Pacific Northwest NATIONAL LABORATORY

Towards mechanistic unraveling of plant physiological response to increasing vapor pressure deficit

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U.S. DEPARTMENT OF ENERGY BATTELLE

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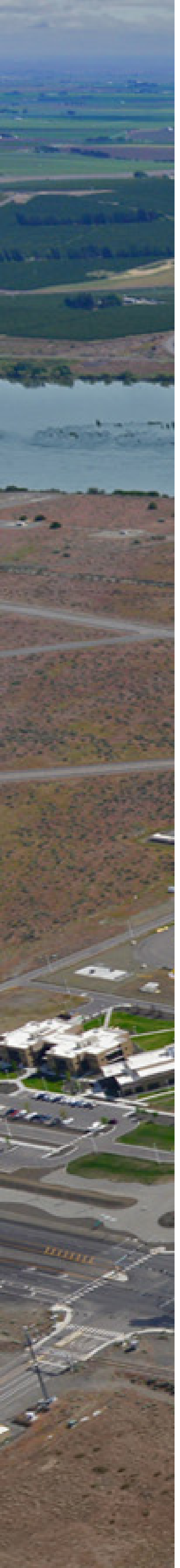
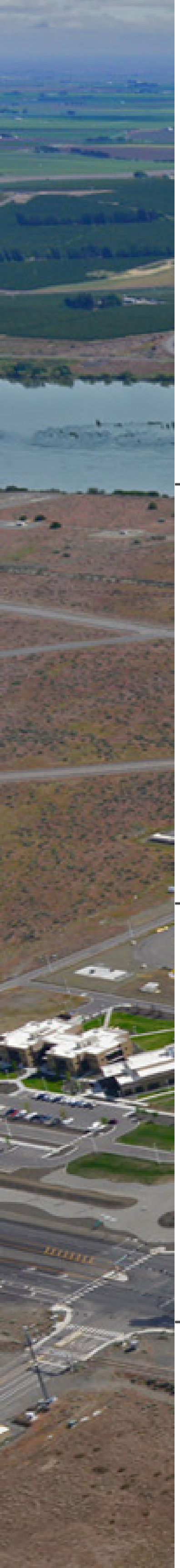
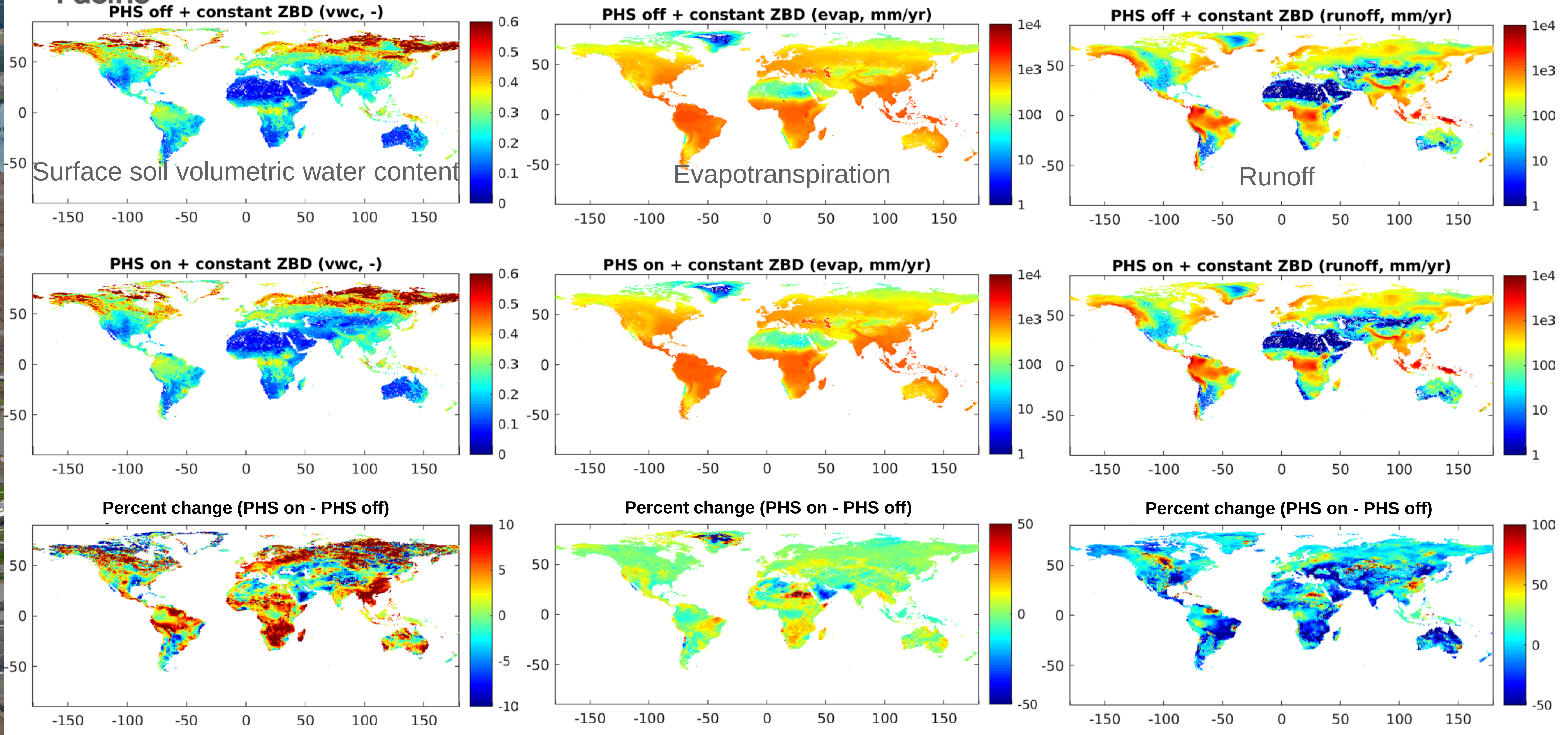


Introduction

- More severe and widespread droughts in the future are predicted due to elevated atmospheric CO_2
- Recent forest mortality related to drought has been attributed to the increased vapor pressure deficit (VPD) worldwide
- Previous study suggested that hydraulic redistribution by plant hydraulic processes may modify seasonal climate
- It has become important to understand the link between the plant hydraulic traits and climate with a mechanistic representation of plant responses to drought

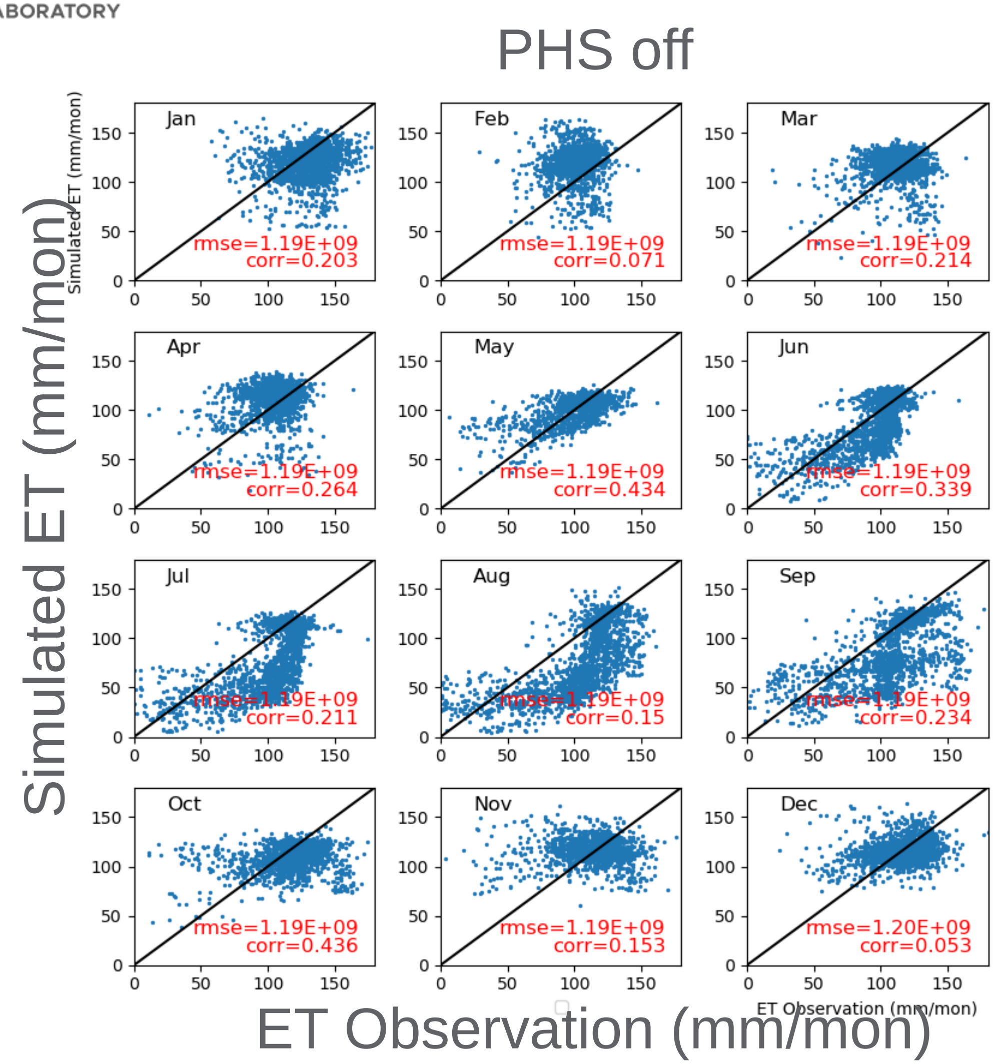


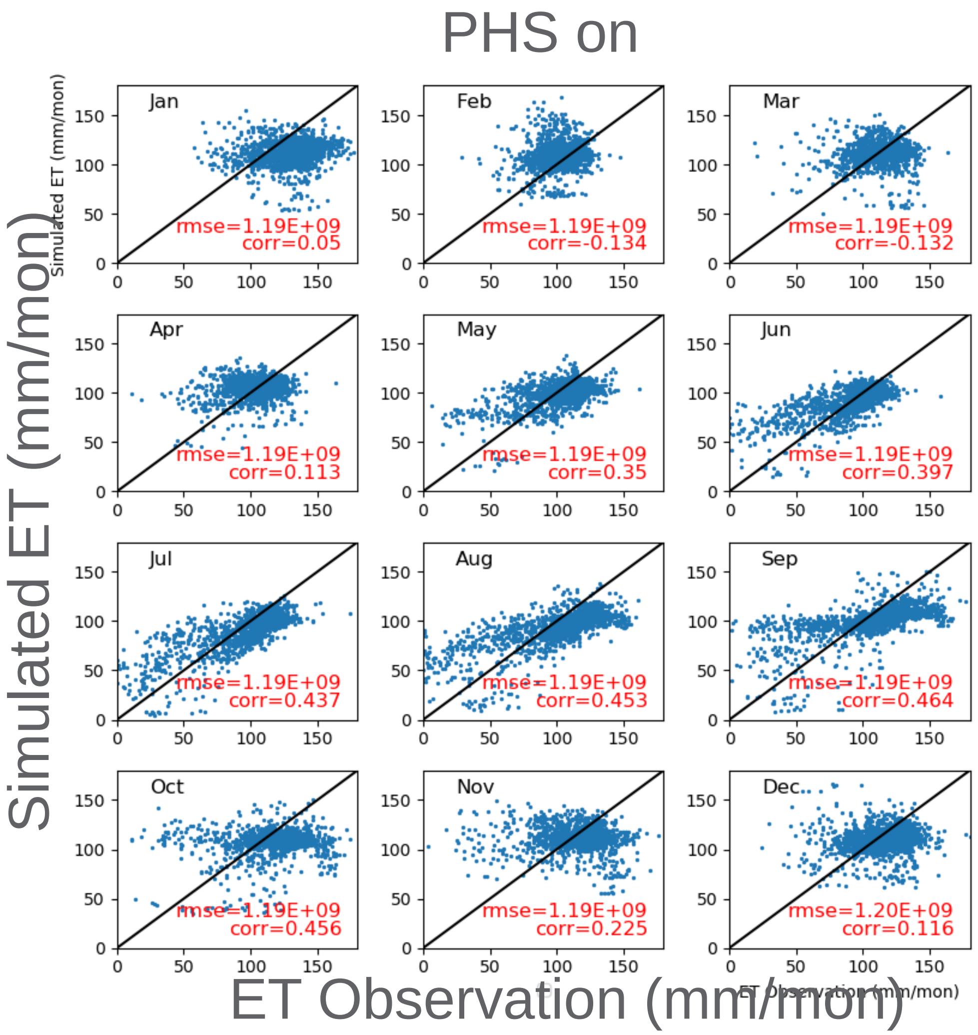
Global annual average of selected variables



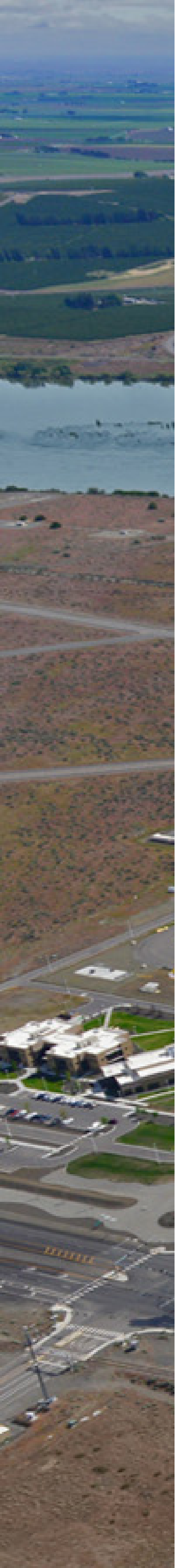
- Globally wetter soil with PHS.
- PHS mainly affects ET (+) and runoff (-) in deciduous forest of tropical regions.

Amazon ET (2005)





- Observation re-gridded from 0.0025º product based on results from six global products (GLEAM, SEBS, ALEXI, CMRSET, MOD16, and SSEBop) (Paca, VHdM (2019))
- Improved ET with PHS in the dry season



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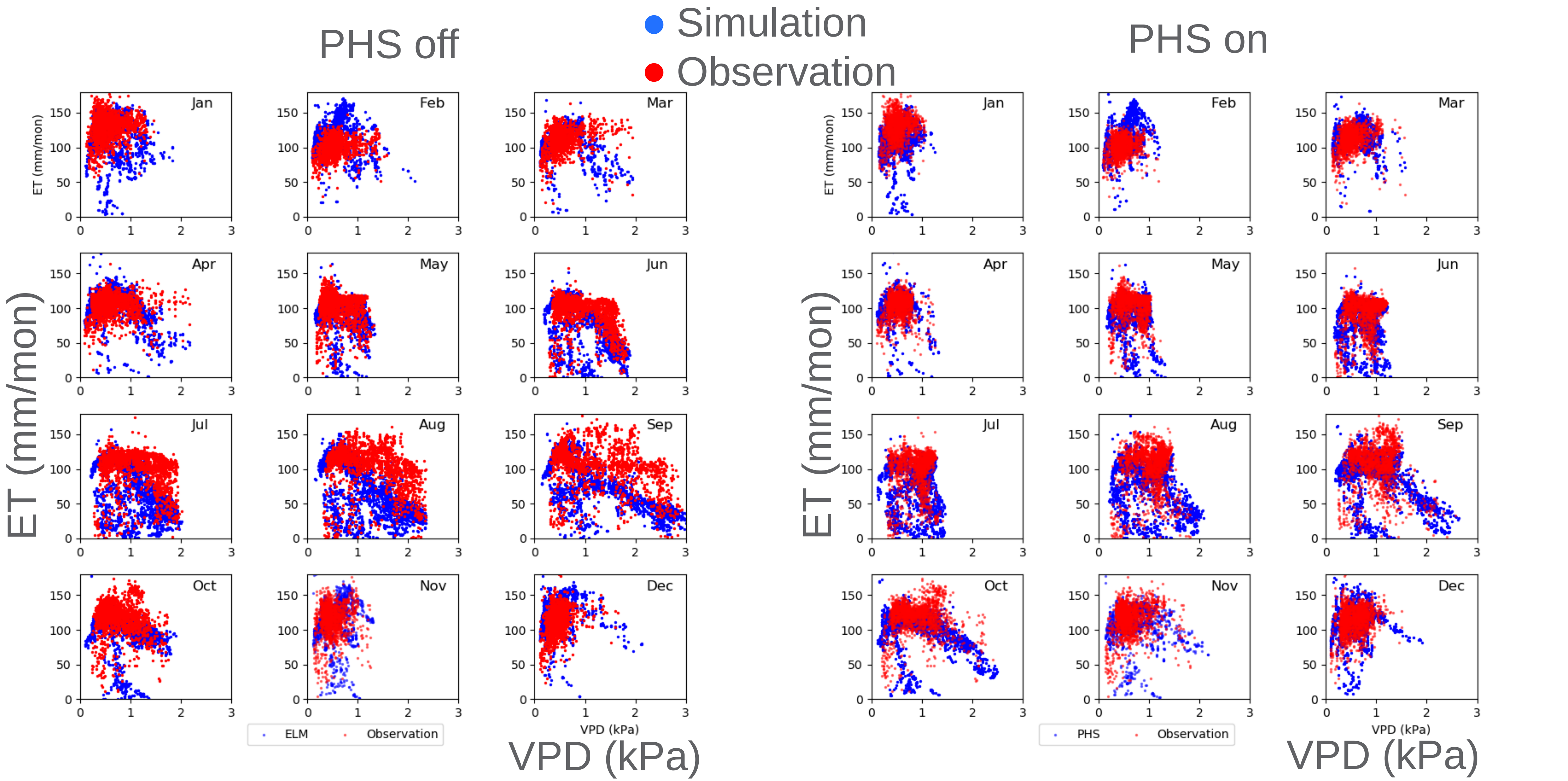
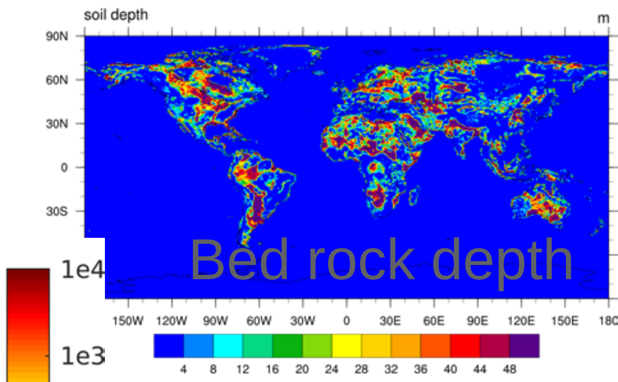
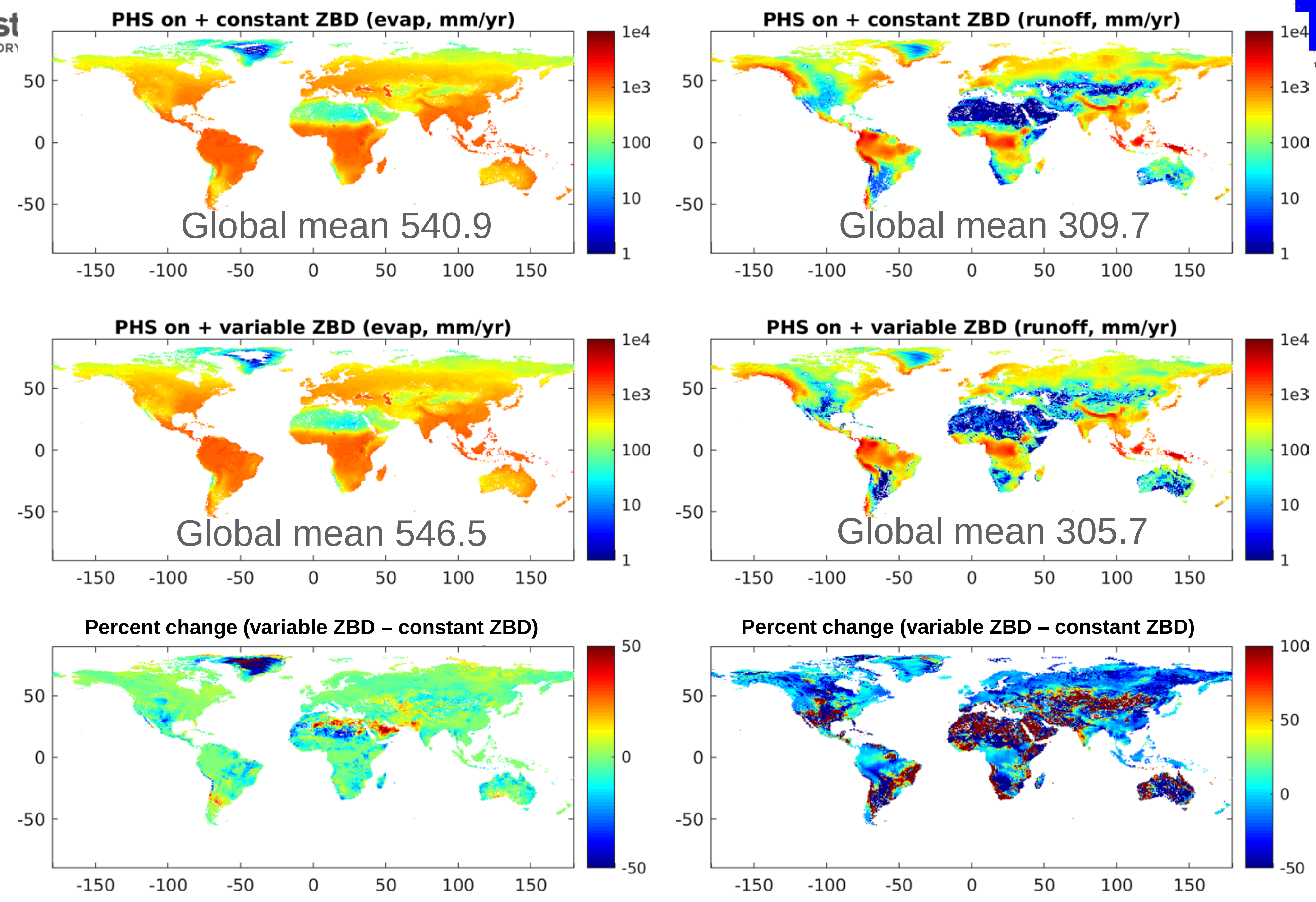


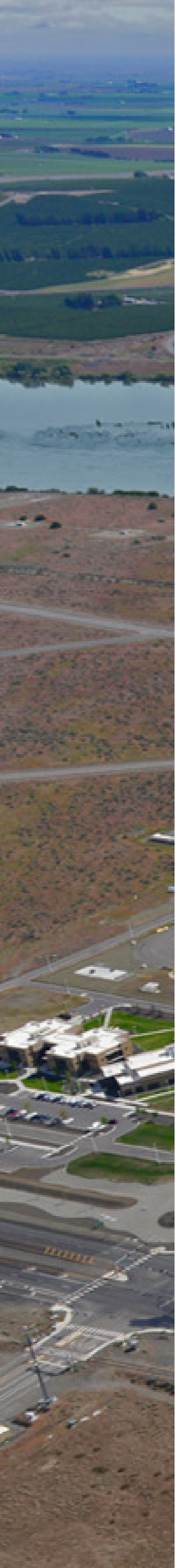
- Underprediction of ET without PHS at higher VPD in dry season
- Improved ET~VPD relationship with PHS

Sensitivity to variable bedrock depth





Variable bedrock depth caused significant increase of runoff in desert areas



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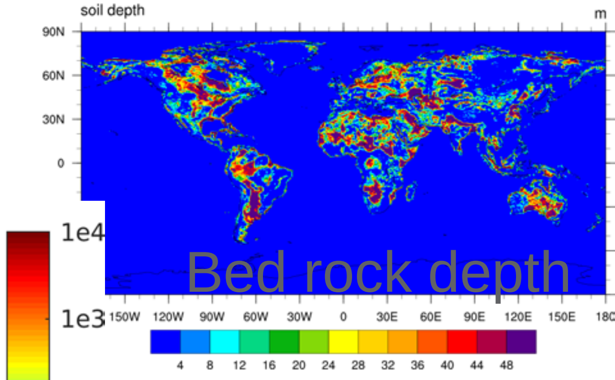
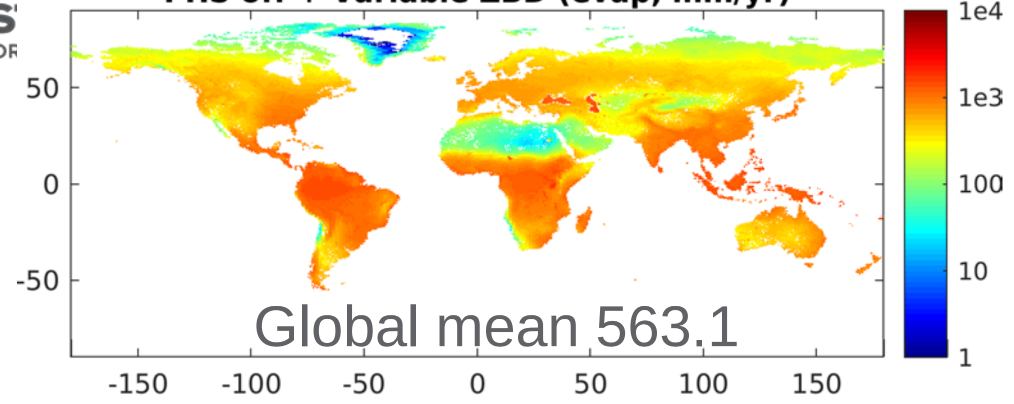
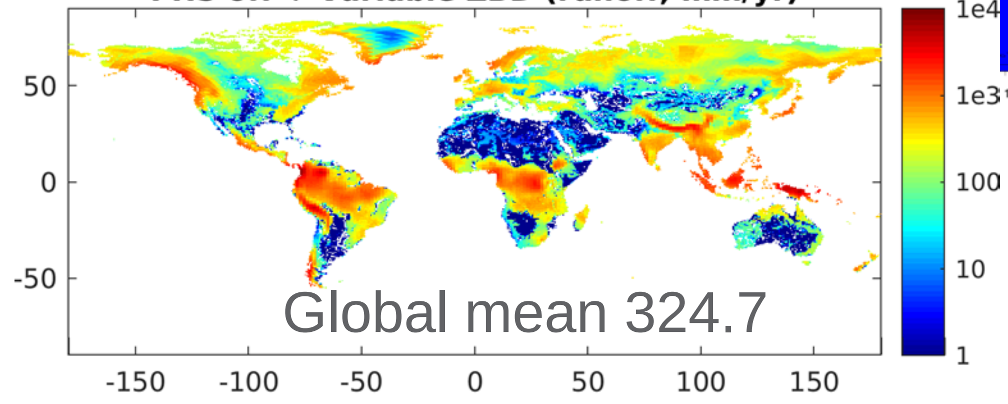


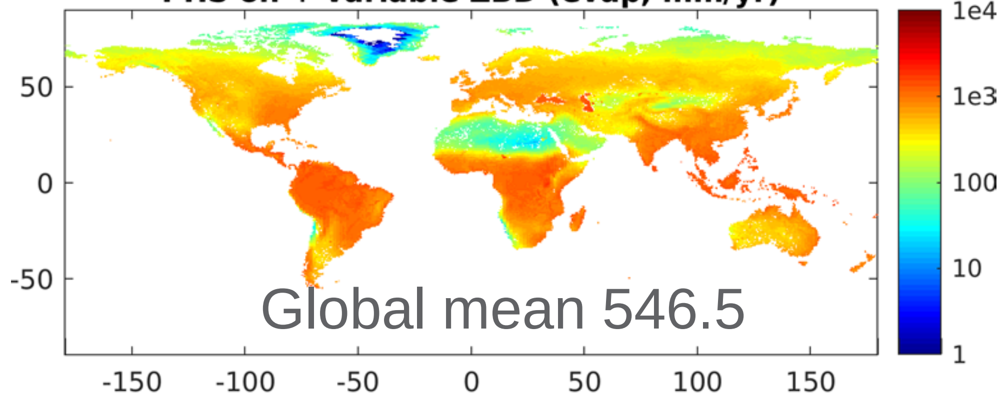
PHS off + Variable ZBD (evap, mm/yr)



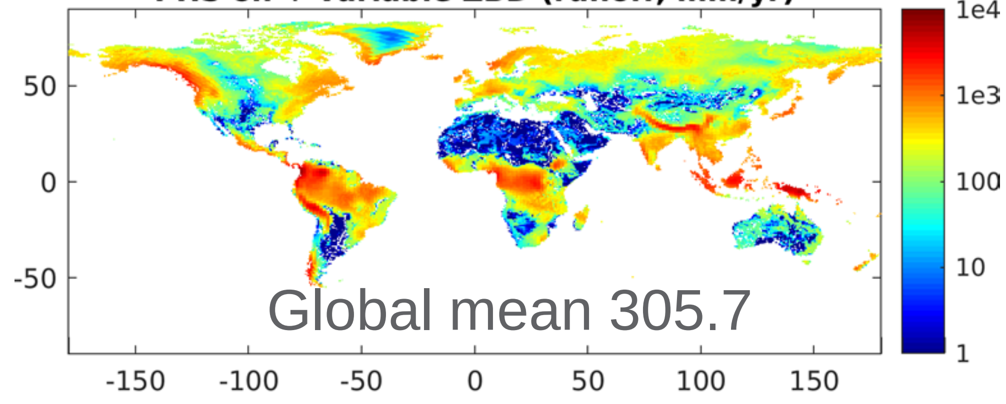
PHS off + Variable ZBD (runoff, mm/yr)



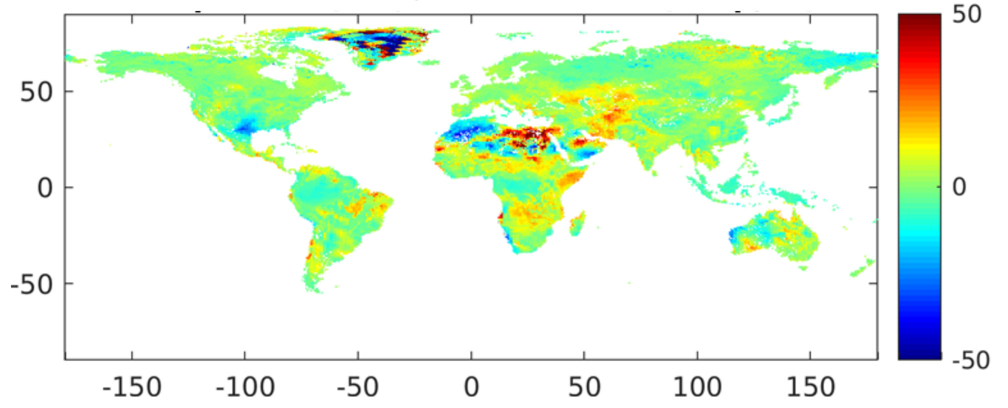
PHS on + variable ZBD (evap, mm/yr)



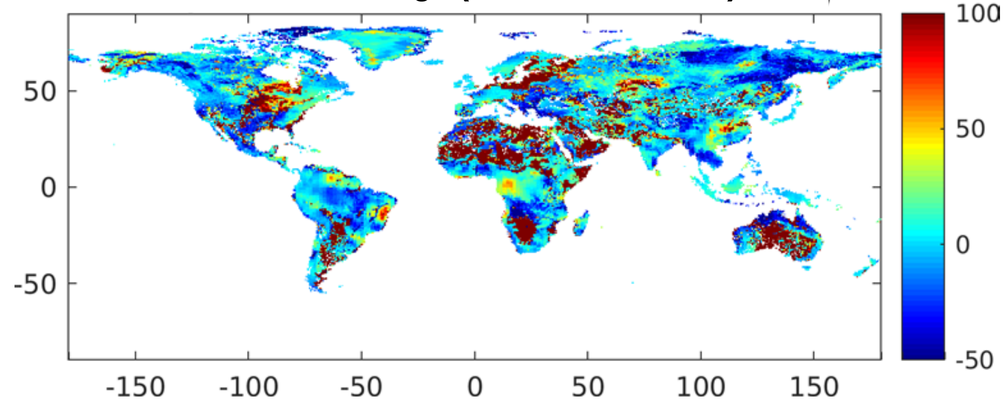
PHS on + variable ZBD (runoff, mm/yr)



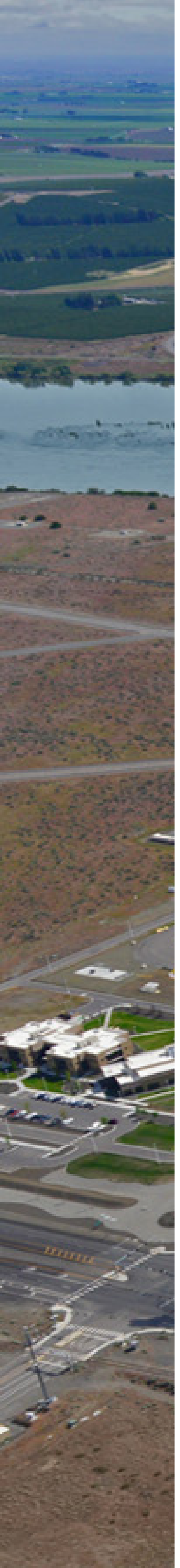
Percent change (PHS on - PHS off)



Percent change (PHS on - PHS off)



Difference between simulations with PHS on/off becomes larger compared to constant ZBD



Conclusion

- Simulated annual average ET and runoff are more affected by PHS in the deciduous of tropical regions (>10%) than in the other regions
- ET simulated with PHS is better correlated with observations in the dry season
- ET and VPD relationship is improved with PHS
- PHS has a larger effect on runoff (higher percentage change) than on ET with variable bedrock depth

Future work

- Evaluate if VPD is a dominant driver constraining stomatal conductance under future climate