

# 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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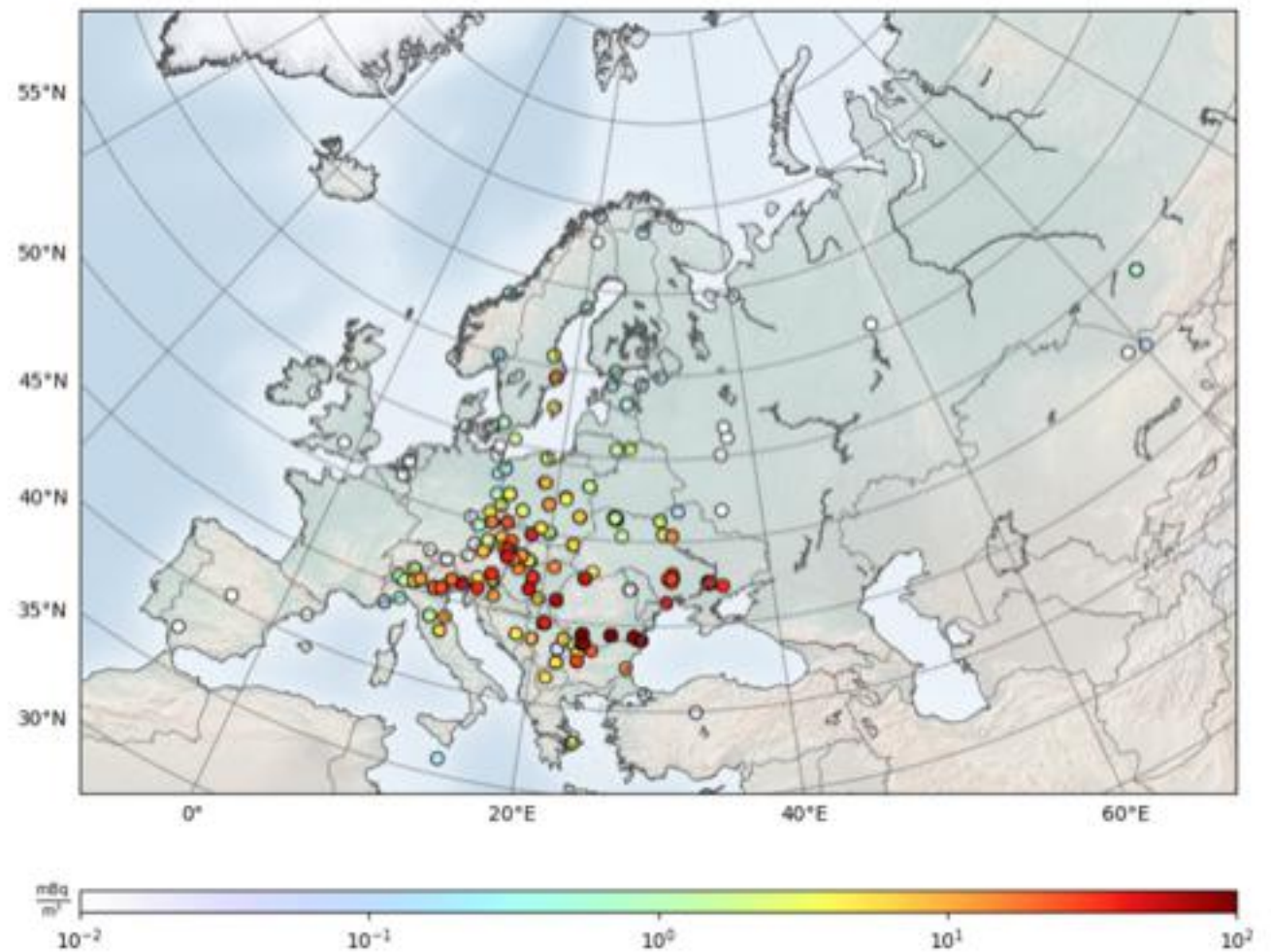
<sup>1</sup> Bundesamt für Strahlenschutz

# 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)

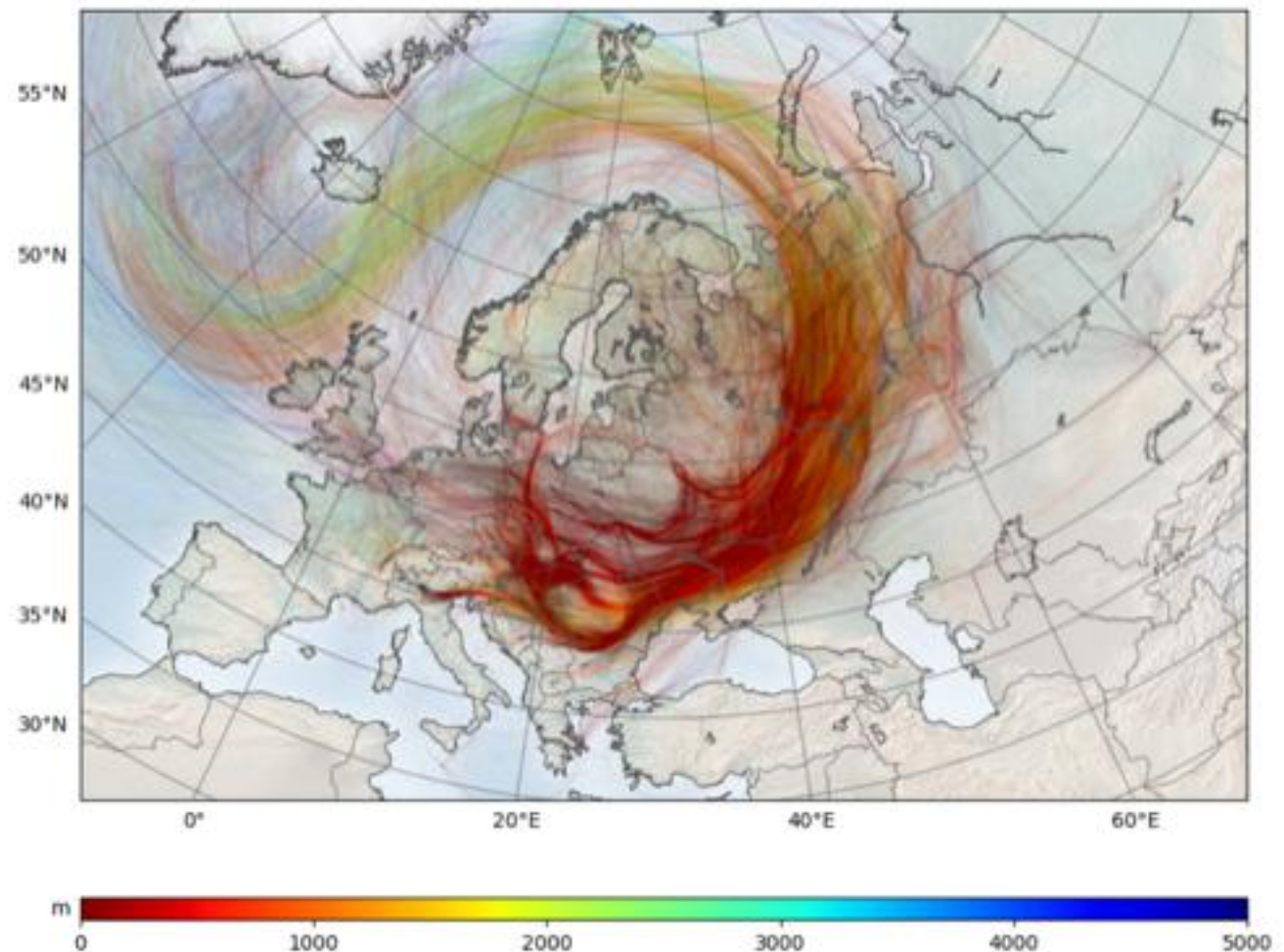


# Backward trajectories from observation sites

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

~ 10 000 trajectories

Model: HYSPLIT, GFS

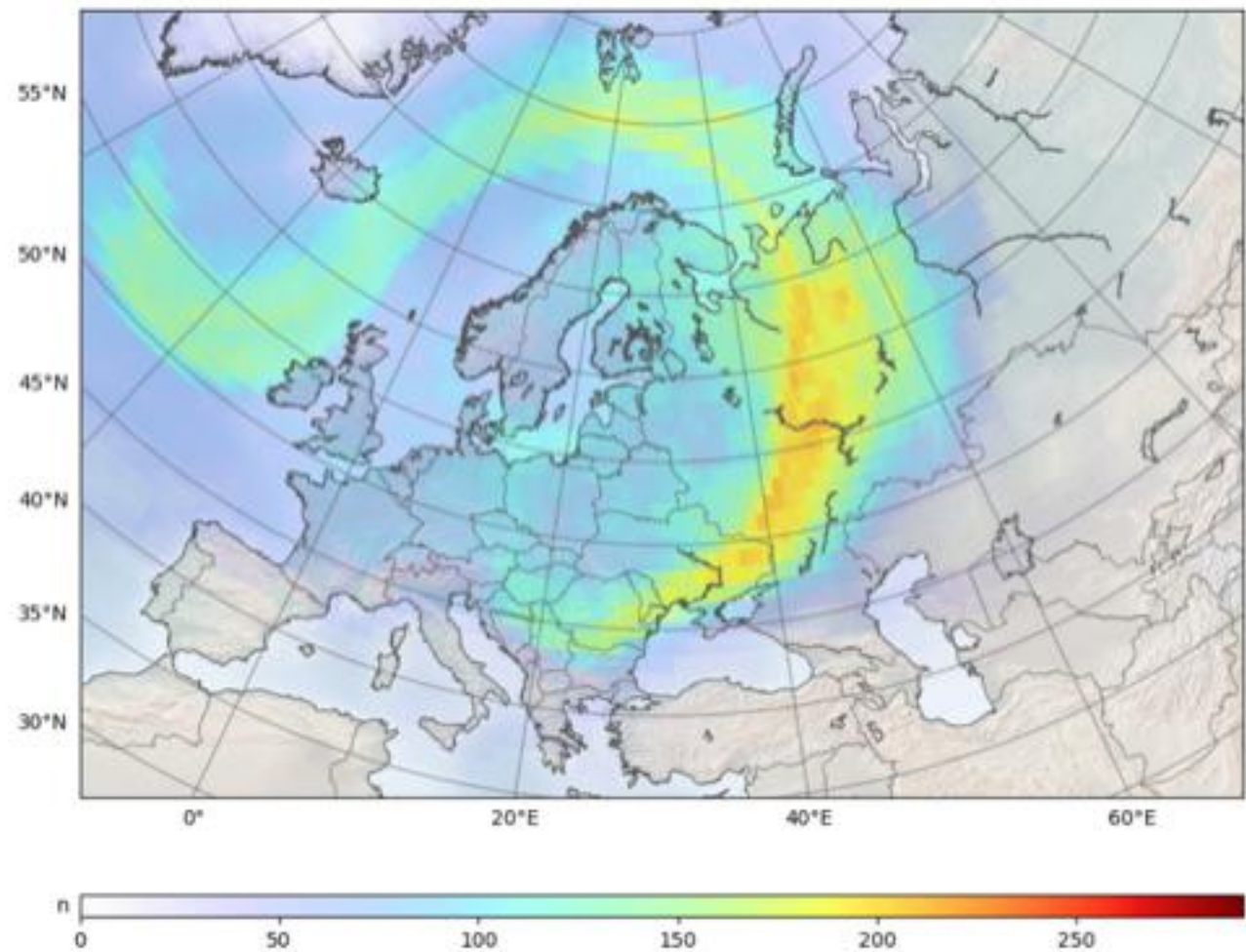




# Trajectory frequency

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

$n$  = number of trajectories  
per grid cell

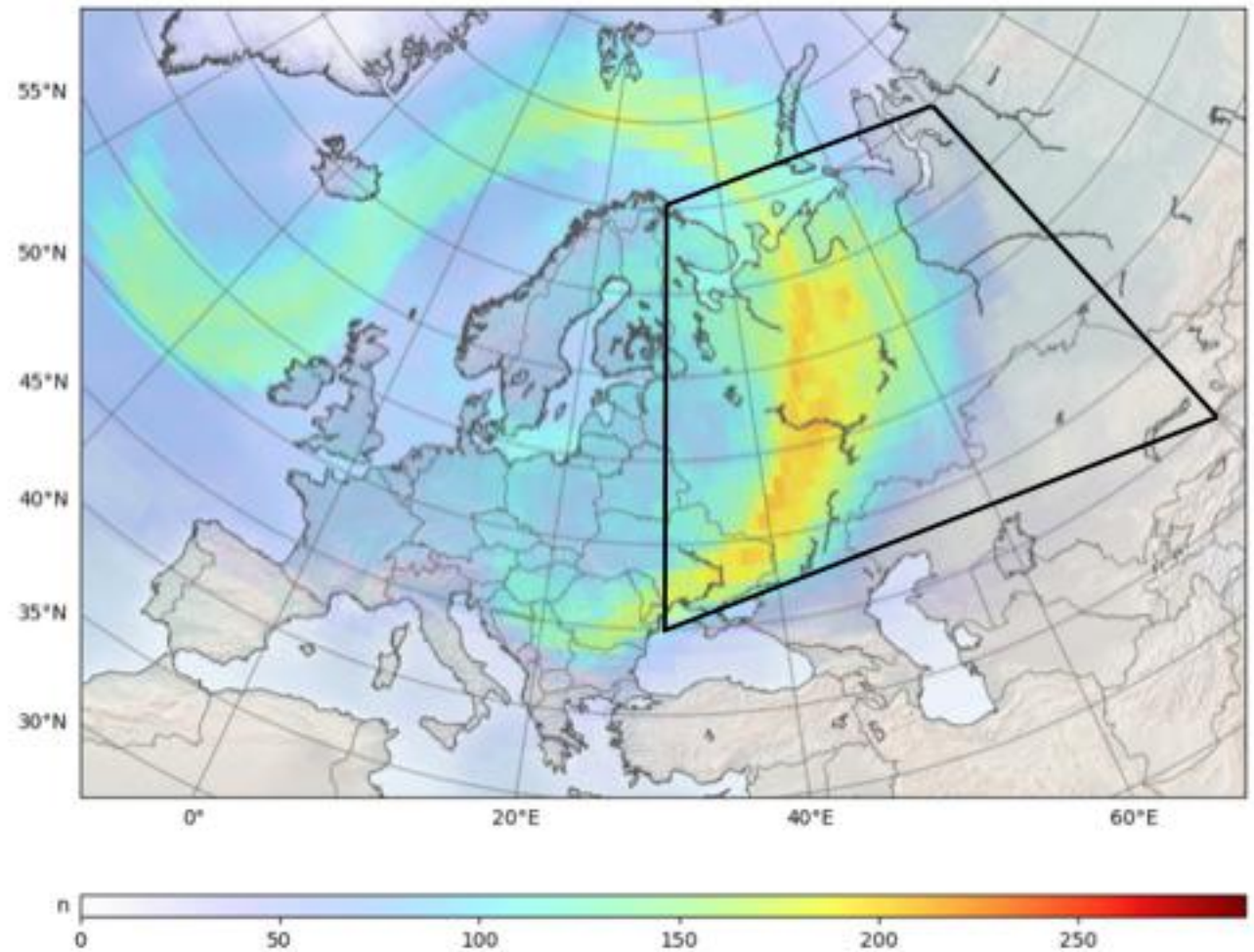


# Source region “first guess”

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

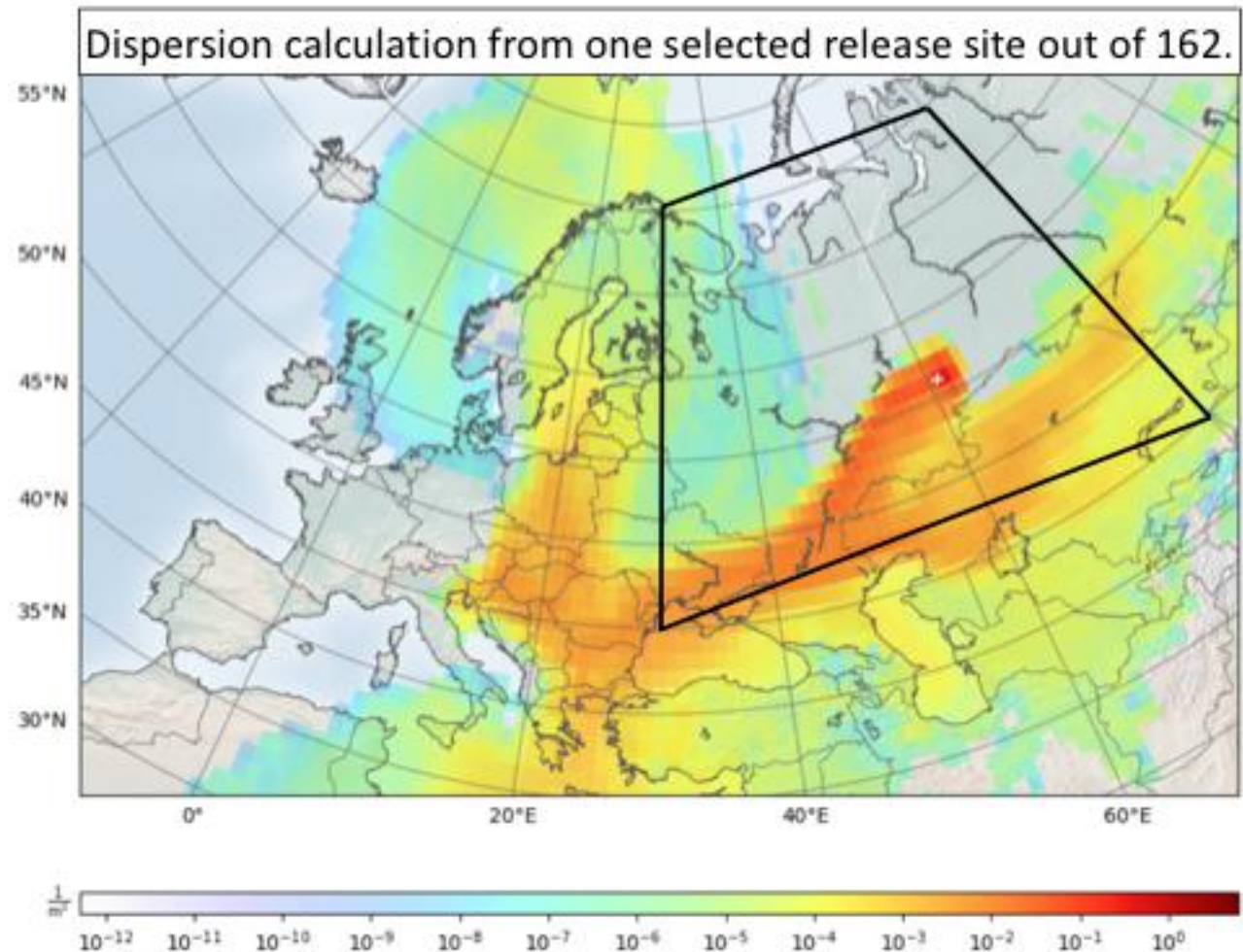
Pearson R:

$$R = \frac{(C_o - \overline{C_o})(C_p - \overline{C_p})}{\sigma_{C_o} \sigma_{C_p}}$$

$C_o$  observations

$C_p$  predictions

$\sigma_C$  standard deviation



# Correlation between simulation and observation

Dispersion calculations (HYSPLIT)  
from 162 potential release sites

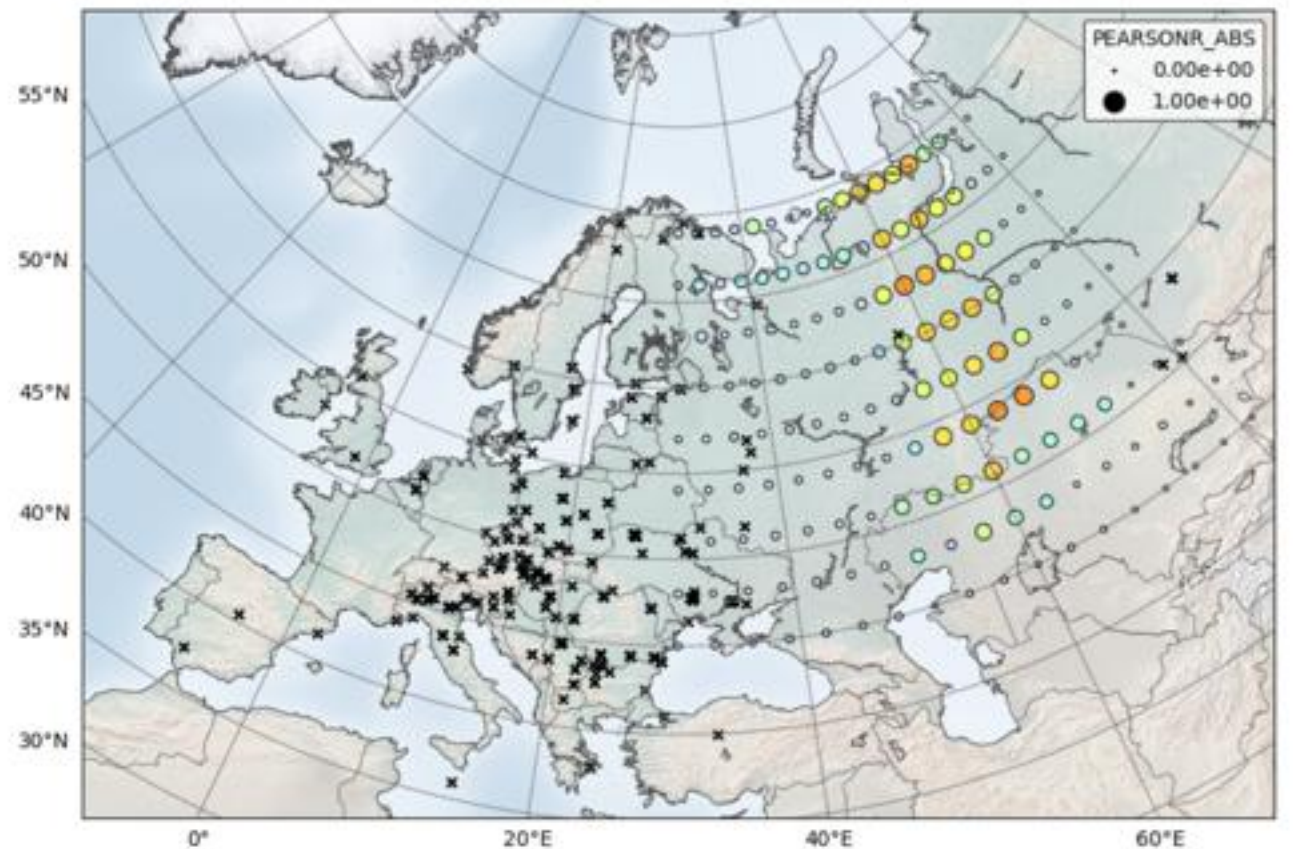
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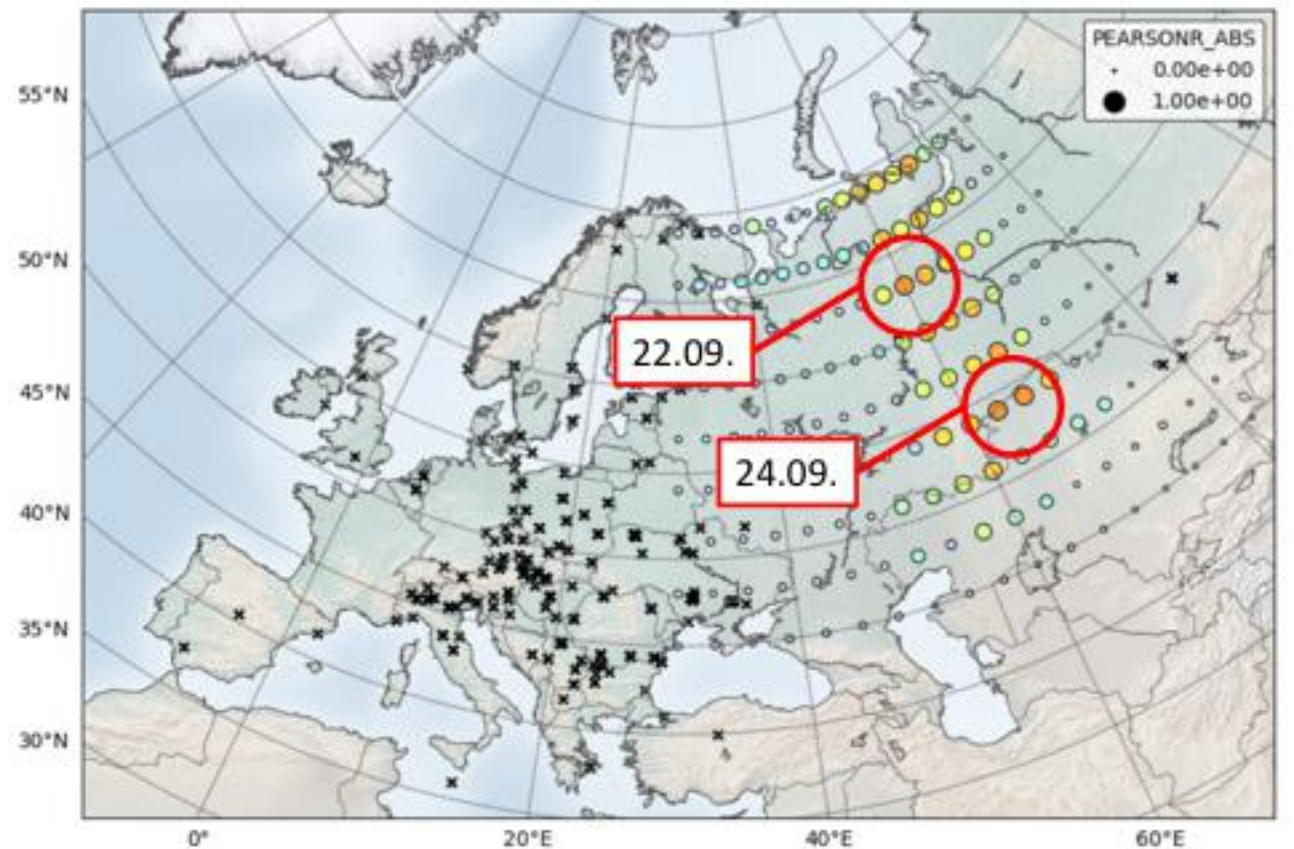
$\sigma_C$  standard deviation





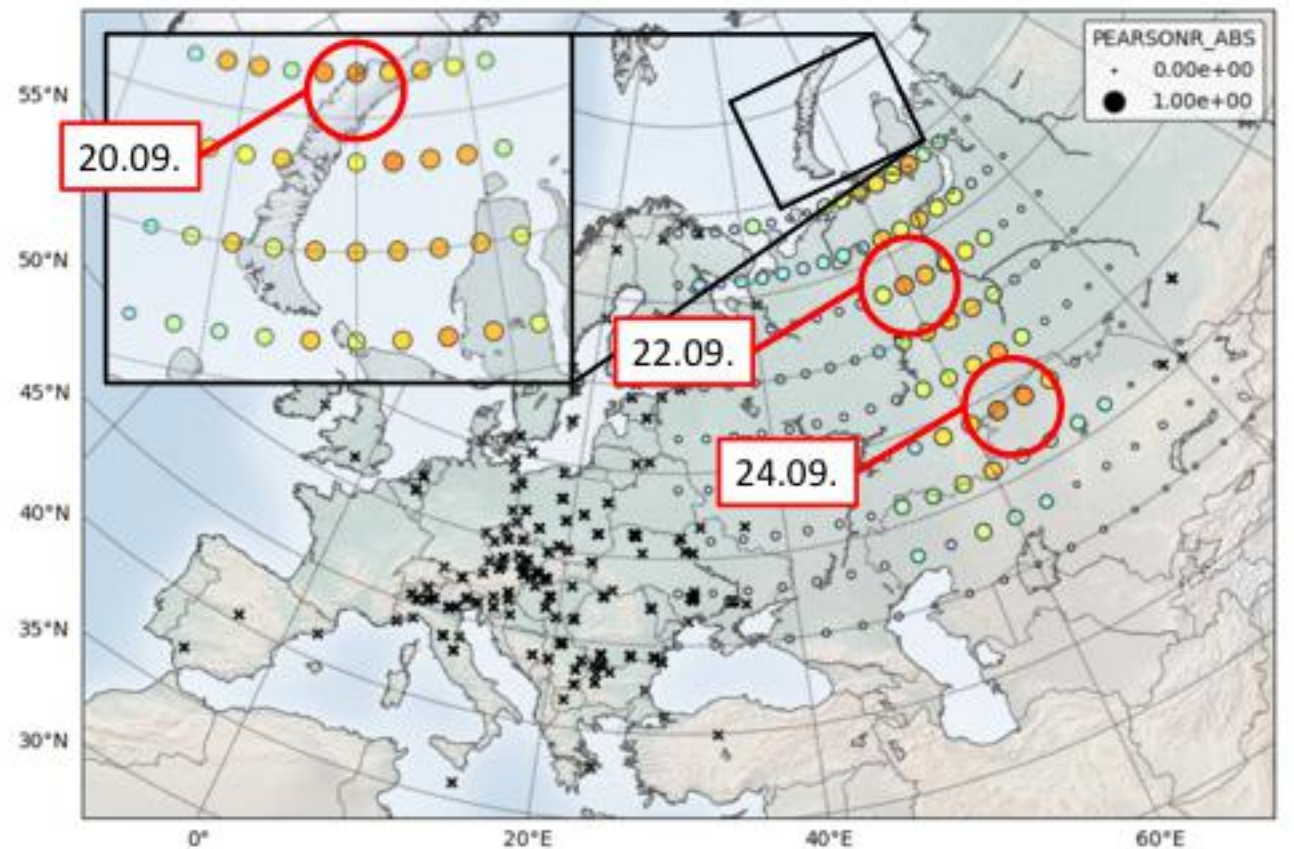
# Correlation between simulation and observation

Release @ 50m  
20.09. – 26.09.2017



# Correlation between simulation and observation

Release @ 50m  
20.09. – 26.09.2017





# Estimation of source term (FAC2)

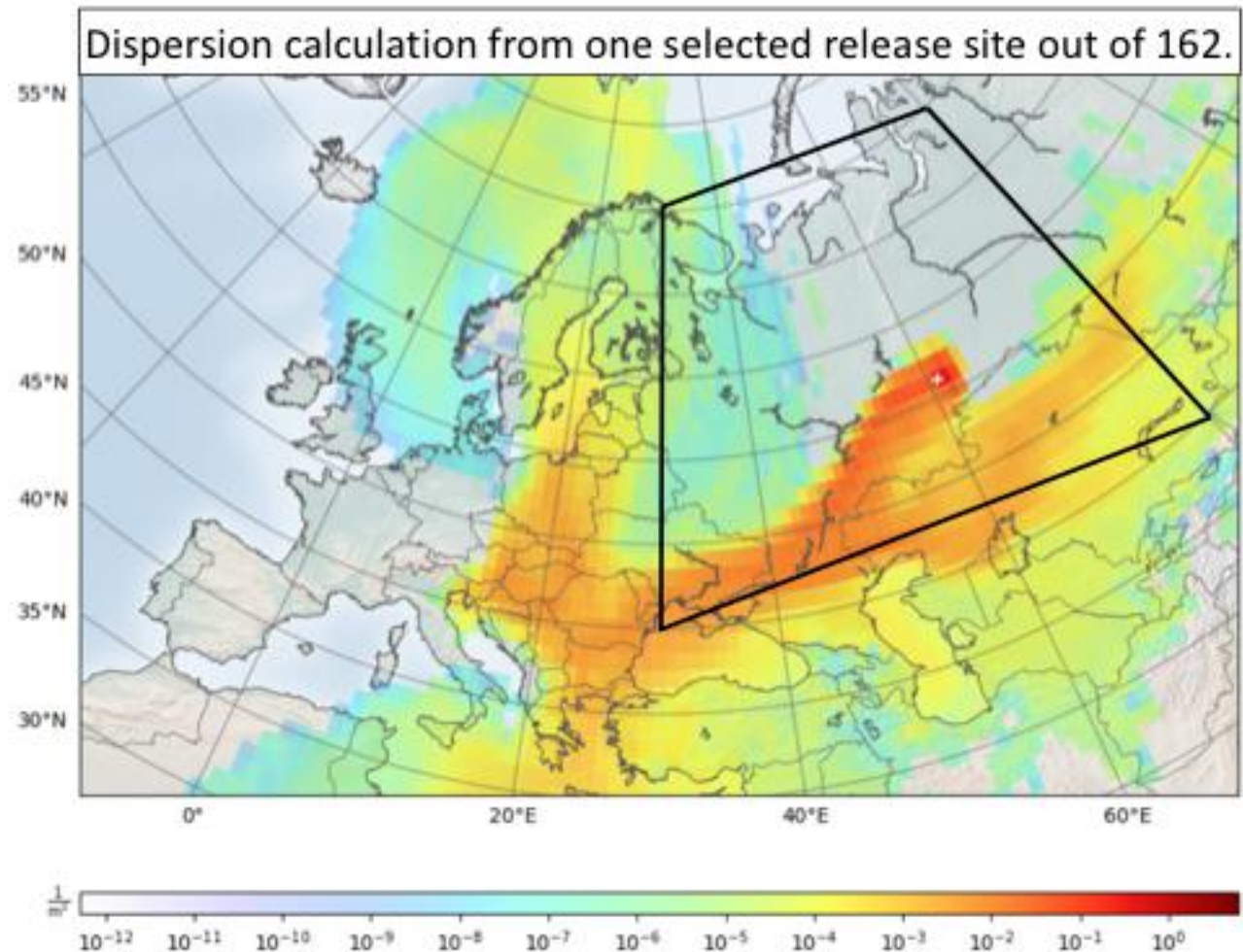
Dispersion calculations from  
162 potential release sites

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)

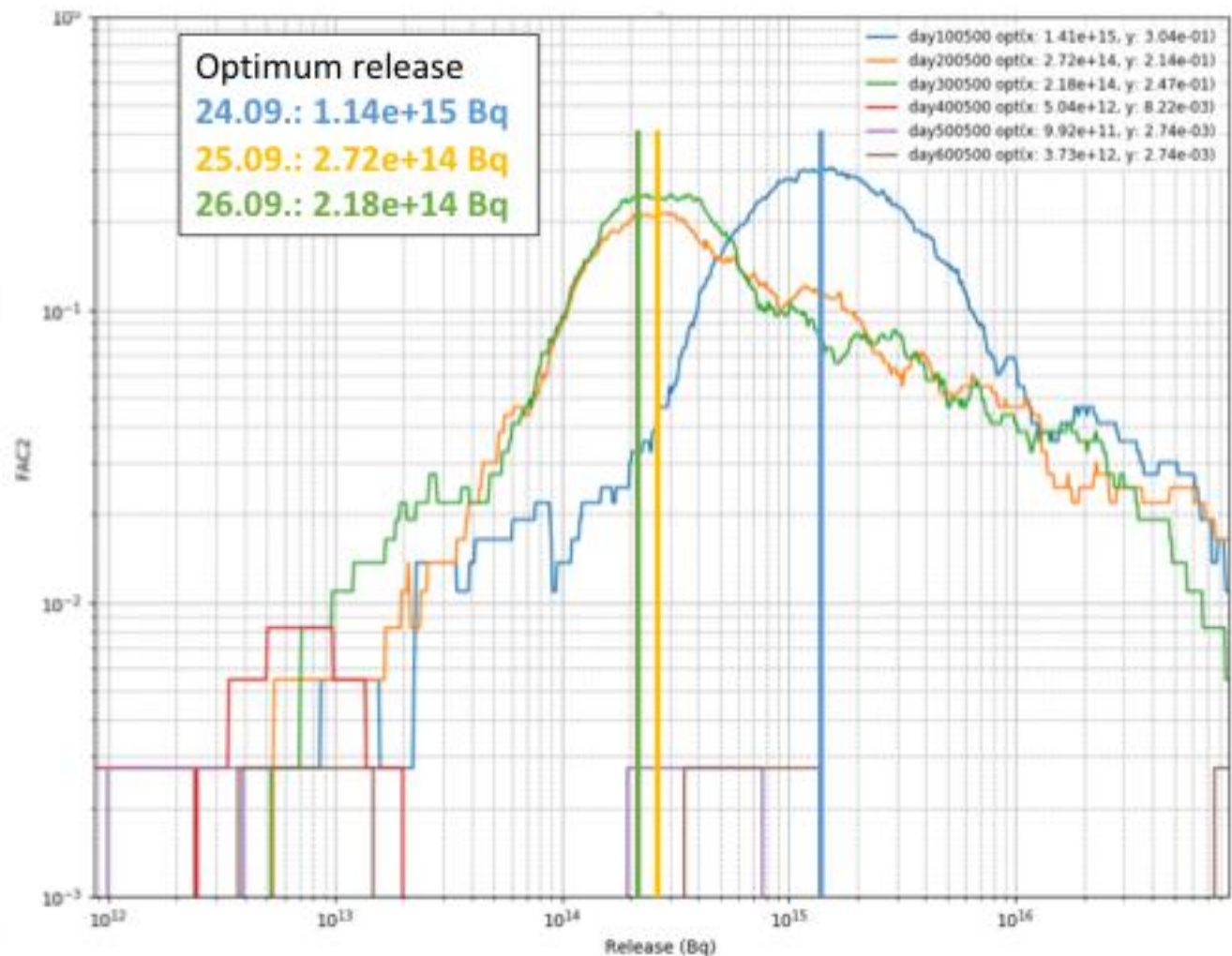
Dispersion calculations from  
162 potential release sites

FACx = fraction of data for which

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

$C_o$  observations

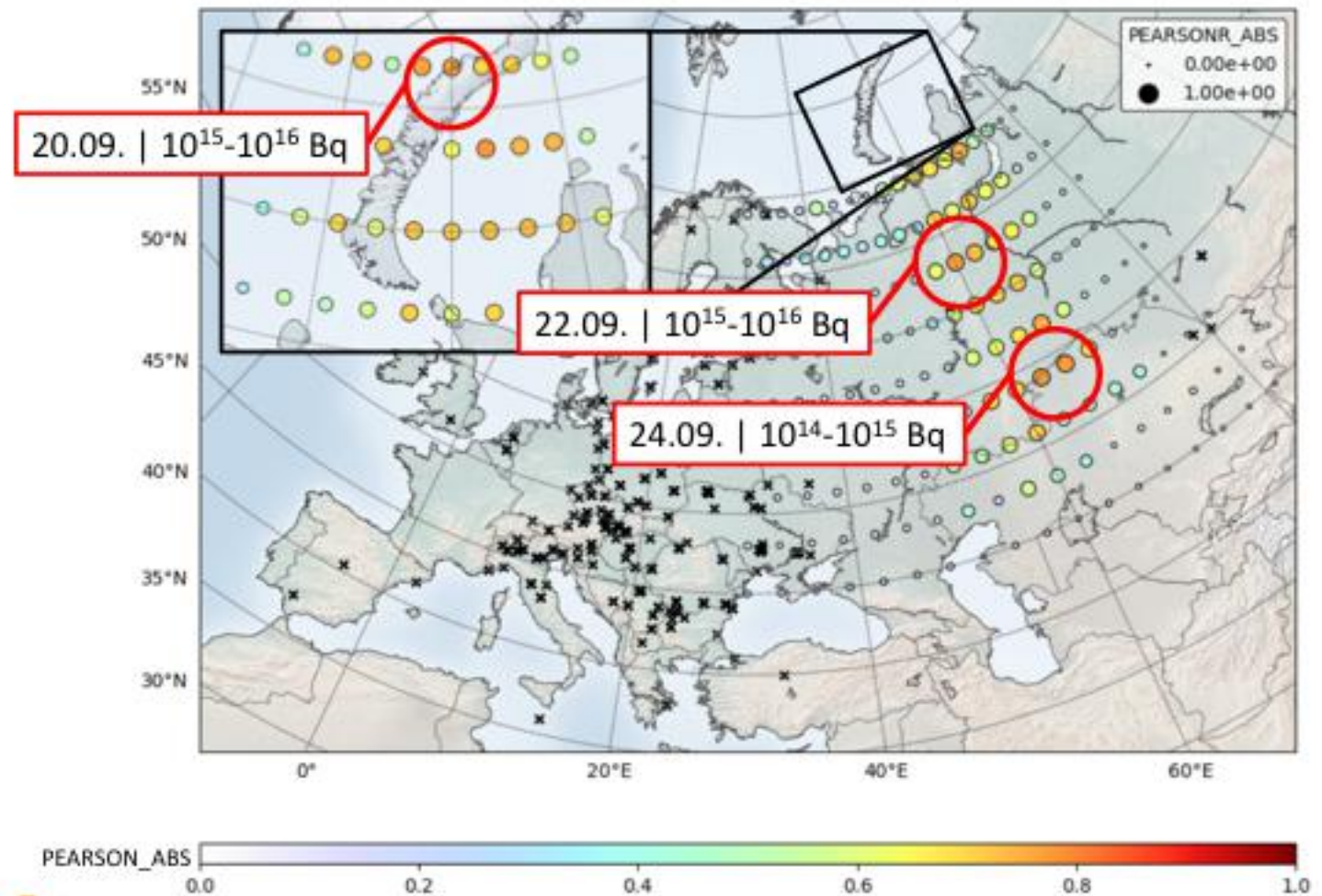
$C_p$  predictions



# Estimation of source term (FAC2)

Release @ 50m  
20.09. – 26.09.2017

100 TBq – 10 PBq

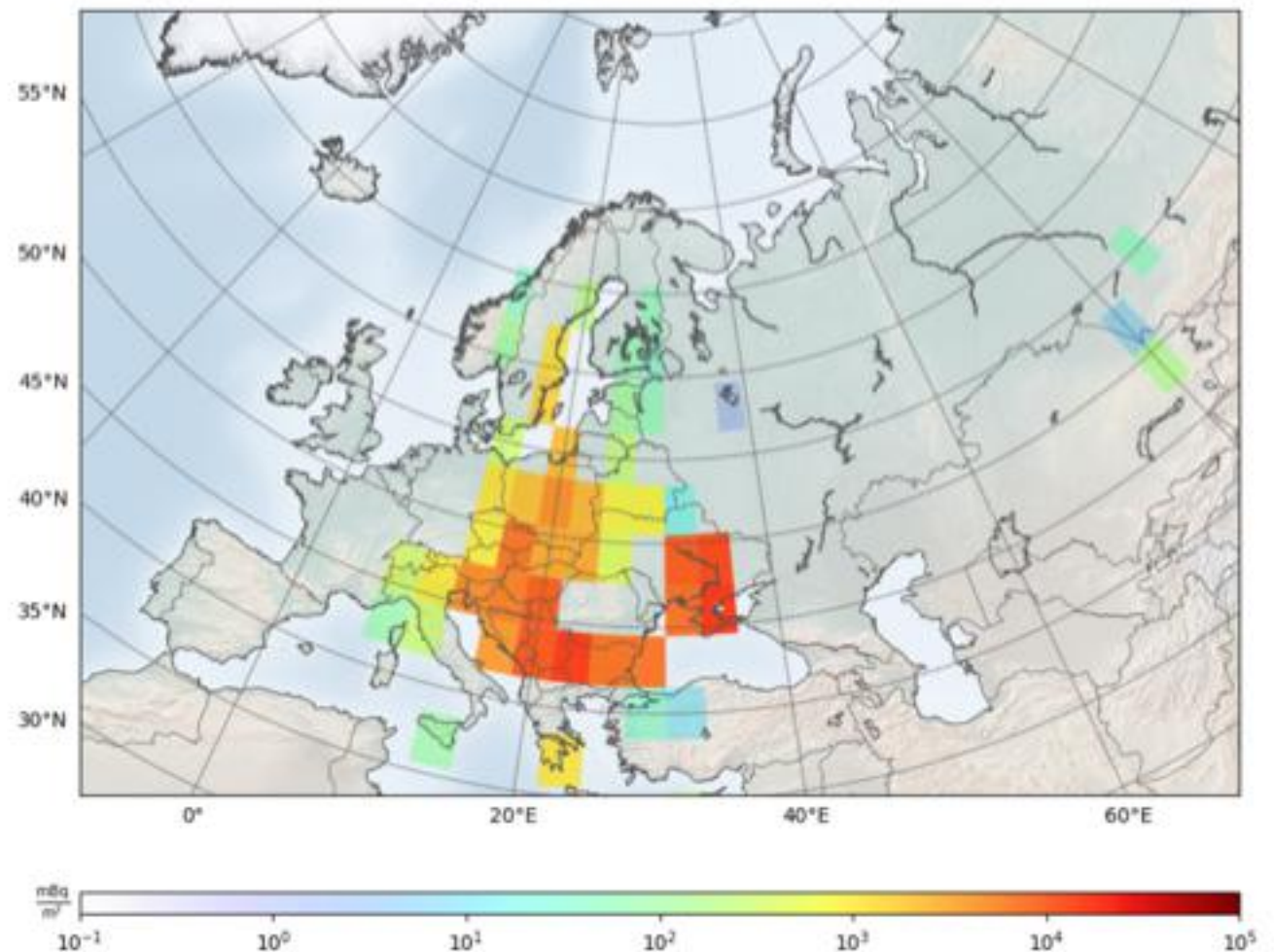


# Estimation of deposited activity concentrations

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

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

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





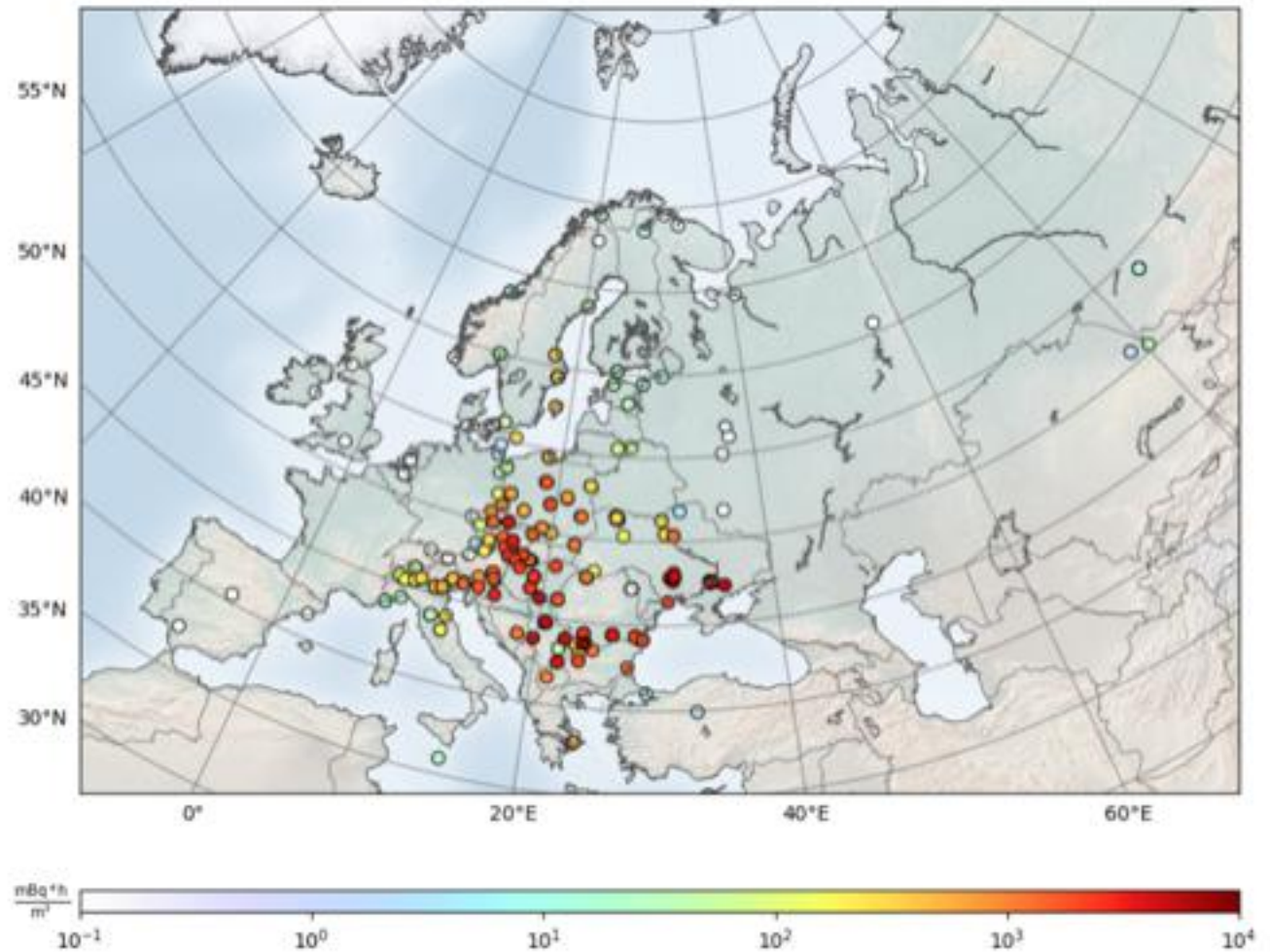
# Summary

- 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)  
 $\sim 100$  TBq – 1 PBq Ru-106
  - 20.09. – 23.09.2017  
Arctic (Barents Sea, Novaya Zemlya), Northern Ural  
 $\sim 1$  PBq – 10 PBq Ru-106

# Thank you!

# Ru-106 observations (IAEA, CTBTO)

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

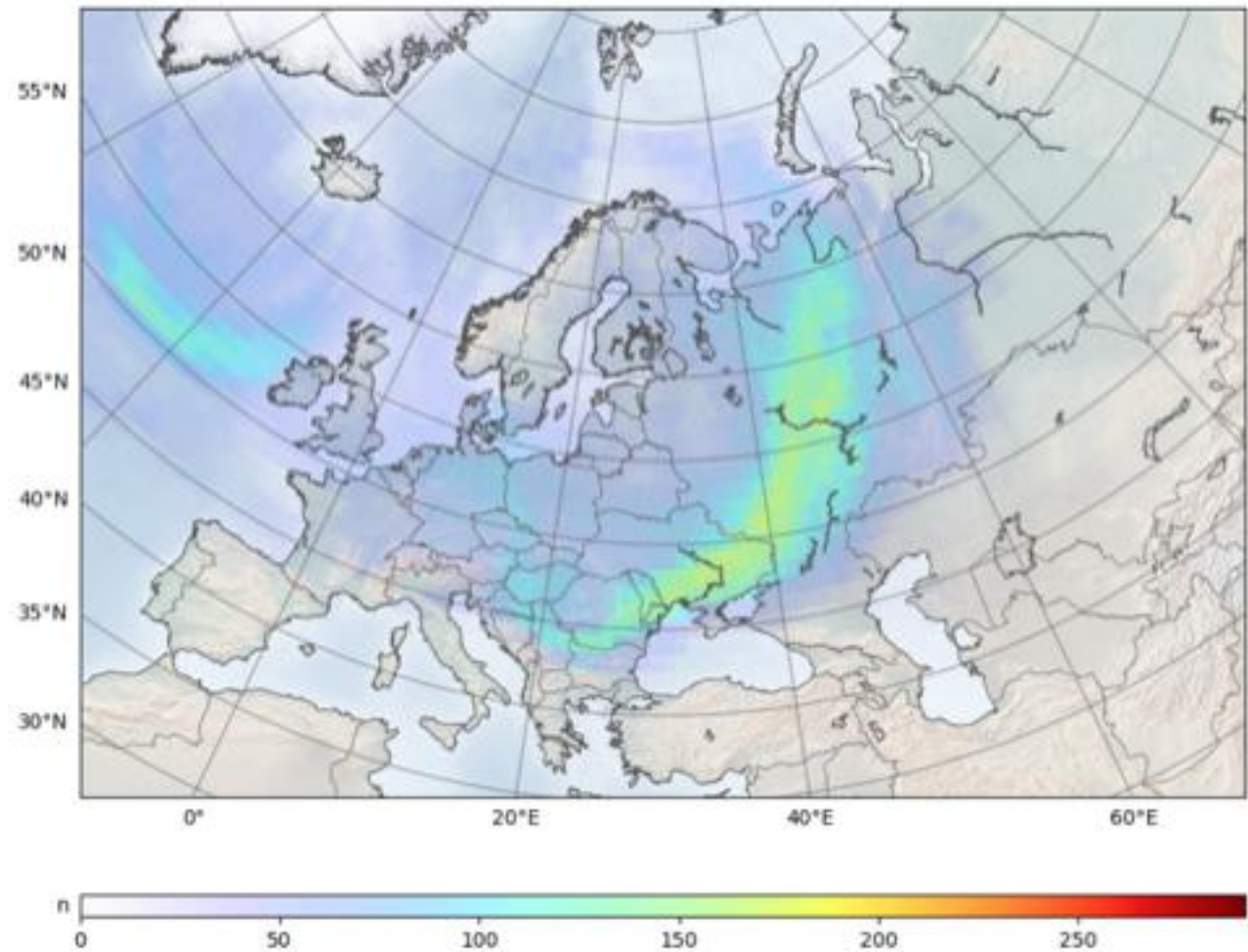




# Trajectory frequency inside PBL

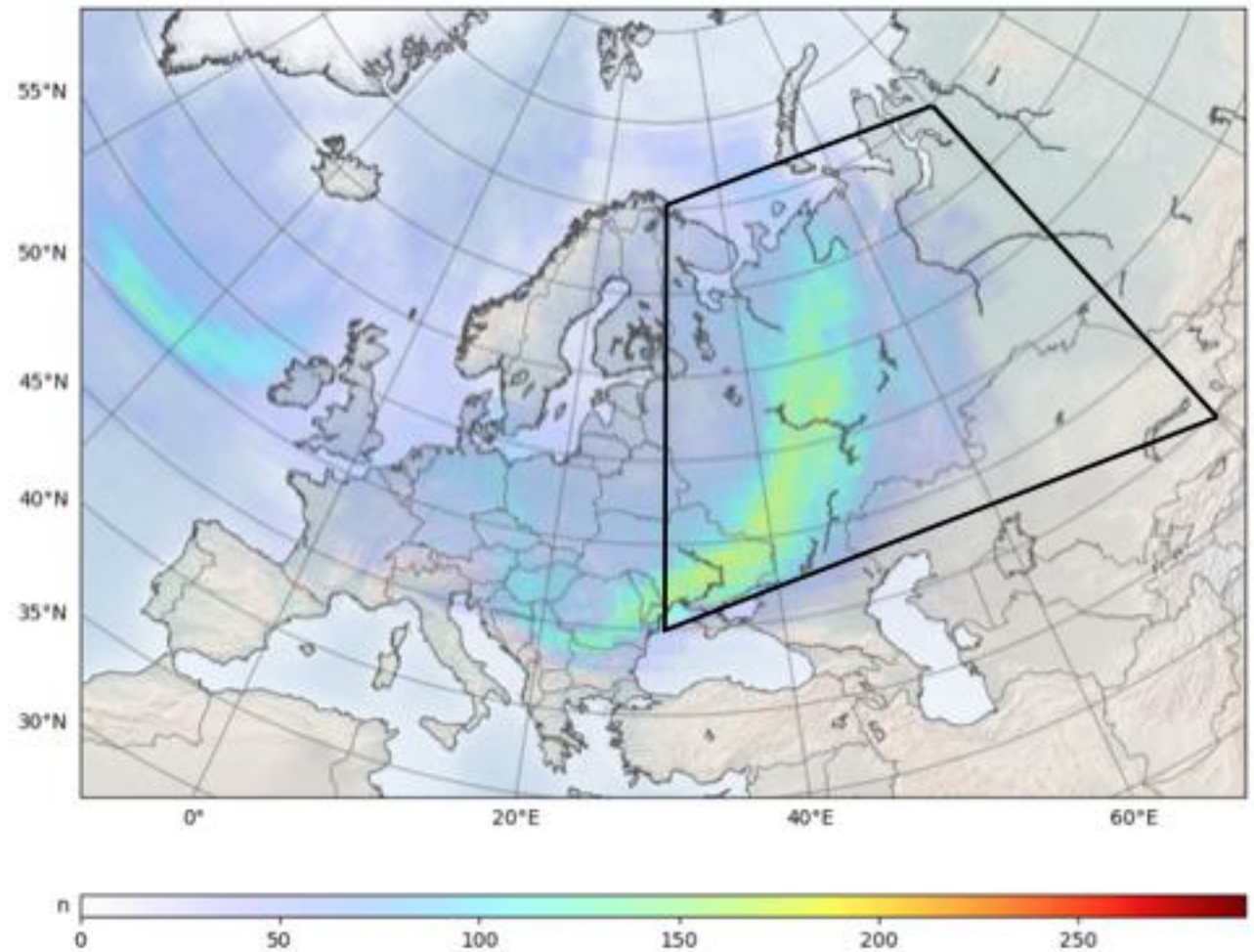
Trajectory frequency to define a first guess for the field of regard inside the planetary boundary layer (PBL) for ground based sources

$n$  = 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

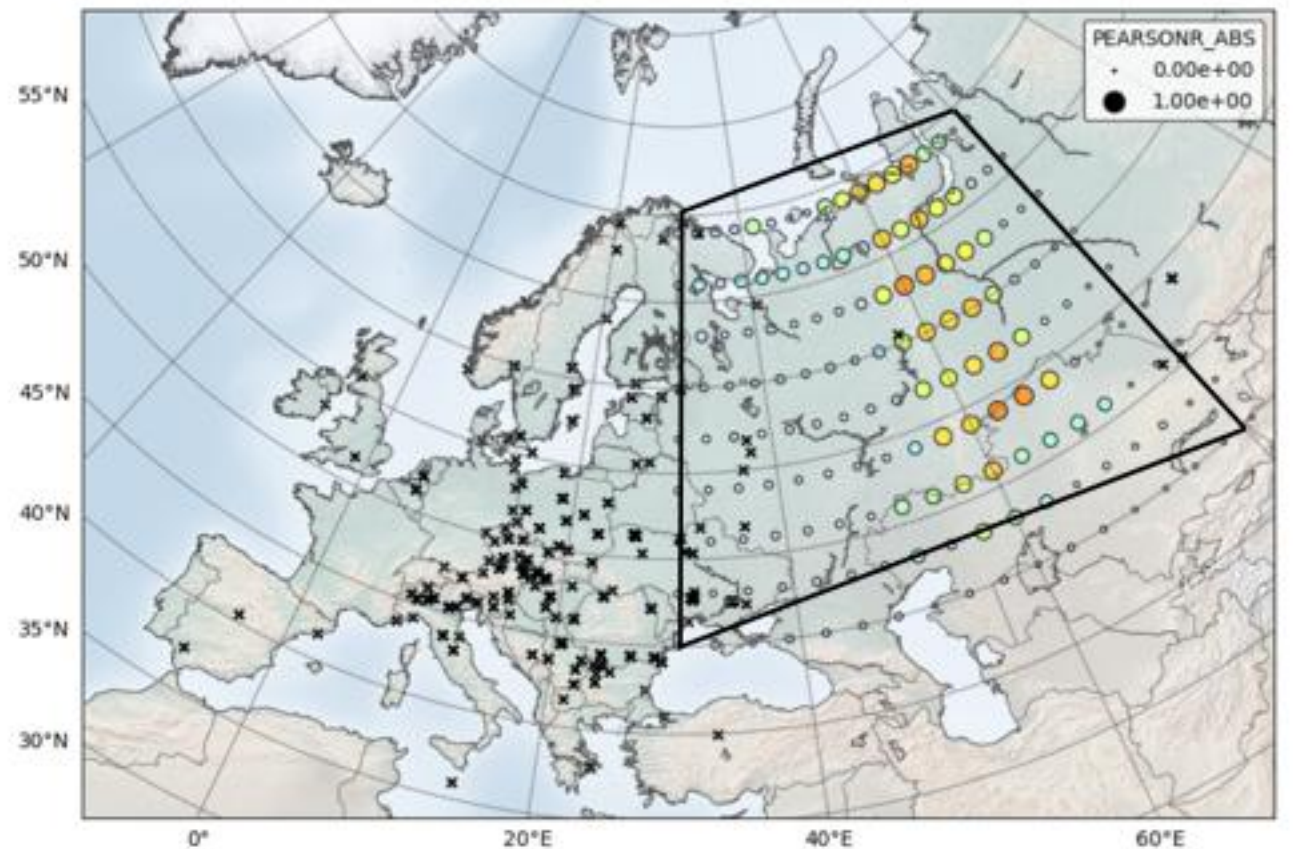
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$$R = \frac{(C_o - \overline{C_o})(C_p - \overline{C_p})}{\sigma_{C_o} \sigma_{C_p}}$$

$C_o$  observations

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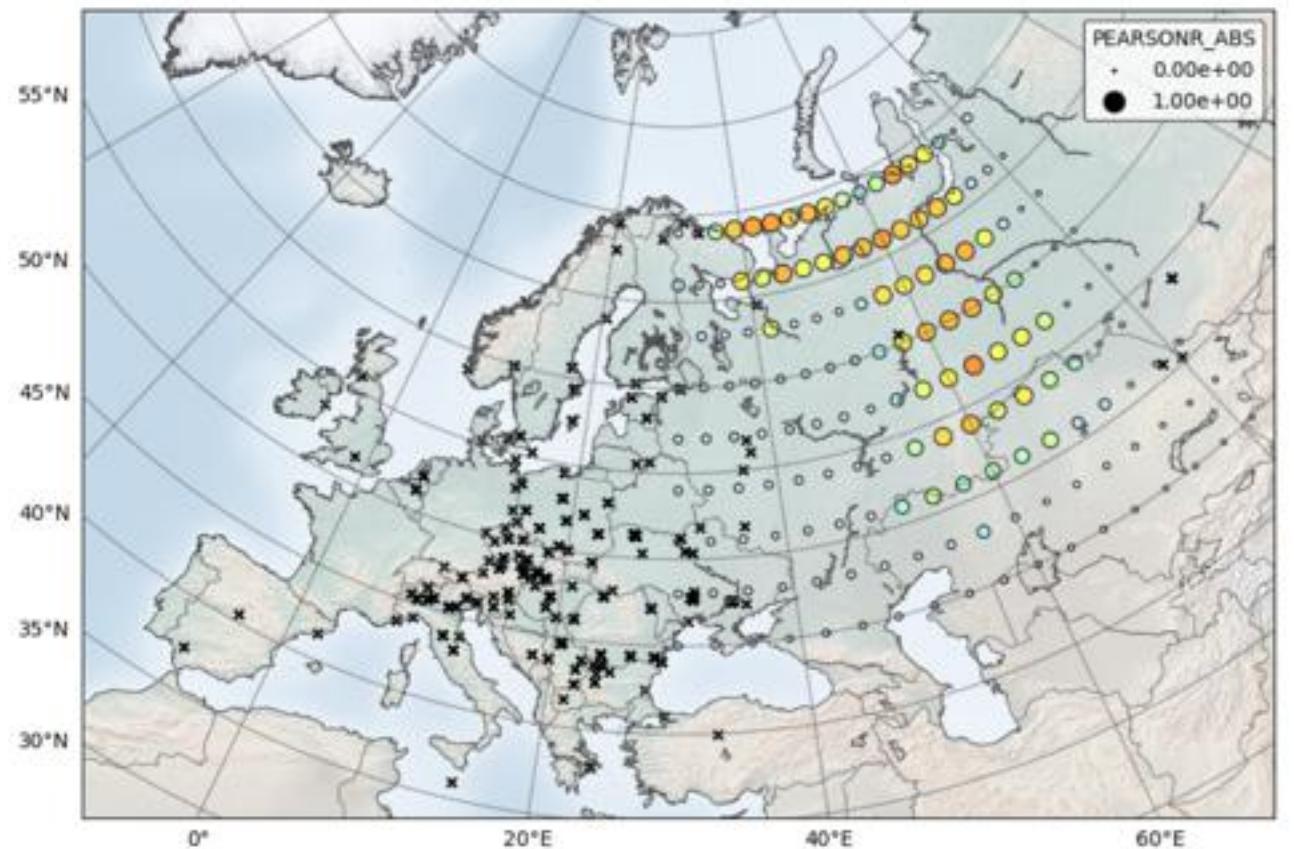
$\sigma_C$  standard deviation





# Correlation between simulation and observation

Release @ 2000m  
20.09. – 26.09.2017



# Estimation of deposited activity concentrations

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

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

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

