Distributed Land in the SP-CESM

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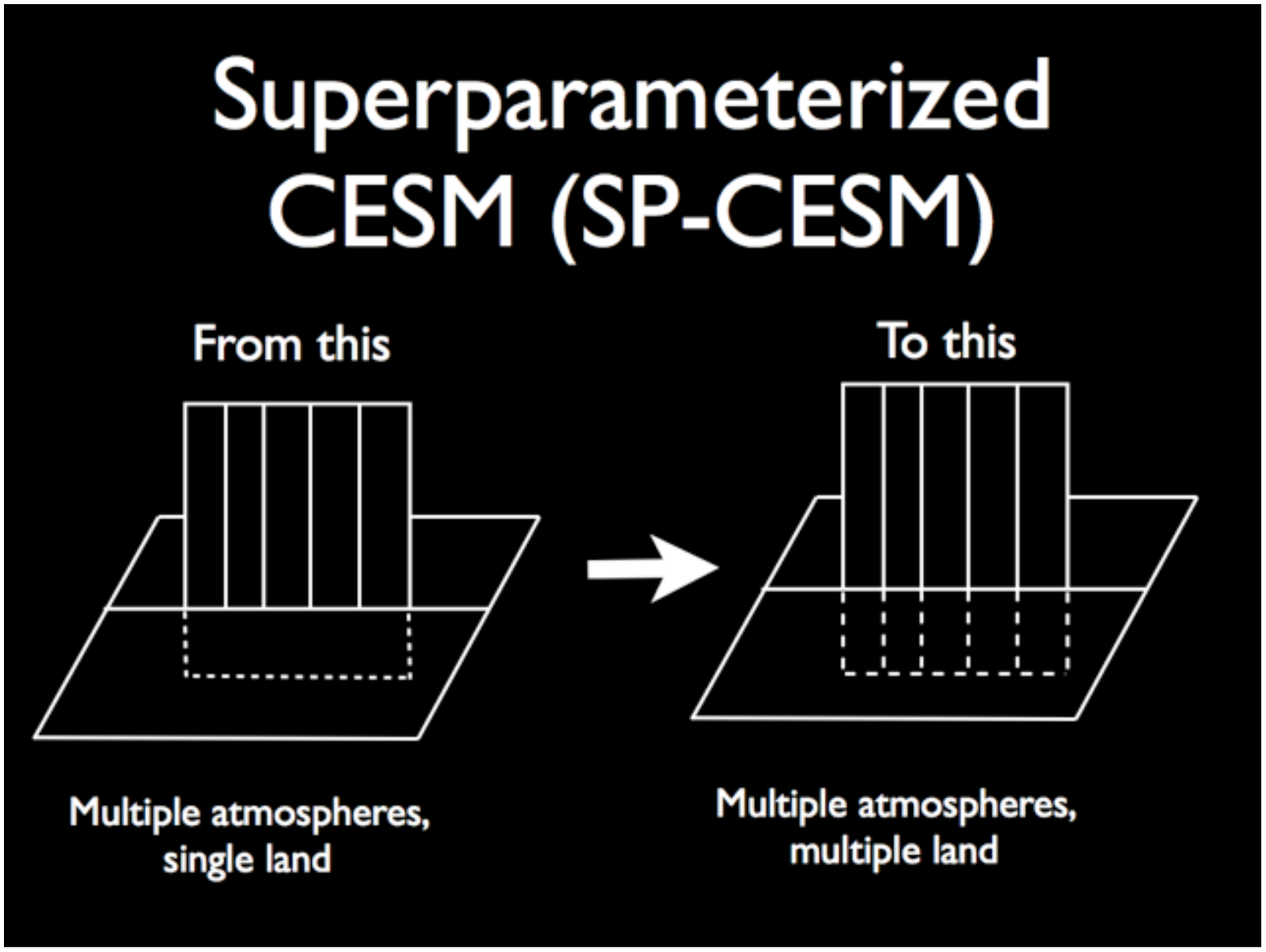
Superparameterized
CESM (SP-CESM)
From this
To this
Multiple atmospheres,
single land
Multiple atmospheres,
multiple land

Multi-Instance Functionality in the CESM

- CESM1.1 includes new capability to run multiple component instances under one model executable
- **Caveat:** if N multiple instances of any one active component is used then N multiple instances of **ALL** active components are required
- Primary motivation: Ability to run an ensemble kalman filter for data assimilation and parameter estimation.
- Also provides ability to run a set of experiments within a single CESM executable (each instance can have a different namelist)

Multiple Component Instances in the SPCESM

- Extend multi-instance capability to couple each cloud-resolving model (CRM) column with a unique land grid cell
  - **Trick in env_mach_pes.xml:** Set NINST_ATM=NINST_LND (= # of CRMS) but set NINST_ATM_LAYOUT to “sequential” instead of “concurrent”
- One instance of CAM running, but the coupler will think there are as many instances as cloud columns per grid cell

Software Engineering

- Add **inst_index** component to coupler variables: sensible and latent heat fluxes, albedos, surface upward longwave flux, etc.
  - cam_in%shf(ncols) becomes cam_in%shf(ncols,inst_index) in coupler code
  - cam_in%shf(ncols) becomes cam_in%shf(ncols,crm_nx) in CAM code
    - Do this **everywhere** they are found!!!

Software Engineering (2)

- Pass CRM-level variables through coupler to CLM:
  - Lowest layer: T, U, V, q, z, rho, theta
  - Rain and snow
  - Radiation: surface downward LW, sfc net SW, etc.
- **Turn the CRM-level v winds back on!**

Software Engineering (3)

- Get single column version working (SCAM)
  - regular SCAM works
  - non-multi-instance SP-SCAM works
  - multi-instance SP-SCAM not quite working

Multi-instance SP-SCAM

- Challenge: SCAM is compiled as a serial job
- But we need to run it as parallel job to use the multi-instance functionality
- Although it's overkill, there's no reason that SCAM can't be run as a parallel job
- Problem: Parallel decomposition is normally dependent on the grid size, but for SCAM we have plat=1

Latent Heat Flux Standard Deviation

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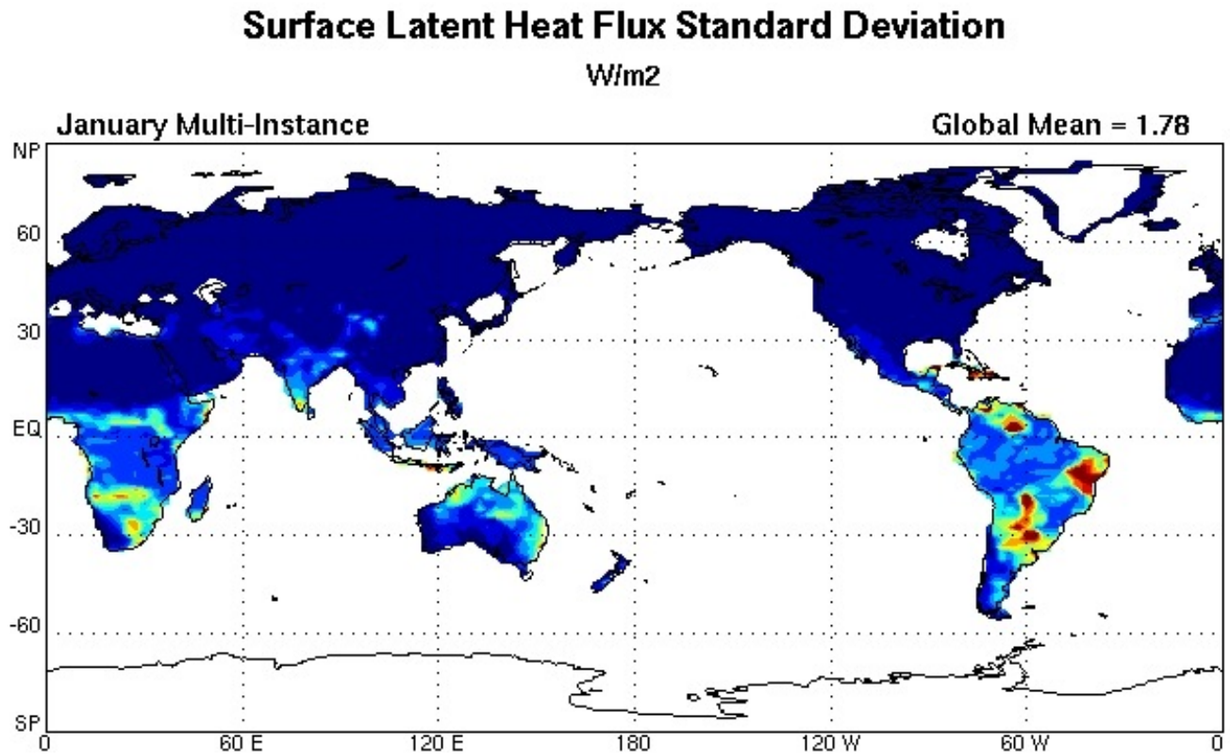

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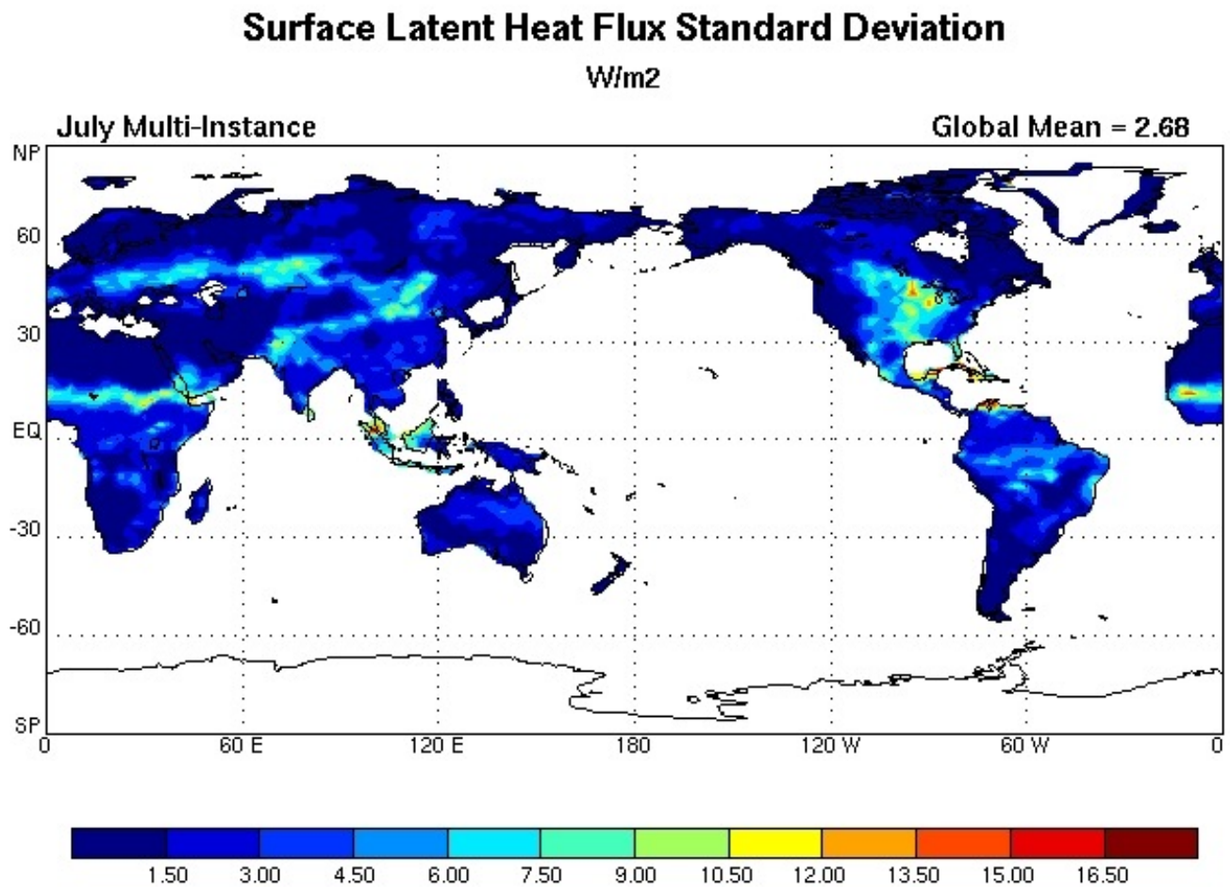

Sensible Heat Flux Standard Deviation

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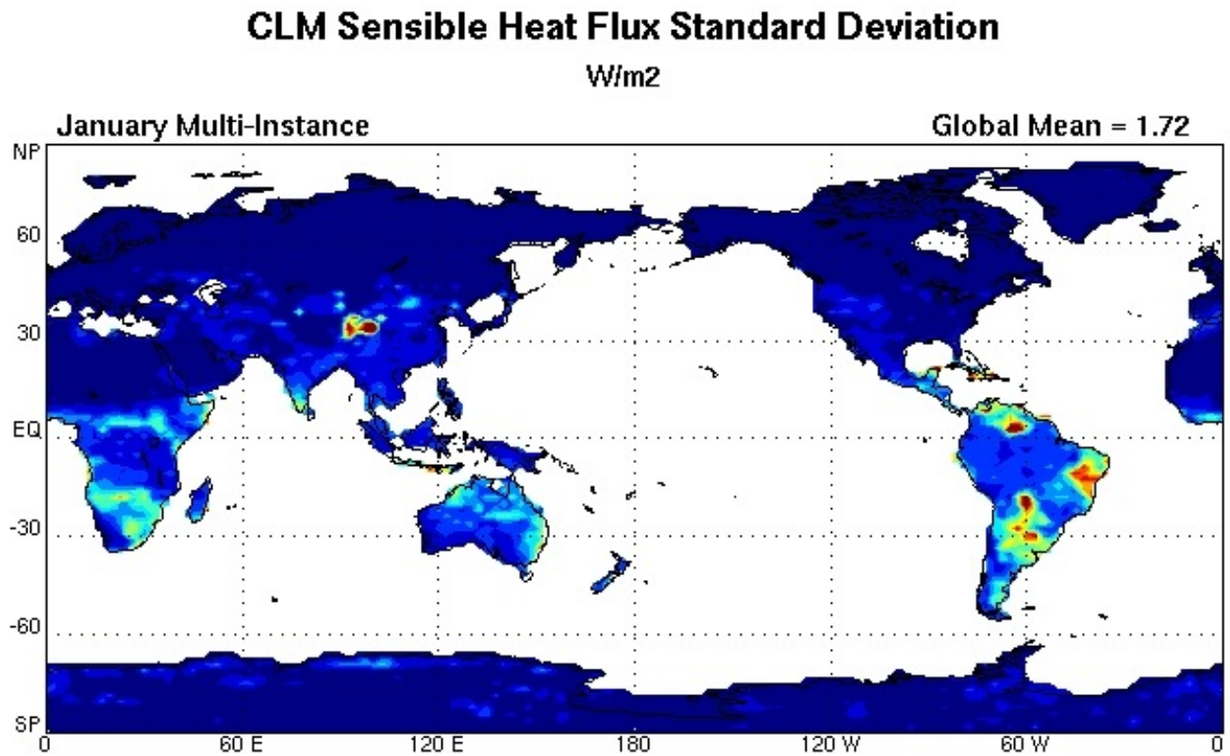

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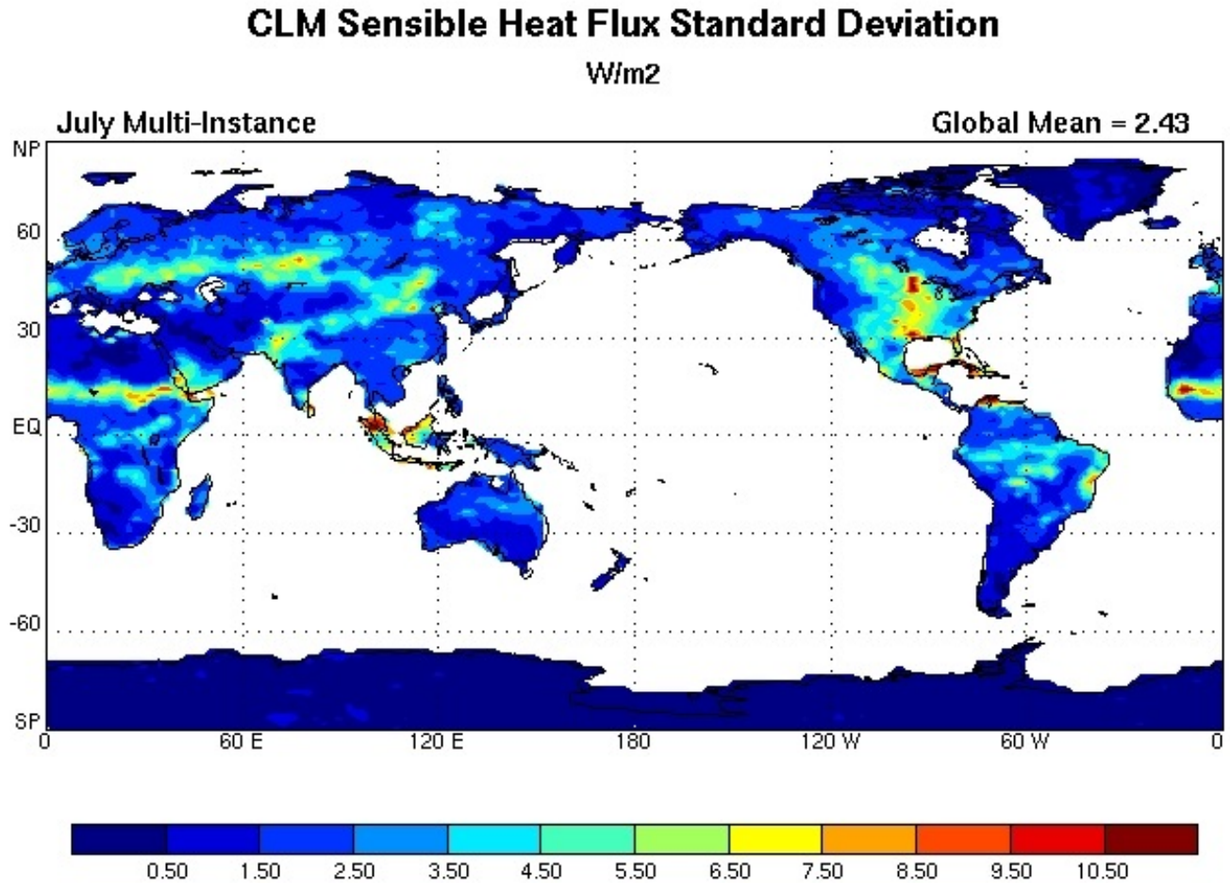

Precipitation Rate Standard Deviation

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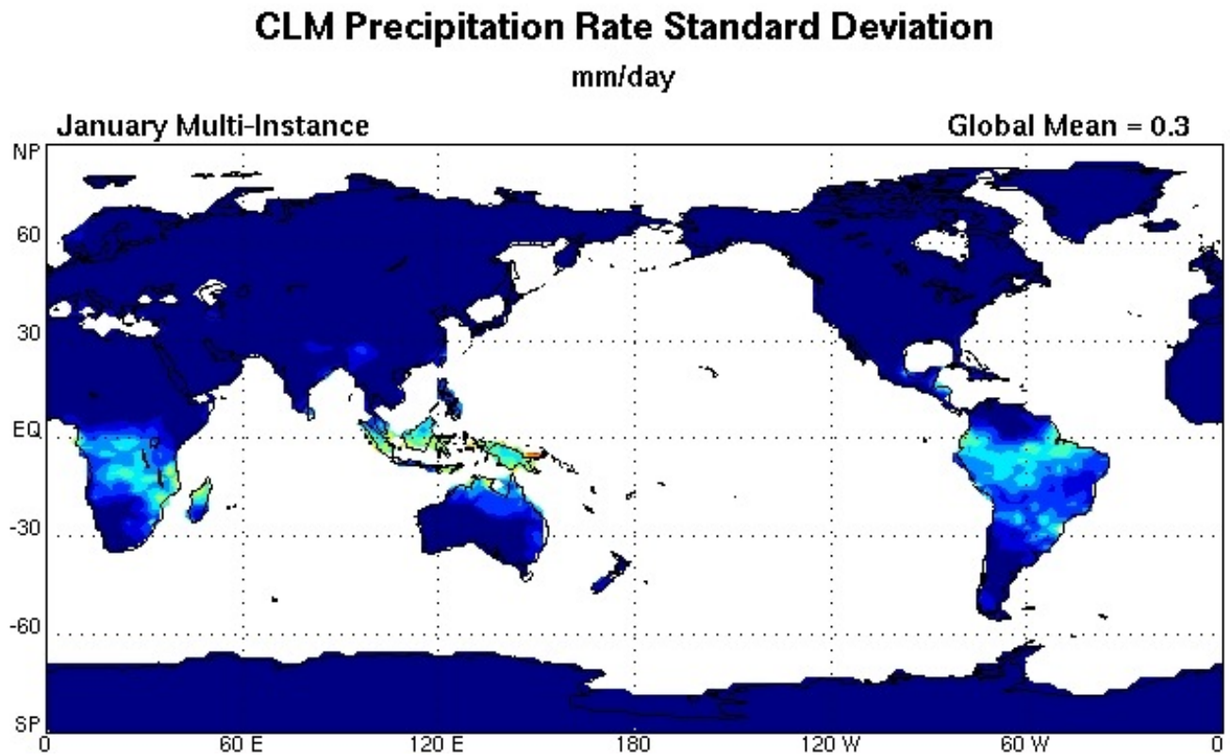

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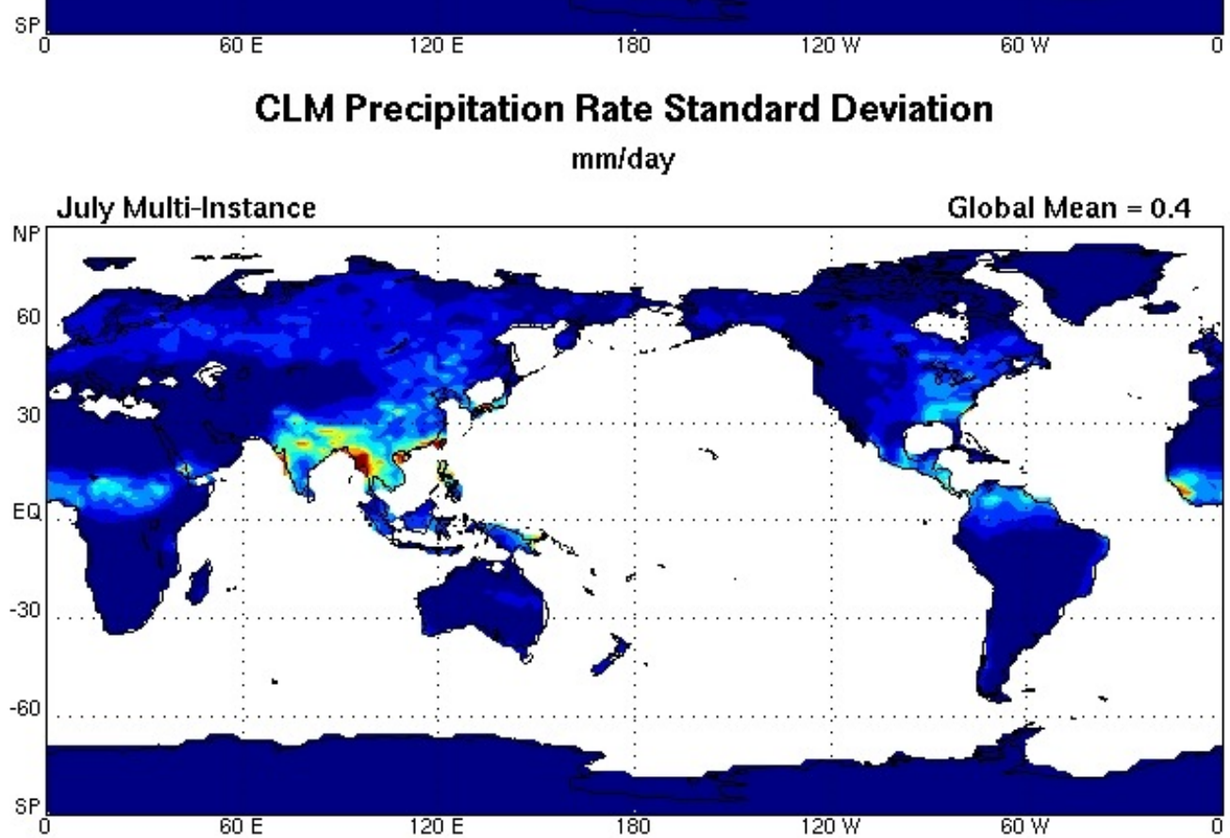

Soil Water Standard Deviation

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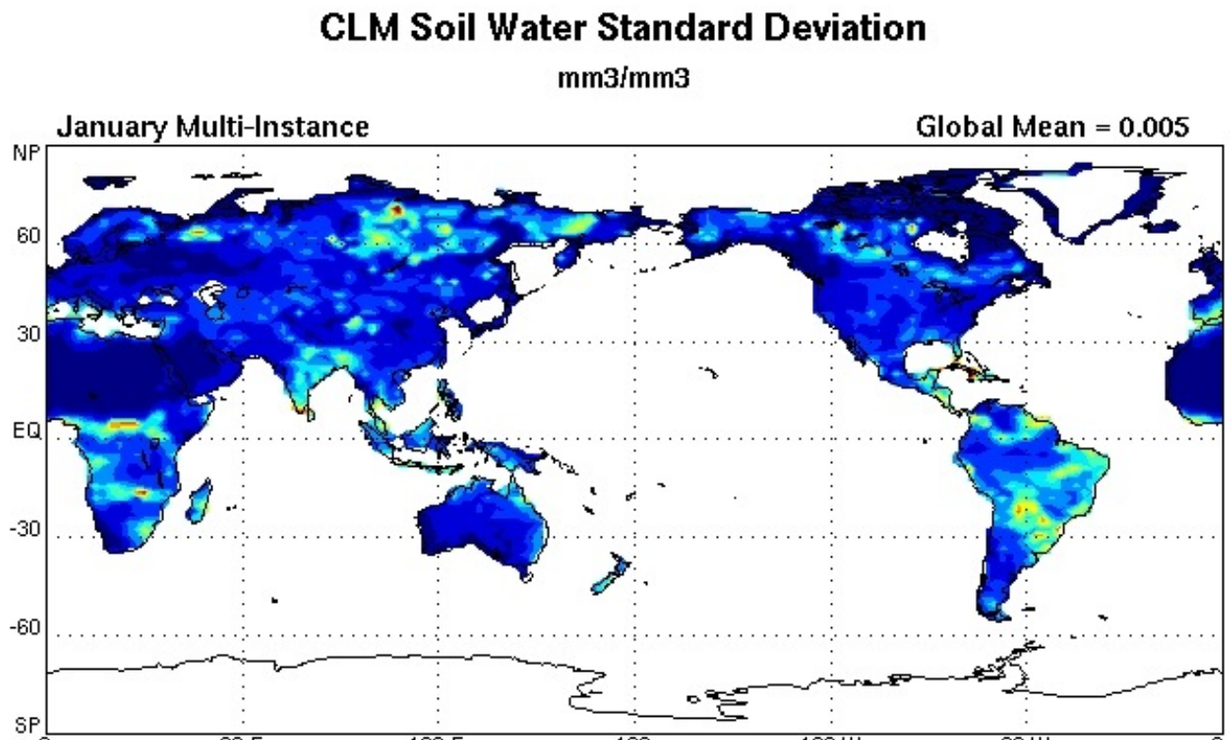

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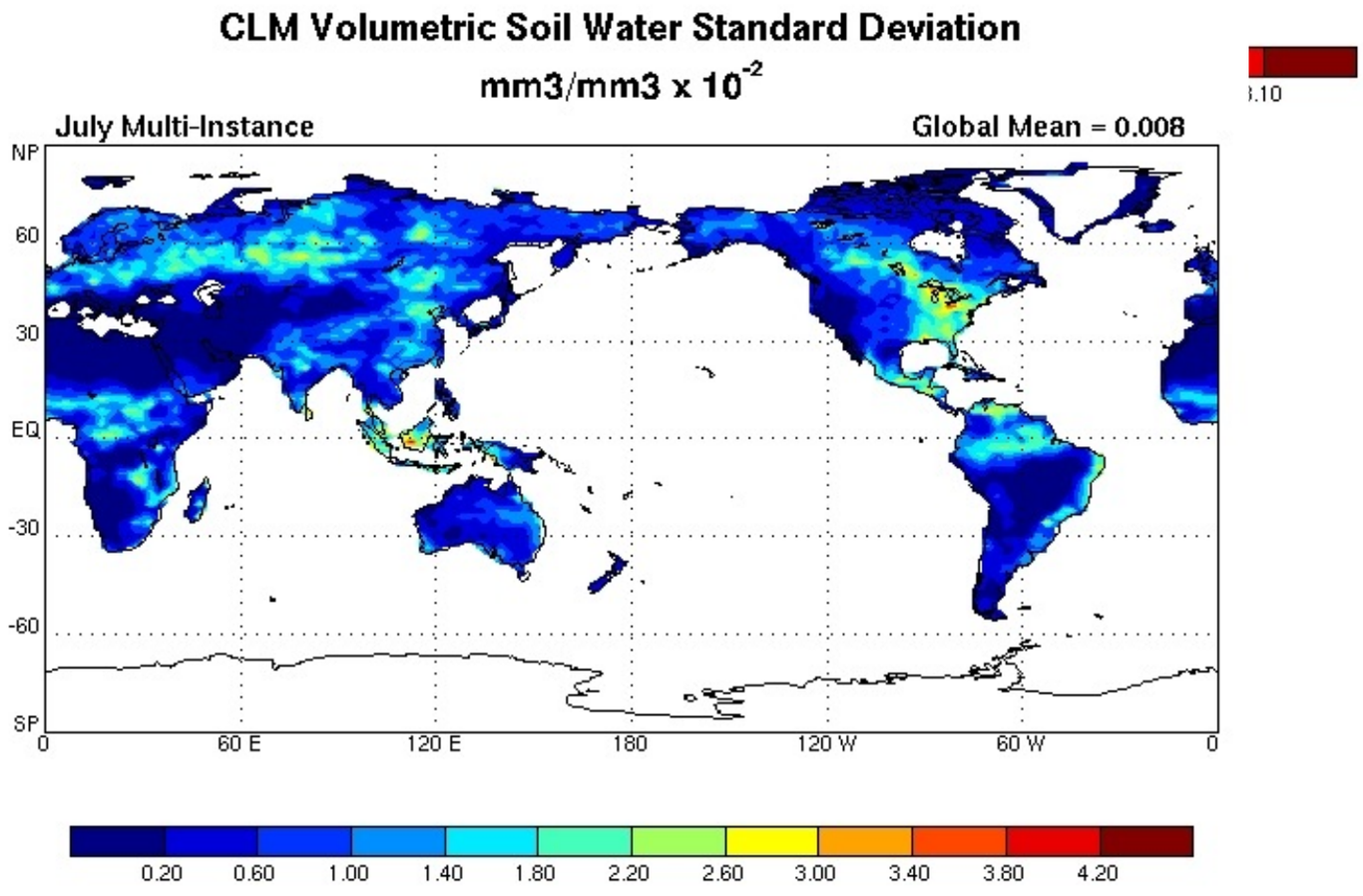

Going Forward

- Explore spatial heterogeneity within the CRM framework
- Incorporate tracer (CO2, OCS, isotopes?) fluxes
- Run a fully-coupled simulation: How to handle enormous ocean history files for all instances