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 2015

Project Title: Atmospheric waves in the middle atmosphere measured by the ALIMA lidar onboard the research aircraft HALO

Computer Project Account: SPDEKAIF

Principal Investigator(s): Bernd Kaifler

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

Start date of the project: 2014

Expected end date: 2016

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)	100000	0	100000	0
Data storage capacity	(Gbytes)	40	0	40	0

The data used in in the current year for this special project was retrieved by A. Dörnbrack (SPDESCAN) as part of a collaboration on the DEEPWAVE campaign.

Summary of project objectives
(10 lines max)

The objective of the project is to study atmospheric waves using the ALIMA instrument (short for Airborne LIDAR for the Middle Atmosphere). The lidar will measure atmospheric density, temperature and disturbances caused by atmospheric waves between 10 and 120 km using different scattering mechanisms. A prototype for the new instrument will be built and tested on ground before ALIMA is certified for operations on the research aircraft HALO. Atmospheric gravity waves are excited near ground level, e.g. by flow over mountains and propagate throughout the atmosphere up to thermospheric altitudes (> 100 km). Gravity waves interact with the background flow by convective or dynamic instabilities and are subject to selective filtering. They contribute significantly to the energy budget of the atmosphere and play a major role in the vertical coupling of the atmosphere.

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

The Temperature Lidar for research of the Middle Atmosphere (TELMA), developed as prototype for the ALIMA lidar, was part of the international Deep Propagating Wave Experiment (DEEPWAVE, Fritts et al., 2015). Between June and November 2014, a large dataset was acquired at NIWA's station at Lauder, New Zealand. From temperature measurements in the stratosphere and mesosphere (22 to 85 km), temperature perturbations caused by gravity waves are extracted using a polynomial filtering technique. The highest resolution is 10 min x 900 m.

For comparison with the DEEPWAVE lidar and radiosonde dataset obtained at Lauder, temperature data from one hourly predictions of ECMWFs integrated forecast system were retrieved for the location of Lauder. During events of strong orographic forcing, high-amplitude quasi-stationary waves (mountain waves) in the lower stratosphere were observed with the lidar instrument. The same gravity wave filtering technique was applied to lidar data as well as ECMWF temperature data. Temperature perturbations of both lidar and ECMWF model data were found to match very well between 25 and ~65 km. Results were presented by Dörnbrack et al., 2014. Two figures are reproduced in Fig. 1 and Fig. 2.

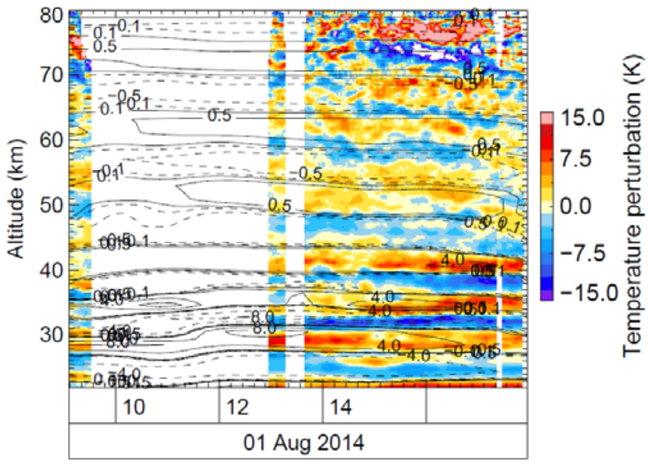

Fig. 1: Temperature perturbation obtained by the TELMA lidar at Lauder, New Zealand (color) and calculated from one hourly ECMWF temperature data at Lauder (contour).

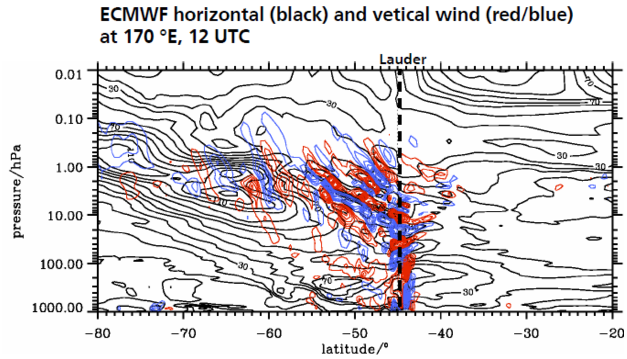

Fig. 2 Mountain wave excitation in New Zealand visible in a longitude section of ECMWF winds (courtesy A. Dörnbrack)

Stratospheric mountain waves are thought to be excited by strong orographic flow over New Zealands Southern Alps. To test this hypothesis, stratospheric gravity wave activity in general, and the mountain wave activity in particular, were compared to tropospheric horizontal winds perpendicular to the mountain range (Fig. 3, from Kaifler et al., 2015). ECMWF horizontal winds were retrieved for the location of Lauder and a location upstream approximately 50 km off the coast of New Zealand. Atmospheric conditions for the transmission of excited gravity waves were assessed by means of the wind vector rotation of the horizontal wind at each altitude. A correlation between the horizontal wind component perpendicular to the Southern Alps at 1 km and 12 km altitude and stratospheric gravity and mountain wave activity was found. These results are currently being prepared for publication.

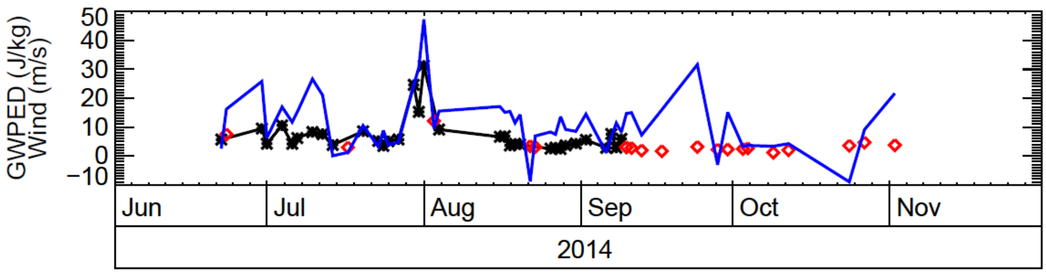

Fig. 3: Time series of (blue) ECMWF horizontal wind component at 12 km altitude and (black/red) stratospheric gravity wave activity. Red symbols denote dates when gravity waves are expected to be filtered below 30 km due to rotation of the horizontal wind vector.

List of publications/reports from the project with complete references

(1) Fritts, D. C., R. B. Smith, M. J. Taylor, J. D. Doyle, S. D. Eckermann, A. Drnbrack, M. Rapp, B. P. Williams, P.-D. Pautet, K. Bossert, N. R. Criddle, C. A. Reynolds, P. A. Reinecke, M. Uddstrom, M. J. Revell, R. Turner, B. Kaifler, J. S. Wagner, T. Mixa, C. G. Kruse, A. D. Nugent, C. D. Watson, S. Gisinger, S. M. Smith, R. S. Lieberman, B. Laughman, J. J. Moore, W. O. Brown, J. A. Haggerty, A. Rockwell, G. J. Stossmeister, S. F. Williams, G. Hernandez, D. J. Murphy, A. R. Klekociuk, and I. M. Reid, The Deep Propagating Gravity Wave Experiment (DEEPWAVE): An Airborne and Ground-Based Exploration of Gravity Wave Propagation and Effects from their Sources throughout the Lower and Middle Atmosphere, Bulletin of the American Meteorological Society, accepted, 2015.

(2) Dörnbrack, A., Rapp, M., Gisinger, S., Kaifler, B., Kaifler, N., Ehard, B., Doyle, J.D., Eckermann,S.D., Fritts, D.C., Smith, R.B., Taylor, M.J., Uddstrom, M., Large-scale atmospheric conditions during DEEPWAVE-NZ, American Geophysical Union, Fall Meeting 2014, abstract #SA31B-4099, 2014.

(3) Kaifler, B., Kaifler, N., Ehard, B., Dörnbrack, A., Gisinger, S., Rapp, M., Thermische Struktur und Schwerewellen in der mittleren Atmosphäre über Neuseeland. DPG-Frühjahrstagung, 9.-13. March 2015, Wuppertal.

Summary of plans for the continuation of the project

(10 lines max)

The Rayleigh lidar is currently back at Oberpaffenhofen and is being prepared for upcoming campaigns in Scandinavia. Analysis of the DEEPWAVE data will continue. The ALIMA instrument will be integrated and certified for operation on the research aircraft HALO.