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Time-wise analysis of satellite gravity data and hydrological modeling of the Po watershed basin and the Alpine divide

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Hydrological Modelling

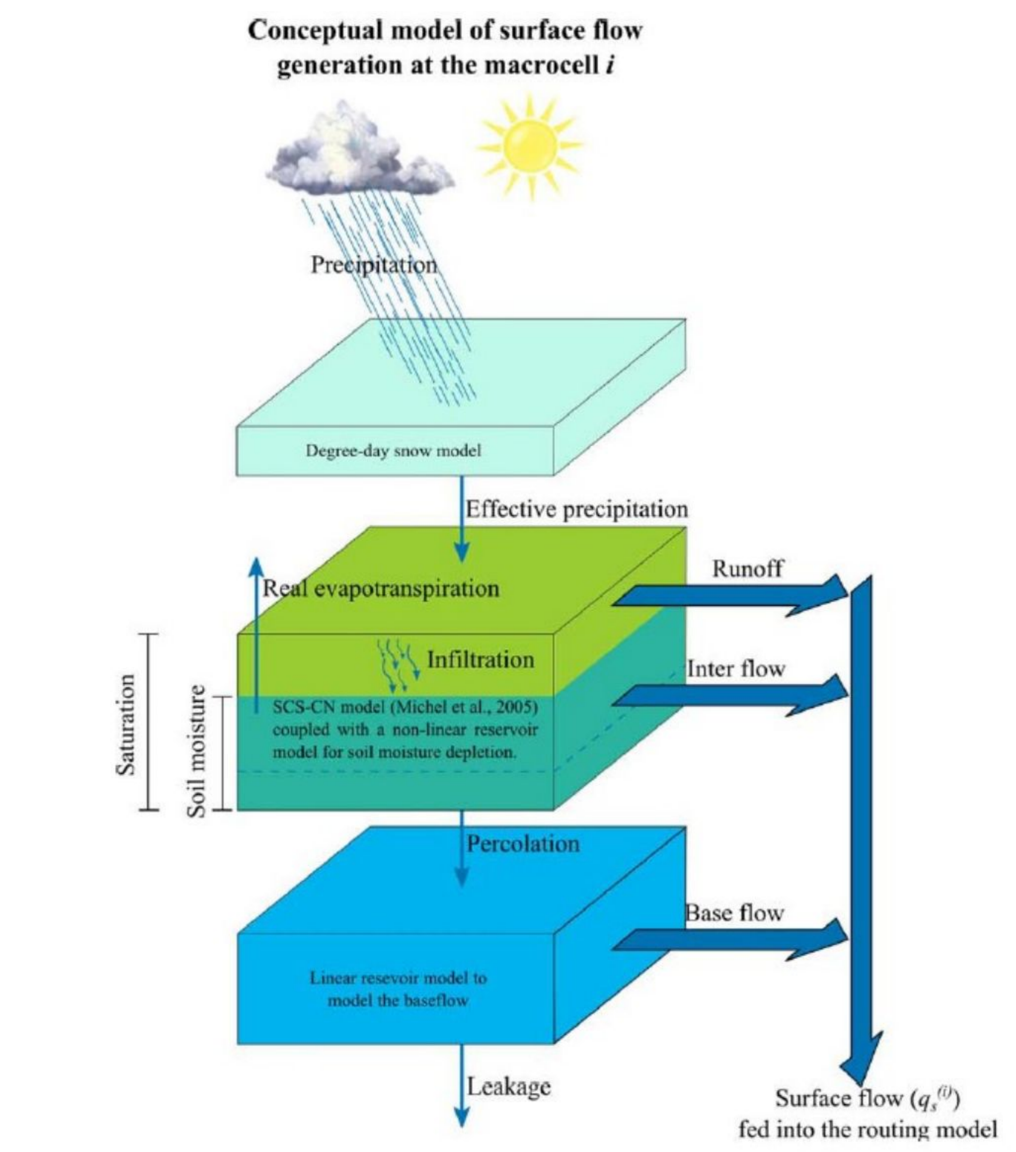
The HYPERstream routing scheme includes a continuous hydrological kernel and a specific model for accounting the contribution of soil moisture.
[Piccolroaz 2016].

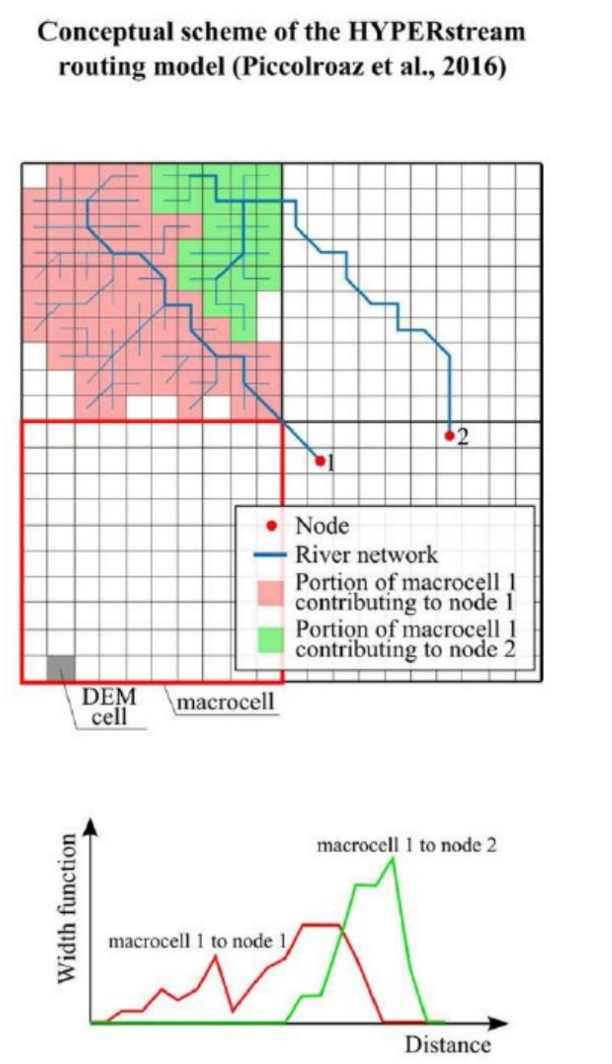
Runoff calculation is performed via WFIUH approach, in which each node is linked to each contributing area by means of width functions (node-cell pairs).

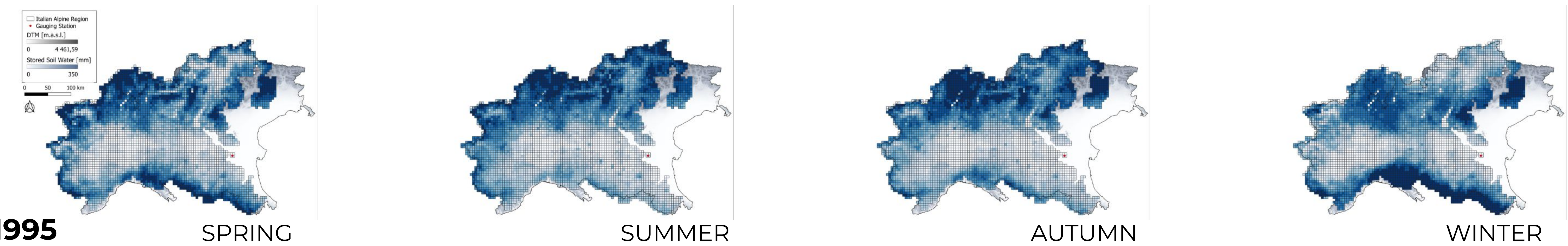
As meteorological input data for the hydrological model, gridded datasets with the best performances on the study are have been used: APGD for precipitation, EOBS for temperature, Hargreaves-Samani for evapotranspiration.
[Isotta 2014; Cornes 2018].

Maps (5x5 km²) of calibrated superficial soil water (SSH) and snow (SNW) is simulated on a daily basis from 1995 to 2008.

Calibration metric observed vs simulated discharges KGE=0.85.





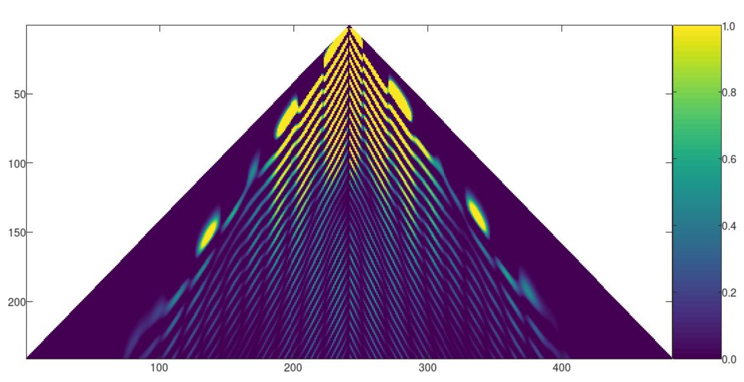


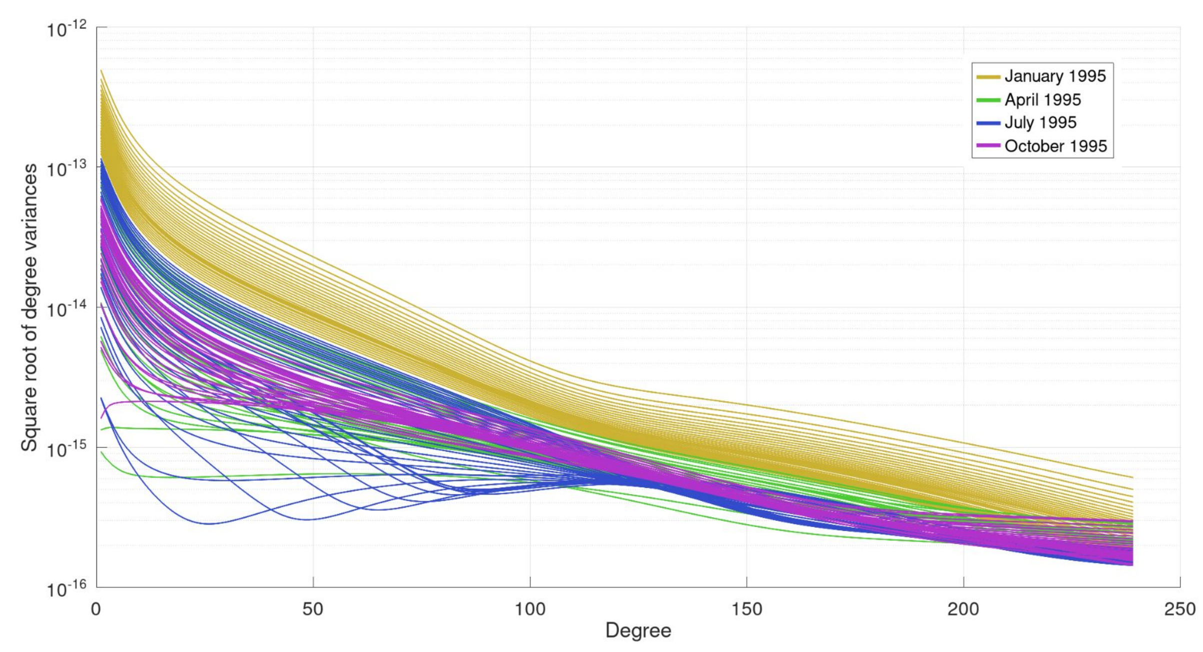
1995 SPRING SUMMER AUTUMN WINTER

Forward gravitational modeling

Positions of equivalent superficial water content (SSW+SNW [mm]) were resampled on o regular grid (0.5°x0.5°).
The contribution of the temporal mean (1995-2008) was assumed included into the static gravity field and hence removed at each epoch.

A spherical harmonic synthesis for each epoch was performed and the set of coefficients used to simulate the gravitational signal at the satellite altitude.

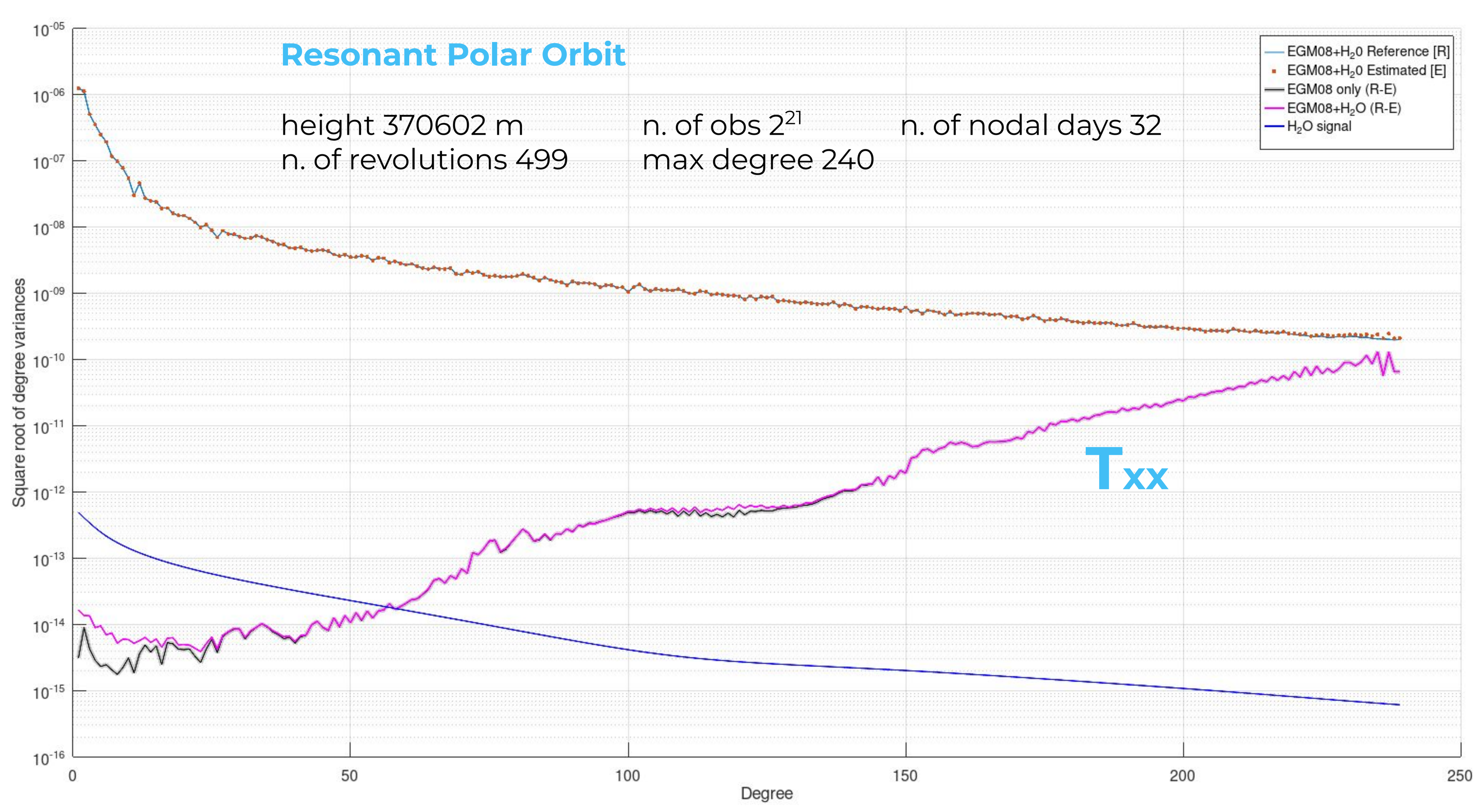




Time-wise approach

The time-wise approach works in the frequency domain after a Fourier transform, making the simulation very efficient from the computational point of view and permitting a formal error propagation of realistic instrumental noise power spectral densities, but this comes at the cost of some simplifications: regular sampling and resonant orbits.
In this work gradiometric-like observations (T_{xx}) have been considered in the starting phases of the analysis of the performances of the time-wise approach in accounting for the time-variable components of the Earth field observed by a NGGM like mission.

In practice geometrical quantities can be converted to gravity field tensor component Txx according to:
range_rate / range ≅ T_{xx}
and georeferencing the point-wise observation in the middle of the LOS. Such a gradiometry approach will however introduce an error due to the linearization of the gradients at the middle point between the two satellites.



ASI Project

"Modelli di gravità dei dati Next Generation Gravity Mission – NGGM"

Entrusted to the Politecnico di Milano
[AA 2021-25-HH.0, CUP F45F21000790005]

References

Piccolroaz S., et al. (2016). *HYPERstream: a multi-scale framework for streamflow routing in large hydrological model* Hydrol. Earth Syst. Sci., 20 – doi:10.5194/hess-20-2047-2016
Cornes, R.C.,et al. (2018). *An ensemble version of the E-OBS temperature and precipitation data sets* Journal of Geophysical Research: Atmospheres, 123, – doi:10.1029/2017JD028200
Isotta F.A. et al. (2014). *The climate of daily precipitation in the Alps* International Journal Of Climatology 34 – doi:10.1002/joc.3794.