MISR Arctic and Antarctic Sea Ice Albedo 2000-2022: Product Creation, Trend Analysis and Validation

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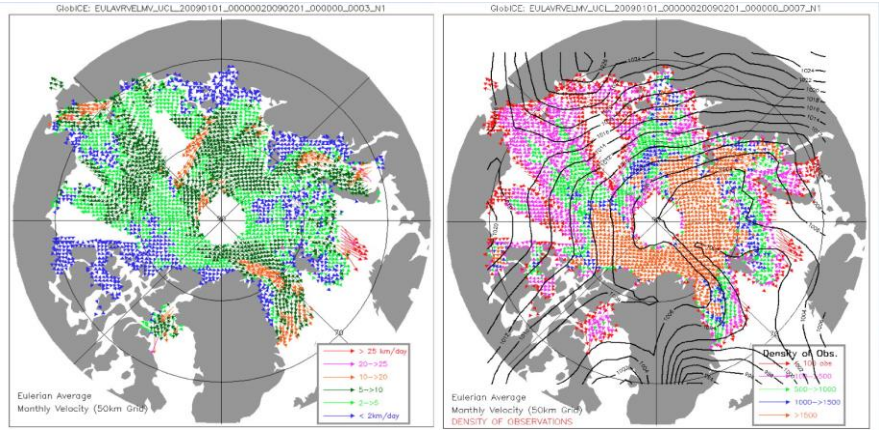
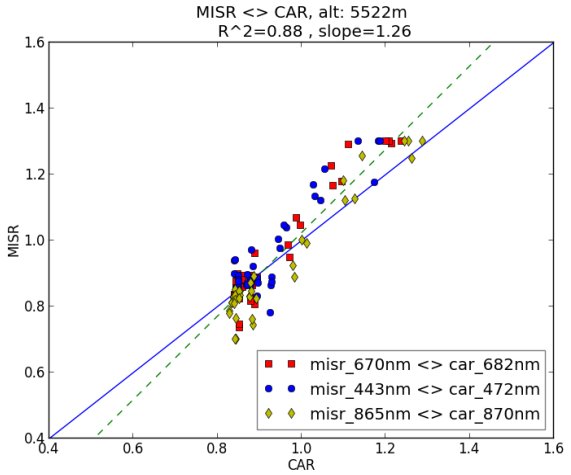
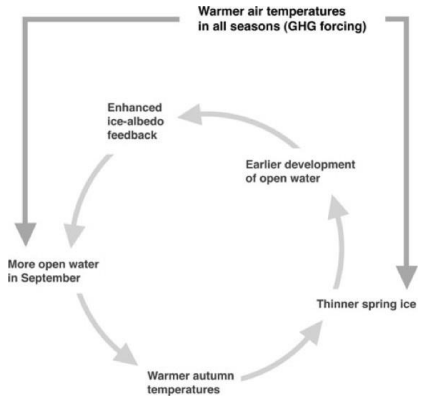
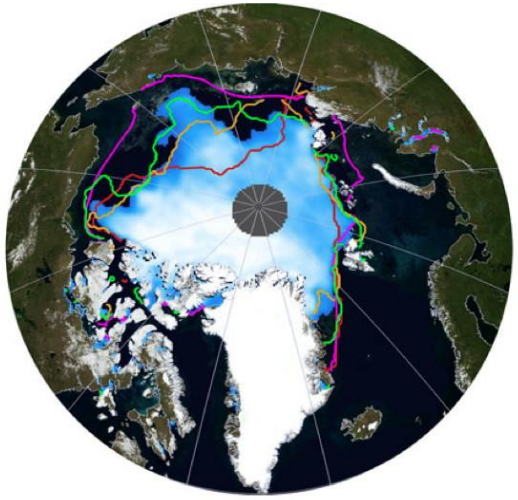
Relevance of MISR Sea Ice Albedo science

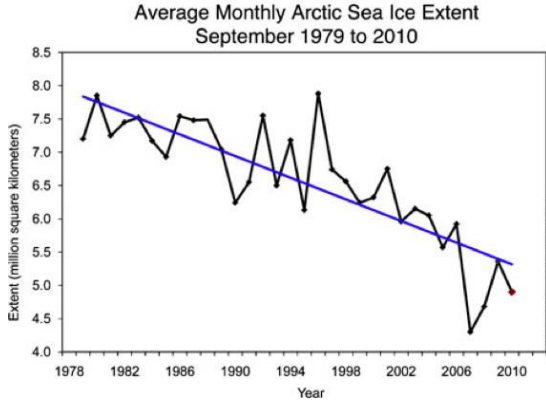








- Ice Cap is melting. But we don’ know the effect on sea ice surface albedo.
- This work is a first attempt at creating a long time series to study these effects
- For MISR, we can take instantaneous BRFs and compare these against near-simultaneous airborne spectral BRDF sampling system by CAR
- Selected NASA-CAR from ARCTAS campaign (7 April 2008), previously studied by Lyapustin et al. (2011)
- MISR comparisons with CAR indicate that without accounting for any aerosols, we have very good agreement between MISR BRF and corresponding CAR BRF data
- Sea ice is anisotropic and moves fast.
- MISR is the <u>only EO sensor flying in space</u> which has the potential to map instantaneous sea-ice albedo, a key Essential Climate Variable



Stroeve et al., Climatic Change (2012) 110:1005–1027, DOI 10.1007/s10584-011-0101-1

Sea Ice Albedo production Flowchart

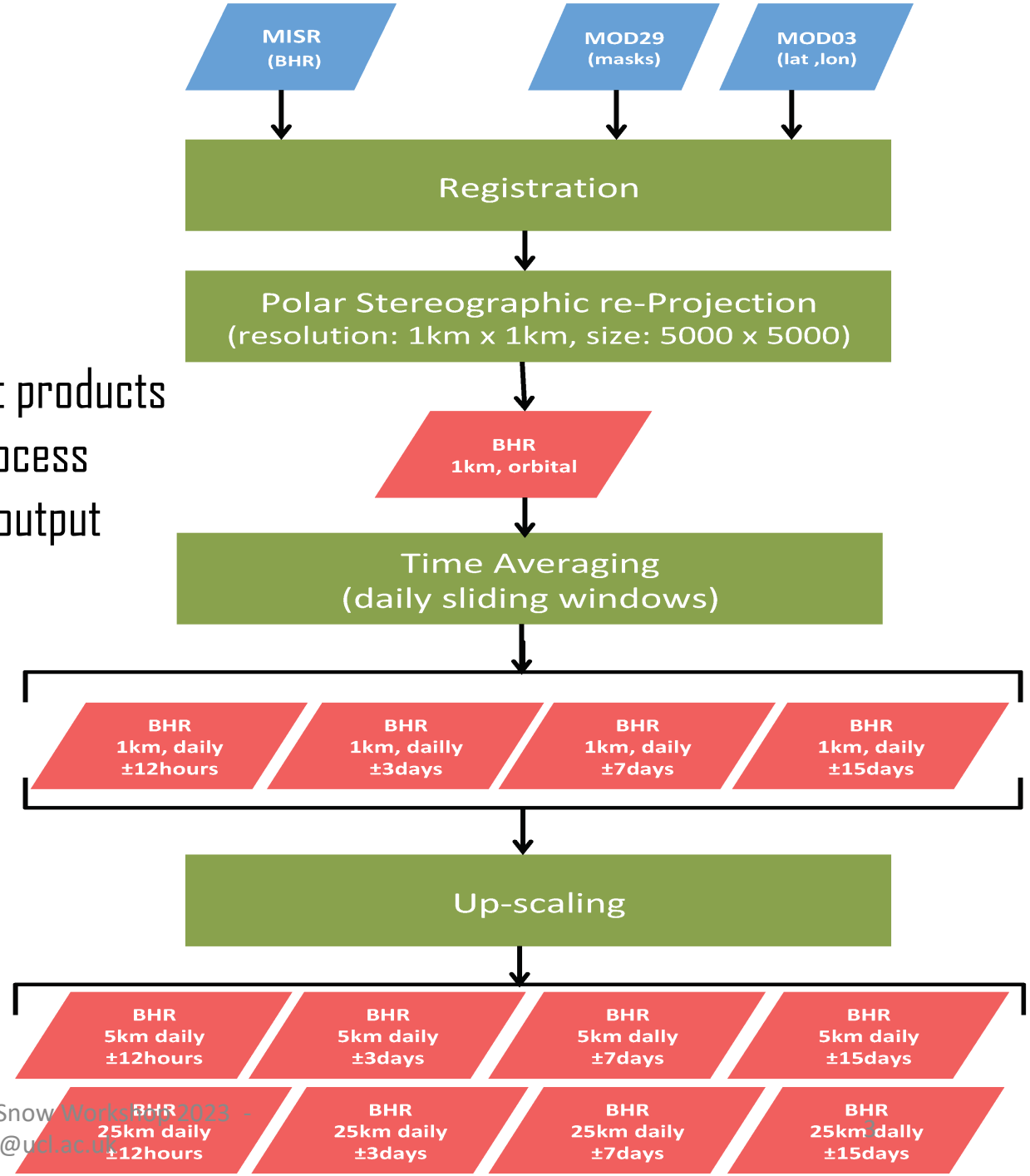
Merging of 3 products:

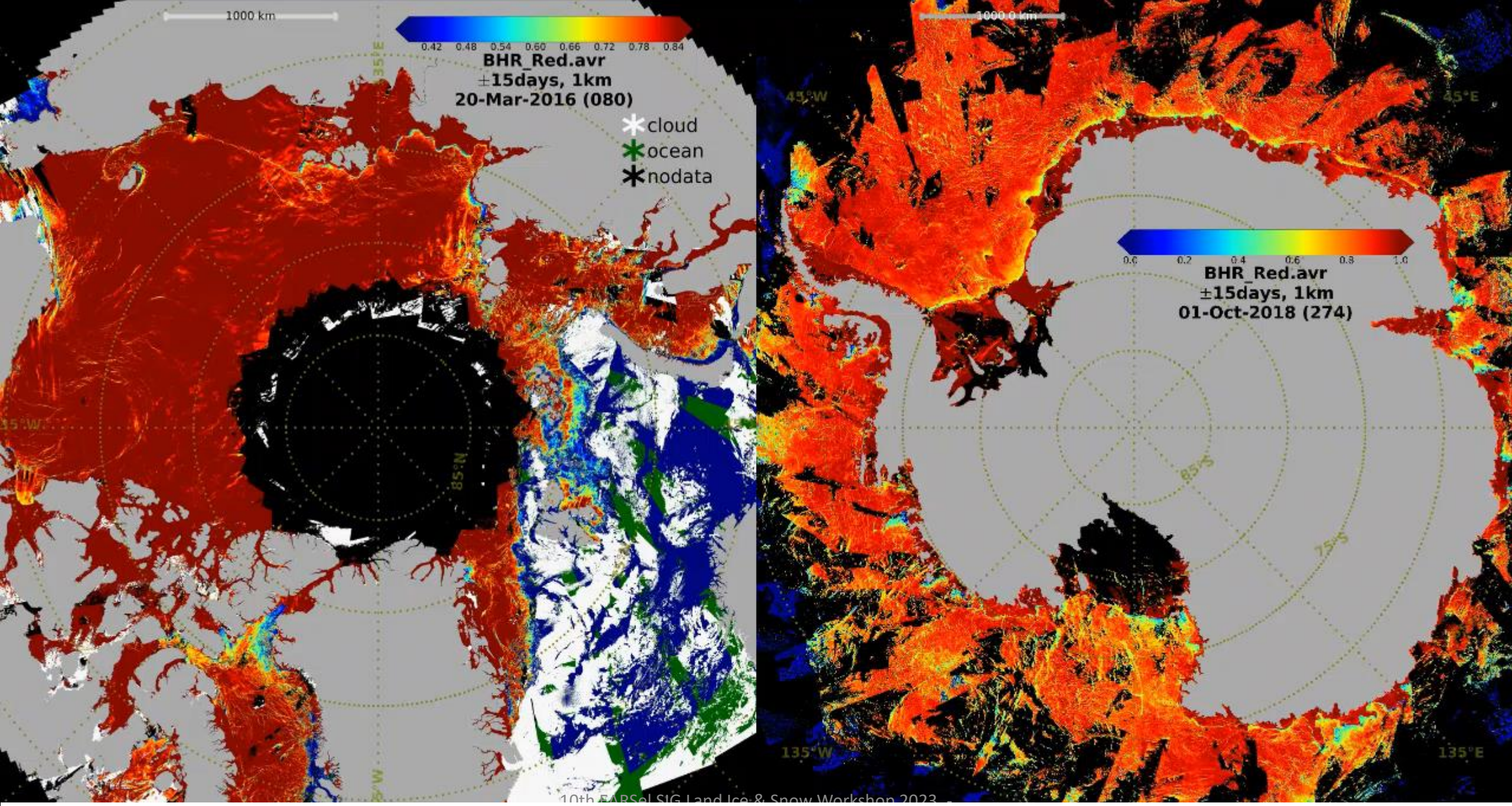
- MISR L2AS: red, green, blue, NIR spectral bandwiths (2% absolute radiometric uncertainty) at 1.1km resolution.
- MOD29: Surface Temperature and Ice Extent products containing MOD35 Cloud Mask. 1km resolution.
- MOD03: geolocation product. 1km resolution.

Final output products:

- BHR Orbital swaths.
- BHR daily sliding windows for the 4 spectral bands and statistics.
- Total of 12 daily Sea Ice BHR products, with different averaging time window (31days, 15days, 7days and 1 day) and spatial resolutions (1km, 5km, 25km).

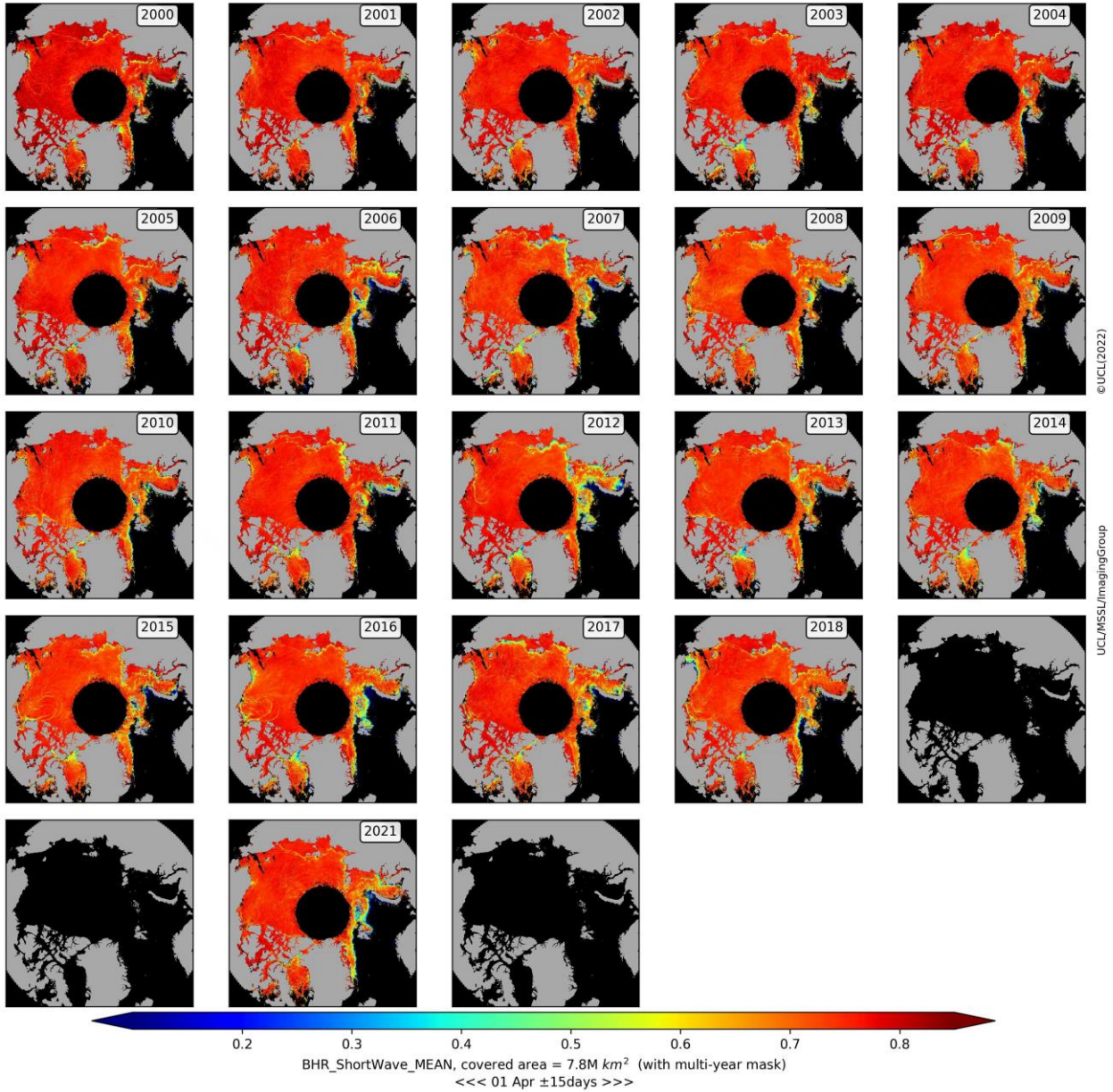
Blue: input products
Green: process
Red: final output products



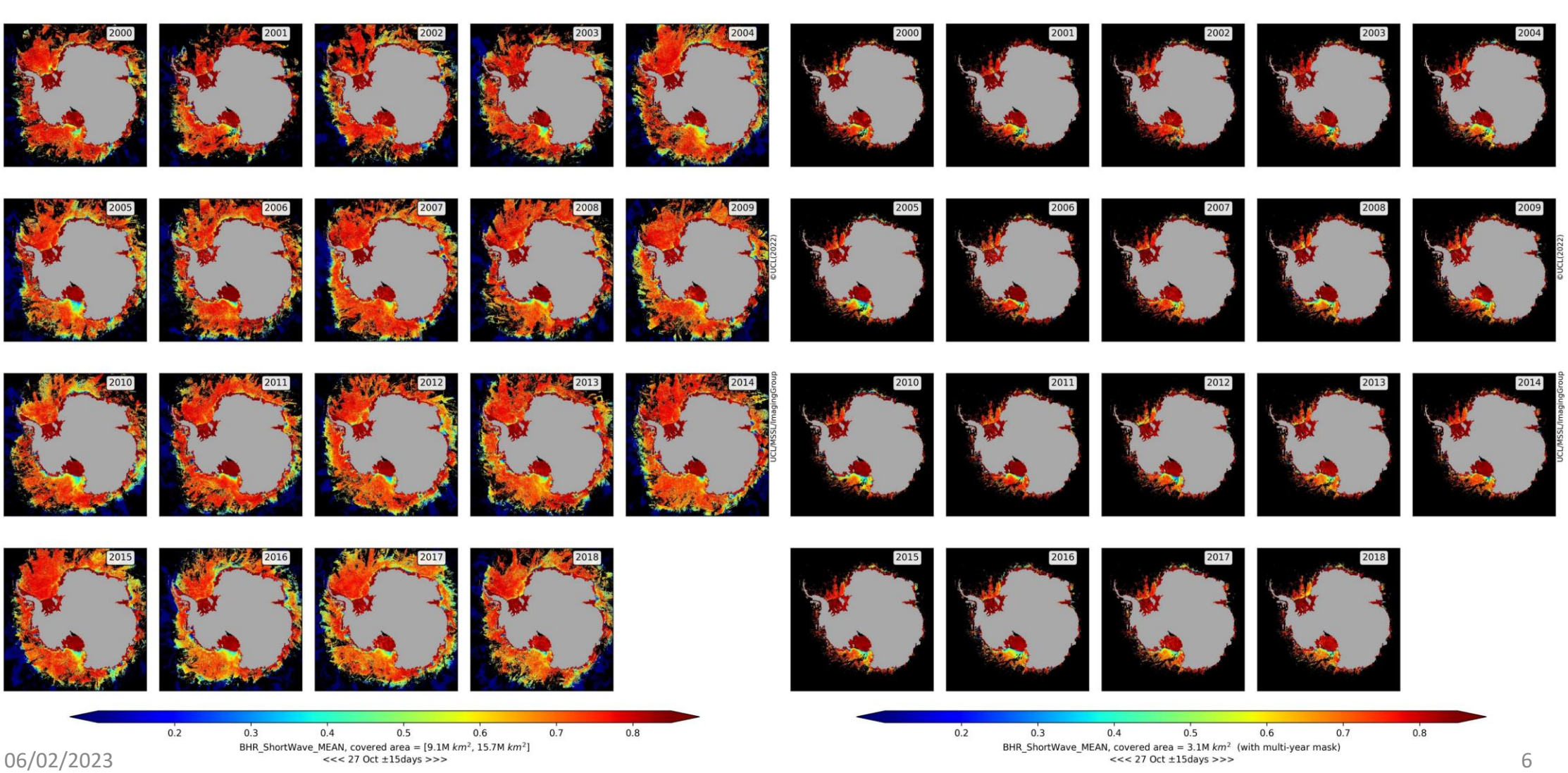


31 days average BHR_{Red} pre-melt season for the Arctic (2016) and Antarctic (2018-2019), at 1km resolution.

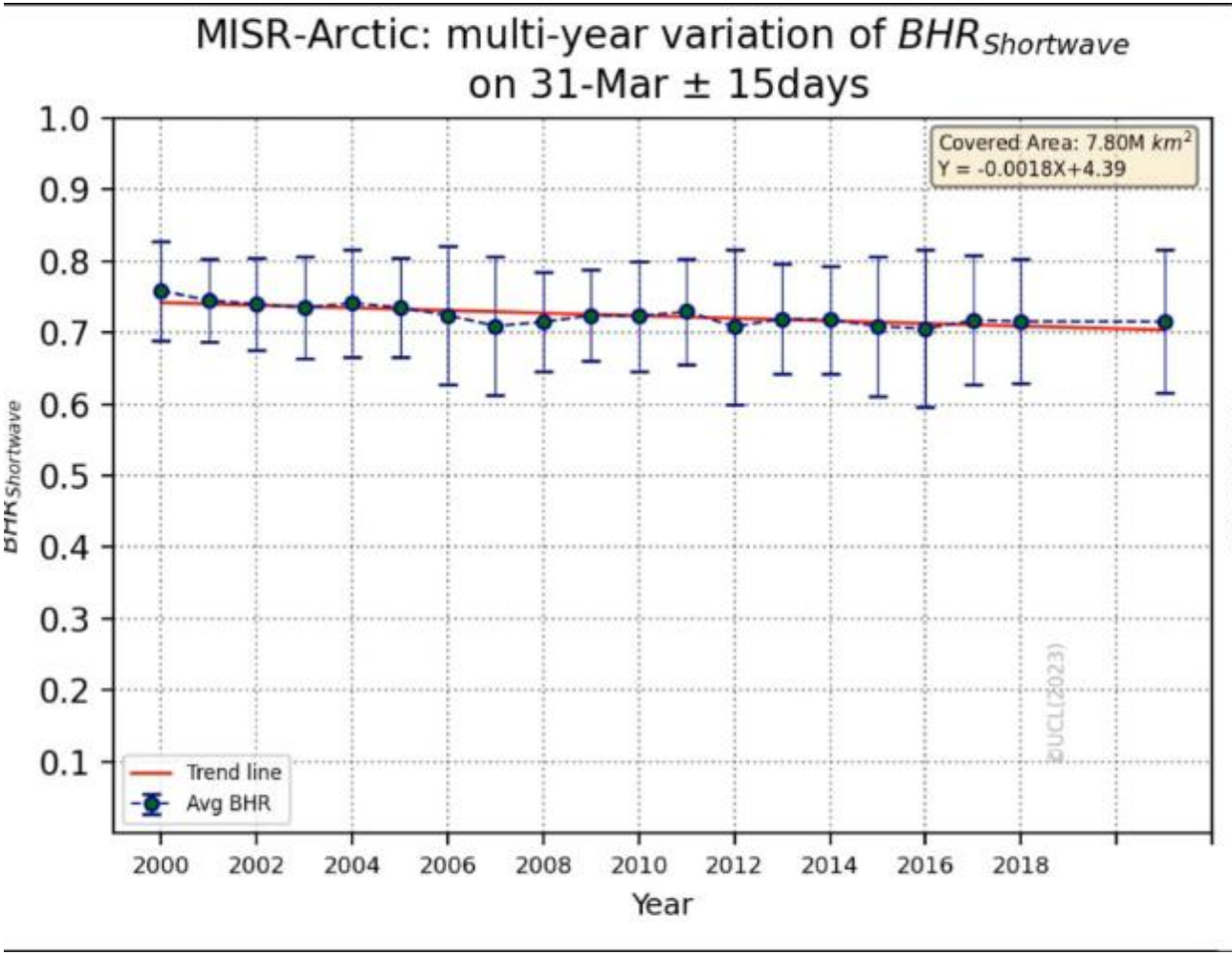
Arctic 31 days average $BHR_{Shortwave}$ multi-year results - 1km resolution.

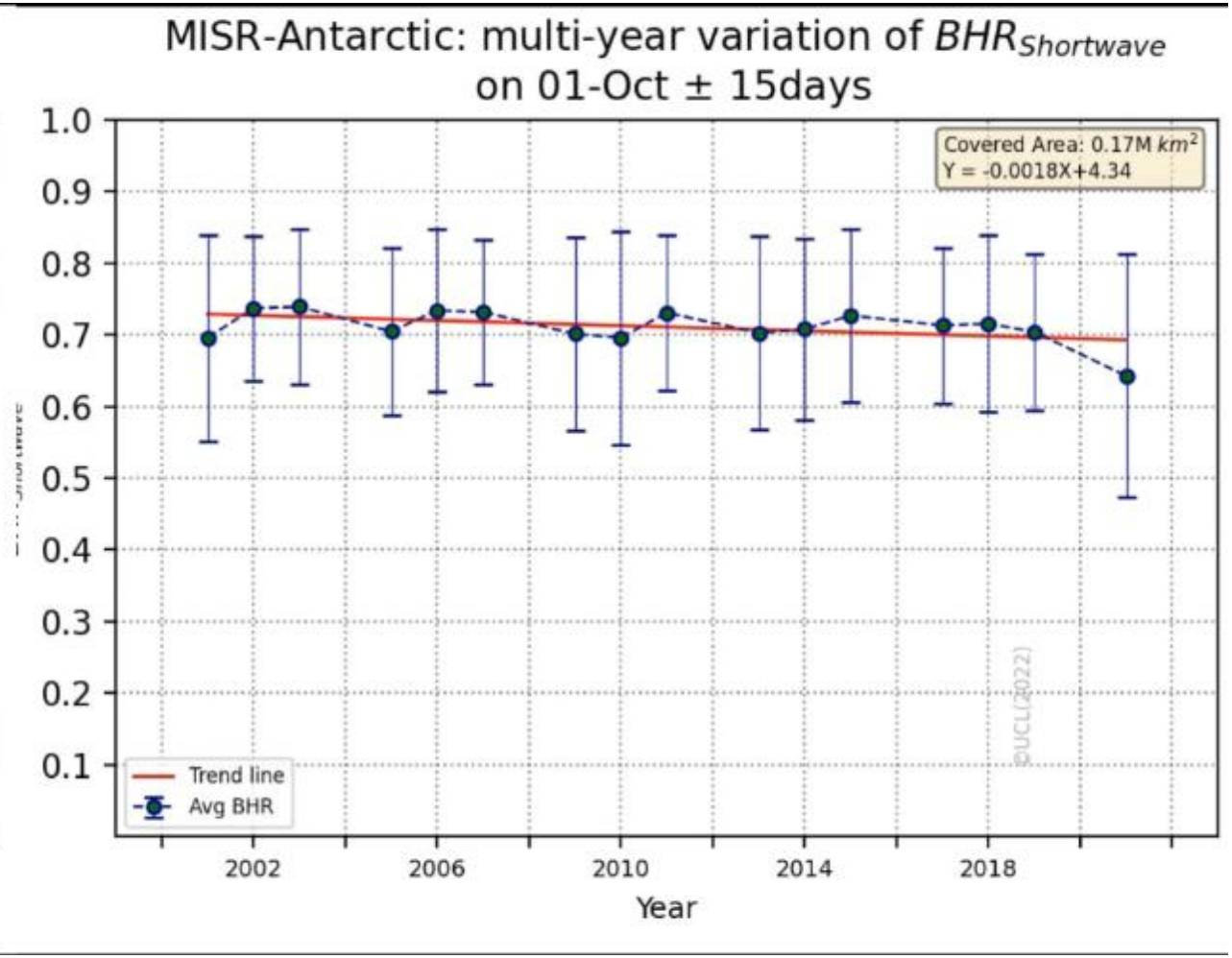


Antarctic 31 days average $BHR_{Shortwave}$ multi-year result for the 27th Oct (2000-2018), pre-melt onset, at 1km resolution.

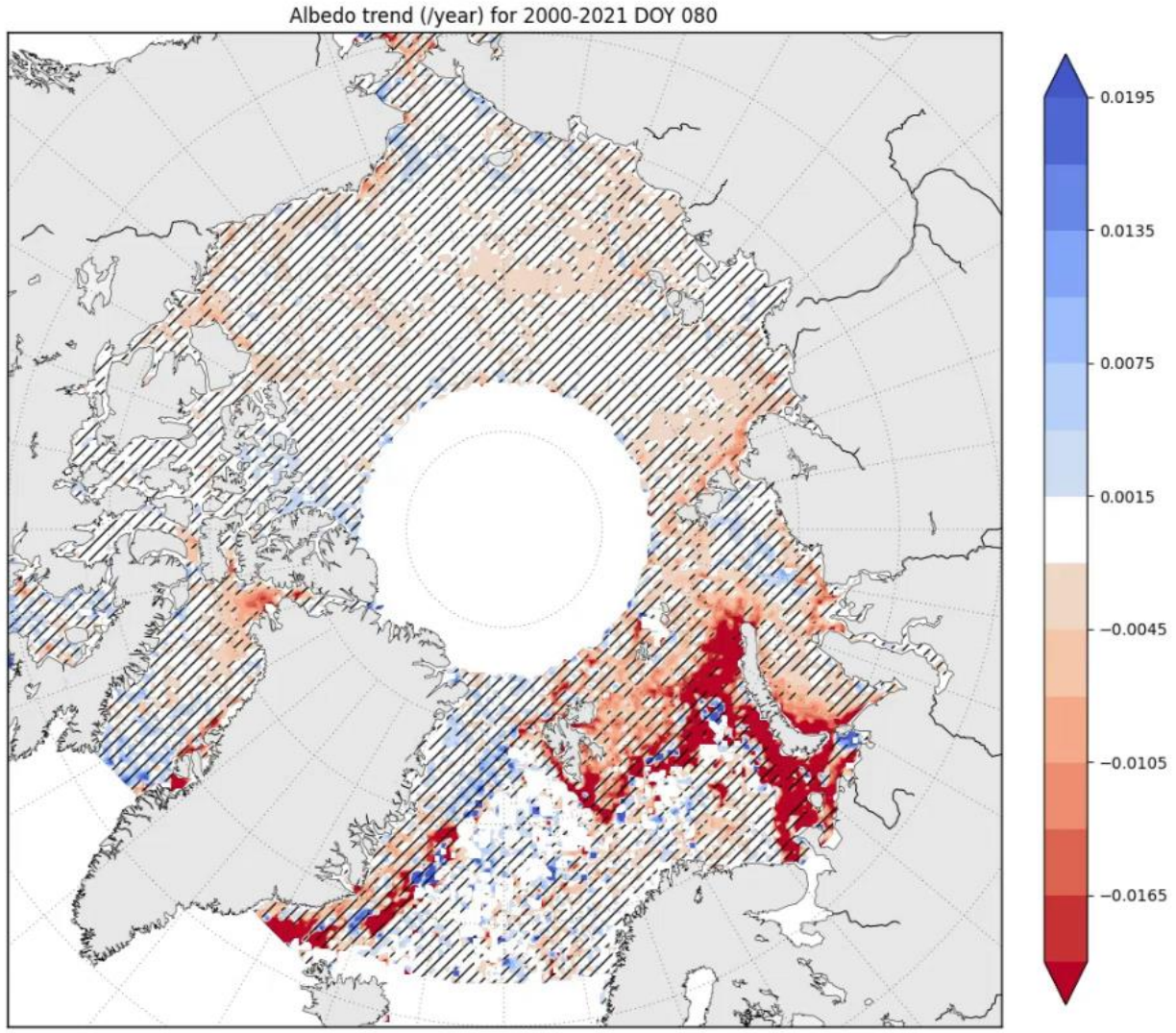


Average $BHR_{Shortwave}$ trendlines for the Arctic (2000-2021) and Antarctic (2000-2022).

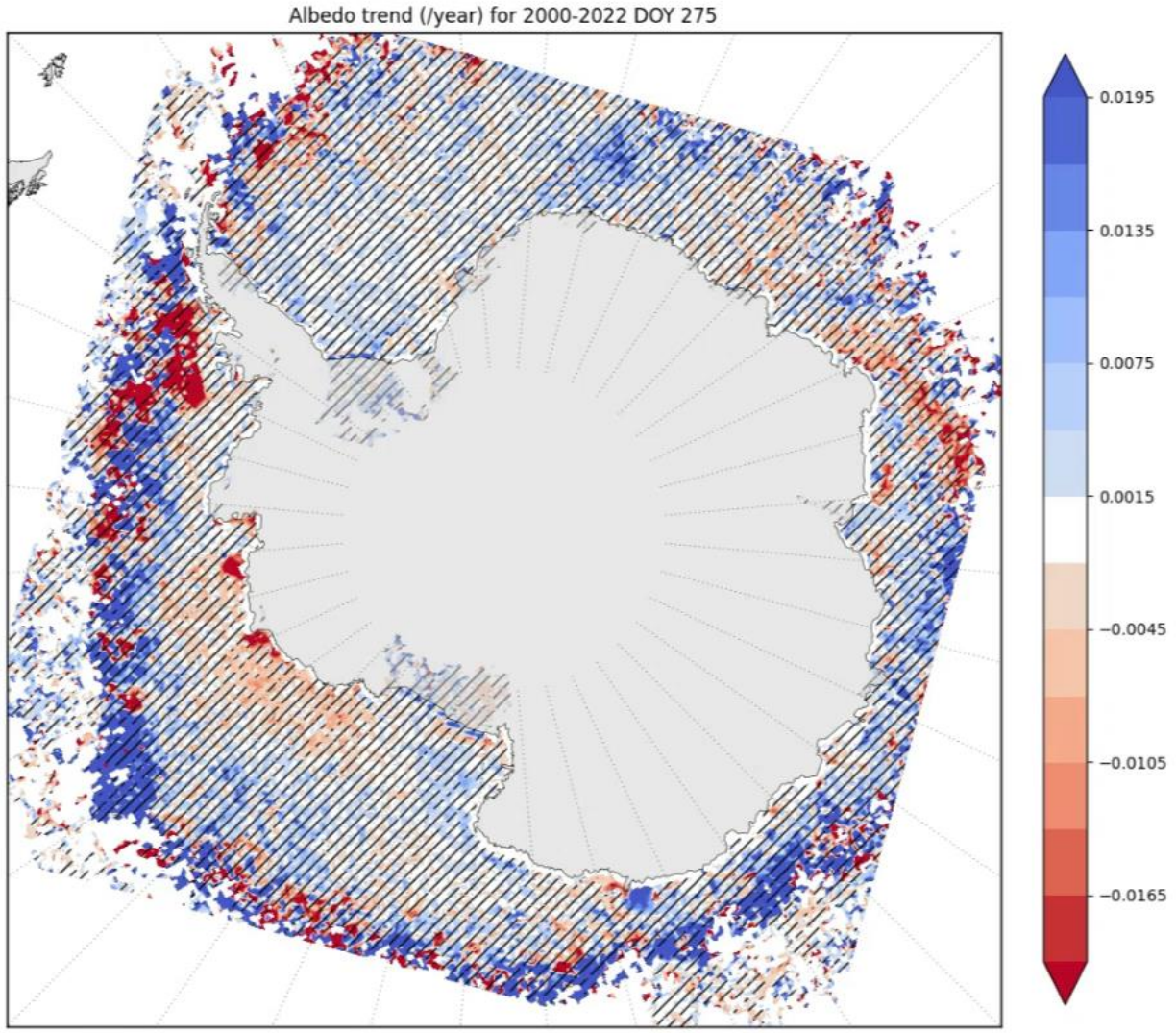




Albedo Trends at 25km resolution for the Arctic (2000-2021) and Antarctic (2000-2022) – 10 days intervals



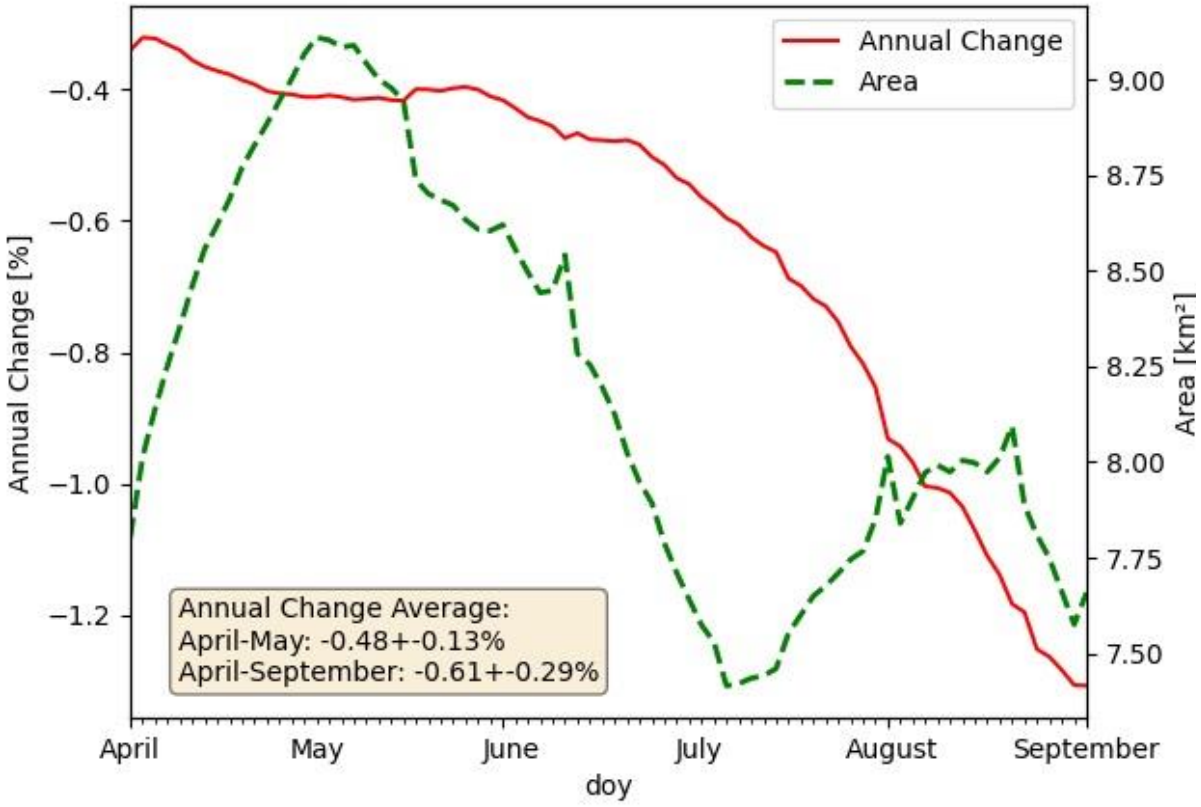
Arctic (2000-2021)



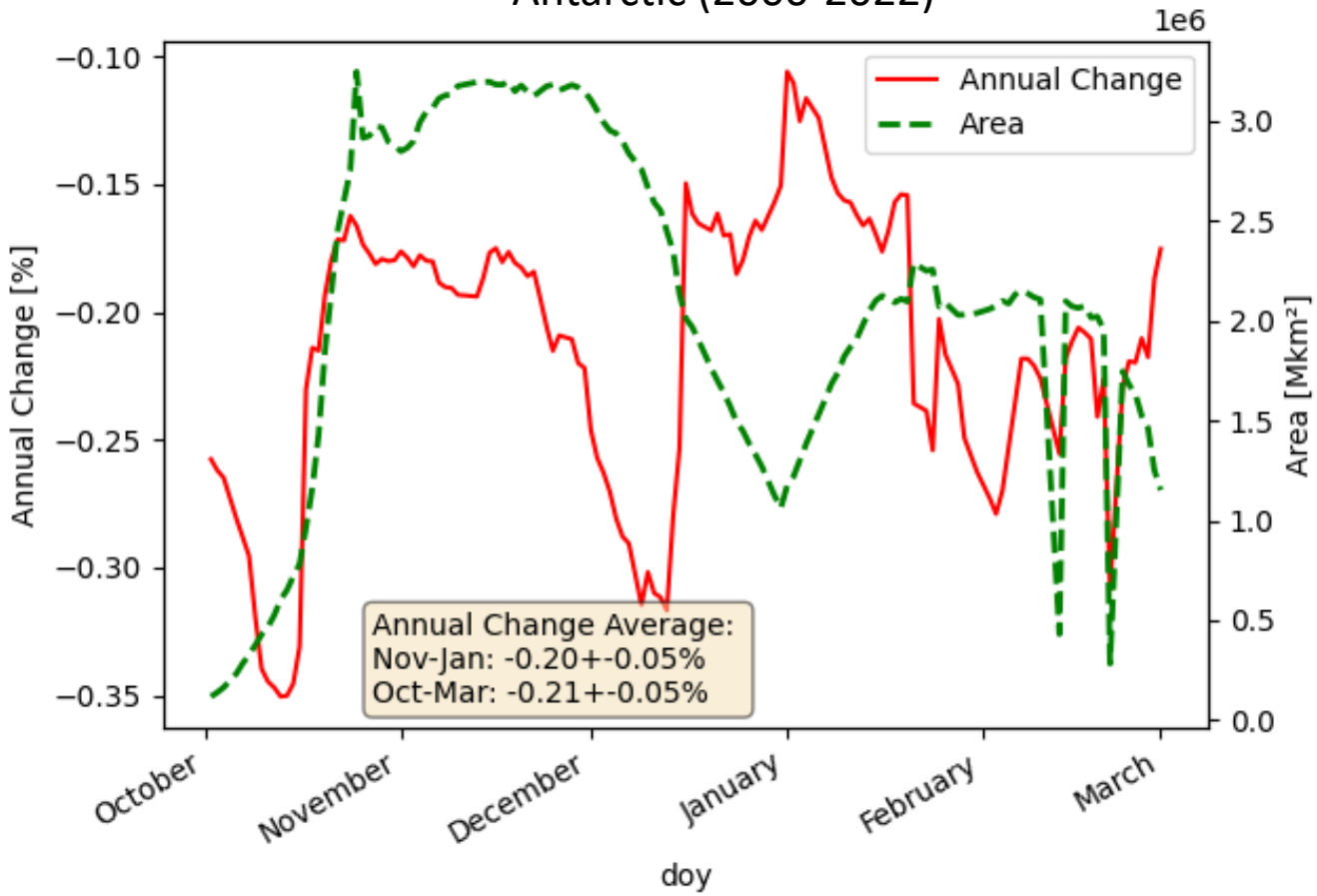
Antarctic (2000-2022)

Annual Change of $BHR_{Shortwave}$ for the Arctic and Antarctic before the onset of melt period and for the entire period.

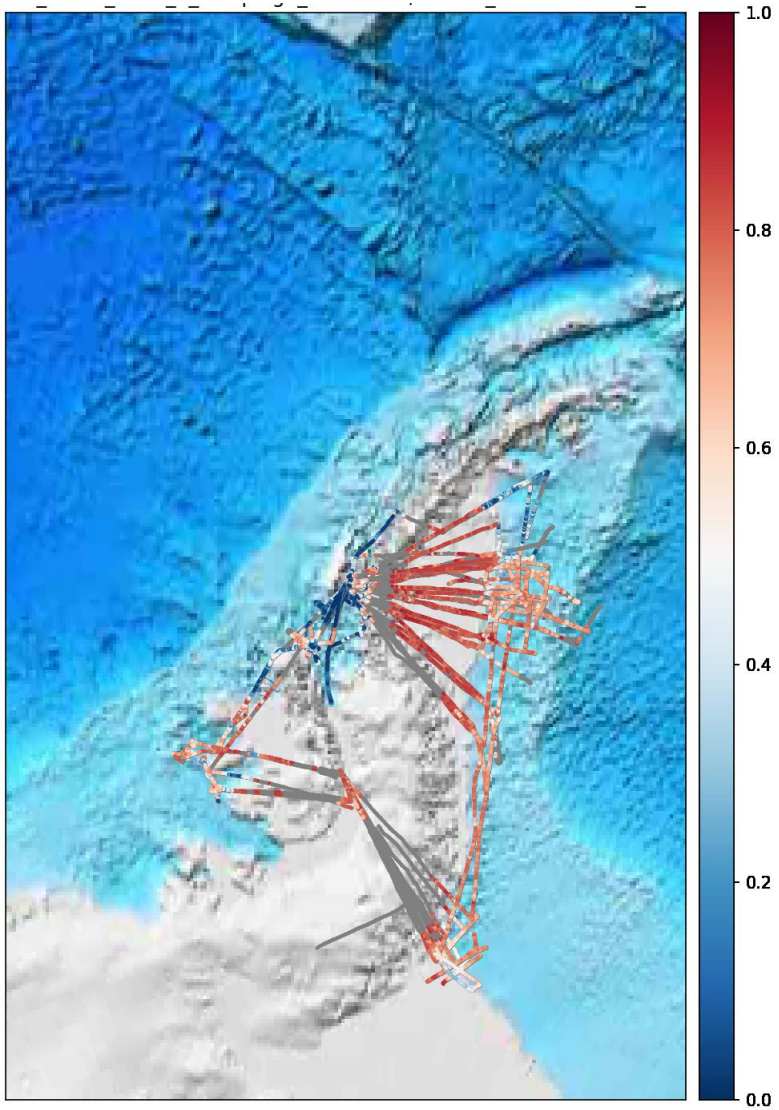
Arctic (2000-2021)

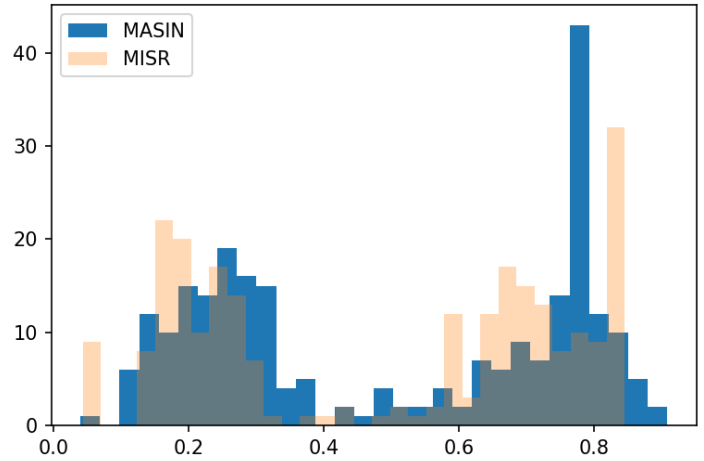


Antarctic (2000-2022)

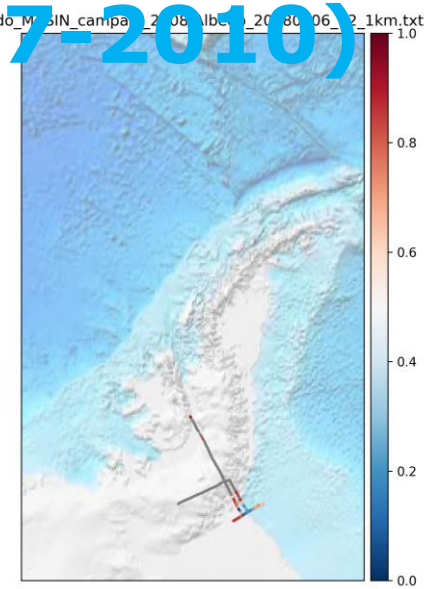


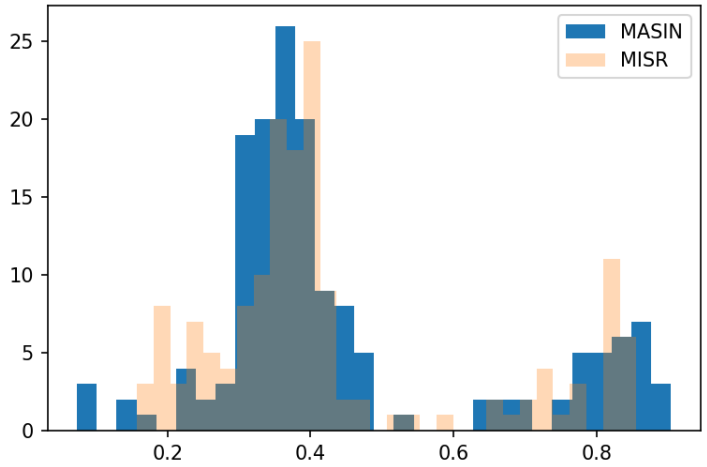
ANTARCTIC Sea ice Albedo validation using Aircraft measurement intercomparison – MASIN (2007-2010)



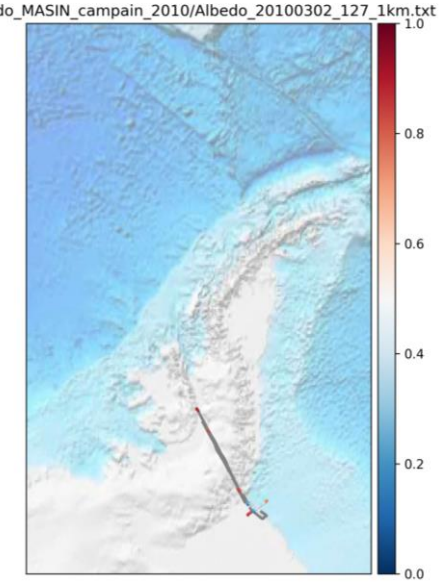


2008
R^2 = 0.872





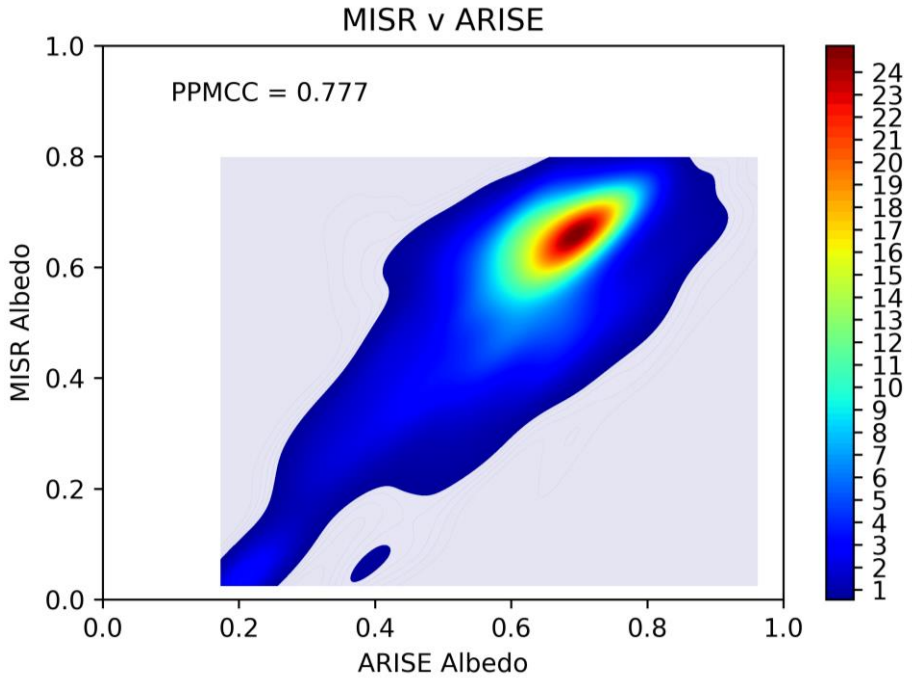
2010
R^2 = 0.936

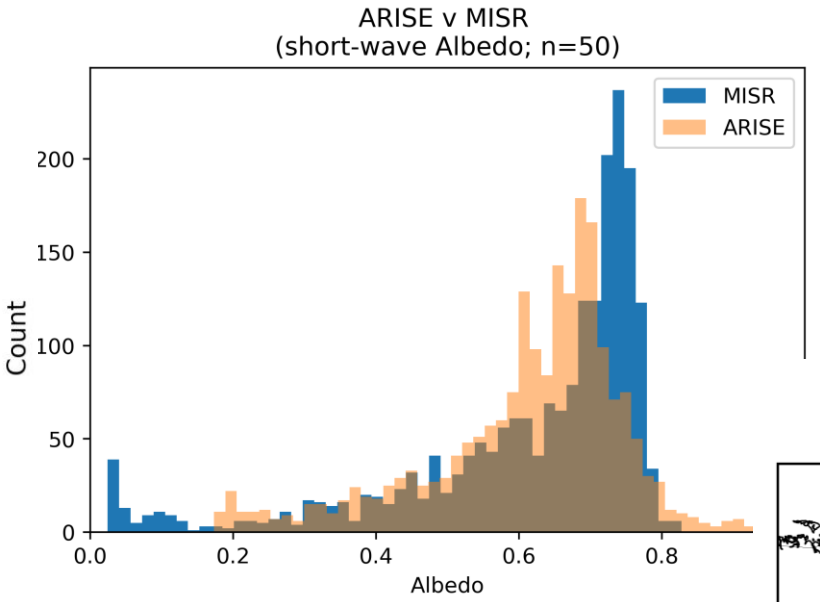


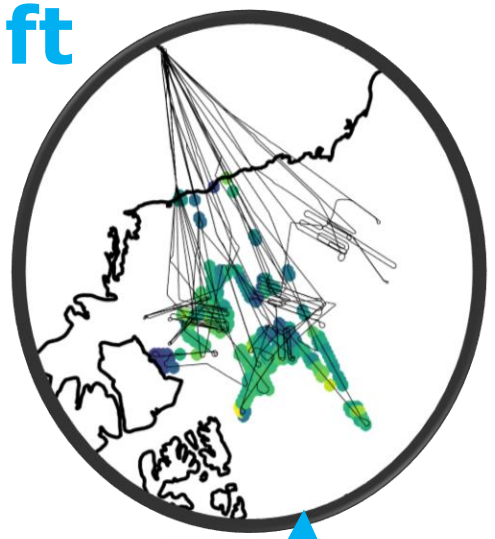
Courtesy of **BAS**: Weiss et al., (2012), The Cryosphere, 6, 471-479, doi:10.5194/tc-6-479-2012

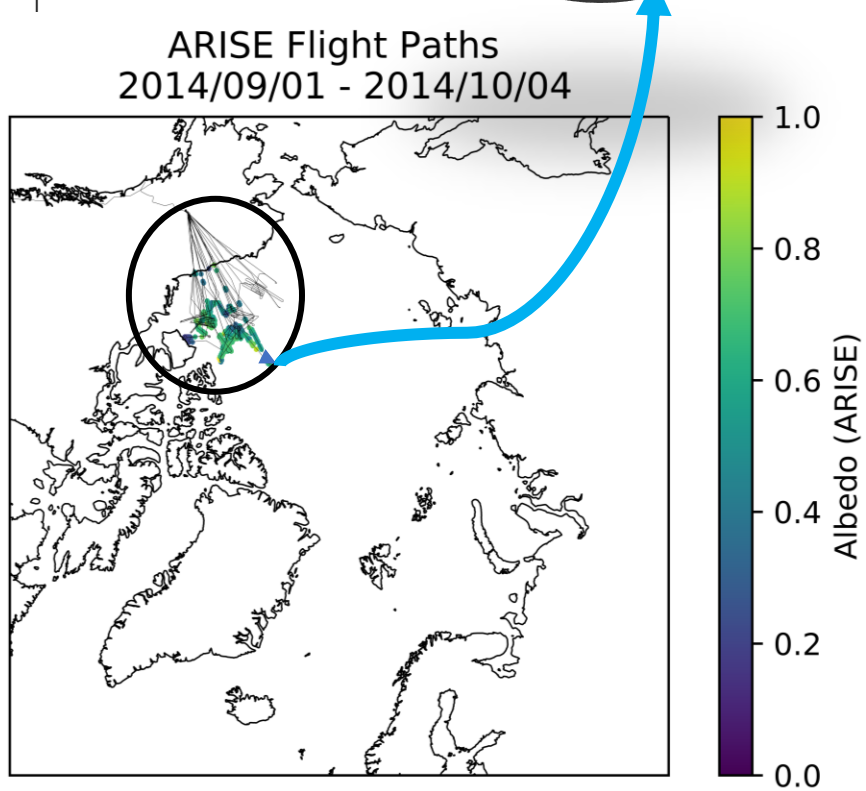
Aguilar, **Tsamados**, Johnson, **Weiss**, Muller et al. (in preparation)

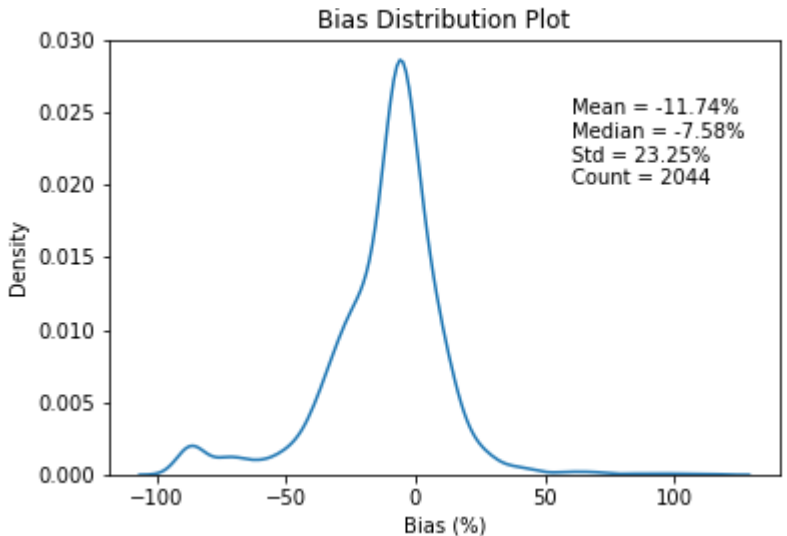
ARCTIC Sea ice Albedo validation using Aircraft measurement intercomparison – ARISE











2014

$R^2 = 0.777$

Primary Conclusions

- ✓ 12 New multi-source satellite derived broadband BHR sea ice albedo products for each pole.
- ✓ Arctic (2000-2021) BHR shortwave annual change of -0.61+- 0.29%.
- ✓ Antarctic (2000-2022) BHR shortwave of annual change of -0.21+-0.05%.
- ✓ Arctic validation so far shows R^2=0.777
- ✓ Antarctic validation so far shows R^2=0.937

Secondary Conclusions

- ✓ Multiyear masking may be too restrictive for Antarctic compared to Arctic.
- ✓ Annual change % for subregions in Antarctic should lead to more conclusive results.
- ✓ High confidence in annual change calculation methodology -> in line with literature.
- ✓ Shortwave to Broadband conversion matched well Barrow station. But we know its not great at NIR.

Future work

- Median Filtering to surpass the multiyear pixel restriction over the Antarctic and subsequent underestimation of sea ice albedo.
- Validation to be continued with Arctic MOSAIC data.
- **Mixed-Pixel problem**: Use MODIS Lead and MODIS meltpond products to analyse the BRDF response of each surface type and fine tune the conversion factors (weighted BRDF)
- External information to interpret the Albedo, where it is valid or not.
- Correlation with sea ice Extent products/results from literature.
- Quantisation of MODIS cloud mask product error propagation.
- Comparison with CLARA-SAL2 25km resolution product.

The data in netCDF4 (CF) format can be downloaded from: **http://www.qa4ecv-land.eu/get-polar-sea-ice.php**.

Previous Arctic products can also be found at:
Dataset Record: QA4ECV Polar sea-ice spectral albedo (2000-2016) (ceda.ac.uk)

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