An advection-diffusion model for radioactive substance dispersion released from the Fukushima-Daiichi nuclear power plant

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Introduction

The tsunami that followed the earthquake at the 11th March in Japan that has destroyed the Fukushima-Daiichi nuclear power plant caused considerable radiation leakage into the atmosphere and into the sea. While principal attention is given to the global effects of the accident consequences, which is relevant for preventive actions related to radiation protection of the population in Japan and other affected countries, less attention is paid to the radioactive contaminant dispersion in the direct surrounding of the power plant (coordinates in latitude, longitude: 37°25'17"N, 141°1'57"E) [1]. Such information is essential for the planning and conduction of actions that focus on limiting and controlling the radioactive hot-spots. Since, radiation doses in and around the nuclear reactors is not only fatal for human beings but also may be destructive for remote controlled machinery, the contaminant dispersion process is essential in order to estimate the source dose rate by measurements made in the surroundings. This sort of inverse engineering procedure is the principal issue of the present work.

In order to analyze the consequences of the afore mentioned radioactive discharge, atmospheric dispersion models are of need. These have to be tuned using specific meteorological parameters and conditions in the considered region as well as they shall be subject to the local orography. To this end in the present study we start with a meso-scale simulation by WRF [2] that supply space-time advection-diffusion characteristics for the Fukushima-Daiichi site during a few days after the disaster. Once, the parameterization is determined, the advection-diffusion equation is solved by the 3D-GILTT method [3]. The 3D-GILTT model is solved analytically using integral transform and a spectral theory based methods that provide relative radioactive material concentrations and permit to assess the high contamination level studies of the accident scenario, which shall guide the pertinent counter-actions.

Results and conclusions

In the sequel we show the preliminary results obtained combining the WRF and 3D-GILTT method. In Figure 1 we report a visualization of the surface potential temperature and mag(U10,V10), as well the isolines of concentration on the day 12th March at 08:00 (Fig. 1a) and 16:00 (Fig. 1b) obtained with the WRF and 3D-GILTT method, respectively.

Simulating micro-meteorology for a short period for the Fukushima Nuclear Power Station Accident may be considered a first step into a direction where the impact of the contamination of radioactive material in the site may be simulated and evaluated for the whole period of the accident until today. Thus the present work may be understood as one tile in a larger program development that simulates radioactive material dispersion using analytical solutions. In a longer term we intend to build a library that allows to predict radioactive material transport in the atmospheric boundary layer that extends from the micro- to the meso-scale.

Agradecimentos

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References

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a)

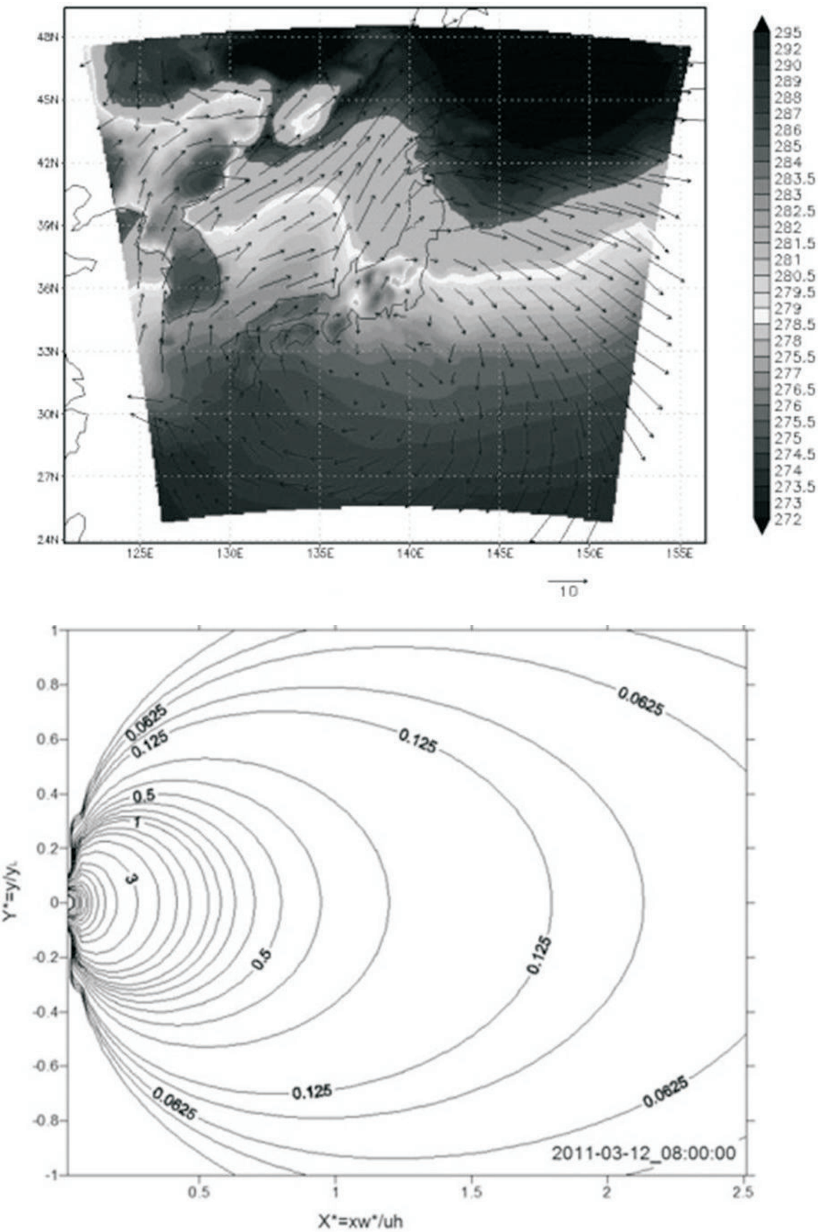

Figure 1. Surface potential temperature and mag(U10,V10), and isolines of concentration on the day 12th March at **a)** 08:00 **b)** 16:00. (continua ...)

b)

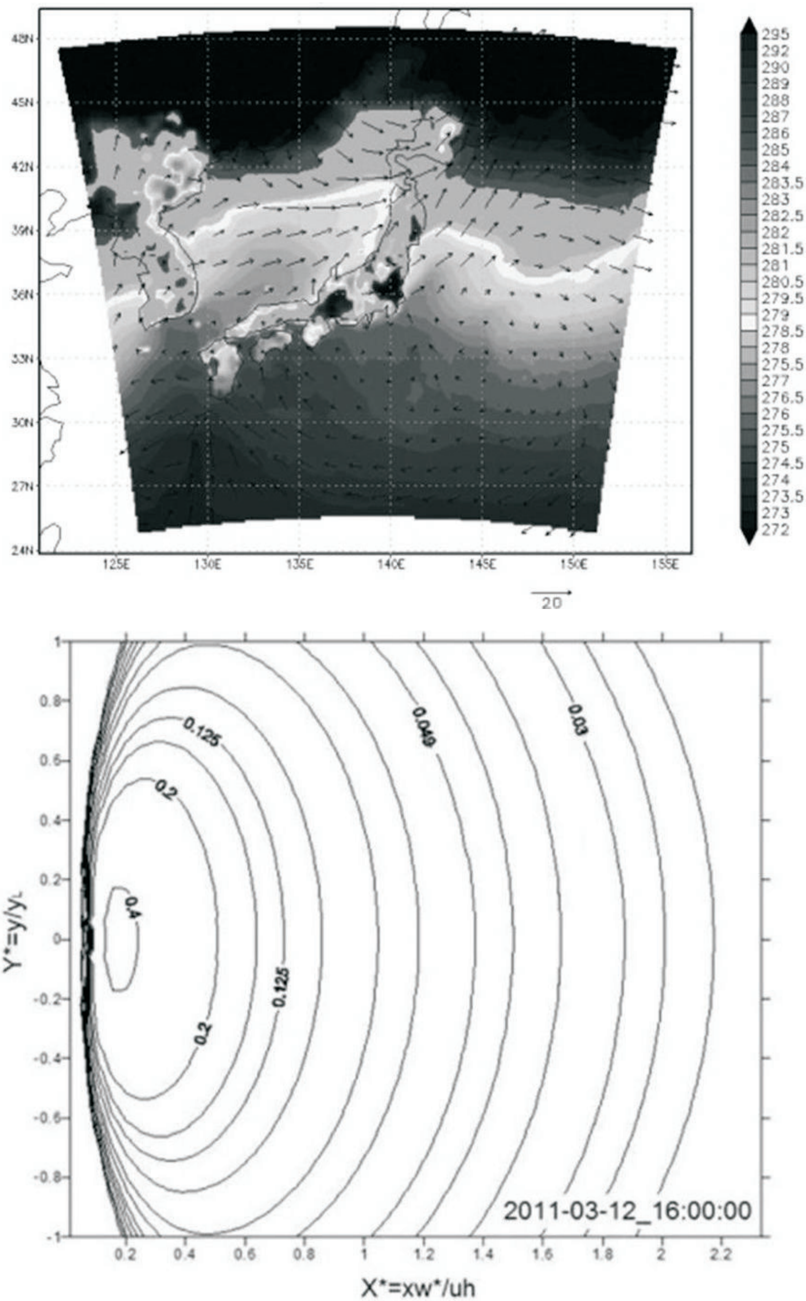

Figure 1. Surface potential temperature and mag(U10,V10), and isolines of concentration on the day 12th March at **a)** 08:00 **b)** 16:00. (conclusão)