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MODELING OF PESTICIDE ATMOSPHERIC CONCENTRATIONS WITH CHIMERE

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Introduction

Necessity to have high-resolution maps of pesticide concentrations for epidemiologists in order to study the impact of pesticides on human health

Air quality models could be used to simulate maps of pesticide concentrations at the regional or national scale

A Soil/Vegetation/Atmosphere exchange module was implemented into CHIMERE to simulate pesticide volatilization from contaminated crops

The pesticide version was tested for two pesticides:

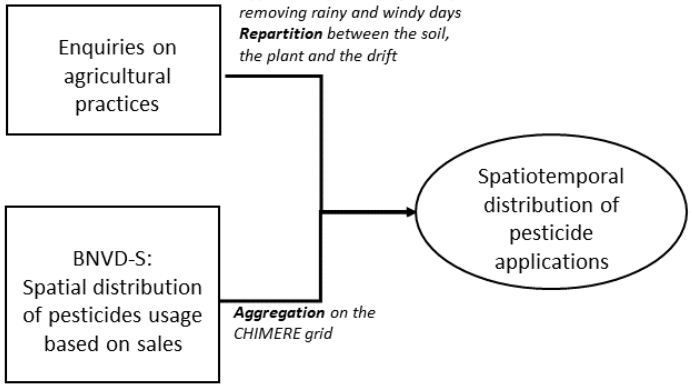
- **S-metolachlor:** a herbicide mainly use on maize at the early stage of the crop growth. One of the most frequently detected pesticide in air in France**. Representative of pesticide emissions from soils.**
- **Folpet:** a fungicide mostly used to treat mildew in vineyards. **Representative of pesticide emissions from vegetation.**

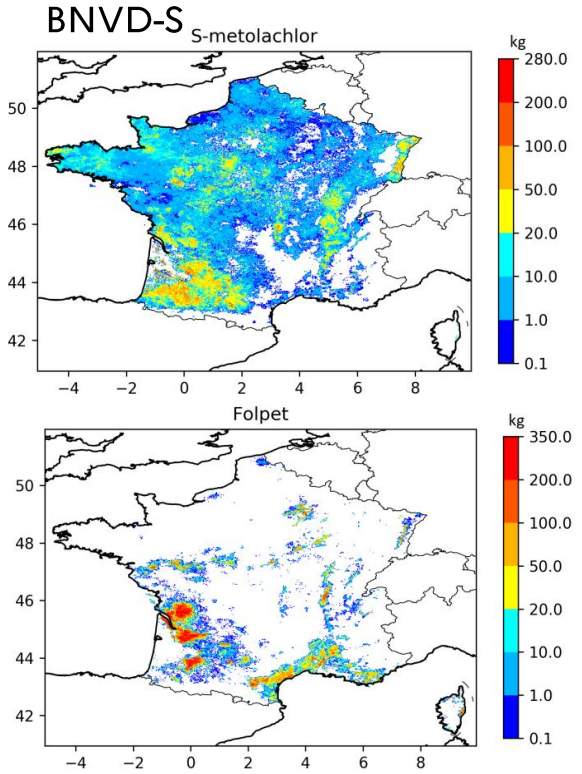
Methodology

First step: Estimating the spatiotemporal distribution of pesticide applications

Over France, the BNVD-S database provide a good estimation of pesticide usages (methodology based on sales and provided ZIP code)

Temporal distribution determined based on expert enquiries for the southeastern region of France (applied for the whole country)

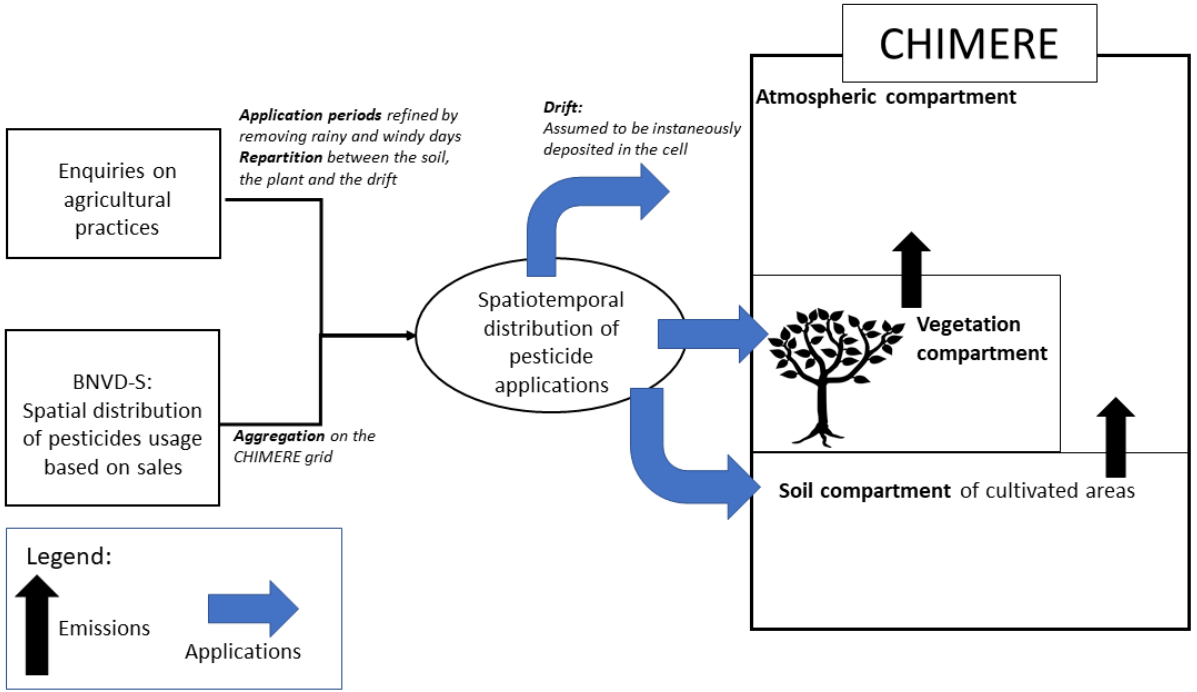




Methodology

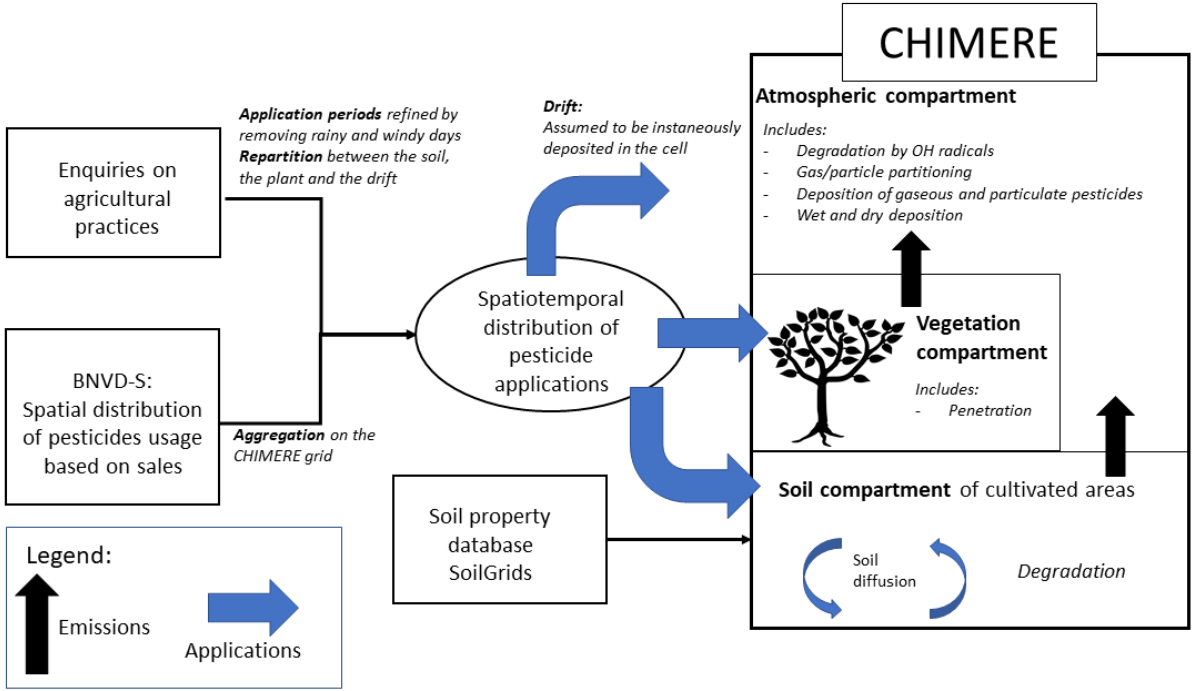
Second step: Distributing pesticide usages on the different compartments

Estimation based on the type of materials used



Methodology

Third step: representing the different processes into CHIMERE



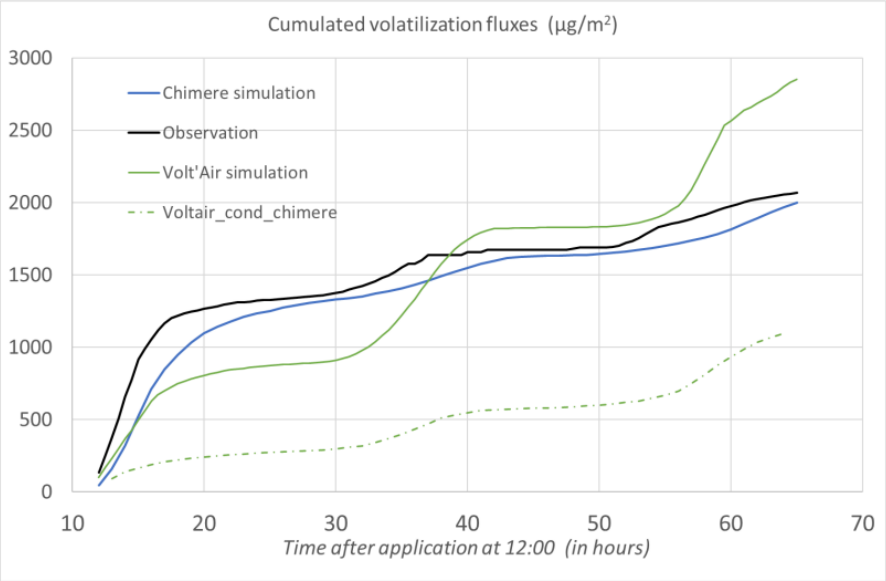
Evaluation of volatilization fluxes

Measured fluxes of pesticides are scarce whereas the physicochemical parameter needed to calculate volatilization are very uncertain (saturation vapor pressure, lifetime of the compounds in the soil)

Comparison of **S-metolachlor** volatilisation fluxes predicted by CHIMERE to measurement and to the result of the Volt'Air model (developped by INRAE). No data for Folpet.

Good fluxes simulated by CHIMERE but:

- No information on the long-term volatilization of pesticides
- Soil humidity and temperature taken from IFS



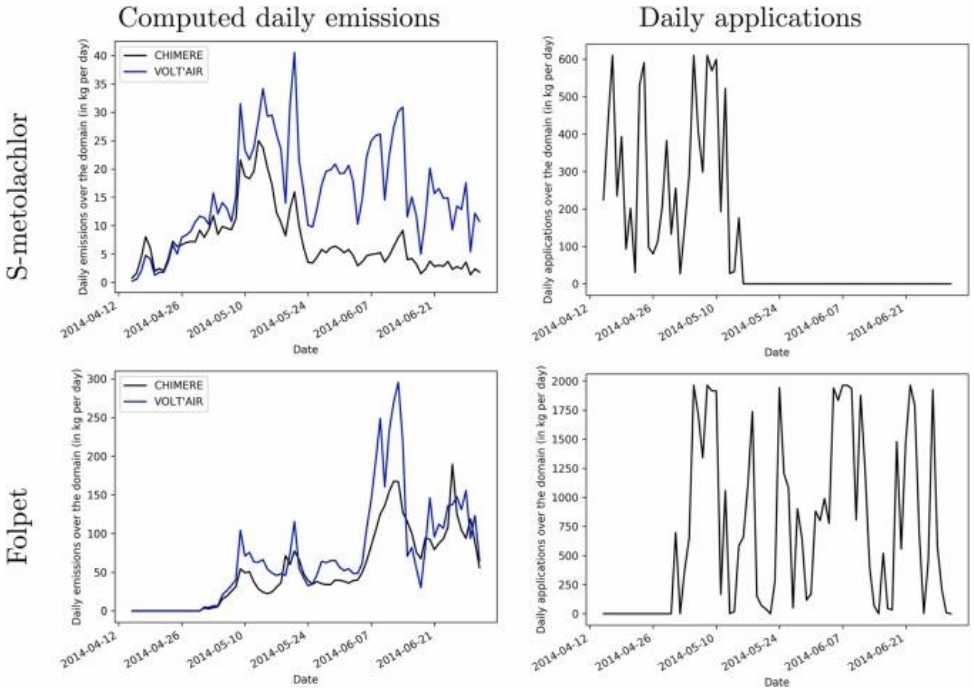
Estimation of emissions over France

Applications are evenly distributed throughout the application period:

- Rainy days and windy days (above 19 km/h) are removed
- Application periods are determined based on enquiries.

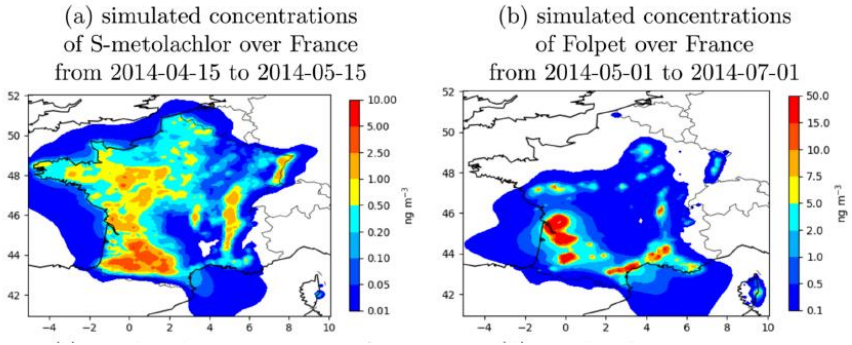
For S-metolachlor, similar emissions between Volt'Air and CHIMERE during the application period but very different estimations after the application period

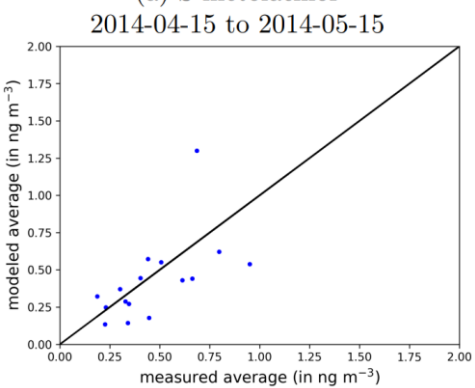
Very similar estimations for Folpel



Main results

Concentrations in ng/m³





Year of simulation: 2014. Only year for which the BNVD-S database was available at the time of the project

Resolution: 0.1°

The model can reproduce the order of magnitude of pesticide atmospheric concentrations

- ✓ S-metolachlor and folpet

Can reproduce the spatial distribution of concentrations over France

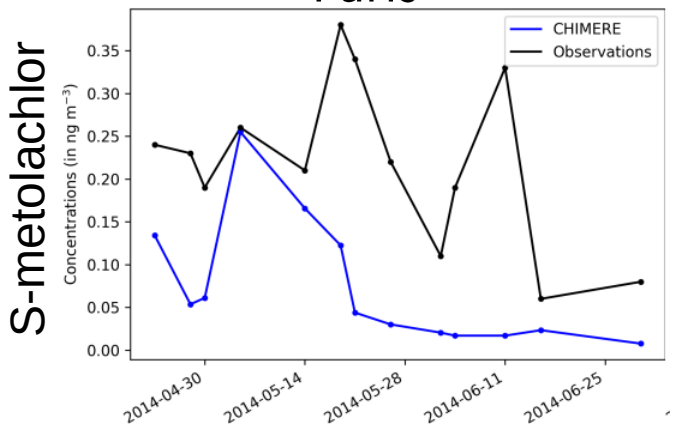
- ✓ S-metolachlor – spatial correlation of 0.79 (correlation between measured and modeled temporal average)
- ✓ Folpet : high detection limit – few exploitable data

Main results

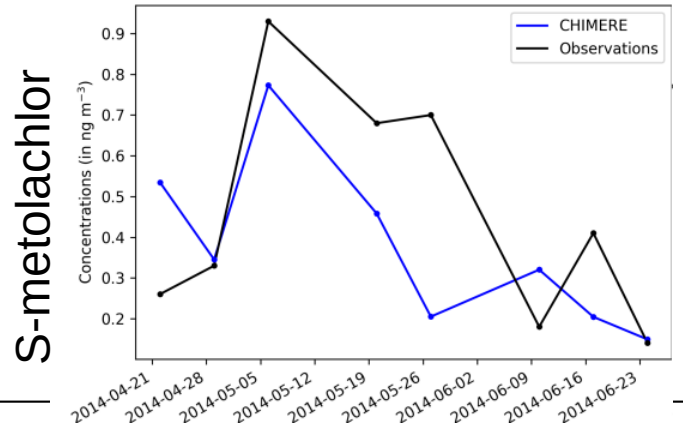
The estimation of the temporal evolution of concentrations is very difficult:

- Lack of precision in application period
- The temporal coverage of measurements was poor
- Possible underestimation of the lifetime of S-metolachlor in soils: around 1 month (PPDB) but data in the literature are between a few days to more than 200 days

Paris



Roussillon (Southeast of France)

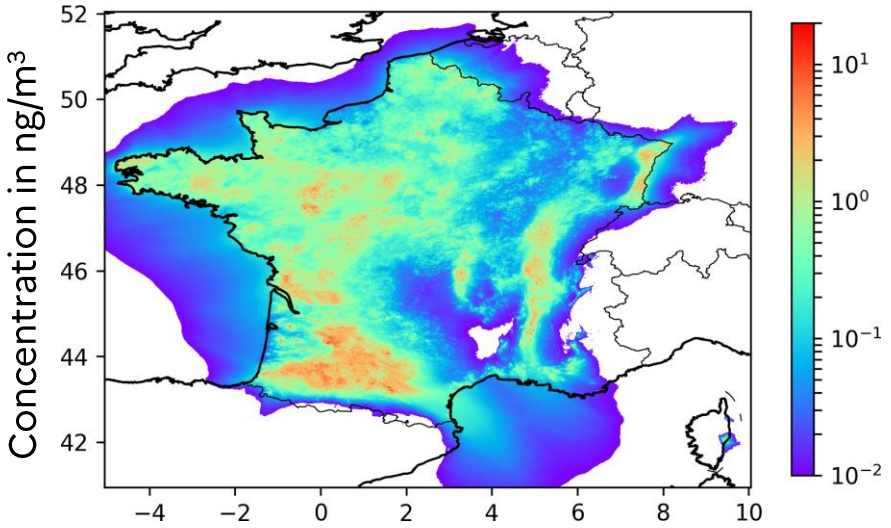


Downscaling

The resolution of CHIMERE simulations can be a limit to their use for exposure calculations

- A downscaling method has been implemented in CHIMERE (Couvidat et al., in prep)
- Consist in redistributing information (emissions, gas-particle partitioning, chemical degradation) on the coarse grid on a finer grid
- Resolution still insufficient to calculate exposure to drift droplet (Possibility to combine CHIMERE with models dedicated to drift dispersion)
- Errors generated by the downscaling approach around a few percents.
- Limited increase in computation time. Increase by a factor between 1.6 and 9 (depending on the way the downscaling is performed) for a resolution increased by a factor 25

S-metolachlor (around 400 m de horizontal resolution)



Conclusions

CHIMERE-pesticides : methodological barriers were removed. Could be used as a basis for epidemiological studies.

The lack of information on spatiotemporal application of pesticide is currently the primary barrier to the use of CHIMERE-pesticides for exposure determination

For each pesticide, modeled emission fluxes should be compared to multiple flux measurements performed under different conditions. Need of data to evaluate the long-term emissions of pesticides (several days/weeks after the application)

The French national campaign on pesticides should be simulated

Specific cases of certain substances such as lindane, which would require the reconstruction of concentrations on a global scale over several decades because of its long lifespan

Thank you for your attention

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Simulating the impact of volatilization on atmospheric concentrations of pesticides with the 3D chemistry-transport model CHIMERE: Method development and application to S-metolachlor and folpet

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