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Fukushima accident: Uncertainty of atmospheric dispersion modelling NKS-B project FAUNA

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12.09.2018 NKS-AVESOME Seminar

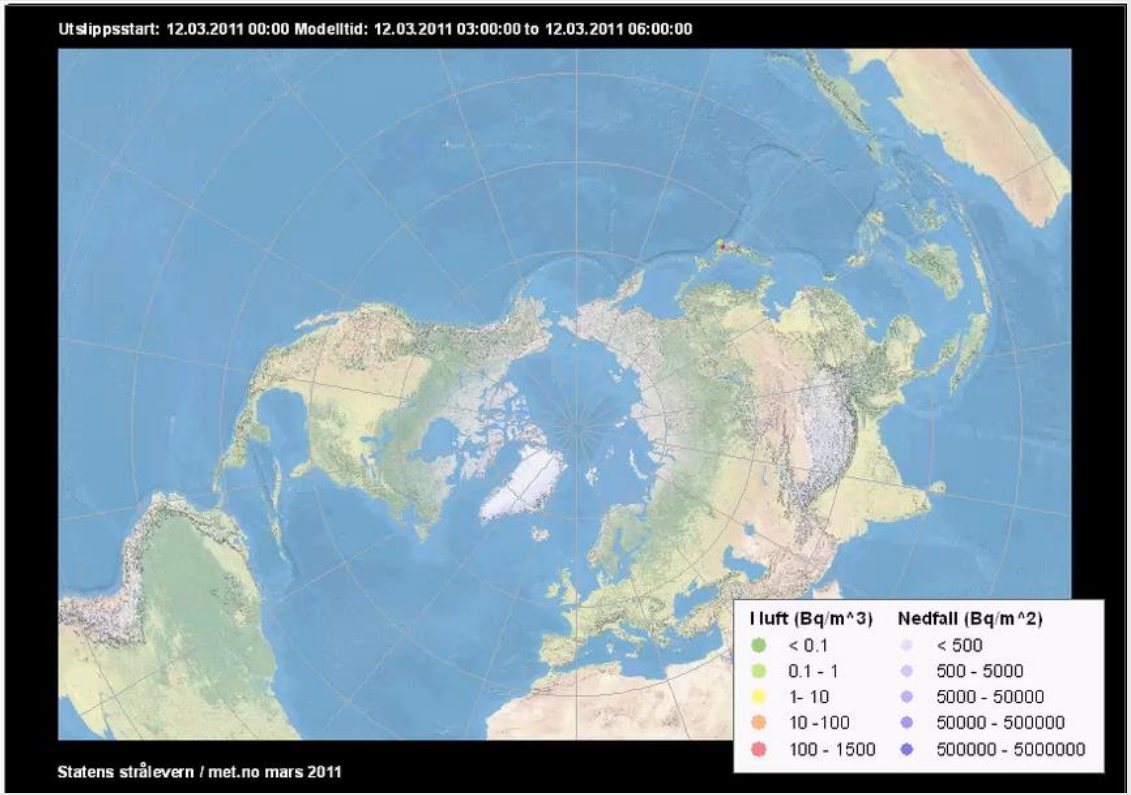
Objectives of FAUNA

- Apply ensemble-statistical methodology from MUD to Fukushima Daiichi NPP accident
- Address real-time forecasting of atmospheric dispersion and depositions taking into account meteorological uncertainties
- Implement uncertainties in decision support systems
- Investigate implications of uncertainty estimates for emergency management

Fukushima Daiichi NPP accident

- Level 7 major accident caused by tsunami following an earthquake, 11 March 2011 in Japan
- Loss of cooling due to disabled power generators
- Hydrogen-air explosions and release of radioactive material in 3 units
- Atmospheric release from 12 March to beginning of April

Real time (during accident) simulation



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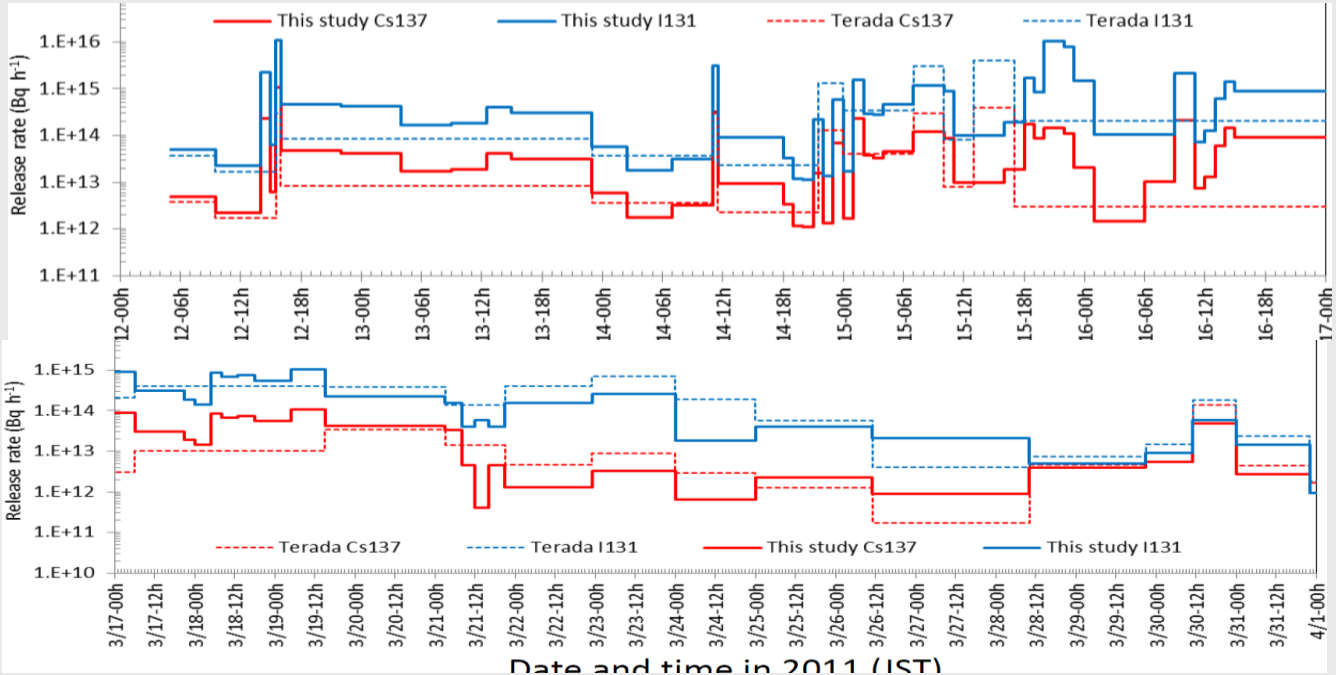
Release rates



- Katata et al. (2014) estimates of I-131 (blue) and Cs-137 (red)
- Based upon Terada et al. (2012, dashed line) and Chino et al. (2011), reverse estimations from daily and monthly measurements
- Used without ‘uncertainties’ within FAUNA

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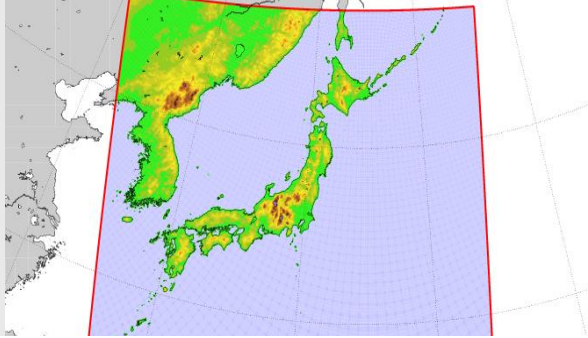
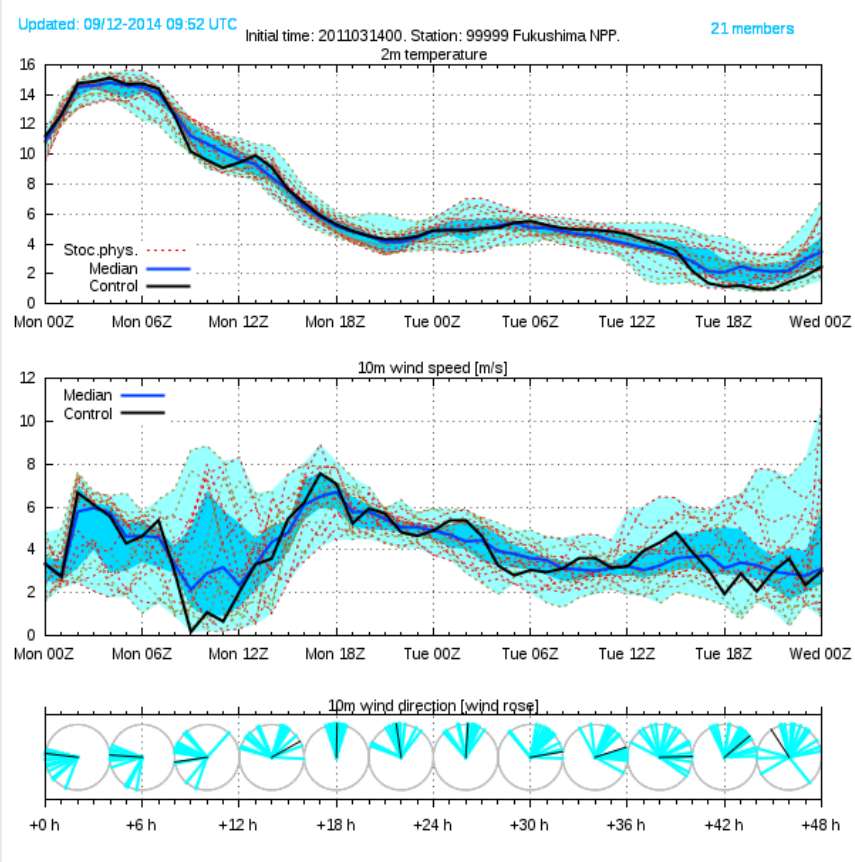
Meteorology used

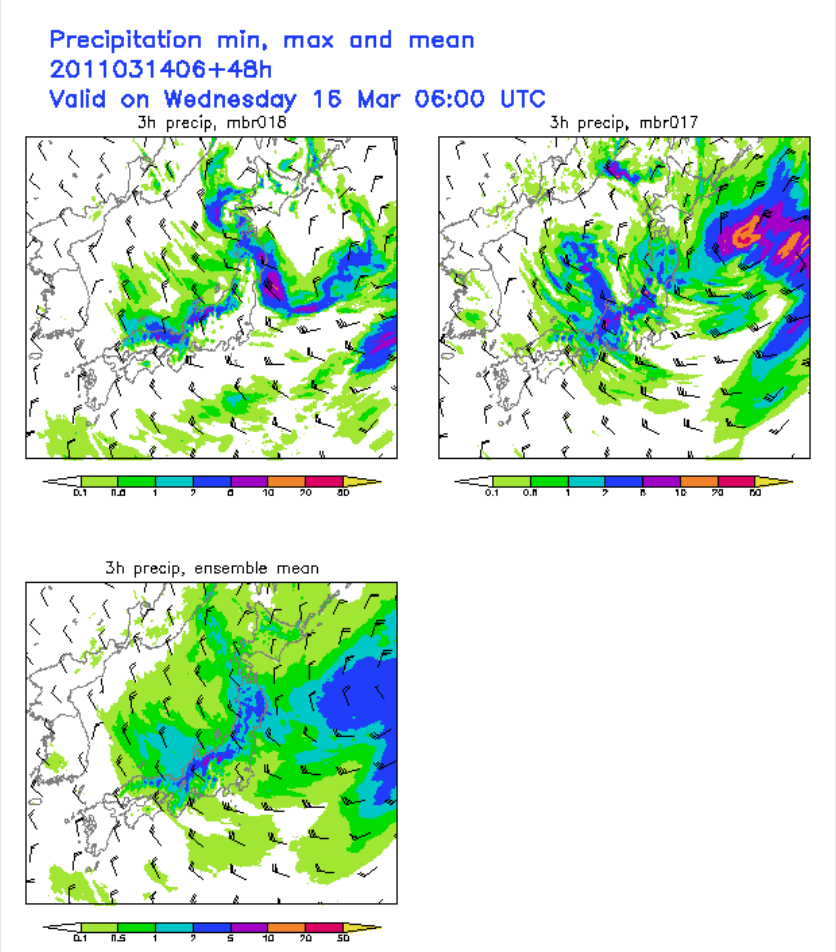
- HIRLAM model in 0.05°×0.05°, 496×420
- Disturbed boundary conditions: ECMWF-model
- 20 members + 1 control-run
- Windrose plot shows substatial spread in wind-speed (middle) and wind-direction





Uncertainties in precipitation

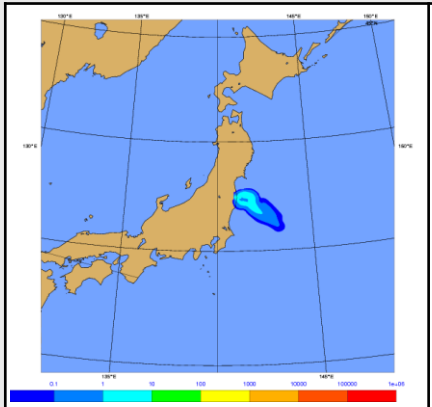
- Precipitation is one of the most important parameters for deposition, but is also most uncertain in forecasts
- Figure showing min, max and mean precipitation on 14.03.



Atmospheric dispersion modelling

- Using Katata source-term as known input (simplification)
- For each day X of the accident, dispersion calculations use 00UTC ensemble forecast meteorology for the next two days
- Initial concentrations and depositions until day X are calculated using hindcast meteorology
- Timeseries of plots for the day before X and 48hours after X are given
- Plots are given as statistical properties using the MUD methodology
- 2 dispersion models: DERMA and SNAP
- Results presented to hypothetical ‘expert group’ in the morning

13.03.2011, inst. avg. CS-137



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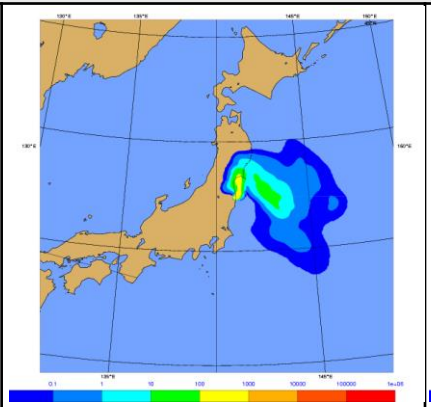

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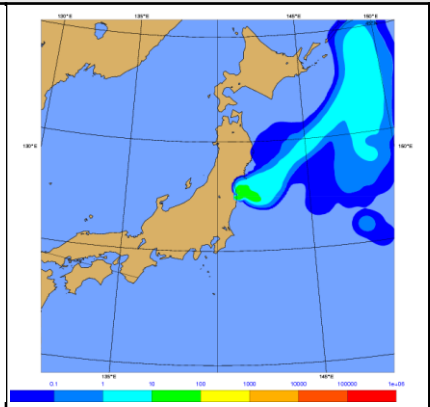

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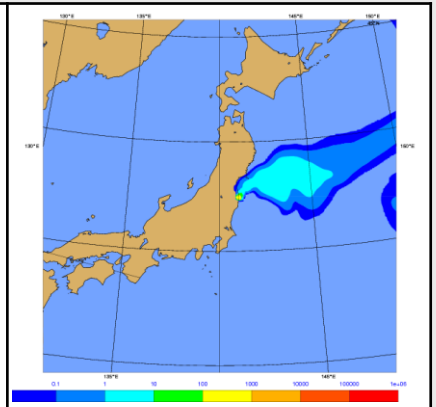

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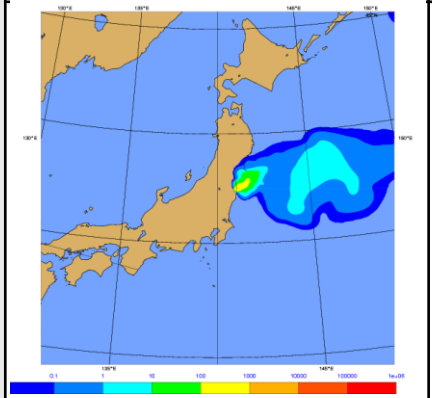

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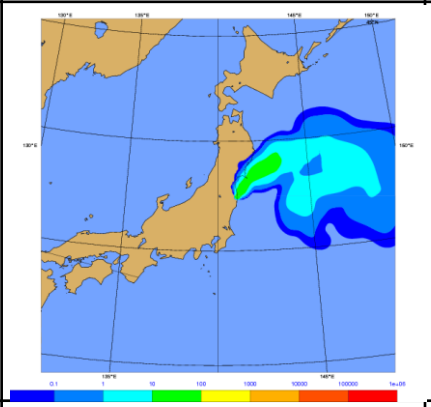

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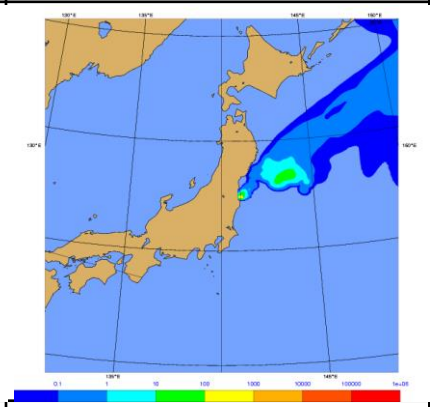

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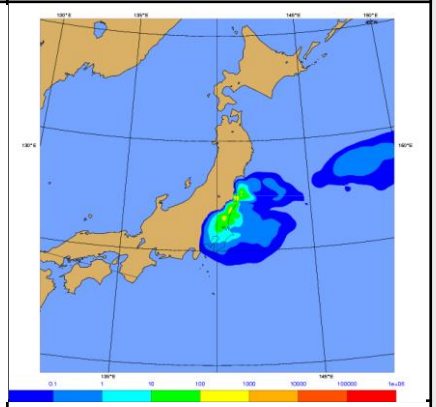

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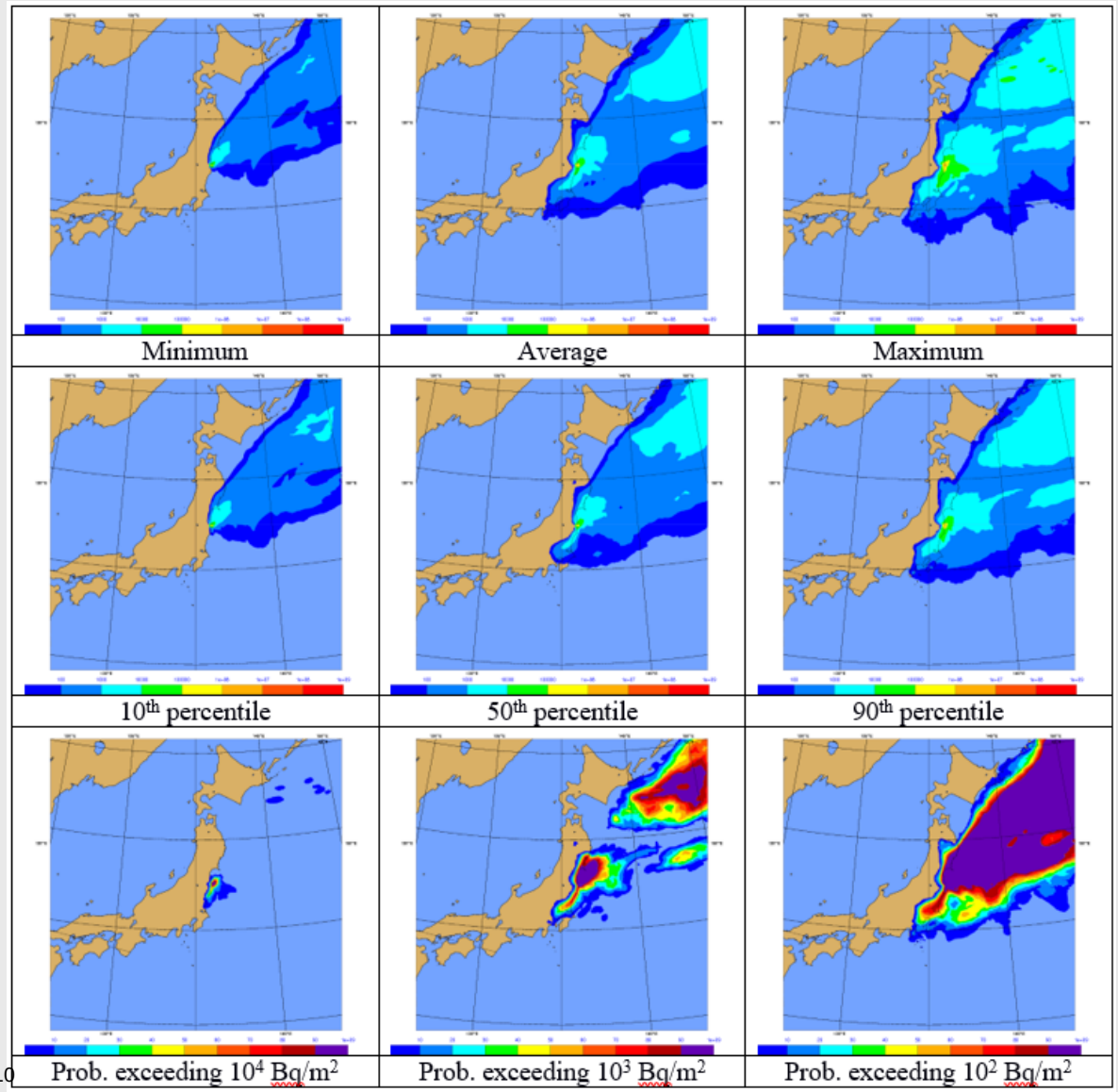

Acc. Dep CS137 14. 23:00

Statistical properties of the ensemble dispersion runs

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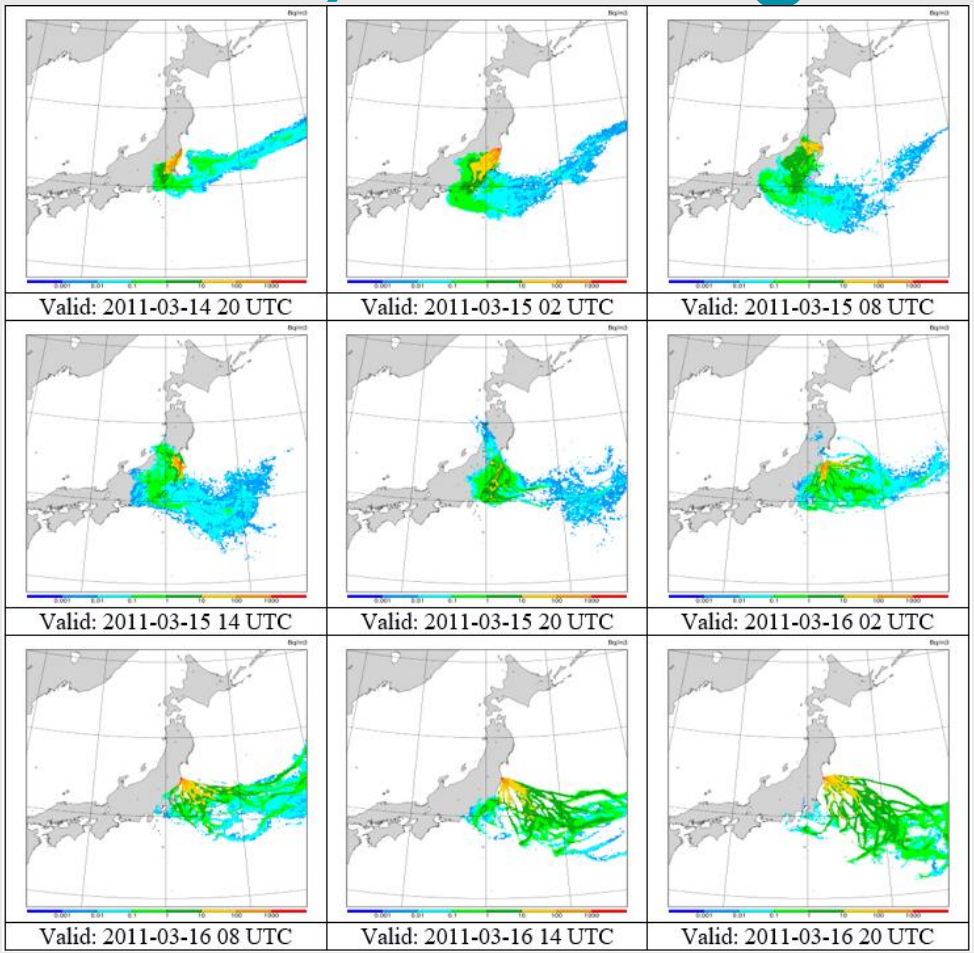
15.03.2011, inst. avg. CS-137



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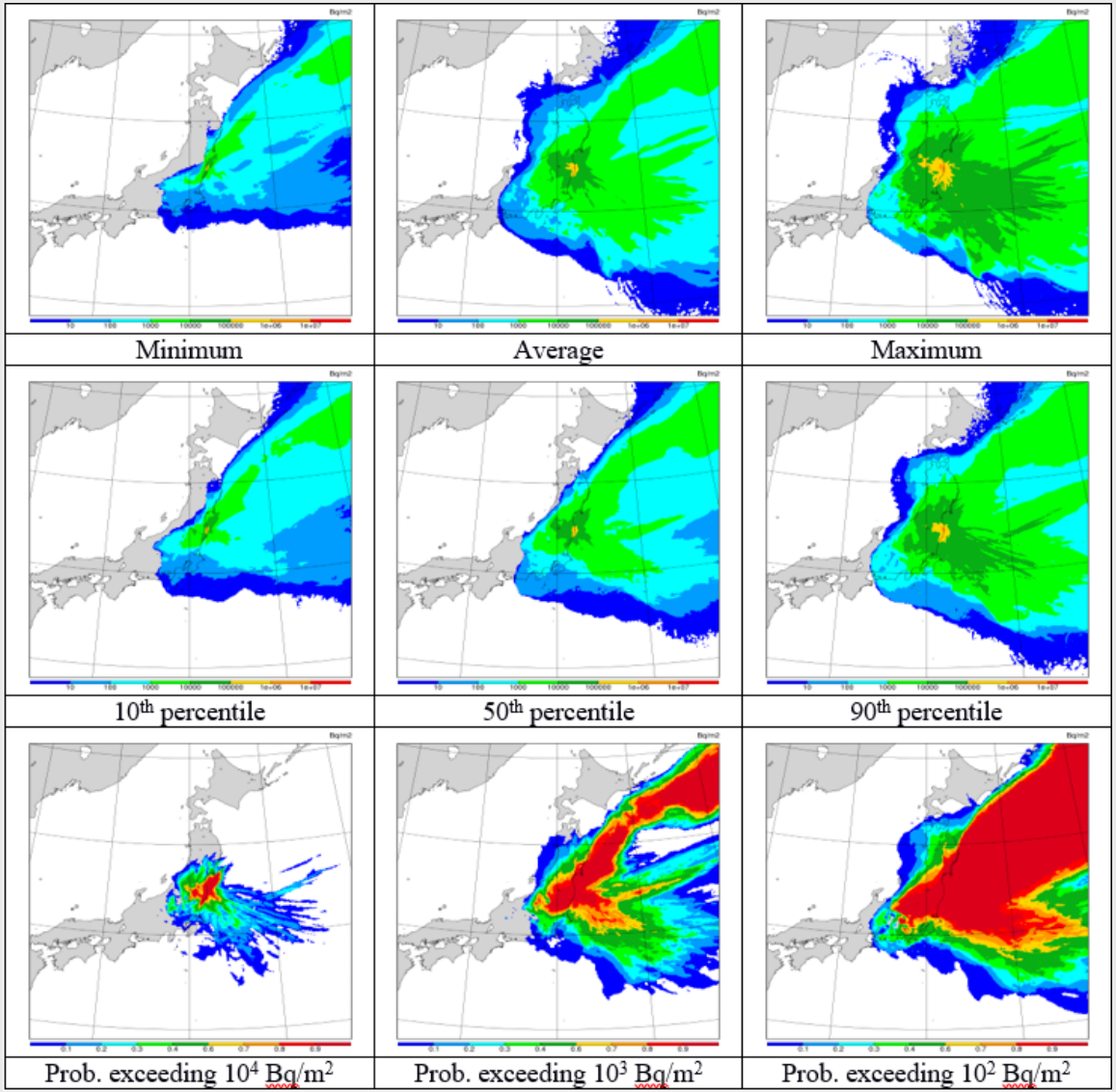

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Statistical properties of the ensemble dispersion runs

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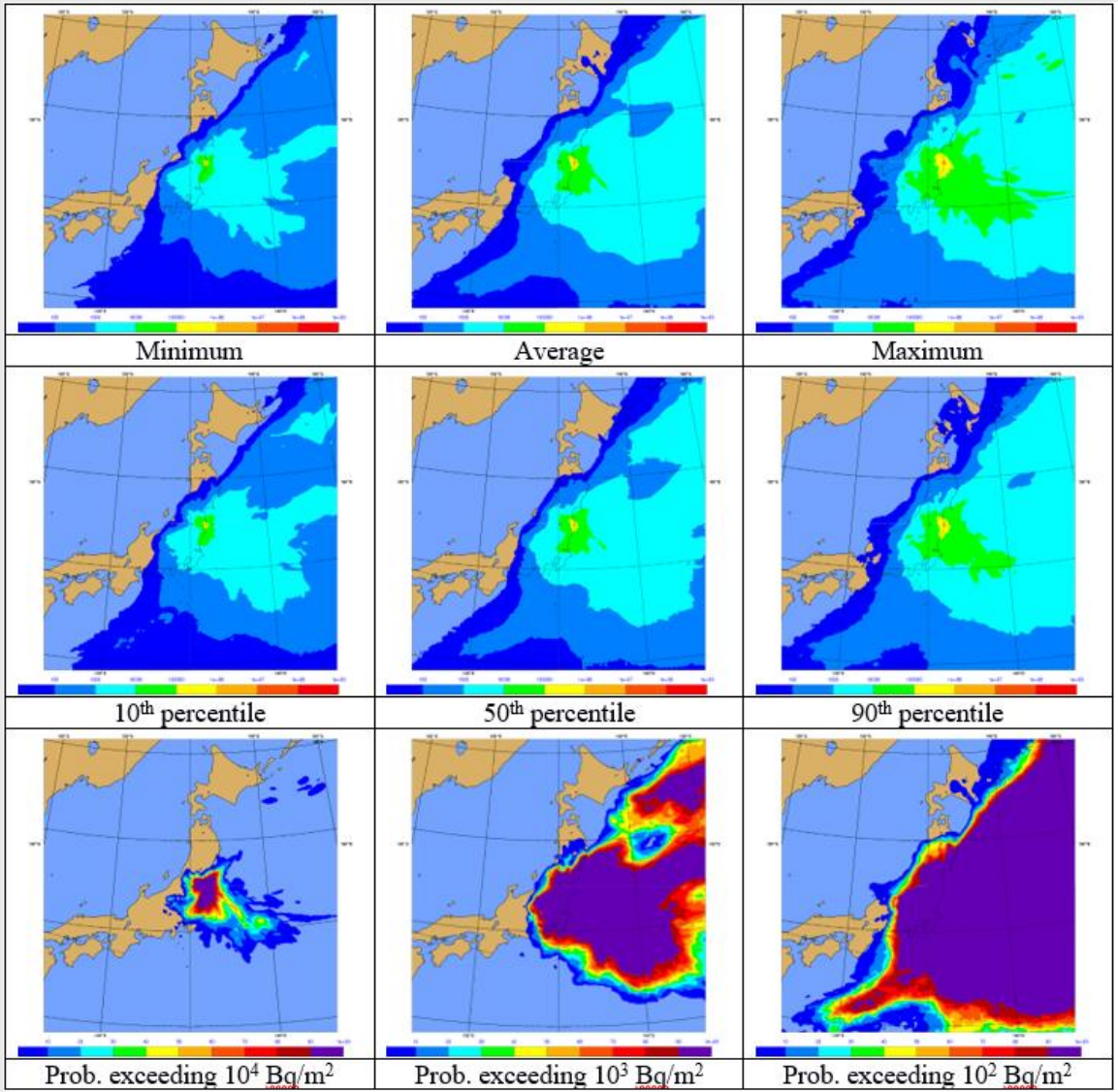

Acc. Dep CS137 5.04. 5:00

Statistical properties of the ensemble dispersion runs

Dispersion runs mainly using analyzed NWP data and max. 5 hours forecast.

Least uncertain model results, but still large uncertainties

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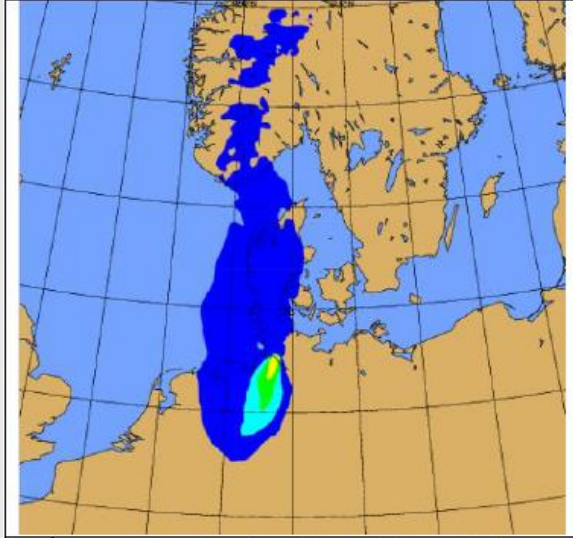
Workshop for decision making

- Hypothetical case: large release from Brokdorf NPP
- How should Danish crisis management react?
- Met. Office has provided plots of anticipated thyroid doses
- Iodine prophylaxis countermeasure limits are: 50 mGy (adults), 10mGy (children)

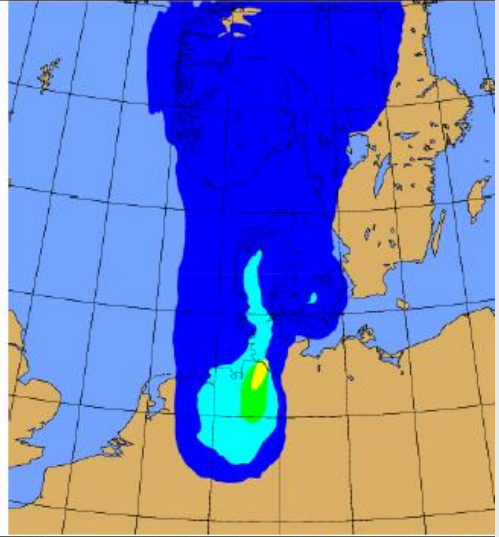
Thyroid doses

Thyroid doses from a hypothetical accident at Brokdorf NPP

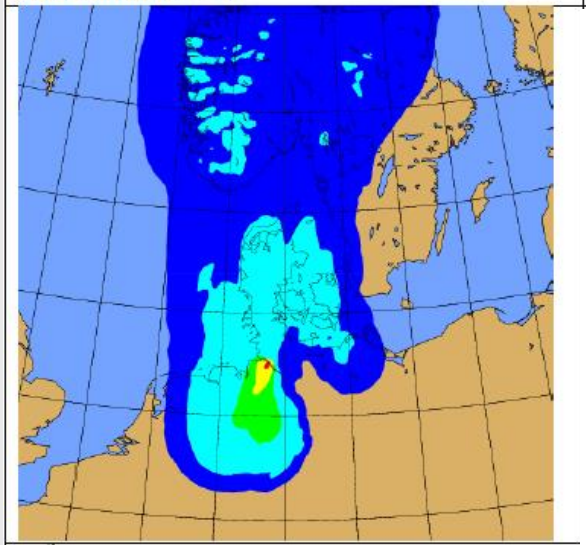
Probability to exceed limits:
50 mGy (adults)
10 mGy (children)



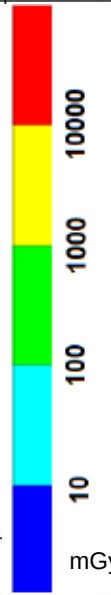
10th percentile of projected thyroid dose 54 hours after start of release.

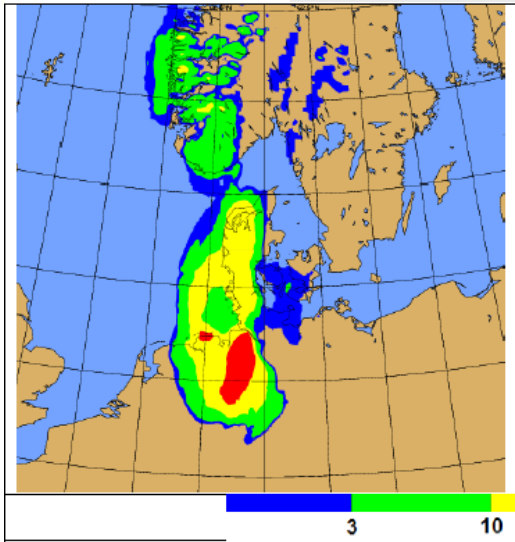


50th percentile of projected thyroid dose 54 h after start of release.

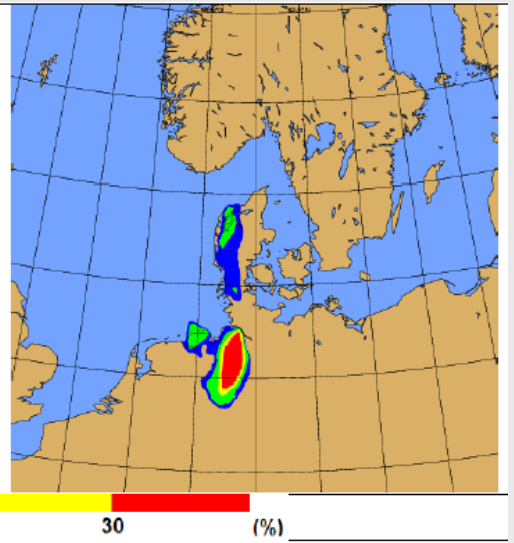


90th percentile of projected thyroid dose 54 hours after start of release.





Probability of projected thyroid dose exceeding 10 mGy 54 hours after start of release.



Probability of projected thyroid dose exceeding 50 mGy 54 hours after start of release.

Conclusion from workshop

- Methodology useful for protective actions
- Uncertainties requires training of emergency response staff
- High percentiles most useful, percentile/percentage confusing – use quantile
- Color scheme of exceedance should be chosen carefully and not be confused with values
- Communication of risks should rather be «high» and «low» than quantitative measures (10%)
- Decision making becomes more difficult with uncertainties, but will have a more comprehensive basis.

NKS-FAUNA Team

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