Assessing the interactions of atmosphere and land surface over South Africa with convective-permitting coupled atmospheric-hydrological modeling

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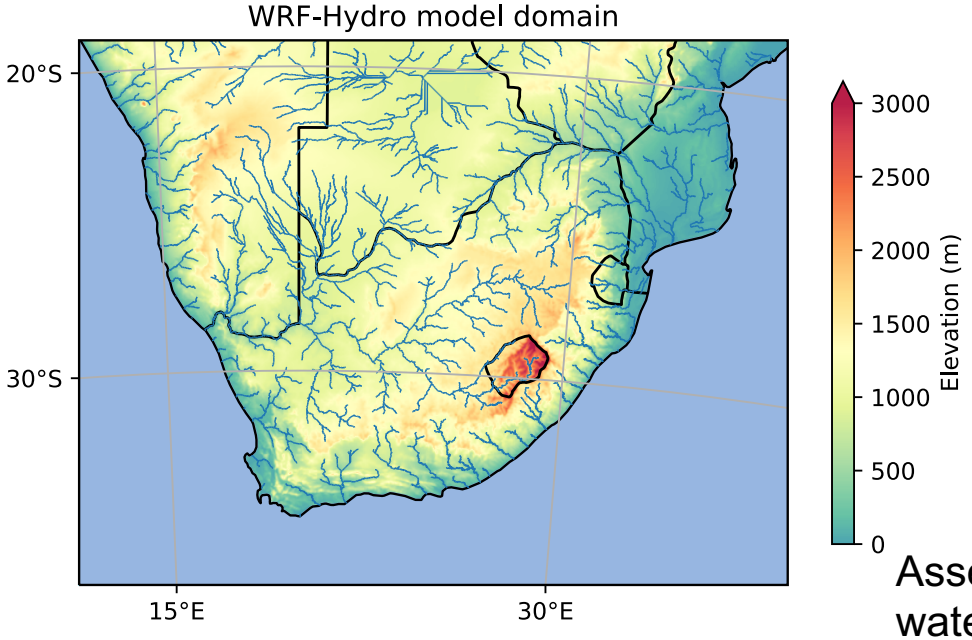
Study Concept

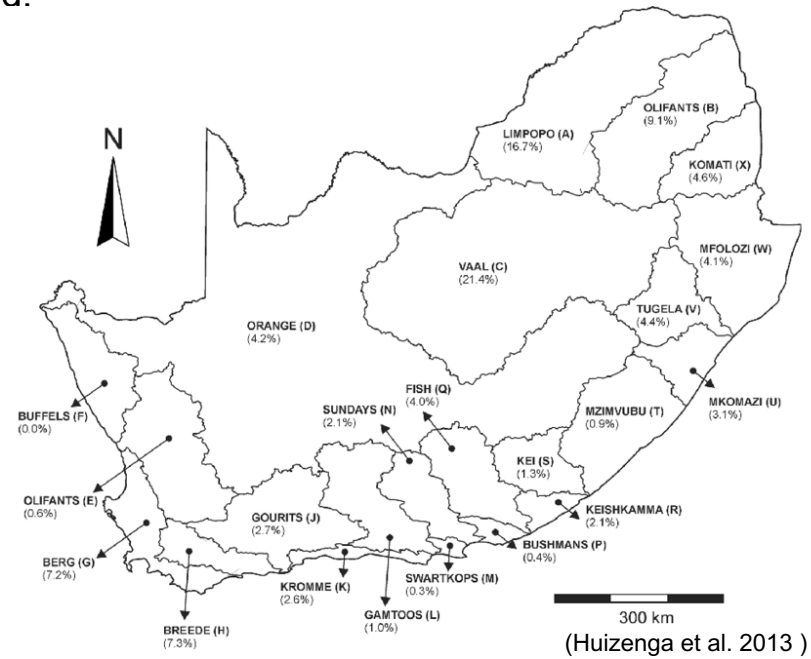
- Land degradation is a significant issue in South Africa, with more than 60% of the land currently degraded and 90% of the land potentially susceptible to desertification
- Accurately assessing land degradation processes requires detailed knowledge of localized atmosphere–land surface interactions and regional water cycle
- Fully coupled atmosphere–hydrological modeling considers the hydrology complexity induced by horizontal soil moisture redistribution in the land surface, thus provides an improved regional water and energy cycles, and it is suitable for assessing the heterogeneity of atmosphere–land surface interactions
- Adapting the high resolution coupled WRF-Hydro modeling in southen Africa

Model Setup

Fully coupled WRF-Hydro model setup:

- ERA5 reanalysis forcing, 3-hourly.
- Atmospheric grid: 650×500 pts @ 4km, convection permitting scale, covering southern Africa
- Noah-MP LSM, with lateral terrestrial water routing.
- Hydrological grid: 6500×5000 pts @ 400m
- Simulation period: Year 2010





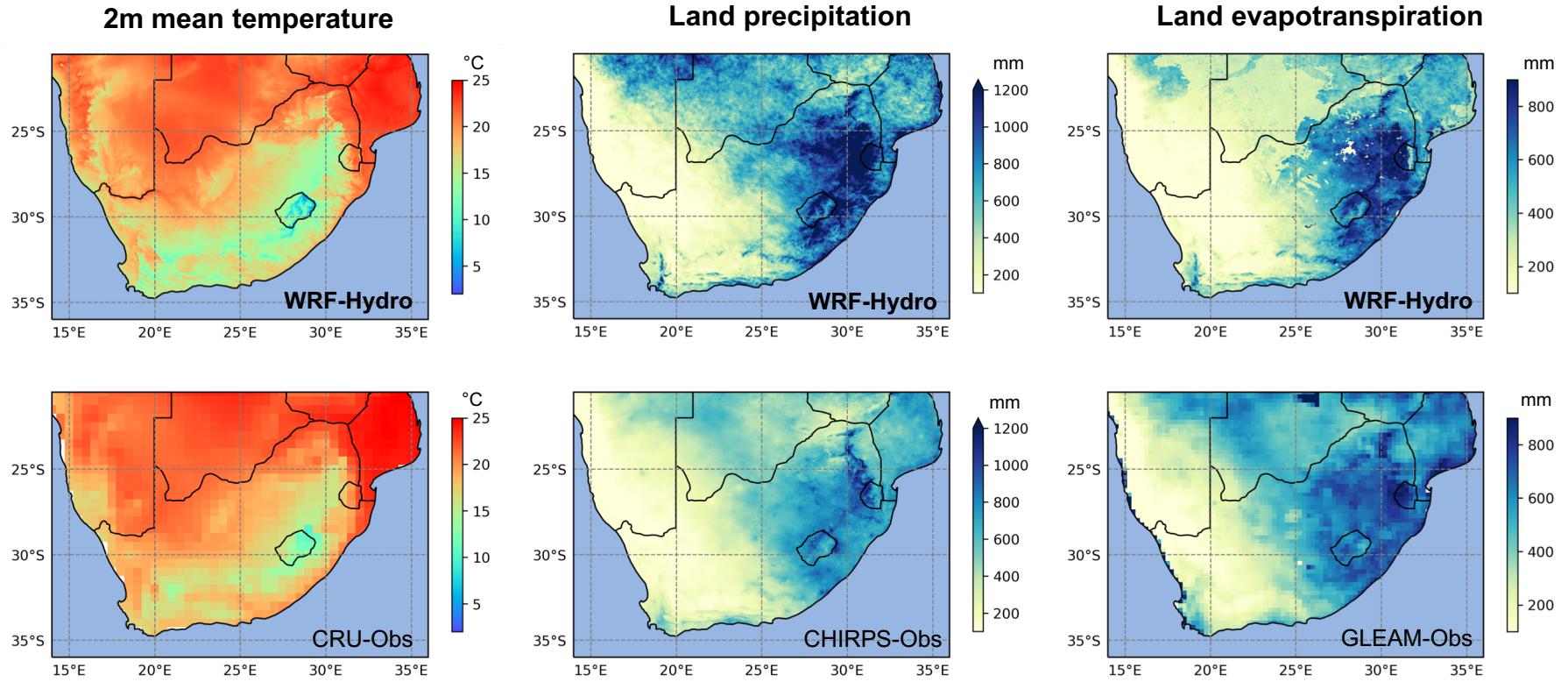
(Huizenga et al. 2013)

Assessing and analyzing WRF-Hydro in simulating water and energy exchange over 22 primary drainage regions in South Africa

Huizenga et al. (2013). An inorganic water chemistry dataset (1972–2011) of rivers, dams and lakes in South Africa. Water S.A. 39. 335-339.

Coupled modeling results

Spatial comparison of coupled WRF-Hydro results with observations for the year 2010:

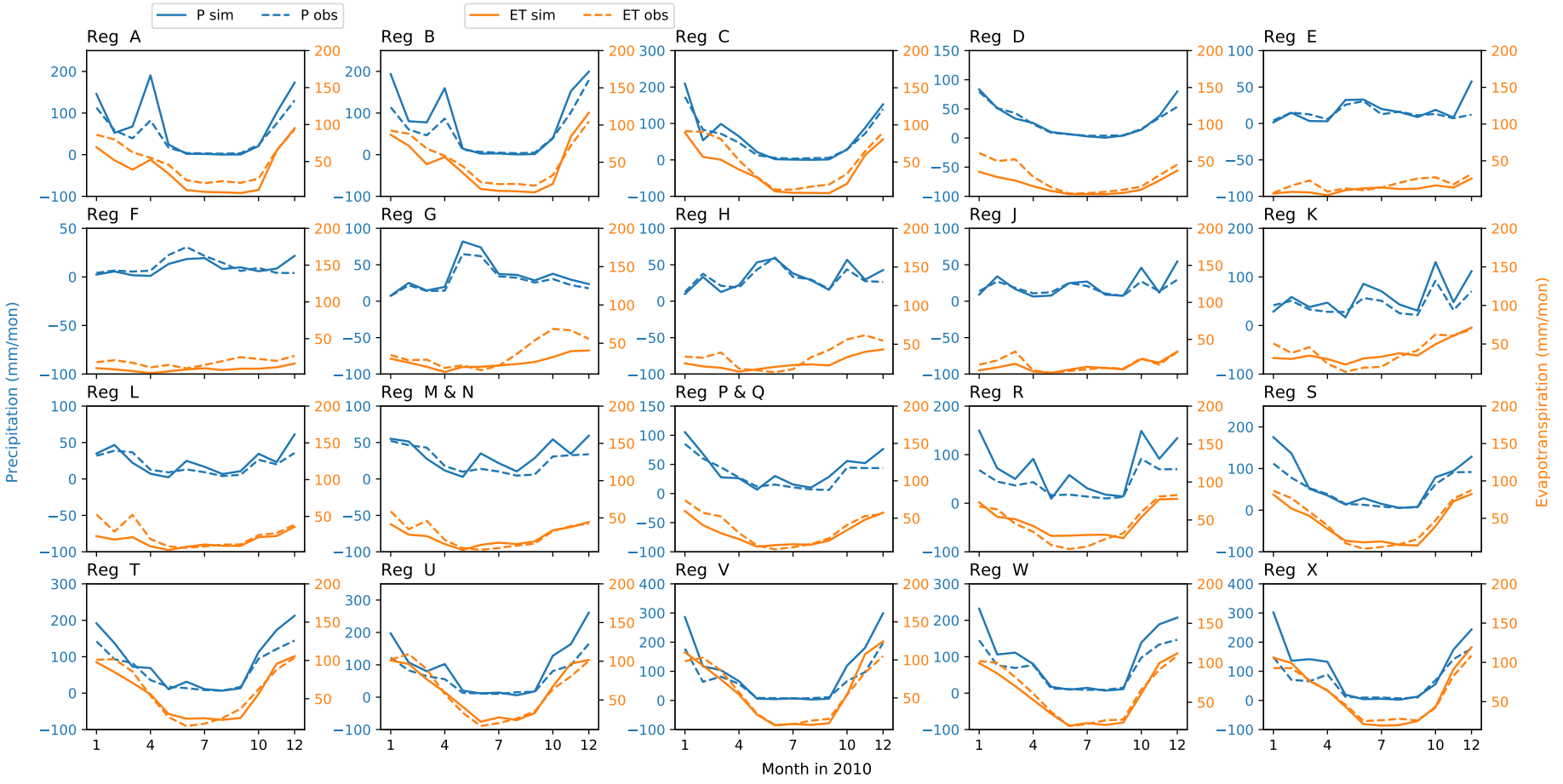


- Realistic spatial variation of hydrometeorological fields

CRU: Climatic Research Unit. CHIRPS: Climate Hazards Group InfraRed Precipitation with Station data. CLEAM: Global Land Evaporation Amsterdam Model

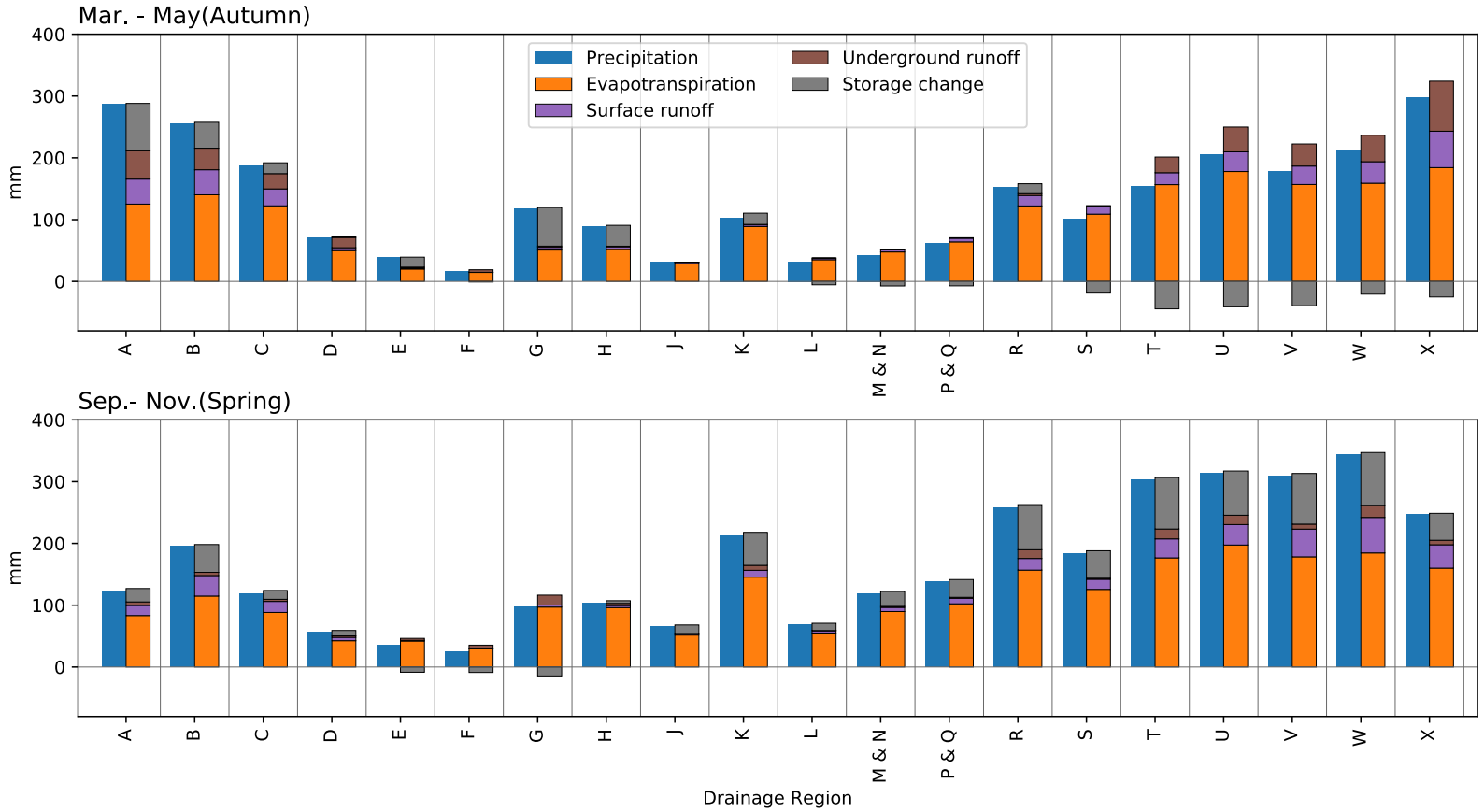
Coupled modeling results

Comparison of coupled WRF-Hydro results with observations for all drainage regions:



Coupled modeling results

WRF-Hydro derived seasonal water balance for all drainage regions:



Summary

- Coupled WRF-Hydro model shows reasonable ability on simulating hydro-meteorological fields in southern Africa
- High resolution coupled modeling is able to present seasonal and spatial variations of regional water balance in different drainage regions

Outlooks

- Extend the coupled modeling for a long-term period, to further study the coupled model capability in simulating water and energy balance
- Analyze the regional joint atmospheric–terrestrial water budget and derive indicators and measures for land surface–atmosphere interactions