Review of the article titled "*Numerical modeling of surface wave development under the action of wind*" by Dr. Dmitry Chalikov (2018)

General Comments:

Recommendation: **Minor Revision**

The manuscript presents simulations of two-dimensional wave fields under steady and homogeneous winds. The wind input term S_{in} or β was obtained from a wave-boundary layer model which was established by using Reynolds equations in Chalikov and Rainchik (2011). The kinematics and dynamics at the sea side, i.e., below the air-sea interface, was simulated with three-dimensional equations of potential motion. Within this direct wave model, dissipation of wave energy consists of two terms: i) wave breaking as represented by a local highly selective diffusion operator, of which the diffusion coefficients depend on the local curvilinearity; ii) another selective filter which is only applicable to high wavenumbers. The redistribution of wave energy over spectral space as a result of nonlinear interactions is directly described by the potential equations. Numerical experiments suggest that this wave model is able to yield realistic evolution of wave spectrum. First, the downshifting of the spectral peak and the angular spreading as wave develops are well simulated. Second, the shape of the nonlinear term, modelled by this direct model, is in a good agreement with Hasselmann's integral. Third, the simulated peak frequency ω_p and wave energy E, as a function of fetch, are comparable to measurements collected in the JONSWAP project. Discussion about the disadvantage/weakness of this wave model is also presented.

The direct wave model described in the manuscript is very unique, and the results shown here are quite encouraging. The reviewer is very impressed by Fig. 11 that nonlinear terms from the author's model is qualitatively similar to solutions from Hasselmann's equation.

There are, however, also some details that need to be clarified by the author:

- To suppress the numerical instability at spectral tail, the author employed a filtration term which only applies to high wavenumbers. In my opinion, an alternative method to dissipate energy at high wavenumbers might be to include the induced breaking of short waves by long waves. The field study by Young and Babanin (2006) found the dominant wave breaking can induce the dissipation of wave components at high frequencies. The latest spectral wave models use a wave breaking term S_{ds} consisting of two components: a) inherent breaking when waves are too steep, b) induced breaking due to the modulation of long waves. It's interesting to see how this induced breaking mechanism can be applied in the author's direct model in the future. At this stage, the author may just discuss about this briefly in the manuscript if possible. See, for example,

Donelan, M., 2001: A nonlinear dissipation function due to wave breaking. Ocean Wave Forecasting, 2-4 July 2001, ECMWF, Shinfield Park, Reading, ECMWF, 87-94.

Young, I. R., and A. V. Babanin, 2006: Spectral Distribution of Energy Dissipation of Wind-Generated Waves due to Dominant Wave Breaking. Journal of Physical Oceanography, 36 (3), 376-394.

Babanin, A. V., K. N. Tsagareli, I. R. Young, and D. J. Walker, 2010: Numerical Investigation of Spectral Evolution of Wind Waves. Part II: Dissipation Term and Evolution Tests. Journal of Physical Oceanography, 40 (4), 667-683.

Donelan, M.A., Curcic, M., Chen, S.S., Magnusson, A.K., 2012. Modeling waves and wind stress. J. Geophys. Res. 117 (November 2011), C00J23. doi:10.1029/2011JC007787.

- The English and the quality of figures need to be improved. All the figures in the manuscript don't look very clear. The author may enhance the resolution (dpi) of those figures, or alternatively use vector format such as pdf, eps. Besides, the format of a number of citations in the text is not correct. I have pointed out some, but not all, of them.

Specific Comments:

L18: "thousands degrees" to "thousands of degrees"

L25-26: "hundreds and thousands periods" to "hundreds and thousands of periods"

L31: "capable to describe" to "capable of describing"

L32: "that of extreme wave generation" to "the generation of extreme waves"?
L32: "Chalikov, Babanin, 2016a" to "Chalikov and Babanin, 2016a"

L38: "a perfect instrument" to "an useful instrument". I think here the word "perfect" is too strong.

L41: "in (Chalikov et al. 2014, Chalikov, 2016)" to "in Chalikov et al. (2014) and Chalikov (2016)"

L43: "A unique example" to "An unique example"

L44: “in (Chalikov and Babanin, 2014)” to “in Chalikov and Babanin (2014)”

L59: the meaning of $h_{k,l}(\tau)$ as wave mode amplitude is not mentioned here.

L68: Please mention explicitly that Φ or φ is velocity potential.

L112: delete “respectively”

L120: I think it is necessary to cite the WAM work here as it is the first third-generation wave model and also uses a parameterization of S_{in} based on a field experiment conducted by Synder et al. (1981).

The WAMDI Group, 1988. The WAM model - a third generation ocean wave prediction model. J. Phys. Oceanogr. 18 (12), 1775-1810.

L123: “so well” to “reasonably well”

L124-126: It also might be useful to mention works by some other researchers, such as Gent and Taylor (1976), Riley et al (1982), Al-Zanaidi and Hui (1984).

L144: “This is why the function derived in (Chalikov and Rainchik, 2010)” to “This is another reason why the function derived in CR”

L159: “on the contrary” to “on the other hand”

L162: “modes which amplitudes” to “modes of which amplitudes”

L171: “Tolman, Chalikov” to “Tolman and Chalikov, 1996”

L173: “to include” to “to be included”

L161-182: The symbol Ω_0 in Eq. (14) and Ω in Eq. (15) are quite confusing. It’s not clear to me that which wave mode is using when Ω_0 or Ω is calculated. When the author said $\Omega_0 = 6$, it appears that the initial peak wavenumber of the JONSWAP spectrum is used, i.e., $k_p = 100$. Besides, when the author said “In our case wind speed is fixed”, it is unclear that at which height wind speed is fixed. Is it U_{10}, that is the wind speeds at 10 m above the sea surface? Please clarify these details if possible.

L190: “This phenomenon well known” to “This well-known phenomenon”

L218-219: “Since there are no waves in spectral models, no local criteria of wave breaking can be formulated.”

Just a short comment here: Progress has been gradually made in spectral wave modelling over the past decade. One important outcome is that the wave breaking term S_{ds} in the state-of-art wave models now accounts for the threshold-behavior of dominant wave breaking, that is, waves won't break unless their steepness exceeds a threshold. The saturation spectrum $B(f) = k^3F(k)$ is used to quantify the *local* steepness of each wave component. See, for example,

Alves, J. H. G. M., and M. L. Banner, 2003: Performance of a Saturation-Based Dissipation-Rate Source Term in Modeling the Fetch-Limited Evolution of Wind Waves. Journal of Physical Oceanography, 33, 1274-1298.

Babanin, A. V., K. N. Tsagareli, I. R. Young, and D. J. Walker, 2010: Numerical Investigation of Spectral Evolution of Wind Waves. Part II: Dissipation Term and Evolution Tests. Journal of Physical Oceanography, 40 (4), 667-683.

L227: "... many theoretical and laboratory investigations (e.g., Alberello et al., 2018)"

Alberello, A., A. Chabchoub, J. P. Monty, F. Nelli, J. H. Lee, J. Elsnab, and A. Toffoli, 2018: An experimental comparison of velocities underneath focussed breaking waves. Ocean Engineering, 155, 201-210.

L287-288: It might be necessary to explain explicitly that B_ξ and B_ϑ are diffusion coefficients. And for L288: "the first versions" to "the first version"

L329: "$d\zeta_{j+1} = vd\zeta_j$" — It may be better to use the symbol χ instead of v here for the consistency with L86 where $\Delta\zeta_{j+1} = \chi\Delta\zeta_j$ is used.

L352: "'to33filtration' to "to filtration"

L367-402: The author mentioned in L632 that $\overline{\overline{N}}$ in RHS of Eq. (26) is very small. Is it possible to show the evolution of $\overline{\overline{N}}$ in Fig. 2? I expect $\overline{\overline{N}}$ is almost zero and does not vary with time as the nonlinear interaction only redistributes energy over spectral space and does not change the wave energy of the entire volume.

L429: "calculated by averaging ... 100 units of nondimensional time t" — This was already mentioned in L424-426. So maybe just simply say "The resulting wave spectra $S_h(r)$ are presented in Fig. 3."

L550-560: From Fig. 7 and Fig. 8 we know that the tail dissipation $D_t(r)$ is comparable to or even higher than the breaking dissipation $D_b(r)$. Is this an expected behavior of this wave model?

L611: Please clarify what is x in Fig. 9.

L632-675: It's very impressive that the shape of $N(r)$ shown in Fig. 11 is in good agreement with Hasselmann's integral. It also might be useful to mention that Hasselmann's integral exhibits another positive lobe at high frequencies. See, for example,

Hasselmann, S., K. Hasselmann, J. H. Allender, and T. P. Barnett, 1985: Computations and Parameterizations of the Nonlinear Energy Transfer in a Gravity-Wave Specturm. Part II: Parameterizations of the Nonlinear Energy Transfer for Application in Wave Models. Journal of Physical Oceanography, 15 (11), 1378-1392.

L707-709: the use of the symbols ω_p and k_w are not correct here as the author intends to say ω_w.

L711-714: the step shape of the curve for ω_p could be possibly resulted from the discrete nature of wave models and the method utilized to calculate ω_p. Rogers et al. (2012, JTech) showed the similar step-shaped evolution of peak period T_p (see their Fig. 3).

Rogers, E. W., A. V. Babanin, and D. W. Wang, 2012: ObservationConsistent Input and Whitecapping Dissipation in a Model for WindGenerated Surface Waves: Description and Simple Calculations. Journal of Atmospheric and Oceanic Technology, 29 (9), 1329-1346.

L727: "the wavenumber of spectral peak k_p" — Please use peak frequency ω_p for consistency with the caption of Fig. 13.

L734: "three-dimensional equations potential motion" to "three-dimensional equations of potential motion"

L756: "any observation data" to "any observational data"

L759: "which characteristics" to "of which characteristics"

L756-759: This argument appears too strong as β measured from field experiments, such as the one proposed by Donelan et al. (2006), is also proved well-performed in operational forecasts/hindcasts.

L764-767: This sentence does not read well. It sounds like "This approach was quite accurate " due to some drawback/weakness. Please reword it, and the right bracket ")" is missing in the end of this sentence.

L768: "(Chalikov, Rainchik, 2014)" to "(Chalikov and Rainchik, 2014)"

L805: "(Ducroset et al. 216)" to "(Ducroset et al. 2016)". Besides, the year shown here and in the References list is not consistent with L738 "(Ducroset et al. 2017)".

Please correct them if necessary.