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

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eLECTRONET
cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY
COST is supported by the EU Framework Programme Horizon 2020

Objectives of the STSM

The purpose of this STSM was to receive advice from INAR on atmospheric nanoparticles and share knowledge in relation to the Cost Action 15211 ELECTRONET:

* To assess and validate the dataset quality registered in the measurement UC campaign.
* To describe the air electrical properties in the Atlantic Domain in Northern Spain using ELPI+®data.
* To analyze the ELPI+® data records for understanding the link between atmospheric circulation and atmospheric nanoparticles aerosols.
* To determine the deposition of the atmospheric nanoparticles in the human tract respiratory system.

Introduction

Geobiomet, the Biometerorology group of the University of Cantabria, conducted a measurement campaign on sample collection of atmospheric nanoparticles during summer. 2018 The campaign was for studying atmospheric electrical proprieties and we collected data on the charge distribution, concentration, mass, size distribution, means and superficial area of atmospheric nanoparticles (Fig. 1). Atmospheric nanoparticles were measured in the size range of 6 - 10 000 nm to investigate the linkage between nanoparticle properties and human health.

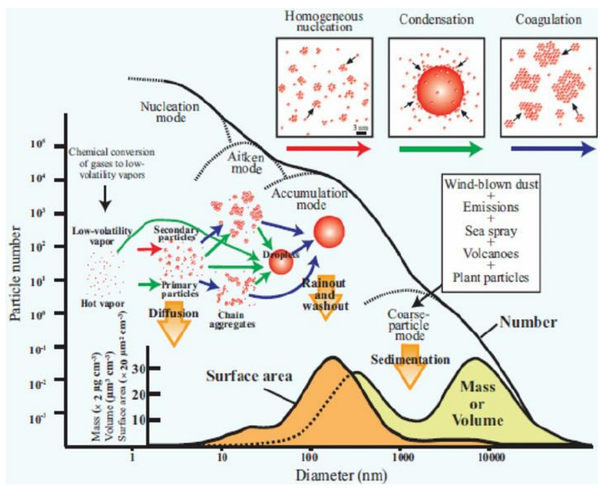

Figure 1. Santanu et al. (2015) Natural Nanoparticles: Implications for Environment and Human Health[1].

Atmospheric New Particle Formation (NPF) and growth refer to the formation of molecular clusters and their subsequent growth to larger sizes, 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). According to Kerminen et al. (2018)[2], 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 (Kulmala et al., 2014)[3] .

Description of work carried out

PEEX IMPLEMENTATION MEETING (23-24 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 arctic and boreal regions.

Description of work carried out

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

- The ELPI+® instrument measures from 6nm to 10 µm in 14 channels. Talking about the channels, the three lower one range has a mean (D50%) of 6nm, 16nm and 30nm (Figure 2).

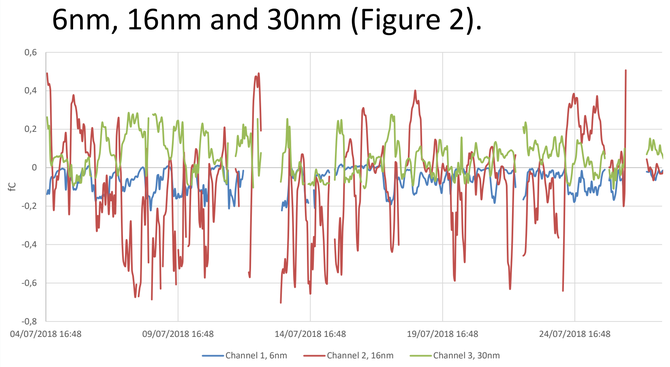

Figure 2. Atmospheric nanoparticles charge in Santander during July 2018.

Atmospheric nucleation is the dominant source of aerosol particles in the global atmosphere and an important player in aerosol climatic effect. The key sets of this process occur in the 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)[4], (Figure 3).

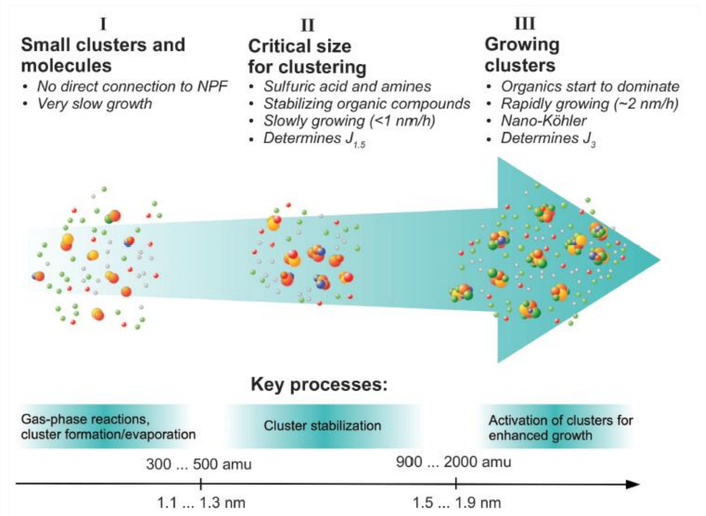

Figure 3. Schematic description of main size regimes of atmospheric neutral clusters and the main processes related to those size ranges, (Kulmala et a. 2013)[4].

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 4).

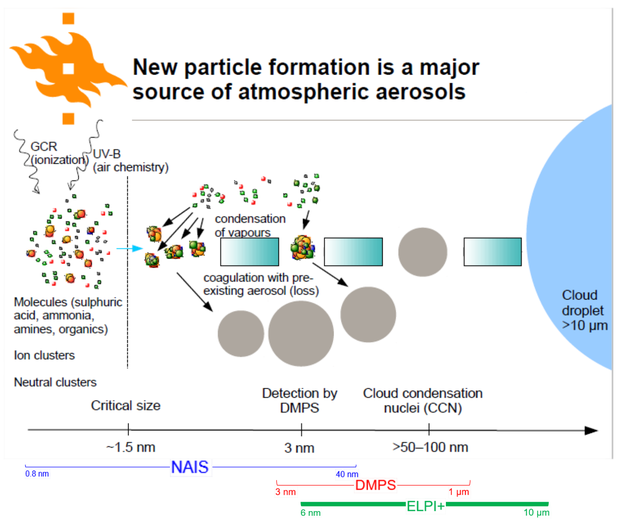

Figure 4. NPF is a major source of atmospheric aerosols. Figure courtesy of Tuomo Nieminen, adapted by Ciro Salcines.

Description of work carried out

PRESENTATION (24 April)
I gave the presentation "Deposition of atmospheric electrically charged nanoparticles in the human respiratory tract" in INAR/Physics, University of Helsinki.

MODELLING IN DIFFERENT SCALES (26 April)
Discussions with researchers about modelling of atmospheric processes were fruitful (Figure 5).

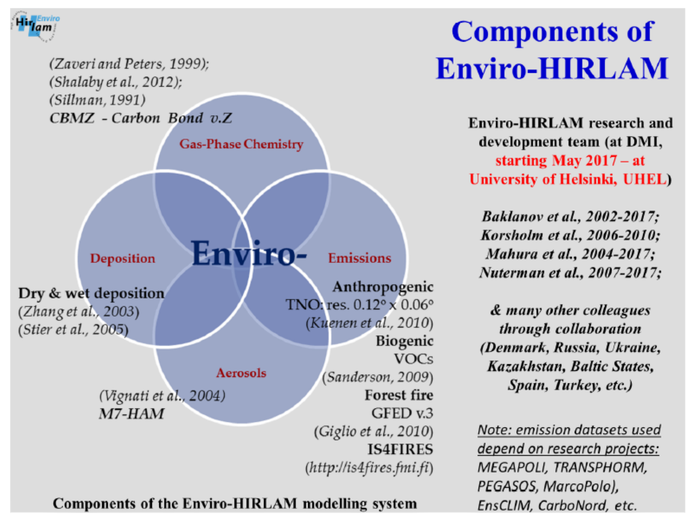

Figure 5. Components of Enviro-HIRLAM. Figure courtesy of Alexander Mahura.

SMEAR II STATION IN HYYTIÄLÄ

SMEAR II STATION IN HYYTIÄLÄ (25-26 April)

- To visit Hyytiälä field station SMEAR II (Station for Measuring Forest Ecosystem-Atmosphere Relations). In Hyytiäla I received a full explanation about different instruments of atmospheric measurements and ecosystem relations. The different measurement strategies and methodologies were constantly discussed. Measurements analysis with real database (Figure 6). Locations of SMEAR II, towers, mast, containers and instruments (Figure 6).

Figure 6. (from left to right) 127m mast equipped with atmospheric measuring devices, SMEAR memorial plaque, new particle formation events analyzed with real database, 35m Tower and instruments on the top 35m Tower.

Results

* STSM approach allowed to rely on the correct data collected during UC campaign. We have found a link to study about NPF analysis with the dataset for UC campaign with INAR researchers.
* 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 field.
* 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 biometeorological indices.

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Acknowledges

I would like thank to Xuemeng Chen PhD., Pauli Paasonen Prof., Tuomo Nieminen Prof., Janne Lampilahti PhD Student and Alexander Mahura PhD., their support and help for the development of this STSM. I would like also to acknowledge to the Institute for Atmospheric and Earth System Research (INAR) from the University of Helsinki the given support.

References

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Action Title: "Atmospheric Electricity Network: coupling with the Earth System, climate and biological systems (ELECTRONET)" Cost Action 15211