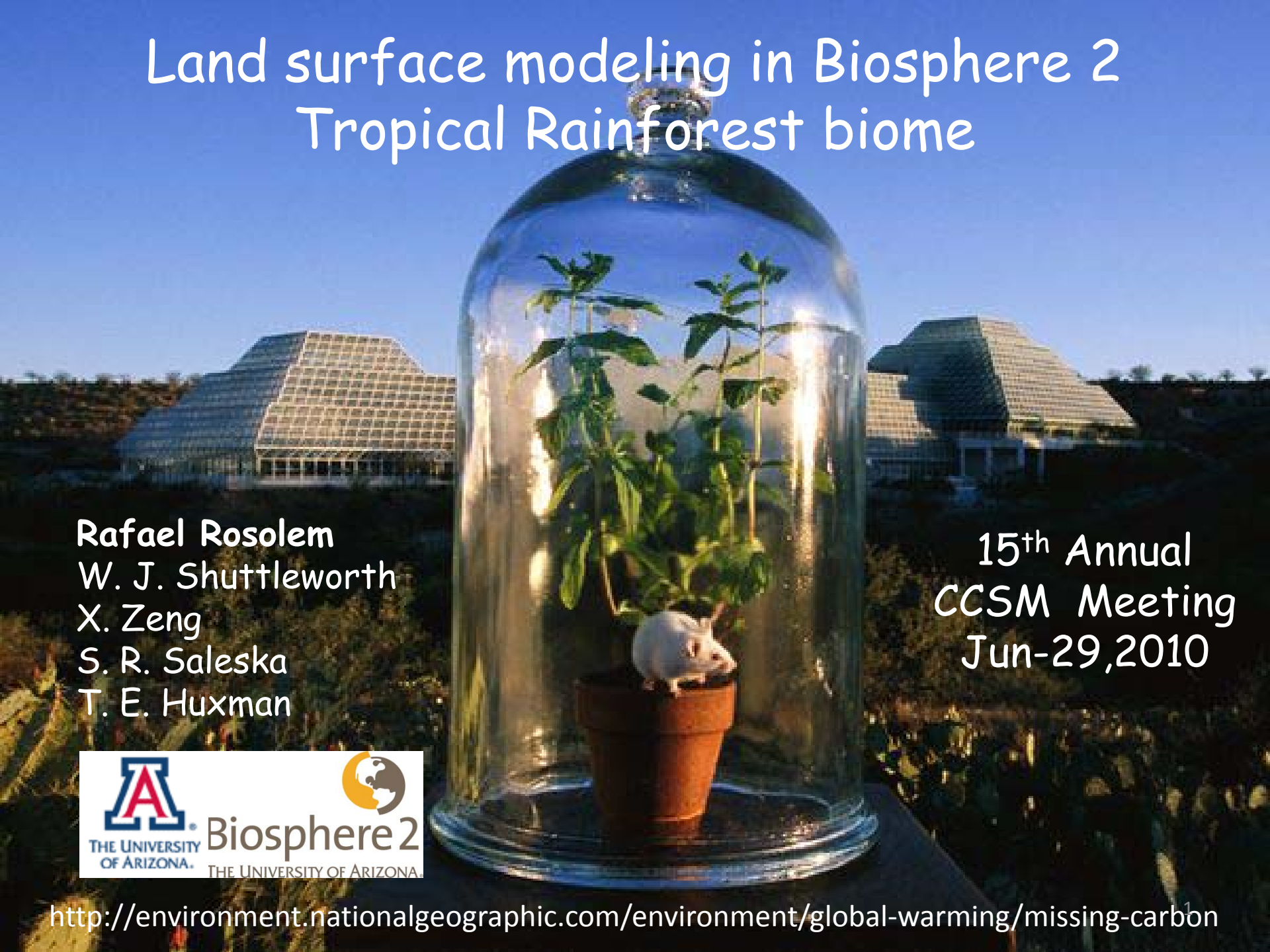
Land surface modeling in Biosphere 2 Tropical Rainforest biome



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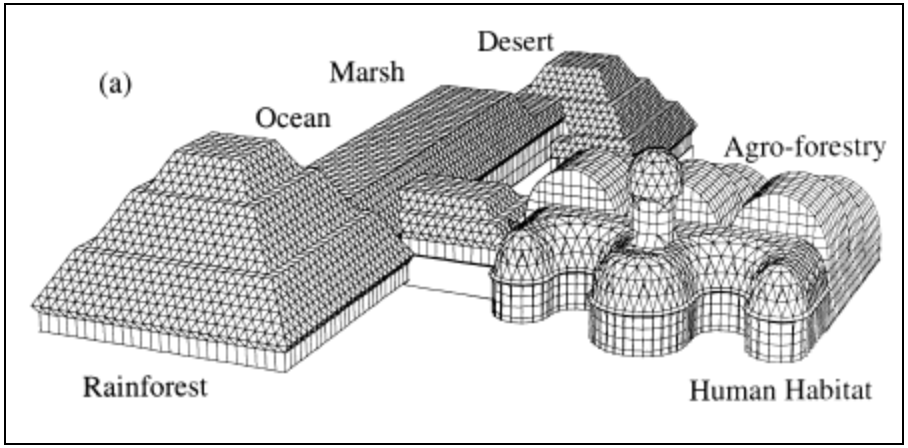
http://environment.nationalgeographic.com/environment/global-warming/missing-carbon

Objectives

(1) to provide a high-quality database of the atmospheric forcing variables needed for land surface modeling inside B2-TRF

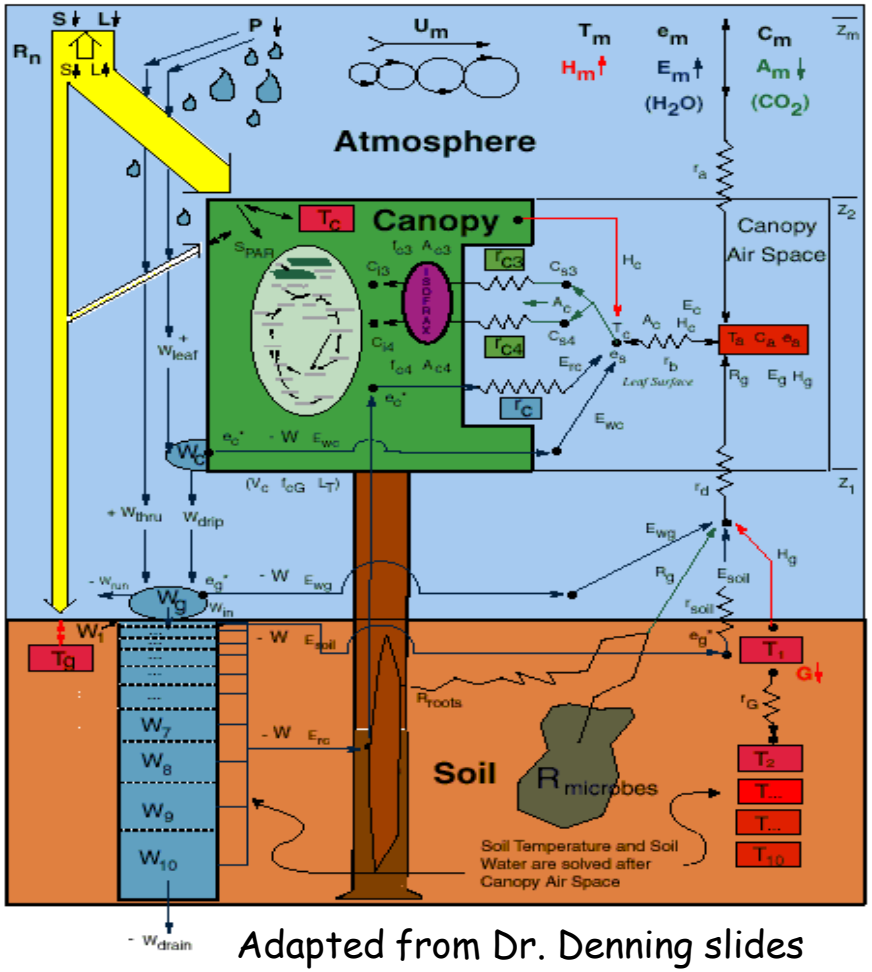
(2) to investigate whether SiB3 is capable of representing the vegetation response in the B2-TRF controlled environment.



Simple Biosphere 3

Original code provided by Ian T. Baker (CSU)

References: Baker et al. (2003, 2008)

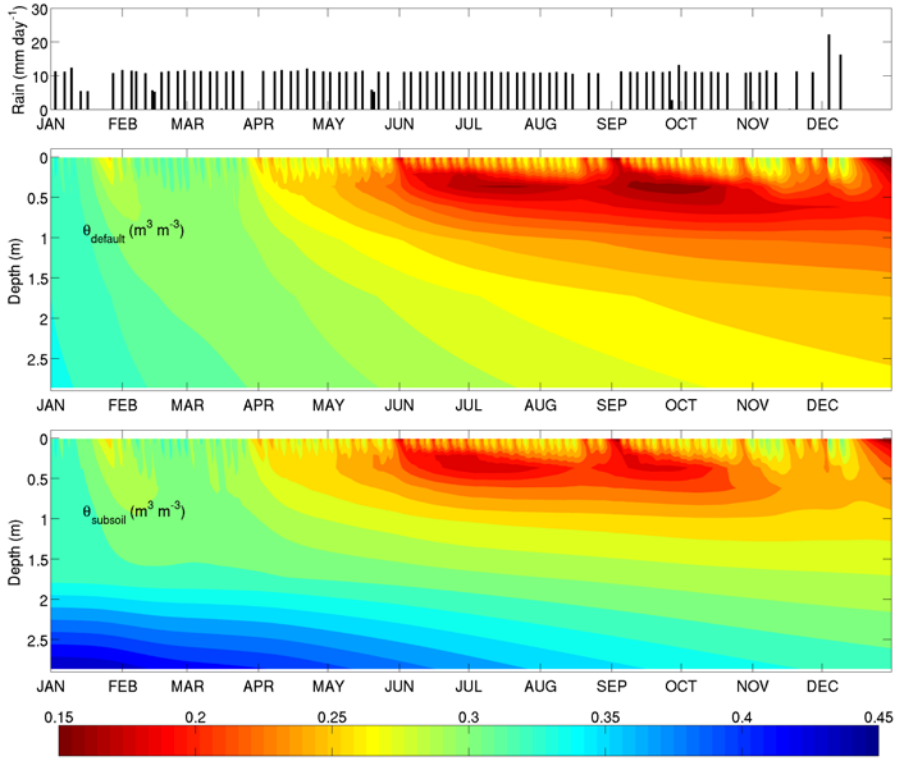


Adapted from Dr. Denning slides

<u>Modifications due to physical characteristics of B2-TRF:</u>

- Rooting profile based on direct measurements

- Bottom layer modified to produce subsoil drainage rates consistent to observations (soil moisture profile shown below)

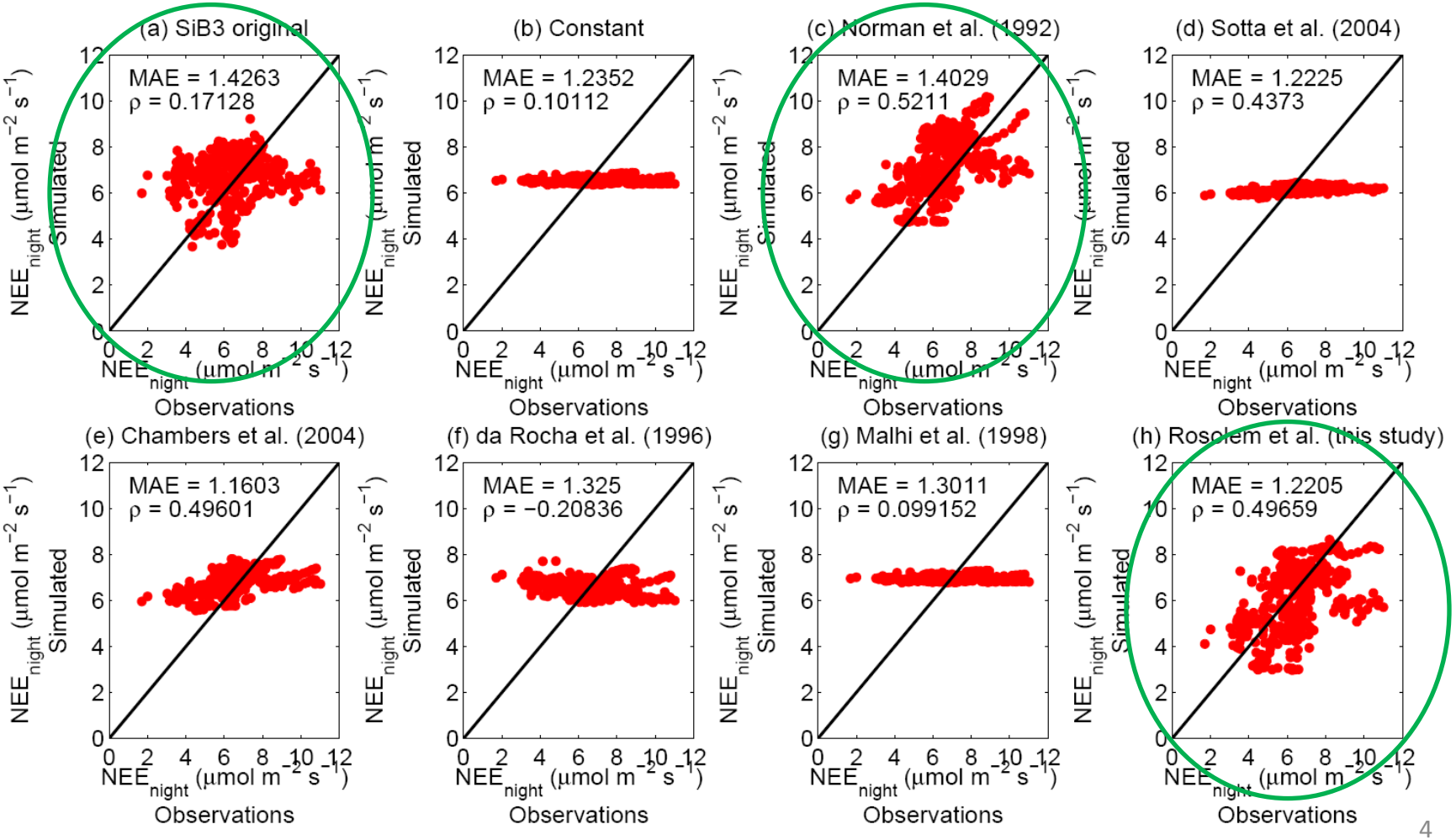


Soil Respiration Calibration

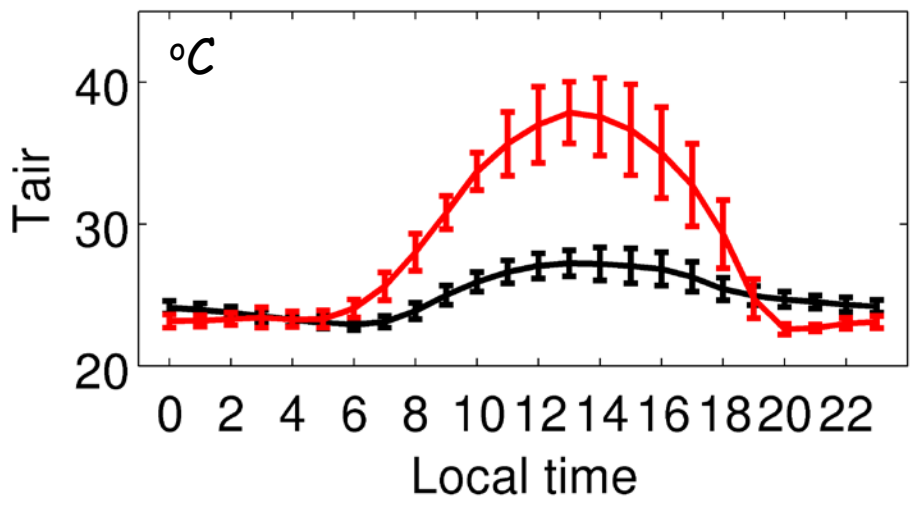
Multi-objective approach: 1,000 parameter sets (Latin Hypercube Sampling)

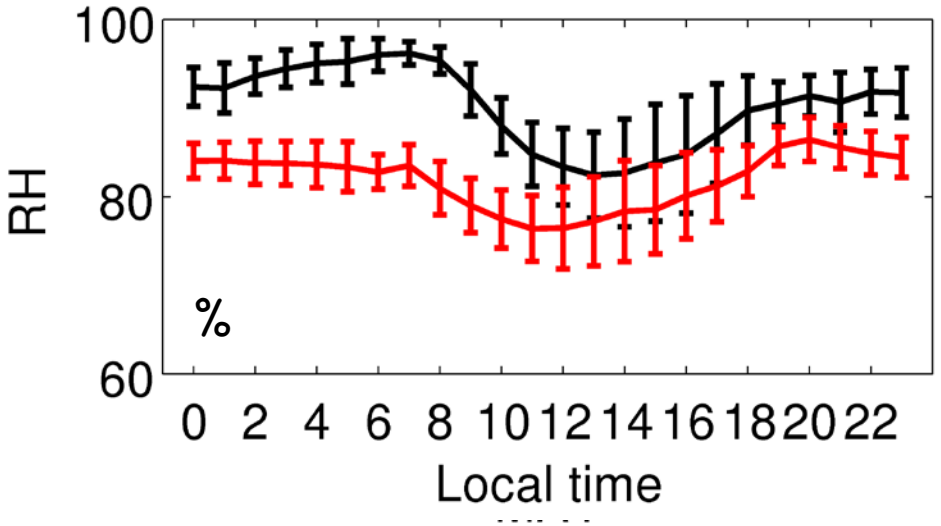
Calibrated w.r.t. daily nighttime NEE (Mean Absolute Error and ρ)

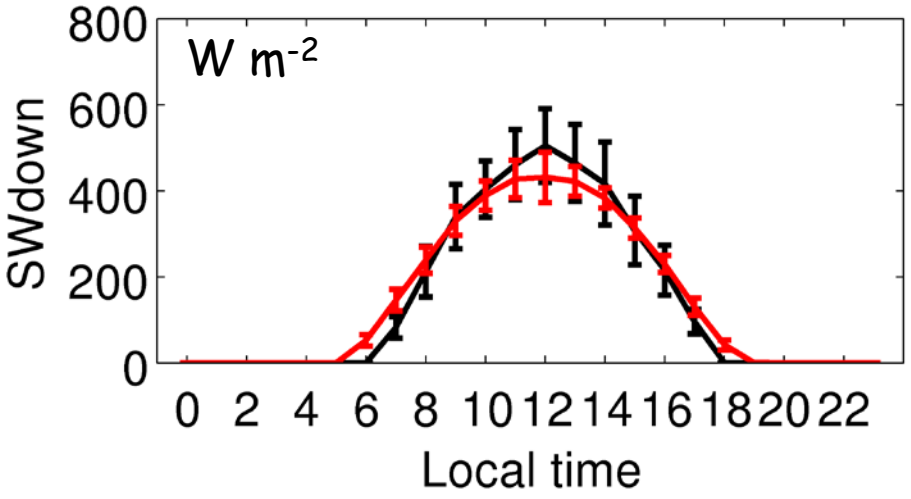
Soil respiration dominant component of NEE at night

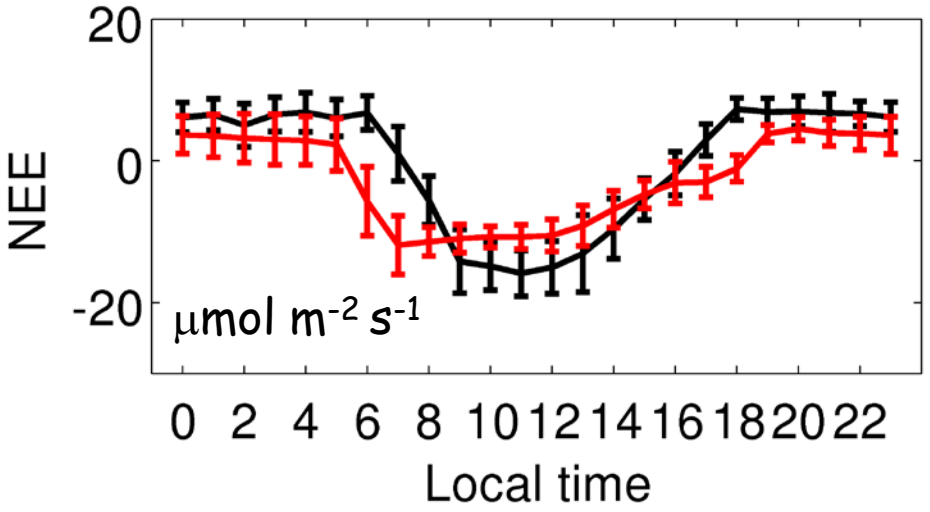


B2 and Amazon (K67) environmental conditions
Mean diurnal variation for May 2001

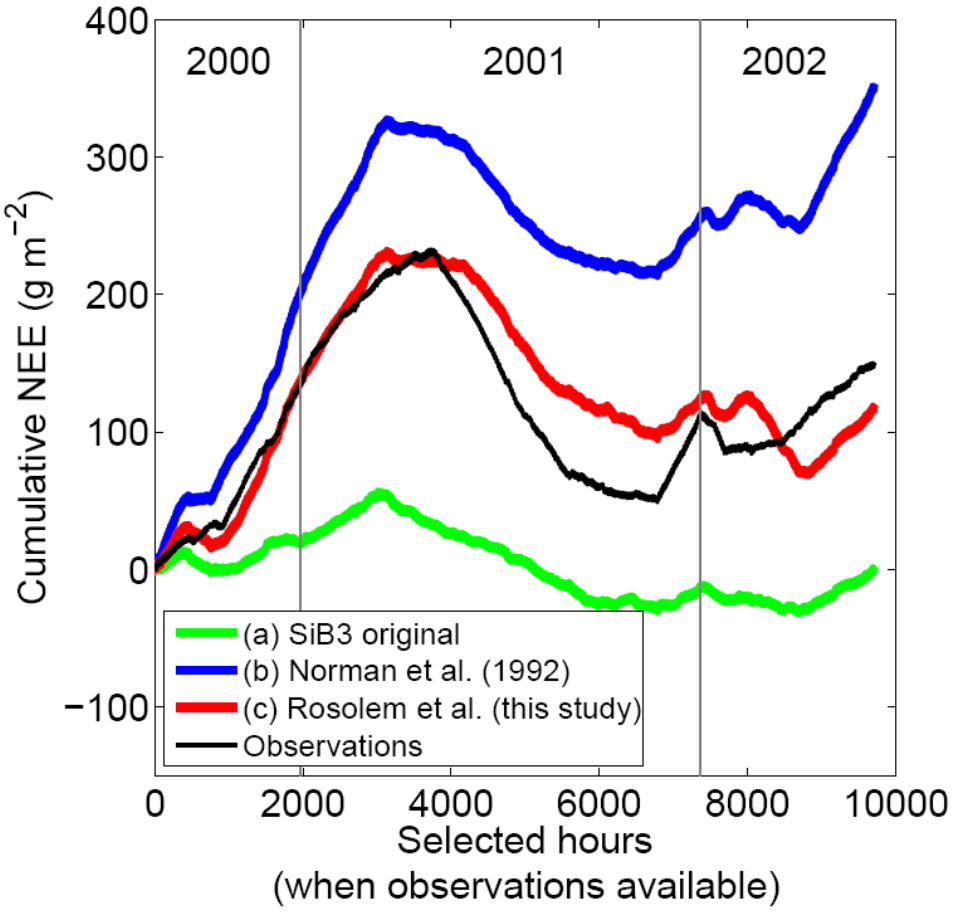








Thermal tolerance Calibration



Multi-objective approach: 1,000 parameter sets (LHS)

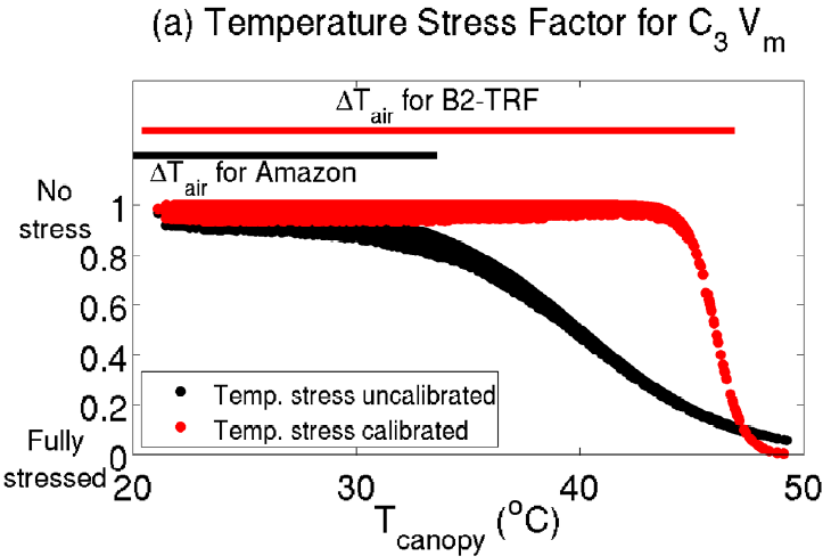
Calibrated w.r.t. hourly daytime NEE (MAE and ρ)

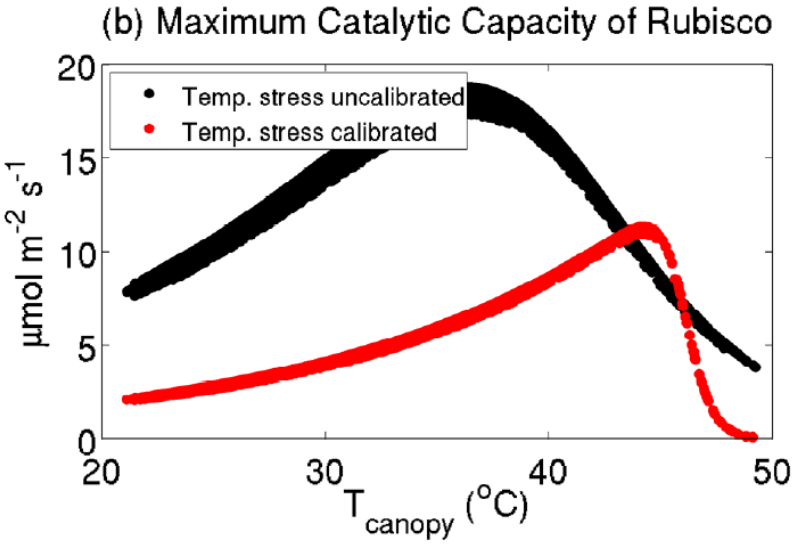
Photosynthesis mainly affected by temperature stress function

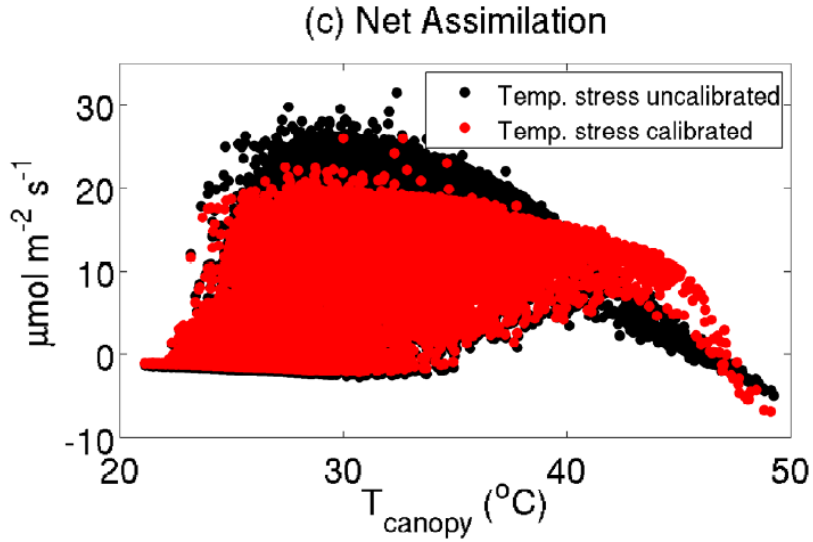
Photosynthesis dominant component of NEE during the day

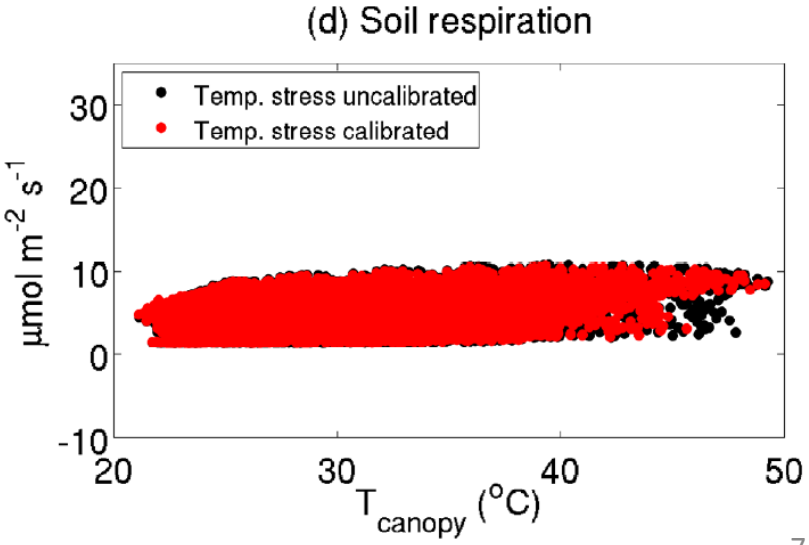
$$R_s = \langle R_0 \rangle \sum_{i=1}^{nsoil} R^*(i)\, rootf(i)$$

Interpreting Thermal Tolerance Results for Tropical Ecosystems

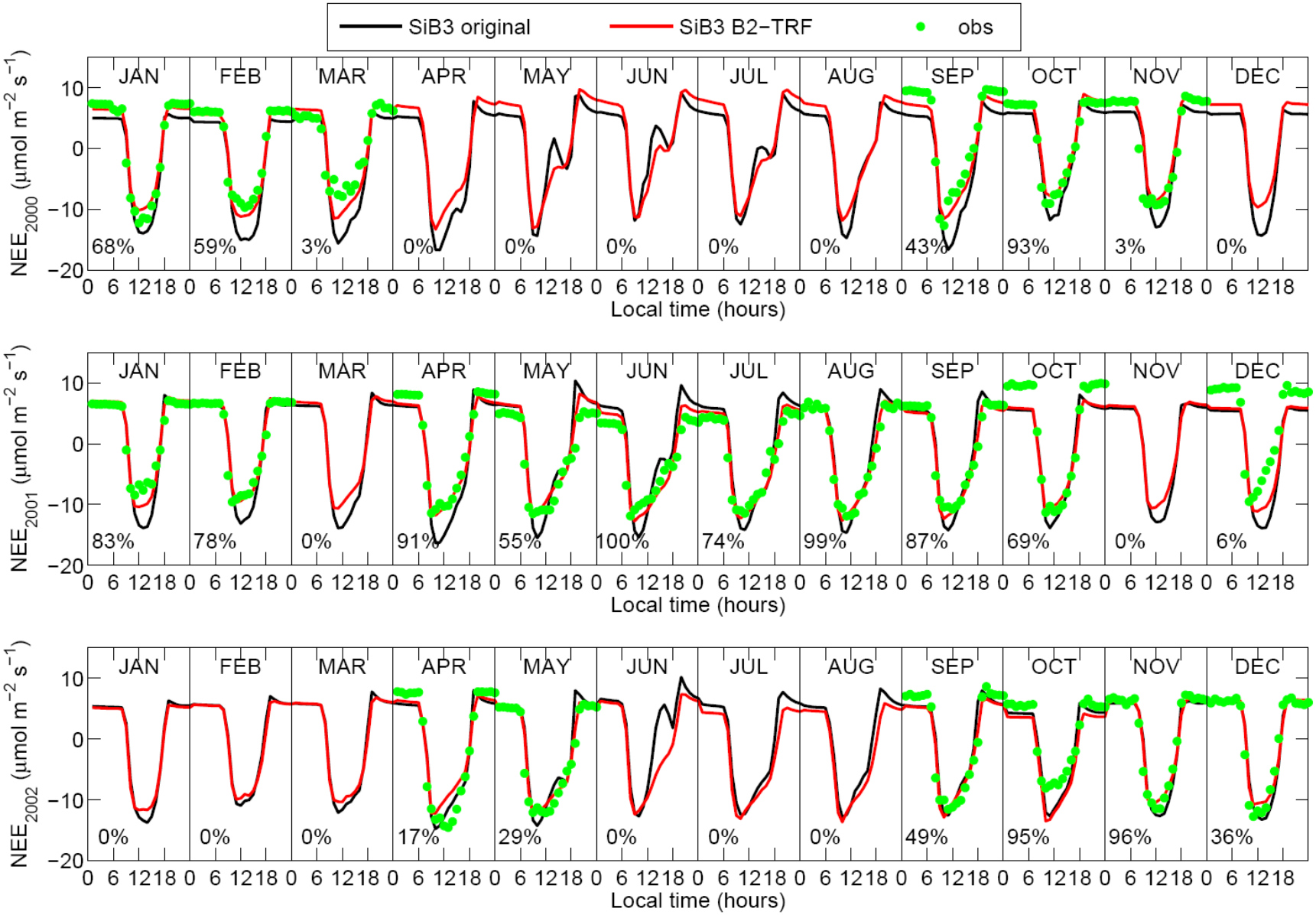








Mean diurnal variation (original versus modified SiB3)



Conclusions

- New soil respiration formulation suggests superior model performance compared to all other tested parameterizations

-Tropical rainforest plant species may be more resilient to climate change than previously thought: Either (1) tropical rainforest species can function at higher temperatures than previously thought, or (2) plants in B2-TRF have adapted to continue functioning at higher temperatures → and natural plant species could do also

- There may be some radiation limitation inside B2-TRF due to reduction of incoming radiation caused by structural characteristics in B2 (i.e., space-frame)

-Under a controlled ecosystem, we can obtain multiple information from the same variable → this is important and desirable for multi-objective calibration/optimization

-B2-TRF can serve as a tested for land surface models to investigate model responses under different conditions not easily observed in natural ecosystems. Therefore, we invite other models to be tested with B2-TRF forcing data (e.g., CLM, Noah)

Acknowledgements

- Dr. A. Arain and Dr. U. Rascher for providing the original dataset from B2-TRF

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Thank you!

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