Report on CNR-funded project for visit of William Lahoz (NILU – Norwegian Institute for Air Research) to Federico Fierli (CNR): 12-23 October 2015

Title of project. Making sense of ubiquitous monitoring and Citizen Science[1] observations

Objectives of project.

Primary.

- Provide value-added air quality maps at Citizen Science scales

Secondary.

- Understand error characteristics of ubiquitous monitoring and Citizen Science observations (i.e., Citizen Science observations);
- Understand error characteristics of model output at Citizen Science scales;
- Develop data assimilation methods to provide added-value air quality maps from Citizen Science observations and models;
- Understand communication of Citizen Science information, and uncertainty.

Activities performed.

During the scientific visit, Dr. Lahoz provided information on Citizen Science activities in Norway, as well as general data assimilation activities at his institution, NILU by: (i) two presentations to the team of Dr. Fierli at CNR, and other interested parties (on general concepts of data assimilation, and on citizen science observations); (ii) advice to PhD students in the team of Dr. Fierli; (iii) advice on access to Citizen Science methods developed or to be developed in Norway (e.g., observational information, code); (iv) discussion of potential, and/or initiation of common, peer-reviewed papers to be written in collaboration between the teams of Drs. Fierli and Lahoz; and (v) advice toward developing Citizen Science methods at CNR, and potential proposals for common funding. The presentations and supporting material, e.g., papers, are available to the team at CNR.

Outcomes of the visit. The visit had two main outcomes:

Collaboration. A collaboration was set up between the teams of Drs. Fierli and Lahoz on a paper describing the use of the methodology of observing system simulation experiments (OSSEs) to study various network configurations to monitor atmospheric pollutants in one or more regions of Italy (e.g., Lazio, Campania). Dr. Lahoz has been involved in various projects to use OSSEs to assess additions to the Global Observing System, and has published various papers on OSSEs in the peer-reviewed literature (Lahoz et al., 2005; Claeyman et al., 2011; Lahoz and Schneider, 2014; Hache et al., 2014; Timmermans et al., 2015). The network will consider ground-based stations, and perhaps micro-sensors, measuring atmospheric pollutants such as NO_2 and particulate matter (PM).

Before setting up the OSSE, we will set up a Nature Run with a spatio-temporal resolution appropriate to the urban scale (1 km; 1 hr or less) – if resources make such a target resolution unfeasible, we will focus on scales of 10 km and a few hours. We will sample the Nature Run to produce the synthetic observations to be tested in the OSSE; this sampling will include the observational errors. The type of experiments performed in the OSSE will consider various network configurations. Examples include a baseline set-up with only ground-based stations,

[1] The Socientize 2014 White Paper states «Citizen Science refers to the general public engagement in scientific research activities when citizens actively contribute to science either with their intellectual effort or surrounding knowledge or with their tools and resources»

including their errors, distributed at different spatial locations and resolutions; ground-based stations with different errors from the baseline set-up; and ground-based stations (in one or more of the selected spatial/error configurations) plus micro-sensors. The OSSE will assimilate these data into an air quality model run at high spatio-temporal resolution (similar resolution to that of the Nature Run), and compare the results from the assimilation (the assimilation runs) against the Nature Run set up beforehand. A free run of the model (the control run), i.e., without assimilation of observations, will also be compared against the Nature Run. To avoid a common problem in OSSEs (namely, the "identical/fraternal twin" problem), we will try to perform the OSSE experiments with a model different to that used to create the Nature Run. If the use of different models is not possible, the results will be flagged as likely to be optimistic. We will assess the skill of the network to monitor atmospheric pollutants (e.g., NO_2 and PM), with a focus on the impact on the skill from the type of observations, the observation design and the observational errors. A potential outcome of this paper would be an air quality network designed under optimality criteria. This information would be useful for policy makers and regional and national public authorities in Italy.

Proposals. Preparation for a proposal to the H2020 call SC5-18-2017 "Novel in-situ observation systems", with opening 8 Nov 2016 and deadline 7 Mar 2017. The proposal's main objective is to "Demonstrate feasibility and added value of soil moisture information in the Sahel from citizen science observations". Currently, the CNR and NILU teams are discussing the composition of workpackages in the proposal, and identifying potential partners. The team of Dr. Lahoz has both experience of working with citizen science observations and with soil moisture. With citizen science observations, NILU coordinates the EU-funded CITI-SENSE project[2] (2012-2016) and is a partner in the recently funded H2020 HackAIR project[3] (2016-2018). For soil moisture studies, NILU is funded by various projects from the Norwegian Space Centre, the Norwegian Research Council and ESA. In particular, NILU is a partner in the ESA CCI (Climate Change Initiative) project for the essential climate variable of soil moisture[4].

References.

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[2] http://www.citi-sense.eu/

[3] http://www.draxis.gr/en/news/79

[4] http://www.esa-soilmoisture-cci.org/