Ecosystems and water: impacts, adaptation and mitigation

Meudon, 3 novembre 2015

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Ecosystems and water: impacts, adaptation and mitigation

- **Downscaling of climate for studies of ecosystems impacts: understanding the benefits and limits**

- **Using ecological indicators to improve understanding of past climate and climate impacts**

- **Improving understanding & modeling of the mechanisms of climate impacts on biodiversity, ecosystem function & hydrology**

- **Climate adaptation and mitigation: quantifying and managing uncertainty**

AFOCLIM, CARBOSOIL, CCTV2, HUMBOLDT, MED-ICCBIO, Parts of MORCE-MED, PASTEK, PLUIES-TIBET, REGYNA, ROOFSCAPE

Downscaling of climate for studies of ecosystems impacts: understanding the benefits and limits

REGYNA, HUMBOLDT, PLUIES-TIBET

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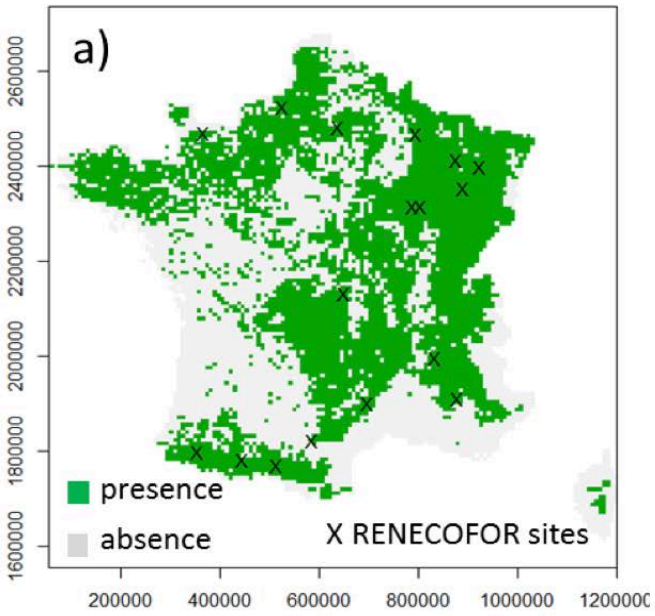
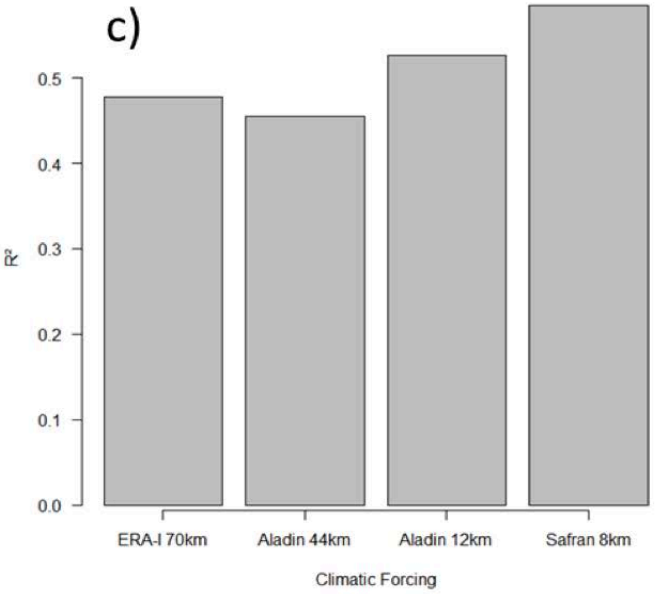
Downscaling climate for modeling impacts on trees

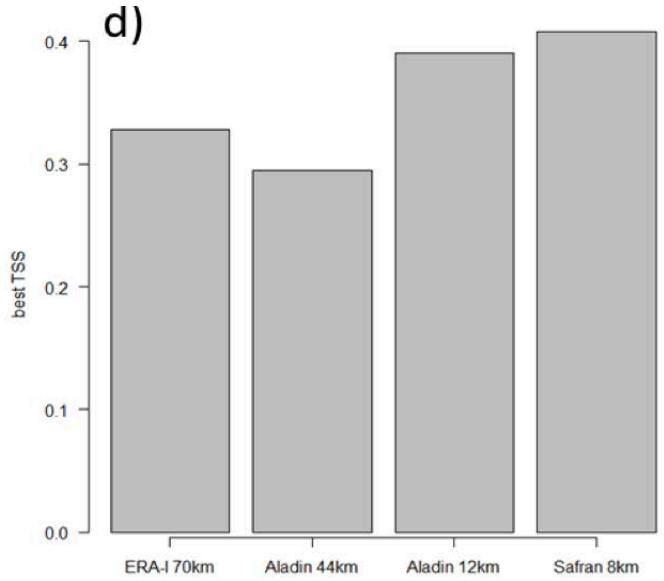
HUMBOLDT



Modeled vs. observed beech growth rates



Modeled vs. observed beech distribution



70km 44km 12km 8km

Climate downscaling improves model fit to observations for European beech

Martin-St.Paul et al. in prep

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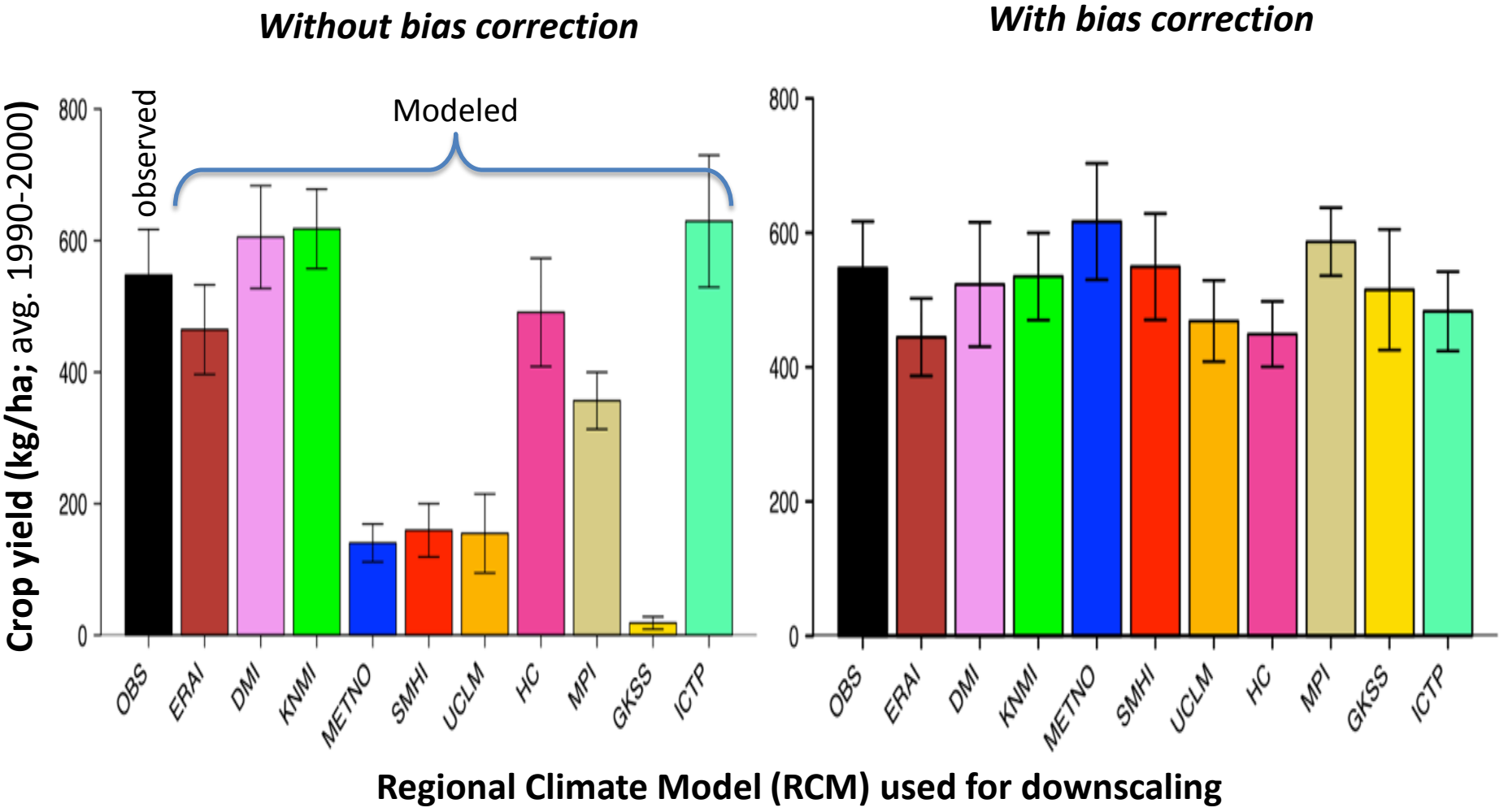
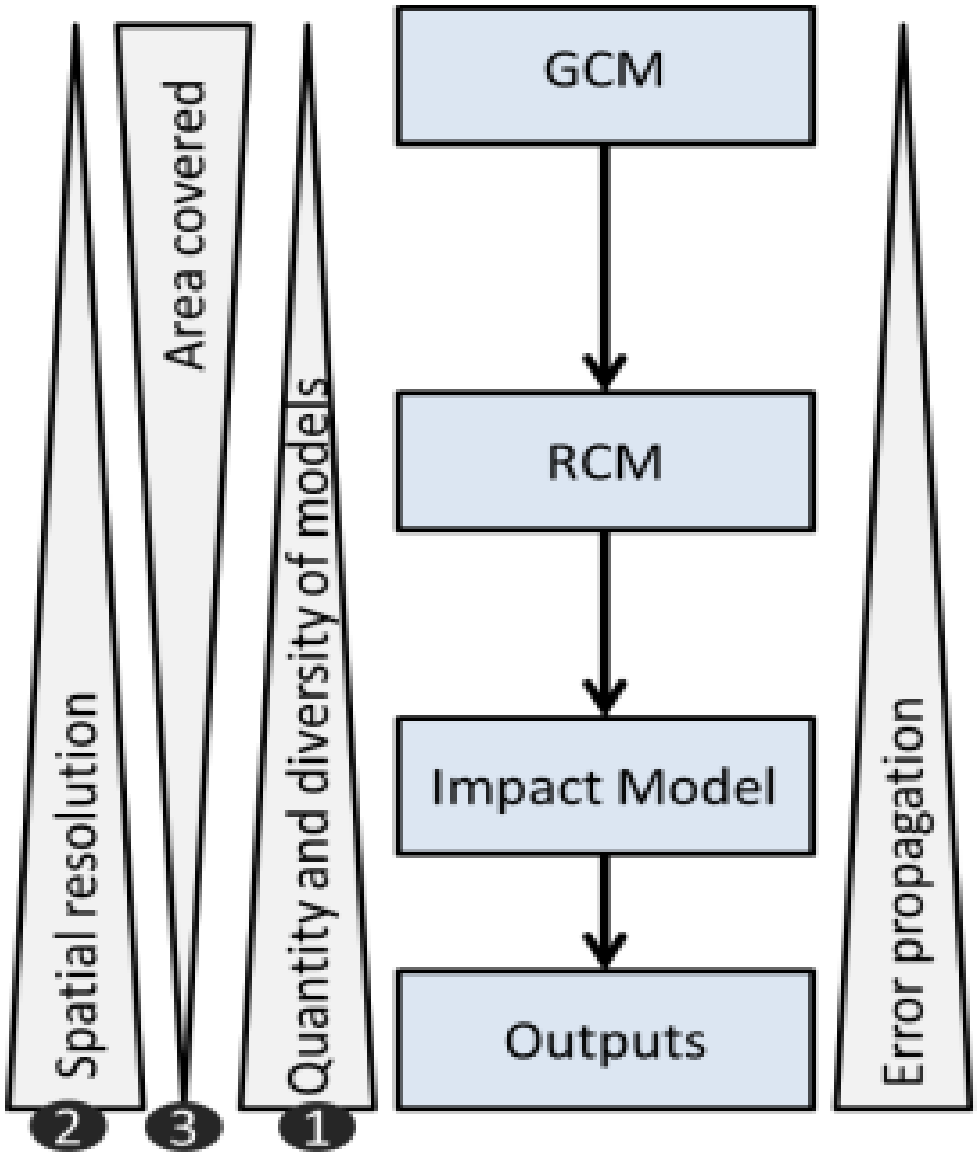
Downscaling climate for modeling impacts on crop yields in West Africa - REGYNA



Oettli et al. (2011)



Workshop "ClimEcol: from climate to ecology, a dialog among communities"

HUMBOLDT

Highlighted the need to strengthen the dialog between climate scientists and ecologists concerning the benefits and limits of downscaling

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Downscaling of climate for studies of ecosystem impacts: understanding the benefits and limits

- **Finer spatial resolution of climate drivers can improve modeling of ecosystem responses in areas of strong climatic gradients, or where regional climate is not well represented in global scale climate models.**

- **Downscaling climate adds substantial uncertainty and complexity to impact studies. So:**
  - **Users must understand the benefits & limits of downscaling**
  - **Uncertainty should be evaluated by comparing multiple methods of downscaling,**
  - **Bias correction is often needed,**
  - **Downscaling should not be evaluated on climate criteria alone; impacts models should also be used to evaluate downscaled climate.**

- **Downscaling is often done without sufficient communication between climate and ecosystems scientists leading to misunderstandings of the limits and benefits of downscaling by both communities.**

Using ecological indicators to improve understanding of past climate and climate impacts

PLUIES-TIBET, AFOCLIM

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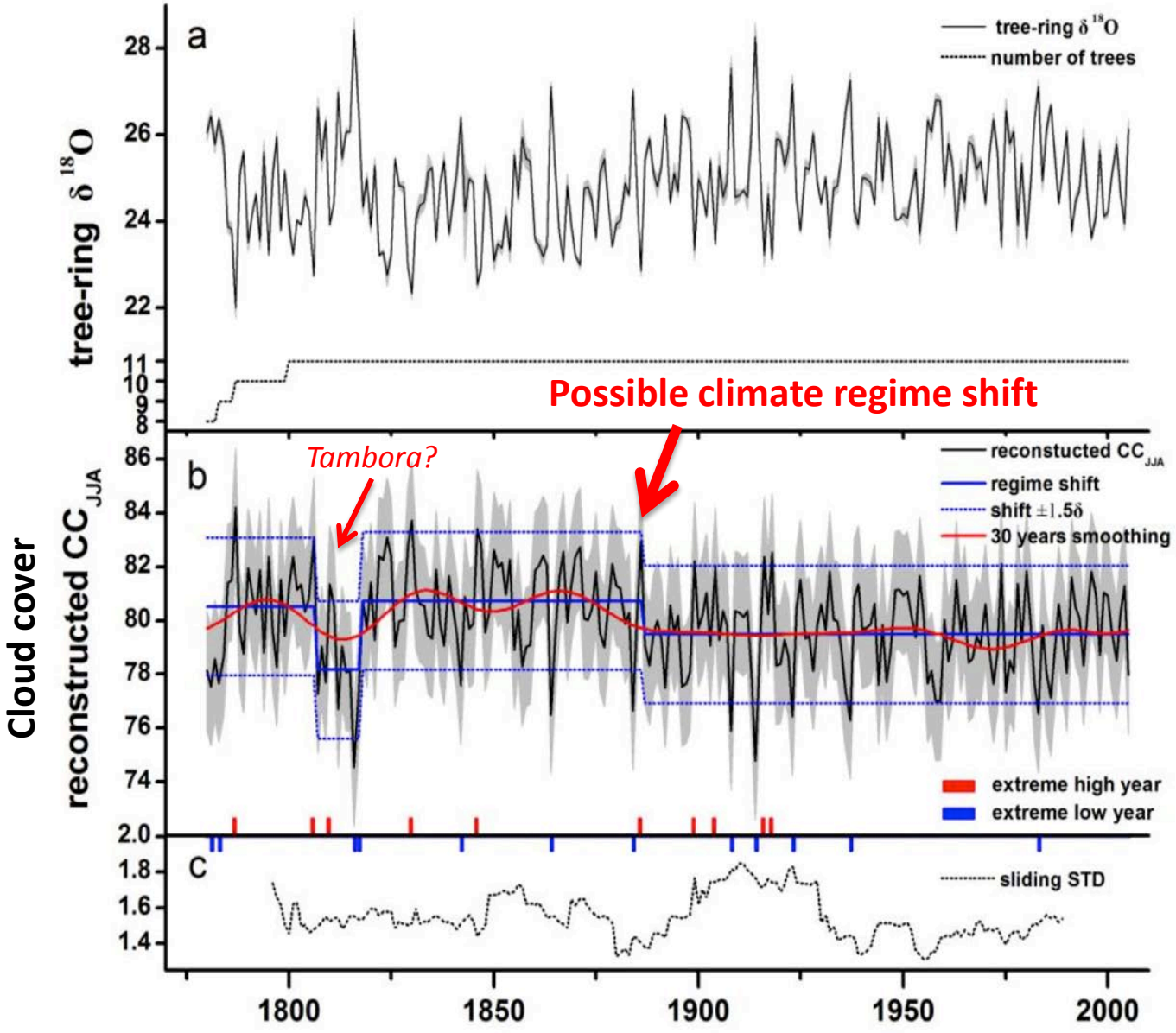
Using stable isotopes of oxygen to reconstruct climate in Tibet

PLUIES-TIBET



Shi et al. (2012)

Compared to other tree ring methods, proxies using ^{18}O can be based on very few trees because of strong coherence within a tree and between trees & little effect of tree age.

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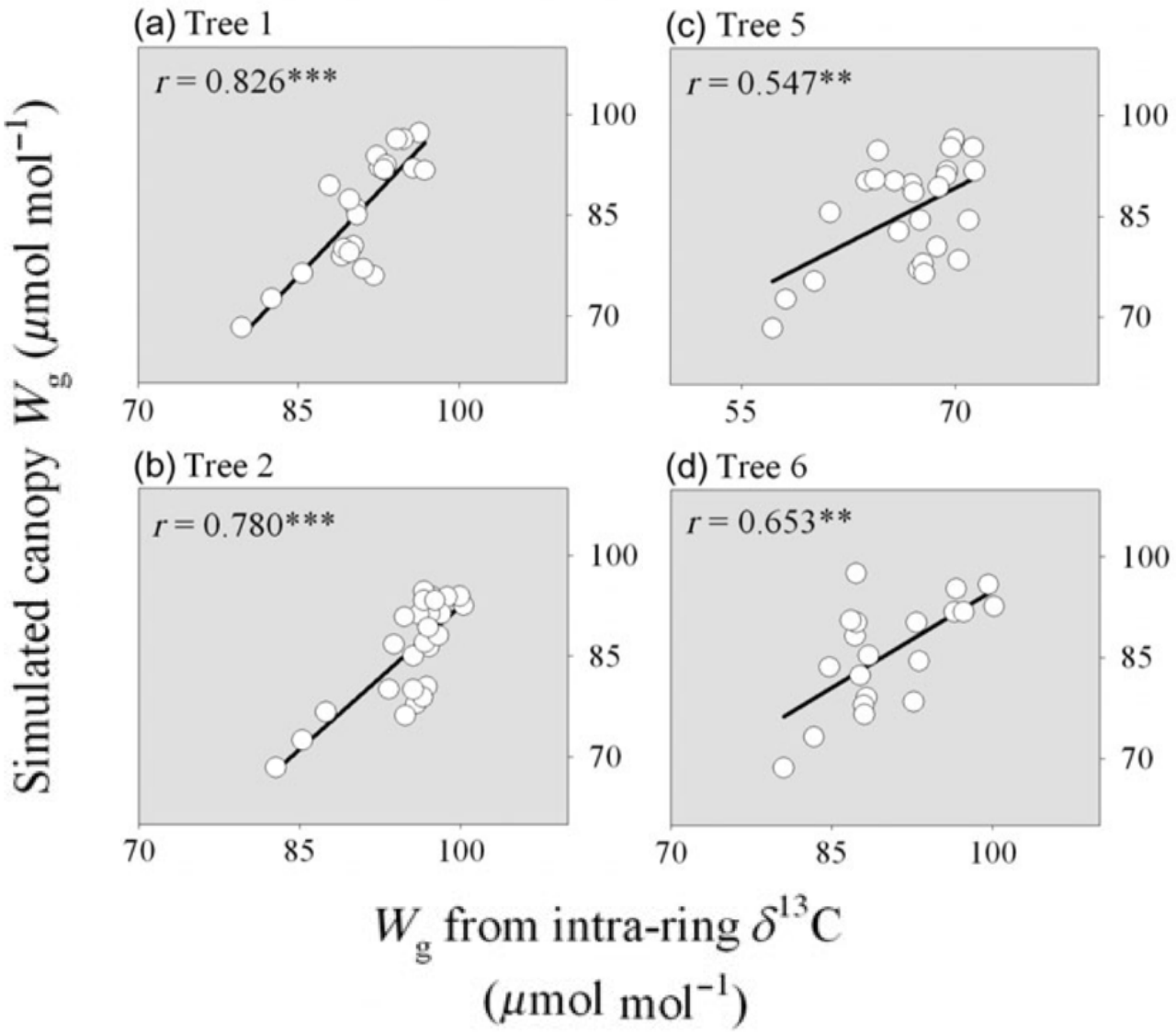
Modeled and measured (∂^{13}C proxy) canopy level water use efficiency (W_g) in oak trees in the Fontainebleau forest



Using intra-ring measurements of stable carbon isotopes to reconstruct seasonal variation in tree water use efficiency

AFOCLIM

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Using ecological indicators to improve understanding of past climate and climate impacts

- **Recent developments in the use of stable isotopes of oxygen and carbon in tree rings have enhanced insights into past climate and climate impacts on ecosystems at temporal scales ranging from intra-annual to centuries.**

- **Stable isotopes of oxygen in tree rings are promising indicators of precipitation and drought stress.**

- **However, isotopic indicators in tree rings must be interpreted with caution since they integrate many climatic and non-climatic signals.**

- **Mechanistic tree and ecosystem models that account for isotopic tracers can provide valuable insight into the mechanisms underlying stable isotope signals.**

Improving understanding & modeling of climate impacts on biodiversity, ecosystem function & hydrology

CARBOSOIL, MED-ICCBIO, HUMBOLDT, PASTEK, REGYNA

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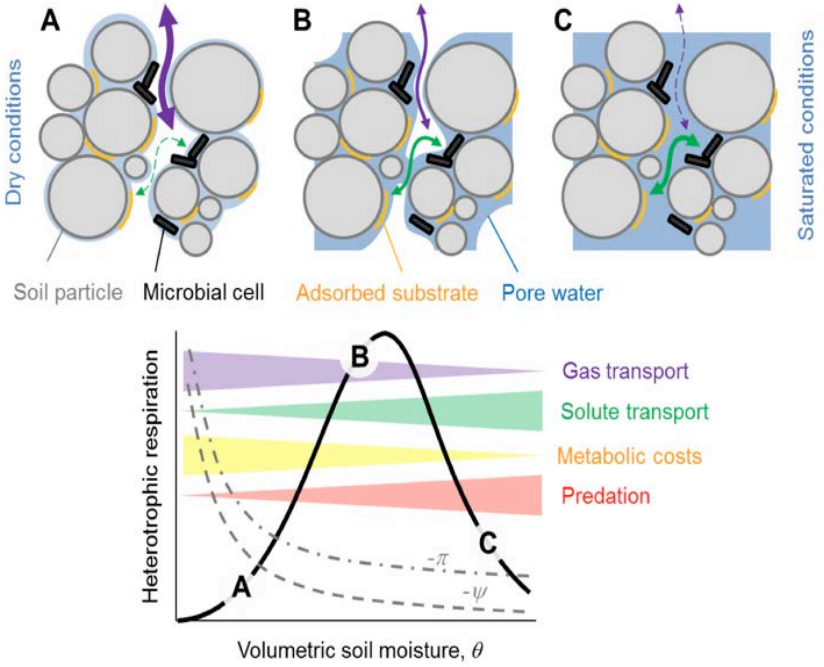
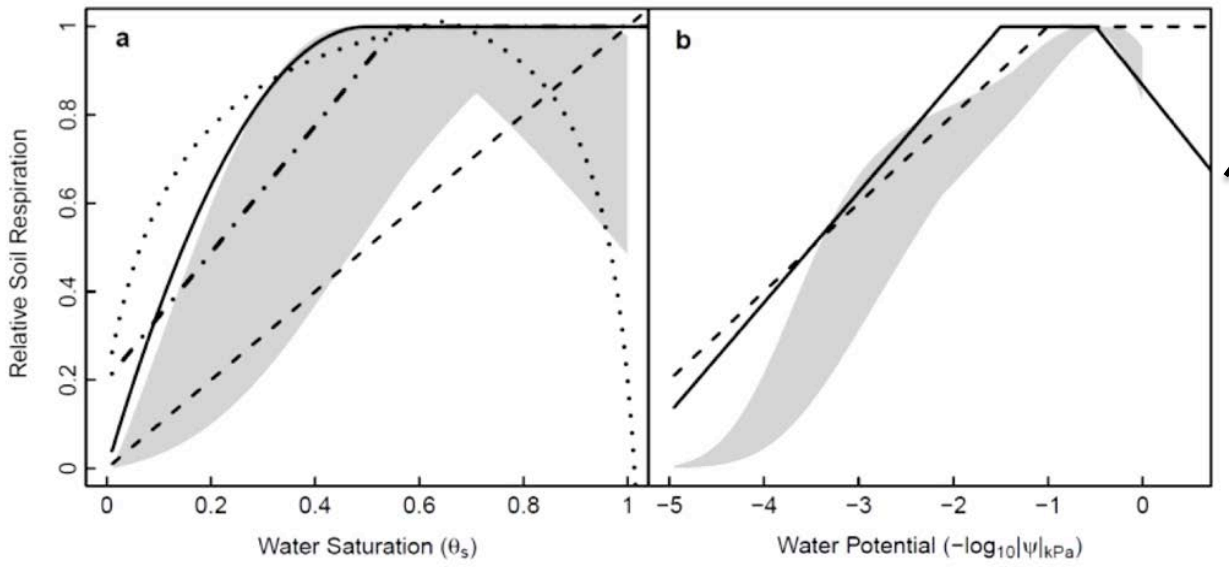
A new approach based on key physical and biological mechanisms driving soil respiration as a function of volumetric soil water content.
Moyano et al. (2013)



Testing soil respiration models using large data sets

CARBOSOIL



Current models of soil water effects on respiration (lines) do not compare well with data (grey areas).
Moyano et al. (2012)

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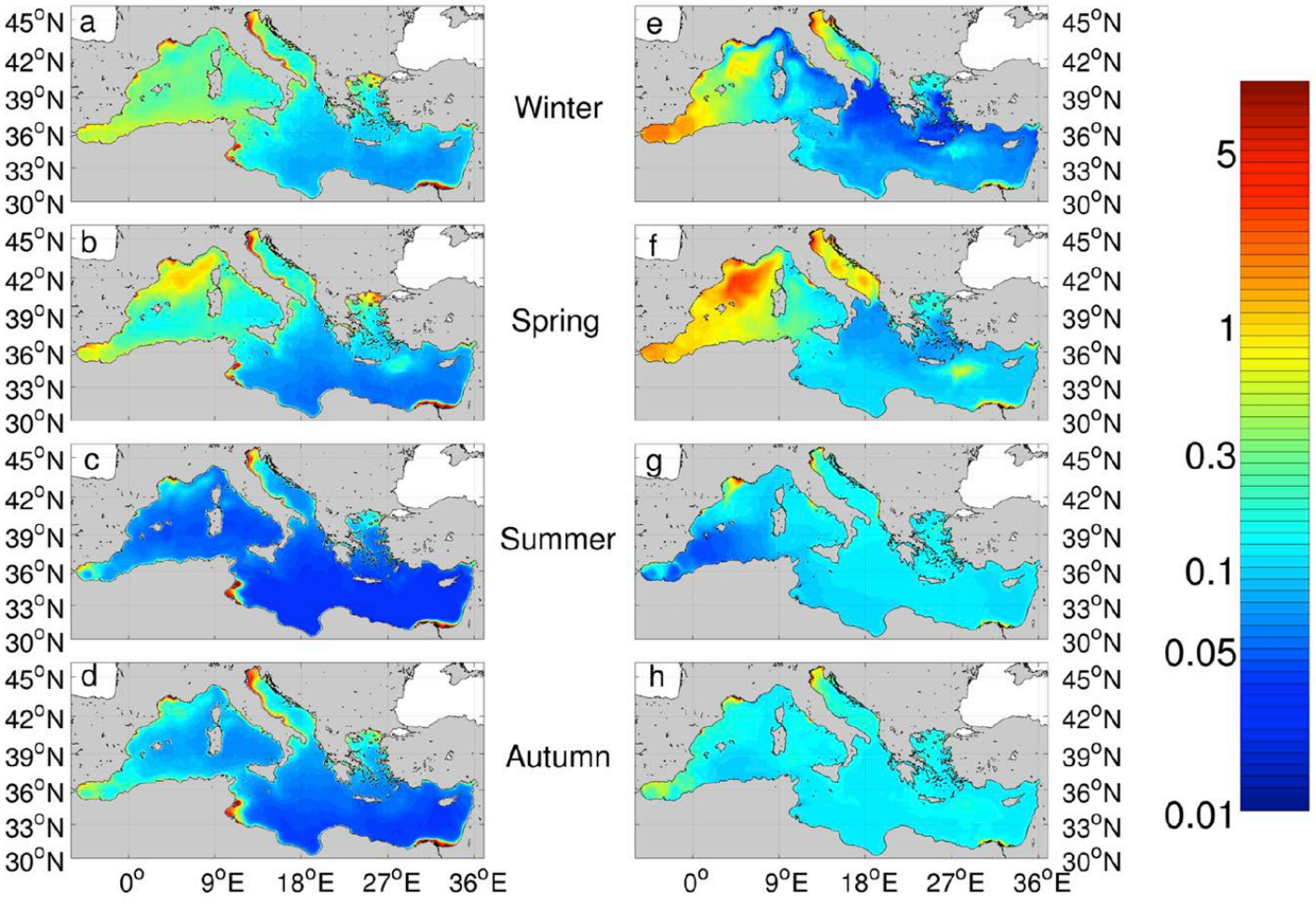
Improving modeling of ocean biogeochemistry through better representation of plankton functional diversity

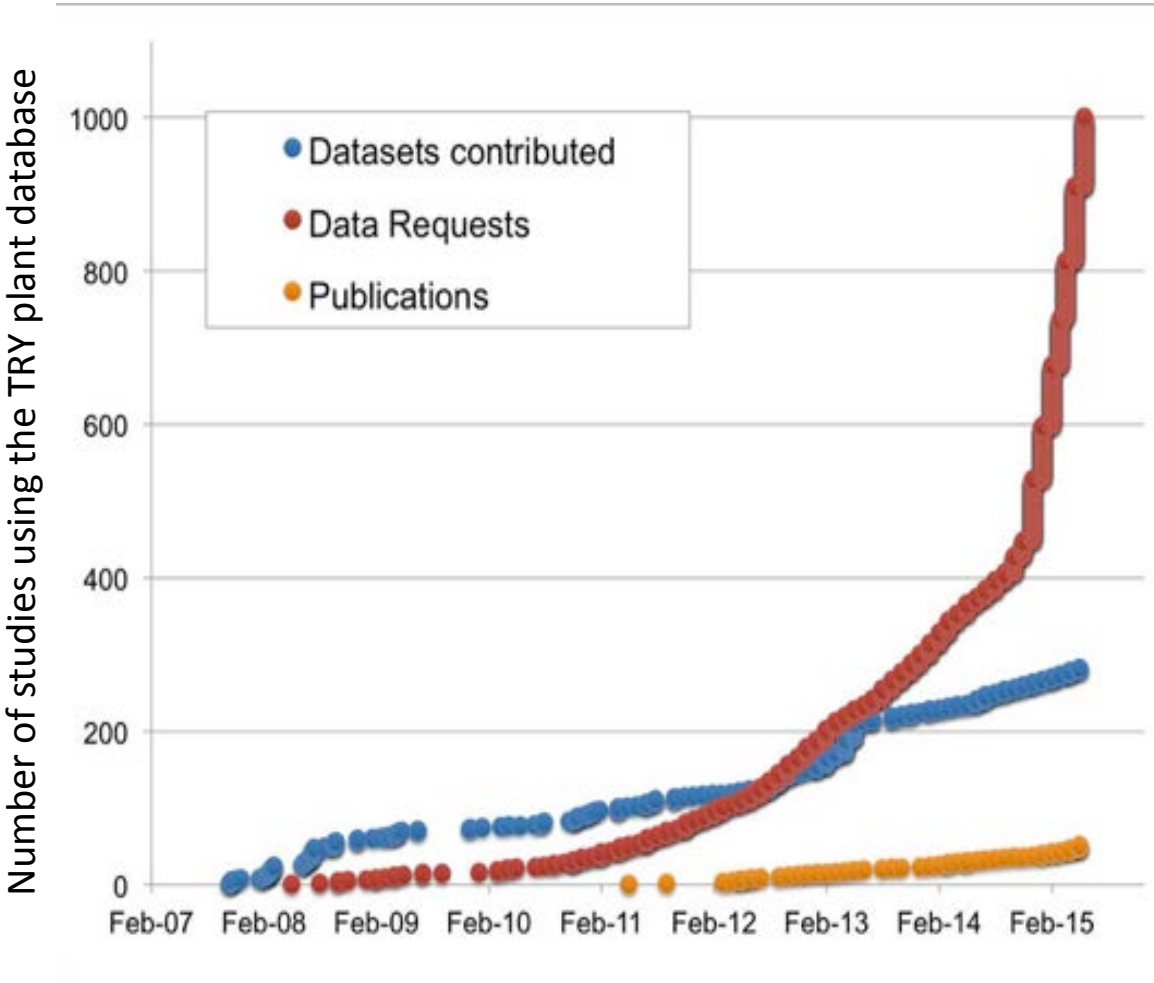
MED-ICCBIO

Mean surface chlorophyll concentrations from satellite measurements (left) and simulated by the coupled NEMO-Med12/ECO3M model (right)



Guyennon et al. (2015)

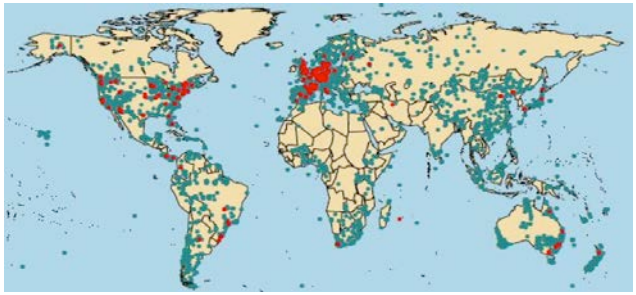
International collaboration to help build a global plant trait data base (TRY) for modeling vegetation response to environmental change - HUMBOLDT



TRY: a web-based dataset that contains >5.6 million trait records for >100,000 plant species and is largely open access

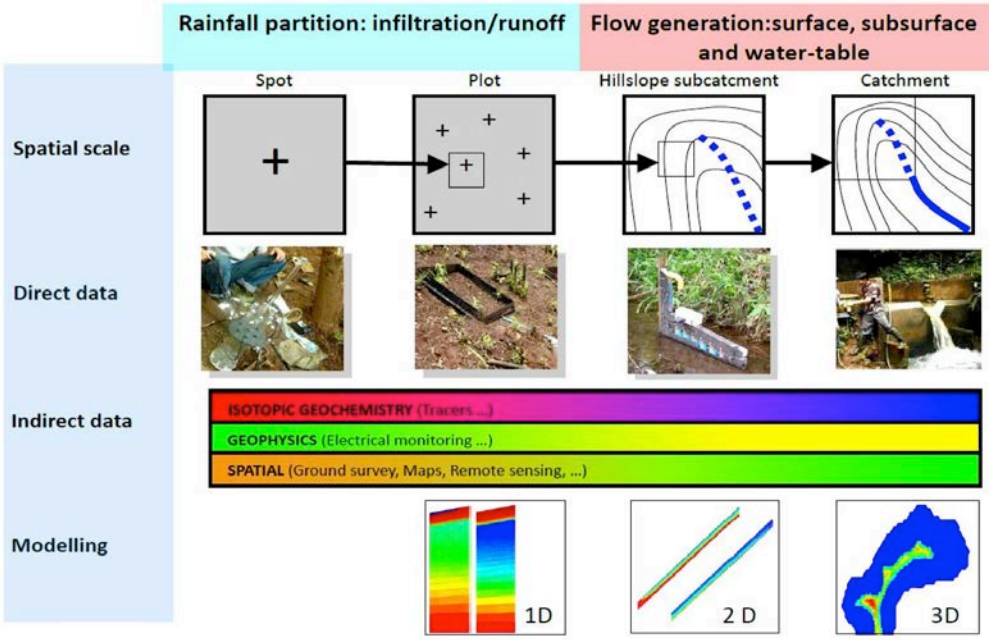
Kattge et al. (2011)

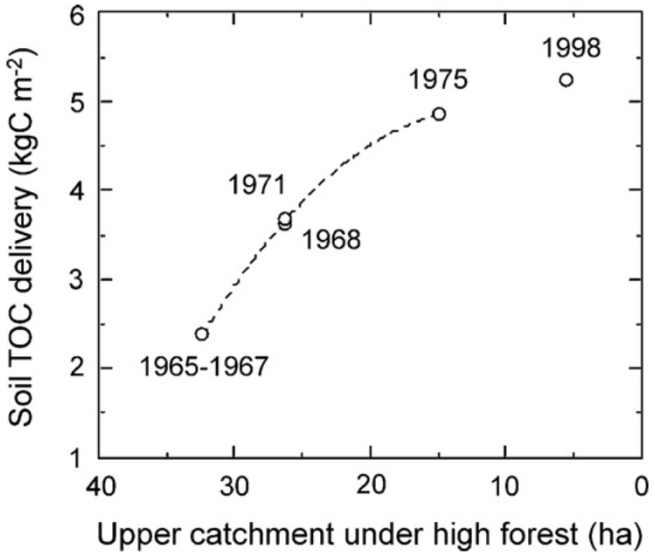
100 million records provided as of today!



locations of observation sites (green dots) and institutions (red dots) involved in TRY. https://www.try-db.org/TryWeb/About.php

Scaling up methods for modeling water flows and water quality the Mekong River in Laos





Soil total organic carbon (TOC) delivery as a function of forest cover in the upper areas of the Houay Pano catchment in Laos

Huon et al. (2013)

Measuring and modeling the drivers of water flow and water quality in Laos

PASTEK

Principal drivers of water flow and water quality change across scales -

Small scale: soil surface conditions and land use

Basin scale: climate

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Improving understanding and modeling of climate impacts on biodiversity, ecosystem function & hydrology

- **Inclusion of knowledge of fine scale soil processes into regional and global scale models can substantially alter projections of carbon fluxes and carbon sequestration in soils.**

- **Global and regional scale models are being developed that substantially increase the extent to which they account for biodiversity in marine and terrestrial ecosystems. This is being facilitated by very large databases that provide information for building and testing models.**

- **Improving the representation of biodiversity in models increases their ability to provide pertinent indicators for scientists and decision makers and can improve the ability to simulate biogeochemical cycles.**

- **Inclusion of fine scale knowledge can substantially improve the capacity of hydrological models to simulate dynamics at large watershed scales.**

Climate adaptation and mitigation: quantifying and managing uncertainty

CARBOSOIL, MORCE-MED, HUMBOLDT, CCTV2, GIS program

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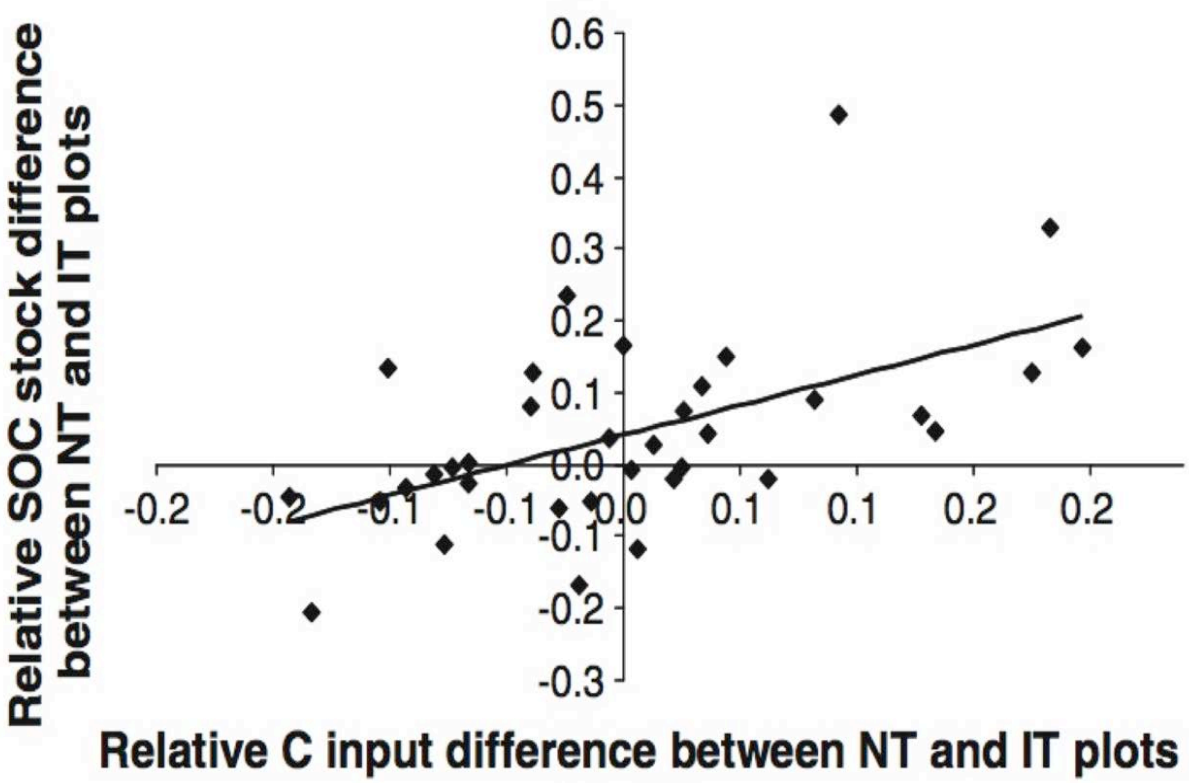
Benefits of no-till agriculture for climate mitigation may be overestimated - CARBOSOIL



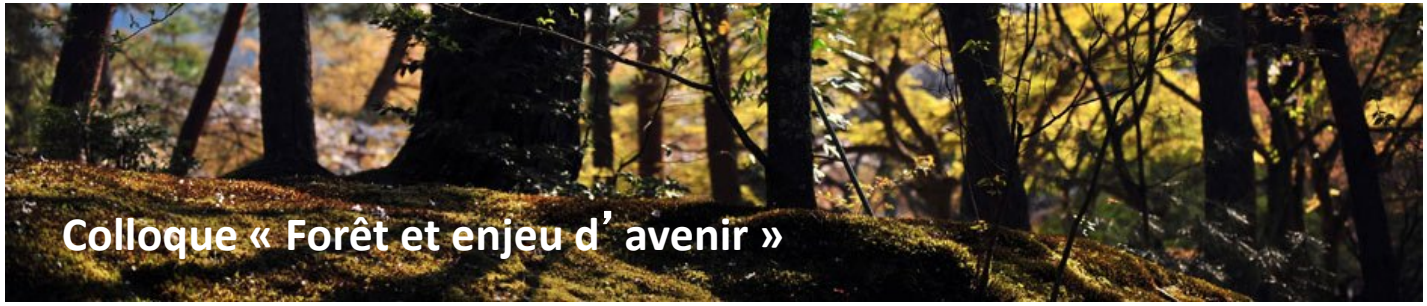
Relative soil organic carbon (SOC) stock differences vs. relative yearly C input differences between no-till (NT) & conventional till (IT = inversion tillage) plots.

There is no significant difference between no-till and conventional till

Virto et al. (2012)

Strengthening the dialog between scientists, practitioners and policy makers for adaptive management of forests – GIS

Organized by the GIS Climat, the Association NSS-Dialogues and the Université du Québec à Montréal – Paris 2011



Organized by the Université Paris-Sud and the Sénat – Paris 2011

Climate change and urban green spaces

CCTV2

CCTV2 mobilized researchers from social sciences, atmospheric sciences and ecology (LADYSS, BIOEMCO, LSCE and LIVE laboratories) to examine the relationships between urban green spaces and adaptation to climate change

Issues covered:

- **Vegetation and urban climate**
- **Urbanization and regional climate**
- **Soil-plant interactions as determinants of urban climate**

***One of the take-home messages*: The program of green ways in France could potentially play an important role in climate adaptation, but the public and policy makers are either unaware of, or have serious misconceptions about the interactions between urban vegetation and climate.**

Climate adaptation and mitigation: quantifying and managing uncertainty

CARBOSOIL, MORCE-MED, HUMBOLDT, CCTV2, GIS program

- **Putting climate adaptation and mitigation strategies into action are moving higher on the agenda of practitioners and politicians. However, uncertainties are often greatly underestimated when developing these strategies.**

- **Progress has been made in communicating scientific knowledge and its limits, as well as providing easily understandable indicators. However, successfully implementing climate adaptation and mitigation strategies will require greater interdisciplinary research and reinforcement of communication between and among scientists, policy makers and citizens.**

Follow-up

Many of the research themes in Axis 3 have are being followed up in the LabEx BASC (Biodiversity, Agroecosystems, Society & Climate):

- **Additional studies of the feedbacks between land use and regional climate using coupled climate-ecosystem models,**
- **Continued development and testing of the Regional Earth System model in collaboration with the MORCE platform,**
- **Further research on climate downscaling for studies of climate impacts on terrestrial ecosystems,**
- **Development and application of an urban-periurban to study the effects of urban development on climate and ecosystem services,**
- **Continued research on the mechanisms regulating and the effects of management on carbon storage in agricultural soils.**

Follow-up

The **University Paris-Saclay** was established in 2015 and brings together many of the labs that participated in work outlined in this Axis. Concrete examples of “GIS type” initiatives:

- International Master's program entitled "**CLUES**: Climate, Land Use and Ecosystem Services” starting September 2015.
- **BASE** (Biodiversity, Agriculture/Food, Society, Environment) School at UPSay

+ Interdisciplinary project **FATES** (FAst Climate Changes, New Tools To Understand And Simulate The Evolution of The Earth System) - Foundation BNP-Paribas