

GC Carbon feedbacks in the climate system - Report

1. Highlights for JSC

- Kick-off workshop was held in November 2016 in Hamburg, Germany;
- Outline of proposed activities for 2017-2019 supporting the development of the GC-Carbon;
- Description of major partners in carbon community in response to JSC request following previous JSC-meeting in 2016.

Background

The WCRP Grand Challenge on Carbon Feedbacks in the Climate System ([GC-Carbon](#))¹ aims to enhance the understanding on how biogeochemical cycles and feedbacks control CO₂ concentrations and impact the climate system. The Grand Challenge will be addressed through community-led research initiatives focusing on the following guiding questions:

- *What are the drivers of land and ocean carbon sinks?*
- *What is the potential for amplification of climate change over the 21st century via climate-carbon cycle feedbacks?*
- *How do greenhouse gases fluxes from highly vulnerable carbon reservoirs respond to changing climate (including climate extremes and abrupt changes)?*

The overall effort to address these three guiding questions will focus on specific advances in our understanding of biogeochemical processes that will lead to significant improvement in climate projections, with substantial progress expected in the next 5-10 years. This effort is divided into four research areas, addressing the three guiding questions and expected to progress in parallel. These **four research areas** are: process understanding on land; process understanding in the ocean; learning from the existing record; and towards improving projections.

2. Early success and/or planned activities in 2017/2018

The GC-Carbon was launched via a kick-off workshop held in Hamburg, 21st and 22nd of November 2016. The objective of this workshop was to strengthen the links between the guiding questions and research initiatives as well as to emphasize major gaps to sharpen the priorities and plans of the program as a whole. The workshop had about 35 participants, covering a wide range of expertise such as plant physiology, marine biology, atmospheric inversions, land and ocean biogeochemistry, paleo-climate, Earth system modelling, etc.

The workshop comprised of a brief introduction on the WCRP Grand Challenges (David Carlson), a presentation of the GC-Carbon (Tatiana Ilyina and Pierre Friedlingstein), followed by two inspirational talks (Niki Gruber and Chris Jones) aimed to initiate discussions on the key gaps in knowledge and how to move forward. The rest of the workshop was organised in four breakout groups, each focusing on one of the four research areas listed above. Breakout groups outcomes were presented at the end of the meeting, with proposals for specific

¹ <https://www.wcrp-climate.org/grand-challenges/gc-carbon-feedbacks>

research activities. Full report, workshop agenda and list of participants available on the WCRP GC-Carbon [website](#)².

Planned activities in 2017/2018 are summarised here:

2017

1. *Feedback framework*: A workshop is proposed to develop an extended climate-carbon cycle feedback framework. This workshop would bring together mathematicians, experts in climate feedbacks, carbon cycle and Earth System feedbacks.
2. *Decadal prediction*: It is proposed to have an initial brainstorming meeting between the grand challenge on carbon feedbacks in the climate system and the grand challenge on near term climate prediction to explore the potential scientific and societal interest in near term predictions of the carbon cycle.

2018

3. *Ecosystems turnover time*: A focused meeting is proposed in order to provide robust observation-based estimates of vegetation and soil carbon fluxes, pools and turn-over times and to design a ¹⁴C global modelling framework for evaluation of land carbon dynamics. This workshop would bring together a few experts in atmospheric and soil carbon isotopes, ecosystem biogeochemists, and ESM modellers.
4. *Ocean physics and biogeochemistry*: A workshop has been proposed on the ocean boundary layer and its impact on the carbon cycle focusing on mixing parameterizations in models, variation in stratification from data, projected trends with climate change. This workshop would bring together experts in ocean physics and biogeochemistry.

2019

5. *CO₂ fertilisation over land*: A workshop has been proposed on CMIP6 models evaluation against observations and proxies for CO₂ fertilisation, including the design of specific FACE site level benchmarking of land surface components of ESMs. The workshop would bring together FACE experimentalists, plant physiologists, remote sensing and atmospheric CO₂ experts, and ESM modellers.
6. *Oceanic export production*: A workshop has been proposed that would focus on the response of the export flux of carbon to temperature (Q_{10}) and on the stoichiometric ratio of the exported material (C:N:P). Such workshop on model parameterizations would combine experimentalists, process modellers and earth system modellers.

3. Partners for GC implementation

Within WCRP:

DC-decadal: initiate a discussion on decadal variability and predictability of the global carbon cycle Activity 2)

CLIC: permafrost and carbon, importance for overall feedback (Activity 1) and turnover time (Activity 3)

CLIVAR: Ocean boundary layer physics, importance on biogeochemistry (Activity 4)

Outside WCRP:

Global Carbon Project and other Future Earth programmes e.g. AIMES, SOLAS and iLEAPS

4. Overall GC timeline

Summer 2017: Activity 2: GC-carbon and GC-decadal meeting. To be organised by WCRP

Autumn 2017: Activity 1: Feedback framework workshop. To be lead by P. Cox (U. Exeter and T. Frölicher, ETH).

5. Issues and challenges: None so far.

² <https://www.wcrp-climate.org/gc-carbon-feedbacks-meetings/139-grand-challenges/grand-challenges-carbon-feedbacks/1021-kick-off-meeting-carbon-feedbacks-in-the-climate-system>