SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year	2016
Project Title:	Ice-supersaturation and cirrus clouds and their feedbacks to tropopause dynamics
Computer Project Account:	SPDESPIC
Principal Investigator(s):	Prof. Dr. Peter Spichtinger (JGU Mainz) Dr. Klaus Gierens (DLR Oberpfaffenhofen)
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Name of ECMWF scientist(s) collaborating to the project (if applicable)	…… ……
Start date of the project:	February 2016
Expected end date:	December 2018

Computer resources allocated/used for the current year and the previous one
(if applicable)
Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	N/A	N/A	100 000	0
Data storage capacity	(Gbytes)	N/A	N/A	500	0

Summary of project objectives

(10 lines max)

We investigate ice supersaturation and cirrus clouds in the upper troposphere and their interaction with tropopause dynamics and radiation. We want to address the following research questions:

- What are the dominant formation mechanisms for ice crystals in the tropopause region under certain environmental conditions?
- What is the radiative impact of cirrus clouds in the tropopause region in terms of net contribution and vertical profiles of heating rates?
- How often does shallow cirrus convection occur and how does it determine exchange processes at the tropopause?
- How are enhanced water vapour and tropopause inversion layer correlated? What is the role of cirrus clouds for the tropopause inversion layer?

Summary of problems encountered (if any)

(20 lines max)

No problems encountered so far.

Summary of results of the current year (from July of previous year to June of current year)

This section should comprise 1 to 8 pages and can be replaced by a short summary plus an existing scientific report on the project

The project just started in February, thus there is not much progress.

1. Quality of ERA water vapour data

We used in situ water vapour measurements as obtained from the MOZAIC/IAGOS project. The MOZAIC data provide a good temporal and spatial coverage over some parts in the Northern hemisphere, especially over the North Atlantic region (http://www.iagos.org/).

In a first step we compared the water vapour measurements with the ERA water vapour fields. In order to have a reliable intercomparison we collect MOZAIC data in the respective ERA grid boxes. We compared relative humidity with respect to ice (RHi) as well as absolute humidity (water vapour mixing rations) and temperature measurements.

First results show that ERA water vapour data do not show realistic ice supersaturation. In fact, relative humidity usually does not exceed values RHi~120%, whereas MOZAIC data even on a coarse resolution frequently show values RHi>120%. Generally, there is a large scatter in the data. However, most data are centered around the 1-1-line in the scatter plot diagrams. A first zoom into the data shows that structures might be shifted in the different data sets. For instance, analysis along single flight tracks showed that features of high or even low relative humidity are represented with a spatial shift. We will further investigate these data, using statistical methods and other techniques for data evaluations.

2. Case studies on ice clouds and ice supersaturation over Northern Germany

During two aircraft campaigns in spring and autumn 2013 several situations of ice supersaturated regions (ISSRs) and cirrus clouds were investigated. For a better understanding of the processes of formation and evolution of ISSRs and cirrus clouds we use trajectory calculations and large eddy simulations.

For each case in the measurement campaign (ca. 8 relevant measurement flitghts) ECMWF analysis and 3 hourly forecasts were used as input for the trajectory tool LAGRANTO. The trajectories were started along the flight track of the aircraft and calculated backwards time in order to investigate the dynamical situation and especially vertical motions in the upper troposphere. Along these trajectories boxmodel calculations were carried out in order to investigate the onset of nucleation and the formation and evolution of the ice clouds. In addition the estimated mean vertical updrafts together with temperature and humidity data from ECMWF operational analyses were used to run the large eddy simulation model EULAG together with a detailed ice microphysics.

Currently, these model simulations were evaluated. First results show a very rare case of an ice nucleation event, which was measured by the aircraft. The measurements are consistent with the dynamic large scale situations as obtained from ECMWF analyses and the formation could be resimulated using the model EULAG. Other cases are currently evaluated in details.

3. Tropopause dynamics, water vapour and ice clouds

We used few days in May 2015 from ECMWF operational analyses for investigating the relation between the so-called tropopause inversion layer (TIL) and water vapour in the tropopause region. First investigations show that the TIL is very strong at occurrence of high relative humidities in the tropopause region and, in contrast, is quite wweak at dry conditions. We will investigate this correlation in more details in future, since the interaction between these two “features” is not clear at all. Former investigations claimed a correlation between TIL and water vapout mixing rations but not relative humidity.

List of publications/reports from the project with complete references

N/A

Summary of plans for the continuation of the project

(10 lines max)

- Extension of case studies (combination of ECMWF data and in situ measurements)
- Further assessment of water vapour and cloud variables in ERA data using MOZAIC data
- Investigation of horizontal/vertical extensions of ISSRs and ice clouds using ERA data
- Investigations on the interaction between tropopause dynamics and ice clouds at case studies, as derived from ECMWF analysis data
- Model simulations with EULAG for certain idealized situations
- Radiative transfer calculations for clouds as extracted from ECMWF analysis/reanalysis data