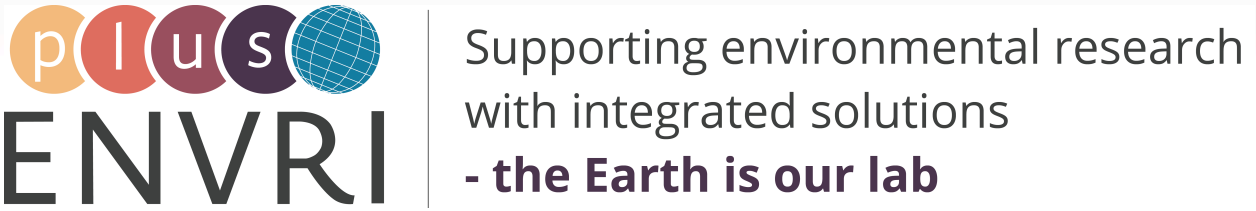
# THEME 1 TECHNICAL INNOVATION

JEAN-DANIEL PARIS
CEA



# MOTIVATION

- **RIs participating in ENVRI+ have under-exploited commonalities in the way they conceive, develop, deploy, operate and upgrade their measurement systems**
- most Ris are distributed network of observatories with needs for remote operations
  - drifting buoys, geophysical observatories, ocean-bottom stations….
- Most RIs have to deal with calibration and standardization issues.
- Many problems are common, and some Ris are more advanced than others on a particular issue. Sharing information is key.
- Scientific questions and excellence lies at the interface between Ris, and Ris have non-null overlap in terms of scientific perimeter

# COARSE-GRAINED QUESTIONS

- 1) *Measurement technologies*: Can RIs share expertise and proceed to common development and tests on transversal technologies?
- 2) *Metrology* : how do we tackle together the diversified challenge of quality assurance and standardization?
- 3) *Remote operations*: can we address together the common need for autonomy, robustness and remote data handling?
- 4) *joint operations for research*: are RIs together able to provide relevant data to support excellent research.

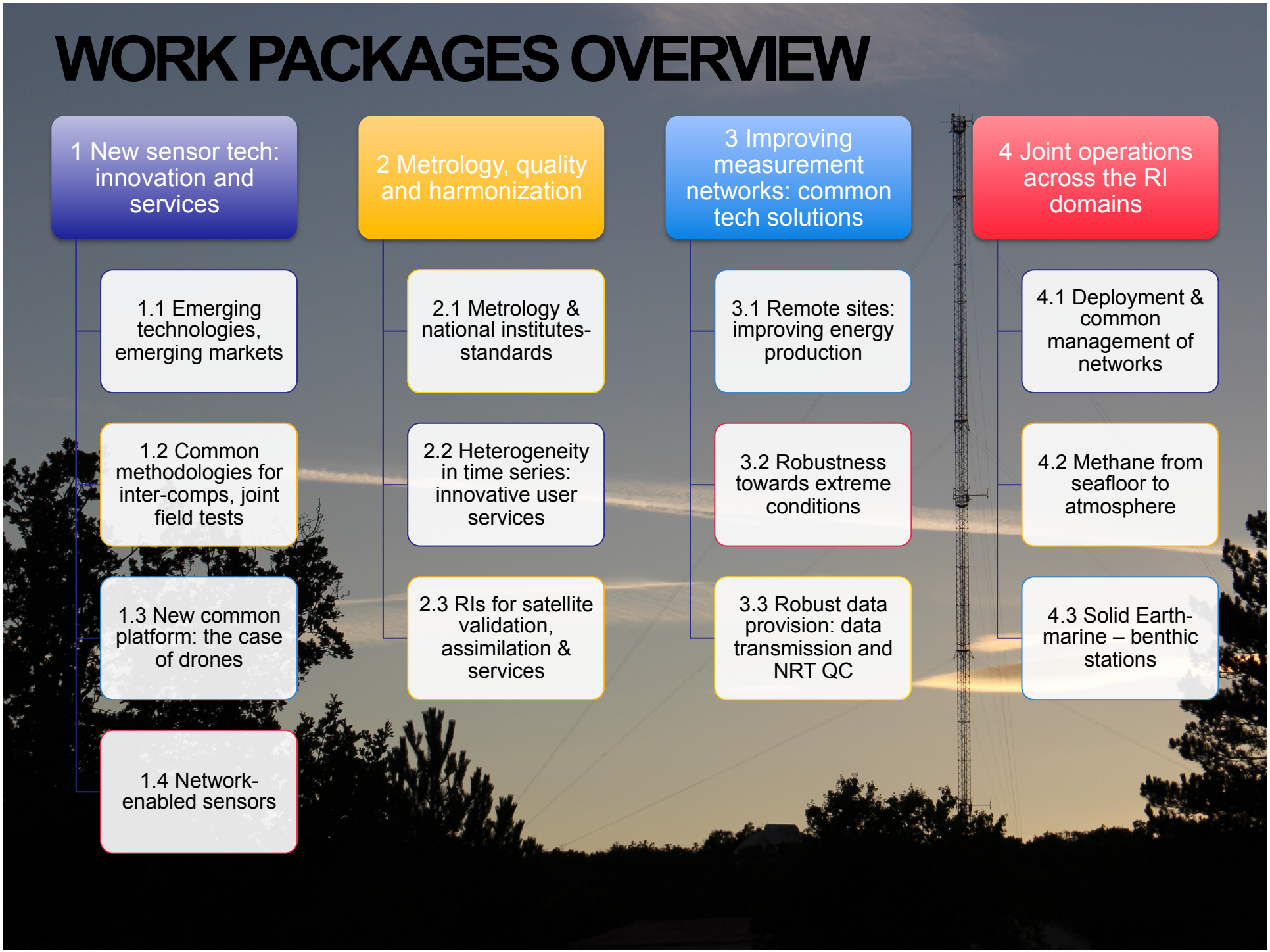
# THEME 1 OBJECTIVES

- Identifying common opportunities for innovation, and pursue common vision of technical matters
- Supporting common research and development across RIs on transversal issues, and
- Spread state of the art techniques among participants, sharing best practices.
- Demonstrating that Ris together can fill gaps, address scientific questions and environmental challenges that cannot be tackled by invidividual Ris.

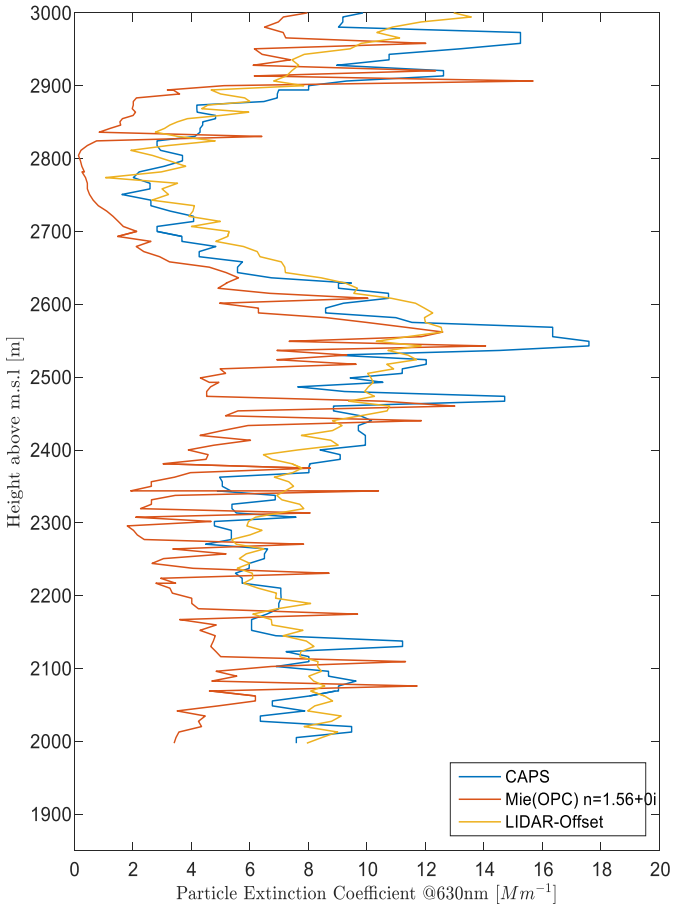

# THEME 1 & RESEARCH INFRASTRUCTURES

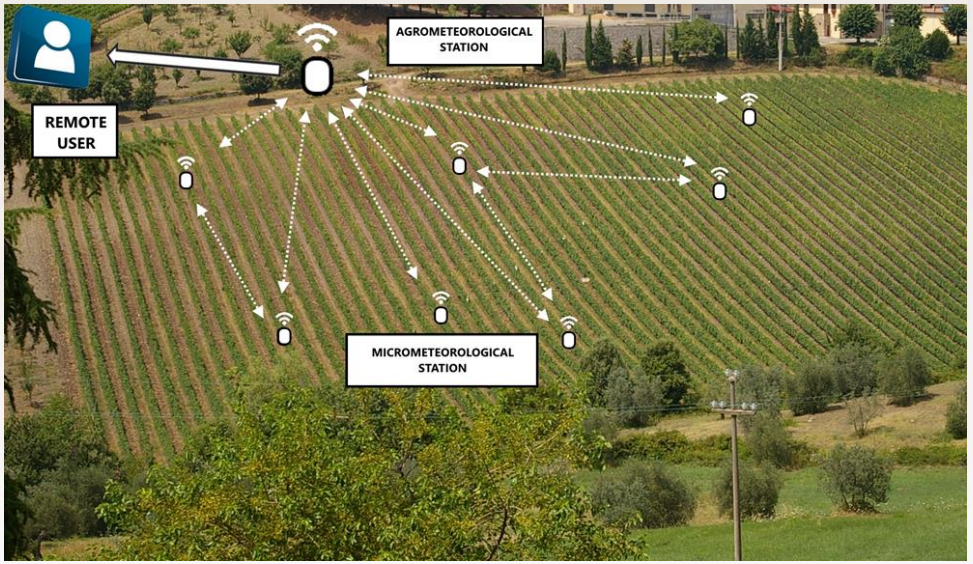
- From and to Ris
  - stimulating R&D for RIs procurement, a common innovative
  - develop a common metrological language adapted to the observation of our environment
  - Involve the key technologists of the RIs for a greater mutual benefit
  - a space for exchange on the “hardware” issues of our networks of observatories,
  - a forum that allows fast transmission across RIs of best practices and state of the art technology,
  - a platform for joint research and co-development, demonstration of added value in the combination of Ris

# WORK PACKAGES OVERVIEW



# WP 1 NEW SENSOR TECHNOLOGIES: INNOVATION AND SERVICES



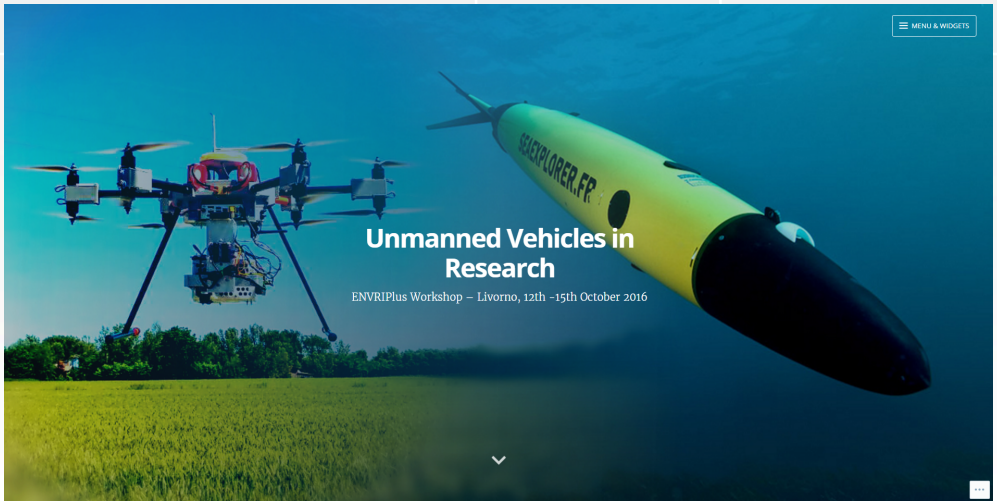
# WP 1 NEW SENSOR TECHNOLOGIES: INNOVATION AND SERVICES

- Goals
  - 1) Consolidating RI requirements for new sensors and the associated market
  - 2) Defining common approaches for sensor requirements across disciplines
  - 3) Defining modalities for use of common technical unmanned platforms and application
  - 4) Promoting the use of Network-enabled sensors across the Ris

- Overview of situation
  - Large number of deliverables, high activity in Grenoble this week related to liaison with industry!
  - Some activity have progressed beyond expectation for period 1

# WP 1 MILESTONES

| No. | Title | Deadline | Status |
|---|---|---|---|
| 18 | Meeting on sensor inter-comparison methodologies | 14 ✔ | Meeting held (4 meetings) |
| 24 | Meeting to assess drones potentialities for common observations | 18 ✔ | Meeting held (Livorno) |



# WP 1 DELIVERABLES

| No. | Title | Deadline | Status |
|---|---|---|---|
| 1.1 | Roadmap for the emergence of European industry providers and market landscape analysis | 24 (+12) | Delayed (after Grenoble event) |
| 1.2 | Specification report of common test protocols and inter-comparison methodologies | 18 (+9) | Delayed (harmonization in marine pCO2 measurements tech challenge) |
| 1.3 | Final prototype of ARGO float with pCO2 and pH launched | 24 (+9) | Alternative solution focusing on pCO2 challenge, slowing down |
| 1.4 | Report on integration across networks: common strategy and common sensors for lidar and aerosol ext measurements | 18 ✔ | Done |
| 1.5 | Report on opportunities and applications of unmanned observatories for usage across RI | 48 | On track (work nearly completed, TNA discussion) |
| 1.6 | Results and recommendations from the comparison exercise of sensor embedded processing practices | 36 | On track |
| 1.7 | Report on technological choices for dense networks of small sensors | 42 | On track (work nearly completed) |

# WP 1 OVERALL STATUS

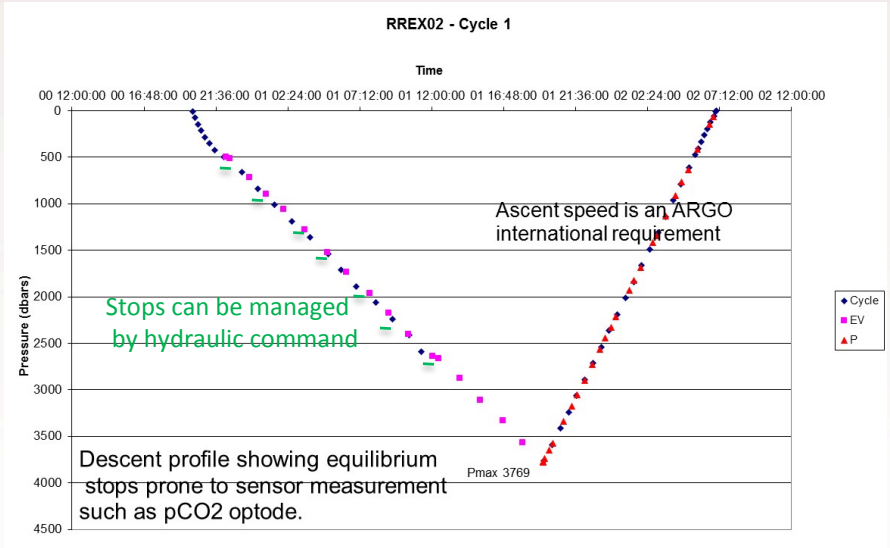
- Successes
  - The Grenoble event session 1 (hopefully)
  - TC_4 „SensorRegistry“
  - Common workshop on marine/aerial drones in Livorno
- Issues and corrective actions
  - Delay in the Industry relation report tied to Grenoble meeting
  - Delay in the pCO2 measurments due to 1) technical challenge of float integration of pCO2/pH and 2) scientific challenge of harmonizing sensor systems
- Plans for the next period
  - Reinforce link to industry
  - Open discussion for drone TNA approaches
  - Promote OGC standards in sensor systems

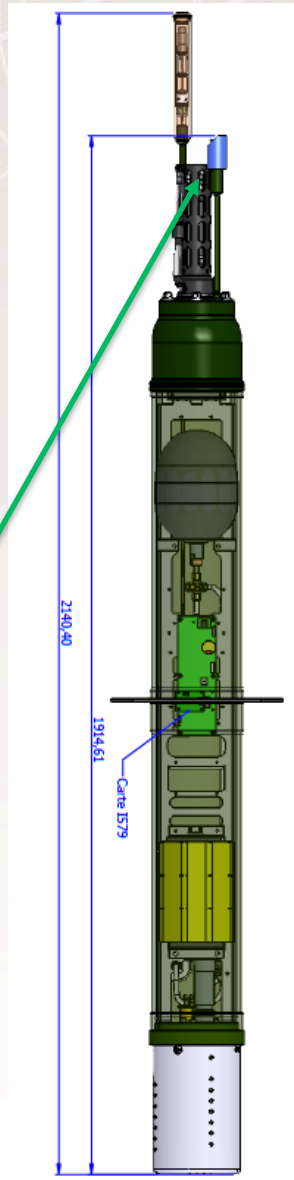
# ENVRI$^{PLUS}$ WP1 MARINE USE CASE – THE METHODOLOGY COMPROMISE

- pCO2 sensor on ARGO Floats (potentially some of the 4000 floats)
- Modify the profile of descent by some stops to compensate the

Sensor slow time response of existing sensors

- Correlate with glider profiles
- Compare with reference ship measurements




**9 months delay**

H2020 Project

Project Number: 654182

# HIGHLIGHT #1 ON:
# COMMON METHODOLOGIES FOR INTER-COMPARISONS AND JOINT FIELD TESTS
# (D1.4)
# IAGOS – ACTRIS SENSORS

ULRICH BUNDKE, ANDREAS PETZOLD, FZ JÜLICH
GELSOMINA PAPPARLADO, CNR
JEROME TARNIEWICZ, CEA

plus ENVRI
Supporting environmental research with integrated solutions
**- the Earth is our lab**

# ENVRI$^{PLUS}$ USE-CASE 2

Use-case 2: Common sensors – case of ***aerosol lidar and in-situ light extinction measurements***

Lidars and in situ light extinction provide atmospheric information relevant to ACTRIS, ICOS and IAGOS.

***Definition of common needs*** will permit selection of appropriate technologies and robustness requirements.

The study includes ***deployment and test of final prototype*** based on commercial lasers and optics *including* ***multi-purpose raw data processing and harmonized instrument selection criteria***.

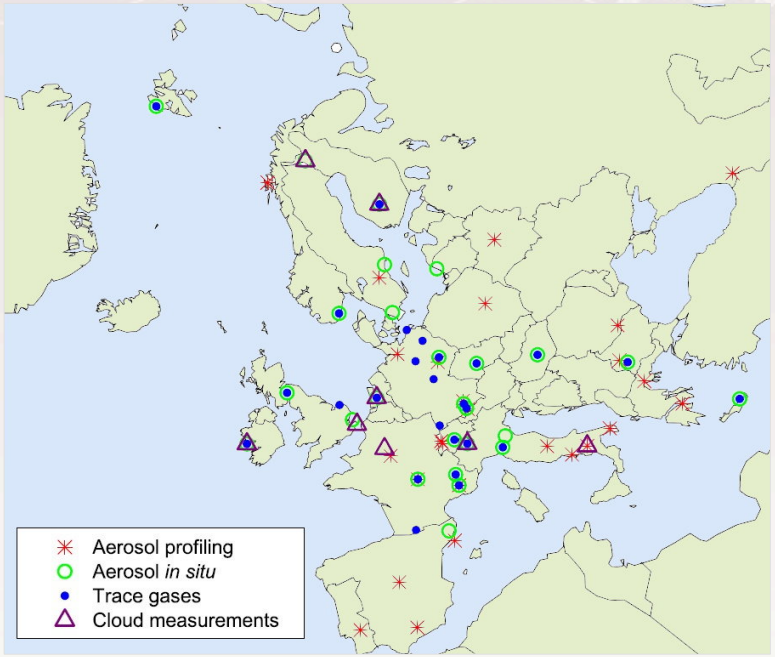
Constraints associated to ***coastal/ocean/arctic regions*** will be considered. Potential cross-benefits of combining observations between RIs have been assessed.

## Earth Observation by Passenger Aircraft


Lufthansa AIRFRANCE CHINA AIRLINES CATHAY PACIFIC IBERIA HAWAIIAN AIRLINES

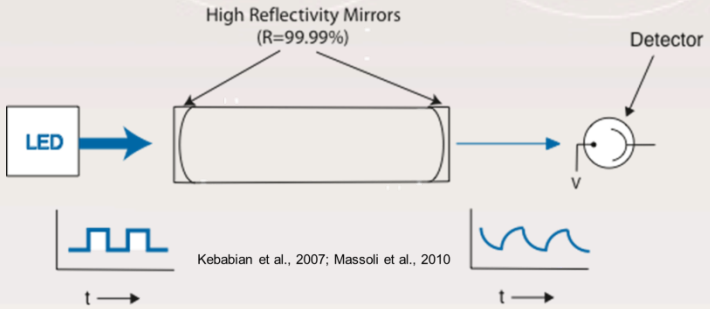
- Operational since January 2014
- Today 9 a/c and 1 flying lab
- Parameters (today): $H_2O$, $O_3$, CO, $NO_x$ , clouds, GHG

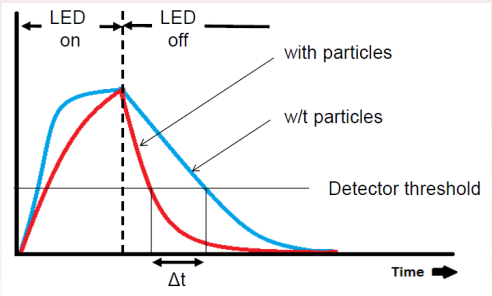
## Aerosols, Clouds, and Trace Gases RI




- Ground-based component of global EO System
- Combines LIDAR, aerosol in-situ and cloud observation

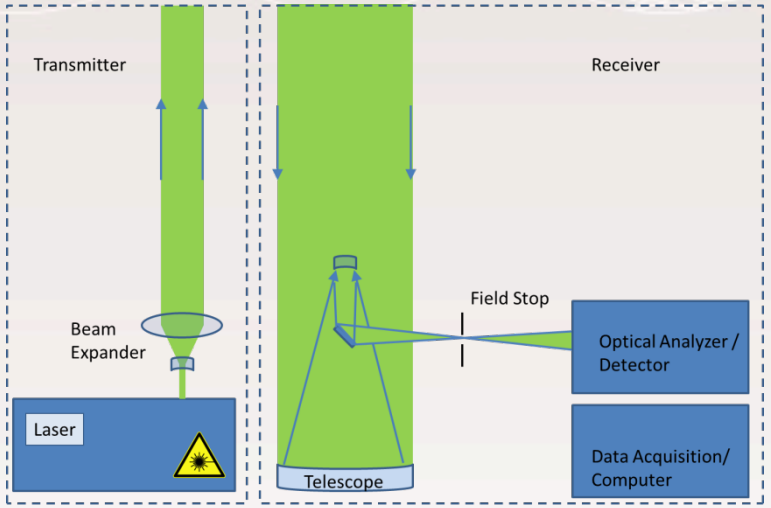
## Earth Observation by Passenger Aircraft




- Cavity Attenuated Phase Shift (CAPS) allows in situ observation of light extinction
- Robust set-up suitable for airborne operation

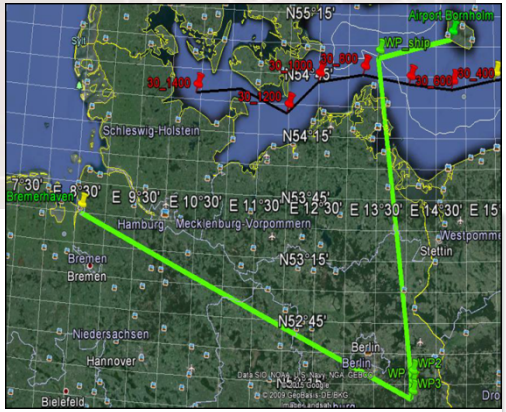
## Aerosols, Clouds, and Trace Gases RI

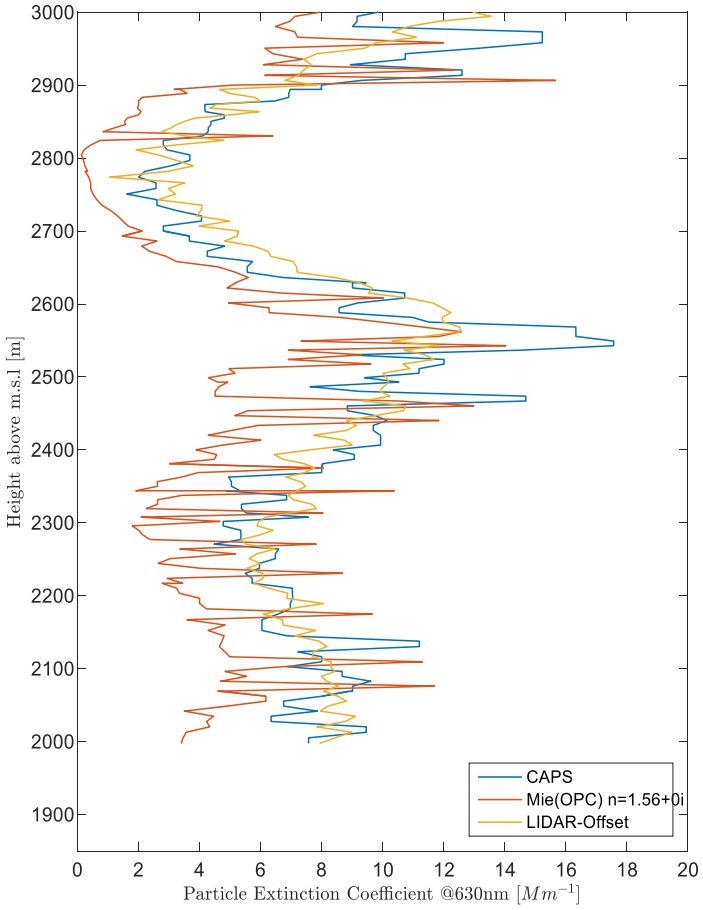


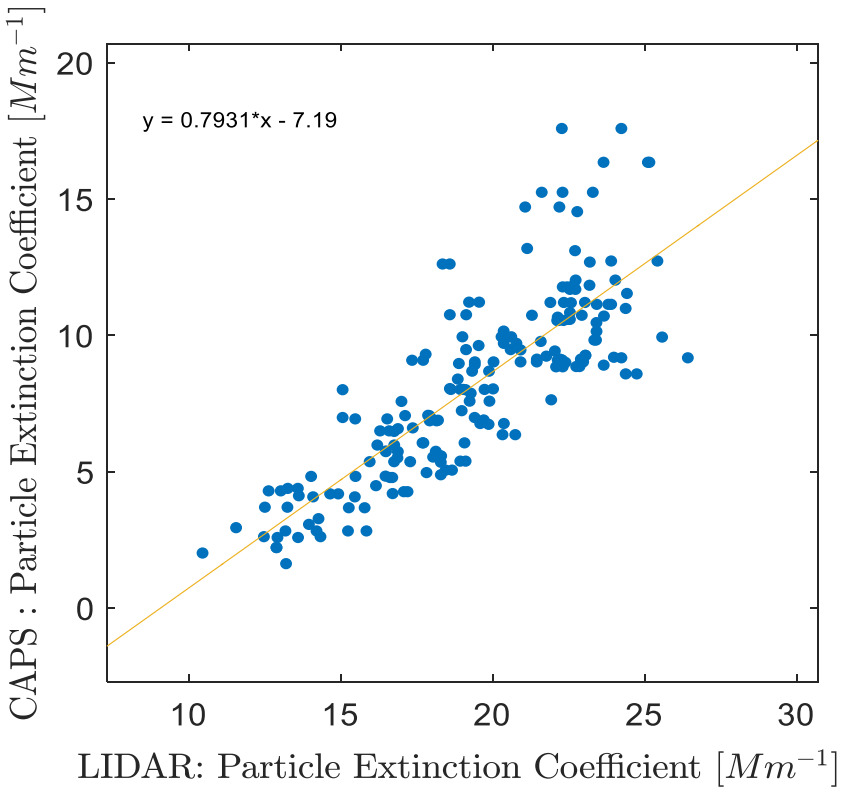

- LIDAR techniques represent the optimal tool to provide range-resolved aerosol data
- Several LIDAR techniques (Raman, HSRL) are suitable for dedicated aerosol studies

# IAGOS – ACTRIS INTERCOMPARISON

## CAPS $PM_{Ex}$ VS. LIDAR OVER LINDENBERG OBSERVATORY

# IAGOS – ACTRIS INTERCOMPARISON

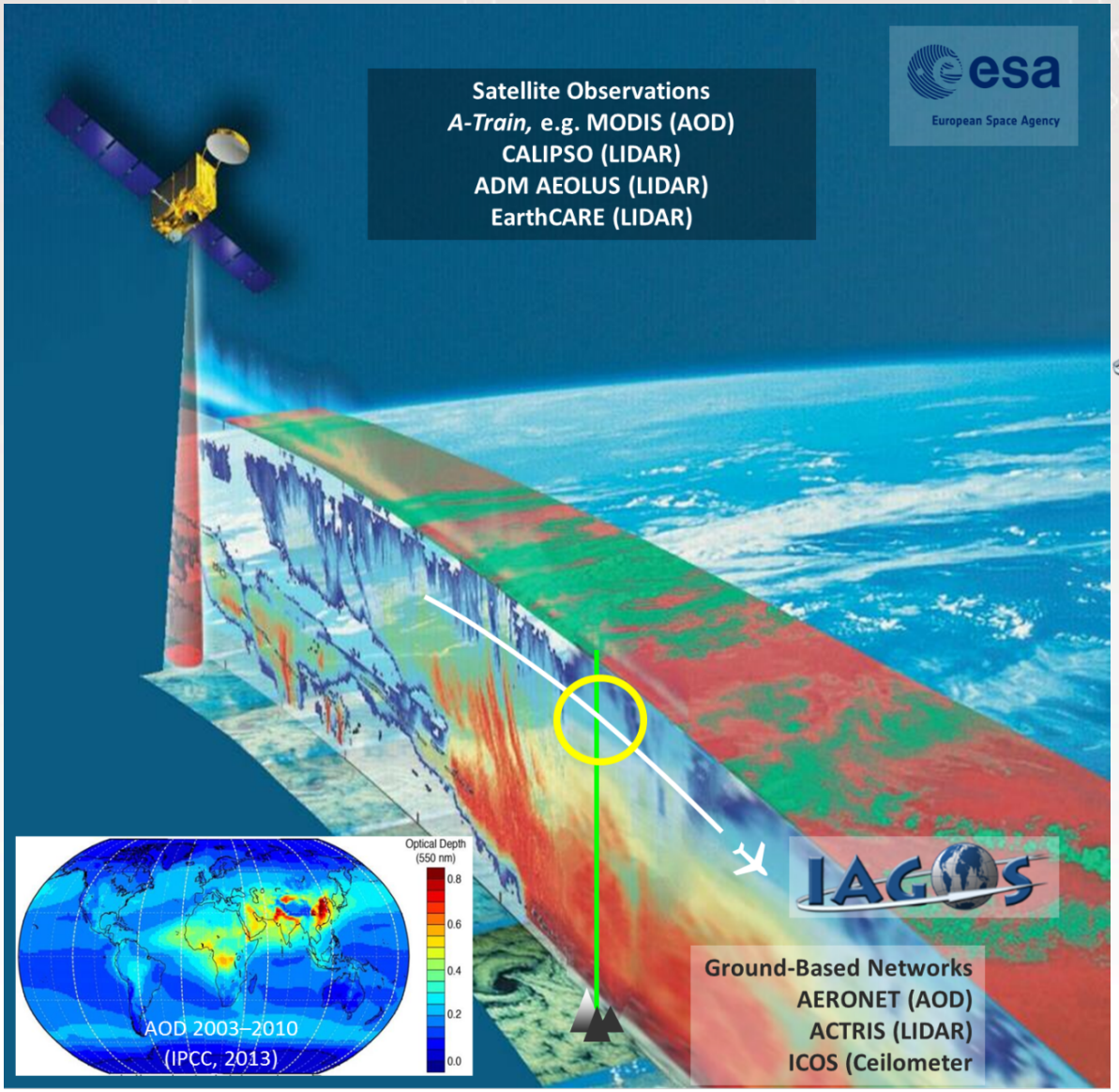
## *IMPACT ON PROJECT*

- The definition of standard methods measuring the aerosol extinction coefficient support the cross fertilization of the Ris.
- Direct contacts of individual scientists and technicians have been initiated and will sustain through enhancing the knowledge and data transfer on a direct personal way across Ris.

## *IMPACT ON STAKEHOLDERS*

- Defining standards for LIDAR and complementary in situ technologies and calculus chains will help RIs to enhance their data quality and to build joint data sets.
- RIs like ICOS which is in the planning phase will profit from the knowledge transfer from the start.
- Furthermore, standardized observations mean that e.g. data sets from different platforms can be merged.

# Future Integrated AOD observation

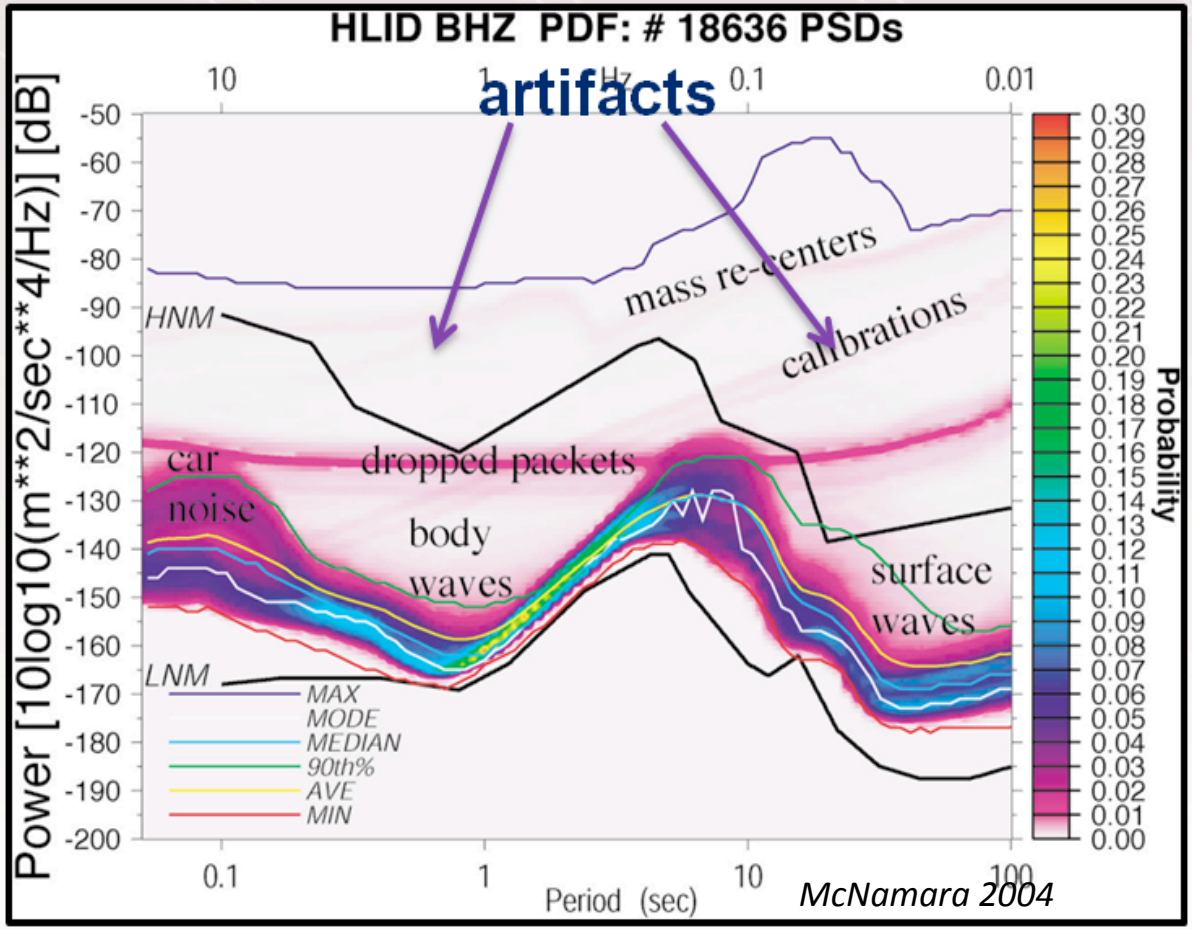



IAGOS

ACTRiS

ICOS INTEGRATED CARBON OBSERVATION SYSTEM

# WP 2 METROLOGY, QUALITY AND HARMONIZATION



# WP 2 METROLOGY, QUALITY AND HARMONIZATION

- Goals
  - Address the needs for standardization of measurements and methods across the Ris to assure our capability to obtain a correct picture of actual status and trends of the Earth system
  - Develop new services to promote use of heterogeneous time series produced by Ris and enable the unbiased usage of data series
  - Develop new services to meet requirements for using heterogeneous networks for satellite validation; to increase integration of ground-based observations with space-borne

- Overview of situation
  - Strong added value of first engagement actions on metrology
  - Link with Copernicus activated

# WP 2 MILESTONES

| No. | Title | Deadline | Status |
|---|---|---|---|
| 11 | First workshop on use cases for satellite/assimilation validation | 12 ✔ | Meetings held, including the Copernicus workshop |
| 27 | Report on traceability and standards in Environmental RIs: actual status, best practices, recommendations | 24 ✔ | Internal report |

# WP 2 DELIVERABLES

| No. | Title | Deadline | Status |
|---|---|---|---|
| 2.1 | Report on standardization in RIs and tree of metrology references (from international reference labs to RI collected data) | 42 | On track (several meetings, invitations, questionnaire, common projects for deepening collaboration) |
| 2.2 | Methodology report for handling of data heterogeneity | 24 ✔ | Done (deliverable ok with subset of expected variables, work will be continued with all variables until end of next reporting period) |
| 2.3 | Harmonization strategy report toward support to space mission and assimilation systems based on RI data | 36 | On track (common strategic approach) |

# WP 2 OVERALL STATUS

- Successes
  - Strategic participation to Madrid meeting on metrology, MMC/meteonet
  - Results on cross-domain time series heterogeneity analysis (UV-B, O3)
  - Copernicus workshop in Prague
  - Good work on the marine side in task 2.3 : chla essential ocean parameter key issue for satellite – in situ comparison
- Issues and corrective actions
  - D2.2 ambition has been reviewed, will be submitted with subset of variables, and application work will continue on more variables
  - Task 2.3 too large, partners involvement has been reviewed
- Plans for the next period
  - Metrology session in Grenoble industry forum
  - Gather complementary variables for time series analysis

# HIGHLIGHT #2 ON:
# METROLOGY & NATIONAL INSTITUTES-STANDARD

LÉONARD RIVIER AND TASK 2.1 PARTICIPANTS


Supporting environmental research
with integrated solutions
**- the Earth is our lab**

# Task 2.1. ENVRI Metrology & national metrology institutes

Metrology, the science of measurements is a **tranverse activity by definition** > good case for ENVRIplus.
Special relevance to climate in early detection of slowly varying changes.

- What are the standards used in ENVRIplus ?
  - Exchange of **good practices, increase scope** of existing standards, harmonization an synergies across Ris
- How can traceability to SI Units be improved ?
  - **Improve involvement of National Metrology Lab** towards our community
  - Improve quality assessment in your RI
  - New research topics and projects

# Identified Typology of Trees of Metrology in ENVRIplus

- **Use of manufacturer certificate**
- **In situ instruments calibrated to reference instruments traceable to SI**
  - Accredited lab (e.g. Euro-Argo for T, P)
  - Secondary standard instruments calibrated in WMO World Calibration Center (WCC); operated within the GAW QA/ QC. WCC instrumentations are traceable to meteorological standards (ACTRIS)
- **Cascade of reference material**
  - Primary gas standards , under responsability of WMO GAW subcontracted to NOAA:ESRL in the US (ICOS-Atm, SIOS)

# Testcases for improved metrology standards

- **pH** (ocean acidification)
  - ➢ Joint proposals submitted

- **Eddy covariance measurements** (greenhouse gases fluxes)
  - ➢ Draft standard discussed at international level; to be submitted to CIMO this year

- **$CO_2$** (climate forcer emissions)
  - ➢ Ongoing international intercomparaison wih NMIs

- **Black Carbon** (climate change and air quality)
  - ➢ BIPM/WMO-GAW priority for a BC equivalent standard

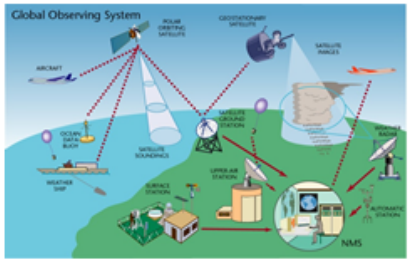
# Joint workshop ENVRIplus, Metrology community

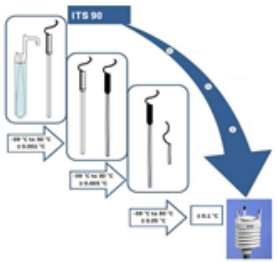
**WORKSHOP**

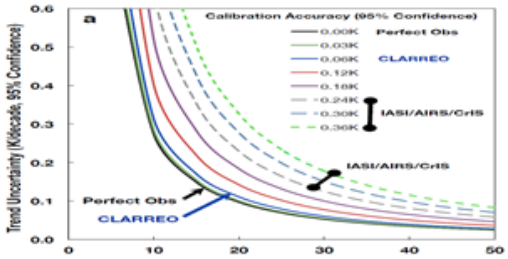
**Environmental Research Infrastructures meet Metrology community**

***Madrid***
***27 September, 2016***

**Announcement**




**An international event to reciprocally increase knowledge and understanding**

**Joint ENVRI+ and MMC: Metrology for Meteorology and Climate during the WMO/CIMO/TECO international conference Sept 2016, Madrid, Spain**

1. Brief introduction and scope of the workshops (V. Vitale)
2. ENVRIplus and its activities related to metrology (WP2) (L. Rivier)
3. Development of primary standard for black carbon (P. Laj)
4. Development of pH standards for marine domain (D. Stoica, F. Salvetat)
5. Metrology of thermodynamic quantities for atmospheric and oceanic research (F. Sparasci)
6. Standards for gas analysis (M. Sega)
7. METEOMET, EURAMET and BIPM: metrology for environmet. (A. Merlone)

- Presentation of concrete testcases

- **Cooperation installed with EURAMET Task Group on Environment, chaired by A. Merlone**

- **presence of the EURAMET Task group at next ENVRI week in Grenoble, France, May 2017**

# **WP 3** IMPROVING MEASUREMENT NETWORKS: COMMON TECH SOLUTIONS

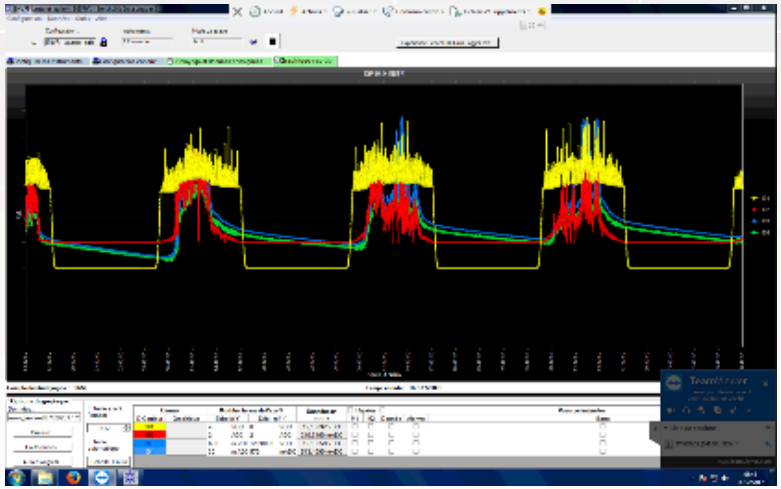
# WP 3 IMPROVING MEASUREMENT NETWORKS: COMMON TECH SOLUTIONS

- Goals
  - To review the existing technologies addressing energy production at remote sites, data transmission and adaptation of technologies to extreme conditions used by RIs,
  - To propose innovative solutions including testing of components, subsystems, materials, techniques and dedicated software to improve networking at distributed Ris
  - Evaluate potential for improved standardization of transmission technologies among RIs and benefits for the cluster

- Overview of situation
  - Good progress since inception, with questionnaire feedback and solid developments

# WP 3 MILESTONES

| No. | Title | Deadline | Status |
|---|---|---|---|
| 9 | Report reviewing technologies currently used at research Infrastructures for unmanned operation (power and transmission technologies) | 12 ✔ | Internal report, done (based on a questionnaire and EW meetings) |
| | | | |



# WP 3 DELIVERABLES

| No. | Title | Deadline | Status |
|---|---|---|---|
| 3.1 | Report on application of energy-unit in extreme environments and communication to SMEs | 48 | On track |
| 3.2 | New set of standards for the qualification of instruments towards extreme conditions | 30 | On track, reviewing proposed existing standards for new set of standards |
| 3.3 | Report for best practices on robust telecom/data transmission | 24 ✔ | Done |
| 3.4 | Report on improved robustness in extreme conditions | 36 | On track |

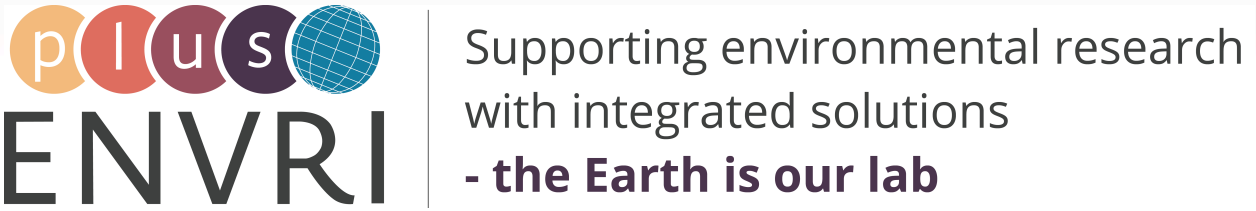
# WP 3 OVERALL STATUS

- Successes
  - Col du Lautaret test site for power supply solutions
  - Use case IC_14 (with WP9) on upstream standards-compliant data transmission technologies application with EGI tech framework
- Issues and corrective actions
  - Very diverse and advanced state of the art applicable to extreme conditions to be considered
- Plans for the next period
  - Continue in situ test at Lautaret (visit this week)
  - IC_14 ongoing
  - New waveGlider field test for OGC standards at sensor/deployment level

# HIGHLIGHT ON:
# « ENERGY FOR SCIENCE »
# ISOLATED MEASUREMENT STATIONS

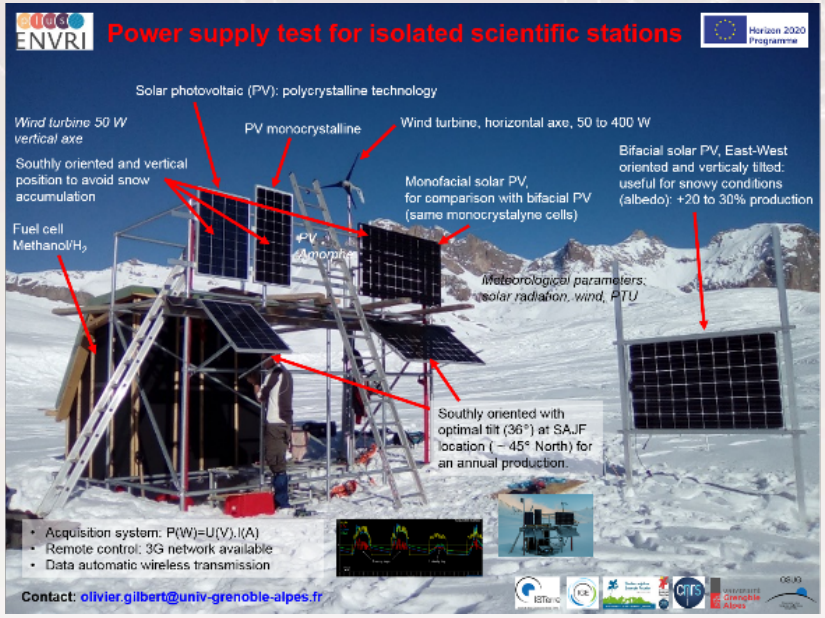
OLIVIER GILBERT
CNRS

AN EPOS-ACTRIS-ANAEE COLLABORATION



# ENVRI COMMUNITY ENHANCED COMMON CAPACITIES FOR SCIENCE

**Energy for isolated measurement stations: Whatever is the job: you need energy.**




**ENVRI+ WP3 brings together 20 European Research Infrastructures to improve their common expertise on:**

- **Autonomous energy system for isolated measurement stations.**
- **Robust data transmissions system (and quality control).**
- **Facing extreme conditions (polar regions, deep forest, high mountain, warm desert,…)**

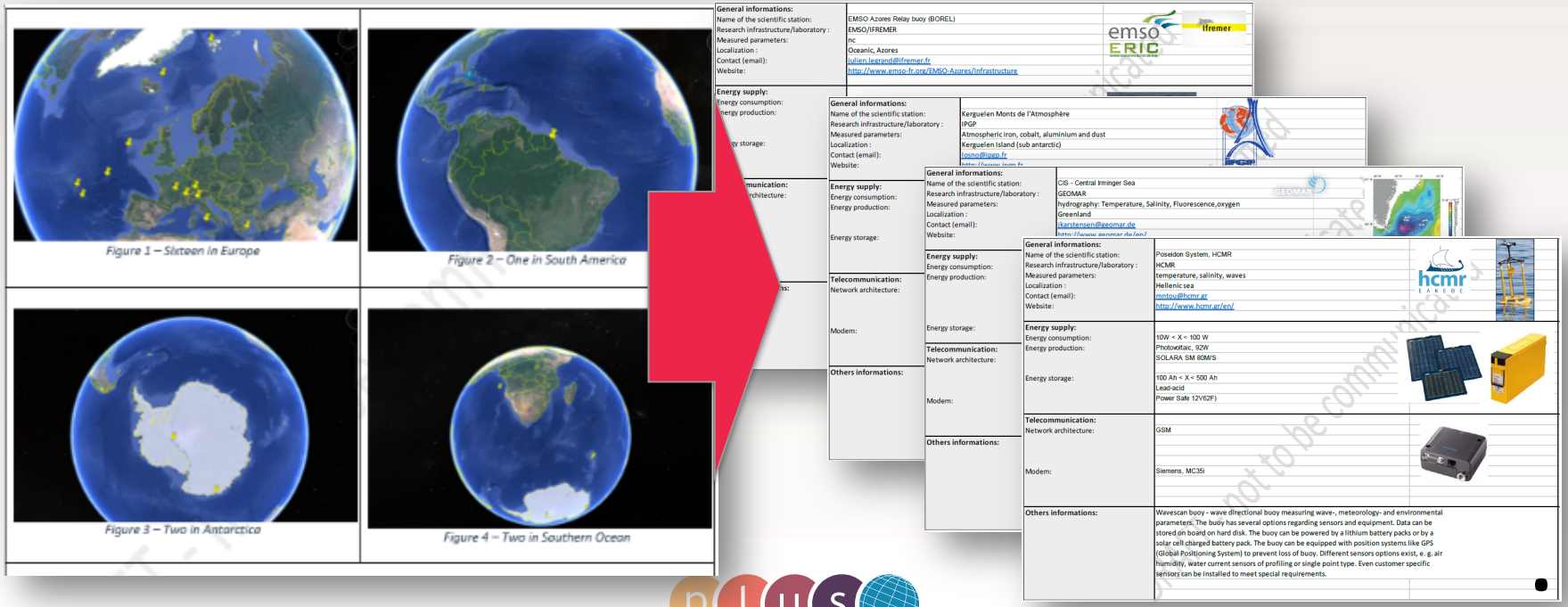
# **FIRSTLY:** GATHERING DISPERSE EXPERTISE IN A SHARED INTERDISCIPLINARY KNOWLEDGE

Shared database from questionnaire: “Energy: Who is using what ?”

| Scientific domain | Isolated scientific stations |
|---|---|
| Ocean | 10 |
| Atmosphere | 3 |
| Biodiversity-ecosystem | 1 |
| Solid Earth | 10 |
| TOTAL | 24 |

*24 responses in v1, representative of large networks, expecting increased completeness*

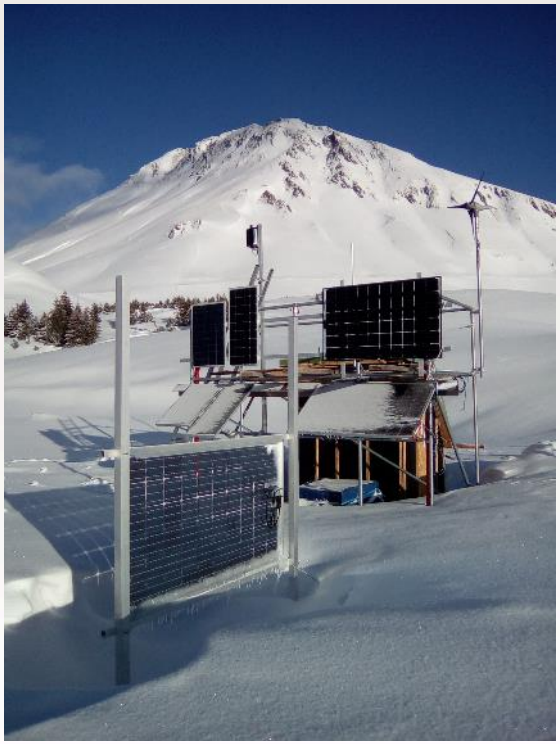
=> We build a catalogue of **operational technical solutions** for energy and data transmissions for isolated scientific stations



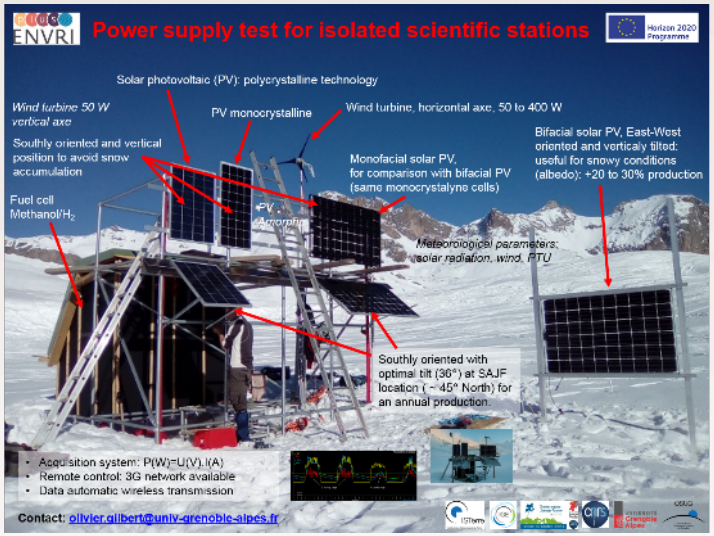
# **SECONDLY:** TESTING A SELECTED AND APPROPRIATE SET OF TECHNICAL SOLUTIONS

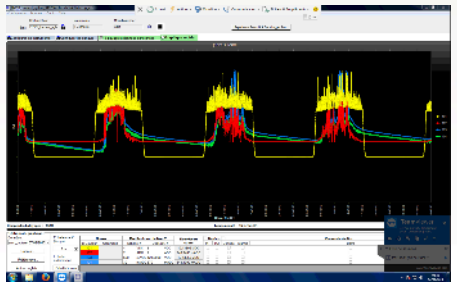
- Setting up an on site energy bench test
  - Autonomous power supply system in extreme environments

On site



And in Lab

P(W) = U(V) x I(A)

# THIRDLY: DISSEMINATING KNOWLEDGE

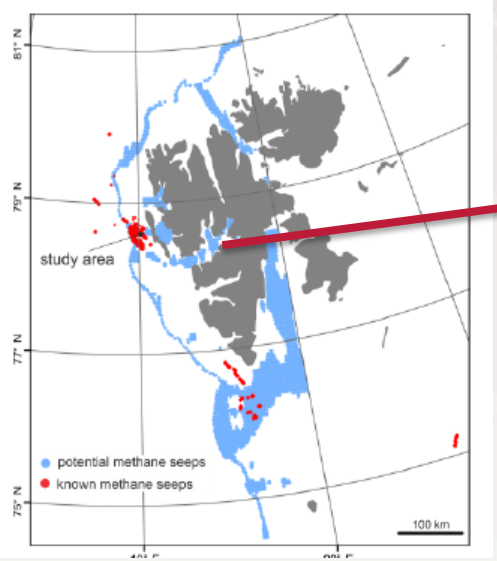
- Through the ENVRI Community, and wider through the ESFRI (European Strategy Forum on Research Infrastructures)
- Creating a real efficient technical & scientific cluster
- Acting for long term improvement (long term and wide operational range)

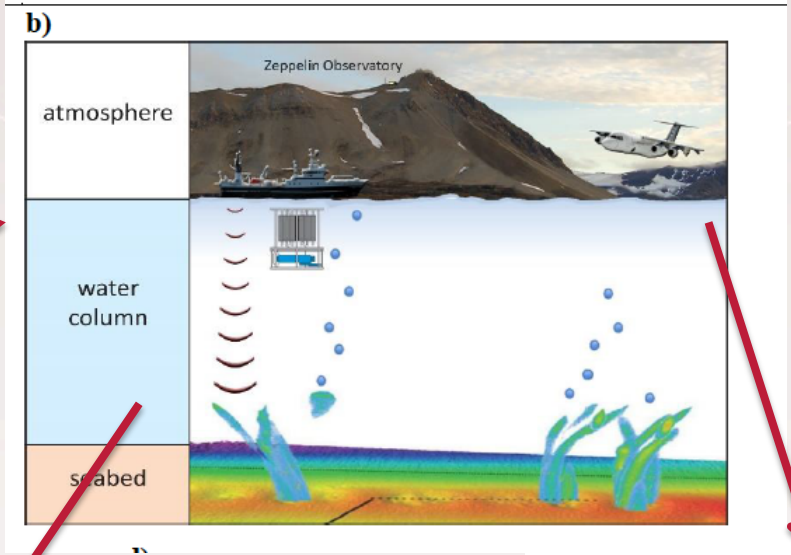
Main idea to summarize:

ENVRI+ allowed to join together multidisciplinary expertise, helping facing extreme conditions for isolated scientific measurement stations
-> Energy supply.


*"The more we share, the better we are"*

# WP 4 JOINT OPERATIONS ACROSS THE RI DOMAINS

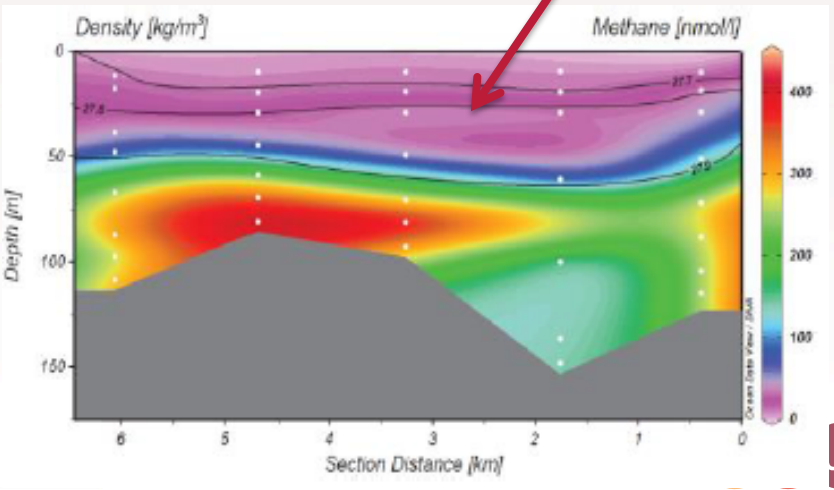


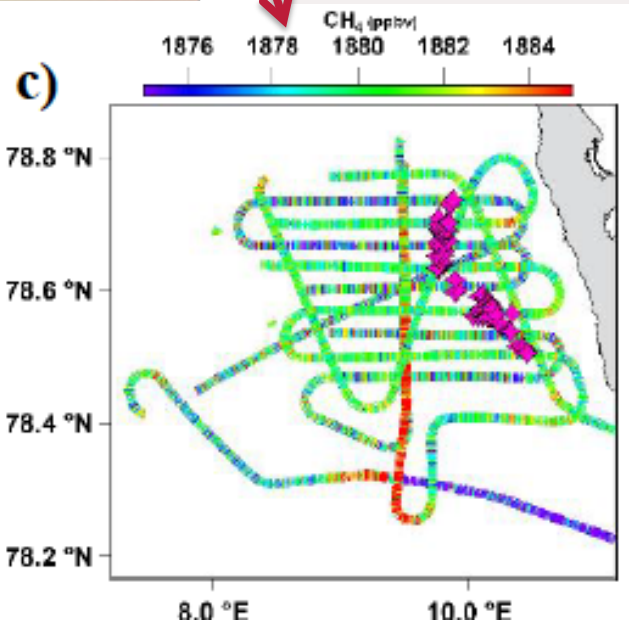




*ICOS, ACTRIS*

*FixO3, ICOS Eurofleets*

*EMSO*




*Lund Myhre et al., GRL, 2016*

ENVRI

Project Number: 654182

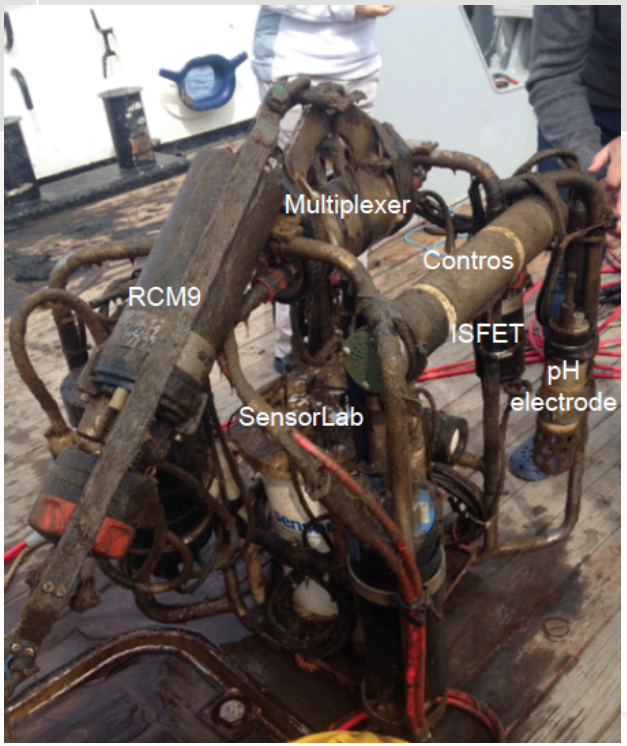
# WP 4 JOINT OPERATIONS ACROSS THE RI DOMAINS

- Goals
  - Through different use-cases, developing common network design, sharing of methodologies and protocols, instrumentation deployment, including the development and field-testing of integrated observatories.
  - 1) To address strategies for enhancing common RI field operations
  - 2) To perform 2 proof-of-concept experiments joining expertise from several RIs

- Overview of situation
  - First period of the project focused on definition of cross-domain collaboration and field work planning
  - Second period will focus on field work and protocol definition

# WP 4 MILESTONES

| No. | Title | Deadline | Status |
|---|---|---|---|
| 10 | Review of critical methane sensing technologies and gaps at interfaces | 12 ✔ | Done (spreadsheet and document) |
| 12 | Interdisciplinary workshop held and open case studies selected | 12 ✔ | Done (meeting held in Zandvoort 2016) |
| 23 | Validation of new benthic stations and scientific analysis of spatial coverage around Europe in scenarii of green repeaters implementation | 18 ✔ | Done (Report validated) |



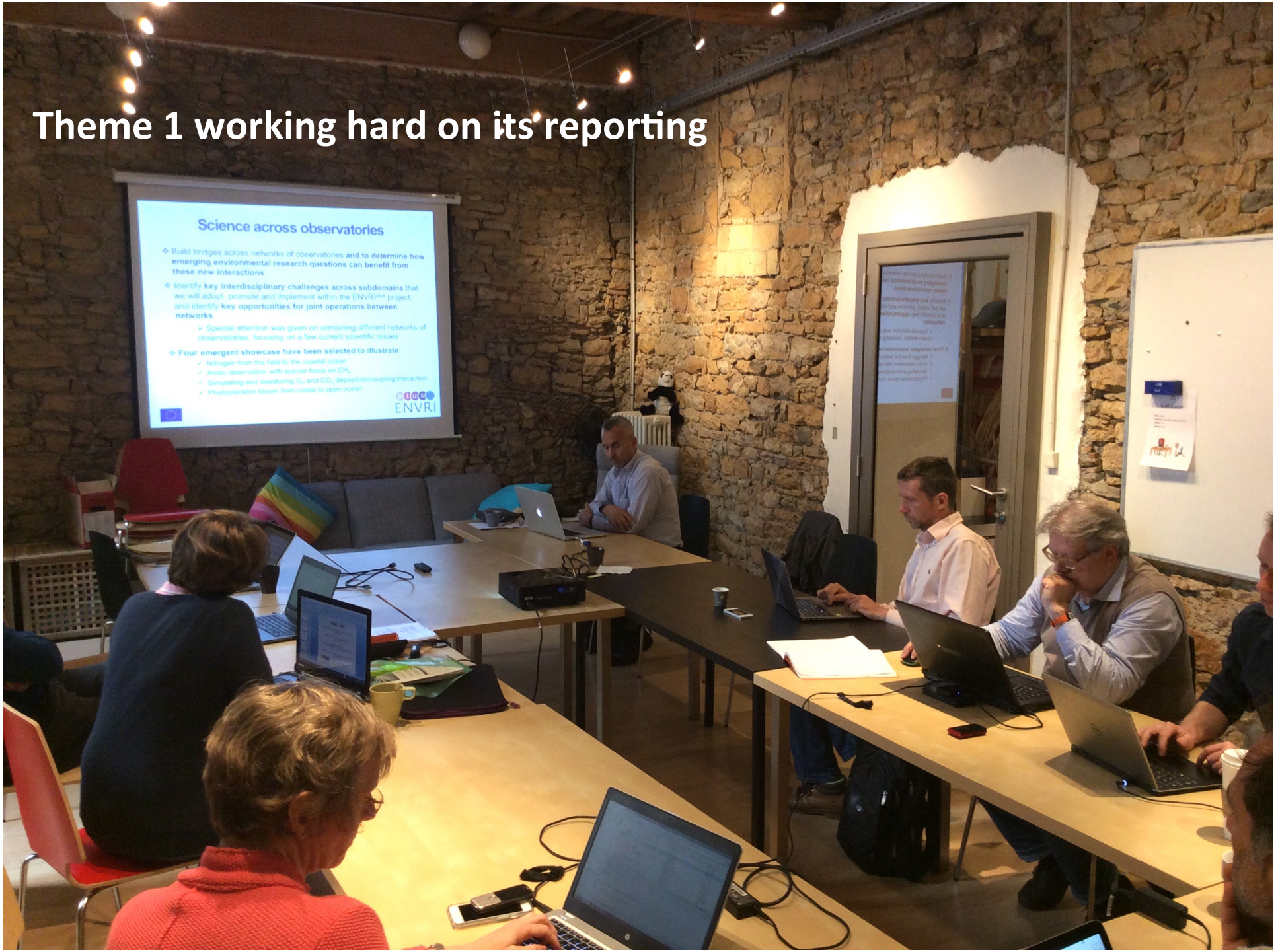
# WP 4 DELIVERABLES

| No. | Title | Deadline | Status |
|---|---|---|---|
| 4.1 | Report on cross-cutting issues, associated existing monitoring capacities and selected open case studies resulting from the Interdisciplinary workshop | 18 ✔ | Done |
| 4.2 | Achievements report on open interdisciplinary case studies highlighting the common operation of networks | 42 | On track (4 showcases with white papers being written) |
| 4.3 | Reference document for methane harmonized monitoring | 46 | On track (field campaigns planned) |
| 4.4 | Report on inter-calibration with Green repeater initiative | 42 | On track (initial solid Earth-marine collaboration initiated in France and Italy) |

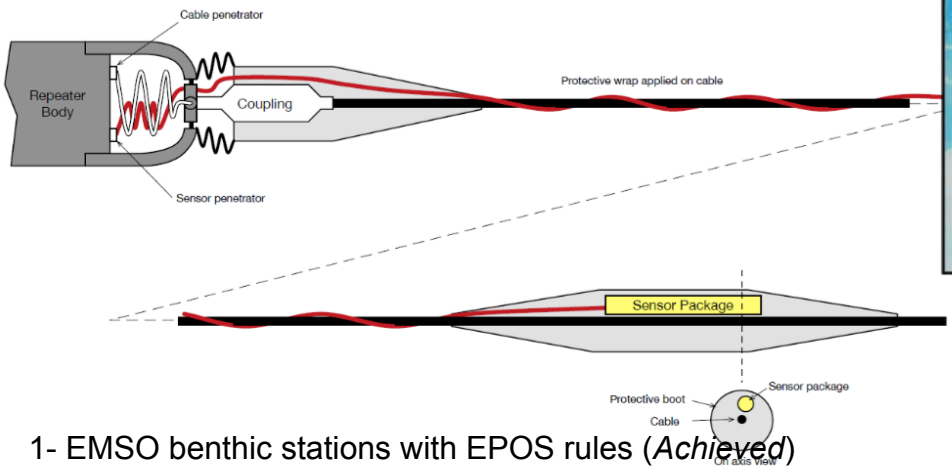
# WP 4 OVERALL STATUS

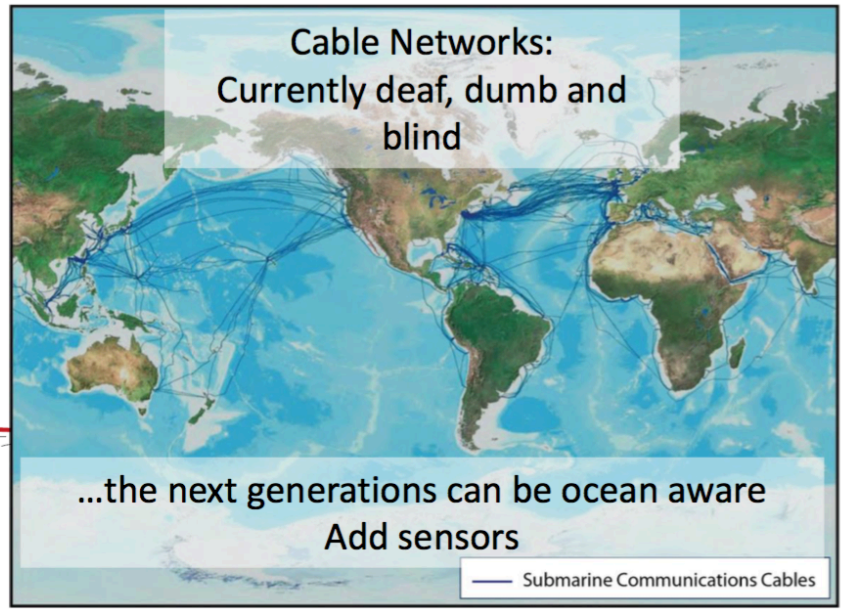
- Successes
  - Scientific workshop on joint operations, as a platform to launch use cases
  - 1 strategic paper submitted, 3 in preparation
- Issues and corrective actions
  - Implementation of use cases in 4.1's use cases on a voluntary basis
  - Complexity of campaign planning on external resources
  - Benthic station tied to exogenous progress in SMART initiative
- Plans for the next period
  - Case studies: finalize papers and seek support to campaigns
  - Intercalibration bench for dissolved CH4 in seawater at Ifremer
  - Palermo deployment of methane sensors, october 2017
  - Participation to the SMART cable initiative and recognition of ENVRI+

# Theme 1 working hard on its reporting



# ENVRI PLUS WP4 TASK 3 SOLID EARTH – MARINE COMMON OPERATION OF PLATFORMS - BENTHIC STATIONS


Source: TE subcom

1- EMSO benthic stations with EPOS rules (*Achieved*)

- Validation of the SDPCHAIN software
- Transformation of OBS data from EMSO-MOMAR site
- Documentation of the transformation of temperature and pressure data from the EMSO-MOMAR site
- New EMSO-France webpages

2- EPOS European level (*Next period*) we are prepared to intercalibrate with Smart cable when it will be demonstrated

(*Next period*)

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3- Then we are prepared to intercalibrate with Smart cable when it will be demonstrated (*Next period*)