SHORT TERM SCIENTIFIC MISSION (STSM)
SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA 15211
STSM title: METHODOLOGY OF THE COMPARATIVE STUDY OF AIR IONS AND NANOPARTICLES MEASUREMENTS IN DIFFERENT LATITUDES OF THE NORTHERN HEMISPHERE BASED ON THE MEASUREMENT CAMPAIGN IN THE UNIVERSITY OF CANTABRIA AND WORK DONE BY THE INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH
STSM start and end date: 23/04/2019 to 29/04/2019
Grantee name: SALCINES SUAREZ, CIRO LUIS

PURPOSE OF THE STSM:

(max.200 words)
The purpose of this STSM was to receive advice fron INAR on atmospheric nanoparticles and share knowledge in relation to the ELECTRONET COST Action in general and more specifically on the following topics:

- To assess and validate the dataset quality registered in the measurement campaign of the University of Cantabria (UC campaign).
- To describe the air electrical properties in the Atlantic Domain in Northern Spain using Electric Low Pressure Impactor (ELPI+) measurements, and compare them with a Boreal and Antartic measurements.
- To analyze the ELPI+ data records for understanding the dynamic changes of atmospheric nanoparticle aerosols.
- To determine the deposition of the atmospheric nanoparticles in the human tract respiratory system.
- To give a presentation on bio-effects of charged atmospheric nanoparticles in INAR/University of Helsinki.
- To visit measurement station SMEAR II.
- To meet with INAR group that work on dispersion modelling in different scales.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

PEEX IMPLEMENTATION MEETING (23 and 24 April)

During the STSM I had the opportunity of attend to the PEEX Implementation Meeting. PEEX "Pan-Eurasian Experiment" study is a multidisciplinary climate change, air quality, environment and research infrastructure program focused on the Northern Eurasian particularly arctic and boreal regions. The overall goal of PEEX is to solve interlinked global challenges like climate change, air quality, biodiversity loss, chemicalisation, food supply, energy production and fresh water in integrative way recognizing the increasing role of the arctic and northern boreal forests in the context of global change.

TO VALIDATE THE DATASET UC CAMPAIGN AND NEW PARTICLE FORMATION LEARNING (24, 26 and 29 April)

The ELPI+ instrument measures from 6nm to 10 µm in 14 channels.Talking about the channels, the three lower ones range has a mean of 6nm, 16nm and 30nm. The data collected covers concentration, diameter, area, volume, mass and charge (Figure 1a).

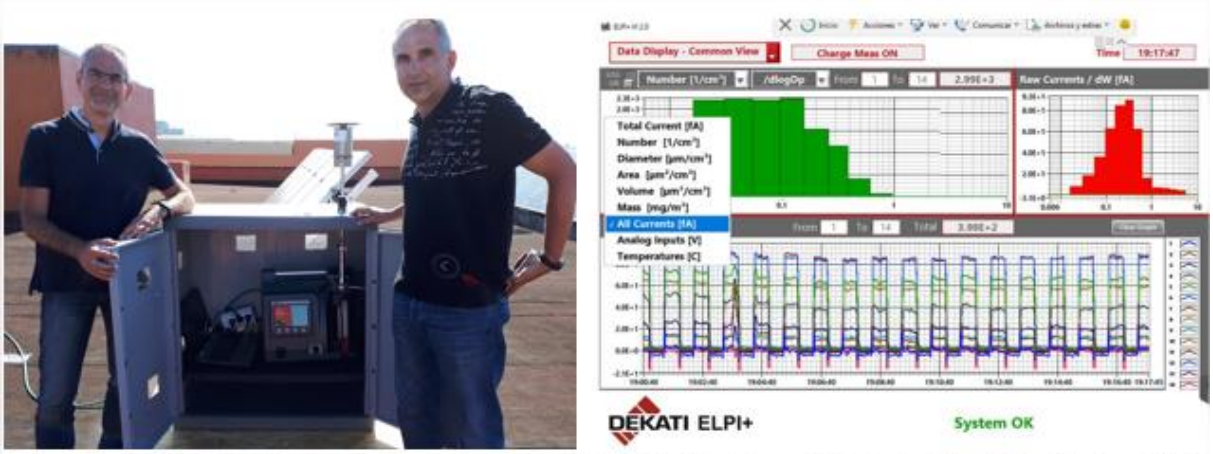

Figure 1a. (Left) Prof. Pablo Fernández De Arroyabe, Chair of Working Group IV Biological effects Cost Action 15211 and Ciro Salcines research fellow. (Right) Screenshot of dataset collected during UC campaign.

INAR has been measuring since 2009 in order to present detailed observations of atmospheric nanoparticles and cluster down to 1nm mobility diameter. Atmospheric nucleation is the dominant source of aerosol particles in the global atmosphere and an important player in aersol climatic effect. The key setps of this process occur in ths sub-2-nanometer size range. Atmospheric New Particle Formation (NPF) and growth refer to the formation of molecular clusters and their subsequent growth to larger sizes (Kulmala et al., 2013), (Figure 1).

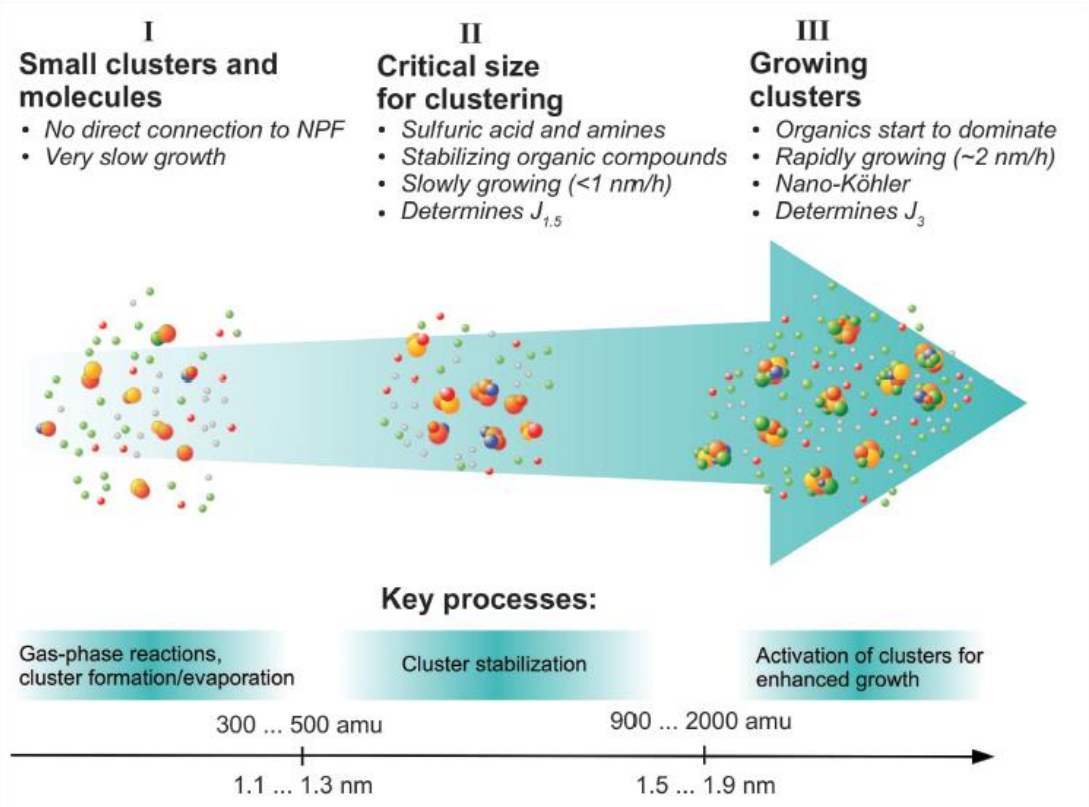

Figure 1 Schematic description of main size regimes of atmospheric neutral clusters and the main processes related to *those size ranges.*

First to a few nm in particle diameter, then to nucleation and Aitken mode particles in the sub-100 nm size range, and possibly up to sizes at which these particles may act as cloud condensation nuclei (CCN).

Molecular cluster formation appears to take place almost everywhere and all the time in the atmosphere, whereas the formation of growing nanoparticles either by homogeneous or heterogeneous nucleation requires more specific atmospheric conditions.

The joint measurements with differente instruments give the range of data required for studying NPF event in boreal forests. Some of the instruments linked with ELPI+ are the following ones:

- Particle Size Magnifier (PSM) at 2m and 35 m height, measures particle size distribution from 1-3 nm.
- Twin Differential Mobility Particle Sizer (DMPS) with Condensation Particle Counters, measures aerosol particle number size distribution from 3-1000nm.
- NAIS is a multichannel aerosol instrument for measurement of size and mobility distributions of aerosol particles and air ions in the atmosphere.NAIS measures from below 1nm to 40 nm in 21 channels.
- From May 2005 to October 2016, Electric Lower Pressure Impactor (ELPI) measured aerodynamic size distribution from 30nm-10µm.

The three lower channels of the ELPI+ (means of 6nm, 16nm and 30nm) of the measurement campaign shares the range with the upper channels of NAIS and the whole range of the DMPS. This joint work is the key for setting a potential continuous range from the beginning of the nanometric scale to micrometric scale. The study of the units of measurement can give a thorough study (Figure 2).

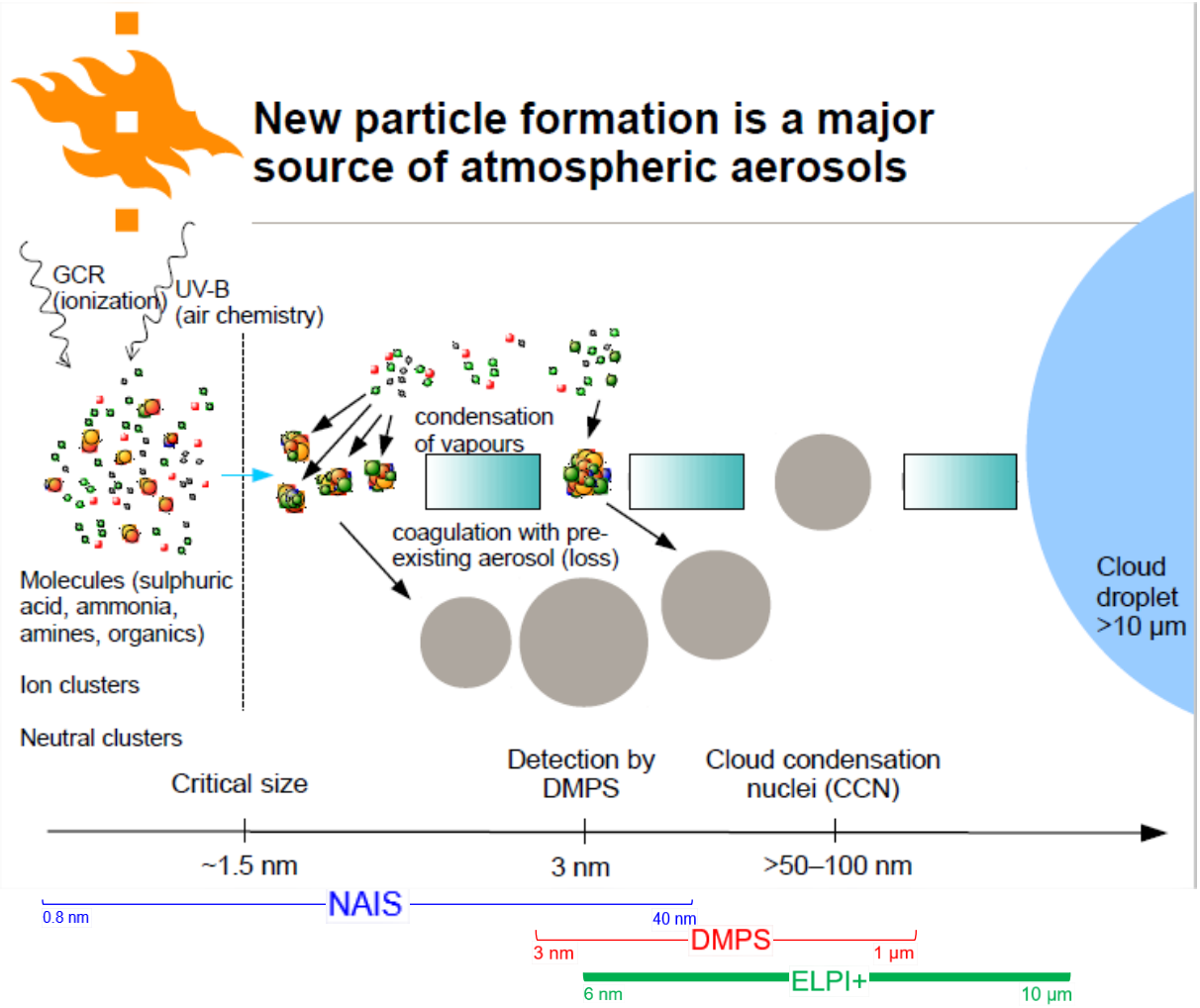

Figure 2. New particle formation is a major source of atmospheric aersols. Figure courtesy of Tuomo Nieminen, adapted by Ciro Salcines.

Thoroughout the STSM we had several meetings and discussions about these topics with Tuukka Petäjä and the researchers Pauli J Paasonen, Tuomo Nieminen and Janne Lampilahti. Here are some of the

issues related with the methodology that contributed to validate the dataset registered and the measurement strategy of UC campaign:

- Location of the instrument far enough away from incidental contamination antropogenic and natural contamination.
- Measurement parameters, period of tiempo selected and range recorded.
- Samplers collected for offline characterization.
- Standar metereologic measurements.

PRESENTATION (24 April)

I gave a presentation in INAR/University of Helsinki with the title “Deposition of atmospheric electrically charged nanoparticles in the human respiratory tract” and these topics:

- Cost Action 15211 Electronet
- Biometeorology
- Introduction to Nanoparticles
- Nanoparticle Measuring Device
    - Real-Time Measurement
    - To Characterize Air Samples
- Nanotoxicology
    - Nanoparticle Deposition in the Human Respiratory Tract
    - Biological Aspects

During the question time we discussed about the main challenges about the deposition of atmospheric nanoparticles and their urgent needs.

MODELLING IN DIFFERENT SCALES (26 April)

The discussions with the research Alexander Mahura about modelling of atmospheric processes were fruitful, too. He introduced me about these modelling suitable with UC campaign:

- Environment-High Resolution Limited Area Model (Enviro-HIRLAM) online integrated meteorology-chemistry modelling system: strategy, methodology, developments and applications (v7.2). The downscaling for Enviro-HIRLAM goes from global hemispheric scale, regional scale, sub-regional scale until urban scale.
- The components of Enviro-HIRLAM are; gas phase chemistry (carbon bond v.Z), deposition (dry and wet), emissions (antrophogenic, biogenic, VOCs, forest fire) (Figure 3).

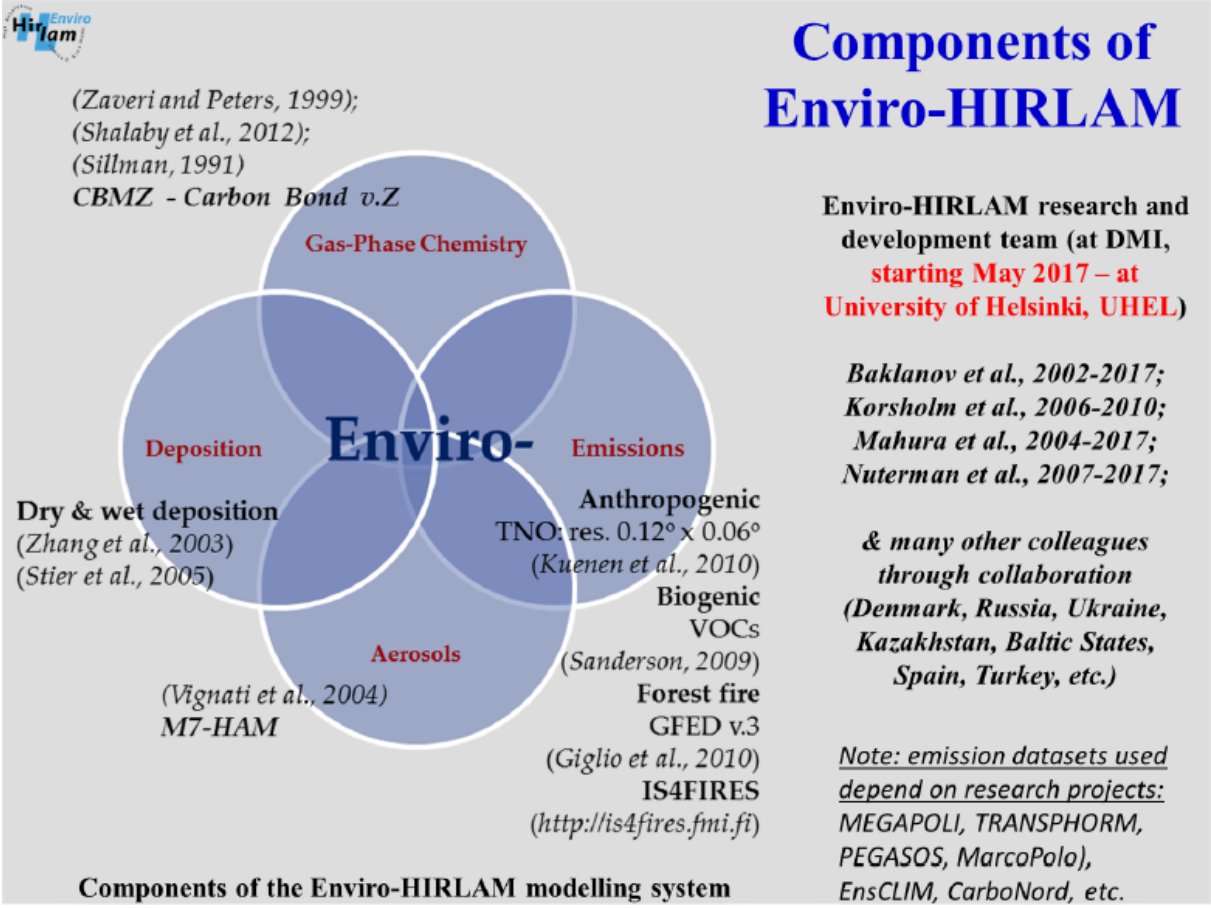

Figure 3. Components of Enviro-HIRLAM

SMEAR II STATION IN HYYTIÄLÄ (25-26 April)

The researcher Janne Lampilahti accompanied me to Hyytiälä field station SMEAR II (Station for Measuring Forest Ecosystem-Atmosphere Relations). Hyytiälä is three hours driven by car away from Helsinki, so we decided to spent one full day and to stay one night there. The following day we returned back to Helsinki.

In Hyytiäla I received a full explanation about different instruments of amospheric measuremts and ecosystem relations. The different measurement strategies and methodologies were constantly discussed.

- Neutral cluster and Air Ion Spectrometer (NAIS) (Figure 4) (Manninen et al., 2009).
- Real-time NAIS measurements (Figure 5).
- NAIS (Figure 6).
- HITU HU instruments location (Figure 7).

Figure 7. HITU HUT

Figure 6. NAIS

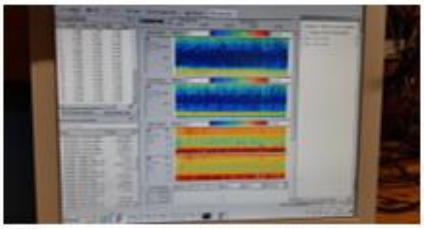

Figure 5. Real-time NAIS measurements

Figure 4. Inside the INAIS

- Cloud Condensation Nuclei Counter (CCNC) (Figure 8)
- Condensation Particle Counter (CPC). (Figure 9)
- Ultrafine Condensation Particle Counter (UCPC) (Figure 9)
- Differente locations of SMEAR II, towers, mast, containers and instruments (Figure 10).
- Measurements analysis with real database (Figure 11)

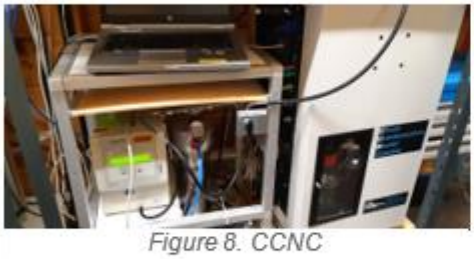

Figure 8. CCNC

Figure 9. CPC and UCPC

Figura 10. 35m Tower, Instruments on the top 35m Tower, 127m mast, instruments in containers and SMEAR memorial plaque

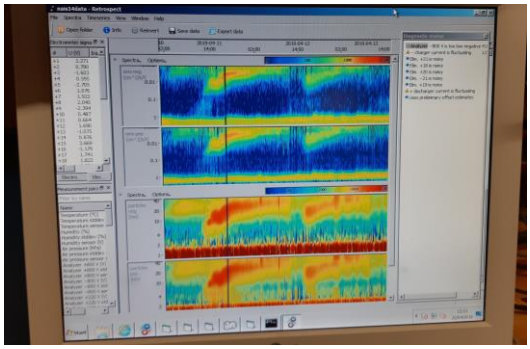

Figure 11. Measurements analysis with real database.

Figure 22. Prof. Tuukka Petäjä host researcher and Ciro Salcines

DESCRIPTION OF THE MAIN RESULTS OBTAINED

UC campaign approach allow to rely on the correct data collected. We have found a link to study about NPF analysis with the dataset for UC campaign with INAR researchers. When this work will be finished, a paper can be published.

After the presentation on bio-effects of charged atmospheric nanoparticles in INAR, we discussed about the main challenges about the deposition of atmospheric nanoparticles and their urgent needs.

To have visited station SEMAR II. To have learnt NPF instruments and to have known new atmospheric measurement strategies relied on with atmospheric electric fleld.

To have met with INAR group that work on dispersion modelling in different scales. Enviro-HIRLAM can let us to study fluxes scenarios on urban boundary layer of the city of Santander. In addition, could have the option of adding biometeorogial indices

To describe the air electrical properties in the Atlantic Domain in Northern Spain using Electric Low Pressure Impactor (ELPI+) measurements, and compare them with a Boreal and Antartic measurements.

FUTURE COLLABORATIONS (if applicable)

We have agreed to examinate jointly with INAR the database in order to look for NPF during UC campaign and to publish a paper about this topic.

To study OxyAlert App and oxiygen biometeorogical indice as a component of Enviro-HIRLAM.