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:	**Direct numerical simulation of long-term evolution of wind waves: dynamics vs kinetics, with applications to freak waves prediction**…
Computer Project Account:	**SPGBSHRI** ……
Principal Investigator(s):	**Prof V.I. Shrira** ……
	……
Affiliation:	**School of Computing and Mathematics, Keele University, Keele ST5 5BG UK** ……
Name of ECMWF scientist(s) collaborating to the project (if applicable)	……
	……
Start date of the project:	**2019**……
Expected end date:	**2021**……

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)	**N/A**	**N/A**	**500000**	**570**
Data storage capacity	(Gbytes)	**N/A**	**N/A**	**100**	**5**

This template is available at:
http://www.ecmwf.int/en/computing/access-computing-facilities/forms

Summary of project objectives (10 lines max)

The target of the project is to perform long term DNS simulations and to compare them with high quality observations. As shown by Annenkov & Shrira (2014), higher-order moments of a random wave field, and hence the probability of freak waves, are dependent on spectral shape, not just the on integral characteristics of a wave field. Preliminary estimates show that the found discrepancies in spectral shape can strongly affect higher-order moments, in particular kurtosis, and the difference is expected to be substantial (of the order of 100%). This has huge potential implications for the prediction of extreme wave events. Specific objectives include exploring the discrepancy between the shape of the DNS (verified by observations) and the Hasselmann equation predictions, examining implications for probability of freak waves, mixing via the vortex force and other processes sensitive to the shape of spectra, getting new insights into the input and dissipation functions.

Summary of problems encountered (10 lines max)

No particular problems encountered

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

In the next part of the project, we will perform simulations of spectral evolution based on the set of data collected in the Mediterranean Sea with the airborne radar system KUROS. We will continue short-term simulations of evolution of higher statistical moments of wave fields with and without wind forcing, and simulation of evolution of directional distributions.

List of publications/reports from the project with complete references

Annenkov S.Y., Shrira V.I. When is the dynamic non-Gaussianity essential for water wave fields? WISE 2019, Jozankei, Hokkaido, Japan, 12--16 May 2019

Annenkov S.Y., Shrira V.I. Evolution of random wave fields and the role of the statistical closure. 8th International Symposium on Bifurcations and Instabilities in Fluid Dynamics, University of Limerick, Ireland

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 project was started this year. The first part of the project is based on simulations of spectral evolution with realistic wind forcing, and comparison with the available experimental data. Earlier numerical experiments have revealed that although both DNS and kinetic equations algorithms give essentially the same evolution of integral characteristics of a wave field, for large time tending to the known asymptotics of self-similar evolution, there are certain notable differences in spectral shapes, with important implications for prediction of extreme events, and other implications. Current simulations are based on the set of data collected in the Mediterranean Sea with the airborne radar system KUROS. Data has been selected and preprocessed. Preliminary analysis of

the collected data has shown that the peakedness properties of the observed spectra are in good agreement with the DNS simulations in similar wind forcing conditions.

Simulations of higher statistical moments of wave fields without wind forcing has allowed to identify cases when dynamic non-gaussianity is not negligible compared to the bound harmonics one, and should be taken into account in estimates of p.d.f. of wave amplitudes.