

# EARLINET history and the EARLINET-ASOS project

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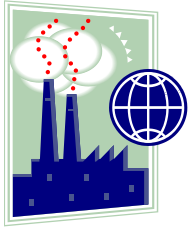
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# OUTLINE

- *Introduction*
- *EARLINET*
- *Organization*
- *EARLINET-ASOS*
- *WMO-GAW: GALION*
- *Summary and future plans*

## *Aerosols have important effects on human life:*

*Degradation of visibility*



*Aerosols can be toxic*

*Ecosystems are affected by significant mass transport.  
Eutrophication of lakes and seas*

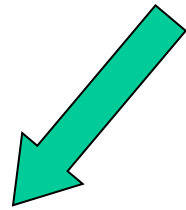
*Aerosols influence atmospheric chemistry by providing reactive surfaces.  
Stratospheric ozone depletion.*



*Aerosols affect the radiation budget and hence temperature distribution within  
the atmosphere and on the ground, including change in spectral distribution.  
The details depend strongly on type and vertical distribution*

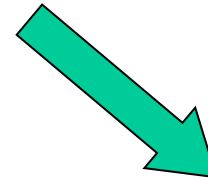
# AEROSOLS AND THE EARTH RADIATIVE BUDGET

Aerosols contribute to radiative forcing



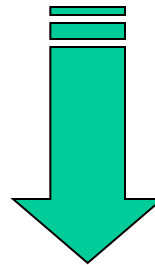
Directly:

absorbing or reflecting  
radiation

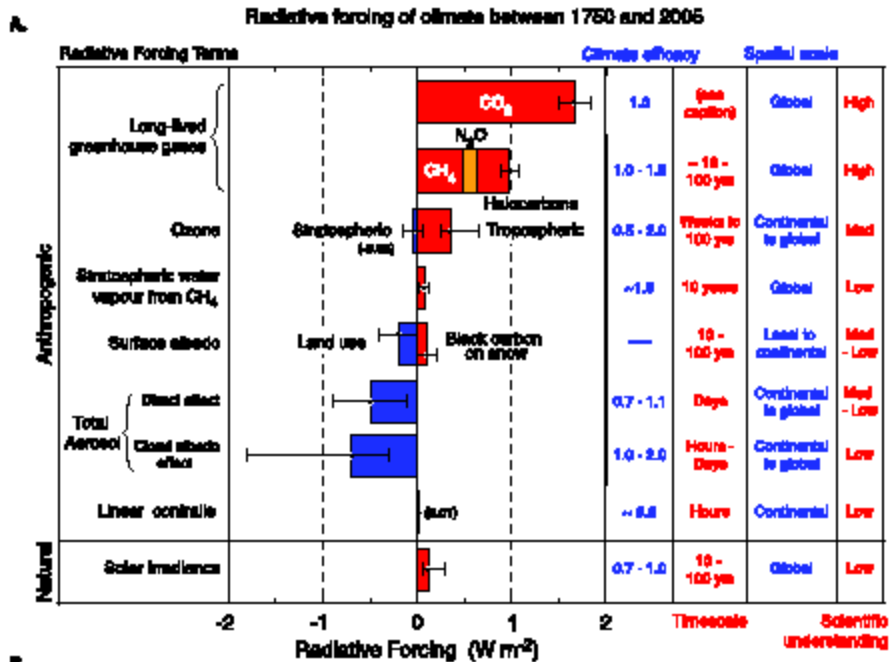


Indirectly:

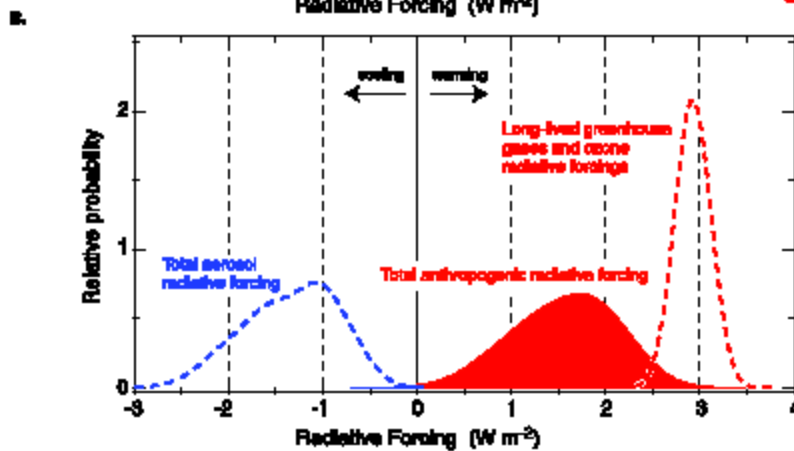
by modifying clouds optical  
properties and precipitations  
cycle



*Climate change*



IPCC 2007



Aerosols are very difficult to handle in models

Aerosols are produced by many different processes, some sources are localized, others are distributed over large volumes

Aerosols interact dynamically in a nonlinear way (nucleation, condensation, coagulation, deposition)

Aerosols can be transported over large distances

Measurements are needed to assess and improve understanding of aerosol processes and their treatment in models

- in situ measurements
- Ground based remote sensing measurements
- Satellite measurements

## *Lidar measurements*

It is in particular the information about the vertical distribution of aerosols that is missing.

The exact altitude of any aerosol layer is required to trace it back to the source.

Lidar provides excellent information about the vertical structure of aerosol layers.

Advanced lidar methods provide very good information about aerosol optical properties (extinction, backscatter, optical depth).

Advanced lidar plus advanced retrieval methods provide important information about microphysical properties of aerosols.

## *Lidar Network*

Aerosol distribution is highly variable, single point measurements are insufficient for characterization.

At least continental scale coverage is needed for, e.g., climate impact studies, source localization, comparative statistics.

It helps to build a community with common understanding of aerosol related processes and observation techniques.

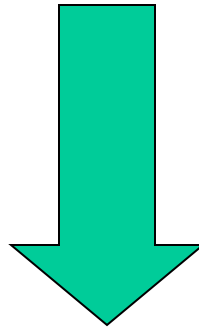
*Aerosol profiling for climate and air quality research*

*Lidar measurements*

*Long term measurements*

*Distributed measurements*

*Advanced lidar systems for microphysical properties*

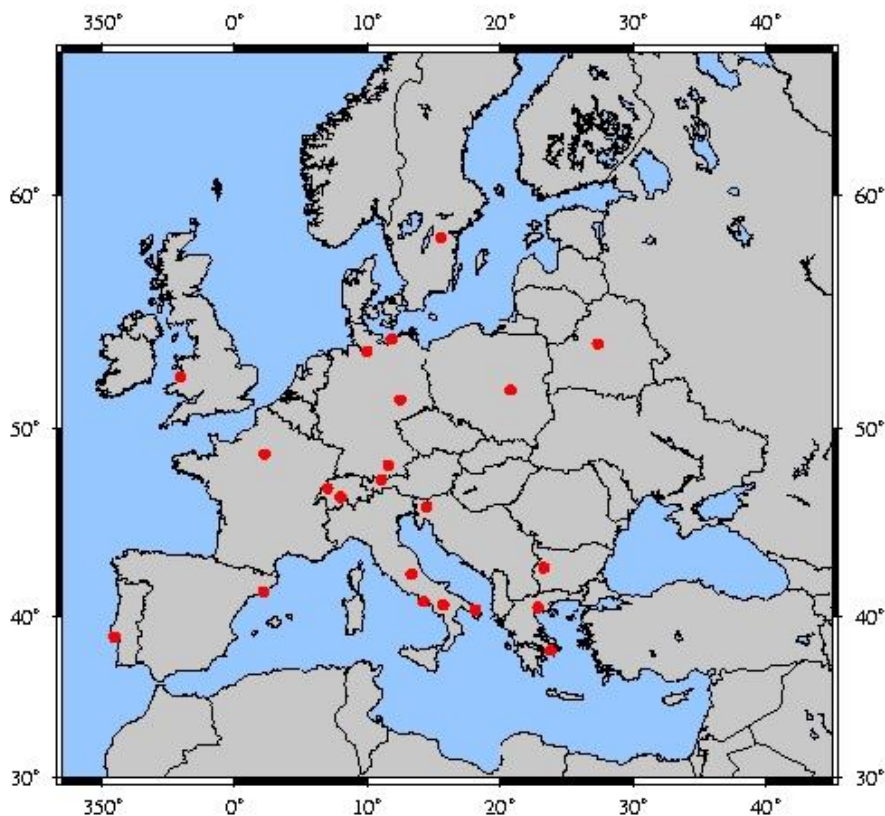


**EARLINET**



## European Aerosol Research Lidar NETwork

EARLINET was established in February, 2000 as a research project supported by the European Commission under the Fifth Framework Programme within the Energy, Environment and Sustainable Development Programme, contract No EVR1-CT-1999-40003.



- *22 lidar stations distributed over 14 European countries*
- *main objective: to establish a qualitatively and quantitatively significant database for the horizontal and vertical distributions of atmospheric aerosols over Europe*
- *3 systematic regular aerosol lidar measurements per week*
- *special measurement campaigns to study special events (Saharan dust outbreaks, volcanic eruptions, forest fires)*
- *system level and retrieval algorithms intercomparisons*

EARLINET was established in February, 2000 as a research project supported by the European Commission under the Fifth Framework Programme within the Energy, Environment and Sustainable Development Programme, contract No EVR1-CT-1999-40003.

After the end of the EC-project EARLINET continues to operate as a voluntary association of research institutions with specific interest in atmospheric aerosol research.

The objectives and rules of the association are described in the constitution and bylaws as accepted by the foundation assembly on July 12, 2004 in Matera, Italy.

*[www.earlinet.org](http://www.earlinet.org)*



# EARLINET organisation

- Speaker
- Council
- General Assembly

## Main common tasks:

- Routine measurements at fixed dates, 3 per week (on 2 days)
- Compilation of aerosol profile data, extinction and backscatter
- Compilation of back-trajectory data

## Task groups for special investigations:

- Quality assurance (instruments)
- Quality assurance (algorithms)
- Observation of special events (Saharan dust, forest fires, volcanic eruptions)
- Statistical/climatological analysis
- Microphysical retrieval algorithms
- Synergy and Integration (models/observations)
- Support to satellite missions

EARLINET measurements started in May 2000

The EARLINET database represents the largest database for the aerosol distribution on a continental scale

All the files are divided in different categories related to regular and special conditions:

- *Climatology*
- *Cirrus*
- *Diurnal cycles*
- *Volcanic eruptions*
- *Forest Fires*
- *Photosmog*
- *Rural/urban*
- *Saharan dust*
- *Stratosphere*

Data are available at [www.earlinet.org](http://www.earlinet.org) through a web-based interface to provide easy access to the data products for both internal and external users.



# EARLINET ASOS

## European Aerosol Research Lidar Network: Advanced Sustainable Observation System

EC Infrastructure Project Started on 1st March 2006

The overall objectives are:

- To extend the development of the European Aerosol Research Lidar Network as a world-leading instrument for the observation of the 4-dimensional spatio-temporal distribution of aerosols on a continental scale, resulting in accurate, well-defined, and easily accessible data products for use in science and environmental services.
- To enhance the operation of this instrument to foster aerosol-related process studies, validation of satellite sensors, model development and validation, assimilation of aerosol data into operational models, and to build a comprehensive climatology of the aerosol distribution.
- To play a leading role in the development of a global observation network for the aerosol vertical distribution as a major innovative element of GEOSS, by setting the standards for instruments, methodology, and organization in this specific area.



# EARLINET ASOS

To facilitate the verification of achievements more specific technical objectives are defined:

- a) Maintain quality assurance for all the stations at the highest possible level. This includes spreading of good practice for system control and operation as well as end-to-end checks of performance.
- b) Establish common standards for advanced aerosol lidar instruments with improved temporal coverage, operation procedures, data processing, and retrieval of optical, microphysical, and other derived parameters.
- c) Extend an observation scheme of regularly scheduled measurements and additional measurements for special purposes towards better temporal coverage.
- d) Collect data, including auxiliary data, in a comprehensive data base and implement a user interface providing fast and easy access to well structured data for both internal and external users, e.g., atmospheric researchers, global and regional climate modellers, satellite community, and environmental agencies.
- e) Establish a platform for cooperation and coordination with the relevant observation and user communities, and serve as a nucleus for a world-wide aerosol lidar network.

### NA1 - Management of CA

Management will comprise the areas of communication with the Commission for all contractual and administrative matters, organization of annual and special reports, organization of consortium meetings, monitoring the progress of work based on milestones and deliverables.

**NA1**  
*Management*  
**Coordinator**  
**Deputy Coordinator**

### NA2 - Exchange of expertise

- organized flow of information both between the participants and between the participants and the external scientific community.

- cooperation and coordination with the relevant observation and user communities

**NA2**  
*Exchange of expertise*

### NA3 - Quality assurance

To establish a common European standard for routine quality assurance of lidar instruments and algorithms

**NA3**  
*Quality Assurance*

**NA4**  
*Optimization of instruments*

**NA5**  
*Optimization of data processing*

**NA6**  
*Data base construction and operation*

### NA6 - Data base construction and operation

The establishment of the EARLINET-ASOS database and the development of a web-based interface to provide easy access to the data products for internal and external users.

### NA4 - Optimisation of instruments

To improve the observation system on the basis of well defined subsystems and system integration by selection of the optimal approach from various solutions existing at individual stations.

### NA5 - Optimisation of data processing

Optimisation of data processing to retrieve aerosol optical properties and microphysical properties.

Common single chain data processing procedure for the automatic retrieval of aerosol properties.

## 21 Partners

1. Consiglio Nazionale delle Ricerche - Istituto di Metodologie per l'Analisi Ambientale, Potenza, Italy
2. Max-Planck-Institut für Meteorologie, Hamburg, Germany
3. Aristotle University of Thessaloniki, Thessaloniki, Greece
4. Universitat Politècnica de Catalunya, Barcelona, Spain
5. Meteorologisches Institut der Ludwig-Maximilians-Universität, München, Germany
6. Leibniz-Institut für Troposphärenforschung, Leipzig, Germany
7. National Institute for Public Health and the Environment, Bilthoven, The Netherlands
8. Zentrum für Dynamik komplexer Systeme, Universität Potsdam, Potsdam, Germany
9. Institute of Physics National Academy of Sciences, Minsk, Belarus
10. Norwegian Institute for Air Research, Tromsø, Norway
11. CSEM - Observatoire Cantonal de Neuchatel, Neuchatel, Switzerland
12. Ethnikon Metsovion Polytechnion Athinon, Athens, Greece
13. Università del Salento, Lecce, Italy
14. Università degli Studi dell'Aquila, Italy
15. Ecole Polytechnique Fédérale de Lausanne, Switzerland
16. Institute of Geophysics, Polish Academy of Sciences, Belsk, Poland
17. Consorzio Nazionale Interuniversitario per le Scienze Fisiche della Materia, Unita' di Napoli, Napoli, Italy
18. Institute of Electronics, BAS, Sofia, Bulgaria
19. Karlsruher Institut für Technologie, Institut für Meteorologie und Klimaforschung, Garmisch-Partenkirchen, Germany
20. Institute Pierre Simon Laplace, Paris, France
21. Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, Department of Environment Air Pollution Unit, Madrid, Spain



# EARLINET-ASOS

## 3 Associates partners

Centro Andaluz de Medio Ambiente - Universidad de Granada, Granada, Spain

Joint Research Centre - Institute for Environment and Sustainability, Ispra, Italy

National Institute of R&D for optoelectronics, Bucharest

## Further EARLINET stations

Centro de Geofísica de Évora CGE , Évora, Portugal

Swedish Defence Research Agency, Linköping, Sweden

University College Cork, Cork, Ireland

## Future EARLINET stations

Georgian National Astrophysical Observatory, Georgia

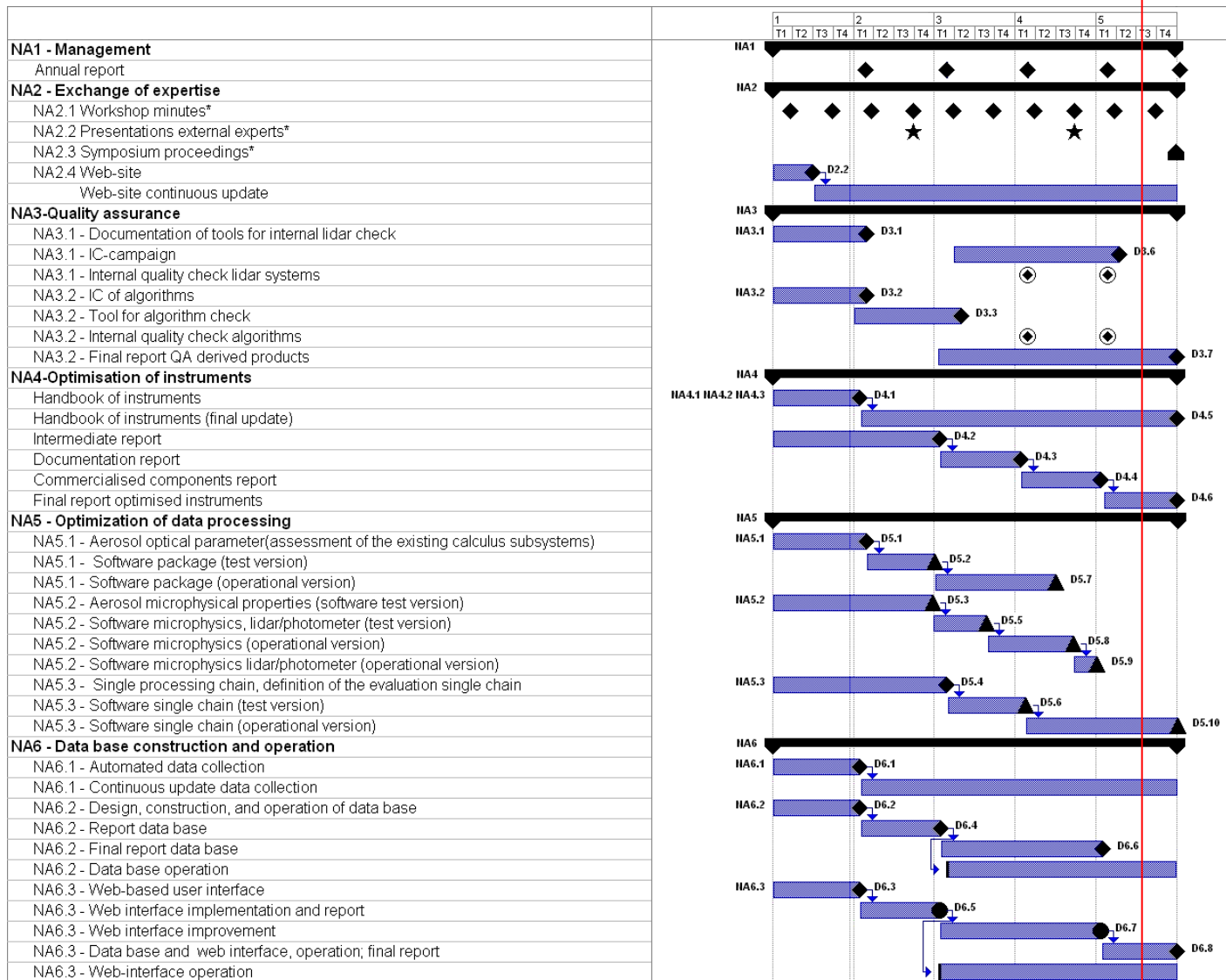
IIBR – Israel Institute for Biological Research, Ness-Ziona, Israel

Cyprus University of Technology, Cyprus

Institute of Physics, University of Belgrade, Belgrade, Serbia and Montenegro

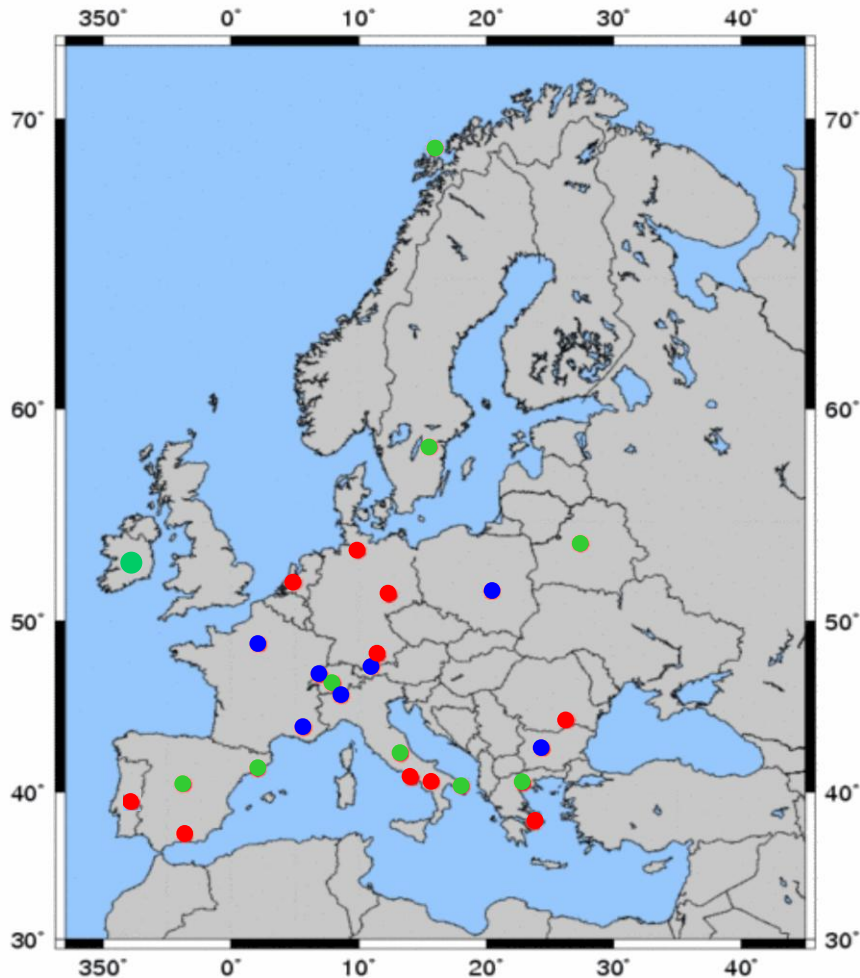
Further in United Kingdom, Sweden, Finland, Poland, France





\* Dates of workshops and symposium are to intend as foreseen dates.

# European Aerosol Research Lidar Network (2010)



- 27 lidar stations

- **10 multiwavelength Raman lidar stations**

backscatter (355, 532 and 1064 nm) + extinction (355 and 532 nm) + depol ratio (532 nm)

- **10 Raman lidar stations**

- **7 single backscatter lidar stations**

- comprehensive, quantitative, and statistically significant data base
- Continental and long-term scale

[www.earlinet.org](http://www.earlinet.org)

# EARLINET: European Aerosol Research Lidar Network

## First tool for 4D aerosol measurements on continental scale

- Quality assurance program
  - Instruments
  - Data analysis
- Predefined measurement schedule (3 per week) → unbiased
- Coordinated network observations for special events (e.g., Saharan dust, forest fires, photochemical smog, diurnal cycle, volcanic aerosols)
- Standardized data format
- Access to data via centralized data base

## WMO Global Atmosphere Watch mission

- to reduce environmental risks to society
- to meet the requirements of environmental conventions
- strengthen capabilities to predict climate, weather and air quality
- to contribute to scientific assessments in support of environmental policy

The mission is accomplished through:

- maintaining and applying global, long-term observations of the chemical composition and selected physical characteristics of the atmosphere;
- emphasizing quality assurance and quality control;
- and delivering integrated products and service of relevance to users.

Within GAW there is a specific program for aerosol observations

- in-situ measurements of aerosol chemical, microphysical, and radiative properties;
- ground-based measurements of columnar aerosol optical depth;
- ground-based measurements of aerosol vertical profiles of backscattering and extinction with lidar.

Coordination of the individual stations and networks within each of these categories is the responsibility of the GAW Science Advisory Group for Aerosols (SAG-Aerosol <http://gaw.tropos.de/>).

# GALION – the GAW Aerosol Lidar Observation Network

The objective:

The GAW aerosol program strives "to determine the spatio-temporal distribution of aerosol properties related to climate forcing and air quality up to multidecadal time scales".

The specific objective of GALION is to provide the vertical component of this distribution through advanced laser remote sensing in a network of ground-based stations.

The aerosol properties to be observed include the identification of aerosol layers, profiles of optical properties (backscatter and extinction coefficients at selected wavelengths, lidar ratio, Ångström coefficients), aerosol type (e.g. dust, maritime, fire smoke, urban haze), and microphysical properties (e.g., volume and surface concentrations, size distribution parameters, refractive index).

The operation will be designed to serve the following main areas:

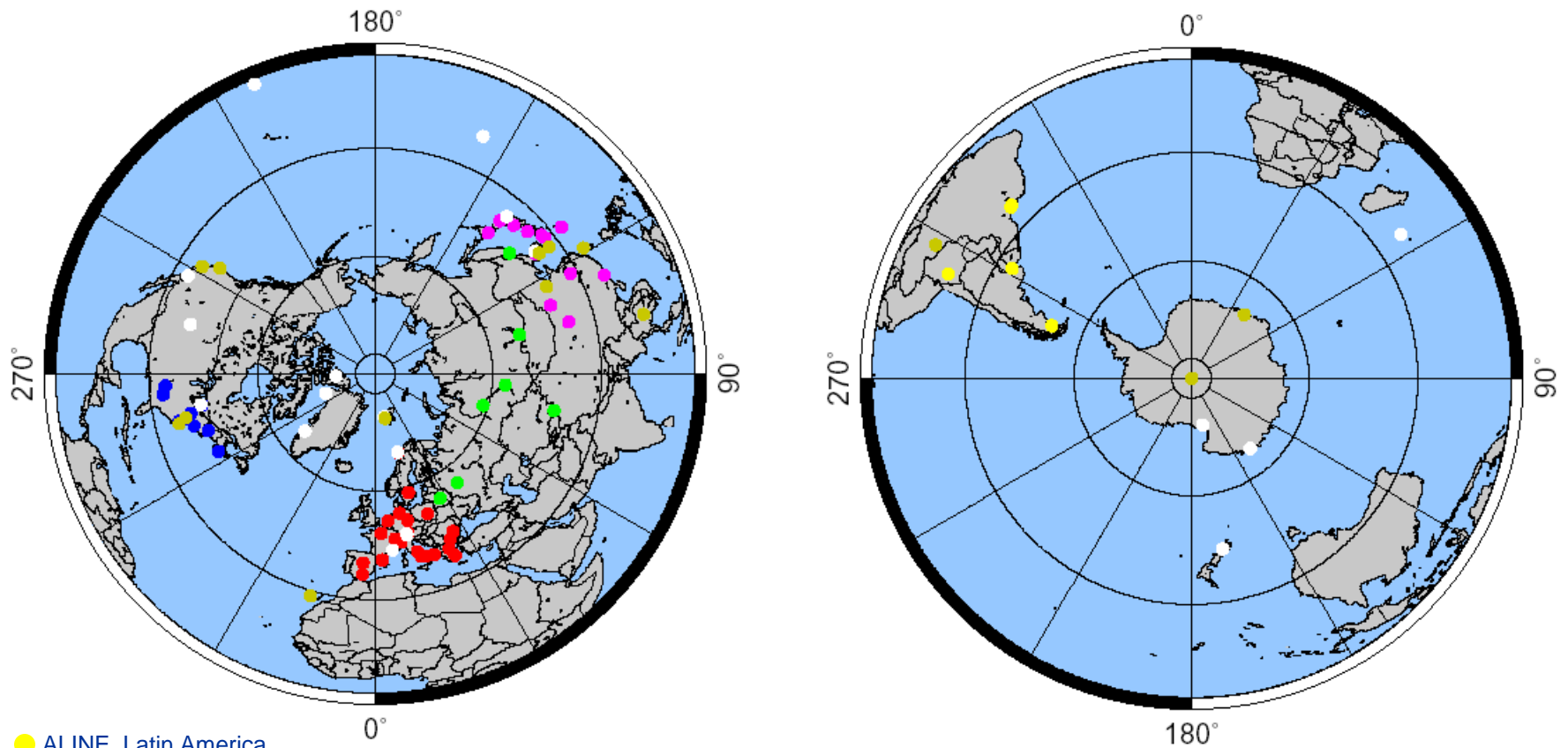
1. Climate research and assessment
  - 1.1 Global climatology
  - 1.2 Model evaluation
  - 1.3 Aerosol transport and tracers
  - 1.4 Impact on radiation, particularly UV, direct effect
2. Air quality
  - 2.1 Air quality assessment
  - 2.2 Air quality forecast
3. Plumes from special events
4. Support for spaceborne observations



GALION is organized as a Network of Networks, coordinating

- ❑ ALINE, Latin America
- ❑ AD-Net, East Asia
- ❑ CIS-LINET, Commonwealth of Independent States
- ❑ EARLINET, Europe
- ❑ NDACC, Global Stratosphere
- ❑ CLN, Eastern North America
- ❑ CORALNET, Canada
- ❑ MPLNET, Global, Micropulse Lidar

# Distribution of stations



- ALINE, Latin America
- AD-Net, East Asia
- CIS-LINET, Commonwealth of Independent States
- EARLINET, Europe
- NDACC, Global Stratosphere
- REALM, Eastern North America
- MPLNET, Global, Micropulse Lidar

# Summary and perspectives

- ❑ *Strong need for integrated long term aerosol observations*
- ❑ *4-dimensional space-time distribution of aerosols*
- ❑ *Aerosol profiling*      **→** *LIDAR*
- ❑ *the EARLINET example and the EARLINET-ASOS project*
- ❑ *Cooperation and coordination with the relevant observation and user communities*
- ❑ *Support to current and future satellite missions with lidar onboard*
- ❑ *GALION at global scale*

# ACKNOWLEDGEMENT

EARLINET colleagues

European Commission grant RICA-025991 EARLINET-ASOS

WMO - GAW

European Space Agency

German Weather Service for the air mass back-trajectory analysis

NOAA Air Resources Laboratory (ARL) for the provision of the HYSPLIT  
backtrajectory analysis

NASA for MODIS images

Maltese Euromediterranean Center (ICoD) and Barcelona Supercomputing  
Center for Dust Regional Atmospheric Model (DREAM)

AERONET

The CALIPSO team of the NASA Langley Research Center for the provision  
of the CALIPSO ground track data and for the CALIPSO data