Periodic Report Summary 2 - STRATOCLIM (Stratospheric and upper tropospheric processes for better climate predictions)

Project Context and Objectives:
Anthropogenic emissions of greenhouse gases (GHGs), aerosols and their precursors are all drivers of changes in Earth’s climate. Growing evidence indicates that changes in the chemical composition of the Upper Troposphere and Stratosphere (UTS) also play a key role in affecting surface climate. On a decadal timescale, there is strong evidence that variability in the UTS affects the troposphere and surface climate. The impact of changes in the UTS on surface climate is inextricably linked to many other components of the climate system. However, the representation of these components in current Chemical Climate Models (CCMs) and Earth System Models (ESMs) is still largely inadequate.

The overall goals of StratoClim are (a) to quantitatively assess the role of the UTS in climate change, and (b) to improve climate projections by developing and including within ESMs new, interactive modules for stratospheric aerosols and ozone and by improving our understanding of UTS water vapour variations and the representation of upper tropospheric clouds. To reach these overarching goals the objectives of StratoClim are: (1) to develop the scientific basis for including the climate relevant components of the UTS as interactive modules in ESMs, (2) to construct and implementing such modules, (3) to assess the UTS’s role in climate, and (4) to produce new and better climate model projections.

To achieve these goals StratoClim combines a large scale tropical aircraft campaign, longer-term operation of a tropical measurement station, (3) satellite data analysis including development of new satellite data products, (4) process and regional modelling, (5) global modelling with CCMs and ESMs, (6) studies of the socioeconomic Climate Change implications of the findings and stakeholder fora, expert panels and public outreach programs. Work will focus on two areas: (a) improving the understanding of the chemical and dynamical processes that determine the composition of the UTS and the formation, loss and redistribution of ozone, aerosol, water vapour and clouds, and how these processes will alter under climate change; (b) developing model tools that allow to fully include the interactive feedbacks from UTS ozone and aerosol on surface climate and use of these models to produce improved climate predictions.

Project Results:
The project has been mainly focusing on finalizing the preparation for the field activities and implementing modelling and socio-economic tasks.

From discussions with the government agencies on the Indian subcontinent it became clear already during the first reporting period, that submitting formal requests for flight and research permissions more than a year in advance would be inefficient. Hence, these requests were submitted during the second reporting period, Nagpur (India) being the main campaign base option, and the Arabic peninsula, including VAE, Oman and Saudi Arabia, Kathmandu (Nepal) and Muscat (Oman) being explored as secondary options. The development with permissions in India looked promising throughout the 2nd reporting period or until late spring 2016. In early June it became however clear that the political environment and many unexpected administrative constraints in Indian aviation authorities would not allow permissions to be obtained in due time for the main
aircraft campaign in July-August 2016. In order to rapidly respond to the situation, it was decided to split the aircraft activities into two separate campaign phases in European and Asian Monsoon locations in order to secure the fulfillment of STRATOCLIM scientific objectives. Following, the first phase aircraft campaign, concluding the instrument testing and measuring the outflow from the decaying anticyclone in the Asian Monsoon region was conducted in August-September 2016 in Kalamata, Greece. First quick look data products are now available, while data retrieval and analyses will continue during the rest of the project.

The setup of the tropical ground station on Palau took place during winter 2015 and regular FTIR and ozone sonde measurements with the modified ECC ozone sensor were conducted in an intense campaign in the first months of 2016. The measurements were continued throughout the spring in cooperation with Coral Reef Research Foundation, which is located permanently on Palau. Analysis of the data lead to the first measurement of the seasonal cycle of the tropospheric ozone abundance in the area of the West Pacific warm pool and will be used for constraining the modelling of the oxidizing capacity of the troposphere in this area.

Satellite data analyses has worked toward improved characterization of clouds and aerosols based on combining data from different sensors and will refine the retrieval of SO2 and sulfate from satellites. Near real time satellite data products were made available during the first phase aircraft campaign to support flight planning.

A fast chemical box model of tropospheric SO2 chemistry in the framework of the ATLAS model has been developed and deployed on backward trajectories from the stratosphere to the troposphere to examine the chemistry of SO2 and its transport to the stratosphere.

Potential Impact:

Even though the Asian Monsoon has been identified as one of the most important regions for transport of trace gases and aerosols to the stratosphere in general, and probably the most important region for transport of anthropogenic pollutants in particular (Randel et al., 2010), there have not been any major aircraft campaigns investigating the dynamical and chemical processes in this region. Thus, the StratoClim aircraft campaign represents a pioneering endeavour, and with the Geophysica being able to fly at all levels below, within and above the TTL carrying the most comprehensive suite of instruments measuring dynamical tracers, aerosol precursor gases and aerosol properties, it will help to answer many of the open questions on vertical transport and chemical processing in the Asian Monsoon.

The Climate service elements of StratoClim are expected to make an important contribution to the recently constituted Global Framework for Climate Services (GFCS) of the World Meteorological Organisation (WMO). StratoClim directly addresses the main goal of GFCS which is to enable better management of the risks of climate variability and change and adaptation to climate change, through the development and incorporation of science-based climate information and prediction into planning, policy and practice on the global, regional and national scale as articulate at the World Climate Conference-3. The model development and results of StratoClim will directly contribute to the Intergovernmental Panel on Climate Change (IPCC) and will become a major contribution to the ozone assessment process under the WMO and the United Nations Environment Program (UNEP) in the framework of the Montreal protocol. StratoClim also contributes to the priority objectives of the Proposal for a new EU Environment Action Programme to 2020 by improving the EU's effectiveness in addressing regional and global challenges related to the environment and climate change.

List of Websites:
www.stratoclim.org

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