JPI CLIMATE

First joint call 2013, call topic 2

Russian Arctic & Boreal Systems

Objectives and relevance of the call

Through improved knowledge, JPI Climate aims to enhance our understanding of the climate and improve climate prediction capabilities for Europe and regions of key interest for European policy. Underlying these ambitions is the ongoing improvement in our understanding of key climate processes, including feedbacks, and climate phenomena. Improved observation, understanding and modelling of the key processes and mechanisms in those regions that have been recognised as the main hot-spots of climate change are therefore needed.

The Pan-Eurasian region is of crucial importance to enhancing our knowledge and understanding of how the climate will change. Pan-Eurasia, and especially its Russian tundra-taiga and coastal regions, is very vulnerable to change and, in addition, provides an important source of climate feedbacks. In light of the significance of the area and the overall scarcity of detailed information, more investigation is called for.

The aim of this call is to improve the fundamental understanding of the key biological and physical drivers and feedbacks in Russian Arctic/Boreal system (tundra-taiga-coastal region), through observations and modelling efforts in the Pan-Eurasian region, to enable better representation of these processes in climate models. Projects under this call should focus on enhancing the understanding of the key processes and improved parameterisation in the climate/Earth system models.

Through this joint call, JPI Climate will support high-quality research in the Russian domain of the Pan-Eurasian area, which represents a strategic priority for climate change research both nationally and internationally. The joint research call is targeted towards enhancing the knowledge of key processes in the tundra-taiga-coastal regions related to long-lived greenhouse gases (GHGs) such as carbon dioxide and short-lived climate forcers (SLCFs), notably methane, which are important, yet poorly quantified players in the Earth System Models. The topics chosen for this call are of the highest relevance to JPI Climate and will be best dealt with through a multinational approach.

The call is designed to strengthen the coordination of research activities at the European level, and collaboration will be extended beyond Europe through the involvement of Russian researchers and funders. While many research groups in the different European countries already have ongoing research activities and bilateral cooperation with scientists in Russia, this cooperation is widely dispersed and not coordinated, which means there is a risk of fragmentation and duplication of research efforts and resources at the European level. Through this call, JPI Climate aims to streamline the research activities in the Russian domain and promote synergies and enhance the efficiency of the transnational research activities in the Russian Arctic/Boreal (tundra-taiga-coastal) region. The proposed call is therefore important in terms of both scientific outcome and the enhancement of international cooperation within JPI Climate and beyond.

Contribution to SRA and links with modules FTAs:

This joint call is of high relevance to the JPI Climate Strategic Research Agenda (SRA)[1], principally in relation to Module 1 “Moving towards reliable decadal climate predictions”. Section 1.3.3: “Observing, understanding

[1] http://www.jpi-climate.eu/publications/10826597/JPI-Climate-Strategic-Research-Agenda

and modelling key processes/mechanisms" points out that there are fundamental limitations in our knowledge that affect our ability to realistically simulate climate variability and our confidence in climate change projections. These limitations can be only overcome by improving our understanding of the basic processes and feedbacks in the main hot-spots of climate change.

JPI Climate anticipates funding 3–5 transnational collaborative research projects within this call topic.

Call topics

1. **Improving the understanding and the modelling of permafrost and its impact on the capture, storage and release of GHGs.**
2. **The dynamics and drivers of climatically relevant gases in the terrestrial, freshwater and coastal environments.**

Topic 1: Improving the understanding and the modelling of permafrost and its impact on the capture, storage and release of GHGs.

The Russian Arctic regions are characterised by the presence of permanently frozen ground (permafrost) which is often formed during previous glaciations. This represents a globally important store of organic carbon, a significant proportion of which resides in the upper metres of permafrost that are particularly vulnerable to climate change. Degradation of the permafrost leads to multiple effects on the environment, including disrupting ground stability, and will therefore have a major impact on local populations. The thawing of permafrost in the Arctic regions promotes the decomposition of the organic matter it contains, and thus increases the emission of GHGs. The magnitude of carbon losses through CO_2 and CH_4 emissions from thawing permafrost regions is largely unknown with a broad range of current estimates. In addition, many Earth System Models either do not include these processes, or lack detailed process descriptions.

It is therefore necessary to understand and accurately quantify the processes involved in the formation of permafrost and the capture of organic matter. There is also a need to understand how the thawing of the near-surface permafrost and resulting changes in the physical and chemical environment, including the influence of snowpack, results in the release of GHGs. The complex interactions between the changing physical and biogeochemical properties in the region need to be better incorporated into numerical models if we are to accurately predict the impact of the warming Arctic on GHG release and the implications of this on the global climate system.

Topic 2: The dynamics and drivers of climatically relevant gases in the terrestrial, freshwater and coastal environments.

The Russian Arctic/Boreal system is a source of both long-lived climate gases (notably CO_2 and nitrous oxide) and short-lived climate forcers - SLCF (radiative active climate agents), which include methane and non-methane volatile organic carbon (MMVOC). Interactions of nitrogen oxides and hydrocarbons result in the formation of ozone, a very effective SLCF. Regional modelling studies indicate that tundra regions across the Arctic have recently been acting as a weak sink of atmospheric CO_2 and current models suggest this will continue throughout the 21st century in response to the projected changes in climate. Boreal forests are also a CO_2 sink, but forest fires (and peat fires) generate black carbon, which is another SLCF that alters the albedo of snow and ice and absorbs incoming solar radiation in the atmosphere. Nitrous oxide and particularly methane in the Arctic are more recently recognised as emerging issues for climate warming. Methane emissions are highly variable, both temporally and spatially, depending on factors such as hydrological state, temperature and even biological community structure. Thawing permafrost can lead to both dry and wet conditions, which result in significantly differing balance of emissions

To estimate the significance for global warming of organic carbon reservoirs it is not sufficient to simply measure the direct release of GHG from the Siberian taiga and tundra into the atmosphere. It is also necessary to quantify the organic carbon carried by the rivers draining into the Arctic Ocean and the contribution of permafrost soils eroded from the Siberian coastline. Furthermore, large quantities of GHG are buried in former terrestrial permafrost soils now located underneath sediments across the vast Siberian continental shelf. Previous work has identified substantial leakage of GHG from these shelf seas into the water column and subsequently into the atmosphere. However the knowledge of the amount of GHG stored, its stability and the process of sub-seafloor permafrost degradation is at best rudimentary. It is clear that the release into the atmosphere is substantial and is likely to increase as a response to warming of the Arctic Ocean and the loss of sea ice cover.

Aerosols released from terrestrial and aquatic environments can affect clouds and cloud formation in various ways, both directly and indirectly. Highly active secondary chemical agents such as ozone formed in the overlying atmosphere bring further complexity to identifying and understanding the dynamics of climate relevant GHG's in the Arctic environment. Observing aerosol processes pushes our current technology to the limits and challenges our ability to describe the number, distribution and properties of these aerosols over several orders of magnitude. A necessary addition to observation is numerical modelling of processes and transport models and more detailed descriptions. A main goal of this topic should be to quantify natural sources of primary aerosols and the precursor gases for production of secondary aerosols.

As with aerosols themselves, the chemical processes and resulting products in these environments are difficult to measure, and process and chemical tracer modelling is necessary to interpret observations. One main goal is to quantify the importance of source regions and source types for the Boreal concentrations of anthropogenic aerosols and to determine their transport pathways.

The lifetime of end-products of both aerosols and chemical species can be weeks or months, and local production aerosols and species will thus have a regional effect.

In addition to radiative effects, the SLCF's such as black carbon are important for pollution and effects on humans and the biosphere on local and regional scales.

SLCFs may be having climate impacts in the Arctic that are comparable to that of long-lived GHGs. In order to estimate the effects of SLCFs on the changing climate, the investigation of the dynamics and drivers in the different environments of the Eurasian region is needed.