

# Probable Maximum Precipitation (PMP): A Brief Summary of Hydrometeorological Reports (HMRs) and Recent Improvement Procedures

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# Probable Maximum Precipitation (PMP)

What is PMP?

HMR PMP values

Recent improvements

# Probable Maximum Precipitation

## Definition:

The **theoretically** greatest depth of precipitation for a given duration that is **physically possible** over a given storm area at a particular **geographic location** at a certain time of year (HMR 59, 1999)

# Probable Maximum Precipitation

- **Concept of Probable Maximum Precipitation (PMP)**
- **Definition**
  - i. **Theoretical values**
  - ii. **Maximum depth of precipitation**
  - iii. **Physically possible**
  - iv. **Geographic region**
  - v. **Certain time of year**
- **Summary of Hydrometeorological Reports (HMRs)**
- **Improved Procedures**

# Probable Maximum Precipitation

- **Definition:**

The *theoretically* greatest depth of precipitation for a given duration that is physically possible over a given storm area at a particular geographic location at a certain time of year (HMR 59, 1999)

# Probable Maximum Precipitation

- **Theoretically**

- No technology exists to compute theoretical maximum precipitation values
- Historic storms are used as the basis for computing maximum rainfall values
- Procedures are used to adjust the observed rainfall from historic large rainfall events to determine the “theoretical” maximum rainfall
- Meteorological computer models are providing useful tools for evaluating orographic effects
  - = Spatial distribution are provided
  - = Not useful for determining upper limit magnitudes

# Probable Maximum Precipitation

- **Definition:**

The theoretically greatest depth of precipitation for a given duration that is *physically possible* over a given storm area at a particular geographic location at a certain time of year (HMR 59, 1999)

# Probable Maximum Precipitation

## *physically possible*

- The PMP design storm must have characteristics that can combine naturally to produce an extreme rainfall storm
- Many worst case storm characteristics cannot co-occur within an extreme rainfall storm
- Some historic PMP analyses have inappropriately combined worst case storm characteristics

# Probable Maximum Precipitation

- **Definition:**

The theoretically greatest depth of precipitation for a given duration that is physically possible over a given storm area at *a particular geographic location* at a certain time of year (HMR 59, 1999)

# Probable Maximum Precipitation HMR 51

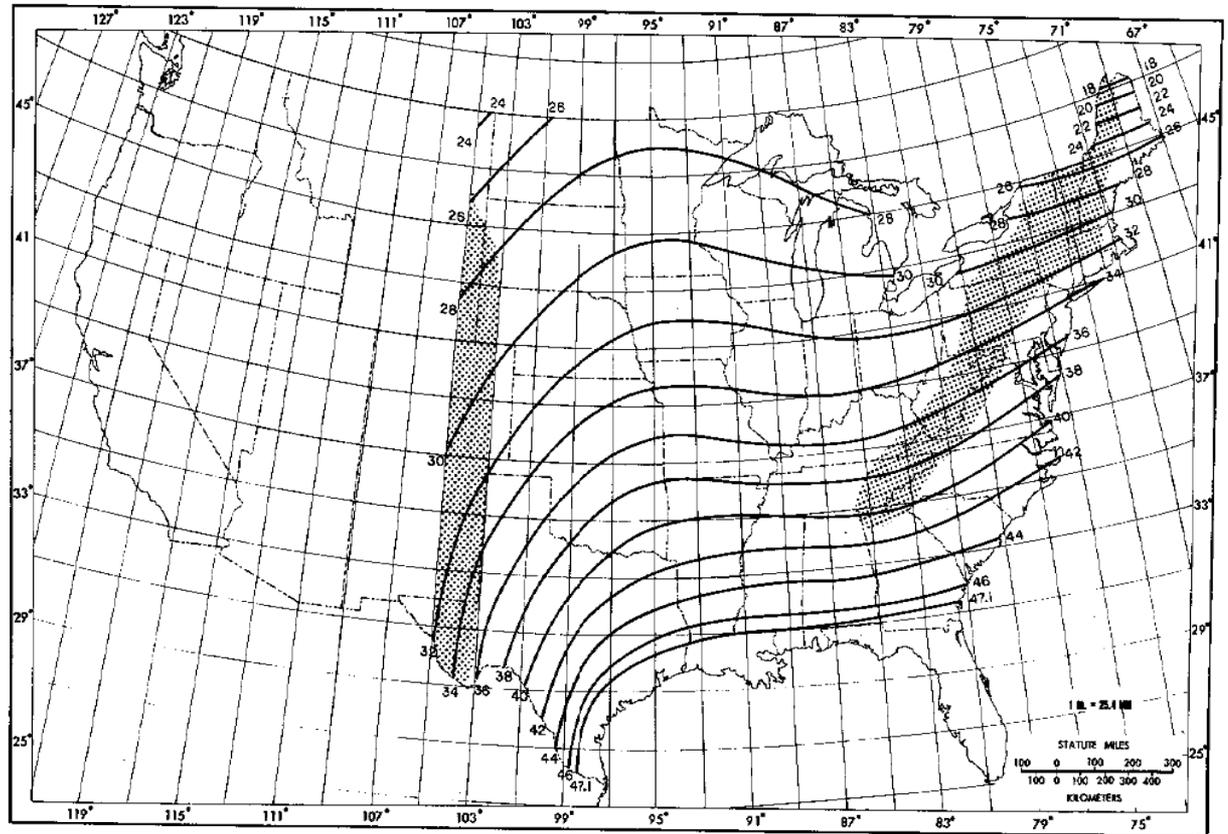


Figure 20.--All-season EMP (in.) for 24 hr 10 mi<sup>2</sup> (26 km<sup>2</sup>).

# Probable Maximum Precipitation

- **Theoretical values**
- **Evolution of PMP determination procedures**
- **Differences in procedures used in current HMRs**

**HMR 49**

**HMR 51**

**HMR 55A**

**HMR 57**

**HMR 59**

# **HMR 49**

## **Southwest U.S.**

- **Oldest of the current HMRs**
- **Methods no longer used in any of the other HMR**
  - **Orographic methods not used in subsequent HMRs**
  - **No storm Depth-Area-Duration analyses**
    - **Ratios are used from point rainfall amounts**
    - **area sizes**
    - **durations**
  - **Very little actual storm data analyzed**

# HMR 51

## Eastern 2/3 of the U.S.

- **No orographic procedures used**
  - stippled regions
- **Maximum dew point climatology not representative of moisture feeding storms**
- **Implicit influence of storms throughout large areas of domain not appropriate**
  - Smethport, PA
- **Improper storm analyses**
  - Smethport (1942), Yankeetown (1950), Alta Pass (1916)
- **Storm database outdated**
  - Newest general storm: Hurricane Agnes 1972
  - New Midwest thunderstorm complex: Ritter, Iowa 1953

# Probable Maximum Precipitation HMR 51

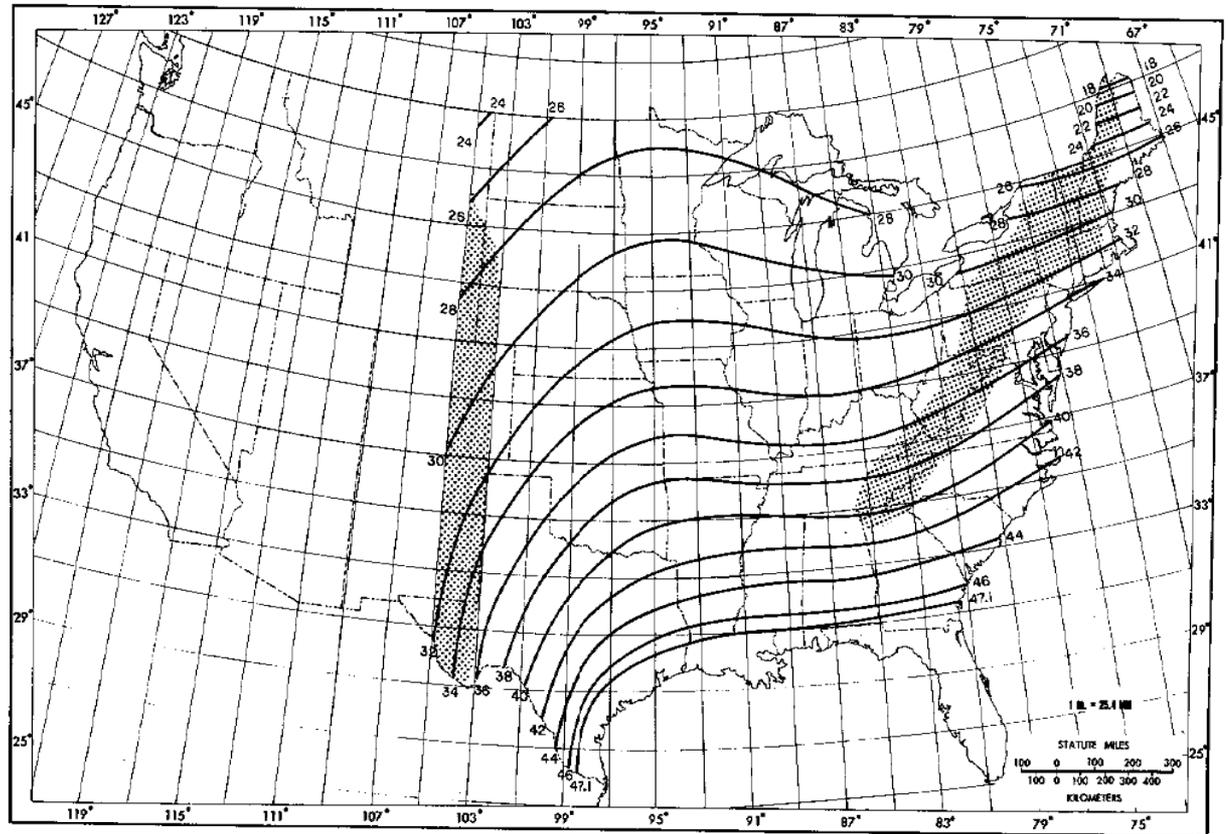


Figure 20.--All-season PMP (in.) for 24 hr 10 mi<sup>2</sup> (26 km<sup>2</sup>).

# **HMR 55A**

## **Continental Divide East to the Midwest Plains**

- **Storm Separation Method (SSM) introduced**
  - **“Highly complex involving a number of subjective decisions”**
  - **Use of actual storm rainfall analysis data is not clear**

# **HMR 57**

## **Northwest U.S.**

- **No working papers are available**
- **Storm Separation Method used**
  - **Unclear how storm rainfall spatial and temporal data were used**
- **Sea Surface Temperatures used to determine maximization and transposition factors**
- **Many storm maximization factors can not be replicated, numerous errors/inconsistencies**

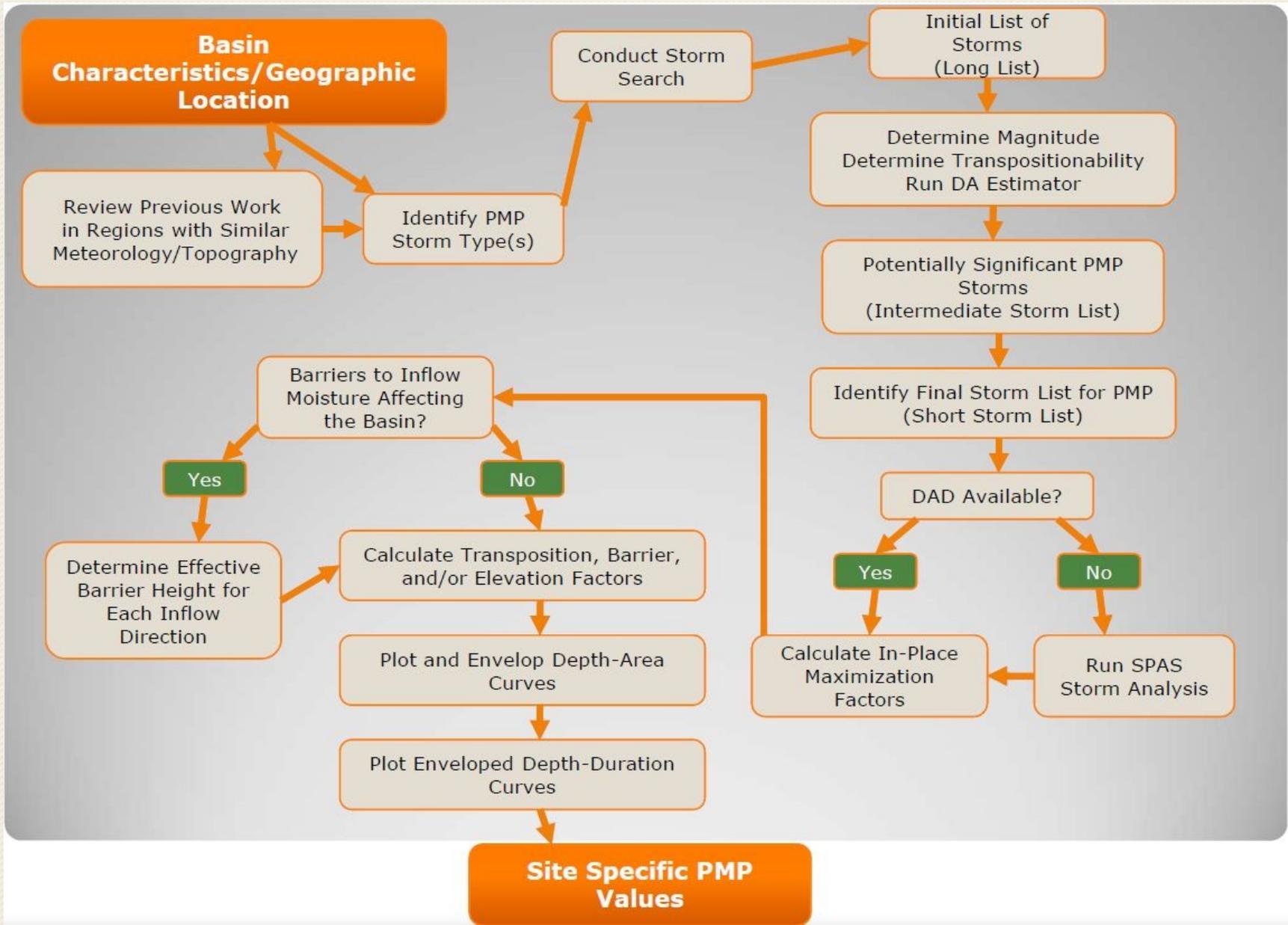
# **HMR 59**

## **California**

- **No working papers are available**
- **Storm Separation Method used**
- **Use of storm rainfall data to derive PMP values is not presented**
- **Results cannot be reproduced**
- **Many errors/inconsistencies in storm maximization/transposition values found**

# Method for Computing PMP Values

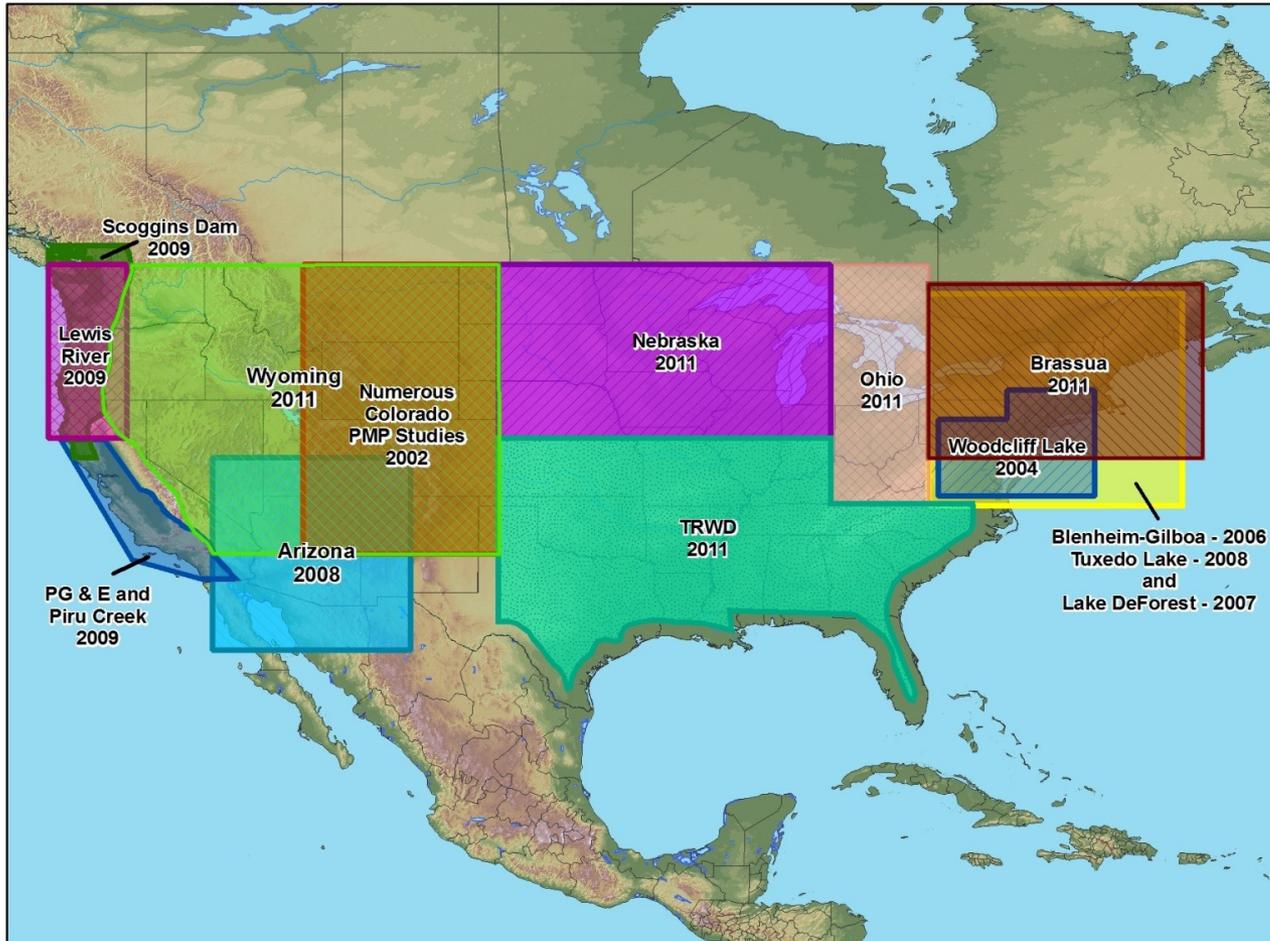
- No physically based theoretical method (yet)
- Observed extreme rainfall events are used
- Standard procedures are applied to the storm rainfall
- Primary steps
  - Storm Search
  - Identification of most significant storms
  - Maximization procedures are applied
  - Transpositioning procedures are applied
  - Enveloping procedures are applied



# Updated Storm Search Locations

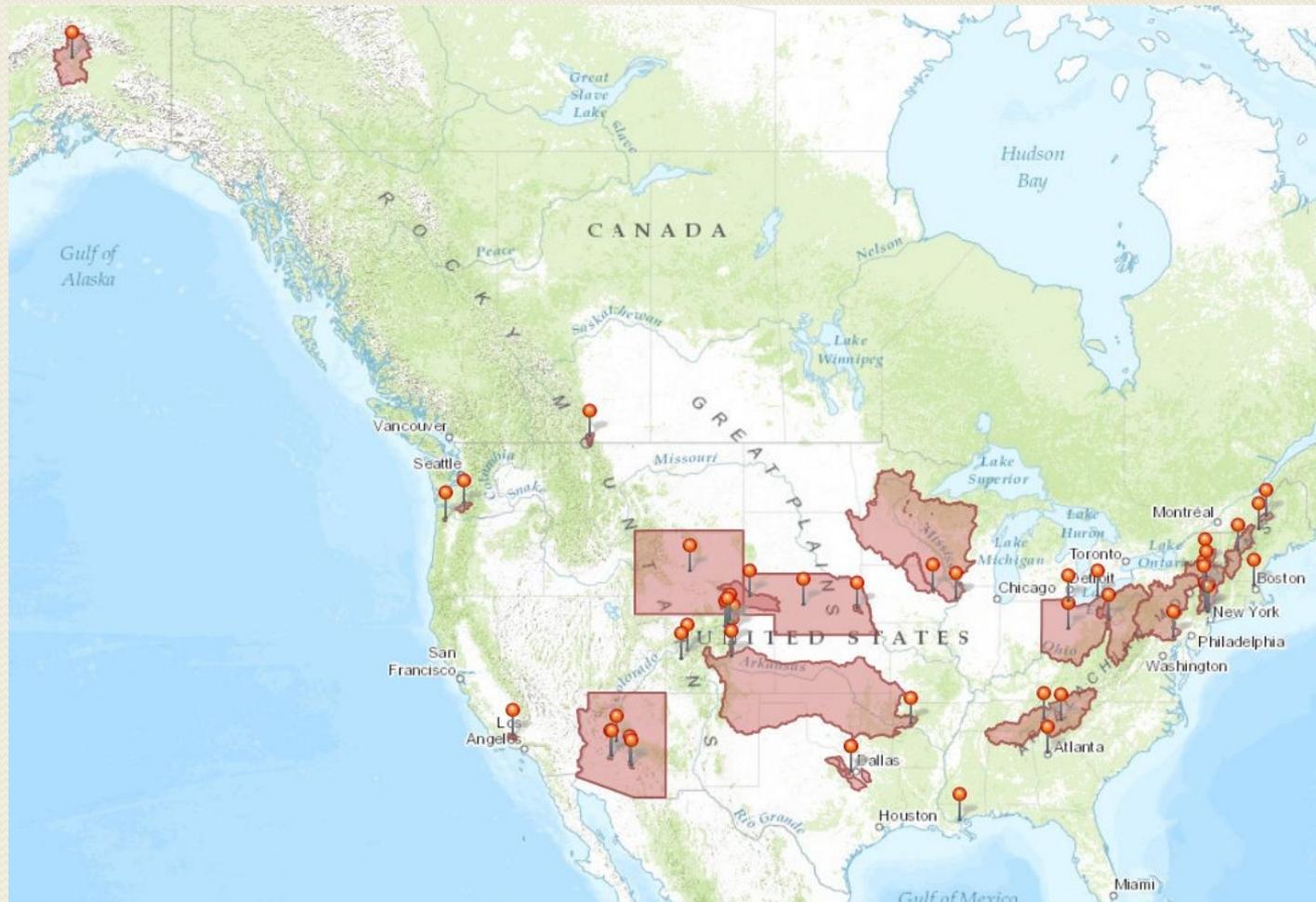
## Current through 2013

Storm Search Domains

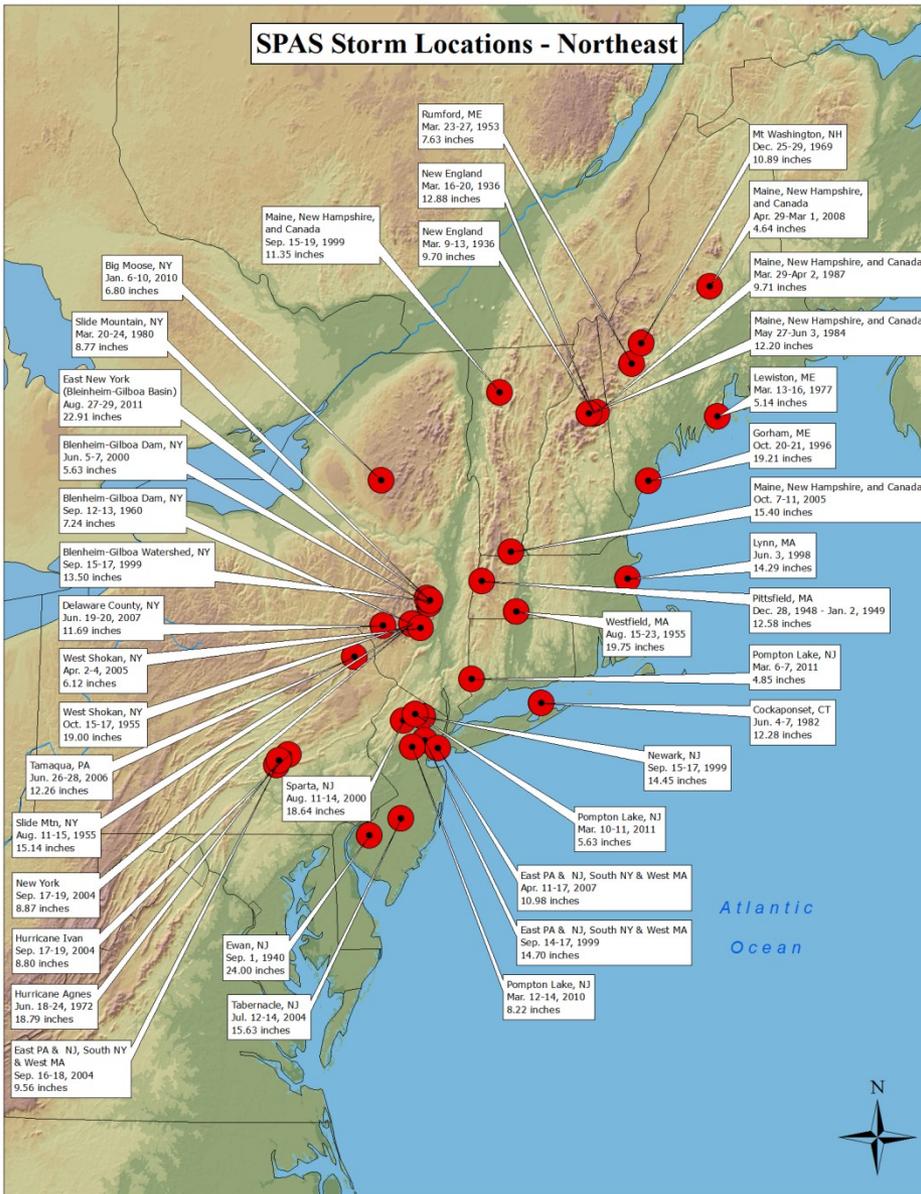


# Updated Storm Search Locations

## Current through 2013



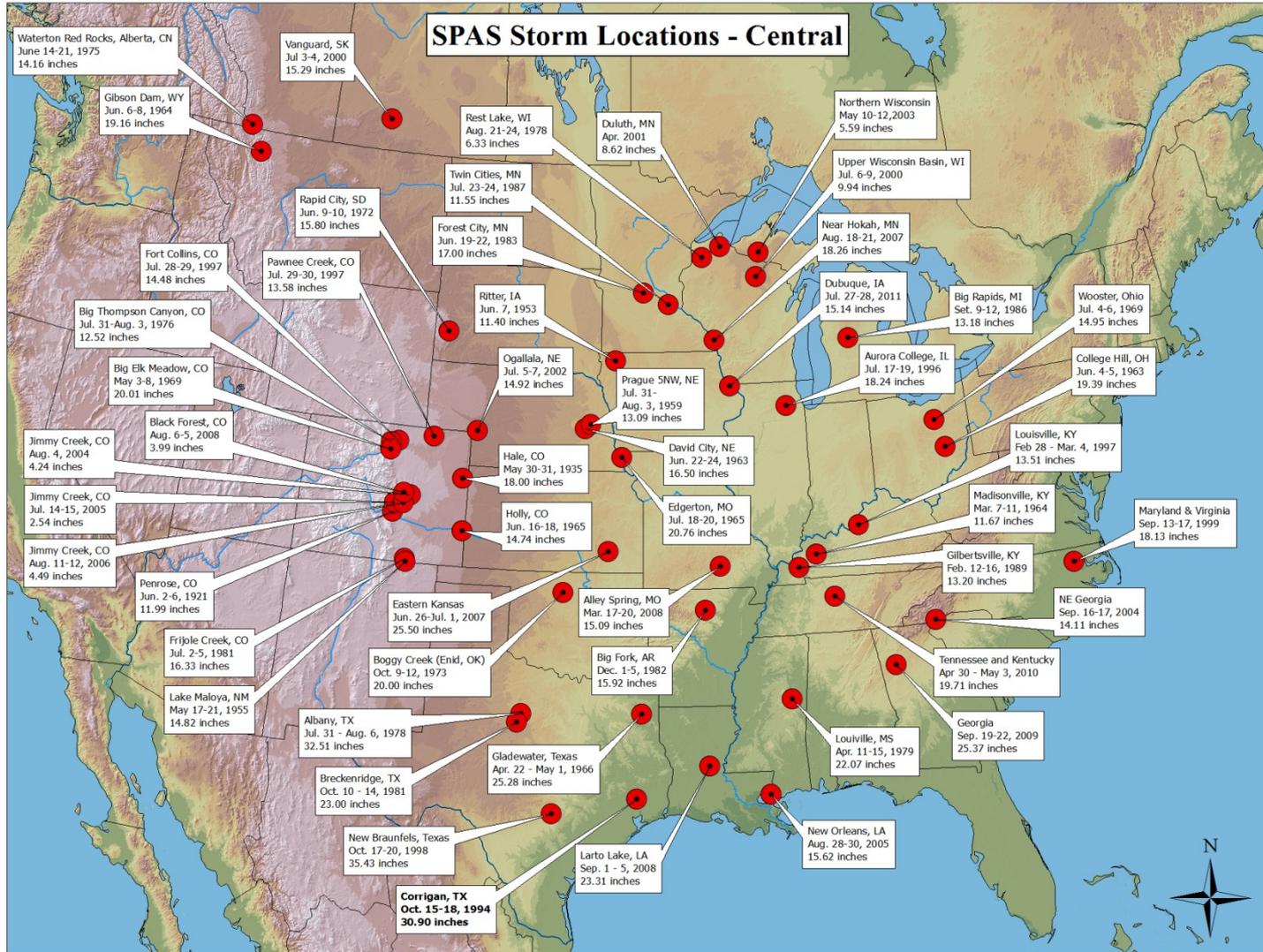
## SPAS Storm Locations - Northeast



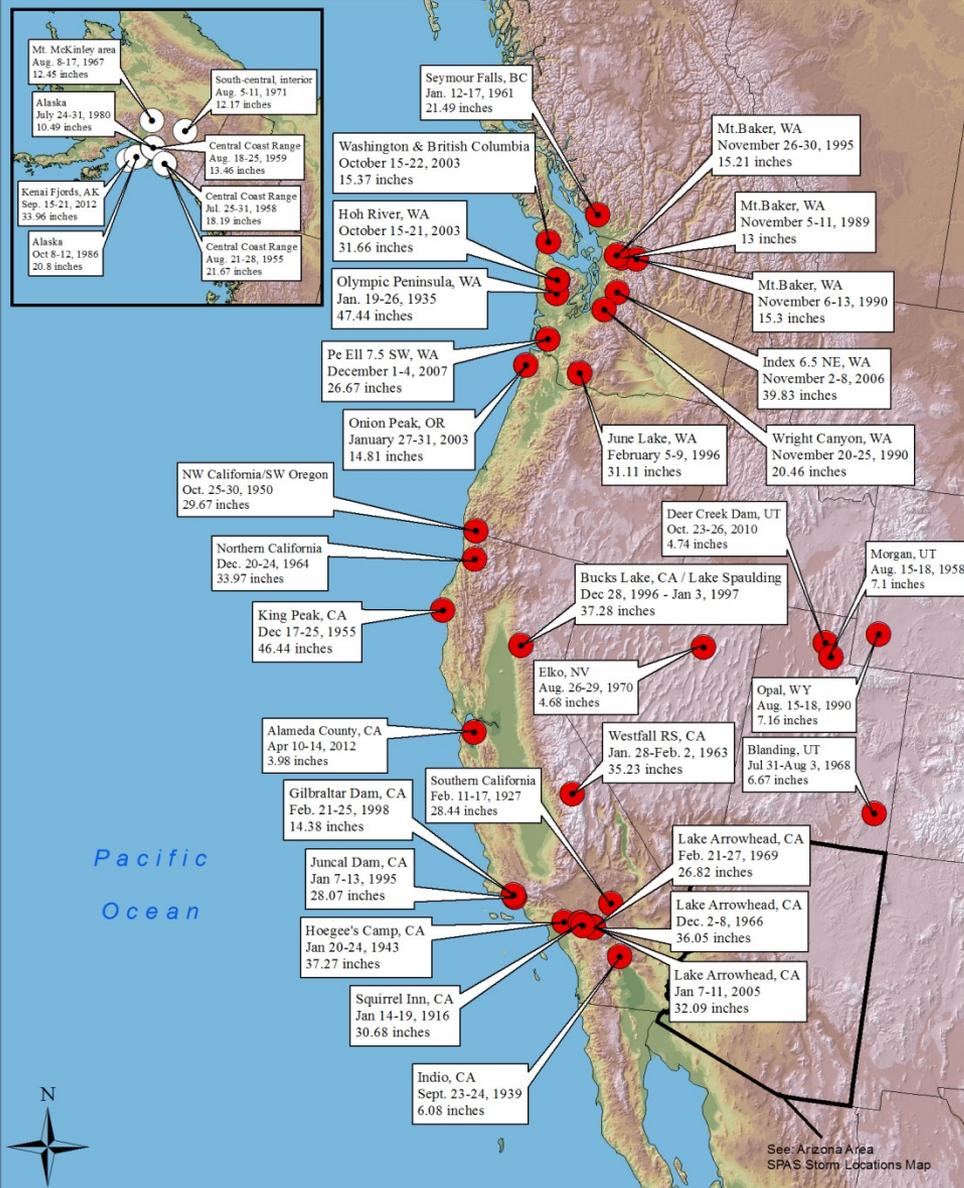
# New Storms Analyzed for PMP Development



# New Storms Analyzed for PMP Development



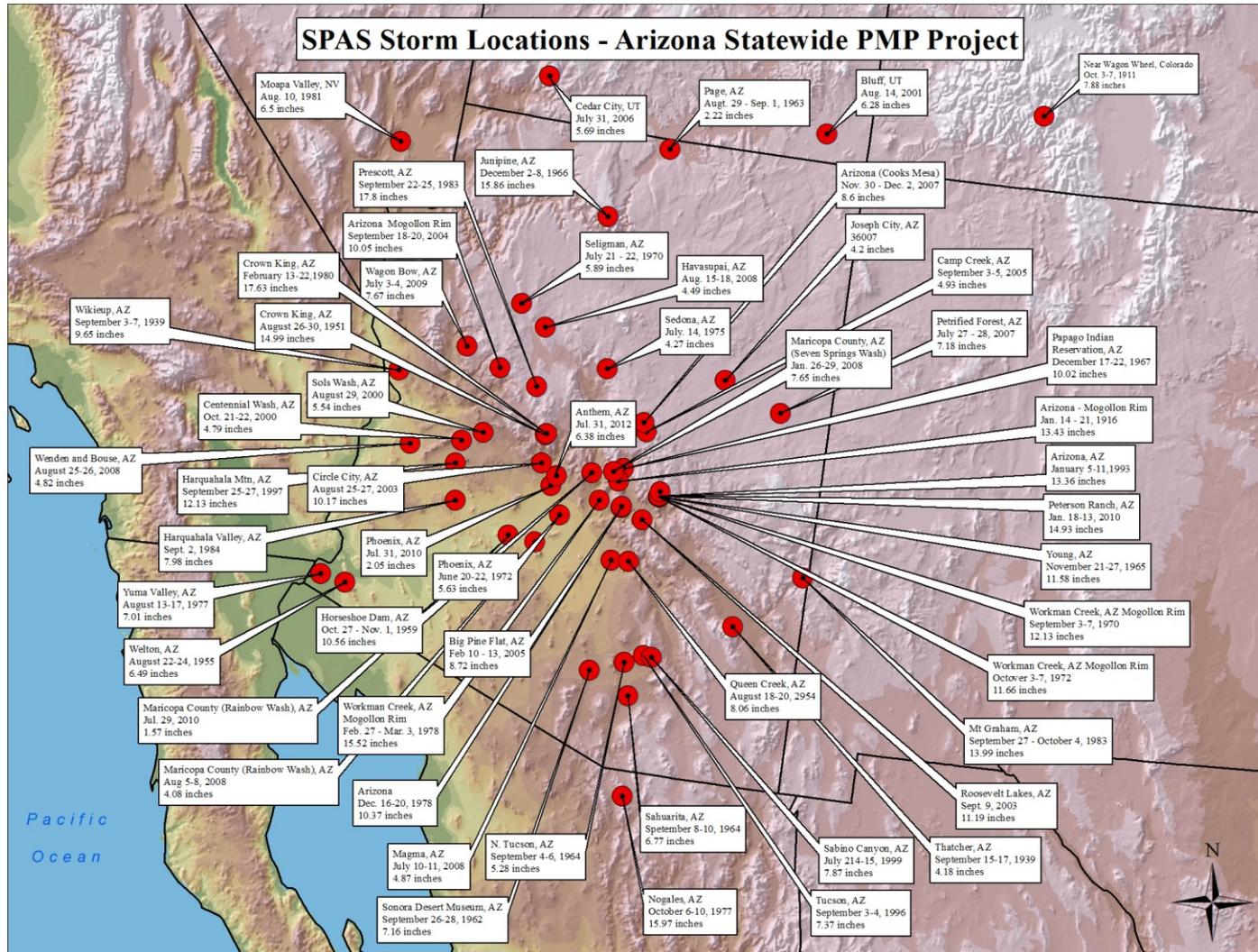
## SPAS Storm Locations - West of Continental Divide



# New Storms Analyzed for PMP Development

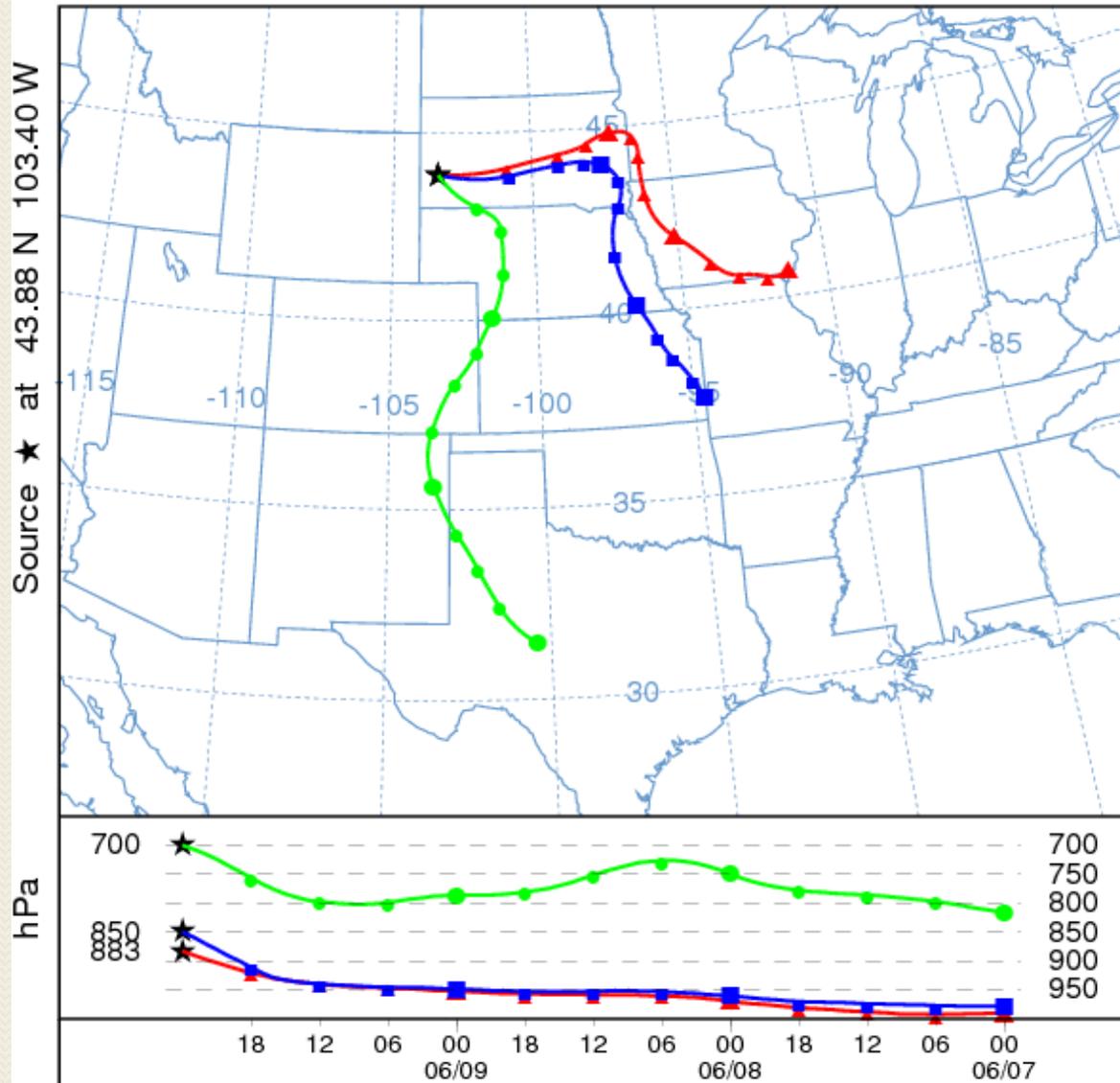


# New Storms Analyzed for PMP Development



# Use of a trajectory model

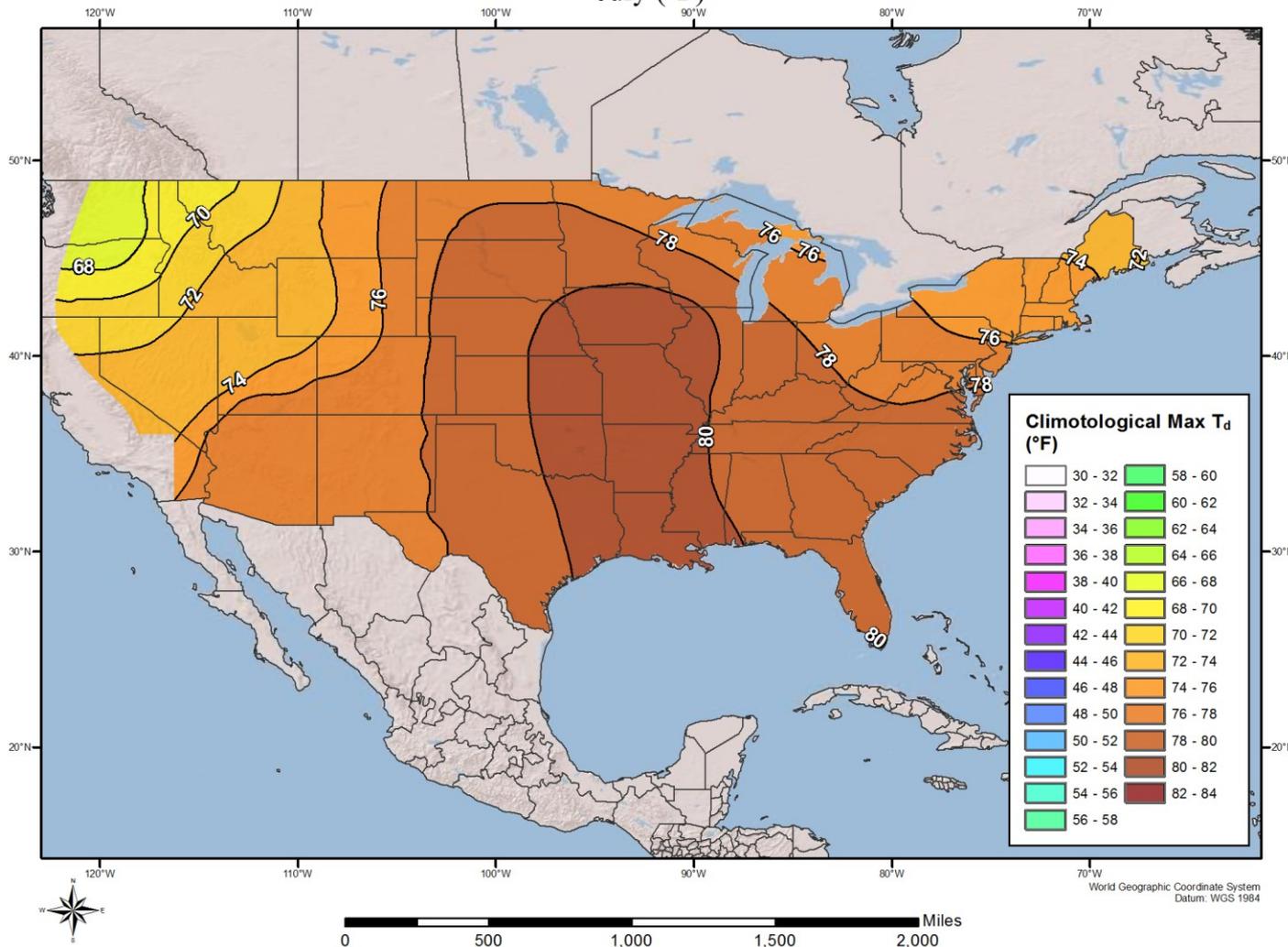
NOAA HYSPLIT MODEL  
Backward trajectories ending at 0000 UTC 10 Jun 72  
CDC1 Meteorological Data



This is not a NOAA product. It was produced by a web user.  
Job ID: 393867 Job Start: Mon Oct 1 20:34:21 UTC 2012  
Source 1 lat.: 43.88 lon.: -103.40 hgts: 0, 335, 1970 m AGL  
Trajectory Direction: Backward Duration: 72 hrs  
Vertical Motion Calculation Method: Model Vertical Velocity  
Meteorology: 0000Z 01 Jun 2072 - reanalysis

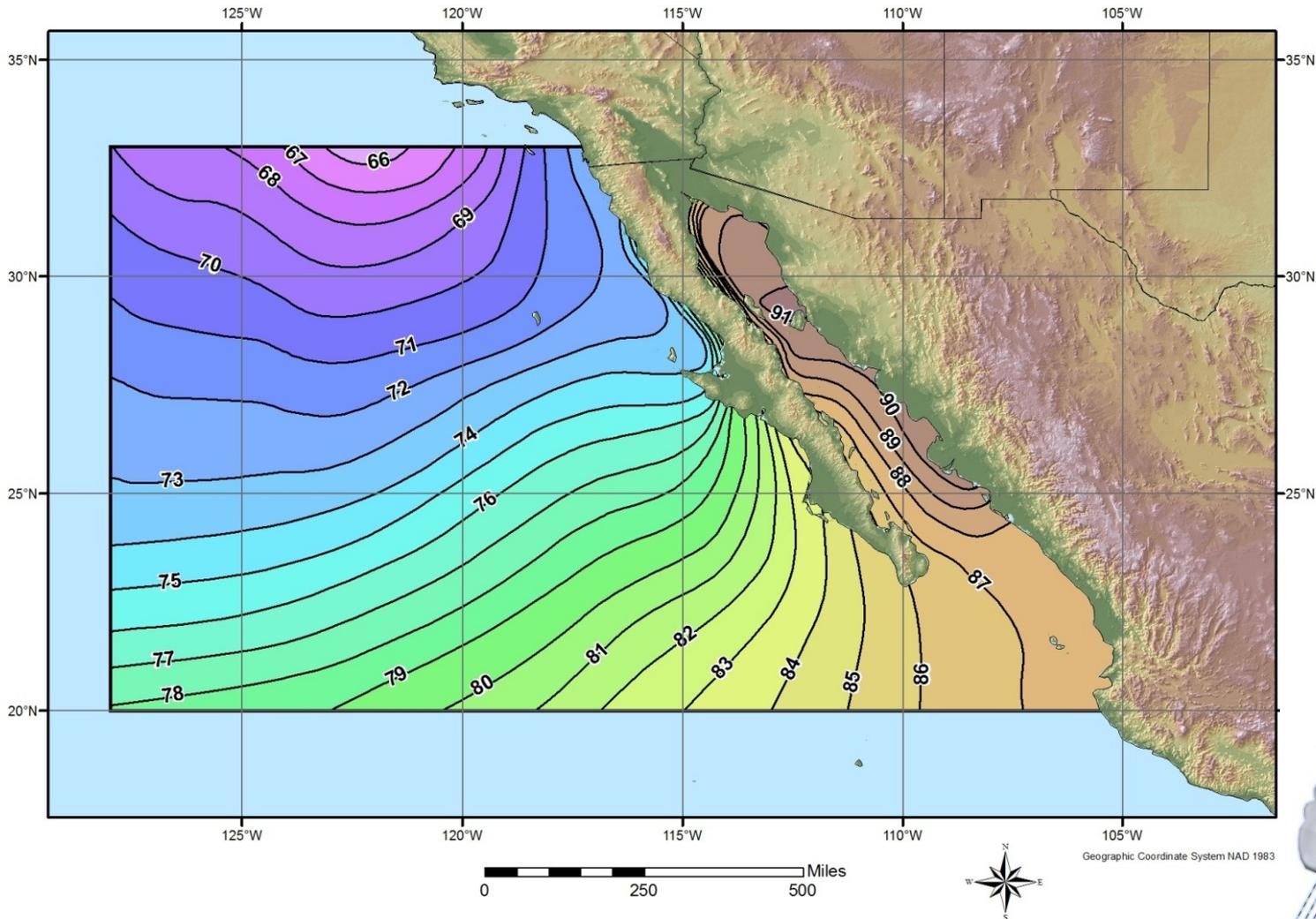
# Updated Maximum Dew Point Climatology Map

24-hour Monthly Dew Point Climatology  
July (°F)



# Updated 2 Sigma SST Map

August 2 Sigma SST °F

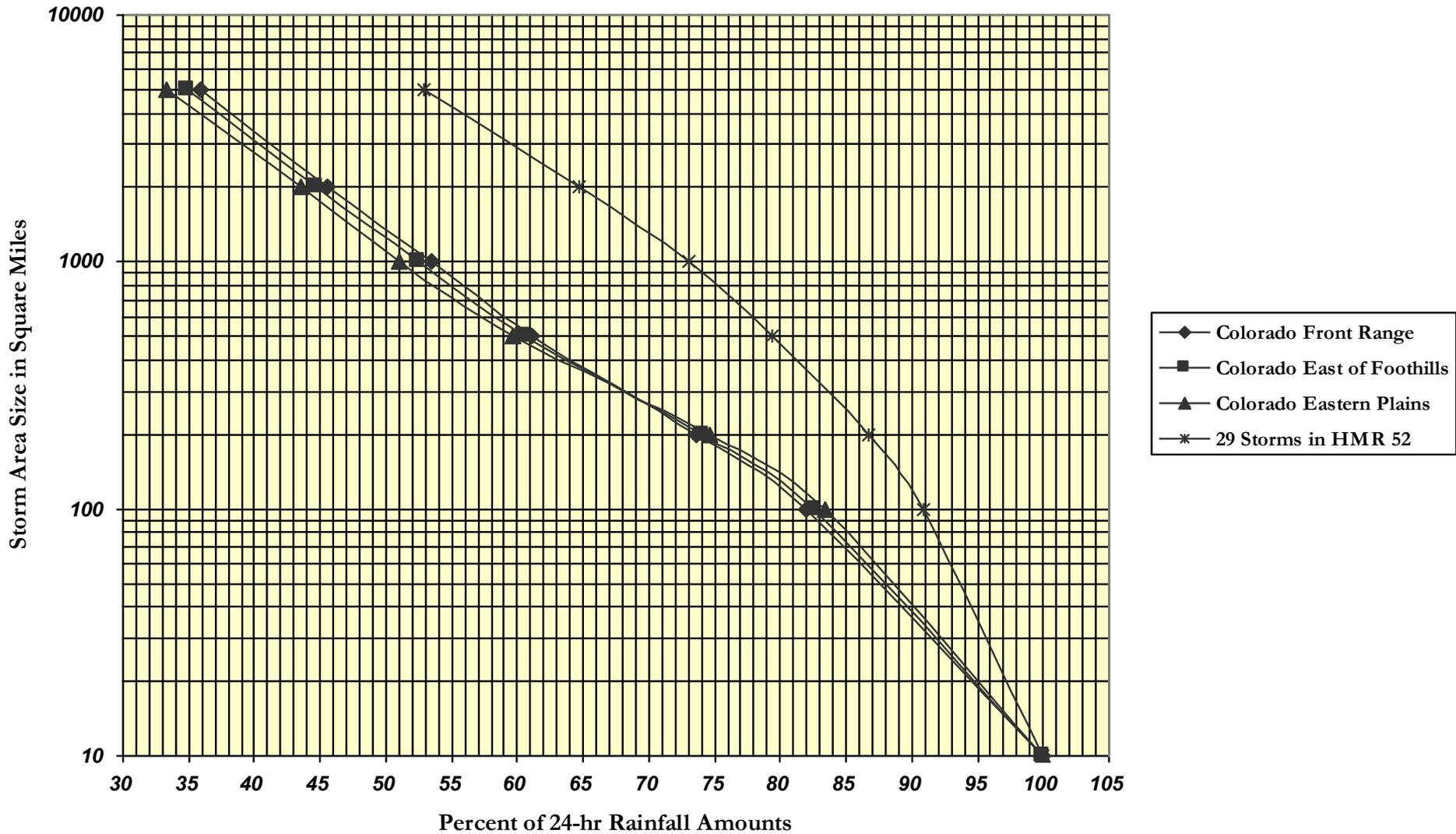


# Method for Computing PMP Values

## Transpositioning

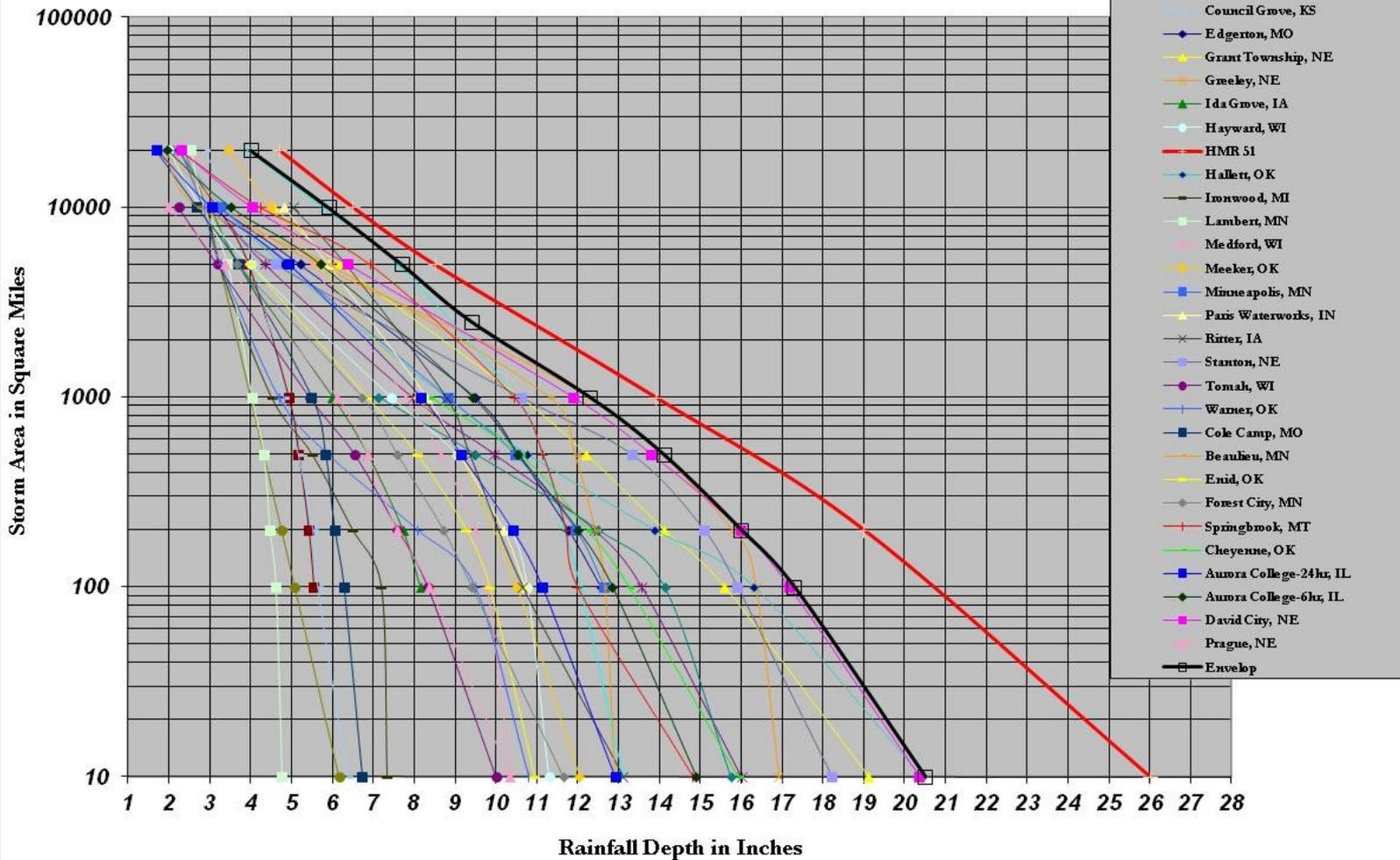
- The largest storms over a region are identified
  - The transposition region contains storm that are similar
    - Meteorologically
    - Climatologically
    - Topographically
  - The rainfall from each storm is adjusted to other parts of the region
    - The adjustment is the **transpositioning factor**

# Comparison of Within / Without Storm Average Curves for Different Study Regions 10 Square Mile Areas



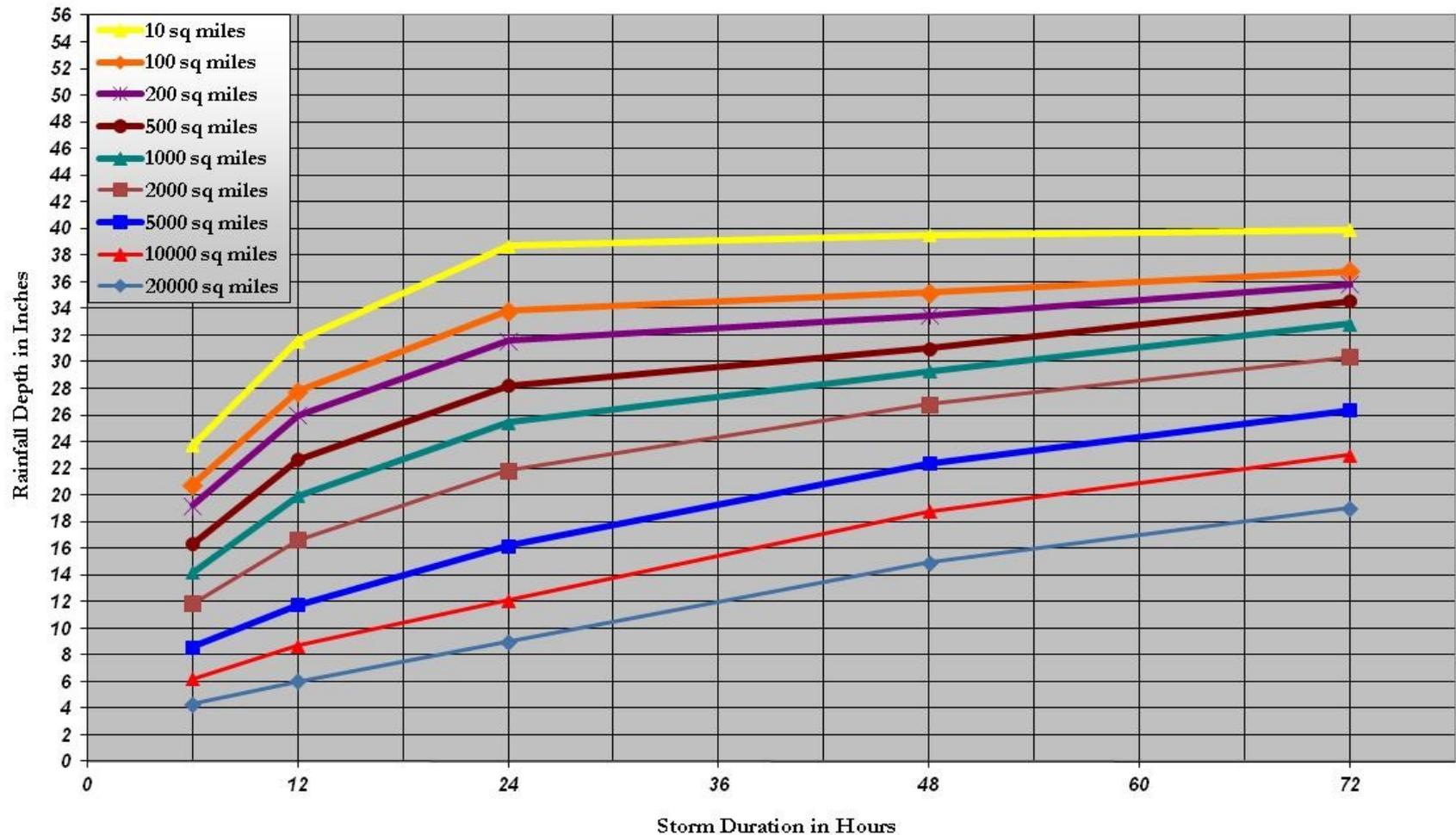
# Area Enveloping

Six-Hour Depth-Area Curves for Maximized and Transpositioned Storm Events In the Lake Wanhoo Drainage Basin



# Duration Enveloping

Depth-Duration Chart of Enveloped Storm Data for the Cedar Creek Drainage Basin



# Probable Maximum Precipitation

- **Generalized PMP values (HMRs)**
- **Site-Specific PMP values**
  - **Regional**
  - **Statewide**
  - **Individual basins**



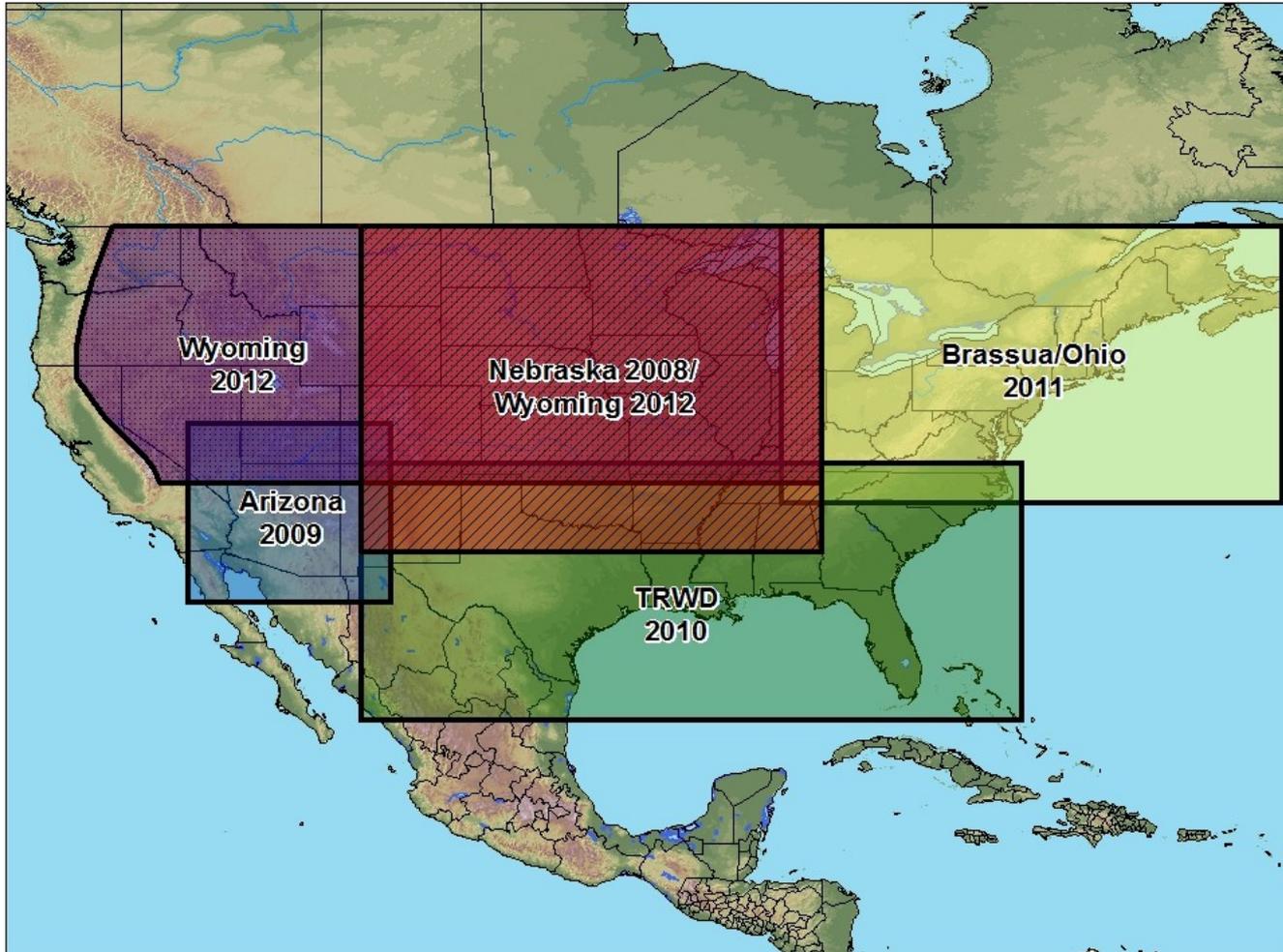
# Examples of Site-Specific PMP Study Findings

- **Maximum Dew Point Temperature Climatology**
  - **Published 1968 NOAA Climatology**
    - **Combination of several analyses**
    - **Not well documented**
    - **Represented maximum observed values**
  - **New climatology can be produced**
    - **Long period of record of quality controlled data**
    - **Return frequencies can be computed**
    - **Climatologies of persisting and average values can be provided**



# Updated Dew Point Climatologies

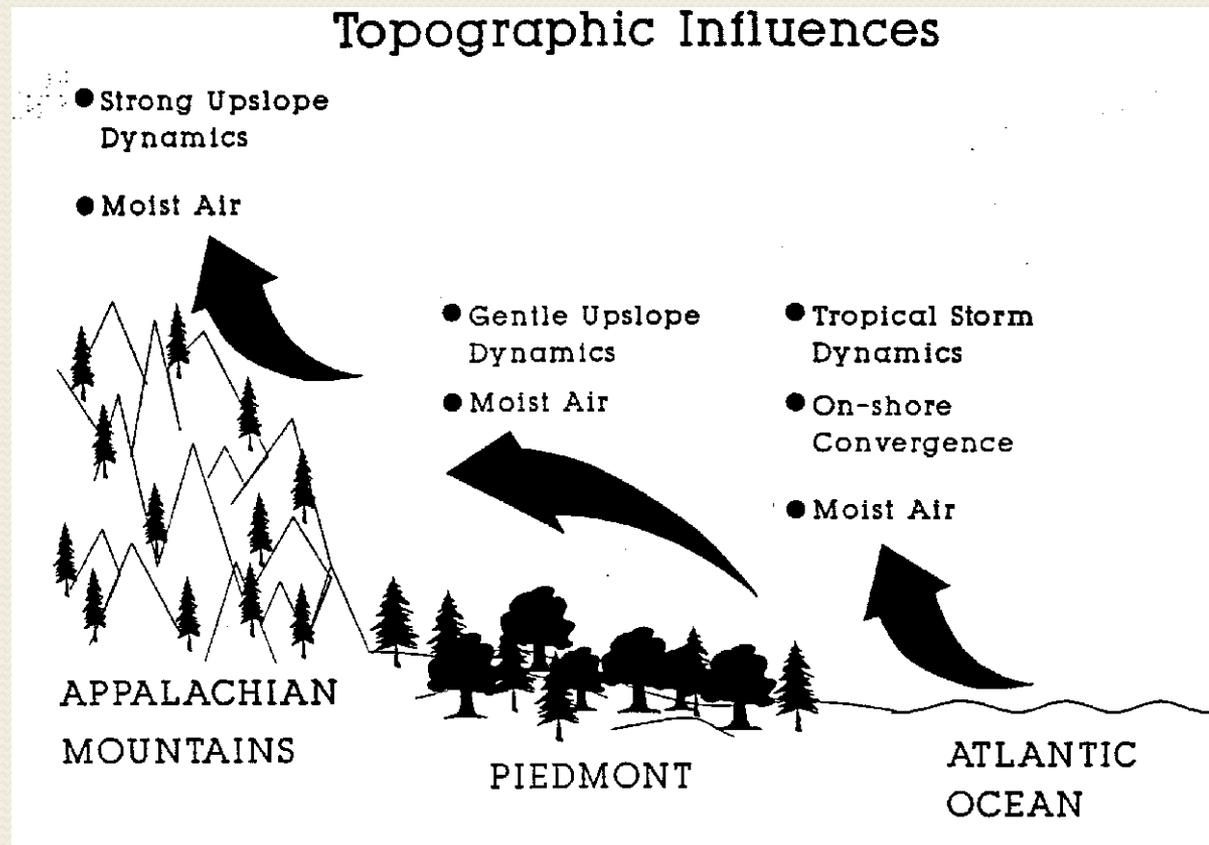
Dewpoint Climatology Domains



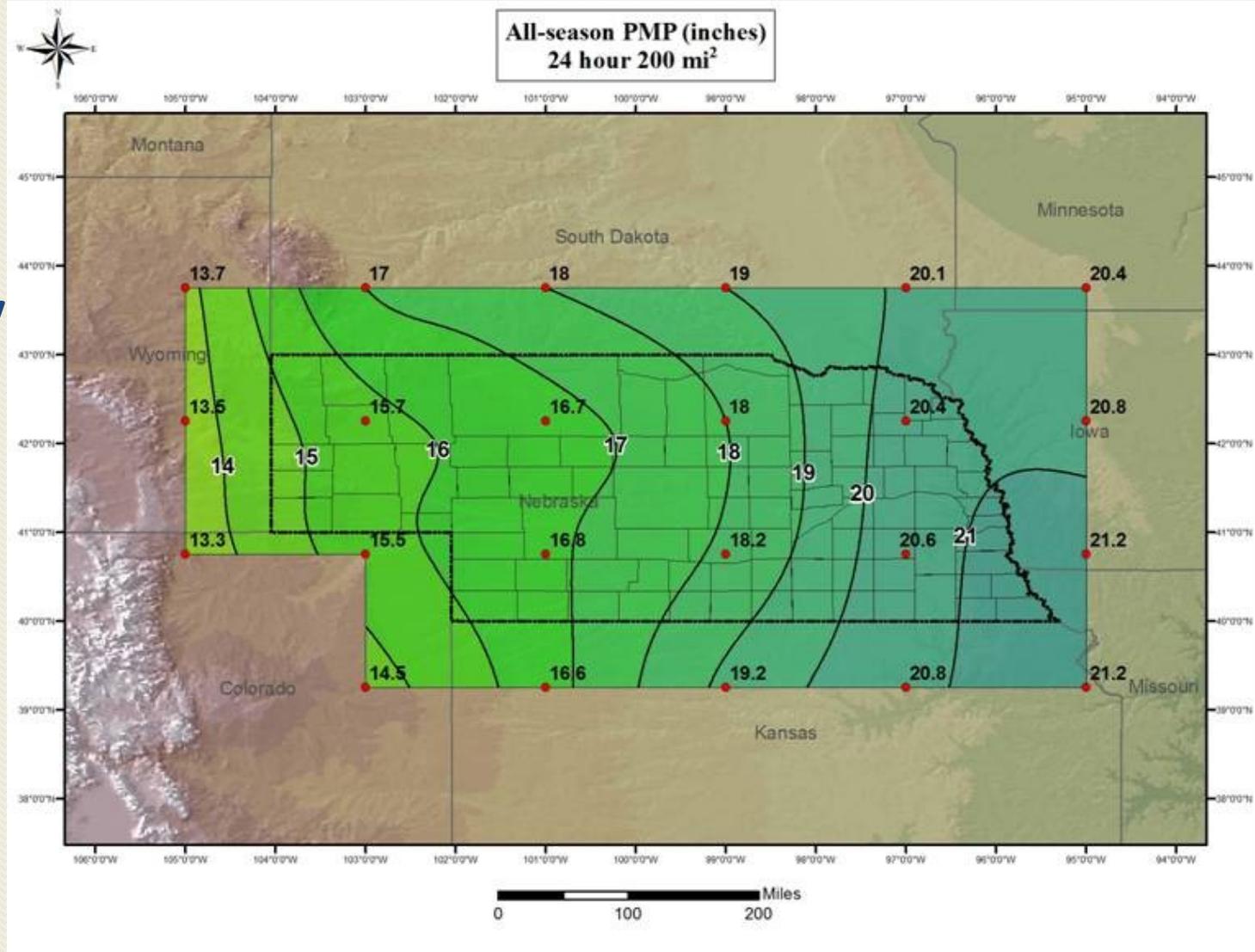
# Examples of Site-Specific PMP Study Findings

- Homogeneous Climate Regions

- Select storms
  - For each region
- Transposition
- Maximize
- Envelop

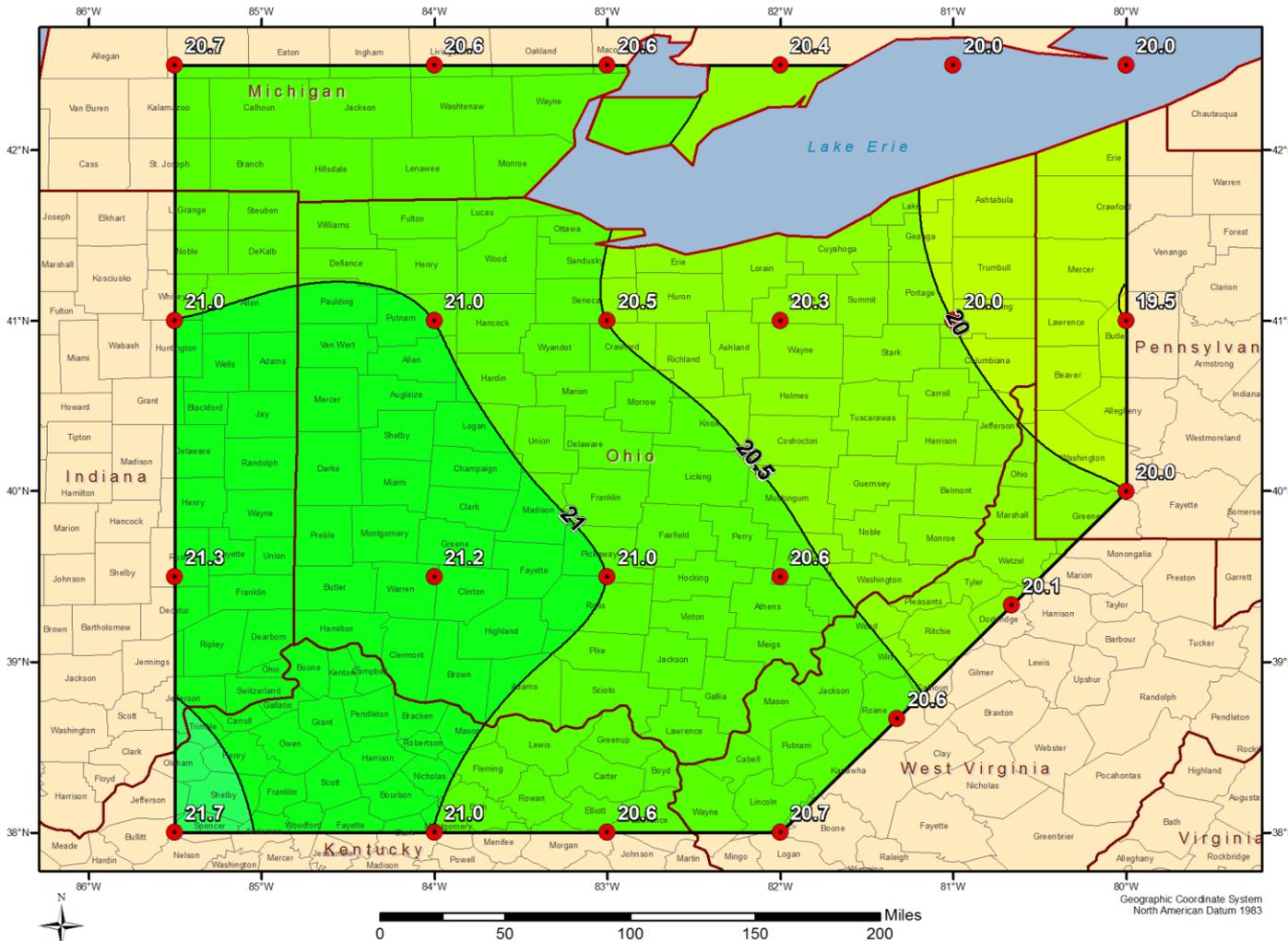


# Statewide PMP Study Results vs HMR 51

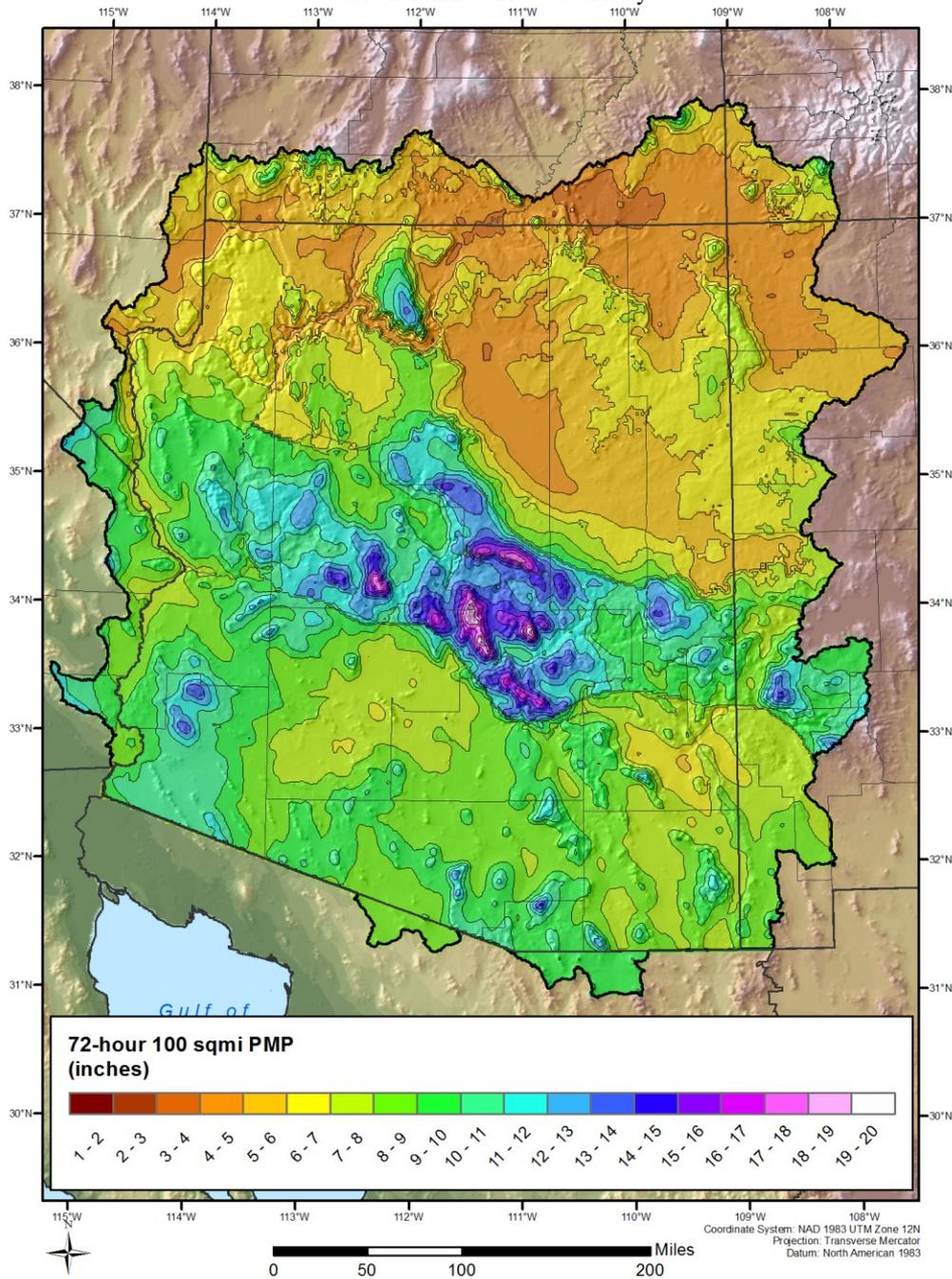


# Recently Completed PMP Studies

All-Season PMP - 24-hour 100 mi<sup>2</sup> (inches)  
Ohio Statewide PMP Study



# Preliminary General Winter Storm 72-hour 100 mi<sup>2</sup> PMP Arizona Statewide PMP Study



# Recently Completed PMP Studies



