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Effects of Deep Water Source-Sink Terms in 3rd generation Wave Model SWAN using different wind data in Black Sea

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Coastal development in Black Sea has increased in recent years. Therefore, careful monitoring of the storms and verification of numerical tools with reliable data has become important. Previous studies by Kirezci and Ozyurt (2015) investigated extreme events in Black Sea using different wind datasets (NCEP's CFSR and ECMWF's operational datasets) and different numerical tools (SWAN and Wavewatch III). These studies showed that significant effect to results is caused by the deep water source-sink terms (wave growth by wind, deep water dissipation of wave energy (whitecapping) and deep water non-linear wave-wave interactions). According to Timmermans(2015), uncertainty about wind forcing and the process of nonlinear wave-wave interactions are found to be dominant in numerical wave modelling. Therefore, in this study deep water source and sink term solution approaches of 3rd generation numerical tool (SWAN model) are tested, validated and compared using the selected extreme storms in Black Sea.

45 different storms and storm like events observed in Black Sea between years 1994-1999 are selected to use in the models. The storm selection depends on the instrumental wave data (significant wave heights, mean wave period and mean wave direction) obtained in NATO-TU Waves project by the deep water buoy measurements at Hopa, Sinop, Gelendzhik, and wind data (mean and peak wind speeds, storm durations) of the regarding events.

2 different wave growth by wind with the corresponding deep water dissipation terms and 3 different wave –wave interaction terms of SWAN model are used in this study. Wave growth by wind consist of two parts, linear growth which is explained by Cavaleri and Malanotte-Rizzoli(1981),and dominant exponential growth. There are two methods in SWAN model for exponential growth of wave, first one by Snyder et al. (1981), rescaled in terms of friction velocity by Komen et. al (1984) which is derived using driving wind speed at 10m elevation with related drag coefficient (WAM Cycle 3).The second method follows the quassi linear wind-wave theory by Janssen(1989,1991) which also considers the atmospheric boundary layer effects and the roughness length of the sea surface (WAM Cycle 4).(SWAN Technical Documentation,2015) The dissipation caused by whitecapping depends on the steepness of the waves. There are two different steepness dependent coefficient configurations in SWAN model corresponding to the selected wind-wave interaction formulations which are mentioned above (Komen and Janssen approaches). Lastly ,there are 3 options for defining deep water non-linear wave-wave interaction, which are DIA(Discrete Interaction Approximation)by Hasselman (quadruplets), XNL(which is based on the original six-dimensional Boltzmann integral formulation of Hasselmann), and multiple DIA which considers up to 6 wave number configurations by Hashimoto et al. (2002).(SWAN Technical Documentation,2015)

In this study, 540 test cases are modelled using all possible selections of deep water source and sinks approaches available in SWAN model. The computed results are compared with buoy measurements. The uncertainty due to different source sink selections are quantified using different statistical analysis. Preliminary results show that some of the term configurations predict the significant wave height (Hs) less than actual values measured at the buoy locations. One of the reasons of the underestimation of the wave parameters could be the lower wind speed estimated in closed basins and the other one is the uncertainties in the wind-sea interaction. All of the results, comparisons and discussions will highlight the best source sink approach to be used to model extreme wave events in Black Sea.

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