# Meeting summary from the mini-workshop "Climate scenario data in ECOCLIM"

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Participants: Jens Hesselbjerg Christensen, JHC (CRES, DMI), Camilla Geels, CG (Århus Univ), Anne Sofie Lansø, AL (Århus Univ), Jørgen Bendtsen, JB (Climatelab), Karen Gustafsson (Climatelab), Thomas Friborg, TF (KU), Rasmus Jensen, RJ (KU), Andrey Sogachev, AS (DTU), Omar Daraghmeh , OD (DTU), Kristina Hansen, KH (RUC), Eva Bøgh, EB (RUC).

## JHC, CRES/DMI:

**CRES:** Communication important. CRES objectives to reduce uncertainties and assist decision taking; Climate/sea level, Hydrology, and Biosphere (ECOCLIM)

**IPCC-AP5**: new methods based on Representative Concentration Pathways (RCP). RCP's are not based on emission scenarios, but they represent radiative forcing due to different atmospheric concentrations. Instead, the international model community can study impacts of emissions on atmospheric concentrations, and then decide which RCP to use. RCP 6.0 corresponds roughly to A1B (2050 scenario). RCP 8.5 corresponds to A2 (2100 scenario). RCP 2.5 is unrealistic (requires negative emission).

**ENSEMBLES** is based on SRES A1B and uses ECMWF ERA40 as forcing. ENSEMBLES include downscaled results from 13 RCMs and provide reference and scenario data in 25 km grids. Reference and scenario data are available at http://ensemblesrt3.dmi.dk . Climate model outputs are precipitation, minimum and maximum temperatures, minimum and maximum relative humidity. Choices are needed on "which reference and scenario data to use (which periods?)?" and "which models to use?". ***Recommends use of reference baseline 1975-1994 and near-range climate scenario 2031-2050*** (as in Madsen et al., 2012). For the "near-range" scenario 2031-2050, uncertainty due to the chosen emission scenario is smaller! Long-term scenario 2031-2100.

At least two sets of GCM/RCM model results should be used to account for uncertainty. It is recommended to ***use the Dutch KNMI model ECHAM5/RACMO, as it performs best with respect to present-day climate. Another model recommended is the HC-Had RM3Q0 model*** (see also Madsen et al., 2012)

**Downscaling:** Further downscaling of 25 km ENSEMBLES scenario data required for local impact assessment. Impact assessment requires the use of at least two models (see above) to account for uncertainty. Data can be downscaled using a Weather Generator / statistical downscaling. See Madsen et al., 2012, for daily temperature, precipitation and solar radiation. The project HYACINTS have applied downscaling for hydrological impact assessment. Contact: Jens-Christian Refsgaard, GEUS.

Third Nordic international Conference on Climate Change Adaptation, Denmark 2014: bring together researchers and decision makers.

IPCC underestimates sea level change.

High resolution ocean modelling? Sea-ice poorly represented at global scale.

## AL & CG, AAU

**Modelling N deposition:** changes of climate and anthropogenic emissions. DEHM. Model trends and spatial patterns in Denmark - Validation 5 sites. Some overestimation over land but trend captured well. NH3 emissions 1 km resolution (EDAR, IER, EMEP, RCP, GEIA); Inputs of natural fluxes due to fire (GFED), CH4 (LPJ-WhyMe), and daily CO2 fluxes from European data/estimates. Spatial simulations 6 km resolution. Simulated temporal N deposition to forest in Sorø reduced by nearly 50 % in 1990-2009.

Climate/weather effect on NH3-emissions and N-deposition studied in the ECLAIRE project by "transferring" Danish farm emissions to other (European) climates: climate change can lead to changes in emissions (emissions are a function of temperature)

Global emission changes 2000-2100 - corresponding to RCP 4.5

**Climate scenarios** preference for ECHAM5 with A1B scenario. ***Emission scenarios*** made based on RCP (global), newer/better data from IIASA (Europe) and available projections for Denmark (data from ENVS).

**Periods:** mean over 10-20 years or selected years? Reference 1990-2009. Scenarios 2040-2059 and 2080-2099)

Should model sensitivity or climate impacts be assessed ? Impacts require more than sensitivity analysis.

## JB & KG, Climatelab

**Air-sea CO2 exchange modeling:** Observations of seasonal changes in surface $pCO_2$ in Kattegat and the Baltic Sea has been calculated from alkanility and pH.

Surface pCO2 is influenced by coastal carbon fluxes due to runoff, groundwater and sediment-water exchange and by biological and chemical processes.

Strong seasonal variations in pCO2 characterize the region. In general, there is $CO_2$ outgassing during winter. pH and alkanility measurements are used to calculate the air-sea CO2 flux in the period 1994-2008: Previous results indicate that Kattegat is a sink, Bornholm and East Gotland Sea are sources. Higher pCO2 will cause acidification of the Baltic Sea waters.

**Nitrogen-carbon coupling and climate change impacts**: Nitrogen from atmospheric N deposition & N2 fixation; runoff and sediment/water exchange. Used to increase organic matter production and leading to hypoxia due to increasing decay rate of organic matter. Acidification due to increasing CO2.

Cyanobacteria fix atmospheric N2 (warm and N-depleted waters) – increased N2 fixation. Cyanobacteria existence in N-depleted waters – can be monitored from satellite (MODIS). Bendtsen and Hansen (2012): Effects of global warming on hypoxia. Ecol. Modelling.

**Periods:** discussed/suggested that it is easier to model impacts of long-term scenario (- 2100) for marine areas because it is easier to model impacts of large change compared to small change... But larger uncertainties in runoff inputs to coastal regions because the terrestrial hydrological cycle (and ecosystems) are expected to change rather drastically.

**EB & KH, RUC**

**Daisy** model for simulating climate impacts on agricultural CO2 fluxes. Daisy includes > 50 crop types and is parameterized for the most typical Danish crops and soil types. Management (fertilization, irrigation and other cultivation actions) represented. Daisy set up spatially in GIS for Sjælland (see also Boegh et al., 2009) using DMI climate grids (2000-2010), CORINE land use, and agricultural crop distribution from Statistics Denmark; converted to major land use classes.

Examples Daisy simulations heat wave years 2003 and 2006; and 2009 (LAI, water balance, net photosynthesis). Simulation of heatwave years can be used to study sensitivity to increased temperature and to assess the performance of Daisy during extreme conditions.

FluxNet data from 4 stations at Sjælland. Lille Bøgeskov, Sorø : increasing net CO2 uptake 1996-2009 due to longer growing season (by one week) and - possibly – increased leaf nitrogen concentrations (Pilegaard et al., 2011), but seems to decrease CO2 uptake in heatwave years , so sensitive to increased temperature – need confirmation from model studies. In agriculture, land use change seems to have a larger impact on CO2 uptake than climate change. Need confirmation from model studies.

Climate impacts: CO2 fertilization, temperature, precipitation (drought, flooding).

Land use scenarios and impacts: land use change due to climate change (maize). N quotes? Current land use plans (water plans) aimed at reducing N loads of water environment by introducing wetlands and riparian buffer zones. Other changes impacting CO2 uptake and decreasing N-leaching: Perennial crops, catch crops.

Data requirements: Daily data of global radiation, air temperature, relative humidity, windspeed are needed for Daisy agro-ecosystem modelling. Daily input data converted to hourly data by Daisy.

JHC refers to the project RISKCHANGE which is a multidisciplinary project also working with downscaling *(I found the webpage here:* http://riskchange.dhigroup.com/*)*.

For land use scenarios, Jørgen Olesen, Århus Univ., should be contacted.

**RJ & TF, KU**

Nutrient availability -> reflected by leaf nitrogen and impacts the maximum photosynthetic capacity, Vcmax (Vc,max is a key parameter in photosynthesis models and in Earth system models) which is often assumed constant in Earth System models, but it has a large seasonal variation. Under most conditions (fairly clear sky), photosynthesis is limited by Vcmax and not by light. Vc,max can be estimated from leaf nitrogen data.

Measurement based assessment of Vcmax were made over the growing season for NEE modelling – it is found to be very high for fertilized agriculture. It is shown that the use of a standard Vc,max value in CLM (Community Land Model) model causes large underestimation of NEE!

CO2 and CH4 fluxes measured in wetland over 3 years (Herbst et al., BGS, 2013). CH4 fluxes are controlled by water level and temperature (Herbst et al. 2013) and cattle grazing. Snow delays CO2 emission due to

soil respiration in spring, but no clear effect on CH4 fluxes. Grass cutting and grazing reduce CO2 uptake in late summer. Cattle grazing increases CH4 emissions.

Annual carbon budgets (CO2 and CH4) of wetland for 2009, 2010 & 2011 show large variations due to climate and management, in particular grass cutting and grazing!

Change in agriculture (and fertilizer management) -> major player for ocean ecosystems and fluxes.

**OD & Andreas Ibrom**

Impact of ENSEMBLES climate change scenarios (ENSEMBLES) on soil respiration of a heathland ecosystem (Brandbjerg). Simulated using inputs from 3 ENSEMBLE RCM's.

Observed climate 2006-2011 (E-OBS gridded climate dataset). 3 GCM models (ARPEGE, ECHAM-r3, BCM) downscaled by DMI-HIRHAM5. Scenario data 2061-2090. Baseline 1961-1990.

Ecosystem model: CoupModel – a coupled heat and mass transfer model for soil-plant-atmosphere systems. Very good performance for soil moisture and soil temperature 2006-2011.

Measured and modeled soil respiration during ambient and drought (climate experiment) conditions 201-2012.

Predicted future soil respiration decreasing. The reasons for this is discussed but not clear – perhaps due to lower biomass productivity and thus reduced input of organic matter to soils

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Valg af perioder og klima model scenarie data diskuteres. Near-range scenario (-2050) is less uncertain than far-range scenario (-2100). For ocean ecosystems, impact of 5° change is easier to assess than impacts of 0.5 °C change, however runoff from terrestrial surfaces (incl change in agricultural systems) will change drastically and is more uncertain. Important to take decision on which future periods to represent in ECOCLIM.

Difference between terms "predictions" and "projections". Predictions relate to the near-future (similar boundary conditions) while projections are based on assumptions about changing boundary conditions (ie. greenhouse gases/emissions). Not possible to predict more than two years…!

Det aftaltes at der snarest skal afholdes et nyt møde med henblik på endelig beslutningstagen om scenarie perioder og anvendelse af modeller (scenarie data) i ECOCLIM. *(Dette tages op ved det kommende ECOCLIM årsmøde)*. JHC udleverer artikel der beskriver de valg der er foretaget i CRES regi og som anbefales at følge *(artiklen er vedlagt)*.