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Pacific Northwest NATIONAL LABORATORY

Atmospheric Transport Study of Japan Noble Gas System

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Motivation

Atmospheric models are often used to infer upwind sources of material sampled at the surface. Here, we explore the effect of spatial resolution of meteorology on dispersion near Japan.

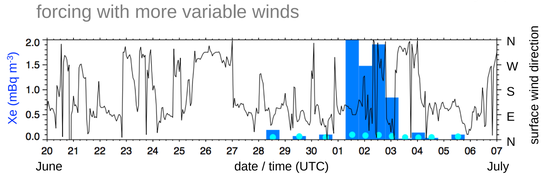
- Lagrangian dispersion models, such as HYSPLIT, usually use **global meteorological analyses** available at 0.25 to 1 degree grid spacing and at 3 to 6 hour intervals.
- The spatial temporal of archived global analyses may be sufficient for many cases of **long-range transport**, …
- However, **local-scale meteorological variability** caused by topographic effects, land/sea contrasts, land-atmosphere coupling, and cloud populations can impact the mean transport, turbulent mixing, and removal of tracers in the atmosphere.

Model Configuration

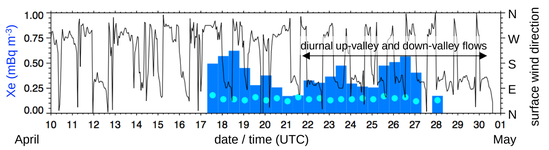
The HYSPLIT model is used to simulate the dispersion of tracers over east Asia using the Global Forecasting System (GFS) analyses and predictions made from the Weather Research and Forecasting (WRF) model.

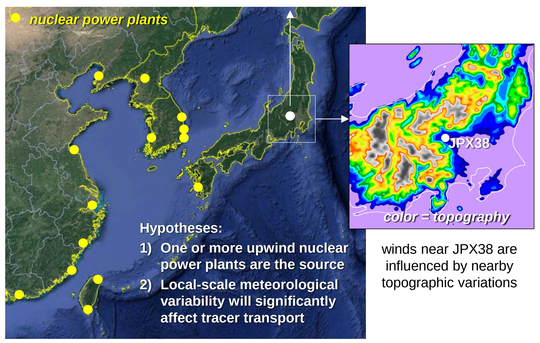
- 3 simulations performed driven by GFS meteorology: **Δx =1, 0.5, 0.25 deg**; Δt = 3 h
- 4 simulations performed driven by WRF meteorology: **Δx = 108, 36, 12, 4 km**, Δt = 1 h
- Two periods with contrasting synoptic conditions are examined when Xe was detected at JPX38 near Takasaki, Japan:

Case 1: June 20 – July 7, 2016, weaker upper-level synoptic forcing with more variable winds



Case 2: April 10 – 30, 2015, stronger upper-level synoptic forcing with winds predominately from the west to the east

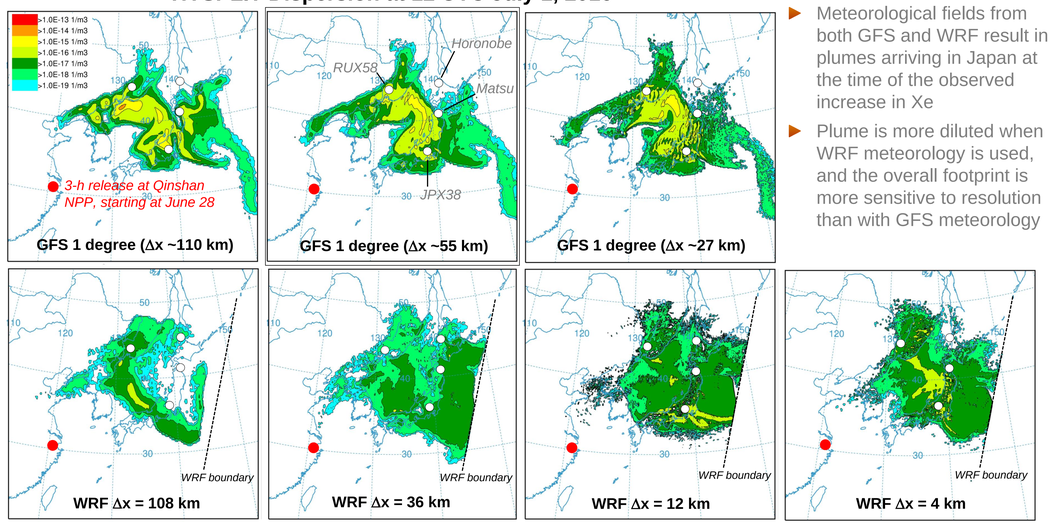




winds near JPX38 are influenced by nearby topographic variations

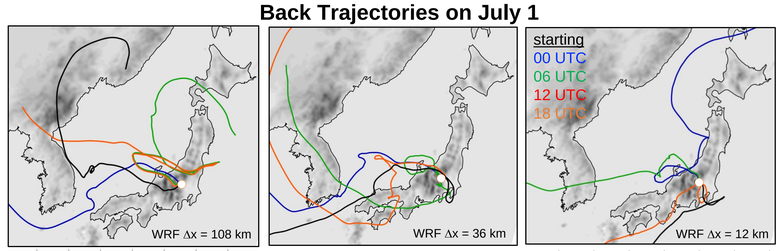
Results

HYSPLIT Dispersion at 12 UTC July 1, 2016



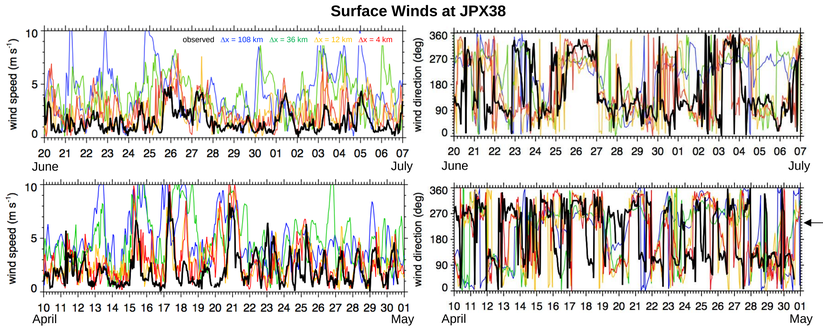
- Meteorological fields from both GFS and WRF result in plumes arriving in Japan at the time of the observed increase in Xe
- Plume is more diluted when WRF meteorology is used, and the overall footprint is more sensitive to resolution than with GFS meteorology

Back Trajectories on July 1



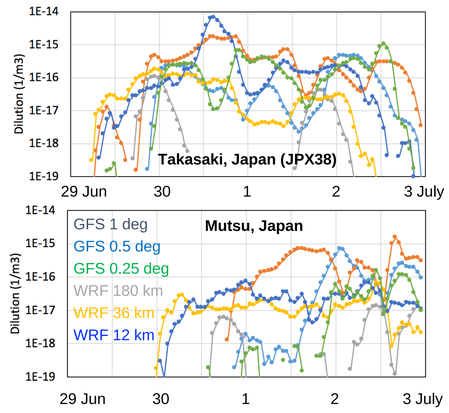
- For this release scenario, JPX38 and RUX58 would likely sample the plume; however, a plume could easily miss both sites so having additional samplers would be useful to detect plumes in the region
- Back trajectories illustrate potential differences in transport

Surface Winds at JPX38

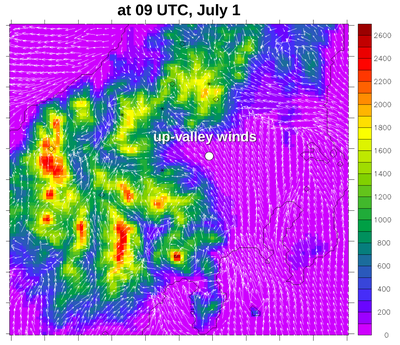


- As expected, simulated surface winds among the four WRF simulations are different, since Δx affects how terrain (and other factors) is represented and thus the development of local dynamically- and thermally-driven circulations.

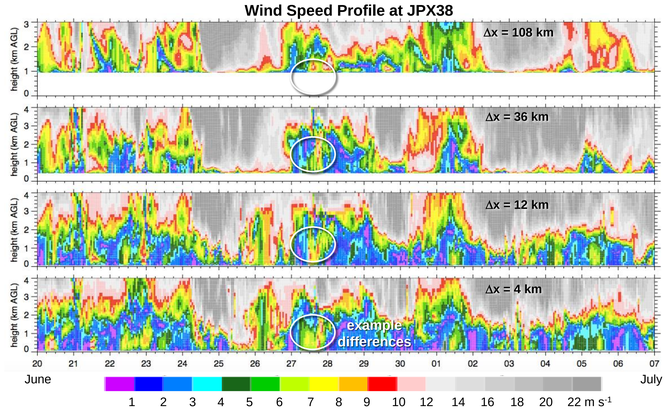
Effective Dilution Factors



Near-Surface Winds from WRF Δx = 4 km at 09 UTC, July 1



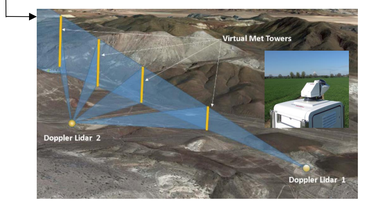
Wind Speed Profile at JPX38



- Winds from Δx = 12 and 4 are qualitatively similar and closer to the observations, particularly for up-valley / down-valley circulations between April 22 and 30, 2015.
- Winds aloft among the four simulations are more similar
- Differences in the winds are likely affect how tracers are transported into and out of the valley surrounding JPX38

Next Steps

- Perform a more detailed evaluation of the meteorological analyses and predictions compared to observations
- Examine effect of spatio-temporal resolution on dispersion from other potential sources as well as on transport and mixing near sources
- Use tracer capability in WRF to perform on-line dispersion calculations of noble gases at small time steps, instead of off-line HYSPLIT dispersion calculations that temporally interpolate meteorology from files
- Explore how vertical wind profiles from lidars at IMS sampler sites could be used to better understand source attribution



ABOUT

Pacific Northwest National Laboratory

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