New Dose Evaluation System In Taiwan And Its Application In Fukushima Accident

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Abstract

In Fukushima accident, large amount of radioactive material was released to the atmosphere, and transported to the global with atmospheric dispersion. Our government, mass media, and the public paid much attention on the radiation effect from Fukushima to Taiwan. After that, a new dose evaluation system has been developed in order to meet demands for emergency response for any domestic and foreign nuclear accident.

In meteorology part of this system, we developed a new mesoscale dynamic downscaling method (MDDS) to get high resolution meteorology forecast field from global forecast system. We also established a multi-nested grid structure of dispersion and dose evaluation model to satisfy the transport and deposition process of radioactive substances in both global and regional scale.

In this article, we try to rebuild the effect of Fukushima accident by using this new system, focuses on the deposition distribution of cesium-137 in the early 124 hours of this event. Results show that the distribution of the deposition is quite similar to results in Katata et al. (2012), except in March 15 which is due to the impact of wind farm transition time and wet deposition by rainfall. When considering the dry deposition efficiency due to turbulence intensity in near-surface layer and viscous forces in near surface, the quantity is about ten times to that without this consideration, and the results are closed to the results in Katata et al. (2012).

Meteorology part

In order to obtain real-time high-resolution and long-term meteorology forecast data, Central Weather Bureau develops a new downscaling method called MDDS in cooperation with NOAA/ERSL/GSD. This method is a pure 3-dimension variational method with complete meteorological physics equations in terrain-following coordinate, attempting to solve the meteorological field variations caused by complex terrain in steady state.

Figures 1 show the test results of MDDS in an ideal case. From 32km down to 4km resolution, MDDS can rebuild some higher resolution pattern that can not be seen in initial field, such as the leeward vortex and low pressure pairs as well as upward propagating gravity wave. Although the intensity of these phenomena is not enough as in the contrast experiment, but their locations and distribution are quite similar.

Figures 2 show the preliminary results of MDDS in a real case near Taiwan. The initial guess of MDDS is taken from the 0.5° resolution (about 55 km in Taiwan area) NCEP/GFS analysis fields on 00Z, Oct. 14, 2014. There are many mesoscale phenomena when the north-east wind through the complex terrain of Taiwan which are not shown in the initial guess. These include the around mountain airflow in Datun mountain and easterly wind in Taipei city, return flow in the Lan-Yang plain in north-east Taiwan, arc flow in both east and west side of Taiwan, strong wind in the south edge of Taiwan.

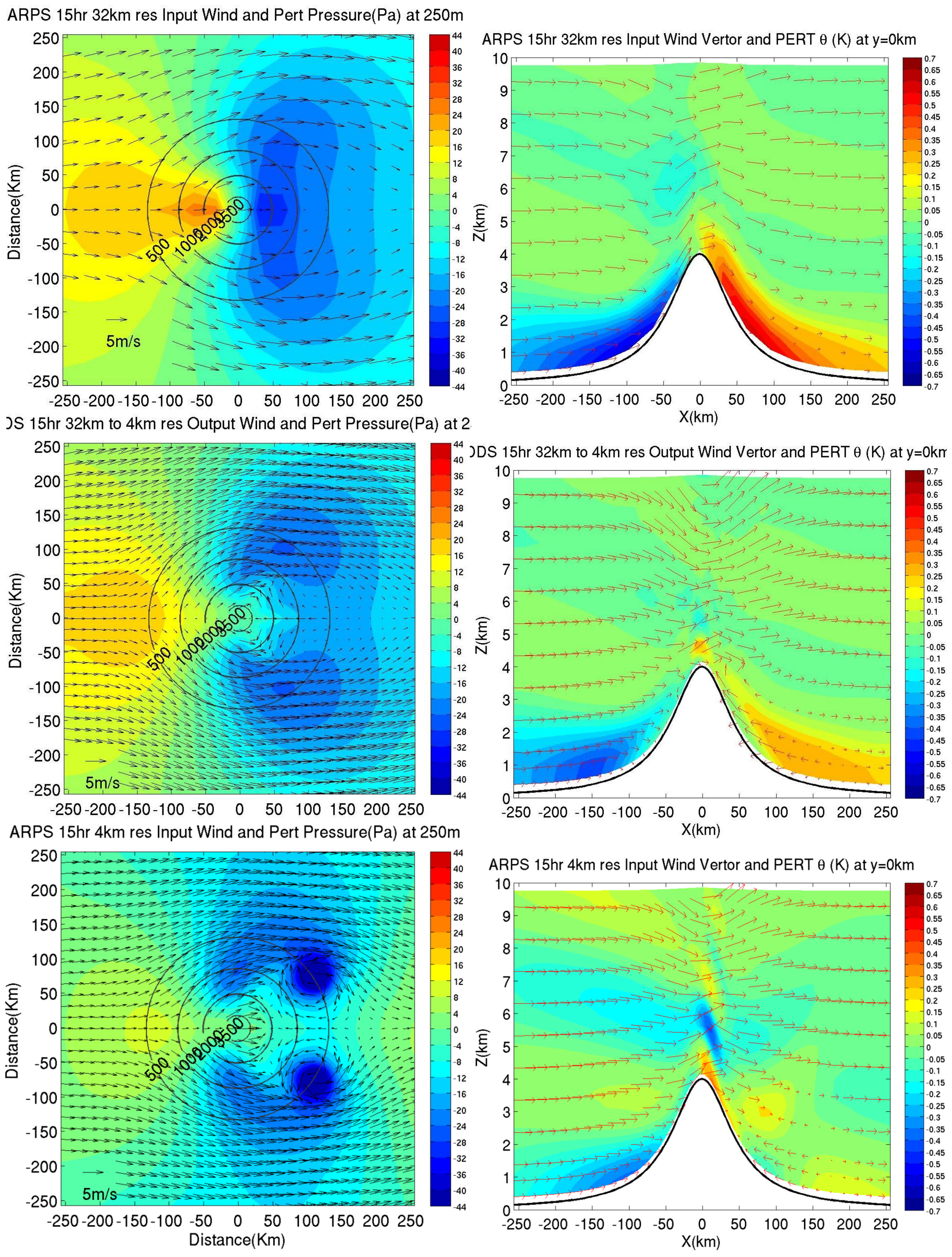

Figure 1: MDDS test results in the bell-shaped mountain case. Upper panel are the first guesses of MDDS by using the 15 hour simulation data within 32 km resolution from ARPS. Middle panel are the results of MDDS in 4 km resolution. Bottom panel are the contrast data from 15 hour simulation data by ARPS 4 km resolution run. Left panel are the horizontal views of wind and perturbation pressure. Right panel are the vertical views of wind and perturbation potential temperature.

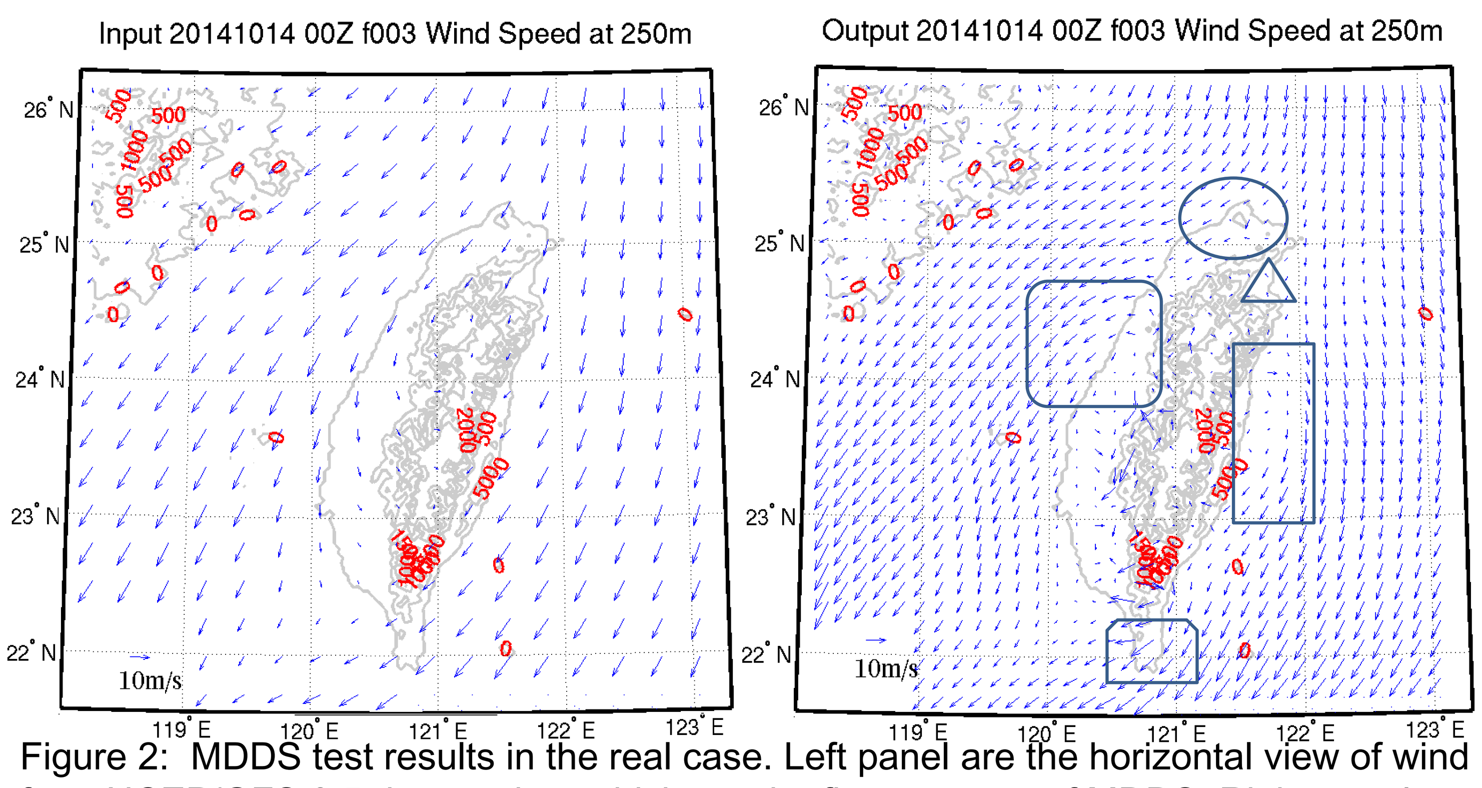

Figure 2: MDDS test results in the real case. Left panel are the horizontal view of wind from NCEP/GFS 0.5 degree data which are the first guesses of MDDS. Right panel are the horizontal view of wind from MDDS.

Dispersion and Dose part

In order to take advantage of different sources, domain and resolution of the meteorological field in our atmospheric dispersion model, we established a multi-nested grid structure of dispersion and dose evaluation model to satisfy the transport and deposition process of radioactive substances in both global and regional scale. This model is based on A2Ct&d model, except to re-build in latitude and longitude coordinates, and add the long-term transport scheme and physical process of dry and wet deposition as in HYSPLIT and AERMOD systems. Finally combined the dose calculation module to calculate dose value.

Figures 3 show the results of our new dispersion model in Fukushima case. The distribution of the deposition of cesium-137 is quite similar and the quantity is a little smaller to results in Katata et al. (2012), except in March 15 which is due to the impact of wind farm transition time and wet deposition by rainfall. When considering the dry deposition efficiency due to turbulence intensity in near-surface layer (ra term) and viscous forces in near surface (rp term), the quantity is about ten times to that without this consideration.

Meteorological data we used in here is the MDDS downscaling output from NCEP / GFS analysis field in 6 hour interval. It is difficult to catch the right time and the location of front passed through Japan in March 15. We tried to delay 3 hours of the peaks of sources in March 15. The results show larger amount of deposition take place in north-eastward than control run (Fig. 4).

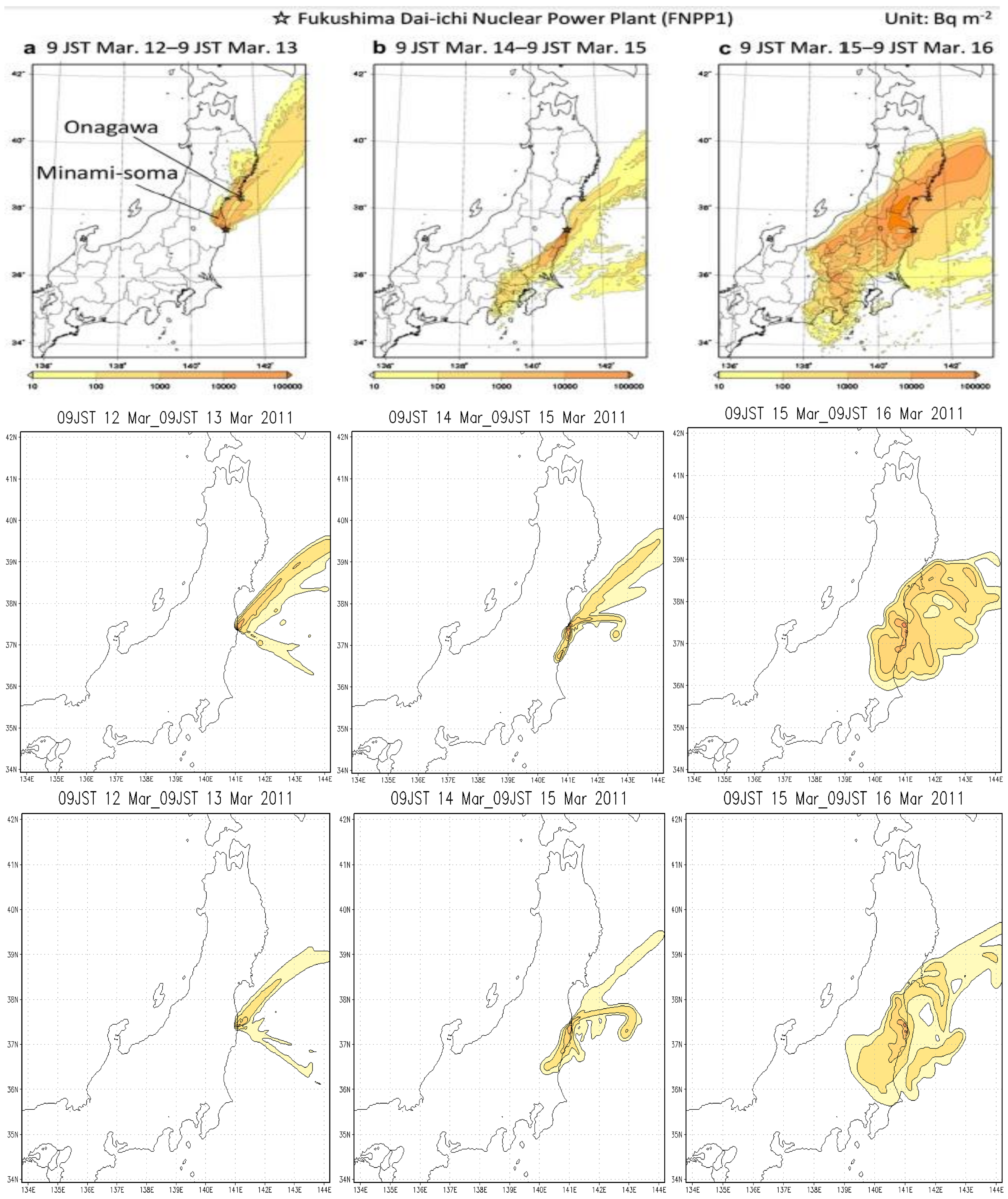

Figure 3: Daily surface deposition of Cs-137 from WSPEEDI (upper panel) , from new dispersion model in Taiwan for control run (second panel), from new dispersion model in Taiwan without ra and rp term (bottom panel).

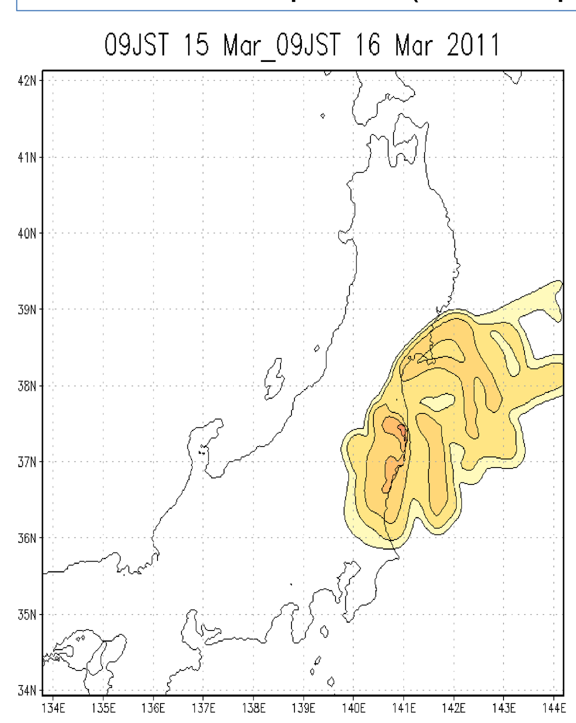

Figure 4: Daily surface deposition of Cs-137 from from new dispersion model in Taiwan as the control run in Fig.3, but the release source term is about 3 hour delay.