ICOS
The Integrated Carbon Observation System

Where we are, where we want to go and why we need InGOS (and InGOS+)

Werner L. Kutsch, Director General of ICOS RI, Helsinki, Europe

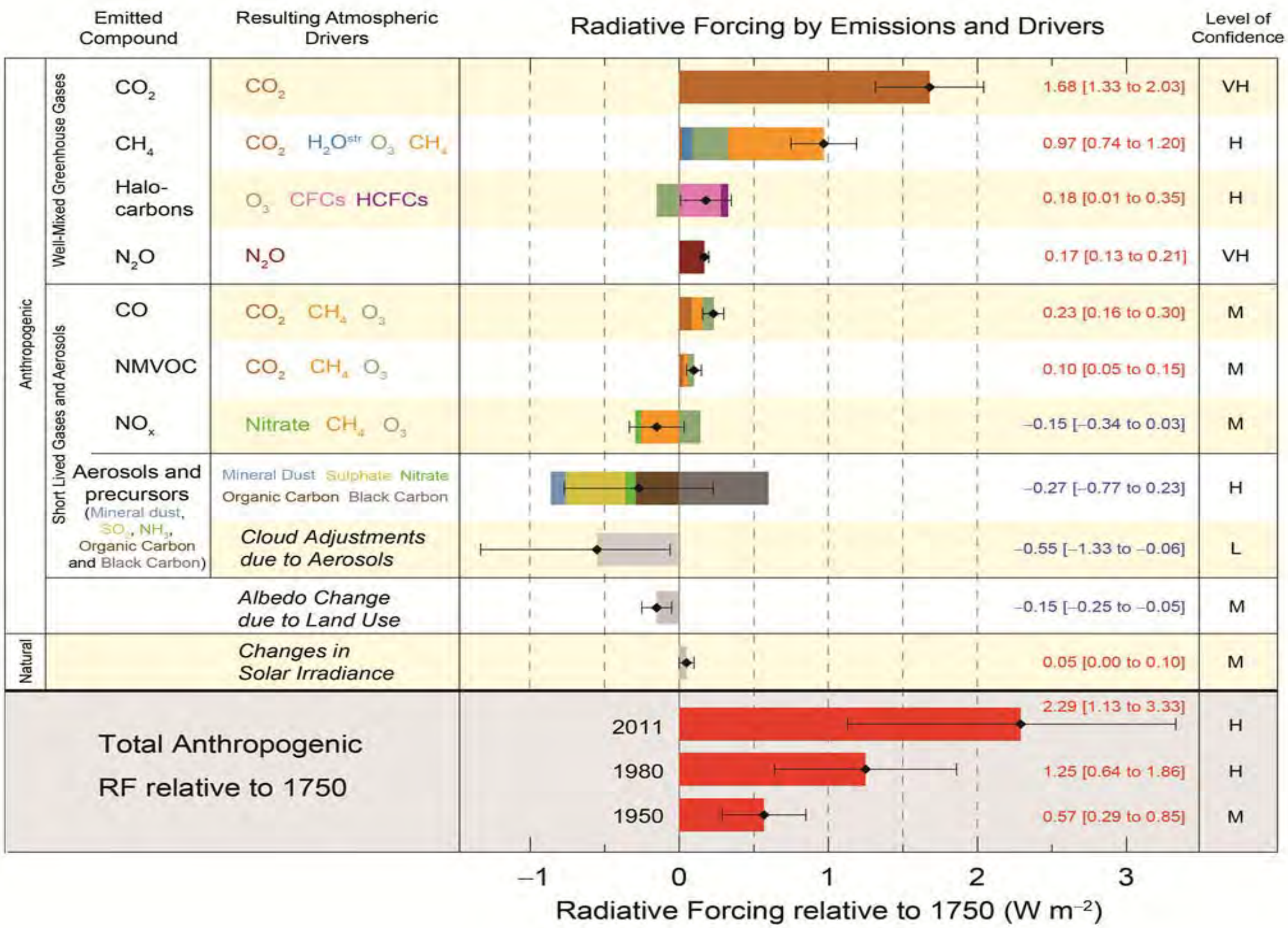
Florence, 16. Oct. 2014

ICOS INTEGRATED CARBON OBSERVATION SYSTEM

Introduction and background

Climate changes caused by
the increase of greenhouse gases
represent a major challenge to mankind.

Climate and greenhouse gases



IPCC, 2013

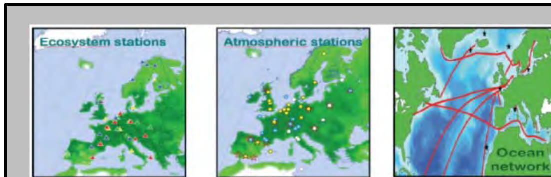
The vision and the scientific mission of ICOS

- fundamental understanding of carbon cycle, greenhouse gas budgets and pertubations and underlying processes,
- ability to predict future changes,
- verify the effectiveness of policies aiming to reduce greenhouse gas emissions,
- technical and scientific innovation,
- education and capacity building.

The vision of ICOS

All important parameters

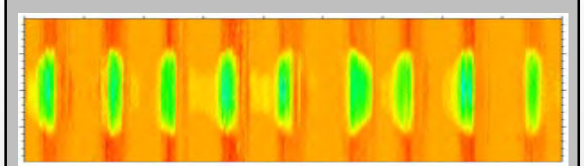
State of the art techniques



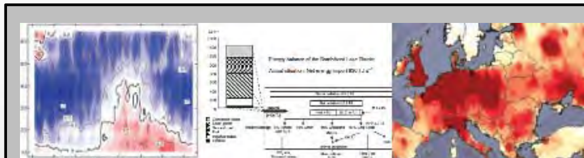
Representative networks

Relevant data products

Optimum data streams

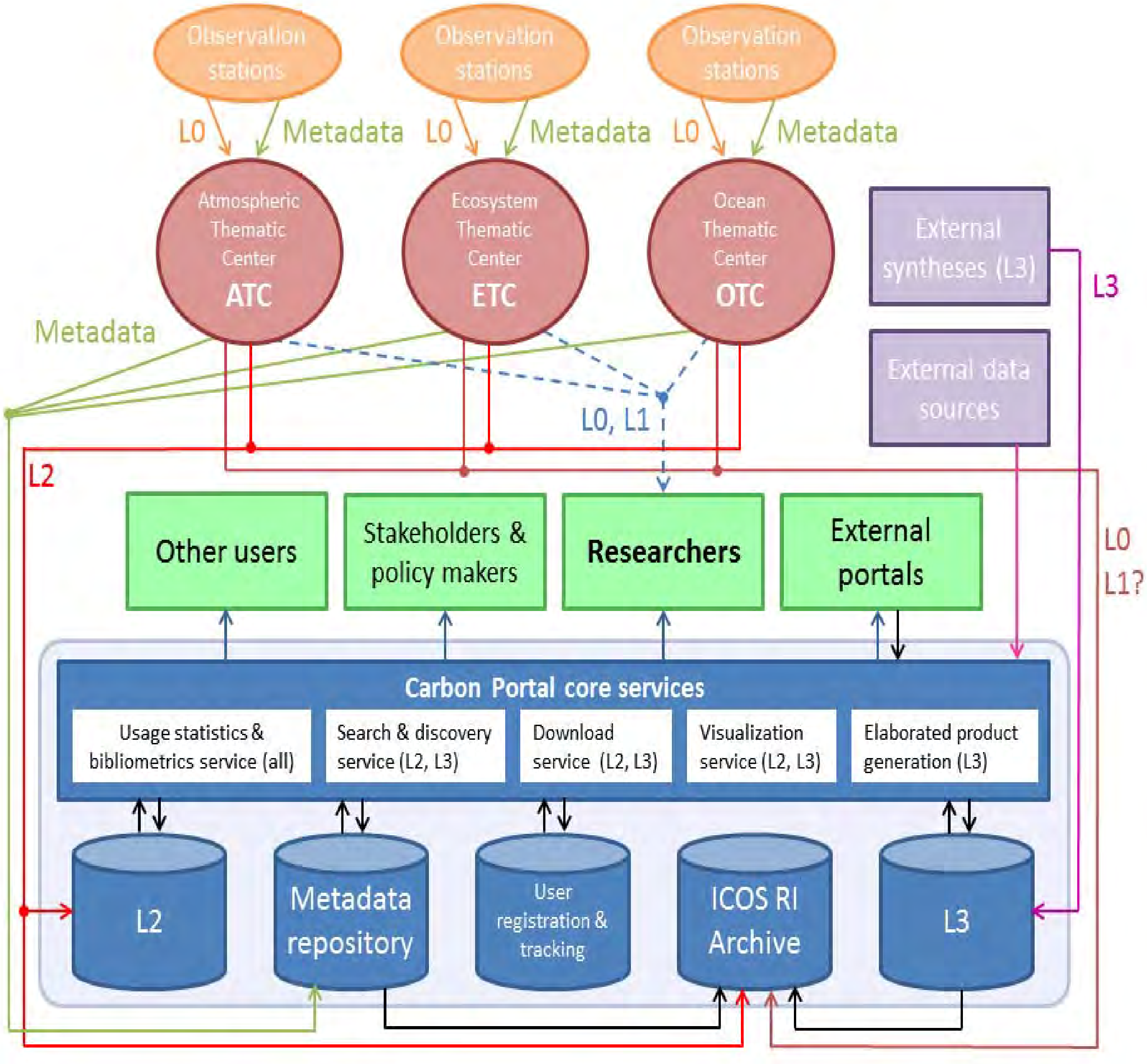


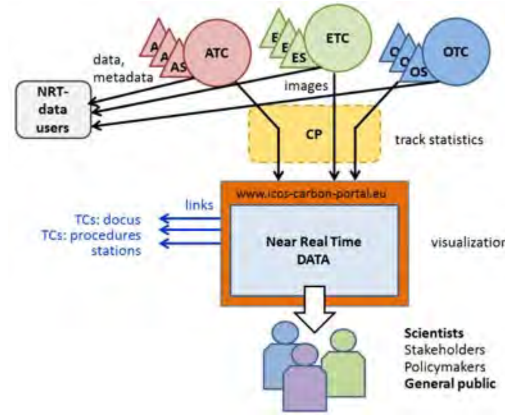
Long-term financial security of all partners

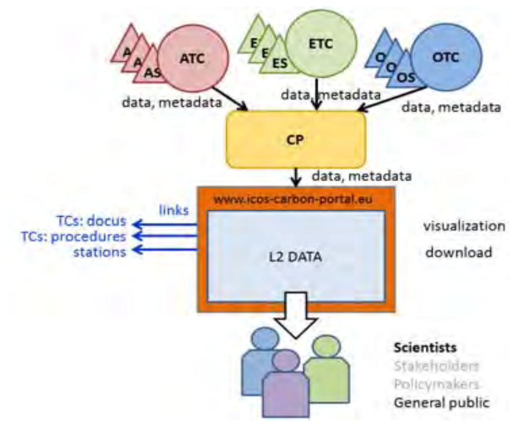


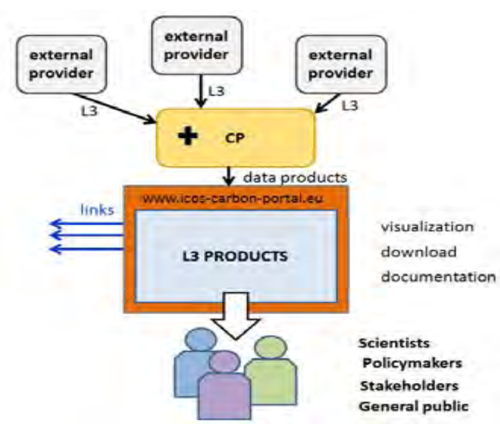
A community to produce higher level output

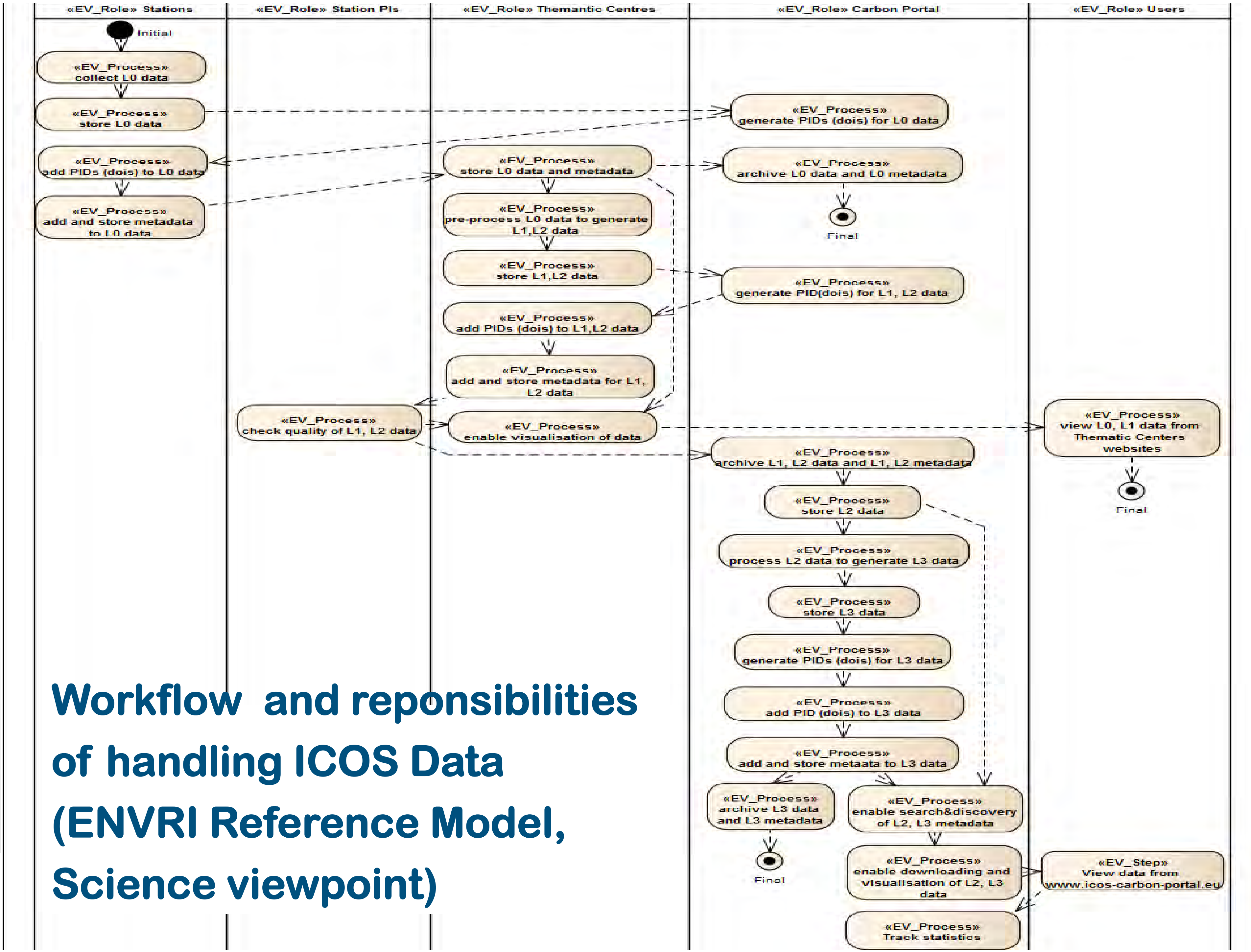
Identifying ICOS RI Workflow







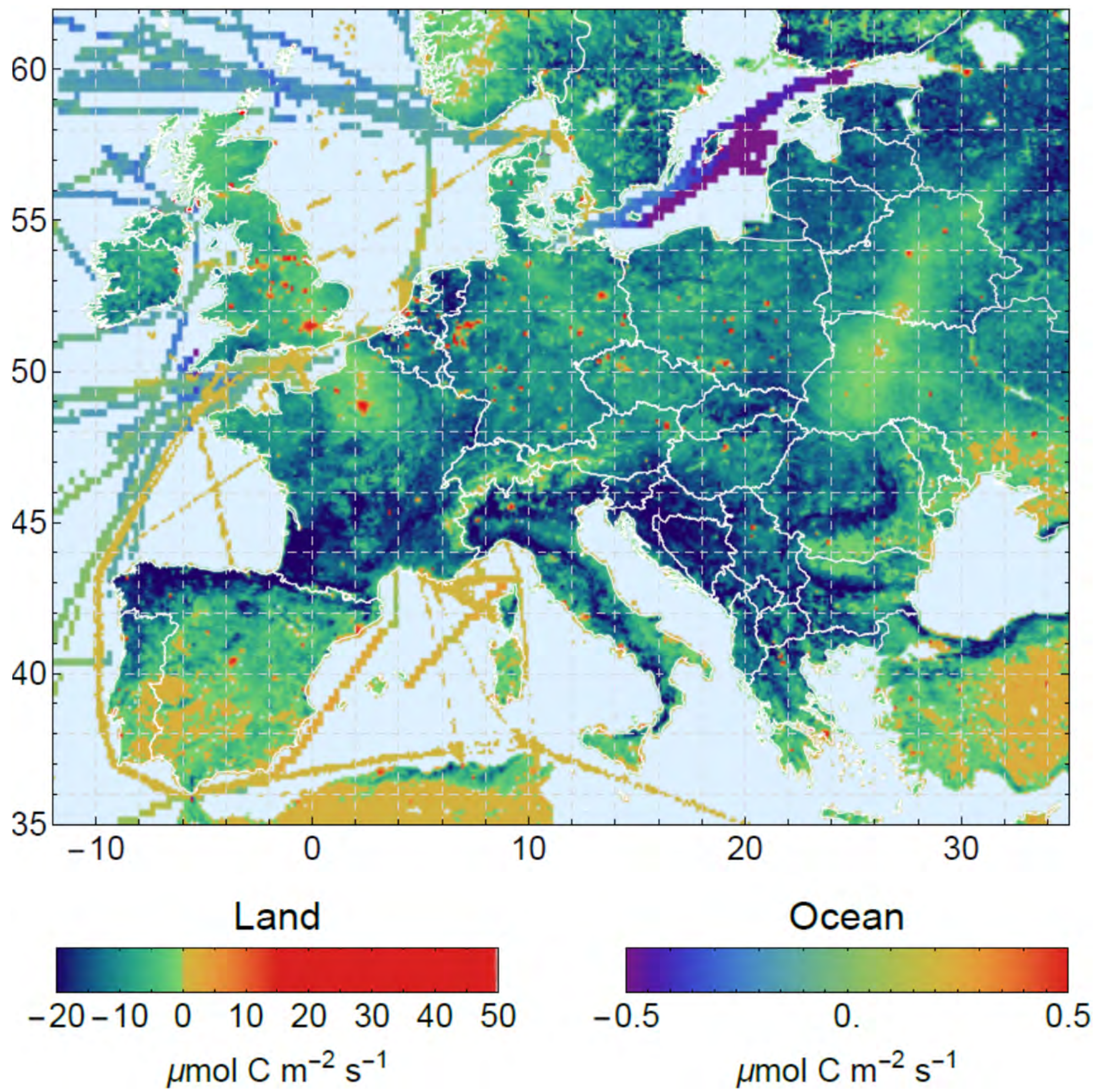




Workflow and reponsibilities of handling ICOS Data (ENVRI Reference Model, Science viewpoint)

Our main data product: maps provide information

- on space
- on risks
- on safe passages
- on alternatives

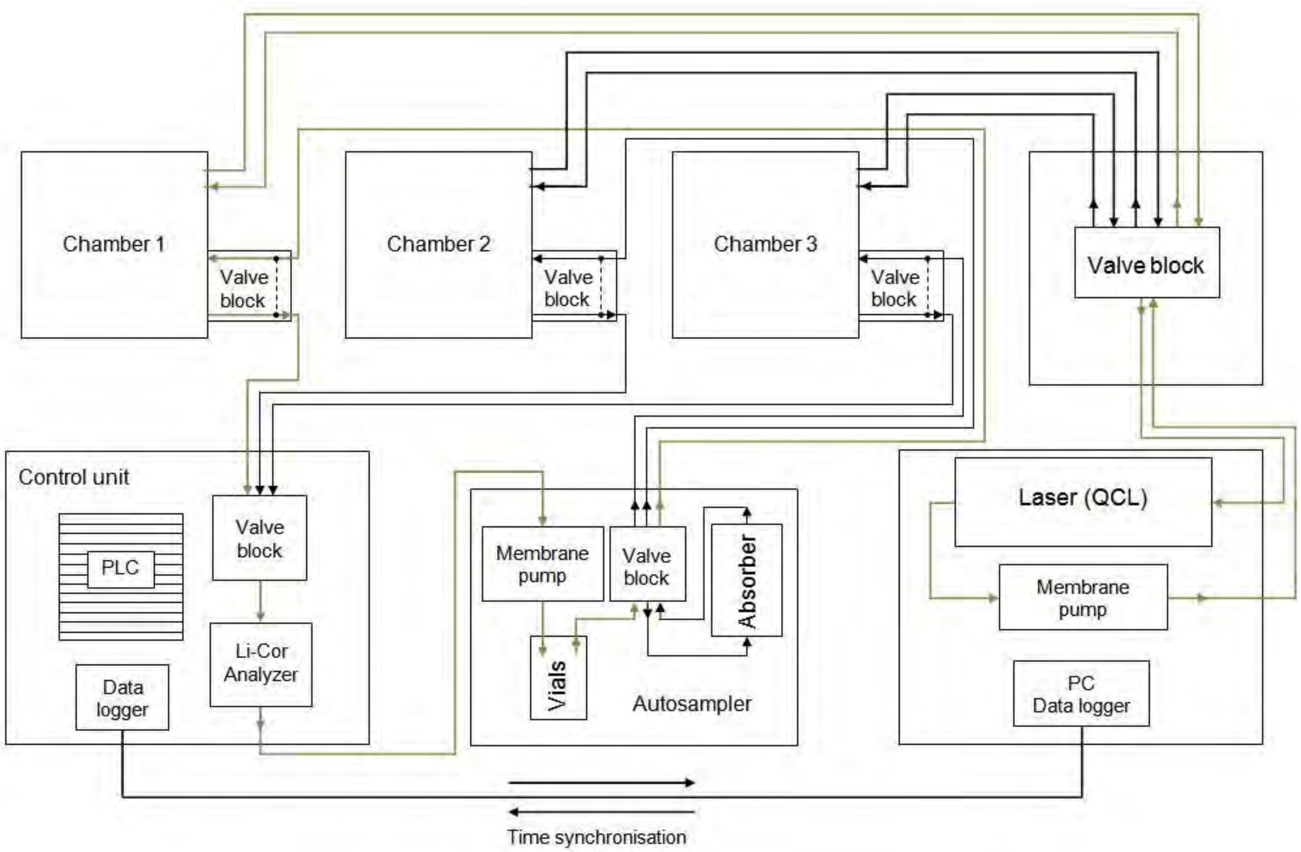


Distribution of CO_2 fluxes in Europe at mid day in July 2009 in the model world

[curtesy: Martin Heimann]

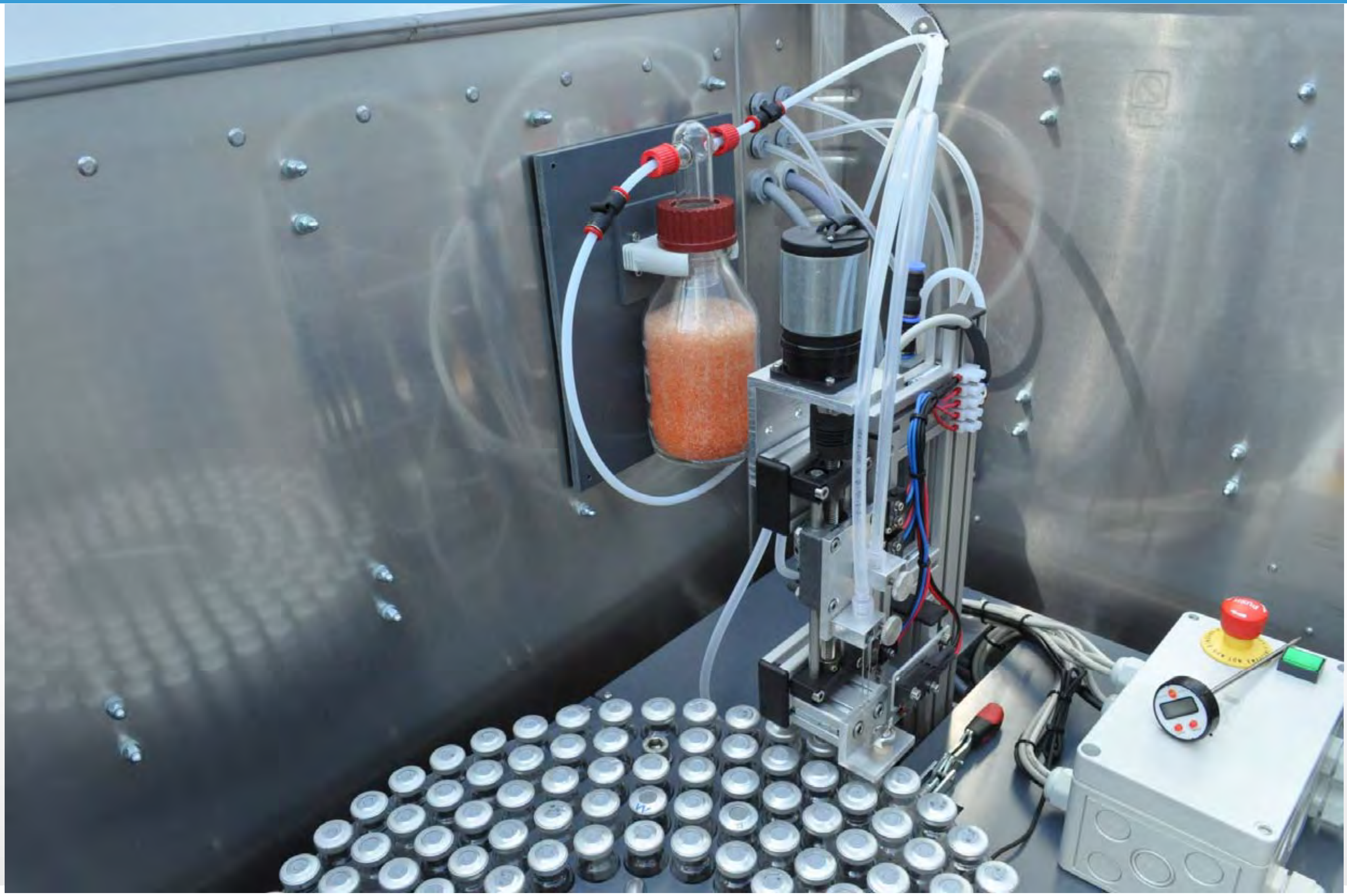
Further development of ICOS: not only more sites but also more parameters

Design of automated chamber system

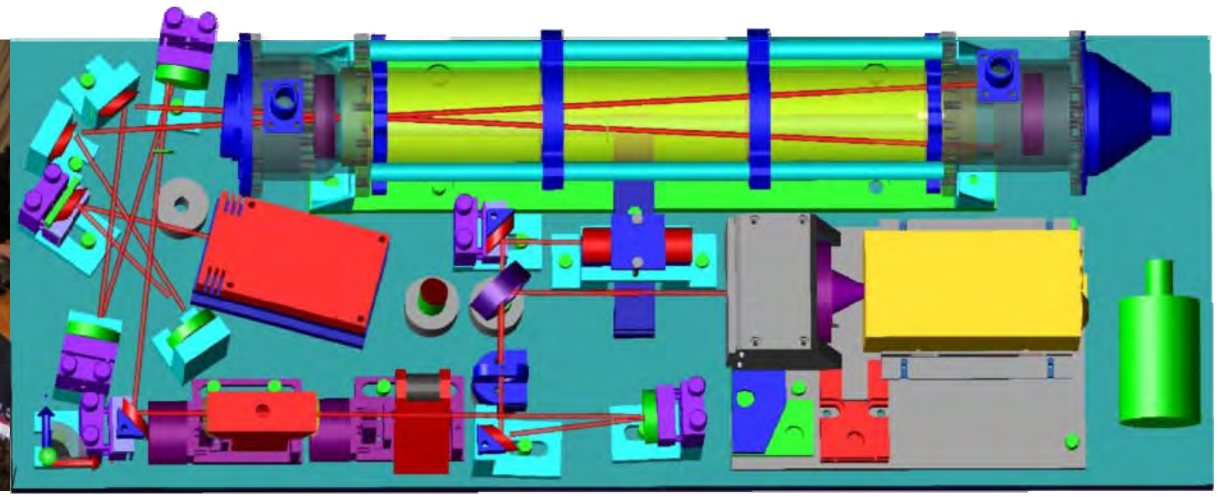


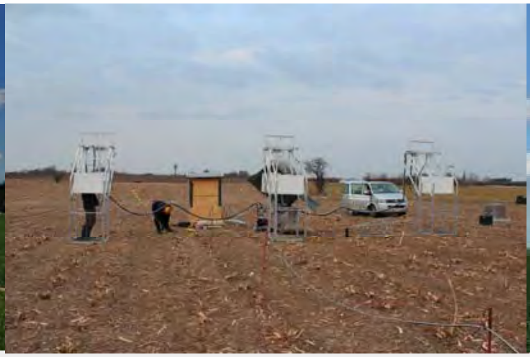
Development and Design by Dirk Lempio

Automated flask sampler

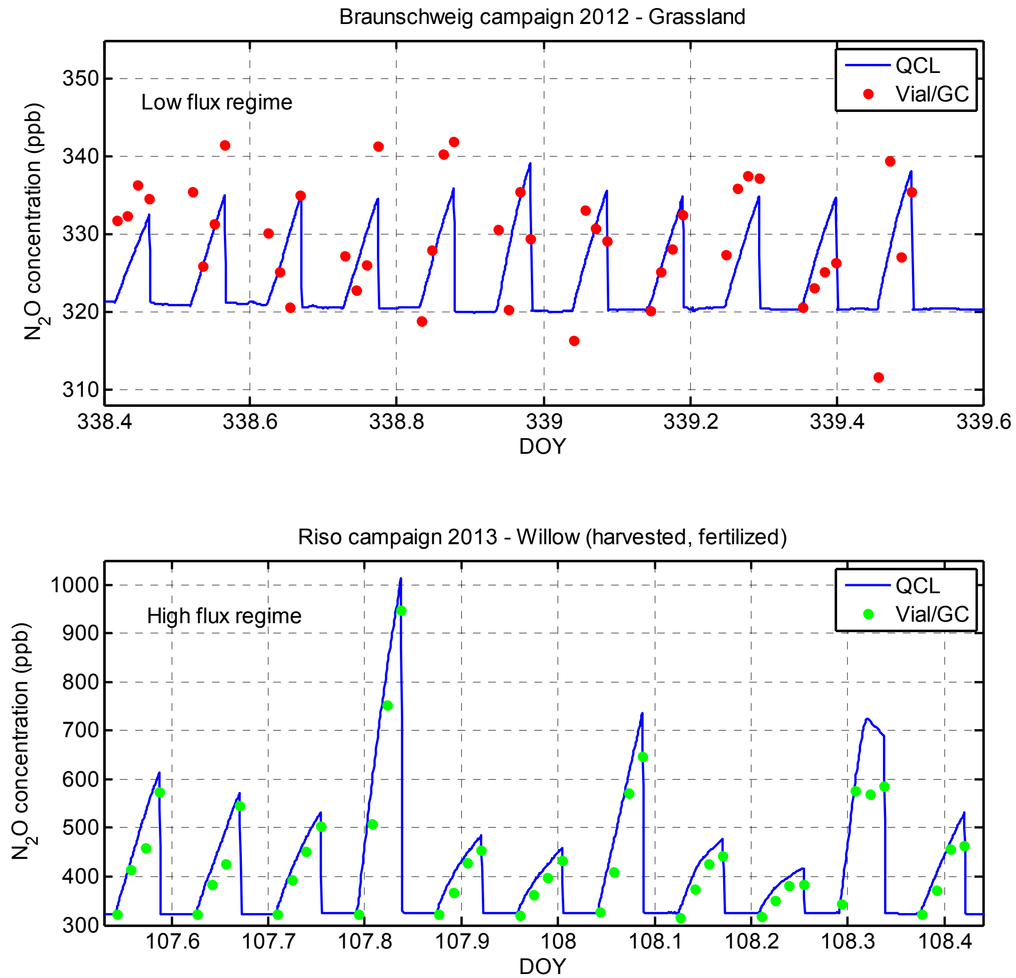


Quantum cascade laser



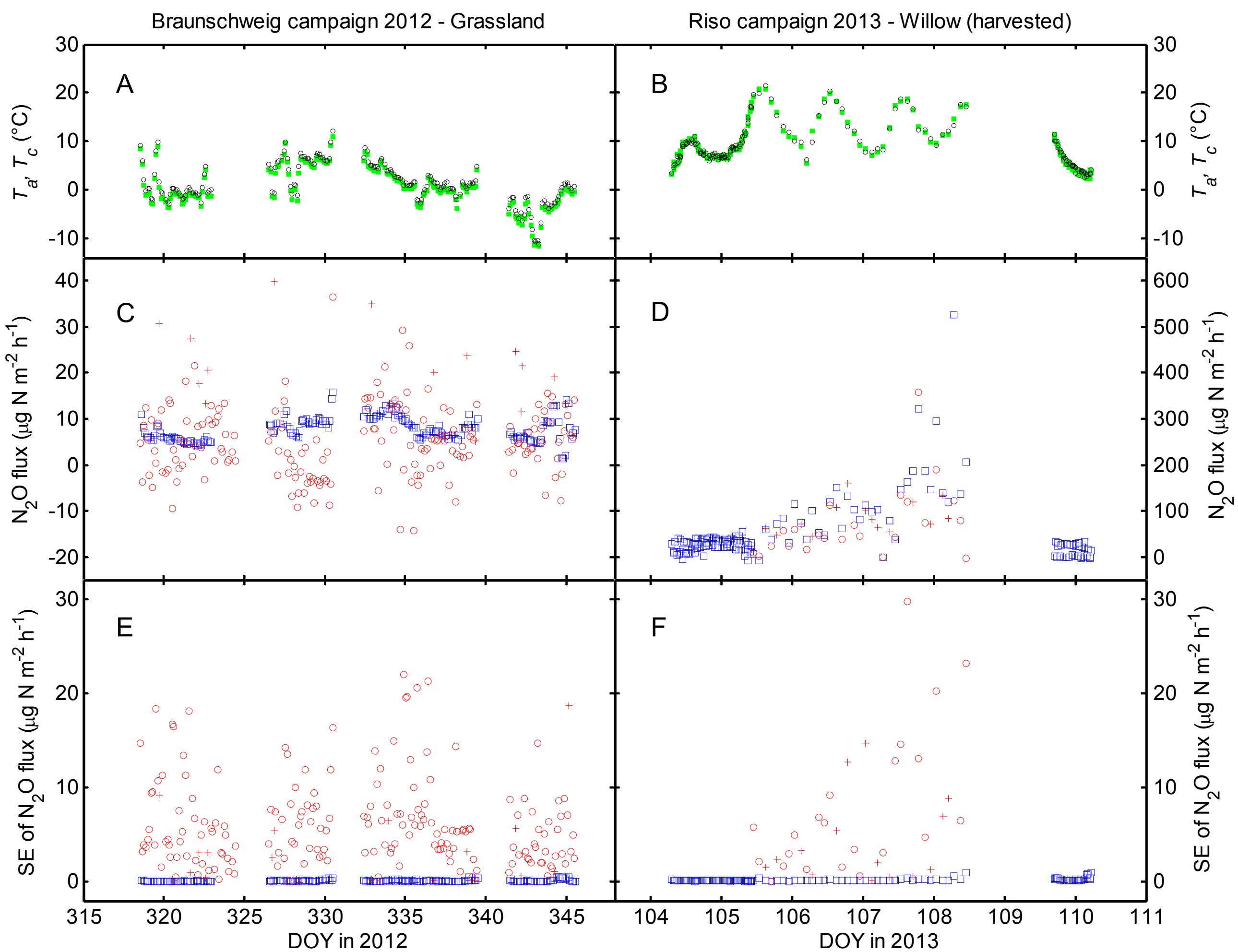


Laser vs flask sampling



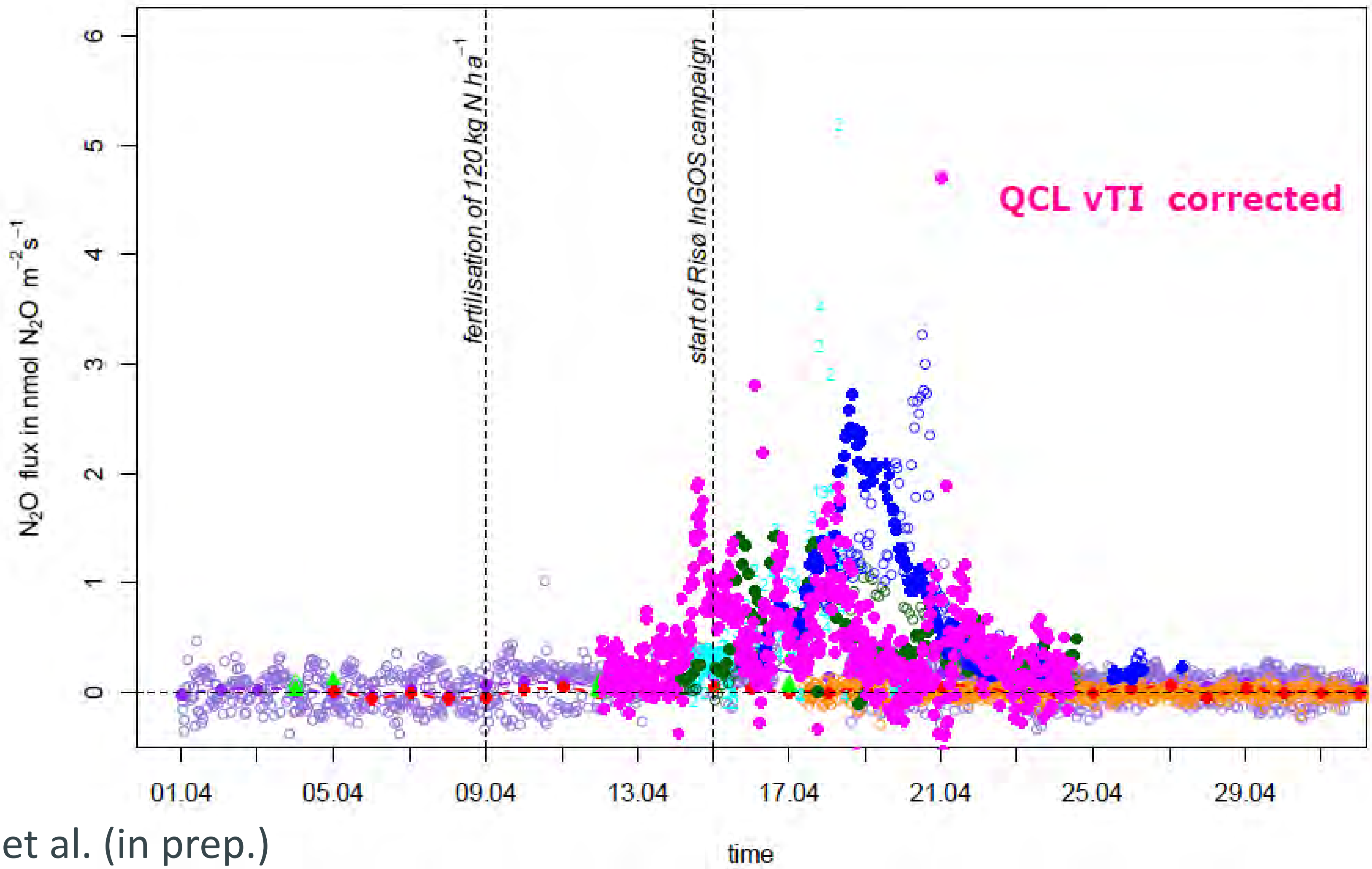
[courtesy C. Brümmer]

Laser vs flask sampling



[courtesy C. Brümmer]

Chamber measurements vs eddy-covariance



Ibrom et al. (in prep.)

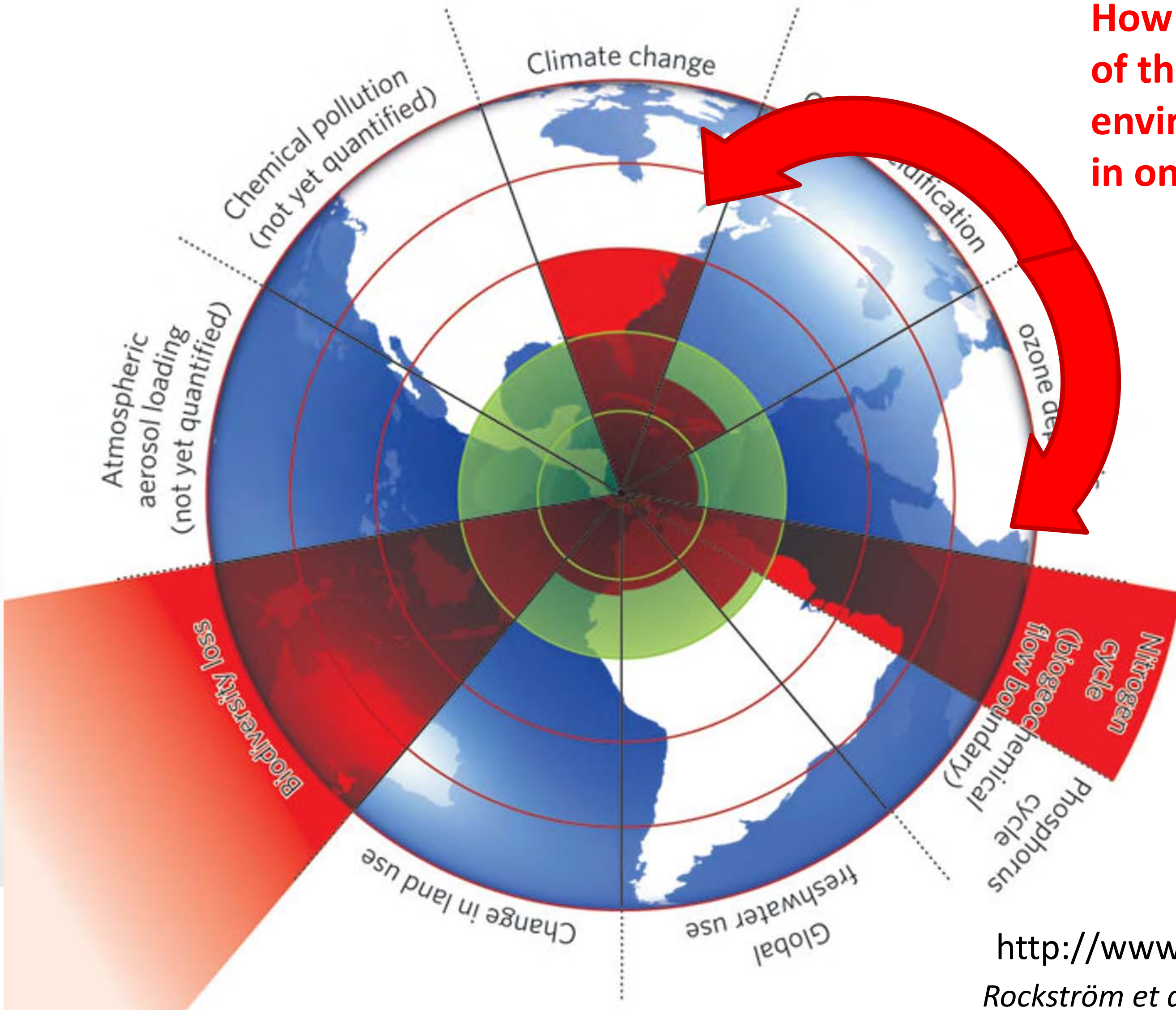
First conclusions

- ICOS and InGOS have high technical innovation,
- Fluxes of other GHG (CH_4 and N_2O) can be measured by eddy covariance as well, but automated chamber systems may be more accurate at low fluxes.
- Data post-processing of N_2O-fluxes is still work under progress.
- ICOS may develop standards for these measurements one day.

Integrating GHG fluxes from agriculture
Two examples for application

- Agricultural GHG fluxes are driven by th N-cycle.
- We can observe a specialisation on the farm as well as the landscape level: cash crops on one site (in one area) and intense meat production on the other.
- Imbalances in N cycle.

The background: nine planetary boundaries
Concept by Stockholm Resilience Centre

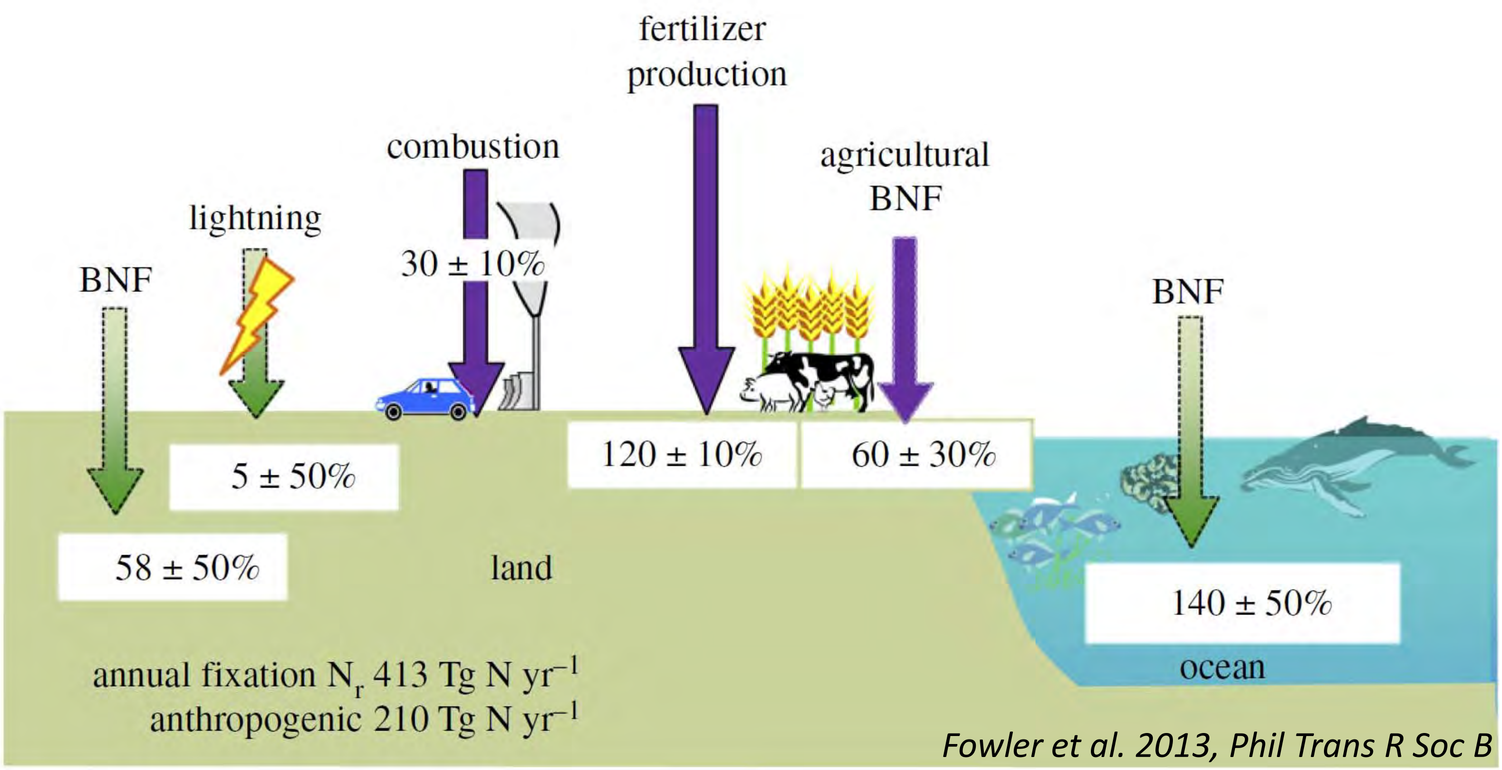


How to connect two of the most urgent environmental problems in one observing system?

http://www.stockholmresilience.org

Rockström et al. 2009, Ecology and Society

Global nitrogen fixation

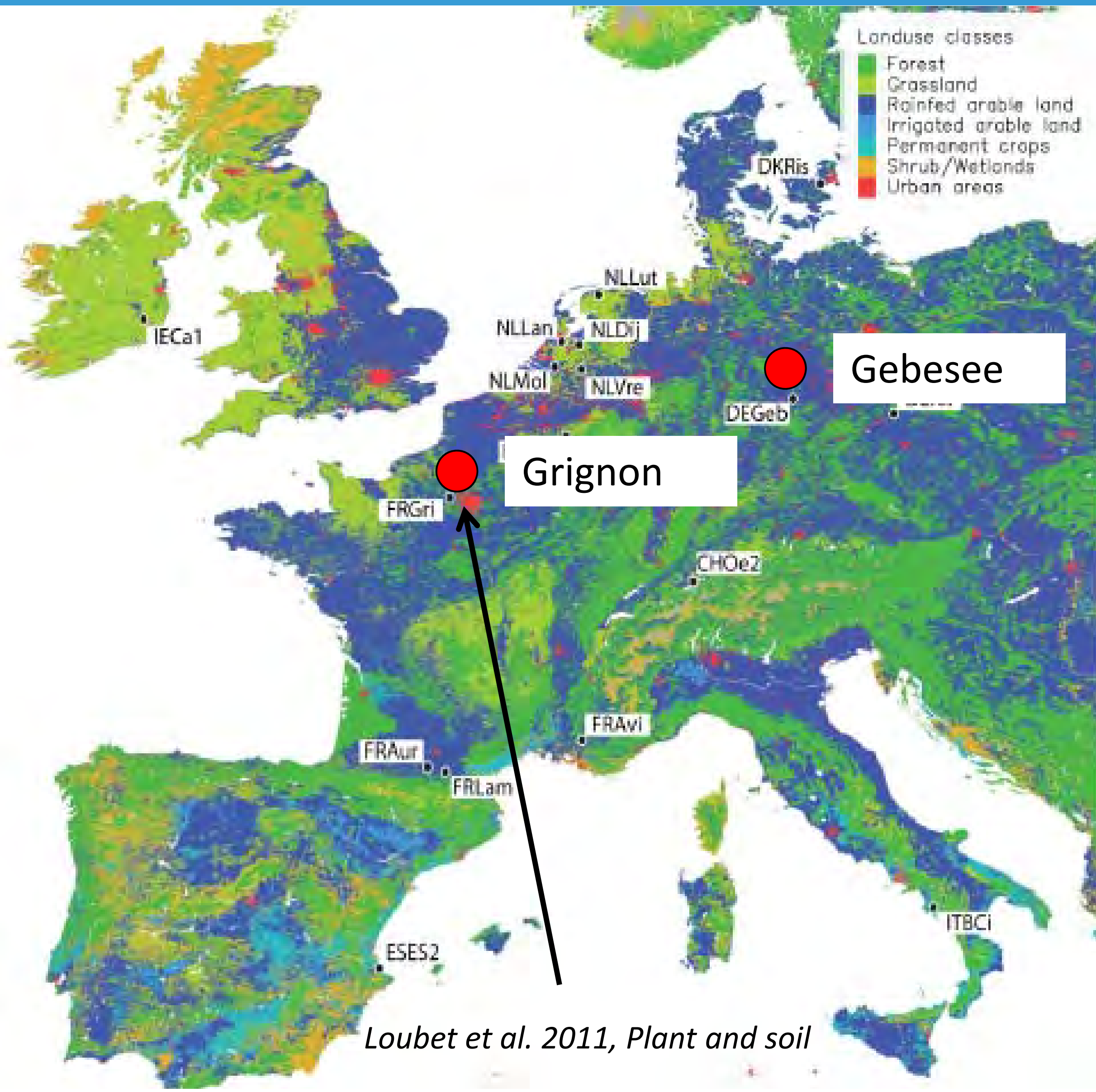


Fowler et al. 2013, Phil Trans R Soc B

Eutrification of terrestrial ecosystem, freshwater ecosystems and oceans, groundwater pollution , enhanced production of N_2O (increase radative forcing),

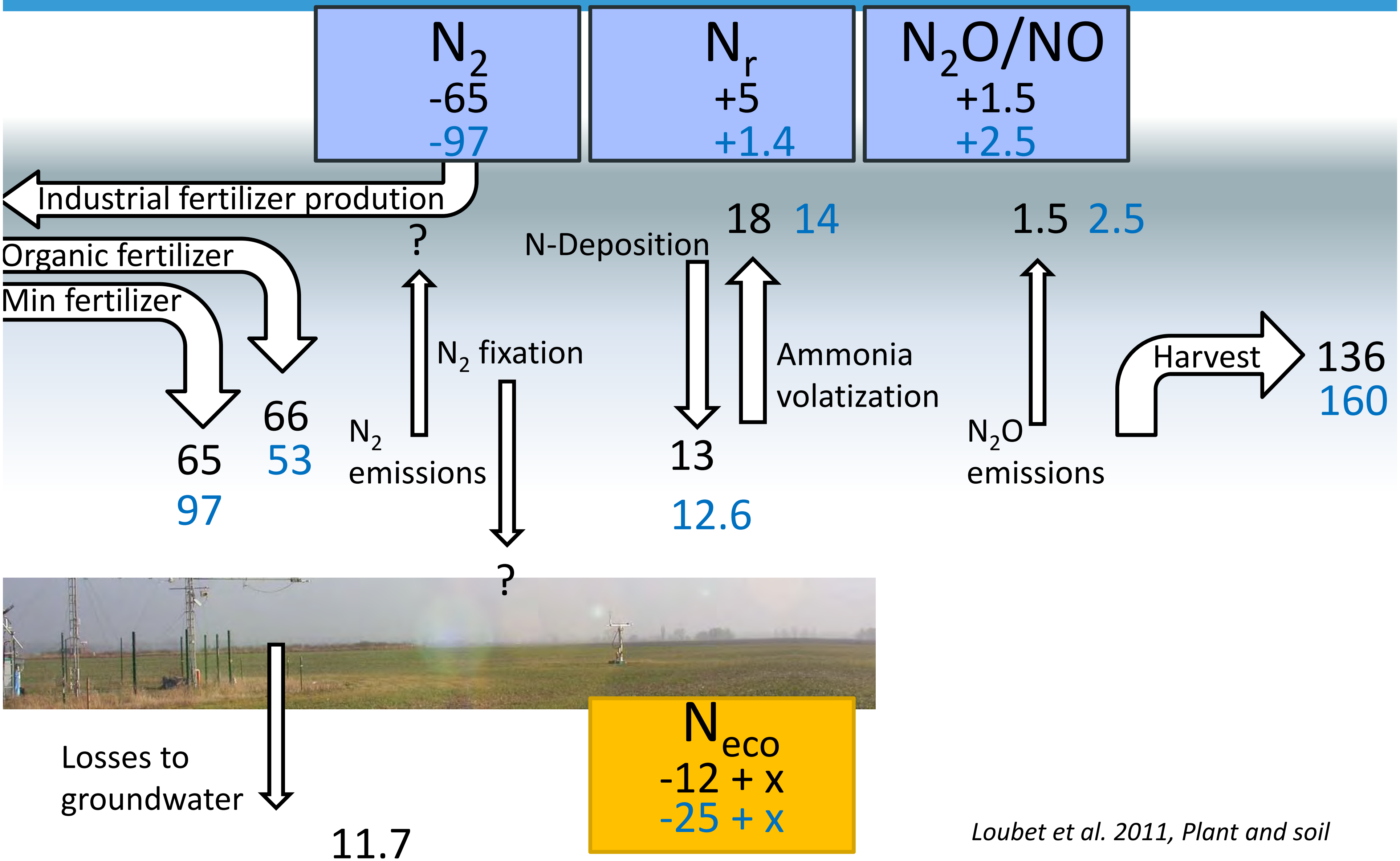
CARBO EUROPE IP

NitroEurope IP



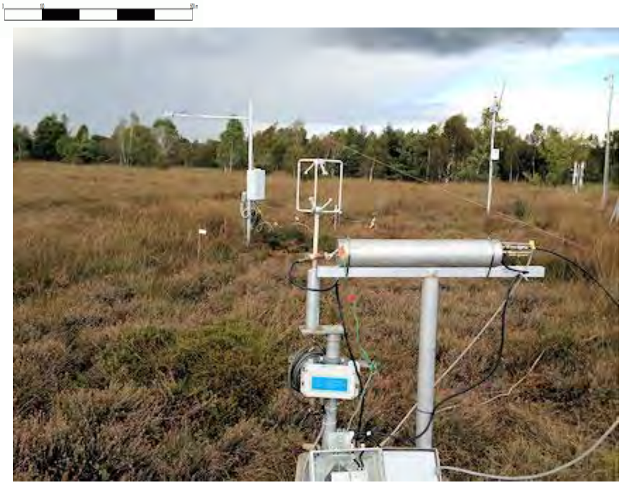
Loubet et al. 2011, Plant and soil

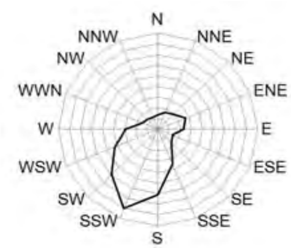
N-balance for Grignon and Gebesee



Loubet et al. 2011, Plant and soil

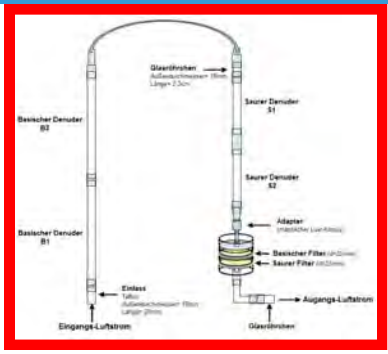
Example: ICOS–D Test site on N_r and GHG fluxes Bourtanger Moor ('Nitrosphere‘)



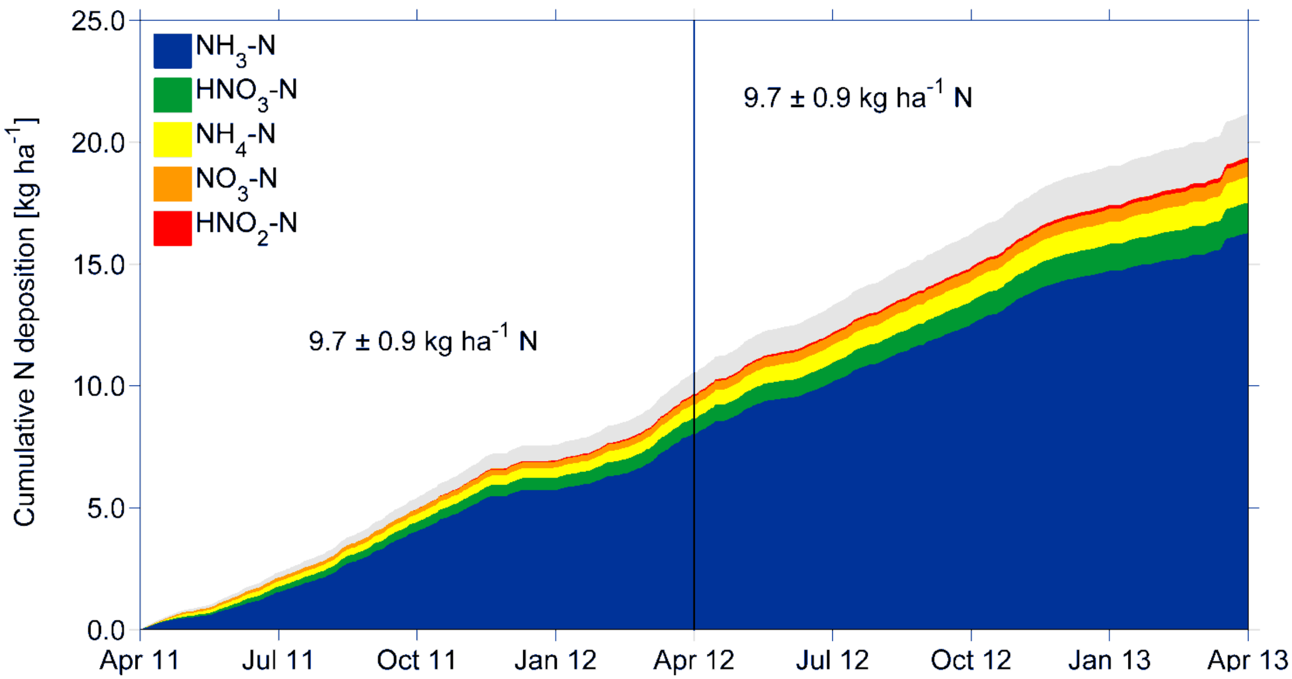


Intensive livestock production,
High organic fertilization,
High ammonia volatization

N_r fluxes between ecosystems and atmosphere



DELTA-Denuder
→ N_r concentrations (NH_3, HNO_2, HNO_3, pNH_4, pNO_3)
→ dry deposition by modeling
(*Hurkuck et al., Atmospheric Environment, 2014*)



[courtesy C. Brümmer and Miriam Hurkuck]

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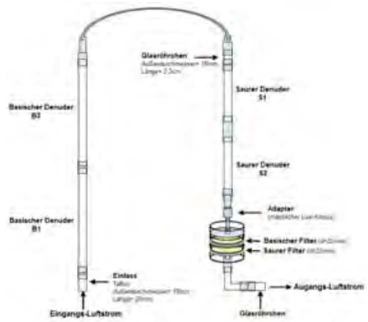
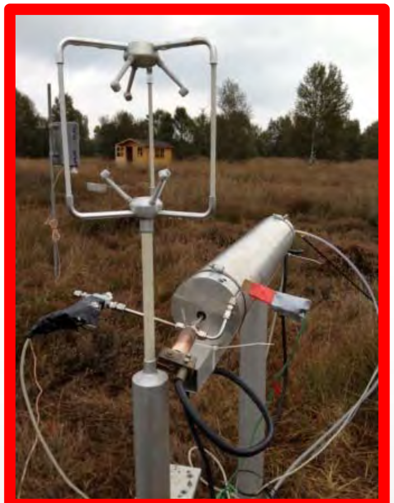
N_r fluxes between ecosystems and atmosphere





TRANC
→ total N_r bi-directional, net fluxes by EC
→ direct measurements
(*Brümmer et al., Tellus B, 2013*)

Aerodyne Ammonia QCL
→NH_3 (bi-directional, net fluxes by EC)
→ direct measurements

[courtesy C. Brümmer and Miriam Hurkuck]

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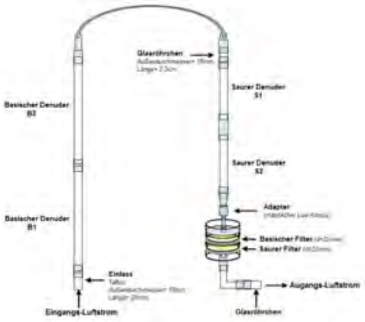
Ecosystem response to N_r fluxes



Eddy covariance
→ $CO2, H_2O$, N_2O

Chamber measurements
→ $CO2$, CH_4, N_2O

[courtesy C. Brümmer]

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Summary and take home message

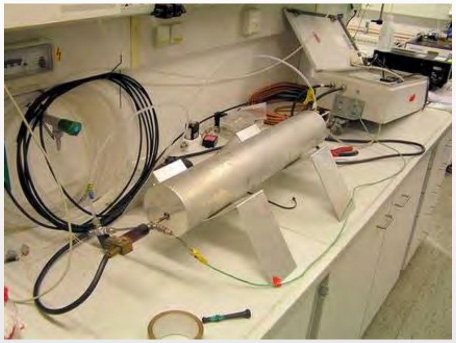
- The developments in InGOS are supporting the further developments of ICOS technically and scientifically.
- ICOS is currently on a good way from a network to an infrastructure.
- An InGOS+ project would be very helpful for further developments.

Thanks !

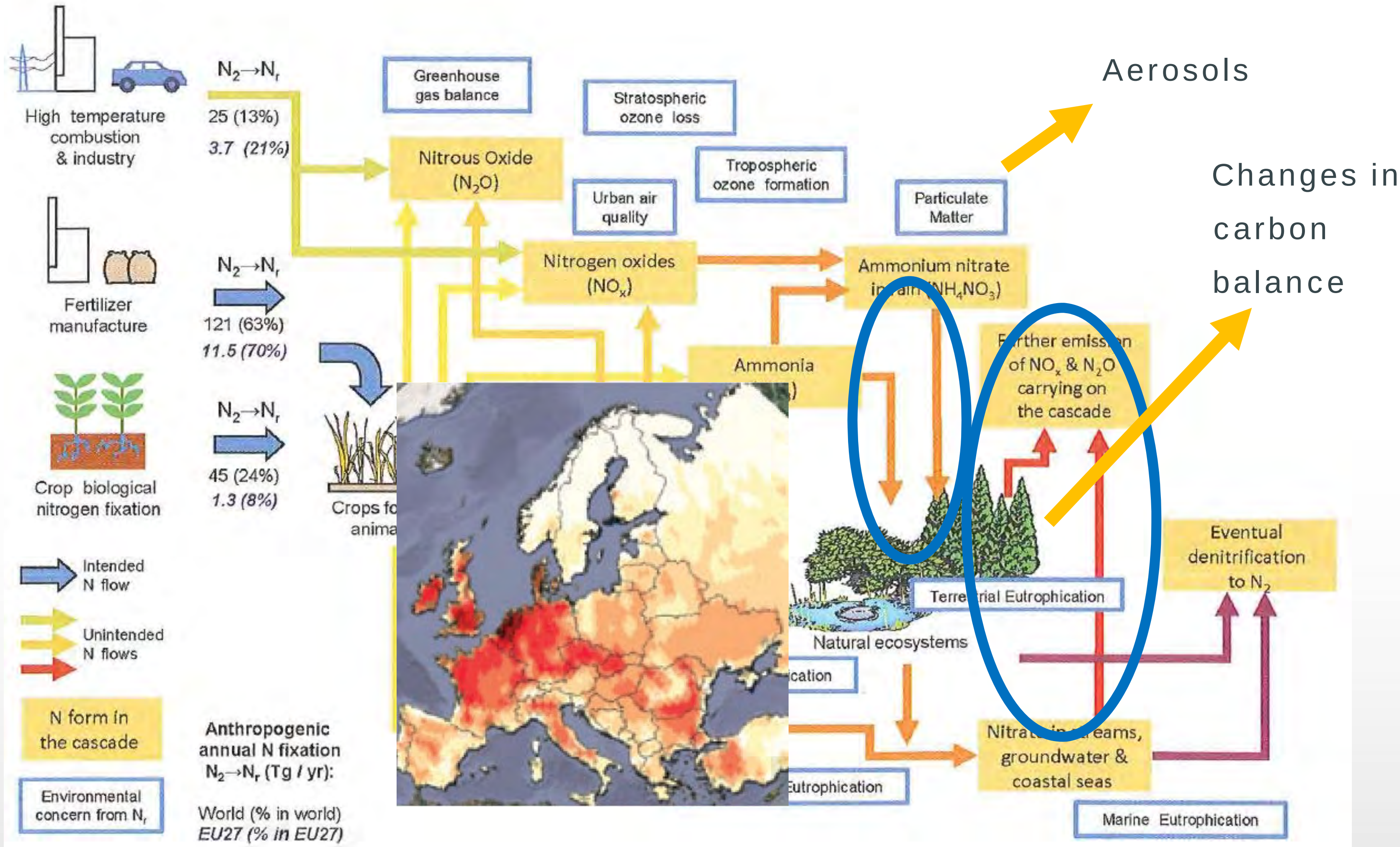
to Freiland Group and Labteams of MPI-BGC, Jena;

- the never tired Gebesee-drivers from TIAK:
  Andrea Oehns-Rittgerodt and Peter Braunisch;
- the Labteams of TIAK,
- Catharina Don, Jean-Pierre Delorme, Jeremy Smith,
- the Federal Ministry of Education and Science for funding
  (ICOS-D Pilot and Demonstration Phase; Nitrosphere),
- the European Commission for funding
  (Carboeurope, Nitroeurope)

…and the unknown German and European taxpayer!



The Nitrogen Cascade



After Sutton et al. 2010

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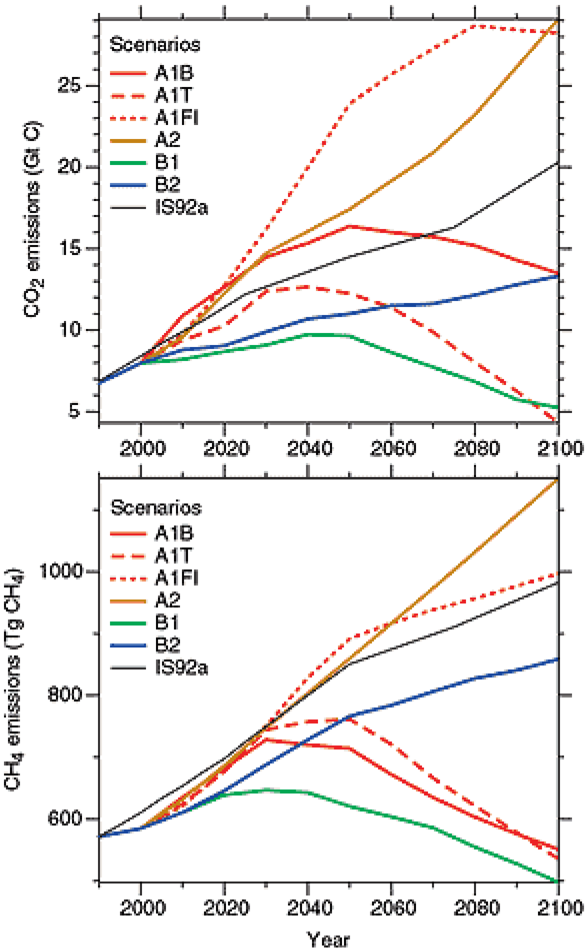
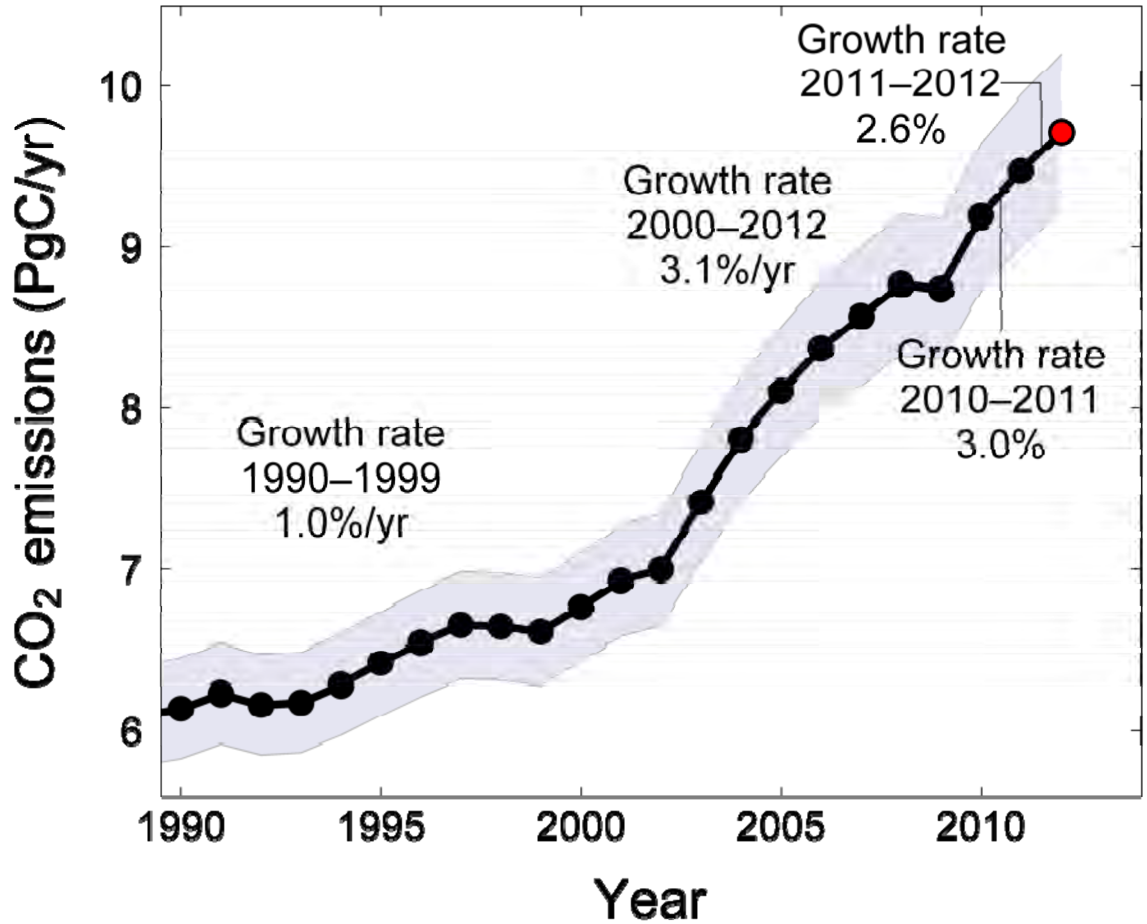
Thank you for your attention!

And my acknowledgements to my colleagues in ICOS and the ENVRI Reference Model Team!

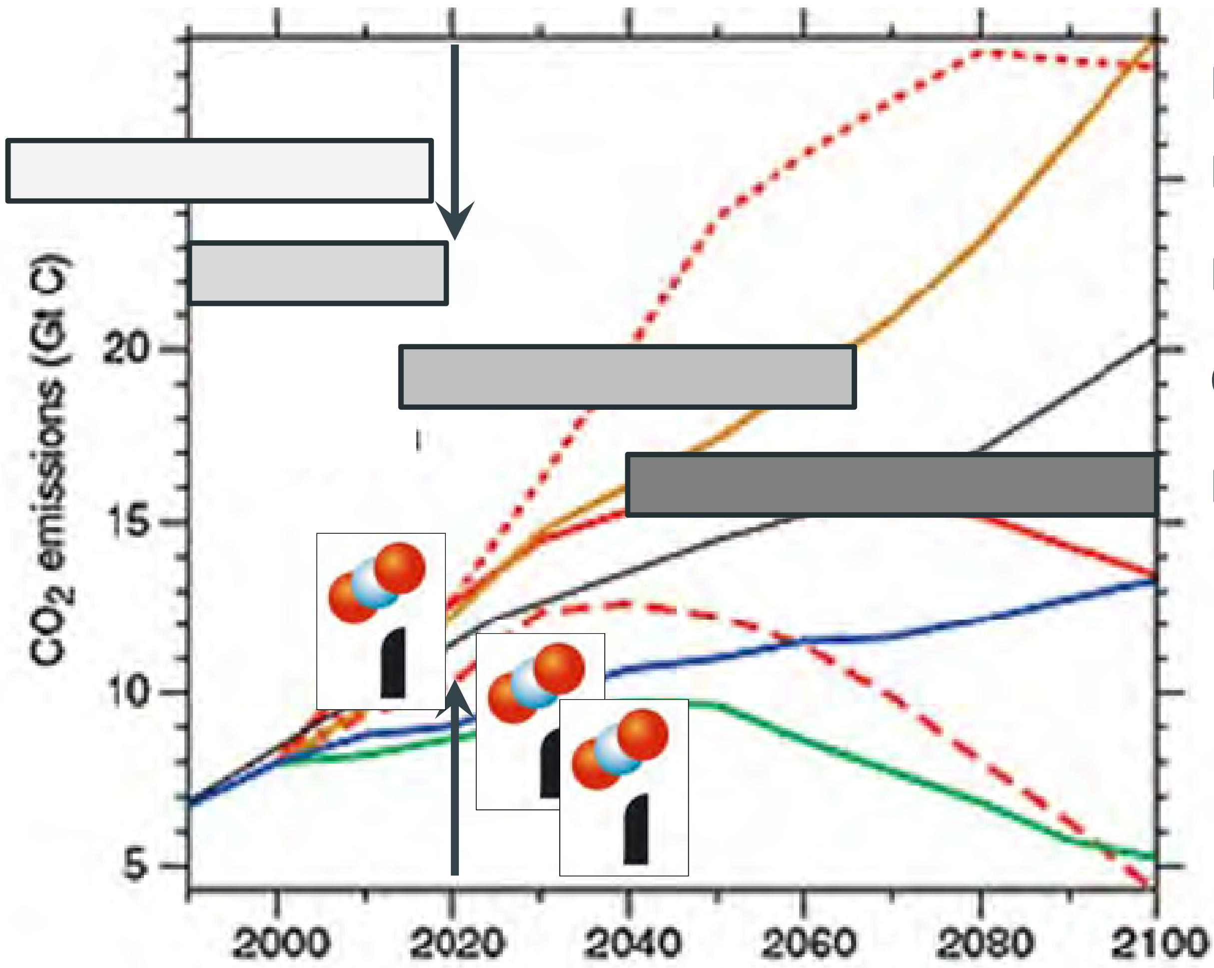
Verification of policies to reduce GHG emissions





Sources: IPCC; Peters et al. 2012a; Le Quéré et al. 2012; CDIAC Data; Global Carbon Project 2012

Verification of policies to reduce GHG emissions



Post-Kyoto agreement (2020)

Develop observing techniques

Establish baselines

Critical Verification Period

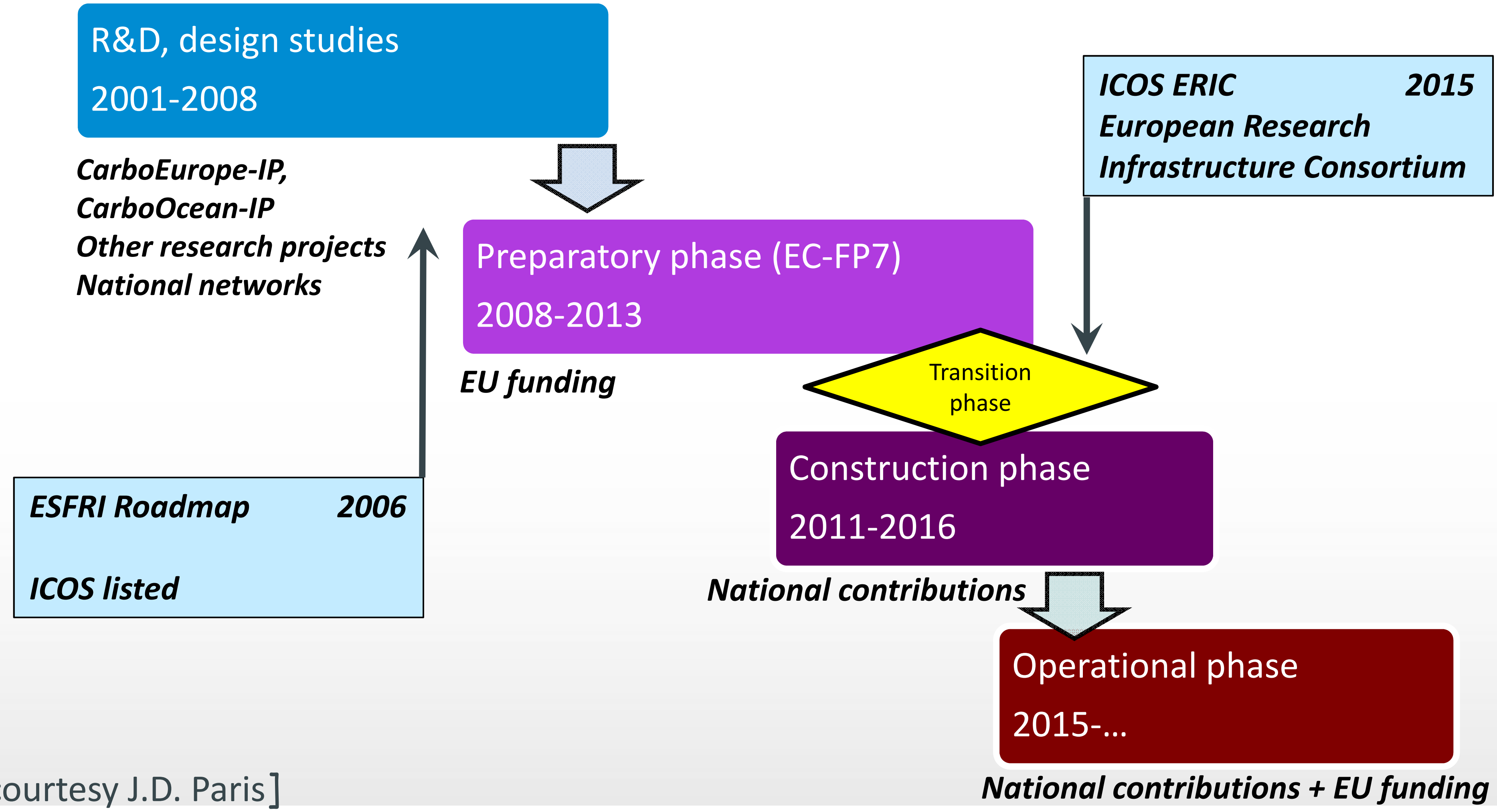
Robust verification, fine grid

Initial capability, ERIC (2015)

Fully operational (2020)

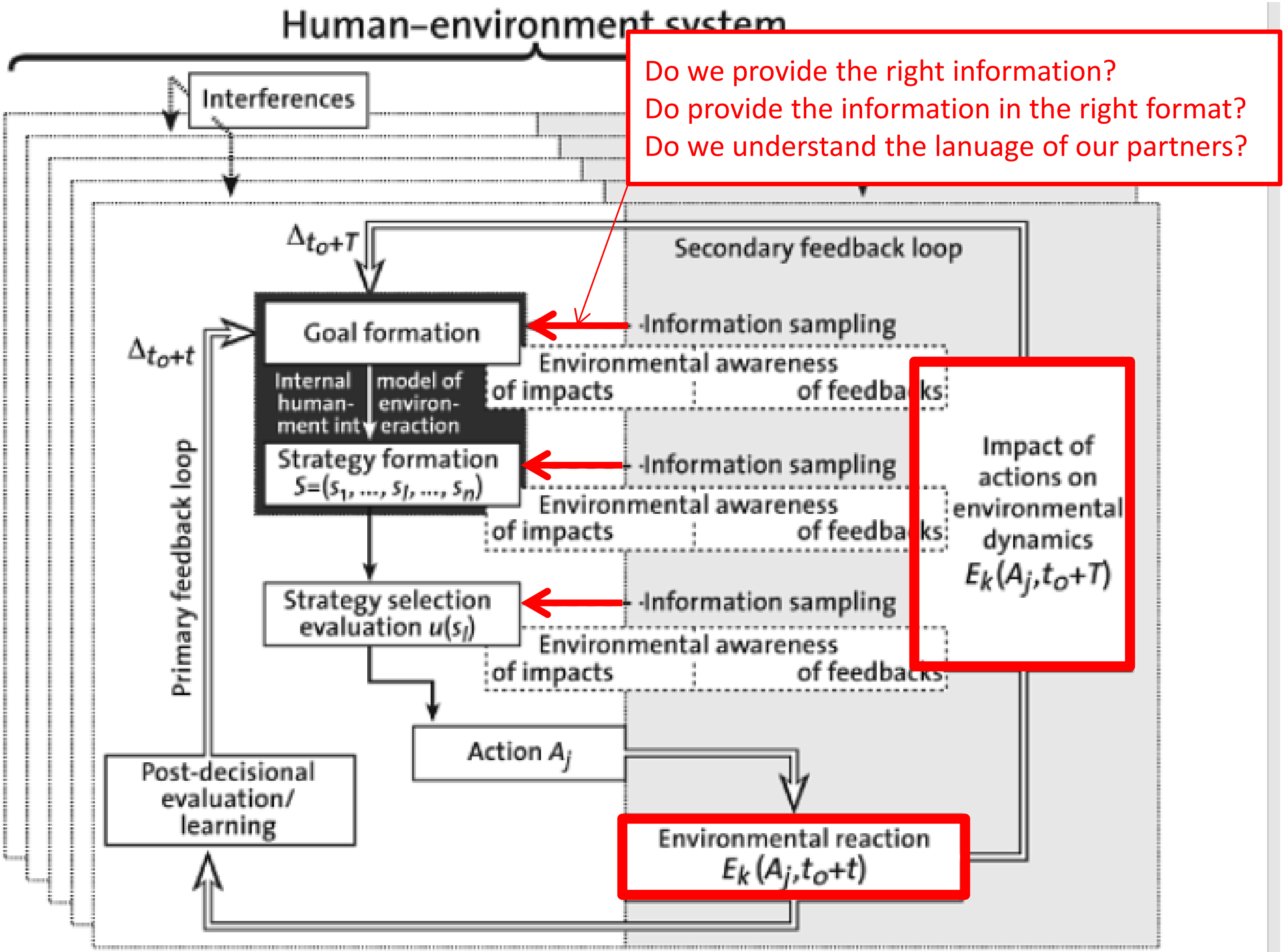
Future enhancements (2030…)

Development of ICOS



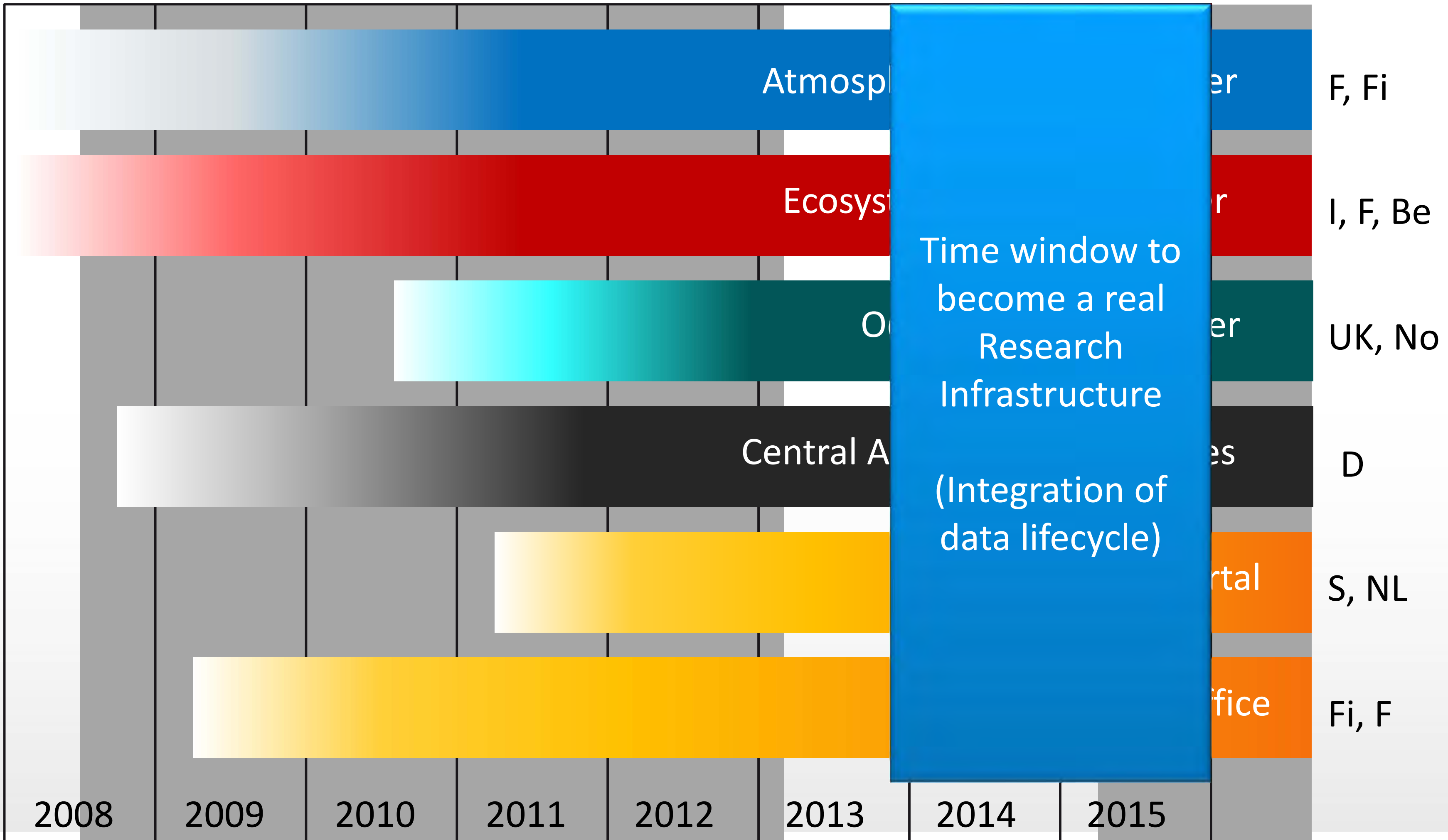
[courtesy J.D. Paris]

From information to knowledge (ability to act)



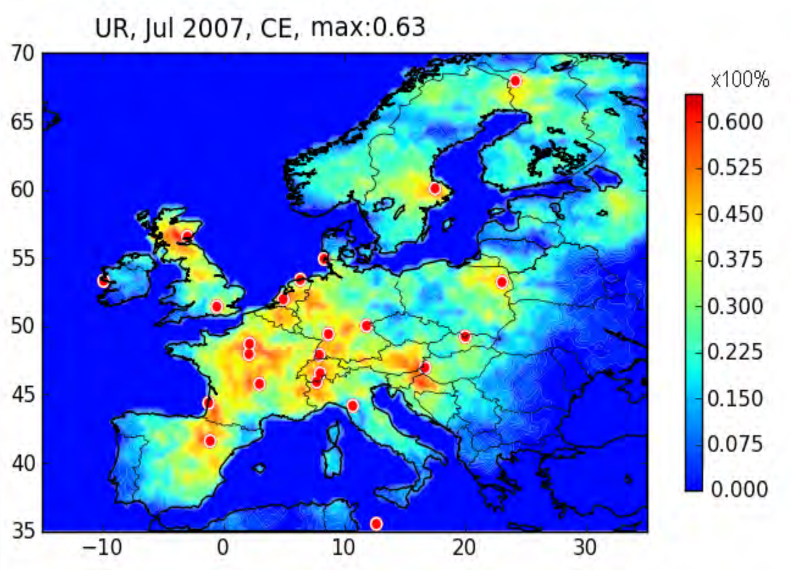
Environmental Literacy in Science and Society: From Knowledge to Decisions
By Roland W. Scholz, Claudia R. Binder

ICOS Central Facilities

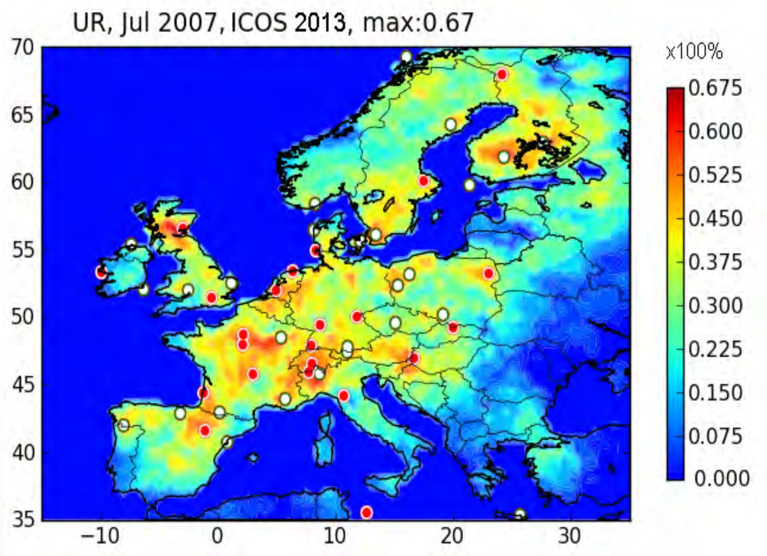


ICOS atmospheric stations and inverse modelling of CO_2 fluxes

ICOS 23 stations Europe



ICOS 50 stations Europe



Kadygrov et al. EGU 2013

Uncertainty reduction on CO_2 fluxes during the month of July 2007
red = CO_2 flux is better constrained

[courtesy J.D. Paris]

Sketch of the ICOS data structure (ecosystem network)

Instrument

Computer or other data storage and processing unit

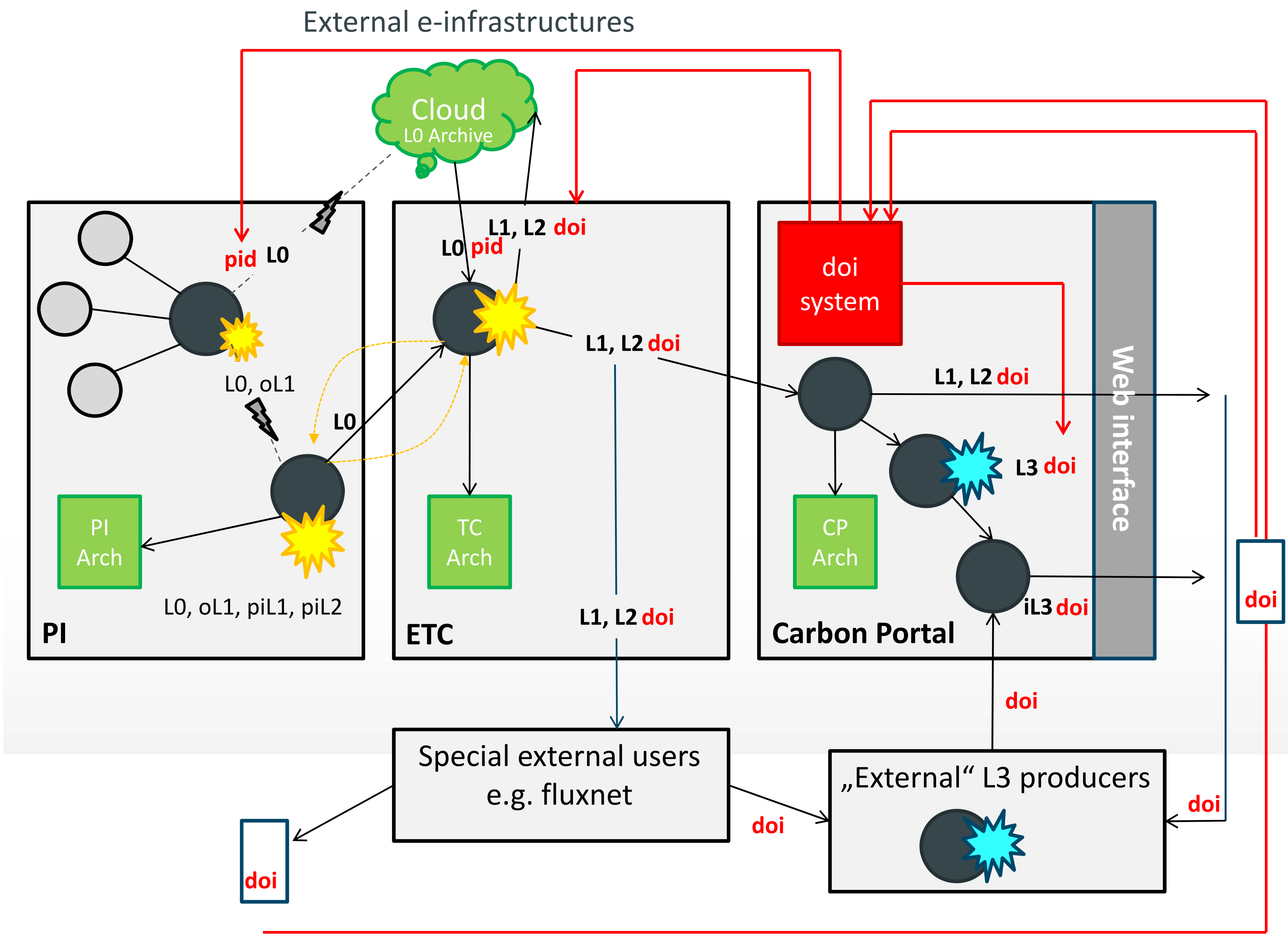
Data post-processing and QC

Data archive

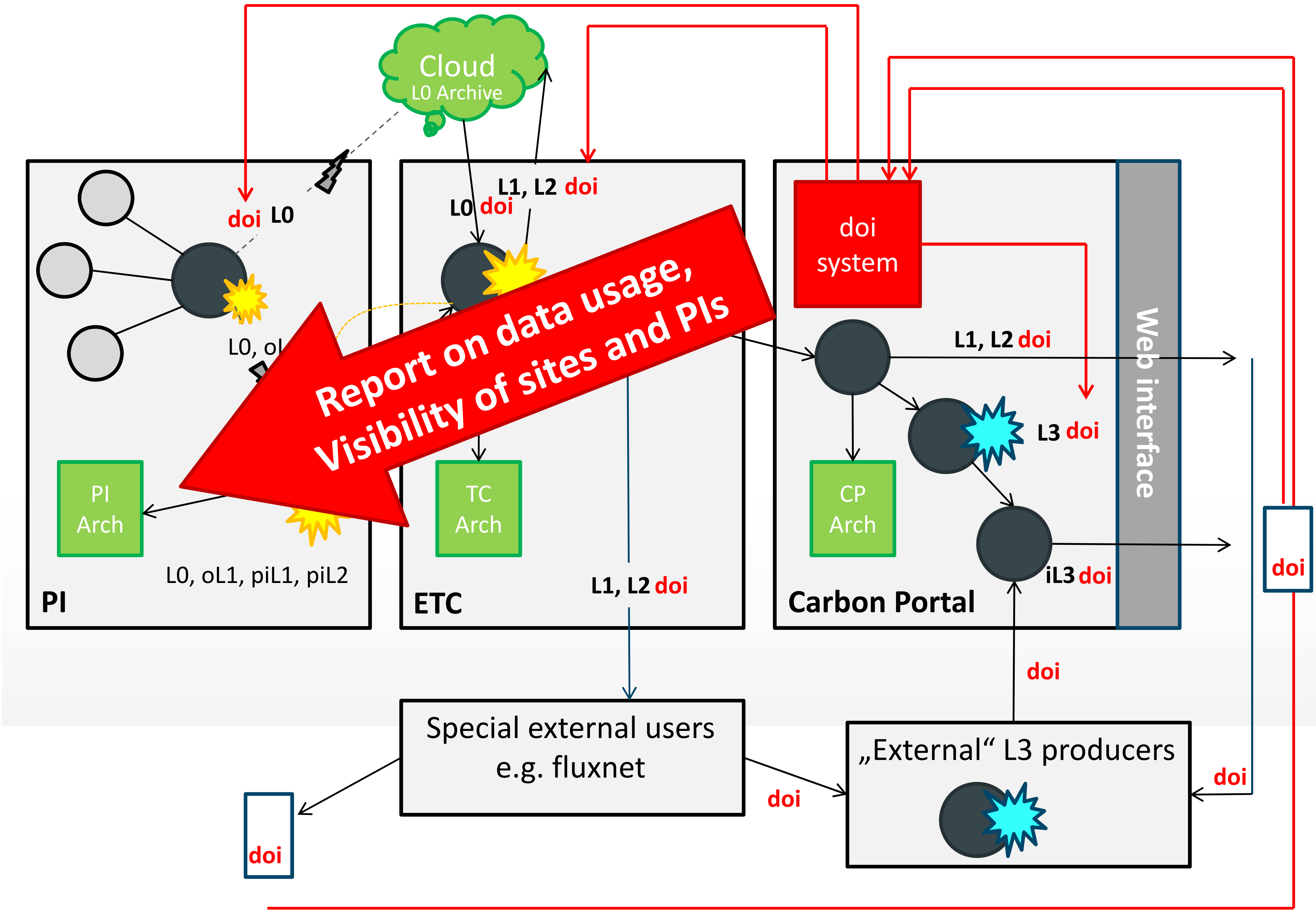
Data processing, usage for production of L3 products

Product, e.g. scientific publication or report

Feedback between PI and ETC



External e-infrastructures
Cloud
L0 Archive
pid
L0
L0, oL1
L0
PI
Arch
L0, oL1, piL1, piL2
PI
L0
pid
L1, L2
doi
L1, L2
doi
TC
Arch
L1, L2
doi
ETC
doi
system
L1, L2
doi
L3
doi
CP
Arch
iL3
doi
Carbon Portal
Web interface
doi
doi
Special external users
e.g. fluxnet
doi
„External“ L3 producers
doi
doi



Cloud
L0 Archive
doi L0
L0 doi
L1, L2 doi
doi
system
Report on data usage,
Visibility of sites and PIs
L0, oL
L1, L2 doi
L3 doi
Web interface
PI
Arch
TC
Arch
CP
Arch
L0, oL1, piL1, piL2
PI
ETC
L1, L2 doi
Carbon Portal
iL3 doi
doi
doi
Special external users
e.g. fluxnet
„External“ L3 producers
doi
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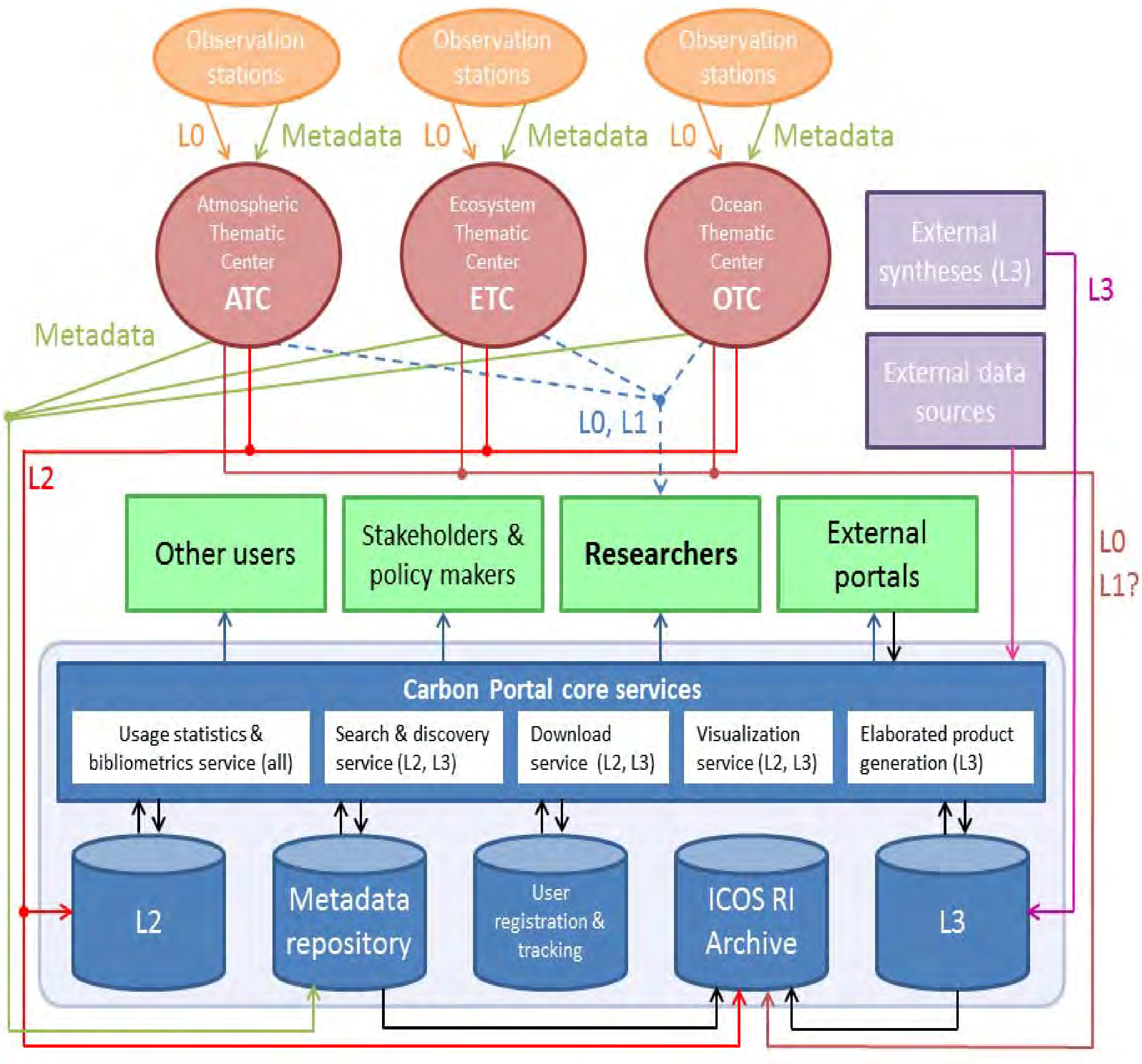
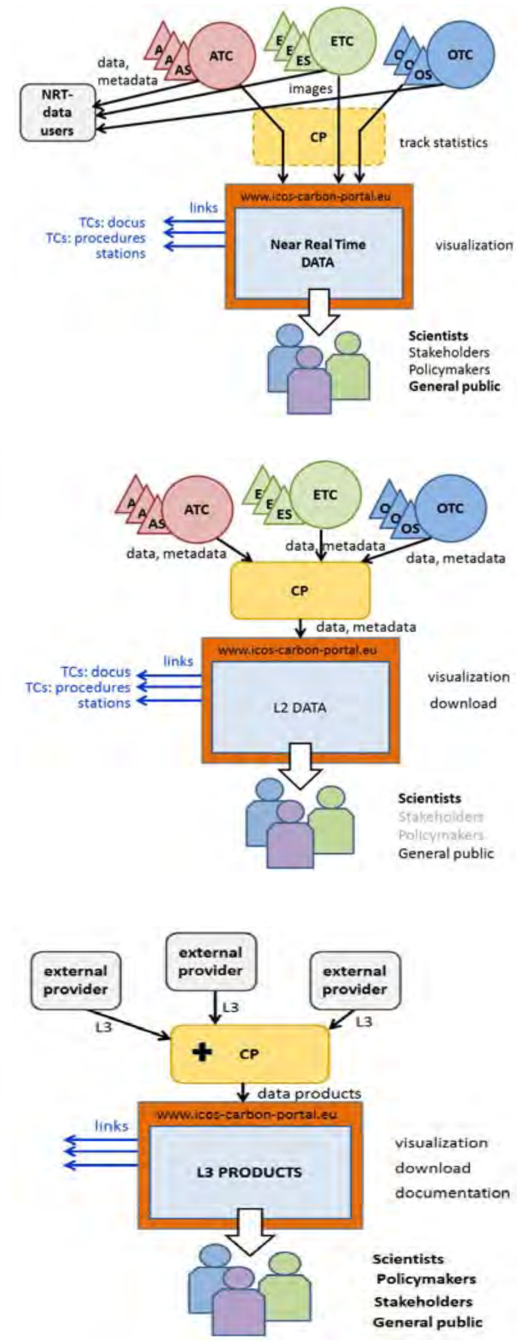
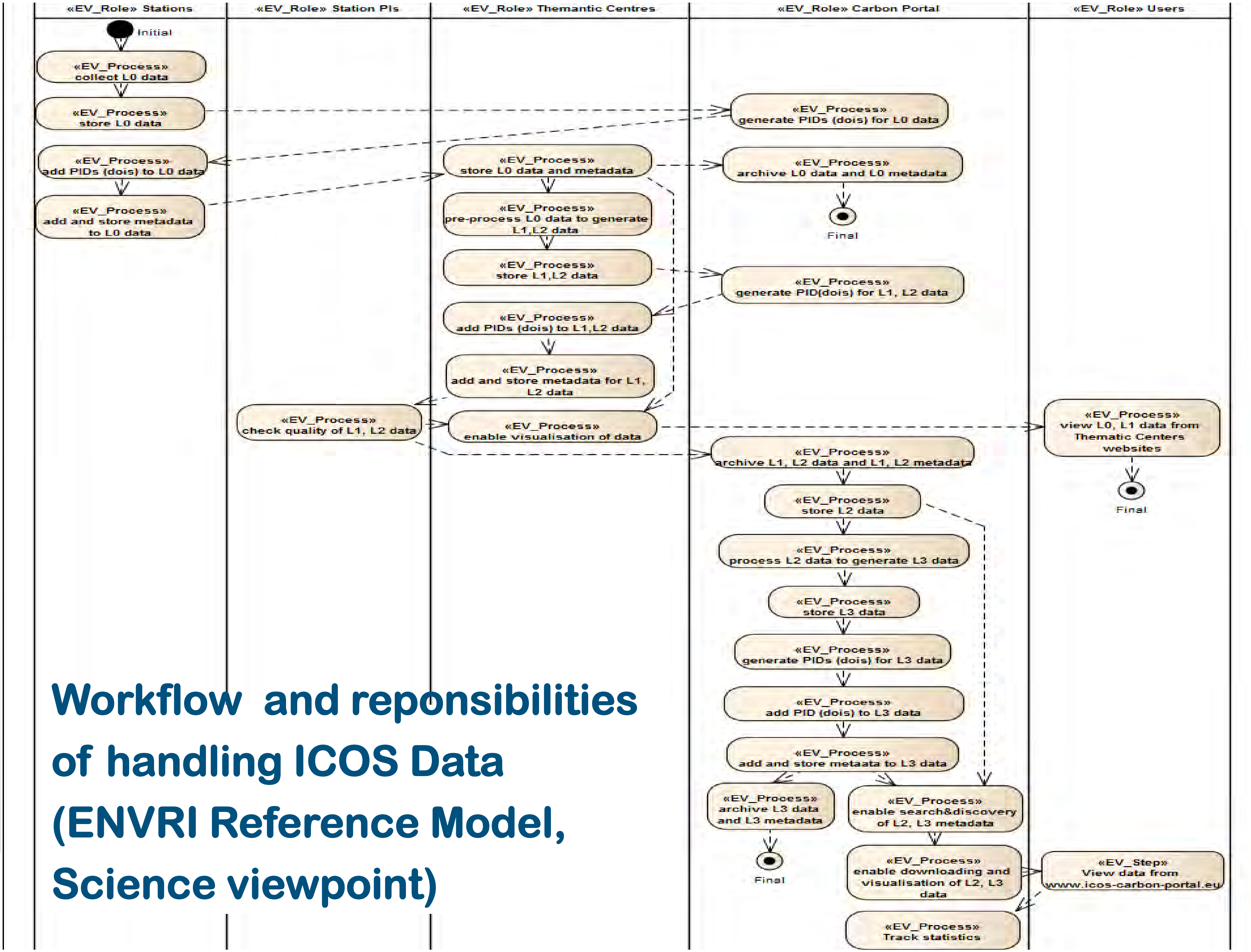
Identifying ICOS RI Workflow







Workflow and reponsibilities of handling ICOS Data (ENVRI Reference Model, Science viewpoint)

ENVRI Reference Model Information Viewpoint: *ICOS Data Lifecycle*