

REQUEST FOR A SPECIAL PROJECT 2013–2015

MEMBER STATE: Norway.....

Principal Investigator¹: Prof. Jón Egill Kristjánsson.....

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Ph.D. students: Marianne Lund, Ragnhild B. Skeie, Camilla W. Stjern
Master students: Tobias Wolf, Marit Funnemark

Project Title: Modeling of chemistry-climate interactions

If this is a continuation of an existing project, please state the computer project account assigned previously.	SPNOKRIS	
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 2013-2015: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2015.)			
	2013	2014	2015
High Performance Computing Facility (units)	50 000	50 000	50 000
Data storage capacity (total archive volume) (gigabytes)	2 000	2 000	2 000

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 April 2012.....

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

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.

At the Department of Geosciences of the University of Oslo, there is a strong research activity on modeling of atmospheric chemistry, aerosols and clouds. This effort can be divided into two main themes:

1) *Aerosol-cloud interactions*: In this activity, regional models are increasingly becoming the tools of choice. In particular, The Weather Research and Forecasting model (WRF) is now being used in many of our projects, either in a stand-alone setting (e.g. Polar WRF) or, more often, with an extension for atmospheric chemistry and aerosols (WRF-CHEM). In addition, such studies often involve running the FLEXPART model to do particle advection. In many cases, we simulate episodes or cases for which we have observational data for model validation, e.g., campaign data (GFDex, ISDAC, IPY-THORPEX, etc.). In order to realistically simulate the transport, as well as the aerosol and cloud features of interest to us, we need to use the best available initial and boundary conditions. It is our experience that ECMWF reanalysis data are by far the most suitable for this purpose. Therefore, we need continuous access to the ECMWF data archives.

Here are some examples of ongoing projects in our group using WRF with ECMWF input data:

- *AERO-CLO-WV: Climate feedbacks of aerosols via water vapour in cloud-free air.* Funded by the the Norwegian Research Council.
- *CRYO-MET: Bridging models for the terrestrial cryosphere and the atmosphere.* Funded by the Norwegian Research Council.
- Master's project #1: *Vertical propagation of biomass burning aerosols assessed by LIDAR retrievals, satellite and aircraft data and model calculations.*
- Master's project #2: *Numerical simulations of supercooled cloud water of significance for air traffic.*
- Master's project #3: *How well can we simulate supercooled water in Arctic clouds?*
- Master's project #4: *A study of synoptic scale dispersion using ECMWF data in conjunction with the FLEXPART model.*

Some examples of recent publications from our group using WRF with ECMWF input data:

Blechschmidt, A.-M., J. E. Kristjánsson, H. Ólafsson, J. F. Burkhart, and Ø. Hodnebrog, 2012: Aircraft-based observations and high-resolution simulations of an Icelandic dust storm. *Atm. Chem. Phys. Discuss.*, 12, 7949-7984.

Føre, I., J. E. Kristjánsson, E. W. Kolstad, T. J. Bracegirdle, B. Røsting and Ø. Sætra, 2012: A 'hurricane-like' polar low fueled by sensible heat flux: High-resolution model simulations. *Q. J. R. Meteorol. Soc.*, in press.

Nygaard, B. E. K., J. E. Kristjánsson, and L. Makkonen, 2011: Prediction of in-cloud icing conditions at ground level using the WRF model. *J. Appl. Met. Clim.*, 50, 2445-2459.

Pfeffer, M. A., J. E. Kristjánsson, F. Stordal, T. Berntsen, and J. Fast, 2011: Indirect radiative forcing of aerosols via water vapor above non-precipitating maritime cumulus clouds. *Atmos. Chem. Phys. Discuss.*, 11, 27637-27659, 2011.

2) *Chemical-transport modeling*: The IFS model is run to produce meteorological input data for the off-line Chemical Transport Model Oslo CTM2, which is used to calculate the distribution and changes in chemically and radiatively active atmospheric compounds. The Oslo CTM2 covers both the troposphere and the stratosphere and includes gas-phase oxidant chemistry as well as aerosol modules (primary and secondary). Forecast data are used since fields that are crucial for CTM modelling of chemical tracers are not available in the MARS archive (e.g. convective statistics). Though convection statistics are available in the ERA-40 dataset, the spin-up for these data is short, and the residual circulation in this data set is most likely too strong, giving unrealistic ozone fluxes from the stratosphere into the troposphere.

The Oslo CTM2 has been thoroughly validated against observations, showing that the use of the IFS data makes it very suitable for comparisons both with campaign data and long term observations. The IFS data are also suitable for doing specific process studies (transport and chemistry). The use of IFS data is essential for our participation in a number of EU projects (including ECLIPSE, ECATS and REACT4C) and non-funded international projects (AEROCOM and ACCMIP). We are further participating in projects funded by the Norwegian Research Council where data from the IFS model are used as input for the Oslo CTM2 to do extensive production runs (e.g. Myhre et al., 2011; Skeie et al., 2011a, 2011b; Hodnebrog et al., 2011, Ødemark et al., 2012).

During the last years we have significantly extended our use of the IFS data, and this will continue to generate data for the most recent periods. We use the IFS 60 layer version (up to approximately 65 km), run at T319 resolution, to give full coverage of the stratosphere. We will continue using the IFS 60 layer version to have a long continuous time period of data, but because of changes done in the IFS model (new cycles and old cycles not available anymore) we have to rerun some of the years already run. The new meteorological data is crucial to make use of recent observations to develop and verify the model.

- Hodnebrog Ø., T. K. Berntsen, O. Dessens, M. Gauss, V. Grewe, I. S. A. Isaksen, B. Koffi, G. Myhre, D. Olivié, M. J. Prather, J. A. Pyle, F. Stordal, S. Szopa, Q. Tang, P. van Velthoven, J. E. Williams, and K. Ødemark, Future impact of non-land based traffic emissions on atmospheric ozone and OH – an optimistic scenario and a possible mitigation strategy, *Atmos. Chem. Phys.*, 11, 11293-11317, 2011.
- Myhre, G., K.P.Shine, G.Rädel, M.Gauss, I. S.A. Isaksen, Qi Tang, M.J. Prather, J. E. Williams, P. van Velthoven, O. Dessens, B. Koffi, S. Szopa, P. Hoor, V. Grewe, J. Borken-Kleefeld, T.K. Berntsen, J.S. Fuglestad, Radiative forcing due to changes in ozone and methane caused by the transport sector, *Atmos. Environ.*, 45, 387-394, 2011.
- Ødemark, K., S. B. Dalsøren, B. H. Samset, T. K. Berntsen, J. S. Fuglestad, and G. Myhre, Climate forcing from current shipping and petroleum activities in the Arctic. *Atmos. Chem. Phys.*, 12, 1979-1993, 2012.
- Skeie, R.B., T. Berntsen, G. Myhre, C. A. Pedersen, J. Ström, S. Gerland, and J. A. Ogren, Black carbon in the atmosphere and snow, from pre-industrial times until present, *Atmos. Chem. Phys.*, 11, 6809-6836, 2011a.
- Skeie R.B., T. K. Berntsen, G. Myhre, K. Tanaka, M. M. Kvalevåg, and C. R. Hoyle, Anthropogenic radiative forcing time series from pre-industrial times until 2010. *Atmos. Chem. Phys.*, 11, 11827-11857, 2011b.