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

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)	900000	900000	900000
Accumulated data storage (total archive volume)[2]	(GB)	25000	25000	25000

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.

There are different types of cyclones in the troposphere relating to their thermal structure and dynamic: tropical cyclone (TC), extratropical (EC) and subtropical cyclone (STC), showing the latter, combinations of the two former in its thermal structure. For decades, the Eastern North-Atlantic Ocean (ENA) has witnessed numerous extreme events. In particular, intense subtropical cyclones (STCs) have been developed in that area, causing important widespread loss and damage. STCs are low pressure systems with both tropical and extratropical characteristics, having hybrid thermal structures. Such structures can mainly be described by cold upper-tropospheric and warm lower-tropospheric thermal anomalies during several days with gale-force winds around 17 ms-1 near the surface, at 925 hPa (Evans and Guishard, 2009). The difference between these systems and conventional ECs is really slight. Contrary to the midlatitude systems, the STCs develop with relatively shallow and weak baroclinicity (González-Alemán et al., 2015). Moreover, the environment in which STCs develop is characterized by little low-level baroclinicity in juxtaposition with diabatic processes (Hart, 2003; Davis, 2010).

Although the ECs have been simulated in numerous studies, few studies have been carried out on numerically simulating a STC development. Quitián-Hernández et al. (2016) examined the STC developed near the Canary Islands on October 2014 from both the large-scale and mesoscale approaches, analyzing the main features in its synoptic evolution and in its environment using three different numerical models (one of them was the Harmonie model).

Concerning ensembles, different sensitivity analysis have been carried out on TCs in the Mediterranean Sea (Miglietta et al., 2015; Moscatello et al., 2008). On the other hand, some studies have been focused on analysing the sensitivity to particular parameterization schemes on several Atlantic hurricanes (Li and Pu, 2008). However, excepting Quitián-Hernández et al. (2018), no sensitivity analysis has focused on STCs over the eastern Atlantic. In Quitián-Hernández et al. (2018), the WRF model was used to simulate the October 2014 STC in order to obtain an ensemble of this system. The combination of parameterization schemes that best simulated this type of phenomenon was determined. In this study, the simulations were carried out with two-nested domains. The first domain had 27 km of horizontal resolution and the second one 9 km. It is necessary to increase the resolution, both temporally and spatially, in order to deeply analyse this kind of phenomena.

With this Special Project, we want to simulate different STCs in order to study their transitions from EC to STC and, if happened, to TC (Bentley and Metz, 2016), as in the case of the Ophelia Hurricane (Figure 1). The transition from STC to TC must be deeply analysed due to the important damage that can generate in an inhabited area, in particular, the Canary Islands zone. In order to achieve these objectives, very high-resolution, both spatial and temporal, simulations are needed. 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.

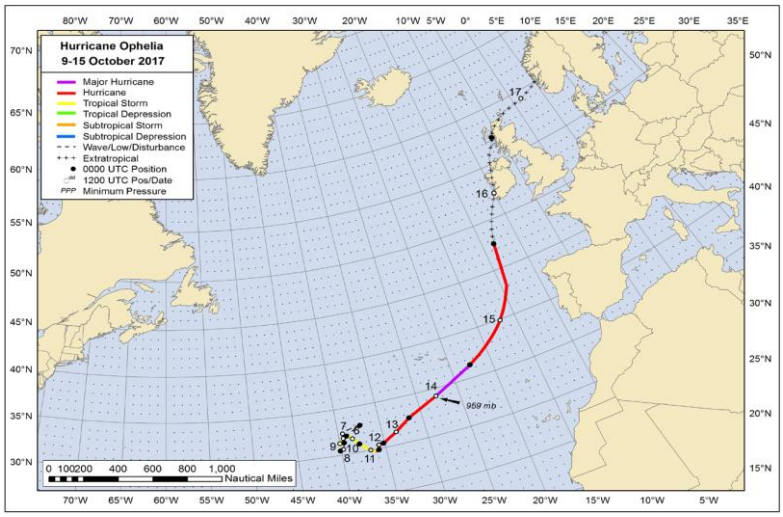

Figure 1: Best track positions for Hurricane Ophelia, 9–15 October 2017. Source: National Hurricane Center. Tropical Cyclone Report.

Therefore, the strategy in this Special Project is to run the Harmonie model that will provide such very high-resolution simulations of different variables such as wind speed, convective precipitation, temperatures and other derived important variables, very important in the transition phases (EC-STC-TC). The Harmonie model will give us high-resolution variables which we will help us to determine both the critical instants in the cyclone transitions and the key atmospheric variables in such instants. Furthermore, this model have never been used for the simulation of any STC, being an important motivation for requesting this project. Moreover, differences between the simulated results by means of WRF and Harmonie models will be also analysed, providing new perspective in the study of these events.

The objectives of this study can be summarized as follow:

1. Different STCs in the ENA will be simulated with Harmonie. In particular, they are the following STCs with their corresponding time periods:

   - STC10: 0000 UTC 01 Mar 2000 - 0000 UTC 11 Mar 2000
   - STC11: 1200 UTC 29 Sep 2005 - 1200 UTC 09 Oct 2005
   - STC12 (Pre-Vince): 0600 UTC 03 Oct 2005 - 0600 UTC 13 Oct 2005
   - STC13 (Pre-Delta): 1800 UTC 17 Nov 2005 - 1800 UTC 27 Nov 2005
   - STC14: 0600 UTC 01 Oct 2007 - 0600 UTC 11 Oct 2007
   - STC15: 1800 UTC 24 Jan 2010 - 1800 UTC 03 Feb 2010
   - STC16: 1800 UTC 15 Oct 2014 – 1800 UTC 25 Oct 2014

The STC acronyms follow the mentioned ones in González-Alemán et al. (2015).

2. These simulated STCs will be analysed and the key variables in the transition of the cyclone life will be determined.

3. Ensemble simulations of specific STCs to TCs transition cases in order to elucidate physical mechanism favouring the phenomenon, and to also improve forecast by using a clustering method (González-Alemán et al., 2018).

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 STCs. Besides, the support of the Spanish Meteorological Agency (AEMET) is also thanked, providing us extrasources if needed and available.

It is important to note that the SBUs and GBs indicated in the table are approximate because we have not had any previous special project. Therefore, the data above included are to be considered in an estimated way.

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