# The SMAP Level-4 ECO Project: Improving terrestrial flux estimates through coupled hydrology-vegetation data assimilation

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(3) Science Systems and Applications

# The SMAP Level-4 ECO project

Objective: Develop a fully coupled hydrology-vegetation data assimilation algorithm to generate improved estimates of hydrological fields and carbon fluxes

## L4 Soil Moisture:

Assimilate SMAP observations into a land surface hydrology model to generate improved soil moisture estimates

## L4 Carbon:

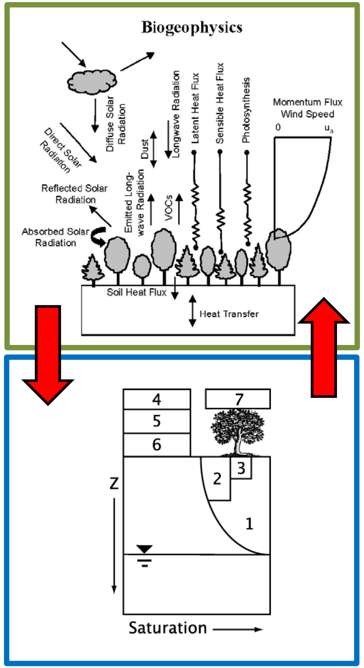
Use L4 SM estimates and MODIS fraction of absorbed photosynthetically active (FPAR) observations in carbon model to estimate carbon fluxes

# The L4-ECO project

## Catchment-CN:

- Coupled land surface hydrology model (Catchment) and dynamic vegetation model (CLM4) to allow full feedback

Catchment-CN (*Koster et al., 2014*)




CLM4 dynamic vegetation model (*Oleson et al., 2010; Thornton et al., 2007*)

Catchment land surface model (*Koster et al., 2000; Ducharne et al., 2000*)

# The L4-ECO project

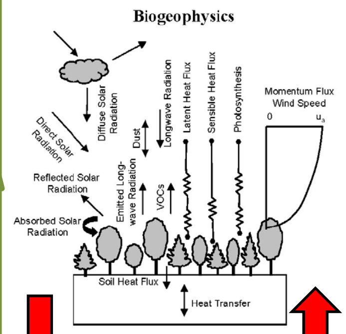
Catchment-CN (*Koster et al., 2014*)

## Catchment-CN:

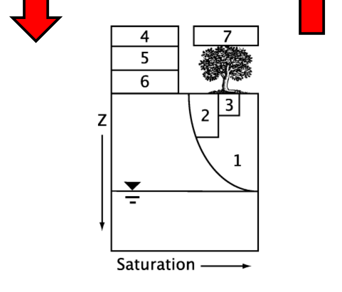
- Coupled land surface hydrology model (Catchment) and dynamic vegetation model (CLM4) to allow full feedback

- Assimilate:
  - MODIS fraction of absorbed photosynthetically active radiation (FPAR)
  - SMAP brightness temperatures (Tbs)

Generate improved estimates of hydrological fields and surface fluxes (water, energy, carbon)




CLM4 dynamic vegetation model (*Oleson et al., 2010; Thornton et al., 2007*)




Catchment land surface model (*Koster et al., 2000; Ducharne et al., 2000*)

# L4-ECO Project Outline

### (1) Calibrate Catchment -CN

- Use MODIS FPAR observations to estimate optimal vegetation parameters for Catchment-CN
- Obtain more realistic FPAR simulations

### (2) SM and FPAR assimilation

- Jointly assimilate SMAP Tbs and MODIS FPAR observations into *calibrated* Catchment-CN
- Test OCO-2 SIF assimilation

### (3) Data generation

- Use fully coupled data assimilation system to generate improved estimates of hydrological fields and carbon fluxes

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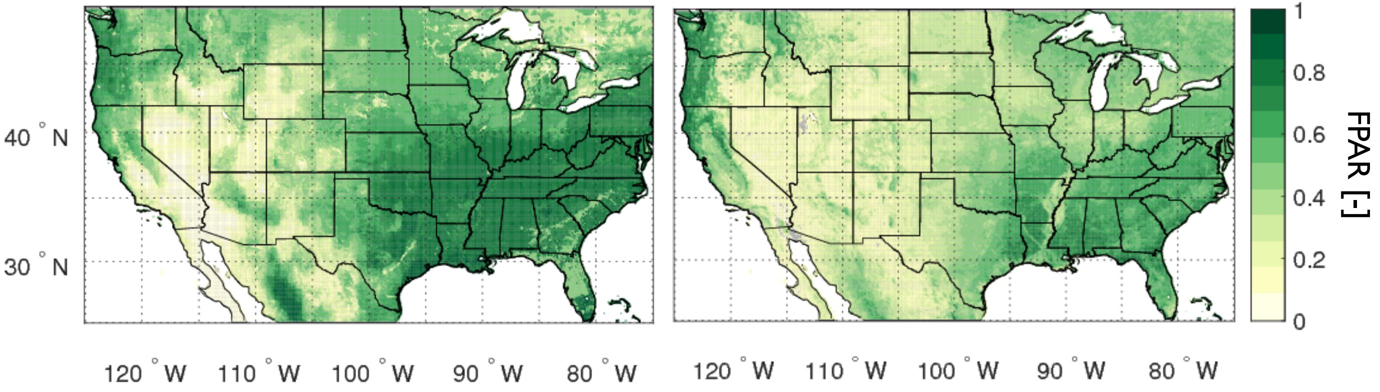
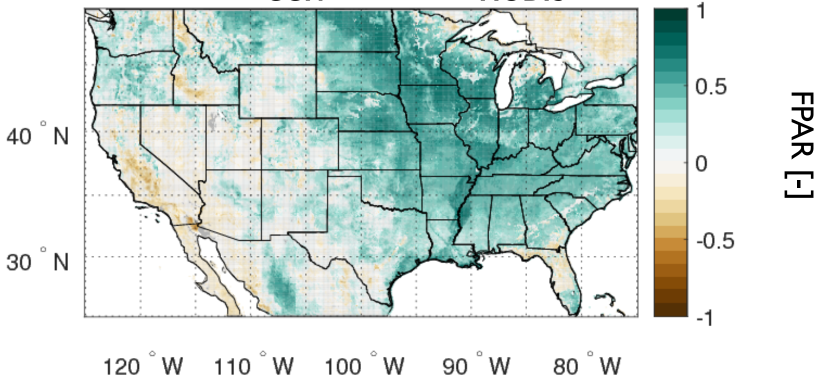
# Catchment-CN parameter estimation: Motivation

**Catchment-CN** **MODIS**




**$FPAR_{CCN}$ – $FPAR_{MODIS}$**

Mean FPAR Apr 2015 - Mar 2017



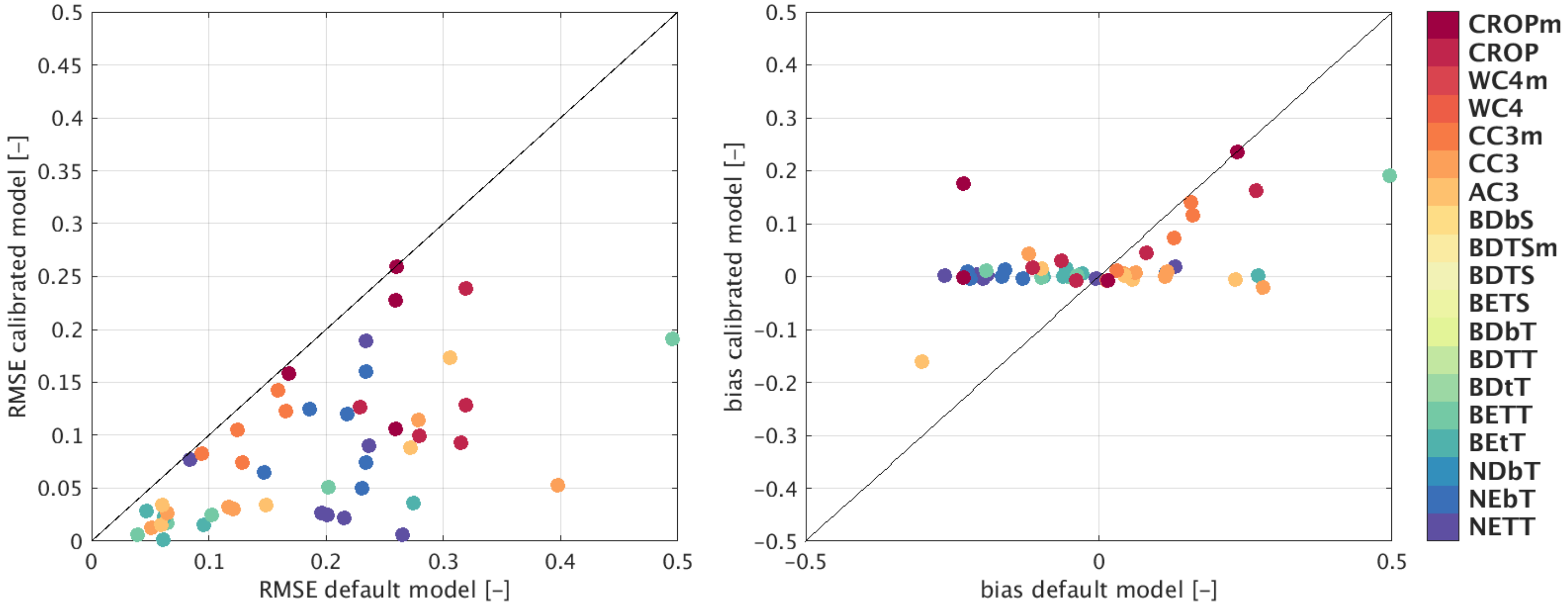
# Catchment-CN parameter estimation

Objective: Use MODIS FPAR observations to optimize Catchment-CN vegetation parameters

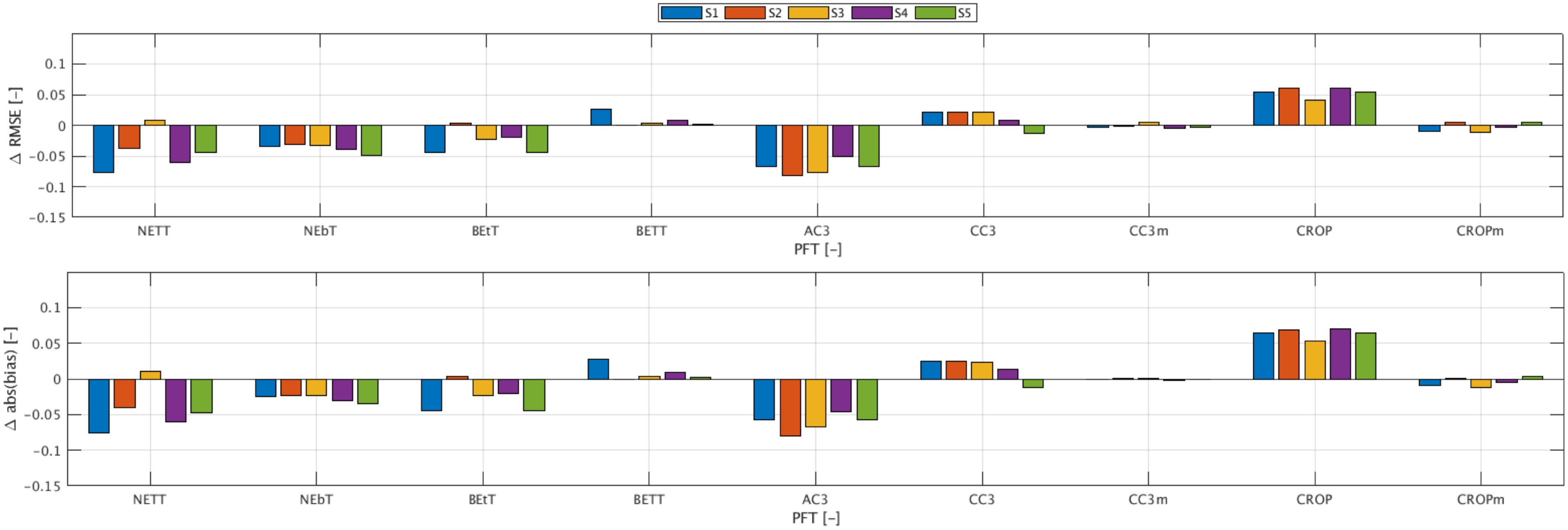
- Calibration parameters:
    - Timing
    - Photosynthetic efficiency
    - Carbon storage/allocation

- Calibration approach:
    - RMSE cost function
    - Particle swarm optimization -> ensemble error surface exploration
    - 10 optimization locations per Plant Functional Type (PFT)
    - use parameter set that works best across all sites

# Catchment-CN parameter estimation: optimization algorithm performance

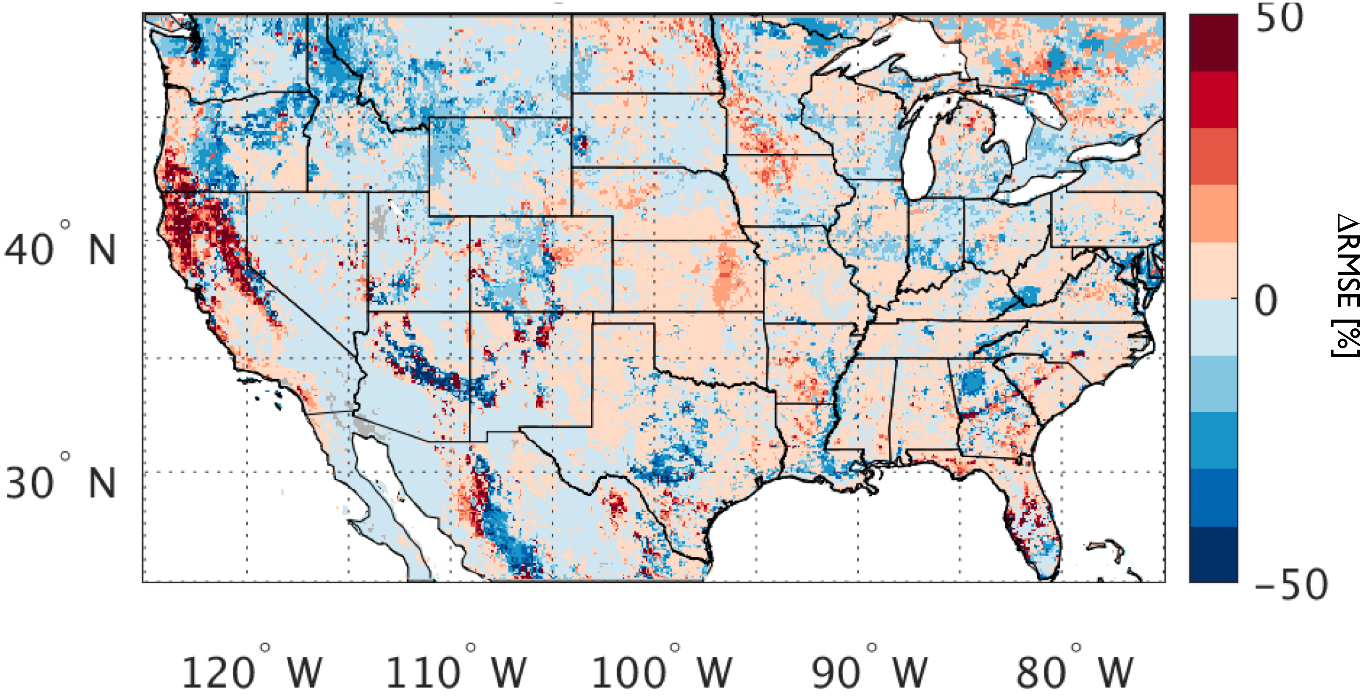


# Catchment-CN parameter estimation: parameter transferability



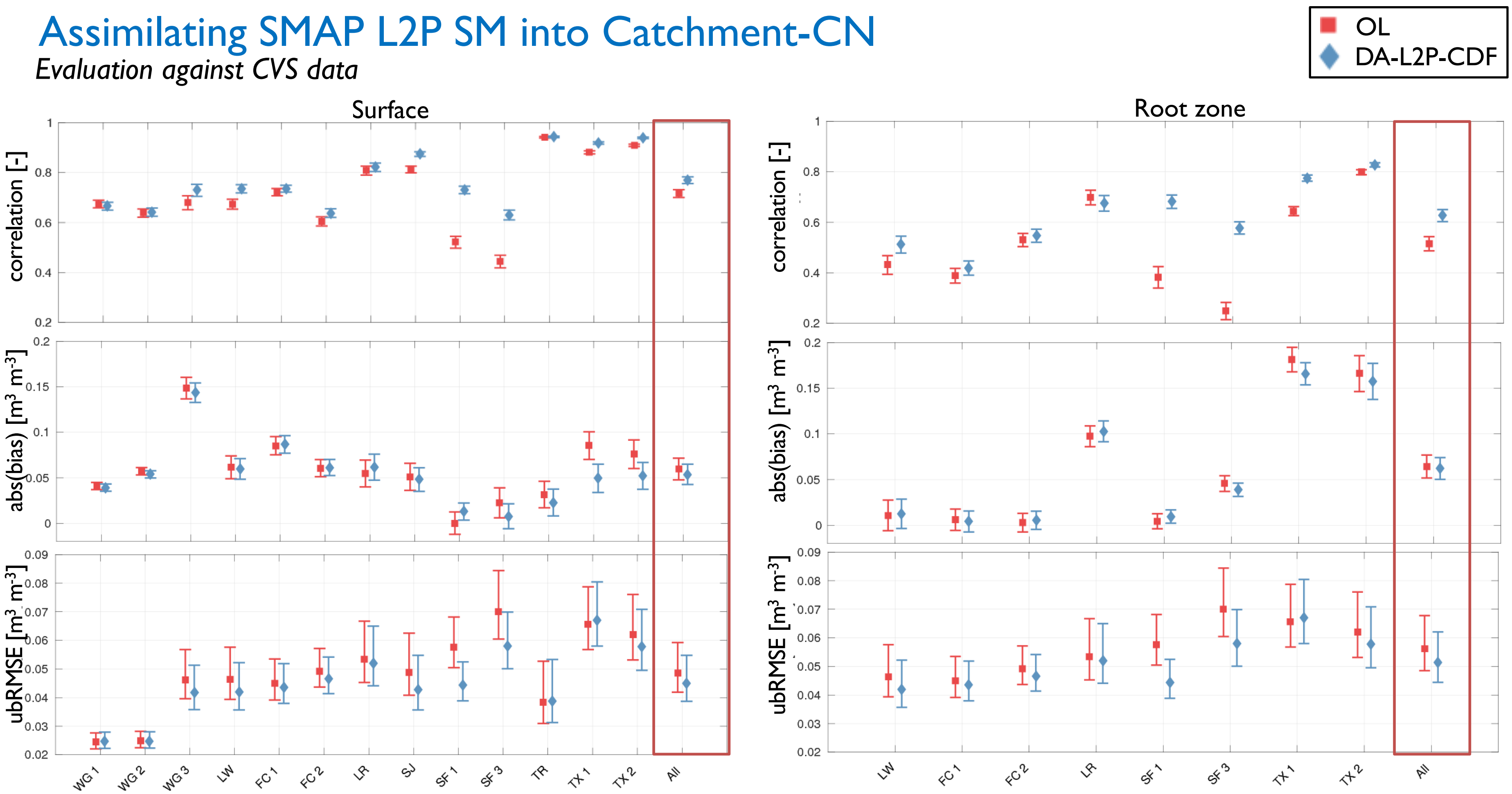
# Catchment-CN parameter estimation: regional performance

**RMSE (calibrated – uncalibrated): ΔRMSE= -5% in updated locations**



# Assimilating SMAP L2P SM into Catchment-CN

*Evaluation against CVS data*



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Thank you!

# References

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