

Capability of HYSPLIT dispersion model in Fukushima disaster

Hamed Abdollahnejad

Faculty of Energy Engineering, Sharif University of Technology, P.O. Box 8639-11365, Tehran, Iran

➤ Introduction

On March 11, 2011, the tsunami induced by the 9.0 magnitude earthquake that occurred east of Japan caused serious damage to the cooling systems of the Fukushima Dai-ichi Nuclear Power Plant (NPP). Due to the lack of cooling, hydrogen and vapor blasts, dewatering of spent fuel rod pools and fires led to the release of radioactive materials into the atmosphere. Contamination transfer to around the earth and because of dry and wet deposition, water and soil affected. There are too many studies conducted about estimation of source term that they used NPP measurement, Atmospheric Transport Modeling (ATM), soil contamination, seawater contamination methods. In this study transport process simulated with Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) dispersion model with the previous source term estimation.

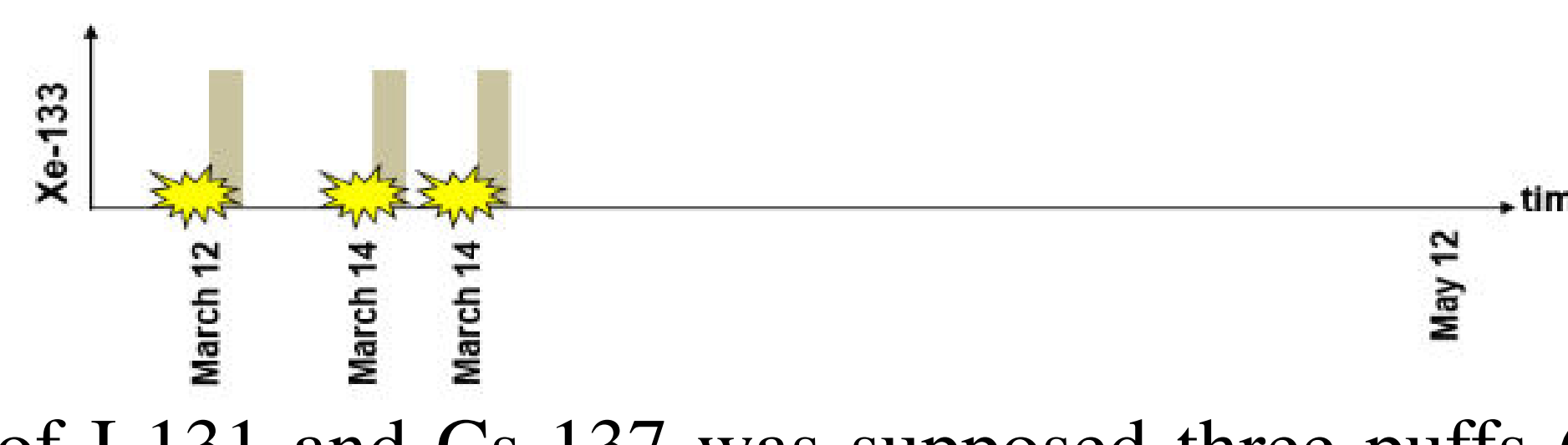
Literature of Fukushima source term estimation (PBq)

Reference	¹³¹ I	¹³⁷ Cs	¹³³ Xe	Method
Nuclear and Industrial Safety Agency (NISA) of Japan	160	15		1
The Nuclear Safety Commission of Japan (NSC, a policy body)		12		1
TEPCO-2011a	320	30	22000	1
TEPCO-2011b	500	10		1
TEPCO-2011b	11	3.6		1
Nuclear Safety Commission (NSC) (2011) and JAEA	130	11		1
Japanese Nuclear Safety Commission	150	12		1
(Chino et al., 2011)	153-160	12-13		2
(Hamada and Ogino, 2012)	130-160	6.1-15		2
(Winiarek et al., 2012)	190-380	12		2
(TenHoeve and Jacobson, 2012)	65.2	17		2
(Kobayashi et al., 2013)	200	13		3
(Stohl et al., 2012a)		36.6	12200-18300	2
(Stohl et al., 2012b)			14200-19000	2
Bowyer et al. (2011)			12000	2
Katata et al. (2012)	151			2
IRSN	200	30	20000	1
ZAMG (Central Institute for Meteorology and Geodynamics, 2011)	360-390	50		2
NILU (2011)		36	16700	2
(Saunier et al., 2013)	105.9	15.5	12000	2
(Nagai et al., 2014)	120	8.8		2
(Mathieu et al., 2012)	190	20		2
(Akahane et al., 2012)	100-200	10-20		1
Eslinger et al., 2014			12400	2
(Achim et al., 2012)	100-400	10	6000	1, 2
(Bailly du Bois et al., 2012)		12-41		3
(Morino et al., 2011)		10		2
(Yasunari et al., 2011)		12		4
(Kawamura et al., 2011)	153	13		2, 3
(Honda et al., 2012)		15		3

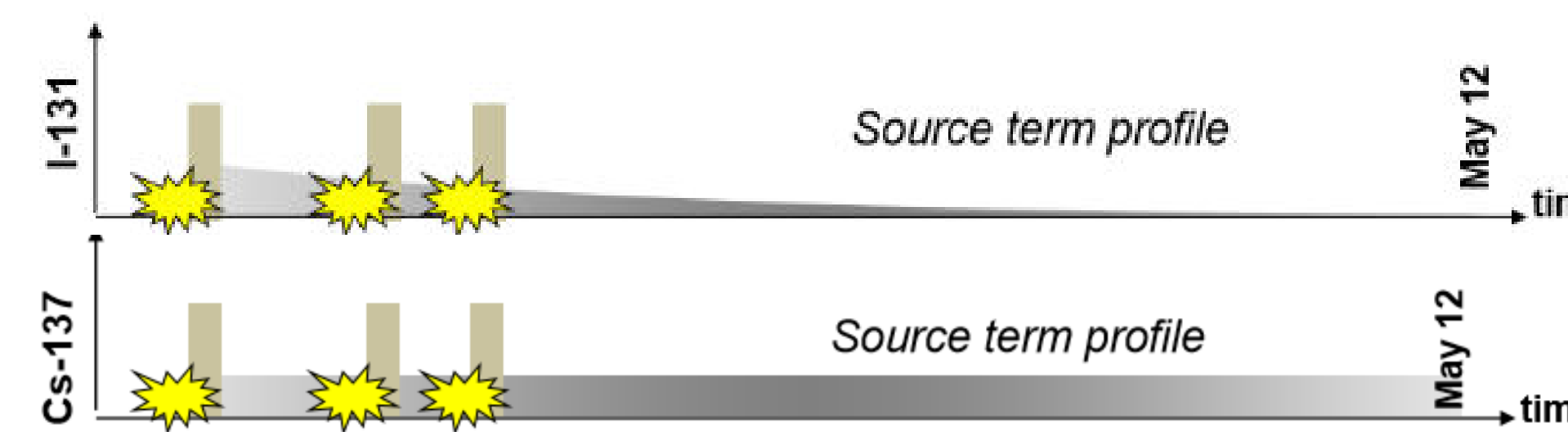
- 1= NPP measurement
- 2= ATM
- 3= Seawater contamination
- 4= Soil contamination

➤ Methodology

HYSPLIT model with support of the Global Data Assimilation System (GDAS) meteorological databases was used to simulate the Fukushima disaster and results were compared with the measurements at IMS stations. Literature of Fukushima source term estimation showed ATM is the most common method so ATM based results of G. LE PETIT in WOSMIP2011 was used. Whole Xe-133 was supposed to be quickly emitted in the atmosphere after the explosions of units. Three main puffs (6hr) have been considered with $2 \cdot 10^{18}$ Bq for each ($\sim 0.6 \cdot 10^{19}$ Bq total).

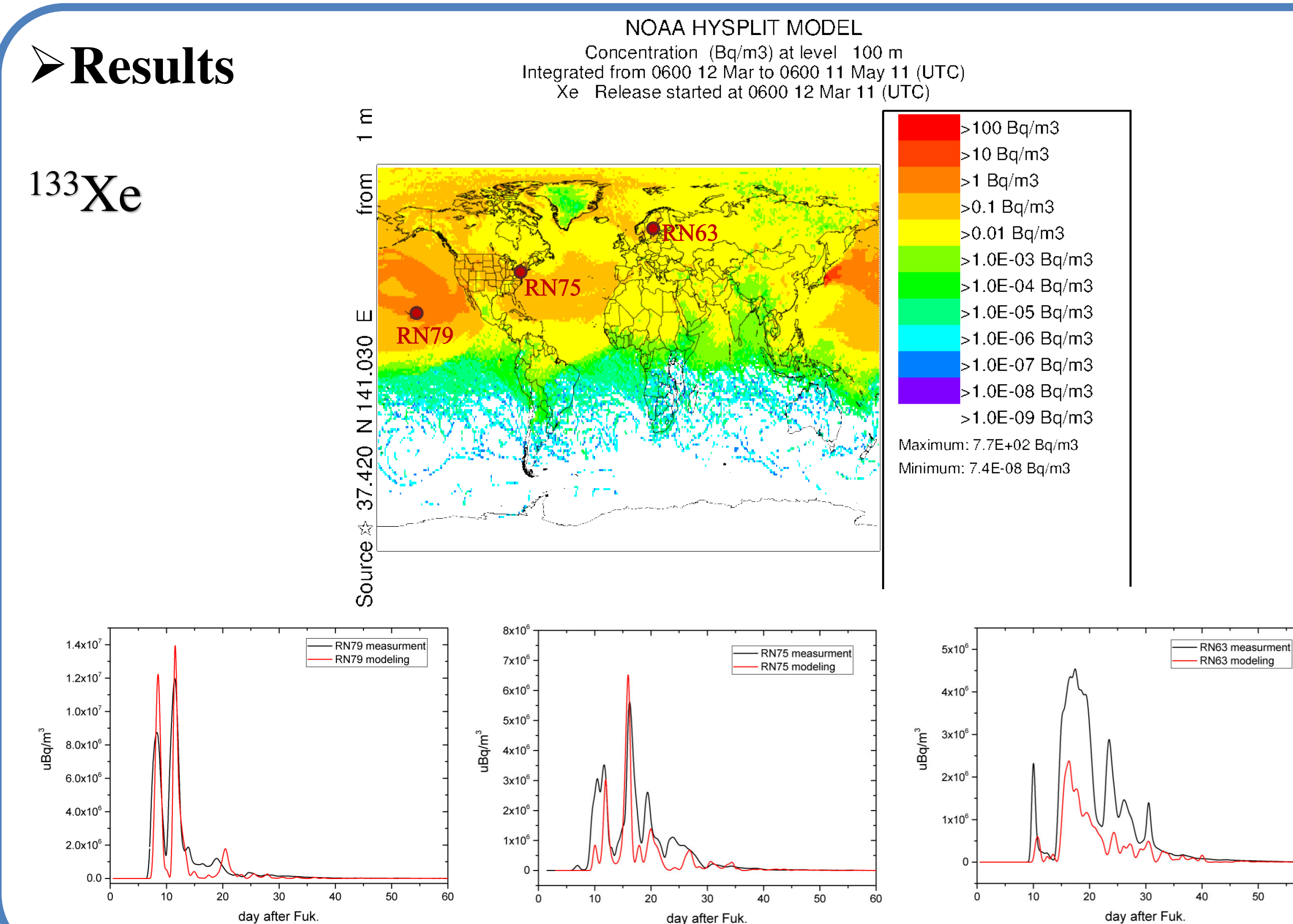


Release of I-131 and Cs-137 was supposed three puffs (6hr) have been considered with 10^{15} Bq and 10^{13} Bq for each respectively, with continuous leakage. Release rate following the half-life of radionuclides. Integrated activity released during considered period (2 months) for I-131 and Cs-137 was 10^{15} Bq and 10^{12} Bq respectively.

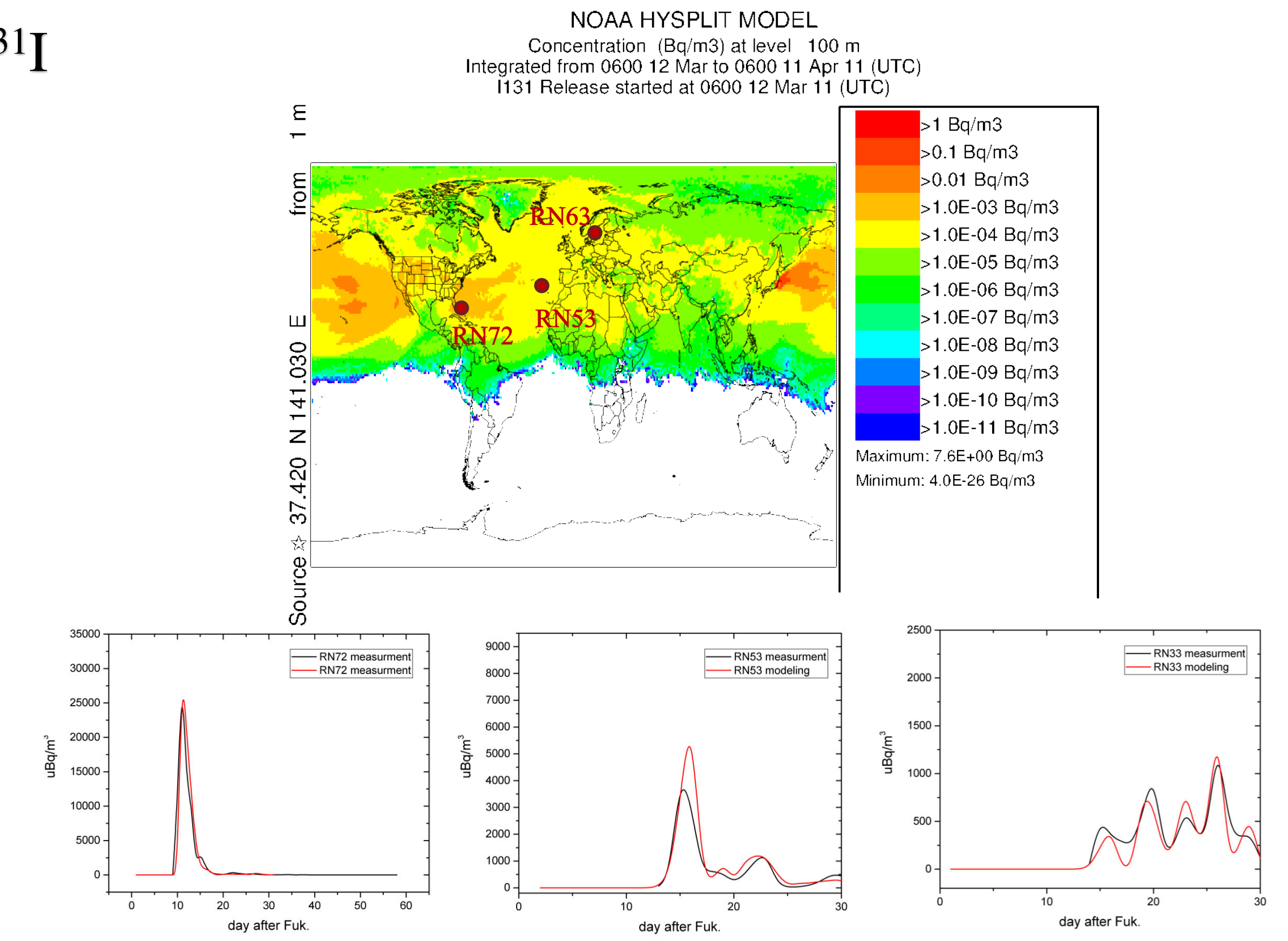


➤ Results

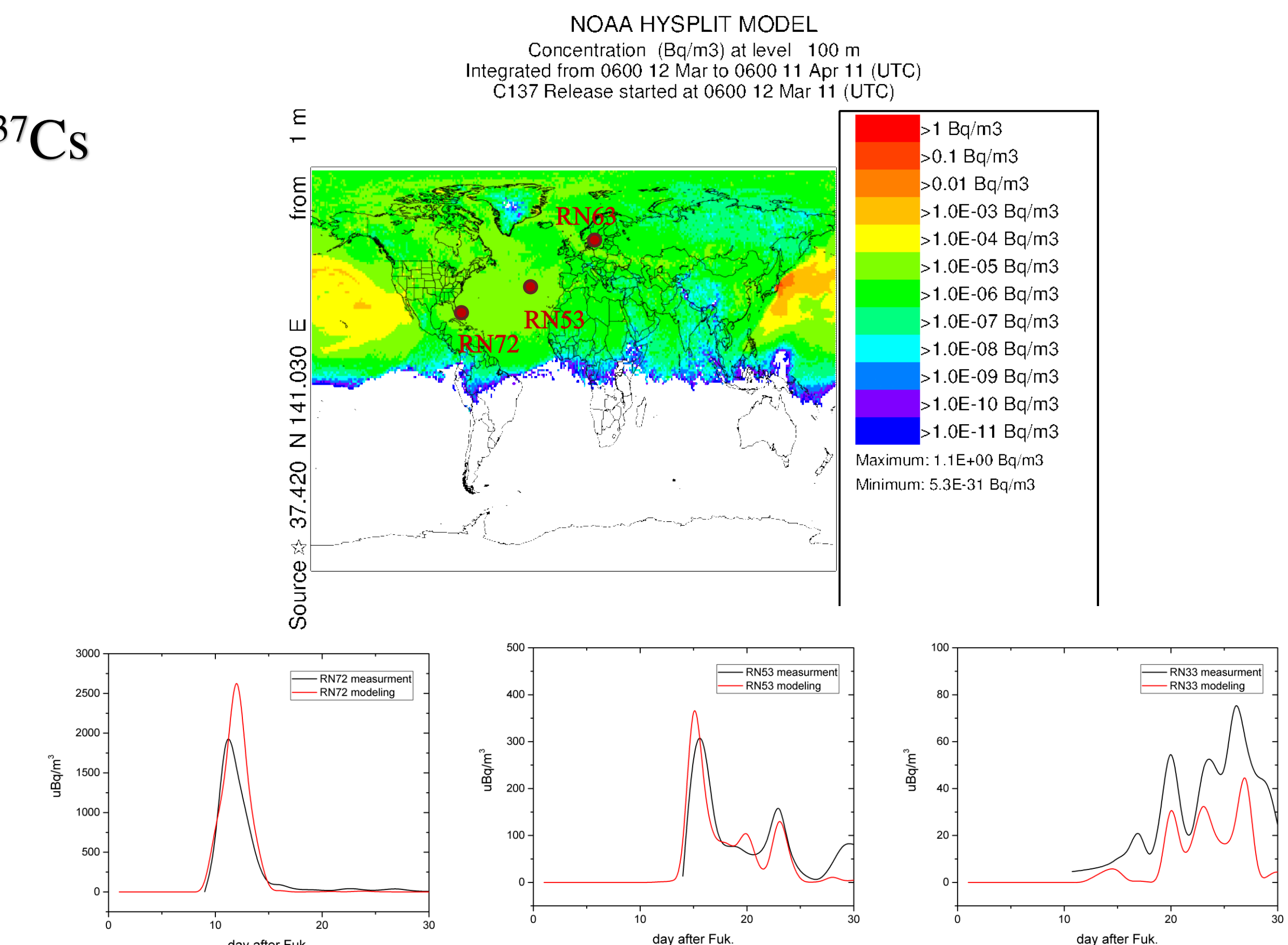
¹³³Xe



¹³¹I



¹³⁷Cs



➤ Conclusion

Fukushima accident was simulated with HYSPLIT model and used the previous study as a source-term. The results were compared with some IMS stations and it indicated that in majority cases this model has acceptable outcome. Although there are some discrepancies between the model and observations, considerably due to uncertainties in the problems in the treatment of emission, transport, and deposition processes in the model. Furthermore in some cases difference between modeling and measurement was increased by increasing distance from the point source.