

Towards validating reservoir operations in global hydrological models using space-borne satellite remote sensing – A case study in the CONUS

Naota Hanasaki, Kedar Otta,
Hannes Müller Schmied, and Simon N. Gosling

**Cross-sectoral ISIMIP and PROCLIAS Workshop
ISIMIP3a results (“from too dry to too wet”)**



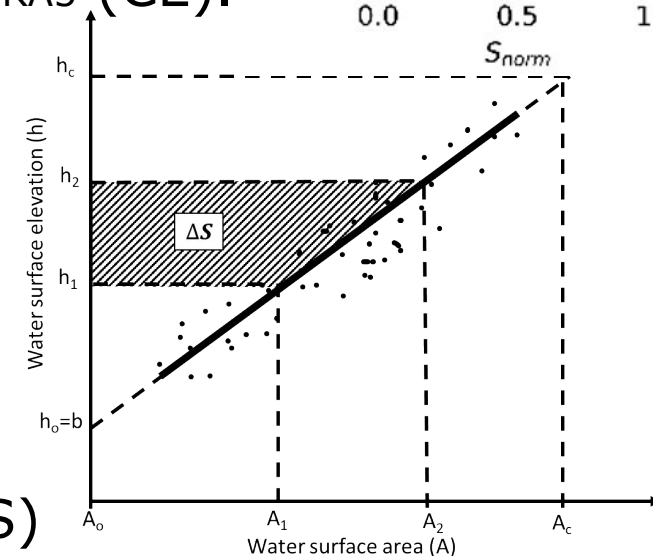
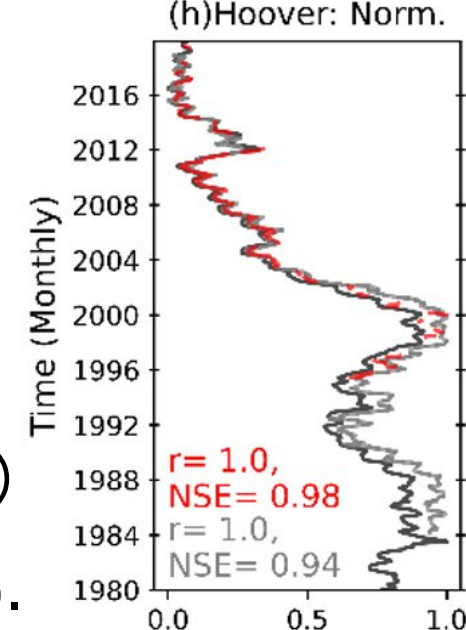
Introduction

- Background
 - Reservoir operation in Global Hydrological Models (GHMs)
 - ☾ Validation is insufficient because of the lack of ground observation data.
- Earlier works
 - Reservoir sub-model intercomparison (Masaki et al., 2017, ERL)
 - ☾ Under ISIMIP2a. Only two rivers due to data limitation
 - Satellite remote sensing of water surface area and elevation (e.g. Pekel et al. 2016, Nature; Zhao and Gao 2018, GRL)
 - ☾ Seldom used for GHM validation/intercomparison.
- Research questions
 - Can we determine which GHM or meteorological forcing performs better than others in ISIMIP, solely by satellite-based storage estimation?
 - Do the findings on reservoir storage validation with satellite data align with ground observations?

Methods

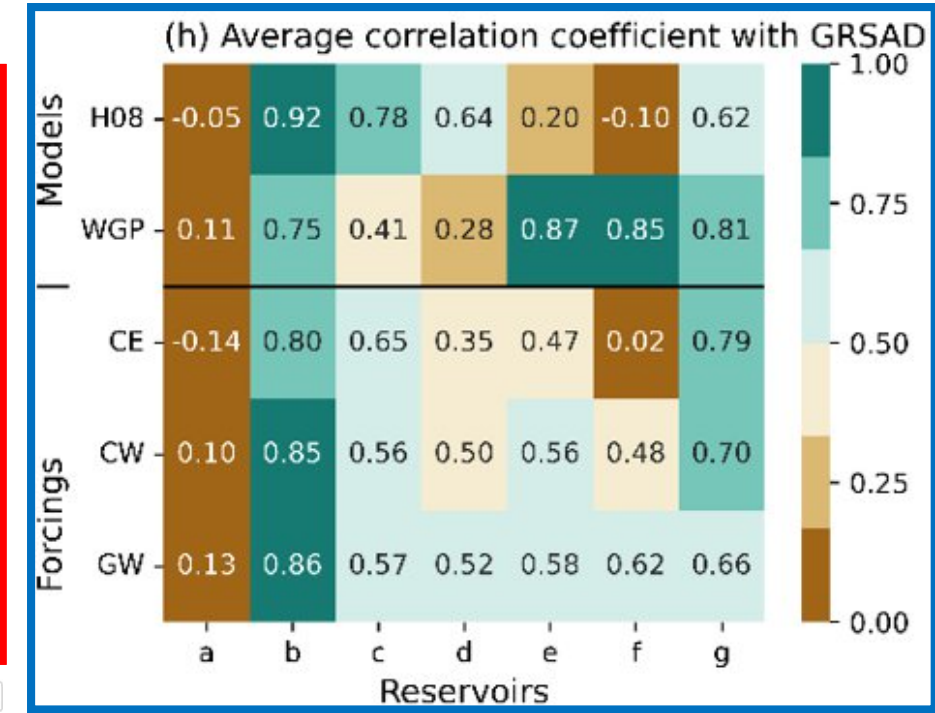
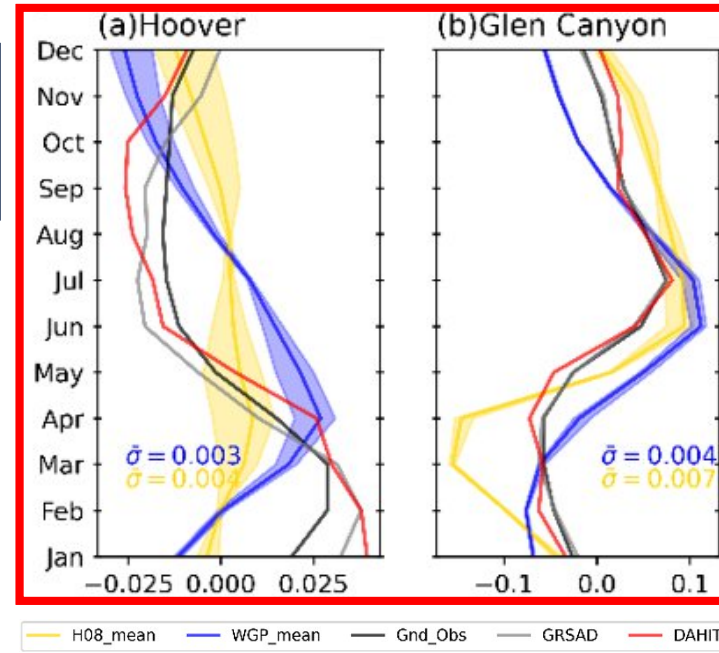
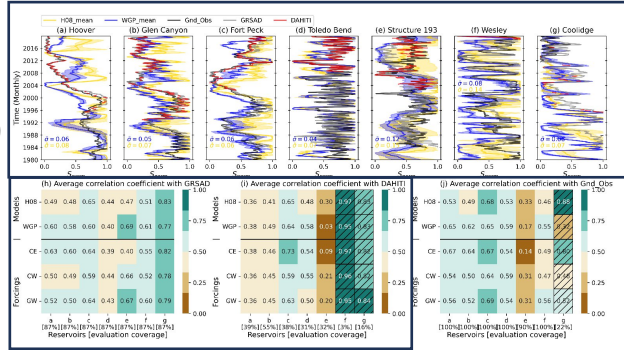
- Data (GHMs)
 - Framework: ISIMIP 3a (global, 30 arc-min, monthly, 1901-2019)
 - Models: H08 and WaterGAP2 (WGP)
 - Forcings: GSWP3-W5E5 (GW), CR20v3-W5E5 (CW), and CR20v3-ERA5 (CE).
- Data (Satellite)
 - DAHITI (Schwatke et al. 2015): Elevation (h)
 - GRSAD (Zhao and Gao, 2018): Surface area (A)
 - Height-Area-Volume conversion
- Data (Ground observation)
 - ResOpsUs (Steyaert et al. 2022)
- Analysis
 - Seven reservoirs in the contiguous United States (CONUS)
 - Storage data were normalized.

— DAHITI
— GRSAD
— Ground Obs



1) Which GHM or meteorological forcing performs better than others?

Seven dams



- WaterGAP2 generally outperforms H08 (but the difference is not very remarkable)
- the CW forcing dataset demonstrated superior results compared with GW and CE

2) Do the findings on reservoir storage validation with satellite data align with ground observations?

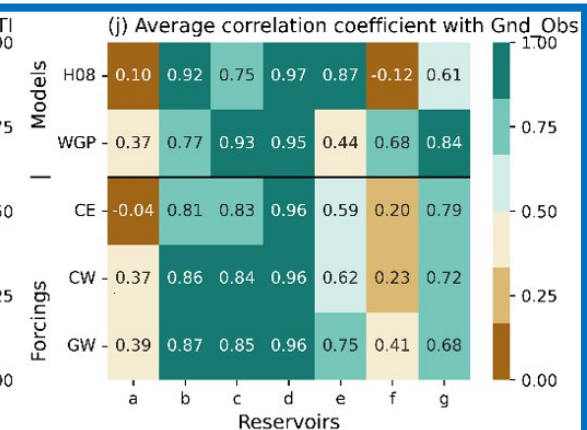
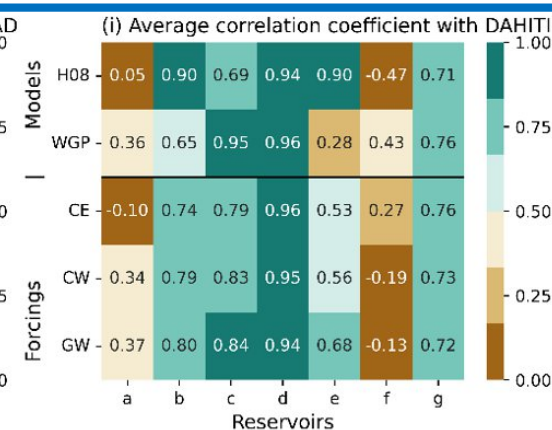
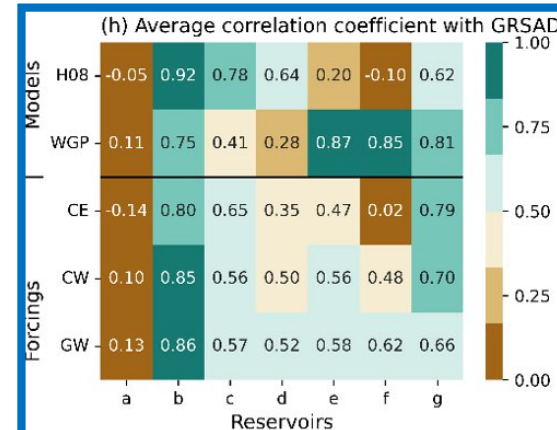
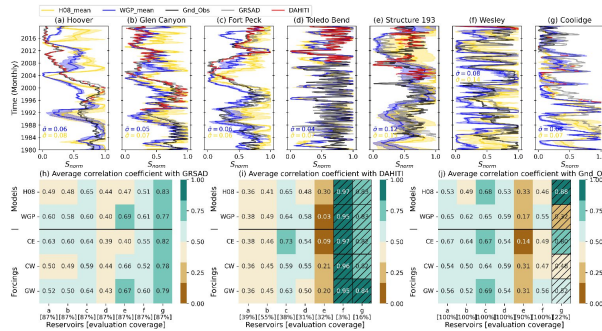
Seven dams

GRSAD (Area)

DAHITI (Elevation)

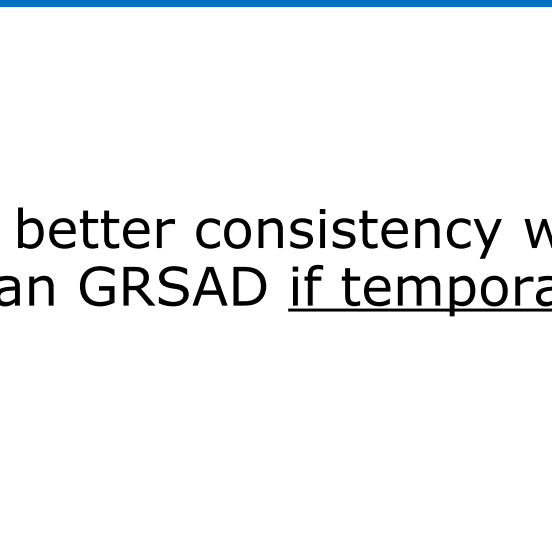
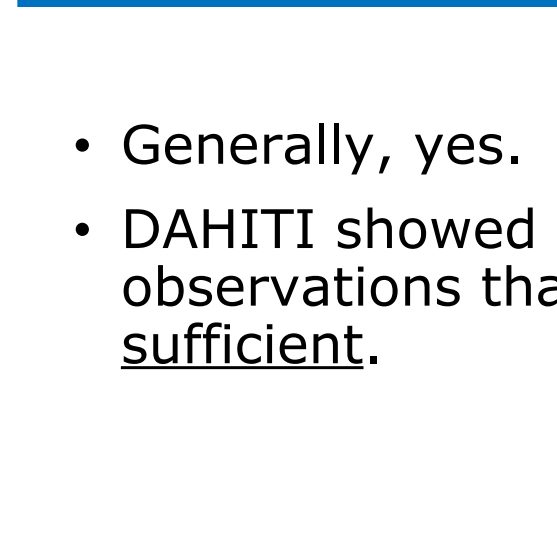
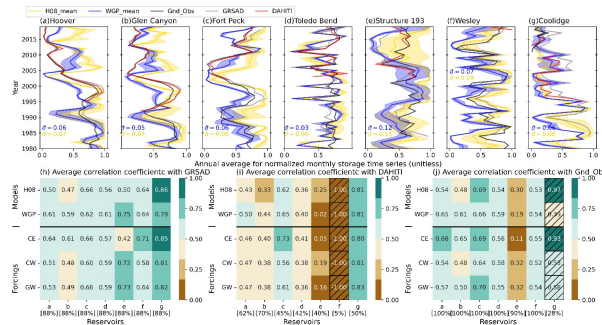
Ground Obs

Monthly
Storage

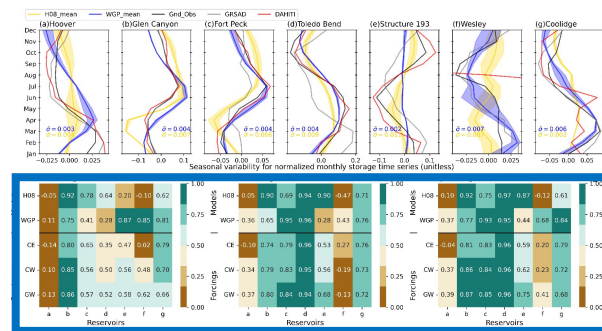


- Generally, yes.
- DAHITI showed better consistency with ground observations than GRSAD if temporal coverage is sufficient.

Annual
change



Seasonal
change



Conclusions

- Conclusions

- Which GHM or meteorological forcing performs better than others?
 - WaterGAP2 generally outperforms H08.
 - The CW forcing dataset demonstrated superior results compared with GW and CE.
- Do the findings on reservoir storage validation with satellite data align with ground observations?
 - Generally, yes. DAHITI showed better consistency with ground observations than GRSAD if temporal coverage is sufficient.

- Take-home message

- A methodology was proposed for validation and intercomparison of reservoir storage within GHM simulations using satellite-derived data.
 - ☞ The next step is a global-scale and multi-model (>2) application.
- Normalization was needed for improved validation efficacy.
 - ☞ Rapid improvement in satellite-based reservoir storage estimation is predicted (e.g., SWOT).

Thank you very much!

HESSD - Use of satellite remote X

https://hess.copernicus.org/preprints/hess-2023-215/

EGU European Geosciences Union

Hydrology and Earth System Sciences

ARTICLES & PREPRINTS SUBMISSION POLICIES PEER REVIEW EDITORIAL BOARD ABOUT EGU PUBLICATIONS

Preprint

Preprints / Preprint hess-2023-215

Search

https://doi.org/10.5194/hess-2023-215
© Author(s) 2023. This work is distributed under the Creative Commons Attribution 4.0 License.

Abstract Assets Discussion Metrics

12 Sep 2023

Status: this preprint is currently under review for the journal HESS.

Use of satellite remote sensing to validate reservoir operations in global hydrological models: a case study from the CONUS

Kedar Otta, Hannes Müller Schmied, Simon N. Gosling, and Naota Hanasaki

Abstract. Although river discharge simulations from global hydrological models have undergone extensive validation, there has been less validation of reservoir operations, primarily because of limited observational data. However, recent advancements in satellite remote sensing technology have facilitated the collection of valuable data regarding water surface area and elevation, thereby providing the ability to validate reservoir storage. In this study, we sought to establish a methodology for validation and

Download

- Preprint (2567 KB)
- Metadata XML
- Supplement (2055 KB)
- BibTeX
- EndNote

Short summary

Reservoirs play important roles in hydrology and water resources management globally and are...

Read more

Share

https://hess.copernicus.org/#

Otta, K., Müller Schmied, H., Gosling, S. N., and Hanasaki, N.: Use of satellite remote sensing to validate reservoir operations in global hydrological models: a case study from the CONUS, Hydrol. Earth Syst. Sci. Discuss. [preprint], <https://doi.org/10.5194/hess-2023-215>, in review, 2023.