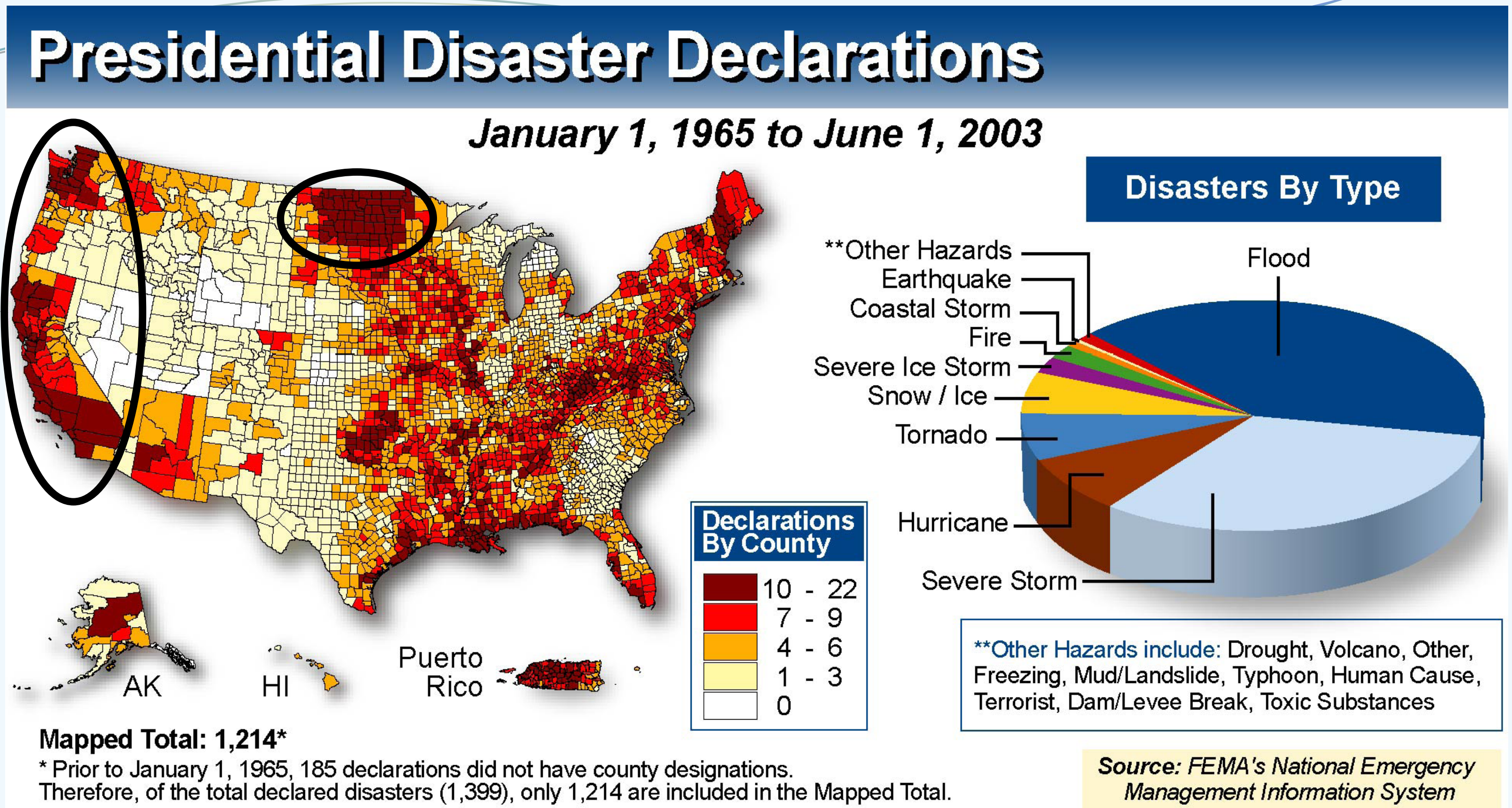
Climate, Weather, and Water Services

Earth System Research Laboratory

F. Martin Ralph

Research to Improve Climate, Weather and Water Services



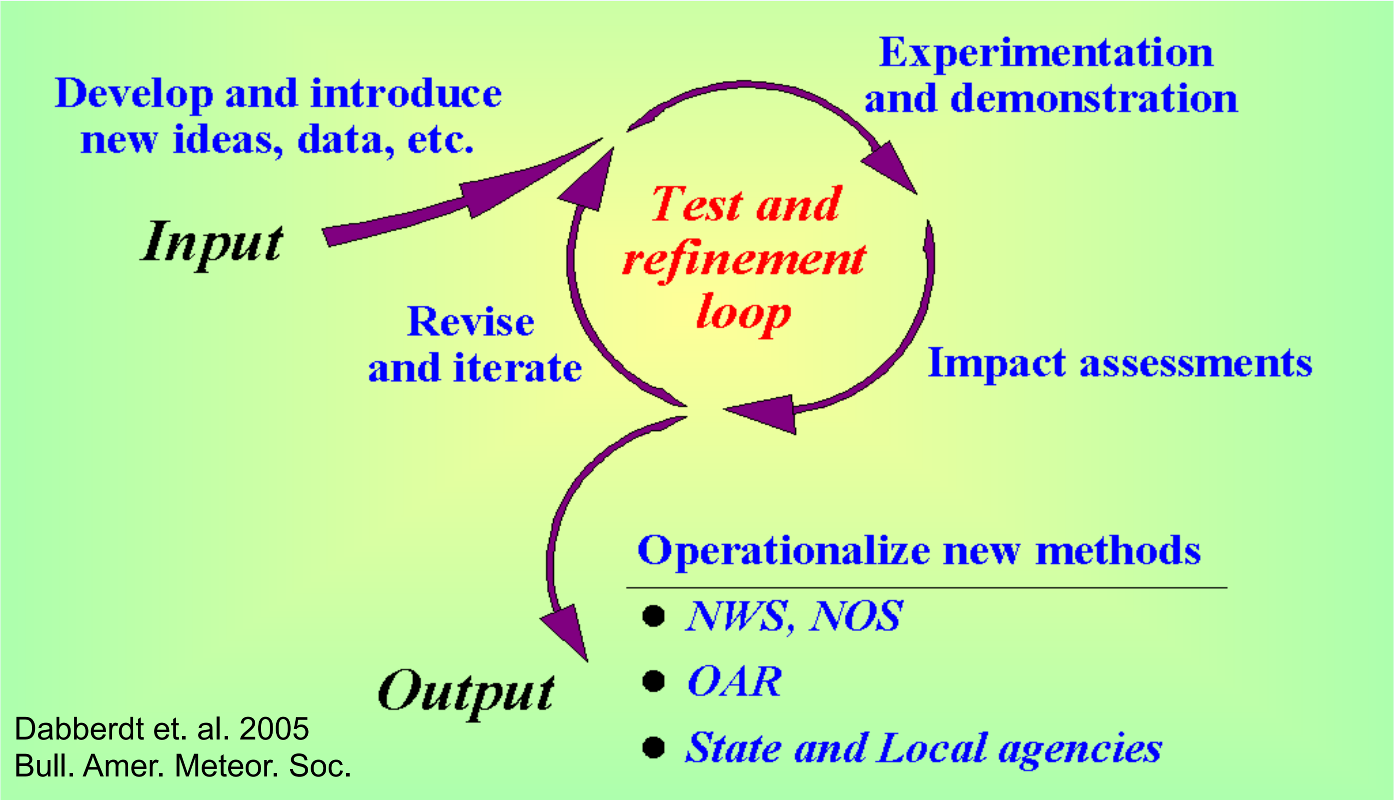
- Floods annually cause 80 fatalities + $5.2 B damage on average (~50% of the annual average U.S. natural disaster losses)
- West Coast & North Dakota are especially vulnerable (M. Hoerling will discuss “attribution”)
- Losses from drought are not typically tracked this way (see R. Pulwarty presentation)

Source: NOAA Economic Statistics, 2006

Focus: Extreme Precipitation

- Issue:
  - Accurate information on extreme precipitation is crucial for disaster mitigation, water supply & infrastructure planning - but errors are large
- Context:
  - Skill in precipitation monitoring & prediction has been slow to improve
- Action:
  - Created the **Hydrometeorology Testbed (HMT)** to better define science and service gaps, accelerate innovation, and improve services
- Outcomes:
  - A broad team is working on 7 major underlying technical challenges
  - New tools and methods are being prototyped and implemented
  - New performance measures are being developed

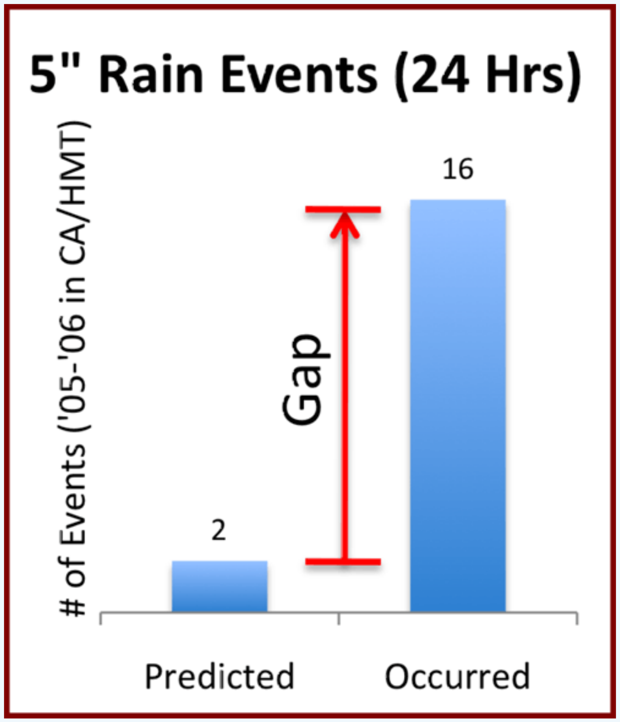
The Testbed Concept



See poster by Schneider et al. on the Hydrometeorology Testbed (HMT)

HMT and Extreme Precipitation at the Watershed Scale on the U.S. West Coast

- **Step 1: Understand both the state of the science and the major gaps in predictive services and related requirements (*extreme precip forecasts are key, but tough to get right – See Schneider et al. and Sukovich et al. posters*)**

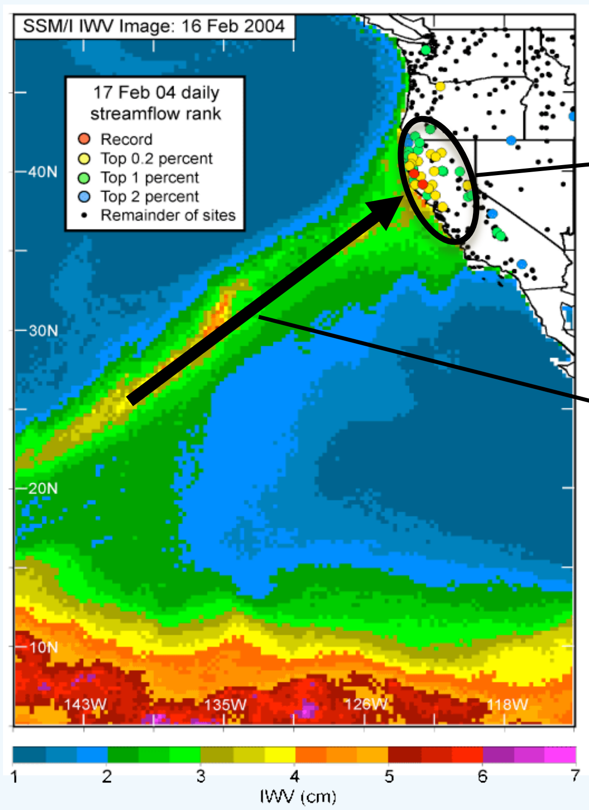


"Assessment of Extreme Quantitative Precipitation Forecasts and Development of Regional Extreme Event Thresholds Using Data from HMT-2006 and COOP Observers"

Ralph et al. 2010 (J. Hydrometeorology – accepted)

HMT and Extreme Precipitation at the Watershed Scale on the U.S. West Coast

- **Step 2: Identify and understand the underlying physical processes and the current predictive system (*atmospheric rivers and shallow rain are key, but not handled well – see Kingsmill et al., Williams et al. posters from Theme 1*)**

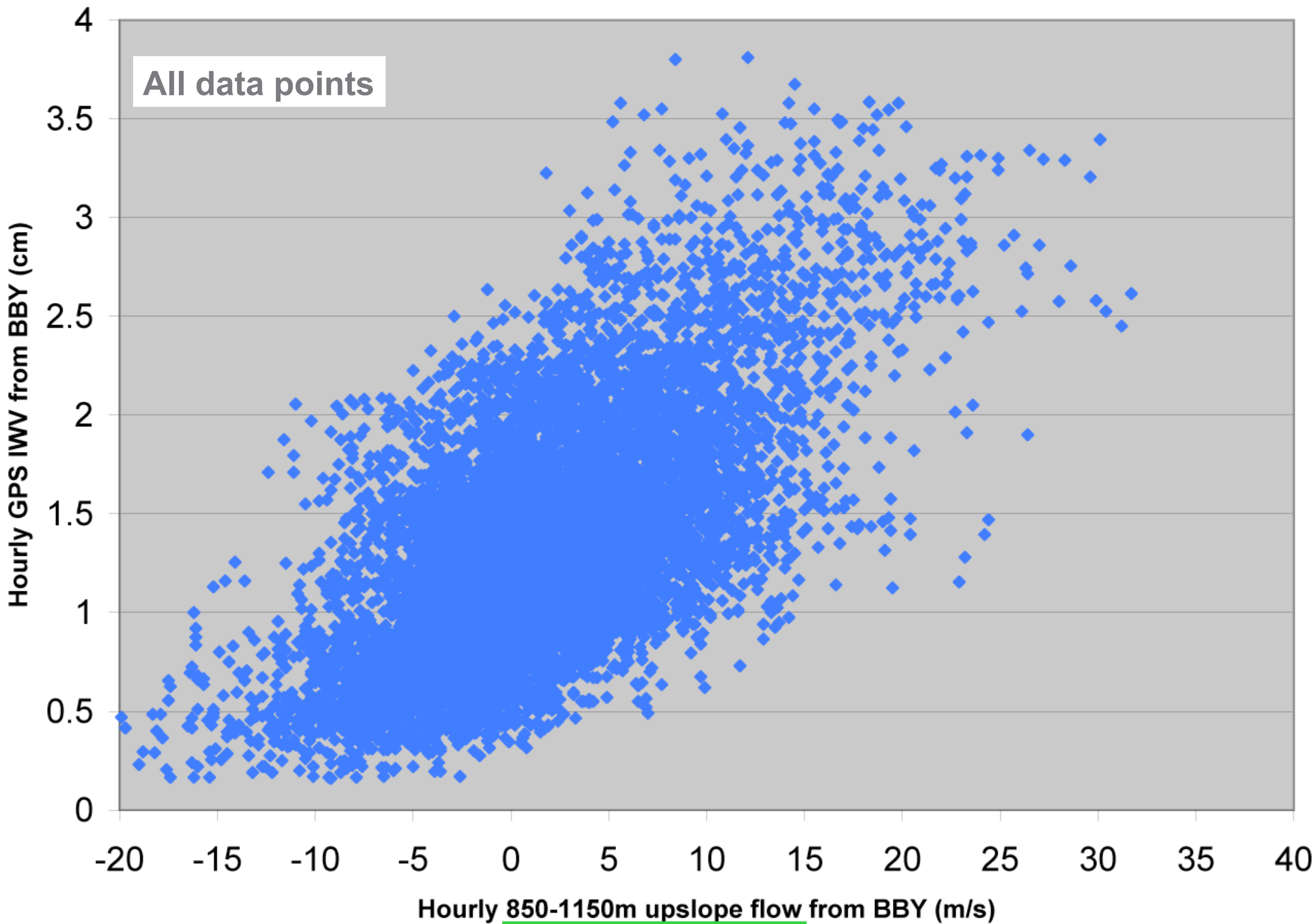


Stream gauge data show extreme runoff where the AR hit the coast

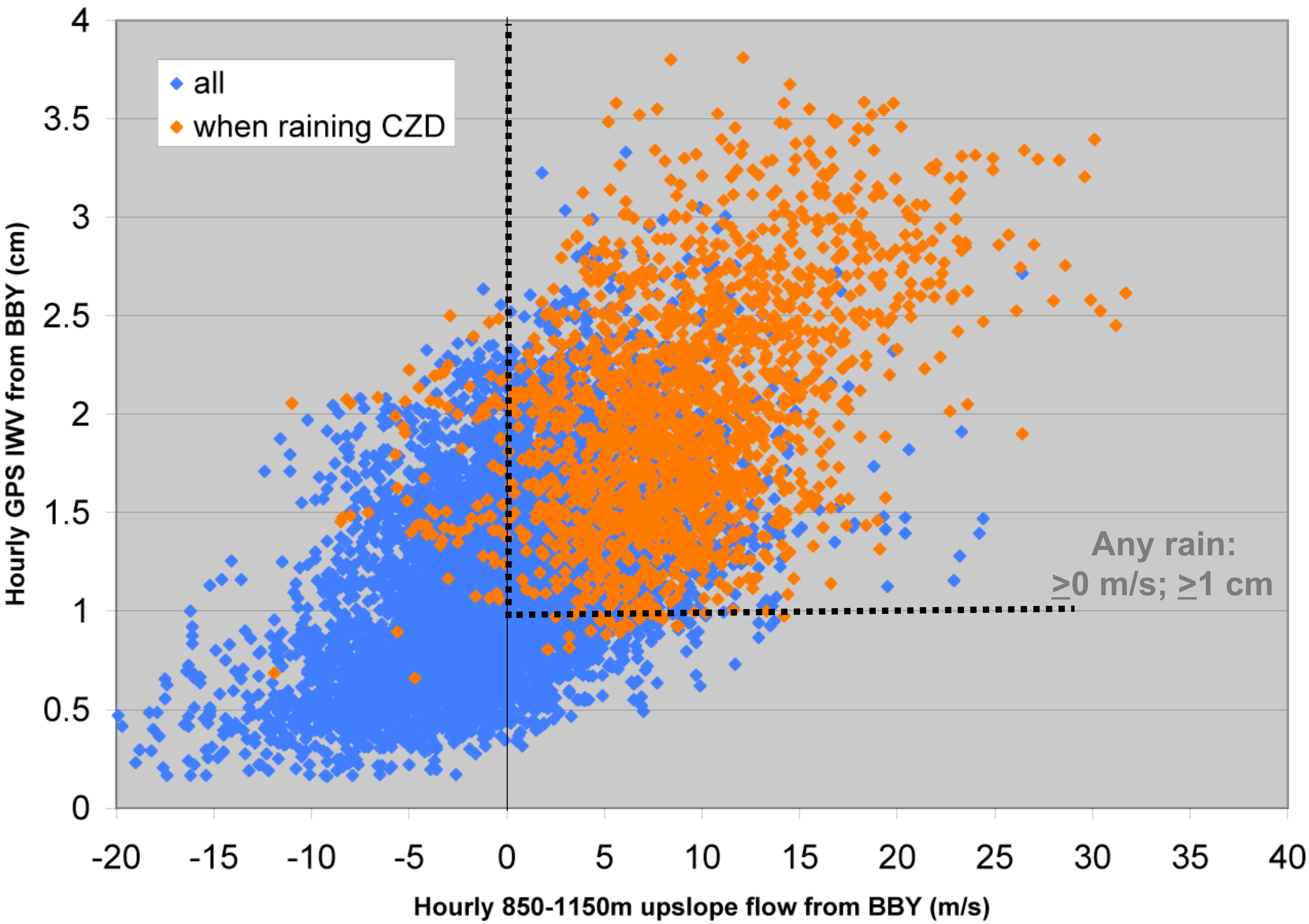
SSM/I satellite image shows
pattern of IWV that conformed
to the criteria established by *Ralph et al. (2004)*

HMT and Extreme Precipitation at the Watershed Scale on the U.S. West Coast

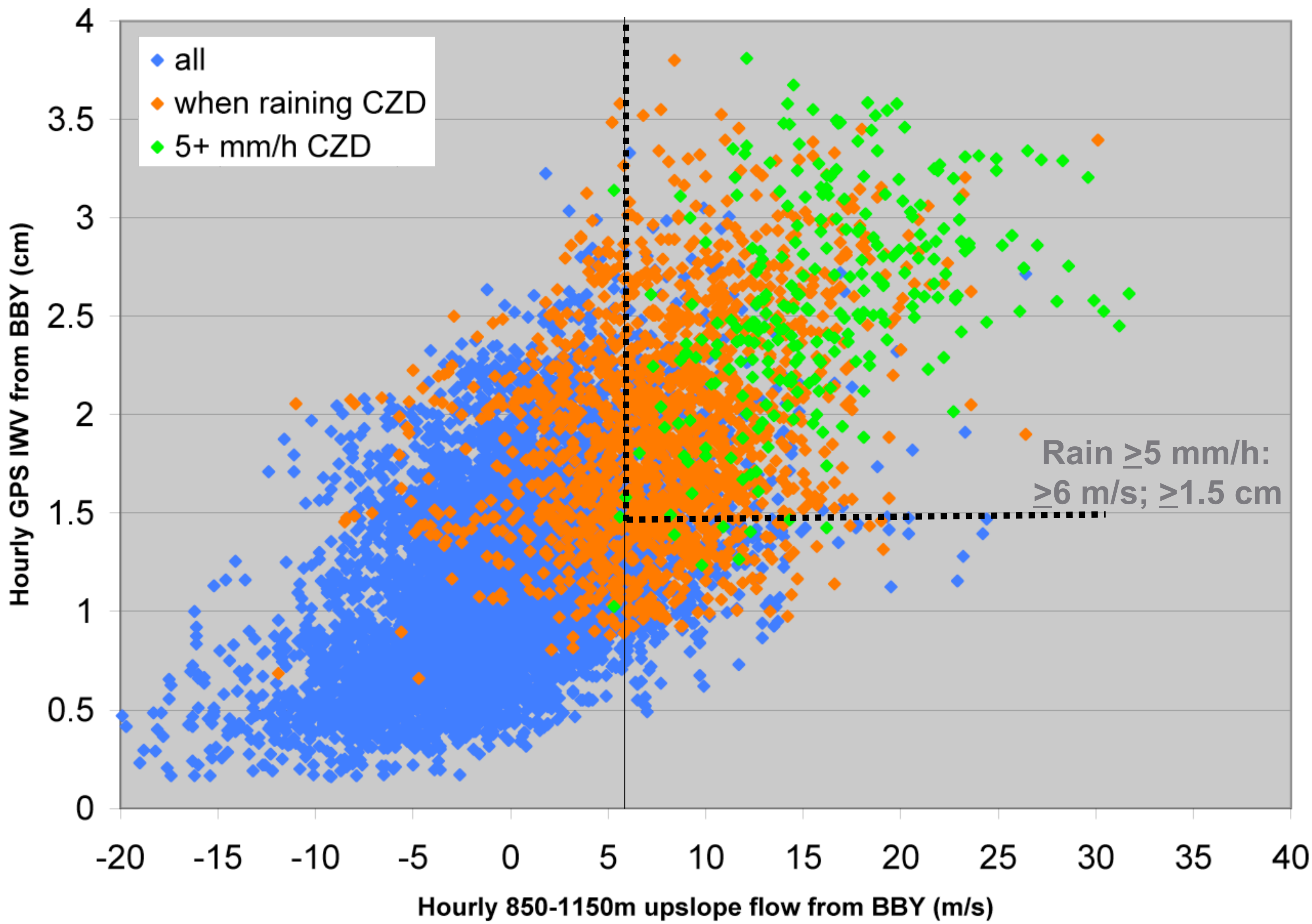
- **Step 3: Develop methods to better monitor and predict key physical processes (*better observations of lower-tropospheric water vapor transport is required – see Jordan et al. and Zamora et al. posters in Theme 3, and Matrosov et al. poster Theme 5*)**



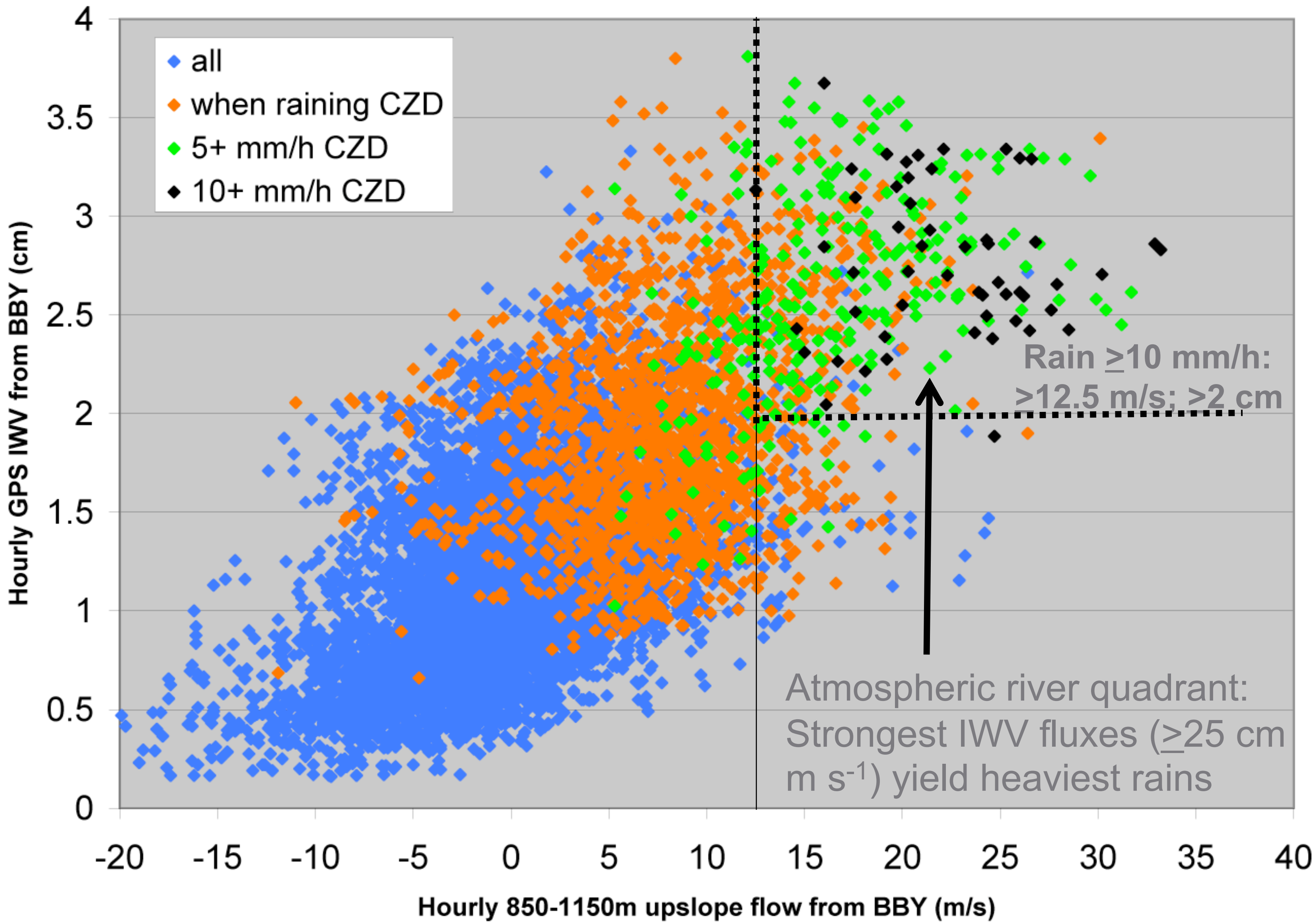
Component of the flow in the orographic controlling layer directed from 230°, i.e., orthogonal to the axis of the coastal mtns



all
when raining CZD
Any rain:
≥0 m/s; ≥1 cm
Hourly GPS IWV from BBY (cm)
Hourly 850-1150m upslope flow from BBY (m/s)
4
3.5
3
2.5
2
1.5
1
0.5
0
-20
-15
-10
-5
0
5
10
15
20
25
30
35
40



all
when raining CZD
5+ mm/h CZD
Rain ≥5 mm/h:
≥6 m/s; ≥1.5 cm
Hourly GPS IWV from BBY (cm)
Hourly 850-1150m upslope flow from BBY (m/s)
0
0.5
1
1.5
2
2.5
3
3.5
4
-20
-15
-10
-5
0
5
10
15
20
25
30
35
40



Neiman et al., 2009
J. Water Management

HMT and Extreme Precipitation at the Watershed Scale on the U.S. West Coast

- **Step 4: Prototype tools for potential use in future predictive systems and for use by policy makers (*atmospheric river observatory; testing in HMT-West*)**

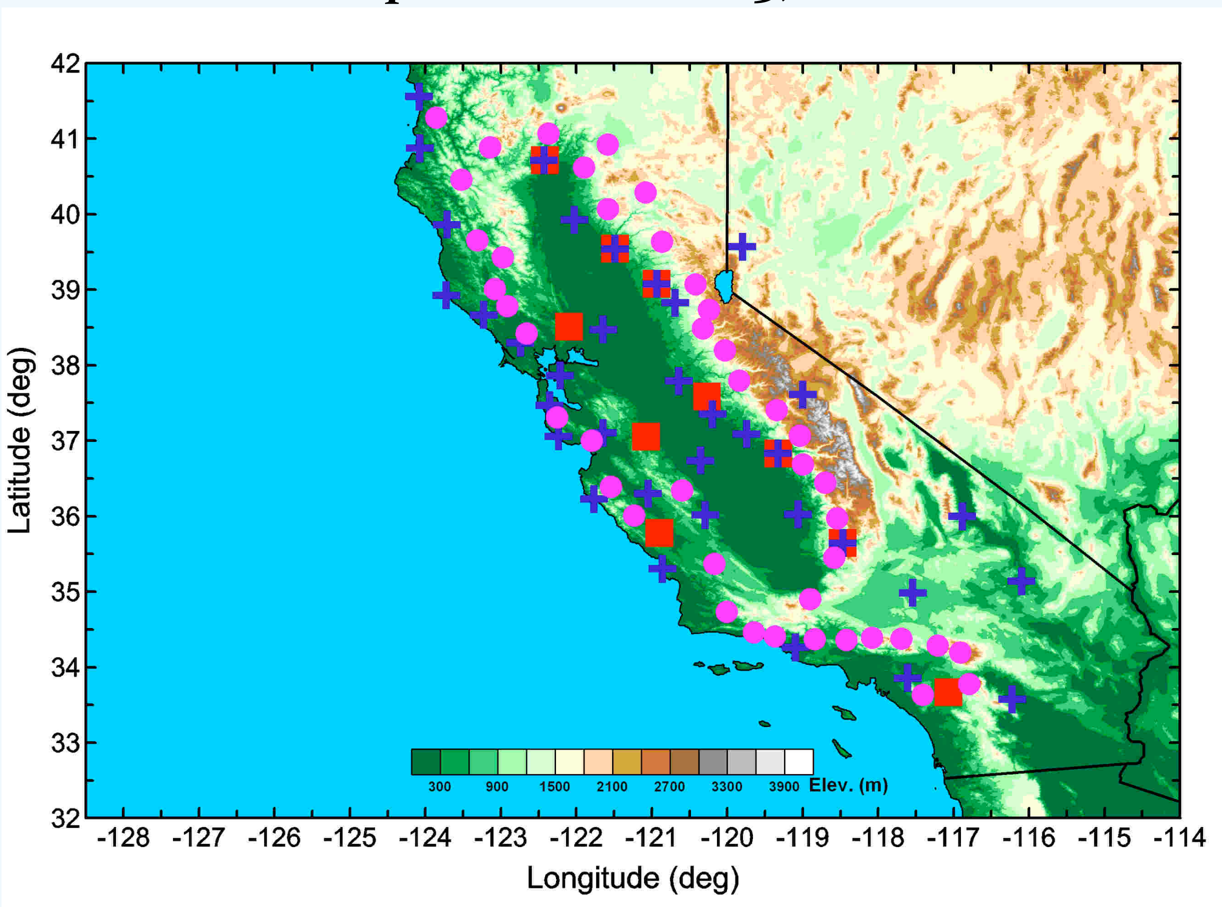
Testimonials on Decision Making

- "**The knowledge HMT has given us is situational awareness**," "I can see what is coming, and I can prepare my customers—particularly emergency managers—for what is coming." - Jan 2010 Dave Reynolds (Meteorologist in Charge-NWS Monterey Forecast Office)

- "During this current AR rain event, I have found the Westport ARO (for Wynoochee dam) and Spanaway ARO (for HH dam) very useful in short range forecast information which I needed to consult our water management people. The question was whether to take over the dam and operate for flood control today. **We were right on the threshold of taking over Wynoochee today for flood control, but had high confidence we didn't need to with the ARO info that the rain would taper off quickly -- and it did**. The Spanaway ARO is currently catching the brief heavy ran increase for HHD, but we remain confident it will move on as per forecast. Clearly the ARO info with radar, sat pix and precip trends gave us good confidence today. " (L. Schick, ACE - Seattle)

HMT and Extreme Precipitation at the Watershed Scale on the U.S. West Coast

- **Step 5: Implement long-term capabilities for "operational" use (*DWR… - see White et al. poster in Theme 3*)**



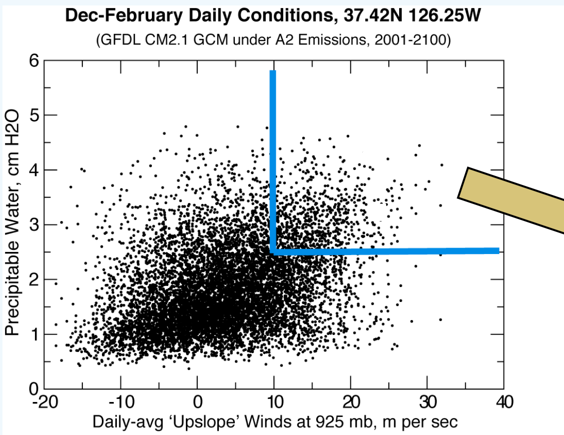
Tier 1: Builds on existing networks and adds proven, low cost technologies:

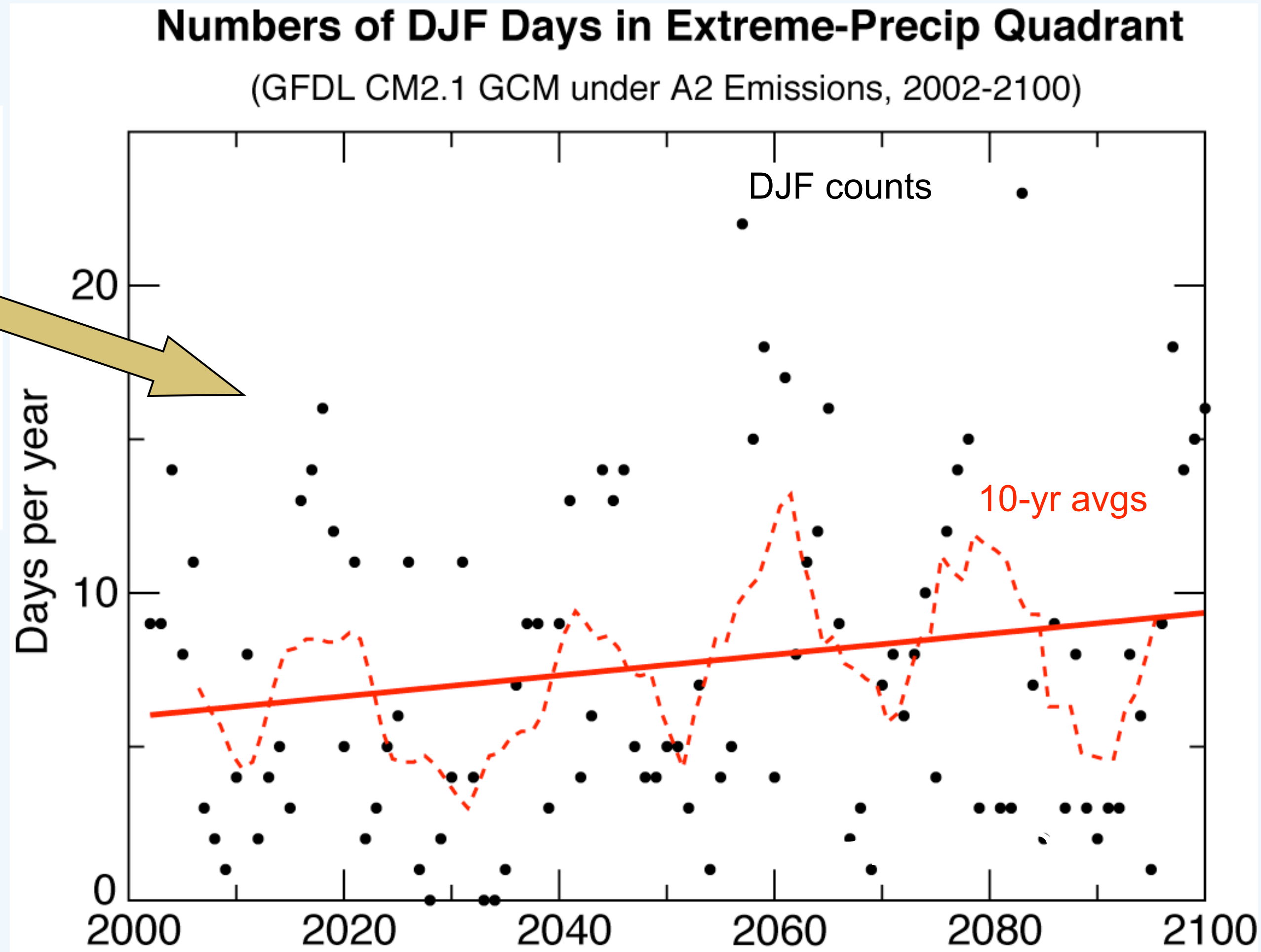
- **GPS-met**
- **Soil moisture**
- **Snow-level radars**

Future Directions:

- Implement HMT in other regions
- Develop a HydroClimate Testbed (HCT)
- Document key synoptic-to-planetary scale physical processes crucial to extreme precipitation
- Test how well climate models represent key processes
- Quantify how uncertainties in key processes manifest as uncertainty in climate projections of extreme event precipitation, runoff and water supply regionally

How often are historical extreme-precip conditions realized per winter as climate-change progresses?





Courtesy of
Mike Dettinger, Scripps

From ~ 6/winter now
--> ~ 9/winter in 2100

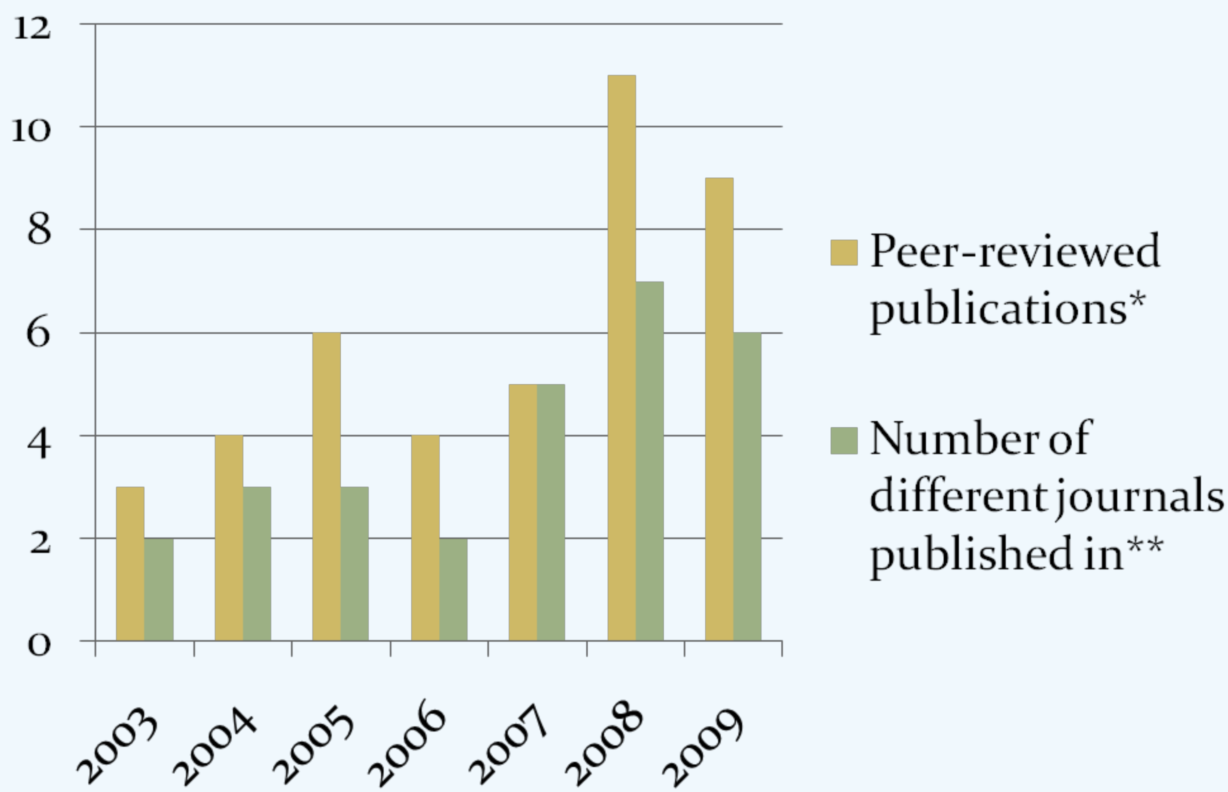
A 50% increase in number of "flood-worthy" storms?

Summary

PSD performs research to improve climate, weather and **water services with a focus on extreme events**

- From Too Little to Too Much Precipitation
- From Weather to Climate and Runoff
- From Science to Decision Making

HMT Uses Scientific Peer Review to Ensure Results Have A Solid Scientific Foundation and Multidisciplinary Impacts



*Papers must have used data or model information directly from HMT or its predecessors CALJET and PACJET (full bibliography is available at hmt.noaa.gov)

**Journals published in (12): Geophys. Res. Lett., J. Hydrometeor., Mon. Wea. Rev., J. Tech., Water Resources Research, Water Management, J. Climate, Bull. Amer. Meteor. Soc, Weather and Forecast, IEEE Trans. Geoscience and Remote Sensing, etc…