REQUEST FOR A SPECIAL PROJECT 2013–2015

MEMBER STATE: **UK** ……………………………………………………………..…

Principal Investigator[1]**:** **Prof V.I. Shrira** ……………………………………………….……

Affiliation: **Keele University, UK** ………………………………………….…….

Address: **Department of Mathematics, EPSAM, Keele University, Keele ST5 5BG UK**………….……
…………………………………………………………………..…….
…………………………………………………………………..…….

E-mail: **v.i.shrira@keele.ac.uk** …………………………………….…….

Other researchers:

Dr S.Y. Annenkov **s.annenkov@maths.keele.ac.uk**……….……
………………………………………………………………….…….

Project Title:

New kinetic equations and their modelling for wind wave forecasting ……………………………………………….……
…………………………………………………………………..…….

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SPGBVSSA** ________________	
Starting year: (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	**2012**	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for 2013-2015: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2015.)	**2013**	**2014**	**2015**
High Performance Computing Facility (units)	**100000**		
Data storage capacity (total archive volume) (gigabytes)	**100**		

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):

21 May 2012………………………

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: **Prof V.I. Shrira** ……………………………………………………

Project Title: **New kinetic equations and their modelling for wind wave forecasting** …………………………………………………………

Extended abstract

All the existing approaches to the modelling of longtime evolution of wind waves are based upon the key concept of wave turbulence. Within the framework of the wave or weak turbulence paradigm, the wave field statistical description is provided by the so-called kinetic equation (KE) for the second statistical moments of the field with appropriate input and dissipation terms. By construction the KE has a $O(\varepsilon^{-4})$ timescale of evolution, which in principle cannot describe reaction of wave fields to more rapid changes in the environment. Moreover, the KE derivation relies upon a number of assumptions, and there is no built in quality control. In particular, the KE presumes a quasi-Gaussianity of the wave field, but there is no explicit small parameter characterising the required smallness of the departure from the Gaussianity, and the KE in its present form does not provide a way to estimate and monitor this parameter in the process of field evolution. This is important not only for the overall quality of wave modelling, but, crucially, for predicting the situations with large non-Gaussianity and hence large probability of rogue waves. Besides that, the KE-based models can predict evolution of wave spectra only, while it is highly desirable to model evolution of higher momenta of wave field as well; ideally, of the wave height probability density function. The latter, in particular, is badly needed for forecasting rogue waves.

Recently, we have derived the generalized kinetic equation (gKE), by lifting the approximation of the long-time asymptotics employed in the classical derivation of the KE. In order to take into account in the kinetic equation the finiteness of the small departure from Gaussianity, we (together with Prof M. Stiassnie) have discovered that a new, more accurate closure can be used in the consistent derivation of yet another novel kinetic equation. This new equation explicitly takes into account the finiteness of the small departure from Gaussianity. We refer to it as the enhanced generalized kinetic equation (egKE).

This project aims at creating a new conceptual and numerical framework for the study of wind wave evolution, by developing a new way of wind wave modelling based on novel kinetic equations derived from first principles. The target is to find an effective way of numerical evaluation of the generalised kinetic equations and develop a robust parallel code. The developed code will first be applied to basic prototype situations, which are beyond the limits of applicability of the classical kinetic equation, such as instantly changing or gusty wind forcing. The results will be validated by comparing with direct numerical simulations (DNS). The, the code will be applied to situations, which are both beyond the limits of applicability of the classical kinetic equation and beyond the limits of DNS; in particular, interaction of wind waves and swell. We will study the evolution of kurtosis and other higher momenta of wave field for a number of model situations, both within and outside the limits of applicability of the classical kinetic theory. Recommendations for wave forecasting will be formulated.

During the first year of the project, the numerical model was constructed, both for one- and two-dimensional wave fields. The code was used for simulation of higher statistical momenta, in particular kurtosis. In the second year, the code will be applied to the basic prototype situations with a sharp increase or decrease of wind. Numerical simulations of the gKE and egKE will be tested against the already carried out DNS simulations obtained earlier by the authors.