



Towards the forecast of false positives in nuclear network monitoring due to atmospheric radon.

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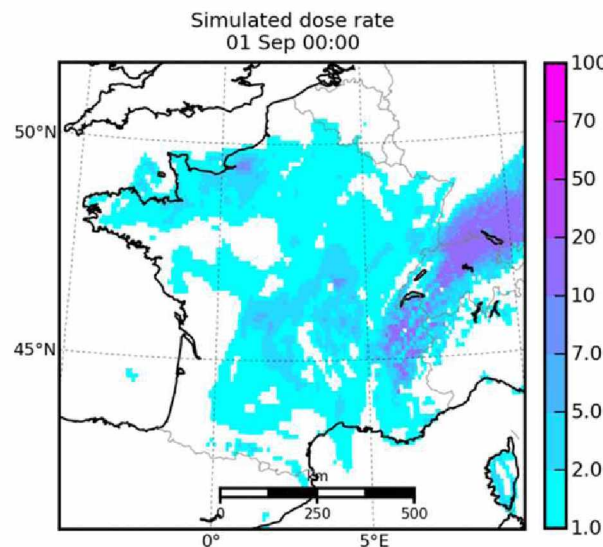
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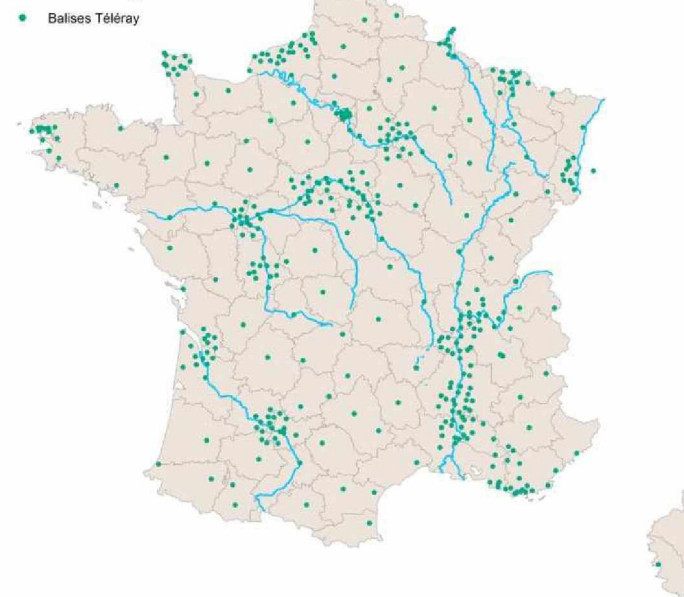
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire

Towards the forecast of false positives in nuclear network monitoring due to atmospheric radon



Réseau Téléray au 20/11/2018



EGU 2019 18762

April, 11th 2019

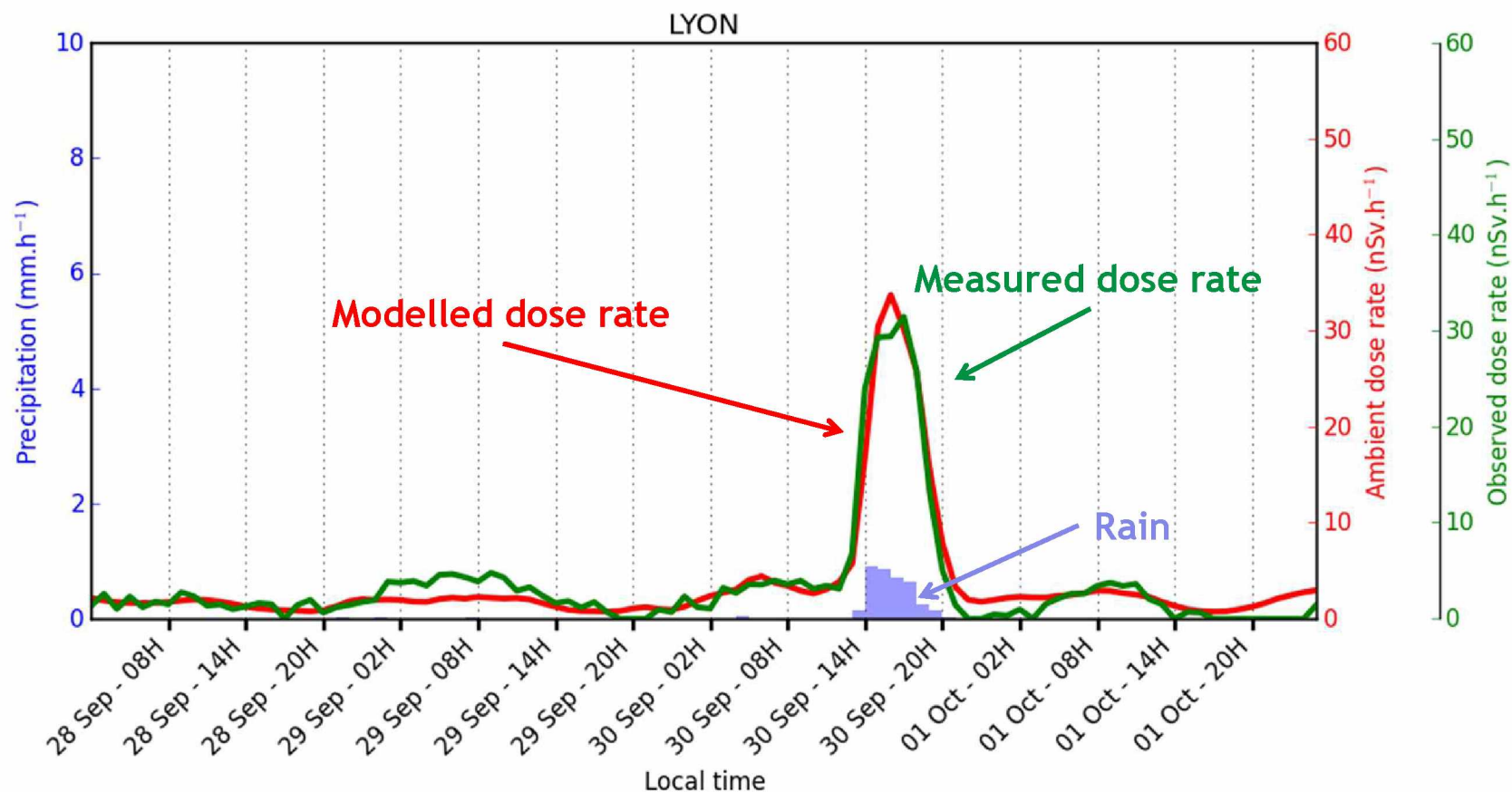
Arnaud QUÉREL

Denis QUÉLO

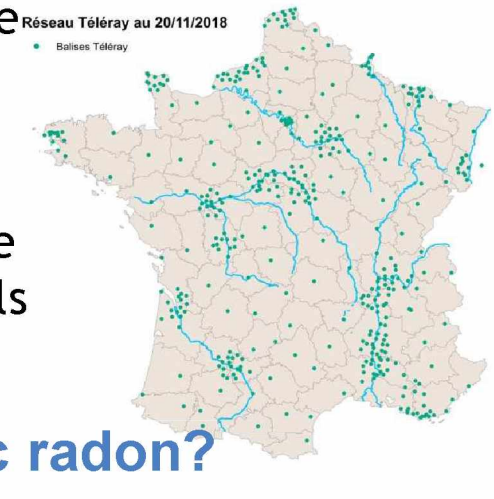
Thierry DOURSOUT

© IRSN

A preliminary study showed encouraging results...



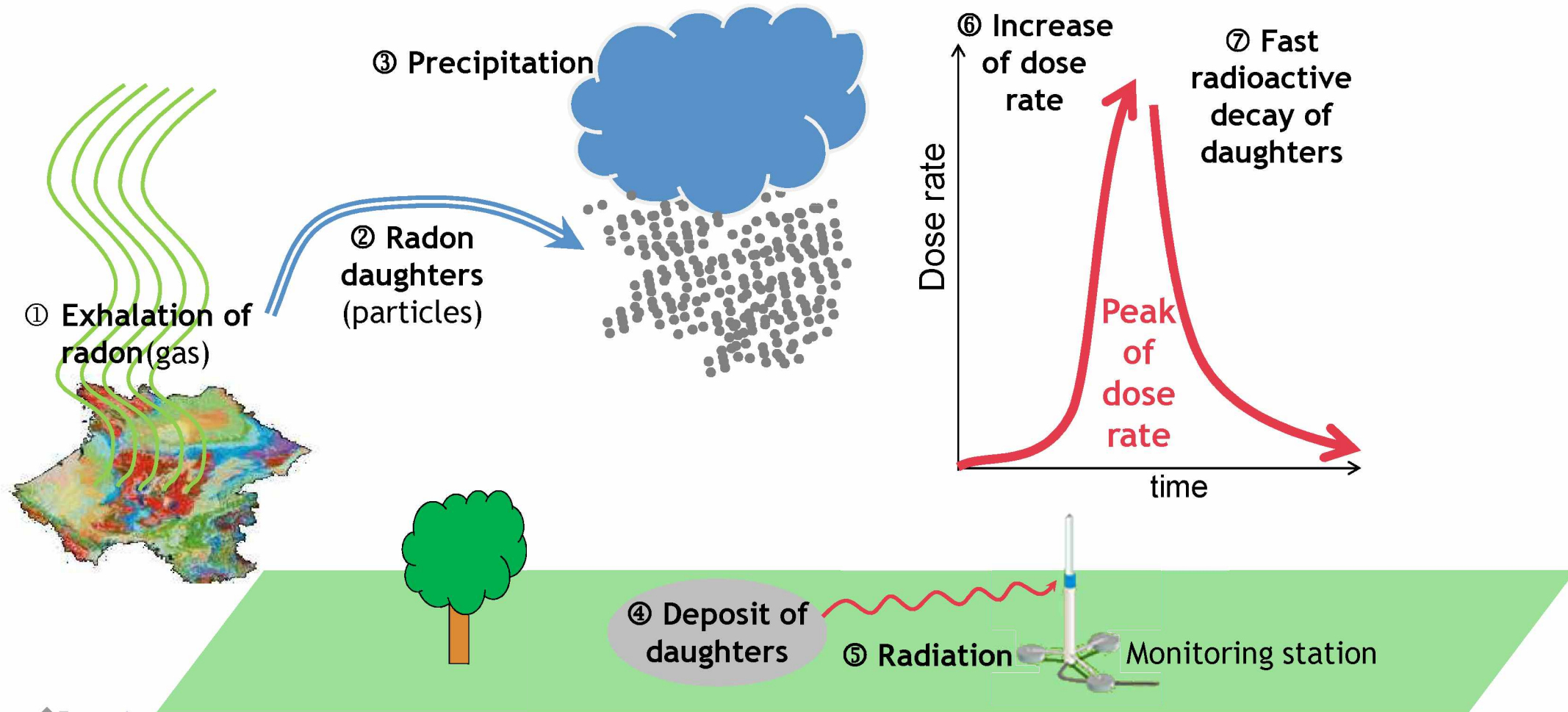
- In the event of an incident or accident involving radioactive materials, IRSN provides guidance to public authorities on the technical, public health and medical measures to be taken to protect the population and the environment.
- The monitoring network Teleray in France: Hundreds of gamma dose rate monitoring stations recording data each ten minutes all year round.
- 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 do not present any risks to 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.



Is it possible to forecast peaks due to atmospheric radon?

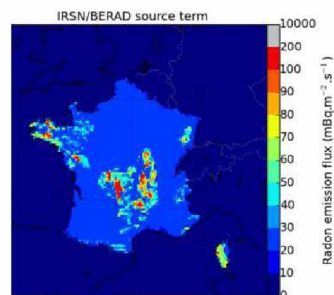


Atmospheric transport of radon

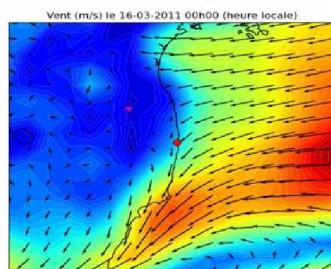


Modelling

① Exhalation of radon(gas)



① Meteorological data



① Decay chain & Chem/phys form data

② Atmospheric transport model IdX

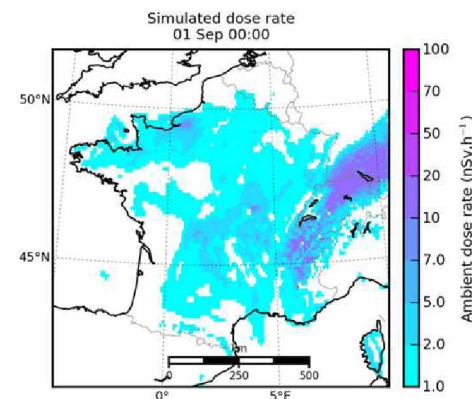
③ Dose rate computation

For each time step :

- Dose rate at ground level (2D)

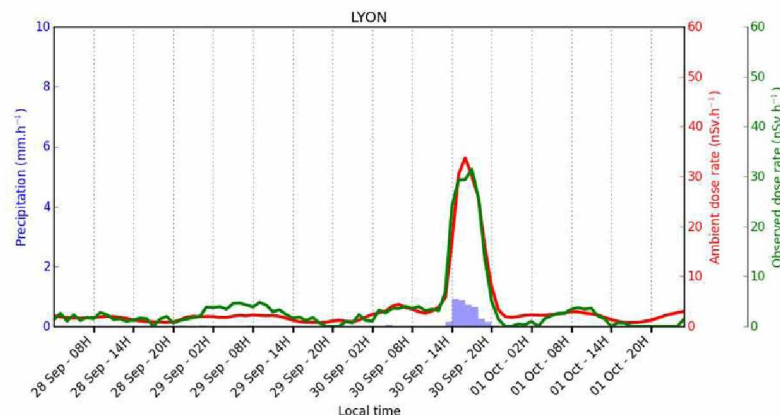
④ Outputs

■ Dose rate maps



■ Dose rate at a given location

- To be compared to the measurements



Teleray: the French monitoring network of gamma dose rate

- Hundreds of stations (~420)
- Freq : 10 min

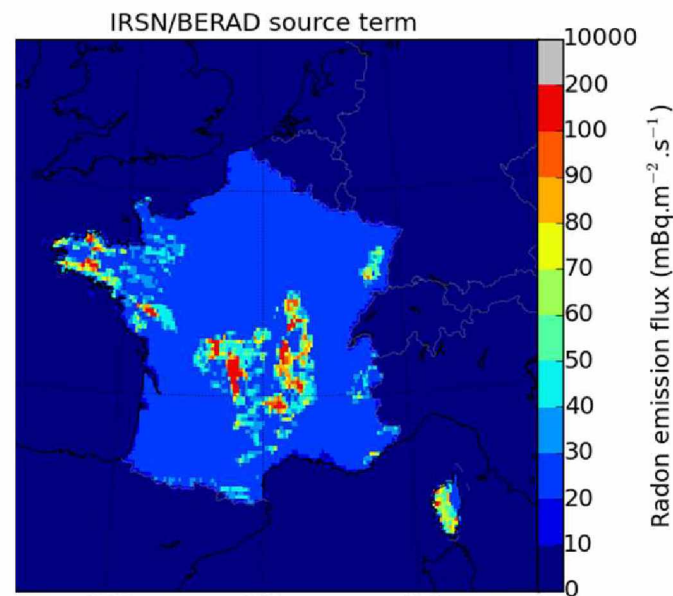
Source
termMet
dataAtmospheric
transportDose rate
assessment

Output

Observations

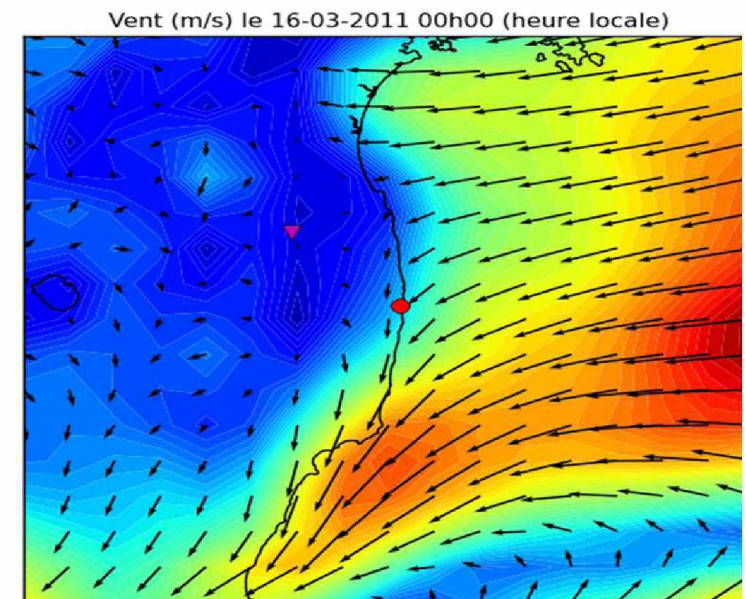
Source Term : Exhalation of radon(gas)

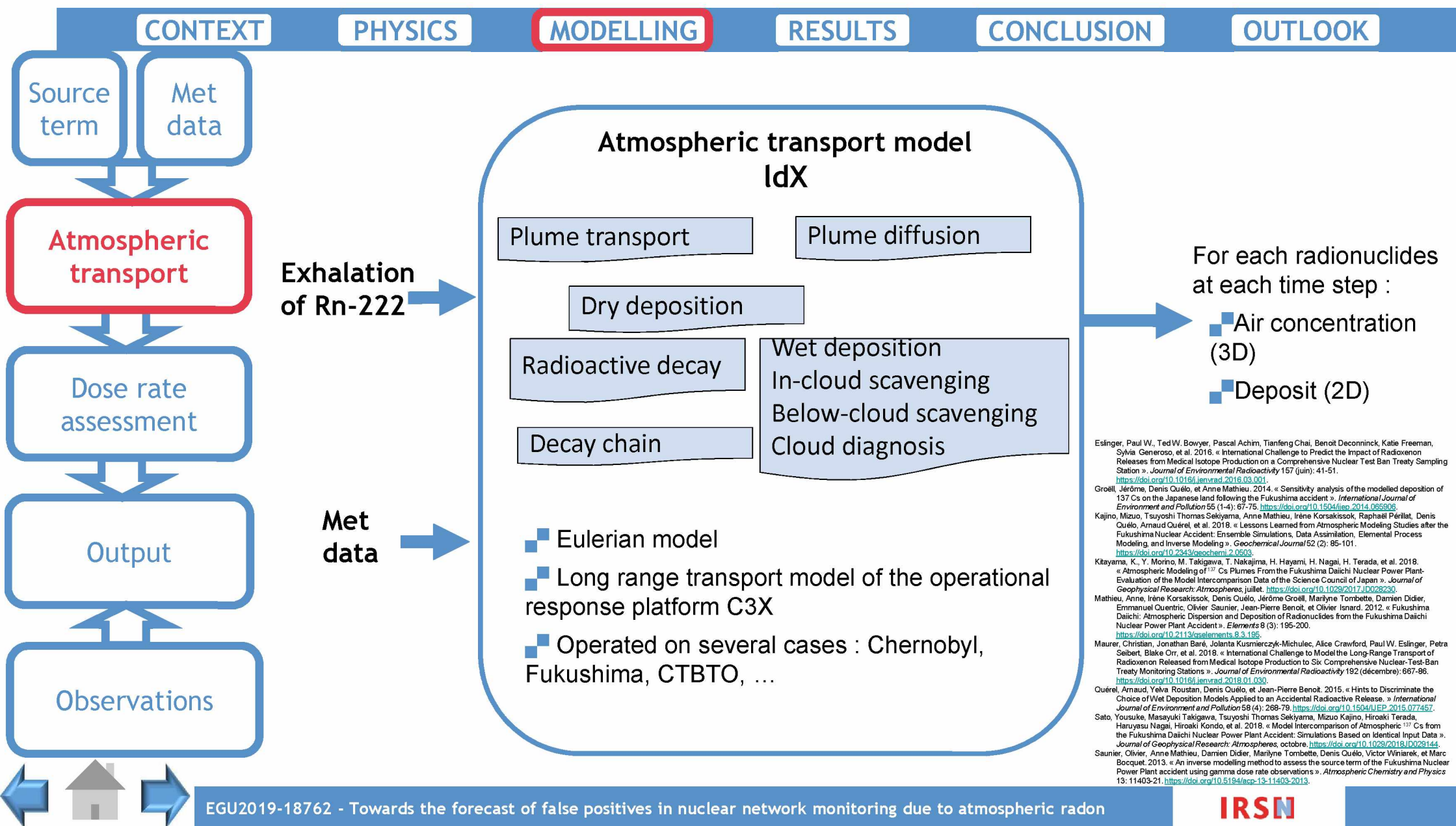
- Based on an exhalation flux of Rn-222 computed by the IRSN.
- In this study, considered constant in time

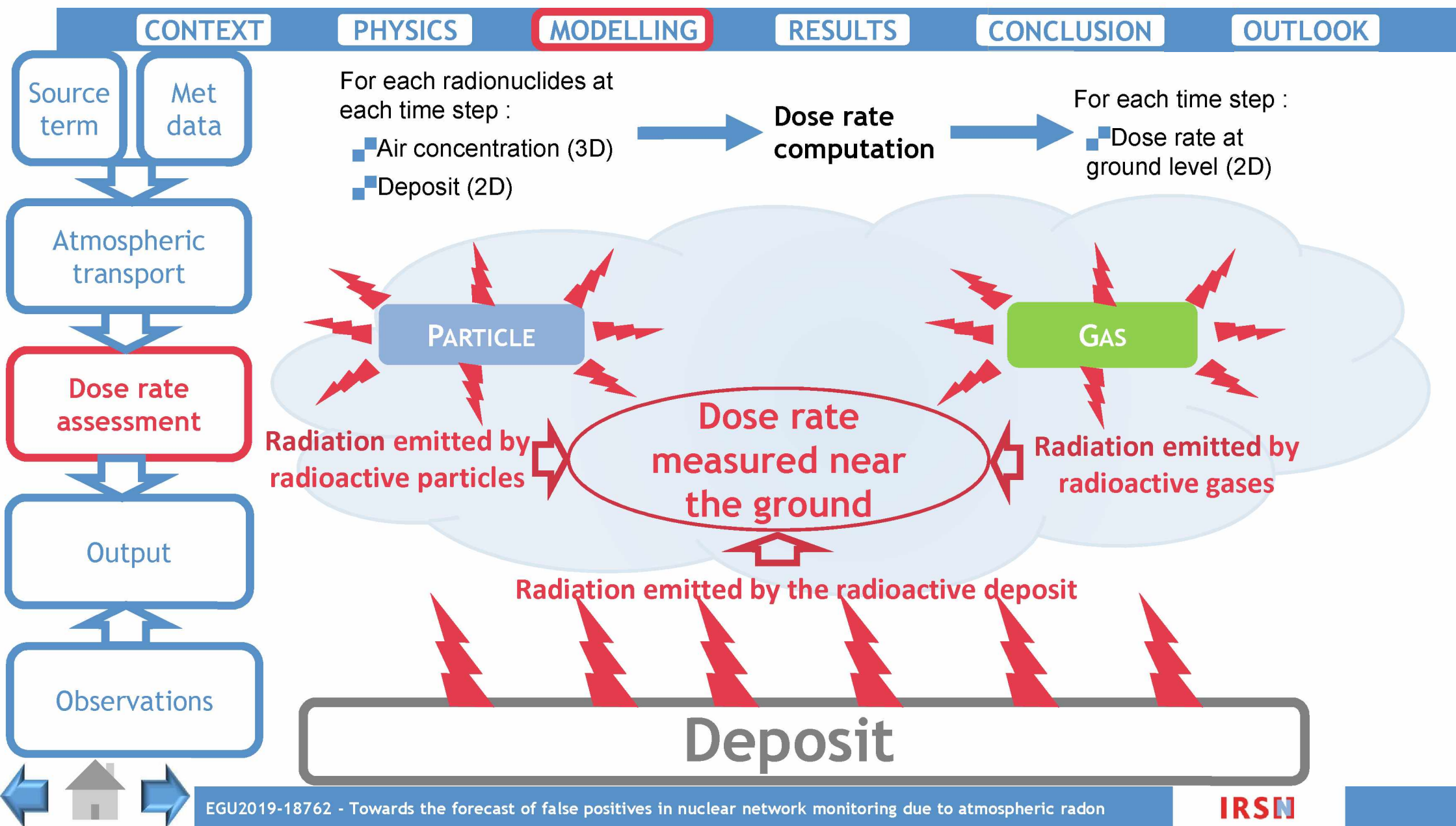


Meteorological data

- Météo-France meteorological data: **ARPEGE**
- $\Delta t: 1\text{h}$; $\Delta x = \Delta y = 0.1^\circ \approx 10\text{km}$







CONTEXT

PHYSICS

MODELLING

RESULTS

CONCLUSION

OUTLOOK

Source term

Met data

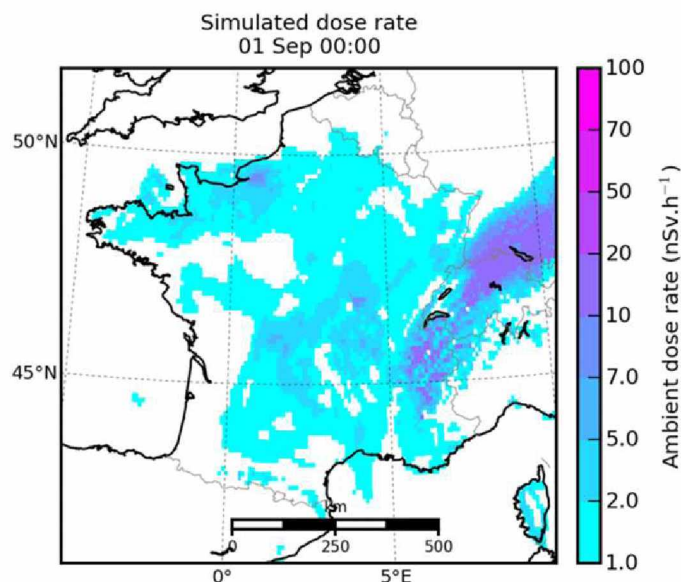
Atmospheric transport

Dose rate assessment

Output

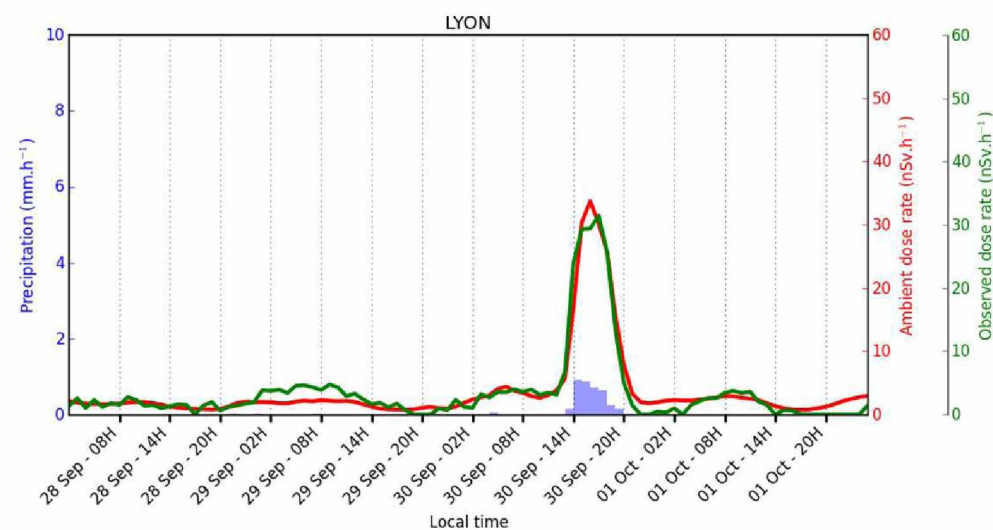
Observations

Dose rate maps



Dose rate at a given location

Compared to the local observation



CONTEXT

PHYSICS

MODELLING

RESULTS

CONCLUSION

OUTLOOK

Source
term

Met
data

Telera : the French monitoring network of gamma dose rate

- Hundreds of stations (~420)
- Freq : 10 min

Réseau Téléray au 20/11/2018

● Balises Téléray



Atmospheric
transport

Dose rate
assessments

Output

Observations



Aiguille -du-Midi

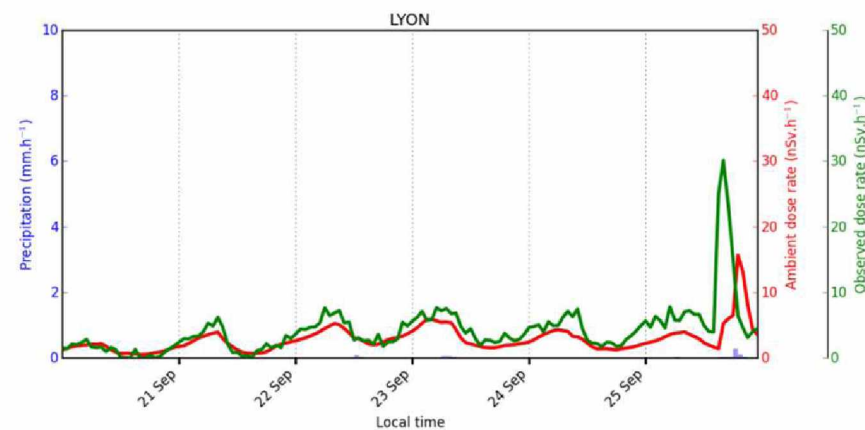
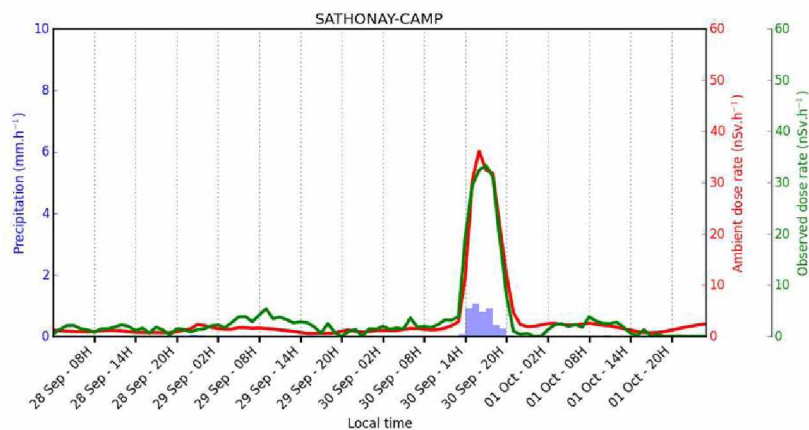


Clermont-Ferrand

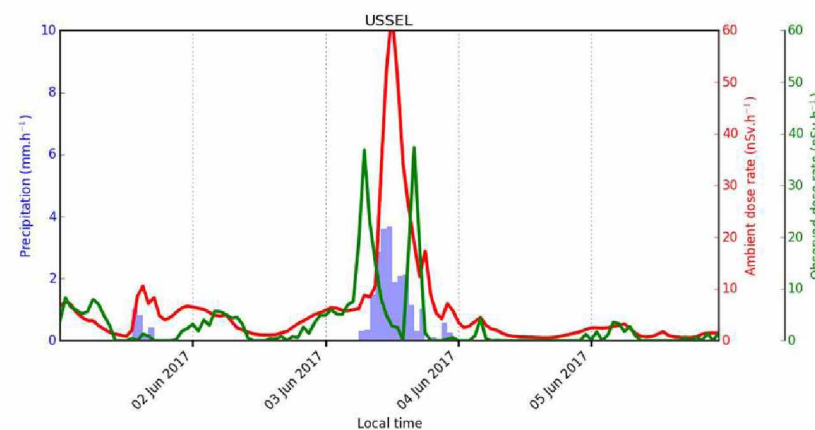
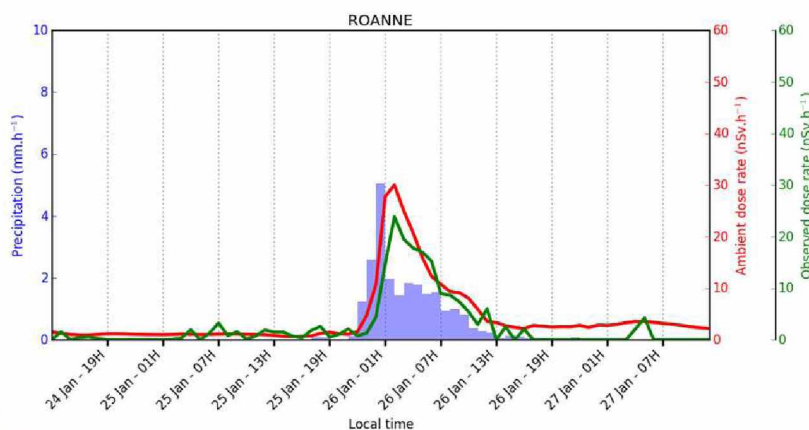
Model-to-data comparison...

Some comparisons of dose rate : **model** vs **measurements**

Some peaks are very well modelled in time and intensity



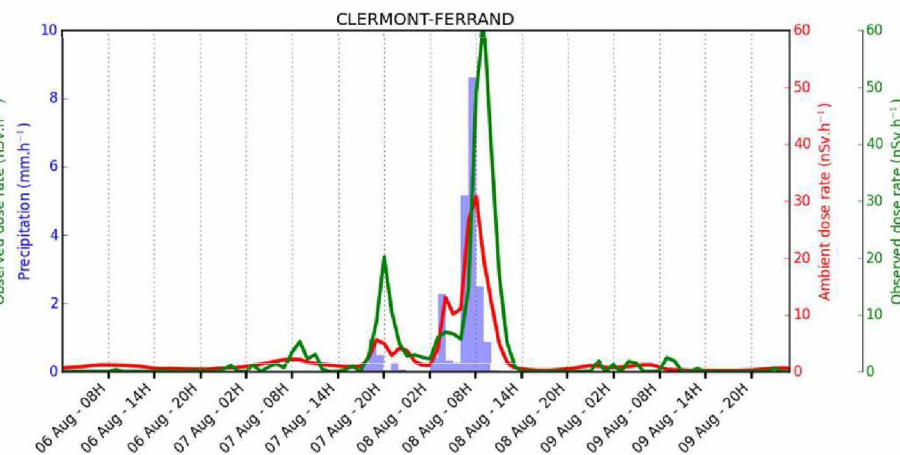
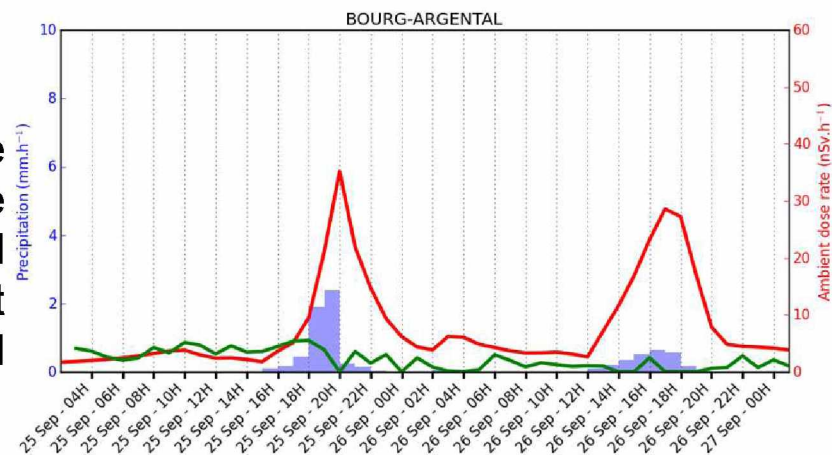
Day/night cyclic variation is correctly reproduced



Model-to-data comparison...

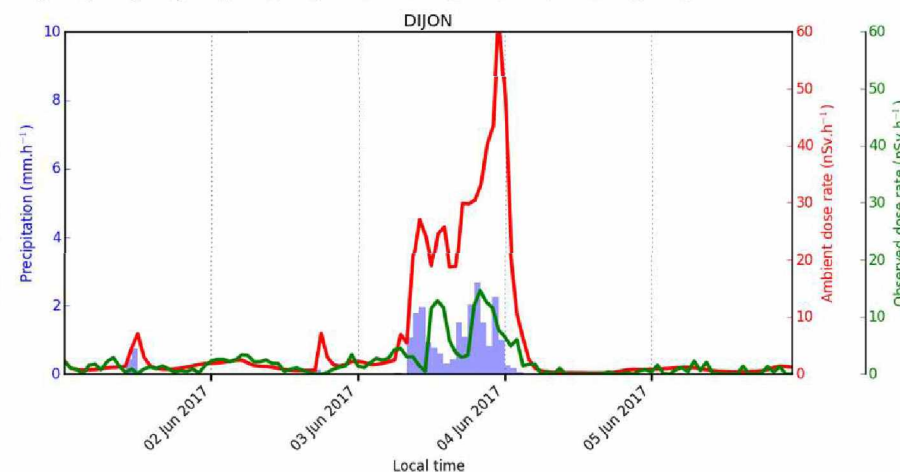
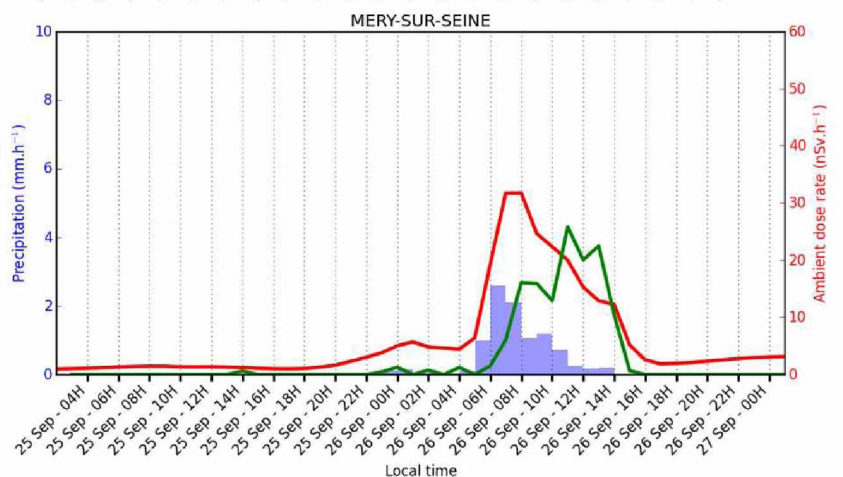
Some comparisons of dose rate : **model** vs **measurements**

Some peaks are modelled but not observed



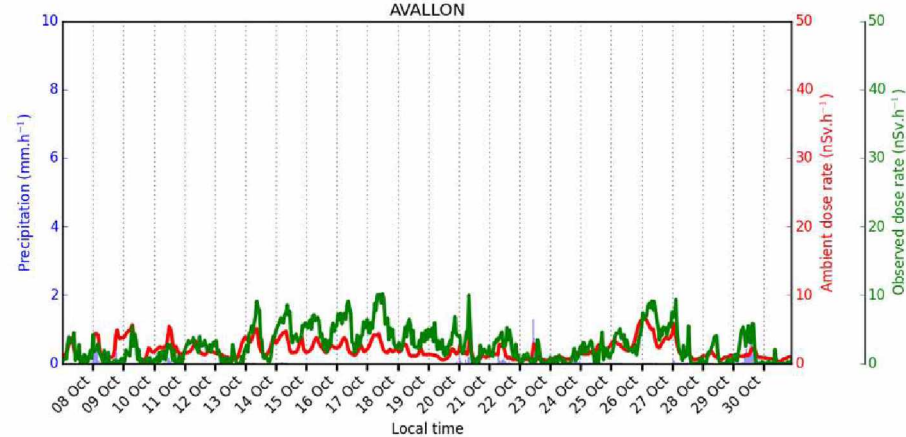
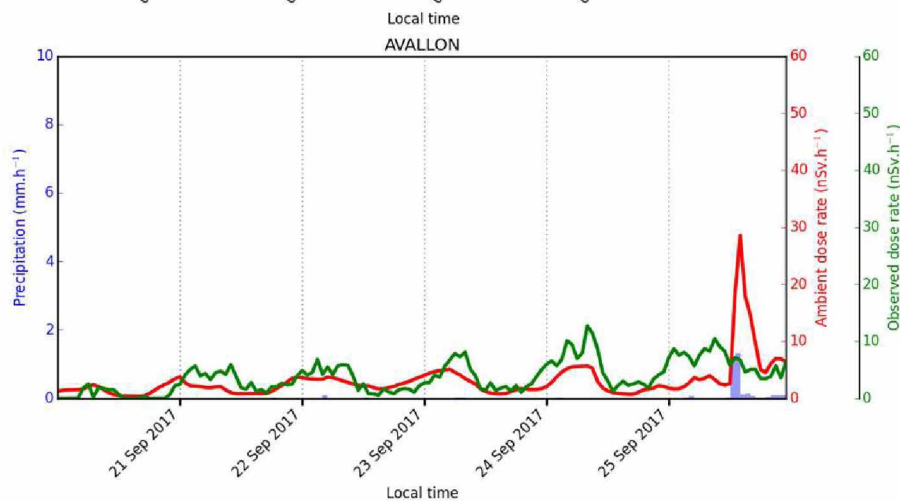
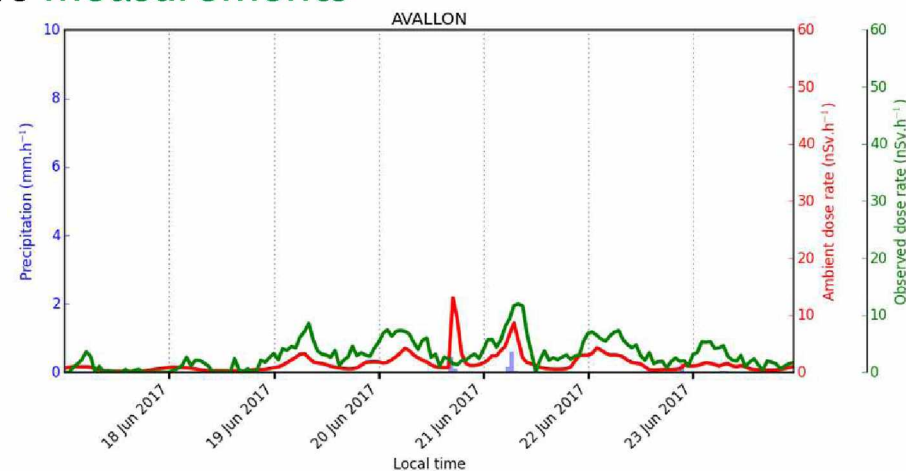
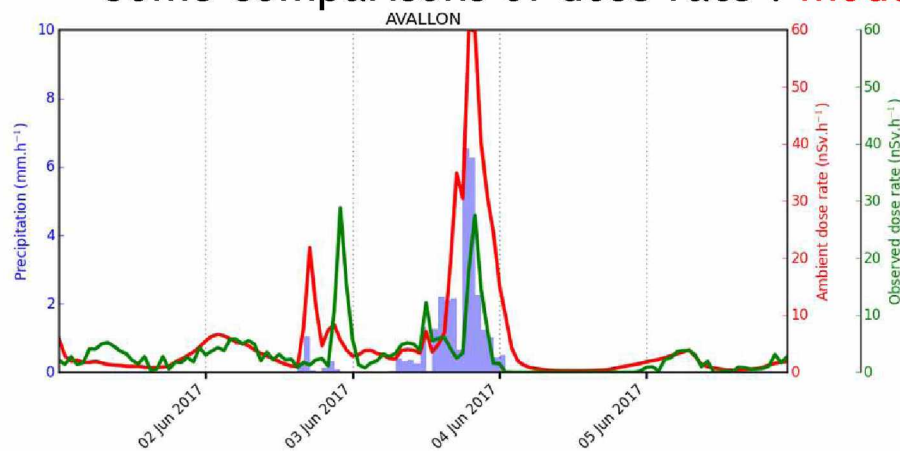
The height of the peaks can also be challenging to model

Time shifting



Model-to-data comparison...

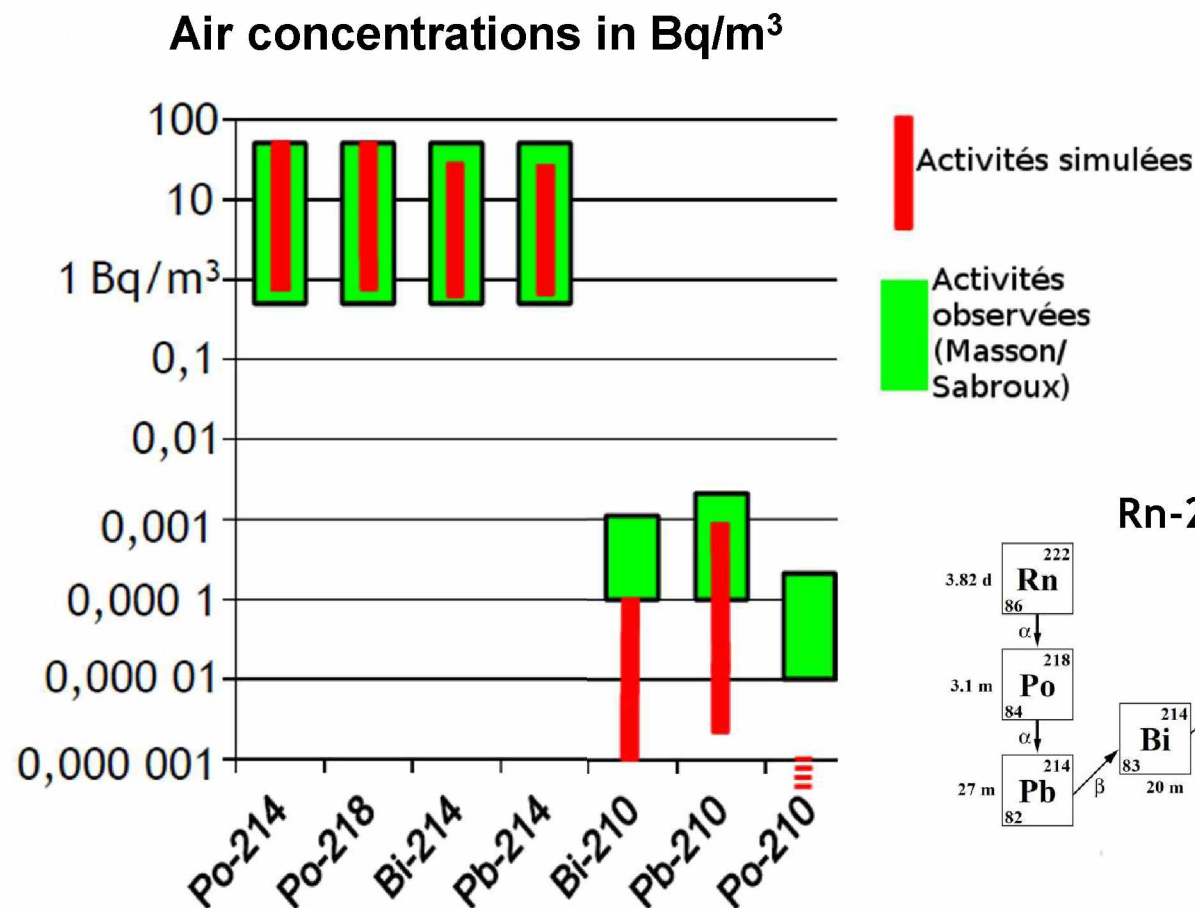
Some comparisons of dose rate : **model** vs **measurements**



Other
examples



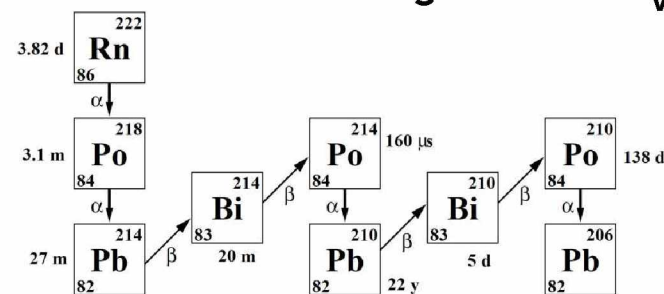
Air concentrations: order of magnitude



Modelling : Lyon
from may 2017 to
may 2018

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

Rn-222 daughters

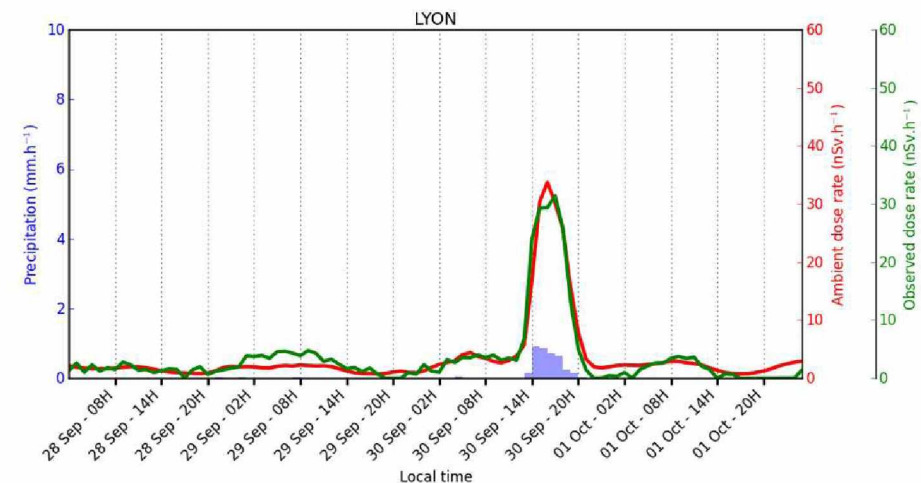


Conclusion

- This preliminary study shows encouraging results for the feasibility of atmospheric radon modelling at regional scale
- To be done...
 - more realistic source term
 - take into account radar measurements for rain events

Outputs for IRSN

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



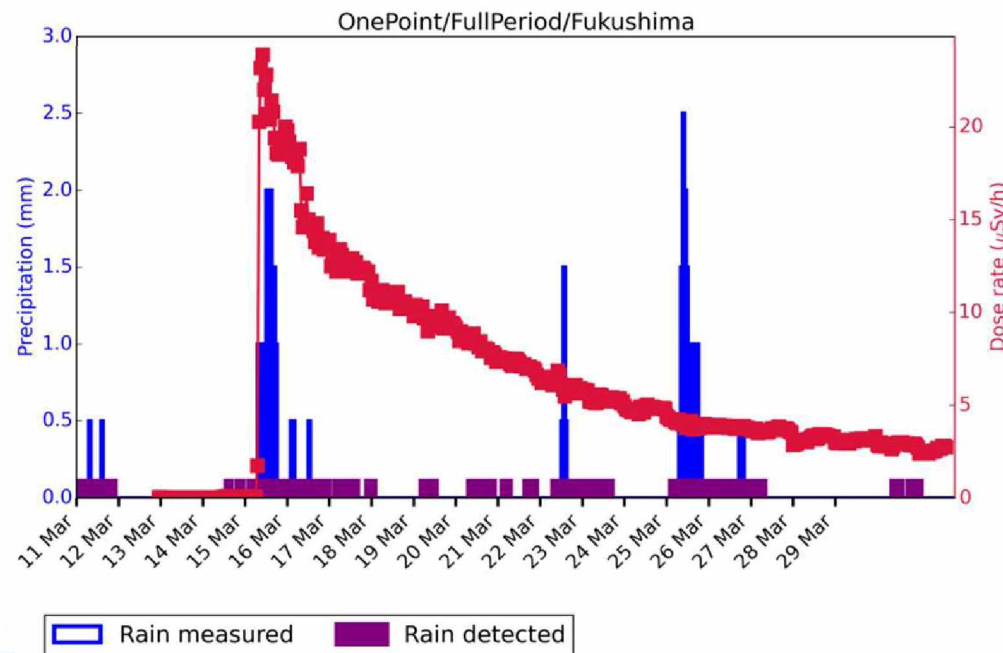
...perspectives

- Studying a large period in the past (5 years) :
statistical analysis on French monitoring network
 - Where and when is the model able to reproduce the measurements?
- Analysing of specific events
 - Case studies to fully understand recent peaks for which additional information are easy to gather (meteorological observations).
- Daily learning
 - To experience routinely the operational product chain
 - To forecast potential risk of dose rate peaks for monitoring purpose



Improve the atmospheric transport model (wet deposition modelling)

- The Fukushima accident was a privileged case study for verification of the model capability to simulate accidental releases.
- The newly available emission inventories of Radon-222, joined with a network of gamma dose rate stations, can be used as a suitable radiological case study for model validation and improvement.



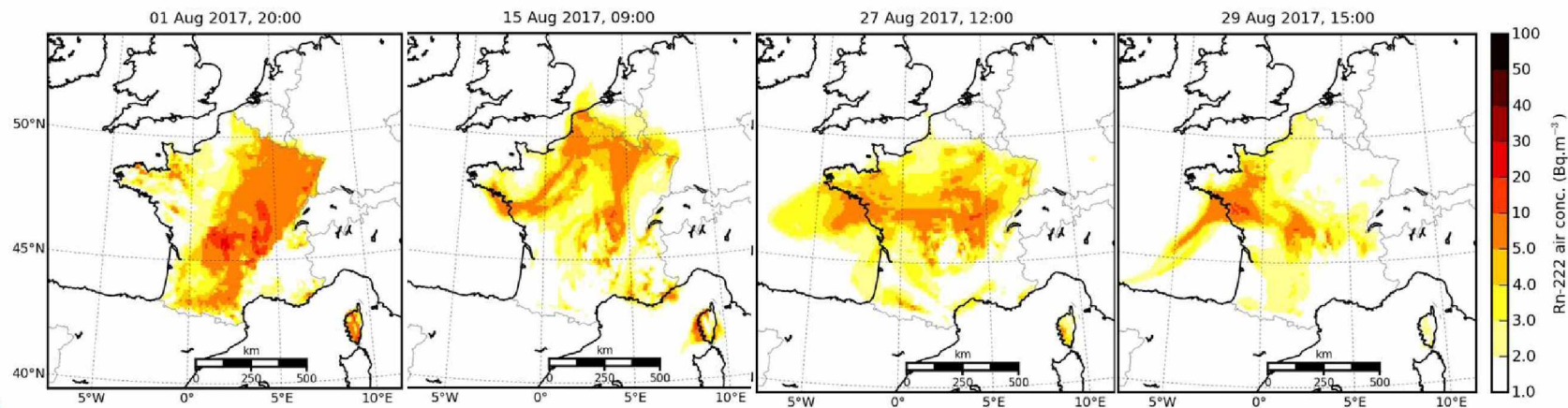
- Dose rate increase triggered by a rainfall = similarity between dose rate peaks observed during the plume passing of Fukushima and those attributed to radon daughters



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

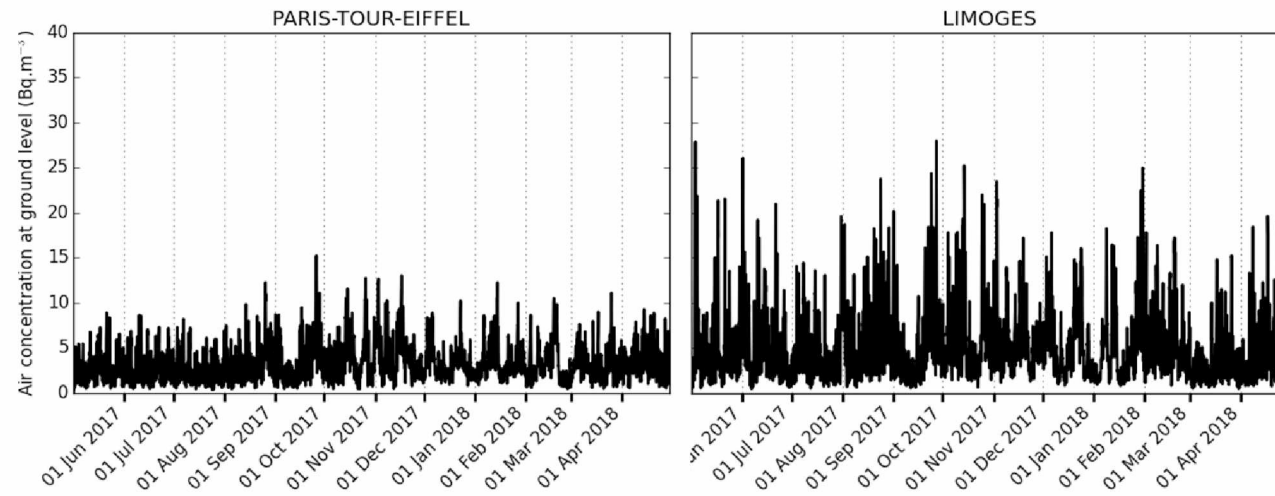
- When breathed, the radon-222 disintegrated inside the lung can damage the cells, increasing the risk of cancer.
- Radon-222 air concentration at one location is the combination of a potentially high local source - within few kilometres - and probably a long-distance origin - dozens or hundreds of kilometres.

Variability of Rn-222 air concentration at the ground-level for several times during August, 2107

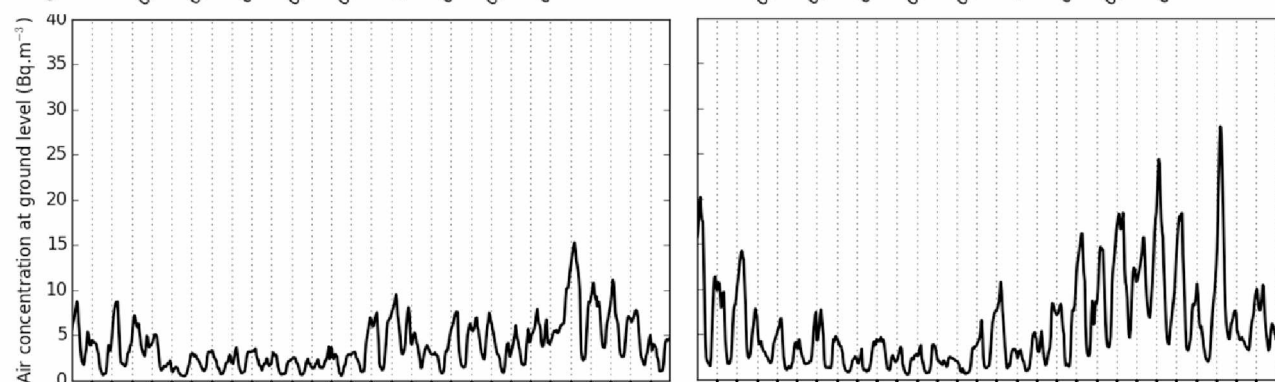


Air concentrations of Rn-222

1 year



1 month
September



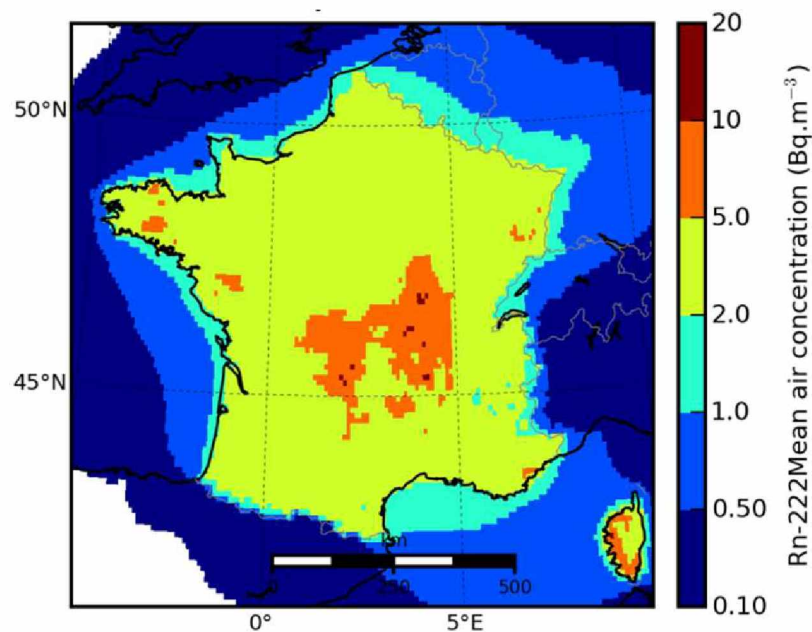
...a site with a local radon exhalation VS a remote one



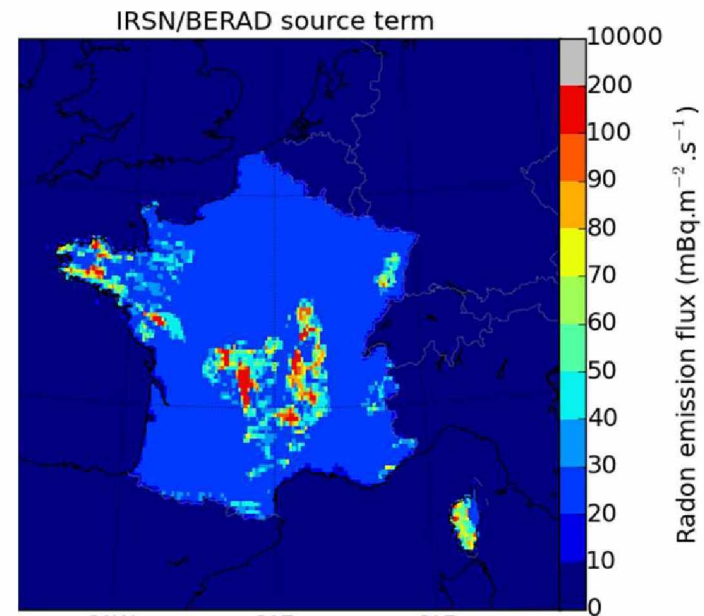
Outdoor exposure to radon: annual mean

...similar patterns

Annual mean of air concentration of Rn-222

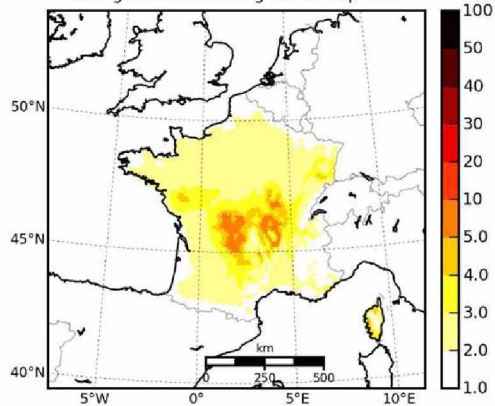


Exhalation rate of Rn-222

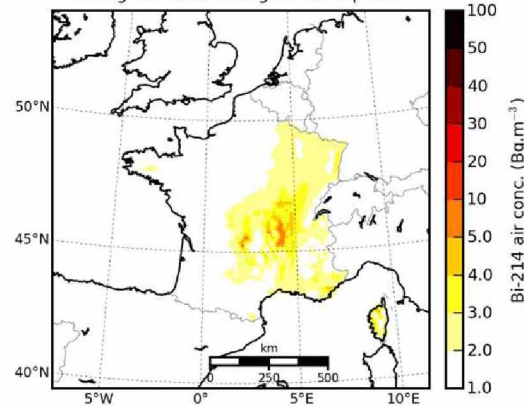


Air concentrations of Bi-214

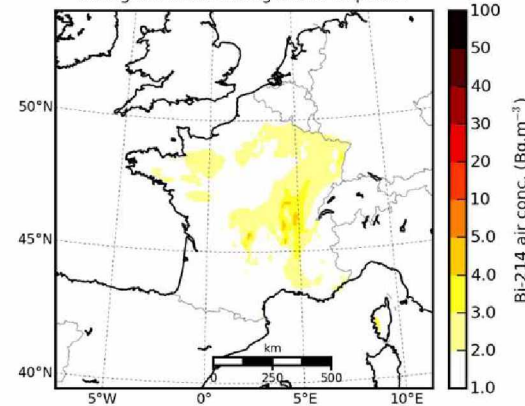
Mean air concentration
during the week ending the 03 Sep 2017



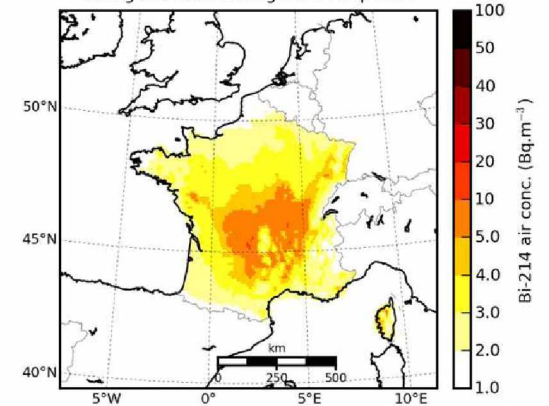
Mean air concentration
during the week ending the 10 Sep 2017



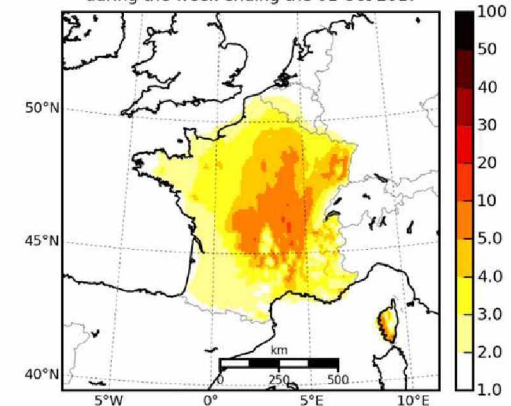
Mean air concentration
during the week ending the 17 Sep 2017



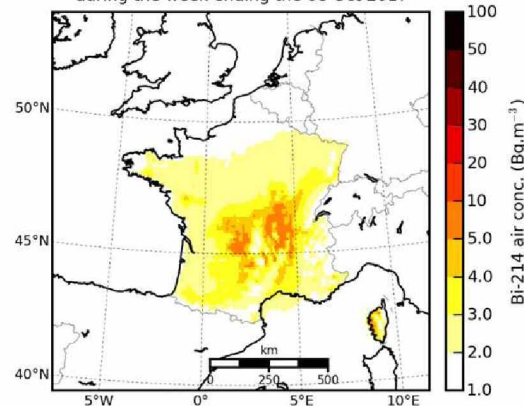
Mean air concentration
during the week ending the 24 Sep 2017



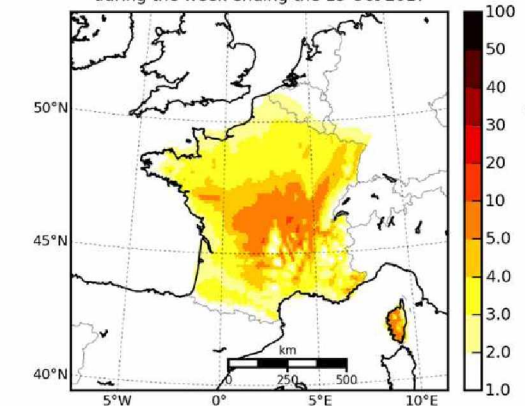
Mean air concentration
during the week ending the 01 Oct 2017



Mean air concentration
during the week ending the 08 Oct 2017



Mean air concentration
during the week ending the 15 Oct 2017



Mean air concentration
during the week ending the 22 Oct 2017

