

# **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

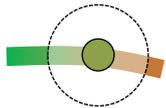
ARIANET Day  
29<sup>th</sup> March 2023



# The mission of SCAN360

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

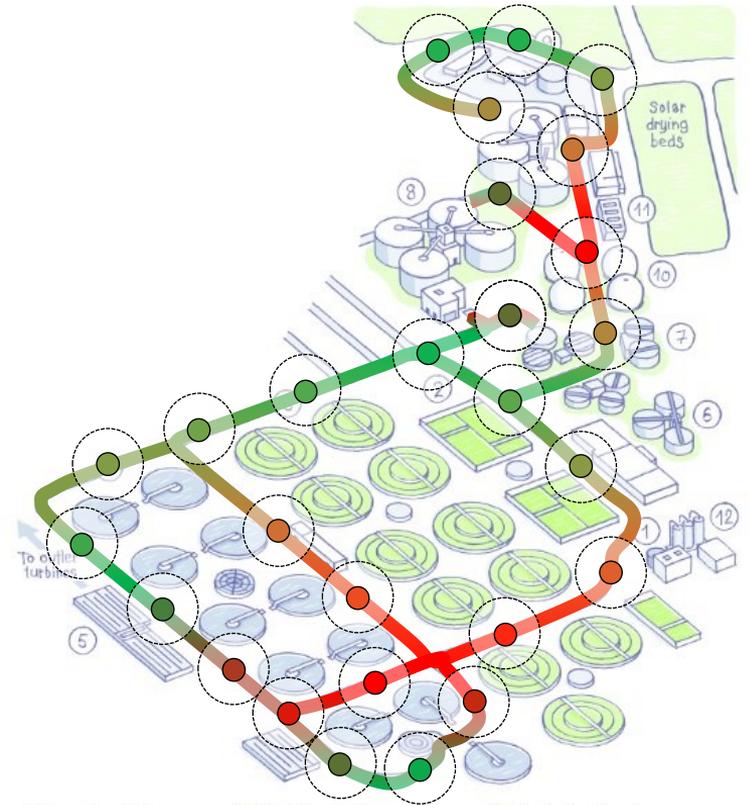
- **Idea:** The sensor used to measure GHG concentrations is expensive. Positioning many of these sensors at different fixed locations is not conceivable
- **Approach:** Mobile sensor covers the whole domain, capturing peaks of concentration around all sources ( $f = 1 \text{ Hz}$ )



Measurements are **concatenated into fictitious sensors**

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

**Numerical dispersion model: PMSS**



- |                         |                               |                                 |
|-------------------------|-------------------------------|---------------------------------|
| 1- Raw water inlet      | 5- Final disinfection         | 9- Mechanical dewatering system |
| 2- Primary settling     | 6- Primary sludge thickening  | 10- Biogas holders              |
| 3- Biological treatment | 7- Activated sludge flotation | 11- Gas power generation        |
| 4- Clarification        | 8- Anaerobic digestion        | 12- Odor control                |

# The process steps

STEP 1



STEP 2



STEP 3

## 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

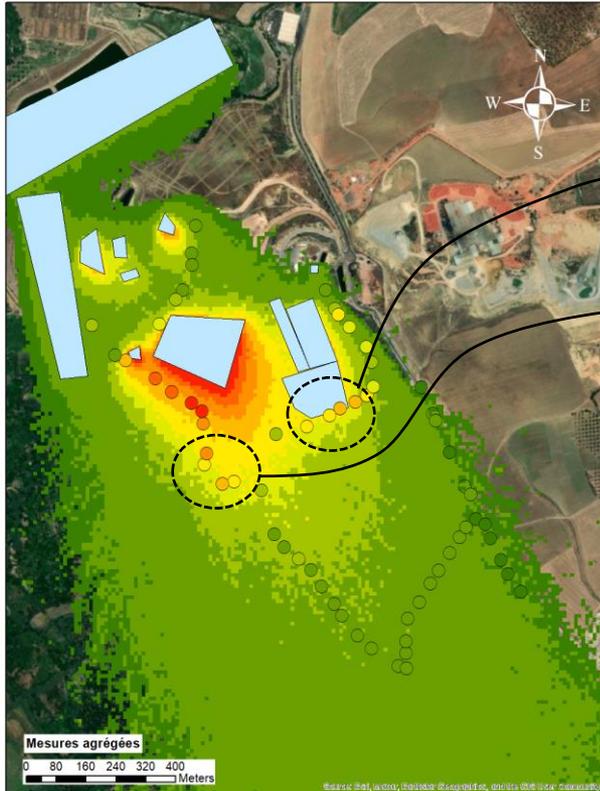
## Source quantification

- **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<sub>4</sub>**

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

# THANK YOU

Victor David – Study engineer

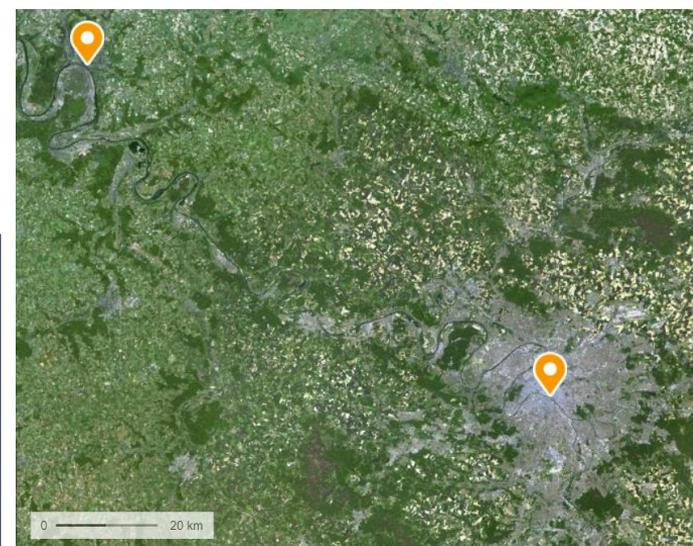
[Victor.david@suez.com](mailto:Victor.david@suez.com)



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



## Sign in

SIGN IN

[Forgot password?](#)
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SIMPAC Air Quality Platform

 bribstein
 

Version: 2021.08.11

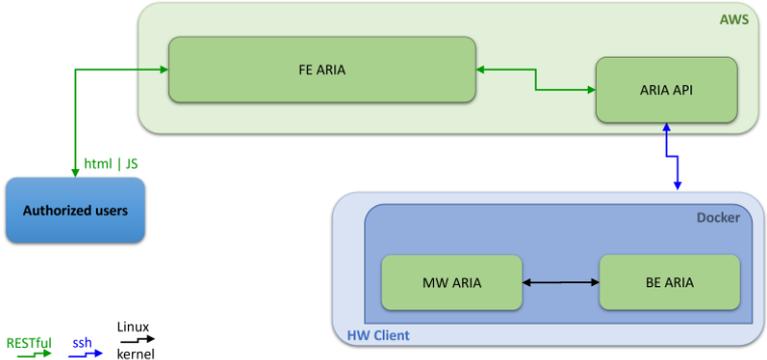
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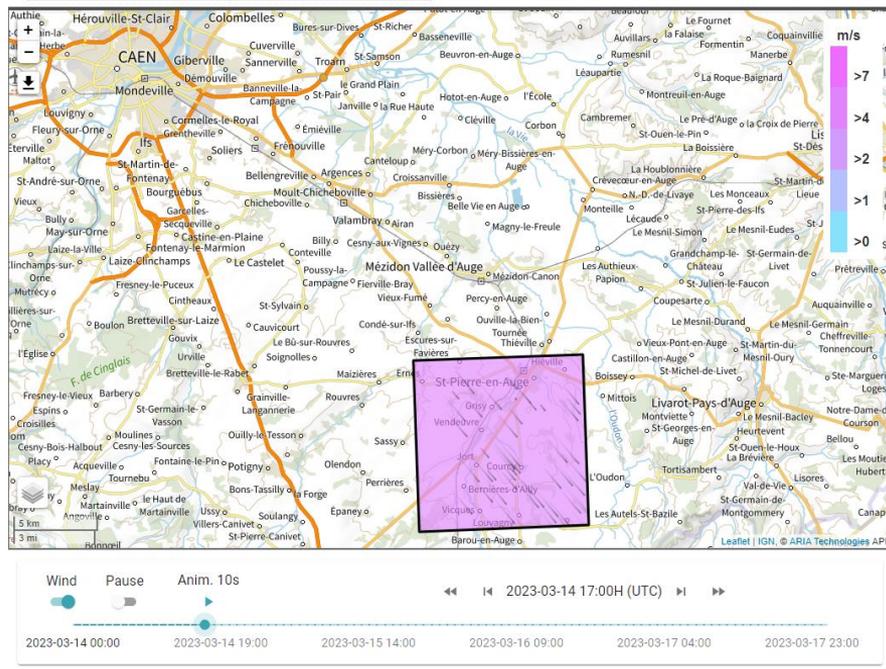



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<input type="radio"/>	241	doctest	Spray/Unit	doctest	2021-08-17 07:43:23	run_has_finished	<input type="checkbox"/>
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<input type="radio"/>	196	retro-traj-2	Rétro-Spray Traj	retro-traj	2021-08-10 13:04:30	run_has_finished	<input type="checkbox"/>
<input type="radio"/>	194	traj	Spray Traj	traj	2021-08-10 10:07:11	run_has_finished	<input type="checkbox"/>
<input type="radio"/>	191	retro-traj	Rétro-Spray Traj	retro-traj	2021-08-10 09:03:47	run_has_finished	<input type="checkbox"/>
<input type="radio"/>	145	STE-2	Rétro-Spray with STE	STE	2021-07-22 13:40:57	run_has_finished	<input type="checkbox"/>

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PSWIFT is a diagnostic atmospheric model that imposes mass conservation

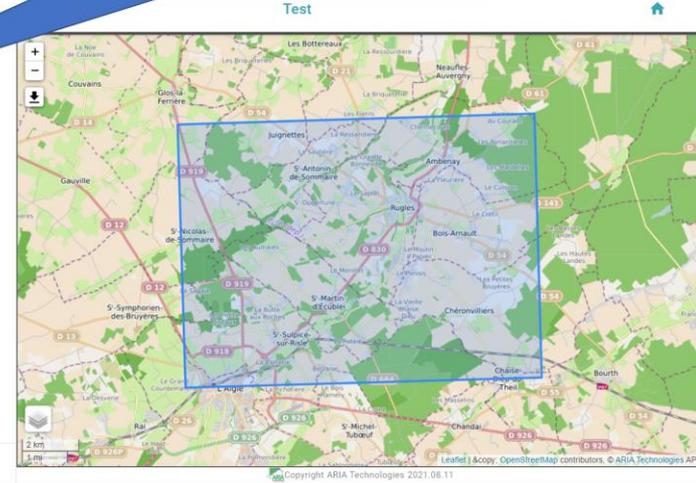


Start date (UTC) 2021-08-16 15:00 End date (UTC) 2021-08-16 20:00

SITE METEO

From large scale model  
From meteo stations  
User defined

Choosing the type of meteorological modelling for a simulation



Launching the simulation

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.**

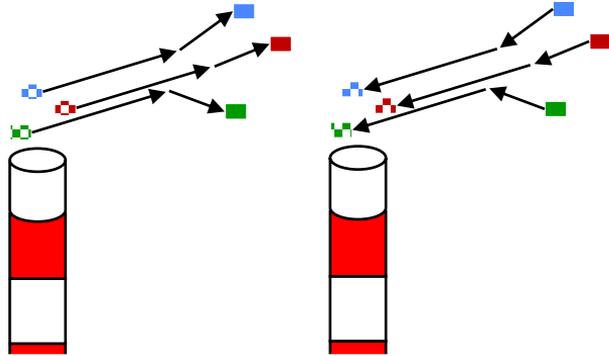
The emitted particles are numerical particles, and each carry a part of the emitted mass.

*Direct simulation :*

$$\bar{X}_0(t + dt) = X_0(t) + \bar{U}(X_0(t), t)dt + U'(X_0(t), t)dt$$

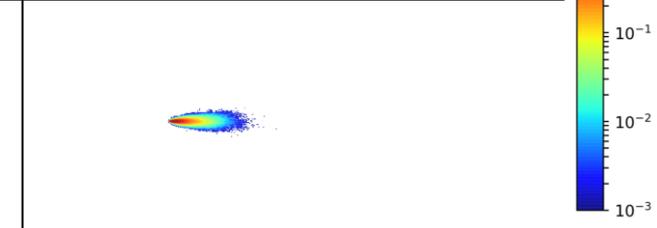
*Inverse simulation :*

$$\bar{X}_0(t - dt) = X_0(t) - \bar{U}(X_0(t), t)dt - U'(X_0(t), t)dt$$

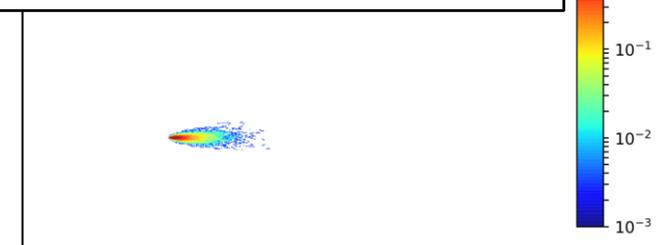


Configuration	Particle per time step	Species	Emitted flux
Trajectory	1	Tracer	1kg/h
Unitary	100	User define	1/kg/h
Cartographic	600	User define	User define

100 particles per seconde ~ 1min



1000 particles per seconde ~ 10min



# PSPRAY in SIMPAC

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

The screenshot shows the SIMPAC Air Quality Platform interface. On the left, there is a form titled 'Create a new source' with the following fields: Source type (SURFACE), List of sources of the simulation, Source name (Immeuble), Choose a source type (SURFACE), Type of emission source (POINT, SURFACE), Source group (Installation), Source site (Centre), and Location (92 m 1). A 'VALIDATE' button is at the bottom of the form. On the right, a map shows a city street grid with a blue polygon being drawn around a central area. A tooltip says 'Click that point to close this shape'.

The screenshot shows a map with a cluster of orange dots representing point sources. A dialog box is open with the following text: 'Name:', 'h: 10; d: 1; t: 150; v: 1;', and 'ADD TO SIMULATION'.

The screenshot shows a document titled 'RAPPORT D'ETUDE' with the following text: '14 / 03 / 2014', 'Ref. : DRA-14-141478-03176A', 'Formalisation du savoir et des outils dans le domaine des risques majeurs (DRA-76)', and 'Ω-2 Modélisations de feux industriels'.

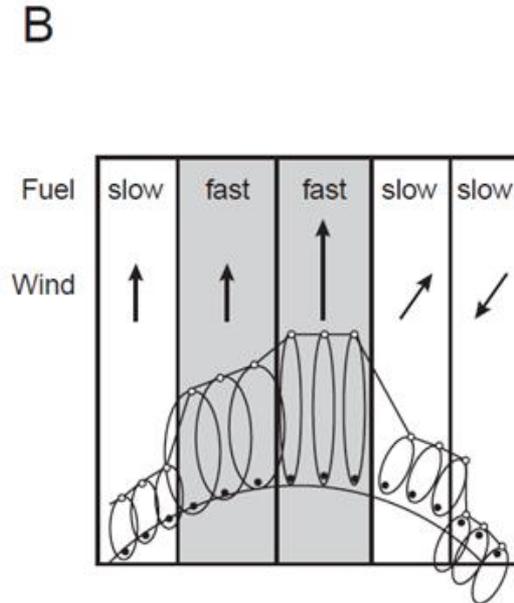
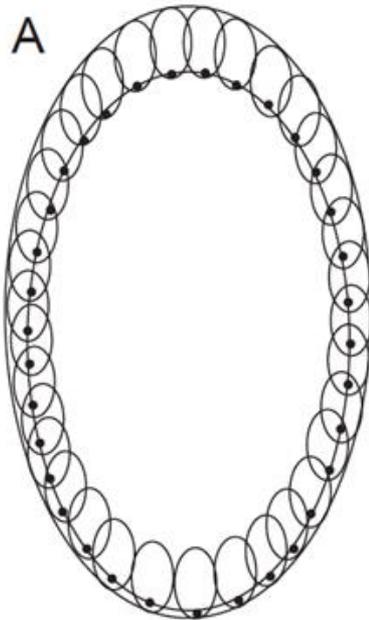
The user can define surface sources, using the computer mouse through the interface .

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

# Forest Propagation Model in SIMPAC

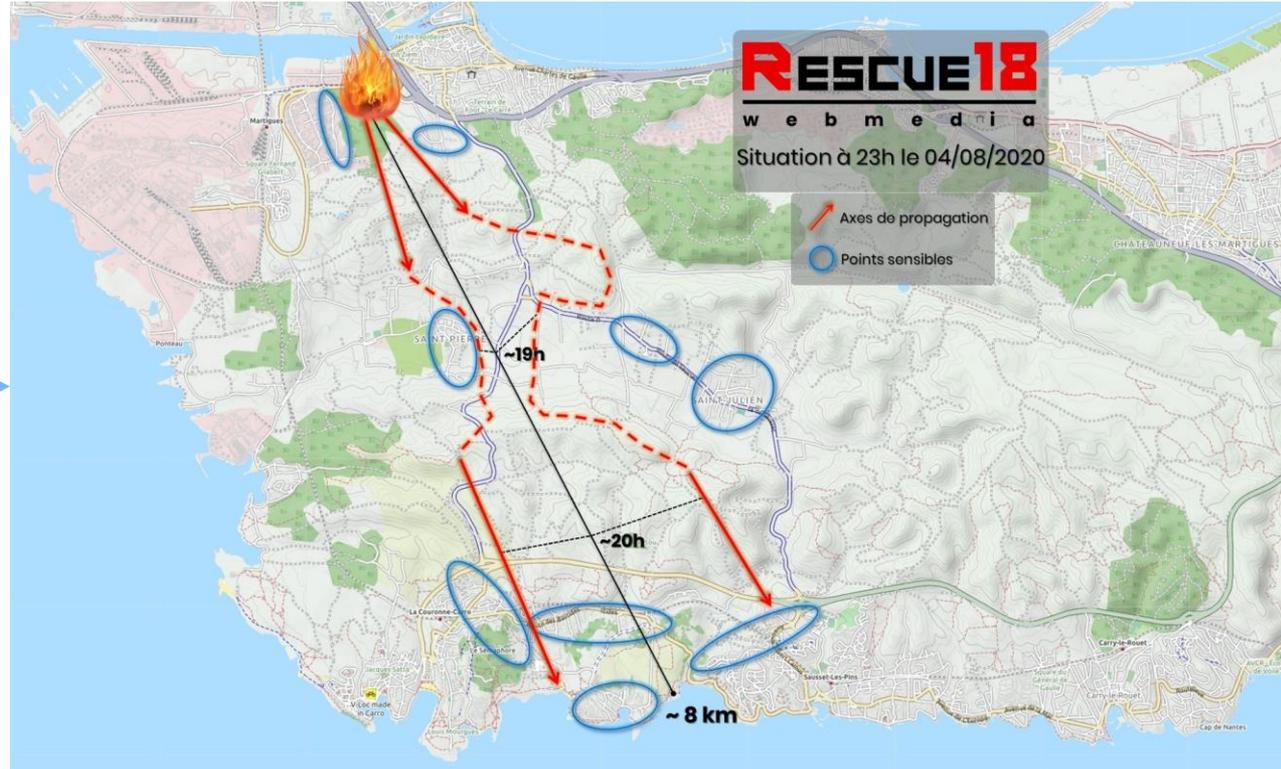
The FARSITE model follows a vectorial approach.

- 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.



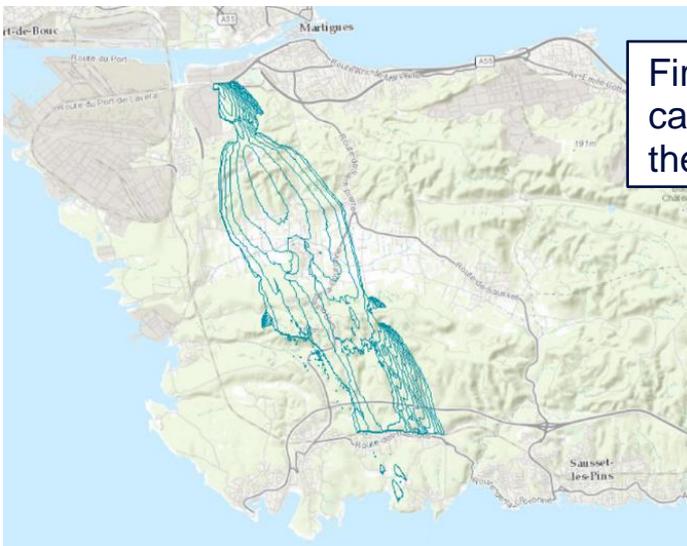
# FARSITE in SIMPAC

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

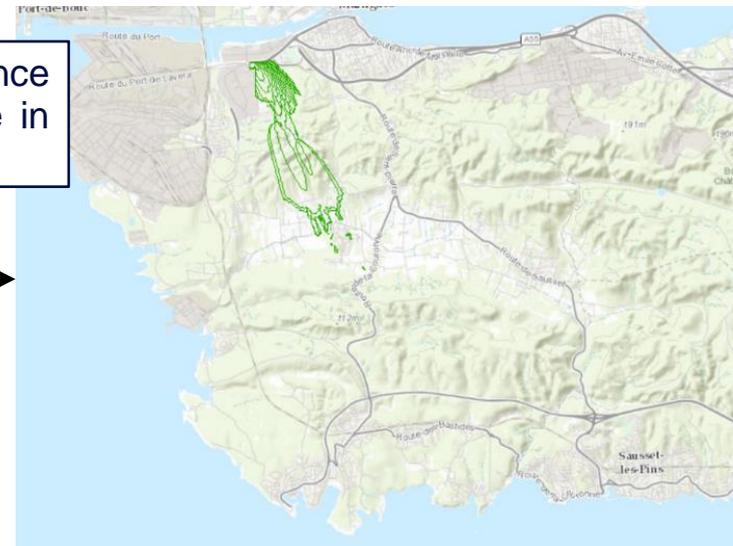


**The humidity of the fuel is the ratio of the amount of water contained in the wood divided by the mass of the anhydrous wood. The humidity of the fuel strongly influences the fire spread.**

- 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.



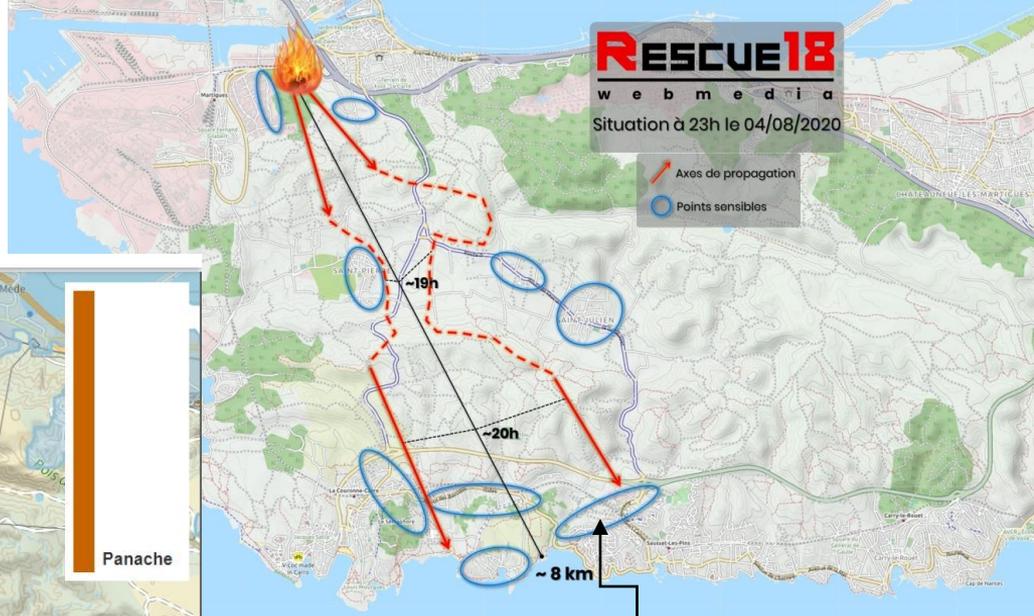
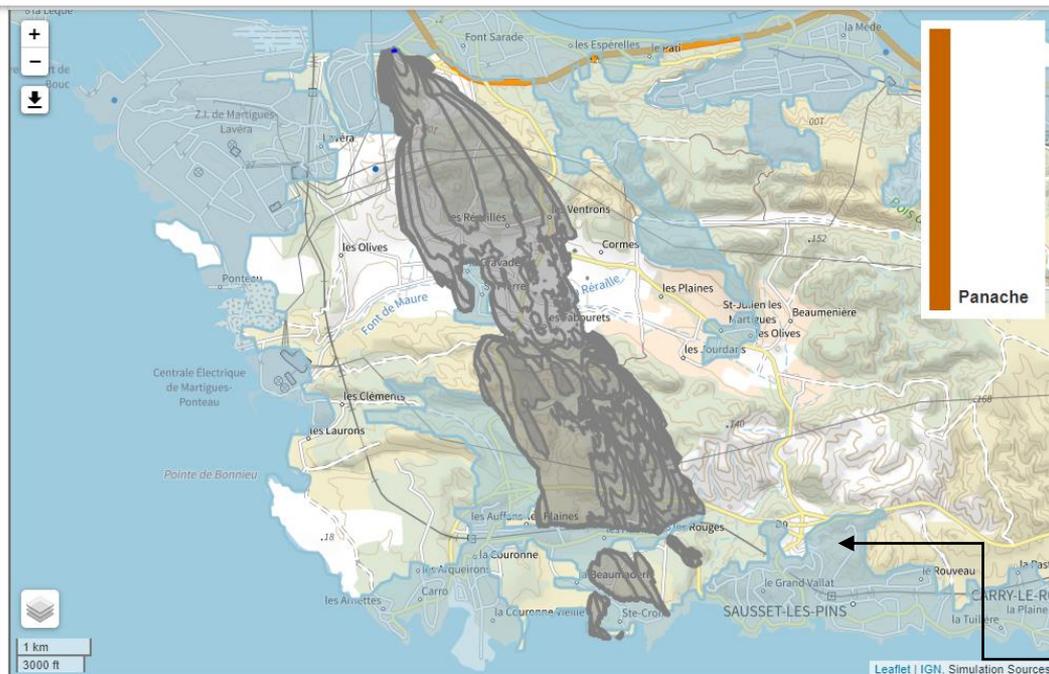
Fire front obtained for the reference case (left) and with an increase in the fuel humidity of 5% (right).



# 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.

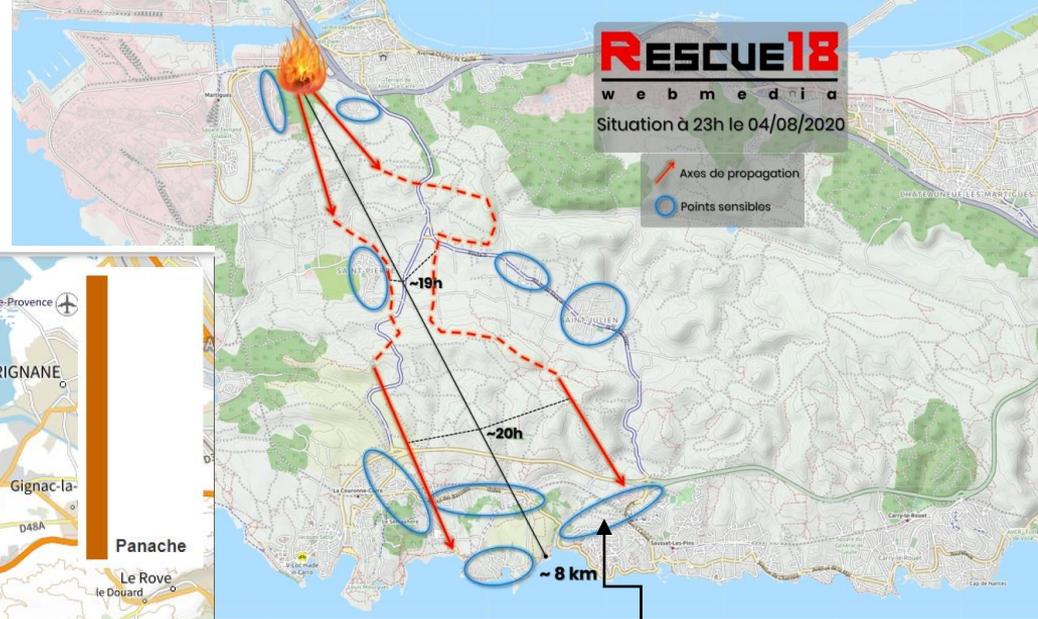
non-burnable area (sea or urban areas)



# FARSITE in SIMPAC

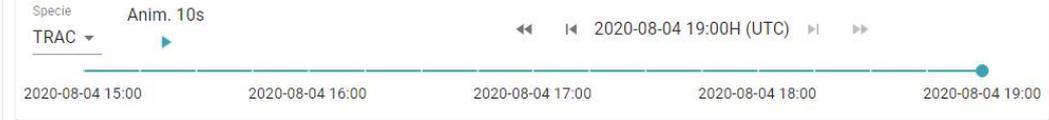
Istres and Marignane met stations

CPU time : FARSITE + PSPRAY = 9min



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

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



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Bruno Ribstein



**Merci**

Any questions ?