REQUEST FOR A SPECIAL PROJECT 2012–2014

MEMBER STATE: United Kingdom.....

Principal Investigator[1]: Dr. Gregor C. Leckebusch

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Project Title: Investigation of large scale precursor conditions for extreme cyclone development in the extra-tropics

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** _____	
Starting year: (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2012	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for 2012-2014: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2014.)	**2012**	**2013**	**2014**
High Performance Computing Facility (units)	5000	5000	5000
Data storage capacity (total archive volume) (gigabytes)	2000	2000	2000

*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): .....

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.

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Extended abstract

This project aims at the investigation and diagnosis of severe storm events in different geographical regions of the earth. Several kinds of dynamical systems are highly affecting social and technical infrastructures and for a proper risk assessment analysis the estimation of wind storm related risks for e.g. Europe or other wind storm affected regions is of crucial interest. Thus, this project addresses extreme Polar Lows, severe mid-latitude winter storms, and tropical cyclones. Basically, studies on (historical) wind storms suffer from a lag of comparable knowledge about meteorological conditions responsible also for the storm developments and thus for related impacts.
Consequently, studies to the main physical processes for the generation and transition to severe storms are performed in order to estimate their risk of occurrence for different regions over Europe, the northern oceans, and the tropics. In the project key circulation patterns will be identified and related to their physical origins with respect to different characteristics of polar, extra-tropical, and tropical storm events (e.g. size, area of maximum destructive wind speed, maximum wind gusts, rate of intensification, etc.). Responsible large to synoptic scale precursor parameters (e.g. baroclinicity, latent heat release, upper-tropospheric divergence) will be related to the occurrence of extreme cyclones (e.g. Ulbrich et al., 2001). In this research area, integrating the existing knowledge of understanding for the occurrence of extreme storms, also potential storm situations will be investigated by use of the storms included in the Ensemble Prediction System (EPS) of the European centre for medium range weather forecast (ECMWF). Basis for the relevant storm identification will be the storm identification algorithm developed by Leckebusch et al. (2008, 2011). In principle, the project will address three main types of systems:

A) Polar Lows

Polar lows originate over open waters of the northern polar region due to high local baroclinicity, and/or katabatic outflow from ice covered land areas, especially at ice edges, and do have severe impact on the maritime activities in the Arctic Ocean. Additionally, they contribute to the energy transport to higher latitudes. Beside the actual difficulties in forecasting this meso-scale meteorological phenomenon, information derived from climatological observations remains also spare. Actual studies often make use of satellite based information by a manual analysis of available data for certain periods. With the wind storm identification algorithm (cf. above) an objective detection also of these small scale atmospheric vortices is possible in suitable re-analysis data. An assessment and of interannual variability and possible linear trends will be planned here.

B)Mid-latitude extreme cyclones and cyclone development

Cyclones and their developments leading to storms will be investigated in a more detailed way. Especially, this includes analyses of the typical characteristics of storms, e.g. the investigation of the development of the cyclones with respect to path velocities, spatial extension, time duration, intensity (Laplace p, wind speed) in reanalysis and ECMWF EPS data for present day conditions. In order to achieve a more homogeneous classification of the characteristics of different wind storms a Storm Severity Index (SSI) as developed in Leckebusch et al. (2008), will be applied. Additionally, investigations to the relationship between large/synoptic scale cyclone systems and local wind speeds, including the identification of the link between cyclone tracks and wind speed tracks (Leckebusch et al., 2006a; Nissen et al., 2010), will be carried out.

Potential wind storm situations will also be identified based on the ECMWF Ensembles prediction system in order to increase the statistical basic ensemble of extreme situations. Results from this investigation will lead to the production of maps of probabilities (risk) for the occurrence of extreme cyclone events (producing windstorms) over Europe identifying sensitive regions.
Large-scale fields influencing cyclones and storms will be analysed. Based on ECMWF ensemble forecasts, ERA40 data (analyses + forecasts), and GCM data from IPCC 4AR investigations of the role of different large scale (dynamic) parameters like baroclinicity (Eady parameter), latent heat release, upper tropospheric divergence, relevant terms of the Lorenz energy cycle (local energy transformations) and how they influence the path, duration, intensity and spatial extent of extreme cyclones will be carried out. Estimations of a typical time lag between relevant atmospheric conditions and the occurrence of extremes will be deduced.
Further on, in the North Atlantic region, high cyclone rates are often associated with strong jet streams [i.e., positive phase of the North Atlantic Oscillation (NAO)] and NAO has traditionally been regarded as the principal large-scale pattern that explains the variation in the rate of cyclones arriving in western Europe on decadal as well as seasonal scales (Renggli et al., 2011). Variability in the NAO will be linked to the occurrence of extreme cyclone systems over the Northeast Atlantic and Europe and investigated with respect to the work planned on seasonal to decadal timescales (Leckebusch et al., 2006b, Pinto et al., 2008).

C) Tropical cyclone systems

At third, first test have demonstrated that the objective assessment of tropical cyclones is also possible with the wind-tracking method. By means of this diagnostic tool, characteristics of tropical vortices can be deduced, like effective radius, affected area, travel speed, etc. This studies will help to objectively identify spatial and time based variability pattern in tropical cyclone activity.

4.) References

Leckebusch, G.C., B. Koffi, U. Ulbrich, J.G. Pinto, T. Spangehl, S. Zacharias, 2006: Analysis of frequency and intensity of European winter storm events from a multi-model perspective, at synoptic and regional scales. Climate Research, Vol. 31, 59-74.

Leckebusch, G.C., T. Kruschke, D. Renggli, P. Lorenz, T. Pardowitz, and J. Grieger, 2011: Application and further development of an objective wind storm identification and tracking algorithm for different latitudes. In preparation.

Leckebusch, G.C., D. Renggli, and U. Ulbrich, 2008: Development and Application of an Objective Storm Severity Measure for the Northeast Atlantic Region. Meteorol. Z., Vol. 17, No. 5, 575-587. DOI: 10.1127/0941-2948/2008/0323.

Leckebusch, G.C., S. Zacharias, J.G. Pinto, U. Ulbrich, A.H. Fink, 2006: Factors for the development of extreme north Atlantic cyclones and their relationship with a high frequency NAO index. Second THORPEX International Science Symposium (STISS), Landshut, 4.-8.12.2006. WMO/TD No. 1355, WWRP/THORPEX No. 7, 200 – 201.

Palmer, T.N., A. Alessandri, U. Andersen, P. Cantelaube, M. Davey, P. Délécluse, M. Déqué, E. Díez, F.J. Doblas-Reyes, H. Feddersen, R. Graham, S. Gualdi, J.-F. Guérémy, R. Hagedorn, M. Hoshen, N. Keenlyside, M. Latif, A. Lazar, E. Maisonnave, V. Marletto, A. P. Morse, B. Orfila, P. Rogel, J.-M. Terres, M. C. Thomson, 2004. Development of a European multi-model ensemble system for seasonal to inter-annual prediction (DEMETER). Bulletin of the American Meteorological Society, 85, 853-872

Pinto, J.G., S. Zacharias, A.H. Fink, G.C. Leckebusch, U. Ulbrich, 2008: Factors contributing to the development of extreme North Atlantic cyclones and their relationship with the NAO. Clim. Dyn., DOI 10.1007/s00382-008-0396-4.

Ulbrich, U., A.H. Fink, M. Klawa and J.G. Pinto, 2001: Three extreme storms over Europe in December 1999. Weather, 56, 70-80.

It is expected that Special Projects requesting large amounts of computing resources (500,000 SBU or more) should provide a more detailed abstract/project description (3-5 pages) including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The Scientific Advisory Committee and the Technical Advisory Committee review the scientific and technical aspects of each Special Project application. The review process takes into account the resources available, the quality of the scientific and technical proposals, the use of ECMWF software and data infrastructure, and their relevance to ECMWF's objectives. - Descriptions of all accepted projects will be published on the ECMWF website.