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Large-scale hydrological modelling of the Peruvian Amazon basin

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Outline

- Research objective
- Method and Data
- Results and conclusions

Research objective

To assess the performance of JULES in large-scale humid tropical upland basins using

1. Simulation of streamflow

2. Simulation of “observed” surface fluxes

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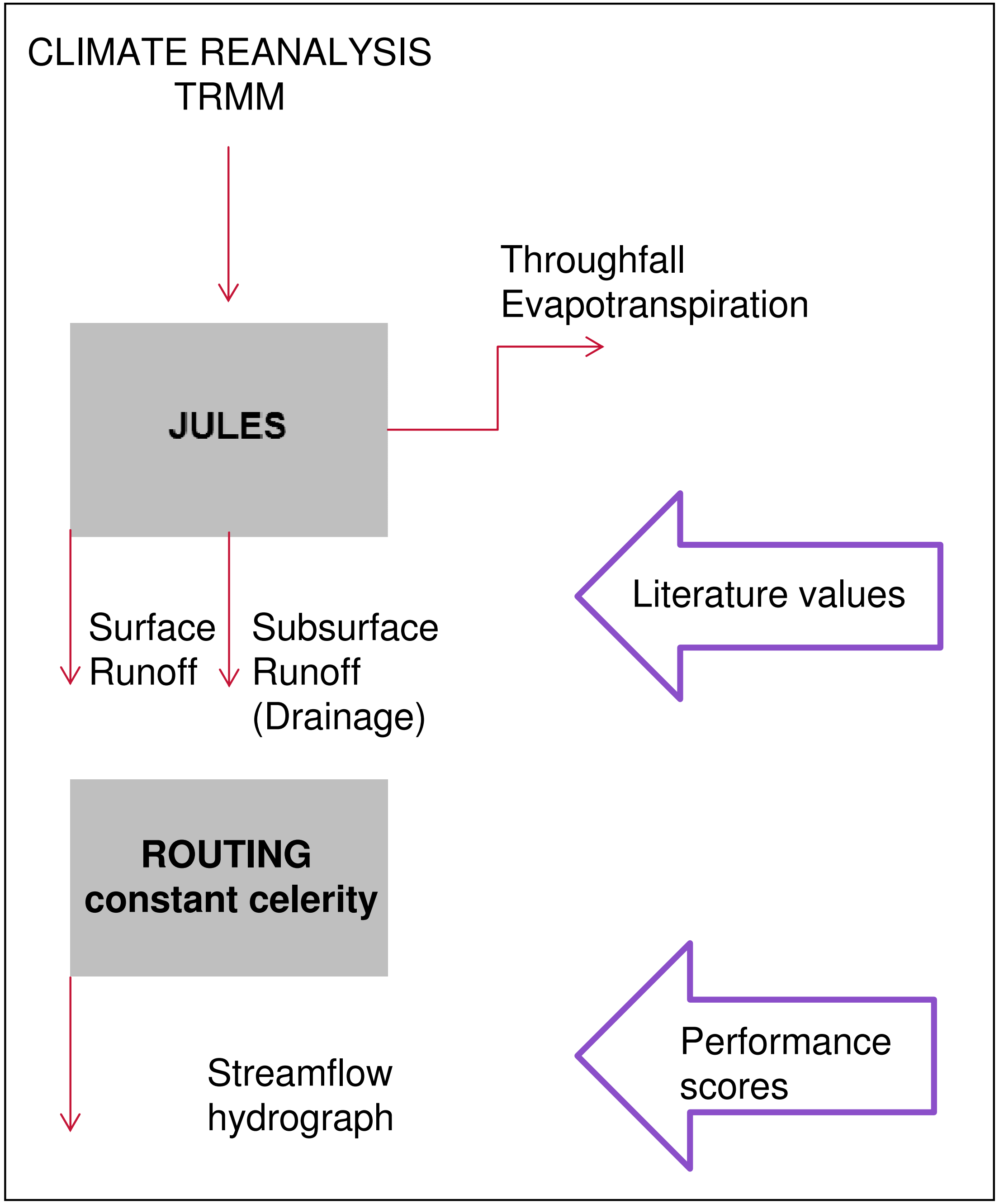
Method of evaluation

1. Simulation of daily streamflow - conventional performance scores

2. Representation of "real" systems
    - simulated local surface fluxes

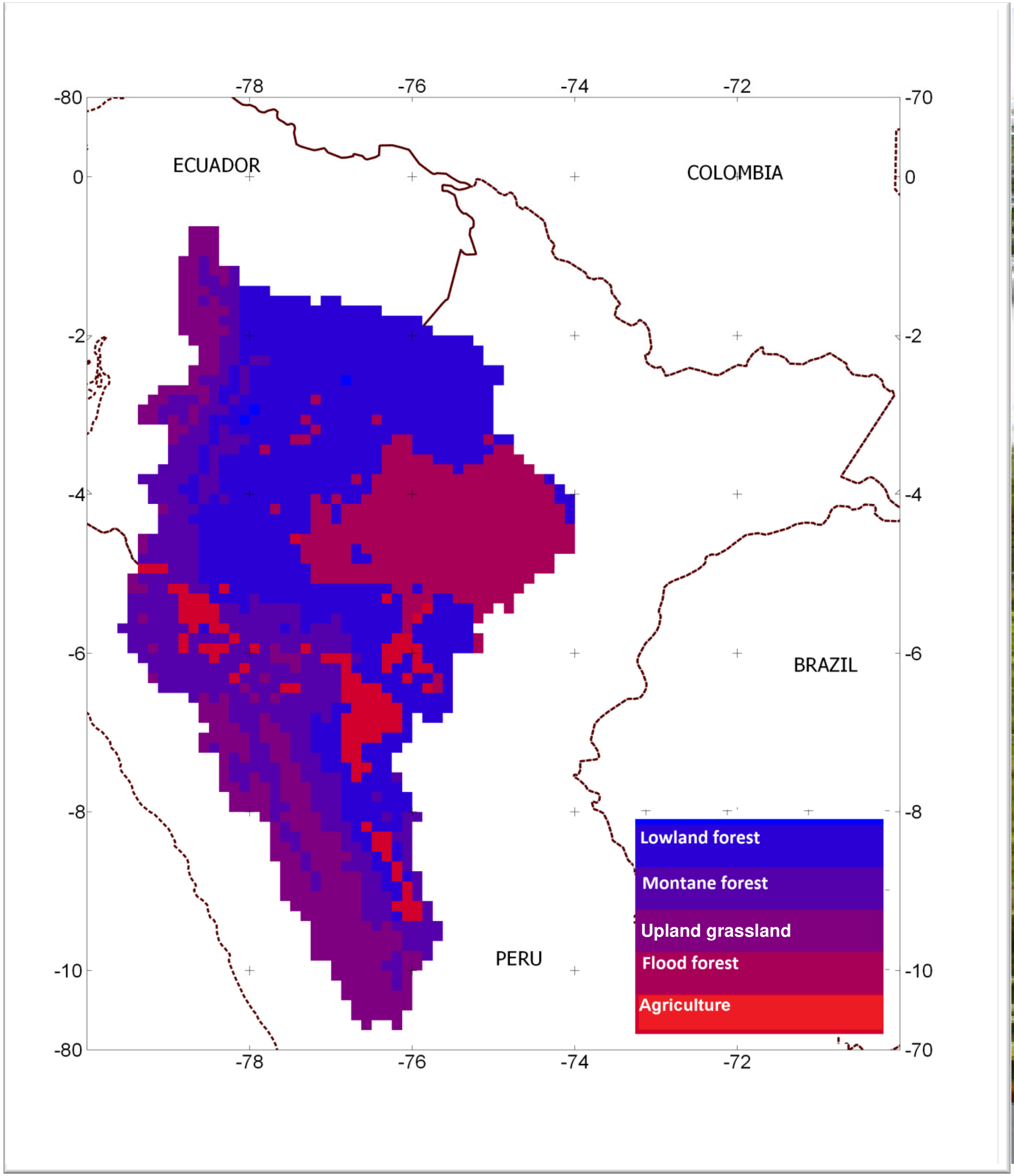
      versus

    - observed magnitudes and variations from the literature



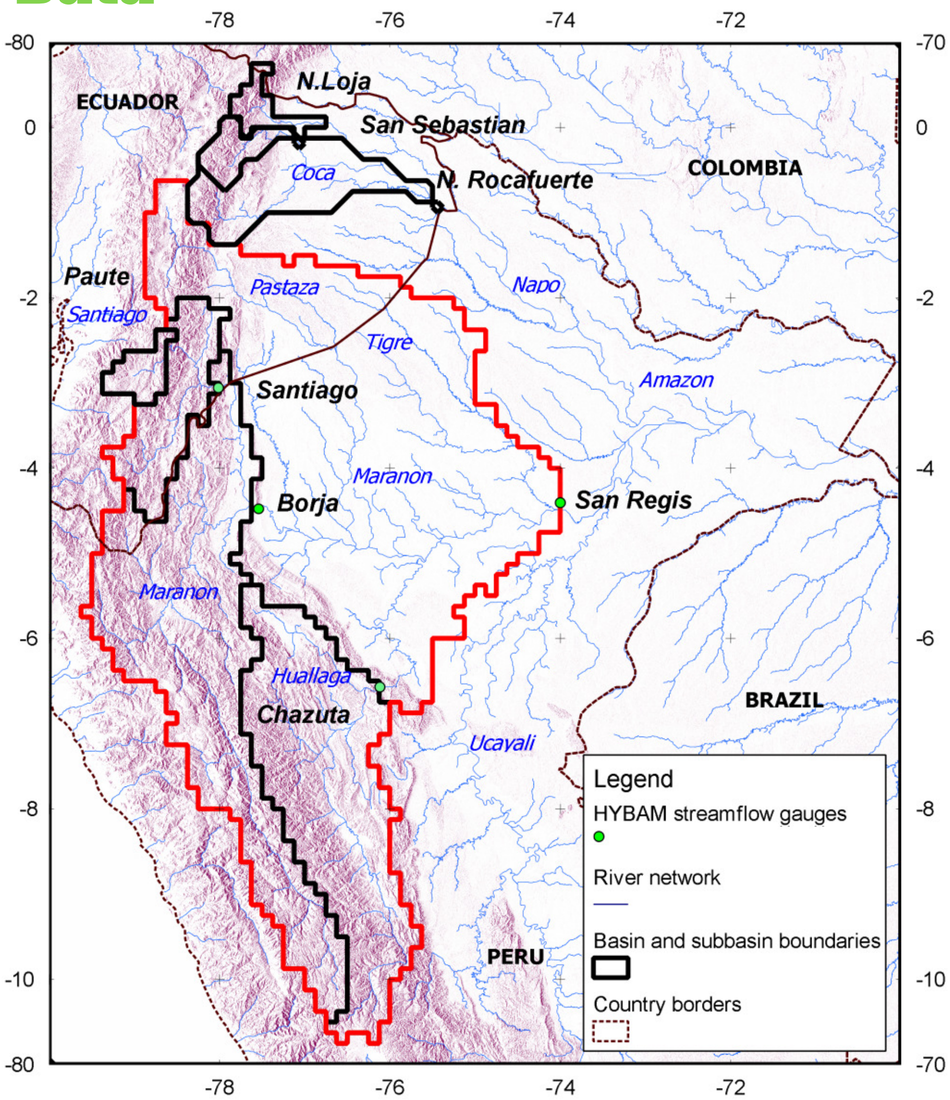
Study area

- The Peruvian Amazon river basin
- 360,000 km^2



-78
-76
-74
-72
-80
-70
ECUADOR
COLOMBIA
0
-2
-4
-6
-8
-10
BRAZIL
PERU
Lowland forest
Montane forest
Upland grassland
Flood forest
Agriculture

Data



Daily streamflow:

- San Regis – mainstem, downstream

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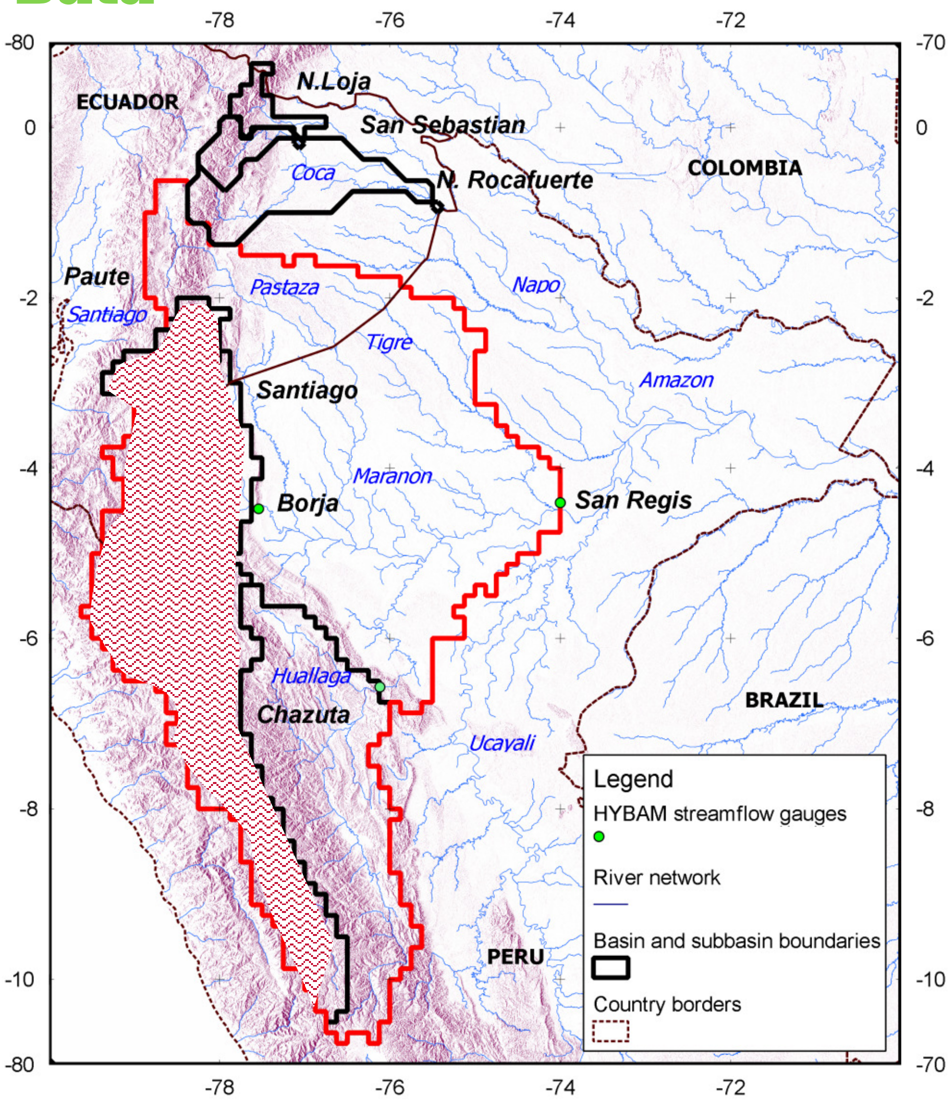
Data



Daily streamflow:

- San Regis – mainstem, downstream
- Borja – mainstem, upstream

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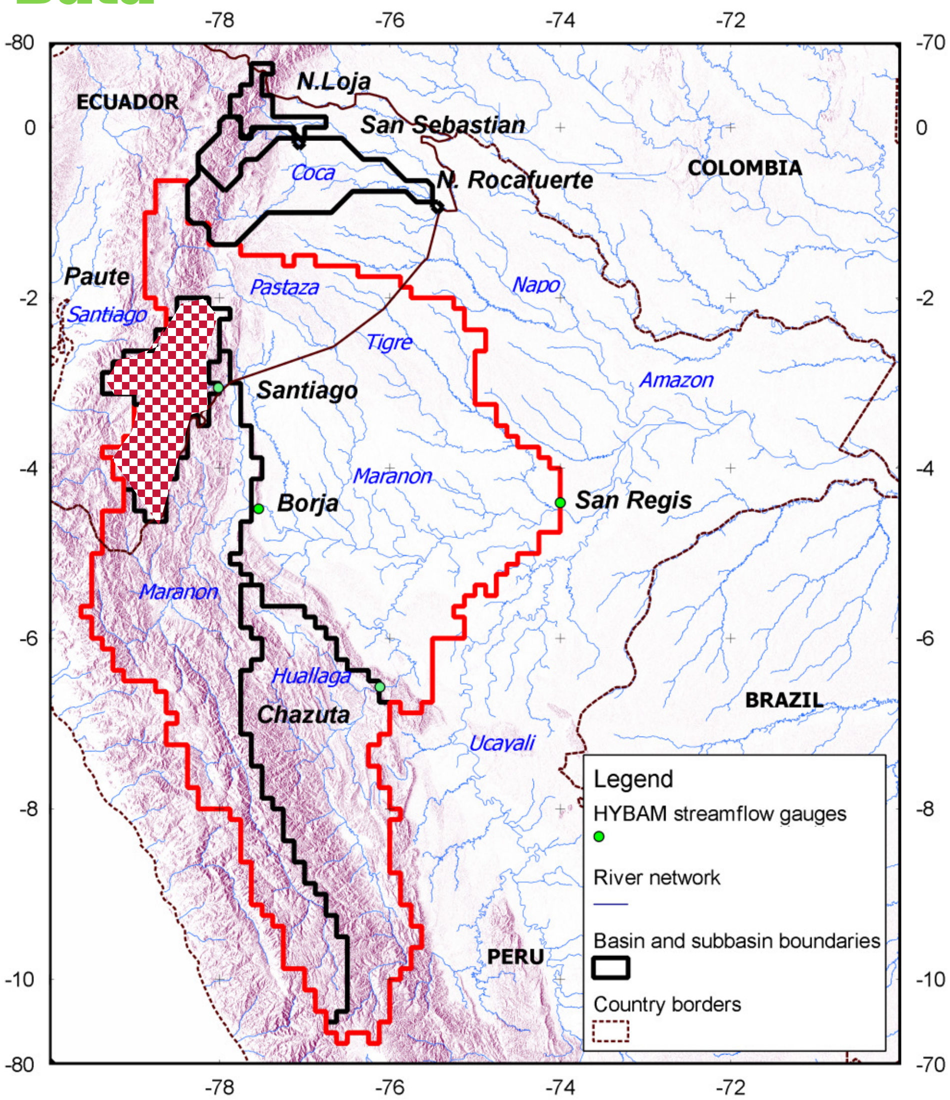
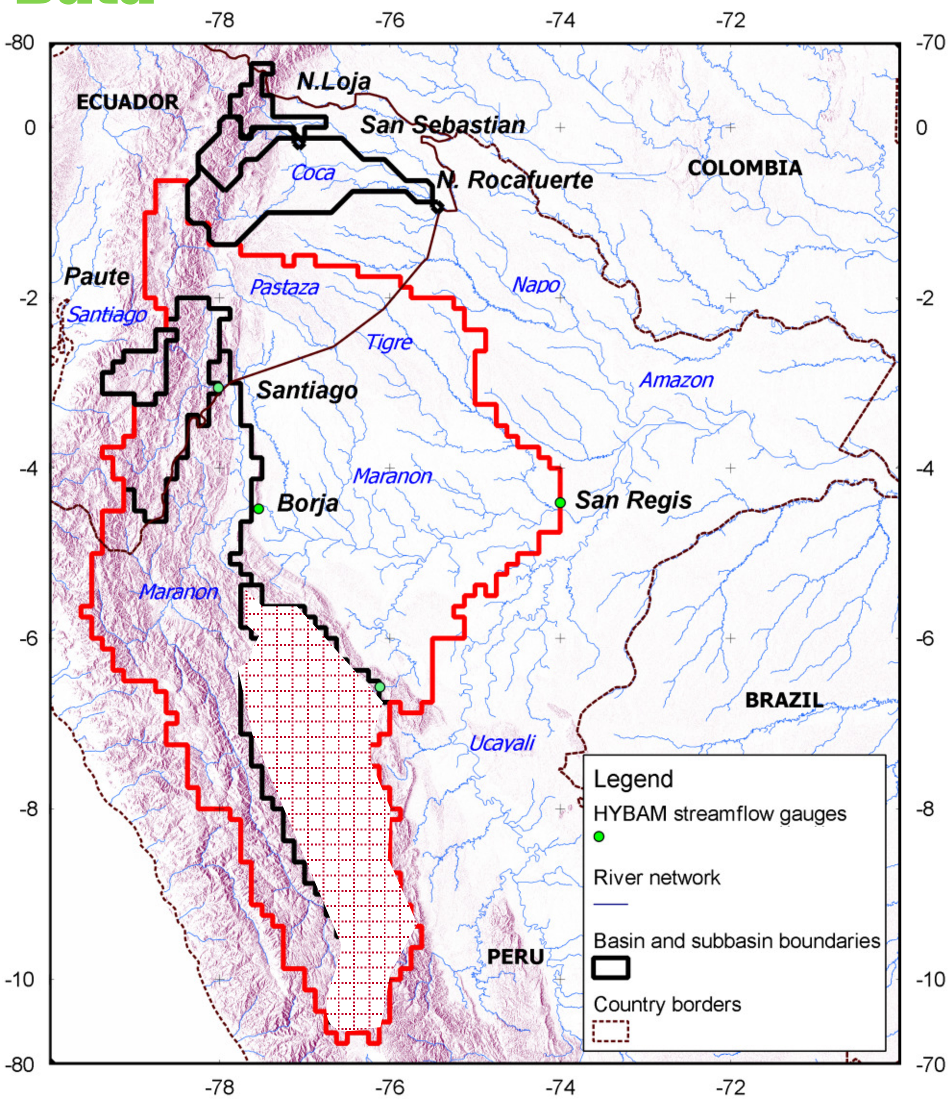
Data



Daily streamflow:

- San Regis – mainstem, downstream
- Borja – mainstem, upstream
- Santiago – Andean

Data



Daily streamflow:

- San Regis – mainstem, downstream
- Borja – mainstem, upstream
- Santiago – Andean
- Chazuta – southern tributary

Data

- Land cover data:
  - › Digital ecological systems map of Bolivia and Peru (90m, Josse et al. 2009)
  - › IGBP classification (MODIS – 1km, Loveland et al. 2000)
  - › Aggregated to model resolution of 0.125 degree x 0.125 degree

- Soil data:
  - › Harmonized World Soil Database (–1km, FAO, 2009)

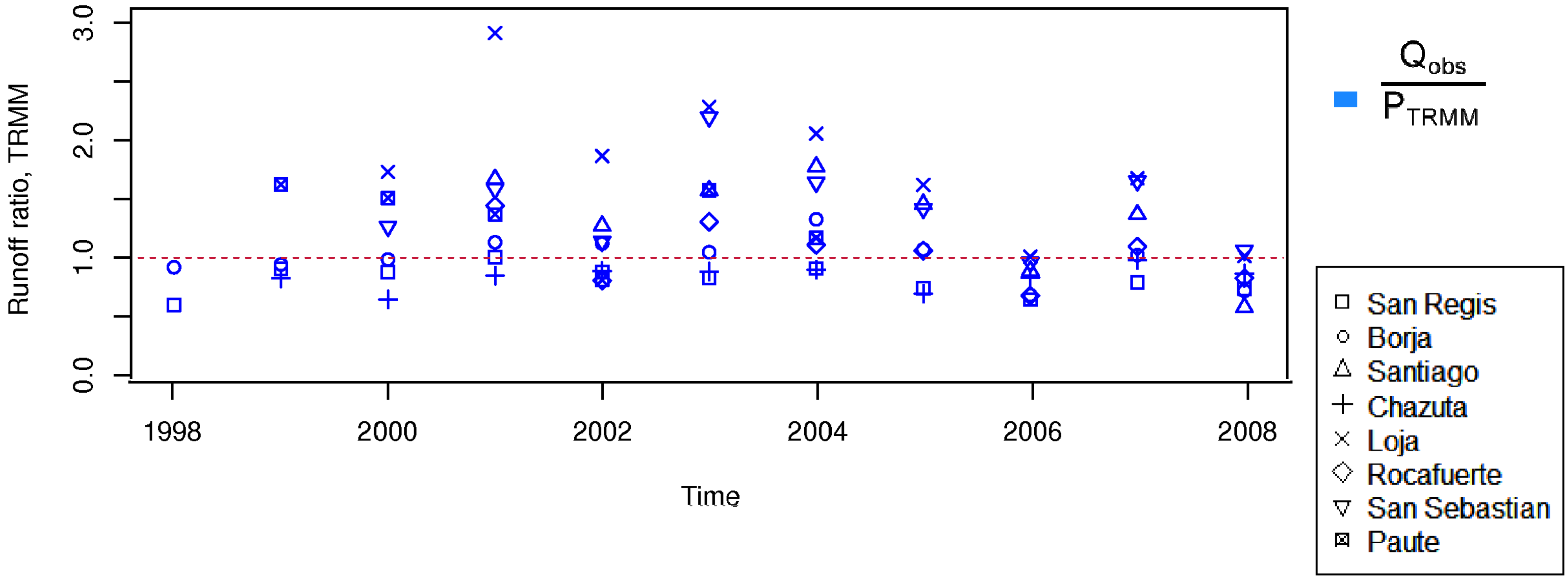
- Driving data:
  - › TRMM 3B42 3-hourly rainfall, 0.25° resolution (Huffman, 2007)
    - Bias correction using the TRMM 2A25 climatology (Nesbit and Anders, 2009), 0.1° resolution
  - › NCEP Climate reanalysis, post-processed by Sheffield et al. 2006
    - 1° resolution, disaggregated to 0.125° by lapse rate interpolation

Model Parameters

- Most default parameters are retained
- PFT:
  - Canopy heights for broadleaf trees from 10-38m
- Soil hydraulics:
  - Brooks & Corey soil water retention parameters calculated using the pedotransfer functions of Tomasella & Hodnett, 1998.

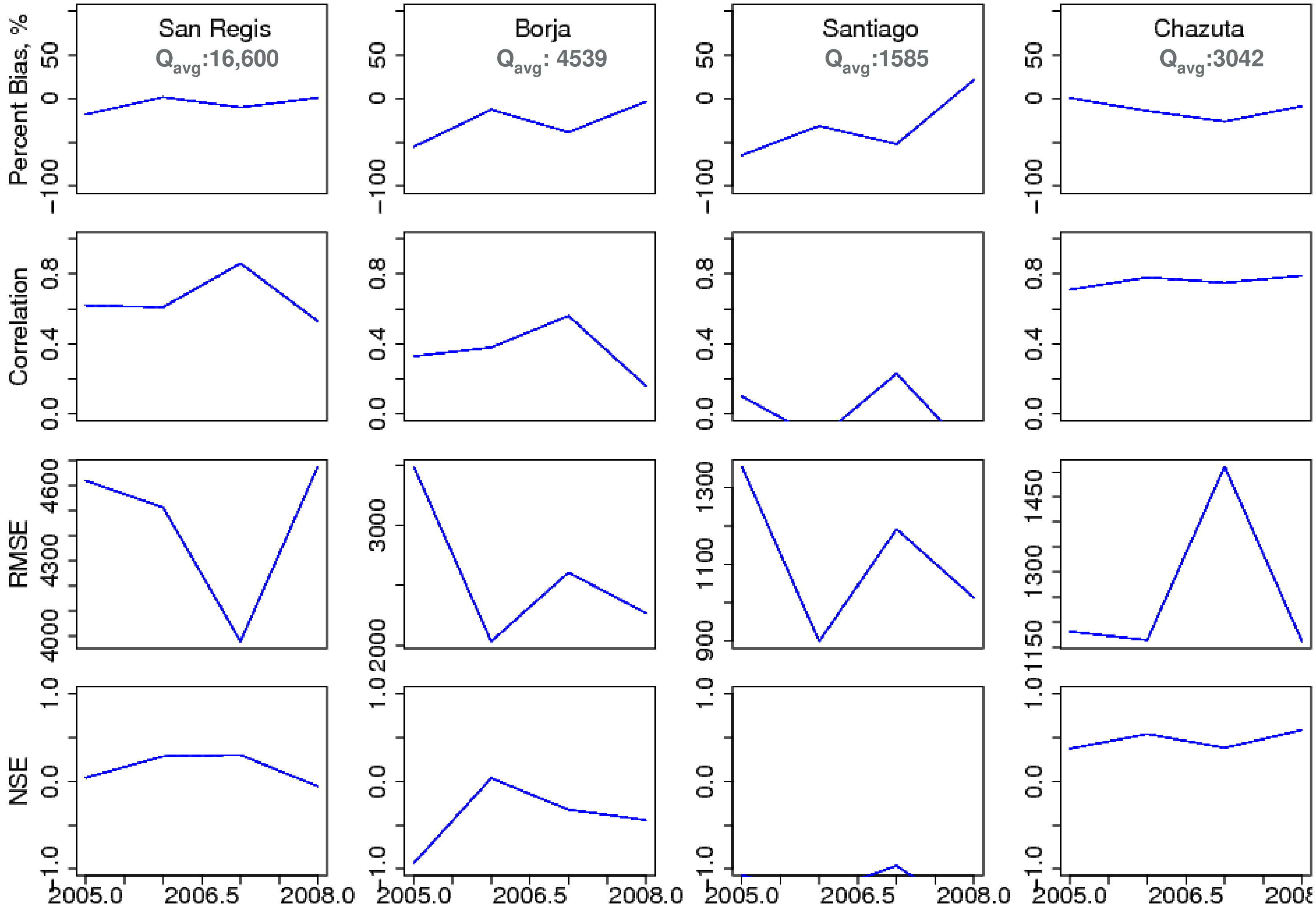
RESULTS

Data uncertainty



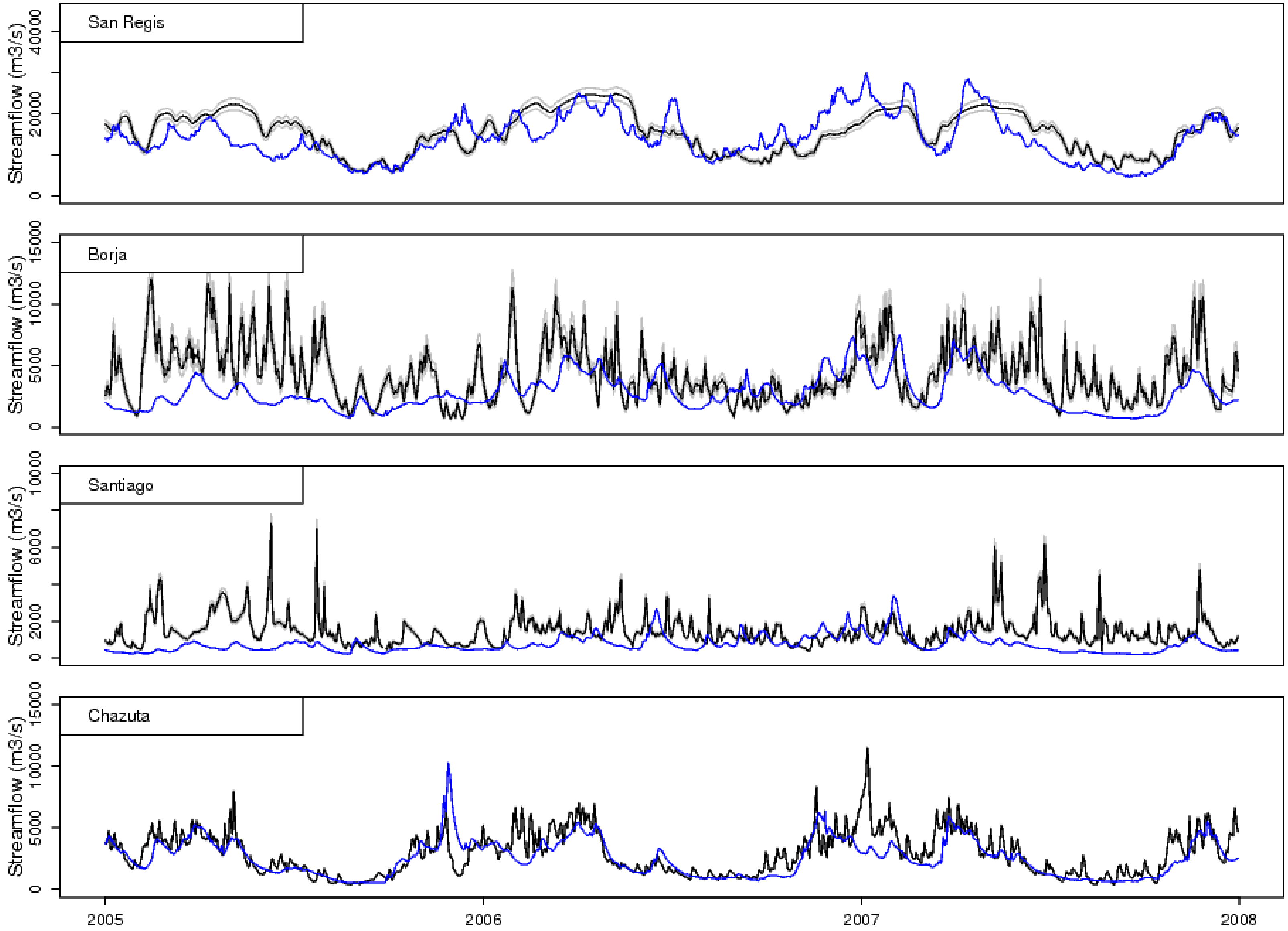
- Modelling period: 1998-2008
- Q/P > 1 for most of the modelling period
  - Evaluation focused on 2005-2008

Performance scores



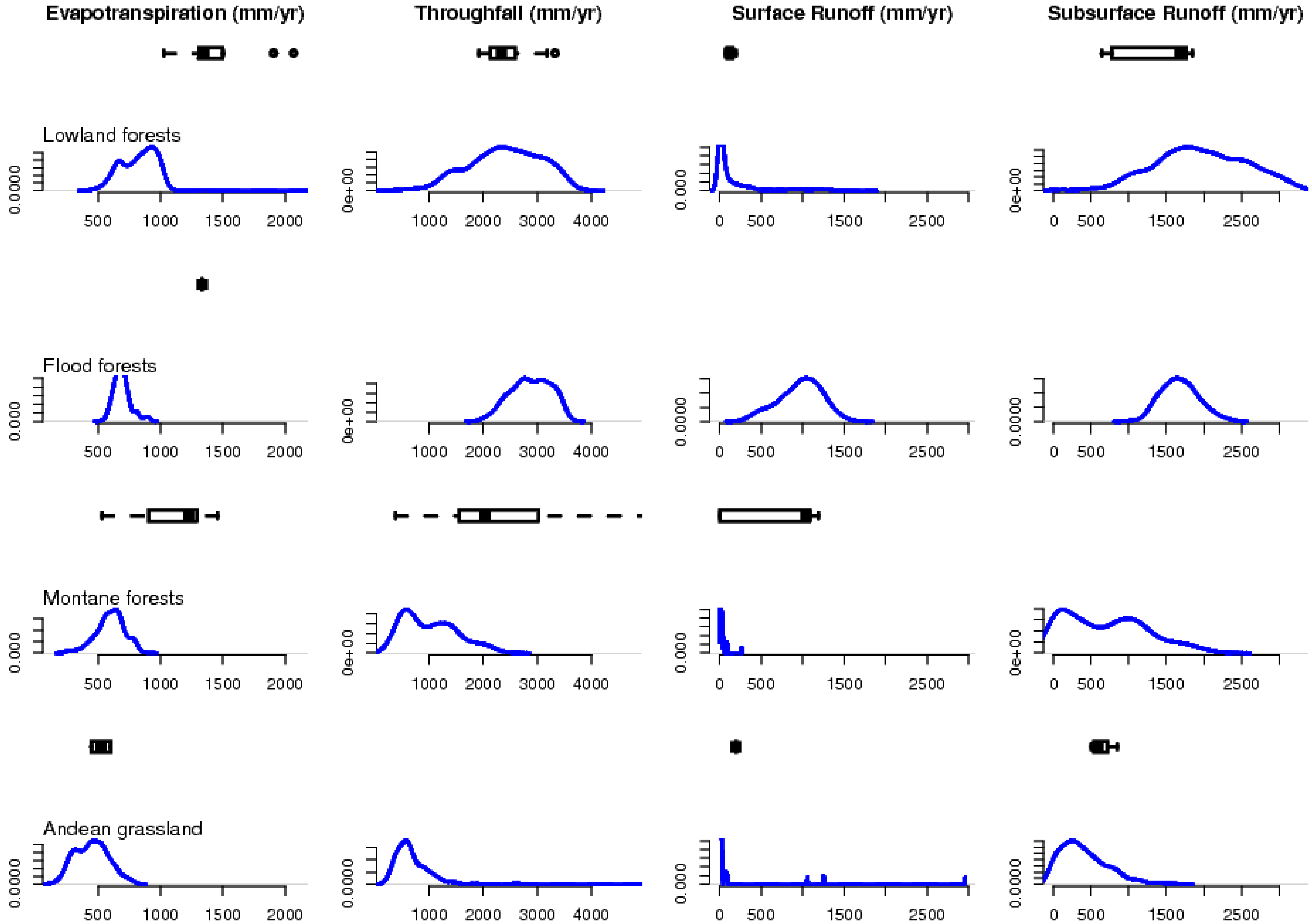
- Trends follows the trends in the runoff ratios

Hydrological response



- Seasonality is well captured
- Good simulation of rising and recession limbs
- Inadequate simulation of floodplain regulation and baseflow contribution

Surface fluxes



- Blue plots are constructed from JULES simulated fluxes over the entire basin, separated by biomes
- Boxplots are constructed from published values in other lowland, flood, montane forests and Andean systems

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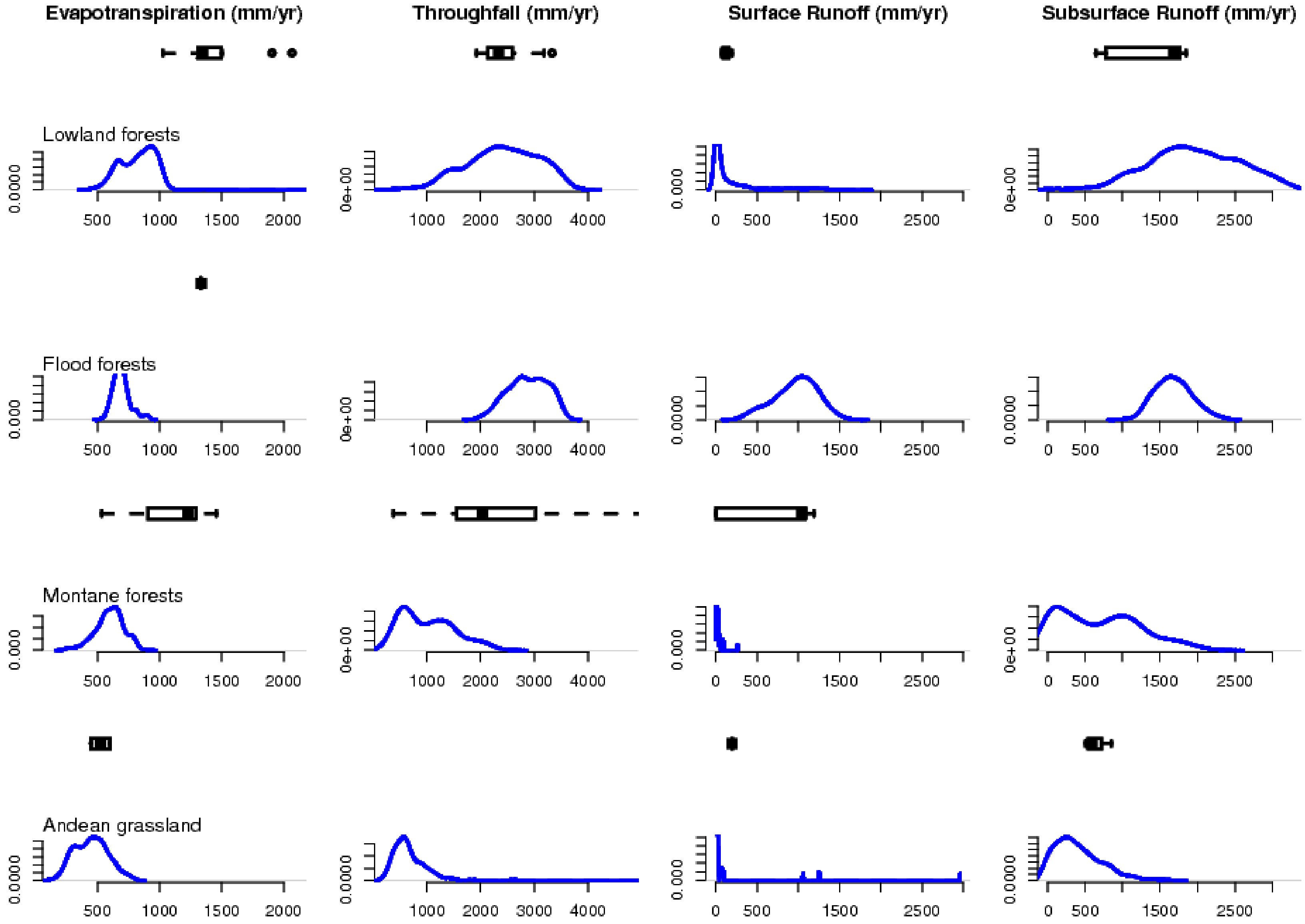
Surface fluxes



- Underestimation of ET in the lowland and flood forests
- Underestimation of surface runoff in the montane forests and Andean systems

Conclusions

- JULES performance in humid tropical upland systems:
  - Assessment is limited by data uncertainty
  - Good simulation of hydrological response
    - except in baseflow-dominated and flood-regulated basins
  - Tendencies to underestimate the region's high evapotranspiration rates

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- Strategies to improve the representation of tropical systems:
  - addressing errors in the data
  - Improving the soil representation
  - Incorporating floodplain storage

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- Discussion paper: Zulkafli, Z., Buytaert, W., Onof, C., Lavado, W., and Guyot, J. L.: A critical assessment of the JULES land surface model hydrology for humid tropical environments, Hydrol. Earth Syst. Sci. Discuss., 9, 12523-12561, doi:10.5194/hessd-9-12523-2012, 2012

THANK YOU.

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