Neuantrag auf Mistral für EU Projekt CRESCENDO

Project:
Project title: CRESCENDO - Coordinated Research in Earth Systems and Climate: Experiments, kNowledge, Dissemination and Outreach
Project granted by EU Horizon 2020
Project administrator: Stefan Hagemann (MPI-M)

Abstract
CRESCENDO is a five-years EU project starting at 1 November 2015 and is coordinated by Colin Jones (UKMO). It brings together 7 European Earth System Modelling (ESM) teams and 3 European Integrated Assessment Modelling groups, as well as experts in ESM evaluation methods, projection and feedback analysis, climate impacts, regional downscaling and science communication with the overarching aim to: Improve the process realism and future climate projection reliability of European ESMs, while evaluating and documenting the performance quality of these models using a project -developed and openly-available community ESM evaluation tool (ESMValTool). Through the World Climate Research Program’s (WCRP) 6th Coupled Model Intercomparison Project (CMIP6) CRESCENDO will contribute to the development of a new set of socio-economic/land use/ emission scenarios and apply the project ESMs to these new data sets to generate an ensemble of novel and advanced Earth system projections sampling a range of plausible future development pathways. These projections aim to deliver the most realistic estimate possible of the full Earth system response to future anthropogenic greenhouse gas emissions and land use change. By full Earth system we refer to both the physical climate response and interacting biogeochemical responses and feedbacks. Furthermore, through using ESMs that include representations of both the physical climate and key biogeochemical processes it becomes increasingly possible to assess interactively both Earth system change and a number of environmental responses to these changes which have important socio-economic or ecosystem impacts. Advanced analysis of biogeochemical processes and their climatic feedbacks will deliver an improved understanding of the reliability of these projections as well as isolating and quantifying the main Earth system feedbacks controlling both the magnitude and uncertainty of future climate conditions. Through this we will provide robust and trustworthy Earth system projection information to European researchers, policymakers and the public.

The primary objectives of CRESCENDO are:

- To significantly improve the representation of key biogeochemical, biogeophysical and aerosol processes and feedbacks in seven European Earth System Models.
- To develop and apply a range of process-level evaluation methods to assess the realism of these newly developed Earth system processes in the project ESMs.
- To diagnose and categorize key Earth system biogeochemical and aerosol feedbacks and their associated radiative forcing using a common framework.
- To develop and apply advanced methods to quantify sources of uncertainty in Earth system projections and clearly document these uncertainties.
- To further advance the discipline of emergent constraint analysis, apply these techniques to ESM projections to constrain key future Earth system feedbacks and help focus model development onto processes crucial to the magnitude and spread of future Earth system change.
- To develop and apply, an openly-available, evaluation tool for routine ESM benchmarking and more advanced analysis of feedbacks and future projections.
As part of the CMIP6 Scenario Model Intercomparison Project (ScenarioMIP), contribute to the development of a new set of policy-relevant future scenarios using the project IAMs.

To deliver a coordinated ensemble of ESM projections based on new CMIP6/ScenarioMIP scenarios and ensure these data are saved on the Earth System Grid Federation (ESGF).

To provide a coordinated set of simulations and advanced analyses to a range of CMIP6 Model Intercomparison Projects (MIPs) that align with the main project goals.

To work with the climate impacts and regional downscaling communities to ensure ESM data produced in CRESCENDO is both useable and used in these complementary research areas.

To ensure knowledge developed in the project is communicated to key stakeholder communities in an engaging and understandable form.

Several groups at MPI-M (THY – Stefan Hagemann, CBI – Victor Brovkin, OBG – Tatiana Ilyina) will contribute to CRESCENDO within the following work packages:

RT1: Improving process parameterizations in ESMs
- WP1.1 – Terrestrial biogeochemical processes (Lead: Victor Brovkin)
  - T1.1.1 Carbon and nitrogen dynamics in vegetation and soils
  - T1.1.2 Wetlands and permafrost systems and methane emissions
  - T1.1.3 Land use and Land cover in ESMs (Lead: Victor Brovkin)
- WP1.2 – Marine biogeochemical processes

RT2 – Process-level evaluation of improved parameterizations (Lead: C. Jones and Tatiana Ilyina)
- WP2.1 – Evaluating Terrestrial Processes in ESMs (Lead: Sönke Zähle, MPI-BGC)
  - T2.1.3 Land use and Land cover in ESMs
- WP2.2 – Evaluating marine processes in ESMs

RT3 – Evaluation and analysis of ESM simulations
- WP3.1 – Towards routine Benchmarking of ESM (Lead: Alex Löw, LMU)
  - T3.1.1 Enhanced platform for routine evaluation and benchmarking of ESMs
  - T3.1.2 Maintenance, Technical Infrastructure, Interfaces, and Documentation
- WP 3.2 – Understanding and constraining model projections
  - T3.2.4 Emergent constraints on ocean carbon cycle feedbacks
- WP 3.3 – Quantification of forcing and feedbacks
  - T3.3.3 Transient experiments

RT4 – New scenarios and ESM projections
- WP4.2 – Assessing the robustness of ESM performance and projection response to model resolution
  - T4.2.1 CMIP DECK simulations using low resolution ESMs
- WP4.3 – Organising ESM simulations for CMIP6 ScenarioMIP
  - T4.3.1 Coordinated ESM projections for ScenarioMIP

RT5 – Knowledge and data dissemination
- WP5.1 – Knowledge Dissemination
  - T5.1.1 Targeted interaction with policy makers
  - T5.1.2 Science communication training
- WP5.2 – Data dissemination
  - T5.2.1 Archiving ESM data on the ESGF
In addition, contributions to several Model Intercomparison Projects (MIPs) are planned that comprise:

- ScenarioMIP: Scenario Model Intercomparison Project
- C4MIP: The Coupled Carbon Cycle Climate Model Intercomparison Project
- LUMIP: Land Use Model Intercomparison Project (Victor Brovkin)
- LS3MIP: Land Surface, Snow and Soil Moisture Model Intercomparison Project (Stefan Hagemann)
- OCMIP6: Ocean Carbon Cycle Model Intercomparison Project (Tatiana Ilyina)

**Planned simulations for 2016**

Within RT 1 – WP1.1, model improvements of the land surface model of MPI-ESM, JSBACH, will be conducted. These will be associated with test and sensitivity simulations of JSBACH in offline mode and coupled to the atmosphere in AMIP mode at T63L47 resolution:

- 300 years of JSBACH-offline to test new model developments at T63 resolution
- 5 * ECHAM6/JSBACH AMIP2 runs at T63 resolution for 1979-2008 = 150 years

For RT3 - WP 3.3, we want to quantify the biophysical (physiological) effect of CO2 in terms of radiative forcing. For this, we need to make a MPI-ESM experiment with instantaneous 4xCO2 increase in which JSBACH sees 1xCO2. This will be associated with a default simulation where the full MPI-ESM sees the instantaneous 4xCO2 increase. By making the Gregory plot (imbalance in TOA radiation vs temperature change) and comparing with the default 4xCO2 experiment, we’ll find the radiative forcing of the physiological effect. Run time: 50 years:

- 2 * 50 years of MPI-ESM 1.1 - LR: T63L47 (existing MPI0-ESM 1.1 version), monthly output

A historical plus RCP8.5 simulation shall be conducted from 1850-2100 with MPI-ESM-LR in a model version that shall be used as reference within CRESCENDO for the various MIPs. Note that this version shall include permafrost-relevant physics, a new fire model and frozen carbon parameterizations that are currently not included in the official MPI-ESM version. This simulation is planned for the **second half of 2016** (3rd and 4th quarter):

- 250 years of MPI-ESM 1.1 - LR: T63L47, 6-hourly output

For different MIPs, several simulations are planned for the **second half of 2016** (3rd and 4th quarter), all using the MPI-ESM version that will be used in CRESCENDO (see above) with 6-hourly output.

For LS3MIP:

- 50 years of 4xCO2 experiment with 1xCO2 biophysical CO2, MPI-ESM at T63L47 GR15

Tropical deforestation for LUMIP:

- 70 years of linear tropical deforestation, MPI-ESM at T63L47 GR15 (Tier 1 experiment)
- 50 years of instantaneous tropical deforestation, MPI-ESM at T63L47 GR15 (Tier 3 experiment)

C4MIP:

- 140 years of 1%-CO2 increase in BGC mode, MPI-ESM at T63L47 GR15 (esm1pcbgc, Tier 1 experiment)

Please note that the EU project CRESCENDO will start in November 2015, having its kick-off meeting in the late November. Thus, it might be that further experiments may be planned.
to be conducted in the second half of 2016. Thus, we hope it will be possible to apply for computing time for those experiments within 2016!

**Technical run characteristics**
All planned simulation will be conducted with MPI-M models that are optimized and well suited for the use of the HLRE 3.

**MPI-ESM 1.1 - LR: T63L47 GR15, 6-hourly output:**
12 node-h / model year
Output: 100 GB / 1 year

**MPI-ESM 1.1 - LR: T63L47 GR15, monthly output:**
7.6 node-h / model year
Output: 1 GB / 1 year

**AMIP2 runs with ECHAM6/JSBACH with T63L47 resolution**
1 node: ~8 node-h/ year
Output: ~35 GB/year

**JSBACH offline simulations with T63 resolution:**
0.4 node-h/yr ‡ 200 years: 40 node-h
Output: ~3 GB / year

**JSBACH offline simulations with 0.5° resolution:**
2.5 node-h/yr
Output: ~36 GB / year

**CPU time requests**

560 years of MPI-ESM at T63L47 GR15, 6-hourly output, to be conducted in the second half of 2016:

CPU time: 560 * 12 = 6720 node-h
Output: 56 TB

100 years of MPI-ESM at T63L47 GR15, monthly output
CPU time: 100 * 7.6 = 760 node-h
Output: 100 GB

150 years of MPI-ESM T63L47 in AMIP2 setup
CPU time: 150 * 8 = 1200 node-h
Output: 5250 GB

300 years of JSBACH-offline at T63 resolution
CPU time: 300 * 0.4 = 120 node-h
Output: 900 GB

**Sum:**

**CPU time** 8800 node-h (6720 in second half of 2016)
**GPFS work:** 10000 GB
**HPSS arch (output):** 62250 GB
**HPSS doku:** 6.2 TB