A new aerosol optical thickness research product over Cryosphere

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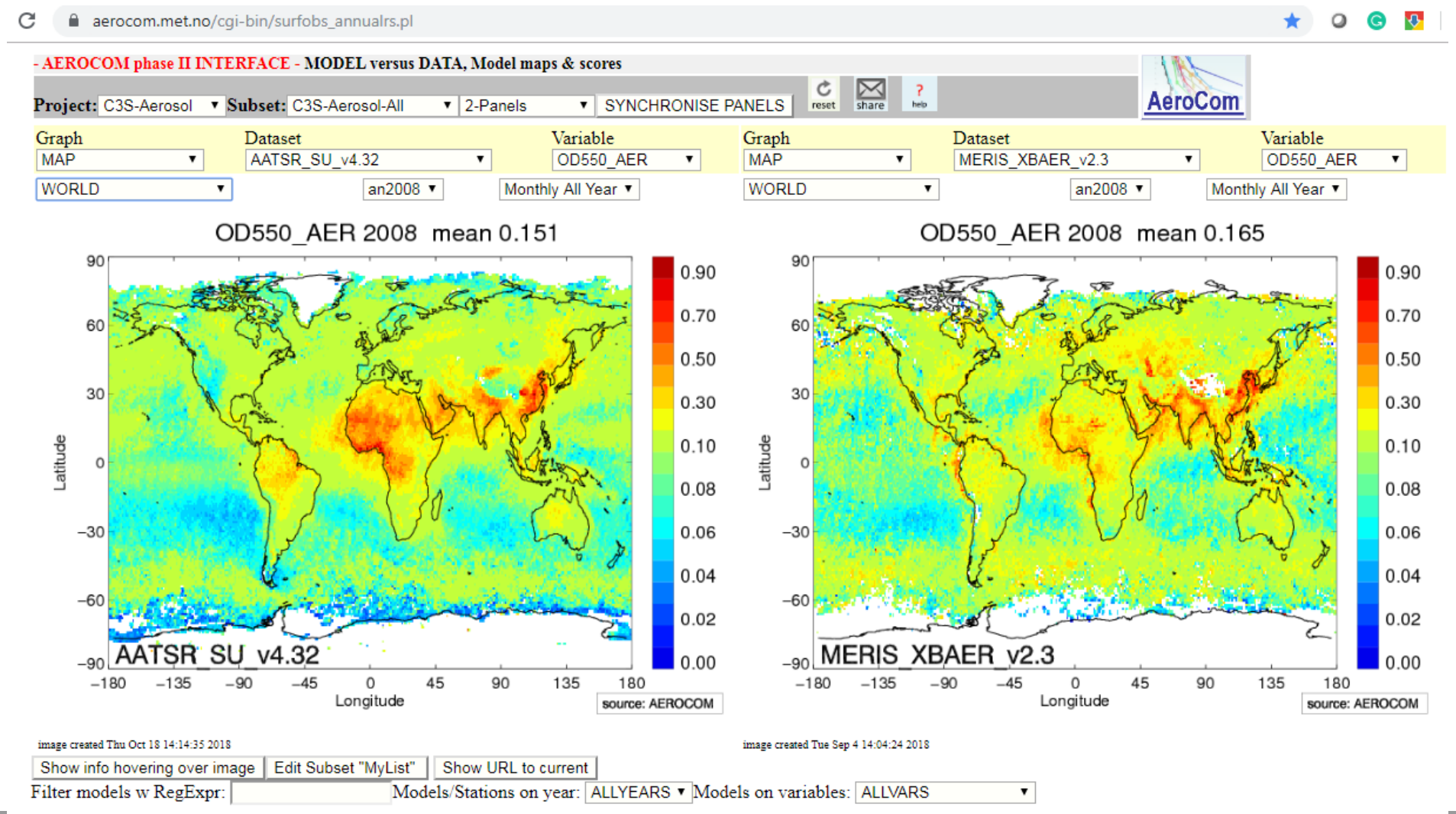
Aerosol passive remote sensing : current status

XBAER: eXtensible Bremen Aerosol/cloud and surfacE Retrieval algorithm



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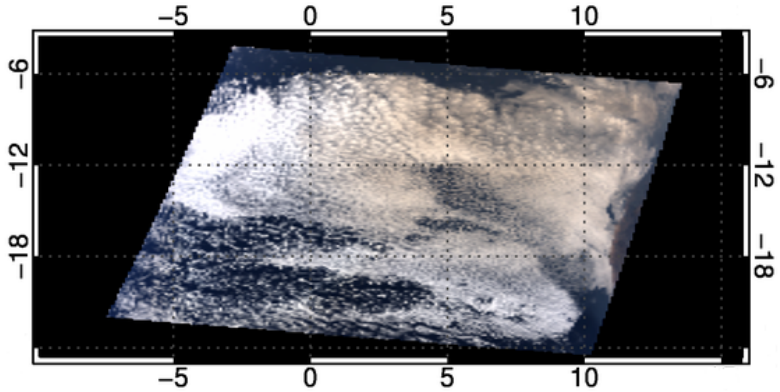
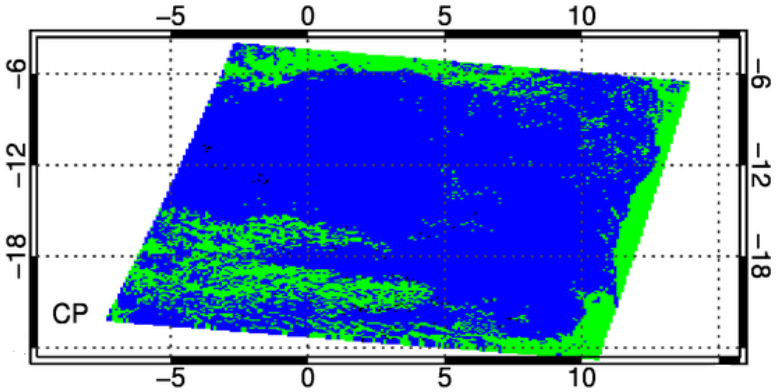
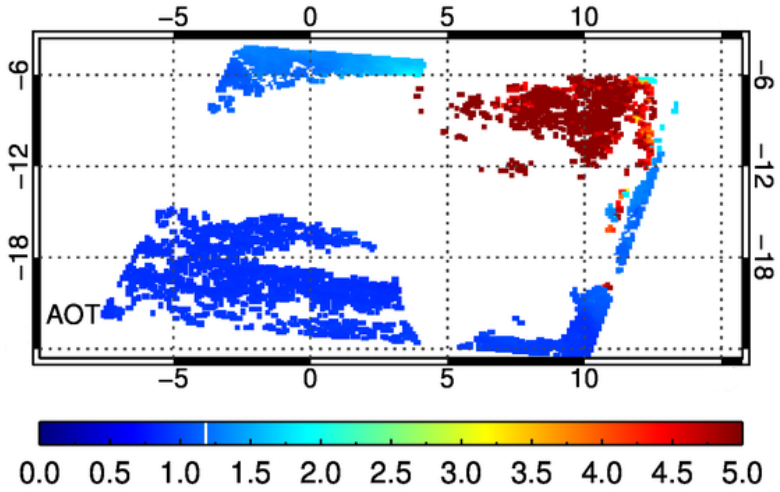
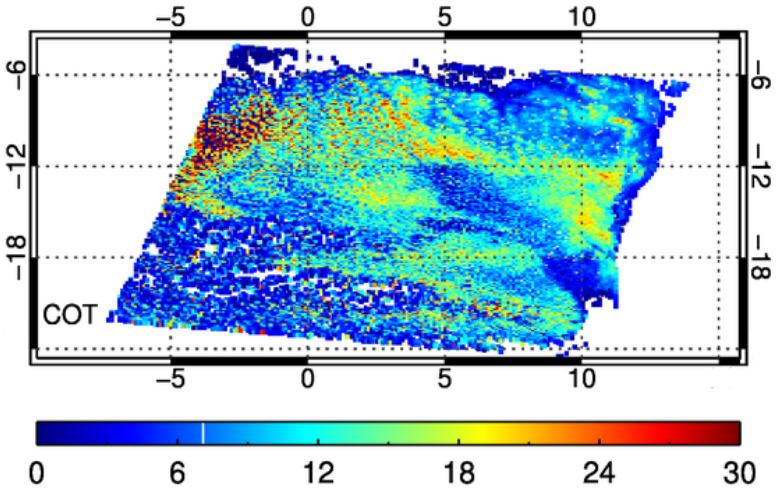
Aerosol passive remote sensing : current status



R(670nm)G(550nm)B(470nm)







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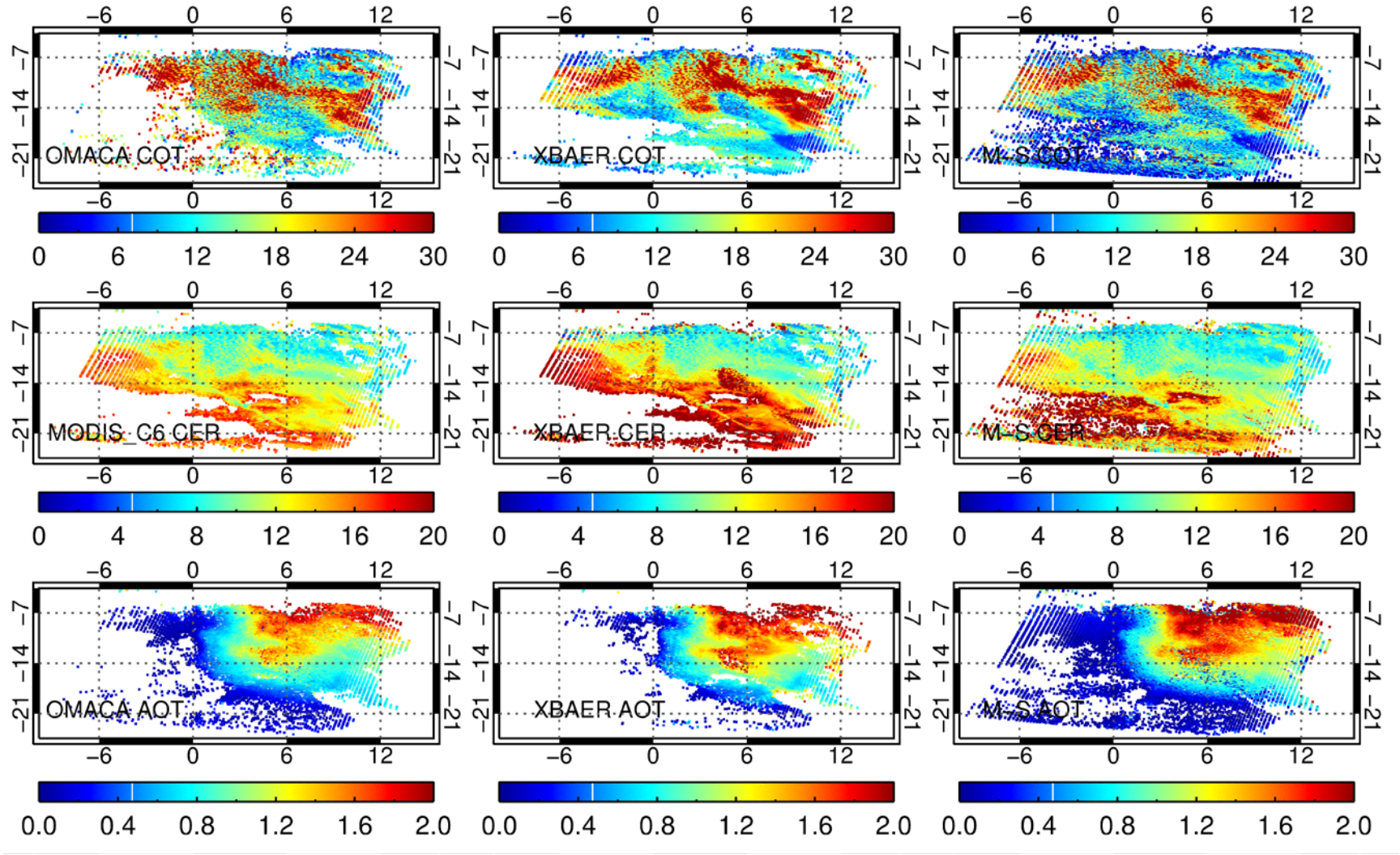
Aerosol passive remote sensing : current status



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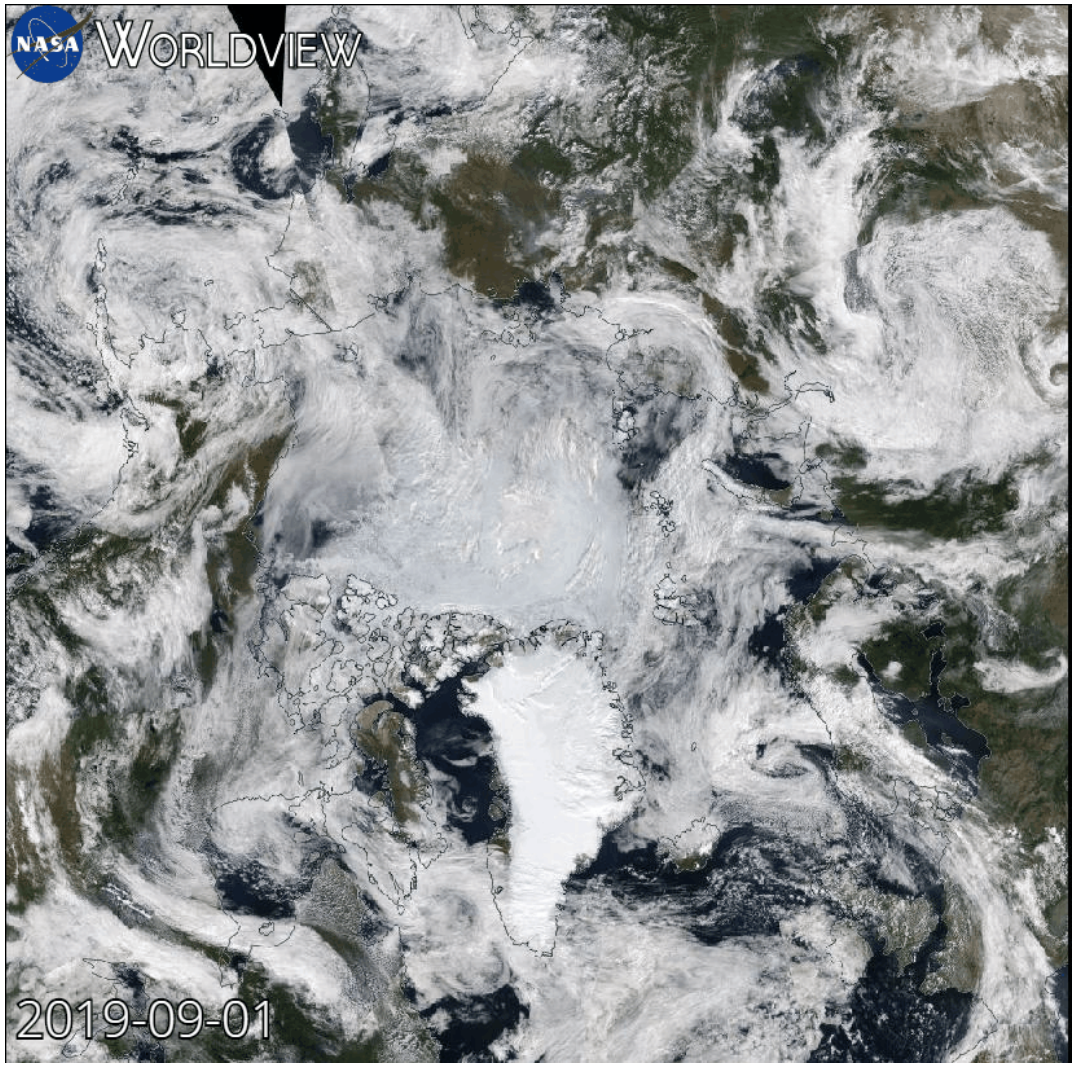
Arctic seen from space?



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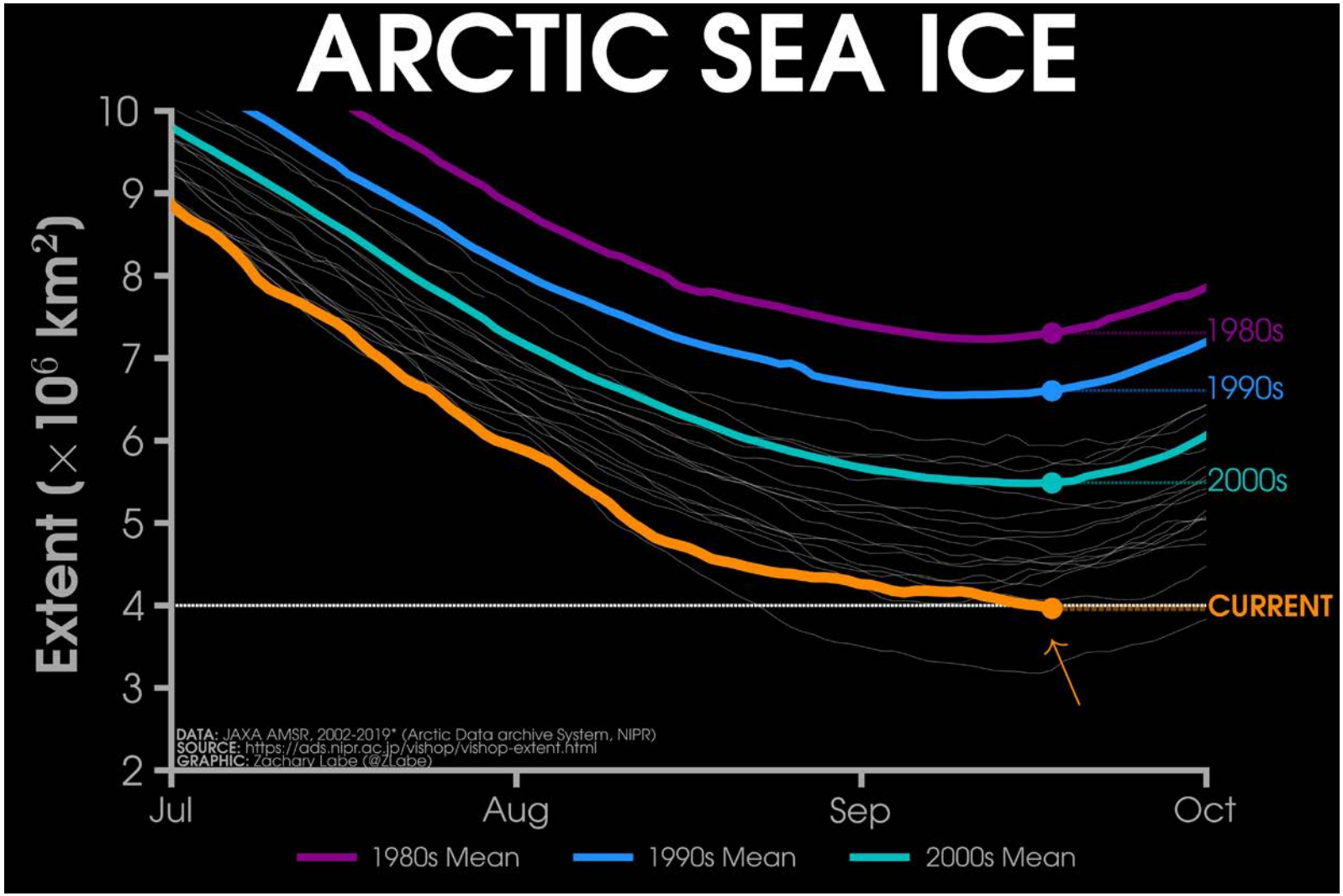
Climate change : Arctic sea ice is shrinking



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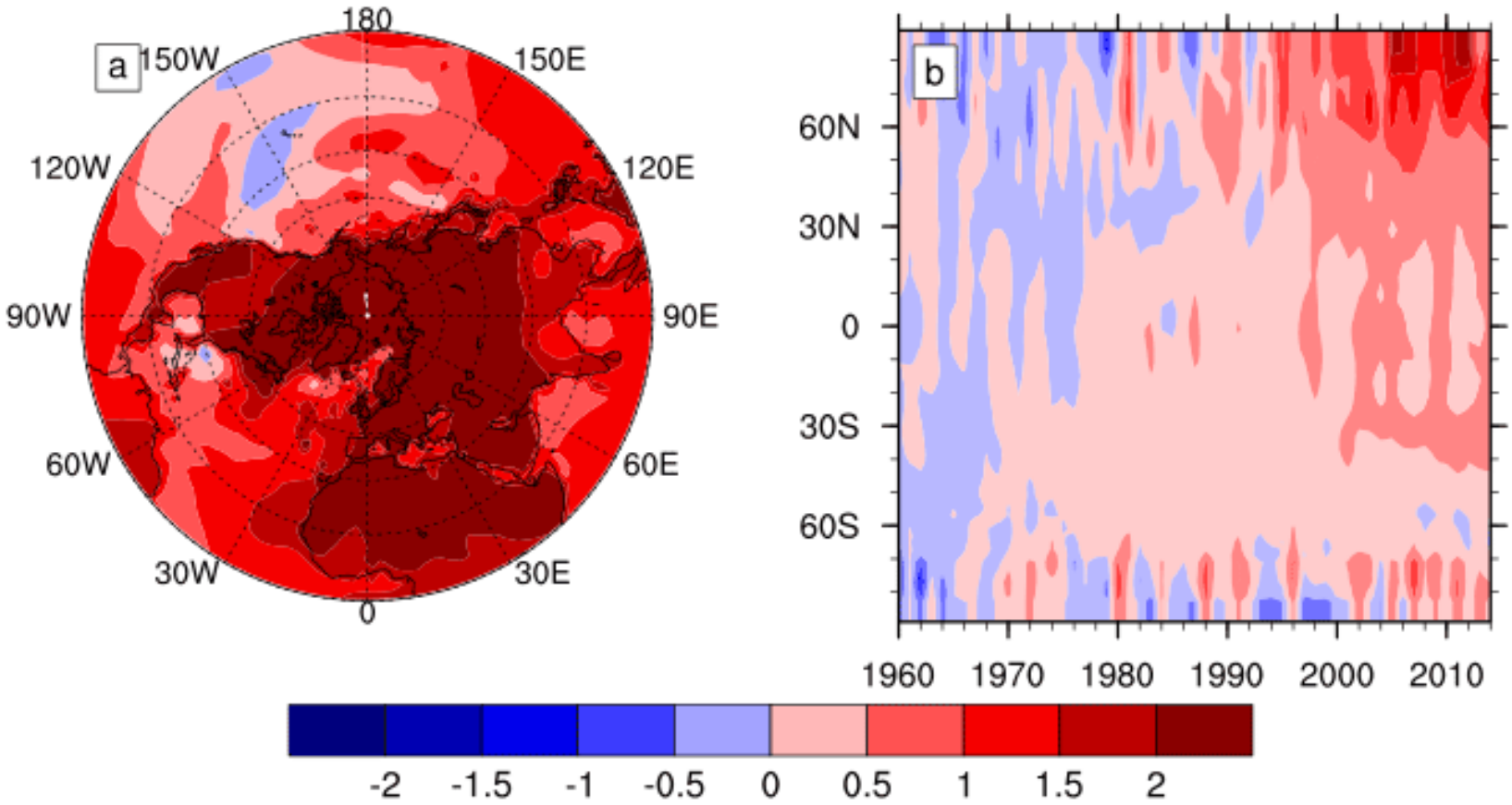
Near-Surface Air Temperature (Observations)



(a) Linear trend of annual–mean near–surface air temperature (1960–2012) in units of Kelvin (K) per century, (b) zonal annual mean temperature anomaly (K) with respect to the 1951–1980 mean. Data are provided by the NASA Goddard Institute for Space Studies Team (GISTEMP Team, 2015).

Source: http://ac3-tr.de

ArctiC Amplification:
Climate Relevant Atmospheric and SurfaCe Processes and Feedback Mechanisms (AC)³

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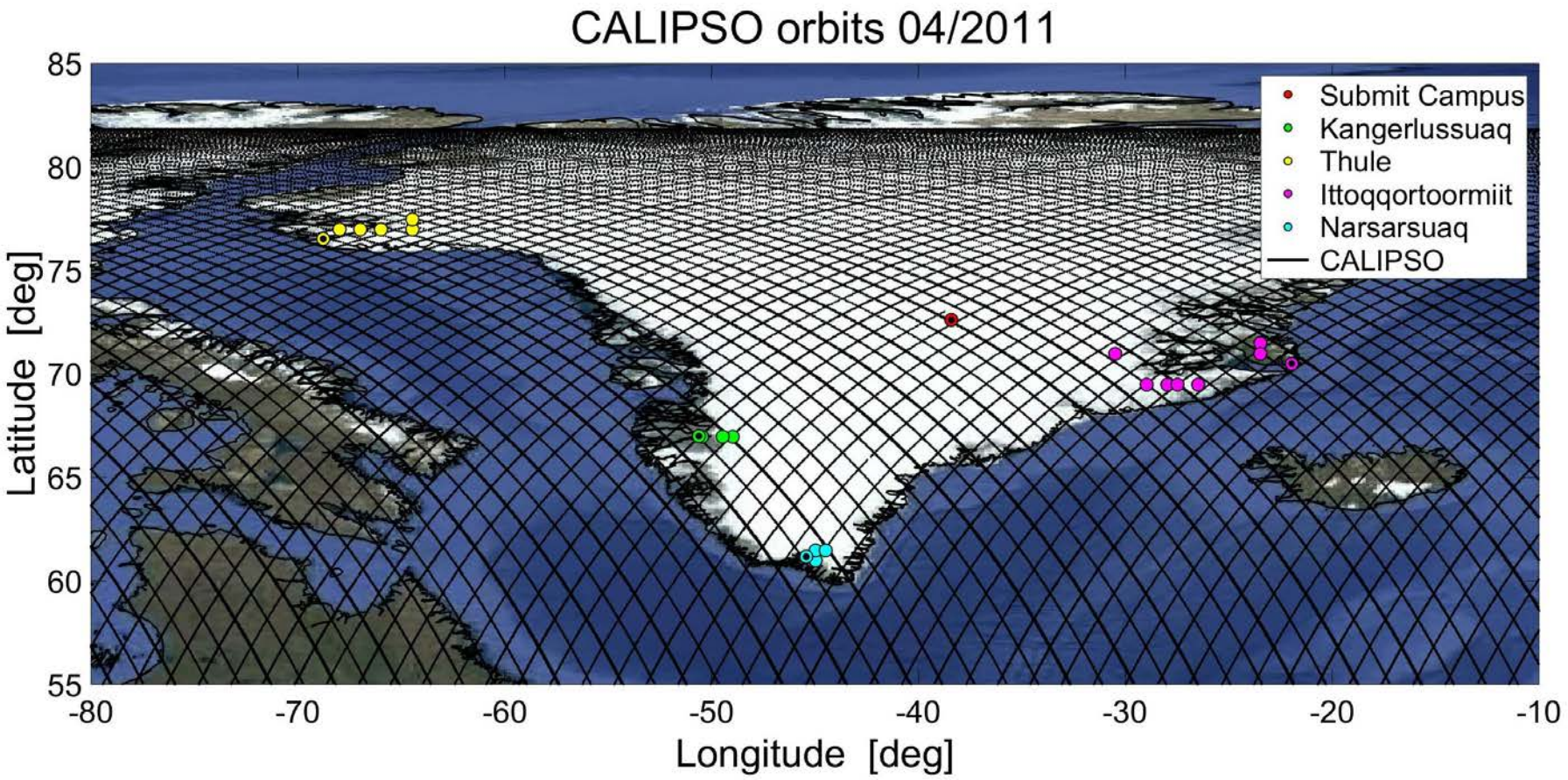
Available observations



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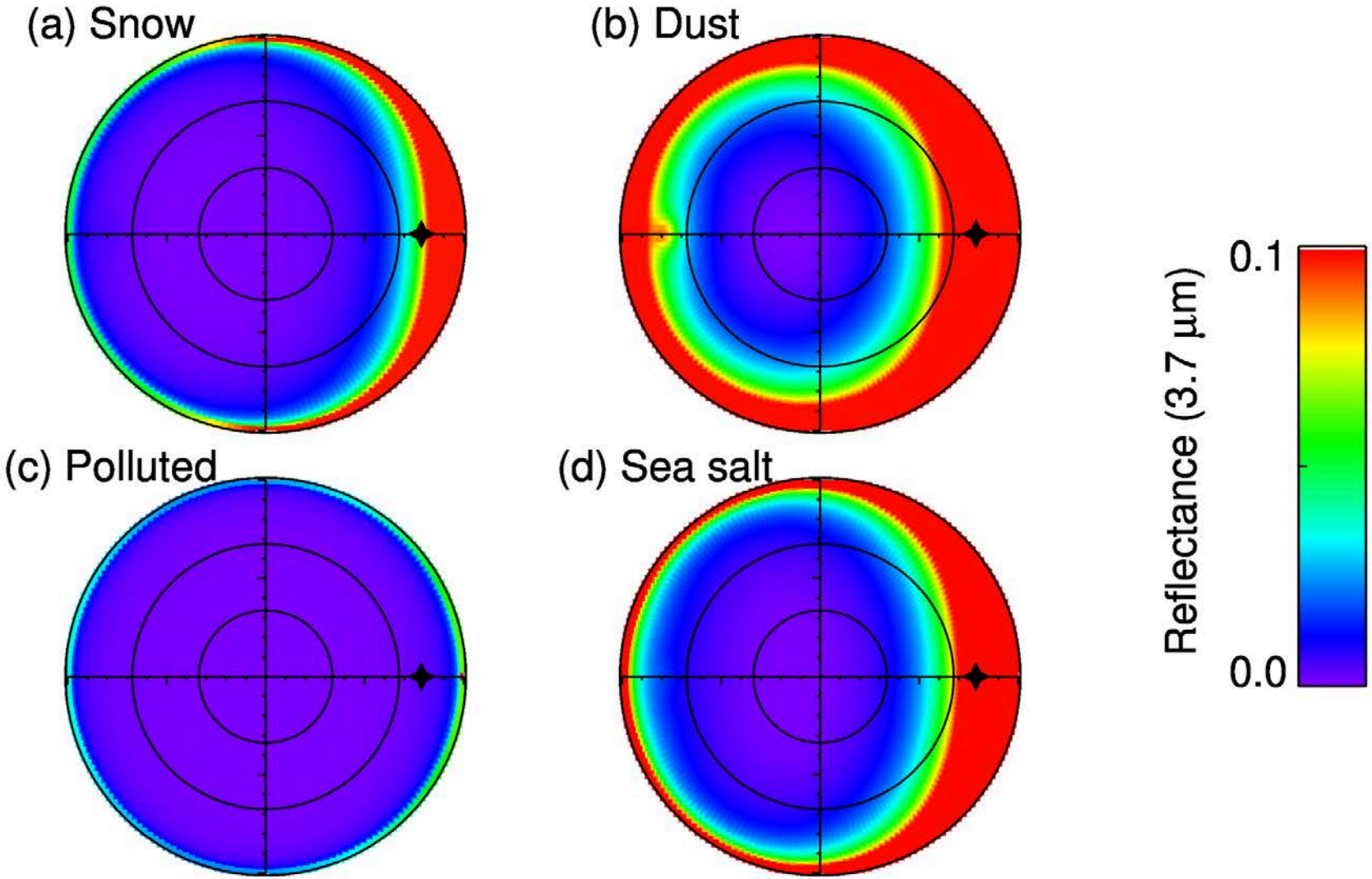
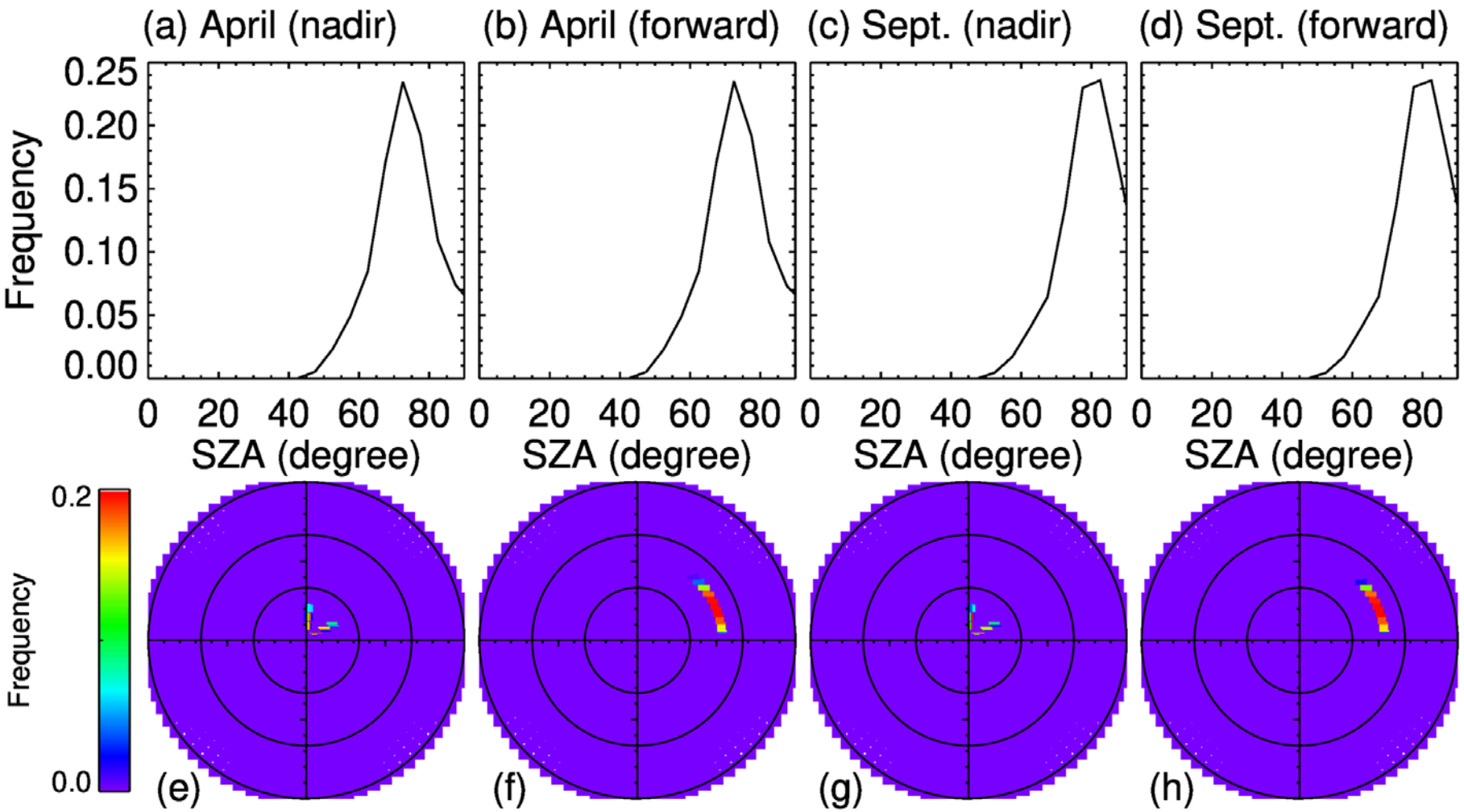
Theoretical background : anisotropic



Theoretical background : observation characteristic



Surface reflectance estimation

The clear-sky radiance at channel 3.7 μm at the Top Of Atmosphere is given by:

$$L(\theta,\theta_0,\varphi) = L_s(\theta,\theta_0,\varphi) + L_t(\theta,\varphi),$$

Assuming that the thermal emission of the atmosphere can be neglected

$$L_t(\theta,\varphi) = \varepsilon B(T_s),$$

Brightness temperature measured at 11 μm (T_{11}) instead of T_s is used

$$L_s(\theta,\theta_0,\varphi) = L(\theta,\theta_0,\varphi) - \varepsilon B(T_{11}),$$

The solar reflected radiation at TOA is given

$$R_s(\theta,\theta_0,\varphi) = R_s^0(\theta,\theta_0,\varphi) + \frac{\xi(\theta,\theta_0)A}{1-sA},$$

Based on the Kirchoff relation for a Lambertian reflector, we have:

$$\varepsilon = 1 - A$$

Surface reflectance estimation

$$aA^2 + bA + c = 0.$$

$$a = \frac{sB(T_{11})}{\mu_0 E},$$

$$b = \xi - sR_s^0 - \frac{1+s}{\mu_0 E} B(T_{11}) + \frac{s}{\mu_0 E} L,$$

$$c = R_s^0 + \frac{B(T_{11}) - L}{\mu_0 E},$$

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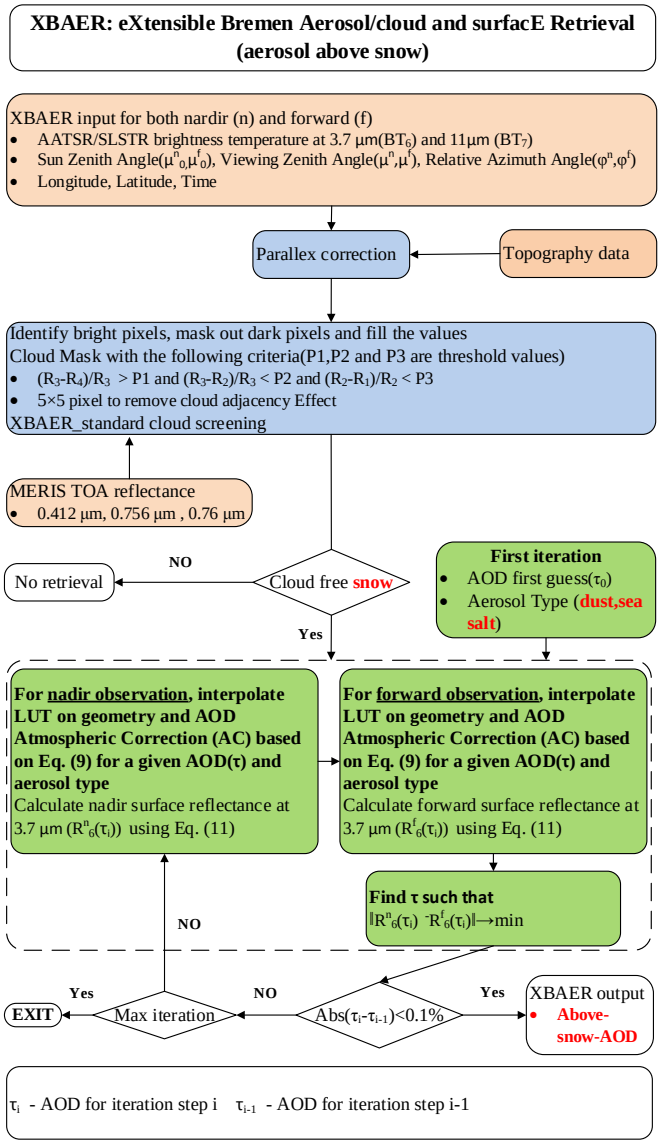
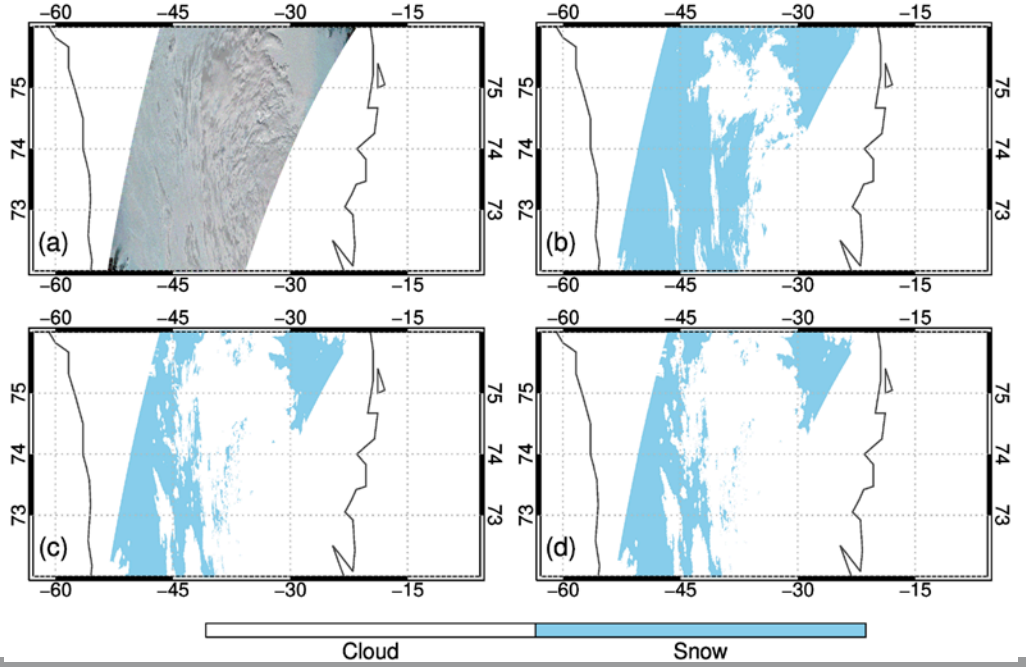
Surface reflectance estimation



- "Parallax effect" correction / SLSTR
- Cloud screening + cloud adjacency / OLCI
- Radiative transfer checking
  - Spherical atmosphere (ignorable)
  - Elevation (0.01%)
  - Atmospheric emission (1%)
  - Brightness temperature (2%)
  - "Effective" bidirectional reflectance / gas (H_2O, CO_2, CH_4, N_2, N_2O)



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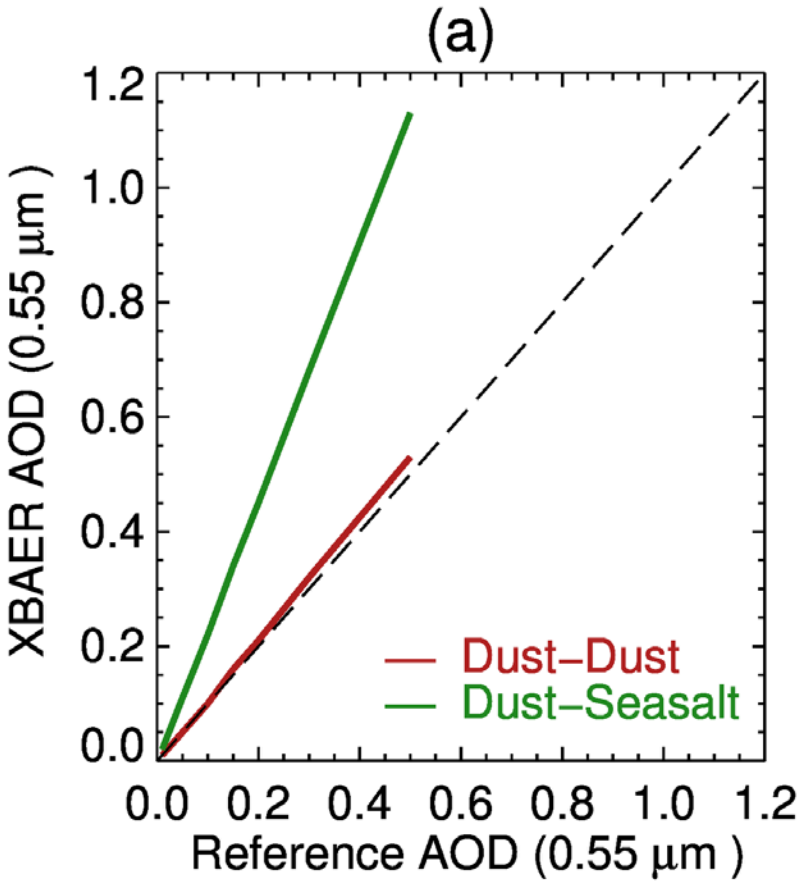
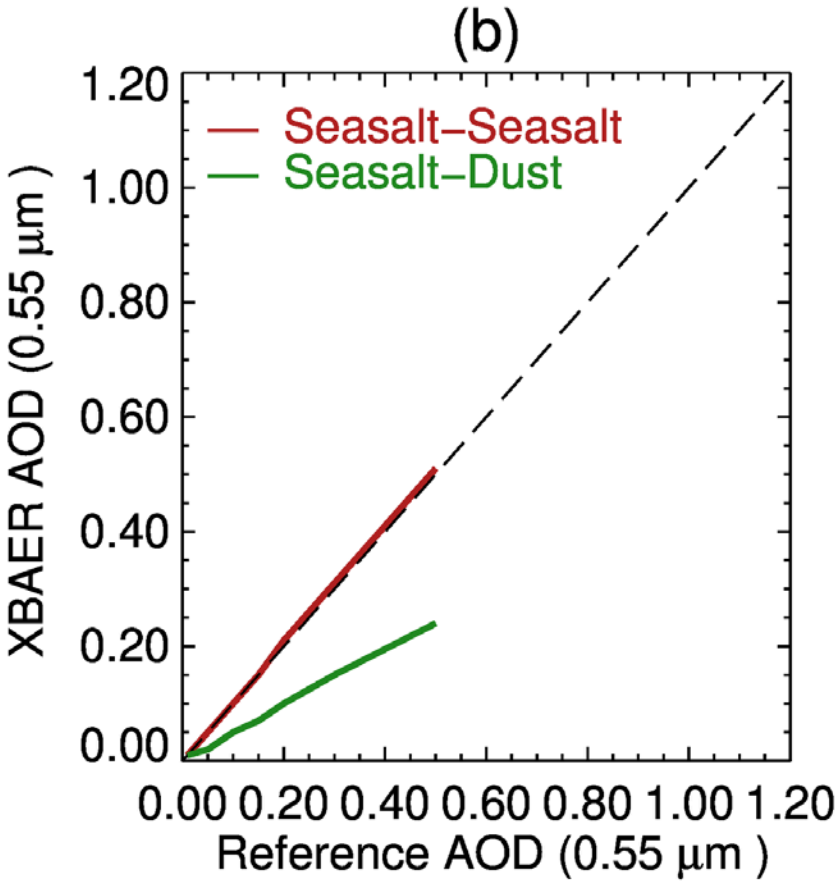
Impact of aerosol typing





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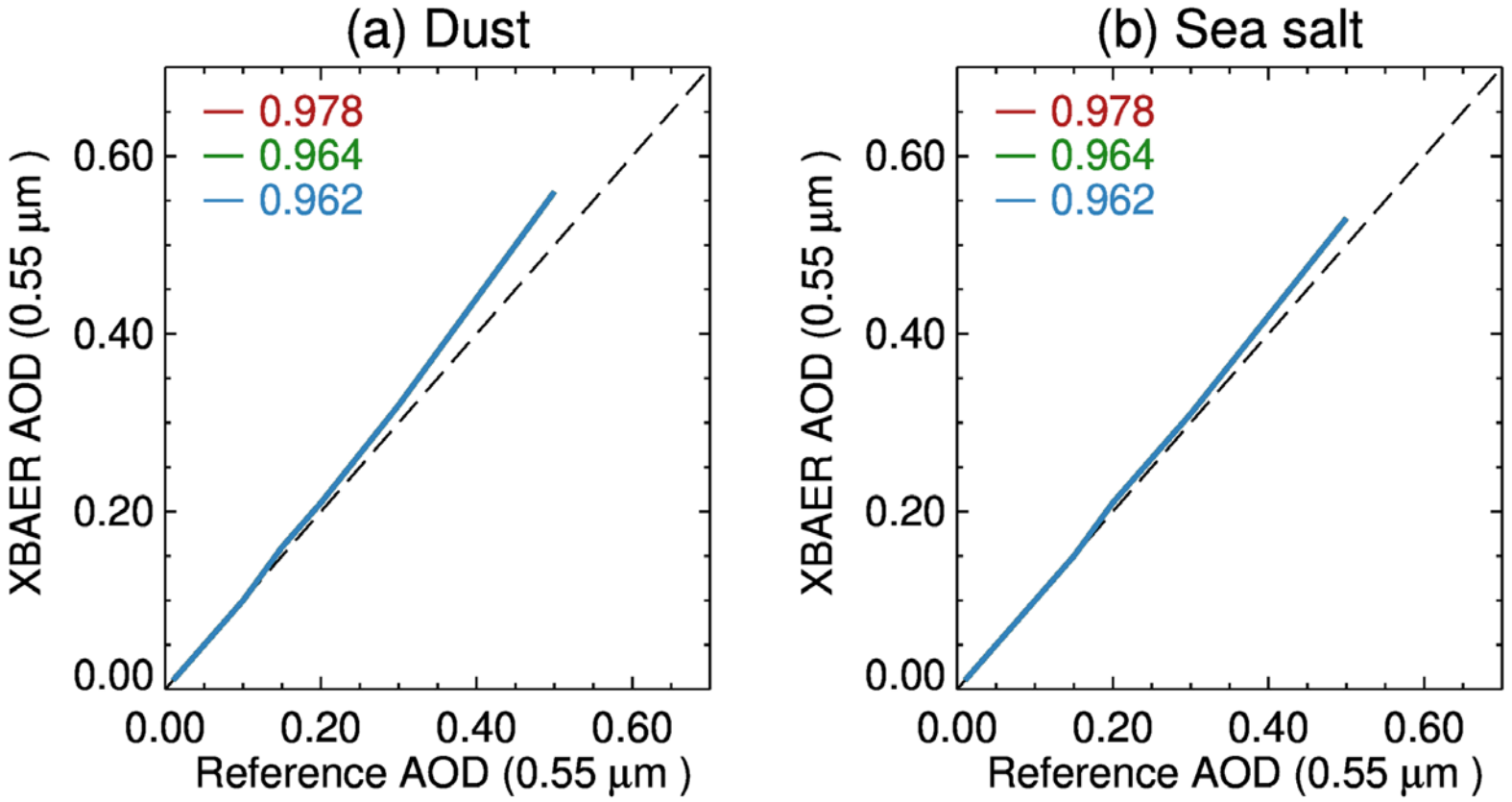
Impact of surface emissivity



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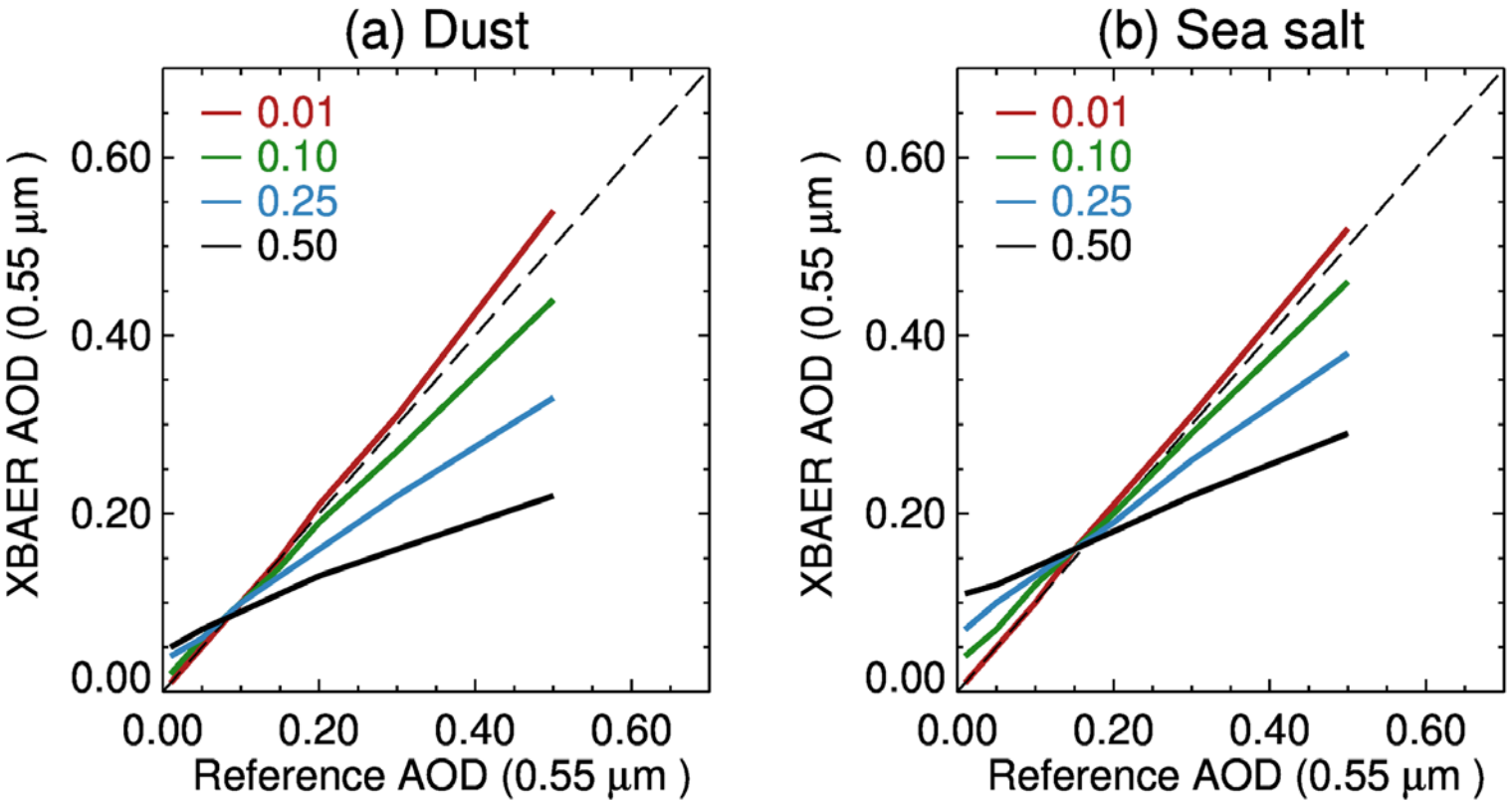
Impact of cloud contamination



Aerosol absorbing/scattering vs ice crystal absorbing with respect to photon path length

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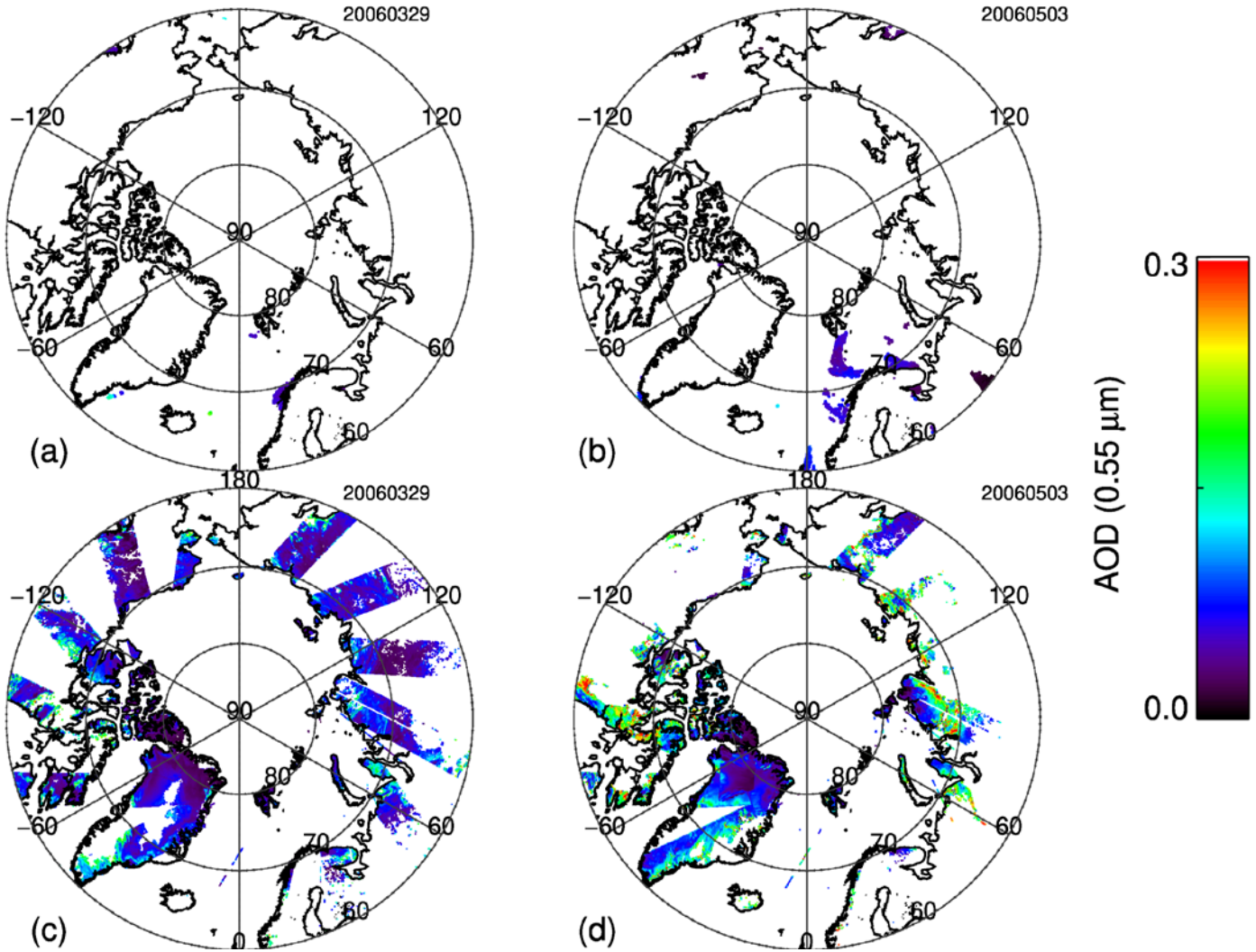
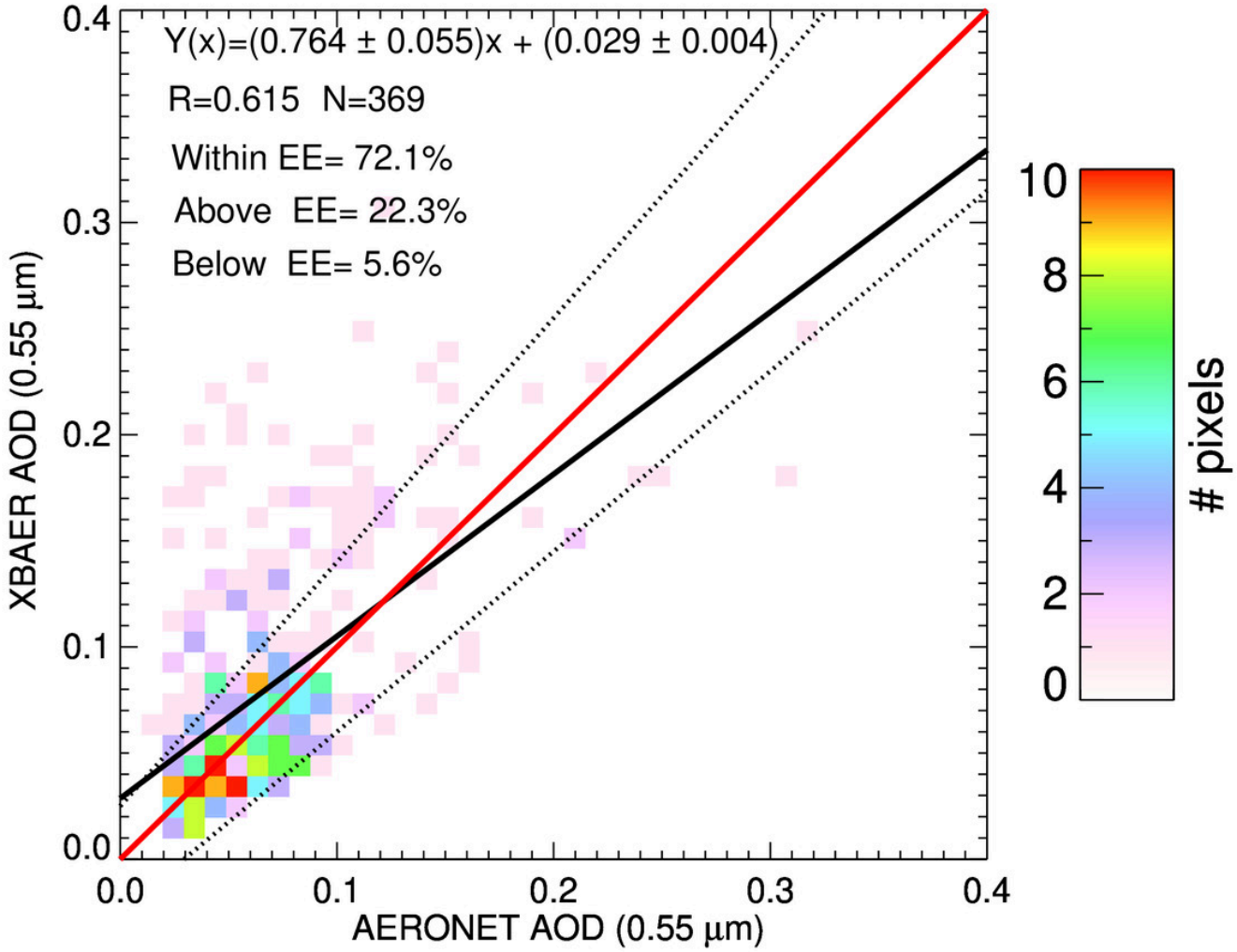
XBAER - comparison



XBAER - comparison



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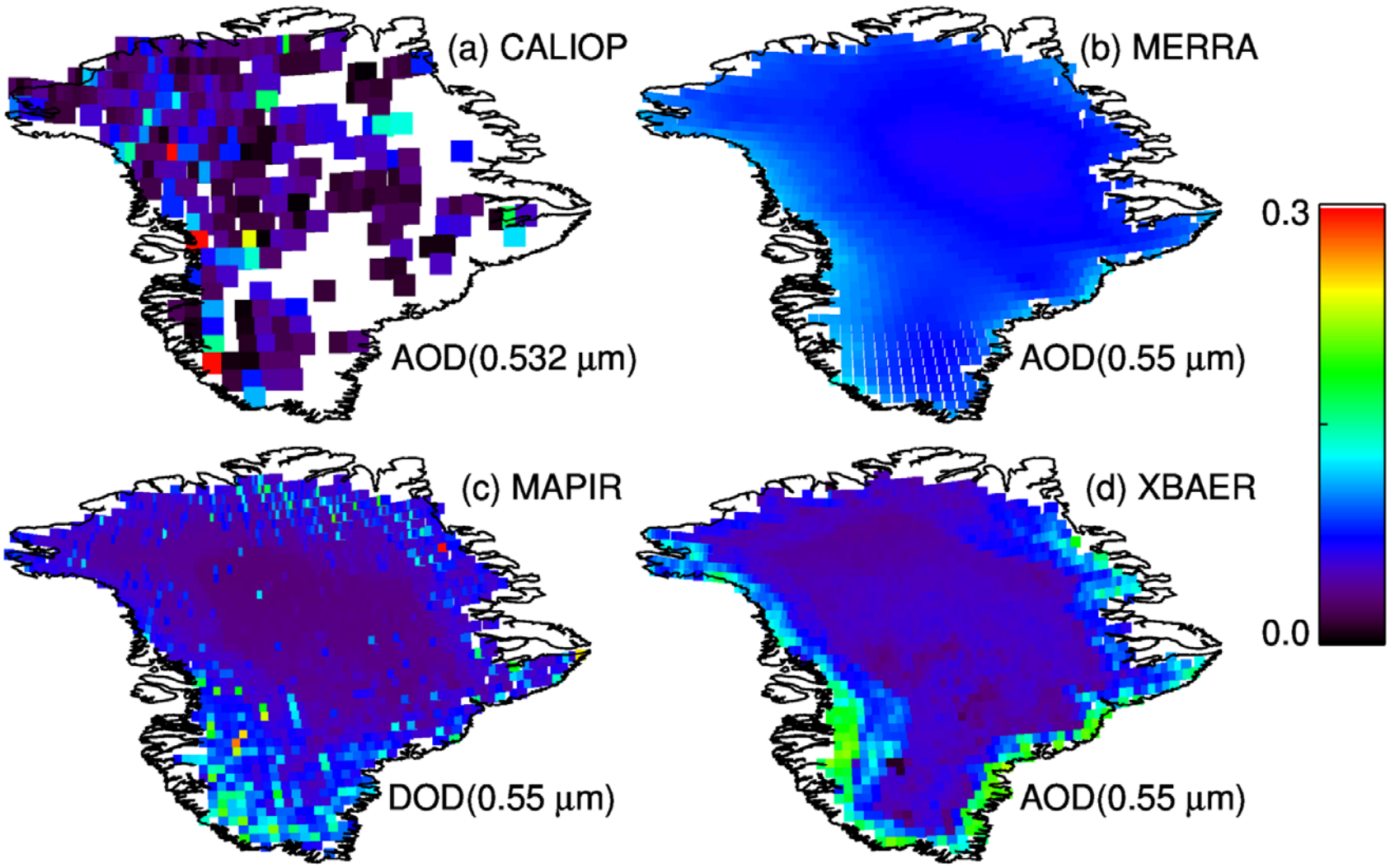
XBAER - comparison



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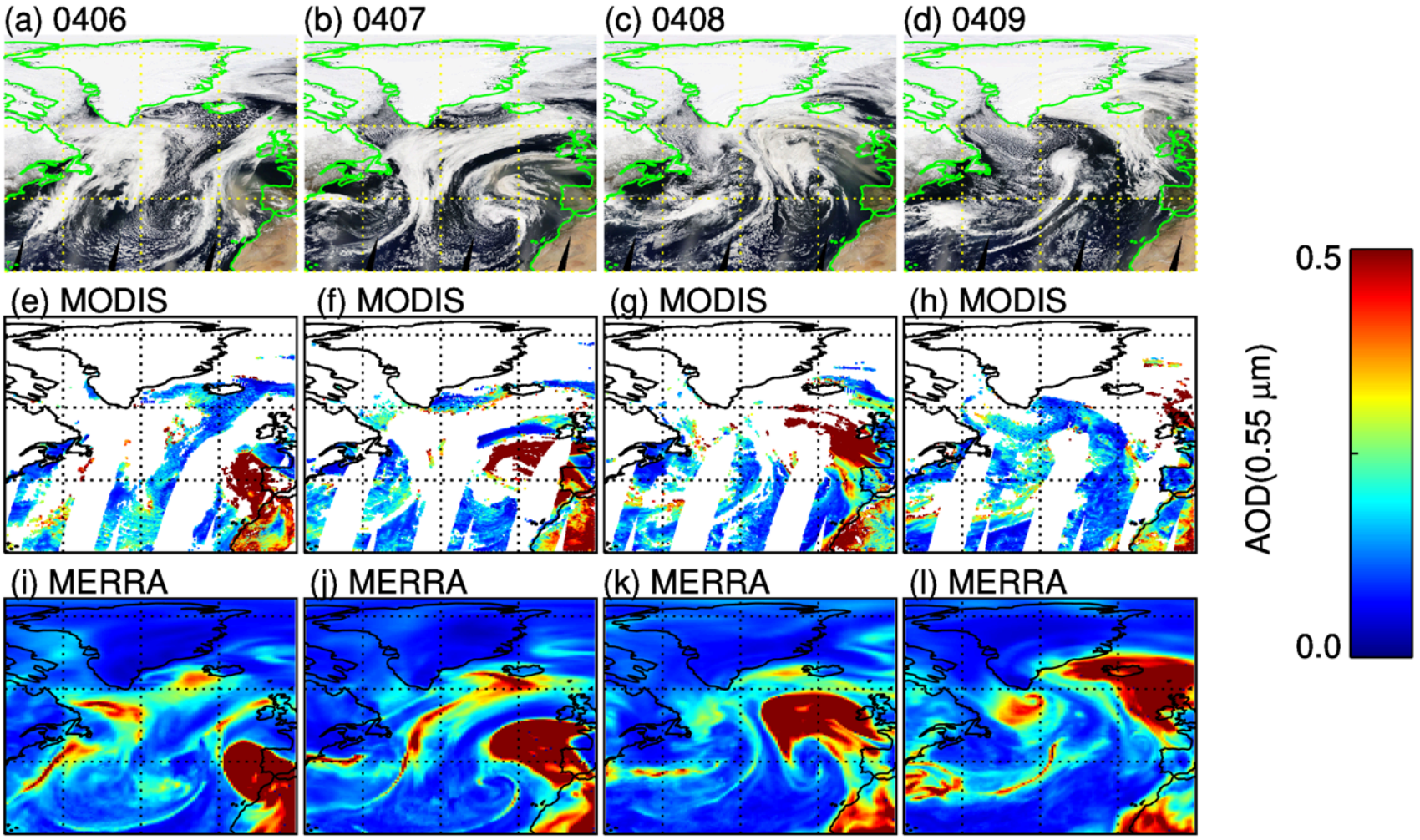
XBAER – case study



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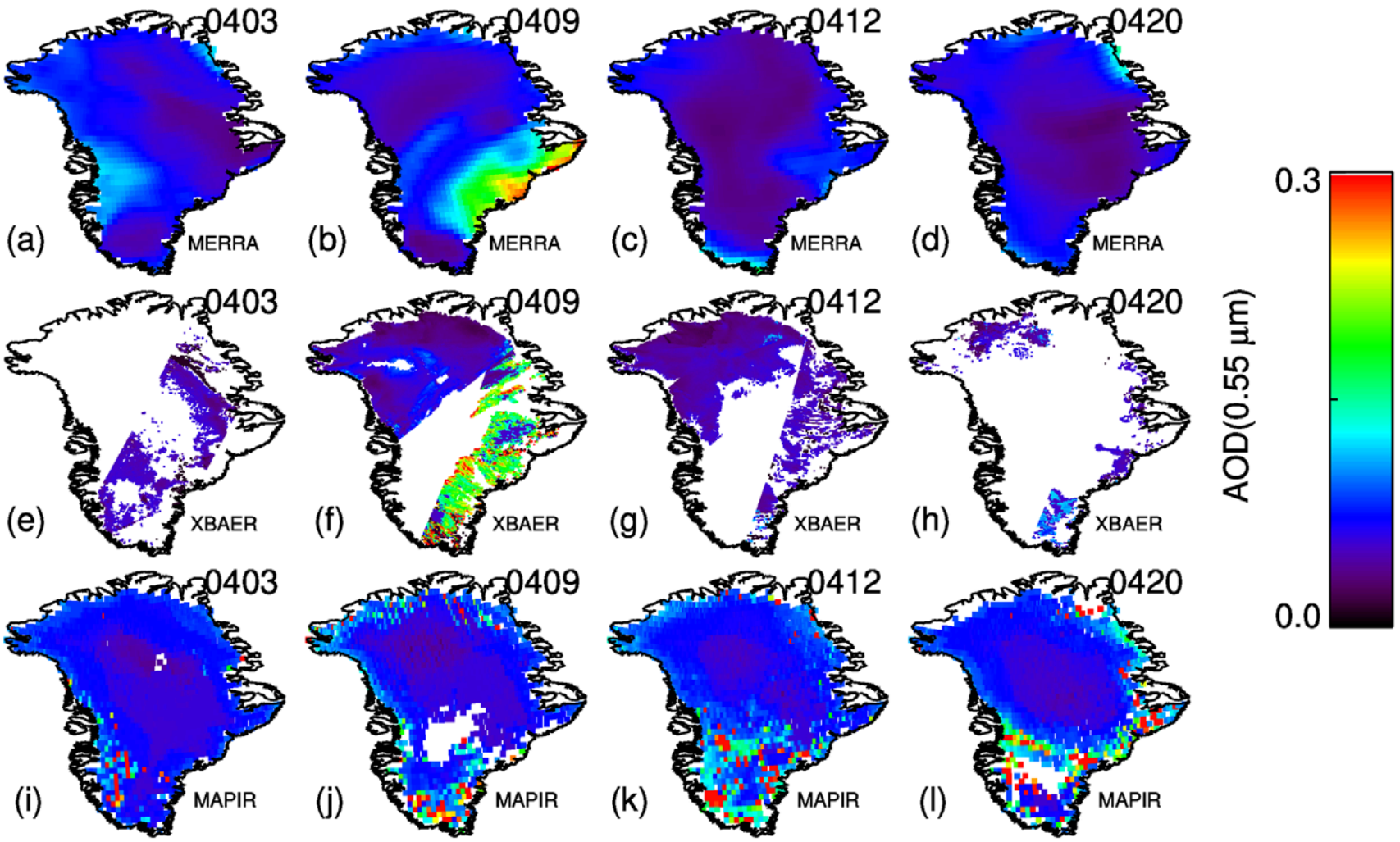
XBAER – case study



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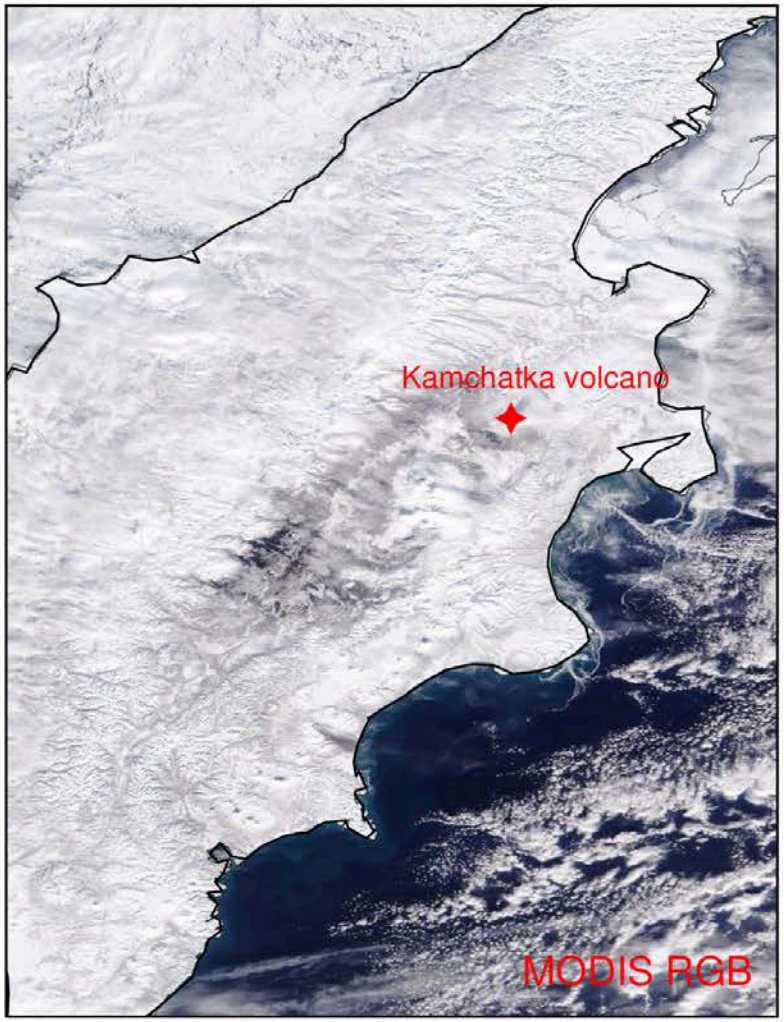
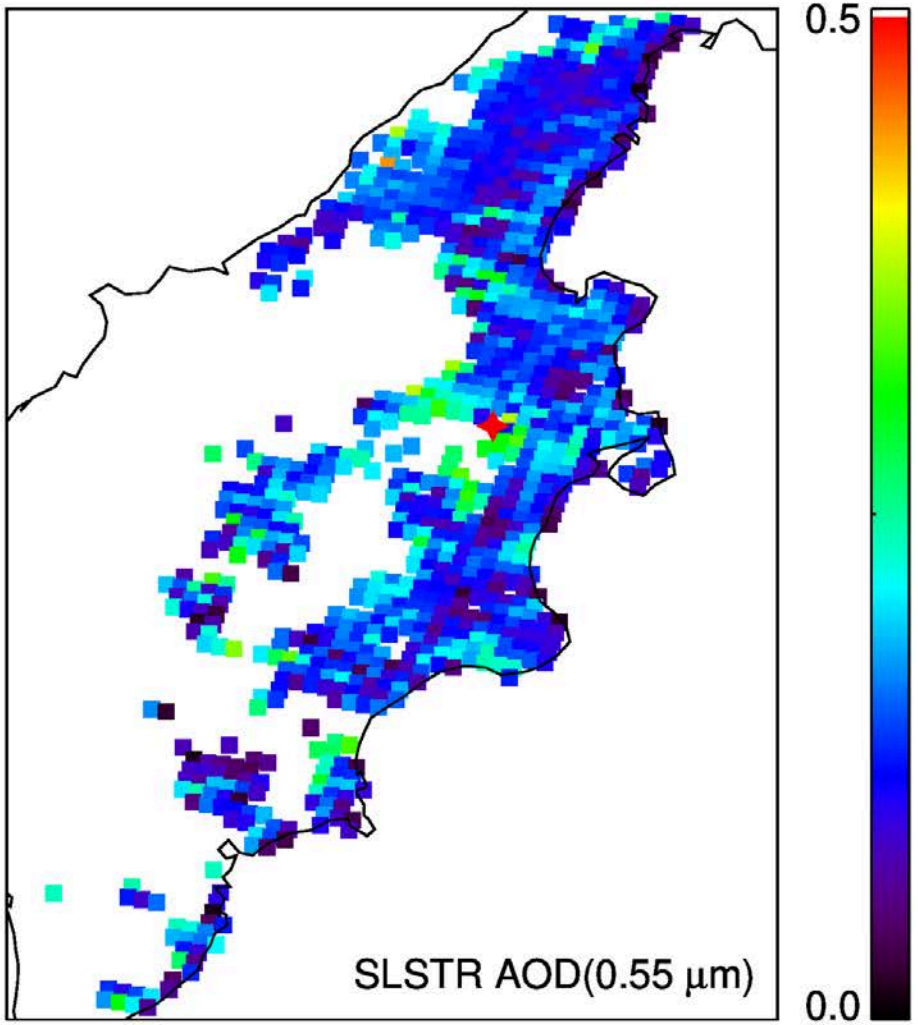
XBAER – SLSTR





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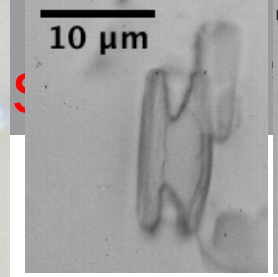
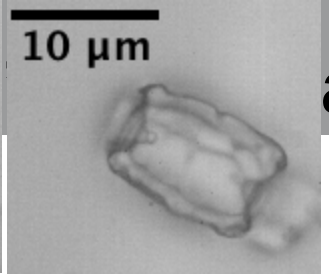
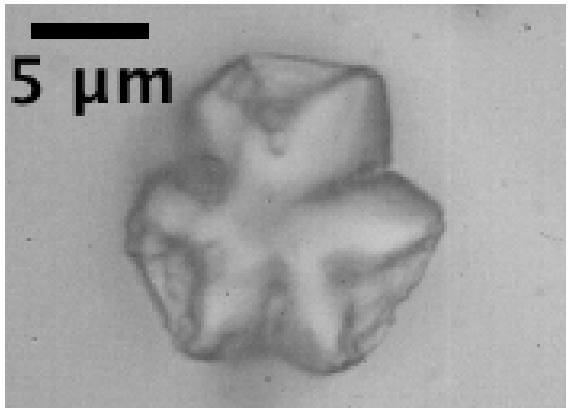
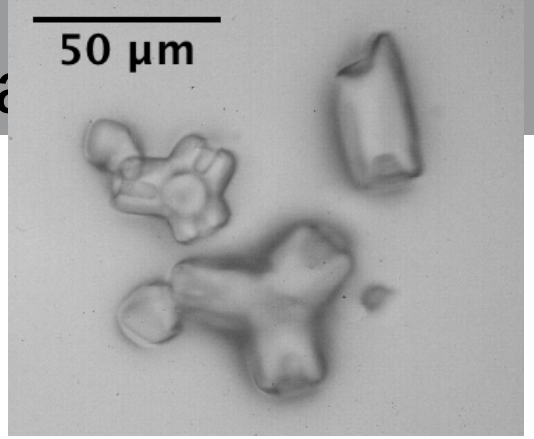
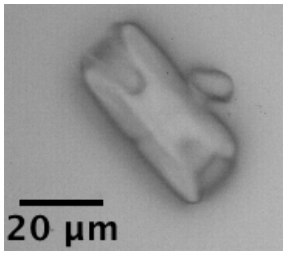
50 µm

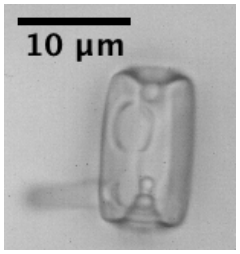

10 µm

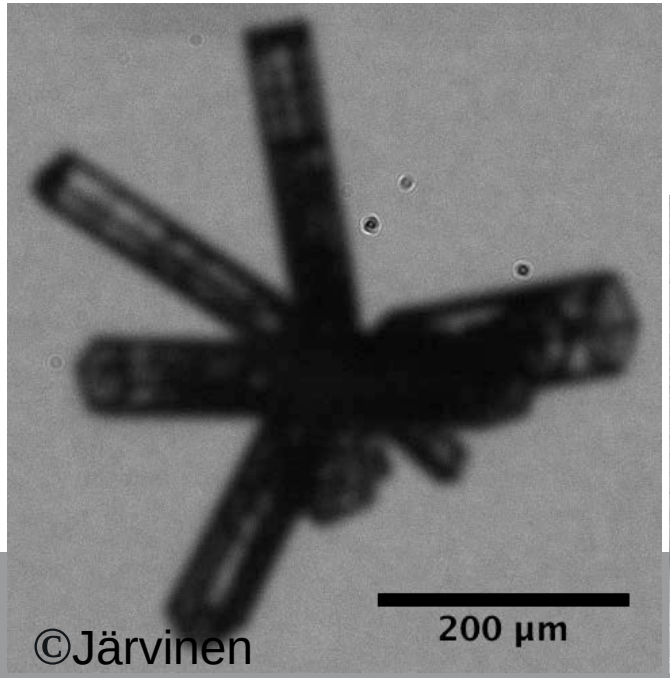

10 µm


5 µm


50 µm


20 µm


10 µm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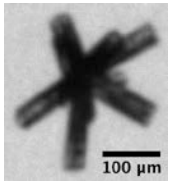
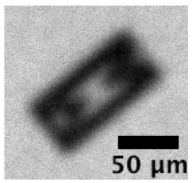
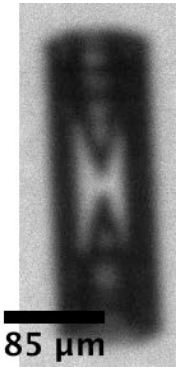
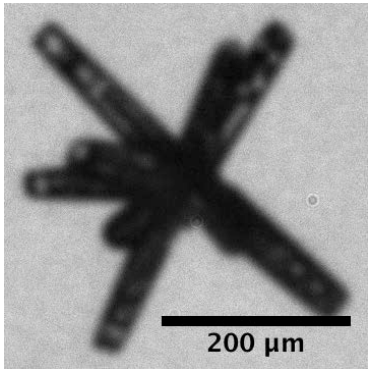

100 µm


50 µm


100 µm


85 µm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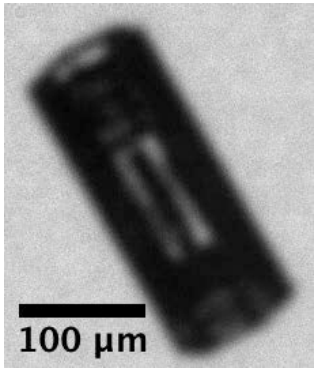
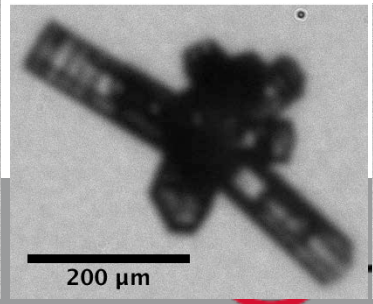
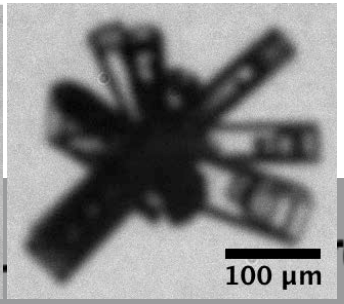

100 µm


200 µm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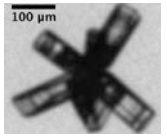
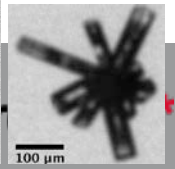
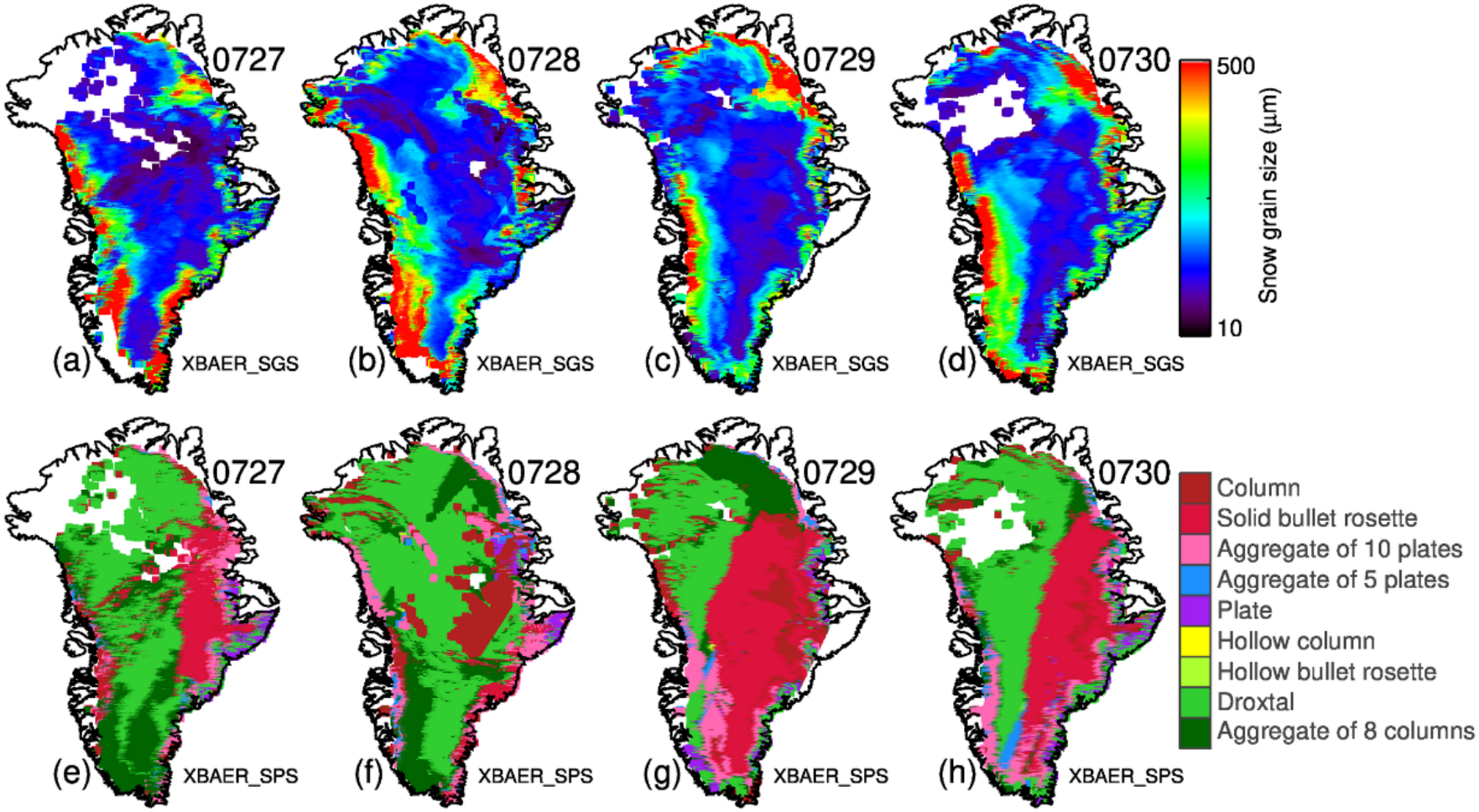

100 µm


100 µm

Perspective: “surface” in the changing Arctic

XBAER: eXtensible Bremen Aerosol/cloud and surfacE Retrieval algorithm
First observation of snow particle shape from passive remote sensing



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Take-home message

We probably can do something about aerosol over cryosphere using passive remote sensing

Thank you!!!

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