Ecosystèmes européens, biodiversité et changement climatique

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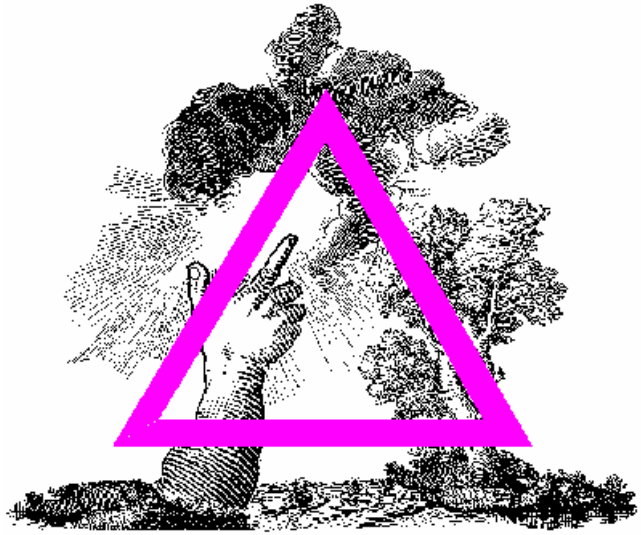

Ecosystèmes européens, biodiversité et changement climatique

- „Dangerous climate change“ ... for European ecosystems?
- Elements for a systematic and comprehensive assessment
- From risk assessment to risk management
- Summary

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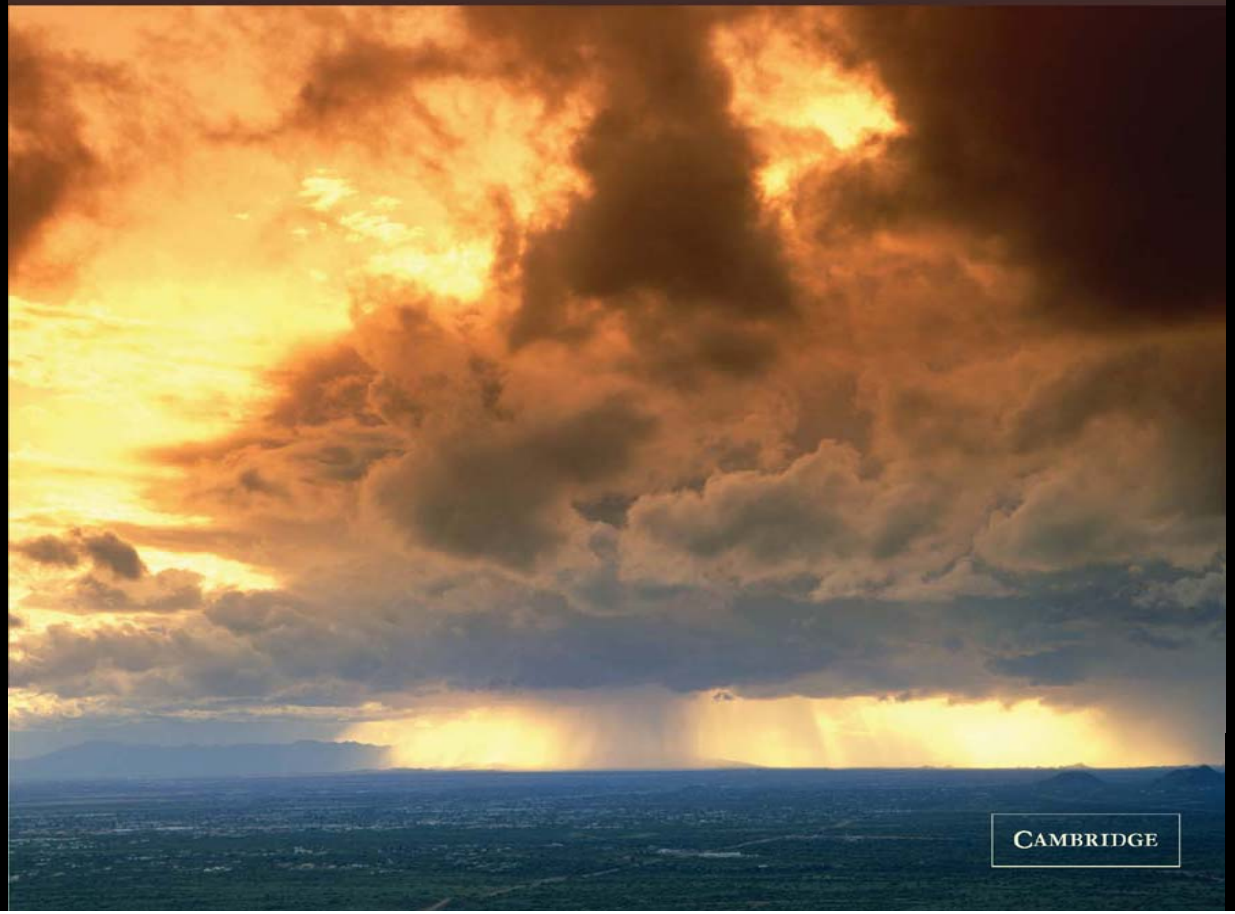
Lorraine, France, August 2003

The Elbe between Bitterfeld and Eilenburg, Germany 2002

Figure 4: Aletsch historical length change: 1856, Martens and 2001, Holzhauser

AVOIDING DANGEROUS CLIMATE CHANGE

EDITED BY Hans Joachim Schellnhuber, Wolfgang Cramer, Nebojsa Nakicenovic, Tom Wigley and Gary Yohe



„…avoid the unmanageable and manage the unavoidable…“

Dangerous anthropogenic climate change exists today, causing multiple impacts on ecosystems and people.

Ecosystèmes européens, biodiversité et changement climatique

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Science is to provide guidance for damage estimation, mitigation and adaptation: climate change impact assessment.

Elements for a systematic and comprehensive assessment

- Detection and attribution of anthropogenic climate change and its impacts
- Cause-effect confounding factors
- Scaling in space and time
- Prognostic capacity

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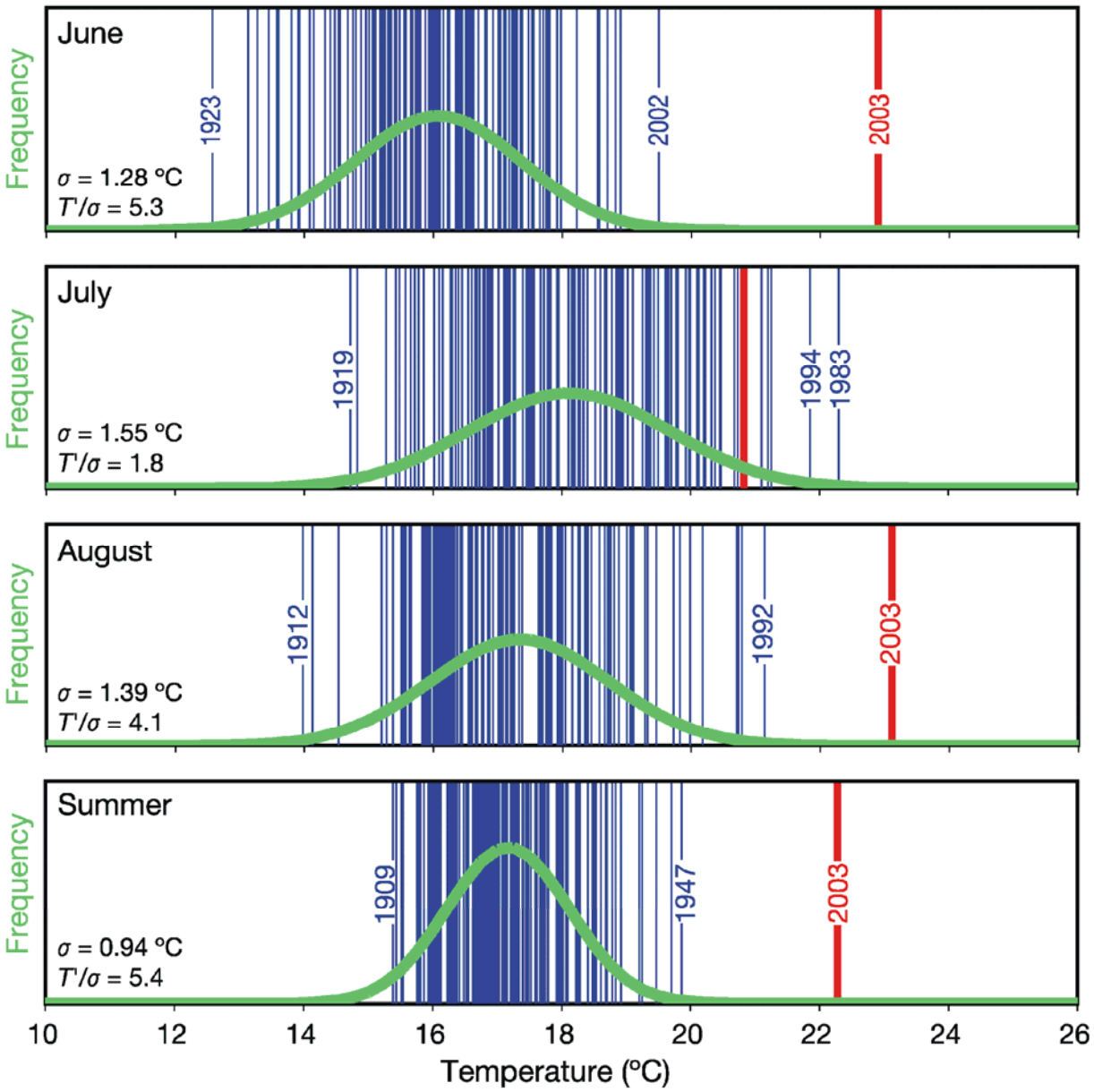


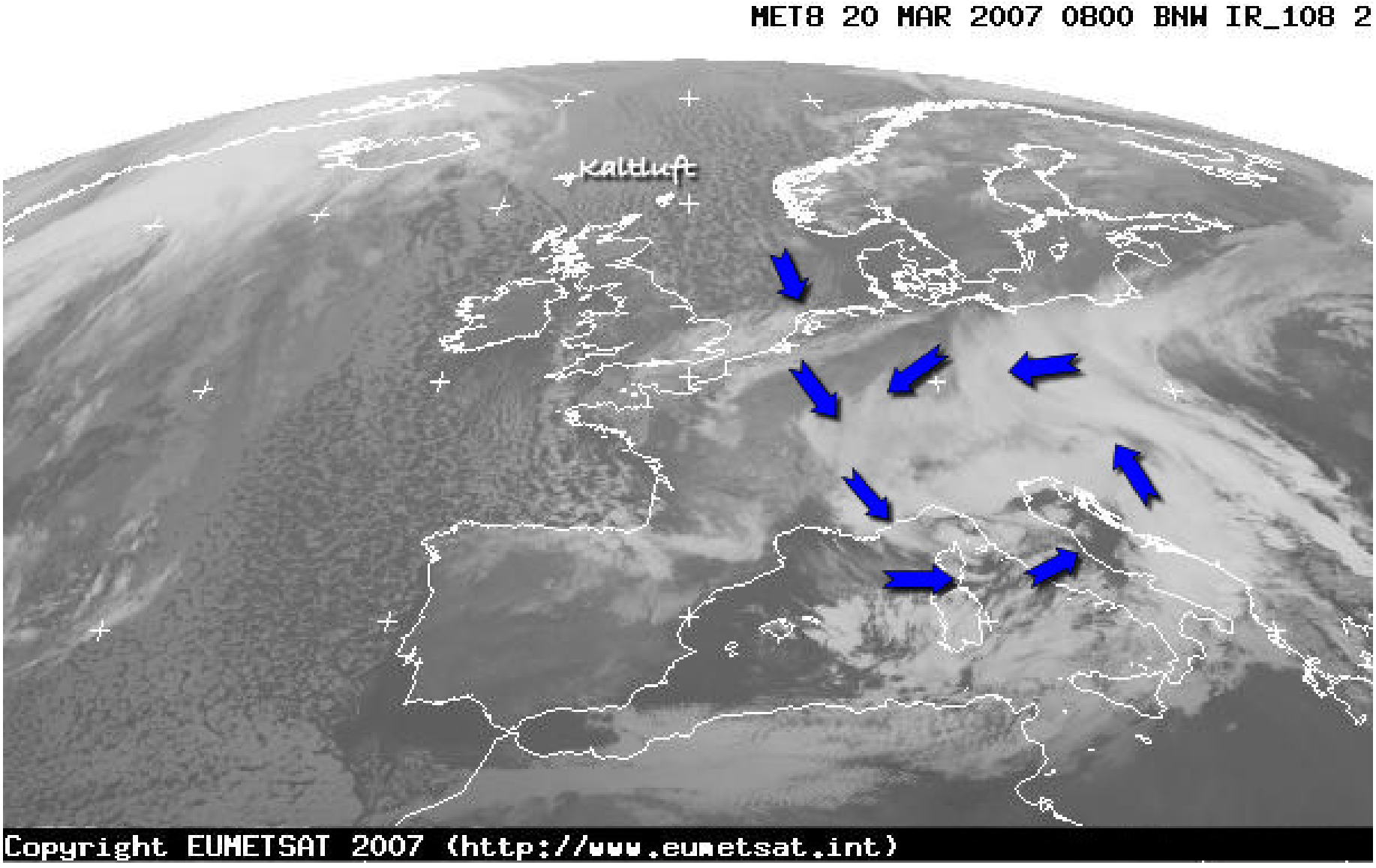
Monthly and seasonal temperature means in Switzerland

1864-2003

Source: Schär et al. 2004

The Elbe between Bitterfeld and Eilenburg, Germany 2002

„Vb Weather“


MET8 20 MAR 2007 0800 BNW IR_108 2
Kaltluft
Copyright EUMETSAT 2007 (http://www.eumetsat.int)

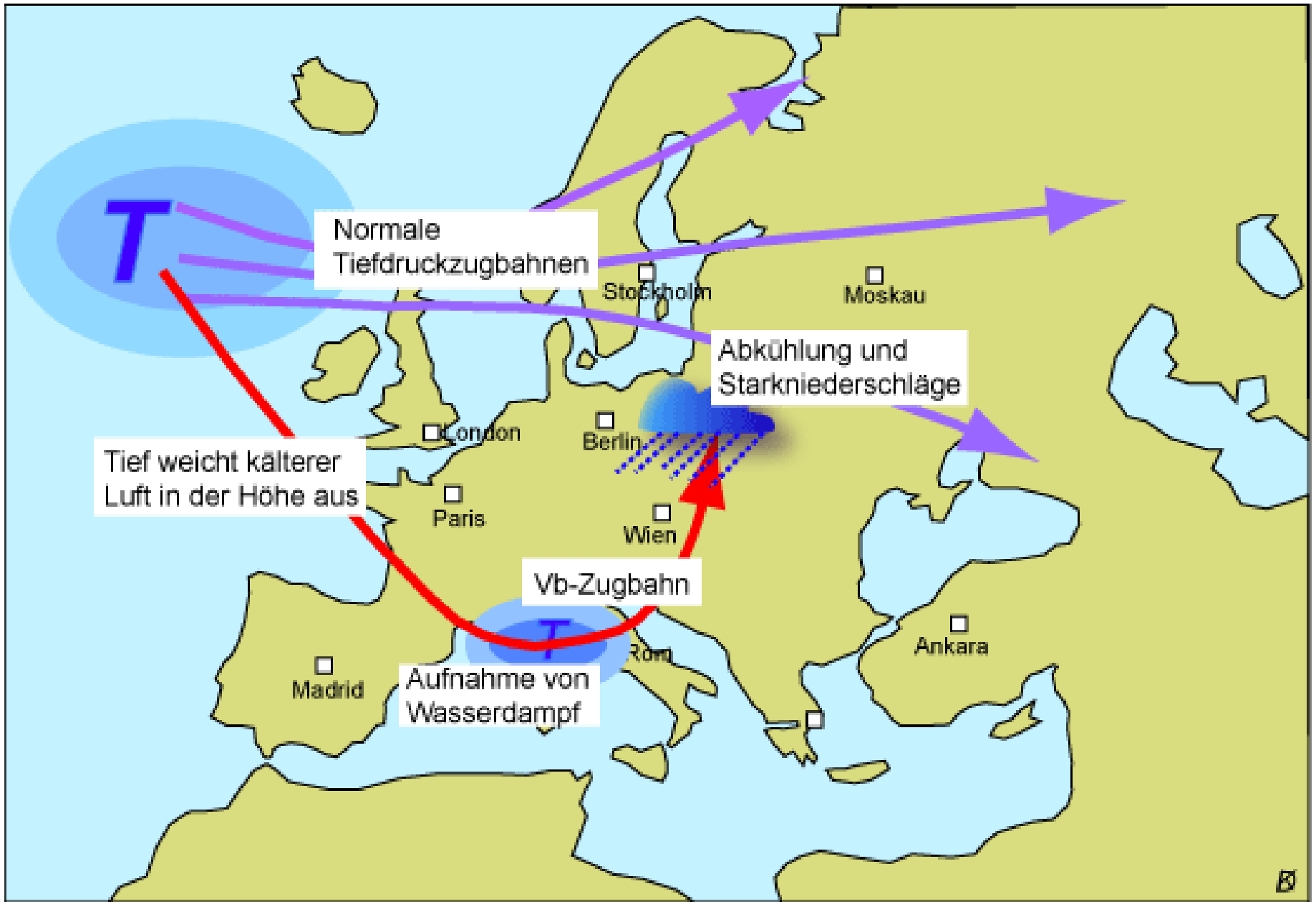
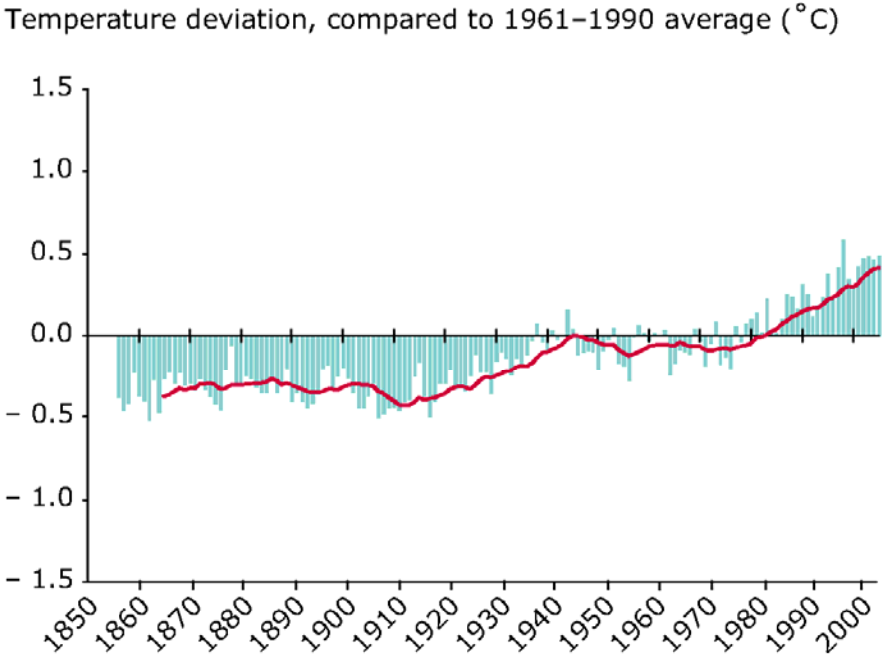
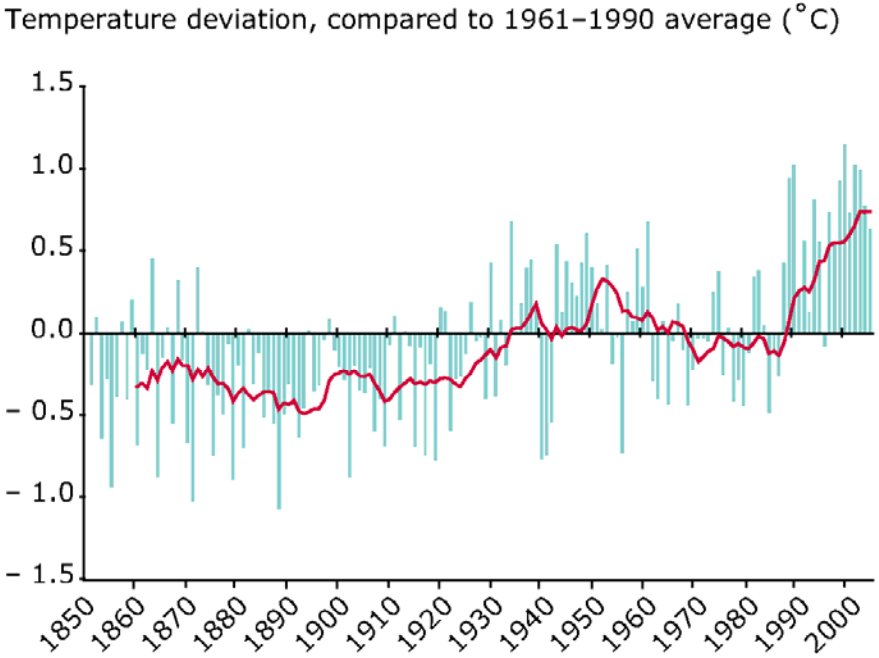

T
Normale
Tiefdruckzugbahnen
Stockholm
Moskau
Abkühlung und
Starkniederschläge
London
Berlin
Tief weicht kälterer
Luft in der Höhe aus
Paris
Wien
Vb-Zugbahn
T
Rom
Ankara
Madrid
Aufnahme von
Wasserdampf

Figure 4: Aletsch historical length change: 1856, Martens and 2001, Holzhauser

Observed annual average temperature – global (left) and UNECE Europe (right)

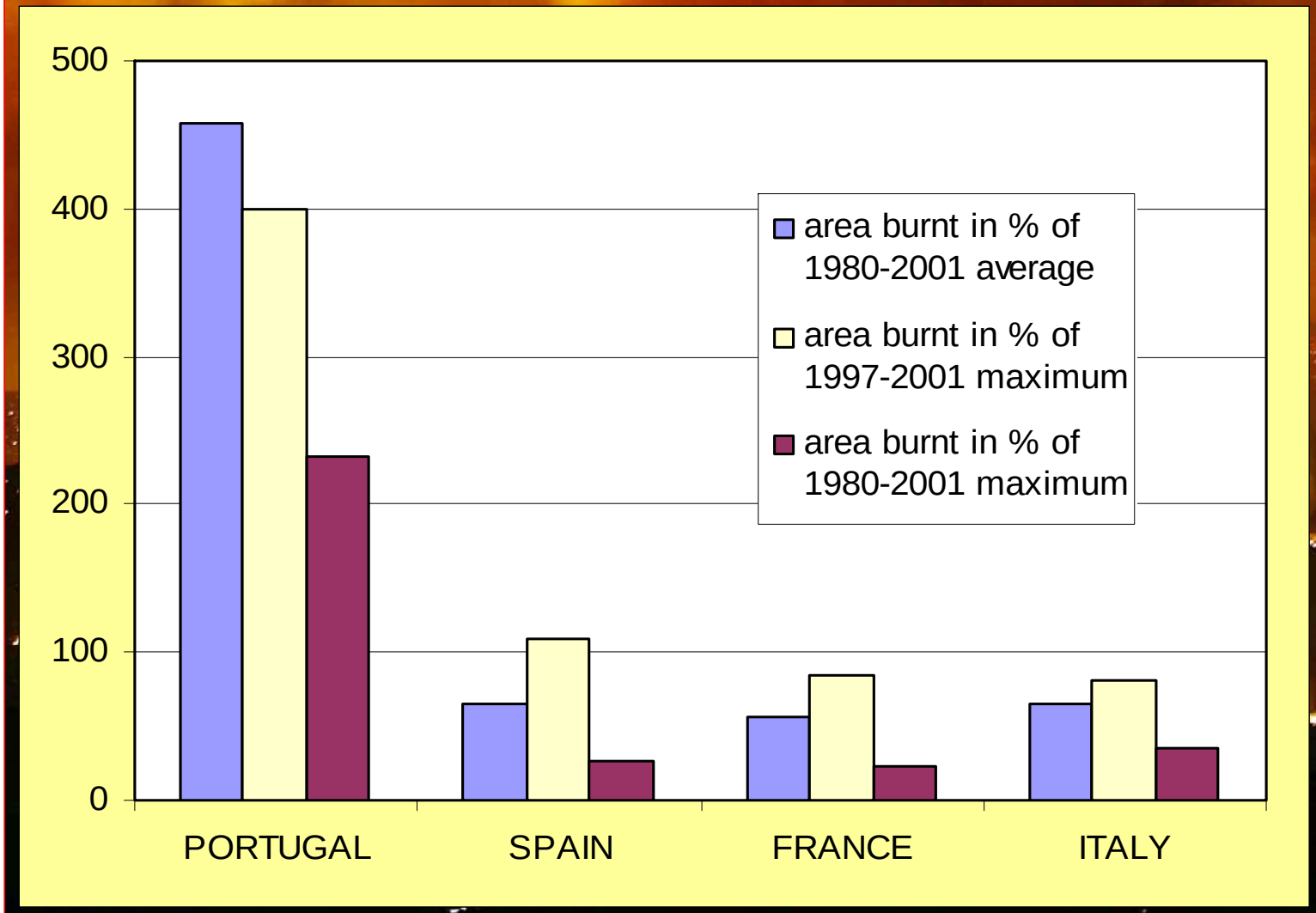




Source: CRU, 2006.

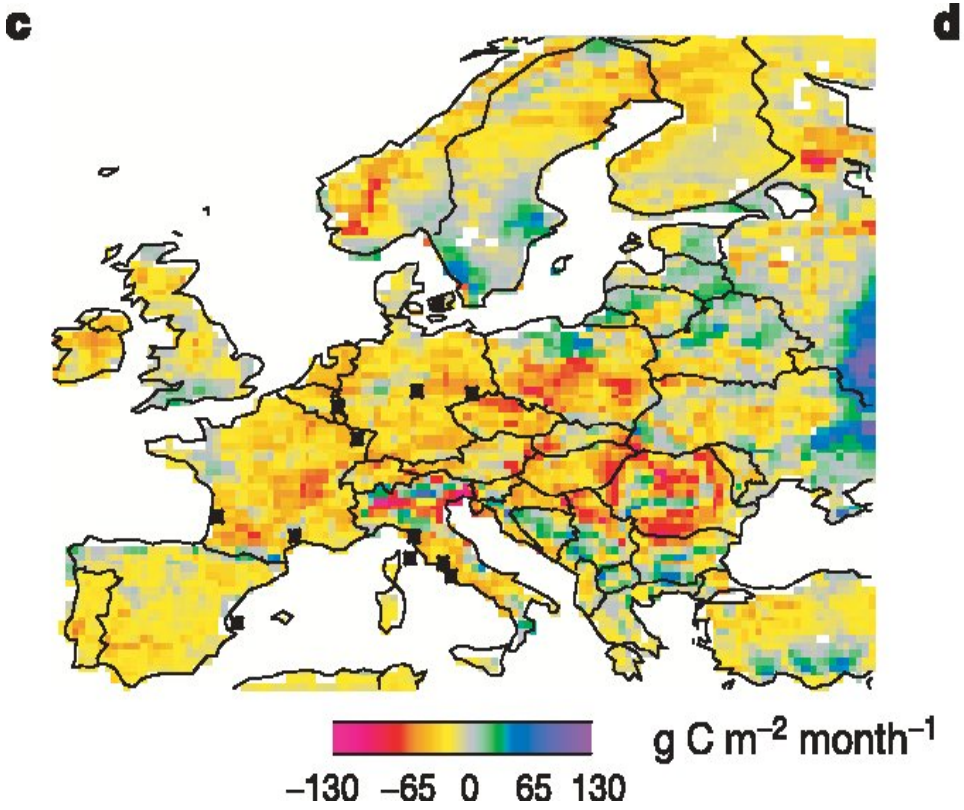
EEA 2007, L'environnement en Europe

Forest fires 2003

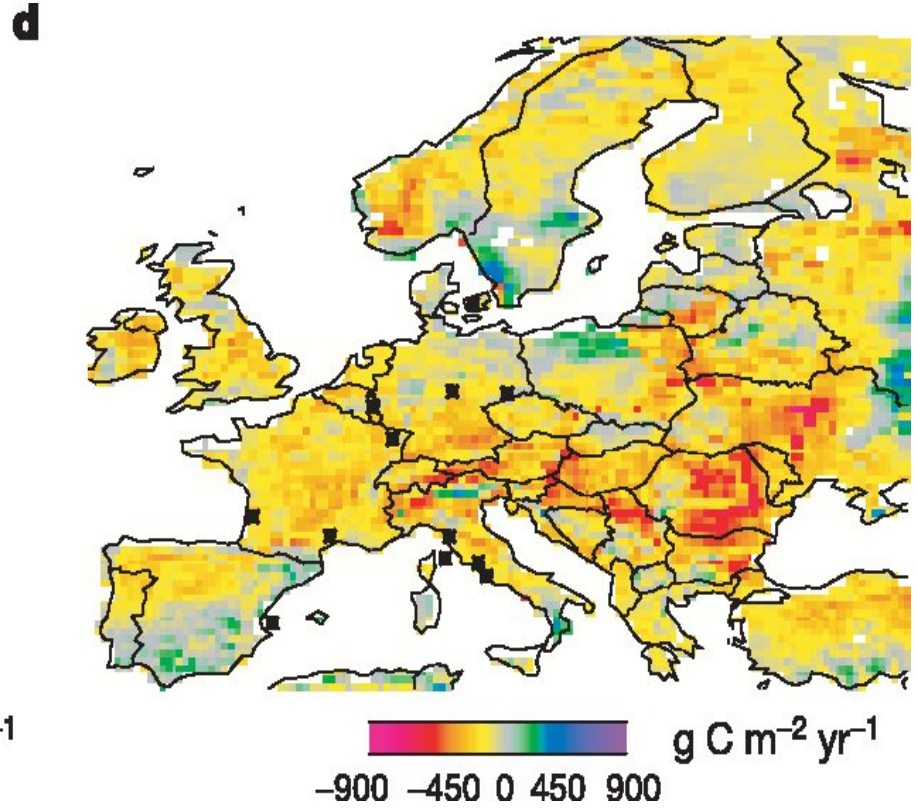


Data for 2003
Jan. through:
Portugal: 31. Oct
Spain: 14. Sep
France: 27. Aug
Italy: 7. Sep
Analysis: PIK

NPP anomaly 2003
(based on validated simulations)



July - September



Annual total

Ciais et al. 2005


IF THERE ARE NO SMOKING GUNS THEN HOW COME MY PANTS ARE ON FIRE?
©Steve Bell 2003-1863-10-1

Elements for a systematic and comprehensive assessment

- Detection and attribution of anthropogenic climate change and its impacts
- Cause-effect confounding factors
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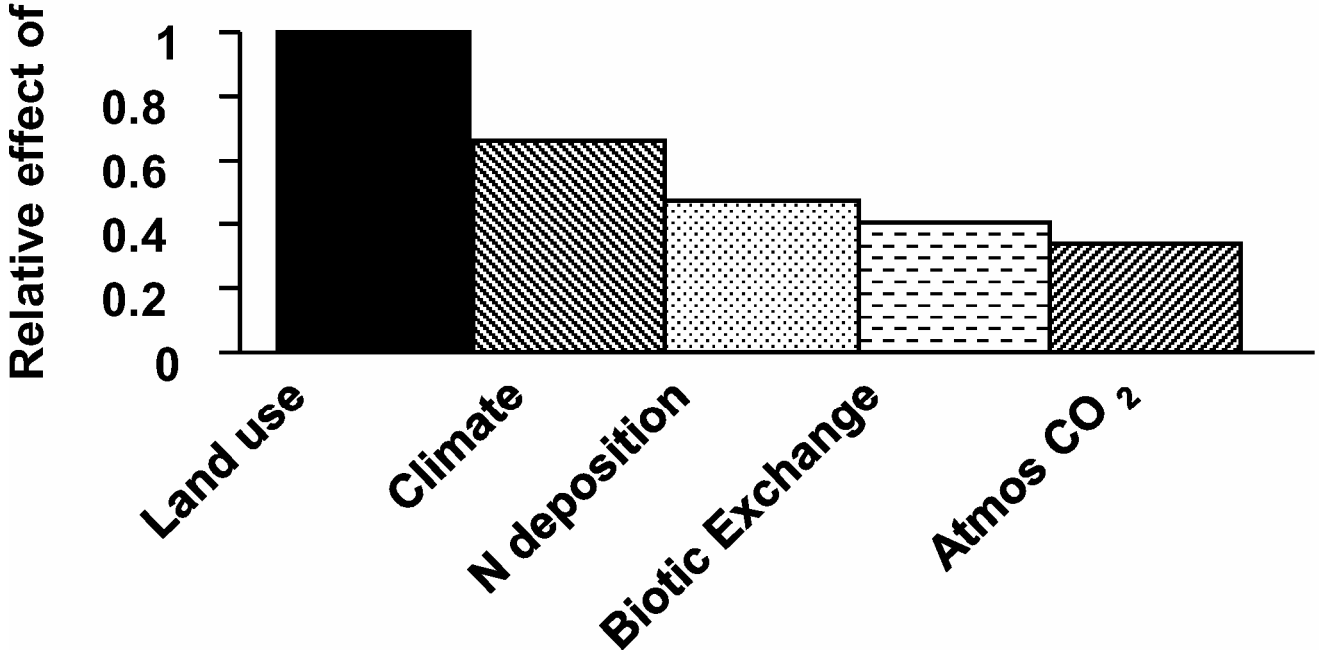
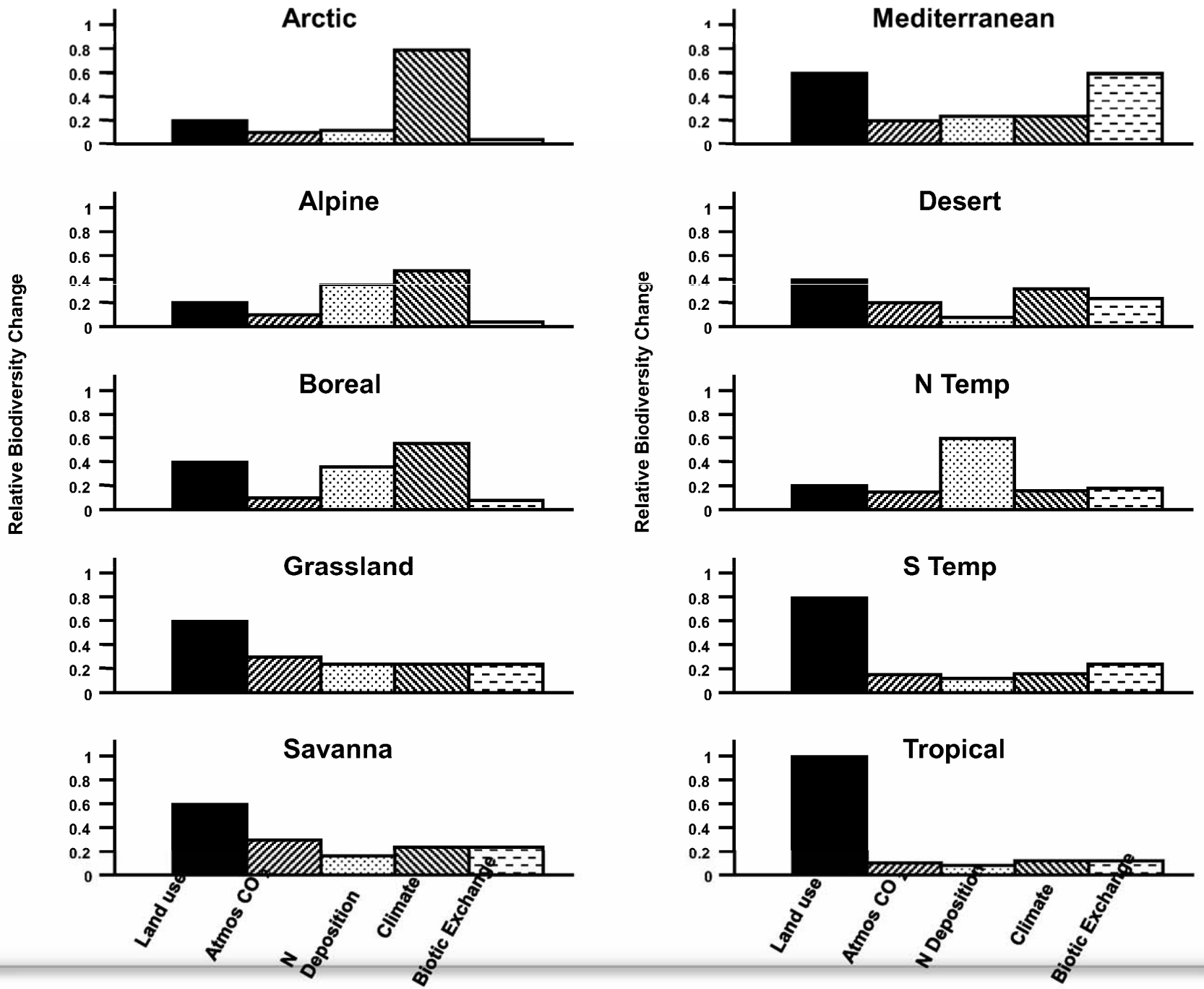
Sala et al. 2000 Global biodiversity scenarios for the year 2100

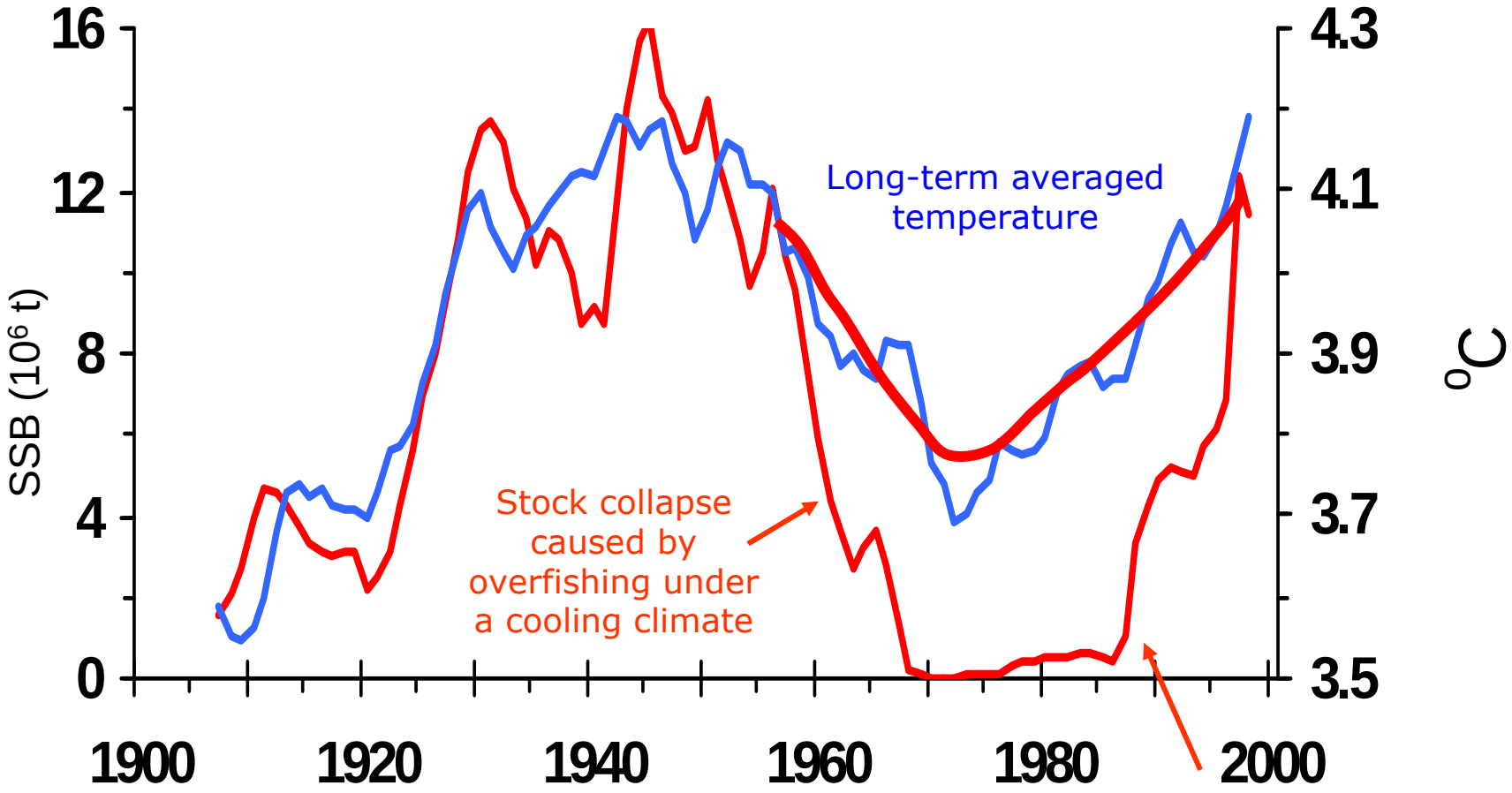
Science 287, 1770-1774




Arctic
Mediterranean
Alpine
Desert
Boreal
N Temp
Grassland
S Temp
Savanna
Tropical
Relative Biodiversity Change
Relative Biodiversity Change
0
0.2
0.4
0.6
0.8
1
Land use
Atmos CO2
N Deposition
Climate
Biotic Exchange

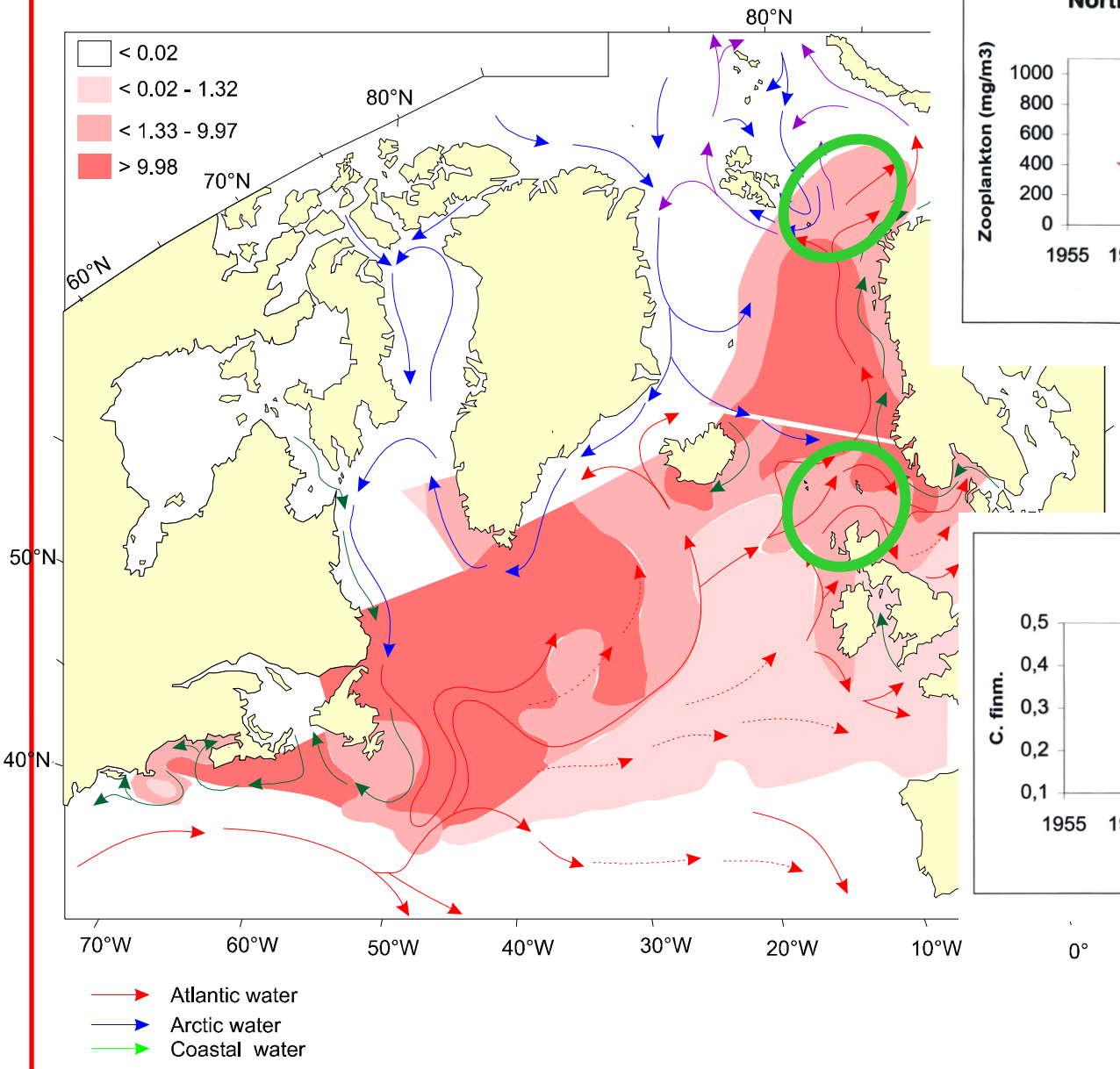
Spawning stock biomass (SSB) of Norwegian spring-spawning herring and the longterm-averaged temperature (the AMO signal)

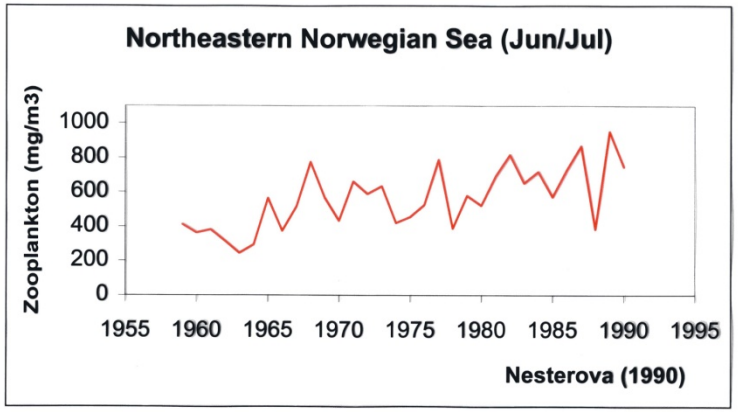
(Toresen og Østvedt 2000)

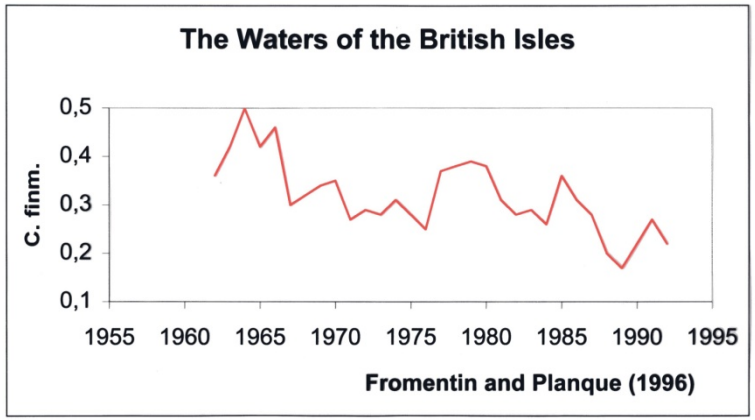


From S Sundby, Bergen, Norway

Distribution of Calanus finmarchicus

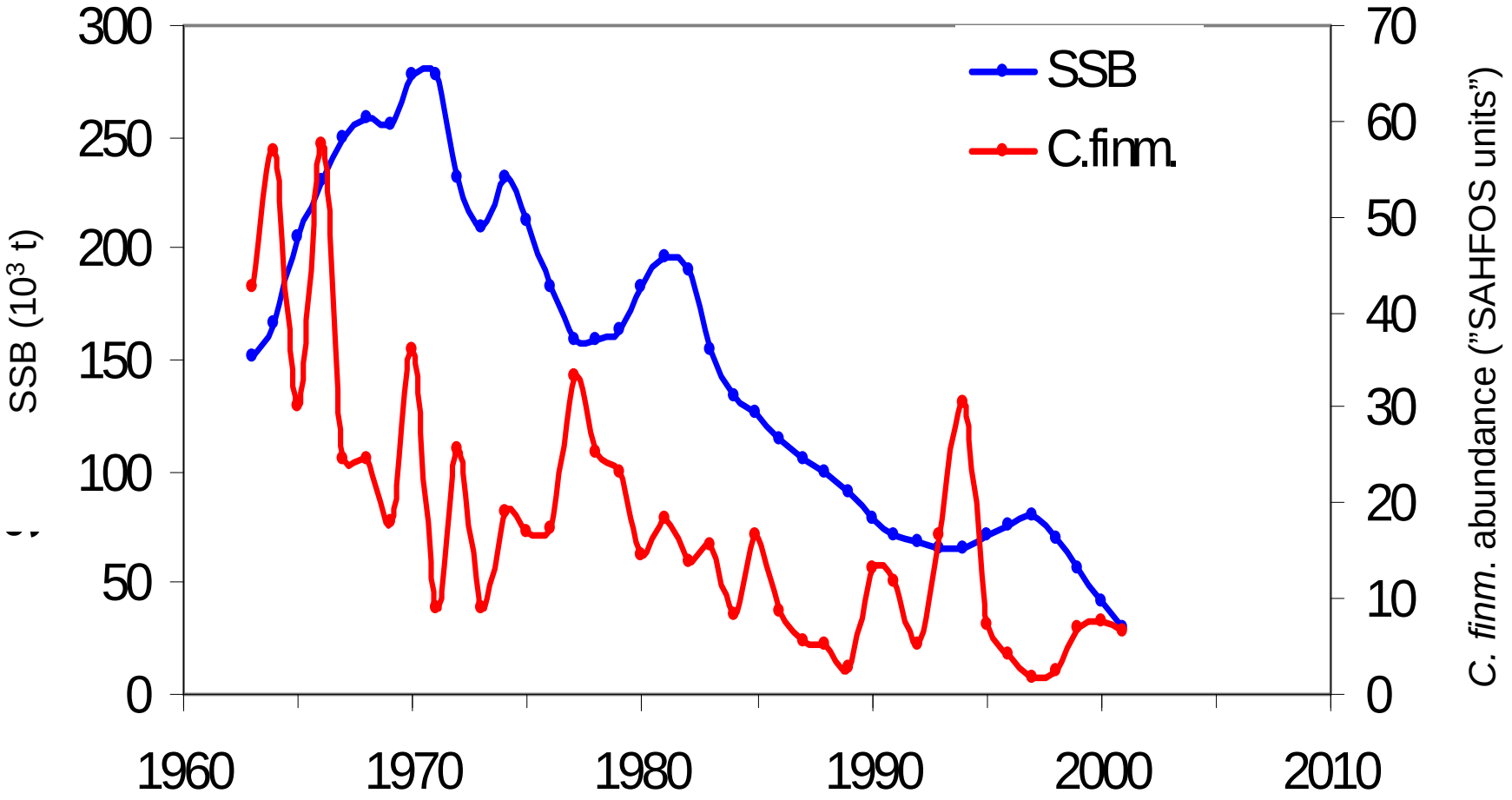






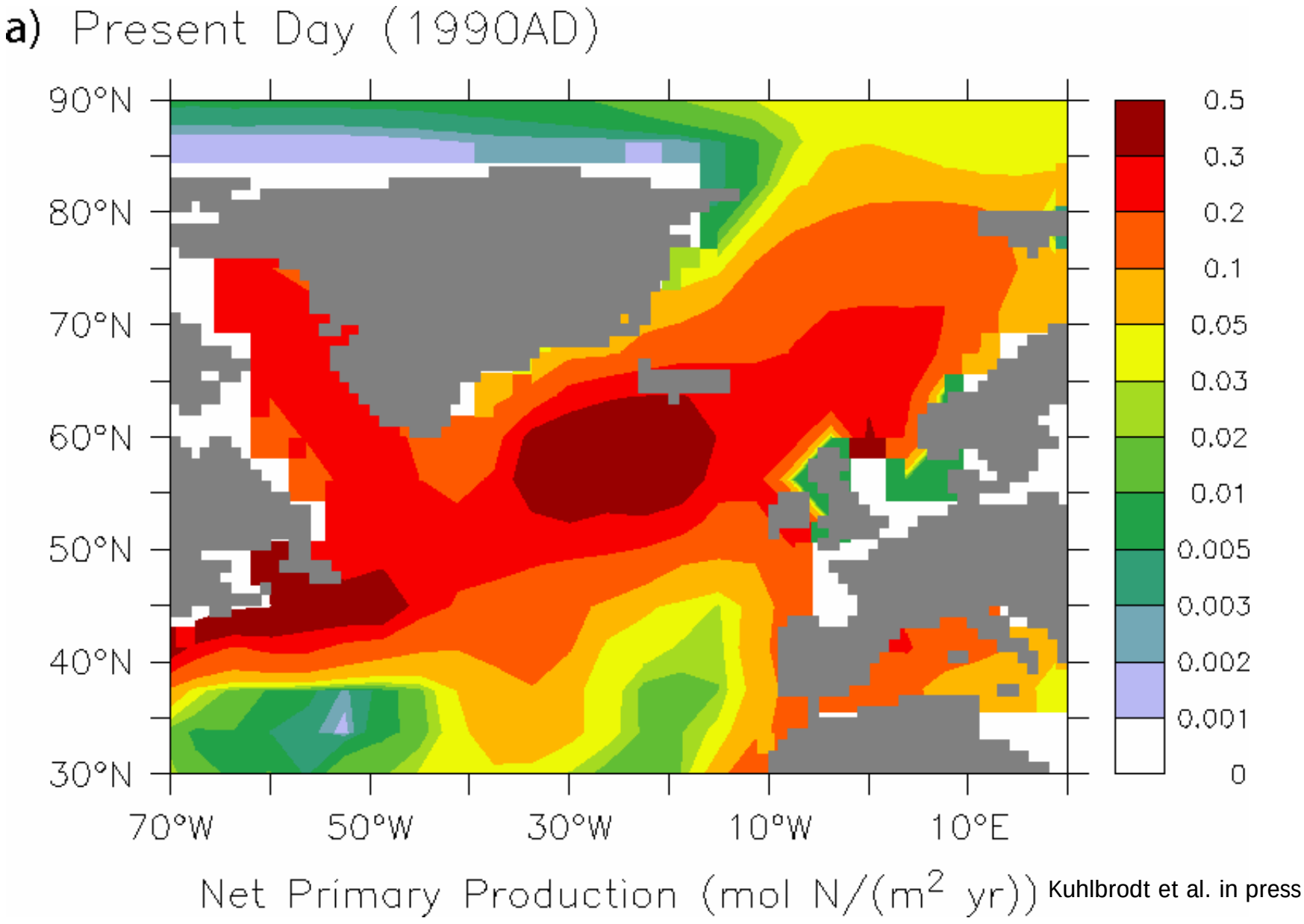
From S Sundby, Bergen, Norway

North Sea cod spawning-stock biomass (SSB) and spring/summer abundance of *C. finmarchicus*



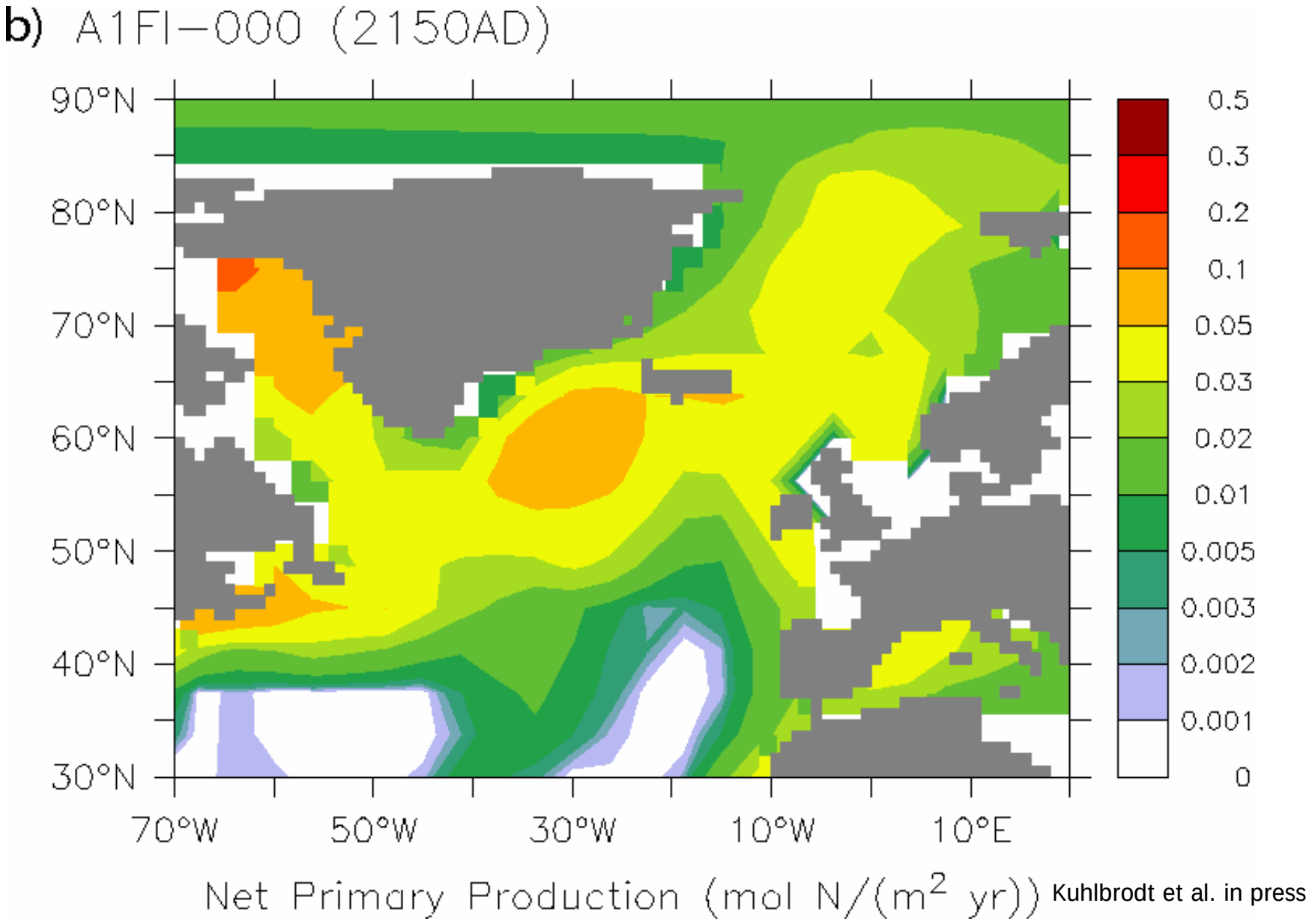
From S Sundby, Bergen, Norway

Marine productivity (present day)



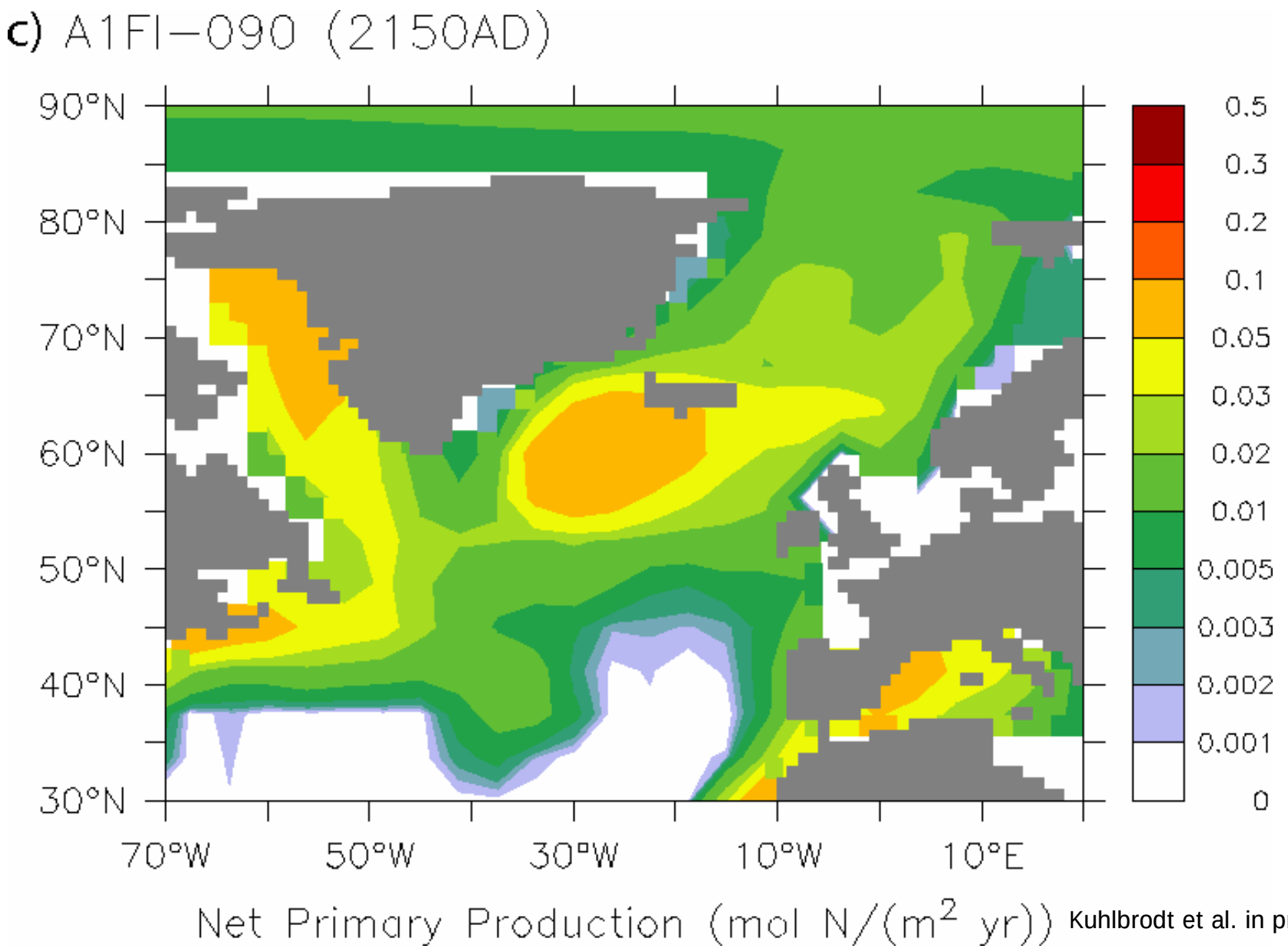
Kuhlbrodt et al. in press

Marine productivity (warming scenario)



Kuhlbrodt et al. in press

Marine productivity (THC breakdown scenario)



Kuhlbrodt et al. in press

Elements for a systematic and comprehensive assessment

- Detection and attribution of anthropogenic climate change and its impacts
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Is the highest possible resolution always necessary?

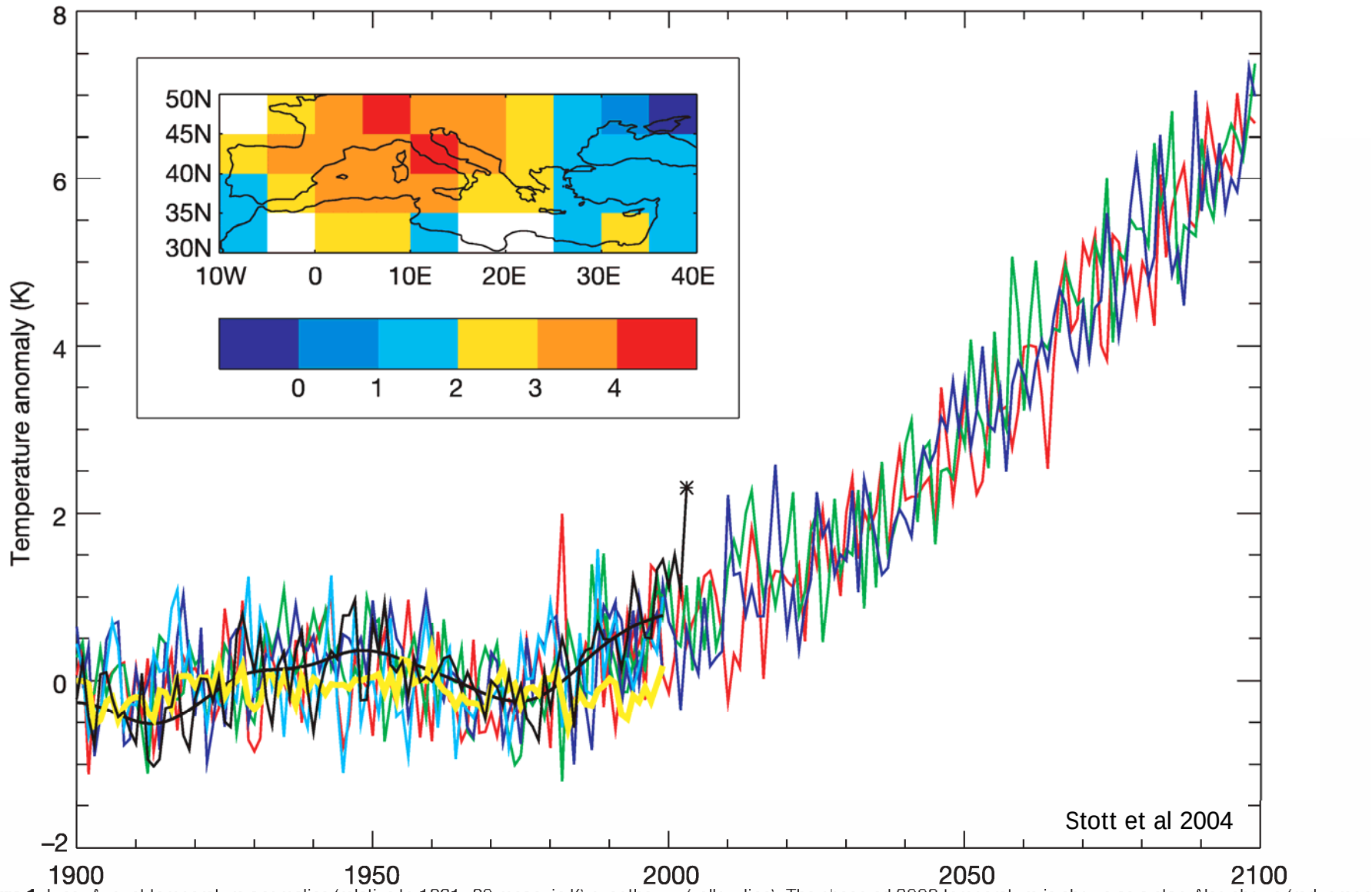
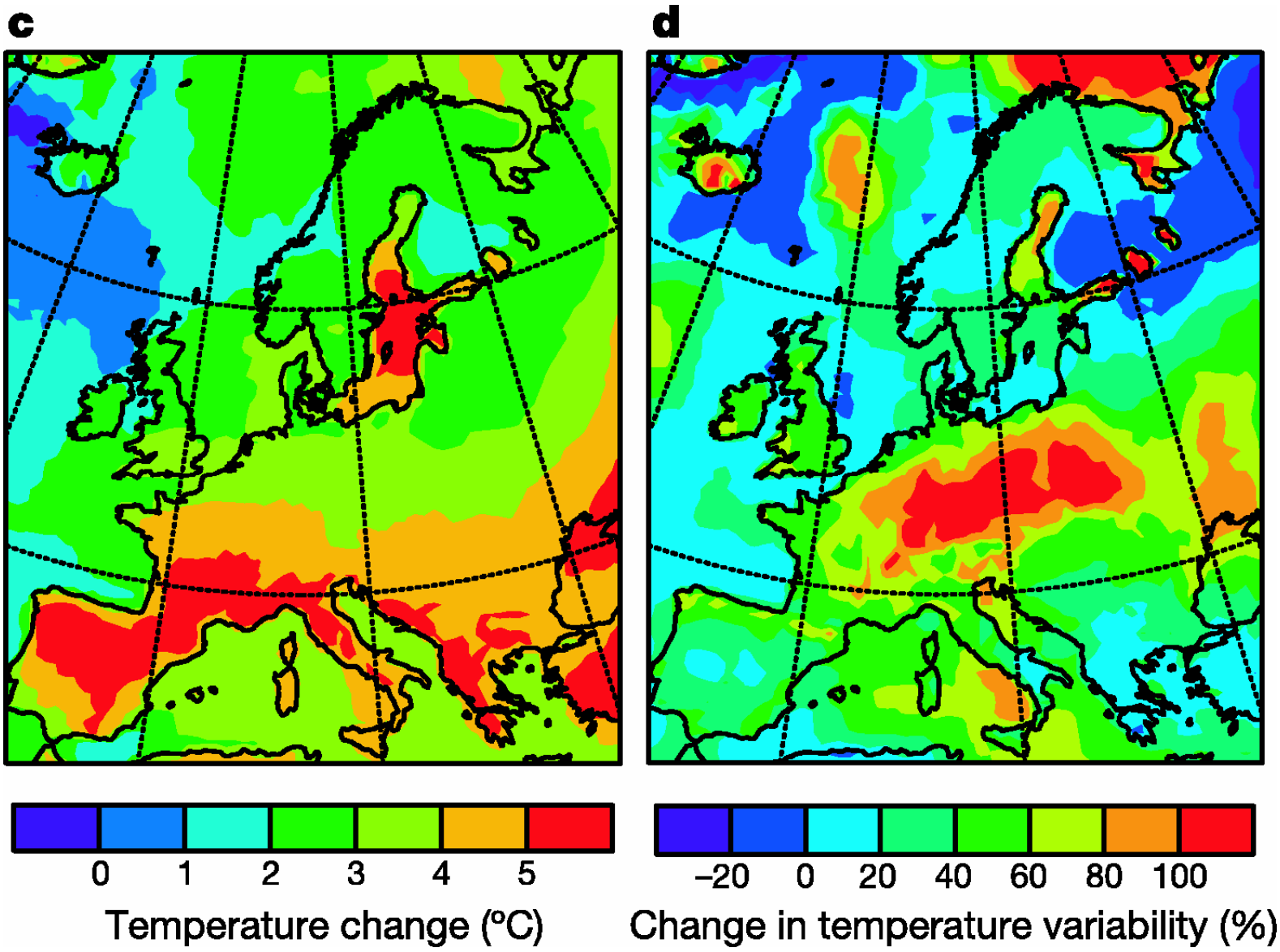


Figure 1 June–August temperature anomalies (relative to 1961–90 mean, in K) over the region shown in inset. Shown are observed temperatures (black line, with low-pass-filtered temperatures as heavy black line), modelled temperatures from four HadCM3 simulations including both anthropogenic and natural forcings to 2000 (red, green, blue and turquoise lines), and estimated HadCM3 response to purely natural natural forcings (yellow line). The observed 2003 temperature is shown as a star. Also shown (red, green and blue lines) are three simulations (initialized in 1989) including changes in greenhouse gas and sulphur emissions according to the SRES A2 scenario to 2100[22]. The inset shows observed summer 2003 temperature anomalies, in K.

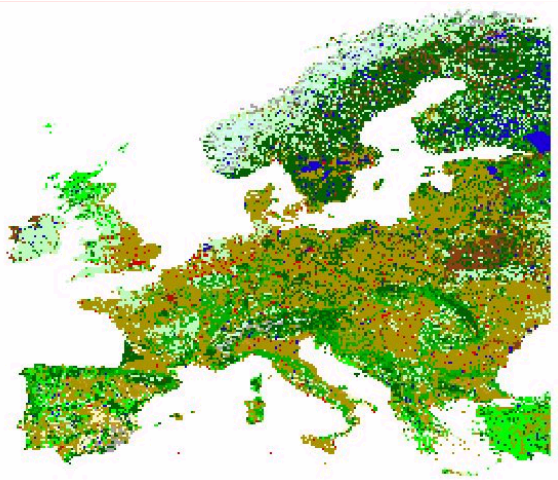


Results from an RCM climate change scenario representing current (CTRL 1961–90) and future (SCEN 2071–2100) conditions. **c**, Associated temperature change (SCEN–CTRL, °C). **d**, Change invariability expressed as relative change in standard deviation of JJA means ((SCEN–CTRL)/CTRL, %).

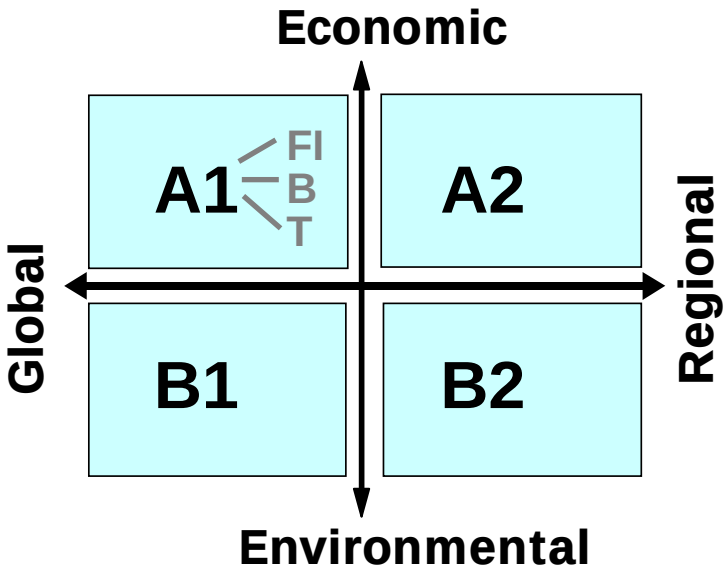
Schär et al 2004

How to achieve consistent scaling for different driving forces?

ATEAM, Land use change



Scenarios*



Land use types

- Urban
- Agriculture → Food crops, Grassland/fodder, Biofuels
- Forestry
- Protected areas

Time slices

- 2020
- 2050
- 2080

Spatial resolution

- 10’ grid

*IPCC Special Report on Emissions Scenarios (SRES)

Global scenarios (SRES)

Scenario	Population	Economy	Environment	Equity	Technology	Globalization
A1FI						
A1B						
A1T						
B1						
A2						
B2						

Elements for a systematic and comprehensive assessment

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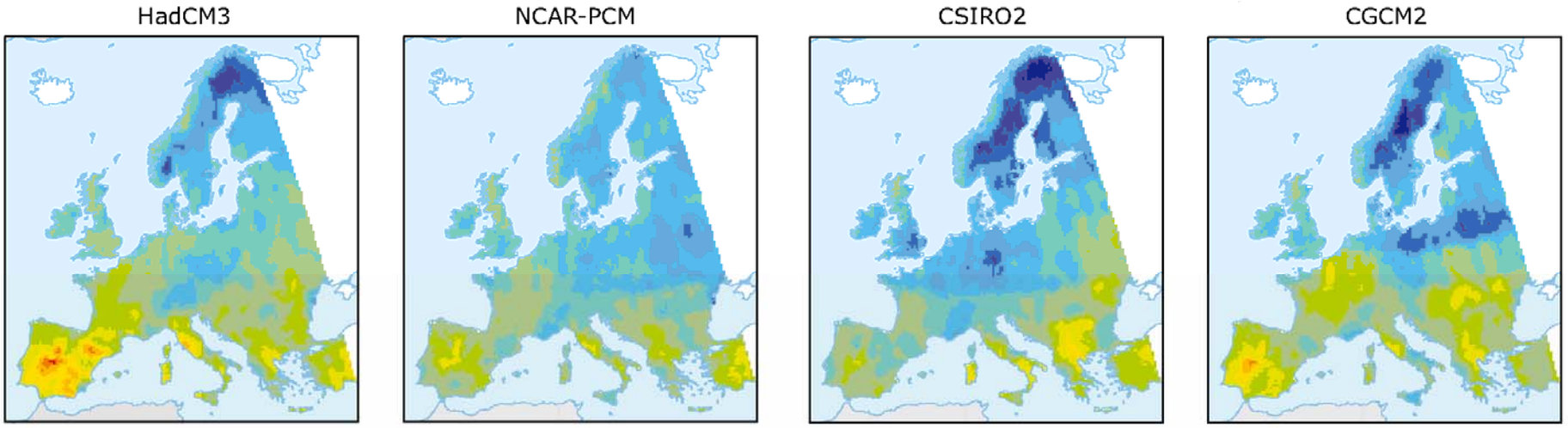
Changes in annual precipitation for the IPCC A2 scenario (2071-2100 compared with 1961-1990) for four different climate models



Annual precipitation change for IPCC A2 emission scenario, 2071–2100 compared to 1961–1990
Calculated with four climate models (HadCM3, NCAR-PCM, CSIRO2, CGCM2)

% anomaly

−25 −20 −15 −10 −5 0 5 10 15 20 25 >25

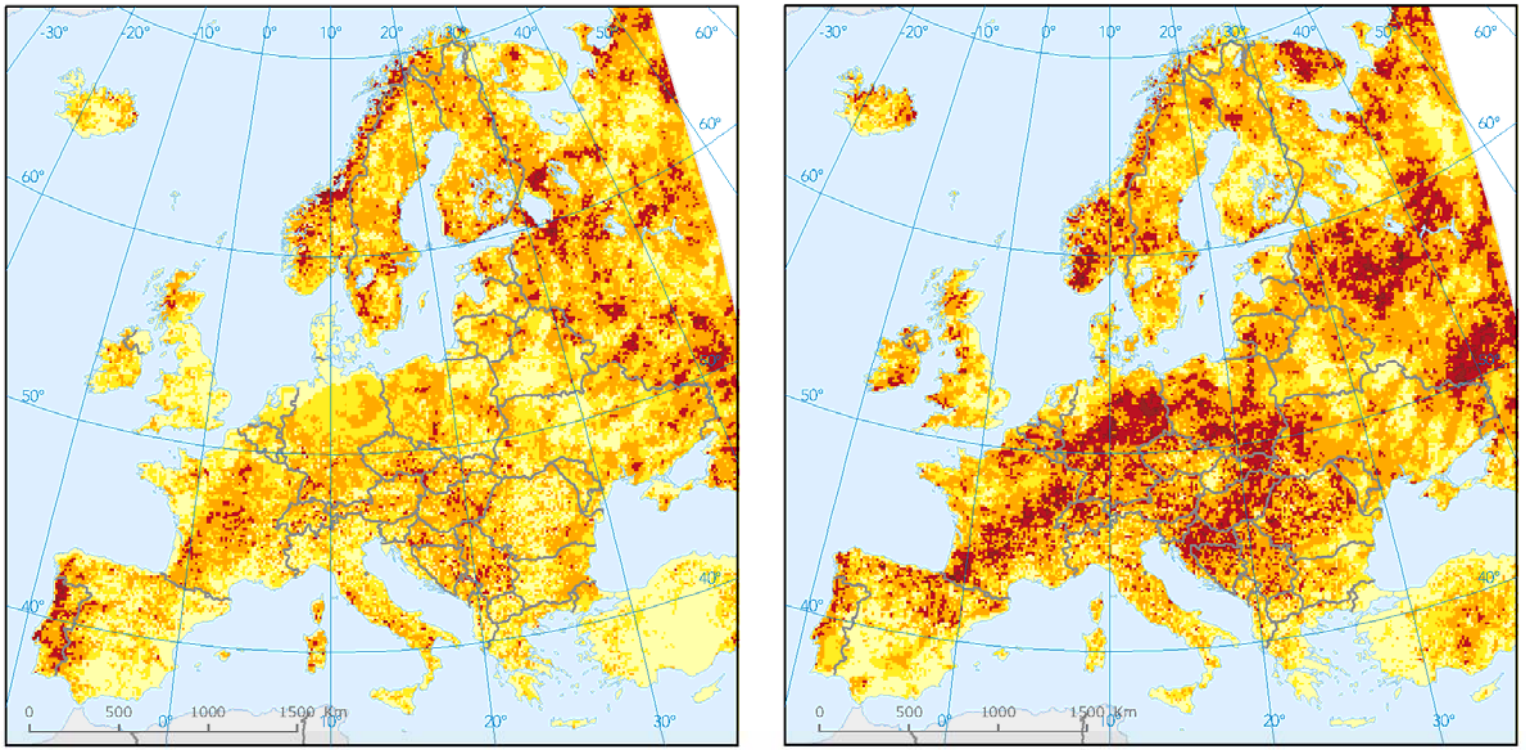
Outside report coverage

Note: The spatial pattern projected by each climate model remains the same for different emission scenarios, only the size of the changes varies.

Source: Schröter *et al.*, 2005.

EEA 2007, L'environnement en Europe

Occurrence of heat wave events with a duration of 7 days (left: 1961-1990 average; right: 2071-2100 average)



Heat wave frequency for the periods 1961–1990 (left) and 2071–2100 (right)
Based on the IPCC-SRES A2 emission scenario and the DMI climate model

< 1 | 1 | 2–3 | 4–5 | 6–7 | 8–9 | ≥ 10 | Outside report coverage

Note: The A2 baseline scenario in combination with the Danish regional climate model.

Source: Indicator elaboration: R. Hiederer, European Commission DG Joint Research Centre, Institute for Environment and Sustainability, 2007.
Data: PRUDENCE Project 12km HIRHAM4, Danish Climate Centre, 2006.

EEA 2007, L'environnement en Europe

European breeding birds (present-day and 2070-2099)

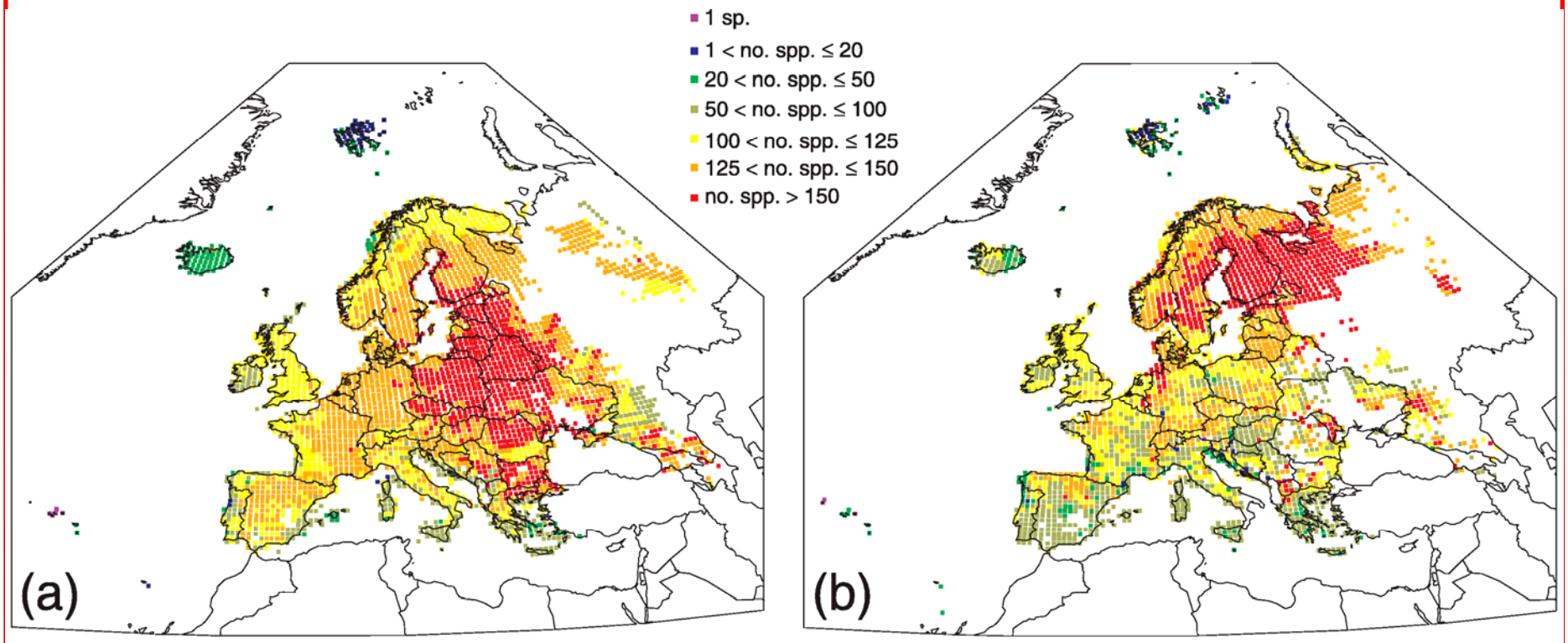
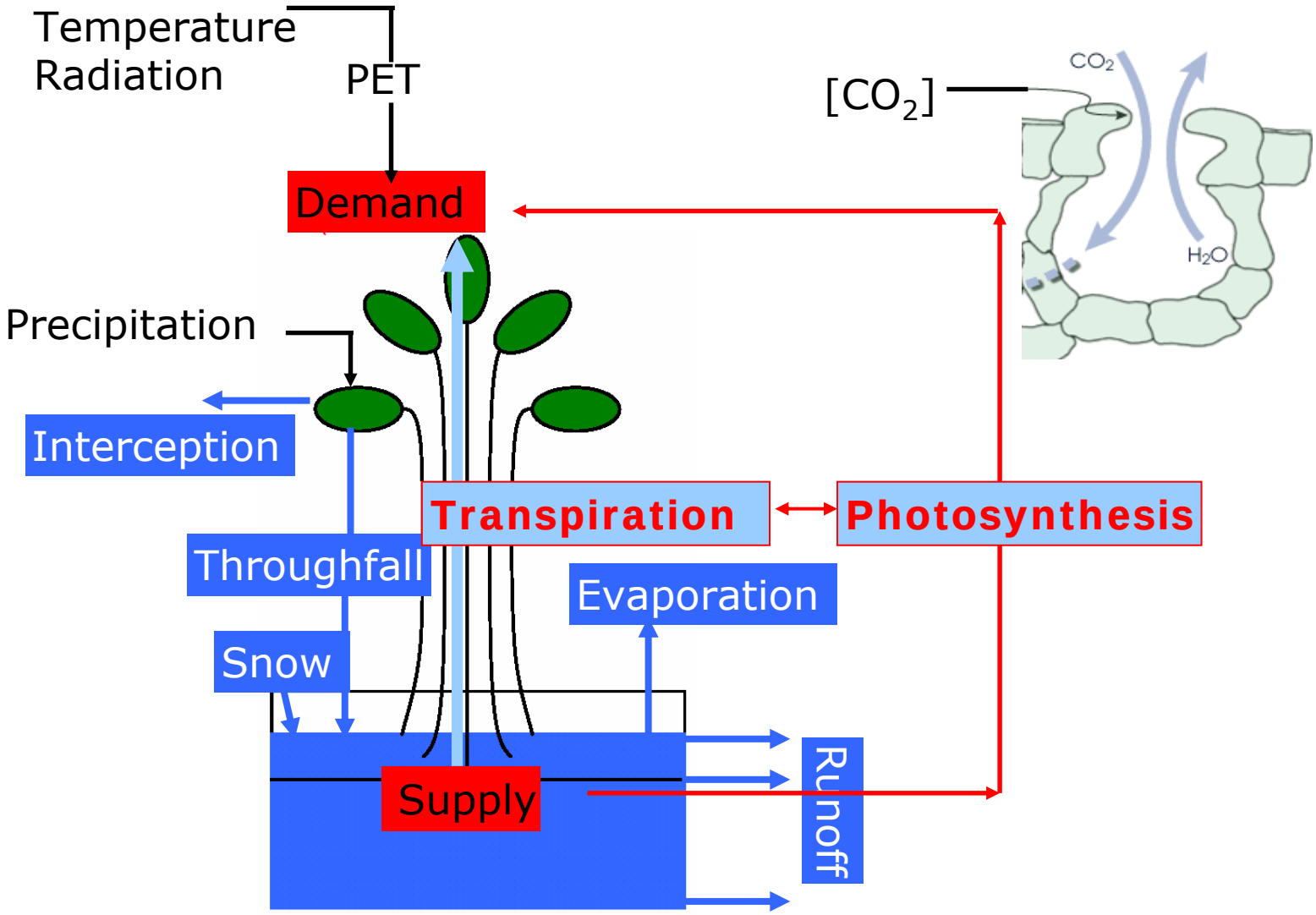


Figure 7. Simulated present and potential future diversity of European breeding birds. The left-hand map (a) shows the number of species simulated breeding in each grid square for the present climate, whilst the right-hand map (b) shows the number of species simulated as potentially breeding in each grid square for a potential future climate scenario for 2070–99 derived from the HadCM3 simulation for the SRES B2 emissions scenario.

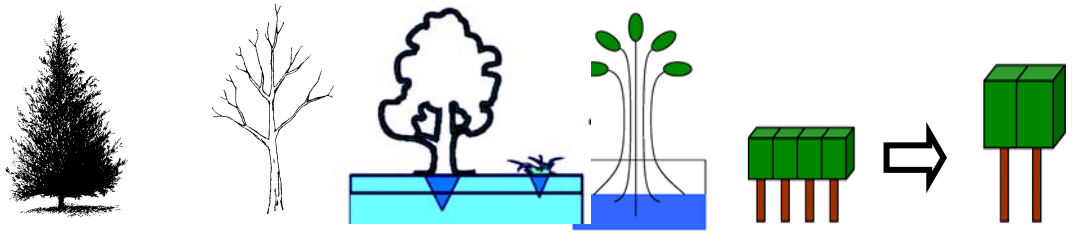
Huntley et al. 2006

H_2O and C fluxes



The LPJ Dynamic Global Vegetation Model (Sitch et al., GCB, 2003)

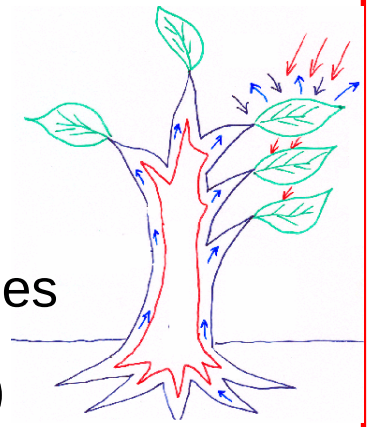
Climate, Soil, CO_2

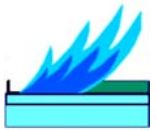


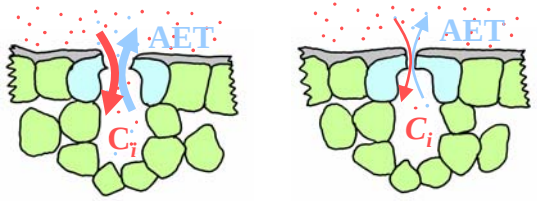
Space & Time Loops

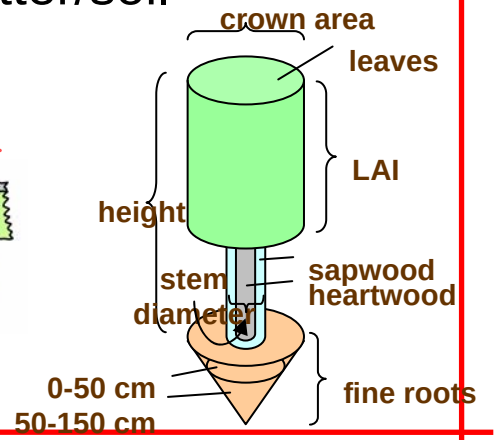
Transformed by process modules into

- 10 plant functional types
- competition, mortality, establishment
- fire, permafrost
- photosynthesis: coupled C and H_2O cycles
- C allocation (funct. and struct. relations)
- Carbon pools: 4 in vegetation, 4 in litter/soil
- Full hydrology









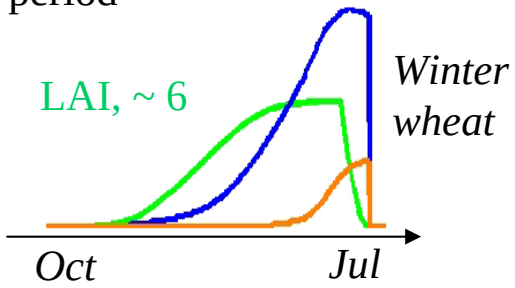
C budget, H_20 Budget, Vegetation Composition

Implementation of agriculture within LPJ – how?

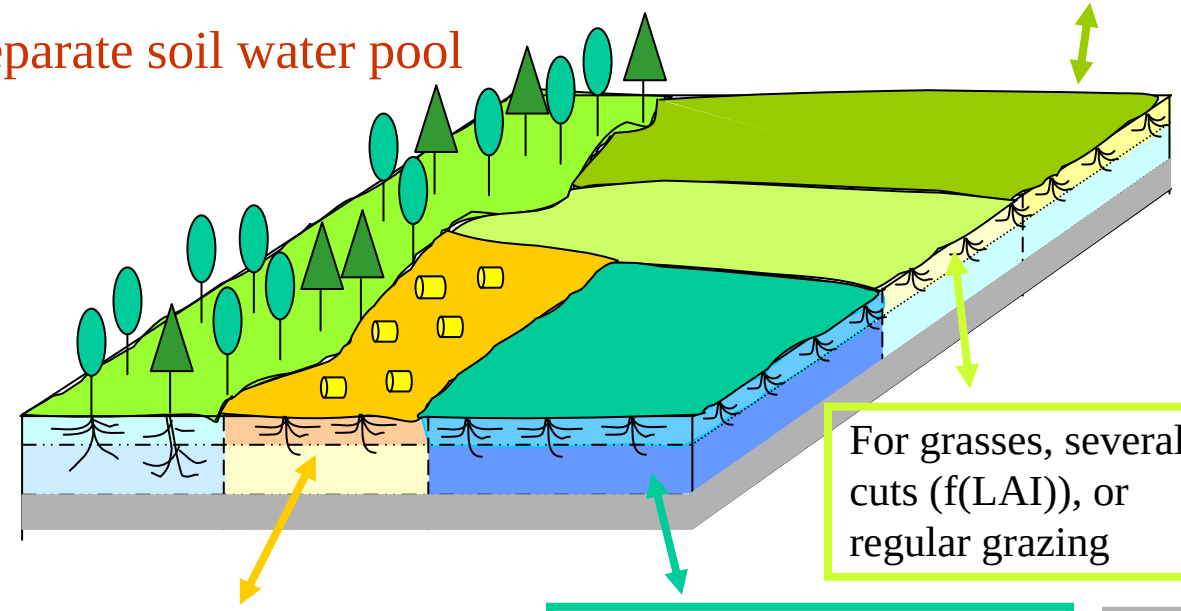
Adaptation of LPJ to simulate the carbon and water fluxes for crops: each CFT on a distinct stand with access to a separate soil water pool

Sowing date estimation:
for 4 temperate CFTs = f(T),
for 4 tropical CFTs = f(P)
Adaptation of heat sum and vernalization requirement

Daily coupled growth and development simulation:
Phenology, LAI change, carbon allocation to leaves, roots, storage organs, ...
Estimation of the harvesting period



Total biomass, ~ 20 tDM/ha
Grain harvested, ~ 6 tDM/ha

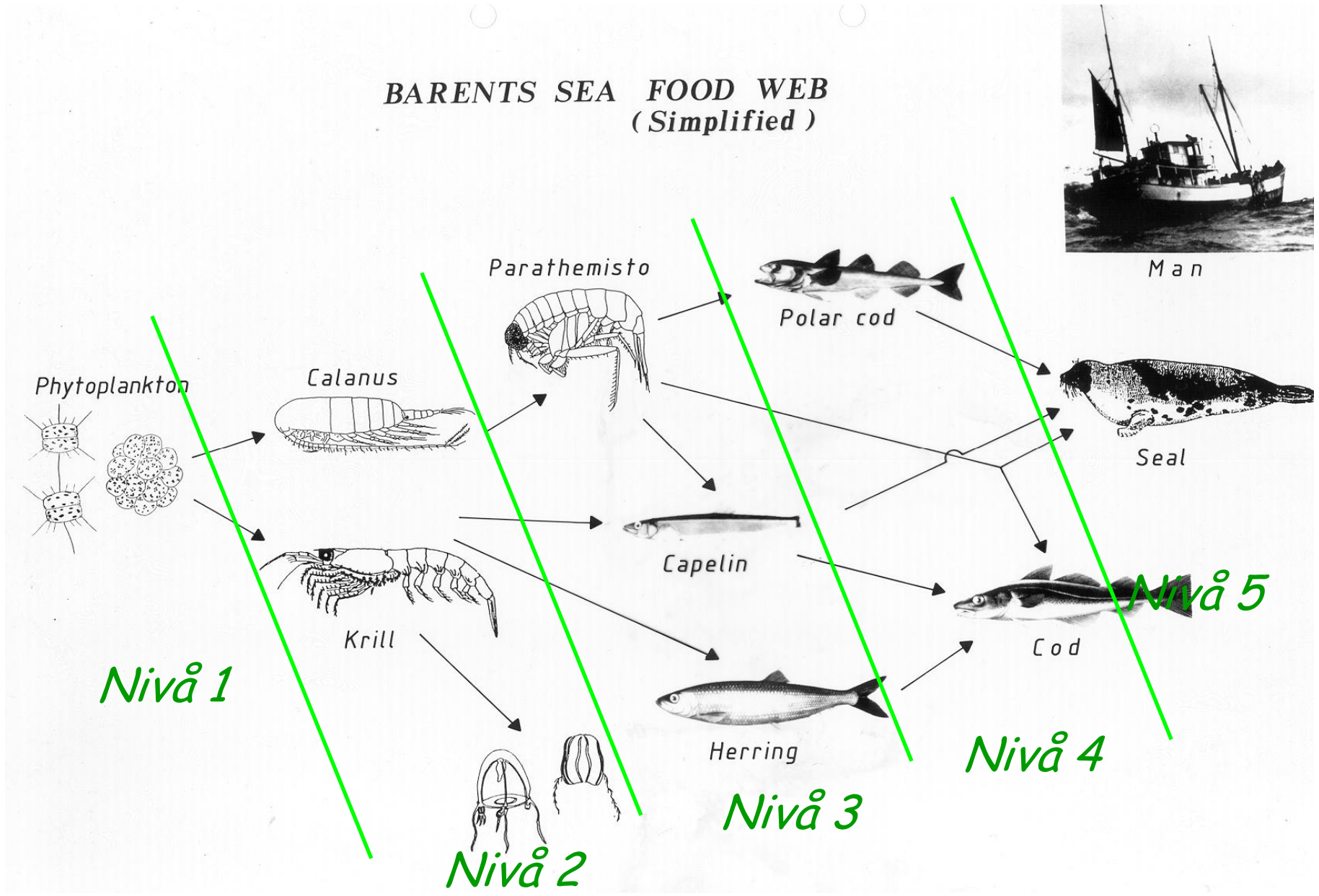


For grasses, several cuts (f(LAI)), or regular grazing

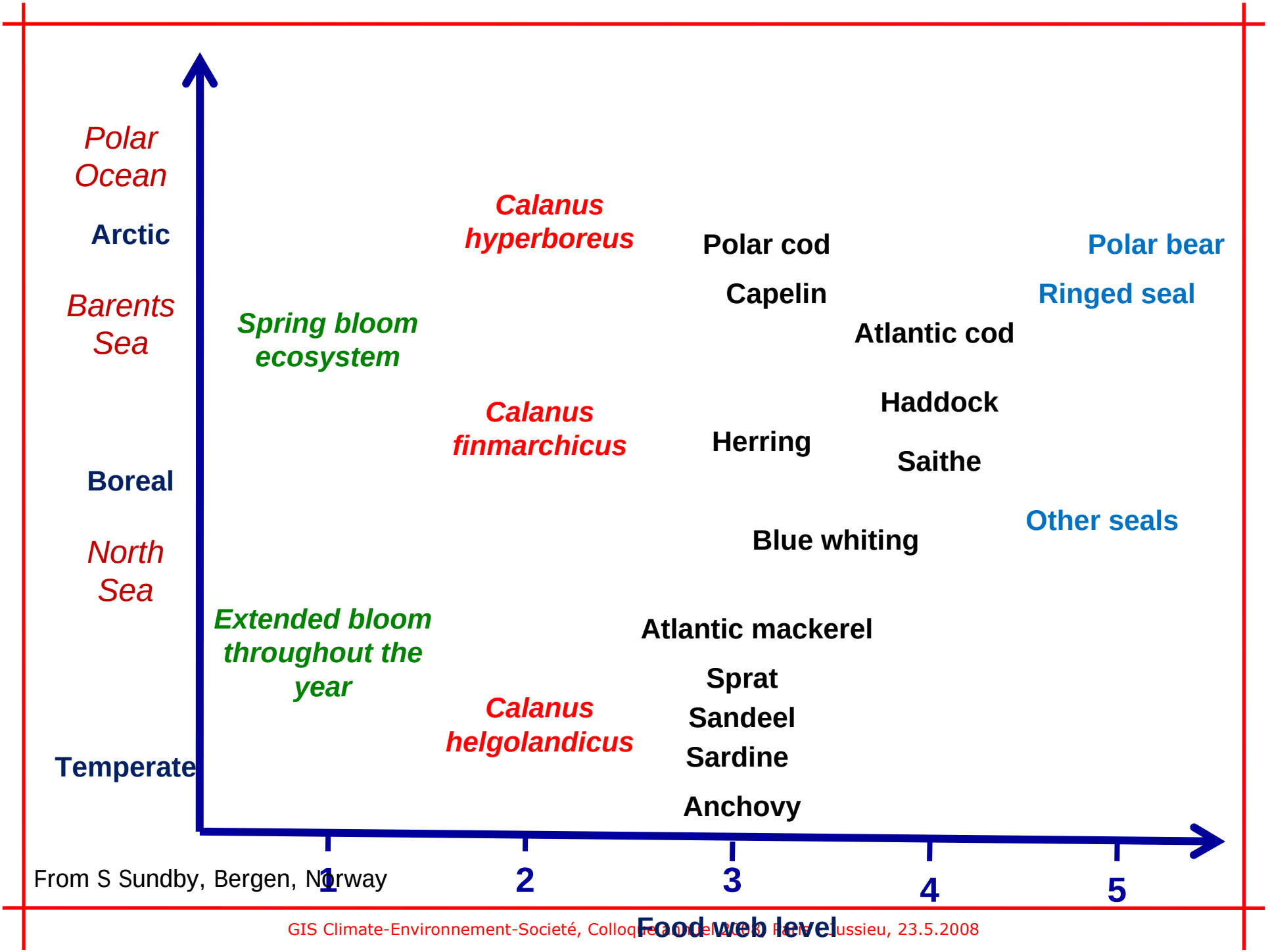
Harvested biomass removed, residues sent to the litter pool or removed (fodder, biofuel, ...)

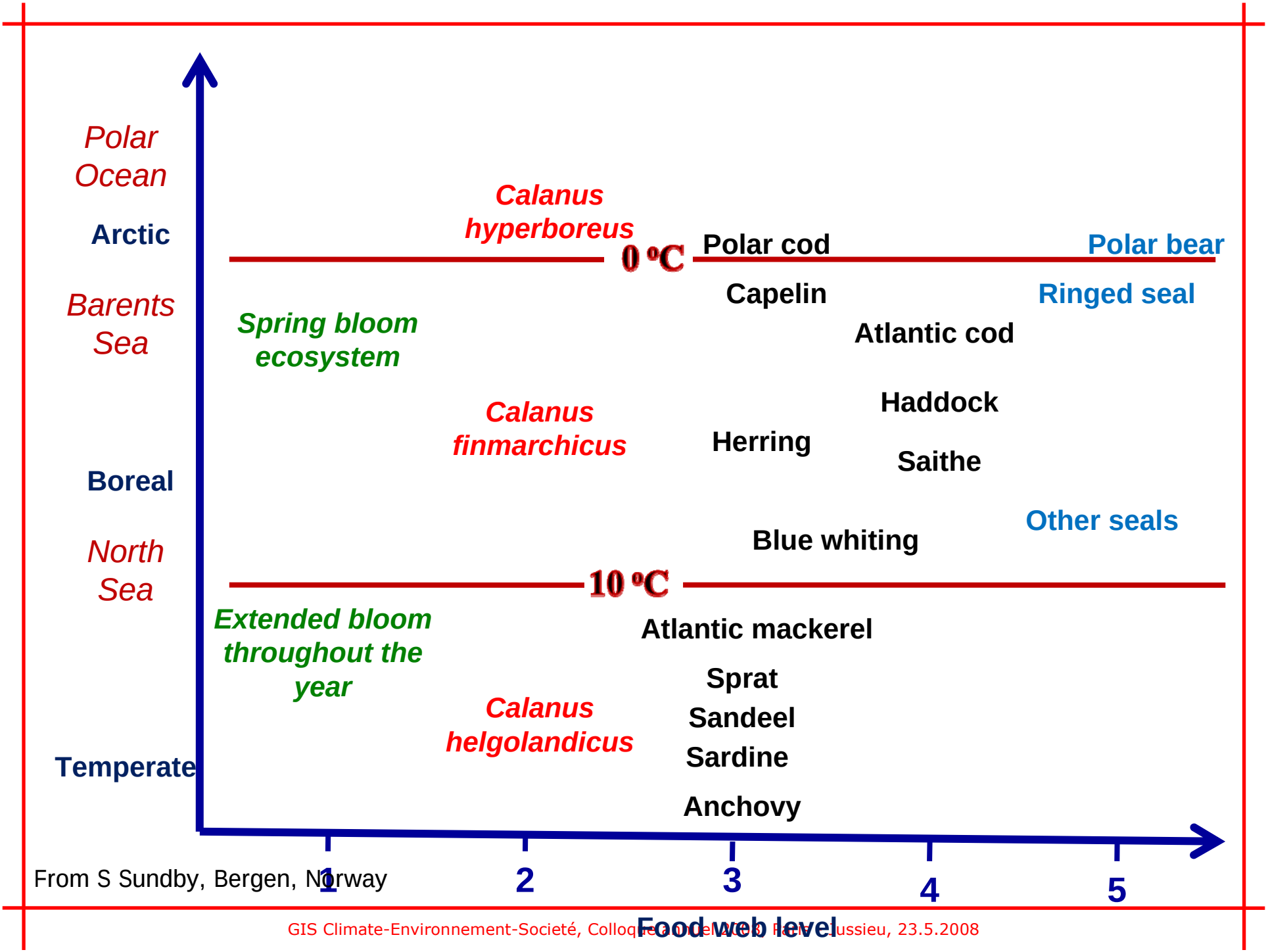
No water stress for irrigated crops,
computation of the water requirement and of the effective irrigation

Possibility of multiple cropping (e.g. rice)
Grass during the intercrop season otherwise



From S Sundby, Bergen, Norway


Polar Ocean
Arctic
Barents Sea
Boreal
North Sea
Temperate
Calanus hyperboreus
Spring bloom ecosystem
Calanus finmarchicus
Extended bloom throughout the year
Calanus helgolandicus
Polar cod
Capelin
Atlantic cod
Haddock
Herring
Saithe
Blue whiting
Atlantic mackerel
Sprat
Sandeel
Sardine
Anchovy
Polar bear
Ringed seal
Other seals
1
2
3
4
5
Food web level
From S Sundby, Bergen, Norway


Polar Ocean
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0 ºC
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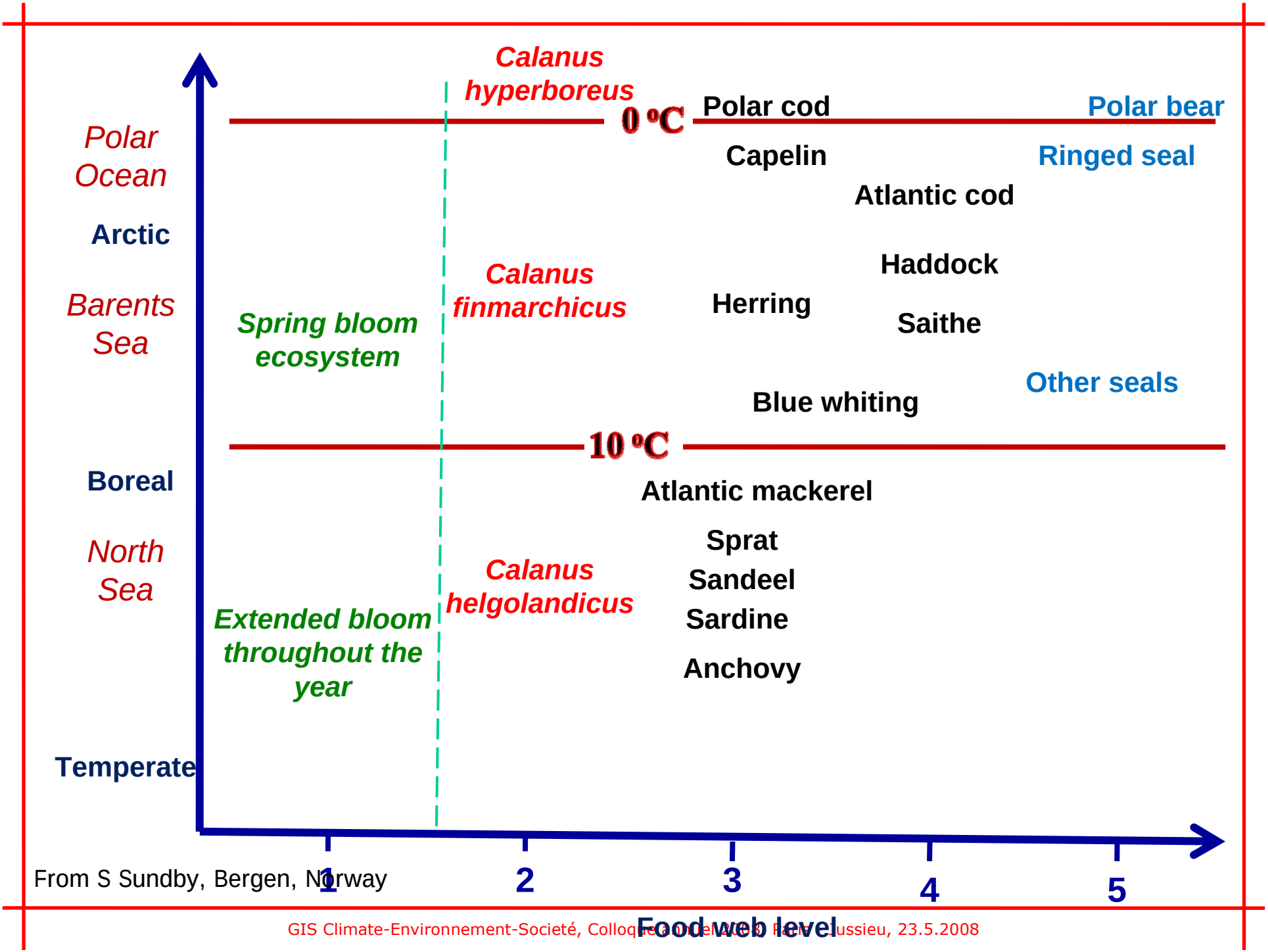
Polar bear
Capelin
Ringed seal
Spring bloom ecosystem
Atlantic cod
Haddock
Calanus finmarchicus
Herring
Saithe
Other seals
Blue whiting
10 ºC
Extended bloom throughout the year
Atlantic mackerel
Sprat
Calanus helgolandicus
Sandeel
Sardine
Anchovy
1
2
3
4
5
Food web level
From S Sundby, Bergen, Norway



From S Sundby, Bergen, Norway

Despite constantly advancing understanding, „high precision adaptation planning“ will not become possible.

Ecosystèmes européens, biodiversité et changement climatique

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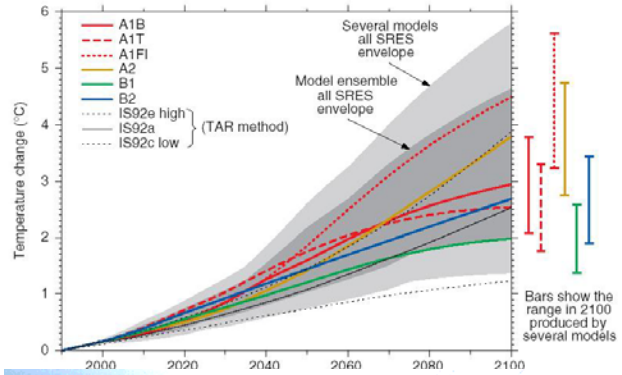
Examples of adaptation

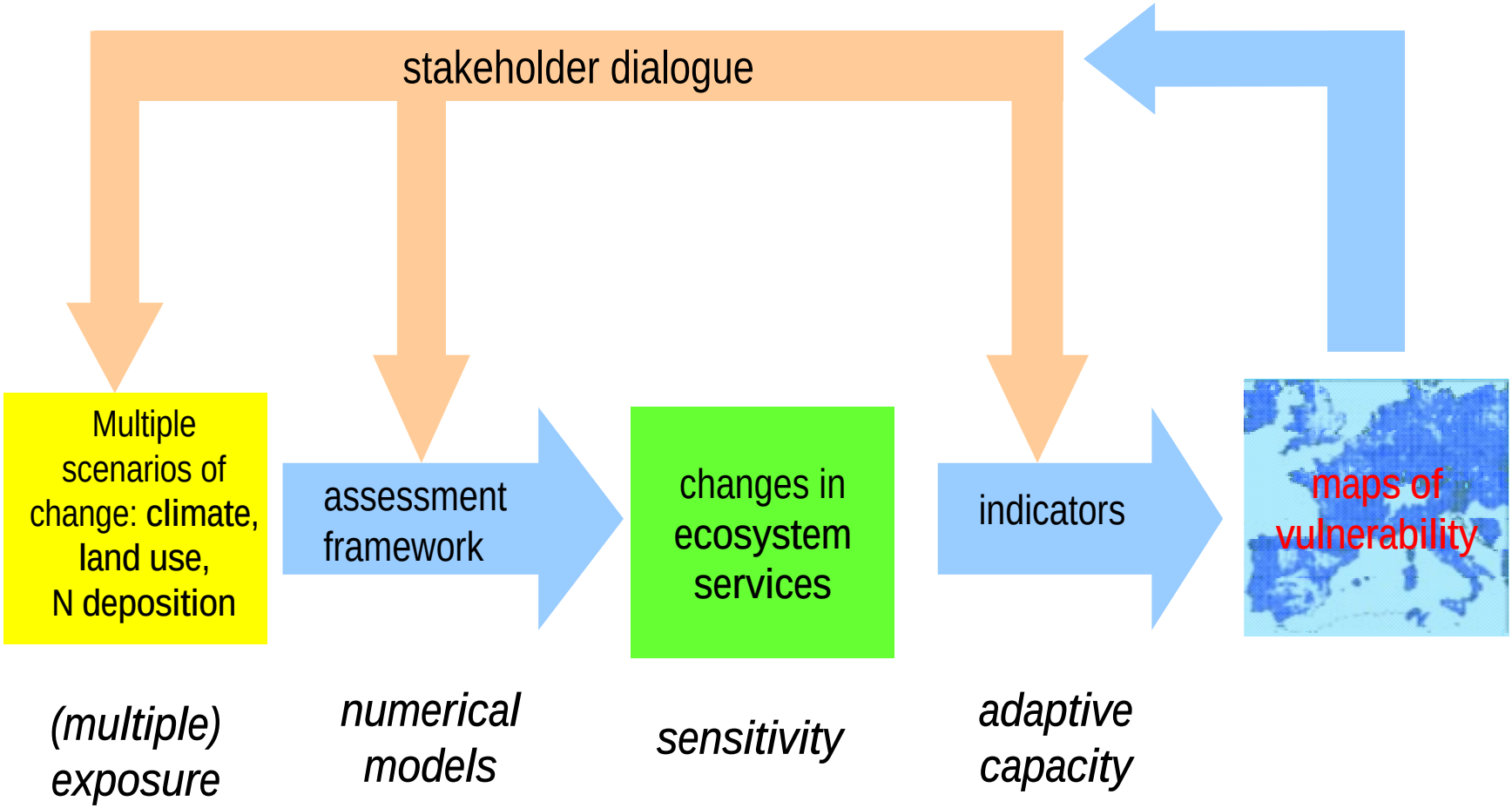
exposure



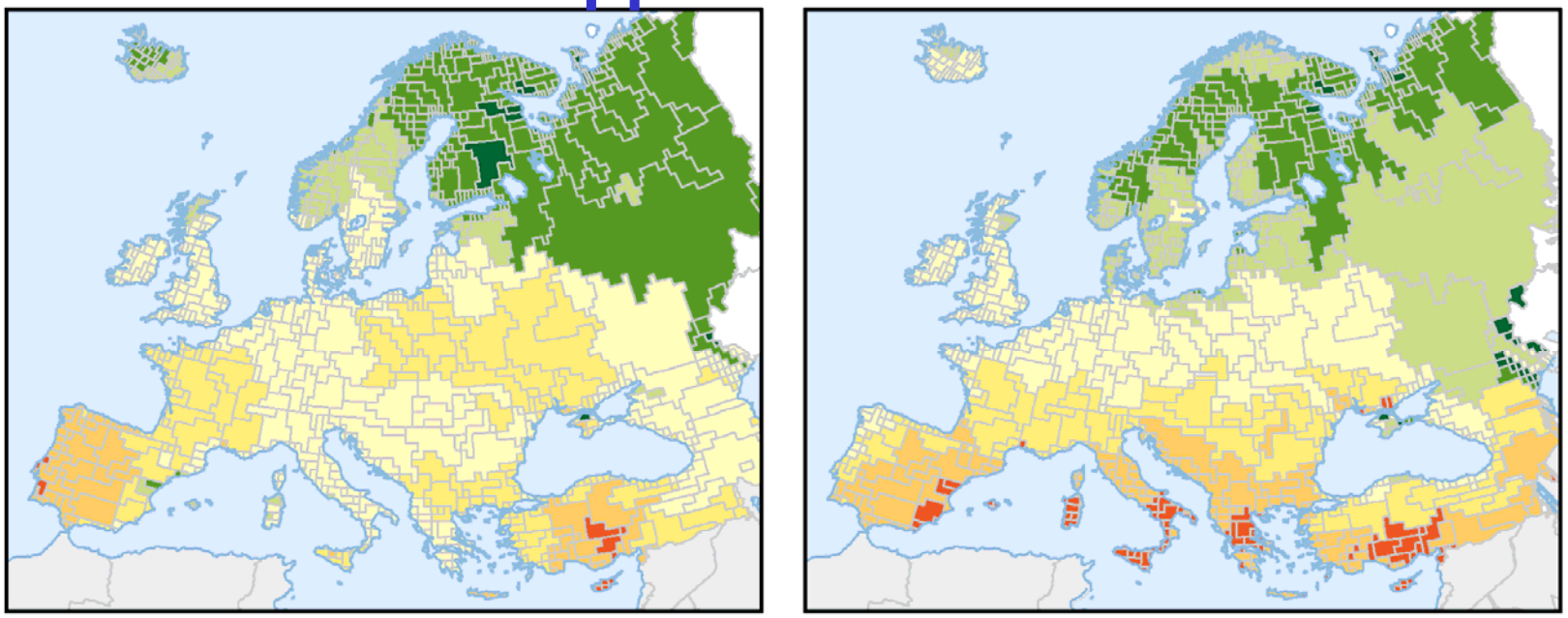
sensitivity

adaptation

The ATEAM framework



Changements concernant les débits fluviaux annuels en Europe pour les années 2070 par rapport à 2000



Sur la base des données de deux modèles climatiques différents :
ECHAM4 (gauche) et HadCM3 (droite)

Diminutions Légères modifications Augmentations

Non couvert par le rapport

– 50 % – 25 % – 10 % + 10 % + 25 % + 50 %

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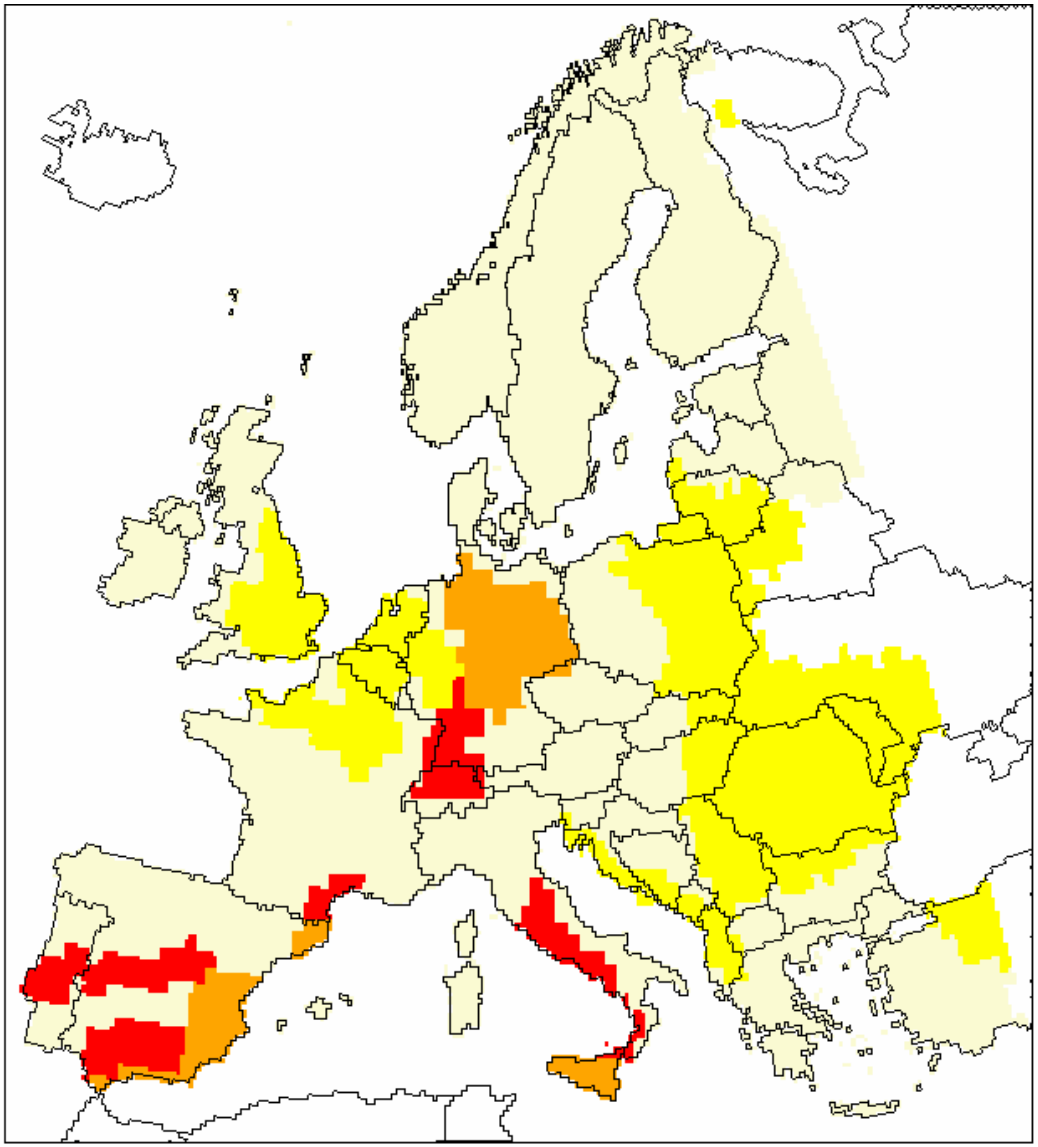
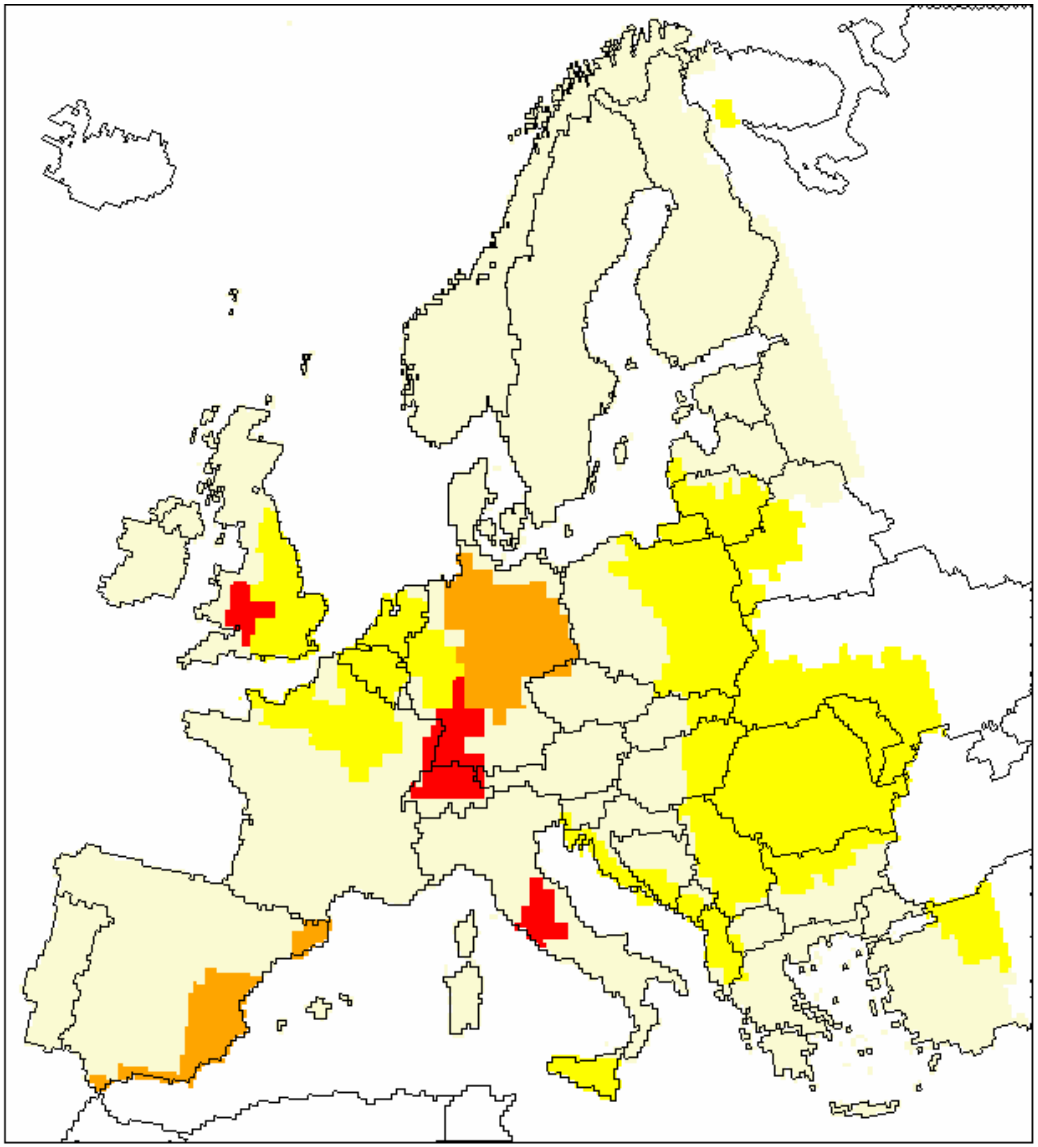
Change in water stress 2080 – A1FI



Δ water stress status

- move out of stressed class
- reduction in stress
- never stressed
- no change
- increased stress
- move into stressed class

Change in water stress 2080 – B2



Δ water stress status

- move out of stressed class
- reduction in stress
- never stressed
- no change
- increased stress
- move into stressed class

Changing fire risk (Germany)

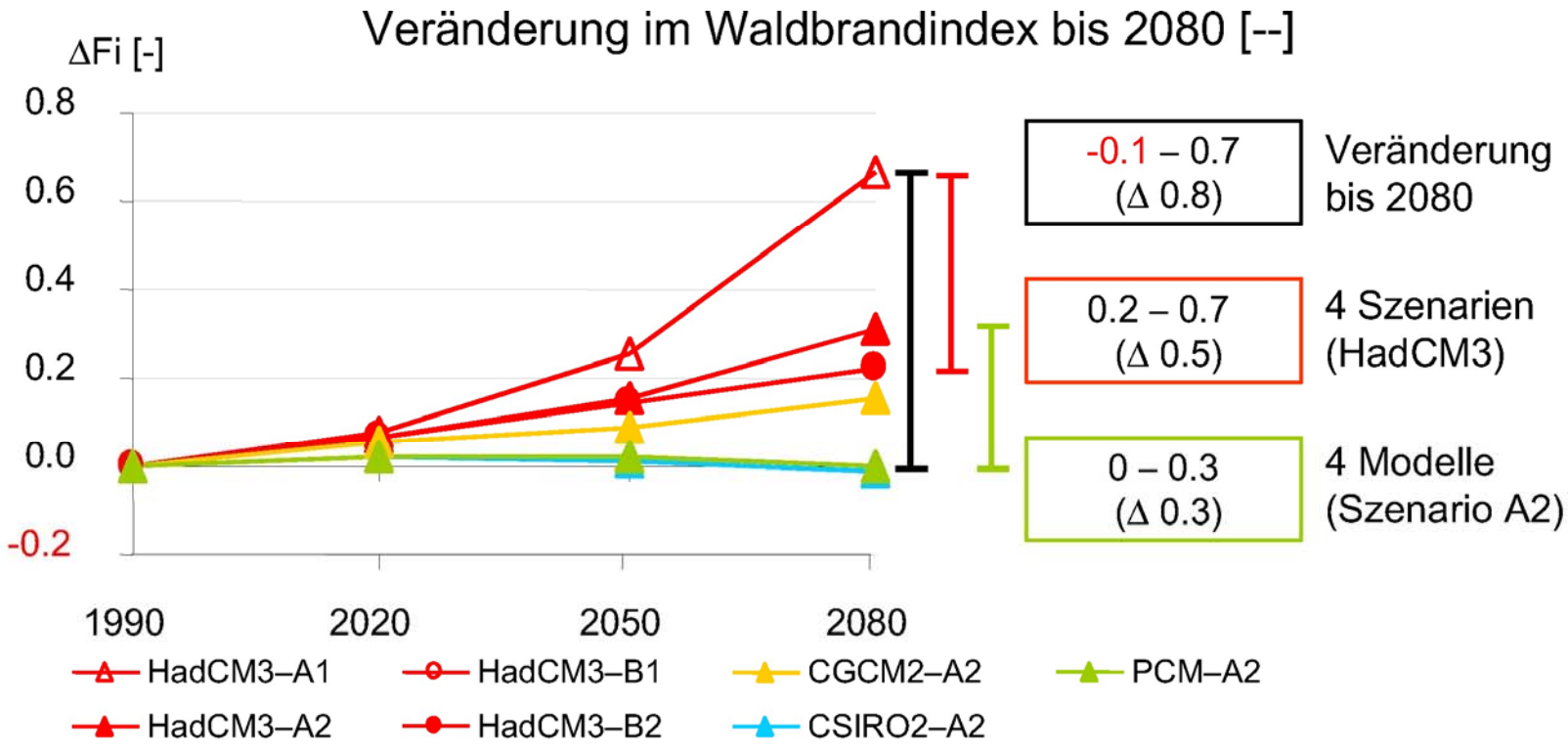


Abb. 4.3-4: Veränderung des Waldbrandindexes (Thonicke, 2002) in Deutschland gegenüber 1990 für sieben ATEAM-Szenarien bis 2080. Der Waldbrandindex ist einheitenlos.

Some ecosystem services


food production


slope stability


tourist attraction


fire prevention


water storage


biodiversity


pollination


fibre production


fodder production


flood protection


carbon sequestration

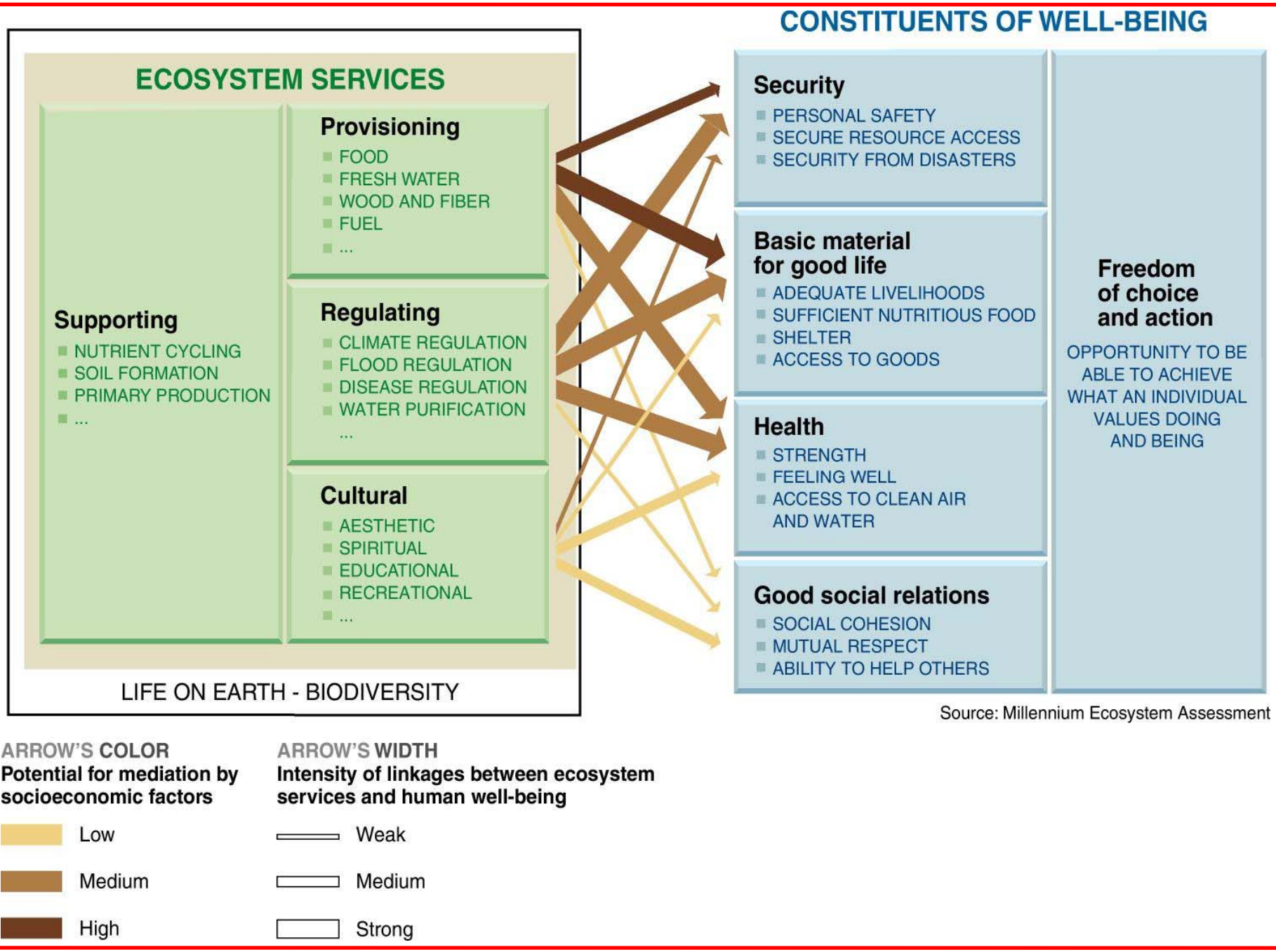

beauty


recreation


stabilising micro-climate

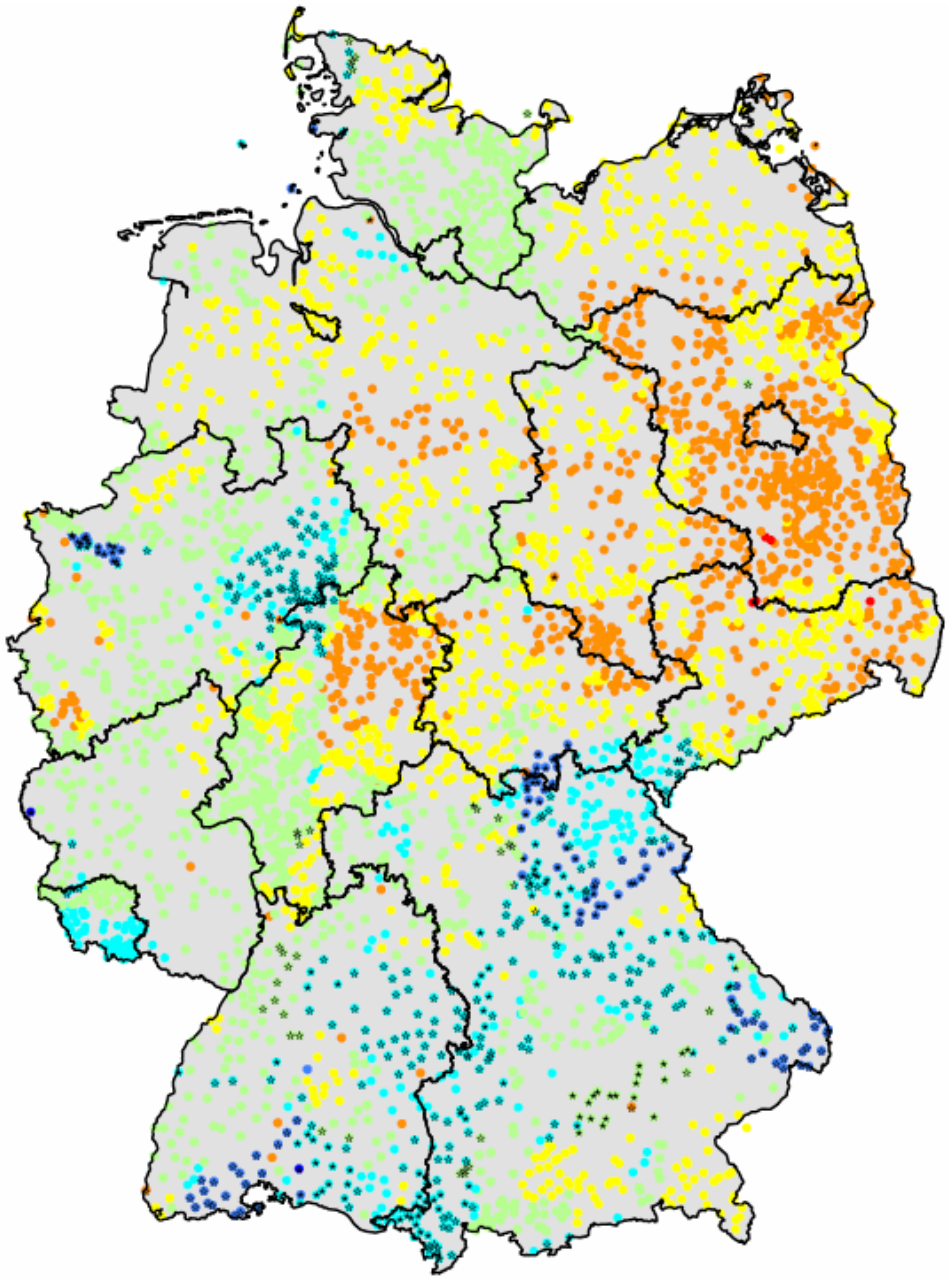

game reserve


shelter for life stock


CONSTITUENTS OF WELL-BEING
ECOSYSTEM SERVICES
Supporting
NUTRIENT CYCLING
SOIL FORMATION
PRIMARY PRODUCTION
...
Provisioning
FOOD
FRESH WATER
WOOD AND FIBER
FUEL
...
Regulating
CLIMATE REGULATION
FLOOD REGULATION
DISEASE REGULATION
WATER PURIFICATION
...
Cultural
AESTHETIC
SPIRITUAL
EDUCATIONAL
RECREATIONAL
...
LIFE ON EARTH - BIODIVERSITY
Security
PERSONAL SAFETY
SECURE RESOURCE ACCESS
SECURITY FROM DISASTERS
Basic material for good life
ADEQUATE LIVELIHOODS
SUFFICIENT NUTRITIOUS FOOD
SHELTER
ACCESS TO GOODS
Health
STRENGTH
FEELING WELL
ACCESS TO CLEAN AIR AND WATER
Good social relations
SOCIAL COHESION
MUTUAL RESPECT
ABILITY TO HELP OTHERS
Freedom of choice and action
OPPORTUNITY TO BE ABLE TO ACHIEVE WHAT AN INDIVIDUAL VALUES DOING AND BEING
Source: Millennium Ecosystem Assessment
ARROW'S COLOR
Potential for mediation by socioeconomic factors
Low
Medium
High
ARROW'S WIDTH
Intensity of linkages between ecosystem services and human well-being
Weak
Medium
Strong

Ecosystem services and indicators

Sectors	Services	Indicators (examples)
Agriculture	Food & fibre production Biofuels	•Crop yield, yield variability & profitability •Physical suitability of crops
Forestry	Wood production Biofuels	•Tree productivity •Biomass energy wood suitability and yield
C storage & Energy	Carbon storage	•Carbon storage in Vegetation & Soil
Water	Water supply Drought & flood prevention	•Stream flow quantity & quality
Biodiversity & Nature Conservation	Aesthetics Landscape diversity	•Species richness & persistence •Habitat richness
Mountains	Tourism & Recreation Carbon and Water	•Snow dynamics •Slope stability



Rainfall trends 1951-2003 in German FFH Protected Areas

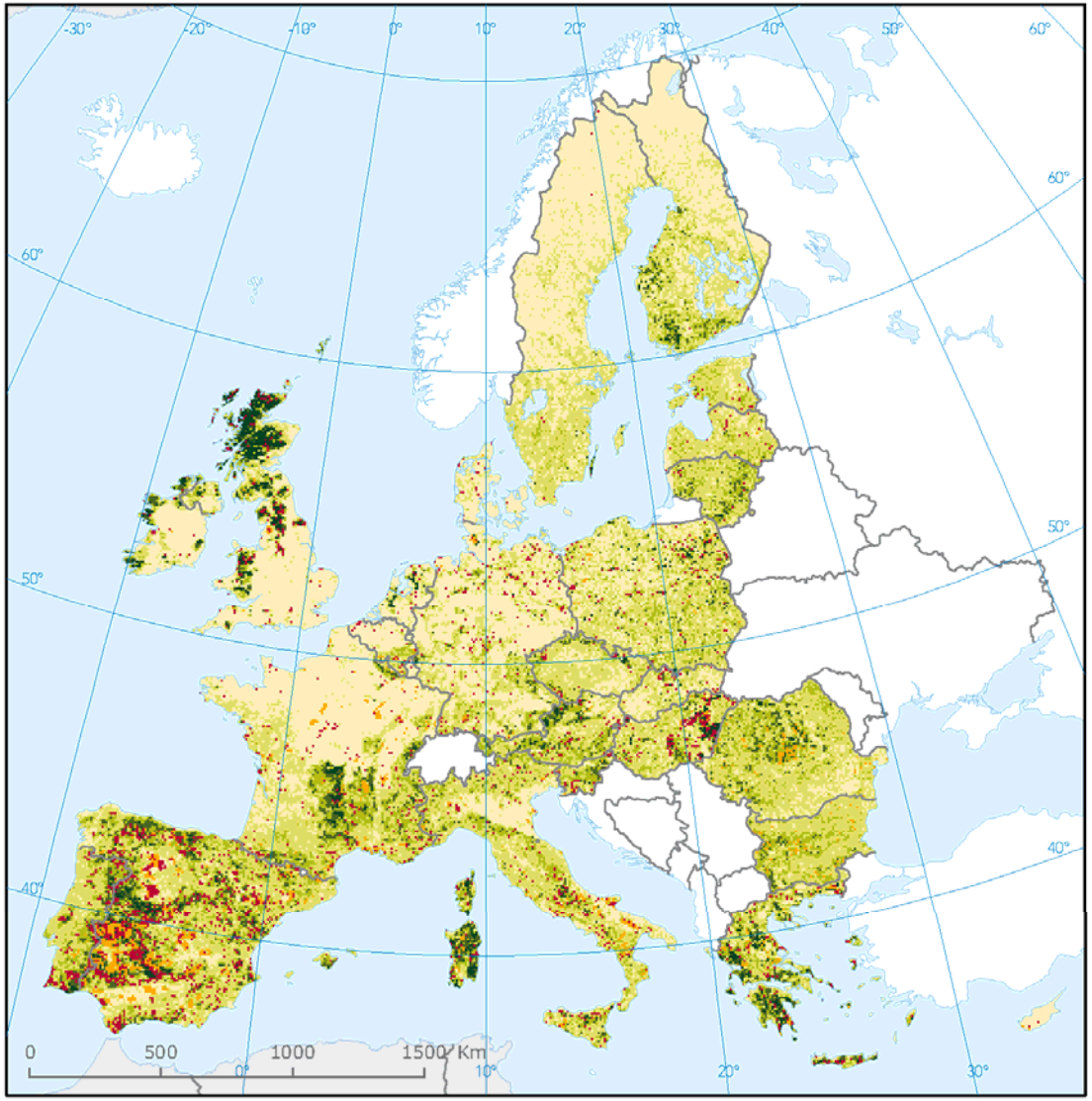
Niederschlagstrend (1951-2003) [mm]

- - 100 - -50
- - 50 - 0
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250

Signifikanzniveau

- ★ 0.003830 - 0.050000
- ☆ 0.050001 - 0.100000

„High nature value“ farmland



Preliminary distribution map of high nature value (HNV) farmland in western and central Europe

- Natura 2000
- Prime butterfly areas
- Important bird areas

HNV farmland % (Corine land cover based estimate)

- 0
- 1–25
- 25–50
- 50–75
- 75–100

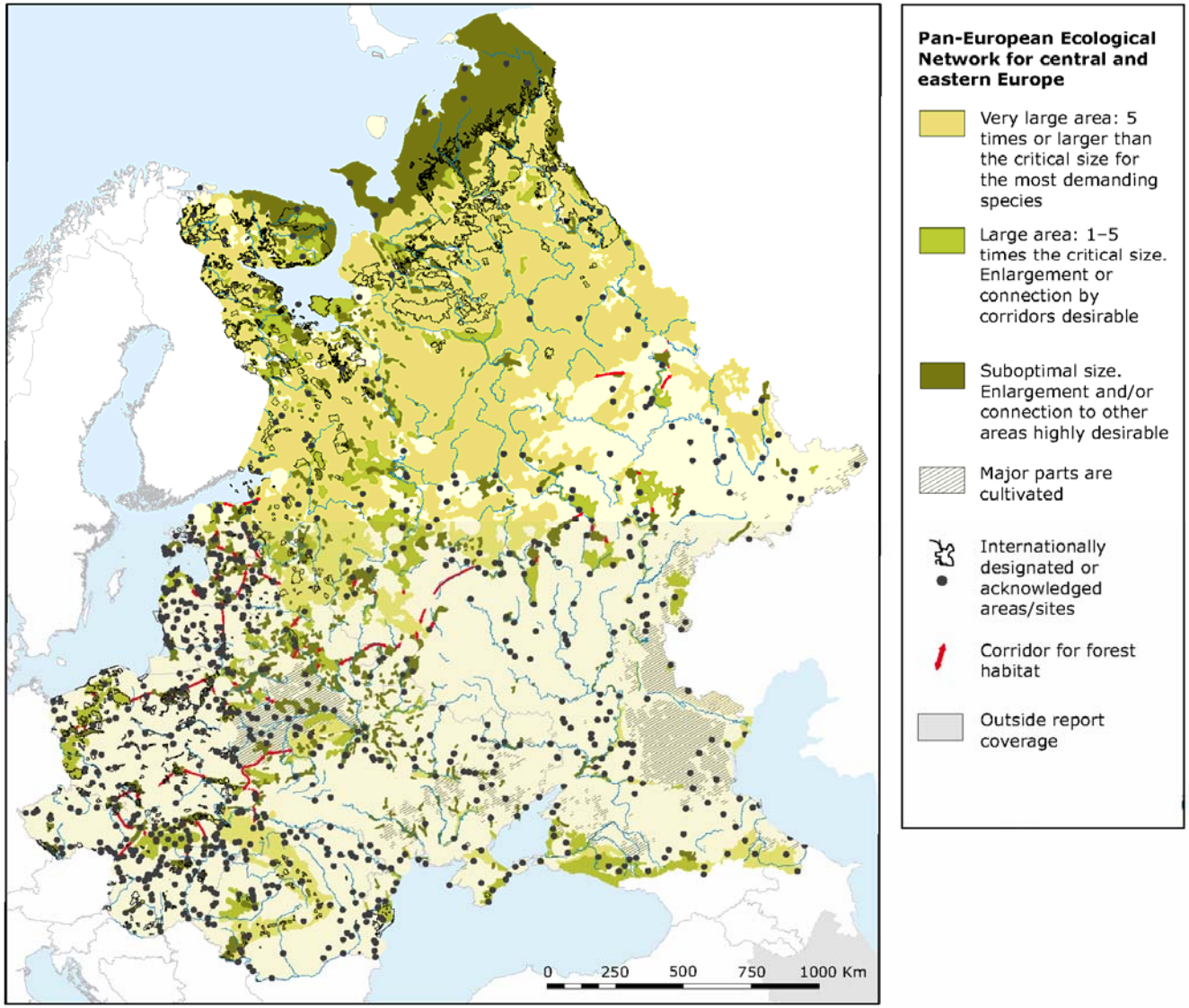
Outside report coverage

Note: This map is subject to further improvement. Important bird areas will be reselected on the basis of an updated list of HNV farmland birds. In addition, refinements on the basis of national datasets may be carried out.

Source: Preliminary data EEA/DG JRC.

EEA 2007, L’environnement en Europe

A Pan-European Ecological Network for central and eastern Europe



Source: Alterra, Wageningen UR (unpublished).

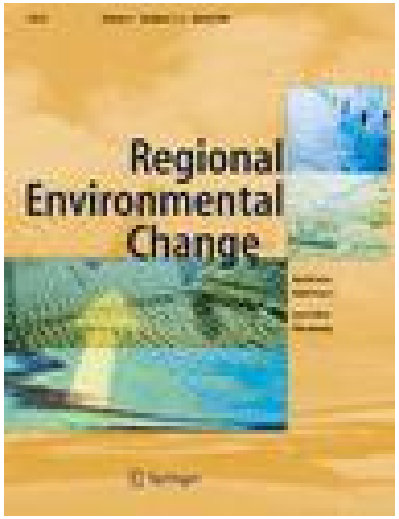
EEA 2007, L'environnement en Europe

Ecosystèmes européens, biodiversité et changement climatique

- „Dangerous climate change“ ... for European ecosystems?
- Elements for a systematic and comprehensive assessment
- From risk assessment to risk management
- Summary

Summary

- At the scale of needed adaptation, „classical" attribution (emission – climate – impacts) will always be difficult, but circumstantial evidence is strong enough
- There will not be sufficient prognostic capacity for „precision adaptation", although improvements are possible
- Integrated risk management for the protection of biodiversity under climate change will focus on enhanced resilience of all sensitive systems



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The goal of *Regional Environmental Change* is to publish scientific research and opinion papers that improve our understanding of the extent of these changes, their causes, their impacts on people, and the options for society to respond. "Regional" refers to the full range of scales between local and global, including regions defined by natural criteria, such as watersheds and ecosystems, and those defined by human activities, such as urban areas and their hinterlands.

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Merci pour votre attention!