ICRA
Institut Català de Recerca de l'Aigua

GEOCAMB
Universitat de Girona
Departament de Ciències Ambientals

ONLINE CONFERENCE
IWRA 2020

Expected effects of future hydrological water balances on the antibiotic and ARG occurrence in groundwater

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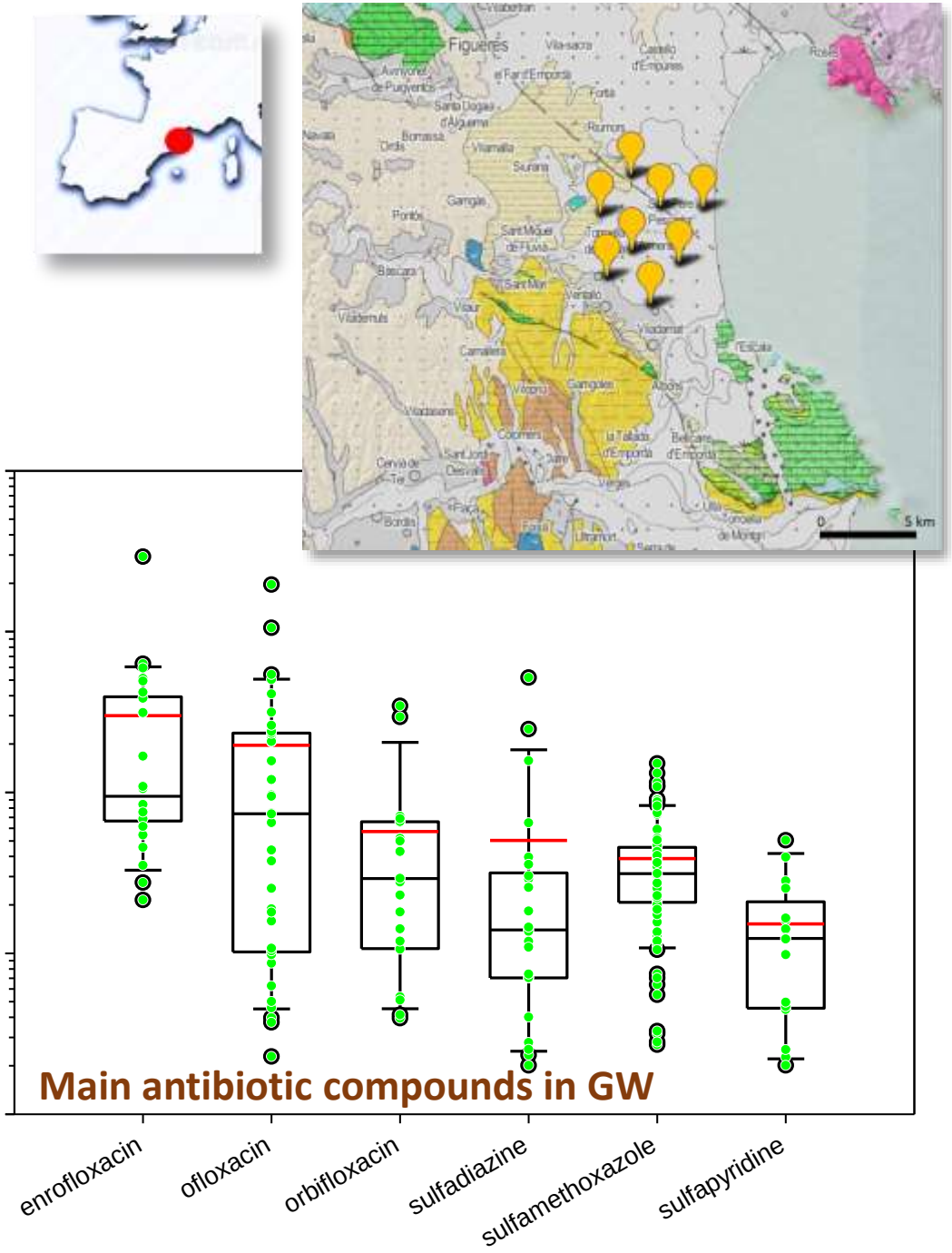
Introduction

This research addresses the hydrological behavior of *antibiotics and ARG* in groundwater under changing hydrological conditions, so monitoring and prevention strategies can be efficiently delineated.

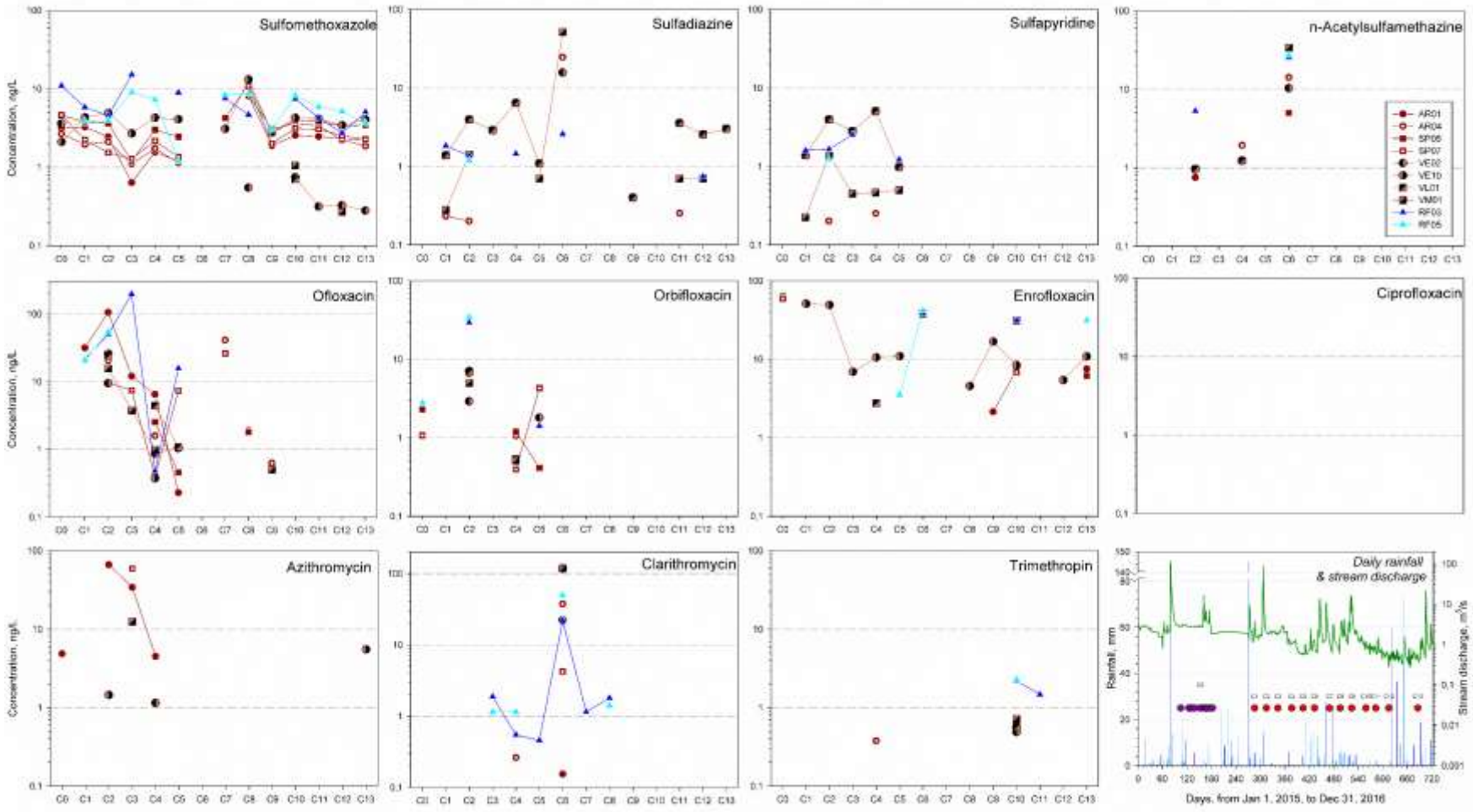
This work links two relevant issues,

i. the effect of *hydrological changes* on their fate, affected by climate change,
ii. how to adequately include them in the groundwater *management plans*.

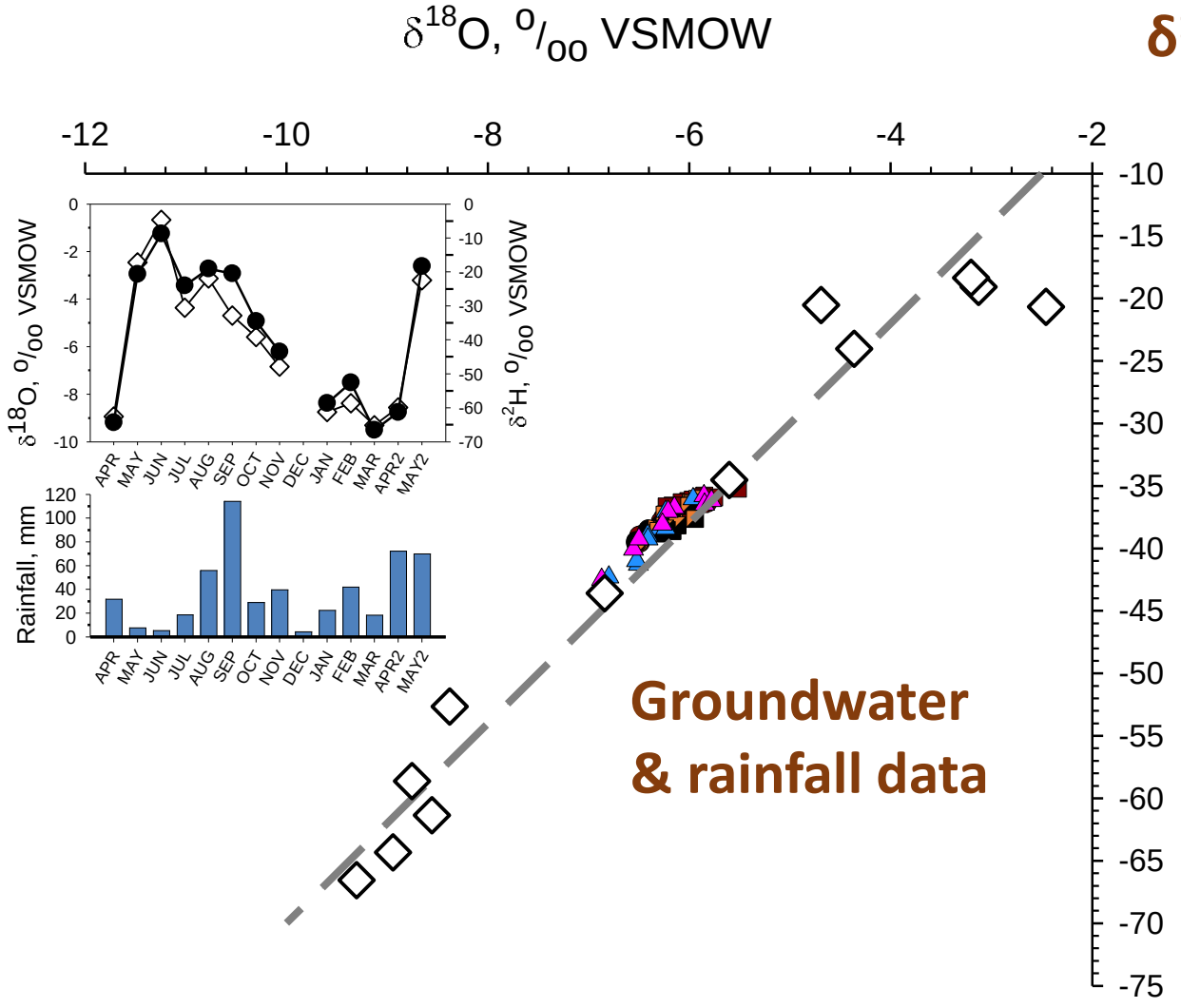


Goals & raw antibiotic data

The purpose of this work is to explain the *temporal variability* of antibiotic and ARG occurrence in the 10 monitoring wells based on *hydrogeochemical* processes.

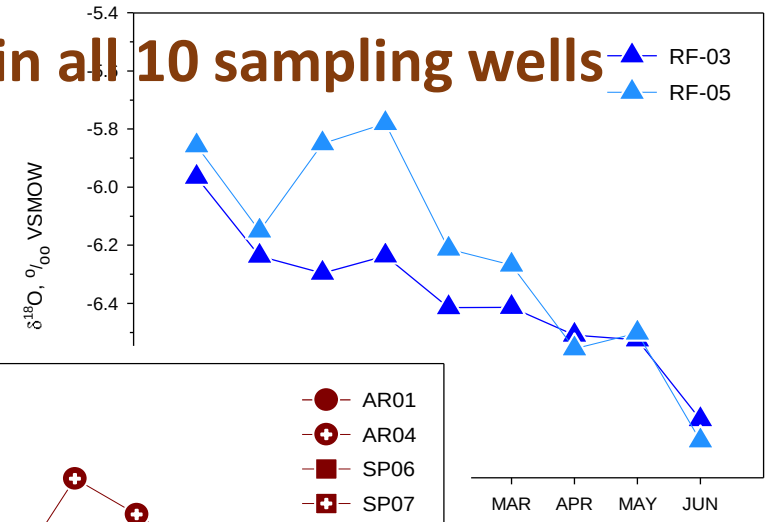


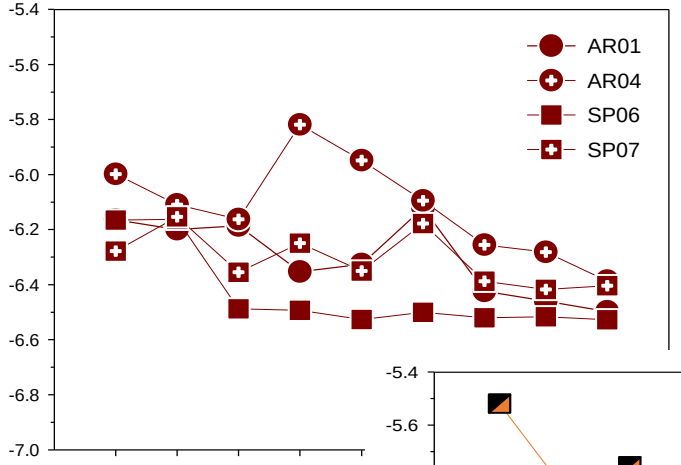
Isotopic GW & recharge data

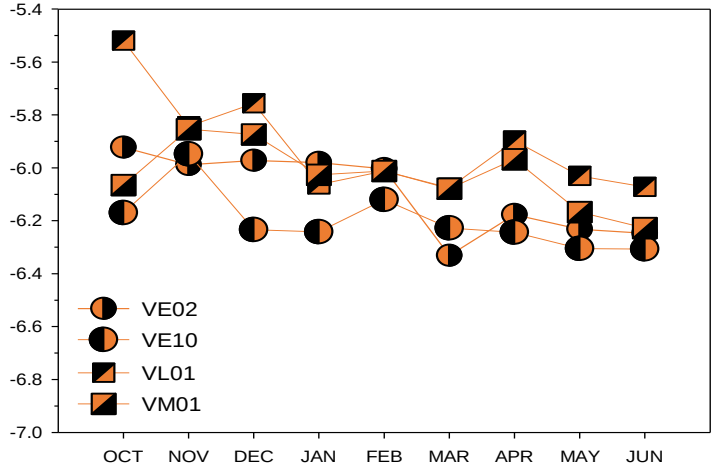


Groundwater & rainfall data

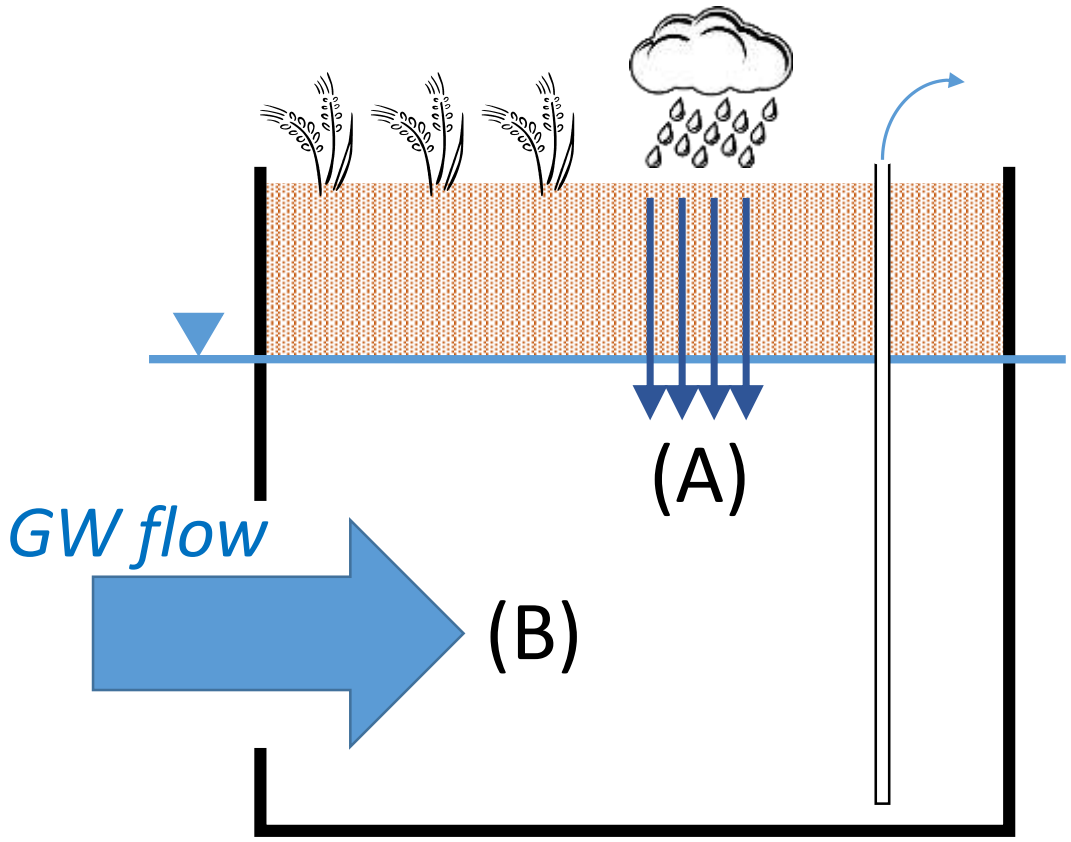
$\delta^{18}O$ evolution in all 10 sampling wells

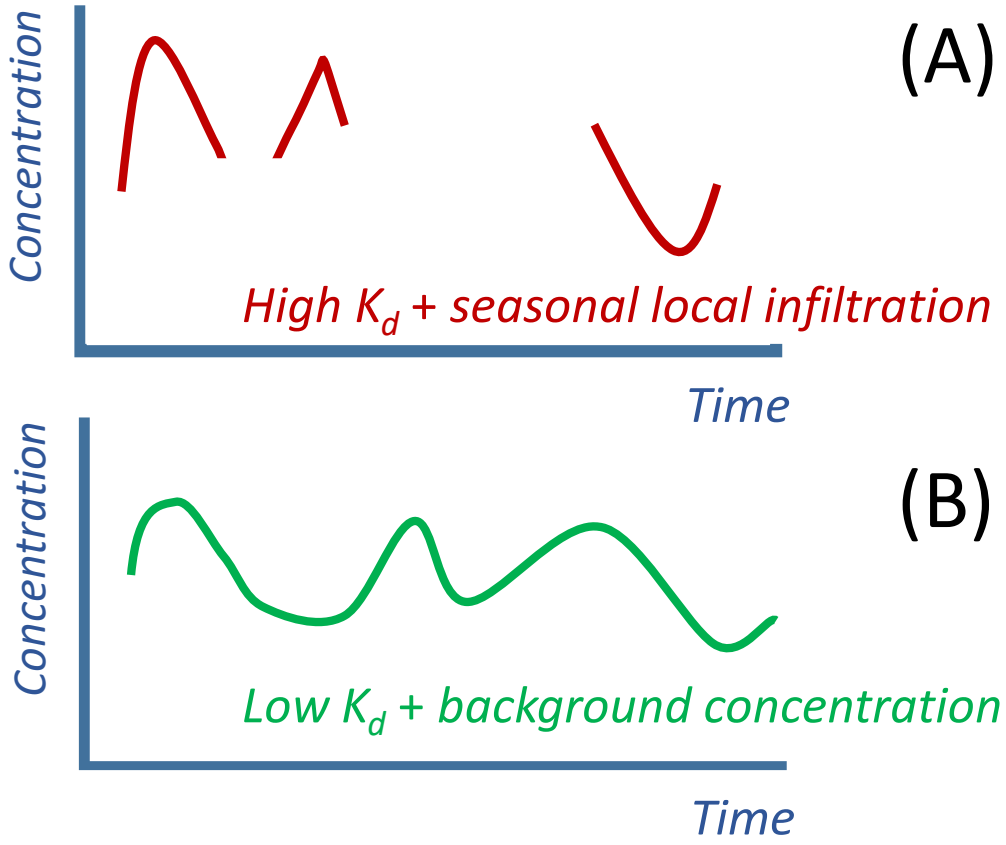






Proposed hydrogeochemical hypothesis





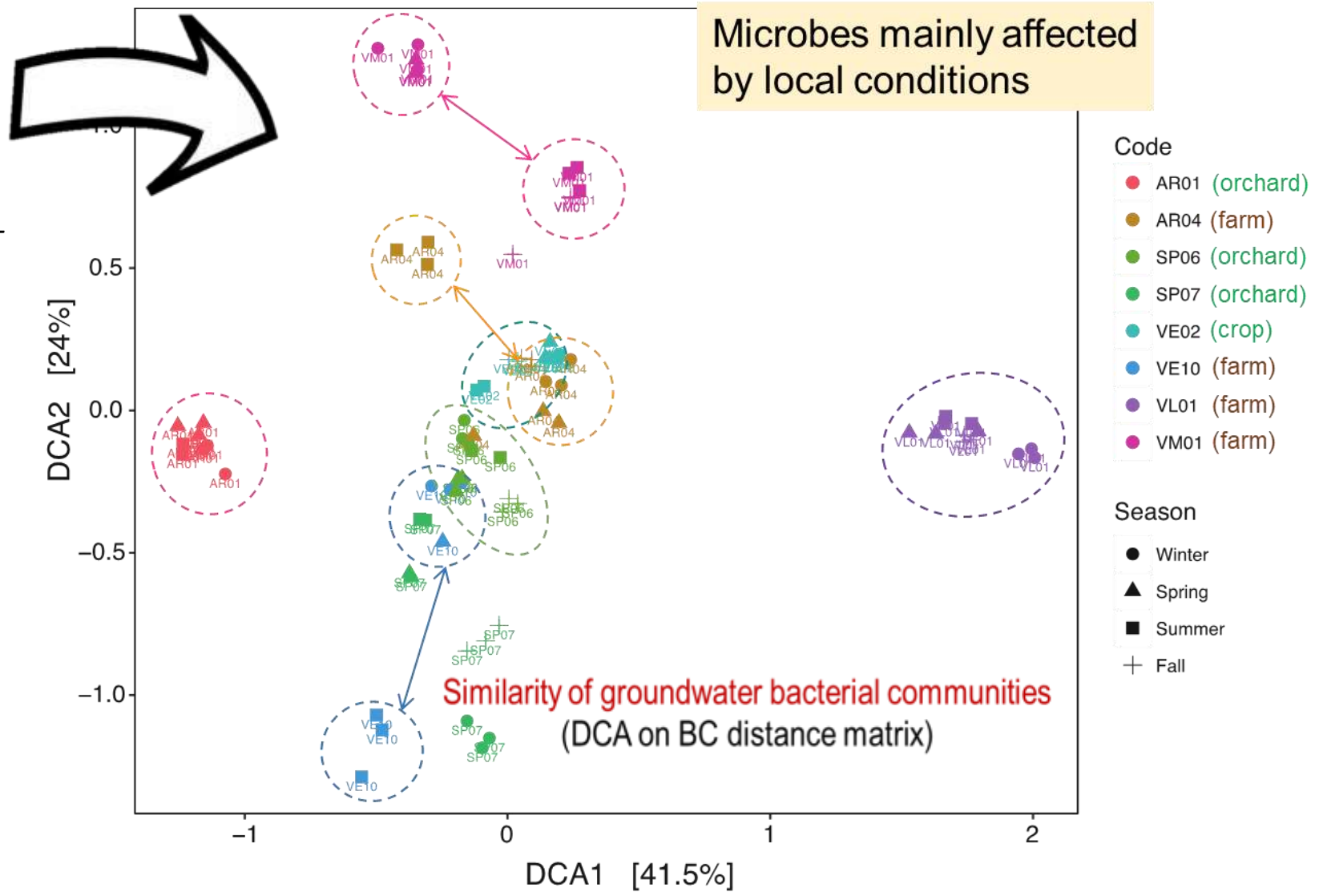
Seasonal recharge influences antibiotic occurrence. Given the high adsorption and degradation rates, some antibiotics are only found when intense infiltration occurs. Their usual low values result from *mixing* with the regional groundwater flow. Only a few compounds (i.e., those with large input loads and lower sorption conditions) are uniformly distributed along the aquifer, and define a *background level*.

However, microbiome behaves differently

Ordination of samples (DCA) according to bacterial community composition*

** Detrended Canonical Analysis (DCA) using the Bray Curtis distance matrix on Hellinger-transformed abundance data*

Seasonal behavior of ARGs *was not satisfactorily proved* in the Baix Fluvià alluvial aquifer, which addresses the issue of their dependence on *local environmental conditions* (around the well capture zone).

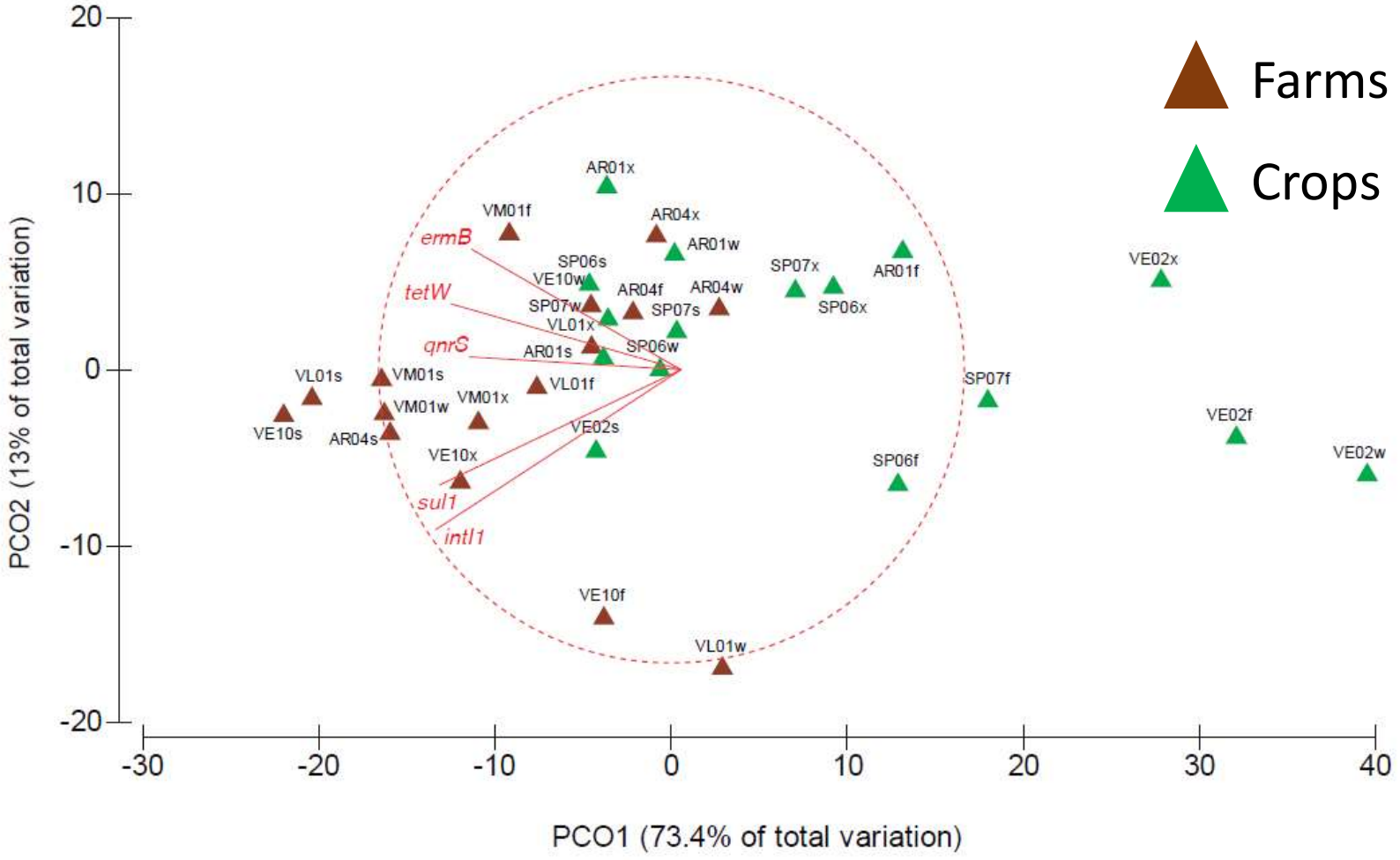


… but ARGs are more linked to land use.

Genes conferring resistance to antibiotics:

intI1: Proxy for human pollution
sul1: sulfonamides
ermB: macrolides
tetW: tetracyclines
qnrS: fluoroquinolones

PCoA ordination of samples according to their absolute concentration of gene intI1 and targeted ARGs (Bray-Curtis distance matrix). Overlay vectors (in red) show the multiple partial correlations of genes to PCoA axes (Spearman rho >0.6; circle has a radius =1).



Final remarks

Antibiotics occurrence in aquifers is largely influenced by the hydrodynamics of the system, whereas *ARGs* are more related to local conditions.

Regarding *climate change* in Mediterranean areas, future lower average infiltration rates due to a rainfall decrease and temperature increase (i.e., larger ET rates) would enhance the accumulation of antibiotic residues in the uppermost layers of the vadose zone, thus obstructing their arrival to the aquifer. If the *intensity of rainfall events* increases as predicted, the outcome can be reversed, and their occurrence be otherwise larger.

Effects on *ARGs* are still unpredictable as it is unsure whether bacteria can actually be treated as solutes in a hydrogeological environment; and ARGs appear to be more affected to land use in the well vicinity.

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THANK YOU !!!

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