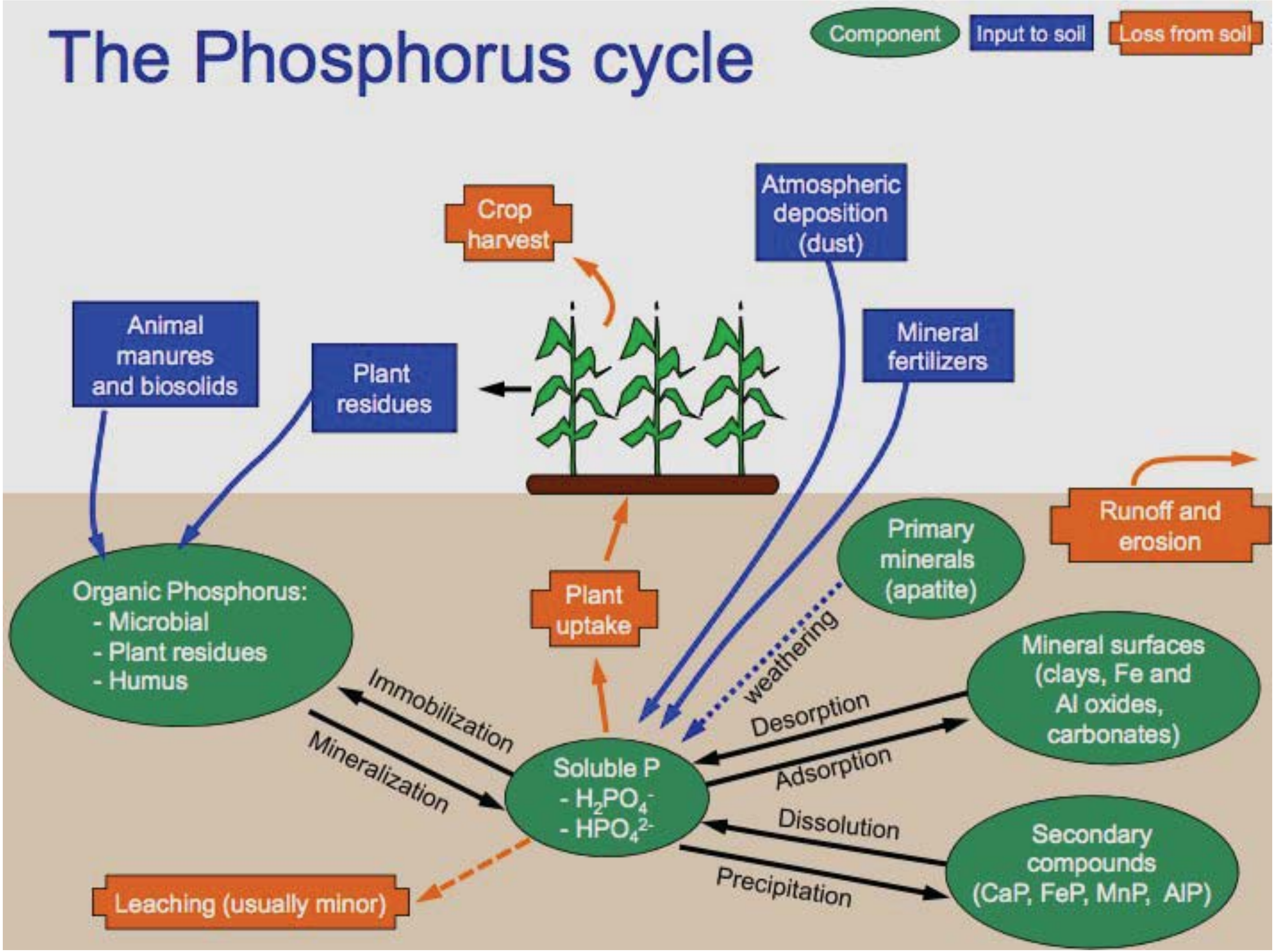
FINNISH METEOROLOGICAL INSTITUTE

Finnish Carbon Action pilot project

Jari Liski


The Phosphorus cycle
Component
Input to soil
Loss from soil
Crop harvest
Atmospheric deposition (dust)
Animal manures and biosolids
Plant residues
Mineral fertilizers
Runoff and erosion
Primary minerals (apatite)
Organic Phosphorus:
- Microbial
- Plant residues
- Humus
Plant uptake
weathering
Mineral surfaces (clays, Fe and Al oxides, carbonates)
Immobilization
Desorption
Mineralization
Soluble P
- $H_2PO_4^-$
- HPO_4^{2-}
Adsorption
Dissolution
Secondary compounds (CaP, FeP, MnP, AlP)
Precipitation
Leaching (usually minor)

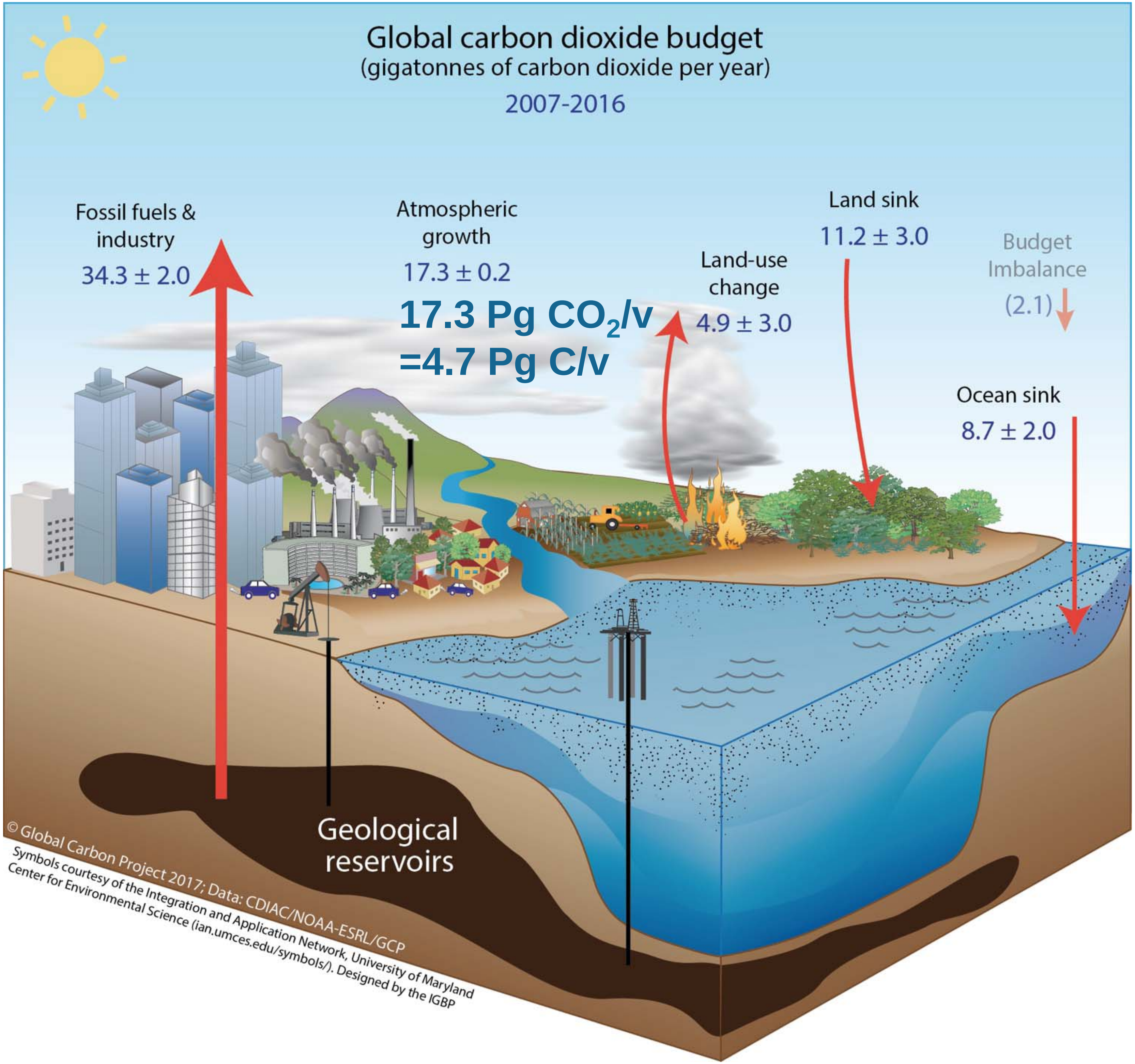
16.11.2017

Negative-emissions technology

What they don’t tell you about climate change

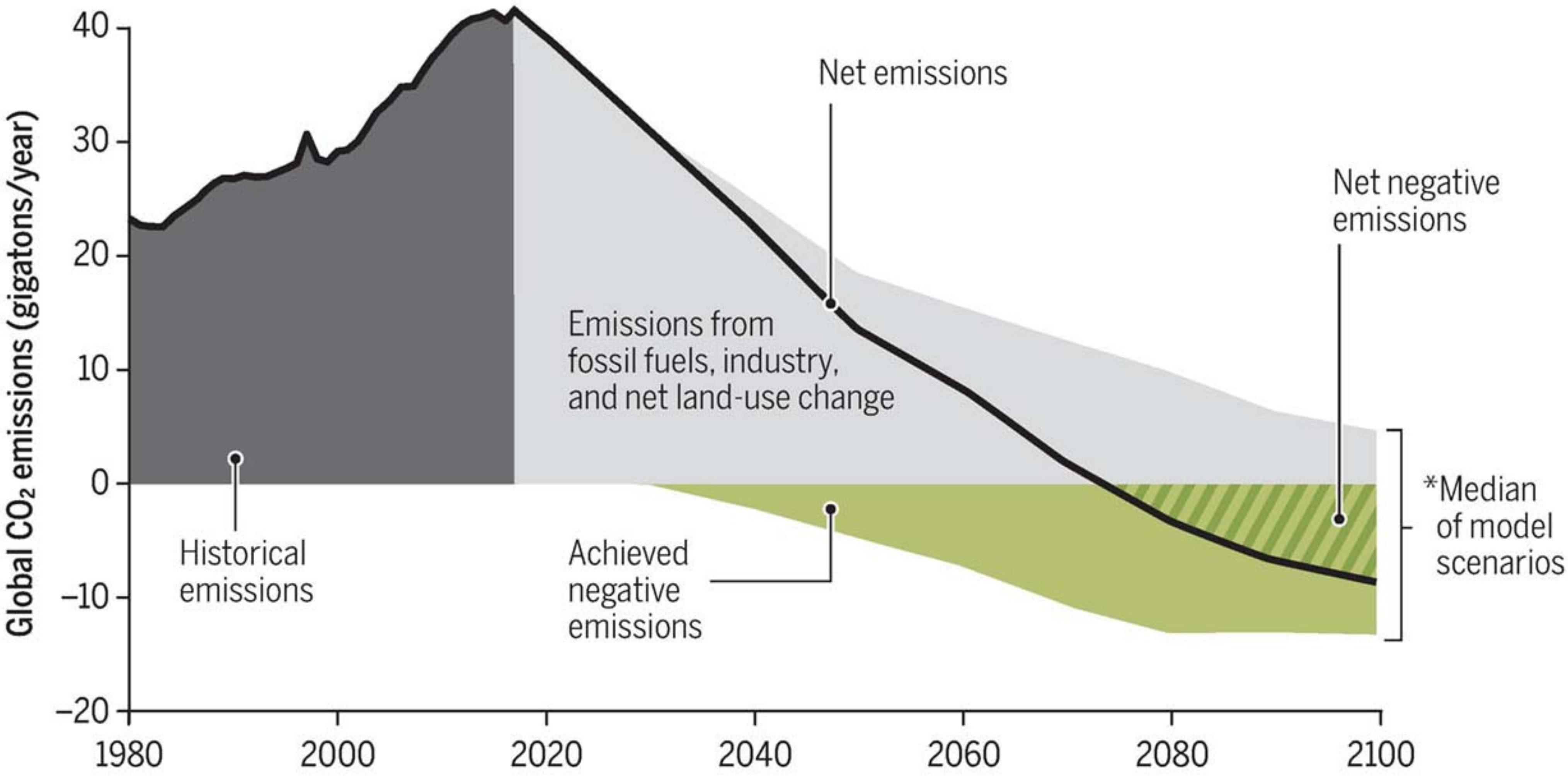
Stopping the flow of carbon dioxide into the atmosphere is not enough. It has to be sucked out, too

Jon Berkeley


Global carbon dioxide budget
(gigatonnes of carbon dioxide per year)
2007-2016
Fossil fuels & industry
34.3 ± 2.0
Atmospheric growth
17.3 ± 0.2
17.3 Pg CO_2/v
=4.7 Pg C/v
Land-use change
4.9 ± 3.0
Land sink
11.2 ± 3.0
Budget Imbalance
(2.1)
Ocean sink
8.7 ± 2.0
Geological reservoirs
© Global Carbon Project 2017; Data: CDIAC/NOAA-ESRL/GCP
Symbols courtesy of the Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/symbols/). Designed by the IGBP

A global unwinding

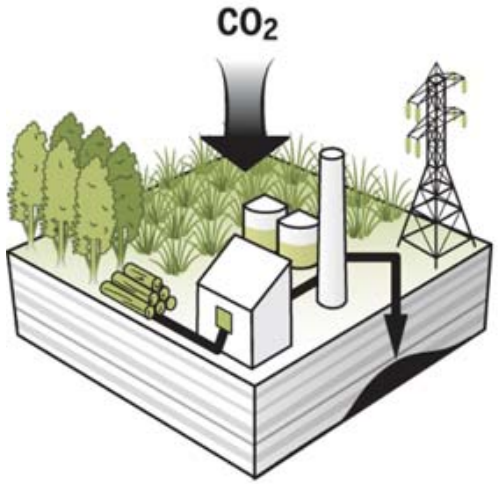
In order to prevent the world from warming more than 2°C, models count on the fast development of NETs. But many scientists question whether they can be scaled up in time.



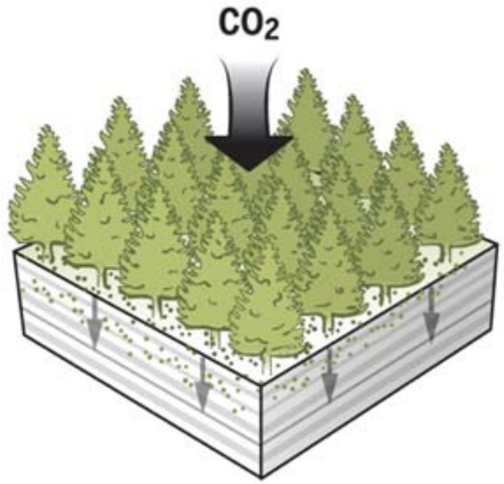
*Median values at 10-year time steps of 18 scenarios evaluated by six models using shared socioeconomic pathways assessed in the next report of the Intergovernmental Panel on Climate Change.

Rosen. 2018. Science.

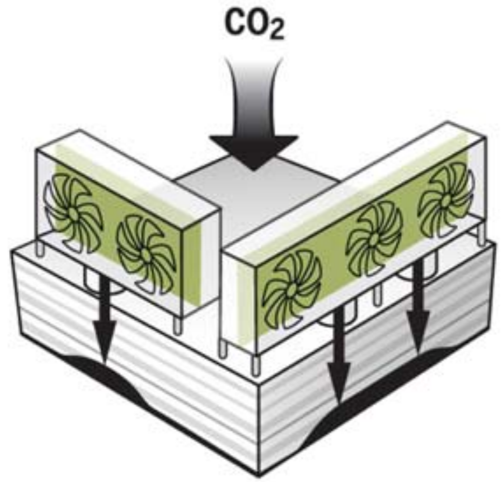
Six ways to pull CO_2 out of the air



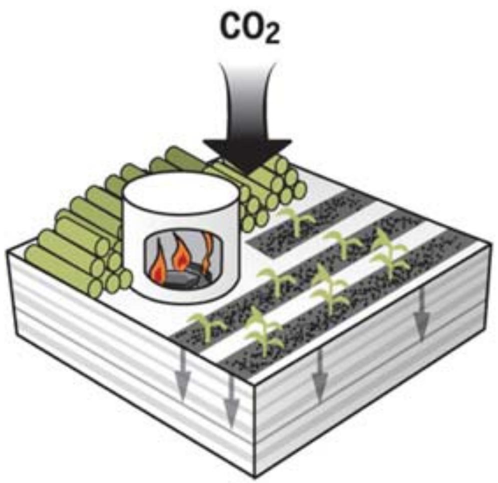
BECCS
Fast-growing plants are harvested and burned to make energy. Exhaust carbon is captured and piped underground.



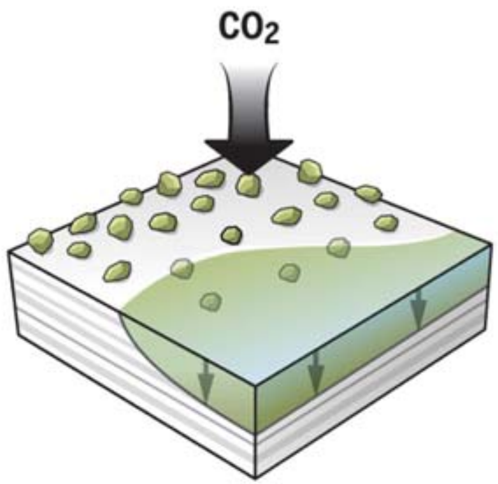
Forestation
Planted trees capture CO_2 as they grow. The carbon remains sequestered as long as forests are not cut down.



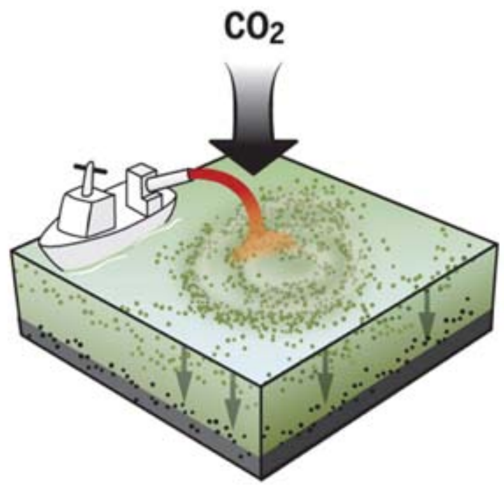
Direct air capture
CO_2 in air selectively "sticks" to chemicals in filters. Filters are reused after releasing pure CO_2, which can be stored underground.



Biochar and soil sequestration
Charring biomass stores carbon in soil by making it resistant to decomposition. Altered tilling practices also enhance CO_2 storage.



Enhanced weathering
When spread across fields or beaches and wetted, crushed silicate minerals like olivine naturally absorb CO_2.



Ocean fertilization
Injections of nutrients like iron spur phytoplankton blooms, which absorb CO_2. When they die, they take the carbon to the sea floor.

Rosen. 2018. Science.

Table 2 Summary of strengths, weaknesses and uncertainties of NETs (refer to text and annexes for details)

	AR	LM	BECCS	EW	DACCS	OIF	CCS
Technical status	Existing	Existing	Demonstration	Research	Demonstration/ commercial	Research	Commercial and demonstration
Potential in literature (Gt C/year)	1.1–3.3	2–3	3.3	1	3.3+	<1	4+
Cost	L	L	M	M	M/H	L/H	L
Is the amount of CO_2 removed consistent across different applications?	Case specific	Yes	Case specific	Rate uncertain	Yes	Uncertain	Yes
Carbon removal secure in long-term?	Vulnerable (1)	Vulnerable (2)	Vulnerable (1)	Yes	Yes (3)	Uncertain	Yes (3)
Possible reverse effects on climate? (4)	Yes	No	Yes	No	No	Yes	No
Large ecosystems and biodiversity effects likely	Yes	No	Yes	Uncertain	No	Yes	No

AR, afforestation and reforestation; LM, land management; EW, enhanced weathering. Approximate costs: L, less than €100/tCO_2; M, €100–400/tCO_2; H, more than €400/tCO_2. Notes: (1) To climate change, fires, pests, diseases, forestry policy changes. (2) Warming increasing soil respiration, return to intensive agriculture. (3) On assumption that secure geological sites used for storage. (4) For example, release of other GHGs, effects of land use change, albedo. **N.B.: this table is to assist in highlighting the strengths and weaknesses of the various NETs and should only be used as a guide to the main issues identified in the text and annexes, not as a definitive summary of this analysis.**

EASAC 2018

4 PER 1000

CARBON SEQUESTRATION IN SOILS FOR FOOD SECURITY AND THE CLIMATE

The quantity of carbon contained in the **atmosphere** increases by **4.3** billion tons every year

+4.3 bn tons carbon / year

CO_2 emissions

Forests ⊖⊖

Oceans ⊖⊖

Human activities ⊕⊕⊕⊕

Deforestation ⊕

⊖ *absorption* ⊕ *emission*

The world's **soils** contain **1 500** billion tons of carbon in the form of organic material

absorption of CO_2 by plants

storage of organic carbon in soils

1 500 bn tons carbon

If we increase by 4‰ (0.4%) a year the quantity of carbon contained in soils, **we can halt the annual increase in CO_2 in the atmosphere,** which is a major contributor to the greenhouse effect and climate change

increased absorption of CO_2 by plants:

farmlands, meadows, forests…

+4‰ carbon storage in the world's soils

= more fertile soils

= soils better able to cope with the effects of climate change

HOW CAN SOILS STORE MORE CARBON?

The more soil is covered, the richer it will be in organic material and therefore in carbon.
Until now, the combat against global warming has largely focused on the protection and restoration of forests.
In addition to forests, we must encourage more plant cover in all its forms.

- *Never leave soil bare and work it less, for example by using no-till methods*
- *Introduce more intermediate crops, more row intercropping and more grass strips*
- *Add to the hedges at field boundaries and develop agroforestry*
- *Optimize pasture management – with longer grazing periods, for example*
- *Restore land in poor condition e.g. the world's arid and semi-arid regions*

*"This international initiative can reconcile the aims of **food security** and the **combat against climate change,** and therefore engage every concerned country in COP21."*

Stéphane Le Foll, French Minister of Agriculture, Agrifood and Forestry

Climate-smart soils

Science and technology

Basic research on soil–plant processes

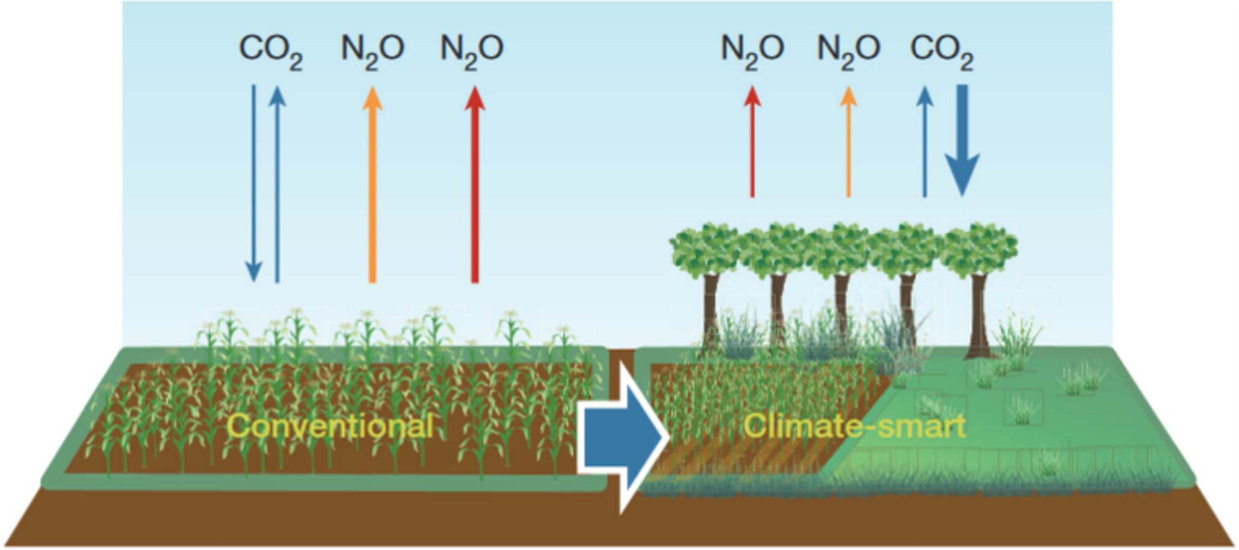
Research measurement networks

Soil monitoring networks

Advanced greenhouse gas networks

Remote sensing

Spatial databases and model integration



Practices

Reduced tillage

Biochar

Land restoration

Improved crop rotations

Organic amendments

Nutrient management

Cover crops

Agroforestry

Implementation

National and international greenhouse gas mitigation programme

Greenhouse gas offset and ecosystem service markets

Agricultural product supply chain management

Decision-support systems

Land-user engagement

“*Expanding the role of agricultural soil GHG mitigation will require an integrated research support and implementation platform*”

Paustian ym. 2016. Nature.


BALTIC SEA
ACTION GROUP
HOME
SUOMEKSI
CARBON
ACTION
CLIMATE - SOIL - BALTIC SEA
carbonaction.org

Carbon Action

- Brings together and conducts top research.
- The aim is to find out
  - How carbon is sequestered in soils,
  - How to verify sequestration, and
  - What are the types of agricultural practices which speed up the carbon sequestration.
- This information is critical for mitigating climate change presently, since simply cutting down emissions is not enough.
- Research in Carbon Action is done in cooperation with the farmers registered in the project

ILMATIETEEN LAITOS

SITRA

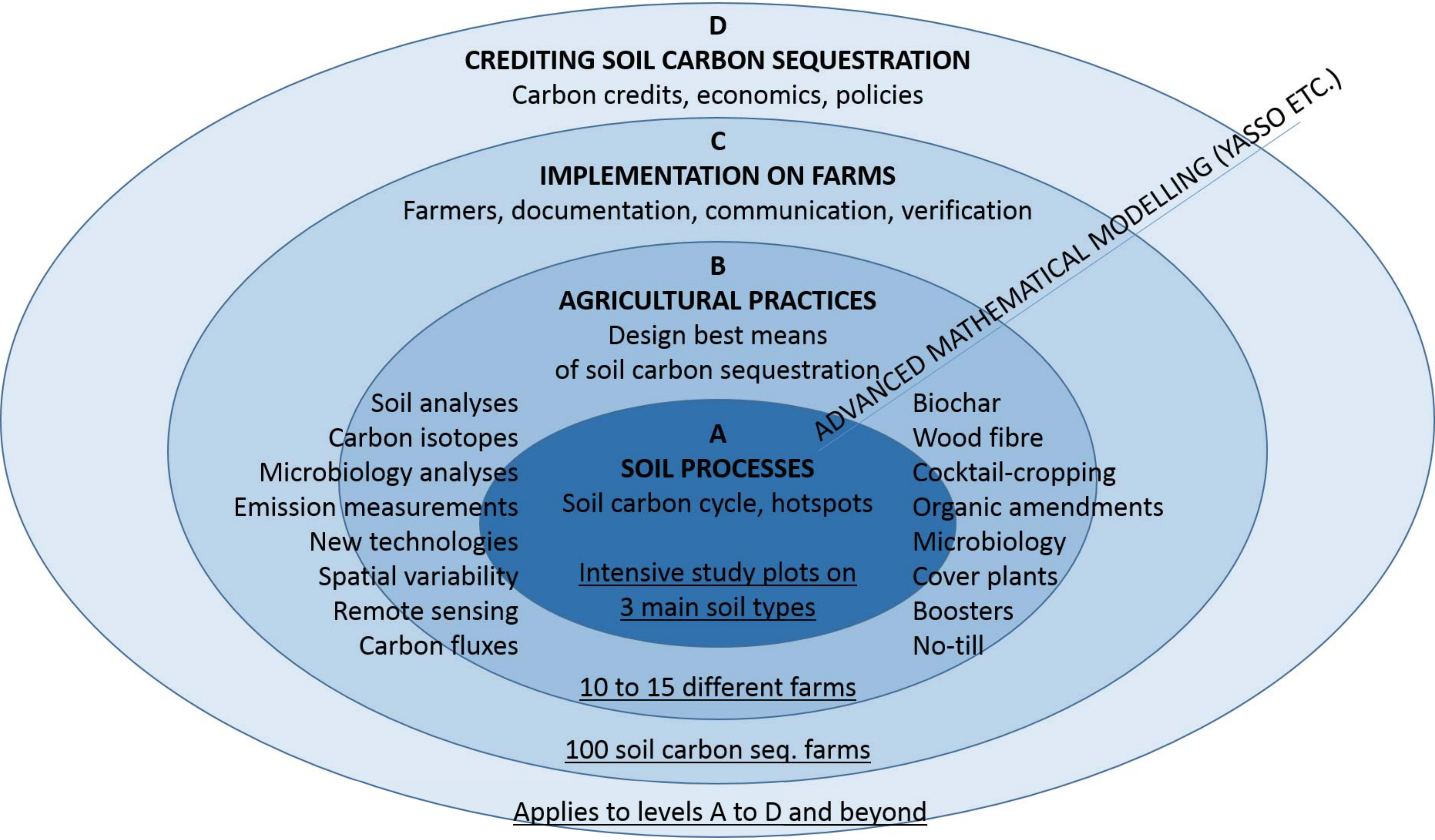
Luke
LUONNONVARAKESKUS

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

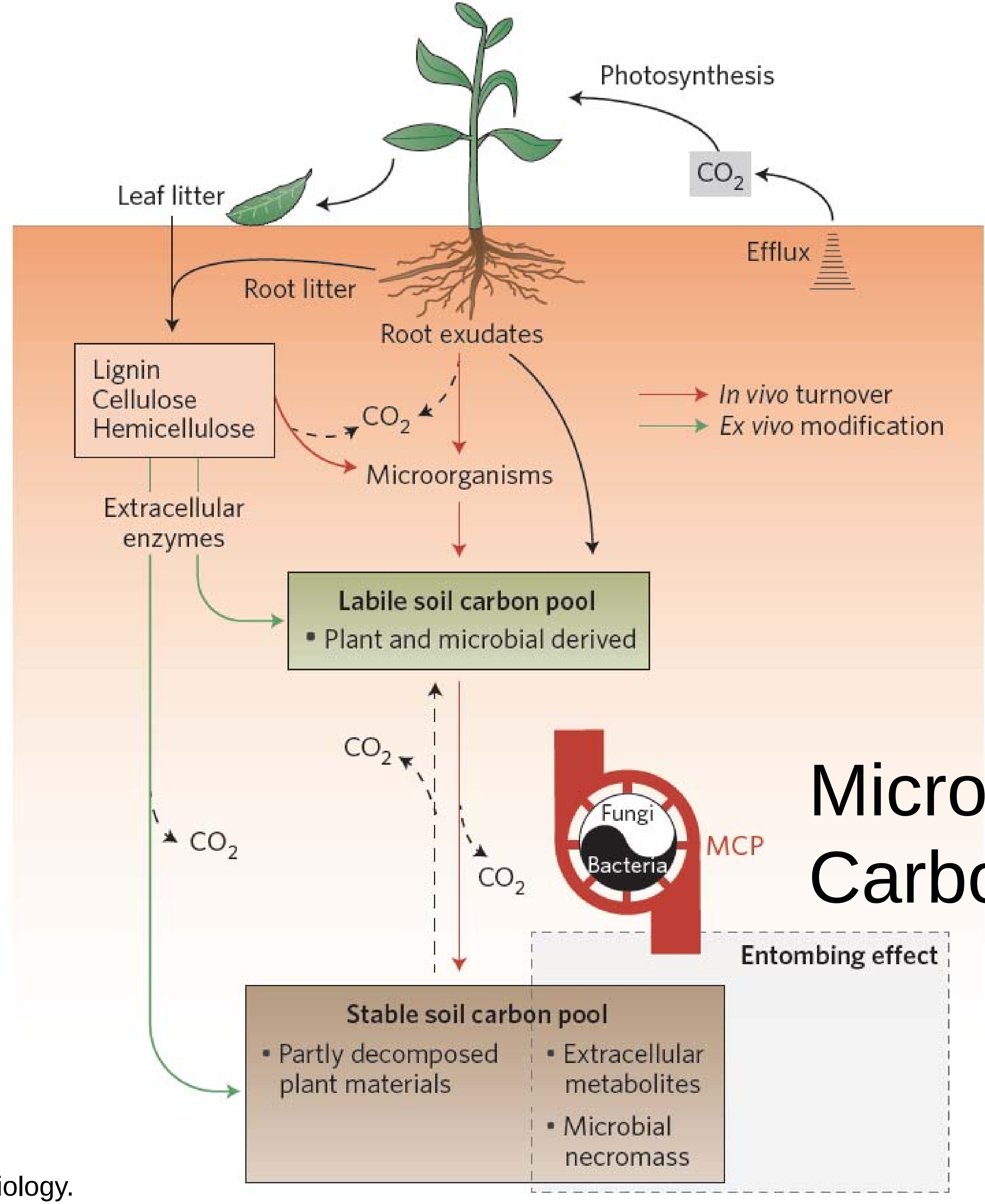
BSAG®
Baltic Sea Action Group

SYKE

New researchers are welcomed to join!



BSAG ja Ilmatieteen laitos 2017



Microbial Carbon Pump

Liang ym. 2017. Nature Microbiology.

Soil process research


KOE 716
Karike
Koealat 1-3
Ruskeat lehdet
15.10.2002
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IN ENGLISH
CARBON
ACTION
ILMASTO - MAAPERÄ - ITÄMERI

Kuva: Retu Liikanen / Yle

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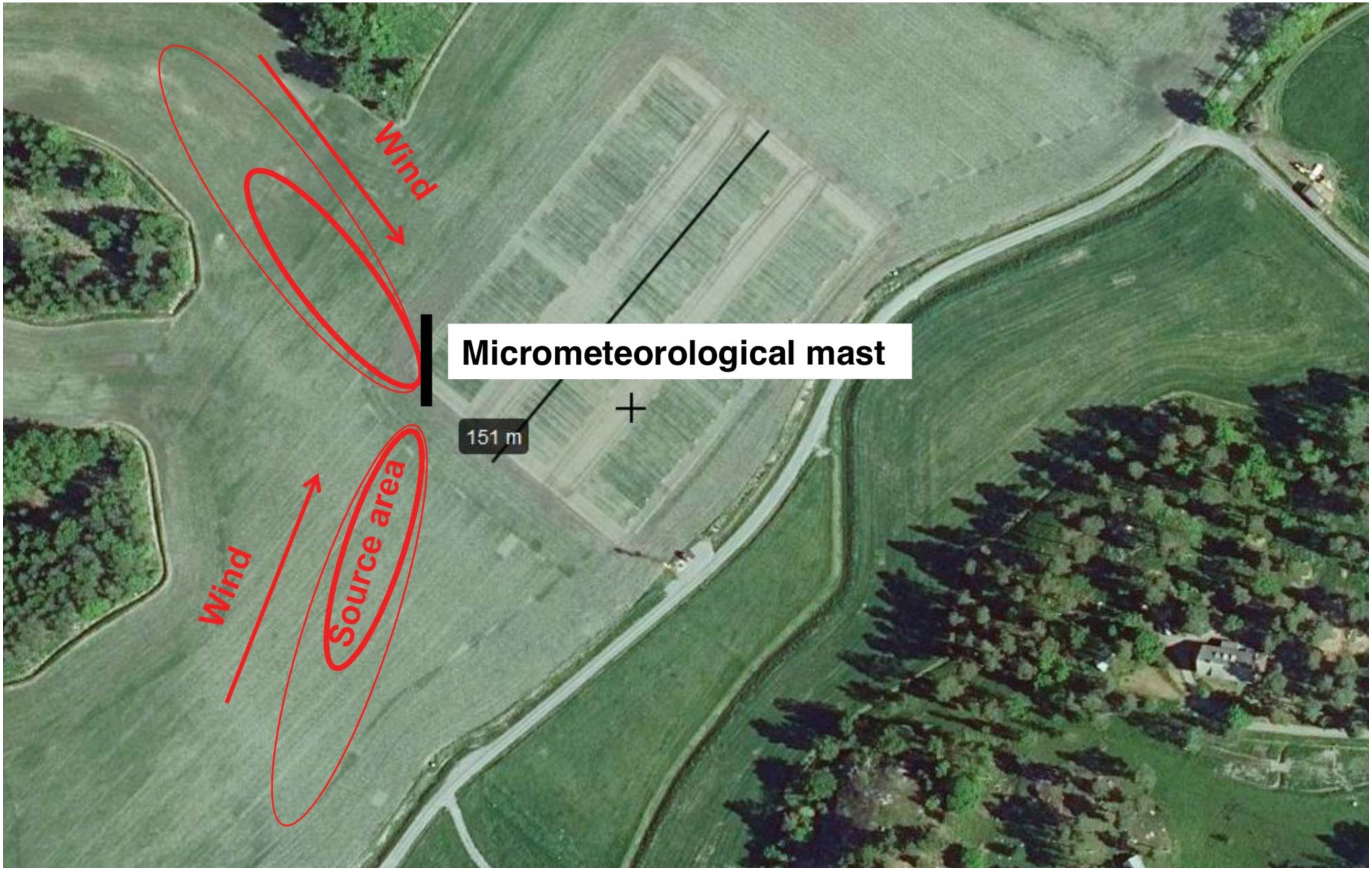
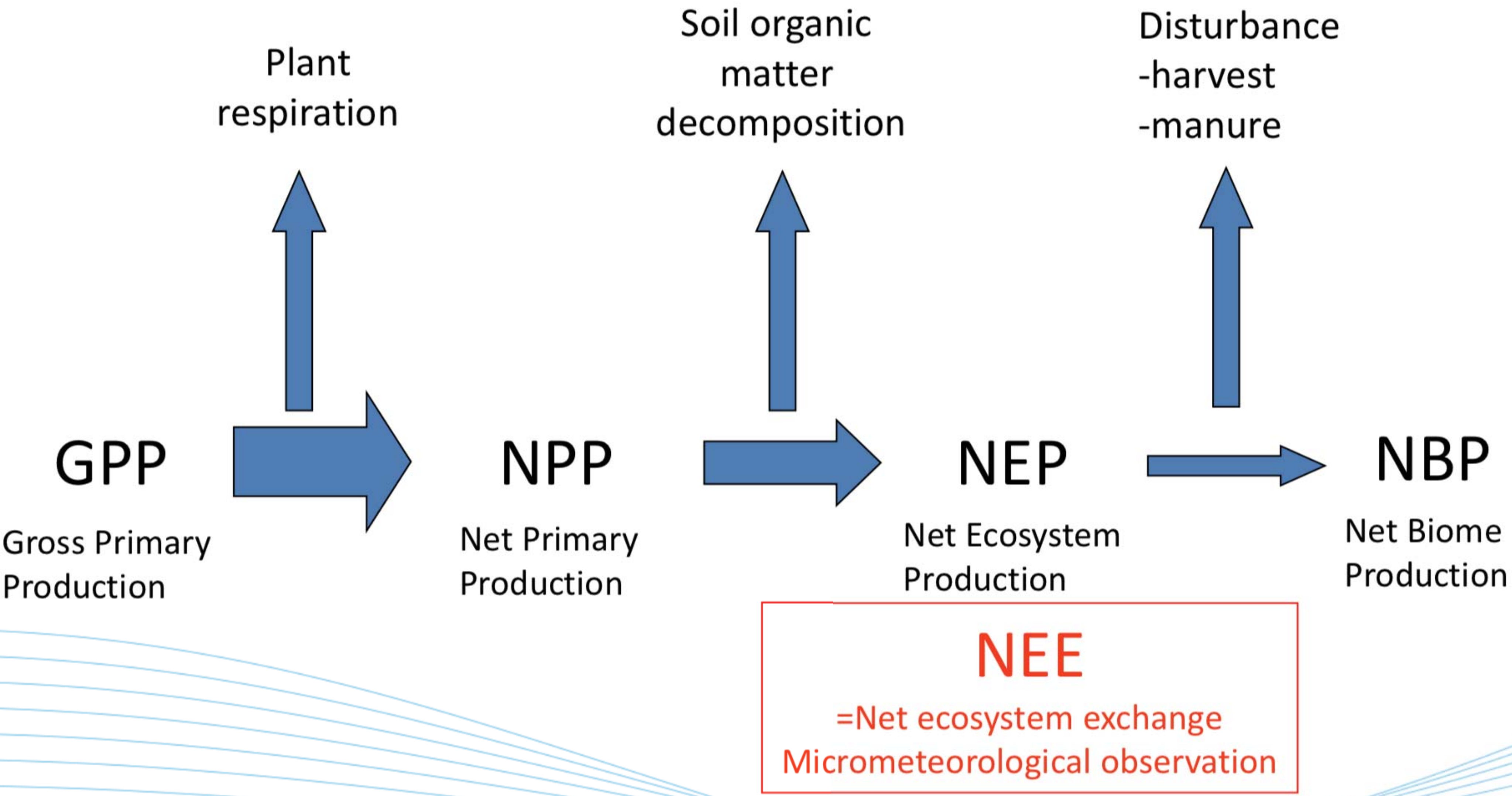
Micrometeorological measurement

- We observe source area upwind.
- Dimensions depend on the turbulent structure of the flow and measurement height



The carbon budget of an ecosystem

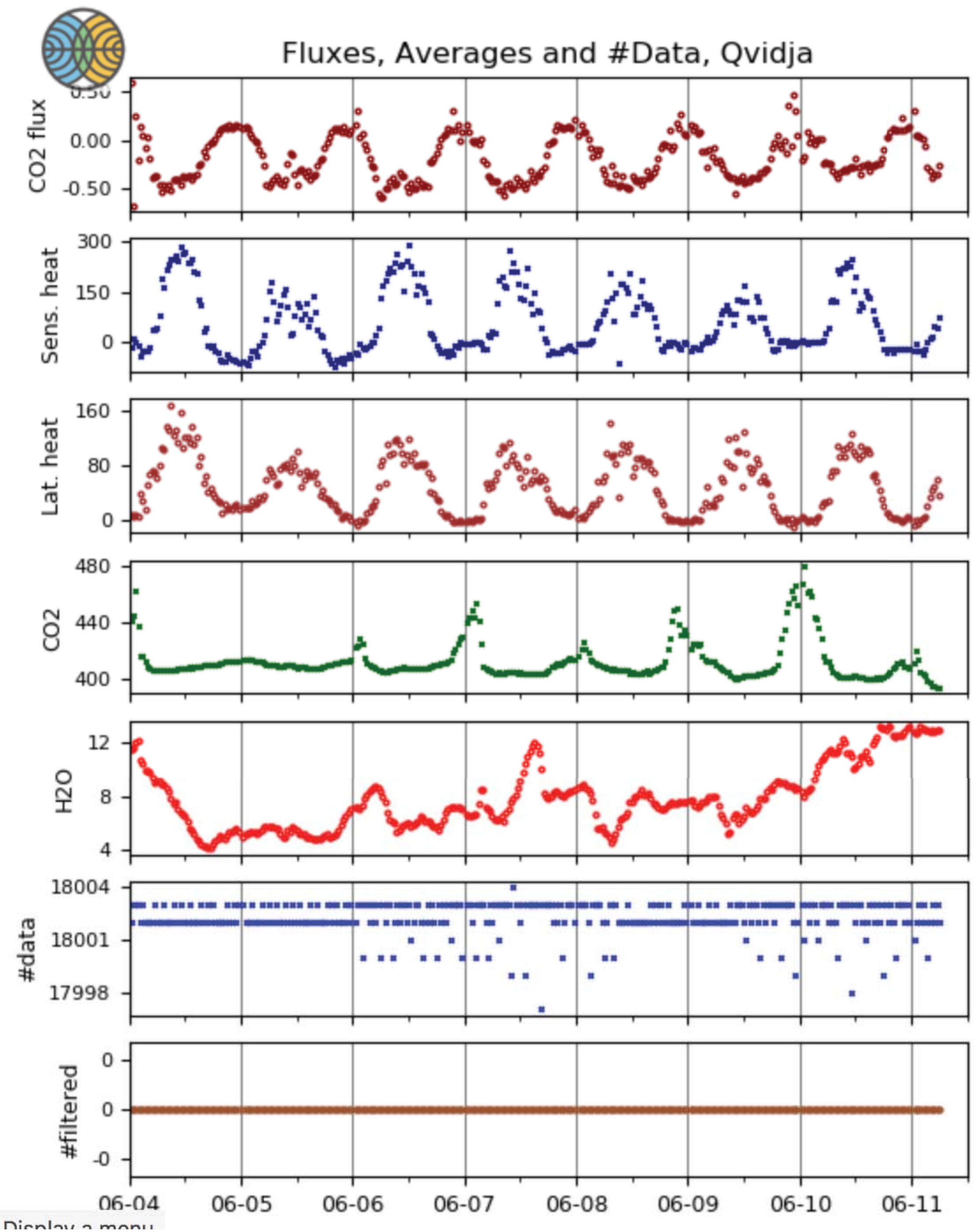


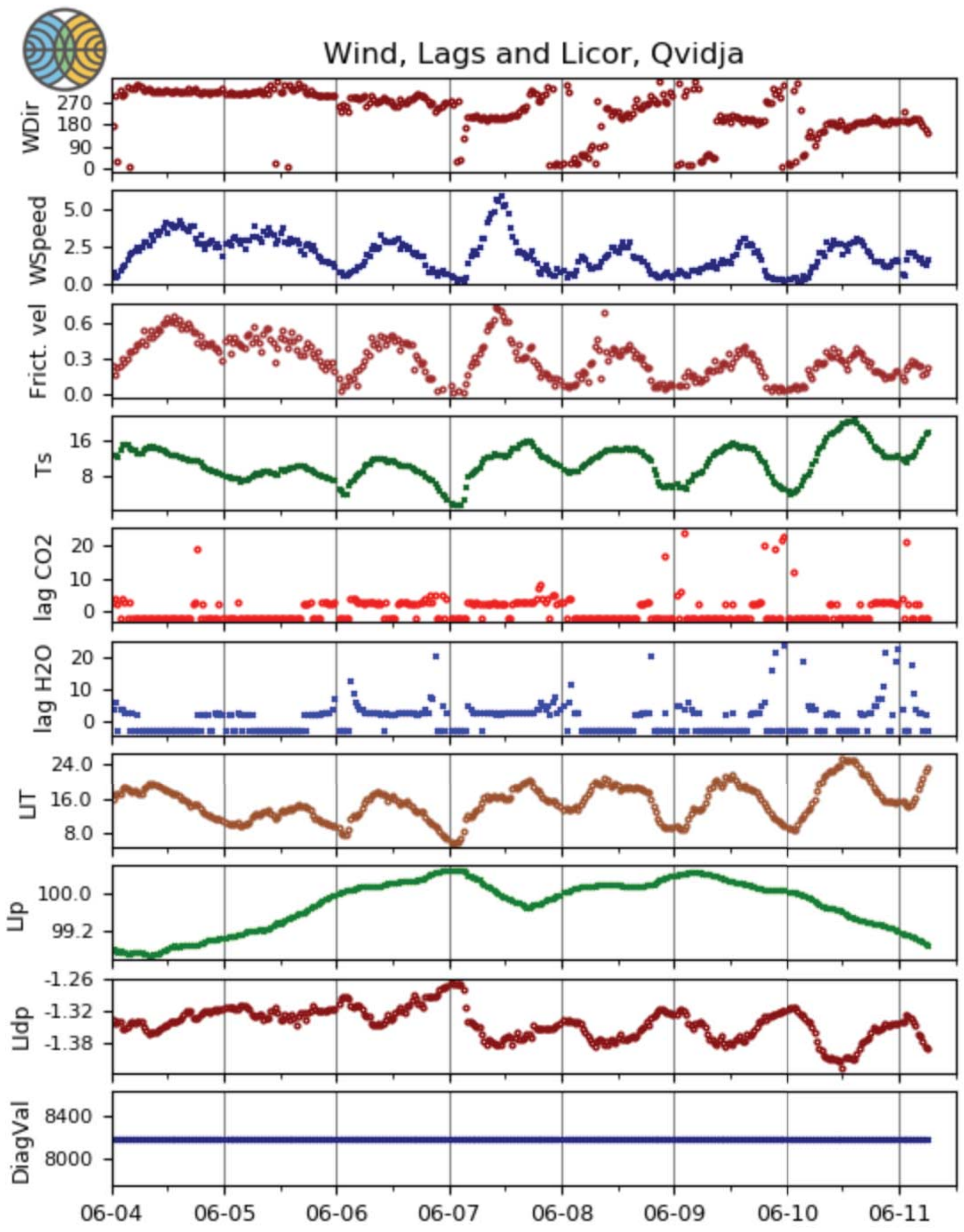
NEE = GPP + Rtot

Rtot = Respiration (plant + soil)

Qvidja data plots

data

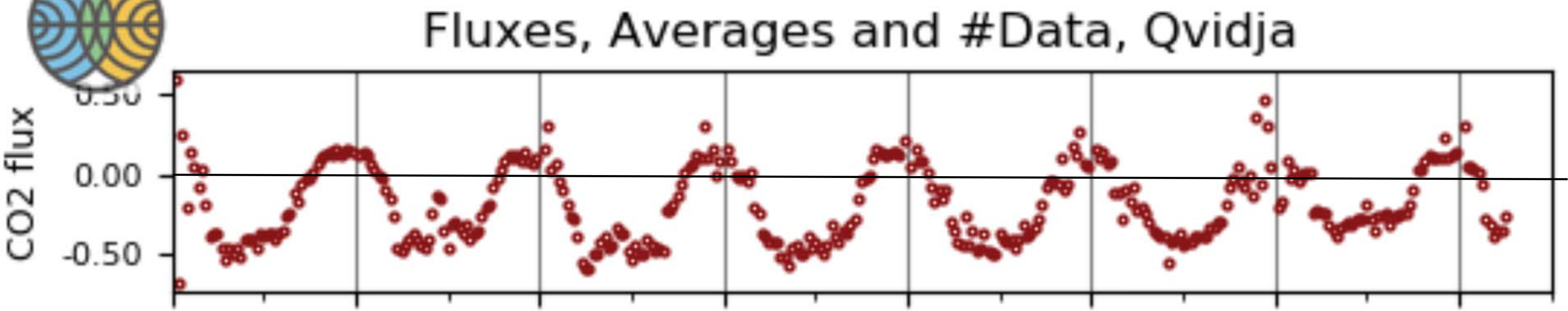




Display a menu

Qvidja data plots

data



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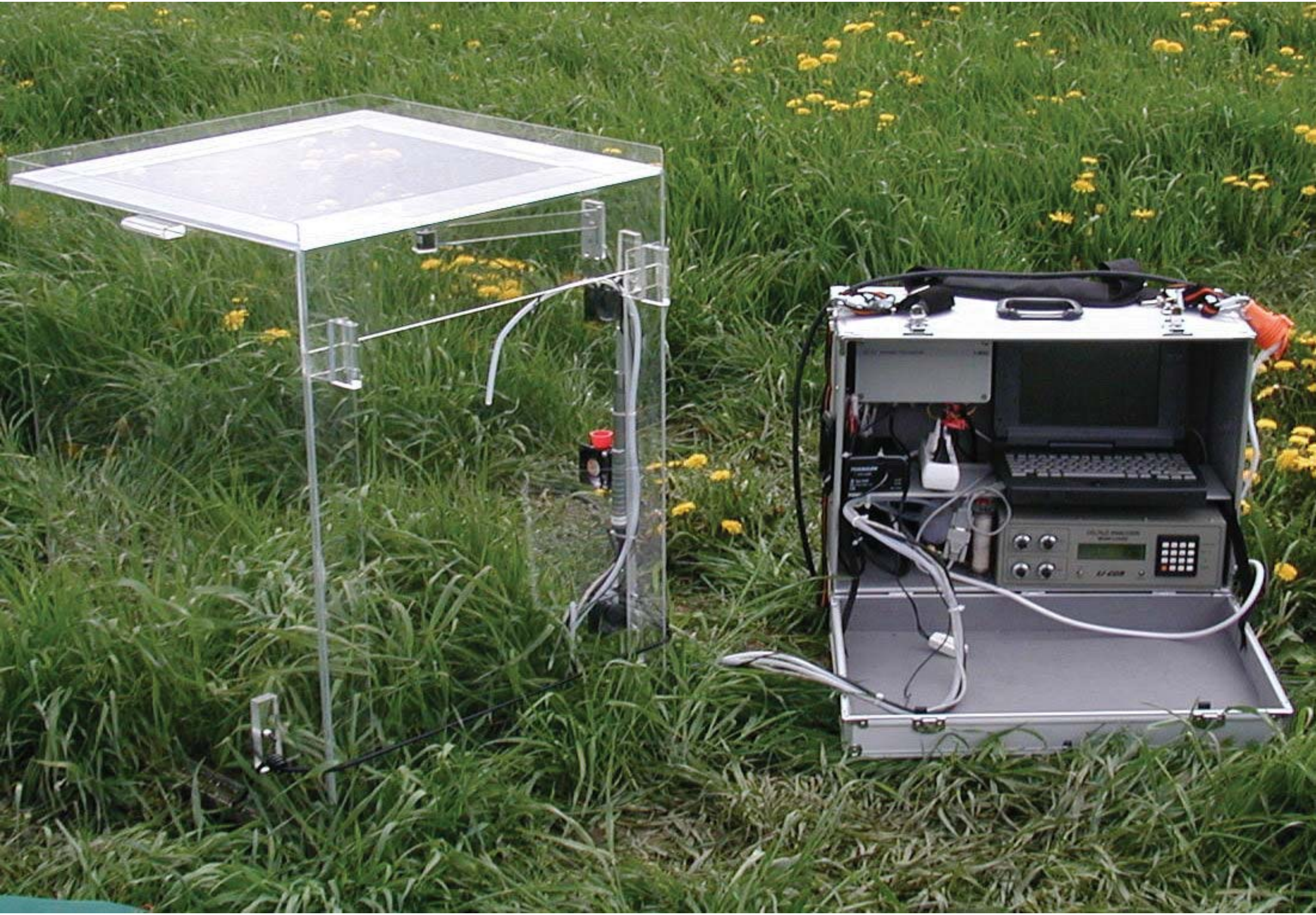
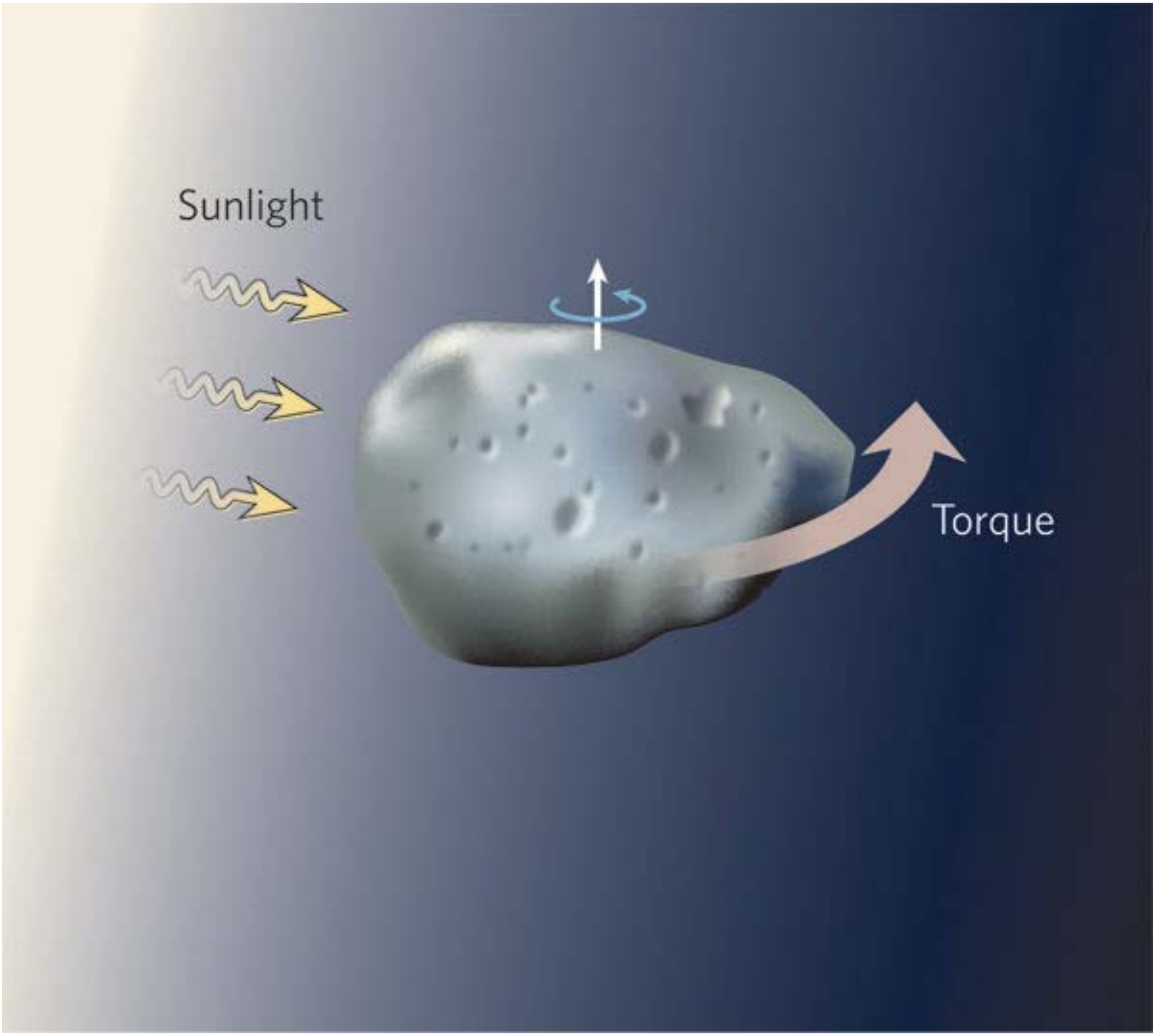
Treatments

1) untreated, 2) 80 kg N/ha
3) 120 kg N/ha,
4) Ravinnekuitu, 5) Nollakuitu,
6) Pajubiohiili, 7) Kuusibiohiili,
8) Sulfaattiligniini, 8) Maanparannusturve, 10) Peittauskontrolli,
11) Humusvesi, 12) Lignosulfonaatti,
13) Sikalaliete + Combooster,
14) Ravinnekuitu + Combooster ja 15) Nollakuitu + Combooster

Koekenttä syksyllä 2016 maanparannusaineiden levityksen jälkeen.

Kenttäkoe kuvattuna dronella 6.7.17.





Kaasalainen ym. 2007. Nature.

Anglada-Escude ym.
mm. Tuomi 2016. Nature.

Soil carbon model Yasso

Applications

- Other modelling systems, incl. Max Planck –institute Earth System model
- UNFCCC National greenhouse gas inventories in 9 European countries
- Research arcticles ca. 180
- Doctoral thesis 13

Soil carbon model - Yasso

Dynamic model of the cycling of organic carbon in soil. Yasso calculates the amount of soil organic carbon, changes in the amount of soil organic carbon and heterotrophic soil respiration. Current applications of Yasso include earth system modeling, global climate simulations, greenhouse gas inventories and research on land ecosystems and climate change.

Photo: Konsta Punkka

Contact

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8.2.2017

Tweets

Jari Liski
@JariLiski

Expanding #Yasso #soil model use in European #LULUCF #forest carbon monitoring, our @FACCE_ERAGAS project kick-off @UniNMBU this week bit.ly/2rA6SKD #climatechange

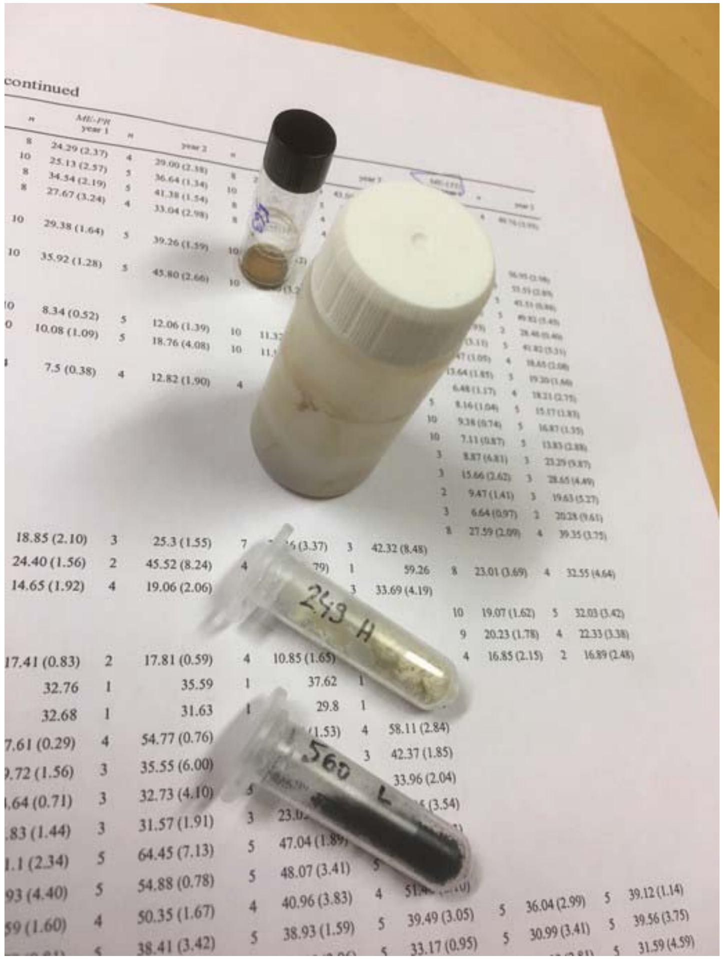
Nov 15, 2017

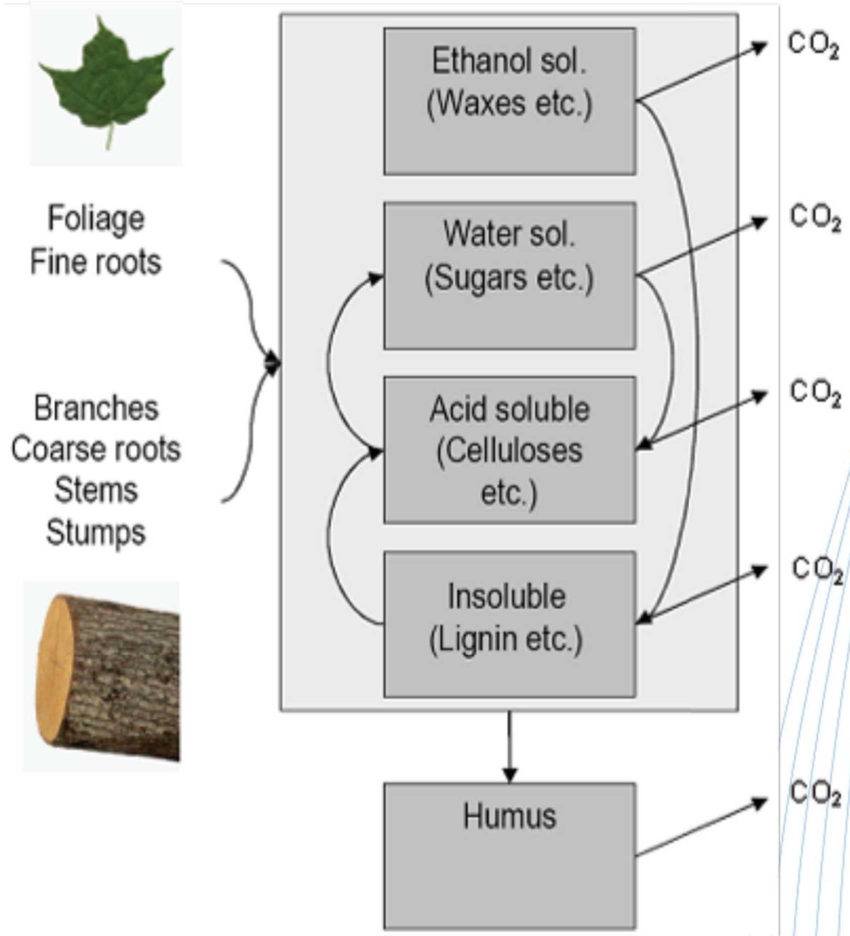
Jari Liski
@JariLiski

Can we model carbon sequestration in agricultural #soil? @IlmaTiede

http://en.ilmatieteenlaitos.fi/yasso

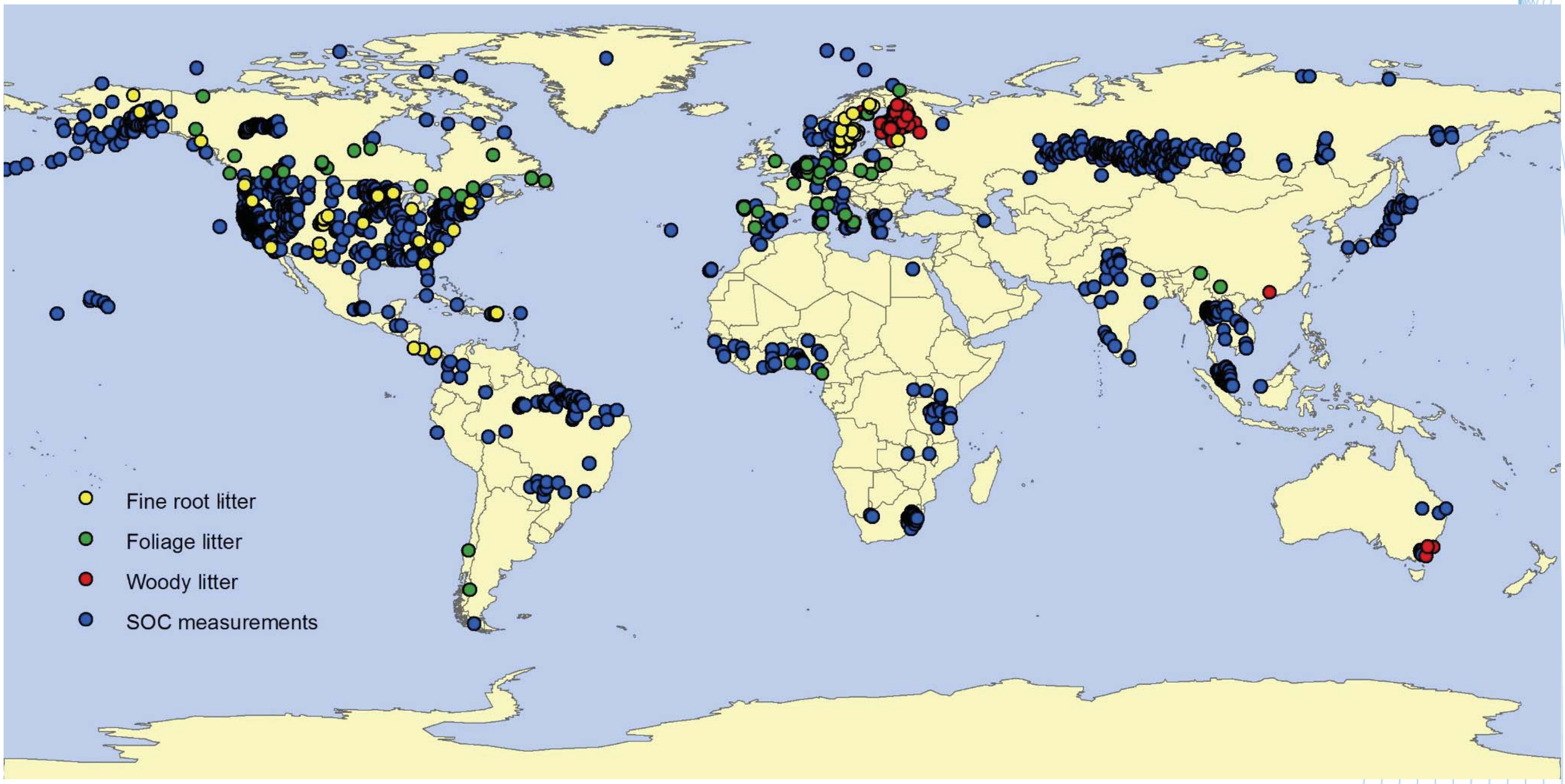
Soil carbon model Yasso





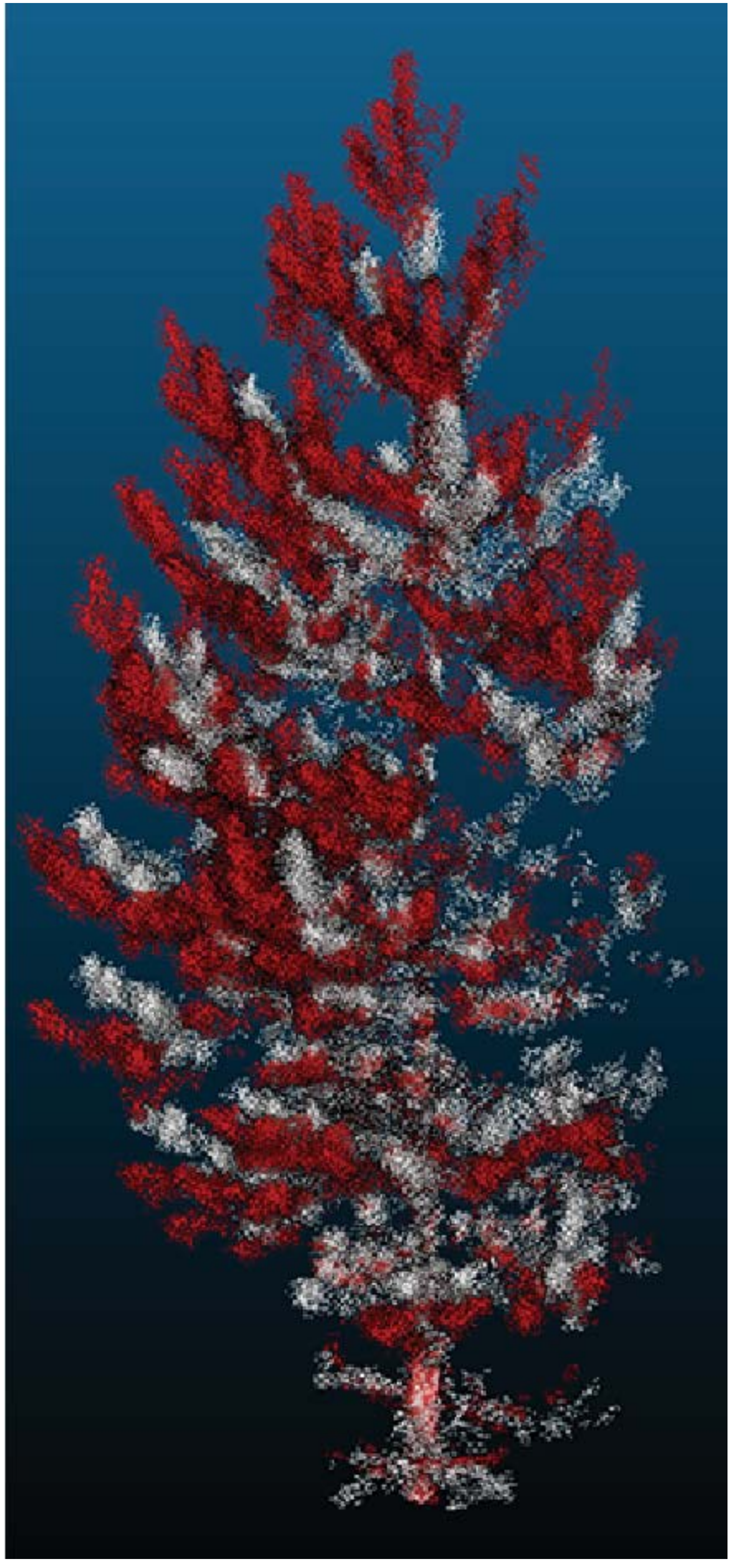
Yasso-database

21 000 different soil carbon related records



TAMPEREEN TEKNILLINEN YLIOPISTO

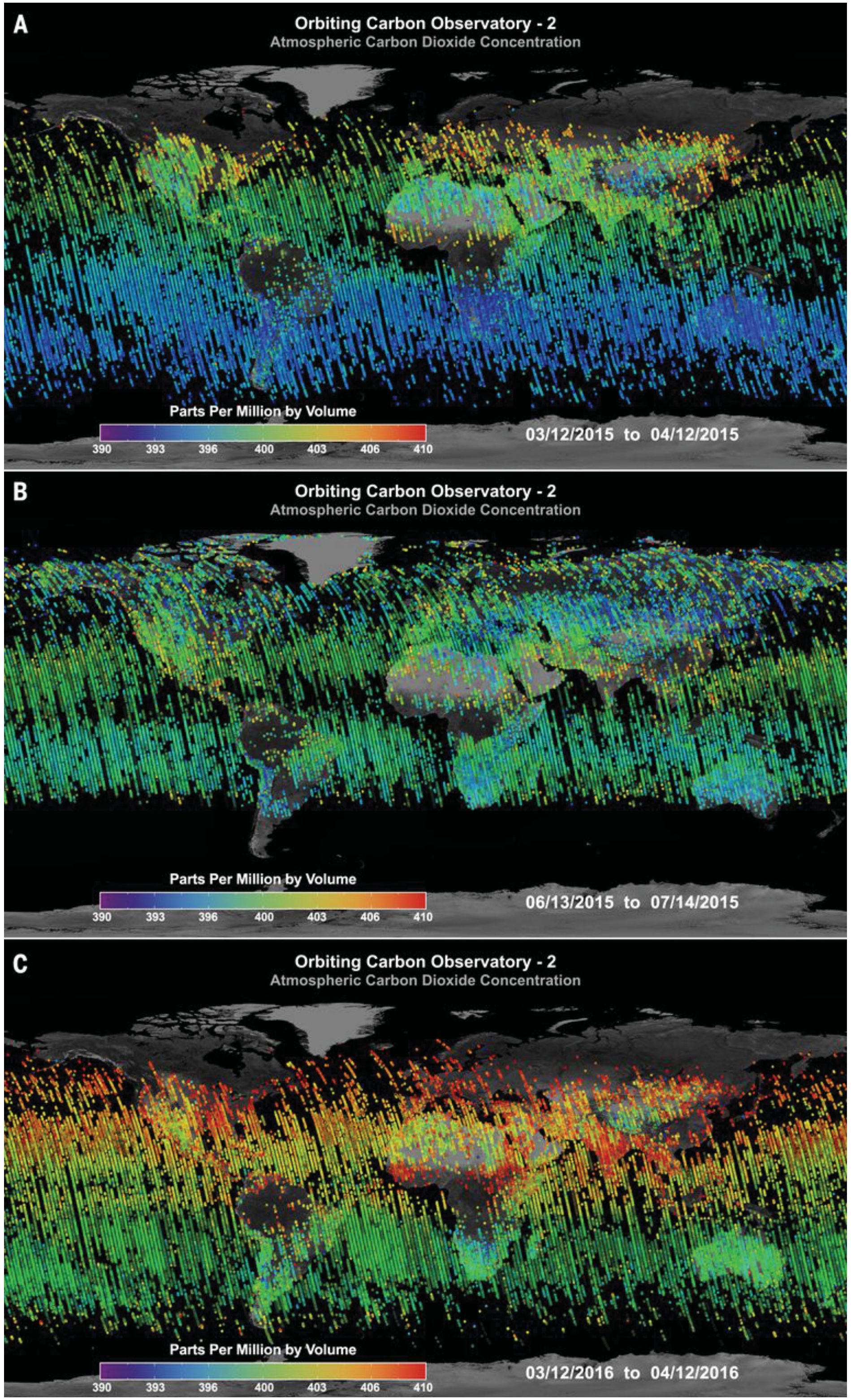
Finnish Centre of Excellence in
Inverse Modelling and Imaging
2018-2025



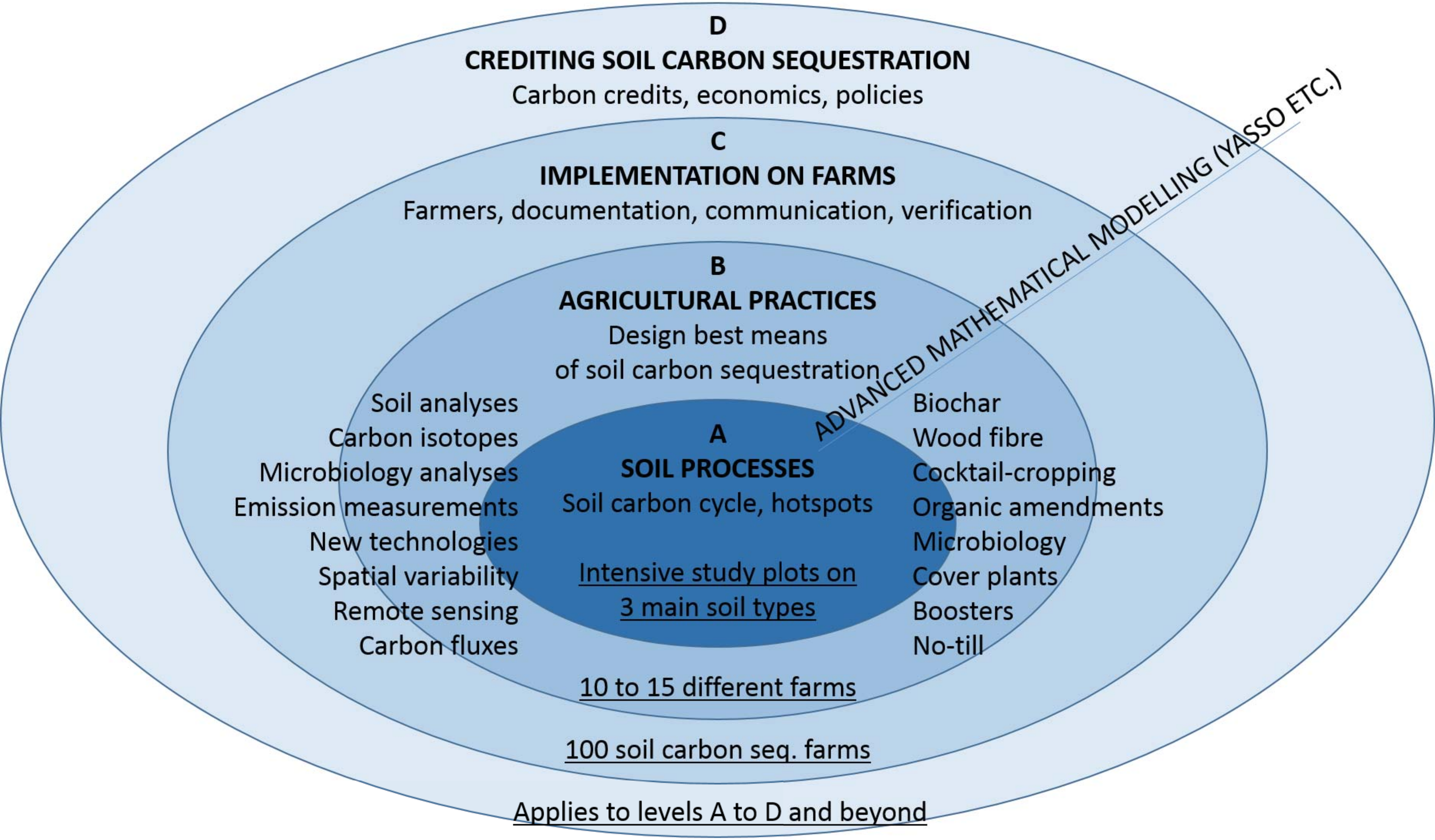
Hakala et al. 2014.

Sentinel 2

OCO-2



Eldering et al. 2017. Science.



BSAG ja Ilmatieteen laitos 2017

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