



# ARISE

The innovative and  
multidisciplinary  
platform  
for atmospheric  
dynamics  
research and  
applications



# ARISE TEAM

## Who is embarking for ARISE?

The ARISE community currently includes 24 institutes and universities. They are all involved in research and applications and belong to 10 European member states, 4 associated countries, 1 international organisation and 3 African countries.

1. Commissariat à l'Energie Atomique et aux Energies Alternatives\*(FR)
2. Bundesanstalt für Geowissenschaften und Rohstoffe (DE)
3. Centre National de la Recherche Scientifique (FR)
4. University of Reading (GB)
5. Stiftelsen Norwegian Seismic Array (NO)
6. Università degli Studi Di Firenze (IT)
7. Deutsches Zentrum für Luft – und Raumfahrt (DE)
8. Koninklijk Nederlands Meteorologisch Instituut (NL)
9. Leibniz Institute of Atmospheric Physics (DE)
10. Andoya Space Center (NO)
11. Institutet för rymdfysik (SE)
12. Norwegian University of Science and Technology (NO)
13. Ústav Fyziky Atmosféry (CZ)
14. European-Mediterranean Seismological Centre (EMSC)

\* Commissariat à l'Energie Atomique et aux Energies Alternatives is in charge of project coordination and provides the Project Coordinator, Dr. Elisabeth Blanc.

## ARISE



15. Université de la Réunion (FR)
16. Institute of Applied Physics – University of Bern (CH)
17. Tel Aviv University – Department of Geosciences (IL)
18. National University of Ireland Maynooth (IE)
19. Veðurstofu Islands/Icelandic Meteorological Office (IS)
20. Institut et Observatoire de Géophysique d'Antananarivo (MG)
21. National Institute for Earth Physics (RO)
22. Universidade dos Açores – Fundação Gaspar Frutuoso (PT)
23. Centre National de la Cartographie et de Télédétection (TN)
24. Station géophysique de Lamto (CI)

The ARISE specificity is to gather strong and complementary participants to elucidate the dynamics of the middle and upper atmosphere in broad time and space scales.

A collaborative effort of 24 institutions funded by the European Commission's H2020 Programme which runs from 2015 till 2018 under contract number 653980.

# ARISE KEY CHALLENGES

## What are the major objectives?

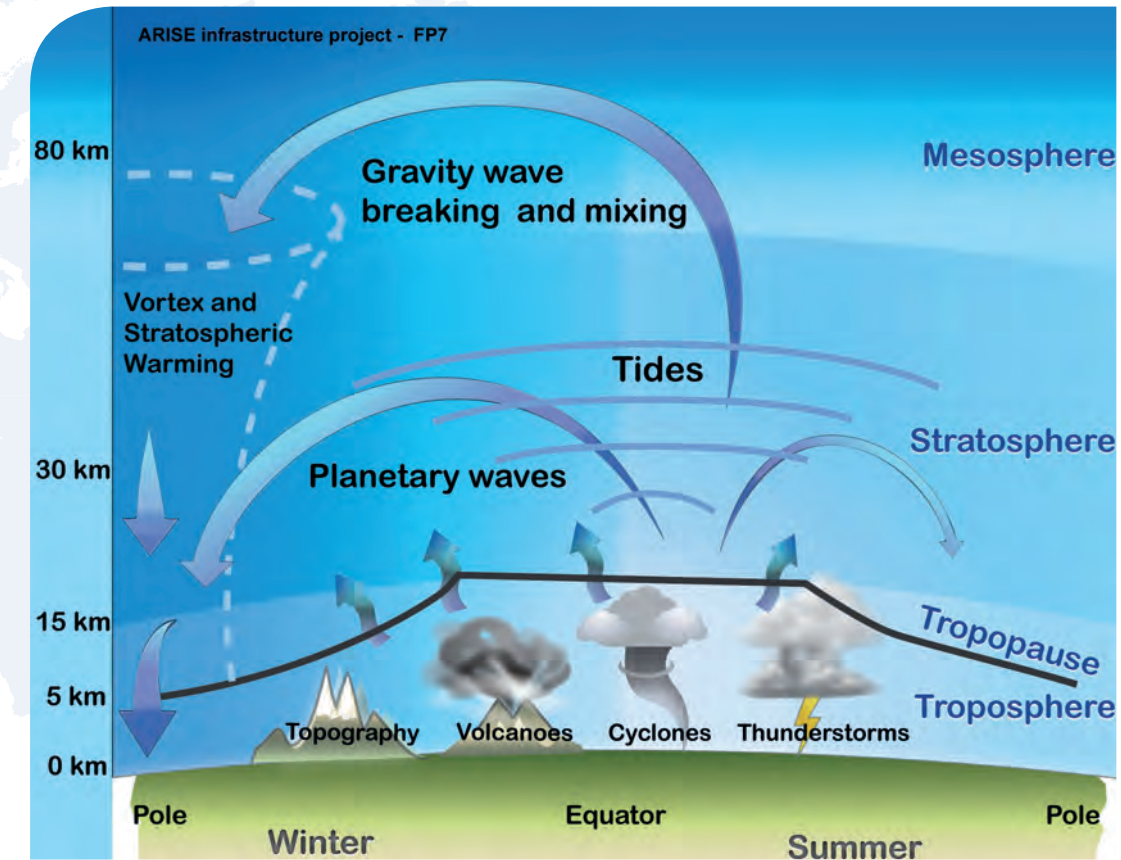
ARISE aims at establishing a unique atmospheric research and data platform in Europe. It combines observations with theoretical and modelling studies to improve our understanding of the dynamics of the middle and upper atmosphere.

For the first time several technologies (infrasound, LIDAR, airglow, radars, ionospheric observations and satellites) are used simultaneously and in a complementary way. The collected data are required to improve weather forecasting to monthly or seasonal scales, remote volcano monitoring, climate monitoring and other applications. The ARISE data portal provides high-quality, easy-to-use data and advanced data products to a wide scientific community.

The ARISE project contributes and leads to important advances in the field of atmospheric sciences extending from short-term impacts such as volcanic eruptions and climate related extreme events to long-term climate change with a great societal and commercial impact to Europe and beyond.

Large scale sources are at the origin of gravity waves and planetary waves which can impact the middle atmosphere and disturb the global circulation system producing for instance stratospheric warming in polar regions. They therefore have to be taken into account in numerical weather prediction models to improve weather forecasting up to several weeks or a season.

*Dynamics of the troposphere-stratosphere-mesosphere*



Joining forces and sharing data to improve weather forecasting and climate studies.

# ARISE OBSERVATION NETWORK

## What is new?

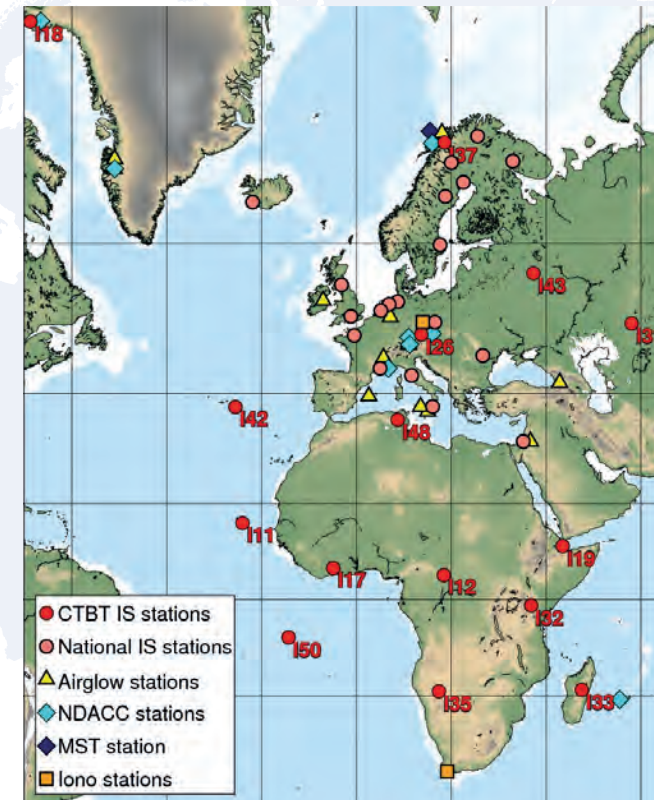
The ARISE project implements a new infrastructure that integrates complementary atmospheric observation networks and stations to provide a new 3D image of the atmosphere in the different atmospheric layers from ground to mesosphere with unprecedented spatio-temporal resolution. The coverage is Europe and outlying regions, including polar and equatorial regions.

The infrastructure consists of:

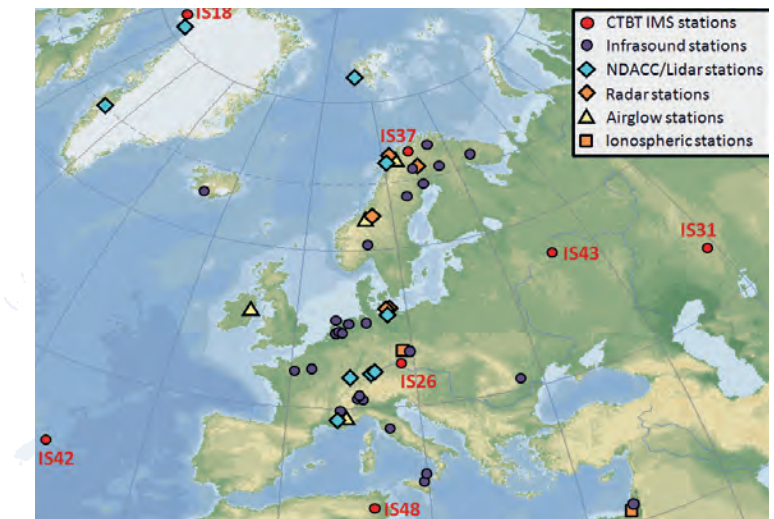
- European parts of the International Monitoring System (IMS) infrasound network developed to ensure compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT);
- European infrasound network composed of national stations and networks;
- Network for the Detection of Atmospheric Composition Changes (NDACC) using Light Detection And Ranging (LIDAR);
- Andoya Space Center observatory;
- Reunion Island Observatory (Maïdo);
- complementary radars and ionospheric sounding systems to study the coupling with geospace.

Satellite data are used to complement further model validations.

ARISE observation network



Providing 3D images of the atmospheric layer dynamics by integrating complementary measurements of the station networks.



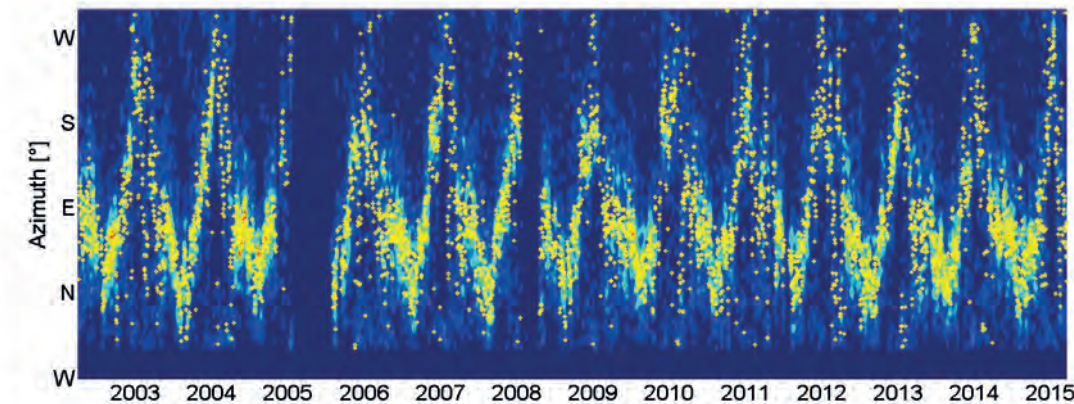


# ARISE SCIENTIFIC HIGHLIGHTS

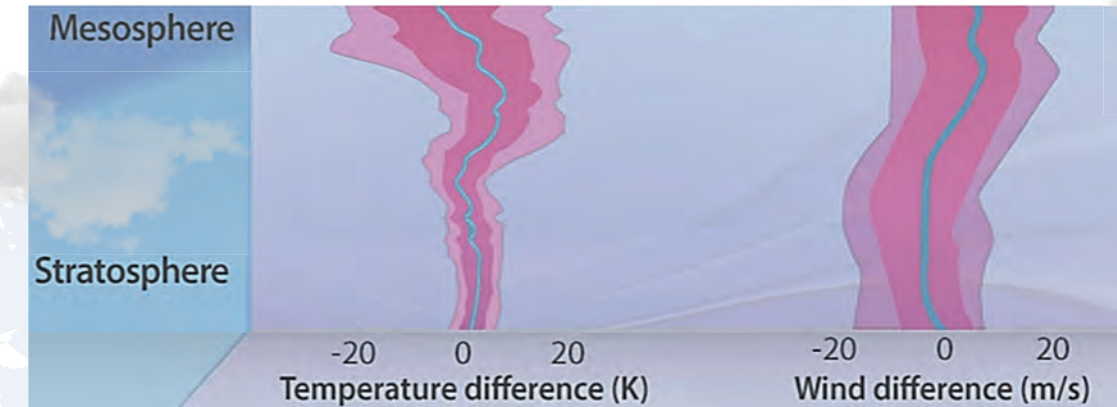
## What did the ARISE project reveal?

### THUNDERSTORM CONVECTION IN AFRICA

Thirteen years of gravity wave activity measured by the Ivory Coast infrasound station contribute to the understanding of large scale disturbances from thunderstorm convection in Africa. The large oscillation of the wave azimuth is associated to the annual oscillation of the intertropical convergence zone of surface winds which drives the thunderstorm activity. ARISE demonstrates that this huge wave activity mainly originates from convection.



*Understanding large scale disturbances from thunderstorm convection in Africa*



*Comparison between ARISE observations and models (median and standard deviations)*

### INTEREST OF ARISE DATA TO CALIBRATE MODELS

ARISE data products reveal differences between temperature and wind models, and observations reaching 20 K and 15 m/s in the stratosphere and mesosphere, especially during stratospheric warming events. This difference arises from the lack of routine observations at high spatial and temporal resolution in these regions.

One ARISE objective is to provide an improved description of the middle and upper atmospheric dynamics. ARISE data already start to be used as benchmark for the ECMWF (European Centre for Medium Range Weather Forecasts) model updates.

Data innovation and quality will contribute to build an unique data set for research and applications related to weather, climate and natural hazards.

## Which added value does the ARISE data centre create?

## DATA MANAGEMENT

- ## DATA PROCESSING

- ## WEB ACCESS TO DATA PRODUCTS

- The ARISE data centre supports the EU open data policy. It does so by supporting downloading of scientific products in order to foster collaboration among the scientific community.

The diagram illustrates the Earth's atmosphere and the impact of various phenomena. The vertical axis shows altitude from 0 km to 80 km, with labels for the Troposphere, Stratosphere, Mesosphere, and Thermosphere. The horizontal axis shows latitude from Pole to Equator to Pole, and seasons from Winter to Summer. Key phenomena shown include Topography, Volcanos, Cyclones, and Thunderstorms at the surface; Planetary waves, Tides, and Gravity wave breaking and mixing in the lower atmosphere; and Airglow in the upper atmosphere. The diagram also indicates Vortex and Stratospheric Warming and the Tropopause. The title is 'Earth Observation (Satellite)' and the project is 'ARISE infrastructure project - FP7'.

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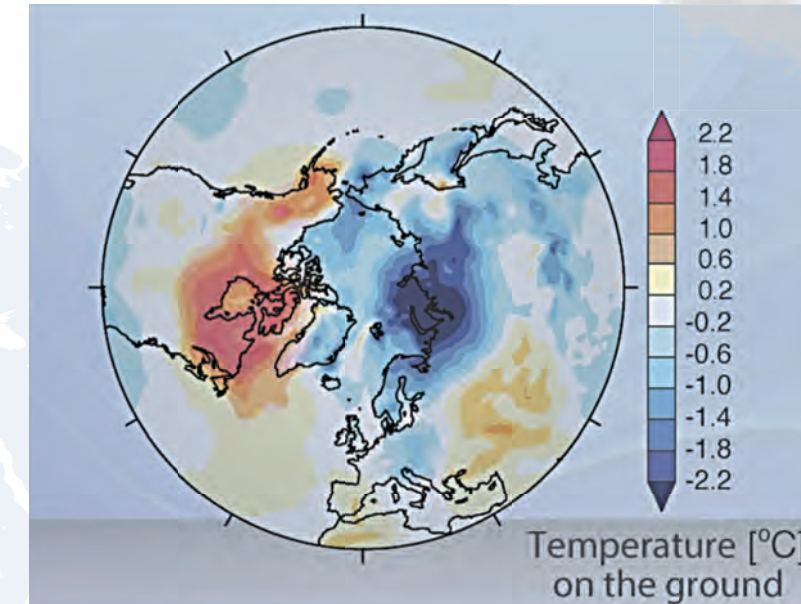


# SCIENTIFIC IMPACTS

## What does the ARISE project contribute to science?

- It integrates a new and improved set of observations of the middle and upper atmosphere for the future initialization of model forecasts at unprecedented spatial and temporal resolution.
- It generates observations of gravity wave parameters used for future improvement, testing and validation of numerical atmospheric models which will ultimately lead to improved meteorological and climate forecasting.
- It monitors climate-related phenomena such as severe weather, thunderstorms and sudden stratospheric warming (SSW) events. It does so over a large period of time in order to identify their intensity and evolution with climate change.
- It provides high quality data from the ground to the mesosphere and ionosphere for a better understanding of atmospheric extreme events.

The major SSW event of January 2013 was followed a few weeks after by the cooling of the surface temperature over Northern Europe and a warming over North America. This was accompanied by a decrease in precipitation over the North Atlantic and an increase in the Mid-Atlantic.



*Sudden stratospheric warming impact on weather*



*Cold weather in France (Vaux-de-Cergy) a few weeks after the January 2013 stratospheric warming*

# SOCIETAL IMPACTS

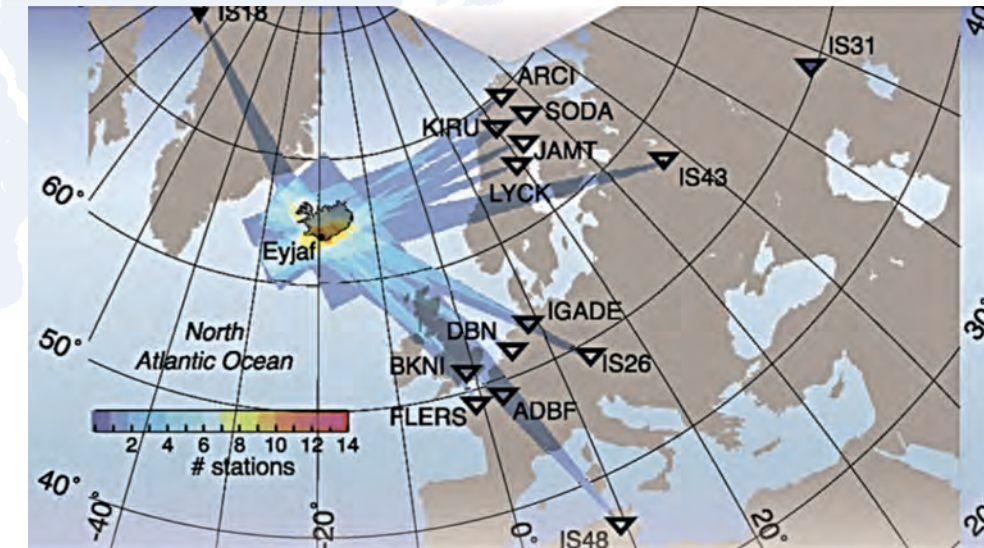
## What does the ARISE project bring to our society?

Besides new climatological insights the ARISE project also offers a wide range of civil security applications that have the potential to contribute to human welfare and safety. ARISE's integrated way of monitoring the atmosphere of the Earth with data from cutting edge technologies – using infrasound, LIDAR and complementary technologies – can also be used for observing extreme events such as distant volcanic eruptions.



Stromboli Eruption  
on 08 August 2014.  
Courtesy of Manuel  
Oliva.

Infrasound technology has revealed to be extremely efficient in providing near real-time reliable source-term parameters from local to long-range (thousands of km) observations. It is well adapted to monitor activity of distant non-instrumented volcanoes, providing information about eruption class and confidence index depending on environmental conditions.



Long range volcano monitoring  
using distant infrasound stations  
(May 2010 Eyjafjallajökull eruption)

Infrasound is used to  
construct the eruption  
chronology with  
high temporal reso-  
lution and complete  
satellite detection  
which can suffer  
from cloud cover.



# NEXT GRAND CHALLENGES

## How to gather missing data?

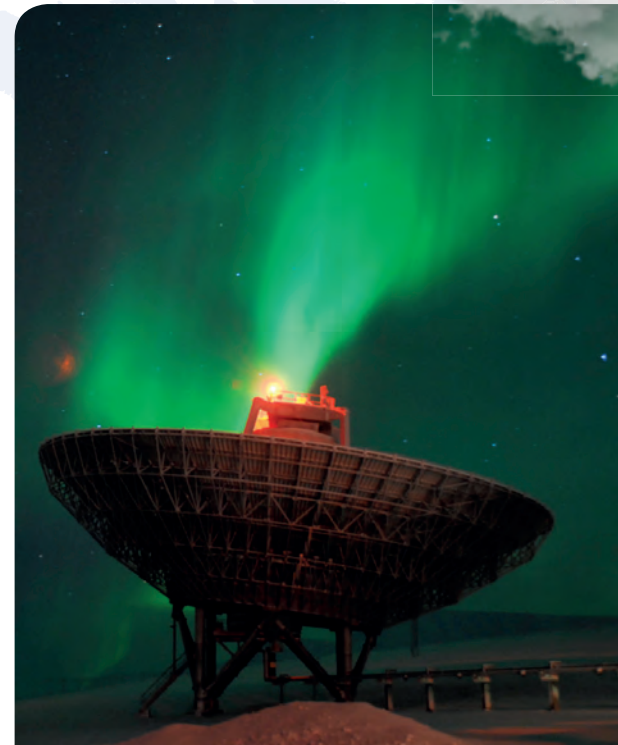
### INNOVATION IN INSTRUMENTATION

#### Extended coverage

ARISE covers geographical regions such as equatorial and tropical Africa where atmospheric disturbances (thunderstorms, convection) are intense. In these regions only a few infrasound stations are currently in operation. The feasibility of LIDAR wind and temperature observations in equatorial African regions is investigated. In the tropics the atmospheric observatory of Reunion Island is integrated in the project while in polar regions, relevant European infrastructures such as ALOMAR and EISCAT will be used in complement. These regions are submitted to geomagnetic storms and auroras which are at the origin of infrasound and other disturbances in the atmosphere, observed by the ARISE stations.

#### Extended altitude range

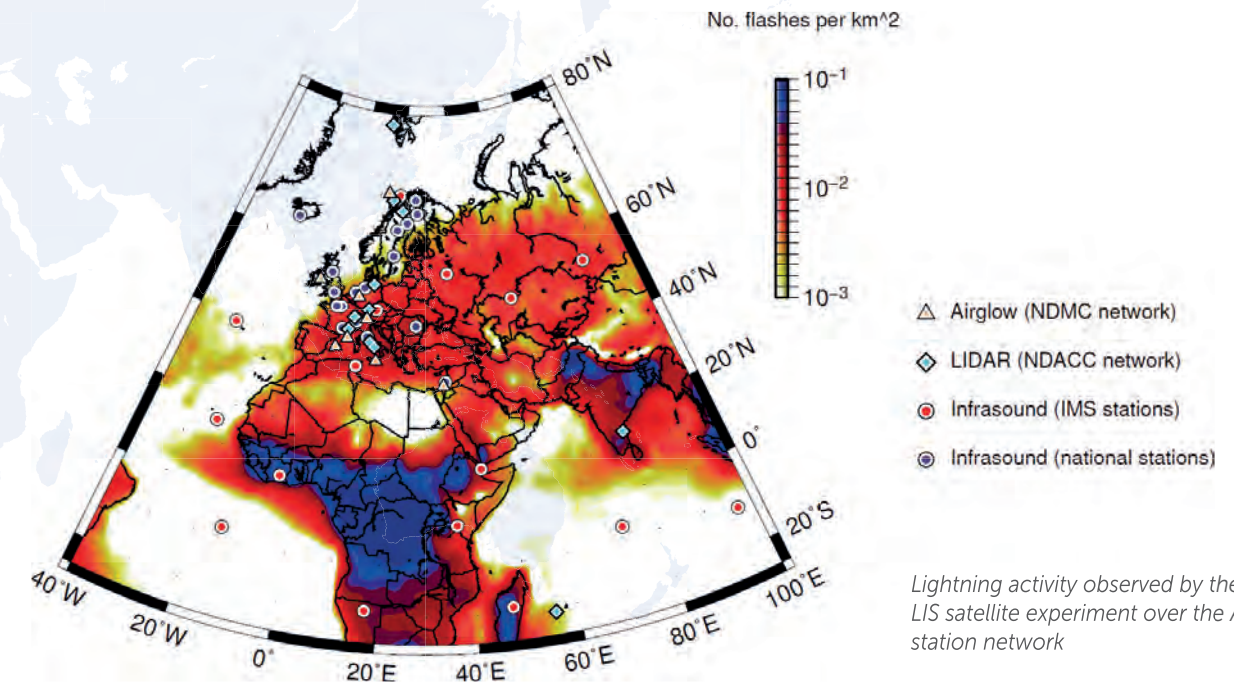
Innovative prototypes providing complementary observations in the stratosphere and mesosphere will be developed and tested for future implementation in the ARISE stations. ARISE plans to reinforce mesospheric and ionospheric measurements to determine the link with the near geospace environment.



Aurora above Svalbard, Norway on 19 December 2006.  
Courtesy of Cyril Simon Wedlund, Aalto University (Finland)

#### Striving for continuous observations

Several instruments, such as LIDAR's and Mesosphere-Stratosphere-Troposphere (MST) Radars, are in regular operation throughout the year, but these instruments are designed for basic research and do not use near real-time data processing. Unprecedented automatic procedures for quasi-continuous observations in a survey mode will be developed.



Lightning activity observed by the NASA LIS satellite experiment over the ARISE station network

# LOOKING AHEAD

## To whom is dedicated the ARISE platform?

The concept of the proposed design study is based on ambitious collaborations of European complementary institutes providing additional data or expertise. It integrates complementary international infrastructures and observatories to develop a groundbreaking new system for atmospheric studies within Europe beyond the current state-of-the-art studies of the atmospheric dynamics.

The ARISE project opens an improved way to monitor and study the atmosphere in the different atmospheric layers. Future grand challenges are:

- to provide all needed data by updating the station network coverage and processing methods;
- to assimilate new data sets in models for improving weather forecasting up to weeks and months;
- to develop applications for decreasing environmental risks;
- to measure the long-term evolution of atmospheric disturbances to understand and predict their evolution with climate change.

The impacts are important for many applications (agriculture, prediction of energy consumption, renewable energy production, tourism...).

*ARISE products are used to reveal climate change indicators such as icequake events, severe weather, temperature anomalies in the stratosphere.*



With the plan of an improved network and extended coverage, the data collected in ARISE will help to improve weather forecasting to monthly or seasonal scales. It also contributes to climate monitoring and offers a wide range of civil applications. A broad scientific community will be able to deepen their research with the advanced ARISE data portal.



# INTERESTED IN MORE?

Visit  
<http://arise-project.eu>

