REQUEST FOR A SPECIAL PROJECT 2019–2021

MEMBER STATE: SPAIN
This form needs to be submitted via the relevant National Meteorological Service

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Project Title: NUMERICAL SIMULATION OF MOUNTAIN WAVES AND ICING CONDITIONS IN THE IBERIAN PENINSULA

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.)	2019	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for 2019-2021: (To make changes to an existing project please submit an amended version of the original form.)		**2019**	**2020**	**2021**
High Performance Computing Facility	(SBU)	300000	300000	300000
Accumulated data storage (total archive volume)[2]	(GB)	10000	10000	10000

An electronic copy of this form must be sent via e-mail to: special_projects@ecmwf.int

Electronic copy of the form sent on (please specify date): **24th June 2018**

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] 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 and Technical Advisory Committees. 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 will receive a detailed review by members of the Scientific Advisory Committee.

Aircraft icing is one of the most dangerous weather phenomena in aviation safety. Therefore, avoiding areas with high chance of icing episodes along arrival and departure routes to airports is strongly recommended. Although such icing is common, forecasting and observation are far from perfect. Reducing the risk associated to mountain waves and icing conditions involves a combination of danger, exposure and susceptibility. Danger is the probability of particular weather conditions and therefore, this factor cannot be modified. The exposure is connected with the volume of air traffic, and the future decades is supposed to dramatically increase. Finally, the susceptibility can be reduced through an improvement of the spatially and temporally forecasts. If susceptibility is reduced, we minimize the risk, enhancing aviation safety.

In the case of the icing conditions, the concentration of super liquid droplets (SLD) is difficult to be accurately simulated by numerical models, since the parameterizations used in other mesoscale models, tend to overestimate the presence and amount of frozen water content, while they underestimate the existence and concentration of supercooled liquid water (SLW). Therefore, all options require an improvement in the knowledge of the factors involved in the presence of SLDs and mountain waves, i.e., analysing case studies well documented and from them setting up the analysis of the involved factors.

Fernández-González et al. (2014) and Fernández-González et al. (2015) analysed some episodes of freezing drizzle in the Guadarrama Mountains, at the center of the Iberian Peninsula, and simulated such episodes using the WRF model. They identified some meteorological factors, at both synoptic scale and mesoscale, that caused those episodes. Bolgiani et al. (2018) simulated with the WRF model an episode of mountain waves and ice conditions in the same zone. These ice conditions were observed and registered by an airplane flying over that area. In the obtained simulations, alternating updrafts and downdrafts and moderate to strong turbulence experienced by the aircraft are shown, suggesting clear air turbulence above the mountain wave cloud top. At the aircraft icing altitude, SLW associated with orographic clouds and mountain waves is simulated. The results encourage the use of mesoscale models and also images from the Meteosat Second Generation (MSG) satellite to minimize aviation risks associated with such meteorological phenomena.

Several episodes of mountain waves (Table 1) have been recorded in the Iberian Peninsula using MSG images (example in Figure 1). With this Special Project we want to use others high resolution meteorological models for predicting mountain waves and icing conditions with the aim of being helpful in aviation safety. These episodes will be simulated and those key meteorological factors involved in the development of these conditions will be obtained. Therefore, the modelling strategy is to run the Harmonie model that offer very high-resolution mesoscale simulations, both temporal and spatial, of different variables such as updrafts and downdrafts or SLW, crucial variables in the development of mountain waves and icing conditions (Fernández-González et al., 2015; Bolgiani et al., 2018). The Harmonie Reference system is being maintained on the ECMWF HPC platform. The Reference System includes the code, scripts and needed tools for the deterministic model and those for the Harmonie-based convection-permitting ensemble firecastubg system HarmonEPS.

Figure 1: Mountains waves over the northern Iberia (2017/11/05)

Year/Month/Day	Year/Month/Day	Year/Month/Day
20171102	20171209	20180215
20171103	20171212	20180219
20171105	20171213	20180220
20171106	20171214	20180221
20171108	20171215	20180222
20171109	20171216	20180227
20171110	20171218	20180228
20171111	20171219	20180301
20171112	20171220	20180302
20171113	20171221	20180303
20171122	20171226	20180306
20171123	20180104	20180307
20171124	20180105	20180308
20171125	20180110	20180312
20171129	20180111	20180319
20171201	20180116	20180320
20171202	20180117	20180321
20171203	20180119	20180615
20171208	20180120	…

Table 1: Some episodes with mountain waves

The scientific tasks of this project can be summarized as follow:

- Analysis of those synoptic environments related to mountain waves and icing conditions in the Iberian Peninsula.
- Evaluation of the mesoscale atmospheric factors responsible for mountain waves and icing development.
- Different numerical very high-resolution simulations will be obtained, using different physical schemes on the preselected events.
- Study and analysis of the high-resolution simulations from both deterministic and probabilistic point of view. For some particular episodes, an ensemble will be obtained.

This project team does not have the needed infrastructure to obtain such high-resolution accuracy simulations and we need enough computer resources in order to attain these all objectives. Therefore, this SPECIAL PROJECT 2019–2021 will be the principal source of computing time for the diverse simulations needed in the analysis of the mesoscale atmospheric factors involved in the development of mountain waves and icing conditions. Besides, the support of the Spanish Meteorological Agency (AEMET) is also thanked, providing us extrasources if needed and available.

The team has not had any previous special project. Therefore, the SBUs and GBs indicated in the table are approximate.

References

Bolgiani, P., Fernández-González, S., Martin, M.L., Valero, F., Merino, A., García-Ortega, E., Sánchez, J.L. 2018. Analysis and numerical simulation of an aircraft icing episode near Adolfo Suárez Madrid-Barajas International Airport Atmos. Res., 200, 60-69. http://dx.doi.org/10.1016/j.atmosres.2017.10.001.

Fernández-González, S., F. Valero, Jose L. Sanchez, E. Gascón, L. López, E. García-Ortega, A. Merino. 2014. Observation of a freezing drizzle episode: A case study. Atmos. Res., 149, 244–254. https://doi.org/10.1016/j.atmosres.2014.06.014.

Fernández-González, S., F. Valero, J. L. Sánchez, E. Gascón, L. López, E. García-Ortega, A. Merino. 2015. Analysis of a seeder-feeder and freezing drizzle event. J. Geophysical Research, 120, 3984–3999.