# SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

**Reporting year** 2017……

**Project Title:** Improvement of wind stress parameterization in coupled wave-atmospheric models
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**Computer Project Account:** SPFRARDH
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**Principal Investigator(s):** Fabrice Ardhuin
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**Affiliation:** LOPS (Laboratoire d'Océanographie Physique et Spatiale), CNRS
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**Name of ECMWF scientist(s) collaborating to the project** (if applicable) Jean Bidlot
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**Start date of the project:** 2016……

**Expected end date:** 2018……

**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) | 3,000,000 | 2,277,890 | 3,000,000 | 237,590 |
| **Data storage capacity** | (Gbytes) | 8 | | 10 | |

## Summary of project objectives

*(10 lines max)*

Wind stress is a key parameter for ocean-atmosphere mechanical exchanges. As such, its realistic parameterization in atmospheric models is of special interest. In particular, it may significantly influence evolution of storms, both hurricanes and extra-tropical storms (e. g. Emanuel 2003). This research work aims at better representing the wind stress in numerical models, leading to an improved parameterization of turbulent fluxes, namely momentum flux, sensible and latent heat fluxes. This study will be based on experiments using Integrated Forecasting System (IFS) coupled with Wave Model (WAM).

The objective is to define an optimal wind stress parameterization, based on a more physical approach, taking into account (1) the wave influence, especially dependence of the drag on the wave age, by moderate to strong winds, (2) the spray influence by very high winds.

## Summary of problems encountered (if any)

*(20 lines max)*

We encountered only a small problem with IFS/createfws due to incorrect permissions on the log directory, but it has been fixed very quickly thanks to Paul Burton.

## Summary of results of the current year (from July of previous year to June of current year)

*This section should comprise 1 to 8 pages and can be replaced by a short summary plus an existing scientific report on the project.*

The results are detailed in the following paper, submitted to Quaterly Journal of the Royal Meteorological Society (2 June 2017).

**Strong winds in a coupled wave-atmosphere model during a North Atlantic storm event: evaluation against observations.**

L. Pineau-Guillou, F. Ardhuin, M.-N. Bouin, J.-L. Redelsperger, B. Chapron, J.-R. Bidlot, Y. Quilfen

**Abstract**

Strong winds may be biased in atmospheric models. Here the ECMWF coupled wave-atmosphere model is used (1) to evaluate strong winds against observations, (2) to test how alternative wind stress parameterizations could potentially help to better match observations. For the period of storms Kaat and Lilli (23 to 27 January 2014), we have compared simulated winds with in-situ - moored buoys and platforms - and satellite observations available over the North Atlantic. Five wind stress parameterizations have been evaluated. The first result is that moderate simulated winds (5-20 m $s^{-1}$) agree well with all observations. For strong winds (above 20 m $s^{-1}$), mean differences appear, as large as -7 m $s^{-1}$ at 30 m $s^{-1}$. Large differences also exist between observations, with buoys and ASCAT-KNMI generally giving lower wind speeds than the platforms and other remote sensing data used in this study (AMSR2, ASCAT-RSS, WindSat, SMOS and JASON-2). It is difficult to conclude which dataset should be used as a reference. Yet, buoy and ASCAT-KNMI winds are likely underestimating the true wind speed. The second result is that the common wave-age dependent parameterization results in unrealistic drag and is not appropriate for coupling, whereas a newly empirically-adjusted Charnock parameterization produces higher winds than the default ECMWF parameterization. This proposed new parameterization could yield acceptable results in an operational context.

## List of publications/reports from the project with complete references

Results have been presented to following conferences:

- Poster, Air sea gas flux climatology international workshop, OceanFlux, 6-9 Sept. 2016, Brest, France
- Oral presentation, International workshop of measuring high winds speeds over the ocean, 15-17 Nov. 2016, Exeter, UK
- Oral presentation, Ateliers de Modélisation de l'Atmosphère, 30 Jan.-3 Feb. 2017, Toulouse, France

Publication:
L. Pineau-Guillou, F. Ardhuin, M.-N. Bouin, J.-L. Redelsperger, B. Chapron, J.-R. Bidlot, Y. Quilfen (2017). Strong winds in a coupled wave-atmosphere model during a North Atlantic storm event: evaluation against observations. Submitted to Quaterly Journal of the Royal Meteorological Society.

## Summary of plans for the continuation of the project

*(10 lines max)*

Results showed that common wave-age dependent parameterization (Oost et al., 2002) results in unrealistic drag and is not appropriate for coupling. Meteo-France is currently developing a wave age dependant parameterization, with a drag close to the newly empirically-adjusted Charnock parameterization, developed in the framework of the Special Project. We will test this parameterization on the Kaat and Lilli storms, with the same method as presented in the paper submitted to QJRMS.

### References

Emanuel K. 2003. A similarity hypothesis for air-sea exchange at extreme wind speeds. J. Atmos. Sci., 60, 1420-1428

Oost WA., Komen GJ, Jacobs CMJ, van Oort C. 2002. New evidence for a relation between wind stress and wave age from measurements during ASGAMAGE. Boundary-Layer Meteorology 103(3): 409-438