

#### 137 CS Desorption within an estuary: modelling and experiments

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Égalité

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# <sup>137</sup>CS DESORPTION WITHIN AN ESTUARY: MODELLING AND EXPERIMENTS O. Radakovitch, A. Delaval, C. Duffa, I. Pairaud, P. Boyer, L. Flipo, F. Coppin,

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# Estuaries are hot spot areas for the transfer of radionuclides



13 nuclear plants installed in France along four rivers.

Scenario of accidental releases of radionuclides must take into account the coastal areas.

Estuaries are hot spot areas where specific physicochemical processes (particles cycle, salinity changes, desorption...) may change speciation and fluxes.

They must be correctly simulated to predict the fluxes transferred to the sea and potential impact on the ecosystems.

137Cs Emitted in most accidental scenarios
 137Cs Half-life: 30 years
 Gamma emitter → internal and external irradiation
 Bioaccumulation within the trophic chain



### **IRSN Numerical models for radionuclide transfers in aquatic systems**

#### CASTEAUR: 1D numerical model for radionuclides transfer in rivers

IRSI



Sea surface currents



# DRACAR : Désorption des RAdionuCléides à l'interfAce littoRale

#### DRACAR

Box-model for freshwaterseawater mixing within estuary and structure of water masses. Based on

- Solving salt, volume and potential energy budgets.
- Knudsen's theorem.

Physical outputs

- Physical structure of the water masses
- Water residence time in the estuary
- 2D salinity
- Water and salinity fluxes at sea





Delaval et al 2022







IRSN

O RADAKOVITCH - IEBS SYMPOSIUM, SIBENIC, MAY 2023

Salinity - 8th july 2022





#### Salinity profile - 8 km inland



#### Surface salinity - 15km inland





 More realistic value for river flux to the sea.
 Flushing time for particles

between 0 and 37 g/L.

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#### Integration of desorption process

Intensity of particulate <sup>137</sup>Cs desorption due to the exchange with dissolved seawater cations (K<sup>+</sup>, Na<sup>+</sup>)



# Desorption of <sup>137</sup>Cs at the fresh-seawater interface

Compilation of 32 studies from 1963 to 2017



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60 60 <u>desorbed</u> T\_sorption =1 h 50 % 40 T\_sorption =3 j desorbed 30 လ T sorption =30 j 20 % 500 300 200 Desorption 0 25 20 time(h) 15 salinity 100

Desorption in laboratory to test

the influence of salinity and ageing effects

Desorption initiates at 0,2-4 g/L salt

Ageing effect influences desorption

A two kinetics model simulates well the process



# **Simulation of Cs flux (Bq/s) along the continuum**



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# Adsorption-desorption experiments for Cs, Co, Mn and Ag

- <sup>137</sup>Cs <sup>110m</sup>Ag <sup>60</sup>Co <sup>54</sup>Mn onto Rhone suspended particulate matter
- Desorption after 30 min to 2 months



 Define which sorption-desorption model is most suited to described changes in the river continuum (transit time, chemical changes...)





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#### First results of the experiment





#### Conclusions

The hydrodynamic of the water masses are well represented for a salt-wedge estuary, as well as water and salt budgets.

The desorption of <sup>137</sup>Cs occurs very quickly (2 g/L) in brackishwater

The duration of adsorption have an influence on the <sup>137</sup>Cs desorption, still difficult to constrain.

Geochemical models including sorption – desorption kinetics are more realistic, but parameters are difficult to acquire.

