Projections of wind-waves in South China Sea for the 21st century

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IPCC-coordinated work has been completed within Fourth Assessment Report (AR4) to project climate and ocean variables for the 21st century using coupled atmospheric-ocean General Circulation Models (GCMs). GCMs are not having a wind-wave variable due to a poor grid resolution; therefore, dynamical downscaling of wind-waves to the regional scale is advisable using well established models, such as Wave Watch III (WWIII) and SWAN.

Rectilinear-coordinates WWIII model is adapted for the far field comprising the part of Pacific and Indian Oceans centered at the South China Sea and Sunda Shelf (90 °E-130 °E, 10 °S - 26.83 °N) with a resolution of 10' (about 18 km). Near-field unstructured-mesh SWAN model covers Sunda Shelf and centered on Singapore Strait, while reading lateral boundary values from WWIII model. The unstructured grid has the coarsest resolution in the South China Sea (6 to 10 km), medium resolution in the Malacca Strait (1 to 2 km), and the finest resolution in the Singapore Strait (400 m) and along the Singapore coastline (up to 100 m). Following IPCC methodology, the model chain is validated climatologically for the past period 1961-1990 against Voluntary Observing Ship (VOS) data; additionally, the models are validated using recent high-resolution satellite data.

The calibrated model chain is used to project waves to 21st century using WRF-downscaled wind speed output of CCSM GCM run for A1FI climate change scenario. To comply with IPCC methodology the entire modeling period is split into three 30-years periods for which statistical parameters are computed individually. Time series of significant wave height at key points near Singapore and on ship sea routes in the SCS are statistically analysed to get probability distribution functions (PDFs) of extreme values. Climatological maps of mean and maximum significant wave height (SWH) values, and mean wave period are built for Singapore region for each 30-yrs period. Linear trends of mean SWH values for northeast (NE) and southwest (SW) monsoons have been derived.

The maximum values of predicted 100 year return period (YRP) SWH are obtained for the 1st 30-yrs period (2011-2040). In the deep eastern part of the Singapore, 100yrp SWH are 2.4 - 2.8 m, whereas those at the shallow nearshore areas are 1.7-2.3 m. On the ship routes at Sunda Shelf the 100 YRP SWHs are 1.1 - 3.2 m, and those at the SCS routes are 3.6 - 10.4 m. The biggest changes in future against hindcasted SWH is in first 30-yrs, where extreme 100 YRP SWH will grow up in the range from 36%-120% at points near Singapore and to 39%-108% at ship sea routes.