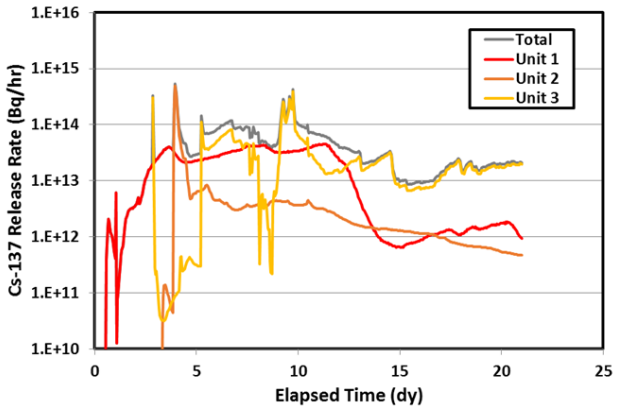
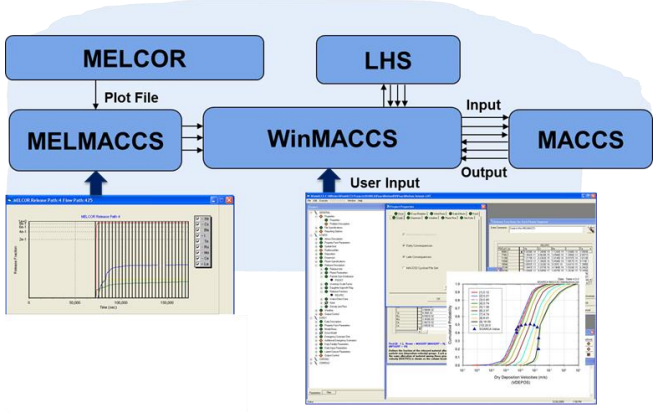
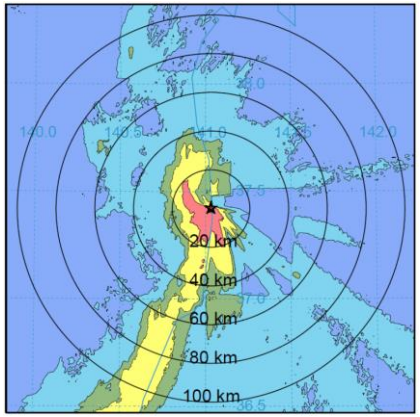
Exceptional service in the national interest

Sandia National Laboratories







Current Atmospheric Transport and Land Contamination Results for Fukushima Daiichi Units 1, 2, & 3

Nathan E. Bixler and Daniel J. Clayton

Sandia National Laboratories

Presented at the 8th IMUG Meeting, Sept. 14 – 15, 2017

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

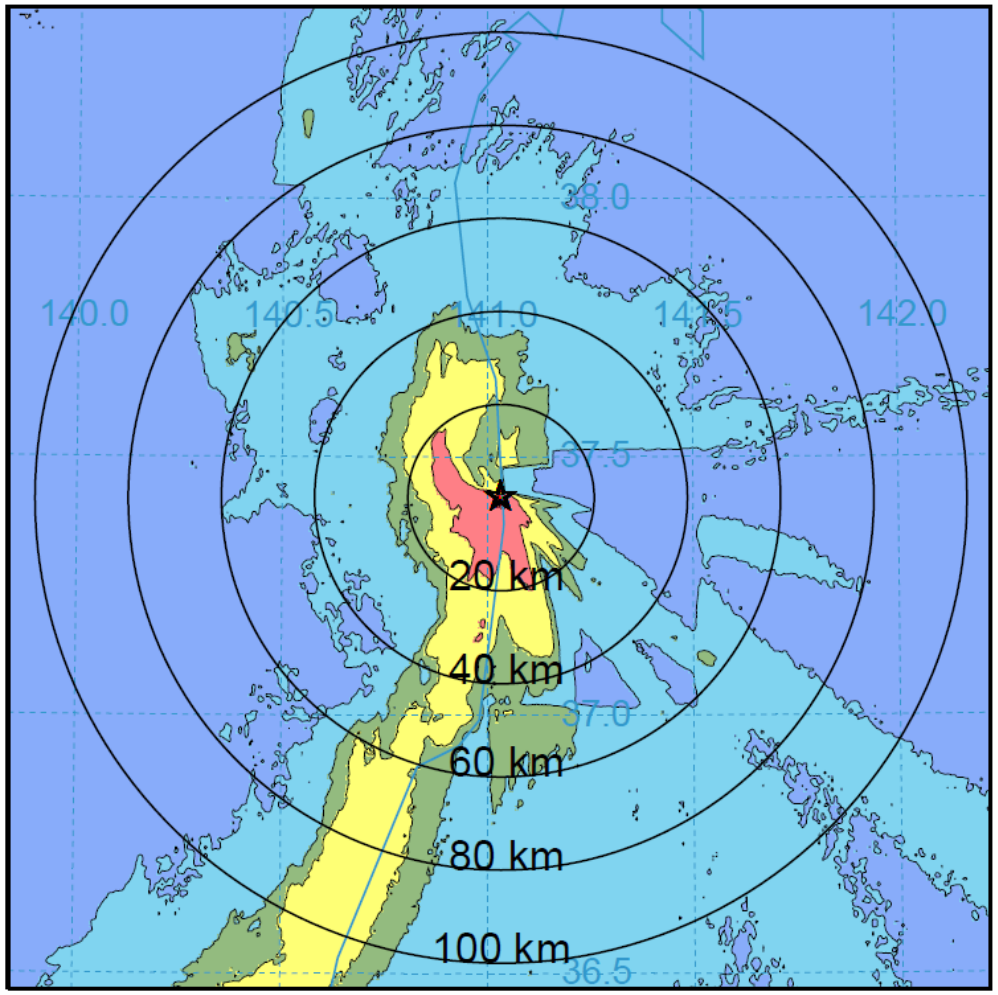
U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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Overview

- Objectives
- Source terms
- Deposition predictions
- Summary
- Future work



Objectives of Atmospheric Transport Analysis

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- Evaluate viability of MELCOR source terms by replicating ground deposition patterns
  - Focus on Cs-137
  - Primary focus on deposition toward the northwest
  - Secondary focus on general deposition pattern
- Provide guidance in release timing and magnitude for MELCOR analysts
- Benchmark models against real data
  - HYSPLIT particle tracking model
    - As a stand-alone model
    - Integrated with MACCS (future)

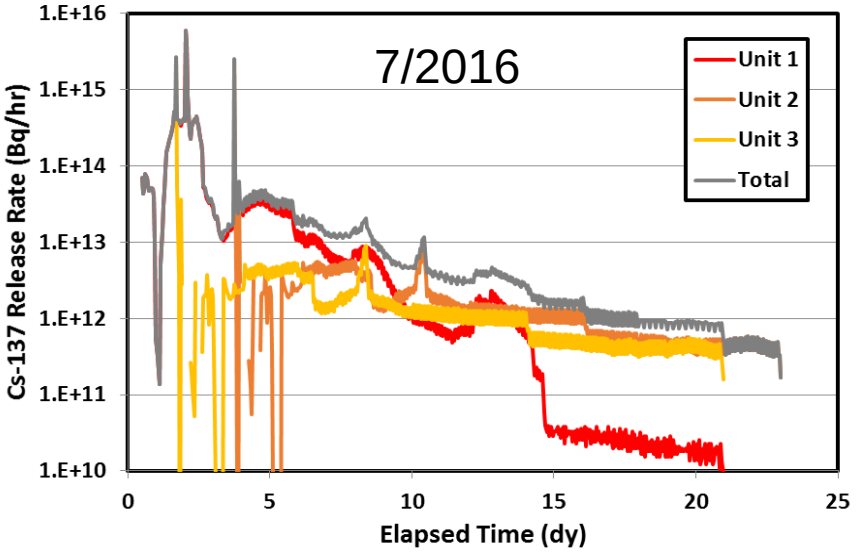
Atmospheric Transport Analysis

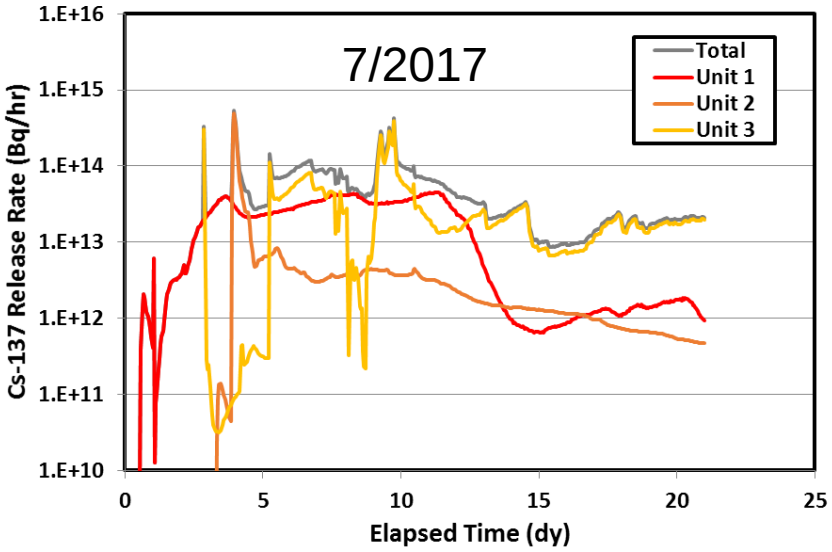
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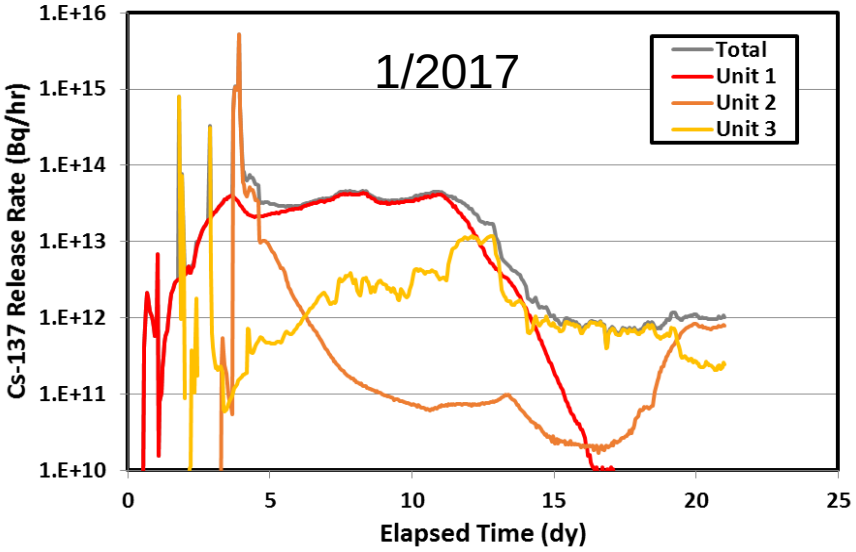
- Weather data calculated with WRF
  - 4-km spatial discretization along earth surface
  - About 20 vertical levels
  - 20-min time resolution
- MELCOR source term data
  - Based on best-estimate forensic analyses
- HYSPLIT atmospheric transport analysis
  - Releases use correct location for each unit
  - Account for plume buoyancy

Evolution of MELCOR Source Terms

- 7/2016
  - Unit 3 with delay used as surrogate for Unit 2
  - No models for reactor buildings
- 1/2017
  - All three units simulated for 3 weeks
  - Models account for reactor buildings
- Current, 7/2017
  - Updated source terms with lower peaks

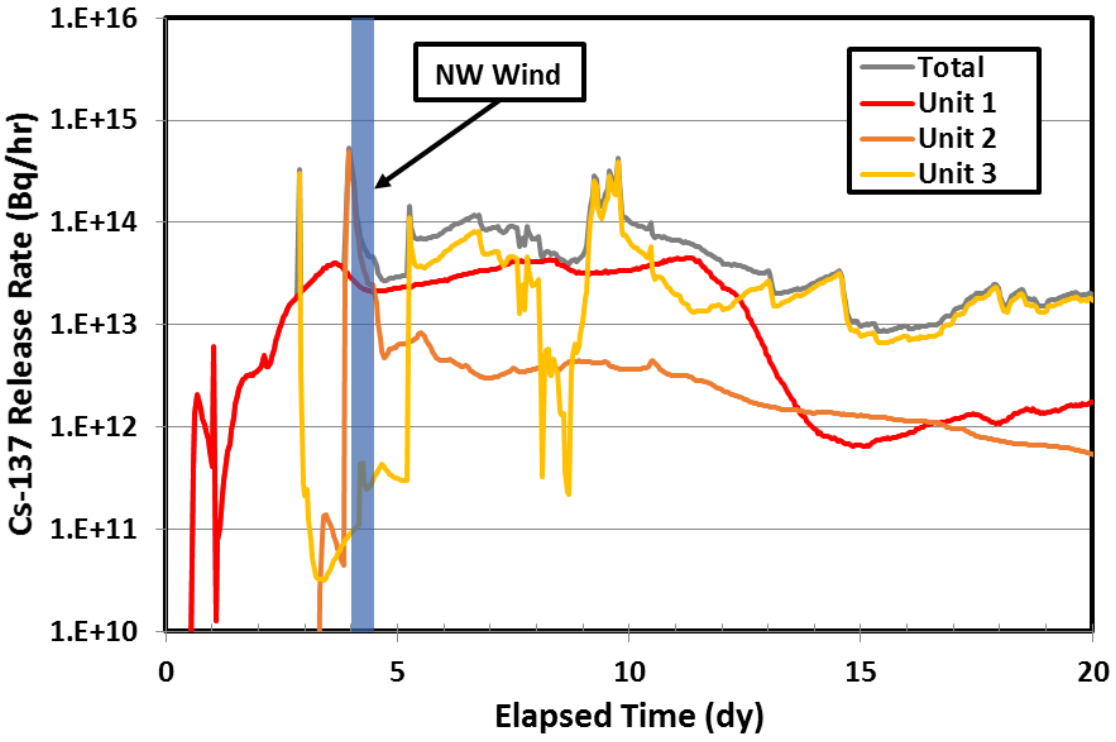




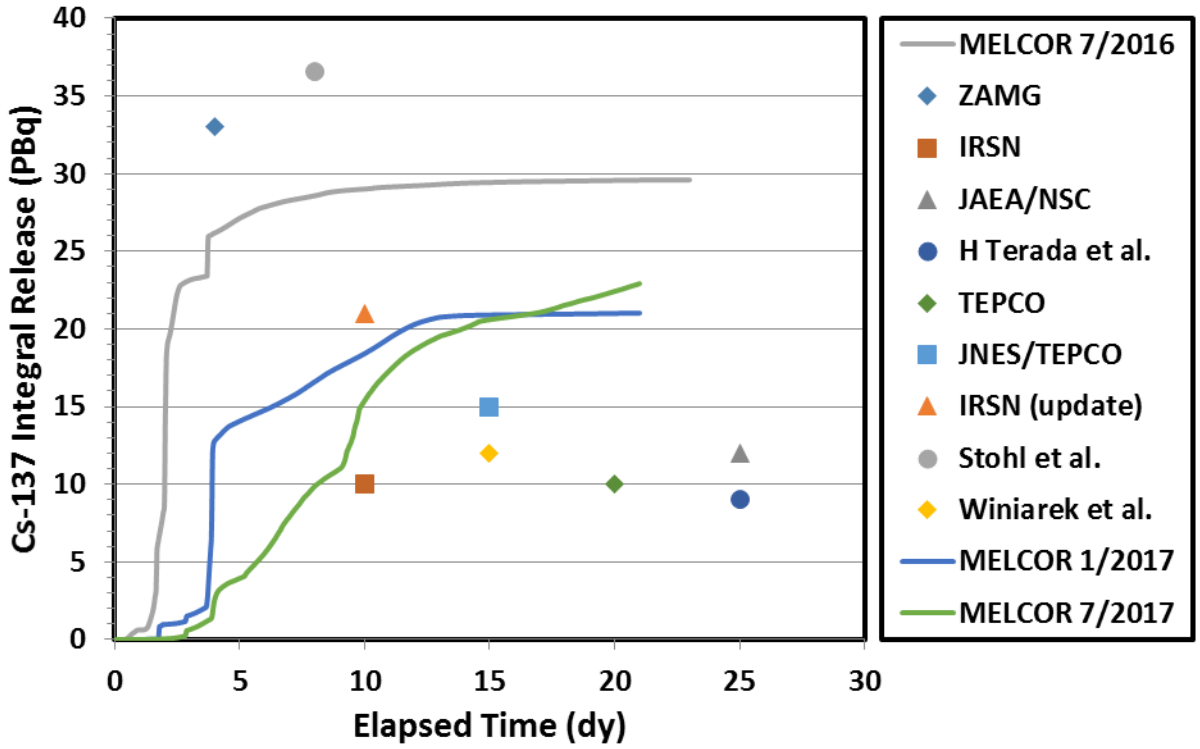


Observations on Updated Releases

- Release rate is 10^{13} to 10^{14} Bq/hr over most of the transient
- Larger release spikes (> 10^{14} Bq/hr) occur at
  - 69 hours (U3)
  - 94-99 hours (U2)
  - 219-241 hours (U3)
- Second spike starts at the beginning of transition to NW wind

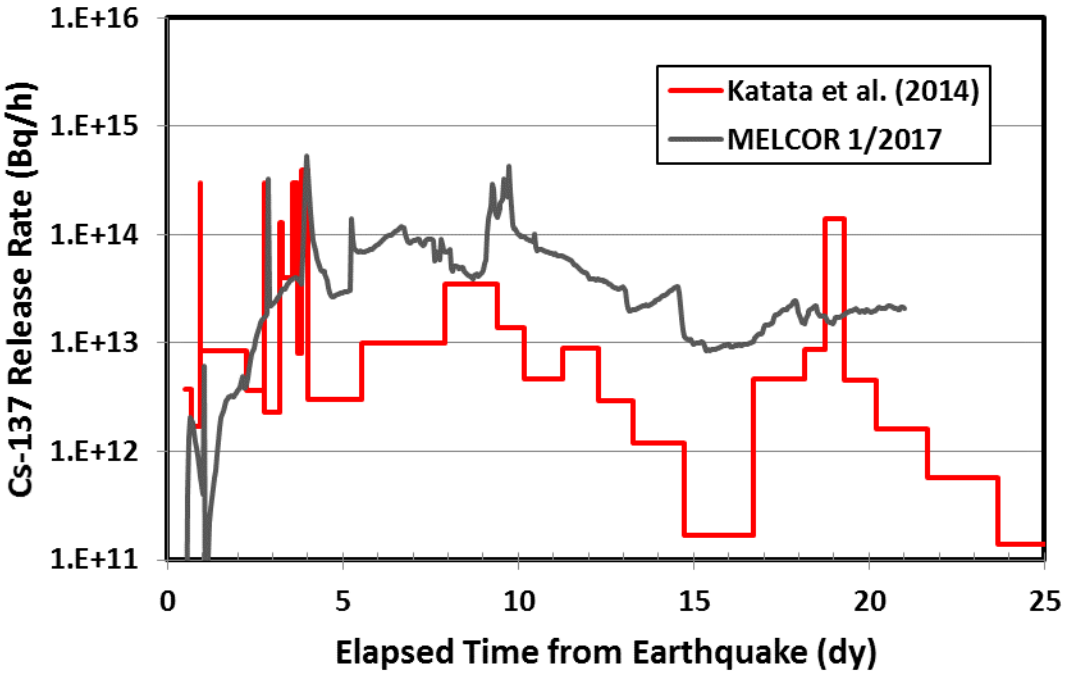


Integral Release Estimates



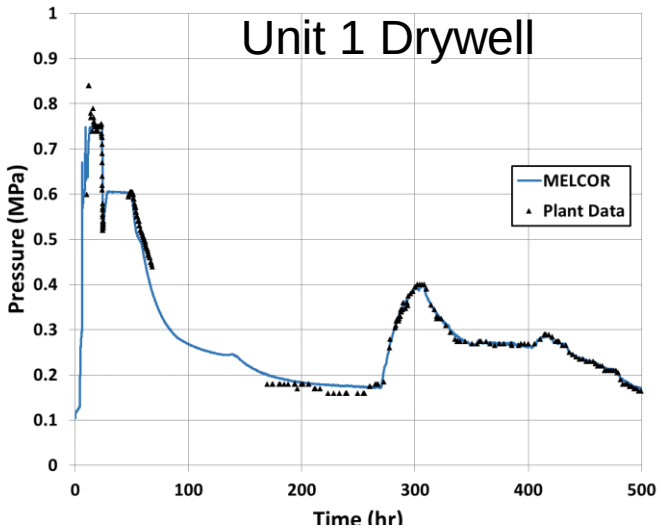
- Current MELCOR total Cs-137 release for all three units
  - Total is bout 23 PBq
  - Activity is within range of other estimates, but above the average
  - About 35% is from Unit 1, 12% from Unit 2, and 52% from Unit 3

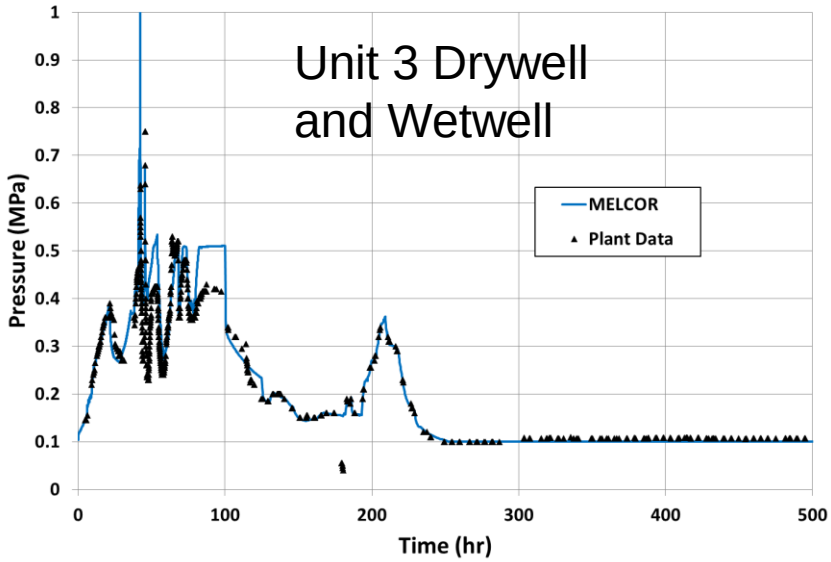
Comparison with Katata Estimate

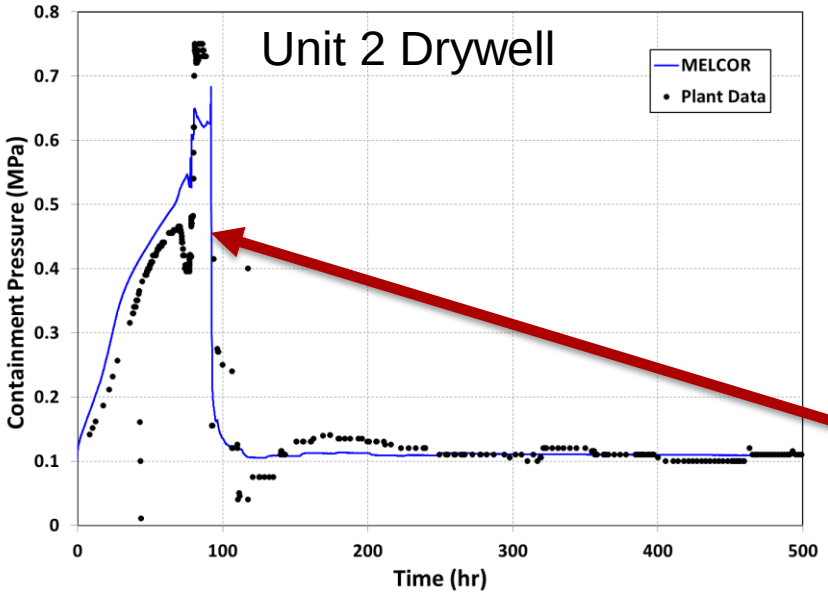


- Several of the early release peaks reasonably match
- Release rates after 5 days are generally an order of magnitude greater for MELCOR than Katata et al.
- Release from Unit 3 may be too large

Containment Pressure Histories



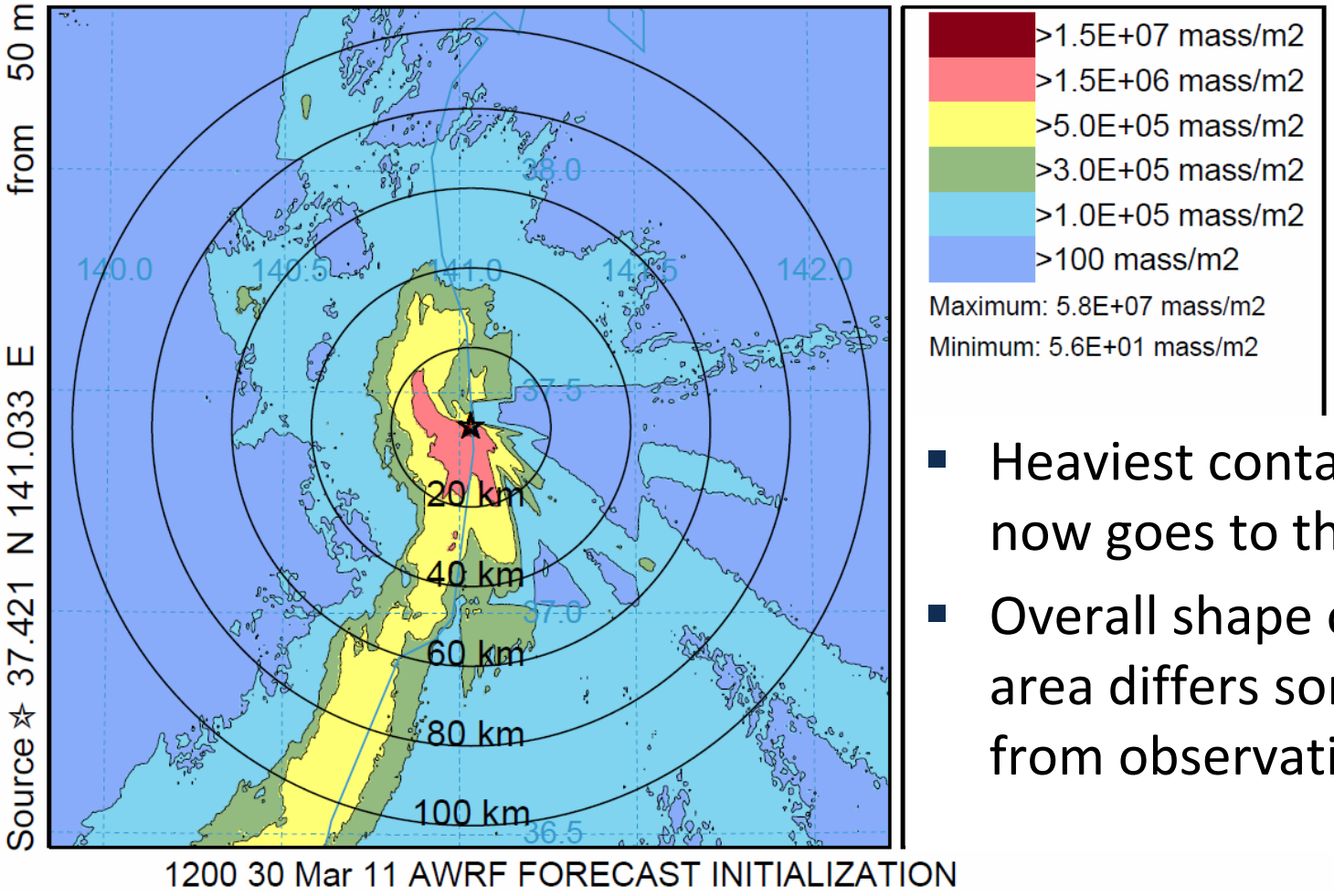




Overall agreement with plant data is excellent

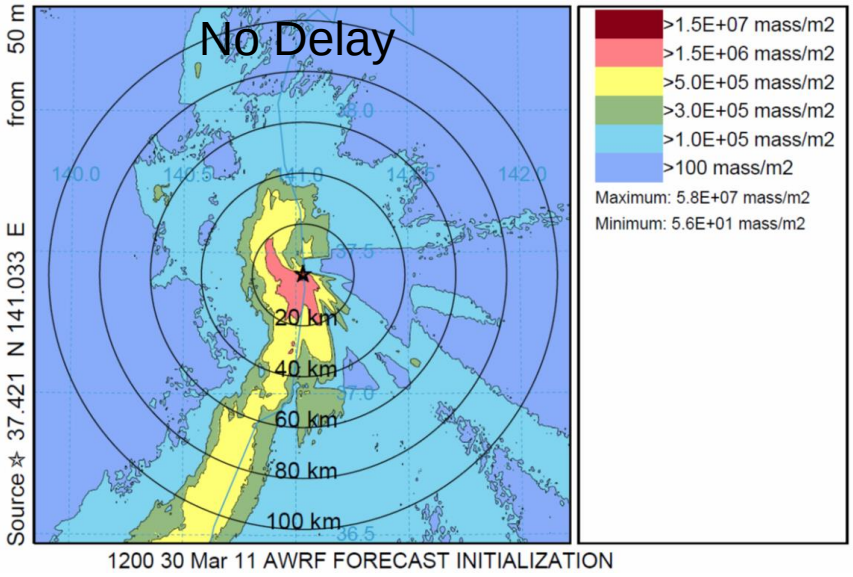
Drywell depressurization for Unit 2 starting at 94 hr and comes close to matching plant data

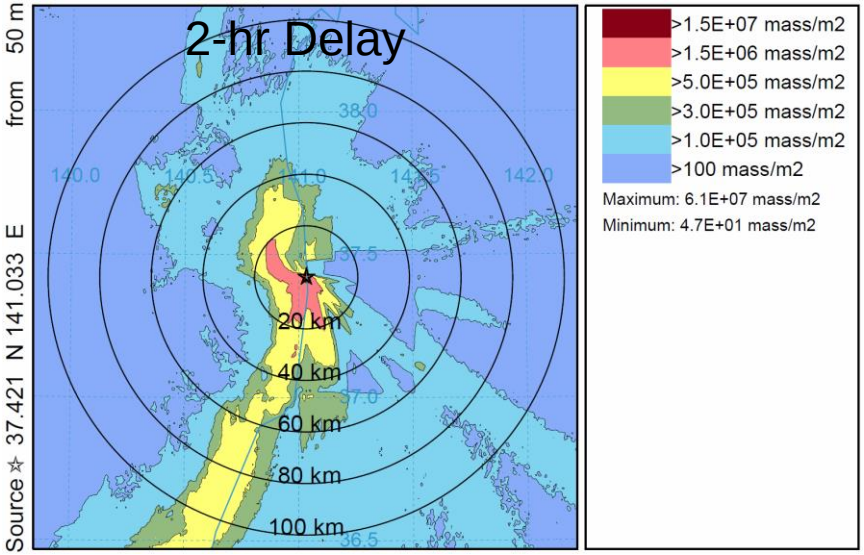
Predicted Ground Deposition for MELCOR (7/2017) Source Term

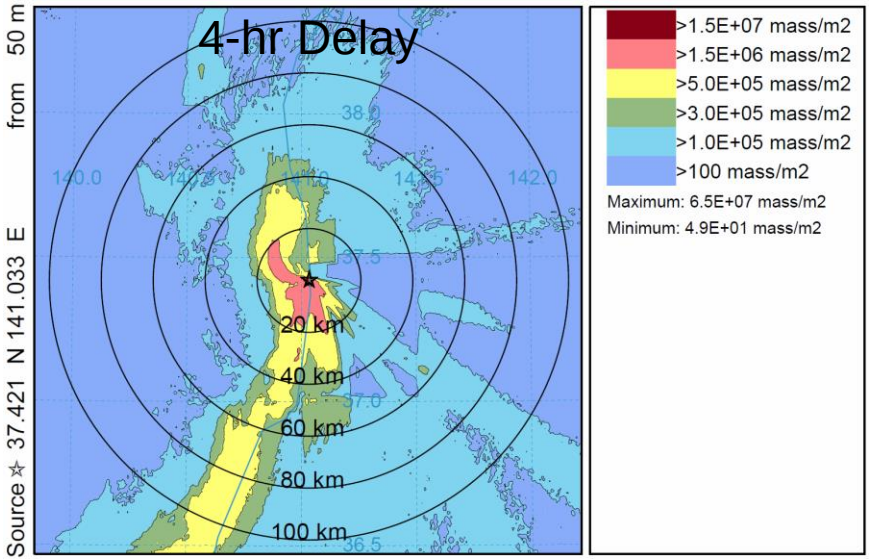


- Heaviest contamination now goes to the NW
- Overall shape of affected area differs somewhat from observations

Effect of Delay in Unit 2 Release





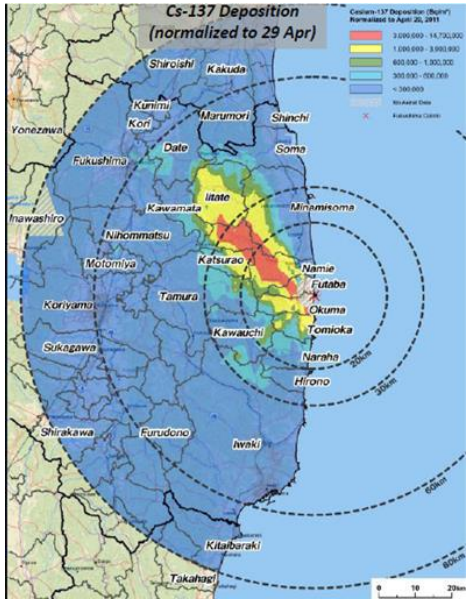


- Additional delay in Unit 2 release has insignificant effect on deposition pattern.
- Peninsula to the NW is reasonably captured.
- Overall deposition pattern is not captured.

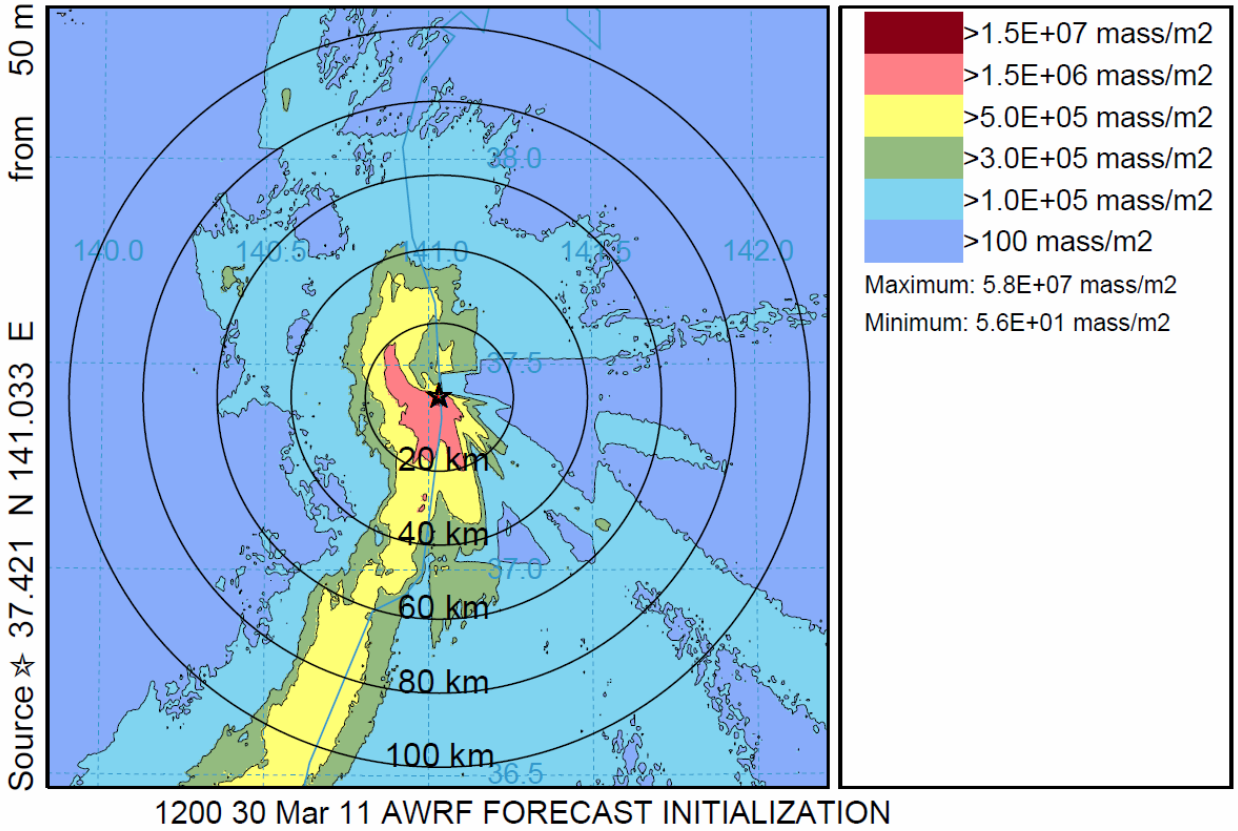
Comparison with Observations

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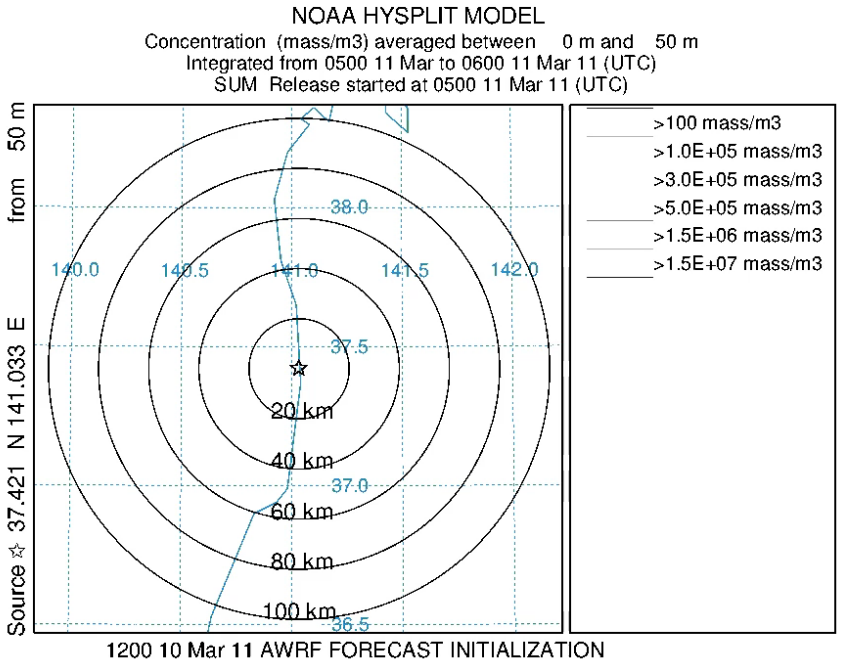
Observed Concentrations



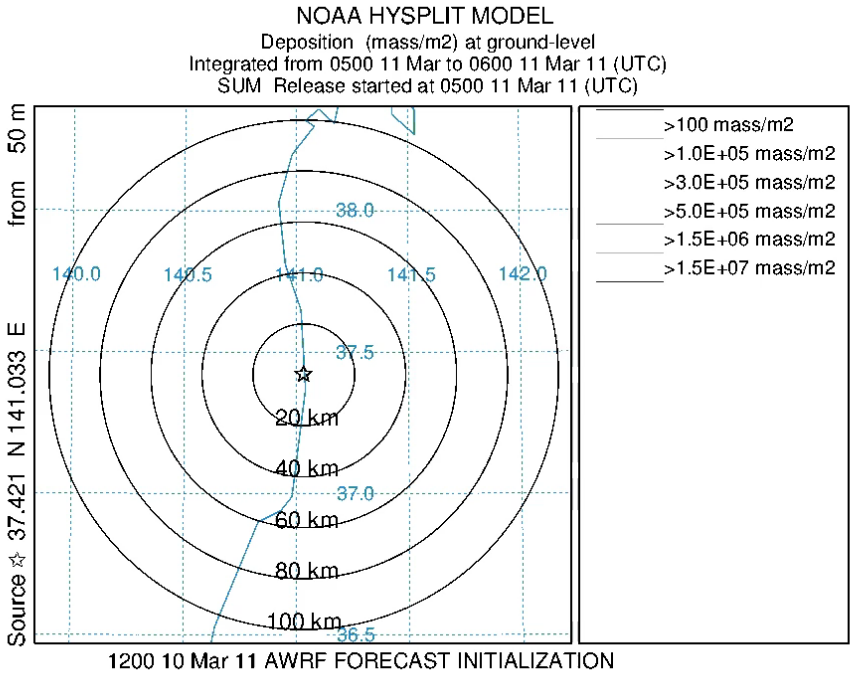
MELCOR Source Term with No Delay



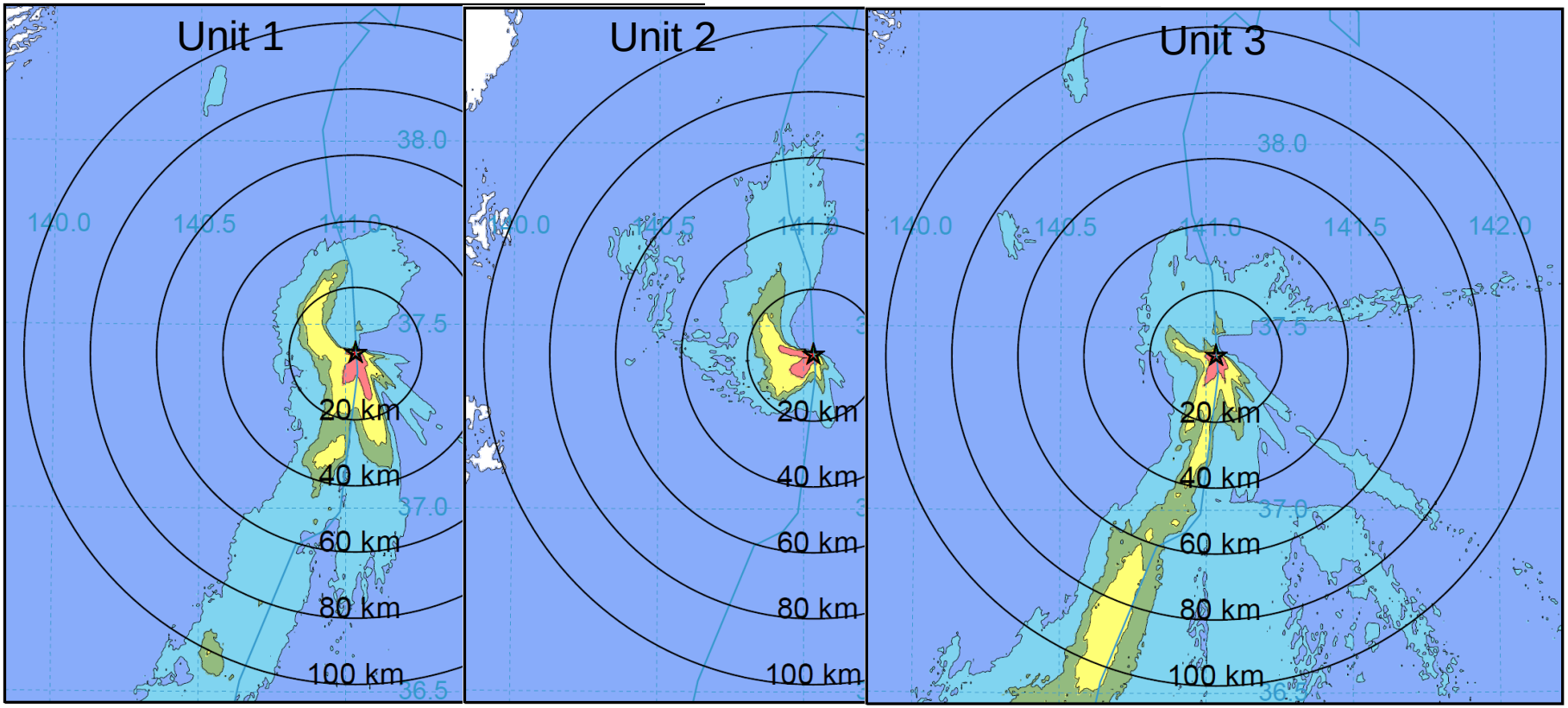
Predicted Air Concentrations MELCOR (7/2017)Source Term



Predicted Ground Concentrations MELCOR (7/2017)Source Term



Contributions to Deposition Pattern



- Figures show final deposition patterns created by each unit
- Unit 2 creates initial NW deposition pattern on 3/15
- Units 1 enhances NW deposition pattern on 3/22
- Unit 3 contributes the least to the NW pattern

Summary

- MELCOR forensics
  - Source terms are predicted for all three Fukushima units for 21 days
  - Predicted release from Unit 2 looks to be very close to correct timing
- ATD modeling
  - Allows evaluation of viability of source terms
  - Corroborates that timing of release from Unit 2 is about right
  - Unit 1 contributes to final deposition pattern
  - More work is needed to understand effects of weather data
    - Currently working with Hiroaki Terada to obtain Japanese data

Future Work

- MELCOR Source Term
  - Further examine release timings and magnitude
- Atmospheric Transport
  - Evaluate Japanese meteorological dataset
  - Evaluate new source term data as they become available

