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Inverse modeling of April 2013 radioxenon detections

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Significant concentrations of radioactive xenon isotopes (radioxenon) were detected by the International Monitoring System (IMS) for verification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) in April 2013 in Japan. Particularly, three detections of Xe-133 made between 2013-04-07 18:00 UTC and 2013-04-09 06:00 UTC at the station JPX38 are quite notable with respect to the measurement history of the station. Our goal is to analyze the data and perform inverse modeling under different assumptions. This work is useful with respect to nuclear test monitoring as well as for the analysis of and response to nuclear emergencies.

Two main scenarios will be pursued: (i) Source location is assumed to be known (DPRK test site). (ii) Source location is considered unknown. We attempt to estimate the source strength and the source strength along with its plausible location compatible with the data in scenario (i) and (ii), respectively. We are considering also the possibility of a vertically distributed source.

Calculations of source-receptor sensitivity (SRS) fields and the subsequent inversion are aimed at going beyond routine calculations performed by the CTBTO. For SRS calculations, we employ the Lagrangian particle dispersion model FLEXPART with high resolution ECMWF meteorological data (grid cell sizes of 0.5, 0.25 and ca. 0.125 deg). This is important in situations where receptors or sources are located in complex terrain which is the case of the likely source of detections-the DPRK test site. SRS will be calculated with convection enabled in FLEXPART which will also increase model accuracy.

In the variational inversion procedure attention will be paid not only to all significant detections and their uncertainties but also to non-detections which can have a large impact on inversion quality. We try to develop and implement an objective algorithm for inclusion of relevant data where samples from temporal and spatial vicinity of significant detections are added in an iterative manner and the inversion is recalculated in each iteration. This procedure should gradually narrow down the set of hypotheses on the source term, where the source term is here understood as an emission in both spatial and temporal domains. Especially in scenario (ii) we expect a strong impact of non-detections for the reduction of possible solutions. For these and also other purposes like statistical quantification of typical background values, measurements from all IMS noble gas stations north of 30 deg S for a period from January to June 2013 were extracted from vDEC platform.

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