# Groundwater investigation of WaterGAP performance over river basins in France

Kuei-Hua (Bell) Hsu, Laurent Longuevergne, Annette Eicker

Kuei-hua.hsu@hcu-hamburg.de

# Aim of study

Research question:

**How can we validate WaterGAP modeling results?**

Attempt to answer this question:

**We evaluate its performance by comparing it with real world data!**

We obtained **groundwater data** going back to the 1960s, collected from measurements of around 4000 boreholes in **France**. In order to compare this data with WaterGAP results, the data was cleaned, normalized and will be interpolated. We chose January 2002 – December 2016 as the research period (GRACE period) and 4 river basins (Garonne, Loire, Rhone, Seine) as our validation areas.

(WaterGAP is developed since 1996 at University of Kassel and Goethe University Frankfurt)

# WaterGAP (Water Global Assessment and Prognosis)

WaterGAP results are a combination of water resources and uses

Resources: flows and storages

water balance equation:

**P**(precipitation)=

**R**(streamflow) +

**E**(evapotranspiration) +

**ΔS**(change in storage)

Input data sets: e.g. WATCH Forcing data and GPCC

&

Uses: domestic, thermal power, manufacturing, irrigation, livestock

Input data sets:
global water use models

=>

WaterGAP:

Resolution:

Spatial: 0.5*0.5 deg

(all continents except Antarctica)

Temporal: 1 month

We validate **groundwater** output of WaterGAP in this study!

# GW borehole distribution in France

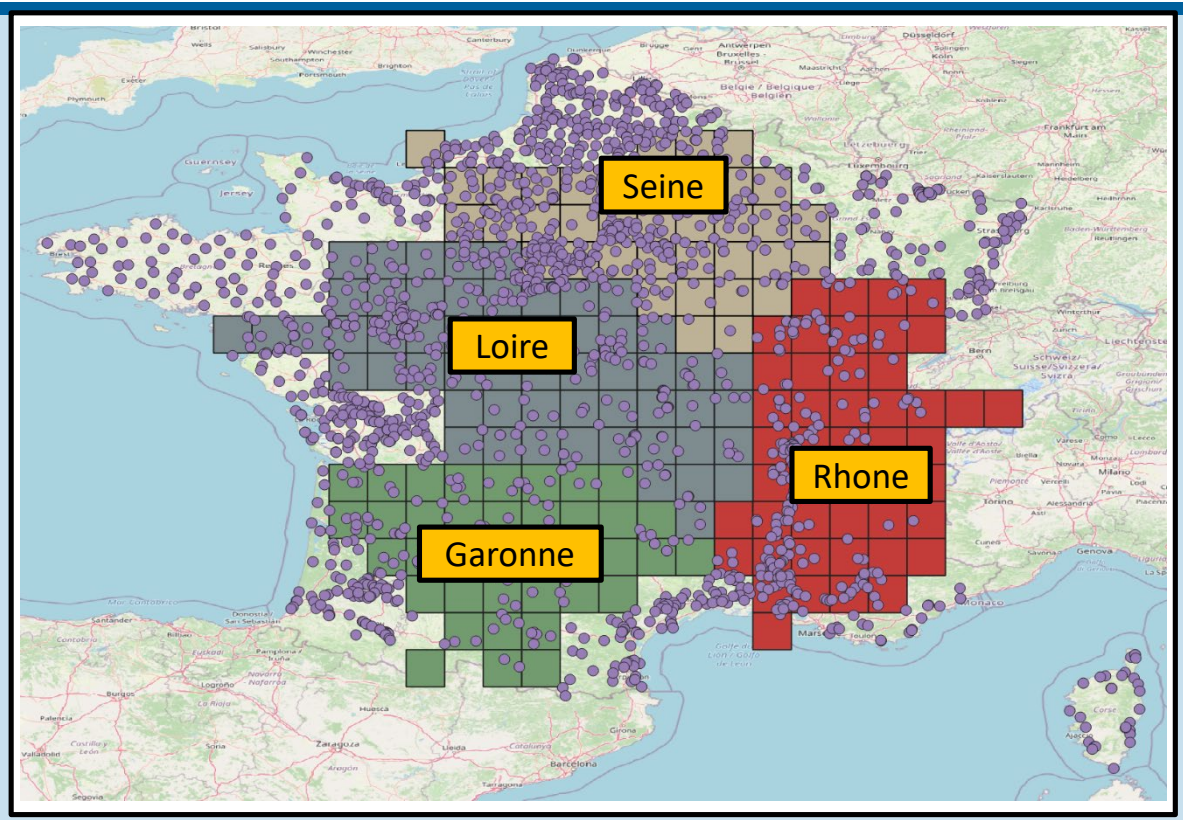
~4000 boreholes

Keep GRACE period
Remove bad timeseries
Remove domestic data
Remove outliers (iqr)

~3200 boreholes

Keep unconfined aquifers

1788 unconfined boreholes (purple dots)

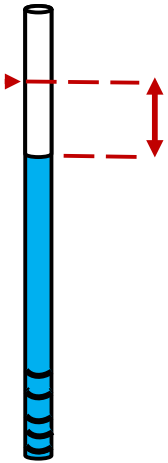


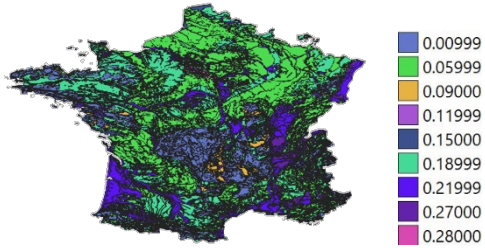

(data obtained from ADES, France: https://ades.eaufrance.fr/)

# GW borehole and WaterGAP comparsion

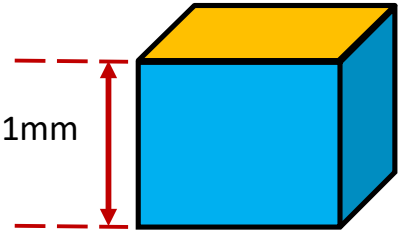
GW borehole unit: GW head variation $[m]$ * Porosity [unitless] * Water density: 1000 $[kg/m^3]$ = WaterGAP unit: $[kg/m^2]$

Mean of timeseries GW head



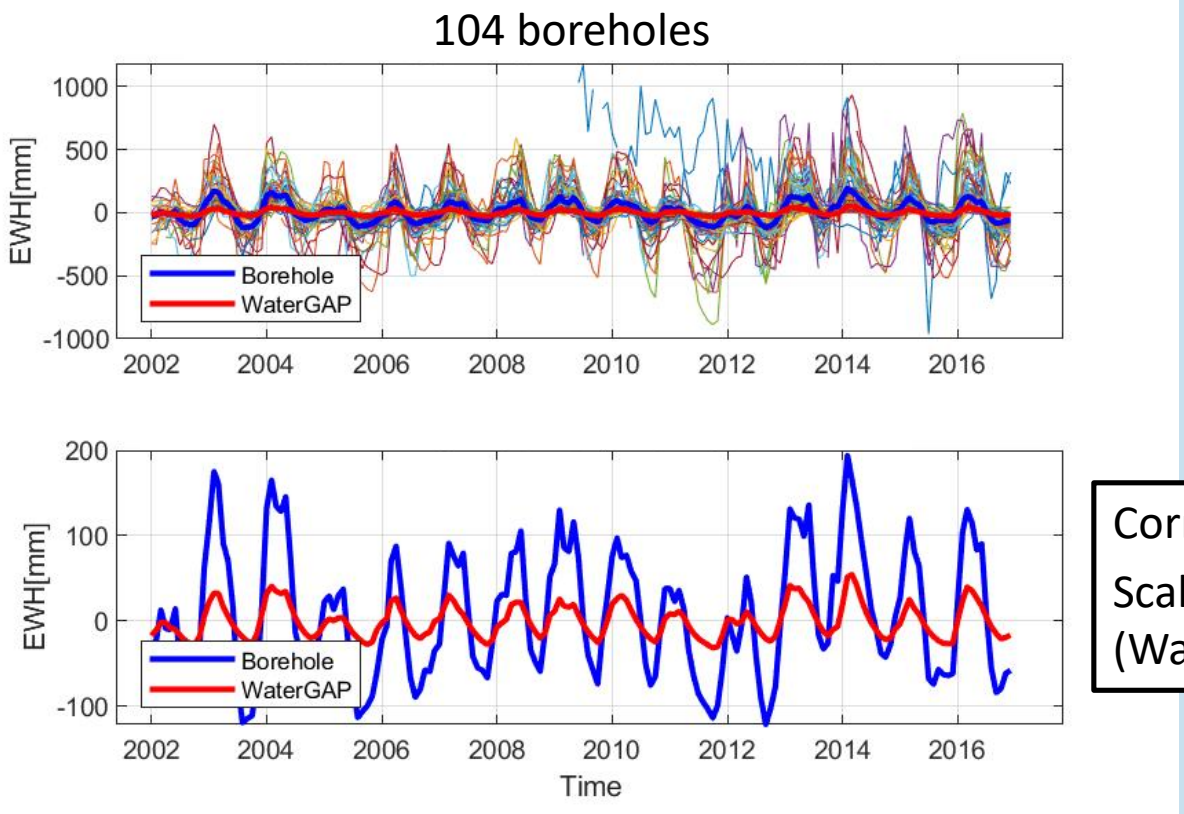



Glesson et. al (2014)




height of 1 $kg$ water on 1 $m^2$ area is 1 $mm$, so called equivalent water height (EWH)

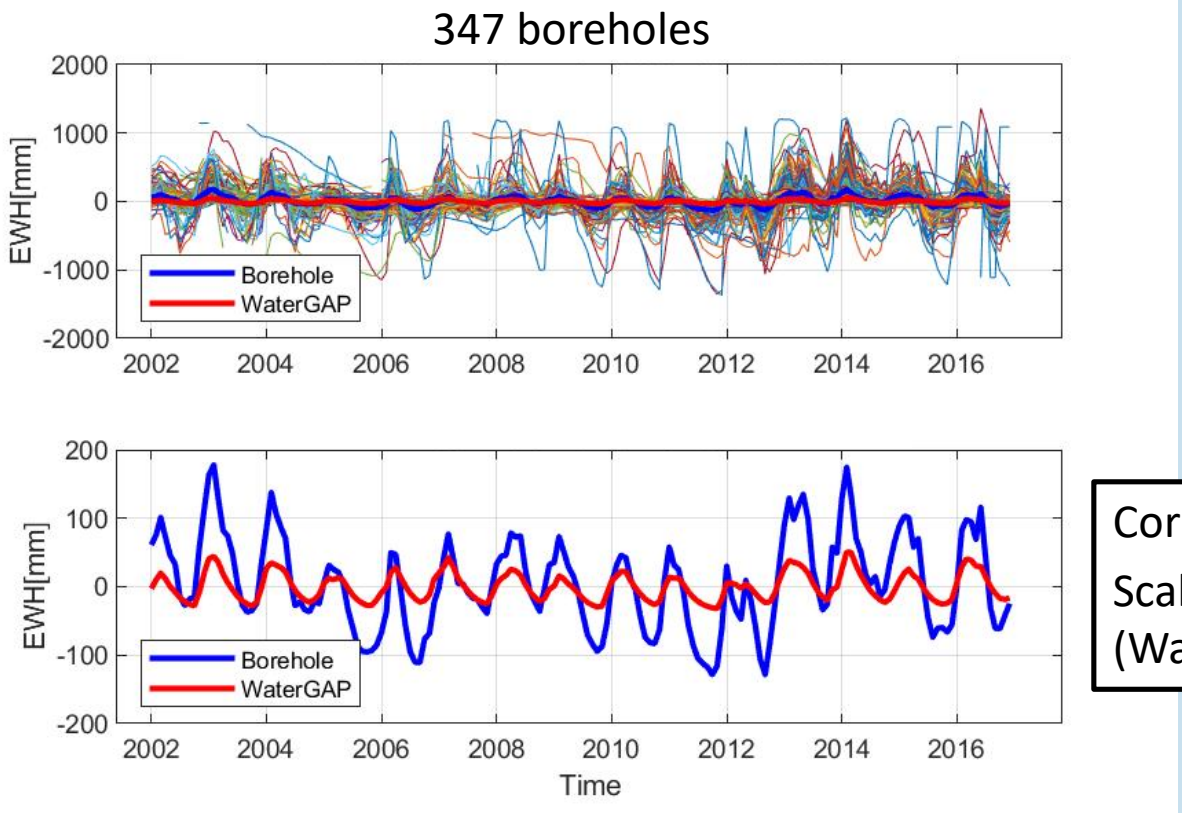
# Monthly mean of GW variation (Garonne)




Correlation = 0.94

Scaling factor (WaterGAP/boreholes) = 0.25

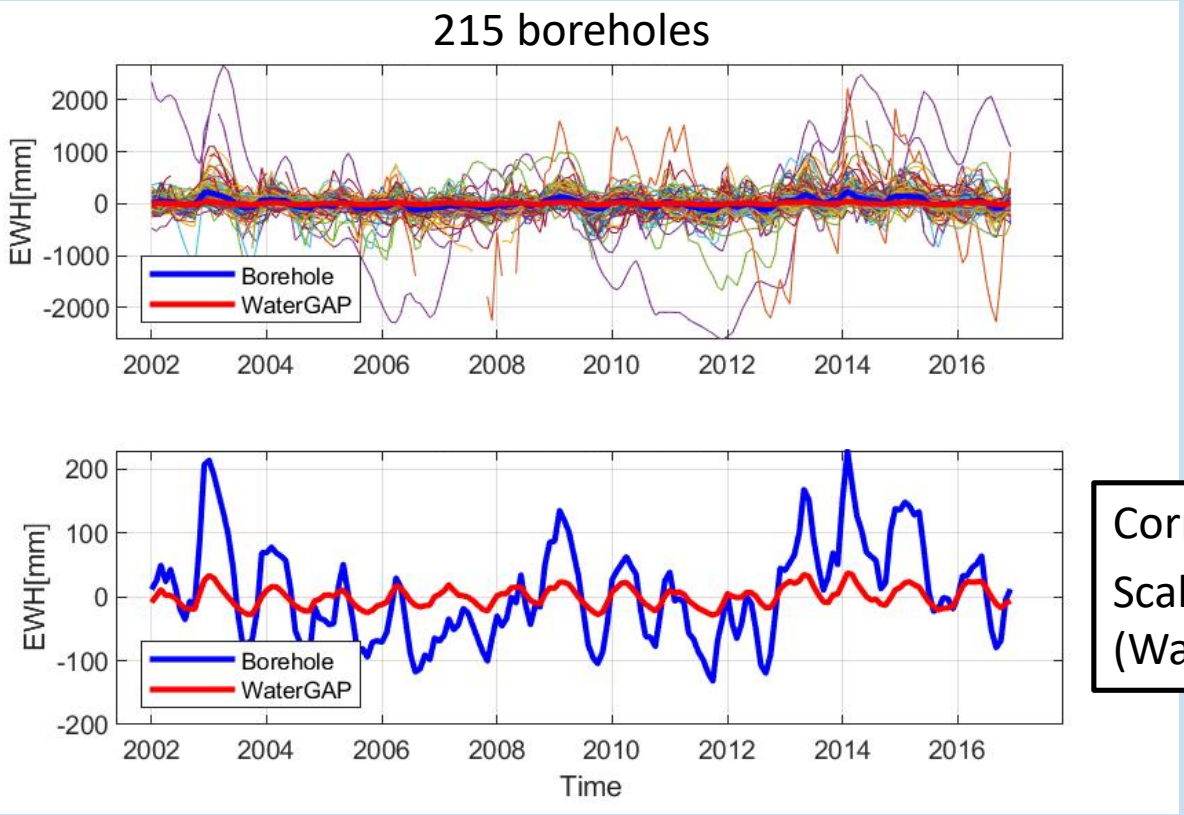
# Monthly mean of GW variation (Loire)




Correlation = 0.87

Scaling factor (WaterGAP/boreholes) = 0.26

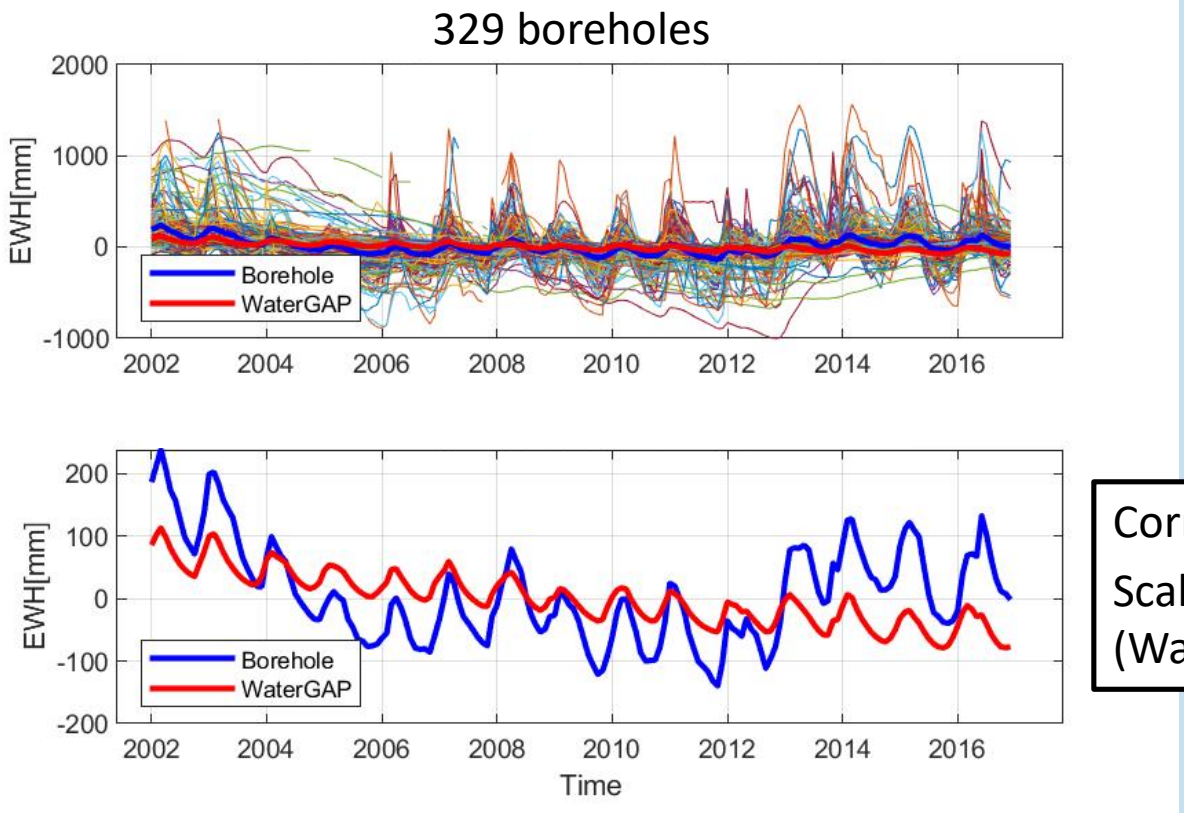
# Monthly mean of GW variation (Rhone)




Correlation =0.8

Scaling factor (WaterGAP/boreholes) = 0.16

# Monthly mean of GW variation (Seine)

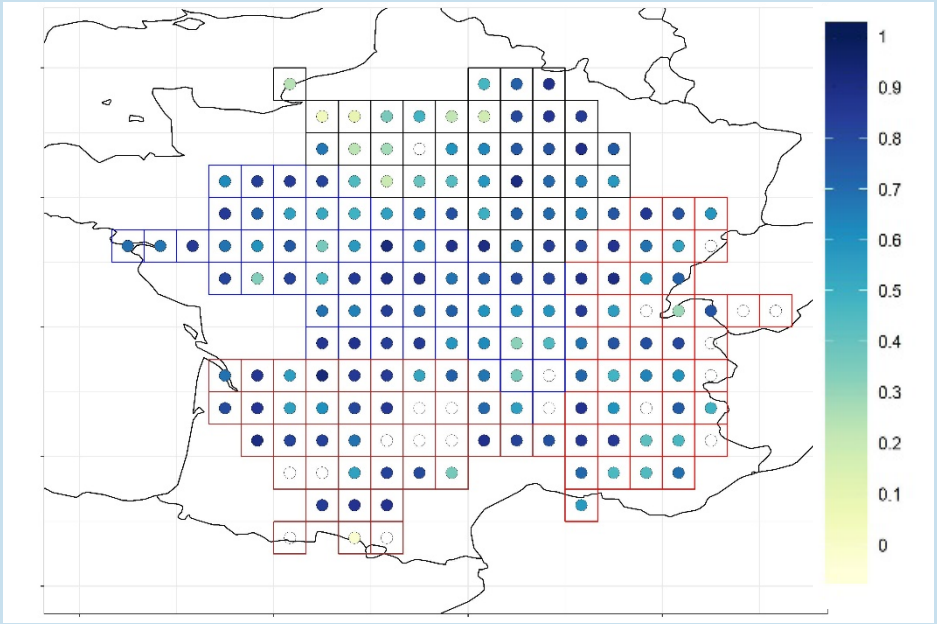



Correlation = 0.5

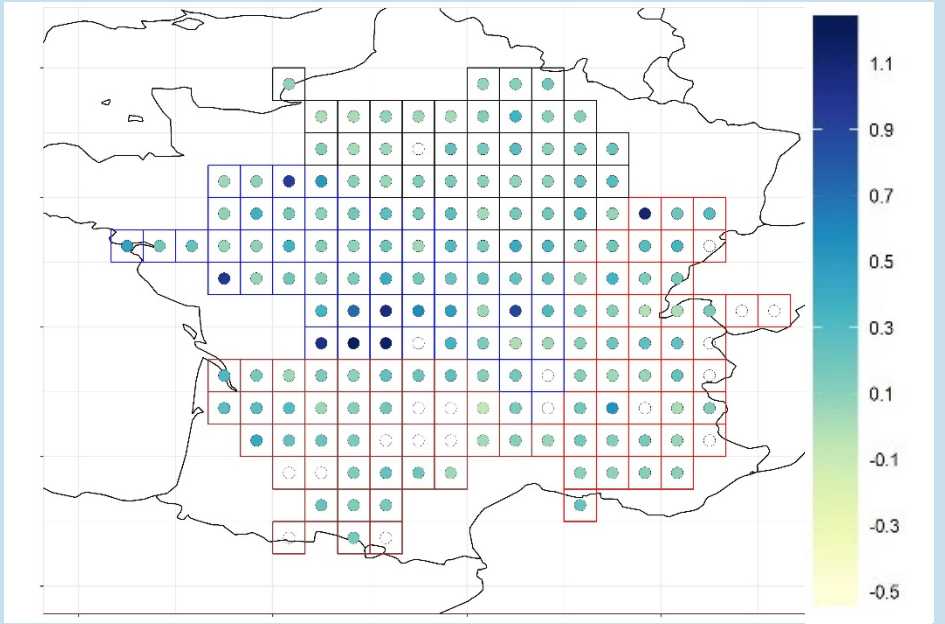
Scaling factor (WaterGAP/boreholes) = 0.28

# Scaling factor and Correlation

Correlation




Scaling factor




Preliminary results: WaterGAP captures groundwater seasonality and phase well, but seems to generally underestimate magnitudes.