1 - S6 of the instrument SLSTR and comparable channels of the instrument OLCI on Sentinel-3 plotted in a diagram of the spectral behavior of different snow and ice




New Brunswick
Newfoundland
Sentinel-3A
22. Jan. 2020
14:24 UTC



Sentinel-3A
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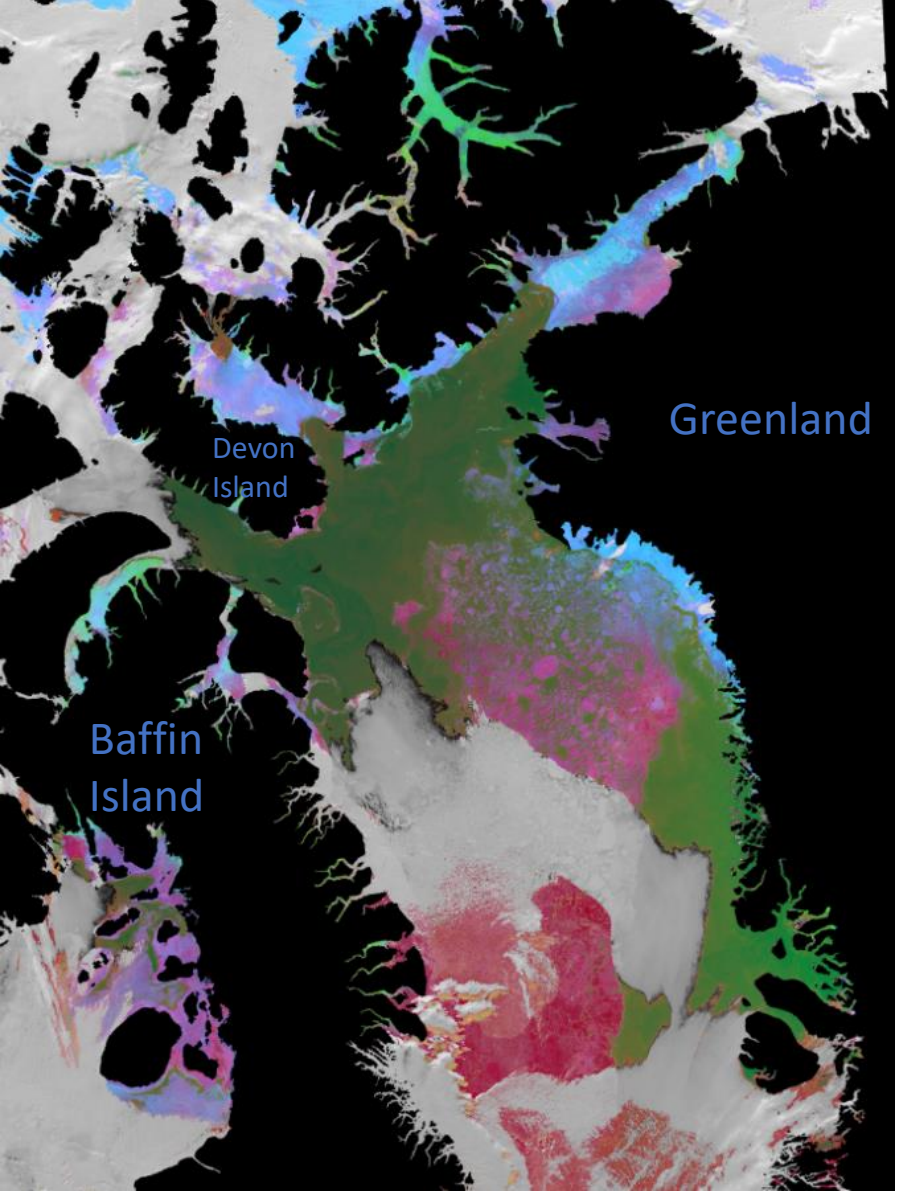

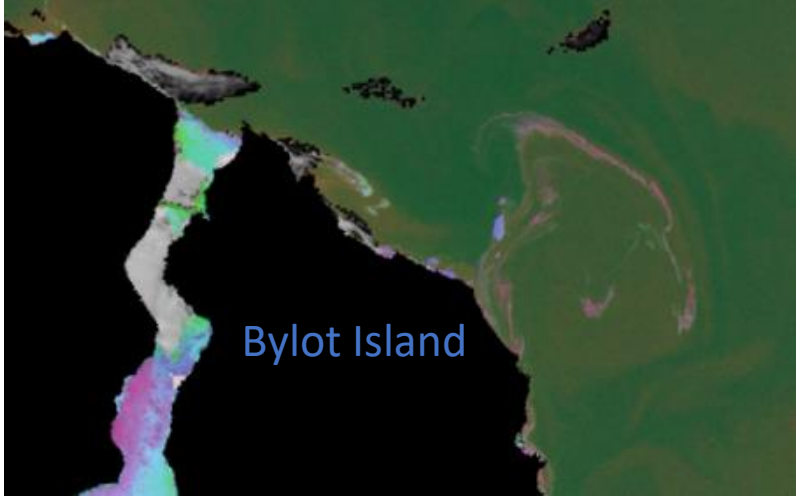

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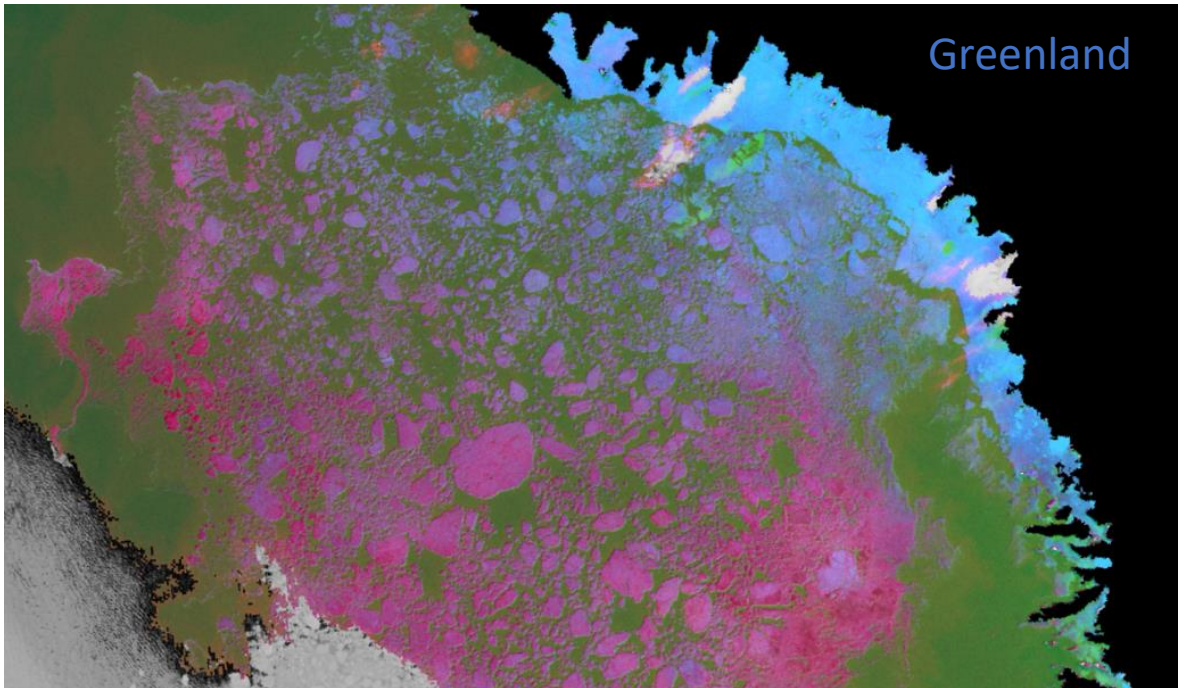
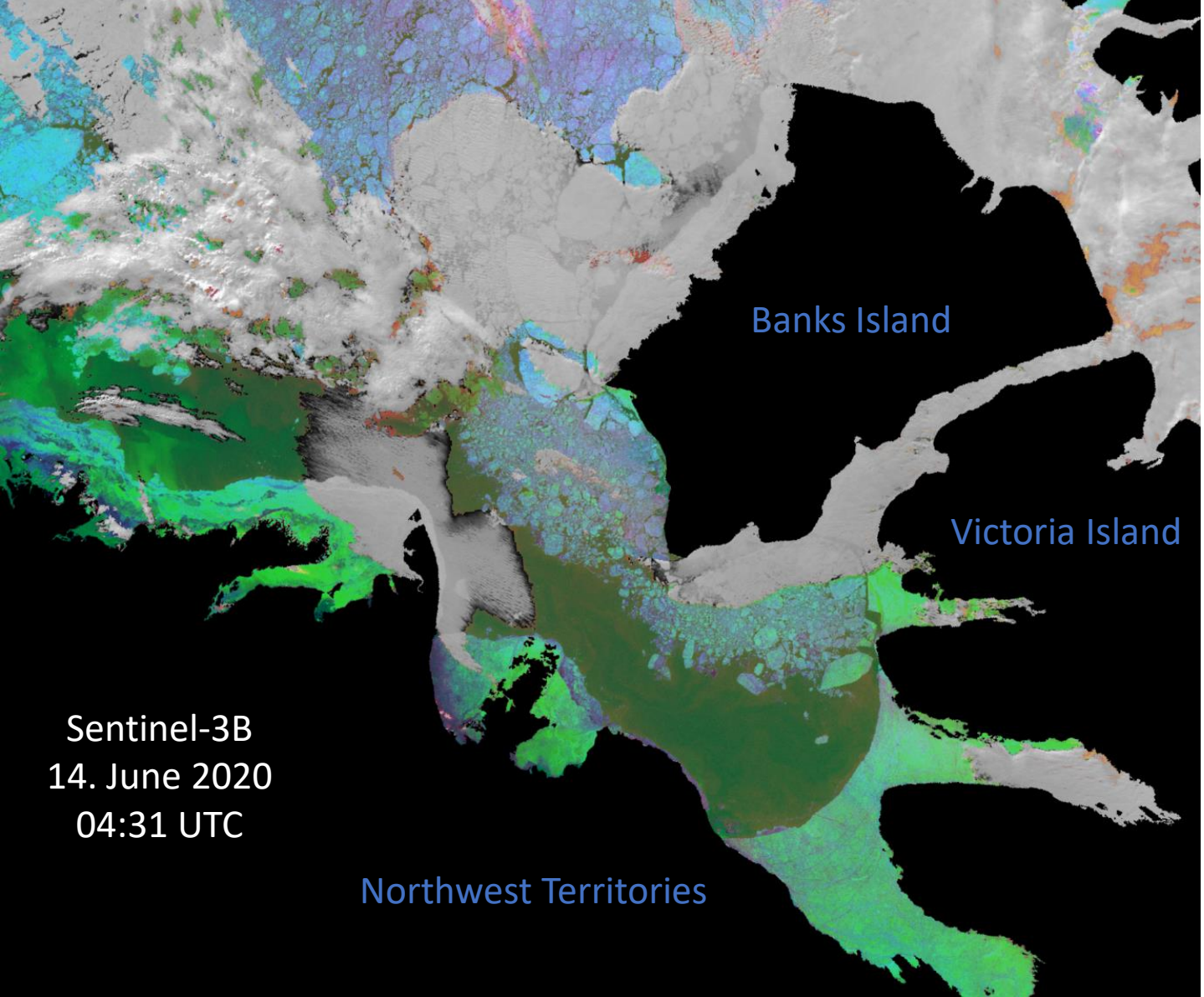
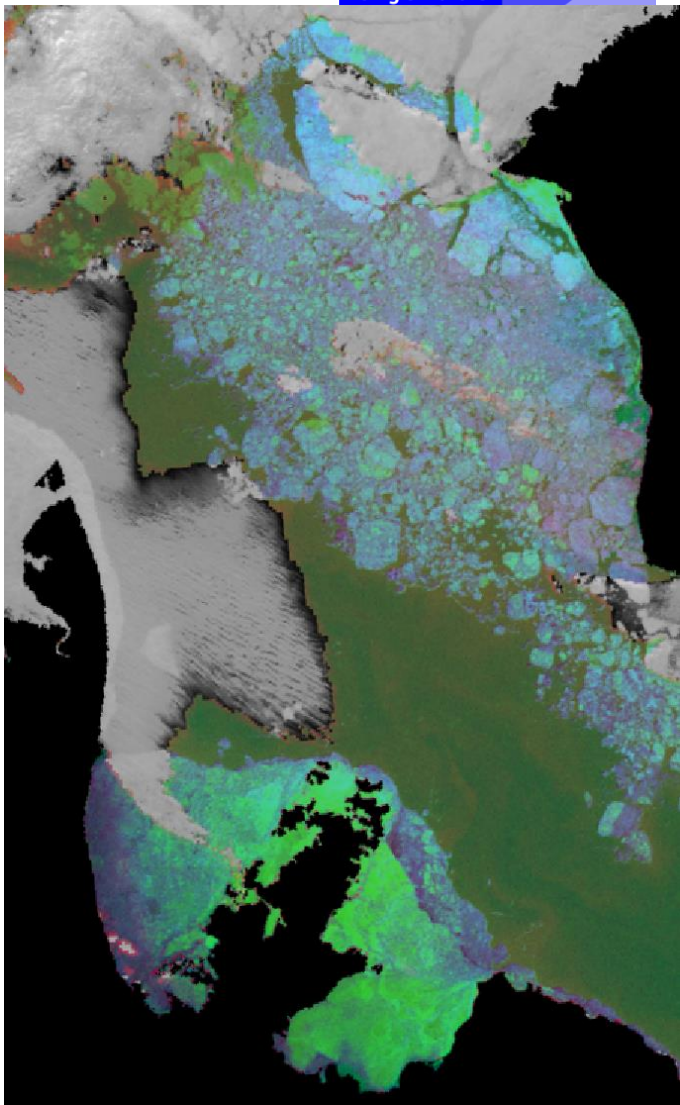
Sentinel-3B
14. June 2020
01:09 UTC







EisKlass31 Sea Ice Classification Results in Comparison to Modis True Color Image

Case: June 15, 2017

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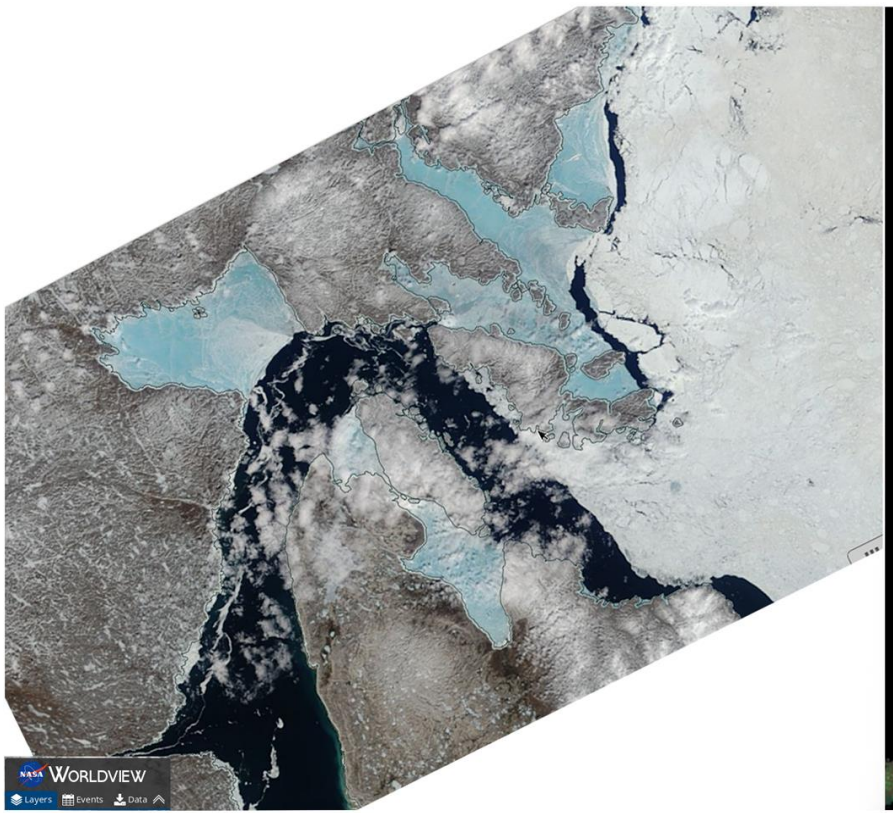
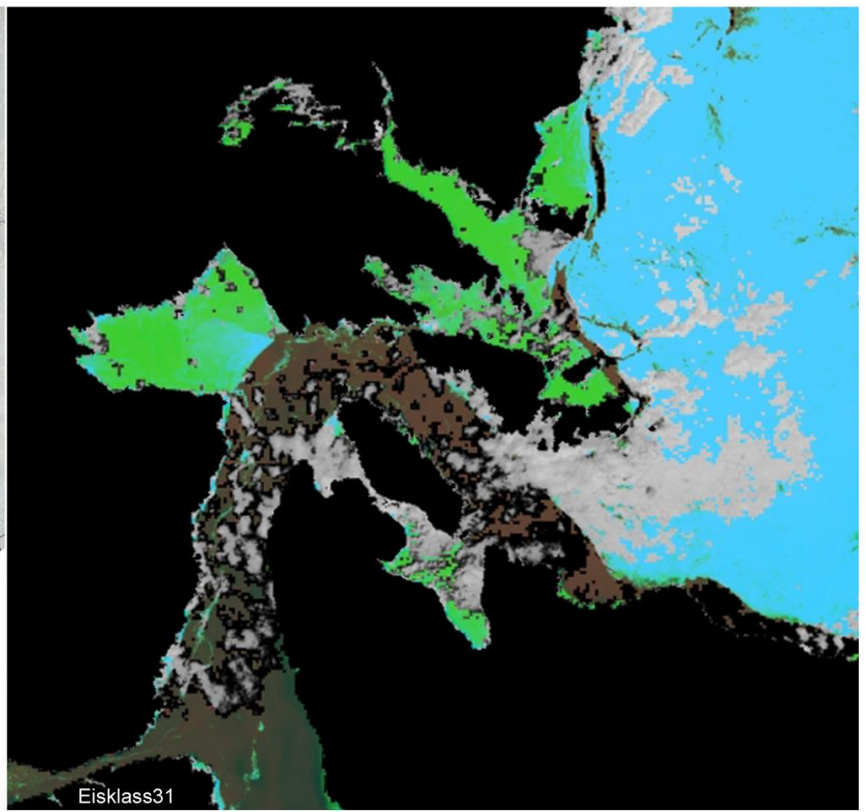
Repulse Bay 15. Juni 2017 16:58:18 UTC





Legend for ice-classification Eisklass31 Sentinel-3 SLSTR

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- Open water
- nearly freezing water or mixed ice/water Pixel or very thin ice (e.g. frazil ice)
- ice without snow cover especially: dark and light nilas (<10cm)
- young ice without snow cover especially: grey ice (10-15 cm)
- young ice without snow cover especially: grey-white ice (15-30cm)
- ice without snow cover thicker than grey-white ice (probably > 30 cm)
- ice of uncertain thickness with dry snow cover
- ice of uncertain thickness with aged dry snow cover
- ice of uncertain thickness with less aged snow cover
- ice of uncertain thickness covered by aged snow (increased grain size of snow)
- ice of uncertain thickness covered by further aged snow compared to dark pink
- ice of uncertain thickness covered by further aged snow compared to dark pink
- ice of uncertain thickness covered by aged snow but with increasing temperatures than with the color pink
- ice of uncertain thickness covered by aged snow but with increasing temperatures than with the color dark violett
- thick ice covered by slightly wet snow; (thickness not well defined)
- ice covered by encreasingly wet snow; partial pixel coverage by meltponds possible
- ice with standing water on the surface either flat or in the form of meltponds or re-frozen water
- Land
- grey variations clouds

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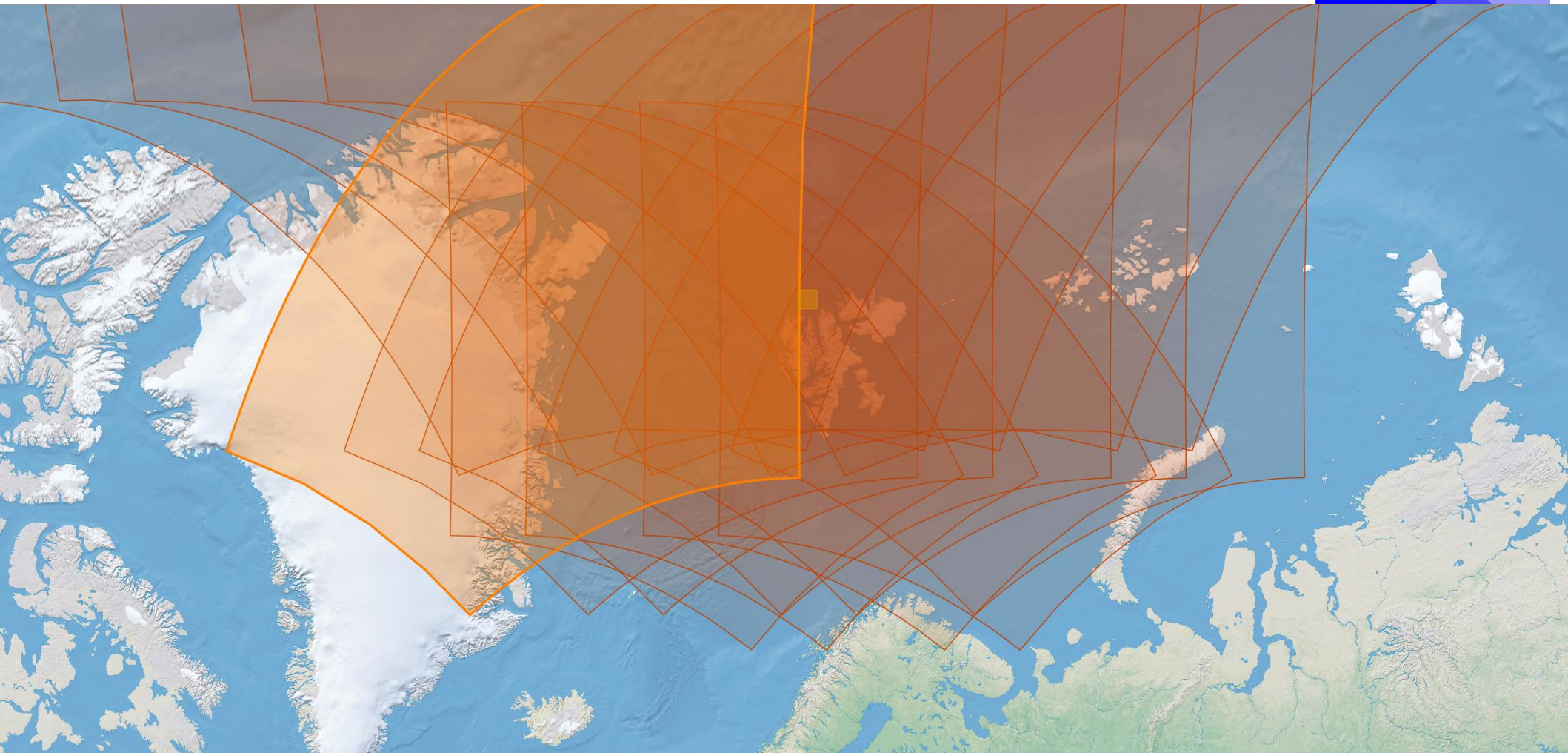
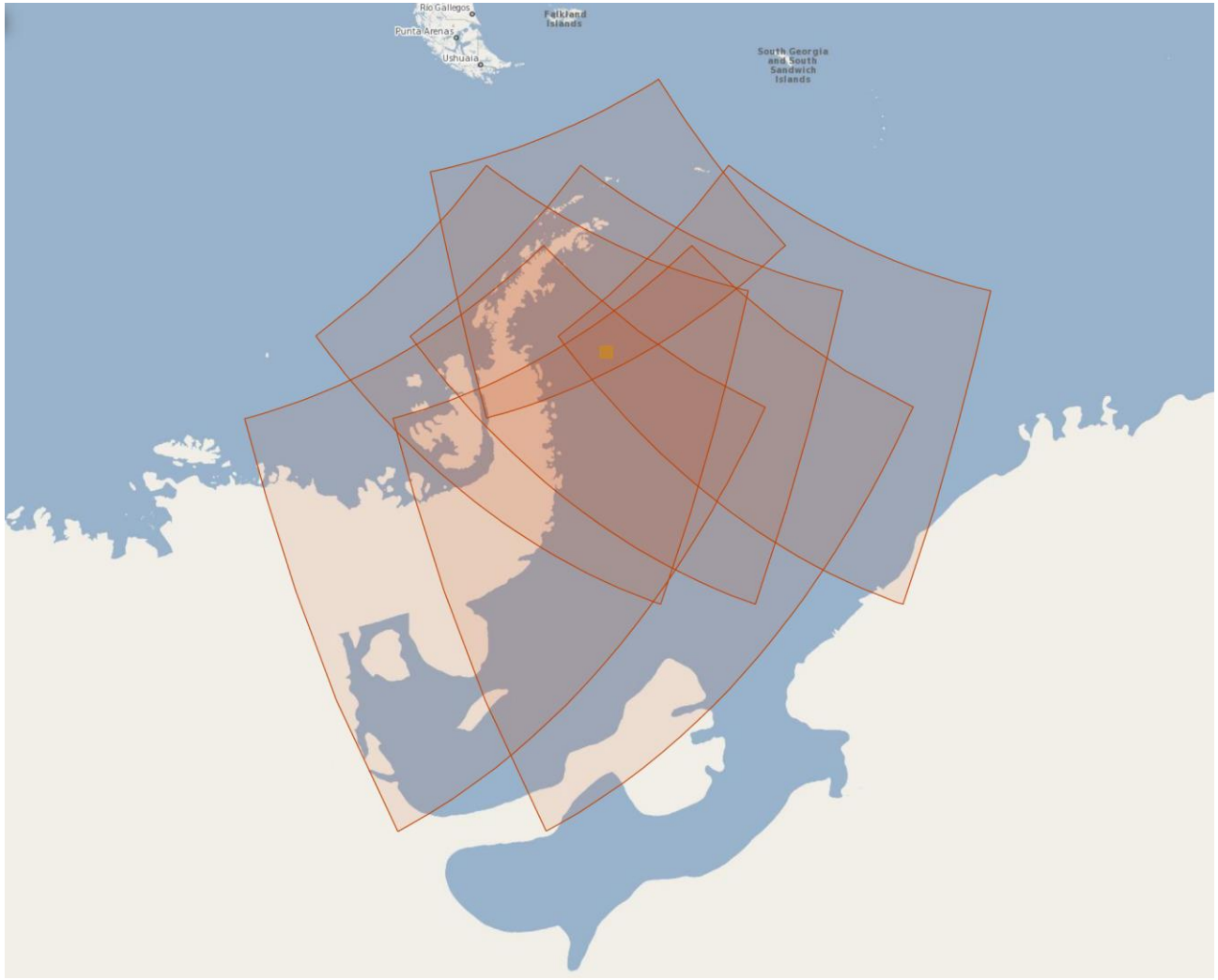
Advantages of Optical Satellite Data of Type SLSTR and Similar Sensors

- provide optical data with relevant spectral properties
- wide swath width (1400 km), medium spatial resolution (500m)
- high repetition rate (up to 14 overpasses per day)
- long term satellite systems
- data available in near-realtime (less 3 hours)
- data available for low cost

Location of 15 Sentinel-3 SLSTR Scenes Covering a Small Area Near Svalbard, (approximately 80°N, 16°E) on Aug. 15, 2020



Location of 6 Sentinel-3 SLSTR scenes available on Jan. 1, 2023 covering a small area in Weddell Sea, app. 69°S, 56°W



Example of Weekly Cloudiness Map

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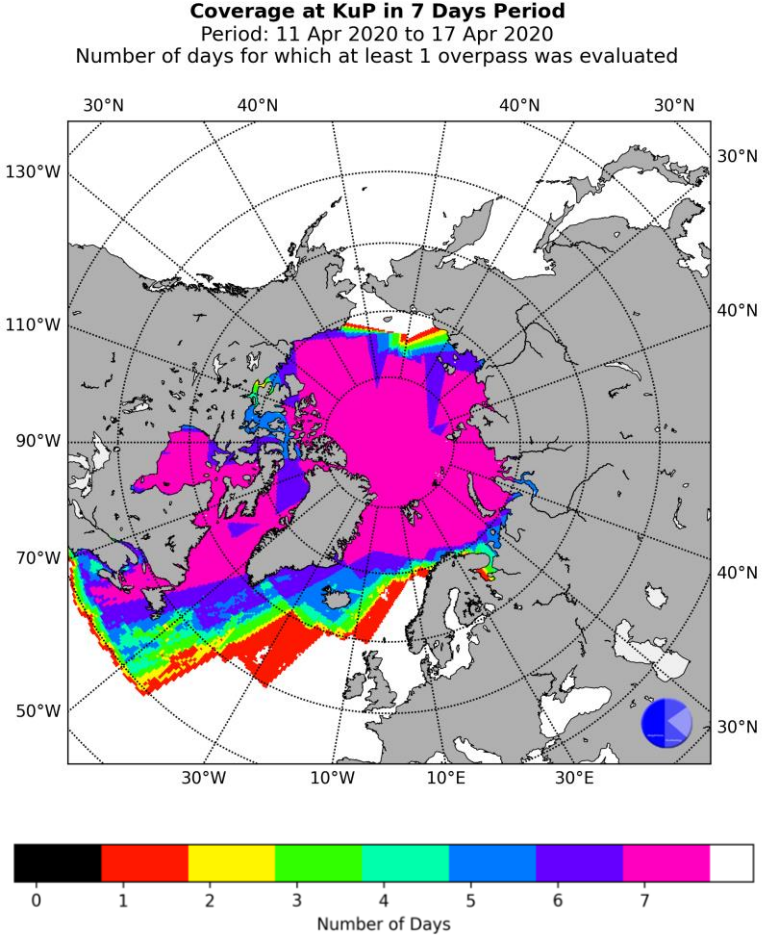
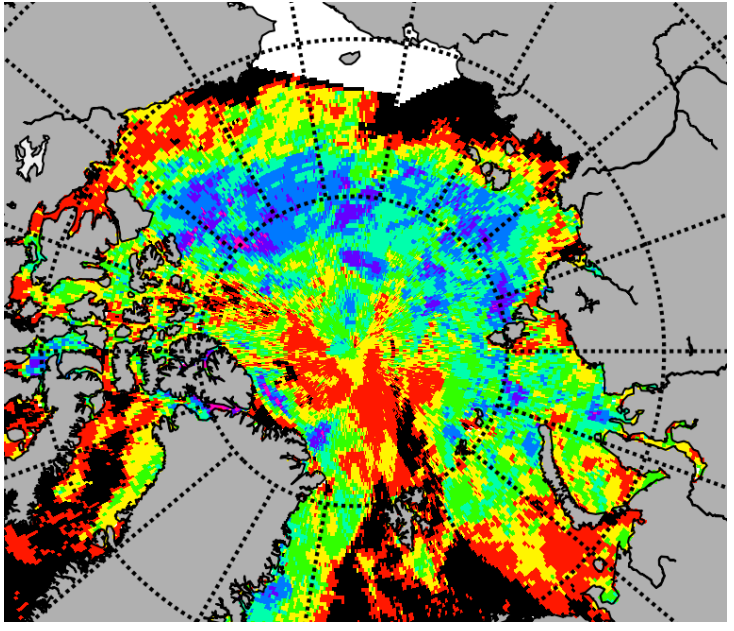


Bin size:
¼° latitude, ½° longitude for latitude < 80°
1° longitude for latitude > 80°



Contribution of König & Partner to Endurance22 Expedition

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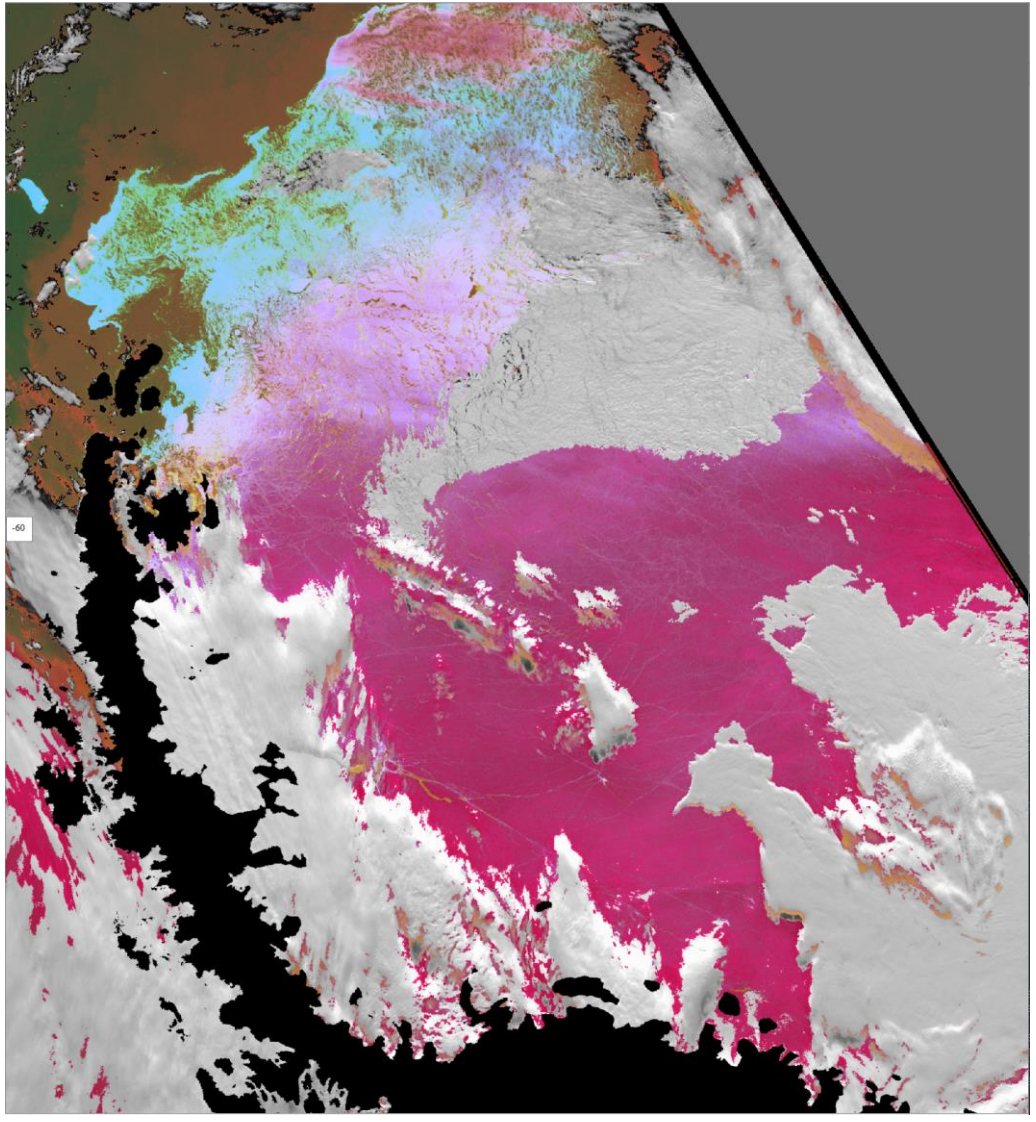
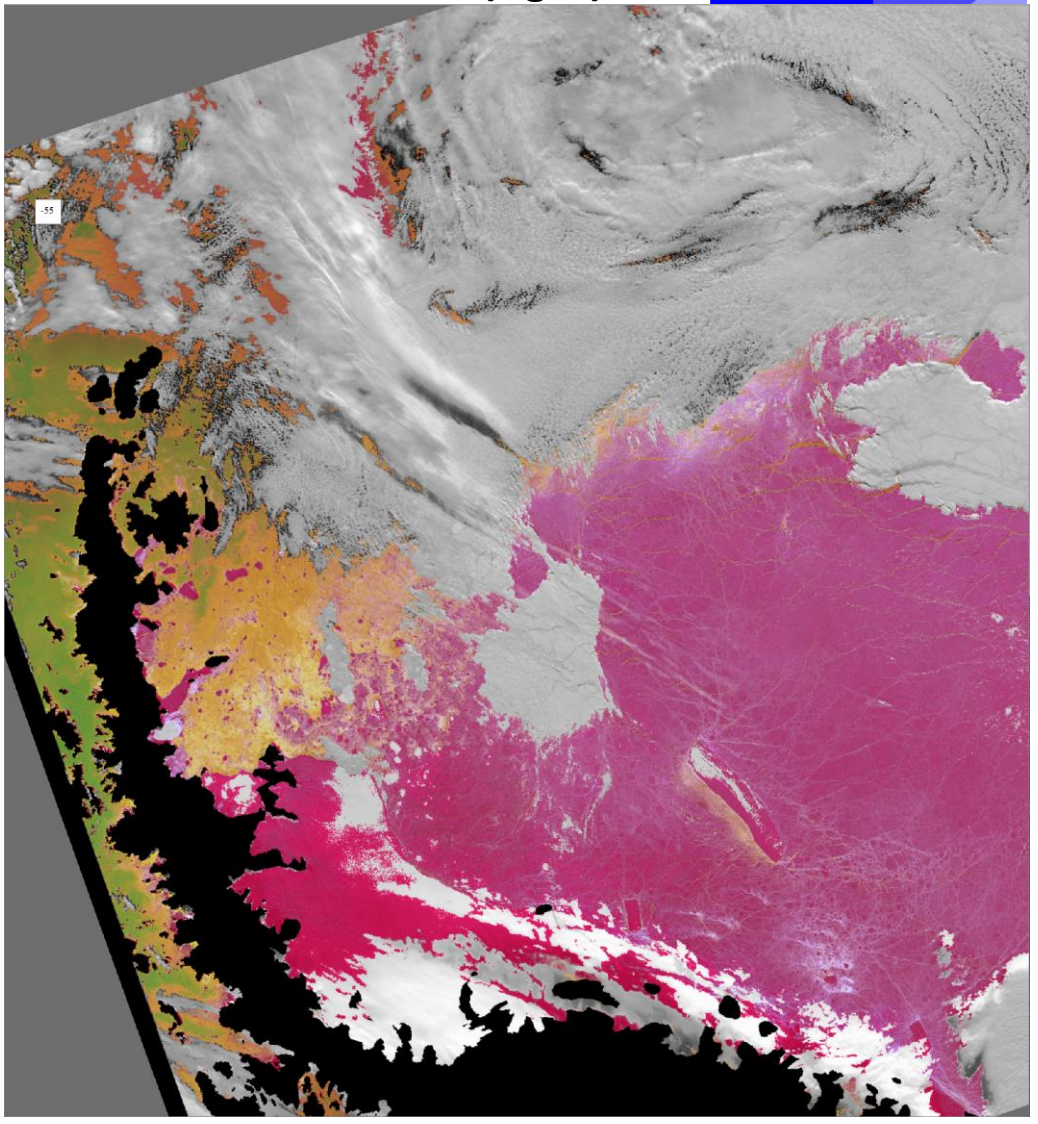
- Daily acquisition and processing of SLSTR Copernicus Level 1 products
- Making available 36 overpasses (58 scenes) of SLSTR sea ice classification results (via DN)
- Acquisition and preprocessing of Landsat-7/-8 scenes over Weddell Sea
- Making available 6 overpasses (17 scenes) of preprocessed Landsat imagery (via DN)

- Assistance in data collection efforts for verification of SLSTR sea ice classification

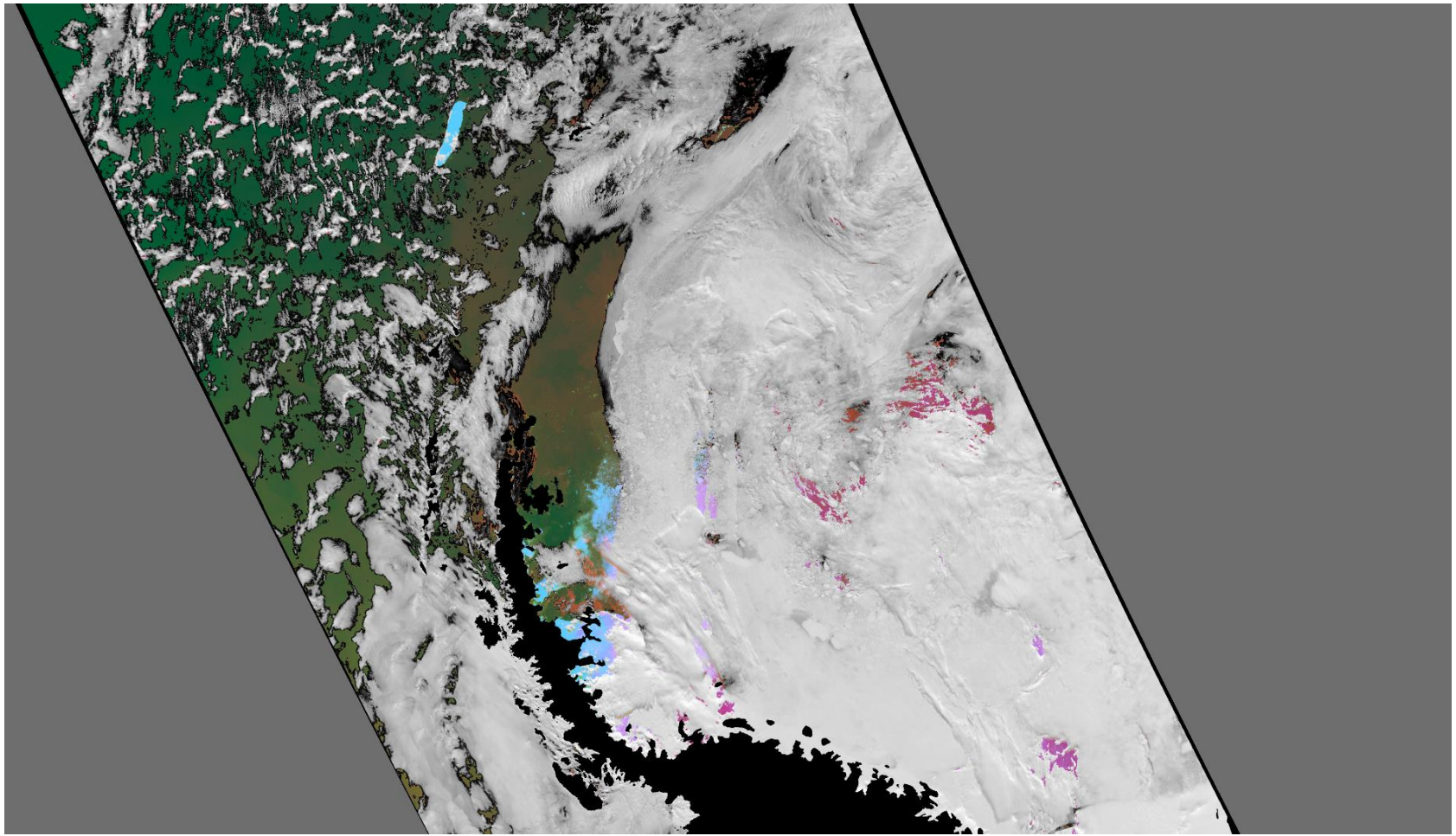
Ice Situation March 18, 2018 (left) in Comparison to March 24, 2022 (right)

Dr. Thomas





Ice Situation Jan. 17, 2023



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Sea Ice Classification Overview for Endurance22 Expedition

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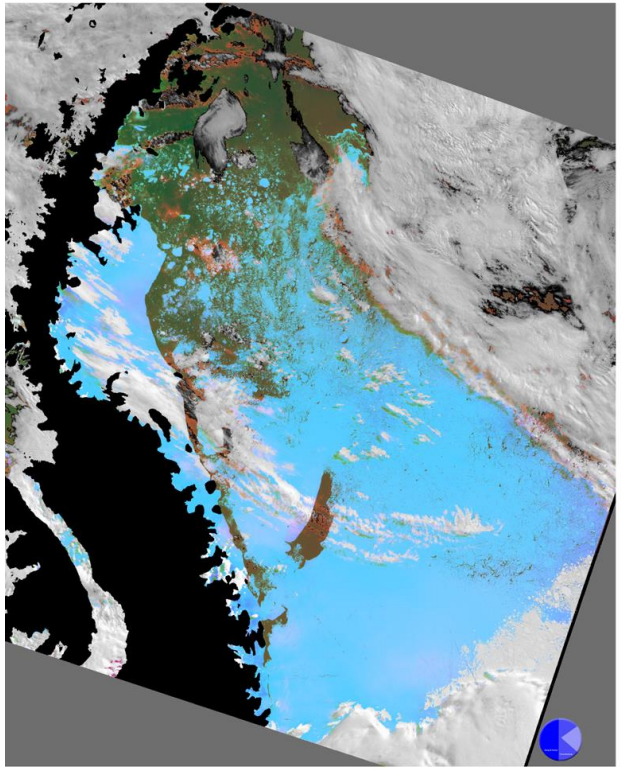
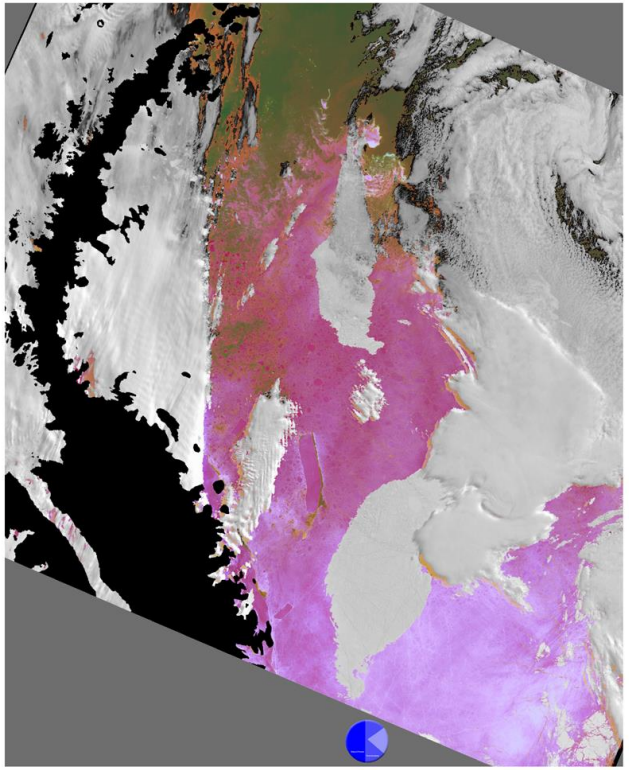
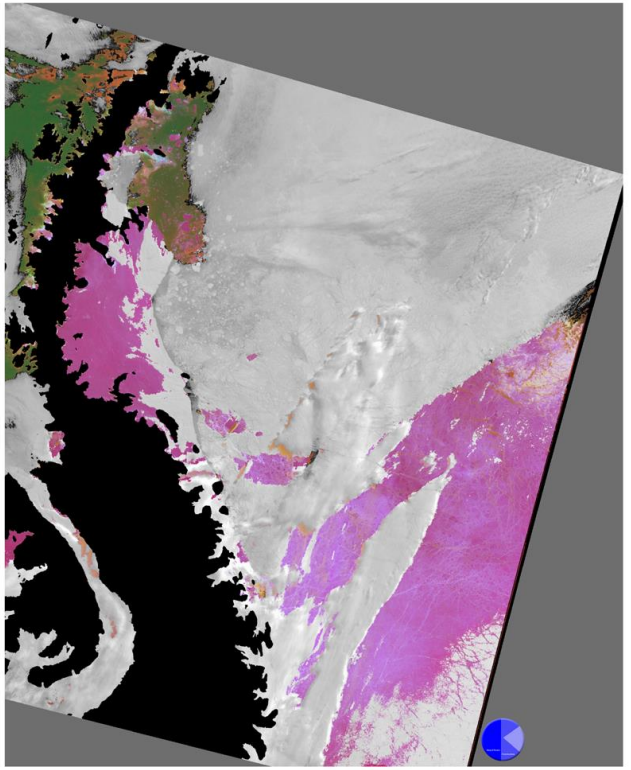


Weddell Sea 2022-02-10

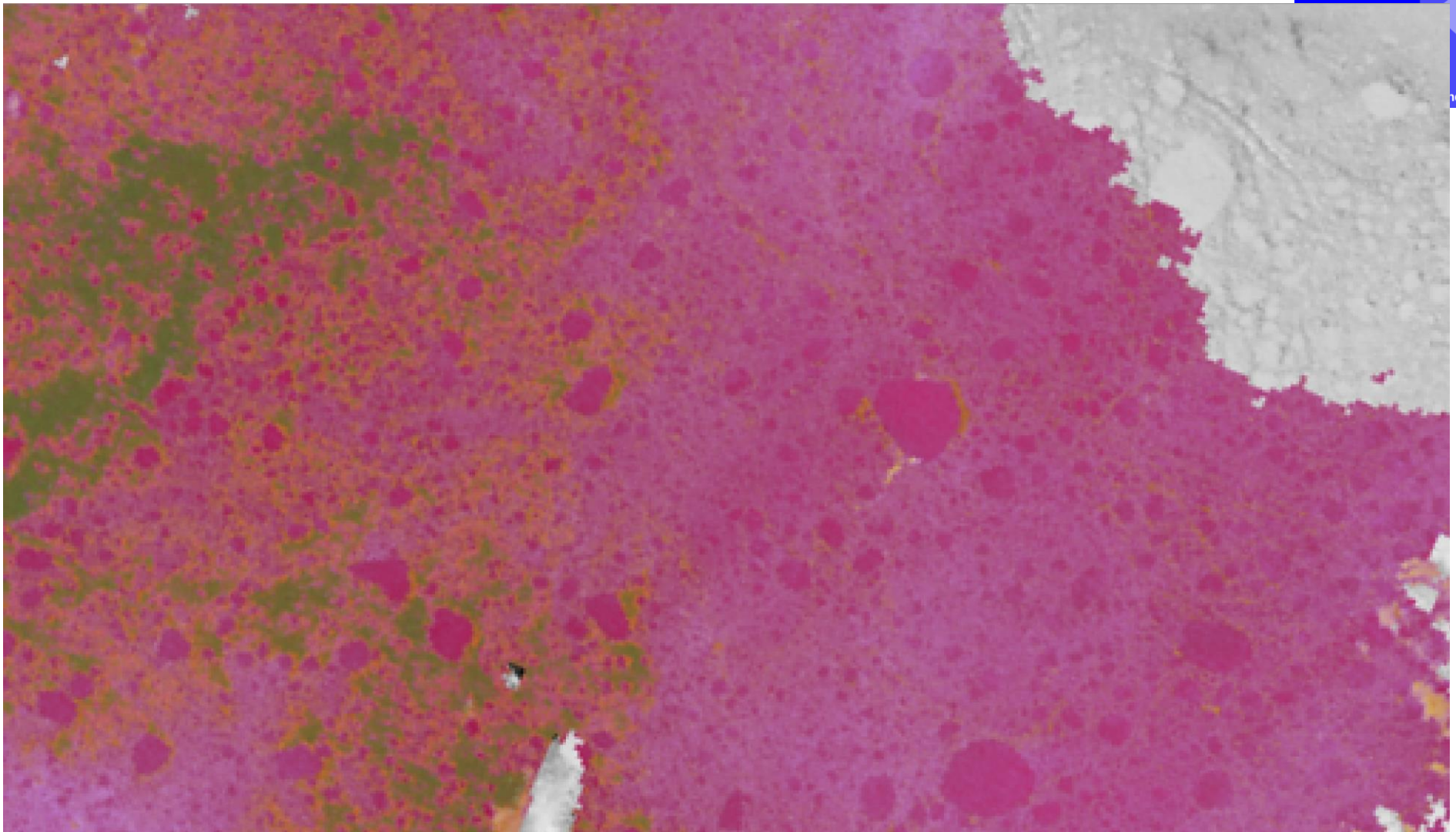


2022-02-20



2022-03-06

EisKlass-31 Sea Ice Classification, Detail. Sentinel-3A, Feb. 20, 2022, 11:34 UTC



SLSTR Ice Classification at Feb. 10, 2022 and Landsat Overpasses Made Available

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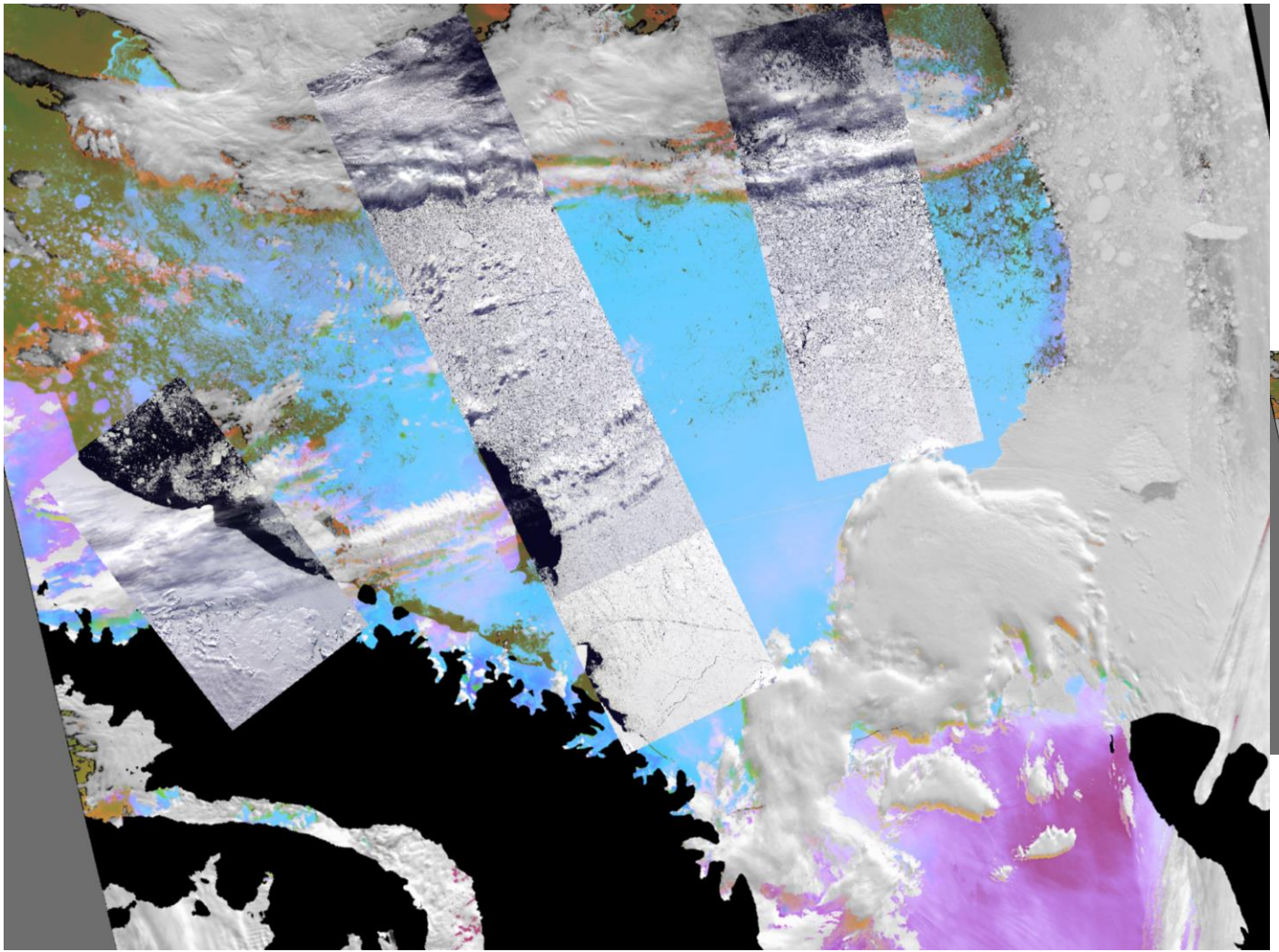

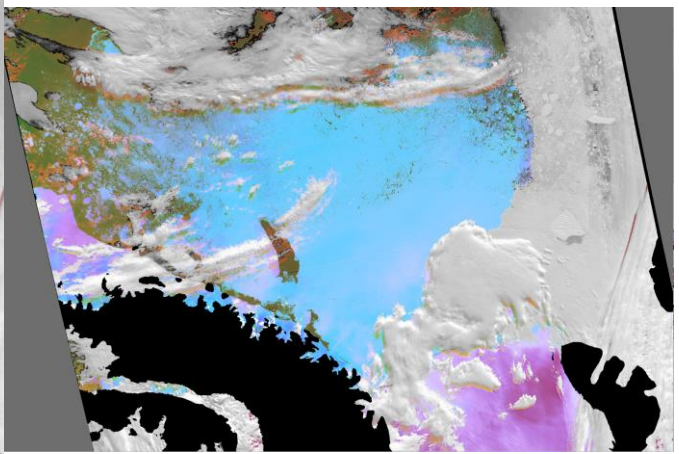

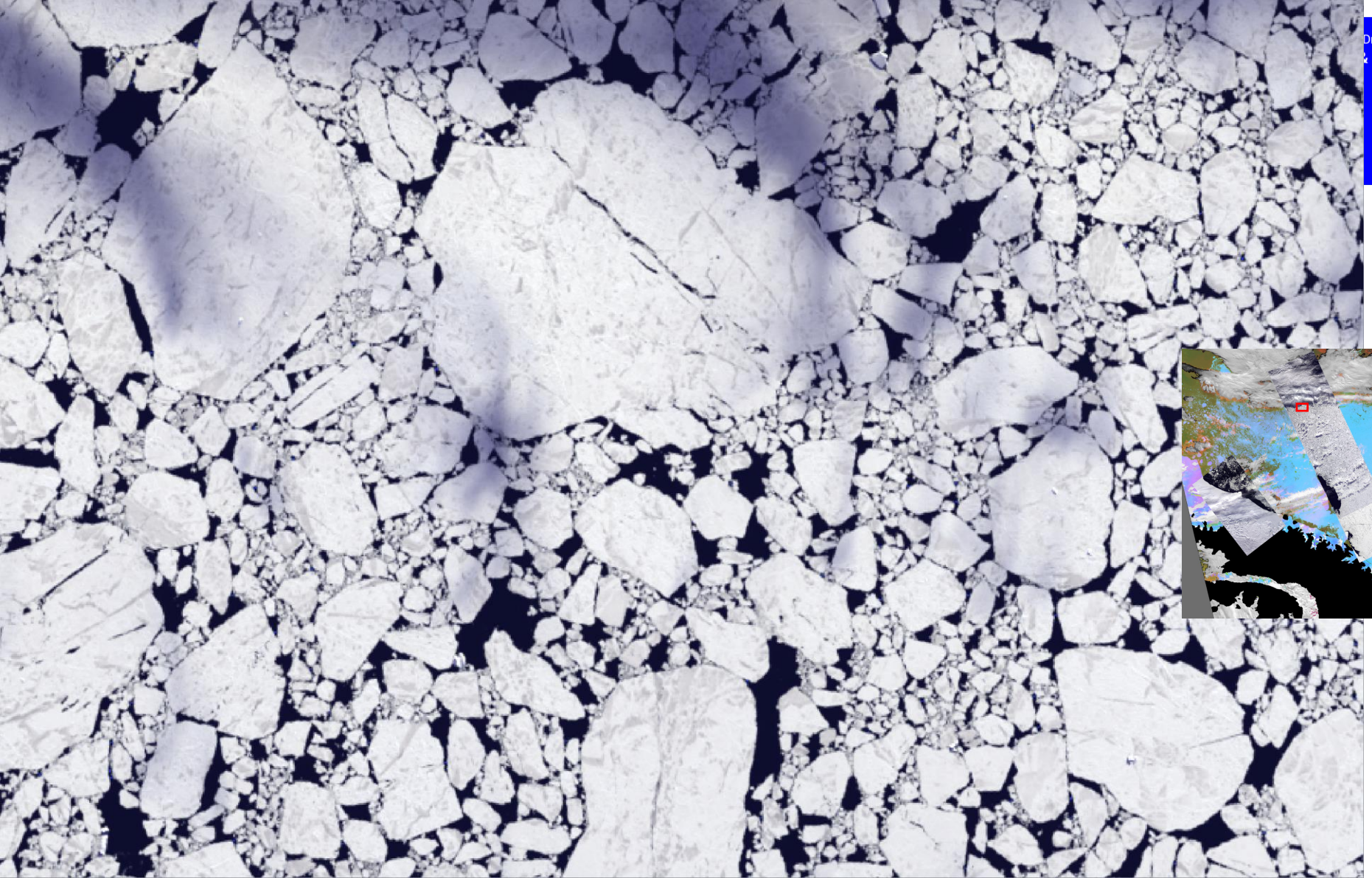

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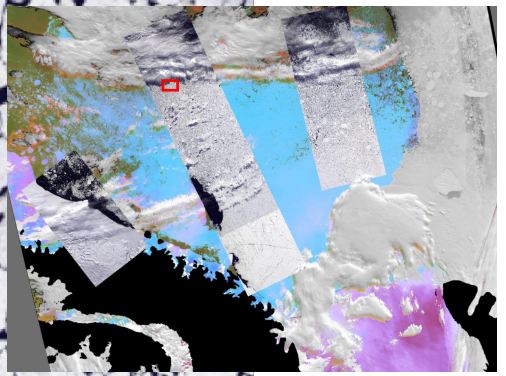

SLSTR Ice Classification at March 6, 2022 and Lansat Scene

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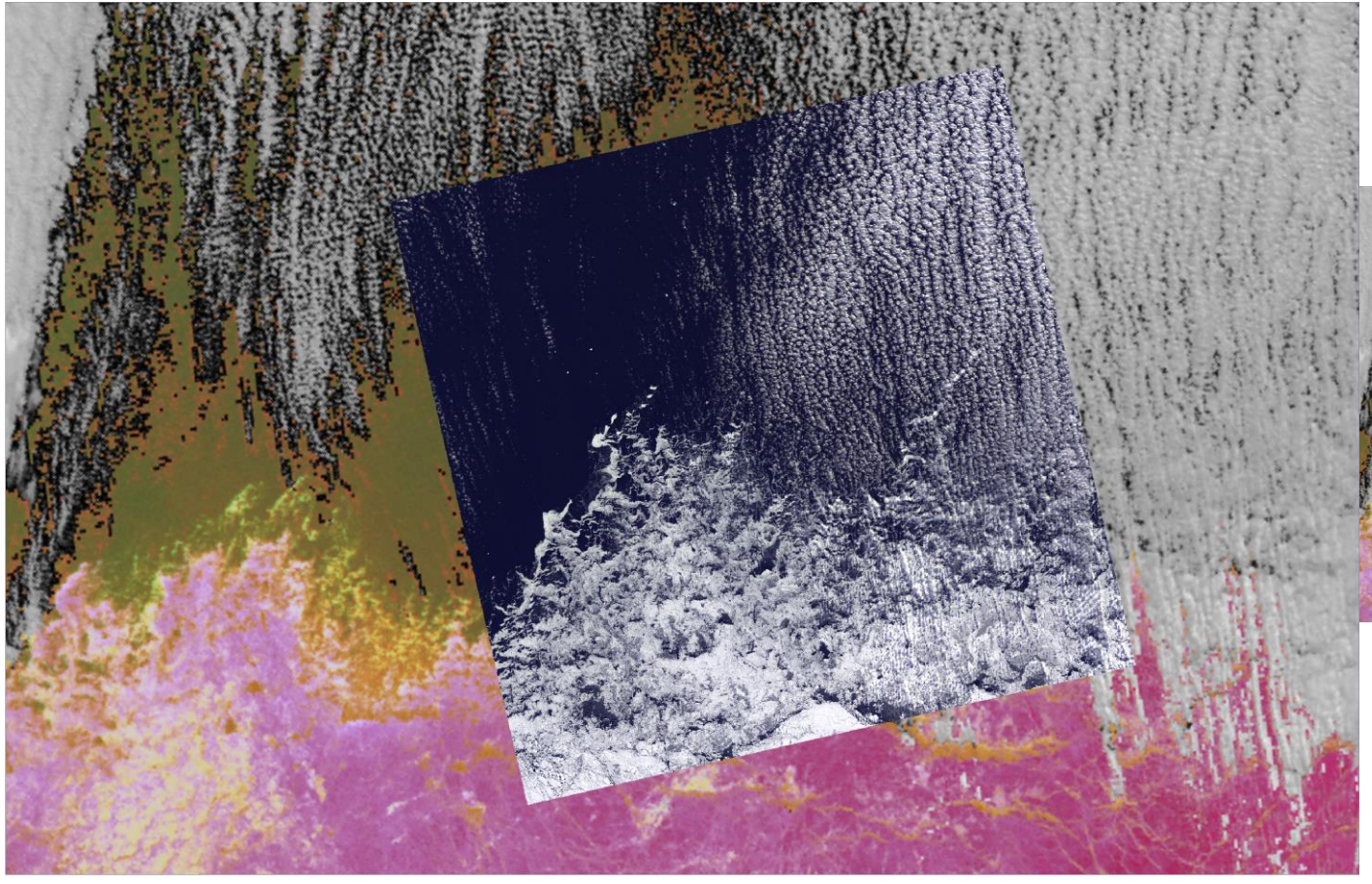

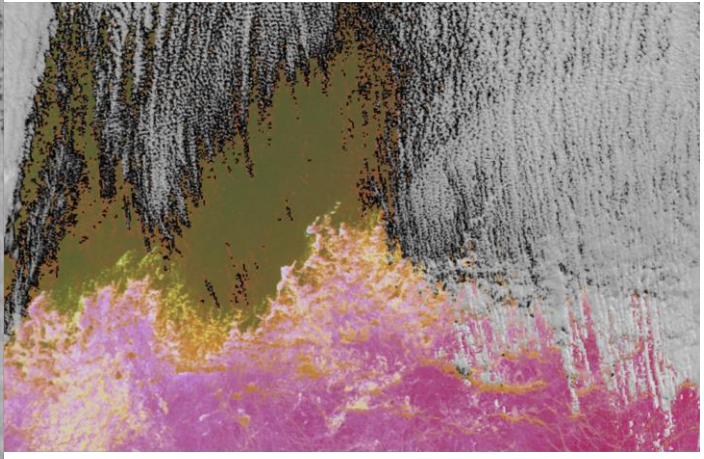

SLSTR Ice Classification at March 6, 2022 and Lansat Scene; Detail

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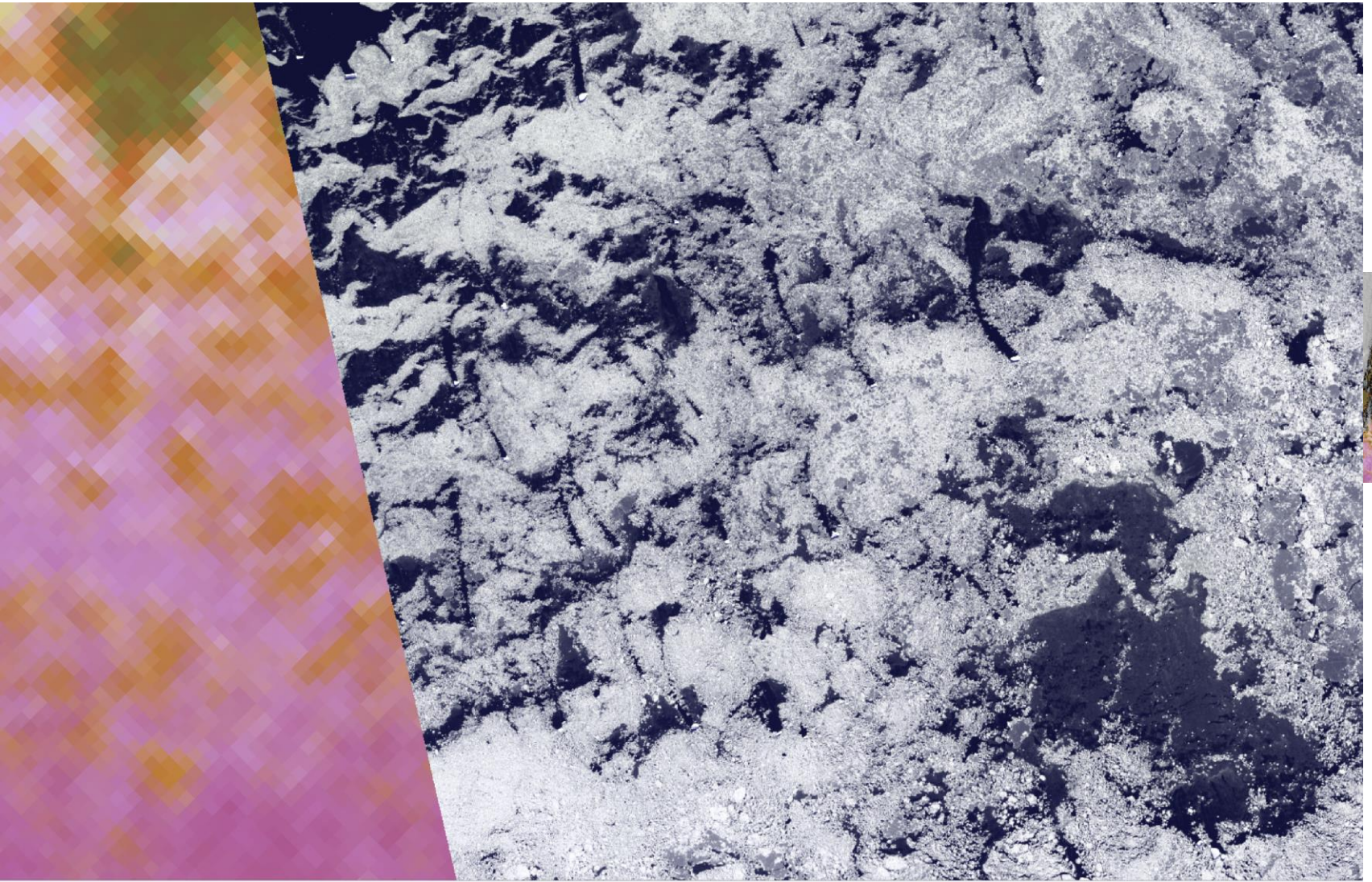

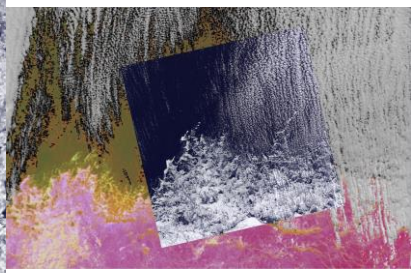

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Thank you for your attention