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

Paul R. Frisbie, J.D. Colton, J.R. Pringle, J.A. Daniels, J.D. Ramey Jr. and M.P. Meyers
NOAA/NWS, Grand Junction, CO

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.

How the LPI is Calculated

A = (Relative Humidity at -10°C)² ; Lifted Index² - 880 Lapse Rate at 600 mbo; - (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) x 0.001

LPI = (A + B) x (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.

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.

Bordellos 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.

Why is Forecasting Lightning a Challenge?

Spatial and Temporal variability. Charge separation created by strong fronts promotes stronger negative charging.

Advantages and Disadvantages

Advantages:
- Shows 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.

WHY IS FORECASTING LIGHTNING A CHALLENGE?

Change separation created by strong fronts promotes stronger negative charging.