REQUEST FOR A SPECIAL PROJECT 2015–2017

MEMBER STATE: GERMANY

Principal Investigator[1]: Dr. Andreas Dörnbrack

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Andreas Schäfler

Project Title: Mission Support System for HALO research flights

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP**DEHALO	
Starting year: (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2015	
Would you accept support for 1 year only, if necessary?	YES ☐	NO ☒

Computer resources required for 2015-2017: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2017.)	**2015**	**2016**	**2017**
High Performance Computing Facility (units)	100000	100000	100000
Data storage capacity (total archive volume) (gigabytes)	80	80	80

*An electronic copy of this form **must be sent** via e-mail to:* *special_projects@ecmwf.int*

Electronic copy of the form sent on (please specify date): 30 June 2014

Continue overleaf

[1] The Principal Investigator will act as contact person for this Special Project and, in particular, will be asked to register the project, provide an annual progress report of the project's activities, etc.

Principal Investigator: Dr. Andreas Dörnbrack

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Extended abstract
Mission Support System for HALO research flights

This special project is dedicated to assist activities that support research missions with the German research aircraft HALO (High Altitude and Long Range Research Aircraft)[2]. The activities include the ongoing development of further software components for flight planning, research in visualisation of numerical weather predictions, and the deployment of developed modules during HALO-based field experiments. The project builds on work performed in the context of the existing special project SPDEHALO.

After a long-lasting period of complicated certification work, HALO is now in a yearly schedule to conduct at least two large field campaigns for atmospheric research per year. During the current year, HALO flew for NARVAL and ML-CIRRUS and will be deployed during the ACRIDICON campaign in autumn. During the past missions, it became clear that the extensive possibilities offered by HALO require novel strategies for flight planning and flight operation.

The research aircraft HALO exceeds many capabilities of currently available research aircraft in Germany and Europe. Its maximum payload of 3 tons allows the simultaneous operation of a multitude of instruments. Combined with flight altitudes of up to 14 km and a horizontal range of more than 10000 km, a variety of mission objectives in a single flight can be achieved. To carry out successful research flights, thorough flight planning is as essential as the aircraft with its instruments itself, see Rautenhaus et al. 2012.

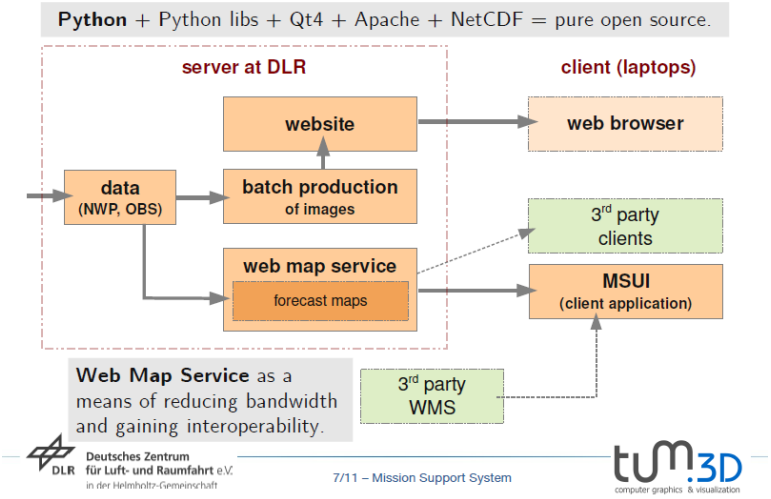

Fig. 1: Conceptual design of the Mission Support System developed in collaboration between the DLR and the Technical University of Munich.

During the preceding project period, we have refined our software infrastructure that provides web-service based access to plan views and vertical cross-sections of ECMWF forecast products. As layout in Fig. 1, the mission support system essentially consists of two components, the website containing predefined products which are tailored for each research mission. This web page

[2] http://www.halo.dlr.de

provides access to standard 2D visualisations and serves as a communication platform during the campaign. The other component is the mission support system user interface (MSUI). The MSUI allows the user interactively plan a flight route in relation to the forecasts, including flight performance computations, see Figure 2.

This software, the Mission Support System, is designed as a distributed system with interfaces based on the OGC[3] Web Map Service (WMS), the user interface MSUI and WMS server implemented in the open-source Python programming language. In some parts of the system, the ECMWF software packages Metview and Magics++ are used for visualisation.

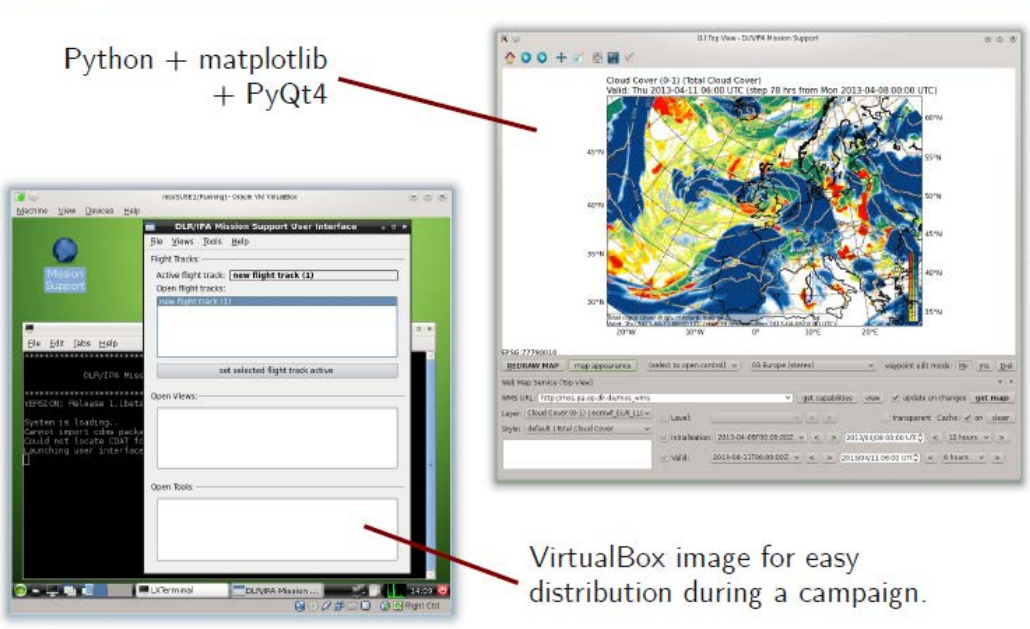

Fig. 2: The Mission Support System User Interface.

We request the present special project to continue research on the development and deployment of the system. The continuing access to ECMWF's meteorological forecast and analysis products will enable us to adapt the software to the requirements of future research aircraft campaigns and, due to ECMWF's global coverage, to deploy the system during campaigns all over the world. In respect of research and development, a focus will be put on novel visualisation methods for ECMWF forecasts that are suitable for the demands of research flight planning, see the article of Rautenhaus et al. in the ECMWF newsletter for winter 2013/2014. Here, we are particularly interested in exploiting the uncertainty information provided by the Ensemble Prediction System when planning flights several days in advance. Regarding our research, we will continue and strengthen our collaboration with the ECMWF visualisation group that was initiated during the existing SPDEHALO project.

Specific tasks of the proposed project will be:

- Access to the meteorological archive of the ECMWF and to the sensible forecast data before and during the respective HALO campaign, in order to adapt the Mission Support System to the campaign and to provide forecasts during the mission.

- Conduction of runs with the ECMWF Integrated Forecast System in support of particular flight missions to provide meteorological data with higher temporal resolution (only in the hindcast mode).

[3] Open Geospatial Consortium: http://www.opengeospatial.org

- Usage of the ECMWF deterministic and EPS prediction data to develop novel visualisation methods, focussing on three-dimensional techniques and uncertainties.

- Continuation of the collaboration with the ECMWF visualisation group with respect to our research work and in using MetView and Magics++ within the Mission Support System.

Forecasts from the ECMWF have become an integral part of aircraft-based field experiments at DLR. With this project, the support of future HALO campaigns with global atmospheric predictions will be ensured.

References

Rautenhaus, M., Bauer, G., and Dörnbrack, A., 2012: A web service based tool to plan atmospheric research flights, *Geosci. Model Dev.*, **5**, 55-71, doi:10.5194/gmd-5-55-2012, 2012.

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.

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