

## 1 Background and purpose

Our activities after the Fukushima Daiichi Nuclear Power Plant (FDNPP) accident:

- Source term estimation (release rate/amount, release time)

Chino *et al.* (2011), Terada *et al.* (2012), Kobayashi *et al.* (2013), Katata *et al.* (2015)...

: refined as new observation data are obtained

- Atmospheric dispersion analysis in Eastern Japan with these source term

- Analysis on the formation process of high dose rate zone
- Estimation of radiological doses over Japan .....etc

**Purposes:** Hemispheric atmospheric dispersion analysis of the FDNPP accident

- to verify **Katata *et al.* (2015) source term** using WSPEEDI-II and CTBT-IMS data
- to survey the contribution of each release day to Cs-137 concentrations

## 2 Models of WSPEEDI-II

WSPEEDI-II: Worldwide version of System for Prediction of Environmental Emergency Dose Information version II

| Model  | developed by   | input                              | output                                 |
|--|--|------------------------------------|--|
| <b>Atmospheric dynamic model WRF</b><br>(Weather Research and Forecasting model) | National Center for Atmospheric Research (NCAR; USA) (Skamarock W.C. <i>et al.</i> , 2019) | topography, forecast/analysis data | wind, rain, temperature, turbulence... |
| <b>Particle dispersion model GEARN</b>   | Japan Atomic Energy Agency (Terada and Chino, 2008)  | WRF output, source term            | air concentration, deposition, doses   |

## 3 Calculation conditions

**Domain:** about 16,000 \* 16,000 km<sup>2</sup> area

**Period:** 00UTC 11 Mar – 00UTC 01 Apr 2011

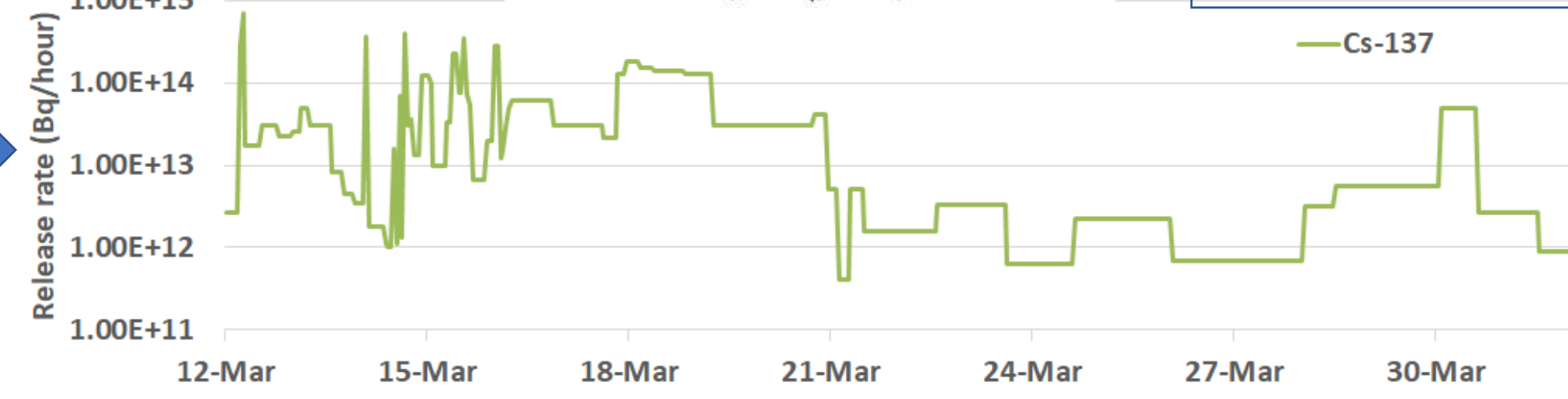
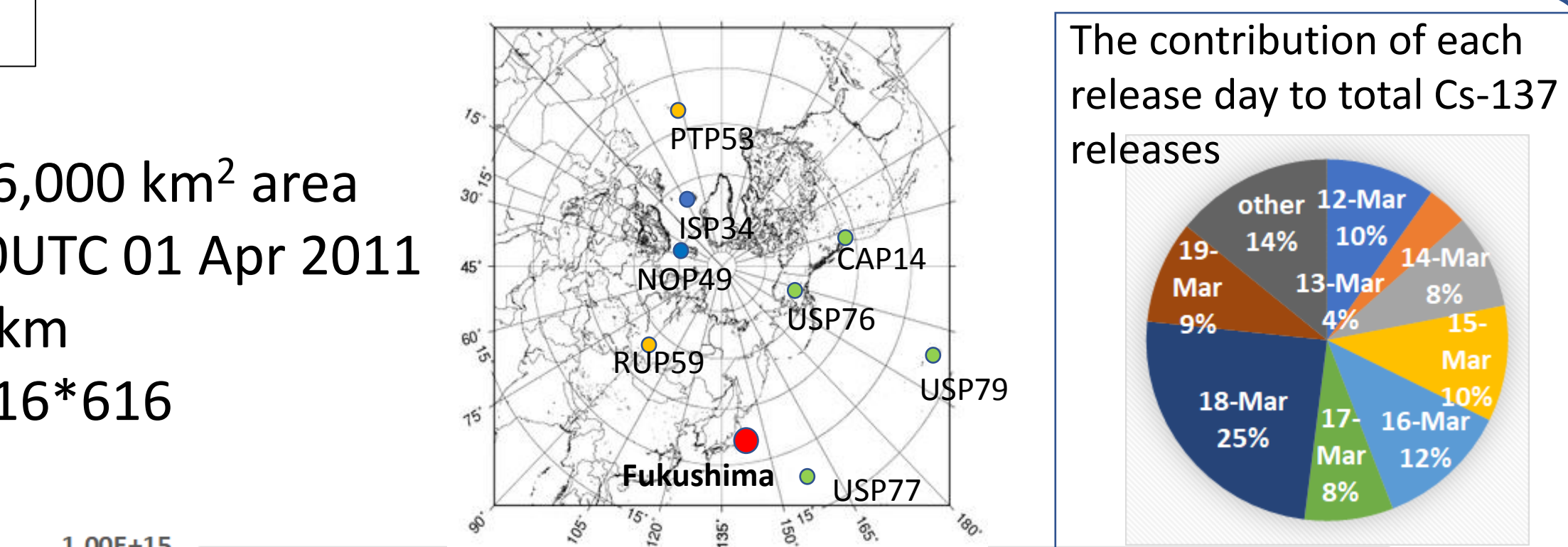
**Horizontal resolution:** 27km

**Horizontal grid number:** 616\*616

**Source term**

**(release rate):**

Katata *et al.* (2015)



### model configuration (WRF)

|                |  |
|----------------|--|
| Input data     | GSM-Global (4xdaily, 0.5°*0.5°) by Japan Meteorological Agency |
| Microphysics   | Morrison double-moment scheme                                  |
| Land surface   | 5-layer thermal diffusion                                      |
| Boundary layer | Mellor-Yamada Nakanishi and Niino Level 2.5 PBL                |
| Cumulus        | Betts-Miller-Janjic scheme                                     |

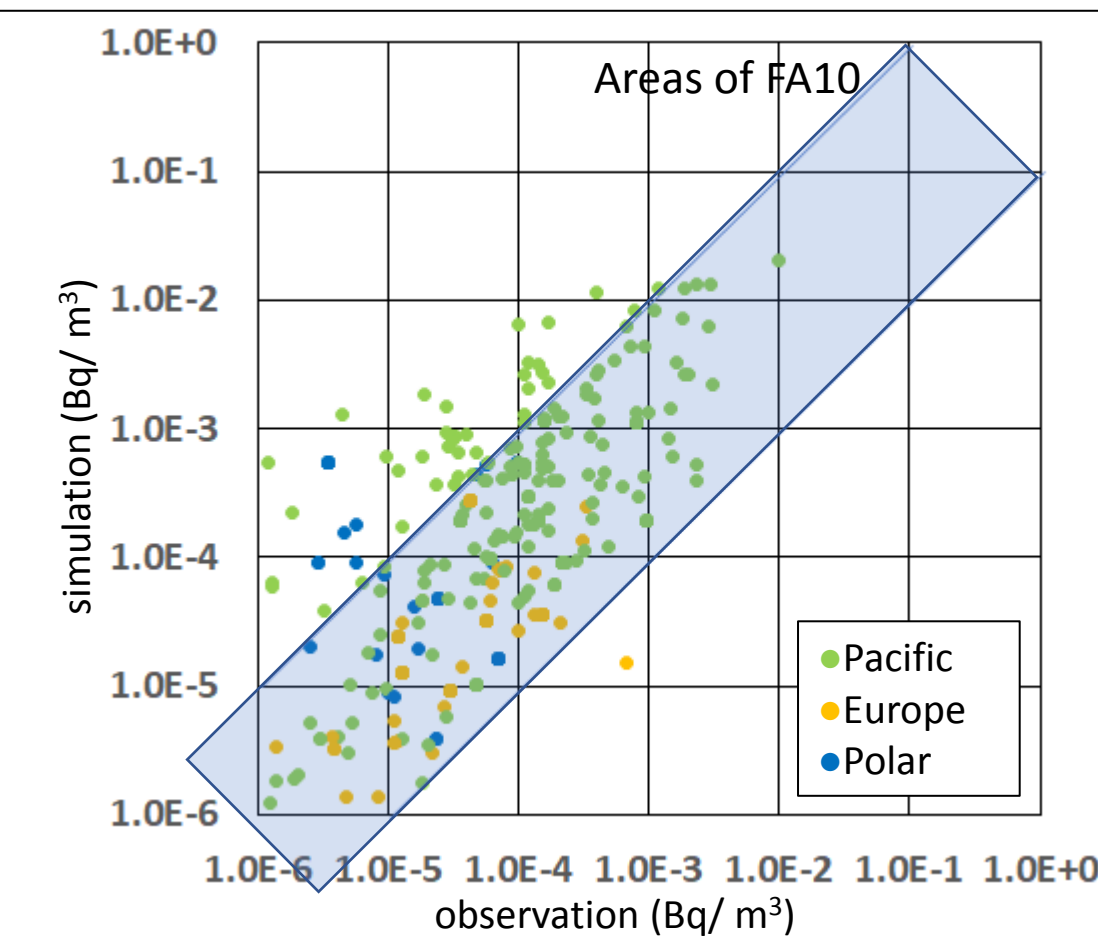
### model configuration (GEARN)

|                      |   |
|----------------------|---|
| Horizontal diffusion | Terada <i>et al.</i> (2013)                                   |
| Dry deposition       | constant deposition velocity                                  |
| Wet deposition       | simple exponential function of precipitation intensity by WRF |

**References** Chino *et al.* (2011): J. Nucl. Sci. Technol., 48, 1129-1134; Terada *et al.* (2012): J. Environ. Radioactiv., 112, 141-154; Kobayashi *et al.* (2013): J. Nucl. Sci. Technol., 50, 255-264; Katata *et al.* (2015): Atmos. Chem. Phys., 15, 1029-1070; Skamarock *et al.* (2019): NCAR Tech. Note NCAR/TN-556+STR, 145 pp.; Terada *et al.* (2008): J. Nucl. Sci. Technol., 45, 920-931; Terada *et al.* (2013): J. Nucl. Sci. Technol., 50, 1198-1212

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## 4 Statistical comparison with CTBT-IMS Data (24h accumulated concentration)



|         | Bias  | FA5  | FA10 |
|---------|-------|------|------|
| Total   | 0.05  | 0.57 | 0.77 |
| Pacific | 0.25  | 0.53 | 0.74 |
| Europe  | -0.53 | 0.68 | 0.84 |
| Polar   | 0.19  | 0.54 | 0.77 |

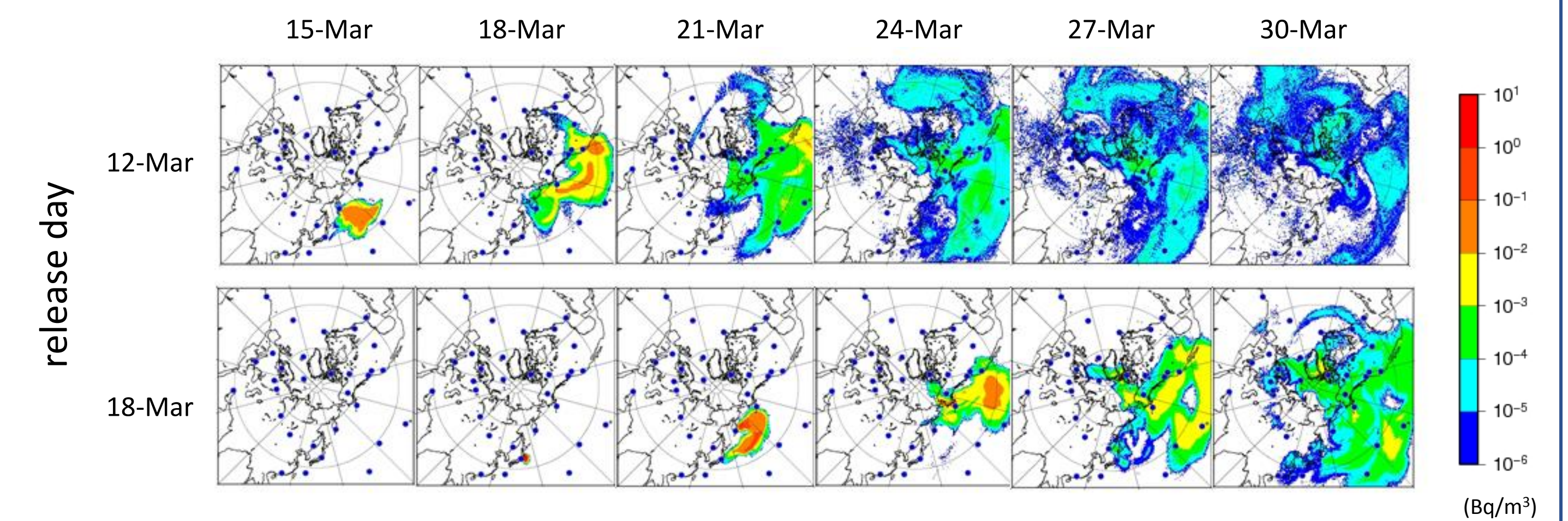
$$FAx : 1/x \leq \text{calc}/\text{obs} \leq x$$

$$\text{Bias} : \sum \{ \log(\text{calc}) - \log(\text{obs}) \} / n$$

Pacific: CAP14, CAP16, CAP17, JPP37, RUP60, USP70, USP71, USP72, USP74-79  
Europe: DEP33, MNP45, PTP53, RUP54, RUP59, SEP63 Polar: CAP15, ISP34, NOP49

- ◆ The ratio calculated within FA10 exceeded 70%
- ◆ Simulated concentration were in good agreement with IMS data

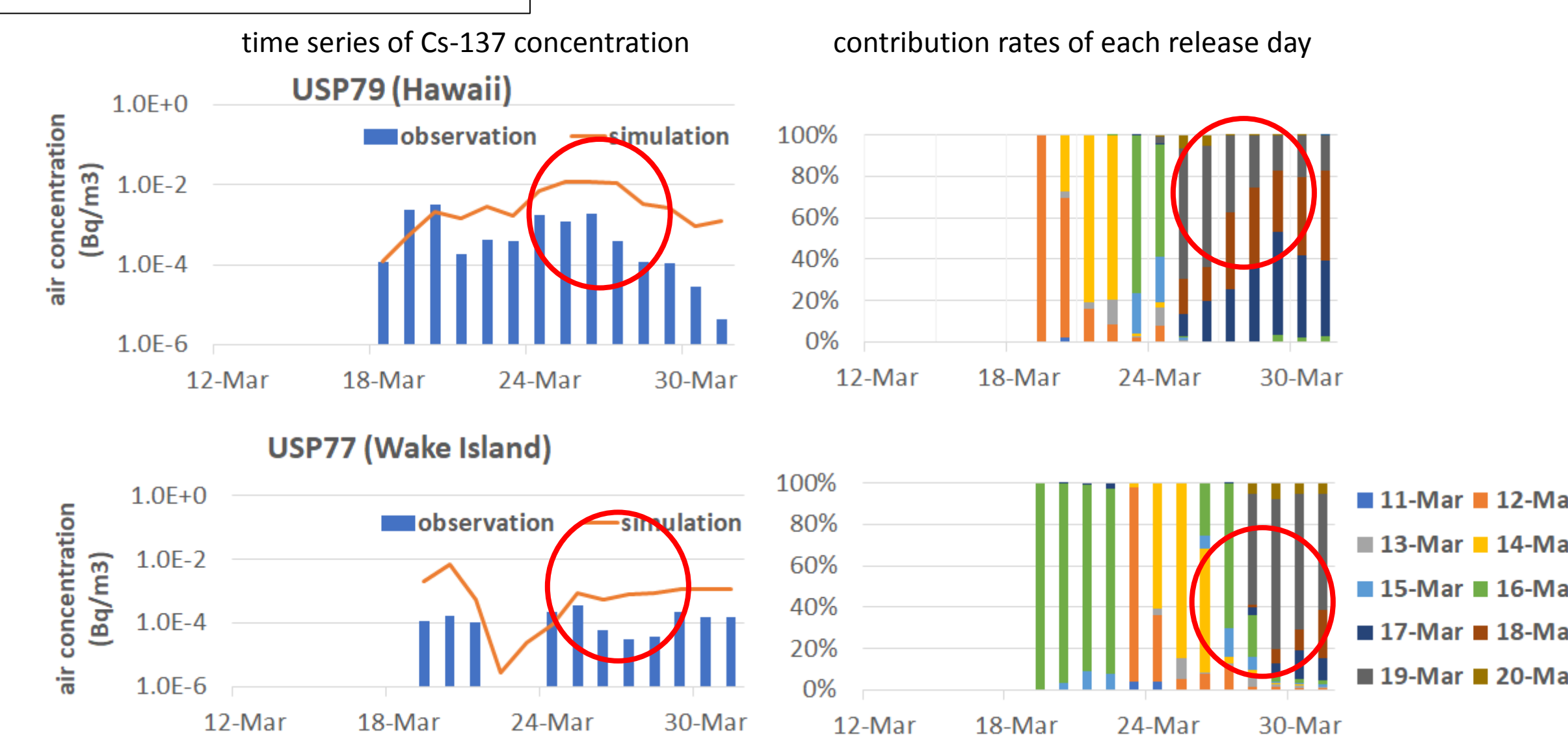
## 5 Surface horizontal distributions of Cs-137 for each release day



- ◆ Cs-137 released on 12-Mar: widely dispersed in the hemisphere
- ◆ released on 18-Mar: mainly dispersed towards the Pacific, then to the polar regions

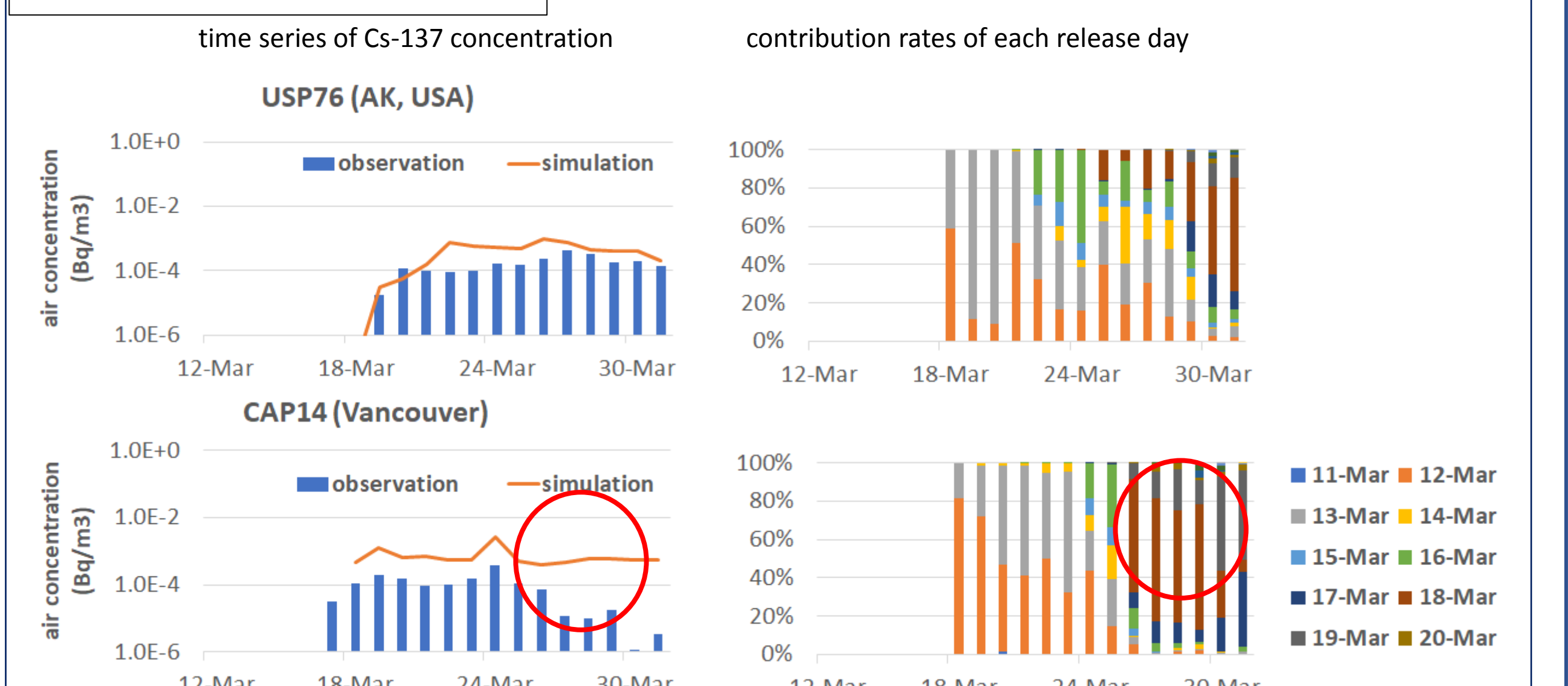
## 6 Time series of the Cs-137 concentration and contribution rates of each release day at the CTBT-IMS stations

### 6-1 Pacific islands area



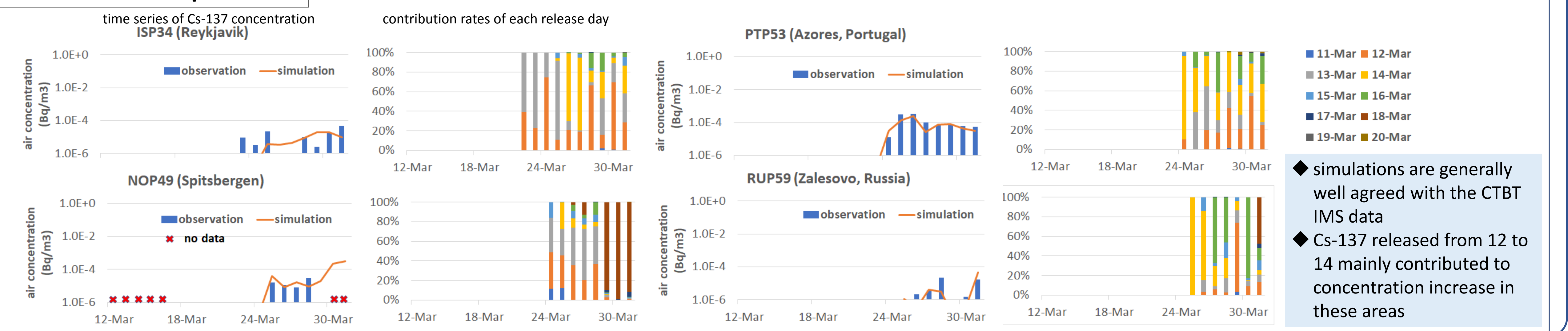
- ◆ 24-Mar ; Cs-137 released from 12 to 14 March contributed to concentration increase in these areas
- ◆ 25-Mar ; mainly released from 16 to 19 Mar contributed → cause of overestimation

### 6-2 US west coast area



- ◆ 25-Mar ; Cs-137 released from 12 to 13 March contributed to concentration increase in these areas
- ◆ 26-Mar ; released from 16 to 19 Mar contributed → cause of overestimation

### 6-3 Arctic and Europe area



- ◆ simulations are generally well agreed with the CTBT IMS data
- ◆ Cs-137 released from 12 to 14 mainly contributed to concentration increase in these areas

## 7 Conclusion and future remarks

- ◆ Hemispheric atmospheric dispersion simulation of the FDNPP accident using WSPEEDI-II are generally well agreed with the CTBT IMS data
- ◆ As results of analysis for contribution rates of each release day to simulated concentration :
  - Cs-137 released on 12-Mar widely dispersed in the hemisphere including the arctic and Europe area
  - Cs-137 released from March 17 to 19 mainly reached around the Pacific Islands area and they are cause of the overestimation
  - ➔ useful information for re-estimation of the release amount of Cs-137 from the Fukushima Daiichi Nuclear Power Plant