Atmospheric Transport Results for BSAF Phase 2

PRESENTED BY

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Objectives of Atmospheric Transport Analysis at Fukushima

- Provide guidance to source-term modelers by estimating ground deposition patterns
  - Focus on Cs-137 (best quantified of the released isotopes)
  - Deposition pattern depends critically on chronological alignment of release with weather pattern
- Benchmark atmospheric transport models against real data
  - HYSPLIT Lagrangian particle tracking model
    - As a stand-alone model
    - Integrated with MACCS

Two Major Sources of Uncertainty

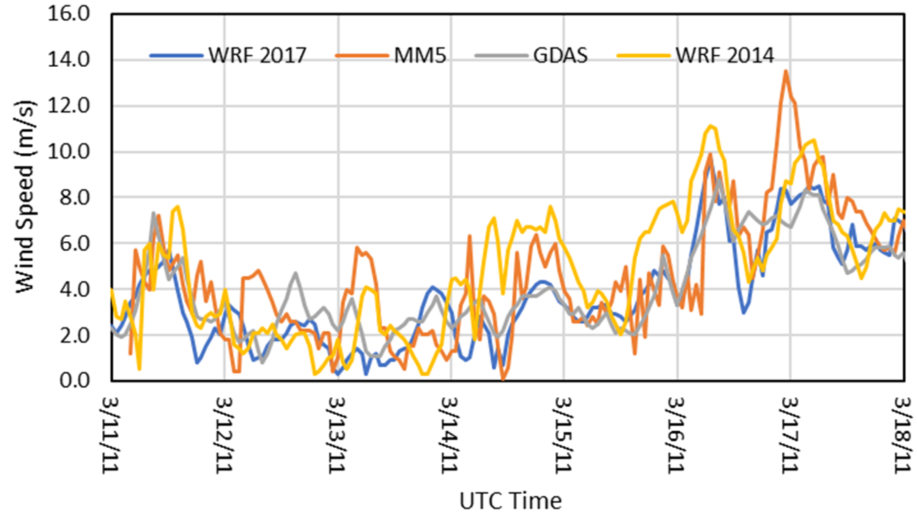
- Uncertainty in weather was investigated using three sources of weather data, all from NOAA
  - WRF (Weather Research and Forecasting) model, generated in 2014
    - 4-km spatial, 20 min temporal discretization
    - No nudging
  - GDAS (Global Data Assimilation System)
    - 0.5 degrees spatial, 3 hour temporal discretization
    - No nudging
  - WRF model, generated in 2017
    - 4-km spatial, 5 min temporal discretization
    - Nudged with observations
- Uncertainty in source term was assessed using source terms from BSAF contributors

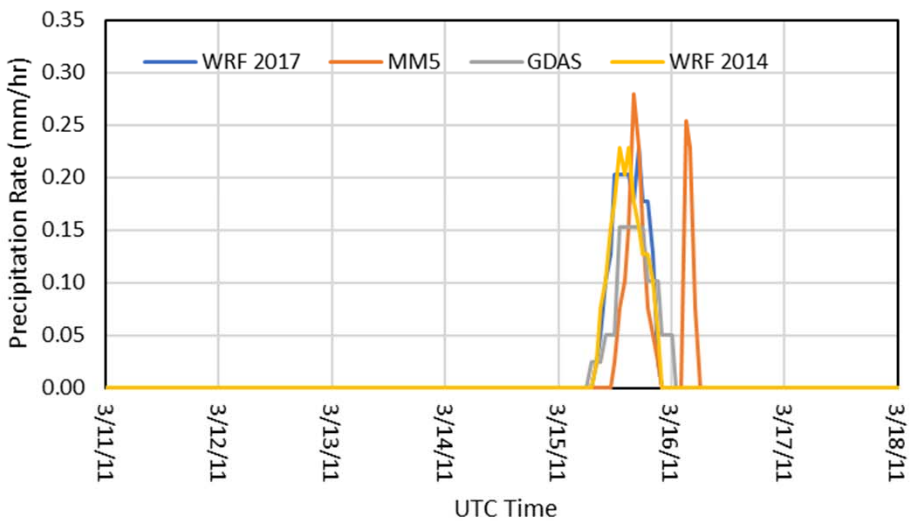
Meteorological Data for First 7 Days

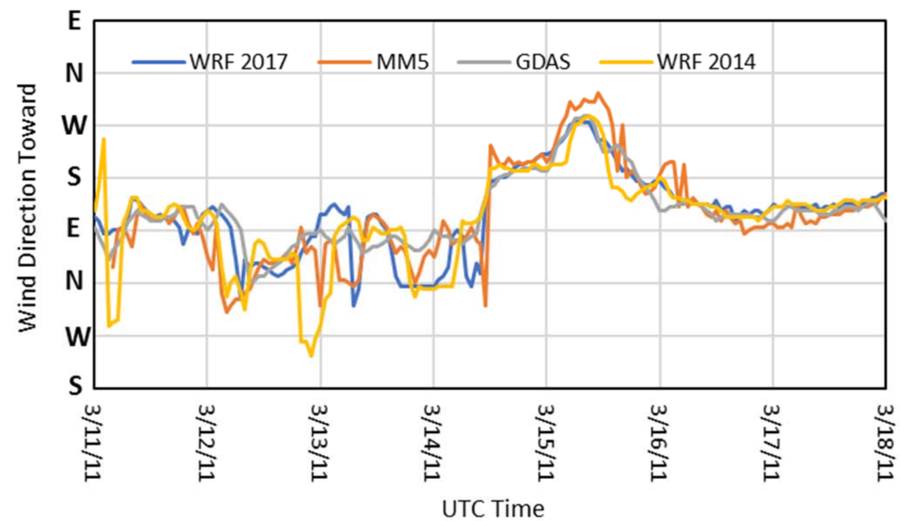
- Weather data have similar trends

but

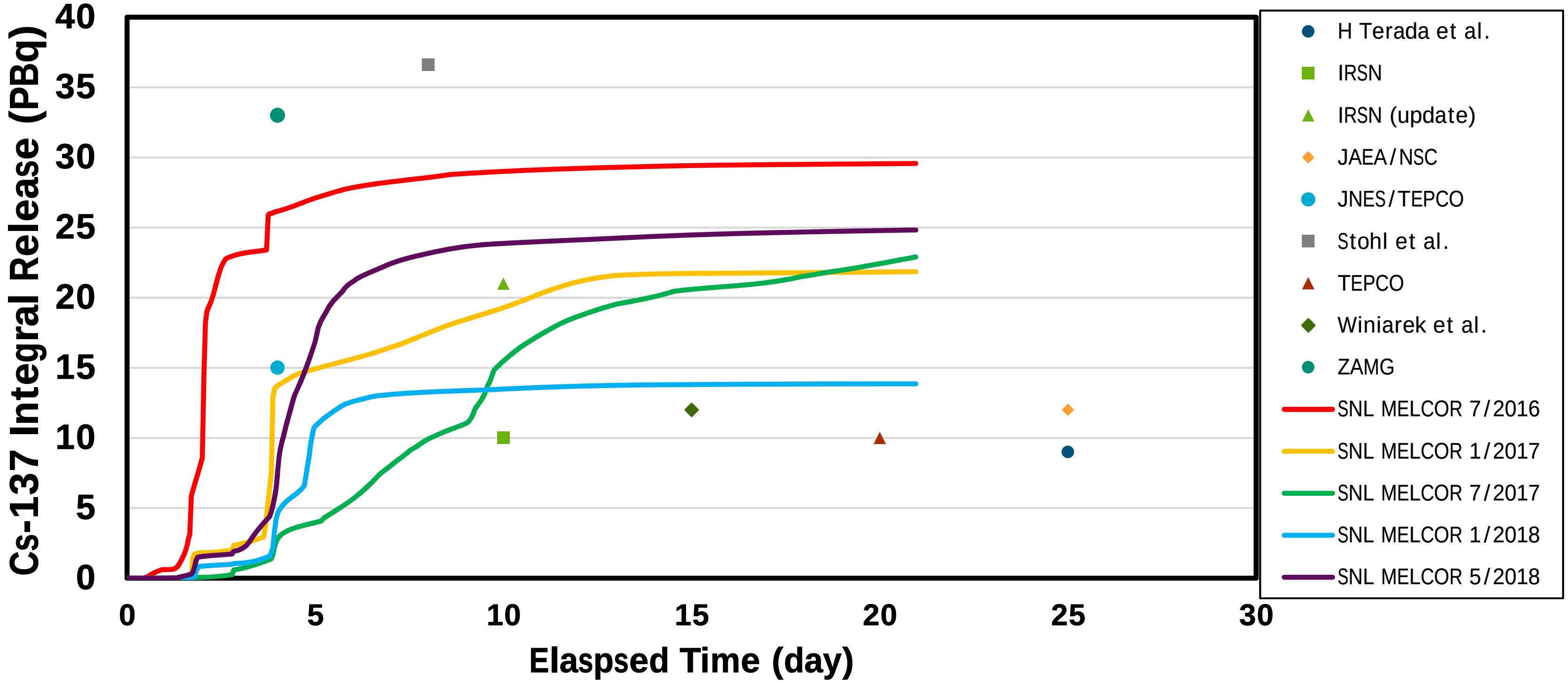
- Significant variations in detail





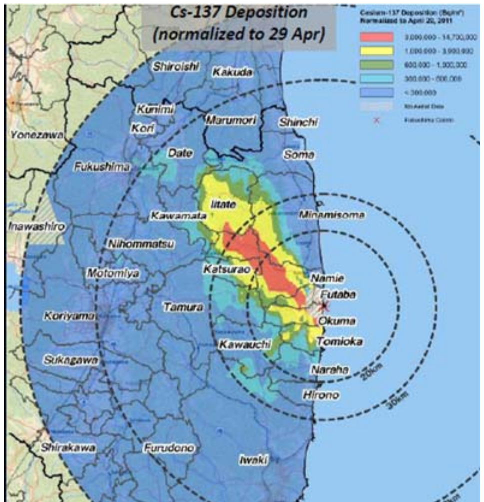


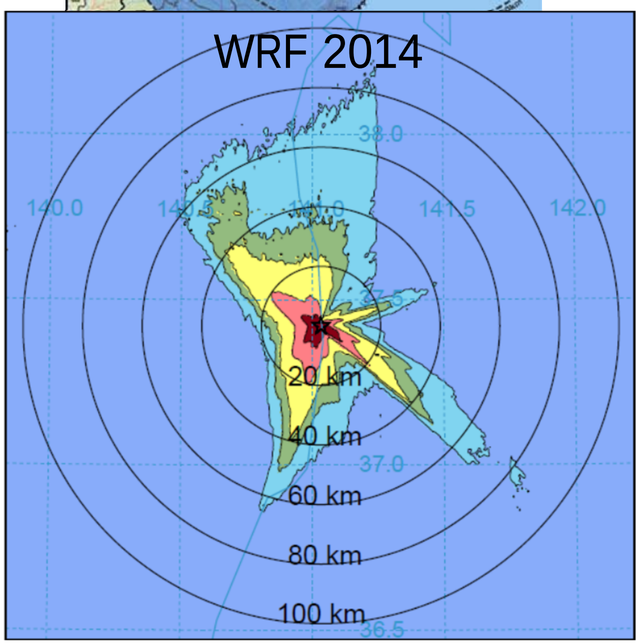
Evolution of Integral Release Estimated by NRC/SNL



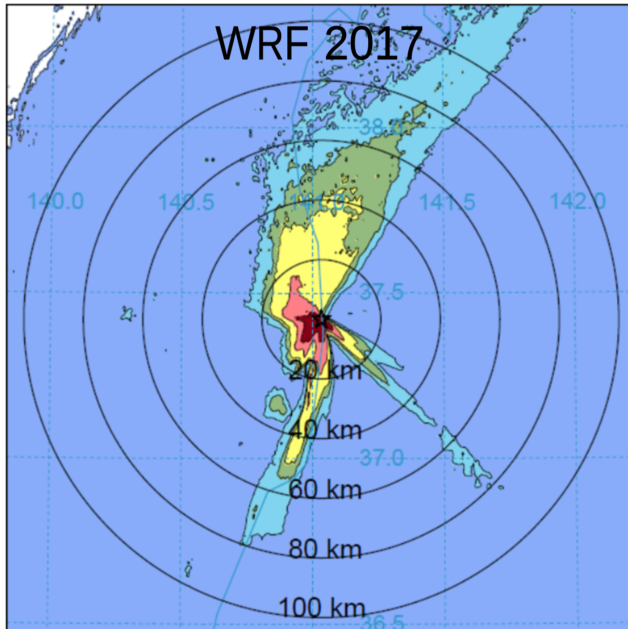
- Curves indicate evolution of integral release for three units as estimated by NRC/SNL over the course of BSAF Phase II
- Many of the initial and boundary conditions needed to estimate accident progression were poorly understood
  - Initial damage state was unknown
  - Water injection may have failed, succeeded, or partially succeeded

Weather Data Comparison





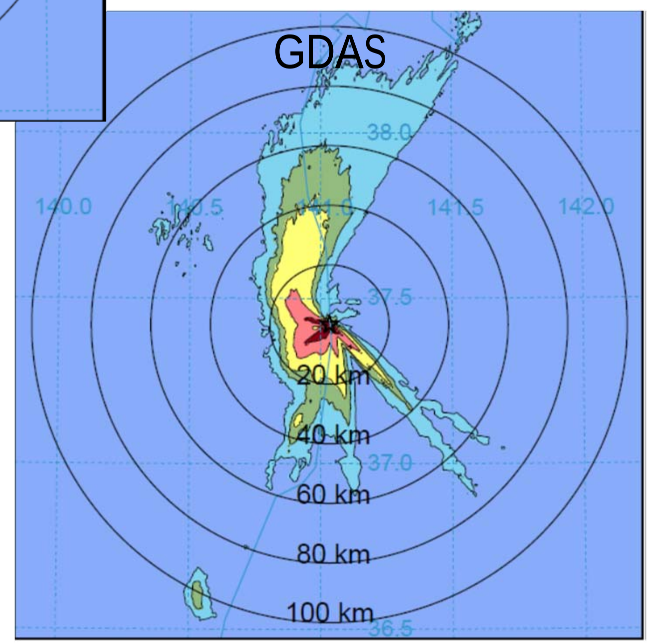
SNL MELCOR 5/2018



- >1.0E+07 Bq/m2
- >3.0E+06 Bq/m2
- >1.0E+06 Bq/m2
- >6.0E+05 Bq/m2
- >3.0E+05 Bq/m2
- >100 Bq/m2

Maximum: 9.1E+07 Bq/m2

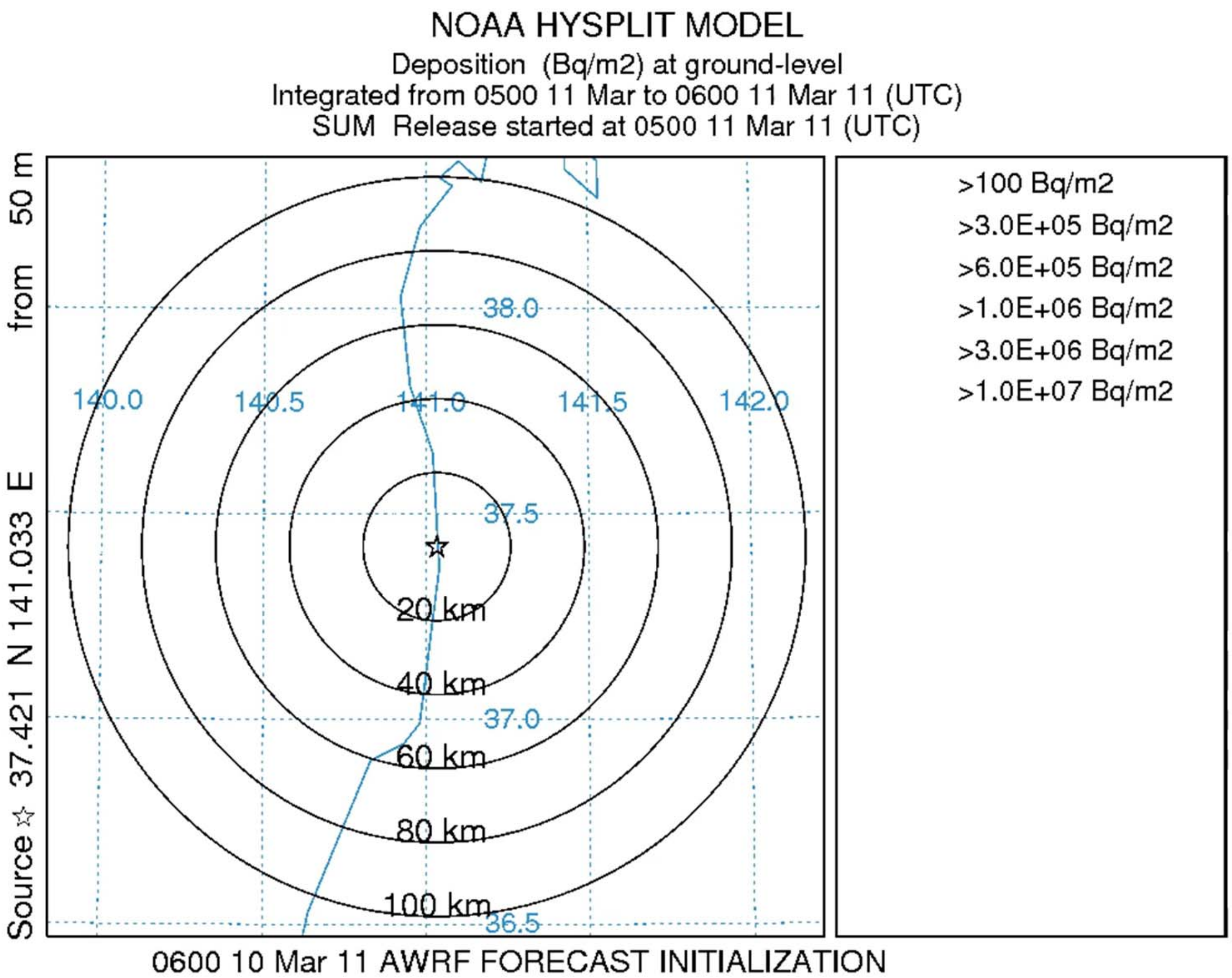
Minimum: 2.0E+01 Bq/m2



Plots use
- **Consistent scale**
- **Consistent isopleth shading (1 additional level in SNL plots)**

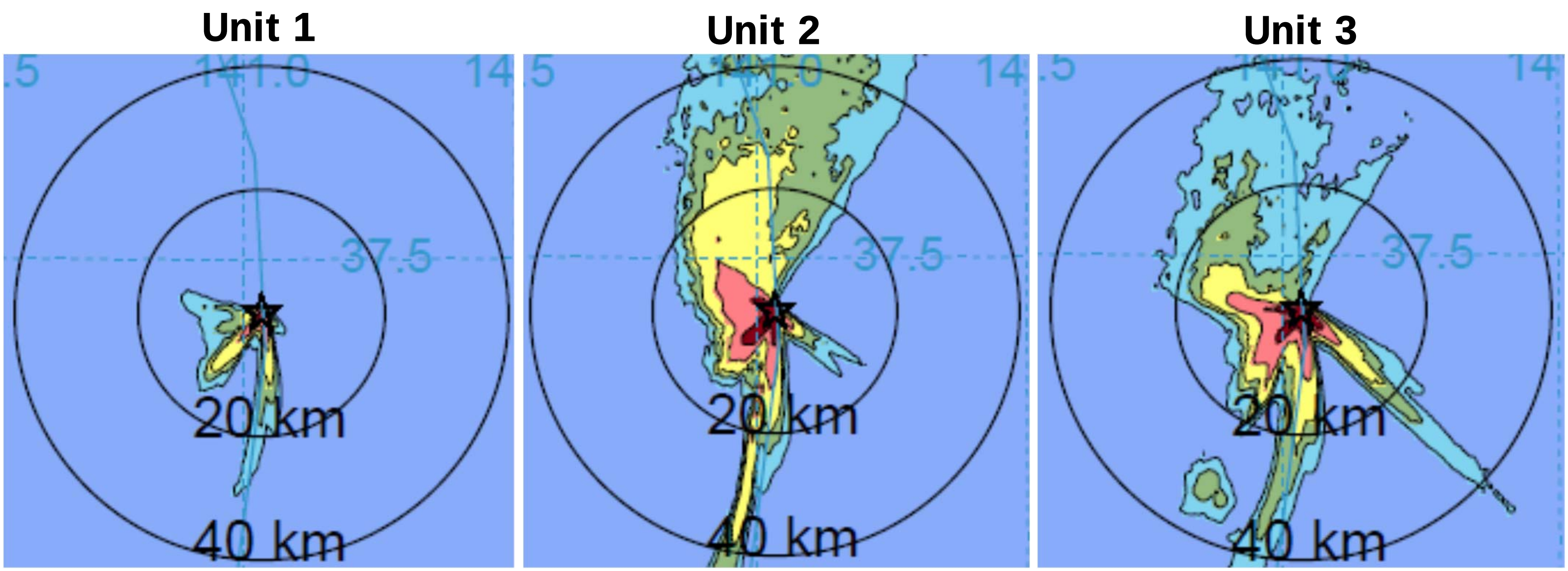
Predicted Ground Deposition

WRF 2017 SNL MELCOR 5/2018 Source Term



Contributions to Deposition Pattern from Individual Units

- Figures show final deposition patterns created by each unit based on final NRC/SNL source term using WRF 2017 weather data
- Unit 1 contributes very little to the overall pattern
- Unit 2 and, to a lesser extent, Unit 3 create much of the NW deposition pattern, mostly on 3/15



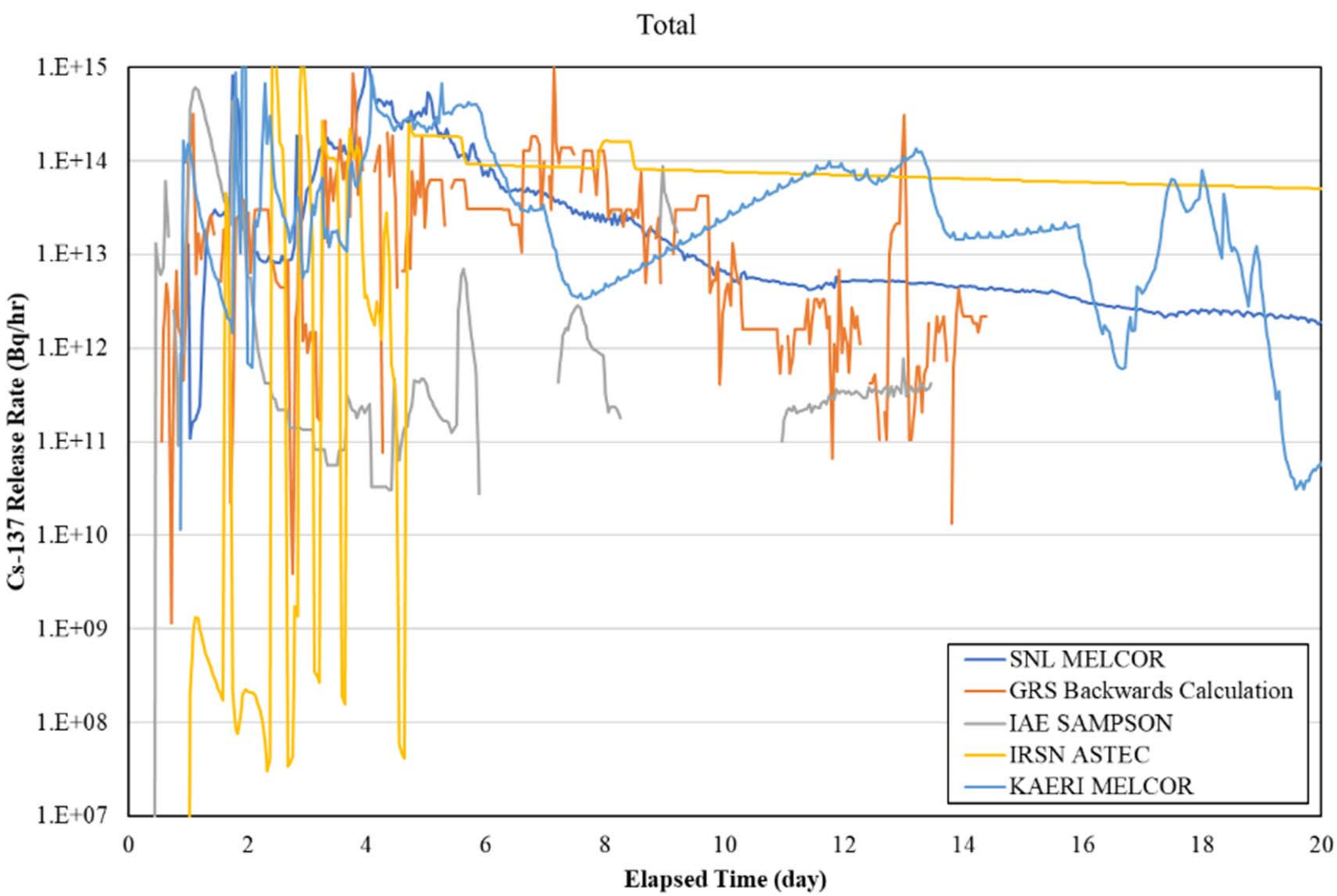
BSAF Source Terms

- SNL received source terms from eight BSAF organizations

Organization	Country	Code	Units
SNL	USA	MELCOR	1, 2, & 3
IAE	Japan	SAMPSON	1, 2, & 3
IRSN	France	ASTEC	1, 2, & 3
KAERI	Korea	MELCOR	1, 2, & 3
CIEMAT	Spain	MELCOR	1
CNL	Canada	MELCOR	2
CRIEPI	Japan	MAAP	2
PSI	Switzerland	MELCOR	3

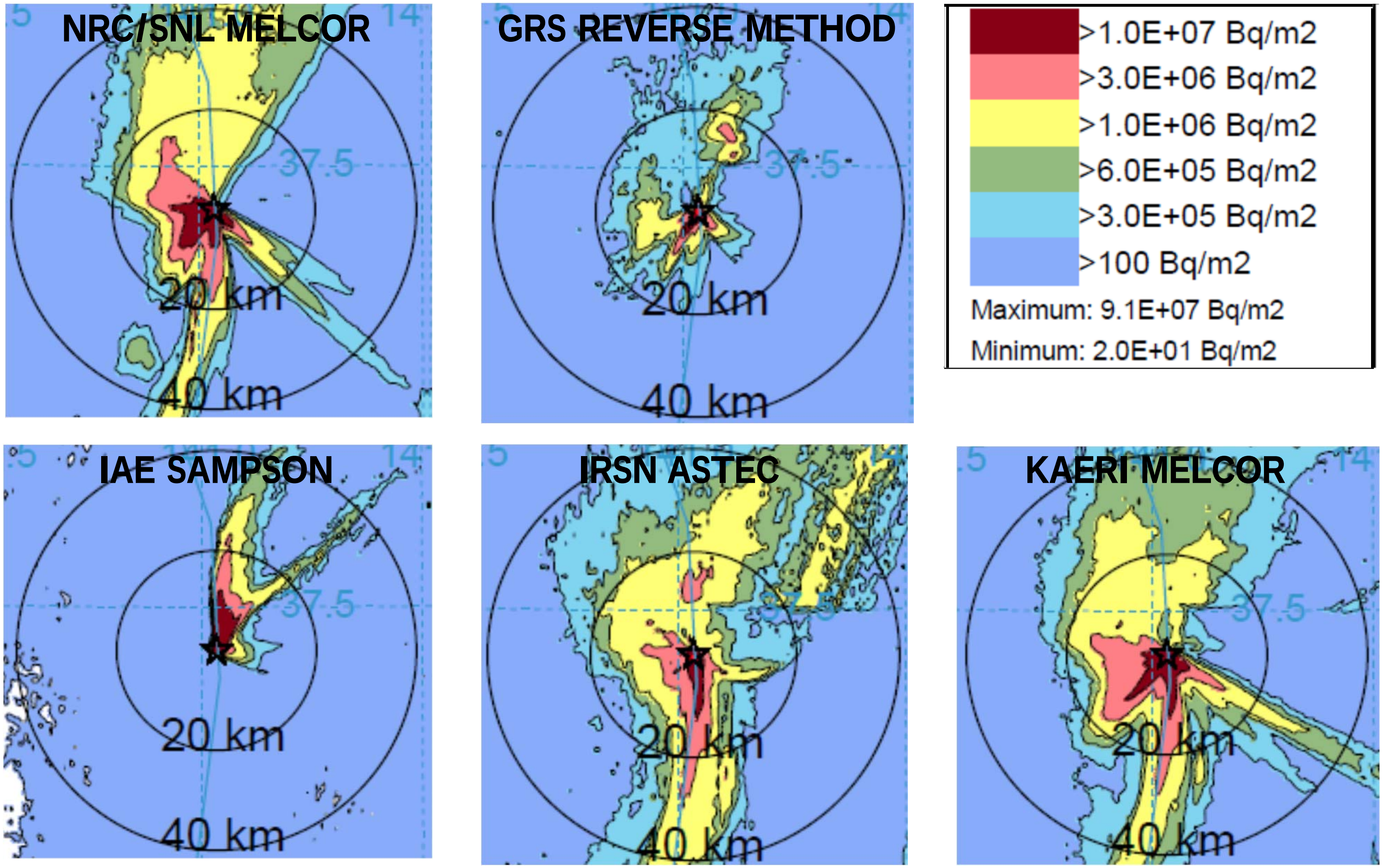
- Four provided a source term for all three units
- GRS (Germany) reconstructed a source term using data from radiation monitors in the area surrounding Fukushima (reverse method)

Total Source Term Comparison



Total Deposition Comparison

Using WRF 2017 Weather Data



Summary of Fukushima ATD Modeling

- NRC/SNL evaluated atmospheric transport with HYSPLIT and MACCS
- Uncertainty in meteorology makes a significant difference in the deposition pattern
- Uncertainty in source term makes an even larger difference in the deposition pattern
- Insights from atmospheric transport modeling improved the fidelity of the source terms over the course of BSAF Phase II
- BSAF results have provided preliminary guidance for decommissioning the Fukushima Daiichi units

List of Acronyms

ATD	Atmospheric Transport and Dispersion
BSAF	Benchmark Study of the Accident at the Fukushima Daiichi Nuclear Power Station Project
CRAC	Calculation of Reactor Accident Consequences
DCF	Dose Conversion Factor
DHS	Department of Homeland Security
GDAS	Global Data Assimilation System
GDP	Gross Domestic Product
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory
MACCS	MELCOR Accident Consequence Code System
MUPSA	Multi-Unit Probabilistic Safety Assessment
NISAC	National Infrastructure Simulation and Analysis Center
NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
PRA	Probabilistic Risk Assessment
RDEIM	Regional Disruption Economic Impact Model
REAcct	Regional Economic Accounting tool
SGTR	Steam Generator Tube Rupture
SNL	Sandia National Laboratories
SOARCA	State-of-the-Art Reactor Consequence Analyses
WRF	Weather Research and Forecasting Model