Atmospheric dispersion and ground deposition induced by the Fukushima Nuclear Power Plant accident

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On March 11th 2011, an earthquake of magnitude 9.0 occurred off northeastern Japan, causing a tsunami and damaging the Fukushima Daiichi Nuclear Power Plant (FNPP1). As a result, large amounts of radionuclides were released into the ocean and the atmosphere. Released radioactive nuclides were deposited in the environment over a wide area. Modeling studies estimated that less than 80% of the atmospheric emissions were deposited in the Pacific Ocean and about 20% were deposited over Japan [Kawamura et al. 2011; Morino et al. (2011), Aoyama et al. (2012), Korsakissok et al. (2013), Groëll et al. (2014)]. Observations show that the size of the contamination zone in Japan with levels > 185 kBq/m² covers approximately 1 700 km² [Steinhauser et al, 2014] and the area with levels > 10 kBq/m² covers about 24 000 km² [Champion et al. (2013)].

In 2015, ^{137}Cs hourly air concentrations retrieved from filter tapes of air quality monitoring sites in Japan became public [Tsuruta et al. (2014)]. This large volume of data is a valuable complement to the other environmental measurements such as:

- dose rates at monitoring posts and total deposition of radionuclides on the ground;
- the meteorological measurements: AMEDAS and rain radar observations.

All these observations were very helpful to improve the understanding of aerial transport of the plumes and their deposition over the Japan territory. However, uncertainties remain and measurements alone are not sufficient to fully understand episodes of deposition.

The current state of knowledge will be presented by highlighting the main difficulties which limit our understanding.

Understanding the formation process of contaminated areas cannot be achieved through measurements only. Thus, improving atmospheric dispersion simulations remains a key issue.

Two main model inputs are required to perform simulations: the meteorological fields and the quantification of atmospheric releases. Shortly after the accident, the meteorological inputs used to simulate the consequences of the Fukushima accident had a too low spatial and temporal resolution to correctly take into account the impact of the complex Japanese terrain [Mathieu et al. (2012), Korsakissok et al. (2013), Arnold et al. (2015)].

Therefore, meteorological fields with a finer resolution have been produced improving significantly the simulations of the Fukushima accident [WMO (2011), Sekiyama et al. (2015)].

The source term is the temporal evolution of the atmospheric release rate of each radionuclide. Currently there is no source term estimated only by modelling the evolution of the reactor state. The existing ones were assessed with methods using both environmental measurements and simulations of atmospheric dispersion and deposition. Several source terms were published [Chino et al. (2011), Stohl et al. (2011), Mathieu et al. (2012), Winiarek et al. (2012), Terada et al. (2012), Saunier et al. (2013), Winiarek et al. (2014), Katata et al. (2015)].

A critical analysis of the meteorological inputs and the source terms will be presented. It will be shown that the modelling aerial transport of the plume and the formation process of contaminated areas have been improved but some deposition events remain difficult to model.

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