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Wet deposition modelling capabilities investigated through a comprehensive study of dose rate peaks events due to atmospheric radon

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MEMBRE DE ETSON

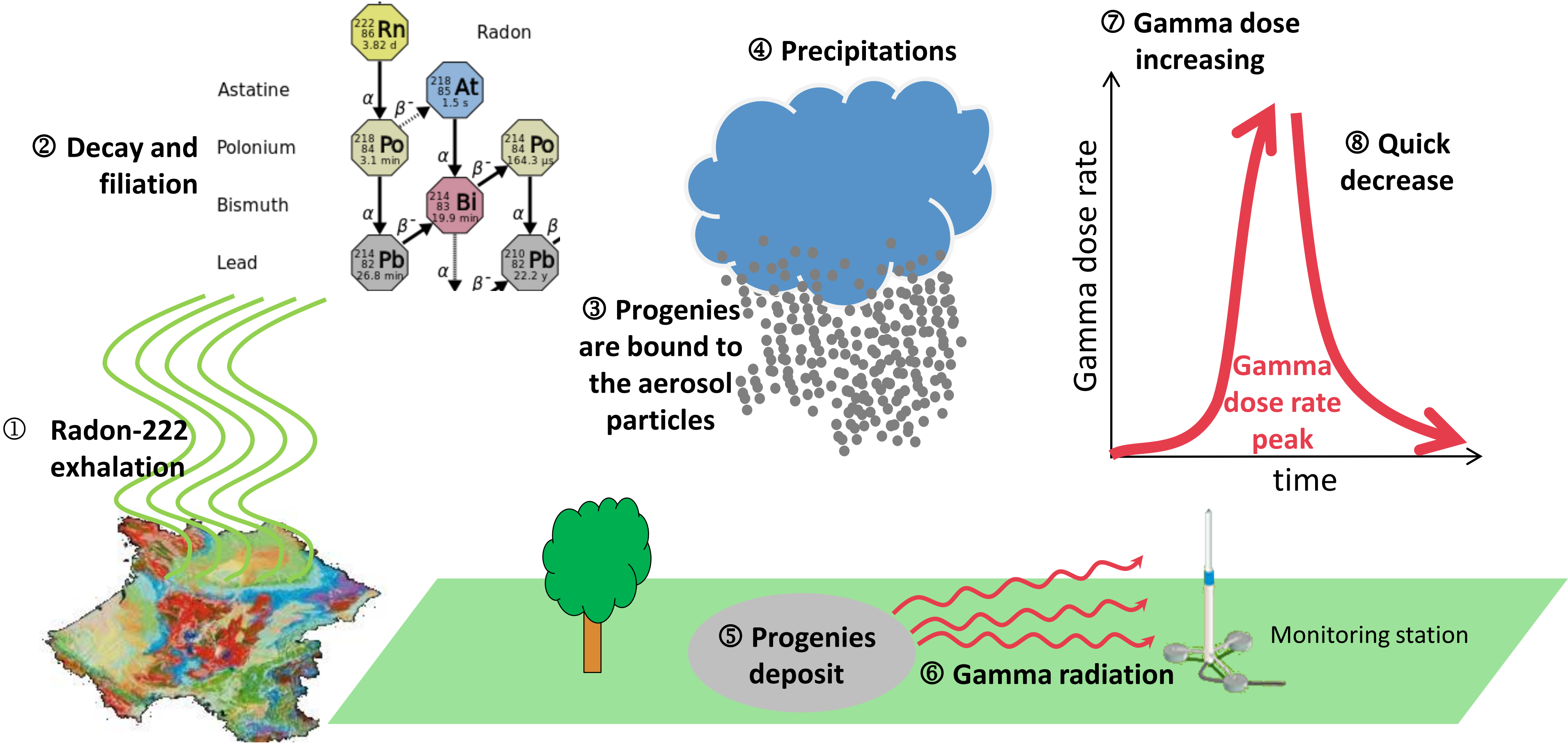
Context

- Difficulties in validating atmospheric transport models (ATM) dedicated to radionuclides for a large diversity of meteorological conditions.
  - Due to the (fortunately) lack of cases of study

- Difficulties in validating wet deposition schemes.

- Atmospheric radon could be **dependable** for the ATM validation and the domain of validity of the model.
  - Frequent phenomenon
  - Easily observable
  - Subject to the wet deposition

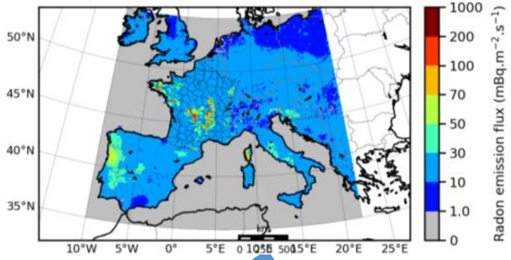
Physics of the atmospheric radon



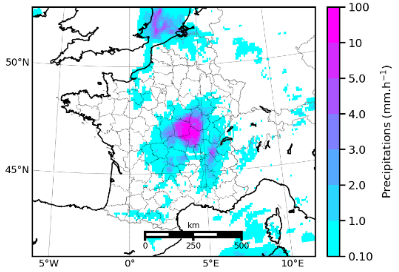
Modelling the atmospheric radon

Exhalation of radon

(Karstens et al 2015 + Ielsch et al 2017)



Meteorological data



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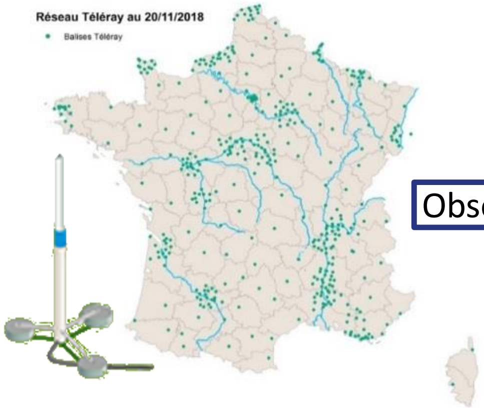
Physical properties (decay chain, phys. form, …)

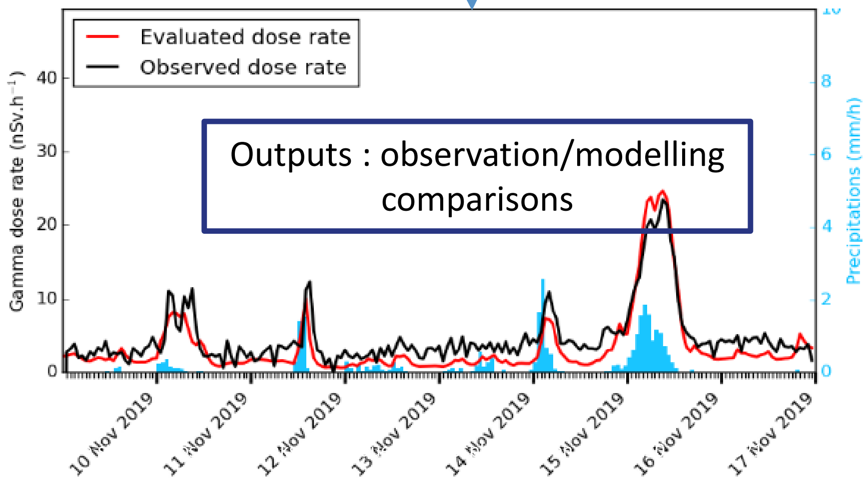
Atmospheric transport modelling (IdX, part of C3X, Groëll et al., 2014)

Including in-cloud and below- cloud scavenging

Dose rate modelling



Observations

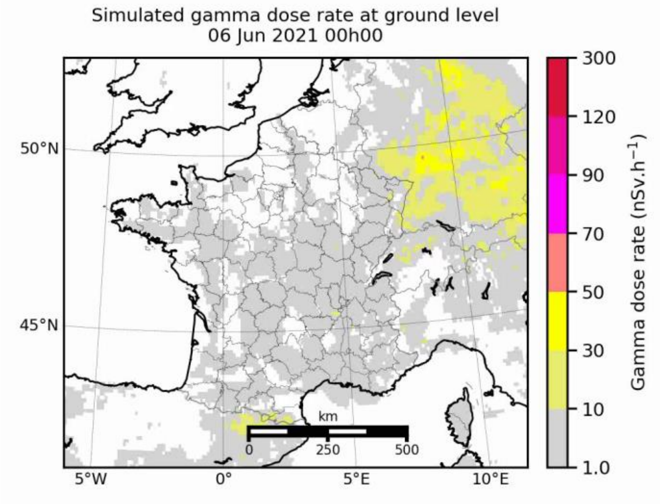


Outputs : observation/modelling comparisons

Model validation

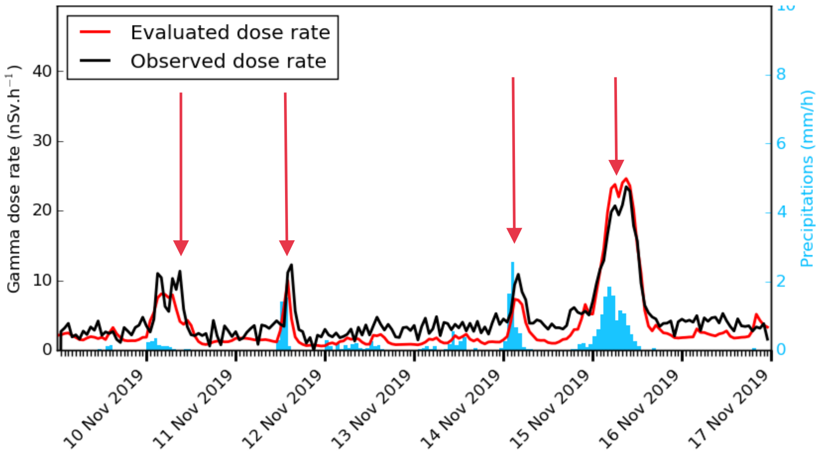
- Gamma dose rate peaks > 50 nSv/h: from 0 to 15 events per month

- Gamma dose rate peaks > 10 nSv/h: more than 1000 events per month



Example of gamma dose rate simulation

Gamma dose rate observed and modelled

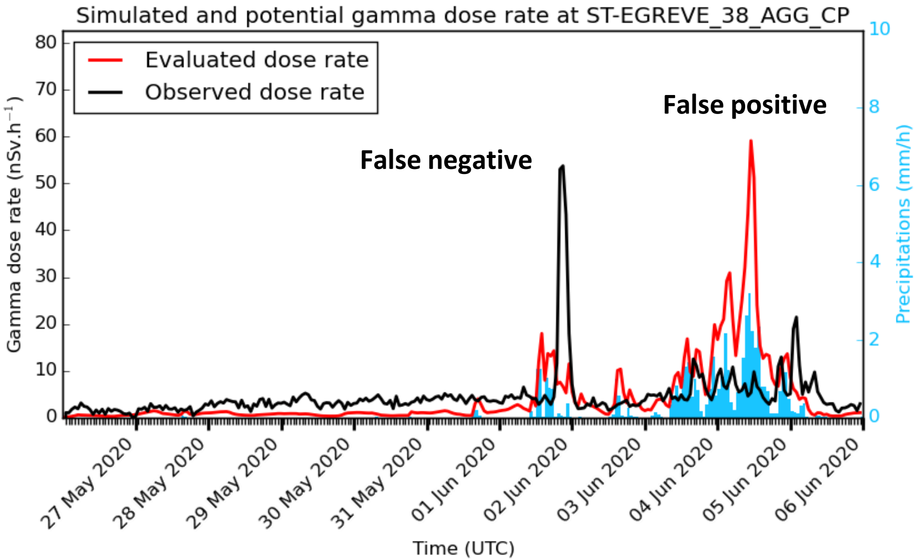


Four peaks greater than 10 nSv/h on this example

Methodology

[TO IDENTIFY THE FAILURE MODE → TO IMPROVE THE ATM OR TO KNOW ITS LIMITS

- Failures can be false negative or false positive.
- A false negative is a case where a gamma dose rate peak is observed but not simulated.
- A false positive is a case where a peak is simulated but not observed.

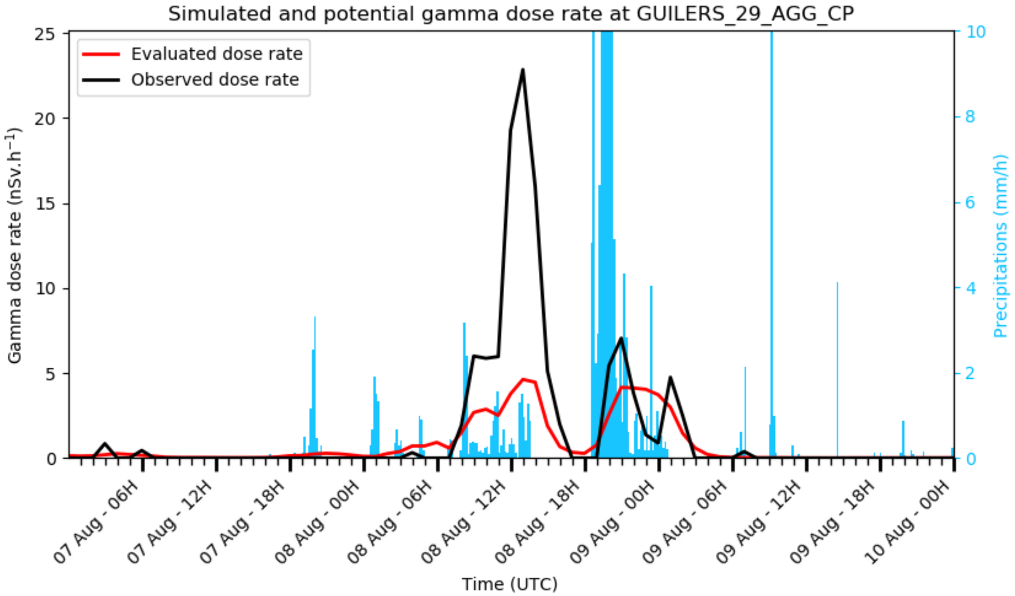


Time series at St-Egreve (near Grenoble, Alpes).

[3 FAILURES EXAMPLES ARE NOW STUDIED

Case 1. Guilers, Brittany: an atmospheric transport issue

- False negative in Guilers, near Brest in France, the 8th August 2019
- The peak reaches 23 $nSv.h^{-1}$ but the simulated value does not exceed 5 $nSv.h^{-1}$.

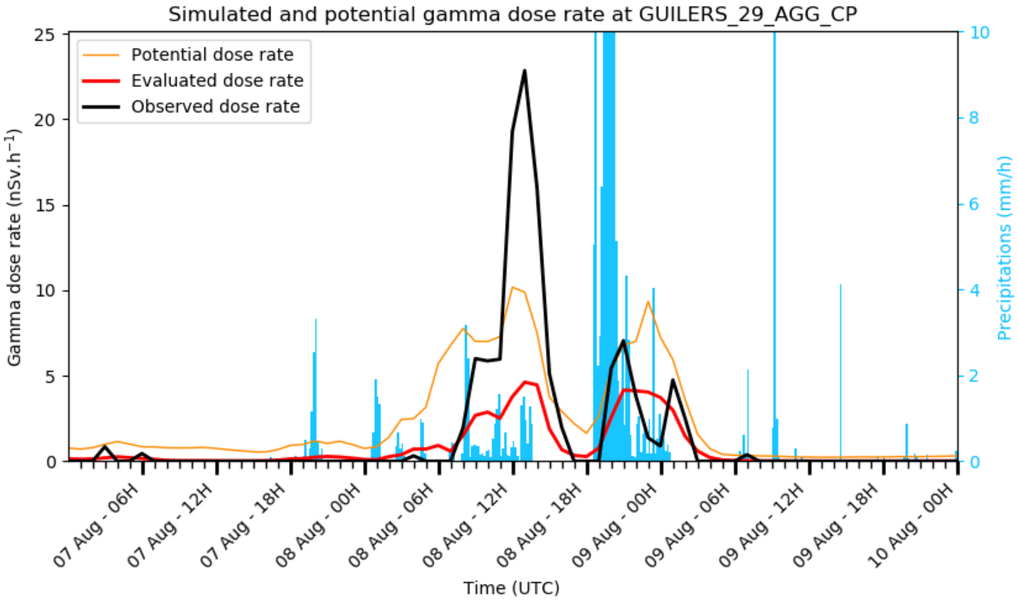


Case 1. Guilers, Brittany: an atmospheric transport issue

- In the simulation, even by scavenging all the radon progenies (the yellow curve), the gamma dose rate do not reach the gamma dose observed.
  - The issue is not the lack of precipitation or a wet deposition scheme weakness.

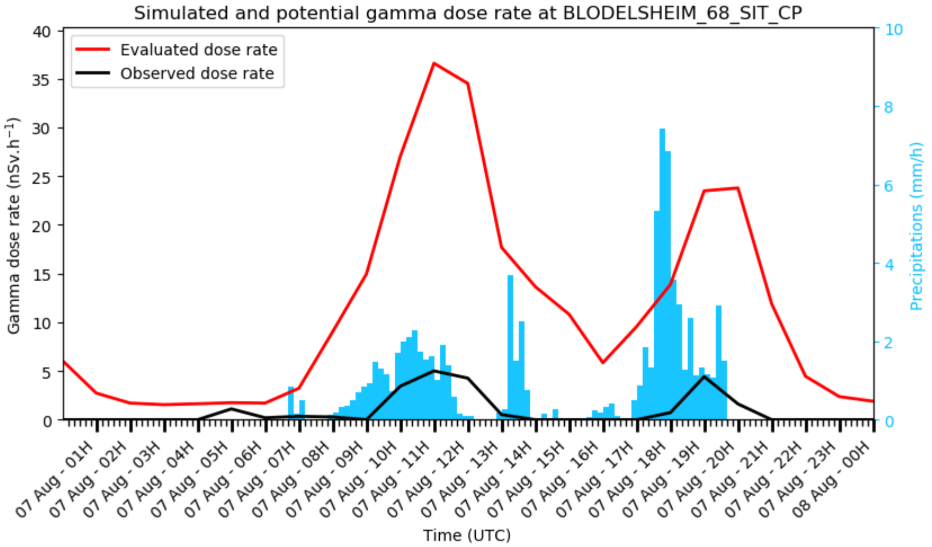
- False negative probably due to a lack of radon concentration in the atmosphere:
  - Galicia is a region known for its high radon exhalation rate (López-Coto et al. 2013).
  - x5 on radon exhalation over Spain brings enough radionuclides to fit the observation.

THE GUILERS FALSE NEGATIVE WAS POSSIBLY CAUSED BY EXHALATION UNDERESTIMATE



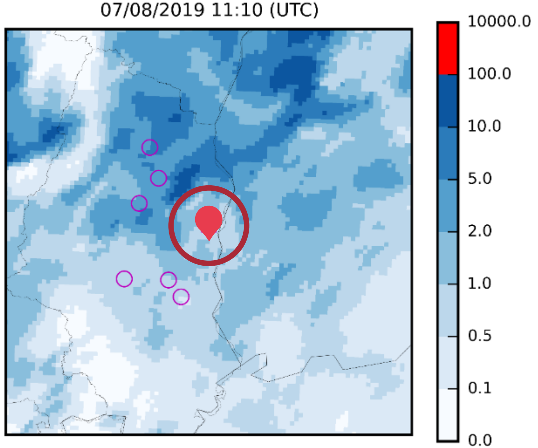
Case 2. Blodelsheim, Grand Est: probably a precipitation issue

- False positive at Blodelsheim, East of France, the 7th August 2019.
- The simulated peak reaches 37 $nSv.h^{-1}$ but the observed value does not exceed 5 $nSv.h^{-1}$.
- The event occurred during a summer thunderstorm.

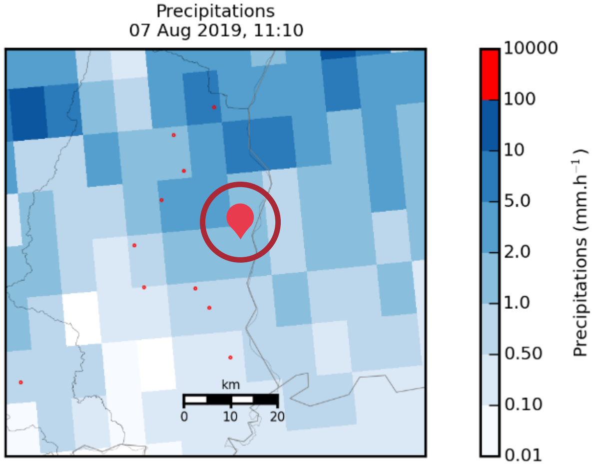


Case 2. Blodelsheim, Grand Est: probably a precipitation issue

- The downgrading of the radar data to the NWP model resolution.



a) Precipitations with a 1 km resolution (radar obs.).

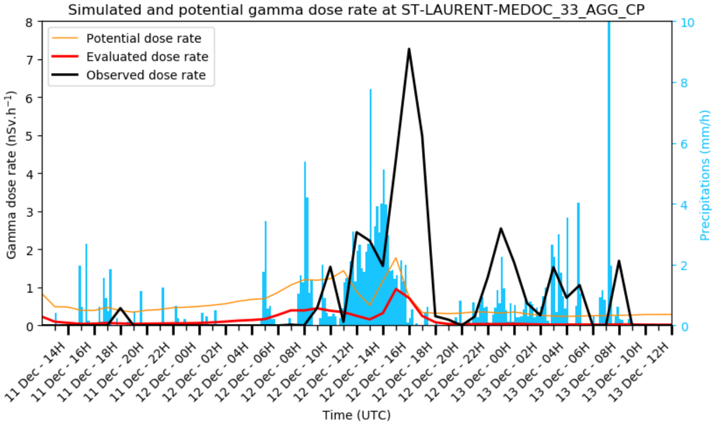


b) Precipitations with a 10 km resolution (ARPEGE NWP).

BLODELSHEIM FALSE POSITIVE WAS PROBABLY DUE TO A RAINFALL MISREPRESENTATION

St-Laurent-Médoc, Nouvelle-Aquitaine: where ensemble of simulations could be useful

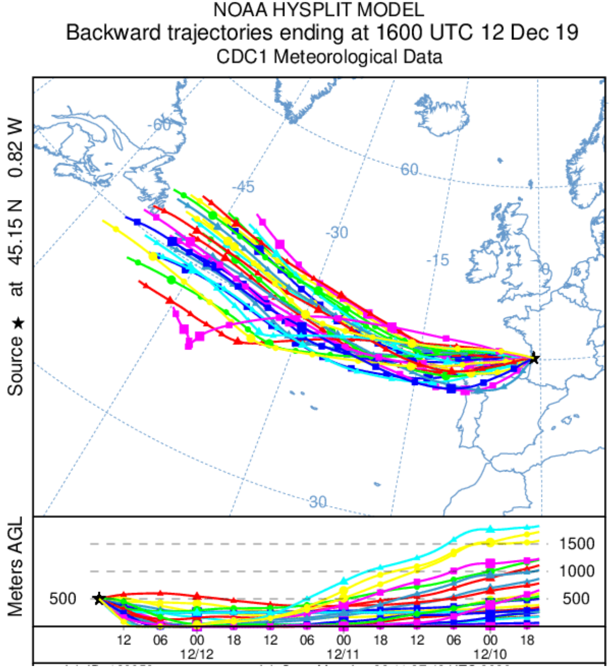
- A false positive in Saint-Laurent-Médoc, near Bordeaux in France the 12th December 2019.
- The peak reaches 7 $nSv.h^{-1}$ but the simulated value does not exceed 1 $nSv.h^{-1}$.
- Even by scavenging all the radon progenies in the atmosphere, the gamma dose rate does not reach 1 $nSv.h^{-1}$ (the yellow curve in Figure 8, labelled Potential dose rate).
- The HYSPLIT/GDAS backward trajectories also do not show a passage over Spain before reaching the French coast.



St-Laurent-Médoc, Nouvelle-Aquitaine: where ensemble of simulations could be useful

- Using an ensemble of trajectories, it seems that some of them came indeed by the North-West of Spain before reaching the monitoring station.

- The deterministic meteorological simulation was not able to catch the proper advection field.



[AN ENSEMBLE OF SIMULATIONS CAN BE USEFUL TO UNDERSTAND A RADIOLOGICAL EVENT.

Conclusion

[SUMMARY

- The atmospheric transport modelling of the radon-222 and its short-lived progenies is a good alternative for the validation of ATM dedicated to radionuclides dispersion in accidental context.

- To validate the wet deposition processes we need good input data (met data & exhalation).

[OUTLOOK

- The next step will be to statistically estimate the extent of these failures and to evaluate the potential improvements.
  - Study on the wet deposition scheme
  - Study on the vertical diffusion

- Evaluation also done directly with Rn-222 air concentrations.