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Forecasting the weather
- ensemble techniques
in probabilistic weather prediction

Atmospheric transport modelling for radionuclides from the Fukushima accident and their measurement with the International Monitoring System for CTBT verification

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After the Tohoku earthquake and tsunami of 11 March 2011 a series of reactor accidents at Fukushima-I nuclear power plant site lead to a considerable release of radioactive substances into the atmosphere.
In this study, the plume dispersion was simulated using the HYSPLIT model driven by NCEP GDAS analysis and partly GFS forecast data in 0.5 degree horizontal resolution. First goal was to predict the arrival times and dilution of the plume at the radionuclide stations of the International Monitoring System (IMS) for the Comprehensive Nuclear-Test-Ban Treaty (CTBT) verification. In nuclear explosion monitoring, besides the waveform technologies for detection and localisation of seismic, hydroacoustic and infrasonic signals, a global network of currently 63 highly sensitive radionuclide stations is operated to detect radioactive debris in the air. All radionuclide stations are able to measure radioactive particulates in air filter samples, some of them are also equipped for measurements of radioactive xenon isotopes produced in nuclear fission. In normal operation, the possible source region of detected radionuclides is determined analysing Source Receptor Sensitivity (SRS) fields generated with Lagrangian Particle Dispersion Models in backward mode. In case of the Fukushima accident due to the known source location, forward modelling was applied at the BGR, which operates as the German National Data Centre for CTBT verification.
Detections of the Fukushima plume were made after the first explosion at stations sited in Kamtchatka (Russia) and Takasaki (Japan) followed by measurements in USA, Canada, and on some Pacific Islands. After about one week, Iceland and continental Europe joined. Within three weeks all IMS radionuclide stations on the Northern Hemisphere measured radioactive substances originating from Fukushima. Although the activity concentrations were quite remarkable from the CTBT verification perspective, the corresponding dose rates were negligible small in terms of radiation protection and health aspects. The detections of the first two weeks after the beginning of the accident are well predicted by the model within the time accuracy of the measurements. Several simulation experiments were performed to test sensitivity of station arrival times and concentrations considering a variation of emission height and time function of the release.
In early April, first small traces occurred at some stations on the Southern Hemisphere. By using analysis data from ECMWF and NCEP, the possible pathways were investigated which could have been taken by the radionuclides for overcoming the Intertropical Convergence Zone.
Turning finally the perspective, the localisation capability of the standard atmospheric transport modelling tools for CTBT verification was checked under the assumption of an unknown source location. The possible source region was determined analysing the backward SRS fields for the detections at radionuclide stations, and consistence with the Fukushima nuclear power plant as source was tested.