SIMPAC FIRE OPERATIONAL SAAS PLATFORM AND SCAN360 FOR QUANTIFICATION OF METHANE EMISSIONS

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SCAN360 AS A METHOD TO SOURCE QUANTIFICATION

Presentation of methodologies and typical applications

ARIANET Day
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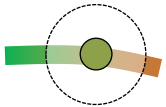
The mission of SCAN360

Goal: quantifying GHG emissions for given sources based on a series of on-site measurements and the numerical model PMSS

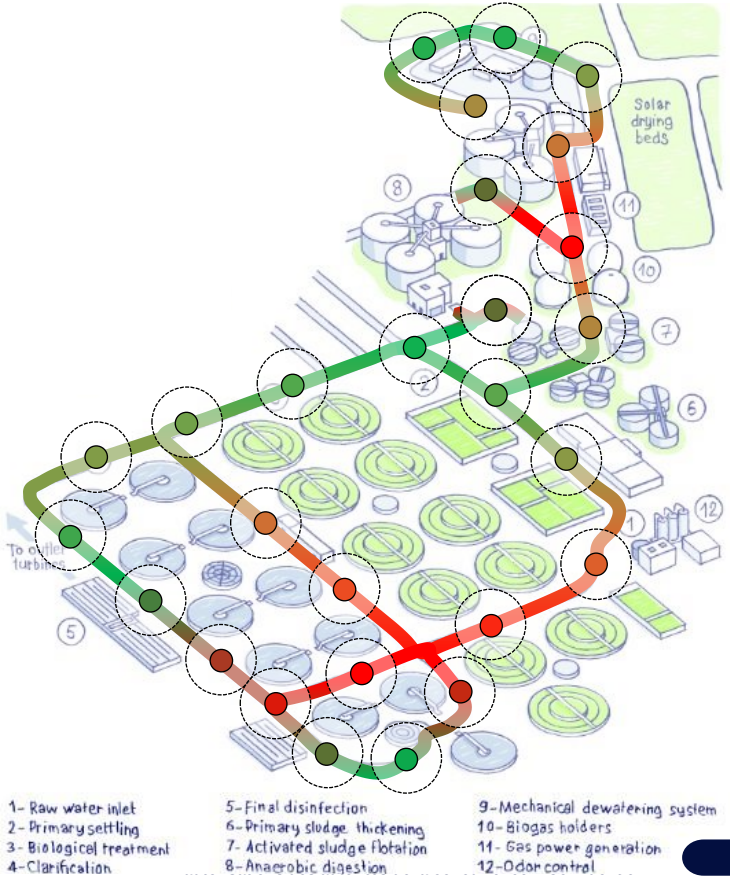
- **Idea**: The sensor used to measure GHG concentrations is expensive. Positioning many of these sensors at different fixed locations is not conceivable
- **Approach**: Mobile sensor covers the whole domain, capturing peaks of concentration around all sources ($f = 1\ Hz$)



Measurements are **concatenated into fictious sensors**

- **Methodology**: Calibrate each source's emission so as to match the fictious sensor's concentration values

Numerical dispersion model: PMSS



The process steps

Data preprocessing

- The raw sensor data is **preprocessed and filtered** via a series of algorithms
- A period of **stable wind** is chosen – only data inside this period is treated
- Concentration peaks are identified, and virtual sensors are **concatenated** around these peaks

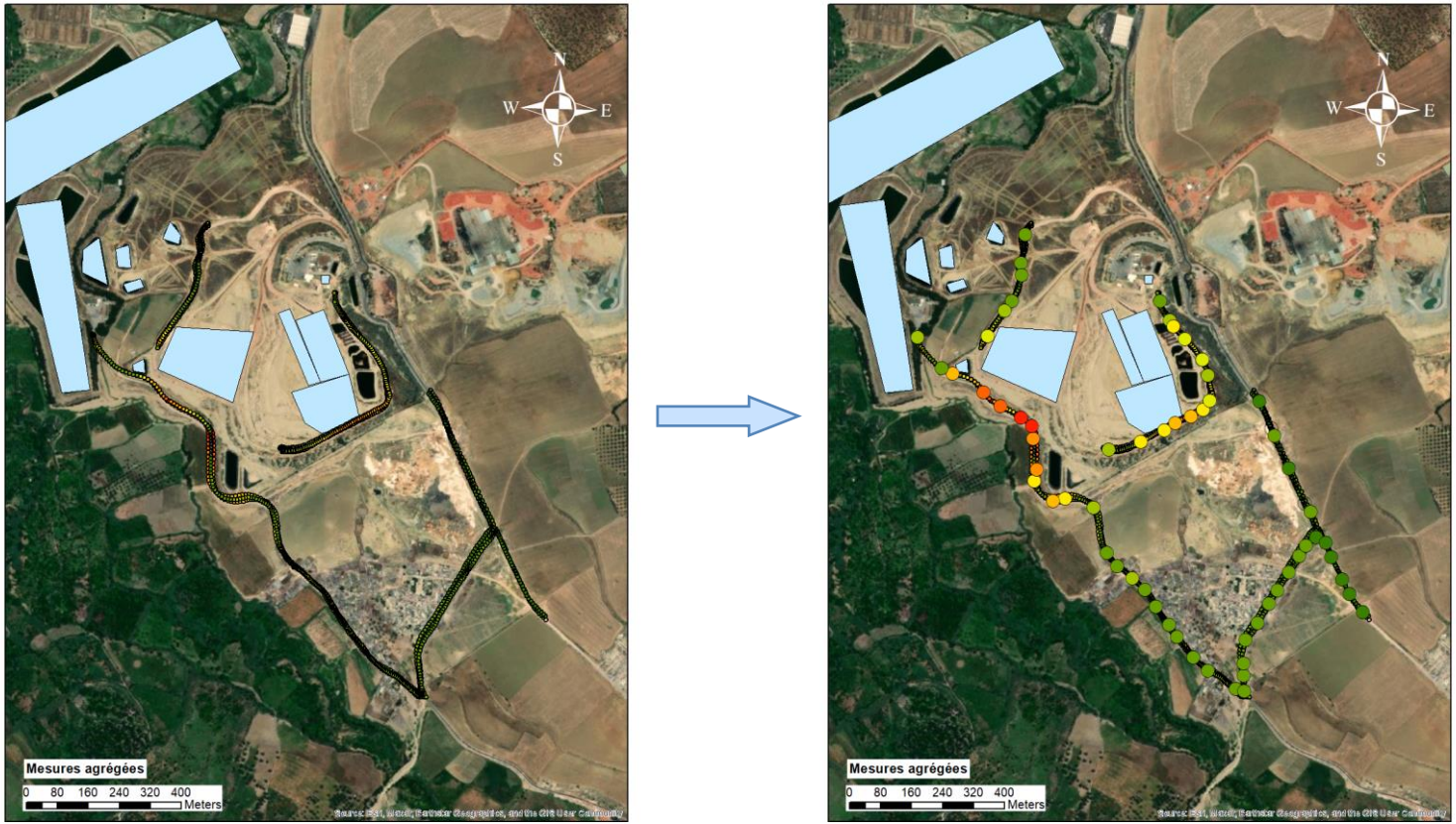
Numerical domain

- Definition of the **sources**' geometries and definition of a first guess for their emission rates
- Definition of **obstacles** inside the studied domain
- Definition of the **domain's characteristics** (terrain, rugosity, etc.) and discretization into a numerical mesh

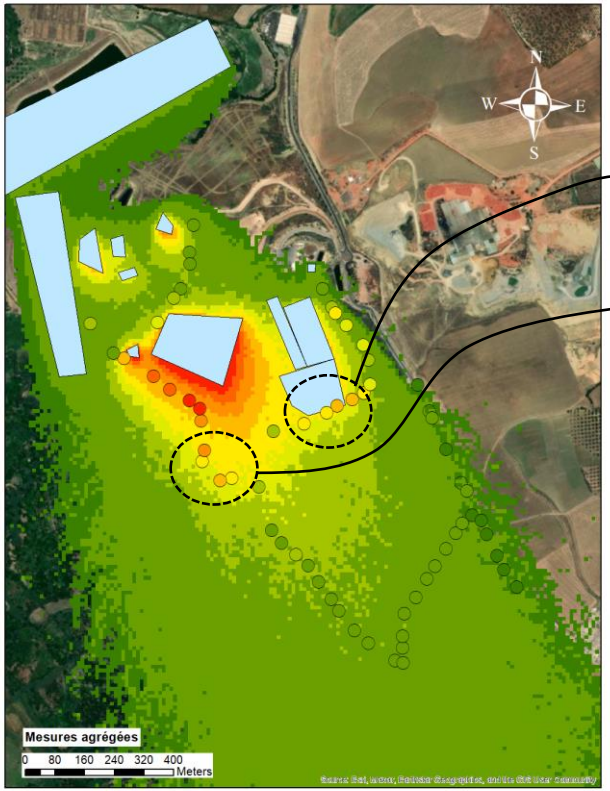
Source quantification

- **Simulation** of the dispersion of the GHG inside the domain using PMSS
- Adjustment of each source's emission using a **regression progress** between the simulated concentration field and the concatenated sensors

Example for the concatenation process



Example for the regression process



Slight **underestimation** of the concentrations close to the sources, suggesting an increase of the emission level at this point.

Still a slight **underestimation** of the concentration in this area, however the sensors more upwind seem fine

- Information from colleagues on site: presence of a populated area and livestock

→ **potential source of CH_4**

Typical threshold for the **uncertainty level**: **15 – 30 %**

THANK YOU

Victor David – Study engineer

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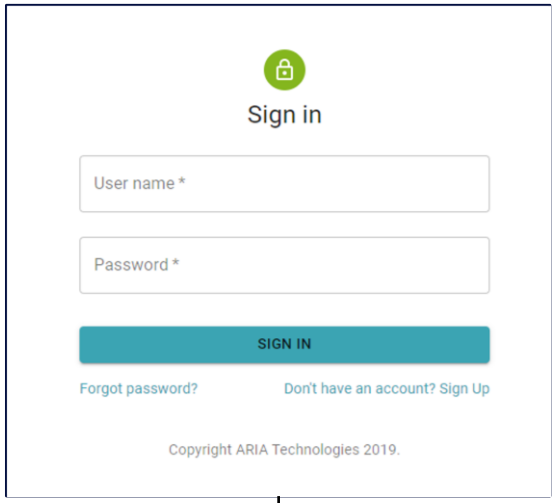
Lubrizol

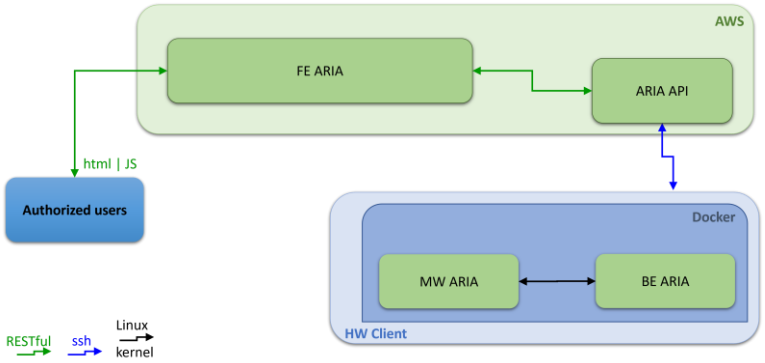
The Lubrizol company in Rouen is a “high risk” chemical plant.

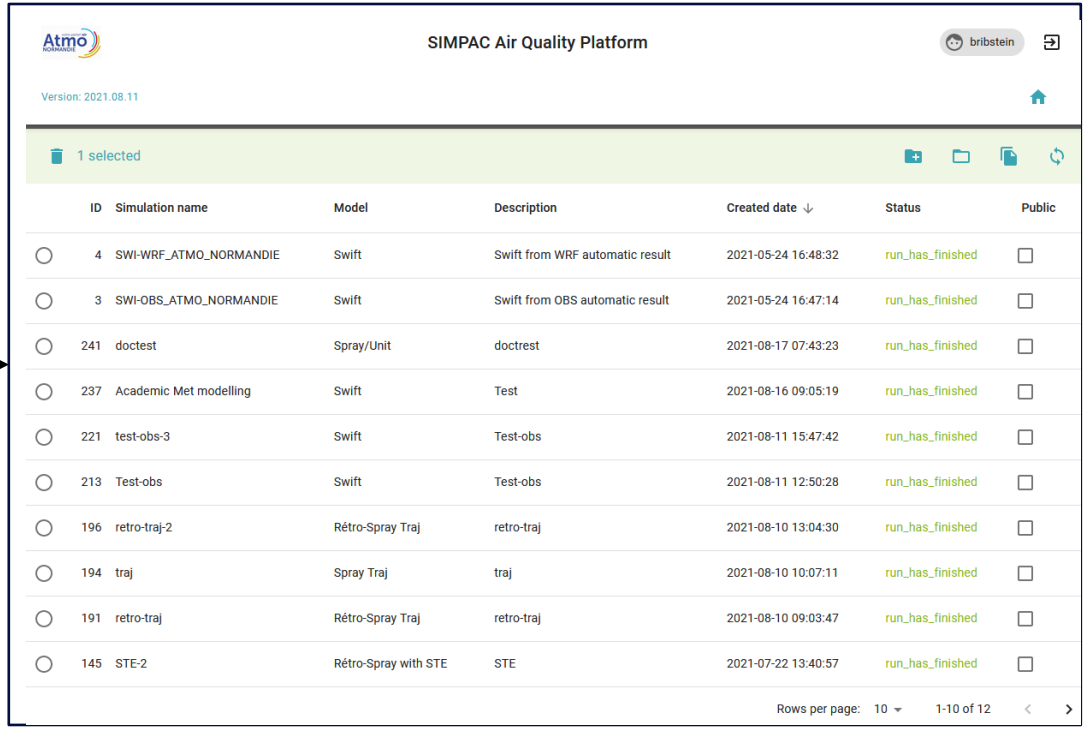
- In January 2013, a leak of a malodorous gas, *mercaptan*, was smelled about a hundred kilometers from the site, notably in Paris and the United Kingdom.
- A fire at the plant took place on September 26, 2019. A thick plume of black smoke formed, reaching more than 20 km.

- The 2013 incident led to the development of the first SIMPAC platform for AtmoSud, as part of a *rapid intervention force* (FIR).
- The SIMPAC platform is a software that provides an integrated user-friendly interface, directly accessible from a Web browser.
- SIMPAC allows the configuration of dispersion’s calculation by people who do not have a training in modeling atmospheric dynamics. Results are synthetic, easily exploitable and understandable in a context of emergency.

Architecture of the SIMPAC platform

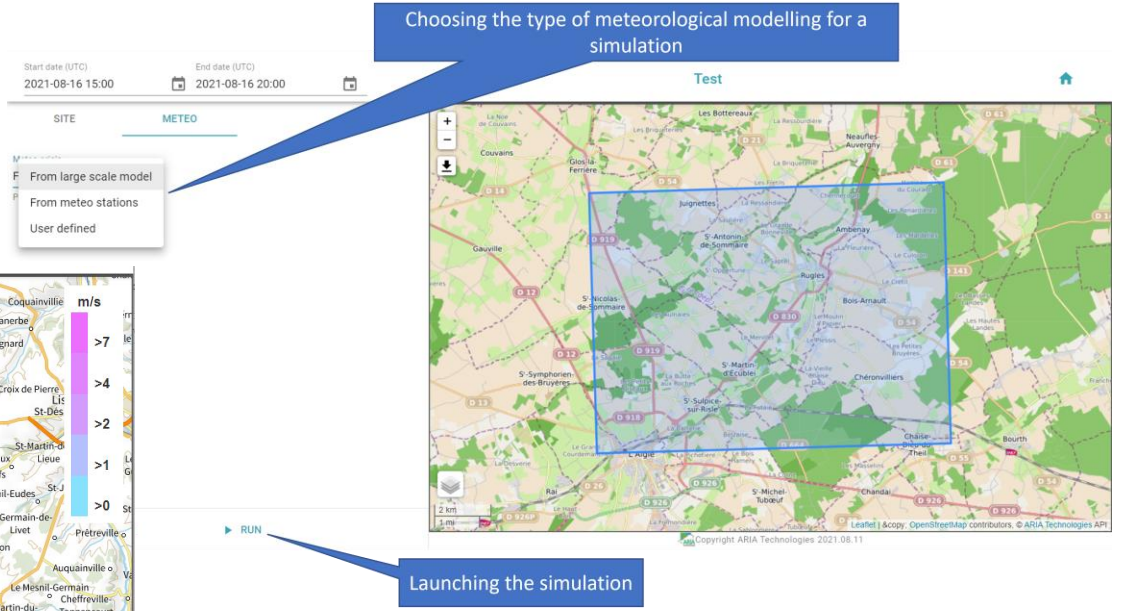


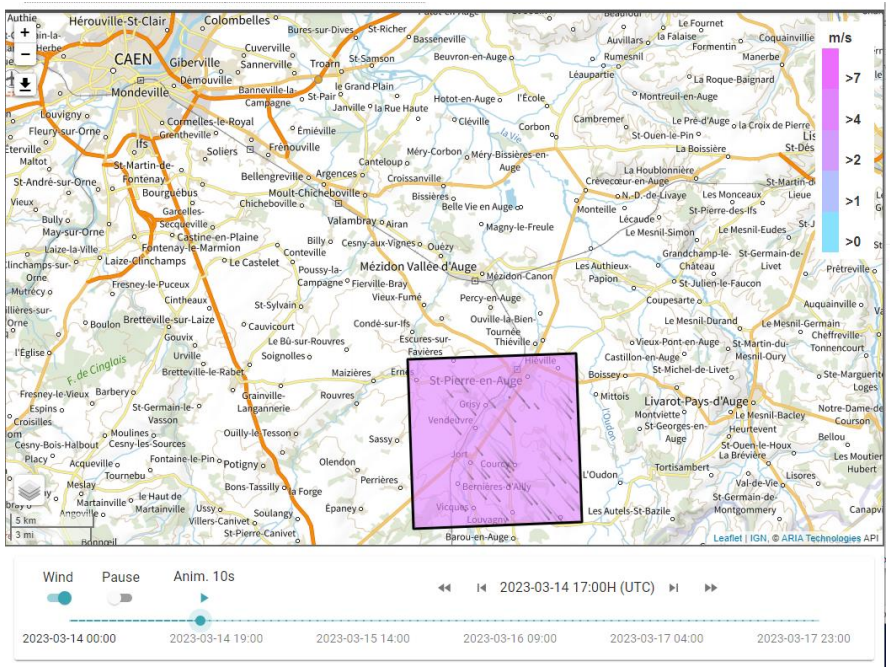




PSWIFT in SIMPAC

PSWIFT is a diagnostic atmospheric model that imposes mass conservation





Meteorological modelling are possible using:

- One or several Meteorological Stations,
- Large Scale Model (e.g. WRF or MM5),
- Uniform, constant and user define condition.

PSPRAY in SIMPAC

PSPRAY is a stochastic lagrangian three-dimensional-dispersion-model.

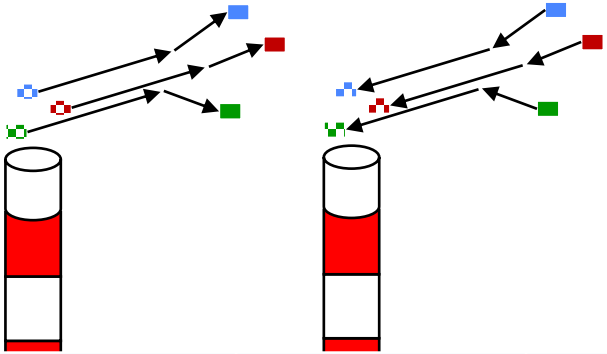
The emitted particles are numerical particles, and each carry a part of the emitted mass.

Direct simulation :

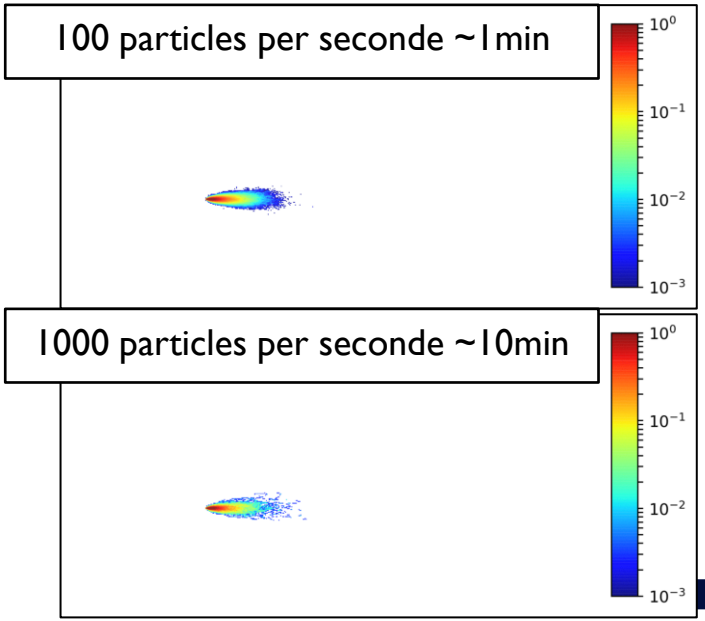
$$\overline{X_0}(t+dt) = X_0(t) + \overline{U}(X_0(t),t)dt + U'(X_0(t),t)dt$$

Inverse simulation :

$$\overline{X_0}(t-dt) = X_0(t) - \overline{U}(X_0(t),t)dt - U'(X_0(t),t)dt$$

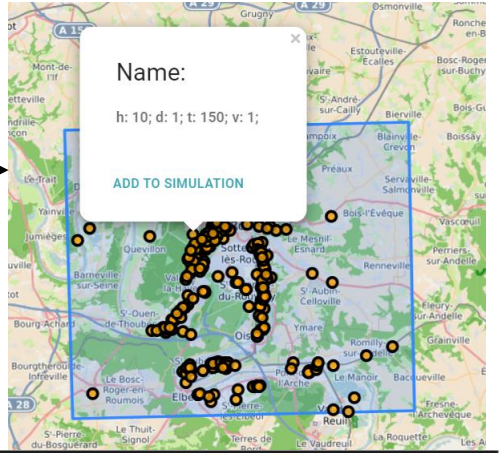


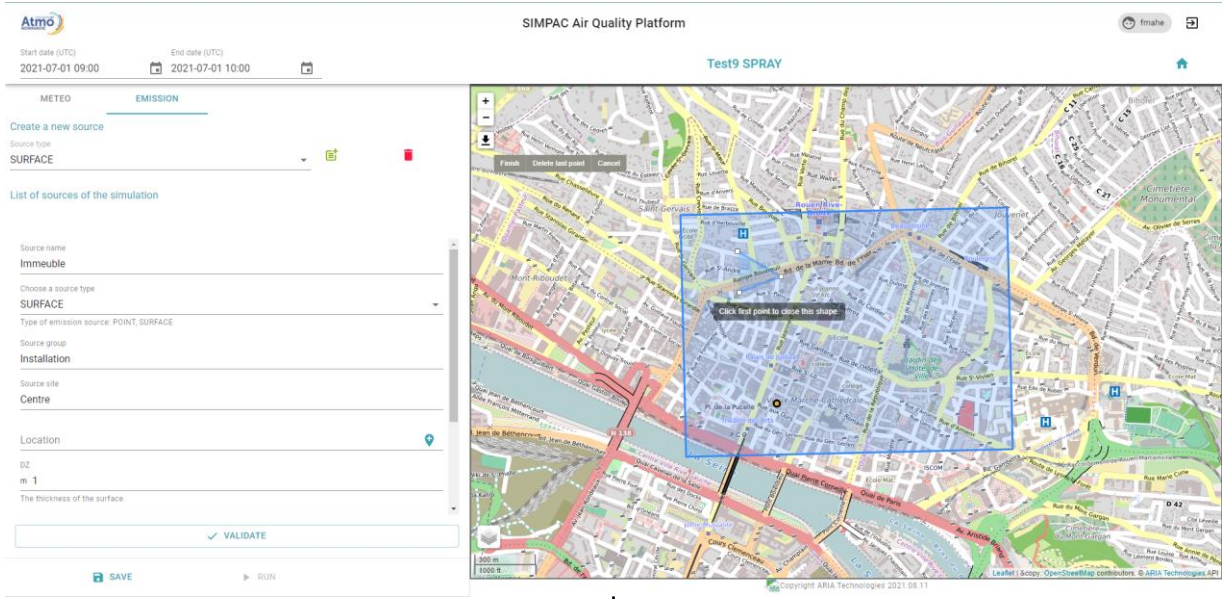
Configuration	Particle per time step	Species	Emitted flux
Trajectory	1	Tracer	1kg/h
Unitary	100	User define	1/kg/h
Cartographic	600	User define	User define

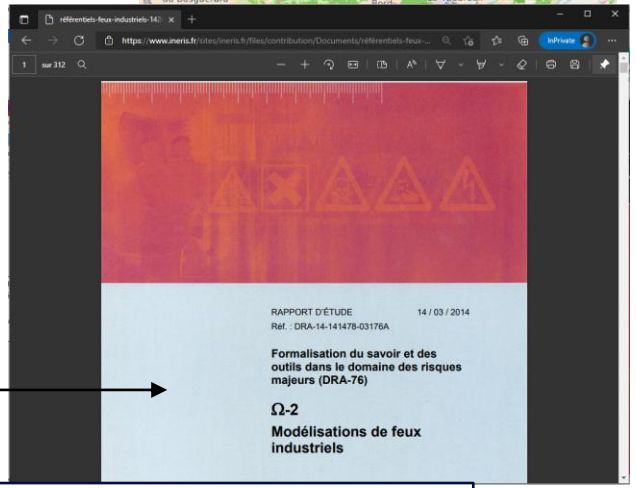


PSPRAY in SIMPAC

The user can *define manually point source* characteristics or *use pre-available sources*.







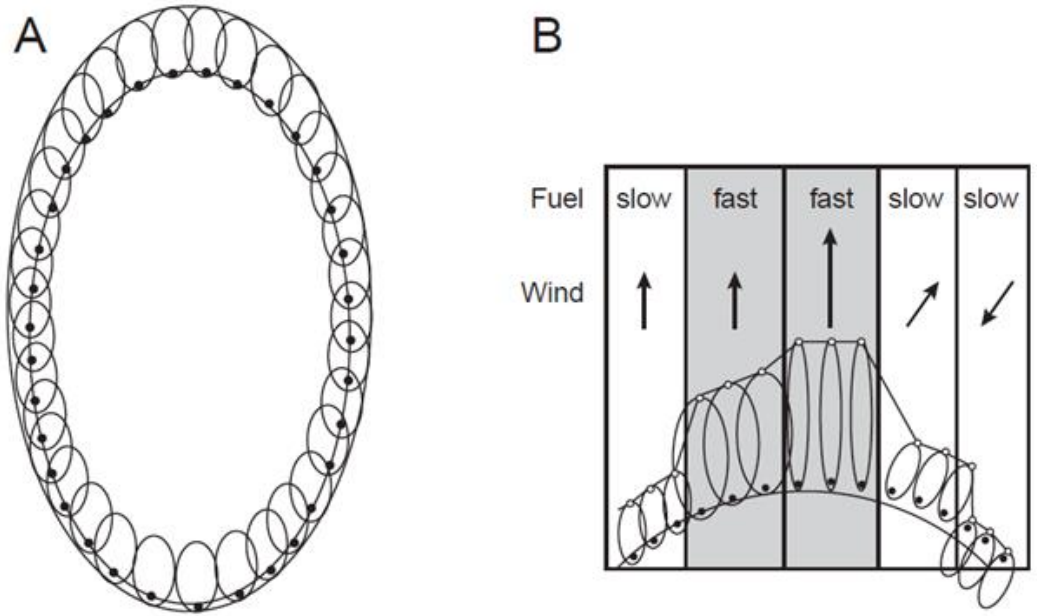
The user can define *surface sources*, using the computer mouse through the interface .

Source term of industrial fire (INERIS methodology) can also be used.

Forest Propagation Model in SIMPAC

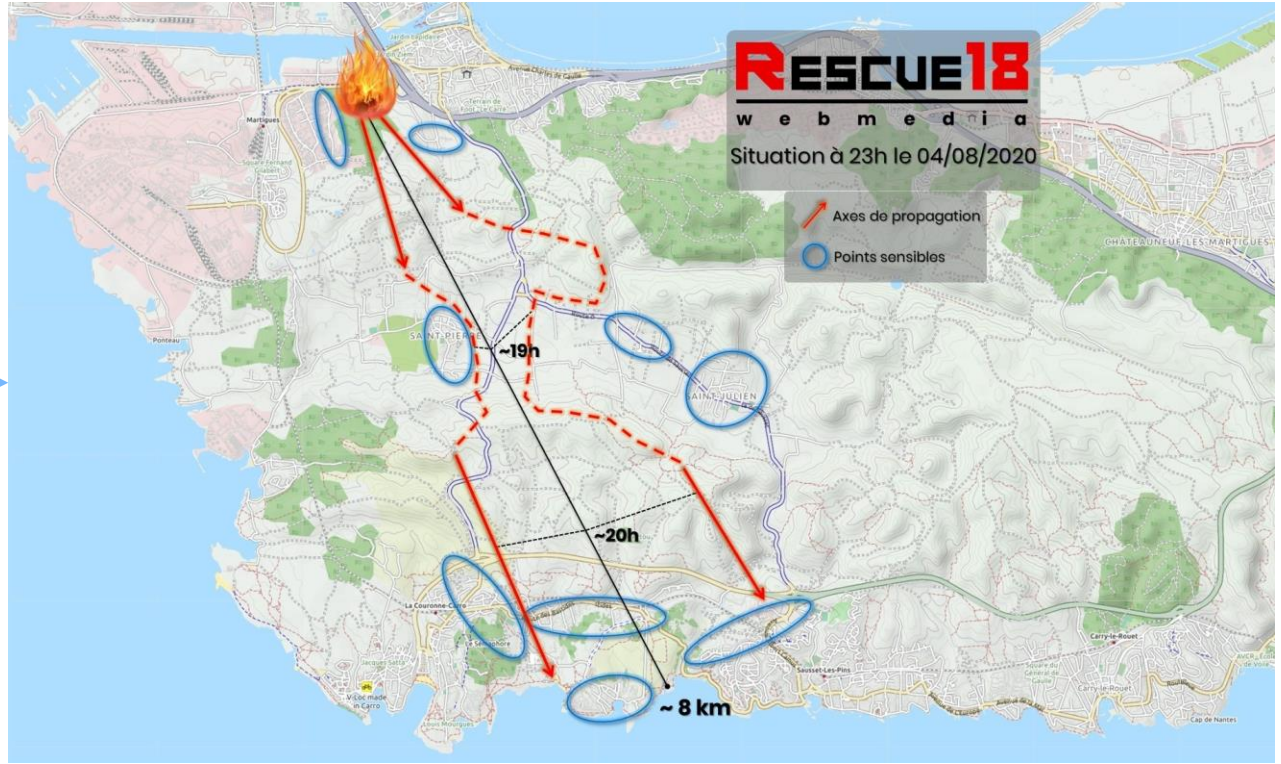
The FARSITE model follows a vectorial approach.

- The fire polygon is defined by a set of two-dimensional vertices. The number of vertices increases as the fire develops over time (the polygon expands).
- At regular time intervals, the expansion of the fire polygon is determined by calculating the velocity and direction of propagation for each vertex.



FARSITE in SIMPAC

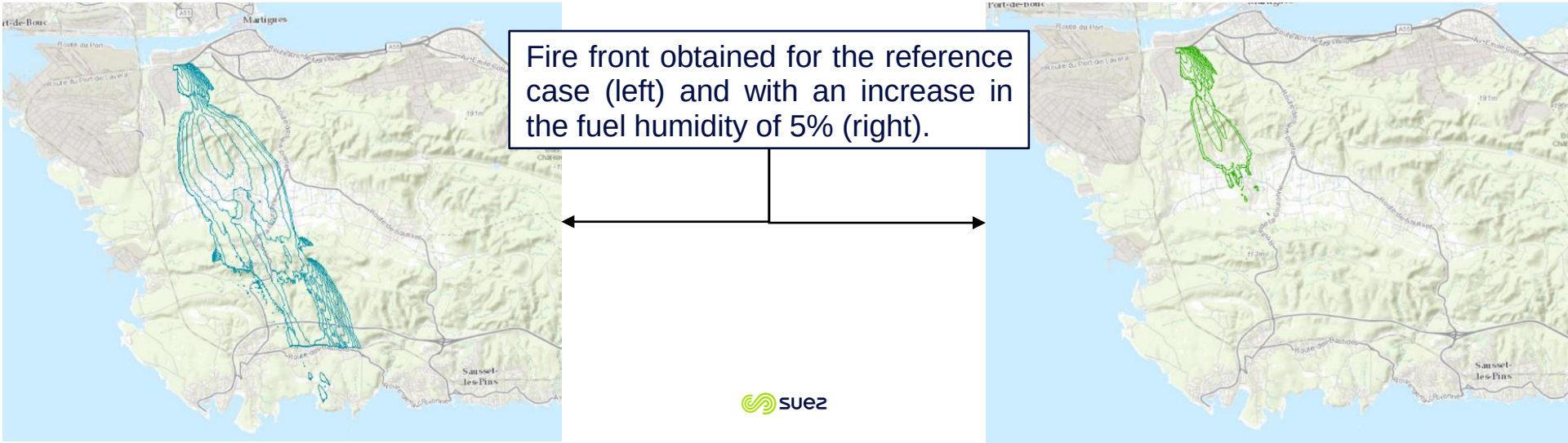
The Martigues fire occurred on August 4, 2020 at 15:00 (UTC) and ended at 19:00 (UTC) by the sea.



FARSITE in SIMPAC

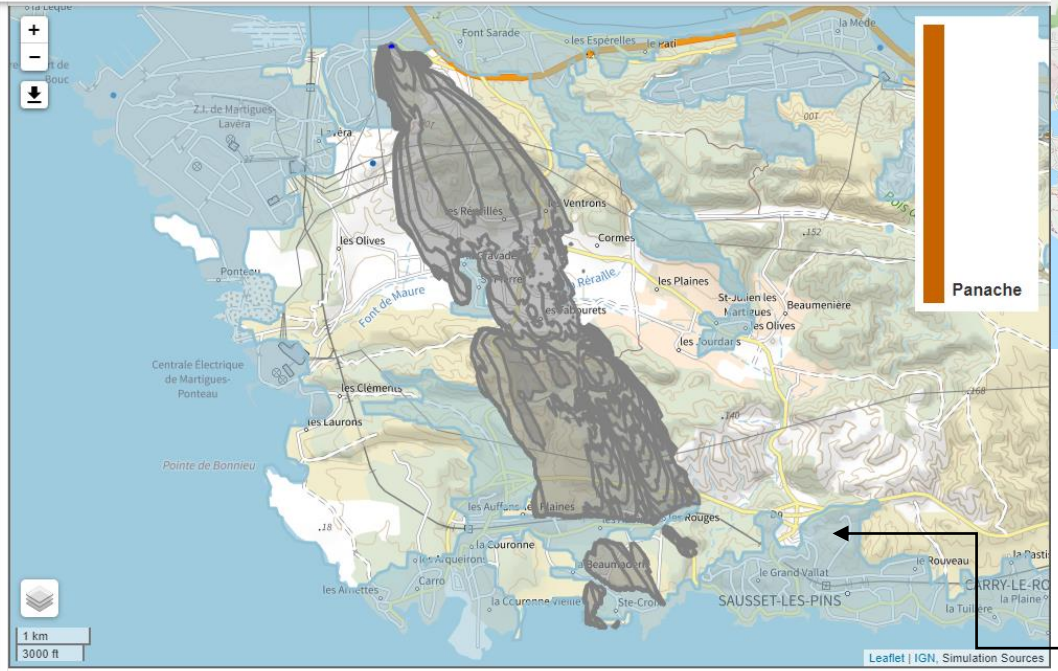
The humidity of the fuel is the ratio of the amount of water contained in the wood divided by the mass of the anhydrous wood. ***The humidity of the fuel strongly influences the fire spread.***

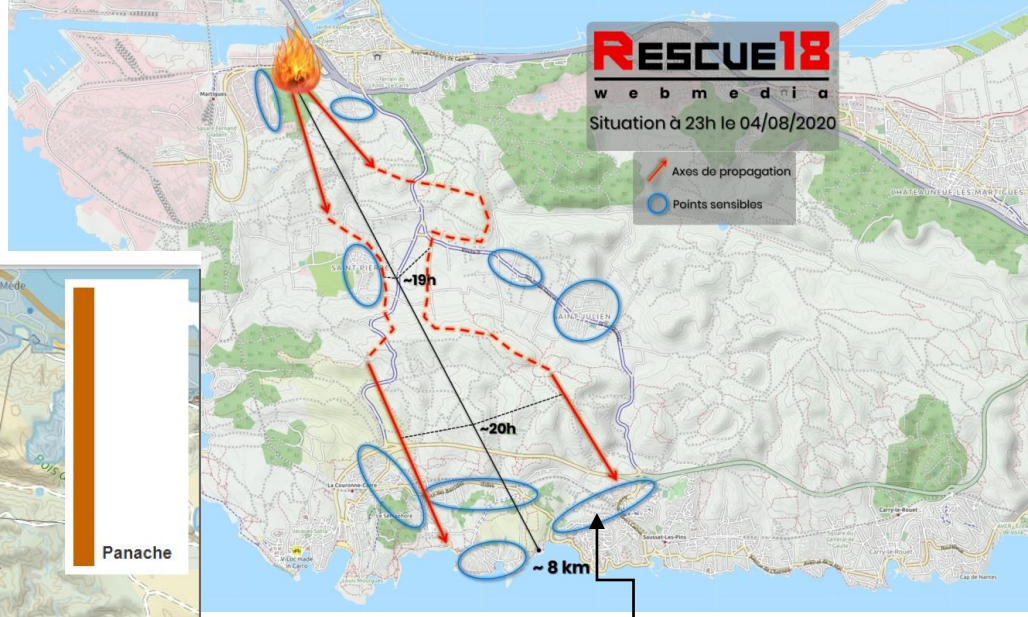
- The humidity of the living fuel is assumed to be constant over the duration of the simulation, homogeneous over the entire domain, and equal to that of the ignition point. It depends on the relative humidity and temperature modeled by PSWIFT.
- The humidity of the burning fuels is calculated for each vertex of the fire polygon and at each time step starting from the initial conditions.



FARSITE in SIMPAC

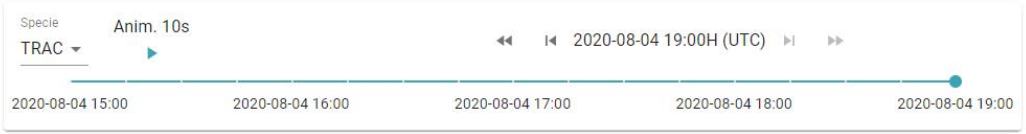
Istres and Marignagne met stations
CPU time : FARSITE + PSPRAY = 9min





The work of firefighters to limit the fire propagation is not considered.

non-burnable area (sea or urban areas)



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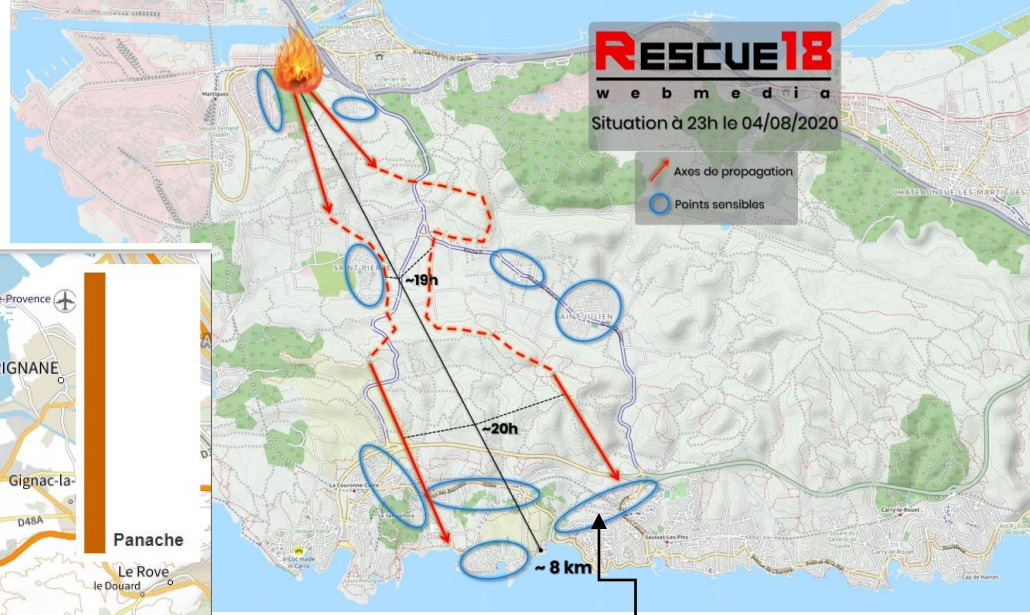

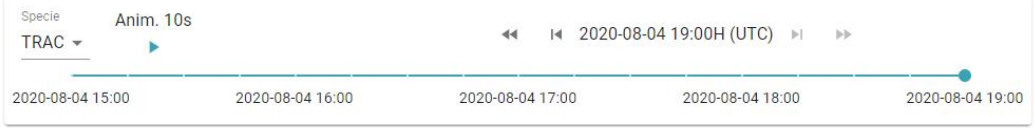

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Smoke plume (Tracer with an emitted mass of 1kg/h)

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Merci

Any questions ?