# Comparative analysis of carbon balance and dynamics: influence of climate variability

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CARBO EUROPE $CO_2$

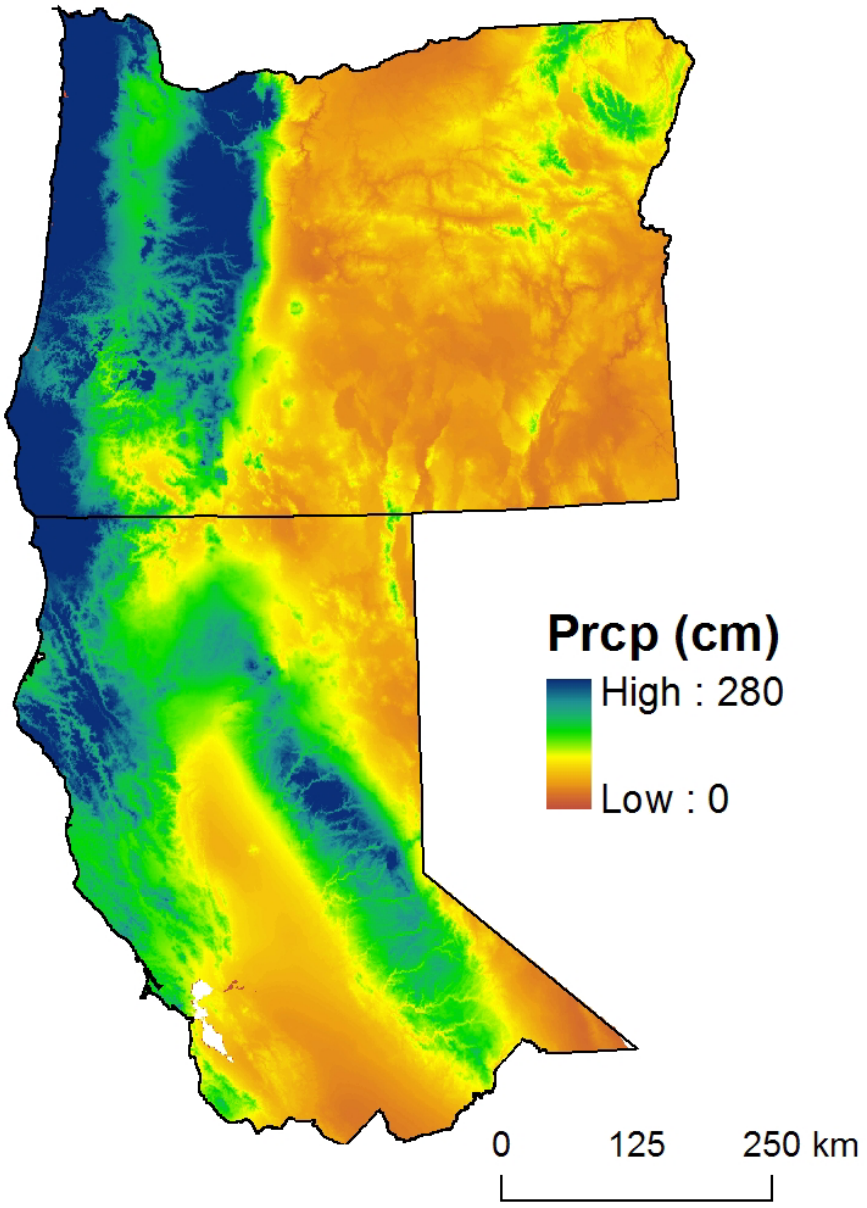
AmeriFlux

# Comparison of Regions with Similar Climate and Vegetation

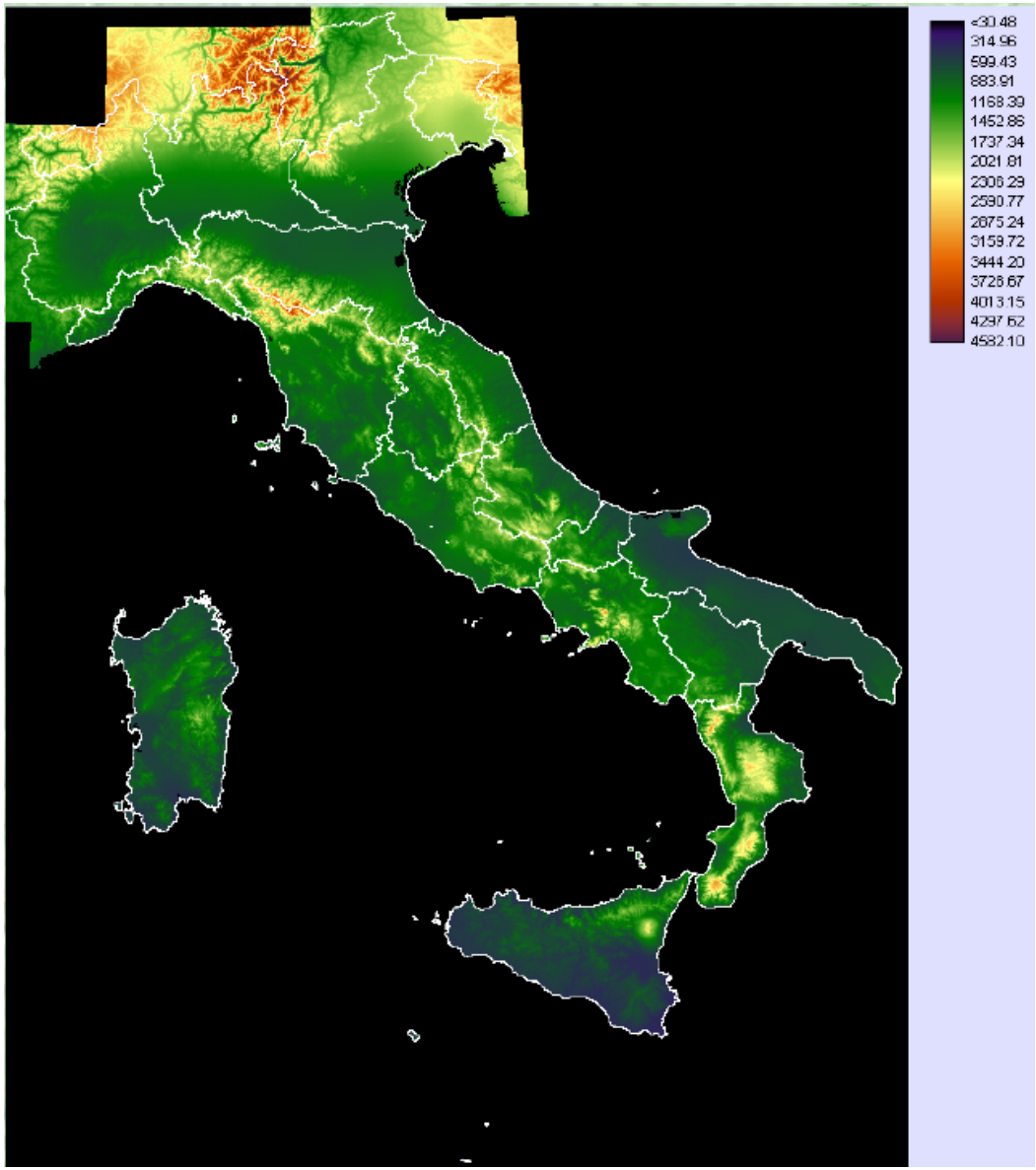
- Study region: Italy, West Coast of the U.S.
- Similarities
  - Climate: Seasonal droughts, maritime to continental
  - Vegetation: Evergreen forests and woodlands, grasslands
  - Disturbance: harvest, wildfires
- Differences
  - Fossil fuel emissions
  - Land use history
  - Demographics

# Strong Precipitation Gradients

**West Coast US**




**Italy**



# Collaboration

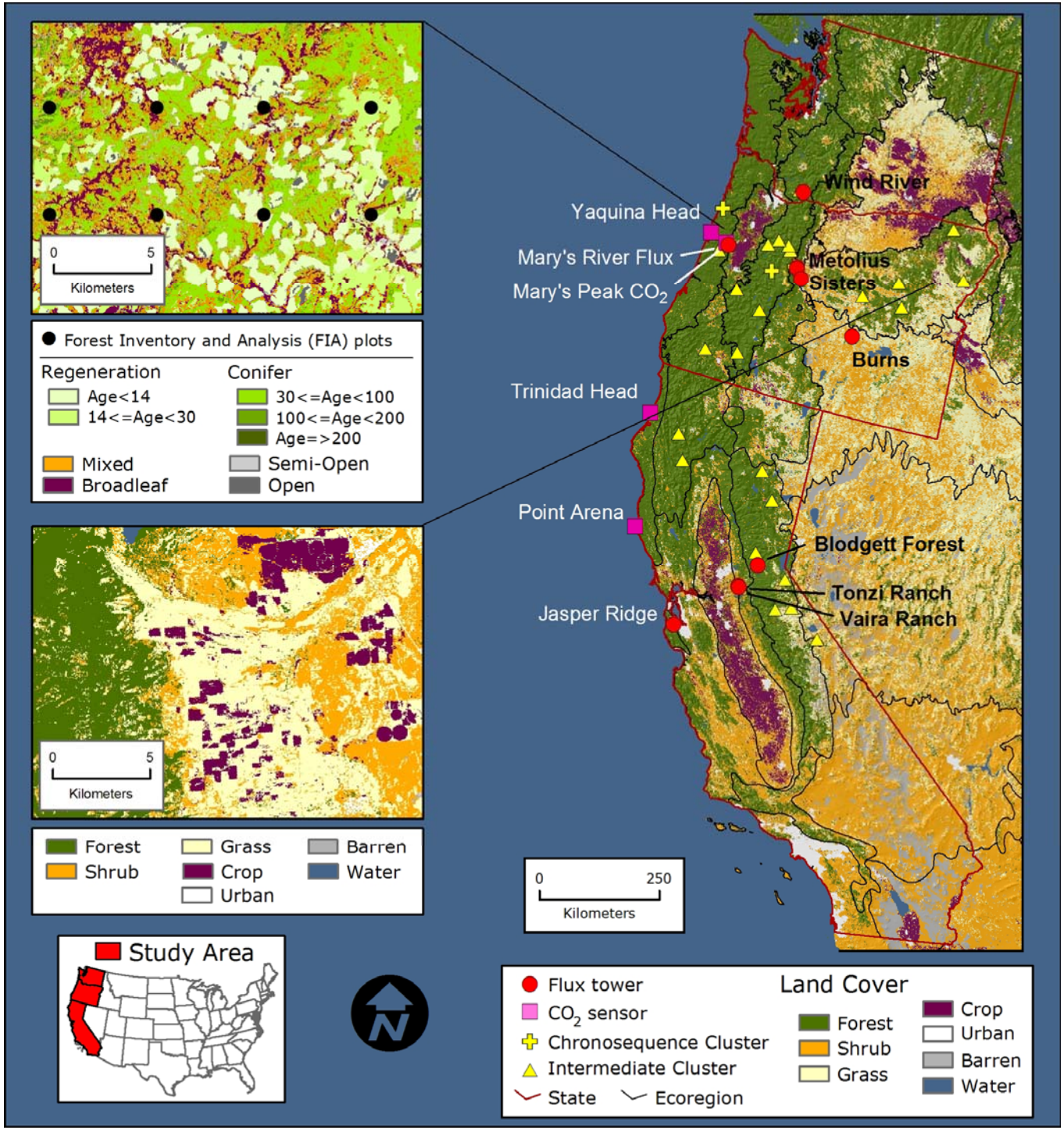
Objectives:

- Share methods of regional analysis
- Compare carbon and water fluxes across sites in relation to climate variability in W US and Italy
  - Observations: Flux networks – AmeriFlux, CarboItaly
  - Experiments: Manipulations of water availability
- Compare regional carbon balances, and interactive role of climate (precipitation) and disturbance (harvest, wildfire)
  - Models: Prognostic carbon balance models

# West Coast U.S.

## Models informed by observations:

- AmeriFlux sites (9)
- $CO_2$ concentration sites (5)
- Inventories
- Remote sensing (Landsat, MODIS)
- Address issues relevant to North American Carbon Program, and Western Regional Climate Initiative in 3 of the 5 states



# Tower Land-Atmosphere Measurements

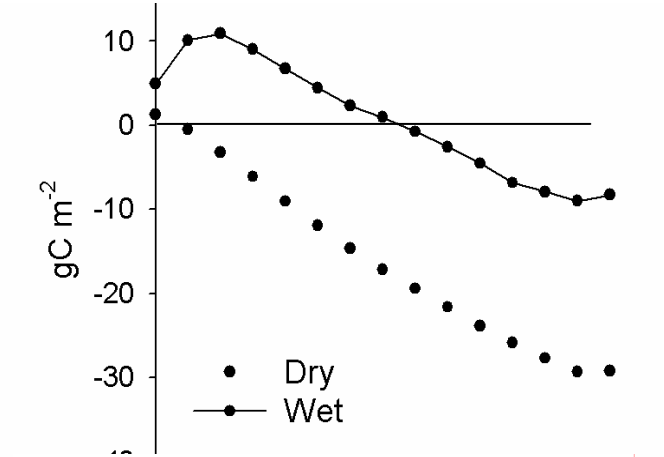
**AmeriFlux network**
**$CO_2$, water exchange**

**$CO_2$ concentration sites along maritime to continental gradient**

# Carbon Uptake Dry vs Wet Forests: Oregon

**Carbon sequestration in typical dry summer**

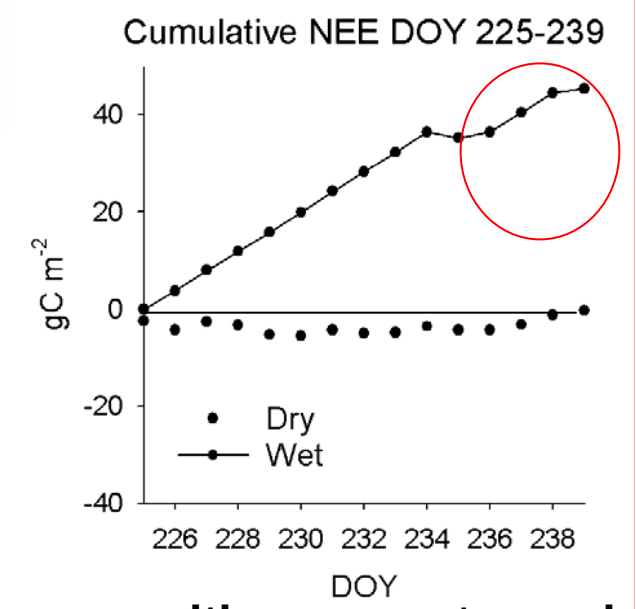
**1998 avg year**




**source**

**sink**

**2003 dry year**

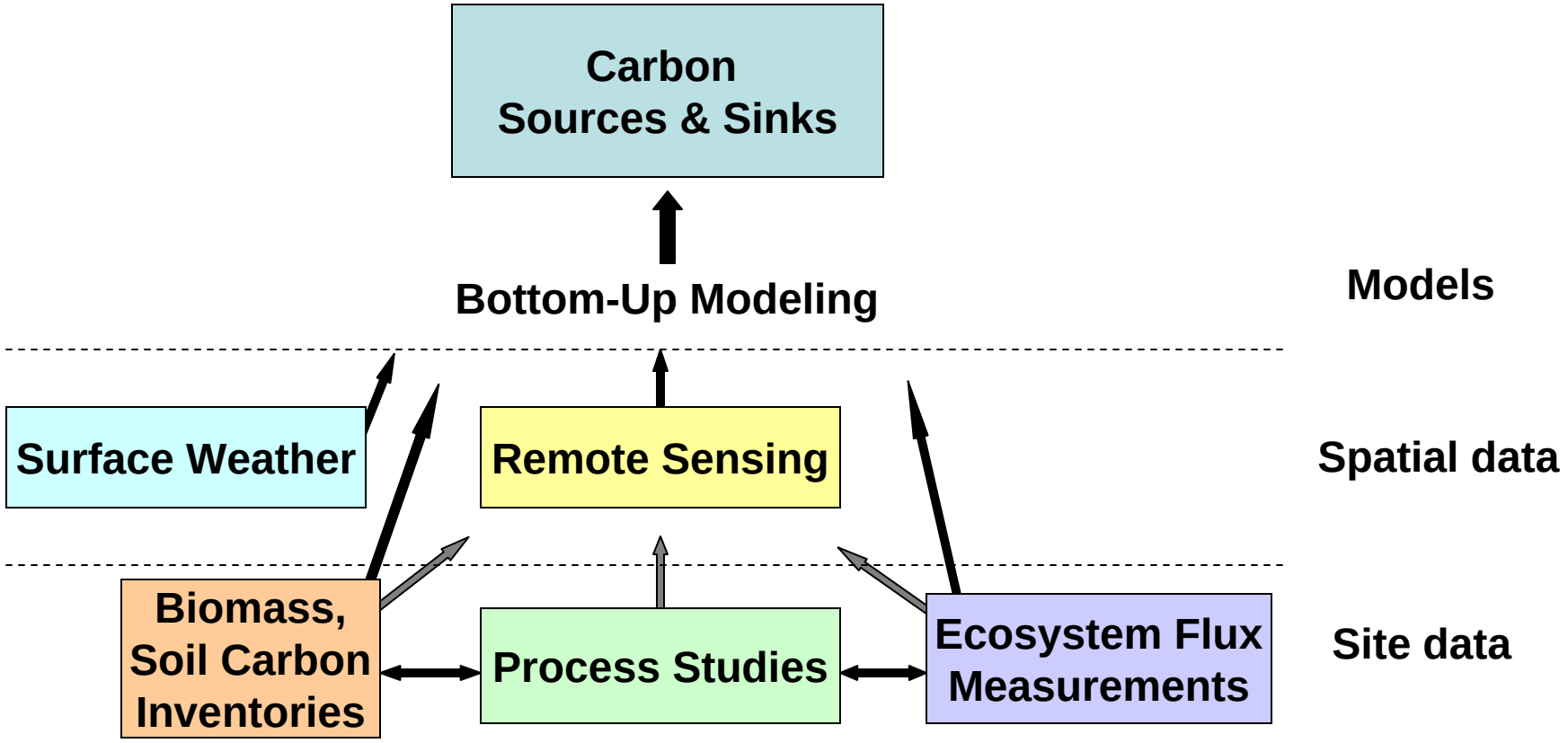



**source (wet site)**

**sink**

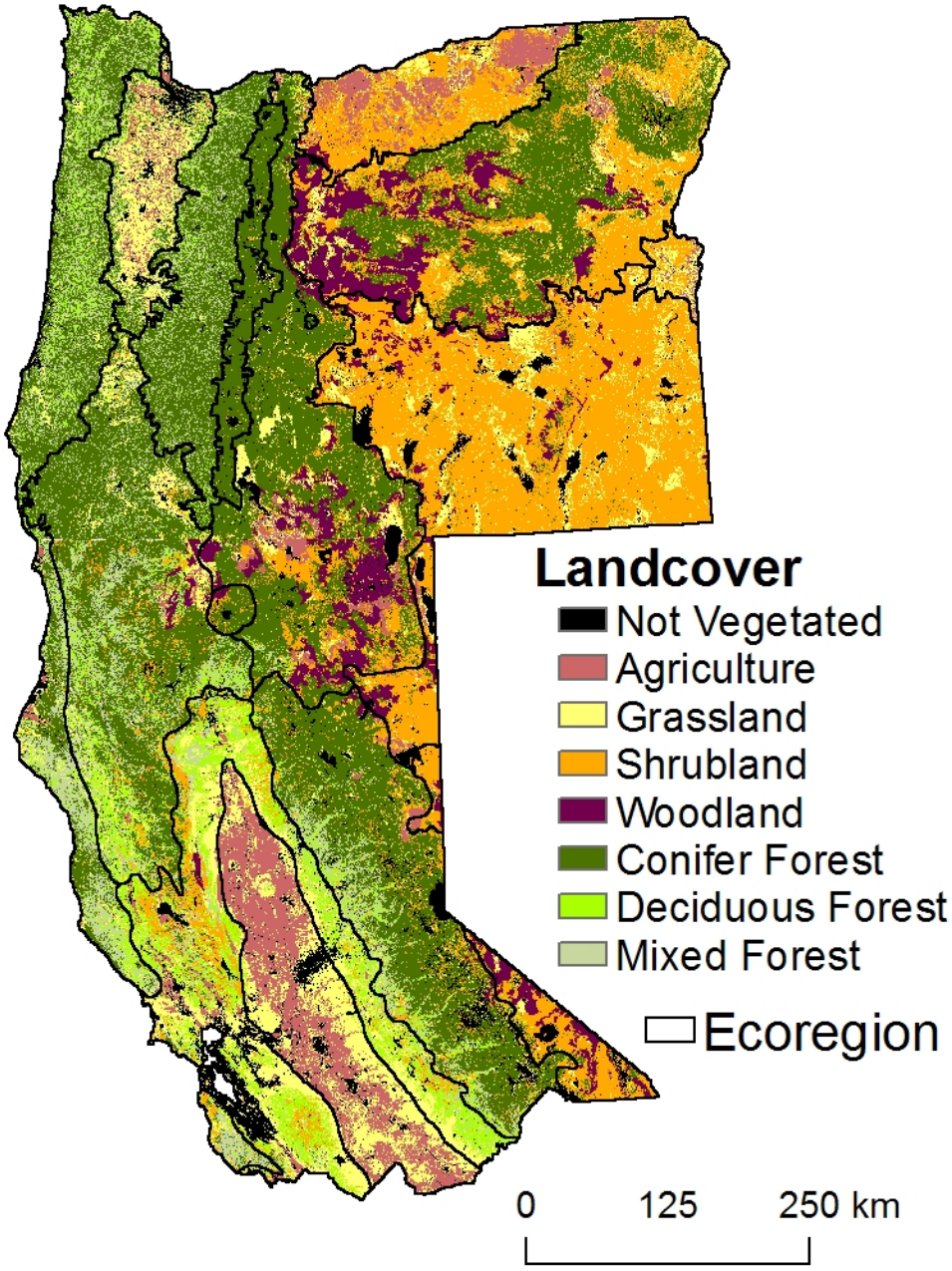
**Forests growing in areas with more water recharge in winter become carbon source, weak sink during droughts**

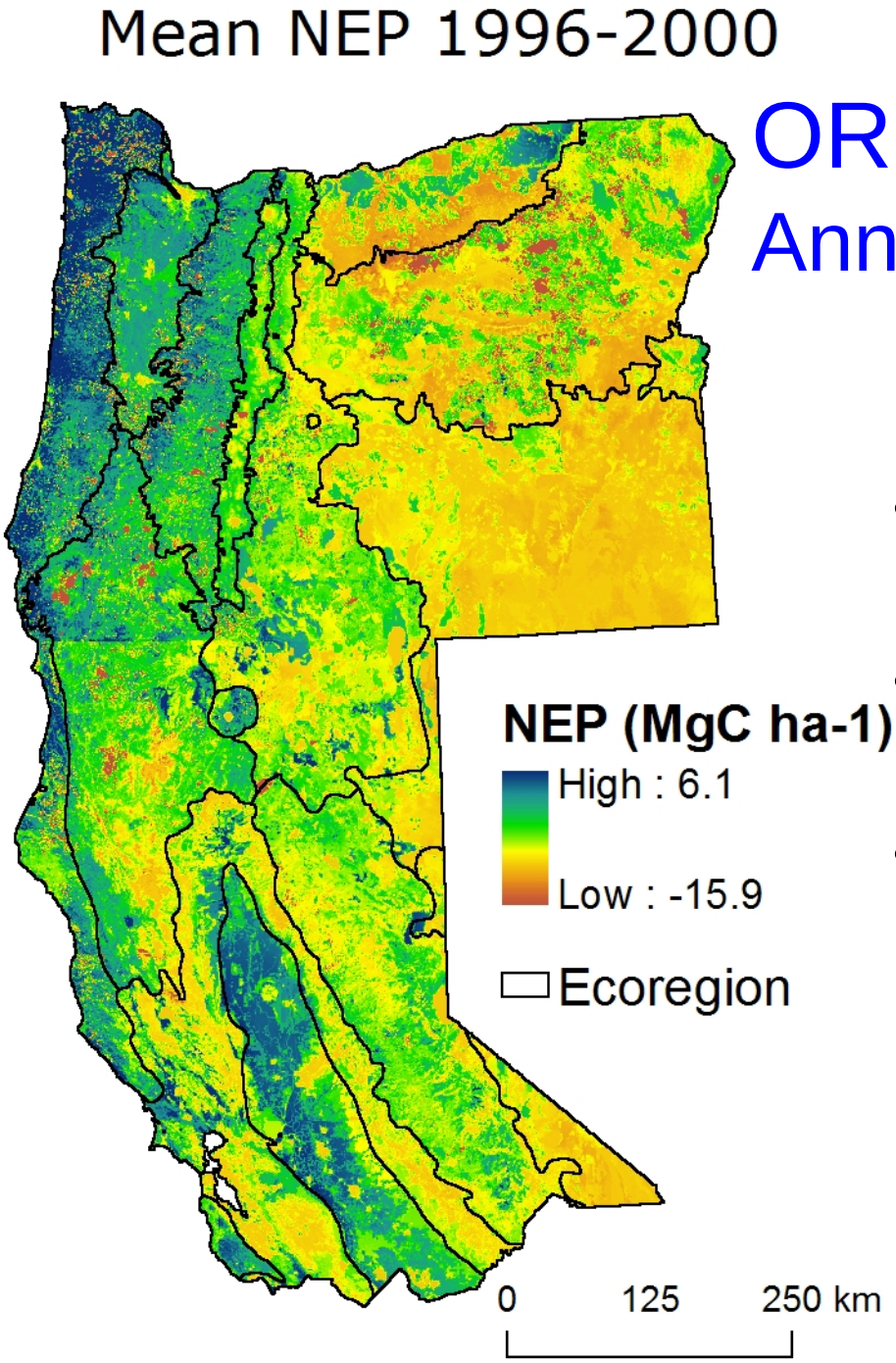
# Regional Analysis of Carbon Balance Data Integration with Process Models




**AmeriFlux, CarboEurope play a major role as data providers**

# Oregon and N California Land Cover





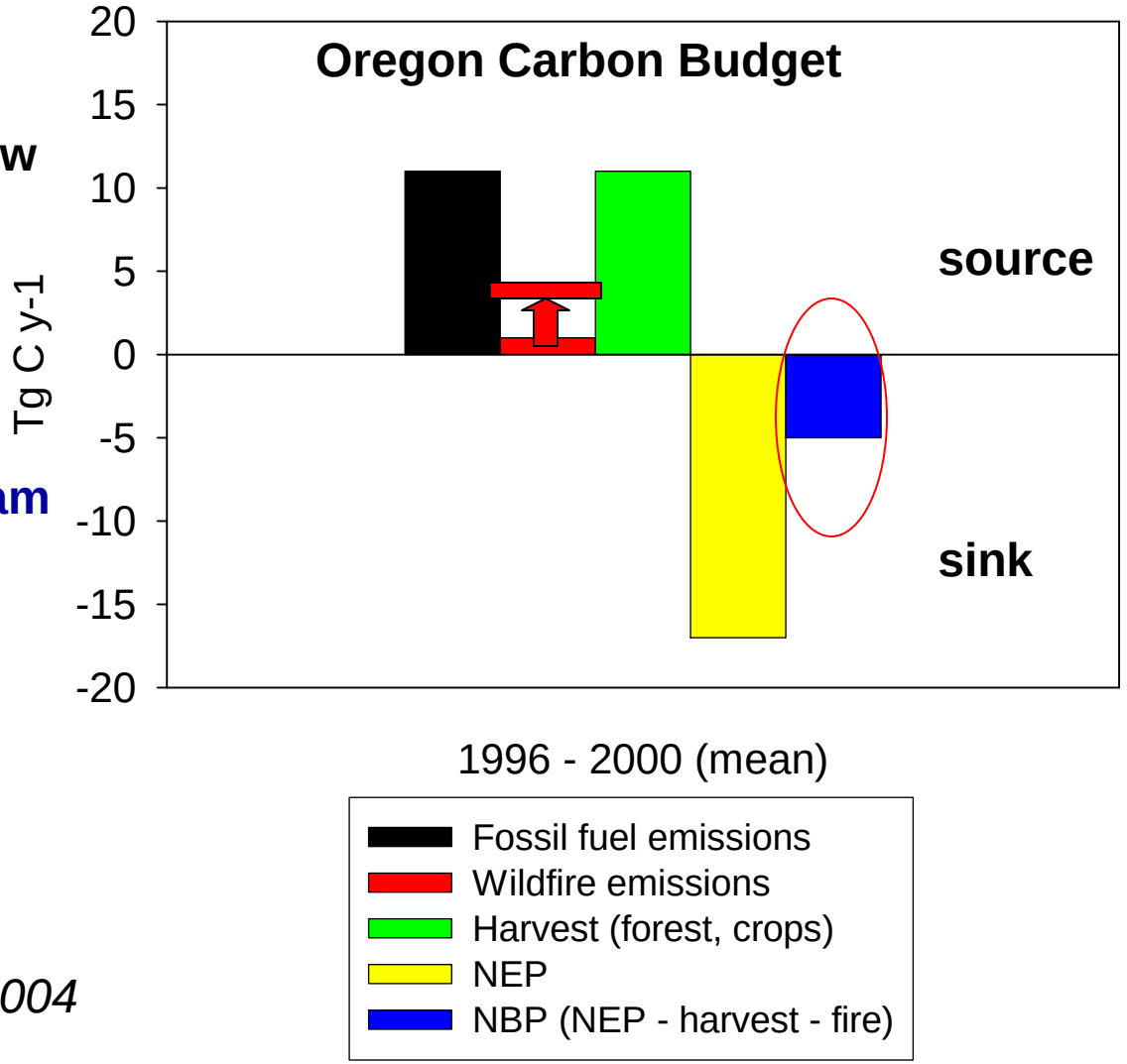

# OR, CA

## Annual Net Carbon Uptake

- Strong carbon sink in wet coastal forests
- Carbon source to near neutral in arid Great Basin
- Harvested forests = source of carbon to atmosphere for 5-20 yrs

# Regional Analysis of Carbon Balance that Influences Atmospheric $CO_2$ scenarios

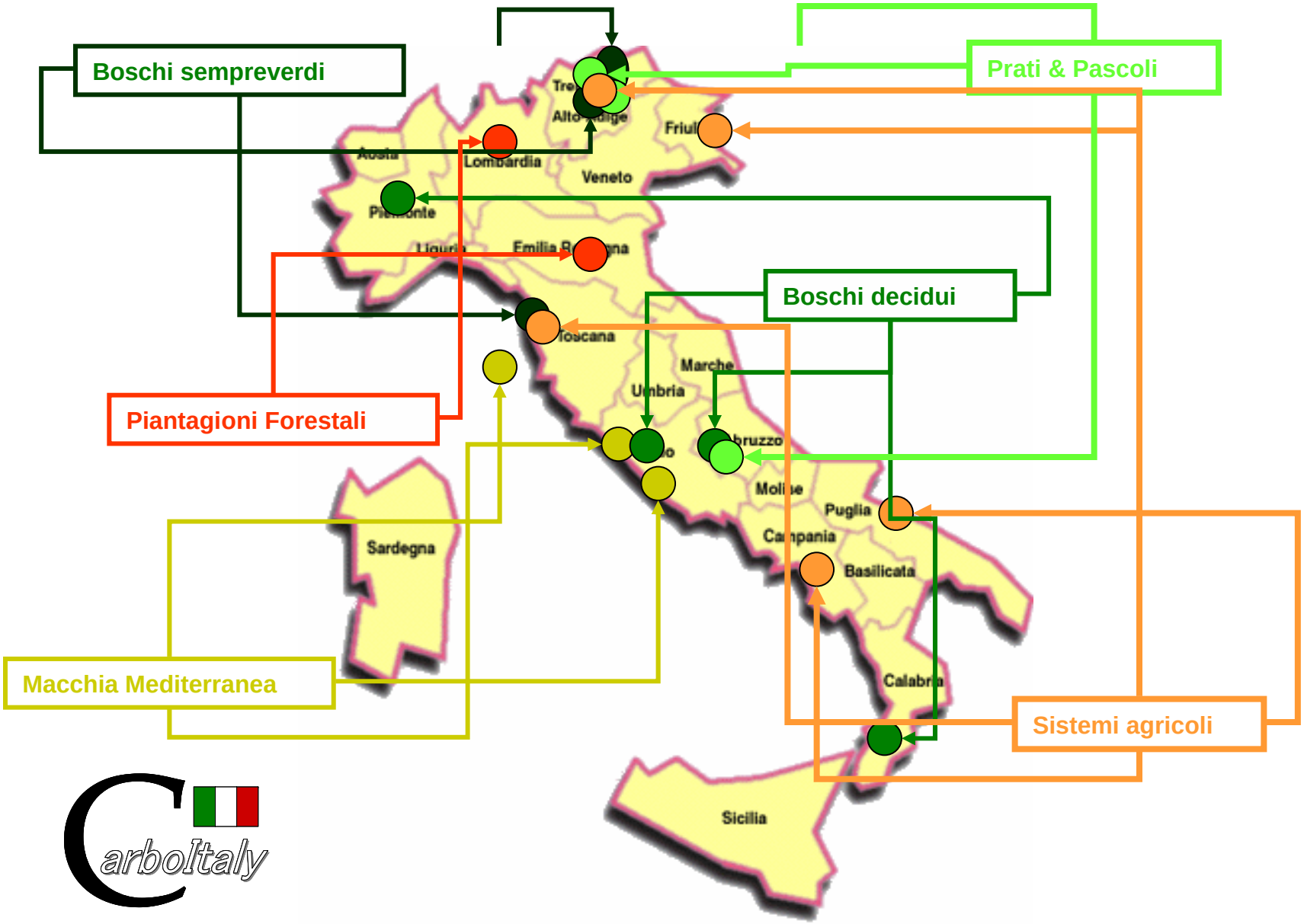
- **Harvest as high as fossil fuel**
- **Wildfire emissions relatively low except in fire year (2002)**
- **Terrestrial sink (NBP) offset ~50% of fossil fuel emissions in average fire year**
- **North American Carbon Program – terrestrial ecosystems offset ~30% of fossil fuel emissions (SOCCR - www.nacarbon.org)**



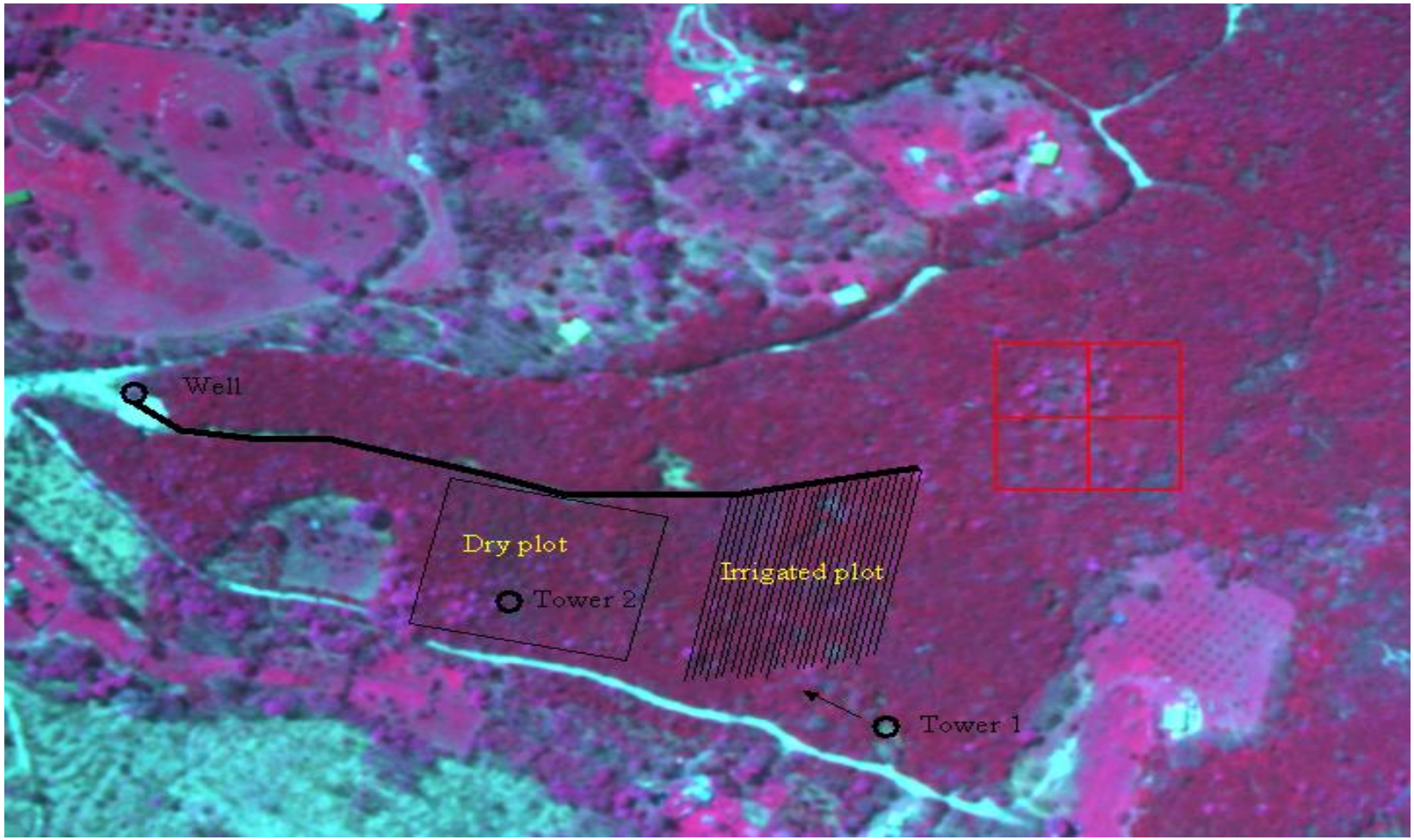

*Law et al. Global Change Biology 2004*

*Turner et al. BGD (accepted)*

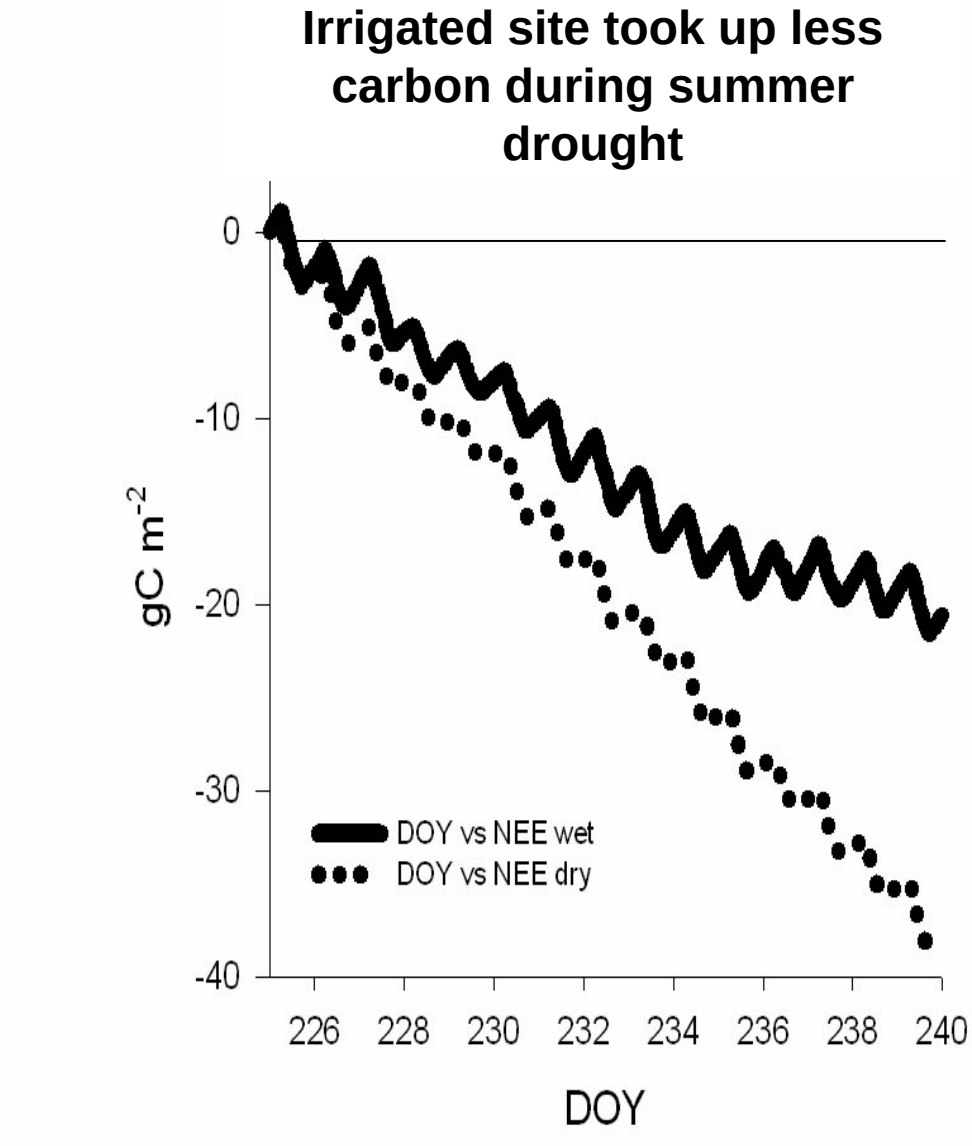
# Flux Network for Analysis & Models



# Water Manipulation Study - Italy



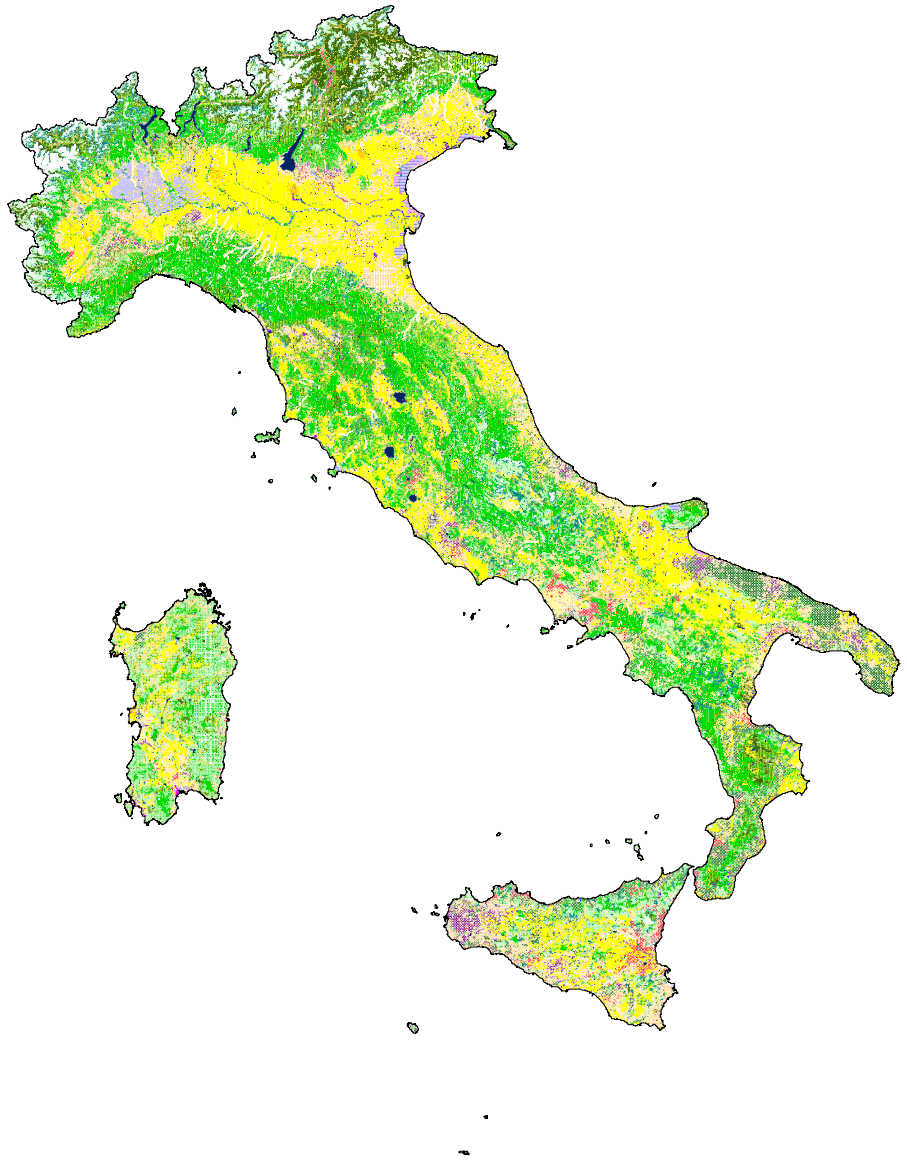
# Carbon Uptake Dry vs Wet Forest: Italy

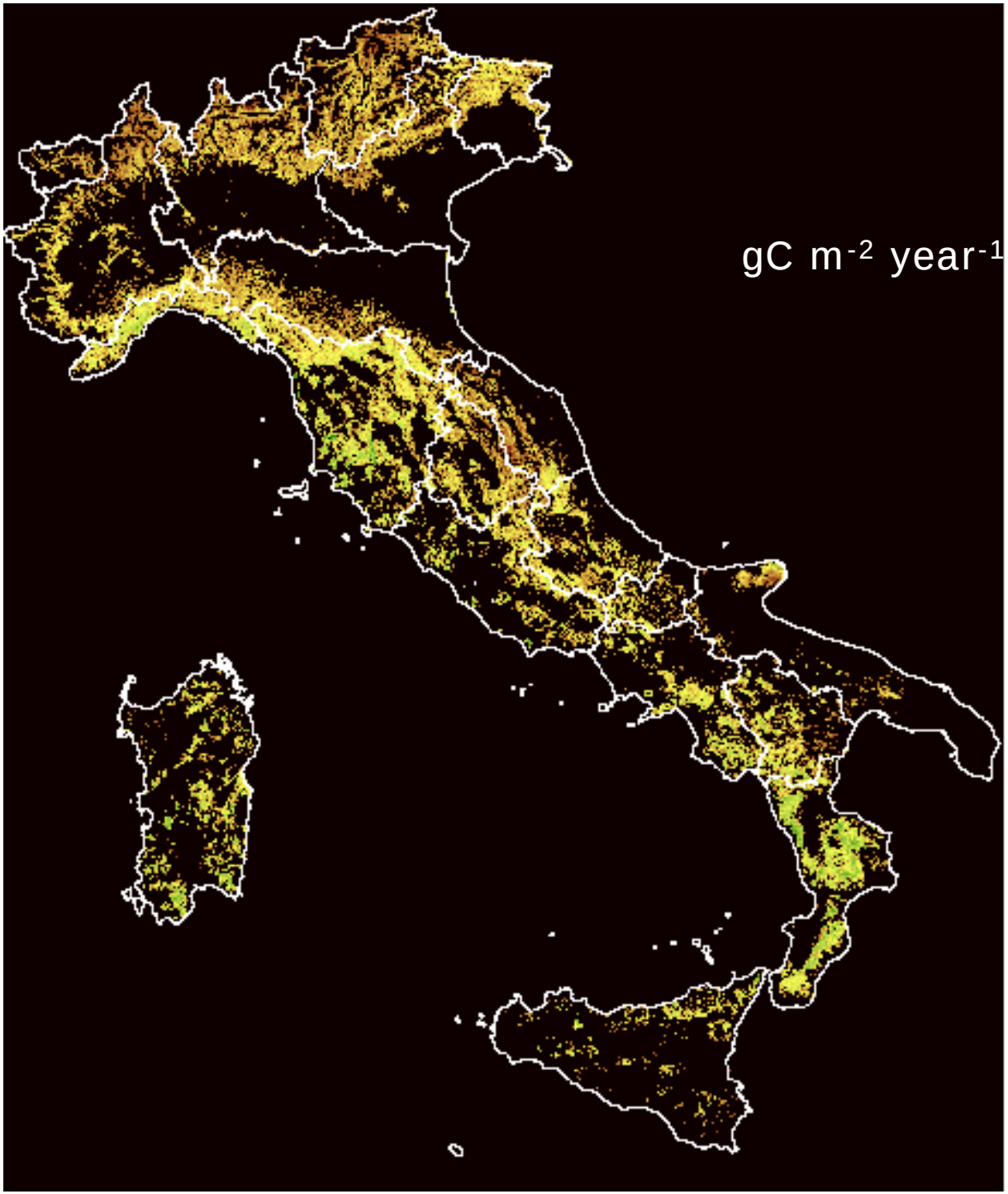


# Italy Land Cover

Legend

- Continuous urban fabric
- Discontinuous urban fabric
- Industrial or commercial units
- Road and rail networks and associated land
- Port areas
- Airports
- Mineral extraction sites
- Dump sites
- Construction sites
- Green urban areas
- Sport and leisure facilities
- Non-irrigated arable land
- Permanently irrigated land
- Rice fields
- Vineyards
- Fruit trees and berry plantations
- Olive groves
- Pastures
- Annual crops associated with permanent crops
- Complex cultivation patterns
- Land principally occupied by agriculture, with areas of nat. veget.
- Agro-forestry areas
- Broad-leaved forest
- Coniferous forest
- Mixed forest
- Natural grasslands
- Moors and heathland
- Transitional woodland-shrub
- Sclerophyllous vegetation
- Beaches, dunes, sands
- Bare rocks
- Sparsely vegetated areas
- Burnt areas
- Glaciers and perpetual snow
- Inland marshes
- Peat bogs
- Salt marshes
- Salines
- Intertidal flats
- Water courses
- Water bodies
- Coastal lagoons
- Estuaries






# Italy Net Primary Productivity

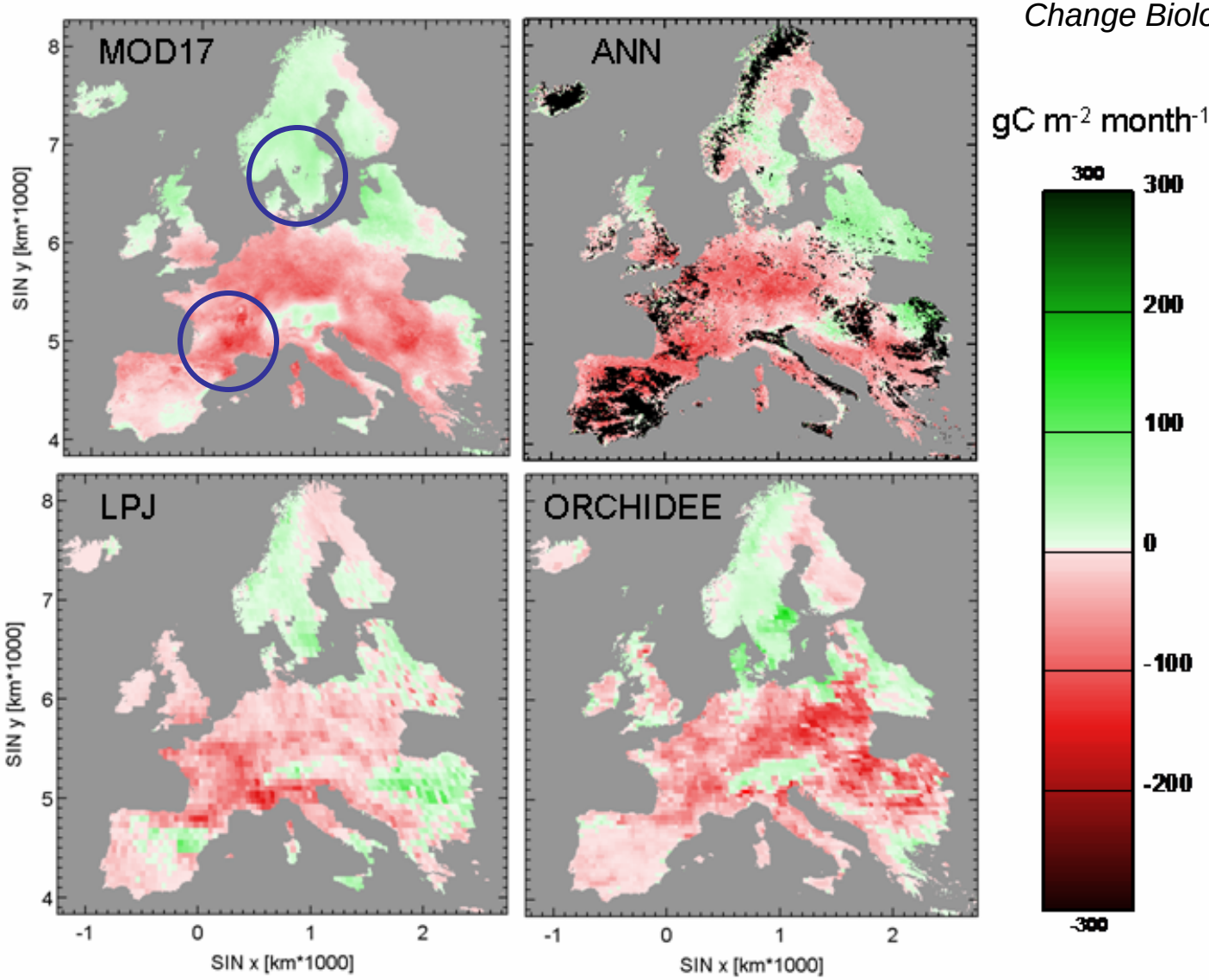
*C-NPP* estimates obtained by the applied integration procedure for the 12 forest types considered

| Class index | Forest type | Average estimated *C-NPP* (g m$^{-2}$ year$^{-1}$) |
|---|---|---|
| 1 | White fir/Norway spruce forest | 465.1 |
| 2 | Chestnut forest | 654.8 |
| 3 | Exotic conifer forest | 638.8 |
| 4 | Beech forest | 619.8 |
| 5 | Exotic broadleaf forest | 662.5 |
| 6 | Hygrophilous broadleaf forest | 585.7 |
| 7 | Mediterranean broadleaves | 579.3 |
| 8 | Holm oak | 752.8 |
| 9 | Bushlands | 558.2 |
| 10 | Mediterranean pine forest | 669.9 |
| 11 | Mountain pine forest | 642.3 |
| 12 | Other oaks | 688.8 |

**Chirici et al. 2007, Forest. Ecol. Manage.**

# GPP Anomaly in Europe:
# Dry Summer (2003) minus Avg Summer (2000-2002)

*Reichstein et al. Global Change Biology 2006*



# Collaboration Summary

- Data Harmonization
  - CarboEurope standardized data processing transferred to US
  - AmeriFlux database design and data submission protocols transferred to CarboItaly
- Planned Analysis
  - Compare relative influence of climate and disturbance on the carbon balance of the two regions (effects of forest harvest, droughts)

# Organizational Collaborations

- CarboEurope, AmeriFlux networks
- COCOS (EU proposal)
- GTOS Terrestrial Carbon Observatory

# GTOS Mission

- Goals
  - identify potential end users and their requirements
  - organize and coordinate reliable data, information on carbon
  - link science community with potential users
- Mission - focus on specific products
  - manuals, standard methodologies, related documentation
  - operational database system
  - validated and parameterized models
  - Common forum

http://www.fao.org/gtos/tcoABT.html

# Current GTOS TCO Activities

Expanding on US-Italy collaboration to global terrestrial science community:

- Harmonizing flux network databases
  - Propose adoption of AmeriFlux data submission protocols in related EU and Italy projects (CarboEurope, CarboAfrica, CarboItaly, IMECC, ICOS, COCOS…)
  - Encourage global use of AmeriFlux data submission protocols
  - AmeriFlux adopted CarboEurope gap-filling, QA; encourage same of other networks
- Biological field measurement protocols
  - West Coast field manual – revise for broader use, possibly publish through FAO
- Compare approaches of data-oriented models and process-oriented models (US-Italy collaboration)

# Acknowledgements


- Oregon State University
  - Dave Ritts (modeling)
  - Maureen Duane (remote sensing)
- University of Tuscia
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