REQUEST FOR ADDITIONAL RESOURCES IN THE CURRENT YEAR FOR AN EXISTING SPECIAL PROJECT

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MEMBER STATE: ……SPAIN…

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Project title: SIMULATIONS OF TROPICAL TRANSITIONS IN THE EASTERN NORTH-ATLANTIC OCEAN: PAST, PRESENT AND FUTURE PROJECTIONS

Project account: **SPESMART**

Additional computer resources requested for		2023
High Performance Computing Facility	(units)	5500000
Data storage capacity (total)	(Gbytes)	25000

Continue overleaf

[1] The Principal Investigator is the contact person for this Special Project

Technical reasons and scientific justifications why additional resources are needed

The goal of this project is to simulate tropical transitions (TTs) with both Harmonie and WRF in ECMWF and compare the differences between both types of simulations. In the last years, TTs have occurred (Hurricanes and Tropical Storms as Vince, Delta, Ophelia, Leslie, etc.) very close to the Iberian Peninsula and surrounding areas (Evans and Hart, 2003). With a previous special project help, the importance of heat fluxes has been addressed in the genesis and development of STCs (Quitián-Hernández et al., 2020; 2021), which are related to TTs, and high-resolution simulations are revealed as needed to obtain more precise information of the TTs. Studies of past TTs (Calvo-Sancho et al., 2022) have provided us information about the atmospheric dynamics of these systems. Evaluating future simulations of these events in areas nearby the Iberian Peninsula will provide knowledge about these atmospheric systems and their behaviour with respect to the Anthropogenic Climate Change (ACC). To study possible changes in the TT behaviours, we are using the EC-Earth projections provided by the Barcelona Supercomputing Center (BSC), with different climate scenarios.

Until April 2023 and once different testing experiments have been needed to set up both models, systems such as Vince, Ofelia, Delta, Theta, Leslie have been simulated using both models. The configuration of both models is as follows: The WRF numerical model in studying STCs has been configured with a single domain of 2.5 km of grid resolution using 1000 grid points in the west-east direction, 1000 grid points in the south-north direction and 65 sigma levels unequally spaced, with a greater number of levels in the lower troposphere for a better representation of the convective planetary boundary-layer processes. Adaptative time steps are used. The WRF physics options used in this study are those defined as the default for Hurricane research mode. Among them, it is worth noting the WRF Single-Moment 6-class (WSM6) (Hong and Lim, 2006) parameterization scheme for microphysics, YSU for the planetary boundary layer (PBL), and Dudhia (Dudhia, 1989) and RRTM for short and longwave radiation, respectively. No cumulus parameterization scheme is used in this study, being cloudiness explicitly computed by the model. Finally, the initial/boundary conditions are obtained from the Integrated Forecasting System (IFS) analysis of the National Meteorological Archival and Retrieval System (MARS) of the ECMWF with 0.25° horizontal resolution every 6 hours. The WRF numerical model for analysing TTs has been configured with two domains: the outer domain with 7.5 km of grid resolution and the high resolution one with 2.5 km, using 1000 grid points in the west-east direction, 1000 grid points in the south-north direction and 65 sigma levels unequally spaced, with a greater number of levels in the lower troposphere for a better representation of the convective planetary boundary-layer processes. Adaptative time steps are used. Same physical schemes have been selected in the TT studies with initial/boundary conditions obtained from the ERA5 Reanalysis of the ECMWF with 0.31° horizontal resolution every 6 hours.

On the other hand, the HARMONIE model configuration (43h2.1 version) has been used to study the TTs. With this version we have been learning the set-up of this model, studying its postprocessing procedures. The final set up used to simulate TTs resembles WRF's one as much as possible to maintain the consistency of the study. Defined with the HARMONIE default physics options (Bengtsson et al., 2017), the model also has a main domain with 2.5 km resolution and the same grid dimensions (1000x1000) in the west-east and south-north directions with 65 hybrid sigma-pressure levels in the vertical. The initial/boundary conditions are the same as those used for WRF. In this case, the model is configured with a temporal resolution of 75 s (Bengtsson et al., 2017). Operated at 2.5 km resolution this model has a convection-permitting configuration and uses a non-hydrostatic spectral dynamical core with a semi-Lagrangian and semi-implicit discretization of the equations. In this way, more realistic results are obtained (Bengtsson et al., 2017) compared to other models, which may provide an added value to the study of TTs, such as the STC events. Once the TTs are simulated with such version of HARMONIE, another model configuration (46h version) has been compiled to simulate the different TTs at very high resolution (500m).

Because of the difficulty of obtaining surface-based observational data in the vicinity of intense atmospheric systems, such as TTs, leading to areas with scarce or missing data, the 10.8 μm long-wave IR channel, related to the MSG-SEVIRI brightness temperature (BT) field, is selected in this study as observational data to validate the model outputs. Figure 1 shows the MSG-SEVIRI BT field (left panel) and simulated BT fields of HARMONIE (middle panel) and WRF (right panel) of the Delta at the transition time. The HARMONIE model quite better captures the observational BT configuration than the WRF model.

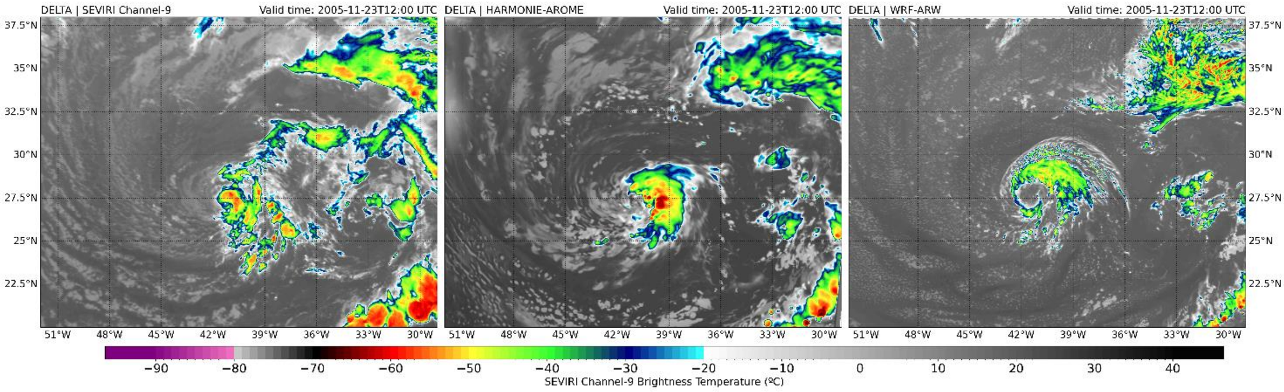

Figure 1: BT (K) spatial distribution for: (left) MSG-SEVIRI satellite, (middle) HARMONIE model, and (right) WRF model for 23 November 2005 at 1200 UTC.

After 12 h (Figure 2), the system develops more intensity and again the HARMONIE skill is better than the WRF. More differences and similitudes are being studied at this moment. To do this, several traditional skill scores and object-based techniques specific to forecasting spatial evaluation are used. Results obtained until April 2023 show that it is the HARMONIE-AROME model that performs better than WRF when reproducing the intensity of the studied TTs.

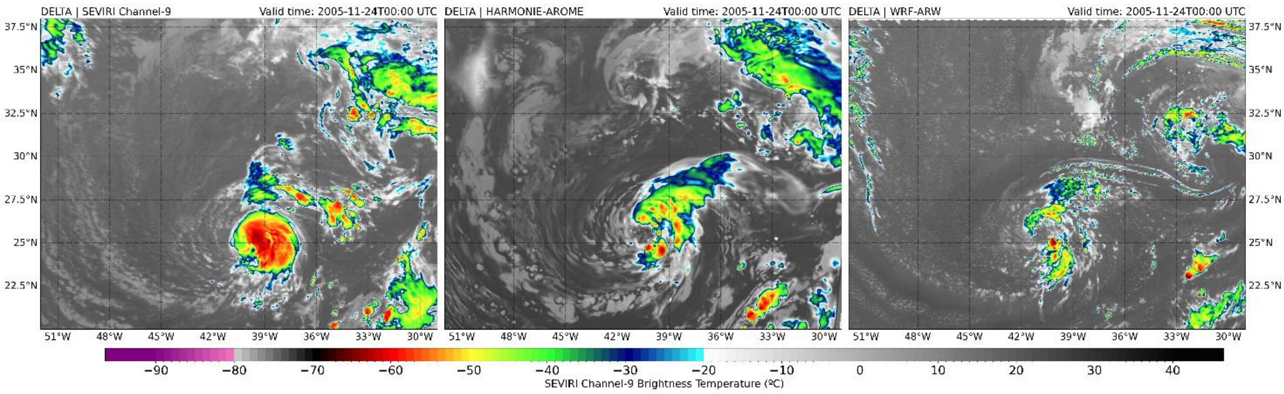

Figure 2: Same of Fig.1 except for 24 November 2005 at 0000 UTC.

For each atmospheric system, 93000 units approximately have been used using WRF and, around 600000 units have cost using the very-high horizontal resolution in HARMONIE. Considering the needed different experiments previous to the final simulations, that is, WRF set-up, and some proofs with different HARMONIE versions, that they have cost around 800000 units, we have also consumed additional 1900000 units in simulating the TTs. This is the reason why we have exceeded the original request.

It is worth noting that the huge domain and very high resolution used to simulate TTs (500m with the second version of the HARMONIE model) require previous needed tasks which means additional SBUs. We are sorry but finally the system setup has utilized more resources than we originally expected. Currently, the setup has been fixed and therefore in this project step we consider that the new estimation of SBUs we may need is realistic. To sum up, we would need additional SBUs to continue simulating these TTs at very high-resolution, because these experiments require additional resources that in the original request, we did not expect to need.

References

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