Updating Oregon's Statewide Probable Maximum Precipitation using a Hybrid HMR-and-Numerical Modeling Method

National Dam Safety Program Technical Seminar | 2024

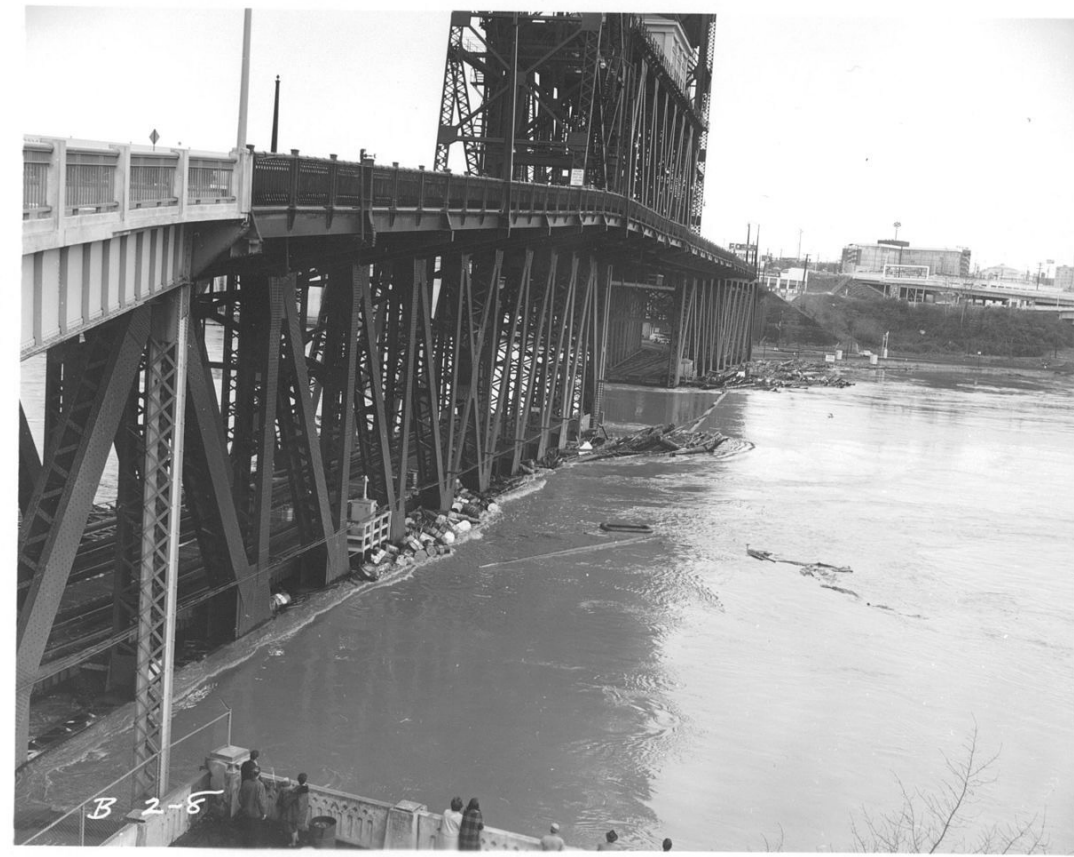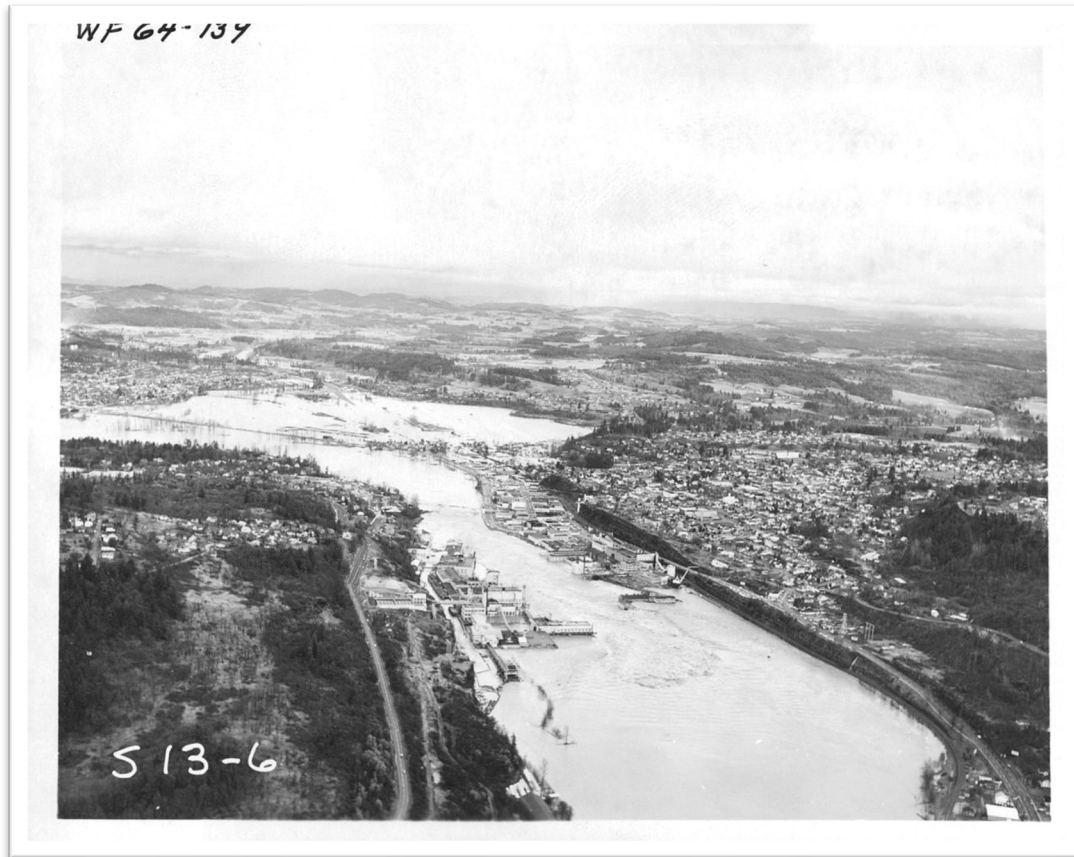# Partners

Where we started off...

Flooding in Oregon ("Thousand Year Flood" of 1964)

Source: Portland USACE

Atmospheric Rivers

2021-10-21 19:00:32 UTC
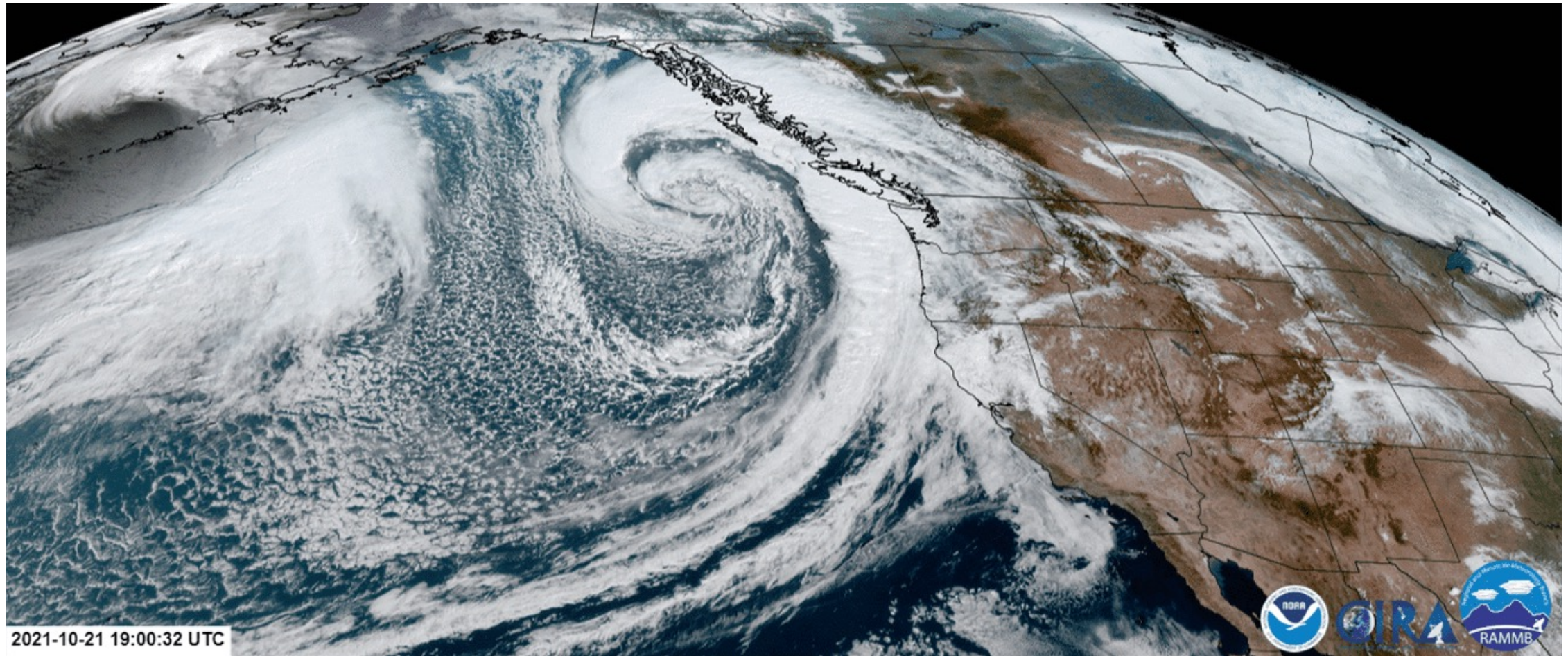
Source: NOAA

Atmospheric Rivers (Continued)
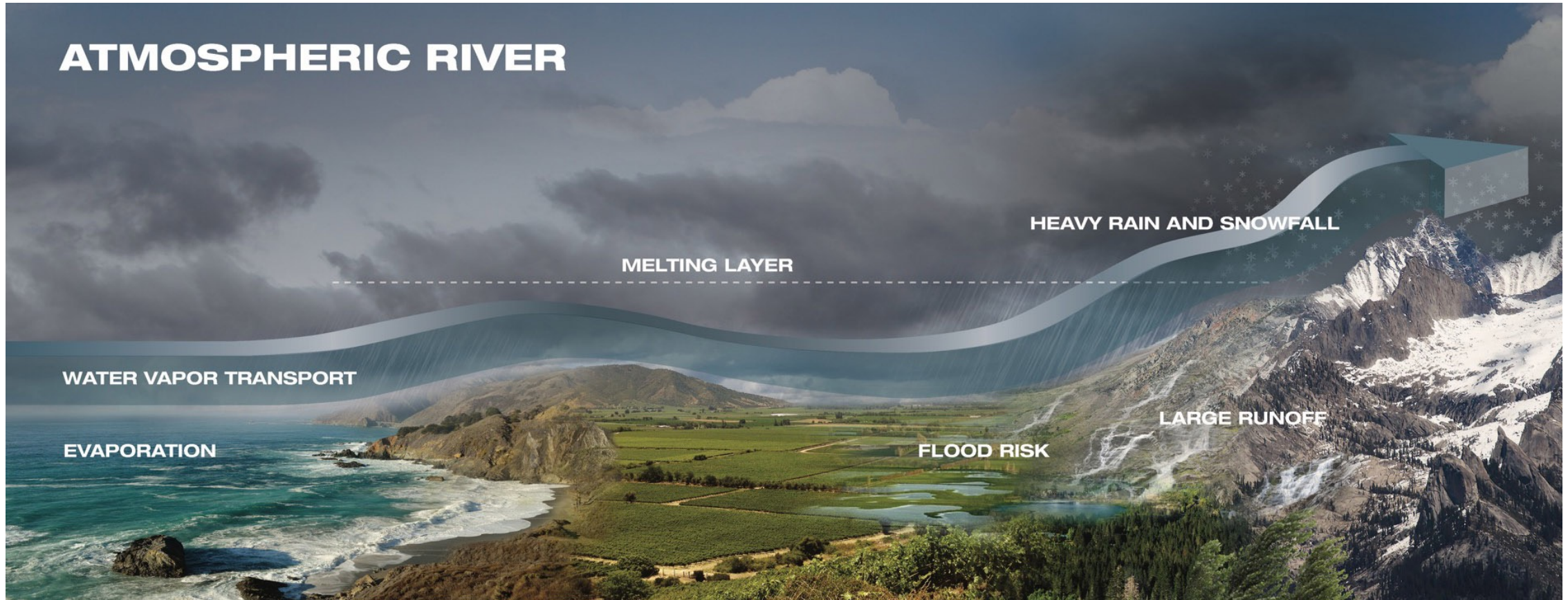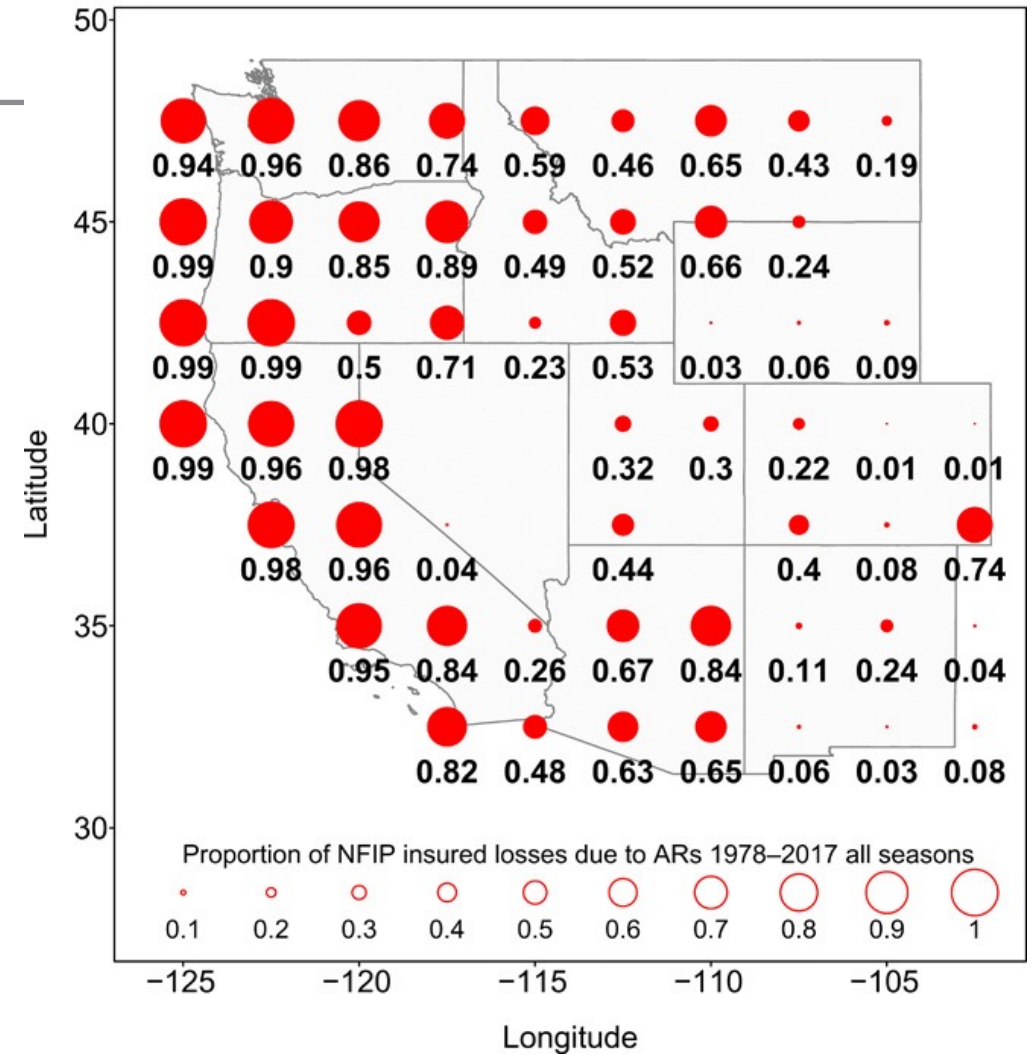

Source: NASA Center for Climate Simulation

Main Cause of Flood Damages

- Atmospheric Rivers (AR) cause the big Oregon floods.
  - \>98% of insured losses.


Proportion of insured losses due to ARs

Proportion of NFIP insured losses due to ARs 1978–2017 all seasons

Source: Corringham et al., 2019
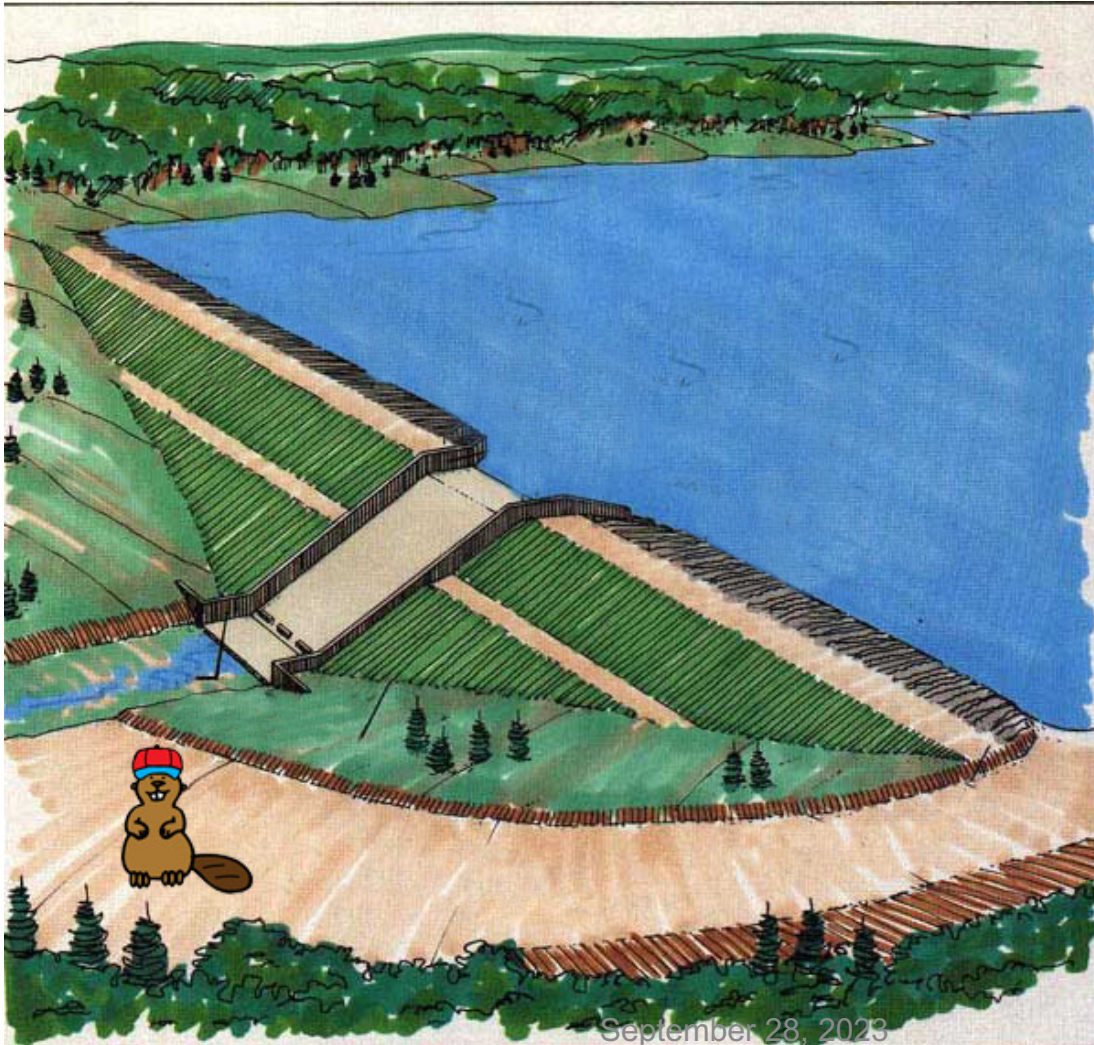
Dams in Oregon

Oregon has:
- >700 State regulated dams (96 High-Hazard Potential Dams)
- >170 Federal regulated dams

- Provide guidance for small and large dam owners

Source: National Inventory of Dams

Spillway Design

Precipitation (PMP)

↓
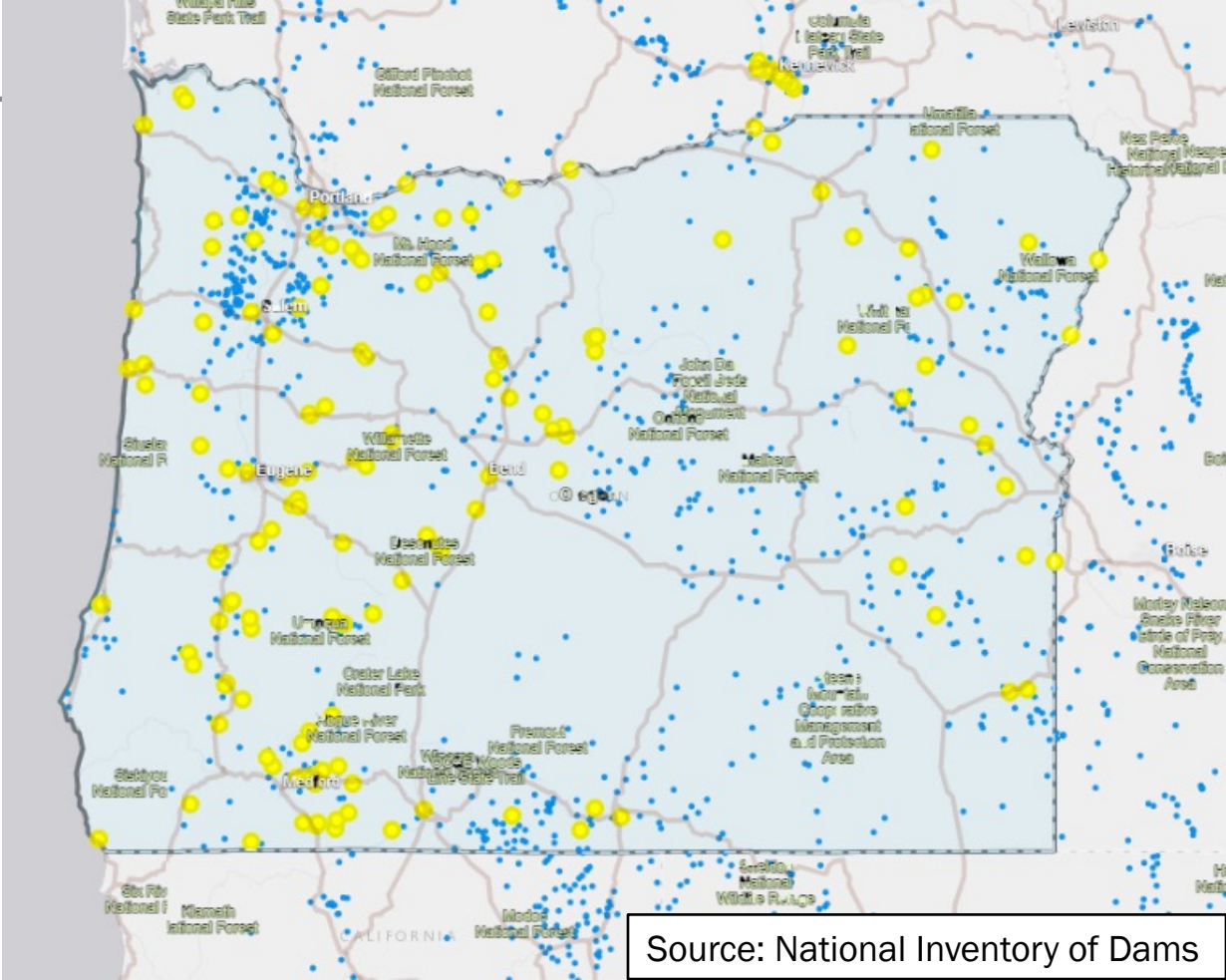
Flooding (PMF)

Source: Association of State Dam Safety Officials

What is Probable Maximum Precipitation (PMP)?

Theoretically: "the greatest depth of precipitation for a certain duration <u>meteorologically possible</u> for a given size storm area at a specific time of year" (WMO, 2009)
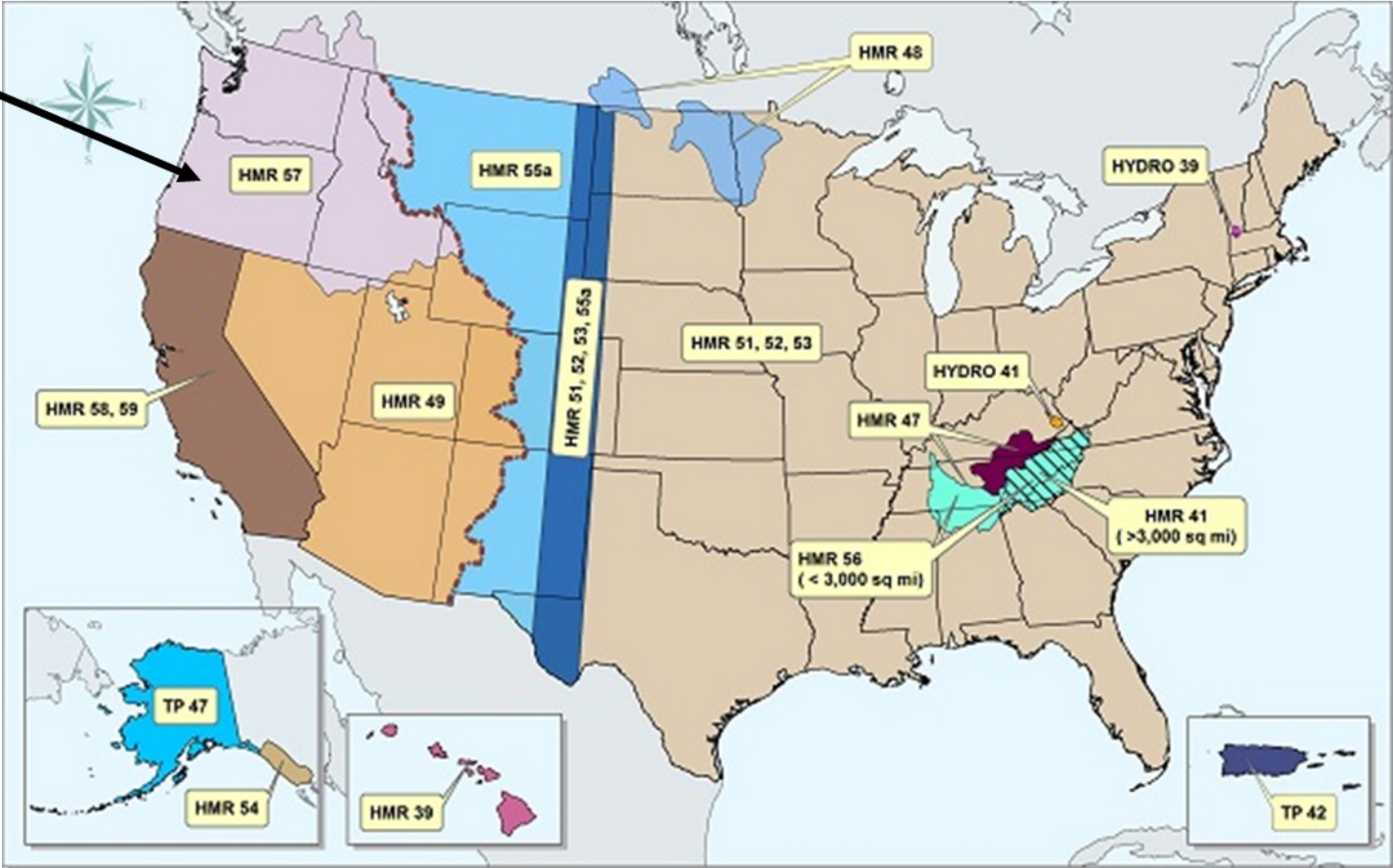
PMP in US: Hydrometeorological Report

HMR-57
(Published: 1994)

Statewide PMP updates:
NE, CO, NM, WY, OH, AZ, VA,
PA, MD, HI, NC, TX, and NJ
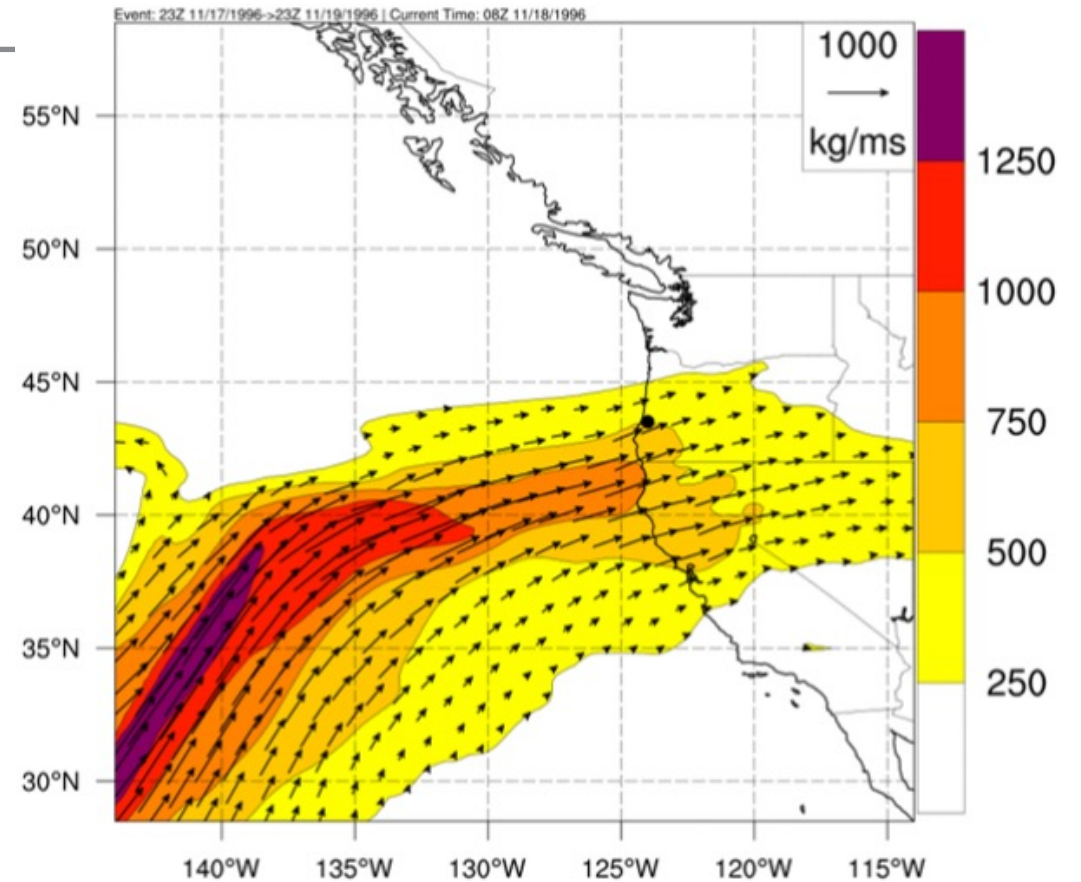Site specific PMPs

HMR: 1961-1999

Source: National Weather Service

Phase 1 (Completed June 2023)

- Evaluated HMR's assumptions

- ARs and Extreme Precipitation in Oregon

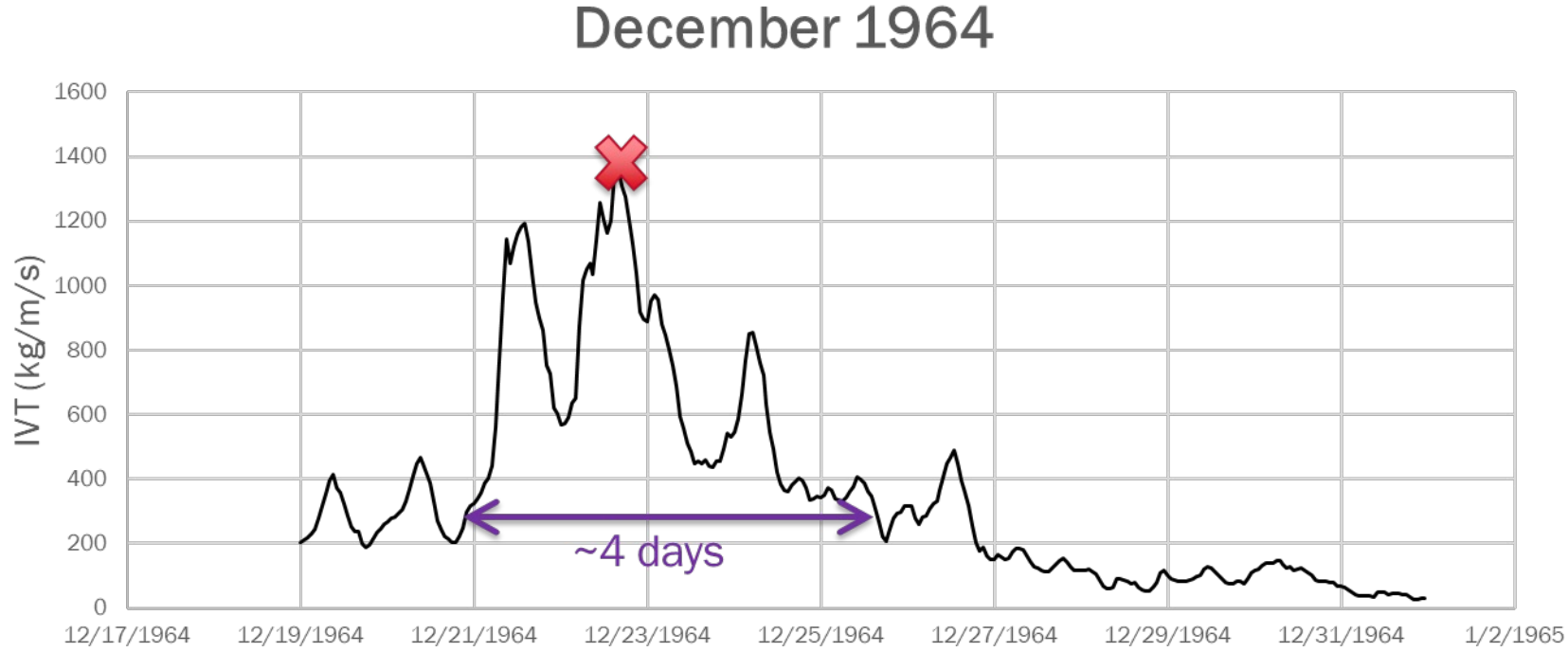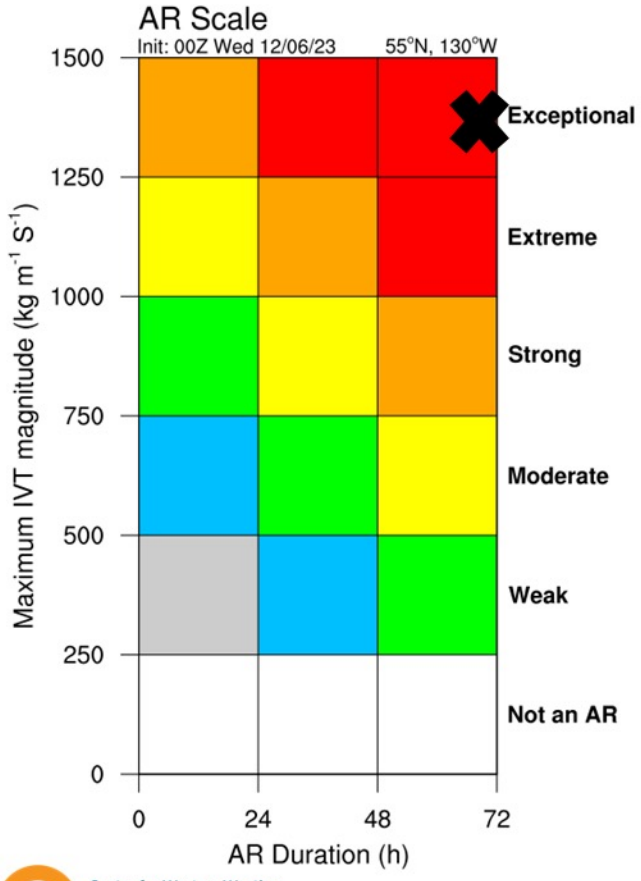- AR Catalogue: CW3E Oregon Landfalling AR Catalog (ucsd.edu)

FEMA

Atmospheric Rivers (AR)

What "ingredients" cause extreme AR-driven rainfall?

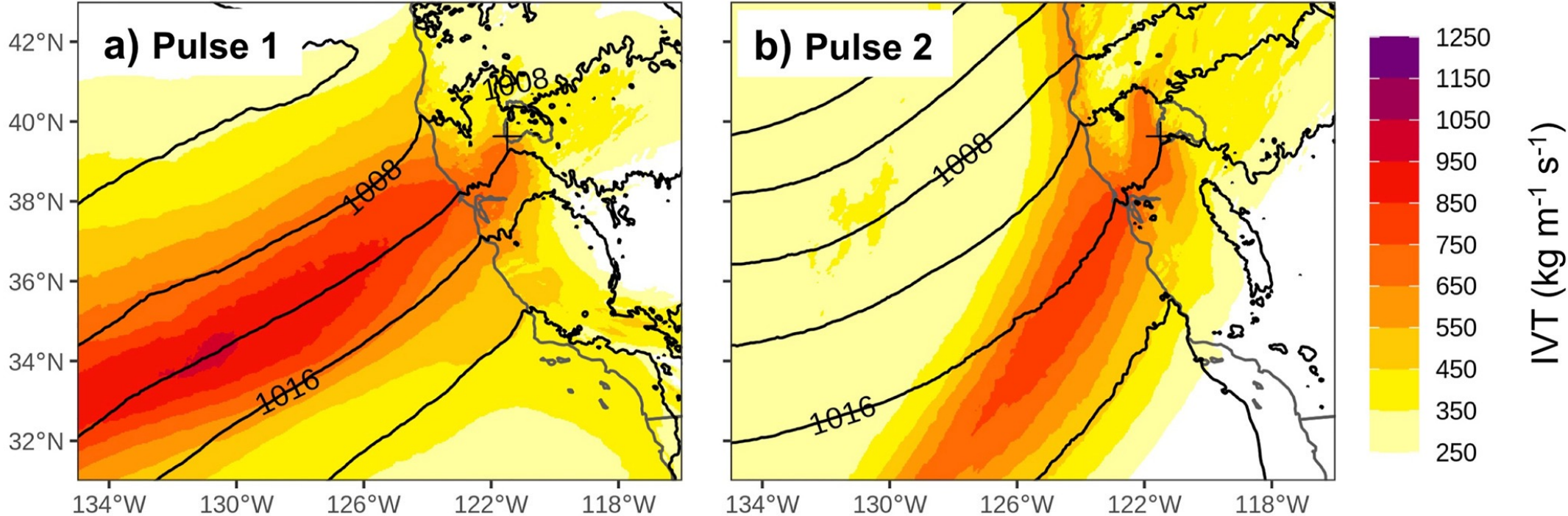# Characteristics of Extreme AR Events

Multiple-Pulse AR Events

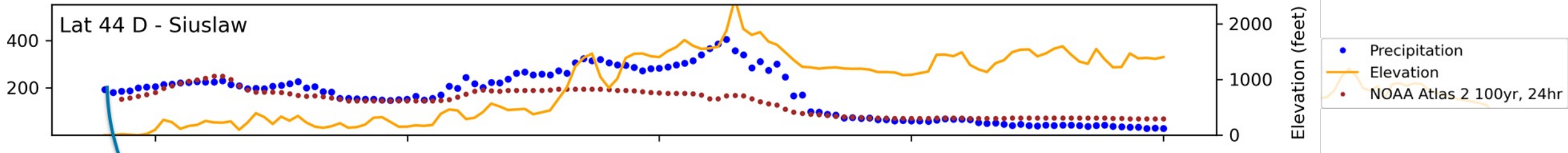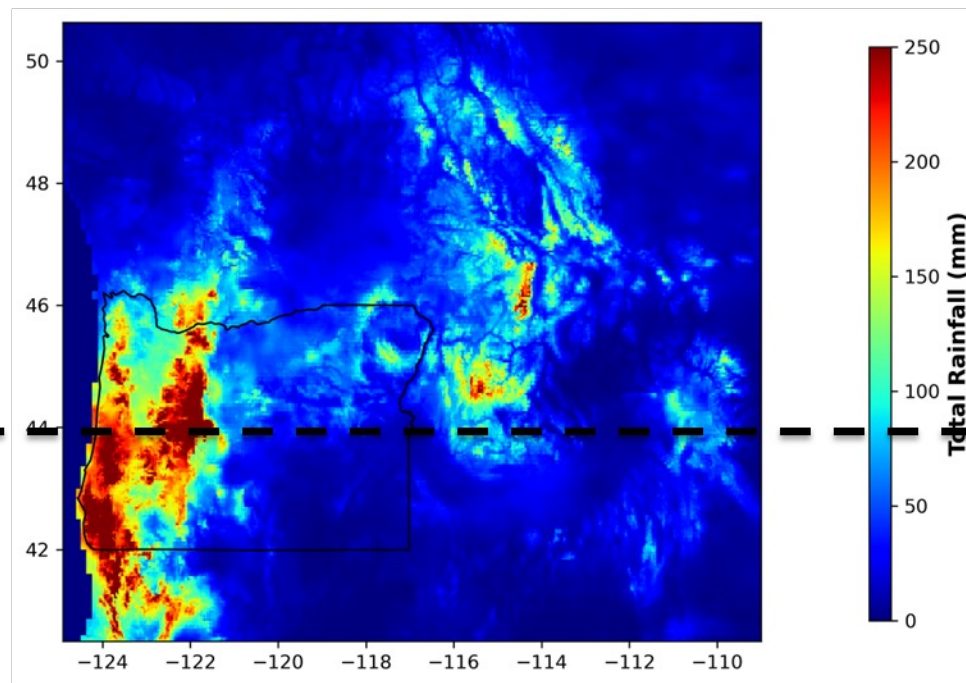# Orographic Interaction

Lat 44 D - Siuslaw

Legend:
- Precipitation
- Elevation
- NOAA Atlas 2 100yr, 24hr

Transect of event rainfall at 44° Latitude

Nov 1996 Event

Where we're going...
Improved-HMR Methodology

A deeper look at the HMR methodology

Convergence component

Orographic component

Maximize
P = f(MPW)

Adjust to sea level

Transpose

Repeat for many storms to get maximum for each location
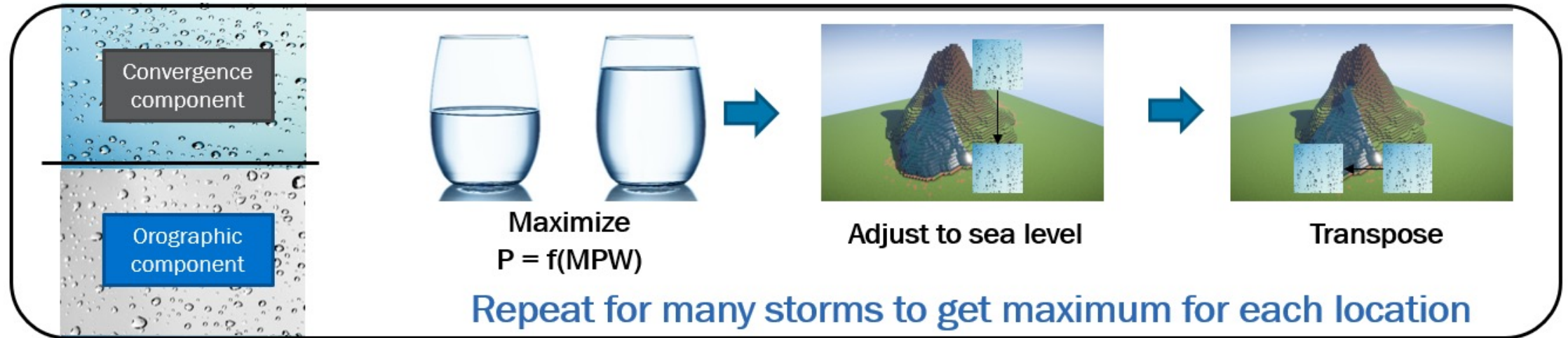
Add back orography

Lack of data + Subjectivity =
lots of assumptions and uncertainties
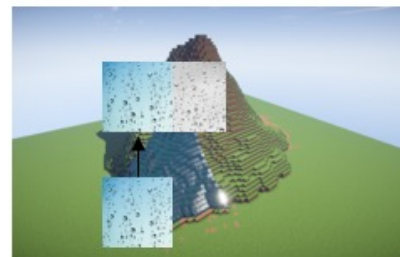
Developing AR-Based PMP
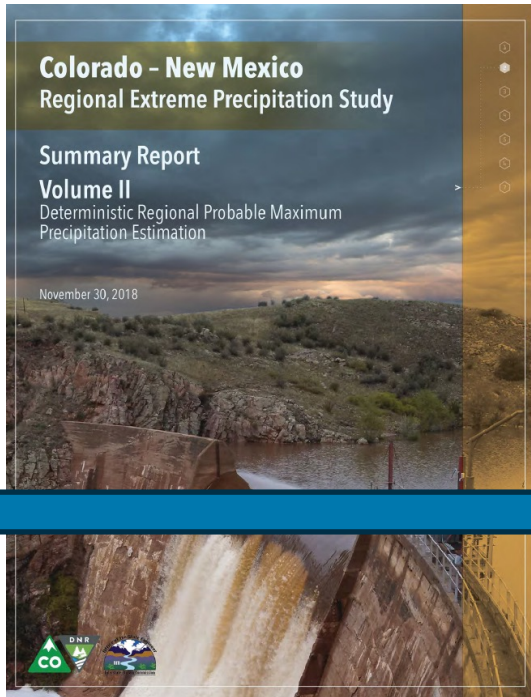
HMR-Based Methods

Numerical Weather Model-Based Methods

We are here!

Moisture Maximization
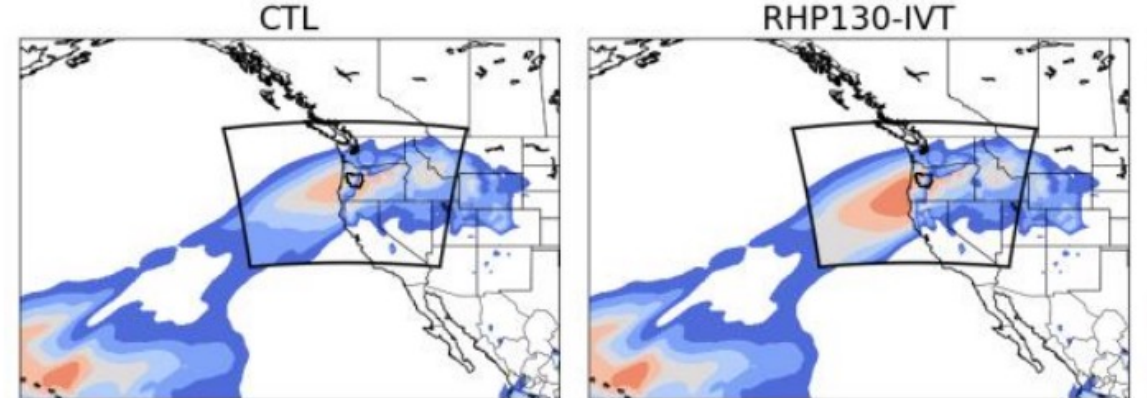
HMR 57

- Scale historical storm's precipitation by the ratio:

$$\frac{PW_{climatological\ max}}{PW_{historical\ storm}}$$

Numerical methods

- Increase moisture directly using model boundary conditions

- Example from UC Davis's PMP study (2019) on the Willamette:

~ 1200 UTC 09 Feb 1996

Original Storm Moisture   Maximized Storm Moisture
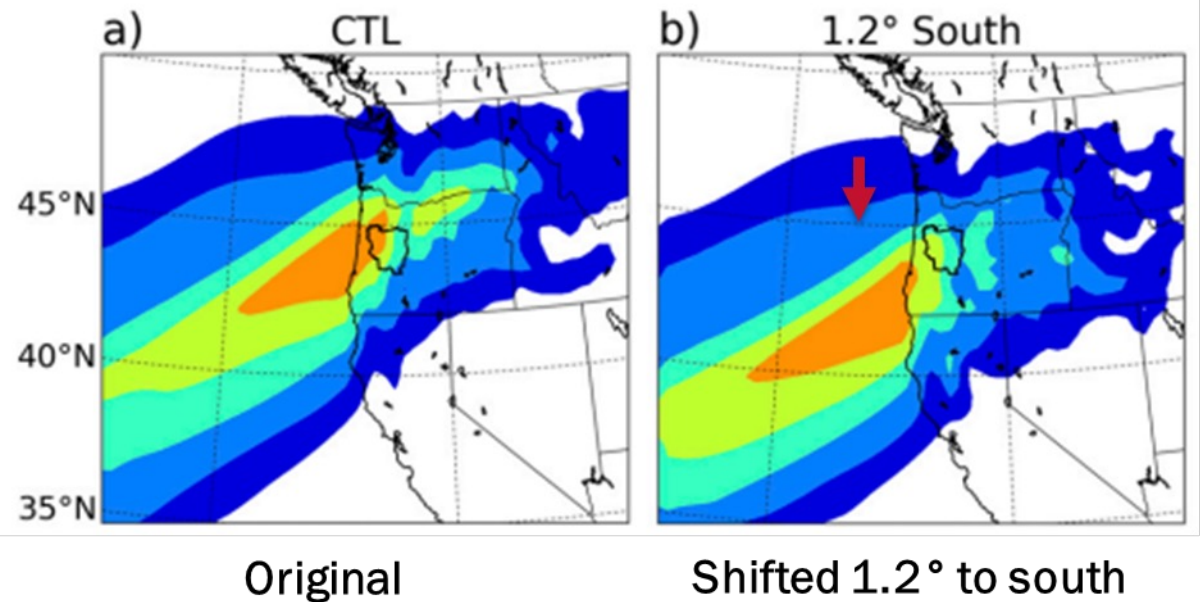
Storm Transposition

HMR Method

- Separate storms into "orographic" and "non-orographic" components

- Apply horizontal and vertical scaling factors (based on pre-1994 data)

Numerical Methods

- Shift boundary conditions north or south (Example from UC Davis Willamette PMP study, 2019)

Original   Shifted 1.2° to south

Improved-HMR ("I-HMR") Method

Updating climatology datasets

⭐ Selecting Extreme AR-rainfall Events

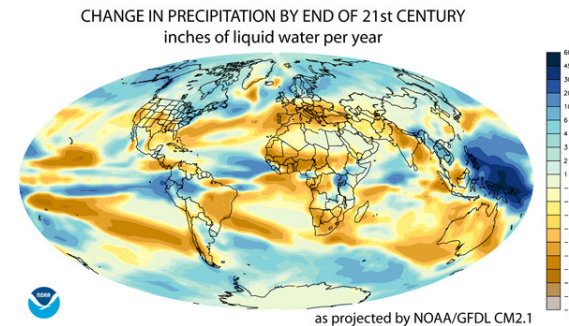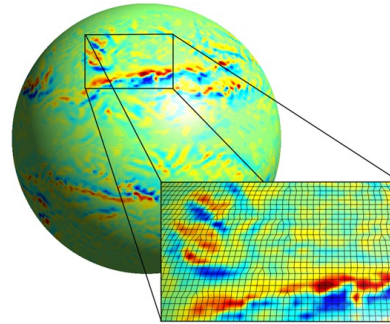Event Maximum Total Rain Locations

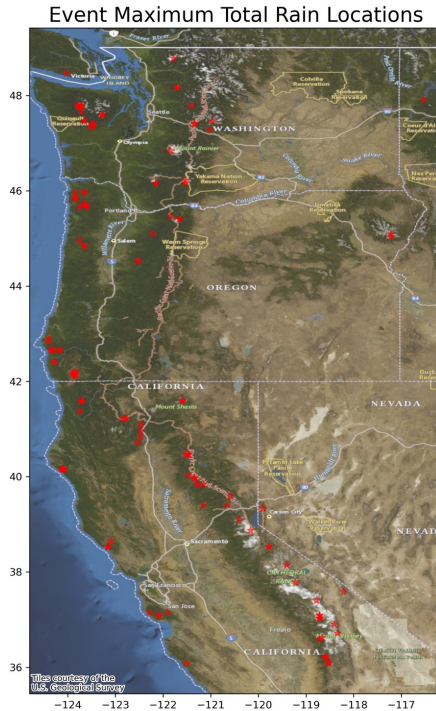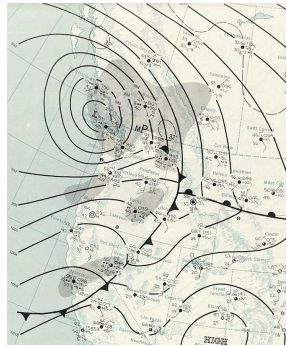⭐ Using Numerical Modeling → refine HMR 57's storm shifting/moisture maximization relationships

⭐ Evaluate Climate Change Impacts on PMP

Evaluate Uncertainty

CHANGE IN PRECIPITATION BY END OF 21st CENTURY
inches of liquid water per year

as projected by NOAA/GFDL CM2.1

⭐ *Provide PMP estimates for Oregon* ⭐

⭐ = Receive feedback from External Review Board

Phase 2: Developing PMP Started October 2023

- Task 1: Develop a database of extreme storms and climatologies

- Task 2: Develop AR-based PMP

- Task 3: Guidance for the generation of PMF

- Task 4: External Review Board

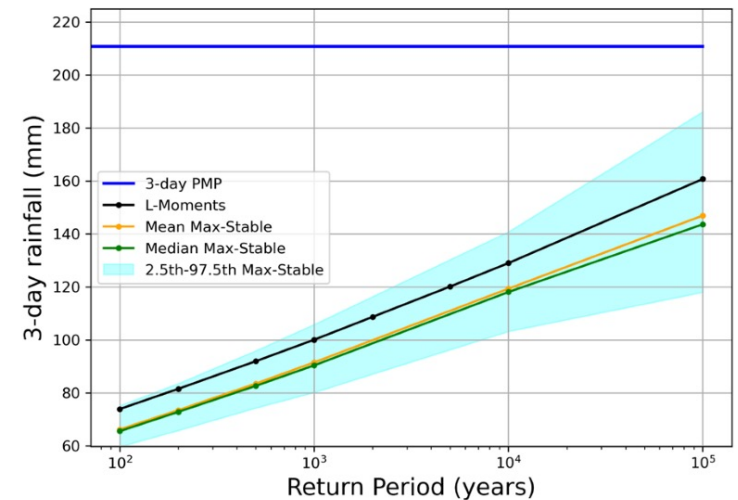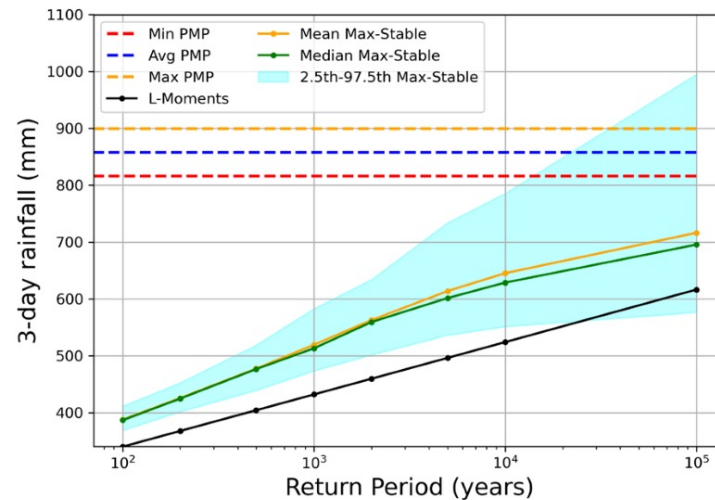- Task 5: Coordination with Precipitation Frequency Analysis team
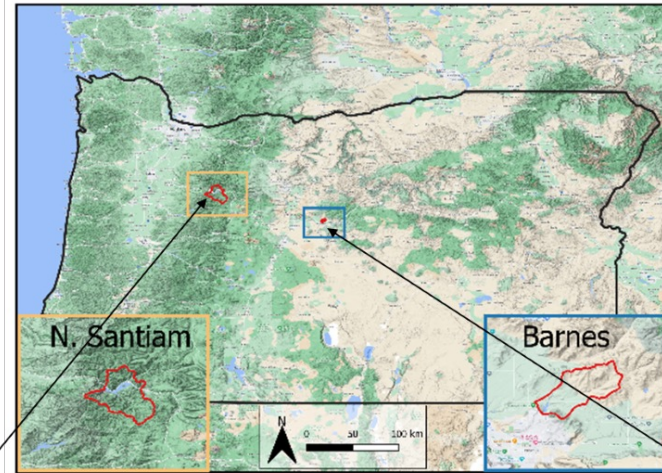
Concurrent Study: Updating Precipitation Frequency Estimates in Oregon

FEMA

Concurrent Study: Updating Precipitation Frequency Estimates

- Update Precipitation Frequency Estimates using Max-stable method

- Web tool with precipitation frequency estimates and PMP

NOAA: under BIL and PRECIP Act
Modernizing PMP estimation

- October 2022 - October 2024 National Academies Study, NOAA prototyping research

- 2024 - 2026 NOAA responds to, implements study recommendations

- **By 2030:** New PMP estimates produced, publicly available

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