Vulnerabilita' ed interazioni negli ecosistemi terrestri

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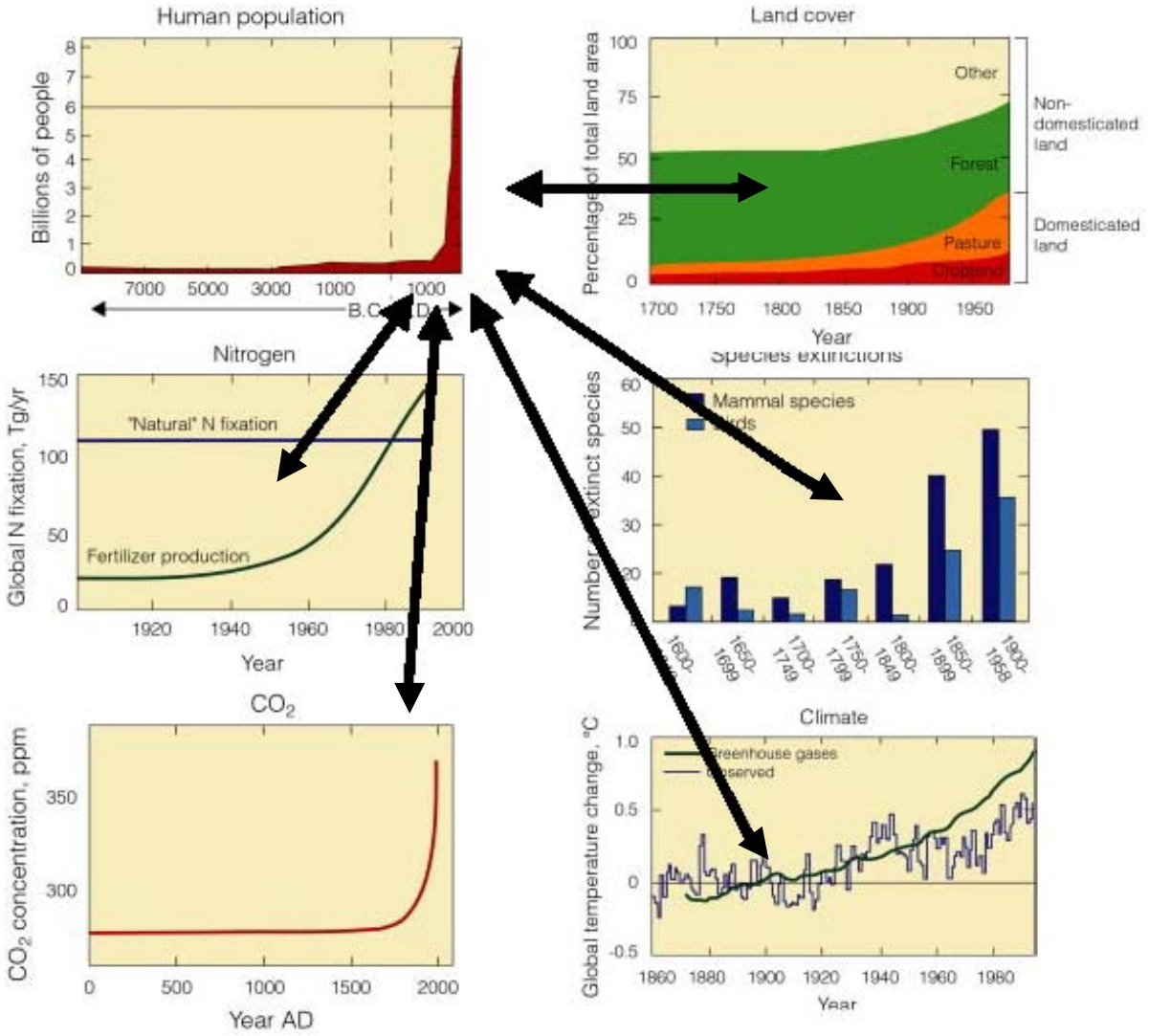
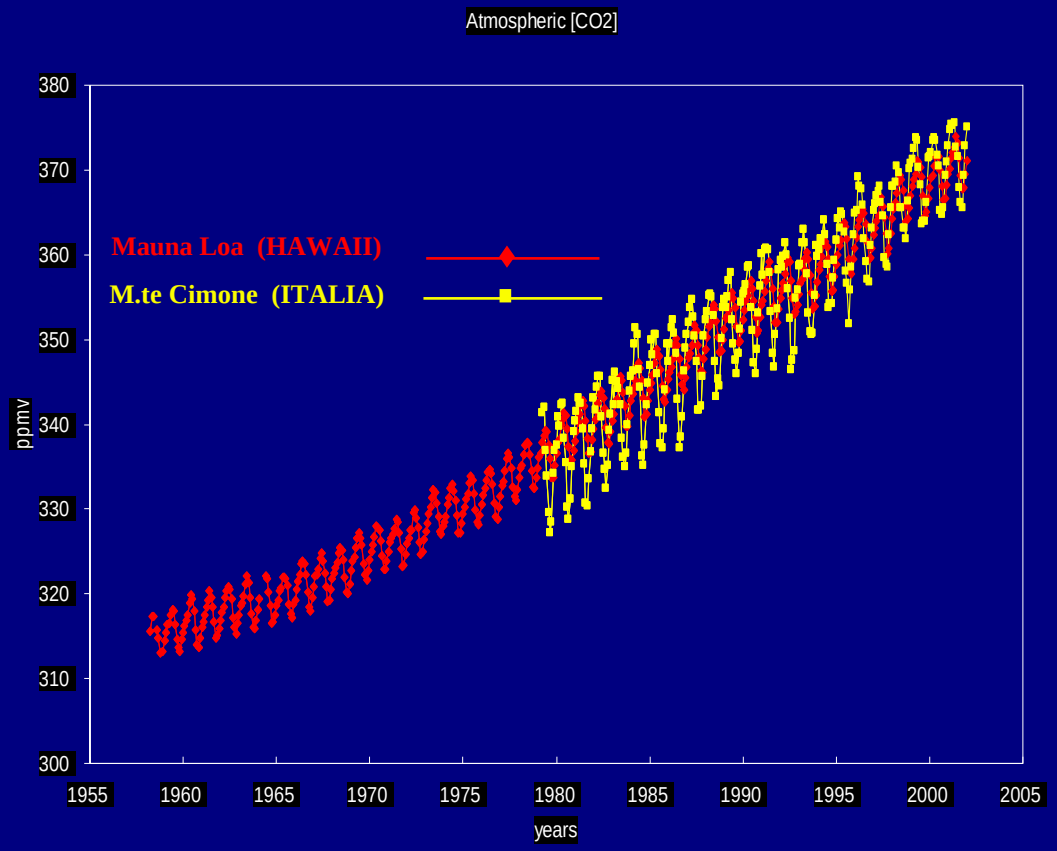
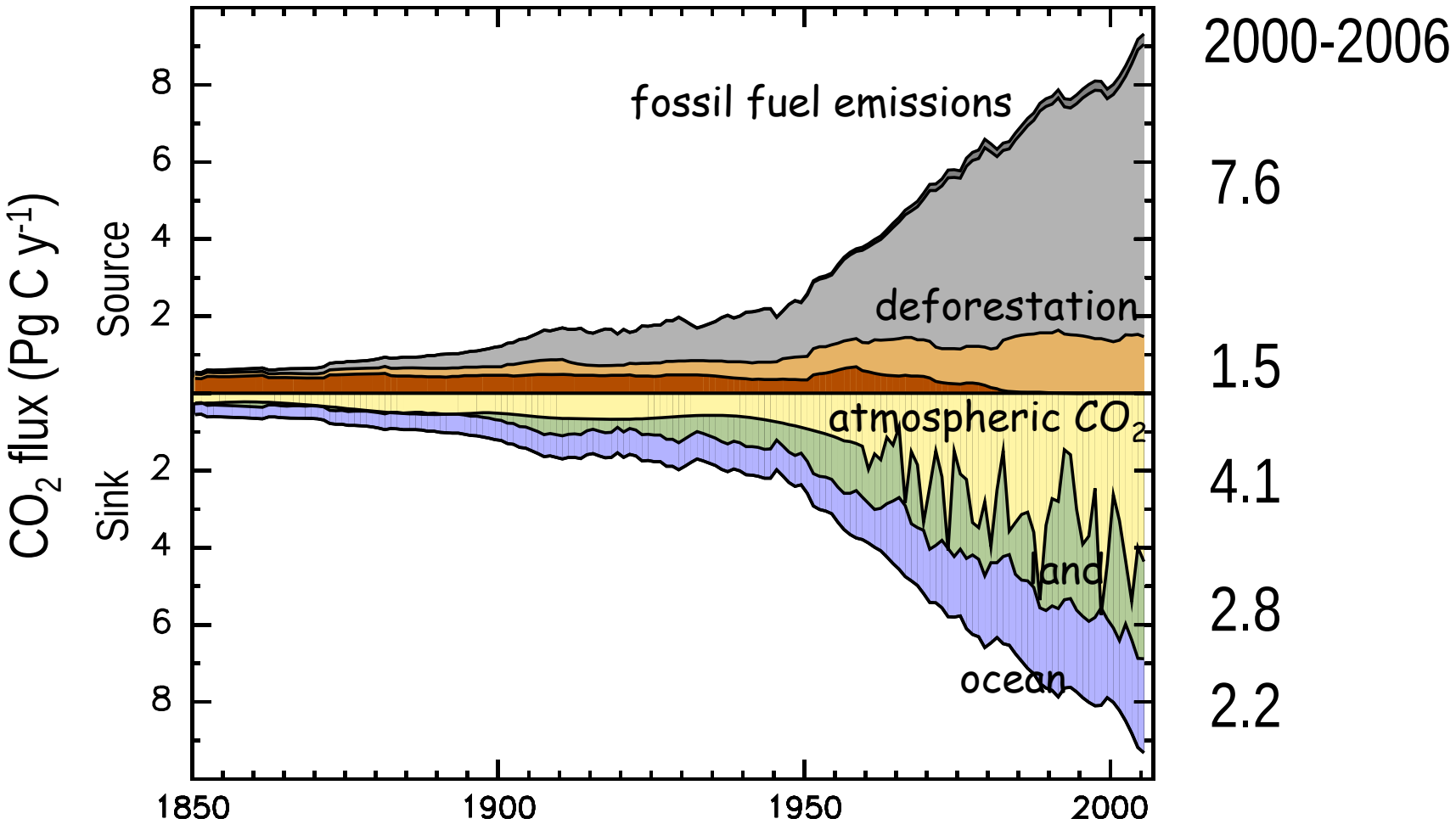

Human population
Billions of people
8
7
6
5
4
3
2
1
0
7000
5000
3000
1000
1000
B.C.
A.D.
Land cover
Percentage of total land area
100
75
50
25
0
Other
Forest
Pasture
Shrubland
Non-domesticated land
Domesticated land
1700
1750
1800
1850
1900
1950
Year
Nitrogen
Global N fixation, Tg/yr
150
100
50
0
"Natural" N fixation
Fertilizer production
1920
1940
1960
1980
2000
Year
Species extinctions
Number of extinct species
60
50
40
30
20
Mammal species
Birds
1600-1699
1650-1699
1700-1749
1750-1799
1800-1849
1850-1899
1900-1958
CO2
CO2 concentration, ppm
350
300
0
500
1000
1500
2000
Year AD
Climate
Global temperature change, °C
1.0
0.5
0
-0.5
Greenhouse gases
Observed
1860
1880
1900
1920
1940
1960
1980
Year

CO_2 increase in the atmosphere

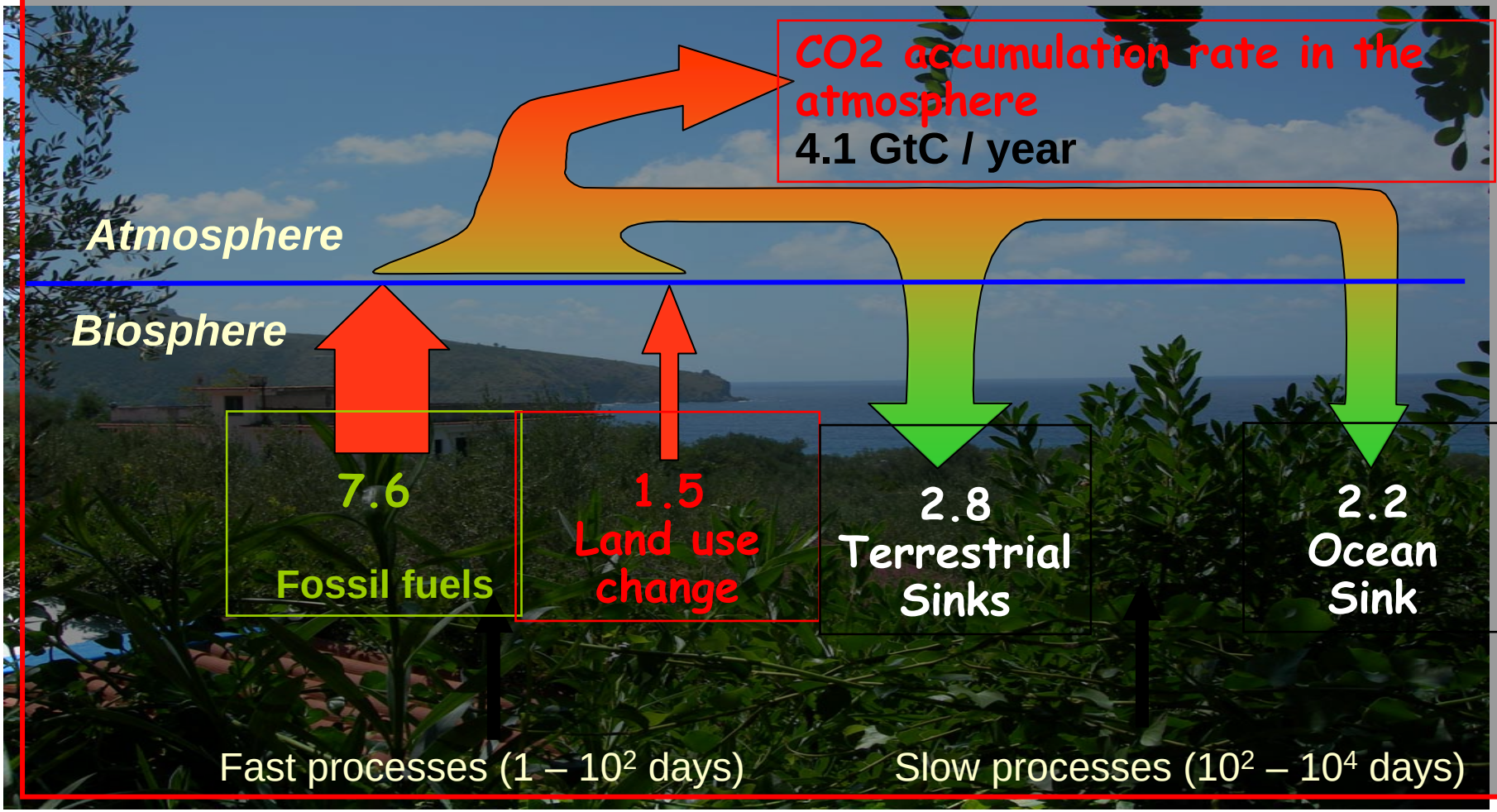


Net exchange of carbon
1850 – 2006



Courtesy of G. Matteucci

Net exchange of carbon 2000 – 2006 (Canadell et al, 2007)



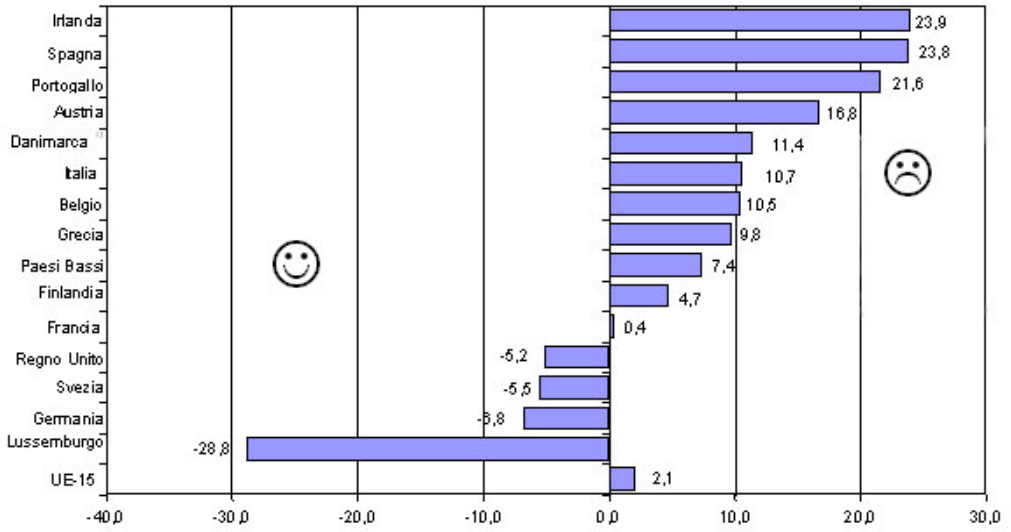
Courtesy of G. Matteucci

The Kyoto Protocol of 1997

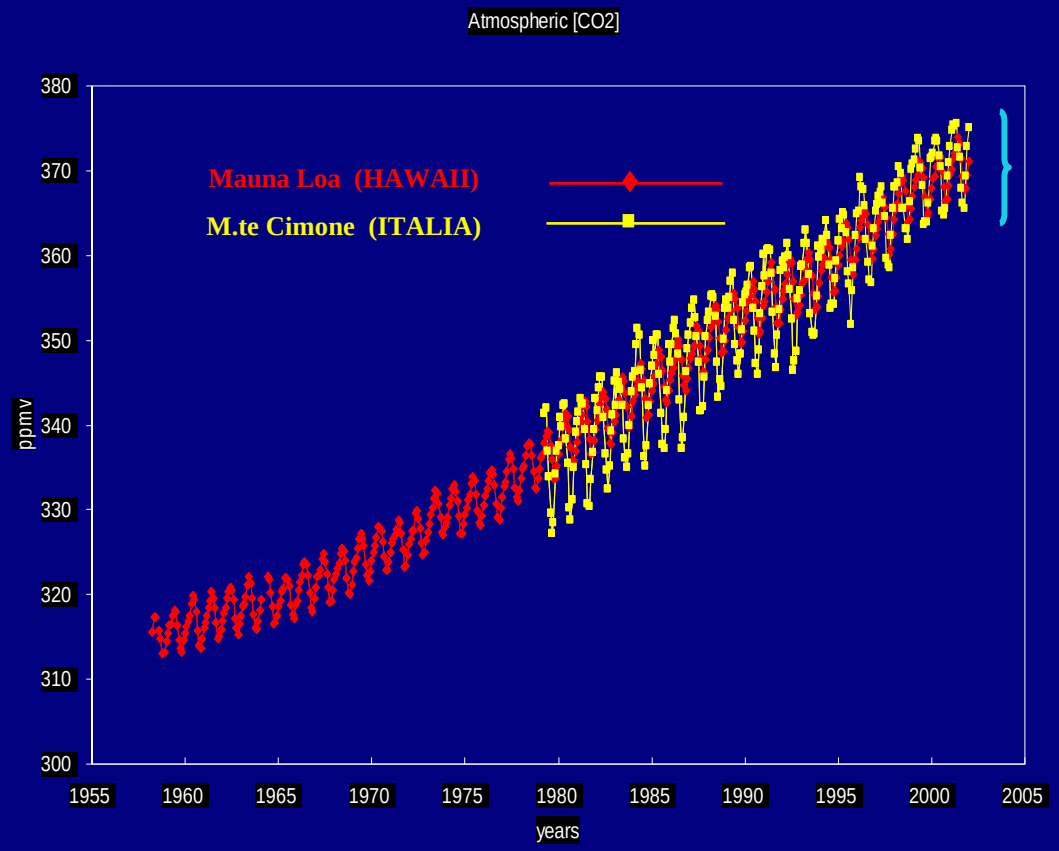
reduce CO_2 emissions to levels 6-8 % below 1990 values

developed countries carry a greater burden than less developed countries

consider forests as carbon sinks to offset carbon emissions

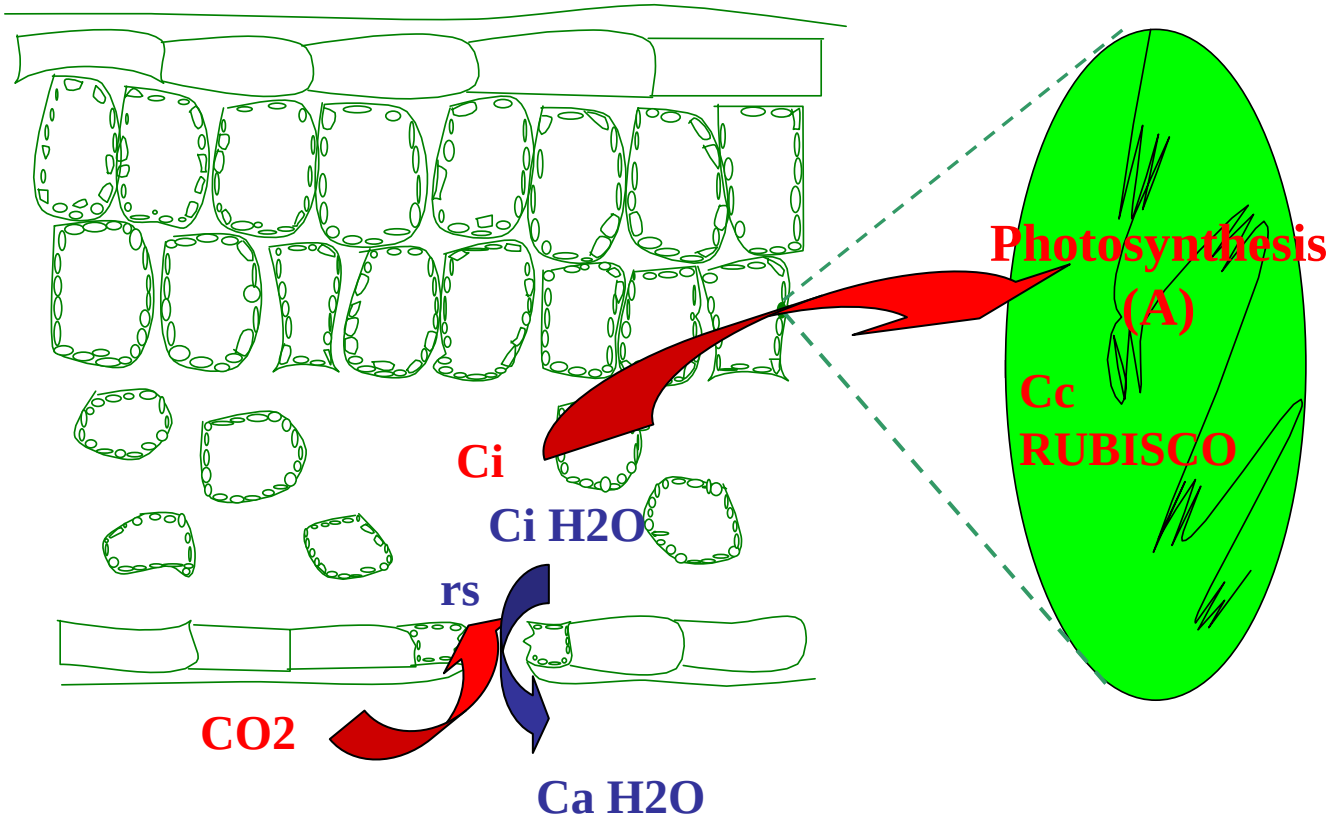


The beneficial role of photosynthesis



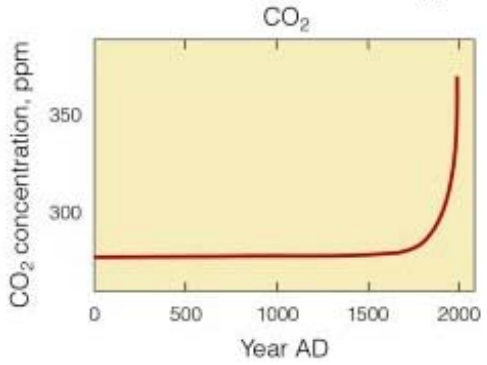
Oscillation mainly caused by photosynthesis of terrestrial ecosystems

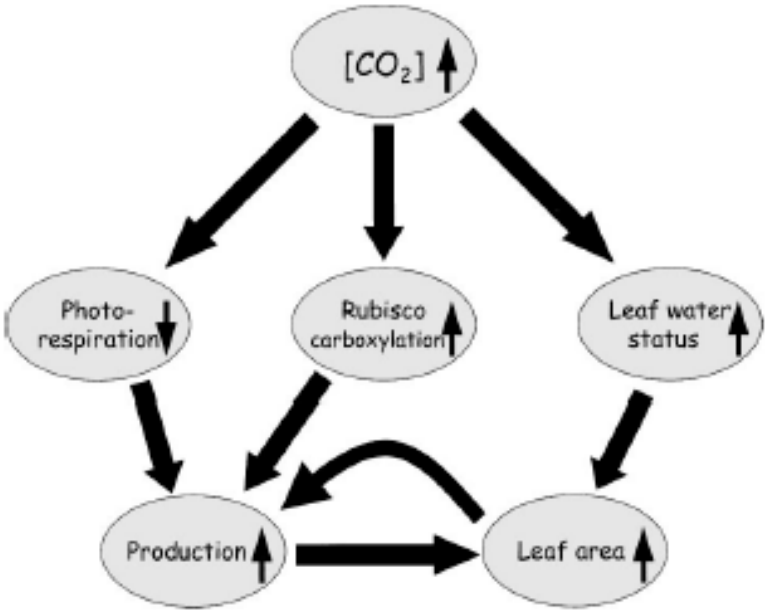
CO_2 rise improves photosynthesis



- More CO2 is taken up because of increasing competitive advantage of CO2 over O2 for Rubisco
- Less water is lost because of CO2-driven stomatal closure
- Water use efficiency (carbon gained/water lost) is improved

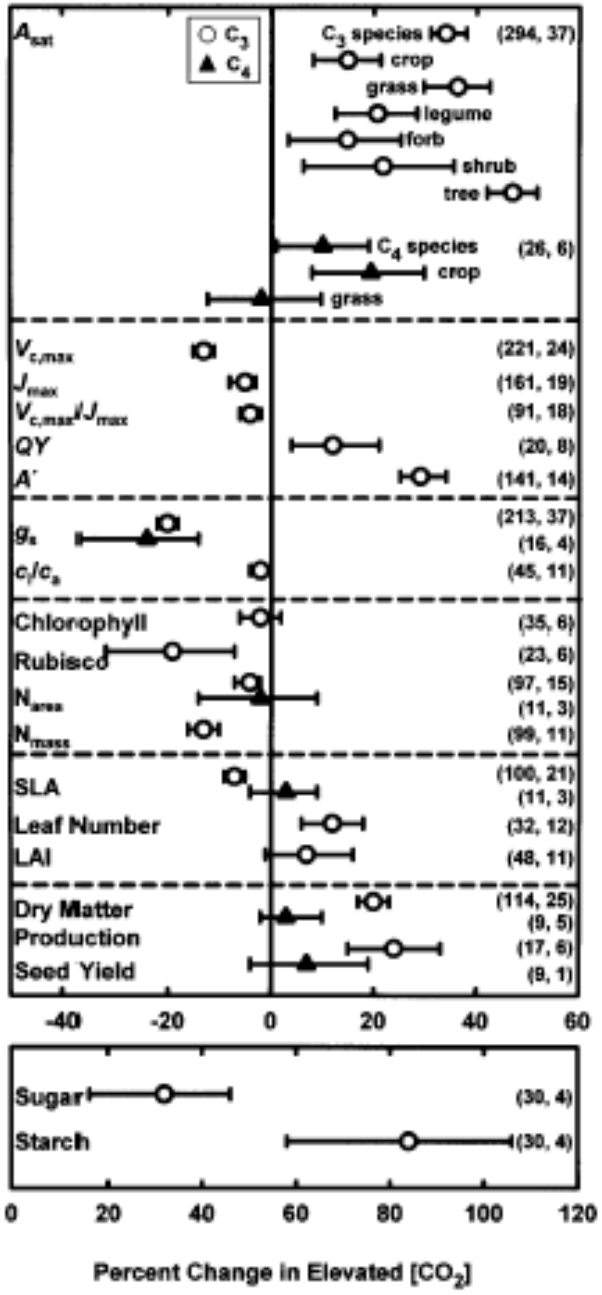
CO_2 rise can improve plant growth and production



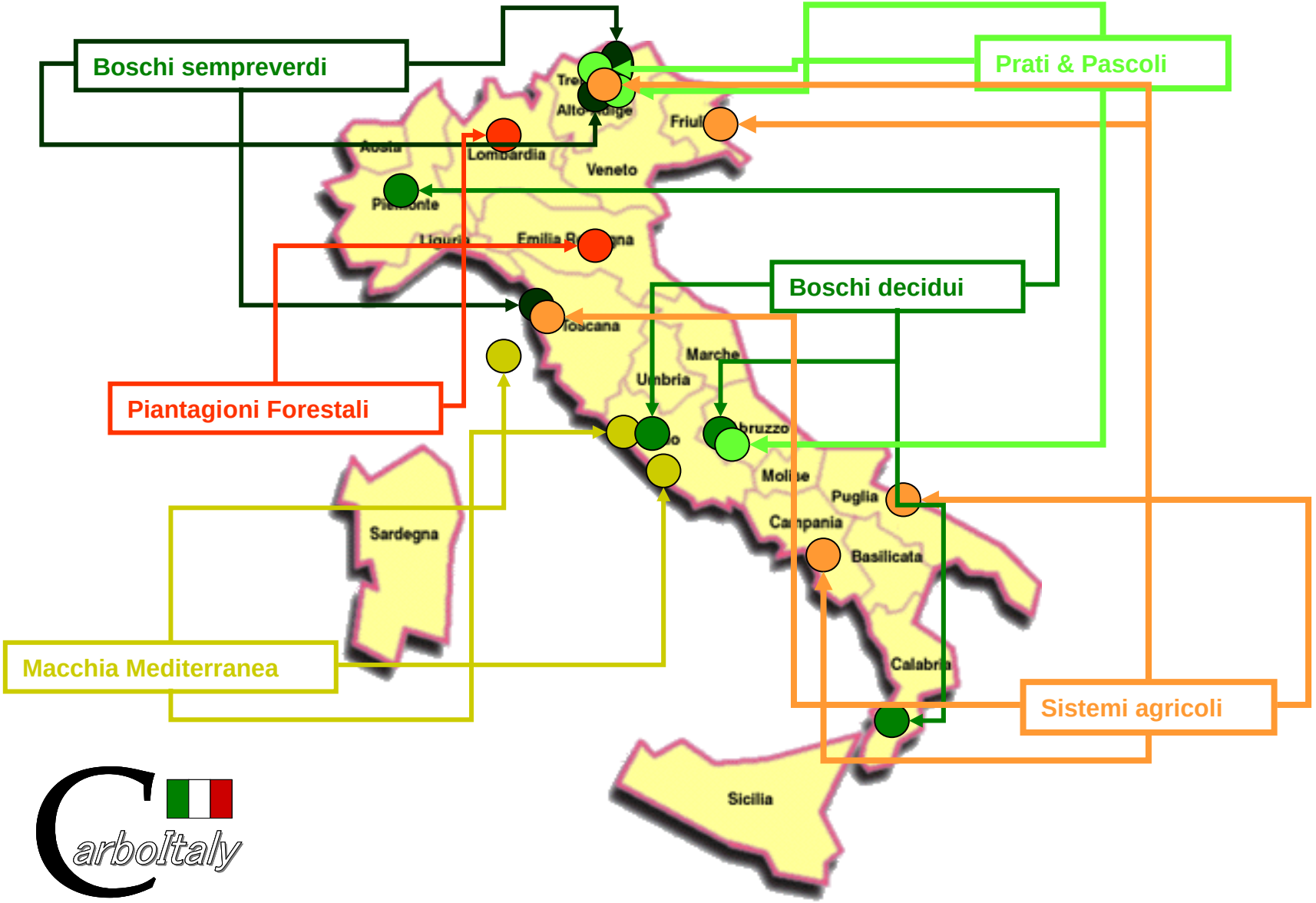


Long et al. 2004

CO_2 rise can improve plant growth and production



Long et al. 2004


Boschi sempreverdi
Prati & Pascoli
Boschi decidui
Piantagioni Forestali
Macchia Mediterranea
Sistemi agricoli
Lombardia
Veneto
Friuli
Toscana
Marche
Umbria
Puglia
Basilicata
Sardegna
Sicilia
Carboltaly

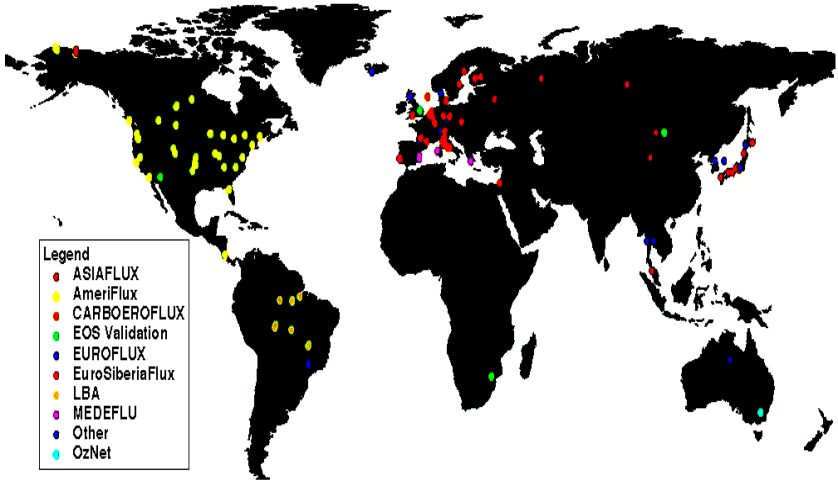
Measuring net C exchange (NEE) Ecosystem and Global Fluxes

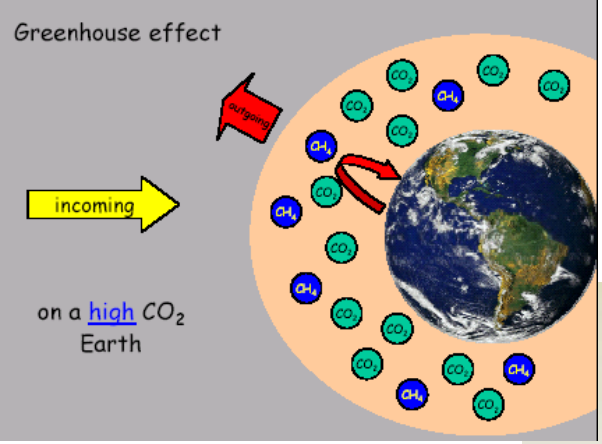
Courtesy of E. Brugnoli

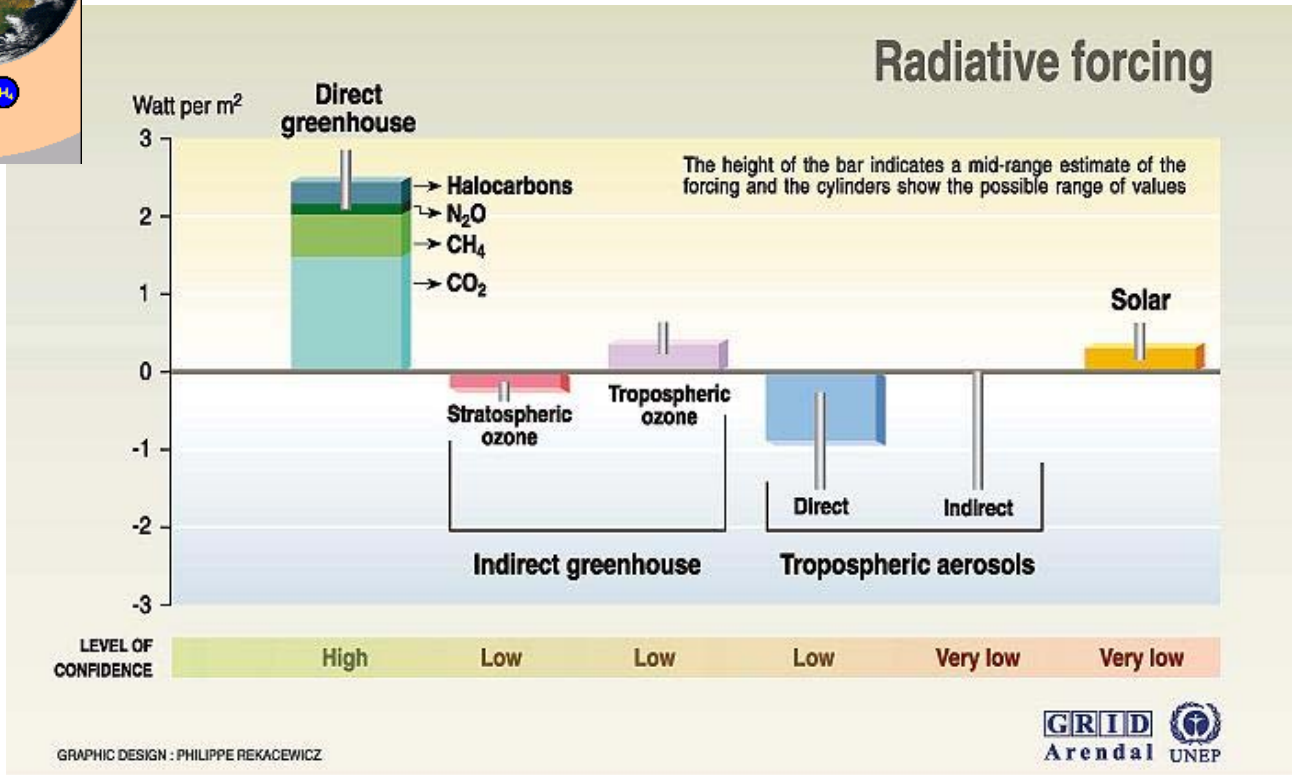
Role of the component fluxes (respiration/ assimilation)

F_R/F_A

The Flux network

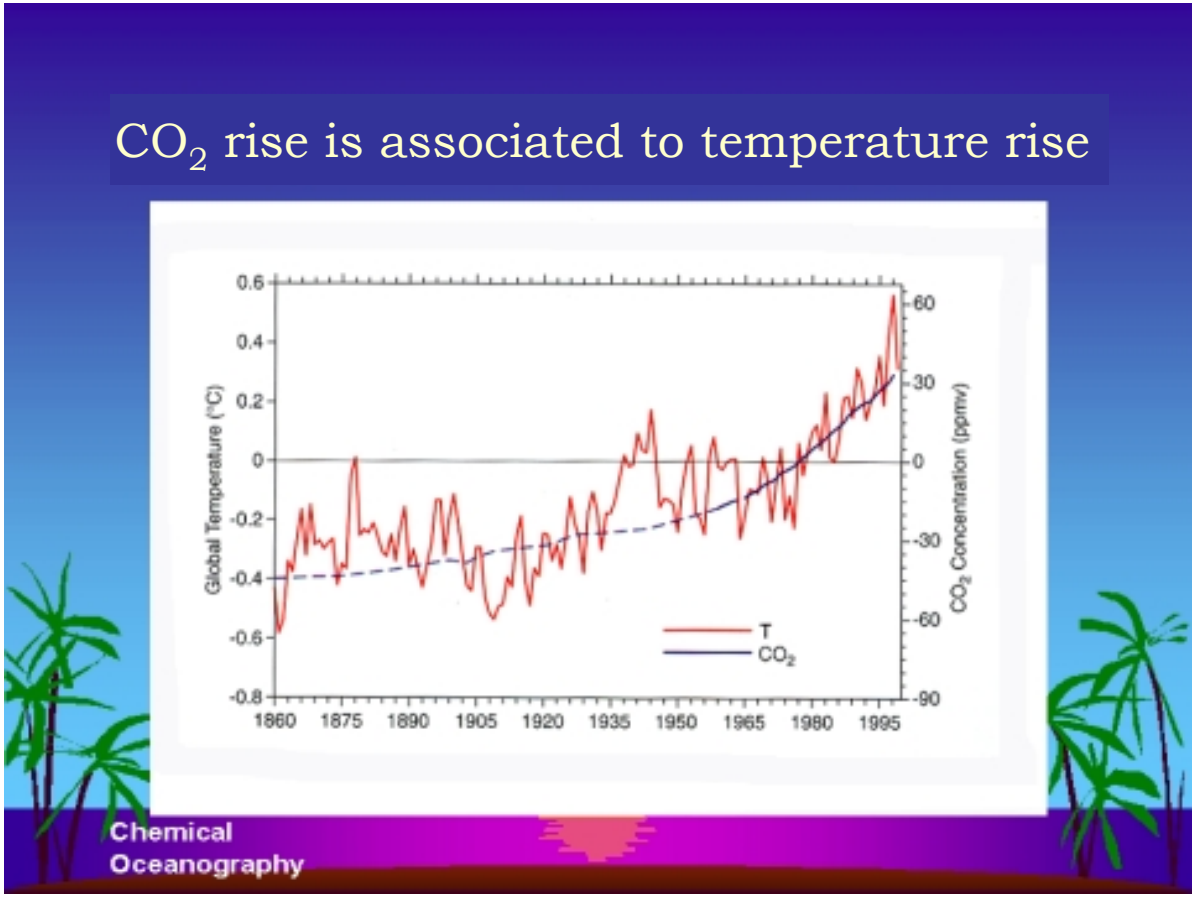


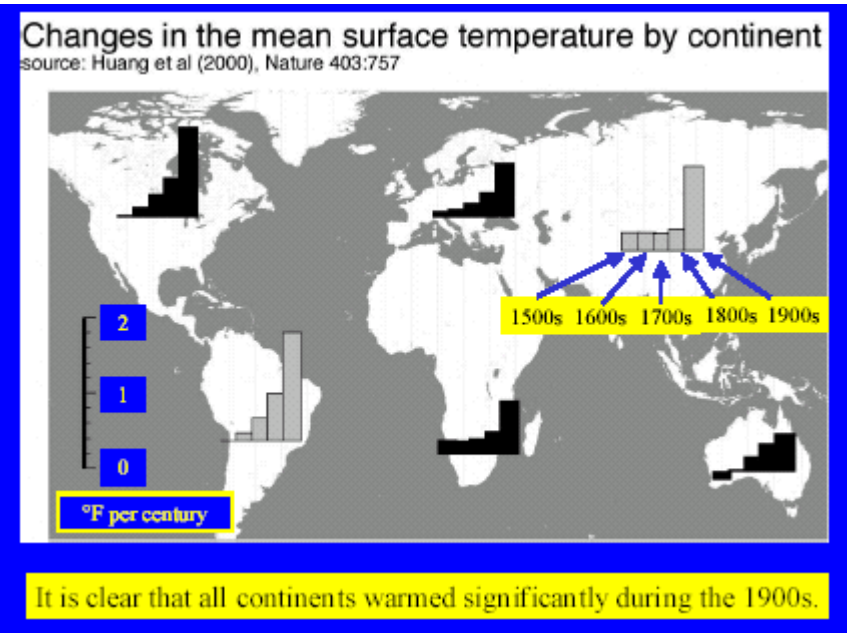


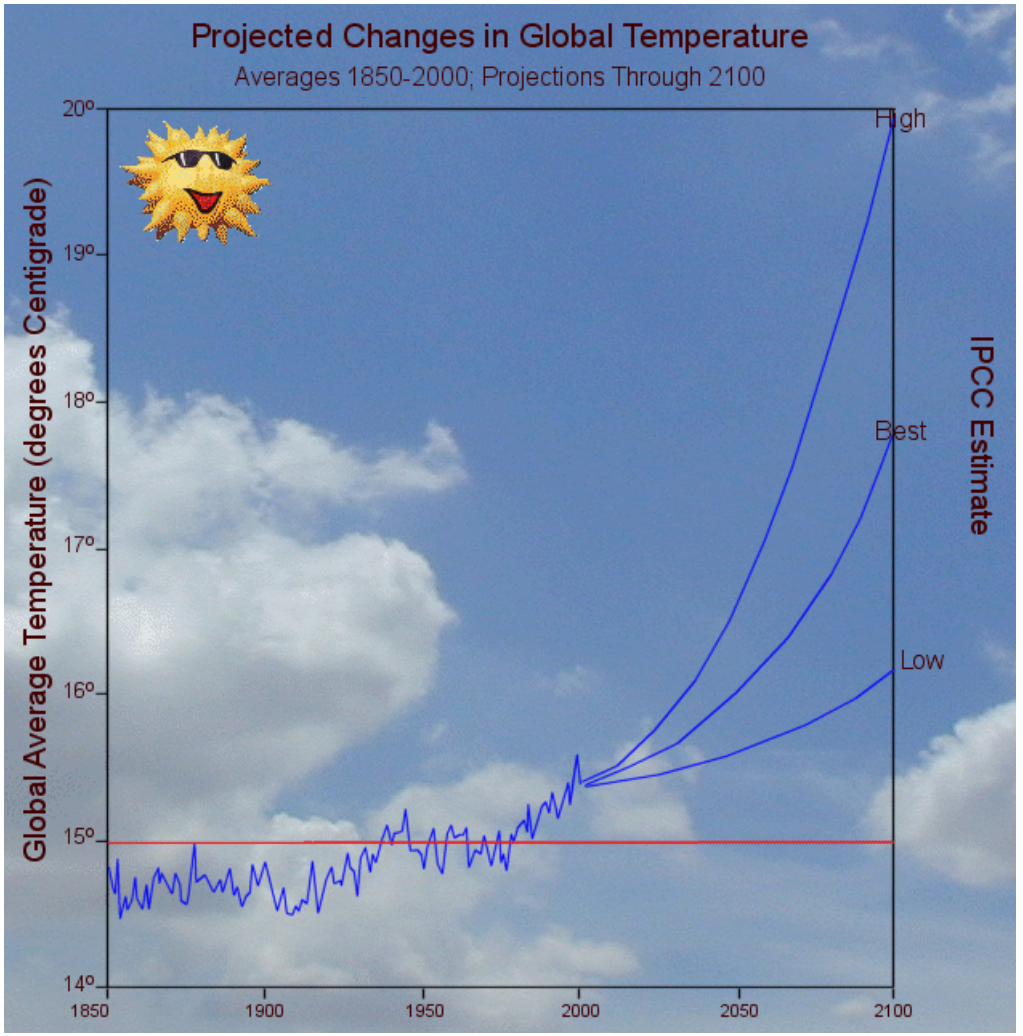


Source: Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

CO_2 rise is associated to temperature rise

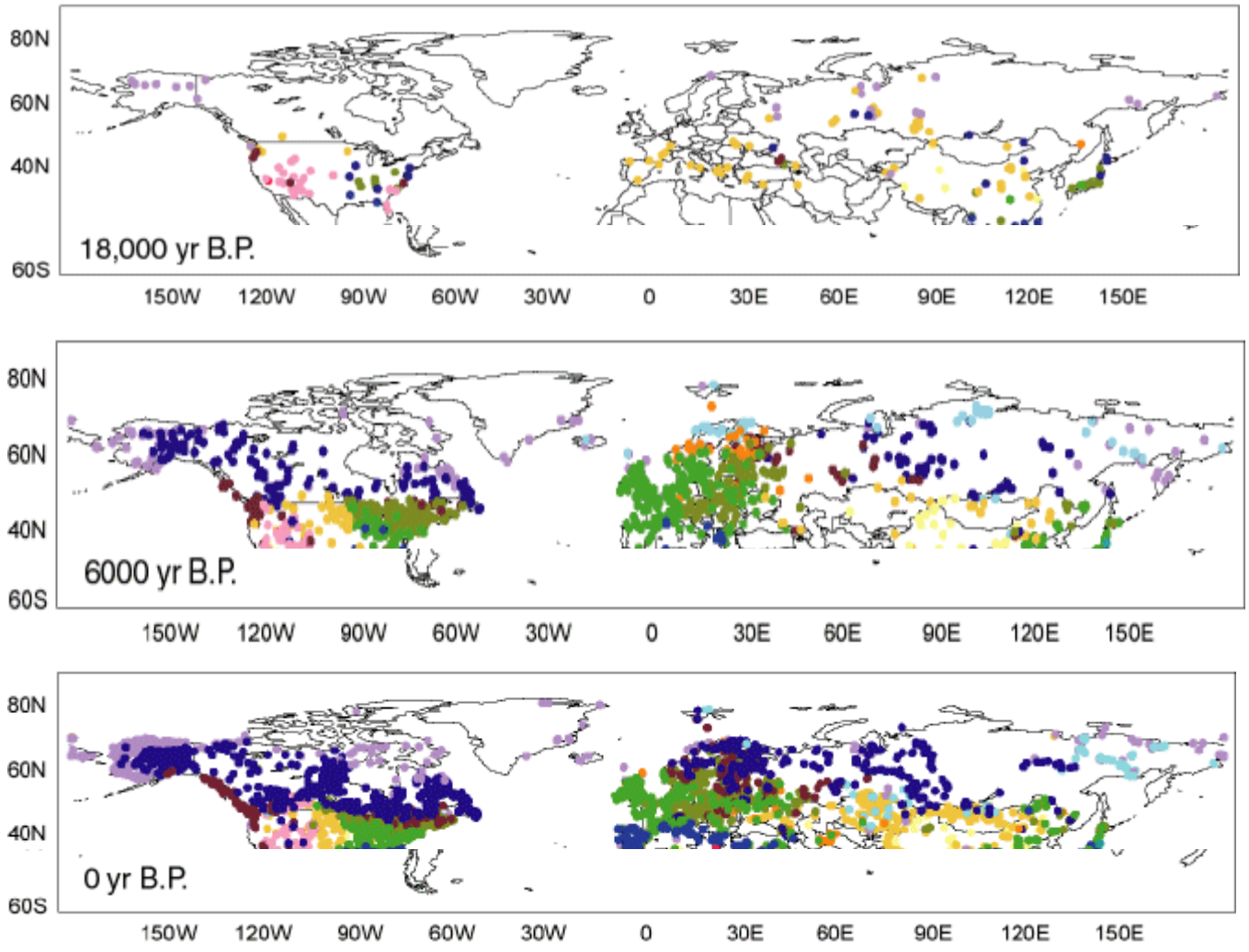



Changes in the mean surface temperature by continent
source: Huang et al (2000), Nature 403:757
1500s 1600s 1700s 1800s 1900s
2
1
0
°F per century
It is clear that all continents warmed significantly during the 1900s.


Projected Changes in Global Temperature
Averages 1850-2000; Projections Through 2100
Global Average Temperature (degrees Centigrade)
20°
19°
18°
17°
16°
15°
14°
1850
1900
1950
2000
2050
2100
High
Best
Low
IPCC Estimate

Consequences of temperature increase on the biosphere:

Consequences of temperature change on the biosphere: Plant distribution



Cooler than present

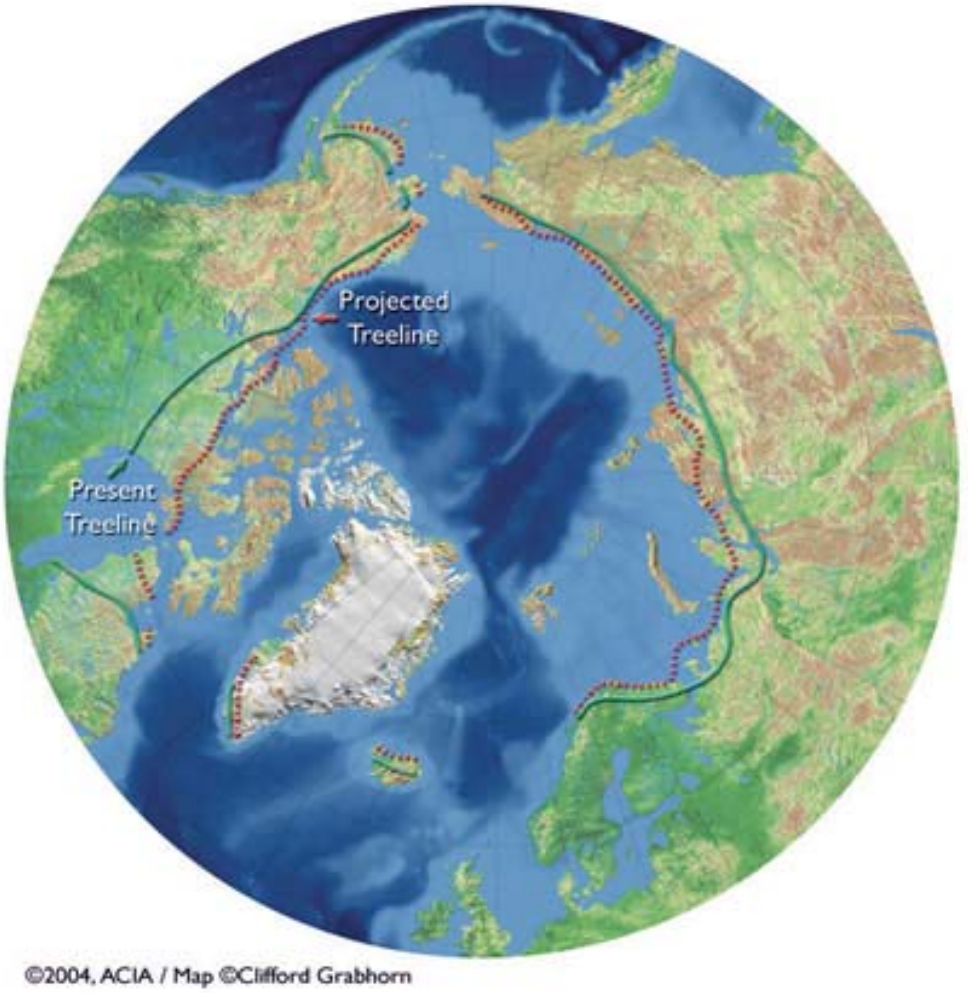
Warmer than present

Present

Prentice et al. 2001

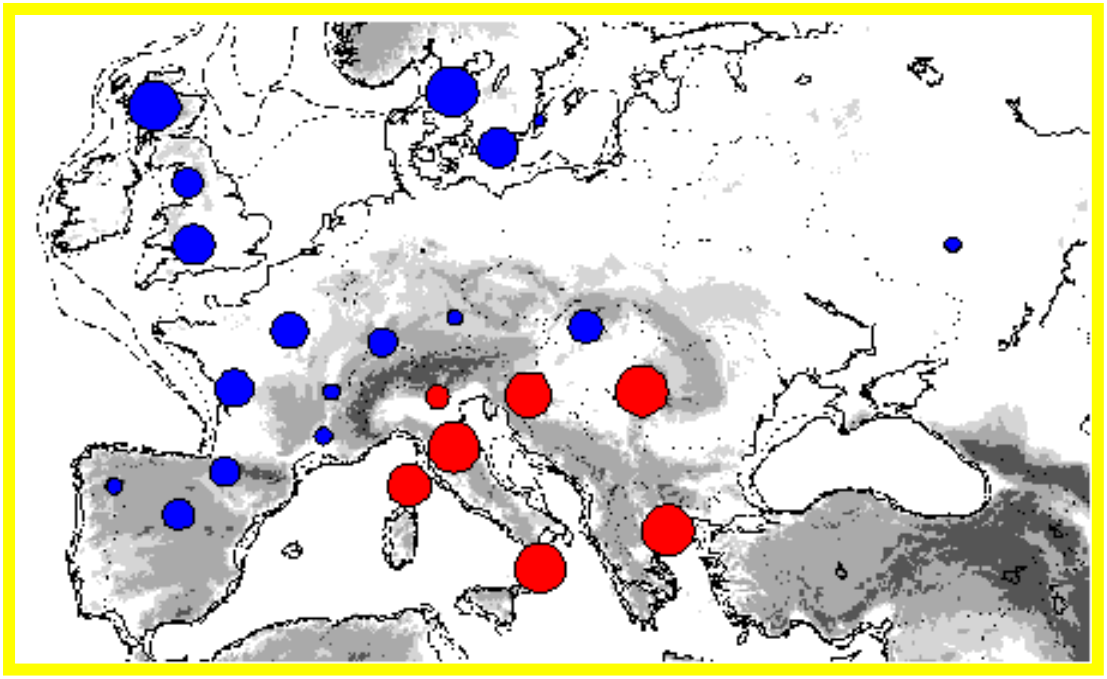
Consequences of temperature change on the biosphere: Migration, population structure, and exctinction

Trees climb mountains and move northward



Consequences of temperature change on the biosphere: Migration, population structure, and exctinction

Multispecies genetic divergence on 25 forests shows more differentiation in Southern populations (Corsica, Italy, Balkans) developed in glacial refugia

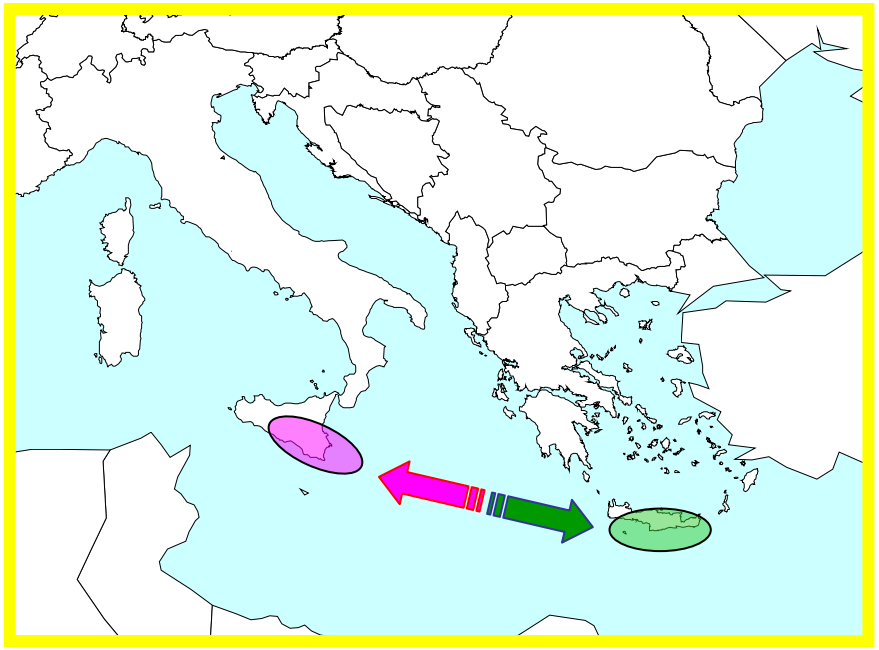


higher than the mean lower than the mean

Petit et al. 2003

Consequences of temperature changes on the biosphere: Migration, population structure, and exctinction

Origin and separation of relic species: The Mediterranean Zelkovas

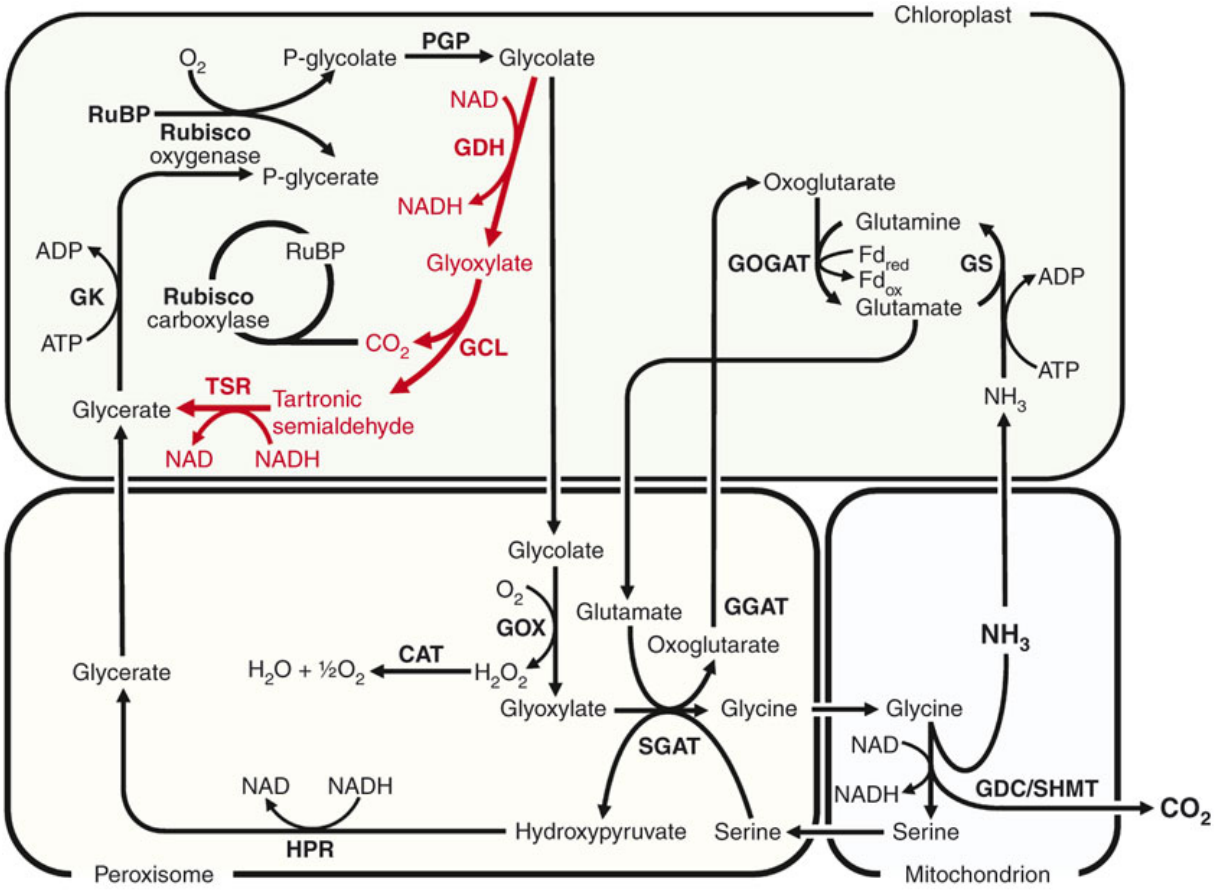


Two relic populations in Europe that have been isolated by environmental constraints

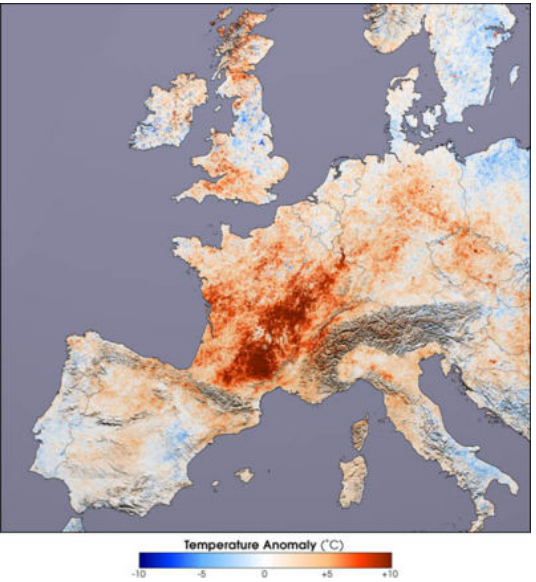
Fineschi et al. 2002

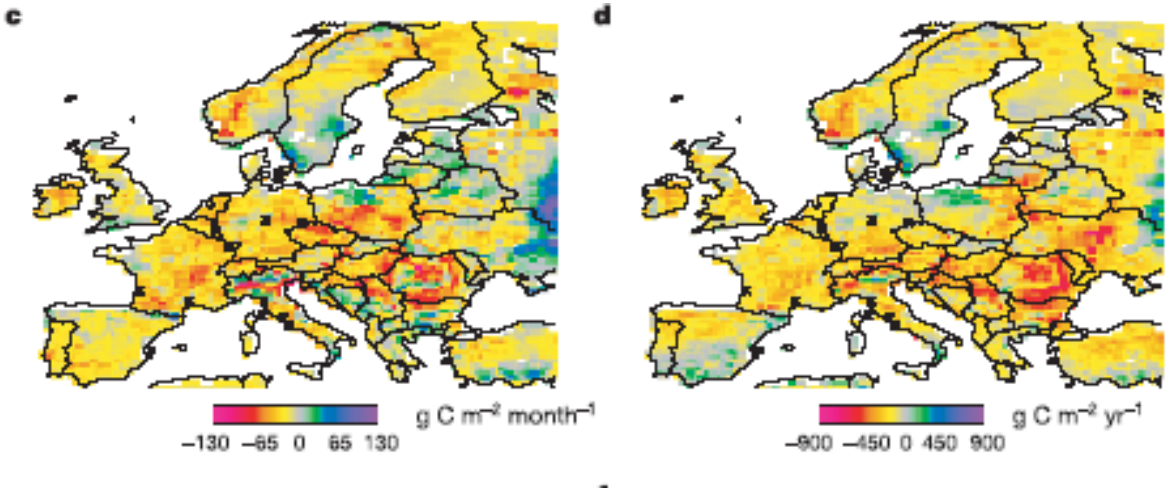
Consequences of temperature increase on the biosphere: Biochemical effects

High temperature makes O_2 more available at Rubisco, favoring photorespiration and reducing net photosynthesis



Consequences of temperature increase on the biosphere: Heat waves

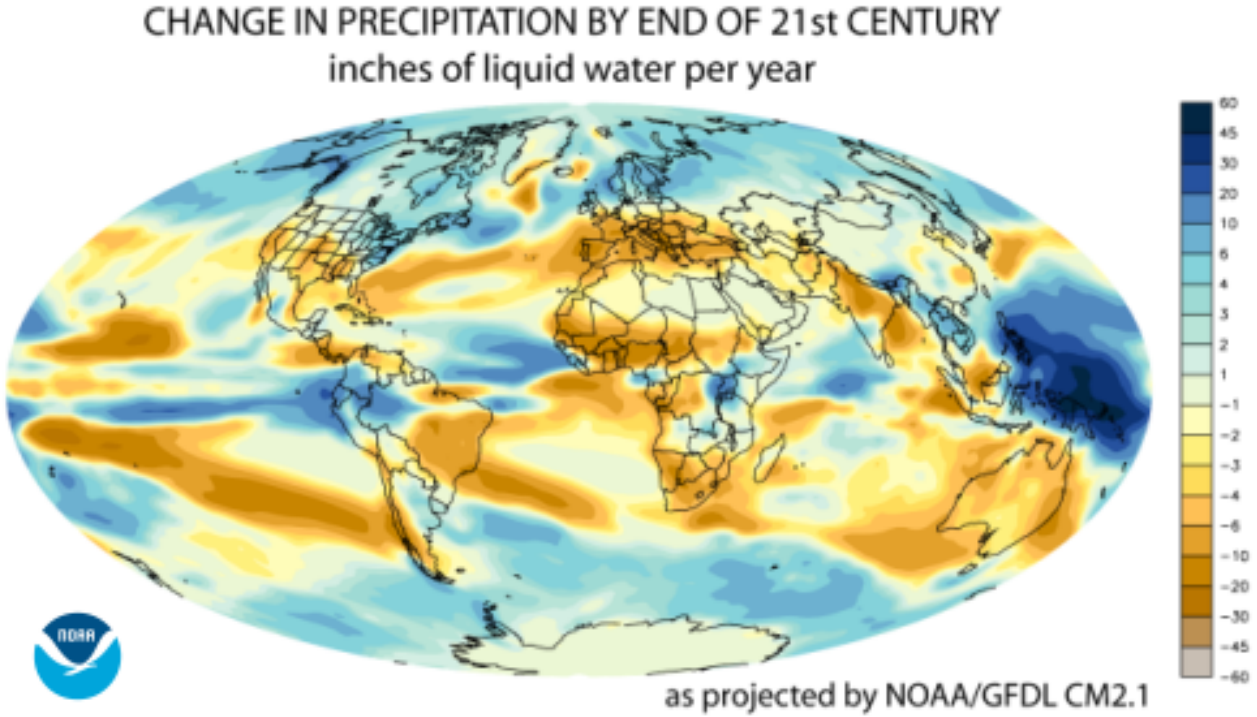




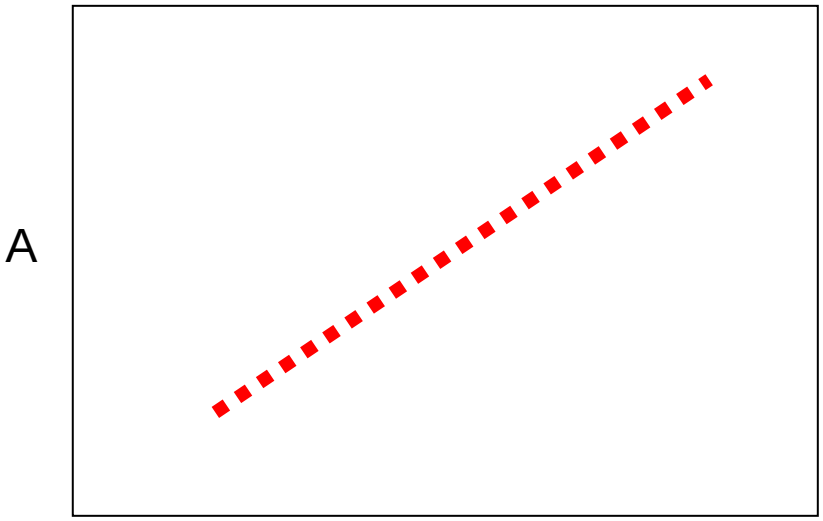
Simulated changes of NPP (compared to 2000-2002) during summer (left) and during the whole year 2003 (right)

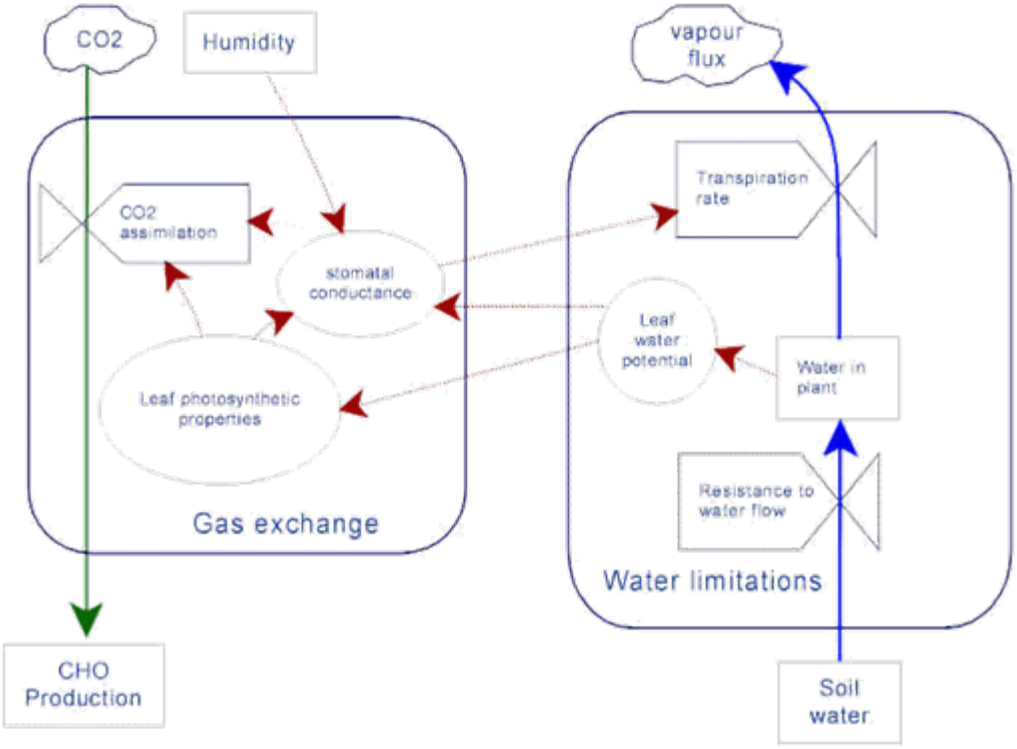
Ciais et al. 2005

Consequences of temperature increase on the biosphere: Enhancing drought



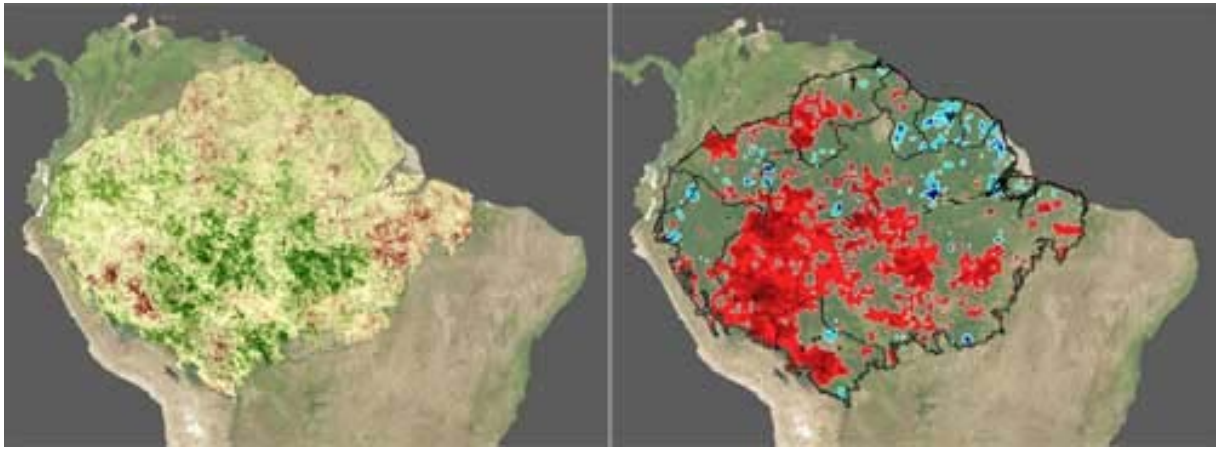
Drought reduces photosynthesis





Association between photosynthesis and stomatal conductance
(Massacci and Loreto, 2002)

Drought reduces photosynthesis …which reduces ecosystem primary production…

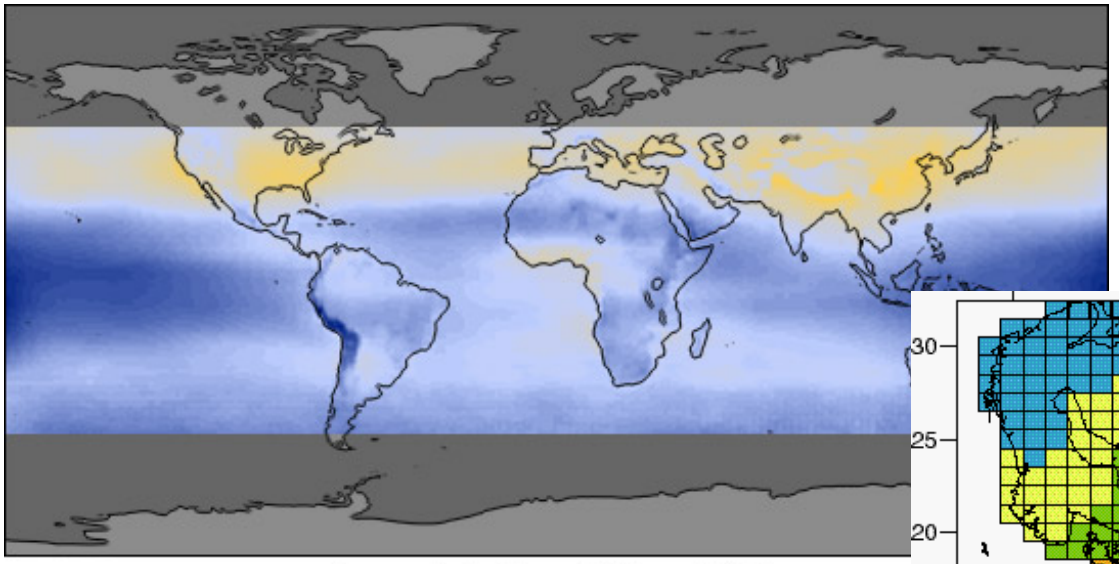


…and exacerbates extreme events

Plants acclimate/adapt to drought

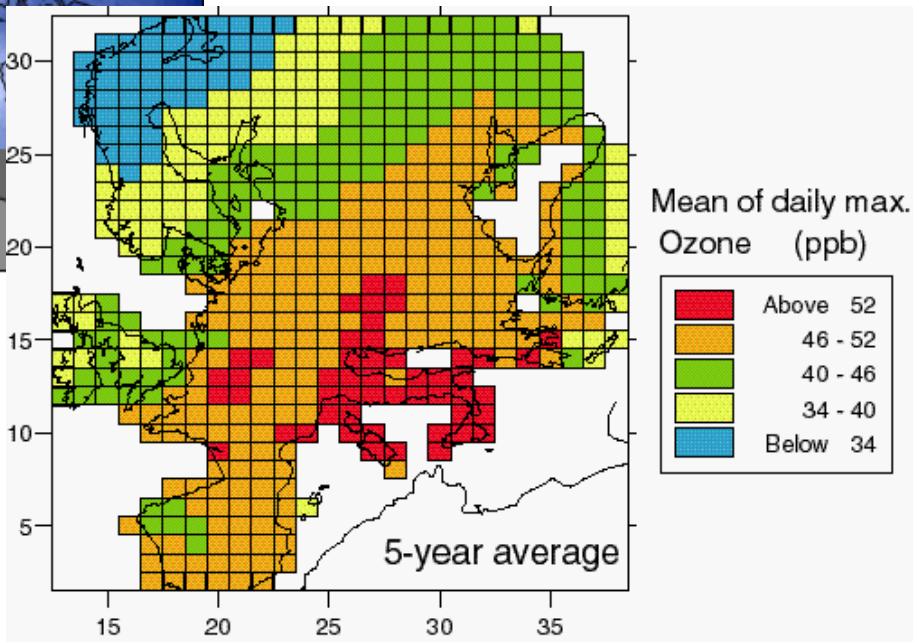
Future scientific challenges:
To understand/exploit molecular-to-ecological mechanisms of adaptation to the environment

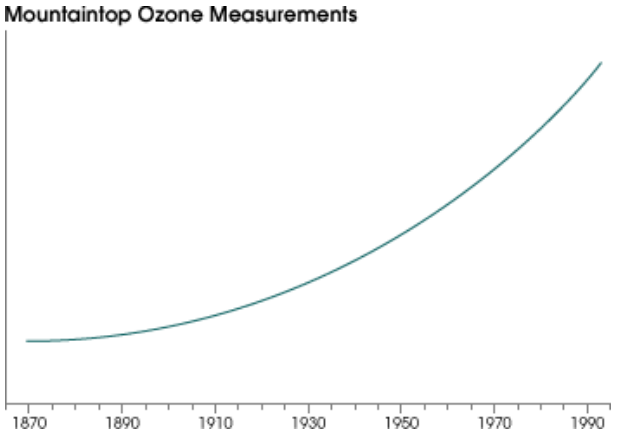
The anthropogenic influence on the biosphere: pollutants



Tropospheric Ozone (Dobson Units)

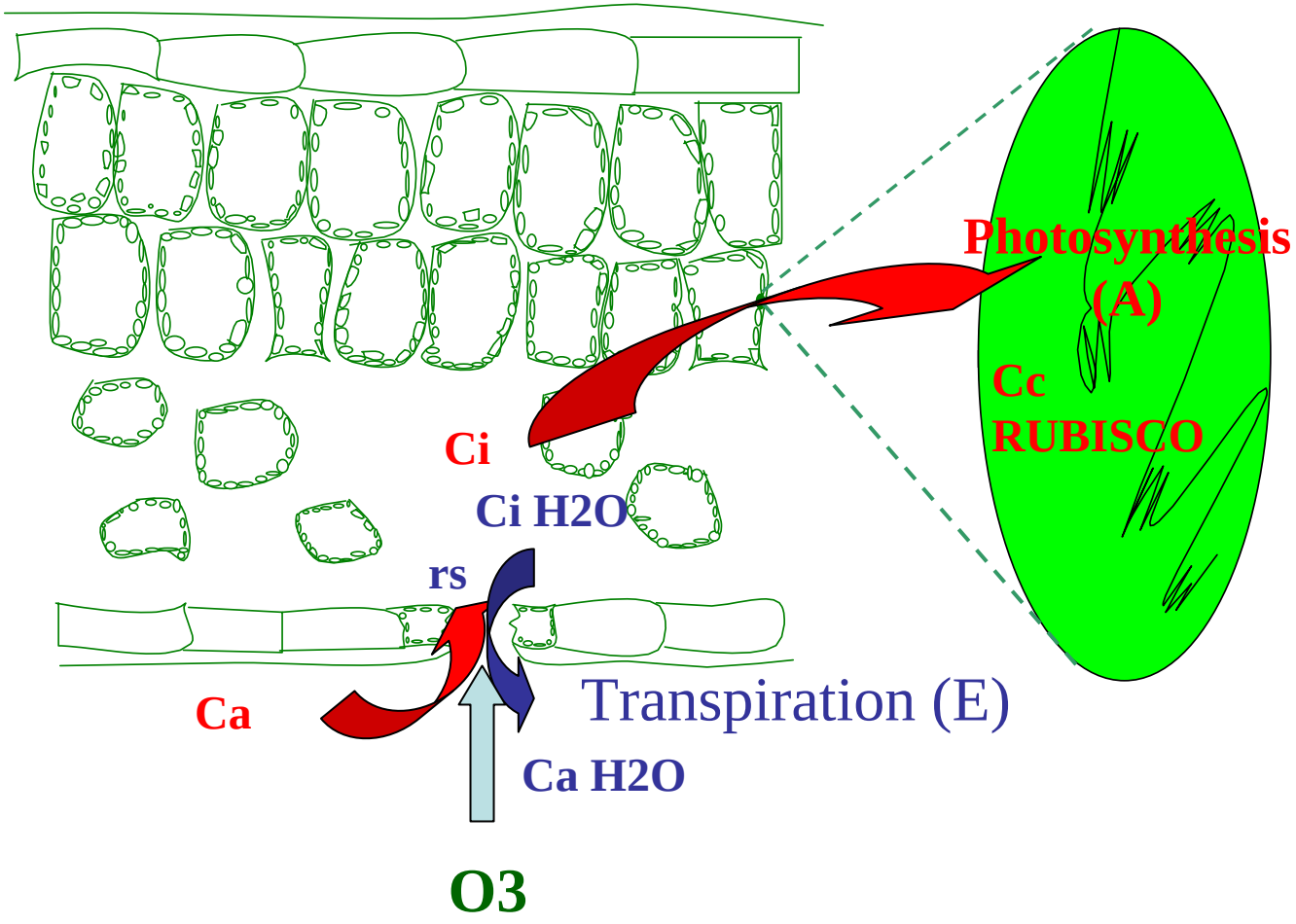
12 55



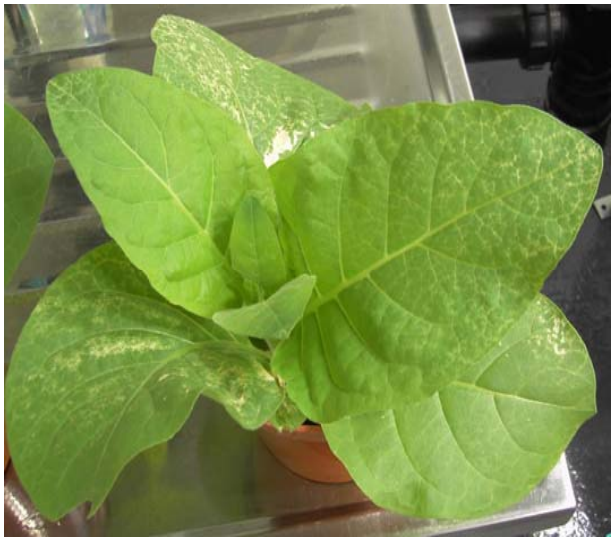


The anthropogenic influence on the biosphere: pollutants

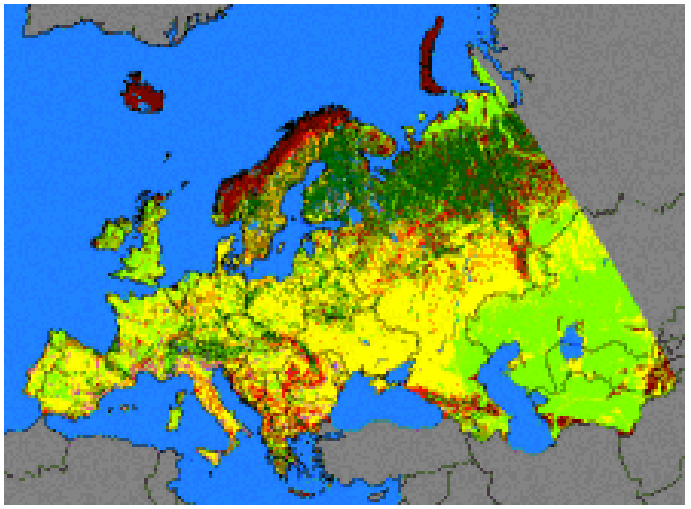
Stomata are the entry port for gases, including ozone



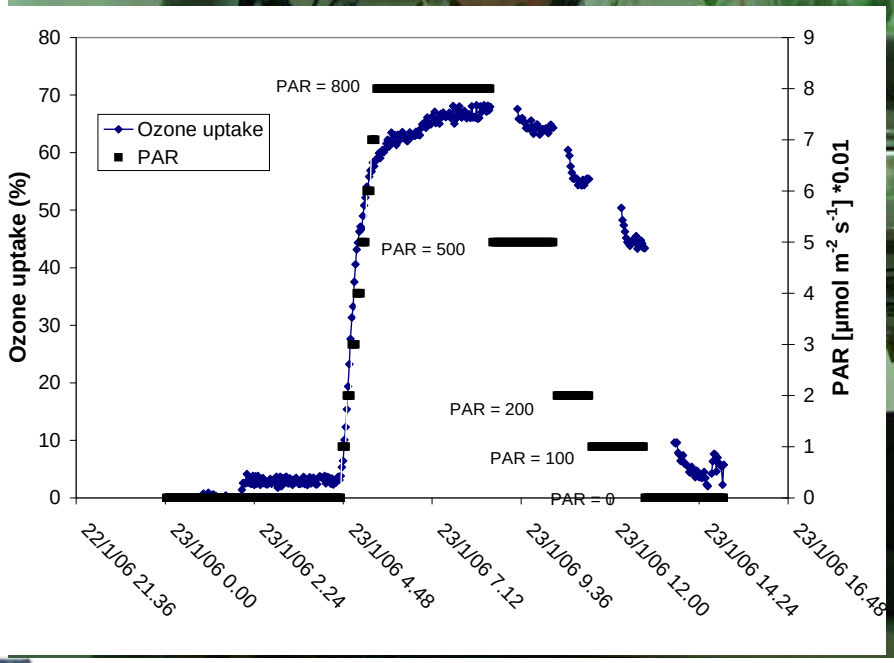
The anthropogenic influence on the biosphere: pollutants

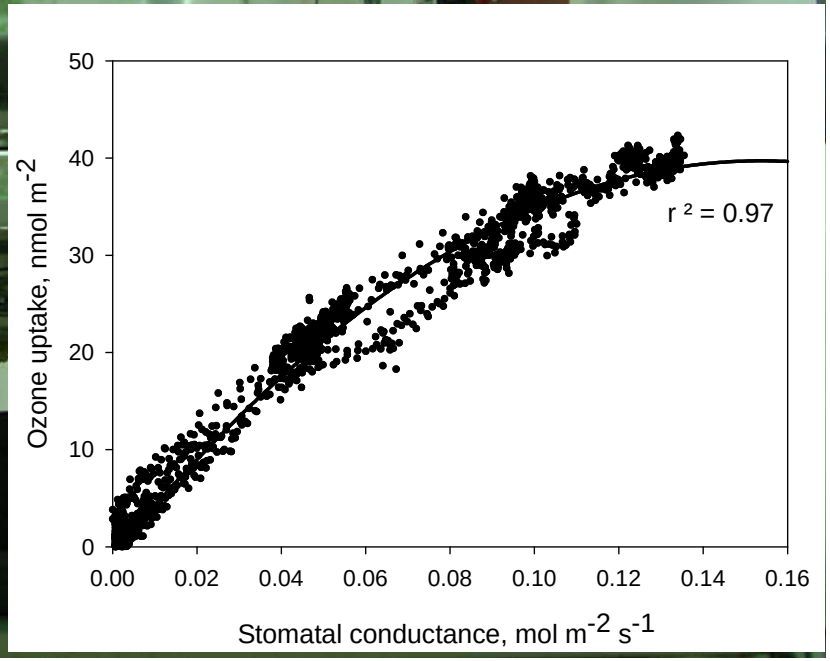


Loreto et al. 2001



The biosphere to remove and detoxify pollutants

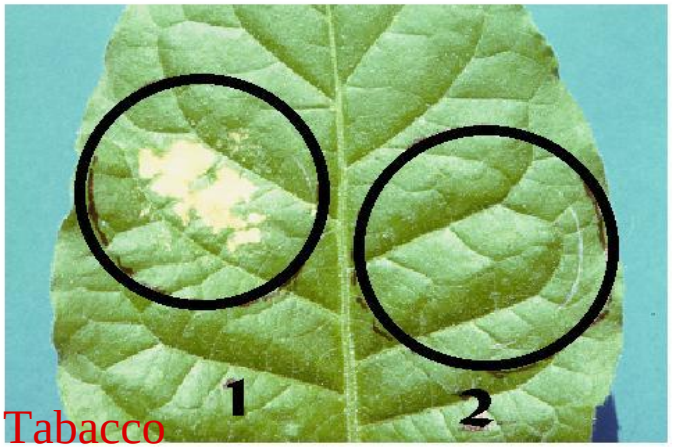




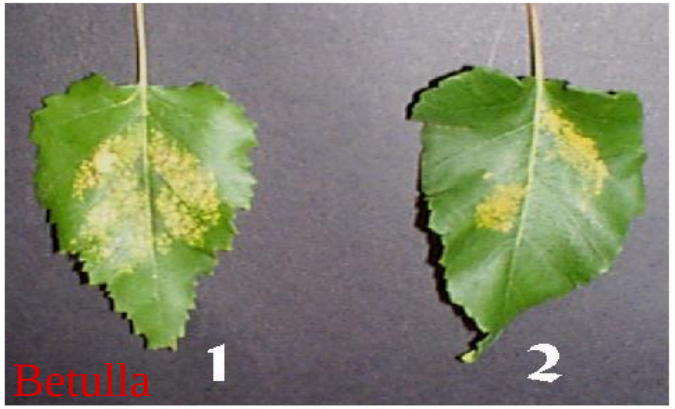
The biosphere to remove and detoxify pollutants

Ozone

(300ppb 3h)



= >> **damage**



Ozone

(300ppb 3h)

+

Isoprene

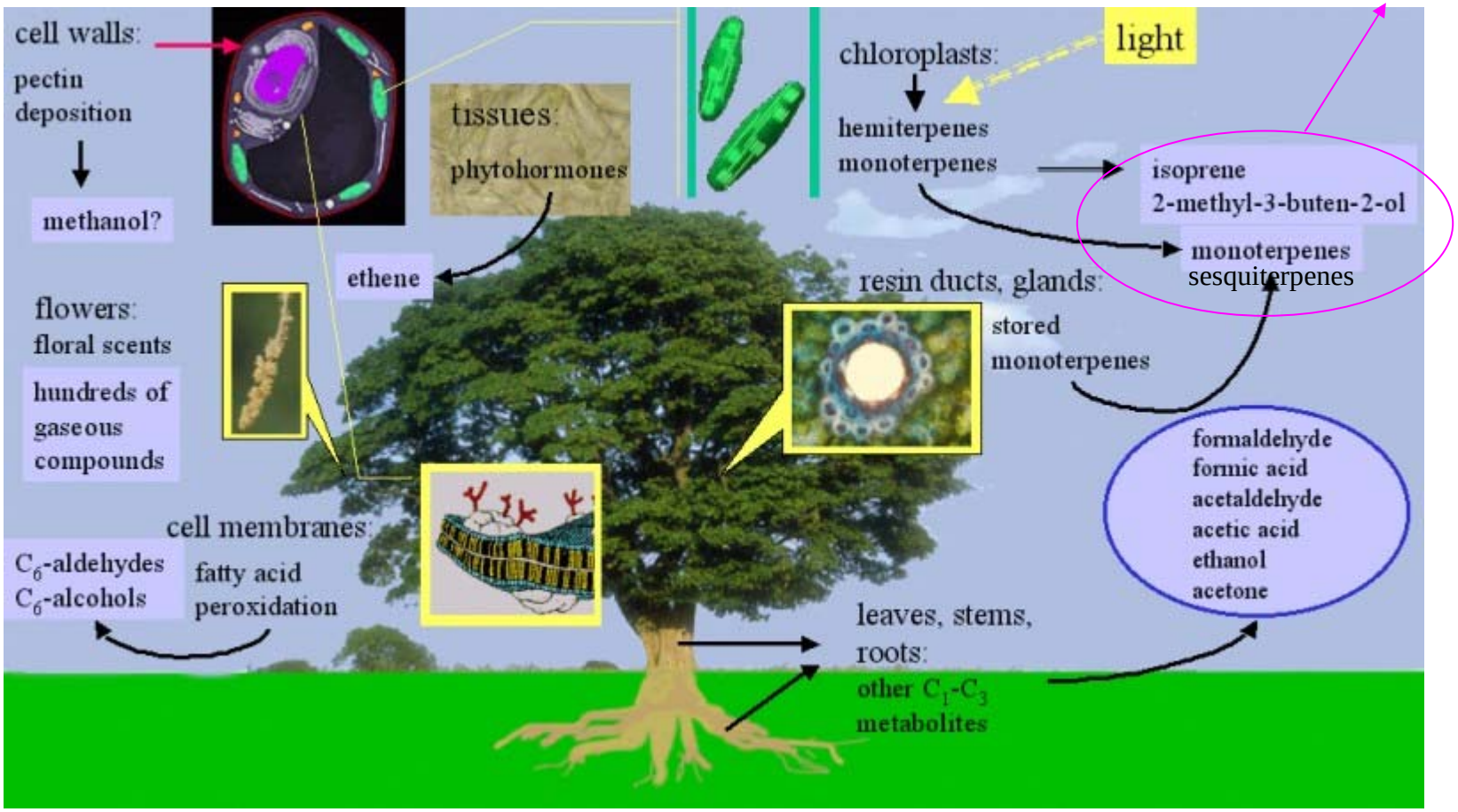
(3ppm)

= << **damage**

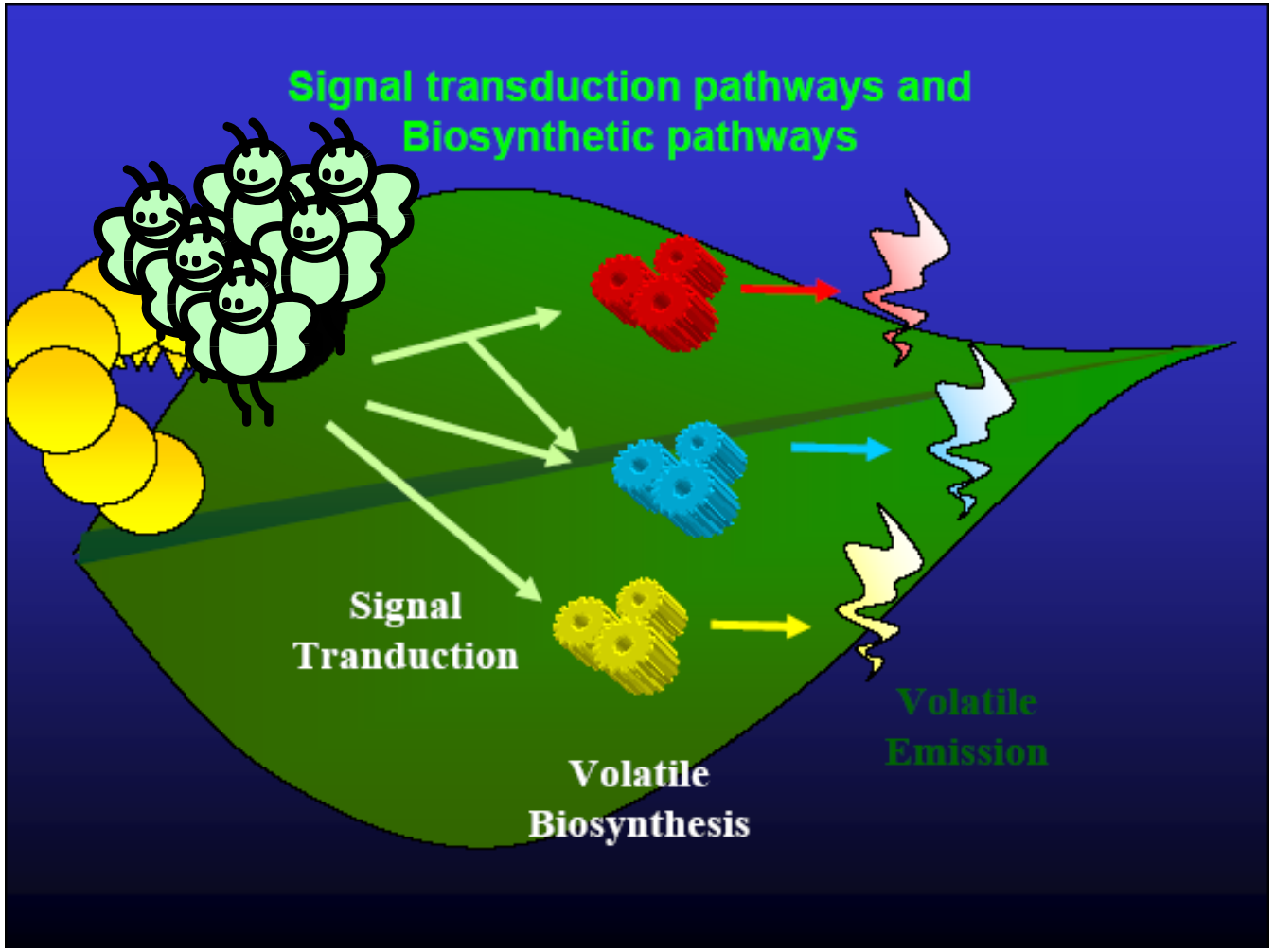
Loreto et al. Plant Physiol 2001

The BVOC family (emission > 1000 Tg C y^{-1})

> 500
Tg C y^{-1}



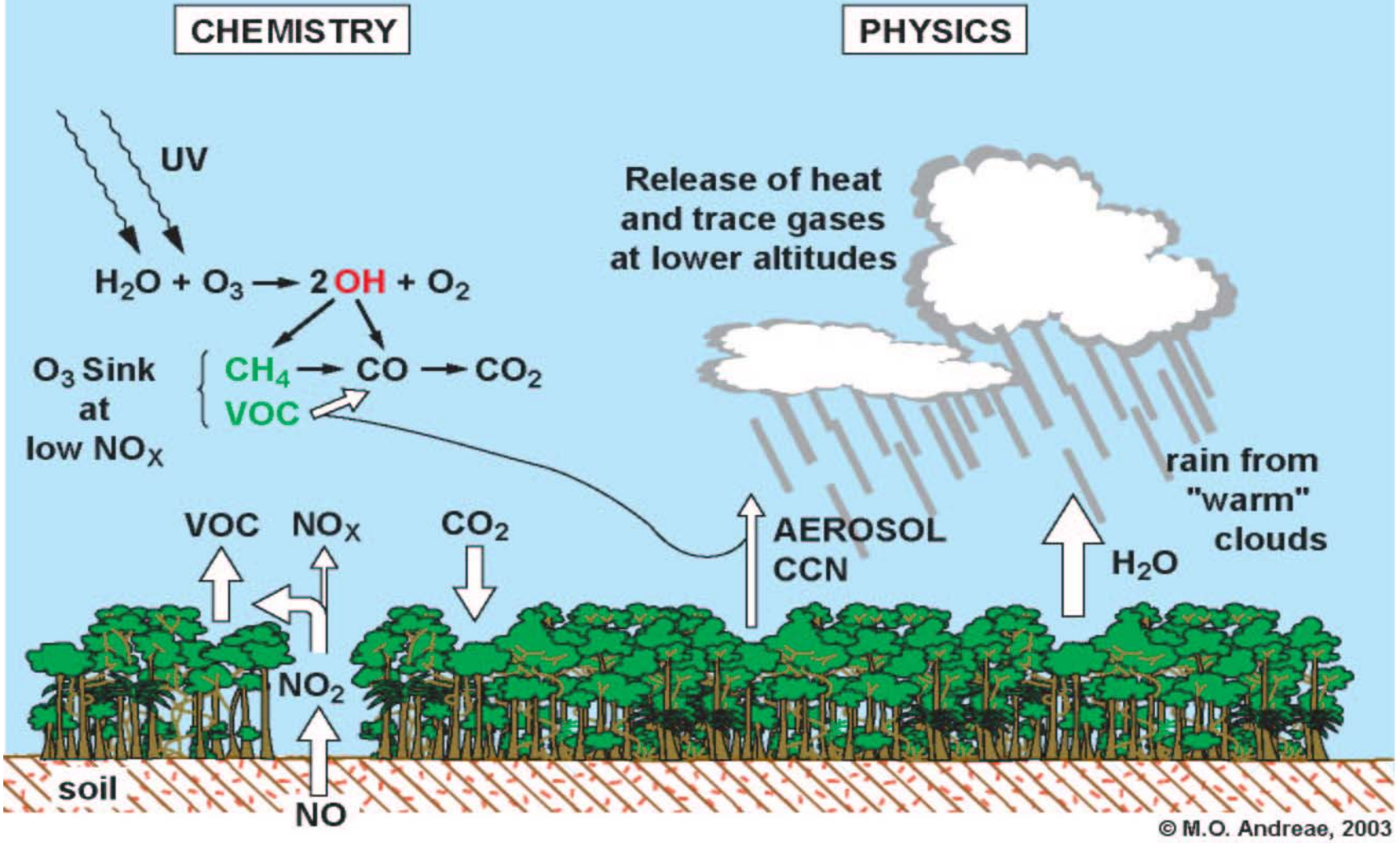
BVOCs in biotic stress interactions

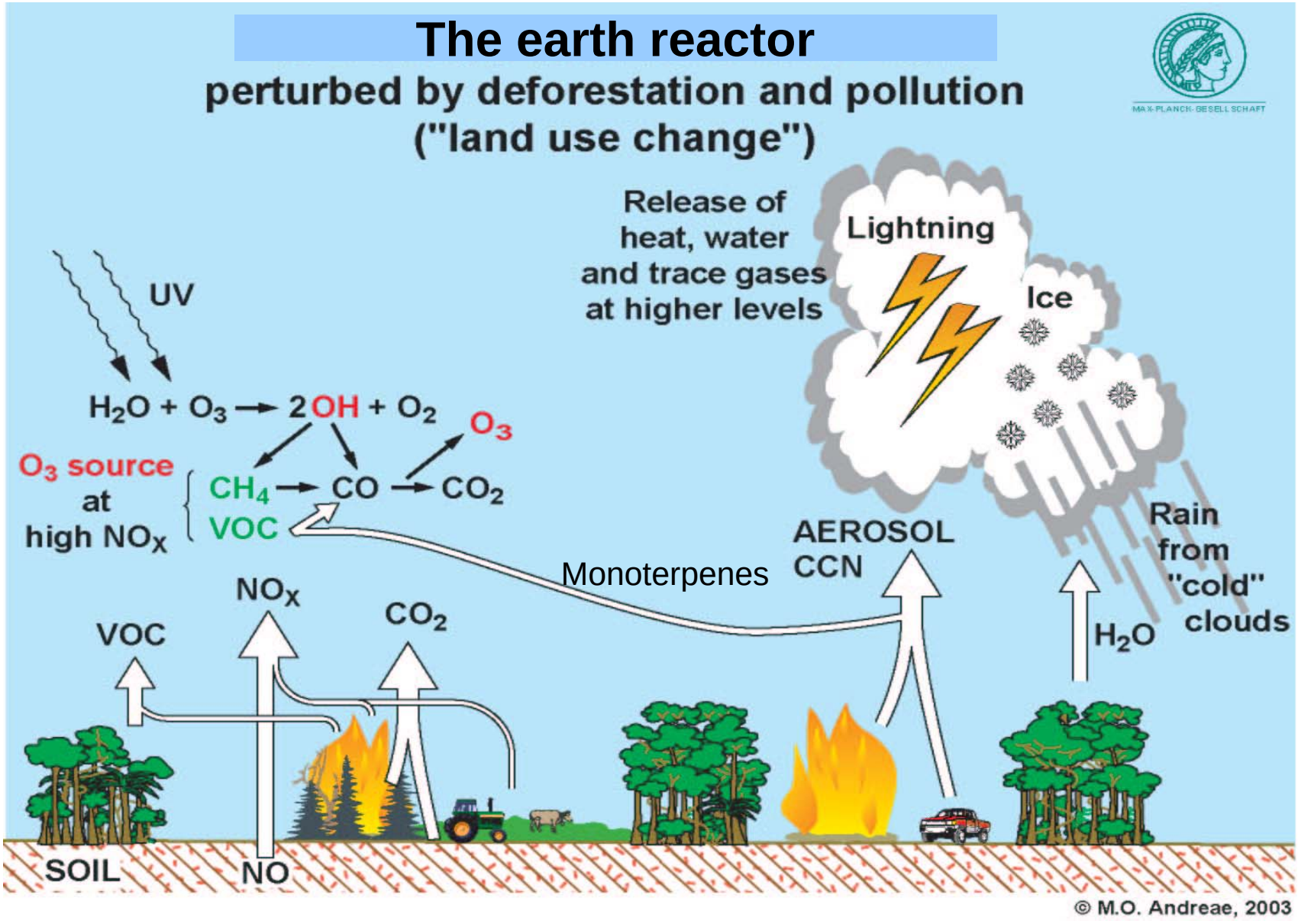


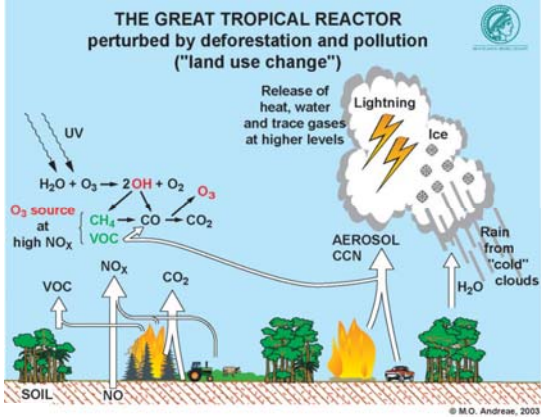
Courtesy of M. Dicke for VOCBAS

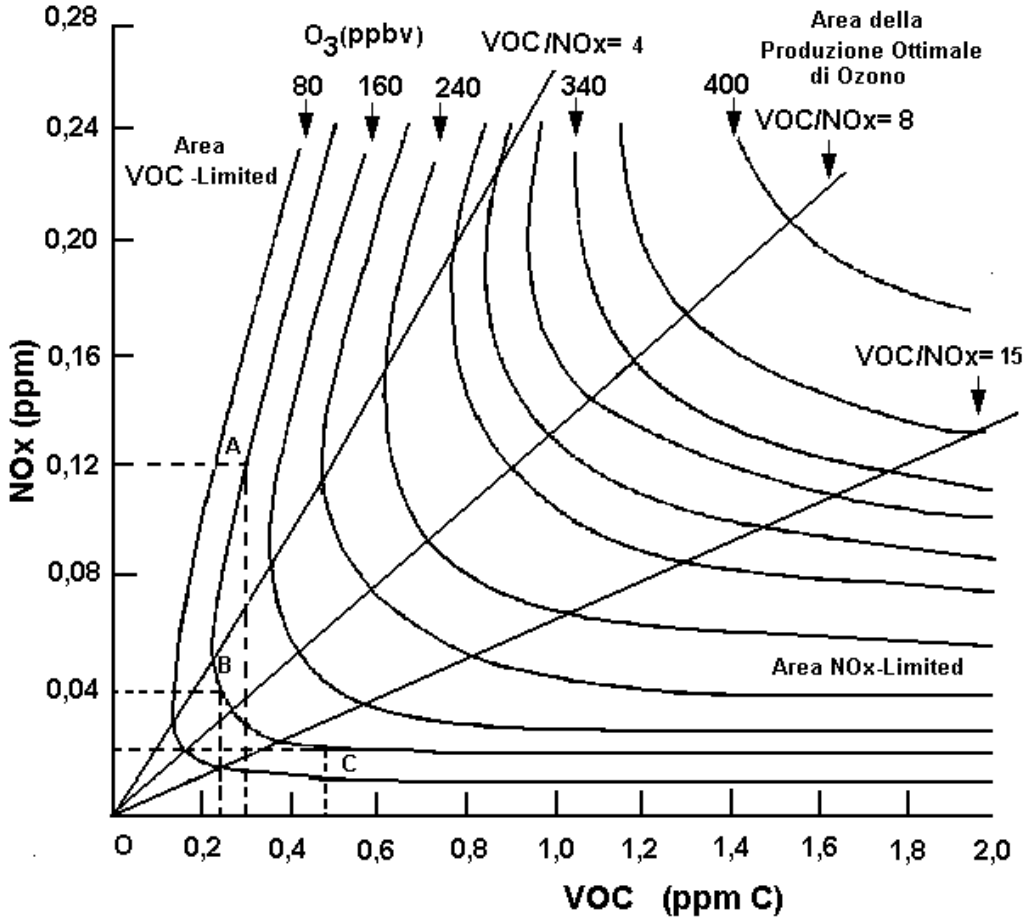
The earth reactor

as operated by the biosphere




The earth reactor
perturbed by deforestation and pollution
("land use change")
MAX-PLANCK-GESELLSCHAFT
Release of
heat, water
and trace gases
at higher levels
Lightning
Ice
UV
$H_2O + O_3 \rightarrow 2OH + O_2$
O_3
O_3 source
at
high NO_X
CH_4
VOC
CO
CO_2
Monoterpenes
AEROSOL
CCN
Rain
from
"cold"
clouds
H_2O
NO_X
CO_2
VOC
SOIL
NO
© M.O. Andreae, 2003



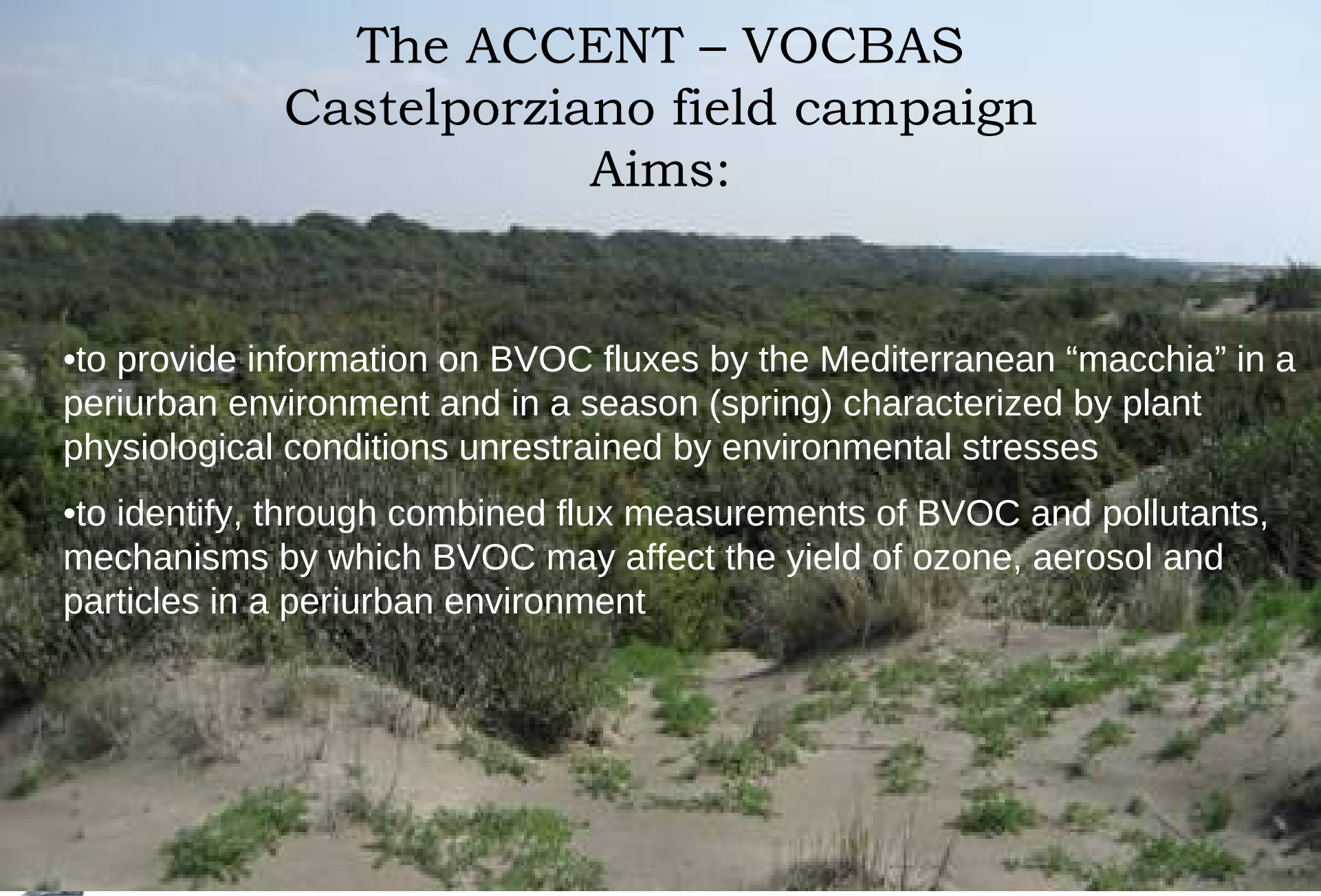


Conferenza
nell'Anno Internazionale del Pianeta Terra

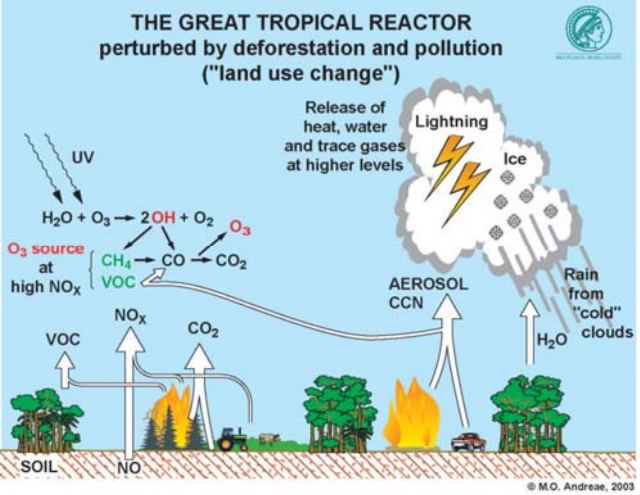
CNR, Aula Convegni, 22-23 Maggio 2008

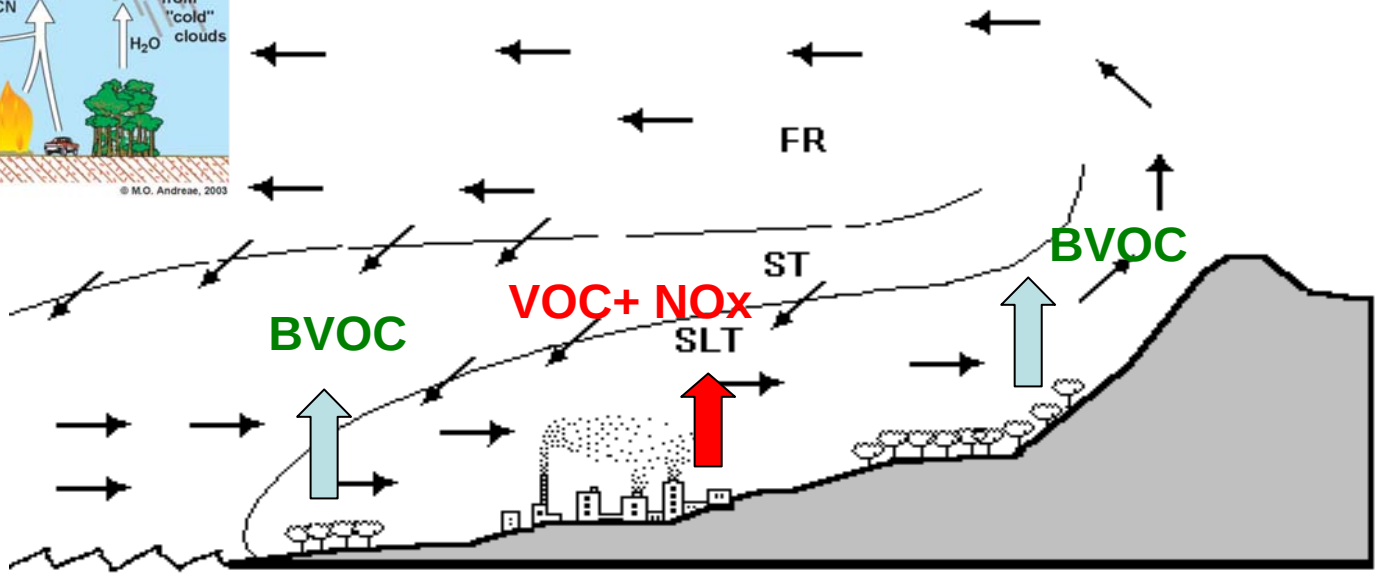
The ACCENT – VOCBAS Castelporziano field campaign

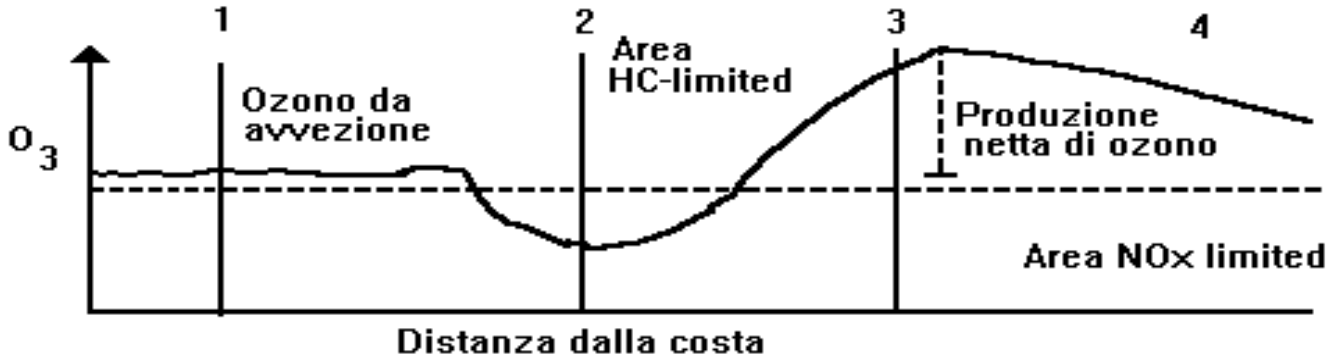
The ACCENT – VOCBAS Castelporziano field campaign Aims:

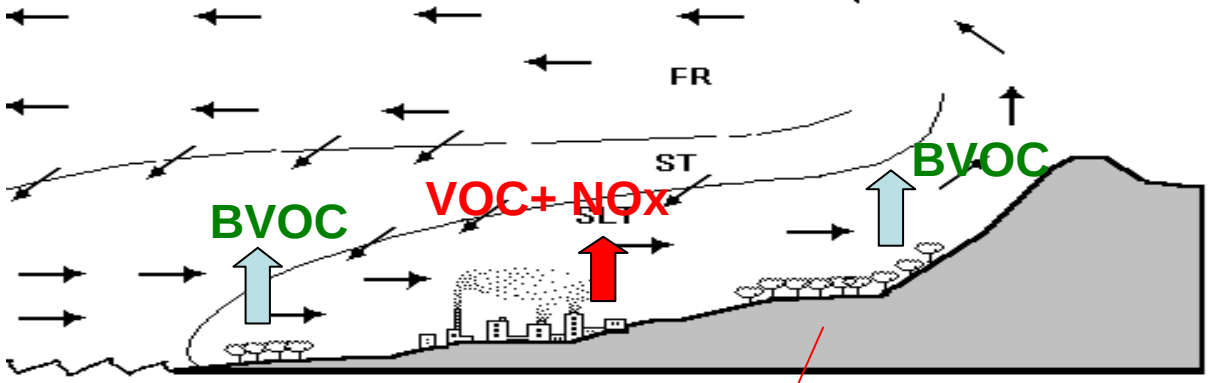


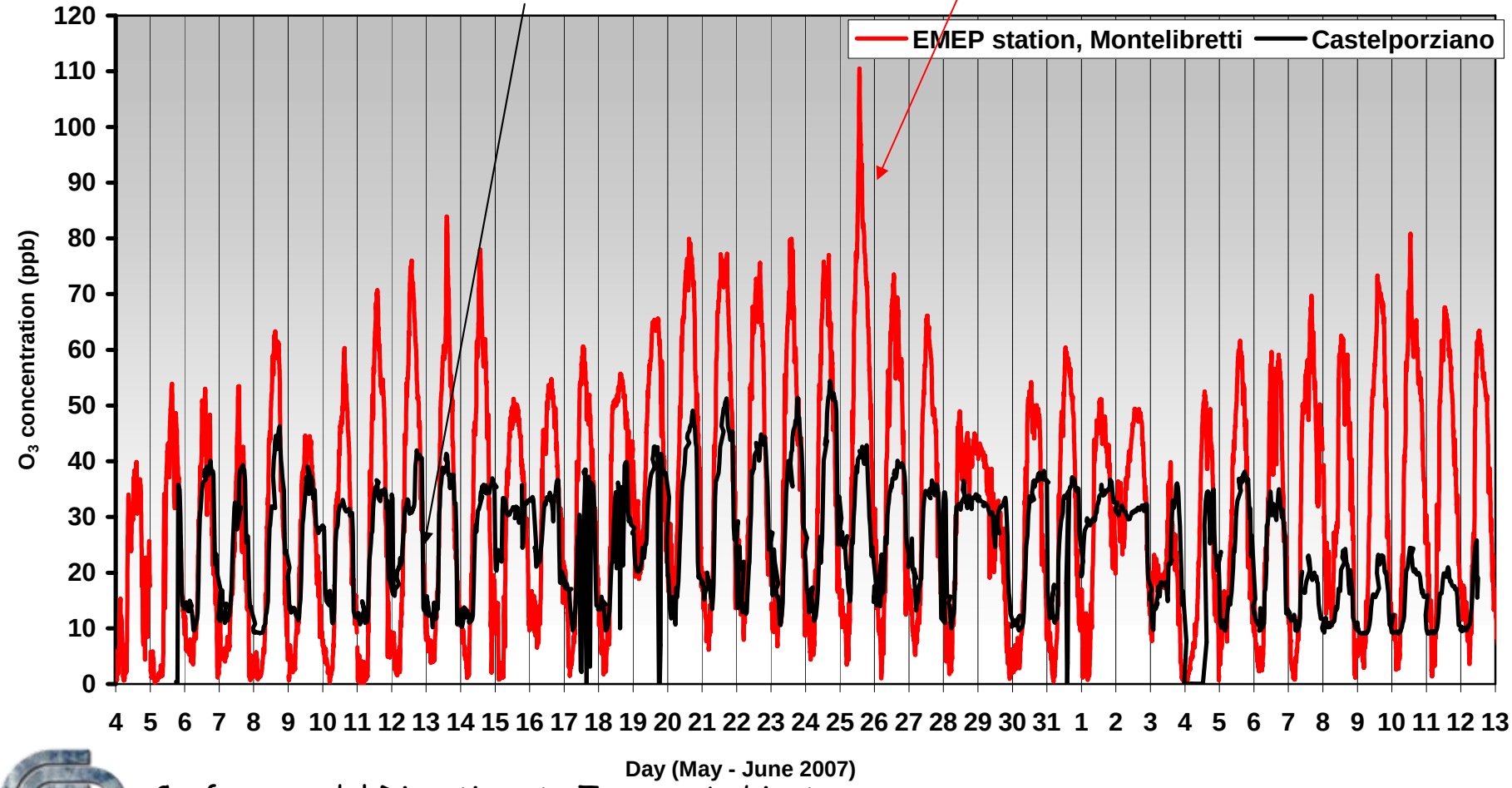
- to provide information on BVOC fluxes by the Mediterranean “macchia” in a periurban environment and in a season (spring) characterized by plant physiological conditions unrestrained by environmental stresses
- to identify, through combined flux measurements of BVOC and pollutants, mechanisms by which BVOC may affect the yield of ozone, aerosol and particles in a periurban environment


THE GREAT TROPICAL REACTOR
perturbed by deforestation and pollution
("land use change")
Release of heat, water and trace gases at higher levels
Lightning
Ice
UV
$H_2O + O_3 \rightarrow 2OH + O_2$
O_3
O_3 source at high NO_X
CH_4 CO CO_2
VOC
AEROSOL CCN
Rain from "cold" clouds
H_2O
NO_X
CO_2
VOC
SOIL
NO
© M.O. Andreae, 2003


FR
ST
SLT
BVOC
VOC+ NOx
BVOC


1
2
3
4
O_3
Ozono da avvezione
Area HC-limited
Produzione netta di ozono
Area NOx limited
Distanza dalla costa


FR
ST
SL
BVOC
VOC+ NOx
BVOC

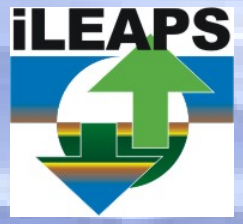

EMEP station, Montelibretti
Castelporziano
O3 concentration (ppb)
0
10
20
30
40
50
60
70
80
90
100
110
120
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13
Day (May - June 2007)

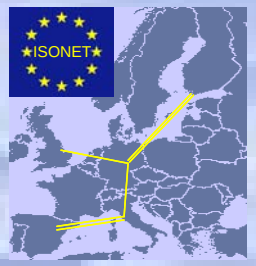
Future scientific challenges: the sustainable use of biosphere resources

The biosphere to mitigate environmental changes

The biosphere for food and non-food uses (bioenergy)

"Agriculture and forest productivity must double in the next years to face requirements for food and non food purposes"
T. Hall – EC officer, yesterday


iLEAPS


ISONET


VOCBAS


ACCENT
ATMOSPHERIC COMPOSITION CHANGE
THE EUROPEAN NETWORK OF EXCELLENCE


CIRCE


CarboItaly


Life in Extreme Environments
CAREX


IONICON
ANALYTIK

Foreseen and unforeseen consequences of rising CO_2

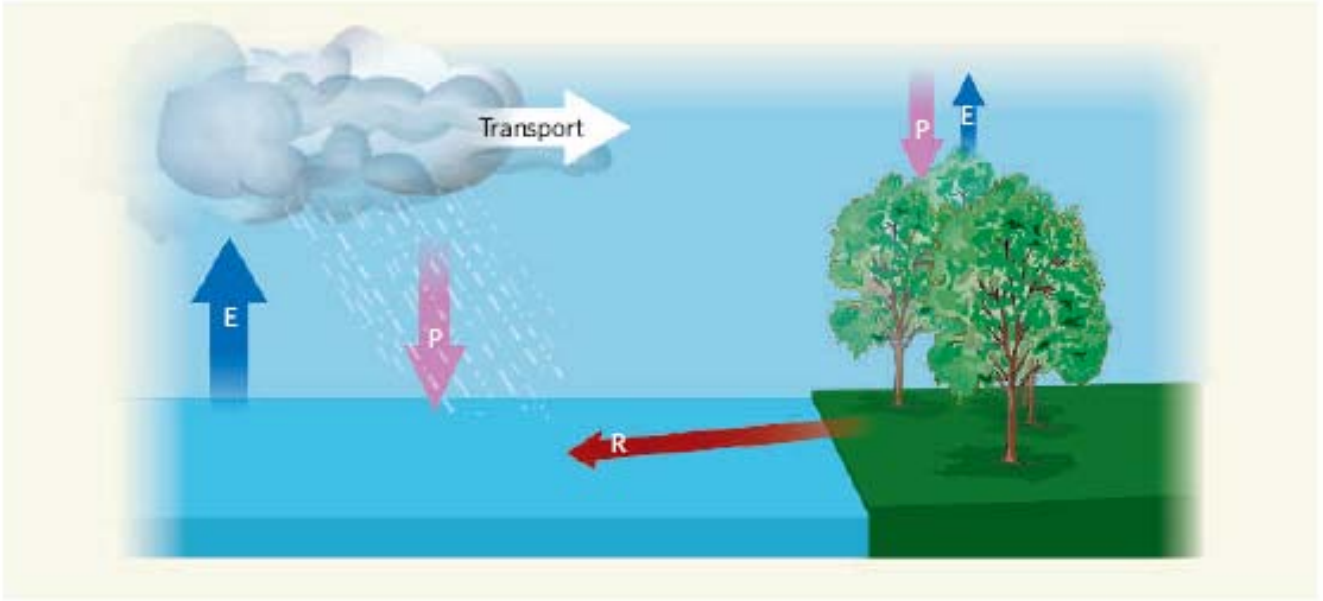


Figure 1 | Plants, CO_2 and the global water cycle. The balance between precipitation (P) and evaporation (E) over land determines the surface runoff (R), which returns water from the continents to the oceans. Plant photosynthesis plays an integral role in the global water cycle, by mediating the transfer of water from the land surface to the atmosphere. Elevated CO_2 can lead to closure of leaf stomata, which reduces leaf water loss and thereby decreases overall continental evaporation. Gedney *et al.*[2] show that this process, initiated by increased atmospheric CO_2, can account for the increases in surface runoff observed over the past century.

Gedney et al. 2006