"hydrometeorological challenges in multi-scale water cycle research": Some Results from Regional Modeling of California's Irrigation Area

Sorooshian, Li
and UC-Irvine CHRS Group

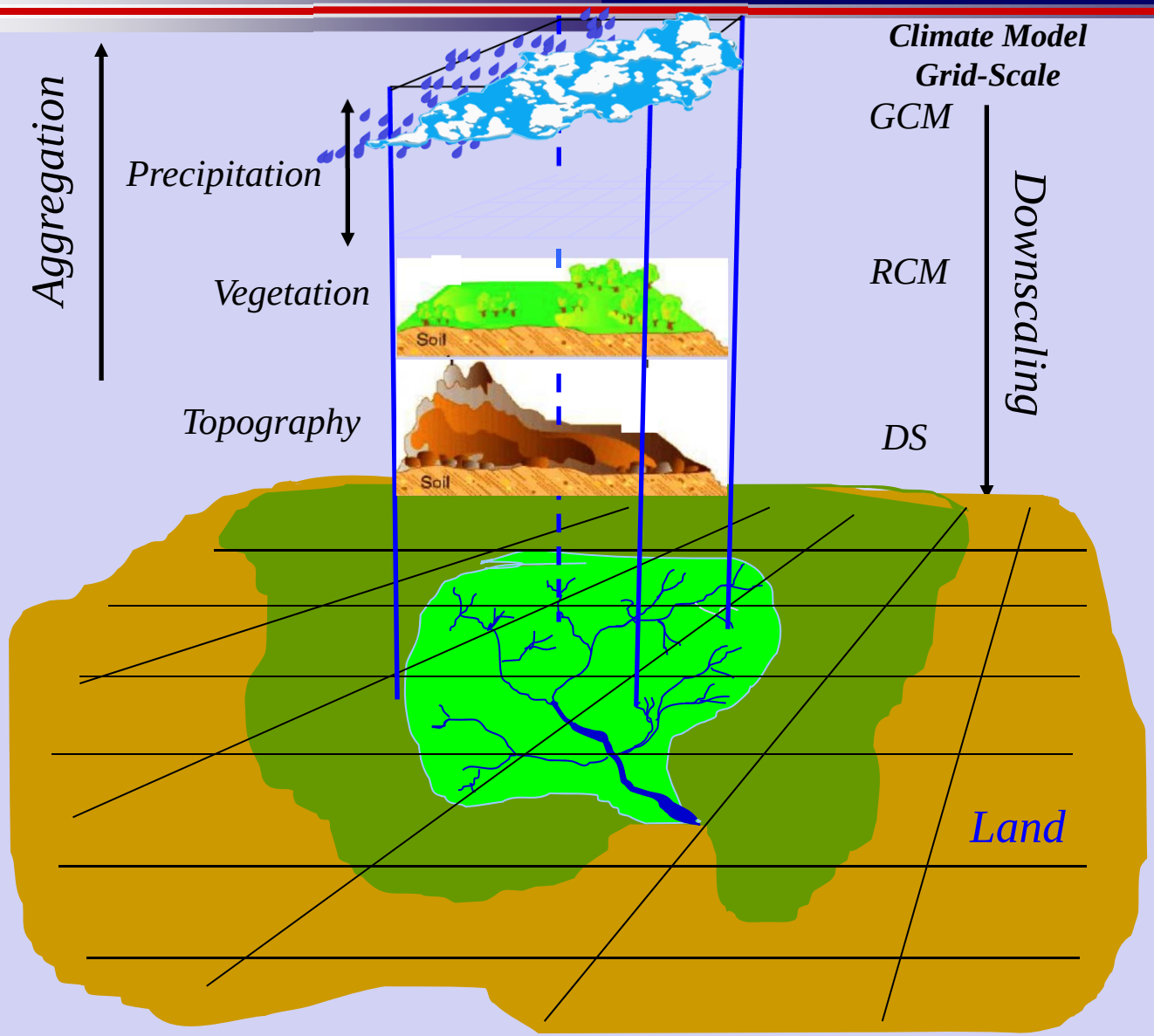
Center for Hydrometeorology and Remote Sensing
University of California Irvine

Supported by NOAA MAPP program and partially NASA-NEWS

Required Hydrometeorologic Predictions

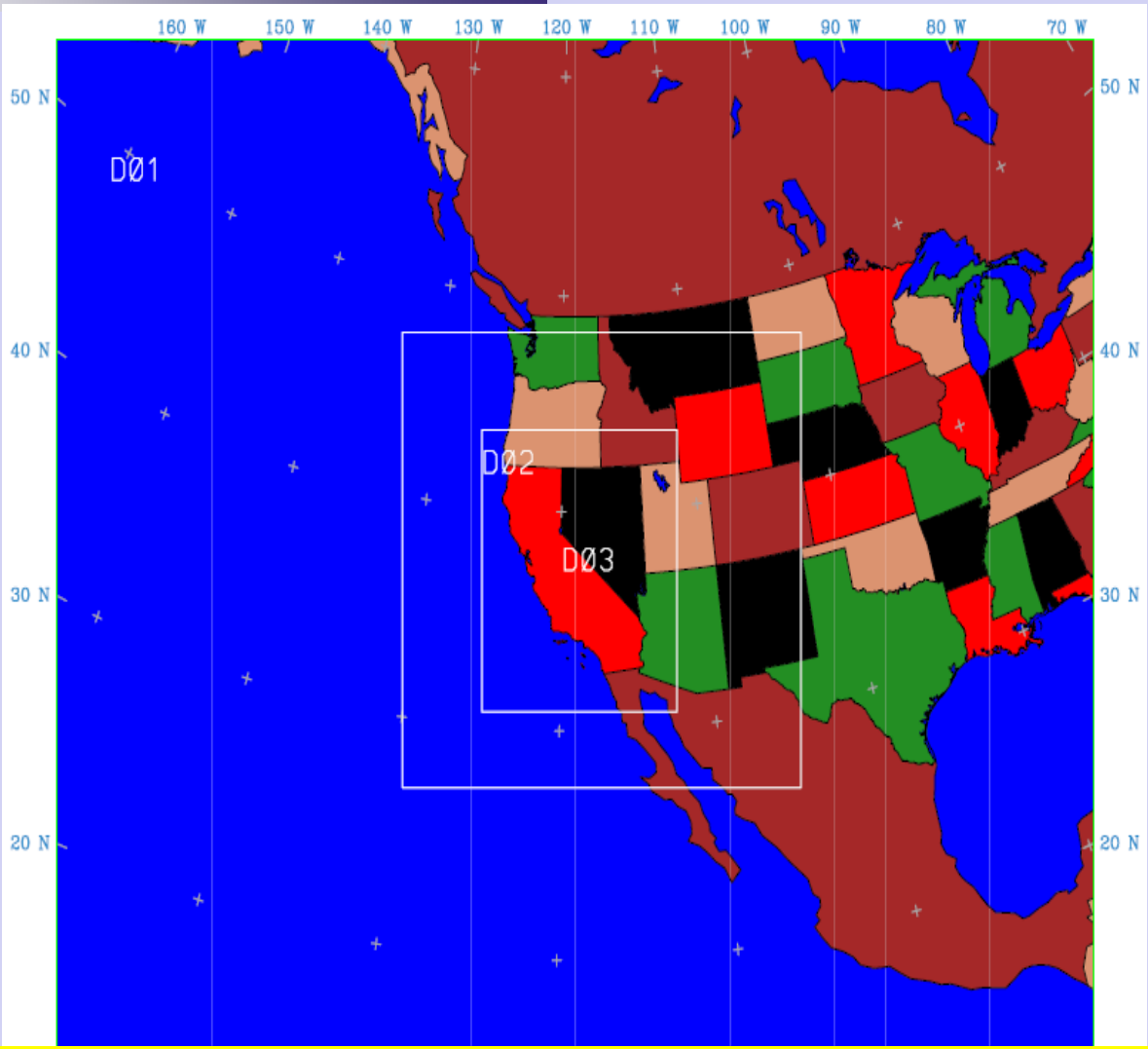
Short Range – · – · – ·

Climate Model Downscaling to regional/watershed Scale



Impact of Irrigation

High Resolution Modeling of Temp and ET



Domain Setup: D1~36km; D2~12km; and D3~4km.

Modeling the effects of irrigation on regional hydroclimate

Previous studies:

1) Based on temperature variation

2) Assuming soil water at field capacity (saturation)

- *the modeled soil layers are kept at field capacity or at full saturation during the simulation runs (e.g.Adegoke, et al. 2003; Haddand et al. 2006; Kueppers at al. 2007)*

Realistic practice: Meteorological conditions are the key factors to decide when and how much water to apply

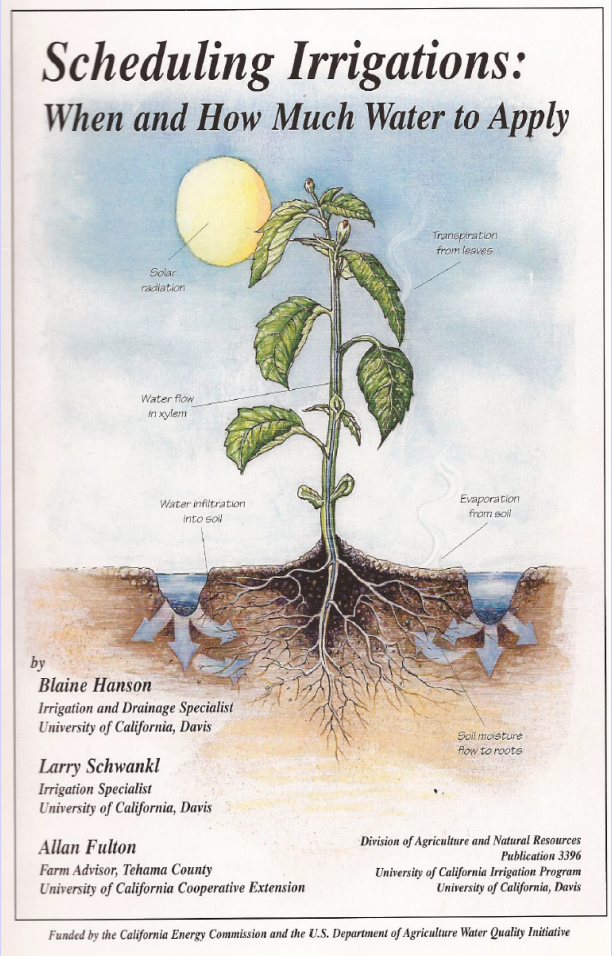
Our studies

Implementing a more realistic irrigation method recommended by Hanson et al. (2004):

Irrigation starts when the root zone's relative available Soil-Water (SW) content is less than maximum allowable water depletion of soil for a crop type (i.e. adding water into model soil);

Irrigation ends when soil moisture reaches field capacity (i.e. stop adding water);

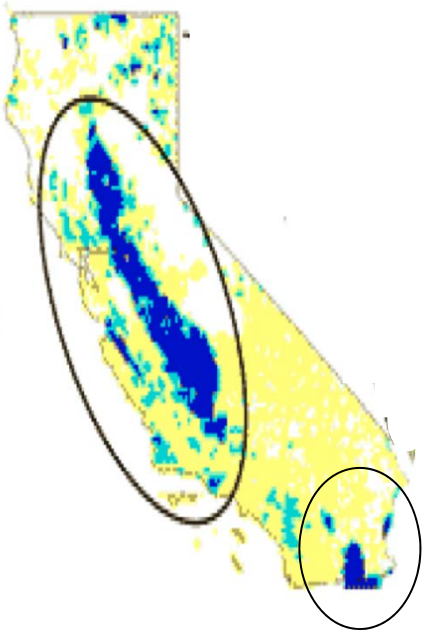
For long-term run, constraints of radiation and soil temp. on irrigation processes are added.



Sorooshian et al. 2011 & 2012

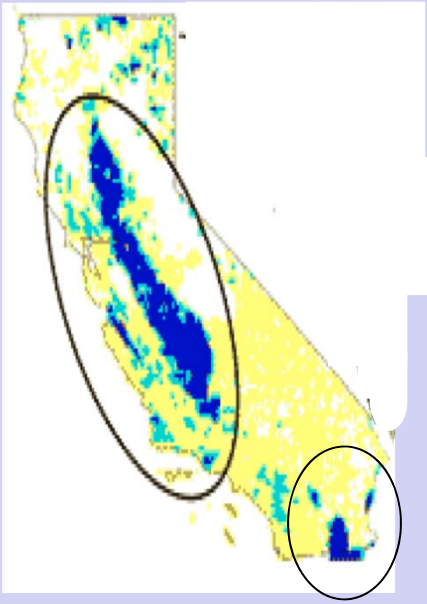
Data Sources:

- *MODIS ET: 0.05-degree, monthly (Tang et al. 2009)*
  http://ftp.hydro.washington.edu/pub/qiuhong/usa/
- *MODIS skin temperature*
  https://lpdaac.usgs.gov/lpdaac/get_data/
- *GLDAS-1 ET: 0.25-degree, monthly*
  http://disc.sci.gsfc.nasa.gov/hydrology/data-holdin
- *Ameriflux at Blodgett Forest site*
  http://public.ornl.gov/ameriflux/
- *California Irrigation Management Information system*
  http://www.cimis.water.ca.gov/cimis/data.jsp

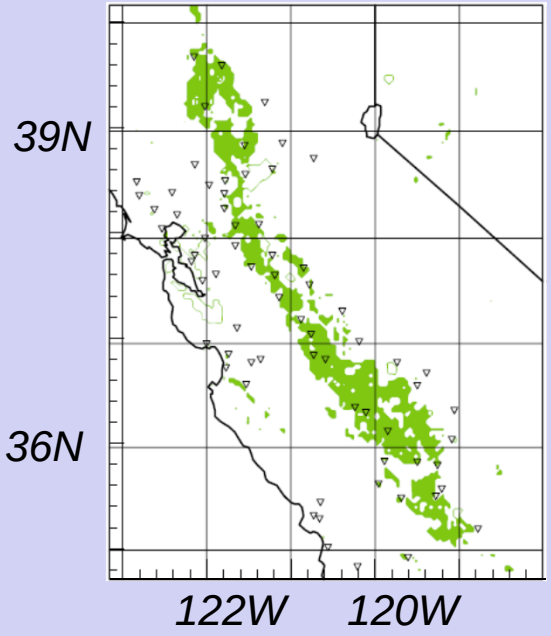


Irrigation over central California

Irrigation areas



CIMIS *stations*



- ***Californian Irrigation Management Information System (CIMIS) with more than 200 stations (nearly 150 active) provides the information to farmers.***

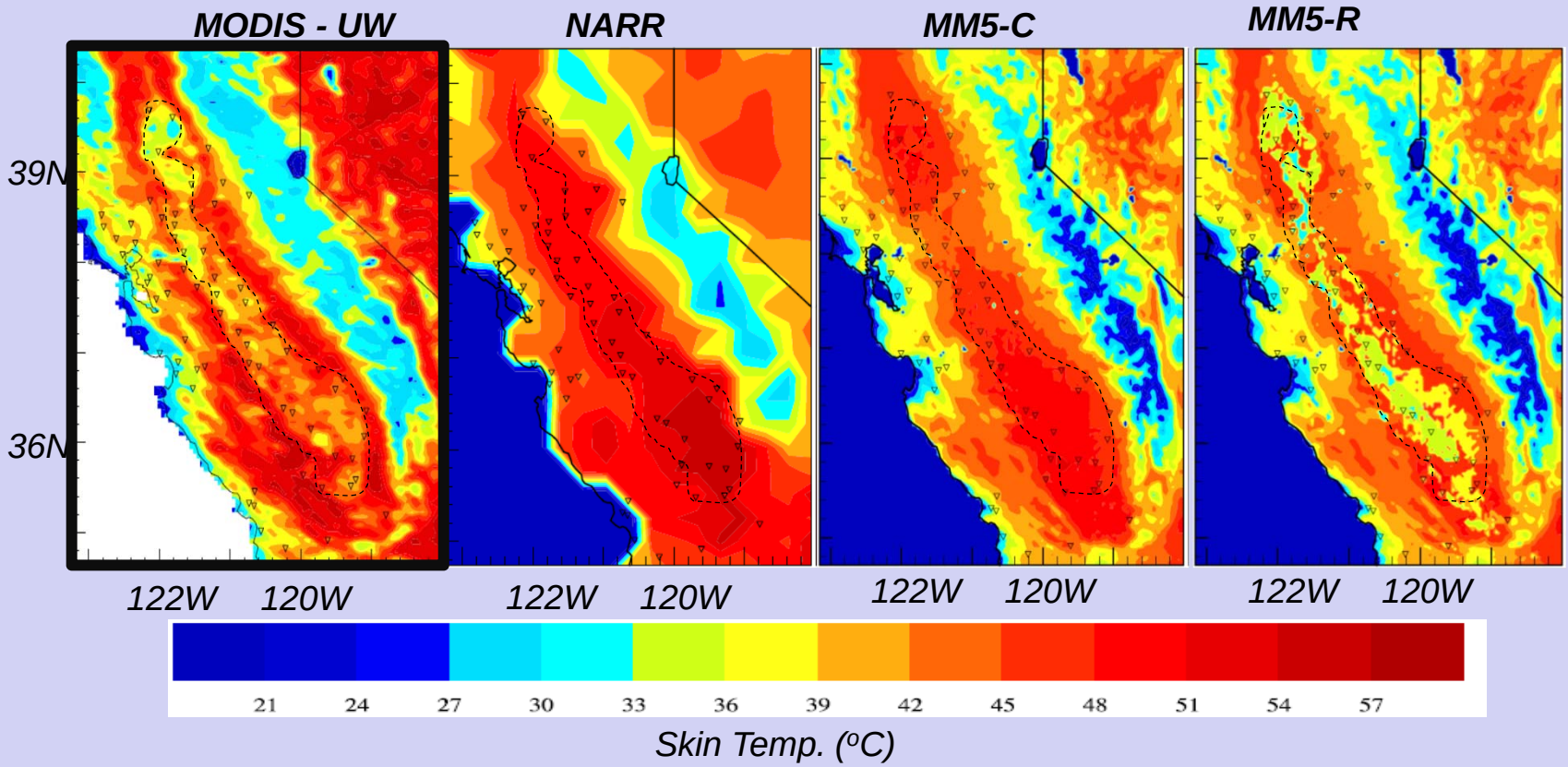
Modeling Study Setup Using MM5

*1- "**Control" run:** without modifying anything (MM5-**C**)*

*2- "**Field Capacity" run:** setting up root-zone soil moisture at **F**ield Capacity at each time step (MM5-**F**)*

*3- "**Recommended" run:** setting up root-zone soil moisture based Hanson et al (2004) method (MM5-**R**).*

Mean skin surface temp. at daytime in June, July and August, 2007.

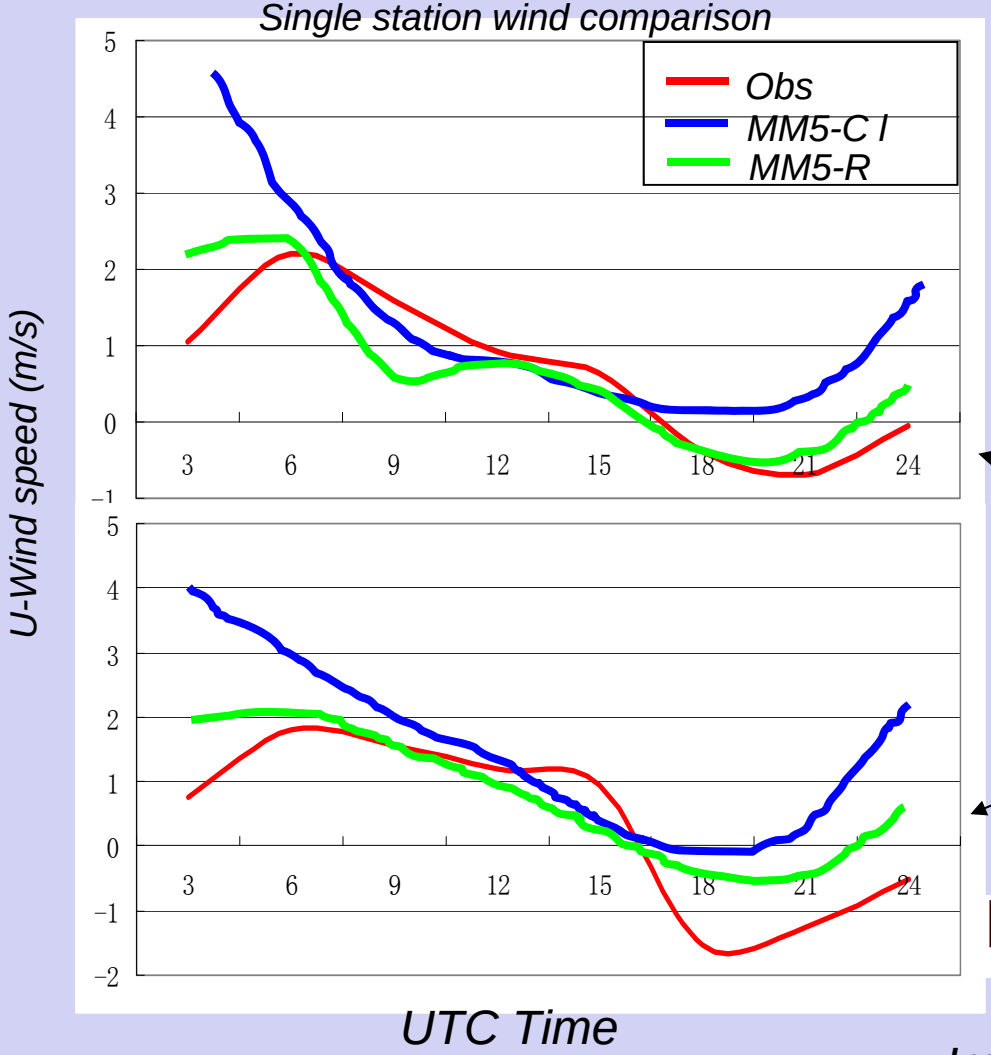


Adding irrigation into RCM (MM5), Improves the model's ability to simulate the temperature patterns observed by MODIS

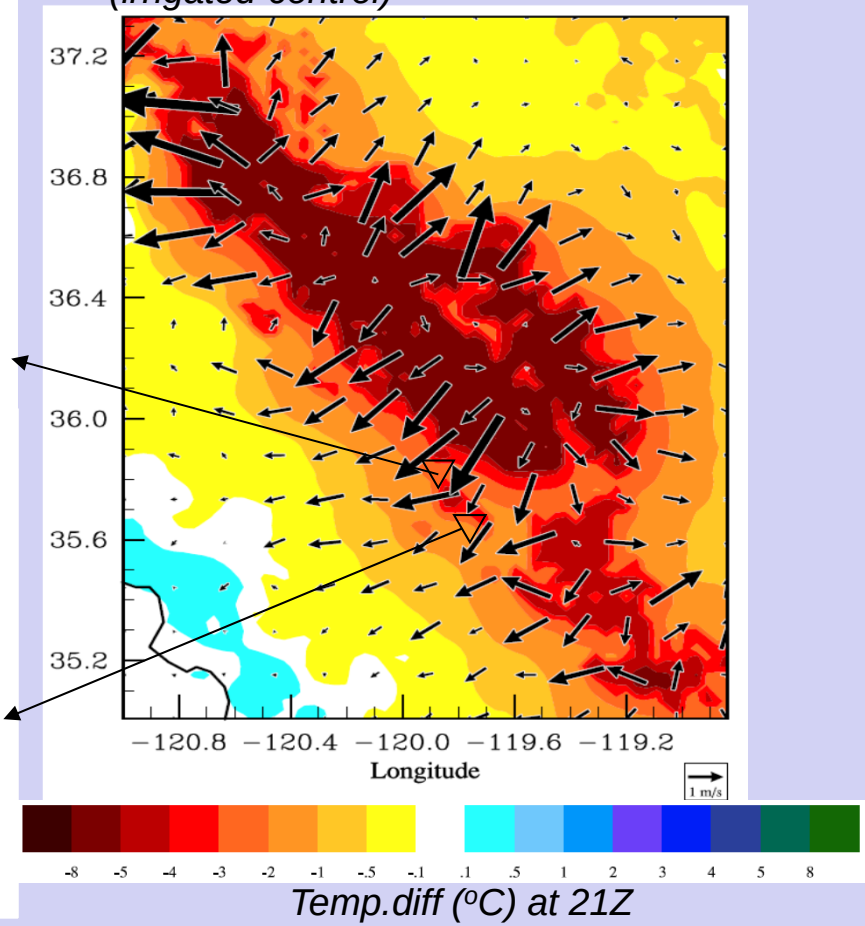
Sorooshian et al, (JGR 2011)

Adding irrigation in model, the surface wind can be improved

Single station wind comparison

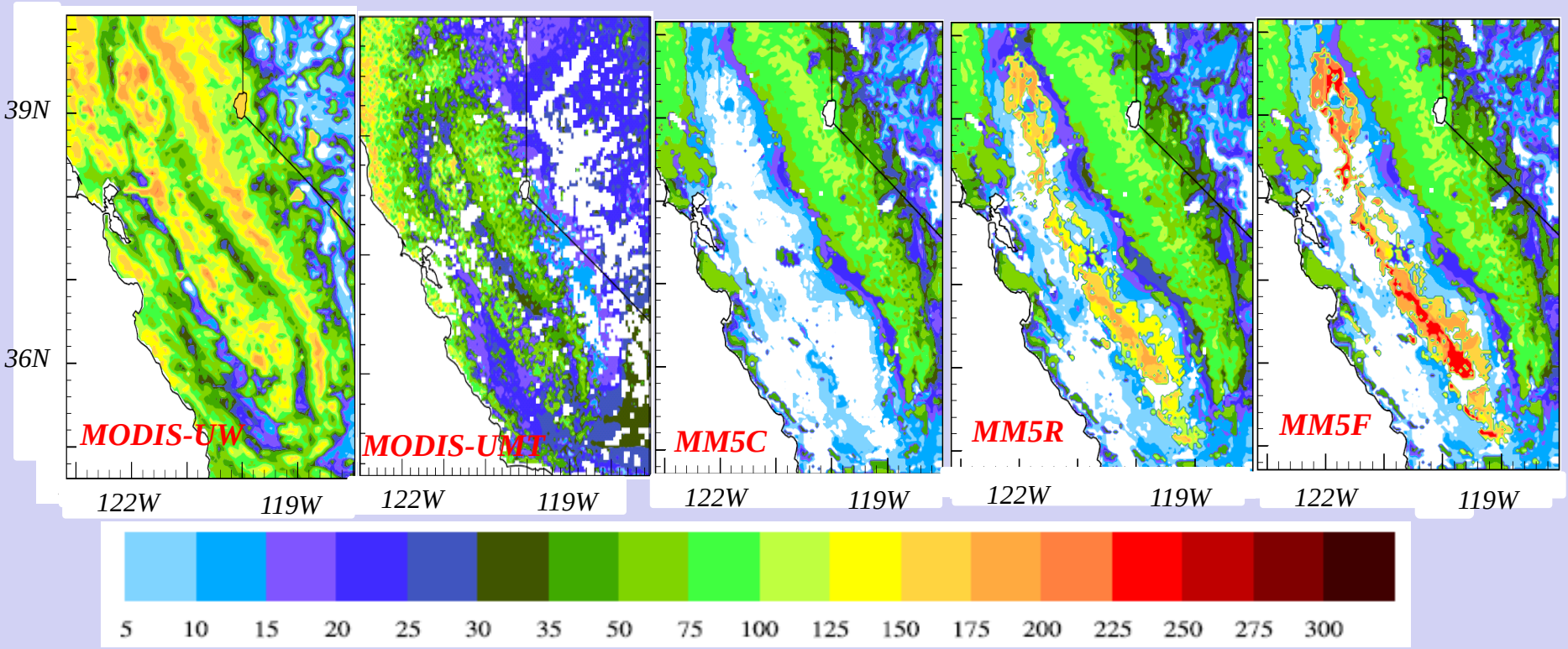


Surface wind and temp. differences between control run and irrigated run (irrigated-control)



Irrigation cause temperature differences as high as 8 C at daytime

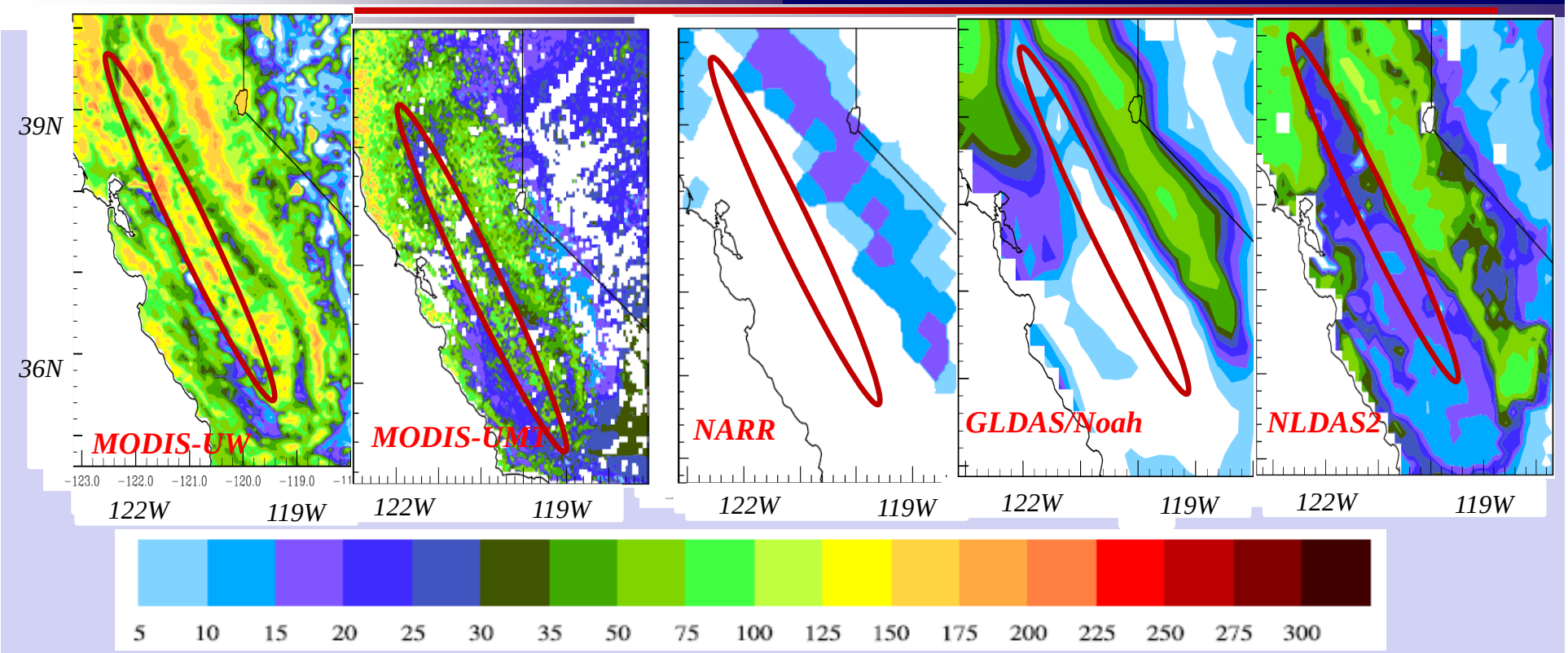
Actual ET comparison results: June, July and August, 2007



2007 JJA Monthly ET (mm)

Modeled ET in Central Valley with/without irrigation in MM5

Actual ET comparison results: June, July and August, 2007



2007 JJA Monthly ET (mm)

ET over California's Central Valley based on different data sets

Li et al, 2011

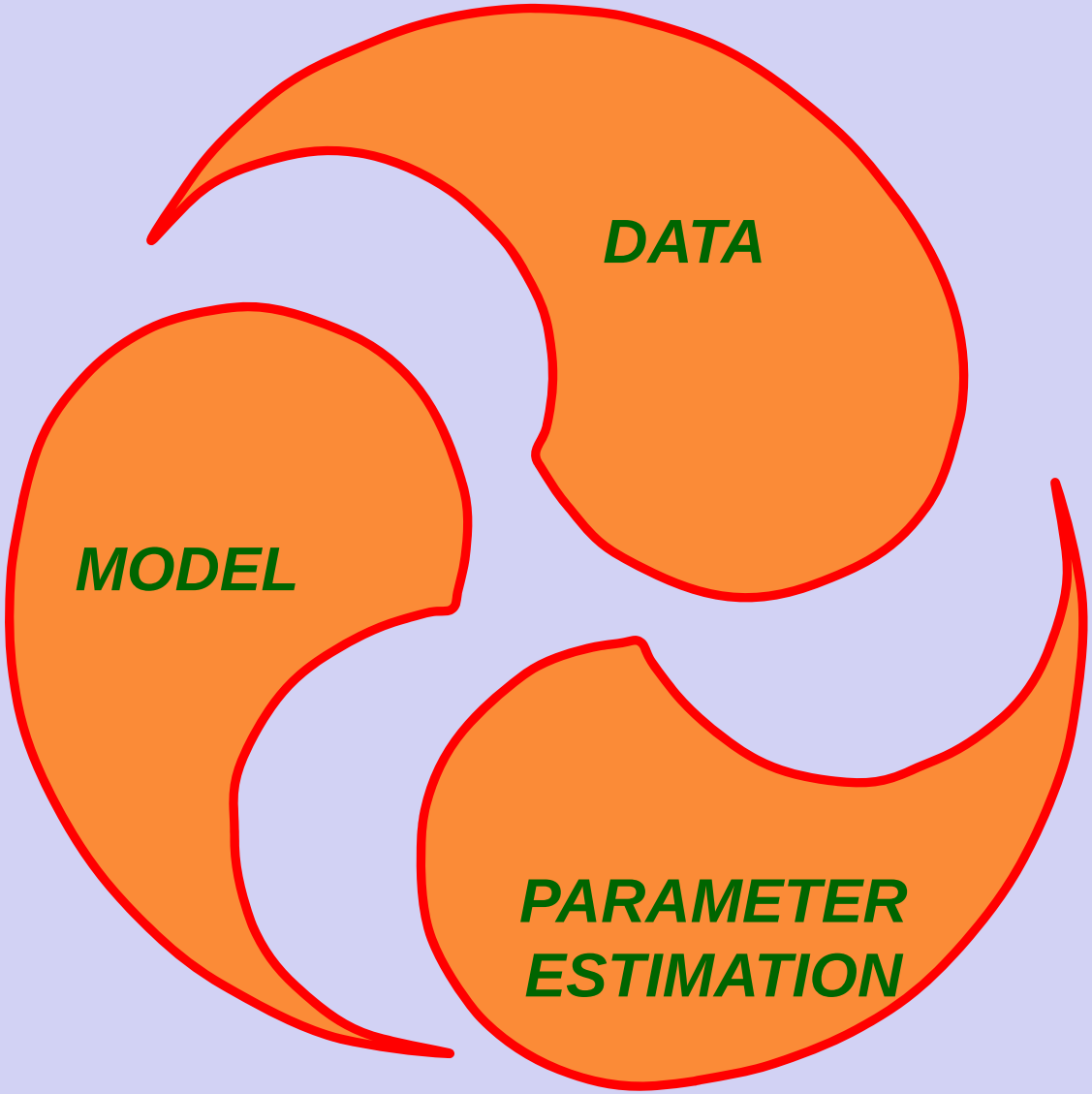
In a nutshell!

- ***ET Underestimation by MM5 control run is roughly about 10 million Ac-Ft of water/yr***
- ***ET Overestimation by MM5 with "full-saturation" irrigation is about 6.5 Million Ac-Ft/yr***
- ***Use of the realistic irrigation scheme results in only 1.5 Million Ac-Ft/yr of overestimation.***

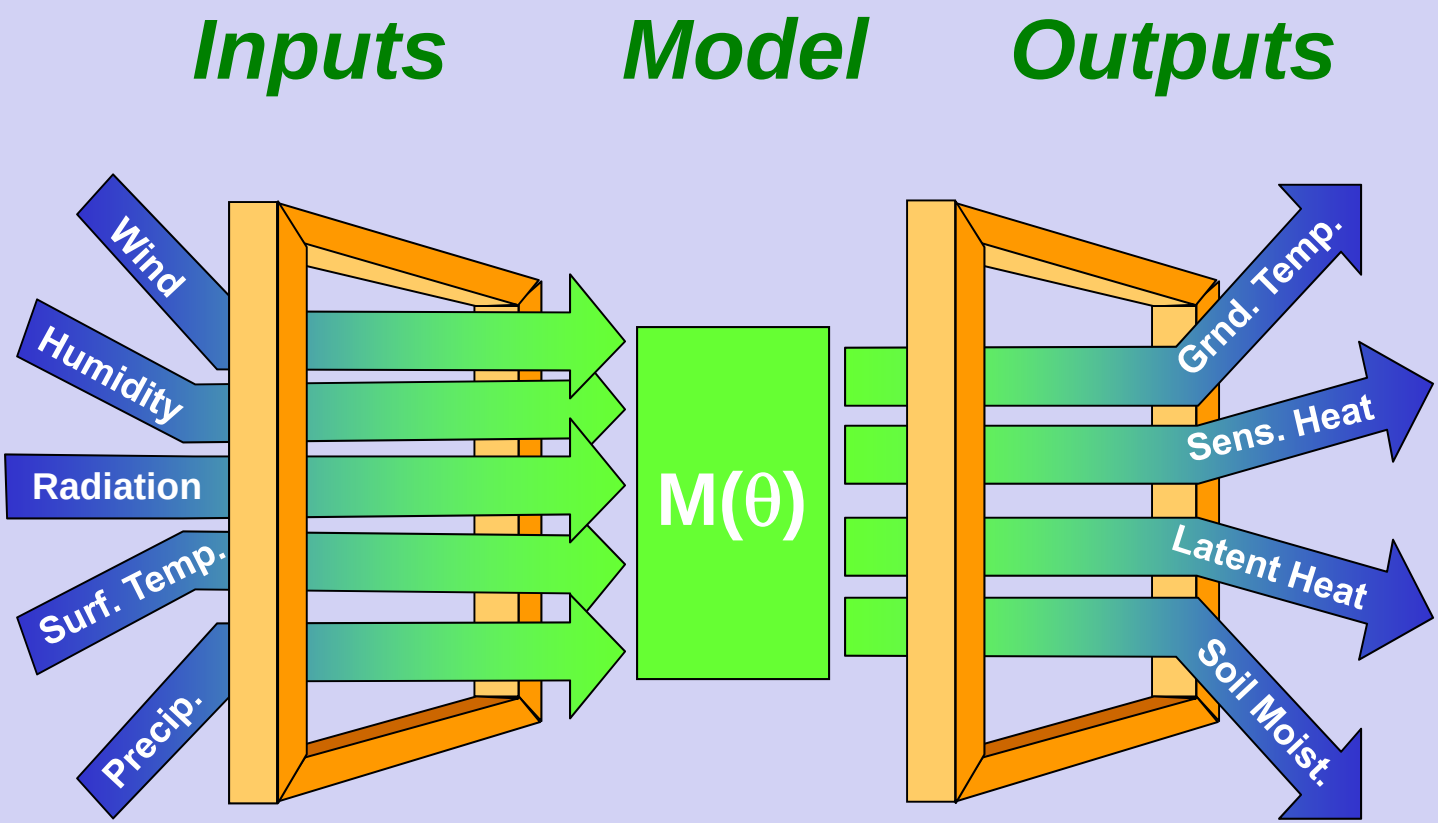
<u>Note:</u>

- ***1 AC-FT is 326,000.00 Gallon and it is estimated that an average household in California (roughly 3 person) uses an average of ¾ AC-Ft/year).***
- ***if placed in human context, amount of underestimation roughly equals supply requirement of 13 million households and the overestimation roughly 9 million households per year.***

Hydrometeorological Modeling: 3 Elements!

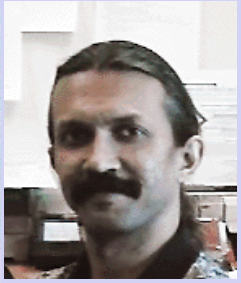


Multi-Objective Approaches

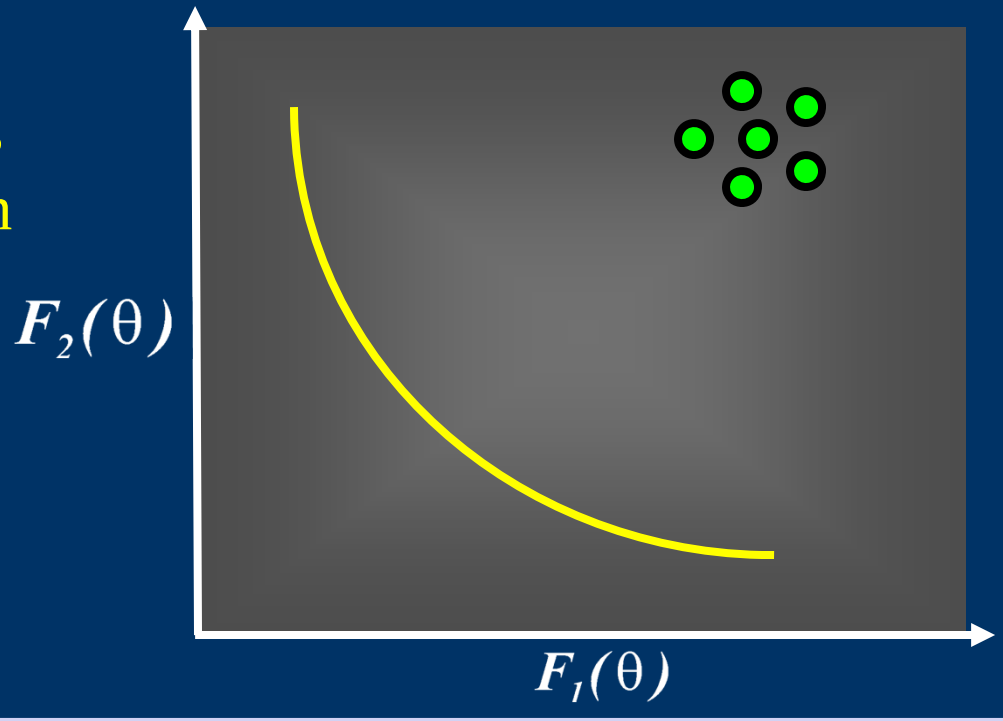


Multi-Objective Optimization Problem

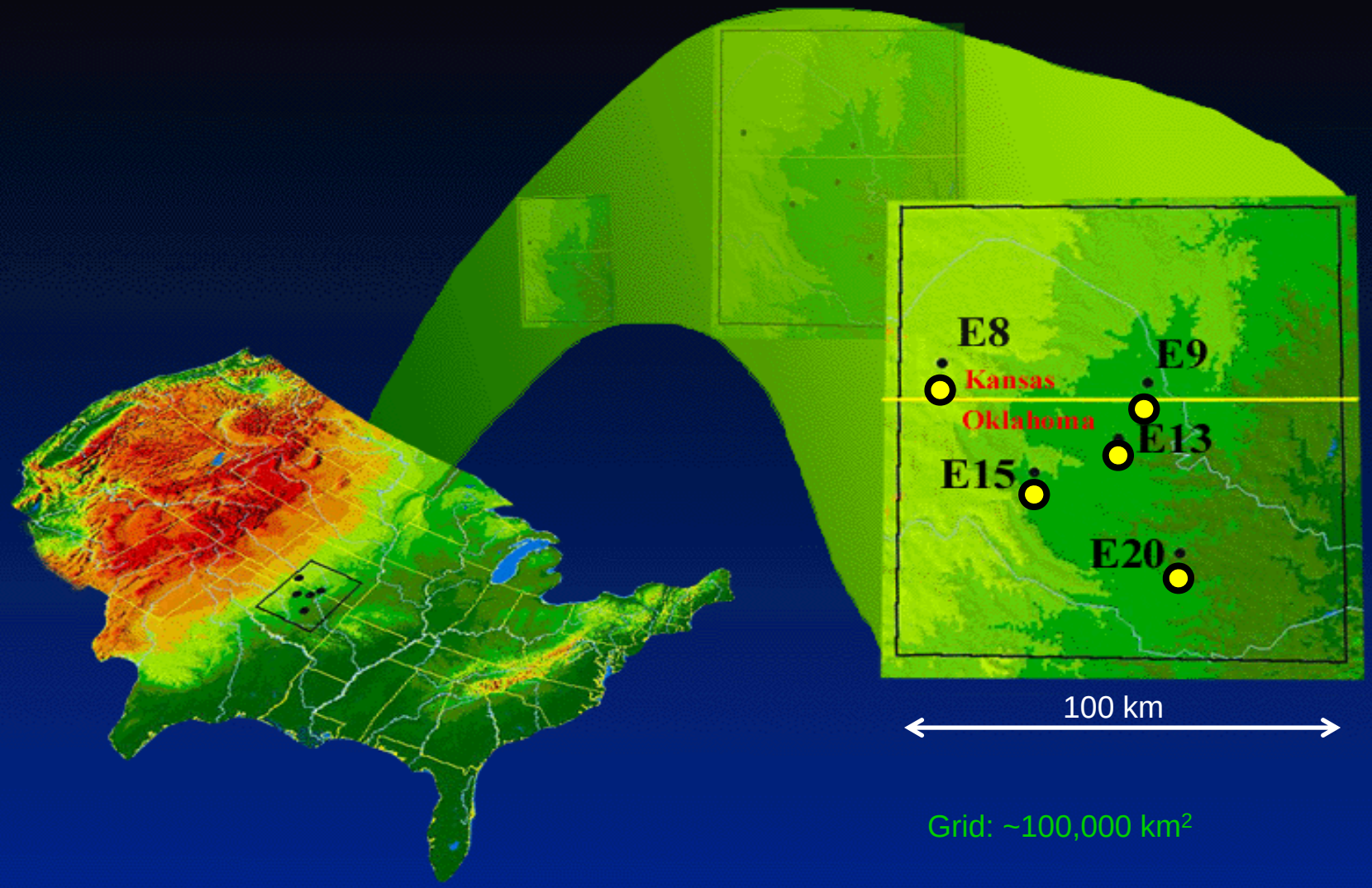
$$\underset{\text{wrt } \theta \subset \Omega}{\textit{Minimize}} \quad F(\theta) = \{ F_1(\theta), \ldots, F_n(\theta) \}$$



- ✓ Simultaneously finds several Pareto Solutions in a Single Optimization



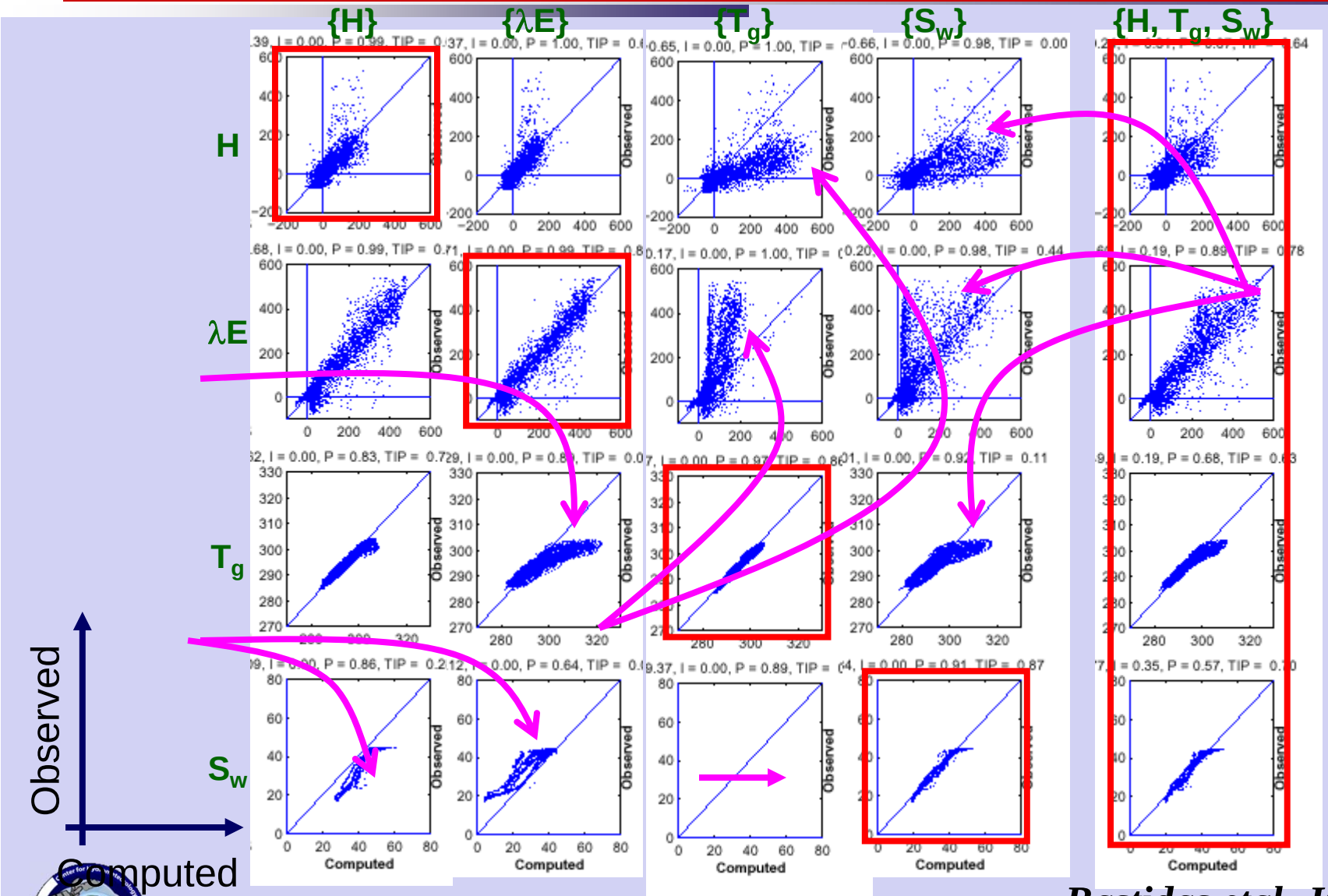
ARM-CART SGP Site



Grid: ~100,000 km^2

Luis A. Bastidas Z. *(lucho@hwr.arizona.edu)*

Single- & Multi-Flux Calibrations: BATS @ARM-CART Site



Bastidas etal, JGR 1999

Lacking!

Sufficient interest in testing and parameterization studies

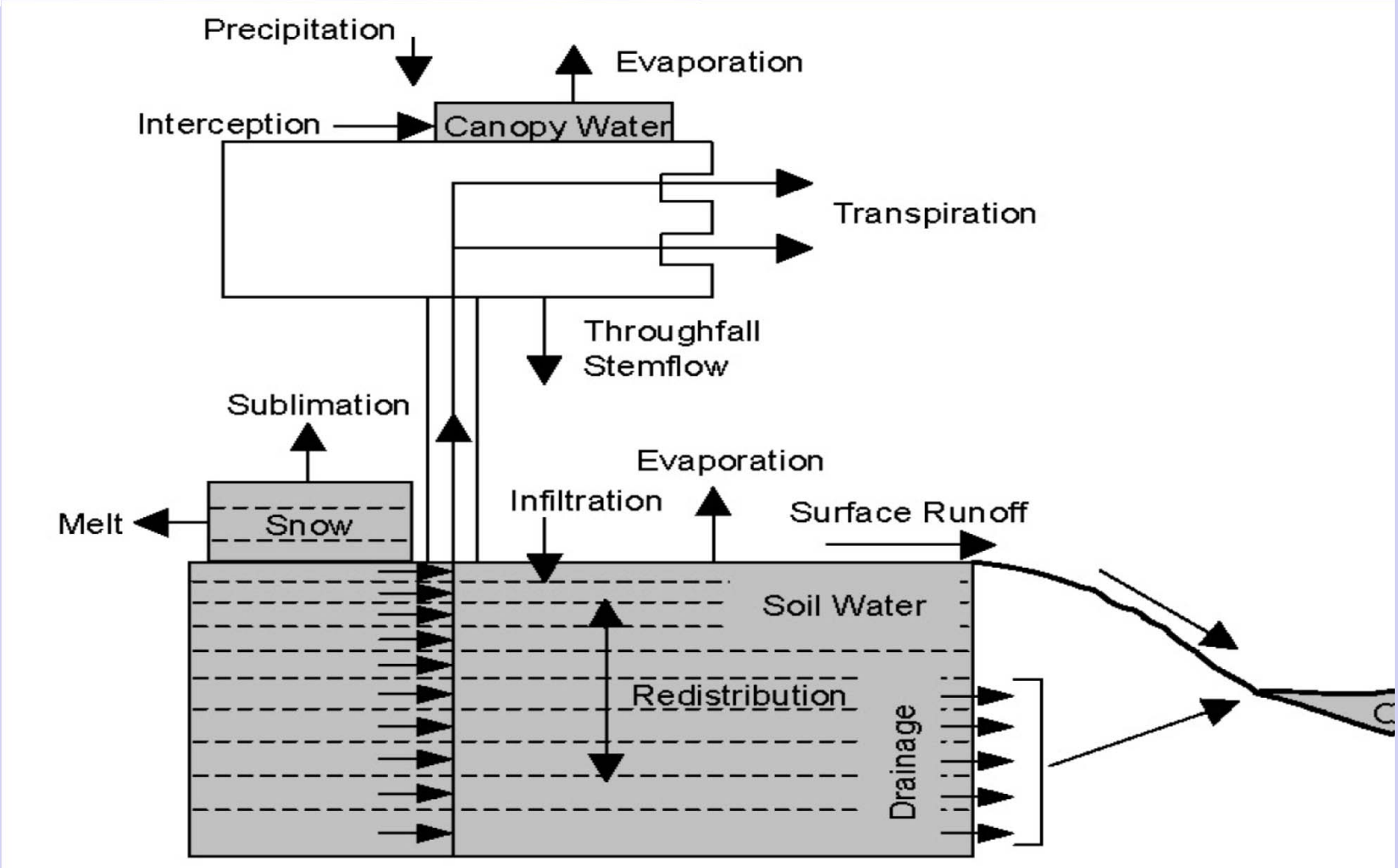
Big Challenge

Availability of "Adequate" Observations for model input and model testing

Thank You For the Opportunity
08/14/2009
Somewhere in New Mexico, USA - Photo: J. Sorooshian

Background ppts

How about Parameterization of 10 (>) Layer Models?

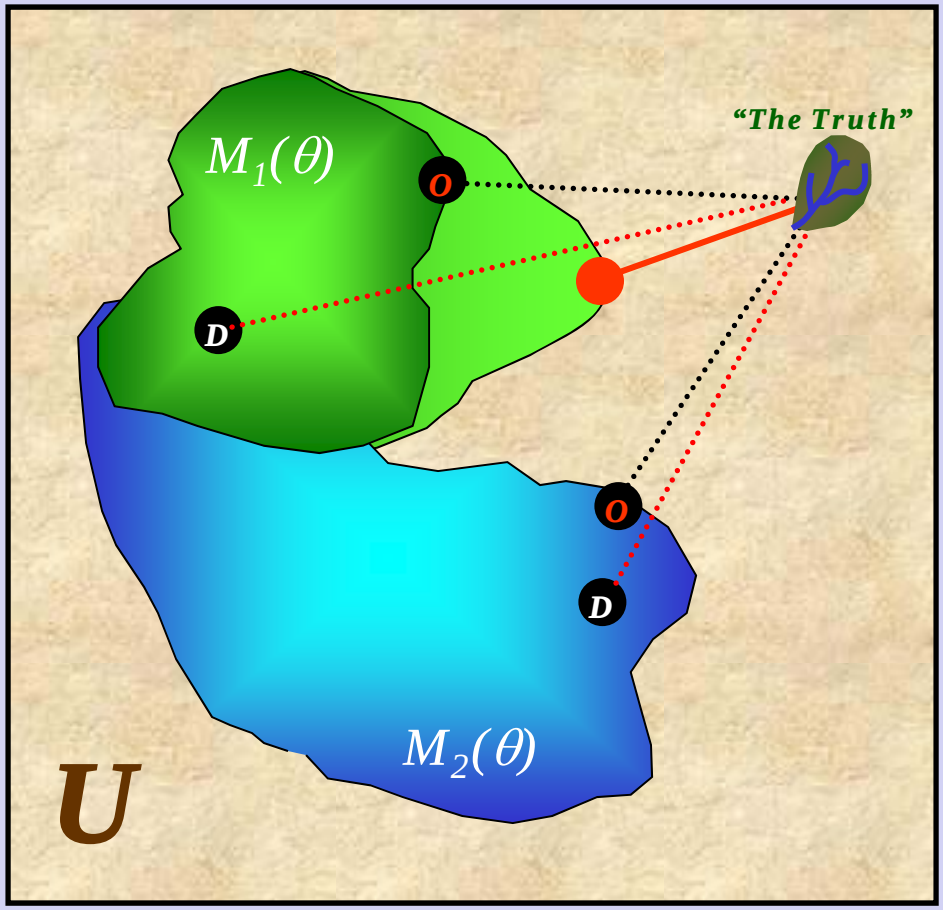


Community Land Model (CLM, Oleson et al. 2007)

The Identification Problem

1. **Select a model structure** (Input-State-Output equations)
2. **Estimate values for the parameters**

U – Universal Set

B - Basin

$M_i(\theta)$ – Selected Model Structure