REQUEST FOR A SPECIAL PROJECT 2018–2020

MEMBER STATE: SPAIN

This form needs to be submitted via the relevant National Meteorological Service.

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Other researchers:

Project Title: EFFECT OF SURFACE HETEROGENEITIES AND EVAPOTRANSPIRATION CHANGES ON THE ATMOSPHERIC BOUNDARY LAYER

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** ESTURB	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2018	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for 2018-2020: (To make changes to an existing project please submit an amended version of the original form.)		**2018**	**2019**	**2020**
High Performance Computing Facility	(SBU)	300000	300000	300000
Accumulated data storage (total archive volume)[2]	(GB)	250	250	250

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):

23th June 2017

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

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 will be 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. Large requests asking for 10,000,000 SBUs or more will receive a detailed review by members of the Scientific Advisory Committee. All accepted project requests will be published on the ECMWF website.

The analysis of atmospheric motions in complex terrain, in our case from the mesoalpha (large basins) to the microscale (tens of meters), is made by our group through the combined use of experimental data (very often from campaigns that we organize or where we participate in with our own instrumentation) and numerical modelling. The principal source of computing time for the very high-resolution simulations has been so far the SPESTURB project at ECMWF. We have been using the resources of the ECMWF since 2002 with full satisfaction and with the support of the Spanish Meteorological Agency (AEMET), that has provided extra resources if needed and available.

During the last decade we mostly concentrated on flows in the stable boundary layer over land, introducing progressively complex terrain to understand the reasons of the observed evolution of wind, temperature and humidity in the nocturnal surface layer and the morning and evening transitions. Lately, the attention became more focused in complex terrain regions and small-scale heterogeneities. As an example, during the last special project the attention was mainly focused in three regions, the north side of the Pyrennes, the Ebro river basin and the island of Mallorca, to cover different degrees of topography and soil cover complexities.

Mesoscale simulations are done with the MesoNH model, and usually with 2 or 3 nested domains: the outer one of horizontal resolutions of the order or kilometer and the inner ones at hundreds of meters. These runs are expensive computationally since the vertical resolution is very high (3m close to the surface) to properly capture the observed features of the lower atmospheric boundary layer. For instance, simulations were used to study: (i) the daily cycle of permanent fog and its interaction with the surrounding slopes, (ii) the evolution of strong surface inversions and the physical mechanisms involved in the cold pool formation, (iii) the organization of the flow at lower levels in two valleys at the north and south sides of the Pyrenees and (iv) the morning and evening transitions of the sea and land breezes in Mallorca.

With the proposed new special project, a combined inspection of the simulations and of the observations of the campaigns that we have organized/participated in will be used to increase the current knowledge of the surface-atmosphere interface, which is the bottom boundary condition for the atmospheric component of numerical weather models. The aim of the proposed special project is twofold. Firstly, we plan to continue performing high-resolution mesoscale simulations to complement the observations of the last experimental field campaigns that we have organized. This is the case of the Cerdanya Cold Pool experiment 2015 (CCP15, autumn 2015) and 2017 (CCP17, winter 2017) whose main objective was to study the cold pool formation and the organization of the flow at lower levels in a complex mountainous terrain region. Simulations of some selected IOPs of CCP15 are now just finished. During CCP17 several snow events were reported and from the model results and observations it is expected to evaluate the effect of the snow in the lower atmospheric boundary layer features.

On the other hand, the interactions between the soil and atmosphere and their impact in the properties of the lower atmospheric boundary layer will be explored through idealized simulations and also through the analysis of observed cases. Our team is setting up test cases from our experimental campaigns, including flat cases with different degrees of heterogeneity and cases with well defined thermal or topographical forcing, in the Ebro valley (in an large irrigated parcel in a semi-arid environment), the Pyrenees (in the bottom of a wide valley), the island of Mallorca (in the plain experiencing sea-land breezes combined with thermally-forced slope flows) and at the Pannonian basin (at a flat and homogeneous site). All these cases comprise adequate measurements of the surface-atmosphere exchanges. These test cases are been prepared at the time of writing this application.

The modelling strategy is to run the selected models (Meso-NH and probably IFS) in forced column mode and to explore how to parameterizations schemes behave compared to the special observations obtained during the campaigns, especially the soil and atmospheric surface layer parts, trying also to introduce in the modelling procedure the observed local variability. The climatology database that typically models use (Corine at 1km resolution) will be updated for the studied site at higher spatial resolution to make the soil features more realistic (surface parameters taken from this database can be far from real conditions for a particular day). Afterwards, LES simulations of the cases with Meso-NH will be run, introducing the observed variability in the surface and in the surface layer, under the same of dynamic forcings. The dynamic forcings will be obtained by making high-resolution simulations with Meso-NH for the selected cases, some of them already completed.

In the case of modelled values of the energy and momentum fluxes being significantly different for the observed ones, identification of the causes of the shortcomings will be tried. The major challenges are expected in semi-arid conditions, where evapotranspiration parameterizations (i.e. latent heat flux) may need to be revised against the observed data. This will be especially relevant in summertime for our measurements at Mallorca, when the upper soil becomes dry and short vegetation dries. We have measurements over different types of surface during the drying season of 2016 (from mid-spring to mid-summer 2016) at distances of near 150 m, where all terms of the surface energy budget may be estimated. Also satellite information is available at high resolution (Landsat and Aster LST fields) and 5 IOPs with LST measured from a drone.