Advancement of the technology for Cal/Val activities: the airborne multiwavelength High Spectral Resolution Lidar MULTIPLY

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Hot topics: the climate

Climate change vs. climate variability

Persistent abnormal variability

↓

Change

Effects **vs.** **causes**

Observations → Observations

↓

Understanding of the physical and chemical processes

↓

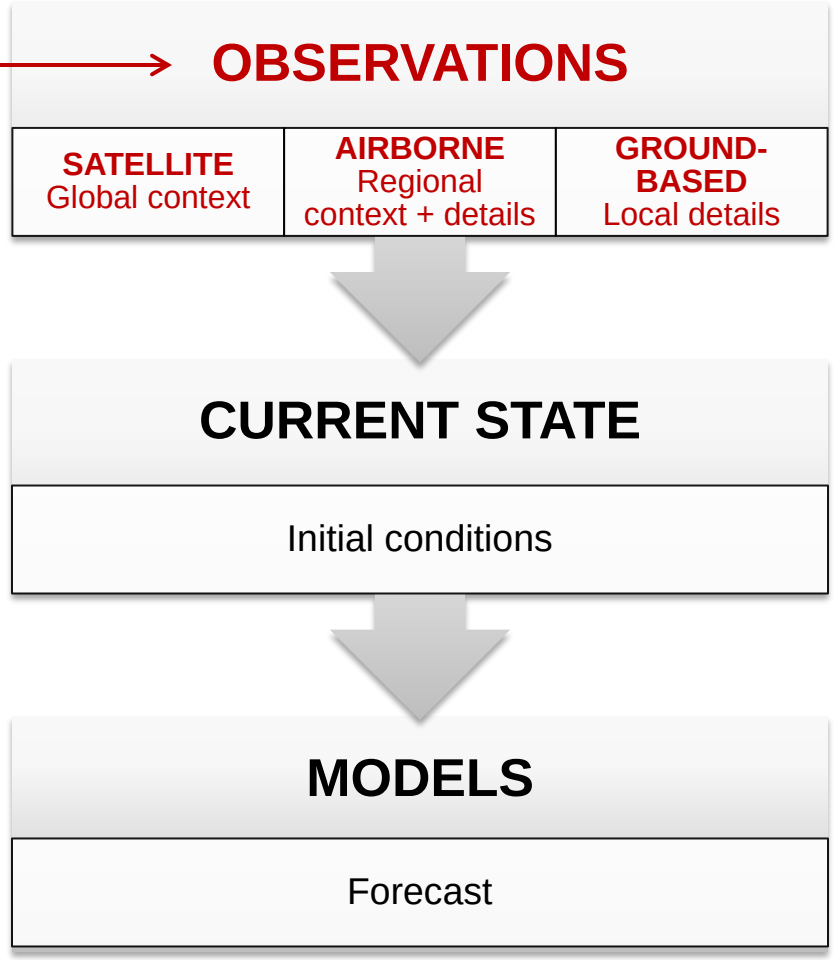
Quantification

↓

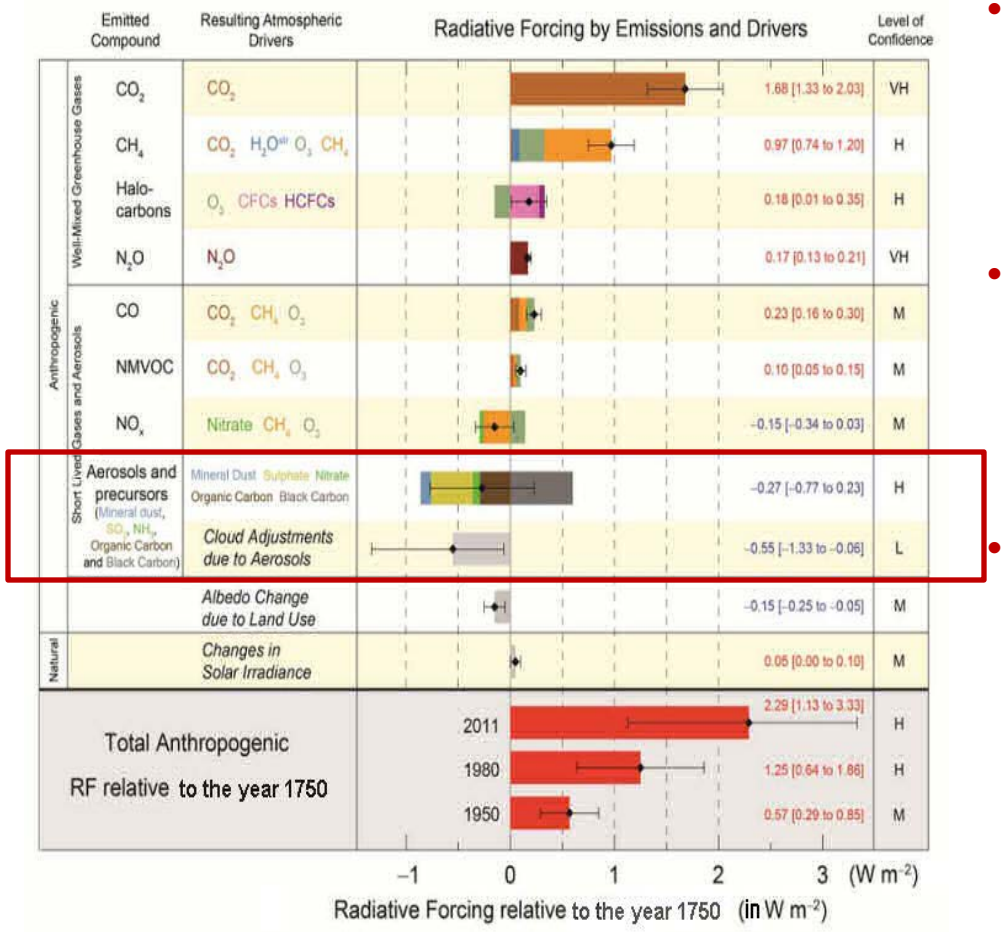
trends → Models

↓

Projections



Science questions

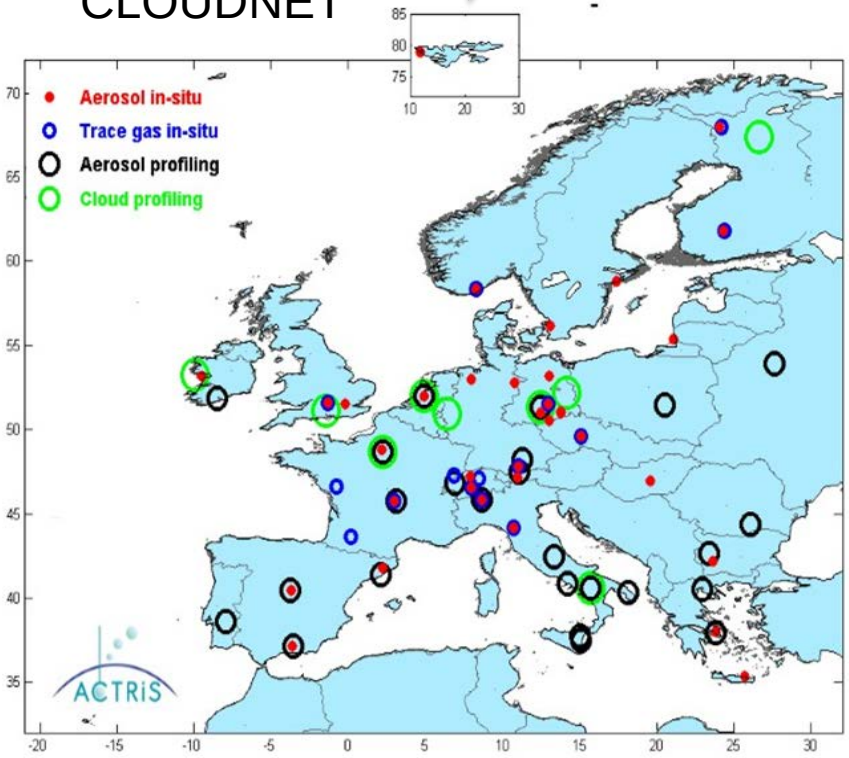


- What is still missing in climate models?
  - accurate representation of clouds, and aerosols
  - aerosols ↔ clouds interaction
- What we don't know well about the aerosols?
  - distribution of aerosol types
  - microphysical properties
  - radiative forcing (direct, indirect)
- What we need in order to quantify the impact of aerosols on climate?
  - global observations >> satellite
  - vertical distribution >> lidar
  - quantitative >> high accuracy
    - minimum assumptions >> Raman, HSRL
    - wide size range >> multi-spectral

Atmospheric observations in Europe

EUSAAR
AERONET
EARLINET
CLOUDNET

ACTRIS

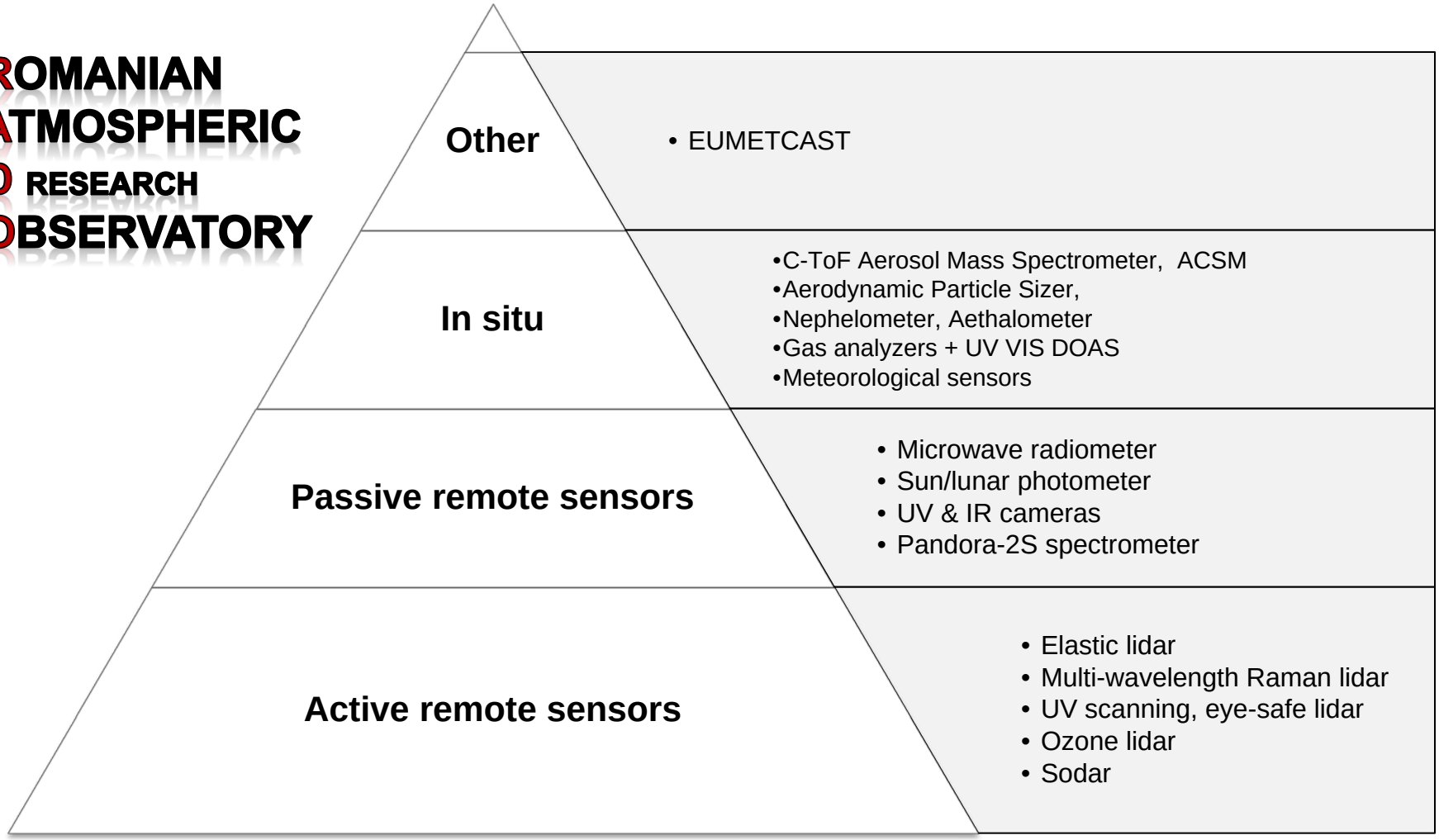


EUFAR

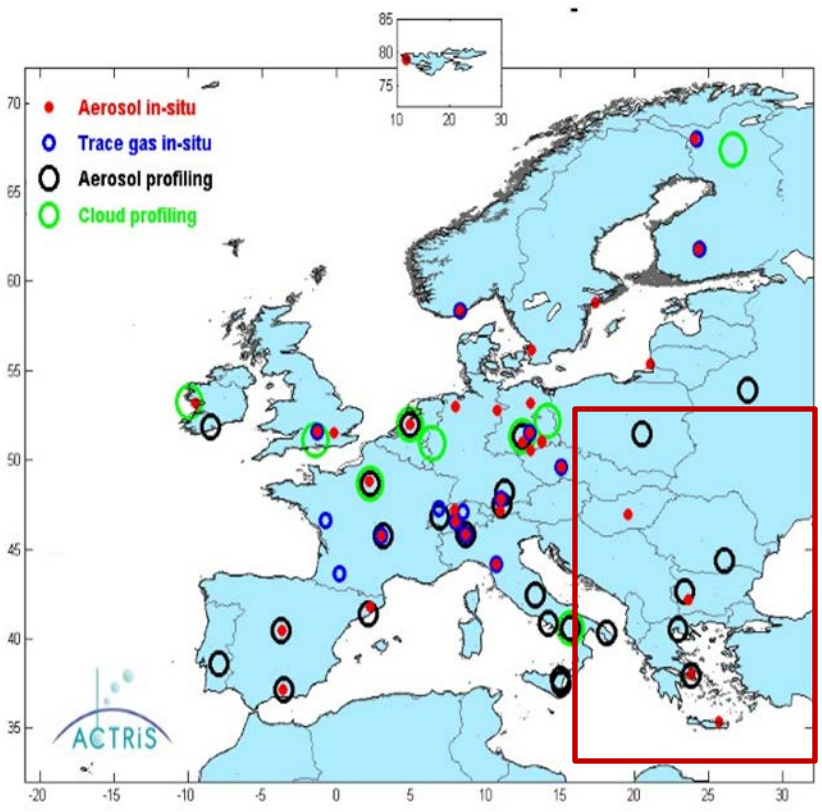
ESA's Sentinels
and Earth Explorers

Atmospheric observations in Romania

ROMANIAN ATMOSPHERIC 3D RESEARCH OBSERVATORY



Atmospheric observations: a regional perspective



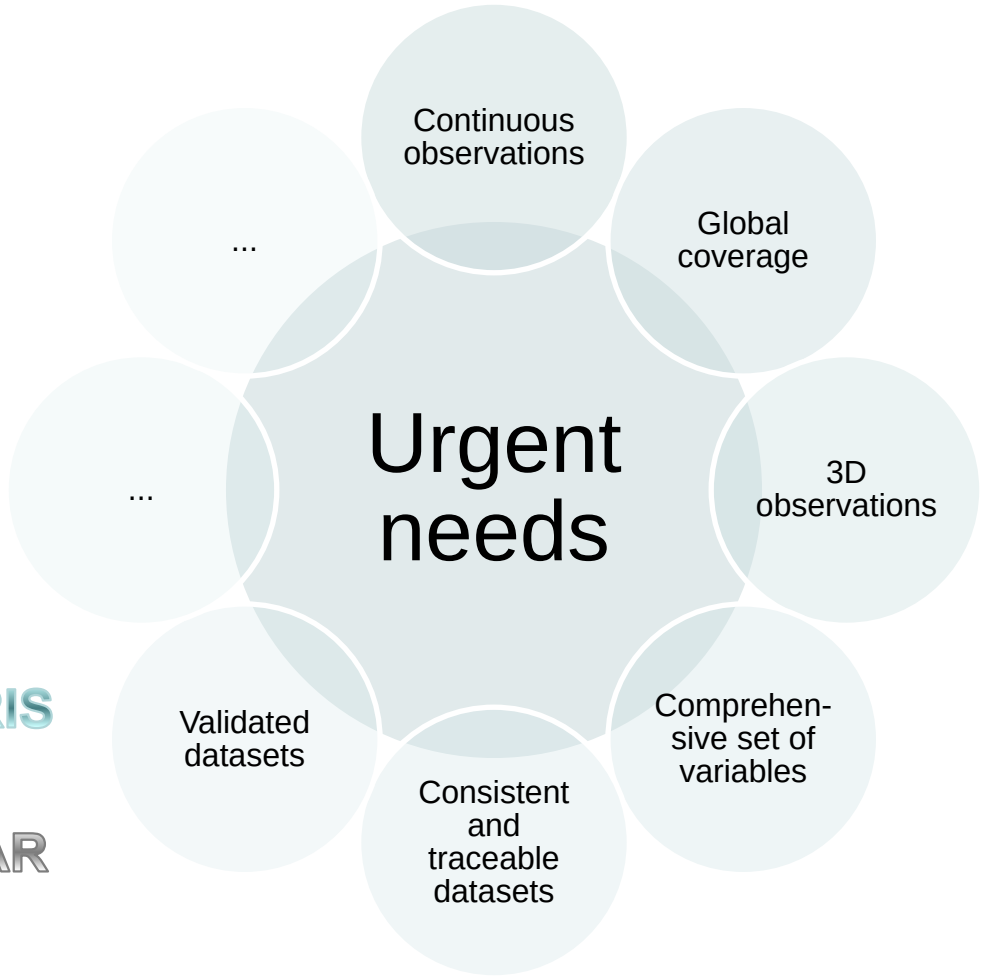
- E and SE Europe
  - Lidar stations: Romania (1*), Greece (3), Cyprus (1), Bulgaria (1), Poland (1*)
  - No data from other EE countries
  - Complex air mass transport: continental, dust, biomass burning, marine
  - Established collaboration
  - Available expertise
  - Relevant infrastructure

⇩

- Significant role in the region:
  - data providers (GAW)
  - targeted services (aviation, air quality)
  - tutoring of new stations (Belgrade, Sankt Petersburg, Cluj, Warsaw, ...)
  - know-how & technology transfer (lidar manufacturers and operators)

Strategic thinking

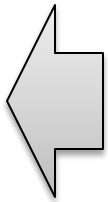
- How the near future looks-like?
  - satellite observations
    - EarthCARE (aerosol extinction, backscatter, linear depolarization ratio)
    - ADM-Aeolus (aerosol backscatter)
    - Sentinel -3/-4/-5/-5p (AOD, Angstroem exponent)
    - CarbonSat (aerosol-related atmospheric corrections)
    - FLEX (aerosol-related atmospheric corrections)
- Cal/Val, synergy?
  - ground-based networks >> direct comparison >> ACTRIS
    - relevance (co-location, simultaneous, footprint)
  - airborne instruments >> EUFAR
    - campaigns (... cross-section, multi-instrument)



Multi-purpose Cal/Val instrument

- What would be the CAL/VAL “dream” instrument for current and future missions related to aerosol and clouds ?
  - lidar
  - multi-wavelength
  - multi-depolarization
  - high spectral resolution
  - daytime / nighttime operation
  - airborne

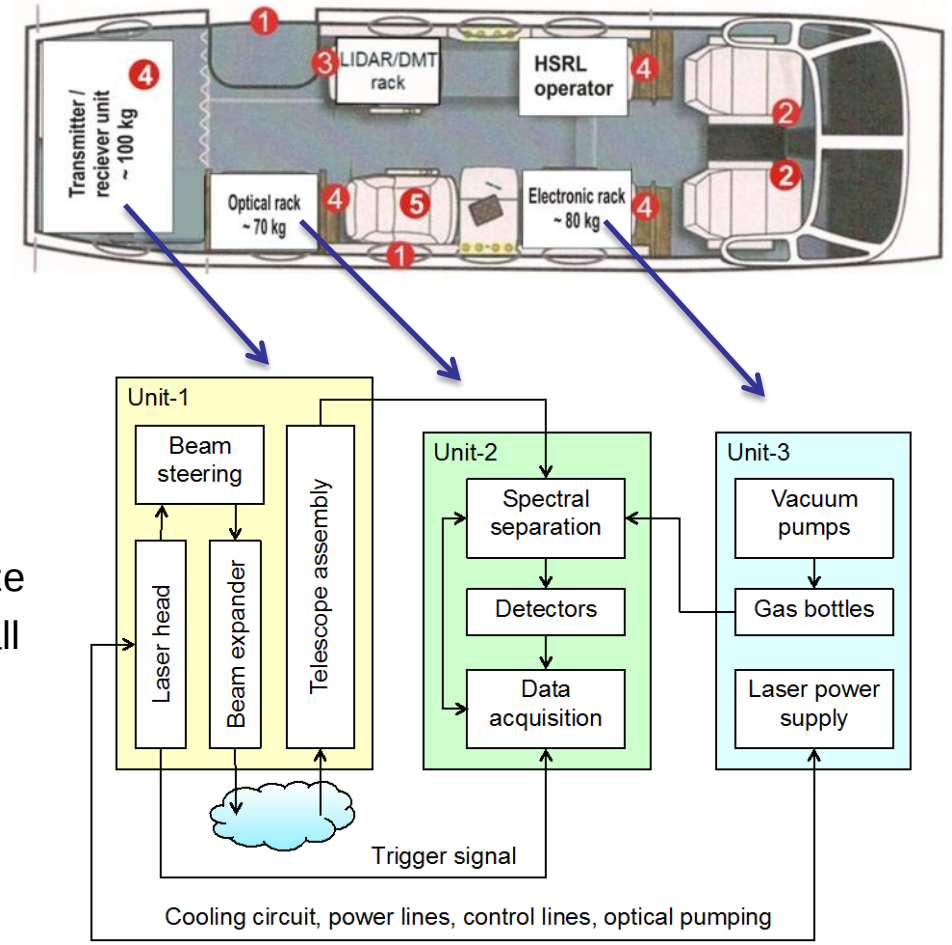
- Ground-based: long-term campaigns, reference instrument
- Airborne: intensive campaigns



- In Europe now:
  - a 532 nm HSRL system (DLR)
  - a 355 nm ALADIN demonstrator (DLR)
  - several airborne backscatter lidars (EUFAR)
  - no multiwavelength capabilities
- MULTIPLY, 4000112373/14/NL/CT
  - Coordination: INOE
  - Airborne constraints: INCAS + NLR
  - Data products requirements: NOA
  - Design & development of the hardware: MPI-M
  - Performance estimator: NOA
  - Procurements: INOE
  - Retrieval algorithm: INOE
  - Test plan: UW

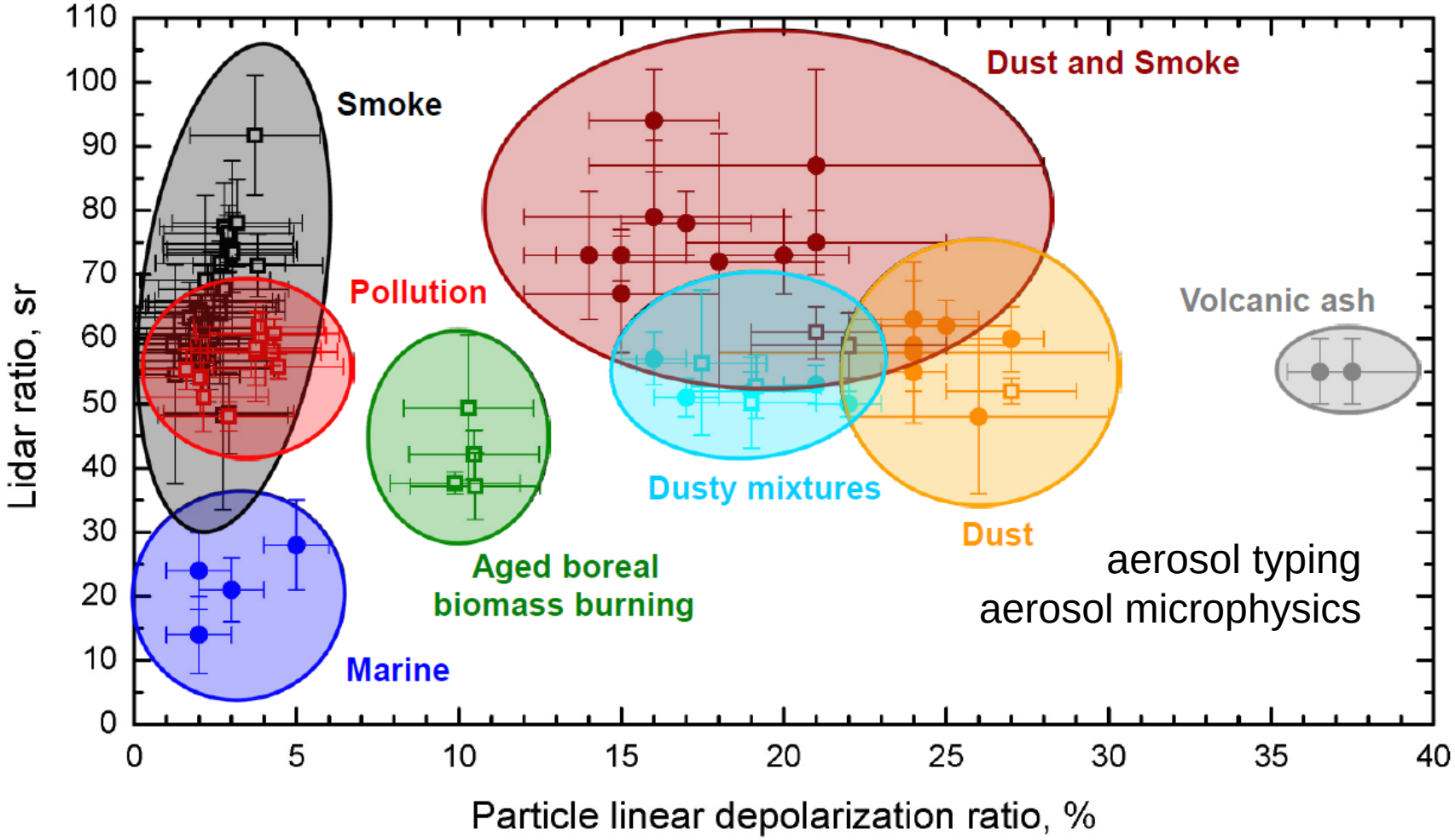
MULTIPLY instrument

- Technological challenges
  - HSRL in UV & IR
  - Eye safety (VIS)
  - Temperature stability
  - Alignment stability
  - Low weight, low volume, low power consumption
  - Time & cost
- Added value
  - Absolute extinction profile in UV & IR >> Angstrom exponent >> particle size
  - Calibrated particle depolarization at all wavelengths >> particle anisotropy
  - Aerosol typing, aerosol microphysics
  - Quantification of the aerosol's direct radiative forcing
  - Activation, cloud condensation, indirect radiative forcing



MULTIPLY science impact

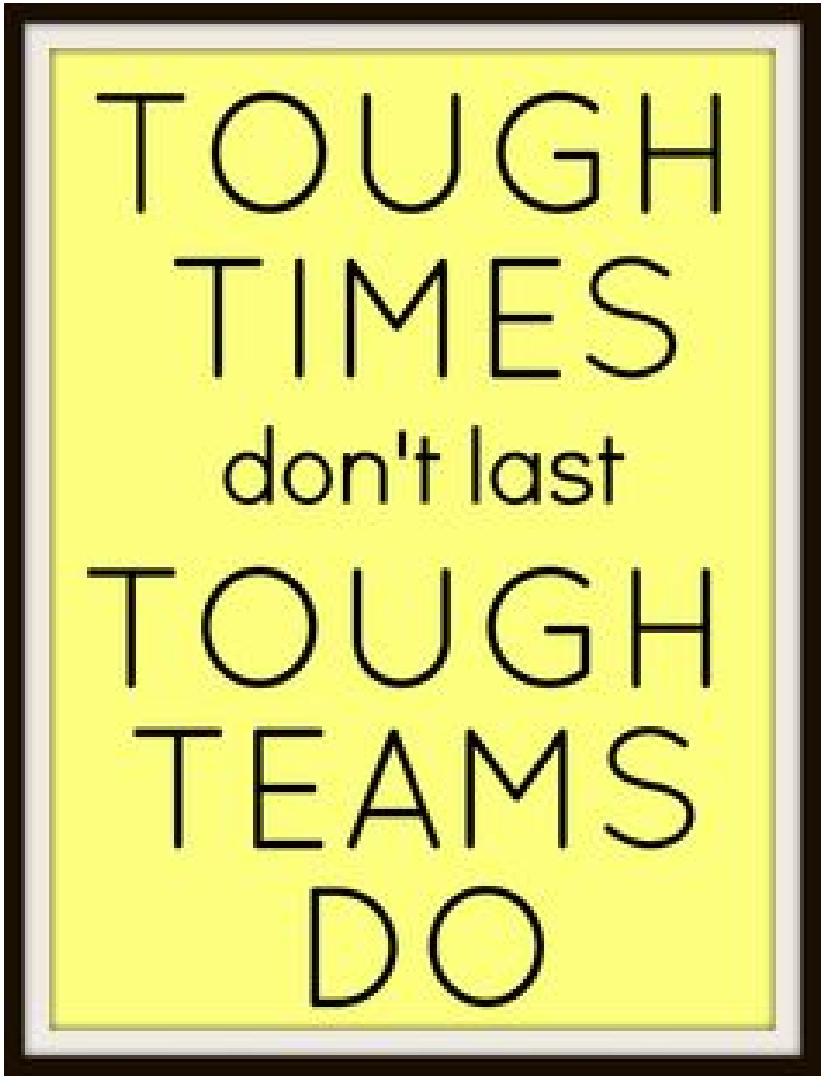
EarthCARE aerosol typing, Ulla Wandinger, personal communication



Still many things to do ...

- Science
  - **ACTRIS-2**, *HORIZON2020*
    - Advanced data products, climatology
    - Data synergy, combined algorithms
  - **NATALI**, ESA/ESRIN
    - Algorithm for aerosol typing
  - many small projects
- Technology
  - **ACTRIS-2,** *HORIZON2020*
    - Calibration centres
    - Daytime lidar
  - **ECARS**, *HORIZON2020*
    - Rotational Raman lidar
    - Airborne lidar
    - Satellite sensors & data products
  - **MULTIPLY – phase B**, *ESA/ESTEC*
    - Aircraft modification
    - On board testing
- Services
  - **GEO-CRADLE**, *HORIZON2020*
  - **ACTRIS-RI***, ESFRI*
  - **ESA** campaigns

To my friend, VASSILIS:



Thank you for your attention.

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