Challenges & strategies for an aerosol closure in the Arctic

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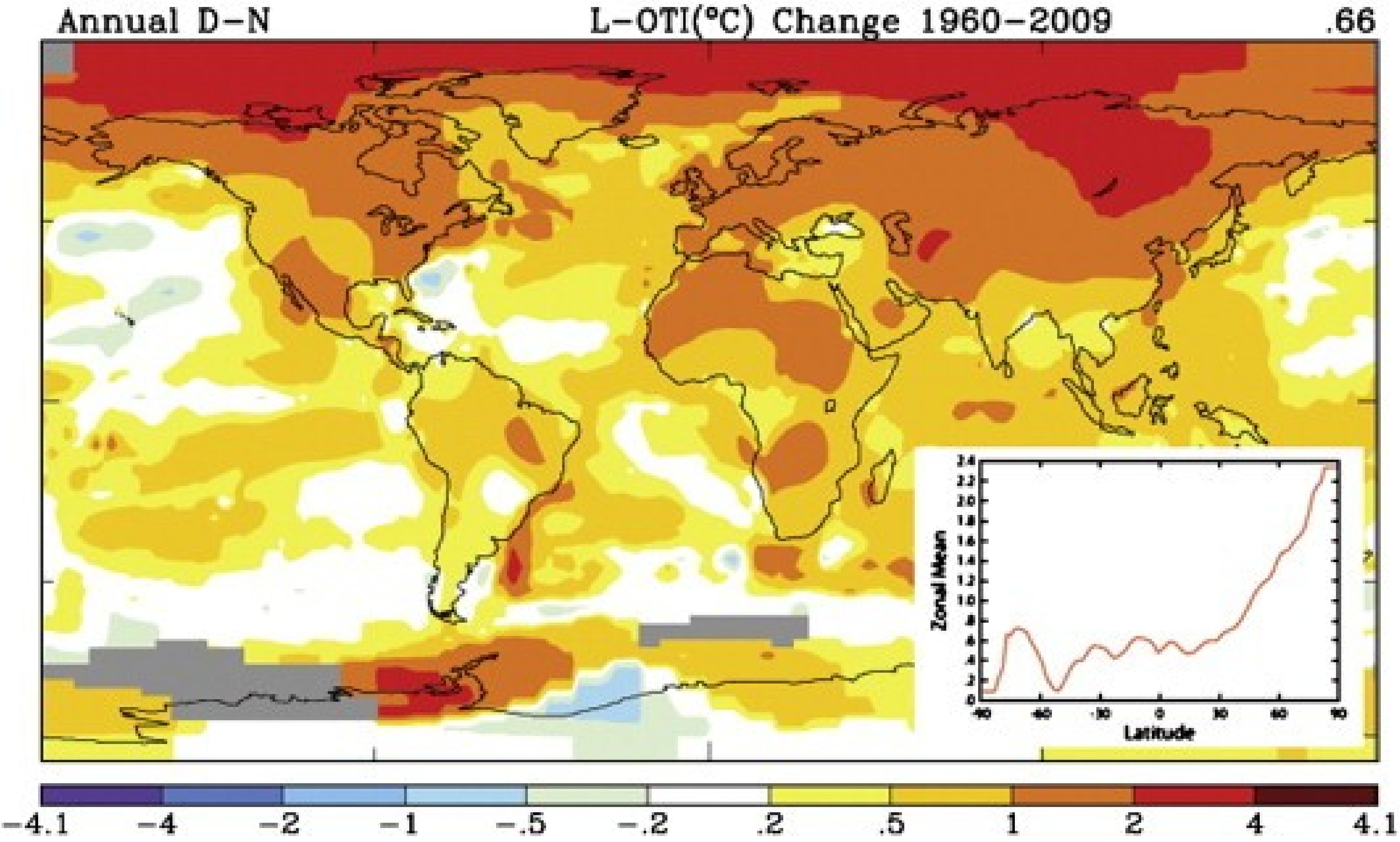
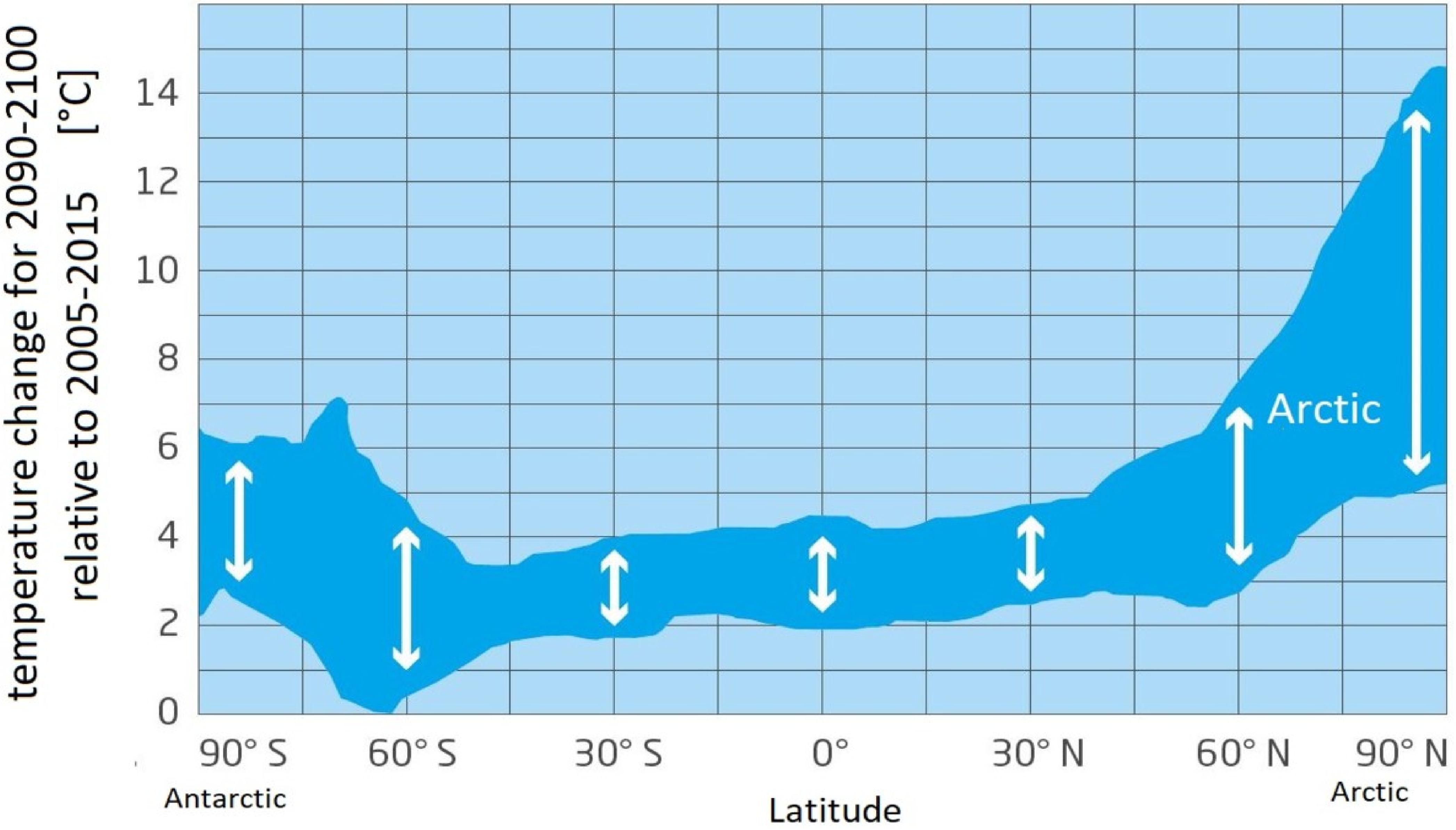
Arctic Amplification

Serreze, Barry, 2011 „processes and impacts of Arctic Amplification…“ Global and Planetary Change.



Observations from NASA



2 conclusions

Knowledge incomplete

Arctic climate may be vulnerable

For the Arctic the uncertainties of climate models are much larger than for any other part of the planet. Here projections of the warming by the end of the century range between 5 and 15 degree Celsius among the different models, for the same rather pessimistic greenhouse gas emission scenario (RCP8.5)

Arctic Haze: spring-time „air-pollution“ in the Arctic

Naming from J. Murray Mitchell 1956, pilot in Alaska

Mantra for decades: anthropogenic air pollution, sulphates, BC,metals (small accumulation mode)
Shaw 1981
Quinn 2007
But Warneke 2009: BB aerosol

But: “Poo-jok” named by Inuit at least since 1750
→ purely anthropogenic?

1750: 0,79 billion humans (18% Europe)
Steam engines by Th. Newcomen

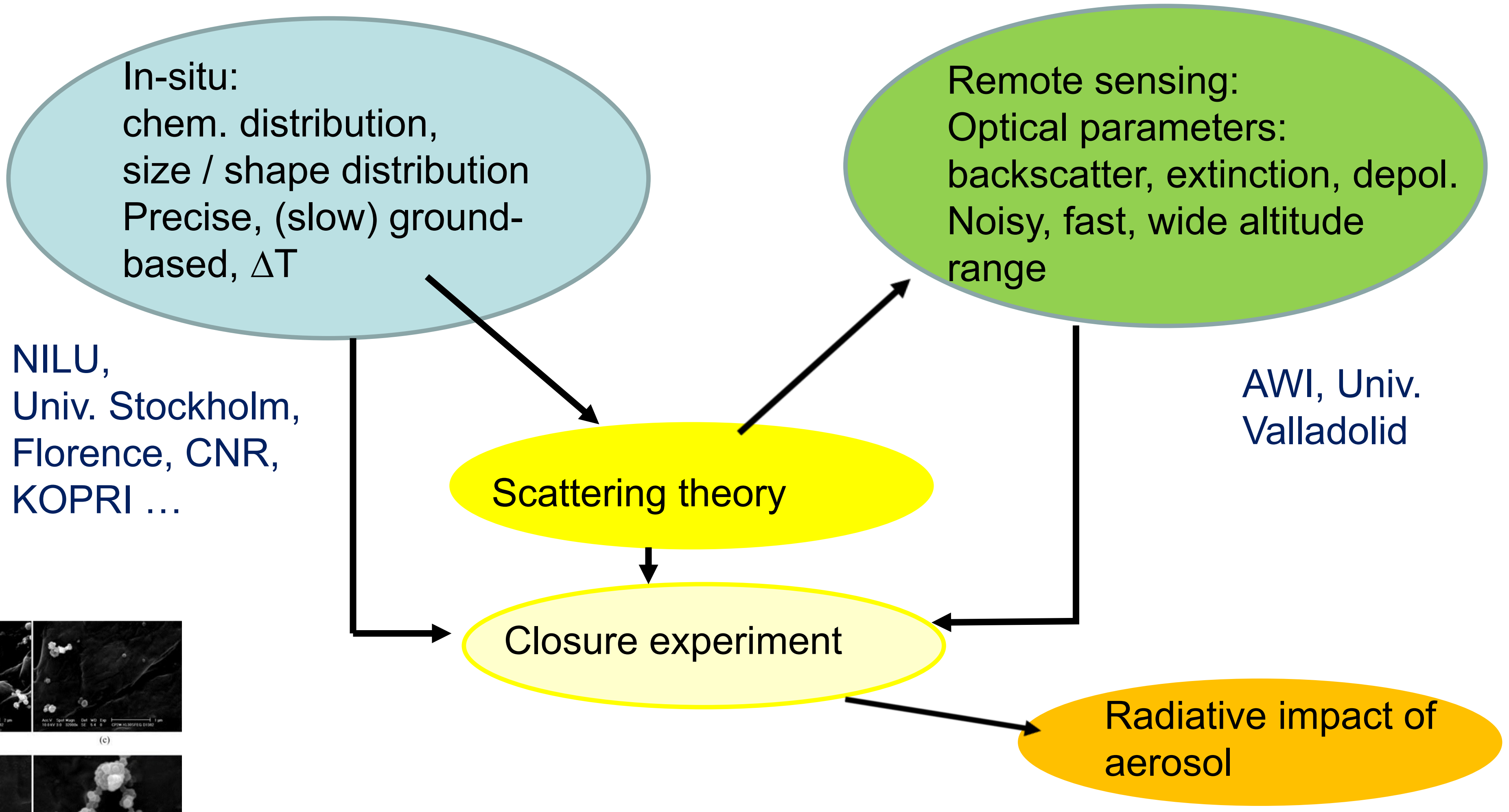
Photo:
By Jürgen Graeser
Extreme event, agricultural flaming May 2006

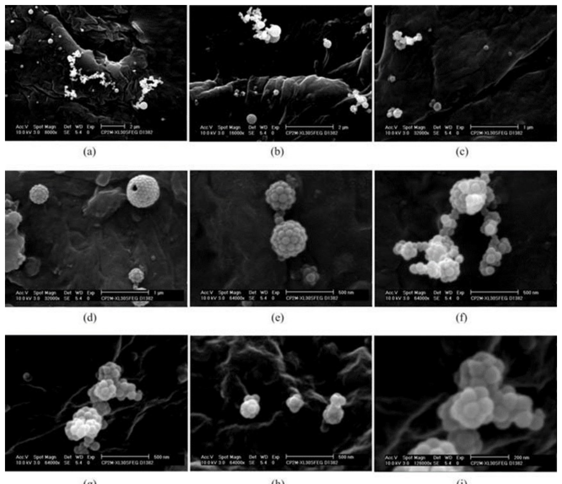
The site Ny-Ålesund

Total solar eclipse over Ny-Ålesund 2015, photo by Natalie Grenzhäuser


N
Balloon launch facility
Observatory
78°55'25"N, 011°55'21"E
Coal mining until 1963
Today science village (I, D, No, Sk, J, Cn, Kor, …)
(+) cheap and quick accessible, comfortable,
many long-term data sets available
(-) warm for the Arctic, mountains introduce
„micrometeorology“
(?) testbed for future

The ~~art~~, ~~complexity~~, ~~problems~~, ~~challenges~~, art of aerosol measurements:





Real aerosol neither spheroidal nor smooth → Scattering theory unknonw → „closure“ must not exist

Aerosol „closure experiments“

In-situ instruments

size distribution
shape (distribution)
chem. composition

calibration?
inlets: drying?
warming?

Scattering theory

Forward: well posed

Inverse: ill posed

remote sensing instruments

backscatter,
extinction,
depolarization

technical & numerical settings

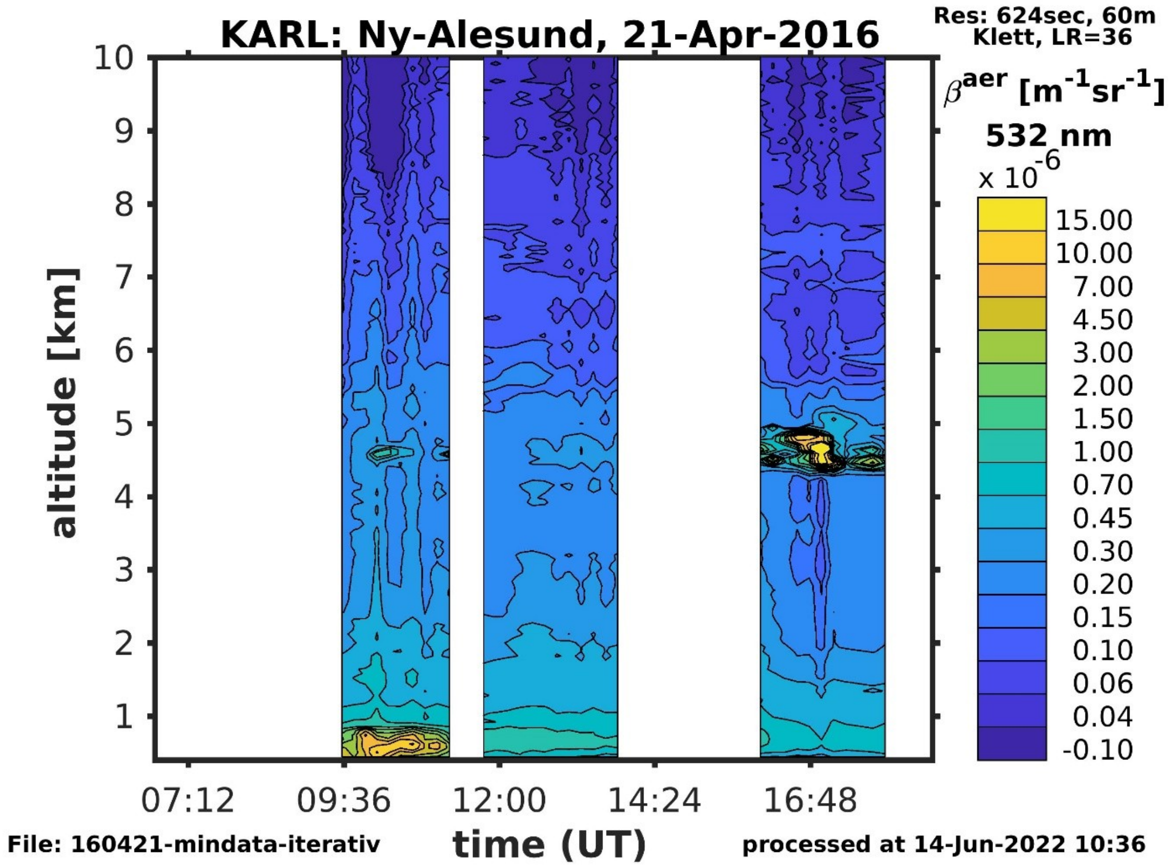
Closure: compare microphysics and optical parameters until:

a) a clear agreement is established
b) understood which aerosol type under which conditions over/underestimate

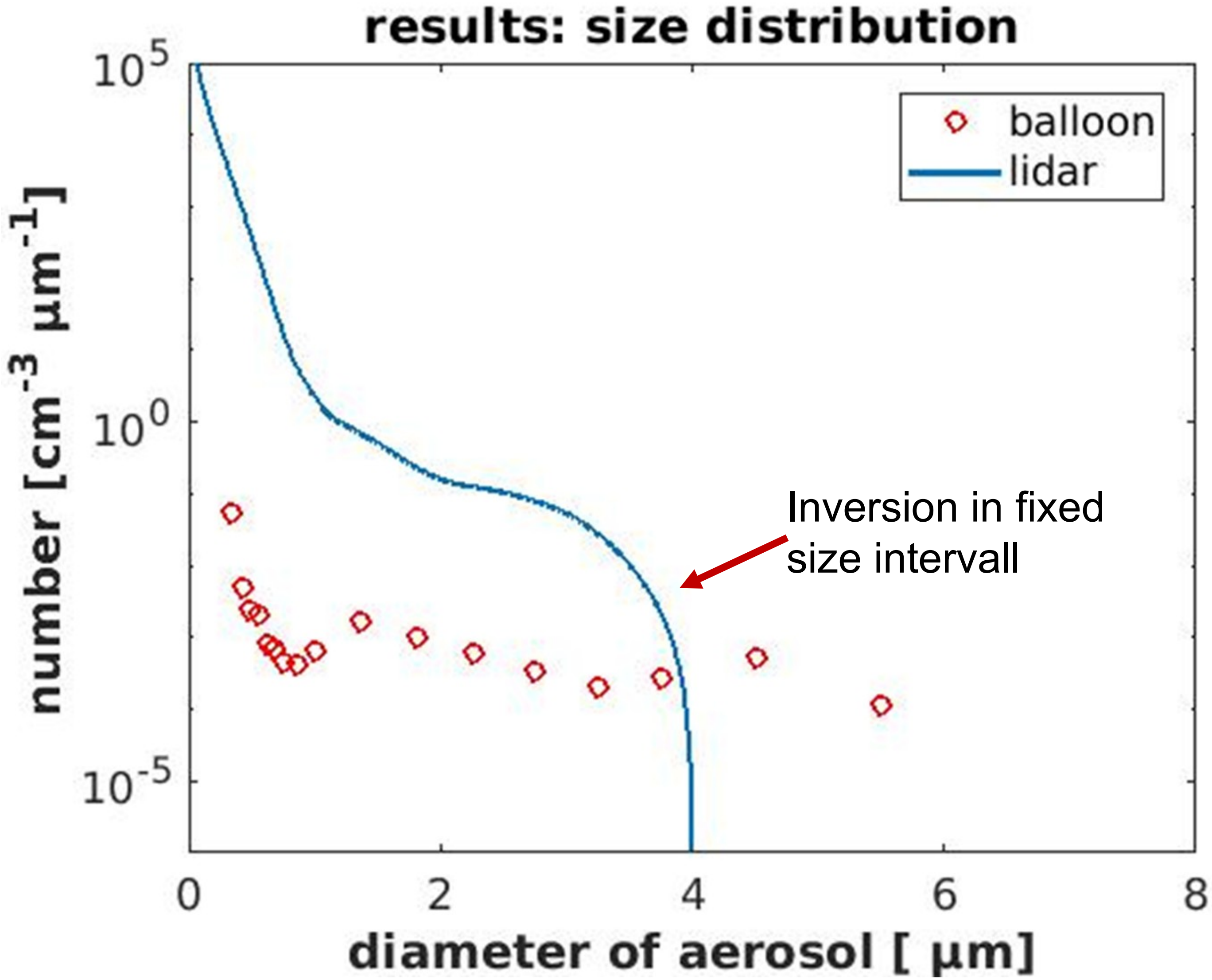
At a site with low ABL height & micrometeorology plenty of data from same air volume needed!

Comparison size distribution lidar vs. OPC (21 sizes 0.28µm – 10µm)

Low wind speed
Low aerosol depolarisation
Rh >=60% but similar in tether balloon & radiosonde
21 Apr 2016, noontime; lidar > 700m   balloon < 1200m



Lidar overestimates aerosol concentration by x 1000
Balloon-OPC saw clear sky
Deviation unexplainable



Arctic:
aerosol is mixed down to surface

Low wind speed: micrometeorology

Needed: lidar vs. In-situ from the same air mass over longer time

Scanning lidar

„which aerosol under which meteorologic situation is over / underestimated in remote sensing“?

The new scanning Raman-Lidar

Planned new system from Raymetrics:

Laser:
Nd:YAG flash lamps! @355 / 532 / 1064 >80mJ per color, 20Hz

Telescope: 30cm Dall Kirkham

Licel electronics pc & ad

PMTs: Hamamatsu R9880

Overlapp = 250m

Δ90 calibration, telecover, dark signal …

Thanks!

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