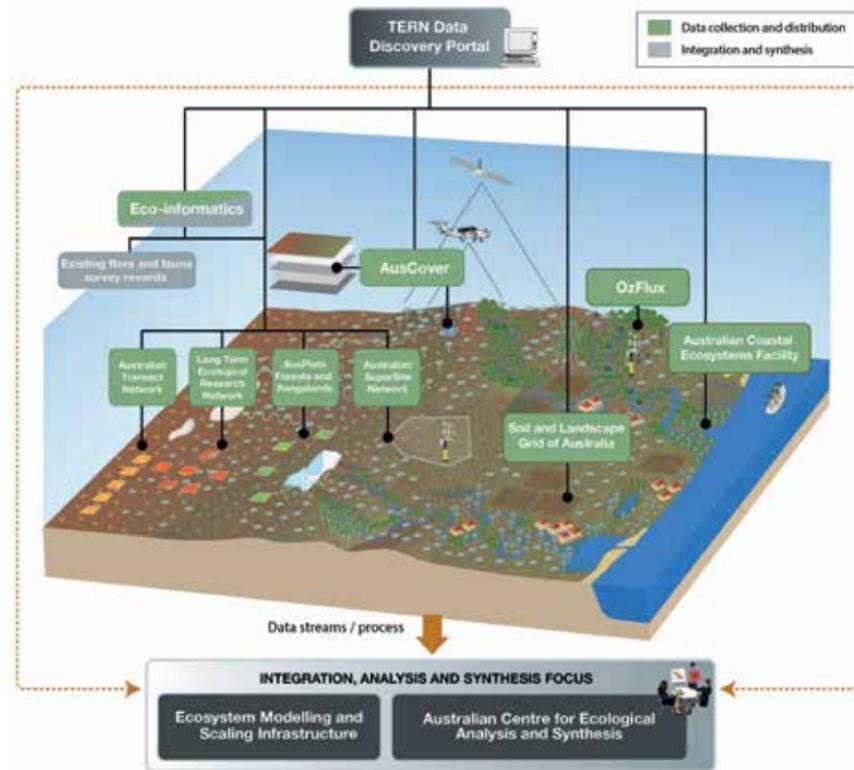


Figure 2: How TERN fits together?



ally-accepted methods for monitoring trend and condition in Australia's rangeland and forest ecosystems, enabling continental-scale assessments ([www.tern.org.au/ausplotsrange-landsmanual](http://www.tern.org.au/ausplotsrange-landsmanual));

- Better capability to inform Australian fire behaviour models and fire danger rating systems in near-real-time through collaborative work with the Australian Bureau of Meteorology and Bushfires Cooperative Research Centre (<http://www.tern.org.au/Newsletter-2012-Nov-MapFireSeveritySavanna-pg24309.html>, <http://www.slideshare.net/TERNCOMMS/ian-grantgrassland-curing-derived-from-nearrealtime-modis-satellite-data-to-support-bush-fire-management>);

- Collaborative combinations of datasets to deliver continental-scale assessments of ecosystem condition for federal agencies, for example the Australian Bureau of Agricultural and Resource Economics and Sciences' Ground cover monitoring for Australia project (<http://www.tern.org.au/Newsletter-2012-Aug-ABARES-pg23191.html>); and

- Imminent publication of Australian guidelines for field-based measurement standards, calibration, measurement and validation protocols for remote sensing data and derived products.

### Moving Forward – Collaborative Ecosystem Science

A critical part of TERN's success to date, has been its capacity to recognise existing efforts and programs, cooperate effectively with these, and build upon them to advance ecosystem science. This principle will underpin the continued development of TERN and its application to ecosystem science, along with recognition of existing discipline-based approaches to data collection. TERN's approach will also enable new and continuing collaborations to develop nationally consistent methods for data collection within and across disciplines and jurisdictions that also build on existing approaches. ■

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#### Acknowledgements

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## B Research Infrastructures

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## COOPEUS – Building the framework for information exchange between the US and EU Environmental Research Infrastructures



#### COOPEUS

Strengthening the cooperation between the US and the EU in the field of environmental research infrastructures

#### Mission

To bring together environmental research infrastructures from different science disciplines from both sides of the Atlantic in order to promote efficient access and open sharing of data

#### Timeline

Start date: 01/09/2012

Duration: 36 months

#### Funding Scheme

European 7th Framework Programme

2 M€

#### Partners

15 partners from EU and US

#### Website

[www.coopeus.eu](http://www.coopeus.eu)

Environmental research today is addressing large-scale challenges in basic research as well as providing understanding for societal benefit. Due to the scale and complexity of these challenges, information is required on a very diverse set of data types from different scientific fields that range over ecosystem production, carbon budgets, biodiversity, geodesy and seismology, and ocean and atmospheric circulation (1,2,3).

The COOPEUS project, funded under the European Commission's 7th Framework Programme and in part by the National Science Foundation's (NSF) Science Across Virtual Institutes (SAVI), is building a framework to facilitate transatlantic interdisciplinary collaboration and interoperability among environmental Research Infrastructures (RIs). COOPEUS brings together RI projects and networks from the EU and US, such as European Incoherent Scatter Scientific Association (EISCAT), European Plate Observing System (EPOS), European e-Science infrastructure for biodiversity and ecosystem research (LifeWatch), European Multidisciplinary Seafloor and Water Column Observatory (EMSO), and Integrated Carbon Observing System (ICOS) in Europe and their US counterparts in Advanced Modular Incoherent Scatter Radar (AMISR), Incorporated Research Institutions for Seismology (IRIS), UNAVCO, EarthScope, Data Observation Network for

Earth (DataONE), Ocean Observatories Initiative (OOI) and National Ecological Observatory Network (NEON). This diverse suite of RIs from the EU and the US comprise 5 scientific work packages, namely Carbon Observations, Ocean Observatories, Space Weather, Solid Earth Dynamics and Biodiversity (Fig. 1). Additionally, COOPEUS has two work packages focused on building a roadmap for cross-disciplinary data interoperability facilitating exchange of data among RIs. The COOPEUS project will serve as a model for the integration of data standards and the implementation of collaborative data and information policies for environmental RIs.

Development of large scale, world-class RIs for collection of consistent, traceable environmental data over decadal timescales has been prioritized in recent years to improve environmental research and science-based decision making on environmental issues [1, 2]. RIs are typically designed for specific scientific fields or specific environments. To address large-scale environmental challenges, however, requires a cross-disciplinary approach that spans multiple RI domains [4, 5, 6]. This requires means to integrate data and information from a diversity of RIs and networks across scientific disciplines, international borders and continents. Challenges to this integration include harmonizing policies for data accessibility, intellectual property rights, standards for data and metadata, se-



**Figure 1:** COOPEUS aims to improve the transatlantic collaboration among environmental research infrastructures working with Carbon Observations, Ocean Observatories, Space Weather, Solid Earth Dynamics and Biodiversity.

mantics and controlled vocabularies, and quality control among RIs and contributing institutions.

The primary goal of COOPEUS is to establish a working framework to improve international data and information exchange among environmental RIs across scientific and national borders. Towards this effort, COOPEUS has identified numerous actionable tasks that include, 1) identifying imminent challenges for transatlantic and cross disciplinary data-exchange, 2) defining and assessing the current state of interoperability, 3) creating a roadmap for harmonization of data policies and 4) establishing a data policy for COOPEUS RIs. In this way, COOPEUS works towards building a framework to foster the exchange of data among environmental RIs, and will provide a working model to further interlink other infrastructures on a global scale.

We recognize that COOPEUS is not the only organization with the goals of international data interoperability, and as such, we are collaborating closely with other complimentary programs and projects to jointly define the future interoperability among environmental RIs. Key among them are; EU's Common Operations of Environmental Research Infrastructures (ENVRI) US NSF's EarthCube ([www.nsf.gov/geo/earthcube](http://www.nsf.gov/geo/earthcube)), Research Data Alliance ([www.rd-alliance.org](http://www.rd-alliance.org)), Data Observation Network for Earth (Data-

ONE, [www.dataone.org](http://www.dataone.org)), International Council for Science's Future Earth initiative ([www.icsu.org/future-earth](http://www.icsu.org/future-earth)), the G8 multilateral initiative called the Belmont Forum, and the activities of the Group on Earth Observations (GEO, [www.earthobservations.org/index.shtml](http://www.earthobservations.org/index.shtml)) and GEO System of Systems (GEOSS, [www.earthobservations.org/geoss.shtml](http://www.earthobservations.org/geoss.shtml)).

COOPEUS has built its collaborations among research infrastructures with a diversity of maturity in their science and governance structures and experience in data collection, processing and distribution. In this way, the more mature RIs can provide guidance and insight to those still in development. COOPEUS aims to improve research infrastructure collaboration between the EU and US through a bottom-up process, where experience of the individual RIs can be beneficial to all involved RIs.

In the initial phase (first year), COOPEUS focused on finding commonalities and differences in data policies, standards and access among the involved RIs, and COOPEUS activities were designed to address data interoperability and standardization issues; some of these activities are presented below:

**Questionnaires:** Questionnaires were used to assess the current use of standards for data and metadata, data formats, accessibility of data, and identifi-

cation of workflow among all of the RIs. Results from the first questionnaires revealed that although most of the COOPEUS RIs provide significant access to data through web services, currently many RIs still restrict full open access. Additionally, although there has been significant international collaboration to develop metadata standards, standardized interfaces are not yet implemented and available at many RIs.

**Workshops:** Through two workshops, COOPEUS in collaboration with ENVRI and EUDAT (European Data Infrastructure) engaged the broader scientific community to discuss 1) the issues that limit the harmonization of data sharing and 2) the use of Persistent Identifiers (PIDs) as they relate to open time series data. Open time series data presents a unique suite of challenges in assigning PIDs due to the dynamic nature of data collection and the need to periodically update the PID and its attribution. These workshop activities are continuing and aim to define the requirements needed to advance/implement the standardization of dynamic PIDs and data citation through broad community and stakeholder engagement.

**Use-cases.** As much as workshops, gap analyses, and community engagement can inform the process to harmonize data, we cannot comprehend the unique informatics-, and implementation-related issues, unless we test the exchange of data between RIs in practice. Therefore, COOPEUS is also developing cross-disciplinary use cases involving multiple RIs from different scientific disciplines.

**Building Blocks.** There is no clear pathway to advance the construction of interoperable datasets and how users can access them. In partnership with Earth Cube and GEOSS, COOPEUS participates in building block activi-

ties such as the GEOSS Standards and Interoperability Forum, web brokering, semantic discovery, and development of user tools to facilitate integration of data from different RIs.

COOPEUS will continue to conduct workshops and develop use cases to further define procedures for data collection, processing and distribution that are accepted by the broader user community. For example, in September 2014, the Carbon Observation work package will conduct a workshop to engage early career scientists in the use of atmospheric and ecosystem greenhouse gas data from large observational networks. The Biodiversity, Carbon Observation and Ocean Observation work packages are collaborating on a use case to identify scientific questions addressing global carbon biogeochemistry, which can be tractably answered through cross-disciplinary efforts. Through activities like these, COOPEUS advances comprehensive issues facing all RIs.

Cross-disciplinary collaborations can be difficult in and of themselves due to differences in shared vocabular-

ies, metadata standards, QA/QC standards etc. Adding to these collaborative challenges are the cultural, language and policy differences among countries. Although virtual collaborations are an important goal in this effort, it is also necessary for collaborators to sit together to work through these challenges, especially early in the process. Interoperability requires human and programmatic commitment, effective communication and trust that is best facilitated by in-person interactions.

Outside COOPEUS, there are also many efforts to establish means to foster international and cross disciplinary (or even discipline specific) interoperability of data, but so far no clear path has emerged. Therefore, COOPEUS strives to create the forum, where diverse user communities can test new ideas, methodologies and philosophies for implementation of international data interoperability initiatives. As such, COOPEUS will provide a framework for discussion, discovery, engagement, adoption and implementation of new informatics to foster the open and widespread sharing of data. We envision these collaborative efforts to become the norm in the future

and result in a global framework for interoperable data for all environmental Research infrastructures and other observatory networks. ■

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**Creative-B**  
www.creative-b.eu

On 26 September 2014 in Brussels will be presented a global Roadmap of biodiversity data research infrastructures, focusing on common priorities and infrastructure engagement, enhancing infrastructure interoperability, and the legal and governance implications.

Registration for this open event from 09:00 – 14:00 is possible after registration at: [www.creative-b-2014.sciencesconf.org/](http://www.creative-b-2014.sciencesconf.org/).

**Location:** Palais des academies – Salles du Trone, 1 rue Ducale, Brussels, Belgium.