

# 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](mailto:special_projects@ecmwf.int)

**Country/Organisation:** Switzerland.....

**Principal Investigator<sup>1</sup>:** Dr. Muhammed Irfan.....

**Affiliation:** École polytechnique fédérale de Lausanne (EPFL)

**Address:** Laboratory of Atmospheric Processes and their Impacts (L)  
EPFL, ENAC, IIE, LAPI, GR C2 534 (Bâtiment GR), Station 2  
1015, Lausanne, Switzerland  
.....  
.....

**Project title:** Improving Cloud Droplet Activation in OpenIFS–HAMM7 through  
Physically-Based and Deep-Learning-Derived Vertical-Velocity  
Variability  
.....  
.....

**Project account:** SPchirfa\_ \_ \_ \_ \_

| Additional computing resources requested for year |       | 2026       |
|---------------------------------------------------|-------|------------|
| High Performance Computing Facility               | [SBU] | 45,000,000 |
| Graphics Processing Unit Cluster - A              | [GBU] |            |
| Graphics Processing Unit Cluster - B              | [GBU] |            |
| Total DHS Data storage capacity                   | [GB]  | 100,000    |
| <b>EWC resources</b>                              |       |            |
| Number of vCPUs                                   | [#]   |            |
| Total memory                                      | [GB]  |            |

<sup>1</sup> The Principal Investigator is the contact person for this EMI R&D Project

|                              |      |  |
|------------------------------|------|--|
| Storage                      | [GB] |  |
| Number of vGPUs <sup>3</sup> | [#]  |  |

*Continue overleaf*

## **Technical reasons and scientific justifications why additional resources are needed**

The Special Project “Improving Cloud Droplet Activation in OpenIFS–HAMM7 through Physically Based and Deep-Learning-Derived Vertical-Velocity Variability” investigates the impact of alternative representations of subgrid-scale vertical-velocity variability ( $\sigma_w$ ) on aerosol activation, cloud droplet number concentration (CDNC), and aerosol–cloud interactions in OpenIFS–HAMM7. The approved scientific plan comprises six global two-year simulations, corresponding to a total of 12 model-years. These experiments include alternative  $\sigma_w$  parameterizations based on prescribed variability, turbulent kinetic energy (TKE), and machine-learning-derived representations.

The project was initially allocated 20 million SBU with an additional 20 million SBU. However, during model development and implementation, additional computational requirements were identified. In particular, the integration and testing of the Morales & Nenes (2014) activation scheme, the TKE-based  $\sigma_w$  diagnostic, and the Wnet machine-learning parameterization required a substantially larger number of development, debugging, restart, and sensitivity simulations than originally anticipated. These simulations are essential for ensuring numerical stability, verifying the scientific implementation, and evaluating parameterization behaviour across a range of atmospheric conditions before undertaking the final production simulations. In addition, the online evaluation of multiple activation and  $\sigma_w$  formulations requires repeated global simulations and dedicated diagnostic experiments. These are necessary to quantify uncertainties and assess the robustness of the machine-learning-based parameterizations under both in-distribution and out-of-distribution conditions. Particular attention is given to physically challenging regimes, including stable Arctic boundary layers and strongly forced Mediterranean orographic environments, where the representation of vertical-velocity variability and aerosol activation may differ substantially from more typical atmospheric conditions.

Based on current resource usage and updated computational benchmarks, the allocation of 45 million SBU is insufficient to complete the full experimental matrix and the associated validation and sensitivity analyses. We therefore request an additional allocation of 45 million SBU. The additional resources will enable completion of the planned production simulations, the necessary validation and sensitivity experiments, and the diagnostic analyses required to meet the scientific objectives of the Special Project. They will also support the generation of the datasets and diagnostics needed for the ongoing activities of the Horizon Europe CleanCloud project. The requested additional allocation is therefore essential to ensure the successful completion of the approved scientific programme and to fully assess the performance and robustness of the proposed physically based and machine-learning-derived representations of subgrid-scale vertical-velocity variability in OpenIFS–HAMM7.