ICOS improved sensors, network and interoperability for GMES

D4.5

Report on datasets and recommendations

D. Papale

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement n°313169.

ICOS-INWIRE (GA n° 313169)
Internal document
Version 1.0, November 2015
www.icos-inwire.lsce.ipsl.fr

Deliverable:	**D4.5, Report on datasets and recommendations**
Author(s):	**D. Papale**
Date:	**23/11/2015**
Activity:	**WP4: Autonomous GHG ecosystem sensor systems**
Lead Partner:	**UNITUS**
Document Issue:	**1.0**
Dissemination Level:	**Public**
Contact:	

	Name	Partner	Date
From	Dario Papale	UNITUS	22/11/2015
Reviewed by	Han Dolman	VU	11/12/2015
Approved by	Jean-Daniel Paris	CEA	18/12/2015

Version	Date	Comment/Changes	Author/Partner
1.0	08/11/2015	version 1.0	UNITUS
2.0			

ABSTRACT

The activities performed in the context of WP4 of the ICOS Inwire project helped to better clarify and identify some of the possible improvements and compatibility issues in the ICOS Research Infrastructure framework, in particular in the context of the ecosystem component.

These results, together with the results obtained in the context of the near real time data processing and link with the end users in WP5 and the support in the new protocols definition also in agreement with other networks (WP6) provide a number of information, feedbacks and challenges for ICOS that in this deliverable are summarized in order to create a report easy to handle and read.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Scope and objectives of the document

The present report illustrates and summarizes the main recommendations that can be passed to the ICOS Research Infrastructure concerning the ecosystem data and measurements. All the feedbacks are coming from ICOS Inwire activities or activities where ICOS Inwire contributed substantially. The report is written with the aim to be read by the ICOS PIs, users and coordinators and for this reason focussed on the topics.

1.2 Structure of the document

The present document is composed of 2 main sections, the first related to recommendations on the data acquisition and coming in particular from activities in the context of WP4 and WP5, the second on recommendation on data processing and distribution based on the experience in WP5 and WP6.

2 RECOMMENDATIONS IN TERMS OF DATA COLLECTION

2.1 WiFi data collection system

In the context of the ICOS Inwire project, WP4 and Task 4.1, a new system to connect sensors through the WiFi connection has been developed and tested. The test highlights that some of the available commercial solutions can have problems in extreme climatic situation and for this reason a new and ad hoc design for scientific applications, functioning also in extreme conditions (between -40 and + 70 °C) has been realized. All the information and details are available in the report in Deliverable D4.2 "Integrated EC system with Wi-Fi connected network for auxiliary variables, including power supply". This is a particular important feedback in the context of ICOS because the heterogeneity of some of the key variables measured (e.g. Soil Water Content or Below Canopy Incoming Radiation) would require a sparse network of sensors impossible to setup with classical, wired instruments.

2.2 Difficult environments experience

Still in the context of WP4, an eddy covariance system has been tested in difficult environments, including Finland, Sweden and Spain (so ranging from very cold to very hot and dusty). The system composed by an IRGA and an Sonic Anemometer has be run in parallel to the standard eddy covariance equipment for a period of few months. The tests confirmed the difficulties in the eddy covariance method application in these conditions, in particular related to sensors maintenance and power failure. Overall however the data collection was positive and highlighted the importance of an accurate sensor setup, sensor maintenance and a stable power availability source. The feedbacks and recommendations are summarized and presented in the report in the deliverable D4.6 "Report on 'heavy-duty' EC sensors system tests performed at 3 harsh-condition stations"

2.3 Raw data acquisition format

The activity developed in the context of WP5, Task 5.2, where eddy covariance and meteorological data are submitted in raw format to the central database contributed to better understand and define limits, risks and possible solutions related to the data acquisition. For the five sites involved in the test (see deliverable D5.2 for more details) it has been decided to leave open the data format and just require specifications of the metadata in order to correctly interpret the measurements. In fact the five sites selected completely different formats and this required an additional effort for the database in order to be able to correctly read and import the data, converting everything to a standard format suitable for the processing. This however highlighted a number of issues: 1) small changes in the data format required an adaptation of the importing script; 2) when not communicated, the changes in the format (like the addition of a variable) led to wrong calculations and results; 3) the original data, important to store for traceability purposes, need to be duplicated (in the standard format) doubling the total amount of memory needed (for eddy data these are 10 or 20 Hz measurements for 10 to 20 variables). For this reason it is strongly suggested to converge to an unique and standard format from the beginning that can be used directly in the processing (no needs of conversion) and that can be interpreted correctly even in case of a change in the variables included thanks to the use of a standard naming system. The risk in this approach that need to be

carefully evaluated are in the correct setup of the new format during the data collection at the different sites.

3 RECOMMENDATIONS IN TERMS OF DATA PROCESSING AND DISTRIBUTION

3.1 NRT data processing

The processing of fluxes in Nera Real Time (day after the acquisition) starting from the raw data has been one of the major success of the WP5 and ICOS Inwire in general for the Ecosystem component. This is confirmed by the fact that thanks to the robustness of the results, estimation of the uncertainty and feedbacks from users (see Milestone 17) the ICOS Research Infrastructure Committee decided to propose these NRT data are standard and official ICOS data product and added it in the ICOS Data Life Cycle document. This is an important success and a clear example of link between ICOS-Inwire and ICOS RI. See D5.2 for more info on the NRT data processing.

3.2 NRT data access

Providing Near-Real-Time (NRT) Eddy-Covariance (EC) data is a challenge to improve model data fusion (MDF) and in particular land surface model (LSM) to better understand the complex dynamic of terrestrial biosphere exchanges of matter and energy. Because uncertainties enter directly into MDF and misspecification of this quantity affects parameter estimates and propagates into the model predictions, both systematic (limited to different processing option schemes) and random (related to sampling error) uncertainties were taken into account and estimated also for the NRT data. All these calculations and data formatting needed to be made as fast as possible to allow direct access to the modellers every day. The experience in the project highlighted the importance to allow and easy and fast access, made in some cases also my scripts, without too many intermediate steps. This experience has been already presented in ICOS in order to help in the design of the data access system as much as possible compliant with the requirements of these class of data users.

3.3 Key variables, uncertainty and format

The identification of the key variables needed in modelling activities, the requests in terms of formats and the need of uncertainty quantification are key aspect that ICOS RI need to take into account in the definition of official data and priorities. In the context of WP5 it has been possible to analyse the needs of example of end users and find common important requirements that are now passed to ICOS. In particular, the data structure and format is in general not a problem is kept stable in time while the data quality is crucial and it is requested an easy identification of the measured and quality filtered data (not gapfilled) also through the use of well documented quality flags. In terms of variables the main variables used actually in the modelling activities are the carbon fluxes (NEE, GPP and TER), energy fluxes (Sensible Heat, Soil Heat and Latent Heat), Soil Water Content, main meteorological variable and CO2 concentration. All the variables are useful as long term timeseries and as Near Real Time (NRT) data (the 5 last days of measurements) because used in different activities. Also in terms of spatial distribution there is a strong request for measurements in areas generally less represented such Tropical, Sub-Tropical and high latitude ecosystems. More information on these activities can be found in Milestone 16 and Deliverable D5.1

3.4 Coordination with other networks

A large research infrastructure like ICOS needs a strong component of coordination, harmonization and standardization with similar activities globally. In the ecosystem domain there are different networks under development such AmeriFlux and NEON in USA, TERN in Australia, ChinaFlux and AsiaFLux in Asia. All these networks have specific goals and requirements/constrains but are also linked by the use of the same technique to measure the ecosystem fluxes.

One of the key activities of WP4 (Task 4.2) has been the establishment of a discussion in order to start a process of certification of the eddy covariance technique as WMO standard. The objective was very ambitious but the results have been also important. ICOS Inwire representatives were invited at a CIMO (WMO Commission on Meteorological Observations) New Technology Workshop from 10-13 September in Geneva to present the ecological observatory/eddy covariance. The summary of the meeting was that the development of an EC standard has high utility and would be useful, and CIMO is the appropriate entity to manage the standard once it has been drafted by a group of experts drawn from the global EC community. After this an activity of preparation of drafts of the document to present started and are still ongoing. It is clear that the process require time but the actions have been taken and now it will be in the hands of the different research infrastructure to continue the work on these documents and present a final version to the CIMO and WMO. Deliverable D4.4 describe in more details the actual status of the activity and next steps.

In the context of WP6 another important networking activity has been carried on with the aim to identify, develop and share common protocols for the measurements. This is something also connected to WP4 Task 4.2 because the protocols identified and discussed has been used as basis for the WMO proposal. The discussion has been particularly intense and productive with AmeriFlux where common standard have been agreed for the variables naming, definition and units and for the data processing level definitions. Also the data processing tools and methods have been agreed and common codes used and shared. This is presented in the reports in the deliverables D6.6 and D6.7. Standardization of measurements protocols with the different networks is more challenging and in the context of ICOS-Inwire it has been summarized the situation in the ICOS protocols, contributing to their development in particular bringing the message of standardization across networks (Deliverable D6.6). The new protocols have been also presented to other networks and are currently still under discussion.

4 CONCLUSION AND REMARK

This report presented a summary of the ecosystem relevant activities performed in ICOS Inwire that should be passed to the ICOS Research Infrastructure community during its development. Different aspects have been addressed in the course of the project, from technical solutions in difficult environments or sparse sensors, to a more clear definition of the possible ICOS data products and their characteristics/limit and finally to the importance of networking activities not only inside ICOS but also with respect to other research infrastructures with a major aim to jointly define a WMO standard protocol for eddy covariance.