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A Lightning Potential Index for Public Safety Developed by WFO Grand Junction

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Improved Lightning Forecasts – Why is it Needed

- Leading weather related killer in Colorado.
  - Including casualties due to seemingly benign isolated short-lived thunderstorms over mountain tops (Hodanish, et al., 2004)
- Lightning related injuries may cause lifelong debilitating injuries.
- Planning for Outdoor Activities
  - Recreation (Hiking, skiing, boating, golfing, etc…)
  - Impacts on Business (e.g., ski industry)
  - Outdoor Work
- Fire Weather – Allocation of resources

Research on Lightning Predictors

Solomon and Baker (1994): CAPE above 400 J/kg was useful.

Hoadley and Latham (1998): Empirical analysis showed that CAPE, lifted index and equivalent potential temperature were the best parameters to predict lightning for the northern Intermountain Region.

Berdeklis and List (2001): High relative humidity in the -12° C to -18°C range promotes stronger negative charging, which precedes the electric field that generates the lightning.

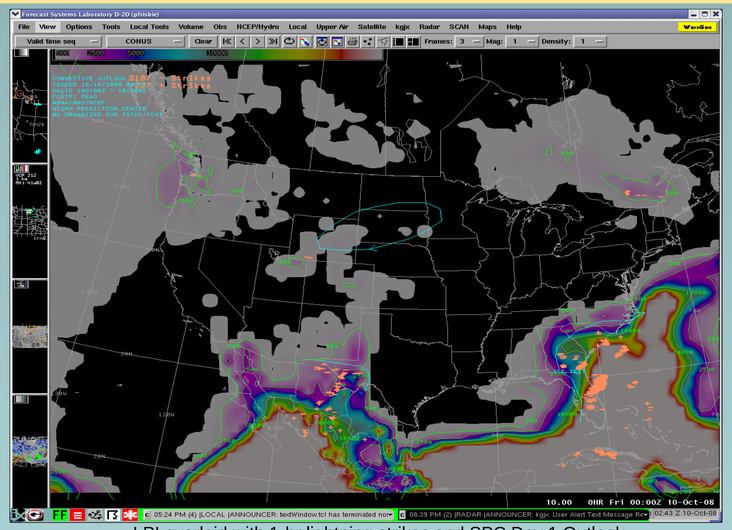
Meteorological Parameters to Calculate the Lightning Potential Index (LPI)

1. *CAPE*
2. *Lifted Index*
3. *Equivalent Potential Temperature Lapse Rate*
4. *850 mb Temperature*
5. *Precipitable Water*
6. *Relative Humidity at -10° C*

First 3 parameters measure instability. Instability is required but higher CAPE values or a lower Lifted Index (and theta-e lapse rate) does not necessarily mean more lightning.

850 mb temperature is used to negate over-prediction of lightning during the cold months.

The last 2 parameters measure moisture in some form. Subjective observations suggest that the last parameter, relative humidity at -10° C, adds skill to lightning forecasting.



LPI overlaid with 1-hr lightning strikes and SPC Day 1 Outlook.

How the LPI is Calculated

Note: The LPI remains experimental and the empirical formula is evolving

A = (Relative Humidity at -10° C)² · (Lifted Index)² · (θe Lapse Rate at 600 mb) · (-1.0); Lifted Index = 0 if Lifted Index > 0

B = (Most Unstable CAPE at 0-3 km AGL) · (Precipitable Water) · (Relative Humidity at -10° C) · 0.001

LPI = (A + B) · (850 mb Temperature – 272 [° K]); *Note: 272 instead of 273.15 (absolute zero) allows for thundersnow*

LPI = 0 if LPI < 0. LPI = 20000 if LPI > 20000.

How the LPI is Created

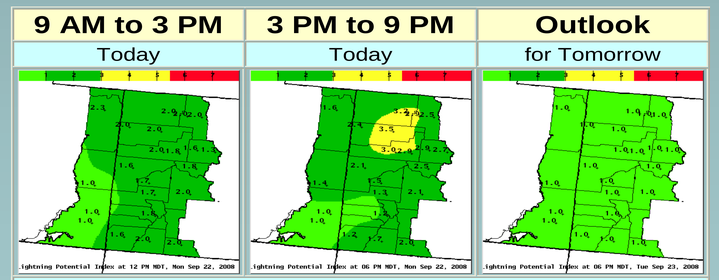
Model Data (i.e., NAM and GFS) is used to calculate the LPI.
Python scripts (smart tools) are used to create the gridded data for the lightning web page.
Routinely available for western Colorado and eastern Utah.
Future Plans: Improve sensitivity on the temporal and areal scale.

Example from the LPI web page:

www.crh.noaa.gov/gjt?n=lightningpotentialindex

The Lightning Potential Index (LPI) provides graphical guidance on the potential of lightning for a 48 hour period beginning at 9 AM. The 48 hour period is broken down into three periods and are defined as follows: The first chart is for the 9 AM to 3 PM period; the second chart is for the 3 PM to 9 PM period, and the third chart will contain an outlook for the next day and is expected to be used for general planning purposes during the afternoon hours.

These charts will be generated once a day, normally around 6 AM. This is an ***experimental product*** and is not part of the official forecast by the National Weather Service Forecast Office at Grand Junction. Consequently, the LPI may not reflect the current graphical forecast produced by the Grand Junction National Weather Service Forecast Office. Visit our Lightning Safety Page for more information.



Color Key and Explanation

Low Risk	Low Risk: The lightning threat may either be negligible or low. Isolated thunderstorms may occur, but the probability of thunderstorms is low.
Moderate Risk	The lightning threat is considered moderate. Isolated thunderstorms are expected within the green area.
High Risk	The lightning threat is considered high. Expect scattered thunderstorms within the yellow area. Plan accordingly, as there is a high probability of lightning in the yellow area. Be aware of lightning safety guidelines.
Extreme Risk	Lightning in the red area will occur. Practice lightning safety, as the threat of lightning is extremely high.

Advantages and Disadvantages

Advantages:

- Show concentrated areas of lightning.
- Lightning does not occur when LPI = 0.

Disadvantages:

- Underestimates Lightning Potential in areas of marginal instability and strong dynamical lift.
- If model underestimates instability and/or moisture, the LPI will be underestimated.