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 2013

Project Title: Support Tool for HALO Missions

Computer Project Account: SPDEHALO

Principal Investigator(s): Dr. Andreas Dörnbrack
Marc Rautenhaus
Dr. Andreas Schäfler

Affiliation: DLR Oberpfaffenhofen,
Institut für Physik der Atmosphäre

Name of ECMWF scientist(s) collaborating to the project (if applicable) ……

……

Start date of the project: 2012

Expected end date: 2015

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)	50000	50000	50000	0
Data storage capacity	(Gbytes)	80	80	80	0

Summary of project objectives

(10 lines max)

High-quality meteorological forecast and analysis products are essential for the successful planning and evaluation of airborne measurements. The novel and outstanding research possibilities offered by the German High Altitude and Long Range (HALO) research aircraft dedicated for atmospheric and geophysical research prompt the development of an innovative instrument in support of HALO missions. This special project is dedicated to access ECMWF's meteorological forecast and analysis products for developing and deploying such a mission support tool.

Summary of problems encountered

none

Summary of results of the current year

(1) HALO aircraft missions 2013/2014

Due to the long-lasting and complicated certifications of diverse instruments, only one HALO aircraft mission -- called NARVAL[1] -- took place at the end of the year 2013. For this mission, the Mission Support System was only used via the web site http://www.pa.op.dlr.de/missionsupport/classic/forecasts/ where standardized products of the IFS high-resolution prediction were displayed. Extensive use of the interactive Mission Support System was made during the ML-CIRRUS[2] campaign in March 2014. Furthermore, the usage of the interactive planning tool was explored during the GW-LCYCLE Falcon mission in December 2013.

(2) **GW-LCYCLE aircraft mission 2013**

The challenge of the Arctic mission "Investigation of the life cycle of gravity waves" (GW-LCYCLE) was to predict gravity waves (GW) excited by the flow over the Scandinavian mountain range at stratospheric and mesospheric altitudes. GW-LCYCLE is part of the German project ROMIC (Role of the Middle Atmosphere in Climate) funded by the ministry of research. In GW-LCYCLE, we investigate the excitation, propagation and dissipation of GW in the whole atmosphere to enhance the knowledge of the sources and the dissipation of gravity wave in the upper atmosphere. The ultimate goal of GW-LCYCLE is to deliver data

[1] http://www.mpimet.mpg.de/nc/communication/news/single-news/article/erster-messflug-forschungsflugzeug-halo-durchleuchtet-passatbewoelkung.html

[2] http://www.pa.op.dlr.de/ML-CIRRUS/

sets used for the improvement of GW parameterizations in NWP models and GCMs. Especially; we seek further advances in quantifying:

- wave sources and the impact of the ambient atmospheric conditions on their capability to launch propagating GWs effectively
- the GW propagation to the middle atmosphere in response to the ambient wind and thermal conditions
- the response of the ambient, large-scale flow to the deposition of momentum by breaking gravity waves, and to test
- the reliability of predictions of GWs (sources, propagation, upper atmosphere) by current state-of-the-art NWP models.

During the campaign, we were focussing on meteorological situations as illustrated in Fig.1:

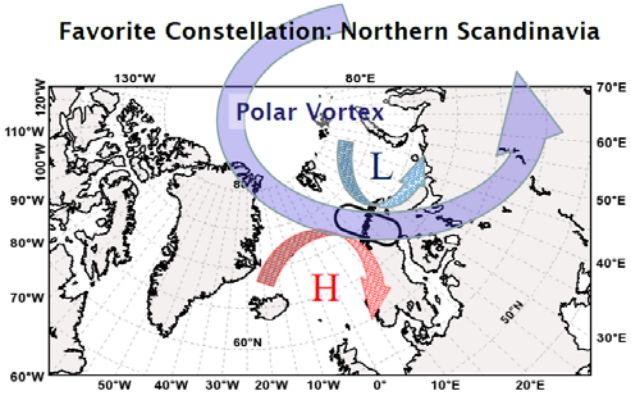

Fig.1: Flow pattern over northern Scandinavia conducive to deep gravity propagation. The large blue arrow marks the polar vortex, the smaller ones the tropospheric low and high pressure systems.

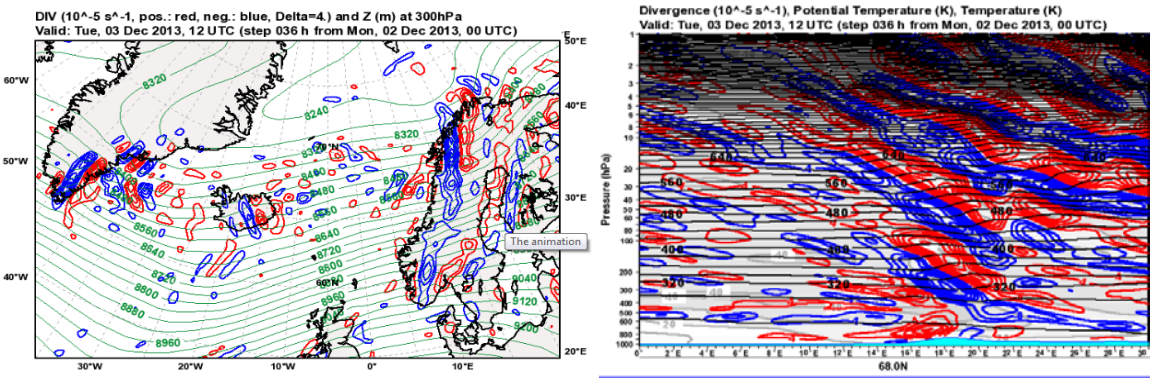

Fig.2: Horizontal divergence at 300 hPa (flight level of the Falcon research aircraft) and a vertical section along the flight track reaching up to 1 hPa altitude. The pictures show the deep vertical propagation of gravity waves excited by the flow across the Scandinavian Alps.

The research flights were planned according to ECMWF forecasts which cover an altitude range from the

Earth surface up to 1 hPa, see Fig.2. In addition to the high-resolution deterministic forecasts of the ECMWF's IFS, mesoscale foecasts driven by the EC model were performed operationally during the campaign and afterwards as hindcasts. Fig. 3. shows an exemplary comparison of the flight lvel wind measurments with the mesoscale forecasts.

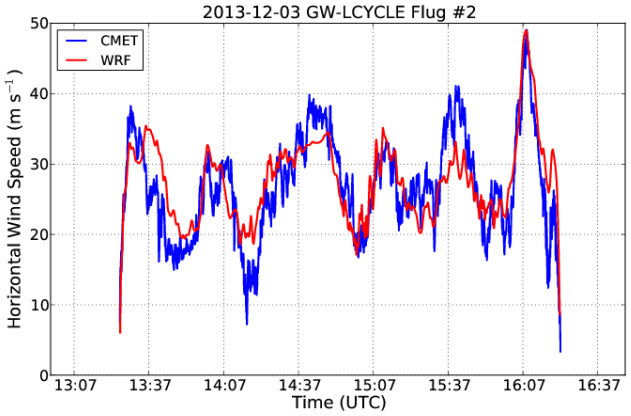

Fig.3: Horizontal wind at flight level as measured from the aircraft (blue line) and the numerical results obtained by mesoscale numerical simulations using the WRF model along a flight track crossing the Scandinavian Alps.

List of publications/reports from the project with complete references

Jurkat, T., C. Voigt, S. Kaufmann, A. Zahn, M. Sprenger, P. Hoor, A. Dörnbrack, H. Schlager, H. Bönisch and A. Engel, 2014: A quantitative analysis of stratospheric O3 and HNO3 in the tropopause region near the subtropical jet, *Geophys. Res. Letters*, submitted 28 December 2013, accepted April 2014

Rautenhaus, M., A. Schäfler, C. M. Grams, and R. Westermann, 2014: GPU based interactive 3D visualization of ECMWF ensemble forecasts, ECMWF Newsletter **No. 138** – Winter 2013/2014, 34-38.

Schäfler, A., M. Boettcher, C.M. Grams, M. Rautenhaus, H. Sodemann & H. Wernli, 2014: Planning of aircraft measurements within a warm conveyor belt.*Accepted by Weather*.

Summary of plans for the continuation of the project

We will accompany the upcoming HALO field campaigns ACCRIDICON planned for autumn 2014 and will test the newly developed Mission Support System.

Further research on the MSS will consider investigating visualisation and data mining questions, with the objective of making the process of exploring the large amounts of prediction data that have to be handled during a campaign more efficient. It would be interesting, for example, to automatically track features of interest to the flight planner or to visualise information about prediction uncertainty. With the on-going development of the WMS standard within the OGC and upcoming related developments, interoperability to third-party providers will improve in the future.

Additionally, advanced functionality may be added to the MSS with little effort. The WMS approach will also be well suited to make new forecast and observation data accessible on-board the HALO aircraft. This will be useful to provide updated information to the aircraft crew during long-range flights.