



# COOPEUS

## WP3: Carbon Observations



### Report from Working groups



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This deliverable is very close related to the  
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## 1 INTRODUCTION

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### 1.1 Motivation

**Global Importance.** The rapid pace of large-scale environmental changes around the globe has underscored the value of accessible long-term data sets for understanding the context of scientific observations, and for forecasting future conditions for societal benefit. We are also entering an era of large-scale, interdisciplinary science fuelled by large data sets that will be analysed by current and future generations of scientists<sup>1, 2, 3, 4, 5</sup>. Natural, managed, and socioeconomic systems are subjected to complex interacting stresses that play out over extended periods of time and space<sup>6, 7</sup>. Some are rapid and visible, like extreme precipitation, wind, and wildfire events, while others are subtle and play out over decades, like changing ocean temperatures and pH that affect the world's fisheries. These ecosystem changes threaten to erode the nation's (and the world's) environmental capital<sup>8, 9</sup>, resulting in disruptions of these services that would likely alter the fundamental trajectory of society and quality of life manifest across the United States and over large parts of the world<sup>10, 11</sup>.

The United States and the world need interoperable global environmental data platforms specifically designed to address large-scale environmental challenges for the expert and non-expert alike. This needs to be designed a priori (albeit dynamically) to meet a wide suite of societal needs that span traditional Federal agency boundaries, existing international entities, and scientific disciplinary areas. Frameworks for identifying such societal needs include the economic sectors used in the USGCRP's National Climate Assessment and the Societal Benefit Areas used in OSTP's National Earth Observation Portfolio Assessment. The data and information by an environmental data platform must be discoverable, accessible, and usable to the wider marketplace of value-added consumers (open access).

**State of the Science.** The need for interoperable environmental data platforms has been widely recognized<sup>7, 8, 9, 11, 13, 15, 16, 17, 18, 19, 20, 21</sup> and few initiatives are underway<sup>22, 23, 24</sup>. The observation of such changes (impacts), and the processes that cause those impacts (stressors), has to date been largely accomplished through ad-hoc integration of data from existing observation programs that were designed for other purposes<sup>12, 13, 14</sup>. While this approach is adequate for certain objectives, the lack of integrated, consistent, long-term data to address these societal questions has been recognized<sup>11, 15, 16</sup>. Current Federal monitoring programs are "distributed to an extent that reduces its potential effectiveness"<sup>8</sup>, and "[The] fragmented federal investment in monitoring ecological change weakens national priorities"<sup>8</sup>. Moreover, this current lack-of-coordinated approach is inadequate for measuring stressors, their impacts, and how they interact at large spatial scales over decades for phenomena driven by large-scale environmental changes (e.g., changing precipitation, temperatures, sea-level, land-use, population, etc). Infrastructure, including cyber infrastructure, that provides a consistent, long-term baseline understanding must be commensurate with the scale of the phenomena under observation.

These efforts to build environmental observatories to date have been characterized by a community-driven bottom-up approach with each scientist/participant having an equal voice. This has resulted in the development trying to be everything to everyone, and an unconstrained process. While this type of approach has a large comfort-level for scientists, it lacks a unifying philosophy and the tools to constrain the problem statement, i.e., requirements-driven.

#### **Efficacy and Interoperability.**

Within the CoopEUS project<sup>22</sup>, ICOS and NEON have developed a unifying framework around the concept of fostering interoperability with other environmental organizations. Simply, it contains four focus areas: linking,

- i) hypotheses-driven questions with requirements (system engineering),
- ii) traceability of measurements to nationally or internationally recognized standards or first-principles (classic metrology),

- iii) the procedural or algorithmic processes to derive data products (e.g., inherently different for instrumentation than from organismal sampling), and
- iv) the bioinformatics.

Once these components are identified and uncertainties quantified, they can be used scientifically in a number of ways (geospatial models, data assimilation, etc.).

This document will give a report of all working group meeting and also focuses on the perspectives on possible synergies with research infrastructures from other domains.

## 1.2 Partners

All work within COOPEUS<sup>1</sup> WP3 has been executed by ICOS<sup>2</sup> from the European side and NEON<sup>3</sup> from the US side. Unfortunately, NOAA could not join as a partner from US side, in the following names WP3 members.

### ICOS and NEON

ICOS and NEON research infrastructures are in-situ observation networks providing research data on greenhouse gas fluxes from ecosystems to the atmosphere. Together, ICOS and NEON aim to make these data available without technical, scientific or political barrier. These data typically include greenhouse gas (GHG) concentration, carbon and energy flux observations, and the surface micrometeorology surrounding these measurements.

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<sup>2</sup> [www.icos-infrastructure.eu](http://www.icos-infrastructure.eu)

<sup>3</sup> [www.neoninc.org](http://www.neoninc.org)

<sup>4</sup> [www.lsce.ipsl.fr](http://www.lsce.ipsl.fr)

## **2 WP3 CARBON OBSERVATION: LIST AND OUTCOME OF EVENTS ORGANISED WITHIN THE COOPEUS FRAMEWORK**

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Within the three years of project time, WP3 Carbon observations has organised approx. 13 strategic face-to-face working groups meetings of various formats to discuss progress in Carbon research in the transatlantic and international context, not only with the WP3 members representing ICOS and NEON, but also with the external audience represented by other Carbon networks. This report do not focus only on working groups supported by exchange of staff but also on all meetings that contributed to deepen the mutual understanding of data policies and interoperability in the perimeter of WP3. The outcome of personnel exchange is further detailed in D3.4. The events have been held on international conferences or together with COOPEUS project meetings, listed in table 1. In addition, various telephone conferences took place, either regularly meetings for giving updates on activities, or external meetings to reach other institutions related to carbon observations.

To reach the users, two Carbon training workshops have been organised in 2014 and 2015, for building a platform to bring senior scientist, researcher and early-career scientists together. The aim was to interact with them on the interplay between interoperability and current scientific questions and discuss with them various aspects of carbon cycle research, including what they thought of data portals, their design and performance.

To reach the greenhouse gas modeling scientists, a Model-data Fusion workshop has been organized, to bring together a diverse group of, from ocean, surface flux and atmospheric expertise, working at the forefront of data model fusion research also working across scales, disciplines, and involved in education, communication and community.

A detailed description of each event can be found in the following. The events are sorted chronologically. A whole list of events can be found in table 1.

### ***AGU 2012***

First COOPEUS meeting took place at AGU in San Francisco/US on 12/12/2012. ICOS and NEON partners had time to talk about the timeline and activities of Work Package 3.

### ***ECO WS 2013a***

The ICOS ecosystems protocol workshop has been organised in January 2013 to discuss ICOS and NEON protocols on plant productivity a biomass with the goal of creating interoperability between datasets. Please read D3.4 for more information.

### ***ICOSPP2013***

The ICOS Preparatory Phase final meeting took place end of March in Biarritz/France. WP3 used the opportunity to reach the Carbon experts, and organised a small preparatory workshop a side of the ICOS-PP final meeting in Biarritz. International experts have discussed and analysed the main gaps and problems in the trans-Atlantic data sharing. Expert knowledge has been exchanged for proposing the best strategy to follow in the project in order to harmonize data access and data use policy and practices. The outcome of this workshop built the base of Deliverable 3.1 "Data sharing across the Atlantic: gap analysis and development of a common understanding."

### **EGU 2013**

The second COOPEUS meeting took place at EGU in Vienna/EU on 10/04/2013. WP3 used the opportunity to meet for a strategic meeting to discuss next actions and activities within Work Package 3.

### **ICOS-NEON 2013**

ICOS-NEON cooperation meeting in Boulder took place in April 2013 to talk about the Memorandum of Understanding (MOM).

### **ECO WS 2013b**

The ICOS-ETC Ancillary Data Products Workshop has been organised in June 2014. Please read D3.4 for more information.

### **COOPEUS 2013**

The 1st COOPEUS annual meeting took place in Boulder/US end of September. WP3 members have met earlier to finalise discussion through the 'Data sharing across the Atlantic' and built up the working group to line out the carbon use scenario. Also, the organisers committee of the Carbon training workshop has been built up, as an activity out of task 3.3.

### **AGU 2013**

The third COOPEUS meeting took place during AGU 2013. Exchange of EU and US side in a strategic WP3 meeting.

### **EGU 2014**

Open COOPEUS work package 3 'Carbon Observation' splinter meeting has been organised at EGU in Vienna. 14 international experts and some COOPEUS members have met to discuss not only the long-term strategy of Data sharing across the Atlantic, data gap identification, Harmonizing protocols, measurements, metadata and data formats, Joint EU US ICOS-NEON-NOAA user workshop on infrastructure and data use and Interoperability and Interworkability analysis; but also on Future Engagement of Carbon Observations centers in view of COOP+. The fourth general COOPEUS meeting took place as well.

### **CarbonWS 2014**

ICOS and NEON jointly held the *Greenhouse gas data training workshop* for early career scientists at Observatoire Haute-Provence in southern France from 7-13 September 2014. The workshop is not only centred on carbon and energy flux observations, and the surface micrometeorology surrounding these measurements, but also aimed at making data available that can be used without technical, scientific, cultural or political barrier in Europe, US and internationally. In addition, practical use cases and scientific hands-on approaches were explored that focused on emerging applications to use large-scale observations to ask regional-to-continental questions. We had a fully supported, very diverse group of 24 conducting science in 16 different countries. World-renowned instructors came from the US and European countries. The OHP ICOS France atmospheric station and the white oak observatory O3HP have been visited during the field trip. The workshop is further covered in D3.2. More Infos: <http://coopeus2014ss.sciencesconf.org>

### **COOPEUS 2014**

The 2nd COOPEUS annual meeting took place in Helsinki/Finland start of October. WP3 members found time to post-discuss the Carbon training workshop 2014 and set deadlines for activities in the last project year, with

the focus on Task 3.3: Joint EU US ICOS-NEON-NOAA user workshop on infrastructure and data use and Task 3.4: Interoperability and Interworkability analysis.

#### **AGU 2014**

The fifth COOPEUS meeting took place during the AGU 2014 in San Francisco. The WP3 members have met in a splinter meeting to work on the use scenario, as well as on the concept papers for the model-data fusion workshop and Carbon training workshop 2015.

WP3 members were also attending a splinter meeting with other international representatives of Flux networks which has been organised out of an activity of the EU FP7 project ICOS-INWIRE. The purpose was to discuss among the eddy covariance experts how to tackle the issue of developing a common (WMO) standard for eddy covariance observations between the continental flux organisations and agree on possible next steps. It was agreed to prepare a draft outline for the contents of the standard.

#### **EGU 2015**

The sixth COOPEUS meeting took place during the EGU 2015 in Vienna. WP3 members were present and were finalising the agenda for the 2<sup>nd</sup> edition of the joint EU US ICOS-NEON user workshop on infrastructure and data use, as well as they were preparing last items for the coming Model-data fusion workshop.

#### **MDFWS 2015**

COOPEUS partners ICOS and NEON convened a *Model-data fusion workshop* at the Cité Universitaire, Paris/France, April 20-21, 2015. The initial objective, from the COOPEUS DoW, Task 3.4 “Carbon Observations – Interoperability and interworkability analysis”, is to ‘*compare experiences and identify issues encountered by the users*’, more specifically ‘*model-data fusion experts*’. WP3 members brought together a diverse group of greenhouse gas modeling scientists, from ocean, surface flux and atmospheric expertise, working at the forefront of data model fusion research also working across scales, disciplines, and involved in education, communication and community engagement. We set two primary objectives to the workshop, i) to present and discuss recent progress of the state of the art of data assimilation approaches - since data assimilation is considered as a large, if not the largest, potential use of data originating from various networks and hence a proxy for interoperability requirement of C networks-, and ii) to gather input on the data management, informatics, and workflow needs for this research community.

The workshop met the goal to gather communities and groups such as TRANSCOM, FLUXNET, MACC, GEOLAND, CARBONTRACKER, Global Carbon Project, and others around the joint use of EU and US infrastructure. The workshop is further covered in D3.5.

#### **CarbonWS 2015**

After the successful first edition of the ICOS-NEON Carbon training workshop, WP3 members have decided to run a second edition of the workshop, which took place again at the Observatory Haute-Provence in Southern France from 2-12 June 2015. This time, we could profit out of our experiences and improved the programme and the speakers list, as well as extend the length.

More Info: <http://carbonws2015.sciencesconf.org>

#### **COOPEUS 2015**

The final COOPEUS meeting took place in Brussels in June 2015. WP3 members were present to conclude, sum-up and sustain achievements as well as finalise project activities.

**Table 1: COOPEUS WP3 events during the project time**

#	Date	Conference/Meeting/Workshops	Location	WP3 Activities
<b>AGU 2012</b>	3-7/12/2012	American Geophysical Union Fall Meeting	San Francisco/ The U.S.	COOPEUS meeting
<b>ECO WS 2013a</b>	8-9/01/2013	ICOS ecosystems protocol workshop	Lyon/France	ICOS-NEON technical meeting
<b>ICOSPP2013</b>	25-27/03/2013	ICOS-PP final meeting	Biarritz/ France	WP3 strategic meeting Task 3.2: Data Harmonisation meeting (preparation of D3.2)
<b>EGU 2013</b>	7-12/04/2013	European Geophysical Union General Assembly	Vienna/Austria	EUDAT and COOPEUS Strategic Workshop
<b>ICOS-NEON 2013</b>	28/04/2013	ICOS-NEON meeting	Boulder/ US	Cooperation meeting
<b>ECO WS 2013b</b>	10-14/06/2013	ICOS-ETC Ancillary Data Products Workshop	Antwerp/Belgium	ICOS-NEON data protocol meeting
<b>COOPEUS 2013</b>	25-27/09/2013	Annual COOPEUS meeting	Boulder/US	WP3 strategic Meeting Use case meeting
<b>AGU 2013</b>	9-3/12/2013	American Geophysical Union Fall Meeting	San Francisco/US	COOPEUS meeting
<b>EGU 2014</b>	29/04/2014	European Geophysical Union General Assembly	Vienna/Austria	ENVRI Townhall meeting WP3 strategic Meeting, with external audience Use case meeting COOPEUS meeting
<b>CarbonWS 2014</b>	7-13/09/2014	ICOS-NEON Carbon training workshop 2014	St. Michel/France	Organised by COOPEUS WP3 WP3 strategic Meeting
<b>COOPEUS 2014</b>	29/09-3/10/2014	Annual COOPEUS meeting	Helsinki/Finland	WP3 strategic Meeting Use case meeting
<b>AGU 2014</b>	14-20/12/2014	AGU Fall Meeting 2014	San Francisco, California/US	WP3 strategic Meeting Use case meeting Meeting on Data standard for WMO (organised by ICOS-INWIRE)
<b>EGU 2015</b>	12-17/04/2014	European Geophysical Union General Assembly	Vienna/Austria	ENVRI+ Townhall meeting WP3 strategic Meeting COOPEUS meeting
<b>MDFWS 2015</b>	20-21/04/2015	ICOS-NEON Model-data Fusion workshop 2015	Paris/France	Organised by COOPEUS WP3 WP3 strategic Meeting
<b>CarbonWS 2015</b>	2-12/06/2015	ICOS-NEON Carbon training workshop 2015	St. Michel/France	Organised by COOPEUS WP3 WP3 strategic Meeting
<b>COOPEUS 2015</b>	29-30/06/2015	Final COOPEUS project meeting	Brussels/Belgium	WP3 strategic Meeting



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<sup>25</sup>Pers. Comm. Maria Uhle, NSF program Officer for Future Earth and the Belmont Forum.

<sup>26</sup>Pers. Comm. Thomas Armstrong, OSTP, Director of National Coordination for the U.S. Global Change Research Program, White House Office of Science and Technology Policy (SAON), Head of Delegation for the Arctic Monitoring and Assessment Programme,