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 2014

Project Title: Diabatic effects in mid-latitude weather systems

Computer Project Account: SPCHBOJO

Principal Investigator(s): Hanna Joos and Maxi Boettcher

Affiliation: ETH Zurich

Name of ECMWF scientist(s) collaborating to the project (if applicable) Dr. Richard Forbes

Start date of the project: March 2012

Expected end date: December 2014

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

		Previous year		Current year (2013)	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	70000	51143	70000	4788
Data storage capacity	(Gbytes)	3000		3000	

Summary of project objectives

(10 lines max)

The project aims at investigation of diabatic processes in extratropical cyclones, in particular in strongly ascending air masses which are called warm conveyor belts (WCBs). Latent heating related to cloud-microphysical processes during the WCB ascent lead to a characteristic potential vorticity (PV) structure. The resulting high PV in low to mid troposphere levels and low PV in the outflow in the tropopause region can have an impact on the surface cyclone intensification as well as on the upper-level waves downstream of the cyclone.
In part 1 of the project the contributions from the various cloud-microphysical processes acting as sources and sinks for PV are evaluated. Case studies are performed to estimate the importance of these processes for the WCB ascent. Part 2 investigates the dynamics of the WCB by artificial moisture modification in the low-level inflow which is hypothesized to determine the WCB ascent.

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

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In the 1st part of the project the WCB case which was studied by Joos and Wernli (2012) has been simulated with the IFS for comparison with the results from the COSMO model. In contrast to the study which was presented at the Workshop on Parametrization of Clouds and Precipitation across Model Resolutions, 5-8 Nov 2012, ECMWF, Reading, the latest operational model version cy40r1 is used as well as a IFS version with improved microphysics provided by Richard Forbes (ECMWF). Based on the IFS model output, trajectories were calculated and the most strongly ascending air masses are selected in order to represent the WCB. Along the WCB trajectories, the various cloud species, the related heating rates due to the phase transition between them and the corresponding PV rates are traced along the WCB. With this method it becomes obvious that the air masses experience various microphysical processes during their strong ascent and that the total potential vorticity (PV) modification is a complex interaction between the different microphysical processes. The comparison between the different IFS model versions and COSMO show significant differences. Although the overall heating along the WCB trajectories is similar for all simulations, strong differences occur in the partitioning of the heating between the microphysical processes. The associated diabatic PV modification therefore differs notably, leading to remarkable differences in the PV field which can have an impact on the cyclone development and the influence of the WCB on the upper level PV pattern and downstream flow evolution. The results of this work will be presented at the WWOSC 2014 conference in Montreal Canada.

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For the 2nd part of the project the WCB of the T-Nawdex-Falcon aircraft campaign in IOP 2 has been used for investigation and experiments. The campaign took place in October 2012 over central Europe and the western Mediterranean. The investigations were performed with a combined model version which allows for additional heating rates output and artificial moisture modification.
Related to the investigations in project part 1 the micropysical heating rates and the corresponding PV modification of this WCB has been analysed for the control run and experiments. The experiments comprised the artificial moisture reduction and addition in the WCB inflow prior to the strong ascent. The box defined for the modifications extends from the surface to the top of the boundary layer. With this experiment the WCB ascent could not be disturbed since ocean evaporation and boundary layer processes have been triggered which restored the moisture budged too fast. To some extend this behaviour of the model might be related to the unstable and hence convective inflow region over the Mediterranean. The results have been presented at the Cyclone Workshop 2013 in Canada. The setting of the experiment gave further ideas to successfully perform future experiments.

List of publications/reports from the project with complete references

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Summary of plans for the continuation of the project

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To continue with the ongoing investigations two master thesis projects are planned for the next autumn semester. One thesis which will be performed by Daniel Steinfeld investigates the PV modification by microphysical processes in diabatic Rossby-waves (DRW). The PV production is the essential part of the self-maintaining DRW mechanism. It is not clear so far which processes in detail act as PV sources and sinks. The student will investigate 1-2 DRW cases which are re-forecast with the special heating rates version of the IFS. The other master thesis by Andrè Piquerez will further investigate the factors determining the WCB ascent by experiments with low-level moisture (and modified SST). Adapted to the findings of Schäfler et al. (2011) and Schäfler and Harnisch (2014) which performed Lidar measurements and found moisture biases in WCB inflows in the ECMWF model the artificial moisture modification experiments will be restarted and investigated.

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