Landscape-level model predictions of ^{131}I, ^{134}Cs and ^{137}Cs transfer through terrestrial systems in the 80-km Fukushima-Daiichi area using the Symbiose platform

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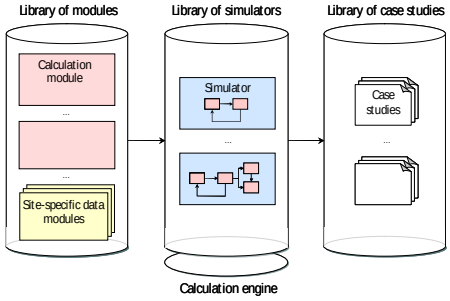
Context & objectives

The SYMBIOSE is a R&D project, co-funded by Electricité de France (EDF), that aims at improving our capability to predict the fate, transport and impact of radionuclides in ecosystems, following radioactive releases from nuclear facilities under accidental, decommissioning or normal operating conditions. The main challenge was to promote a scientific and software approach that was flexible enough to deal with a wide range of situations, extending from simplified generic studies to more realistic spatially-distributed and site-specific assessments. The SYMBIOSE platform has also been designed to manage data/knowledge issued by research activities in radioecology. The industrial version is regularly up-graded to account for the users feedback. The latest version (SYMBIOSE V2) has been delivered in February 2012.

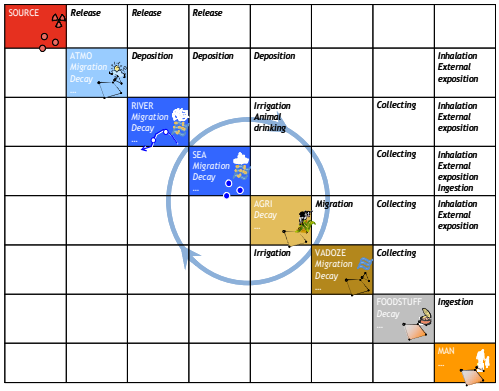
Symbiose Architecture

The SYMBIOSE platform, that runs under Windows/Linux OS, in French/English, features a highly flexible and modular architecture. It consists of four major components:

- A library of modules, a module being an autonomous/reusable piece of software that models an environmental sub-system and encapsulates related parameters (generic/site-specific and deterministic/probabilistic values),
- A library of simulators, a simulator being a fit-for-purpose code that addresses a specific environmental problem, built by instantiating and connecting pre-existing modules through a graphical user-interface,
- A library of case studies, for the various existing simulators, and
- The application itself, for managing modules and simulators, or performing simulations through the use of a powerful calculation engine capable to deal with complex space and time dynamics.



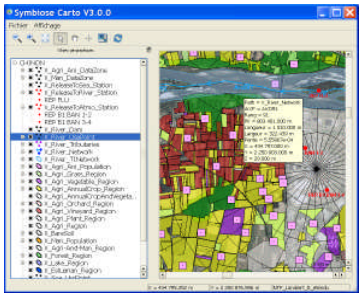
Biosphere modeling approach



Pollutants. SYMBIOSE deals with several hundreds of radionuclides, deriving from up to 70 chemical elements, including chlorine, hydrogen and carbon for which specific non-equilibrium approaches have been proposed (see Poster 716, Le Dizès *et al.*).

Mathematical approach. Outputs such as concentrations, activities, stocks and fluxes of pollutants or (a)biotic mass obey mainly to mass conservation equations (ODE & PDE). When previous approach is not possible, empirical parameterizations such as transfer factors or functions are adopted.

Landscape modeling. Spatial predictions are produced for a given sub-system on a specific spatial frame (*i.e.* collection of points, polylines or polygones). The specification of these frames, along with spatial interactions in-between them, defines a lanscape model.



A French NPP landscape, consisting of 27 spatial frames

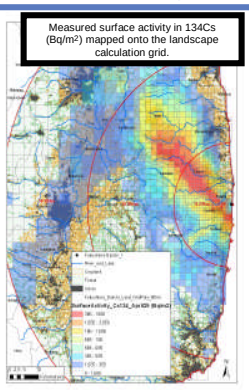
Example of predictions in the 80-km vicinity of Fukushima-Daiichi NPP

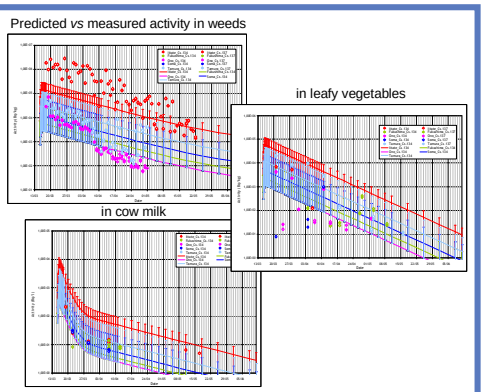
Objective. Testing the SYMBIOSE models through a comparison between $^{134}Cs/^{137}Cs$ activities measured in weeds, vegetables and cow milk (as published by MEXT and MHLW) and predicted activities, at a city scale.

Scenario. Simulations were performed in the 80-km region around the NPP, from March 11 to June 11, considering spatially-distributed atmospheric deposition fluxes as input. These fluxes were hypothesized from measured surface activity (as published by MEXT/US-DOE) and meteorological conditions prevailing at time of releases. A landscape model consisting of 2000 meshes was built from a satellite image. Some assumptions about local agricultural practices were made (*i.e.* animal feeding, vegetative periods).

Preliminary results. Comparisons are displayed for 5 cities, accounting for spatial variability inside each of them, due to the deposition heterogeneity. Numerical results show quite realistic time dynamics, even though activity levels can differ by more than a order of magnitude.

Prospects. Intercomparison to be continued with increased realism.





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