EGU2019-14532: **Regional aquifer parameters by spectral analysis of groundwater head fluctuations – a synthetic study**

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Conclusion

- **Effective aquifer parameters** can be derived by spectral analysis of GW head fluctuations in a confined and homogeneous synthetic scenario.
- Parameter determination works best for observation points at **position x = 1/4 * L**.
- **Characteristic time scale** of aquifer should not exceed 1/10 of modeling (measurement) period and be smaller than 10 times the sampling interval.

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Motivation and Research Questions

Groundwater - the world's largest freshwater resource - is critically important for drinking water supply and irrigated agriculture and hence for global food security. Predictive regional groundwater models are highly needed for a robust estimate of water stored in aquifer systems which constitute the basis of decision-making for sustainable water management plans and policy making.

Regional groundwater models generally suffer from data scarcity in subsurface hydrology. Insights from local groundwater measurements have to be regionalized to supply large scale models with adequate parameter constraints. This study evaluates the potential and limitation of generalization of point source information to a regional scale by analyzing the spectral content of head time series.

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Methodology

Head time series extraction

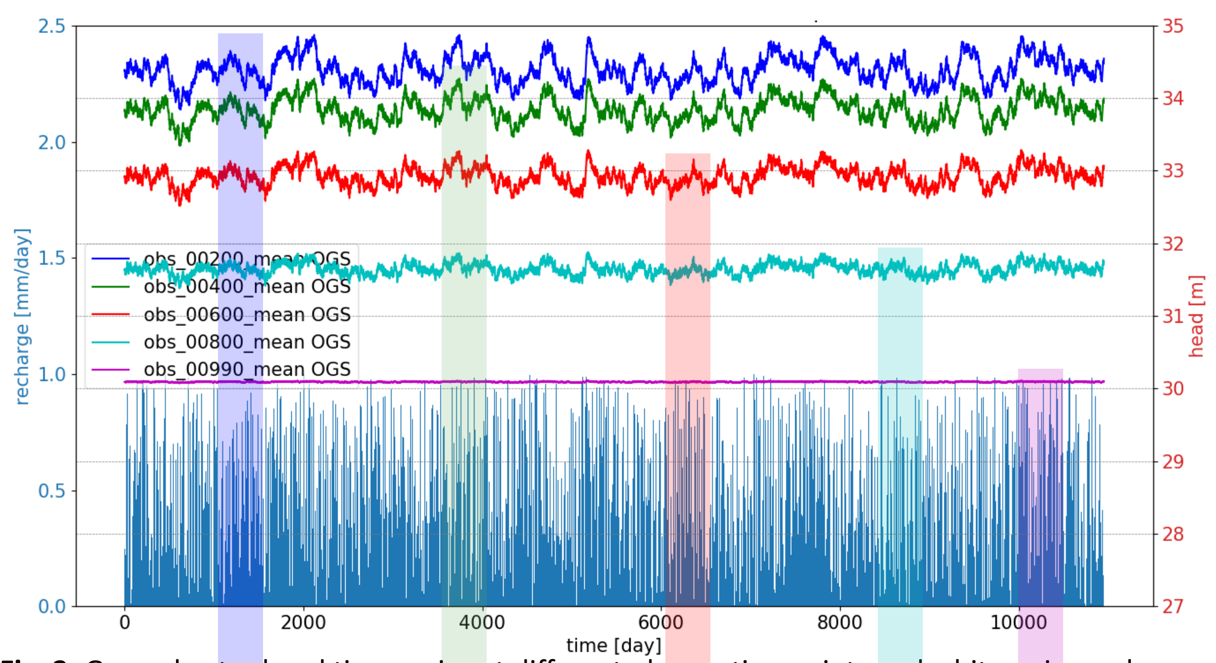

Fig. 3: Groundwater head time series at different observation points and white noise recharge.

- time series transformation into Fourier Space
- calculation of power spectrum (Shh)
- modeled data were fitted with a semi-analytical solution [2]
- detemination of parameters S and T

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- GW flow in a homogeneous aquifer as 2D transect
- white noise recharge, laterally constant
- GW head time series over a modeling period of 30 years
- confined water table was observed between a no - flow and a constant head boundary condition

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Parameter Determination

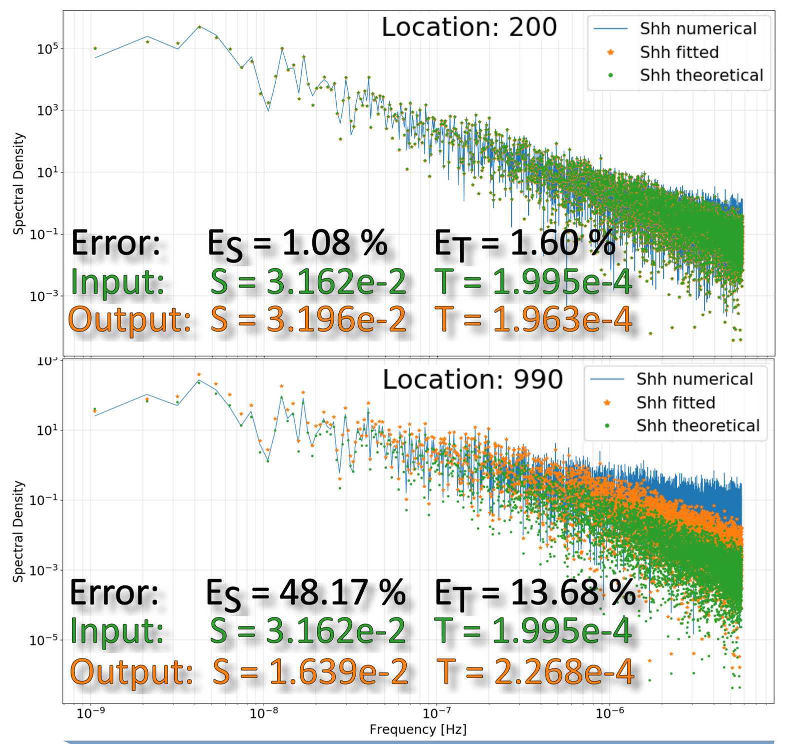

Fig. 4: Power spectrum of modeled data, semi-analytical spectrum of fitted parameters and input parameters.

- input S and T vs output S and T

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Numerical Simulations (OpenGeoSys, OGS5PY [3])

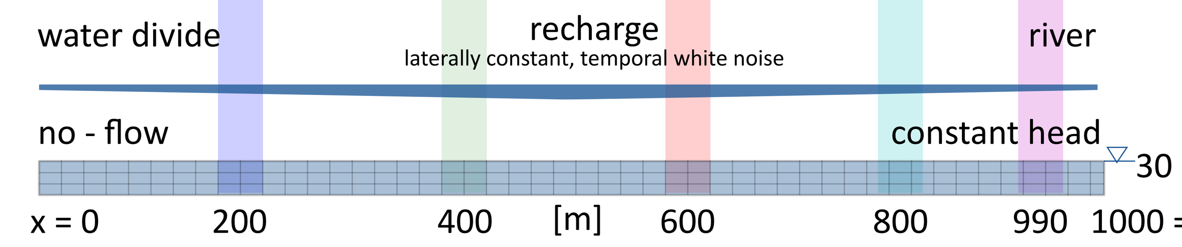

Fig. 2: Vertical 2D transect as model domain for groundwater flow.

Sample Space

- Figure 1: resulting characteristic time t_c for all input parameter combinations of **S**torativity and **T**ransmissivity
- all other parameters const.

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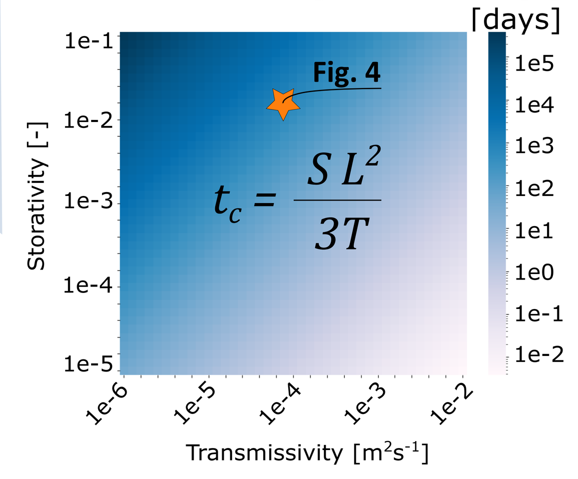

Fig. 1: Input sample space. 41 x 41 values of S and T each result in 1681 model setups.

Results and Discussion

Error in Parameter Determination vs Input Space

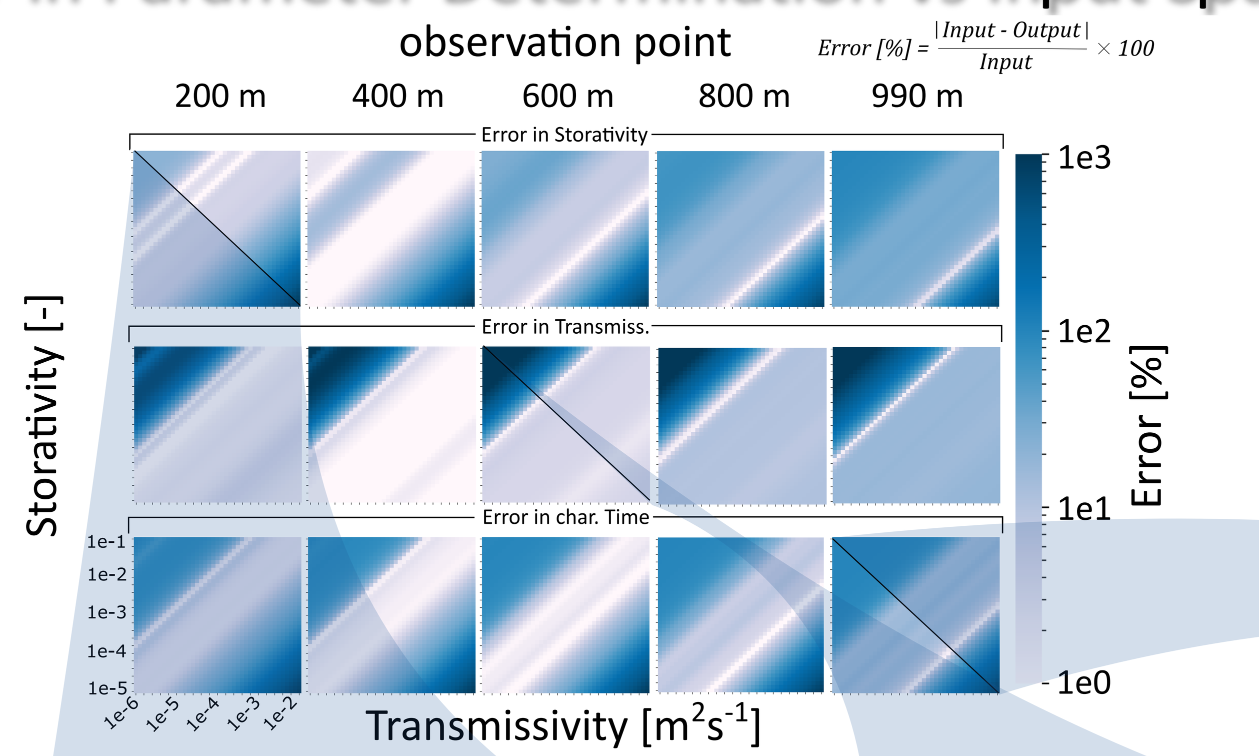

Fig. 5: Error of inferred parameters S, T and t_c along the aquifer for different observation points.

- inferred aquifer parameters S, T and also the resulting char. time scale t_c are compared with the input parameters
- best estimate could be achieved at a position of roughly 1/4 of aquifer length apart from water divide
- determination of S is predominantly constrained by small t_c
- determination of T is limited by high values of t_c
- t_c of investigated aquifer should not exceed ca. 1/10 of the modeling or measurement period
- t_c should not be smaller than roughly 10 times the sampling interval of groundwater head time series.

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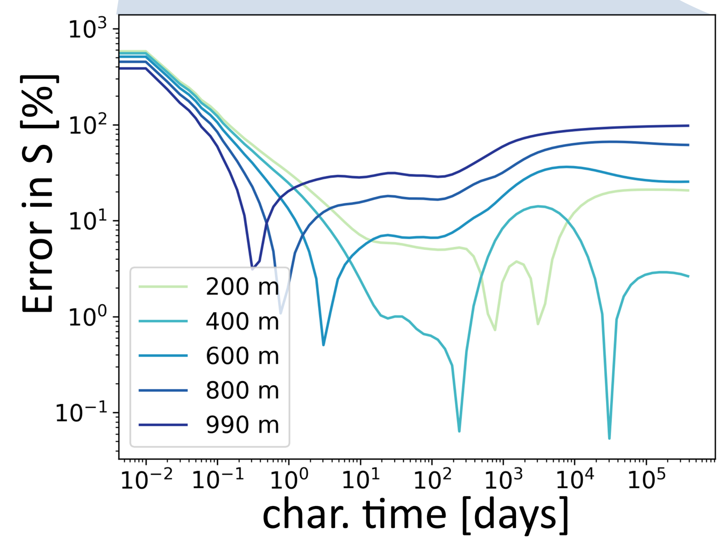

Fig. 6: Error in Storativity versus input char. time scale for different observation points

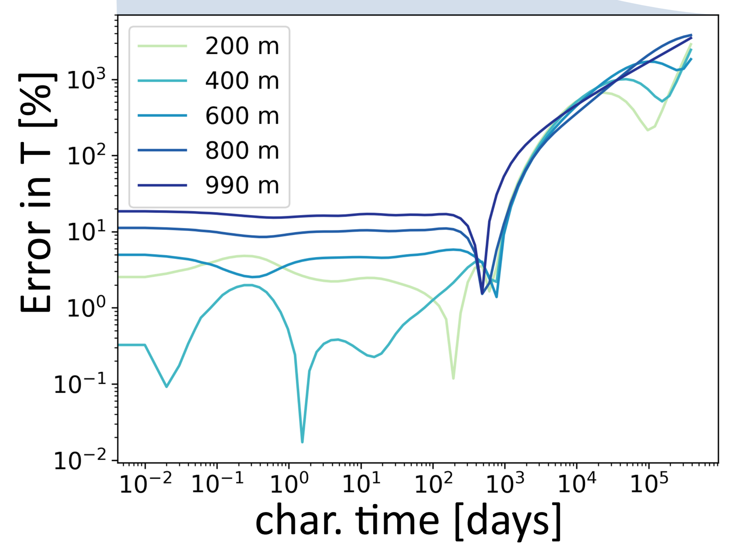

Fig. 7: Error in Transmissivity versus input char. time scale for different observation points

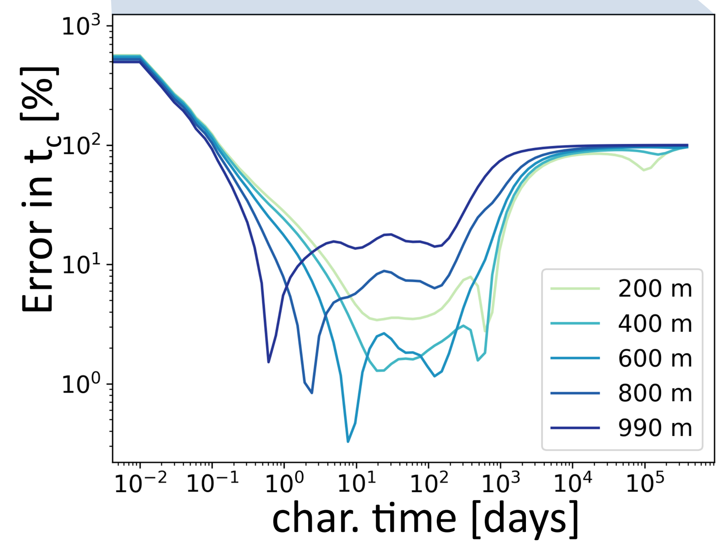

Fig. 8: Error in char. time versus input char. time scale for different observation points

- Figure 6 - 8 show the variation of errors for different t_c
- one graph represents a single observation point with aggregated data for rounded values of t_c (diagonal of the heatmaps)
- two minima with small distance close to the no-flow BC
- approaching the stream one minimum remains

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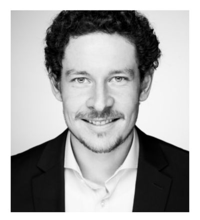
Outlook

- same study with other model setups, modeling periods and time steps
- heterogeneous model domain
- real data from test sites

Photography encouraged

WANTED

- GW head time series with identified constraints (length of time series ~ 10 * t_c, dense measurements)
- catchment should be well known (e.g. S and T from pumping tests) and homogeneous porous aquifer
- uniform thickness, horizontal aquifer basement and well known GW flow directions and recharge



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References

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[2] Liang, X. and Zhang, Y.-K., 2013: Temporal and spatial variation and scaling of groundwater levels in a bounded unconfined aquifer. Journal of Hydrology. http://dx.doi.org/10.1016/j.hydrol.2012.11.044
[3] Müller, S., 2019: GeoStat-Framework/ogs5py v0.6.3. Zenodo. http://doi.org/10.5281/zenodo.2601940

[3]

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