SnT 2019 SCIENCE AND TECHNOLOGY CONFERENCE

Atmospheric Transport Modelling for dispersion conditions after the DPRK 2017 nuclear test and the origin of regional xenon detections

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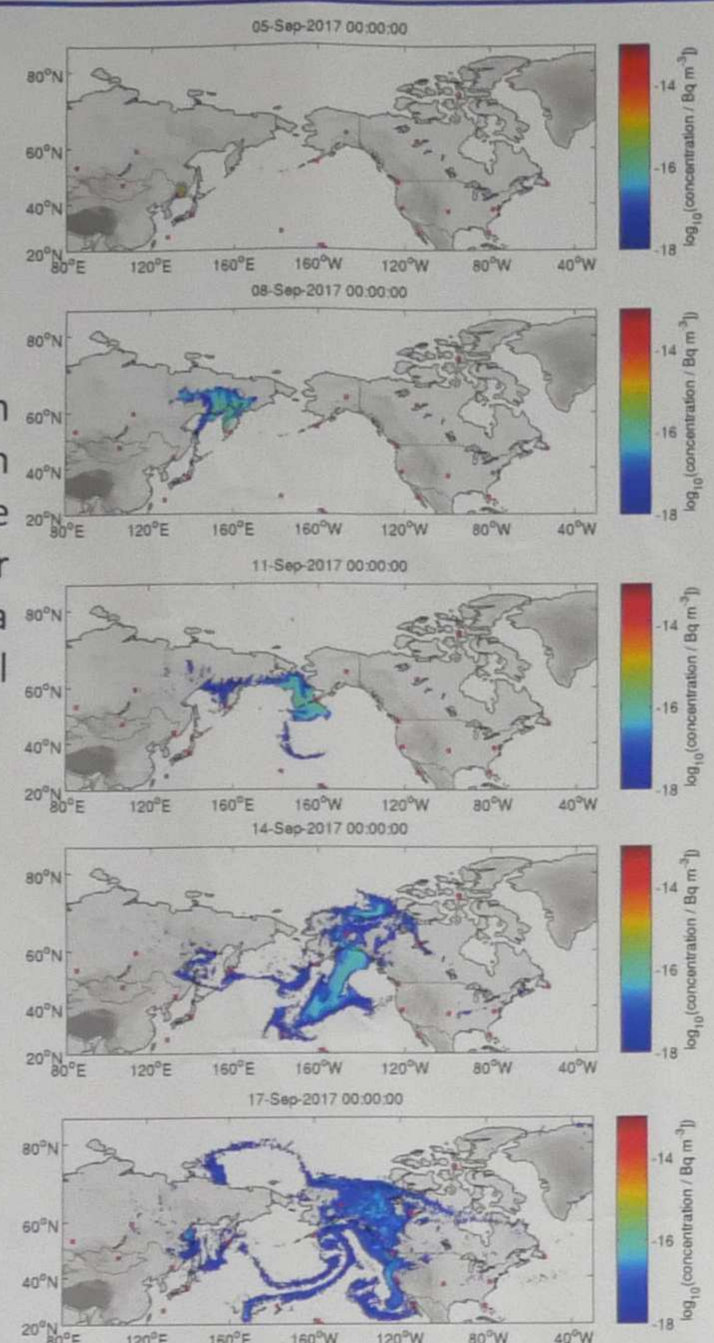
T2.4-P13

Dispersion forecast for immediate release

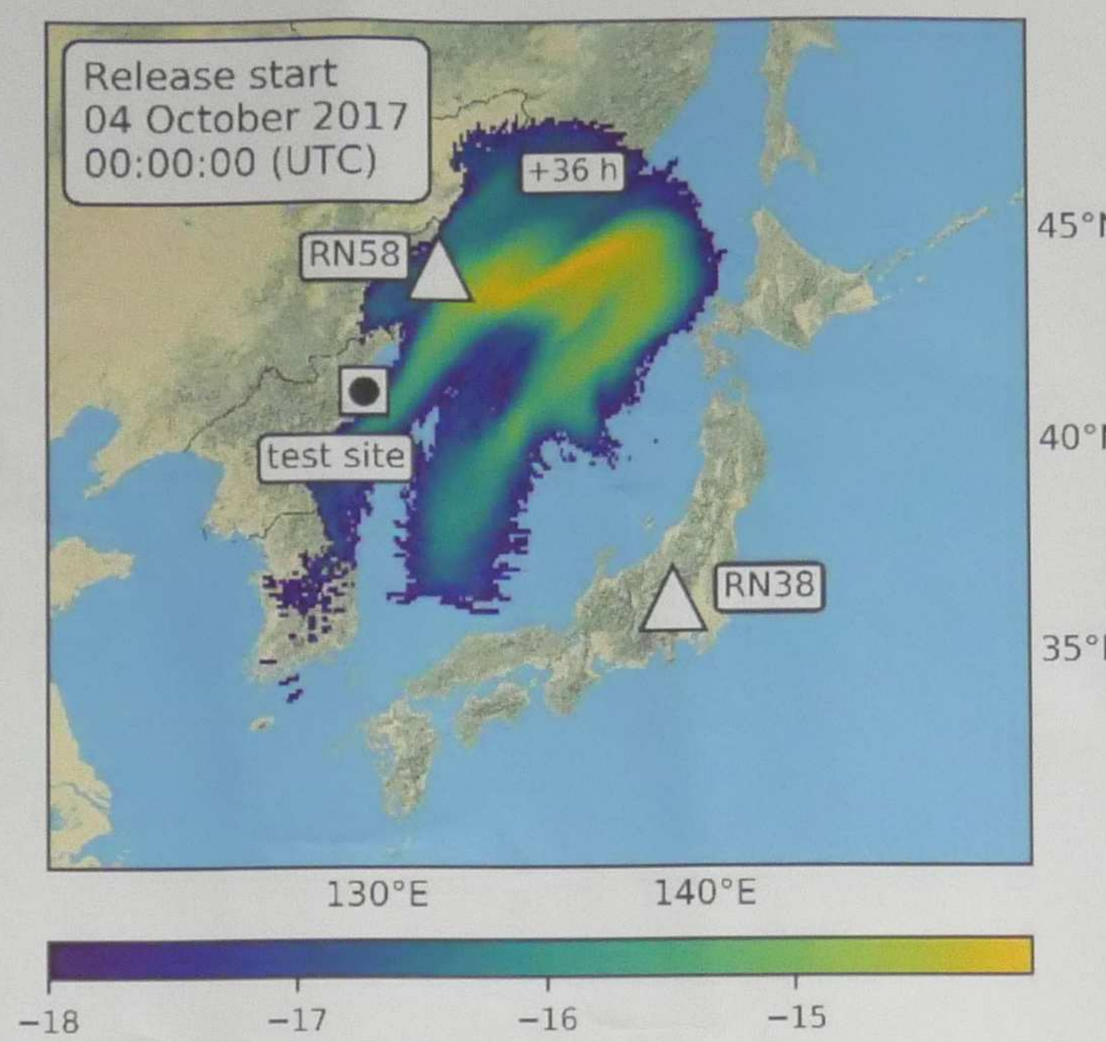
HYSPLIT (NOAA-ARL*) dispersion forecasts with GFS 1° meteorological data and one week simulated time are routinely produced at BGR. After the DPRK eventon Sep. 3rd 2017 in additional simulations were performed with higher resolution, larger lagrangian particle number and longer prediction time and for various vertical layers. Shown on the right is a long term dispersion with GFS 1° meteorological data.

In case of a release on Sep 3rd 2017:

- Good sensitivity of station RN58 Ussurysk, xenon system not operational
- Later on detections possible at RN60 Camtchatka, xenon system not operational
- No particulate RN detection at RN58/RN60, sampling systems up and running
- Dilution later on over North America would have required very high activity release
- No Sensitivity of station station RN38, Takasaki, xenon system operational

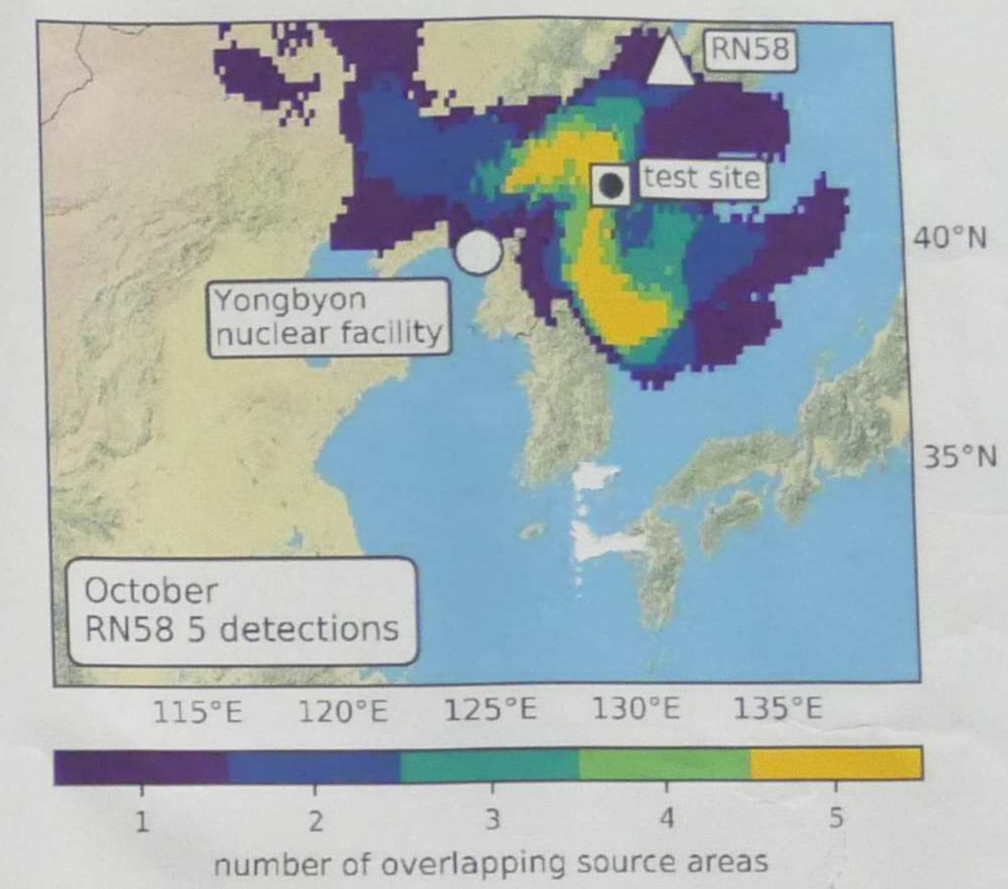


Detections at RN 58, Ussurysk during October 2017



Example for high-res forward simulation für a hypothetical relase at test site on October 4th (HYSPLIT with 0.25° GFS data, 1 million particles)

- Favourable atmospheric conditions for detections at RN58 during October
- 3 Xe-133 Peaks at RN58 (consisting of 5 samples)
  05 October
  19 October
  27 October
- Activity concentrations 0.7-0.9 mBq/m³
- According to ATM Small source term (~E11 Bq) sufficient for detection
- Remaining xenon inventory in cavity large enough alo after 6-10 half-lifes (regardless of nuclear device type)
- No definite detection of Xe-131m, but one candidate sample with correct isotopic ratio if so



- Backward ATM using HYSPLIT for the samples
- GDAS 0.5° Meteorological data
- 500000 particles per simulation
- **All 5 Retroplumes overlap at test site** (transport time shifted to max sensitivity)

Detections in South Korea, September 2017

Nuclear Safety and Security Commission

Conclude that […..] Xenon-133 detected from this air sampling is relevant to the 6th nuclear test of DPRK.

WORLD NEWS SEPTEMBER 13, 2017 / 6:16 AM / 7 MONTHS AGO

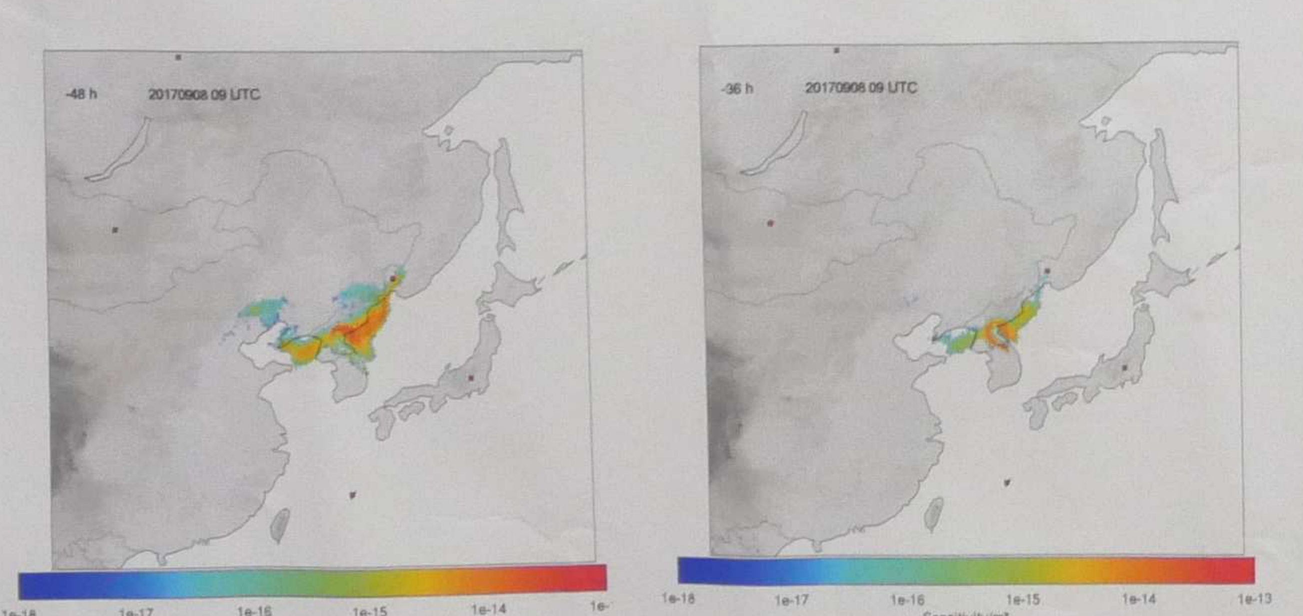
South Korea confirms traces of radioactive gas from North Korea's nuclear test

www.nssc.go.kr/_custom/nssc/_common/board/download.jsp?attach_no=20247 (last access 24 June 2019)

13	Sep 10, 2017 06:12	1.14
14	Sep 10, 2017 18:12	0.92

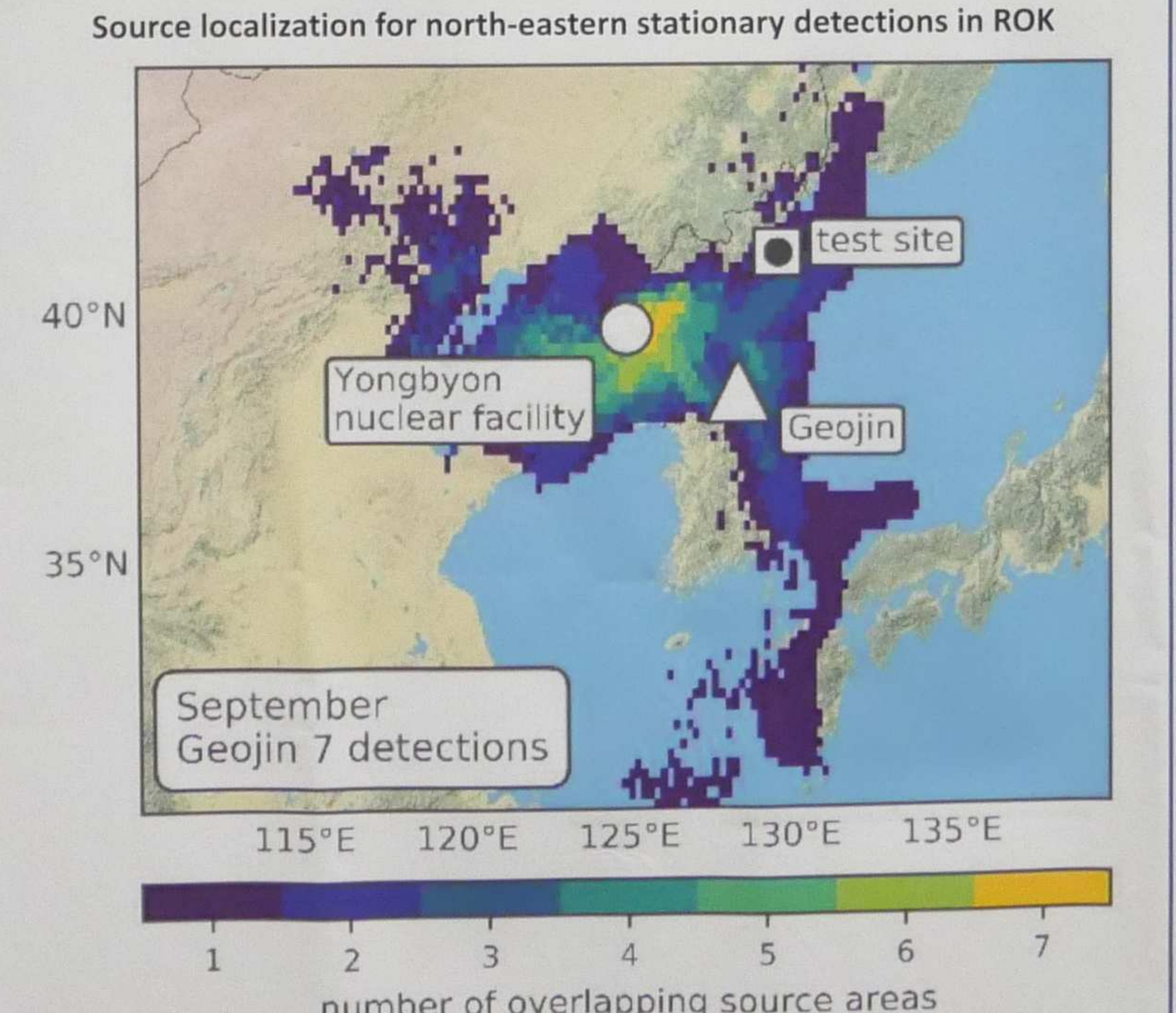
- National sampling campaign in with stationary and ship measurements
- Slightly elevated xenon-133 activity concentrations detected
- Statement was taken as source attribution by the media

- Backward ATM for seven samples from northeastern stationary measurements from 7 to 11 Sep 2017
- HYSPLIT with GDAS 0.5° data
- 500.000 particles per simulation
- concentration grid 0.2°



Example for two SRS-fields of the 2 samples with highest activity concentration

Source localization for north-eastern stationary detections in ROK



- Localization method: Number of overlapping retroplumes fixed to transport time (see T2.4-P15)
- -overlap of all 7 simulated source receptor fields at Yongbyon nuclear facility at ~43 hours transport

Radionuclide summary fo... all announced DPRK tests

Explosion	10/2006	05/2009	02/2013	01/2016	09/2016	09/2017
Detection	^{133}Xe ^{135}Xe ^{133m}Xe	none	^{133}Xe ^{131m}Xe	^{133}Xe	none	^{133}Xe
Where (when)	AFTAC (+2d) FOI (+3d) RN16 (+12d)		RN38 (+54d), RN58 (+57d)	RN38 (+42d)		RN58 (+32d, +46d,+54d)
Specific?	**yes**	no	**yes**	no	no	?*

Summary DPRK 2017

- Immediate release on Sep 3rd would have been transported to the North-East, no IMS detection in first days. No national measurements reported.
- September 2017 xenon-133 detections by South Korea according to backward ATM came rather from Yongbyon nuclear complex than from test site.
- Several xenon-133 detections in at RN58 during October 2017 may originate from the test site. For one sample the presence of ^{131m}Xe was discussed - at the expected isotopic ratio but the detection itself was uncertain.
- Operating noble gas system at RN38, Takasaki, is generally not sensitive to releases from the test site during northern summer
- Conclusion: tiny xenon-133 leakage in October plausible, Measurements at RN58 consistent, but other sources cannot be excluded, similar to 01/2016 event

Gaebler et al. (2019) **A multi-technology analysis of the 2017 North Korean nuclear test**; EGU journal Solid Earth
*Stein, A.F., Draxler, R.R, Rolph, G.D., Stunder, B.J.B., Cohen, M.D., and Ngan, F., (2015). **NOAA's HYSPLIT atmospheric transport and dispersion modeling system**, Bull. Amer. Meteor. Soc., **96**, 2059-2077

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