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Data fusion as an example of a powerful constraint on the reconstruction of atmospheric sources of radionuclides for the verification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT)

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One of the scientific issues falling within the horizon of interest of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) is the reconstruction of accidental sources of radionuclides. The issue arises if a scenario of measurements is detected in the International Monitoring System (IMS) network. Source reconstruction problem for a dispersion of radionuclides faces both physical and mathematical limitations. Due to the presence of turbulent processes in the atmosphere, detections convey a limited amount of information on the location of such a source. From a numerical point of view, source reconstruction is performed up to a grid-box of the mesh covering a computational domain and, consequently, the number of grid-boxes determines the dimension of the source. Given its considerable size and, at the same time, a limited number of observations constituting a measurement scenario, the problem of source reconstruction is severely under-constrained.

Nevertheless, it is both physics and mathematics which help to circumvent some of the difficulties. In the context of verification of the CTBT, atmospheric transport modelling (ATM) is supported by detections made within complementary monitoring networks, namely seismic, infrasound and hydroacoustic. The resulting events are listed in the form of bulletins and their spatio-temporal location is specified therein. The accuracy of their locations can be taken advantage of and employ in order to lower the demand on the radionuclide source reconstruction via fusion of relevant information with possible source regions determined by ATM.

In the first step, possible source regions can be overlapped with the waveform events in order to differentiate between those which could have and could not have been at origin of the measurement scenario. Secondly, the waveform events can then be used to restrict possible source regions so that source reconstruction could be limited to those grid-boxes which overlap with the waveform events. Further constraints can be provided by mathematical techniques of regularization of an inverse problem which allow including additional information consistent with a point release.

In this presentation we propose to report on the recent advancement at the CTBTO on the way towards taking full advantage of the opportunity offered by data fusion. To this end the scenario of the most recent National Data Centre Preparedness Exercise 2009 shall be discussed.