



PERSIANN CDR Applications and “Societal Benefits”

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and the CHRS Team***

***Center for Hydrometeorology and Remote Sensing
University of California Irvine***



***NOAA Climate Data Record (CDR) Annual Meeting
Asheville NC, August 4-6 2015***



University of California Presenters (Ad Ent) Past



and many more ...

Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN)



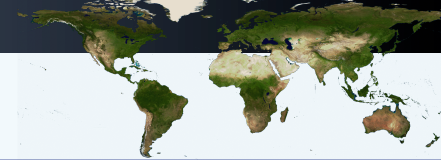
Kuolin Hsu
Algorithm Development



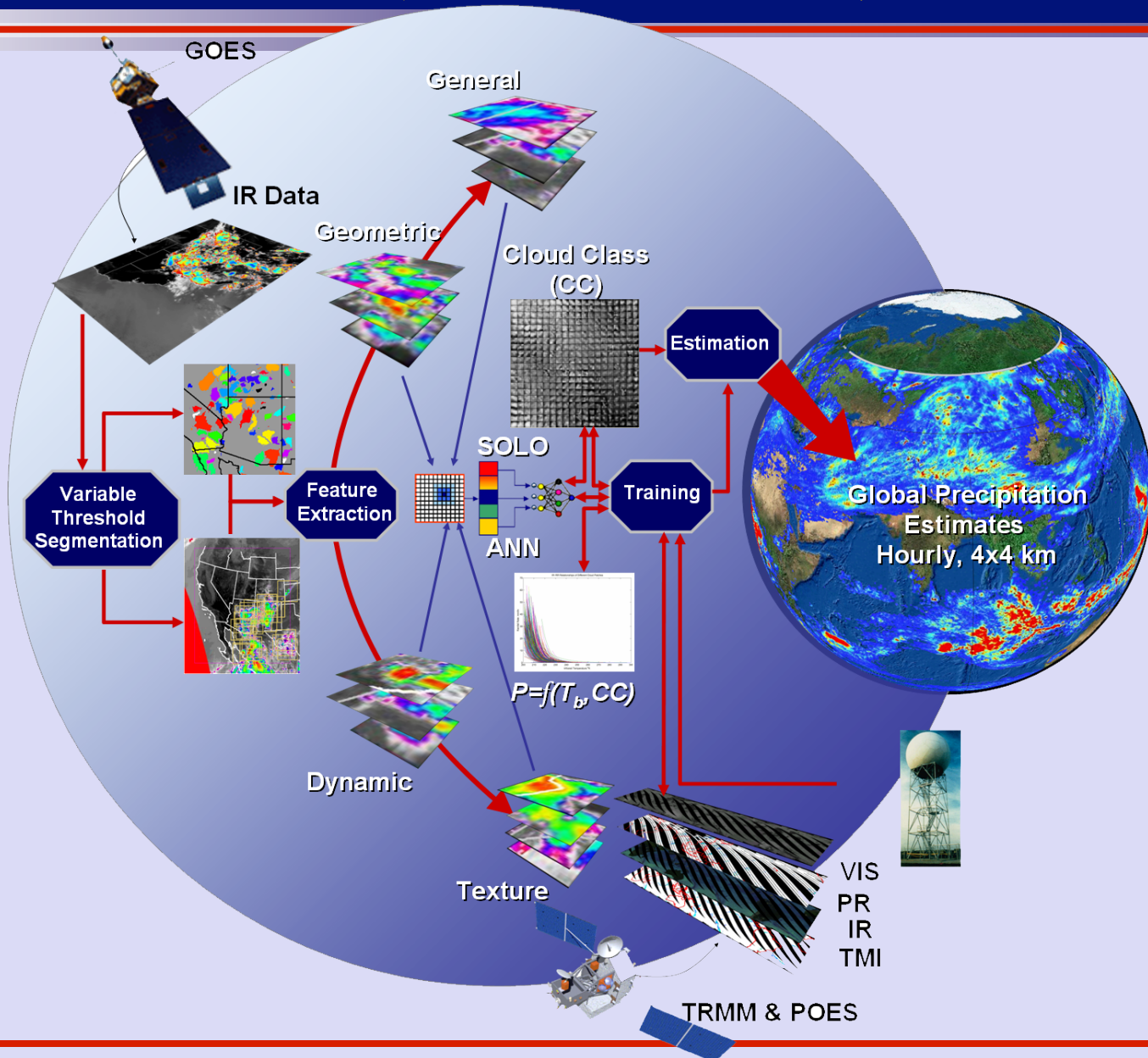
Bisher Imam
G-WADI website development



Geostationary Satellites Infrared (IR) Channel Tb



PERSIANN-CCS (Real-time 4 km)



PERSIANN Extensions: Climate-Related



- PERSIANN-CDR

- PERSIANN-CONNECT



PERSIANN -CDR

<http://www.ncdc.noaa.gov/cdr/operationalcdrs.html>

NOAA'S NATIONAL CLIMATIC DATA CENTER

NOAA's Climate Data Record (CDR) Program

PRECIPITATION ESTIMATION FROM REMOTE SENSING INFORMATION USING ARTIFICIAL NEURAL NETWORK

PERSIANN



PERSIANN CLIMATE DATA RECORD SPECIFICATIONS

- 0.25-deg * 0.25-deg (60°S–60°N latitude and 0°–360° longitude)
- Daily Product
- 1980–present
- Updated Monthly

INPUTS TO THE PERSIANN CLIMATE DATA RECORD

- GridSat-B1 CDR (IRWIN)
- GPCP 2.5-deg Monthly Data

SOME USES OF THE PERSIANN CLIMATE DATA RECORD

- Climatologists can perform long-term climate studies at a finer resolution than previously possible.
- Hydrologists can use PERSIANN-CDR for rainfall-runoff modeling in regional and global scale, particularly in remote regions.
- Performing extreme Event Analysis (intensity, frequencies, and duration of floods and droughts).
- Water Resources Systems Planning and Management

PERSIANN CLIMATE DATA RECORD
<http://www.ncdc.noaa.gov/cdr/operationalcdrs.html>

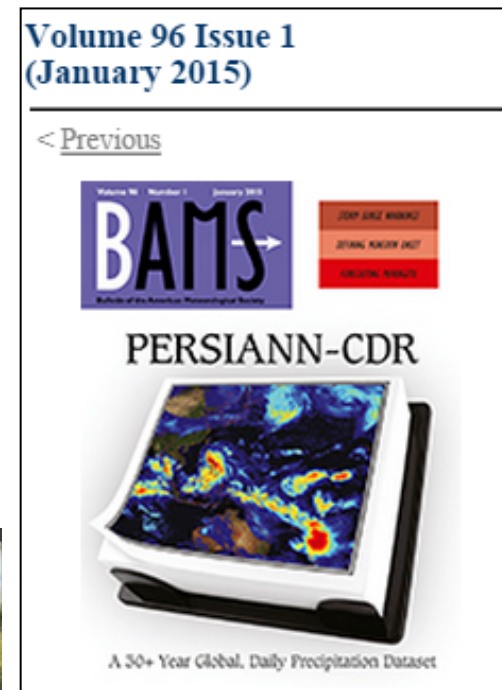
CLIMATE DATA RECORD PROGRAM INFORMATION
<http://www.ncdc.noaa.gov/cdr/index.html>

www.climate.gov
www.ncdc.noaa.gov

Preserving the past... Revealing the future
September 2013



- *Daily Precipitation Data*
- *Data Period: 1983~2014*
- *Coverage: 60°S ~ 60°N*
- *Spatial Resolution: 0.25°x0.25°*




Ashouri, Hsu et al., BAMS, 2015.



PERSIANN-CDR: PERSIANN Climate Data Record

<http://www.ncdc.noaa.gov/cdr/operationalcdrs.html>

**NOAA** NATIONAL CLIMATIC DATA CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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[Serving the Public](#)
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[Development Guidelines](#)
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News

[Climate Data and Applications Workshop - A Focus on Precipitation - Dec 3-4, 2013](#)











[Congratulations Cheng-Zhi Zou](#)

[2013 CDR Annual Meetings. Presentations now available](#)

Operational Climate Data Records (CDRs)

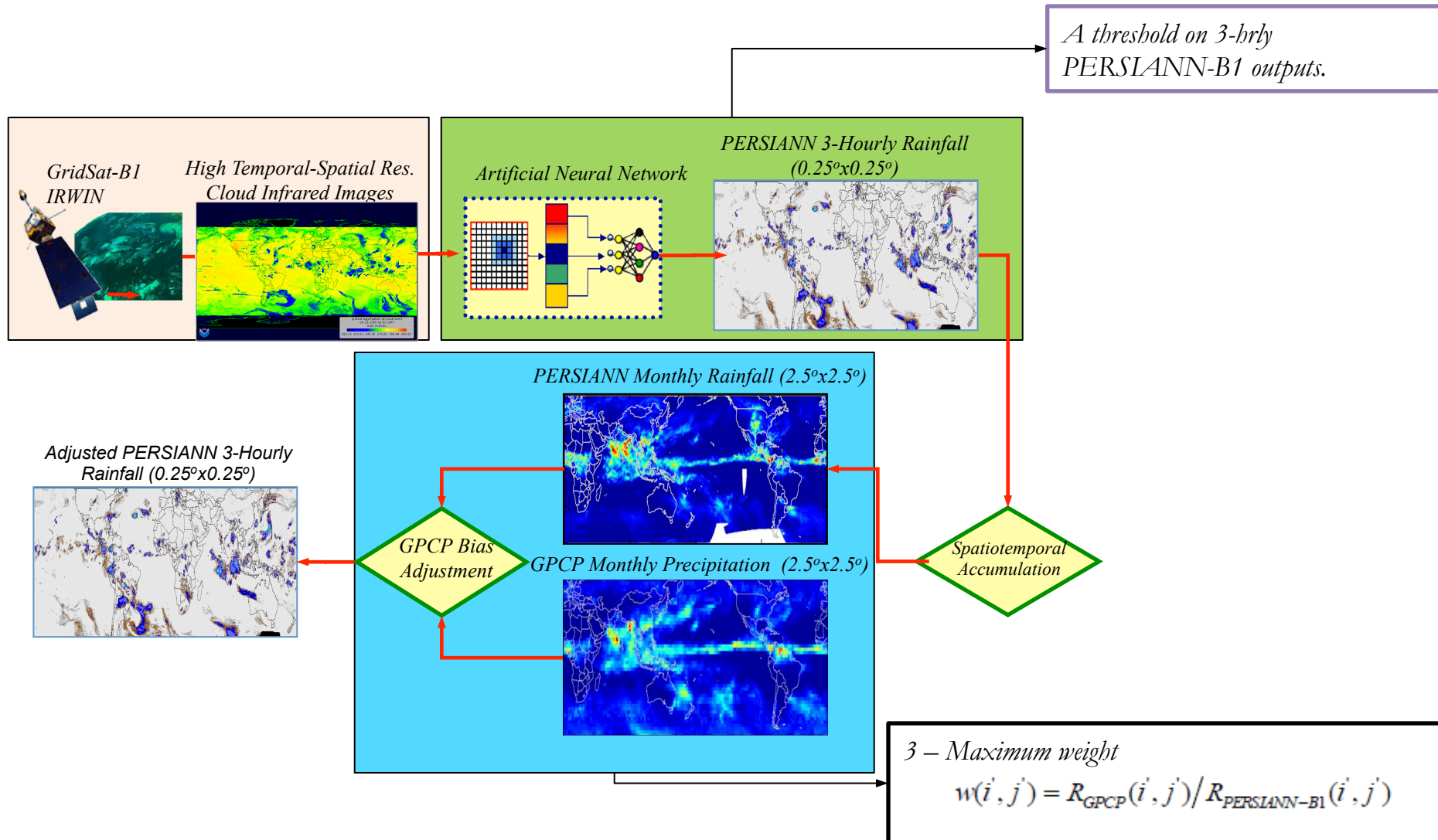
In addition to embracing the National Research Council CDR definition ([Climate Data Records from Environmental Satellites: Interim Report 2004](#)), NOAA operational CDRs are routinely assessed for quality and systematically generated. The first step in establishing an operational CDR includes public posting of the source code that generated the CDR dataset, the dataset itself, and supporting documentation through a six-phase Research-to-Operations process that is described in the [Developers Guidelines](#).

Once posted to the NCDC webpage, the CDRs are grouped by Fundamental CDRs and Thematic (Atmospheric, Oceanic, and Terrestrial) CDRs. Fundamental CDRs are sensor data (e.g. calibrated radiances, brightness temperatures) that have been improved and quality controlled over time, together with the ancillary data used to calibrate them. Thematic CDRs are geophysical variables derived from the FCDRs, such as sea surface temperature and sea ice concentration, and they are specific to various disciplines. Thematic CDRs are often generated by blending satellite observations, in-situ data, and/or model output.

Atmospheric CDRs	Information	Serving Public	Available Data Access	Source Code	Documentation
Aerosol Optical Thickness	Overview Contact Us Registration		Use Agreement THREDDS FTP		Algorithm Description Data Flow Diagram Maturity Matrix
Mean Layer Temperatures - RSS	Overview Contact Us Registration		Use Agreement THREDDS FTP		Algorithm Description Data Flow Diagram Maturity Matrix
Mean Layer Temperatures - UAH	Overview Contact Us Registration		Use Agreement THREDDS FTP		Algorithm Description Data Flow Diagram Maturity Matrix
Outgoing Longwave Radiation	Overview Contact Us Registration		Use Agreement THREDDS FTP		Algorithm Description Data Flow Diagram Maturity Matrix
Precipitation - PERSIANN-CDR	Overview Contact Us Registration		Use Agreement THREDDS FTP		Algorithm Description Data Flow Diagram Maturity Matrix



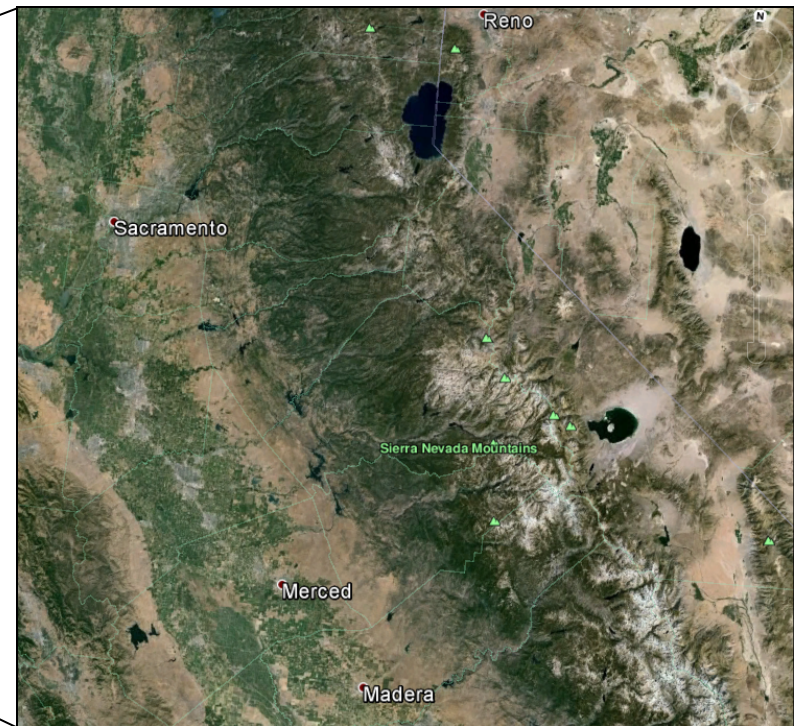
PERSIANN-CDR Algorithm



Sierra-Nevada Mountain Region

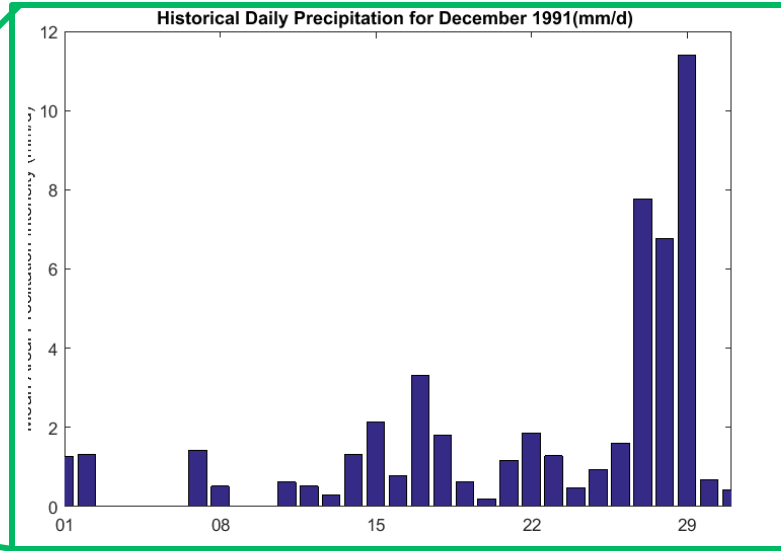
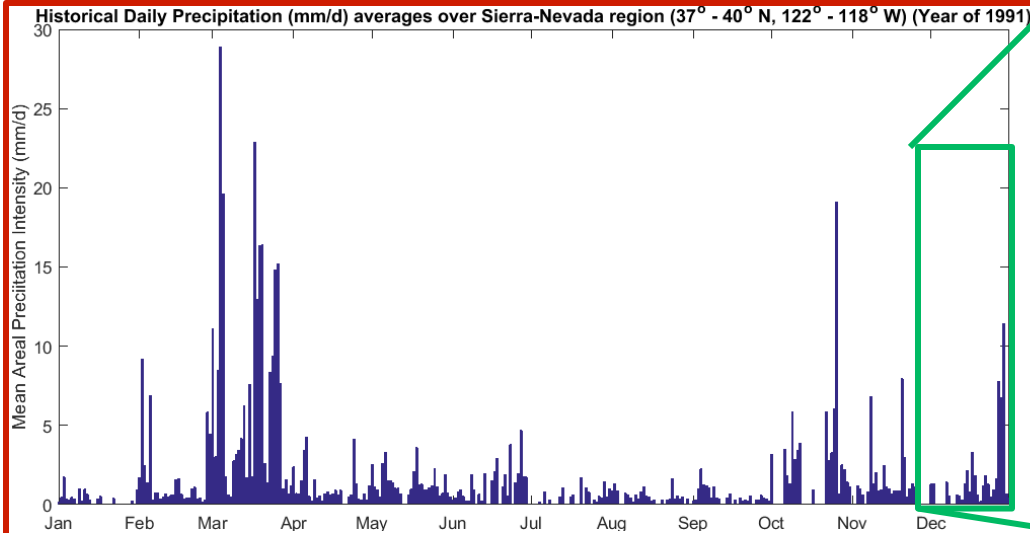
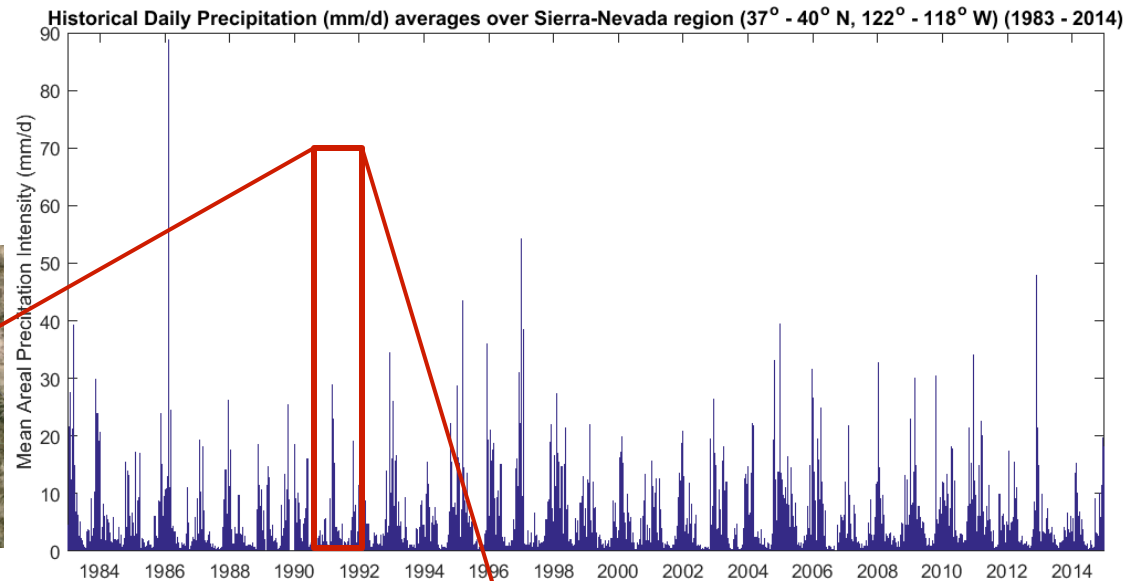
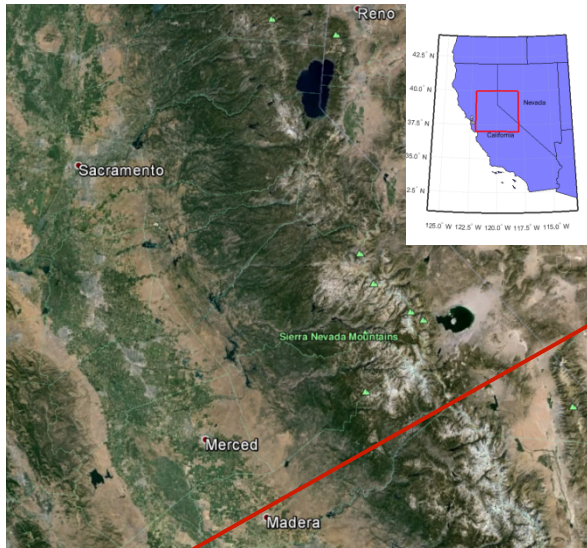
Area: 63,100 square kilometers (24,370 sq mi)

Length: 400 mile, Width: 64 mile.

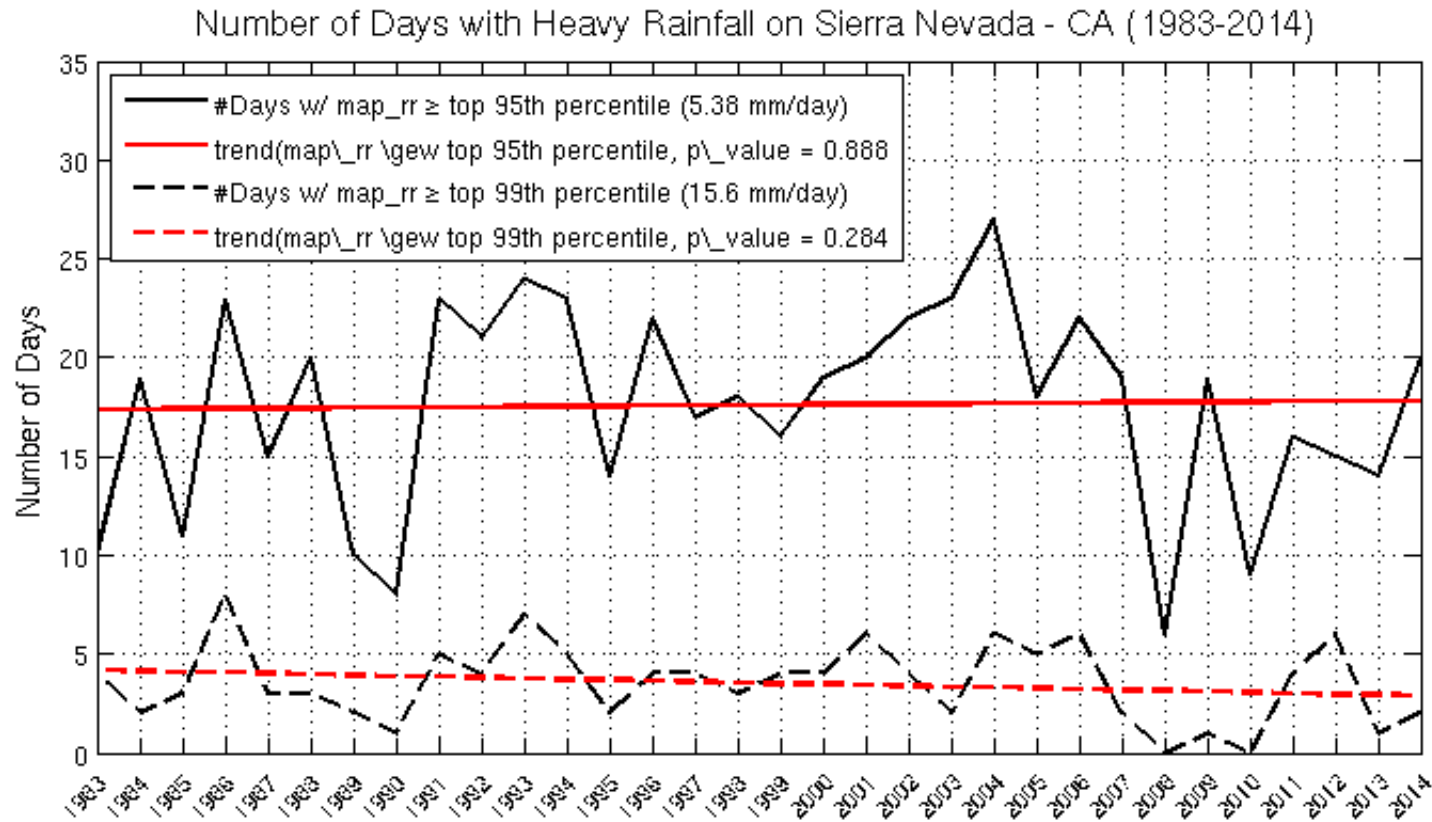


Source: Google Earth

Sierra-Nevada Mountain (California and Nevada)



Trend in the number of heavy rainy days



Though a reduction in extreme precipitation events is identified in the recent years (after 2007), at a 5% significance level (95% CI), none of the above trends is statistically significant.



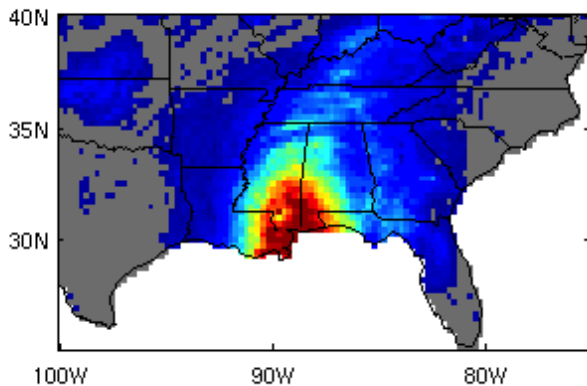
Testing and Validation of PERSIANN-CDR Product



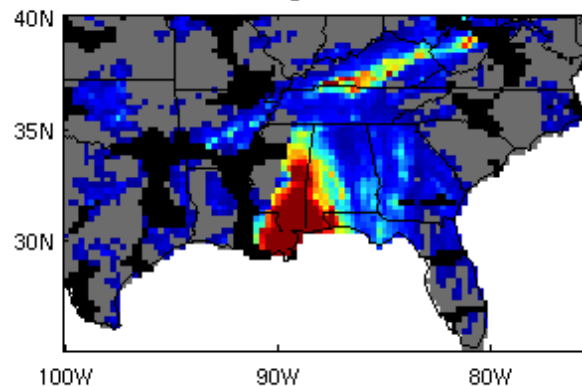
Center for Hydrometeorology and Remote Sensing, University of California, Irvine

Testing of PERSIANN-CDR: Hurricane Katrina, 2005

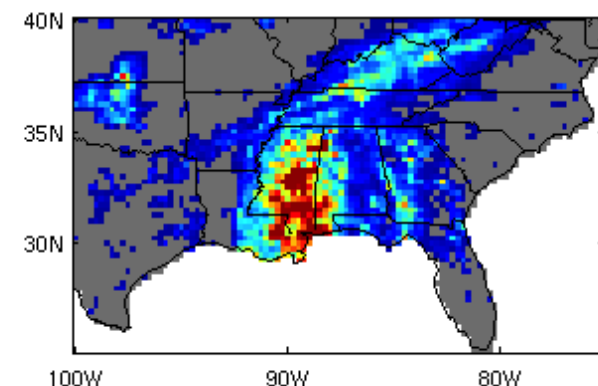
PERSIANN-CDR



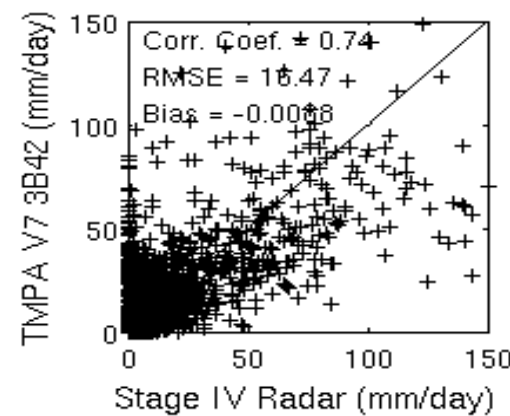
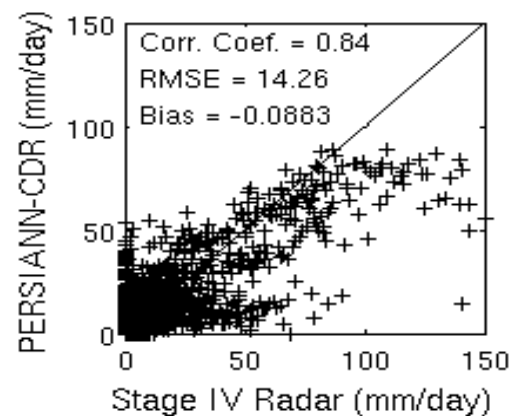
Stage IV Radar



TMPA V7 3B42



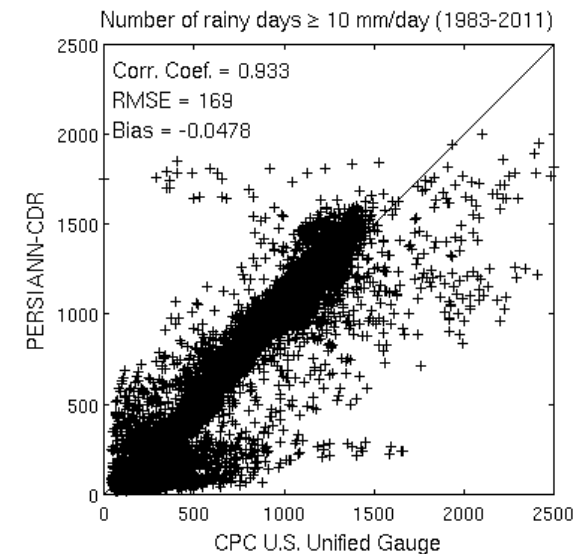
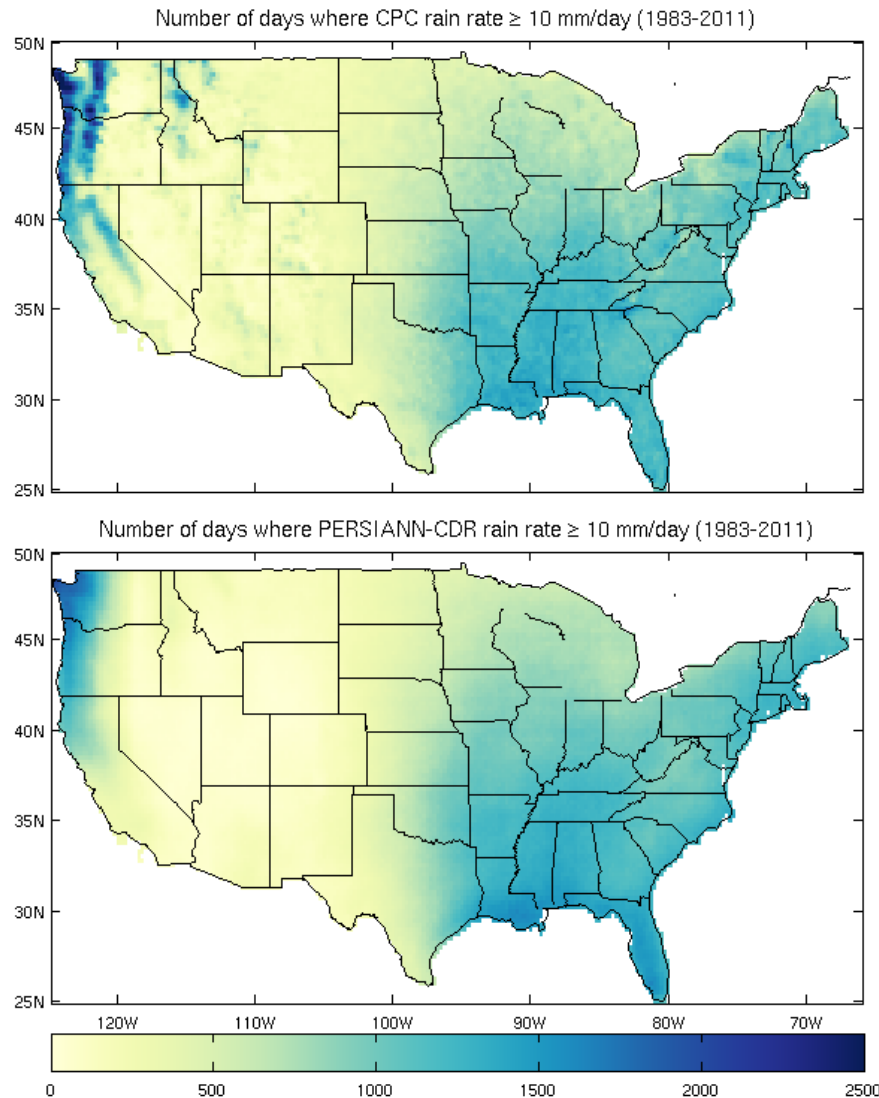
Rain rate (mm/day)



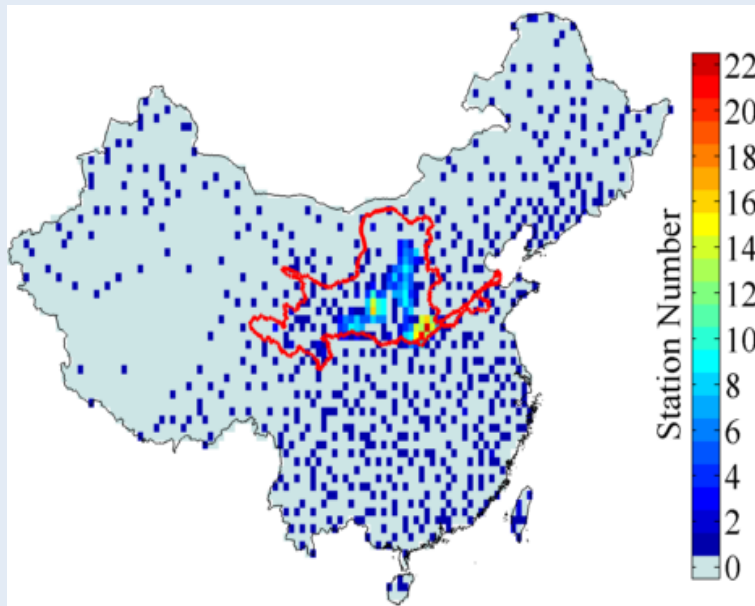
Rainfall (mm/day) over land during Hurricane Katrina on 29 August 2005 from PERSIANN-CDR (top row left), Stage IV Radar (top row middle, Lin and Mitchell 2005), and TMPA v7 (top row right, Huffman *et al.* 2007). Black and gray pixels show radar blockages and zero precipitation, respectively. Scatter plots of PERSIANN-CDR and TMPA versus Stage IV Radar data are provided in the bottom row.



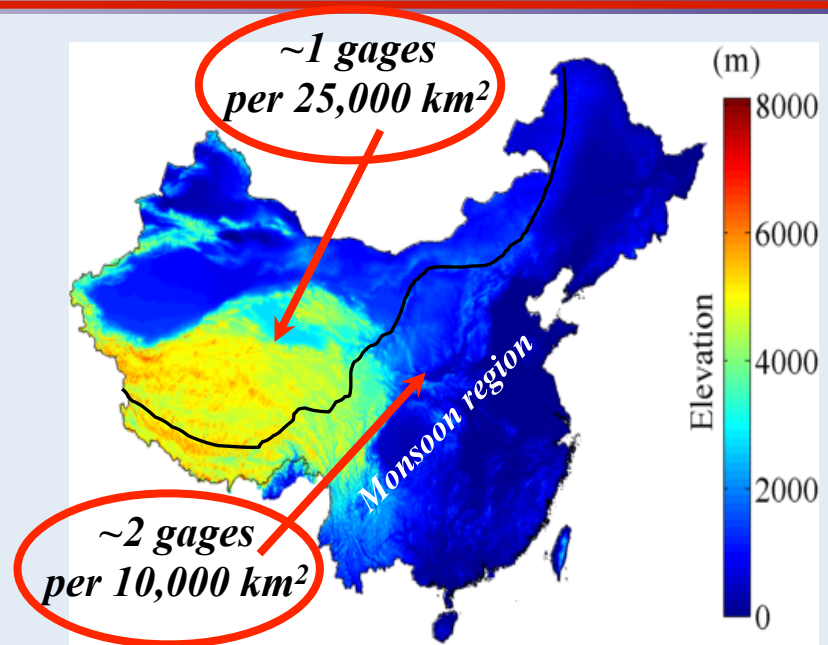
Testing of PERSIANN-CDR: Number of Rainy days ≥ 10 mm/day



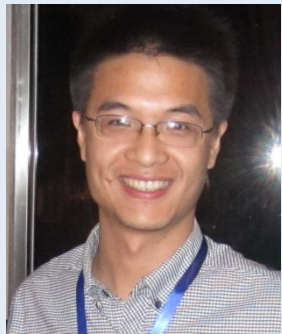
PERSIANN-CDR Evaluation over China



EA Rain Gauge Distribution



Elevation Map



Dr. Chiyuan Miao - BNU

Gauge data: daily precipitation over East Asia (EA) (Xie et al., 2007)

- More than 2200 ground-based stations across China
- 0.5° resolution
- Period 1983-2006

PERSIANN-CDR: up scaled into the same resolution as EA (0.5°)



Evaluation Indices

ID	Definition	Unit
RR95p	The 95th percentile of annual precipitation on wet days (precipitation ≥ 1 mm)	mm/day
R10mmTOT	Annual total precipitation when daily precipitation ≥ 10 mm	mm
R10mm	Annual count of days when precipitation ≥ 10 mm	Days

Extreme precipitation indices used in the analysis



Results: Entire China

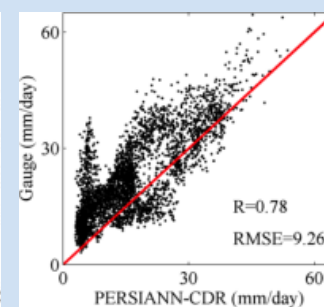
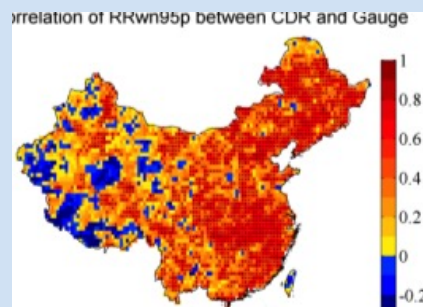
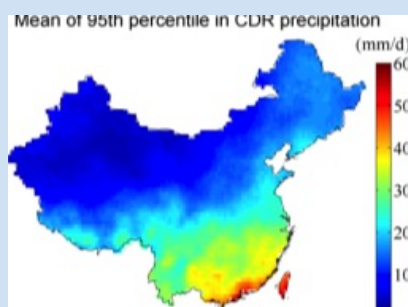
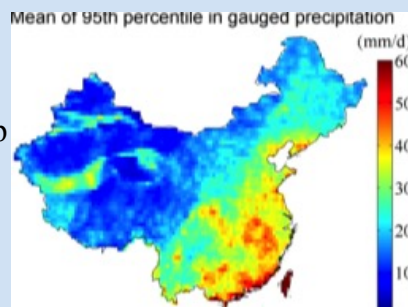
EA

PERSIANN-CDR

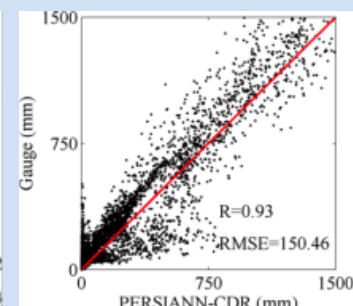
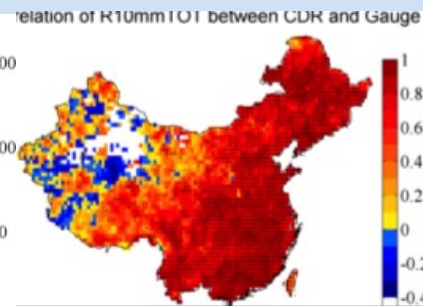
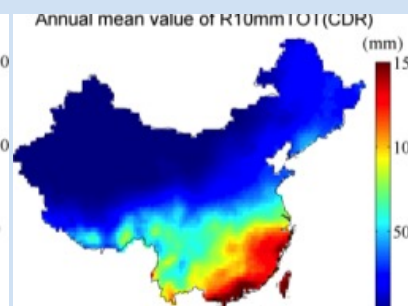
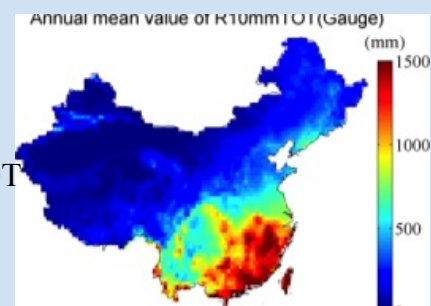
Pixel correlation

Scatterplot of mean

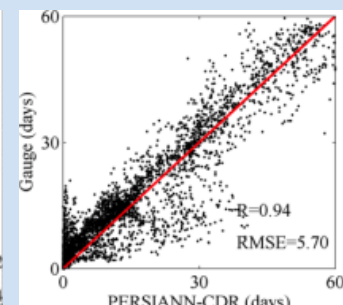
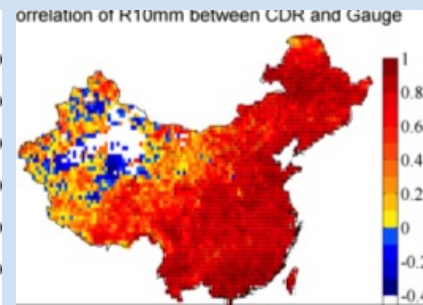
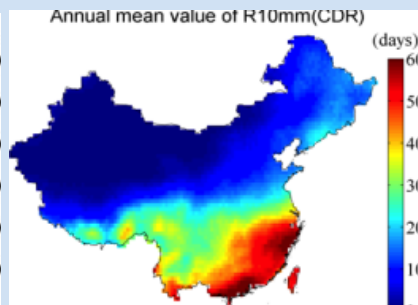
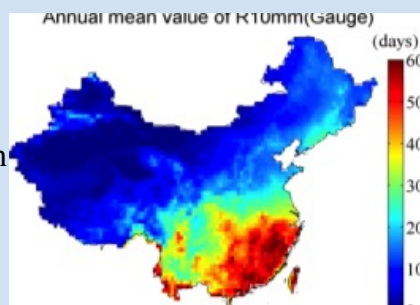
RR95p



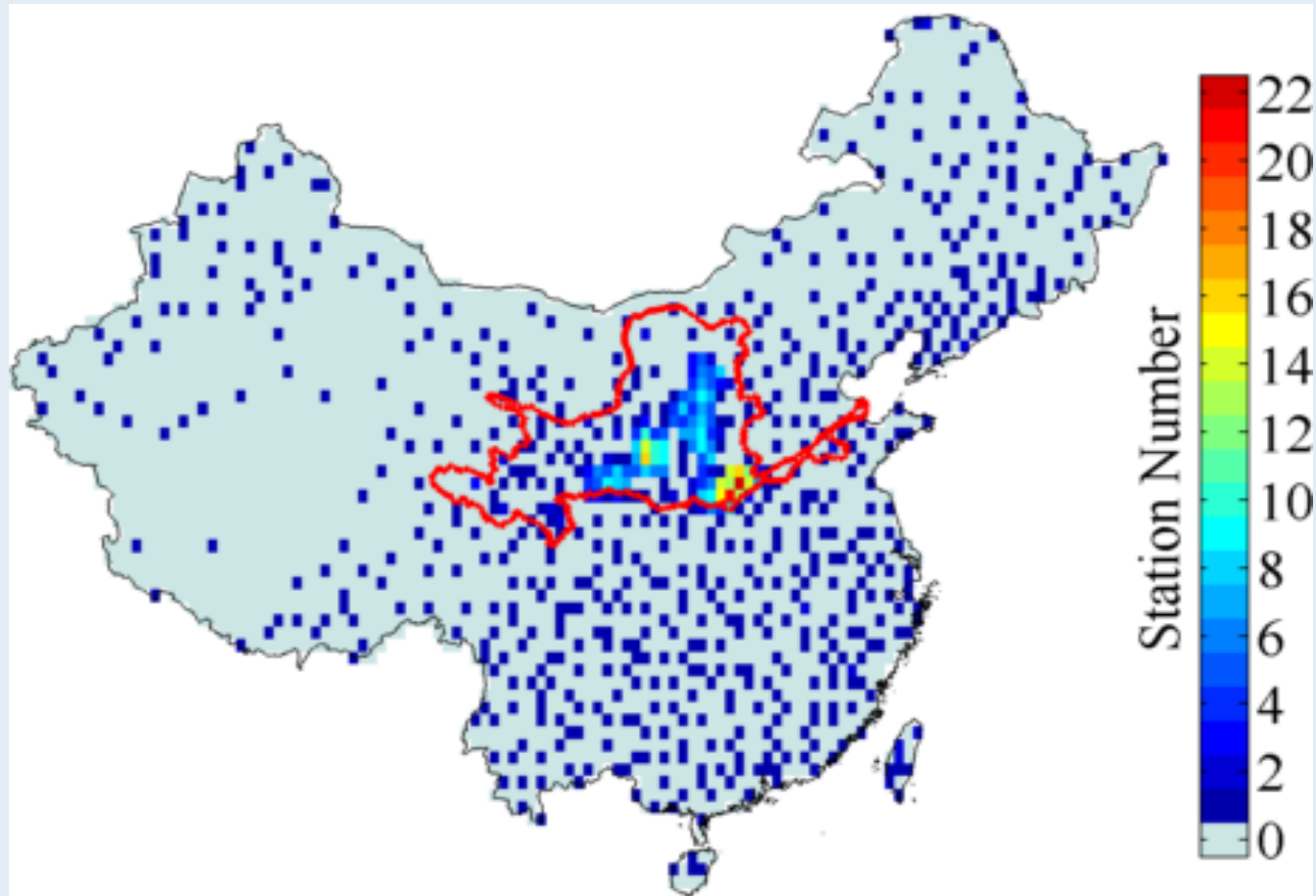
R10mmTOT



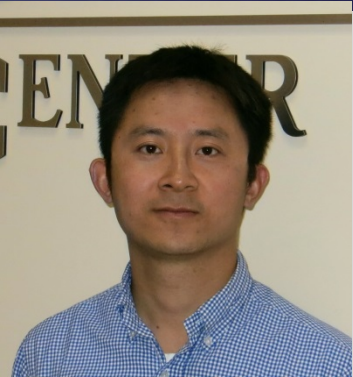
R10mm



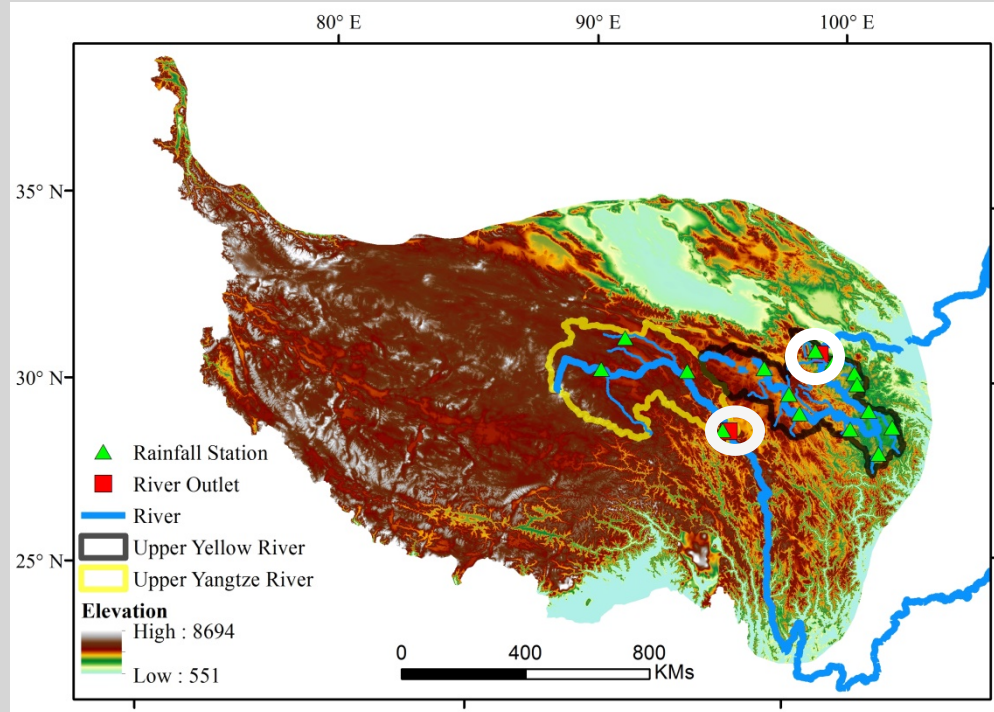
PERSIANN-CDR Evaluation: Zooming over the Yellow River Region



PERSIANN-CDR Evaluation in Tibetan Plateau



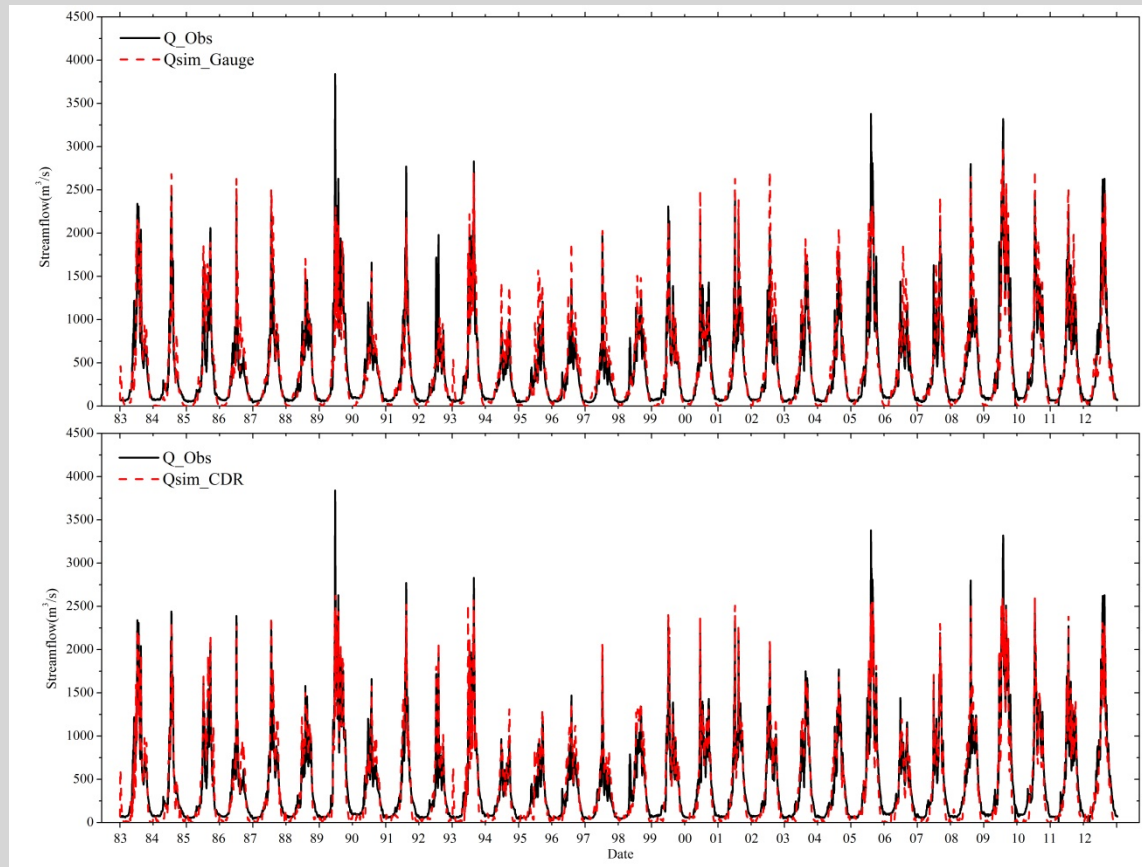
Dr. Xiaomang Liu



TianTian Yang

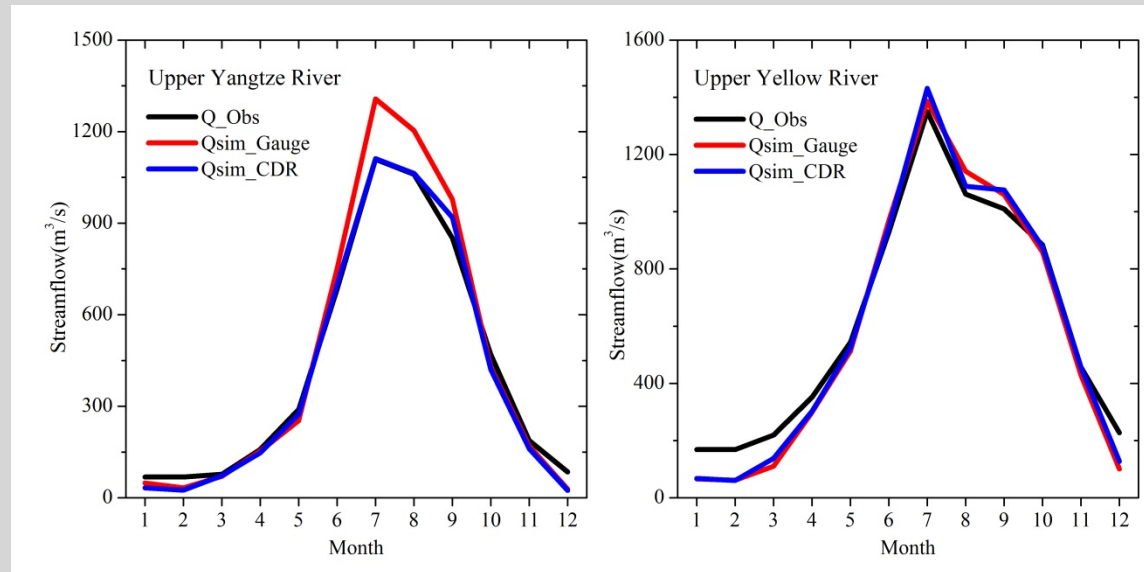
The selected river basins (the upper Yellow River and upper Yangtze River Basin) on the Tibetan Plateau and location of rainfall stations and river outlets.

PERSIANN-CDR Evaluation in Tibetan Plateau



The comparison between the simulated daily streamflow (red) with PERSIANN-CDR and ground-based precipitation and the observed data (black) at the outlets of the upper Yangtze River Basin.

PERSIANN-CDR Evaluation in Tibetan Plateau



Comparisons of the simulated and observed average monthly streamflow driven by the gauge-based precipitation and PERSIANN-CDR precipitation for the two basins from 1983 to 2012.

PERSIANN-CDR:

Potential Usefulness for Model testing

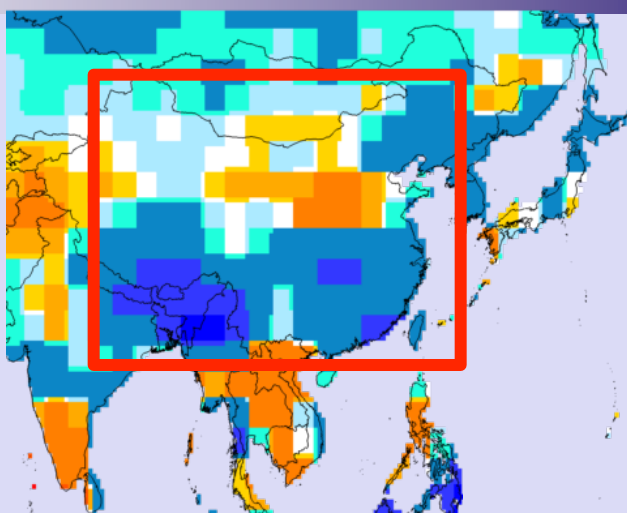


Ashouri et al., BAMS 2015

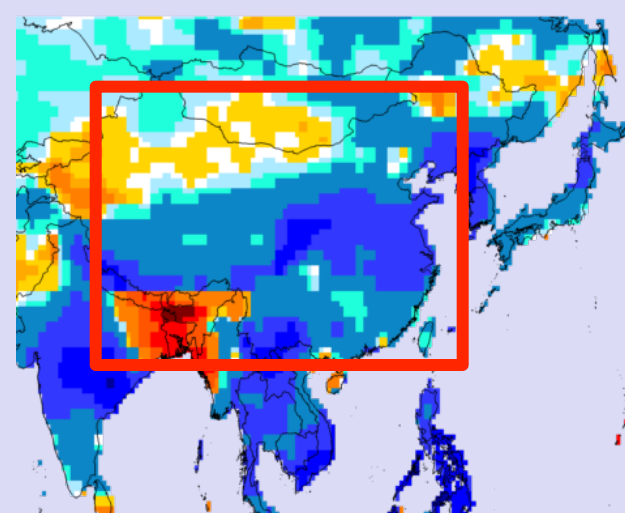
China

RCP2.6 ("Low": 2.6 W/m², Equivalent CO₂ conc. 421 ppm by 2100)

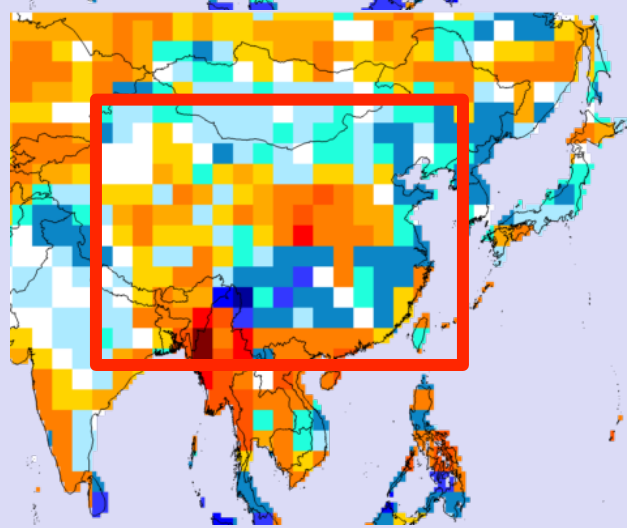
bcc_csm1_1
(Chinese GCM)



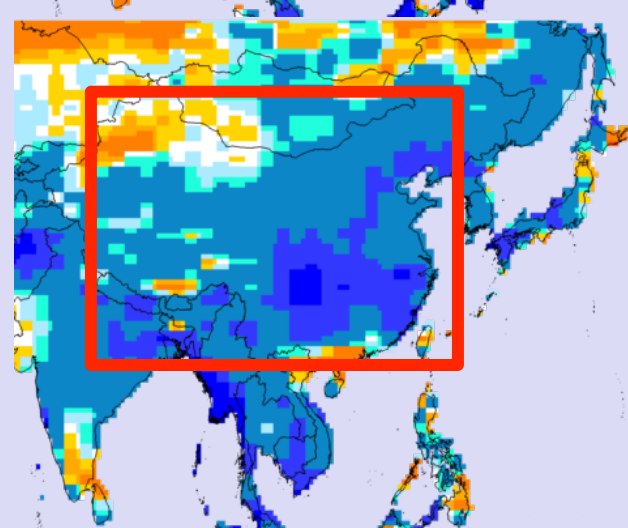
MIROC5
(Japanese GCM)



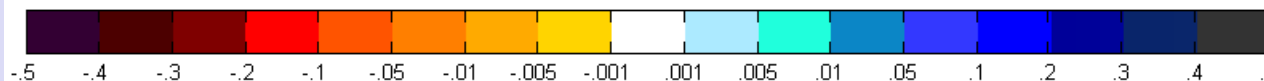
GISS-E2-R
(U.S. GCM)



HadGEM2-ES
(U.K. GCM)

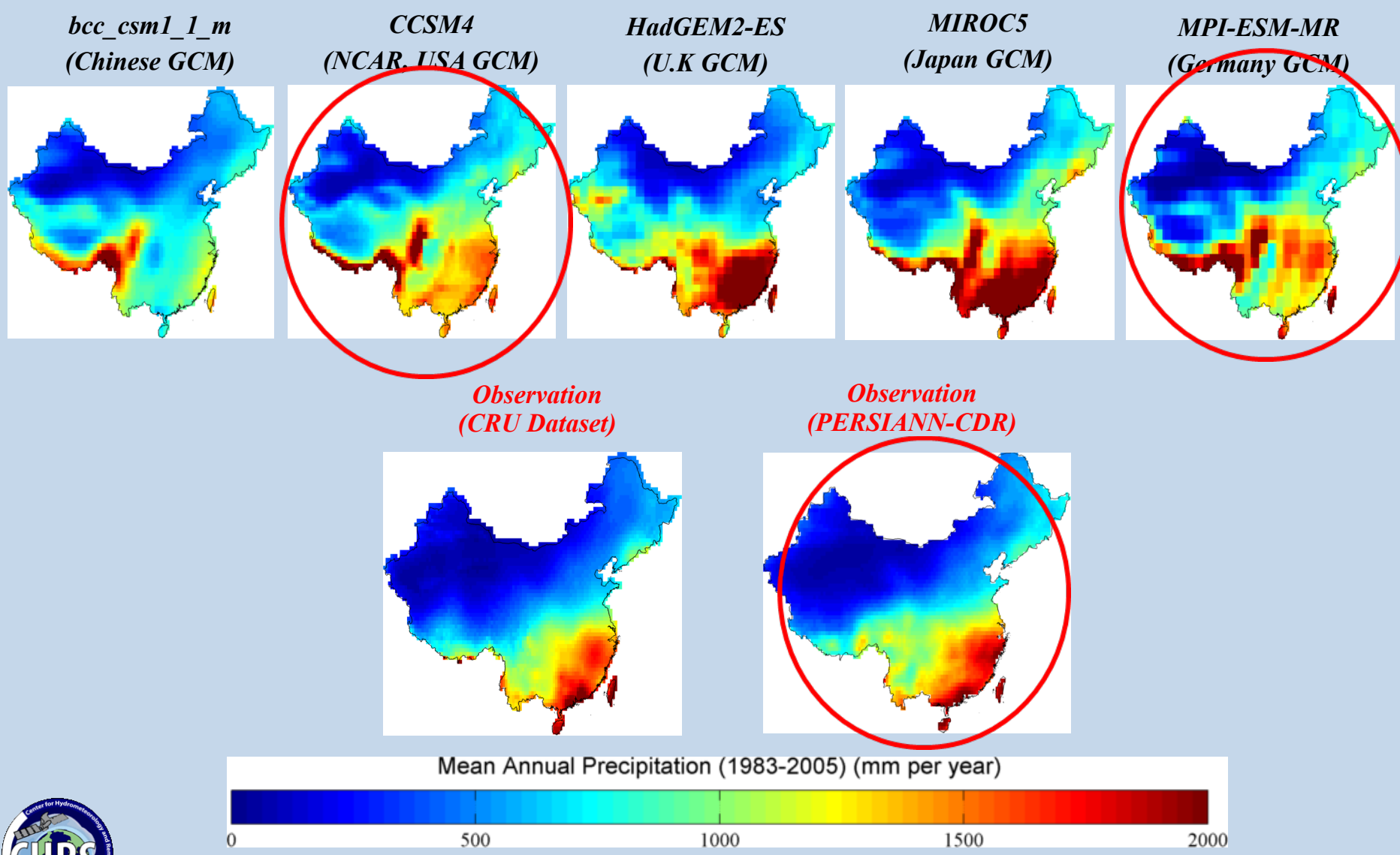


Precipitation change (mm per day per decade)



Resolution: 0.5°x0.5°

CMIP5 Models' historical simulation (1983-2005): CHINA



Middle East Region: Focus on Iran

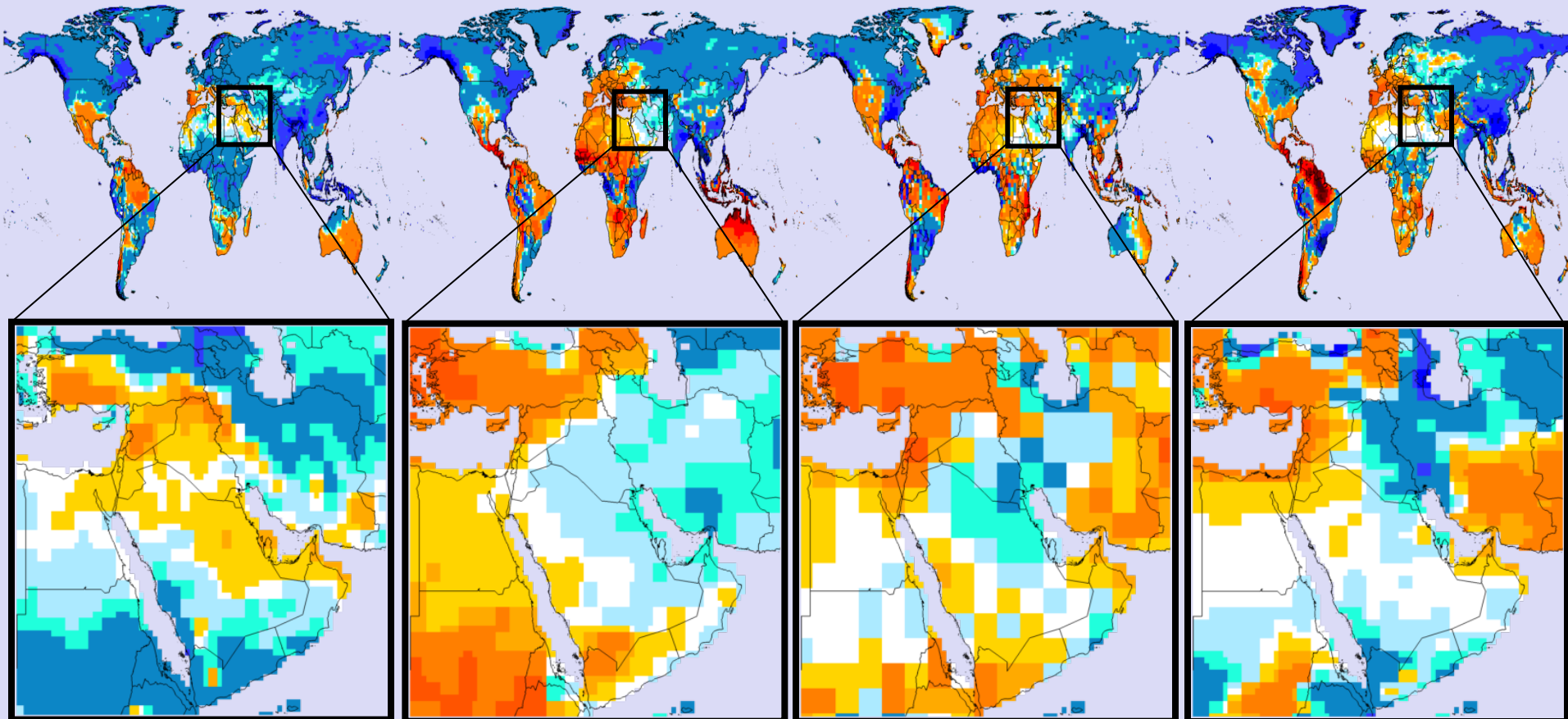
RCP8.5 ("High": 8.5 W/m², Equivalent CO₂ conc. 936 ppm by 2100)

CNRM-CM5
(France GCM)

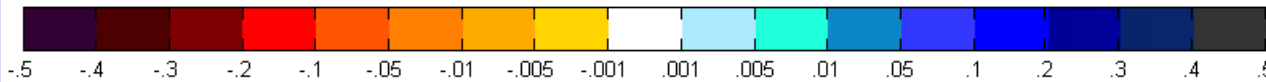
CSIRO-MK-3.6.0
(Australian GCM)

GISS-E2-R
(U.S. GCM)

HadGEM2-ES
(U.K. GCM)



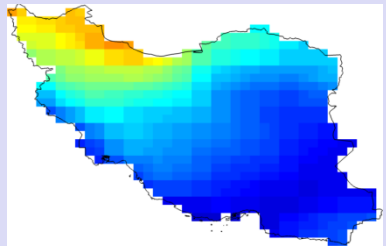
Precipitation change (mm per day per decade)



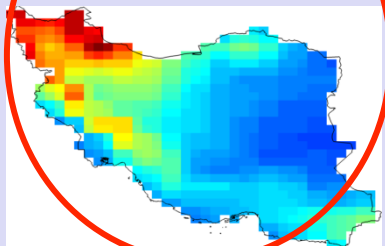
Resolution: 0.5°x0.5°

CMIP5 Models' historical simulation (1983-2005): IRAN

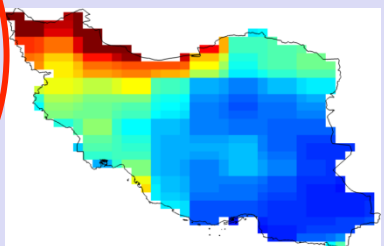
bcc_csm1_1_m
(Chinese GCM)



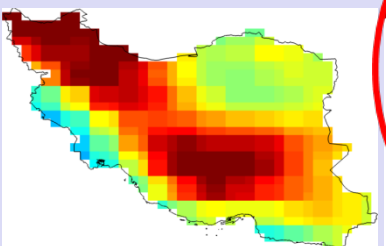
CCSM4
(NCAR, USA GCM)



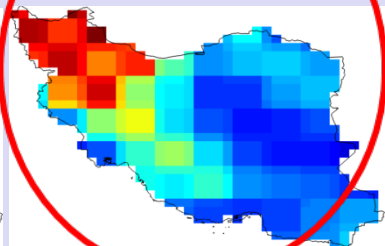
HadGEM2-ES
(U.K GCM)



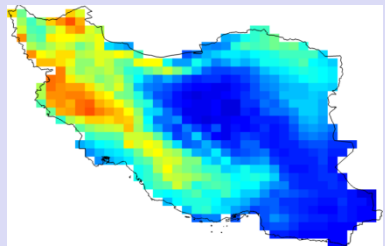
MIROC5
(Japan GCM)



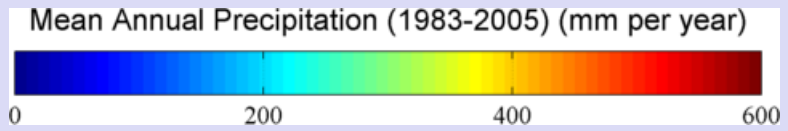
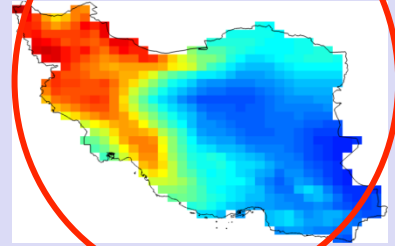
MPI-ESM-MR
(Germany GCM)



Observation
(CRU Dataset)



Remotely Sensed Estimates
(PERSIANN-CDR)



Potential New Directions

EOS

EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

Last Chance: Present at the 2013 Fall Meeting Exploration Station.
Deadline 12 Aug. <http://bit.ly/FMExplore>

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VOLUME 94 NUMBER 32 6 AUGUST 2013

Computational Earth Science: Big Data Transformed Into Insight

More than ever in the history of science, researchers have at their fingertips an unprecedented wealth of data from continuously orbiting satellites, weather monitoring instruments, ecological observations, seismic stations, moored buoys, floats, and even model simulations and forecasts. With just an internet connection, scientists and engineers can access atmospheric and oceanic gridded data and time series observations, seismographs from around the world, minute-by-minute conditions of the near-Earth space environment, and other data streams that provide information on events across local, regional, and global scales. These data sets have become essential for monitoring and understanding the associated impacts of geological and environmental phenomena on society.

If such algorithms are run in a computer environment designed to home in on characteristics of objects or events of interest, then the data can be crunched even more efficiently, allowing insights from big data to be revealed at a quicker pace. Such machine learning evolved from artificial intelligence research and focuses on developing models that are based on the behaviors and characteristics of empirical data. Capturing the behaviors and characteristics from data and determining their underlying probability distributions can provide new knowledge regarding the object or characteristic of interest. Typically, the properties or "true" underlying probability distributions of the observed variable of interest are not explicitly known. However, by seeking to define or describe these underlying probability distributions, data mining can help scientists

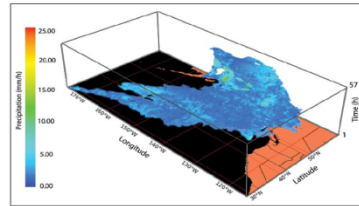


Fig. 1. A connected four-dimensional atmospheric river or "precipitation object" extracted from the PostgreSQL database. The atmospheric river originated in the eastern Pacific and affected the western United States from 26 to 30 December 2005.

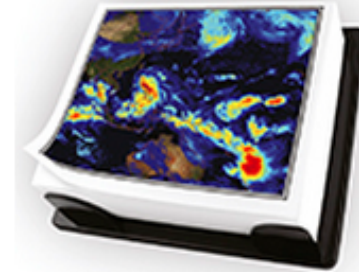
S. Sellars, et.al., EOS Trans. (2013),

Volume 96 Issue 1 (January 2015)

< Previous



PERSIANN-CDR

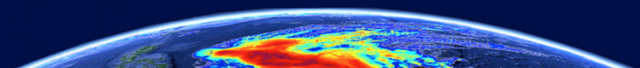


A 30+ Year Global, Daily Precipitation Dataset

Ashouri, Hsu et al., BAMS, 2015.



Center for Hydrometeorology and Remote Sensing, University of California, Irvine



CHRS CONNECT Database Development



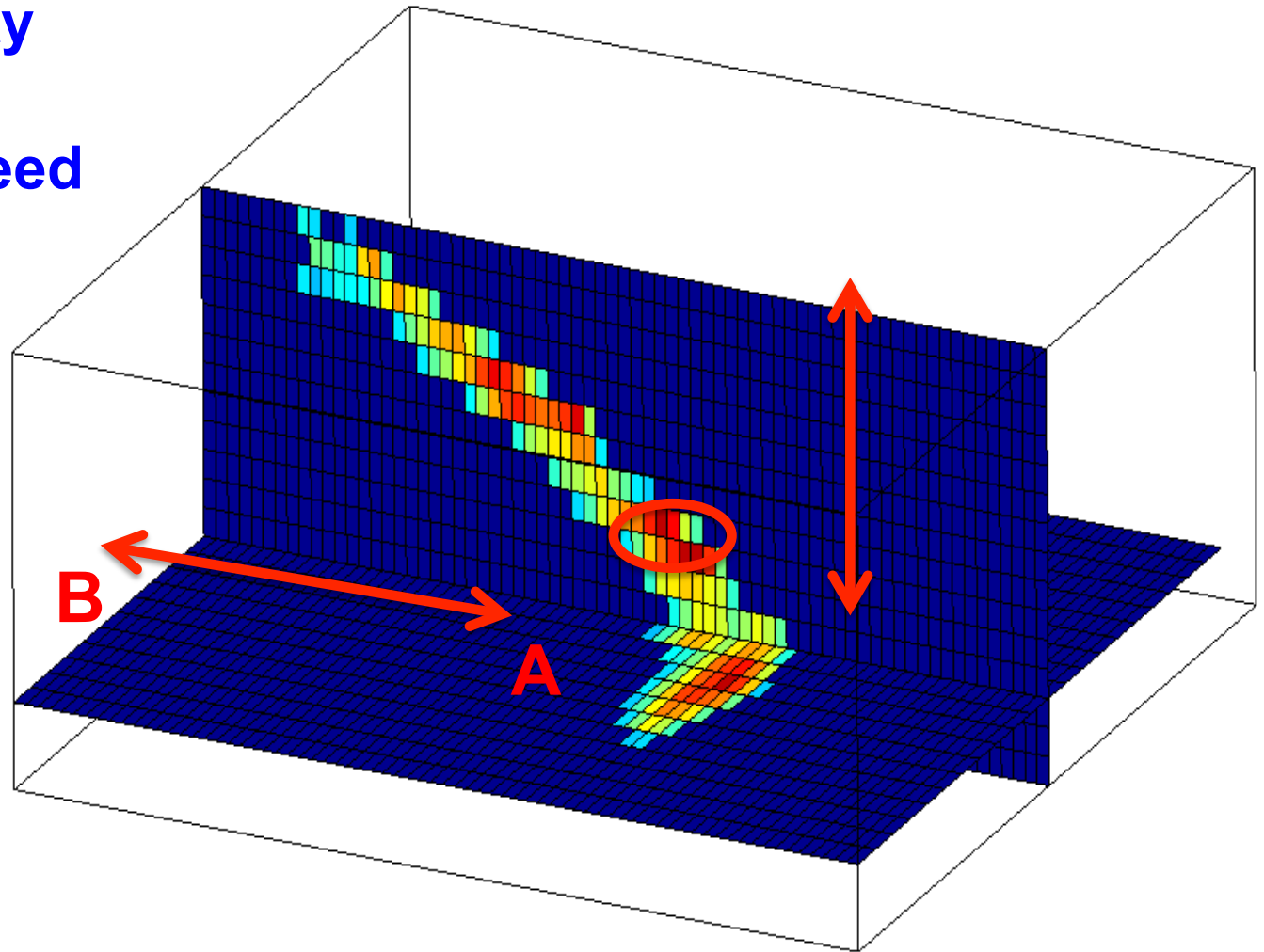
Dr. Phu Nguyen - CHRS



Dr. Hao Liu - CHRS

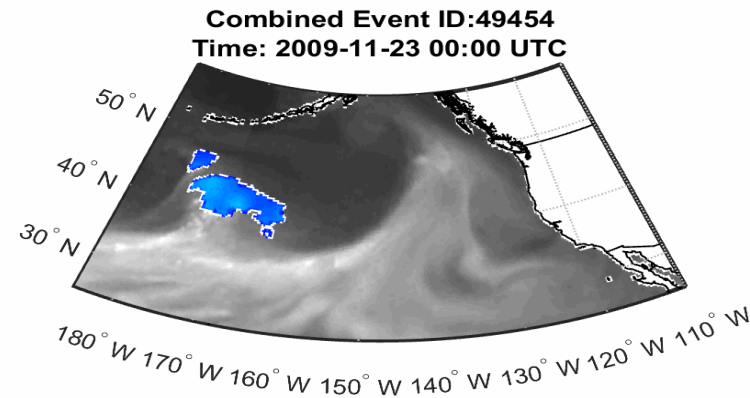
4-D Objects Characteristics

- 1) Max Intensity
- 2) Duration
- 3) Average Speed

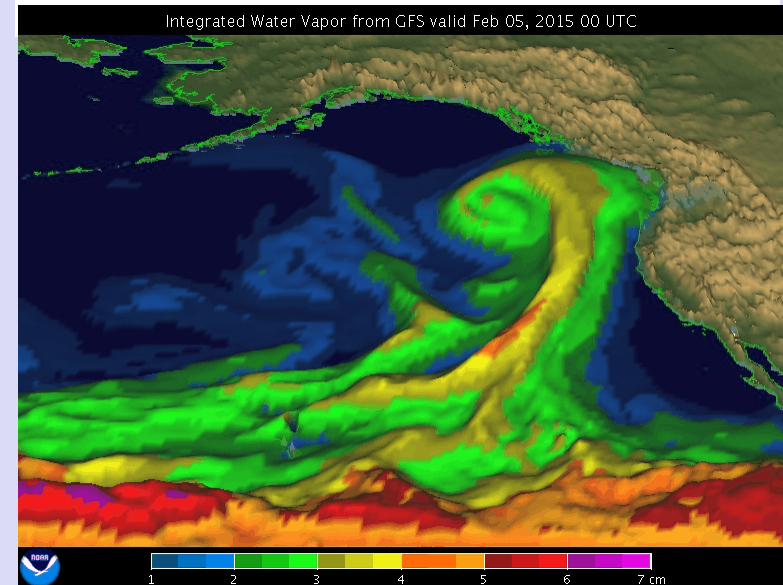


Application of CHRS-CONNECT Database: An Example

- CHRS-CONNECT Features:
 - Current dataset (2000 - present, hourly)
 - Track evolving system through space and time
 - Identify and categorized rainfall systems (i.e., AR)
 - Obtain object's attributes & statistic
 - Advanced search based on storm features
- Atmospheric River (AR, Dettinger et al, 2011)
 - Narrow water vapor “rivers”
 - 1000 km wide, > 2000 km long
 - Water vapor band that is above a threshold
 - Contribute to 30 ~50% California's annual precipitation



Source: UCI & NOAA





Connect.eng.uci.edu

CHRS CONNECT Interface

The screenshot displays the CHRS CONNECT web application interface. On the left is a navigation bar with a search location input field and various search filters. The main area shows a satellite map of the Western United States with a red box highlighting California. On the right is a visualization panel with controls for speed, tracking, and event markers. At the bottom, there are sponsor logos and a download button.

Navigation Bar

Dataset Selection

Search Method

Spatial Selection

Time Period

Define Extreme Event

Search by Features

Search Location

Base maps

Visualization Tools

List of Events Found

Download Results

CHRS CONNECT
A Global Extreme Precipitation Event Database
Inspiring research on climate and water resources

Home Info Tutorial About Us

Select Dataset
PERSIANN-CONNECT

Search Method
Event Name/ID:
Name/ID
Event Features:
California

Coordinate
32.500 42.000
55.000 66.000

Date
Start Date End Date

Min of Max Intensity mm/hr
Min Duration hr
Add Features

Submit Clear

Washington MONTANA NORTH DAKOTA SOUTH DAKOTA OREGON IDAHO WYOMING NEBRASKA NEVADA UTAH COLORADO ARIZONA NEW MEXICO CALIFORNIA SONORA CHIHUAHUA COAHUILA



United States

Visualization
Speed Medium
Tracking OFF
Show Marker(s) ON
Rain Total OFF
Boundary OFF
Results

Download

OUR SPONSORS
NASA NOAA U.S. DEPARTMENT OF AGRICULTURE U.S. ENVIRONMENTAL PROTECTION AGENCY U.S. GEOLOGICAL SURVEY U.S. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION U.S. NATIONAL OCEANOGRAPHIC ADMINISTRATION U.S. NATIONAL WEATHER SERVICE U.S. NATIONAL INTELLIGENCE AGENCY U.S. NATIONAL SCIENCE FOUNDATION U.S. NATIONAL SECURITY AGENCY U.S. NATIONAL TROPICAL BUREAU OF METEOROLOGY U.S. NATIONAL TROPICAL CENTER FOR HYDROLOGICAL PREDICTION U.S. NATIONAL TROPICAL CENTER FOR HYDROLOGICAL PREDICTION U.S. NATIONAL TROPICAL CENTER FOR HYDROLOGICAL PREDICTION

Current CHRS CONNECT System



CHRS CONNECT

A Global Extreme Precipitation Event Database

Inspiring research on climate and water resources

[Home](#) [Info](#) [Tutorial](#) [About Us](#)

Select Dataset
PERSIANN-CONNECT

Search Method
☐ Event Name/ID:
Name/#

☐ Event Features:
California

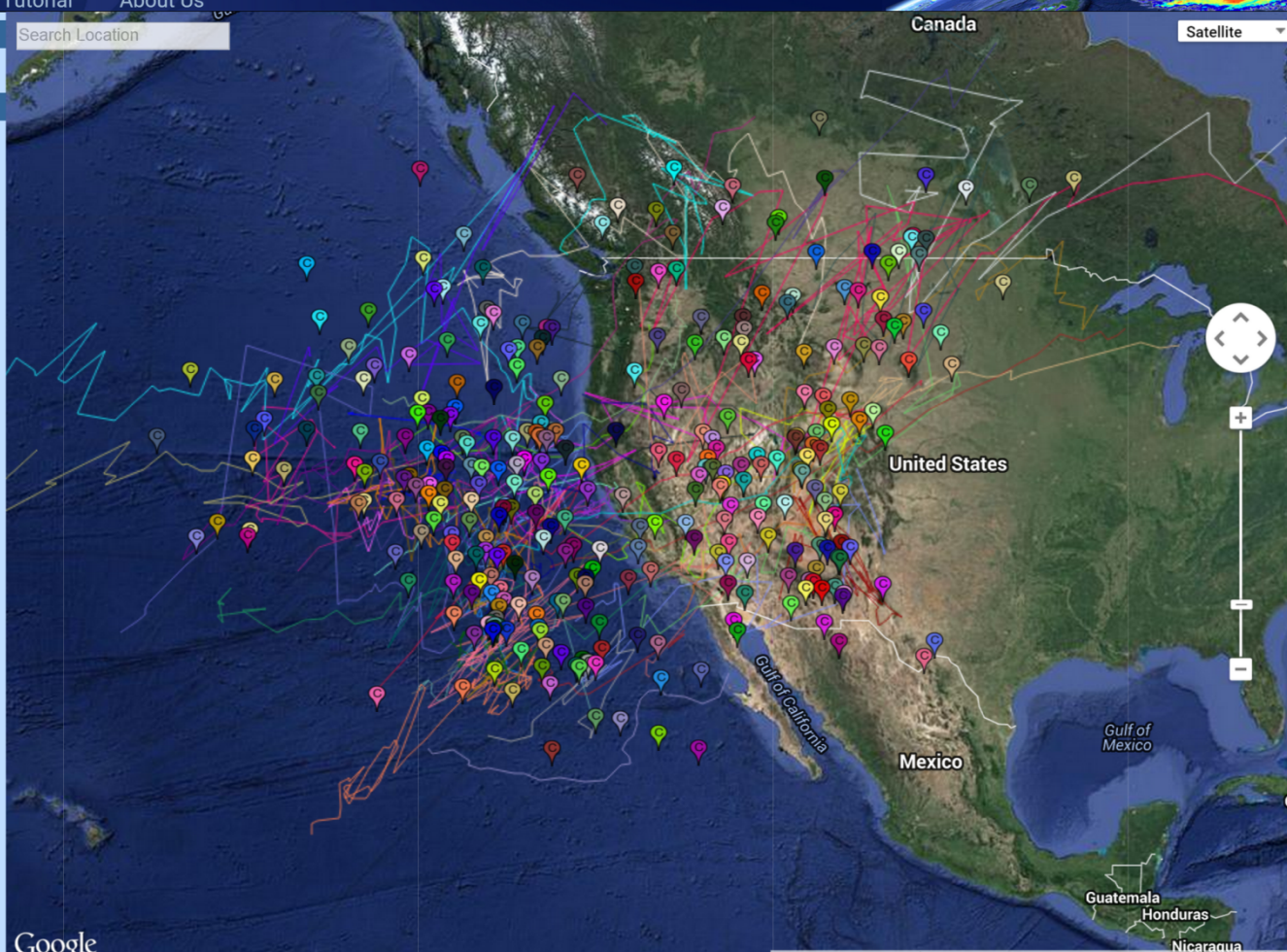
Coordinate

Date

Min of Max Intensity

Min Duration

Add Features



Visualization







Speed
Tracking ☒ ON
Show Marker(s) ☒ ON
Rain Total ☐ OFF
Boundary ☐ OFF

Results
Total Event(s): 315
Select All ☒

Complete loading
[Event # 18604](#) ☒
[Event # 18763](#) ☒
[Event # 19915](#) ☒
[Event # 20847](#) ☒
[Event # 20987](#) ☒
[Event # 21034](#) ☒
[Event # 21106](#) ☒
[Event # 21184](#) ☒
[Event # 21338](#) ☒
[Event # 21410](#) ☒
[Event # 21430](#) ☒
[Event # 21570](#) ☒
[Event # 21594](#) ☒

Google

Map data ©2015 Google, INEGI Imagery ©2015 NASA, TerraMetrics Terms of Use



OUR SPONSORS

Search Events by Start-End Region Domain (Showing both Centroids and Tracking of Events)



CHRS CONNECT

A Global Extreme Precipitation Event Database

Inspiring research on climate and water resources

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Select Dataset

PERSIANN-CONNECT

Search Method

☐ Event Name/ID:

☒ Event Features:
Spatial Selection

Coordinate

Starting Region:

Ending Region:

Date

Min of Max Intensity
 mm/hr

Min Duration
 hr

Add Features

Search Location



Satellite

Visualization

Speed Medium

Tracking ☒

Show Marker(s) ☒

Rain Total ☐

Boundary ☐

Results

Total Event(s): 25
Select All

Completely loaded

Event # 17	<input checked="" type="checkbox"/>
Event # 33	<input checked="" type="checkbox"/>
Event # 606	<input checked="" type="checkbox"/>
Event # 2751	<input checked="" type="checkbox"/>
Event # 2842	<input checked="" type="checkbox"/>
Event # 2999	<input checked="" type="checkbox"/>
Event # 3037	<input checked="" type="checkbox"/>
Event # 3142	<input checked="" type="checkbox"/>
Event # 3251	<input checked="" type="checkbox"/>
Event # 7105	<input checked="" type="checkbox"/>
Event # 7402	<input checked="" type="checkbox"/>
Event # 7506	<input checked="" type="checkbox"/>
Event # 7737	<input checked="" type="checkbox"/>
Event # 8026	<input checked="" type="checkbox"/>
Event # 10225	<input checked="" type="checkbox"/>

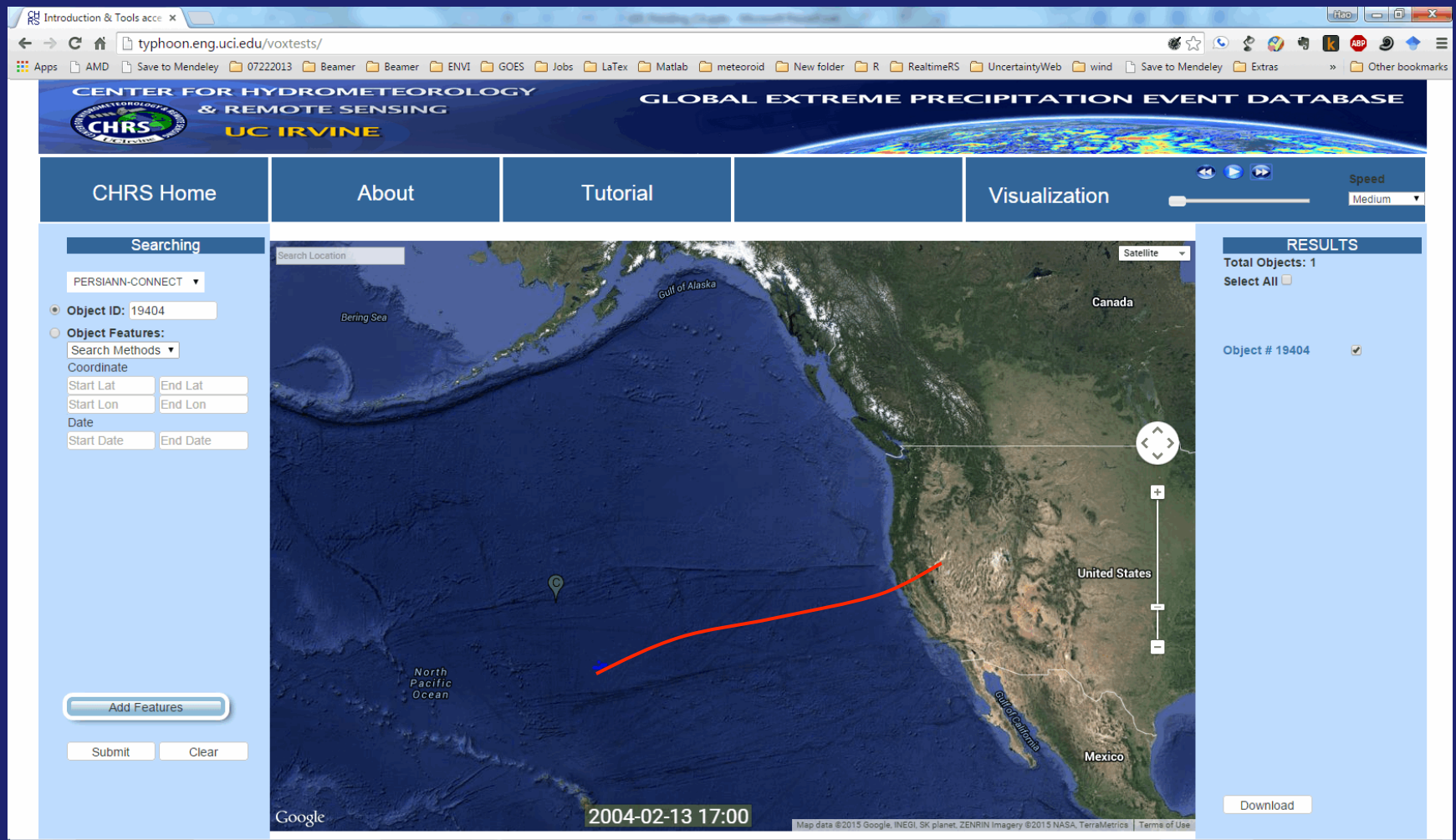
Download

Submit Clear

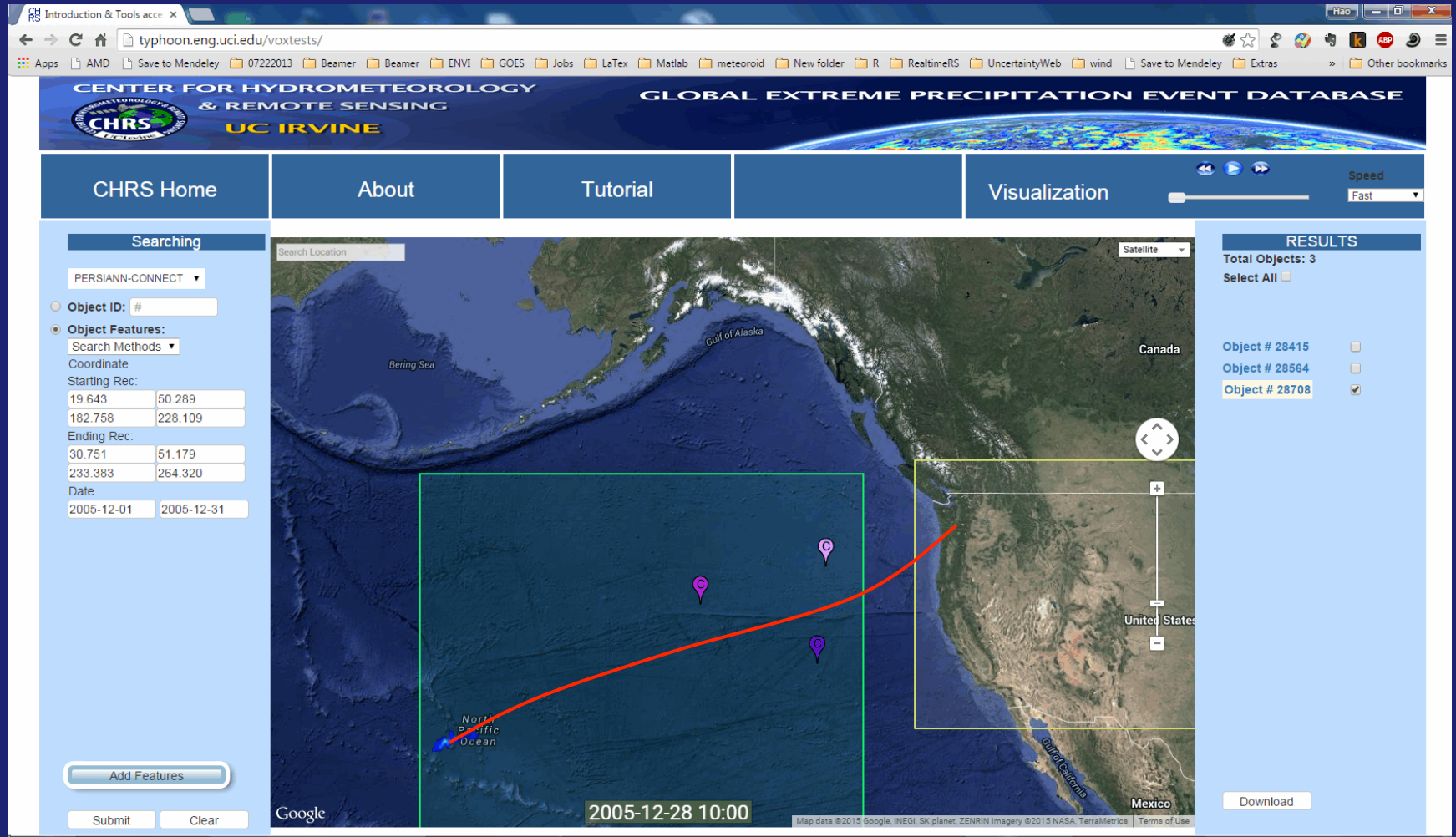
OUR SPONSORS



AR events visualization using PERSIANN-CONNECT: 2004 Feb.



AR event visualization using PERSIANN-CONNECT: 2005 Dec.



Build AR events database using PERSIANN-CONNECT

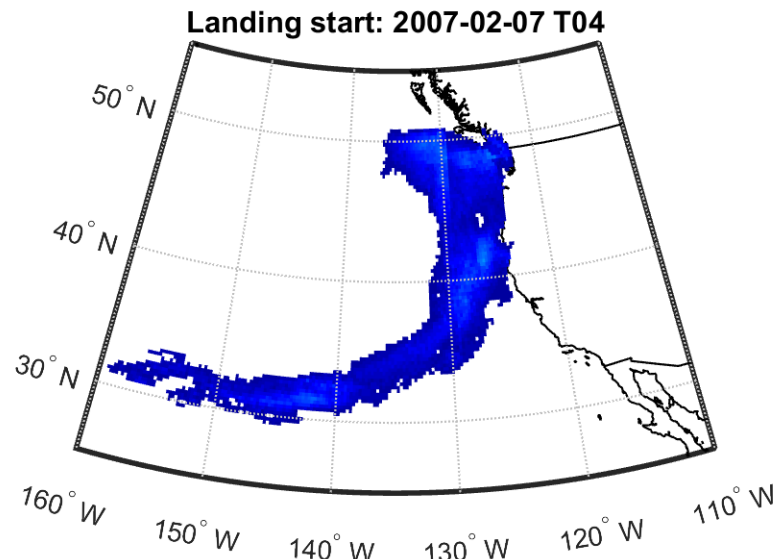
- **Sorting CHRS-CONNECT database for the ARs:**

- Produce rainfall over California
- Originate from West Pacific
- Different from hurricanes

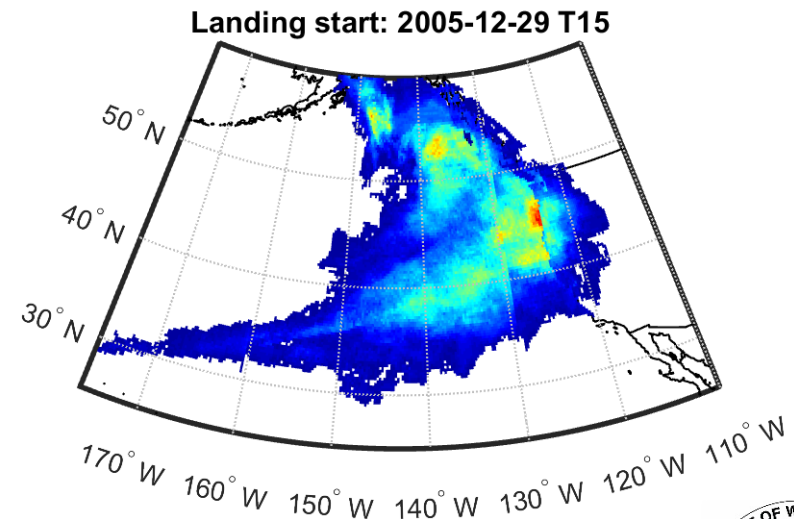
PERSIANN-CONNECT Picked up 164 AR events (2000 to 2010)

PERSIANN-CDR-CONNECT will be the longest record of AR event (1983-2015)

Storm Objects accumulated precipitation amounts & coverages



Not from Pacific (Excluded)

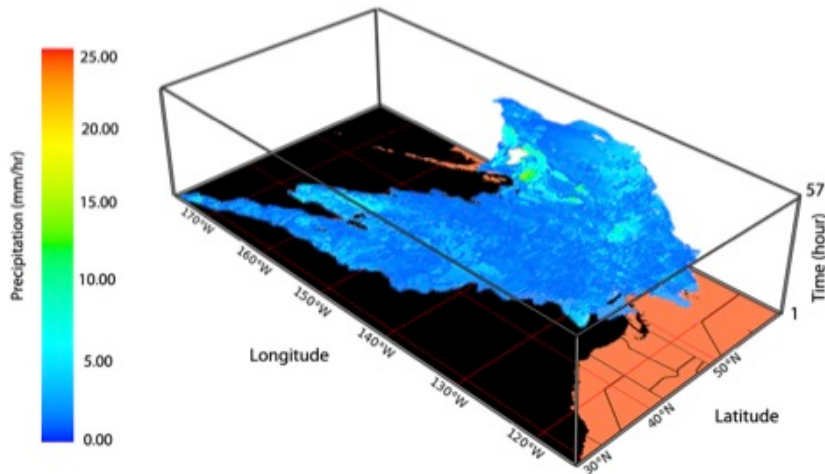


From Pacific (Included)



Next Logical Step!

Atmospheric River: Dec 28th, 2005 - Dec 30, 2005



Incorporate PERSIANN-CDR
into CHRS CONNECT

NATIONAL CLIMATIC DATA CENTER

NOAA's Climate Data Record (CDR) Program

PRECIPITATION ESTIMATION FROM REMOTE SENSING INFORMATION USING ARTIFICIAL NEURAL NETWORK

PERSIANN-CDR

PERSIANN CLIMATE DATA RECORD SPECIFICATIONS

- 0.25-deg * 0.25-deg (60°S–60°N latitude and 0°–360° longitude)
- Daily Product
- 1980–present
- Updated Quarterly

INPUTS TO THE PERSIANN CLIMATE DATA RECORD

- GridSat-B1 CDR (IRW/N)
- GPCP 2.5-deg Monthly Data

SOME USES OF THE PERSIANN CLIMATE DATA RECORD

- Climatologists can perform long-term climate studies at a finer resolution than previously possible.
- Hydrologists can use PERSIANN-CDR for rainfall-runoff modeling in regional and global scale, particularly in remote regions.
- Performing extreme Event Analysis (intensity, frequencies, and duration of floods and droughts).
- Water Resources Systems Planning and Management

PERSIANN CLIMATE DATA RECORD
<http://www.ncdc.noaa.gov/cdr/operationalcdrs.html>

CLIMATE DATA RECORD PROGRAM INFORMATION
<http://www.ncdc.noaa.gov/cdr/index.html>

www.climate.gov
www.ncdc.noaa.gov

Protecting the past... Revealing the future
February 2014

PERSIANN Satellite Product On Google Earth

Google Earth

File Edit View Tools Add Help

Search

Fly To Find Businesses Directions

Fly to e.g., New York, NY

Places Add Content

- Temporary Places
- GWADI Precipitation Click for Info:
- Current Accumulation Le... Click For Info
- Current 3 Hour Accumulatio Click For Info
- Current 6 Hour Accumulatio Click For Info
- Current 12 Hour Accumulatio

Layers

- Primary Database
- Geographic Web
- Roads
- 3D Buildings
- Street View
- Borders and Labels
- Traffic
- Weather
- Gallery
- Ocean
- Global Awareness
- Places of Interest

Accumulated Precipitation (mm)

0 10 50 150 > No data

CHRS

Mobile Devices App:

- Rain Mapper
- IRain

Dr. Phu Nguyen

© 2009 Europa Technologies
© 2009 Tele Atlas
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2009 TerraMetrics

11°23'16.20" S 45°19'52.71" E elev -3383 m

© 2009 Google

Eye alt 14693.32 km

Home - CHRS HyDIS GWADI M... Google Earth gadgets 12:42 PM



Thank You for the Invitation

08/14/2009

Somewhere in New Mexico, USA - Photo: J. Sorooshian

Back up slides

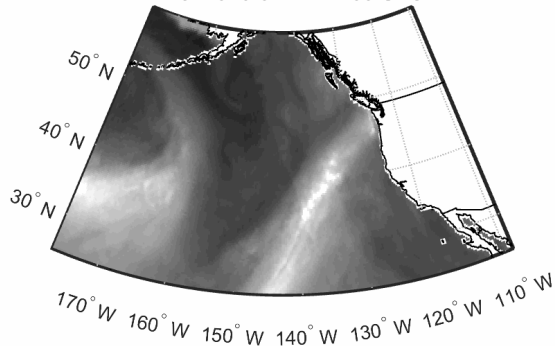


CHRS-CONNECT Captures the lifespan of an AR event

- AR hits California Coast (5 Evolving Stages in CHRS-CONNECT)

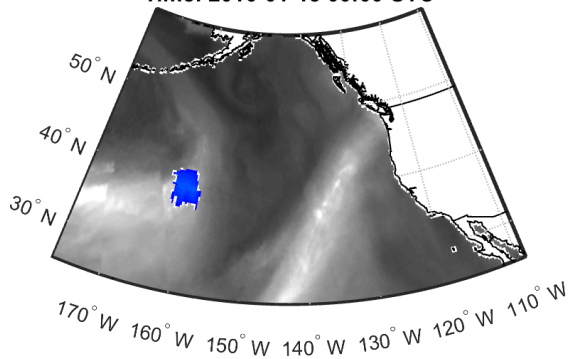
Lifespan of an AR

Combined Event ID:50131
Time: 2010-01-14 21:00 UTC



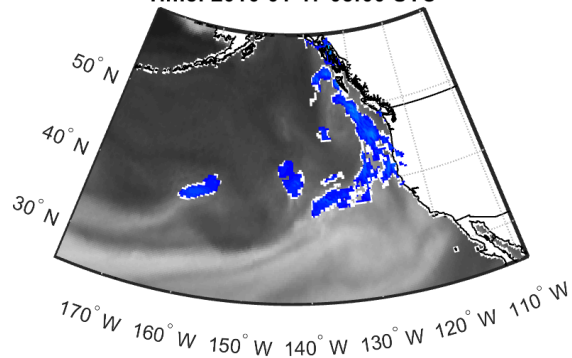
Originate

Combined Event ID:50131
Time: 2010-01-15 00:00 UTC



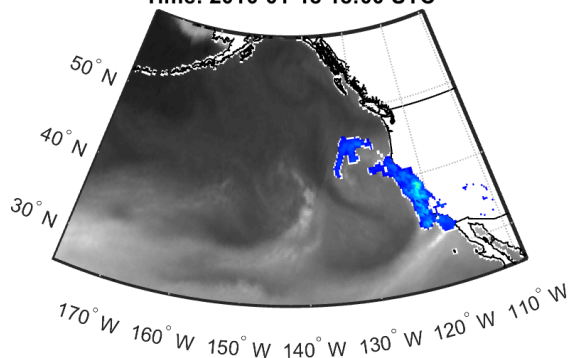
Landfall

Combined Event ID:50131
Time: 2010-01-17 05:00 UTC

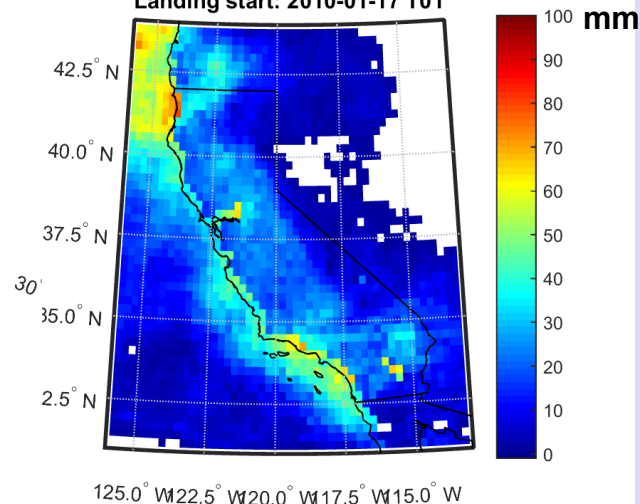


Dissipate

Combined Event ID:50131
Time: 2010-01-18 18:00 UTC



Accumulated Precipitation (mm)
Combined Event ID:50131
Landing start: 2010-01-17 T01





***How about the testing of all
other Remote Sensing
Observations and Model
Generated Data??***

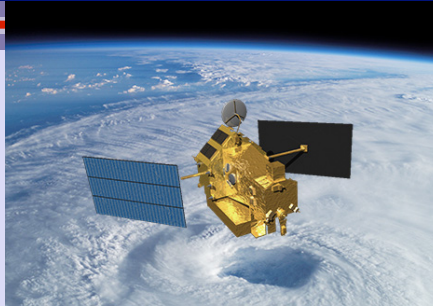


Hydrologically - Relevant Remote Sensing Missions



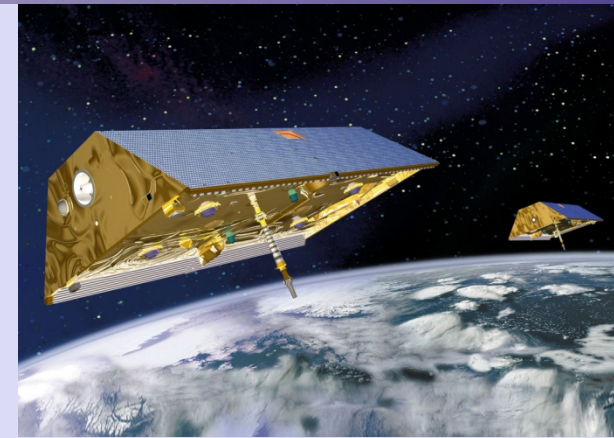
SMOS

ESA's Soil Moisture and Ocean Salinity (2009)



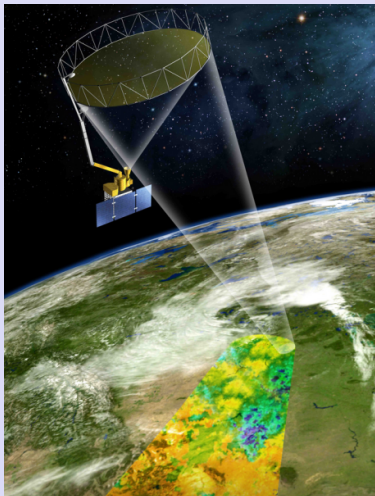
TRMM

The Tropical Rainfall Measuring Mission



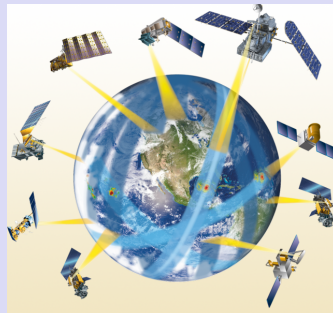
GRACE

Gravity Recovery and Climate Experiment (2002)



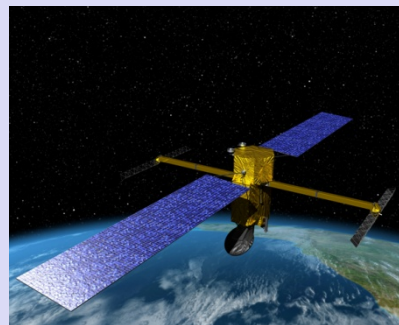
SMAP

Soil Moisture Active Passive Satellite(2014)



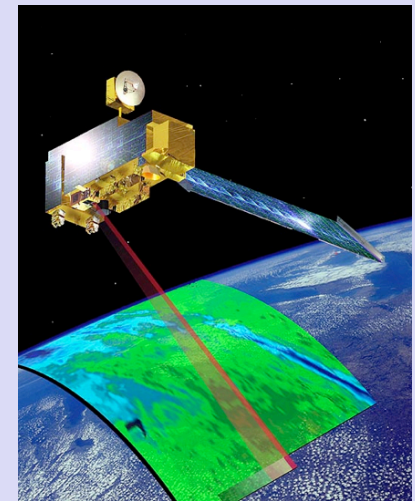
GPM

Global Precipitation Measurements (2014)



SWOT

Surface Water and Ocean Topography (2020)

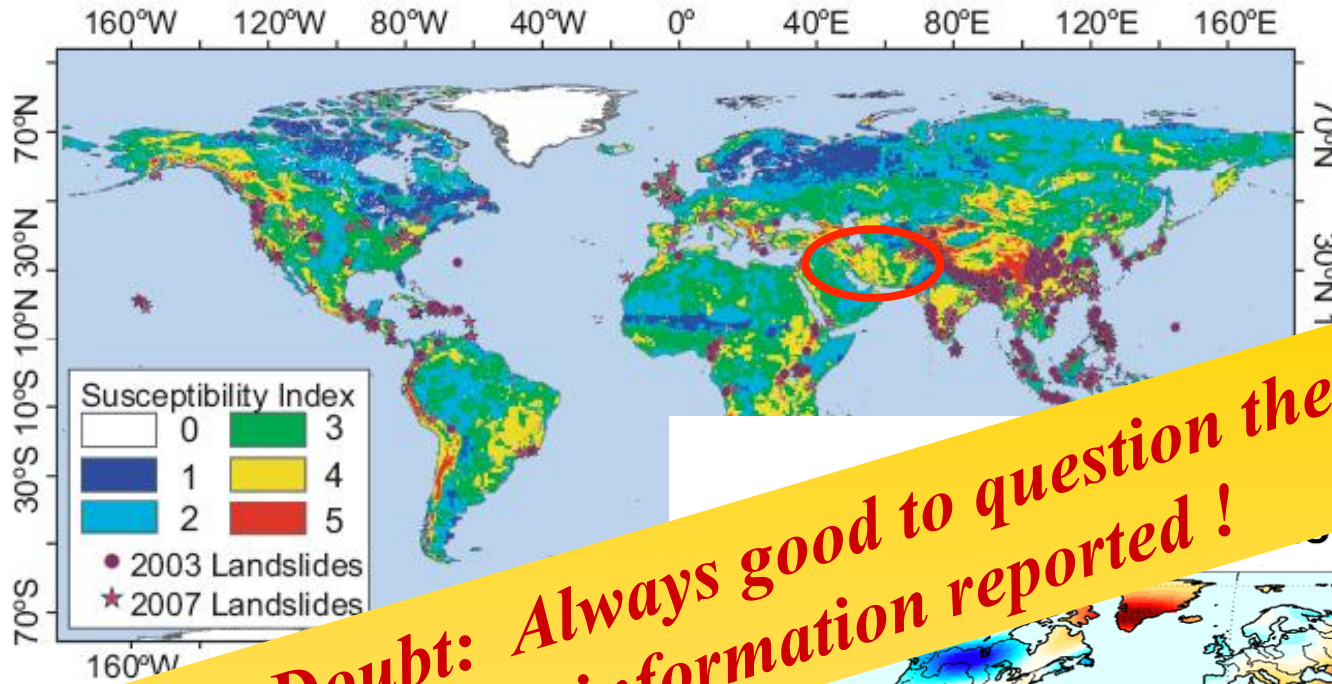


MODIS

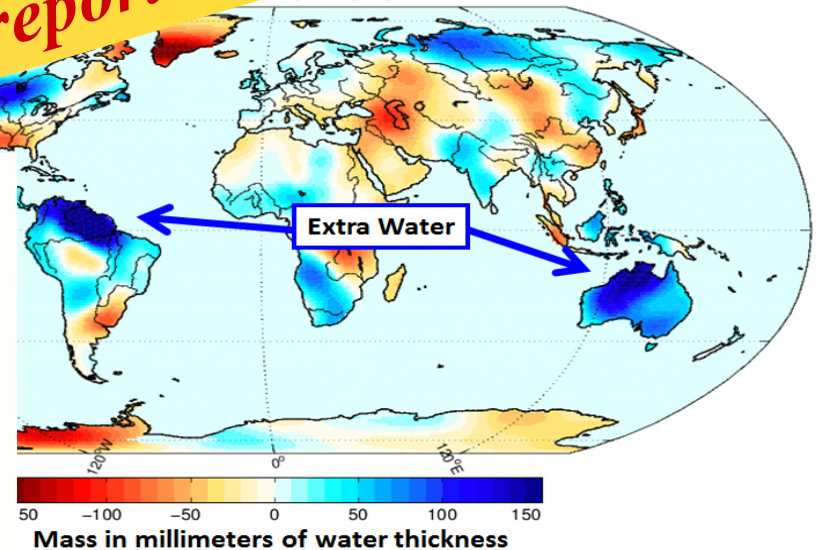
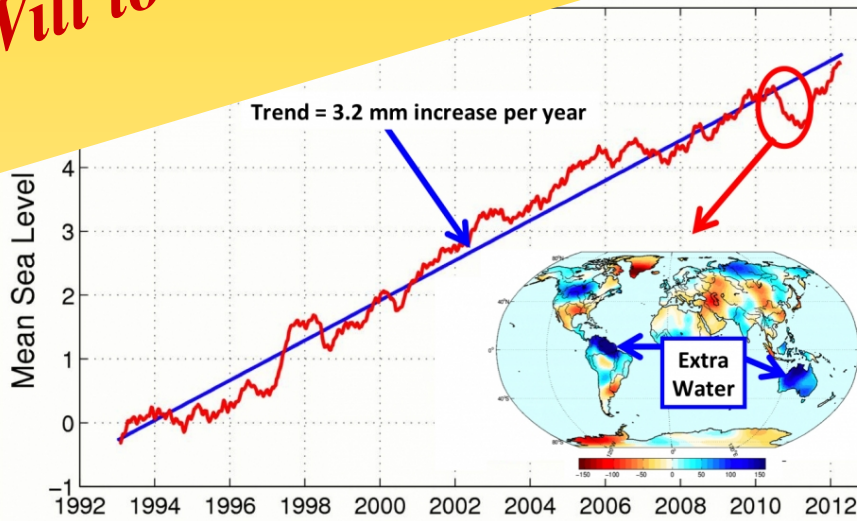
*Moderate Resolution Imaging Spectroradiometer
(1999) , (2002)*



Landslide Risk map:

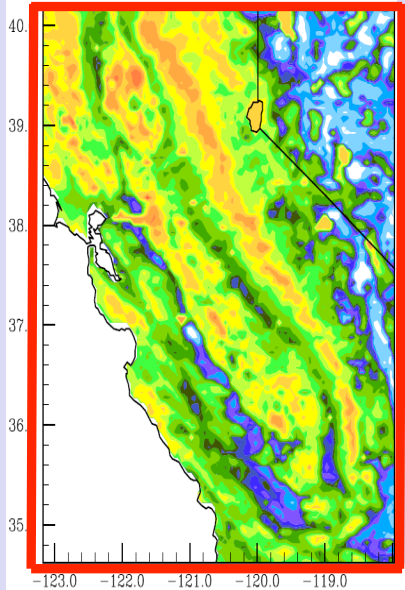


Will to Doubt: Always good to question the credibility of information reported !

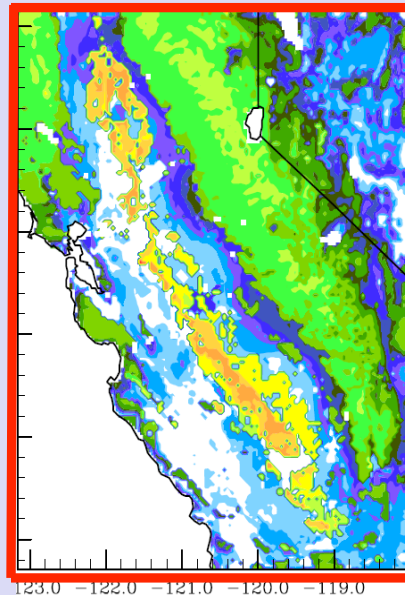


“Observed” vs “Model-Generated” Data

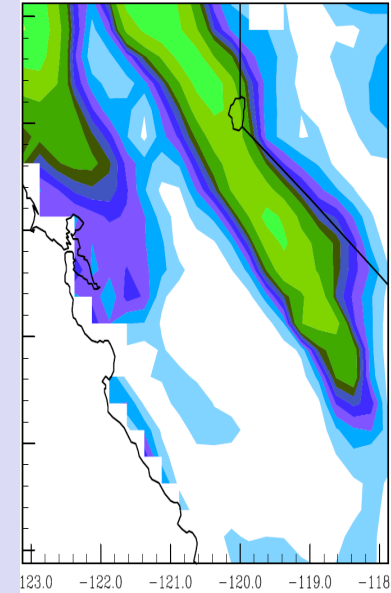
MODIS



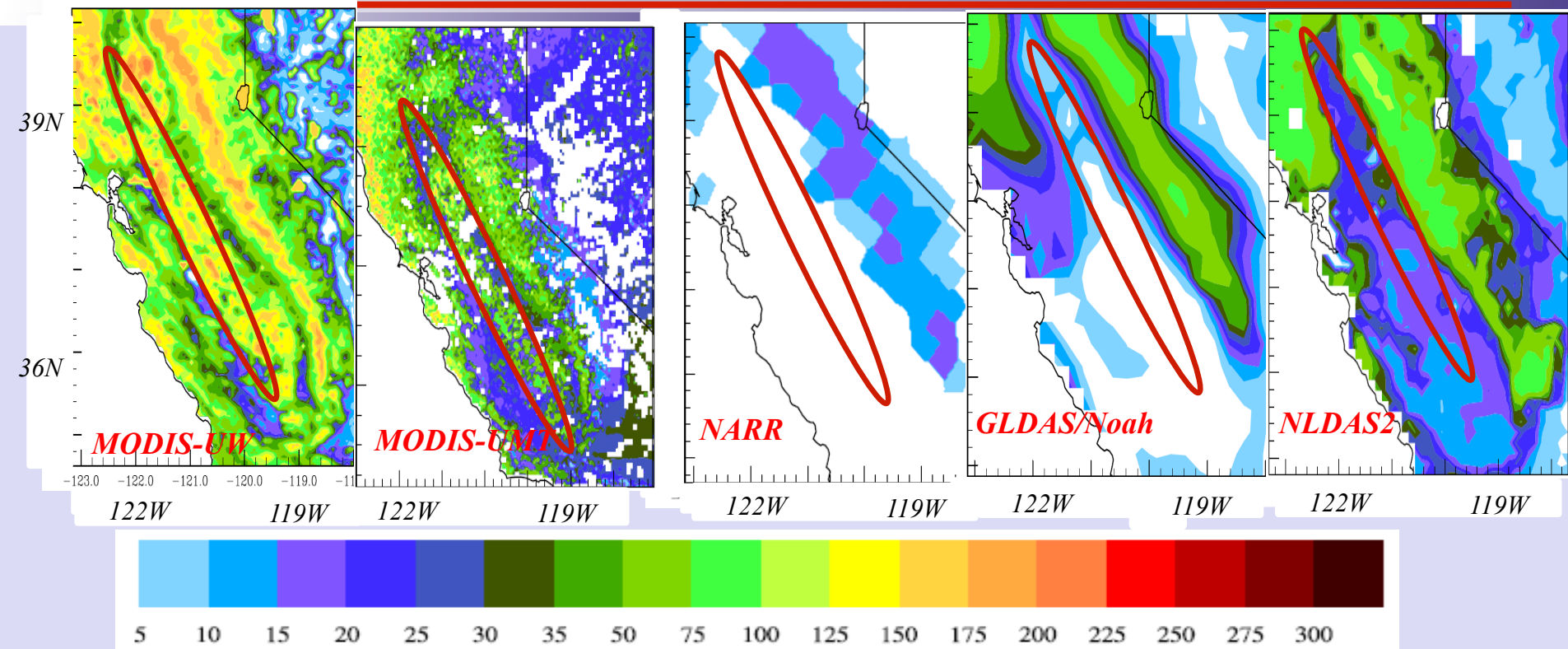
MM5R



GLDAS/Noah



Actual ET Estimates From Different Data sets– JJA 2007



2007 JJA Monthly ET (mm)

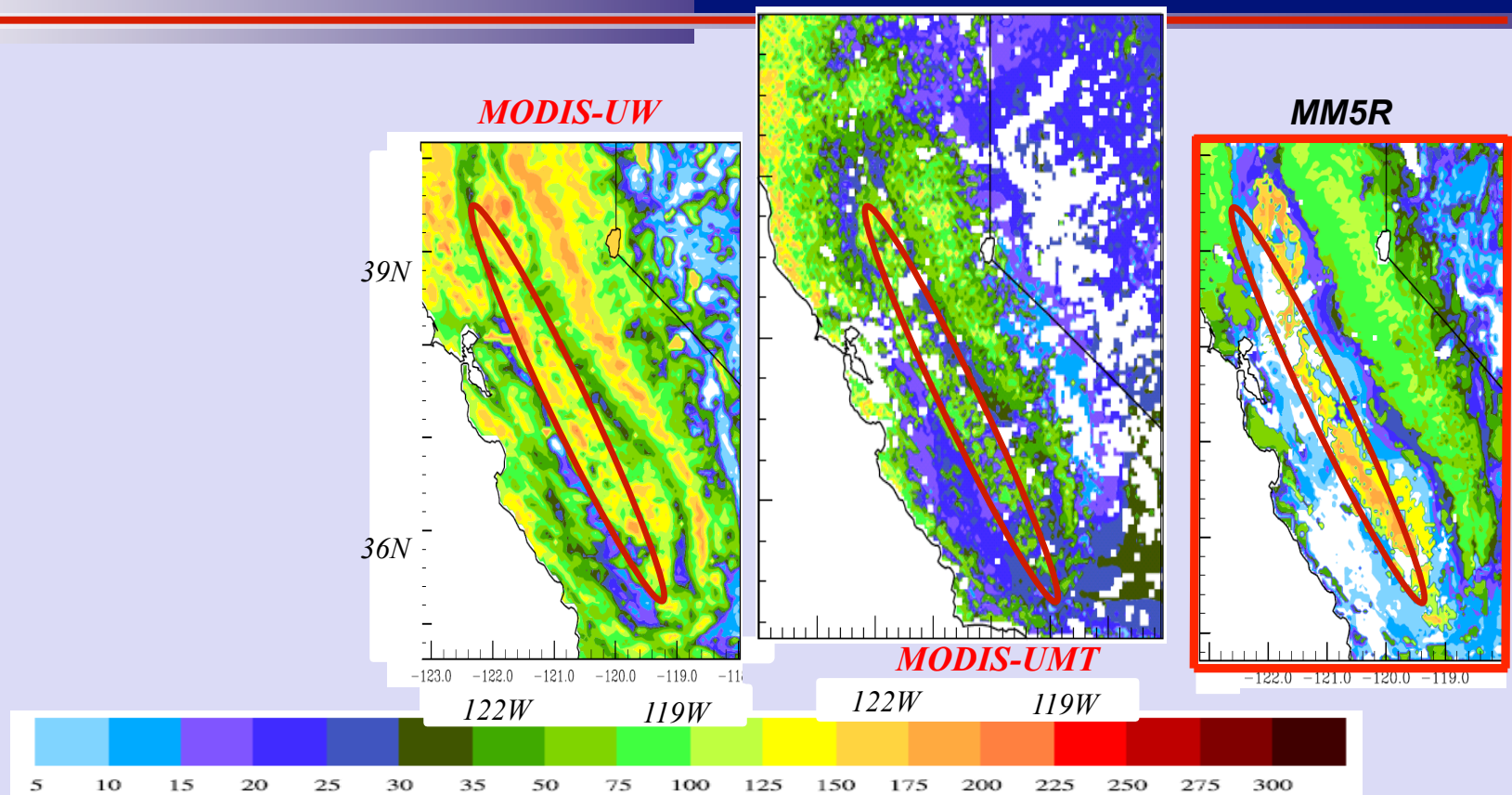


Li et al, 2011



Center for Hydrometeorology and Remote Sensing, University of California, Irvine

Actual ET comparison-spatial distribution – JJA 2007



Monthly ET (mm/month)

An Important Dilemma for the modeling application community will be:
Which Remotely Sensed ET Product should be used for model testing and validation??



What is the Message?

- *Despite advances to date, predicting the future Hydro-Climate variables will remain a major challenge:*

Future is complex and observing and modeling its future is challenging. So, “have a design and planning is still the safest approach!”

will to do so “generated” by models.

- *Long-term and sustained observation programs are critical, especially for model verification. Without some degree of verifiability, hard to expect their use*