REQUEST FOR ADDITIONAL RESOURCES IN THE CURRENT YEAR FOR AN EXISTING EMI R&D PROJECT

Please submit the completed form via https://www.ecmwf.int/en/support (choose *Software and Computing*, then *Gain access to computing resources (create ticket)*) or send to special_projects@ecmwf.int

Country/Organisation: Spain / Instituto de Geociencias, Spanish National Research Council (IGEO-CSIC)

Principal Investigator[1]: Gabriel Chiodo

Affiliation: Instituto de Geociencias, Spanish National Research Council (IGEO-CSIC)

Address: Avenida Severo Ochoa, 7, 28040 Madrid, Spain

Project title: Hindcast experiments using the IFS 49r1 to investigate the impact of stratospheric ozone on predictability for the Horizon Europe project SOCLIM

Project account: **SPESCHIO**

Additional computing resources requested for year		**2026**
High Performance Computing Facility	[SBU]	2,160,000
Graphics Processing Unit Cluster - A	[GBU]	
Graphics Processing Unit Cluster - B	[GBU]	
Total DHS Data storage capacity	[GB]	
EWC resources		
Number of vCPUs	[#]	
Total memory	[GB]	
Storage	[GB]	
Number of vGPUs[3]	[#]	

Continue overleaf

[1] The Principal Investigator is the contact person for this EMI R&D Project

Technical reasons and scientific justifications why additional resources are needed

Project account: **speschio** (esp1963). Allocation for 2026: 2,880,000 SBU; additional resources requested for 2026: **2,160,000 SBU**. No additional data storage is requested beyond the 16,820 GB already allocated.

1. Year-1 experiments and progress to date

The Year-1 objective is to quantify the role of Arctic stratospheric ozone as a source of sub-seasonal to seasonal predictability through hindcasts of four springs (2011, 2018, 2020 and 2023) with the IFS cycle 49r1 (Tco199, ~50 km, 137 levels) under four ozone configurations, as set out in the original proposal. Work so far has focused on re-forecasting the 2020 record Arctic ozone depletion event, using initial conditions from ERA5, comparing the standard operational linearized ozone scheme (HLO) against prescribed ozone climatology (CMIP6), and against an observationally based ozone forcing (SWOOSH). Three main tasks have been completed or are in progress:

(a) A three-member ensemble initialised on 1 February 2020 was run and used to validate the workflow end-to-end (ecFlow/NEXhub job control, MARS archiving and post-processing). These runs reproduce the observed lower-stratospheric polar cap temperature (T100) evolution to within the ensemble spread over the first three months, largely irrespective of the ozone configuration, but substantially underestimate the magnitude of the observed ozone depletion, demonstrating the inability of the linearised ozone (HLO) scheme to simulate heterogeneous chemistry processes, due to the missing term in the linearization. This has been included in the interim 6-month report in June 2026.

(b) A "pilot" 10-member ensemble for the three different ozone configurations, with initialisation date of 1. February 2020, to test the impact of the different ozone configurations.

(c) Three "production" 30-member ensembles, each using a different ozone configuration, and the same three initialisation dates (1 January, 1 February and 1 March 2020), contributing to a key deliverable for Year 1 of the special project, and delivering a basis of skill assessment of the model.

At the time of writing, we have used **2,556,988 SBU** of the **2,880,000 SBU** allocated for 2026, leaving only about **323,000 SBU** for the remainder of the year.

2. Technical reasons why additional resources are needed for November-December 2026

(a) Resources lost to the failed **b0vy** test experiment. An early test of the experimental set-up provided to us (experiment b0vy) was submitted under the assumption that it would not extend beyond a short configuration testing. In reality, it nearly completed a total of 10 forecasts (5 ensemble members x 2 start dates), each reaching 861 forecast hours, and failed only at the very end, in the "nino_atmos" post-processing task that computes atmospheric indices from the coupled forecast output. ECMWF User Support (ticket of 30 March 2026) found that the compute time was correctly used and accounted for, and that the charge of approximately 460,000 SBU was correct and could not be waived. This single erroneous experiment therefore consumed about 16% of the 2026 annual allocation for this Special Project without delivering any scientific output. The "*nino_atmos*" task has since then been disabled (OCDONOTRUNNINO), and we have adopted the recommended practice of leaving failed tasks in the aborted state so that logs are preserved for diagnosis rather than cancelling the experiment.

(b) Underestimated model cost and the move to a 1-degree ocean. Our original request was based on an estimate of 200 SBU per forecast day for the Set A configuration. Early testing showed that the actual cost of the coupled configuration with a 0.25-degree ocean is considerably higher than assumed, and that completing the planned experiments for Year-1 would have not been feasible within the original allocation. To keep the cost close to the original request we have reduced the ocean resolution to 1 degree, which is not expected to degrade skill in the metrics of interest here (stratosphere-troposphere coupling and the stratospheric response to ozone anomalies). Given the inability of the HLO in simulating the observed ozone depletion, we need to reconsider alternative configurations and testing, as described in section 3. Even with this reduction in ocean resolution, the combination of lost resources for **b0vy**, the initial testing using 10-

members, and the additional sensitivity experiments described below (section 3), we cannot complete the Year-1 objectives with the remaining resources of 323,000 SBU.

3. Scientific justification for the additional experiments

The preliminary results using 30 members show that the standard HLO scheme does not reproduce the observed magnitude of the 2020 Arctic ozone loss, which limits our ability to assess the radiative feedback of Arctic ozone on the polar vortex and on surface predictability. We therefore propose the following additional experiments, all for the IFS cycle 49r1 configuration described above:

(a) HLO coefficient sensitivity experiments for 2020. We propose to replace the HLO linearisation coefficients with values taken directly from the observed 2020 ozone evolution, and to run hindcast experiments for spring 2020 using February as initialization, to test whether a more appropriate linearisation allows the scheme to capture polar ozone depletion and its associated radiative and dynamical feedback.

(b) An additional control experiment for spring 2020 with an alternative ozone climatology. In this 30-member ensemble, we will use an ozone field that is more consistent with the model's background state, taken from CAMS reanalysis and from the HLO coefficients directly, rather than from the CMIP6 climatology used so far.

(c) Using daily ozone forcing. We propose to use daily rather than monthly - ozone to better capture the high-frequency variability associated with the observed 2020 ozone depletion. This provides a cleaner reference against which the interactive and observation-based configurations can be compared, to better isolate its radiative and dynamical impacts.

Estimates resources: 200 SBU/day × 120 days × 3 × 30 members = **2,160,000 SBU** (and use the remaining 323,000 SBU as additional reserves)