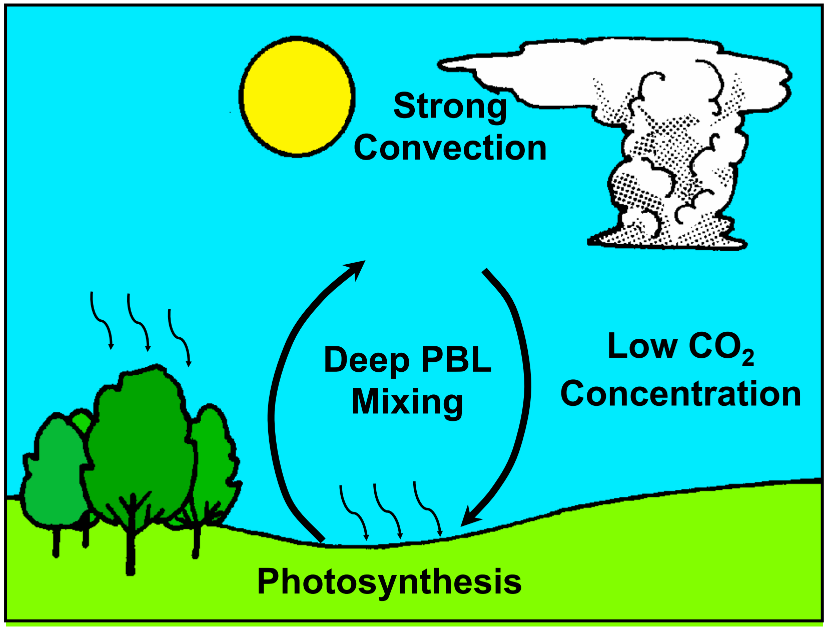
Global Correlations Between Ecosystems and PBL Mixing

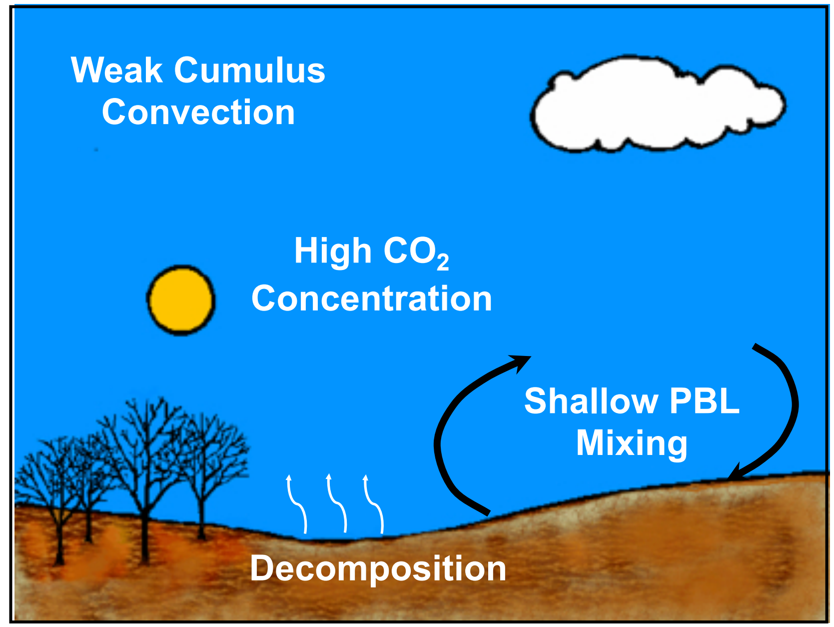
A new analysis based on 1,137,452
CALIPSO LIDAR soundings

Seasonal Rectifier Forcing

Summer



Autumn



Dilution of photosynthesis signal through deep mixing

Transport of low-CO_2 air into upper troposphere

Accumulation of respiration signal near the surface

Elevated CO_2 in lower troposphere

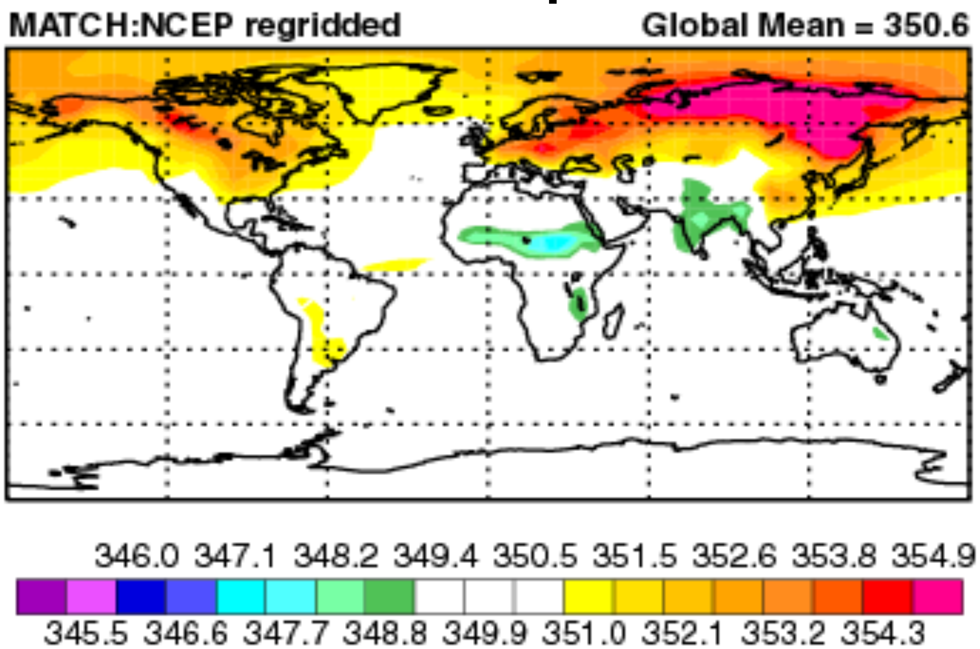
Annual mean: Accumulation of CO_2 near the ground, depletion aloft

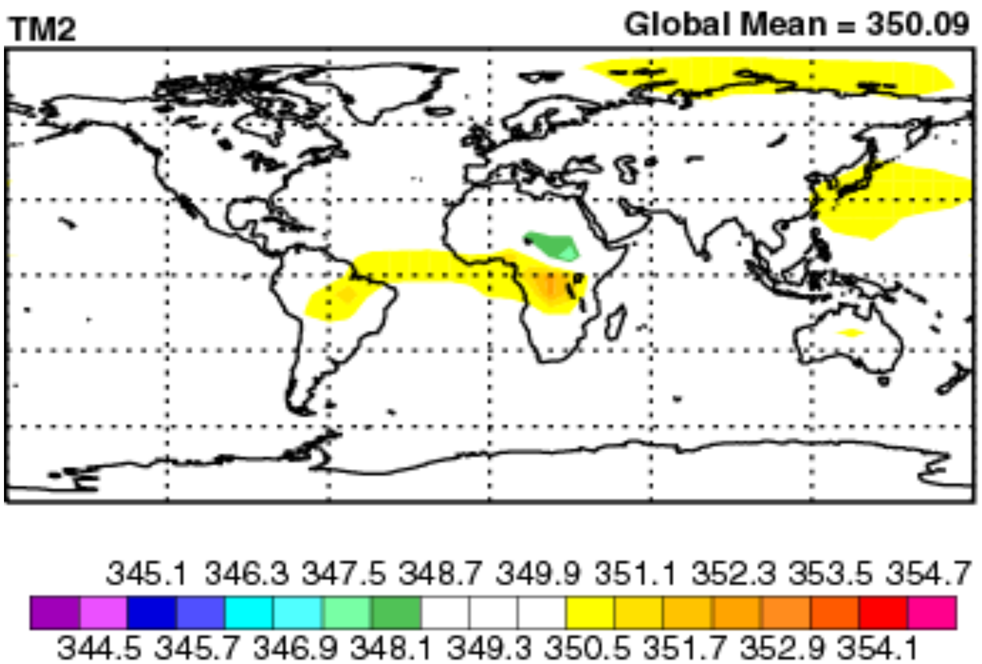
CALIPSO LIDAR Sounder

- Launched mid-2006
- 705 km A-Train orbit
- mid-day overpass
- 532 nm laser ranging
- millions of soundings per month

Speculative Comparison

Simulated Rectifier CO_2 Response

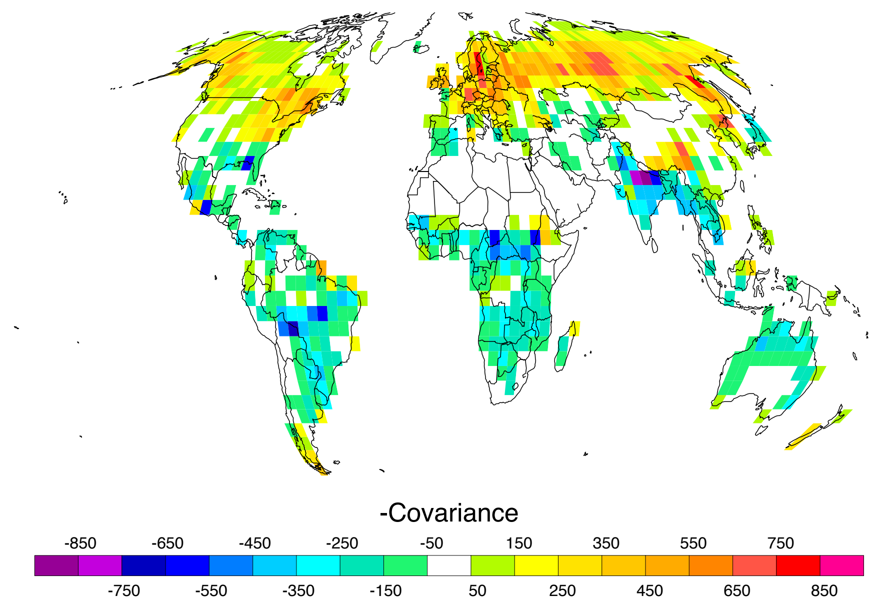




Preliminary results suggest strong rectifier simulated by MATCH much more realistic than weak rectifier simulated in TM2

Observed Rectifier Forcing

Simulated NEE vs Observed PBL Depth



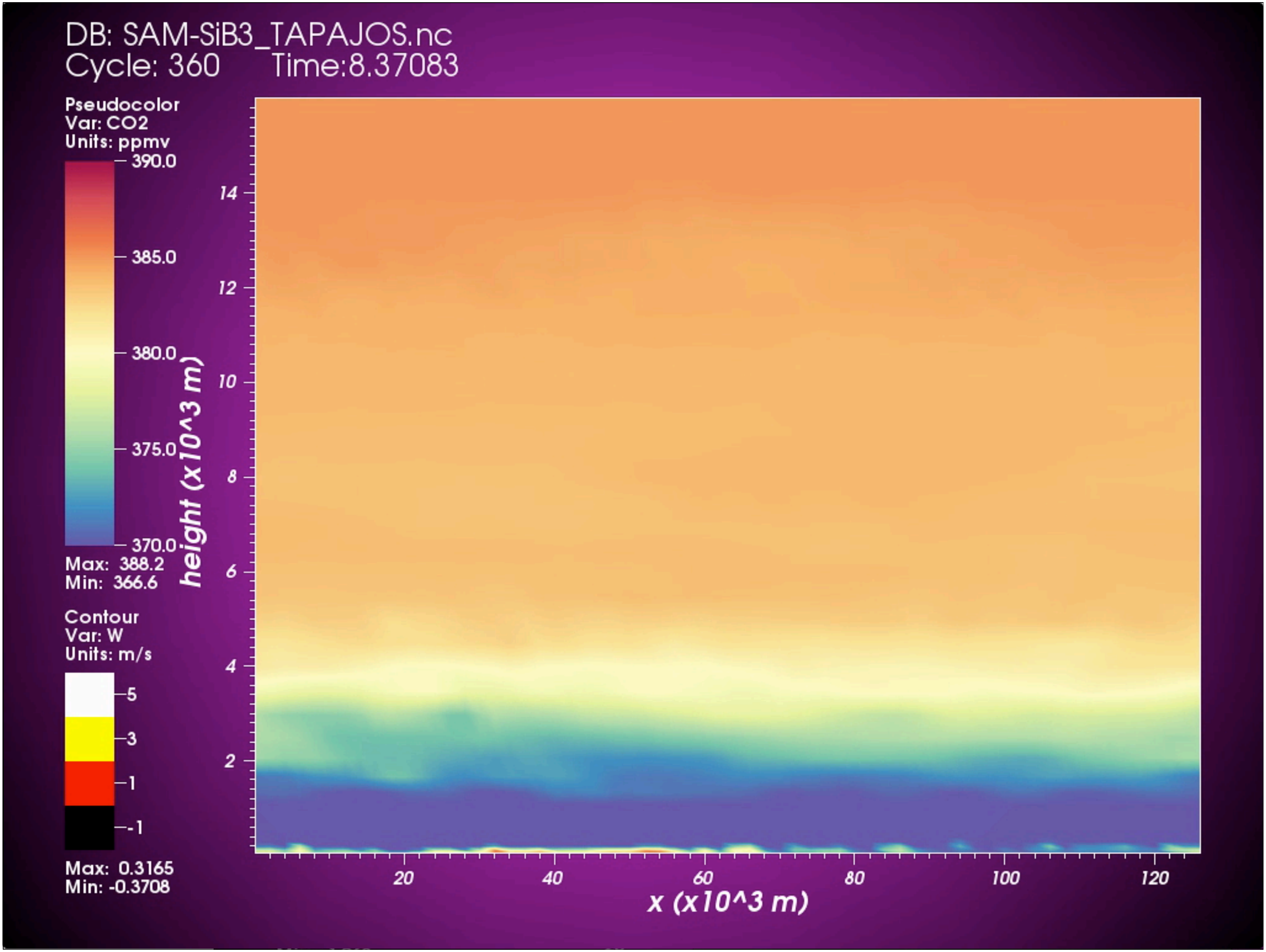
The Soil-Plant-Atmosphere System - A problem of scale.

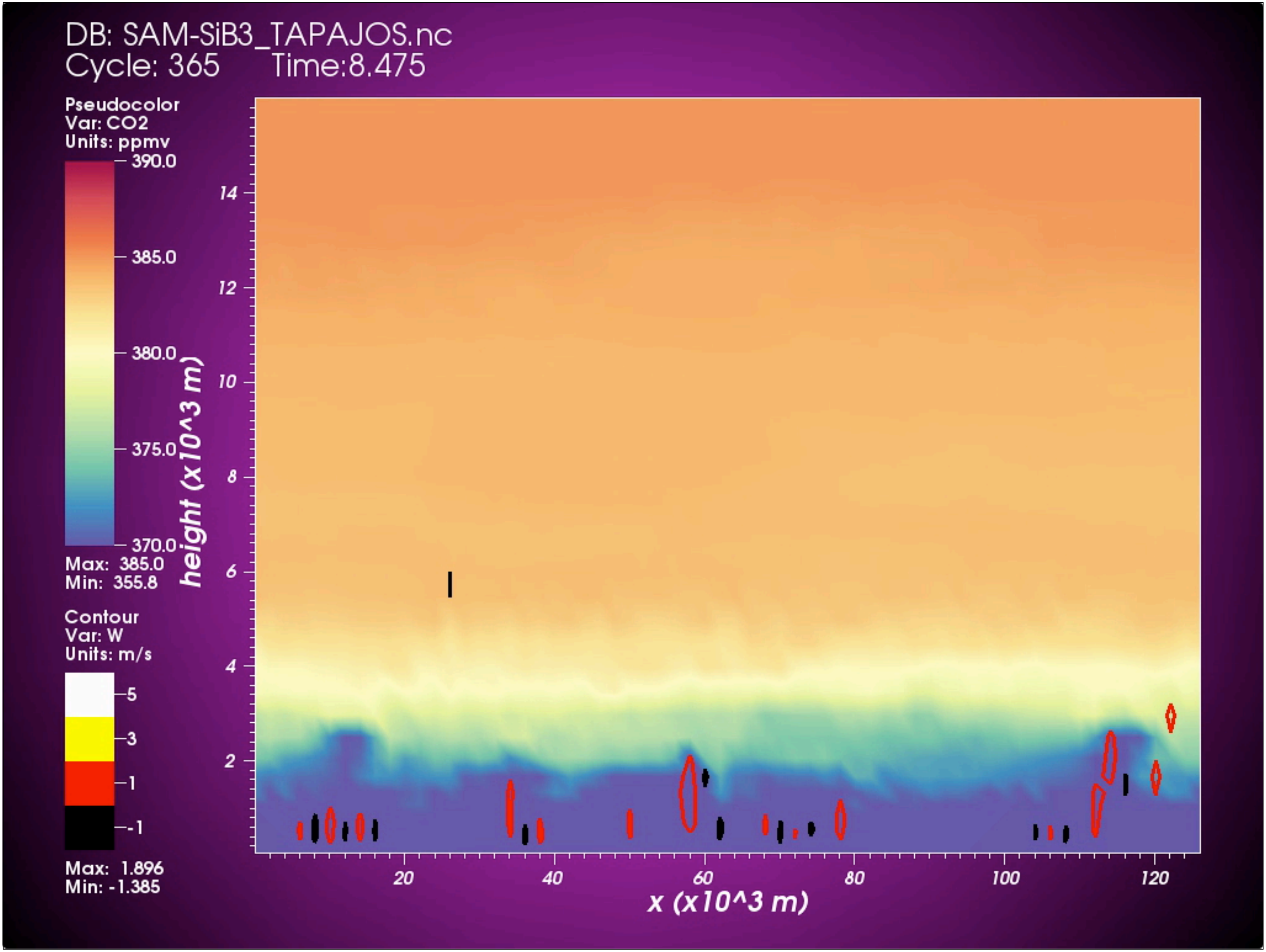
Joseph A Berry[1], Ian T Baker[2], Donald A. Dazlich[2],David A Randall[2],

1. Dept Global Ecology, Carnegie Institution for Science, Stanford, CA, United States.
2. Atmospheric Sciences, Colorado State University, Ft. Collins, CO, United States.
3. Sciences and Exploration, NASA GSFC, Greenbelt, MD, United States.

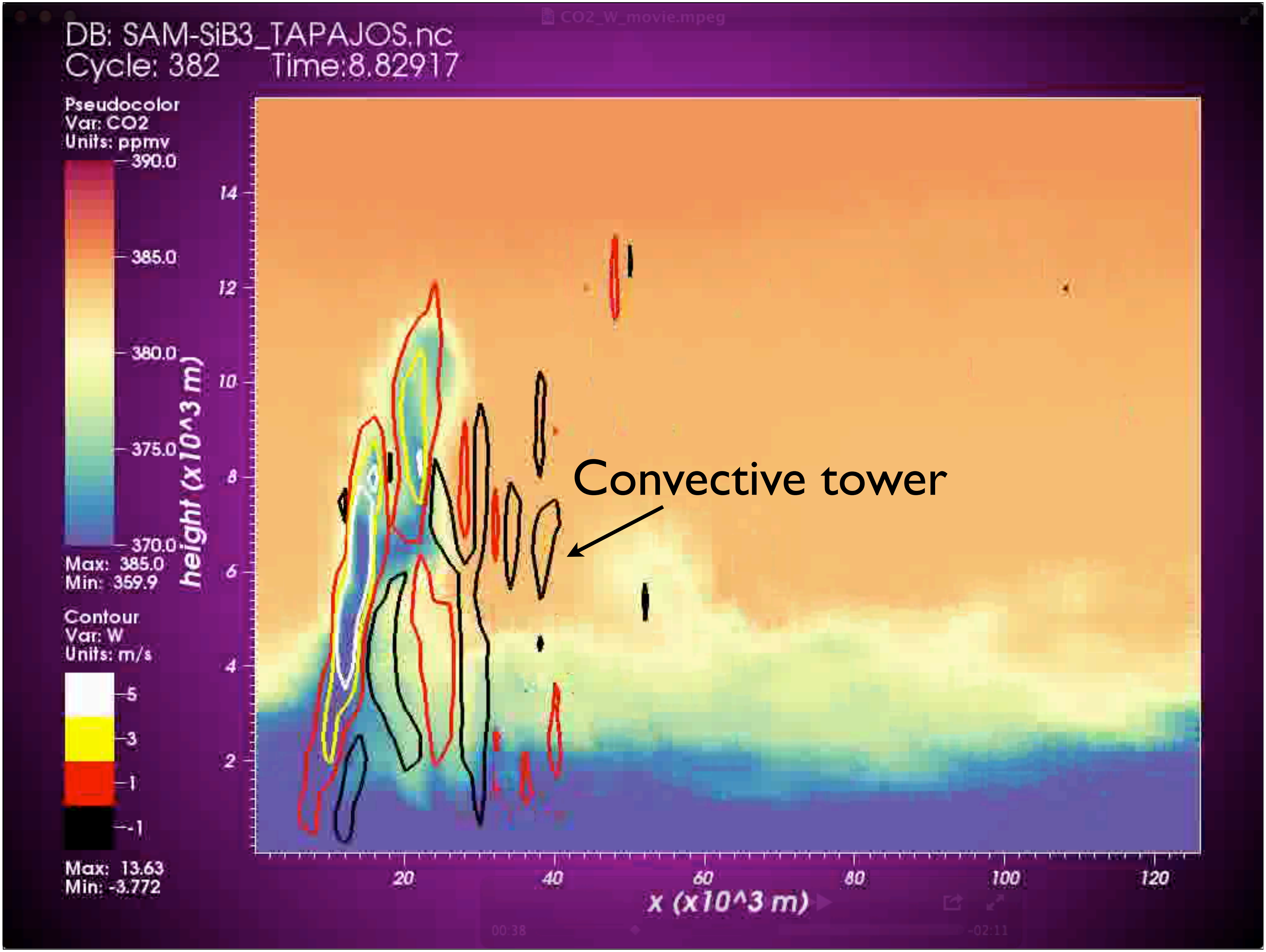
CARNEGIE INSITUTION
FOR SCIENCE DEPARTMENT OF GLOBAL ECOLOGY

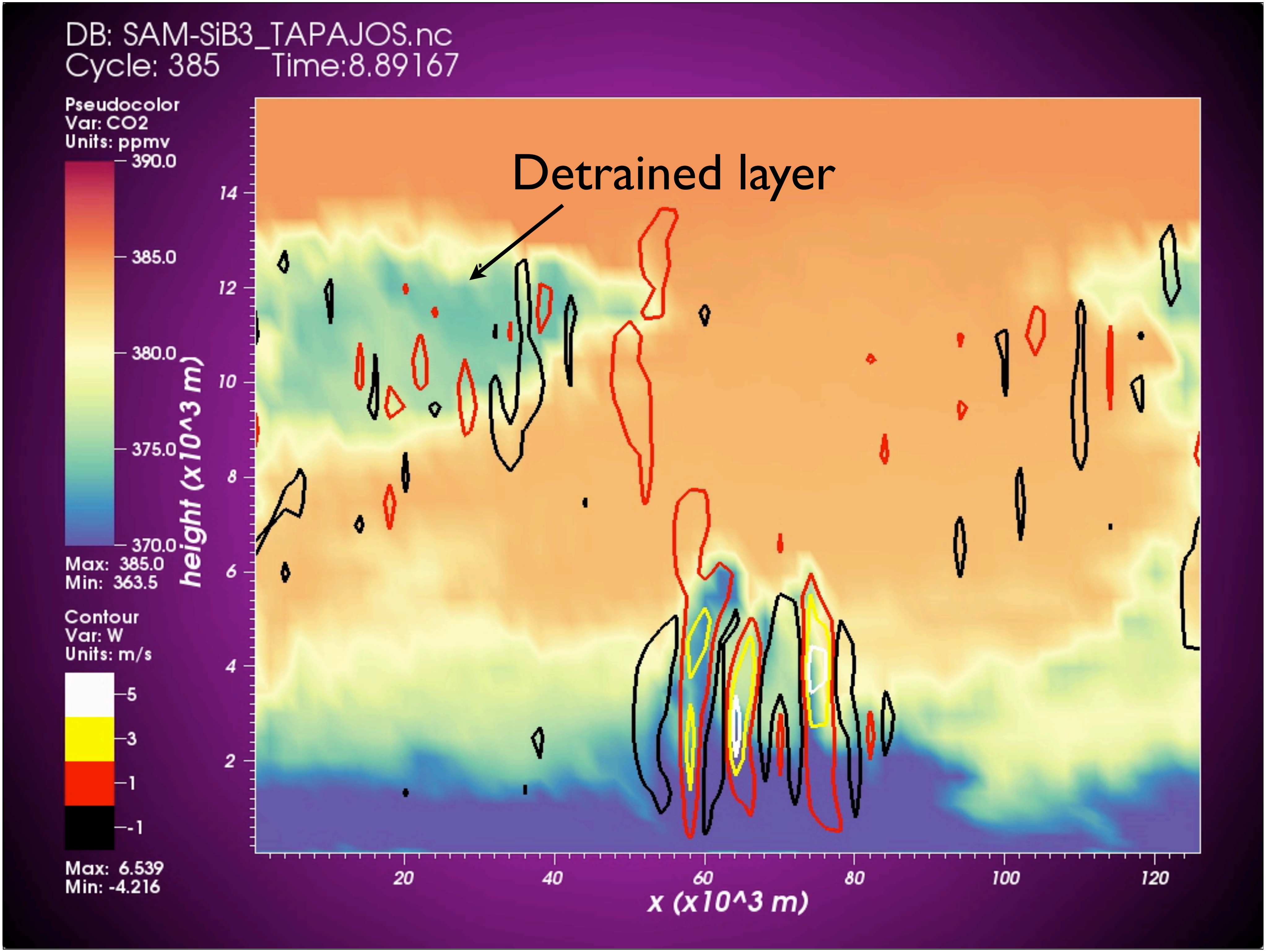
A National Science Foundation Science and Technology Center


DB: SAM-SiB3_TAPAJOS.nc
Cycle: 360 Time:8.37083
Pseudocolor
Var: CO2
Units: ppmv
390.0
385.0
380.0
375.0
370.0
Max: 388.2
Min: 366.6
Contour
Var: W
Units: m/s
5
3
1
-1
Max: 0.3165
Min: -0.3708
height (x10^3 m)
14
12
10
8
6
4
2
20
40
60
80
100
120
x (x10^3 m)

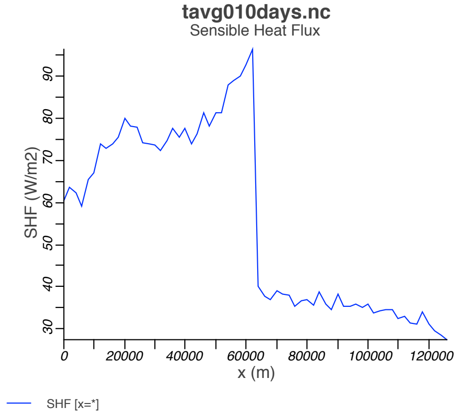


DB: SAM-SiB3_TAPAJOS.nc
Cycle: 365 Time:8.475
Pseudocolor
Var: CO2
Units: ppmv
390.0
385.0
380.0
375.0
370.0
Max: 385.0
Min: 355.8
Contour
Var: W
Units: m/s
5
3
1
-1
Max: 1.896
Min: -1.385
height (x10^3 m)
14
12
10
8
6
4
2
20
40
60
80
100
120
x (x10^3 m)

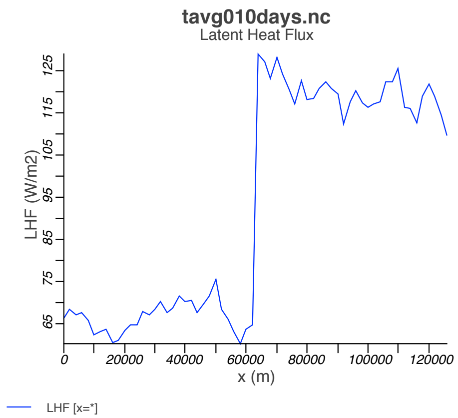

DB: SAM-SiB3_TAPAJOS.nc
Cycle: 382 Time:8.82917
Pseudocolor
Var: CO2
Units: ppmv
390.0
385.0
380.0
375.0
370.0
Max: 385.0
Min: 359.9
Contour
Var: W
Units: m/s
5
3
1
-1
Max: 13.63
Min: -3.772
height (x10^3 m)
14
12
10
8
6
4
2
20
40
60
80
100
120
x (x10^3 m)
Convective tower


DB: SAM-SiB3_TAPAJOS.nc
Cycle: 385 Time:8.89167
Pseudocolor
Var: CO2
Units: ppmv
390.0
385.0
380.0
375.0
370.0
Max: 385.0
Min: 363.5
Contour
Var: W
Units: m/s
5
3
1
-1
Max: 6.539
Min: -4.216
Detrained layer
height (x10^3 m)
x (x10^3 m)
2
4
6
8
10
12
14
20
40
60
80
100
120

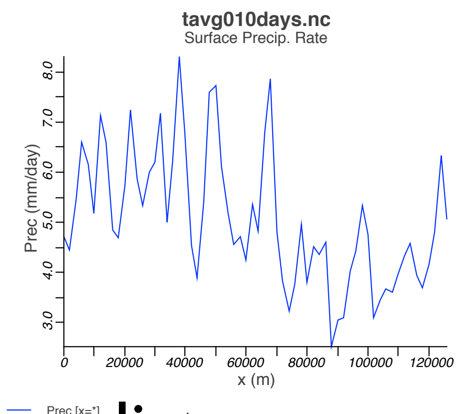
Sensible Heat



Latent Heat



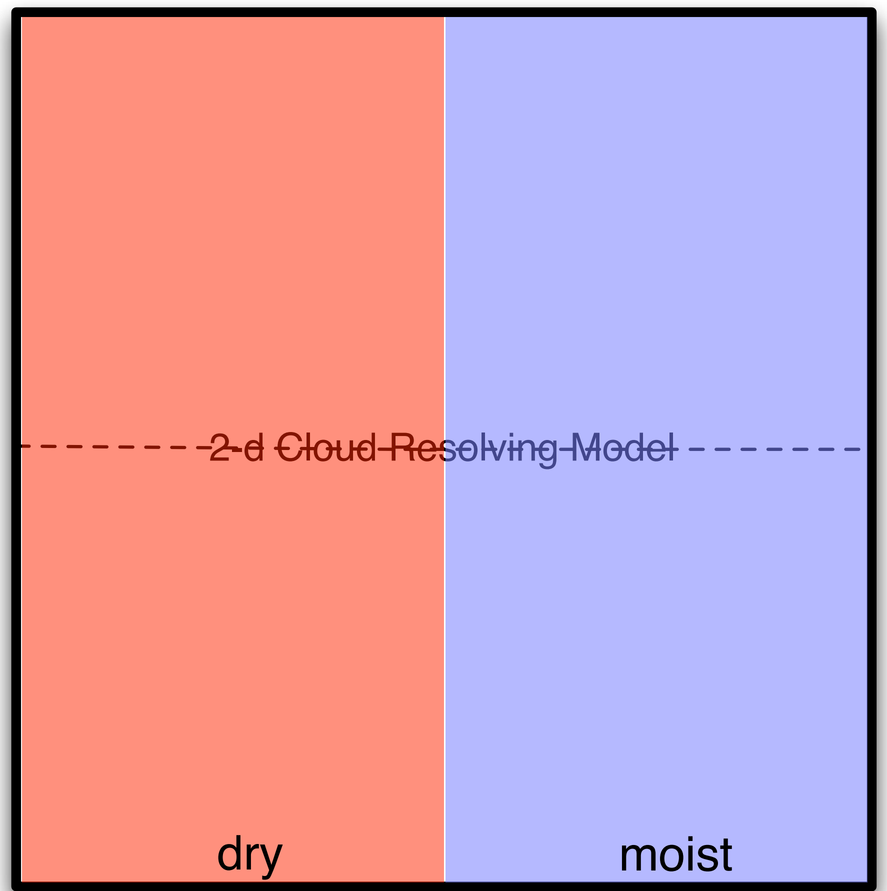
Precipitation

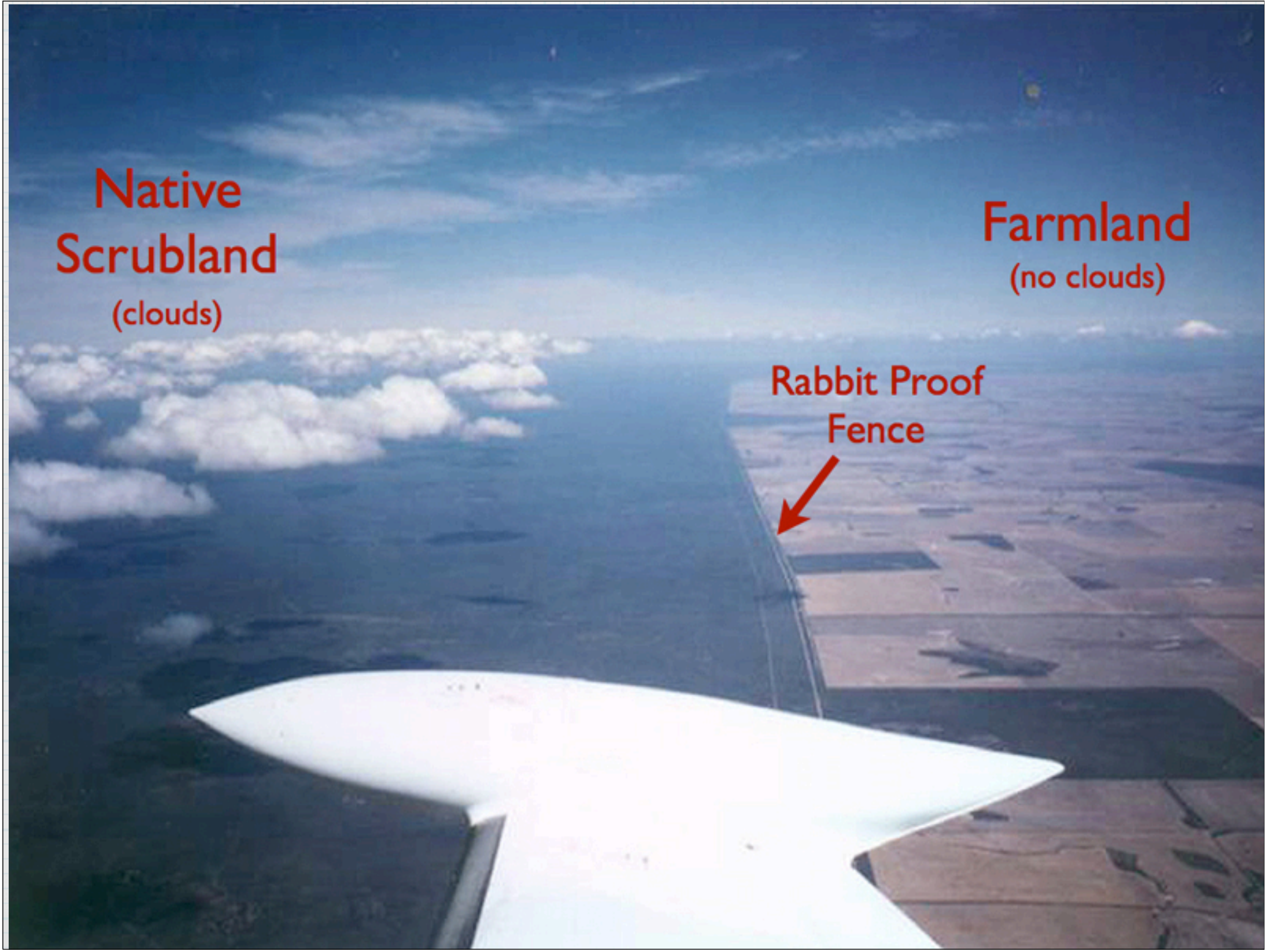


distance, m

This study: Amazon grid cell, start of wet season, half wet/half dry.

Model details: 2D Cloud resolving model 64 gridpoints by 64 layers. 2km horizontal resolution, periodic horizontal boundary conditions, lowest atmospheric layer thickness =75m, stretched vertical coordinate up to 28km, where model layers are 500m thick. The basic model timestep is 10s, SiB and interactive radiation are called every 150s, external forcing, NCEP, 6hr.




Native Scrubland
(clouds)
Farmland
(no clouds)
Rabbit Proof Fence

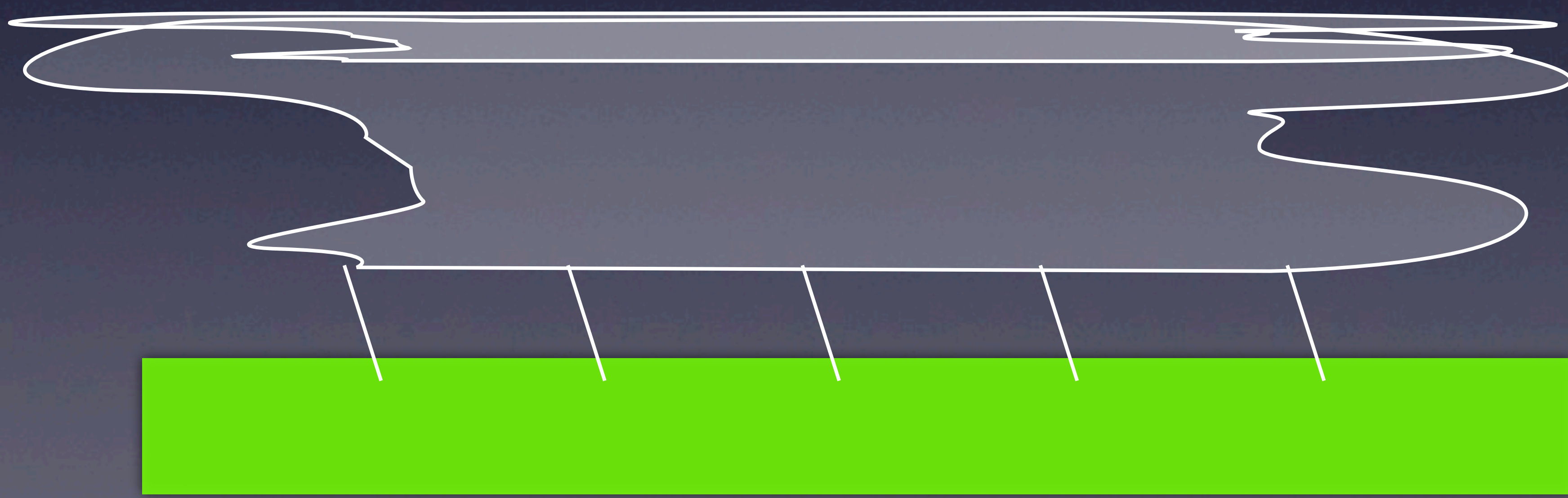
Homogeneous versus Heterogeneous SiB3 in a Cloud-Ensemble model

Donald Dazlich
Ian Baker
Colorado State University, Fort Collins CO

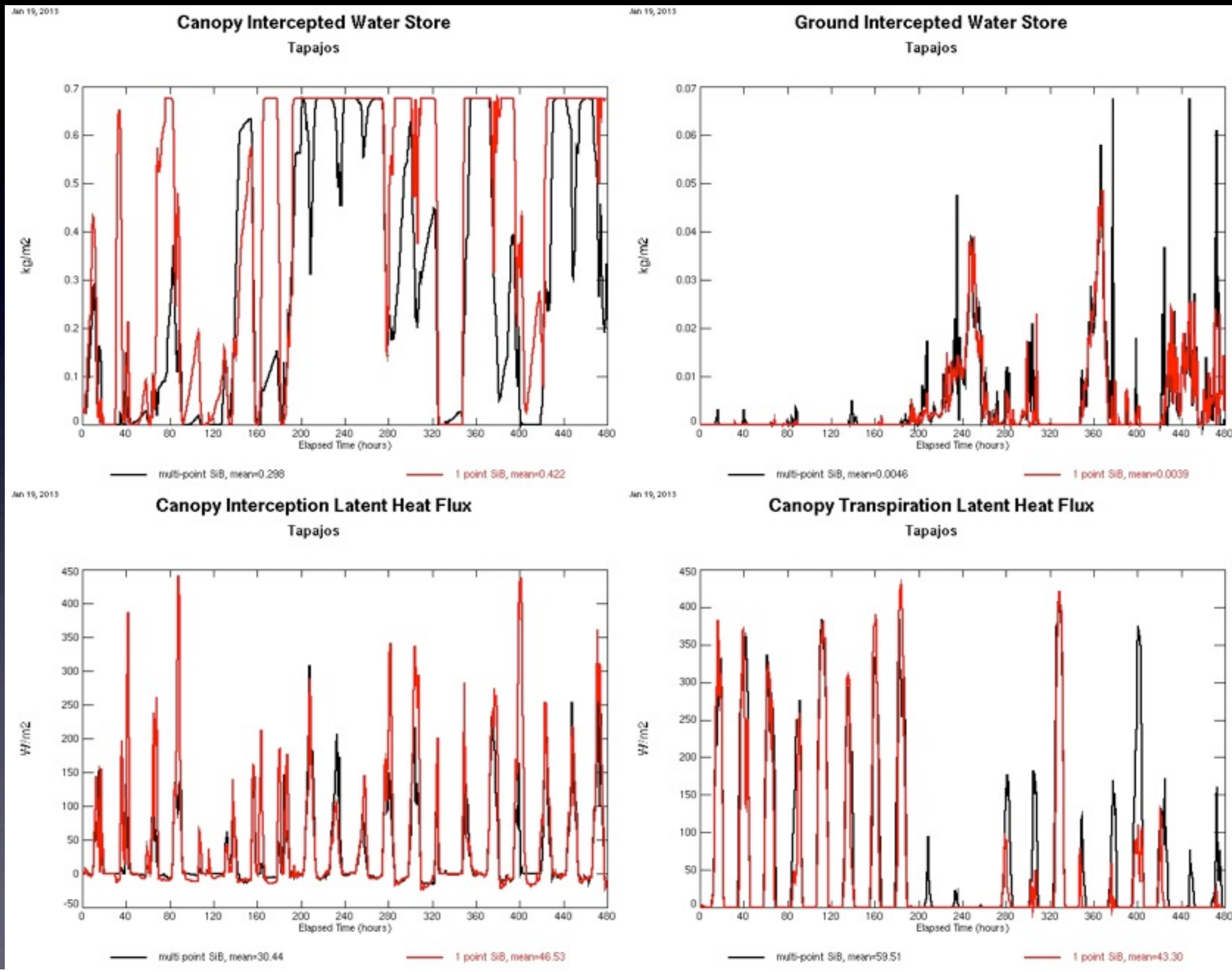
Joe Berry
Carnegie Institution for Science, Stanford CA

Multi-point (heterogeneous) land:

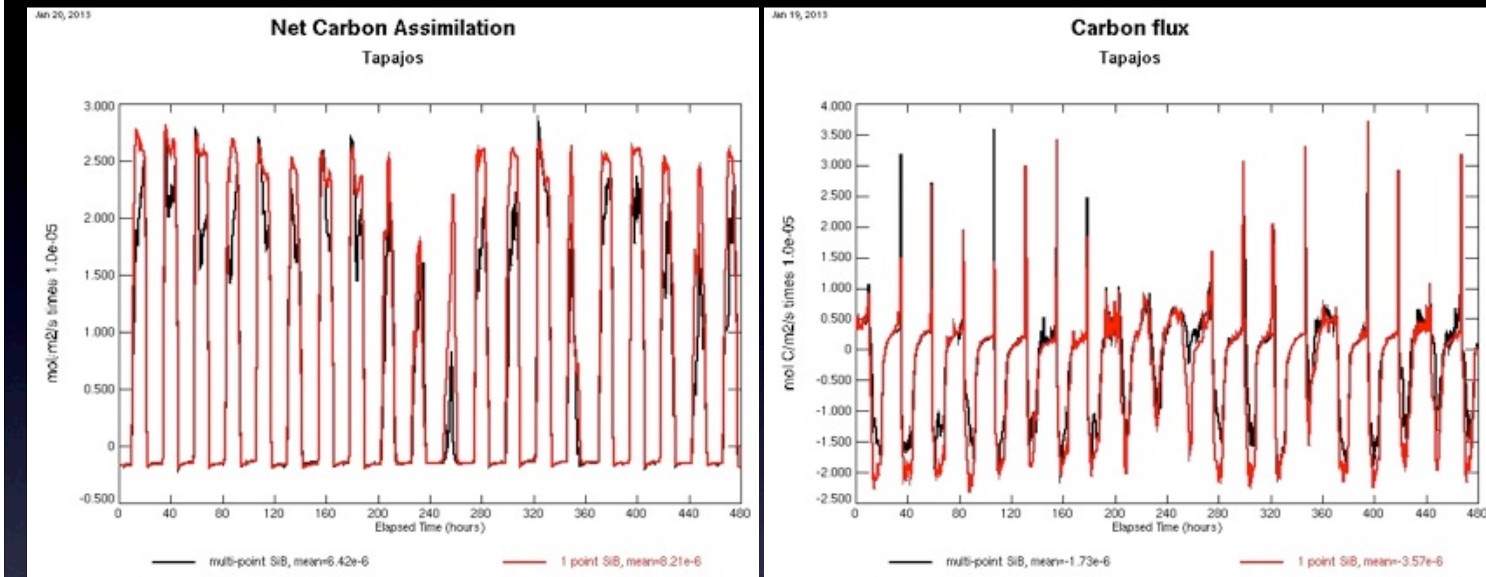
One-point (homogeneous) land:



Tapajos: shift in evaporation from canopy interception to transpiration for multi-point SiB3.



Tapajos: 20% less Carbon assimilation, 50% less net carbon flux into land surface with multi-point SiB3



Summary

- SiB3 is installed in the latest SAM version (6.10.3) and is planned to be part of future releases.
- SAM/SiB3 has been run as a super-parameterized analog to the SCM as a tool to help investigate the impact of multiple instance land surface.
- A comparison of one-point and multi-point land surface runs show an impact in surface hydrology and carbon fluxes.

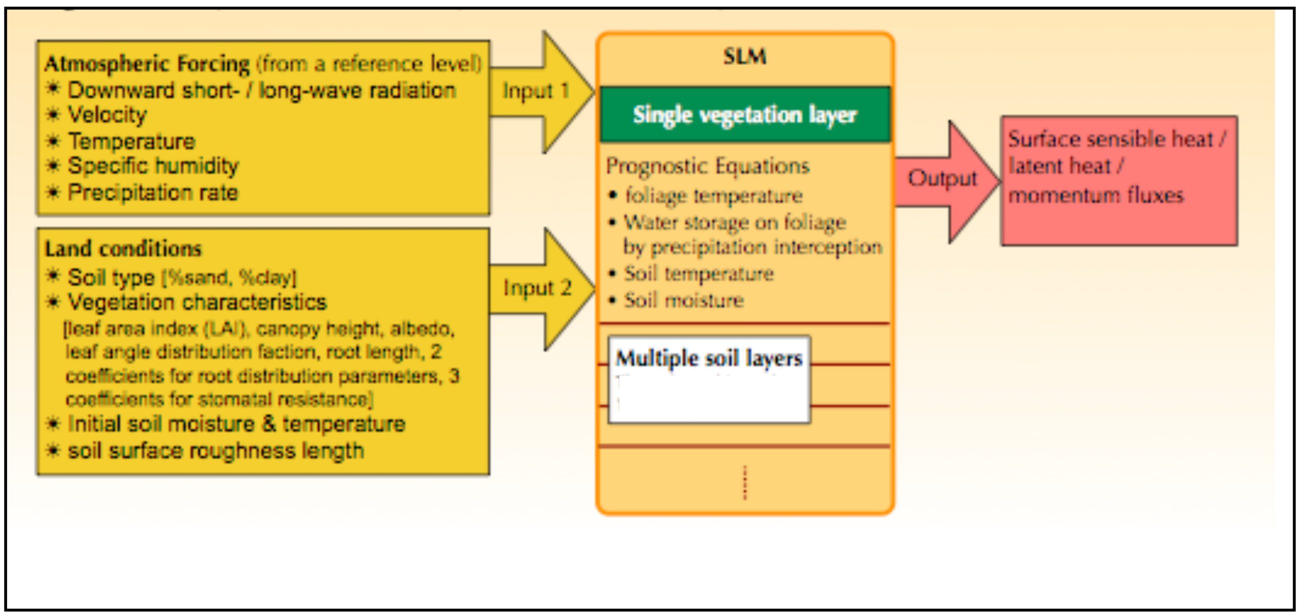
Validation of a simplified land surface model and its application to the case of shallow cumulus convection development

Colorado State University
January 2013
Marat Khairoutdinov
Jungmin Lee

Simplified Land Model (SLM)

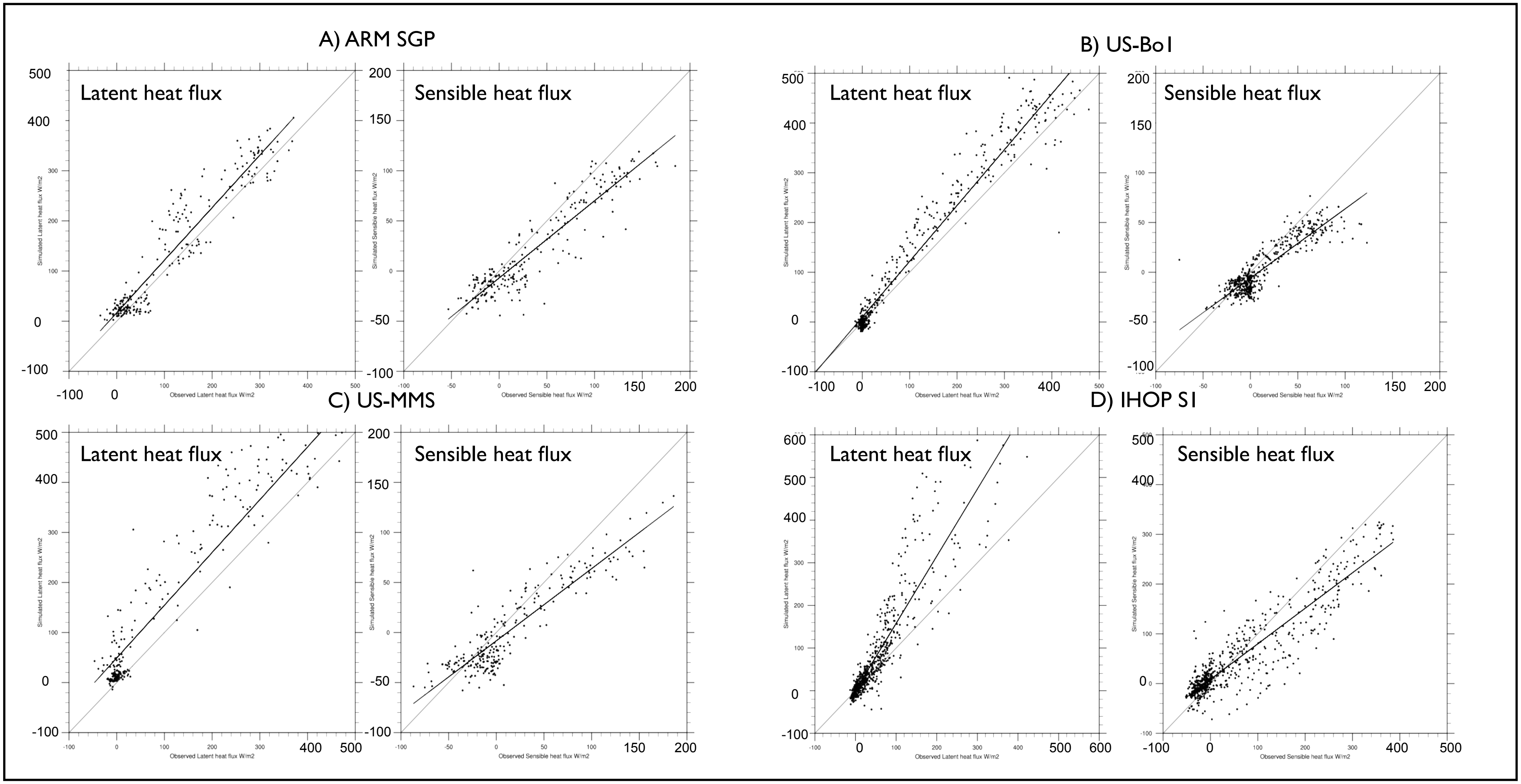
- Design Goal
  - Going back to first generation of land models
  - Use minimal set of parameters characterizing land surface conditions
  - Incorporate only the processes necessary to simulate diurnal convection over land
    - diurnal variations of radiative fluxes / turbulent fluxes of heat, moisture and momentum

- SLM structure
  - 1 vegetation layer + multiple soil layers
  - Vegetation layer : single type of vegetation, 100% coverage
  - Soil layers : soil type invariable with depth



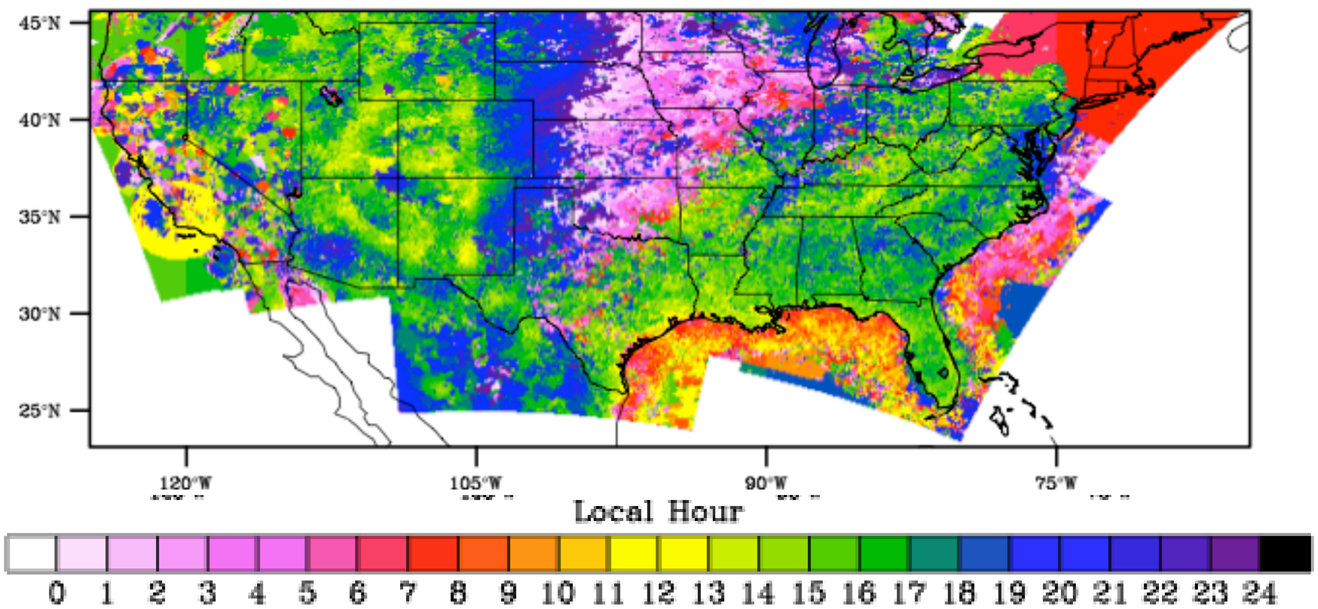
Validation of SLM

- Surface sensible and latent heat flux
  - Observed (x-axis) vs. Simulated (y-axis) sensible and latent heat fluxes
  - Light-grey line is 1:1 line / black line is a regression line
  - Slight overestimation in latent heat flux and underestimation in sensible heat flux over all test sites
    - Discrepancy in diurnal cycle amplitudes



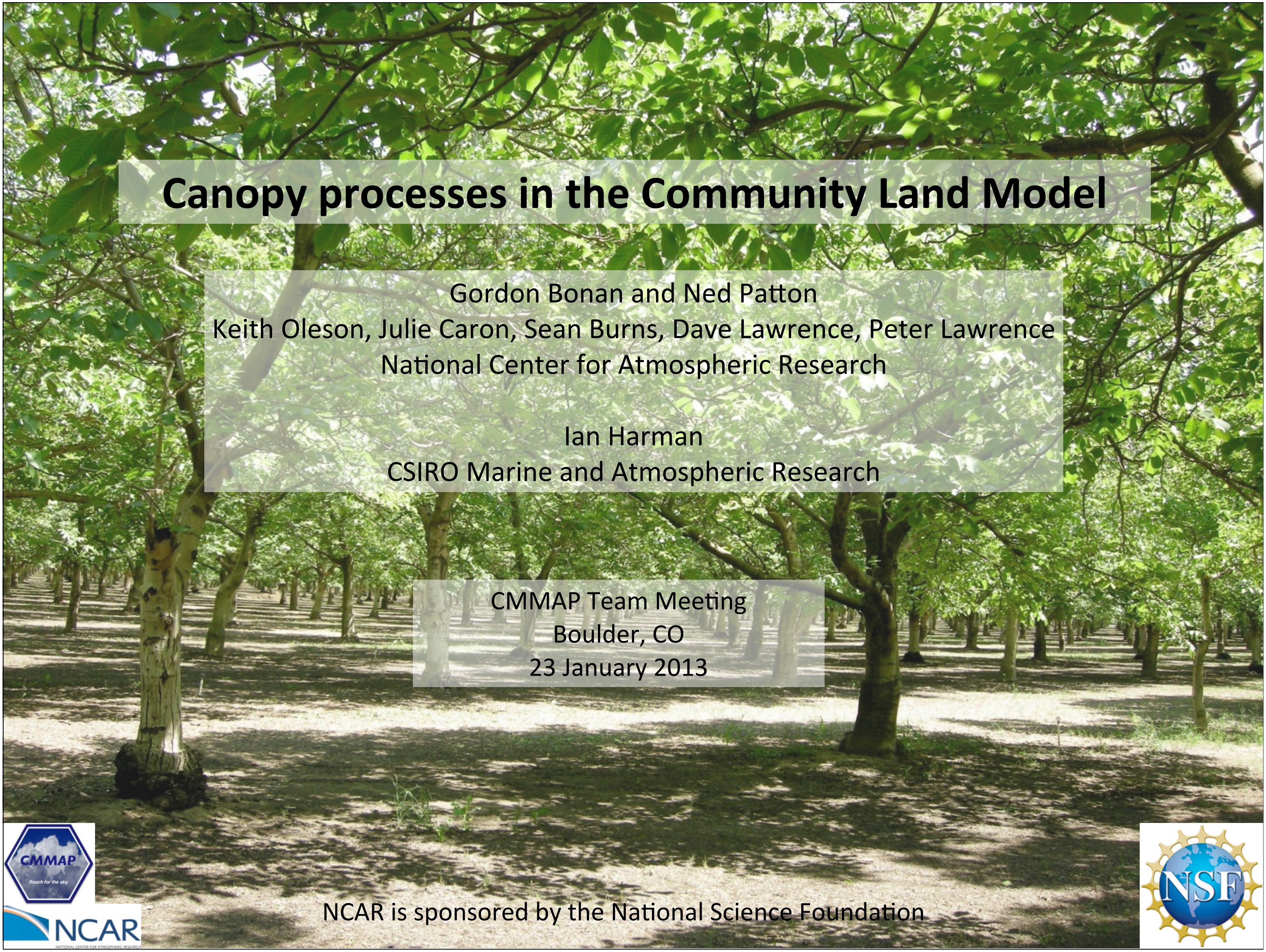
Diurnal cycle of convection over land

- Most inland regions exhibit late afternoon - early evening precipitation maximum.



Map of maximum precipitation hour over US from gridded Radar stage IV data averaged from 2002-2011 (year 2003 data is not included)

- Is diurnal cycle of precipitation purely based on local physics? Or associated with large scale dynamics?



Canopy processes in the Community Land Model

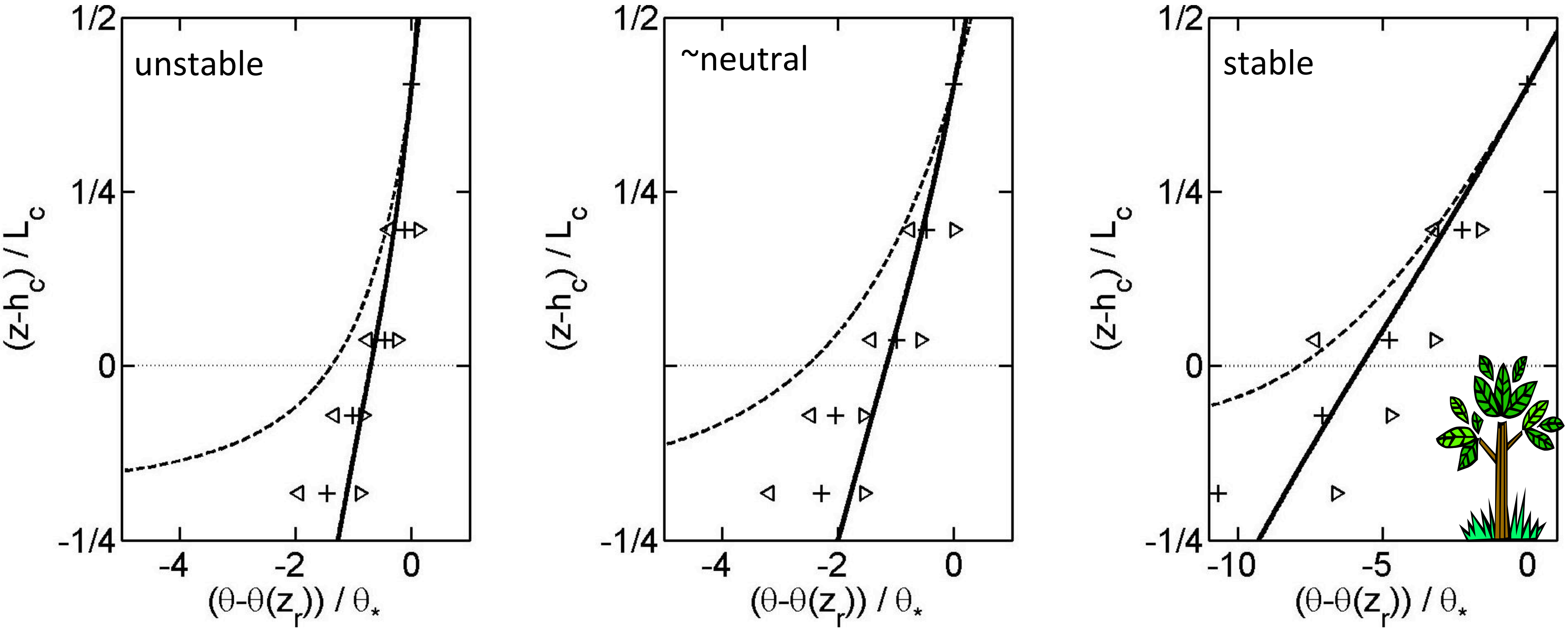
Gordon Bonan and Ned Patton
Keith Oleson, Julie Caron, Sean Burns, Dave Lawrence, Peter Lawrence
National Center for Atmospheric Research

Ian Harman
CSIRO Marine and Atmospheric Research

CMMAP Team Meeting
Boulder, CO
23 January 2013

NCAR is sponsored by the National Science Foundation

Comparison with observations - scalar profiles

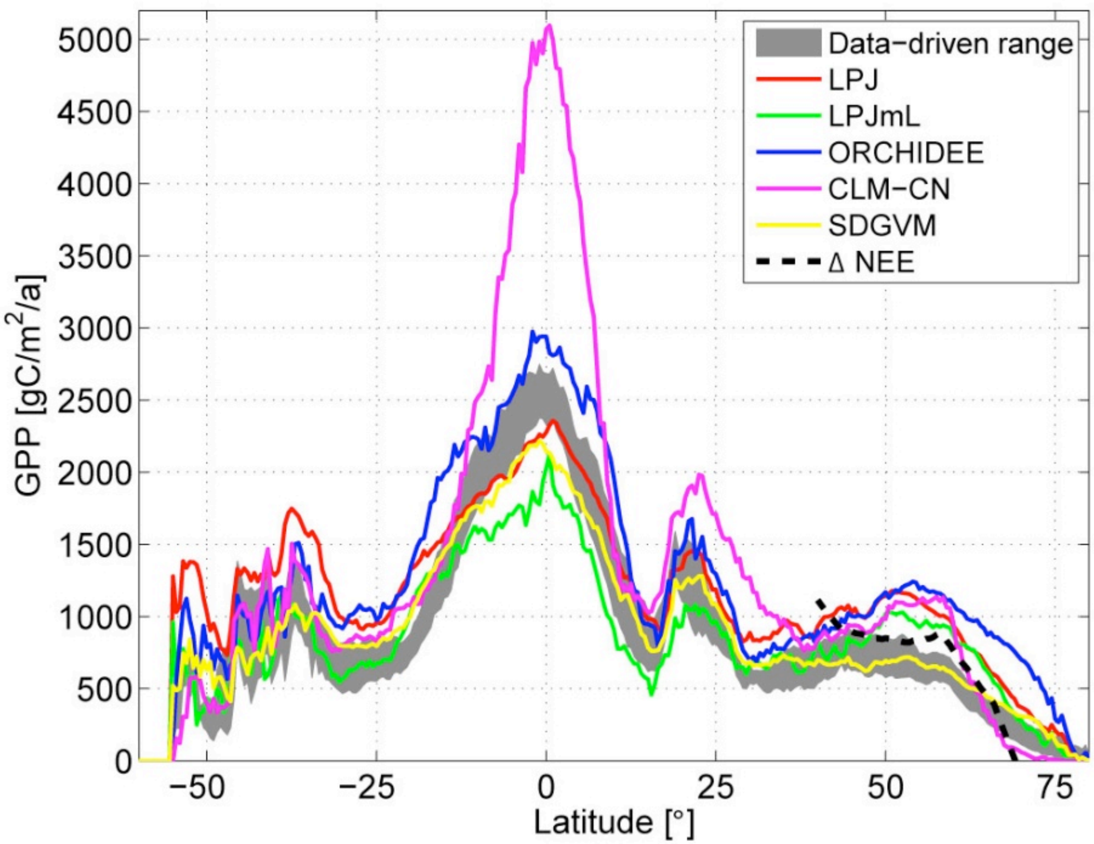


Similar agreement for water vapor concentration but not for CO_2 concentration

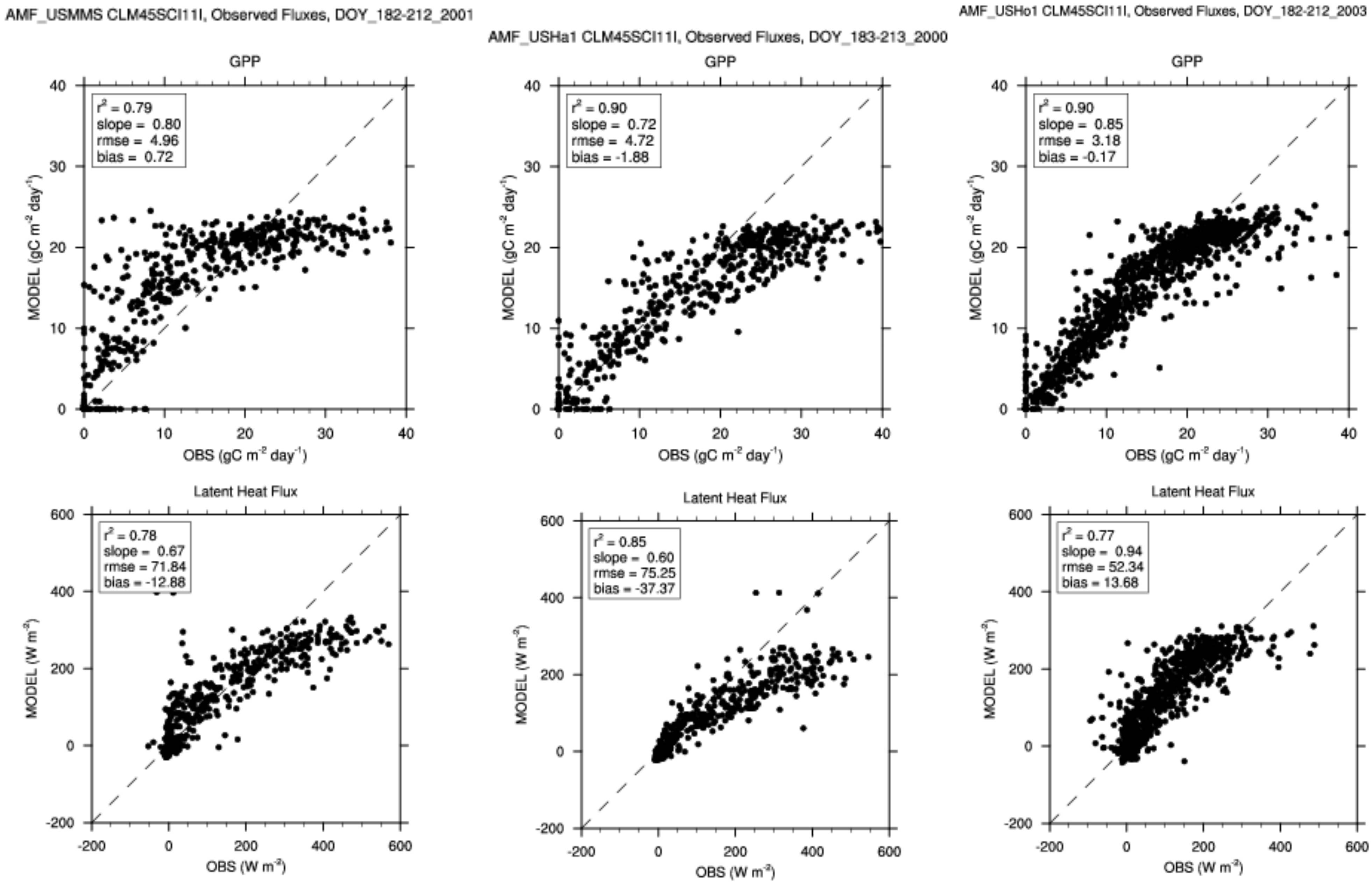
Harman and Finnigan (2008)

GPP biases

CLM4 (purple line) overestimates annual gross primary production (GPP) compared with data-driven estimates and other models



Beer et al. (2010) Science 329:834-838


AMF_USMMS CLM45SCI11I, Observed Fluxes, DOY_182-212_2001
AMF_USHa1 CLM45SCI11I, Observed Fluxes, DOY_183-213_2000
AMF_USHo1 CLM45SCI11I, Observed Fluxes, DOY_182-212_2003
GPP
r^2 = 0.79
slope = 0.80
rmse = 4.96
bias = 0.72
MODEL (gC m^{-2} day^{-1})
OBS (gC m^{-2} day^{-1})
GPP
r^2 = 0.90
slope = 0.72
rmse = 4.72
bias = -1.88
GPP
r^2 = 0.90
slope = 0.85
rmse = 3.18
bias = -0.17
Latent Heat Flux
r^2 = 0.78
slope = 0.67
rmse = 71.84
bias = -12.88
MODEL (W m^{-2})
OBS (W m^{-2})
Latent Heat Flux
r^2 = 0.85
slope = 0.60
rmse = 75.25
bias = -37.37
Latent Heat Flux
r^2 = 0.77
slope = 0.94
rmse = 52.34
bias = 13.68

Leaf-to-canopy scaling using two-leaf canopy

Plant, Cell and Environment (1997) **20,** 537–557

Simple scaling of photosynthesis from leaves to canopies without the errors of big-leaf models

D. G. G. DE PURY & G. D. FARQUHAR

Environmental Biology, Research School of Biological Sciences, Institute of Advanced Studies, The Australian National University, Canberra, ACT, Australia

ELSEVIER

Agricultural and Forest Meteorology 91 (1998) 89–111

AGRICULTURAL AND FOREST METEOROLOGY

A two-leaf model for canopy conductance, photosynthesis and partitioning of available energy I: Model description and comparison with a multi-layered model

Y.-P. Wang[a,*], R. Leuning[b]

[a] *CSIRO Division of Atmospheric Research, PMB # 1, Aspendale, Vic 3195, Australia*
[b] *CSIRO Land and Water, FC Pye Laboratory, Canberra, ACT 2601, Australia*

REMOTE SENS ENVIRON 42 187–216 (1992)

Canopy Reflectance, Photosynthesis, and Transpiration. III. A Reanalysis Using Improved Leaf Models and a New Canopy Integration Scheme.

P. J. Sellers, J. A. Berry,† G. J. Collatz,† C. B. Field,† and F. G. Hall**

**NASA/Goddard Space Flight Center, Greenbelt and †Carnegie Institution, Stanford, California*