Assessing the Impact of Precipitation Input Errors on Model Parameters and Water Budget Components: Insights from Countrywide Hydrological Modeling in Peru

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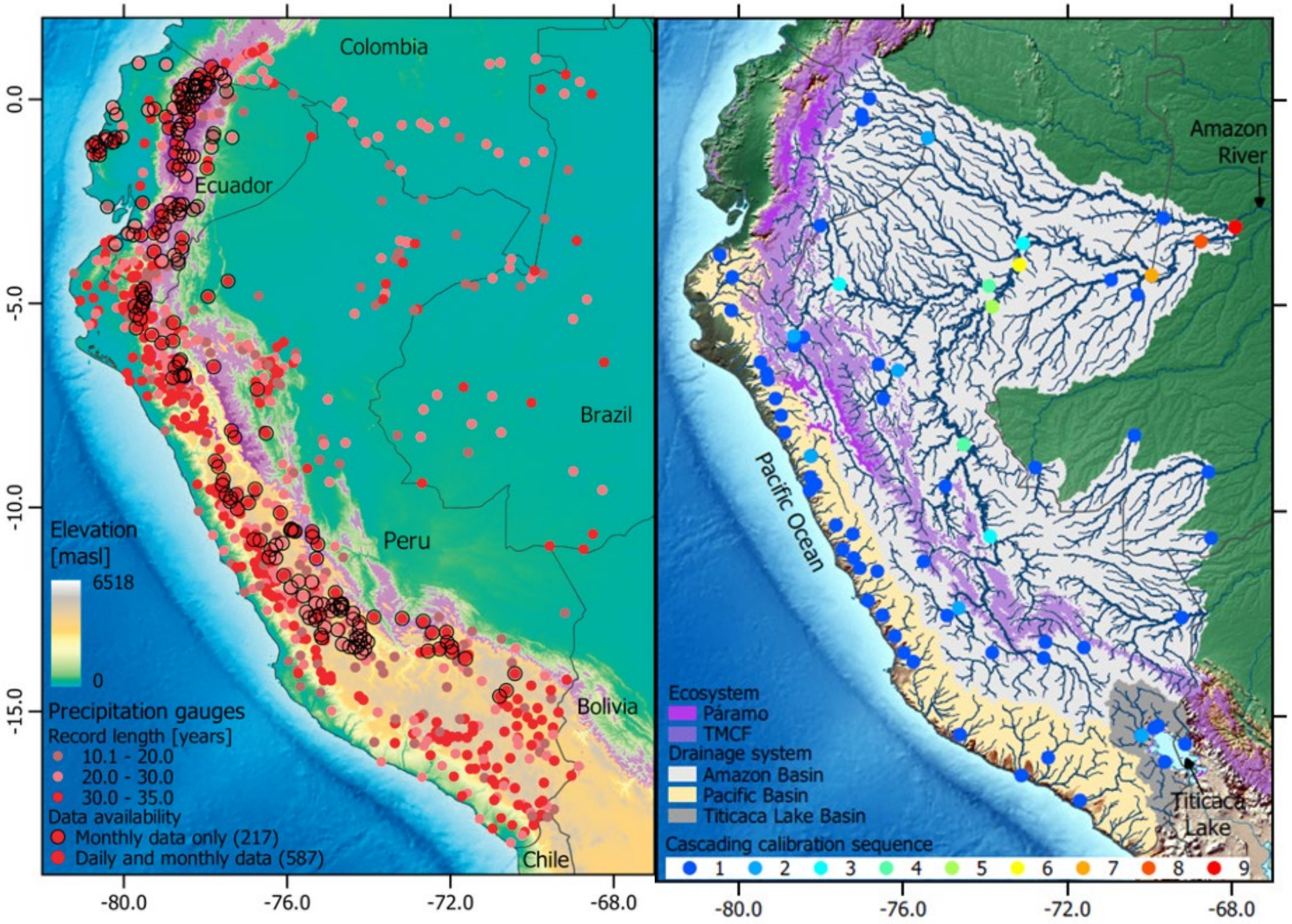
Objectives

1) To assess the impact of precipitation errors on identifying model parameters and water budget components, particularly evapotranspiration

2) To compare the evapotranspiration estimates obtained from SWAT simulations with the estimates from GLEAM and MOD16

Study area and data



Precipitation gauges (804)

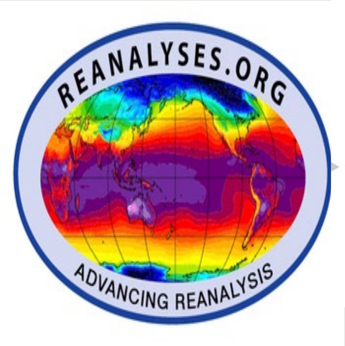
streamflow stations (72)

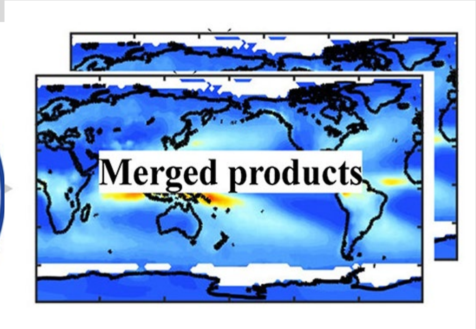
Model setup
Area: 1.6 km^2
2675 subcatchments
6843 HRUs

Study area and data

Long-term gridded precipitation datasets (6)

Satellites





- **CHIRP** (Funk et al. 2015)
- **ERA5** (Hersbach et al. 2020)
- **CHIRPS** (Funk et al. 2015a)
- **MSWEP** (Beck et al. 2019b, 2017)
- **PISCO-prec** (Aybar et al. 2020)
- **RAIN4PE** (Fernandez et al. 2022)

Remotely sensed evapotranspiration datasets (2)

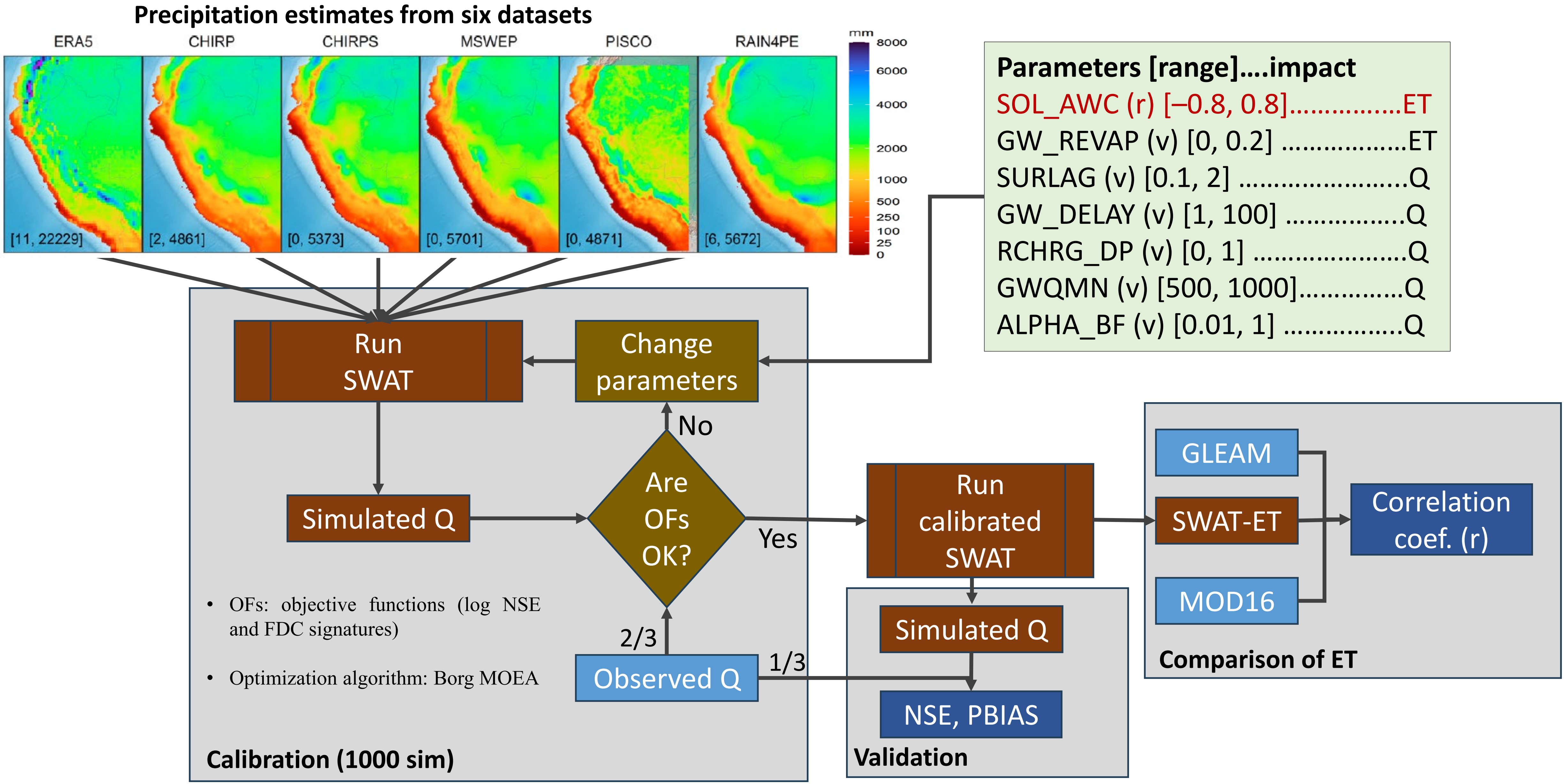
- Global Land Evaporation Amsterdam Model (**GLEAM v3.5a;** Miralles et al. 2011; Martens et al. 2017)
- Moderate Resolution Imaging Spectroradiometer Global Evaporation (**MOD16;** Mu et al. 2011)

More details about RAIN4PE in:

FERNANDEZ-PALOMINO ET AL.

A Novel High-Resolution Gridded Precipitation Dataset for Peruvian and Ecuadorian Watersheds: Development and Hydrological Evaluation

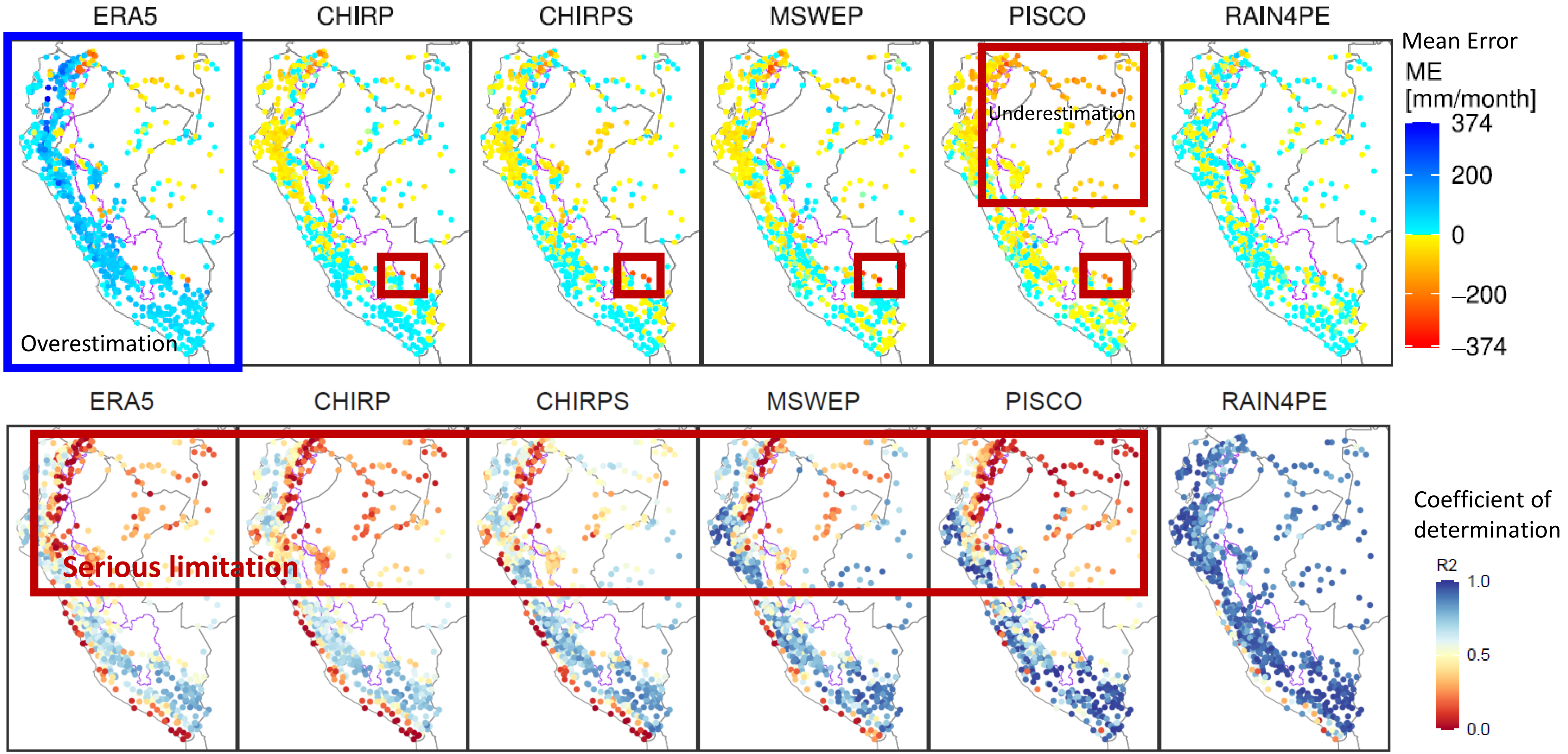
Methodology



Evaluation of precipitation datasets through hydrological modeling

Results: which precipitation datasets are reliable?

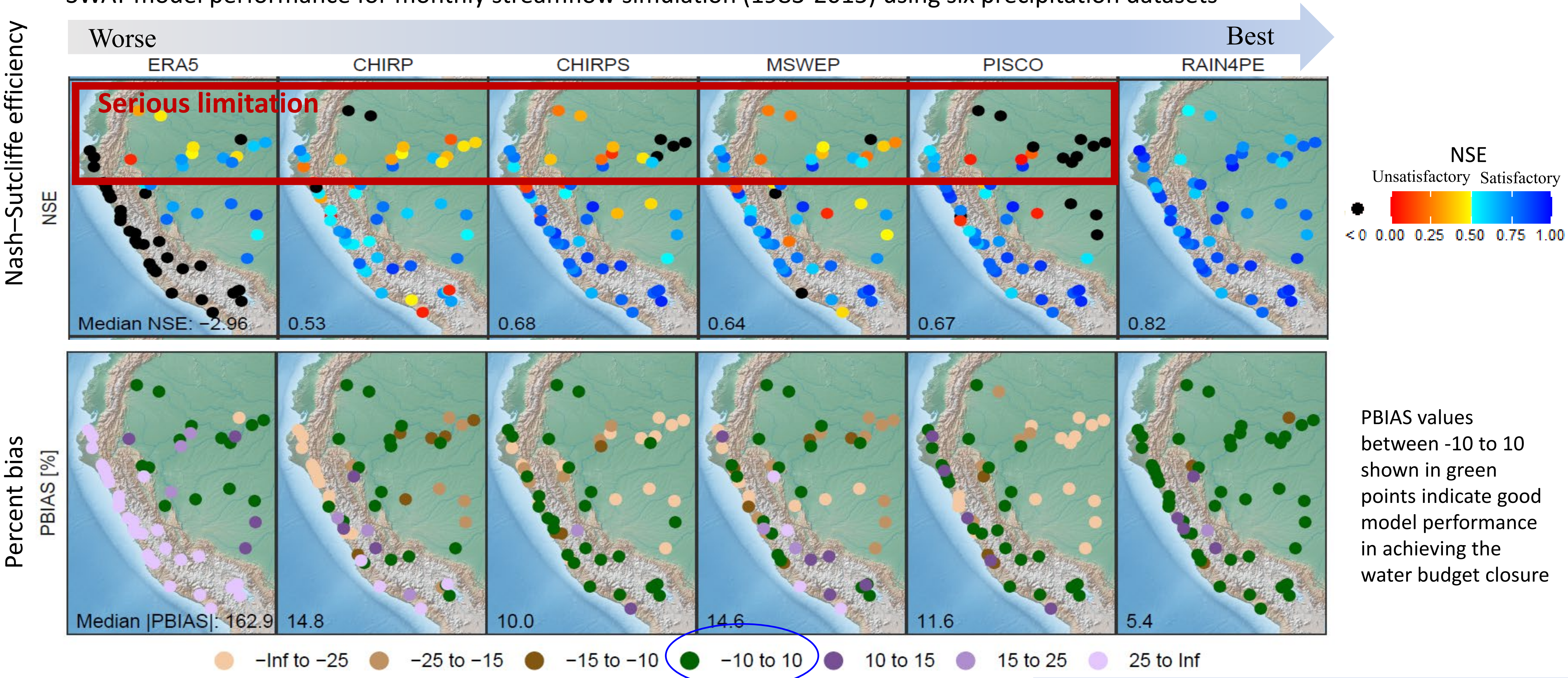
Comparison of precipitation datasets using gauge observations at monthly scale for 1981-2015



RAIN4PE is the most reliable and accurate

Which precipitation products are reliable for hydrological modeling using the Soil and Water Assessment Tool (SWAT) model?

SWAT model performance for monthly streamflow simulation (1983-2015) using six precipitation datasets

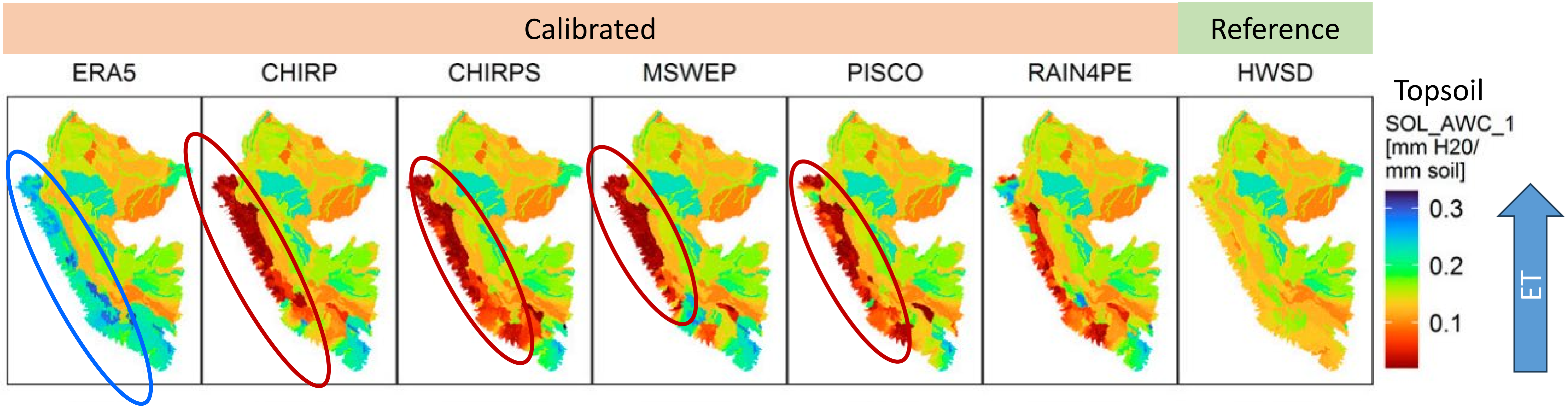


PBIAS values between -10 to 10 shown in green points indicate good model performance in achieving the water budget closure

RAIN4PE is the most reliable and accurate

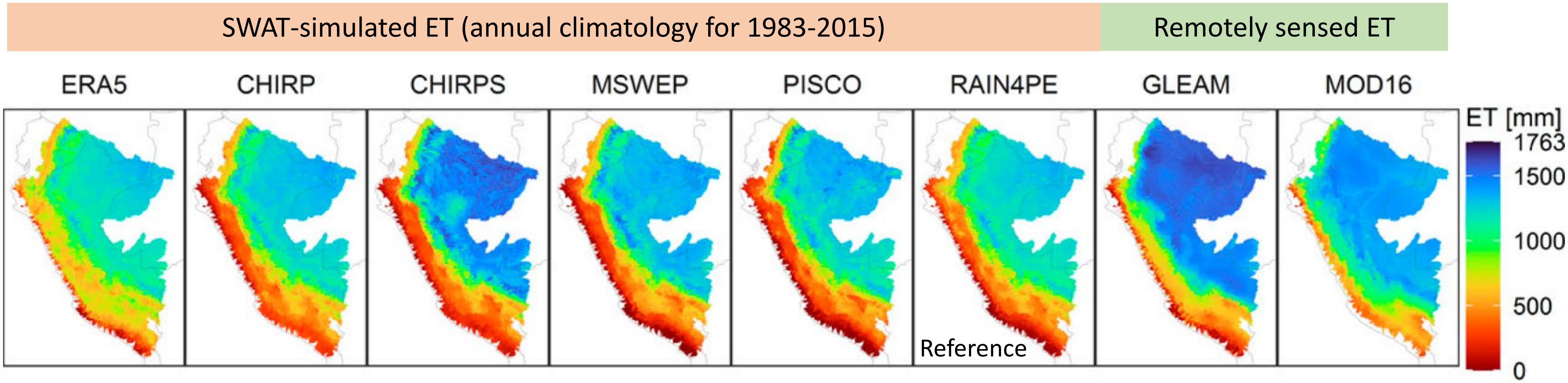
Impact of precipitation input errors on the identification of model parameters

SOL_AWC: soil's available water capacity



- SOL_AWC values for compensating the ERA5 precipitation overestimation
- SOL_AWC values (≈0) for compensating the precipitation underestimation in CHIRP, CHIRPS, MSWEP, and PISCO

Impact of precipitation input errors on evapotranspiration (ET)



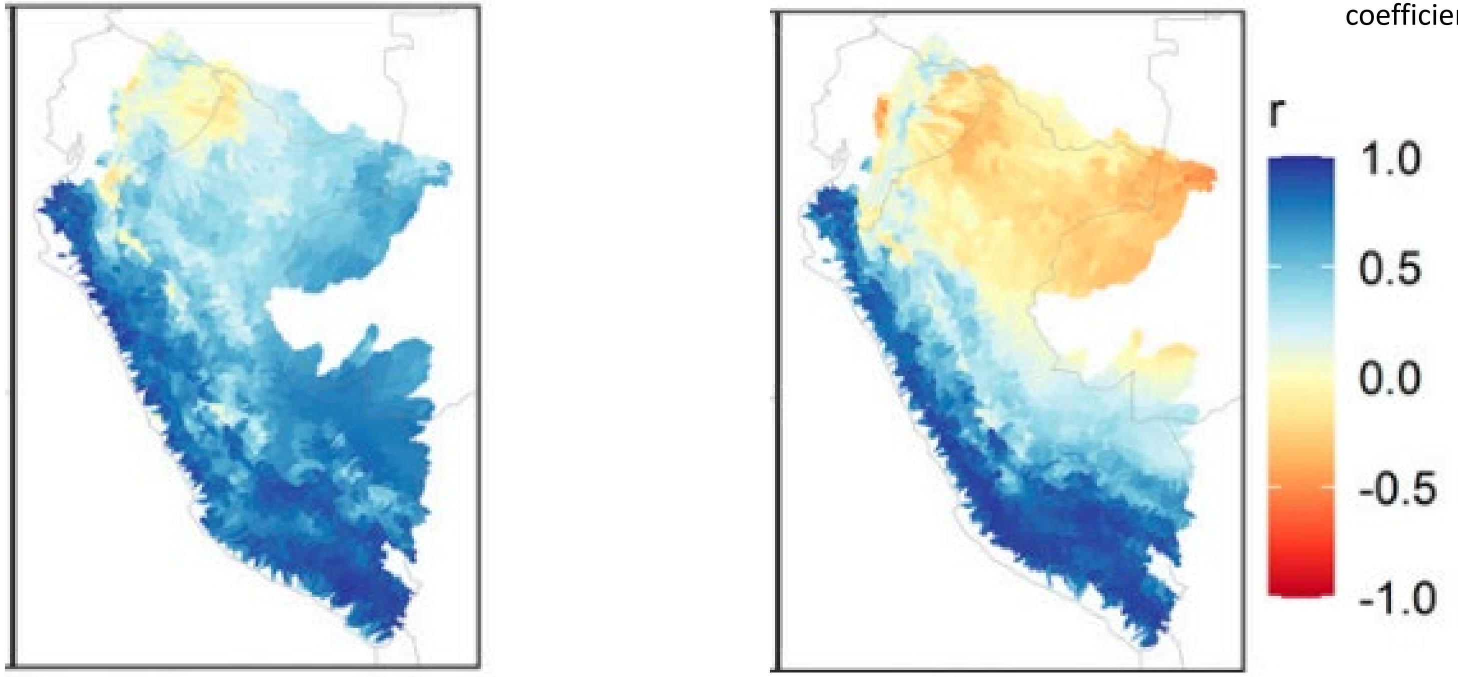
- All ET estimates show similar spatial patterns with increasing ET gradients from west to east
- The differences in the volumes of SWAT-simulated ET can be attributed to inappropriate parameter estimation due to precipitation biases and uncertainties
- GLEAM and MOD16 overestimate ET in the study area compared to SWAT-simulated ET using RAIN4PE

Comparison between the evapotranspiration (ET) estimates obtained from SWAT simulations using RAIN4PE as input and the remotely sensed evapotranspiration data

SWAT-ET vs GLEAM

SWAT-ET vs MOD16

correlation coefficient

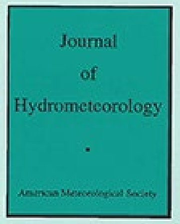


- GLEAM shows better agreement with SWAT-simulated ET, as both are based on the Priestley-Taylor equation for potential evapotranspiration estimation
- GLEAM and MOD16 agree well with SWAT-simulated ET in the Peruvian Andes and southern region of the Peruvian Amazon
- Negative correlation values in the northern Amazon basin suggest inconsistencies in the temporal distribution of evapotranspiration estimates by GLEAM and MOD16

Conclusions

- ✓ The results highlight RAIN4PE as the most accurate and reliable precipitation dataset for countrywide hydrological modeling in Peru.
- ✓ The uncertainties associated with precipitation estimates have implications for estimating hydrological model parameters and evapotranspiration, which are critical for the regionalization of parameters and reliable estimation of the water budget.
- ✓ Remotely sensed evapotranspiration data (GLEAM and MOD16) exhibit higher estimated values and temporal inconsistency, particularly in the northwest Amazon. Therefore, estimating evapotranspiration remains challenging for remotely sensed-based products in the region.

A Novel High-Resolution Gridded Precipitation Dataset for Peruvian and Ecuadorian Watersheds: Development and Hydrological Evaluation



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Towards a more consistent eco-hydrological modelling through multi-objective calibration: a case study in the Andean Vilcanota River basin, Peru

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