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Protecting People and the Environment

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International Panel Discussion on Radionuclide Sources and Migration in the Subsurface

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Carbon 14 (^{14}C) and tritium (^{3}H) transfers in grassland around AREVA La Hague nuclear recycling plant: from the atmosphere to the groundwater

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Why studying ^{14}C and ^{3}H (1/2)?

- **Carbon 14 and tritium are substantially released in the atmosphere around:**
  - Nuclear Power Plants (NPP);
  - Nuclear Recycling Plant (NRP).

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Why studying ^{14}C and ^{3}H (2/2)?

- **Still significant uncertainties on ^{14}C and ^{3}H:**
  - sampling and measurement;
  - evolution of the chemical form in the atmosphere, vegetation, soil and groundwater;
  - quantification of dry and wet deposition;
  - quantification of Organically Bound Tritium (OBT).

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The VATO project : VAlidation of TOcatta model

- **To estimate ^{14}C and ^{3}H fluxes in a grassland ecosystem (*raygrass sp.*, soil and groundwater in both saturated and unsaturated zones), in relation with:**
  - evolution of air concentrations (day versus night);
  - weather conditions;
  - land use (grazing, maïze silage and hay).
- **To study ^{14}C and ^{3}H transfers to cows and cowmilk as a function of the diet.**

In order to validate the TOCATTA model.

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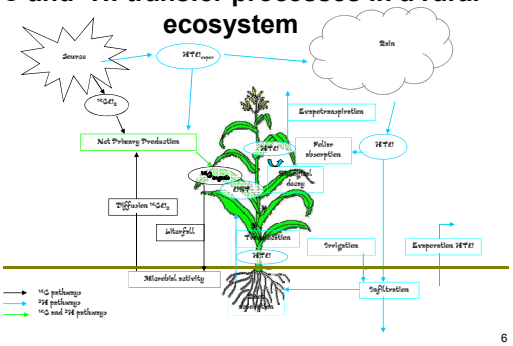
^{14}C and ^{3}H: transfer processes in a rural ecosystem



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TOCATTA conceptual model

- **Atmospheric and/or liquid releases.**
- **Main environmental media: agricultural systems (groundwater, soil, plant and animals).**
- **Multiple source term kinetics: <u>normal and accidental modes.</u>**
- **Temporal scales:**
  - daily time step;
  - during one or several years.

This model assumes a steady state with constant ratios, $^{14}C/C$ and $^{3}H/H$, between all compartments.

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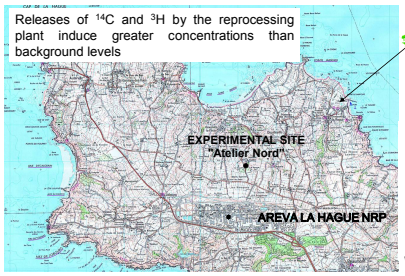
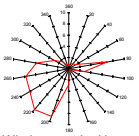
VATO project: *in situ* lab





Wind rose at La Hague

"Atelier Nord": a well located experimental site, considering the most frequent wind directions

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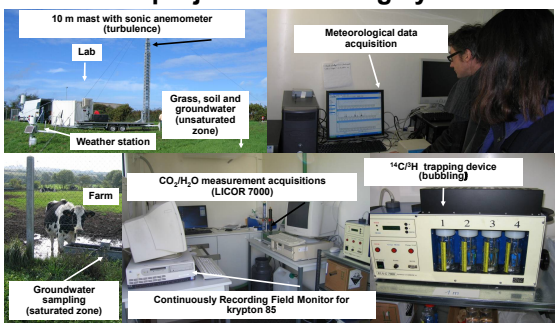
VATO project: monitoring system



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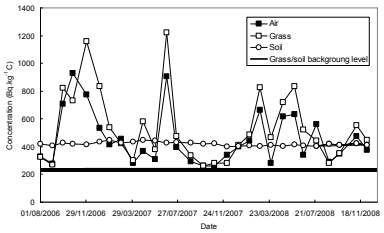
^{14}C concentrations in air, grass and soil



- **Great fluctuations of the signal in the air and the grass due to the wind direction and the operation of the facility.**
- **No fluctuation in soil due to a poorly reactive pool of organic matter.**

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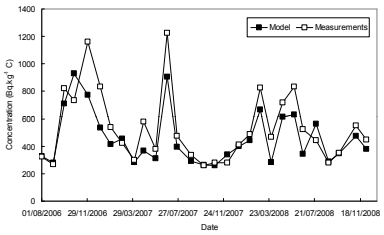
^{14}C in grass: model versus measurements



- **Calculated values are lower (up to 40%) than measured concentrations.**

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The origin of the model underestimation?

- **The model is based on a steady state with constant ratios between all compartments:**
  - For example, there is no difference whether a release occurs during the day or during the night.
- **In other words, the model is better adapted for chronic releases than for <u>accidental releases.</u>**

A new model (PASIM ^{14}C, ^{3}H) is being built. It will take into account the vegetal physiology.

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Conclusion

- **The new model still needs further adaptations to take into account the changes in radionuclide releases and weather fluctuations. An hourly time-step is required:**
  - to simulate photosynthesis: carbon 14 cycling;
  - to simulate water exchange: tritium cycling.
- **In order to evaluate the concentration of ^{14}C and ^{3}H (HTO, OBT) in the different compartments of rural ecosystem, from the atmosphere to the groundwater *via* grassland.**

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Planning

- **Carbon 14:**
  - 2006-2009: transfers between air, grass and soil ;
  - 2009-2010: transfers to cattle ;
  - 2009-2010: model/measurements comparison ;
  - 2010-2011: model fine-tuning.
- **Tritium:**
  - 2011-2013: transfers between air, rain, grass, soil and groundwater (two levels);
  - 2013-2014: transfers to cattle ;
  - 2013-2014: model/measurements comparison ;
  - 2012-2014: model fine-tuning.

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Thank you for your attention

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