Intercomparison of DESIS, Sentinel-2 (MSI) and Sentinel-3 (OLCI) data for water colour applications

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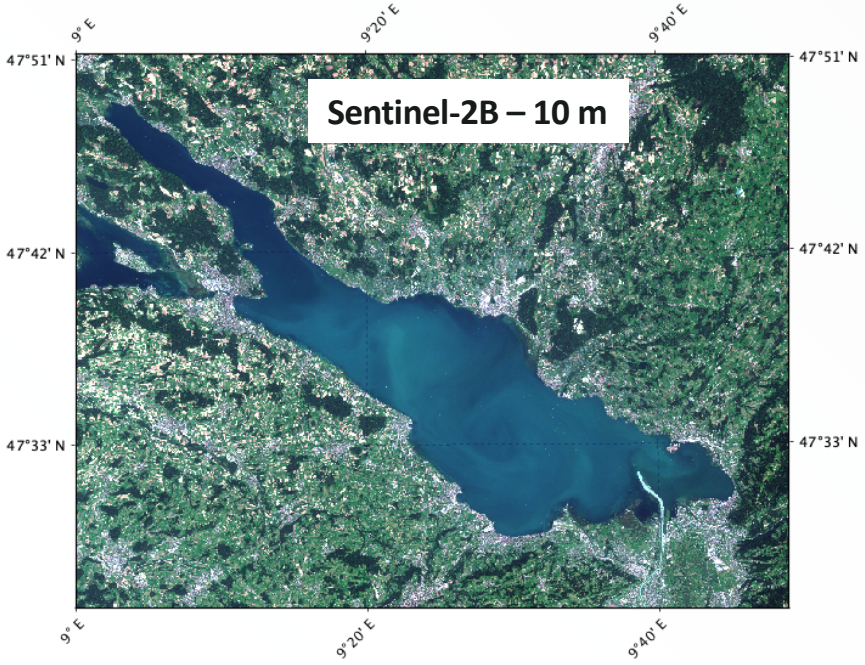
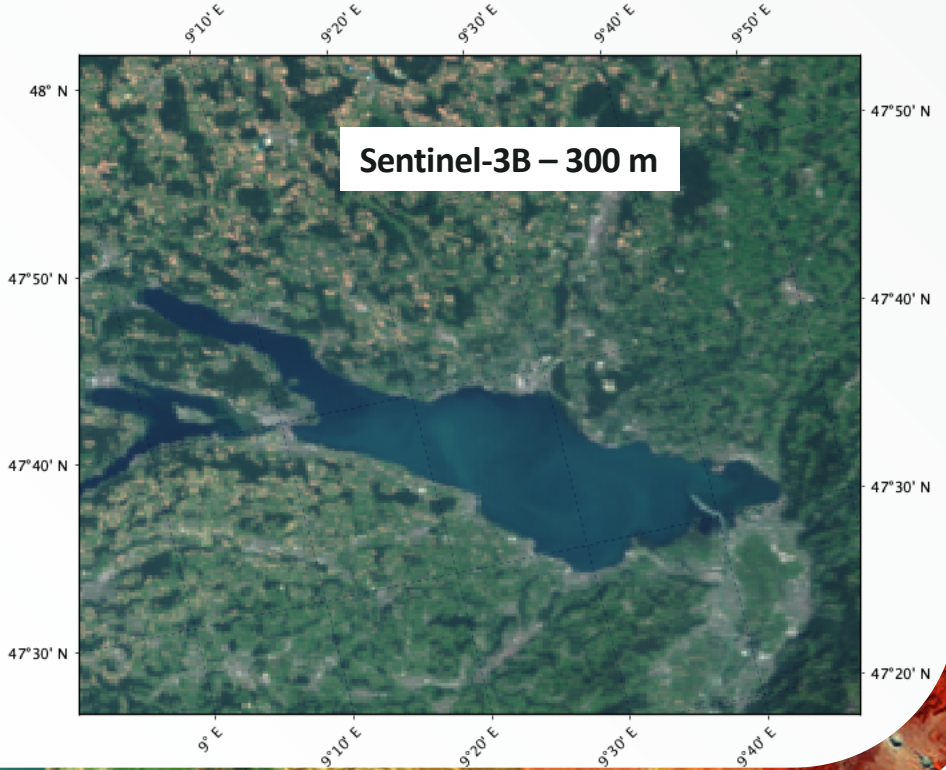
What can we see with S2, S3 and DESIS?

- Lake Constance true colour composites of Level 1 (R:665, G:560, B:490) in 14.08.2021





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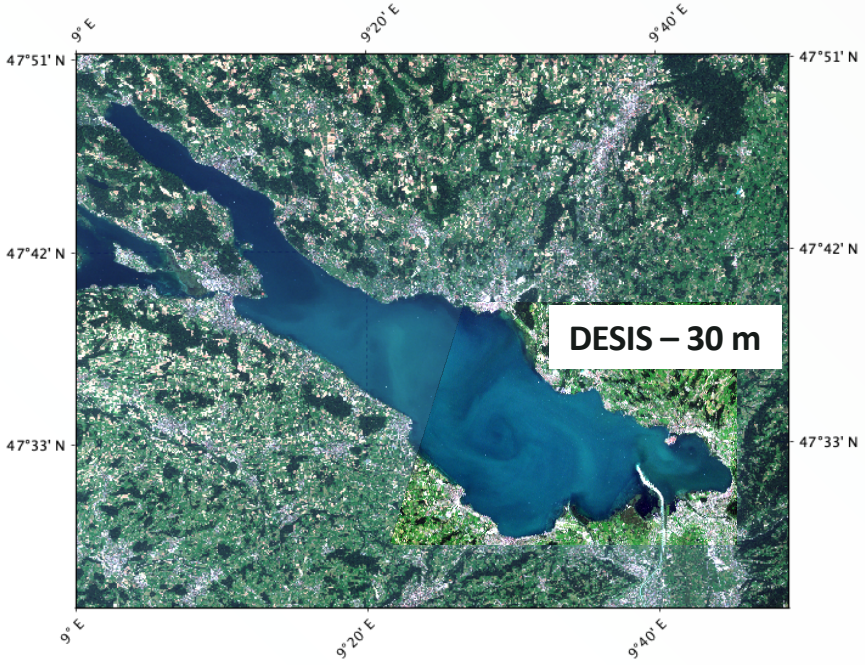
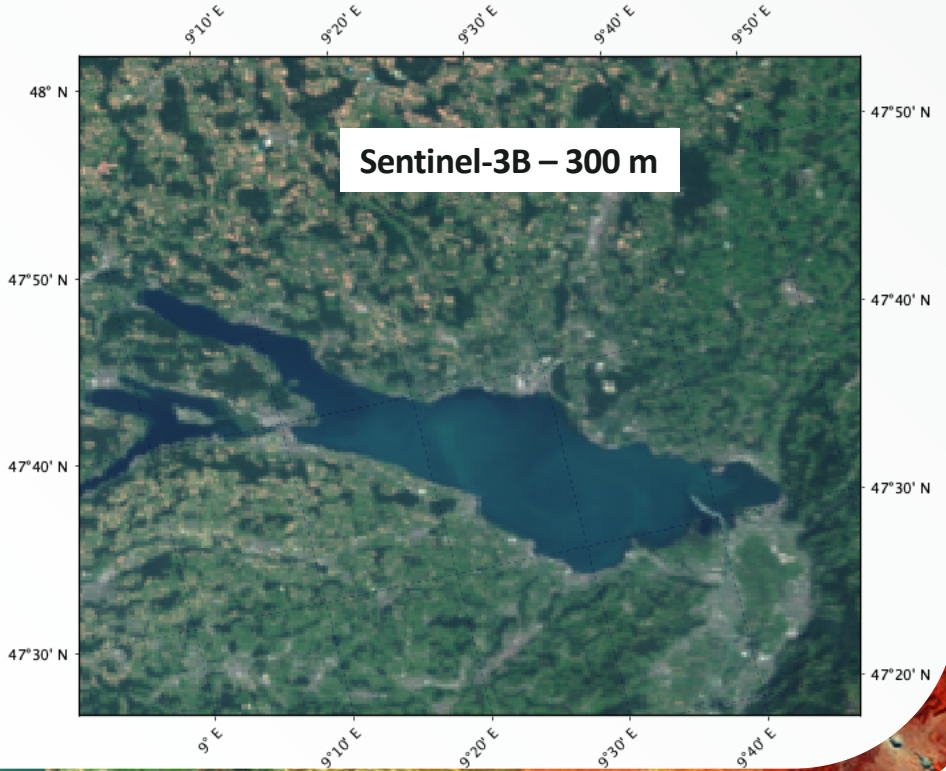


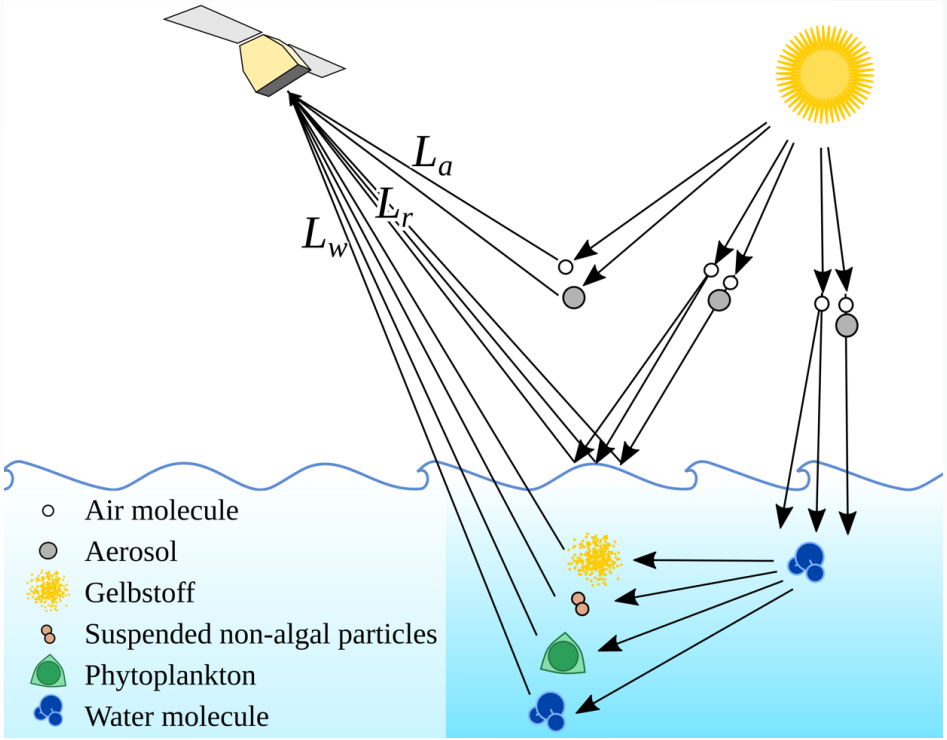


Atmospheric correction over water

- The information of the radiance (L) in the VIS-SWIR part of the spectrum can be used to infer the water optical properties.

- The total radiance (L_{TOA}) measured by the sensor has different origins:
  - atmosphere (L_a)
  - surface (L_r)
  - **water (L_w)**

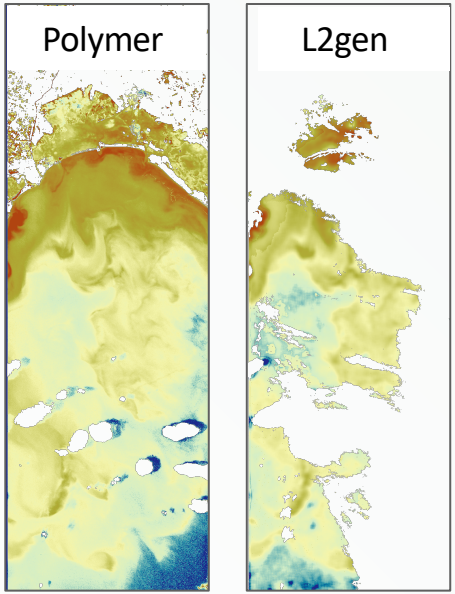
- ***Lw*** is only a **small part of L_{TOA}** (max. 10%)!!



The Polymer Algorithm

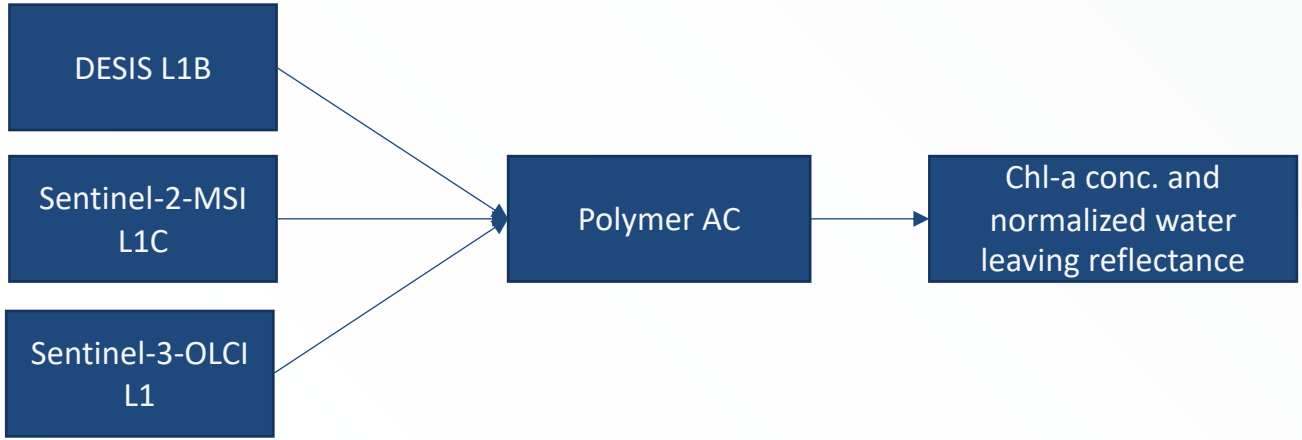
- Polymer: **POLYnomial based algorithm applied to MERIS** (Steinmetz et al. 2011)
- **Python package** available at https://www.hygeos.com/polymer
- Polymer is (almost) **directly applicable to hyperspectral sensors.**
- **Spectral matching algorithm**; uses full available spectrum.
- **Improved spatial coverage** compared to other algorithms due to its possibility to recover the Ocean Colour in presence of sun glint.
- **3 step process**: (1) Pre-correction of the top of atmosphere radiance, (2) spectral matching of the atmospheric and water models, and retrieval of the (3) normalized water-leaving reflectance.
- Polymer applied to **hyperspectral sensors is as good as for multispectral sensors** (Soppa et al. 2021).

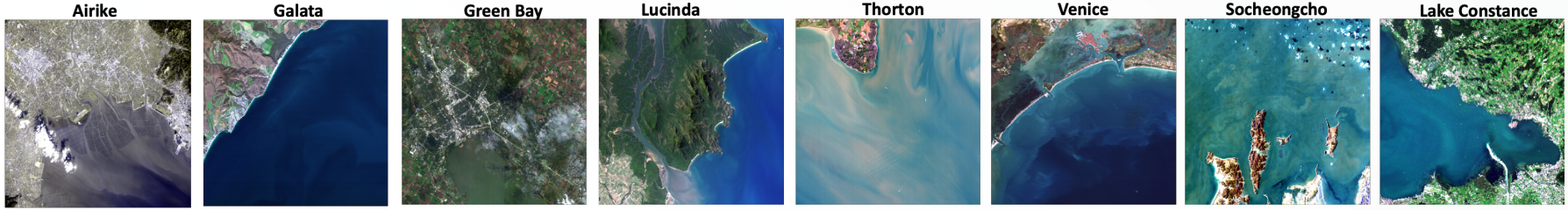
HICO (10-03-2014) - Rrs 553 nm



How Polymer performs applied to DESIS?

- DESIS, S2-MSI, S3-OLCI images at 8 study sites were processed with Polymer AC and intercompared.

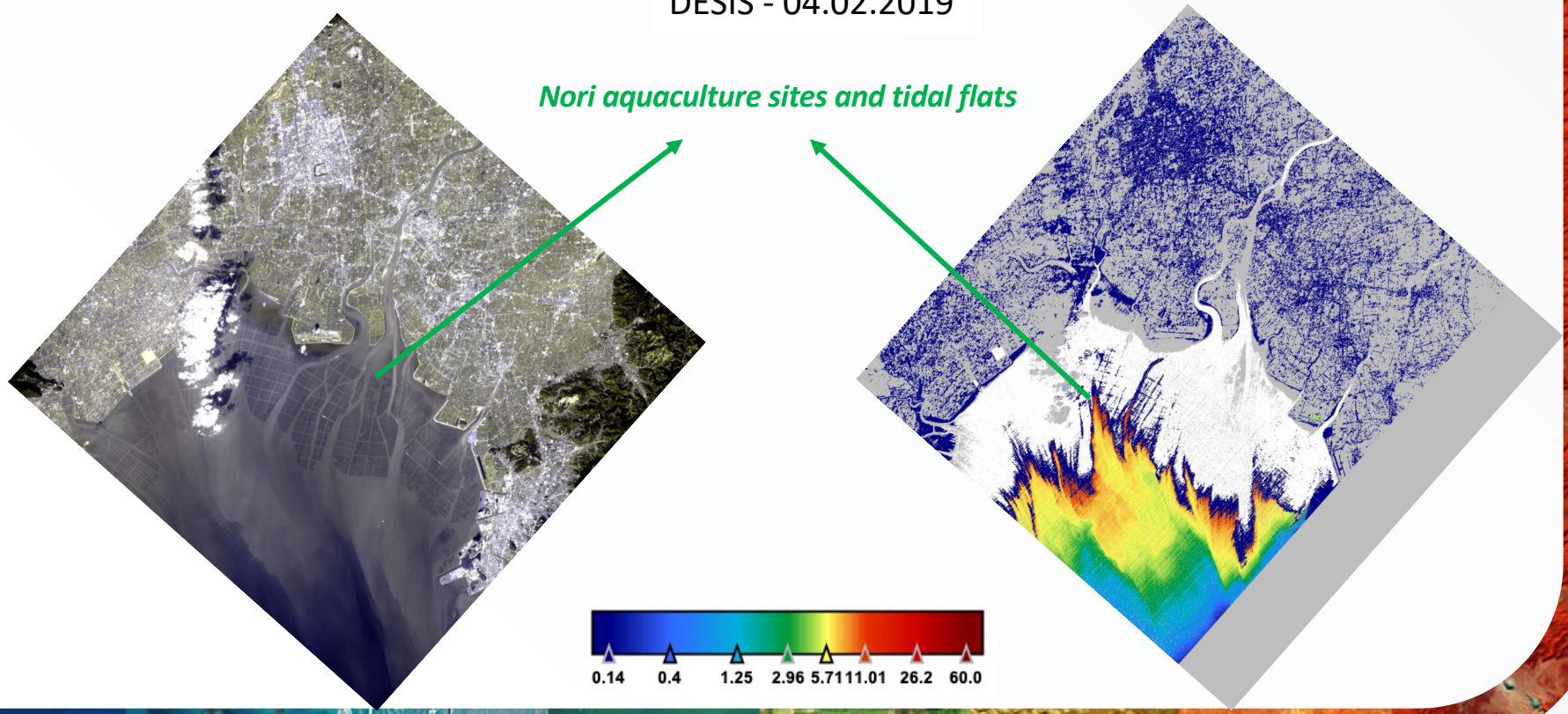




Ariake: Chl-a concentration (mg/m^3)

DESIS - 04.02.2019

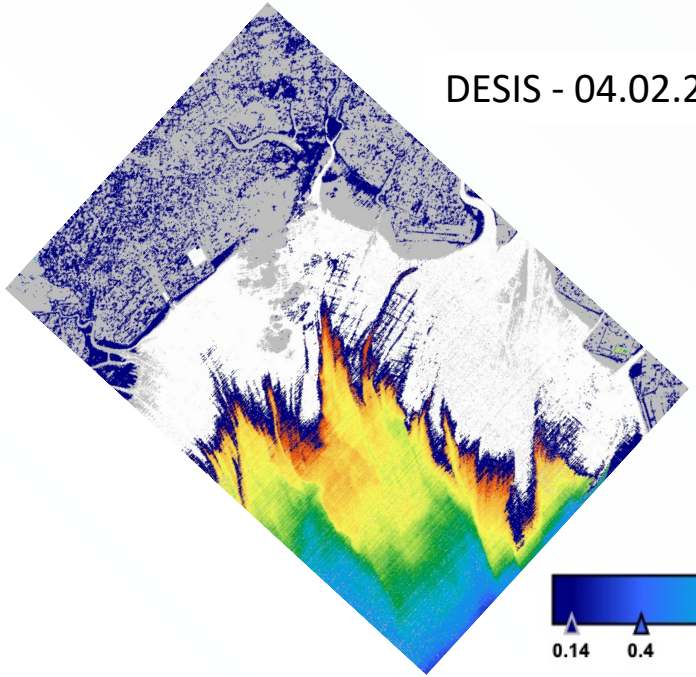
Nori aquaculture sites and tidal flats

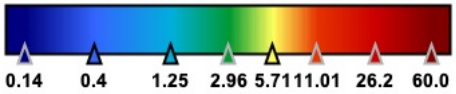


Ariake: Chl-a concentration (mg/m^3)

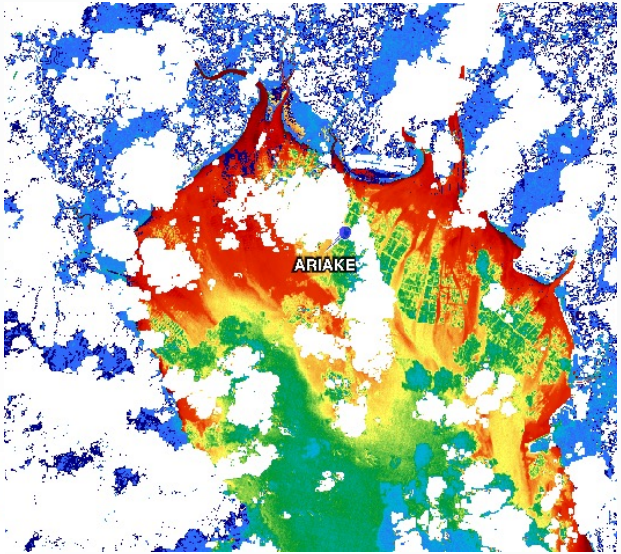
- Grey pixels are flagged regions due to several factors: cloud, thick aerosol plume, optimized parameters out of bunds, etc.
- More pixels are flagged correctly by Polymer in DESIS than S2-MSI.

DESIS - 04.02.2019





S2-MSI - 01.02.2019



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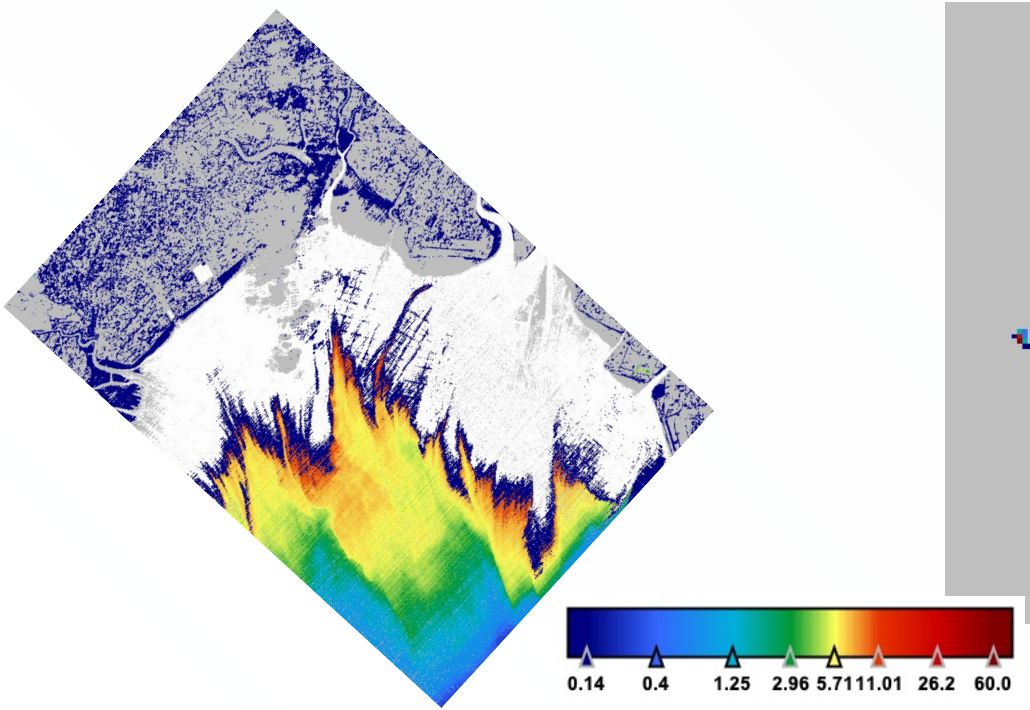
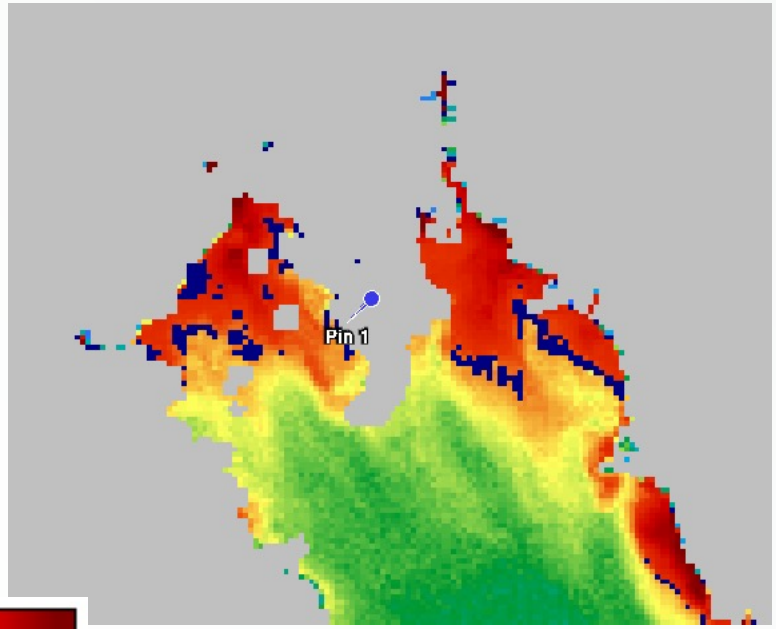
DESIS - 04.02.2019

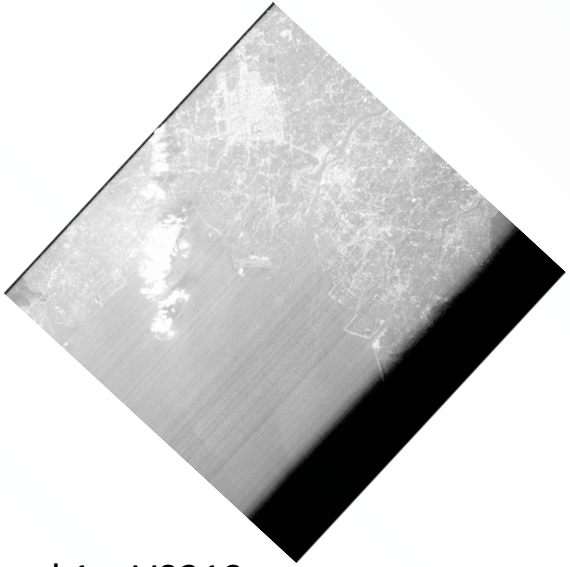


S3-OLCI- 04.02.2019

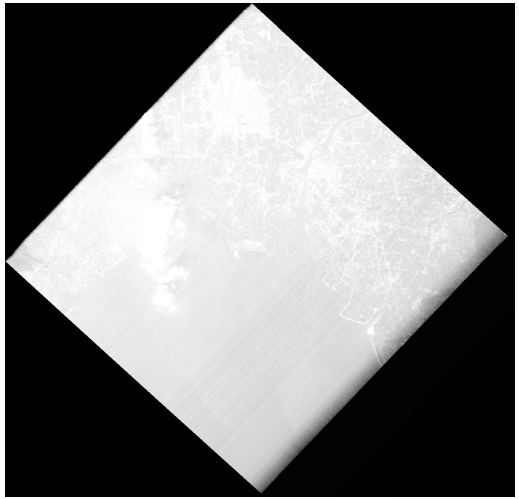


Ariake

- Bands 1 to 6 of L1B DESIS affected by this region with radiance = 0, but the region affected decreases with increasing wavelength → sensor degradation.
- L1C V0213 is less affected.
- Differences due to data version or data level?



DESIS L1B – Band 1 – V0210

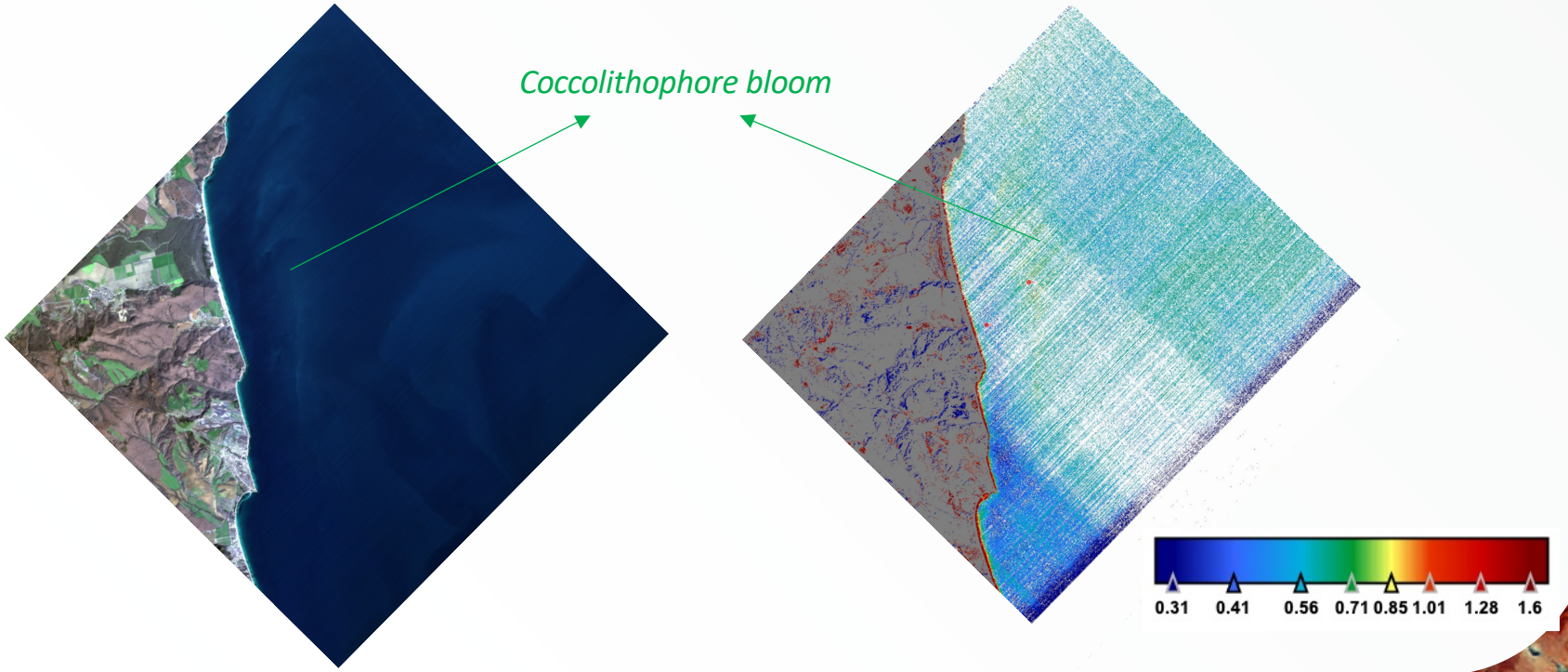


DESIS L1C – Band 1 – V0213

Galata: Chl-a concentration (mg/m^3)

- Adjacency effect along the coastline.
- Striping effect → use L1C data.

Chl-a concentration (mg/m^3)



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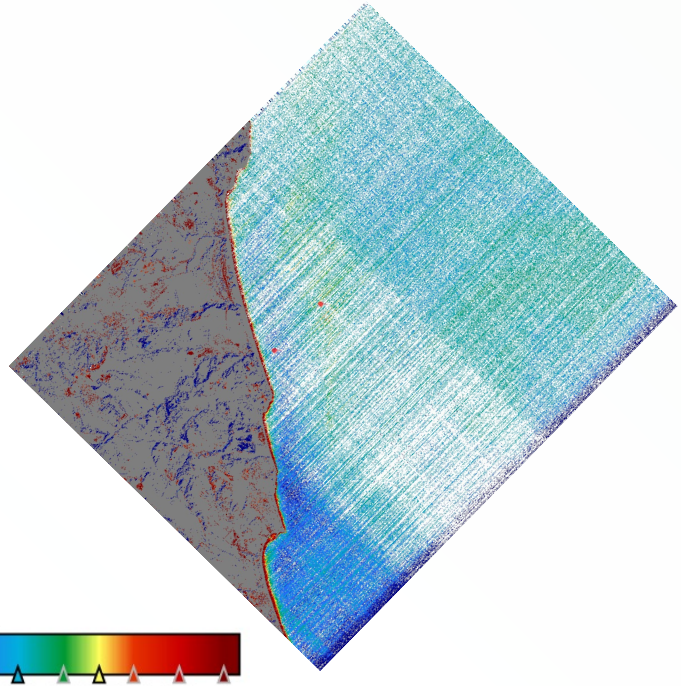
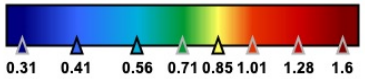
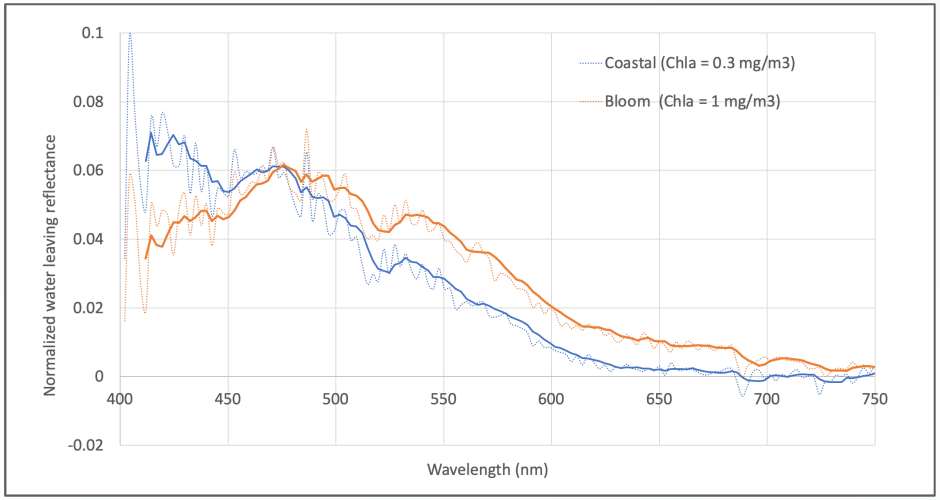




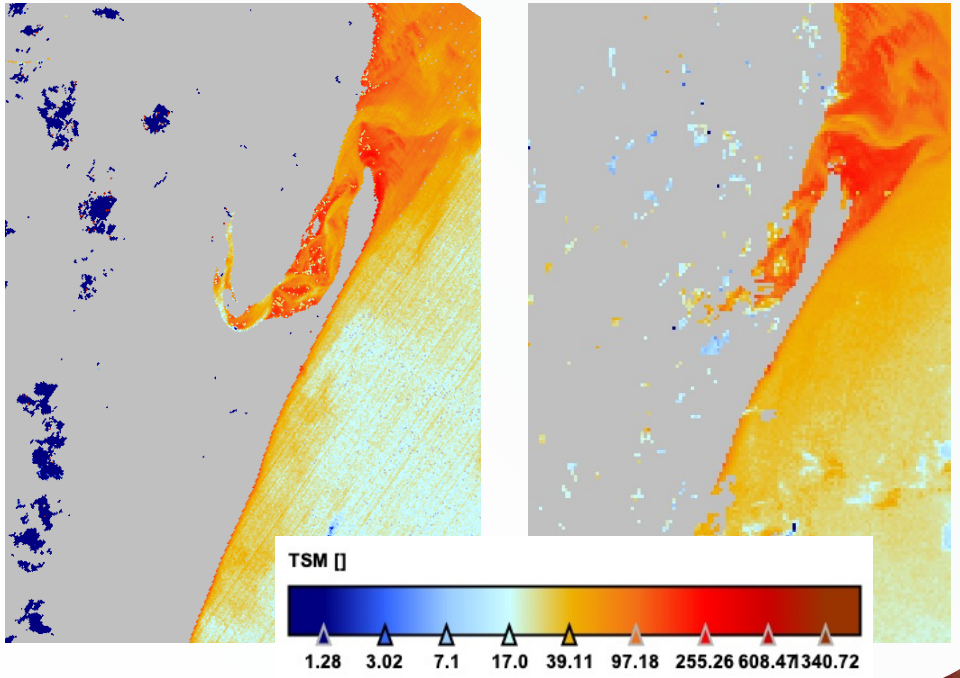


Lucinda: Total Suspended Matter (mg/L)

- TSM derived using a simple empirical algorithm (Nechad et al., 2010).
- Similar distribution and magnitude.

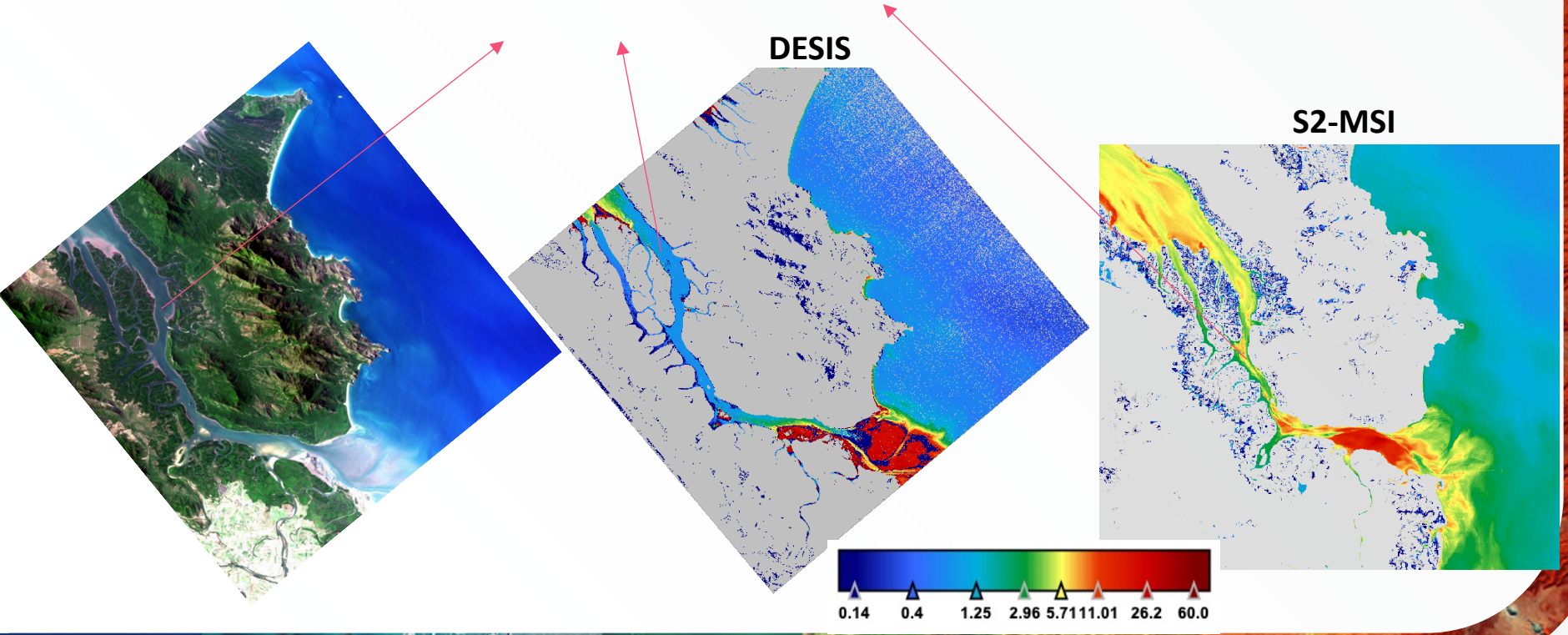
DESIS - 06.12.2019

S2-MSI- 05.12.2019



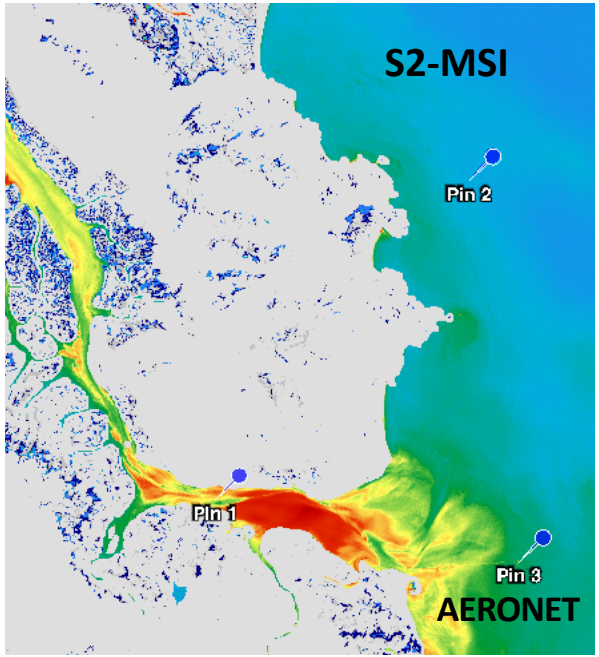
Lucinda: Chl-a concentration (mg/m^3)

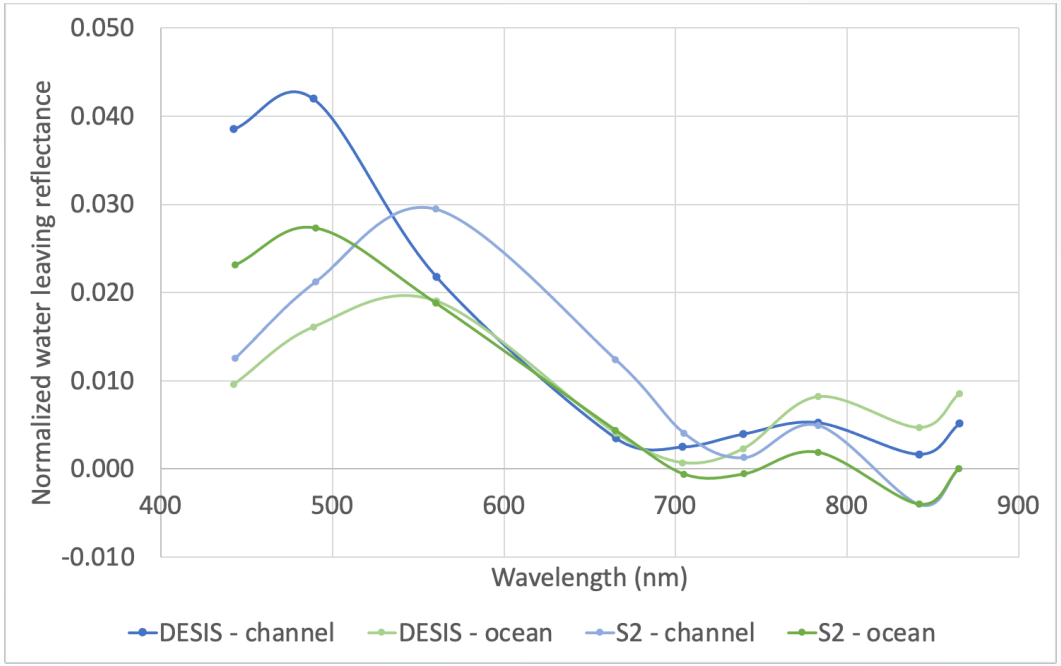
- Better differentiation of TSM and Chl-a with DESIS than S2-MSI.



Lucinda: Chl-a concentration (mg/m^3)

- Larger differences at the blue bands (443 and 490 nm).
- Better agreement at the “ocean” than in the at the “channel”.





Summary

- Consistent retrievals of DESIS products using Polymer atmospheric correction algorithm.
- Overall good agreement between Polymer-DESIS and Polymer-S2-MSI products.
- DESIS-Polymer retrievals will be improved by:
  - replacing DESIS L1B data by L1C;
  - avoiding the < 430 nm due to manufacturing defects;
  - testing different band settings.
- Hyperspectral radiometric data in coastal and inland waters from research cruises, field campaigns, validation sites as WATERHYPERNET (Vansteenwegen et al., 2019), WISPstation network (Bresciani et al., 2020).

Acknowledgments

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- ESA is acknowledged for Sentinel-2 and Sentinel-3 level 1 data.