A Markov track model for simulating Typhoon Tracks in North-Western Pacific Ocean

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Abstract. Typhoons cause enormous damage to infrastructure and lives and more so to developing countries in the region. Hence, to manage and mitigate this natural hazard, robust estimates of typhoon risks are necessary. Historical data is limited in length and incomplete in its variability. Thus, a methodology to generate a rich variety of realistic typhoon scenarios and the associated land fall risk along the coastal regions of their impact is important. We propose a spatial Markov track simulation model. In this, the domain is divided into 5x5 grids, and a typhoon in a grid box has ten states to transit to in the following 6-hour period – they are moving into one of the 8 neighboring grids, staying or fizzling out in the same grid. Based on historical 6-hourly typhoon track data (for the period 1951 – 2013) transition probabilities are computed. Typhoon origination probabilities are also computed for each grid box. A track is initiated from one of the grid boxes based on the origination probabilities and it is propagated by the spatial Markov transition probabilities. A large number of synthetic tracks are generated for the spatial Markov probabilities from which estimates of land falling risks can be computed for different coastal segments.
Wind speed magnitudes at each time step can be generated by K-nearest neighbor resampling of the speeds of the historical tracks within each grid box based on the speed of the previous time step. The Markov probabilities can also be estimated conditioned on large scale climate features that impact typhoon tracks to then generate track scenarios for any given year enable seasonal projection.