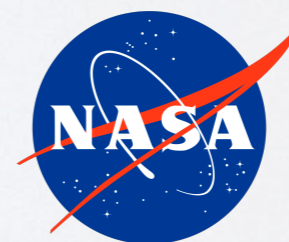




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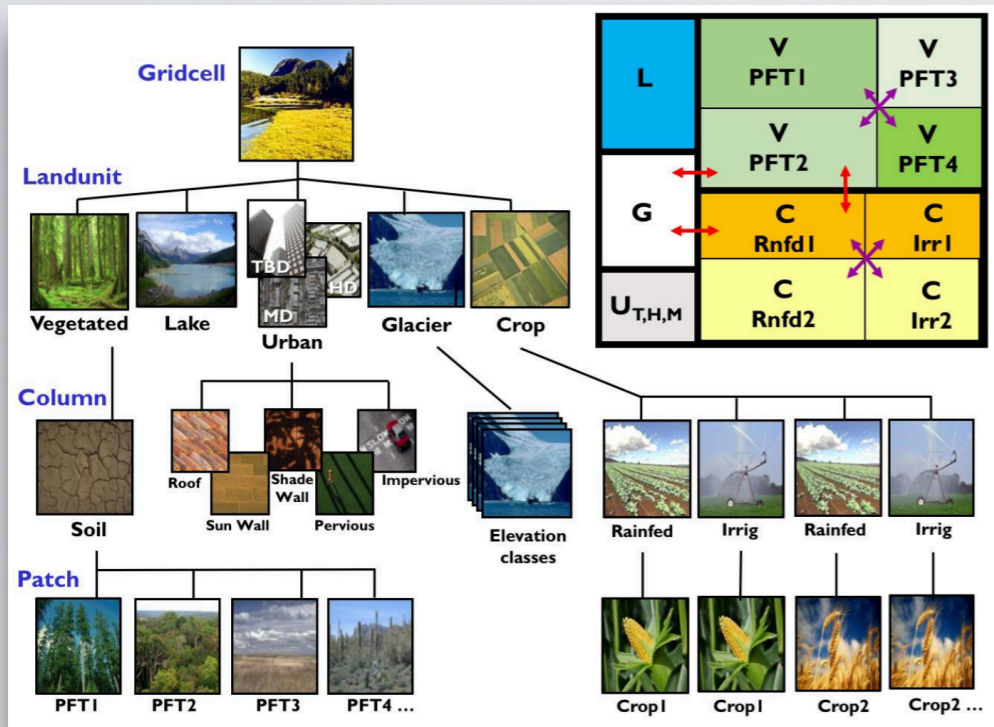
Coupling of **L**and and **A**tmospheric **S**ubgrid **P**arameterizations

Nathaniel Chaney, Kirsten Findell, Po-Lun Ma, David Lawrence, Joseph Santanello, Paul Dirmeyer, Forrest Hoffman, Elena Shevliakova, Michael Ek, Gabriel Katul, et al.



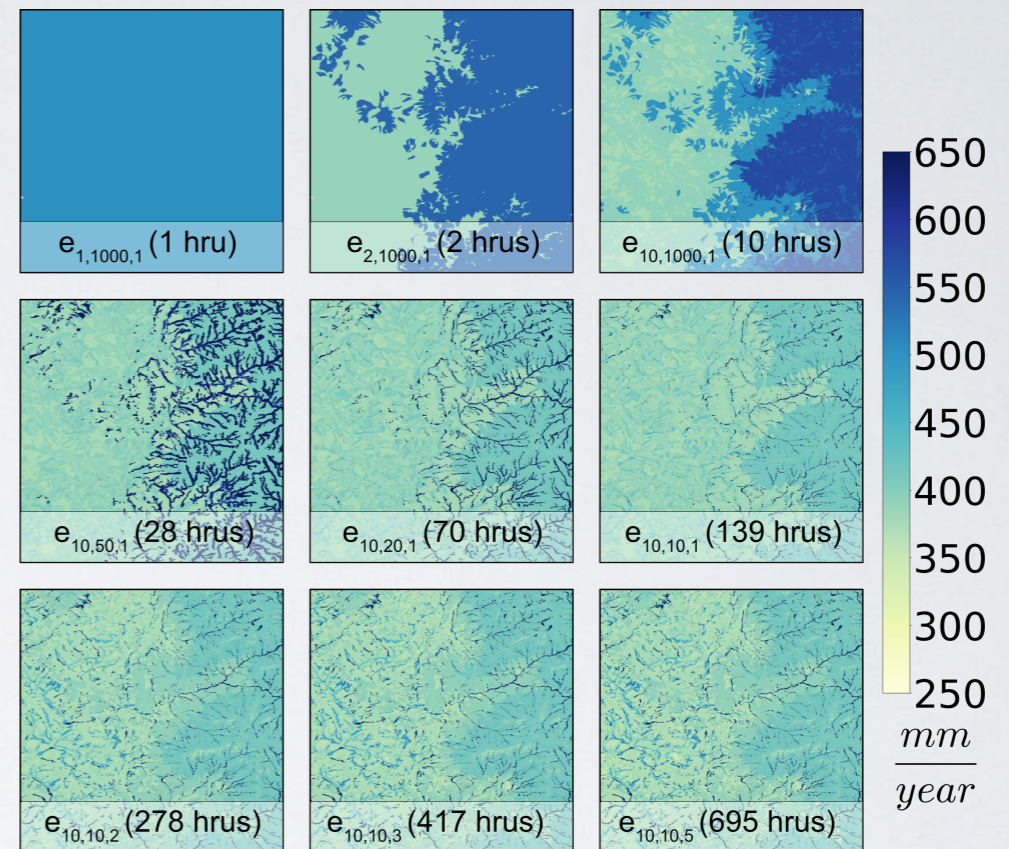
DOE RGMA PI meeting, October 13th, 2020

Sub-grid heterogeneity in the land component of Earth system models

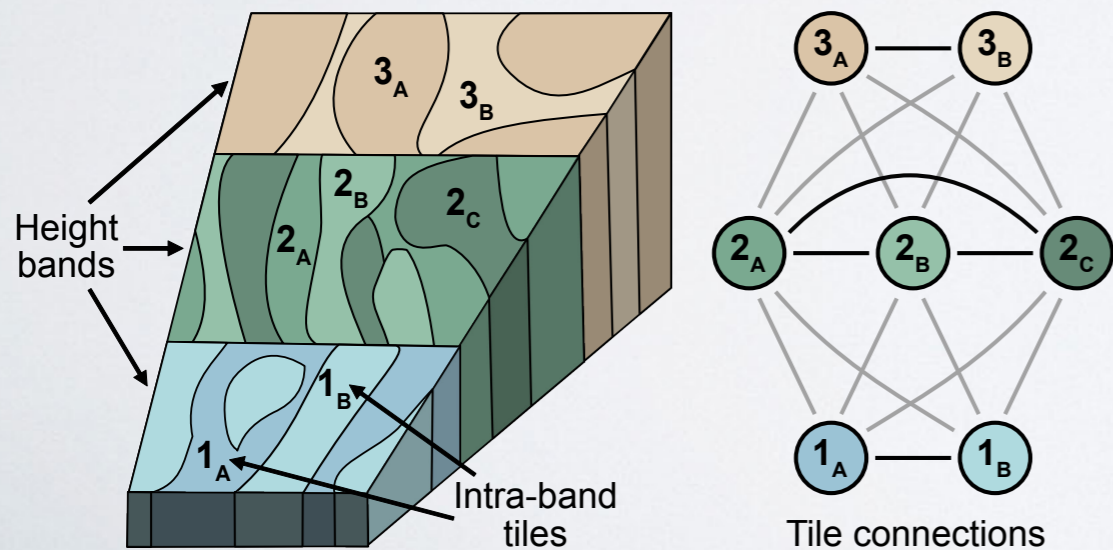


Lawrence et al., 2019

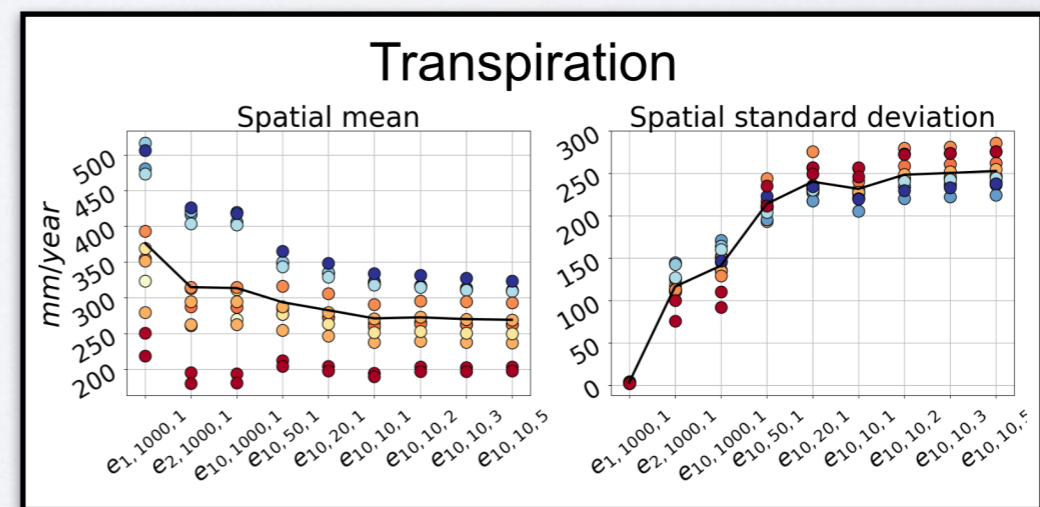
Mapped simulated transpiration annual mean (2002-2014)



Characteristic hillslope

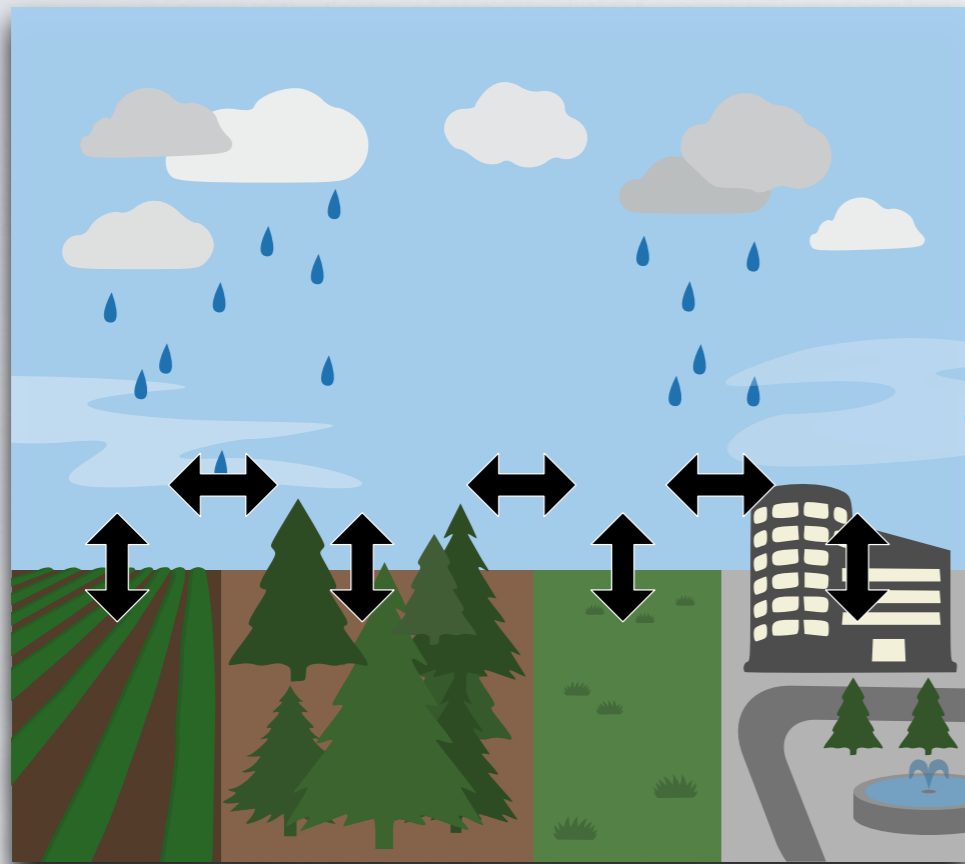


Subin et al., 2014

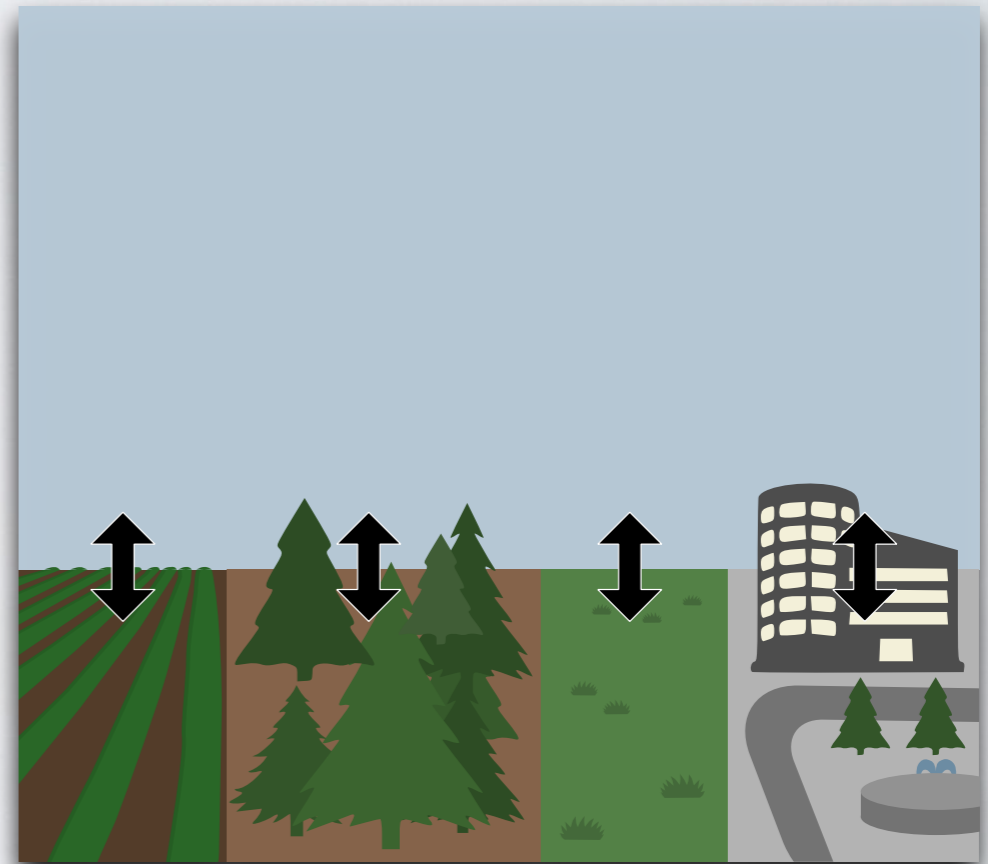


Chaney et al., 2018

The atmospheric column only effectively “feels” the sub-grid spatial mean



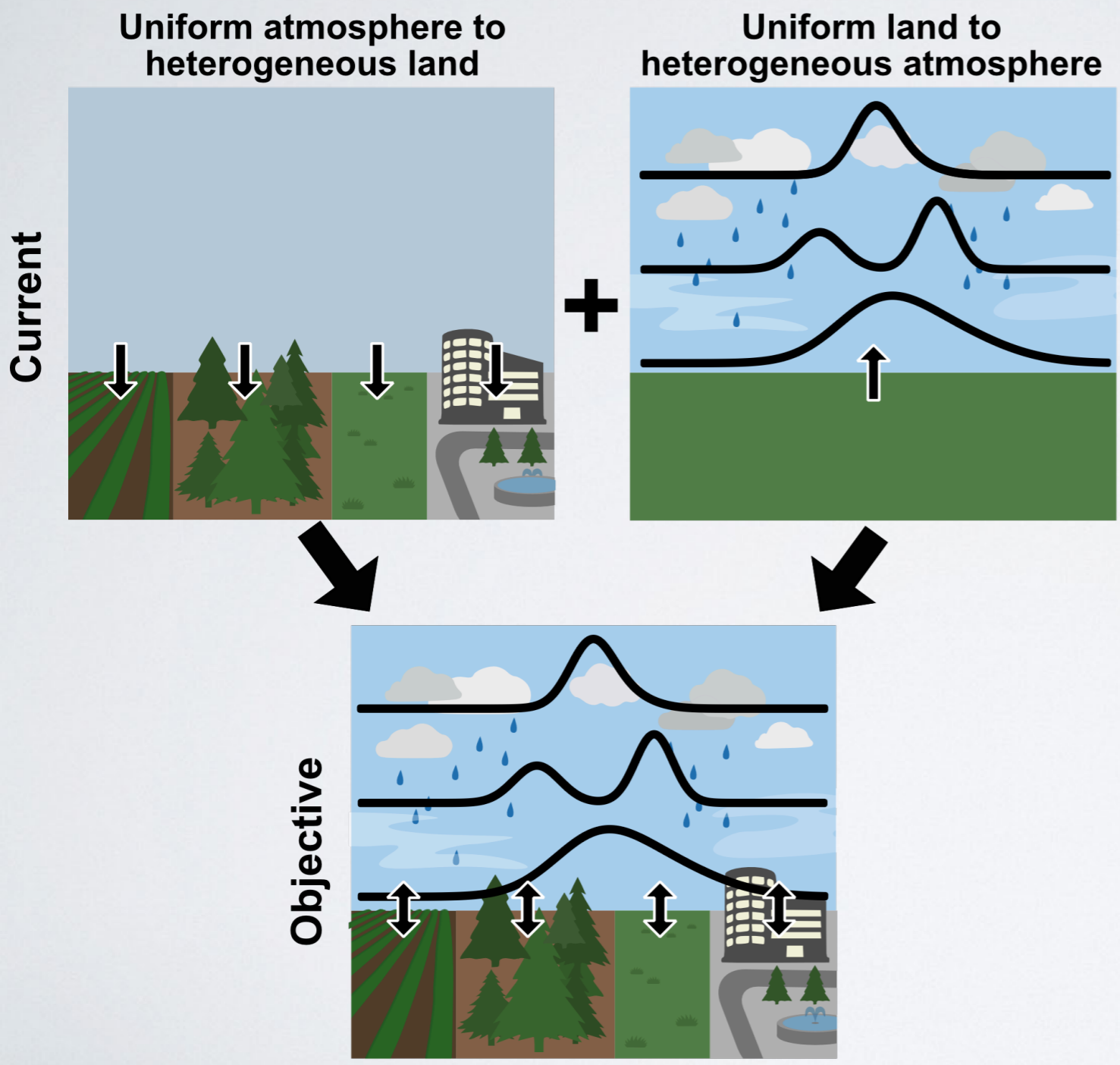
Coupled model: Wishlist



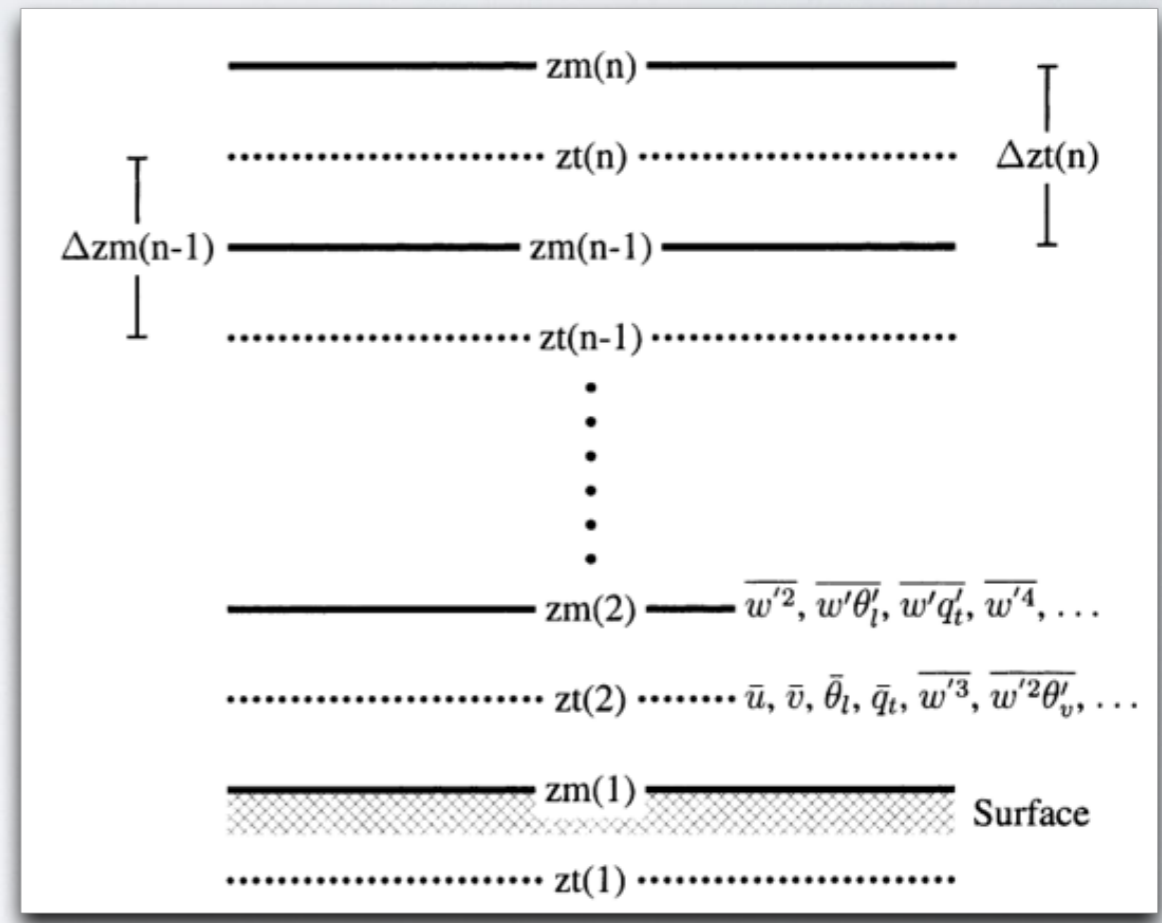
Coupled model: Reality

Problem: Currently, atmospheric models ignore all but the sub-grid spatial mean over land (e.g., latent heat flux)

How do we enable interaction between the “tiling” sub-grid approach over land and existing atmospheric sub-grid schemes (e.g., CLUBB - Cloud Layers Unified By Binormals)?



CLUBB's staggered grid



How do we use the modeled land surface heterogeneity to inform CLUBB's surface boundary conditions?

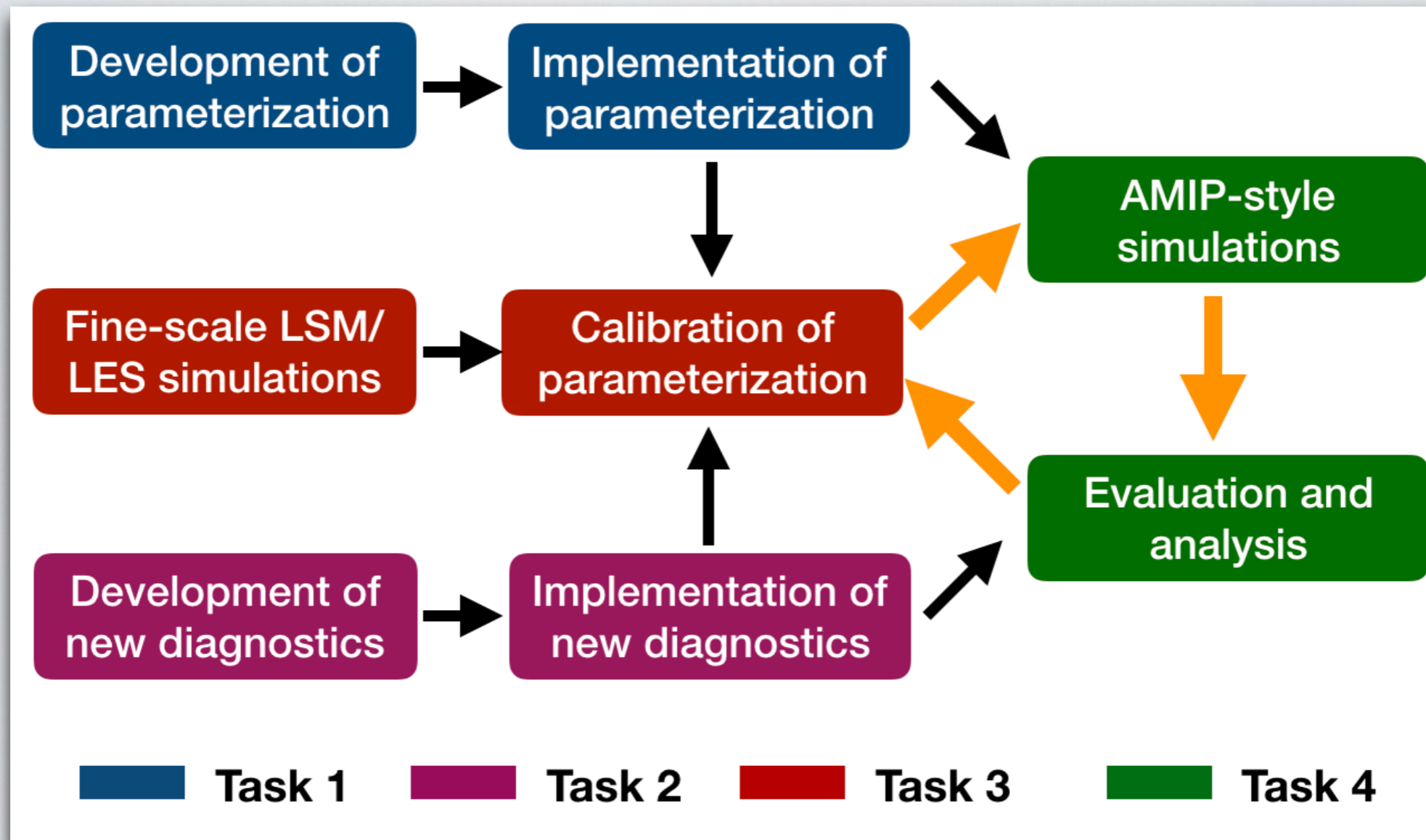


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Coupling of **L**and and **A**tmospheric **S**ubgrid **P**arameterizations

Objective: Parameterize heterogeneous exchanges between the land and atmosphere and to characterize its implications for surface climate, variability, and extremes.

CLASP tasks

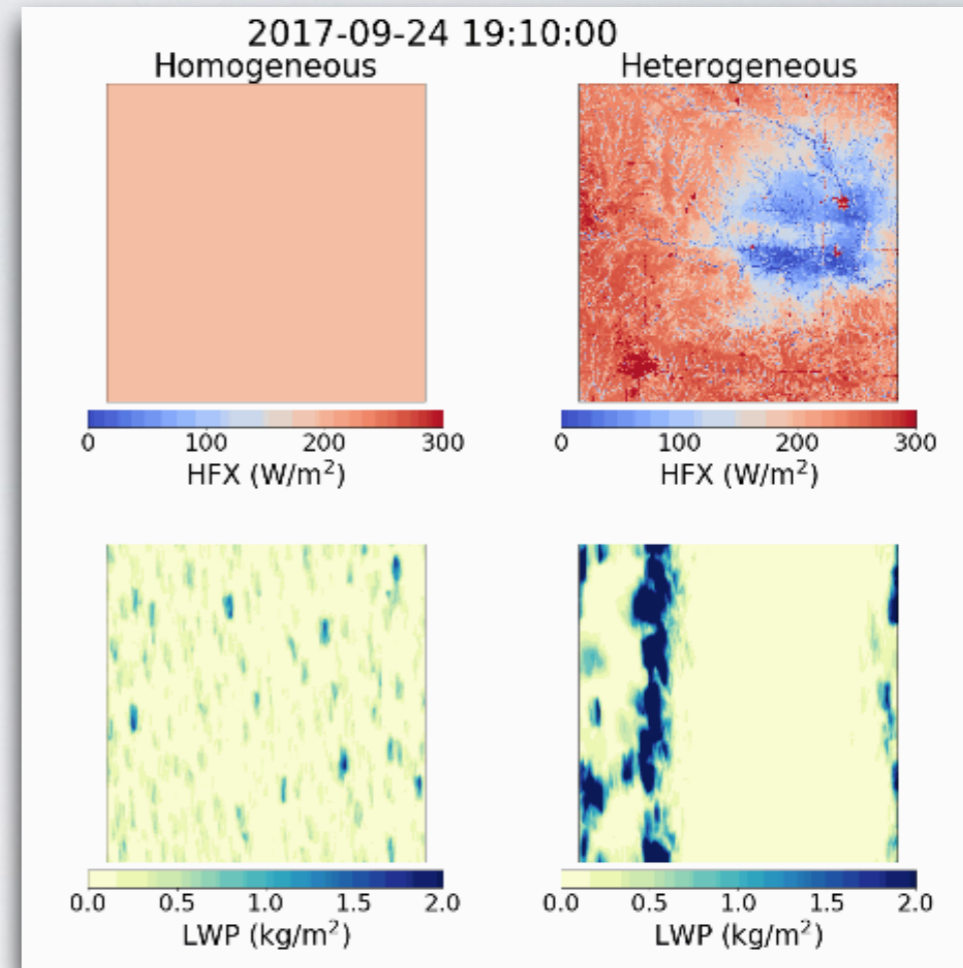
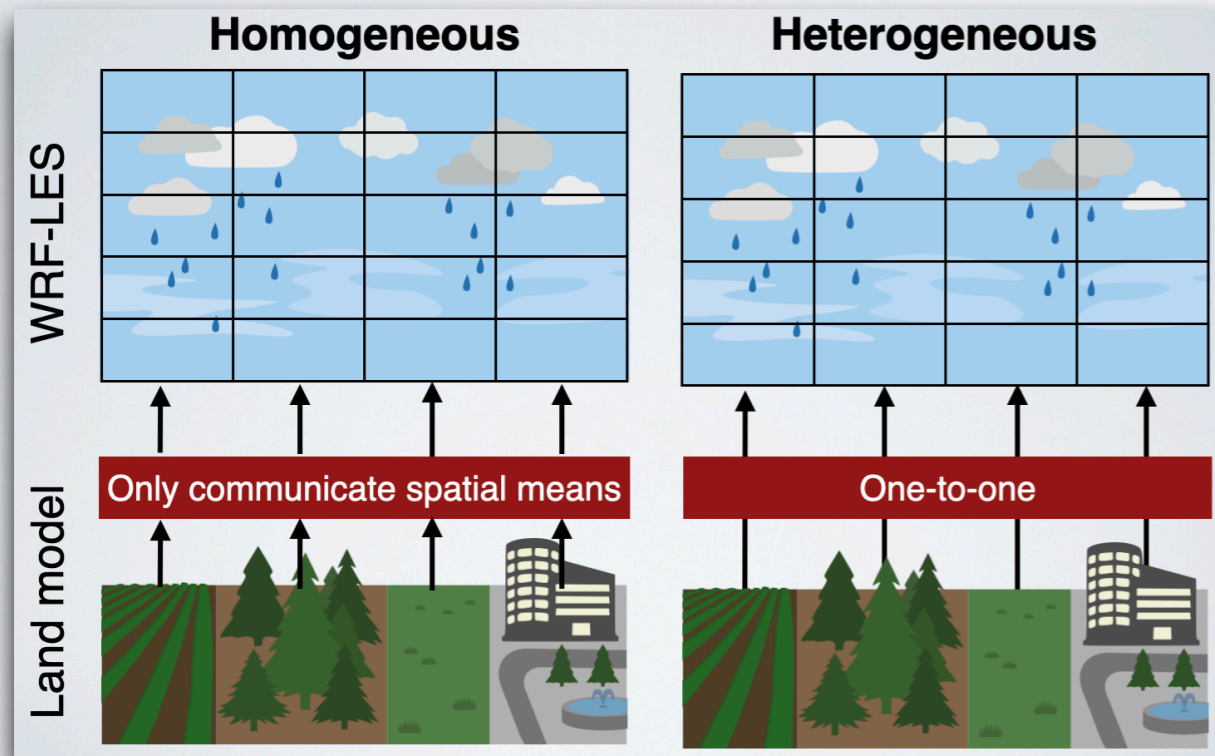


Participating
centers/models

- DOE - E3SM
- NCAR - CESM2
- NOAA - CM4
- NASA - GEOS

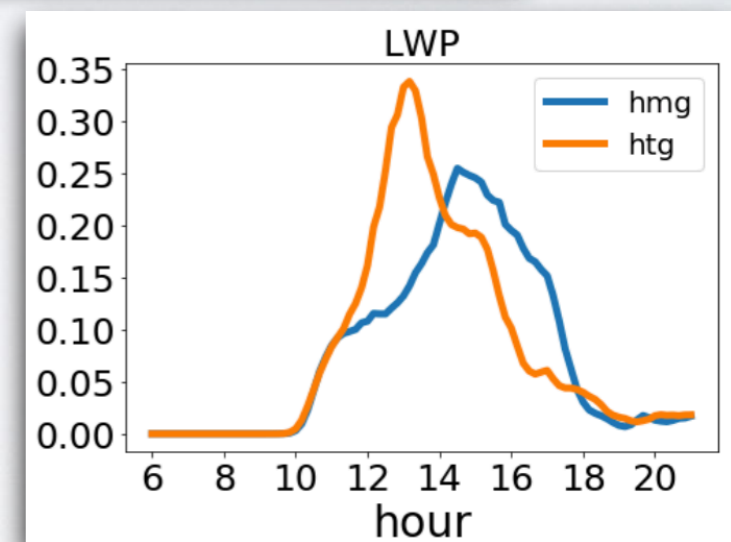
CLASP-LES highlight

Use LES coupled to a land model to determine when/how sub-grid heterogeneity matters in the atmospheric response

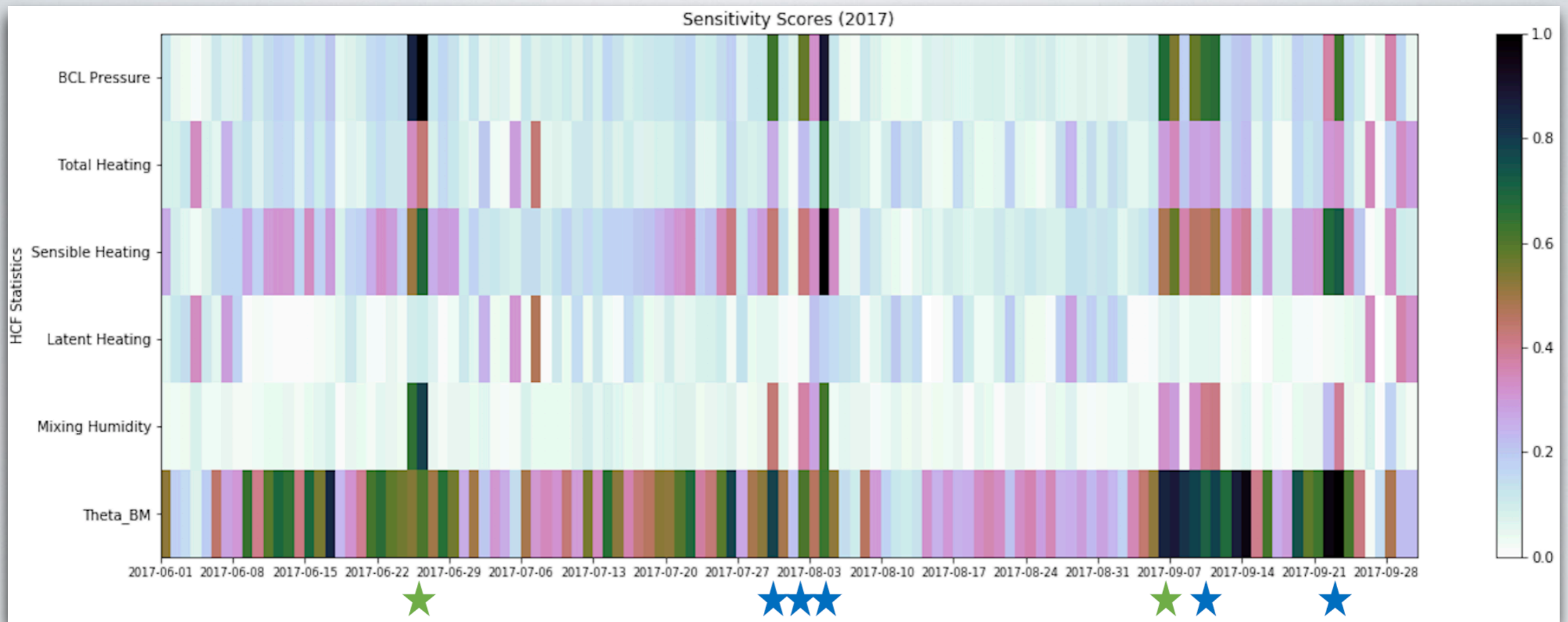


Large Eddy Simulations (LES) coupled to a high resolution land model with homogeneous vs. heterogeneous surface boundary over the ARM Southern Great Plains (SGP) site leveraging the data and model from the DOE LASSO project

- Chaney, N., et al. (2020), *Two-way coupling between the sub-grid land surface and river networks in Earth system models*, Geophysical Model Development, In review.
- Simon, J., et al. (2020), *Semi-coupling of a field-scale resolving land surface model and WRF-LES to investigate the influence of land surface heterogeneity in cloud development*, JAMES, In preparation.



CLASP-Diagnostics highlight

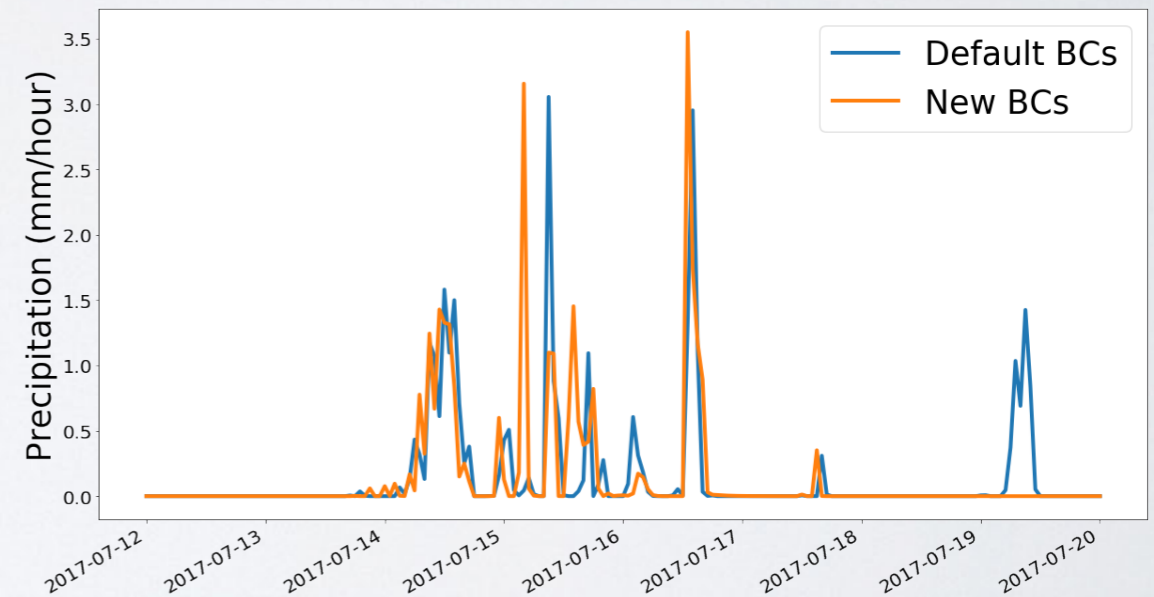
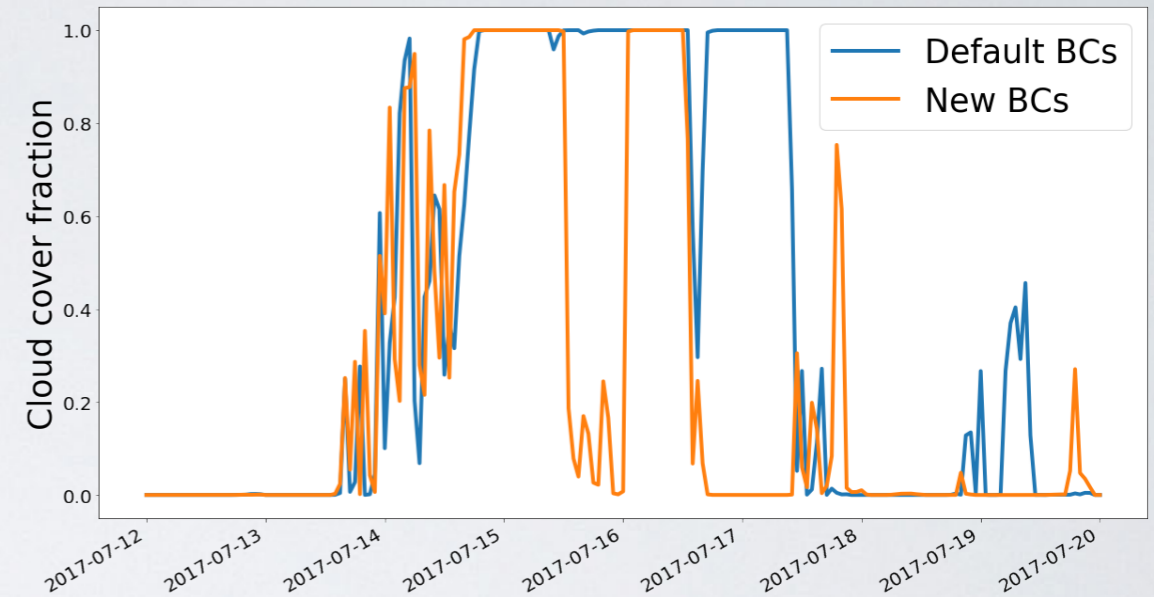
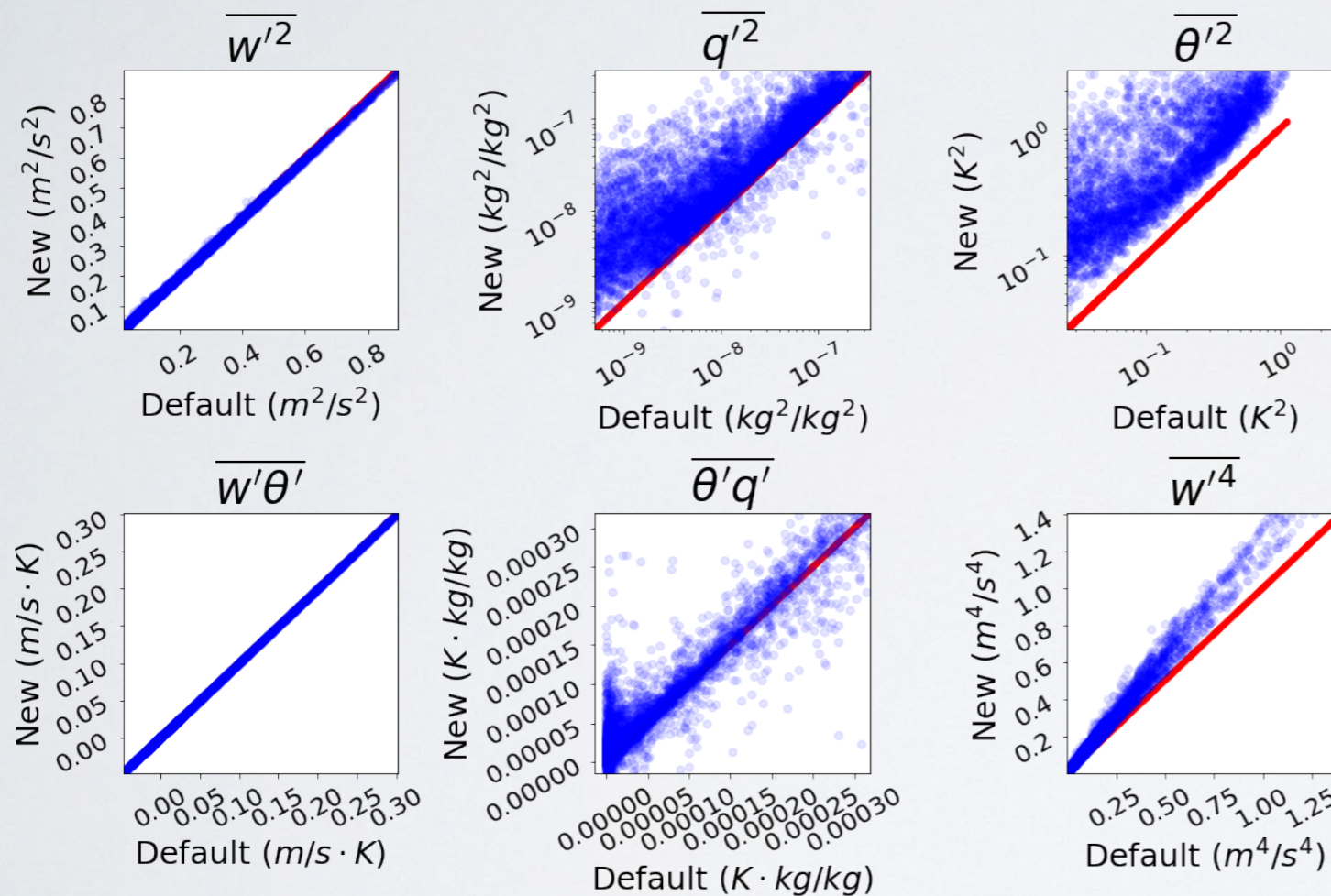


Create new diagnostics to determine when sub-grid heterogeneity plays a role in the macroscale response. Collaborating with CLASP-LES to tune the metric.

- Hay-Chapman, F. et al. (2021), *Diagnosing Sensitive Land-Atmosphere Coupling Days and Investigating the Impact of Land Surface Heterogeneity on the Overlying Atmosphere*, 2021 AMS annual meeting.

CLASP-Parameterization highlight

Leverage LES experiments and NEON eddy covariance data to parameterize the role of sub-grid land heterogeneity in CLUBB surface boundary conditions



- Waterman, T. et al. (2020), *Parameterizing Variance of Temperature Fluctuations Over Heterogeneous Landcover for Surface Boundary Conditions in Atmospheric Models*, *Boundary Layer Meteorology*, In preparation.
- Cai, J., et al. (2020), *Using Landsat-8 and ECOSTRESS land surface temperature to parameterize sub-grid tiling schemes and enable tile-level calibration of land surface models*, AGU Fall meeting.

CLASP Climate Process Team



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