

EarthCARE 2026

Science and Validation workshop

8–12 June 2026 | Rhodes House | Oxford, UK



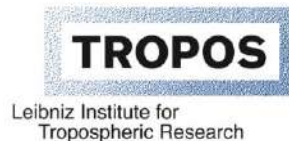
Exploration of novel observations and multi-instrument synergy for studying aerosol and aerosol-cloud interaction in frame of project.



O. Dubovik, Lopatin, P. Litvinov, S. Wang, O. Hasekamp, B. van Dierenhoven, U. Wandinger, J. Hofer, A. Ansmann, H. Baars, V. Amiridis, A. Tsekeri, Anna Gialitaki, G.-J. van Zadelhoff, T. Tsikerdekis, D. Donovan, I. Stachlewska, L. Janicka, J.- C. Pere, F. Waquet, O. Sourdeval, D. Gasbarra and E. Malina



Netherlands Institute for Space Research



Leibniz Institute for
Tropospheric Research



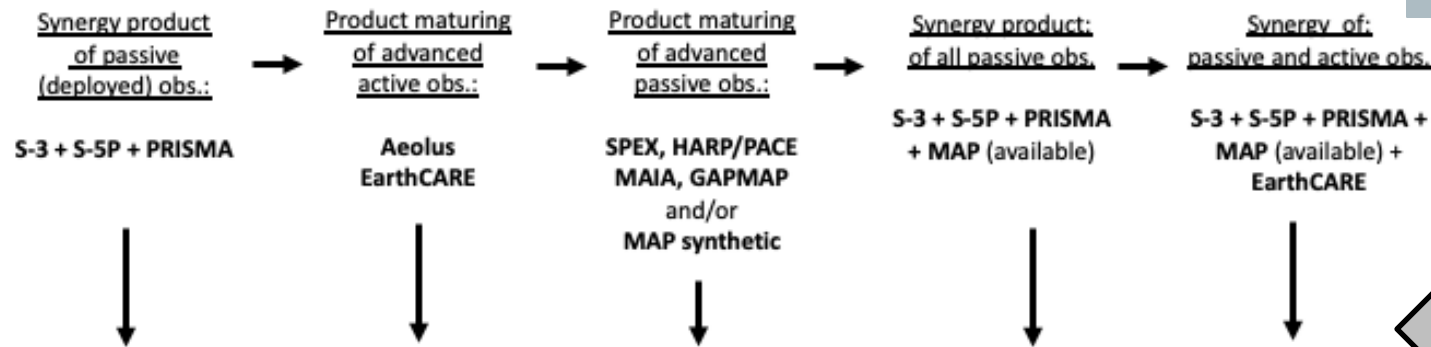
Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu





Aerosol and aerosol-cloud Interaction from Remote SENSing Enhancement

Horizon Europe
Coordinated activities



Novel products from multi-instrument synergy:

- Improved scope: aerosol and cloud type, vertical variability, stratospheric aerosol, etc.
- Improved coverage and time x space resolution.

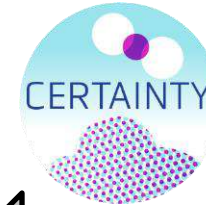
Science studies using observations:

- aerosol-cloud interactions, cloud formation, humidity growth, etc.

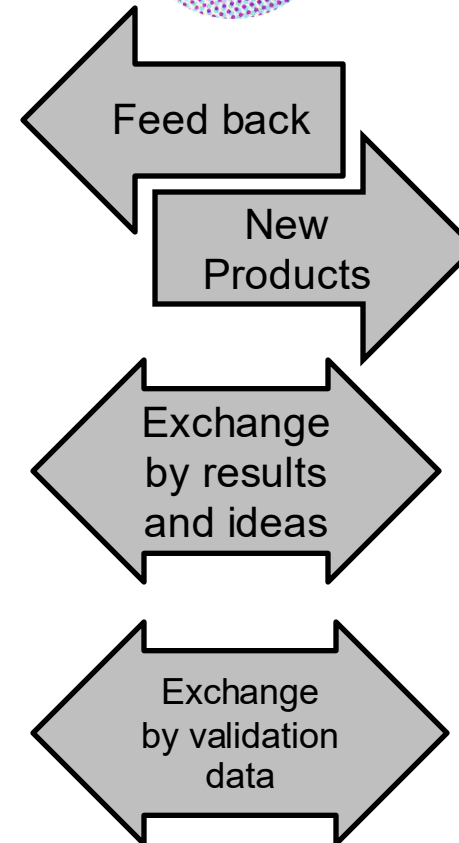
Science studies using models and data assimilation:

- atmospheric dynamics, water cycle

Ground based data (ACTRIS)
Field campaigns (ESA, NASA, Coordinated Activities)



Funded by
the European Union



Assimilation

CERTAINTY
CleanCloud
ACTRIS

To formulate
joint scientific studies
on radiative forcing?

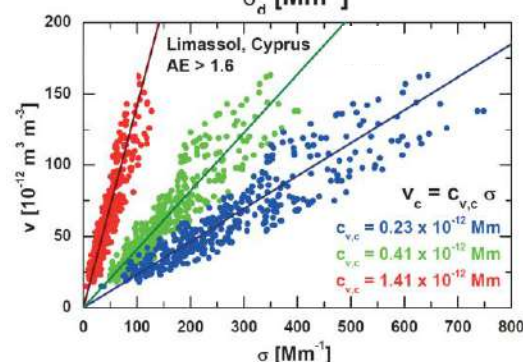
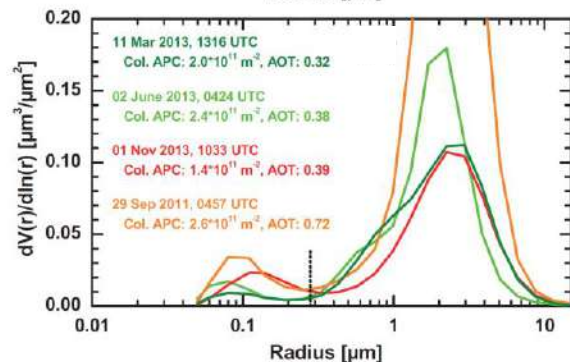
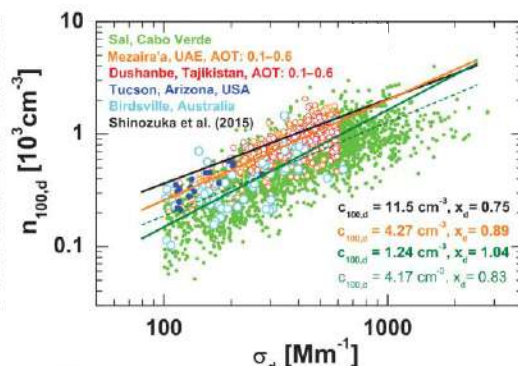
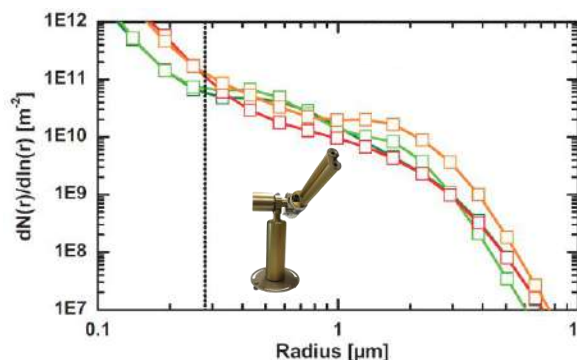


Spaceborne lidar products

TROPOS

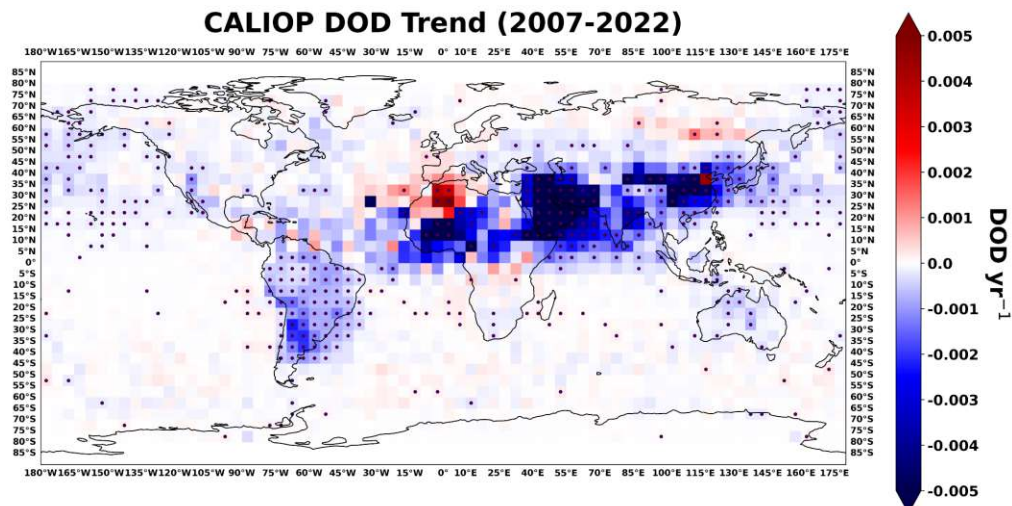
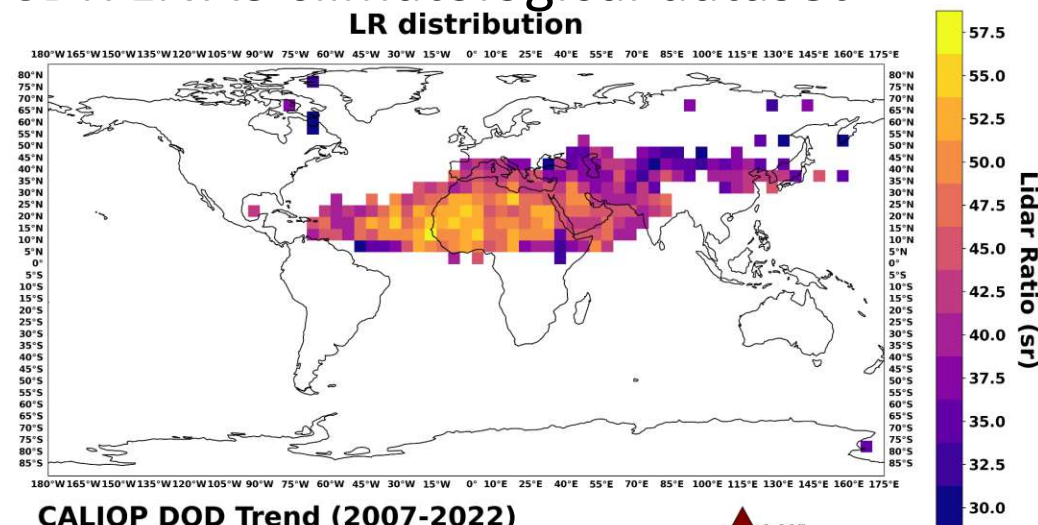
Julian Hofer, Holger Baars

- POLIPHON conversion parameters at 355 nm from AERONET (as for 532)
- POLIPHON application to EarthCARE products



Konstantinos Rizos

- Extend the CALIPSO products in time with, investigate use of Aeolus products
- 3D CDR LIVAS climatological dataset

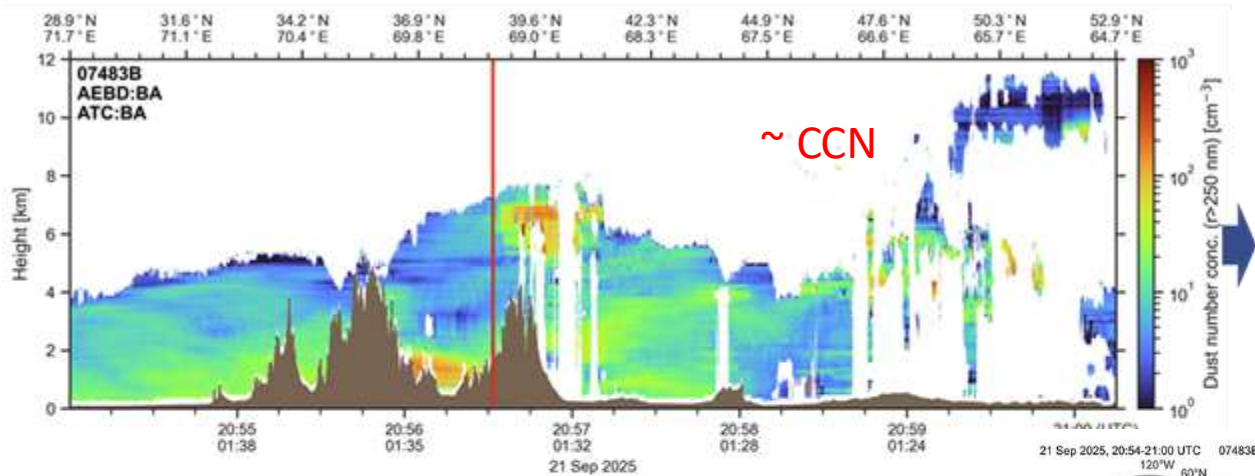


Dust number conc. ($r > 250$ nm)

```
cf = eck.CurtainFigure()
cf = cf.ecplot(poliphon_res, var="n_250_d")
```

D4 - CCN/INP profile
products from EarthCARE,
complementary
POLIPHON products

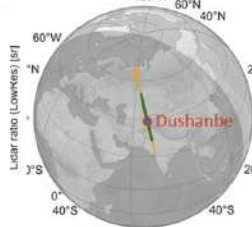
Task 2300.3: Apply
the POLIPHON
method to the
EarthCARE products



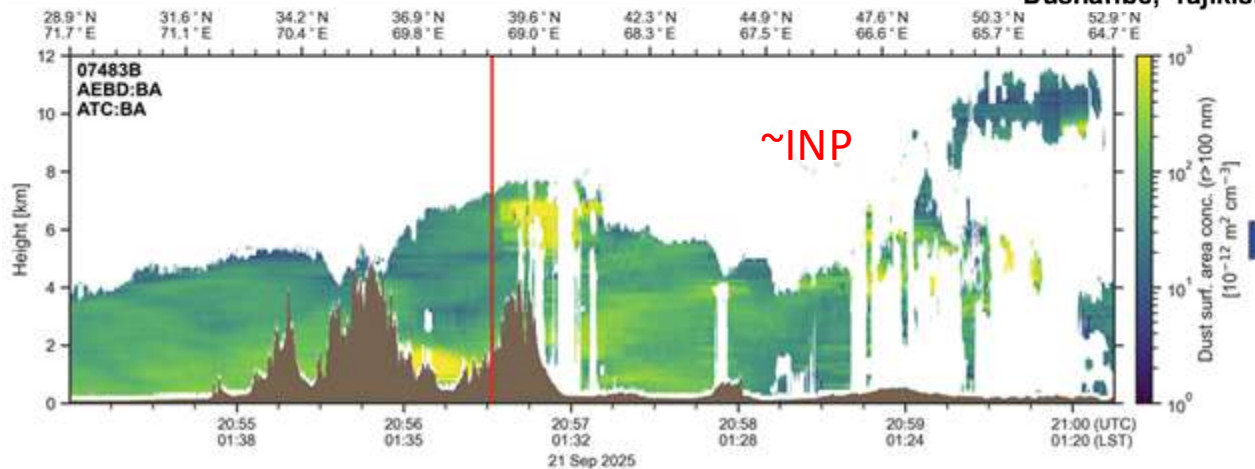
Dust surface area conc. ($r > 100$ nm)

```
cf = eck.CurtainFigure()
cf = cf.ecplot(poliphon_res, var="sa_100_d")
```

TROPOS



Dushanbe, Tajikistan

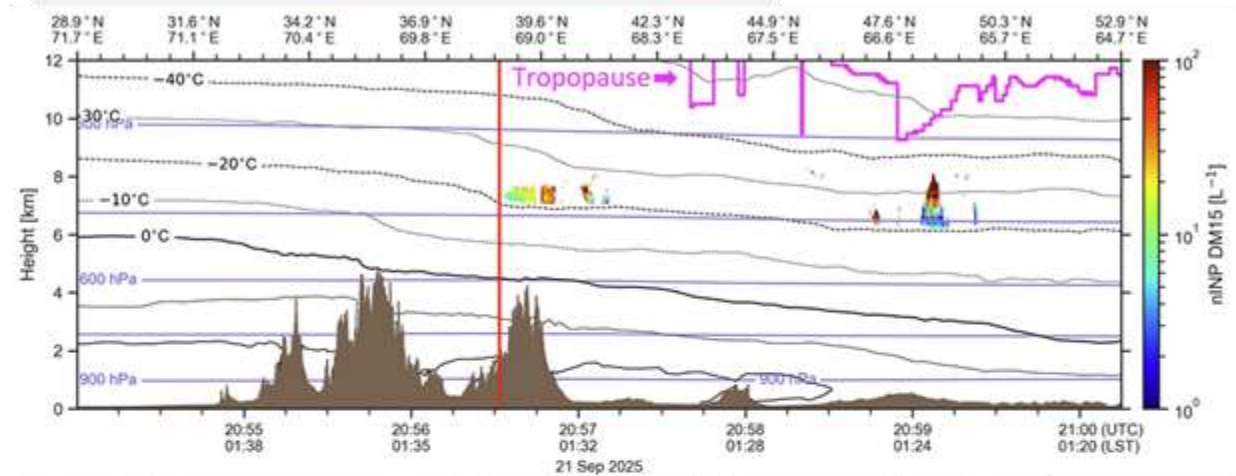


Dust INP concentration (immersion freezing)

(DeMott et al. (2015), on dust number conc. ($r > 250$ nm), X-MET temperature and pressure)

```
cf = eck.CurtainFigure()
cf = cf.ecplot(poliphon_res, var="n_inp_dm15")
```

INP $T \leq -15^\circ\text{C}$

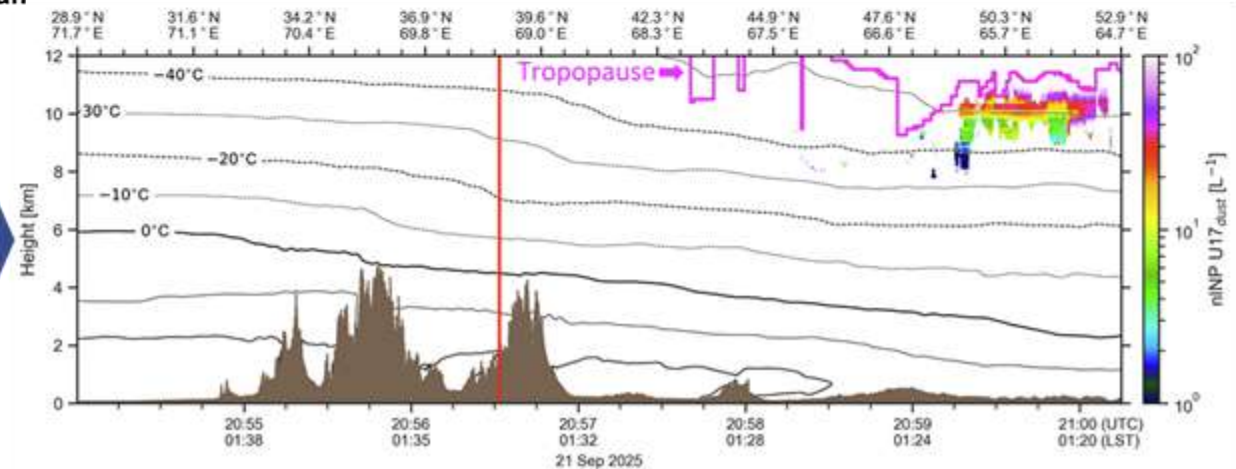


Dust INP concentration (deposition nucleation)

(Ullrich et al. (2017) (dust), $S_{\text{ice}}=1.15$, on dust surface area conc., X-MET temperature)

```
cf = eck.CurtainFigure()
cf = cf.ecplot(poliphon_res, var="n_inp_u17_dust")
```

INP

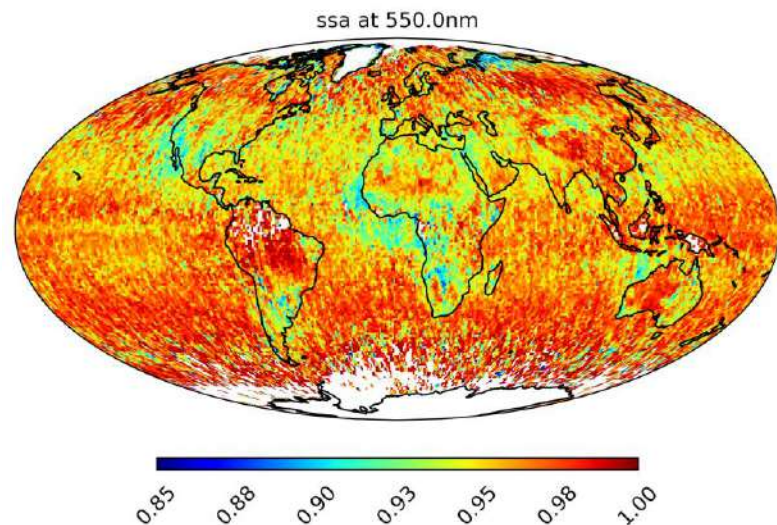
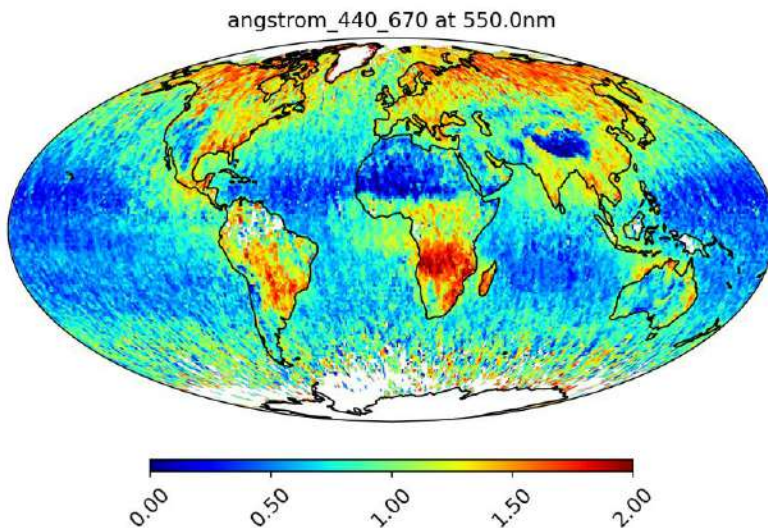
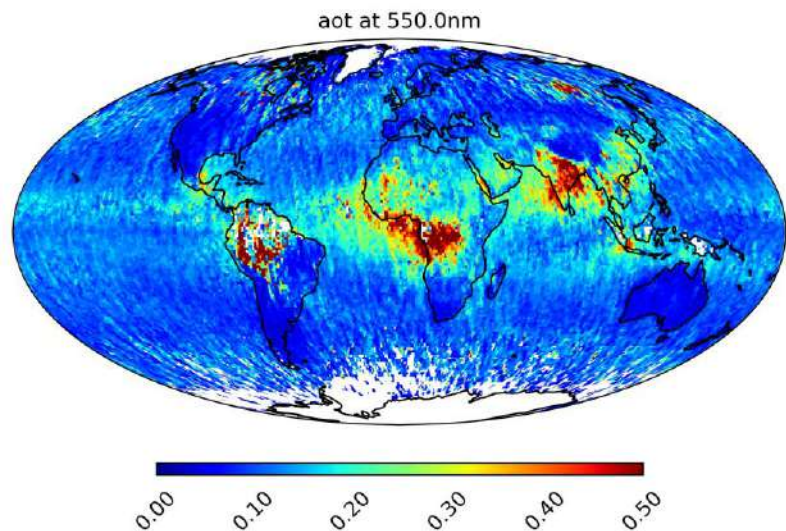




Passive polarimetry products



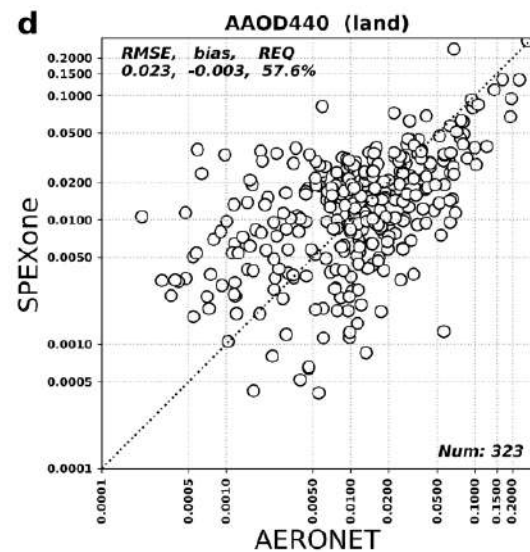
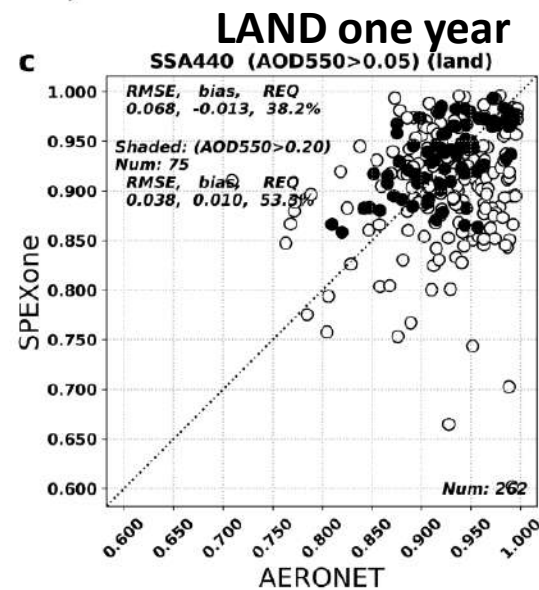
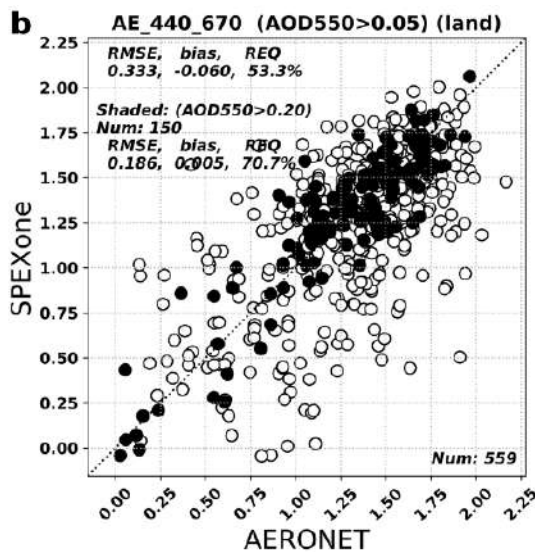
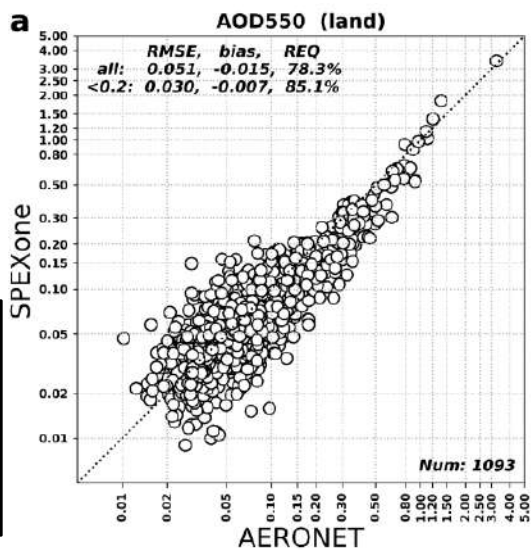
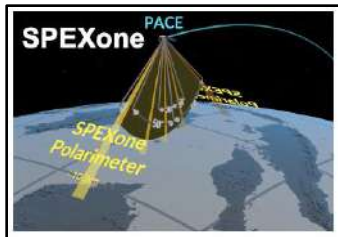
Otto Hasekamp, Bastiaan van Dierenhoven, Piushkumar Patel



RemoTAP

- 385-770 nm continues
- 5 viewing angles
- 30+ day global coverage
- 2.5 km spatial resolution

high information content;
high meas. precision;





Passive polarimetry products CCN proxies

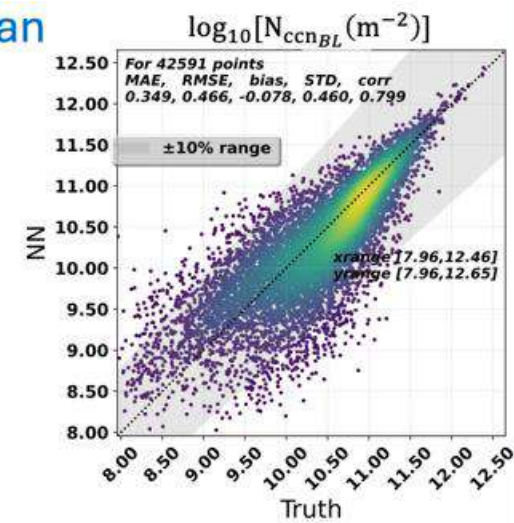
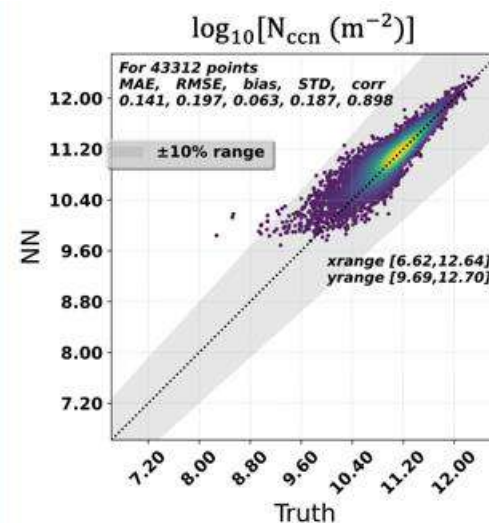
Cloud Condensation Nuclei (CCN)

- NN estimation of dry CCN and CCN_{BL} (in boundary layer)

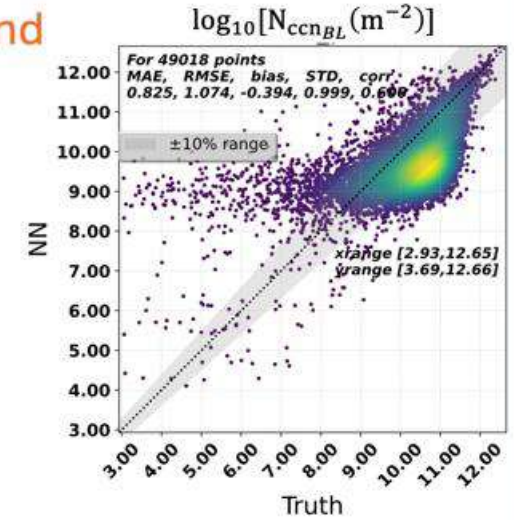
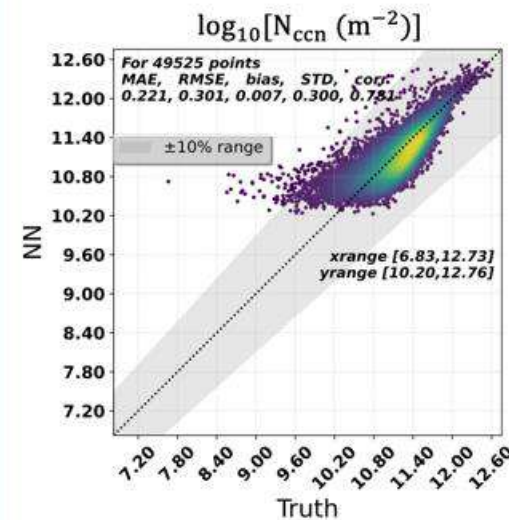
~cloud base

Synthetic study

Ocean



Land

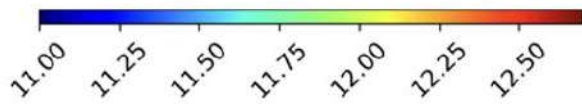
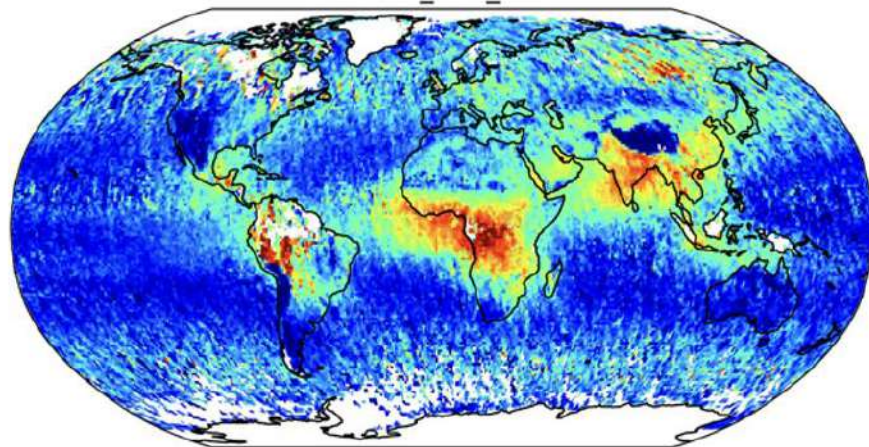


N_{CCN}

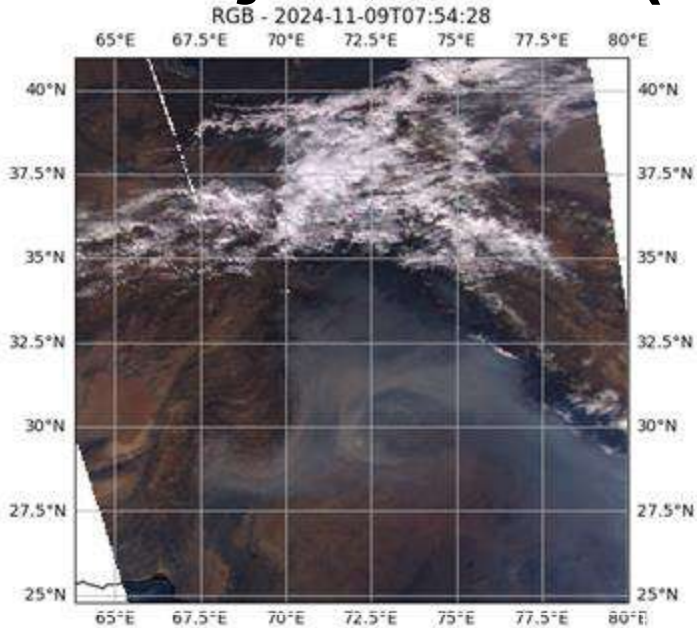
$N_{CCN_{BL}}$

- CCN proxies

Nccn_100_all



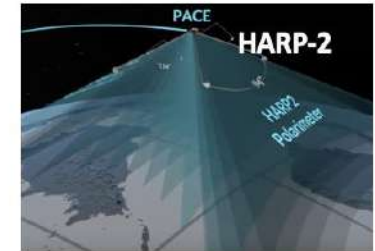
Stubble Burning in Punjab, India (Nov, 2024)



HARP-2/GRASP retrievals

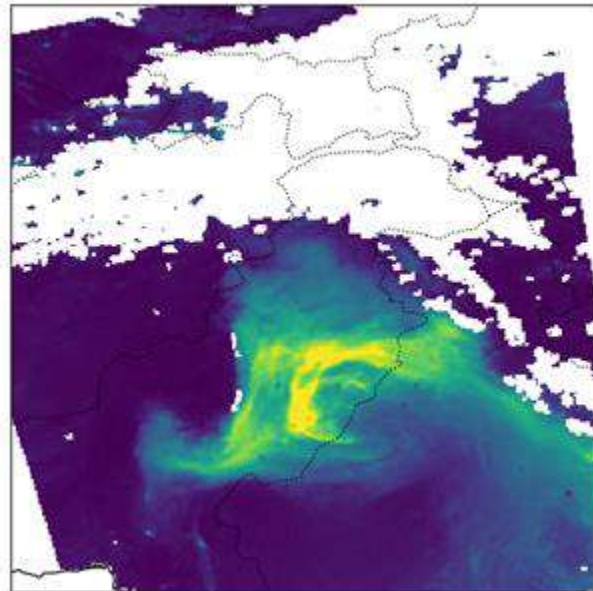
- 440, 550, 670, 870 nm
- viewing angles:
 - 10 for 440, 550, 870 nm
 - 60 viewing angles for 670
- 2 day global coverage
- 3 km spatial resolution

high information content;
wide coverage;



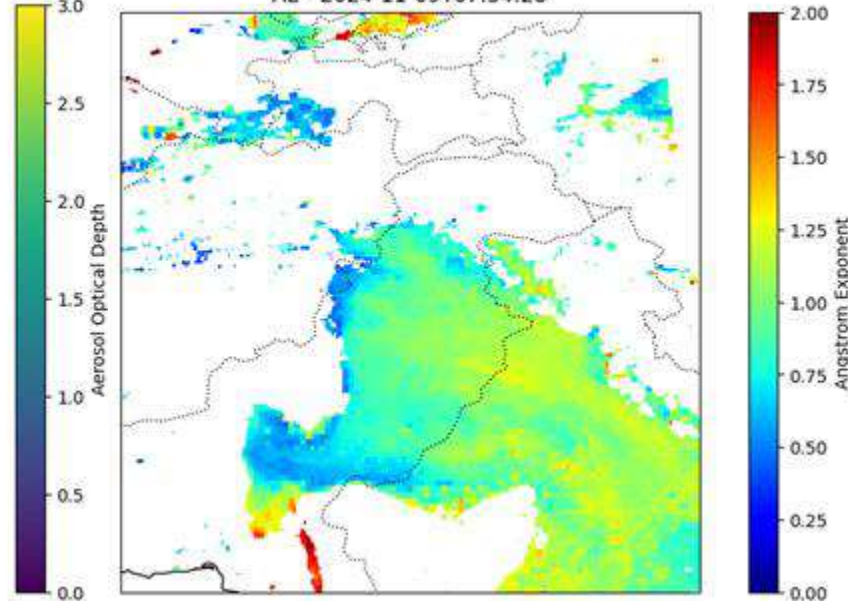
AOD@550nm

AOD550nm - 2024-11-09T07:54:28



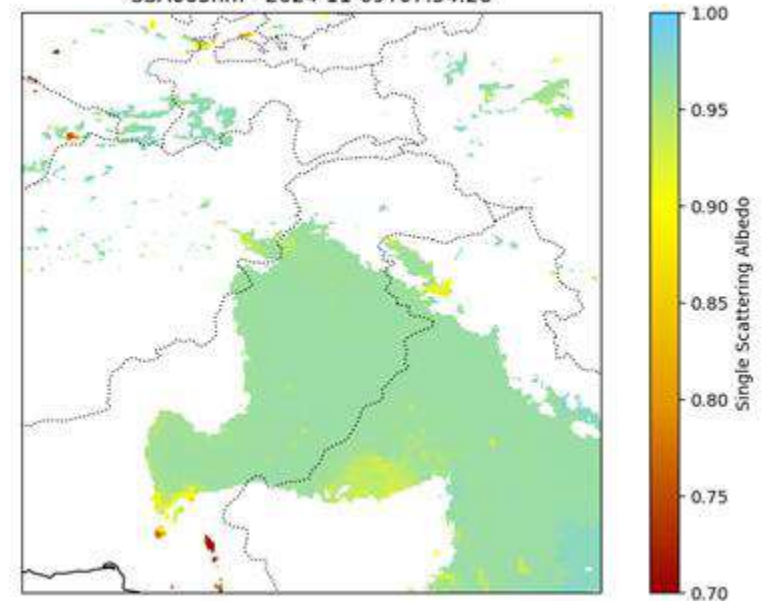
AE@440/870 AOD(550)>0.2

AE - 2024-11-09T07:54:28

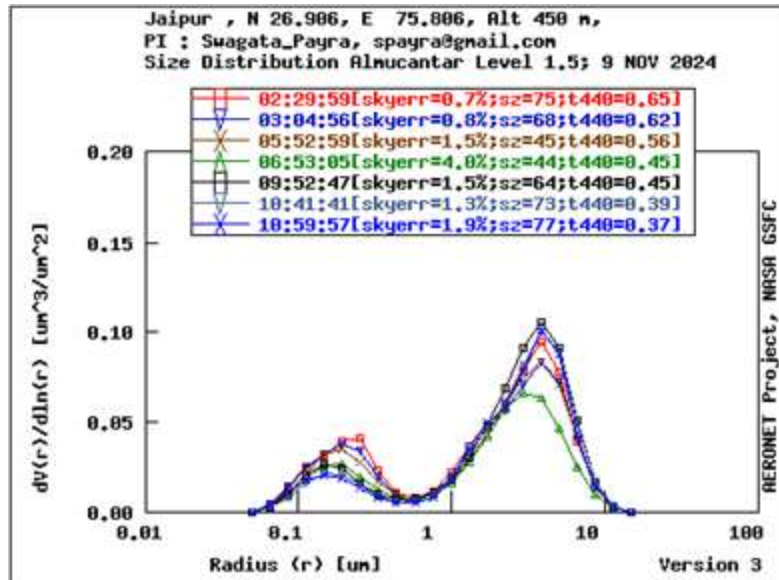


SSA@665nm AOD(550)>0.3

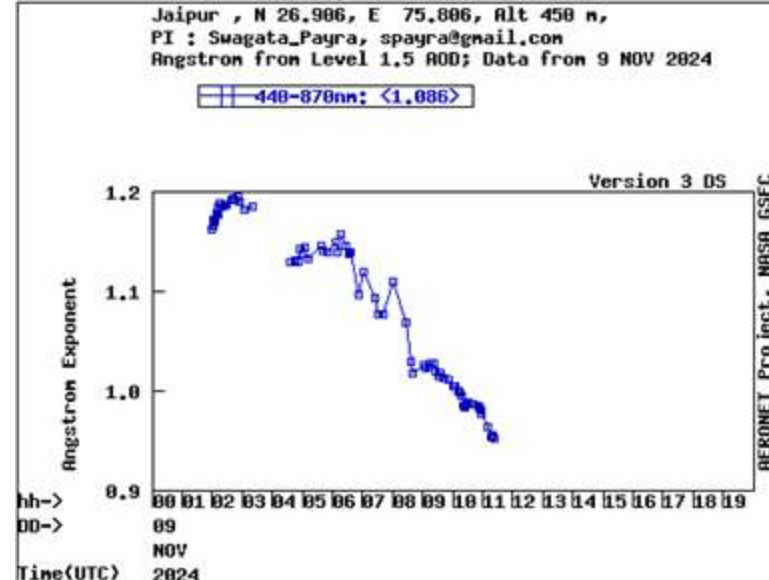
SSA665nm - 2024-11-09T07:54:28



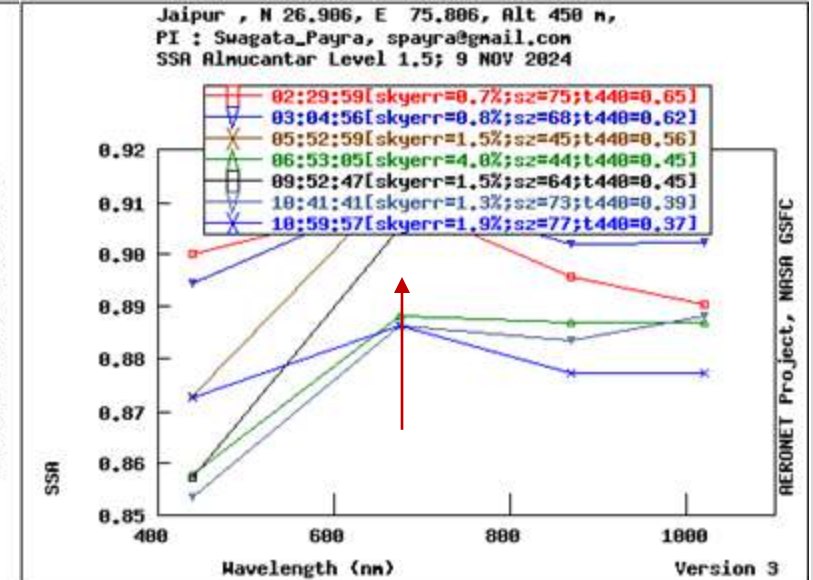
Size Distribution - AERONET



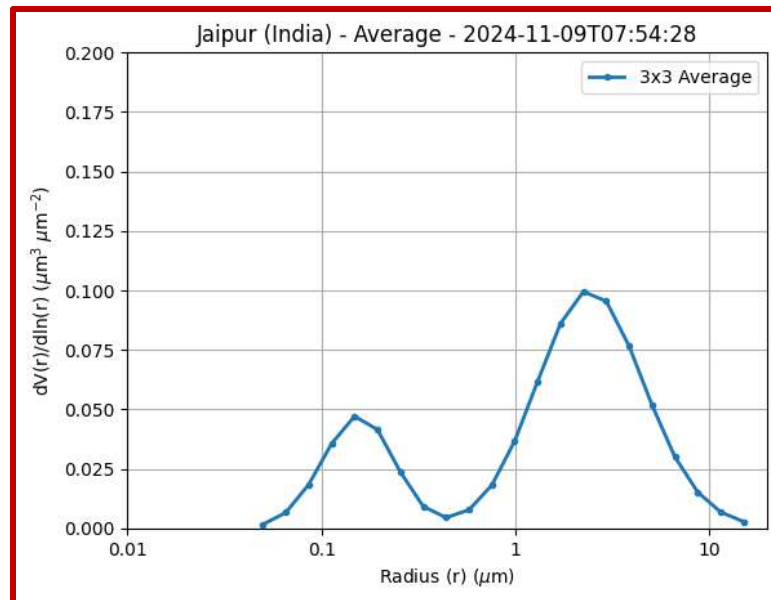
AE@440/870 - AERONET



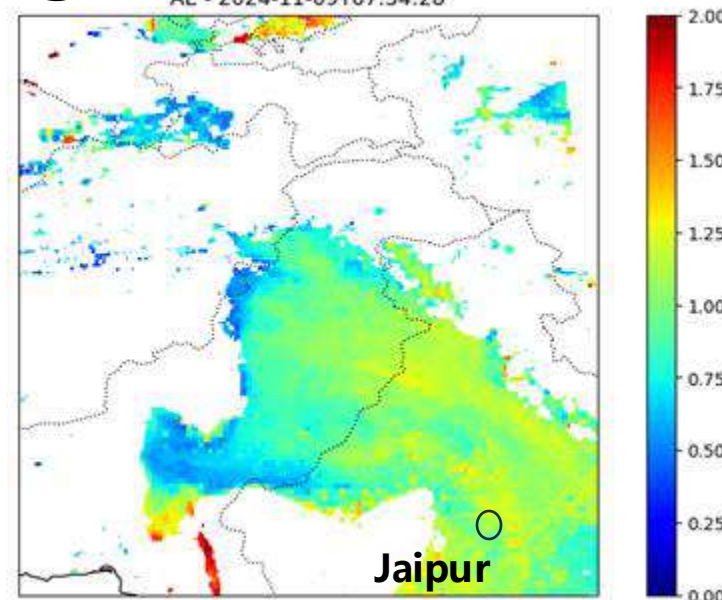
SSA - AERONET



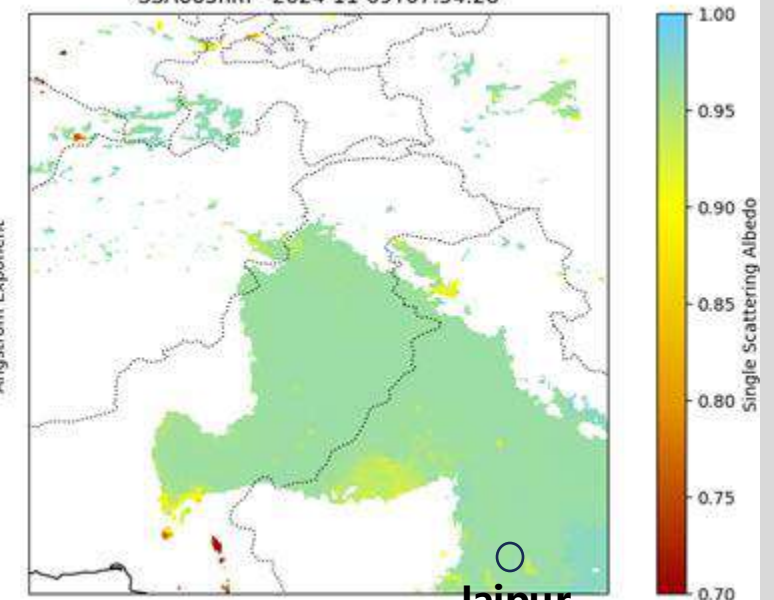
Size Distribution - HARP-2/GRASP



AE@440/870 - HARP-2/GRASP



SSA@665nm





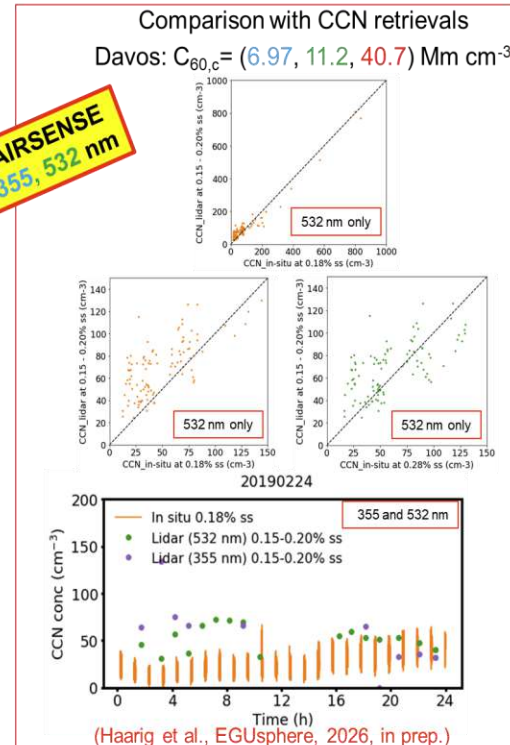
Validation of CCN proxies

Lidar products

TROPOS

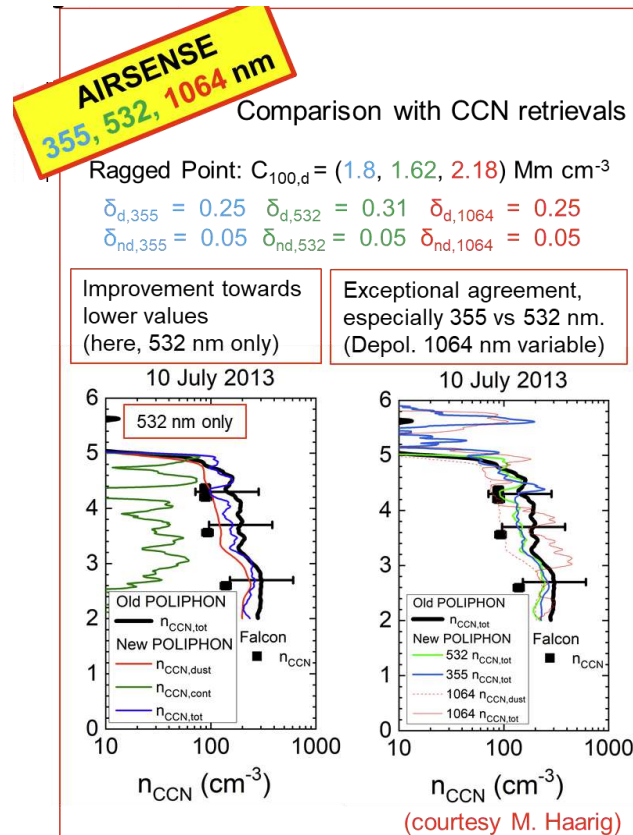
Julian Hofer, Holger Baars

- RACLETS: in situ vs lidar



Barbados

- SALTRACE: aircraft vs lidar



Davos

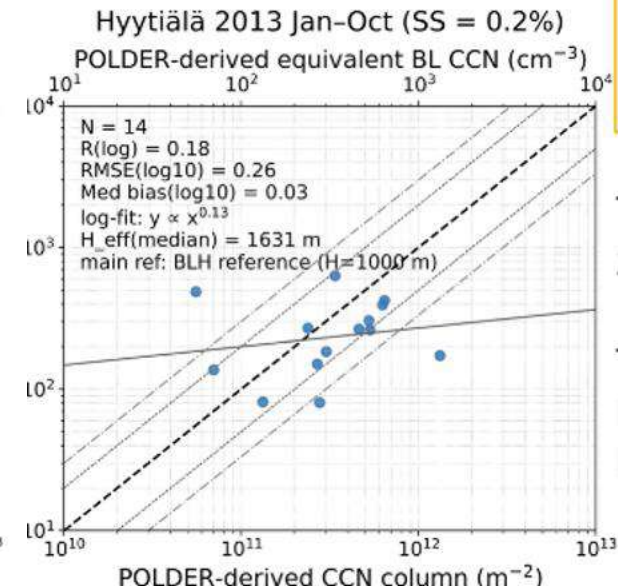
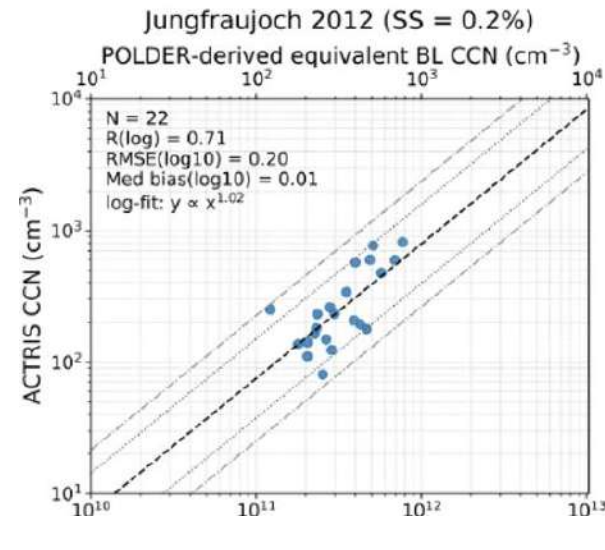
Imagers products

POLDER vs ACTRIS

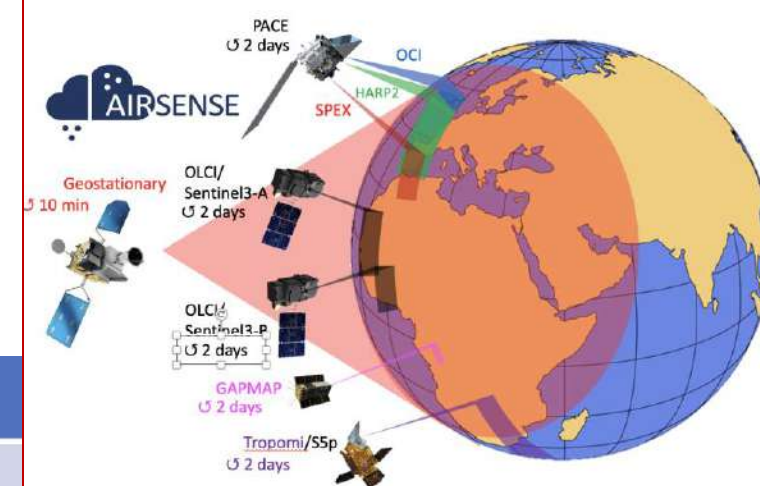
Jungfraujoch (JFJ), Hyytiälä (HYY) stations

Free troposphere/Mountaintop

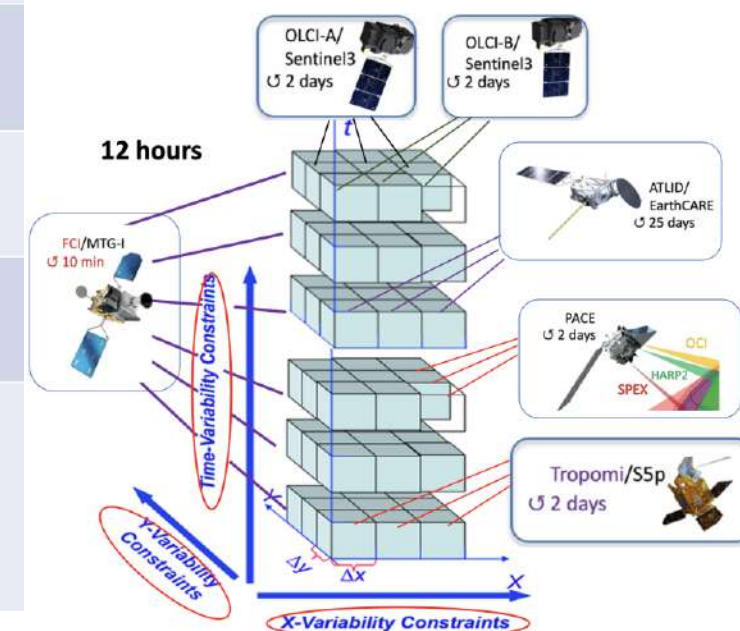
Surface layer



Synergy GRASP processing



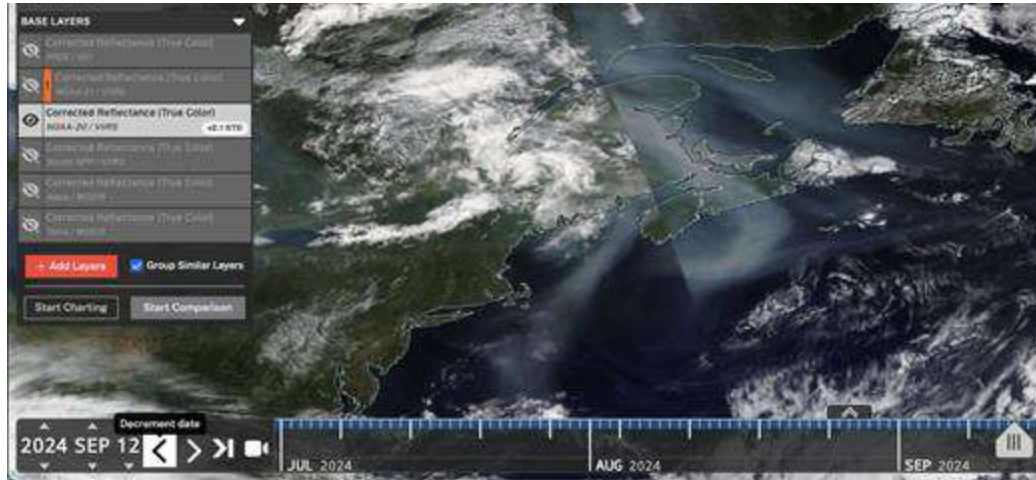
Multi-instrument synergy



Multi-Pixel GRASP Concept, Dubovik et al., 2011

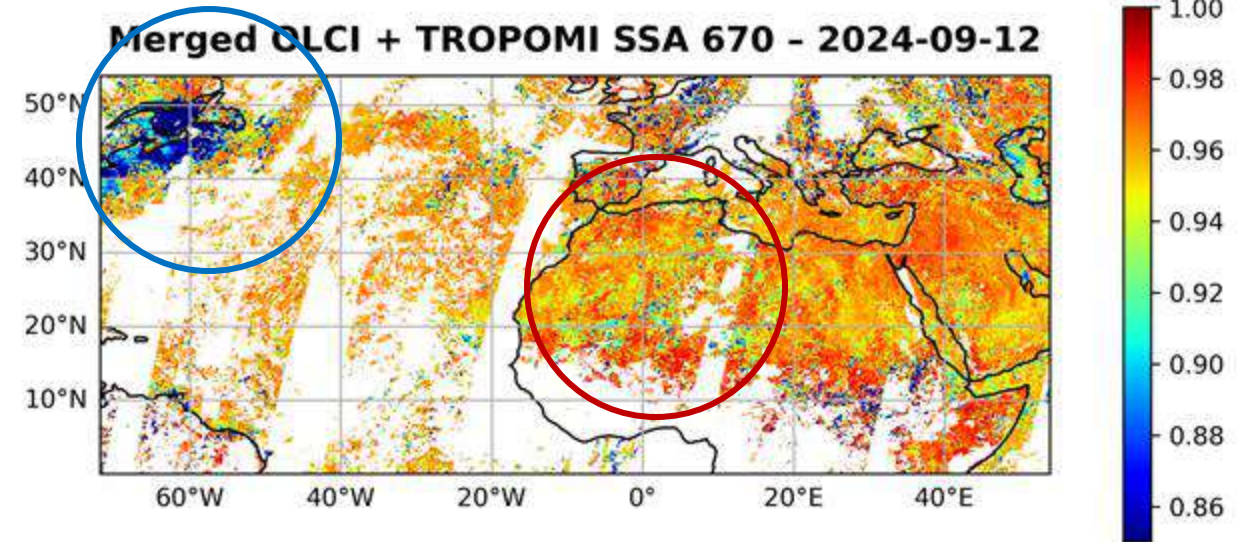
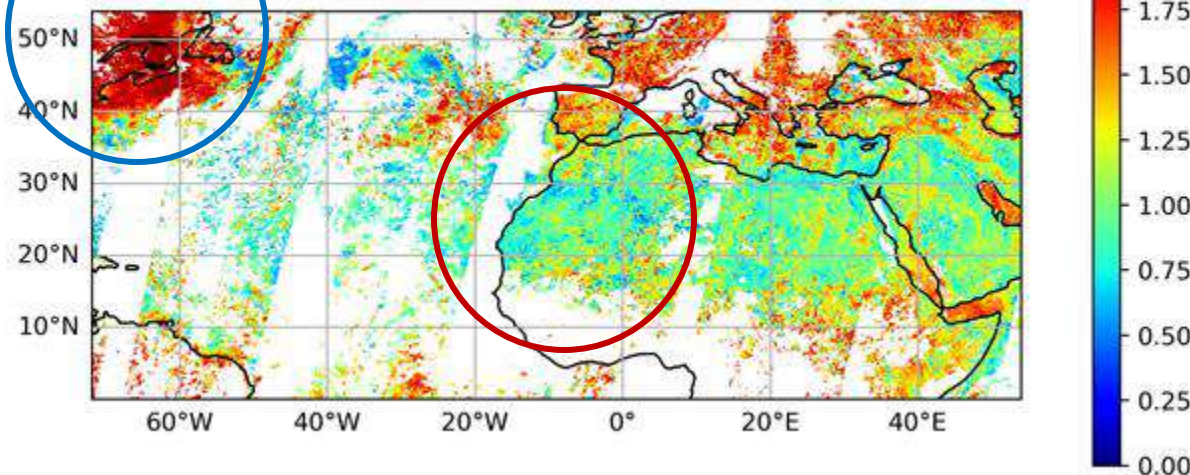
Region	Instruments	Time period	Status
	LEO+LEO: TROPOMI + OLCI-A + OLCI-B	July – September 2021	Done
		August – September 2023	Done
		March, 2021	Done
		June- September 2021, 2022	Done
		May – September, 2018, 2019	Done
	LEO+GEO: TROPOMI + OLCI-A + OLCI-B + AHI	March - May, 2019	Done

Canada Fire Case 12-18 Sep 2024



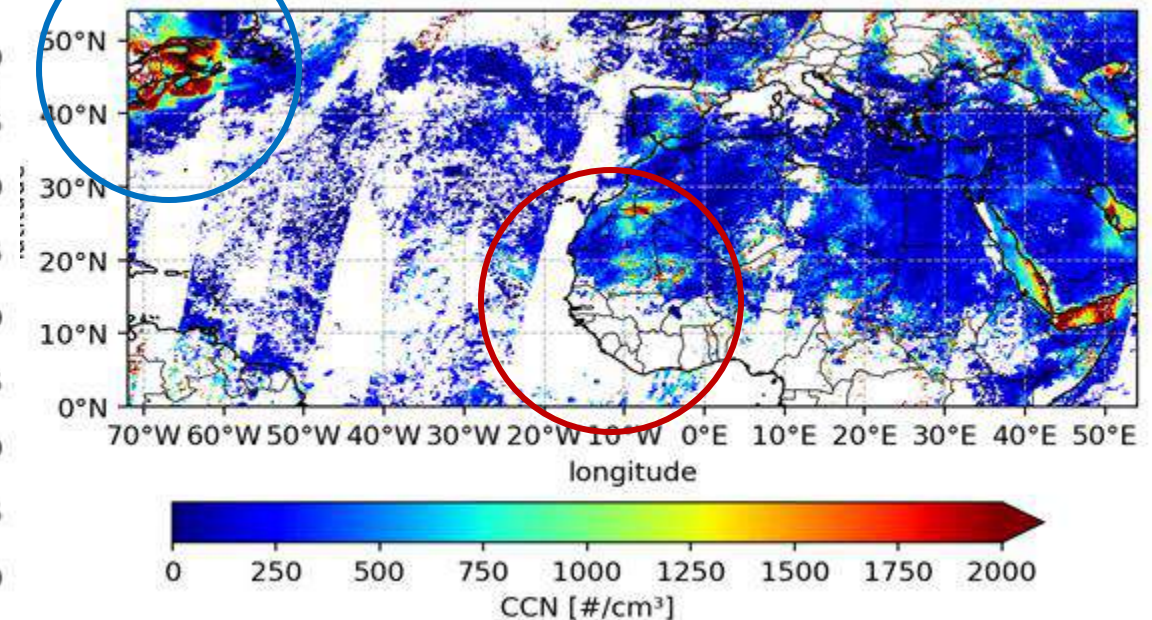
AE

Merged OLCI + TROPOMI Angstrom Exponent 560.0 - 2024-09-12



MERGED (OLCI+TROPOMI) — CCN (BL) 2024-09-12

CCN





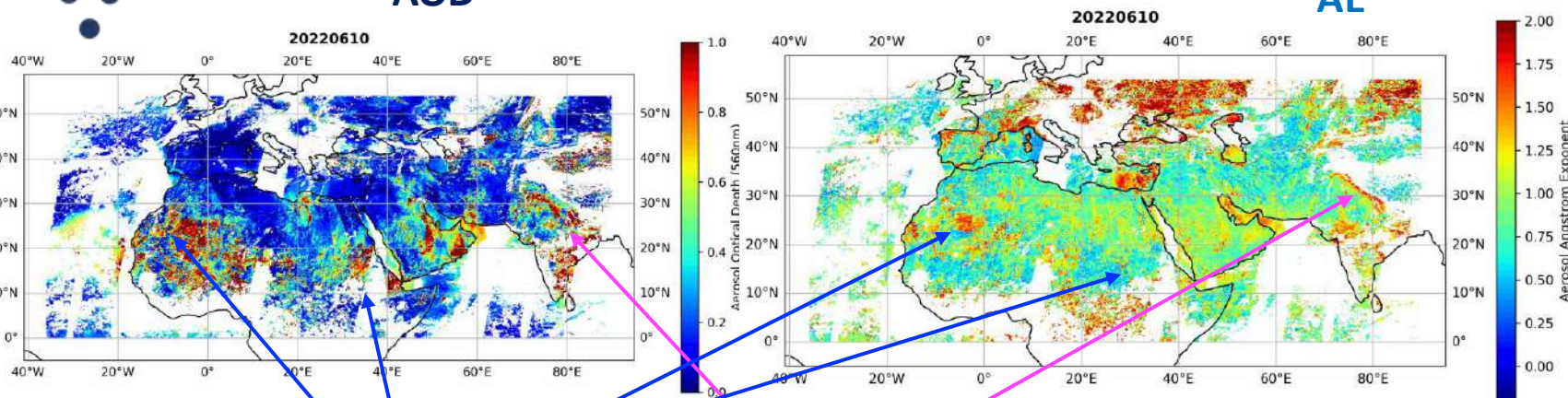
Synergy products: TROPOMI+OLCI-A+OLCI-B

AOD

June 10, 2022

AE

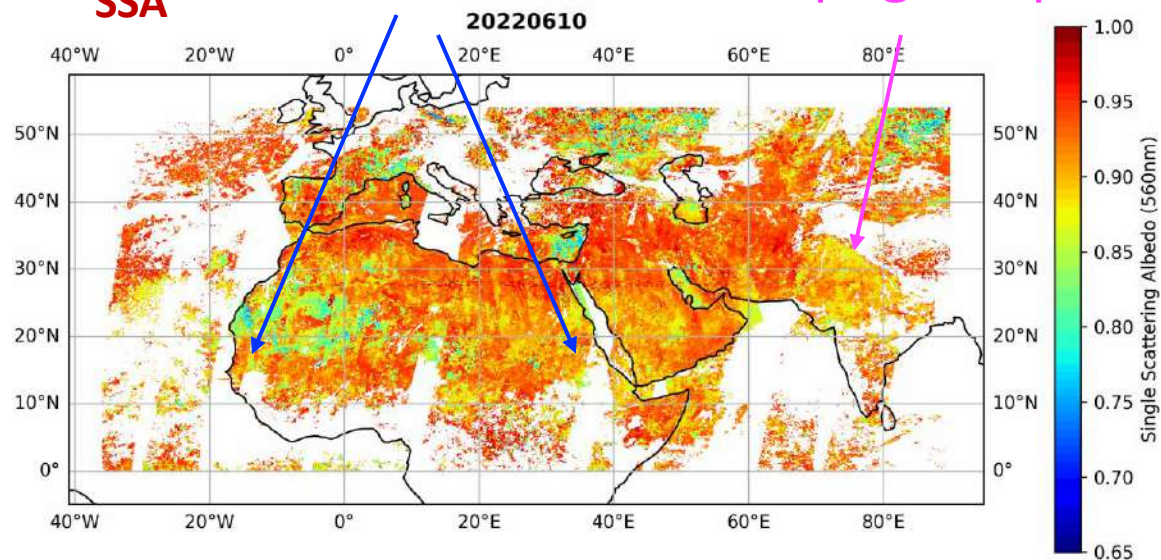
Climatology



Dust

Anthropogenic pollution

SSA

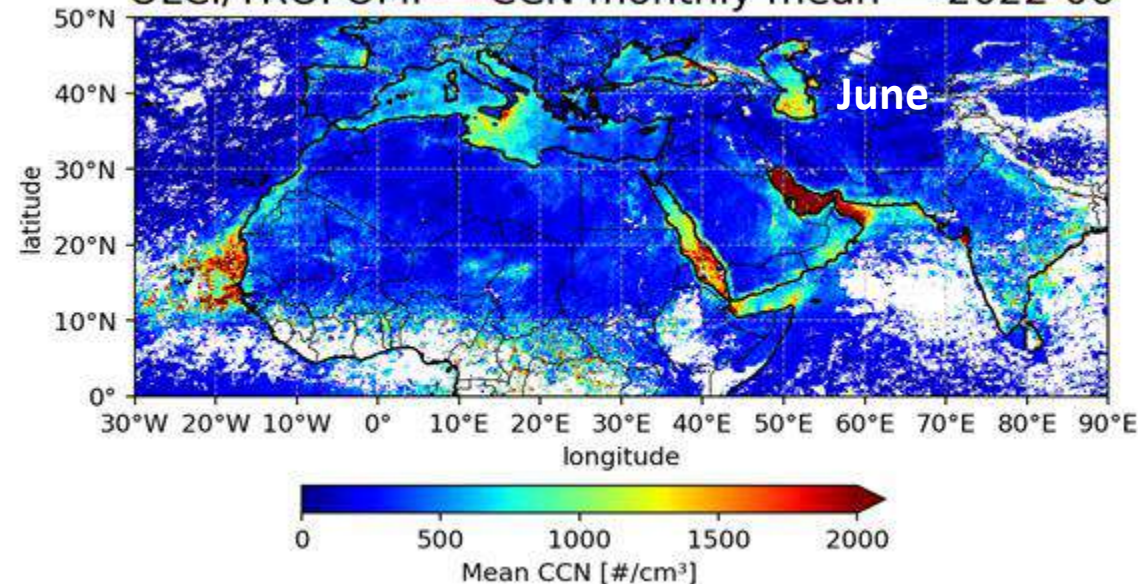


GRASP CCN

June 2022



OLCI/TROPOMI — CCN monthly mean — 2022-06

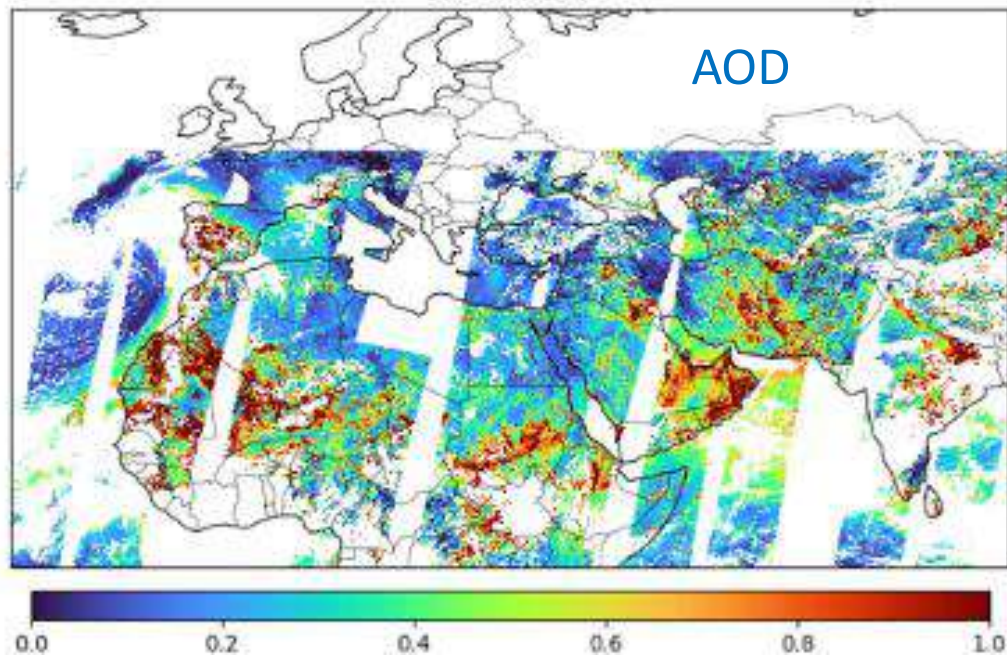


Total AOD at 560 nm
2022-06-15

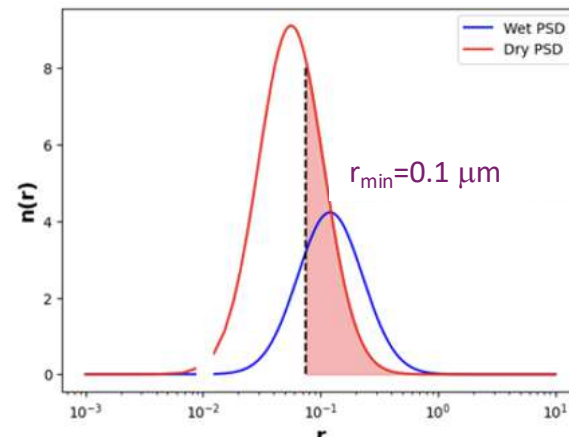
OLCI-A,B + TROPOMI

GRASP

One Day Example, 15 June 2022

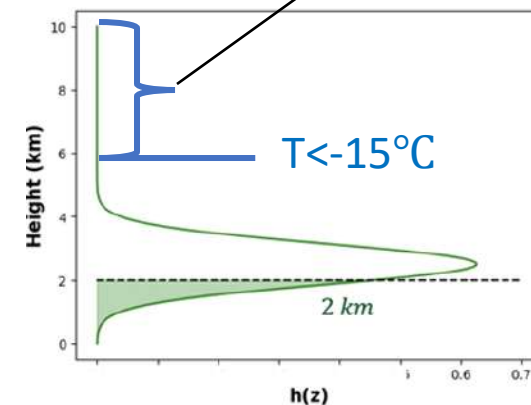


INP – Ice Nucleation
particles

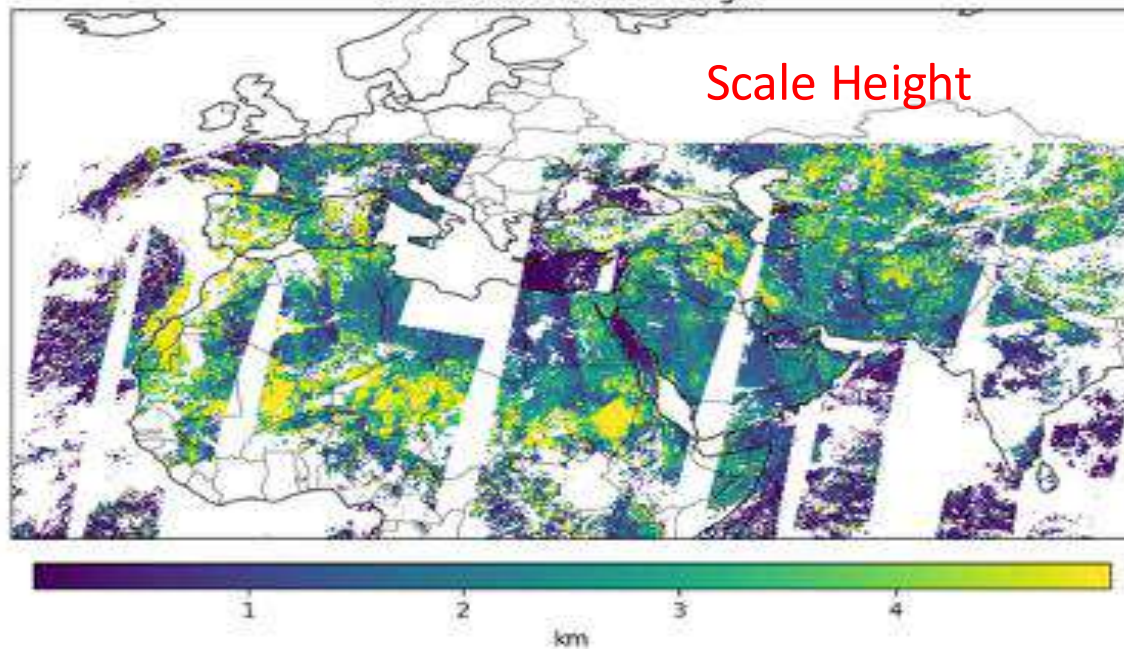


$$INP = A_{\text{dust}} \times f_{\text{freeze}} \times n_s(T)$$

Total particle area

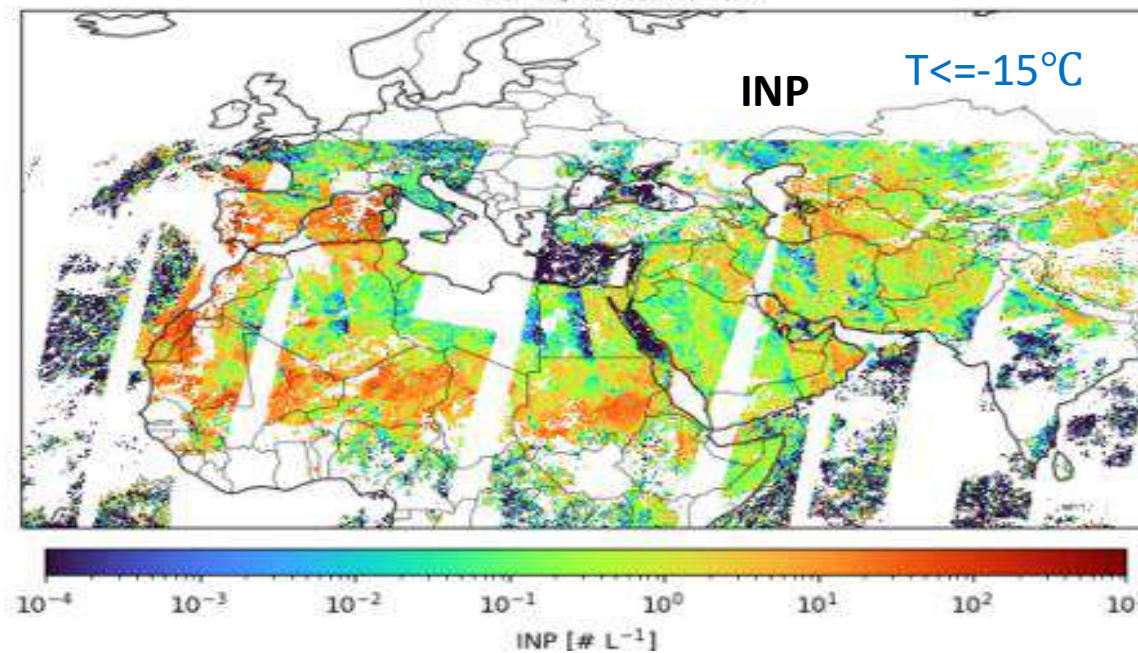


GRASP aerosol scale height



Dust INP using freeze-zone fraction
 $T \leq -15^\circ\text{C}$, 2022-06-15

June 15, 2022





Aerosol Layer Height validation



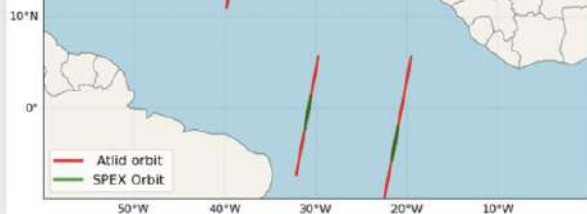
PACE/SPEXone **SRON** SPACE RESEARCH ORGANISATION NETHERLANDS

Collocated events

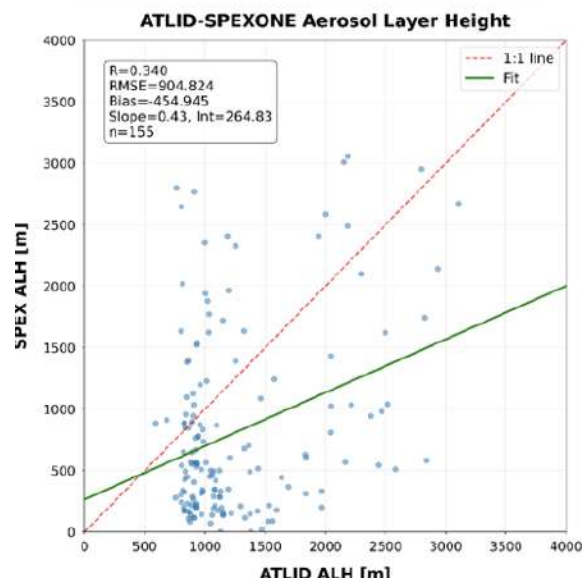
Over ocean - no variable terrain

Collocated events: 7

1. 10/7/2025
2. 12/7/2025
3. 13/7/2025
4. 14/7/2025
5. 17/7/2025
6. 18/7/2025
7. 5/8/2025

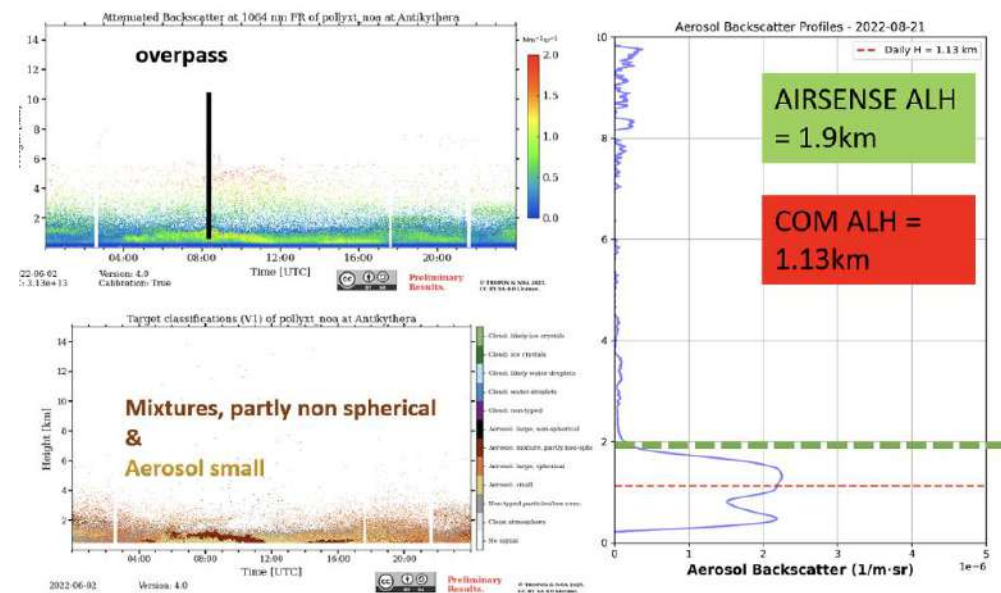
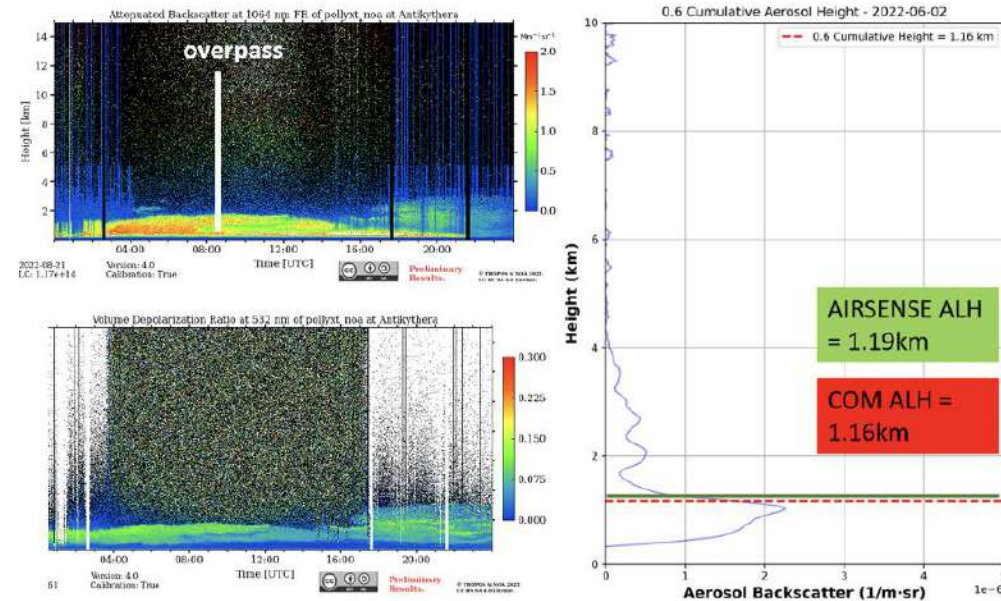


RemoTAP Algorithm



1. First comparison between PACE/SPEXone and EarthCARE/ATLID ALH measurements
2. ALH retrieved from RemoTAP are found lower than altitudes from EarthCARE/ATLID retrievals.
3. FastMAPOL retrieves a larger number of ALH values, but with lower overall agreement compared to EarthCARE /ATLID data.

PANGEA-Antikythera EARLINET GRASP



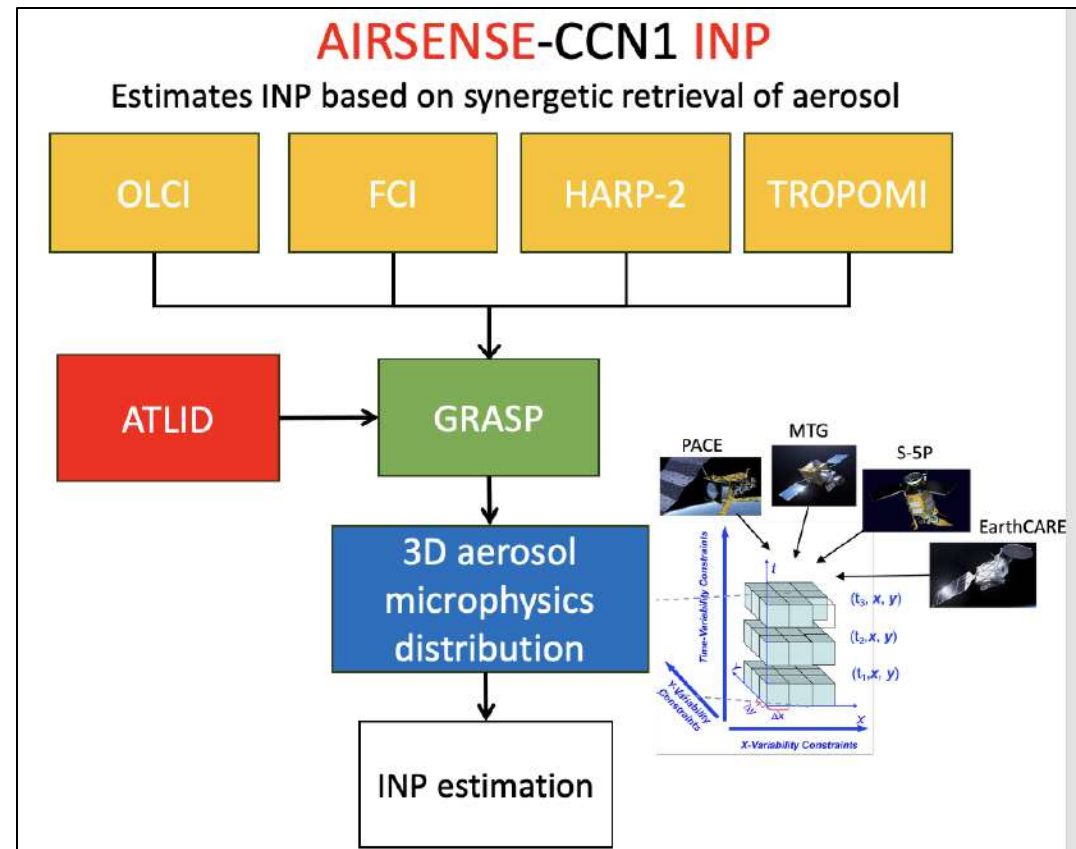
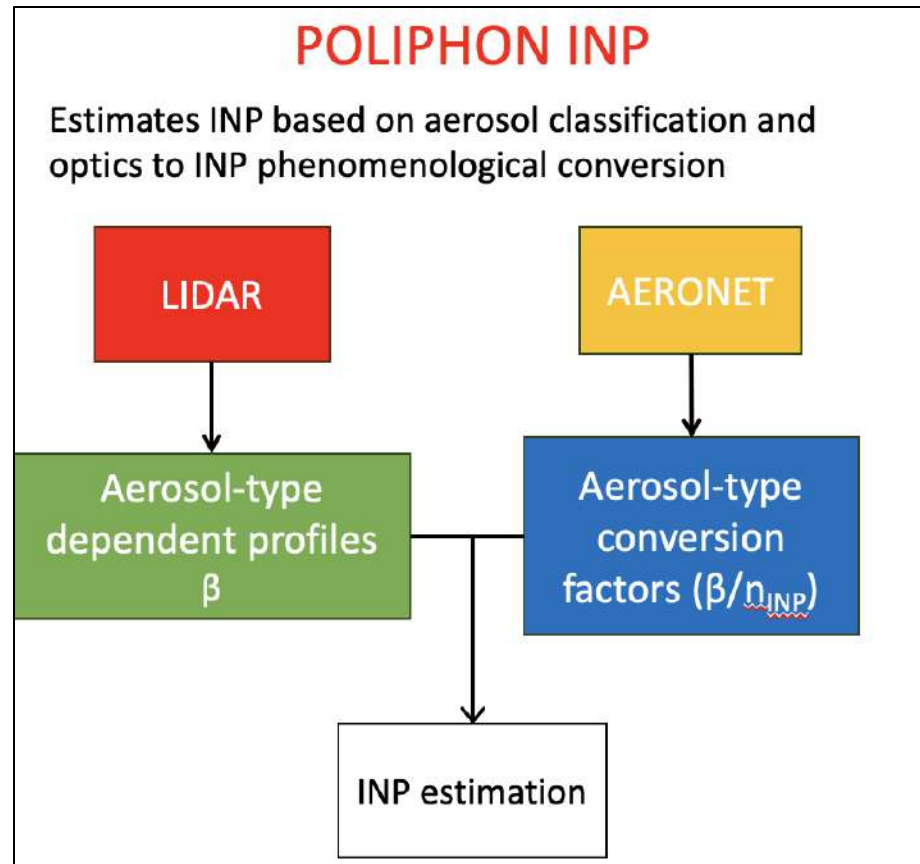
PROSPECTIVE:



Advanced INP from **L1** ATLID and passive imagers

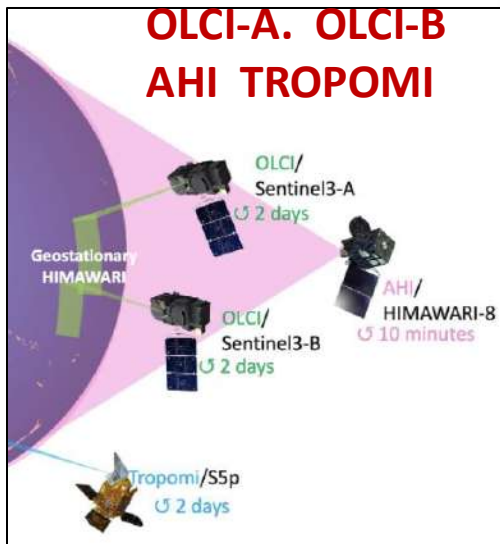
The Objectives: **INP – Global MAPS**

Synergy of EarthCARE with Imagers



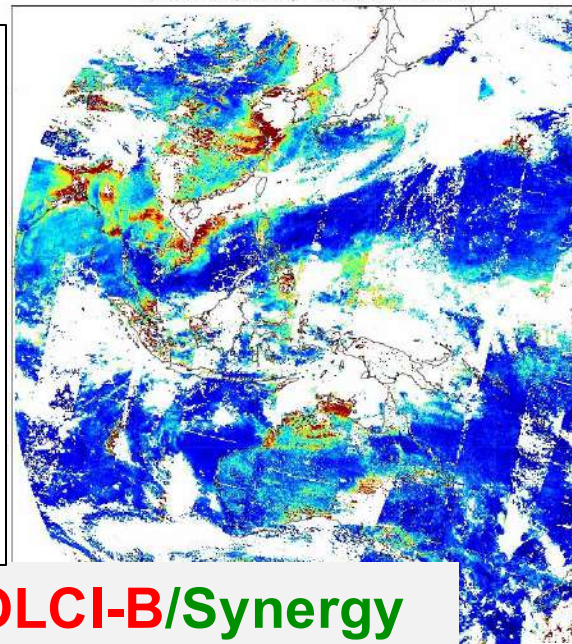
2019-03-11

OLCI - AOD (560nm) - 2019-03-11T00:00:00

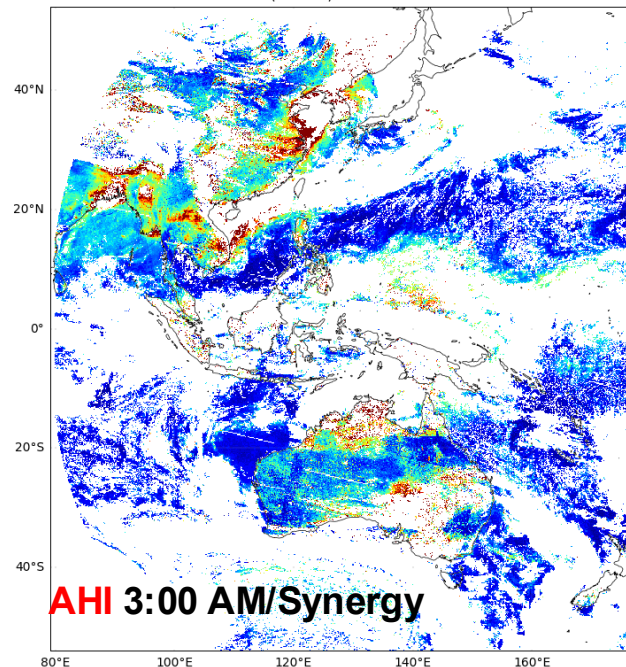


**OLCI-A. OLCI-B
AHI TROPOMI**

OLCI-A + OLCI-B/Synergy

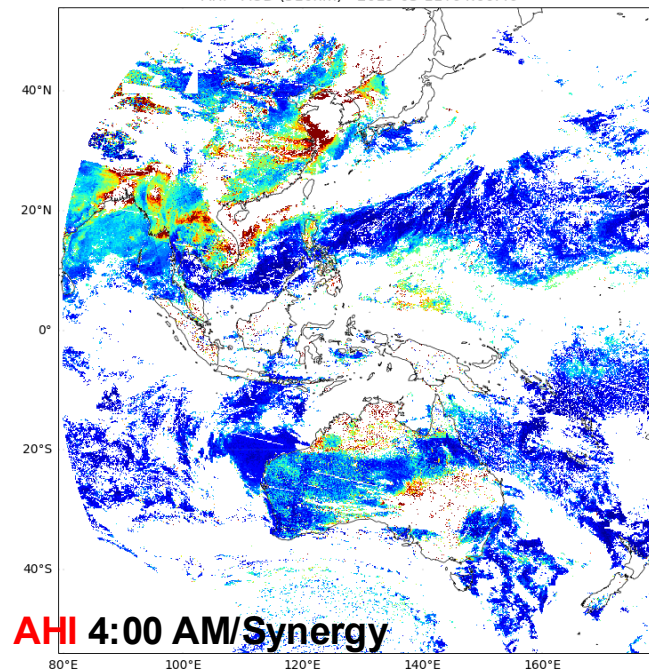


AHI - AOD (510nm) - 2019-03-11T03:00:41



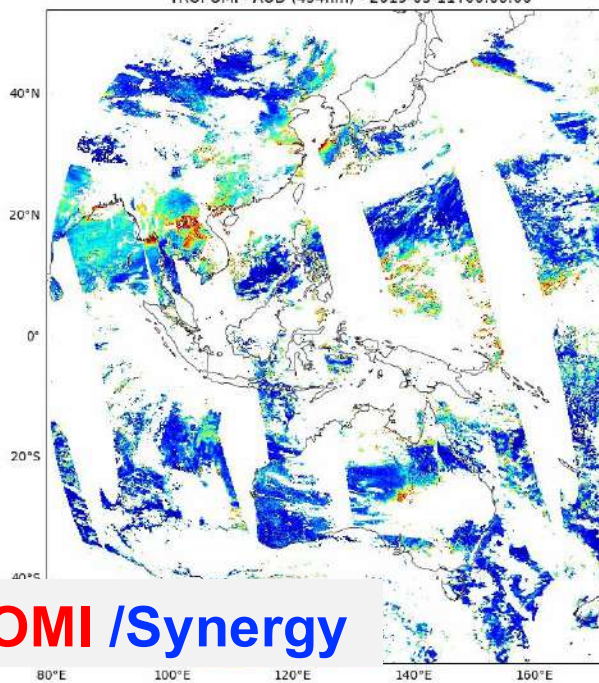
AHI 3:00 AM/Synergy

AHI - AOD (510nm) - 2019-03-11T04:00:40



AHI 4:00 AM/Synergy

TROPOMI - AOD (494nm) - 2019-03-11T00:00:00



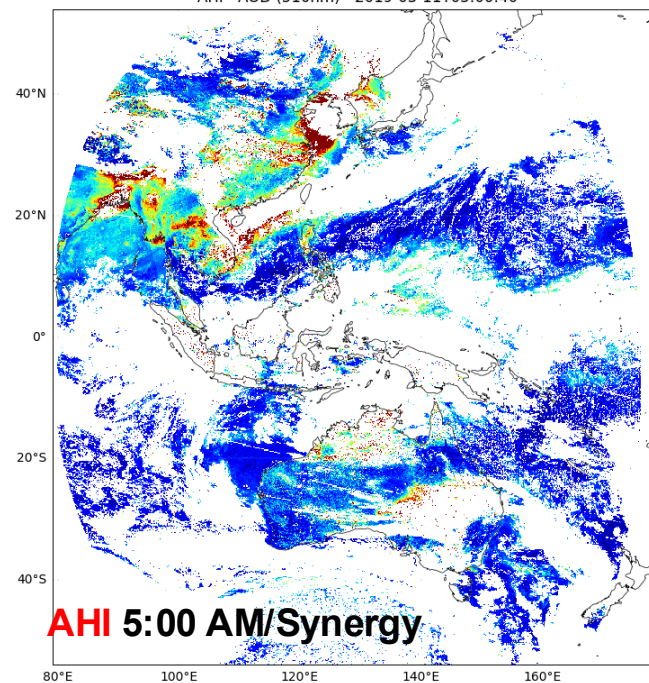
TROPOMI /Synergy

**LEO + GEO
synergy**

**detailed aerosol
diurnal
information**

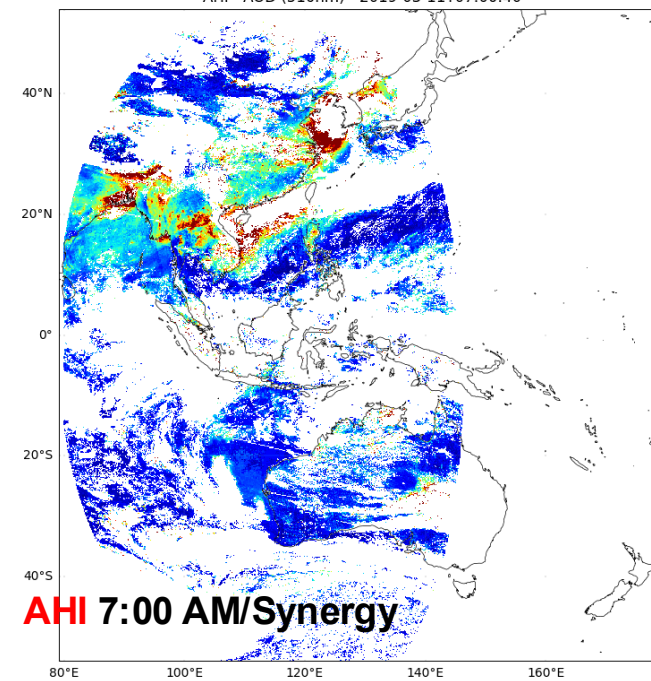
Litvinov et al., 2025

AHI - AOD (510nm) - 2019-03-11T05:00:40



AHI 5:00 AM/Synergy

AHI - AOD (510nm) - 2019-03-11T07:00:40



AHI 7:00 AM/Synergy

Conclusions and perspectives:



- ACTIVE obs.:** - ATLID provides **reliable vertically resolved CCN** and **INP** *with some dependence on climatological assumptions*;
- PASSIVE obs.:** - Novel passive MAP satellite observations provide more details about aerosol properties: particle **size**, **aerosol type**, **layer height**, etc.
- SYNERGY:** - Synergy processing of passive observations from multiple LEO and GEO platforms helps to get **more detailed** and accurate information **with better temporal and spatial coverage**;
- SYNERGY perspective:** - Synergy of **passive** observations from **multiple LEO and GEO platforms** **with ATLID** should provide vertically resolve extensive **CCN** and **INP** data

The banner is split into two panels. The left panel has a dark space background with purple and blue light streaks. The right panel features a white satellite with a long antenna, a stylized white dragon with orange flames, and several hexagonal panels displaying colorful satellite data maps. The text is overlaid on the left panel.

EarthCARE 2026

Science and Validation workshop

8–12 June 2026 | Rhodes House | Oxford, UK

THANK YOU FOR THE ATTENTION !

