# REQUEST FOR A SPECIAL PROJECT 2016–2018

**MEMBER STATE:** …UK……..……...…

**Principal Investigator[1]:** …John Marsham……..……

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**E-mail:** ……J.Marsham@leeds.ac.uk……..……

**Other researchers:** ……Angela Benedetti, Graham Mann, PDRA (to be confirmed)……..……

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**Project Title:** …PaCoDOM…… Parameterising Convective Dust Storms in Operational Forecast Models ……

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| | | |
|---|---|---|
| If this is a continuation of an existing project, please state the computer project account assigned previously. | **SP** _____ | |
| Starting year:<br>(Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.) | 2016 | |
| Would you accept support for 1 year only, if necessary? | YES ☐ Y | NO ☐ |

| **Computer resources required for 2016-2018:**<br>(The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2017.) | | **2015** | **2016** | **2017** |
|---|---|---|---|---|
| High Performance Computing Facility | (units) | 100000 | 100000 | |
| Data storage capacity (total archive volume) | (gigabytes) | 15 000 | 10 000 more, i.e. 25 Tb total | |

*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):

……15 June 2015……

*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.

**Principal Investigator:** ……John Marsham……

**Project Title:** PaCoDOM: Parameterising Convective Dust Storms in Operational Forecast Models ……

# Extended abstract

*It is expected that Special Projects requesting large amounts of computing resources (500,000 SBU or more) should provide a more detailed abstract/project description (3-5 pages) including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The Scientific Advisory Committee and the Technical Advisory Committee review the scientific and technical aspects of each Special Project application. The review process takes into account the resources available, the quality of the scientific and technical proposals, the use of ECMWF software and data infrastructure, and their relevance to ECMWF's objectives. - Descriptions of all accepted projects will be published on the ECMWF website.*

Dust is the most important aerosol species by mass and affects weather through impacts on radiation and clouds. In recent years, substantial efforts have been made to represent these effects in operational weather prediction models, including integration into data assimilation systems. One big problem, however, is the inability of models with parameterized convection (currently all operational global models) to represent dust storms formed by the cold outflow from deep moist convection (called haboobs). Research in the framework of the ERC Desert Storms project has recently shown that (a) haboobs cause about a third of dust emission in the summertime Sahel and southern Sahara, an important dust source globally; (b) haboobs are difficult to observe from space due to cloud contamination and will therefore be likely missed by data assimilation systems, at least in early stages; (c) dust emission related to haboobs can be represented statistically in models with convective mass flux schemes through a simple parameterisation based on the theory of convective cold pools behaving like density currents. It is expected that this parameterisation can significantly improve the geographical distribution and seasonal cycle of dust emission across West Africa and potentially in other regions affected by haboobs such as the Arabian Peninsula and Northwest India. In PACODOM Desert Storms researchers will work directly with two leading centres in operational dust forecasting, the UK Met Office and the European Centre for Medium-Range Weather Forecasting. The parameterisation will be implemented into the current operational systems. It is expected that some adaptation and tuning will be necessary for the new concept to develop its full potential. This will require a series of systematic tests. If a significant improvement can be achieved, the new approach would become fully operational, giving ERC Desert Storms a lasting legacy and great international visibility.

## Section 3: The proof of concept plan

### a. Plan of the activities

The aim of PACODOM is to demonstrate the potential of the parameterisation of Pantillon et al. (2015) to lead to a measurable improvement of forecast skill in operational global prediction models. It is hoped that those improvements reach beyond dust variables, beyond Africa geographically and to longer timescales. The main planned activities in chronological order with approximate timings in Fig. 3 are:

- **Meeting 1 (M1):** Kick-off meeting at ECMWF in Reading with all team members; introduction of postdocs to senior researchers; discussion of technical and scientific details of the work plan and overall project.
- **Task 1 (T1):** Implementation of the parameterisation code in test versions of the current operational systems at ECMWF and MO including the coupling between the cold pool parameterisation and the dust scheme; initial tests of the performance relative to the original system using standard forecast verification methods established at the two centres.
- **Task 2 (T2):** Short-term forecasts with the MO model with convection-resolving resolution over West Africa using a nesting approach and objective identification of cold pools following Pantillon et al. (2015); separate calibration of parameterisation for MO and ECMWF models; comparison between the two systems.
- **Meeting 2 (M2):** Midterm meeting at KIT in Karlsruhe with all team members; discussion of achievements, surprises and problems; if necessary modification of the plan of activities for the remainder of the project.
- **Task 3 (T3):** Sensitivity tests with respect to the treatment of soil moisture generated by convective precipitation in the dust emission process (this aspect could not be investigated fully in Pantillon et al. (2015) but will need to be accounted for in an operational system); possibly re-tuning using data from T2.
- **Task 4 (T4):** Generation of hindcasts for a longer period in a pre-operational mode; evaluation of hindcasts using data assimilation system to test effect of new scheme on forecasts worldwide; simulations with the climate version of the models to evaluate impact of the parameterisation in a climate context.
- **Meeting 3 (M3):** Concluding meeting at UoL in Leeds; discussions of project results and prospects of parameterisation to become fully operational; writing of final report and paper for a scientific journal.

Tasks 1–4 will be largely executed in parallel with the MO and ECMWF modelling systems. Direct exchanges between the postdocs and discussions at the project meetings will ensure model intercomparison and consistency of implementation, although different choices may eventually be made due to the differences between the two models. We regard this project as low risk and potentially high gain. The science behind this new concept is well developed and published in a major journal (Pantillon et al., 2015). We now need to demonstrate applicability in an operational context in order to convert this science into improved forecasts.

| Activity / Month | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1: Implementation | | | | | | | | | | | | | | | | | | |
| T2: Calibration | | | | | | | | | | | | | | | | | | |
| T3: Soil Moisture | | | | | | | | | | | | | | | | | | |
| T4: Pre-operational mode | | | | | | | | | | | | | | | | | | |
| Project meetings | M1 | | | | | | | | M2 | | | | | | | | | M3 |

*FIG. 3: Gantt chart indicating approximate timings of the activities in PACODOM.*

### b. Project-management plan

The project management plan is schematically depicted in Fig. 4. PI Knippertz will have the overall responsibility of the project coordination. This will involve ensuring the project is executed in an efficient manner by facilitating clear communication between the team members. As the lead beneficiary, KIT will be responsible for the financial and scientific reporting to the EU. Technical work and other day-to-day tasks related to the MO UM will be executed by Malcolm Brooks, who will also serve as the main point of contact at MO and make sure access to all necessary resources is provided. Work on the ECMWF CAMS system will be executed by a postdoc at UoL supervised by John Marsham, who will coordinate interactions with others at UoL working on the CAMS system. Angela Benedetti will serve as the main point of contact at ECMWF and provide access to all necessary resources there. She will organize the postdocs' visits to ECMWF and introduce her/him to the CAMS system and relevant individuals at ECMWF. Although the work for the two modelling systems will run in parallel throughout the project, direct exchanges between the

postdocs will ensure model intercomparison and consistency of implementation. Communication between all team members will be

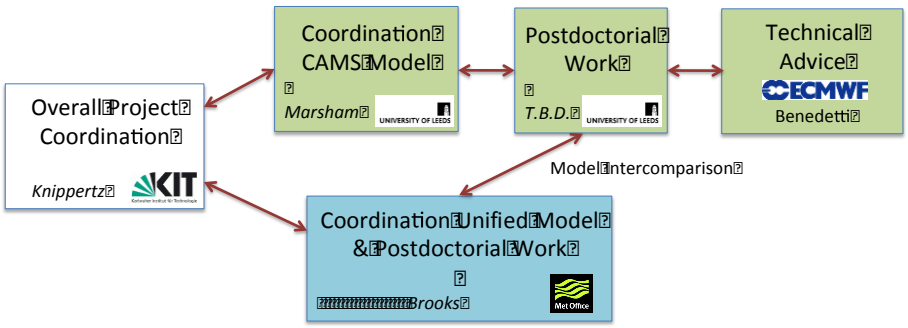


*FIG. 4: Schematic depiction of the implementation of PACODOM showing the roles of the five involved scientists together with the main communication pathways. Green and turquoise stand for the two modelling systems, the CAMS and UM, respectively. Three meetings of the whole team are planned for the project period.*

achieved through e-mail and bi-monthly telephone- or videoconferences, where problems or delays in the technical work and scientific interpretation of results will be discussed. The three one-day project meetings (section 3a) will provide a forum for more extensive and detailed discussions on all relevant project matters.