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ConnectinGEO

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Coordinating an Observation Network of Networks EnCompassing saTellite and IN-situ to fill the Gaps in European Observations

Deliverable D3.2

ENEON methodology for management and coordination and first plenary Workshop minutes

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Executive summary

Although a number of activities, some supported by European Commission funded projects, are aiming to bring together observation networks, there is no overarching umbrella that would bring these networks into a European contribution to GEOSS. There are many EO networks in Europe currently being active. Even the individual stations of filed sites were funded by national of local contributions, some networking came from previous coordinated an support actions European projects and have some problems for sustainability. Others have been converted to other bigger initiatives as ERIC.

This deliverable explores the creation of the European Network of Earth Observation Networks (ENEON) by the H2020 project ConnectinGEO to provide integrated and harmonized perspective of observations, forecasting and projecting, helping to reduce redundancies and detect gaps in the European EO arena.

It is important to clearly define de goals and objectives and ensure minimum overlap with the objectives of ENVRIplus project.

The vision of the ENEON is that all European Earth observation networks are interoperable and coordinated across disciplines and sectors with respect to observations of essential variables with no gaps, no redundancies, resulting in saving costs and fully operational continuity of observations, and they are collaborating in providing integrated knowledge serving user needs. To make progress towards the vision, ENEON has the mission to generate a self-sustained organization that represents and coordinates European EO networks with the goal to increase interoperability between existing networks, reduce gaps, and ensure availability and accessibility of observations required to generate products that meet user needs, including information on the state and trends in the environment. ENEON will be part of the GEO European hub and provide an integrated representation to GEO; participate in the development of sets of essential variables for different themes and areas and document these sets; work with GEO, and Copernicus to ensure that overviews of required and existing observations are available and contribute to publishing this knowledge in the GEO Knowledge Base; develop roadmaps setting priorities and suggesting remedies to reduce current gaps in EO; and engage with the European EO networks to facilitate integrated products and services that require coordination and collaboration between multiple network and integration of environmental, social, and economic data. Moreover, we envision some functions and activities from ENEON to provide to the member networks

The governance of the ENEON will be based on the setting up an Steering Assembly that represents all networks, and Executive Board that will control the day to day activities. Both will benefit from the advice provided by a Senior Advisory Panel, which will include both scientific and non-scientific senior advisors. The work of ENEON will be conducted in Committees, Working Groups and Centers. Committees will be established for long-term activities. Working groups will be established as needed with limited time horizon. ENEON Centers will be operated by the membership under the guidance of ENEON Steering.

The road map towards the full establishment of ENEON was discussed during the first ENEON plenary held in Paris on September 21-22, 2015. Besides (1) working out the legal aspects for the formal establishment of ENEON, it was agreed that (2) refining the concept for ENEON as an umbrella organization; (3) demonstrating the value of ENEON should have a high priority; (4) having a joint activity.

1. Introduction

The last few decades have seen a rapid development of in situ and remote sensing Earth observation (EO) networks on all levels from local to global. Data and products derived from these observations are increasingly available and crucial for many public and private activities, Nevertheless, there are many challenges for the network operators, the providers of products, and the users who want to access and utilize the wealth of information contained in the observations and products.

The European landscape of in situ networks for EO is characterized by many uncoordinated activities, most of them domain-specific and focused on selected user groups. The individual networks exhibit a high degree of diversity. The lack of cross-network coordination and harmonization leads to a high degree of fragmentation, loss of synergies, some degree of duplication, and a low level of integration.

There are significant gaps in the EO networks and the datasets and products available. Despite the usefulness of them, there are problems in maintaining current EO infrastructures. There is a high degree of fractionation between disciplines and societal sectors that limits collaboration across disciplinary and sectoral boundaries and the development of integrated product based on multiple networks. There is also still some level of fractionation in space with large difference in networks and EO infrastructures across Europe.

Understanding the societal knowledge and information needs as guidance for network extensions and new products is limited and there is a necessity to connect the networks better to their users. More comprehensive information on user needs in terms of knowledge, information, and data would allow thorough gap analyses and a prioritization of EO infrastructures that would ensure maximum societal benefits in return of the investments.

The challenges listed above limit the ability of scientists and researchers to provide a clear integrated picture of the status and changes in the planet and to provide valuable guidance to decision makers. They also limit the ability to quantify indicators needed by planners and other decision makers to monitor progress towards societal targets or to assess the impacts of planned activities. It is therefore important to address these challenges.

Many of the European EO networks are contributing in some form to the Global Earth Observation System of Systems (GEOSS). However, there is no envelope that could ensure a comprehensive overview and cross-domain collaboration in the European contribution to GEOSS.

1.1. The Need for ENEON

Although a number of activities, some supported by European Commission funded projects, are aiming to bring together observation networks, there is no overarching umbrella that would bring these networks into a European contribution to GEOSS. An example is ENVRIplus, which is a new project that has the aim to link research infrastructures into a coherent framework. This project is creating a common infrastructure that facilitates integration of data.

There are many EO networks in Europe currently being active. Most of them came from previous European projects and have some problems for sustainability; others have been converted to other bigger initiatives as ERIC. To map all the working networks is far beyond the scope of this

document. However, some of the most important ones are included in the ENVRIplus project as research infrastructures (see Figure 1).

Figure 1 Research Infrastructures included in ENVRIplus project classified by domains

In ConnectinGEO, a study is aiming to review all existing EO networks in Europe and to map their interactions. This effort has resulted in a preliminary picture shown in Figure 2. As can be seen, there are many bilateral interactions while the number of core coordinating elements interacting with many networks is small. Most of these coordinating elements focus on specific needs, such as infrastructures.

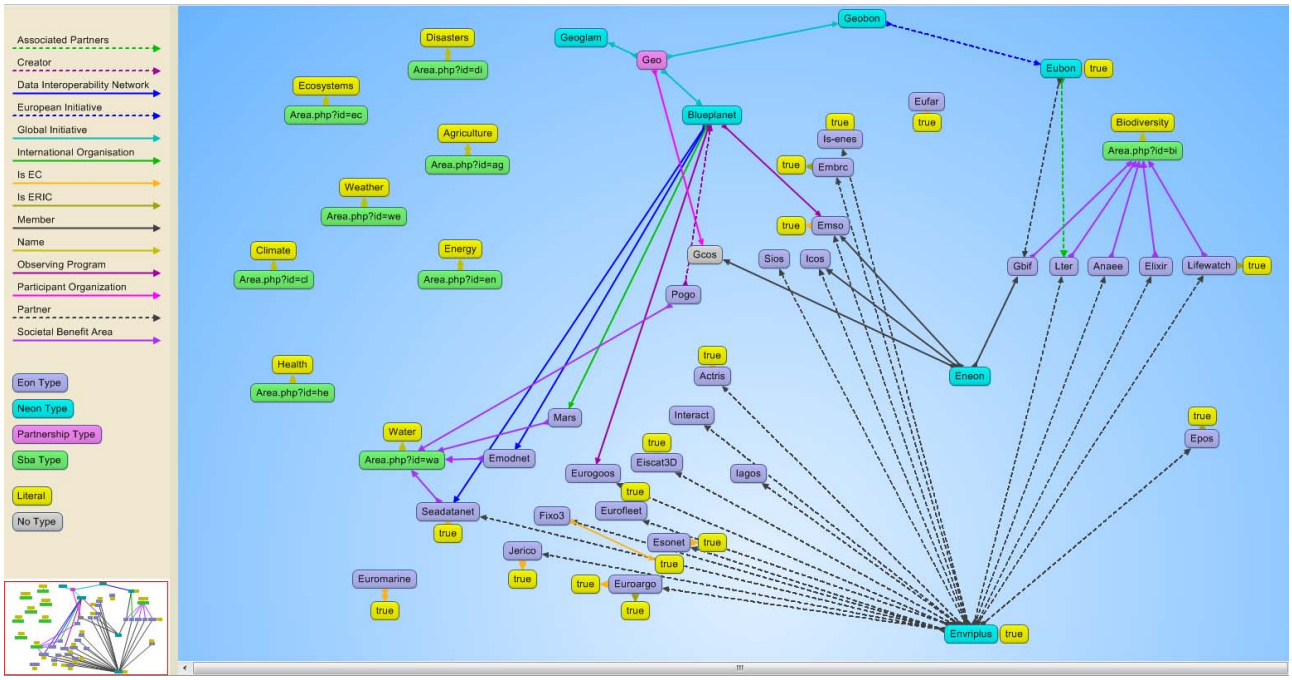

Figure 2 Some of the existing EO networks in Europe and their interactions.

1.2. Definitions in ENEON

In ENEON, the following definitions are used:

- Earth Observation: observation of the Earth environment carried out by space-borne, airborne sensors or any other remote sensing sensors, by in-situ sensors or directly by humans.
- Earth Observation Network: A network of Earth Observation systems or stations and its management structure that makes possible to collect, store and share data about a geoscience theme. It can also create derived products from direct data.
  Earth Observation Infrastructure: An infrastructure that is used to collect, process, analyse, archive, preserve and provide access to Earth observation data.
- Essential Variable: In the context of ENEON, EVs are “variables that determine the system’s state and developments, are crucial for predicting system developments, and allow us to define metrics that measure the trajectory of the system” (ConnectingGEO 2015).

2. Regional Coordination and Collaboration: Benefits and Requirements

2.1. Examples of regional collaboration and coordination networks in Europe

The ENVRIplus is one example of regional collaboration and coordination of networks in Europe. It is a Horizon 2020 project bringing together Environmental and Earth System Research Infrastructures, projects and networks together with technical specialist partners

to create a more coherent, interdisciplinary and interoperable cluster of Environmental Research Infrastructures across Europe.

The project thinks that, to tackle the grand challenges facing human society (for example climate change, extreme events, loss of biodiversity, etc.), scientific collaboration across the traditional fields is necessary. Collaboration within the ENVRIplus enables the multidisciplinary Earth system science across the traditional scientific fields, which is so important in order to address today's global challenges. The cooperation avoids the fragmentation and duplication of efforts, making the Research Infrastructures' products and solutions easier to use with each other, improving their innovation potential and cost/benefit ratio of the Research Infrastructure operations.

The list of networks participating in the ENVRIplus project includes:

- Atmospheric:
  - ACTRIS – Aerosol, cloud and trace gases research infrastructure
  - EISCAT_3D – Multi-static phased array radar system
  - IAGOS – In-service Aircraft for a Global Observing System
- Marine
  - EMSO – European Multidisciplinary Seafloor & water column Observatory
  - EURO-ARGO – European contribution to Argo program
  - EUROFLEETS2 – New operational steps towards an alliance of European research fleets
- Solid Earth
  - EPOS – The European Plate Observing System
- Biodiversity/Ecosystems
  - AnaEE – Infrastructure for Analysis and Experimentation on Ecosystems
  - ELIXIR – European infrastructure for biological information
  - INTERACT – International Network for Terrestrial Research and Monitoring in the Arctic
  - LTER – The Long-term Ecological Research Network
- Multidomain
  - EMBRC – European Marine Biological Resource Centre
  - ICOS – Integrated Carbon Observation System
  - IS-ENES2 – RI for the European Network for Earth System Modelling
  - SIOS – Svalbard Integrated Arctic Earth Observing System

There are many transversal organizations for the use of Remote Sensing Earth observations data such as EARSC, EARSel and Nereus for companies, education and laboratories and for users. Unlike ENVRIplus, these examples are not composed of EO providers.

2.2. Examples of other regional networks

The Earth's Critical Zone is another example of network that concentrated interdisciplinary resources to respond to the common goal. In this case they concentrate in the "heterogeneous, near surface environment in which complex interactions involving rock, soil, water, air, and living organisms regulate the natural habitat and determine the availability of life-sustaining resources".

The Critical Zone includes the land surface, vegetation, and water bodies, and extends through the pedosphere, unsaturated vadose zone, and saturated groundwater zone. The critical zone is the most heterogeneous portion of the Earth. An array of important physical, chemical, and biological interfacial processes and reactions occur in the critical zone over a range of spatial and temporal scales. These processes impact mass and energy exchange necessary for biomass productivity, chemical recycling, and water storage. They also control transport and cycling of contaminants including organics, metals, and radionuclides.

The Critical Zone Exploration Network (CZEN) is a community of people and a network of field sites investigating processes within the Critical Zone, defined as the Earth's outer layer from vegetation canopy to the soil and groundwater that sustains human life. CZEN members are a diverse group of researchers and educators who study the physical, chemical and biological processes shaping and transforming Earth's Critical Zone.

This research spans a wide range of disciplines including geosciences, hydrology, microbiology, ecology, soil science, and engineering. CZEN encourages all researchers working in the Critical Zone to join the effort by registering on this site and contributing content.

There are other example for other purposes such as the INTERACT infrastructure (a project under the auspices of SCANNET) a circumarctic network of currently 71 terrestrial field bases in northern Europe, Russia, US, Canada, Greenland, Iceland, the Faroe Islands and Scotland as well as stations in northern alpine areas. INTERACT specifically seeks to build capacity for research and monitoring in the European Arctic and beyond, and is offering access to numerous research stations through the Transnational Access program.

2.3. Requirements for sustainable regional networks

One of the main issues of maintaining a in-situ network of EO data at the European level is that they have been traditionally funded by national research funding programs. The European Commission only intervene in very specific cases where international coordination is essential to achieve a global goal. This is the case of the ENFRI infrastructures.

The infrastructures maintained under the ENFRI umbrella are:

- COPAL: Heavy Payload Long endurance Tropospheric Aircraft
- EISCAT_3D: The next generation European incoherent scatter radar system
- EMSO: European Multidisciplinary Seafloor Observatory
- EPOS: European Plate Observing System
- EURO-ARGO: Research Infrastructure for ocean science and observations
- IAGOS-ERI: In-service Aircraft for a Global Observing system
- ICOS: Integrated Carbon Observation System
- LIFEWATCH: Science and technology infrastructure for biodiversity data and observatories
- SIOS: Svalbard Integrated Arctic Earth Observing System

With the exception of ENFRI, the sustainability of the in-situ networks is currently limited by national funding programs capacity and the coordination between countries is very limited. This is the reason why a European network of in-situ sensors and field sites is necessary.

2.4. Benefits for ENEON participants

Several benefits can be offered to the organizations that will participate in an initiative like ENEON. These benefits will not include data infrastructure capacities due to this is covered by the ENVRIplus project. Instead, ENEON will have a role more focused on communicate a vision to the outside the scientific community, influence research policies and the European Union research programs (in the same way that the European Innovation Partnerships are doing the same in other sectors such as water and smart cities, etc). The in-situ data networks are still more fragmented in Europe than in other parts of the world and an extra effort need to be done. It is also important to situate Europe in the international arena and integrate in-situ infrastructures in GEOSS. The later has 2 components: ENEON can act as a single point of contact to the work plan but also will help in the practical integration of the current infrastructures to the GEOSS common infrastructure

ENEON internal activities (working groups) can also ask as a common discussion forum to share experiences and components and to work on the consensus for standards profiles, vocabularies and data modelling schemas.

Eventually, being part of the ENEON will create new research opportunities, and will be associated to some degree of recognition and reputation

Currently, the ConnectinGEO team believes that ENEON does not have to offer access to an infrastructure/hosting or data and it does not have to work for improving the data exchange (data access) problems since this is done by other initiatives. It will not be conceived as a marketplace where users and producers can meet and look for business opportunities. However, ENEON will have an important role in convening cross-domain and cross-sectoral issue-focused working groups and in defining new products and services, for which ENEON could help to identify the centers.

2.5. Societal benefits

ENEON contributes to the realization of societal benefits in several ways. Firstly, ENEON will contribute to ensuring the data continuity of the EO networks to monitor the degree of achievement of some of the societal goals such as the energy challenge or the food security and sustainability. By increasing coordination between the networks present in ENEON, scientists will be able to solve problems that were not possible to address before. In particular the energy-food-water nexus can only be addressed by combining the data coming from the 3 domains in addition with socioeconomic data.

ENEON will contribute to saving cost by avoiding redundancies and produce data in a more efficient way, which will impact in an indirect benefit to society. In particular, ENEON will participate in the integration of citizen science measurements into the official networks. By doing so, science will be more popular among society impacting in a better two-way

communication between both collectives. By exploring new methods to engage the private sector in the creation of added value data and the data economy, wealth and job creation opportunities will emerge, that is also a societal benefit.

3. Road Map Towards A European Network of Earth Observation Networks

The road map towards the full establishment of ENEON was discussed during the first ENEON plenary held in Paris on September 21-22, 2015. Besides (1) working out the legal aspects for the formal establishment of ENEON, it was agreed that (2) refining the concept for ENEON as an umbrella organization; (3) demonstrating the value of ENEON should have a high priority; (4) having a joint activity.

For (2), it will be important to have short feedback loop with the European EO networks. This will require that each implementation step is followed by a feedback from the participating networks.

For (3), at the workshop several use cases were discussed for assessments of information needs, e.g.,

- ENEON provision of information relevant for European directives,
- ENEON contribution to SDGs monitoring
- ENEON support for research on the Food-Water-Energy Nexus

It was decided to focus on the Food-Water-Energy Nexus (FWEN) as a first use case.

For (4), it was recommended to review stakeholder needs and carry out a gap analysis for a specific field.

3.1. Legal Aspect and Formal Establishment of ENEON

An *ad hoc* Steering Assembly is governing the initial phase of ENEON. This *ad hoc* Steering Assembly is composed of representatives of ConnectinGEO partners and additional representatives of networks that have already joined ENEON. The *ad hoc* Steering Assembly is chaired by the Coordinator of ConnectinGEO.

An initial activity is a review of legal forms for ENEON and, depending on the option selected, formal Terms of Reference or similar rules and procedures. In order for ENEON to represent the European EO networks in governmental activities and programs, it may be necessary and advantageous to establish ENEON as a legal entity. This will also enable ENEON to receive funds and to participate as a partner in proposals to the European Commission and other relevant national, European and international funding programs.

Options for a legal entity include both European or national for-profit or not-for profit association or a limited liability company. The *ad hoc* Steering Assembly will establish a small group with the mission to review the options for ENEON being a legal entity, consult with appropriate advisors and prepare a proposal to the *ad hoc* Assembly Committee for acceptance. All subsequent steps towards the establishment of ENEON as a legal entity will depend on which option is chosen.

3.2. Feedback Loop

It will be important to establish a short feedback loop that provides rapid feedback on small steps in the implementation of ENEON, This key element of a “lean startup” will ensure that ENEON is not investing a lot in developments that the European EO networks, and in particular the members of ENEON, not need or not want.

3.3. Food-Water-Energy Nexus

This use case will be implemented as a task within the ConnectinGEO Project. The task will apply the ConnectinGEO methodology to indicators related to this FWEN and explore to what extent ENEON provides an environment that supports a transdisciplinary nexus approach to a complex and societally highly relevant issue. Specifically, the use case will conduct the following activities:

- Use the observation inventory and the gap analysis to identify potential stakeholders who can benefit from collaboration across disciplines and domains represented in ENEON and develop a compelling argument for the prioritization of FWEN-related observations and products based on results from the work packages.
- Determine stakeholders, develop plans for further research and investigate regional, national and international funding opportunities to cover the gaps identified.
- Analyze the cost saving potential of collaborations across previously segregated disciplines and domains

In addressing the FWEN under global and climate change, the use case will specifically consider indicators related to food, water and energy security. The recent very rapid changes in the phosphate and nitrogen cycle (see Figure 3) associated with food production will also be considered. Taking into account that the rapidly increasing energy usage during the last roughly 100 years enabled the population growth that is now threatening food and water security, the task will actually have to consider the Energy-Population-Food-Water-Nexus (EPFWN). The nexus approach will help to understanding the interdependencies between energy usage and availability, population growth, global change, food security, water security, and the global boundaries. Specific questions to be consider are:

- How can collaboration and coordination through ENEON help to inform about the FWEN and impacts in Europe?
- Which SDGs relate to the FWEN and which are the relevant indicators?
- Can ENEON help to quantify the indicators for these SDGs?
- What ENEON products could support policy making that takes a nexus perspective?

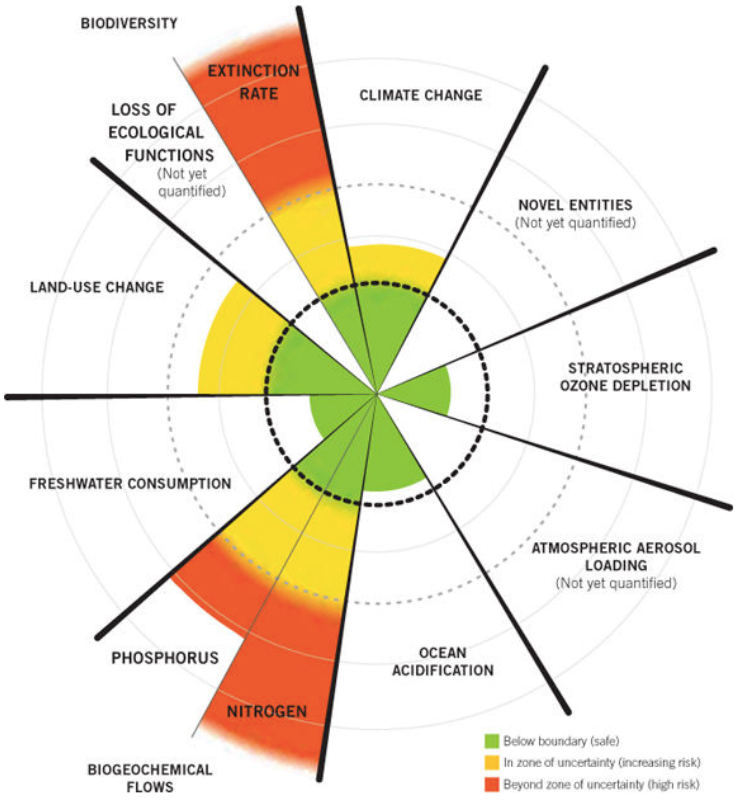

Figure 3 Global boundaries of the “safe operating space for humanity” and the extent to which these boundaries have been crossed, Note that the biogeochemical flows for nitrogen and phosphorus have crossed the boundaries by far and are threatening both the Earth’s life-support system and food and water security. From Rockstrom and Klun (2015).

The use case will employ the concept of Essential Variables (EVs). The EVs to be used will be determined using the ConnectinGEO methodology. The societal tgoals and targets will be extracted from the Sustainable Development Goals (SDGs) accepted by the United Nations. Based on the associated indicators, a specific set of EVs for the FWEN will be established. To the extent possible, these EVs will be extracted from the SBA-specific EVs.

The main gaps to be addressed in this challenge include the lack of collaborations across disciplines and domains, and a gap in GEOSS related to theme-based approaches to data and product discovery. A particular gap is that linking industry and science communities. Another gap relates to links between different observing networks required to address a complex issue such as the FWEN.

The main outcome will be a report characterizing the gaps that hamper the use of GEOSS in addressing complex issues and proposing actions to address these gaps. The report will identify the stakeholders of the FWEN who would are impacted by the identified gaps and who would benefit from actions addressing the gaps. The aim is to quantify the societal benefits and to estimate the benefit-to-cost ration. A particular focus will be on the potential contributions of ENEON in closing the gaps. The report will also describe the EVs relevant for the FWEN and assess to what spatial and temporal extent data for these EVs is available through ENEON.

An attempt will be made to identify at least one product that directly relates to the FWEN and that could be produced based on data provided by ENEON members. Prime candidates are quantification of SDG-related indicators that are relevant to the FWEN. The

It is planned to focus on Europe as the test region. Temporally, the project period is the main timeslot to be considered. However, for the quantification of indicators, it may also be considered to extend the time window into the past.

The result of the challenge will be presented at the second ENEON plenary workshop in October 2016. The challenge will be documented in a report to the EC, and the scientifically relevant parts will be published in scientific papers.

The stakeholders for this challenge include those monitoring the indicators for SDGs related to the FWEN, and those engaged in planning actions to make progress towards these SDGs. The EO networks providing data for EVs required to quantify the indicators are also stakeholders of the FWEN. Researchers studying the FWEN as well as funding agencies at national and international levels providing financial resources for EO networks, research, and monitoring relevant to the FWEN belong to the stakeholders, too. In particular, funding agencies will be interested in cost savings and increased efficiency that may result from the actions proposed by the challenge.

3.4. Gap Analysis

ConnectinGEO is implementing a novel methodology to build a coherent picture of observation requirements, analyze the current state of observations, and eventually identify gaps of European EO networks. Besides the widely used bottom-up approach of the observation inventory, these are (a) top-down derivation of requirements from sustainability goals and the essential variables (EV) that connect these indicators with observable quantities, (b) dialogue with ENEON members (see below), and (c) practical industry challenges that transfer experiences between communities, generate new products based on open access EO, and report obstacles for innovation. Based on this methodology, ENEON will carry out a gap analysis and prepare a white paper on on stakeholder needs and relevant gaps.

4. Defining ENEON

ENEON is a common network of Earth observation networks to provide integrated and harmonized perspective of observations, forecasting and projecting, helping to reduce redundancies and detect gaps in the European EO arena. ENEON considers all thematic areas and is open to contributions from GEOSS as well as Copernicus stakeholders, SMEs and industry, funding agencies, and most importantly European networks for space-based, airborne, ship-borne and in-situ observations.

4.1. Vision

All European Earth observation networks are interoperable and coordinated across disciplines and sectors with respect to observations of essential variables with no gaps, no

redundancies, resulting in saving costs and fully operational continuity of observations, and they are collaborating in providing integrated knowledge serving user needs.

4.2. Mission

To make progress towards the vision, ENEON has the mission to generate a self-sustained organization that represents and coordinates European EO networks with the goal to increase interoperability between existing networks, reduce gaps, and ensure availability and accessibility of observations required to generate products that meet user needs, including information on the state and trends in the environment. In order to achieve this goal, ENEON will

- be part of the GEO European hub and provide an integrated representation to GEO;
- generate inventories of existing EO networks in Europe, with emphasis on non-space based networks;
- participate in the development of sets of essential variables for different themes and areas and document these sets;
- work with GEO, and Copernicus to ensure that overviews of required and existing observations are available and contribute to publishing this knowledge in the GEO Knowledge Base;
- carry out gap analyses to identify knowledge gaps, capacity gaps, infrastructure gaps, and data gaps;
- develop roadmaps setting priorities and suggesting remedies to reduce gaps;
- engage with the European EO networks to facilitate integrated products and services that require coordination and collaboration between multiple network and integration of environmental, social, and economic data;
- provide a convening platform to bring networks and their users from different domains and sector together and to support capacity building.
- connect with citizen science projects and engage with EO companies.

4.3. Goals and objectives

The main goals of ENEON, are:

- Incorporate all EO networks currently active in Europe as members and be able to represent them in international endeavours.
- Consider as much thematic areas as possible; in other to achieve thematic comprehensiveness.
- Connect with gap analysis studies, in particular the ConnectinGEO methodology.
- Adopt and progress in the definition of EV and determine the status of the measures that are contained in each EV. Harmonize the level of maturity
- Guaranty the spatio-temporal continuity of the observations.
- Facilitate the use of standards in the diverse thematic areas (Sensor Observation Service, etc).
- Spatial harmonization of EO in-situ data.

Moreover, we envision some functions and activities from ENEON to provide to the member networks. Functions will be done by committees while activities will be conducted by work groups as later explained.

Functions:

- Unified representation to international EO initiatives (GEOSS, Copernicus in-situ component, INSPIRE, CEN).
- Connect with the European Commission and collaborate with them in cover the EO needs. Also connect with other international funding opportunities.
- Contribute to the consolidation of the European Data Hub.
- Help to maintain the temporal/spatial continuity of the observations.
- Connect with the EO private sector companies and in particular with European SMEs.
- Get more visibility among the science and technology community or users.
- Maintain an inventory of the existing EO networks, Essential Variables, Observations (without getting to the level of datasets), etc.
- Encourage the adoption/alignment with the Essential Variables approach.

Activities:

- Be a forum for discussing observational gaps among EO networks.
- Create opportunities for cross-domain activities and studies that serve as harmonization experiments.
- Find out the gaps in EO, look for consensus and remedies to mitigate the gaps..
- Integration beyond pure in-situ networks by including both citizen science networks and, socioeconomic data networks).
- Regular communication and coordination activities (workshops, whitepapers, recommendations).
- Semantic harmonization (in relation to EV and sensor vocabularies.
- Capacity building among networks.

5. ENEON governance and management

5.1. Legal basis

The legal basis chosen for ENEON will have impacts on its governance and management. It will be important to consider the legal basis at an early point in time. A starting point for the consideration will be an association under European law, and this option will be compared to a number of potential national associations.

5.2. Membership

ENEON will be open to all European Earth Observation Networks as well as organizations that operate Earth observation infrastructure. ENEON will also seek members representing European funding agencies.

The composition of ENEON is currently limited to the ConnectinGEO partners and some additional networks (i.e., Satellite-based Wetland Observation Service (SWOS) and ECOSCOPE - Biodiversity Observation and Data Center for Research). Negotiation on these and additional collaborations are in progress. Other relationships are being established with ENVRIplus membership (i.e., LTER, ANAAE and ICOS). Contacts with other big and historic networks such as EPOS and EUBON have been established.

Candidates for future membership include:

- The GEOSS Science and Technology Stakeholder Network and GEOSS CoPs.
- The GEO national structures (e.g., GEO Spain) and GEO national Principals, as well as European and national funding agencies (in particular, the ones participating in ERA-NET and ERA-Planet).
- The representatives for the Copernicus services, Sentinel missions and other European programmes, regarding to non-exclusively in-situ networks.
- The industry sector.

5.3. Governance, Steering, and Management

The steering of ENEON will be designed to ensure broad representation of the membership. For the time being, it is proposed to have a Steering Assembly with representation of the domains/disciplines and societal sectors of the membership (see Figure 4). The steering will include an executive component that reports to, and acts according to the guidance, of the steering committee. This Executive Board will be responsible for the day-to-day business and interact with all other ENEON components and the membership.

Both the Steering Assembly and the Executive Board will benefit from the advice provided by a Senior Advisory Panel, which will include both scientific and non-scientific senior advisors.

The work of the ENEON will be conducted in Committees, Working Groups and Centers. Committees will be established for long-term activities. Working groups will be established as needed with limited time horizon. ENEON Centers will be operated by the membership under the guidance of ENEON Steering.

A objective of the ENEON is to facilitate products and services that require cross-domain and/or cross-sector collaboration. As needed ENEON will identify and denote product and service centers that have the responsibility to run and maintain these products and/or services.

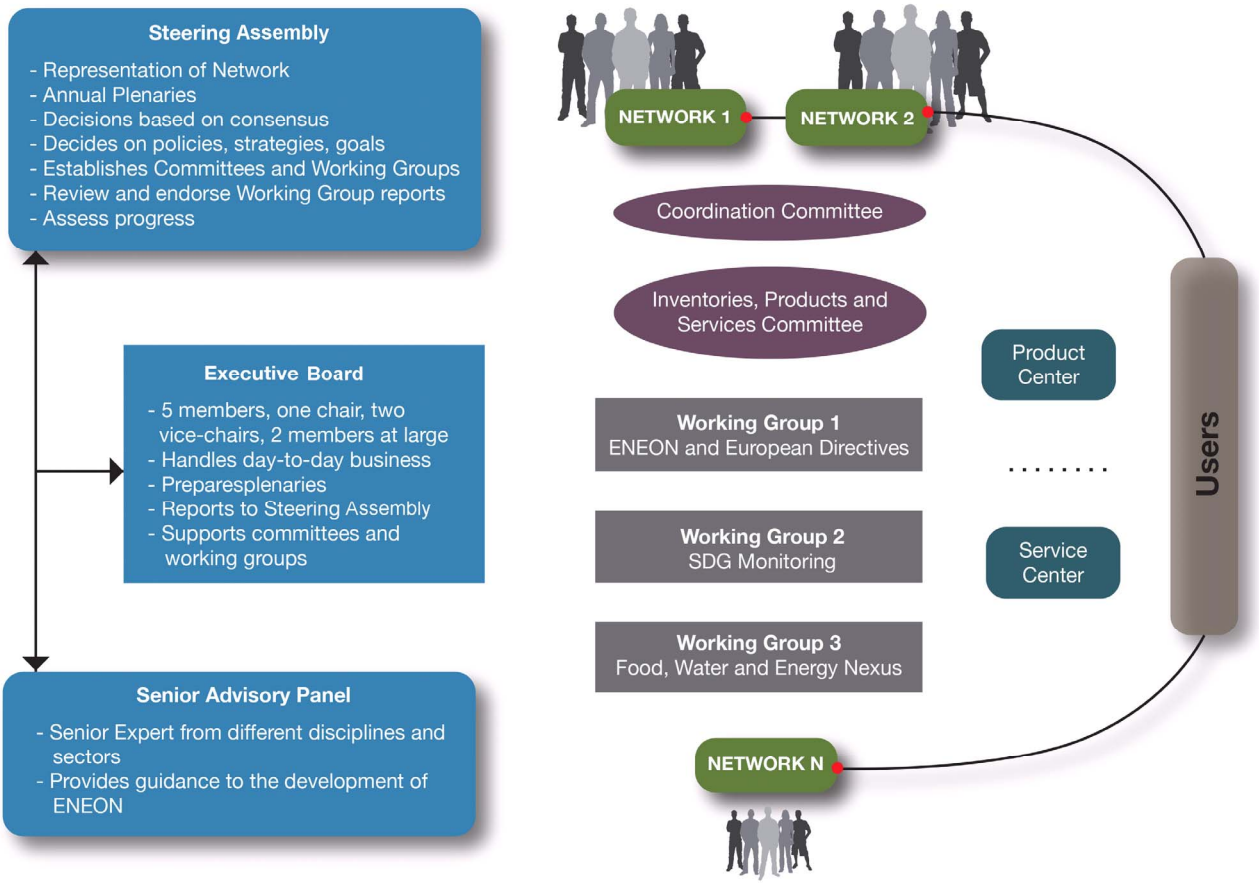

Figure 4 Proposed organization of ENEON.

5.4. Committees

The main working components of ENEON are Committees and Working Groups. A small number of committees will be established on a permanent basis, and these committees engage core activities of ENEON. The two proposed initial Committees are:

- Coordination Committee: which will focus on the cross-domain and cross-sector coordination between networks and infrastructures and in novel in-situ sensor measurements and methodologies that can contribute to cross-domain data.
- Inventories, Products, and Services Committees: that will facilitate, support, and monitor the ENEON activities that establish inventories or facilitate the development of new products and services.

In addition, future committees can be formulated, such us:

- Integration of citizen science in the official networks
- Exploitation of data by the private sector
- Integration of socioeconomic data with EO data.

Committees conceived as permanent act as the point of contact to other organizations and networks such as the European commission, GEOSS and Copernicus and work for a continuous improvement of the network of networks.

5.5. Working Groups

Working groups will be established for a limited time as needed. It is foreseen that Membership in working groups primarily will be drawn from ENEON members but can also include other experts as needed. It is proposed to establish initially the following working groups:

- Working Group 1: ENEON and European Directives: this WG will explore the potential roles of ENEON in linking EO networks better to the needs arising from emerging or existing European directives
- Working Group 2: SDG Monitoring: The purpose of this WG will be to link relevant European EO networks better to the GEO activities related to the Sustainable Development Goals, including the relevant Foundational Tasks and Initiatives
- Working Group 3: Food, Water, and Energy Nexus. This WG initially will focus on the Task 5.6 in the ConnectinGEO Project, which aims to assess the added value of ENEON in addressing this complex cross-domain issue from a nexus point of view.

Working groups are internal activities that are oriented to improve internal communication and looking for a common understanding. Working groups are oriented to achieve a more focused goal, such as a best practices document or a cross-domain problem assessment and will be terminated one the goal is finished.

5.6. Centers

In cases where the Inventory, Products and Services Committee identifies the need and opportunity for new cross-domain/cross-sector products or services, ENEON will engage in facilitating designated centers for these products or services. In general, a call for proposals will be issued to identify candidates for such centers and the proposals will be assessed according to well-established rules and procedures before a candidate is designated as an ENEON Product or Service Center.

6. ENEON membership

7. Annexes

7.1. Plenary Workshop Report

Date: September 21-22, 2015
Location: ARMINES, MINES ParisTech, Paris France
Web Pages: http://www.eneon.net/Events.htm#E4, http://www.gstss.org/2015_Paris.

7.1.1. Eneon workshop scope and objectives

The ENEON Workshop explored the benefits and options of constituting a European Network of Earth observation Networks that encompasses current networks in Europe in a single entity. The ENEON will be a forum for discussing gaps in the EO networks and

proposing concrete solutions to the European Commission in terms of completeness but also for ensuring continuity of critical infrastructures both in-situ and space based. It will also serve as a coordination point for the European contribution to GEOSS in the matter of in-situ networks and to encourage the alignment of a transversal set of Essential Variables GEO is currently advocating.

The Objectives of the workshop were to:

- Learn more about the main current Earth Observation networks in Europe;
- Review previous umbrella initiatives;
- Know more about the scales and frequencies of data collection and gaps in data acquisition, sharing, and products;
- Clarify the need for ENEON and identify potential overlaps with similar initiatives;
- Develop a strategy to setup a sustainable network of networks.

7.1.2. Workshop participants

The Workshop was attended by 34 experts from different networks and institutions in Europe trying to cover all SBA in GEOSS. Below, the list of speakers from the networks demonstrates the wide range of disciplines covered.
From the EC: Michel Schouppe
From the GEO Secretariat: Barbara Ryan
From ENVRIplus: Werner Kutsch
From Copernicus in-situ component: Jan Hendrik Voet (IRCEL)

From the carbon domain:
- ICOS: Werner Kutsch

From the meteorological/weather domain:
- Geir Ole Braathen (WMO)
- EUMETNET: Eric Petermann (Institut Royal Météorologique)

From the ocean domain:
- EuroGOOS: Begoña Pérez
- SEADATANET: Thomas Loubrieu (EUROARGO)

From the water domain:
- Hydrological networks: Wolfgang Grabs (German Federal Institute of Hydrology)

From the atmospheric domain:
- ACTRIS: Wenche Aas (NILU)
- TCCON: J. Notholt (University of Bremen). Presented by Martine de Mazière (BIRA)
- NDACC: Martine de Mazière (BIRA)
- EMEP: Wenche Aas (NILU)

From the ecosystem domain:
- LTER: Michael Mirtl (EEA).
- DOPA: Lucy Bastin (JRC)
- EIONET: Jan Hendrick Voet (IRCEL)

From a cross-cutting domain:

- EUREF: Carine Bruyninx (EPN)
- ECSA: Arne J. Berre (SINTEF)
- EARSC: Geoff Sawyer

7.1.3. Workshop summary

The workshop provided an overview of EO activities in Europe, including selected observation networks, research infrastructures, information systems, and coordination activities. In summary, the various networks described their main issues, challenges, opportunities and needs. Overall, numerous common themes were identified. Issues included among others, issues related to funding, awareness raising, stronger links to GEOSS, trans-thematic products generation, user requirements database and more.

The workshop participants were positive to the establishment of ENEON. Issues common to many of the networks present at the workshop were raised. Hence the potential of such a network to address some of these issues was seen as a real possibility. Going forward, more clarity is needed in terms of the actual goals, vision, membership and activities of ENEON. With a more clearly stated vision, and benefits that can be articulated to the networks, the establishment of ENEON could prove to be a valuable tool for the creation of new information to answer new scientific questions.

7.1.4. Program and speakers

Monday, September 21, 2015

0830 - 0900:	***Registration***
0900 - 0940:	Session 1: Welcome and Introduction (Chairs: Joan Masó and Thierry Ranchin)
0900 – 0910	*Thiery Ranchin (MINES Paris Tech)*: Welcome and Opening Remarks (pptx)
0910 - 0920	*Joan Maso and Ivette Serral (CREAF)*: The ConnectinGEO project (pptx)
0920 - 0930	*Ian McCallum (IIASA)*: ENEON (pptx)
0930 - 1050:	Session 2: Goals, objectives, benefits and impacts (Chairs: Ivette Serral, Hans-Peter Plag)
0930 - 0950	*Barbara Ryan (GEO Secretariat)*: How ENEON should collaborate with and be included in GEO (pptx)
0950 - 1010	*Michel Schouppe (EC)*: The European GEOSS context for ENEON (ppt)
1010 - 1030	*Werner Kutsch (ENVRIplus Coordinator)*: The ENVRIplus Approach to networking (pptx)
1030 - 1050	*Jan Hendrik Voet (IRCEL)*: The Copernicus cross-cutting in situ component (pptx)
1050 - 1100	*Ivette Serral (CREAF) and Hans-Peter Plag (TIWAH)*: Workshop objectives and anticipated outcomes (pptx)
1100 - 1125:	*Coffee Break*
1125 - 1315:	Session 3: European Earth Observation Networks: Needs for coordination and collaboration regarding the detection of gaps and redundancies in GEOSS. (Chair: Joan Maso)
1125 - 1150	*Werner Kutsch (ICOS)*: ICOS: Integrated Carbon Observation System (pptx)

1150 - 1215	*J. Notholt (presented by Martine de Maziere)*: TCCON: Total Carbon Column Observing Network (pptx)
1215 - 1240	*Martine de Maziere*: NDACC: Network for the Detection of Atmospheric Composition Changes (pptx)
1240 - 1310	*Geir Ole Braathen*: How does the World Meteorological Organization manage and exploit its observational networks? (pptx)
1310 - 1410:	*Lunch*
1410 - 1540:	Session 3 continued (Chair: Martine de Maziere)
1410 - 1440	*Stefano Nativi*: GEOSS Infrastructure for Earth Observation Networks (pptx)
1440 - 1505	*Simon Wilson*: Arctic Monitoring and Assessment Programme (AMAP) (pptx)
1505 - 1535	*Wolfgang Grabs*: Hydrological networks (pptx)
1535 - 1605	*Carine Bruyninx*: EPN: EUREF Permanent Network and EUREF (pptx)
1605 - 1625:	*Coffee Break*
1625 - 1815:	Session 3 continued (Chair: Emili Garcia Ladona)
1625 - 1645	*Eric Petermann*: EUMETNET (pdf)
1645 - 1715	*Begoña Perez*: EuroGOOS (pptx)
1715 - 1735	*Thomas Loubrieu*: SEADATANET (Pan-European Infrastructure for Ocean and Marine Data Management) (pdf) and EUROARGO (pdf)
1735 - 1755	*Wenche Aas*: EMEP, ACTRIS (European Research Infrastructure for the observation of Aerosol, Clouds, and Trace gases) and atmospheric measurement activities of OSPARCOM and HELCOM (pptx)
1755 - 1815	*Arne J. Berre*: European Citizen Science Association (ECSA) (pptx)
2000 - 2200:	*Social Dinner (no host)*

- **Tuesday, September 22, 2015**

0830 - 0900:	***Registration***
0900 - 0945:	Session 4: Summary presentations from rapporteurs (Chairs: Ian McCallum, Hans-Peter Plag)
0900 – 0915	*Rapporteur 1 (Ian McCallumn)*: Summary of key issues for sustainable EO networks in Europe (question block 1) (pptx)
0915 – 0930	*Rapporteur 2 (Antonio Bombelli)*: Summary of data availability, sharing, and gaps (question block 2) (pptx)
0930 – 0945	*Rapporteur 3 (Hans-Peter Plag)*: Summary of existing collaboration mechanisms, experience and lessons from the efforts (question block 3) (keynote, pdf)
0945 - 1105:	Session 5: Engaging participation in ENEON: Lessons Learned (Chair: Palma Blonda)
0945 – 1020	*Michael Mirtl*: Long Term Ecological Research Network (LTER): overcoming fragmentation, lack of coordination, and duplication (pdf)
1020 – 1100	*Lucy Bastin*: Linking service infrastructure: Lessons learnt from DOPA: Digital Observatory for Protected Areas
1100 – 1130	*Jan Hendrick Voet*: EIONET: European Environment Information and Observation Network (pptx)
1130 - 1145:	*Coffee Break*
1145 – 1220	*Geoff Sawyer*: Collaboration between Industry and European Networks

	(ppt)
1220 - 1300:	Session 6: Toward enhanced coordination and collaboration (Chair: Hans-Peter Plag)
1220 – 1245	*Hans-Peter Plag, Palma Blonda, Werner Kutsch, Jan Hendrick Voet, Geoff Sawyer*: Panel statements on enhancing coordination and collaboration across disciplines and sectors
1245 – 1315	*Hans-Peter Plag*: The GEO Knowledge Base and Gap Analyses (keynote, pdf)
1315 - 1400:	*Lunch*
1400 – 1430	*Palma Blonda*: Defining user needs and essential variables to support GEOSS objectives (pptx)
1430 - 1600:	Session 7: Refine goals, objectives and benefits of ENEON (Chair: Joan Maso)
1430 – 1440	*Hans-Peter Plag*: Benefits of a European Earth Observation Network of Networks
1440 – 1500	*Ian McCallum*: Draft goals, objectives and benefits of ENEON
1500 – 1530	*All (Moderator: Joan Maso)*: Round table: Goals, Objectives, and Benefits of ENEON
1530 – 1535	*Moderator*: Summary of Round Table outcomes
1535 - 1610:	*Coffee Break*
1610 - 1720:	Session 8: Organization and management of ENEON (Chairs: Hans-Peter Plag, Jay Pearlman)
1610 – 1640	*Hans-Peter Plag*: Draft organization, ToR, and membership of ENEON (keynotes, pdf)
1640 – 1700	*Paola Campus (remote presentation)*: Thoughts on a funding cycle for ENEON (pdf)
1620 – 1630	*Joan Maso*: Coordination of ENEON with similar initiatives, including ENVRIplus (pptx)
1630 – 1710	*All (Moderator)*: Discussion: ENEON organization, management and membership
1710 – 1720	*Hans-Peter Plag*: Summary and revised ToR for ENEON
1720 - 1800:	Session 9: Summary Session: A roadmap for ENEON (Chairs: Ivette Serral, Hans-Peter Plag)
1720 – 1735	*Ivette Serral*: ENEON definition, criteria, processes (pptx)
1735 – 1745	*Hans-Peter Plag*: Steps towards the implementation of ENEON
1745- 1800	*Joan Masó and Thierry Ranchin*: Concluding remarks

7.1.5. Questions to be addressed by speakers

The speakers were asked to give an overview of the status of their network and its potential linkages to higher level coordination and collaboration networks. All speakers addressed the same set of questions to get a coherent overview of the status. These question were:

Introduction of the network:

1. What network are you representing and what is your role in this network?
2. What are the main objectives of the network?
3. Who are the main contributors to your network?
4. What form of commitment do you have for the maintainance your network?
5. How large is your user base and who are your users?
6. Do you maintain a database of user needs and observational requirements?
7. What are the costs and efforts of maintaining the network?
8. What are your main funding sources?
9. What are the key issues for sustainability of your network running?

About data:

1. What observations does your network collect and what products are produced?
2. What are the spatial and temporal characteristics and limits of your network?
3. How is the data archived and made accessible to users?
4. Do you address data quality in some way?
5. Are there risks for data continuity and how are data preservation and network continuity addressed?
6. What are the conditions (licenses) for sharing your data and products with users?
7. What key interface standards are used in making data and products available?
8. Are there known observational requirements that your network is not meeting?
9. Are there observations that are needed but not captured by your network or by other networks that you have access to or products that are not generated?

About a network of networks:

1. What coordination and collaboration interfaces do you have with other networks?
2. Is you network contributing to GEO(SS) and if so, what is this contribution? Could ConnectinGEO help to enhance your contribution to GEOSS?
3. Are there additional interfaces that would be desired and what would be the main benefits of these interfaces?
4. Do you think that your network could benefit from the existence of an ENEON or a similar network?
5. From you point of view, how should an ENEON be organized and managed?

7.1.6. List of participants

Name	Organization
Antonio Bombelli	CMCC
Ariane Dubost-Bonnet	EARSC
Arne J. Berre	SINTEF
Attiglah Mathevi Tetevi	Société Minière et Pétrolière du Gabon
Barbara Ryan	GEOsec
Begoña Pérez	EuroGOOS
Carine Bruyninx	EUREF
Emili García-Ladona	CSIC
Eric Petermann	EUMETNET - Institut Royal Météorologique
Françoise Pearlman	IEEE
Geir Ole Braathen	WMO
Geoff Sawyer	EARSC
Hans-Peter Plag	TIWAH
Ian McCallum	IIASA
Ivette Serral	CREAF
J. Notholt	TCCON
Jan Hendrik Voet	Copernicus in-situ
Jay Pearlman	IEEE
Joan Masó	CREAF
Kjetil Tørseth	NILU
Lionel Menard	ARMINES
Lucy Bastin	JRC
Martine de Mazière	BIRA
Mary Njeri Nyambura	Community Development Productions
Michael Mirtl	LTER - Umweltbundesamt GmbH
Michel Schouppe	EC
Mónica Miguel Lago	EARSC
Nicolas Bellec	IMT
Noel Parmentier	RHEA
Palma Blonda	CNR
Simon Wilson	AMAP
Stefano Nativi	CNR
Stéphane Sauvage	MERA (National observatory of Background air pollution, part of EMEP program)
Thierry Ranchin	ARMINES
Thomas Loubrieu	SEADATANET
Werner Kutsch	ENVRIplus, ICOS
Wolfgang Grabs	German Federal Institute of Hydrology

7.1.7. ENEON workshop minutes

The following minutes were taken during the workshop and reflect the key messages of each speaker along with any points raised during the discussion. They are by their very nature an approximation of the discussion and are presented here as recorded. The workshop began with Session 1 and an introduction by the local hosts, the ConnectinGEO Project coordinator and Project members. This was followed by Session 2 which was opened by GEO and the European Commission. Highlighted sections indicate questions or points raised that ENEON should potentially consider.

***Barbara Ryan* : How ENEON should collaborate with and be included in GEO**

B. Ryan suggested the following main points:

- GEO still has gaps on space-based and in-situ networks.
- Consider the European GEO participating organizations, for instance, EUBON.
- Consider private sector
- GMOS – A good example of a GEO network
- Need for legal framework to generate a GEO activity
- Community portals are an opportunity.
- ENEON as a GEO Initiative?
- ENEON as Community activities?
- ENEON as a GEO Flagships? This has a policy mandate – likely not appropriate
- Need to follow Inspire

***Michel Schouppe*: The European GEOSS context for ENEON**

M. Schouppe emphasized the following main points:

- We need more Union in our Europe to address global challenges. Ten priorities: EU stronger global actor, Digital Single Market, Resilient energy Union linked to Climate change.
- We have lot of data but we need more coordination regarding in-situ.
- “Earth Observation in the global context” survey (EO, GEO, GEOSS, Copernicus). Positive responses for the coordination to GEOSS. EU action in cooperation with other region for global action. An unsecure commitment to GEOSS due to funding cuts context. Accelerate the open data. Strong ERA, Improving collection and coordination data. Stronger synergies between GEOSS and Copernicus.
- IIB there will be different levels of readiness in GEO Community at different speeds.
- Multilateral opportunities for ENEON: SDG, COP21 on climate, Post 2015 Development Agenda, UN-GGIM, G8 Open data charter
- International initiatives opportunities for a better sharing and exploitation data: Belmont Forum (A Place to Stand: e-Infrastructures and Data Management for Global Change Research), RDA.
- GEO opportunities: Reviewed GEO mandate 2016-2025
- EU opportunities 2014-2020: Copernicus, H2020, Digital single market EU Strategy, thriving data-driven economy...
- *“The resulting network of network (ENEON) should consist do a wide spectrum of European stakeholders laying down the foundations for a forum outlasting ConnectinGEO”*. Note the emphasis on outcomes.
- ERA-Planet: 4 strands driven by the member states. This is an unprecedented pilot for EU that could be sustained in the future if successful.
- GEO-CRADLE: leader university of Athens (Nord Africa, middle east and Balkans)

- Strengthening the European Components of the GEOSS Information System: European data hub of the GEOSS information system. Portal of portal focused on European assed.
- Recommendation: Consider the global indicatives mentioned.

***Werner Kutsch*: The ENVRIplus Approach to networking**

W. Kutsch addressed the following main points:

1. Sustainability concept: EC+ Scientific community. Growing towards a solid structure (ICOS will be an ERIC).
2. Favour cross-fertilization between infrastructures. Implementing innovative concepts and devices.
3. Atmosphere, marine solid earth, biosphere.
4. Main challenges: New technologies, Standardization, remote distributed observations, big data, open data, connected data.
5. The biggest part of the project. Data for science. A future cookbook for data. Data identification and citation. Processing and analysis, data curation and cataloguing. Board of Environmental Research Infrastructures (BEERi). ENVRI community chares the same vision as GEO.
6. Cooperation between ENVRIplus and ConnectinGEO:
    - Common solutions and developments among RIs
    - Connection to GEO and transfer data to GEOSS through ConnectinGEO.

***Jan Hendrik Voet* : The Copernicus cross-cutting in situ component**

J. Hendrik Voet covered the following main points:

- Copernicus: Space (ESA and Eumetsat)/in-situ (coordinated by the EEA)/services
- Services and in-situ component for 2014-2020 897MEUR.
- Copernicus Services. Operation: Atmosphere, Land, Marine, Emergency. Security and Comate are not operational
- Eionet (EEA) is an network of institutions (ministries, agencies, institutes) at country level that can provide environmental observation.
- Cross-cutting part: Delegation agreement, copernicus work program. GISC project. 1 dedicated EA staff+ 3-5 Task force members):
    a. Elaborate a comprehensive overview of in-situ data requirement (services). Database with meta-information, update of GISC) contains gaps, data quality.
    b. CORDA (Copernicus Reference Data Access): in-situ for Copernicus services that will contain: references systems (orthophotos, land cover/use), thematic (air quality data), LICAS, LPIS (land parcel system)
    c. Partnerships with data providers for data access (EuroGeographics-EuroGeo Surveys- EuroGOOS,Eumetsat.

Support EC and Copernicus services to find solutions for in-situ; GEOSS, cooperation between services.

***Ivette Serral and Hans-Peter Plag*: Workshop objectives and anticipated outcomes**

I. Serral and H.-P. Plag emphasized the objectives of the workshop:

- Review EON, know about gaps in data, know overlapping initiatives. Questions have been distributed to the speakers concerning the network, data produced, NoN benefits.

The audience had several request:

- Request for 4-5 take home message.

- ENEON needs to "Engage". Need for a message why the networks need to come on board.

***Werner Kutsch*: ICOS: Integrated Carbon Observation System**

W. Kutsch suggested the following main points:

- ICOS is not a network but an infrastructure because we want to be permanent. Understanding carbon cycles. 3 networks:
  - greenhouse exchange between ocean and the atmosphere. Measures in ships, modeling for the final products.
  - Exchange between atmosphere and ecosystems (eddy-covariance stations->global products).
  - Measuring GHG in low atmosphere by towers.
- Infrastructures are financed by the national countries. ICOS has 9 signature countries. 100 stations. License: Attribution-Share Alike CC BY-SA
- GEO Carbon FLAGSHIP initiative:
- Observation (identify observational gaps)->Services (need to improve data harmonization and interoperability)->Decisions (need for data fusion projects and sustainability).
- Question to maintain the measurement towers. ICOS is a 20 year project. Need the commitment for the national governments.

Offering to have the interdisciplinary challenge in the flagship of carbon in GEOSS.

***J. Notholt (presented by Martine de Maziere)*: TCCON: Total Carbon Column Observing Network**

J. Notholt suggested the following main points:

- TCCON based on RS on the ground: sample the whole column of air below the instrument.
- In-situ network: High accuracy, limited spatial coverages and limited value for RS validation.
- RS: Small dependency on vertical mixing. Very complementary with in-situ data.
- TCCON is in the middle and is essential for satellite data. 20 carbon columns in the world. Data is public once a year.

Most of the sites are funded via short-term research projects → there's not a long term funding for the sustainability. Instruments are very expensive.

***Martine de Maziere*: NDACC: Network for the Detection of Atmospheric Composition Changes**

M. de Maziere suggested the following main points:

- NDACC is a mature network moving to a more operational status. It's an association of research institutes over the world. Does not provide funding; each contribution must find its own funding. Financing the operational stations is not secured. NDACC has a European branch. Columns of atmospheric components in HDF4 and data is provided for free two years later. Supports Montreal and Kyoto protocols.
- Associate to ACTRIS ESFRI.
- No formal links to the Work Plan → paper to ENEON or ConnectinGEO.

Identifying an unexpected ENEON role: Communicate knowledge derived from observing networks. Ensure permanent funding. Derive data from the collaboration with other networks.

***Geir Ole Braathen*: How does the World Meteorological Organization manage and exploit its observational networks?**

G. Braathen suggested the following main points:

- WMO also monitors atmospheric chemical composition: Global Atmosphere Watch (GAW) → registered in the GEOSS registry. They have the OSCAR database; Observation System Capabilities Analysis and Review Tool. They have a Rolling Requirements Review Process. Comparison of requirements with capabilities → gap analysis
- Challenges:
    - Better coverage of aerosol measures
    - Cooperation with existing networks measuring water vapour

- NEEDS: Services on volcanic ash, better aerosol measurements, more use of commercial aircraft as sensor platforms.
- Harmonization of vocabularies is also a need.
- Suggestion to provide capacity building: Training and education, twinning (developed countries help developing countries).
- Near real time mode for data sharing. Networks are committed to gather data and to share that using standards. WMO and OGC are standards organizations contributing to this general problem. Going into the details of registration process and registering twice. Use Feature models and semantics in O&M (WaterML and Groundwater...) as a thing that can be generalized.
  ENEON can help all these networks to better define what is needed and what is available.

Questions were asked about OSCAR: Who is populating it and how is it ensured that the information is complete? Can ENEON be a service provider for this? The population involves experts from scientific advisory groups and GCOS requirements list. Filling XLS sheets. MeteoSwiss maintains the database. It was reiterated that the database needs to link to the society needs (justify the need for an observation). E.g., forecasting air quality is one of this requirement. OSCAR is more technical about scales and frequencies.

***Stefano Nativi*: GEOSS Infrastructure for Earth Observation Networks**

S. Nativi suggested the following main points:

- Semantic engines used in the DAB is managed by the JRC. 1.2 10^6 datasets this that. 130 data provides by incorporating all the providers coming from the CRS. DAB is moved to the cloud and provides and API to interact with the DAB (CEOS water portal, MyGEOSS and AIP-8 pilots).
- Finishing brokering the entire GCR.
- GEO Model Web: moving from the software ecosystem to the social ecosystem.

Simon Wilson AMAP Arctic Modeling Assessment program.

S. Wilson suggested the following main points:

- Monitor and assess the status of the Arctic region with respect to pollution and climate change issues. It's not a database.
- Observing the Arctic is very expensive. Needs some direct funding → the biggest challenge is a sustained funding.

- Data collected are about pollution, climate, socioeconomic metrics, ice cores. Monitoring is national financed and stations to the networking themselves. This has to taking into account when talking about layering networks. Efforts are done to move data from XLS files to networks (again the need for a bet practice/white paper on how to move data to services.
- Mentions SAON as the Arctic node of GEO. Need for added value in ENEON. Avoid duplication and do not duplicate. Look for acceptance from the members. Many people only come to the firsts meetings: “there is no money”, “My territory is not in invaded”. Soft approach of mutual benefits and inclusive is recommended. ENEON need to contact EU-PolarNet. Managing expectations is important.

***Wolfgang Grabs*: Hydrological networks**

W. Grabs suggested the following main points:

GTN-H: Global Terrestrial Network (network of networks)

Context:

https://www.wmo.int/pages/prog/gcos/index.php?name=GTNs

- Global Terrestrial Network for Glaciers (GTN-G)
- Global Terrestrial Network for Hydrology (GTN-H)
- Global Terrestrial Network for Lakes (GTN-L)
- Global Terrestrial Network for Permafrost (GTN-P)
- Global Terrestrial Network for Rivers (GTN-R)

Added value:

- Develop standards, management of metadata
- Develop products (gridded runoff)

- Need to create a community of Support Partners to facilitate the development of integrated data and information products. Data policies and data quality standards, interface standards.
- EWV are matured (http://slideplayer.com/slide/5741151/)
- Essential Water Cycle Variables (EWC-V’s) [Structured following the Water-SBA analysis as being of approximately equal high priority when averaged across all user sectors. Some variables/parameters have been combined for simplicity]
- Water Cycle Monitoring Water Cycle Modelling/Prediction Decision Support:--Agriculture Decision Support--Biodiversity Decision Support--Climate Decision Support-- Ecosystems Decision Support--Energy Decision Support--Geohazards Decision Support--Health Decision Support--Land Management Decision Support—Oceans (Coastal) Decision Support--Socio-Economic Decision Support--Water Management Decision Support--Weather Cross-Ref.--ECV’s (Essential Climate Variables as per UNFCCC, IPCC)

PRIMARY

- Precipitation
- Evaporation & Evapotranspiration
- Snow Cover (& Depth, Freeze Thaw Margins)
- Soil Moisture/Temp
- Groundwater
- Runoff/Streamflow/River Discharge
- Lakes/ Reservoir Levels and Aquifer Volumetric Change
- Water Quality

- Water Use/Demand (Agro, Hydro, Energy, Urban,...)
- Glaciers/ ice sheets

SUPPLEMENTARY VARIABLES

- Surface Meteorology
- Surface & Atmospheric Radiation Budget
- Cloud &Aerosols
- Land Cover &Vegetation + Land Use
- Permafrost
- Elevation/ Topography & Geological Stratification

- The above can be expanded into much more detailed sub- parameters/variables. E.g., Water Quality alone could have 10 to 100 or more constituents elements.
- Examples of network:
- EFAS: European Fload Awarenes System. Is a model-based network. Driven by the JRC. Part of Copernicus.
- Connection of EEA. Lack of water use data (Eurostat makes something country based and not river basin; and some countries are not there).

***Carine Bruyninx*: EPN: EUREF Permanent Network.**

C. Bruyninx suggested the following main points:

- 270 GNSS ground stations tracking network. Sub-commission of the International Association of Geodesy. This allows GPS uses to reference their data to the network. Also is monitoring how the Earth is moving, find the water vapor content and monitors the ionosphere.
- Voluntary bases that is reliable though redundancy. It also provides a quality stamp. They are joining EPOS. Generate products e.g. Horizontal movement of Europe: (some similar work here:
- https://www.fig.net/resources/proceedings/2008/lisbon_2008_comm6/papers/pst01/pst01_14_kontny_abs_mc132a.pdf

***Eric Petermann*: EUMETNET**

E. Petermann suggested the following main points:

- The motivation is have Numeric weather prediction. Affordability is adjusting the size of the network of observing sensors.
- Shipborne (T See level pressure), airborne (T and wind), ground based radar and the national wearthe automatic (or manual) stations. EUCOS (European Composite Observing System).
- Humidity sensors in planes will improve predictions near airport. Mostly geographic gaps in-situ. Collaboration with energy, agriculture, roads etc. Opportunities when sharing cost has advantages.
- EC spend on research and services (and issue warnings) but not in operation of the observation networks. These are funded nationally (included the EUMETNET).

***Begoña Perez*: EuroGOOS**

B. Perez suggested the following main points:

- Non-profit Association. 13 regional alliances of GOOS. EuroGOOS strategy to identify priorities for operational oceanographic (OO) variables. It is divided in ROOS (regional OO systems) and they redistribute the data in different portals. Also EMODnet portal has the data.

- EC funding data exchange, modeling services projects. Economic crisis is putting several networks at risk.
- DATAMEG working group (dealing with data quality key gap in observation); Biogeochemical data gaps. Europe need to develop a EOOS: European Ocean Observing System. They have links to EEA, IOC, Copernicus. EuroGOOS is only an observer of GEO. Influence to EC could be useful.
- ESEAS-RI is the last EC project ending in 2005. The tide networks has changed completely in the last 10 years to allow tsunami warning (real time latency. 1 minute sampling). They are also used for detecting see level change (delayed latency). Its application depends on the latency of the data acquisition.
- No stations on Mediterranean Africa. Tide network transformed into real time.

Thomas Loubrieu: SEADATANET (Pan-European Infrastructure for Ocean and Marine Data Management) and EUROARGO

T. Loubrieu suggested the following main points:

- 4000 submerged floats 800 are European (http://www.euro-argo.eu/Activities/Floats-Developments-Deployments/More-on-Profiling-Floats).
- There is a need to measure the bio-geo-chemical observation, deep-see (bellow 2000m) and higher surface resolution (SST). SWE is under development in AtlantOS project.
- ENEON can do this in trans-disciplinary way as SeaDAtatNEt is well organizing standards and reference services (e.g. vocabulary, interface/format checkersetc.) on the marine community. Also contribute to quality/provenance
- ENEON could create a graphic representation of all networks as it is seen by one of the slides of the presenter for the marine theme.

Wenche Aas: EMEP, ACTRIS (European Research Infrastructure for the observation of Aerosol, Clouds, and Trace gases) and atmospheric measurement activities of OSPARCOM and HELCOM.

Wenche Aas suggested the following main points:

- http://ebas.nilu.no contains many datasets. http://actris.nilu.no
- A new detail: National environment agencies finance the EMEP network following international conventions and agreements.
- Data management is very resource demanding. EMEP needs ~2000h/year. Recommendation to avoid data duplication and preoccupation about secondary data “portals”.

Arne J. Berre: European Citizen Science Association (ECSA)

A.J. Berre suggested the following main points:

- After presenting some examples of CO projects presenting the OGC SWE CO profile. ENEON can contribute on profiles for thematic O&M.
- ECSA offers itself as link to ENEON and to discuss on low cost/lower quality sensor units. ECSA has the general Assembly in Barcelona October 29-30.

<u>Second day</u>

Rapporteur 1 (Ian McCallumn), Rapporteur 2 (Antonio Bombelli), Rapporteur 3 (Hans-Peter Plag)

The speakers suggested the following main points:

- Data preservation and curation is an opportunity for ENEON? But avoiding duplication to data in more than one database.
- Making data acquisition sustainable (and continuous) is a challenge Can we do something from ENEON? This is related with costs.
- Data quality techniques could be discussed in ENEON?
- Data standardization and semantics is a possibility for ENEON
- Requirements database is a common need (some networks have mechanisms).
- We do not see a chain for producing a product a data aggregation coming from several themes. This is definitely an opportunity for ENEON. (Is ENVRIplus doing this?)
- Links with policy makers does not seem an issue in Europe except in EUROGOOS. ENEON could help on canalizing better funding.
- Do we have to focus in in-situ? I suppose that satellite is cover by ESA?.
- ENEON need to have representation of the networks in a steering committee.
- ENEON could produce trans-disciplinary reference services connecting with social sciences (private-public).
- EV process and common ontologies are needed. Data harmonization and data sharing standards. Be aware the ENVRIplus is doing this.
- Eurostats is trying to create this knowledge for the World and linking social science and geoscience.
- Let's stratify networks: Networks that are sustainable meteo/hidro. Research network are in danger. RS has continuity and long term problems. Citizens Science are useful for have a snapshot of an emergency reaction.

Michael Mirtl: Long Term Ecological Research Network (LTER): overcoming fragmentation, lack of coordination, and duplication.

M. Mirtl suggested the following main points:

- LTER does a lot of activities in Ecosystem metadata EML, SERONTO, EnvThes (environmental Thesaurus and standards).
- Socieocologial regions have been defined to establish the LTSER. DEIMS repository (site data environment. Interesting variable economic density (EUR/km^2).
- Interoperability checklist. Is this a very practical thing ENEON could do?
- Lobbying for common requirements
- Platform for joint service development and exchange of exiting standards.
- Path for supporting multiple data usage and transdisciplinary reference services and ontologies (starting by SERONTO).

1005 - 1025 Lucy Bastin: Linking service infrastructure: Lessons learnt from DOPA: Digital Observatory for Protected Areas

L. Bastin suggested the following main points:

- Limitations in UncertWeb:
- Lack of quantified resources in GEOSS. Automatic model chaining never materialized. Lack proper interoperability and the right API. In the end WPS are too slow and common things are pre-calculated to be ready in the browser (by country or region statistics). Difficulties in discoverability in the GEOPortal. Difficulties in reproducibility. Even a circular buffer is different depending on the portal (some does buffers in lat/long, use border countries, or equal are projection. At JRC use GoogleEarth Engine but uncertainties on when they will go away or for pay.

- Geonode is used by many new portal but metadata is restricted and there is no lineage and no doi/uri. It includes comments and ratings.
- WPS 1.0.0 is too complex and too simplistic. Proprietary solutions can lock you in. Need for a cloud these days. Identifiers are important and lineage and to attach other things to resources.

1025 - 1045 Jan Hendrick Voet: EIONET: European Environment Information and Observation Network

J. Hendrick Voet suggested the following main points:

- EIONET is a network for the EEA. National Reference Centers (NRC) complement the ETCs. There are 24 themes and many NRCs are involved in in-situ connection. Some of them are related with Copernicus in-situ component.
- The core business of EIONET is collect data (reporting obligations) to create indications to guide policy. JRC (soil and forests), Eurostat, EEA have divided the themes they are responsible of.
- SOER 2015 — The European environment — state and outlook 2015
- New horizons for European and Global land monitoring meeting.
- A clear disconnection between semi-operational EO networks and EEA activities has been identified.

1045 - 1105 Geoff Sawyer: Collaboration between Industry and European Networks

G. Sawyer suggested the following main points:

US businesses are taken oppositions. In EU most of the business is done by small SMEs. Focus on services, GEOSS need to stimulate this. Need to find ways to test industry interest on take on and commercialize these R&D products.

Discussion on Session 6:

- How to connect the environmental knowledge pieces of the puzzle together. Lack of leadership, coordination and communication.
- Sustainability of ENEON (need a business plan) and a clear objective and a “research agenda” (sustainability of network is an issue).
    - Money: Each country participating in ICOS pays (ERIC). EuroGOOS uses international commitment. Networks do not have resources to spend in us.
    - Activities: Regularity on meetings, whitepapers work, data models release...
- Complementary and interaction about SBA and knowledge base, ontologies (EV: Biodiversity-Ecosystem-disaster-water). Support the networks on applying EV, ontologies thought models.
- Coordination is good. Gaps on transfer and funding. How to go from data to knowledge. Need analyze the users first and the demands (not produce and desperately look for users).
- ENEON influential as assessing user needs and requirements for policy. Then create products using centers of excellence. Influence the R&D funding products.
- Do we really need to go to the socioeconomic data?

Hans-Peter Plag: The GEO Knowledge Base and Gap Analyses

H.P. Plag suggested the following main points:

- Combine observations and socioeconomic with Earth Science Models. Information needs is the driver.
- Types of gaps: Geographical, observational, structural, qualitative/quantitative (frequency etc), Capacity.
- ConnectinGEO Gaps: Information Gaps (info missing), capability/technology/tools Gap (no provided for societal goal), Observation Gap (metrics that cannot be calculated...)
- Methodology:
- Compare needs and availability (need to know both). Take a layered approach. One of the 5 priorities activities in GEOSS-2014 was the creation of a knowledge base.
- For priorities we need to know what is essential. EV are the key (IGOSP defined “themes”). Feasibility approach: feasibility/impact can miss important impacts that are not so feasibly. Goal based approach --> the ConnectinGEO way. Values: economical, social, environmental, progress towards the goals...
- What is “essential”? “Indispensable to reach the goals” “states and allow predicting developments and where the system is heading”.
- Goals: Scientific (create knowledge), Strategic targets in GEOSS, SDG. “Safe operating space for humanity” (planetary boundary indicators). The accelerating of the change.
- URR core questions: who are the users, what are they doing, what they need.
- Who will populate the knowledge base? (information needs).
- Registration for a Pub/sub service in the URR.
- Operationalize knowledge by creating products (and the services that provide them).
- Definition of EV in GCOS (feasibility based) is different of the Hans-Peter (ConnectinGEO)
- Is the ENEON name broader enough? There are other communities with the same idealistic story e.g. the EUROstats
- Creating EV versus looking current EV and looking for gaps. The latter is done by the ocean community.
- Practicalities in the current networks: Can we “impose” a collection of EV to networks.

Palma Blonda: Defining user needs and essential variables to support GEOSS objectives

Hans-Peter Plag: Benefits of a European Earth Observation Network of Networks

H.P. Plag suggested the following main points:

- Funding requesting (ENEON as a partner to discuss funding with the EC and the funding agencies)
    - Geoff Swayer: including economy and jobs to all SBA
- ConnectinGEO platform
- Trans-thematic products generation (also dissemination products)
- User requirements database

Ian McCallum: Draft goals, objectives and benefits of ENEON

I. McCallum suggested the following main points (including group discussion):

- Vision and mission

    - Support and represent the EO networks with the purpose of enhancing the visibility of them in Europe and demonstrate the value of trans-disciplinary products & services and cover the needs of GEOSS, Copernicus, EC (EEA, DGs).
        - Increase coordination and collaboration between networks (Complex landscape in EU) and will GEOSS and Copernicus
- Study area: Scientific Earth Observation
    - EV gap assessment and cross-fertilization
    - Trans-thematic coordination and product's generation
    - Ontologies and standard vocabularies
    - Consider as many thematic areas as possible (including socioeconomic)
    - Links to industry and Citizens Observatories
    - Run demonstrations of the usefulness of EO to societal area (e.g. Water Framework directive will be revised, Marine Framework directive idem, Biodiversity directive)
- Understand better the stakeholders needs
    - R&D requirements and priorities database and discussion forum
- Reporting to GEO and EC
- EC wants us to be the AfriGEOSS for Europe (and AmeriGEOSS)
    - In EU the challenge is
        - Ciberinfrastructure (European data hub)
        - Fragmentation

Round table: Goals, Objectives, and Benefits of ENEON

- Scope:
    - Science (not only research) in Earth Observation
- Activities:
    - Align with ENVRIplus meetings that adds Industry and Citizens Observatories (perhaps ConnectinGEO could transfer ENEON to ENVRIplus after finishing the project). As an ERIC, countries have to pay; we have no countries but networks.
    - Regular meetings
    - Whitepapers work:
        - demonstrated requirements in terms that policy level can understand
        - deliverables in ConnectinGEO
            - The gap analysis and priorities
        - recommendations for a research agenda (EO)
        - inventory of EO networks and its relations
        - create policies
    - Connection to GEO
        - Direction
            - From the networks to GEO
            - From GEO to the networks

    - Data models release
- Who does it: Task group
    - Voluntary bases (compatible with busy agendas)
    - ConnectinGEO workforce
    - Include EC and GEO in working groups
    - Go beyond ENVRIplus and include industry

Hans-Peter Plag: Draft organization, ToR, and membership of ENEON

H.P. Plag suggested the following main points:

- Used the Global Geodetic Observing System as an example for a network of networks.
    - Add Stakeholder representatives
    - There are task forces and products. There is a Executive Board and a Steering Assembly
- An internal proposal will be elaborated and then shared to the networks.

Paola Campus (remote presentation): Thoughts on a funding cycle for ENEON

P. Campus suggested the following main points:

- Proposes ENEON as a platform, with some money for dissemination, events, etc.
- Proposes to request a COST action. 5% rate of success and 150k EUR. Proposal for sustain the ENEON.

Ivette Serral: ENEON definition, criteria, processes

I. Serral suggested the following main points:

- Participation of ESA is discussed and also the EC.
- O&M ontology for the EVs?