TRANSFER STUDY OF $^{14}$C and $^3$H BETWEEN AIR, GRASS AND COWS: VALIDATION OF TOCATTTA MODEL (VATO)

Denis MARO$^1$

Séverine Le Dizès$^2$ & Didier Hébert$^1$

$^1$IRSN/Laboratory of Continental Radioecology/Cherbourg-Octeville
$^2$IRSN/DEI/Environmental Modelling Laboratory/Cadarache, St-Paul-lez Durance

IRSN / DEI / SECRE (France)
Context

- Uncertainties in transfer models of $^{14}$C and $^3$H in rural environment in case of accidental release due to a lack of global experimental data.

- In general transfer models are based on constant isotopic ratio and this concept is not very appropriate with accidental releases.

Necessary to acquire well-documented new data of concentrations of $^{14}$C and $^3$H in different compartments of the rural environment.
Objectives

- Estimate fluxes of $^{14}$C and $^3$H in a grassland ecosystem (Raygrass), in relation with:
  - $^{14}$C and $^3$H concentrations in air,
  - Climate conditions,
  - Land use (grazing, silage maize and hay).

- Study transfers of $^{14}$C and $^3$H to cows and milk in function of the alimentary diet.

In order to improve the TOCATTA model or another model.
- Originality: Using the atmospheric release of radionuclides of AREVA NC La Hague reprocessing plant to quantify the transfers of $^{14}\text{C}$ and $^{3}\text{H}$ in rural environment.
$^{14}$C and $^{3}$H atmospheric releases

Lead to greater concentration than the background level in the environment
Example of OBT concentration measured in furze
Site location

Wind conditions 2008 - "Omonville La Petite". Wind speed (m.s⁻¹) and Direction (°)

« Atelier Nord »: a well located experimental site, considering the most frequent wind direction
Experimental design (sampling periodicity 1 month)

- 10 m mast with sonic anemometer (turbulence)
- Weather station
- Grass (Raygrass)
- CO₂ measurement acquisition (LICOR 7000)
- Farm
- Continuously Recording Field Monitor for Krypton-85
- Meteorological data acquisition
- ¹⁴C trapping device (bubble gas through soda)
Example of CO$_2$ atmospheric concentrations
Example of $^{14}$C concentrations

Does the model give a good representation of $^{14}$CO$_2$ between air and grass? No, as it uses constant isotopic ratio (no photosynthetic process).

To get a better model-measures comparison: need to rebuild $^{14}$C atmospheric concentrations on an hourly basis and use a dynamic model.
Krypton 85: a plume tracer measured with short periodicity (1 minute) compared with $^{14}$C (1 month)
Krypton 85: a good indicator of $^{14}$C atmospheric dispersion over a short periodicity

Need to rebuild hourly $^{14}$C atmospheric concentration with hourly $^{85}$Kr concentration and monthly $^{14}$C concentration

To obtain more precise $^{14}$C atmospheric concentrations for calculations
The results analysis needs dynamic modelling of $^{14}$C and $^{3}$H in plants, it’s necessary to take into account the modelling of photosynthesis.

Concerning $^{3}$H modelling in case of accidental release, it is also necessary to consider water transfer processes with a dynamic approach based on a short time step.

Ongoing discussions with INRA (Clermont-Ferrand) to use the PASIM* model.

PASIM* is a biogeochemical grassland ecosystem model that simulates fluxes of C, N, water and energy at the soil-plant atmosphere interface with hourly step time.

Agenda

Carbon 14

2007-2009 : Transfers between air, grass and soil
2009-2010 : Transfers to cow
2009-2010 : Model-measures comparisons
2010/2011 : Publication

Tritium

2010 : Measurement (speciation of $^3$H releases in air)
2010-2011 : Transfers between air, rain water, grass and soil… dry and wet deposition
2012 : Transfers to cow
2011-2012 : Model-measures comparison
2012 : Publication