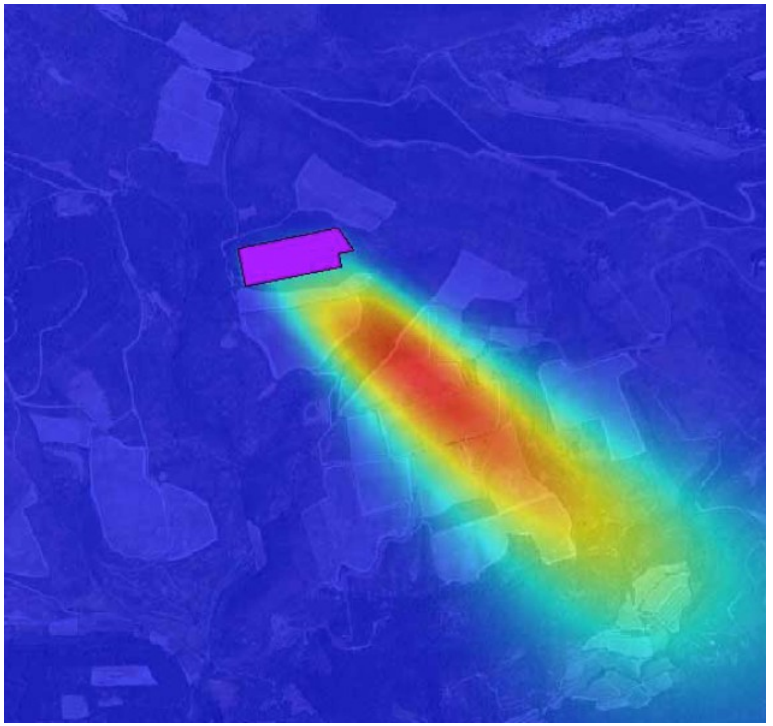
Drift-X WPS:
Pesticide atmospheric dispersion Web GIS



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Presentation outline

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2) Coupling atmospheric dispersion modeling and open source GIS

2.1) Atmospheric dispersion modeling
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Environmental issue (1)

Massive pesticide spraying especially for wine-growing

Contamination of soils, water and air

Typical pesticide sprayer used for wine-growing

Environmental issue (2)

Atmospheric dispersion of pesticide

Pesticide clouds transported by the wind and deposited on the surroundings

Early morning pesticide cloud (France)

Past research goals

- Defining a methodological framework for coupling atmospheric dispersion modeling and Geographical Information Systems

- Running atmospheric dispersion simulations according to wind measurments and the local topography (DEMs)

- Analysing the model's sensitivity according to the topography resolution

- Mapping the pesticides clouds deposition

- Tending to risk analysis

Atmospheric dispersion modelling (ADM)

- ADM is an essential tool in air quality management because it provides a relationship between source terms locations (i.e where discharges to the air occur) and observed adverse effects on the environment and the neighborhood.

- ADM refers to the mathematical simulation of air pollutants in the ambient atmosphere. They are intimately related to numerical simulations as most models are performed with computer programs.

- As ADM is complex and because air pollution cannot be measured in every place it occurs, models are used to simplify and simulate the dispersion of air pollutants from emission sources, and to to predict the downwind concentrations or depositions on a given area.

The Drift-X model

- Drift-X model is a probabilistic simplified Gaussian atmospheric dispersion model able to forecast pesticide spray drift after the treatment, from the plot to the watershed scales.

- The model operates within a domain of several square kilometers corresponding to a typical southern French small wine-growing area

- Drift-X is based on a reduced-order modeling approach to flow field reconstruction with a small number of measurements, as well as to Gaussian plume transport over realistic topographies and unsteady wind flows

- The main goal of Drift-X is to provide the mean trajectory of a pesticide cloud after spraying applications, by forecasting the wind field and the pesticide concentrations for a permanent state. The wind flow is calculated according to the parameters and the DEM layer provided by the user.

- The model was coded in Fortran 77

Example Drift-X simulation

Domain for calculation is 8km2.

Cartographic projection is EPSG:27572

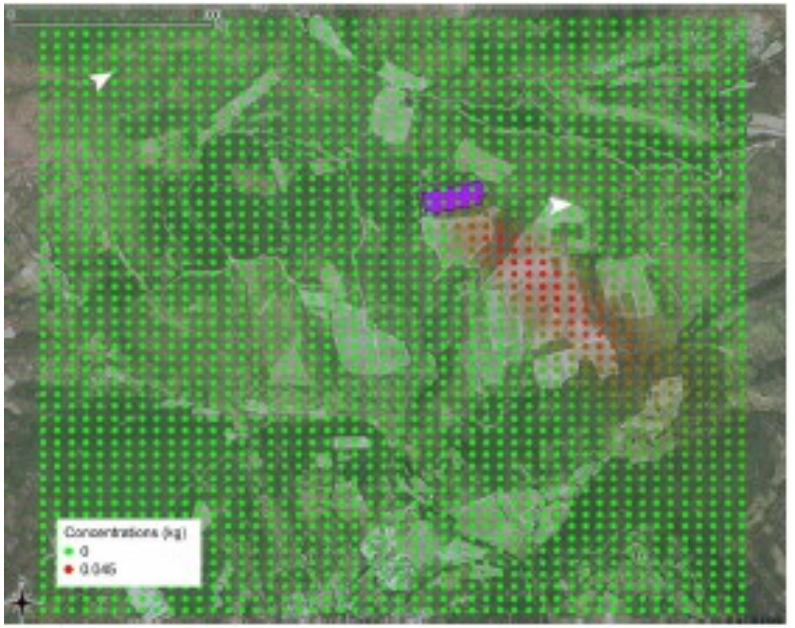
Input DEM layer is SRTM 90m resolution.

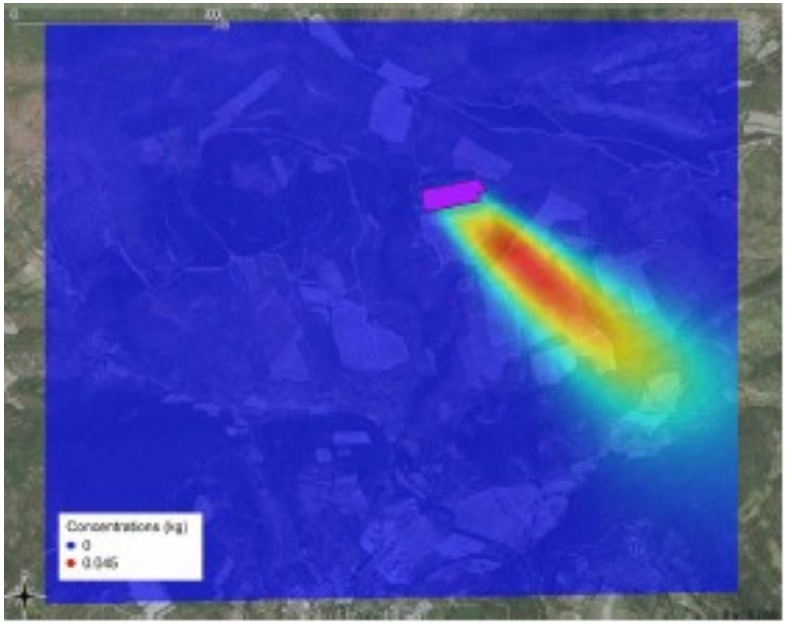
Source plot is 1 ha with 33 rows to treat.

Sprayer treats 3 rows at the same time at the average speed of 1 m/s.

Spraying nozzle output velocity is 7 m/s with an output ow of 0.001 kg/s.

Two wind points are used to calculate the flow field (N 60 - 5 m/s wind , N 30 -4 m/s wind.)





Integration of Drift-X in Quantum GIS

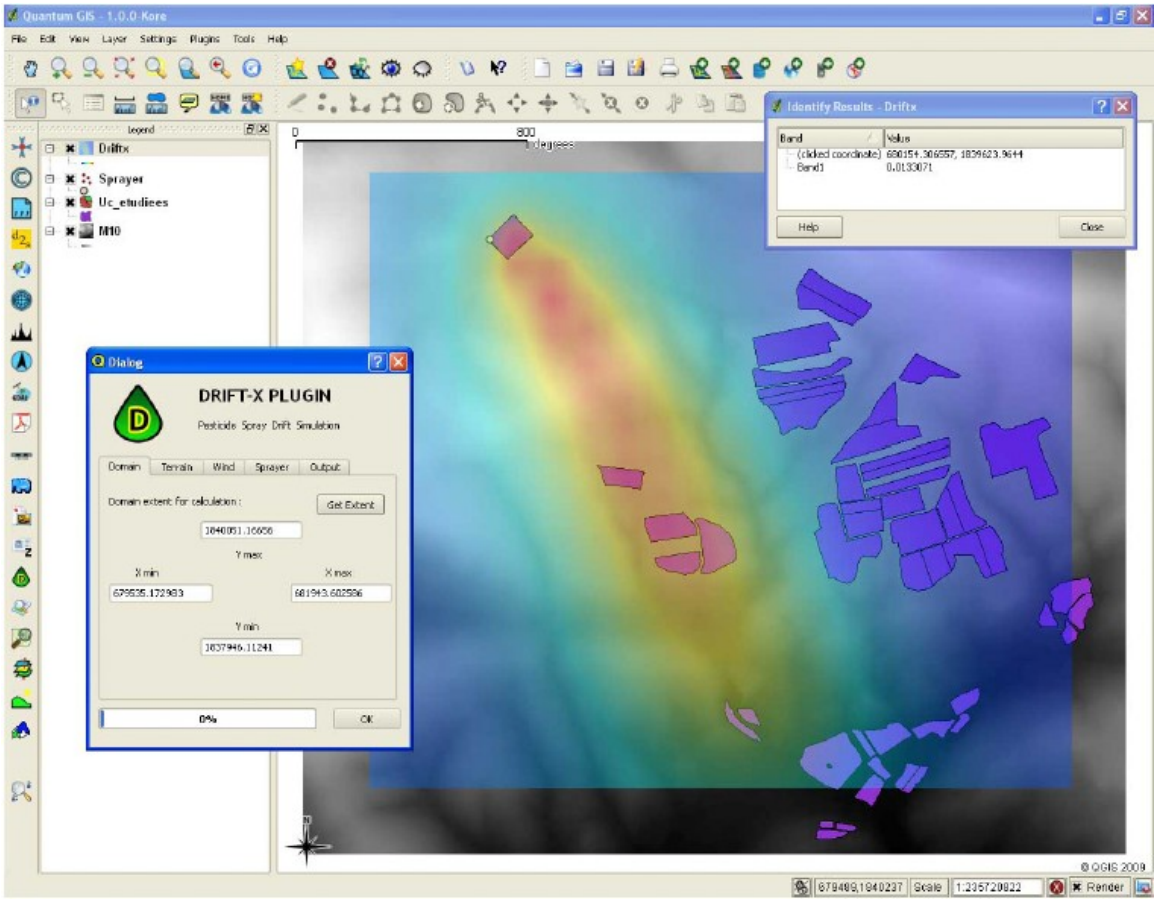
- Using the QGIS API and its Python bindings

- Fortran model called by the Drift-X Python QGIS plugin

- Parameters (wind, plot, sprayer, extent and DEM) given by the user

- Few seconds for calculation depending on the size of the extent

- Other QGIS functionnalities used for querying and using the pesticide layer for risk analysis



QGIS interface with the Drift-X plugin activated and example output displayed

Enabling Drift-X WPS using ZOO 1.0

- New research goals for Drift-X

- ZOO Project presentation

- WPS Chaining for Drift-X

- Pesticide Atmospheric dispersion Web GIS

New research goals for Drift-X

- Adapting the Fortran model to a WPS architecture

- Enabling the Fortran support in ZOO 1.0 (Drift-X WPS as a ZOO Fortran use case)

- Developing a methodology for integrating legacy models in ZOO 1.0

- Implementing WPS Chaining for Drift-X

- Building a pesticide atmospheric dispersion Web GIS

ZOO 1.0: The powerful WPS platform (1)

- ZOO 1.0 is an open-source project providing a server-side C Kernel which makes it possible to create, manage and chain WPS 1.0.0 compliant Web Services, by loading dynamic libraries and handling them on-demand.

- ZOO 1.0 is composed of:

    - ZOO Kernel (C)
    - ZOO Services (C & Python)
    - ZOO API (JavaScript)

- ZOO can easily connect to geospatial libraries and scientific models, but also with the common cartographic engines and spatial databases.

http://www.zoo-project.org

ZOO 1.0: The powerful WPS platform (2)

ZOO Kernel is written in C language, but Web Services can be programmed in C, Python, Java, Fortran, PHP and JavaScript. This multi-language support is convenient for developers and allows above all to use existing code to create new Web Services.

ZOO Services tends to become a suite of example Web services based on various Open Source libraries (GDAL/OGR, GEOS, GRASS...)

ZOO API is a server-side JavaScript API based on Mozilla SpiderMonkey, able to call and chain the ZOO Services, which makes the development and chaining processes easier.

http://www.zoo-project.org

WPS chaining for Drift-X

-WriteParams.py (Python ZOO Service to write the input parameters)

- Gdal_Translate.c (C ZOO Service to extract the 'z' values from the input DEM)

- grd2xyz.py (Python ZOO Service to convert the DEM values from .grid to .csv format)

- driftx.f (Fortran ZOO Service using the original Drift-X code)

- interpolate.c (C ZOO Service to interpolate the output .csv into a Geotiff raster layer)

- driftx-ms.py (Python ZOO Service to update mapfiles to be sent to MapServer and update the pesticide cloud rendering)

- driftx-wps.js (JavaScript ZOO Service to chain the 6 previous processes using ZOO.Request available in the ZOO API)

Building a pesticide atmospheric dispersion WebGIS

- WebGIS interface built with OpenLayers and Jquery

- Input parameters provided by the user using dedicated OpenLayers controls and Jquery forms

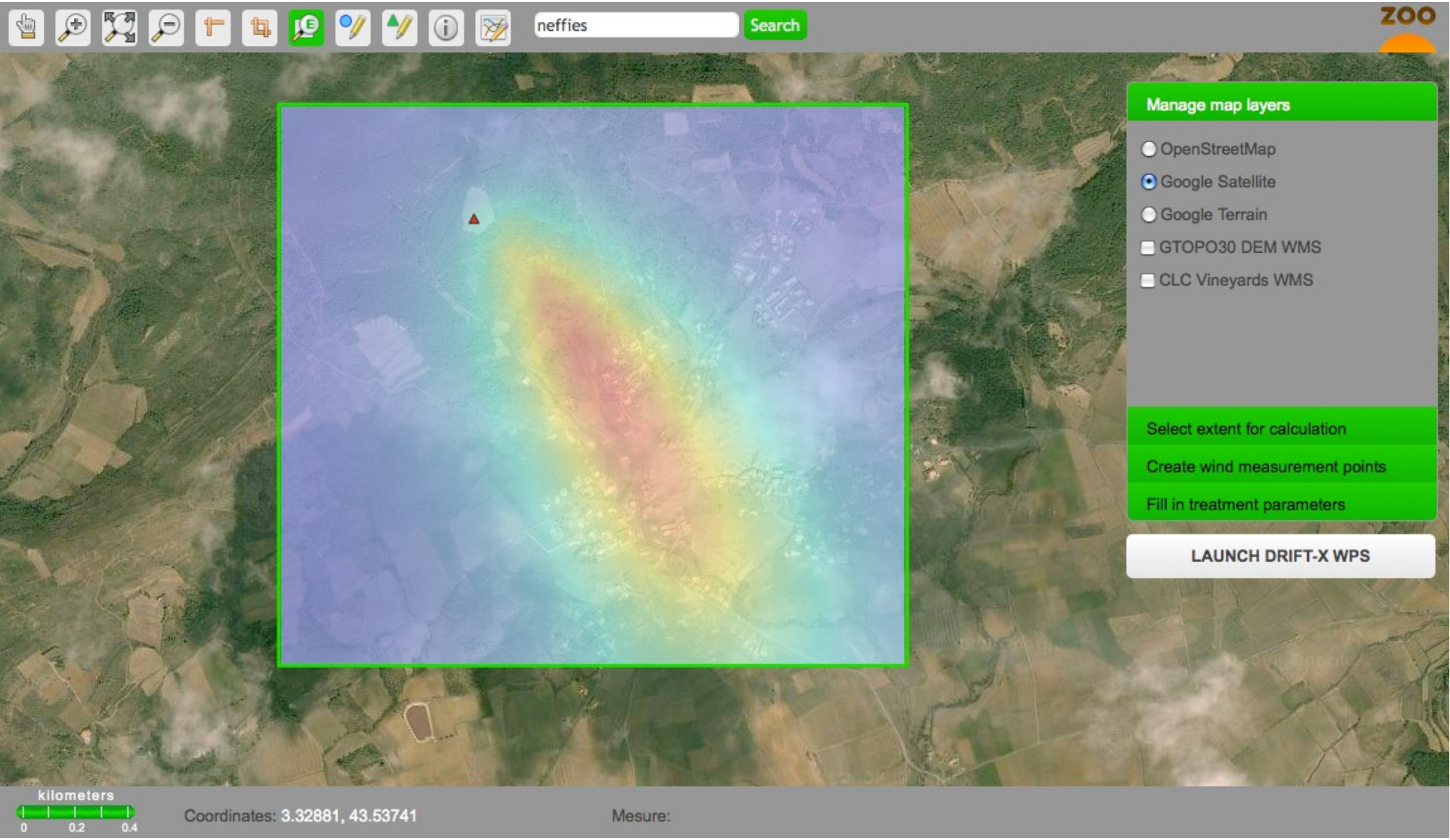
- Input topography data (SRTM) displayed as WMS using MapServer

- WPS chaining launch from the interface with a simple click

- Resulting pesticide cloud raster layer displayed as WMS using MapServer

- Some more specific controls to query the concentration values and profile from the pesticide cloud layer.

Drift-X WPS WebGIS interface



Conclusion

- Drift-X model past and new research goals has been presented

- Legacy models and Fortran support in ZOO 1.0 were demonstrated

- The multi-language capabilities of ZOO 1.0 were used to setup a complex WPS chaining using C, Python and Fortran ZOO Services.

- The power of the ZOO API was also demonstrated, as the whole chaining is driven by Javascript

- A WebGIS client has been setup using FOSS4G in order to provide a user-friendly interface to setup the input parameters, run the model and map the results automatically.

Future works:

- Implement some more controls to export the results in common GIS formats
- Used the developed methodology for implementing other scientific models server-side using ZOO 1.0 (ZOO4C4 project)

Thank you for your time !

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http://www.zoo-project.org