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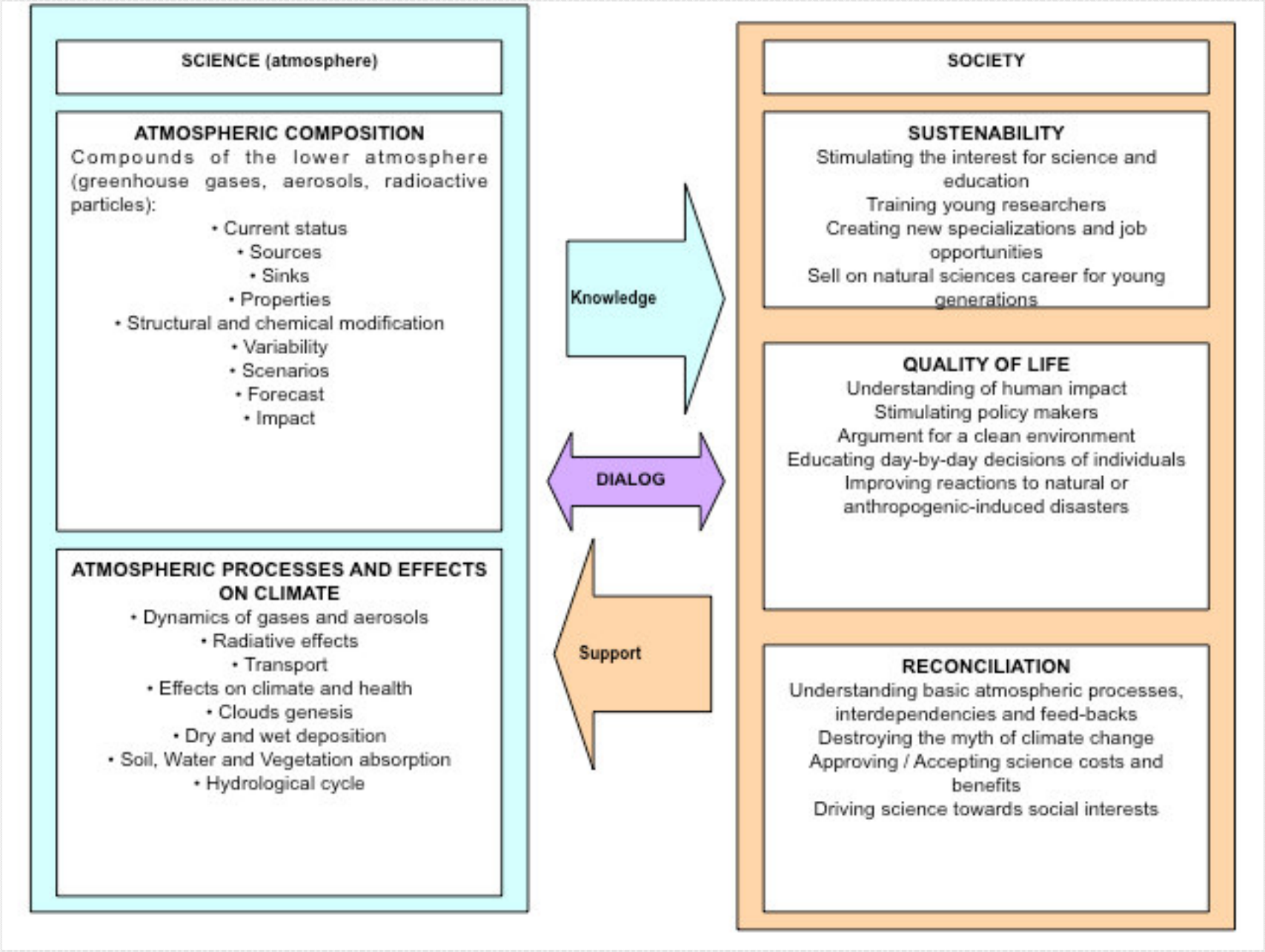
Romanian Atmospheric research 3D Observatory: synergy of instruments

History

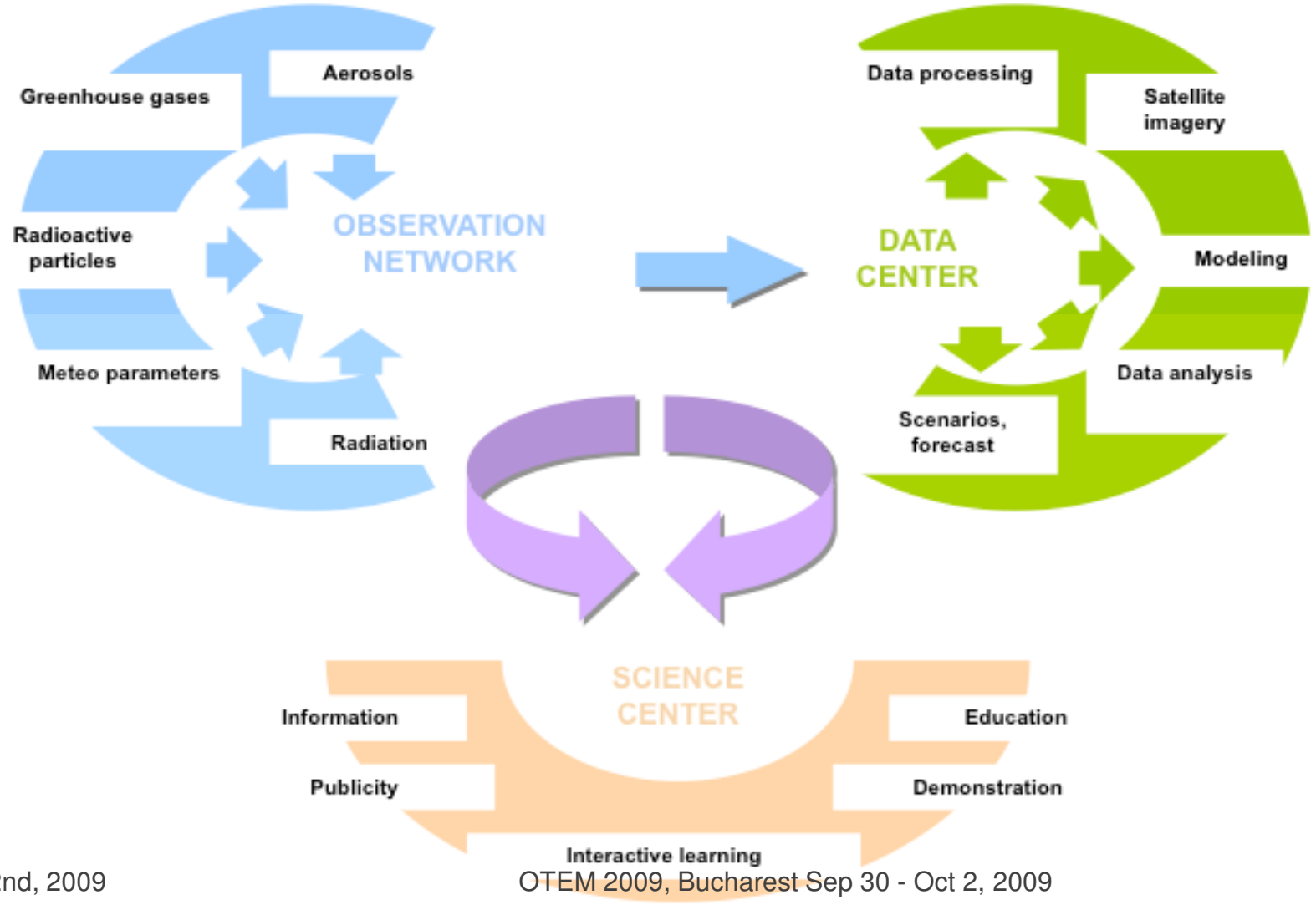
- First lidar activities in Romania: 2004
- First lidar station in EARLINET: 2005
- Romanian Lidar Centre: 2008
  - Multiwavelength Raman lidar
  - Sun photometer
  - Nephelometer
  - APS
- Starting Romanian Lidar Network: 2008
  - 4 new partners in Baneasa, Iasi, Cluj, Timisoara
  - Design of low-cost lidars
- Romanian Atmospheric 3D research Observatory:
  - Main partner: NILU
  - Other partners: ROLINET + IFIN-HH + Fac. Of Physics
  - Budget: 2.870 mil. Eur (2.430 mil. eur grant + 0.440 mil. Eur co-financing from ANCS)


SCIENCE (atmosphere)
ATMOSPHERIC COMPOSITION
Compounds of the lower atmosphere (greenhouse gases, aerosols, radioactive particles):
• Current status
• Sources
• Sinks
• Properties
• Structural and chemical modification
• Variability
• Scenarios
• Forecast
• Impact
ATMOSPHERIC PROCESSES AND EFFECTS ON CLIMATE
• Dynamics of gases and aerosols
• Radiative effects
• Transport
• Effects on climate and health
• Clouds genesis
• Dry and wet deposition
• Soil, Water and Vegetation absorption
• Hydrological cycle
Knowledge
DIALOG
Support
SOCIETY
SUSTENABILITY
Stimulating the interest for science and education
Training young researchers
Creating new specializations and job opportunities
Sell on natural sciences career for young generations
QUALITY OF LIFE
Understanding of human impact
Stimulating policy makers
Argument for a clean environment
Educating day-by-day decisions of individuals
Improving reactions to natural or anthropogenic-induced disasters
RECONCILIATION
Understanding basic atmospheric processes, interdependencies and feed-backs
Destroying the myth of climate change
Approving / Accepting science costs and benefits
Driving science towards social interests

Goals

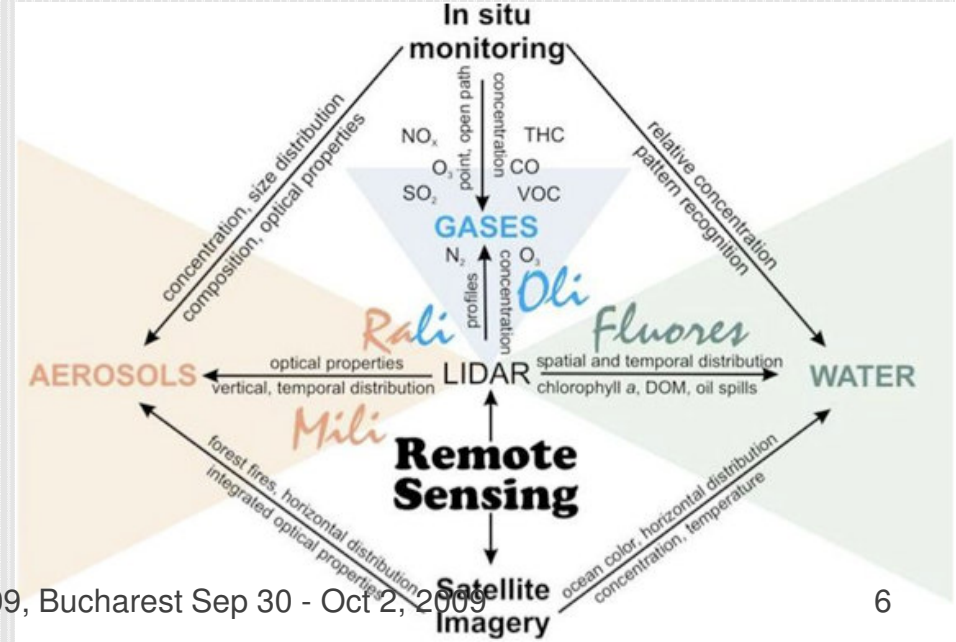
- Goal:
  - improve air research capabilities in Romania
    - a better observation and understanding of atmospheric and hydrologic processes
    - well-informed policy making in the field of environment
- Main objective:
  - creation of the observatory and implementation of specific procedures
- Main functions of RADO:
  - experimental and theoretical research for atmospheric composition and air quality assessment
    - Operational activities (monitoring)
    - Scientific activities (studies, analysis)
  - Education
  - Dialog with civil society
    - Publicity
    - Information
    - Awareness

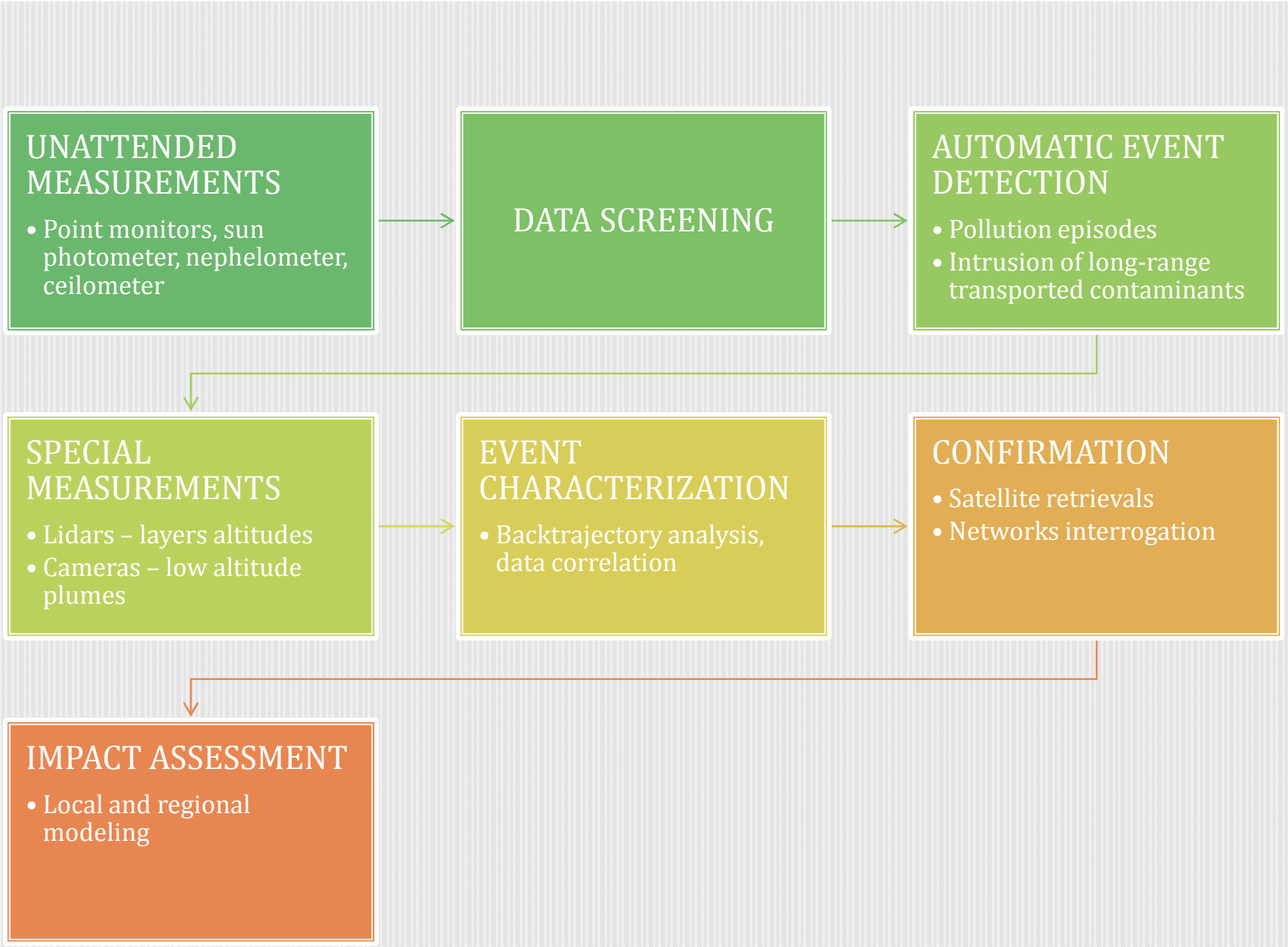
Components


Aerosols
Greenhouse gases
Radioactive particles
OBSERVATION NETWORK
Meteo parameters
Radiation
Data processing
Satellite imagery
DATA CENTER
Modeling
Data analysis
Scenarios, forecast
SCIENCE CENTER
Information
Education
Publicity
Demonstration
Interactive learning

Synergy of techniques

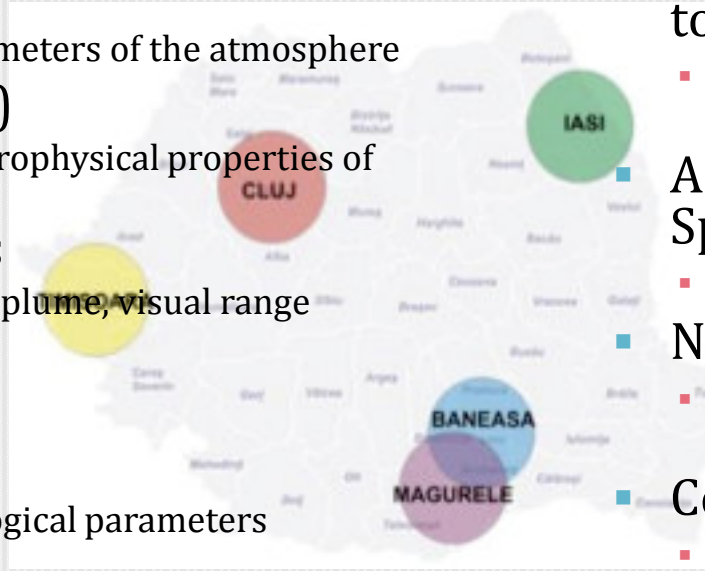
- Automatic, continuous monitoring
  - Ground-level in situ monitoring (point monitors, nephelometer, particle sizer, aerosol mass spectrometer, weather station)
  - Integrated column (sun photometer, microwave radiometer)
  - Remote sensing (ceilometer)
- Regular and special measurements
  - Remote sensing (lidars, UV and IR cameras)
  - Trajectory analysis (FLEXPART)
  - Regional modeling (MAP3D)




UNATTENDED MEASUREMENTS
• Point monitors, sun photometer, nephelometer, ceilometer
DATA SCREENING
AUTOMATIC EVENT DETECTION
• Pollution episodes
• Intrusion of long-range transported contaminants
SPECIAL MEASUREMENTS
• Lidars – layers altitudes
• Cameras – low altitude plumes
EVENT CHARACTERIZATION
• Backtrajectory analysis, data correlation
CONFIRMATION
• Satellite retrievals
• Networks interrogation
IMPACT ASSESSMENT
• Local and regional modeling

Observation Network

- 7 stations, located in 5 places
- Each dot on the map
  - Backscatter lidar
    - clouds and PBL height
    - temporal evolution of aerosol layers
    - optical coefficients profiles
  - Sunphotometer
    - 6 wavelengths
    - integrated optical parameters of the atmosphere
  - Particle sizer (APS)
    - characterization of microphysical properties of ground-level aerosols
  - UV and IR cameras
    - SO2, particles, volcanic plume, visual range
  - Point monitors
    - O3 and CO2
  - Weather station
    - ground-level meteorological parameters



- Magurele super site :
  - Multiwavelength lidar
    - Aerosol level 2 parameters
  - Ozone lidar
    - Ozone concentration profile
  - Microwave radiometer + wind profiler + meteo tower
    - Meteorological parameters at various height levels
  - Aerosol Mass Spectrometer
    - Aerosols composition
  - Nephelometer
    - Integrated backscatter coefficient
  - Ceilometer
    - Cloud base and top

Actual status

Magurele

- Point monitors working
- Sun photometer working
- Aerosol lidars and ceilometer working
- Ozone lidar to be put into operation
- Waiting for microwave radiometer and AMS

Baneasa

- Aerosol lidar working, intercomparison performed, needs upgrade
- Waiting for point monitors

Timisoara

- Aerosol lidar working, intercomparison performed, Raman channels to be added
- Some point monitors working
- Waiting for sun photometer

Cluj

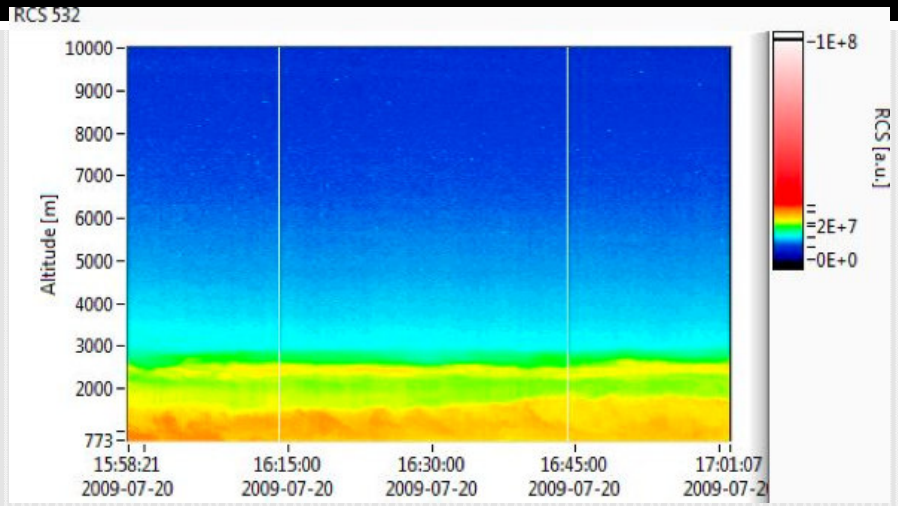
- Aerosol lidar under construction, Raman channels included
- Waiting for point monitors
- Sun photometer to be put into operation

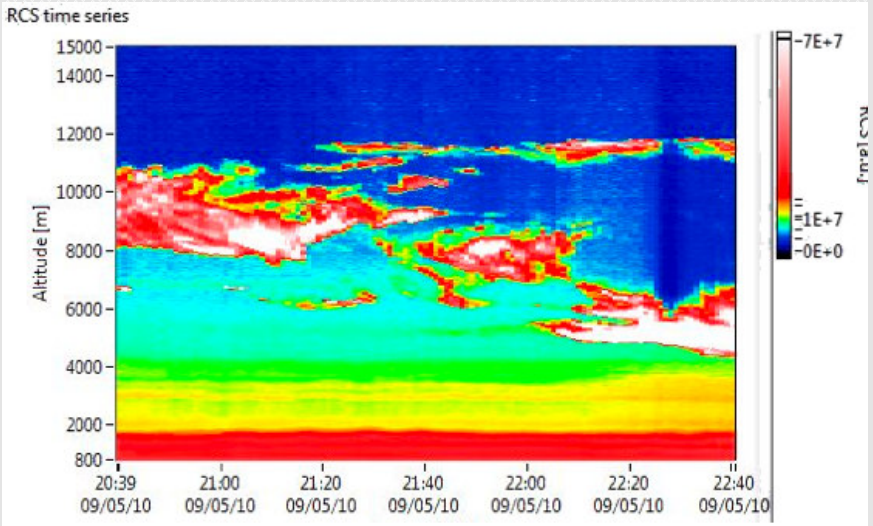
Iasi

- Aerosol lidar under construction, Raman channels included
- Waiting for sun photometer and point monitors

LIDARS - aerosols

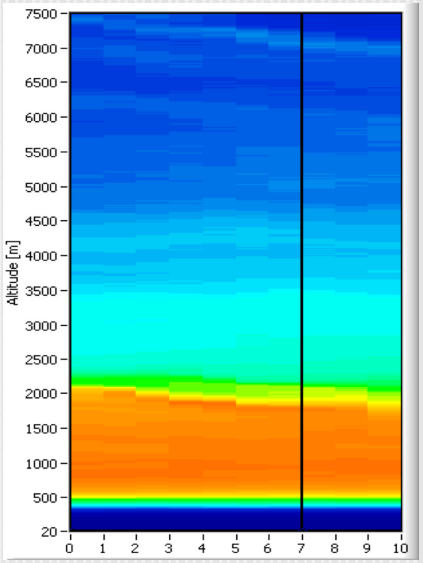
- ROLINET – 532 elastic + Raman + depolarization
  - Backscatter and extinction (nighttime), lidar ratio, particle depolarization
- RALI – multiwavelength (1064, 532, 355) Raman
  - … + color ratios,

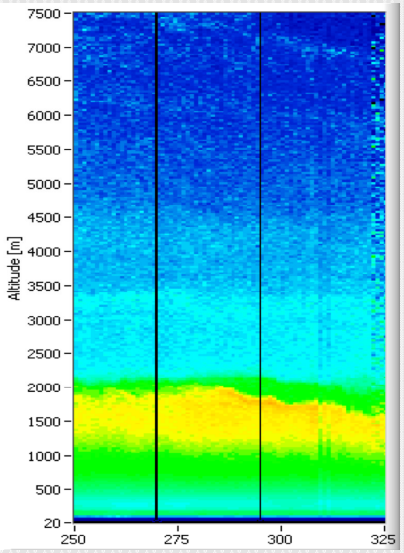


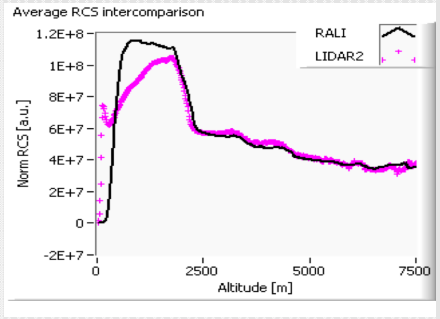


LIDARS - aerosols

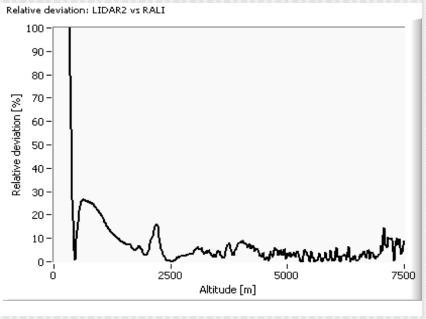
- Intercomparisons:
  - RALI vs. similar systems in EARLINET – May 2009, Leipzig
  - ROLI-BN vs. RALI – July 2008
  - ROLI-TM vs. RALI – July 2009
- Lessons:
  - Raman channels necessary
  - Compromise between low and high range
  - Analog detection for powerful channels
  - New intercomparison campaign after upgrades







RALI, 532p, July 11, 2008, 19:45 – 20:31 UT, 5min res



ROLI-BN, 532p, July 11, 2008, 19:45 – 20:31 UT, 1min res

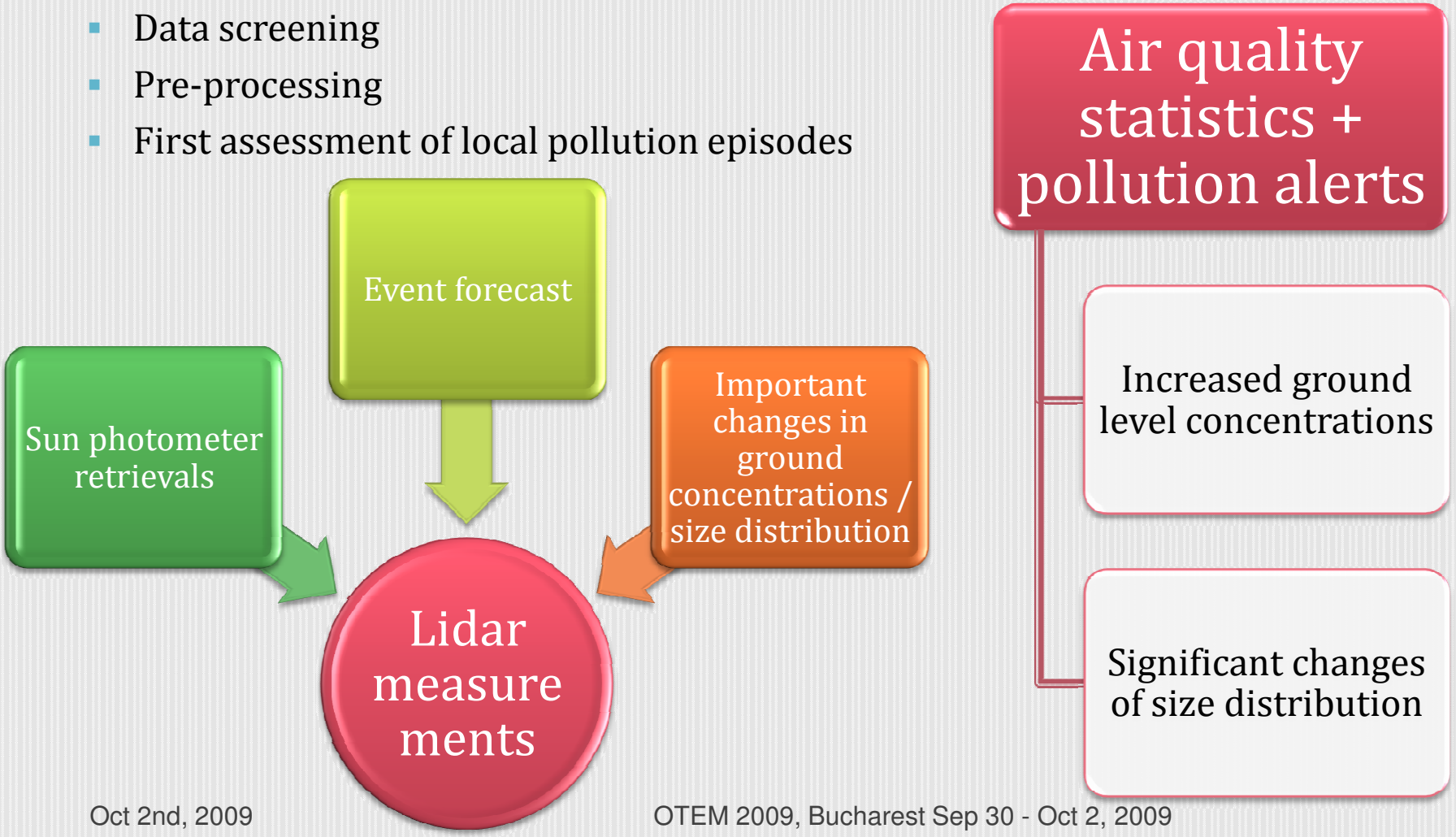
LIDARS – gaseous compounds

- Water vapor lidar
  - Mixing ratio up to 5Km
  - Technique: Raman nighttime
  - Validation: Leipzig campaign + microwave radiometer

- Ozone lidar
  - Concentration profiles up to 10Km
  - Technique: DIAL
  - Validation: NTUA system

Data Center: *Local points*

- Each station:
  - Data screening
  - Pre-processing
  - First assessment of local pollution episodes



Data Center: *Ordinary operation*

- Data Center in Magurele:
  - Early alerts based on forecast models
  - Data collection
  - Quick correlation
  - Event characterization (long-range transported contaminants)
  - Advanced analysis

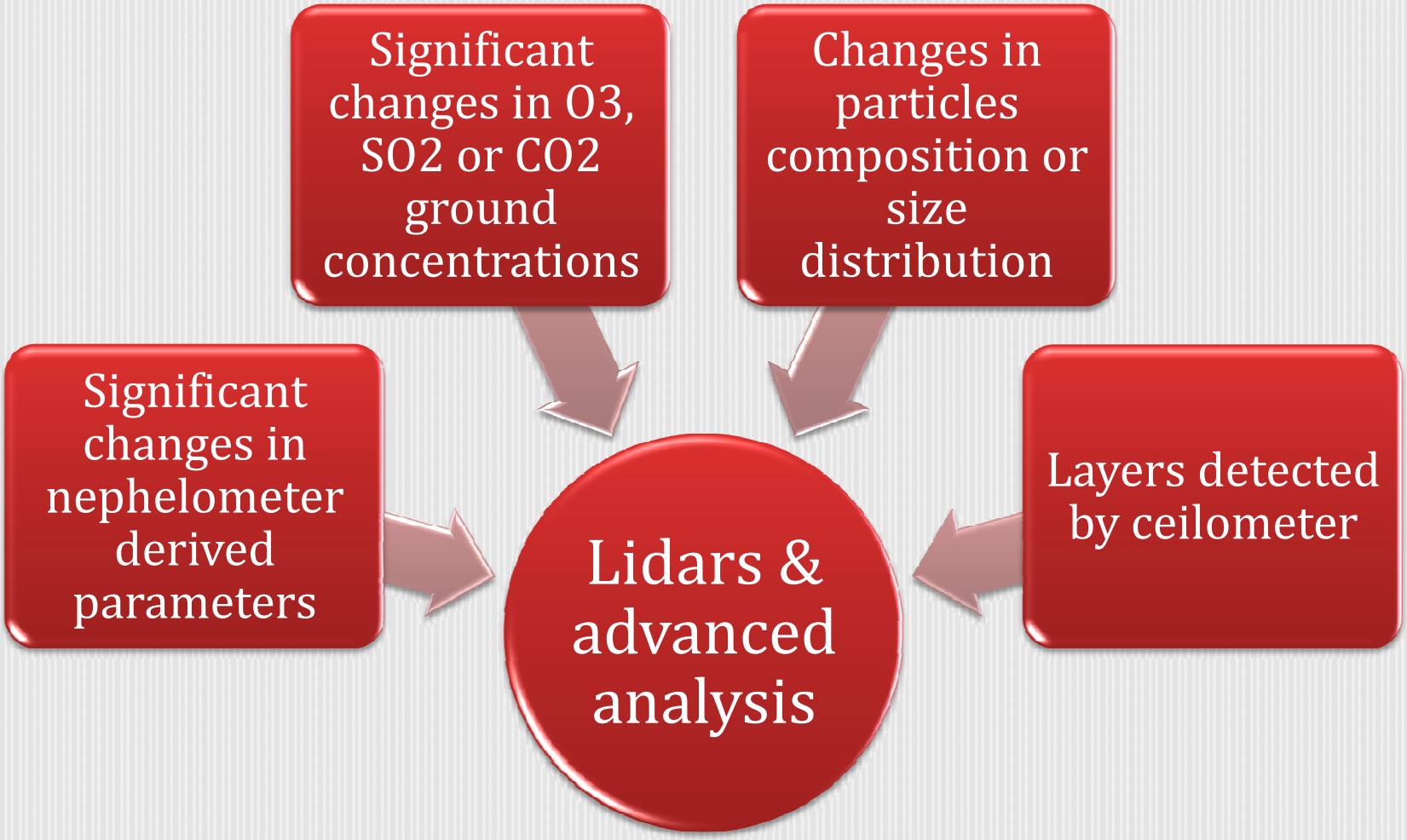
Forecast

- triggers lidar measurements

Reports

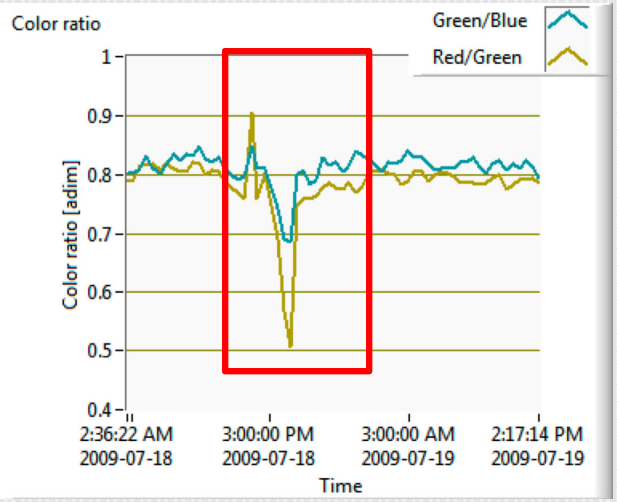
- statistics
- regional modeling

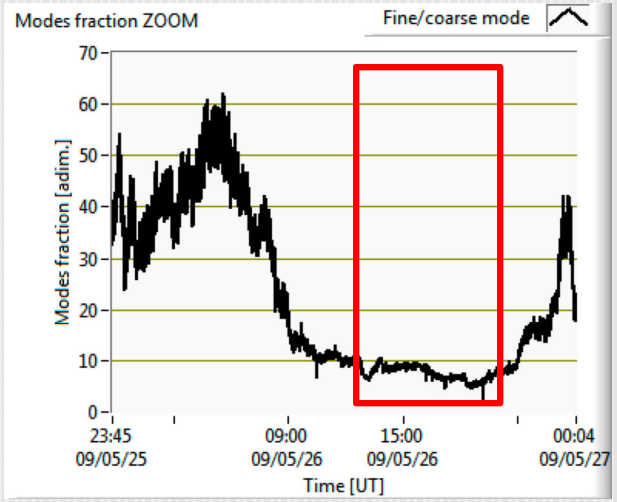
Data Center: *Extraordinary operation*

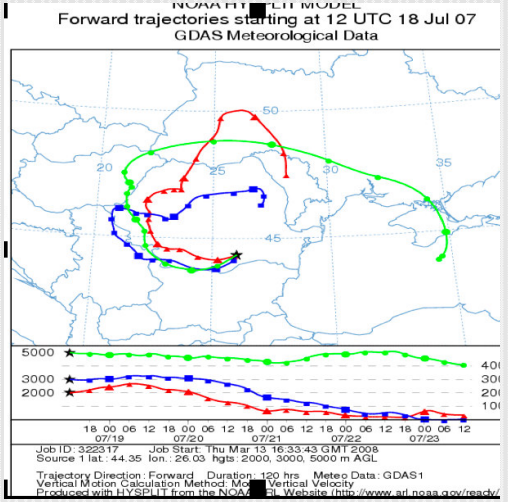


Data Center: *Examples*

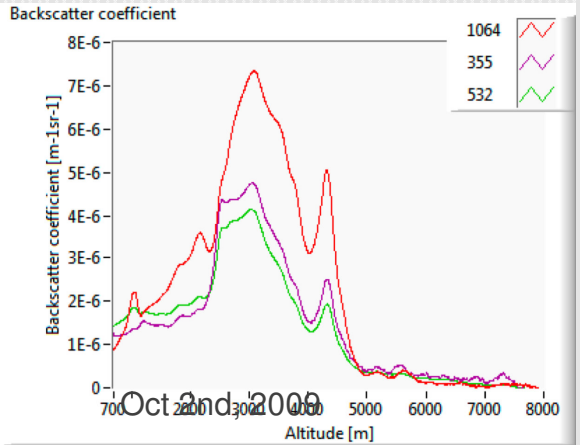
Alerts

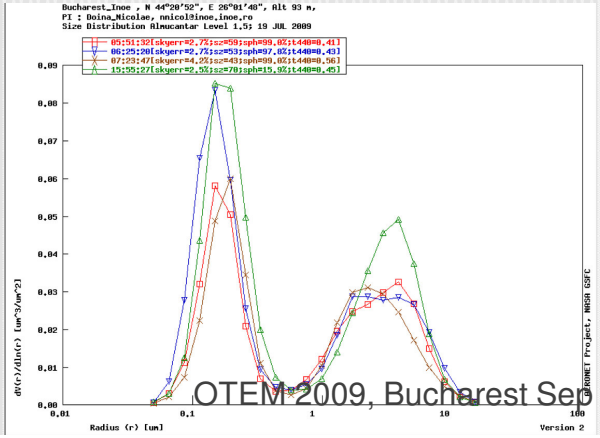




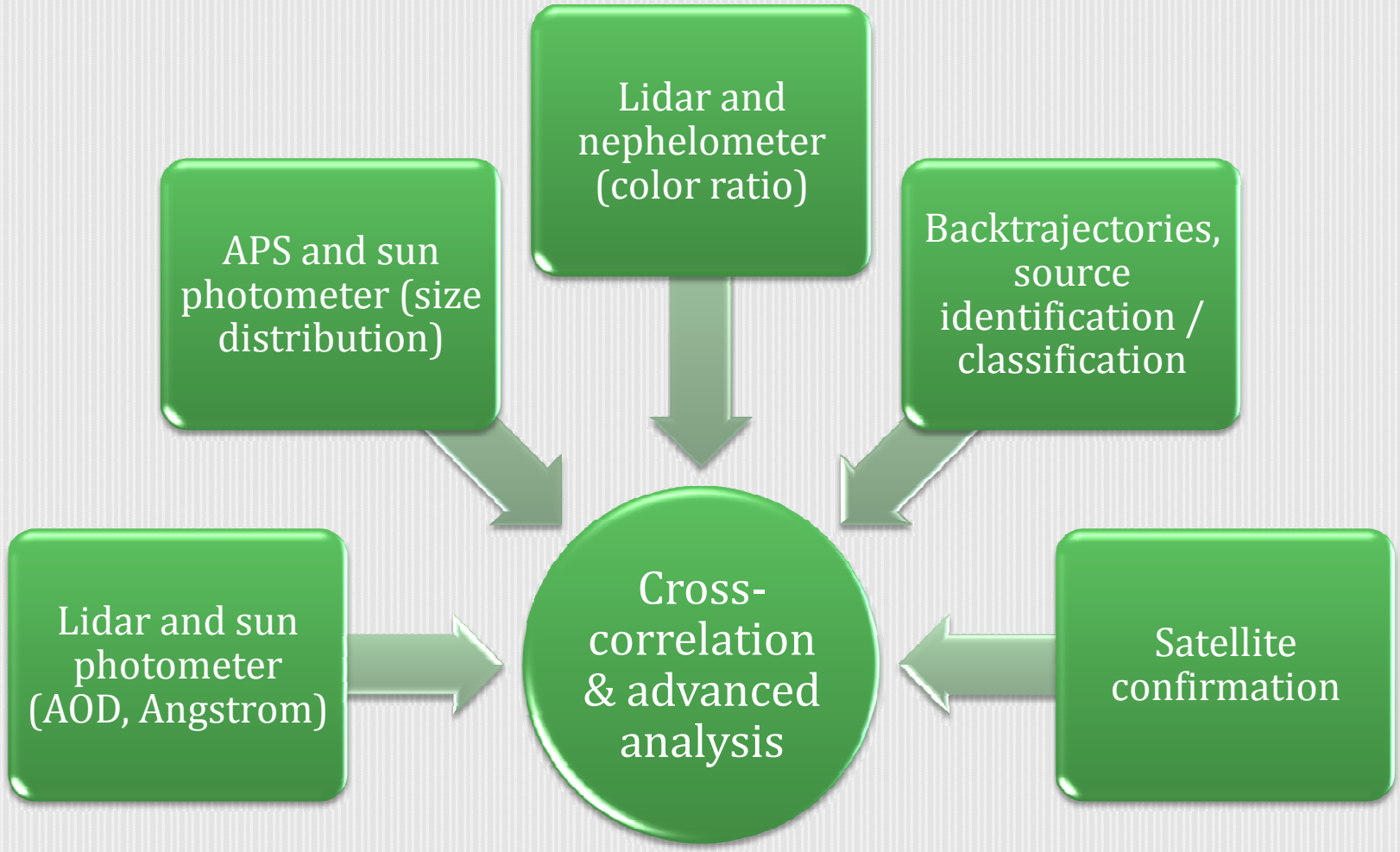


Lidar & advanced analysis



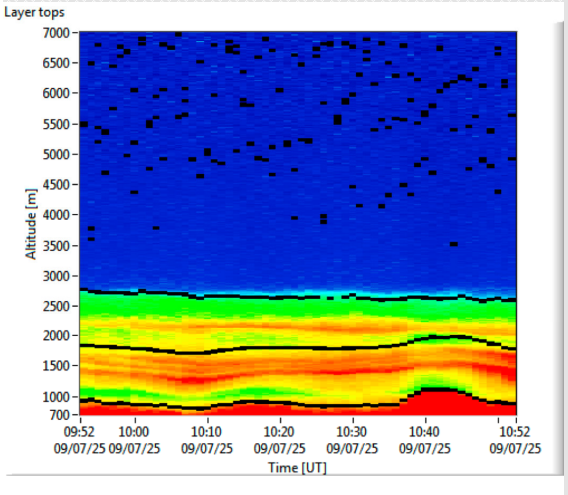


Data Center: *Extraordinary operation*

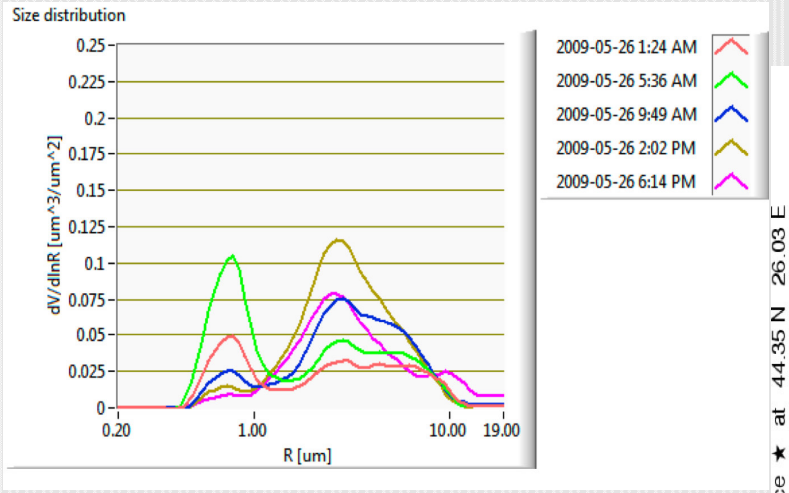


Data Center: *Examples*

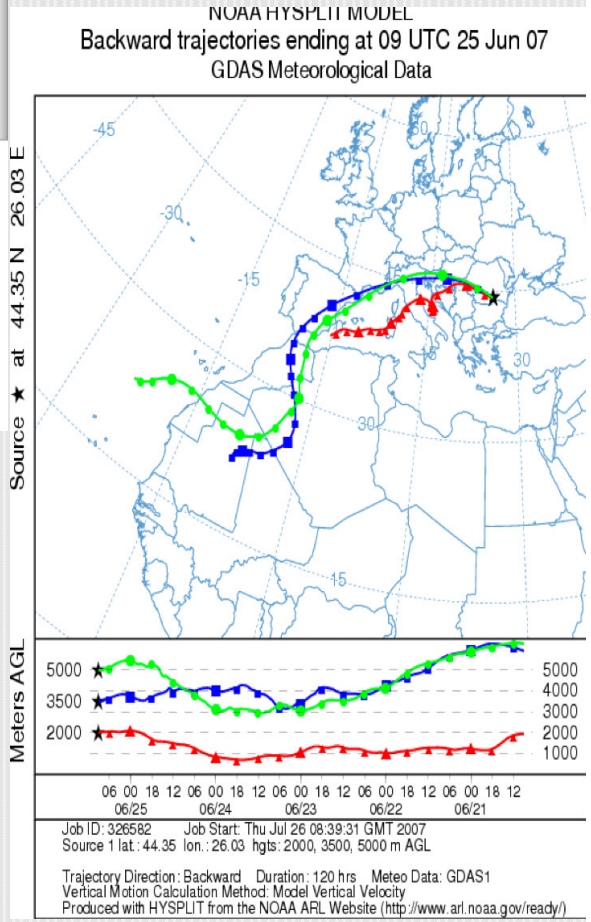
Temporal evolution



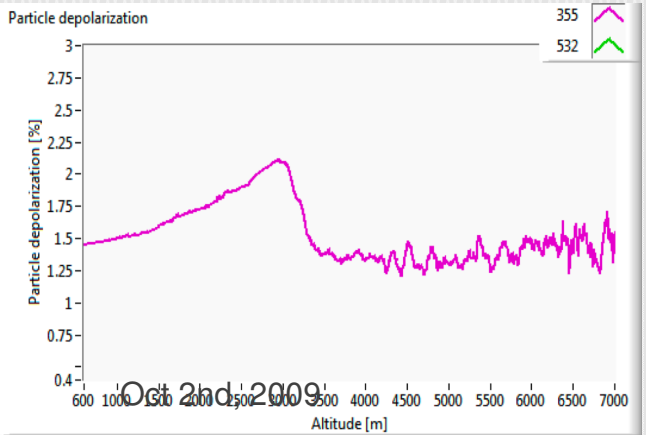
Microphysical properties: APS



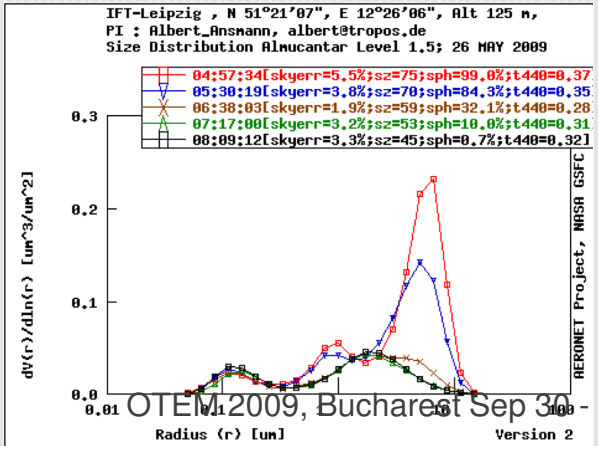
Trajectories and satellite imagery



Optical properties



Microphysical properties: sun photometer



Conclusions

- RADO = state-of-the art facility for atmospheric research in SE Europe
- Added value to already existent air monitoring in Romania: vertical sounding
- Overall strategy: complementary use of instruments and techniques:
  - in situ and remote
  - passive and active
  - ground-based and satellite
  - measurements and modeling
- Challenges:
  - Validation of instruments, operational checks
  - Data handling, data homogeneousity, data correlation
  - Automatic procedures as possible

The authors wish to acknowledge Norway Grants for RADO contract STVES 115266.

Thank you!