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Statistical Downscaling of Storm Surges in Singapore Strait

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Projection of storm surges for the 21^{st} century is an essential part of global climate change science. Unlike Regional Climate Models (RCMs), coarse computational grids of current Global Climate Models (GCMs) can not resolve sea level extremes around small islands, such as Singapore; therefore, application of various downscaling techniques is required. One of the available options (von Storch and Reichardt, 1997; IPCC, 2007) is to use statistical downscaling method for estimation of future storm surges, where an empirical relationship between historical large-scale synoptic conditions (such as wind speed and atmospheric pressure) and observed local sea level extremes are constructed; and then utilised for assessment of future sea level extremes using synoptic parameters projected by GCMs. Additionally, downscaling of driving synoptic parameters with RCMs is required in many cases.

Comparison of tidal gauge data in Singapore Strait versus NCEP wind offshore of Vietnam shown that there is a significant correlation of sea level anomalies (SLAs) in Singapore Strait on wind in the South-China Sea. The daily mean sea level in Singapore Strait may increase gently for a few days up to 50-70 cm due to the remote strong north-east (NE) wind. These cases are more frequent during NE monsoons (December-January) characterised by a persistent wind often exceeding 15 m/s (6-hourly). The empirical formulae relating storm surge height to the wind speed offshore of Vietnam is fitted using power function.

Ten GCMs, including BCCR, CCCMA, CNRM, CSIRO, GFDL, IPSL, MIUB, MPI and MRI, have been used to build distribution functions of wind speed projections for the specific region of the South-China Sea. The wind distribution functions have been converted into storm surge distribution functions using the developed empirical relationship for past storm surges. There is an increase of percentage of 50cm SLA between 1 and 3% from overall number of SLA events as well as existence of small but non-zero probability of 1 m storm surge. Since, the projected storm surges have been driven by GCM-projected wind, and the wind projections do not show a consistent upward trend, the increased number of high storm surge events could be attributed to a natural variability rather than to the global climate change.

References

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