Helmholtz - OCPC - Programme 2017-2021

for the Involvement of Postdocs in Bilateral Collaboration Projects with China

PART A

Title of the project

Impact of climate change on crop yields, N_2O emissions and environmental N losses of agricultural production systems in China and SE Asia

Helmholtz Centre and institute:

Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research - Atmospheric Environmental Research **- Campus Alpin**

Project leaders

Dr. Clemens Scheer

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Web-address

https://www.imk-ifu.kit.edu/regionalization_biogenic_tracegas_fluxes.php

https://mopga.imk-ifu.kit.edu/project

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Description of the project:

Agriculture in China is currently feeding 22% of the world's population with only 7% of the world's arable land. This has been achieved by increased agricultural intensification characterized by large inputs of nutrients on a limited land area. The total consumption of synthetic N fertilizers in China has increased 300% since 1980, but this increase in N-fertilizer use has increased total grain production by only about 70%. Chinese farmers use about 305 kilograms of N per hectare per year, more than four times the global average, greatly surpassing crop demand which has resulted increased losses of N to the environment. There are several main N loss pathways from fertilized agroecosystems, including NH_3 volatilization, NO_3^- leaching, and NO, N_2O and N_2 emissions. These N losses often represent a substantial loss of applied fertilizer; thereby taking away N for plant growth, which finally results in low crop N use efficiencies (NUE). Over the last three decades NUE has declined from 30–50% to 20–30% for the whole of China, and below 20% in some major grain producing provinces, compared with a global average of 40–60%. This inefficient use of N fertilizer has raised not only agronomic but also environmental concerns since N fertilizer losses to the environment have caused a number of serious environmental problems as it is cascading through terrestrial and aquatic ecosystems and into the atmosphere. Besides NO_3^- in ground and surface waters, N_2O is arguably the most important form of environmental N pollution, because it is not only a potent greenhouse gas with a global warming potential 298 times greater than CO_2, but is also the primary contributor to stratospheric ozone depletion.

Consequently, there is substantial interest in mitigating N_2O emissions as well as nitrate leaching from agriculture activities as a part of the strategy to combat global climate change and to reduce water pollution. Yet methods for estimating N_2O emissions and N leaching losses from agricultural sources remain highly uncertain. Current inventories of N_2O emissions from agriculture are mainly based on standard Tier 1 IPCC methodologies, which uses a default emission factor (1% of N inputs in upland systems on mineral soils) and agricultural census data on cropping area and fertilizer use. However, the assumption of a default EF has been questioned from its inception since it does not reflect underlying processes and the impact of management or environmental conditions. A particular concern is that a static EF assumes a linear relationship between N application rates and N_2O emissions, whereas for many fertilized cropping systems the relationship is non-linear. Consequently, the IPCC recommends the use of biogeochemical models (e.g. DayCent, LandscapeDNDC) as the preferred GHG inventory methodology (Tier 3), as it describes the overall N cycle within the land systems and integrates various driving factors (such as fertilizer application, atmospheric N deposition, and climate change) controlling soil N_2O production and emissions.

This project will use the biogeochemical model LandscapeDNDC to evaluate the trade-off between crop productivity, N fertilizer use, N leaching and GHG emissions of agricultural ecosystems in China and SE Asia. The successful candidate will compile N_2O inventories for China and SE Asia for present and future climate and land use/ land management scenarios. This will allow to predict feedbacks of global changes on yields, crop NUE, environmental N losses and N_2O emissions. Based on the

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scenarios the candidate will develop and test climate-smart management strategies at landscape to continental scales for a sustainable management of agricultural ecosystems to minimize their contribution to climate change and environmental N pollution with a clear focus on win-win solutions for economic and environmental benefits.

Description of existing or sought Chinese collaboration partner institute:

Since more than two decades IMK-IFU of KIT is closely cooperating with Chinese partner institutions on research questions related to the biosphere-atmosphere-hydrosphere exchange of GHG gases and N compounds and ecosystem N cycling. Cooperation with the Institute of Atmospheric Physics, Chinese Academy of Sciences, dates back for more than 30 years, but also tight research links have been established with other Chinese institutions such as the China Agricultural University (CAU), the Institute of Botany, Chinese Academy of Sciences, or the Institute of Mountain Hazards and Environment, Chinese Academy of sciences. Cooperation between IMK-IFU and Chinese research institutions have resulted in >100 publications and joined education of >30 PhD students and Post-Docs. With this call we want to continue and further extend our successful cooperation with Chinese research institutions.

Required qualification of the post-doc:

- PhD in geosciences, agricultural science, computer science or related fields
- Experience in crop/ecosystem modeling, high-performance computing and data assimilation/visualization
- Good knowledge of programing (C/C++, Fortran, SVN, Git, Python, R, Bash) and ability to work with large datasets
- Experience with spatial analysis and GIS approaches
- English language proficiency and proven ability to write scientific publications
- Strong communication and teamwork skills

PART B

Documents to be provided by the post-doc, necessary for an application to OCPC via a postdoc-station in China, which is affiliated to a research institution like a university:

- Detailed description of the interest in joining the project (motivation letter)
- Curriculum vitae, copies of degrees
- List of publications
- 2 letters of recommendation
- Proof of command of English language

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PART C

Additional requirements to be fulfilled by the post-doc:

- Max. age of 35 years
- PhD degree not older than 5 years
- Very good command of the English language
- Strong ability to work independently and in a team

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