ASTRE

Accessibility Simulation Tool for Radiological Emergency

Project team:

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EDF R&D

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CONTENT

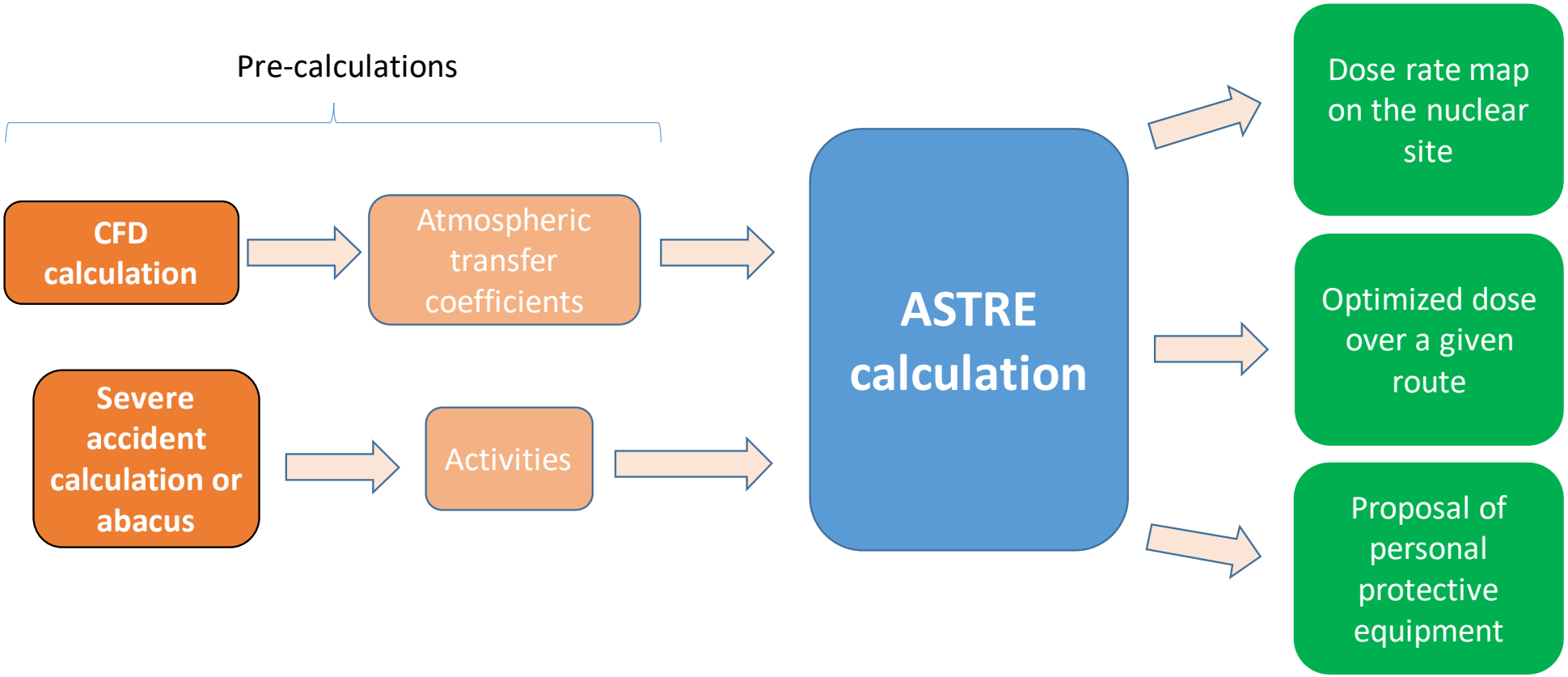
1. CONTEXT AND OBJECTIVE OF THE PROJECT

- Development of a tool at EDF R&D dedicated to the radiological emergency situations on the nuclear site

→ development of the ASTRE tool

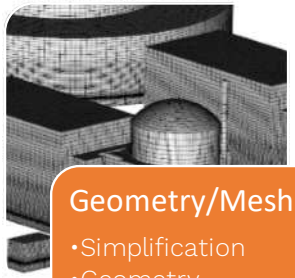
- The main goals of ASTRE are to:
  - evaluate the radiological release on the nuclear site and inside some buildings
  - evaluate a realistic dosimetric prevision for the interventions of agents on the power plant in case of radiological emergency situations,
  - propose the personal protective equipment which would be useful during the intervention,
  - evaluate the best path to minimize the dose rate/integrated dose as well as the contamination undergone during an intervention.

2. General architecture



3.A. CFD SIMULATION USING CODE_SATURNE (1/2)

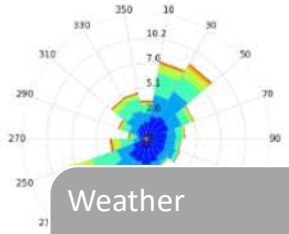
QGIS/Salome



Geometry/Mesh

- Simplification
- Geometry modelling
- Mesh generation

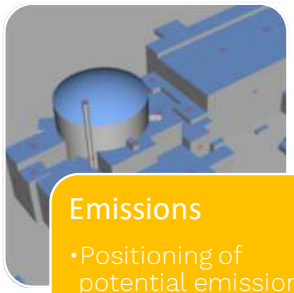
Python
code_saturne



Weather

- Classification of a measured weather data time series (> 5 years)
- Generation of 1D vertical weather profiles

code_saturne



Emissions

- Positioning of potential emission sources

code_saturne

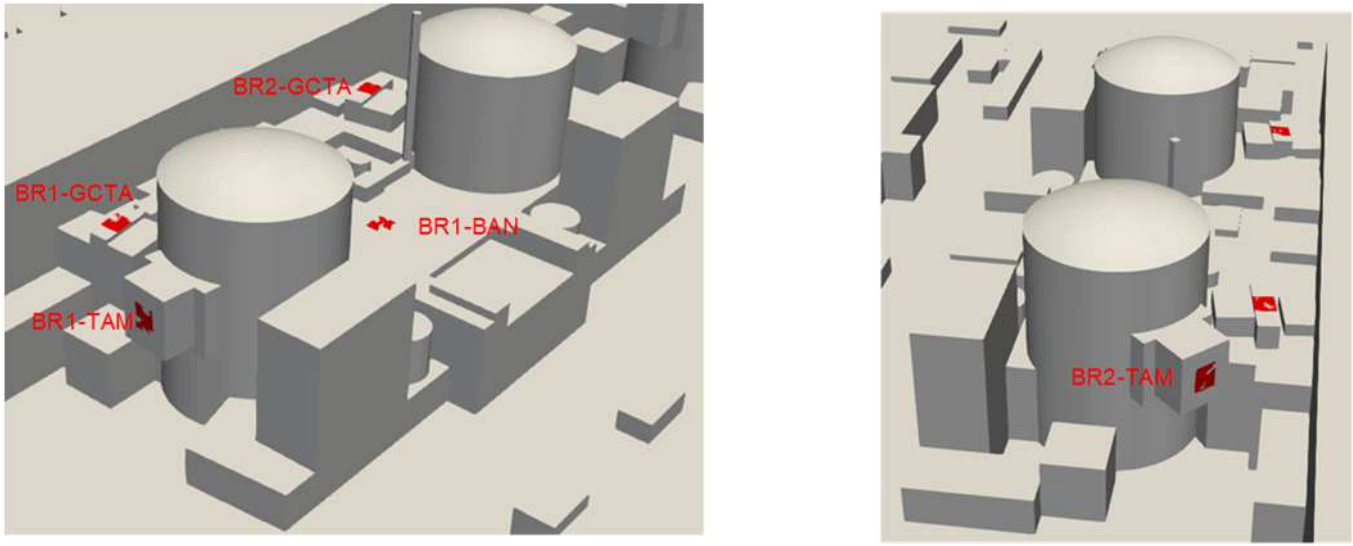
Calculations

- Automated setup of numerous simulations
- Convergence control

Atmospheric Transfer Coefficients (ATC)

3.A. CFD SIMULATION USING CODE_SATURNE (2/2)

- Potential emission sources



Boundary faces representing emission sources in the vicinity of the reactor buildings « BR1 » and « BR2 ».

3.B. ESTIMATION OF DOSIMETRIC QUANTITIES

- **Goal**: Estimate **realistic** dosimetric quantities (dose rate Ded, integrated dose) during the accident

Ded (t) = f(ATC, RN activities) (t)

with

- **ATC:** integration of the weather situation (i.e. thermal stratification of the atmosphere, direction and wind strength) – precalculations performed using code_saturne
- **RN activities:** precalculations performed with a severe accident code or abacus

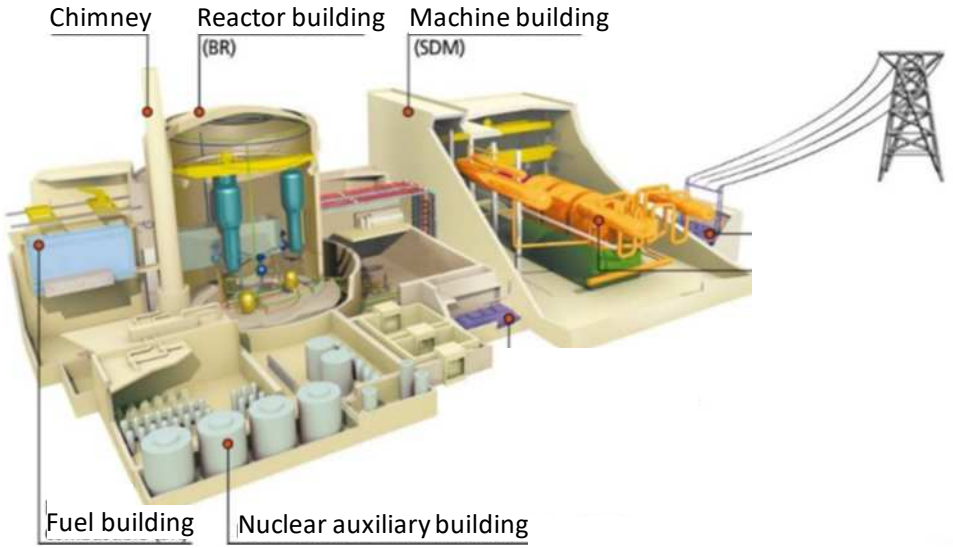
⇨ **Specific on-going studies to improve the estimation of RN activities to realistic values.**

3.C. DOSE RATE INSIDE BUILDINGS

- Goal =
  - to estimate the dose rate in given locals of interest

- Proposed solutions:
  - Simplified model based on a zonal approach
  - More precise one, based on CFD calculations (code_saturne)

- **New and innovative solutions to be studied as from 2023.**



Overview of the main buildings of a nuclear reactor

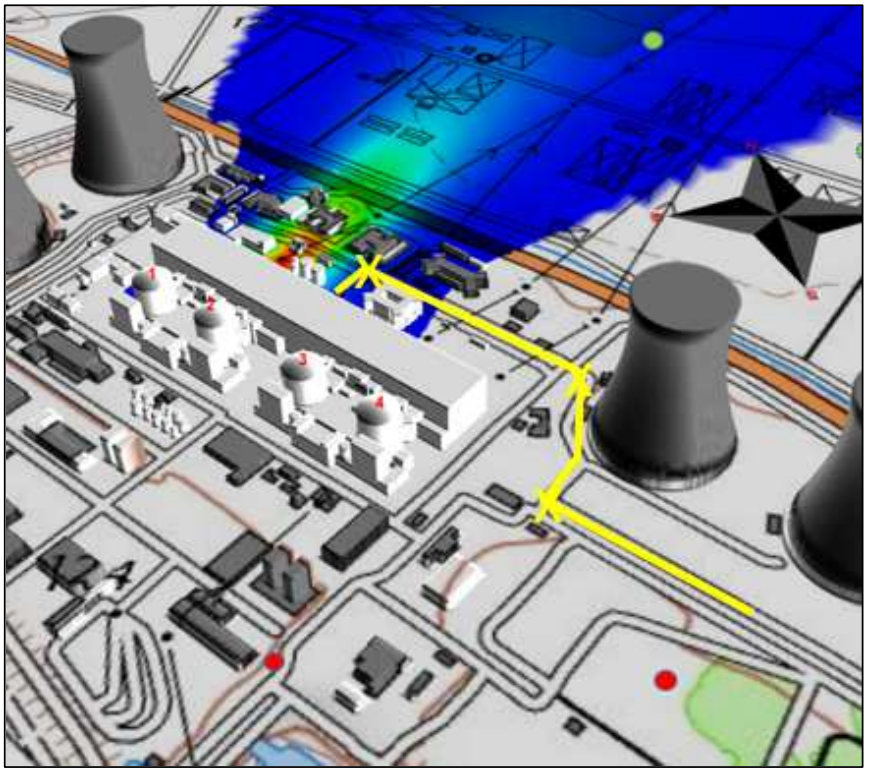
3.D. DATA ASSIMILATION

- *Data assimilation is the technique whereby observation data (here on-site dose rate measurements) are combined with output from a numerical model to produce an optimal estimate of the evolution.*

- Data assimilation may be used to correct the dose rates calculated with ASTRE, using on-site dose rate measurements.

- It could be performed on a given path (too few data to correct the calculation on).

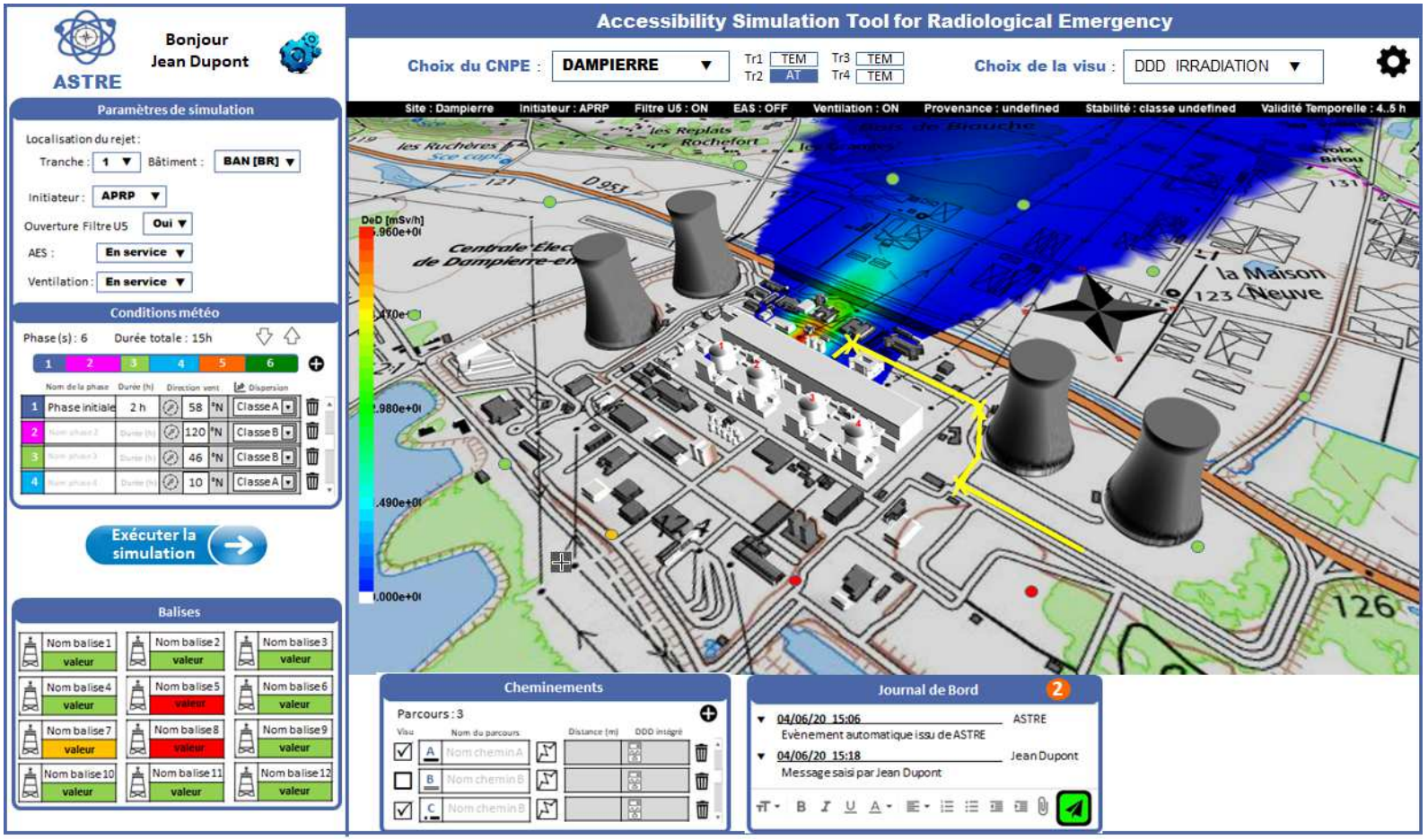
- Application to ASTRE will be studied as from 2023.



Path example

3.E. ASTRE INTERFACE

- Study of the ergonomy of the interface
- Very simple use
- Possibility to manually enter all the data
- Visualization on the site map



3.F. USE CASE: FUKUSHIMA DAIICHI

- Simulation of the Fukushima Daiichi accident using ASTRE
- CFD simulation using code_saturne
- Weather and estimated source term taken into account
- Comparison of ASTRE results to on-site measured data

Geometry for the CFD calculation

4. Conclusions and perspectives

- ASTRE: new tool being developed at EDF R&D to evaluate the consequences on the nuclear site of a radiological emergency release.

- Following steps: Improvement of models ⇒ real R&D challenge !
  - dose rate evaluation inside the buildings
  - more realistic source term
  - use of on-site measurements during the accident

- At mid-term: first version of the tool to be tested by the end-users

Questions