2005 AGU Fall Meeting

"And What is There to be Gained,
if we Never Question our Hydrologic Paradigms?"
Matalas, 1982

Extreme Events and Mountain Hydroclimatology

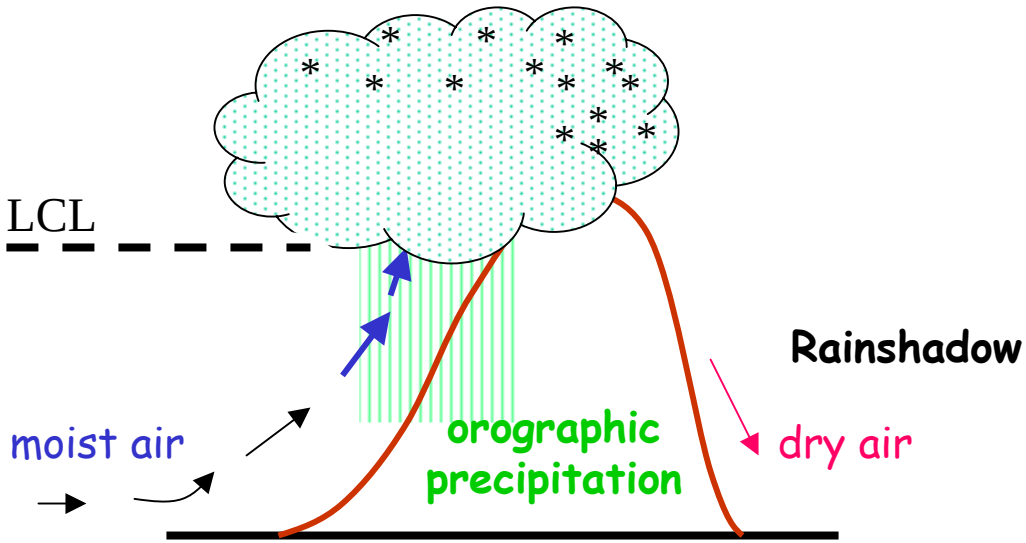
Ana P. Barros
Duke University

The question, then…

- *What is the best (statistically defensible) spatial distribution of precipitation in mountainous regions at seasonal and annual time-scales that can be derived from incomplete and sparse raingauge networks?*

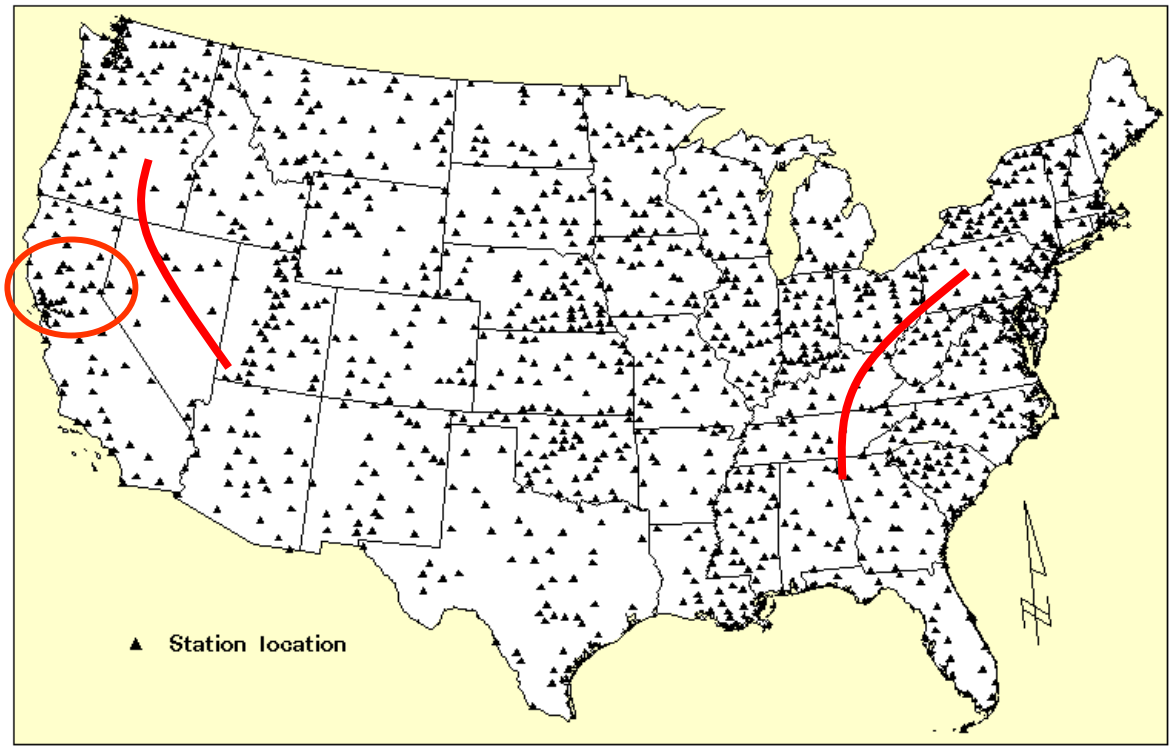
Barros and Lettenmaier, 1993 and 1994

The Conceptual Model



State of Measurement

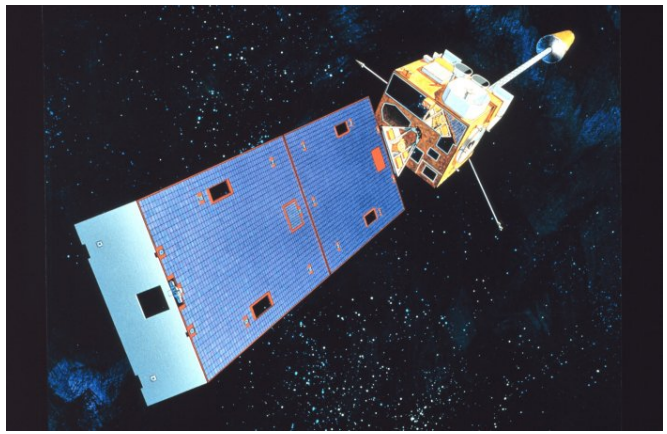
"best" raingauge network



The late 1990's…
Changing the Measurement Paradigm

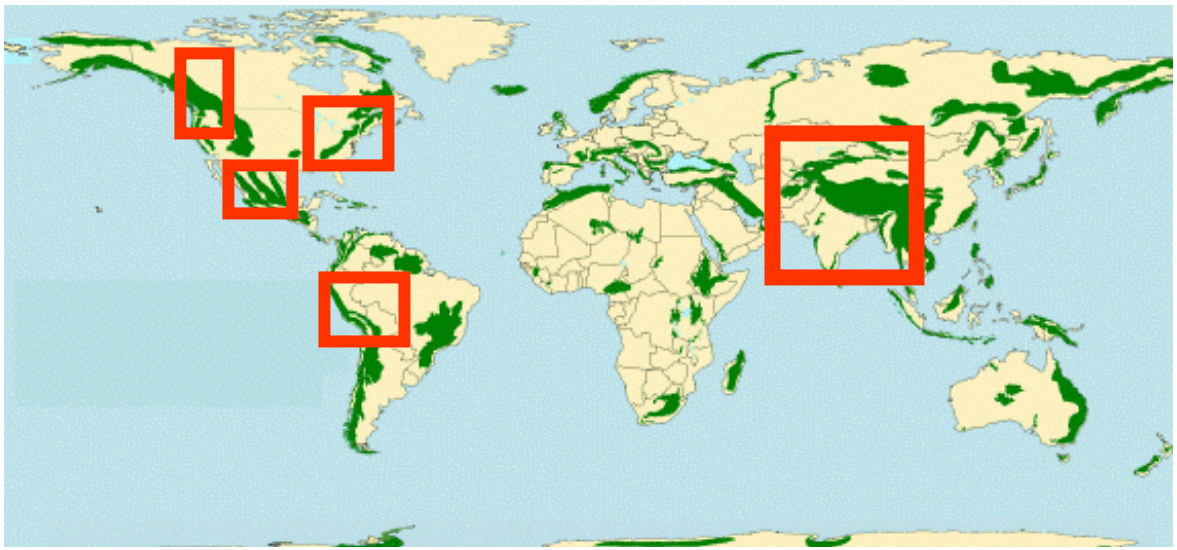
Raingauge

Radar

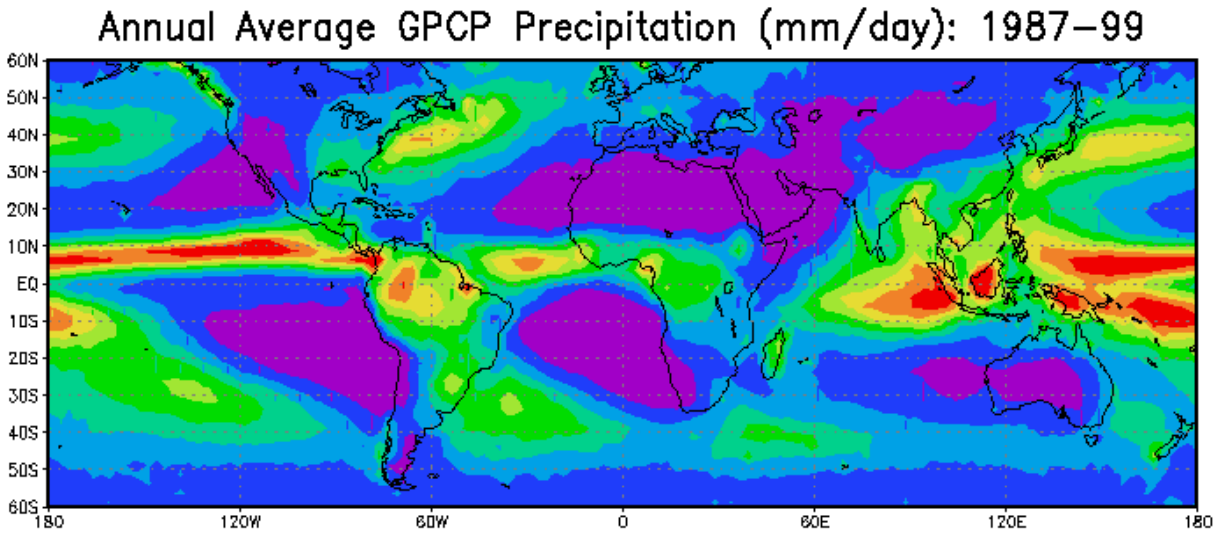


Satellite

Changing Horizons….



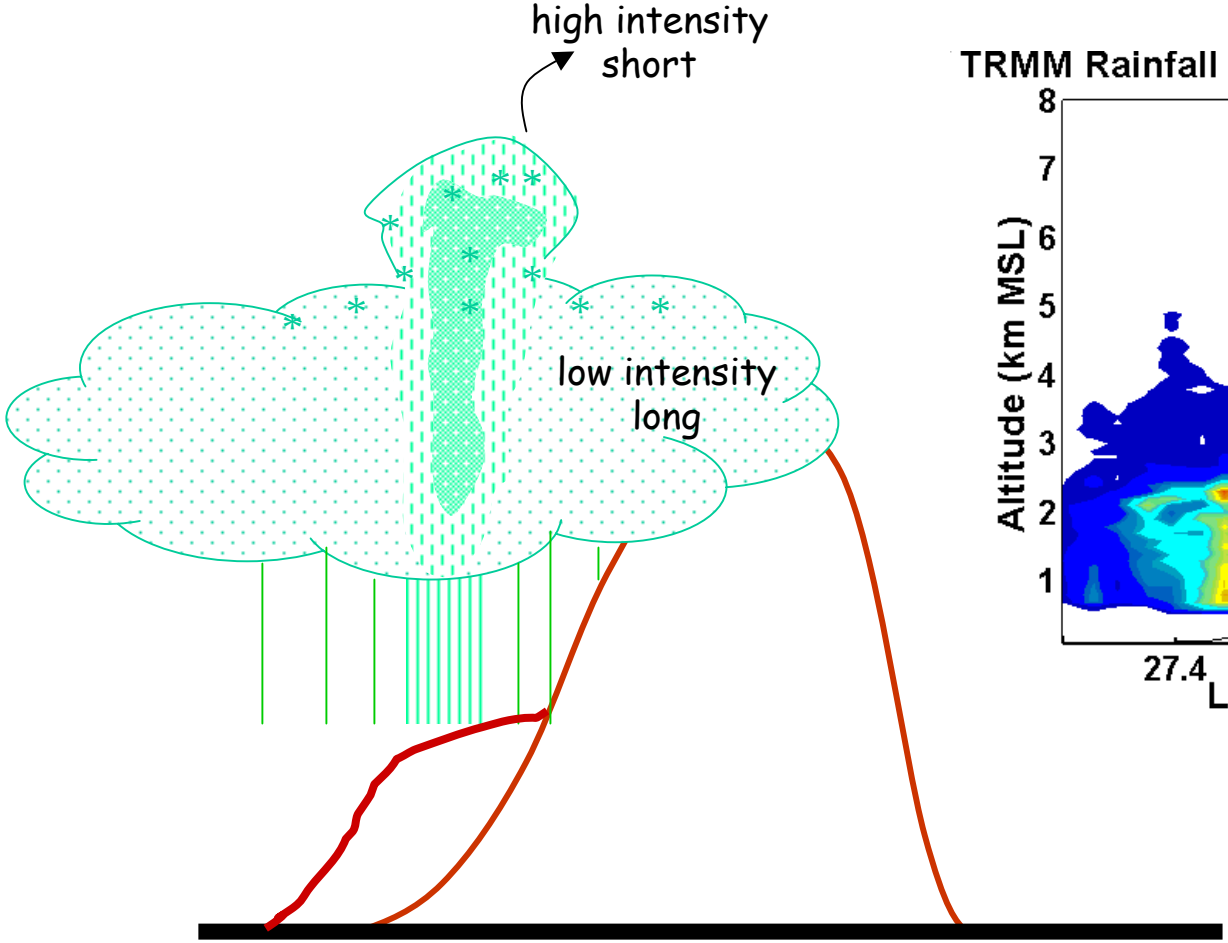
- Structure
- Organization
- Scale

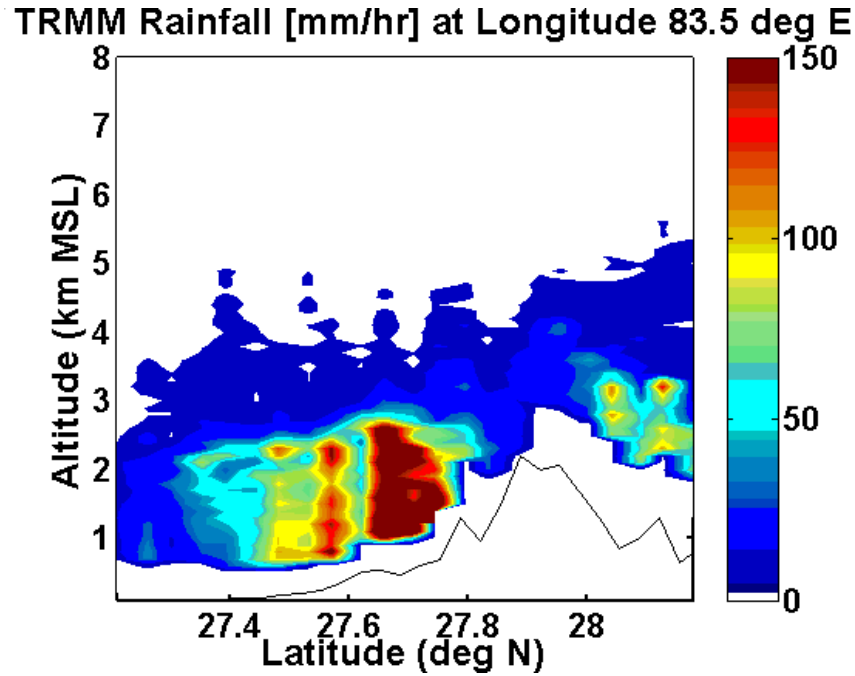


- Time&Space

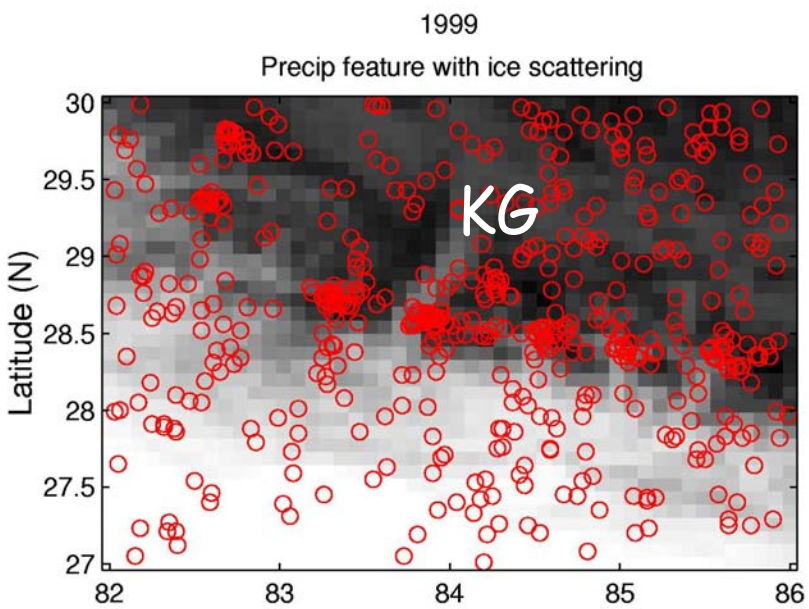
Orographic Lifting with Embedded Convection

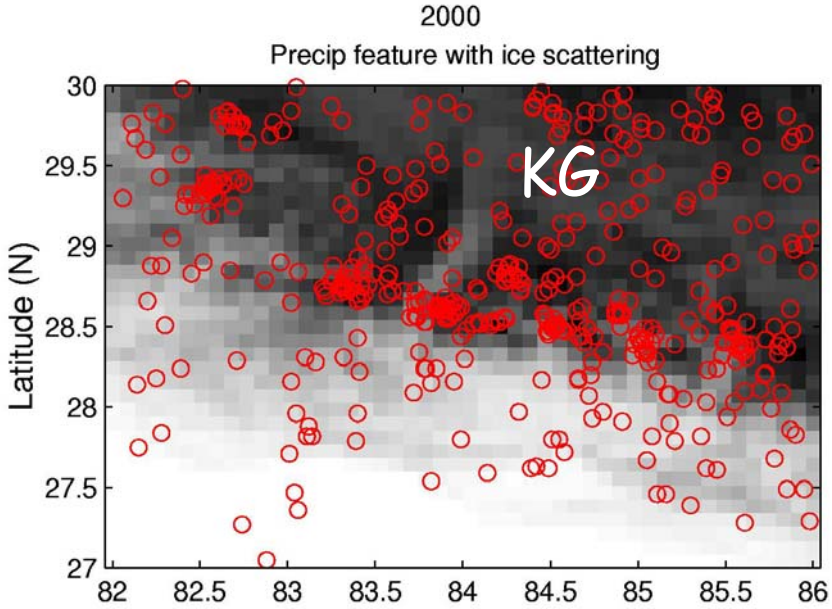
Rainfall Characteristics



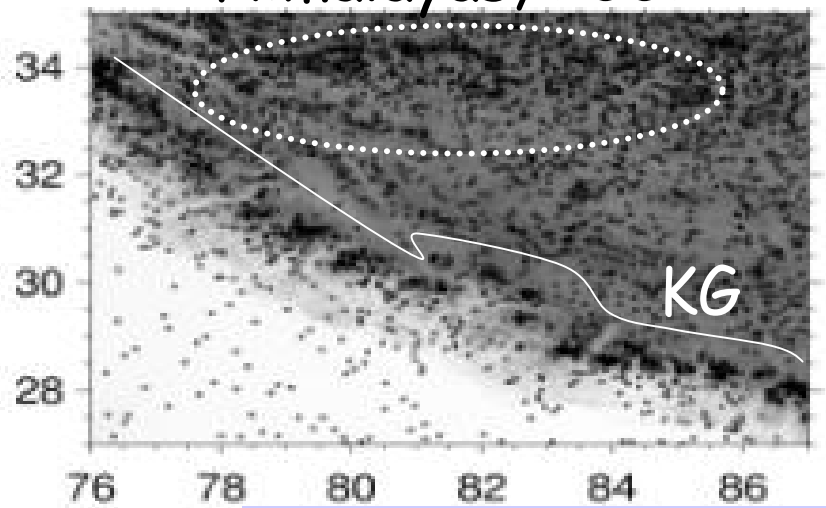


Nocturnal Small-Scale Convection Locked to Landform





Himalayas, 2002

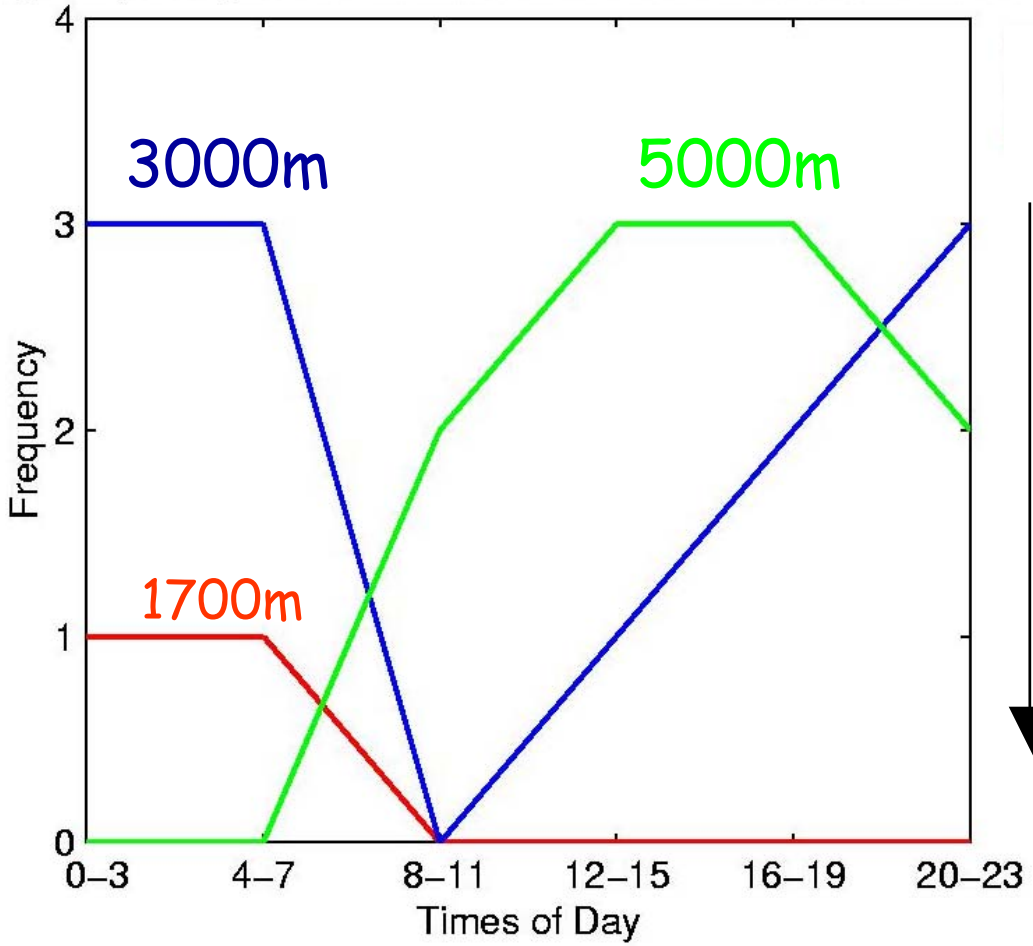


JJAS Composites

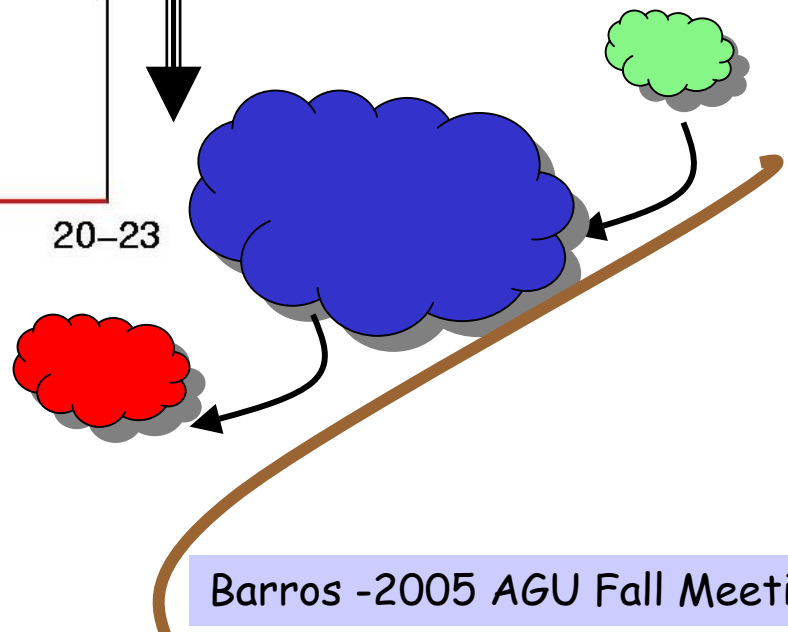
Precipitation Features Algorithm (75 km^2)
(active and passive microwave TRMM)

From Barros et al., NHESS, 2004

Frequency of High Covariances between Cloud and Mountain Series

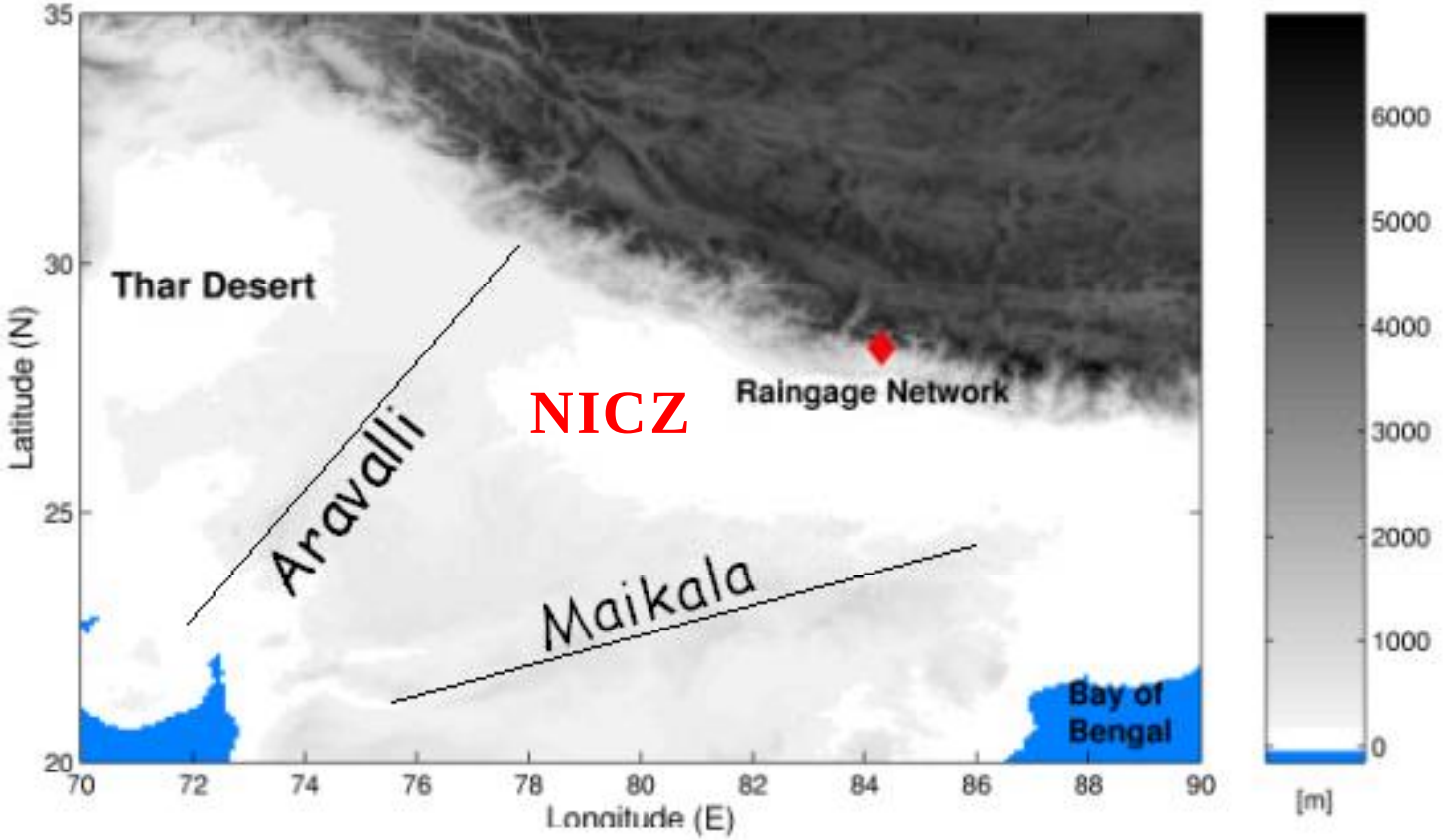


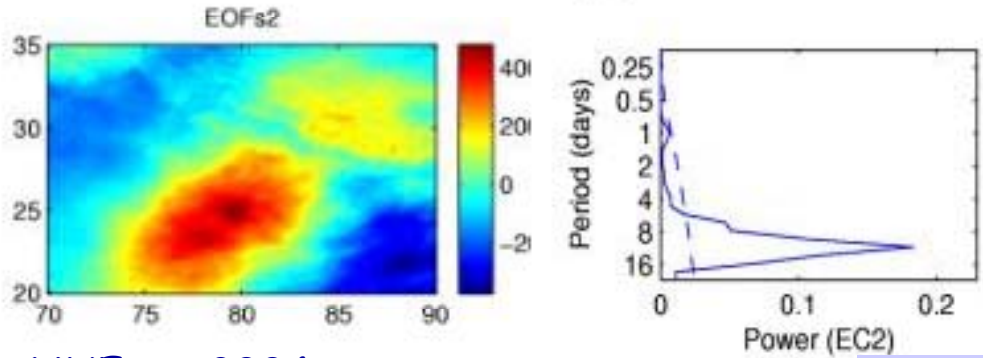
Downslope Propagation



From Barros et al., NHESS, 2004

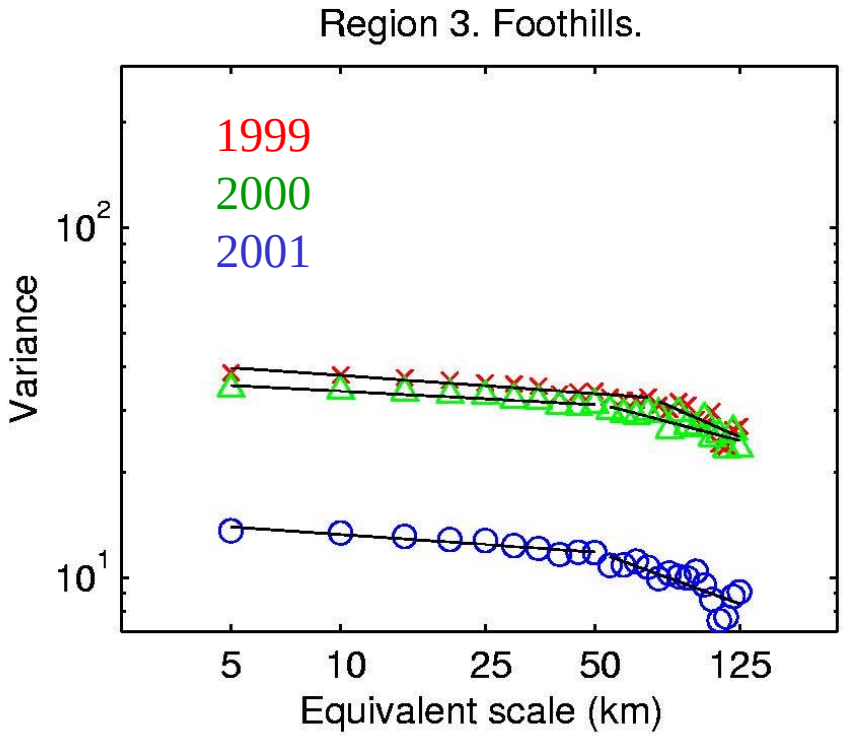
Regional Landform Controls….

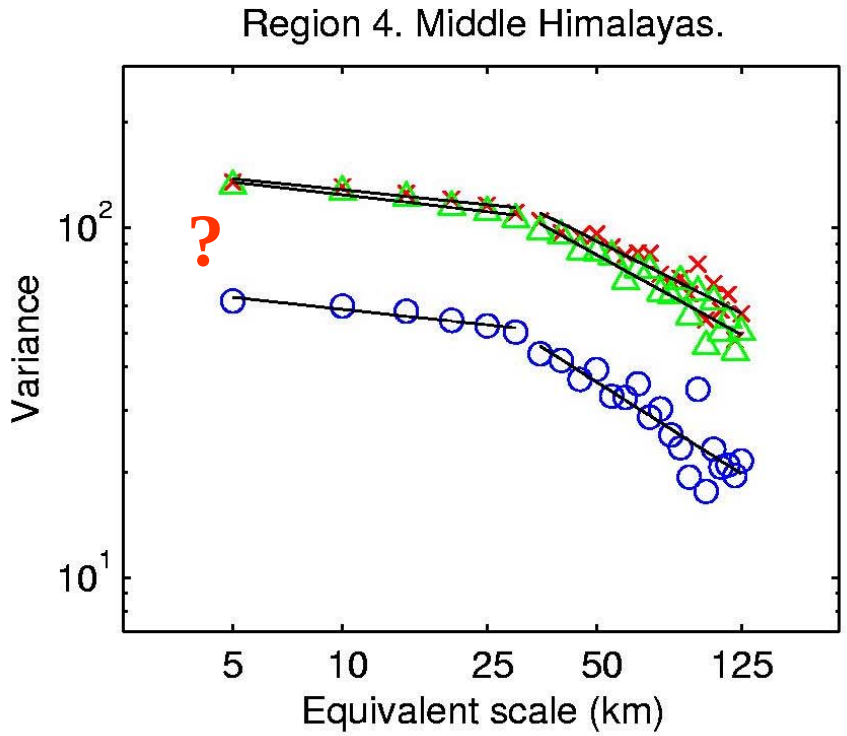


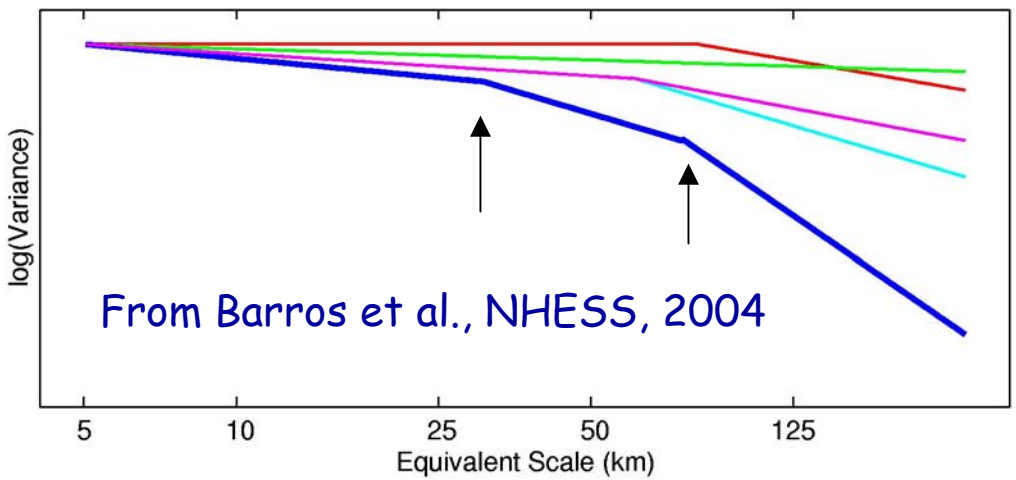


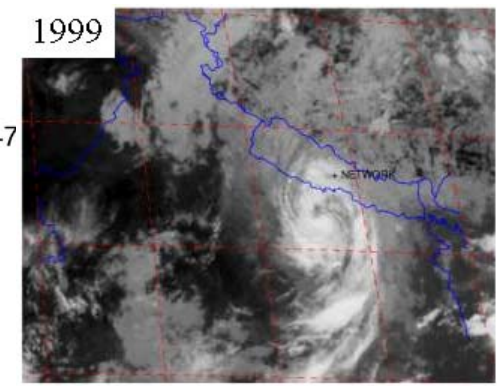
From Barros et al., NHESS, 2004

Scaling Behavior at Range Scale

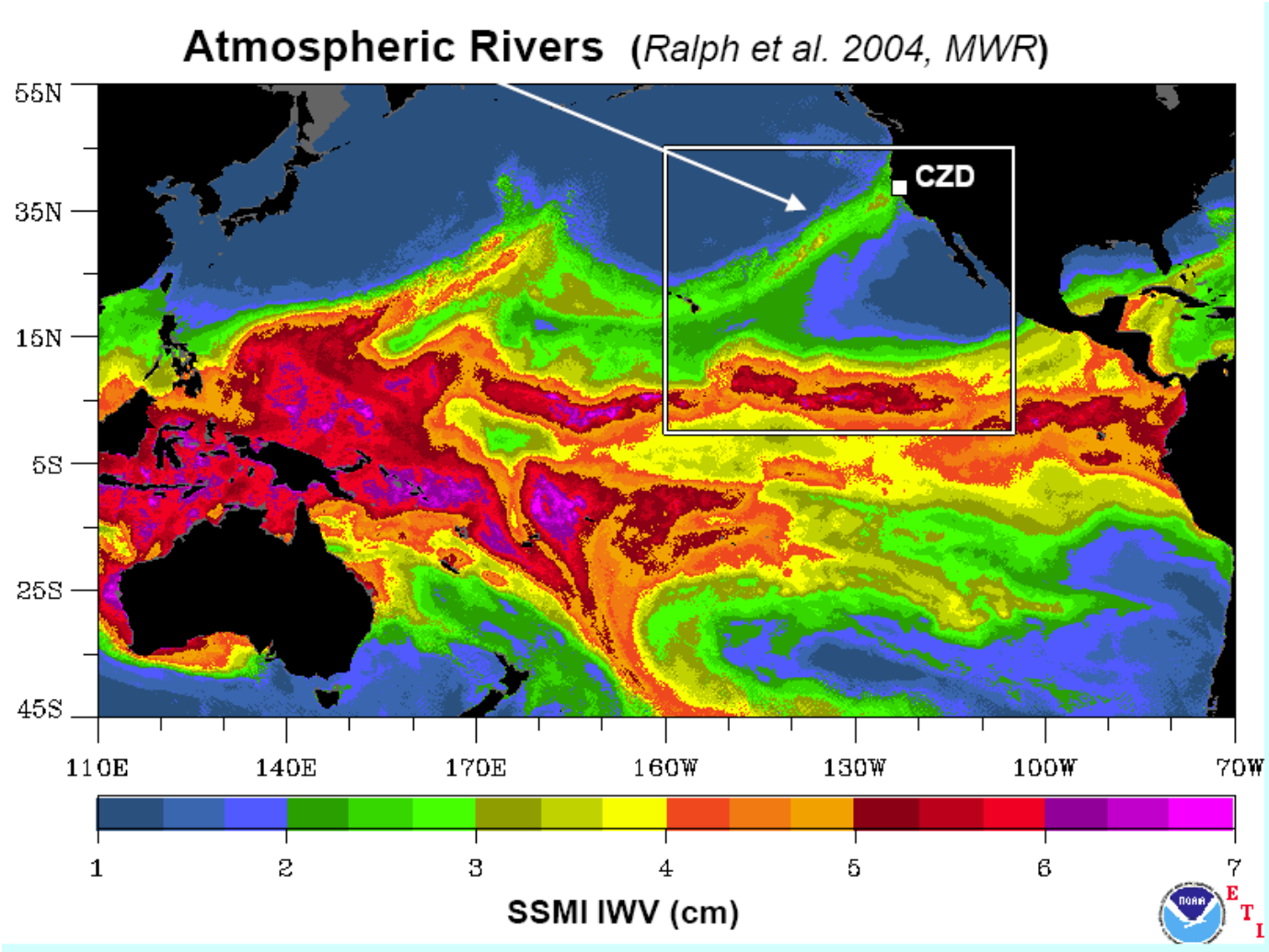




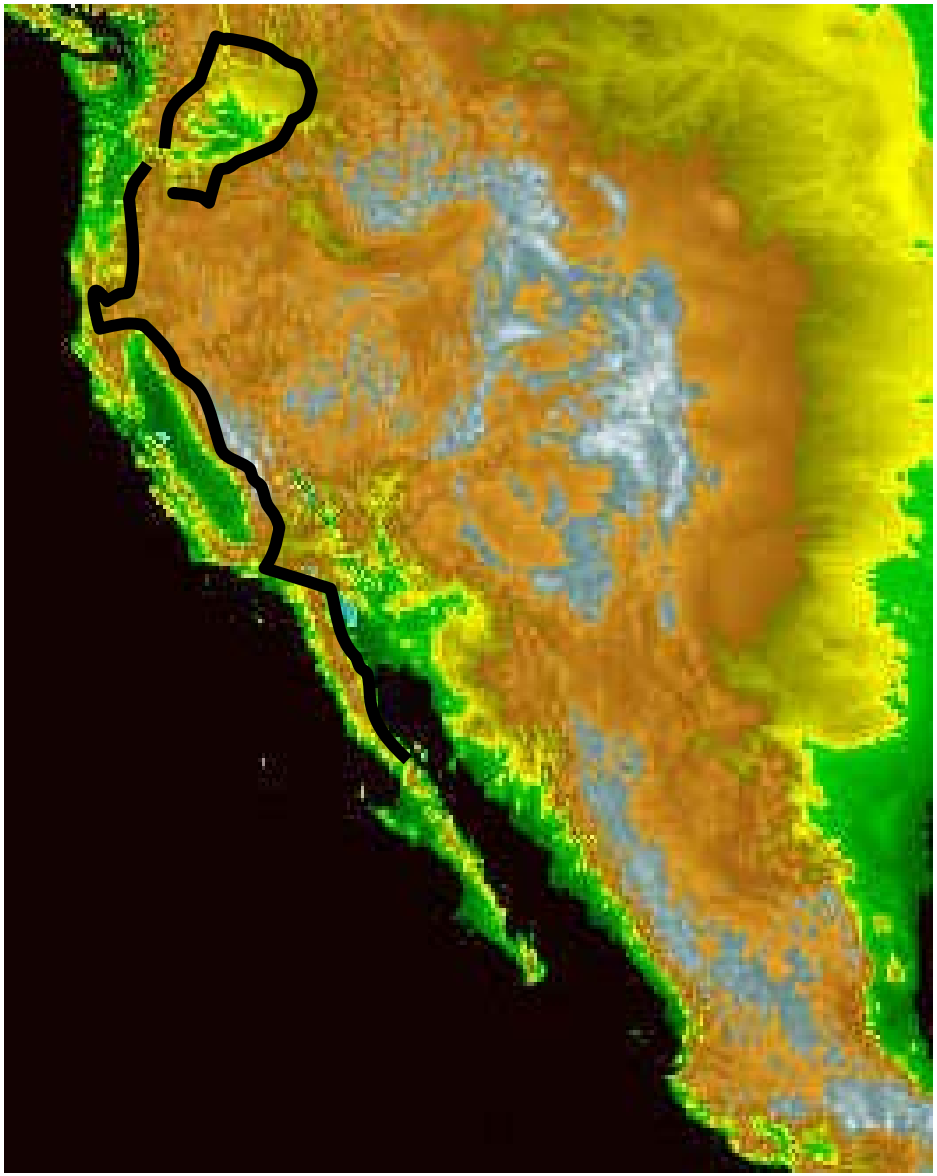




Meaningful Predictability….

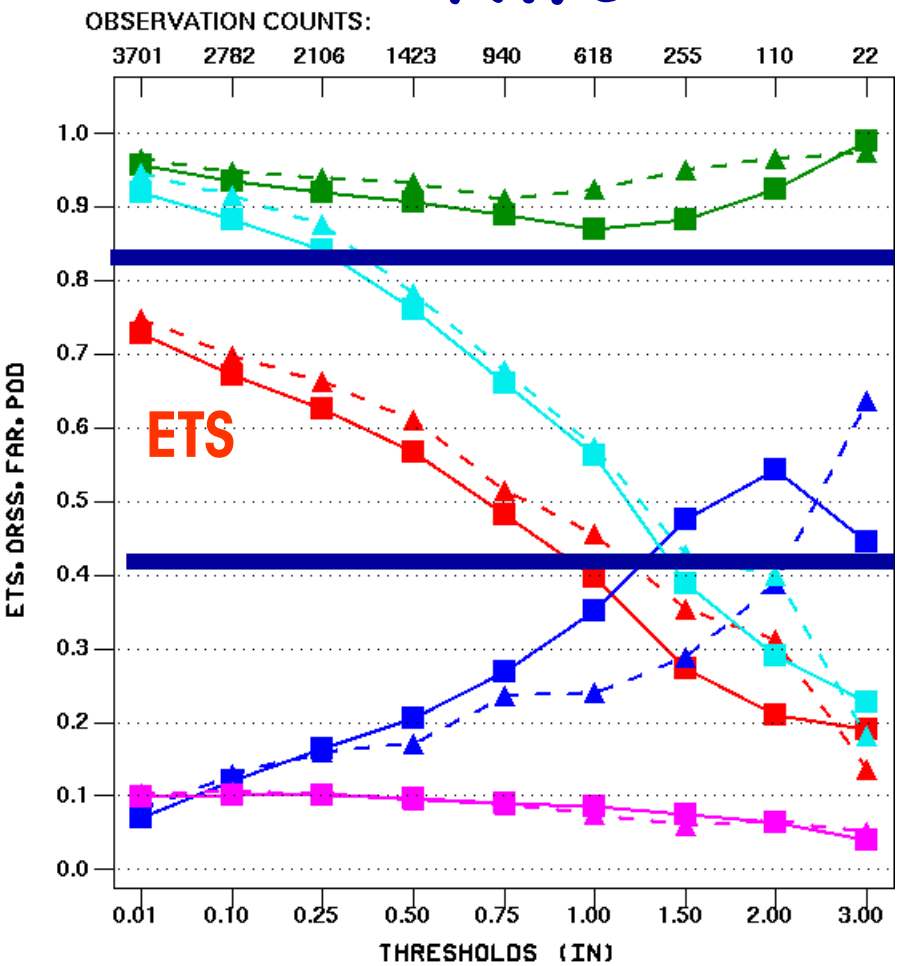


(adapted from D. Kingsmill)

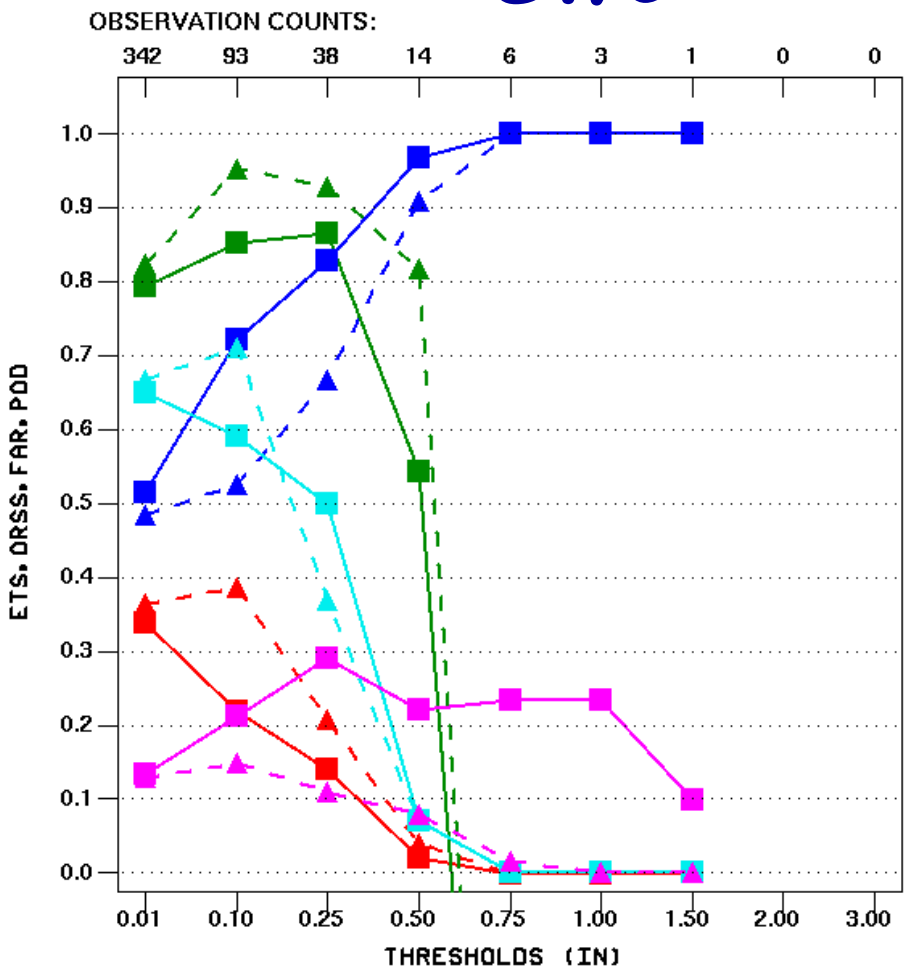



NWC
SWC

NWC



SWC



From NOAA/HPC, current

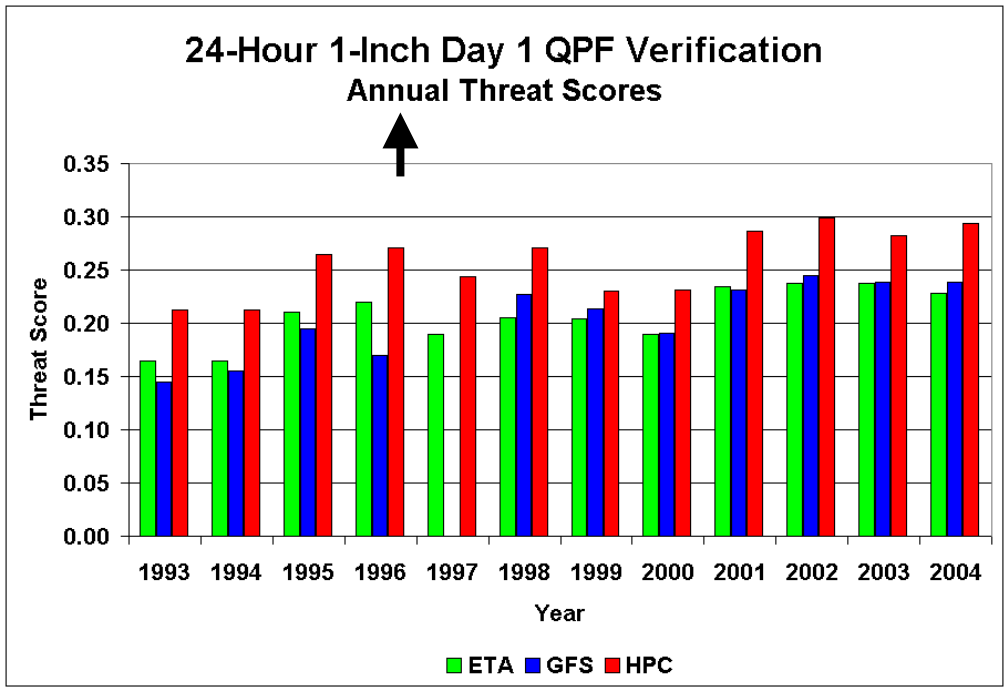
From Barros, JCL, 1995

The question, now…

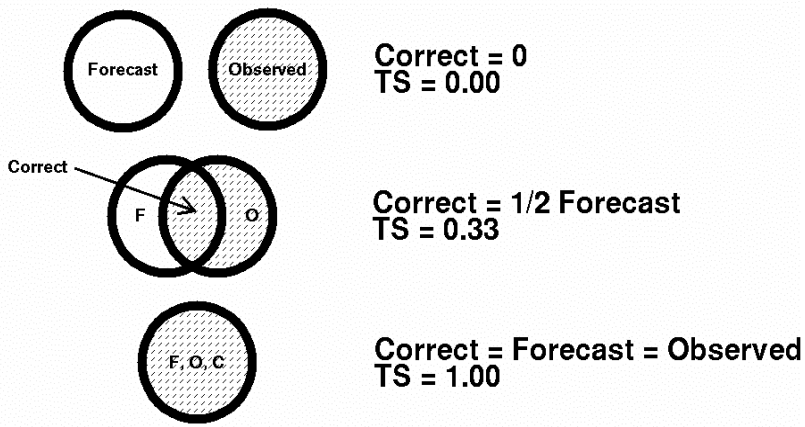
- *What are the fundamental **processes** that control the **spatial organization** of distinct orographic **regimes** at **multiple scales**, and how do these processes determine the **diurnal cycle** of precipitation and extreme events?*

Backup Slides

Predictive Skill– Regional Weather Models

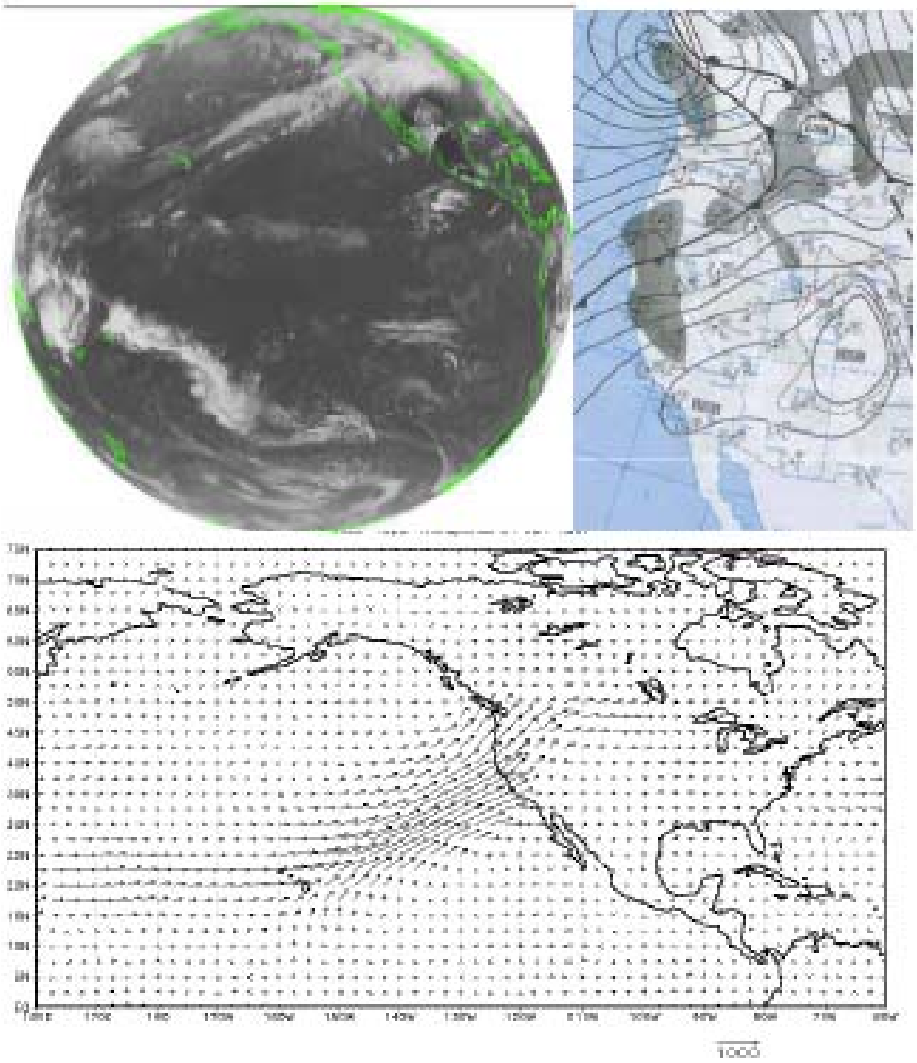


$$TS = \frac{\#\text{Correct Forecasts}}{\#\text{Observed} + \#\text{ All Forecasts} - \#\text{Correct}}$$



Mixed AI and Physical Models
TS > 0.6 for distinct storms
(Kuligowski & Barros 1996,1998,2002)

1800 GMT January 1997



(from Dettinger, PIER rep., 2004)

Dettinger, Michael. 2004. *Fifty-Two Years of "Pineapple-Express" Storms across the West Coast of North America.* U.S. Geological Survey, Scripps Institution of Oceanography for the California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2005-004.

Hypothesis

Space-Time Variability & Orographic Precipitation

1) Interannual-Decadal

Large-scale phenomena control moisture fluxes and path of major storm systems (extreme events)

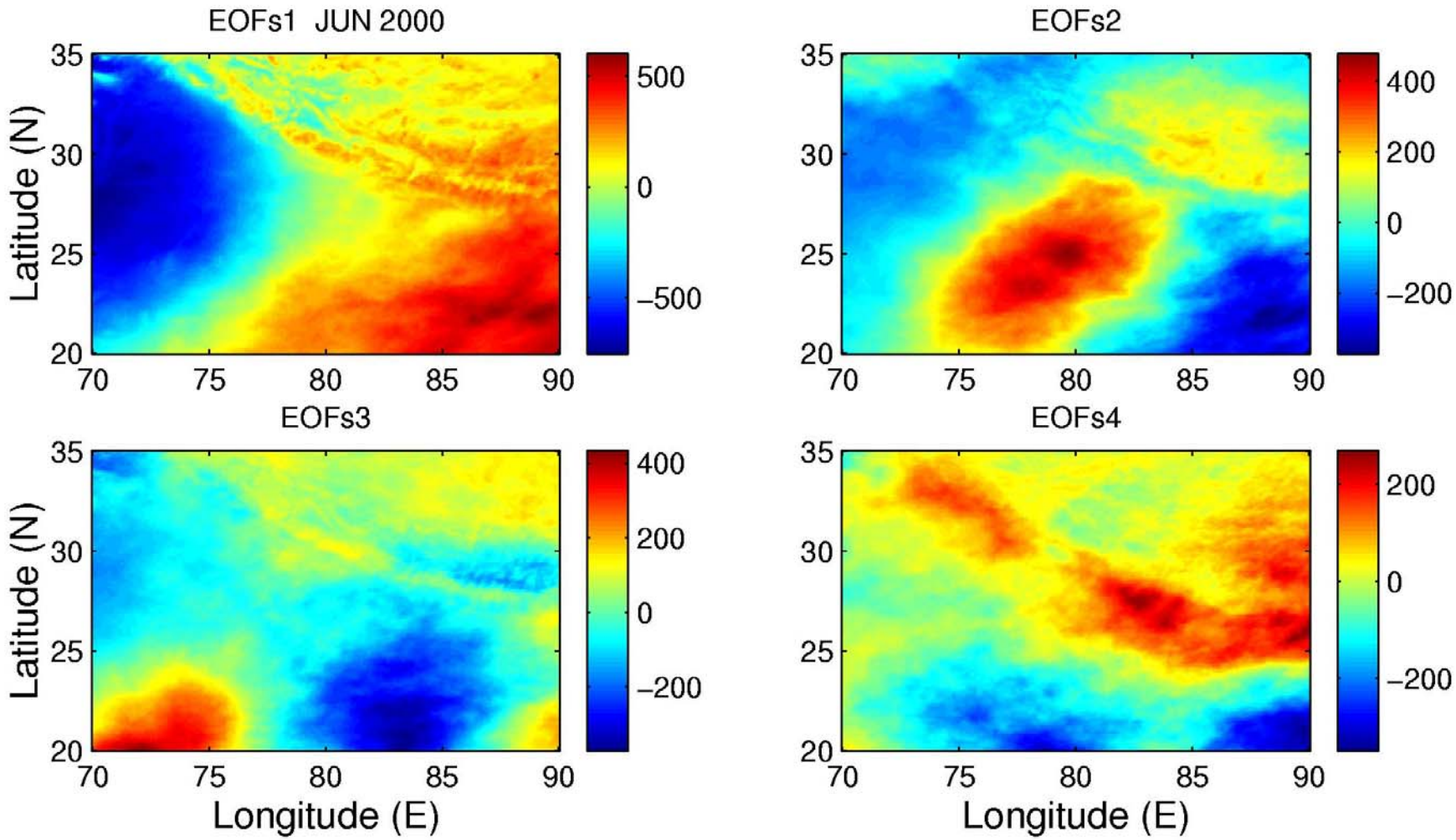
2) Annual Cycle

Landform, land-cover patterns and soil moisture, clouds and precipitation are dynamically interconnected on steep altitudinal gradients;

3) Diurnal Cycle

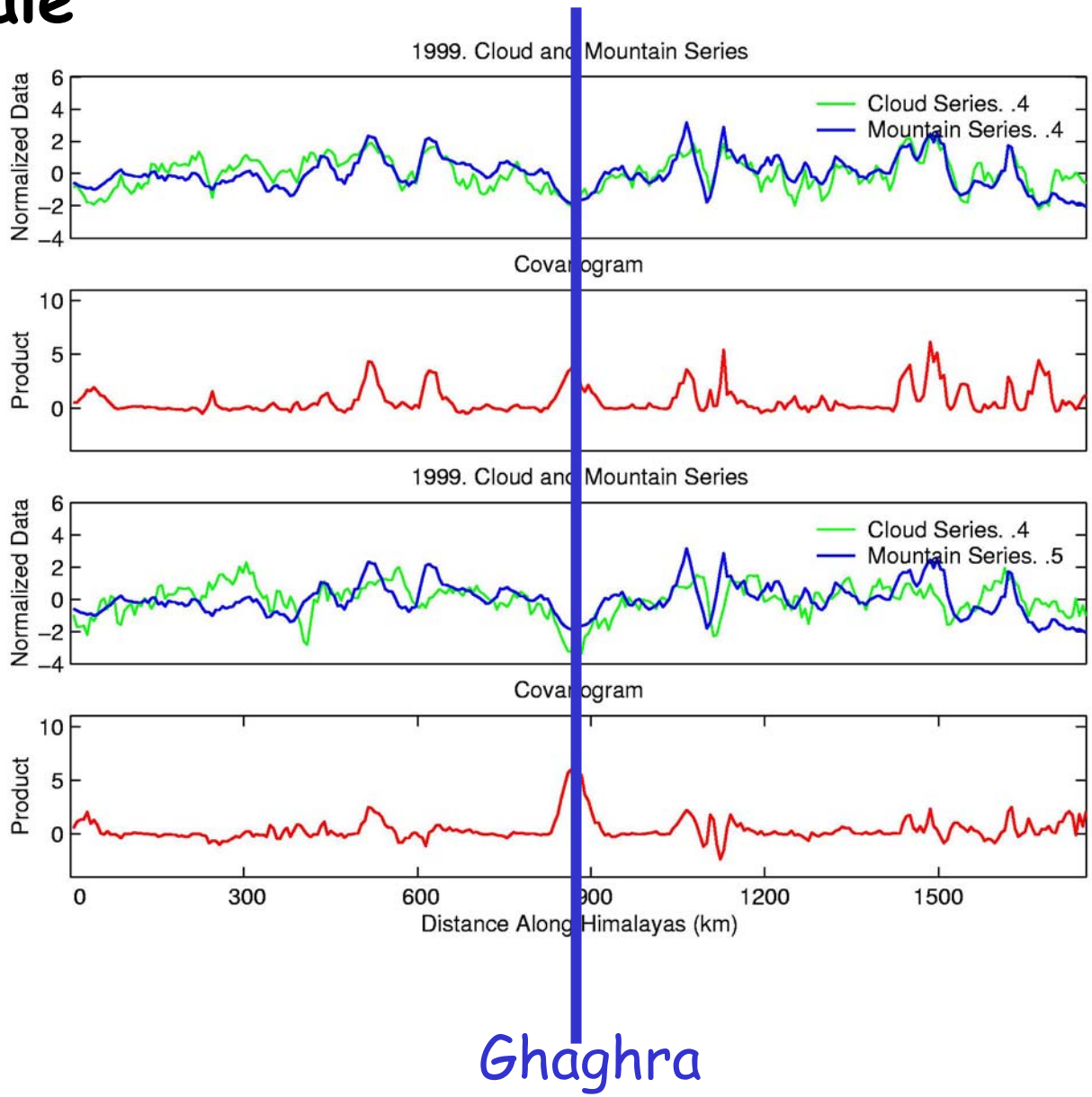
Evapotranspiration plays a key role in the spatial organization of cloudiness and precipitation at the ridge-valley scale, even in the presence of strong monsoon forcing.

Modes of Variability of Cloudiness



From Barros et al., NHESS, 2004

Range Scale



From Barros et al., NHESS, 2004