Towards a Complex Terrain Carbon Monitoring System (CMS-Mountains): Development and Testing in the Western U.S.

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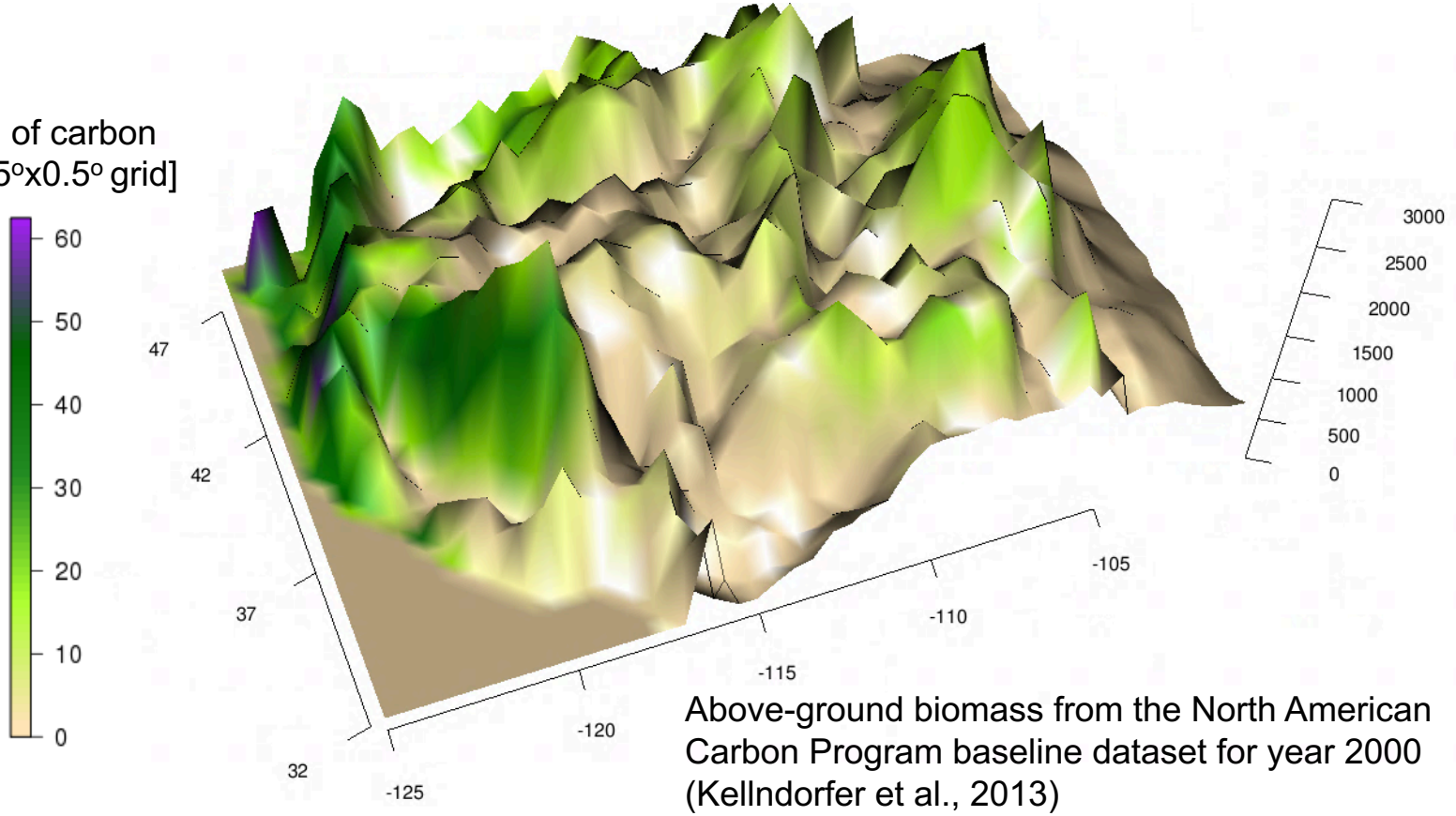
Collaborator: Charles Koven, Lawrence Berkeley National Laboratory

Atmospheric Validation Working Group Telecon: Feb. 22nd, 2017

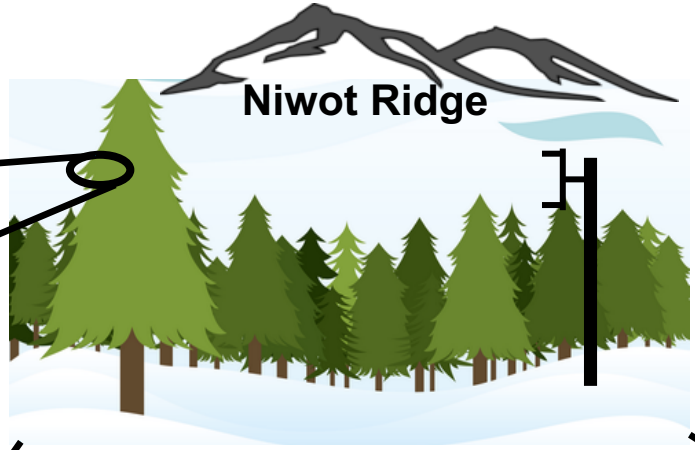
Above-ground Biomass in the Western U.S.

(based on another CMS project: PI Kellndorfer)

[Mton of carbon on 0.5°x0.5° grid]

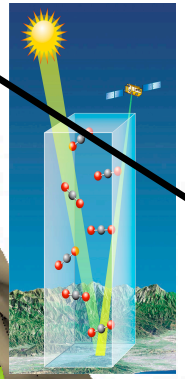


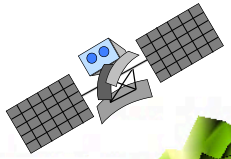
Above-ground biomass from the North American Carbon Program baseline dataset for year 2000 (Kellndorfer et al., 2013)



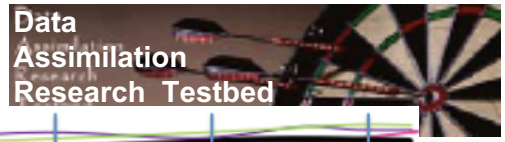
Solar-Induced Fluorescence (SIF)

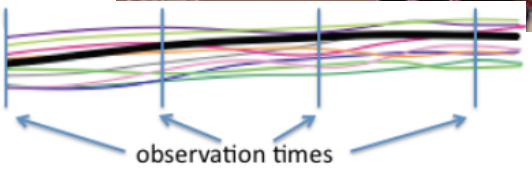
Orbiting Carbon Observatory (OCO-2)





Community Land Model (CLM)

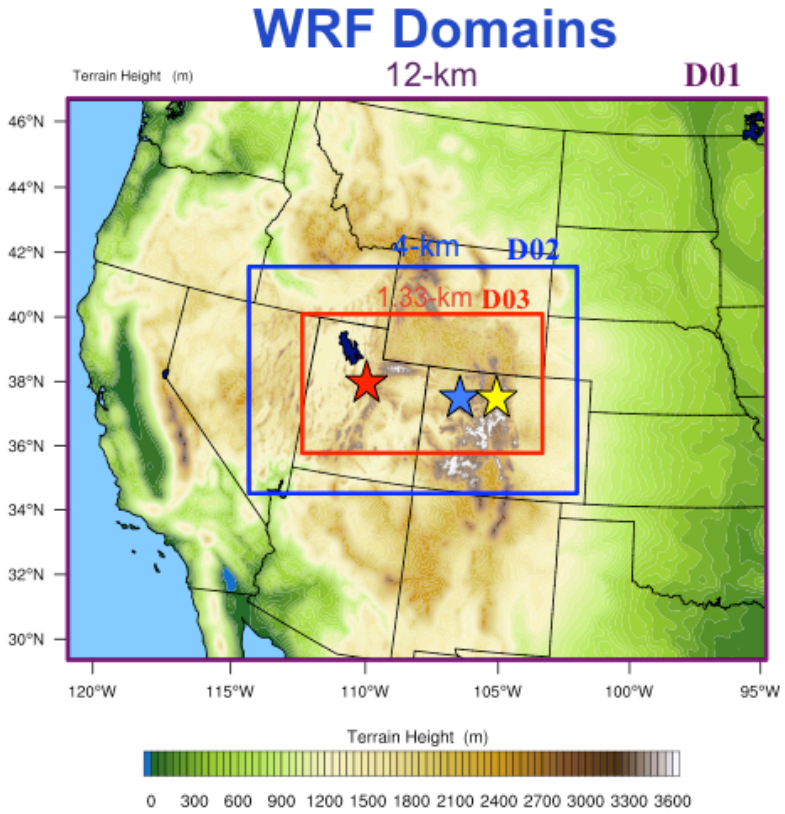




Simulation of atmospheric CO_2 at the Rocky RACCOON sites (B. Stephens, NCAR)

- WRF-STILT framework by Mallia et al. (2015) used as a starting point

Hidden Peak (HDP)
~ Salt Lake City, UT

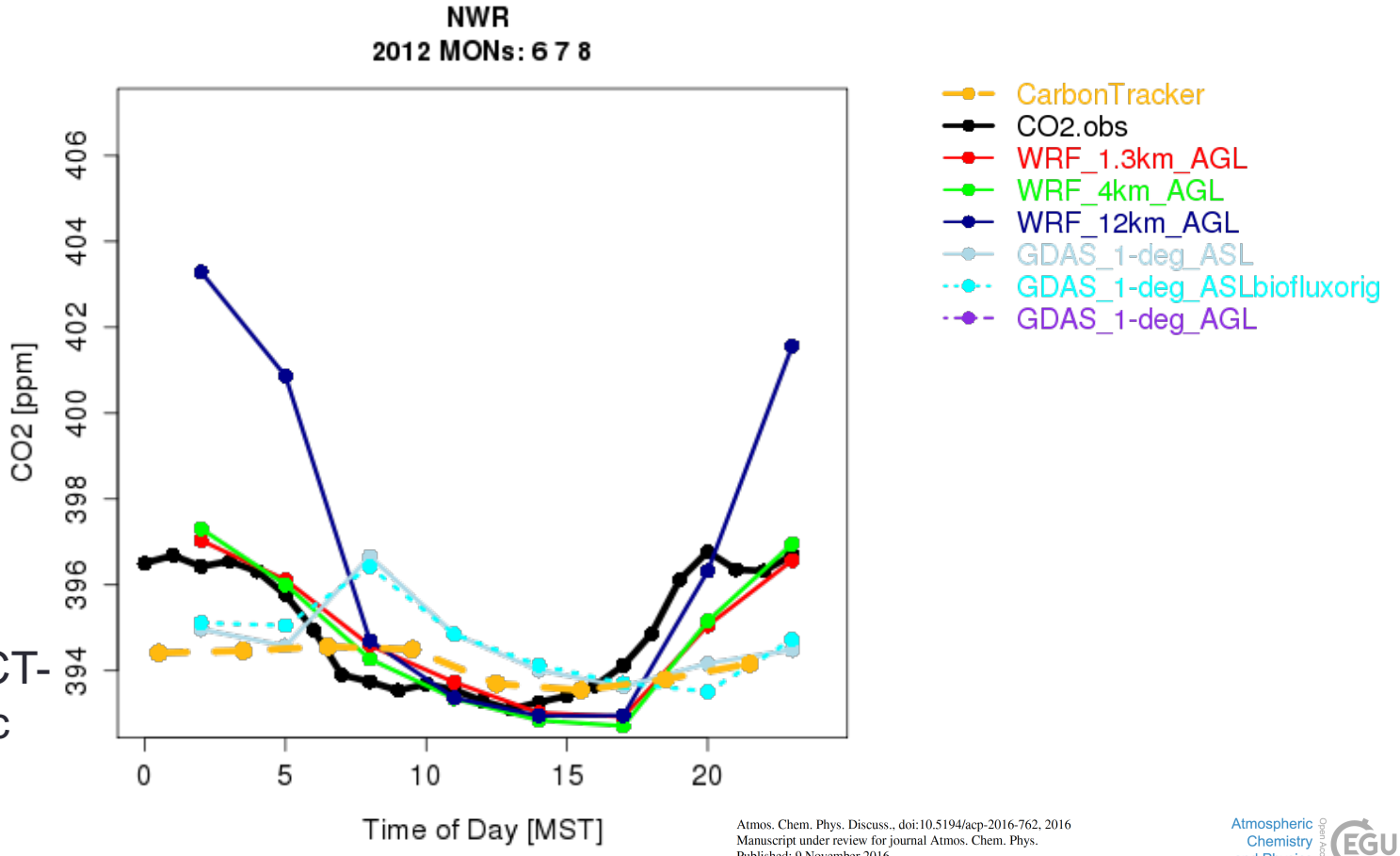


Storm Peak Lab (SPL)
~ Steamboat Springs, CO

Niwot Ridge (NWR)
~ Ward, CO

Simulation of atmospheric CO_2 at the Rocky RACCOON sites (B. Stephens, NCAR)

WRF-STILT atmospheric transport with CarbonTracker (CT-2013b) biospheric fluxes



Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-762, 2016
Manuscript under review for journal Atmos. Chem. Phys.
Published: 9 November 2016

Atmospheric Chemistry and Physics Discussions

1 **How can mountaintop CO_2 observations be used to constrain regional**
2 **carbon fluxes?**
3 John C. Lin[1], Derek V. Mallia[1], Dien Wu[1], Britton B. Stephens[2]

Simulation of atmospheric CO_2 at the Rocky RACCOON sites (B. Stephens, NCAR)

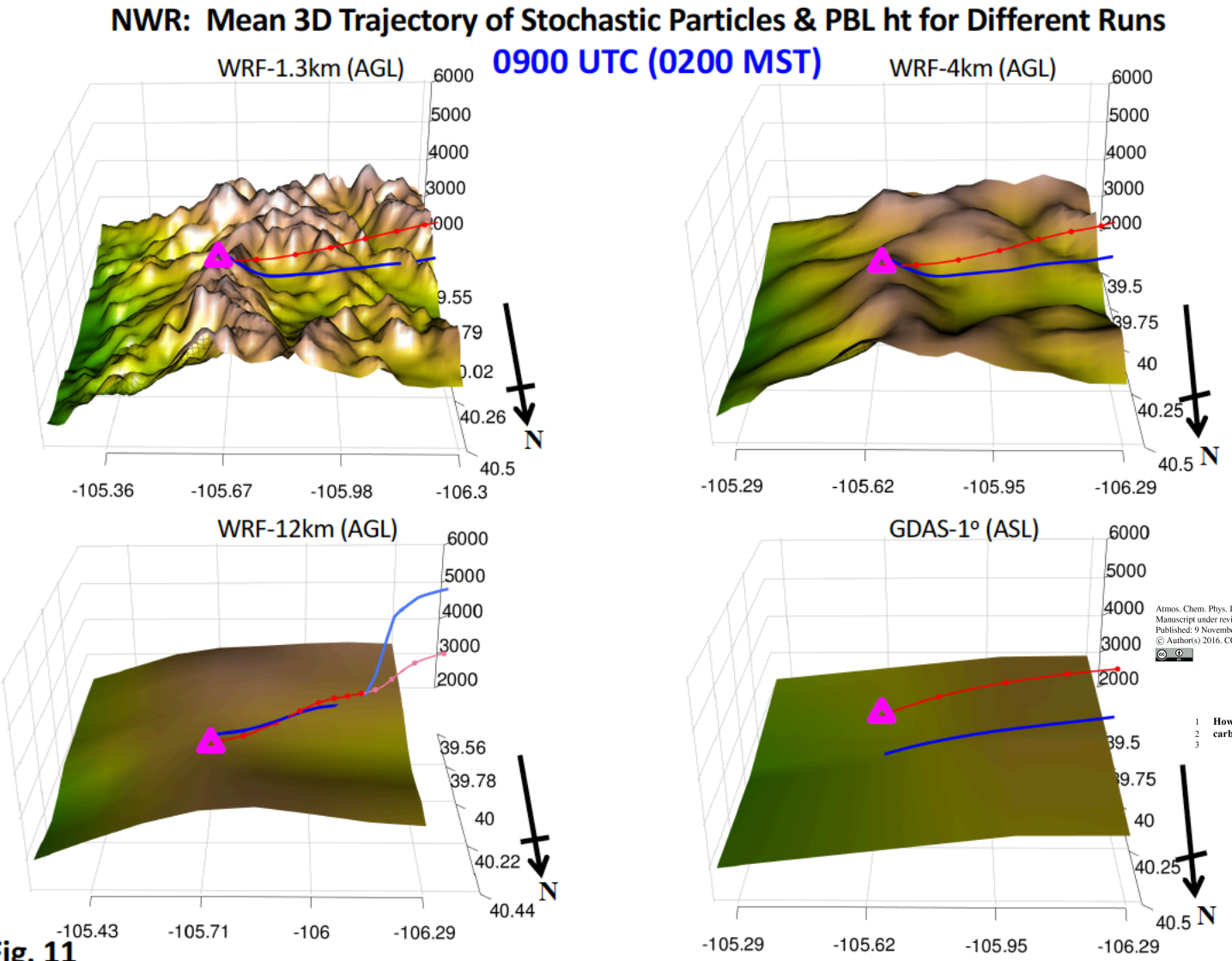


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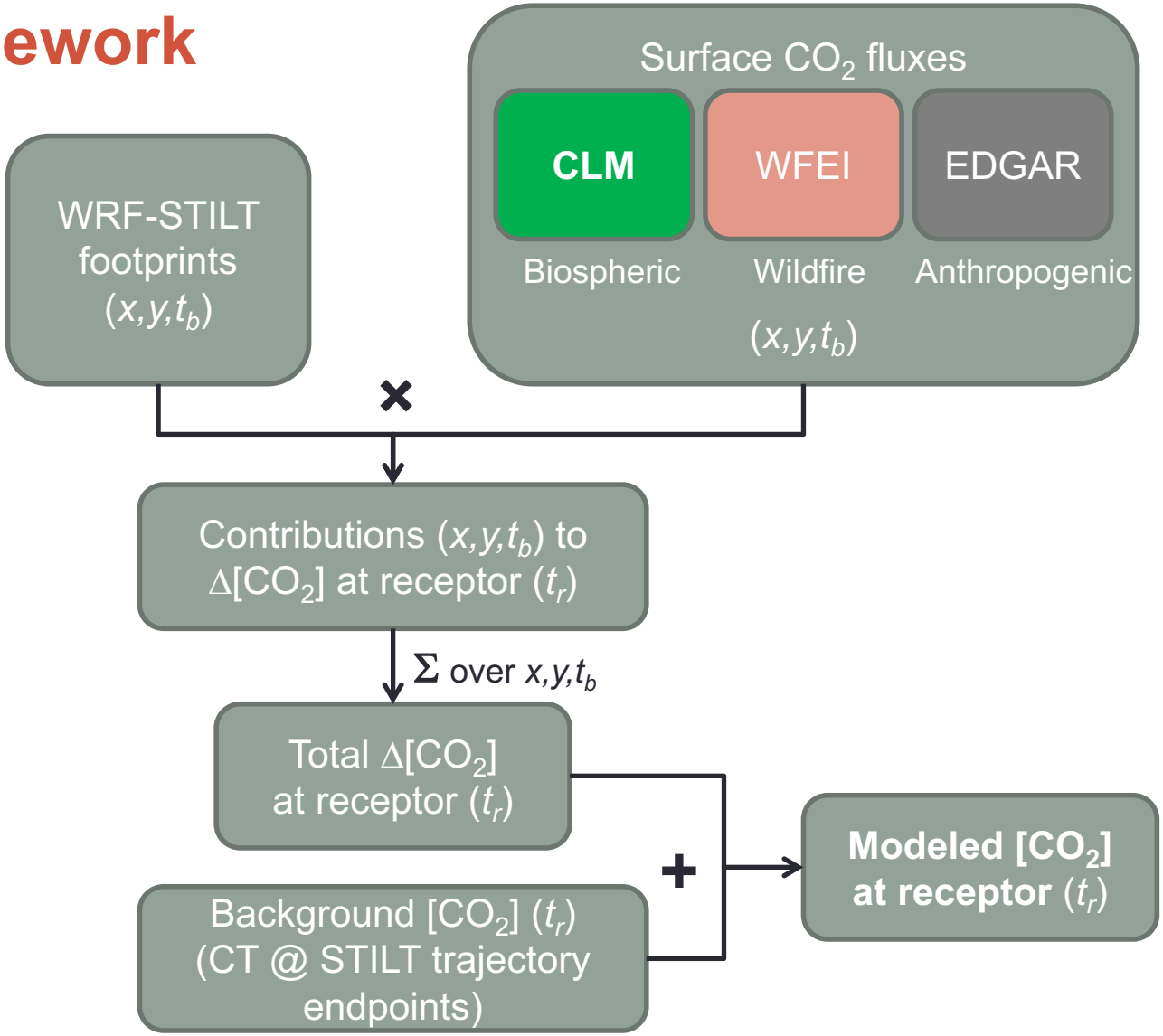
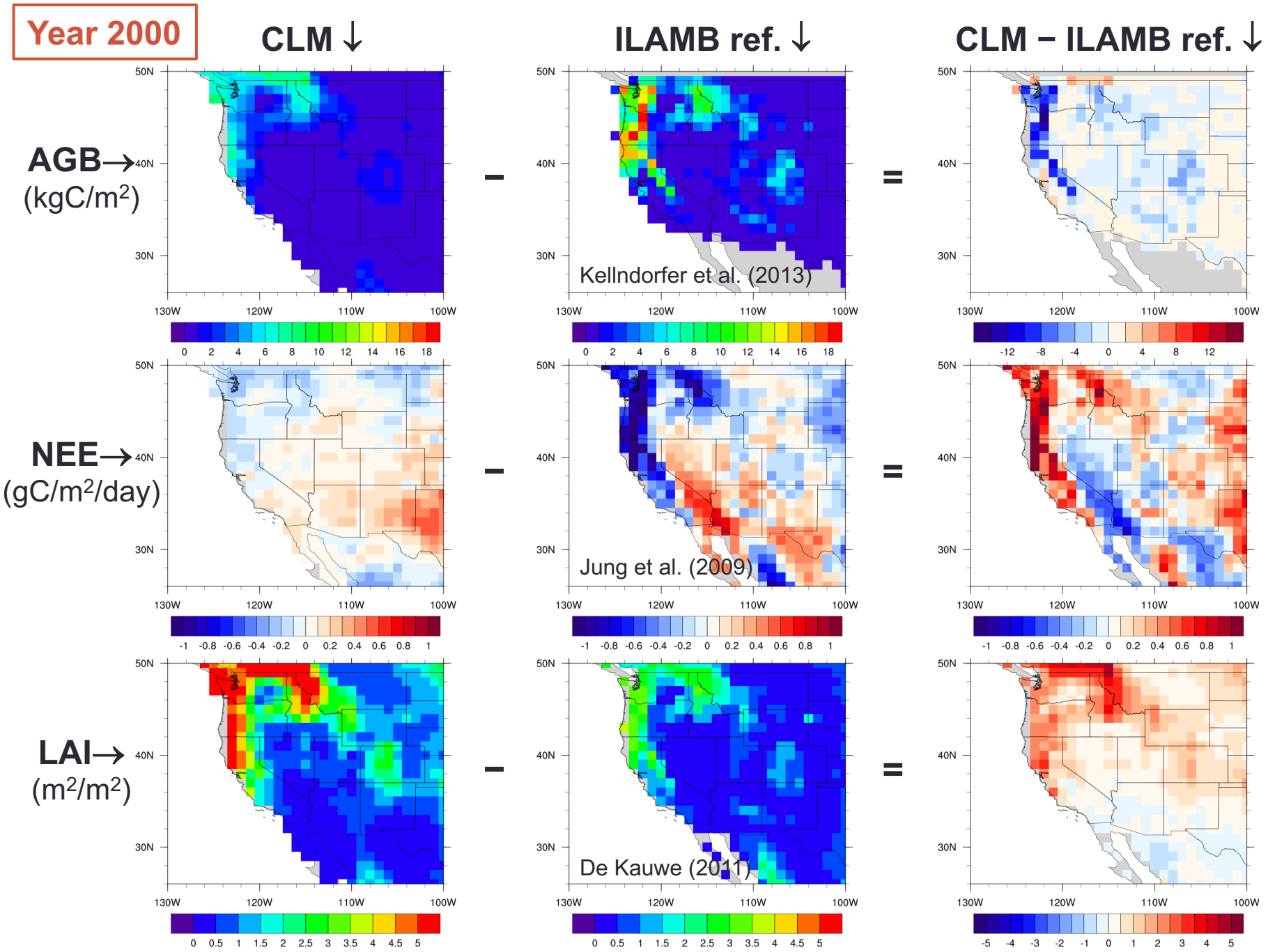
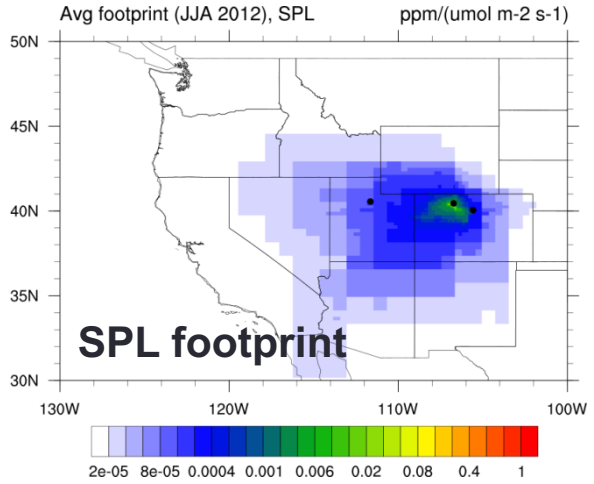
Fig. 11

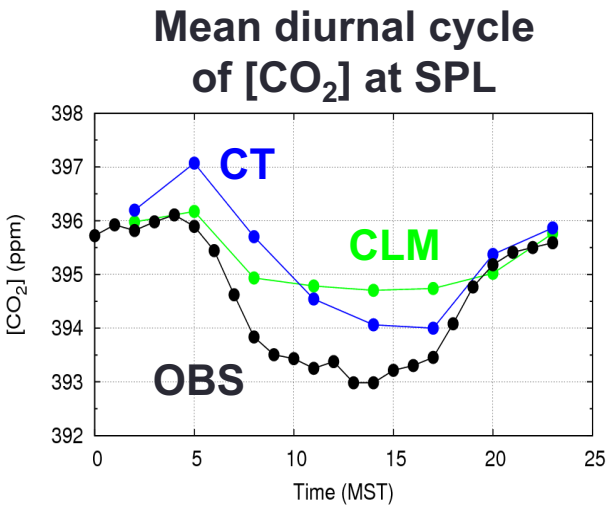
WRF-STILT-CLM Framework

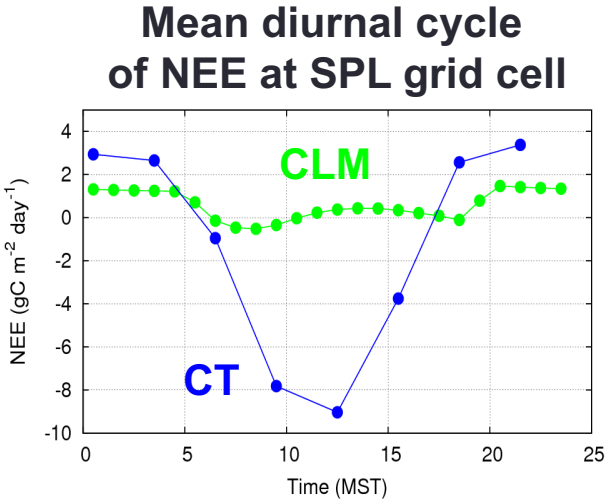


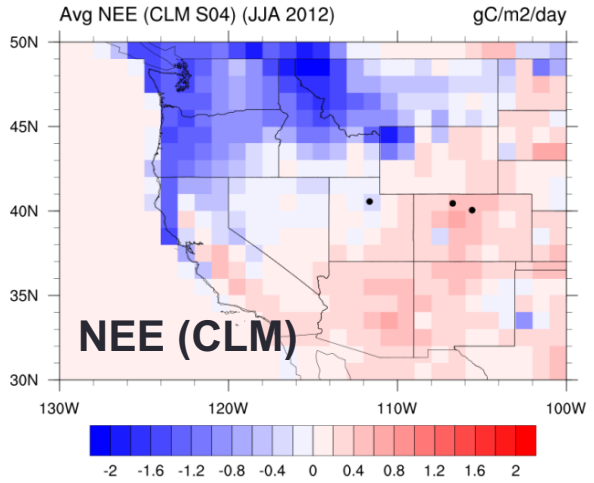

Year 2000
CLM ↓
ILAMB ref. ↓
CLM − ILAMB ref. ↓
AGB→
(kgC/m²)
NEE→
(gC/m²/day)
LAI→
(m²/m²)
Kellndorfer et al. (2013)
Jung et al. (2009)
De Kauwe (2011)
50N
40N
30N
130W
120W
110W
100W
0 2 4 6 8 10 12 14 16 18
-12 -8 -4 0 4 8 12
-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
-5 -4 -3 -2 -1 0 1 2 3 4 5

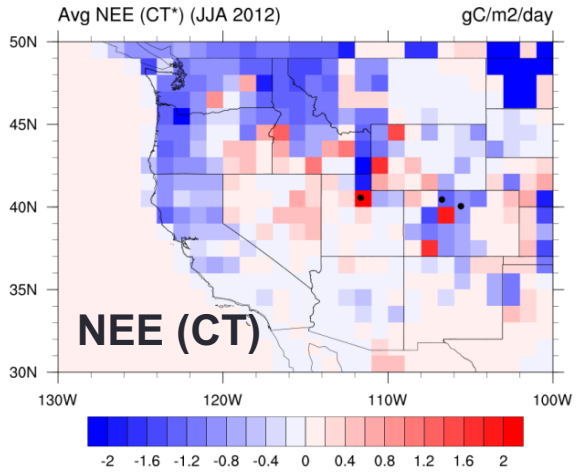
Storm Peak Lab Station, JJA 2012



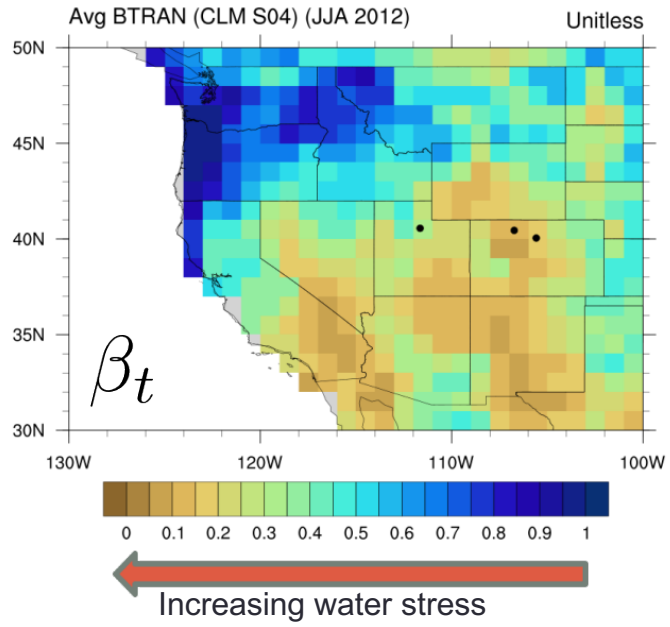


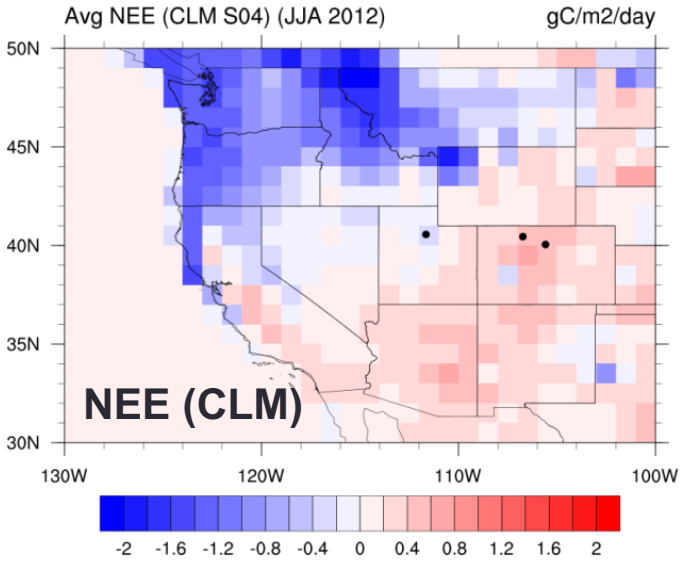






Why such low GPP values in CLM?





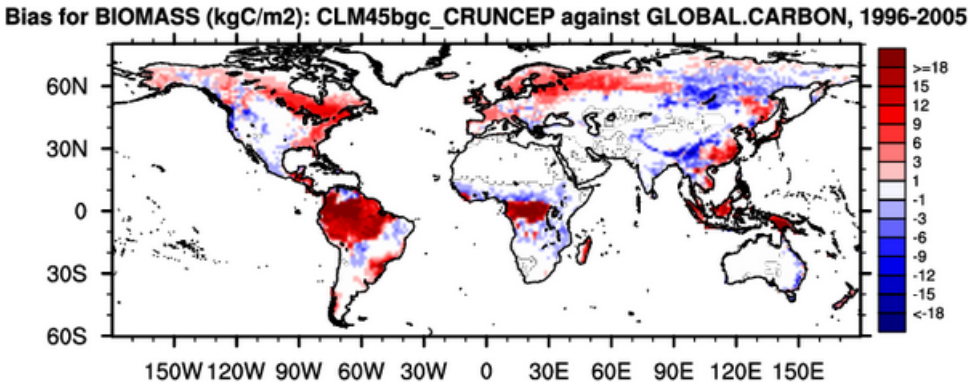
Soil moisture stress in CLM

$$\beta_t = f(\Psi_i, \Psi_c, \Psi_o, r_i)$$

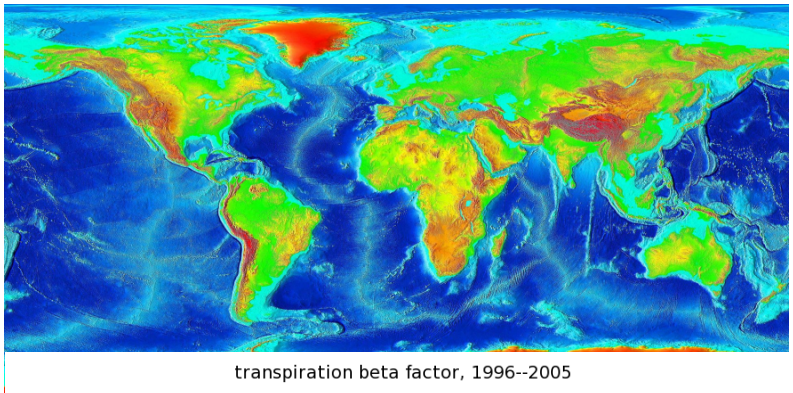
- V_{cmax} is multiplied by β_t
- More than 70% reduction of V_{cmax} near RACCOON sites!
- Summer of 2012 was exceptionally dry, but even so, [CO_2] obs suggest this reduction was excessive

Possible causes for the low β_t values include:

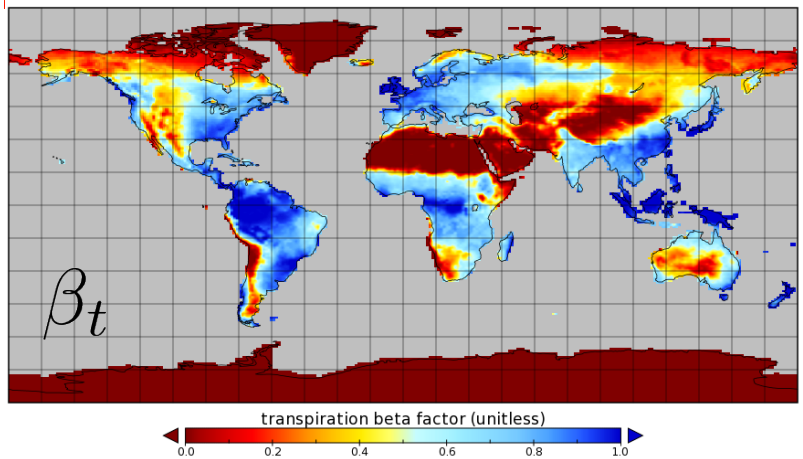
- Inadequate PFT parameters
- Low Ψ (issues with the soil hydraulic parameters; issues with CLM's hydrology model and atmospheric forcing data due to complex topography)



Biomass bias (CLM4.5-BGC with CRUNCEP forcing against Saatchi et al. (2011))
This plot is from the ILAMB project webpage



Topography map



Soil moisture stress from a global CLM4.5-CN run with CRUNCEP forcing

New atmospheric forcing datasets

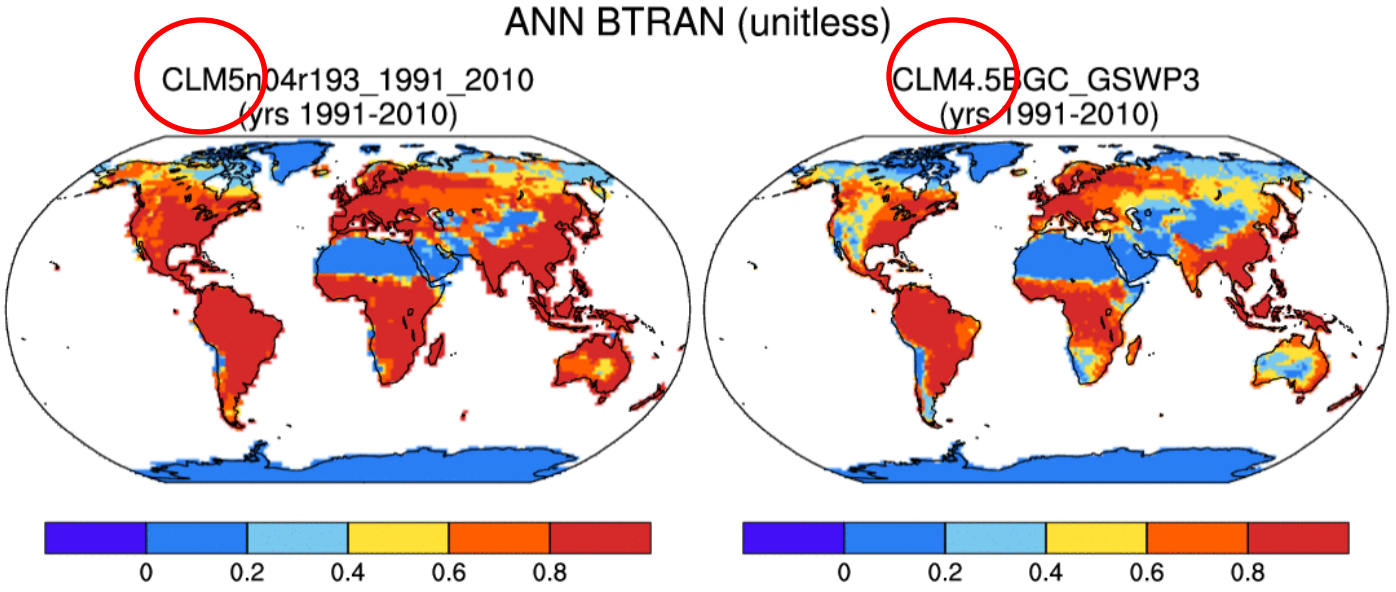
- Default forcing dataset in CLM is CRUNCEP (0.5x0.5deg, 6 hourly resolution)
- 3 new forcing datasets (Wang et al. 2016), based on modern data assimilation systems:
  - NASA Global Modeling and Assimilation Office (GMAO) **MERRA** (0.5x0.33deg, 1 hourly res.)
  - ERA-Interim, **ERAI** (0.75x0.75deg, 3 hourly res.)
  - NCEP Climate Forecast System Reanalysis, **CFSR** (0.5x0.5deg, 6 hourly res.)

  Monthly mean precipitation from GPCP (Global Precipitation Climatology Project) used to bias correct the reanalysis values
- Overall, Wang et al. (2016) found a significant improvement in the simulation of soil moisture and snow quantities with the new forcing datasets in CLM 4.5
- We recently obtained the datasets from Dr. Aihui Wang and will test them soon

New CLM version

- CLM 5.0 will be released this year
- Tests indicate improvements in the simulation of soil moisture over complex terrain

β_t



LMWG CLM5.0 Development plots from
http://www.cgd.ucar.edu/tss/clm/diagnostics/clm5_dev/index.html