LATE REQUEST FOR A SPECIAL PROJECT 2022–2024

MEMBER STATE: JRC

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Project Title: Extend and improve CH4 flux inversions at global and European scale based on ERA5 reanalyses

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** spjrc4dv	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2022	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for the years: (To make changes to an existing project please submit an amended version of the original form.)		**2022**	**2023**	**2024**
High Performance Computing Facility	(SBU)	150000	150000	150000
Accumulated data storage (total archive volume)[2]	(GB)	1500	1500	1500

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.
[2] 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.

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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.

Requests asking for 1,000,000 SBUs or more should be more detailed (3-5 pages).

Following submission by the relevant Member State the Special Project requests the evaluation will be based on the following criteria: Relevance to ECMWF's objectives, scientific and technical quality,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.

All accepted project requests will be published on the ECMWF website.

Project description

EC-JRC performs detailed inverse modelling studies of atmospheric CH_4 at global and European scale, using the TM5-4DVAR inverse modelling system and - for high resolution inversions - the recently developed coupled FLEXPART-COSMO / TM5 4DVAR inverse modelling system ("FLEXVAR"). This special project (SP) largely builds on the previous SPs "Improve European and global CH_4 and N_2O flux inversions (2018-2020)" and "Extend and improve CH_4 flux inversions at global and European scale (2021)" and aims at further extending and improving the global and European CH_4 flux inversions. Furthermore, the project plans to start a development of a regional CH4 flux inversions over the boreal zone.

Extend and improve estimates of global CH_4 emissions by using ERA5 reanalysis for the meteorological forcing

The global CH_4 flux inversions (as provided by JRC in MACC-III [Bergamaschi et al., 2013] and ESA GHG cci projects) will be further improved (using updated satellite retrievals from GOSAT [Parker et al., 2020]) and extended in time coverage. These global flux inversions will also serve as benchmarks for the evaluation of the CAMS CH_4 inversion / assimilation products in the framework of the support of JRC of the Copernicus services (administrative arrangement between JRC and DG GROW), updating and extending the previous evaluations [*Koffi and Bergamaschi*, 2018]). In particular the project will implement the ERA5 reanalysis for the meteorological forcing, compare the new inversion estimates with those made with the ERA-Interim forcing and provide new estimates over the largest possible temporal interval. The model will be tested with the resolution implemented in the past with the ERA-Interim reanalysis and the higher global resolution.

Furthermore, we will start a development of a regional CH4 flux inversion over the N. Hemisphere boreal zone. Under the accelerated warming in the boreal zone, it is expected that both decomposition of organic material and release of greenhouse gases, especially CH4, will be enhanced. Recent investigation has shown that wetlands in these areas will significantly increase the natural emissions of CH4 (Koffi et al., 2020). We plan to start a regional inversion based on TM5-4DVAR global inversions with zoom over the boreal region. This work will benefit from the previous developments undertaken globally with zoom over Europe.

Further develop, test and apply coupled FLEXPART-COSMO / TM5 4DVAR inverse modelling system ("FLEXVAR") with high spatial resolution.

The coupled FLEXPART-COSMO / TM5 4DVAR inverse modelling system ("FLEXVAR") allows European and regional scale inversions at significantly higher spatial resolution (with FLEXPART currently driven by meteorological fields from the COSMO-7 model at horizontal resolution of ~7 km) as compared to TM5-4DVAR with European zoom (resolution of ~100 km). FLEXVAR should better represent especially regional atmospheric monitoring stations, which are essential to improve regional emission estimates.

The objective is to continue the FLEXVAR model developments performed during the previous Special Projects. The specific objective for the further development of FLEXVAR will include the further improvement and test of the uncertainty estimates of derived fluxes. Furthermore, various sensitivity inversions will be performed, analysing the sensitivity e.g. on specific model settings, observational data, and prior emission estimates.

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