SnT 2019
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

Backward atmpspheric transport modelling coincidence localization of single sources and repeating emitters

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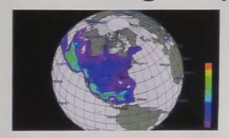
Backward ATM Localization

In the framework of CTBT monitoring the use of atmospheric Lagrangian Particle Dispersion Models is well established to confine source regions of radionuclide detections. For that Source Receptor Sensitivity (SRS) fields are regularly calculated in backward mode for air samples.
Various localization approaches for combining SRS fields for detections at multiple stations caused by an assumed single source were introduced over the last decades. Especially a simple additive coincidence approach overlapping SRS fields for multiple detections has shown to be quite promising in several test cases. This method was expanded to evaluate source regions of repeating radioxenon detections at single stations. The simulated source regions of air samples with elevated xenon-133 activity concentrations are stacked in space in order to evaluate a region of potential common origin. Examples from recent years are shown for different IMS radionuclide stations.

WebGrape Possible Source Region (PSR)



- Quantitative sensitivity
- Evaluation of measured concentrations

- Correlation:
  For each source grid cell and time step:
  simulated ("backward-back") detections with measured concentration pattern

BGR coincidence

- Binary SRS-Fields
- Quantitative concentrations neglected

- Source Coincidence Probability Score
  For each grid cell and time step:
  + # Detections sensitive
  - # Non-detections sensitive

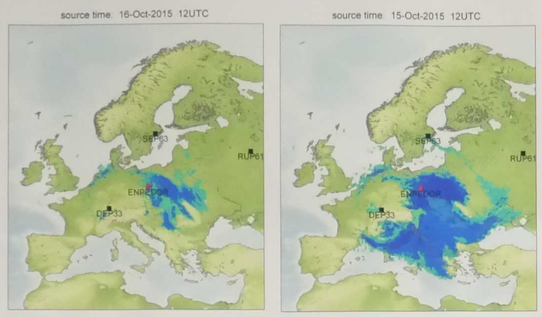
Conclusion

Simple SRS overlap techniques are suitable to confine source regions for first detections of single radionuclide releases as well as for measurements series of persistent sources

*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

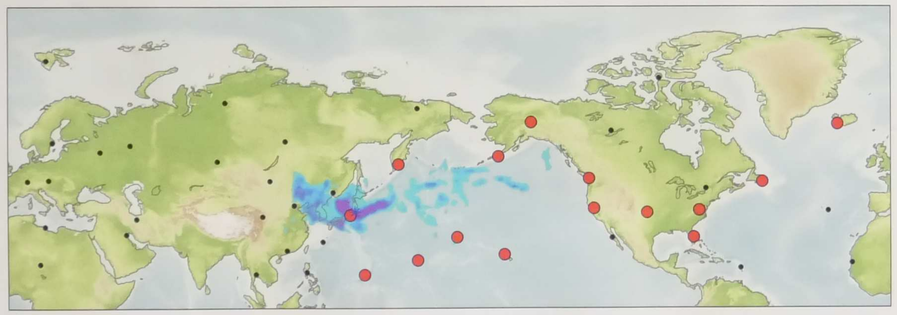
Single source releases

Simulated source: NPE 2015 scenario



The National Data Centre Preparednesse Exercise (NPE) 2015 radiounclide release scenario was simulated forward during a complex weather situaton and with long transport times to the stations. Coincidence Localization included the simulated release at „ENPEDOR" on 15th October (Lubin mining area, Poland), but with high uncertainty.

Known source: First detections of radionuclides from Fukushima

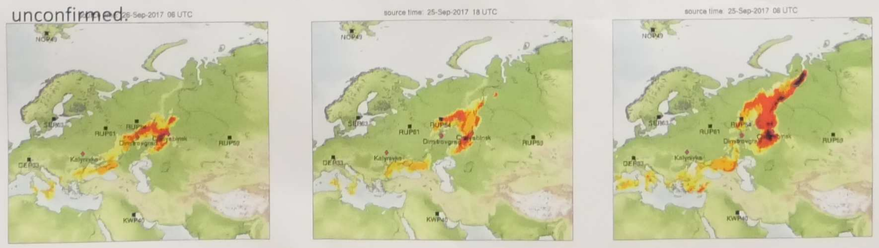


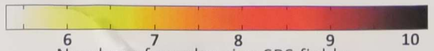
Sampling times: 15-21 March 2011 - Source time 12 March 12 UTC

Source coincidence score for first two samples at each of 15 IMS stations containig iodine-131 from Fukushima. The maximum coincidence of +26 passes the grid cell in which Fukushima Daiichi nuclear power plant is located on early March 12th 2011 (operational IDC-Flexpart SRS fields were used).

Unknown source: Ru-106 episode 2017

In October 2017 ruthenium was detected at many national sampling stations throughout Europe and some IMS stations on the Northern Hemisphere. The coincidence is shown for overlapping ten SRS fields (0.2° HYSPLIT* with 0.5° GDAS) for sampling times of first samples at Prague, Ostrava, Vienna, Athens, Beograd, Stockholm, 2xRN63, 2xRN59. The source remains still unconfirmed.

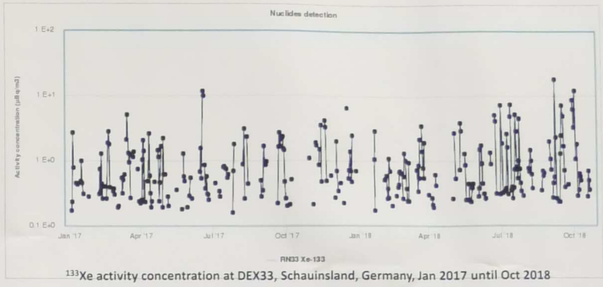




Number of overlapping SRS fields

Repeating emitter

Regular radioxenon at DEX33



^{133}Xe activity concentration at DEX33, Schauinsland, Germany, Jan 2017 until Oct 2018

44 samples had ^{133}Xe activity concentrations > 2 mBq/m^3

DEX33 backward Atmospheric Transport Modelling

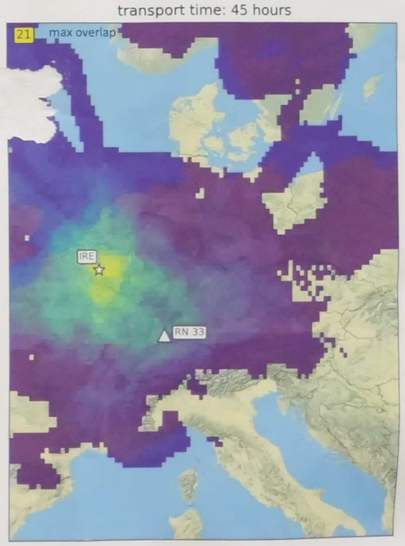
Backward dispersion runs for 44 samples with >2mBq ^{133}Xe

Model: HYSPLIT*
Met-data: GDAS 0.5°, 3-hourly
Conc.-grid: 0.2° x 0.2°
Particles: 240.000

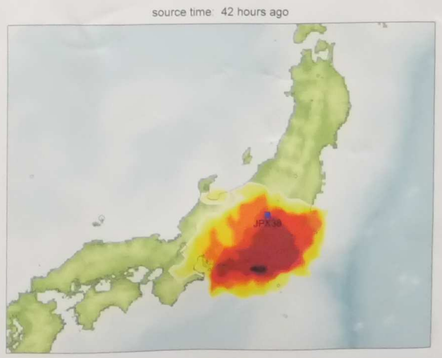
All resulting SRS fields stacked, number of overlapping fileds shown.

IRE, Fleurus, isotope production well within region of maximum overlap

transport time: 45 hours



Xe-133 background peaks at JPX38 during 2015



Atmospheric backtracking for five Xe-133 peaks above 1mBq/m^3 occurring at JPX38, Takasaki, Japan in 2015 shows a coincident source region south from the station for 40-50 hours transport time.

Model:
- HYSPLIT backward modelling
- ECMWF analysis 0.2°

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