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Outdoor exposure due to long-range atmospheric transport of radon can it be assessed by modelling?

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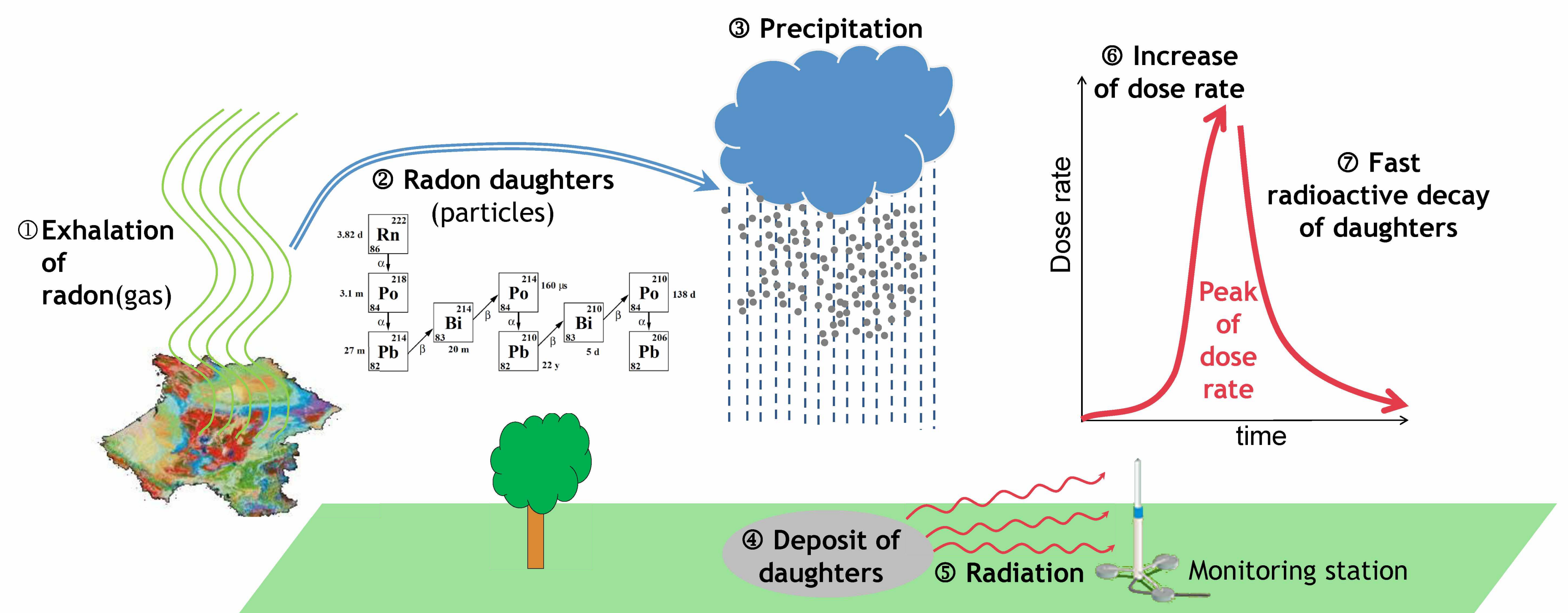
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Significant Radon-222 air concentration at one location is the combination of a potentially high local source – within few kilometers – and a long-distance origin – dozens or hundreds of kilometers. A local source can be estimated by modelling or measuring the ground exhalation rate. A distant origin is far more problematic to determine since it involves all the atmospheric processes and many potential exhalation sites. Therefore, the simulation of Radon-222 air concentrations must be made at regional or continental scale. We built a Radon-222 atmospheric transport modelling calculation chain, from input data to model-to-measurement comparisons.

Case study: atmospheric transport of radon



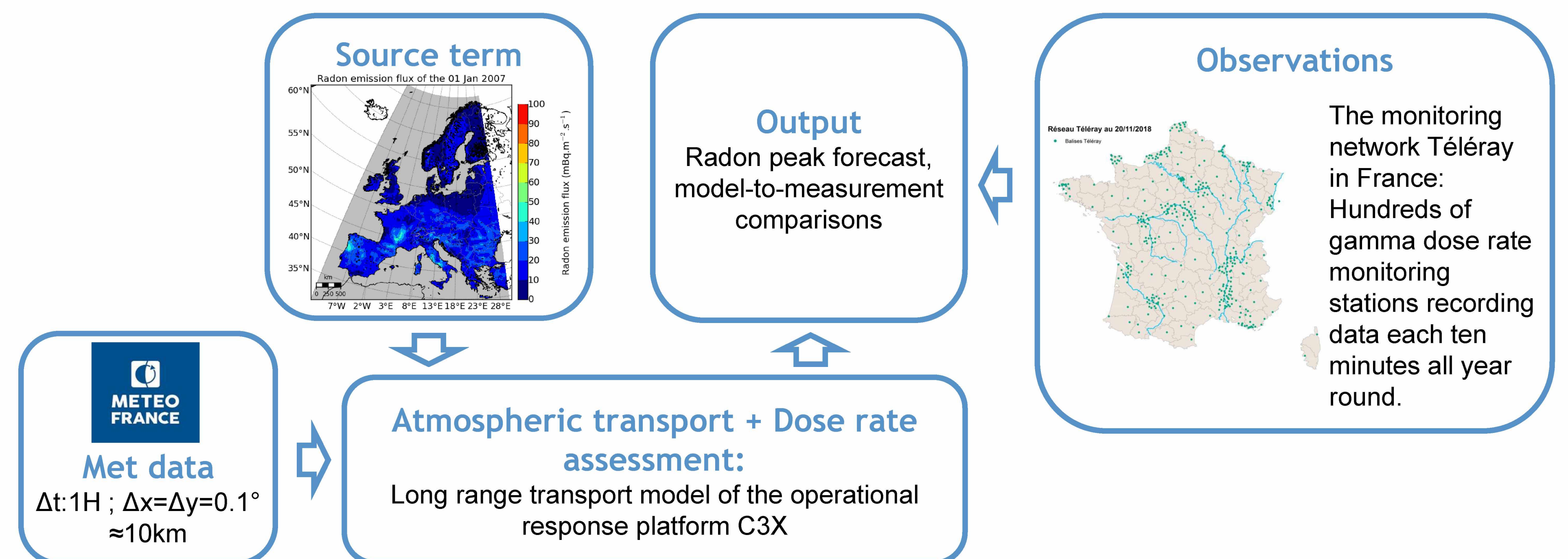
Radon-222 is a progeny of U-238, naturally found in the Earth's crust. After diffusing out of the soil, it reaches the atmosphere. As a noble gas, it does not interact with other gas or aerosol particles. Transported by the atmosphere, it can be breathed. Its disintegration inside the lung can damage the cells, increasing the risk of cancer. Radon-222 is therefore a major public health issue in some regions.

Context

In the event of an incident or accident involving radioactive materials, IRSN provides guidance to public authorities on the technical, public health and medical actions to be taken to protect the population and the environment.

Several times a year, alarms of this emergency monitoring network are triggered: these gamma dose rate peaks occurred during rainfall events because radon progenies concentrate in rain drops and fall down to the ground.

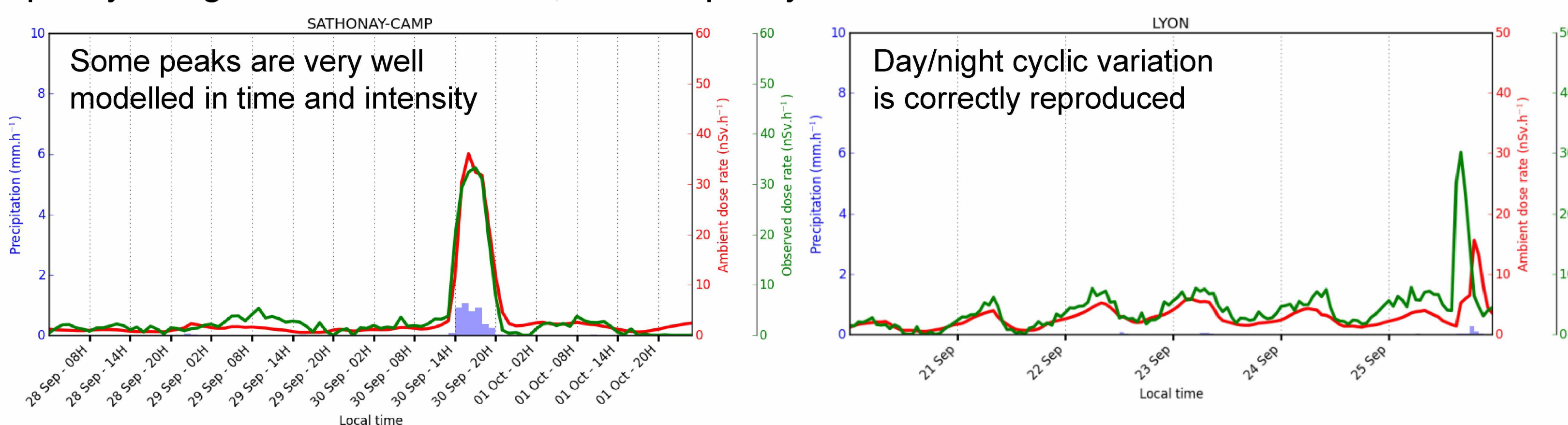
Although these peaks are safe for the population or environment, it is necessary to discriminate whether it comes from the natural radioactivity or if an accidental release of radioactive materials happened.



The model is validated with observed gamma dose rate ...

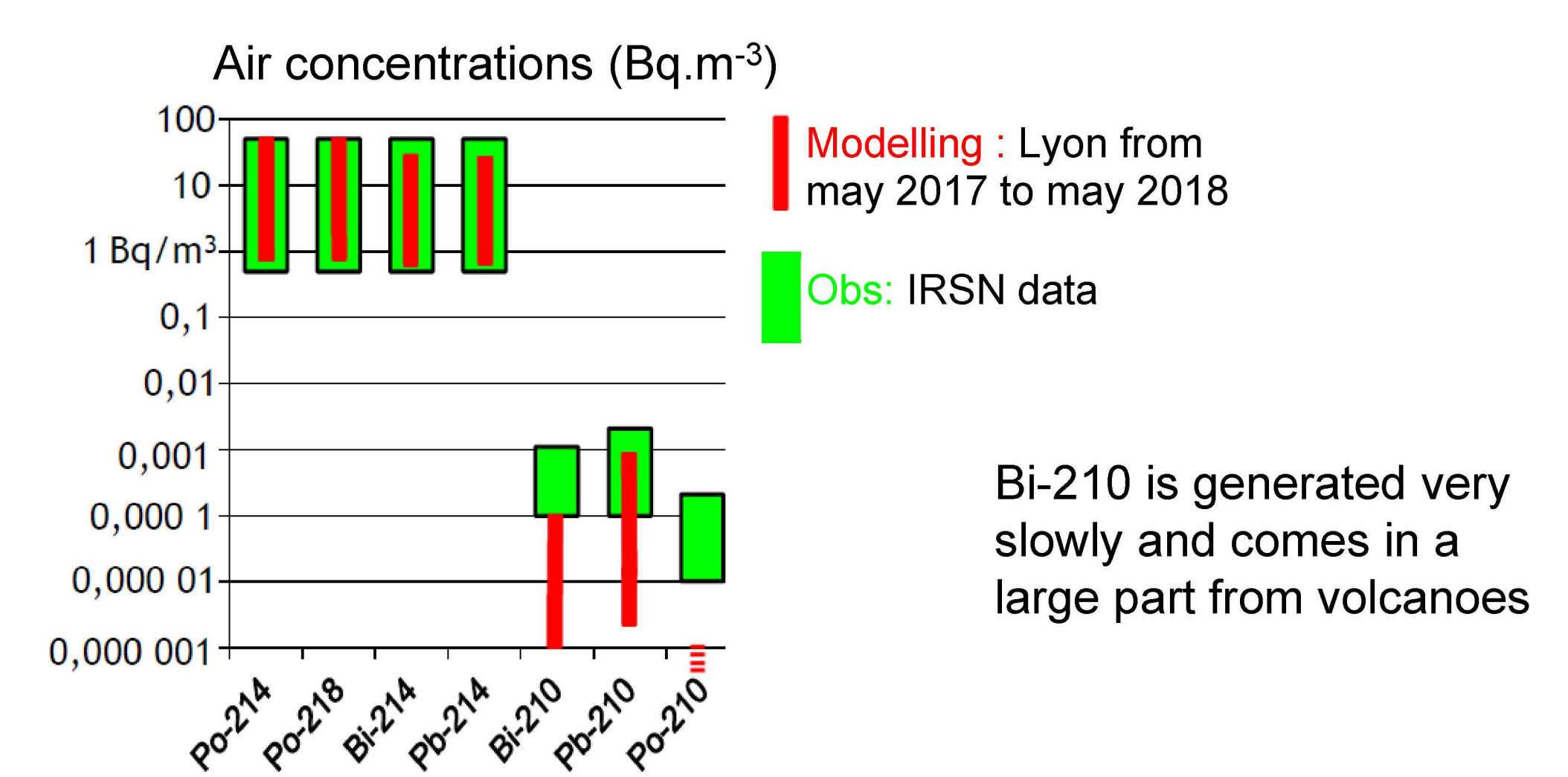
Gamma dose rate simulated and observed are compared. The simulation is satisfying when the source term, the winds and the precipitations are well-performing.

Observed gamma dose is well reproduced. Statistics have to be generated to qualify our gamma-dose results, and to qualify the model itself.



... and radionuclides air concentrations

The mean air concentration of the Rn-222 and daughters is well correlated with the observation, until the Bi-210.



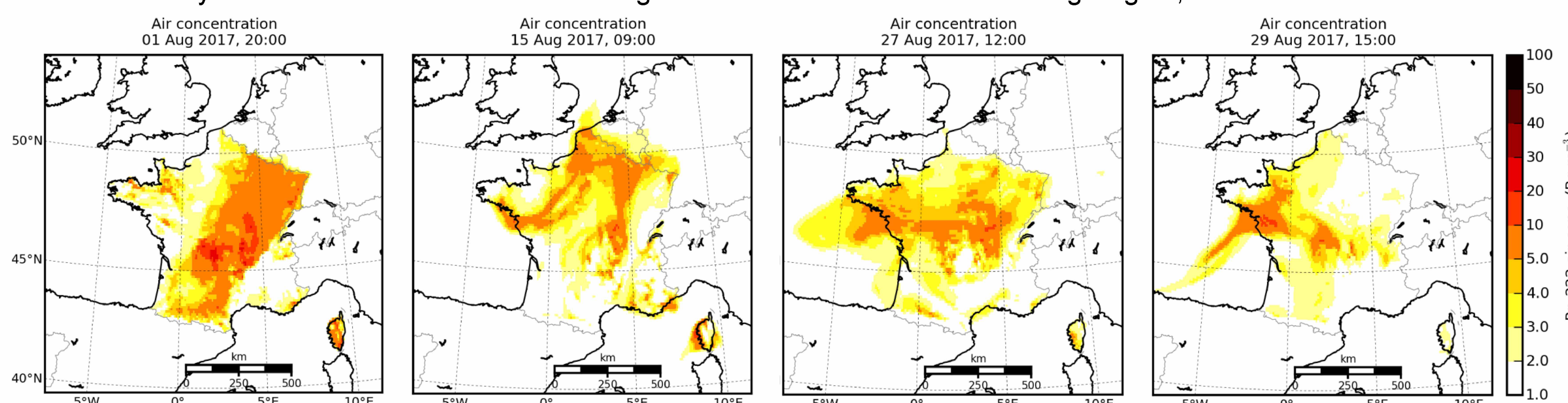
Bi-210 is generated very slowly and comes in a large part from volcanoes

Outdoor radon exposure

Outdoor exposure to radon: the role of long-range atmospheric transport?

When breathed, the radon-222 disintegrated inside the lung can damage the cells, increasing the risk of cancer. Radon-222 air concentration at one location is the combination of a potentially high local source – within few kilometres – and probably a long-distance origin – dozens or hundreds of kilometres.

Variability of Rn-222 air concentration at the ground-level for several times during August, 2017



Conclusion

This preliminary study shows the feasibility of modelling atmospheric radon at regional scale.

Outputs for IRSN:

- Forecast of dose rate peaks.
- Improve the atmospheric transport model (wet deposition modelling).
- Atmospheric radon exposure by inhalation.