Published on 29.3.2024

ENVRINNOV Project: Pilot cases underway to test collaboration mechanisms for new technologies and services.

The Horizon Europe funded project “ENVRINNOV- ENVironment Research infrastructures Innovation Roadmap”, coordinated by CARE-C, The Cyprus Institute, is working towards the development of an Innovation Roadmap for the ENVRI community. This will include proposed mechanisms for collaboration between all innovation-performing stakeholders in the ENVRI ecosystem (RIs, RPOs, and Industry) for the development of new technologies and services. To ensure that these mechanisms are fit for the needs of ENVRIs, they will be tested during the project by five RPOs from different subdomains (Atmosphere, Biosphere, Geosphere) through four small-scale pilot cases.
All four pilot cases have now been initiated by the Consortium. Details are included below, while progress and results from the pilots will be shared as the ENVRINNOV project moves forward.

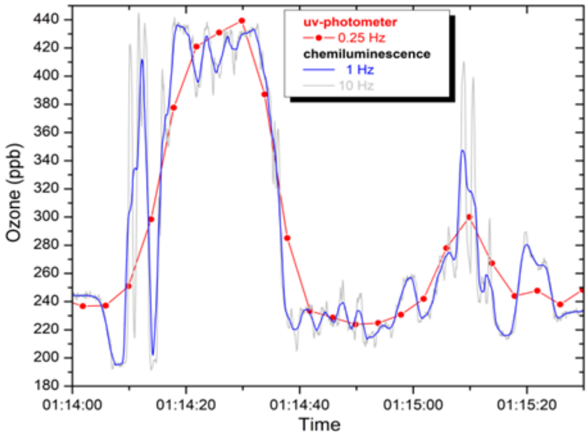
Pilot #1: “Technology Infrastructure”: providing access to ENVRI research facilities, unique state-of-the-art instrumentation, and know-how to the private sector.
Led by CEA and the Cyprus Institute.

This pilot case consists of a mobile CH4 emission measurement system that will ultimately deliver on a need expressed by the waste management and natural gas industries. The purpose is to demonstrate the ability to provide technology infrastructure to the private sector. To that end, the following actions have been taken:

Step 1: Development of a new technology (drone-sensor system to detect and quantify methane leaks) at TRL5 by a National Facility (CyI-USRL) from ACTRIS. Actions: Analysis of industry needs has been fed by previous research involving CEA and CYI (Liu et al., AMT 2024), and led to an appreciation of operational constraints (ATEX, safety) and performance requirements (CH4 leak rate, precision, certifications). The initial design of a technology solution has been done with ABB LGR instrument and 3D sonic anemometer onboard octopter UAV. The flux estimation method exploiting concentration measurement is under development. **Step 2**: Calibration/test at TRL6 by a Central Facility (CEA-ATC) from ICOS. Actions: Conception of a technology infrastructure response. This has involved connecting the USRL UAV infrastructure of CYI (ACTRIS) and the greenhouse gas metrology laboratory at CEA (ICOS ATC), establishing staff exchanges (visit of JD Paris from CEA to CYI in January 2024, visits of CYI staff Roubina Papaconstandinou and Pierre Yves Quehe to CEA in March 2024). **Step 3**: Validation in operational environment at TRL7. Actions: Firsts attempt to sample CH4 emissions from a proxy source close to the UAV flight range (a cattle farm near Orounda, Cyprus).

Pilot #2: “Tech-Boost” pipeline: creating optimal conditions for instrument manufacturers to foster the full “development-to-deployment” chain of technologies fit for the needs of ENVRIs.
Led by KIT

Since 2010, one of the most accurate and fast instruments for the in-situ detection of ozone (O_3) is operated on passenger aircraft (IAGOS), research aircraft (German HALO, US HIAPER and others) and for eddy-flux measurements at ground. It has been developed at the Karlsruhe Institute of Technology (KIT) and applies two techniques: a super-accurate and low-noise 2-channel O_3 photometer and a fast 10 Hz solid-state chemiluminescence detector (Zahn et al., AMT, 2012). Both detectors are quantum-noise limited, the precision at 10 Hz is 0.5 – 1.0% at typical O_3 mixing rations of 50 – 100 ppb. See example of a flight at 12 km altitude around Cape horn, with atmospheric gravity waves and O_3 changes by a factor of 2 in less than 0.3 seconds.



In a close partnership with a medium-sized company (VBE electronics, 70 employees), the development of a new control electronics is initiated which is state-of-the-art, much smaller and provides much more features. Together with a further hardware optimisation and miniaturization, the new ozone instrument shall be distinctly smaller and lightweight, more versatile and ruggedized regarding the operation on different platforms, ready-to-use (plug & play) after a warm-up of less than one minute and shall provide quality pre-assessed data (based on a detailed instrument health status).

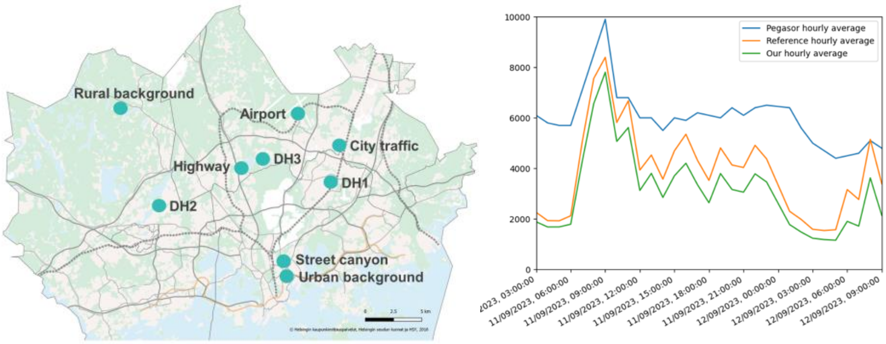
Step 1 of the envisaged Tech-Boost pipeline (sketched in section 1.2.3.2 of the proposal) has largely been detailed and set up, with the following actions and to guarantee an efficient development process and cooperation: **(i)** initial physical meeting at VBE electronics to discuss all development steps and the content of the system description of the new electronics, in which we could nicely combine the (fairly synergistic) expertise and experiences of the involved stakeholders, **(ii)** after discussing the details of shared documents and information, we decided to (only) sign a collaboration agreement for this first development phase (instead of a more official NDA), **(iii)** created a workplan with a series of development steps (especially regarding test procedures first at the company and at a later more mature status at the reference laboratory at the KIT), **(iv)** iterated the description of the new communication protocol and **(v)** started to define the hardware components. In the cooperation agreement, it has been contractually agreed that all documents (including cable plans, routing and layout, and software source code) are provided to the KIT, inter alia, to allow the airworthiness certification for the operation on airborne platforms (e.g. IAGOS) and to simplify future hardware and software updates, e.g. when certain electronic components are discontinued, or new instrument features are requested.

Pilot #3: "Scientific Services": mobilizing ENVRI scientists to develop and provide new services to better serve emerging needs of a wider user community.

Led by University of Helsinki, with two components: in Atmosphere and Biosphere.

#<u>3.1: Atmosphere, number concentration in urban environment with a dense network of instruments</u>

Work regarding urban mapping of aerosol number concentration with a dense network of sensors has been initiated and the pilot will take place in Helsinki. The local air quality monitoring network has been contacted and discussed the options of deployment of novel Condensation Particle Counters within their measurement locations. The authority is positive towards implementing a short pilot activity within their facility. It is also planned to deploy gap-filling measurements with mobile measurements around and between the fixed observation sites and we are preparing the instrumentation for these measurements.



Map of available supersites and sites providing indicative aerosol number concentrations in Helsinki (left) and an example time series of aerosol number concentrations with different instruments participating in the pilot activity (right).

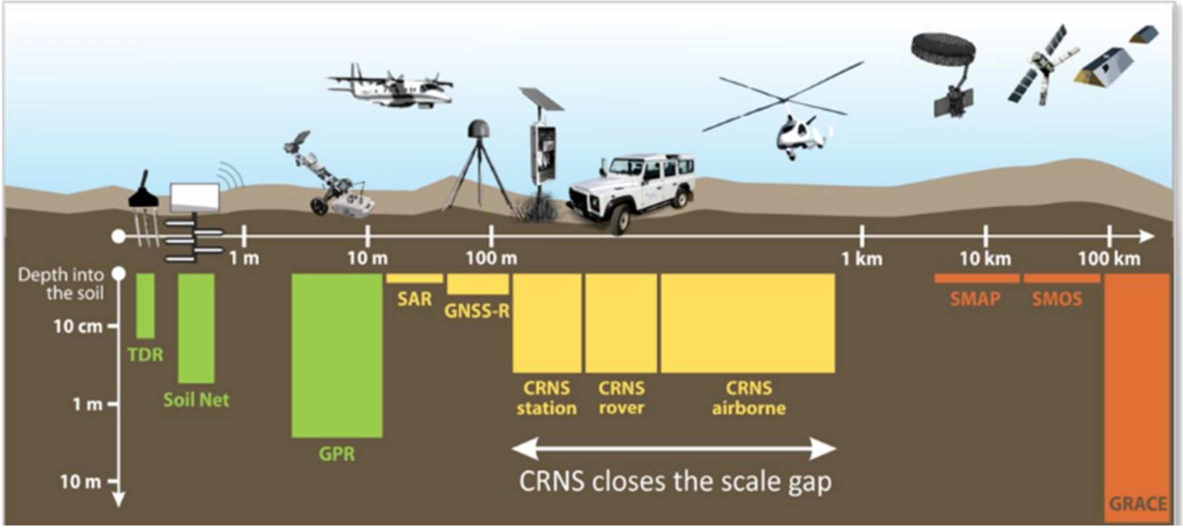
#3.1: <u>Biosphere targets the scientific community's need for better estimates of environmental impacts of abiotic stressors to ecosystem productivity</u>.

Work towards pilot case 3.2 during summer 2024 has begun. Utilizing a combination of emerging technologies, such as drones and prototype optical sensors, this pilot aims to further our understanding of the impacts of plant abiotic stress to ecosystem productivity. The study site will be located at the University of Helsinki Viikki campus (Helsinki, Finland), with the measurements taking place both in field and greenhouse conditions, combining the work of several research groups.

We will be measuring both annual and perennial species, using a combination of reflectance and chlorophyll fluorescence - based optical techniques. Using both established and prototype sensors, the versatile instruments at our disposal allow us to measure both leaf and canopy level variables. The results from this study will hopefully demonstrate the ability of combined hyperspectral and low-cost fluorescence imaging sensor measurements to capture drought stress in a variety of species and pave the way for them as an established means to study plant abiotic stress.

Pilot #4: "Intra-RI Technological Development": to set a process for the development of interoperable/harmonized technologies by RIs and their effective transfer within ENVRIs.
Led by UFZ

This pilot aims to enhance RPO/RI technological autonomy and promote coordinated experimental strategies within ENVRIs towards the adoption of common technologies fulfilling environmental monitoring needs. The pilot case selected here will address the further methodological development of Cosmic-Ray Neutron Sensing (CRNS) processing to enable its deployment across RIs of the Environment Domain for the monitoring of soil moisture, a key state variable of the environment and defined as one of the "Essential Climate Variables" defined by the WMO Global Climate Observing System (GCOS).



Vertical and horizontal scales of soil moisture measurement (modified after Schrön et al., 2021)

CRNS is an innovative technique for monitoring soil moisture based on the interaction between cosmic-ray neutrons and hydrogen atoms in the soil. This non-invasive method measures the intensity of neutrons at the earth's surface, which correlates with the moisture content of the soil over a large area. In contrast to traditional point-based methods such as soil moisture probes or gravimetric measurements, cosmic neutron measurements offer several key advantages. Firstly, it provides a spatially integrated measurement of soil moisture that covers a larger area (several ha, several decimetre depth) without the need for multiple sensors. Secondly, it offers continuous monitoring capabilities, allowing data to be collected and analysed in real time. It is also requiring minimal maintenance once installed. Overall, cosmic neutron sensing offers a practical and efficient solution for soil moisture monitoring, which is particularly beneficial also for environmental applications.

Although CRNS technology is now successfully established worldwide, the successful processing of measurement data requires quite extensive knowledge of the theory of CRNS measurements to calibrate the devices and process the measurement data correctly. An easy-to-use guide to implementing the measurement technology and, above all, high quality research software allowing for an easy-to-use processing of the CRNS data, is an important step to reduce the hurdles to using this technology in a harmonized way across different environmental RIs.
The implementation pilot will develop a community, ready-to-use and open-source processing and visualization technology. In a first step (March 2024) the workplan has been drafted. Furthermore, overlaps and redundancies of methodologies and tools for soil moisture monitoring in European ENVRIs have been evaluated.

The next steps are:
- Step 2: Identifying ENVRI users and specifying user needs and technical requirements: needs for training programs, technical support to ENVRI researchers, ENVRI's needs for user friendly data processing and visualization tools for CRNS
- Step 3: ENVRI community-driven development of a prototype for a ready-to-use software for real-time data processing and visualisation of CRNS data
- Step 4: The final step will be to test the CRNS technology for soil moisture monitoring and the performance of the processing-visualisation tool across different RIs.

Acknowledgements
This news item was developed in alignment with ENVRINNOV Milestone MS2.1: Pilot cases initiated (M3). The ENVRINNOV project has received funding from the European Union's Horizon 2023 research and innovation programme under grant agreement no 101131426.