UK-Russia Climate Change Science Collaboration Project

PROJECT MEETING AND MODELLING WORKSHOP, 1-2 FEBRUARY
Met Office, FitzRoy Road, EX1 3PB, Exeter, United Kingdom

MEETING AND PROGRESS REPORT

Participants:

- Rutger Dankers, Pete Falloon, Andy Wiltshire (*Met Office Hadley Centre, **MOHC***)
- Denise Oakley, Sarah Winne (*AEA Technology, **AEA***)
- Oleg Anisimov, Svetlana Reneva, Vasily Kokorev, Julia Strelchenko (*State Hydrological Institute St. Petersburg, **SHI***)

Background to the meeting:

The UK-Russia Climate Change Collaboration Project is a project of the Foreign & Commonwealth Office's (FCO) Strategic Programme Fund. One of the main purposes of the project is to build the relationship between British and Russian climate scientists and give them an opportunity to engage in collaborative research that improves the understanding of aspects of climate change that are important to both countries.

A joint programme of scientific research is being conducted involving the Met Office Hadley Centre (Exeter, UK) and the State Hydrological Centre (St Petersburg, Russia). Beginning in Dec 2008, this work is exploring the issue of permafrost, soil-carbon balance and sustainability under climate change. The research programme will conclude in August 2010. To date the researchers have completed a comprehensive literature review on 'Climate impacts in Russia: changes in carbon storage and exchange' (Oct 2009) (currently awaiting final approval for publication), and exchanged their respective models and datasets. Initial work at the Met Office has set up and run the JULES model with observation-based climatology, and SHI is working on running their permafrost models with Met Office climate scenarios. The present stage of the work aims to compare the performance of both models with respect to their simulation of permafrost under different climate change scenarios.

The main aim of the meeting in Exeter was to discuss progress with the scientific part of the project and to work collaboratively on learning and comparing the models from both institutes.

In addition, Oleg Anisimov from SHI gave a seminar on climate change and permafrost to a larger Hadley Centre audience. This meeting was well attended and the seminar prompted a number of interesting questions and comments from the audience.

The agenda of the meeting is attached to this report (Annex 1).

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Recent progress and discussion points:

- ***From the Met Office's Hadley Centre***
  The MOHC presented the latest results from the land surface model JULES. The MOHC has spent considerable effort in validating the simulation of permafrost in the model by comparison with single-point observations as well as observed permafrost extent in the Northern Hemisphere. To this end, the model has been run for the entire Northern Hemisphere (north of 25ºN) at 1-degree resolution, driven by observation based climatology for the period 1983 to 1995.

  The model results have been compared with those coming from the SHI permafrost model. Some good progress has been made in representing the effects of deep permafrost and organic soils in their model, which was believed to have improved the simulation. SHI scientists gave some useful feedback on these results. The MOHC is currently preparing the climate scenario runs, in which JULES will be forced with QUMP probabilistic climate scenarios from the Hadley Centre climate model. The results from these climate change runs are expected to become available during the coming weeks and months.

- ***From SHI***
  SHI has made good progress in analysing the probabilistic climate scenarios that were obtained from the MOHC. To accomplish this task, we used the output from runs for the control period 1900-1999 from 21 Global Climate Models (GCMs) (including the MOHC model), and calculated several climatic characteristics that largely govern the thermal state of permafrost, i.e. thawing degree-day sums, annual temperature amplitude, and sums of winter precipitation. Results from different models were interpolated into a single 2.5 by 2.5 lat/long grid and compared with observations at weather stations in the Russian permafrost region to evaluate the skills of the individual models and to rank them in the specific context of predictive permafrost modelling. Ultimately, we identified 6 top-end models (including the MOHC model) that were "better than average" in reproducing the changes of climatic parameters governing the state of permafrost and therefore may be used to construct an 'ensemble' climatic projection for these regions.

  The specific conclusions from this analysis are the following:

  - High-end GCMs that demonstrate excellent skills in conventional atmospheric model intercomparison experiments are not necessarily the best in replicating climatic characteristics that govern the state of permafrost in Northern Eurasia, and independent model evaluation based on the specifically relevant criteria (for this context) is necessary to identify "better than average" models.
  - Each of the 'ensembles' combining results from several "better than average" models were able to replicate permafrost-related climatic characteristics better than any single GCM. The capabilities of each ensemble are parameter-specific and

depend on models that it consists of. The best results are not necessarily those based on the ensemble comprised by all "better than average" models.
  - Comprehensive evaluation of climatic scenarios using specific criteria narrows the range of uncertainties in permafrost projections.

SHI experts are currently evaluating an ensemble climate scenario obtained with a single low resolution (ca. 4 degree lat/long) MOHC model run with perturbed parameters. After this work is completed (anticipated to be by the end of March), the SHI permafrost model will be used in conjunction with selected climatic scenarios to construct hemispheric scale probabilistic projections of the active-layer thickness.

In parallel to this work, SHI revisited the issue of modelling the potential effect of the emission of greenhouse gases from thawing permafrost to the global climate. This was necessitated by the new data regarding carbon stocks in permafrost soil; these which are now estimated to be three times greater than previously thought. The permafrost model with the soil carbon block was forced by the ensemble climate scenario comprised of results from "better than average" models described above. This enabled calculation of the potential increase in methane that would be emitted from thawing permafrost by the end of the 21 century, and to evaluate the effect that this may have on the global climate. Results obtained so far indicate that the estimate obtained in the previous SHI study, i.e. 0.012 °C global temperature rise by mid-21st century may increase by a factor of 20 if all sources, including frozen soils that were previously supposed to have low carbon content, are taken into account. However, it is important to recognise that there are large uncertainties in evaluations of the amount of labile carbon in the Arctic soils at different depths, and that this new estimate is very preliminary. More work in this specific area is needed.

The SHI project team have submitted a paper[1] on modelling carbon balance in permafrost soils and evaluation of the impact it may have on the global climate (in Russian) for publication in an edited volume by Russian Academy of Science devoted to the results of the International Polar Year.

- During the modelling workshops scientists from both institutes spent considerable time working through the source code of their respective models and identifying resemblances and differences in their model approaches.

- As a result of collaborative working and of the model intercomparison, the MOHC has re-evaluated their method of diagnosing maximum thaw depth in the JULES model, which is a measure for permafrost occurrence. This has further improved their simulation of permafrost.

[1] O.Anisimov and S.Reneva, 2010. Carbon balance in Russian permafrost regions and the global climate: current state and projections based on predictive modelling. In book: V.Kotliakov (Ed.). Russian contribution to the International Polar Year, vol. 3. (submitted).

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Related external activities:

Russian co-Project Implementer (Oleg Anisimov) was invited to participate in the Wilton Park conference "Challenges of the High North" (held in UK, 18-21 February). He presented some of the results and conclusions relating to the impacts of climate change in Russian permafrost regions that were obtained in the UK-Russian Climate Collaboration project.

This meeting brought together scientific experts from a number of countries and high-level representatives of the international policy-making community, particularly from the Arctic Council member states and the UK. One of the issues that raised serious concerns was the somewhat speculative nature of the statements being made about the potentially strong feedback of thawing permafrost to the global climate system. This is based on the so-called "methane bomb" concept that was largely adopted by policy makers and extensively discussed in the media even though some recent studies indicate that there are still very large uncertainties in this area of research.

In the discussions during the meeting, it was agreed that one of the key tasks to be acted upon was the necessity to narrow the range of uncertainties. Developments and findings from the UK–Russia CC project – specifically through the modelling carbon emissions from thawing permafrost under scenarios of climate change – to be undertaken during the next several months will assist efforts on addressing this important task.

Future activities:

- SHI and MOHC are planning several scientific publications resulting from the project work, with the aim of feeding into the next IPCC (AR5) report. Our aim is that a draft version of at least 2 papers should be ready before the end of the project.
- SHI and MOHC will prepare a non-technical summary of the literature review; this will be ready by April to allow time for translation so that English and Russian versions can be distributed prior to the final project workshop (in Moscow, July 2010).
- SHI and MOHC will prepare a non-technical summary of the aims of the research programme, results to date, implications of the findings and the remaining questions (by mid June) for circulation to key stakeholders and participants ahead of the final project workshop (see next bullet point).
- A final project workshop is scheduled to take place in the period of 6-8 July 2010 in Moscow. The aim of this workshop is to inform policy makers about the results of the research work. The workshop is planned for one day and the intention is that this will consist of a number of short, non-technical presentations and followed by facilitated discussions on specific questions arising from the research findings. A summary of the workshop presentations and discussions will be prepared.
- A final report will be prepared for the end of the project (draft end of July; final report August 2010).