M.Sc thesis topic 2021-2022

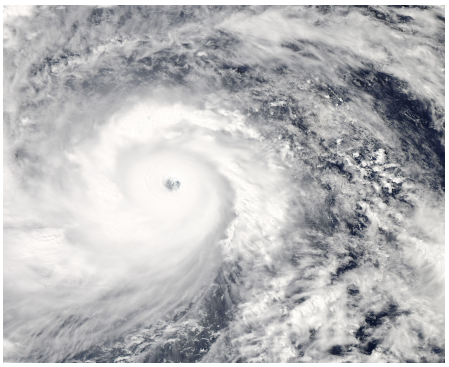
Stochastic Simulation of Rainfall Fields in Tropical Cyclones for Flood Risk Assessment

Description:

Torrential rain from tropical cyclones can have a devastating impact, causing loss of life and billions in damages. To better understand the risk faced by coastal communities, scientists need to estimate how often a tropical cyclone of a given magnitude makes landfall and how the rainfall within the cyclone is distributed and space/time.

Challenge:

The spatial distribution of rainfall within a tropical cyclone can be highly heterogeneous and variable. Accurate prediction of key features such as rain bands, orographic enhancement and asymmetry still represents a major challenge for numerical weather models. Also, the large computational cost of simulating thousands of different scenarios using numerical weather models can be prohibitive. For risks assessments, it might therefore be interesting to have simpler, computationally more efficient stochastic models of rainfall within tropical cyclones.



Project Goals and work plan:

You will work in collaboration with Deltares to add new functionalities to the Tropical Cyclone Wind Statistical Estimation Tool TCWiSE (https://www.deltares.nl/en/software/tcwise/) used to simulate realistic storm tracks and wind fields for risks assessments. TCWiSE offers many functionalities but currently lacks the ability to generate large ensembles of rainfall fields with realistic spatial and temporal structures, which are needed for pluvial flood risk assessments. The goal of this project will be to implement such a simulator. More specifically, you will have three major tasks:

1) formulate conceptual models (based on physics and observations) for characterizing the spatial structure and variability of rainfall within tropic cyclones, focusing on radial profiles, rain bands, spatial autocorrelation and asymmetry, extending the Msc thesis by Judith Claassen https://repository.tudelft.nl/islandora/object/uuid%3Af932c240-db8c-47b3-bef6-68415def0ccd?collection=education.

2) develop a stochastic simulator capable of generating large numbers of synthetic rainfall fields based on prescribed storm tracks and environmental conditions such as pressure and wind. The simulator itself could be based on geostatistical simulation techniques or machine learning.

3) use the simulated rainfall fields as inputs to perform risk assessments and quantify differences in risks and return periods compared to the status quo (e.g., deterministic vs stochastic rainfall patterns, with/without rain bands).

Outcome:

A report (or published article) describing the models and the methodoogy as well as a documented code that can be used by Deltares for further research.

Boundary conditions:

In principle, the candidate will work at an office at Deltares (depending on availability and Covid-19 measures) and will receive a monthly allowance. The candidate must first pass an interview with Deltares before being allowed to work on this topic.

For more information:
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