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Atmospheric Remote Sensing

Doina Nicolae, INOE

ACTRIS, THE GROUND-TRUTH FOR AEROSOLS, CLOUDS AND TRACE GASES

Reasons for ACTRIS

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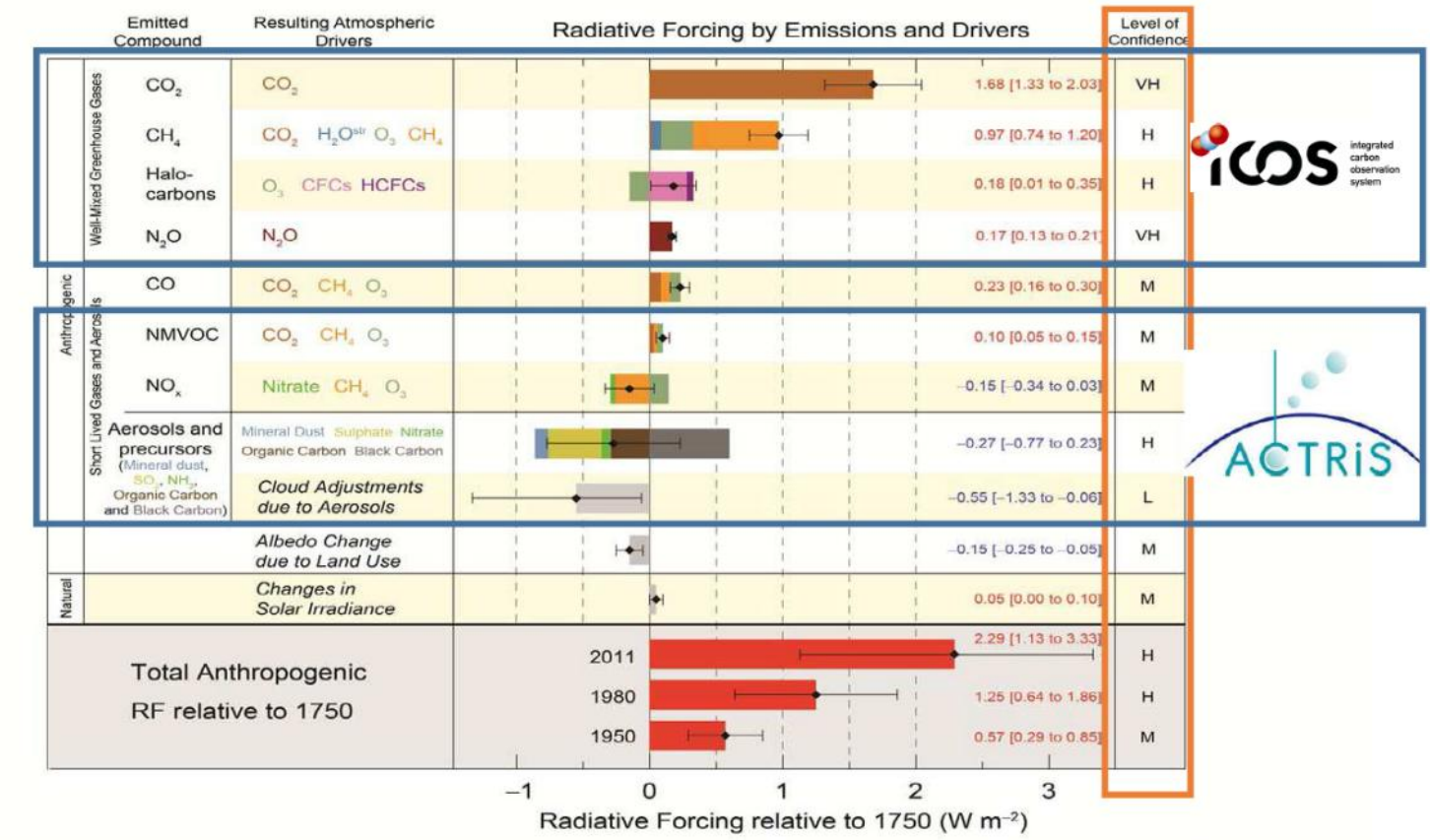

IPCC, 2013

How ACTRIS emerged

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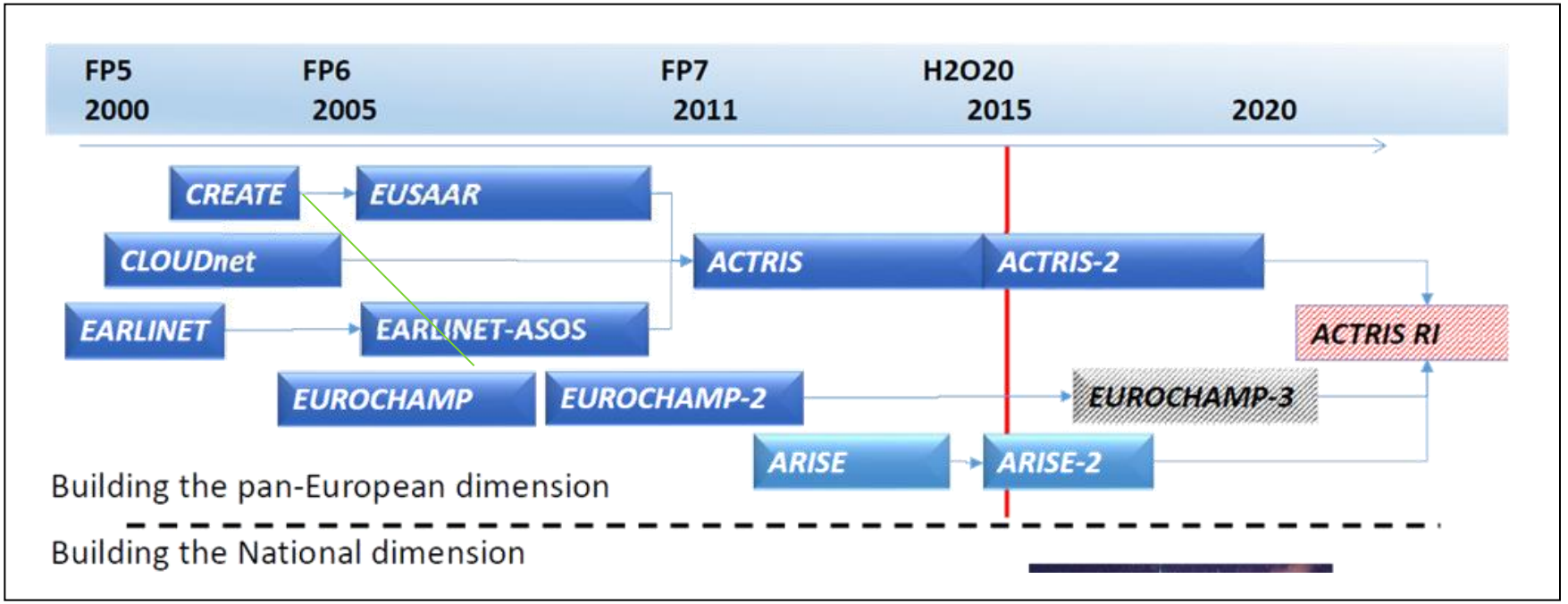
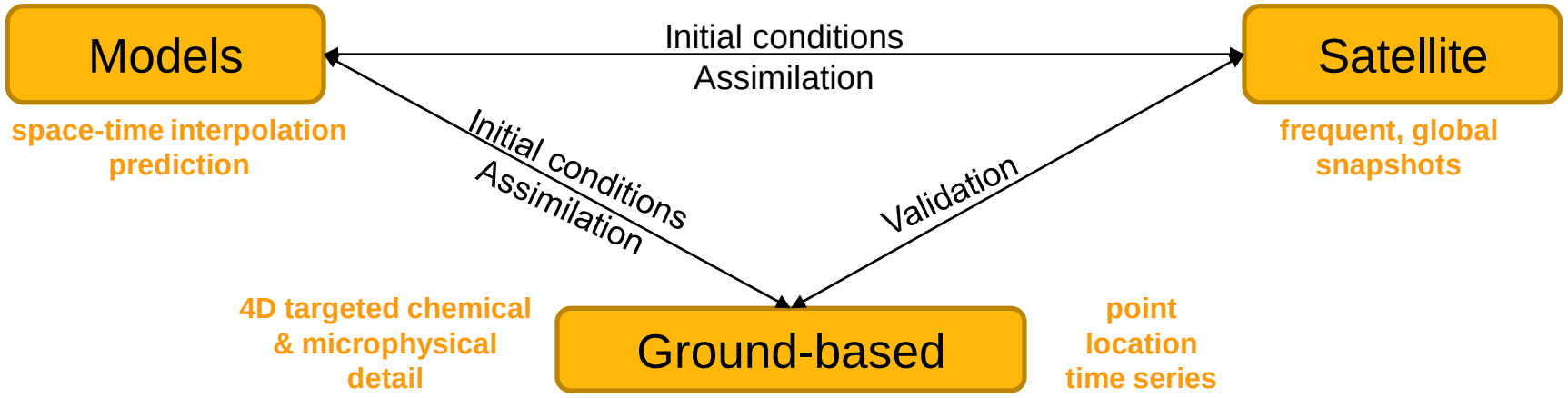


Single instrument → network → network of networks → research infrastructure

↓

Low physical content variables → high physical content variables

ACTRIS role



ACTRIS

EARLINET
- aerosol profiles (troposphere)

AERONET-EU
- aerosol column

CLOUDNET
- cloud profiles (troposphere)

EUSAAR
- near surface aerosol & trace gases

PANDONIA
- trace gases column

ICOS
- carbon fluxes

TCCON
- column-averaged CO_2, CH_4, N_2O, HF, CO, H_2O, and HDO

NDACC
- aerosol, clouds, trace gases, greenhouse gases (stratosphere)

ACTRIS offer

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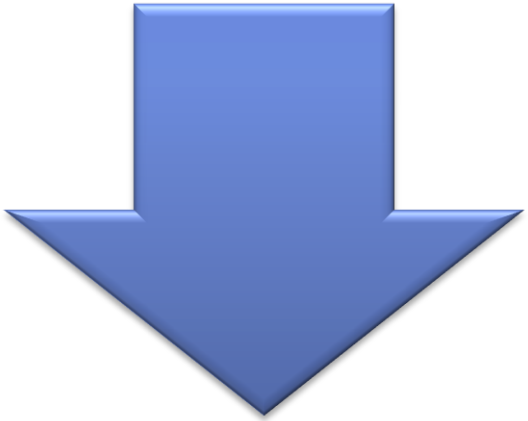
ACTRiS

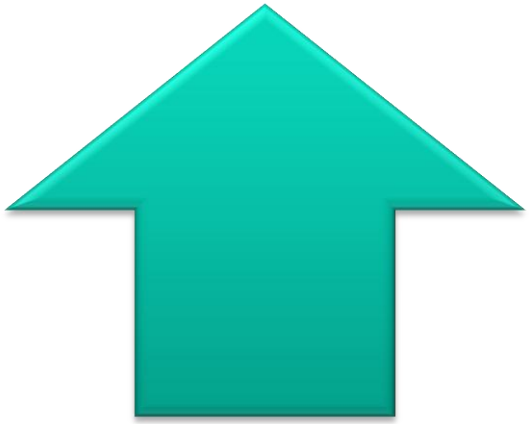


Technology

- Calibration
- Optimization
- Standardization
- Innovation

Science

- Observations
- Data synergy
- Verification/validation
- Trends



ACTRIS observation map

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ACTRIS data portal

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- Aerosol profiles: backscatter, extinction & linear particle depolarization
- Aerosol column: AOD, Angstrom exponent, size distribution, refractive index, …
- Aerosol near-surface: PM1 (+ non-refractory), PM2.5, PM10 (+ non-volatile), absorption coeff., scattering coeff., elemental carbon, …
- Clouds
- Near-surface trace gases: NO, NO2, NH4, …

ACTRIS variables

- **http://actris.nilu.no/**

- **ACTRIS Data Management Plan**

http://actris.nilu.no/

ACTRIS ADDED-VALUE DATA PRODUCTS

NRT data

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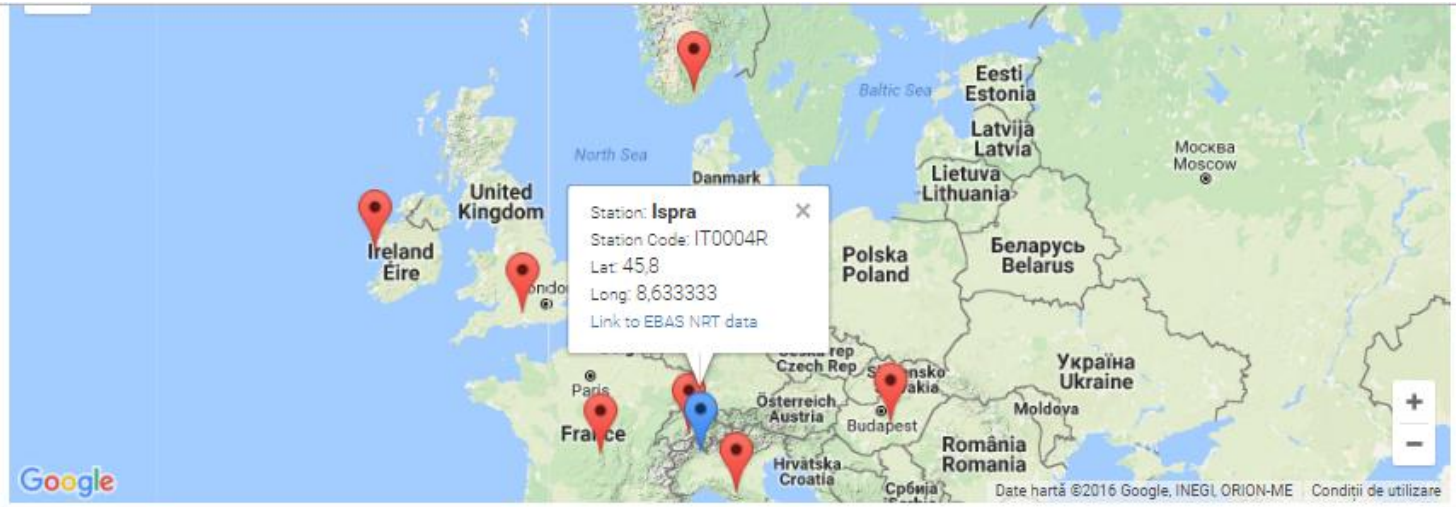

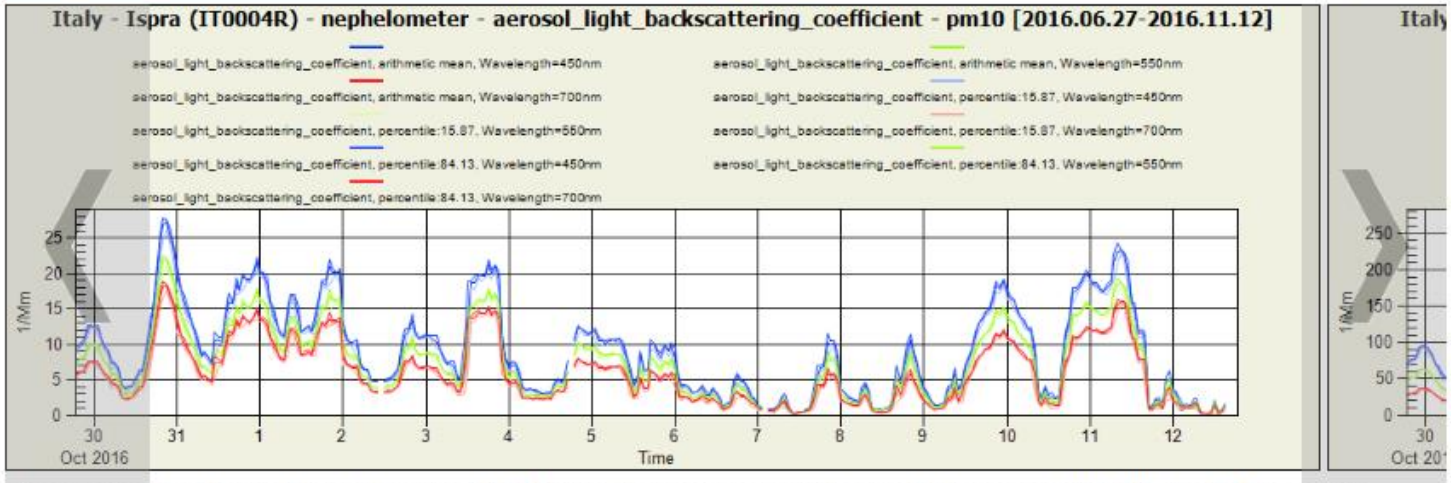

This service has been funded or supported by the Norwegian Institute for Air Research (NILU), the EU research infrastructure ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure), the European Monitoring and Evaluation Programme (EMEP), and the WMO Global Atmosphere Watch (GAW) programme.

NRT data

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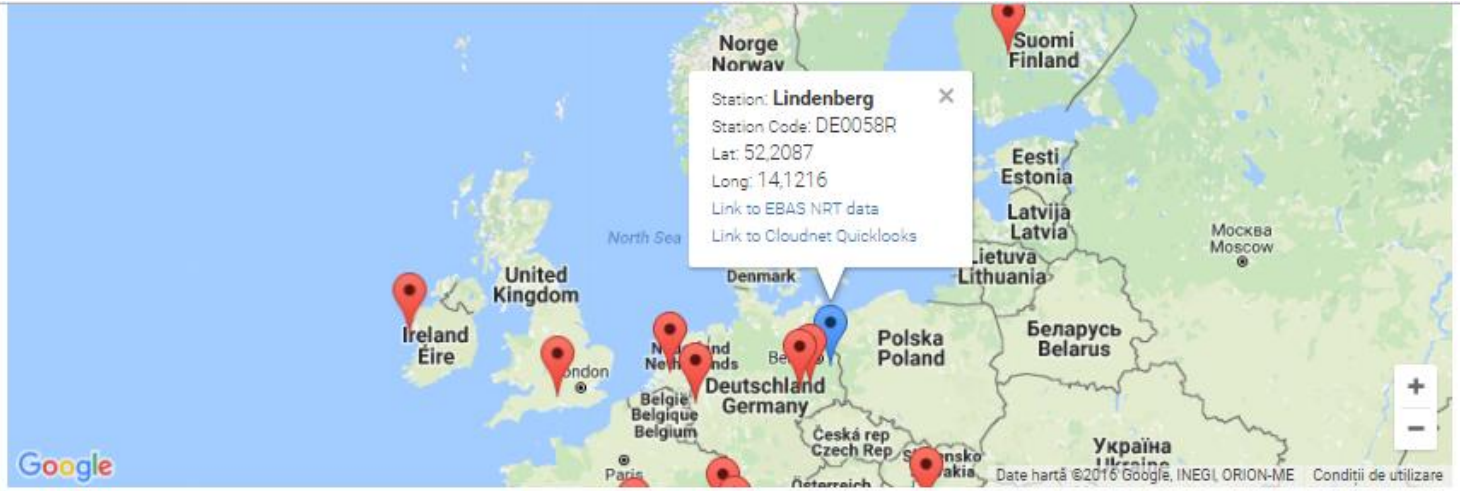

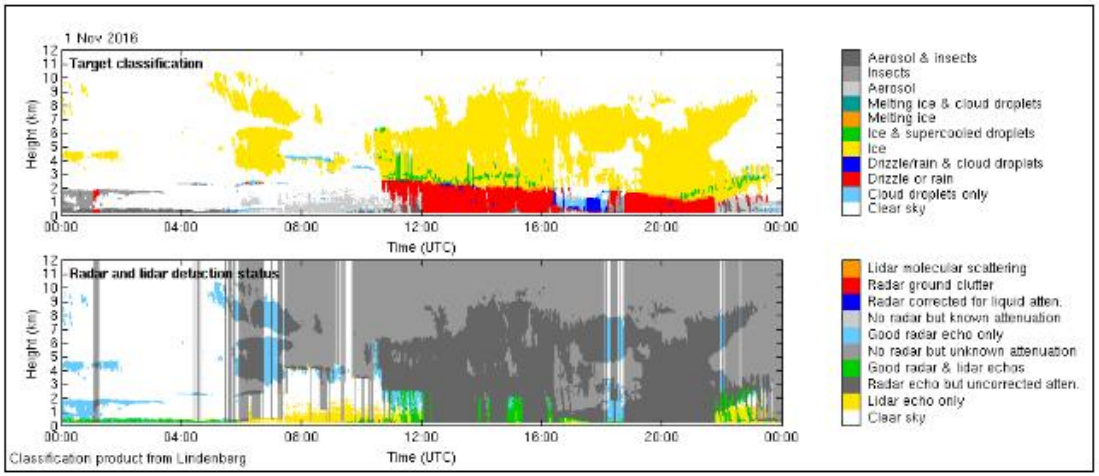

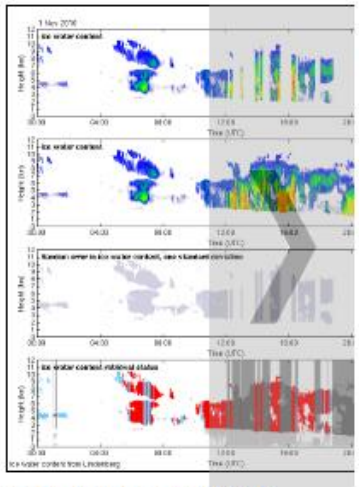

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Model validation

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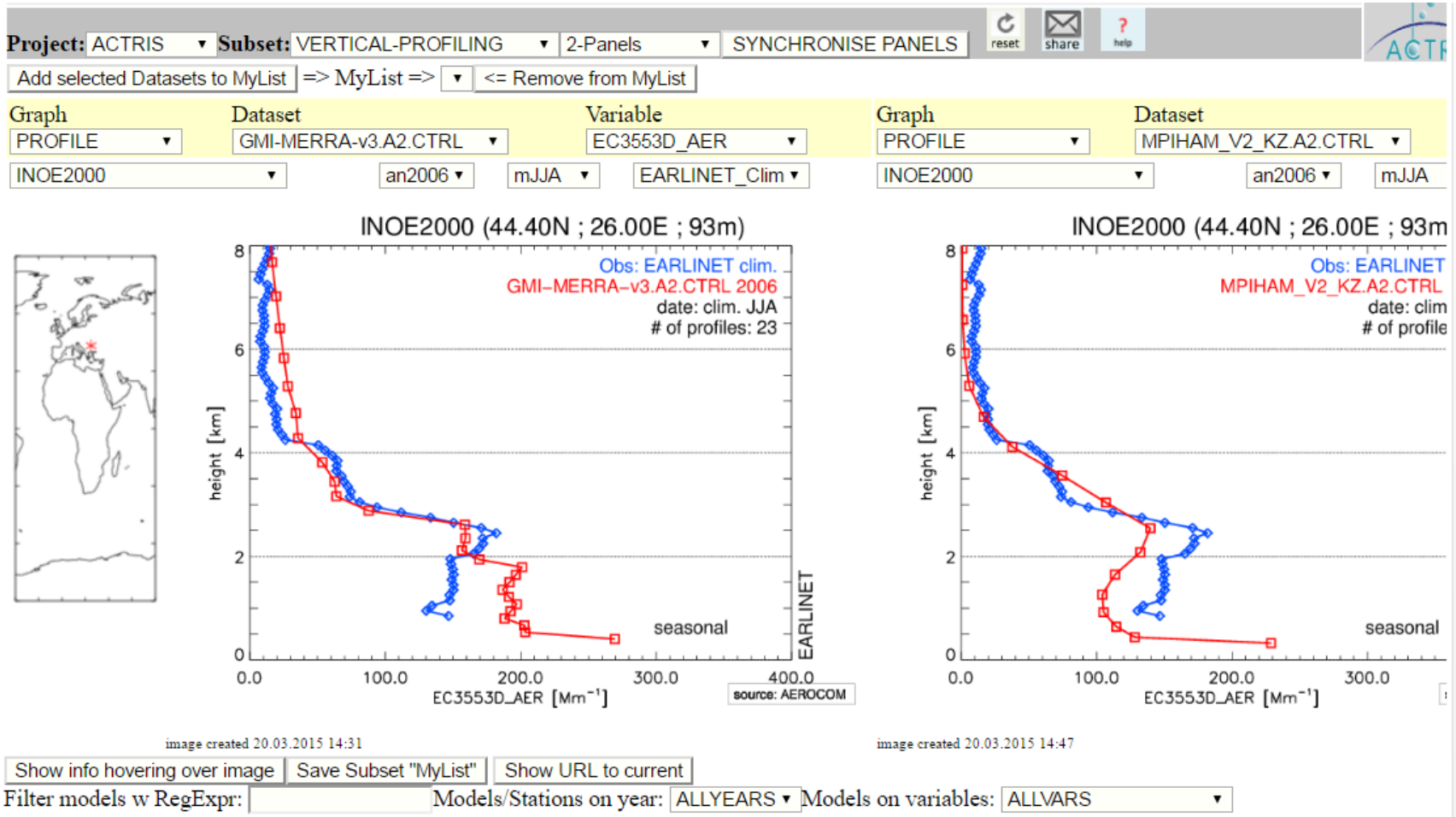
AEROCOM // Michael Schulz , Jan Griesfeller



Trends: AOD

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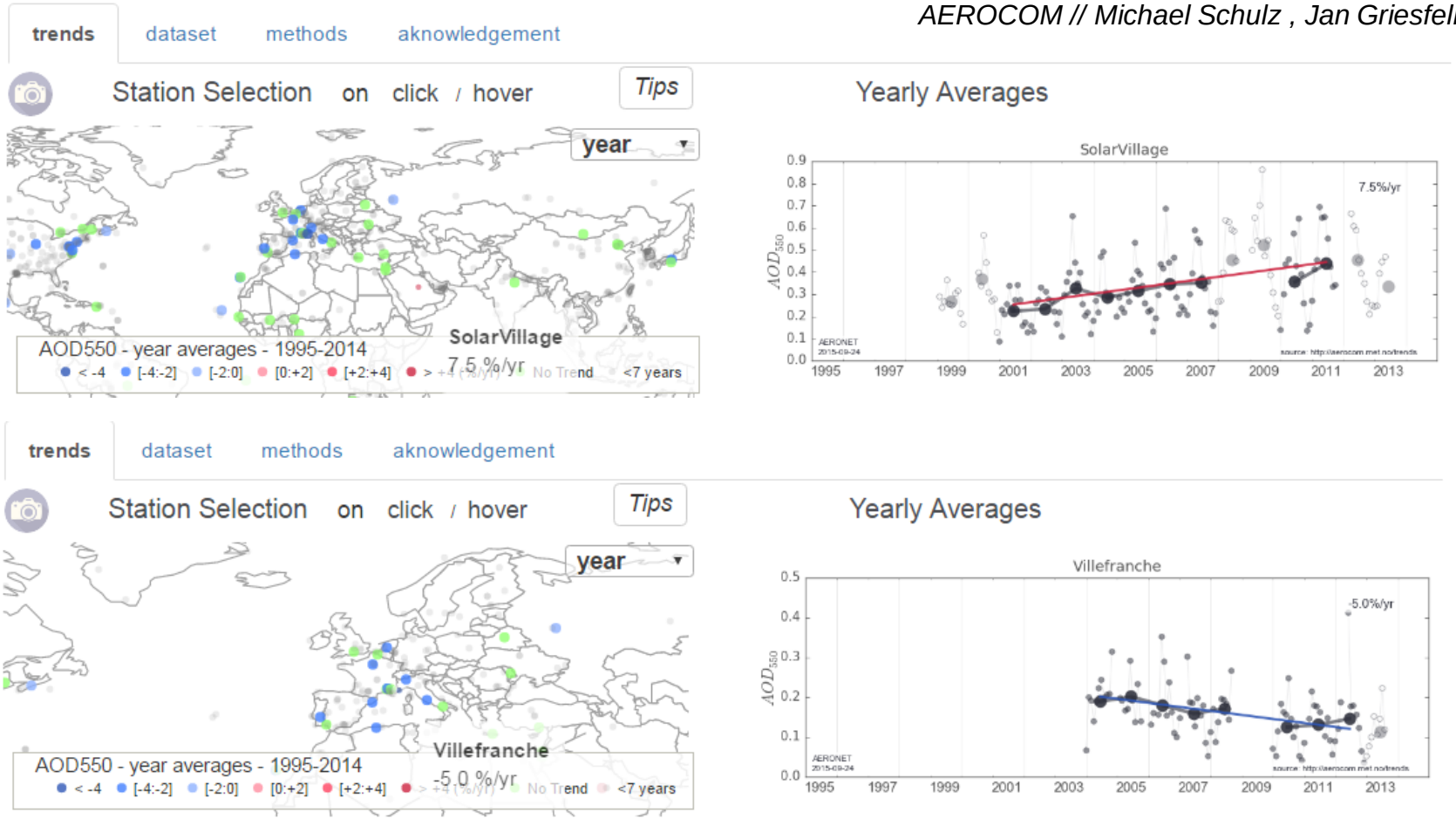
ACTRiS

AEROCOM // Michael Schulz , Jan Griesfeller



Trends: surface SO_2

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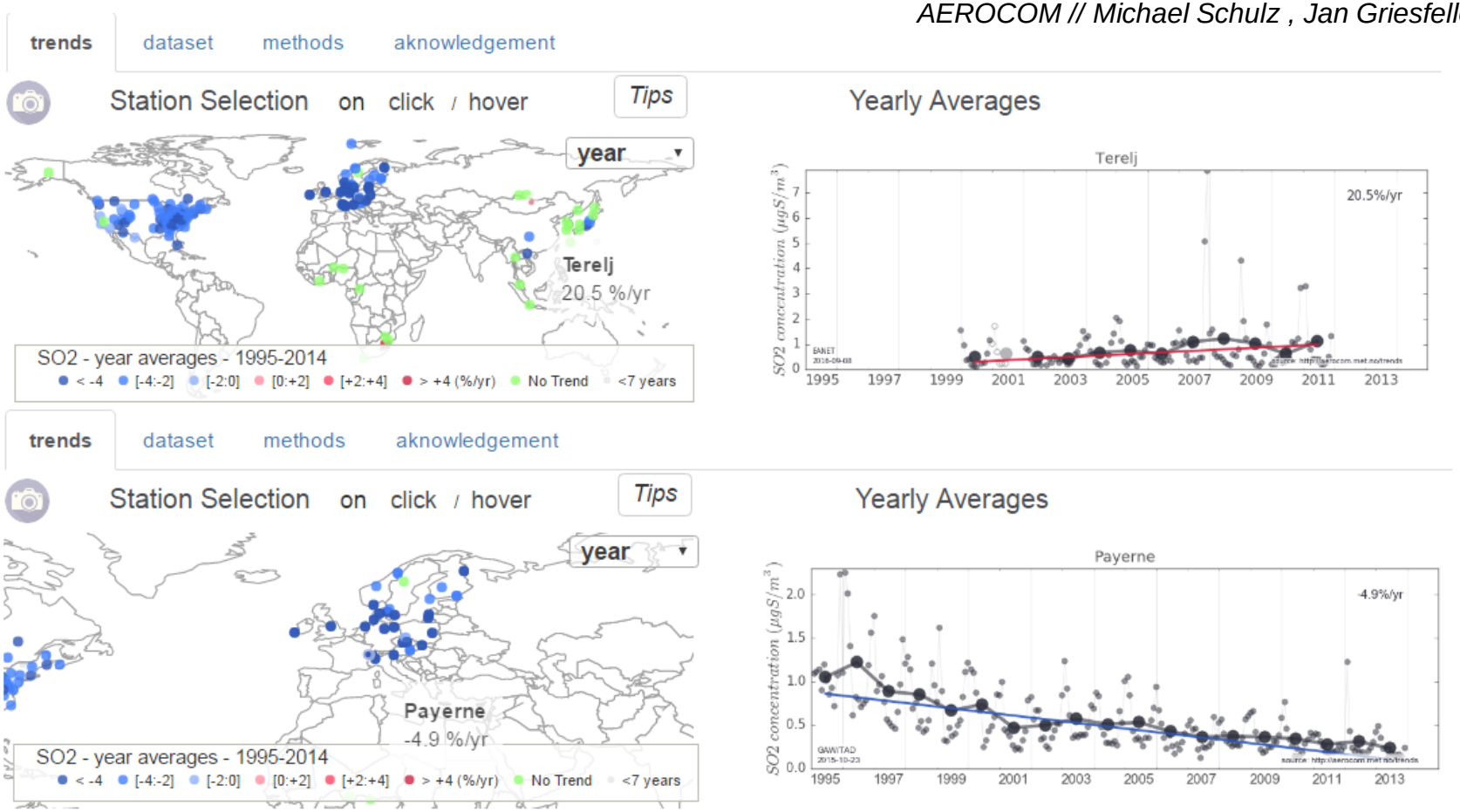
AEROCOM // Michael Schulz , Jan Griesfeller



An example: lidar

WHAT CAN YOU DO FURTHER WITH ACTRIS DATA

… E.g. look into aerosol properties

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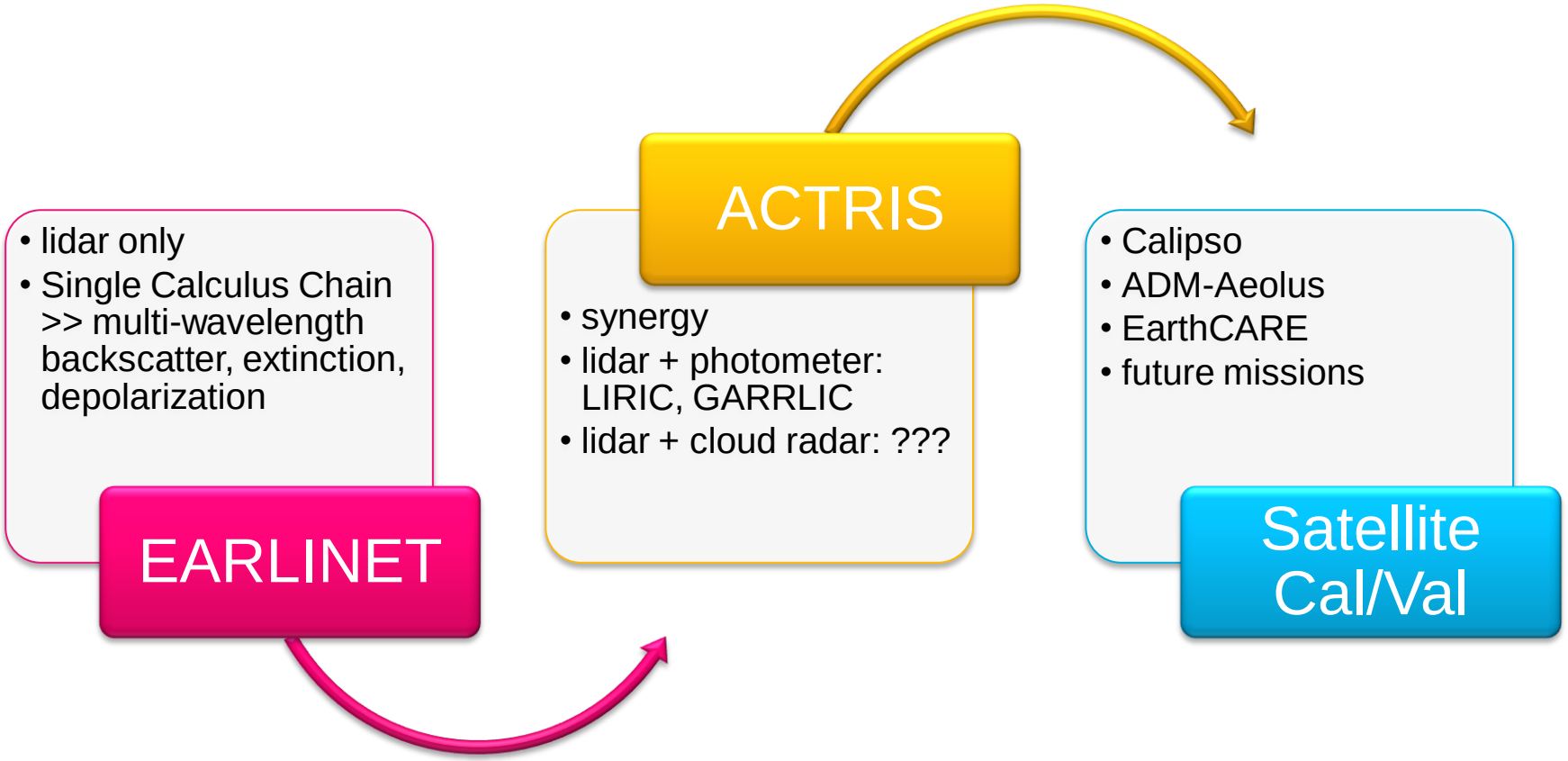

General procedure

- Identification of layers = high SNR
- Calculation of layer-averaged intensive optical parameters (AE, LRs, LPDR, ...)
  - Fine particles / coarse particles
  - Absorbing / non-absorbing
  - Spherical / non-spherical
- Potential source (backtrajectory)
- MODIS fire maps / DREAM model
- Guess of the type
  - General class
  - Mixtures not possible
- If spherical: microphysical inversion
- If smoke & deposited to ground: AMS
- If not spherical: POLIPHON

S. Samaras, D. Nicolae, C. Bockmann, J. Vasilescu, I. Binietoglou, L. Labzovskii, F. Ţoancă, A. Papayannis, Using Raman-lidar-based regularized microphysical retrievals and Aerosol Mass Spectrometer measurements for the characterization of biomass burning aerosols, *J COMPUT PHYS*, vol. 299, pp. 156-174, 10.1016/j.jcp.2015.06.045, 2015

Example

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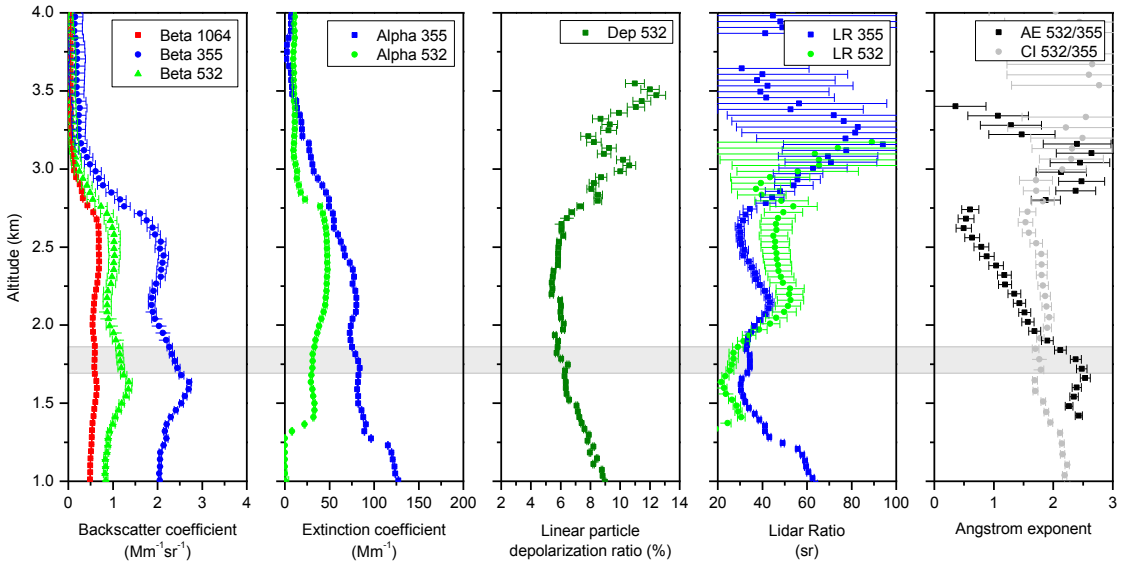
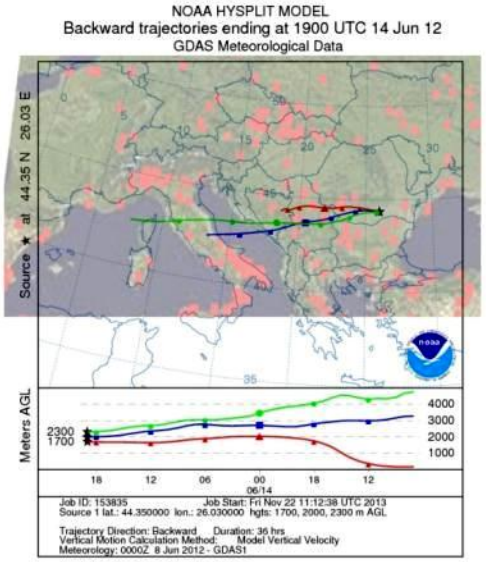
Lidar optical profiles and source

14/06/2012

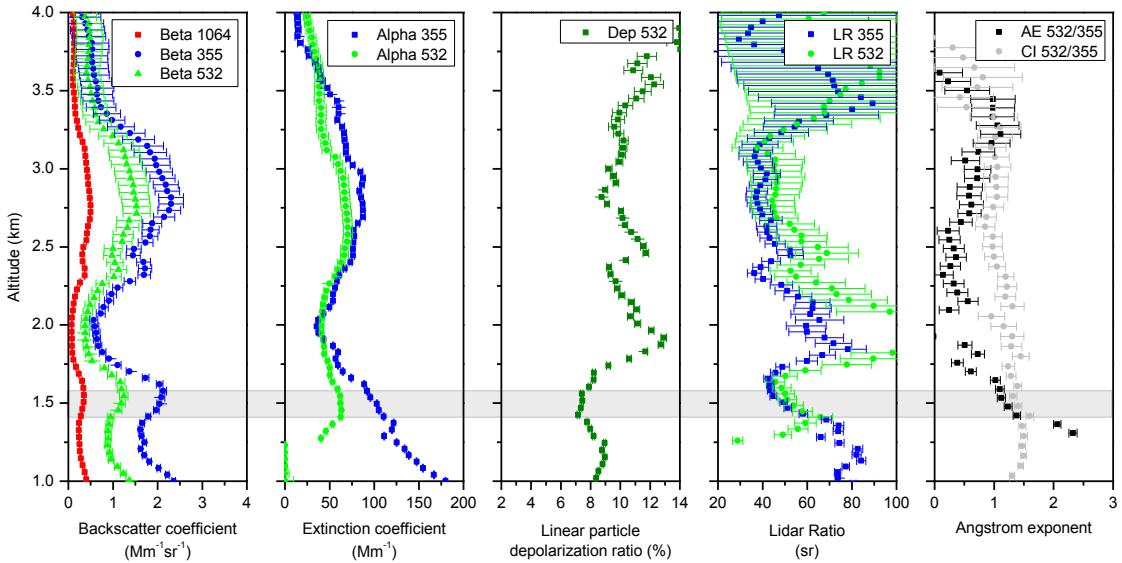


1.5 – 1.7 km trajectory collecting BBA from SW Romania & Serbia

Expectation: relatively fresh BBA

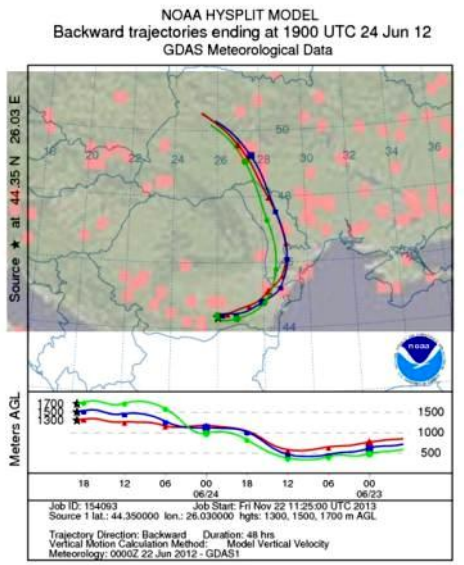


24/06/2012



1.3 – 1.7 km trajectory collecting BBA from Moldova &Ukraine

Expectation: relatively aged BBA



Example

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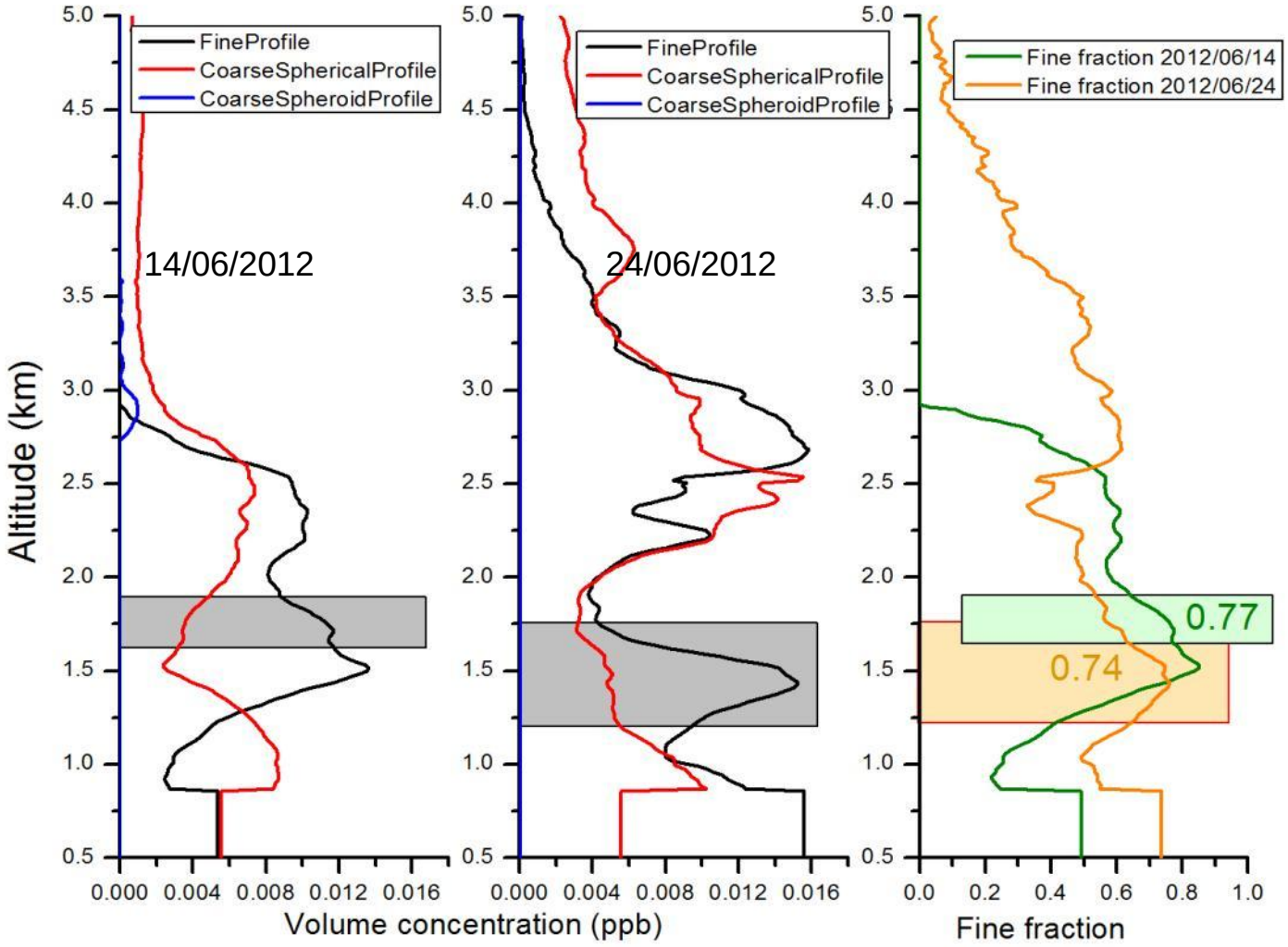
LIRIC profiles



Example

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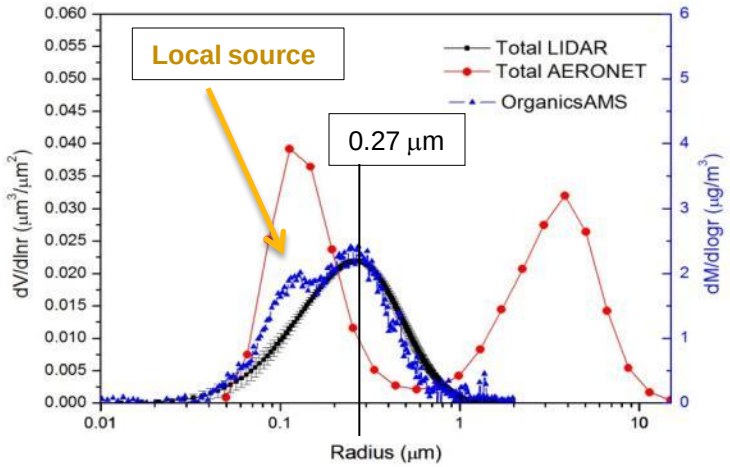
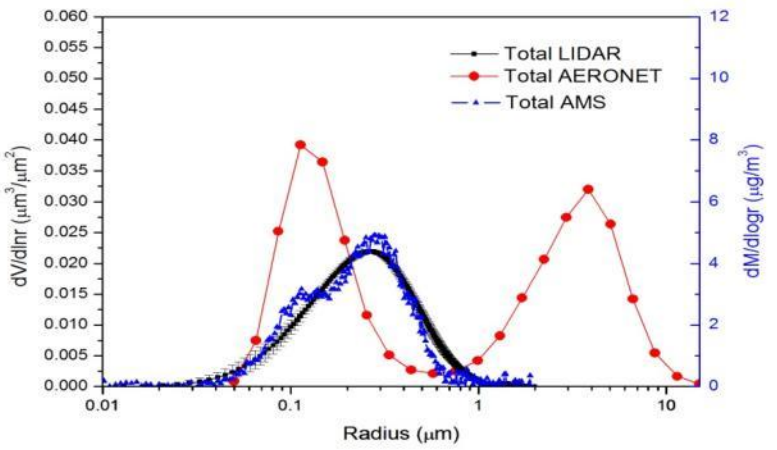
ACTRiS

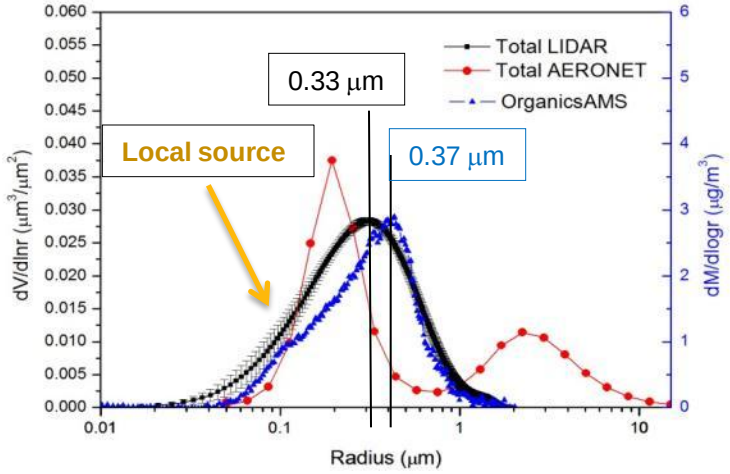
Size distribution: ground*, layer, column

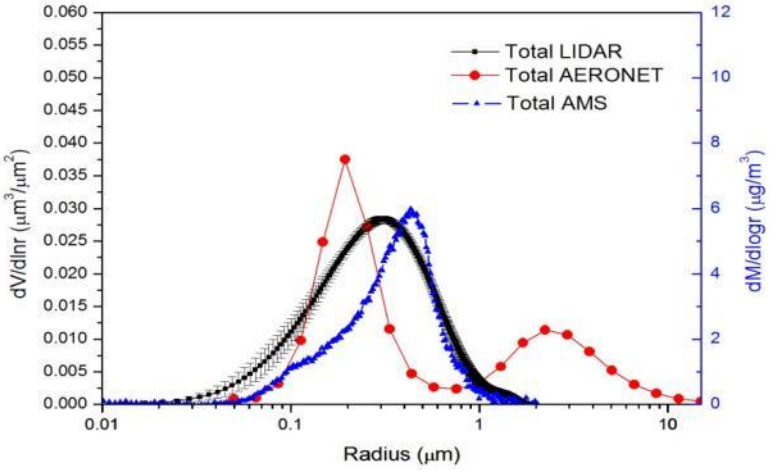
14/06/2012
SW Romania, Serbia





24/06/2012
Moldova, Ukraine





* Aerodynamic diameter to geometric diameter: *DeCarlo P. et al., Particle Morphology and Density characterization by Combined Mobility and Aerodynamic Diameter Measurements. Part 1: Theory, Aerosol Science and Technology, 38:1185–1205, 2004.*

… How about the aerosol type?

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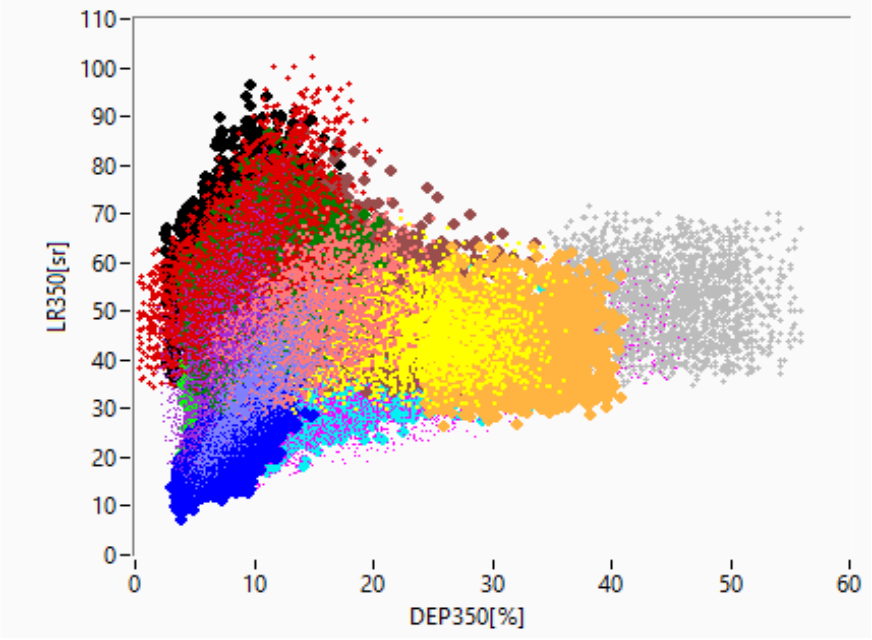
ACTRiS

Model

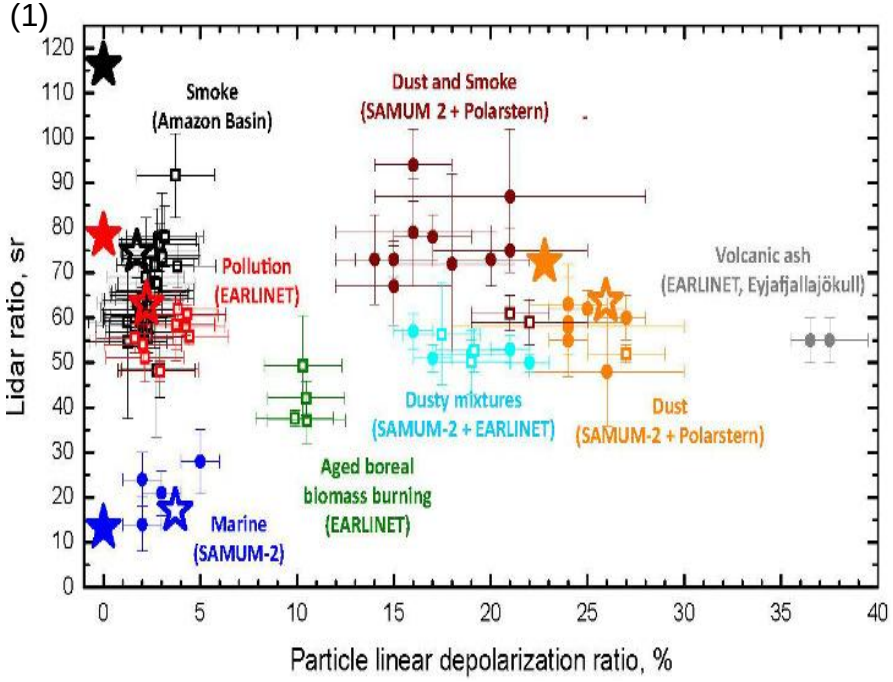


NATALI model
Colors adjusted for comparison with measurements at right

Note: Holger Baars' typing
- RCS files >>> high res. (spatial)
- Features, not types

Observations and simulations at 355 nm

(1)



Observations:
LMU (dots), TROPOS (open square)
Aerosol_cci model (filled stars)
Variations with different refractive index and shape distribution (open stars)

(1) U. Wandinger et al, "HETEAC: The Aerosol Classification Model for EarthCARE", EPJ Web of Conferences 119, 01004 (2016), DOI:10.1051/epjconf/201611901004

Proposed types: source + transport

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Aerosol type	High Resolution	Low resolution
Continental	Continental	Continental
Dust	Dust	Dust
ContinentalPolluted	Continental Polluted	Continental Polluted
Marine	Marine	Marine
Smoke	Smoke	Smoke
Volcanic	Volcanic	Volcanic
Continental + Dust	ContinentalDust	Continental / Dust
Dust + Marine Volcanic + Marine	MarineMineral	Dust / Marine
Continental + Smoke	ContinentalSmoke	Continental/ContinentalPolluted / Smoke
Dust + Smoke	DustPolluted	Dust / Smoke
Continental + Marine	Coastal	Continental / Marine
ContinentalPolluted + Marine	CoastalPolluted	ContinentalPolluted / Marine
Continental + Dust + Marine	MixedDust	Continental /Dust / Marine
Continental + Smoke +Marine	MixedSmoke	ContinentalPolluted / Smoke

NATALI algorithm

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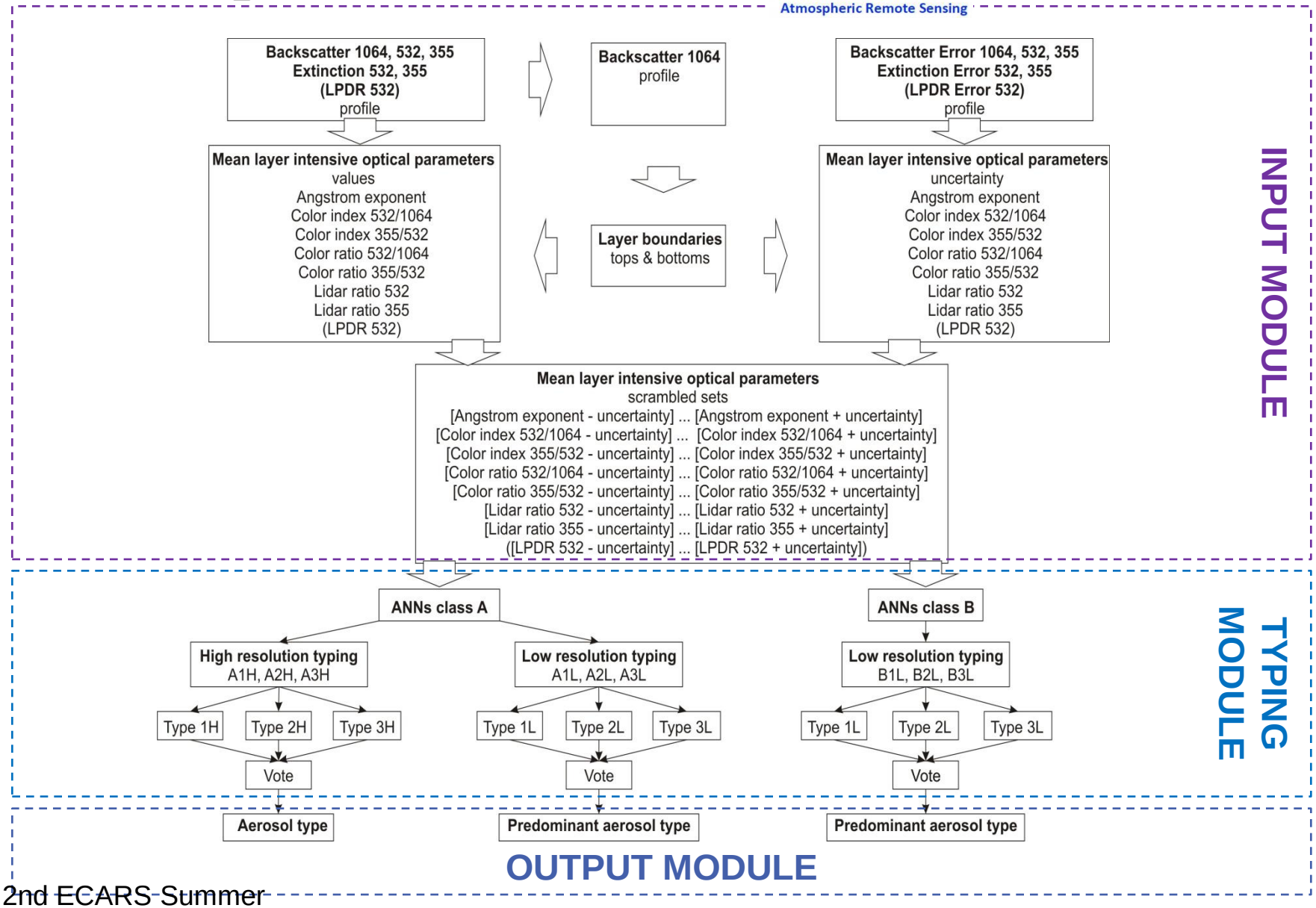

Input module

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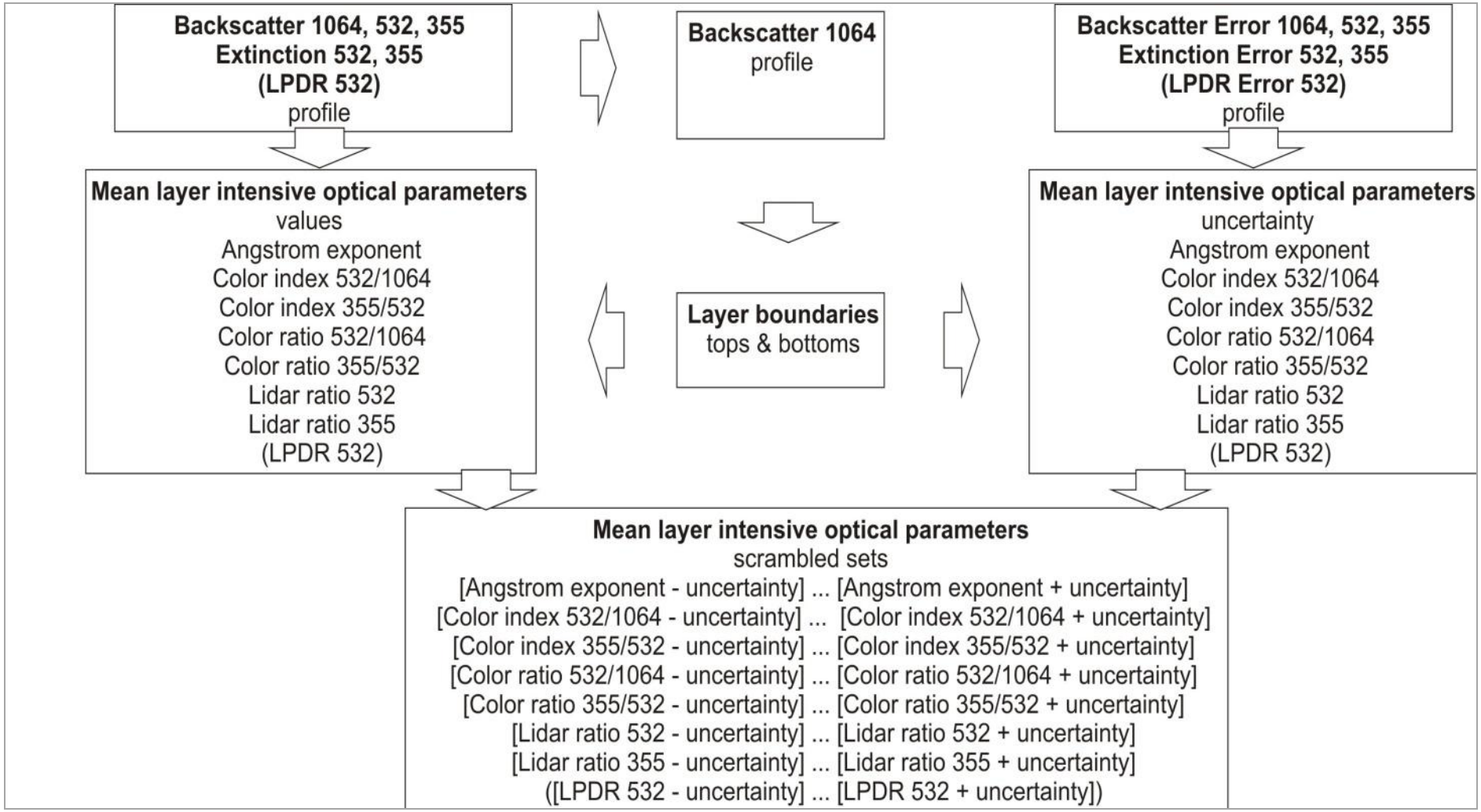

Typing module

- Two options: with or without depolarization
- For each dataset, for each layer:
  - Generates values between error bars
  - Creates all possible combinations
  - Runs 3 different high resolution ANNs + 3 different low resolution ANNs for each set of values in the more complex A class
    - Constrain: min. acceptable confidence level (default 70%)
    - For each: the “best type” = higher no. of agreements / higher confidence level
    - Vote: “best type” out of all
- Information available for each dataset & all layers:
  - layer properties
  - aerosol type retrieved by each ANN, no. of agreements, confidence level
  - “best type” in high and/or low resolution

Output module

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Altitude of the bottom of the layer in meters	Altitude of the top of the layer in meters.	Angstrom Exponent
Angstrom Exponent Absolute Error	Color Index (355nm/532nm)	Color Index (355nm/532nm) Absolute Error
Color Index (532nm/1064nm)	Color Index (532nm/1064nm) Absolute Error	Color Ratio (355nm/532nm)
Color Ratio (355nm/532nm) Absolute Error	Color Ratio (532nm/1064nm)	Color Ratio (532nm/1064nm) Absolute Error
Lidar Ratio (355nm) in sr	Lidar Ratio (355nm) Absolute Error in sr	Lidar Ratio (532nm) in sr
Lidar Ratio (532nm) Absolute Error in sr	Linear Particle Depolarization Ratio (532nm)	Linear Particle Depolarization Ratio (532nm) Absolute Error
Low resolution aerosol type	High resolution aerosol type	Remarks about the aerosol layer
A1L ANN aerosol type	A1L ANN confidence level	A1L ANN confident answers
A1H ANN aerosol type	A1H ANN confidence level	A1H ANN confident answers
A2L ANN aerosol type	A2L ANN confidence level	A2L ANN confident answers
A2H ANN aerosol type	A2H ANN confidence level	A2H ANN confident answers
A3L ANN aerosol type	A3L ANN confidence level	A2L ANN confident answers
A3H ANN aerosol type	A3H ANN confidence level	A3H ANN confident answers
B1L ANN aerosol type	B1L ANN confidence level	B1L ANN confident answers
B2L ANN aerosol type	B2L ANN confidence level	B2L ANN confident answers
B3L ANN aerosol type	B3L ANN confidence level	B3L ANN confident answers

Hands on NATALI v.1.1.7

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- Copy folder v.1.1.7
- Double click “natali.exe”
- Select the data folder
- Select the data files
- Optional: settings
  - Altitude range to be displayed
  - Filter window: layer sub-structures
  - Min. layer depth: disregard thin layers
  - Finesse: statistics of the voting (bins between error bars)
  - Min. accepted confidence
  - Min accepted agreement
  - Display high resolution results
- Start processing
- Open CSV file created in the same place as “natali.exe”

Compare with CALIPSO classification

Compare with EarthCARE classification

Check with LIRIC and GARRLIC

Calculate mass concentration

HANDS-ON NATALI

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THANK YOU.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 602014.