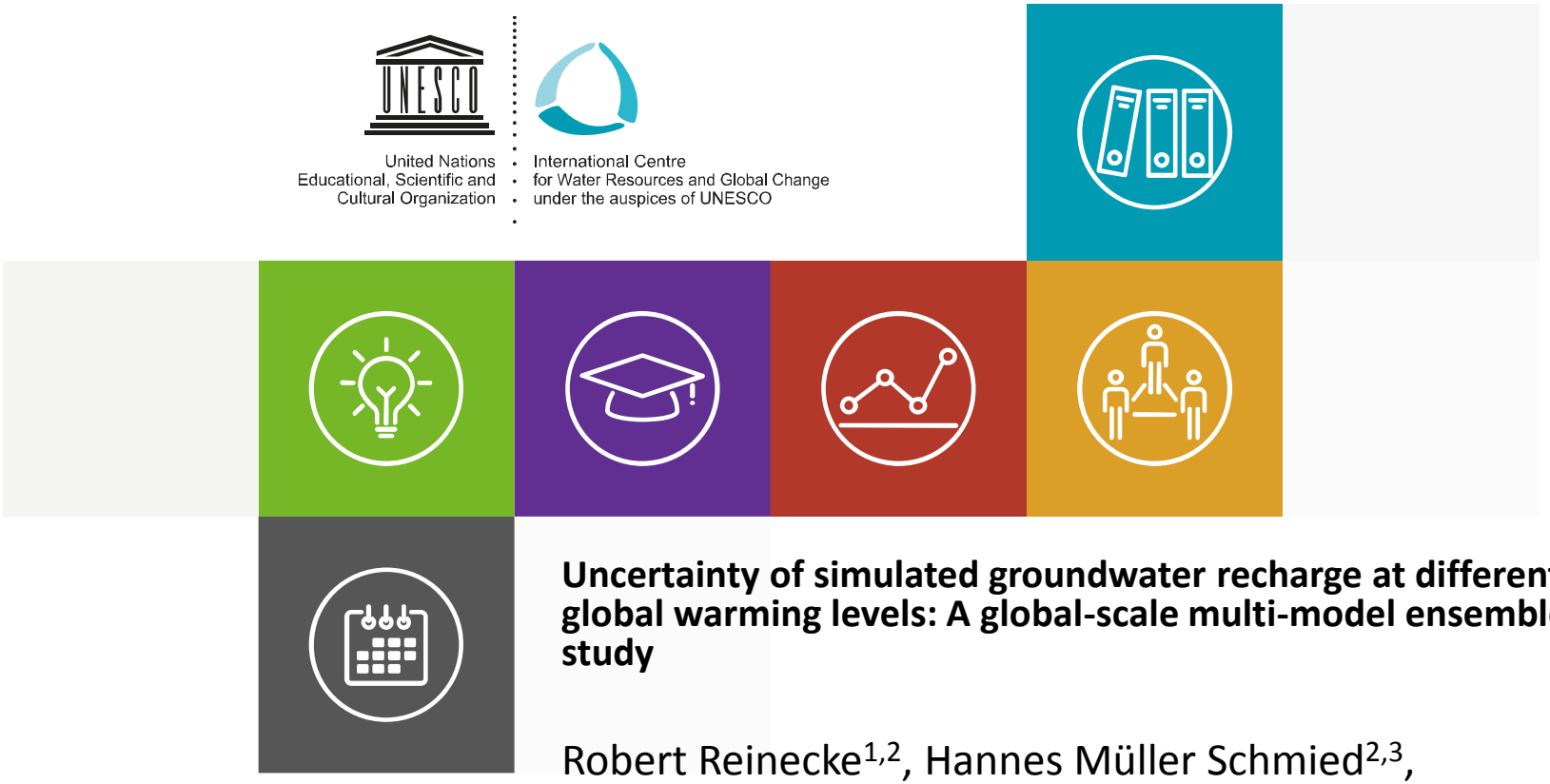
EGU2020-2189 HS8.2.1



Uncertainty of simulated groundwater recharge at different global warming levels: A global-scale multi-model ensemble study

Robert Reinecke[1,2], Hannes Müller Schmied[2,3], Petra Döll[2,3]

[1]International Centre for Water Resources and Global Change (UNESCO)
[2]Goethe University Frankfurt
[3]Senckenberg Biodiversity and Climate Research Centre (SBiK-F)

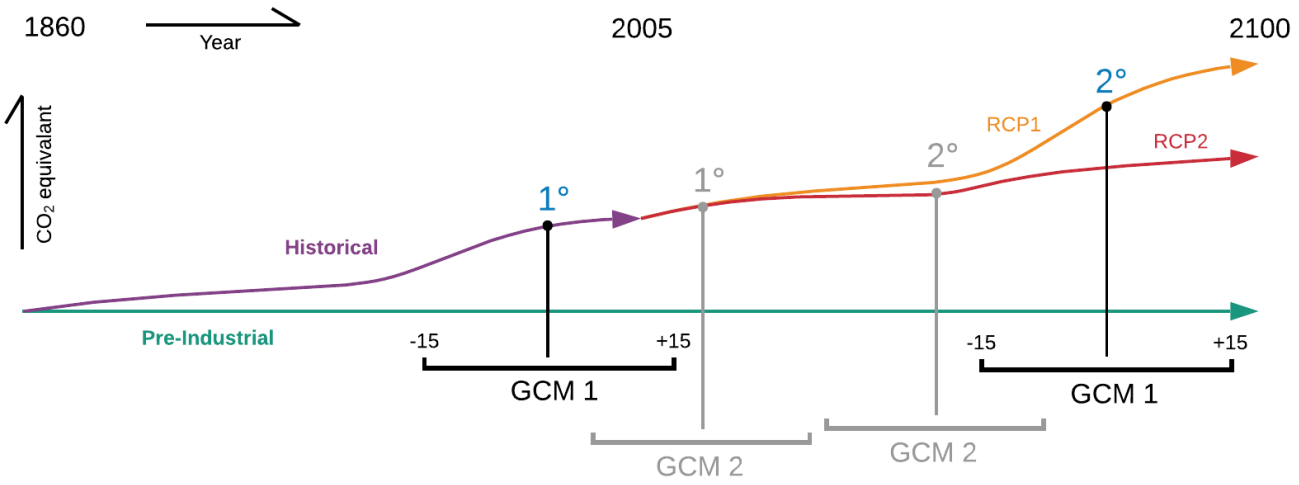
Motivation

- Groundwater as an accessible source of freshwater
- Importance will increase with climate change
- abstractions have already led to depleted aquifers
- **Groundwater recharge** is a central indicator of potential groundwater availability

Source: Robert Reinecke

Methods

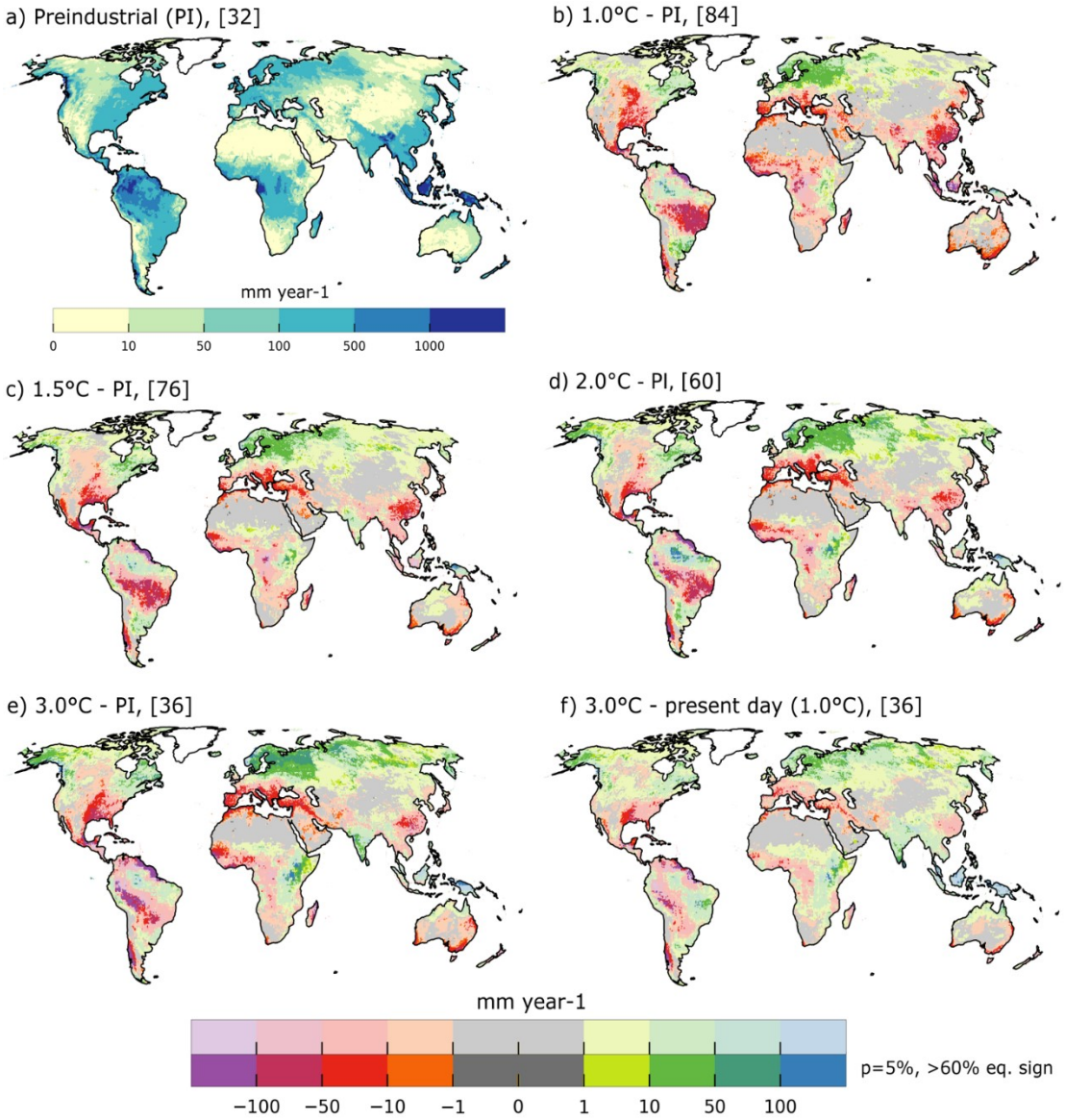
- Use of outputs from ISIMIP2b protocol https://www.isimip.org
- 8 GHMs (global hydrological models) and 4 GCMs (global circulation models) and 3 RCPs
- GWR is averaged over time slices of 30 years per warming level of 1°, 1.5, 2°, and 3°



Not published, submitted to HESS

Results: absolute change of GWR per global warming level

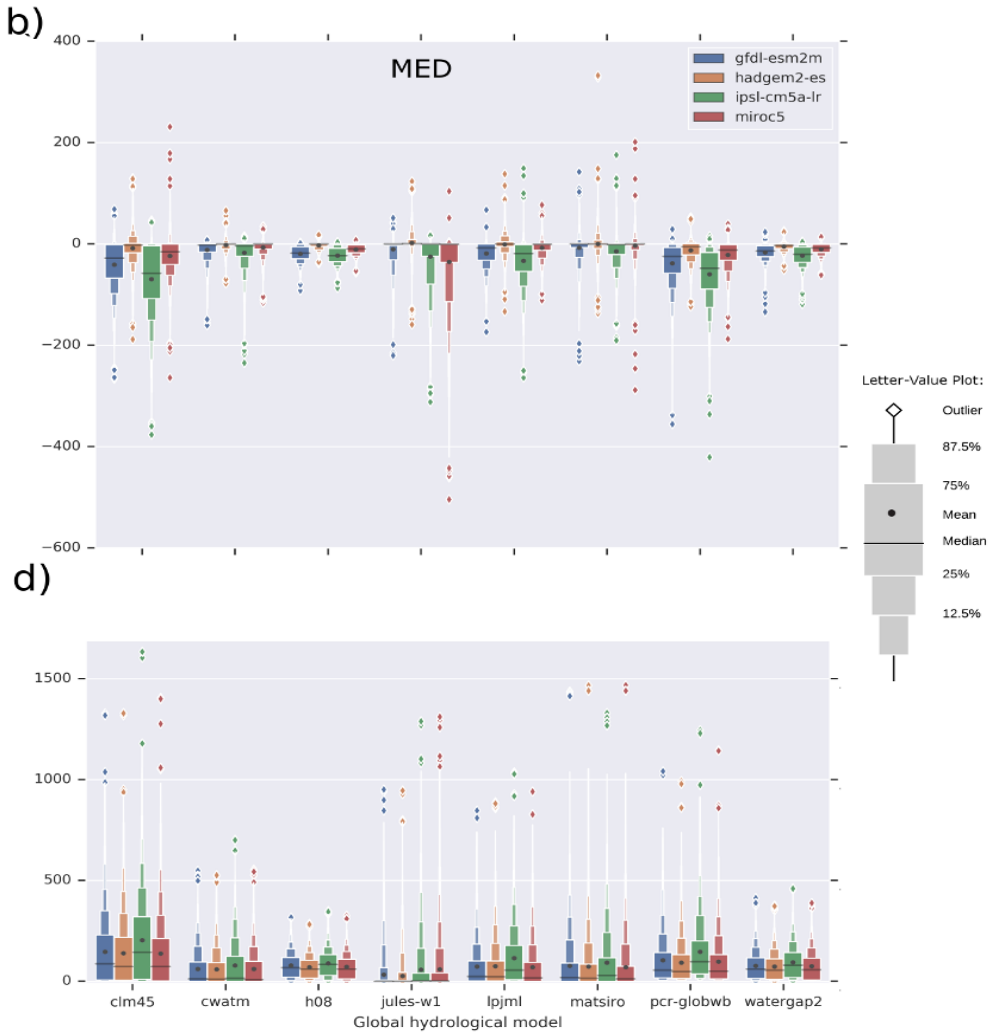
- Absolute change because GWR close to zero leads to infinite relative change
- Ensemble size in brackets
  - Different because not all GCMs reach a warming level with all RCPs
- Solid colors show significant changes
  - Determined by K-S test (p=5%)
  - Additionally test if sign of 60% of the ensemble is equal
- Decreases in the Amazon of over 100 mm per year
- Increases mainly in northern latitudes and East Africa
- Large areas with not significant ensemble result



Not published, submitted to HESS

Results: Changes in GWR in the Mediterranean

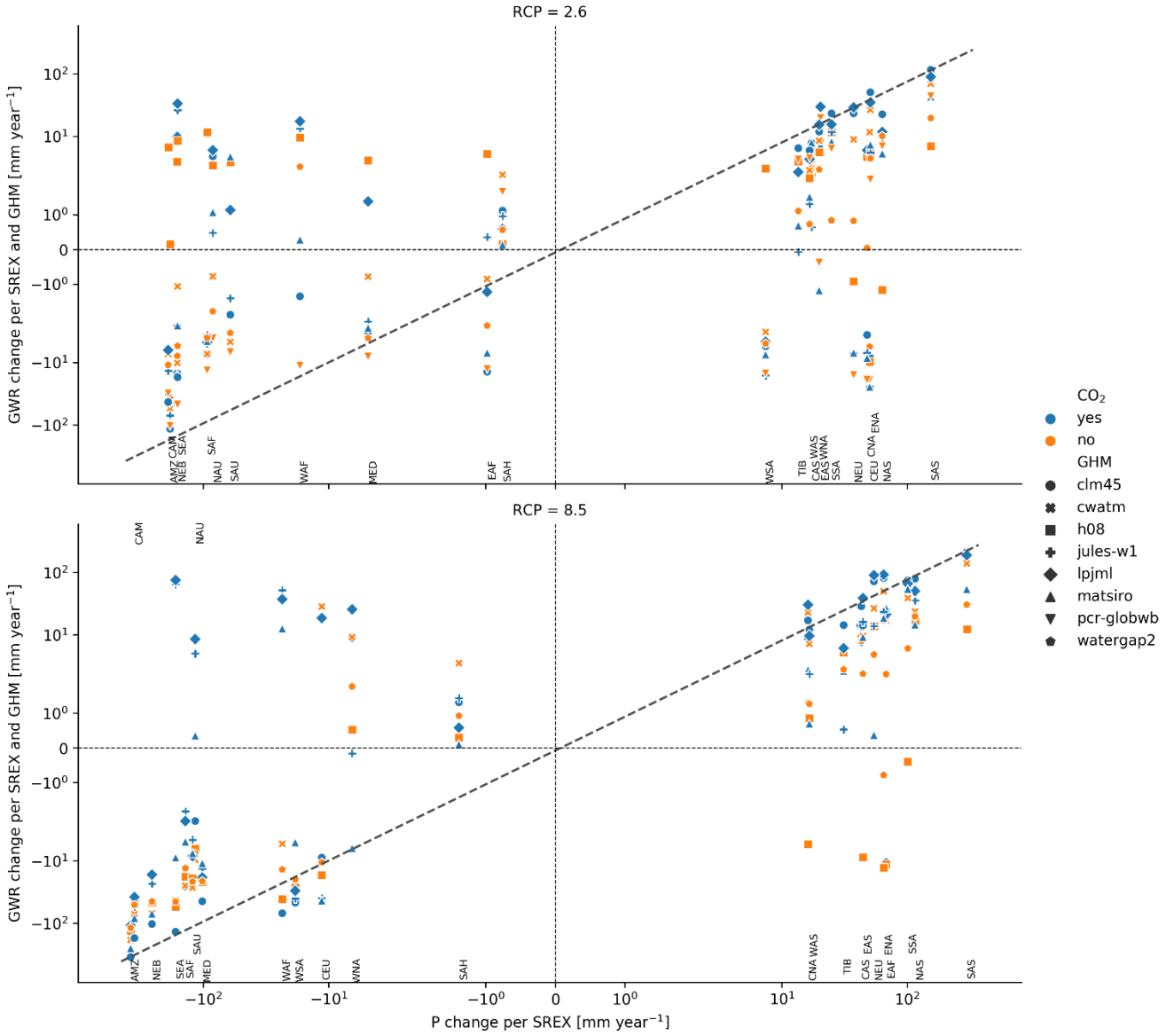
- b) absolute changes per GHM and GCM in mm/year at 1.5° compared to PI
- d) absolute GWR at PI in mm/year
- Letter value plot is similar to box plot
  - Additional boxes show other quantiles
- Simulation of PI GWR and GWR change varies largely in between models



Not published, submitted to HESS

Results: Relation of precipitation (P) to GWR change

- mean(1981-2010) – mean(2070-2099) per SREX
- For the GCM HadGEM2-ES
- Models with dynamic vegetation in blue
- At RCP 8.5 models with dynamic vegetation do not agree when P decreases
- H08 stands out as model that shows decreases in GWR with increases in P

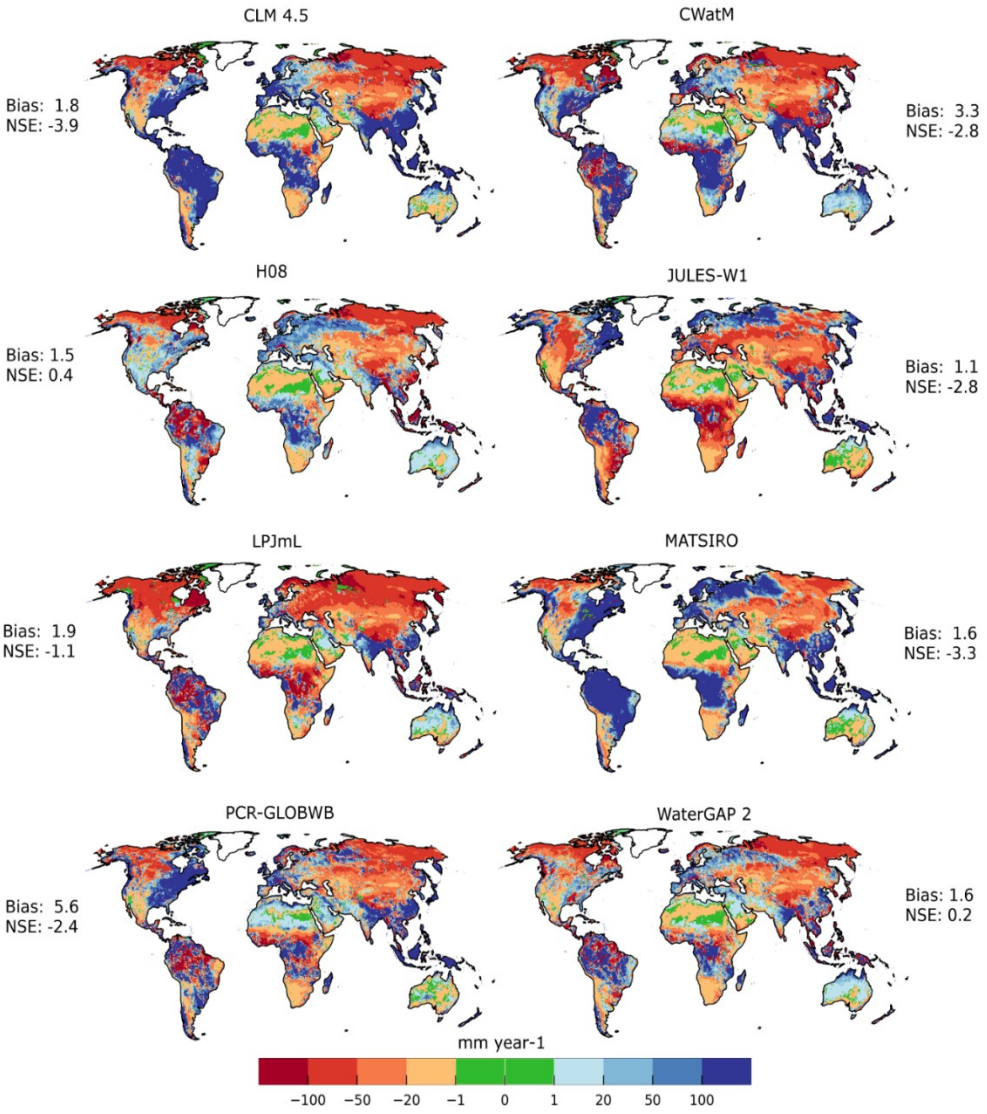


Not published, submitted to HESS

Results: comparison to non-GHM estimates of GWR

- PI GWR per GHM – 34 years (1981-2014) mean GWR [mm year-1] of Mohan et al. (2018)
- NSE is Nash-Sutcliff calculated spatially of all cells instead of time
- Bias: mean(GHM / Mohan et al.)
- GHMs show much lower GWR in permafrost regions as they assume that there is no or little GWR
- Possibly GWR of Mohan et al. (2018) is overestimated here as no measurements informed their results in these regions
- H08 and WaterGAP highest NSE

Mohan, C., Wei, Y., & Saft, M. (2018). Predicting groundwater recharge for varying land cover and climate conditions–a global meta-study. Hydrology and Earth System Sciences, 22(5), 2689-2703



Not published, submitted to HESS

Conclusions

- Simulated global estimates vary broadly between global hydrological models
- On average, a consistent increase of GWR in Europe and a decrease in the Amazon are simulated
- Results suggest that the consideration of CO_2 on vegetation can change the estimates of GWR substantially
- In regions where GCMs predict decreases in precipitation, and thus groundwater availability is important, the model agreement among GHMs with dynamic vegetation is lowest

Contact me via e-mail or on researchgate.net

E-Mail: reinecke@bafg.de

Visit our center:

www.waterandchange.org

Visit our data centers:

Global freshwater quality: gemstat.org

Global Terrestrial Network - Hydrology: gtn-h.info