SPECIAL PROJECT PROGRESS REPORT

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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:	Diabatic effects in mid-latitude weather systems
Computer Project Account:	SPCHBOJO……………………………………..……
Principal Investigator(s):	Maxi Boettcher and Hanna Joos
Affiliation:	ETH Zurich
Name of ECMWF scientist(s) collaborating to the project (if applicable)	Dr. Richard Forbes
Start date of the project:	2015
Expected end date:	2017

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)	90 000	7152	70000	0
Data storage capacity	(Gbytes)	3000		5000	

Summary of project objectives

(10 lines max)

The project focusses on the various microphysical heating rates which have an impact on the dynamics of weather systems. With our special model version of the IFS we are able to relate heating rates and hence PV rates to single microphysical processes. Via a Lagrangian approach, air parcels which experience a diabatic PV modification will be traced in e.g. extratropical cyclones, diabatic Rossby-waves, or blocking situations and so, the influence of microphysical processes on the dynamics of these systems can be determined. Furthermore, the IFS will be applied to cases which will been sampled in the aircraft measurement campaign NAWDEX which will take place in autumn 2016. The aim is to identify microphysical active regions where model and measurements do not coincide.

Summary of problems encountered (if any)

(20 lines max)

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

In the framework of SPCHBOJO we worked on two different projects:

1)

The influence of microphysical processes on the upper level flow features associated with an extra-tropical cyclone is investigated with the ECMWF global atmospheric model. A control simulation and a simulation with changes in the microphysical parametrisations are compared in detail. The influence on the upper-level ridge building and the downstream flow evolution is investigated. It can be shown that while the main characteristics of the warm conveyor belt (WCB) are very similar in both simulations, the changes in the microphysical parametrisation lead to differences in the position of the warm conveyor belt (WCB) outflow. Therefore differences occur in the location of the tropopause in both simulations which leads to distinct differences in the upper level PV pattern. The results highlight the importance for a correct representation of microphysical processes for large-scale flow features and the need for detailed microphysical measurements in extra-tropical cyclones in order to better understand and constrain the microphysical processes in NWP models.

This work has been accepted for publication (Joos and Forbes, 2016; see below)

2)

A case study of a diabatic Rossby wave (DRW) with the associated airstreams which occurred in January 2013 in the North Atlantic has been simulated with the special version of the IFS which allows for hourly output of all microphysical heating rates (provided by Richard Forbes). Cloud microphysical processes in these airstreams provide a significant source of latent heating and cooling that affect the dynamics of the DRW in terms of moist-diabatic PV modification. Lagrangian and Eulerian analysis show, that a strong gradient of latent heating is produced by a mid-tropospheric heating maximum due to in-cloud condensation and convection and by a below-cloud cooling region due to evaporation of rain. This heating gradient and the associated modification of PV ensures for the continuous re-generation and rapid downstream propagation of the DRW's low-level PV anomaly.

This work is in preparation for submission to the Quarterly Journal of the Royal Meteorological Society (see below)

List of publications/reports from the project with complete references

Joos H. and Forbes, R., 2016: Impact of different IFS microphysics on a warm conveyor belt and the downstream flow evolution, accepted for publication in QJRMS

Steinfeld, D., Boettcher, M., Joos, H., Forbes, R. and Martius, O., 2016: The Impact of Microphysical Processes on the Potential Vorticity in a Diabatic Rossby Wave, in preparation for the submission to QJRMS

Summary of plans for the continuation of the project

(10 lines max)

We will use our special IFS version in two PhD projects.

In the first project, which started in March 2016, Daniel Steinfeld is working on case studies of diabatic effects on blocking events.
Recent research based on trajectory calculations has shown that diabatically driven ascent from lower levels can contribute in a substantial way to the formation of blocking anticyclones at upper levels. Here the causal link between latent heat release and blocking formation as well as the impact of this process on blocking predictability will be investigated in 8-10 case studies. In a first part, re-forecast simulations of the blocking events with different lead times (3-10 days) will be performed. Backward trajectories from the blocking regions will be calculated, and the contributions of diabatic trajectories will be compared to a similar analysis based on ERA-Interim reanalysis data. We will then evaluate potential linkages between errors in the representation of such diabatic contributions and forecast errors during the blocking life-cycle. In a second part, IFS sensitivity experiments will be performed for a subset of 3-4 selected blocking events in which the latent heat release during cloud formation will be artificially modified. The altered latent heating will be confined to specific regions and time periods in order to separately evaluate its effect on blocking onset, maintenance and decay.

In a second project, starting on 15 September 2016, Roman Attinger will investigate what cloud types (warm, mixed phase, ice) evolve during the life cycle of different weather systems and how relevant they are for the underlying dynamics. He will thus investigate in detail which microphysical and radiative processes are most important for the formation of potential vorticity (PV) anomalies (negative and positive) occuring in extratropical cyclones and blockings. Therefore, a Lagrangian analysis will be used where backward trajectories are calculated from the identified PV anomalies. The contribution of each microphysical process to the PV modification is then evaluated along the trajectories. This technique will be applied to selected cases of cyclones and blockings. For this project we will also use our special IFS version which allows for hourly output of all microphysical heating rates.