Essential Parameters that Improve Lightning Forecasting Skills across the West

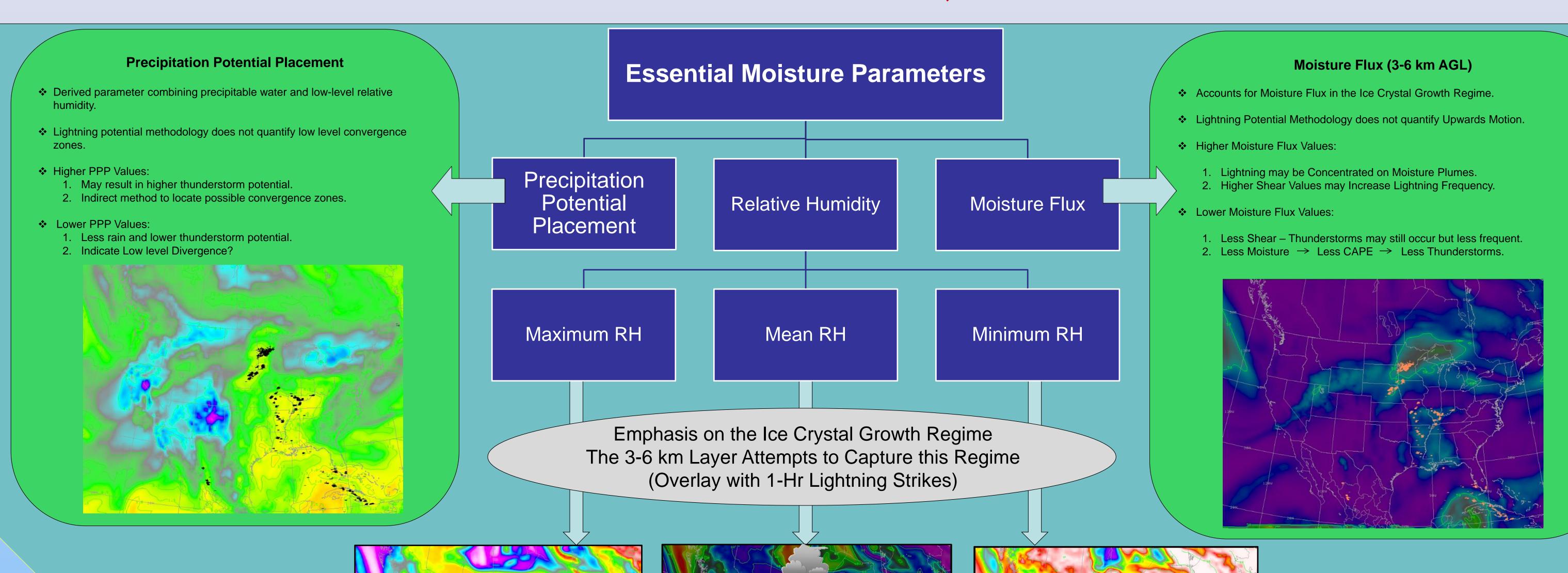Paul Frisbie, Jeff Colton, and Michael Meyers
NOAA/NWS Grand Junction, Colorado

Challenges in the West

Thunderstorm Initiation Typically Occurs over Higher Terrain during the daytime. The Forecast Challenge is How Storms Evolve Afterwards.

1. Do Storms Move Off the High Terrain and Impact Populated Valley Centers, Airports, or prescribed burns or wildfires?

2. Do the Storms Die with the Sunset, or do they Persist well into the Night?

3. Many Popular Recreation Areas Exist in the Mountain Regions, often in areas where cell phone coverage is poor or nonexistent.

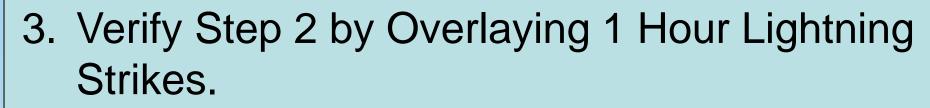4. Mountains Block the Visual Dome. Recreationist May Not See a Developing Storm behind a Mountain.

How the Lightning Potential has Evolved

1. Simple Concept – Combine CAPE with high RH in the Ice Crystal Growth Regime.

2. Use Model data and Parameters in AWIPS to Create Lightning Potential "Algorithm.

3. Verify Step 2 by Overlaying 1 Hour Lightning Strikes.

4. Observe for 1-3 Months Whether New "Algorithm" Improves Results.

5. Refine "Algorithm" to Improve the Lightning Potential "Algorithm"; Repeat Step 3.

6. 3-4 Years of Qualitative Observations to Derive Lightning Potential "Algorithm".

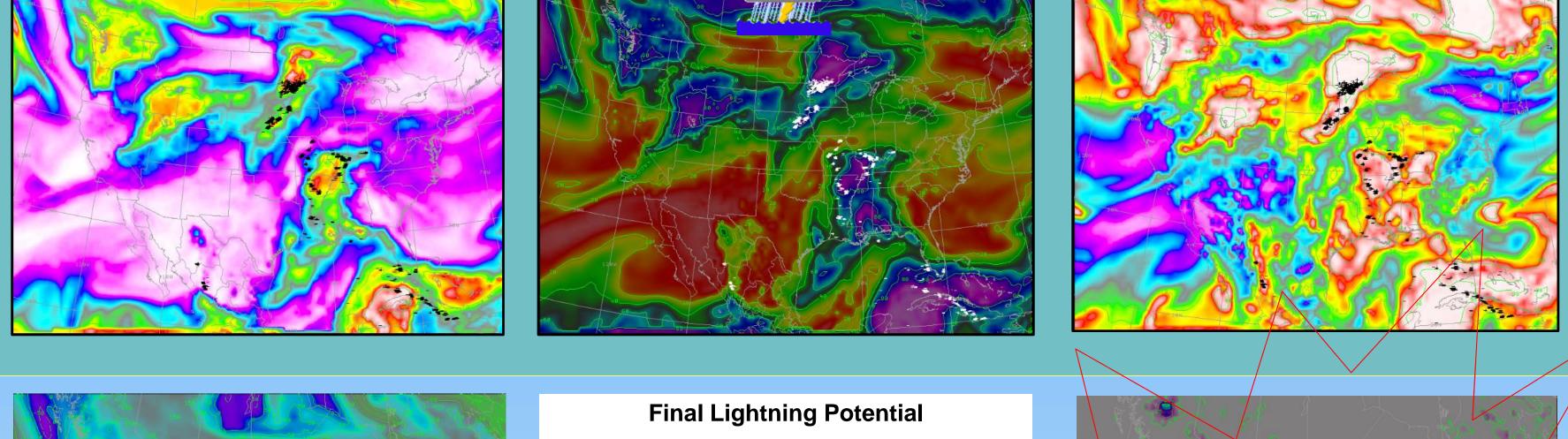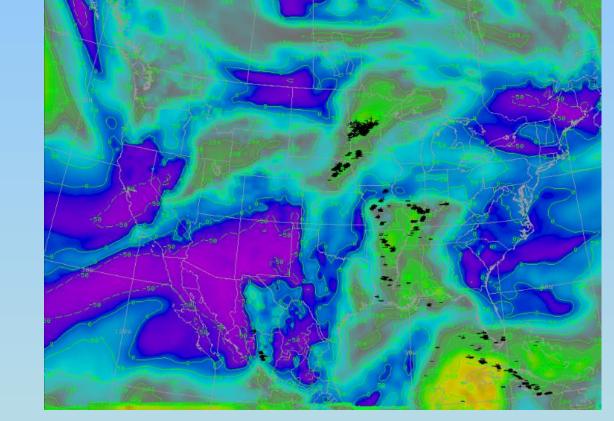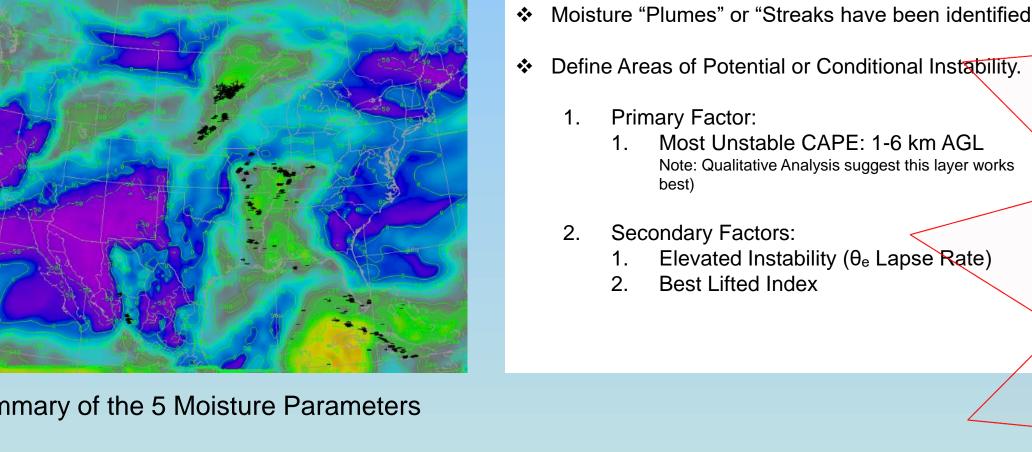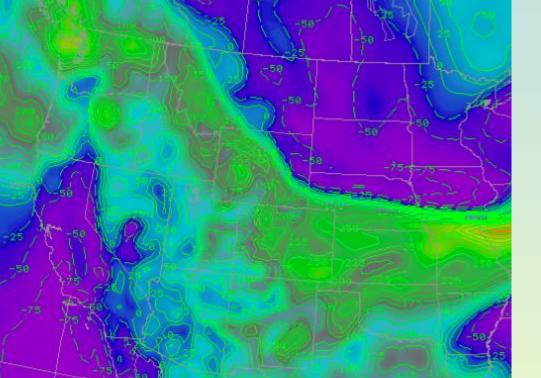7. "Algorithm" Translated to a Python-Based GFE Smart Tool.

8. Display Results and Make Available to our Customers in a Color Coded Format.

Precipitation Potential Placement

❖ Derived parameter combining precipitable water and low-level relative humidity.

❖ Lightning potential methodology does not quantify low level convergence zones.

❖ Higher PPP Values:
  1. May result in higher thunderstorm potential.
  2. Indirect method to locate possible convergence zones.

❖ Lower PPP Values:
  1. Less rain and lower thunderstorm potential.
  2. Indicate Low level Divergence?

Essential Moisture Parameters

Precipitation Potential Placement

Relative Humidity

Moisture Flux

Maximum RH

Mean RH

Minimum RH

Emphasis on the Ice Crystal Growth Regime
The 3-6 km Layer Attempts to Capture this Regime
(Overlay with 1-Hr Lightning Strikes)

Moisture Flux (3-6 km AGL)

❖ Accounts for Moisture Flux in the Ice Crystal Growth Regime.

❖ Lightning Potential Methodology does not quantify Upwards Motion.

❖ Higher Moisture Flux Values:
  1. Lightning may be Concentrated on Moisture Plumes.
  2. Higher Shear Values may Increase Lightning Frequency.

❖ Lower Moisture Flux Values:
  1. Less Shear – Thunderstorms may still occur but less frequent.
  2. Less Moisture → Less CAPE → Less Thunderstorms.

U.S. Lightning Fatalities 2006-2014

2006 — 48
2007 — 45
2008 — 28
2009 — 34
2010 — 29
2011 — 26
2012 — 28
2013 — 23
2014 — (24 so far this year)

♂230 ♀55

For more information:
http://www.lightningsafety.noaa.gov/victims.htm

FACTOID

Lightning is the third greatest storm-related killer behind floods and tornadoes in the United States and causes nearly $1 billion in damages each year.

Final Lightning Potential

❖ Moisture "Plumes" or "Streaks" have been identified.

❖ Define Areas of Potential or Conditional Instability.

  1. Primary Factor:
    1. Most Unstable CAPE: 1-6 km AGL
    Note: Qualitative Analysis suggest this layer works best)

  2. Secondary Factors:
    1. Elevated Instability (θ_e Lapse Rate)
    2. Best Lifted Index
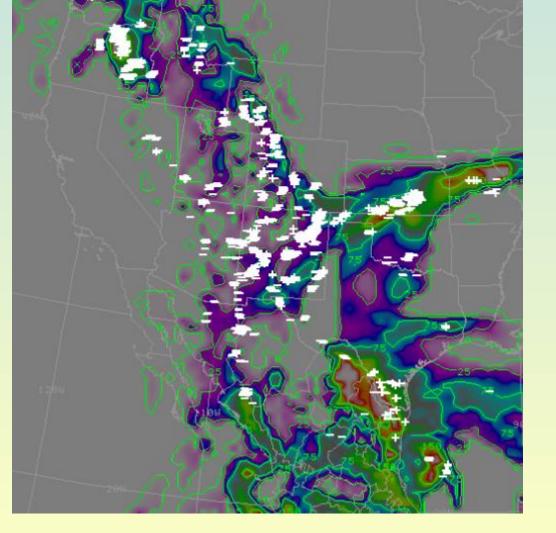
Summary of the 5 Moisture Parameters

Example 2

Lightning Potential

Need Verification Scheme to Improve Skill

Lightning Potential Index Goals

• **Improve Lightning Forecasting**

  • Timing – What time lightning may occur
  • Rate – Indicate whether lightning will be Occasional or Frequent

• **Provide Information that is Easy for the Public, Media to Understand**

  • Enhance Decision Support Services
    1. Public Safety
    2. Fire Weather
    3. Aviation
    4. Outdoor Activities
  • Social Science Input on how to Display this Information?

• **Raise Forecaster Situational Awareness**

  • Boost Forecaster Confidence – Reinforce Current Forecast *"Thinking"*
  • Lightning Potential may Exist at Locations not Considered.

When Thunder Roars Go Indoors!

STOP Activities

Seek shelter immediately in a substantial building or a hard-topped metal vehicle!

www.lightningsafety.noaa.gov

Same as Above

Lightning Potential (w/o Lightning)

Lightning Potential