Simulating ET from ecosystems and the carbon balance for California landscapes

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Objectives for the Pilot Study Discussed between UCD & DWR

- To combine real-time land use GIS and environmental data with UCD-ACASA (UC Davis Advanced Canopy-Atmosphere-Soil Algorithm) to estimate daily ET and CO_2 exchange accurately, especially for the Delta (DeltaVision)

- To compare ACASA ET simulations with data from CIMIS

- To link ACASA to WRF (Weather Research and Forecast model) for making daily ET (and CO_2) forecasts

- To compare ACASA-WRF ET predictions with data from CIMIS

Long Term Applications of the Pilot Study

- Water Consumption and CO_2 exchange for California Landscapes, past, present, short-term predictions, and long-term predictions including Climate Change; snowpack and snowmelt predictions also

Additional Steps Needed to Reach Long Term Applications

- Extension of Study Domain to Entire State
- Historical Weather & Landscape Data (Past)
- Current Weather & Landscape Data (present)
- Synoptic Scale Predicted Weather & Current Landscape Data
- (short-term predictions)
- General Circulation Model Output, Interpolated to Regional Scale Nesting with connection to ACASA (long-term predictions)

ACASA: Biosphere-atmosphere evapotranspiration

CO_2 H_2O
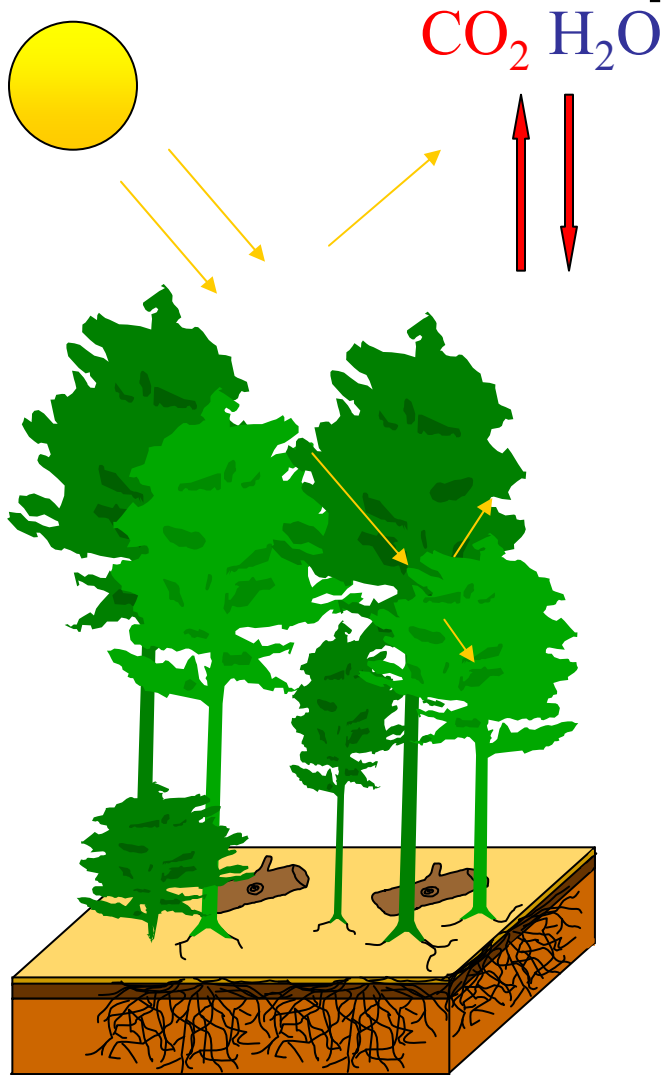
a.) Water Vapor (ET) and energy fluxes

b.) Carbon Dioxide Exchange

c.) Inputs: Radiation, wind, surface type, soil moisture, humidity, temperature, etc.

ACASA Modeling (Process Based) with WRF Linkage

Soil-Plant-Atmosphere Models scale from Leaf to Canopy to Regions of 100's of km

Processes of evaporation and transpiration from Soil, Leaves

Processes of Photosynthesis and Respiration from Soil, Leaves, Stems, etc.

Processes of Turbulent Transfer from Canopy Layers to Atmosphere

Processes of Radiation Transfer through Canopy

Model Overview: Regional Scale (MM5, WRF)
    Linked to Detailed Surface Layer Model
    ACASA

ACASA being shared with U.S., German, Italian,
Australian Colleagues, with training given to their
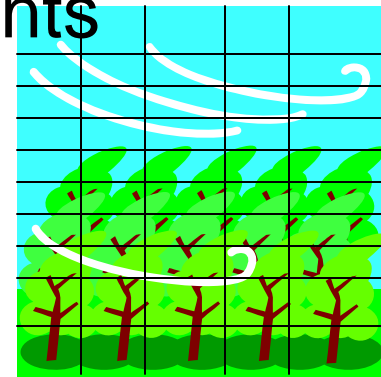personnel

ACASA can be run as a stand-alone model for
field scale estimates of water demand and
carbon exchange, including in conjunction with
remotely sensed data

ACASA-WRF Modeling to Scale Up

Leaf Parameterization
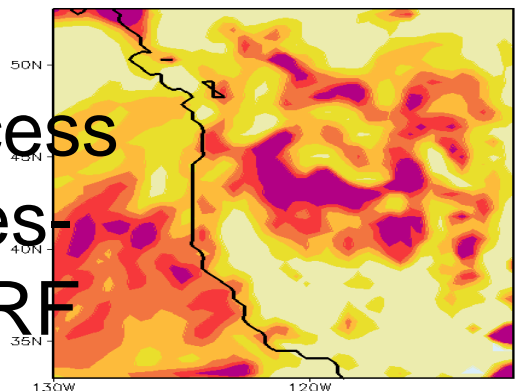(Ball-Berry,Von
Caemmerer-Farquhar);
Soil

Layer or Discretize
Canopy, Equations
for Transfer Between
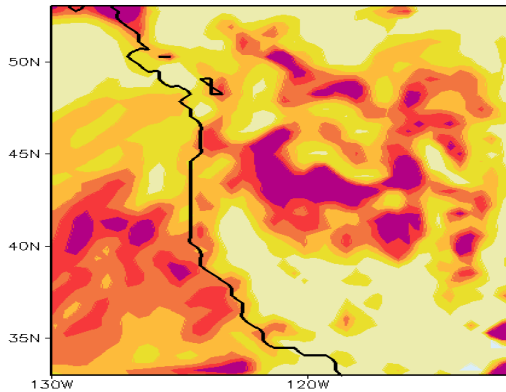Points

Abstract Plants
As Parts of Elements
In Canopies

Continue Process
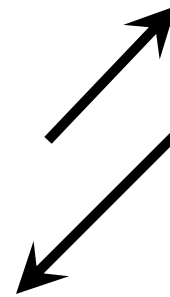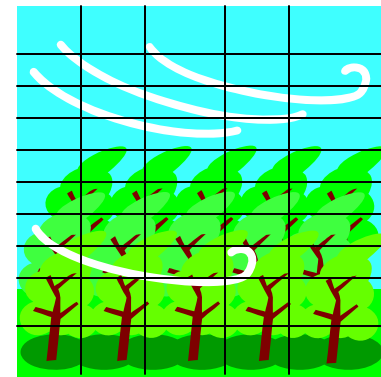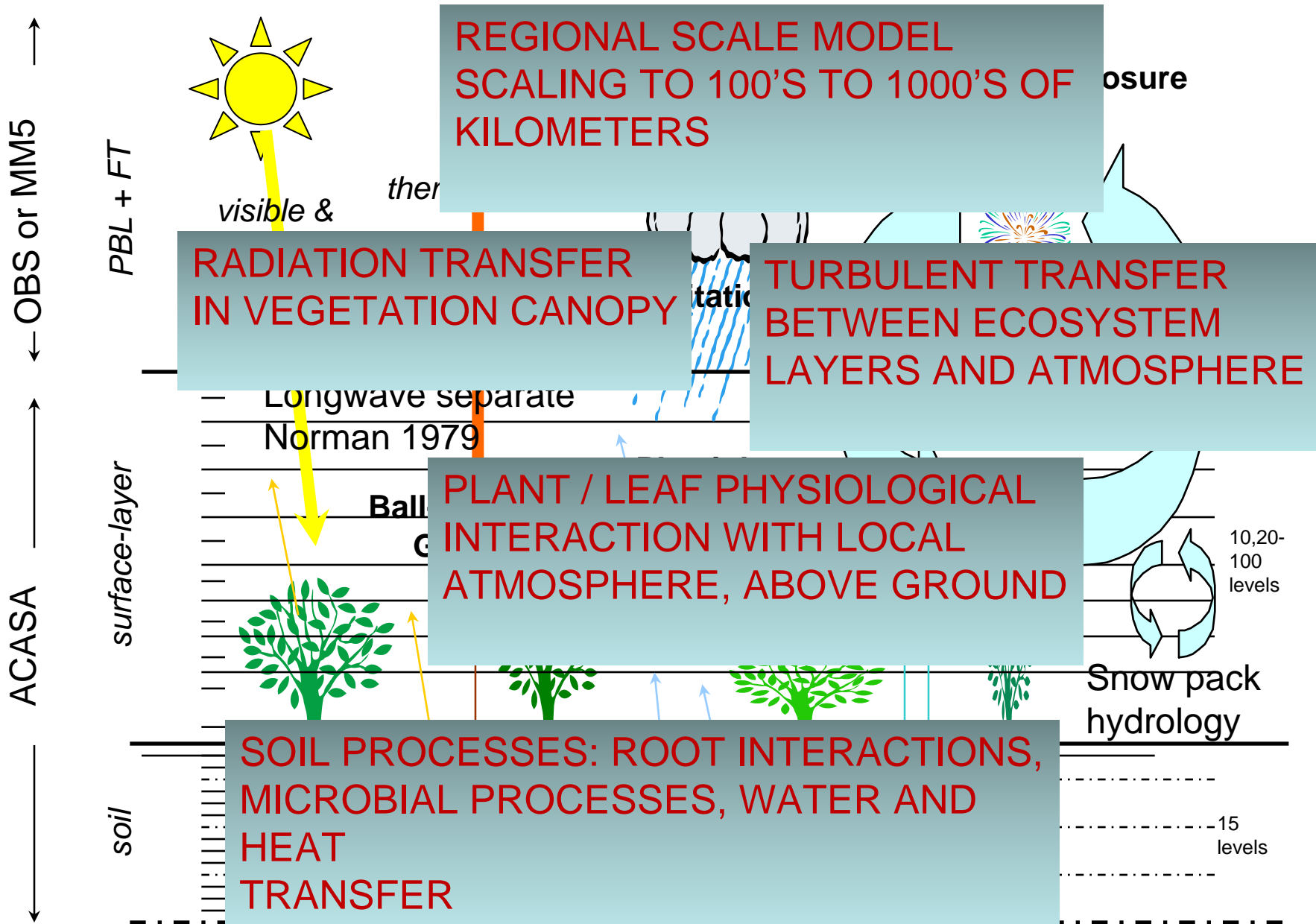to Large Scales-
10's of km; WRF

ACASA-WRF Interactive (WRF Grids)

ACASA

Fluxes and Weather
Variables Interact
Grid size 1-10's km
Domain 100's km

OBS or MM5

PBL + FT

ACASA

surface-layer

soil

visible &

ther...

REGIONAL SCALE MODEL SCALING TO 100'S TO 1000'S OF KILOMETERS

osure

RADIATION TRANSFER IN VEGETATION CANOPY

tatio...

TURBULENT TRANSFER BETWEEN ECOSYSTEM LAYERS AND ATMOSPHERE

Longwave separate
Norman 1979

Ball...
G...

PLANT / LEAF PHYSIOLOGICAL INTERACTION WITH LOCAL ATMOSPHERE, ABOVE GROUND

10,20-100 levels

Snow pack hydrology

15 levels

SOIL PROCESSES: ROOT INTERACTIONS, MICROBIAL PROCESSES, WATER AND HEAT TRANSFER

UCD Advanced **C**anopy-**A**tmosphere-**S**oil **A**lgorithm

(SCALES FROM SOIL & LEAF TO ENTIRE PLANT CANOPY)

REGIONAL SCALE MODEL SCALING TO 100'S TO 1000'S OF KILOMETERS

visible & near-IR

ther...

Radiation

Precipitation

heat, H₂O, CO...

...osure

SURFACE CAN BE BARE GROUND, DESERT, WATER, SNOW, ICE, GRASSLAND, SHRUBS, AGRICULTURAL FIELDS, FORESTS, VILLAGES, CITIES

PBL + FT

OBS or MM5

surface-layer

ACASA

20-
...els

soil

hydrology

Layered heat and moisture (liquid only) transport,
Root distribution—standard diffusion equations

15 levels

UCD Advanced **C**anopy-**A**tmosphere-**S**oil **A**lgorithm

(SCALES FROM SOIL & LEAF TO ENTIRE PLANT CANOPY)

QFX between 2007-12-03_00:00:00 and 2007-12-04_00:00:00

UPWARD MOISTURE FLUX AT THE SURFACE   kg m-2 s-1

5e-05
4.81652e-05
4.63303e-05
4.44955e-05
4.26607e-05
4.08258e-05
3.8991e-05
3.71562e-05
3.53213e-05
3.34865e-05
3.16517e-05
2.98168e-05
2.7982e-05
2.61472e-05
2.43123e-05
2.24775e-05
2.06427e-05
1.88079e-05
1.6973e-05
1.51382e-05
1.33034e-05
1.14685e-05
9.63369e-06
7.79886e-06
5.96402e-06
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2.29436e-06
4.59527e-07
-1.37531e-06
-3.21014e-06
-5.04497e-06
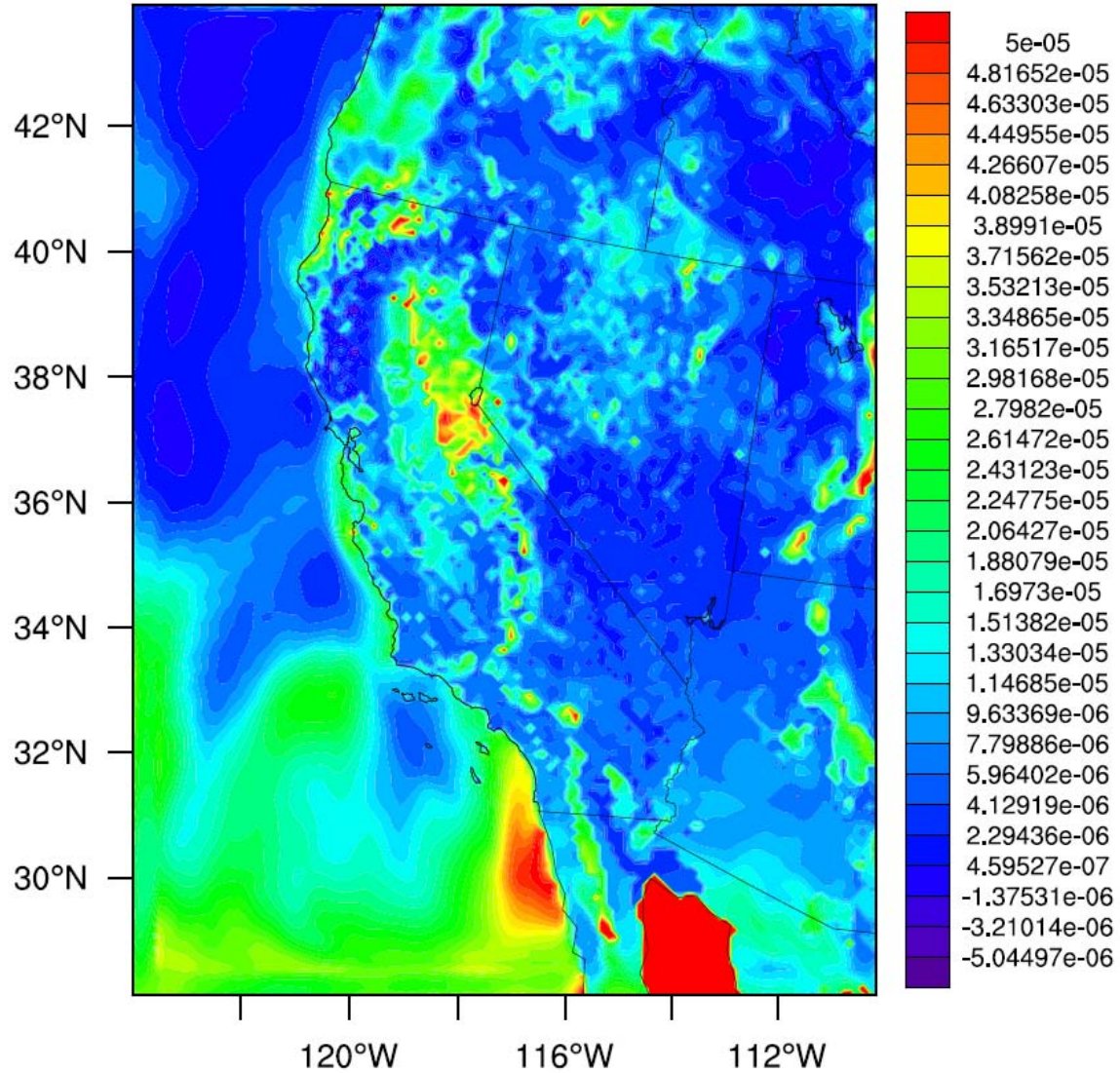
EXAMPLE WRF RUN FOR ACTUAL ET (No ACASA)
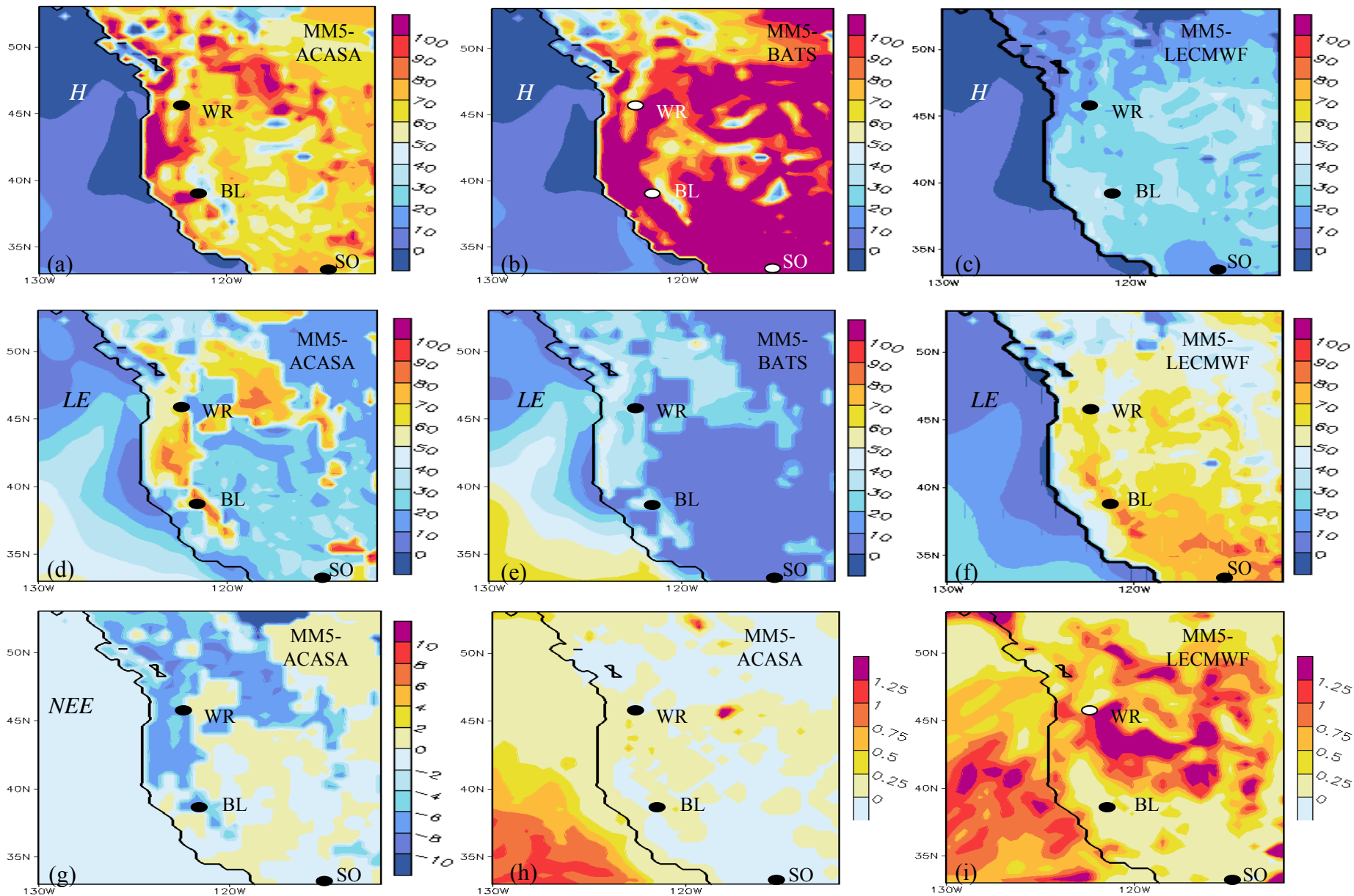
Figure 3: Average July 21-31 fluxes and accumulated precipitation for western North America. Plots (a)-(c) are MM5-ACASA, MM5-BATS, and MM5-LECMWF H (W m^{-2}) values, respectively. Plots (d)-(f) are the same as (a)-(c) but for LE (W m^{-2}). Plot (g) is the average July 21-31 MM5-ACASA NEE, or CO_2 flux density (μmol m^{-2} s^{-1}). Plots (h) and (I) are July 21-31 MM5-ACASA and MM5-LECMWF accumulated precipitation (cm) for western North America, respectively

Land use

Average Surface Fluxes

Latent Heat(Wm^{-2})

July 21-31, 1998

topography

Mean Elevation

savannah
tundra
desert
water
mixed forest
deciduous
range/grass
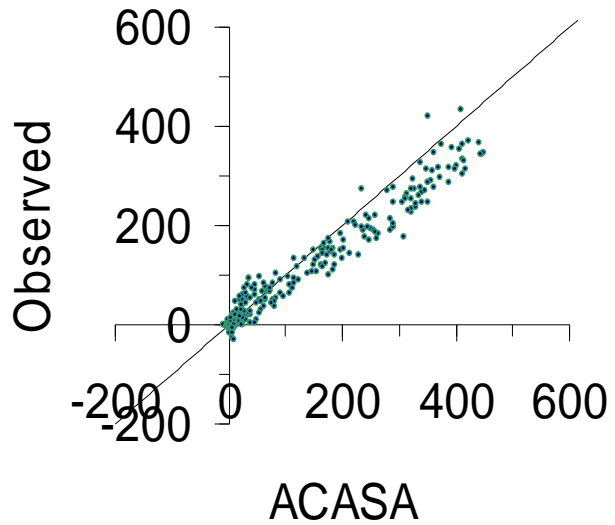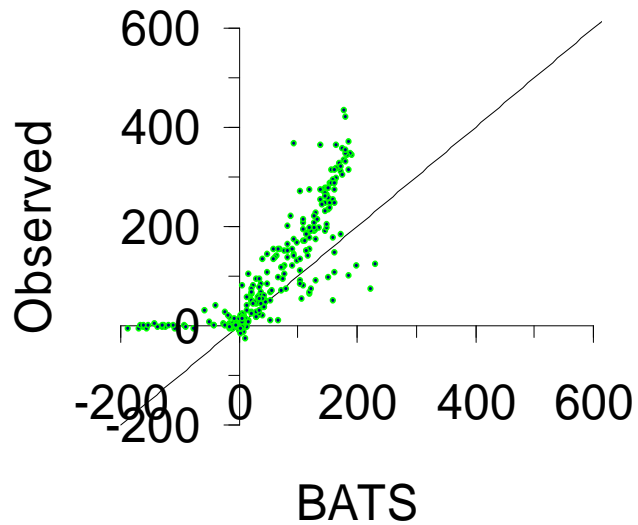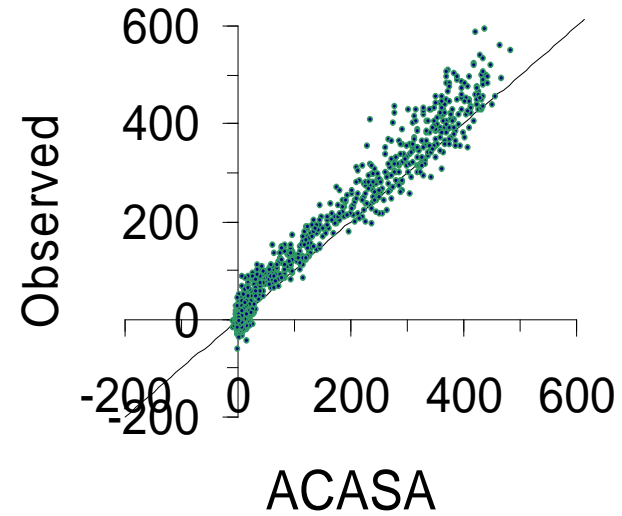agricultural
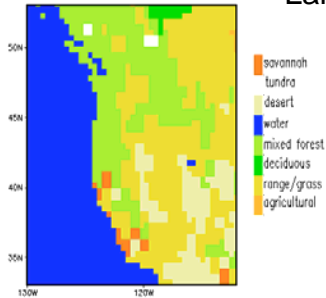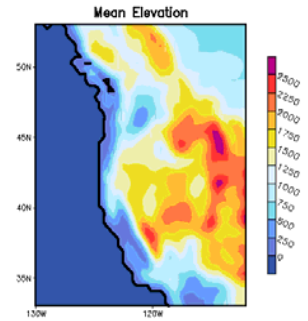
MM5/ACASA
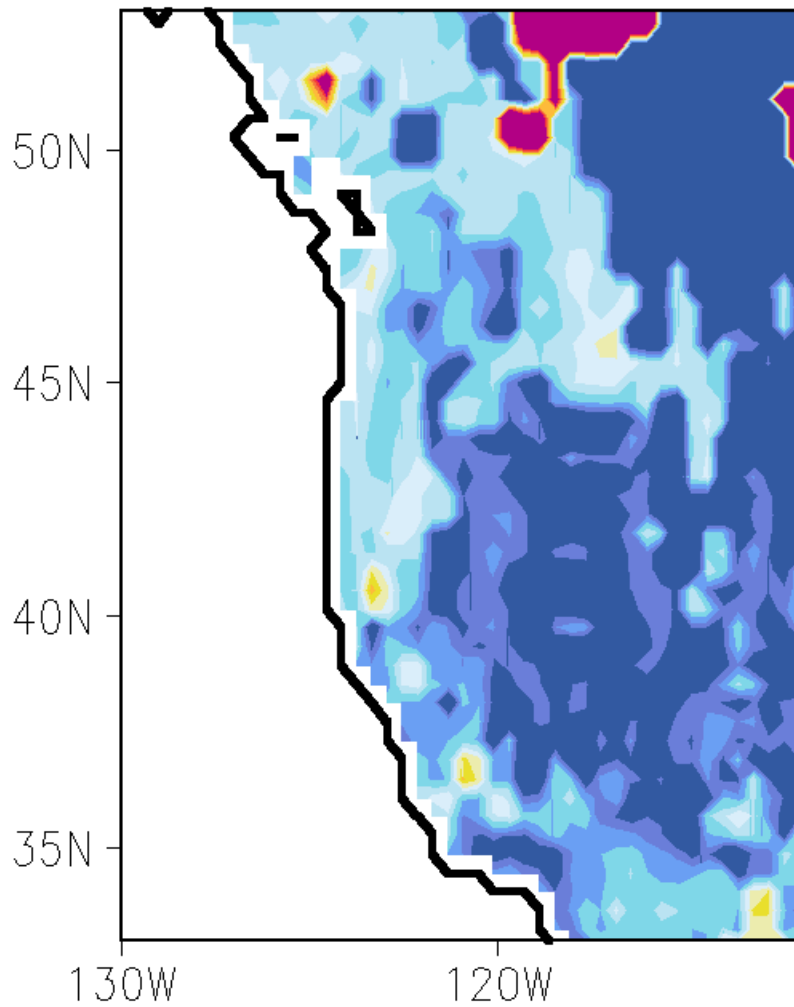
MM5/BATS
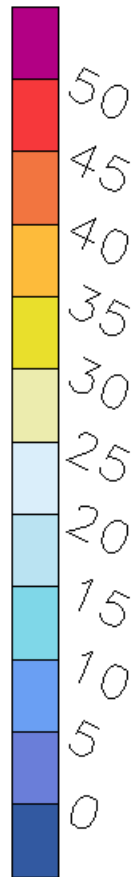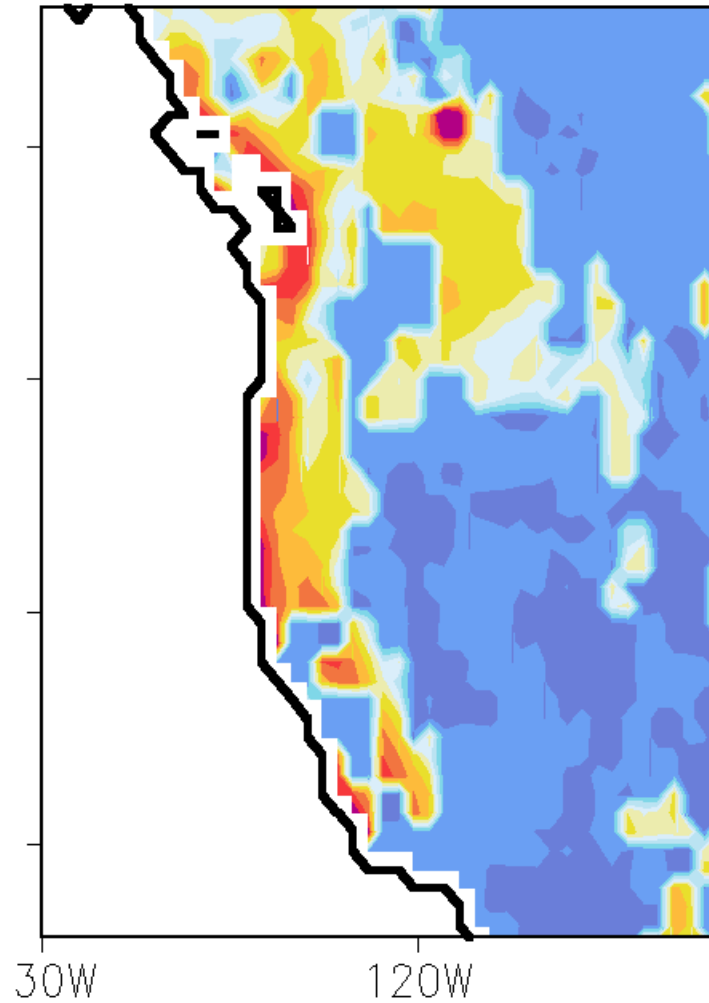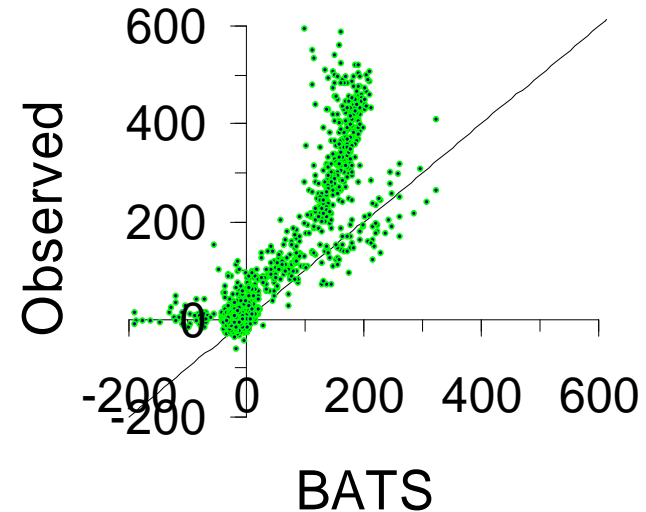
LATENT HEAT FLUX (*LE*) W m^{-2}
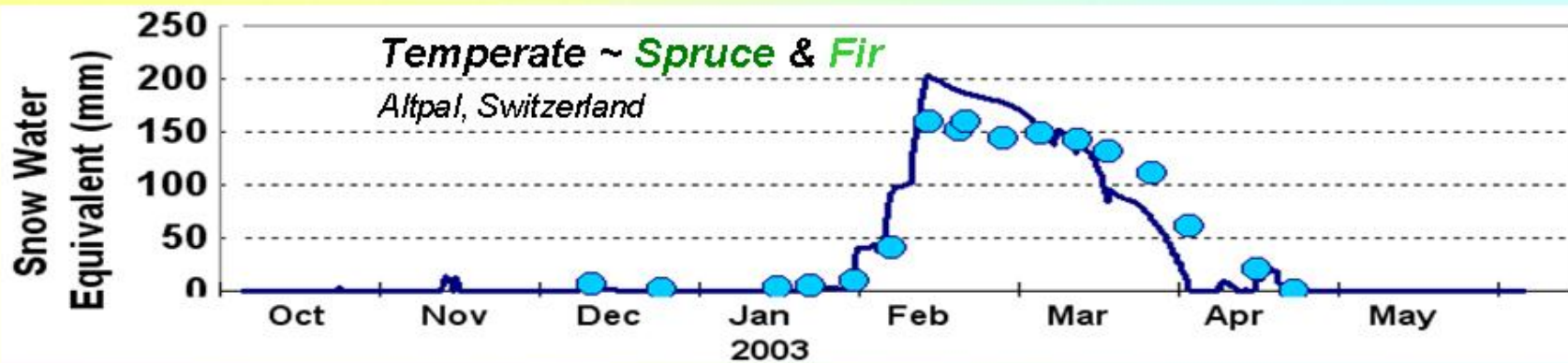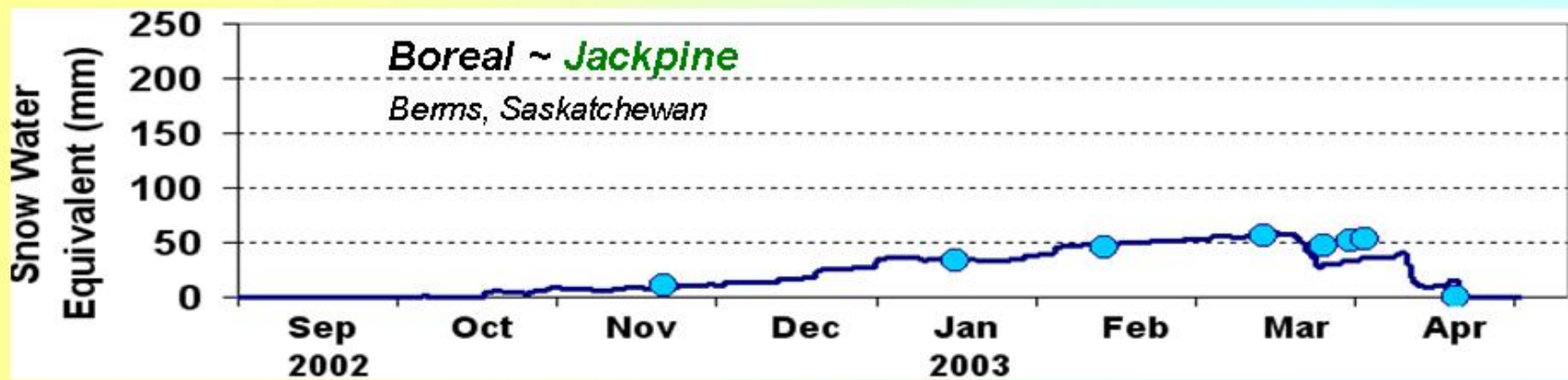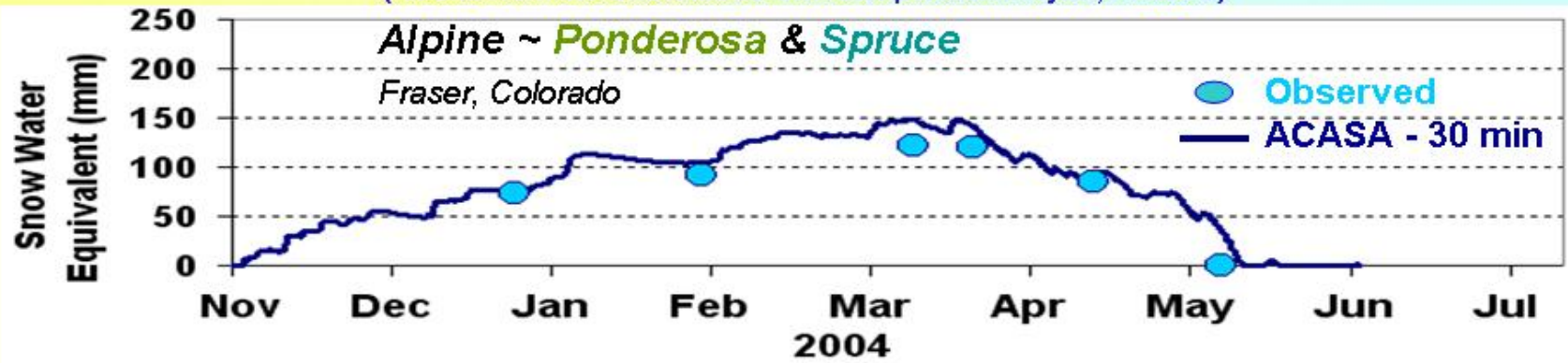

Young Boreal Aspen

ACASA

Tropical Rainforest

BATS

Single-Layer

Pyles, Weare & Paw U, *Q. J. Royal Met. Soc.*, October 2000

FOREST SNOWPACK EVOLUTION – ACASA vs. Observed
(results from the Snow Model Intercomparison Project, Phase II)

SUMMARY

- Potential Collaboration between DWR & UCD for ACASA-WRF Simulations: Water Consumption and CO_2 exchange for California Landscapes, past, present, short-term predictions, and long-term predictions including Climate Change with credible land-surface-atmosphere model of two-way interactions

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Thanks for your Attention!