REQUEST FOR A SPECIAL PROJECT 2021–2023

MEMBER STATE: Austria

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Project Title: FLEXPART energy transport simulations and inverse modelling of atmospheric constituents

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** _____	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2021	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for 2021-2023: (To make changes to an existing project please submit an amended version of the original form.)		**2021**	**2022**	**2023**
High Performance Computing Facility	(SBU)	1000000	2000000	2000000
Accumulated data storage (total archive volume)[2]	(GB)	10000	20000	30000

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 annual progress reports of the project's activities, etc.

[2] These figures refer to data archived in ECFS and MARS. If e.g. you archive x GB in year one and y GB in year two and don't delete anything you need to request x + y GB for the second project year etc.

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Extended abstract

The completed form should be submitted/uploaded at https://www.ecmwf.int/en/research/special-projects/special-project-application/special-project-request-submission.

All Special Project requests should provide an abstract/project description including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used.

Following submission by the relevant Member State the Special Project requests will be published on the ECMWF website and evaluated by ECMWF as well as the Scientific Advisory Committee. The evaluation of the requests is based on the following criteria: Relevance to ECMWF's objectives, scientific and technical quality, disciplinary relevance, and justification of the resources requested. Previous Special Project reports and the use of ECMWF software and data infrastructure will also be considered in the evaluation process.

Requests asking for 1,000,000 SBUs or more should be more detailed (3-5 pages). Large requests asking for 10,000,000 SBUs or more might receive a detailed review by members of the Scientific Advisory Committee.

Introduction

The Lagrangian particle dispersion model FLEXPART is run on ECMWF data to explore the transport and dispersion of various atmospheric constituents, from greenhouse gases, radionuclides and aerosols like black carbon to volcanic ash released during eruptions. The model is used with various inversion techniques to infer emission estimates of many atmospheric compounds. This helps improving transport simulations of these substances and to understand their impacts on air quality and effects on the climate system. The model can also be used to develop Lagrangian climatologies of energy or water transport in the atmosphere.

FLEXPART is a Lagrangian particle dispersion model developed and updated within the working group of Andreas Stohl (Stohl et al., 1998; Stohl and Thomson, 1999; Stohl et al., 2005; Pisso et al., 2019) (see www.flexpart.eu) and used by at least 37 international research institutes. FLEXPART was validated with data from continental scale tracer experiments (Stohl et al., 1998) and was used previously to study the transport of BB emissions into the Arctic (Stohl et al., 2006), as well as the transport of anthropogenic emissions between continents (Stohl et al., 2003) and into the Arctic (Eckhardt et al., 2007; Stohl et al. 2013). FLEXPART can be driven with analyses from the European Centre for Medium-Range Weather Forecasts (ECMWF).

Following Andreas Stohl's recent appointment as a professor at the University of Vienna, further development of the model shall be carried out within our new research group on atmospheric transport processes at the Department of Meteorology and Geophysics and coordinated with other groups worldwide.

Application and model development

Modelling greenhouse gas emissions using a Bayesian atmospheric inversion

To model surface-atmosphere fluxes of greenhouse gases such as halocarbons, methane or carbon dioxide, the inversion framework FLEXINVERT (Thompson and Stohl, 2014) will be used to optimize prior estimates of greenhouse gas fluxes to best fit atmospheric observations. Based on ECMWF data the FLEXPART model will be run in backwards-in-time mode to obtain the relationship between changes in atmospheric mixing ratios and fluxes. This so called source–receptor relationship will be used in atmospheric inversions to determine the spatio-temporal distribution of greenhouse gases globally and regionally. This will improve the knowledge of greenhouse gas

sources and will provide an estimate of the contribution of different countries to observed concentrations of certain greenhouse gas species.

Modelling global and regional energy transport

The FLEXPART model, based on ECMWF data, will be used to analyse total energy, heat and water transport in the atmosphere. By performing domain-filling transport model simulations with the Lagrangian particle dispersion model, as well as forward and backward simulations for particular sites, Lagrangian transport climatologies, as well as global statistics, can be established. Furthermore, case studies of particular extreme events shall be performed, for example to gain a better understanding of the role of heat transport during heat waves, or of energy conversions along trajectories to produce extreme wind events. ECMWF data will also be used to identify such extreme weather events.

References

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