

Predicting extreme weather and sea level for nuclear power plant safety - PREDICT

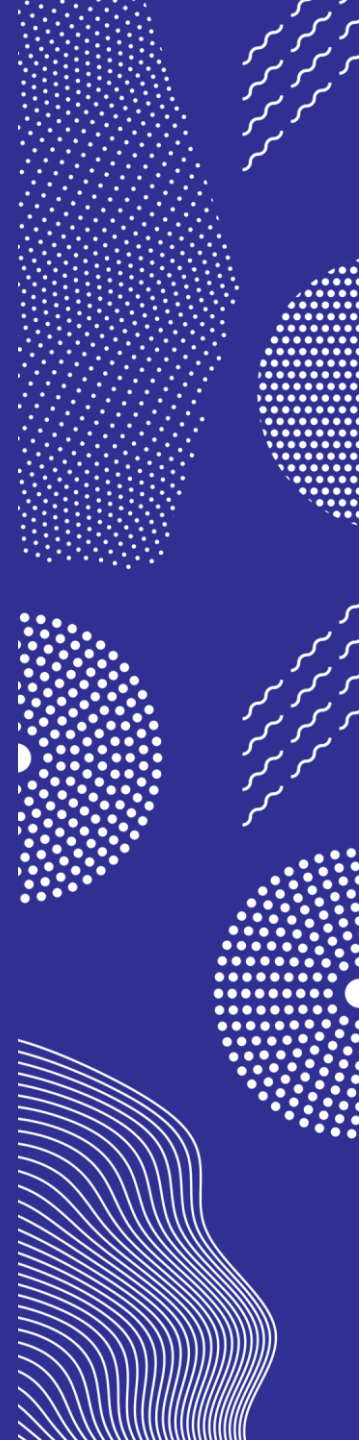
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Finnish Meteorological Institute

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Background

- Any **exceptional weather and sea level event** or combination of events that might affect **any component of the safety system** of an NPP unit is a **potential threat** to nuclear safety.

Objectives

- To produce **hazard curves** of safety-relevant single and compound extreme weather and sea level events in the **changing climate**.
- To **develop methods** for assessing probabilities of occurrence of the events at various time scales.

Results exploitation

- the determination of the design basis for a new NPP unit,
- probabilistic risk assessments (PRA) of new and existing NPPs
- periodic safety reviews of existing NPPs.



**Statistics of
intense coastal
snowfall**

**Probabilistic
forecasts of
strong winds**

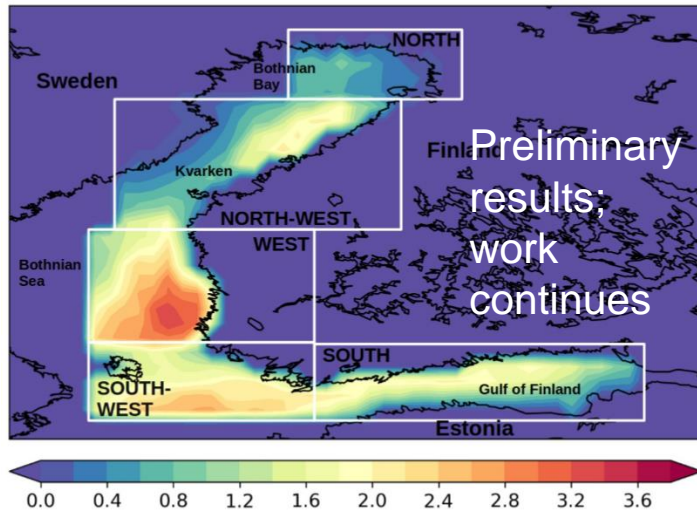
**High sea level
jointly with
heavy precipitation**

**Return level
estimates of
sea level height**

**Studying
unprecedented
events of
extreme sea level**



Intense coastal snowfall

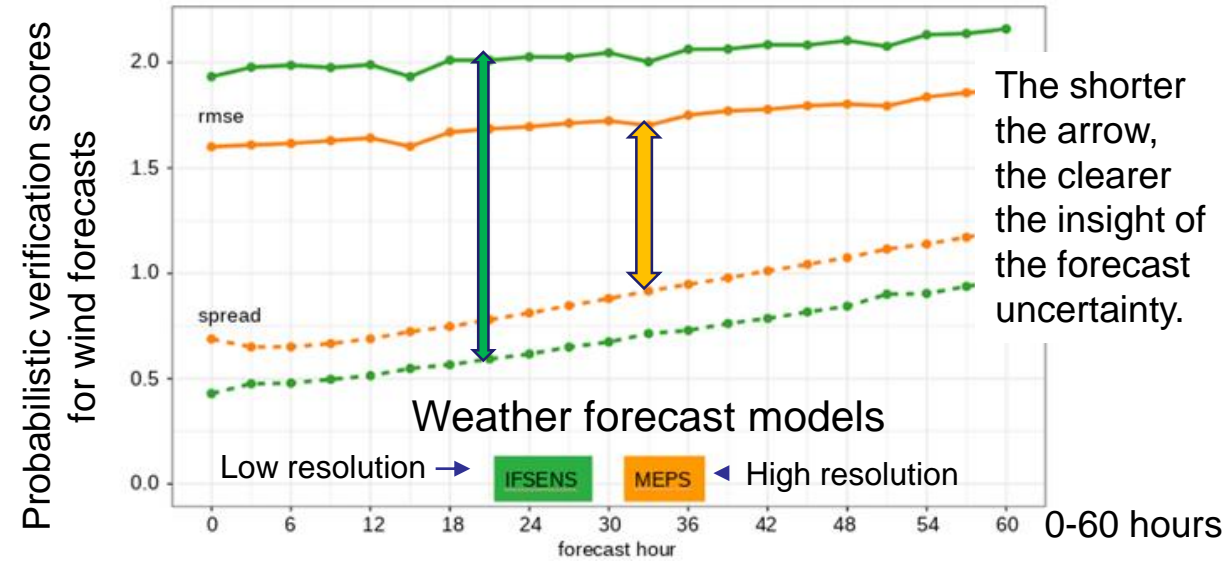


- The mean annual number of days favouring **coastal sea-effect snowfall** to occur in 1979-2018: highest in **western coast** of Finland (average 8, range 1-18 days per year in that domain).
- Trends in time: research continues using a longer period of data (1961-2020).

NPP relevance of very intense snowfall:

Loss of offsite power; possible blockage of ventilation air intakes depending on the site; isolation of the plant

Forecasts of strong winds

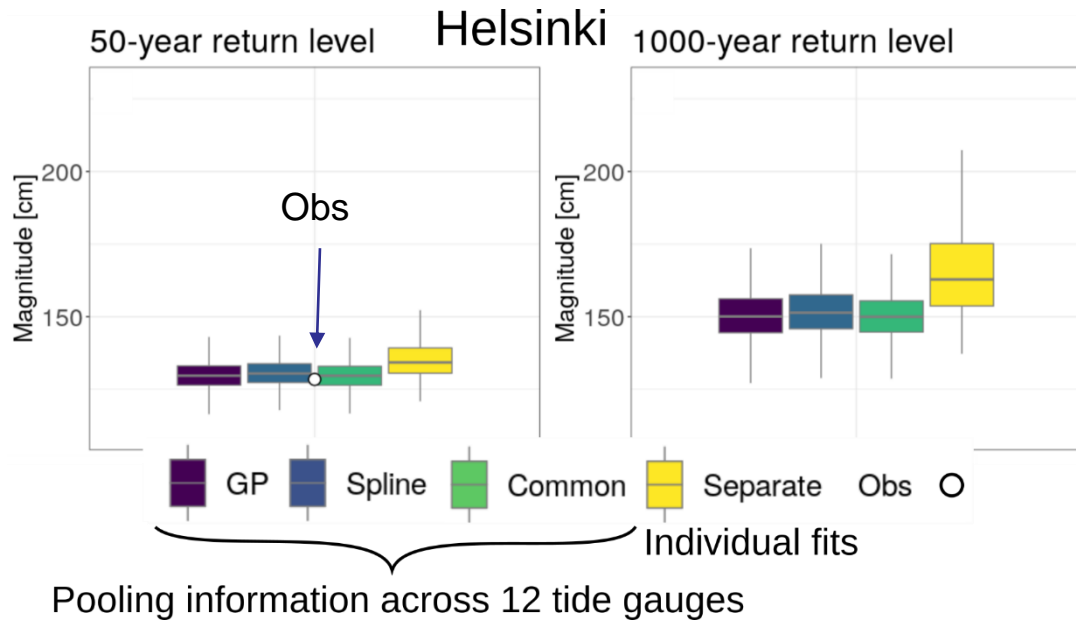


- **Probabilistic forecasts** of 10-min **wind speeds** and wind gusts 0-2.5 days ahead: **high-resolution models** perform better than low resolution models do.
- The higher resolution and probabilistic approach both provide additional support for **decision making** in case of nuclear emergency.

NPP relevance of very strong winds (10-min and gusts):

- *Loss of offsite power due to objects carried by wind to the switchyard or due to structural damage of power line pylons; possible damage to buildings*
- *Dispersion of radioactive releases*

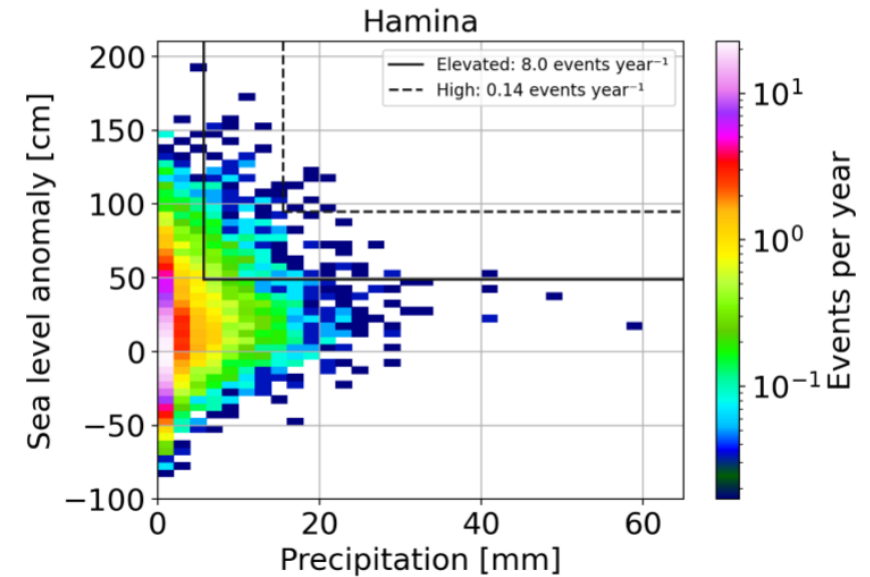
Estimates of extreme sea levels



- Alternative Bayesian hierarchical descriptions for the parameters of the Generalized Extreme Value (GEV) distribution.
- Pooling information across 12 tide gauges **reduced the range of uncertainty** in the return level estimates.
- Synthetically generated low-pressure systems as a tool for studies of **unprecedented** events of extreme sea levels.



High sea level jointly with heavy precipitation



- Simultaneously occurring **two or more external events** may cause **more severe consequences** than single incidents alone.
- **Co-occurring sea level and precipitation extremes:**
 - Most common in late autumn and early winter.
 - Mainly caused by passing low-pressure systems.
 - Statistically significantly **increasing trends** in the annual frequency at Kemi and Oulu during 1961-2019.

NPP relevance: *If beyond the design basis: flooding of safety-critical compartments, especially electric power supply and control systems; severe consequences if the seawater has time to penetrate into the buildings. Reactor trip at lower sea levels.*

Concluding remarks

- ✓ The topics to be studied have been selected based on feedback and enquiries from the end-users:
 - the power companies designing and running the Finnish nuclear power plants, and
 - the nuclear safety authorities defining the safety regulations for constructions of and operations in the power plants.
 - Ad hoc meetings in June 2019, Sep 2019 and Sep 2020 (virtual)
 - PREDICT workshop on probabilistic forecasting in Oct 2019

Evaluations of the deliverables in 2019-2020

Exploitation of the results (by authorities or power companies or in research):

within 0-2 years (7) later (4) no use () cannot say ()

by authorities (7) power companies (9) in research (7)



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Thank you for your interest!

Further information:

<https://en.ilmatieteenlaitos.fi/predict>

