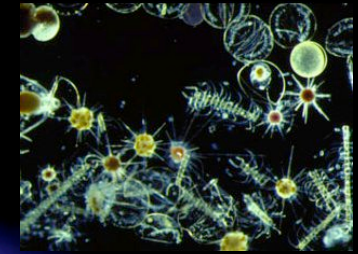


- 30 % LAND
- 70 % OPPORTUNITY



Lösen Algen unser CO₂ Problem ? – Technische Möglichkeiten

Laurenz Thomsen, Jacobs University Bremen

Image © 2007 TerraMetrics

Image NASA



History of Jacobs University

- 1999 - Founded by City-State of Bremen, University of Bremen and Rice University, Texas as International University Bremen
- 2001 - accredited by the Wissenschaftsrat (German Science Council)
- 2004 - all bachelors degree programs accredited
- 2006 - Change of name to Jacobs University Bremen
- Currently 1200 students from over 95 nations, 100 professors
- Residential colleges
- 16 undergraduate programs 14 graduate programs
- Degrees: Bachelor of Arts, Bachelor of Science, Master of Arts, Master of Science, Executive Master / Master of Business Administration, Doctor of Philosophy
- Language of instruction is English
- Research focus on BioGeoMarine Resources (Oceanography, Chemistry, Bioengineering, Microbiology)
- 2008 - Jacobs Holding JCBS-GmbH founded
- **2008 - Spinoff-company Phytolutions founded (4 scientists, 3 technicians, 1 business angel)**



CO₂ mitigation as research topic

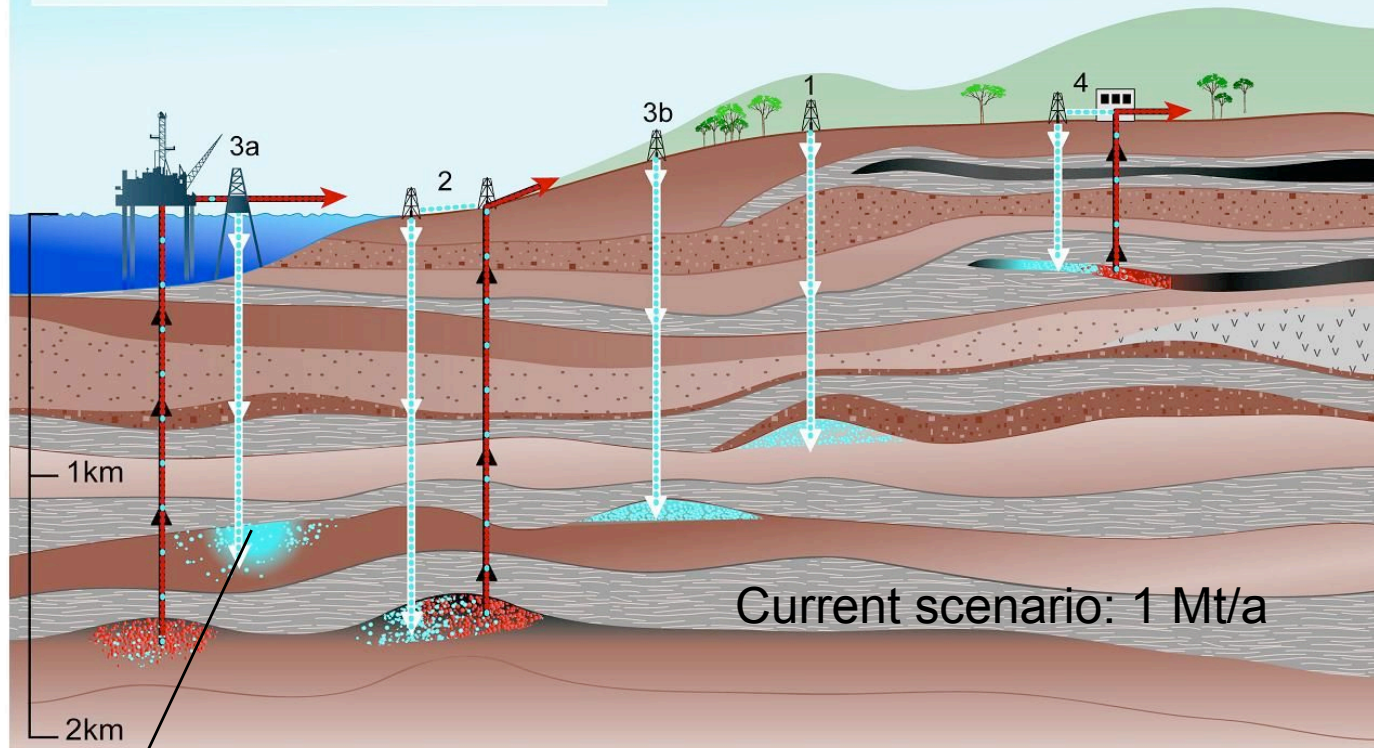


IRCCM concepts and goals: three fundamental pillars
Research: Quantification of methane and carbon fluxes
Education: training and outreach
Infrastructure and expertise for partners

Methods for storing CO₂ in deep underground geological formations

Overview of Geological Storage Options

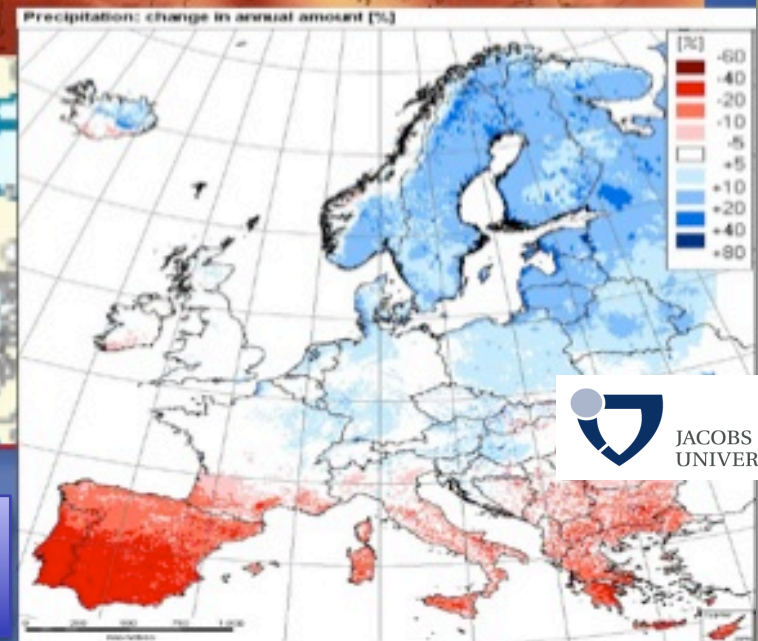
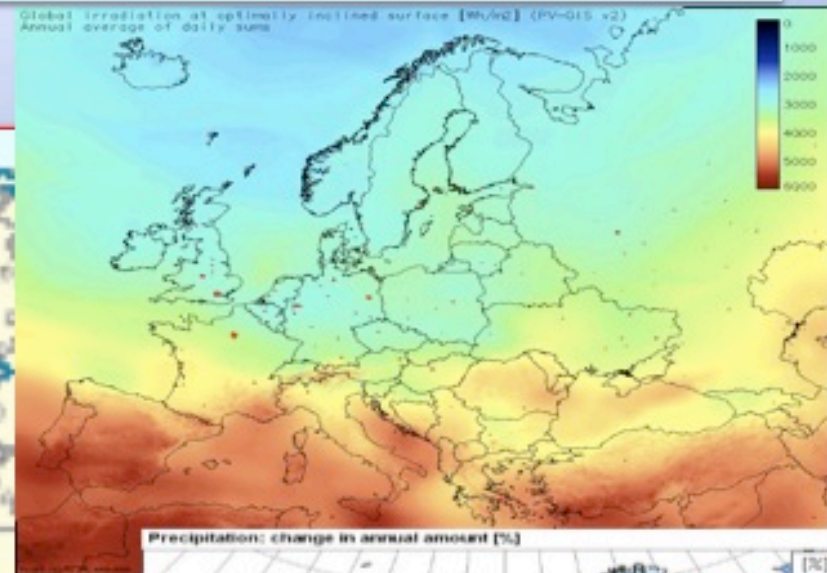
- 1 Depleted oil and gas reservoirs
- 2 Use of CO₂ in enhanced oil and gas recovery
- 3 Deep saline formations — (a) offshore (b) onshore
- 4 Use of CO₂ in enhanced coal bed methane recovery



SRCCS Figure TS-7

IRCCM partner StatoilHydro

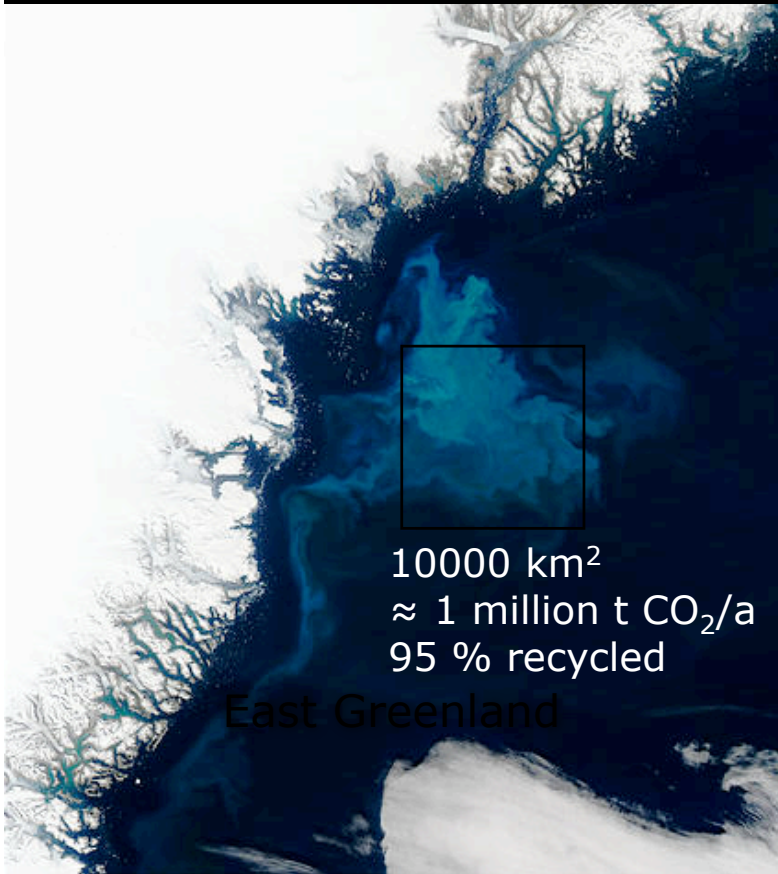
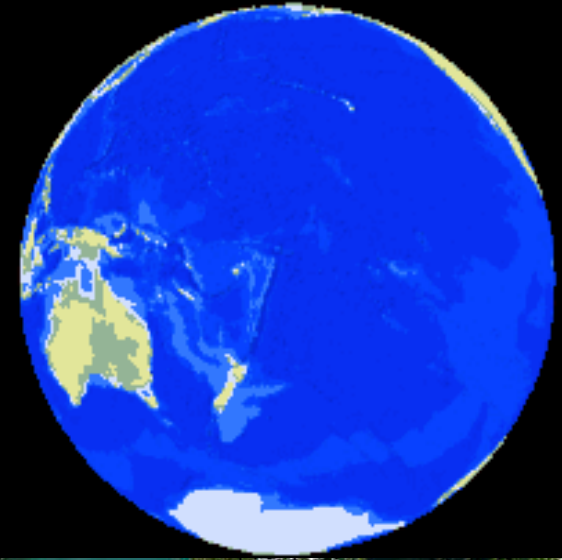
CO₂ emissions of > 1 Mt/a





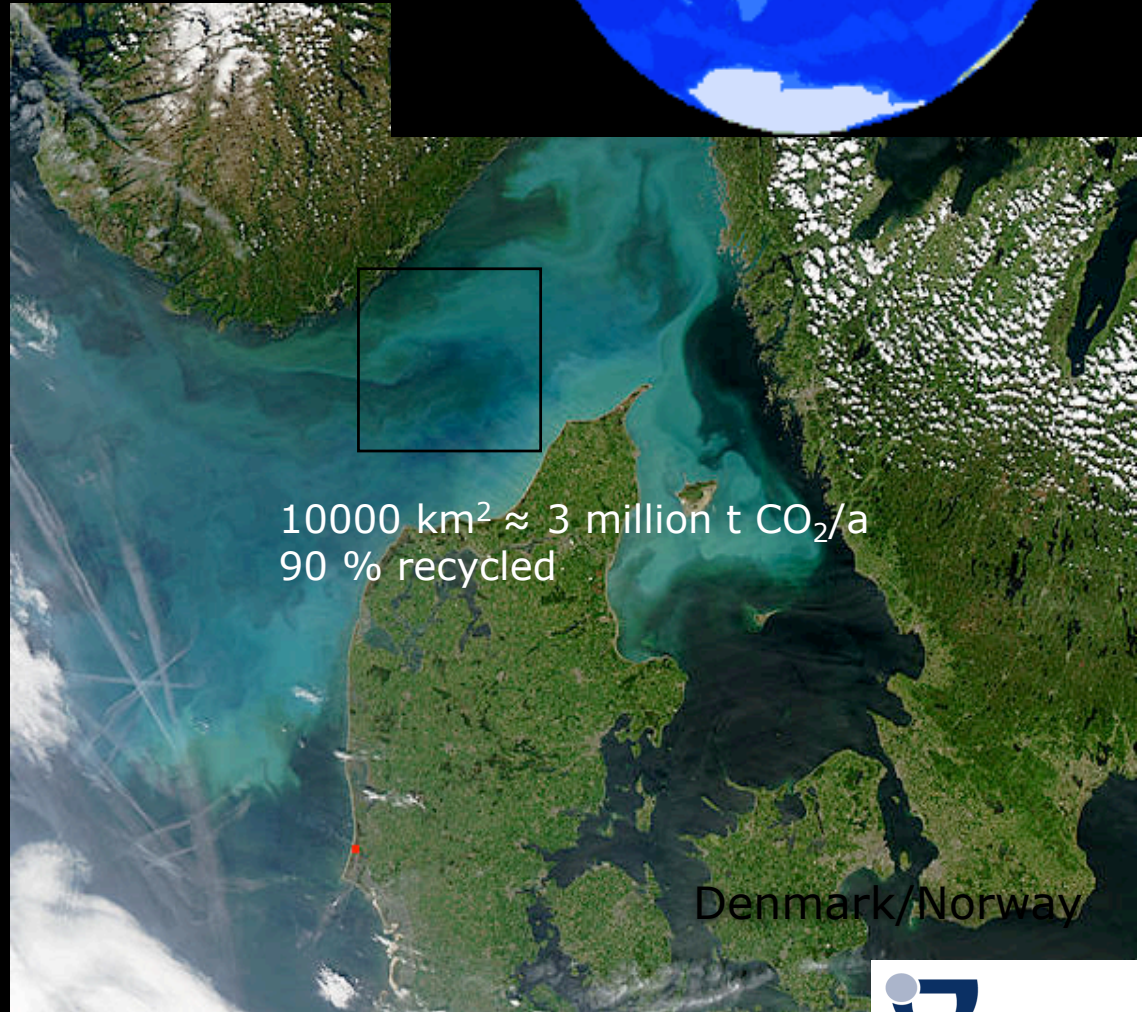
Where is all the planet's water?

- 98 % in the oceans
- 1.6 % in ice caps and glaciers
- 0.4 % in ground water, lakes and rivers



10000 km²
≈ 1 million t CO₂/a
95 % recycled

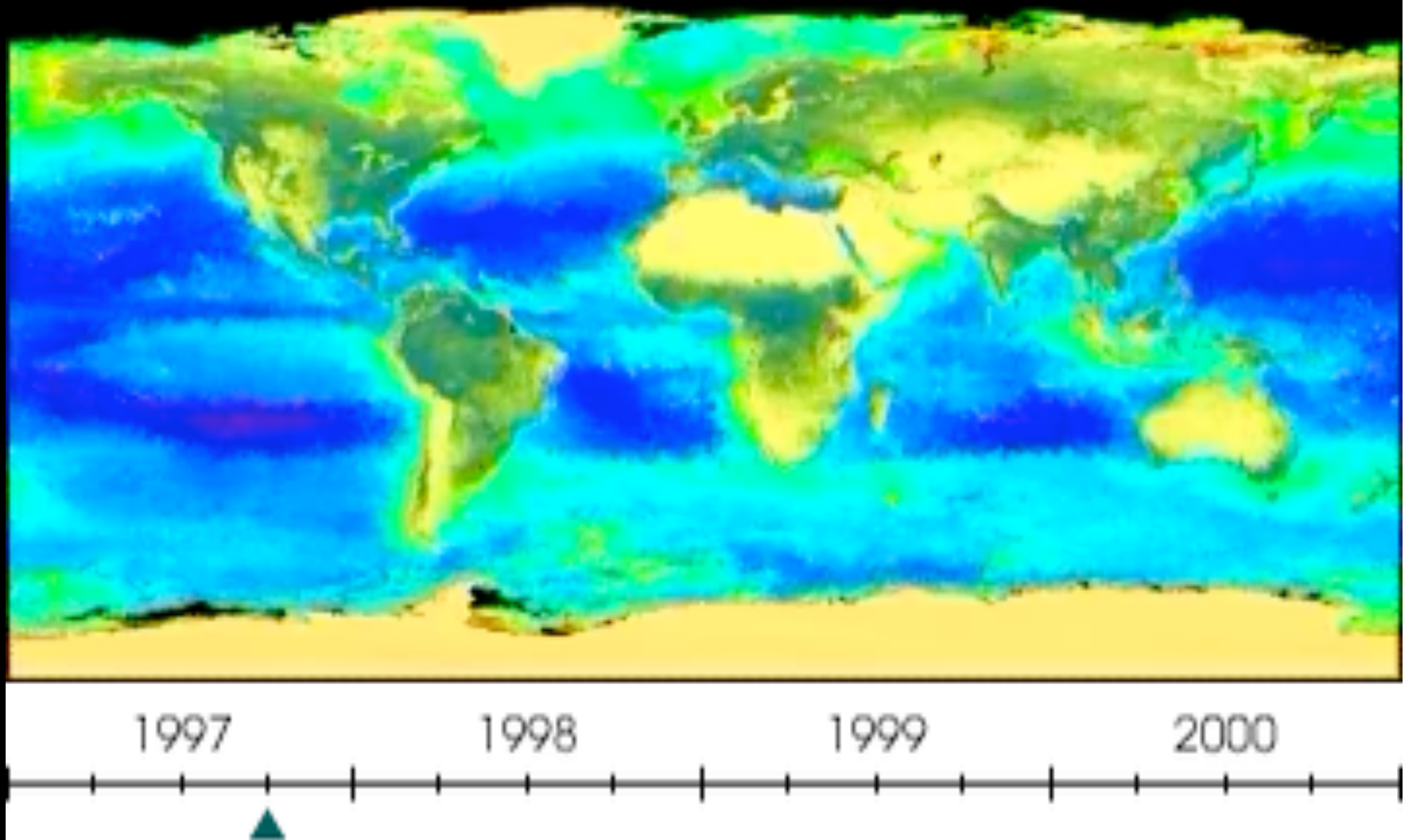
East Greenland



10000 km² ≈ 3 million t CO₂/a
90 % recycled

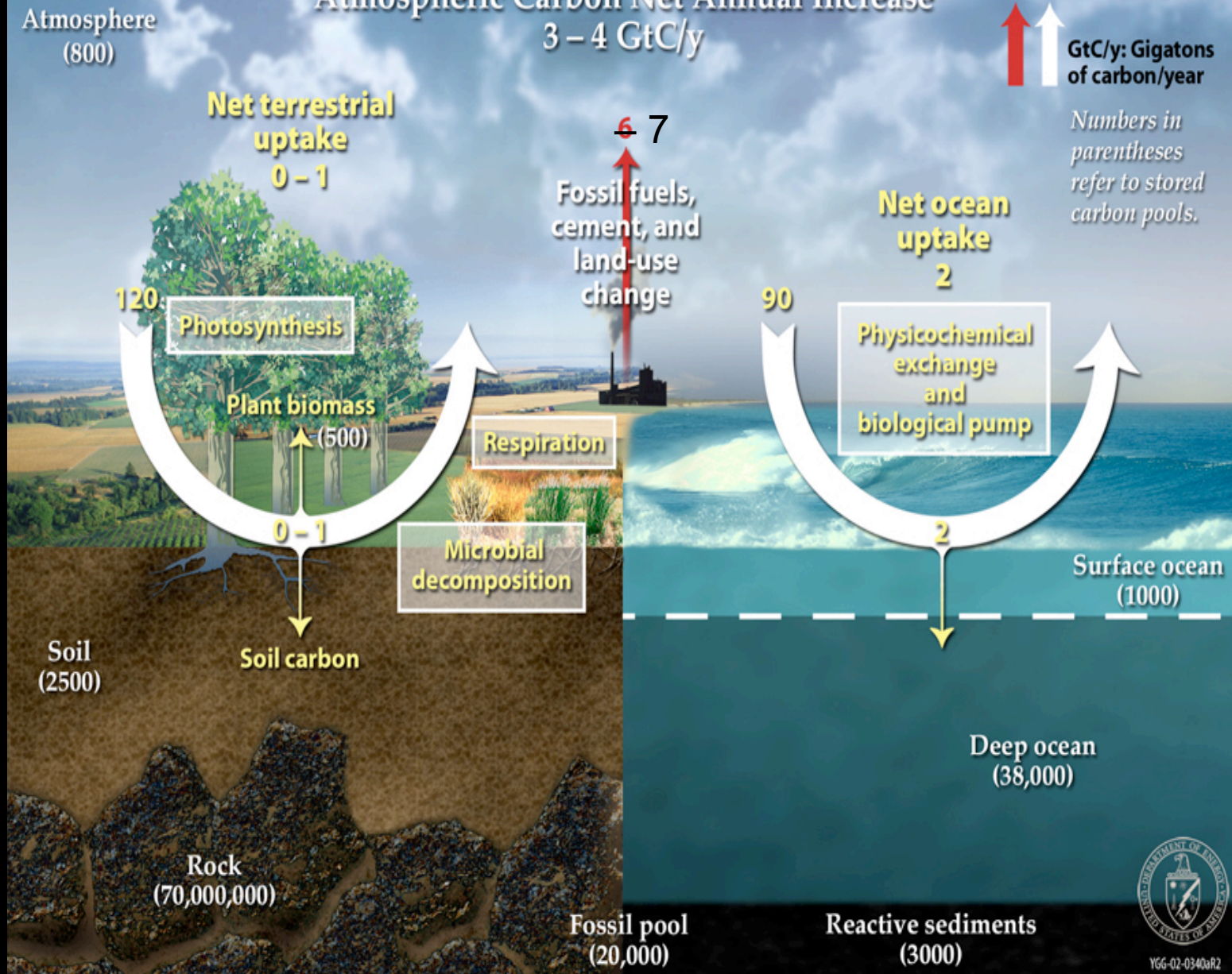
Denmark/Norway

Potential ocean sequestration



Simplified Global Carbon Cycle

Atmospheric Carbon Net Annual Increase
3 – 4 GtC/y



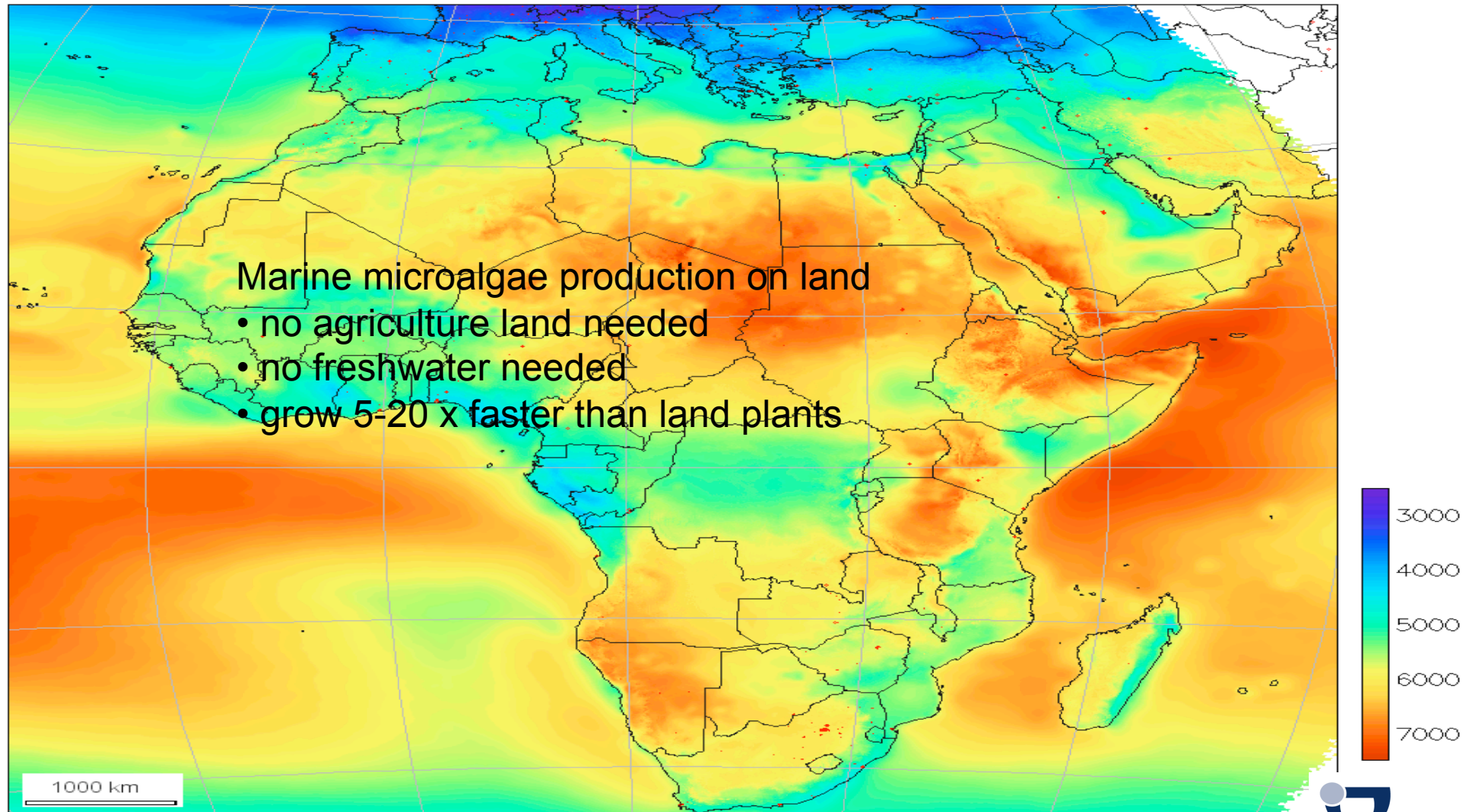
YGG-02-0340aR2

Potential Deployment Sites

Land based approach

Global horizontal irradiation (1985-2004)
(annual average of daily sums, Gh)

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

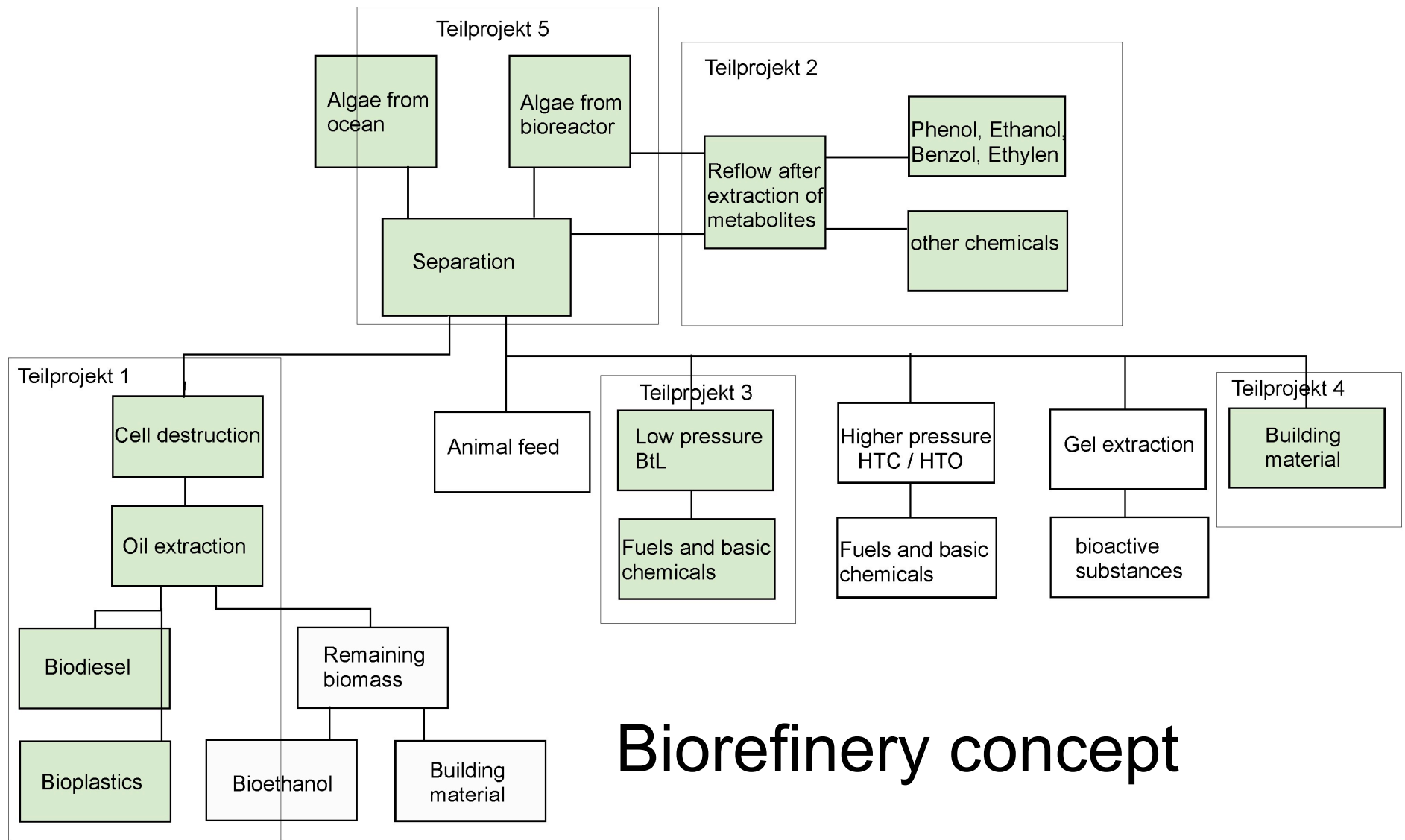


Biofuel and basic chemical production project



800 m² Bioreactor at RWE Lignite-power plant Niederaussem
R&D on a lowcost reactor-technology for subsequent transfer to southern latitudes
Test of costly, high advanced reactor-technology on demand

High-value, low-volume or low-value, high-volume products



Biorefinery concept



Almeria greenhouses Spain 350 km²

CO₂ mitigation ≈ 10 Mt/a

Eddies



Southern Ocean: 140x Germany, Production 20 g/m² would allow 1 Gt CO₂/a
200 Gt CO₂ emissions for 100 a ≈ 1x Germany 1 m thick layer of coal or
1/3 of the global land vegetation
or... a drop in the ocean

- 1 Gt/a into Southern Oceans (50 Mill km², Smetacek))
- Add 1Gt/a via agriculture soils (10 Mill km², Hülsbergen)

- Add 0.1 Gt/a via Ocean on Land technologies
- Add 0.5 Gt/a via greening of arid areas
- Add 1 Gt/a via Deep Ocean Sequestration

-
- Compare agriculture with mariculture

Literatur: The next generation of iron fertilization experiments in the Southern Ocean, Smetacek and Naqvi (Phil. Trans. R. Soc. A (2008) 366, 3947–3967)

Current locations of geological storage

| Project name | Country | Injection start | Daily injection (tCO ₂ /day) | Total planned storage (tCO ₂) | Reservoir type |
|--------------|---------------|-----------------|-----------------------------------------|-------------------------------------------|------------------|
| Weyburn | Canada | 2000 | 3,000 - 5,000 | 20,000,000 | EOR |
| In Salah | Algeria | 2004 | 3,000 - 4,000 | 17,000,000 | Gas field |
| Sleipner | Norway | 1996 | 3,000 | 20,000,000 | Saline formation |
| K12B | Netherlands | 2004 | 100 | 8,000,000 | EGR |
| Frio | United States | 2004 | 177 | 1,600 | Saline formation |

- The next generation of iron fertilization experiments in the Southern Ocean, Smetacek and Naqvi (Phil. Trans. R. Soc. A (2008) 366, 3947–3967)