NASA MAP Program (80NSSC17K0352)

Why Are the Drylands Getting Drier? The Perspective Provided by GRACE and Noah-MP with Plant Hydraulics (PI: Guo-Yue Niu)

ARIZONA

1. Representing Plant Hydraulics and Root Dynamics in Noah-MP (Niu et al., 2020)

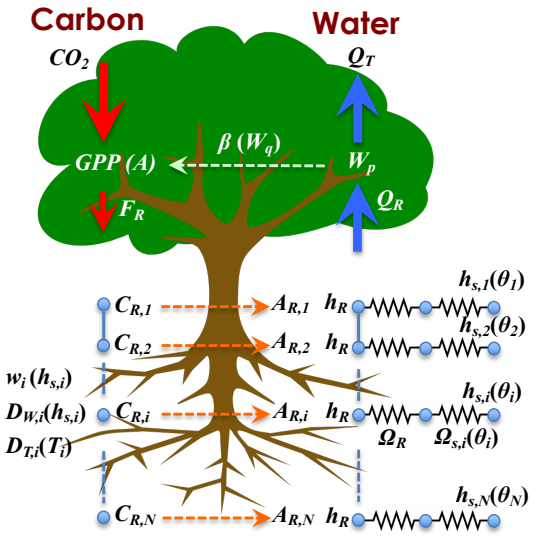

Figure 1. Diagram of the plant water storage and root water uptake model:

1) Explicitly predicts plant water storage
2) Stomatal water stress factor is parameterized as a function of plant water.
3) Represents root hydrotropism through more carbon translocation to roots but less turnover in wetter soil layers.

2. Global drylands are getting drier (from GRACE Terrestrial Water Storage Anomaly) (Chang et al., 2020)

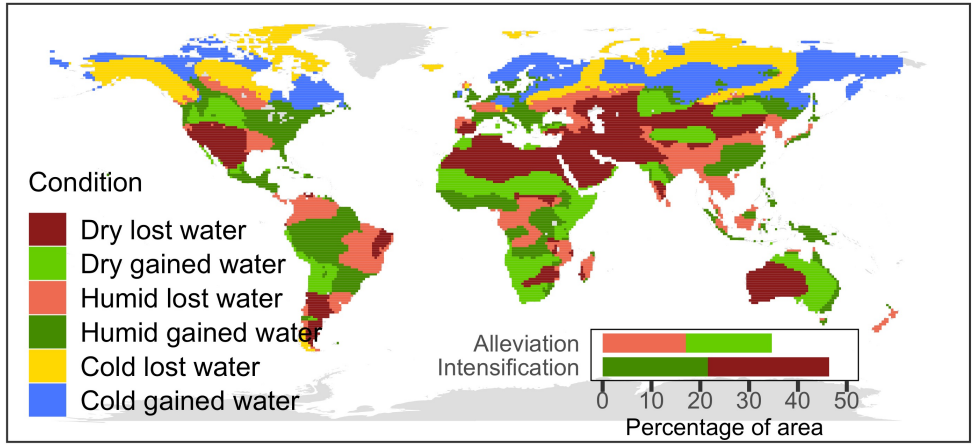

Figure 2. Drying and wetting patterns of different climate zones derived from the GRACE TWS anomaly data: the "*dry-gets-drier*" land area is 23.3%, "*wet-gets-wetter*" is 21.9%, "*dry-gets-wetter*" is 19.2%, and "*wet-gets-drier*" is 16.7%.

Conclusions:

1. *Global drylands are drying.*
2. *Ecosystem adaptation to the drying climates through optimized root distribution plays a critical role in the drying (in addition to human "pumping" of water).*

3. Noah-MP with optimal root water uptake explains most of the dryland drying (Chang et al., 2020)

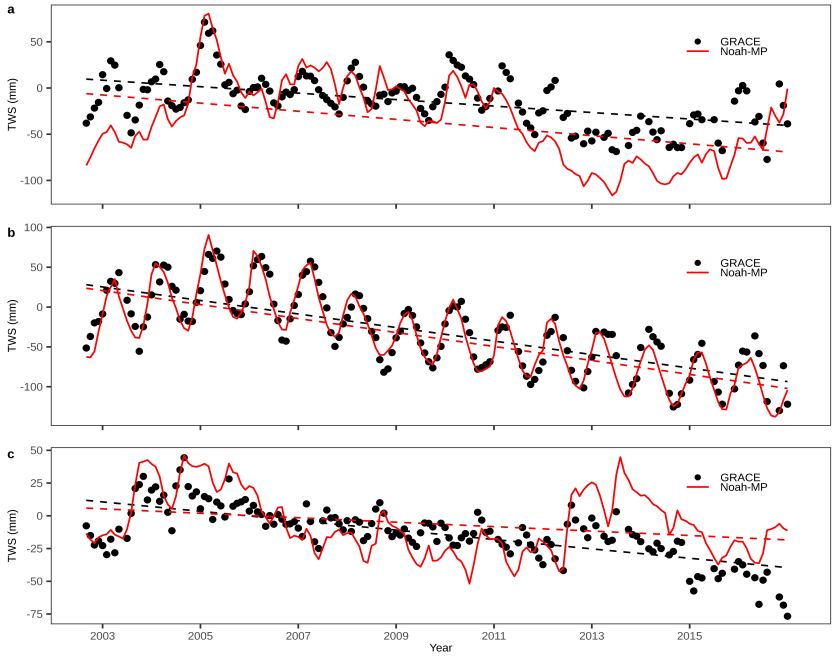

Figure 3. Monthly TWS anomalies by GRACE data and the Noah-MP model simulations over the (a) Southwestern North America, (b) Middle East, and (c) North China Plain.

Chang, L.-L., R. Yuan, H. V. Gupta, C. L. Winter, and G-Y, Niu (2020). Why is the Terrestrial Water Storage in Dryland Regions Declining? A Perspective based on GRACE Satellite Observations and Noah-MP Model Simulations, *Water Resources Research* (revision in review).

Niu, G.-Y., Y.-H. Fang, L.-L. Chang, J. Jin, H. Yuan, and X. Zeng (2020). Enhancing the Noah-MP Ecosystem Response to Droughts with an Explicit Representation of Plant Water Storage Supplied by Dynamic Root Water Uptake, Journal of Advances in Modeling Earth Systems (revision in review).