

Assessment of source regions and source terms based on the Ru-106 measurements in air in Europe in September and October 2017

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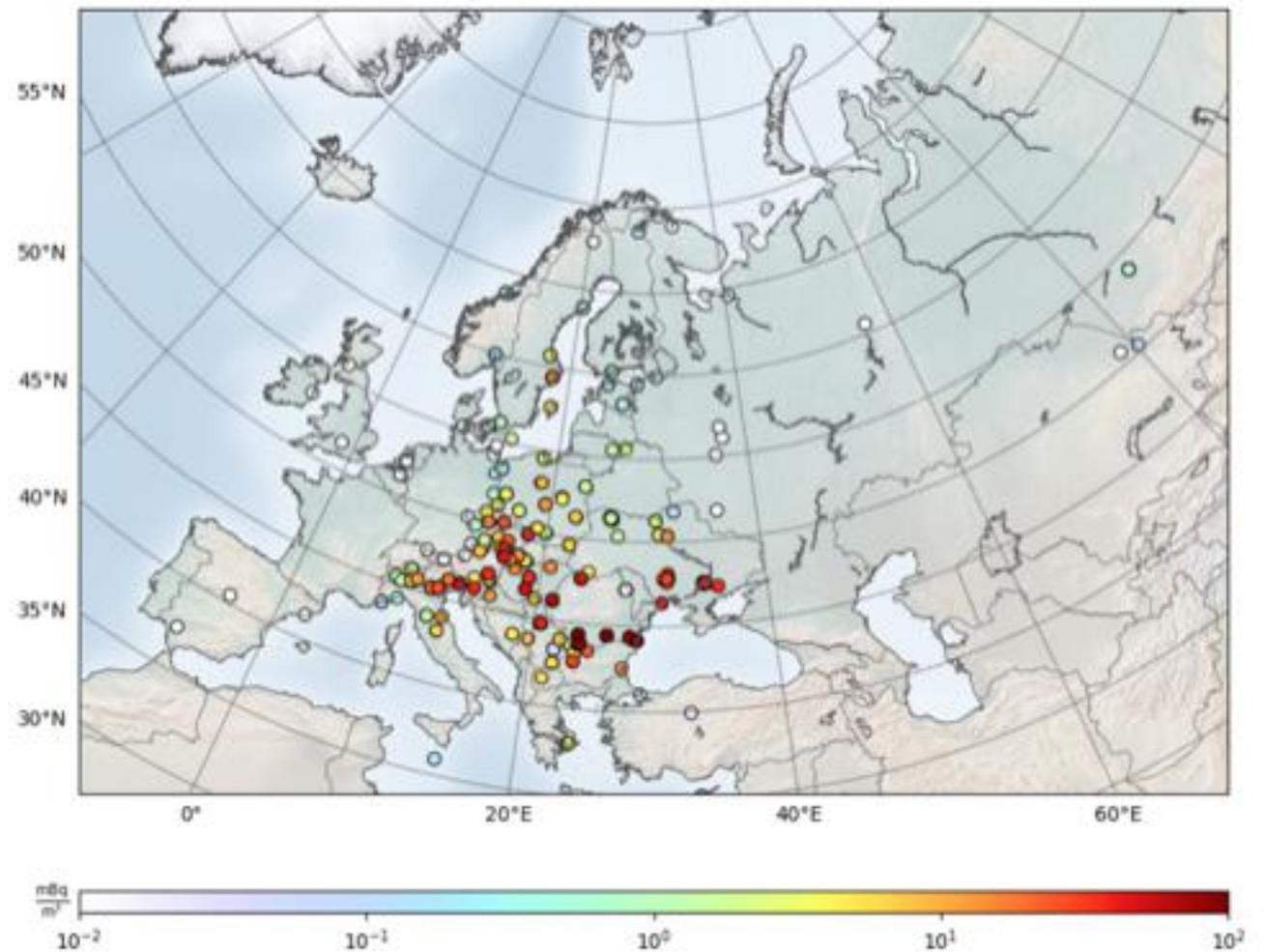
¹ Bundesamt für Strahlenschutz

Overview

- Ru-106 observations in Europe
- Localization of possible source region
- Estimation of amount of released Ru-106
- Summary

Ru-106 observations (IAEA, CTBTO)

Activity concentration in air
(20. Sep – 05. Oct 2017)

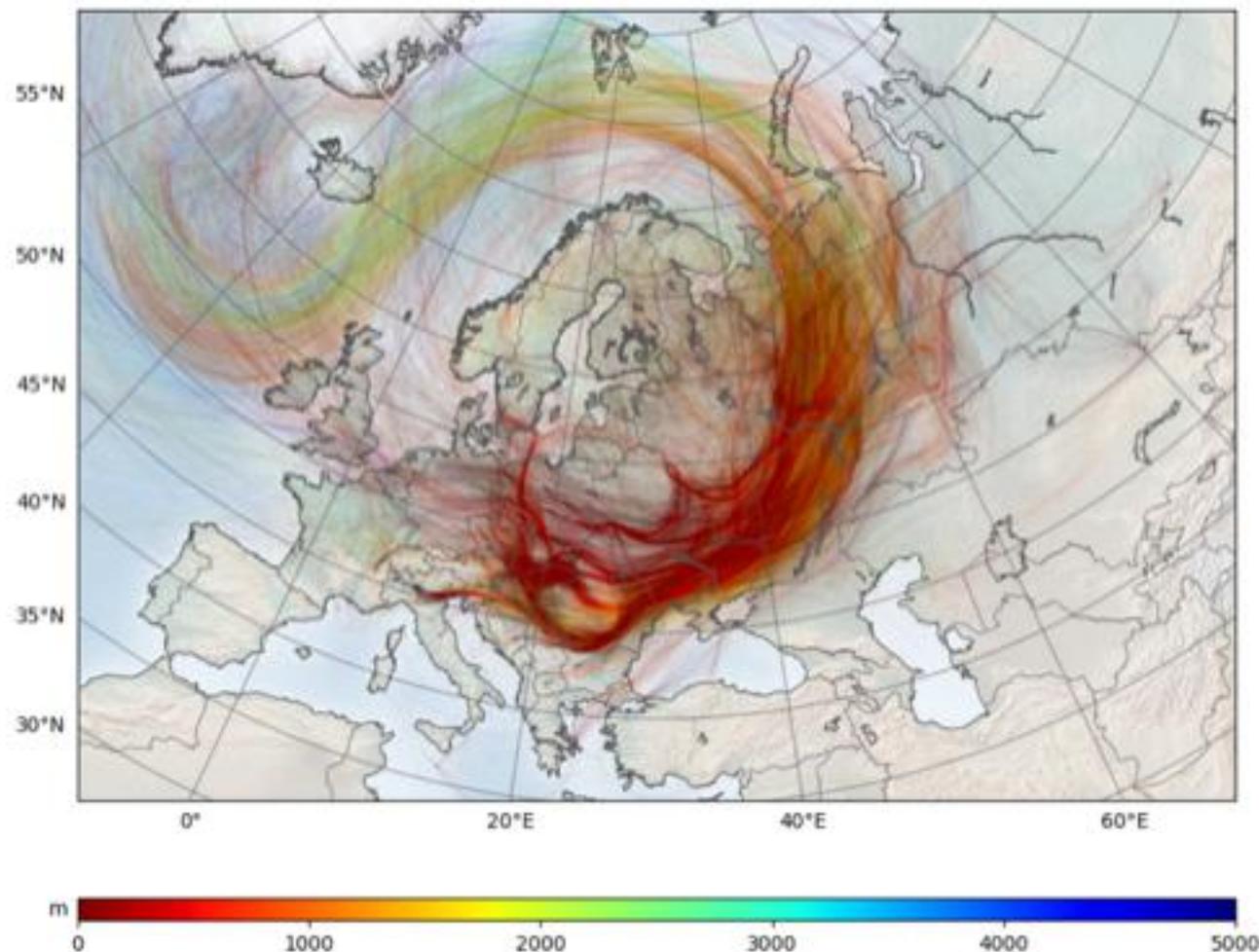


Backward trajectories from observation sites

Backward trajectories starting from ~ 300 positive observations ($> 0.01 \text{ mBq m}^{-3}$)

~ 10 000 trajectories

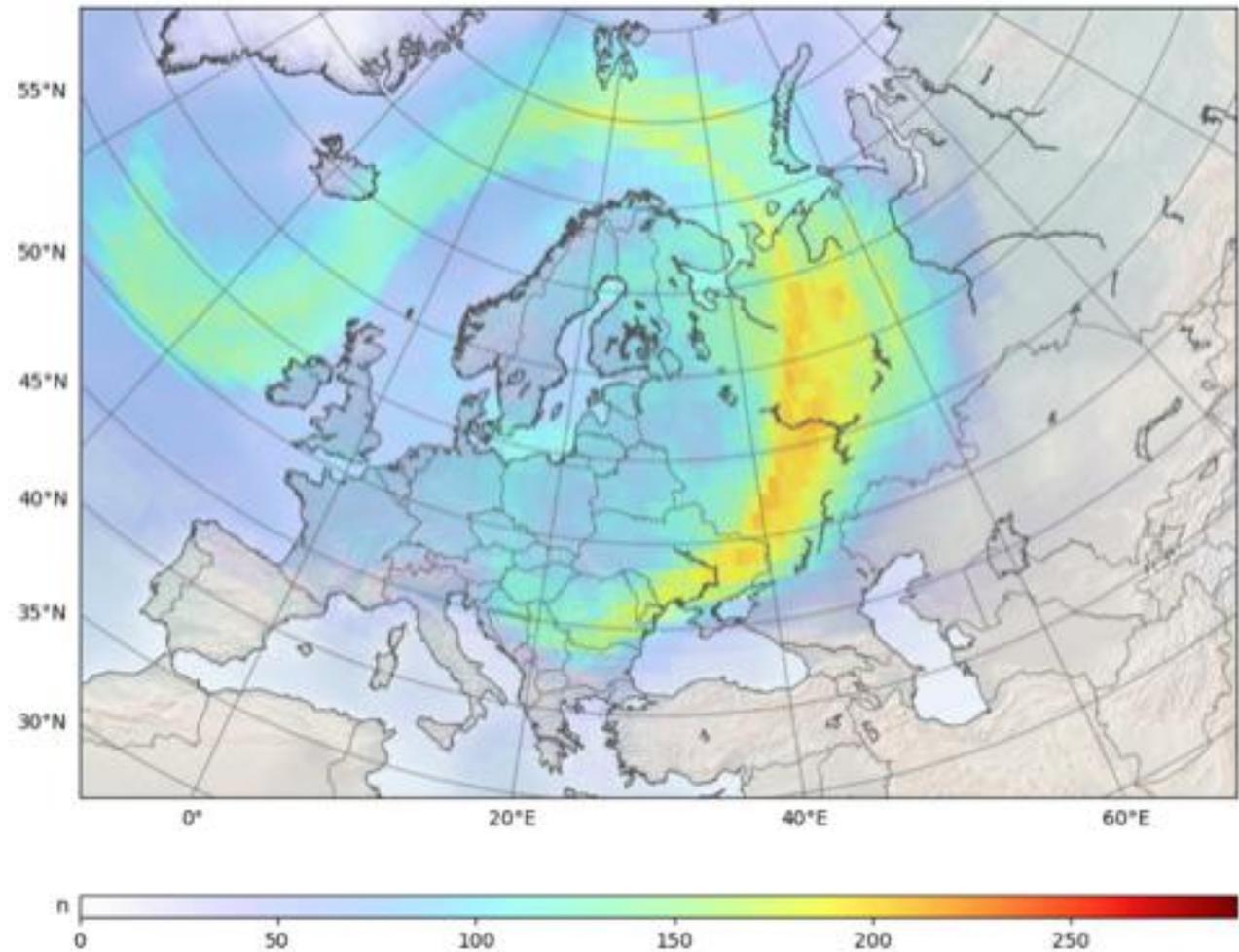
Model: HYSPLIT, GFS



Trajectory frequency

Trajectory frequency to define a first guess for the field of regard

n = number of trajectories per grid cell

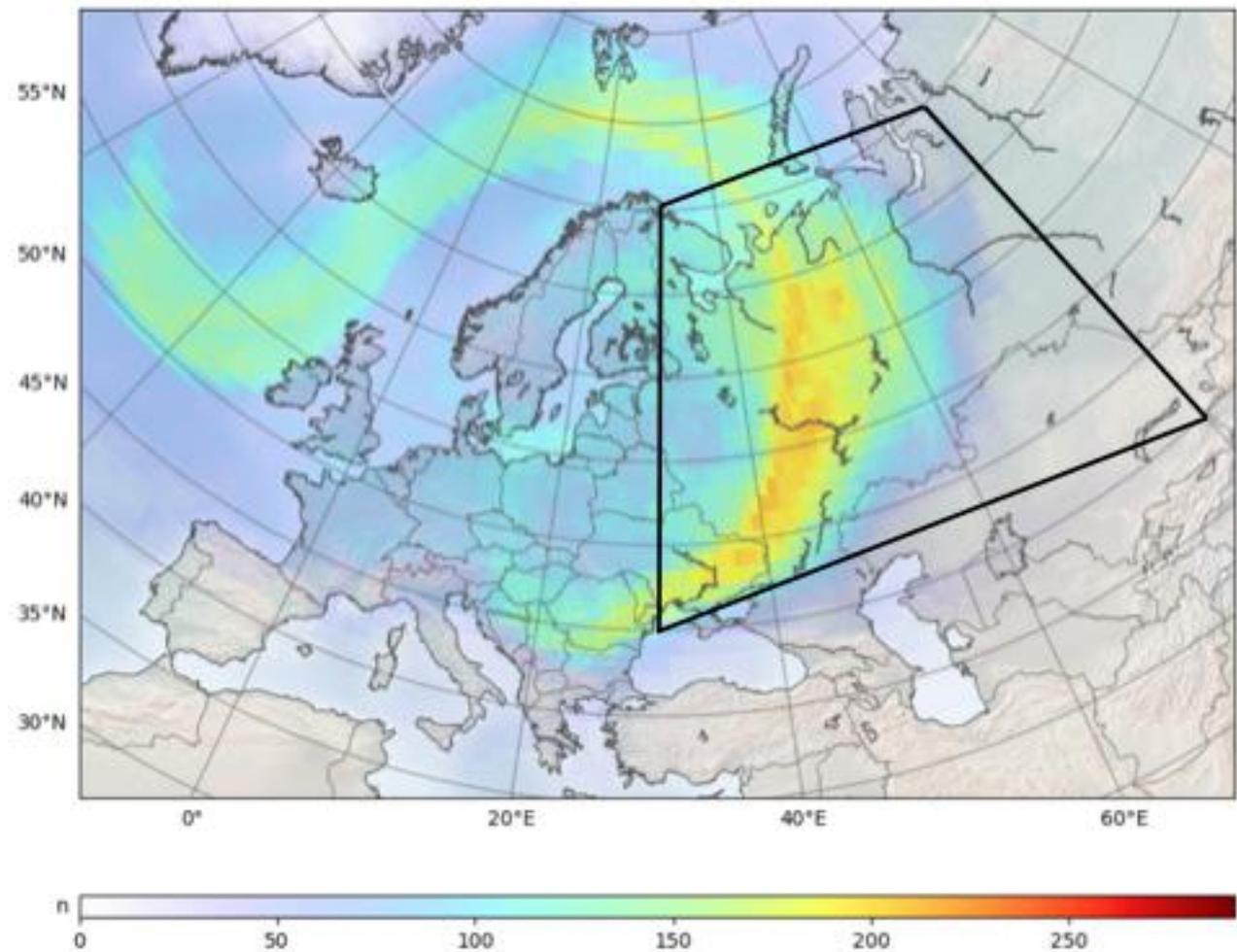


Source region “first guess”

First guess for the
field of regard:

45° - 70° N

30° - 80° E



Correlation between simulation and observation

Dispersion calculations (HYSPLIT)
from 162 potential release sites

Pearson R:

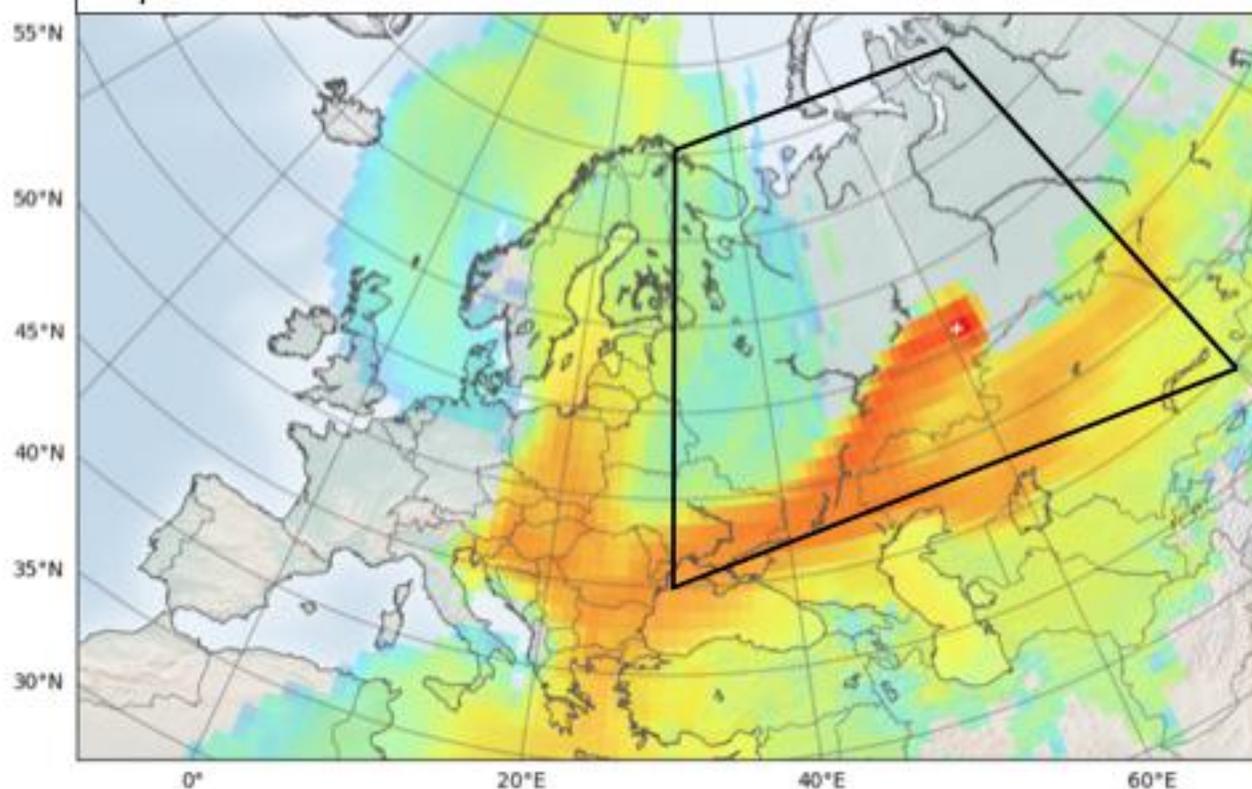
$$R = \frac{(C_o - \bar{C}_o)(C_p - \bar{C}_p)}{\sigma_{C_o}\sigma_{C_p}}$$

C_o observations

C_p predictions

σ_C standard deviation

Dispersion calculation from one selected release site out of 162.



Correlation between simulation and observation

Dispersion calculations (HYSPLIT)
from 162 potential release sites

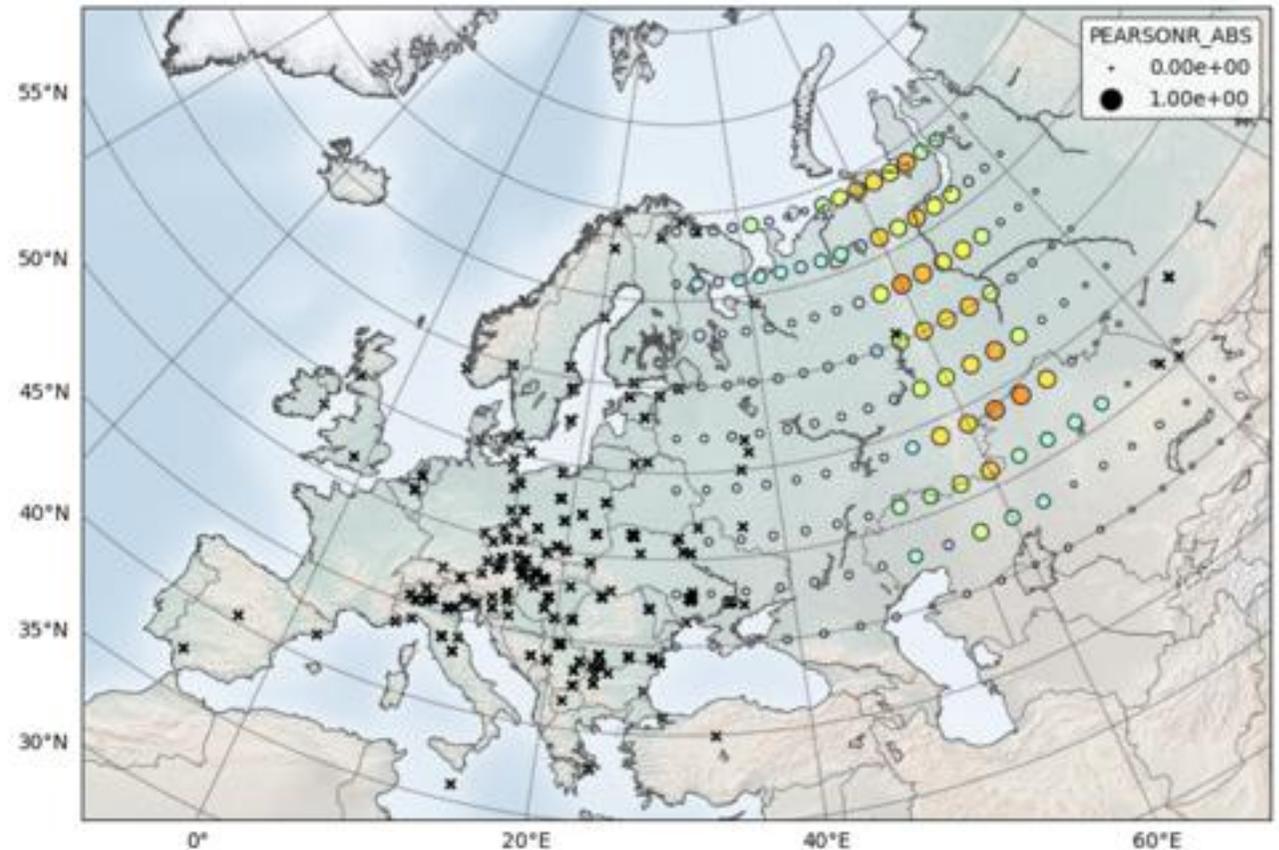
Pearson R:

$$R = \frac{(C_o - \bar{C}_o)(C_p - \bar{C}_p)}{\sigma_{C_o} \sigma_{C_p}}$$

C_o observations

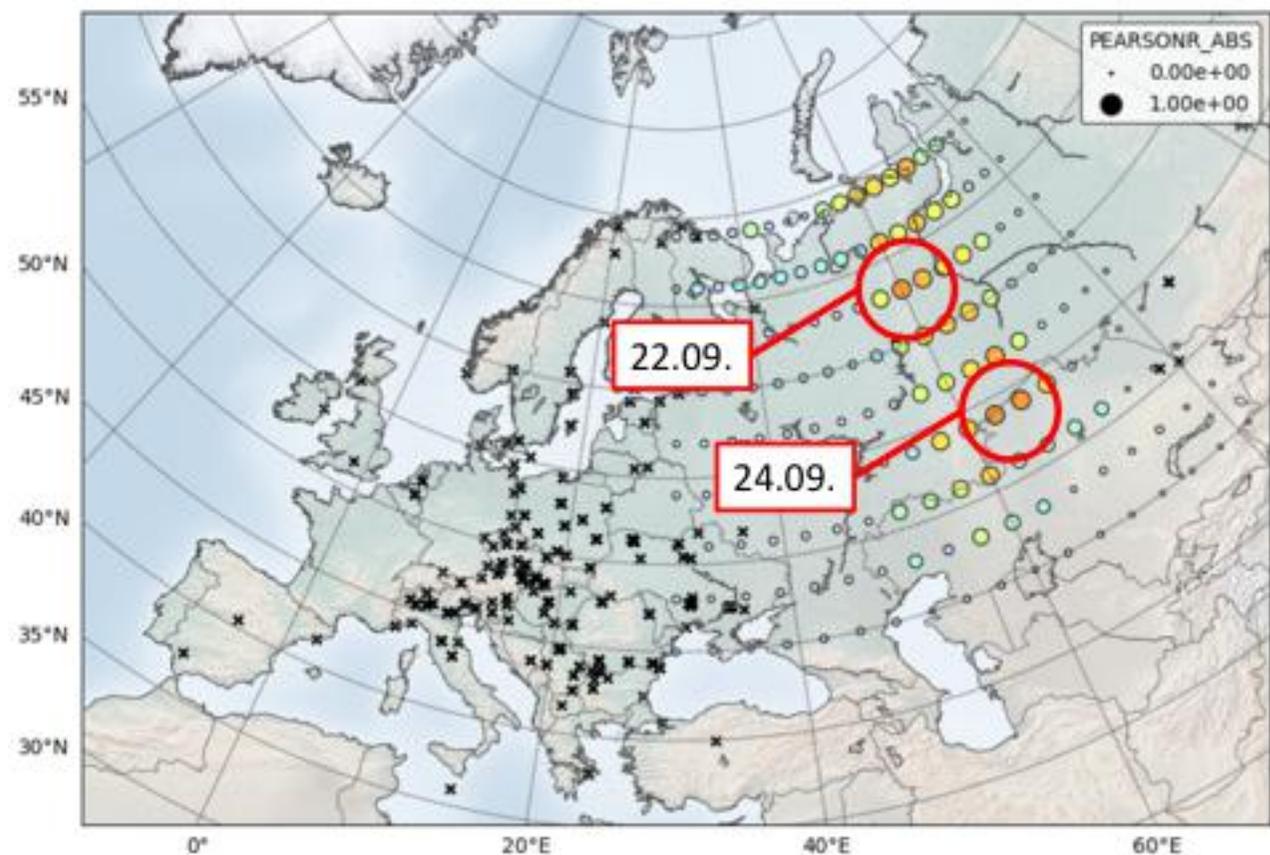
C_p predictions

σ_C standard deviation



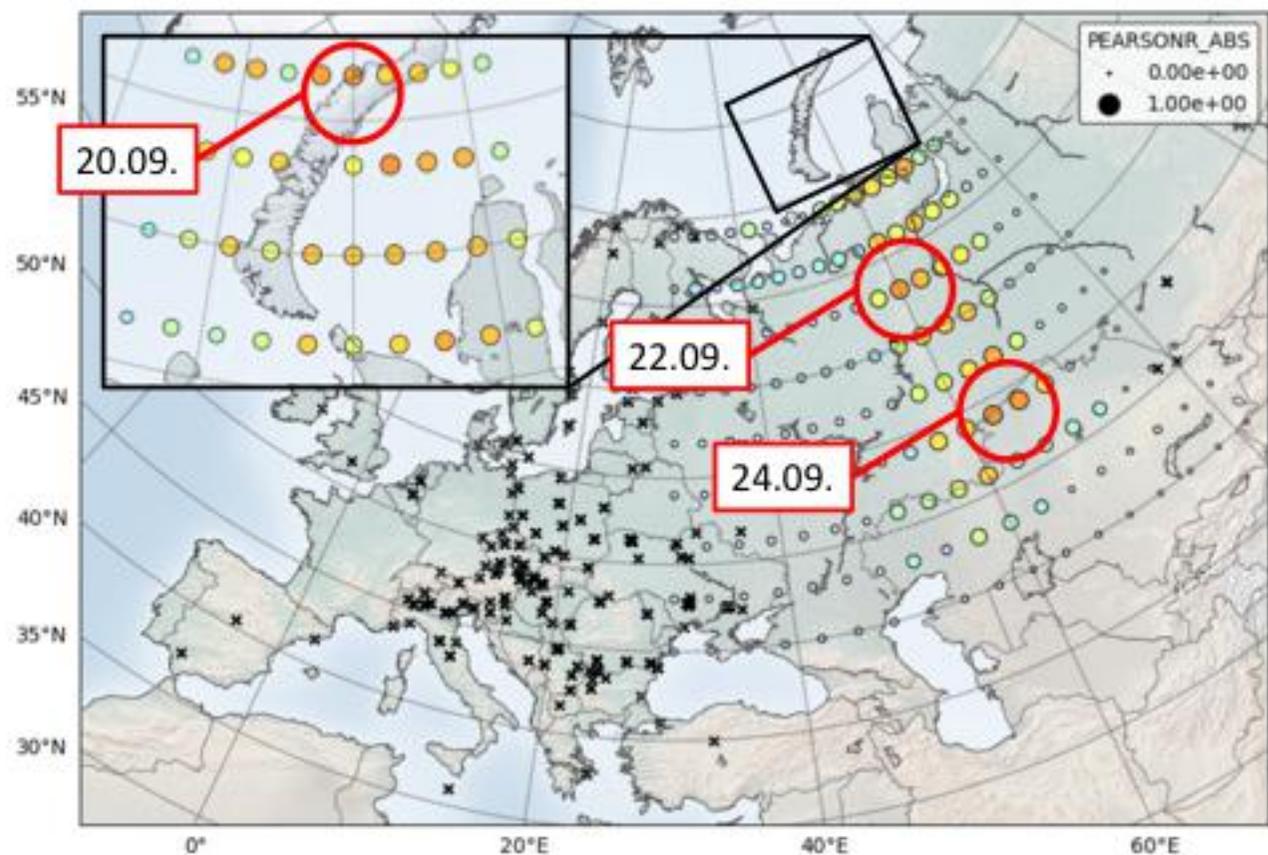
Correlation between simulation and observation

Release @ 50m
20.09. – 26.09.2017



Correlation between simulation and observation

Release @ 50m
20.09. – 26.09.2017



Estimation of source term (FAC2)

Dispersion calculations from
162 potential release sites

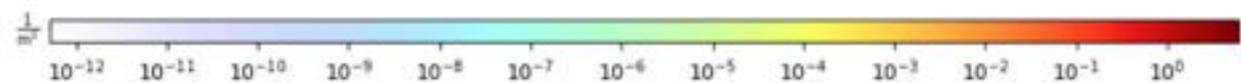
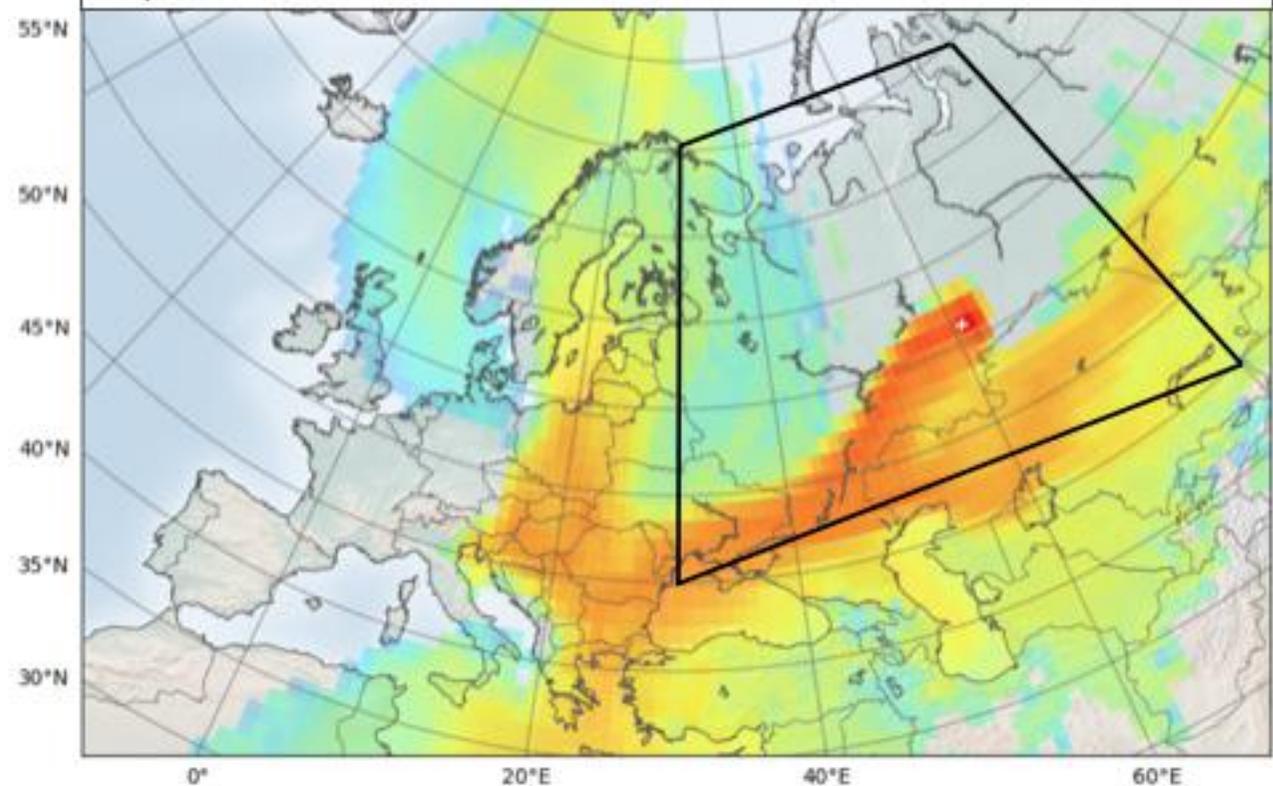
FAC_x = fraction of data for which

$$\frac{1}{x} \leq \frac{C_p}{C_o} \leq x$$

C_o observations

C_p predictions

Dispersion calculation from one selected release site out of 162.



Estimation of source term (FAC2)

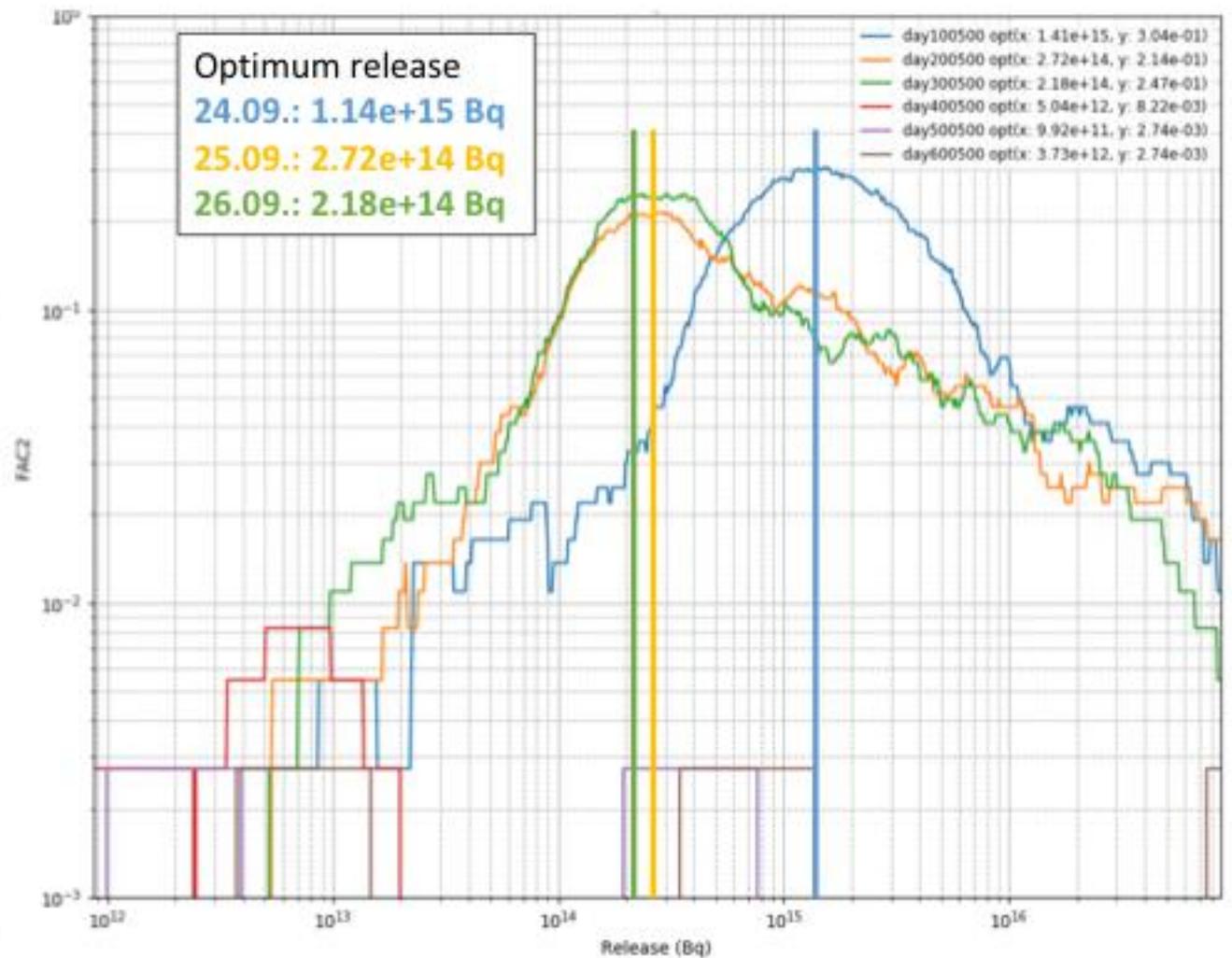
Dispersion calculations from
162 potential release sites

FACx = fraction of data for which

$$\frac{1}{x} \leq \frac{C_p}{C_o} \leq x$$

C_o observations

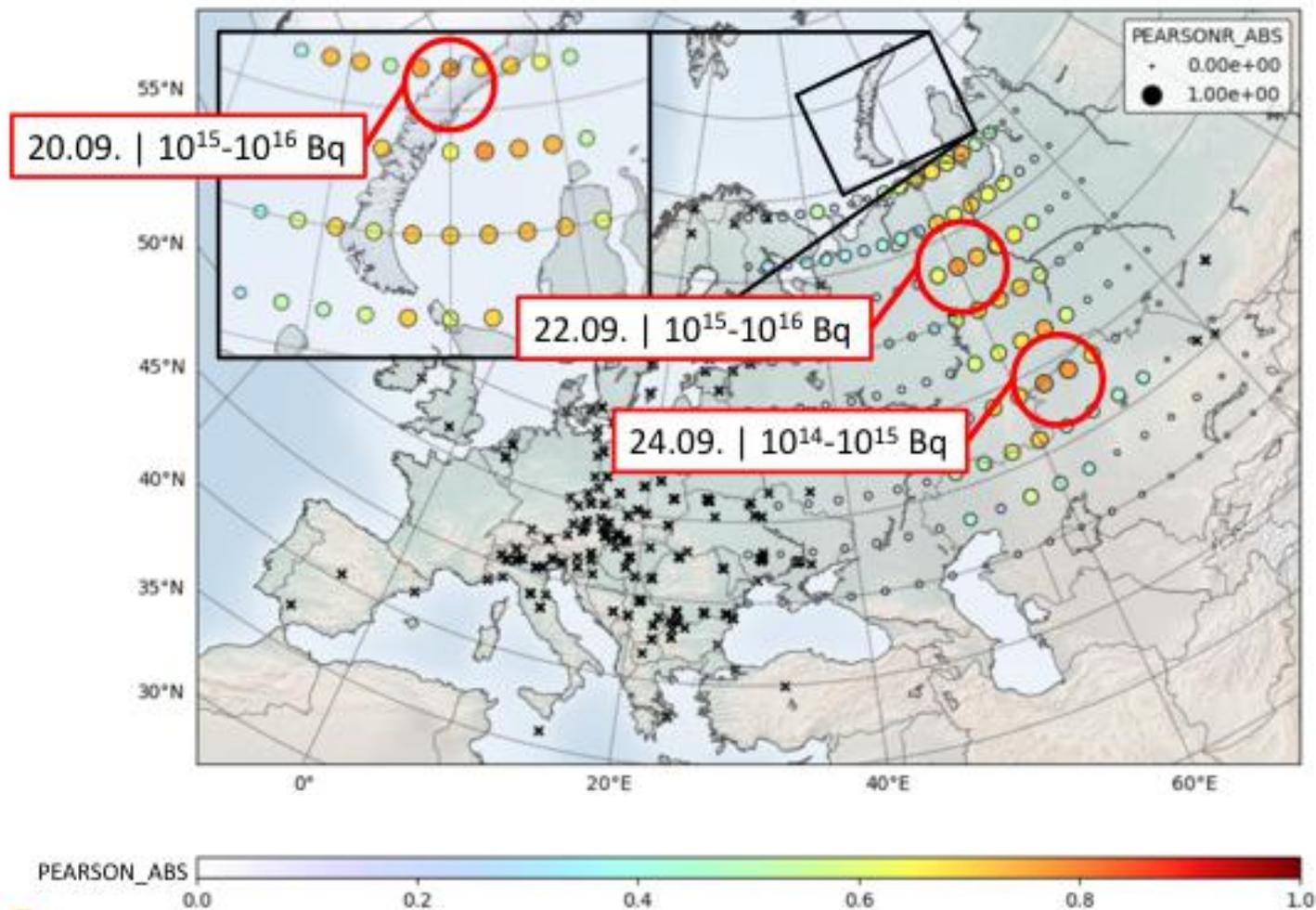
C_p predictions



Estimation of source term (FAC2)

Release @ 50m
20.09. – 26.09.2017

100 TBq – 10 PBq

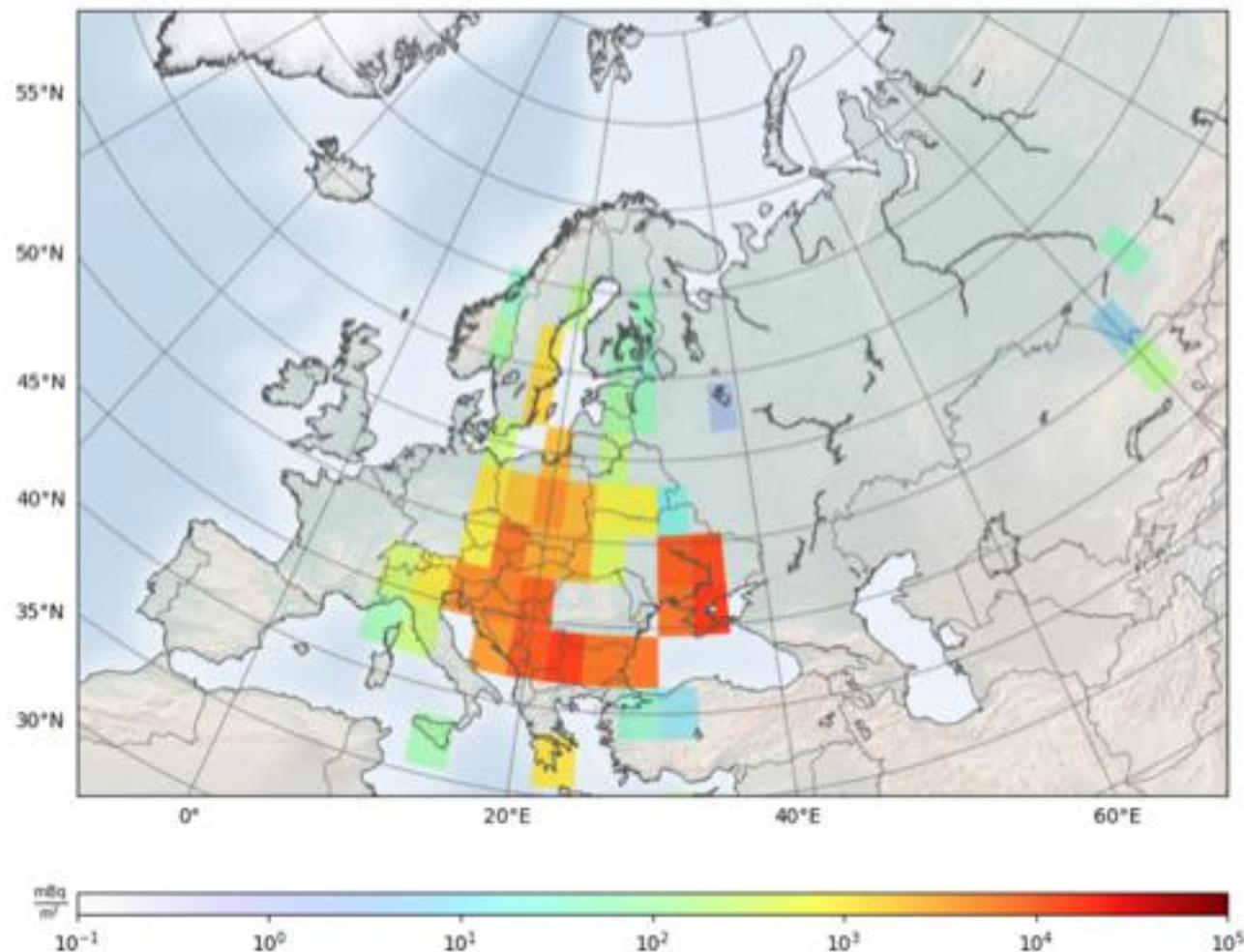


Estimation of deposited activity concentrations

Average deposition (mBq m^{-2})
from air activity concentration
observations

Deposition velocity: 1 mm s^{-1}
Grid resolution $3^\circ \times 3^\circ$

Total deposition:
 $\sim 1.1 \times 10^{13} \text{ Bq} = 11 \text{ TBq}$



Summary

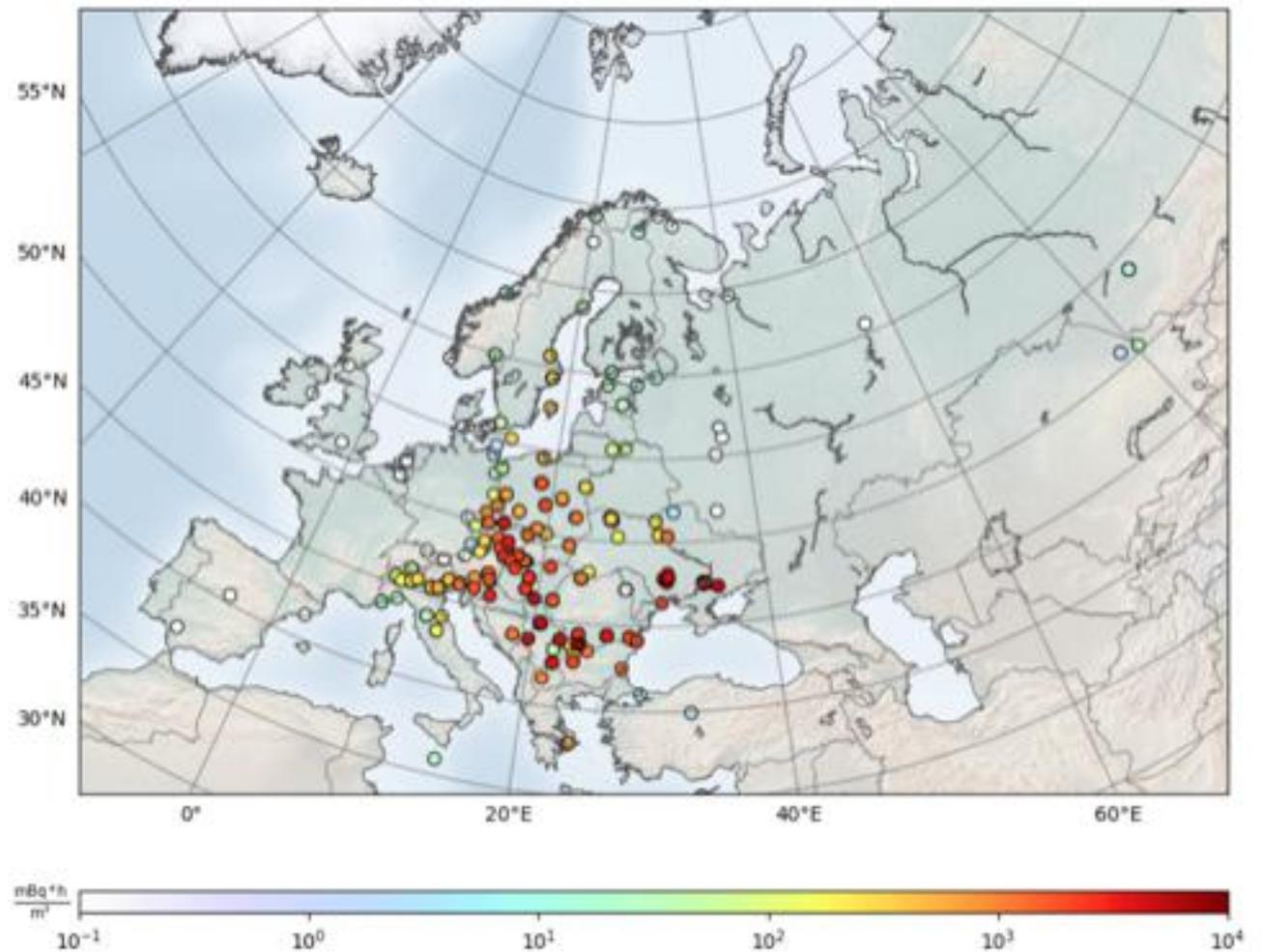
- Based on measurements in Europe the estimated amount of Ru-106 in the air is > 100 TBq
- Possible source regions and source terms based on modeling and measurements in Europe:
 - 23.09. – 26.09.2017
Southern Ural, South-East of Ural (Chelyabinsk region)
 ~ 100 TBq – 1 PBq Ru-106
 - 20.09. – 23.09.2017
Arctic (Barents Sea, Novaya Zemlya), Northern Ural
 ~ 1 PBq – 10 PBq Ru-106

Thank you!



Ru-106 observations (IAEA, CTBTO)

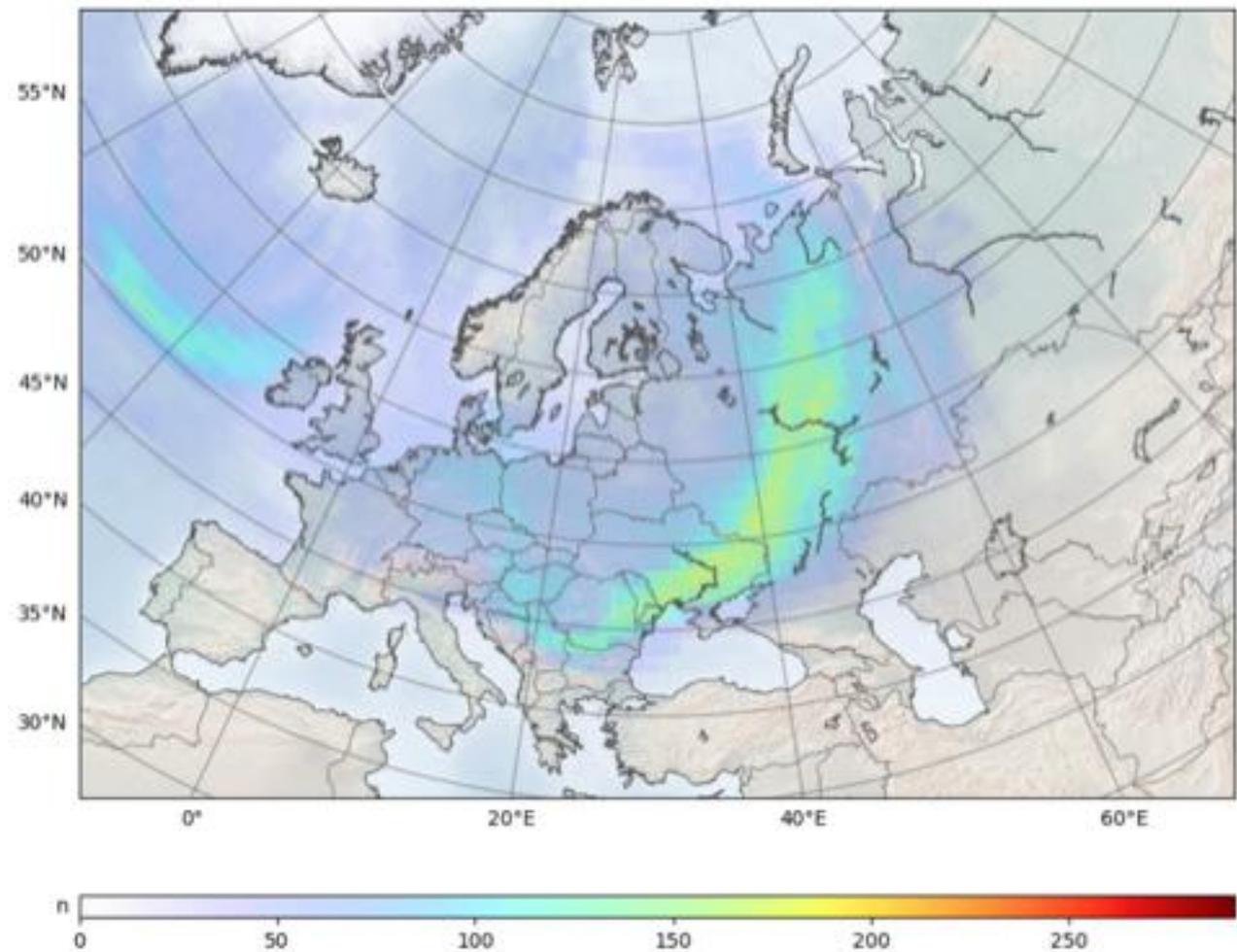
Time integrated
activity concentration in air
(20. Sep – 05. Oct 2017)



Trajectory frequency inside PBL

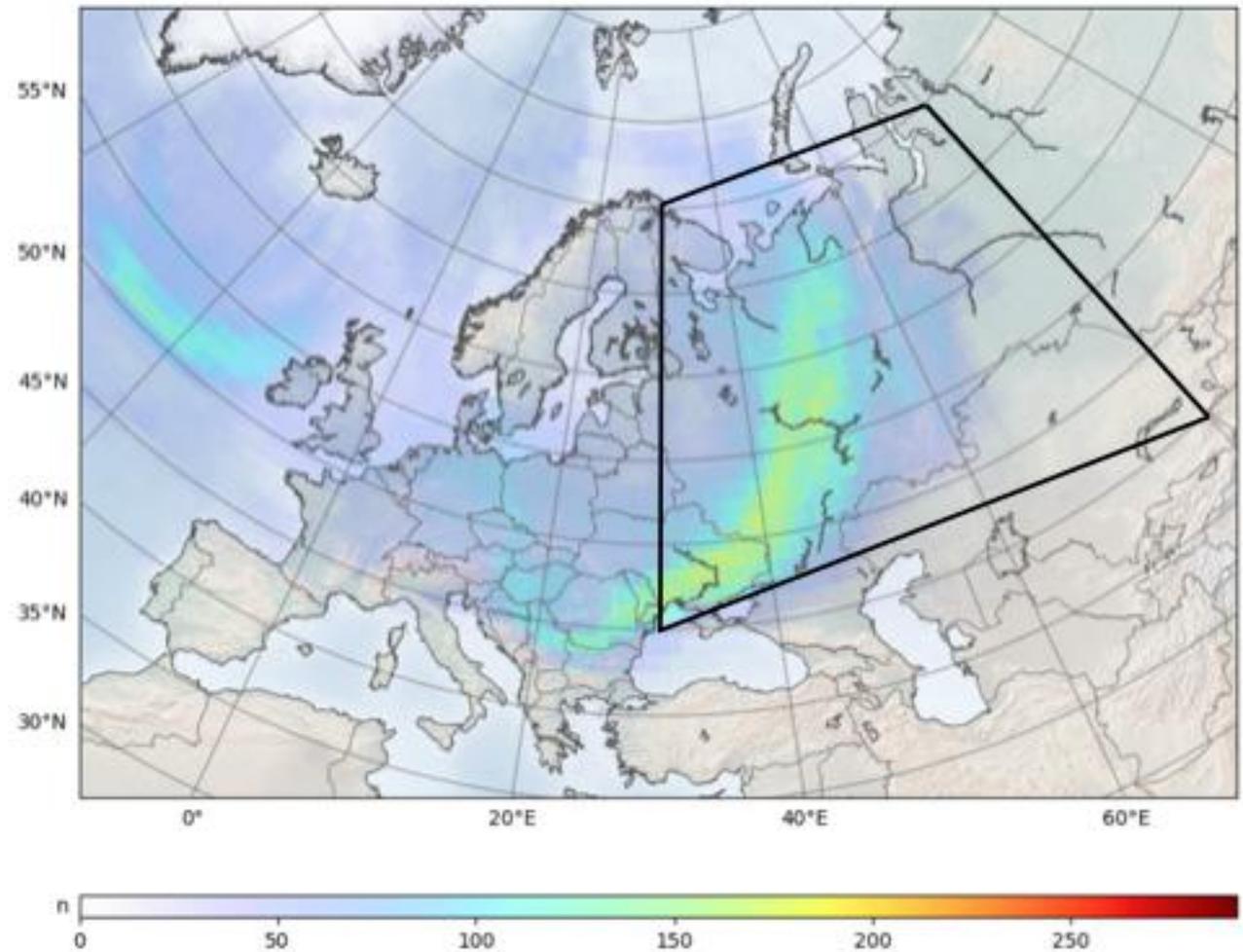
Trajectory frequency to define a first guess for the field of regard inside the planetary boundary layer (PBL) for ground based sources

n = number of observations per grid cell



Source region “first guess”

45° - 70° N
30° - 80° E



Correlation between simulation and observation

Dispersion calculations (HYSPLIT)
from 162 potential release sites

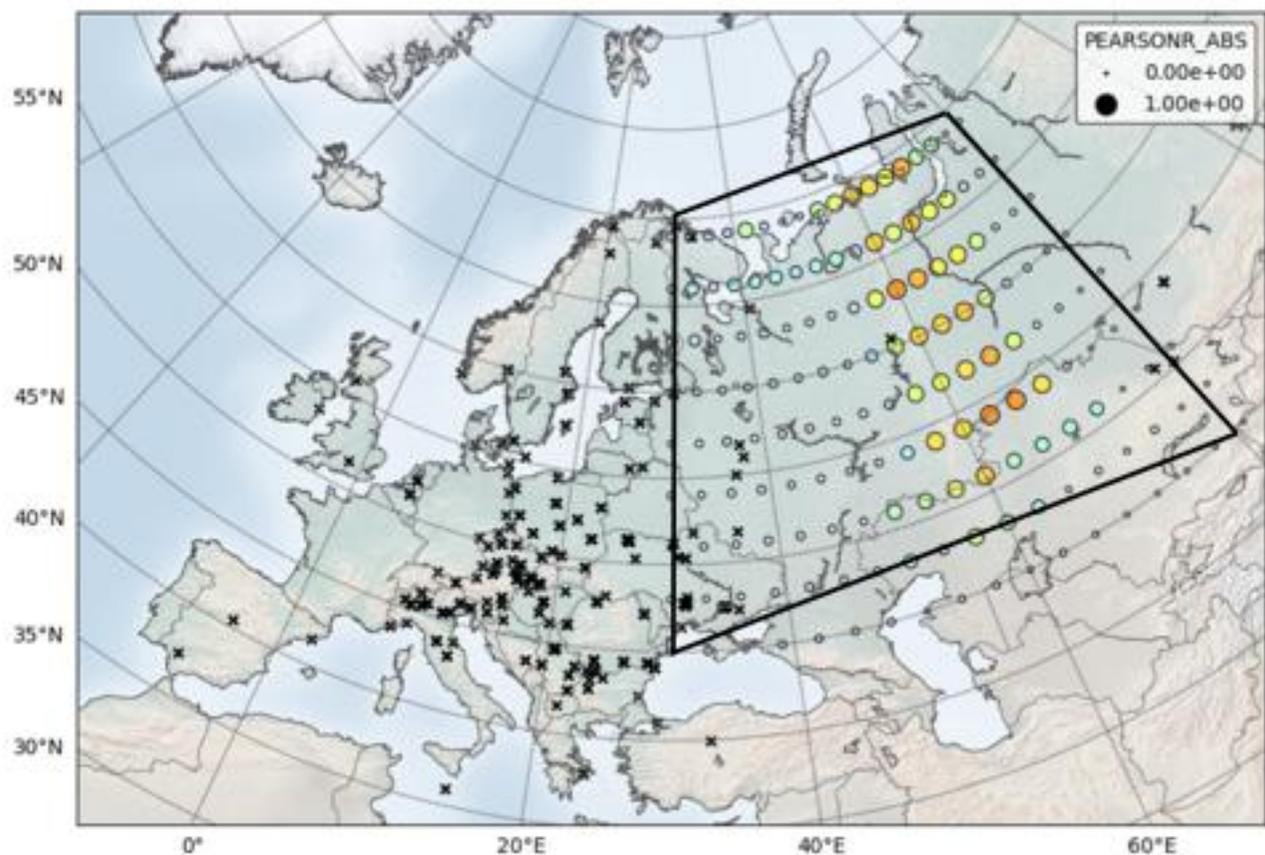
Pearson R:

$$R = \frac{(C_o - \bar{C}_o)(C_p - \bar{C}_p)}{\sigma_{C_o} \sigma_{C_p}}$$

C_o observations

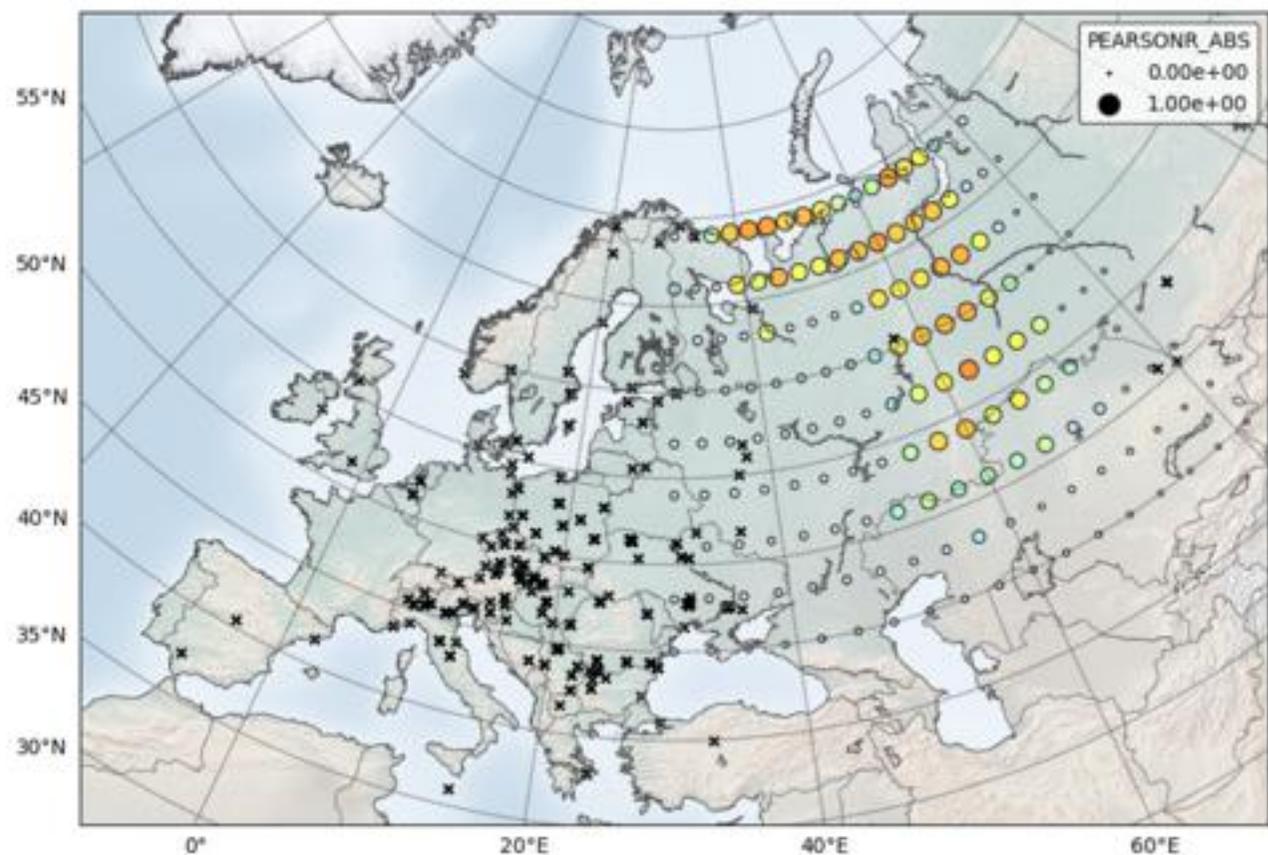
C_p predictions

σ_C standard deviation



Correlation between simulation and observation

Release @ 2000m
20.09. – 26.09.2017



Estimation of deposited activity concentrations

Average deposition (mBq m^{-2})
from air activity concentration
observations

Deposition velocity: 1 mm s^{-1}
Grid resolution $1^\circ \times 1^\circ$

Total deposition:
 $\sim 4\text{e}+12 \text{ Bq}$

