Latest Insights into the Use of MÉRA Data for the Simulation of Storm Surges

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Slides: available upon request.

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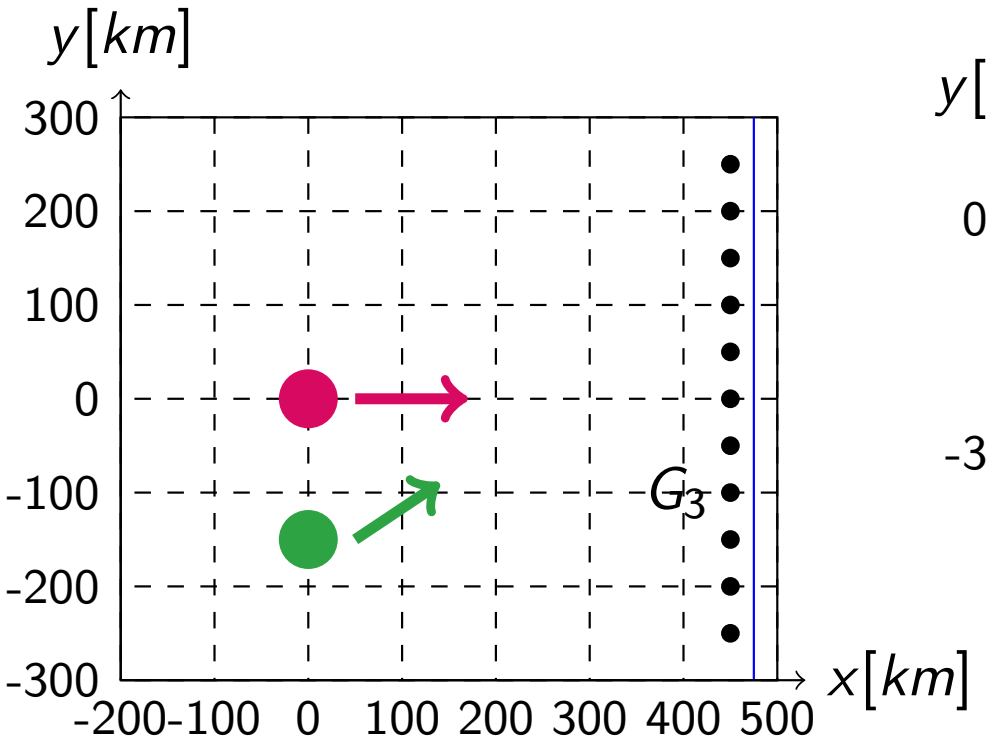
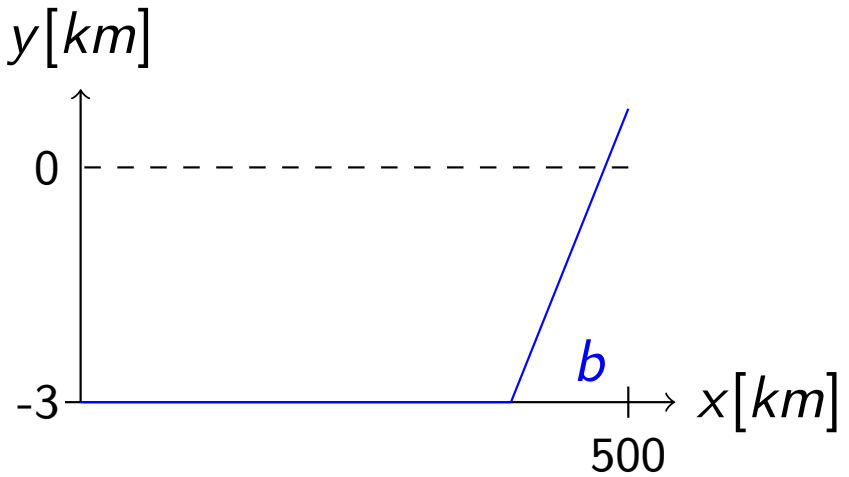
An Chomhairle um Thaighde in Éirinn

Example: Simplified Storm Approaching a Steep Coast

Domain (Top view)



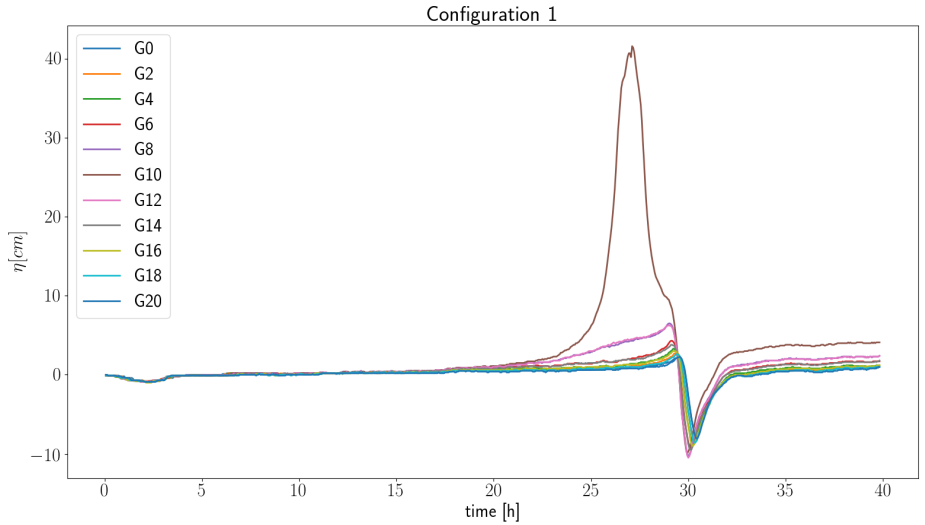
Bathymetry (Crosssection)



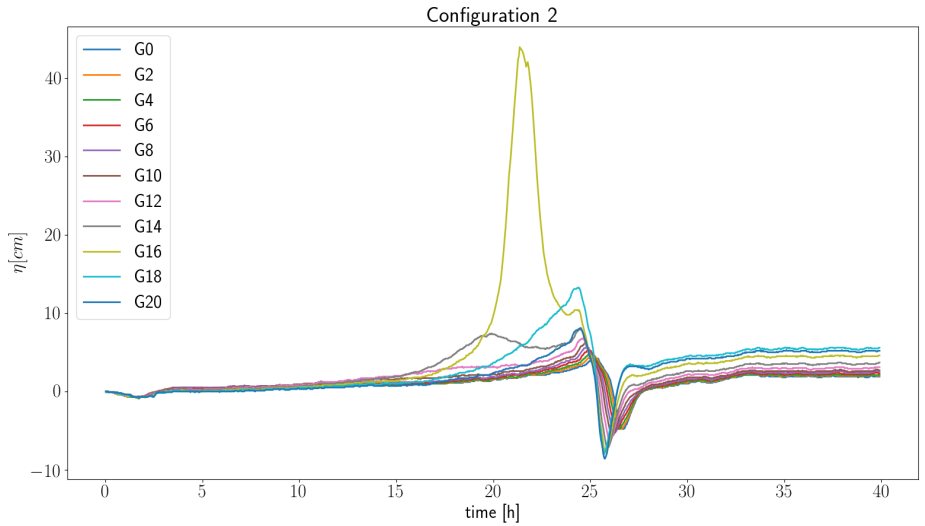
Incoming waves are measured at G_k .
$10^{-2} = (4.5, -2.5 + 0.5k)^\top [km]$.

(Beisiegel et al., 2019 (in prep))

Example: Numerical Gauge Data



Storm approaching in 0° angle at $5m/s$



Storm approaching in 45° angle at $5m/s$

Holland's Model for Wind Stress

In general the wind stress is a term of the form

$$\boldsymbol{\tau}(\mathbf{x}) = c_d \rho_a |\mathbf{v}| \mathbf{v}$$

where c_d is the drag coefficient and ρ_a is the air density which we assume to be 1.15 $[kgm^{-2}]$.

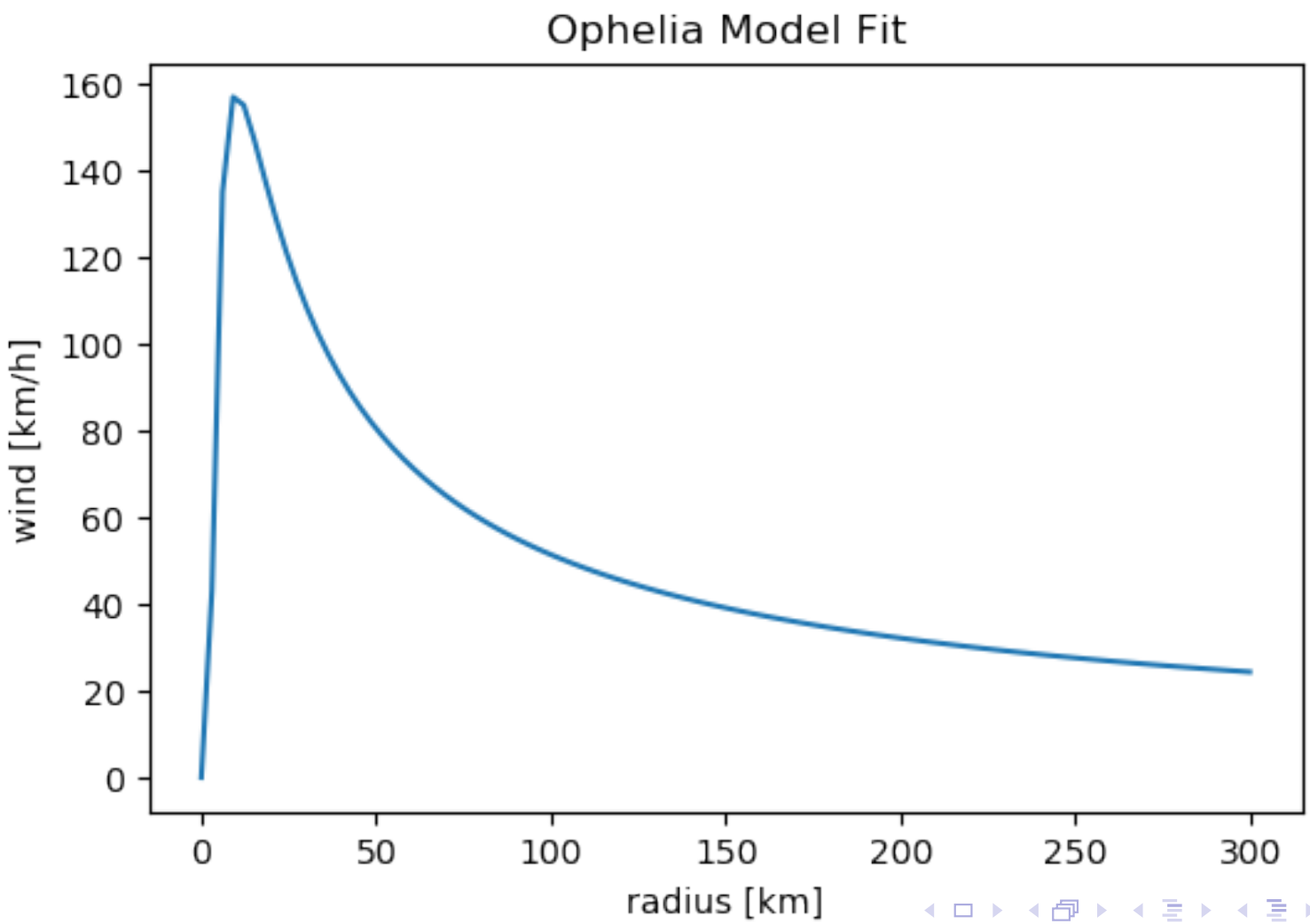
The wind $\mathbf{v}$ can be computed as:

$$C = \frac{AB(p_n - p_c)}{\rho_{air}}$$

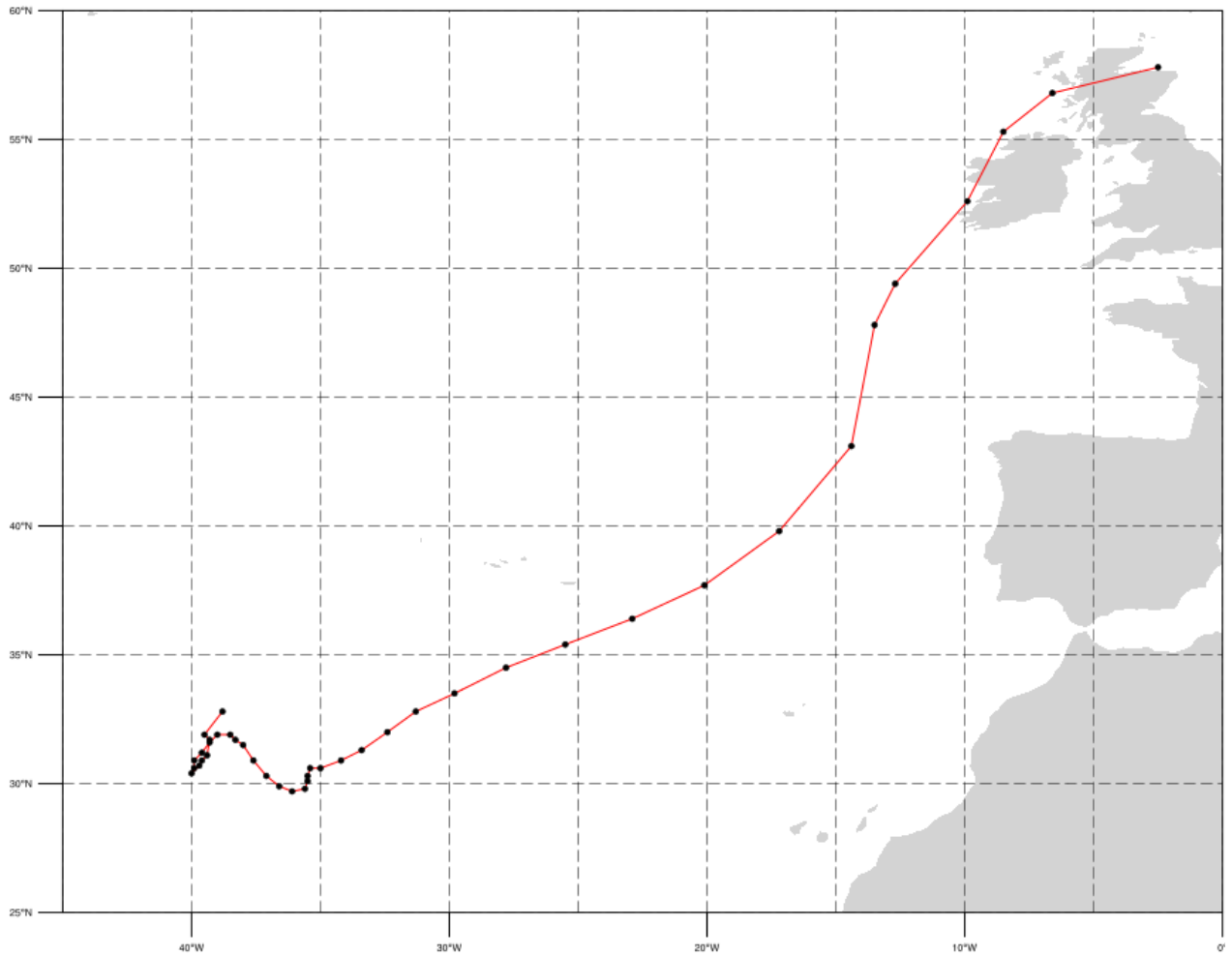
$$(\mathbf{v} \cdot n) = \sqrt{C * \frac{\exp \frac{-A}{r^B}}{r^B} + \frac{r^2 \ f^2}{4}} - \frac{r \ f}{2}$$

Example: Ophelia - Holland's Model Example

Chosen parameters: A= 24.55, B= 1.39:



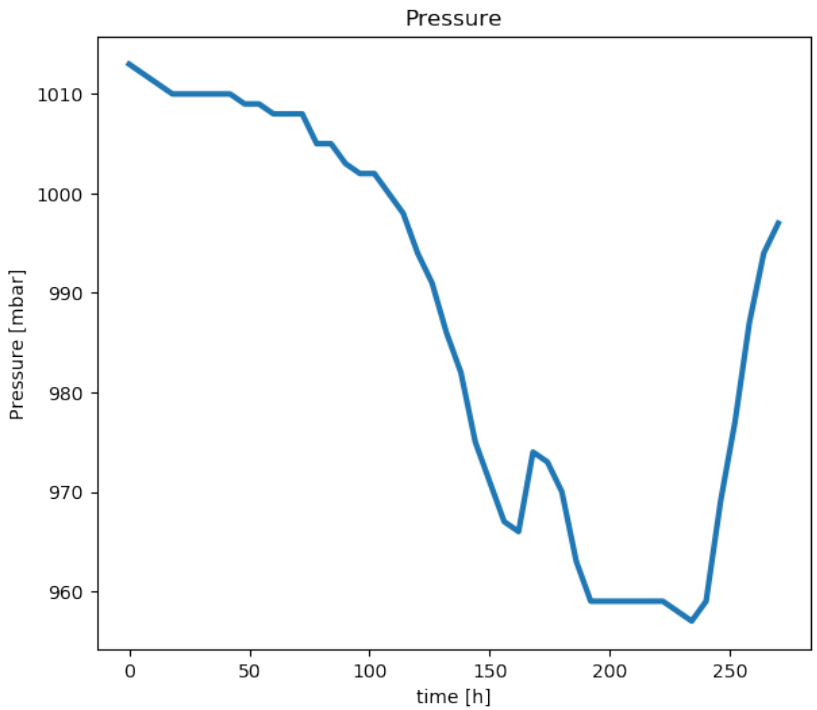
Ophelia - Storm Track (using ERA5 Data)



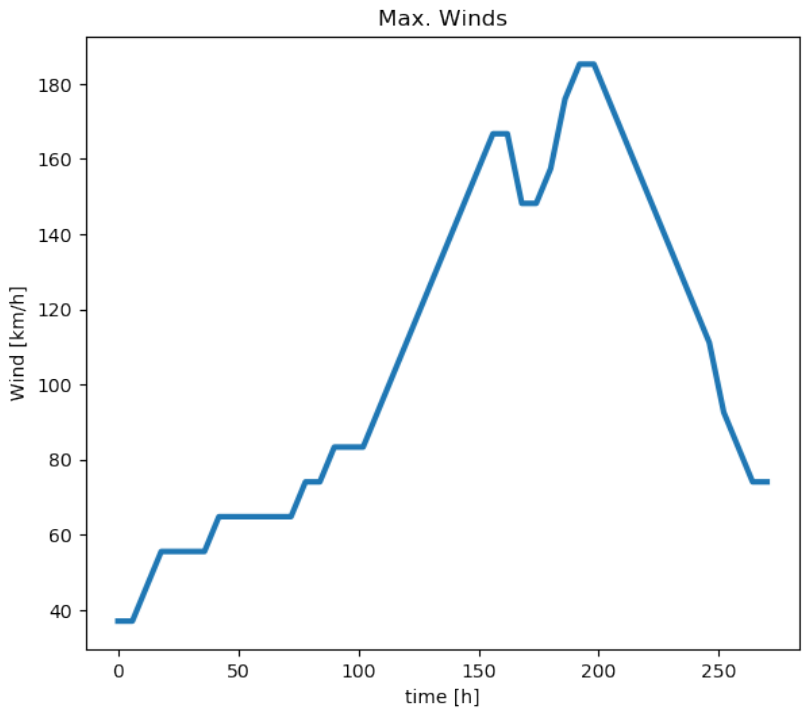
(McGrath, 2019 personal communication)

Ophelia - Best Track from the National Hurricane Centre

Central Pressure



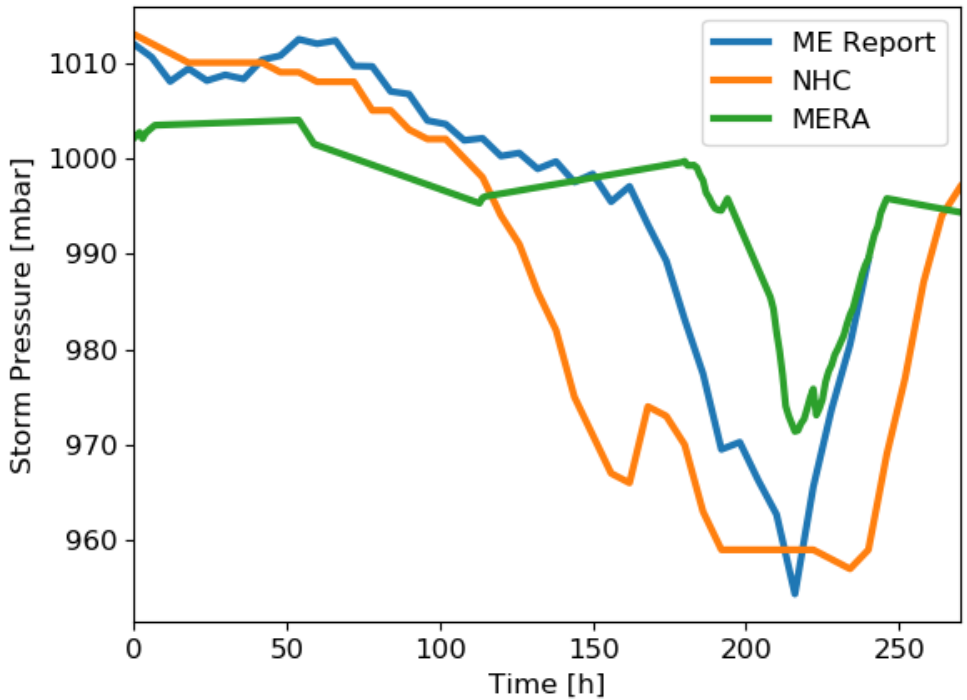
Maximum Winds



Ophelia - Comparison of Different Data Sources

Observation:

- Small domain ⇒ storm detected late
- MÉRA does not capture low central pressure

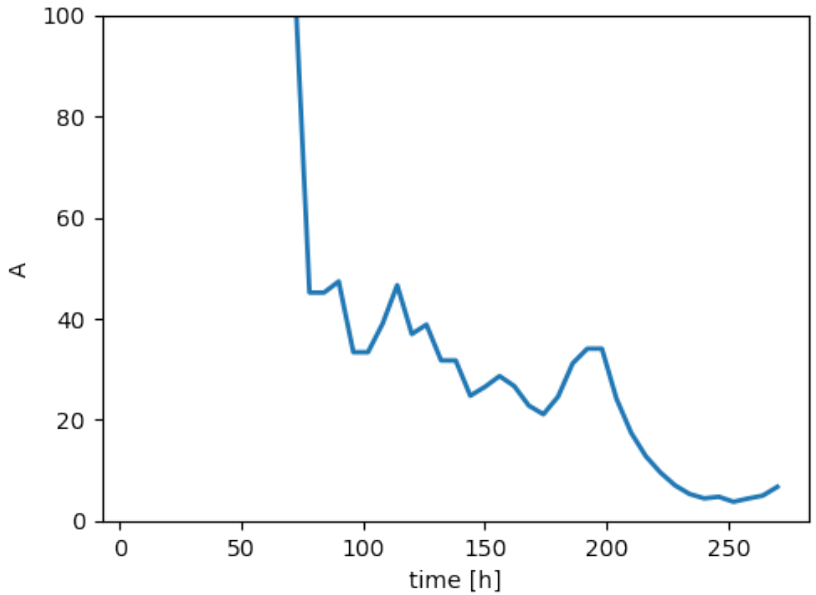


Input Data for DG Model

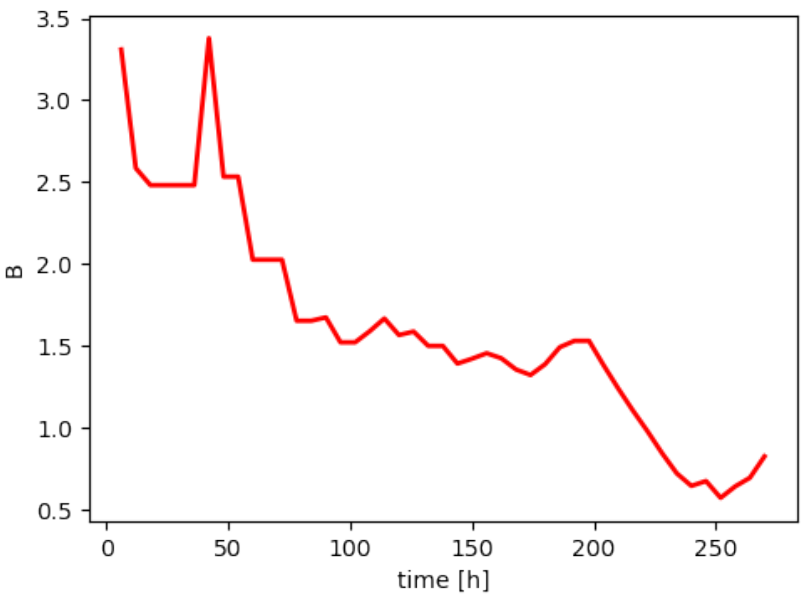
Does it matter?

Ophelia - Holland's Parameters over Time

Shape Parameter A

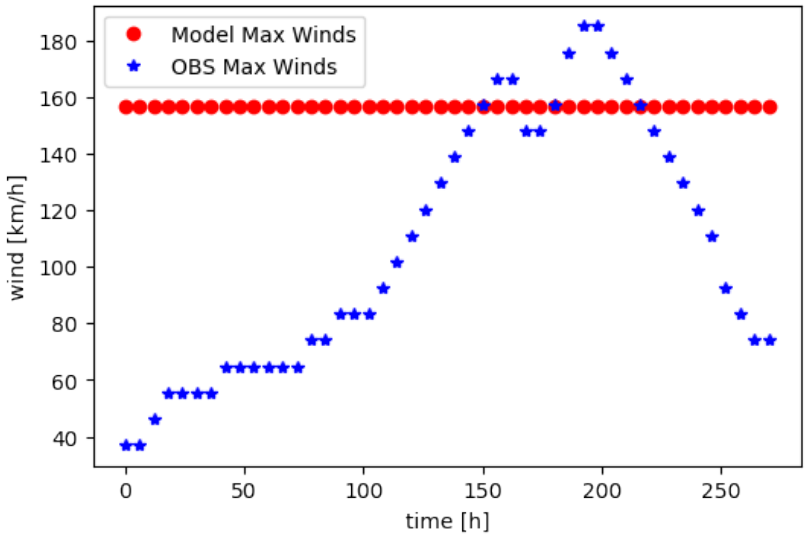


Shape Parameter B

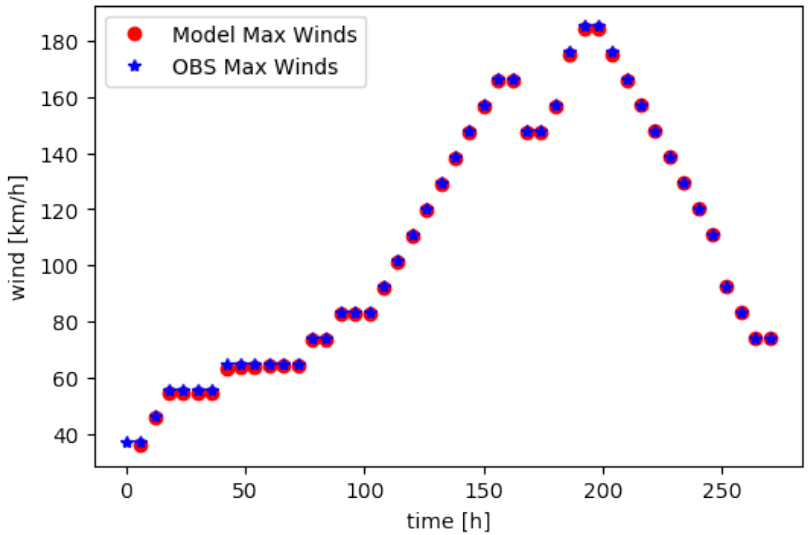


Ophelia - Model Output Maximum Winds

Mean Parameters $\overline{A}$ and $\overline{B}$

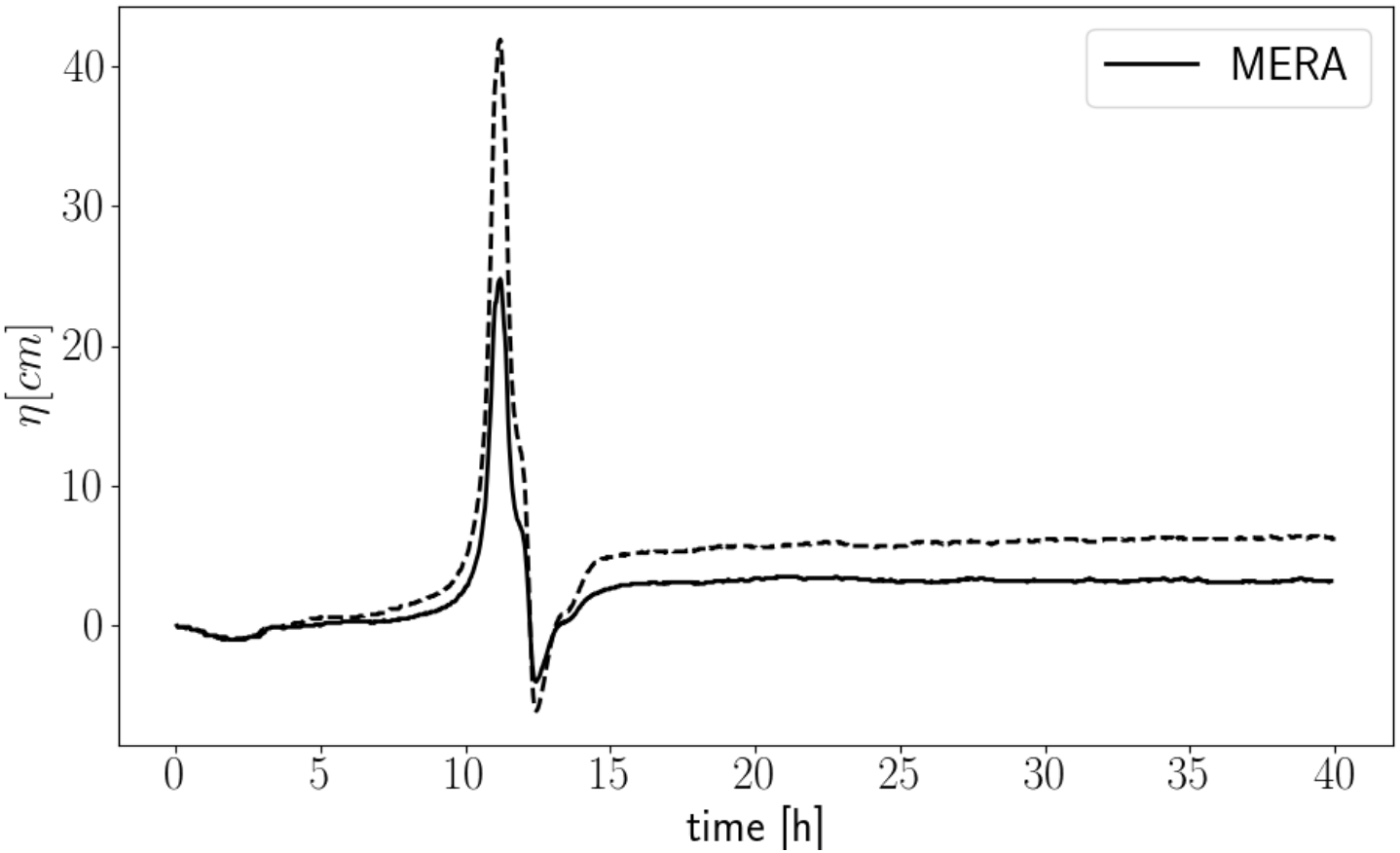


Variable Parameters A and B



Model Simulation – Comparison $p_c = 975$ vs $p_c = 955$

Simplified Flooding with Holland's model



Summary & Conclusion

- Presented Discontinuous Galerkin Model can simulate storm surges and reproduce important physical features
- Extracting depressions from MÉRA data is difficult
- Realistic shape parameters for source model vary in time
- Varying shape parameters influence flooding
- Outlook: Run with realistic bathymetry data.