Assessing the Viability of Forecast-Informed Reservoir Operations

A Multi-agency Research & Development Effort

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Coastal & Hydraulics Laboratory
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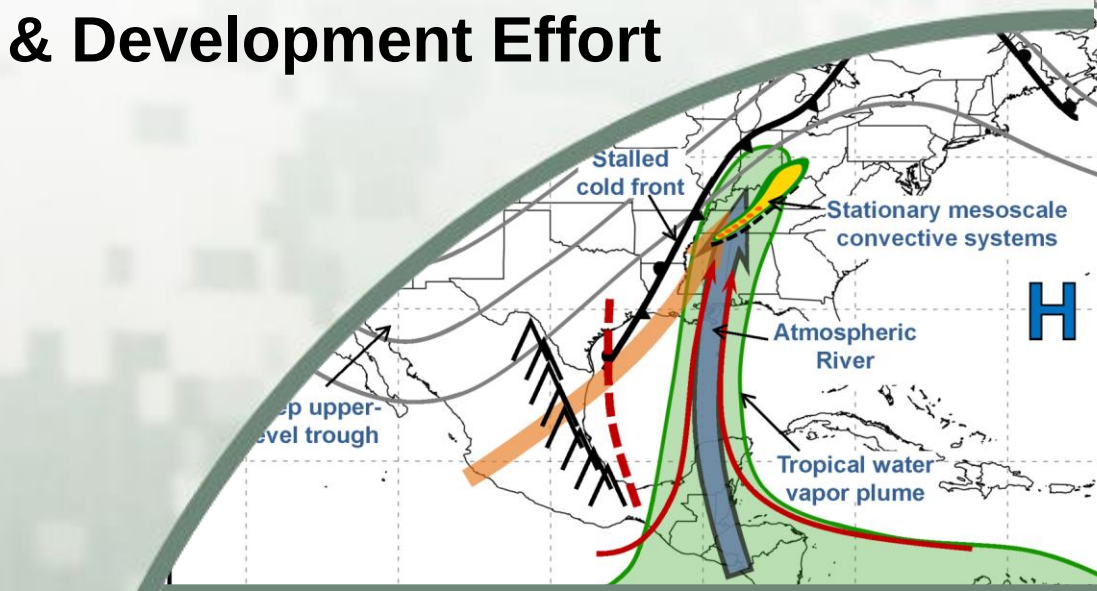

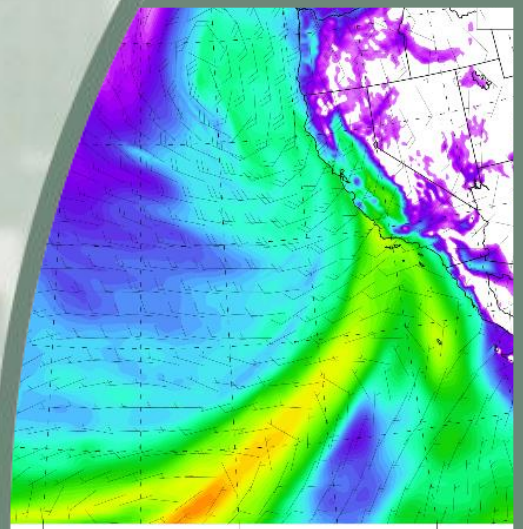

Western States Water Council Fall Meeting
St. George, UT
28 Sep 2016

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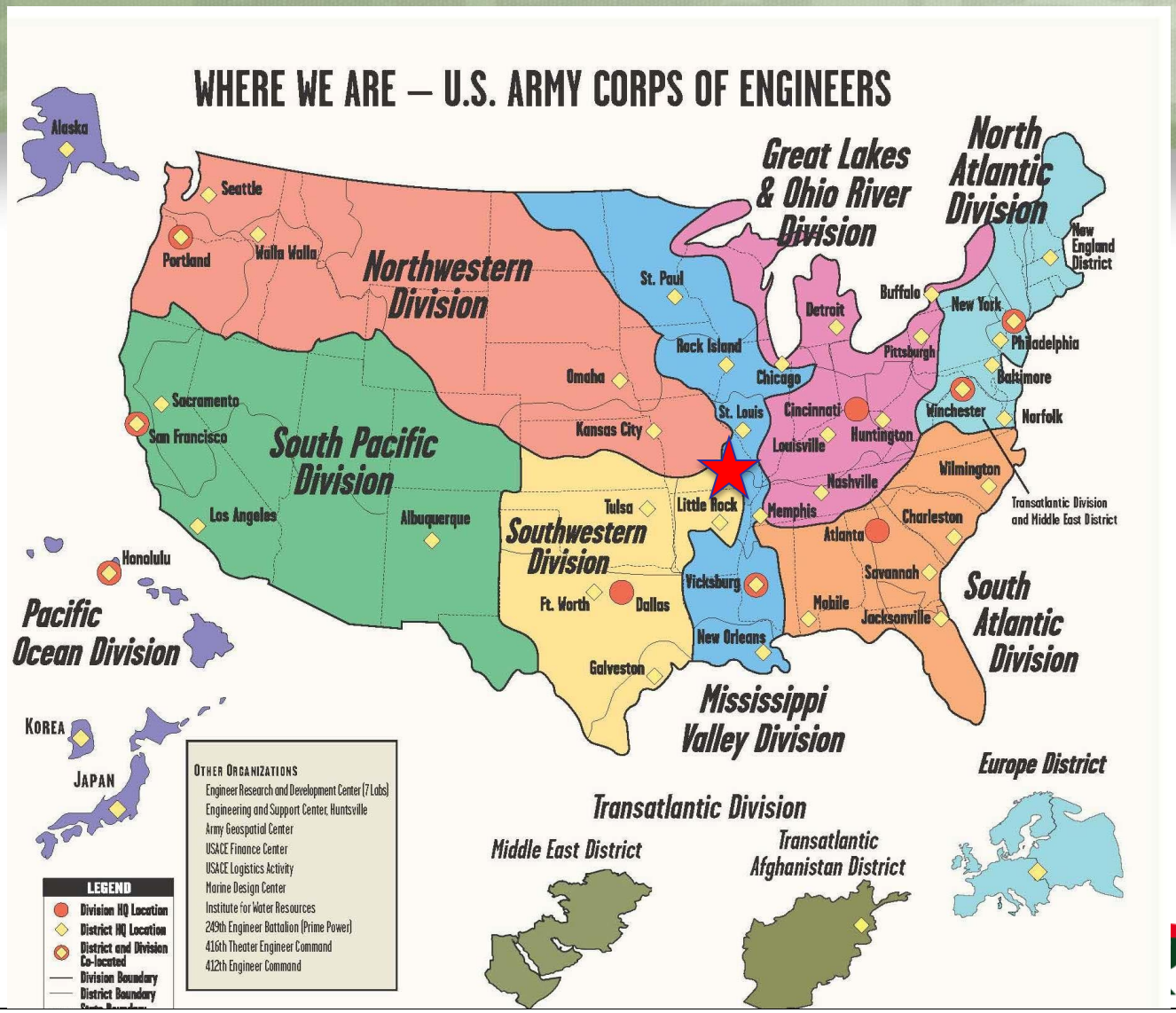
ERDC
Innovative solutions for a safer, better world

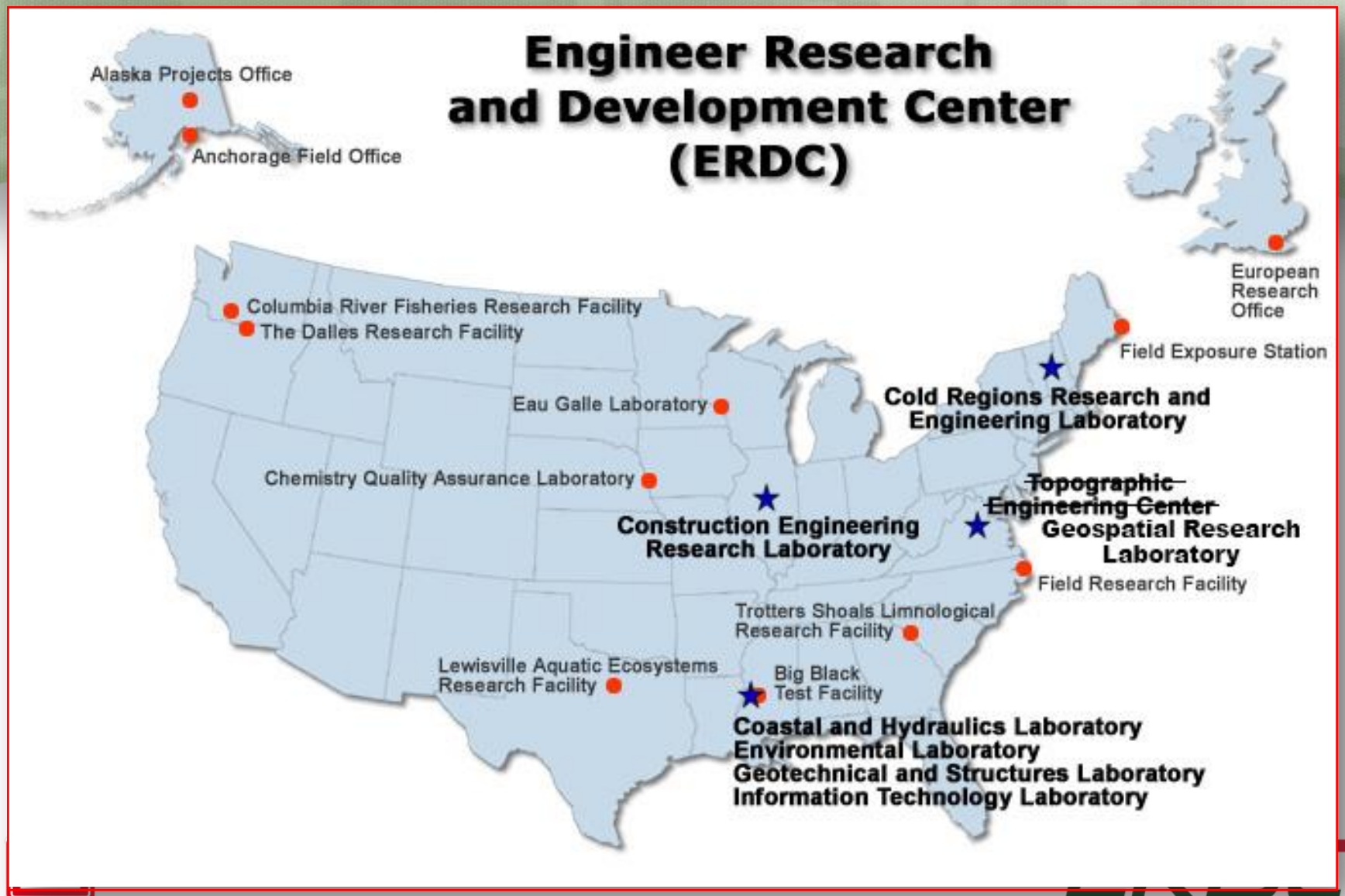
USACE Map


WHERE WE ARE – U.S. ARMY CORPS OF ENGINEERS
Alaska
Seattle
Portland
Walla Walla
Northwestern Division
Great Lakes & Ohio River Division
North Atlantic Division
New England District
St. Paul
Buffalo
New York
Detroit
Rock Island
Pittsburgh
Philadelphia
Chicago
Baltimore
Omaha
Winchester
Norfolk
Sacramento
San Francisco
South Pacific Division
Kansas City
St. Louis
Cincinnati
Louisville
Huntington
Wilmington
Nashville
Tulsa
Little Rock
Memphis
Charleston
Transatlantic Division and Middle East District
Los Angeles
Albuquerque
Southwestern Division
Atlanta
Honolulu
Vicksburg
Savannah
Pacific Ocean Division
Ft. Worth
Dallas
Mobile
Jacksonville
South Atlantic Division
New Orleans
Galveston
Mississippi Valley Division
Europe District
KOREA
JAPAN
Transatlantic Division
Middle East District
Transatlantic Afghanistan District
OTHER ORGANIZATIONS
Engineer Research and Development Center (7 Labs)
Engineering and Support Center, Huntsville
Army Geospatial Center
USACE Finance Center
USACE Logistics Activity
Marine Design Center
Institute for Water Resources
249th Engineer Battalion (Prime Power)
416th Theater Engineer Command
412th Engineer Command
LEGEND
Division HQ Location
District HQ Location
District and Division Co-located
Division Boundary
District Boundary

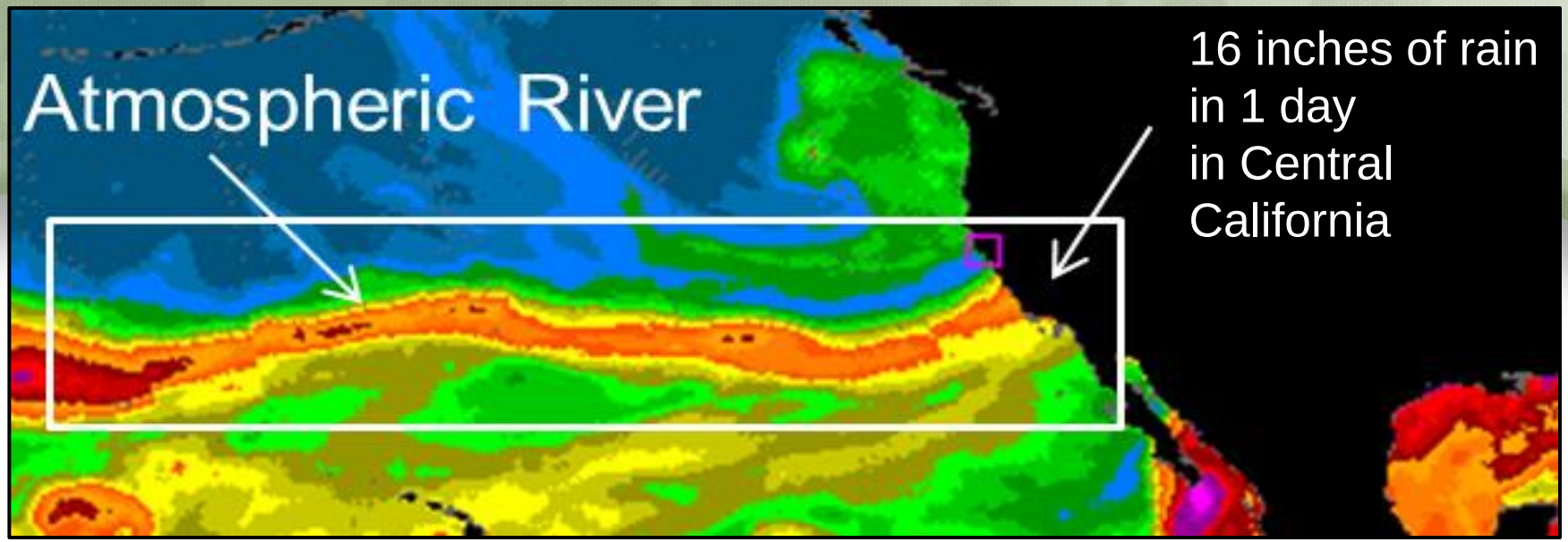
Engineer Research & Development Center (ERDC)

- 7 Laboratories
  - Coastal & Hydraulics Lab (CHL)
  - Construction Engineering Research Lab (CERL)
  - Cold Regions Research and Engineering Lab (CRREL)
  - Environmental Lab (EL)
  - Geotechnical & Structures Lab (GSL)
  - Geospatial Research Lab (GRL)
  - Information Technology Lab (ITL)
- Over 1000 engineers & scientists (~2500 total staff)
  - 28% PhD's, 42% Masters'
- R&D Mission Areas
  - Military Engineering
  - Geospatial Research and Engineering
  - Environmental Quality and Installations
  - Civil Works and Water Resources

ERDC Locations



Atmospheric Rivers

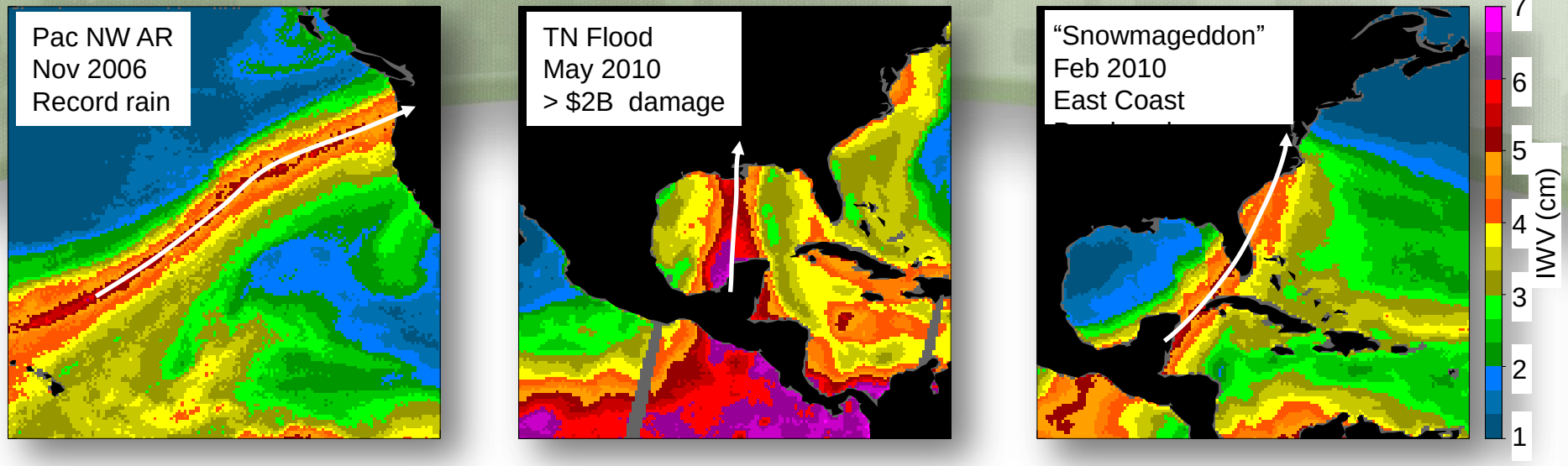


- A narrow “conveyor belt” of water vapor extending from thousands of miles out at sea, carrying, on average, ~10 Mississippi Rivers
- Generally provide 35-50% of annual rainfall across California

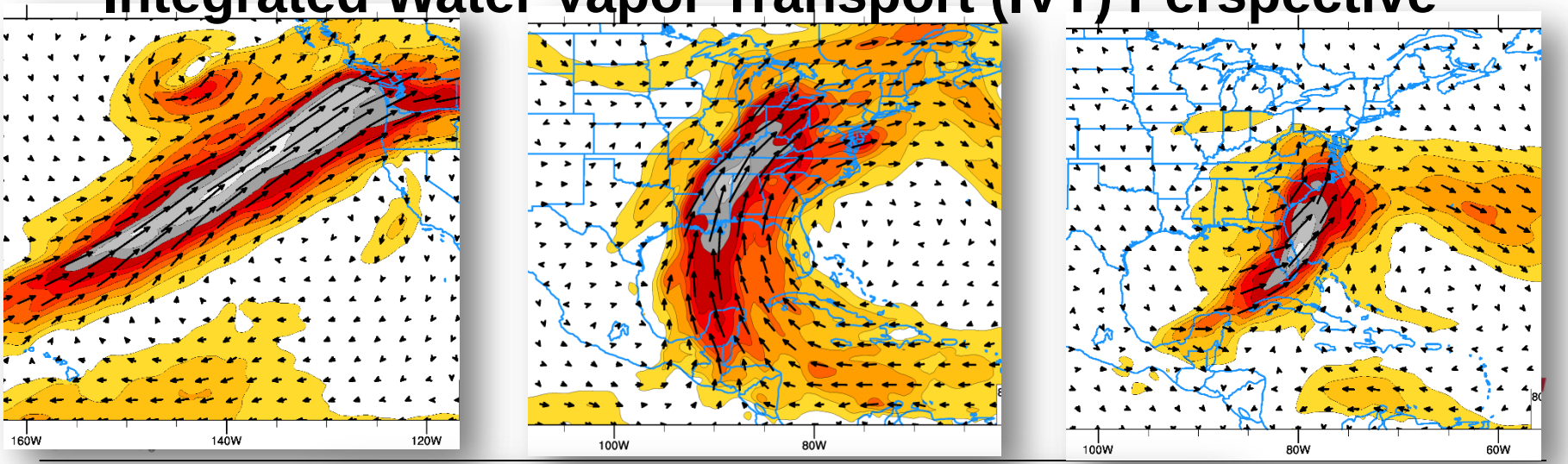
*Dettinger et al., Atmospheric Rivers, “Floods and the Water Resources of California,” **Water**, 2011*

Atmospheric Rivers: Not just a West Coast Issue

Integrated Water Vapor (IWV) Perspective



Integrated Water Vapor Transport (IVT) Perspective



Slide courtesy Marty Ralph

Physical Processes Associated with Heavy Flooding Rainfall in Nashville, Tennessee, and Vicinity during 1–2 May 2010: The Role of an Atmospheric River and Mesoscale Convective Systems

Ben Moore, Paul Neiman, Marty Ralph, Faye Barthold

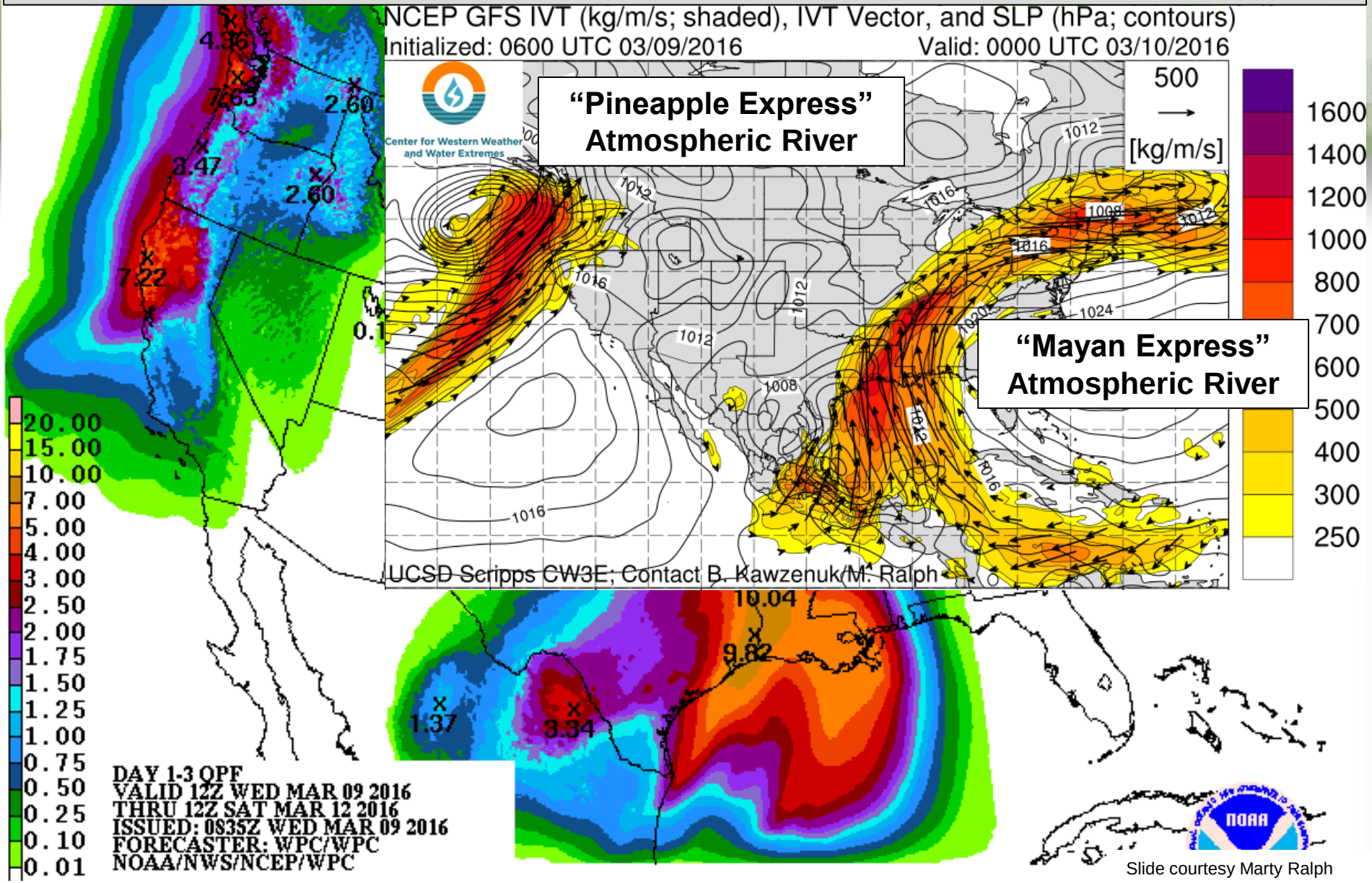
Monthly Weather Review (2012)

Up to 493 mm rainfall in 2 days caused major flooding

Slide courtesy Marty Ralph

Atmospheric rivers and current extreme precipitation events in the Southeast & West Coast

F. M. Ralph (CW3E at Scripps Institution of Oceanography)



Slide courtesy Marty Ralph

Purpose of Research Effort

- Forecast-Informed Reservoir Operations (FIRO)
  - Using advanced hydro-meteorological forecasting capability to inform water supply and flood control operations at reservoirs where atmospheric river events frequently and predictably occur
  - Explore methods for a better balance between flood risk management, water supply and ecological needs

FIRO Project Scope

- Using data from watershed monitoring and modern weather and water forecasting to inform water management decisions to selectively retain or release water from reservoirs in a manner reflecting current and forecasted conditions
- Research effort will carry out an expected 5-year proof-of-concept project using Lake Mendocino as a model and develop a process that can be used to test FIRO at other reservoirs in areas affected by AR events

FIRO Project Participants

Coalition of federal, state, & regional agencies comprised of scientists & water managers

Steering Committee

Federal:	NOAA (OAR, NWS, NMFS), USGS, USACE & USBOR
State:	CA Dept. of Water Resources & Scripps Center for Western Weather & Water Extremes
Regional:	Sonoma County Water Agency
Partnerships:	NOAA Habitat Blueprint, IWRSS

Just Because We're Studying It Doesn't Mean Something is Broken

- R&D is being conducted to determine ***if*** there is sufficient capability, now or in the near future, to reliably and formally incorporate forecast information into water operations decisions
- Current Water Control Manuals and Corps Water Management policy continue to provide appropriate levels of flood risk management
- Water Control Manual age is not an inherent problem in and of itself

FIRO Project Challenges

- FIRO researchers must develop forecast models & tools tailored to provide improved forecasts for weather events (e.g., atmospheric rivers) that are suitable and *sufficiently reliable* for operational decisions
- FIRO researchers must develop improvements to hydrologic and reservoir operational tools that meaningfully enhance simulation of hydrologic events for water supply, flood risk management and ecological considerations
- The FIRO research effort must produce the required key data points needed to inform USACE operational policy with respect to forecast-informed reservoir operations

FIRO Work Plan Provides Roadmap

- Created by Interagency, cross-disciplinary Steering Committee
- Work plan developed in 2014/15; finalized in Sep 2015

A COMPREHENSIVE PLAN TO EVALUATE THE VIABILITY OF
FORECAST INFORMED RESERVOIR OPERATIONS (FIRO)
FOR LAKE MENDOCINO

SEPTEMBER 2015

STEERING COMMITTEE CO-CHAIRS
Jay Jasperse, Sonoma County Water Agency
F. Martin Ralph, Center for Western Weather and Water Extremes at Scripps Institute of Oceanography

STEERING COMMITTEE MEMBERS
Michael Anderson, California State Climate Office, Department of Water Resources
Levi Brekke, Bureau of Reclamation
Mike Dillabough, US Army Corps of Engineers
Michael Dettinger, United States Geological Survey
Rob Hartman, NOAA's National Weather Service
Christy Jones, US Army Corps of Engineers
Patrick Rutten, NOAA Restoration Center
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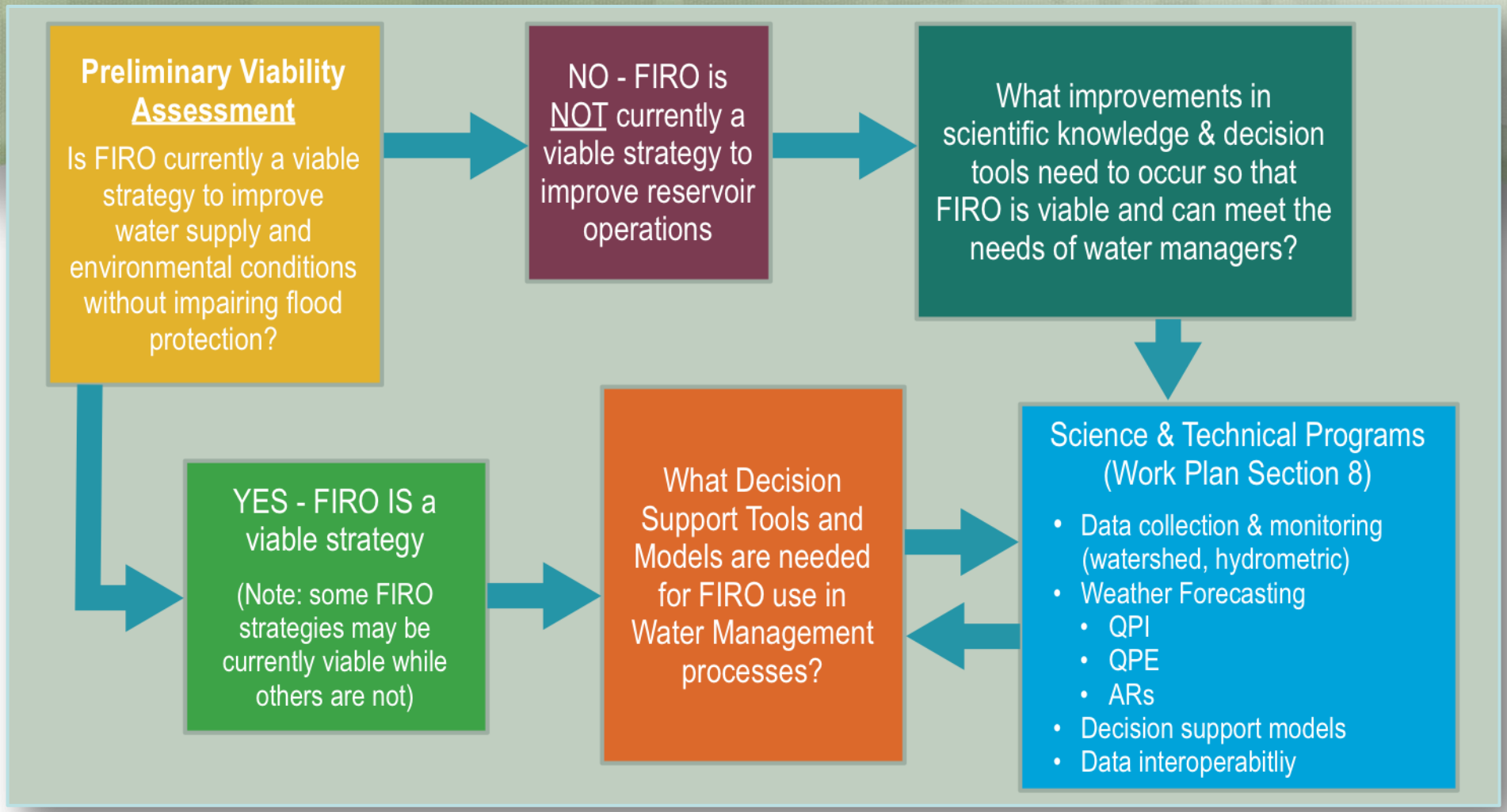
PROJECT PARTNERS

TABLE OF CONTENTS

FIRO Assessment Paths



FIRO Expected Outcomes

Goal of initial phase is to answer the following question:

Is FIRO potentially viable as an operational strategy to improve water supply and environmental conditions without impairing flood protection?

If answer is yes, then next step is to answer the following:

What decision support system & tools need to be developed and employed to operationalize FIRO?

If answer is no, then next step is to address the following:

What research needs to be conducted to improve science & technology to meet the needs of water managers?

Potential tangible benefits include:

Improved water supply reliability for downstream uses

Enhanced flood risk reduction and ecological benefits

FIRO Assessment Timeline

July - September 2015	October - December 2015	January - March 2016	April - June 2016	July - September 2016	October - December 2016	2017 - 2020
• Complete work plan • Form task groups • Assess information • Identify monitoring sites • Develop evaluation criteria	• Develop study strategy • Agree on scenarios, inputs • Convene modeling discussion • Develop evaluation scenarios • Evaluate past forecast performance	• Assemble models • Develop policy scenarios • Install monitoring stations • Evaluate past reservoir operations	• Preliminary model results available • Begin economic benefits analysis	• Finalize modeling results • Conduct stress test • Continue economic benefits assessment • Synthesize atmospheric river advances	• Complete preliminary FIRO viability assessment • Refine scenario testing for years 2-5 • Identify priority research activities	• Full assessment of FIRO viability

USACE FIRO Work Plan

- **Year 1**
  - ► Carry out a Preliminary Viability Assessment
    - Uses actual past forecast and operations performance
    - Quantifies FIRO requirements and identifies science gaps
  - ► Develop ERDC work plan for demonstration of GSSHA, CE-QUAL-W2 and decision science capabilities for FIRO full viability assessment
- **Years 2-5**
  - ► Carry out Full Viability Assessment
  - ► Conduct research efforts to advance the identified science gaps
  - ► Develop and demonstrate new forecast and decision support tools

FIRO Ongoing Activities

- Execution of ERDC & Scripps work plans for specific FIRO tasks
  - GSSHA watershed modeling team fully engaged
  - CE-QUAL-W2 and decision science work plans still under development
- FIRO SC monthly conference calls, regular face-to-face meetings (generally 3x year)
- 3 Task Groups
  - Preliminary Viability Assessment
  - Scientific Research
  - Outreach

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601-634-2625

FIRO web site: http://cw3e.ucsd.edu/FIRO/