REQUEST FOR A SPECIAL PROJECT 2026–2028

MEMBER STATE: ...Italy.....

Principal Investigator[1]: ...Federico Serva.....

Affiliation: ...Consiglio Nazionale delle Ricerche.....

Address: ...Via Fosso del Cavaliere 100, 00133, Rome, Italy...
.....

Other researchers: ...Froila Palmeiro (froila.palmeiro@cmcc.it).....
.....

Project Title: ...Investigating the origin of stratospheric model biases: configuration and boundary conditions
.....
.....

To make changes to an existing project please submit an amended version of the original form.)

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** ITSERV.....	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2026	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for project year:		**2026**	**2027**	**2028**
High Performance Computing Facility	[SBU]	8 000 000	/	/
Accumulated data storage (total archive volume)[2]	[GB]	10 000	/	/

EWC resources required for project year:		**2026**	**2027**	**2028**
Number of vCPUs	[#]	/	/	/
Total memory	[GB]	/	/	/
Storage	[GB]	/	/	/
Number of vGPUs[3]	[#]	/	/	/

[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.
[3] The number of vGPU is referred to the equivalent number of virtualized vGPUs with 8GB memory.

Continue overleaf.

Principal Investigator: ...Federico Serva.....

Project Title: ...Investigating the origin of stratospheric model biases: configuration and boundary conditions .....

Extended abstract

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

Following submission by the relevant Member State the Special Project requests will be published on the ECMWF website and evaluated by ECMWF and its Scientific Advisory Committee. The requests are evaluated based on their scientific and technical quality, and the 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 exceeding 5,000,000 SBU should be more detailed (3-5 pages).

The objective of this Special Project is to follow on with activities started in an earlier Special Project (2025, *Investigating the origin of model biases in the representation of the stratosphere*). An accurate representation of stratospheric processes in weather and climate models is known to be important for scales ranging from the monthly to the decadal. Despite substantial improvements in the last two decades, persistent model biases, such an overly weak and vertically limited quasi-biennial oscillation (QBO) oft found in climate models (Serva et al., 2024).

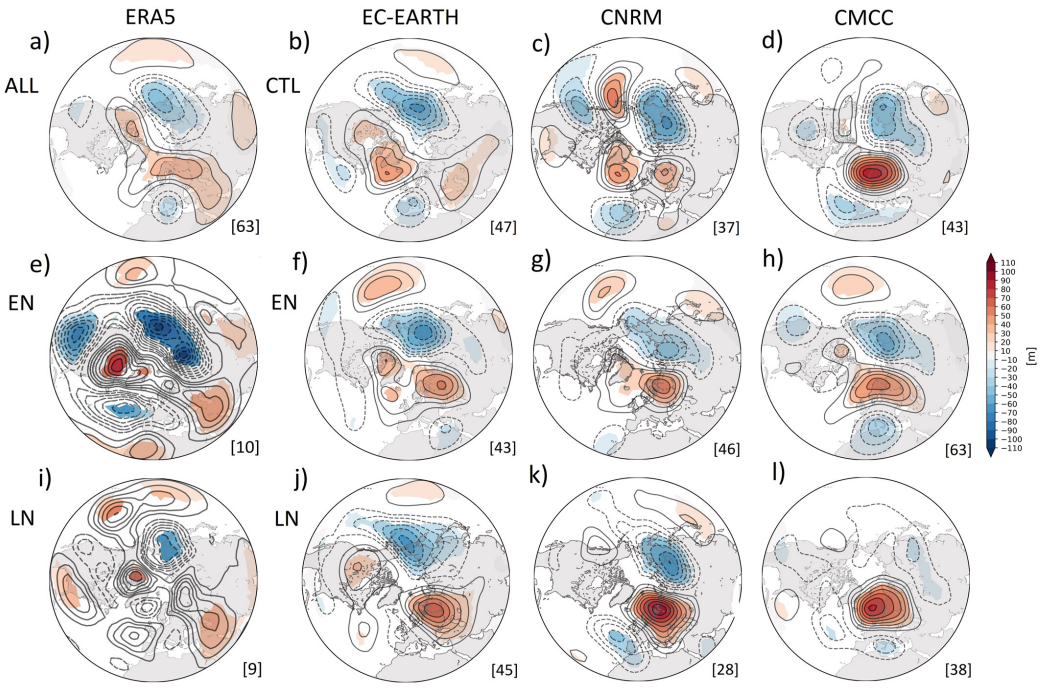

Fig. 1: Anomalies of geopotential height at 500 hPa over the [−10, 0]-day period before SSWs in (from left to right) ERA5 and three models, for ALL conditions, El Niño and La Niña periods. Reproduced from Palmeiro et al. (2023).

As shown in Fig. 1, different climate models can differ both in the climatological characteristics of relevant processes such as sudden stratospheric warmings (SSW), and in their modulation by modes such as El Niño-Southern Oscillation.

An approach for correcting biases in the QBO or other processes is to constrain the model to follow some observation-based dataset, such a reanalysis. This approach has been pursued in a previous Special Project carried out by the proposal Principal Investigator. However, having more flexibility in the nudging procedure brings advantages, such as the capability of exploring less strict constrains, which was not possible with the previously used model (EC-Earth, Doescher et al., 2022). That model was featuring a weak QBO at low levels (Fig. 2), which was corrected by means of a grid-point nudging method.

The proposal features two main set of experiments: in the first, the sensitivity to the OpenIFS model configuration (e.g., resolution and parameterization tuning) are explored by means of decadal atmospheric runs; in the second, the evolution of processes of interest, such as SSWs, is analyzed by using nudging and shorter simulations, to isolate the role of boundary conditions (e.g., ocean or ozone states, thanks to the files produced within the OpenIFS Data Hub). These experiments are meant to inform modellers on the model sensitivities and perform studies on predictability. On this topic the project would benefit from collaboration with Dr. Palmeiro, expert on ENSO and SSWs.

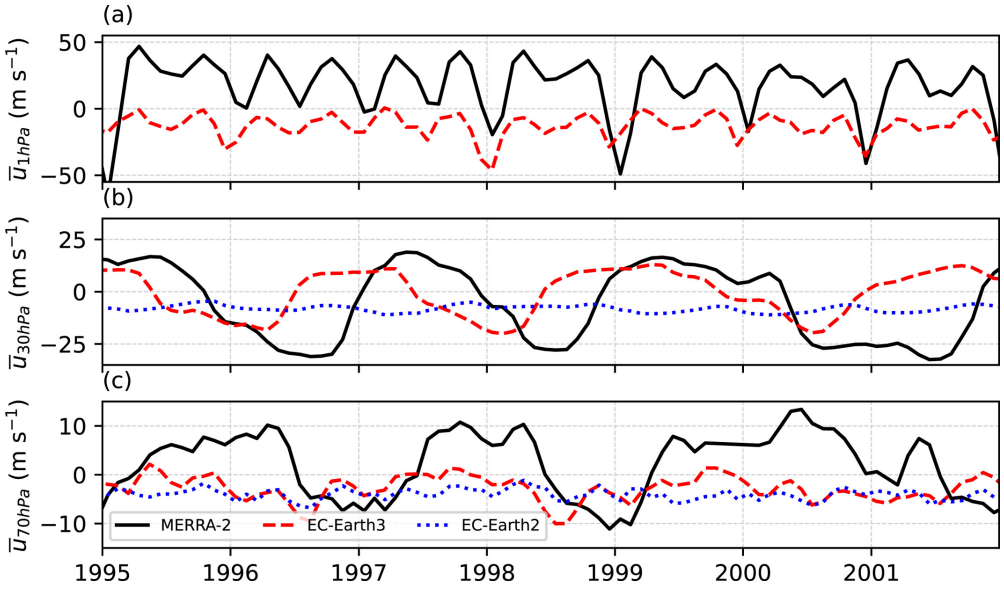

Fig. 2: Time series of the equatorial zonal mean zonal wind at pressure levels (a) 1, (b) 30 and (c) 70 hPa. Reproduced from Serva et al. (2024).

The resources request are aligned with the previous Special Project, and meant to perform atmosphere-only runs and to store post-processed data only on the tape library. Since a full CMOR-compliant processing is not foreseen (this was quite costly with EC-Earth), most SBUs will be devoted to perform simulations, also testing high-resolution configurations for some shorter integrations.

References

Doescher, R., and coauthors, The EC-Earth3 Earth system model for the Coupled Model Intercomparison Project 6, Geosci. Mod. Devel., https://doi.org/10.5194/gmd-15-2973-2022, 2022

Palmeiro, F., and coauthors, On the Influence of ENSO on Sudden Stratospheric Warmings, J. Geophys. Res.: Atmos., https://doi.org/10.1029/2022JD037607, 2023

Serva, F., and coauthors, , Changes in Stratospheric Dynamics Simulated by the EC-Earth Model From CMIP5 to CMIP6, J. Adv. Model. Earth Sys., https://doi.org/10.1029/2023MS003756, 2024