Correlation Between Lightning Flash Count and Meteorological Parameters [AE31A-0027]

[1] W. Walden-Newman, [1] R. Sonnenfeld, [1] M. Stock , [2] X. Shao

[1] Physics Dept., New Mexico Tech, Socorro, NM, [2] Los Alamos National Laboratory, Los Alamos, NM

Introduction

We searched for meteorological parameters derivable from an AM balloon sounding which clearly correlated with afternoon thunderstorms in the south-western US.

Of the 11 parameters selected, the mixing ratio of water vapor to air (MR) most strongly correlates with afternoon lightning, with average correlation coefficients [Taylor96] of 0.7.

We also found, in Oklahoma, the dry-bulb temperature at 500 hPa (weakly) inversely correlates with lightning.

We noted with interest that MR correlated with afternoon flash counts more strongly than CAPE.

Data Sources

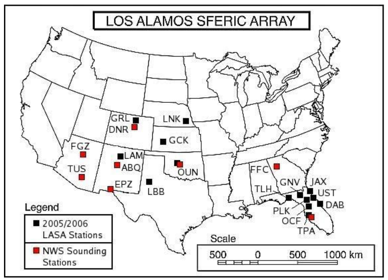


Fig. 1 from [Smith02] modified with additions from [Oolman05]

LASA Array and Sounding Stations

Flash counts from the Los Alamos Sferic Array containing both intra-cloud (IC) and cloud-to-ground (CG) flashes were compared to meteorological parameters obtained from National Weather Service balloon soundings.

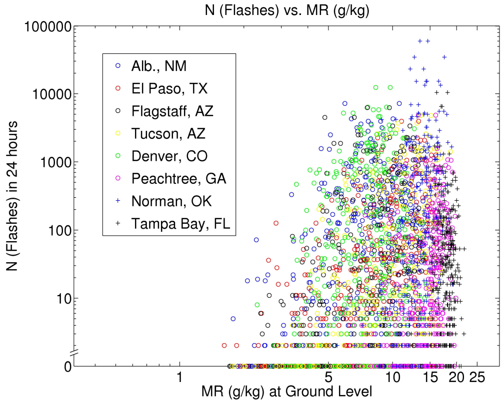
Initial data came from an 85 day period between May 24th and Sept. 4th , 2005. Additional data was added that contained only mixing ratio and flash counts from June 1st to Aug. 31st, 2006.

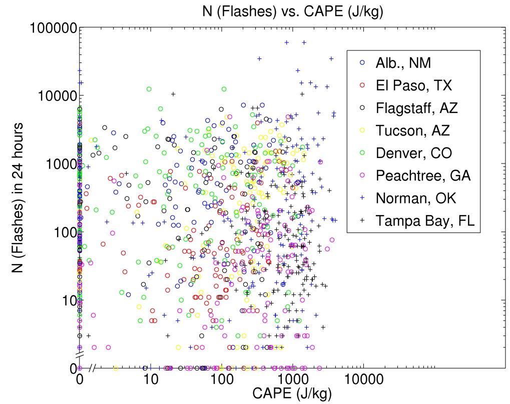
Correlations are accurate up to 300 km away from the sounding stations, after which they rapidly decrease. This agrees with the distance a radio- sonde travels in a sounding [FCM-H3-1997].

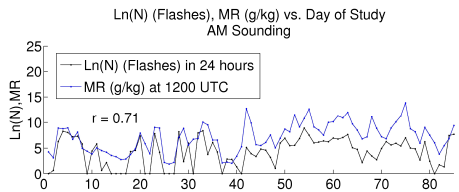
Acknowledgements

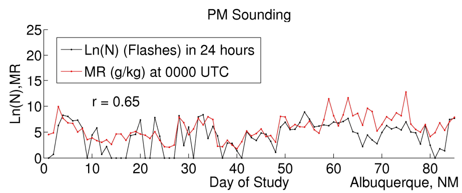
We thank Carlos Lopez Carrillo, Kenneth Eack, and David Raymond for helpful discussions on deep convection. Primary funding for this work provided under NSF Grant # ATM-0331164. Additional funding from New Mexico Space Grant Consortium gratefully acknowledged.

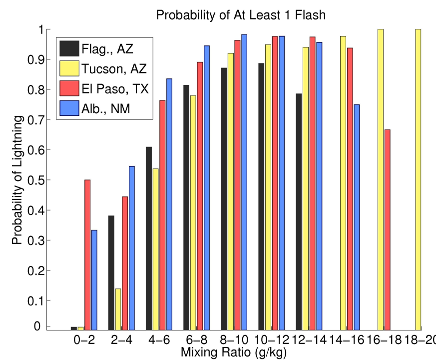
Results: Mixing Ratio, CAPE, and Temperature











r Correlation Coefficients of Log(MR) vs. Log(N) Strikes

Station	AM/Ground	AM/500 hPA	PM/Ground	PM/500 hPa
Albuquerque, NM	**0.71**	0.49	**0.65**	0.22
El Paso, TX	**0.70**	0.48	**0.68**	0.49
Flagstaff, AZ	**0.75**	0.63	**0.76**	0.64
Tucson, AZ	**0.74**	0.60	**0.79**	0.57
Denver, CO	0.27	0.49	0.52	0.24
Peachtree, GA	0.19	0.27	0.14	0.40
Norman, OK	0.10	0.29	0.28	0.17
Tampa Bay, FL	-0.15	0.06	-0.08	0.09

r Correlation Coefficients of Log(CAPE) vs. Log(N) Strikes

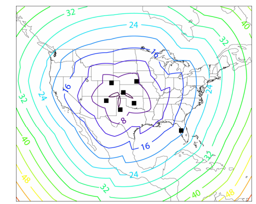
Station	AM CAPE	PM CAPE
Albuquerque, NM	0.49	0.45
El Paso, TX	0.45	0.50
Flagstaff, AZ	0.51	0.29
Tucson, AZ	**0.72**	**0.71**
Denver, CO	0.18	0.04
Peachtree, GA	0.13	0.08
Norman, OK	0.17	0.15
Tampa Bay, FL	-0.11	0.06

r Correlation Coefficients of Log(T) vs. Log(N) Strikes

Station	AM/Ground	AM/500 hPA	PM/Ground	PM/500 hPa
Albuquerque, NM	0.26	0.03	-0.31	0.22
El Paso, TX	0.17	0.07	-0.37	0.20
Flagstaff, AZ	**0.63**	0.11	-0.54	0.01
Tucson, AZ	0.35	0.08	-0.29	0.23
Denver, CO	0.06	-0.21	-0.41	-0.14
Peachtree, GA	0.16	-0.05	-0.05	-0.11
Norman, OK	-0.04	**-0.45**	-0.28	**-0.47**
Tampa Bay, FL	-0.13	-0.27	-0.43	-0.15

LASA Detection Accuracy

Four Station Sensitivity Pattern



Personal Communication [Shao, X.]

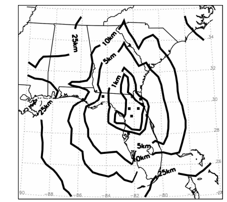


Fig. 7 from [Shao06]

Conclusion

Correlation between total lightning and a meteorological parameter is highest when that parameter is the limiting factor for storm formation.

The table below shows that the average mixing ratios in the Southwest were much lower than the rest of the country. This limited the amount of moisture carried aloft for charge generation processes in thunderstorm clouds.

Other areas regularly had sufficient moisture for storm formation, which allowed other variables such as the temperature at 500 hPa to have stronger correlations. [Carey00 and Peterson05]

Average MR and Number of Days with CAPE > 0

Station	MR (g/kg)	CAPE
Albuquerque, NM	**6.45**	55
El Paso, TX	**6.75**	61
Flagstaff, AZ	**6.05**	54
Tucson, AZ	**7.90**	57
Denver, CO	**7.20**	74
Peachtree, GA	14.74	78
Norman, OK	13.50	78
Tampa Bay, FL	17.75	85

References

[Carey00] Carey, L.D. and Rutledge, S.A. (2000). The Relationship Between Precipitation and Lightning in Tropical Island Convection: A C-Band Plarimetric Radar Study. *Monthly Weather Review*, 128(8):2687.

[FCM-H3-1997] Office of the Federal Coordinator for Meteorology (1997). Federal Meteorological Handbook No. 3: Rawinsonde and Pibal Observations (FCM-H3-1997). Washington, D.C.

[Oolman05] Oolman, L., Atmospheric Soundings, U. of Wyoming, http://weather.uwyo.edu/upperair/sounding. html, 2005.

[Peterson05] Peterson, W.A., Christian, H.J., and Rutledge, S.A. (2005). TRMM Observations of the Global Relationship Between Ice Water Content and Lightning. *Geophysical Research Letters*, 32(14):L14819.

[Shao06] Shao, X. et al., Total Lightning Observations with the New and Improved Los Alamos Sferic Array (LASA), *J. of Atmos. and Oceanic Technology*, 23, 10, 1273-1288, 2006.

[Smith02] Smith, D.A. et al., The Los Alamos Sferic Array: A research tool for lightning investigations, *J. Geophys. Res.*, 107, 4183, 2002.

[Taylor96] Taylor, J.R. (1996). *An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements.* University Science Books, Sausalito, CA.