SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year 2019

Project Title: SIMULATIONS OF DIVERSE SUBTROPICAL CYCLONES AND TRANSITIONS TO TROPICAL CYCLONES IN THE EASTERN NORTH-ATLANTIC OCEAN

Computer Project Account: .....SPESMART.....

Principal Investigator(s): MARÍA LUISA MARTÍN

Affiliation: ESCUELA DE INGENIERÍA INFORMÁTICA. UNIVERSIDAD DE VALLADOLID

Name of ECMWF scientist(s) collaborating to the project (if applicable) .....

Start date of the project: 01/01/2020

Expected end date: 31/12/2020

Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)			900000	180000
Data storage capacity	(Gbytes)			25000	15000

Summary of project objectives (10 lines max)

This project is the first special project that this team has in ECMWF. Our goal is to implement both Harmonie and WRF in ECMWF in order to simulate some STCs and compare differences between both kind of simulations, proposing finally the optimum model to diagnose and forecast these systems. The key objectives in the project can summarized as follow:

- Simulation of different Subtropical Cyclones (STC) with the Harmonie model as well as the WRF model.
- The simulated STCs will be analysed examining the key variables in their genesis, developing and tracking.
- The warm seclusion transitions will be deeply analysed to elucidate physical mechanism favouring such cyclone formation.

Summary of problems encountered (10 lines max)

As this special project is our first project, we have found some problems when Harmonie and WRF are implemented. Currently, we are simulating the STC of 2014 that landfall the Canary Islands, causing widespread damages due to the strong winds and precipitation over the area. These kind of atmospheric systems move from low to high latitudes. Therefore, huge domains in Harmonie and moving nests in WRF are needed to follow properly tracks of the cyclones. We have already simulated Ophelia and Vince Hurricanes and STC 2014 with Harmonie. However, WRF model is also unreliable to produce regular simulations. Now the Harmonie problems has been fixed by HIRLAM community and the WRF ones are under investigation. We hope that such problems are definitively fixed in order to finish the previously mentioned tasks.

Summary of plans for the continuation of the project (10 lines max)

- As soon as the problems with both models are fixed, more STC and/or transitions to TC detailed in the original request will be simulated.
- Currently, the STC2014 has been simulated in Harmonie and WRF. We hope in July we will be able to simulate other cyclones using the WRF model.
- Those simulated variables, key in the genesis and development of the STCs will be studied in order to analyse differences and similitudes between the performance of WRF and Harmonie.
- These high-resolution accuracy simulations will be studied in order to know the possible transitions form STCs to Tropical Cyclones.

List of publications/reports from the project with complete references

Bolgiani, P., Fernández-González, S., Valero, F., Merino, A., García-Ortega, E., Sánchez, J., Martín, M. (2018). Numerical Simulation of a Heavy Precipitation Event in the Vicinity of Madrid-Barajas International Airport: Sensitivity to Initial Conditions, Domain Resolution, and Microphysics Parameterizations. Atmosphere, 9(9), 329.

L.Quitián-Hernández, S.Fernández-González, J.J.González-Alemán, F.Valero, M.L.Martín (2018): Analysis of sensitivity to different parameterization schemes for a subtropical cyclone. Atmospheric Research, 204, 21-36.

S. Fernández-González, M. Sastre, F. Valero, A. Merino, E. García-Ortega, J. L. Sánchez, J. Lorenzana, M. L. Martín (2019): Characterization of Spread in a Mesoscale Ensemble Prediction System: Multiphysics versus Initial Conditions. Meteorologische Zeitschrift, 28 (1), 59 – 67. DOI: 10.1127/metz/2018/0918

A. Manzano, M. A. Clemente, A. Morata, M. Y. Luna, S. Beguería, S. M. Vicente-Serrano, M. L. Martín (2019): Analysis of the atmospheric circulation pattern effects over SPEI drought index in Spain. Atmospheric Research, 230.https://doi.org/10.1016/j.atmosres.2019.104630

Merino, A., E. García-Ortega, S. Fernández-González, J. Díaz-Fernández, L. Quitián-Hernández, M.L. Martín, L. López, J.L. Marcos, F. Valero, J.L. Sánchez (2019): Aircraft icing: in-cloud measurements and sensitivity to physical parameterizations. Geophysical Research Letters. https://doi.org/10.1029/2019GL084424.

Díaz-Fernández, J. (2019): Modelización de ondas de montaña en las proximidades del aeropuerto Adolfo Suarez Madrid-Barajas. Seminario Final de la Red Temática Winter Precipitation and Strong Winds: Observational Studies (WiPSWis) (CGL2016-81828-REDT/AEI). Oral Presentation: Madrid, 8 marzo 2019.

Díaz-Fernández, J., Quitián Hernández, L., Santos-Muñoz, D., Fernández-González, S., Valero, F., Merino, A., García-Ortega, E., Sánchez, J. L., Sastre, M. and Martín, M. L. (2019). Poster: Mountain wave episodes using the high-resolution HARMONIE-AROME model in Spain. Congress of American Geophysical Union (AGU). General Assembly Conference. Poster. San Francisco, 7-11 December 2019.

Lara Quitián Hernández, Daniel Santos-Muñoz, Juan Jesús González Alemán, Javier Diaz-Fernandez, Sergio Fernández-González, Pedro Bolgiani, Mariano Sastre, Francisco Valero, Maria Luisa Martin
(2019): Analysis Of Several Subtropical Cyclones By Means Of The High-Resolution HARMONIE-AROME Model. Congress of American Geophysical Union (AGU). General Assembly Conference. Poster. San Francisco, 7-11 December 2019.

Bolgiani, P., Fernández-González, S., Valero, F., Merino, A., García-Ortega, E., Sánchez, J. L., Martín, M. L. (2020). Simulation of Atmospheric Microbursts Using a Numerical Mesoscale Model at High Spatiotemporal Resolution. Journal of Geophysical Research: Atmospheres, 125(4), 1–23.

Quitián-Hernández, L., J. J. González-Alemán, D. Santos-Muñoz, S. Fernández-González, F. Valero, M. L. Martín (2020): "A subtropical cyclone formation via warm seclusion development: The importance of surface fluxes". *Journal of Geophysical Research: Atmosphere* (accepted). https://doi.org/10.1029/2019JD031526.

Díaz-Fernández, J., Quitián Hernández, L., Santos-Muñoz, D., García-Gago, A., Bolgiani, P., Fernández-González, S., Valero, F., Merino, A., García-Ortega, E., Sánchez, J. L., Sastre, M. and Martín, M. L. (2020). Mountain waves analysis in the vicinity of the Madrid-Barajas airport using the WRF model. Under review.

Bolgiani, P., Santos-Muñoz, D., Fernández-González, S., Sastre, M., Valero, F., Martín, M. L. (2020). Microburst Detection with the WRF Model: Effective Resolution and Forecasting Indices. Under review.

Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

The Harmonie model has been implemented in order to simulate some STCs (detailed in the original request). In particular, some atmospheric systems, such the Ophelia hurricane, the Vince Hurricane and the STC of 2014 have been already simulated with Harmonie at 2.5 x 2.5 km. Some results related to Ophelia and the STC 2014 obtained with Harmonie are presented here (Figures 1).

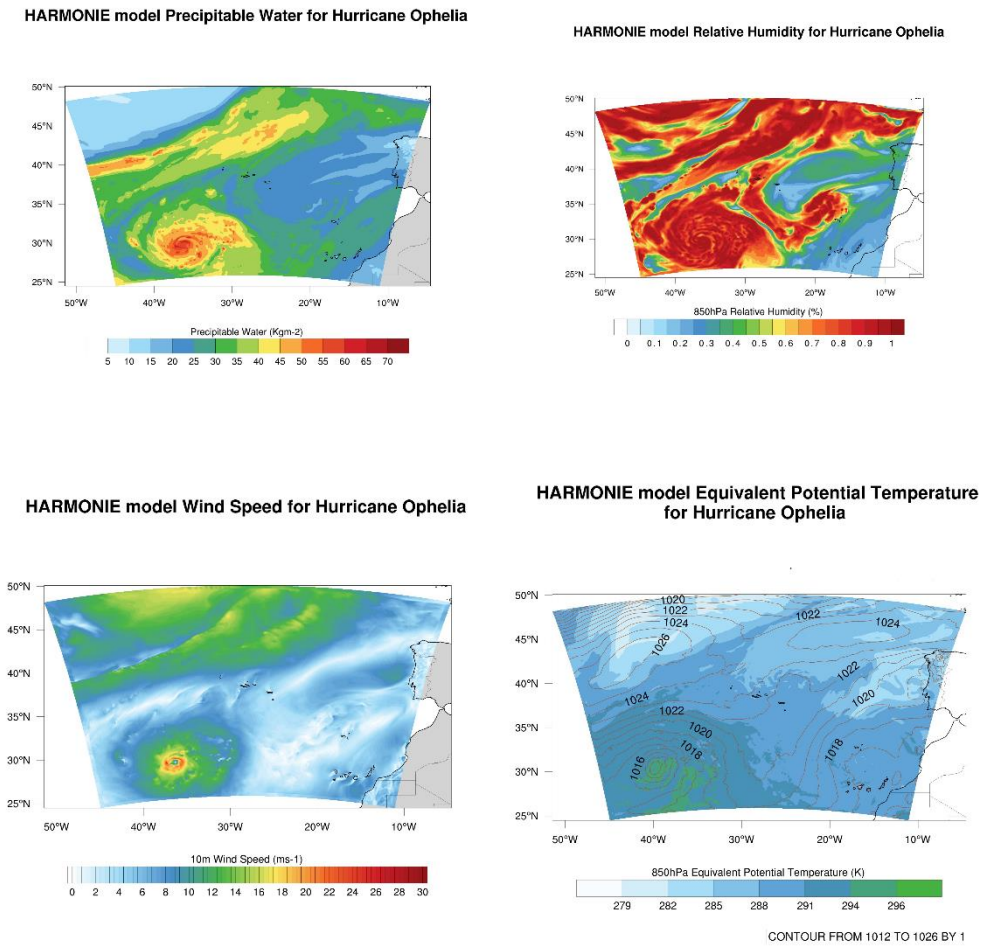

Figure 1: Precipitable water, relative humidity, wind speed and equivalent potential temperature for the Ophelia Hurricane on 11th October 2017 at 18:00 UTC.

These systems are been simulated using the WRF model although we have had some problems in compilating. Currently, such problems have been fixed and the STC 2014 has been simulated both with WRF and Harmonie (Figure 2). The STC of 2014 landfall the Canary Islands, causing widespread damages due to the strong winds and precipitation over the area. The system began to develop in October 18 and its effects lasted until October 21. The cyclone evolved from a typical extratropical cyclone, detached from a highly meridional atmospheric circulation and which became a stationary cut-off low in the subsequent days.

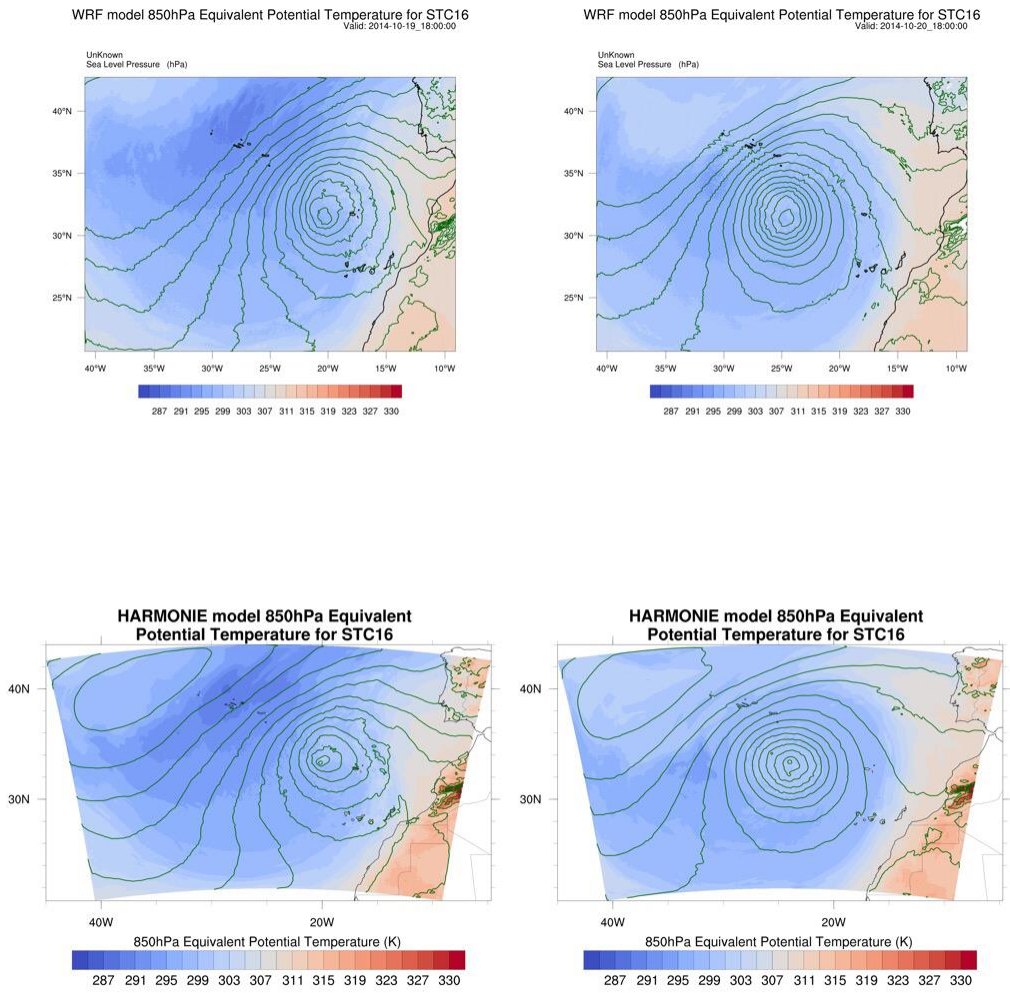

Figure 1: Equivalent potential temperature (K) for the STC on Ophelia Hurricane on 20th October 2014 at 18:00 UTC.

We have to consider all the outputs throughout the life of the system, examining other variables to finally fully analyse this case study. In particular, we are very interested in the transition of extratropical cyclone to STC and from STC to Tropical Transition. Fruitful of the first study is the article Quitián-Hernández et al. (2018). These transitions are very important in the development of the kind of systems and their possible transitions to hurricanes that could affect to Western Europe, such as the Ophelia, the Delta and the Vince Hurricanes (Quitián-Hernández et al., 2010).

We hope that throughout the remainder of the year, the WRF and Harmonie models will be used to simulate more tropical transitions in the vicinity of the Iberian Peninsula. As soon as the runs are finished, we will be able to analyse the simulations in order to study differences and similitudes between key simulated variables (for Harmonie and WRF) in the genesis, developing and tracking of the STCs taking into account the necessity of an ensemble of specific STCs to TCs transition case.