



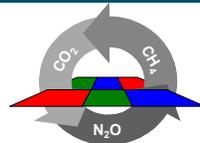
European agriculture: an additional source of greenhouse gases

R.W.A. Hutjes, G.J. Nabuurs,
A. Verhagen

European GHG emissions

Overview

- Climate change and greenhouse gases
- GHG budget European biosphere
 - CO_2
 - CH_4
 - N_2O
- Possibilities for mitigation in agriculture and forestry

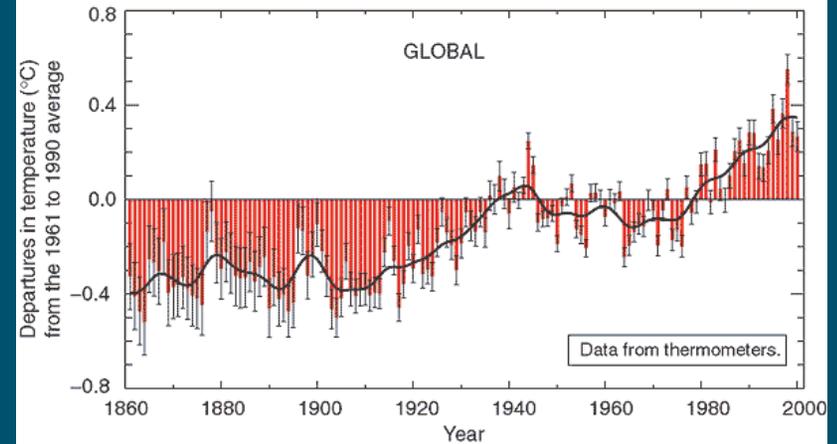


European GHG emissions

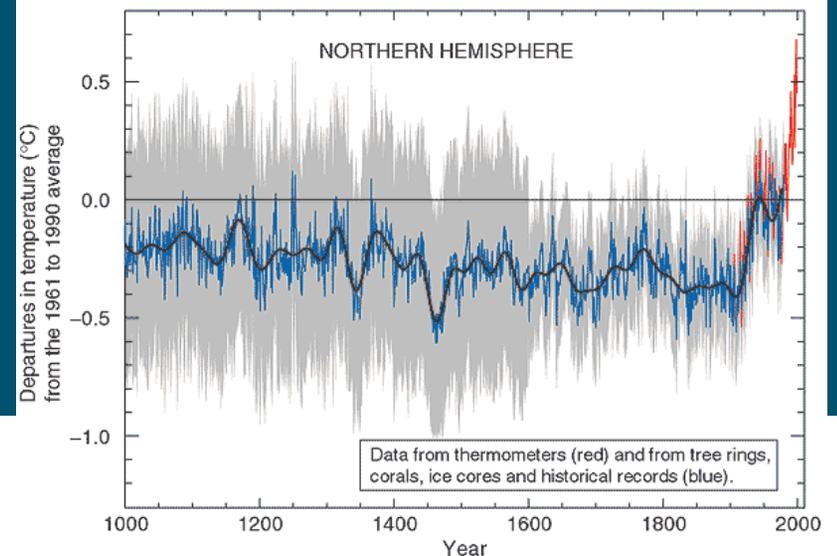
Climate change and greenhouse gases

- Temperature increase

(a) the past 140 years



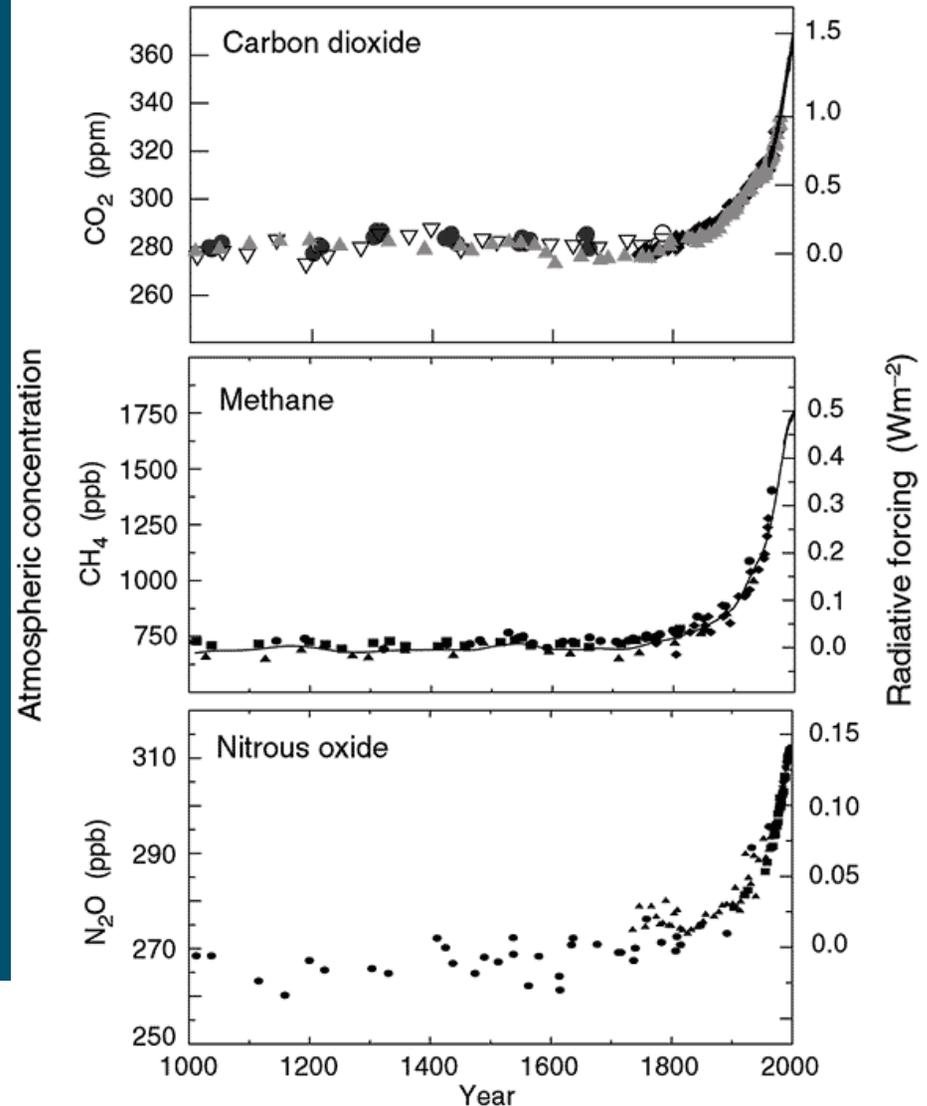
(b) the past 1,000 years



European GHG emissions

Climate change and greenhouse gases

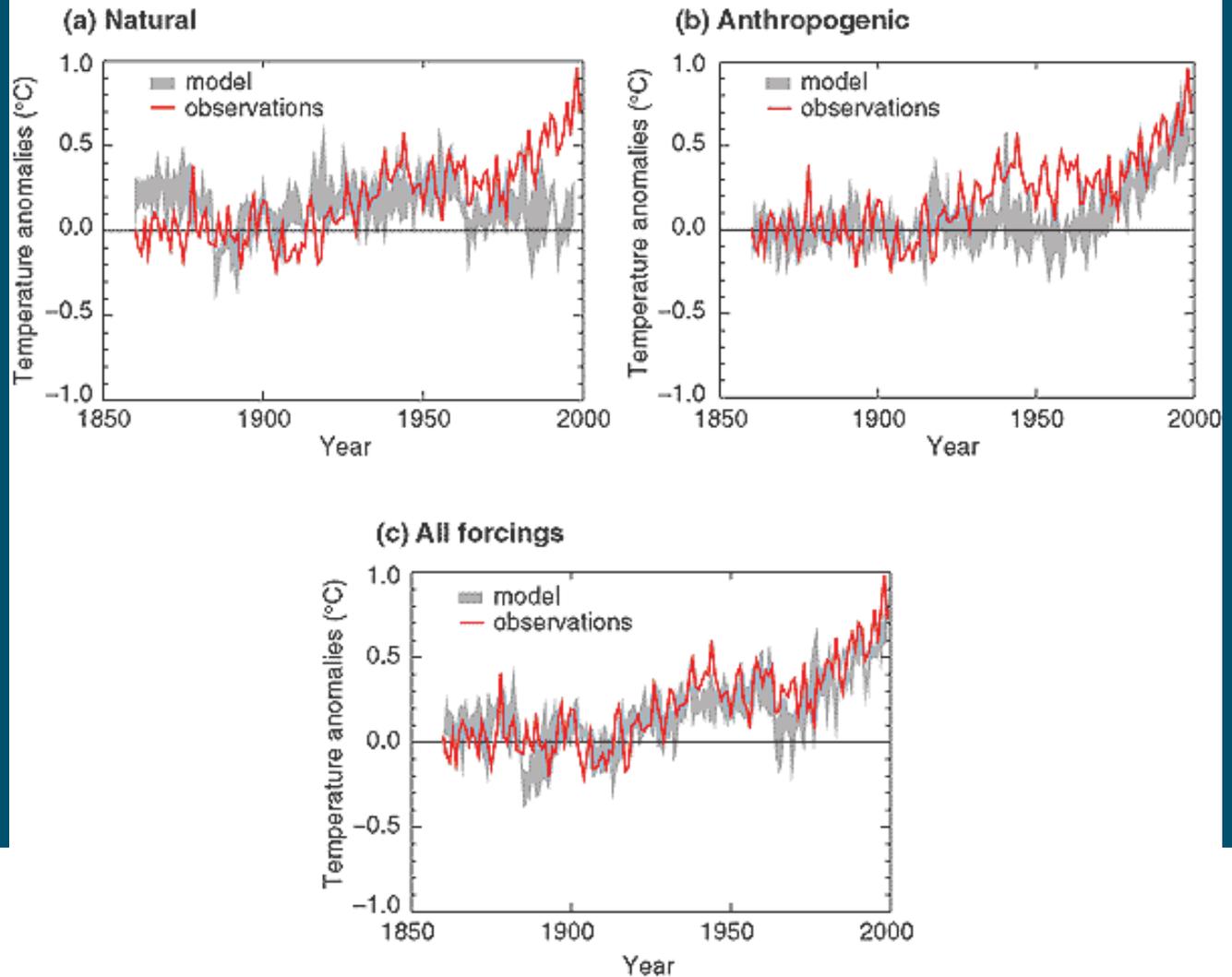
- GHG increase



European GHG emissions

Climate change and greenhouse gases

Simulated annual global mean surface temperatures

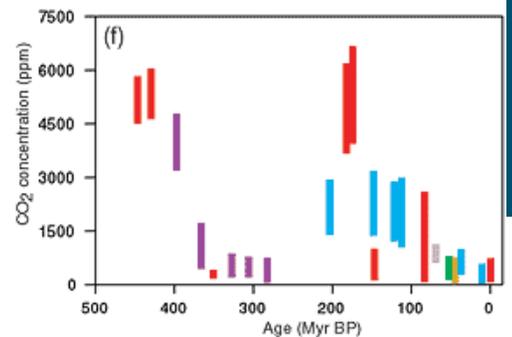
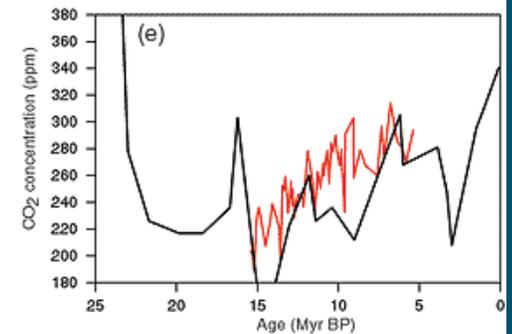
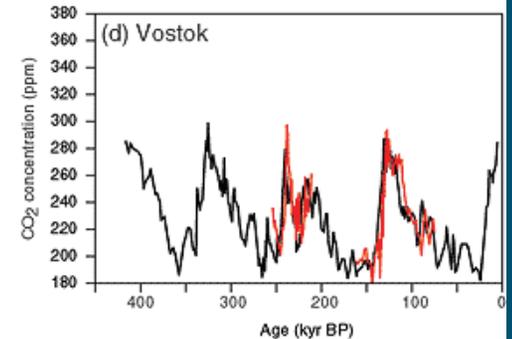
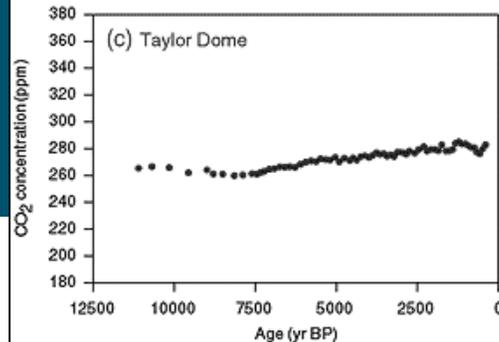
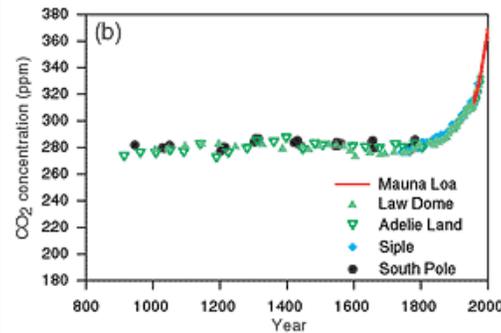
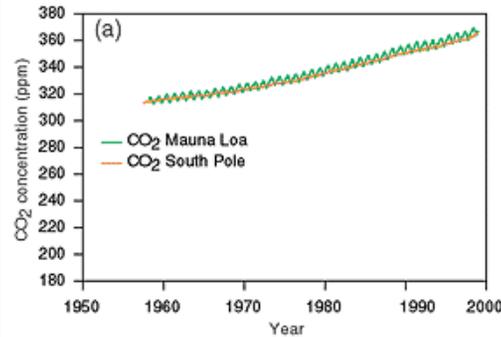


European GHG emissions

Climate change and greenhouse gases

- CO₂ variability

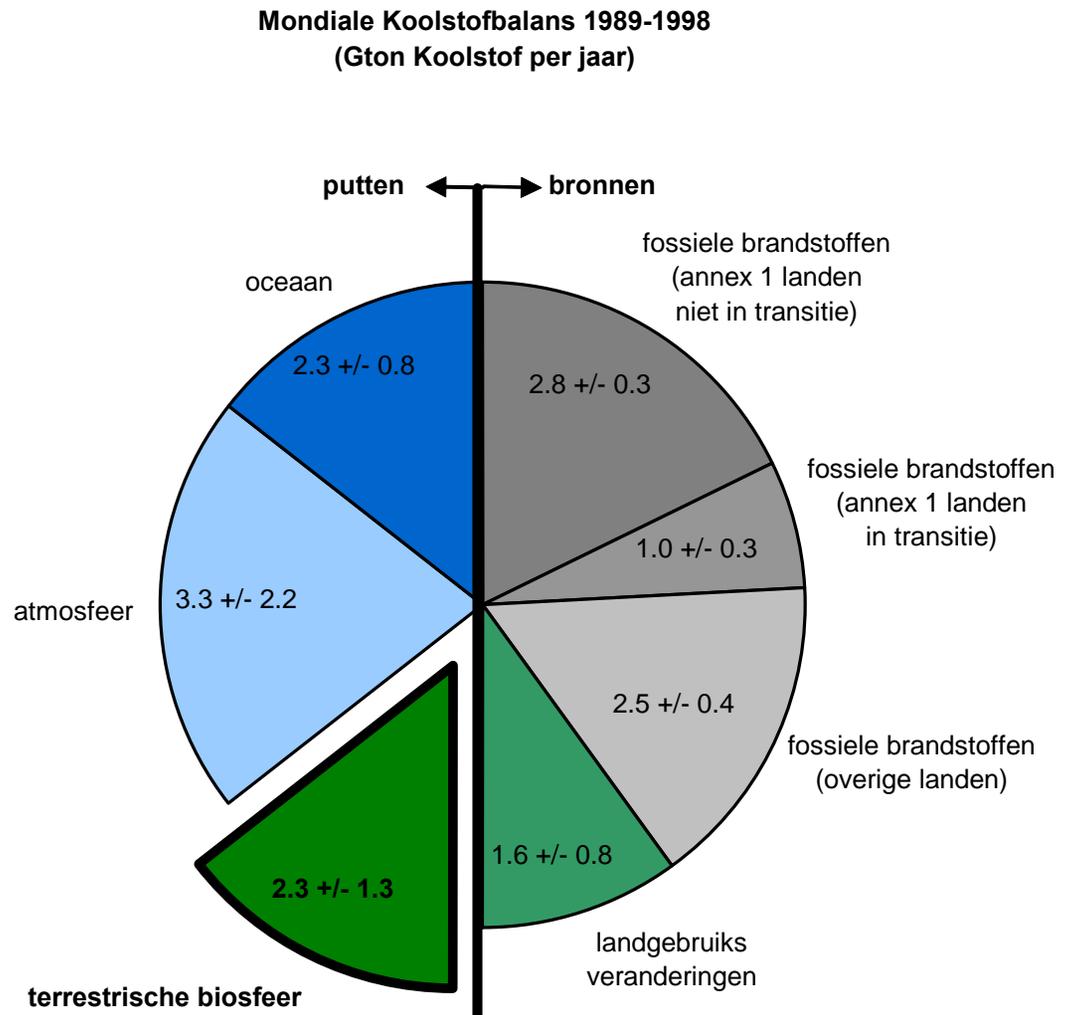
Variations in atmospheric CO₂ concentrations on different time-scales



European GHG emissions

Climate change and greenhouse gases

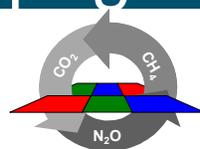
- CO₂ sources



European GHG emissions

GHG budget European biosphere- CO_2

- Bottom – up
 - Ground based measurements
 - Production statistics
 - Biome Models
- Top – down
 - Atmospheric concentration measurements
 - Transport models
 - A-priori flux estimates
(biosphere, anthropogenic)



European GHG emissions

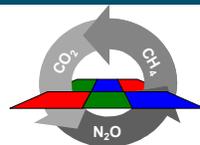
GHG budget European biosphere- CO₂

- Bottom – up combined Top – down

Science, Vol. 300, Issue 5625, 1538-1542, June 6, 2003

Europe's Terrestrial Biosphere Absorbs 7 to 12% of European Anthropogenic CO₂ Emissions

Ivan A. Janssens, Annette Freibauer, Philippe Ciais, Pete Smith, Gert-Jan Nabuurs, Gerd Folberth, Bernhard Schlamadinger, Ronald W. A. Hutjes, Reinhart Ceulemans, E.-Detlef Schulze, Riccardo Valentini, A. Johannes Dolman

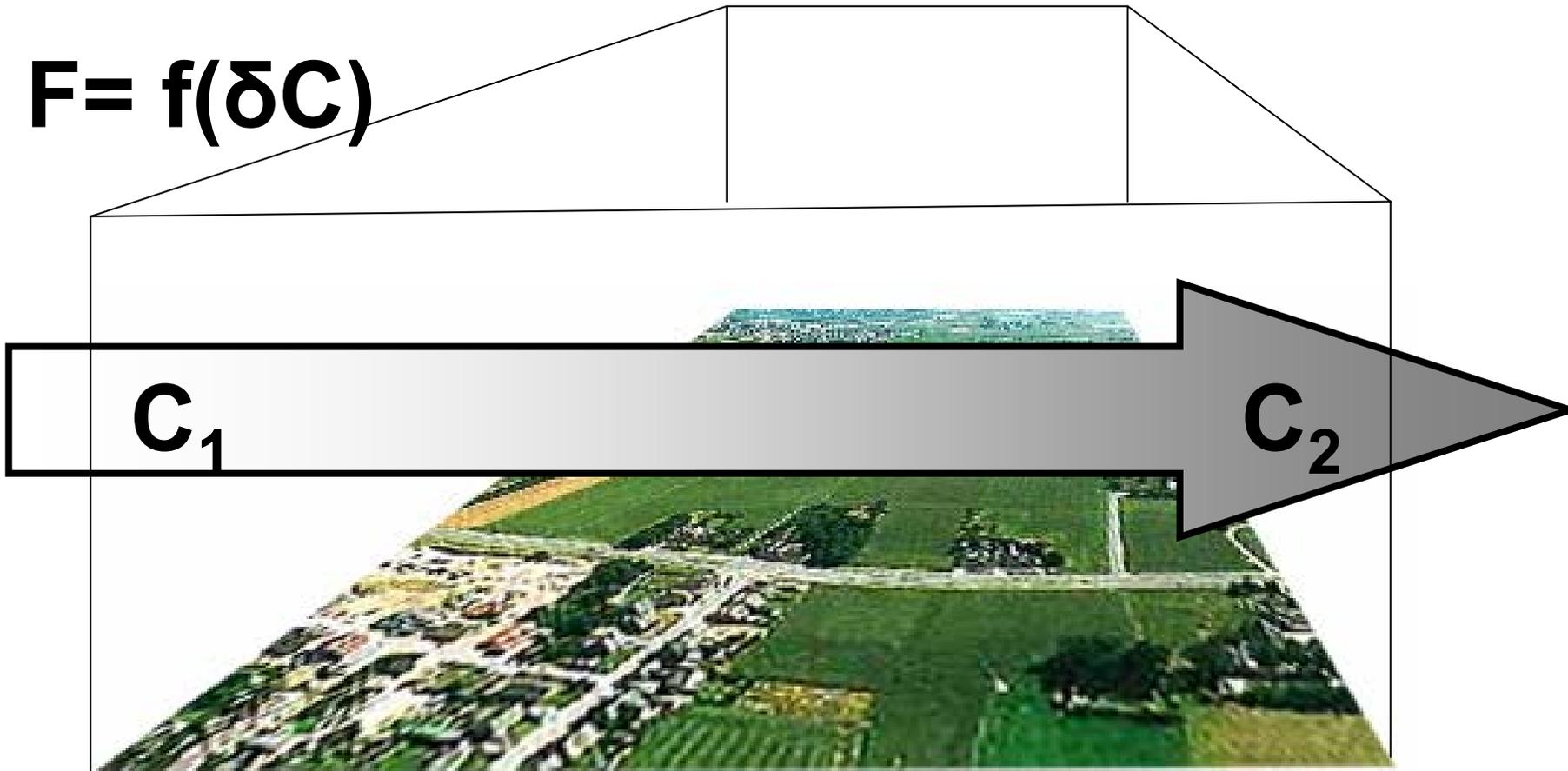


European GHG emissions

GHG budget European biosphere- CO_2

- Top-down – measurements

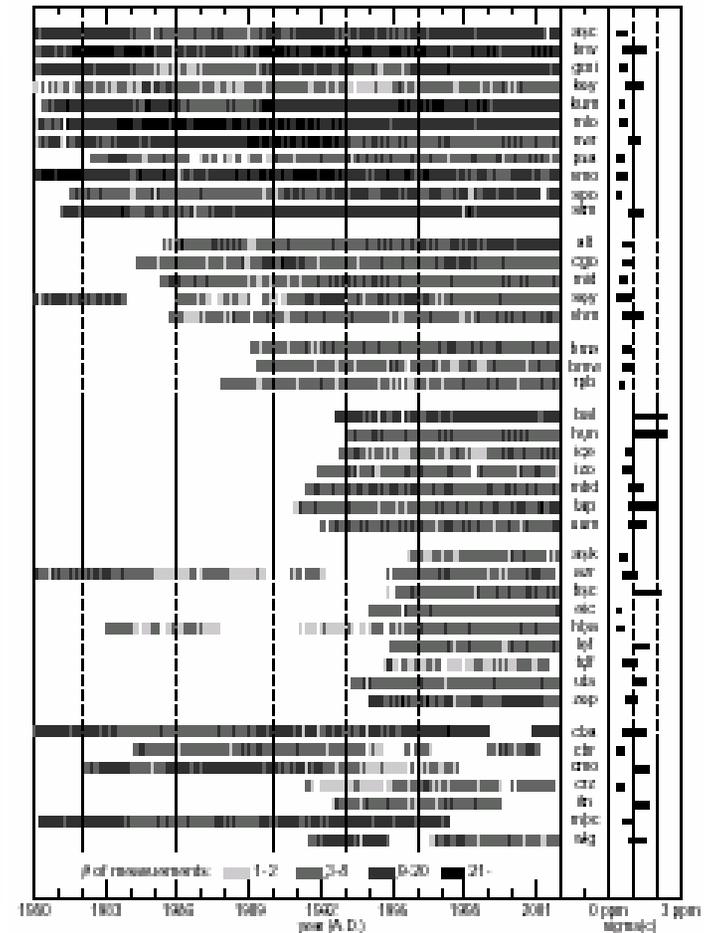
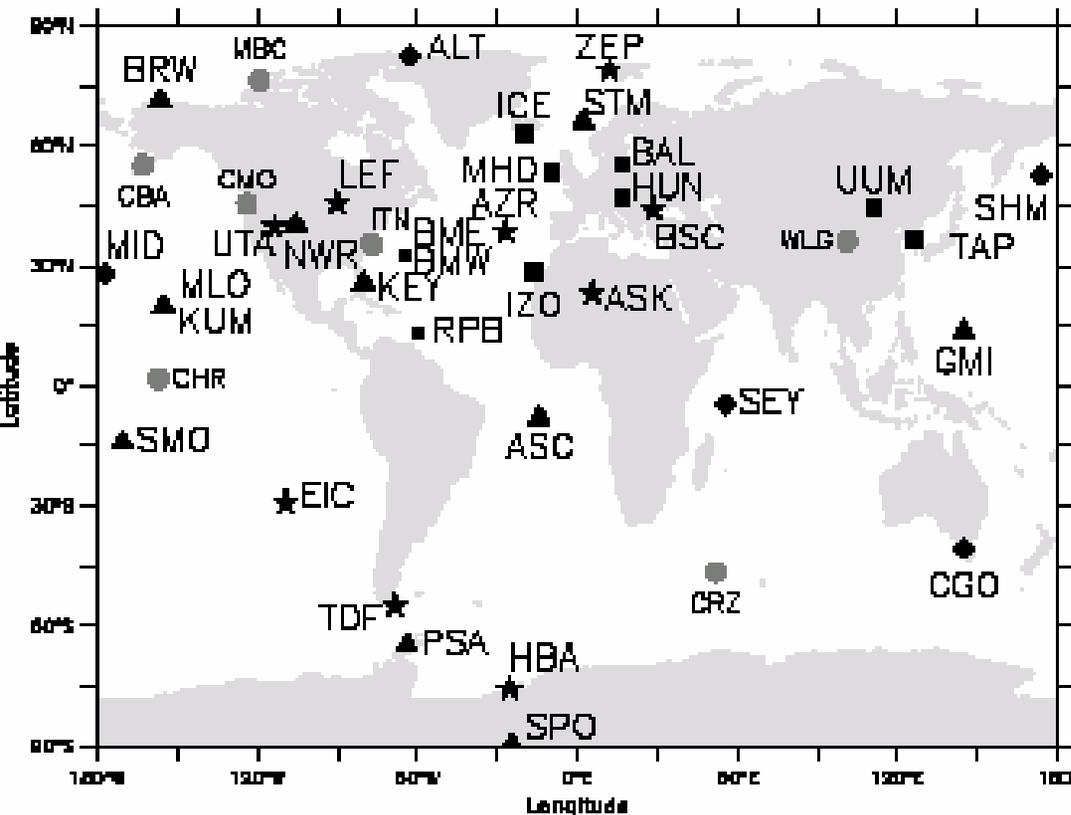
$$F = f(\delta C)$$



European GHG emissions

GHG budget European biosphere- CO₂

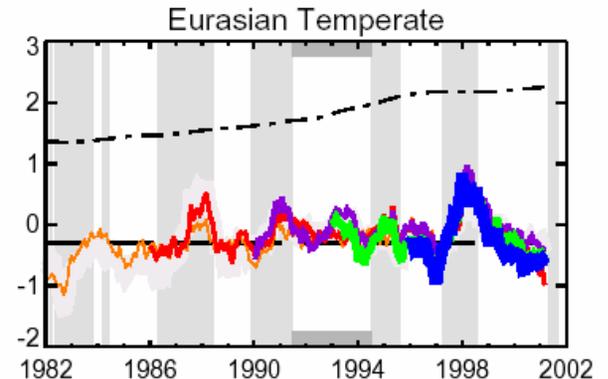
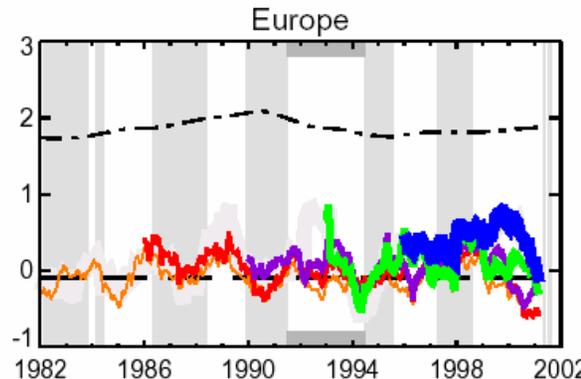
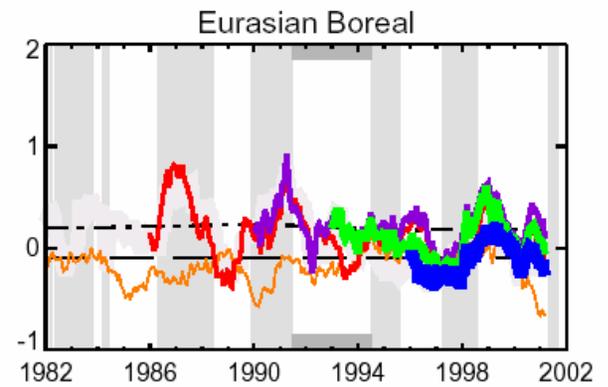
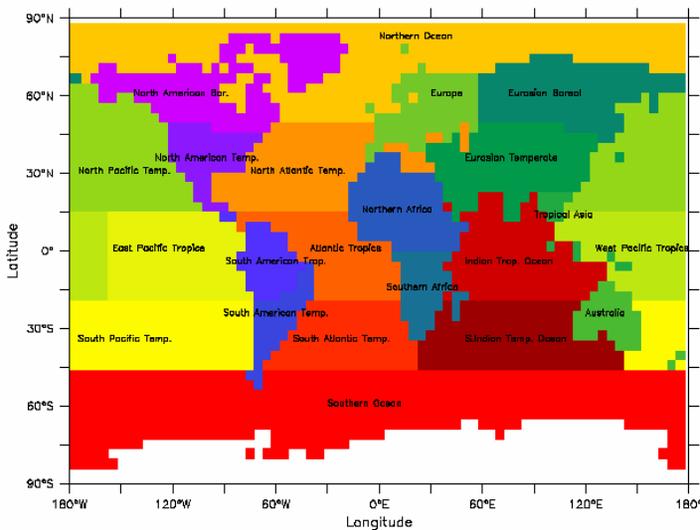
- Top-down – measurements



European GHG emissions

GHG budget European biosphere- CO₂

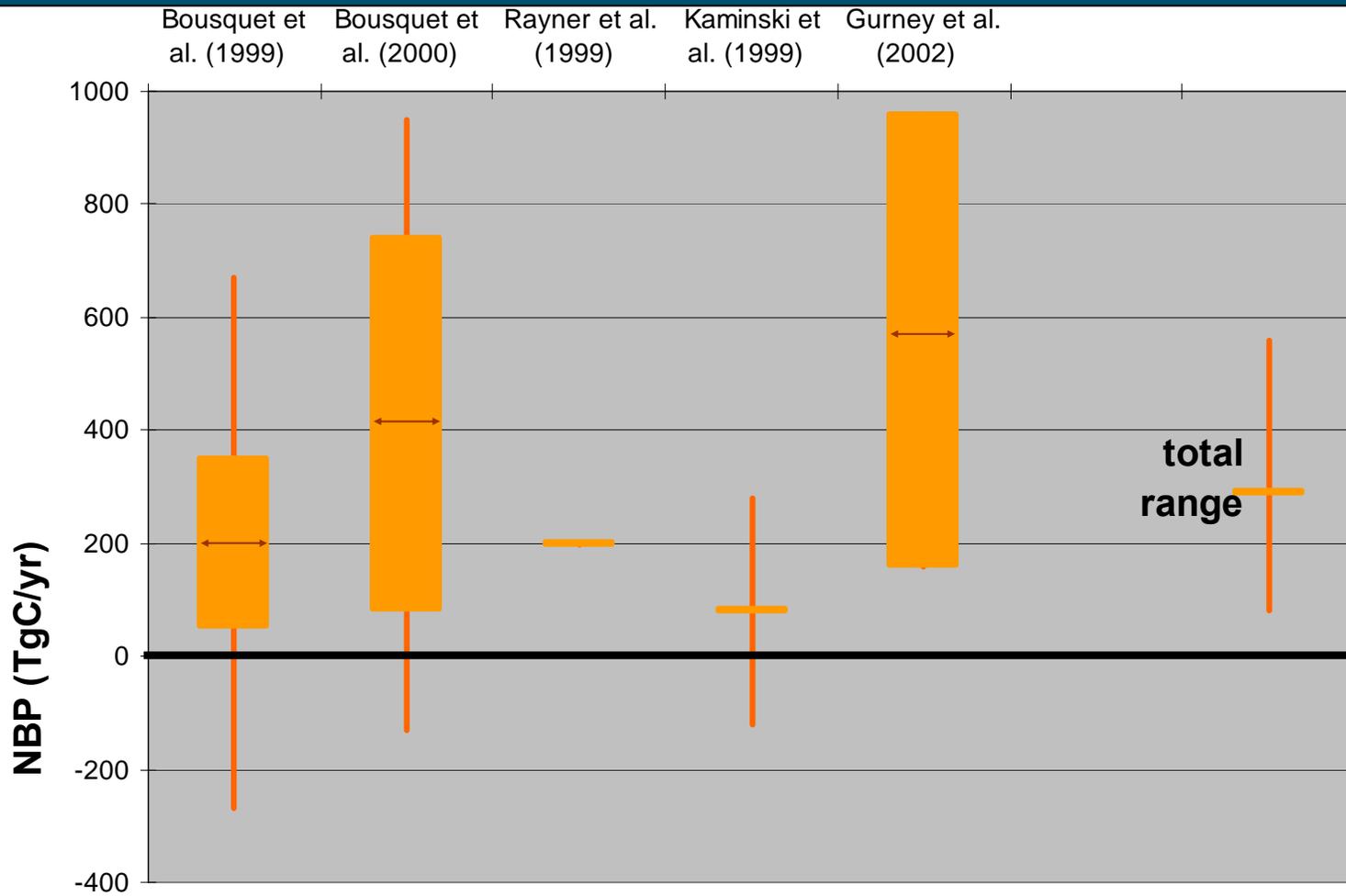
- Top-down – measurements



European GHG emissions

GHG budget European biosphere- CO₂

- Top-down



European GHG emissions

GHG budget European biosphere- CO₂

Top-down average 290 TgC/yr
range 80 – 560 TgC/yr

Corrections

- Uncertainty fossil fuel 7.5% ~140TgC/yr
- C losses in CO, CH₄, VOCs
 - respectively 20, 50, 35 TgC/yr
- Intercontinental trade food/wood
 - Respectively 16, 4

Total 290 - 105 + 20 = 205

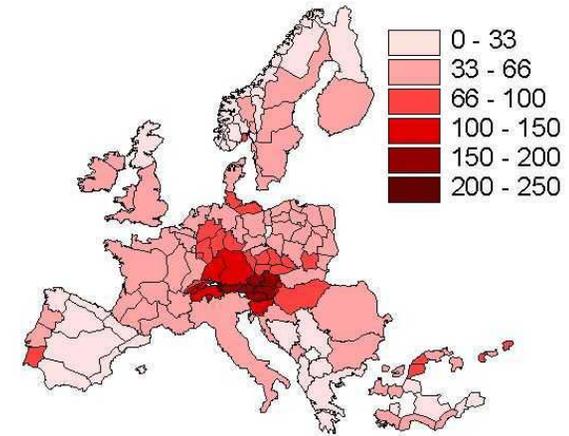
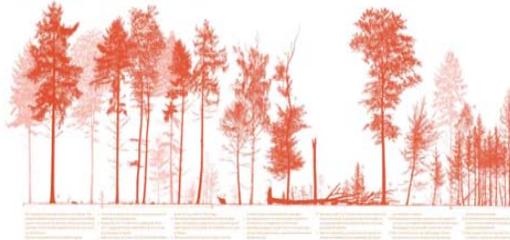
European GHG emissions

GHG budget European biosphere- CO₂

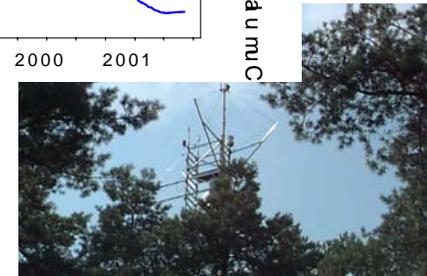
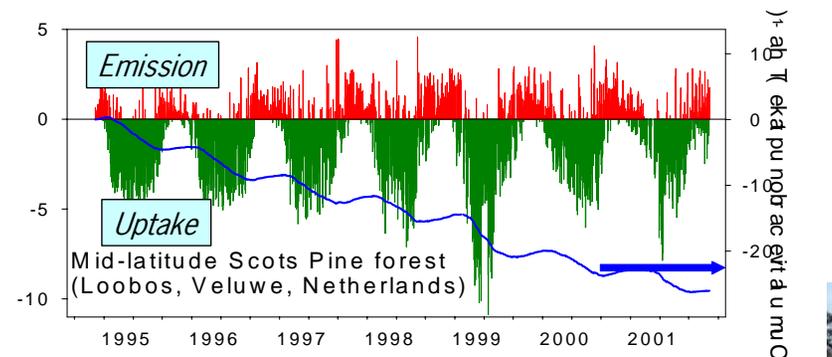
Bottom – up

- Forests
 - Inventories

Honderdwingtig meter pijnboom bos



– Fluxtowers



European GHG emissions

GHG budget European biosphere- CO_2

Bottom – up

- Forests

– Inventories	50 biomass	+	20 soil	70
– Soil studies			110 soil	160
– Flux towers	(185* 0.47)			92

Average

110
 $\text{gCm}^{-2}\text{y}^{-1}$

European GHG emissions

GHG budget European biosphere- CO_2

Bottom – up

- Agriculture production statistics
 - FAO, EUSTAT
 - Representative crops
- Steady state biome model CESAR
 - Yield to Ag, Bg, biomass, residues, litter, etc.

European GHG emissions

GHG budget European biosphere- CO_2

Bottom – up

• Agriculture-croplands	B	A
– CESAR	90	89
– Soil studies	76	24

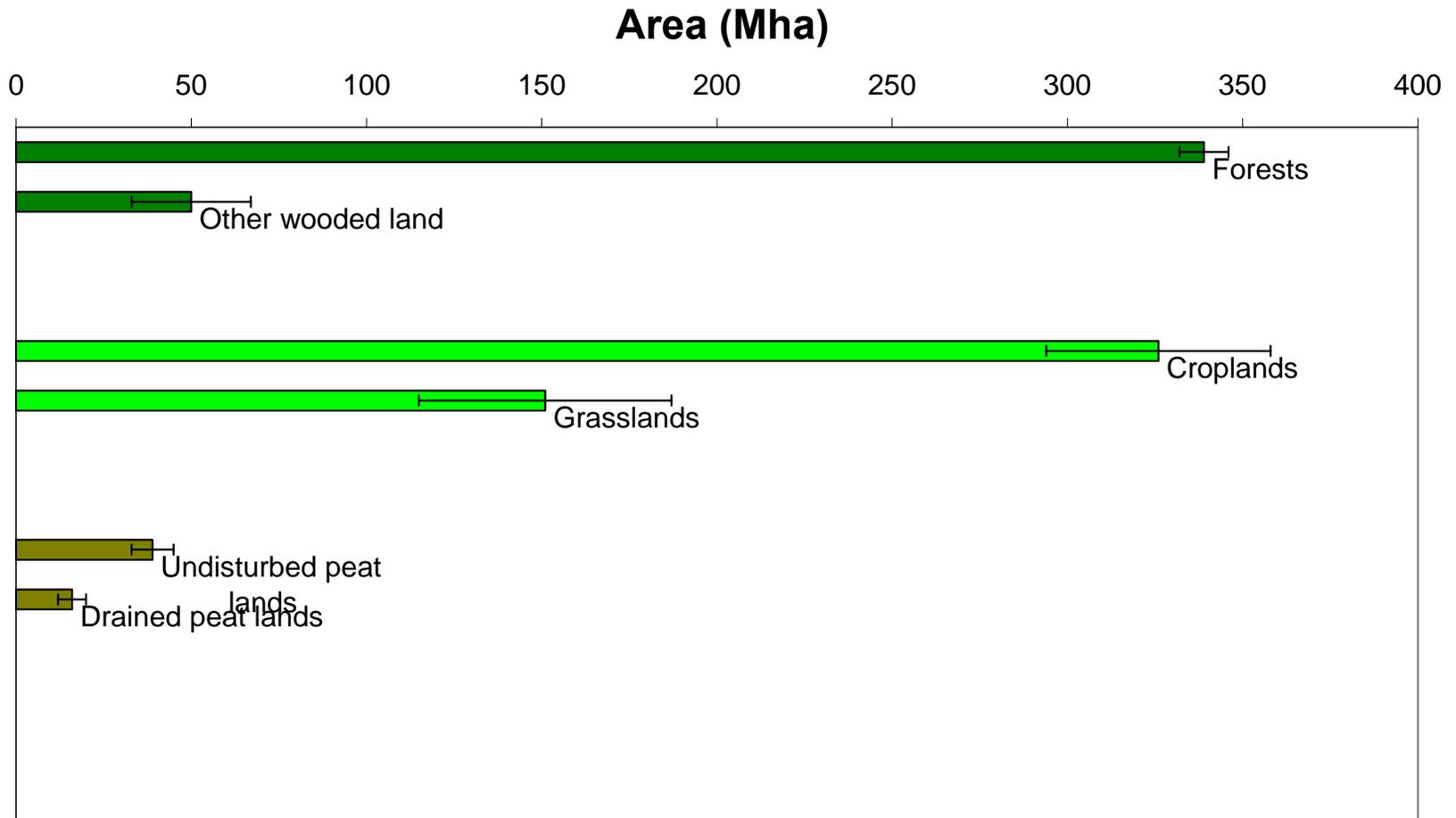
Average EU

92
 $\text{gCm}^{-2}\text{y}^{-1}$

European GHG emissions

GHG budget European biosphere- CO₂

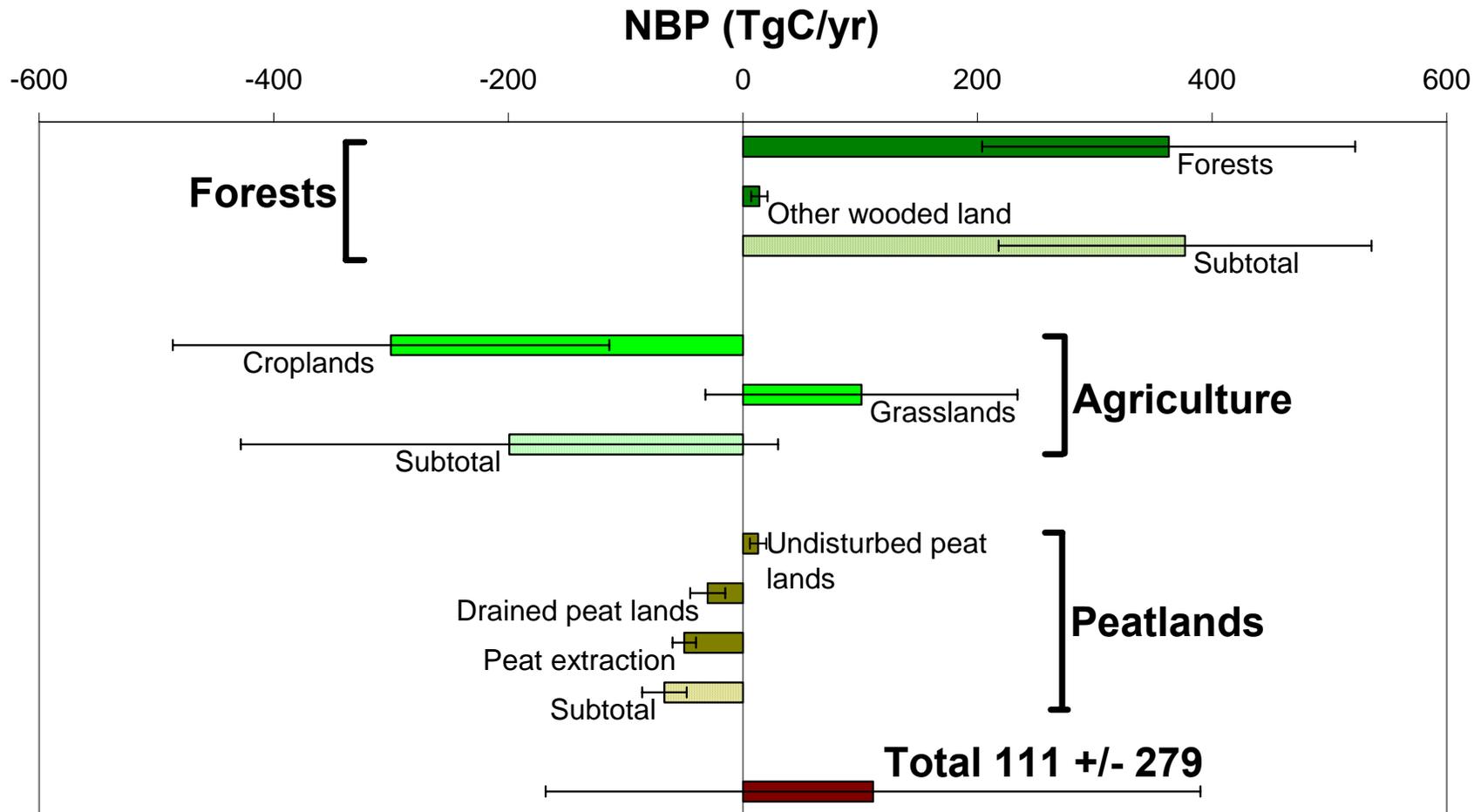
- Bottom – up



European GHG emissions

GHG budget European biosphere- CO₂

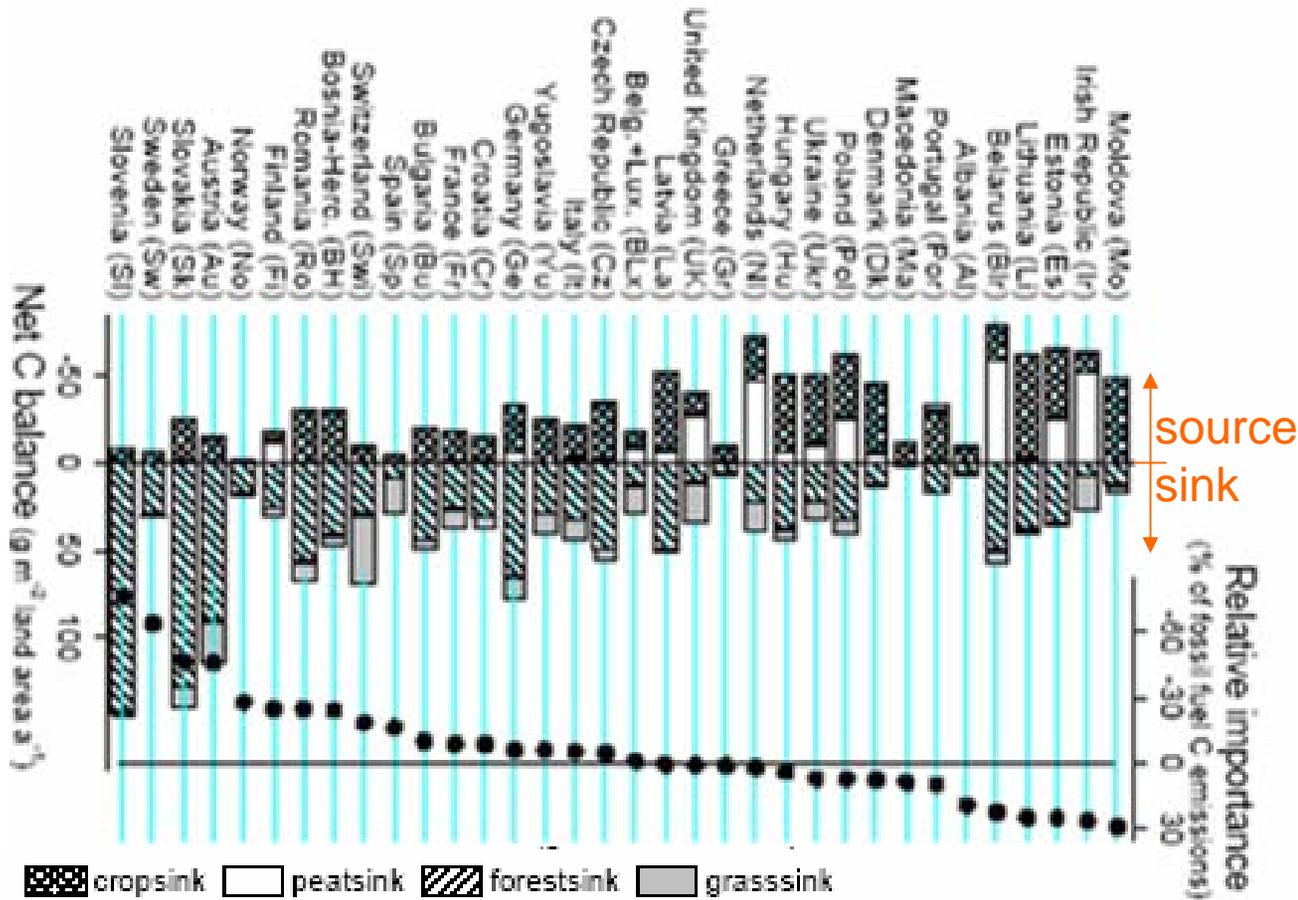
- Bottom – up



European GHG emissions

GHG budget European biosphere- CO₂

- Bottom – up



European GHG emissions

GHG budget European biosphere- CO₂

Bottom – up total 111 +/-279 TgC/yr

Corrections

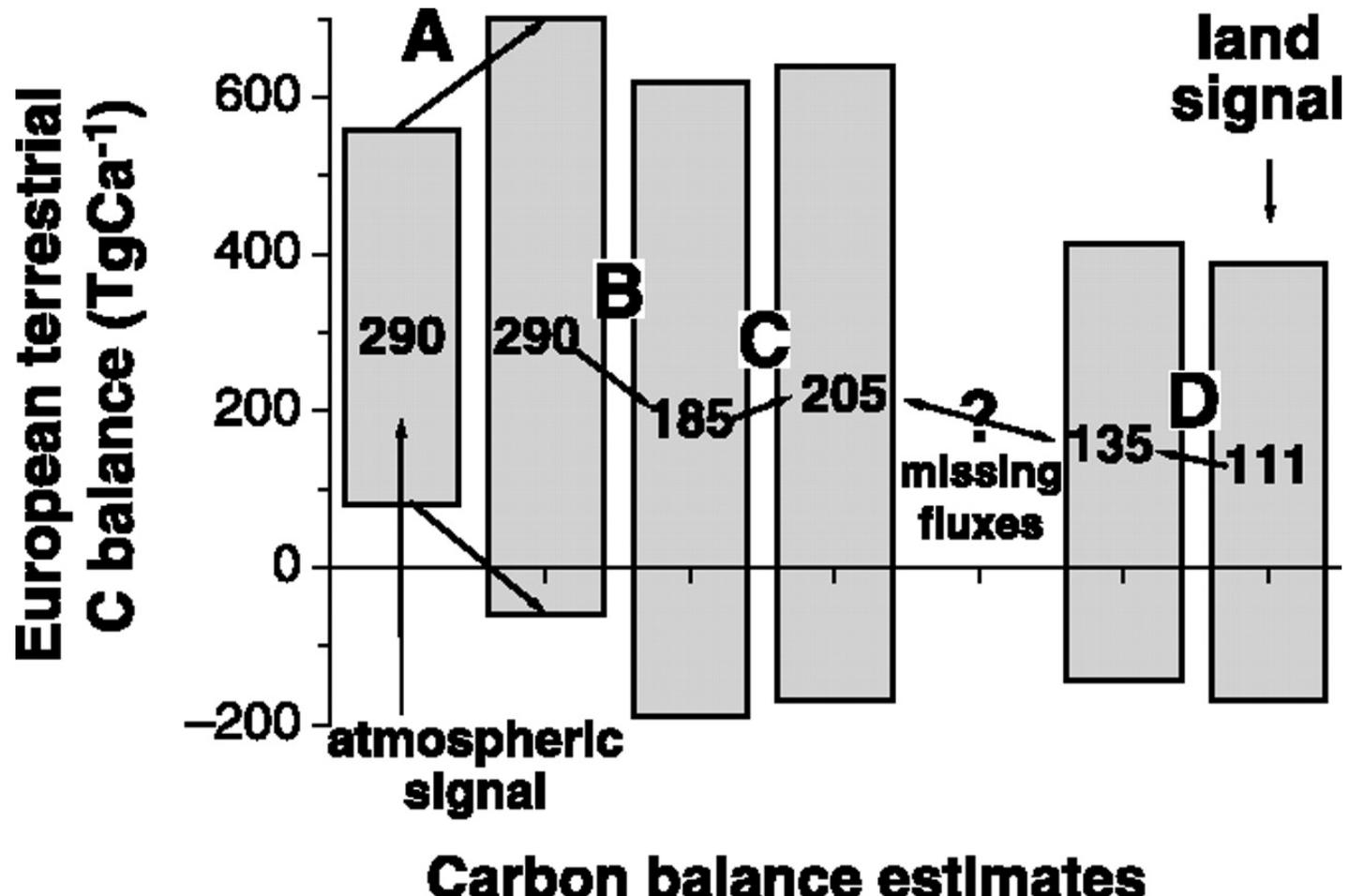
- Wood accumulation 24 TgC/yr

Total 111 + 24 = 235 TgC/yr

European GHG emissions

GHG budget European biosphere- CO₂

- Overall



European GHG emissions

GHG budget European biosphere- CO_2

Missing fluxes ?

- Geologic emissions
 - volcano's, weathering, metamorphosis
- Freshwater ecosystems, estuaries
- Trade outside EU

European GHG emissions

GHG budget European biosphere- CO_2

European terrestrial biosphere is sink

- 135-205 TgC/yr

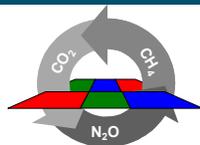
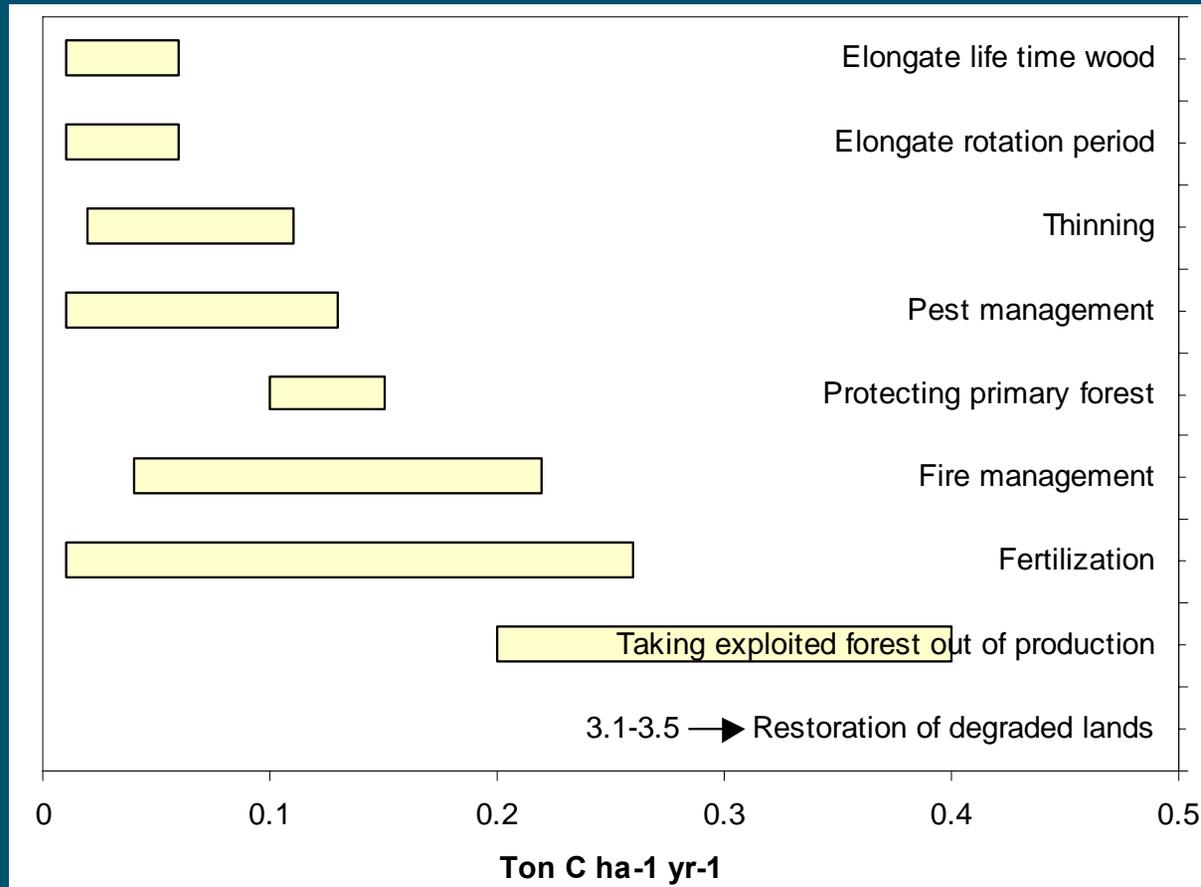
7-12% of anthropogenic emissions

European fossil fuel emissions

- 1870 TgC/yr

European GHG emissions

Possibilities for mitigation - forestry



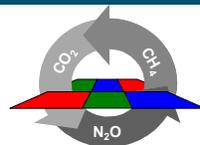
European GHG emissions

Possibilities for mitigation - forestry

COP7 Marrakesh

- Cap on accountable forest management sink 15% = 12 + 33 TgC/yr

Only 12% of 377 TgC/yr forest sink

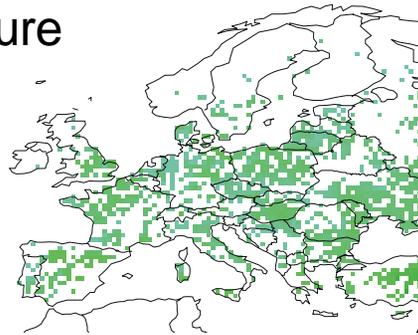


European GHG emissions

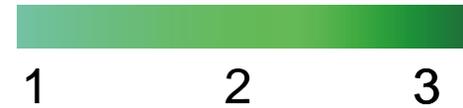
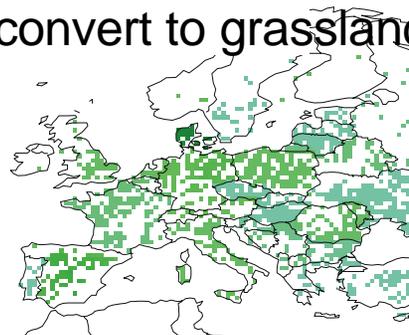
Possibilities for mitigation - agriculture

Cropland
~326 Mha

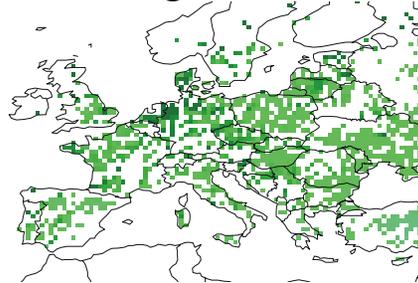
manure



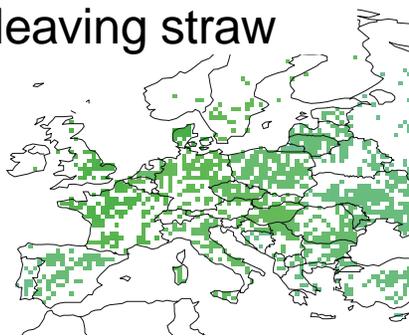
convert to grassland



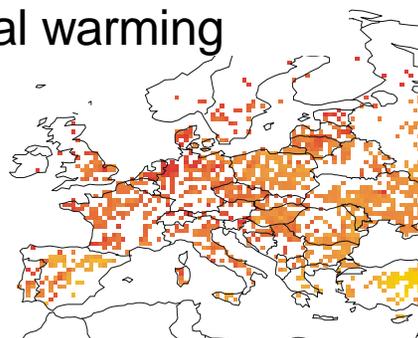
reduced tillage



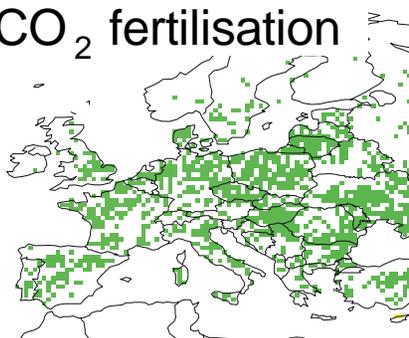
leaving straw



global warming



CO₂ fertilisation



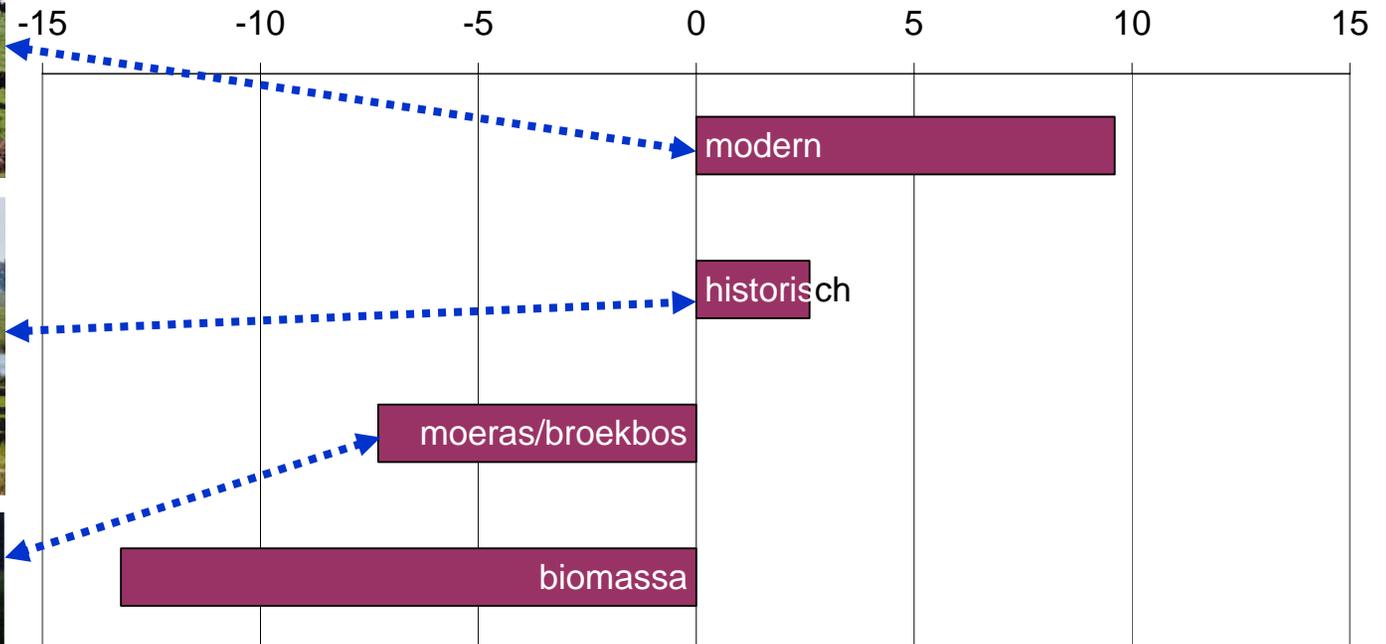
Ton C ha⁻¹ yr⁻¹

European GHG emissions

Possibilities for mitigation - peatlands



CO2 equiv. emissies
Veenweide scenarios

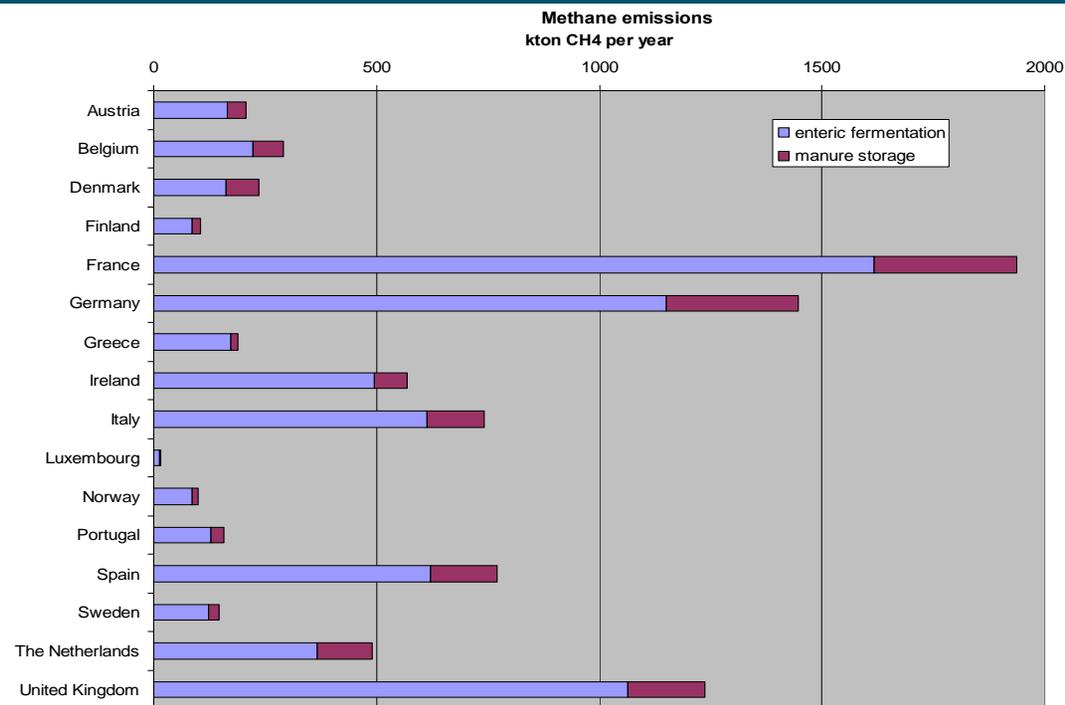
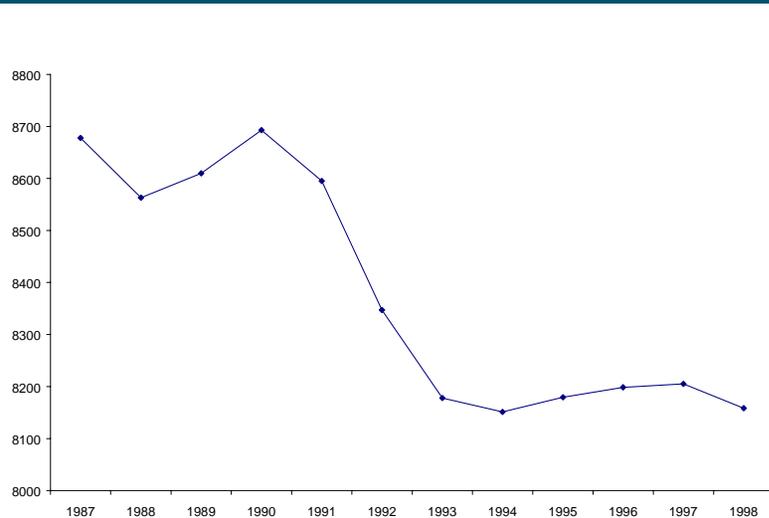


European GHG emissions

GHG budget European biosphere- CH₄

Sources

- Enteric fermentation
- Manure management
- Wetlands
- (Burning)

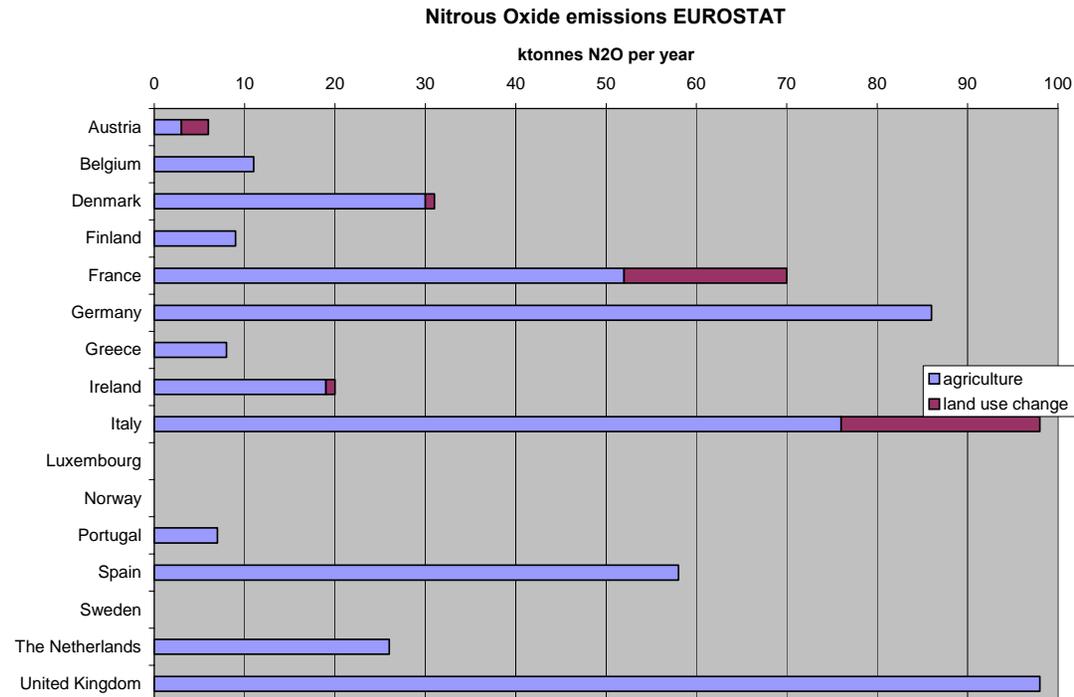


European GHG emissions

GHG budget European biosphere- N₂O

Sources

- Manure/fertiliser management/application
- Indirect emissions

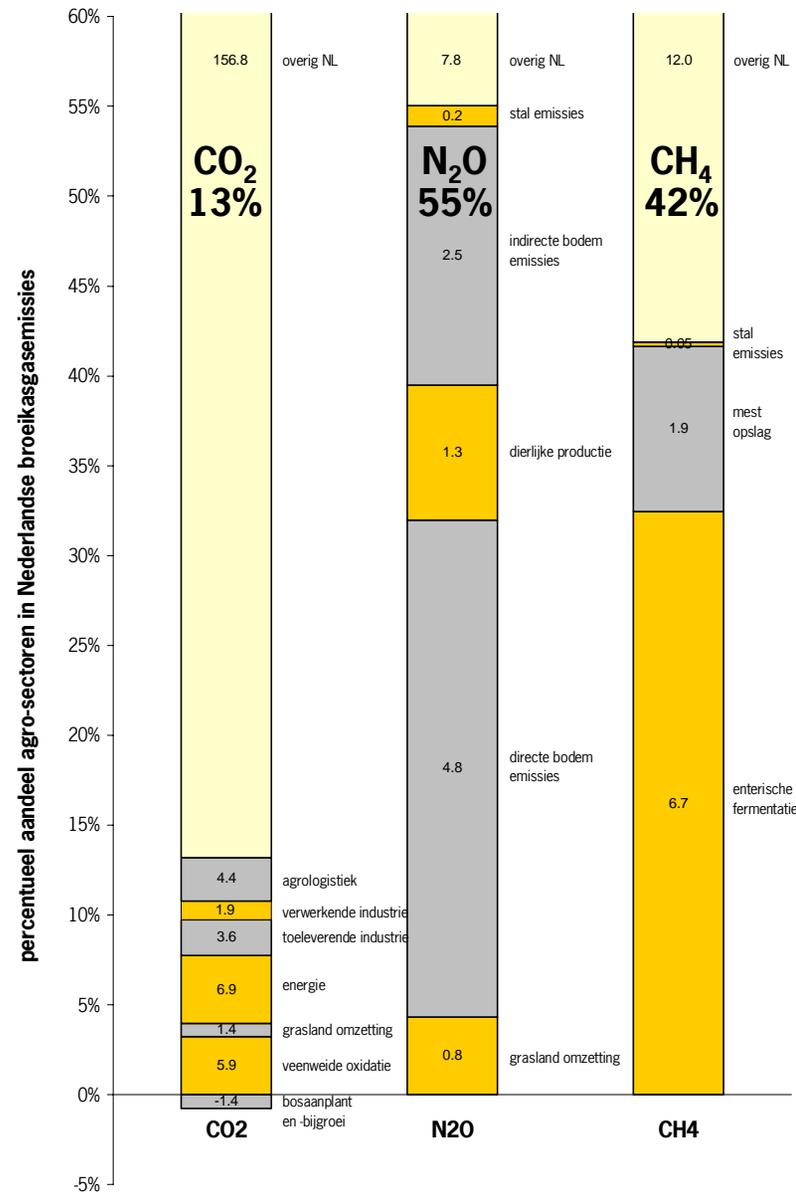


European GHG emissions

GHG budget Netherlands

Landuse significant source CO₂, CH₄, N₂O

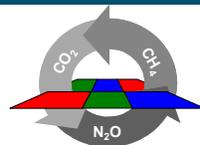
- Intensive livestock production
- Peatland oxidation
- Processing and logistics



European GHG emissions

Conclusions

- European biosphere sink for CO₂
- European agriculture source for CO₂ (and for CH₄ and N₂O)
- Possibilities for mitigation available (KP 3.4) potential ? costs ? attribution ?
- Landuse planning !!!



Chinese GHG emissions

Outlook

- Total emissions 942 MtC
- Total forestry potential 9.7 GtC (IPCC-TAR)
 - Regeneration, plantation forest
- Chinese agriculture source for CH₄, N₂O (rice) and CO₂
 - CH₄ reduction trend improved water management
 - 12.4 Tg/yr (1980) -> 7.6 Tg/yr (2000)
- Possibilities for mitigation available (KP 3.4)
potential ? costs ? attribution ?

