Unifying land modeling across NCAR:
The Community Terrestrial System Model (CTSM)

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The interdisciplinary evolution of land models

Land as a lower boundary to the atmosphere → **Land as an integral component of the Earth System**

Focus on land-atmosphere energy fluxes

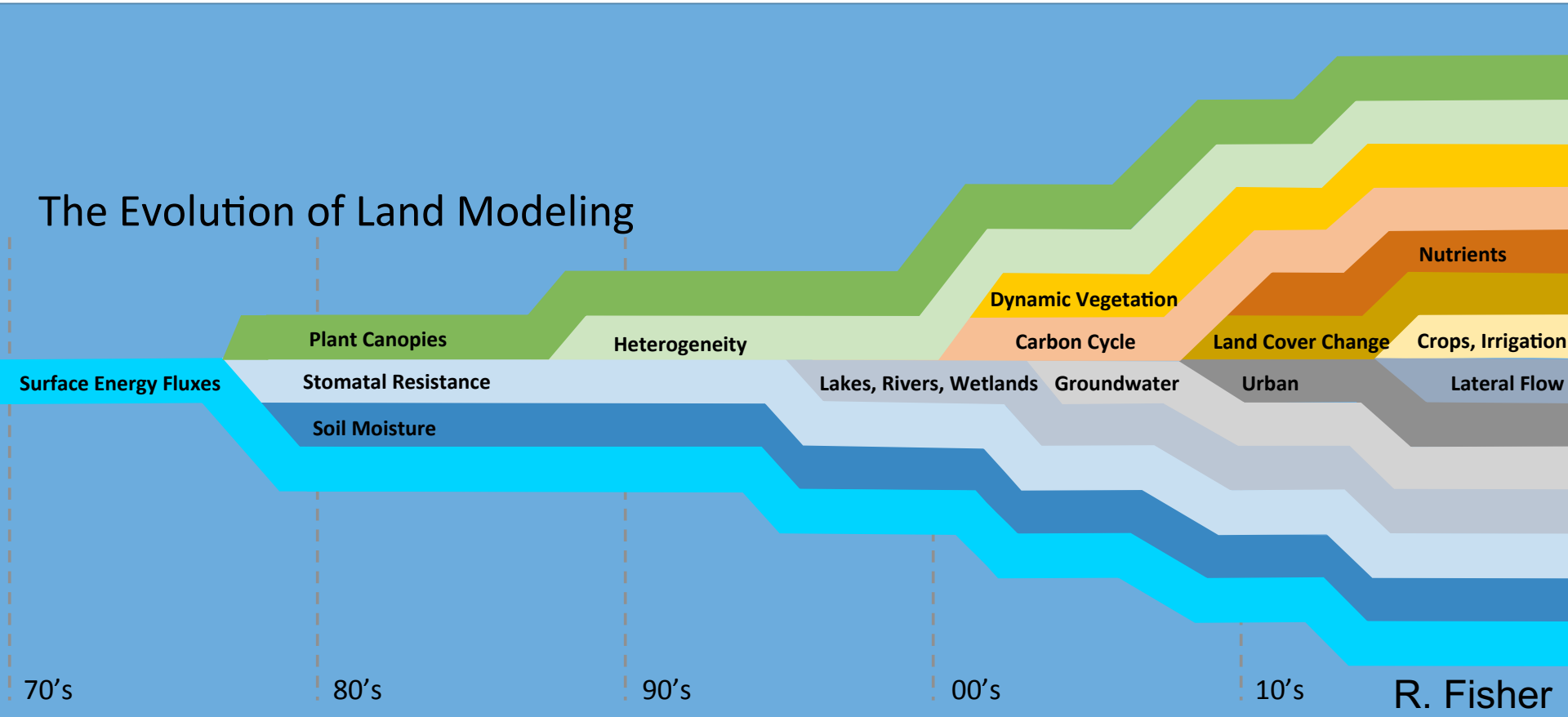
Limited representation of land processes & feedbacks

→ *Mechanistic modeling of land processes*

Properties define processes (focus on short-term fluxes)

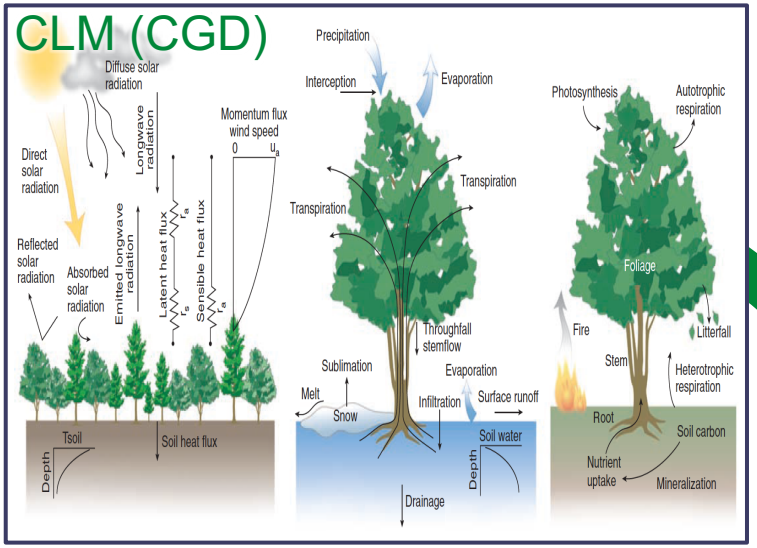
→ *Simulate the dynamics of change (e.g., dynamic vegetation)*

Processes define properties (feedbacks and interactions across time scales)

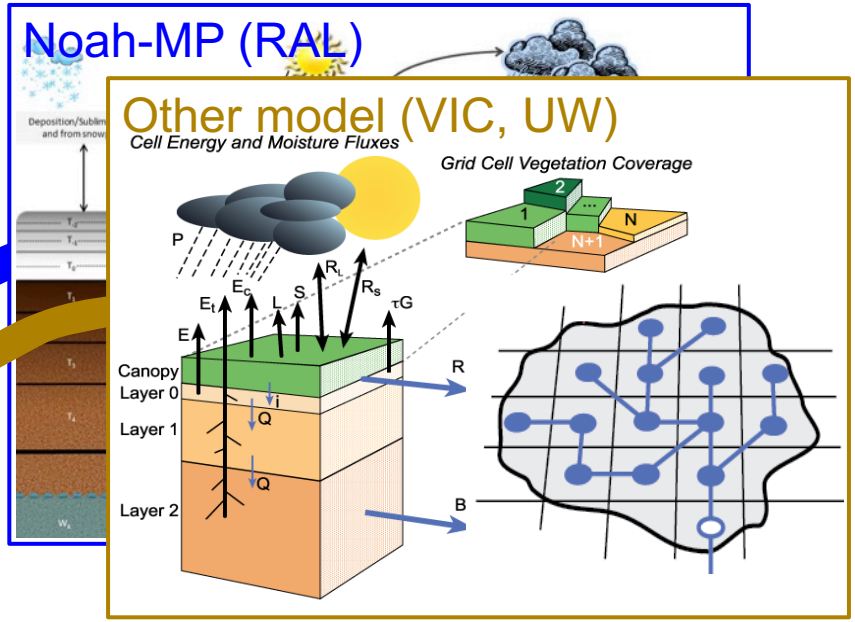


The Community Terrestrial Systems Model

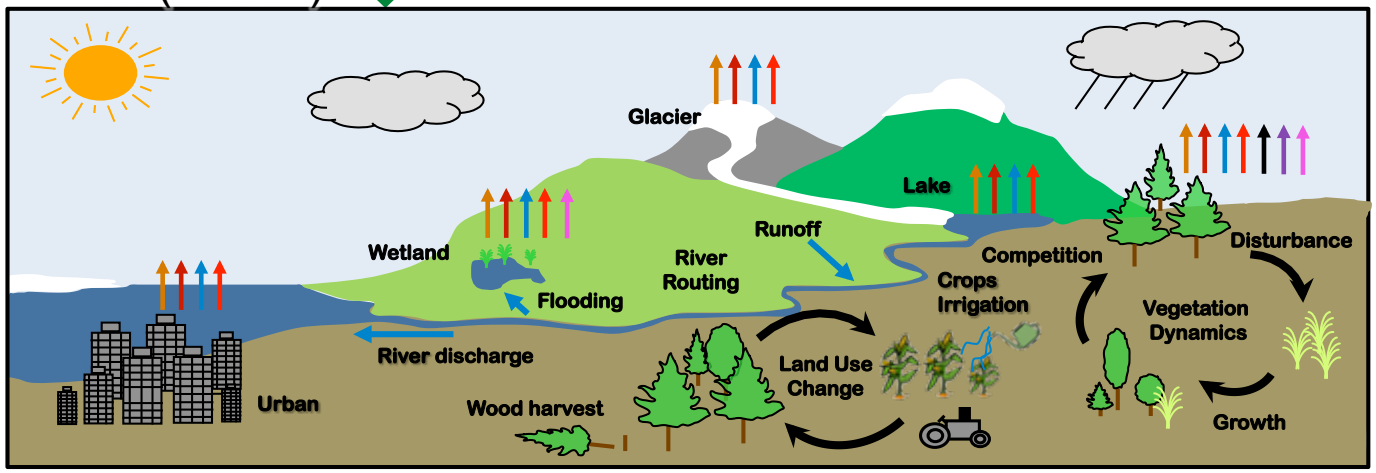
NCAR UCAR



unified SUMMA -based design



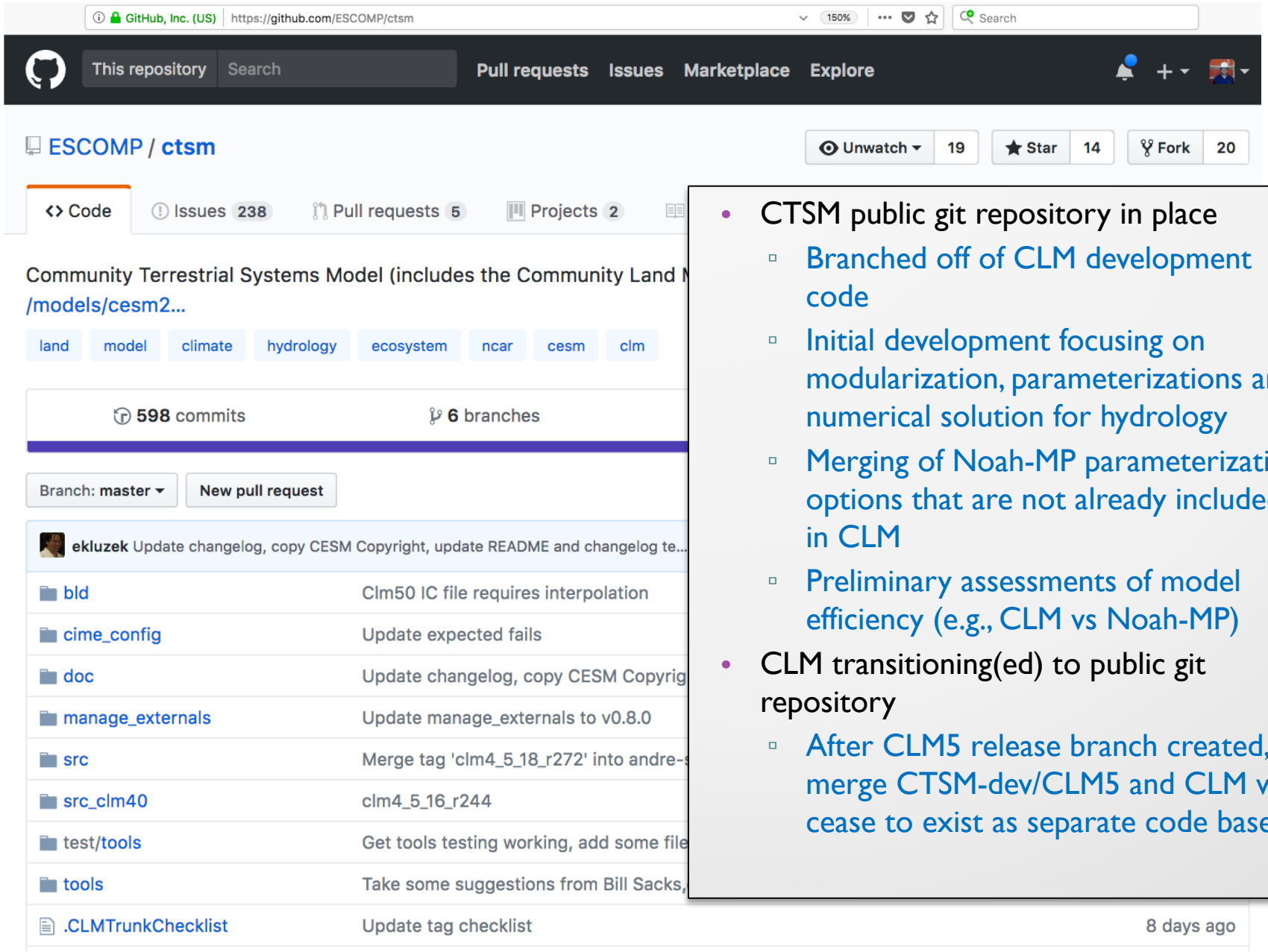
CTSM (NCAR)



A community effort to unify and simplify the terrestrial components of an Earth System prediction framework.

for research and prediction in climate, weather, water, and ecosystems

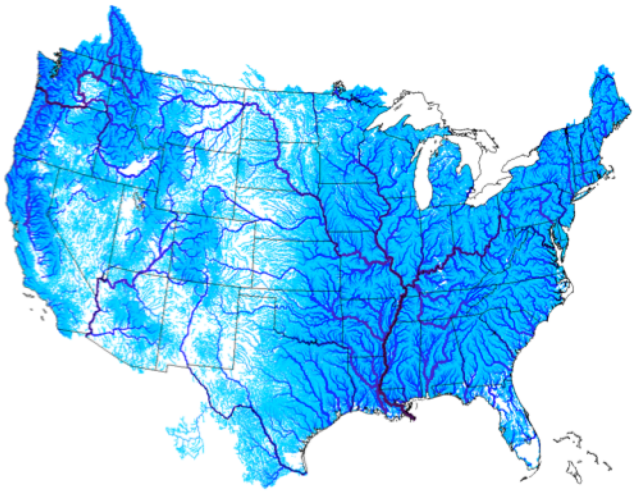
CTSM is now public

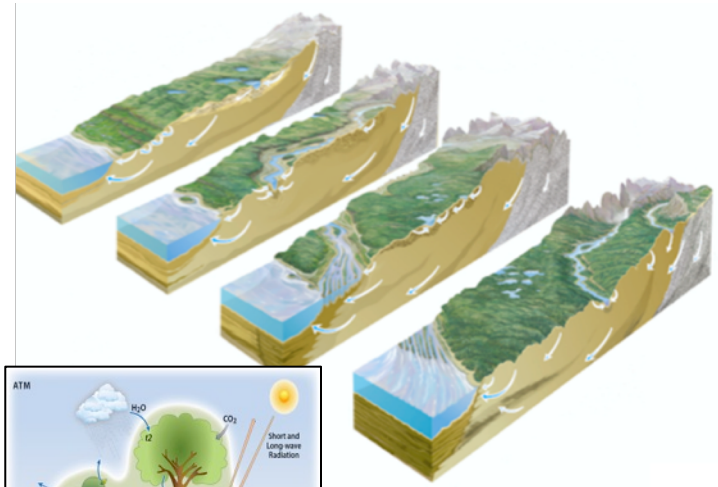


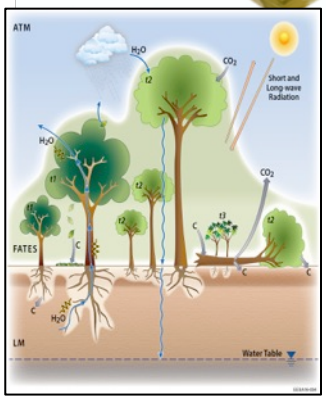
- CTSM public git repository in place
  - Branched off of CLM development code
  - Initial development focusing on modularization, parameterizations and numerical solution for hydrology
  - Merging of Noah-MP parameterization options that are not already included in CLM
  - Preliminary assessments of model efficiency (e.g., CLM vs Noah-MP)
- CLM transitioning(ed) to public git repository
  - After CLM5 release branch created, merge CTSM-dev/CLM5 and CLM will cease to exist as separate code base

Key opportunities

- Integrate land modeling expertise across NCAR
  - Land-atmosphere interactions, hydrologic prediction, water and land management, data assimilation, model analysis
  - Monthly NCAR-wide science discussions
- Simplify incorporating new capabilities in land models
  - Modular structure and separating physics from numerics reduces the in-person cost of modifying CTSM, a cost borne by NCAR scientists and software engineers and university collaborators

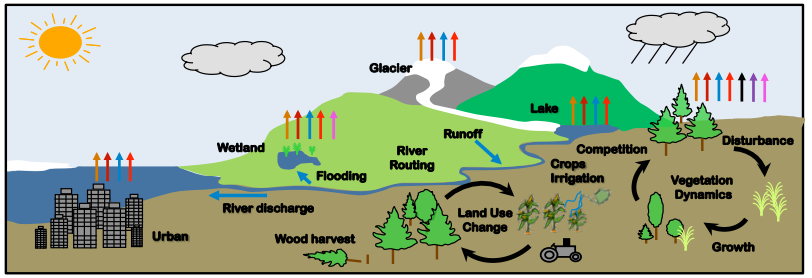




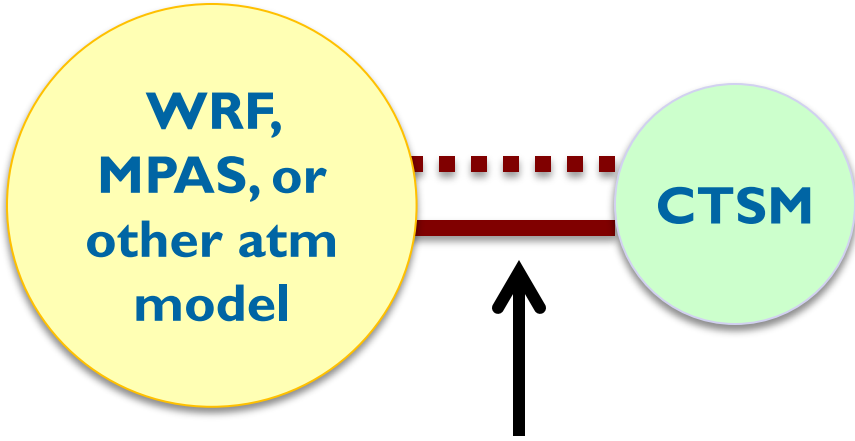


Key challenges

- Parallel development
  - Existing models currently used across multiple projects
  - Initially the effort is diffuse (e.g., individuals developing code for both Noah-MP and CTSM)

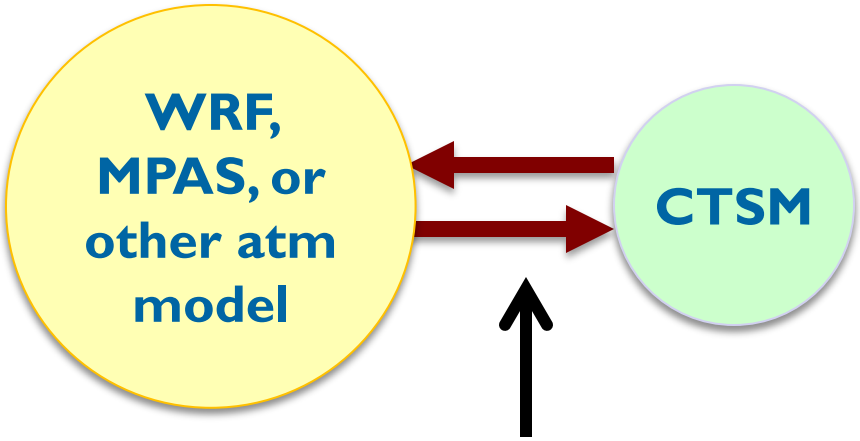


- Diverse Modeling Problems
  - Climate needs vs. NWP needs
  - Land coupling with other components
- Modularity/coupling
  - Support contributions at multiple levels of granularity
  - Community standards for model construction, to simplify sharing code/concepts across model development groups
  - Simplify coupling/ease of use across multiple communities



LILAC
Lightweight Infrastructure for Land-Atmosphere Coupling
Funded NSF Infrastructure project

Coupling – One Potential Vision



- Coupling with LILAC
  - From the ATM model perspective, CTSM will exist as a library
  - LILAC will act as an interface between the ATM and CTSM
  - Called from within ATM, e.g., WRF surface_driver
  - Only fields provided or needed by the ATM are passed through LILAC
  - Initially, LILAC will run on the same processors as ATM
  - CTSM processor decomposition handled by CTSM/LILAC, differ from ATM
  - Output fields, CTSM I/O handled within CTSM
  - LILAC is evolving; if you have suggestions, we would like to hear them


THANKS!