Rainfall Atlas of Hawai‘i

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Commission on Water Resource Management

Department of Land and Natural Resources

State of Hawai‘i

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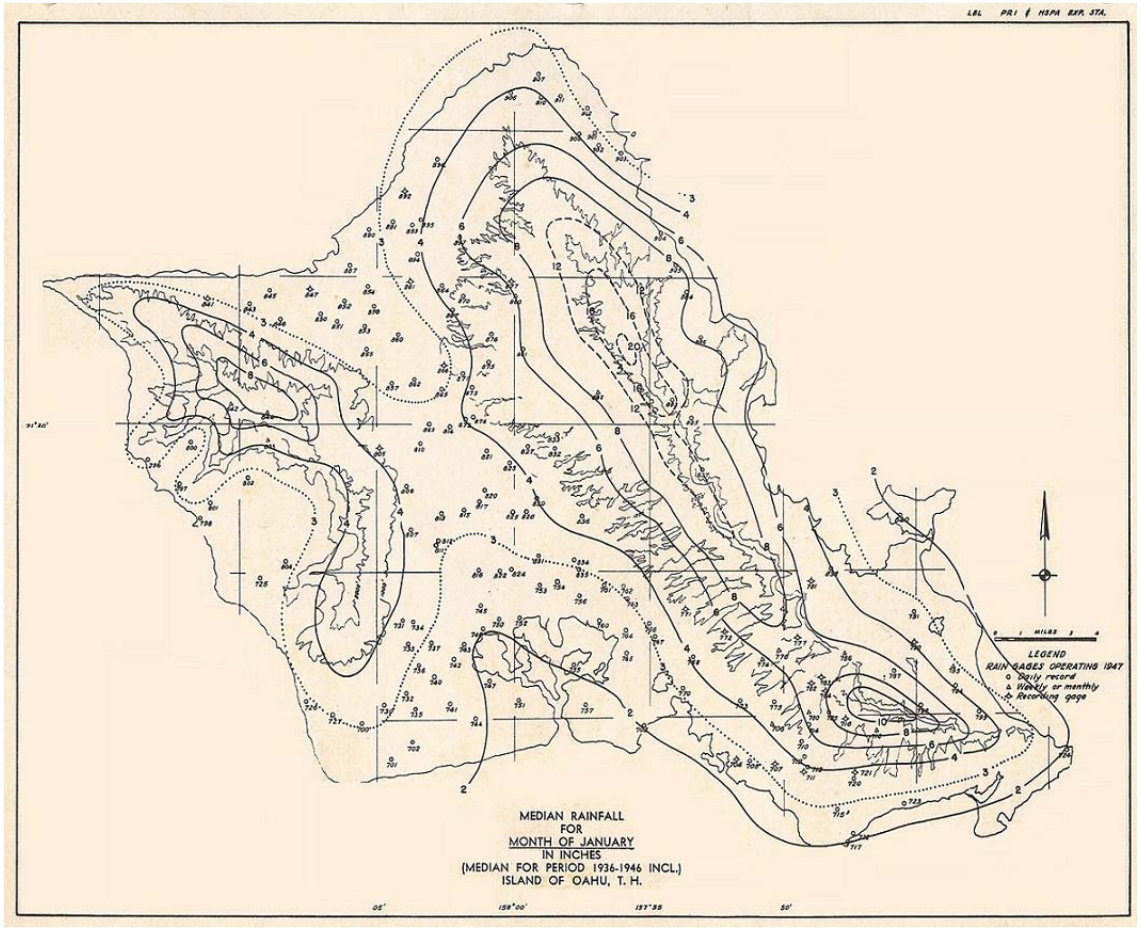
Measurement and Mapping of Hawaiian Rainfall

- Earliest known RF observations taken in 1837 at Nu‘uanu Avenue and Beretania Street
- 106 stations by 1900
- Number of stations increased with the growth of plantation agriculture
- 422 stations by 1920
- Mapping of rainfall patterns began in earnest in the 1920s

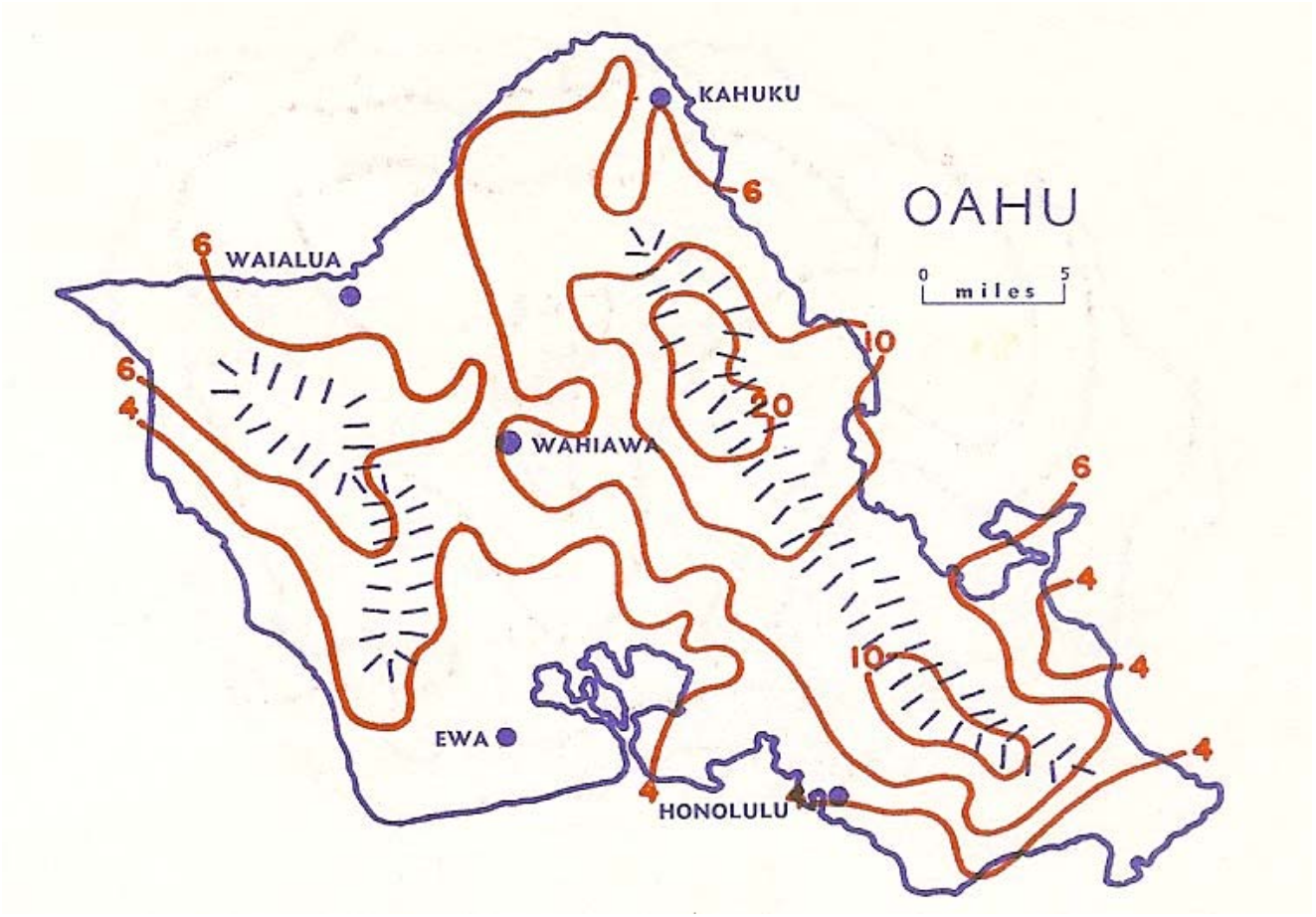
Previous Efforts to Map Hawaiian Rainfall

Halstead and Leopold (1948)



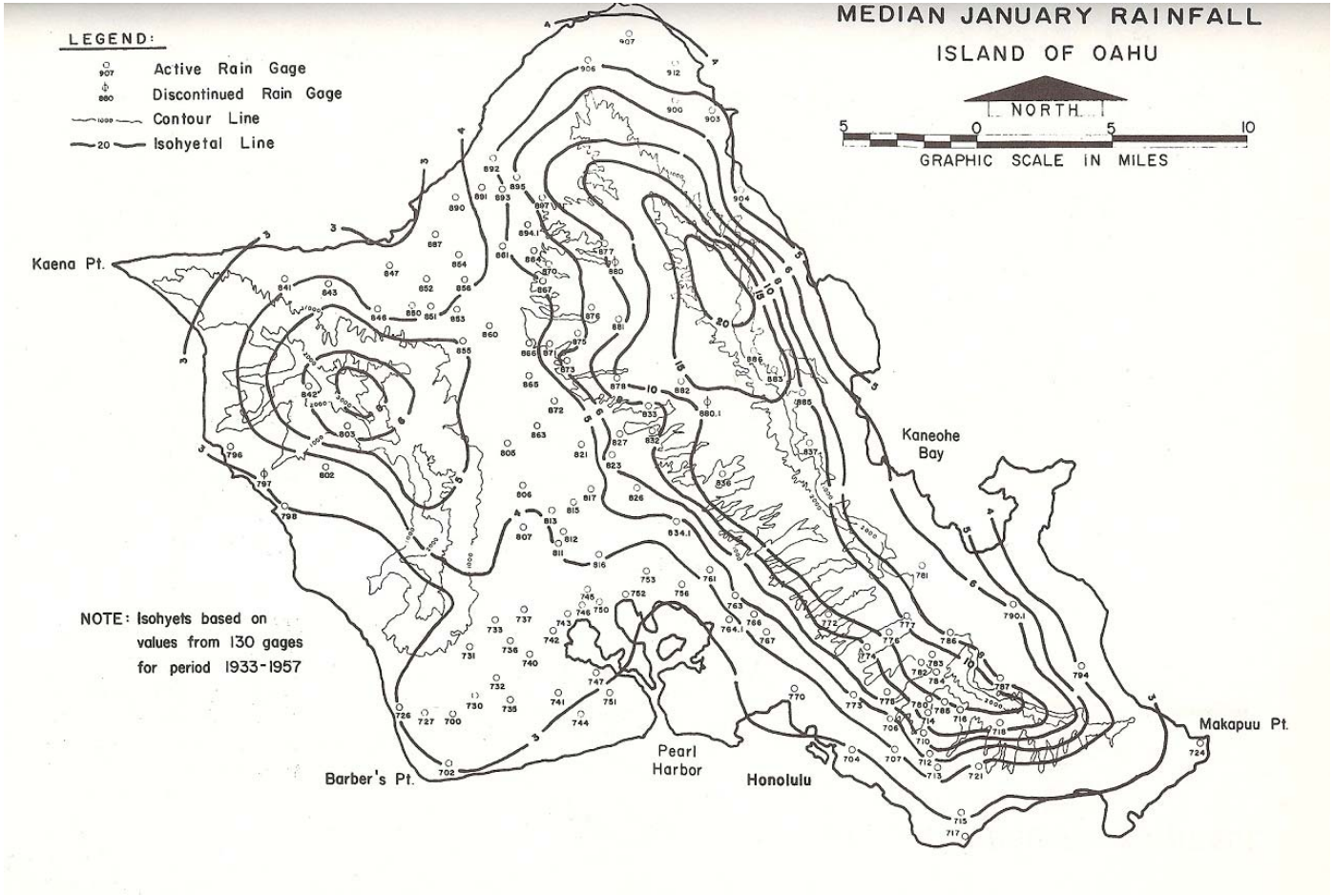
Previous Efforts to Map Hawaiian Rainfall

Mordy and Price (1955)



Previous Efforts to Map Hawaiian Rainfall

Taliaferro (1959)



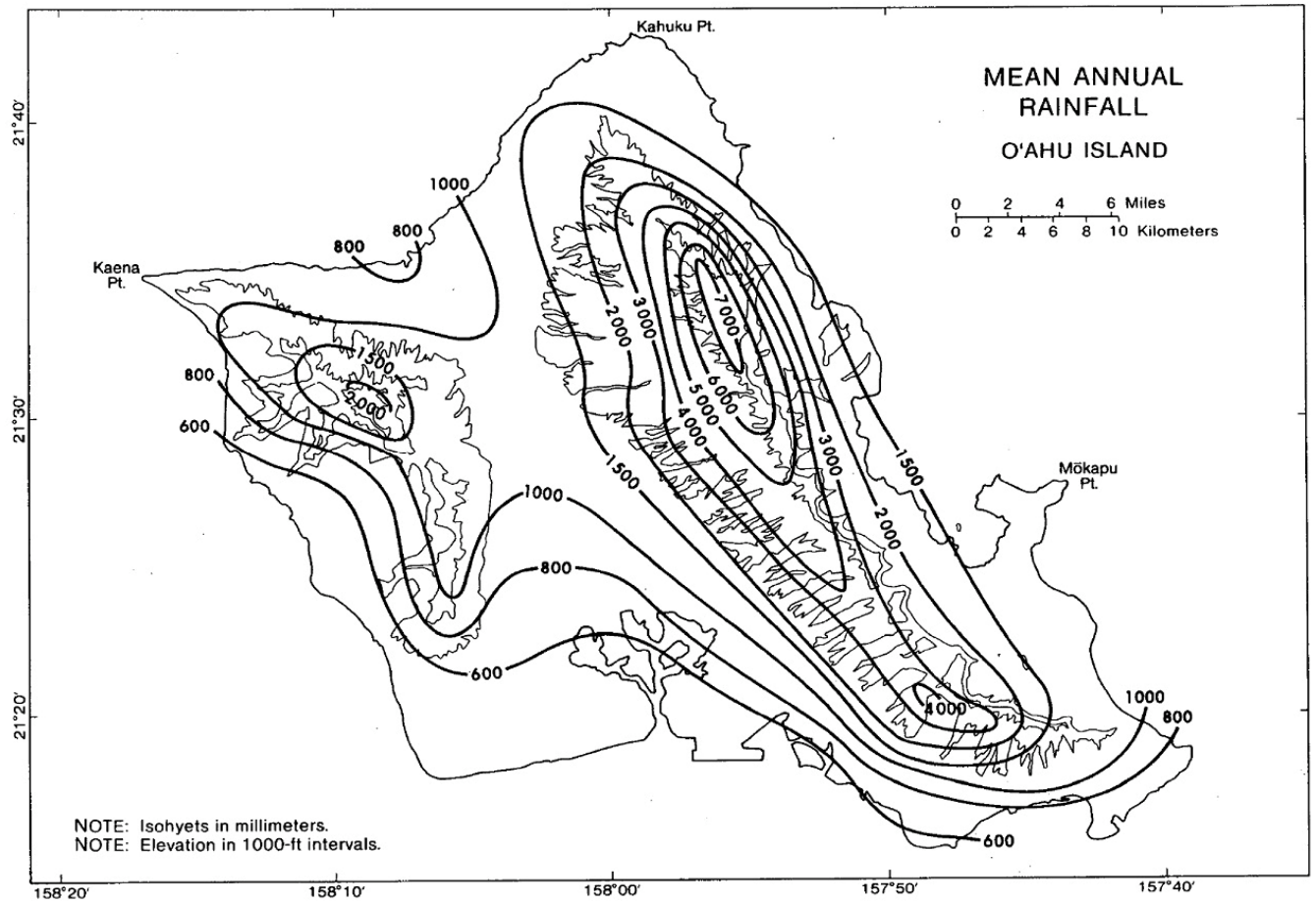
Previous Efforts to Map Hawaiian Rainfall

Meisner et al. (1982)

Previous Efforts to Map Hawaiian Rainfall

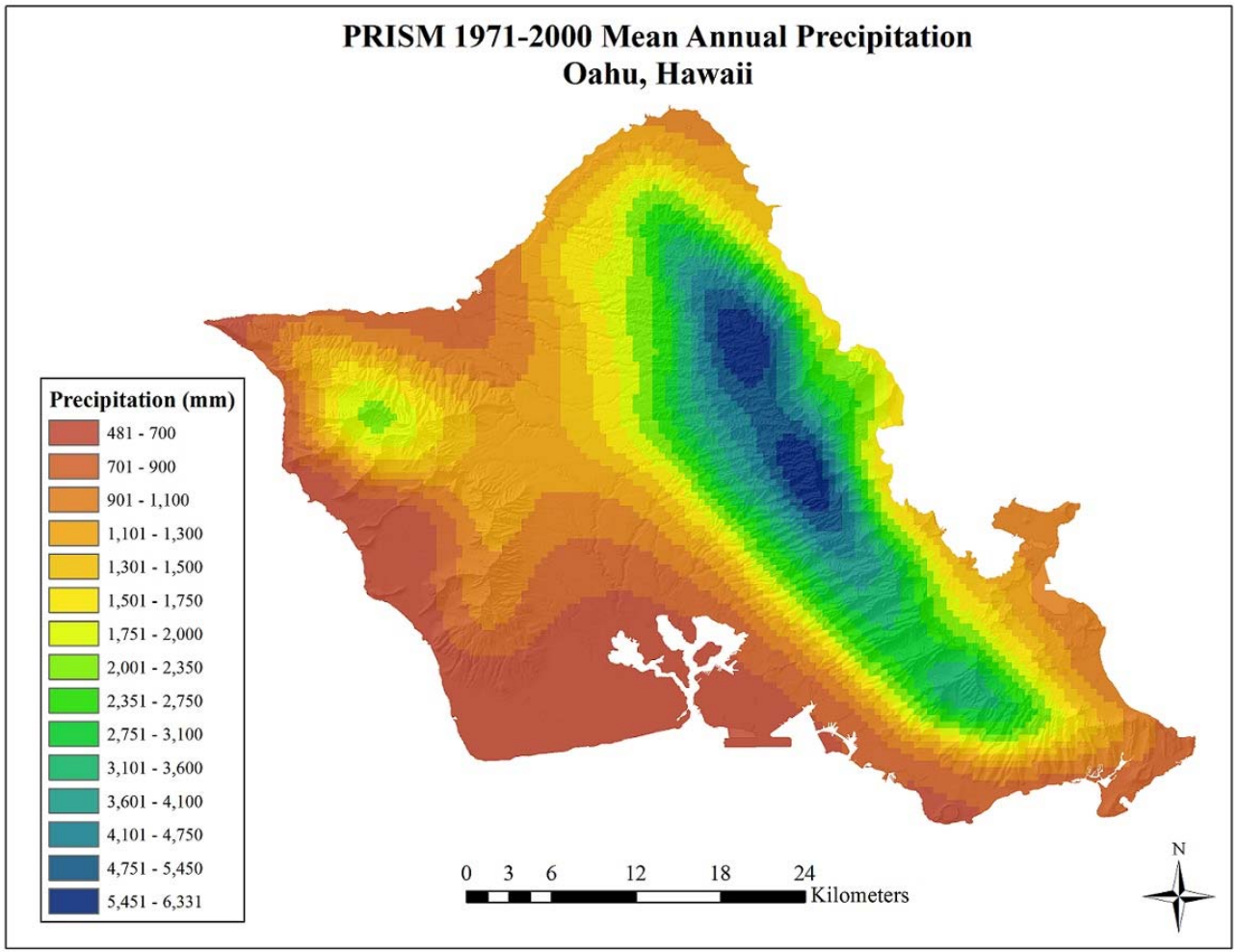
The Original Rainfall Atlas of Hawai‘i

Giambelluca et al. (1986)



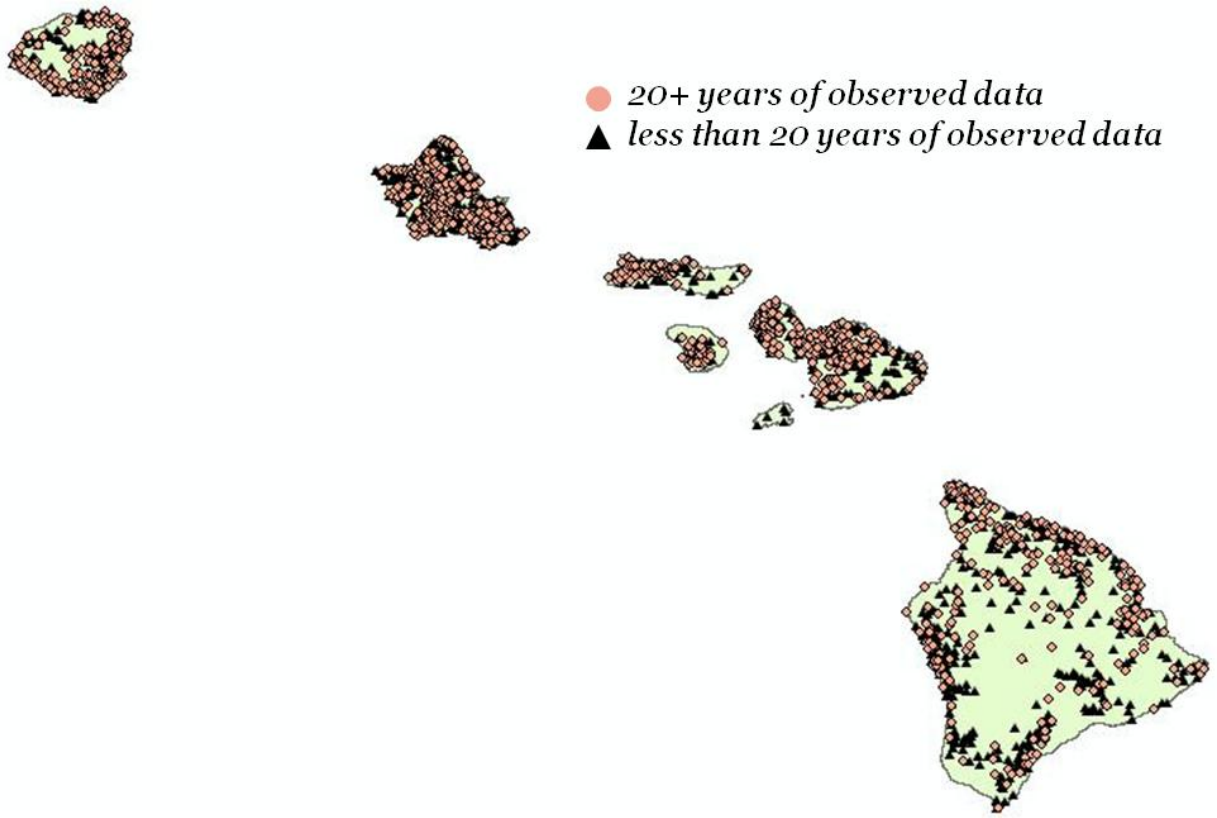
Previous Efforts to Map Hawaiian Rainfall

Daly et al. (2006)



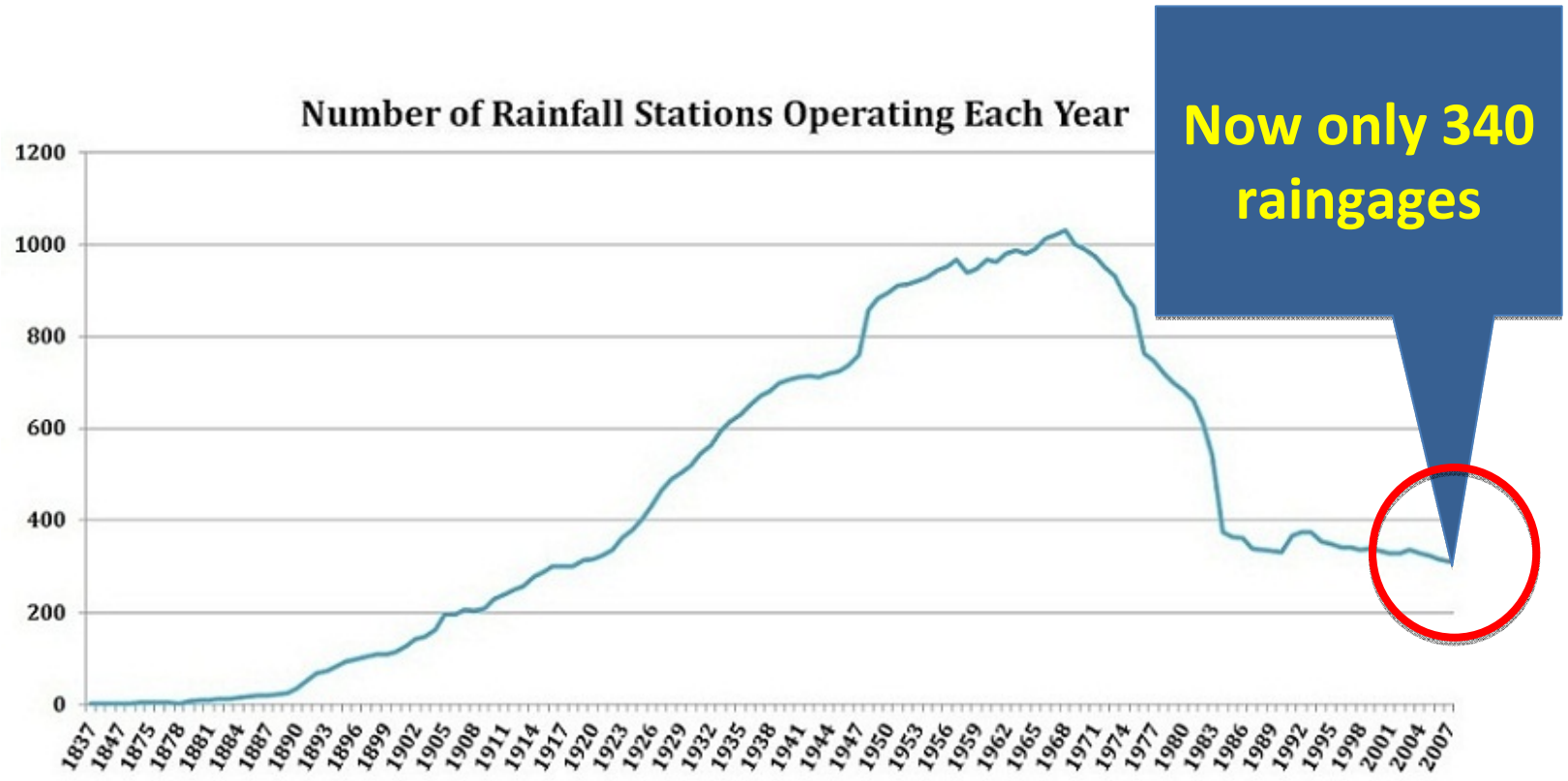
The Rainfall Network

- We compiled a monthly RF database of 2,188 raingage sites
- 517,017 station-months (43,085 station-years) of data
- Average length of record: 40 years



The Rainfall Network

Number of station operating at any given time peaked at 1030 stations in 1968

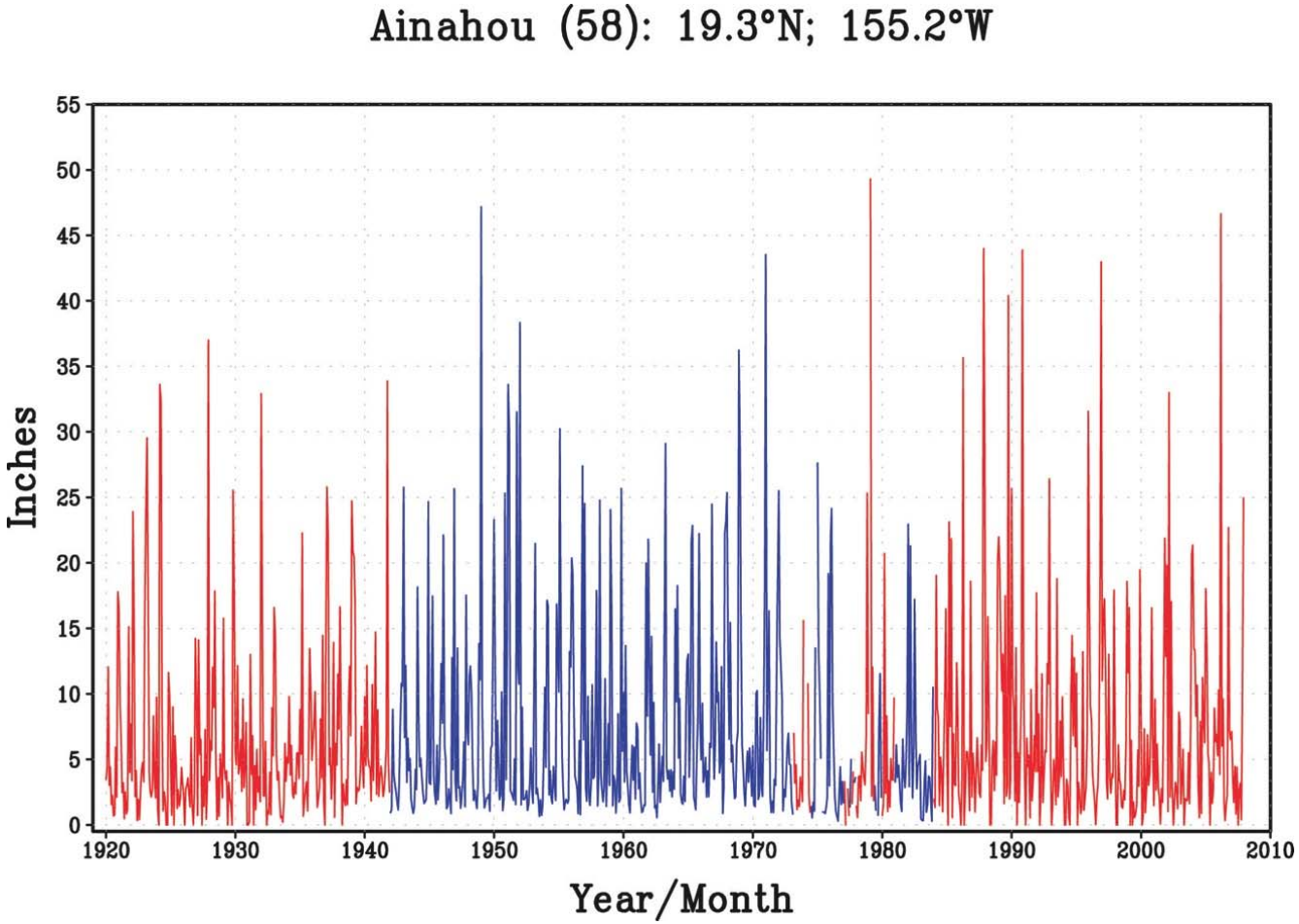


The Rainfall Network

- Large number of stations, but . . .
- Stations active during different periods
  - Need to have common base period for calculating means
  - Previous efforts adjusted means
  - We chose to do gap filling
- Not evenly distributed spatially
  - Most previous efforts relied strictly on subjective, expert knowledge
  - We supplemented raingage stations with "**virtual raingage stations**" based on patterns of natural vegetation
  - We used independent spatial predictor datasets:
    - **PRISM**
    - **MM5**
    - **Radar**

Gap-Filling Station Data

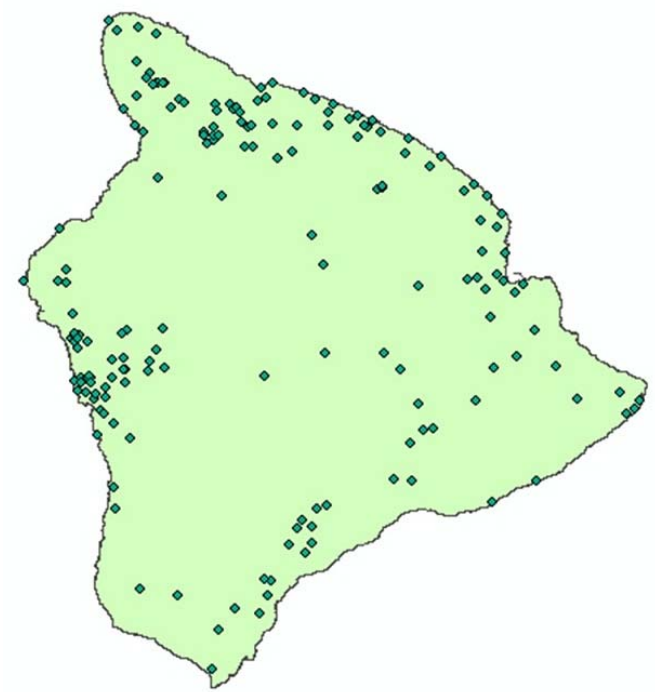
Numerous statistical techniques were used to fill gaps, including periods before and after a station's period of operation



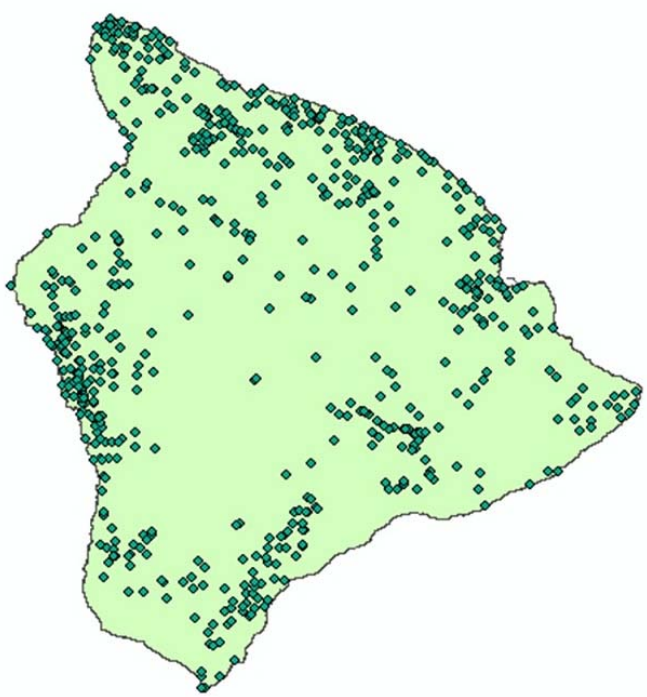
Gap-Filling Station Data

- Resulting estimates were rigorously tested and gap-filling estimates were rejected in many cases
- Results greatly improve the spatial distribution of stations for any given period

Raingages Operating in 1980

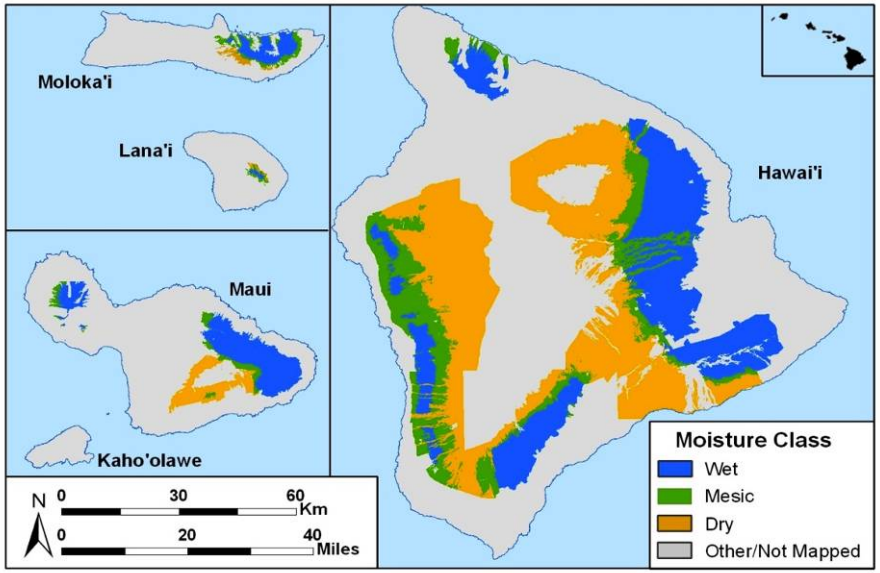


All Raingages

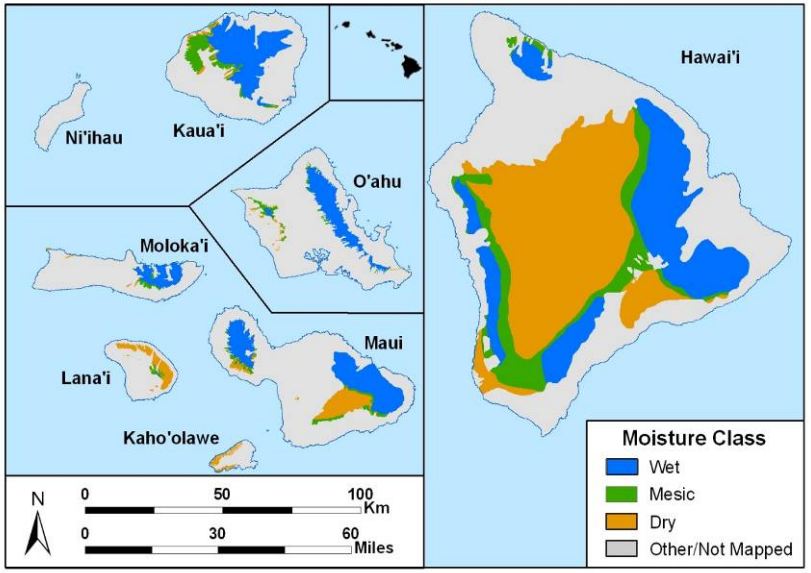


Estimating Mean Rainfall for Virtual Raingage Stations

Moisture zones determined by patterns of natural vegetation



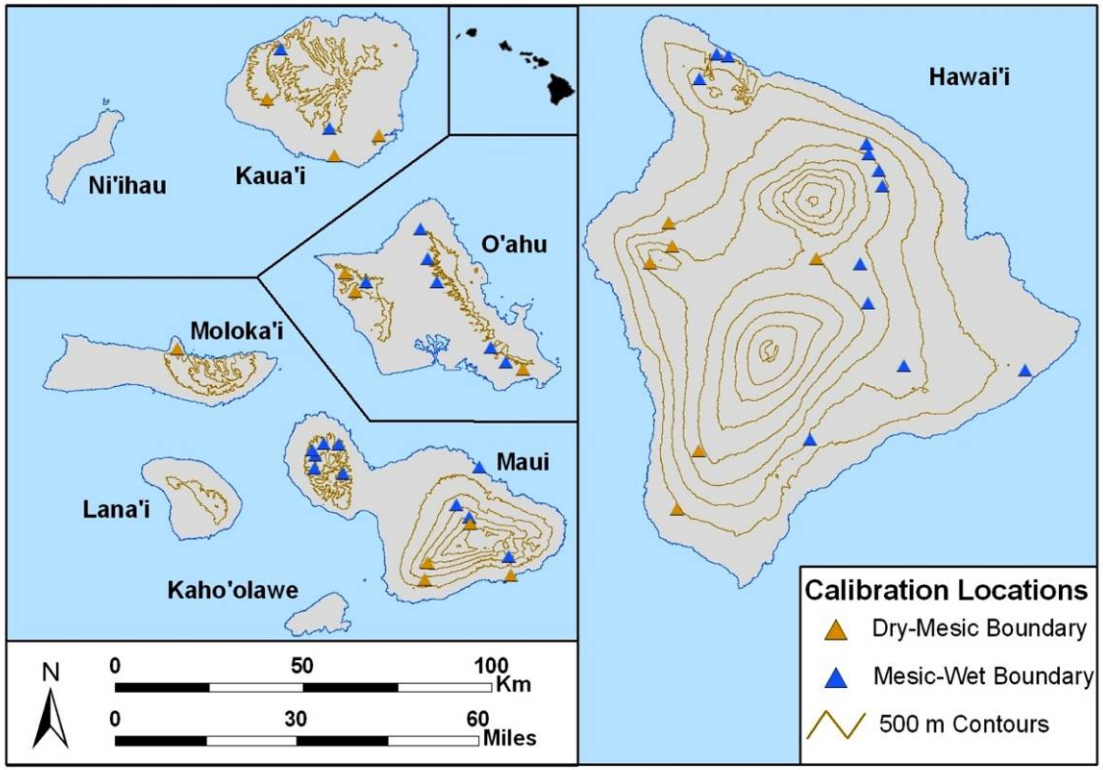
Jacobi (1989)



Gon et al. (1998).

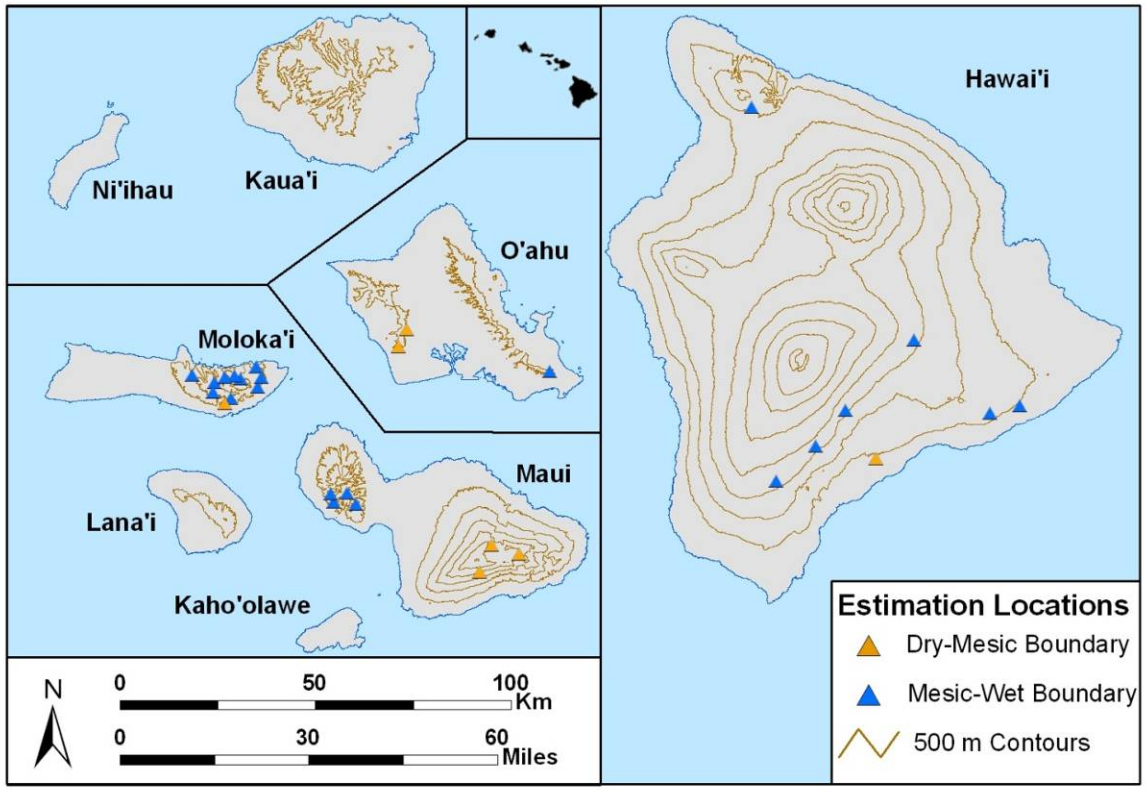
Estimating Mean Rainfall for Virtual Raingage Stations

Sites with known mean rainfall used to calibrate the model



Estimating Mean Rainfall for Virtual Raingage Stations

Mean rainfall estimated for sites with no nearby raingages



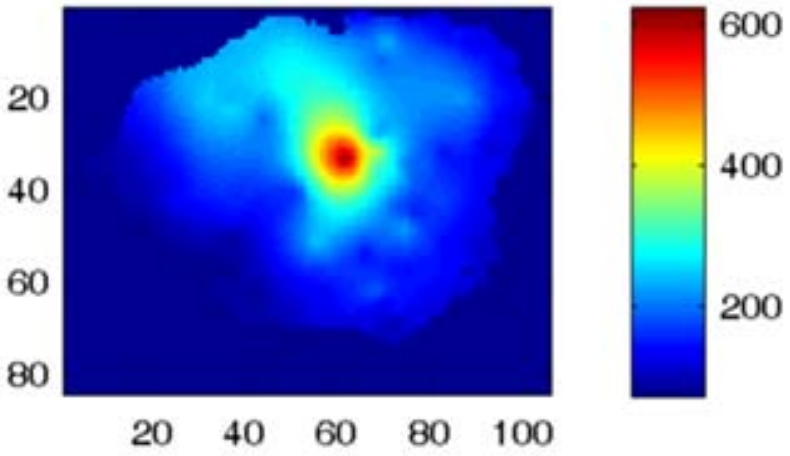
Base Period

- Natural multi-decadal rainfall fluctuations suggest using a long base period
- Long-term secular trends in rainfall suggest using a short, recent base period
- NOAA standard for computing normals: 30 years
- Our choice: Use the most recent available 30 year period:

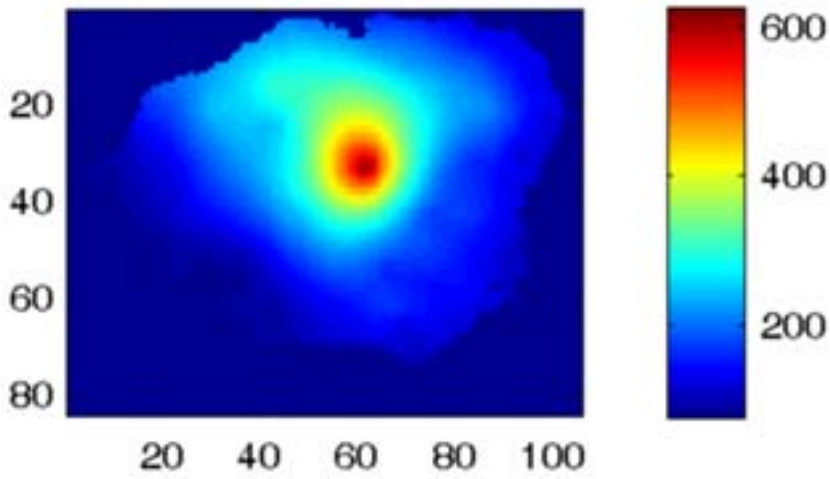
1978-2007

Spatial Interpolation of Raingage Data

Ordinary Kriging



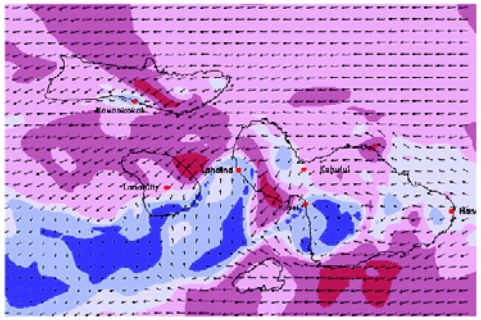
Ordinary Kriging with Variable Observation Uncertainty



Predictor Spatial Datasets

PRISM: Mapping system relying on statistical relationships between rainfall and terrain

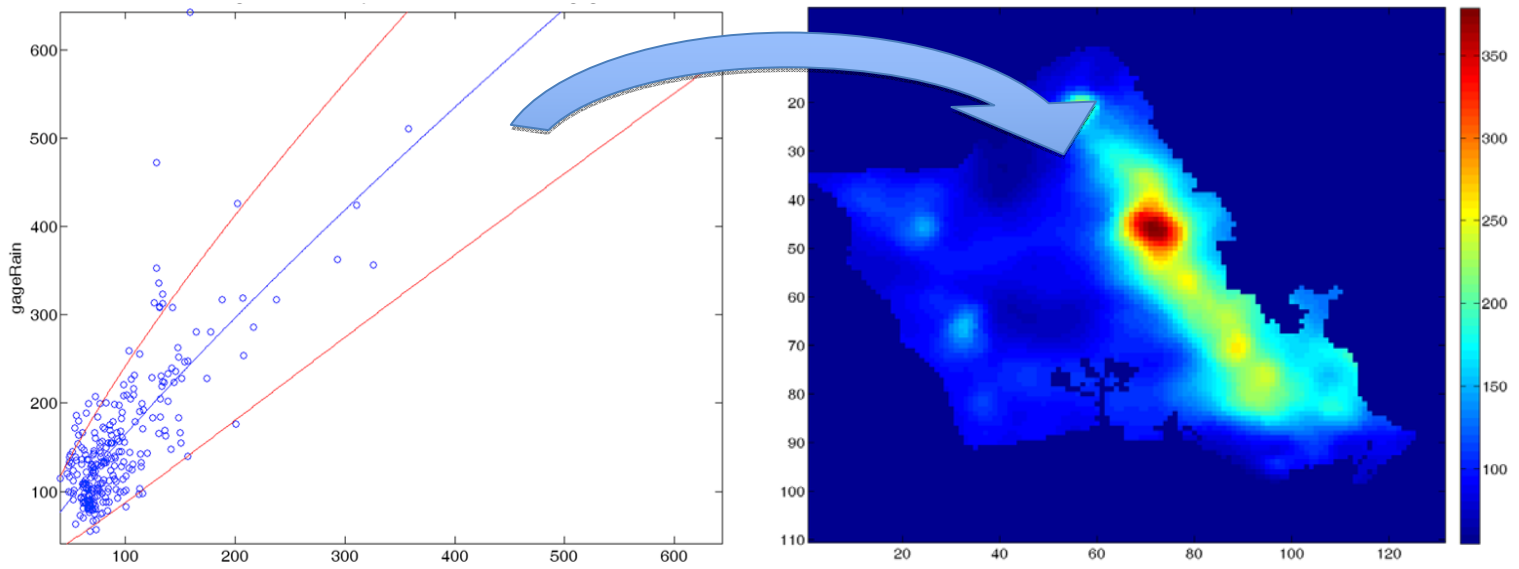
MM5: Mesoscale meteorological model used for operational weather forecasting



Radar Rainfall: Radar used to monitor rainfall and to identify intense rainfall approaching the islands

Adjusting Predictor Maps Using Observations

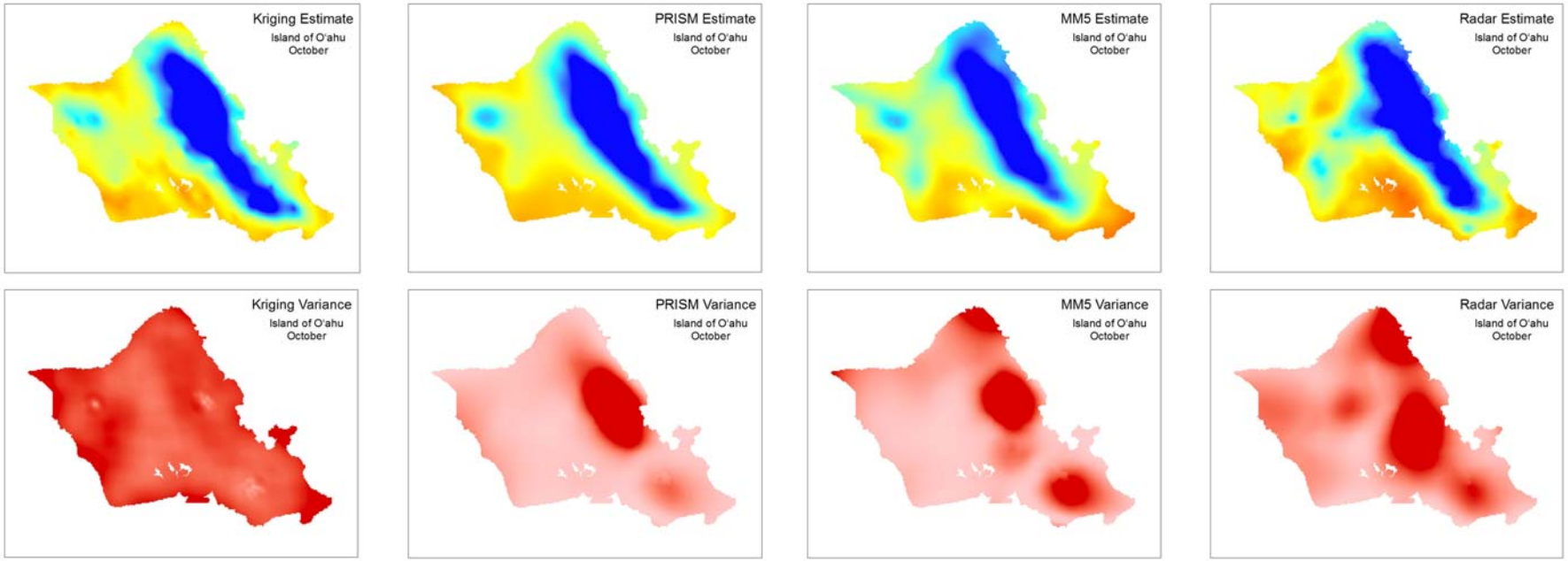
Non-linear regression between raw predictor rainfall and observed rainfall are used to produce adjusted predictor maps and maps of uncertainty.



Regression modeling of PRISM and rainfall at a given month (left) and its associated conditional mean rainfall map (right).

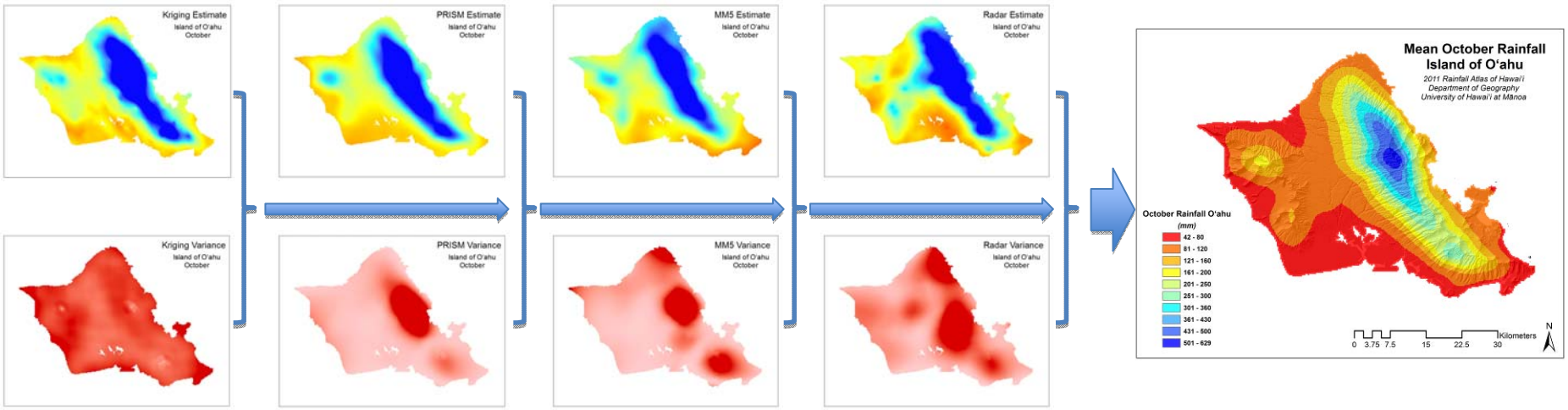
Fusing Interpolated Maps and Predictor Datasets

- Uncertainty used to weight the different estimates



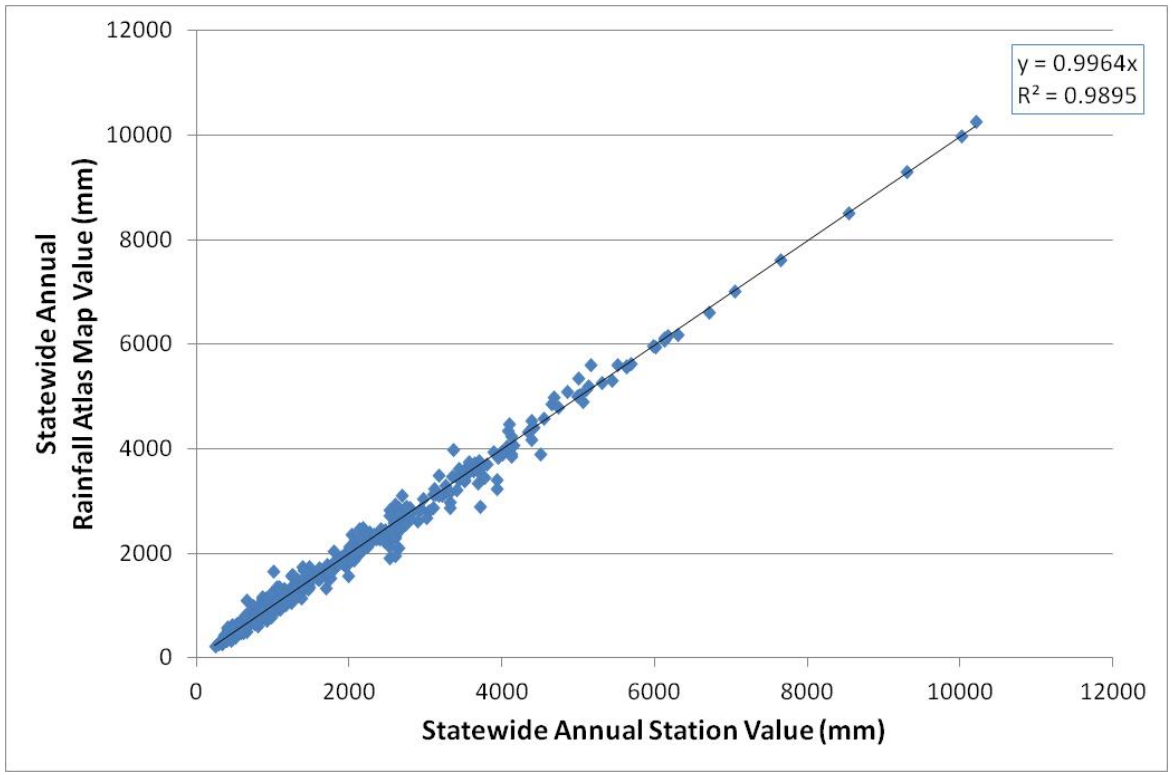
Fusing Interpolated Maps and Predictor Datasets

Bayesian statistics are used to fuse the estimates to produce the final maps



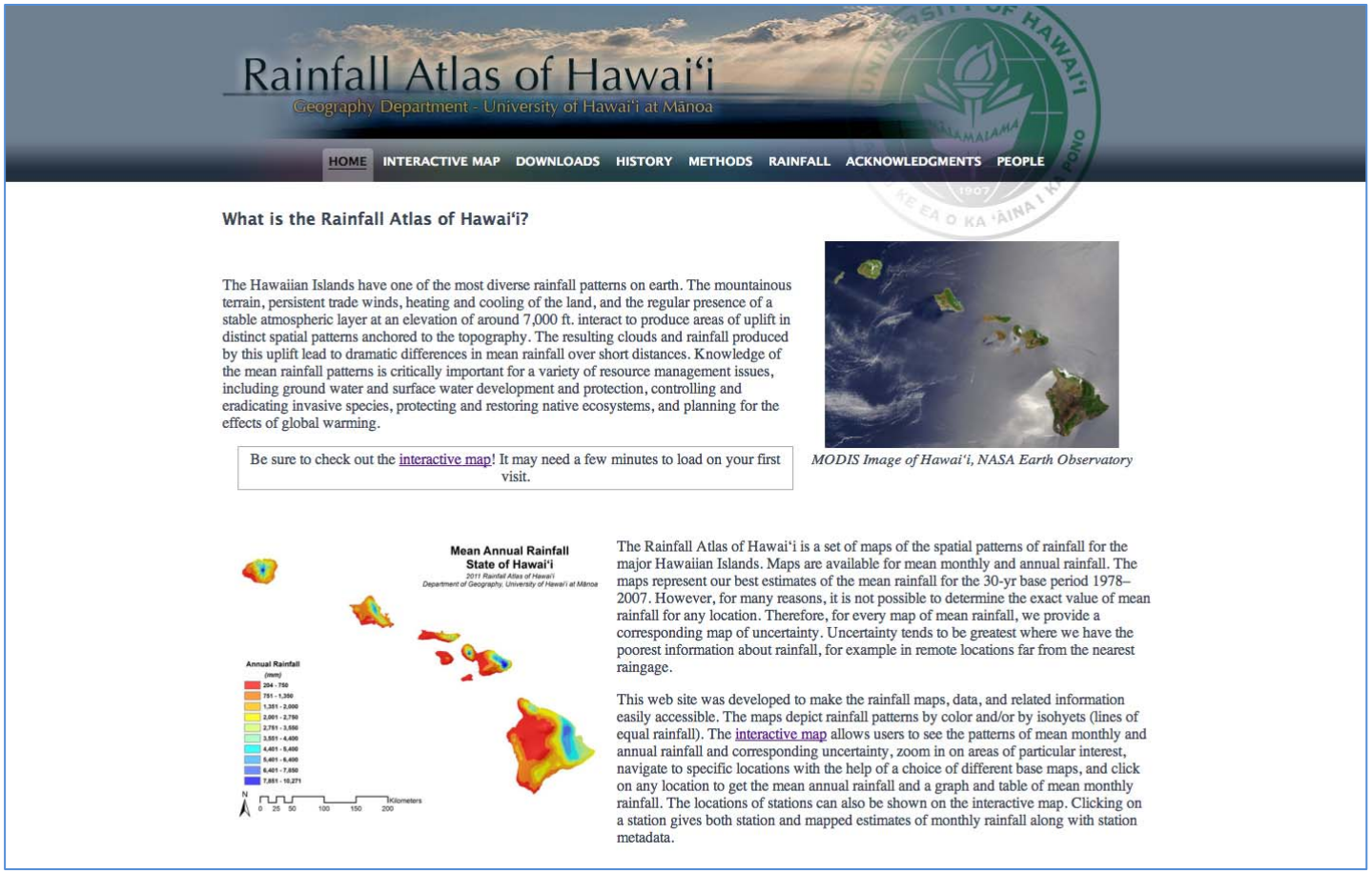
Checking the Final Maps

Mapped and observed mean rainfall lie along the 1:1 line



The Web Site

With the help of the EPSCoR Cyberinfrastructure Team at UH Hilo, we developed a web platform for the new rainfall atlas



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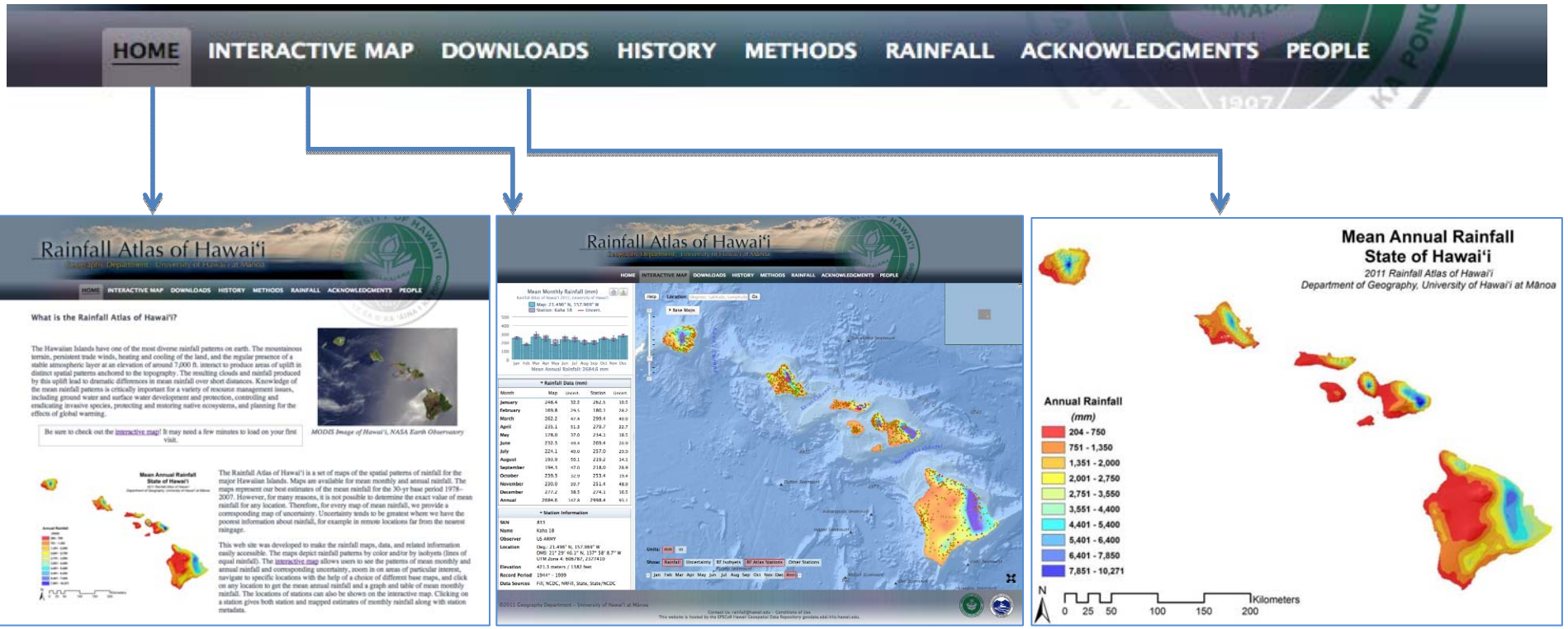
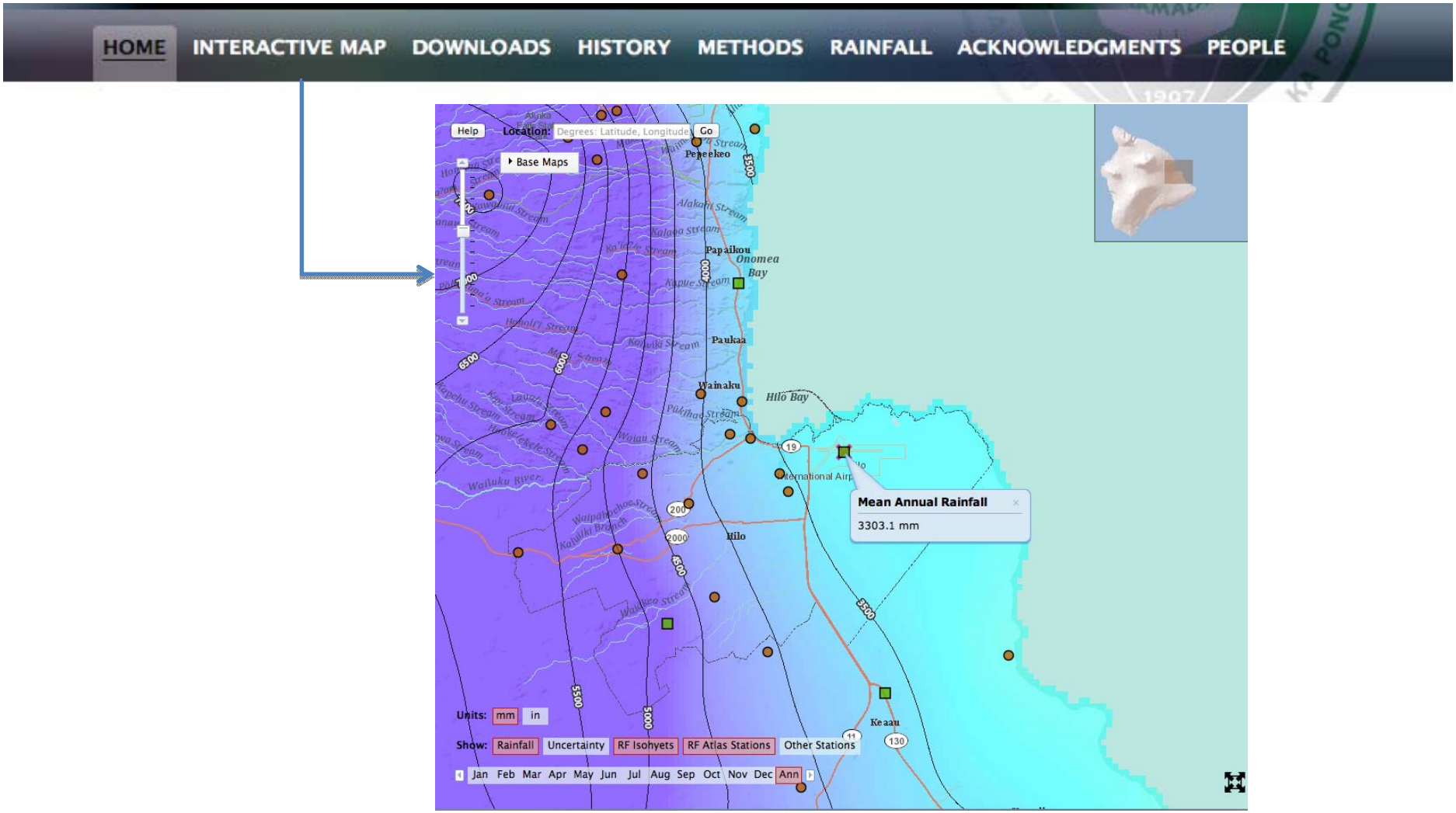
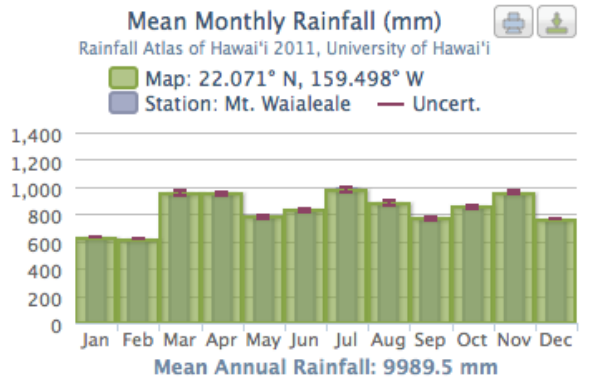


The Web Site

Locate any point of interest on the interactive map and click to get mean annual and monthly rainfall statistics





Rainfall Data (mm)

Month	Map	Uncert.	Station	Uncert.
January	633.0	27.4	629.4	0.9
February	620.7	30.0	620.4	0.2
March	955.4	50.2	961.0	0.5
April	954.4	48.8	958.4	0.3
May	780.3	44.5	782.2	0.1
June	833.2	49.7	835.9	0.4
July	984.1	57.6	986.8	1.0
August	881.4	52.3	884.1	0.4
September	767.4	48.0	768.6	0.1
October	855.3	45.5	857.5	1.2
November	957.9	49.7	955.1	0.5
December	766.4	30.8	764.7	2.2
Annual	9989.5	157.6	10004.0	3.0

Station Information

SKN	1047
Name	Mt. Waialeale
Observer	USGS
Location	Deg.: 22.071° N, 159.498° W DMS: 22° 4′ 15.2″ N, 159° 29′ 52.7″ W UTM Zone 4: 448624, 2440757
Elevation	1570.1 meters / 5150 feet
Record Period	1950 – Present
Data Sources	Fill, USGS
Station Status	Current

The Web Site

Clicking on a station gives both map and station estimates of mean annual and monthly rainfall statistics

The Web Site

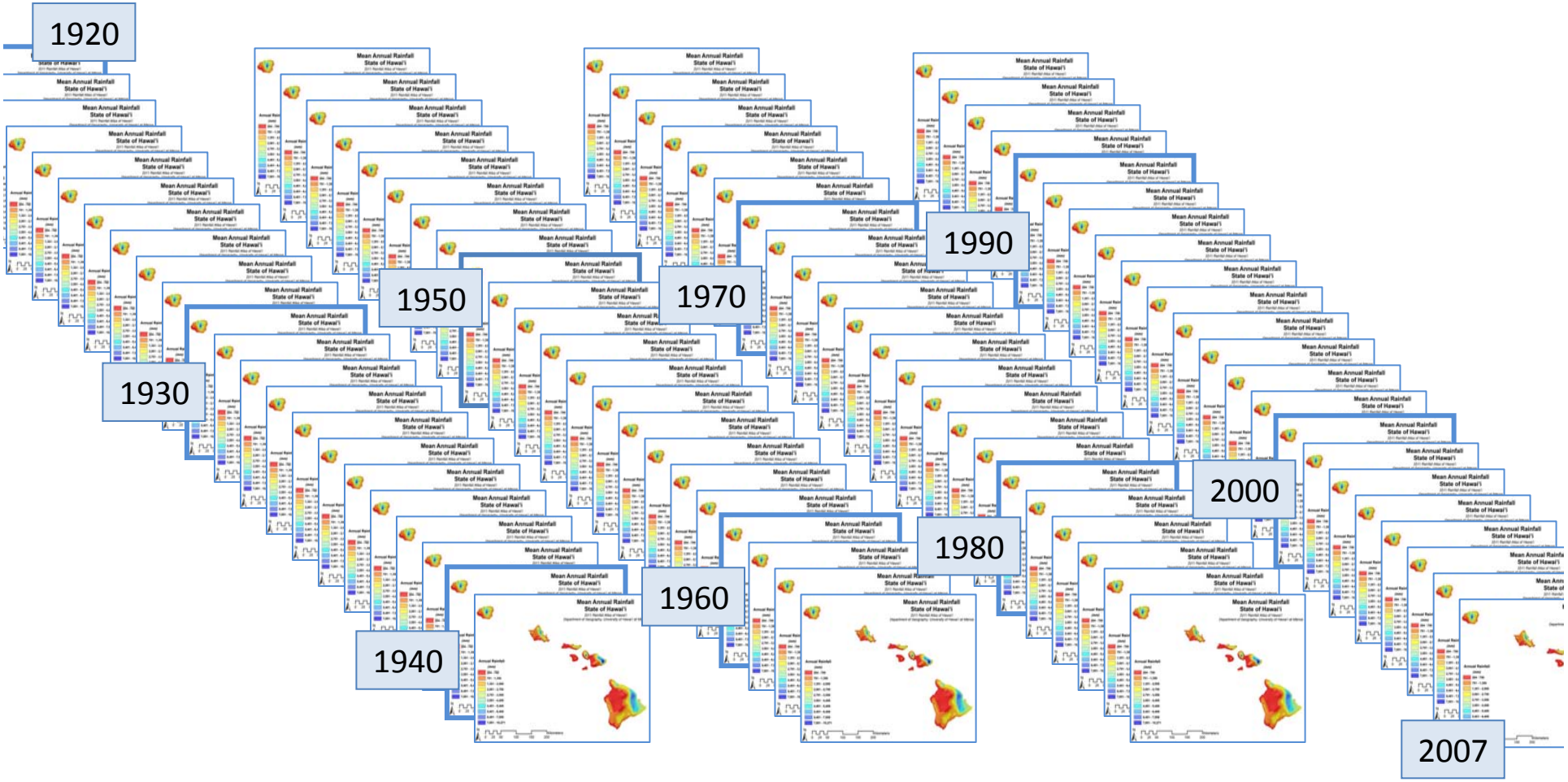
The Rainfall Atlas of Hawai‘i Web Site is up and running.

Check it out:

http://rainfall.geography.hawaii.edu/

Coming Soon

Month/Year Maps from 1920 to 2007



Thank You