Numerical assessment of chemical species infiltration in the Prosecco area

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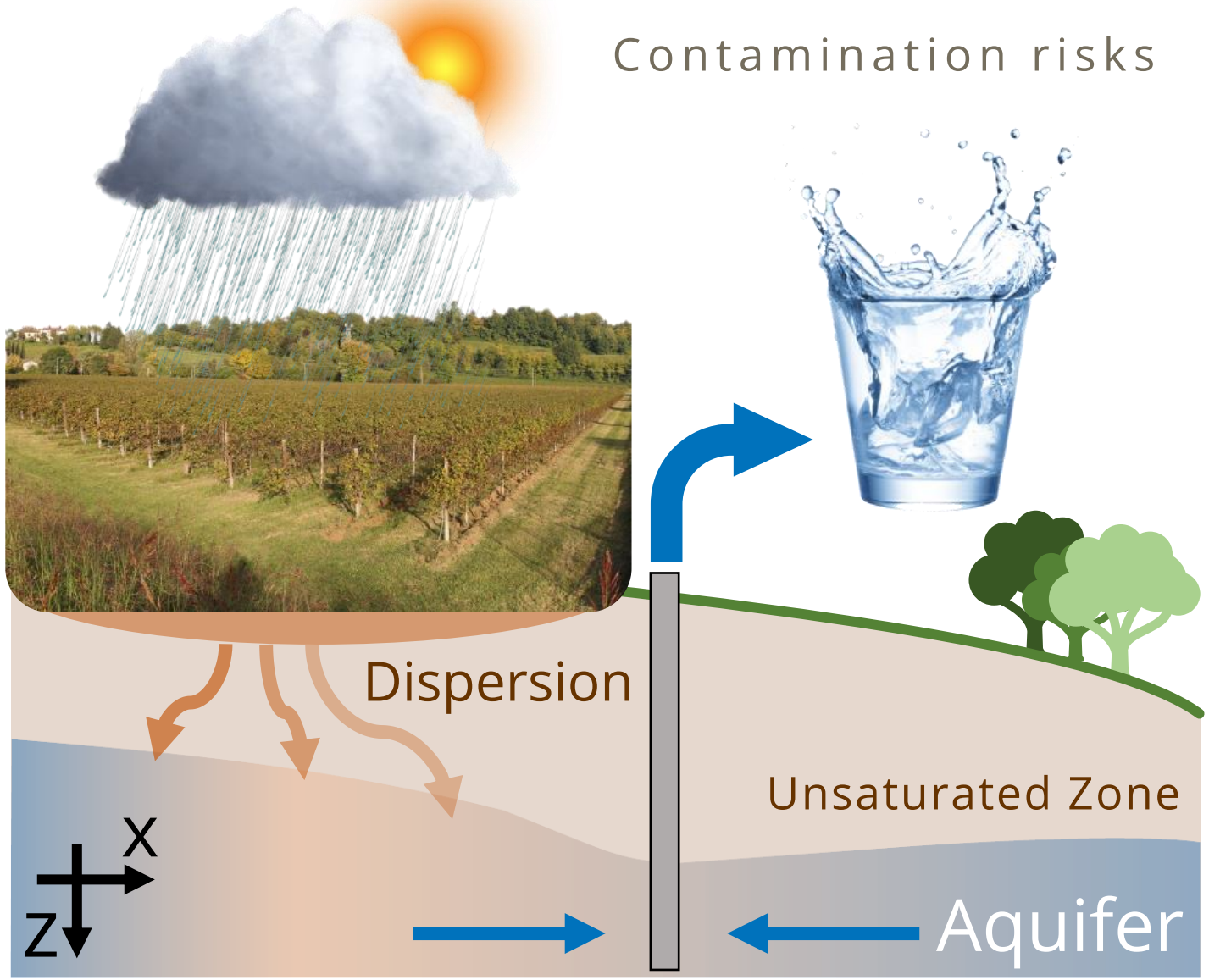
PROSECCO AREA

D.O.C.G. PRODUCTION ZONE

www.prosecco.it/it/territorio/unesco/

Use of herbicide along the vineyards rows

Contamination risks



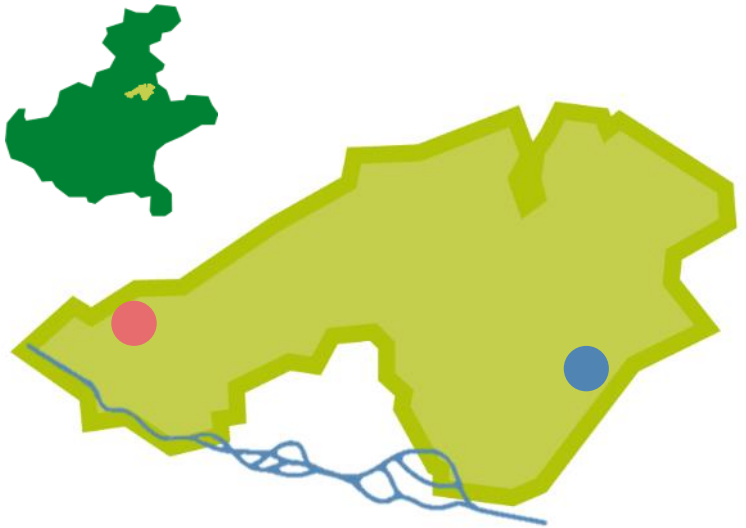
The SWAT project

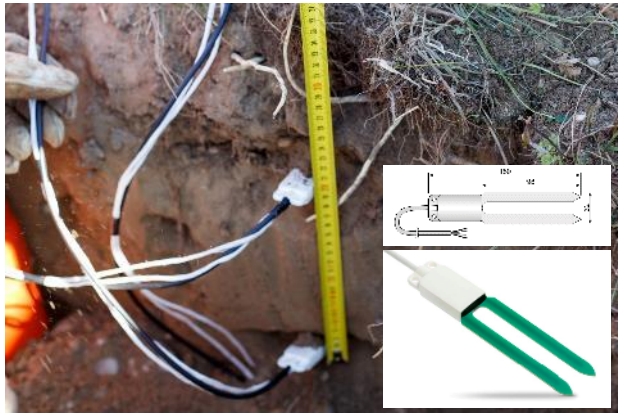
Subsurface **W**ater quality and **A**gricultural prac**T**ices monitoring

2 monitoring installations, each of them subdivided in 2 parcels, were organized in October 2018 in **2 wells protection areas**

- **SETTOLO SITE** (VALDOBBIADENE)
  Settolo North and Settolo South parcels
- **COLNÙ SITE** (CONEGLIANO)
  Colnù East and Colnù West parcels

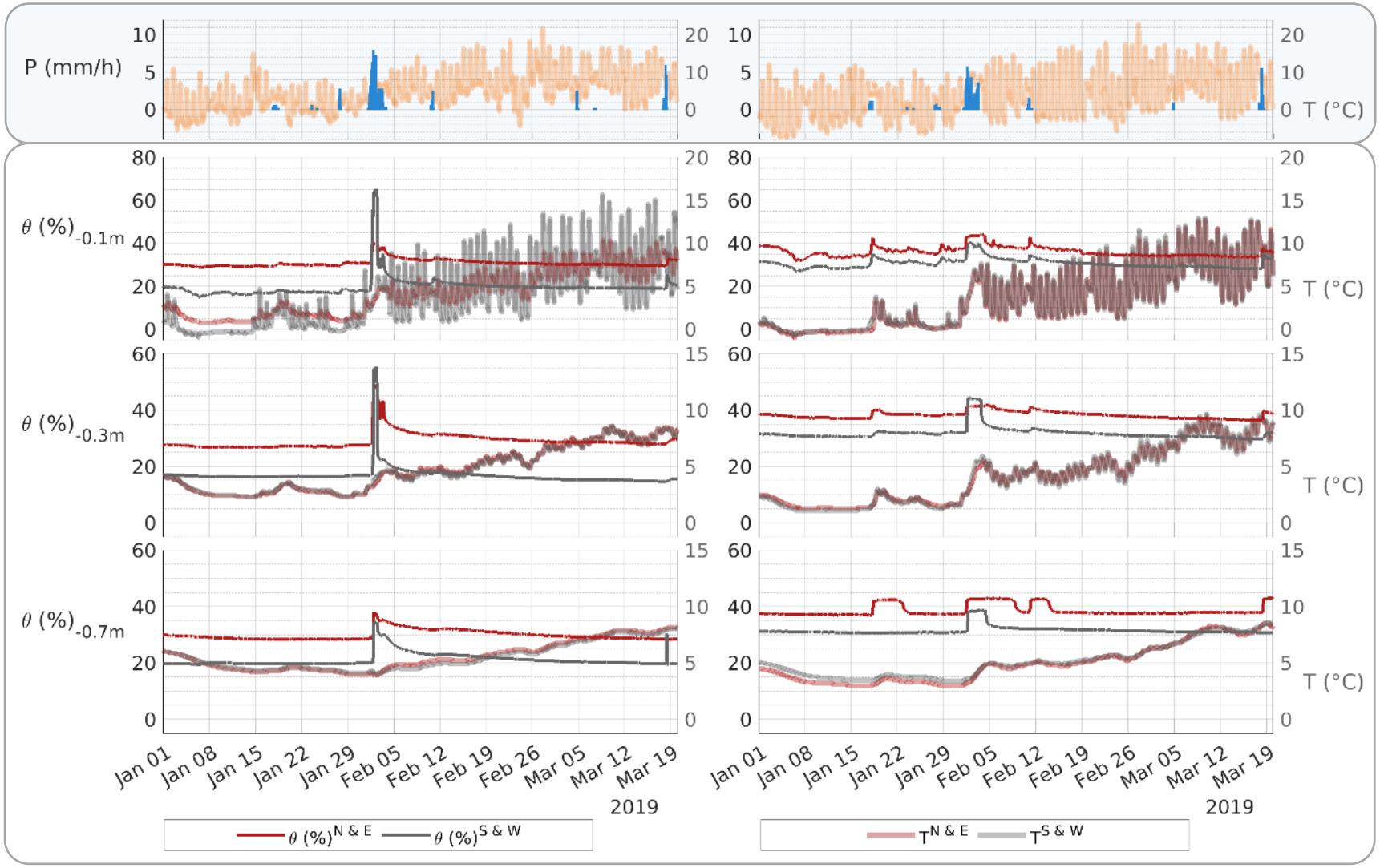
Unconfined aquifers
water tables few meters underneath the surface





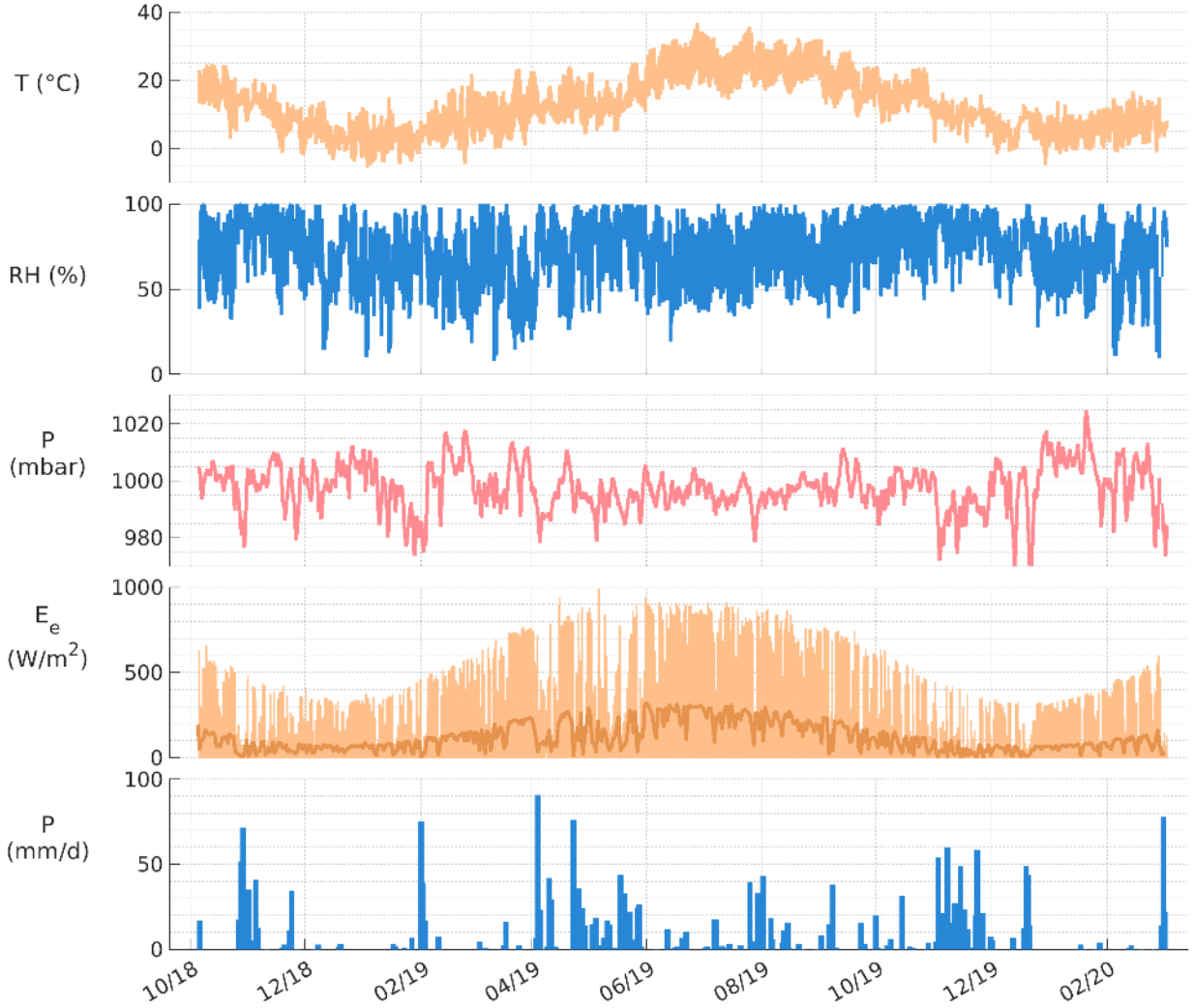
Capacitive sensors and porous cups were installed at
- 0,1 m, - 0,3 m, - 0,7 m (x2 for each site)

Capacitive sensors data logger and transmitter



Volumetric Water Content (θ) and Temperature (T) acquired by the capacitive sensors at Settolo (left) and Colnù (right) (Example: 10 weeks temporal window)

2 meteorological stations were installed (one for each experimental site)



Meteorological variables acquired at Settolo from October 2018 to April 2020

+

var	description	unit
v_w	Wind velocity at 2 m	(m/s)
T_w	Wind temperature	(°C)
D	Wind direction	(degrees)

HYDROLICAL FORCING
and variables needed for
FAO PENMAN-MONTEITH EQUATION
for evapotranspiration modelling

November 2018

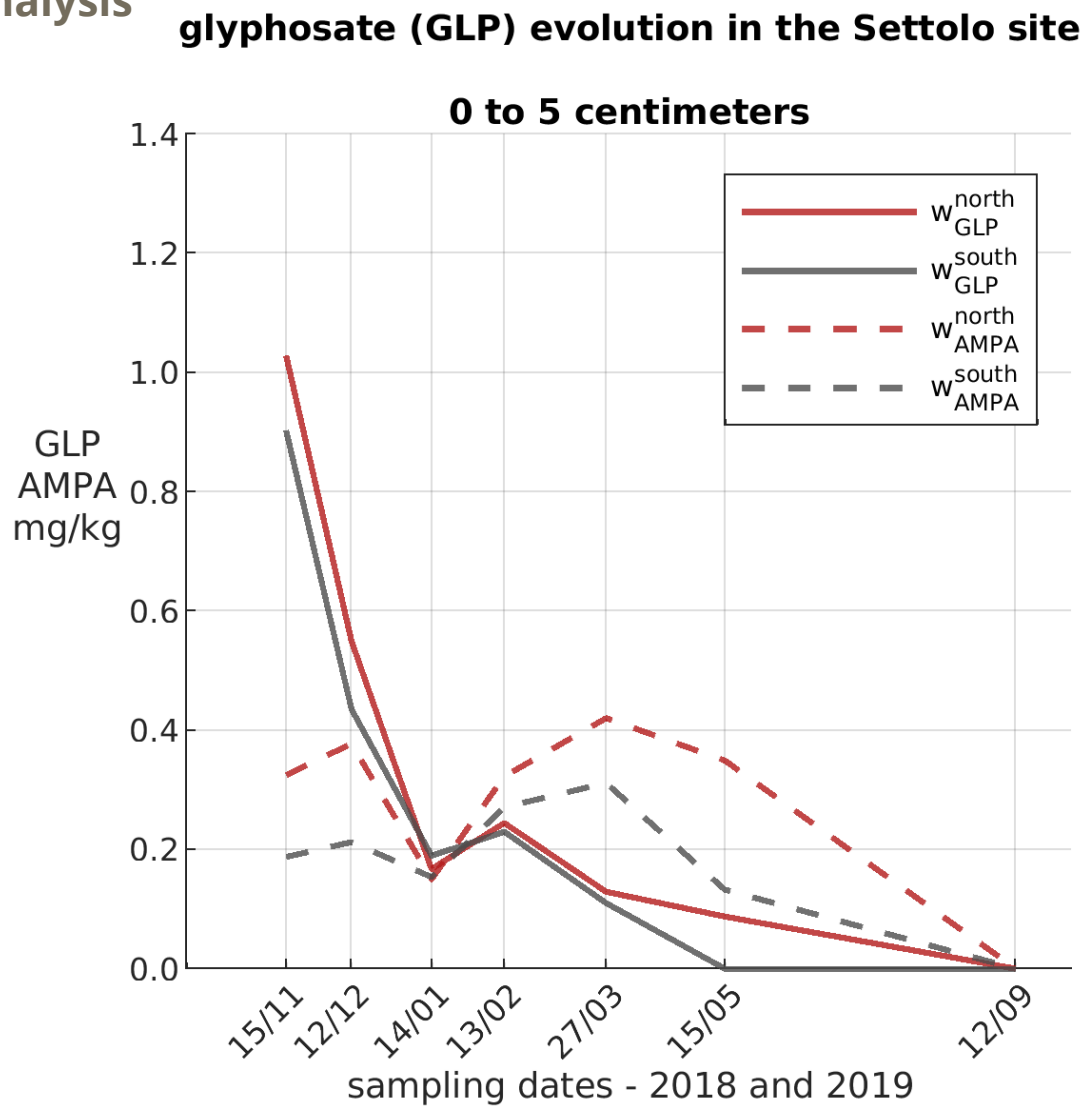
A solution containing **glyphosate (GLP)** and **potassium bromide (KBr)** was applied on all the 4 site parcels

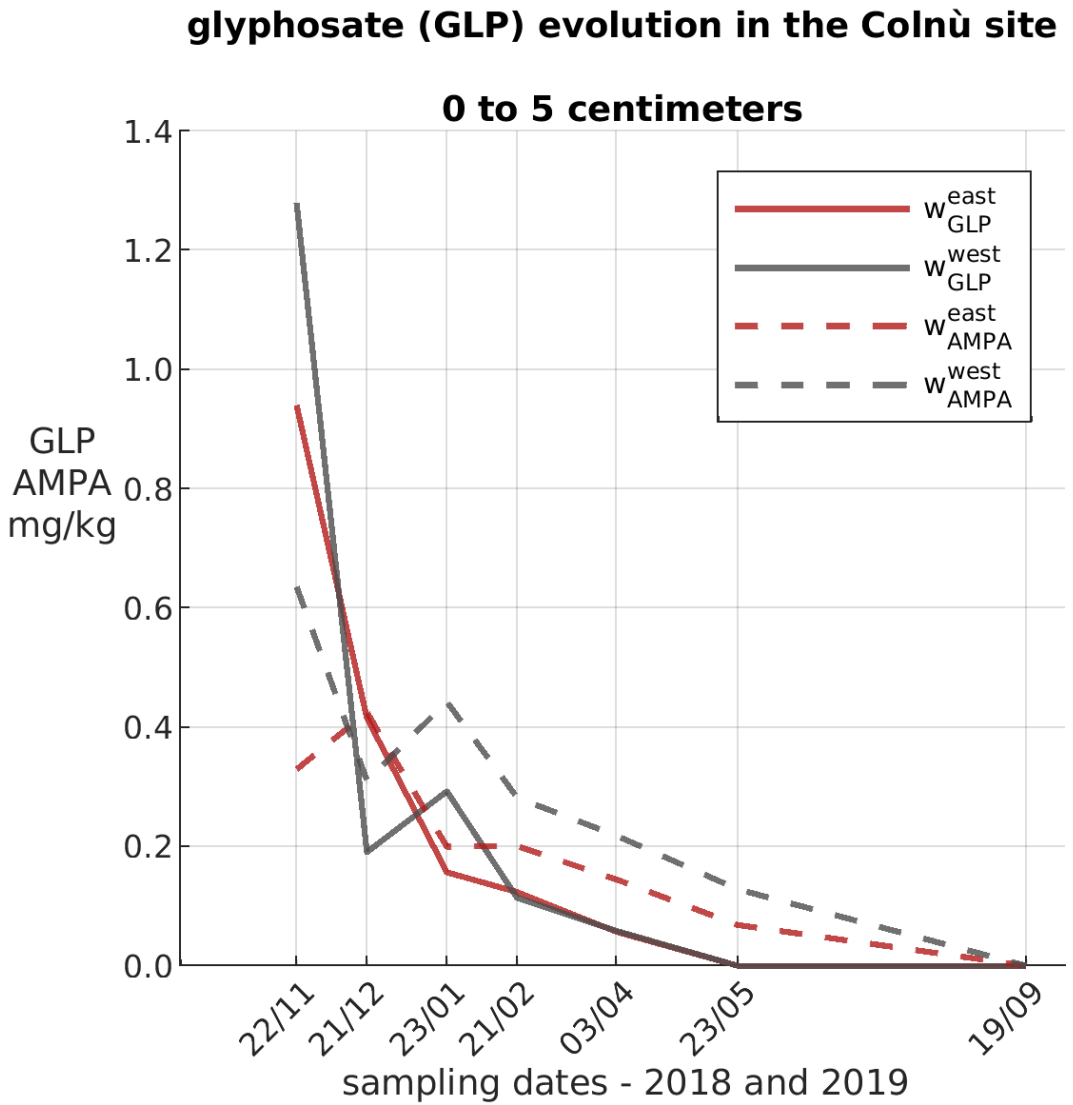
Soil Analysis

Chemical, Physical, Hydraulic properties
GLP and metabolite AMPA concetrations

Water Analysis

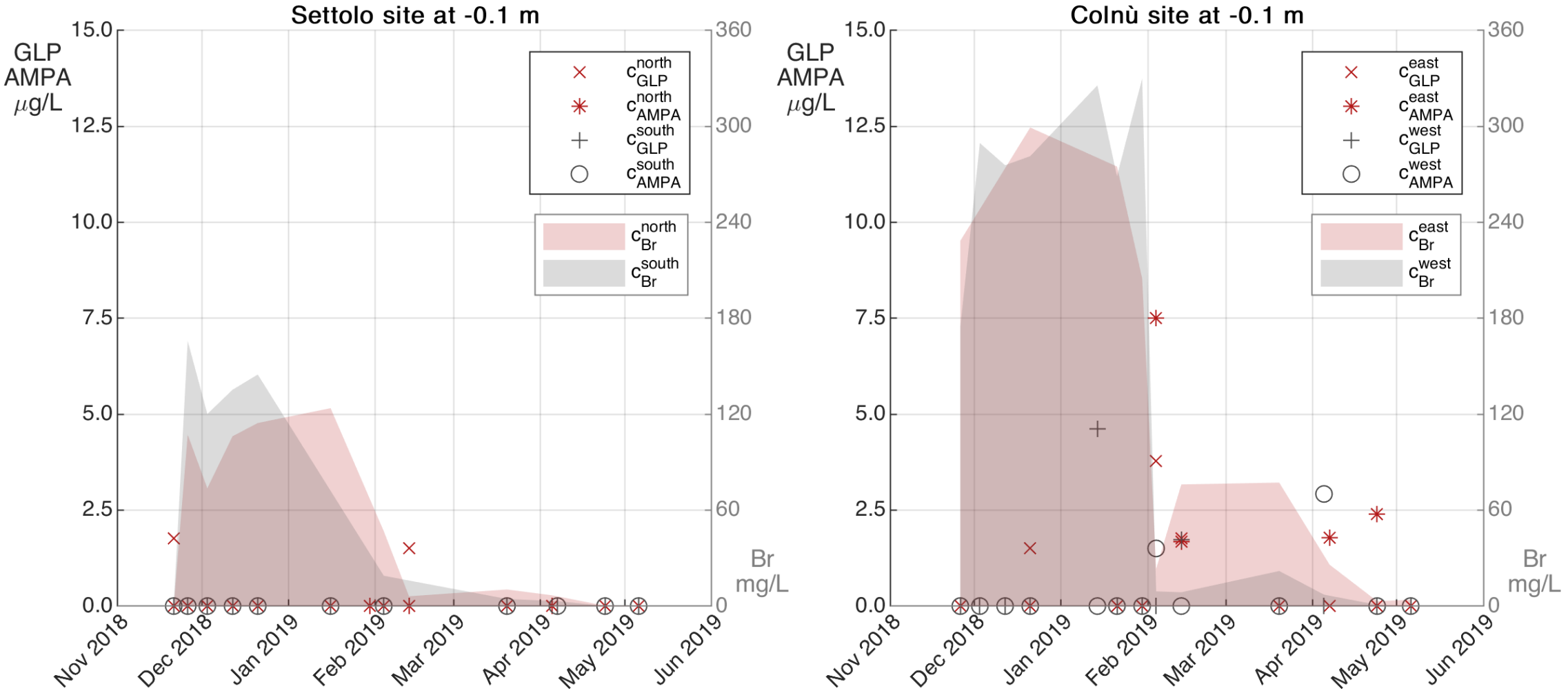
KBr
GLP and metabolite AMPA concentrations
(*Carretta et al.* 2019)



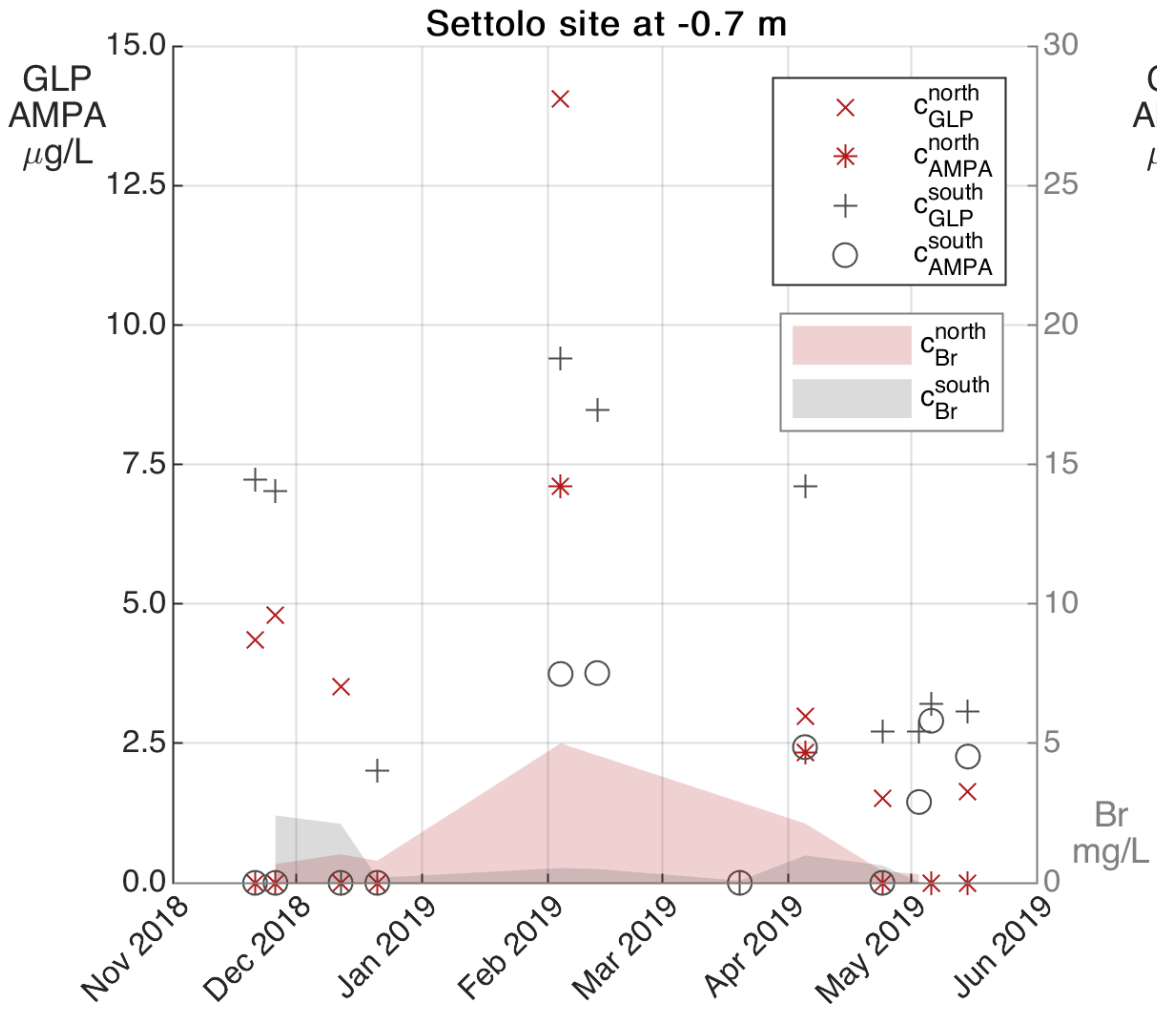


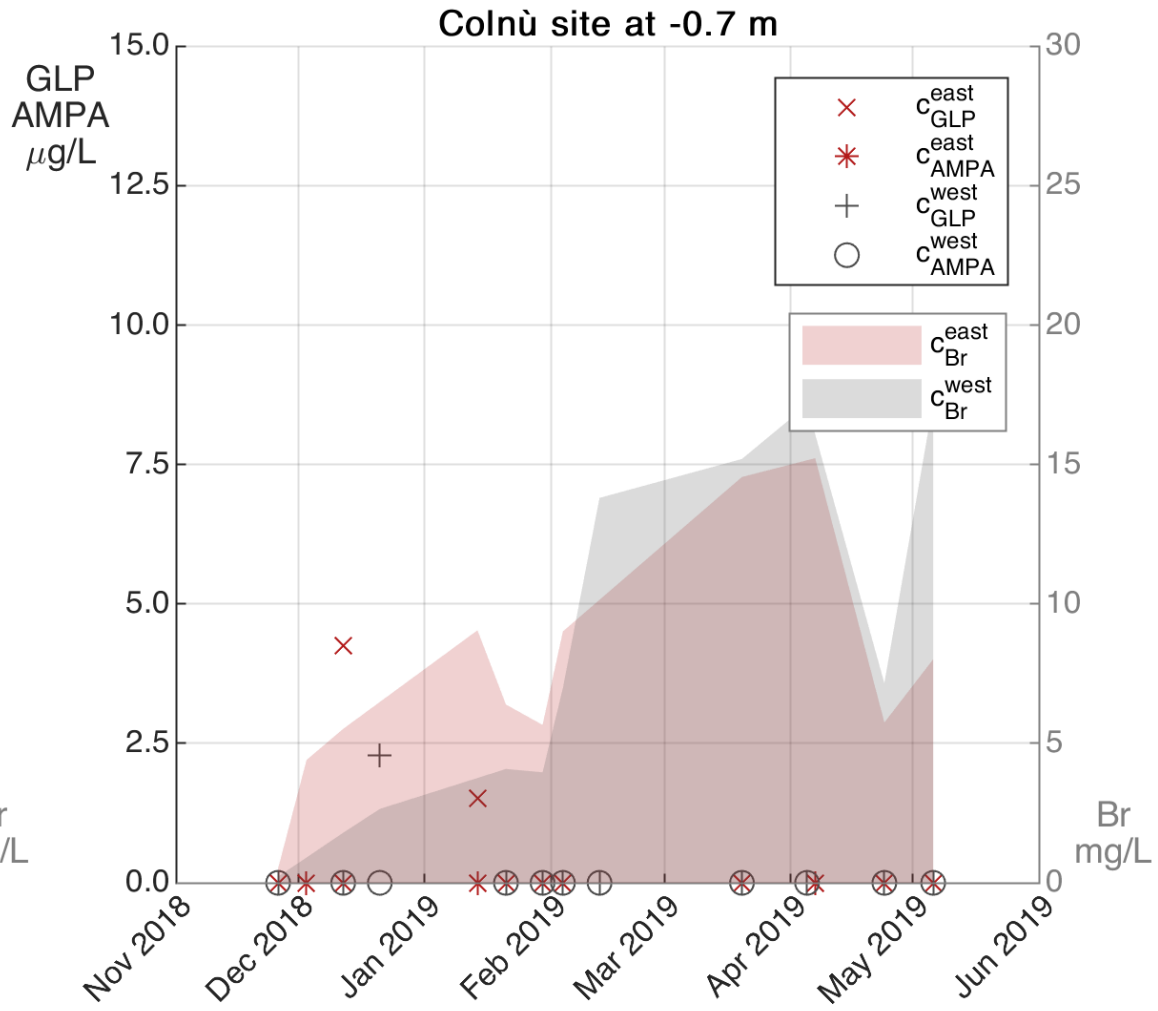
Results of GLP and AMPA analysis on top layer soil samples

Analysis on water samples



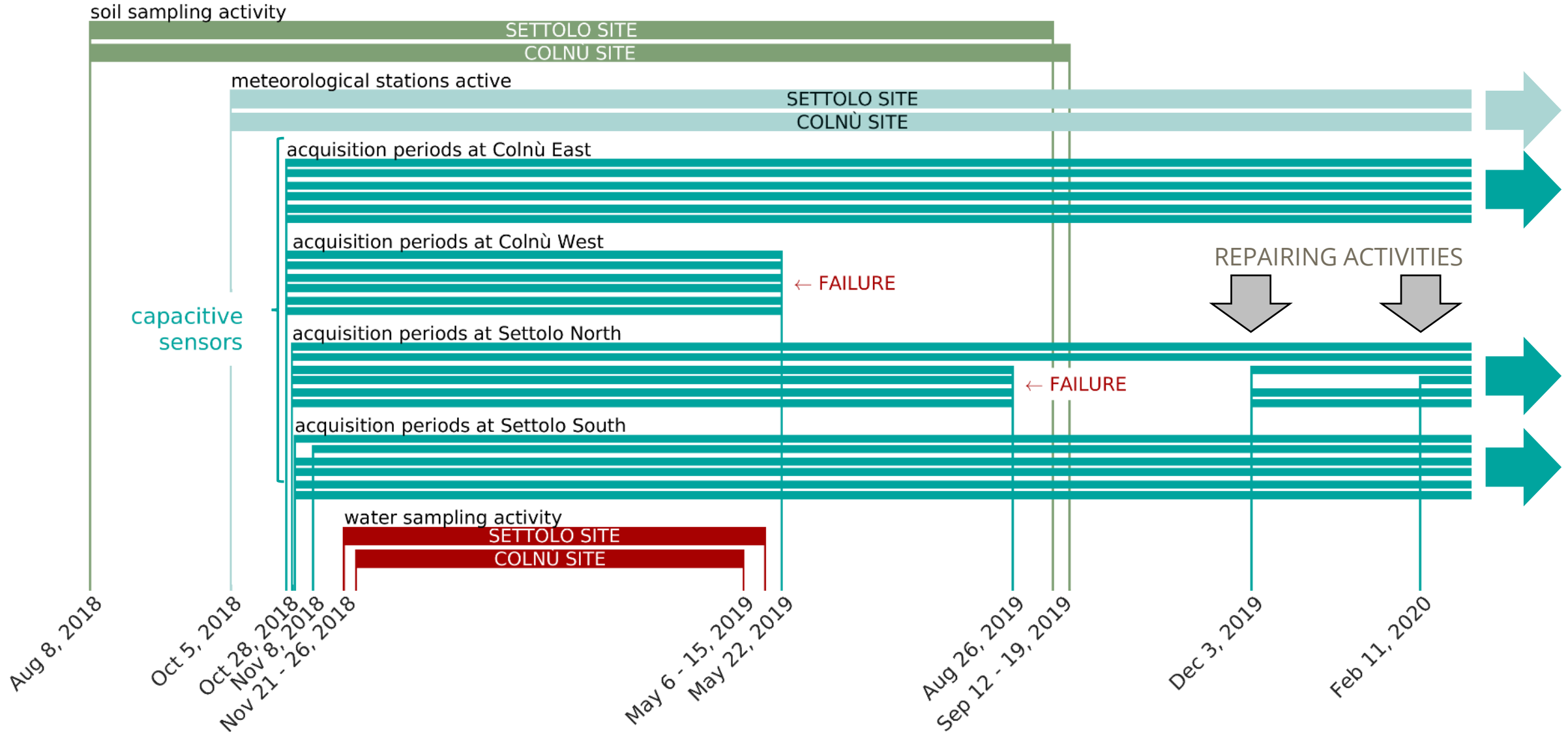
GLP and AMPA analysis on water samples





GLP and AMPA analysis on water samples: different infiltration process among different sites

Periods of monitoring and sampling activity at the experimental sites



BRTSim 1D MULTIPHASE COMPUTATIONAL SOLVER (Maggi, 2015)

Mass balance

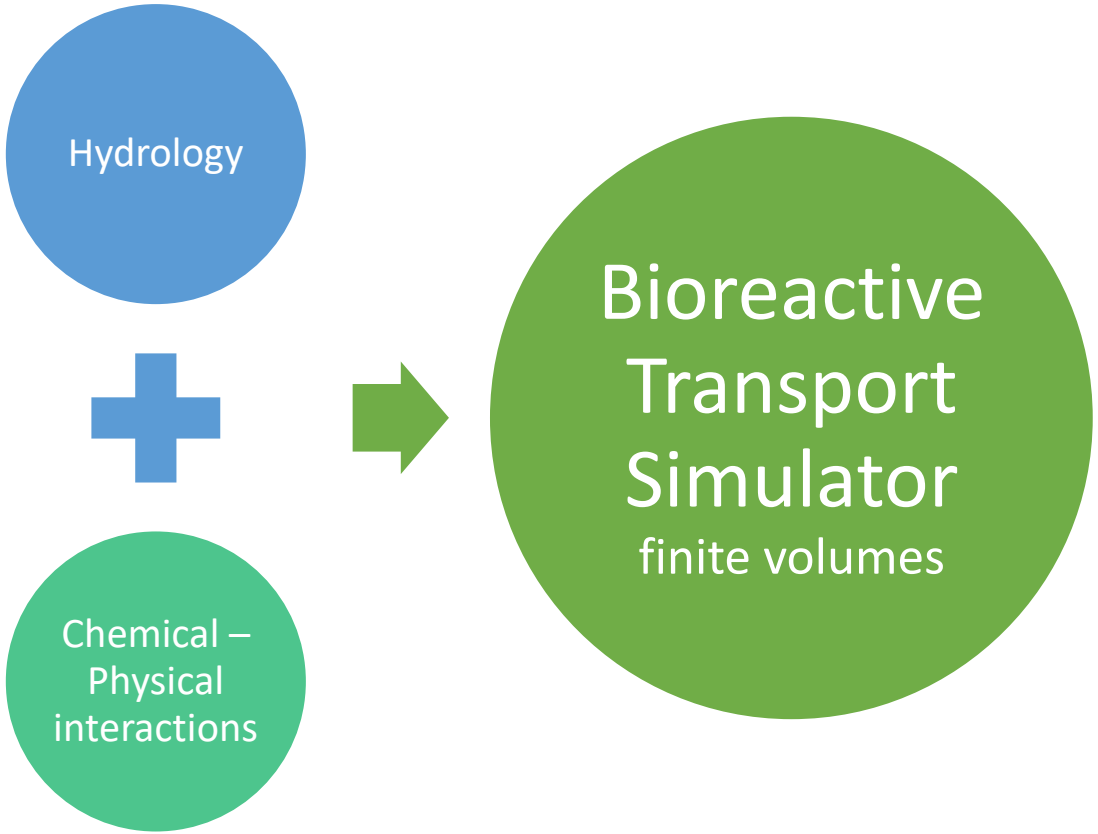
$$n\frac{\partial S_\beta}{\partial t} = -\operatorname{div} v_\beta \qquad v_\beta = -k_\beta \frac{\partial \psi}{\partial z}$$

$\beta = \text{phase}$

Reaction equilibrium

Adsorption isoterms

Cellular metabolism



Calibration procedure for the hydraulic parameters of the infiltration process

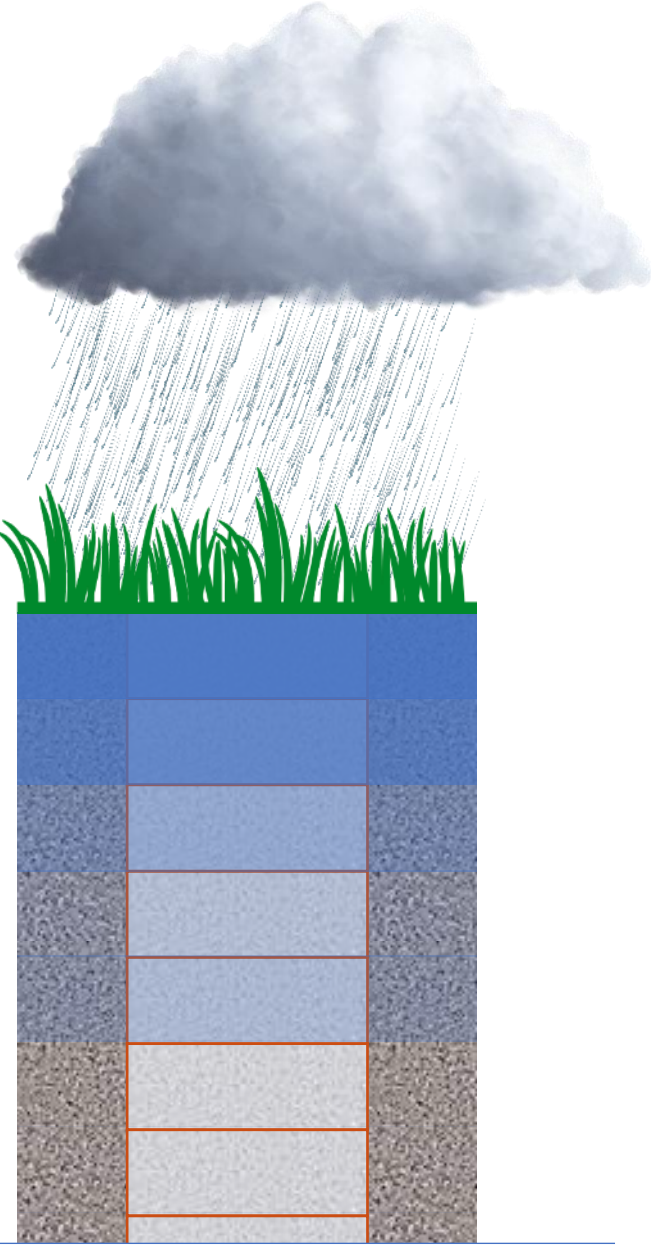
first laboratory analysis

soil textures = input data in ROSETTA

preliminary estimation of porosity *n*, permeability *k* and retention curve coefficients *α* and *m* (Van Genuchten,1980)

calibration (PEST)
($k_{cal}' \rightarrow \alpha,m \rightarrow k_{cal}''$)

Domain geometry
($S = 25m^2 \times D = 1m$)
free-drainage boundary condition at the bottom



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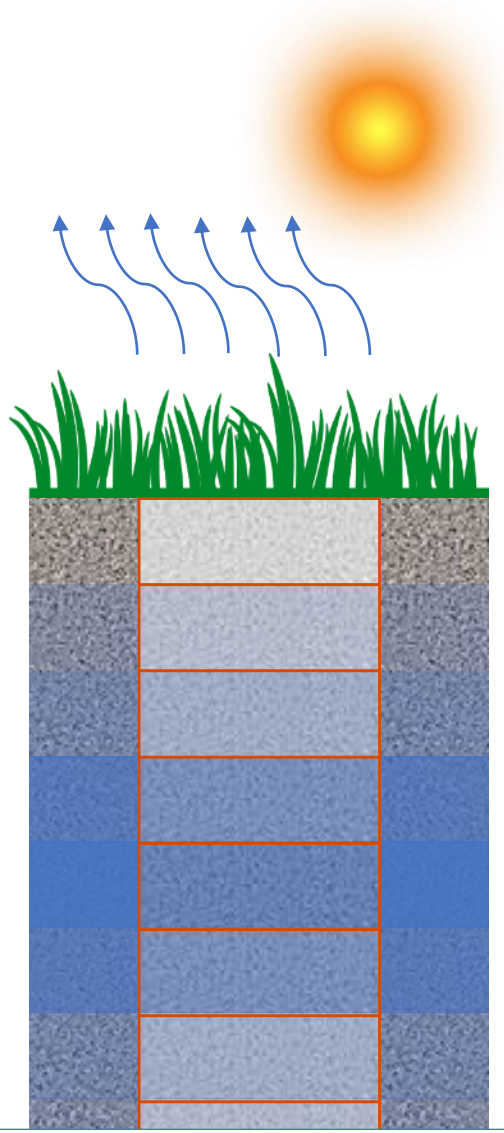
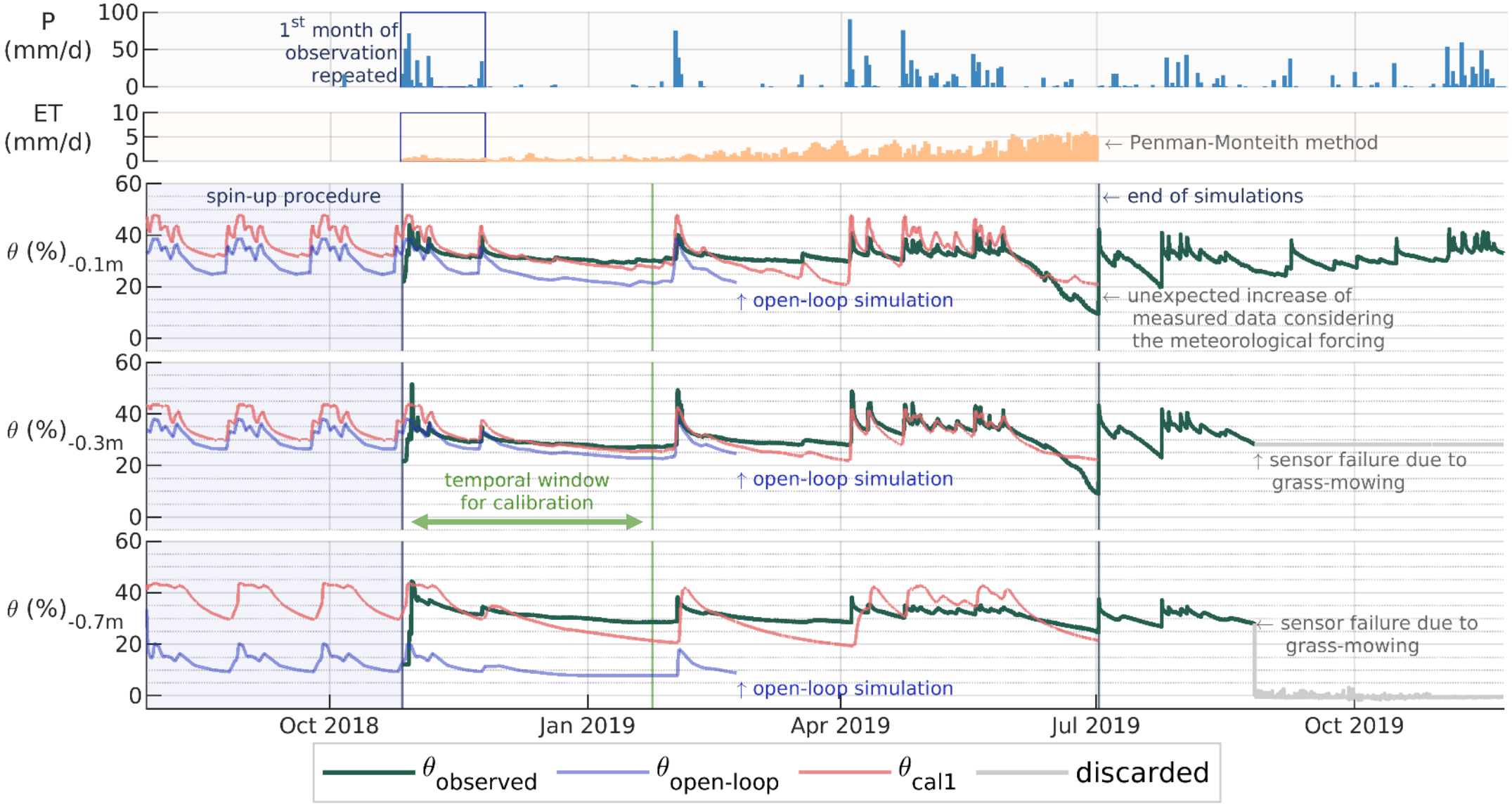
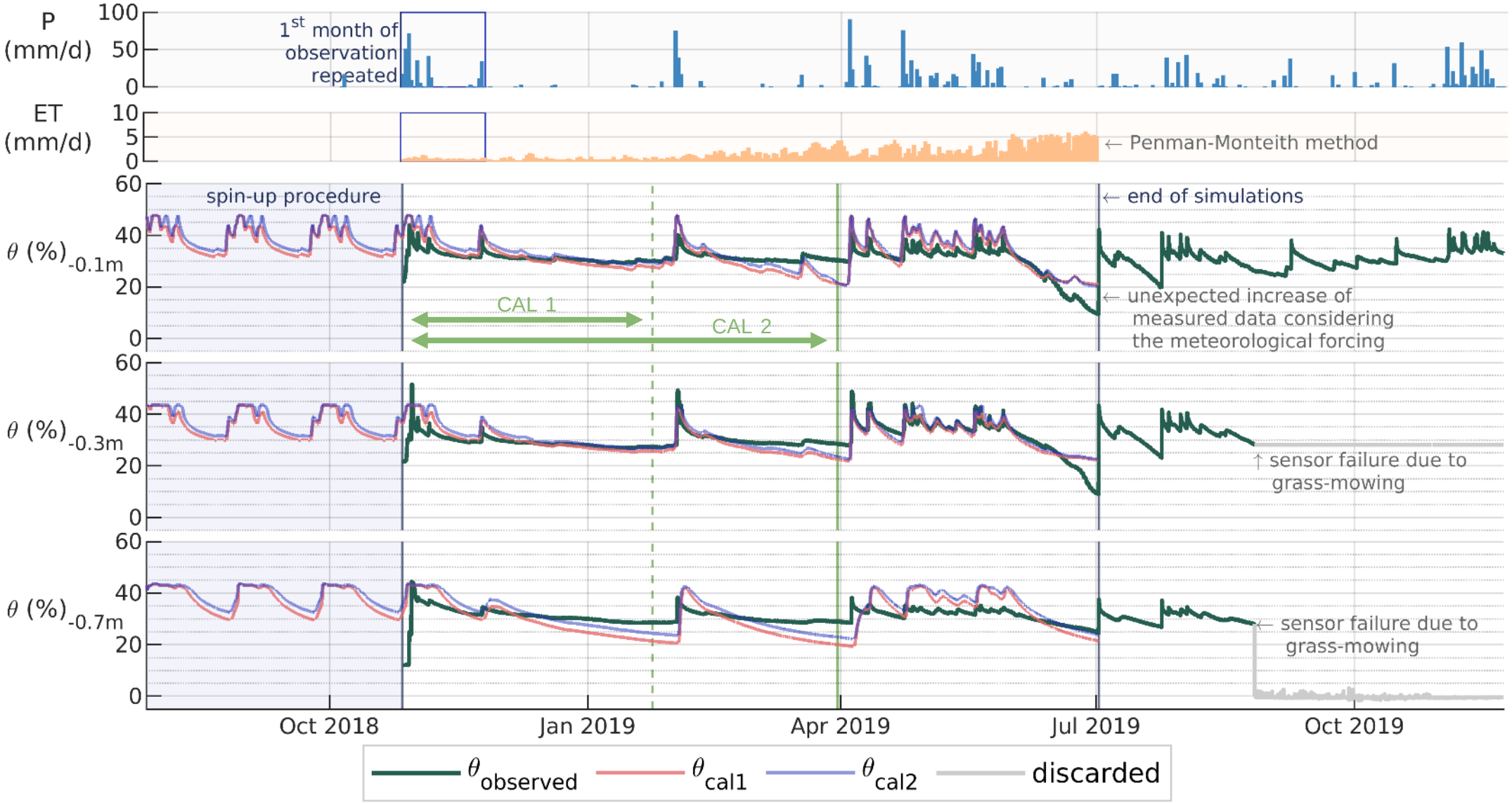


Open-loop simulation VS model calibrated using a 90 days temporal window (27/10/2018 to 24/01/2019)

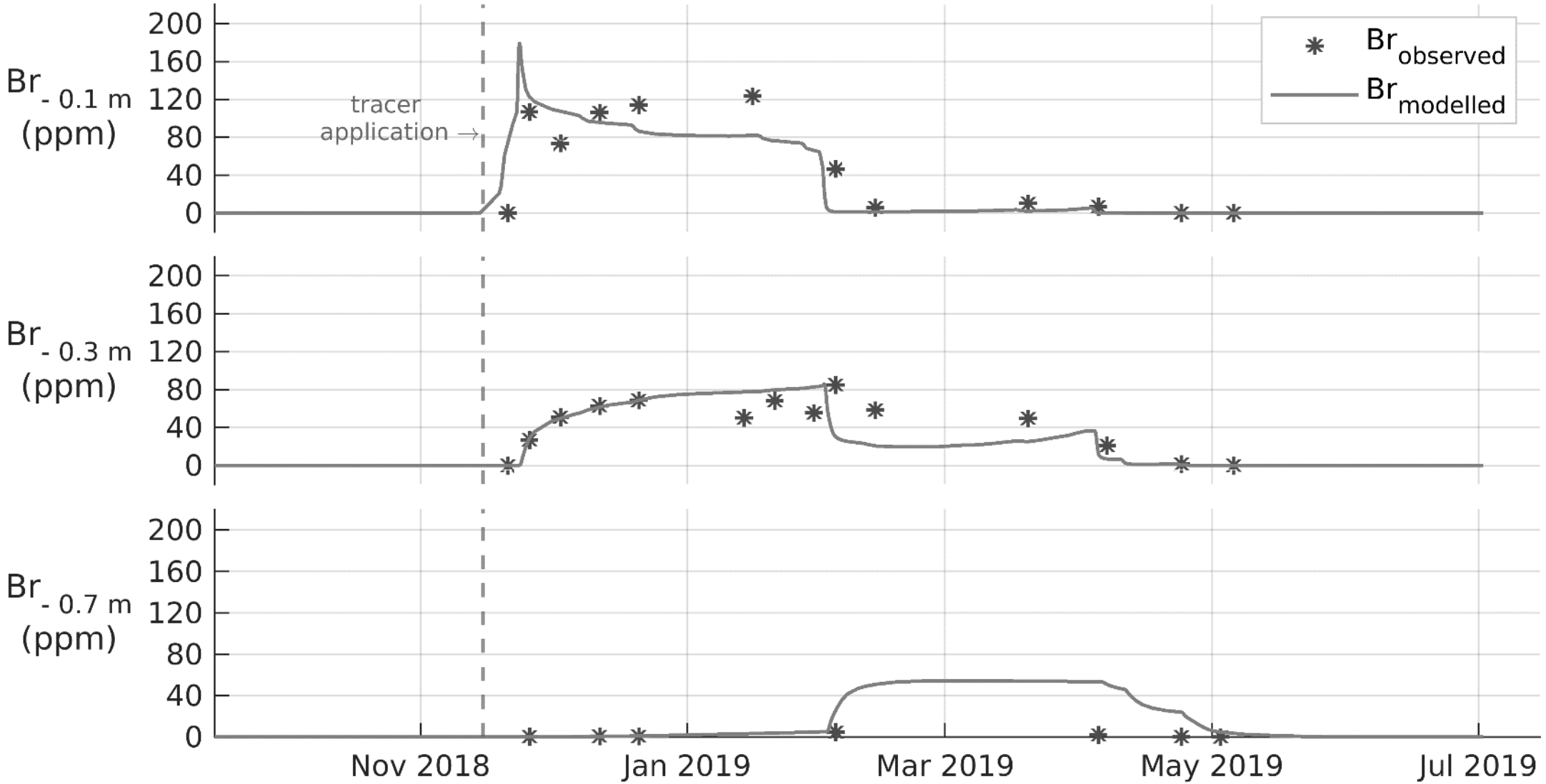


Comparison between different temporal window for calibration (90 days VS 153 days)



Comparison between different depths of influence of the active roots transpiration (10 cm VS 30 cm)

Results of tracer dispersion modelling using a dispersion coefficient of D = 1×10^{-09} m^2/s



TAKE-HOME MESSAGES

- The one-dimensional modelling of the infiltration process achieves the best results in the upper layers of the soil (up to – 0.3 m).
- The extension of the depth of influence of the active roots transpiration up to – 0.3 m increases the accuracy in simulating the soil volumetric water content in the periods subsequent to rainfall events
- At greater depths the accuracy of the one-dimensional modelling of the infiltration process tends to be limited by the three-dimensional nature of the phenomenon.

NEXT STEPS

- Consider a more detailed time description of the meteorological forcing (rainfall and evapotranspiration): from daily to hourly
- To extend the areal domain: from “punctual” to “areal” (based on the spatial heterogeneity of the infiltration process)
- To consider a three-dimensional approach for the subsequent modelling of the glyphosate evolution

ACKNOWLEDGEMENTS

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