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The importance of continuous comprehensive observations: from atmospheric clustering via feedback loops to global climate and air quality

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Currently the observations are typically fragmented into 1) greenhouse gases; 2) aerosols; 3) air quality; 4) trace gases; 5) ecosystems; 6) climate; 7) ... And the different scientific communities typically do not collaborate or even communicate with each other - although these kind of barriers do not exist in nature. However, in order to produce reliable data and in-depth understanding we need integrated approach to be able to answer global grand challenges. The integrated approach is also effective in impact and economy point of view. Therefore, we have developed a SMEAR (Stations for Measuring Earth surface Atmosphere relations) concept.

During the past ten years, the SMEAR II station (in Hyytiälä, Finland) has contributed to several Pan-European research infrastructure that are currently in the ESFRI Roadmap, such as ICOS (Integrated Carbon Observation System), ACTRIS (Aerosols, Clouds, and Trace gases Research Infrastructure), AnaEE (Infrastructure for Analysis and Experimentation on Ecosystems), and eLTER (Integrated European Long-term Ecosystem, critical zone and socio-ecological system Research Infrastructure). SMEAR has provided high-quality data, trans-national access, and contributed to the development of advanced technologies in many research fields. Due to its comprehensive concept, SMEAR is capable for providing data also to several global Earth Observation systems and networks, such as to WMO GAW, GEO-GEOSS, FluxNet, AERONET and SolRad-Net.

There are several benefits that can be gained (and has been already obtained) by the integration of scientific domains and co-location of diversity of methodologies and measurements (comprehensiveness). The most important impact of the integration and co-location is on the scientific results like quantification of feedback loops, understanding biogeochemical cycles (including water and carbon cycles) in details, understanding gas-to-particle conversion in quantified way and understanding interlinks of several processes. Actually it seems that the key in very many feedback loops and in biogeochemical cycles is what happened in molecular and cluster level (size range < 1nm – 3nm). The information from different environments all around the globe is therefore crucial. There are also side benefits like the same staff can be utilized with several infrastructures simultaneously due to co-location. Besides that also the scale and opportunities for training new generation of scientists to use big data provided by SMEAR stations is important.