Technische Universität Braunschweig

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Combined neural network and numerical modeling for extreme storm surges

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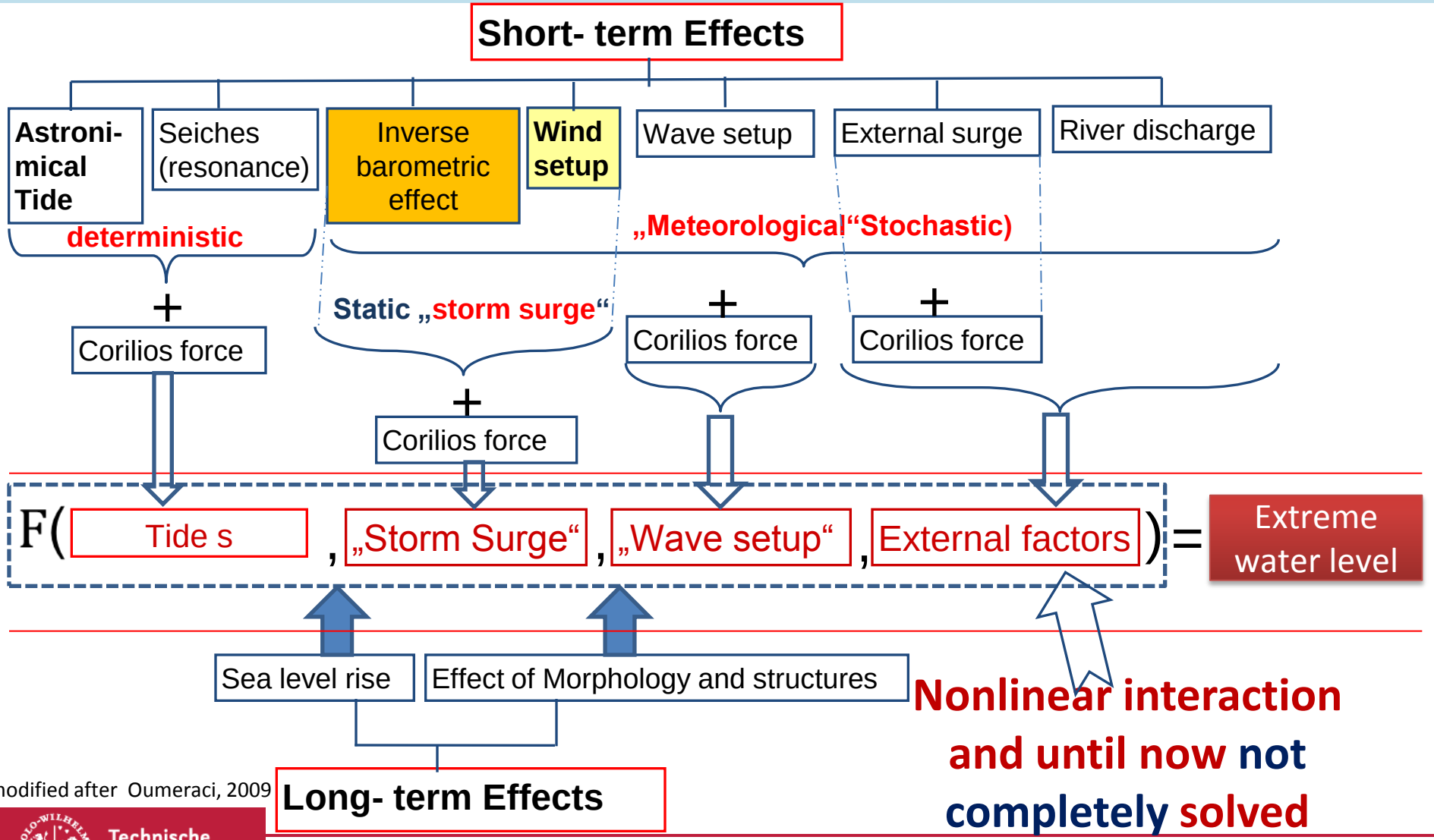
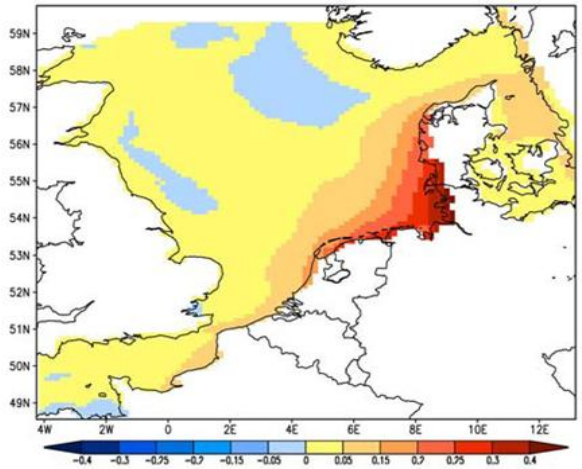
Motivation and background



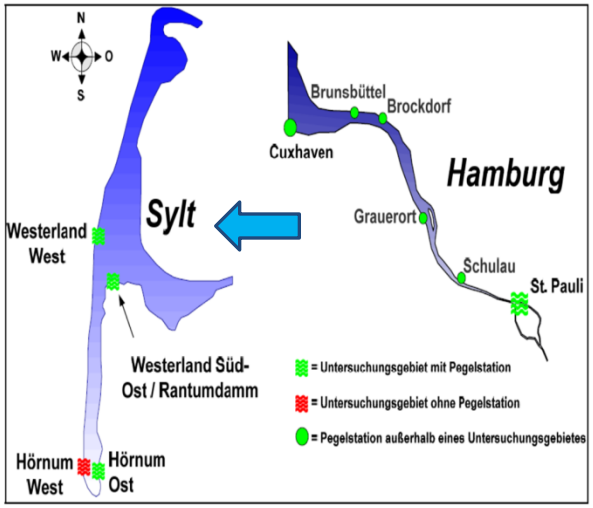
modified after Oumeraci, 2009

Objectives

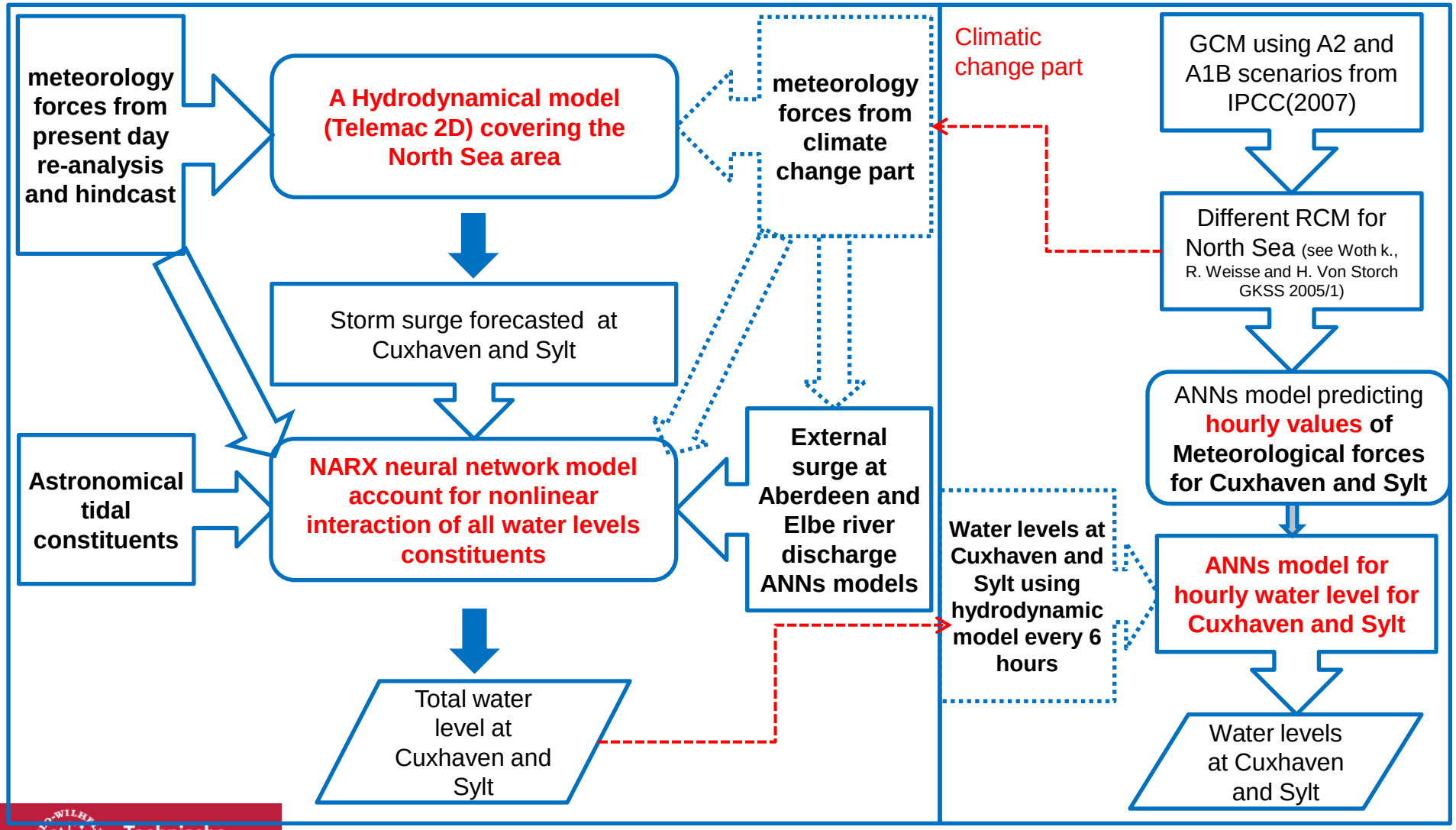
- Developing an "operational model" which combines ANN and numerical modelling.
- Determination of the worst extreme water level, which is physically possible in the 21st century at a given site.
- Building ANNs model to relate and predict extreme water levels at a given site (e.g. Sylt) using data from a neighbouring site (e.g. Cuxhaven).
- Filling water levels data gaps for given sites.



Grossmann I., K. Woth and H. Von Storch Die Küste 2005



Methodology



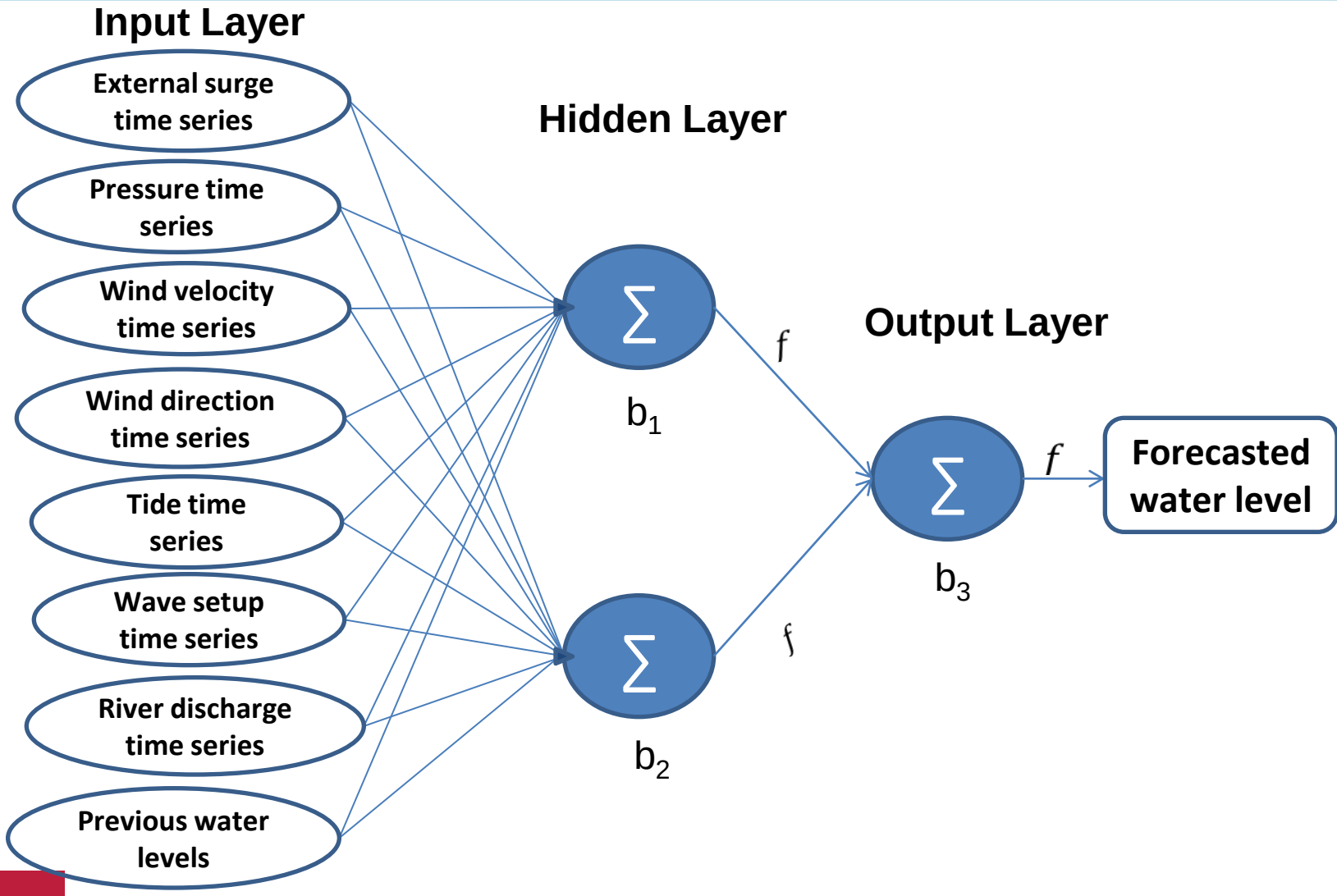
First key results I

First phase

Optimal structure and input parameters

Second phase:

Effect of previous water levels

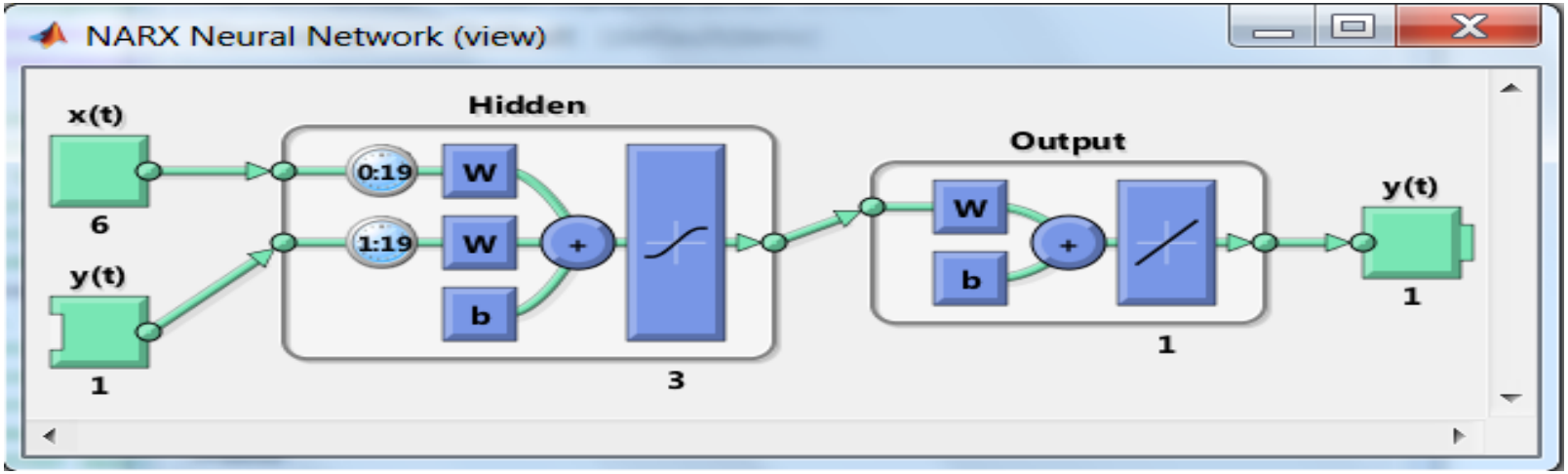


First key results II

Previous time steps	Correlation Coefficient	Error Index (EI)
1	0.887	0.097
2	0.950	0.065
3	0.955	0.062
4	0.962	0.057
5	0.962	0.057
6	0.964	0.056
7	0.966	0.055
8	0.967	0.053
9	0.968	0.053
10	0.969	0.052
11	0.968	0.053
12	0.971	0.050

Previous time steps	Correlation Coefficient	Error Index (EI)
13	0.973	0.048
14	0.973	0.049
15	0.972	0.049
16	0.974	0.047
17	0.974	0.047
18	0.974	0.048
19	0.975	0.047
20	0.973	0.049
21	0.974	0.047
22	0.974	0.047
23	0.972	0.049
24	0.974	0.047

First key results III



$$y(t) = f\{u(t - D_u), \ldots., u(t), y(t - D_y), \ldots., y(t - 1)\}$$

cc= 0.99 and EI= 0.009

Summary

- Combining ANNs with numerical modelling allows to:
  - account for nonlinear interaction of water levels constituents.
  - reduce the training data for ANNs and provide water levels predictions every hour instead of every 6 hours by RCM meteorological forces.
  - provide a powerful and computationally efficient modelling techniques.
- Applications as an operational model for:
  - filling the gaps in long-term data series by using sequential time series predictions at given site.
  - water levels retrieval at given remote site (e.g. Sylt) based on a long-term data recorded at neighboring sites (e.g. Cuxhaven).

Vielen Dank für Ihre Aufmerksamkeit

Thank you