MRS subsurface parametrization for coupled hydrological Marmites model

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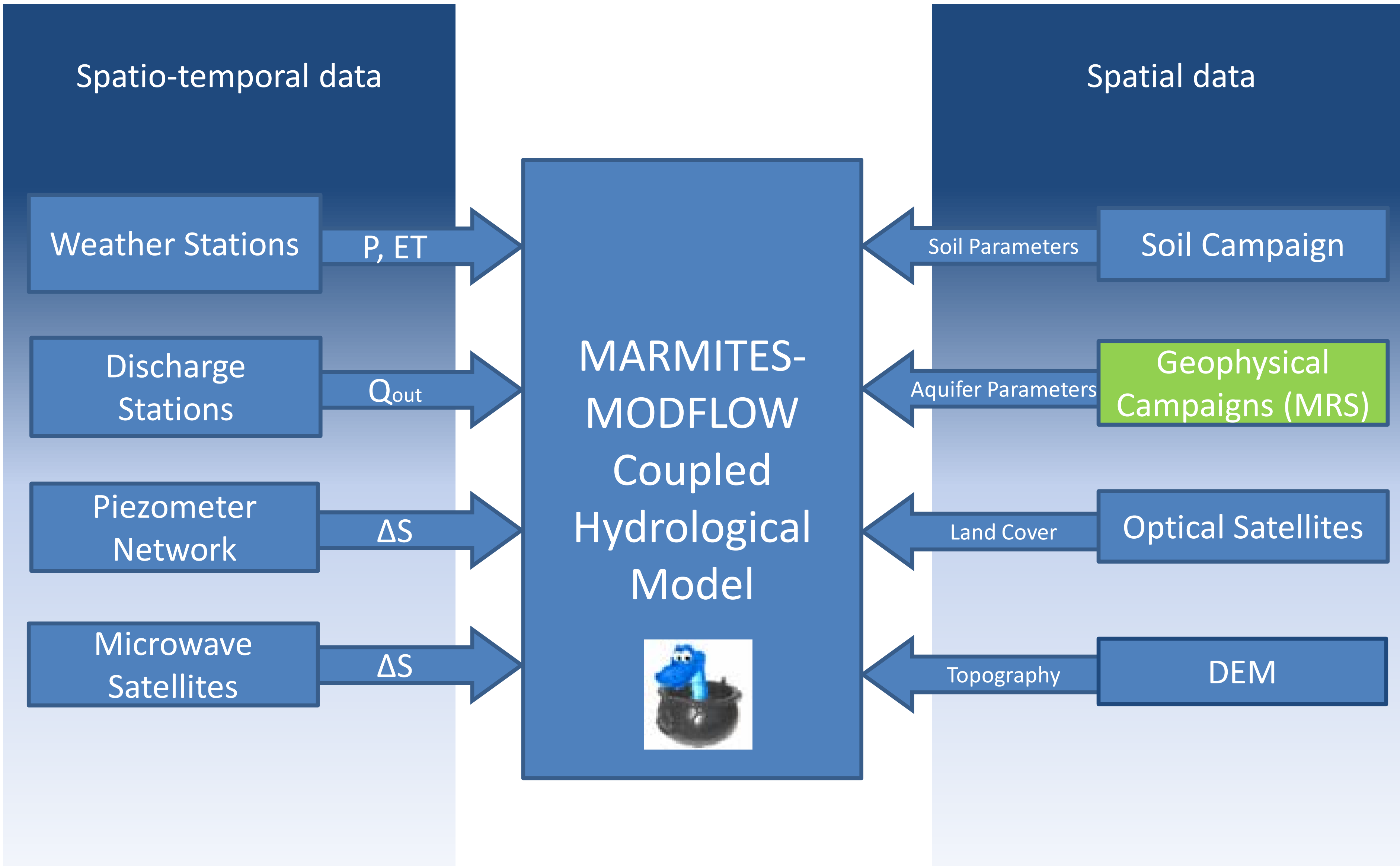
Objectives

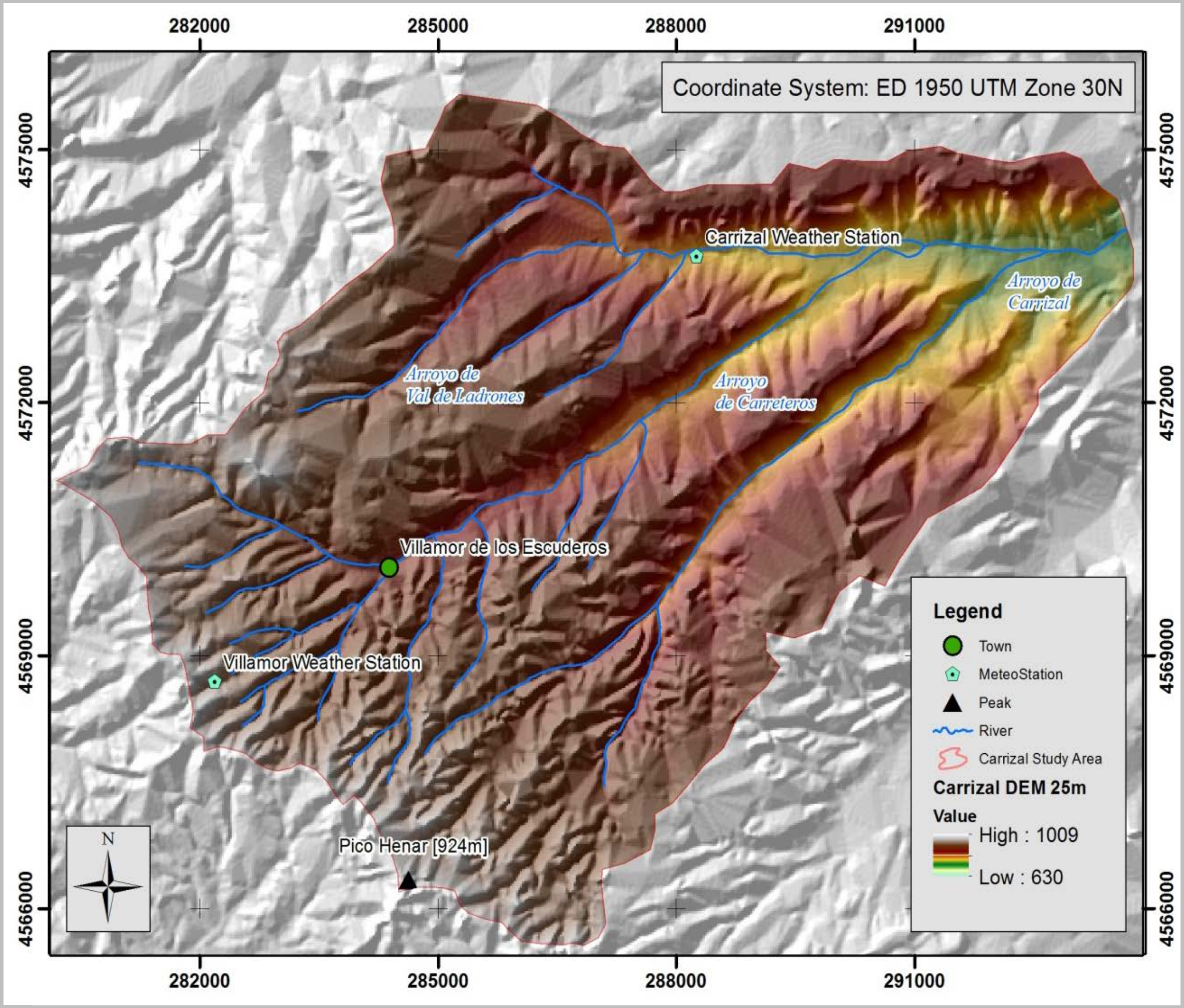
- General objective of the PhD research:
  - **Use of selected non-invasive methods to improve reliability of coupled hydrological models**
- Specific objective of this presentation:
  - **Use of MRS to retrieve:**
    - **Aquifer transmissivity;**
    - **Aquifer storage**
    - **Aquifer geometry**

as input for coupled hydrological model

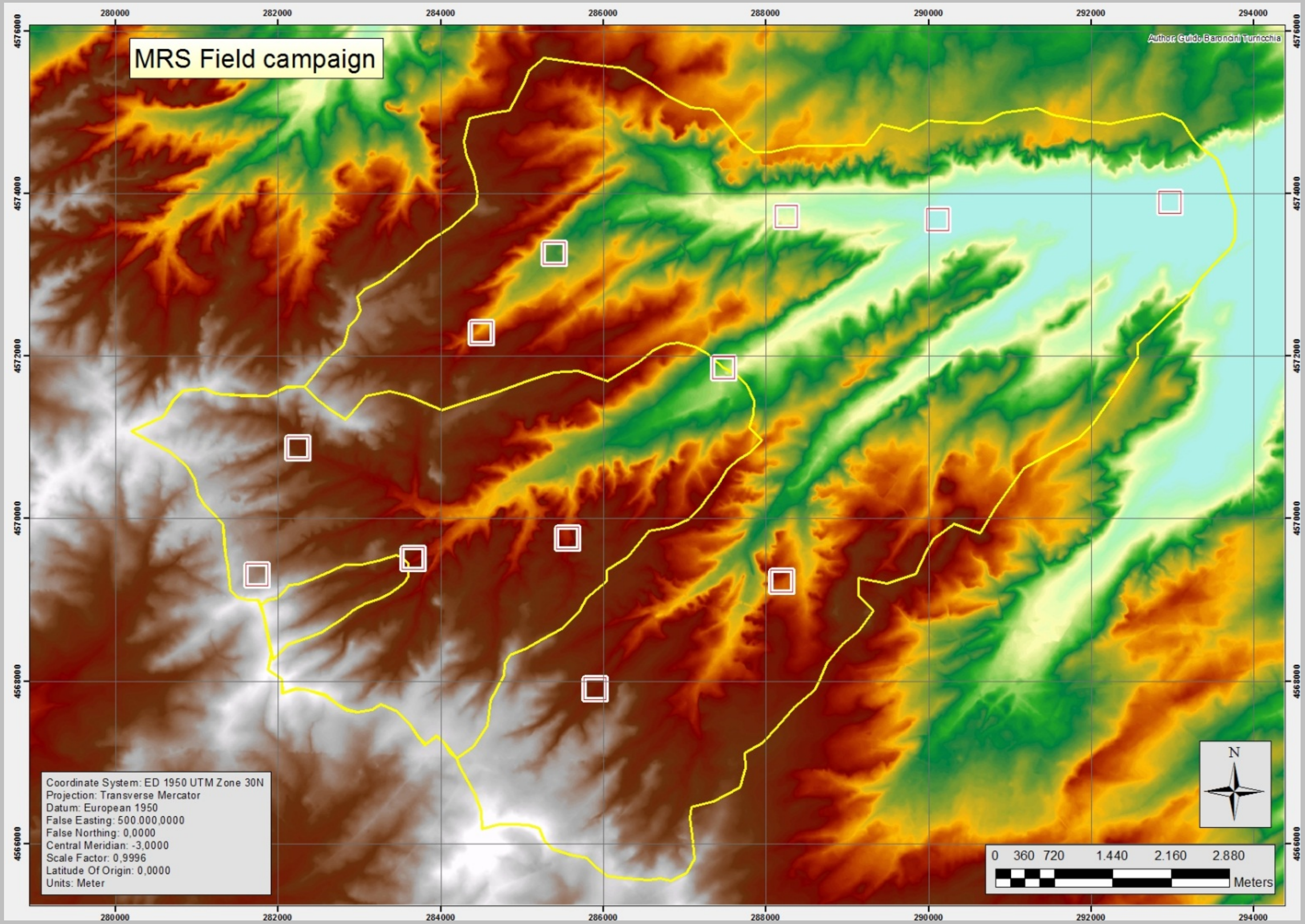
The research scheme



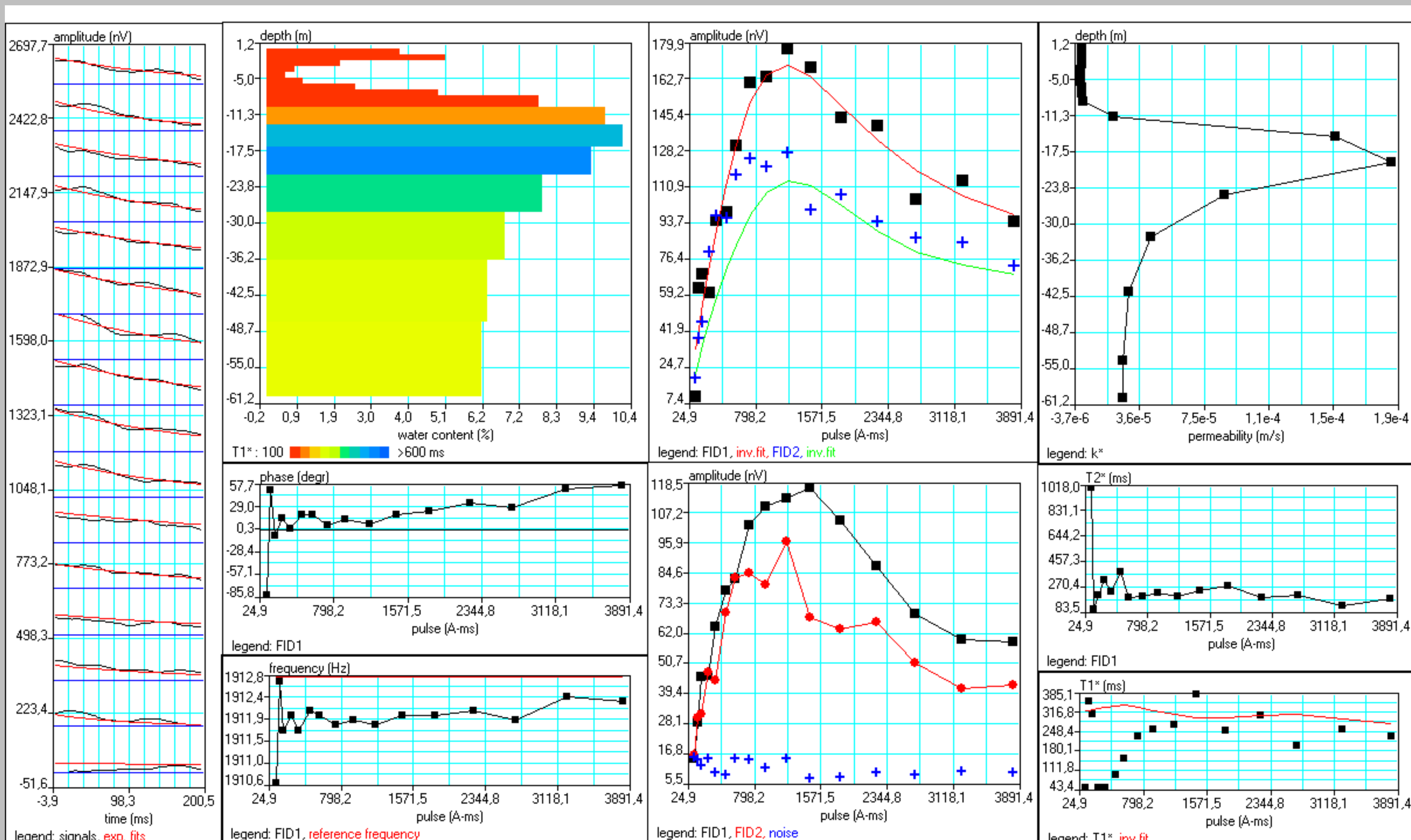
The Carrizal study area



Distribution of MRS survey locations in Carrizal area



Example of Samovar inversion



Transmissivity assessment

To extract the transmissivity, we used protocol defined by **Plata and Rubio (2008)**

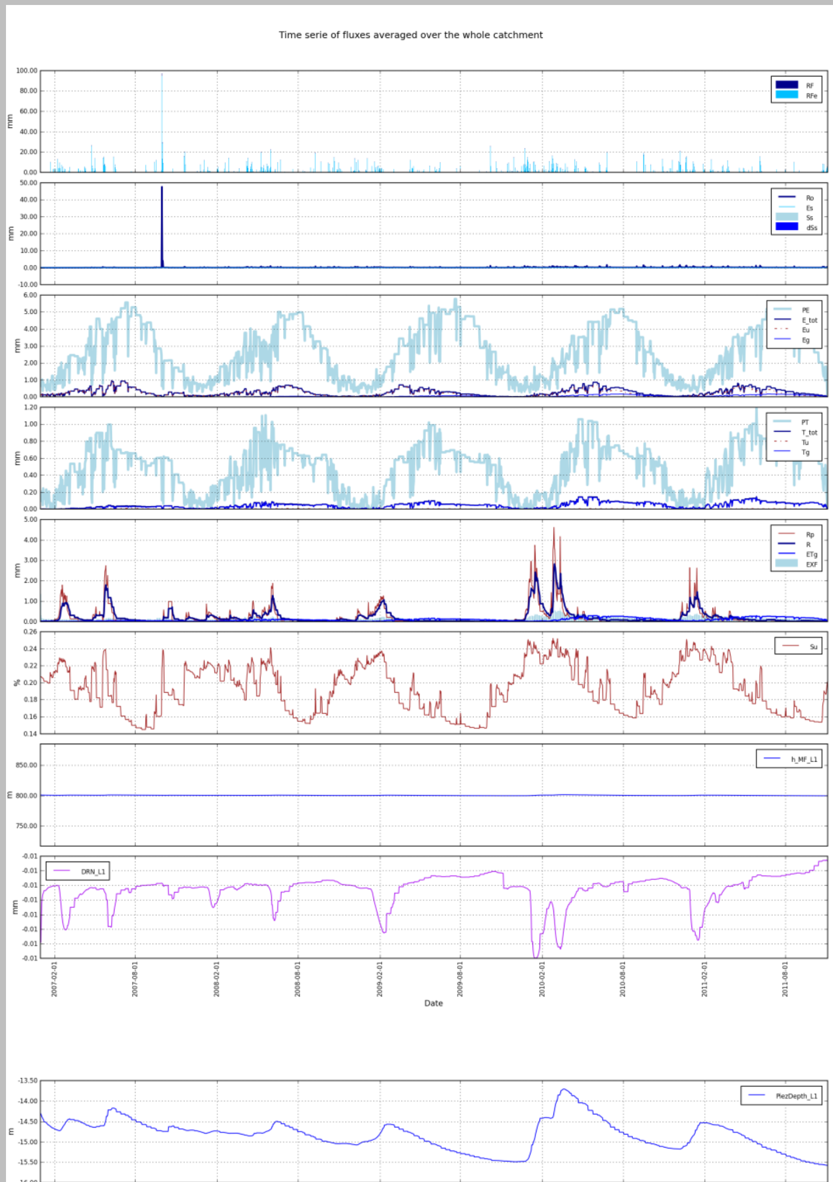
- $T_{MRS} = F^*C_p$
- $C_p = m^*F$^(-n)
- $F= \sum F_i = \sum T^2 \Theta_{MRSi} \Delta z_i$

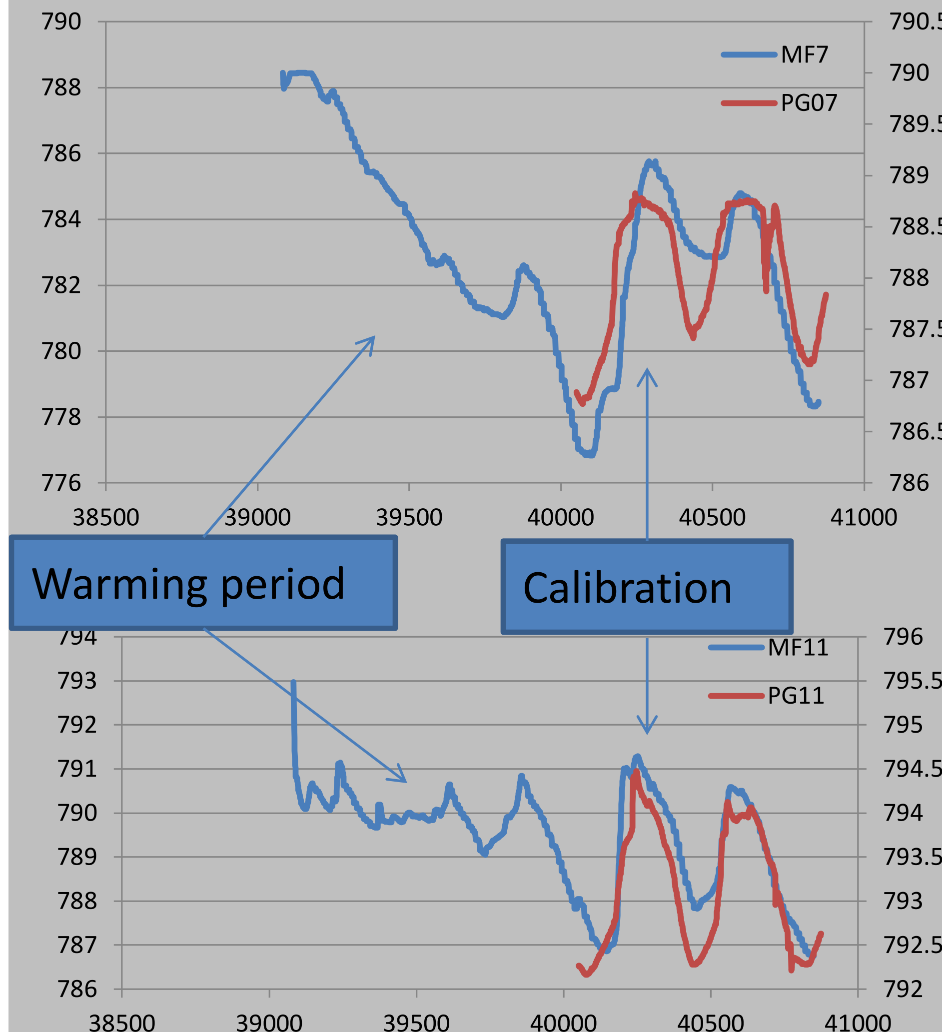
Specific Yield

In the Carrizal catchment the subsurface is composed of coarse-grained material for which **Vouillamoz (2012)** approach was applied

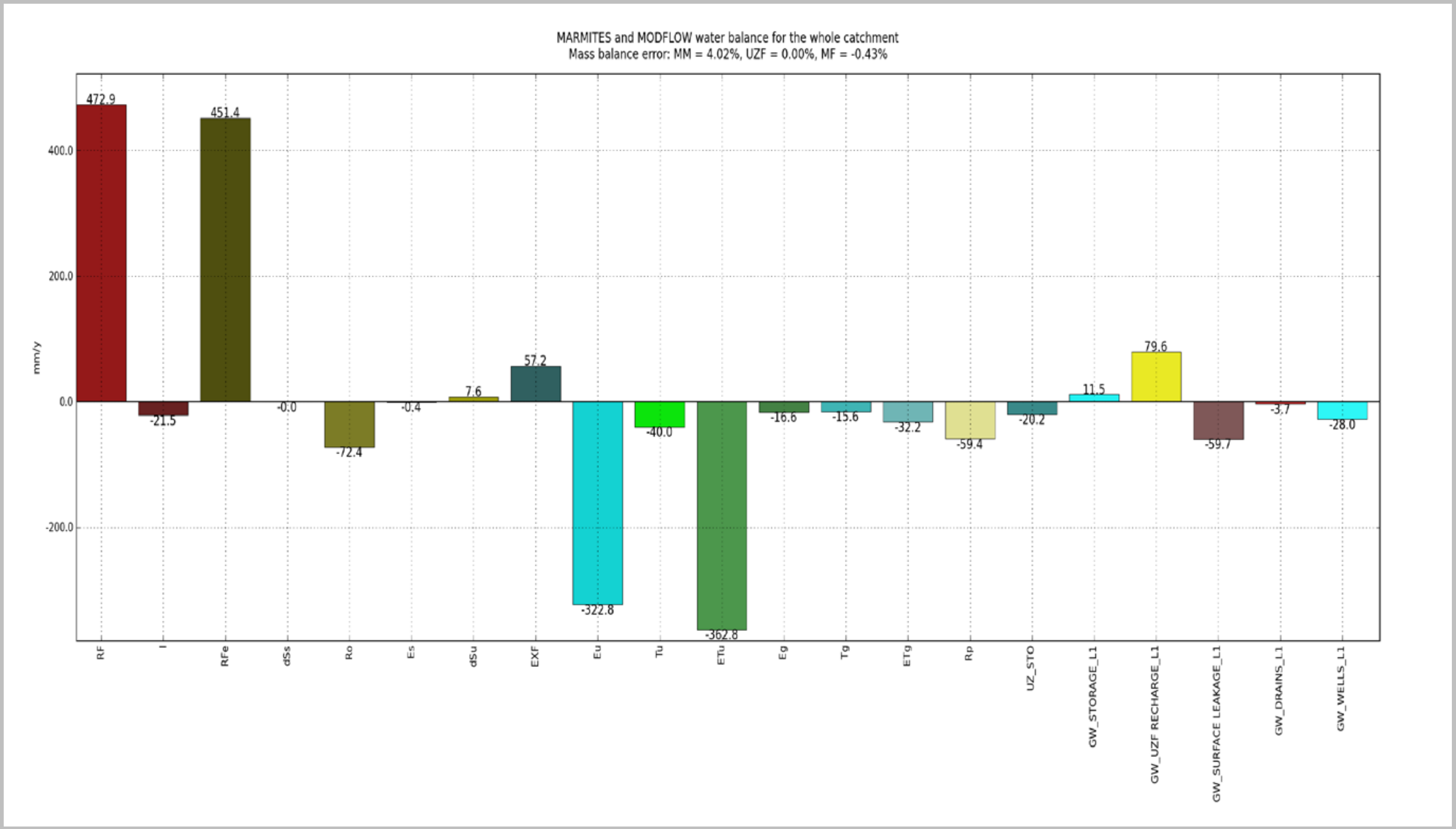
- $Sy = 0.4*\Theta_{MRS} + 0.0056$

MARMITES/MODFLOW results





Carrizal Catchment Water Balance



Conclusions

- In this study the MRS technique allowed to determine hydraulic parameters of Carrizal aquifer (transmissivity and specific yield) but also contributed to geometrical definition of depth of GW table, presence of aquitard and impermeable layers.
- The MRS parameters integrated in coupled hydrological model provided solution that was in good agreement with field measurements.
- The use of MRS as input data provider for the coupled MARMITE-MODFLOW model turned to be cost and time effective solution. Besides, the MRS has an advantage as compared to pumping test and other hydrogeological methods that it can integrate parameters at desired volume defined by model grid.

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Thanks

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SUMMARY

This study presents MRS data integration in the transient and distributed MARMITES-MODFLOW (MM-MF) coupled models (Frances et al. 2011) that simulate the water fluxes between land surface, unsaturated and saturated zones. The MM-MF allows to compute spatio-temporally a water balance at the catchment scale.

The coupled models like MM-MF, due to their spatio- temporally variable input fluxes are better constrained, so more reliable, than the standard groundwater models. They are particularly valuable when facilitated by good monitoring network and supported by reliable aquifer system parameterization. We present MRS data integration following Lubczynski and Roy (2007) in the coupled Carrizal catchment MM-MF model. The Carrizal catchment (73 km^2) is located near Salamanca in Spain. It is a hilly, agricultural land, composed of sedimentary unconsolidated rocks overlain by a sandy soil. The bottom of unconfined Carrizal aquifer is at depth of 10-60 m b.g.s. and a water table at ~4-12 m b.g.s. The study area is well-equipped with weather stations, soil moisture and discharge stations operating since 1999. Additionally in 2009, a network of 12 piezometers registering groundwater levels hourly was installed with the objective of studying the shallow alluvial aquifer regime to assess sustainability of groundwater resources under the increasing water use, mainly due to the expansion of irrigation practices. However in that study area there are no aquifer pumping tests to facilitate aquifer system parameterization. For that purpose we used non-invasive MRS technique which allows to define most important subsurface parameters in non-invasive time- and scale- efficient manner providing valuable constrain for the model calibration.

To parametrize Carrizal aquifer for the MM-MF coupled model, we carried out in total 12 MRS surveys well distributed within the Carrizal catchment. These surveys were done in 2010 and 2011 using $\text{NUMIS}^{\text{Lite}}$ MRS equipment. Our aim was to define: (i) geometry of the shallow unconfined aquifer, i.e. aquifer bottom and water table; (ii) aquifer transmissivity; (iii) aquifer specific yield. The aquifer geometry was defined by analyzing the water content and pore size distribution along the inverted profiles. For the aquifer transmissivity we used MRS forward approach described in Plata and Rubio (2008). Finally, for estimate of specific yield we applied the approach presented by Vouillamoz et al. 2012.

The MM-MF model calibration showed a good agreement between MRS-derived specific yield and transmissivity and coupled model parameters. The Carrizal study confirmed the appropriatness of the forward method of MRS parametrization and its suitability for data integration in coupled models.

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