A HIGH RESOLUTION LIGHTNING MAP OF THE STATE OF COLORADO

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INTRODUCTION

This poster documents warm season (01 April – 31 October) Cloud to Ground (CG) lightning stroke activity over the state of Colorado for 10 years (2003 - 2012).

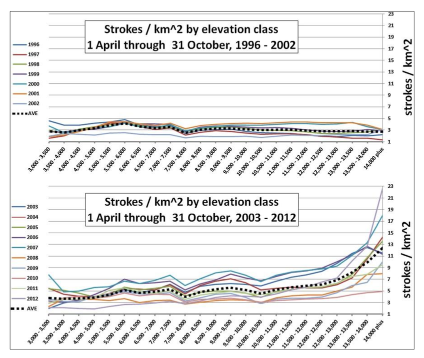
Data are from the North American Lightning Detection Network (NALDN), collected by Vaisala.

12.5 million detected CG strokes were analyzed in this study.

NALDN data spatial accuracy 250 to 500 meters.

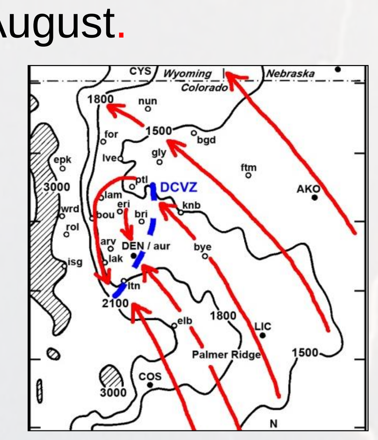
Grid cell resolution used for all stroke density maps is 500m^2. The stroke counts for each cell are multiplied by four to create intuitive legend values (i.e., strokes km^{-2} rather than strokes 500m^{-2}).

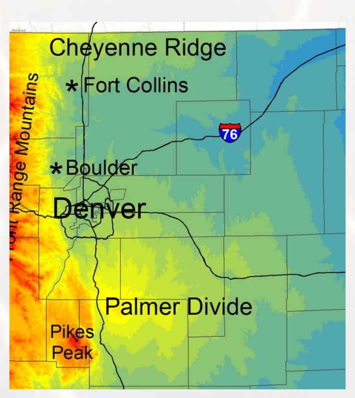
Why only 10 years? NLDN received a major upgrade In 2003. Data quality improved significantly

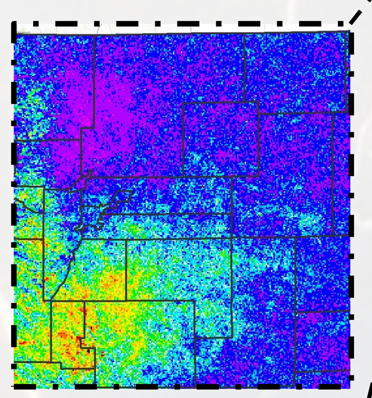


Regional Lightning Stroke Distributions

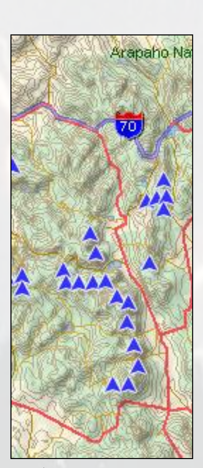
A mesoscale circulation pattern, known as the Denver Convergence Vorticity Zone (DCVZ; Szoke 1984), is believed to be a major player in the CG distribution across northeast Colorado. The surface flow pattern to the northwest of the DCVZ is divergent, inhibiting thunderstorm development. However, the surface flow pattern southwest of the DCVZ is convergent. This convergence combined with upslope flow on the north side of the Palmer Divide enhances lightning activity over the Pikes Peak/Palmer Divide region. The DCVZ surface flow pattern generally occurs 35% of the time between May and August.

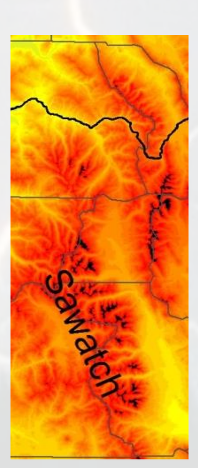


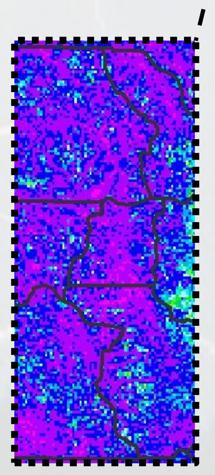




One of the tallest mountain ranges in Colorado, the Sawatch Range, has relatively very little CG lightning. This is due to numerous mountain ranges blocking moisture from reaching this region.

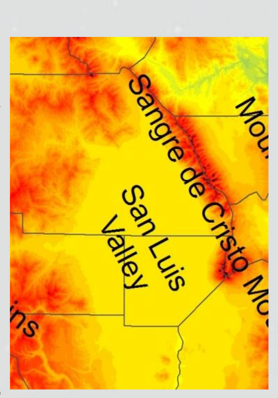


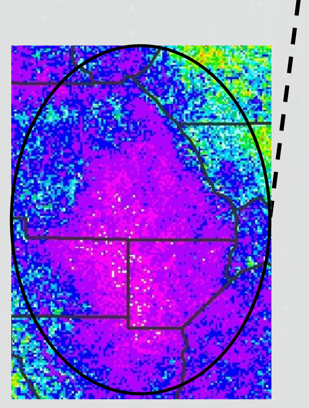


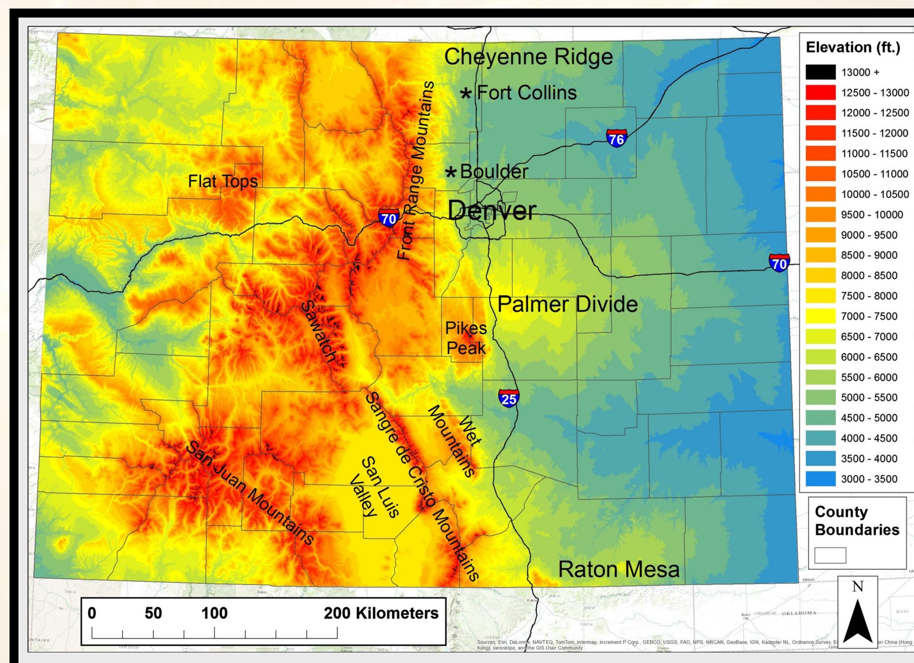


> 14 kFt

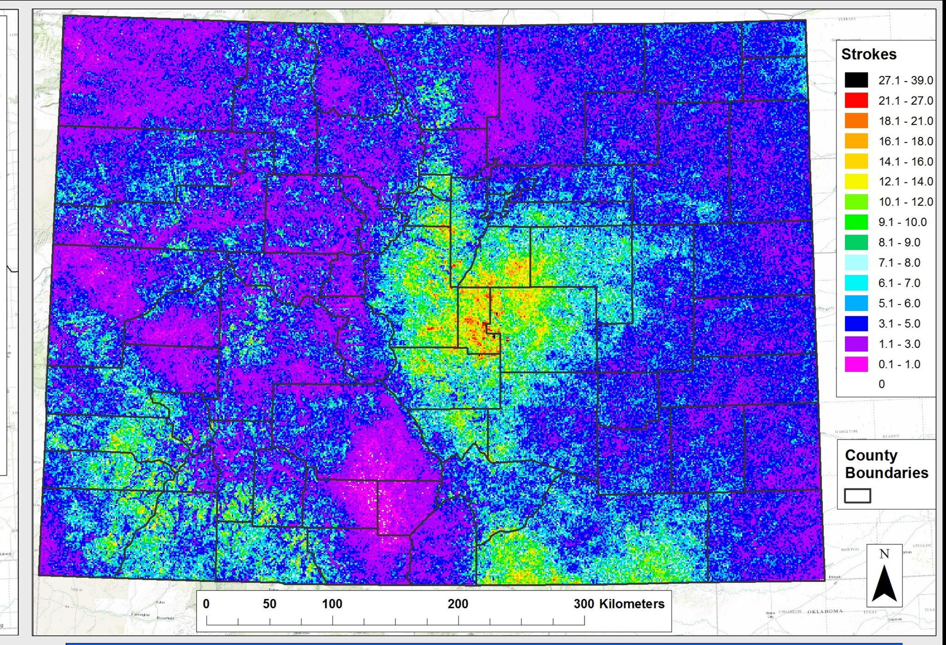
Why the CG minimum here? The San Luis Valley is surround by tall (12-13 kFt / 3.7-4.0 km) mountain ranges; the San Juan Range to the west and northwest, and the Sangre de Cristo Range to the northeast and east.



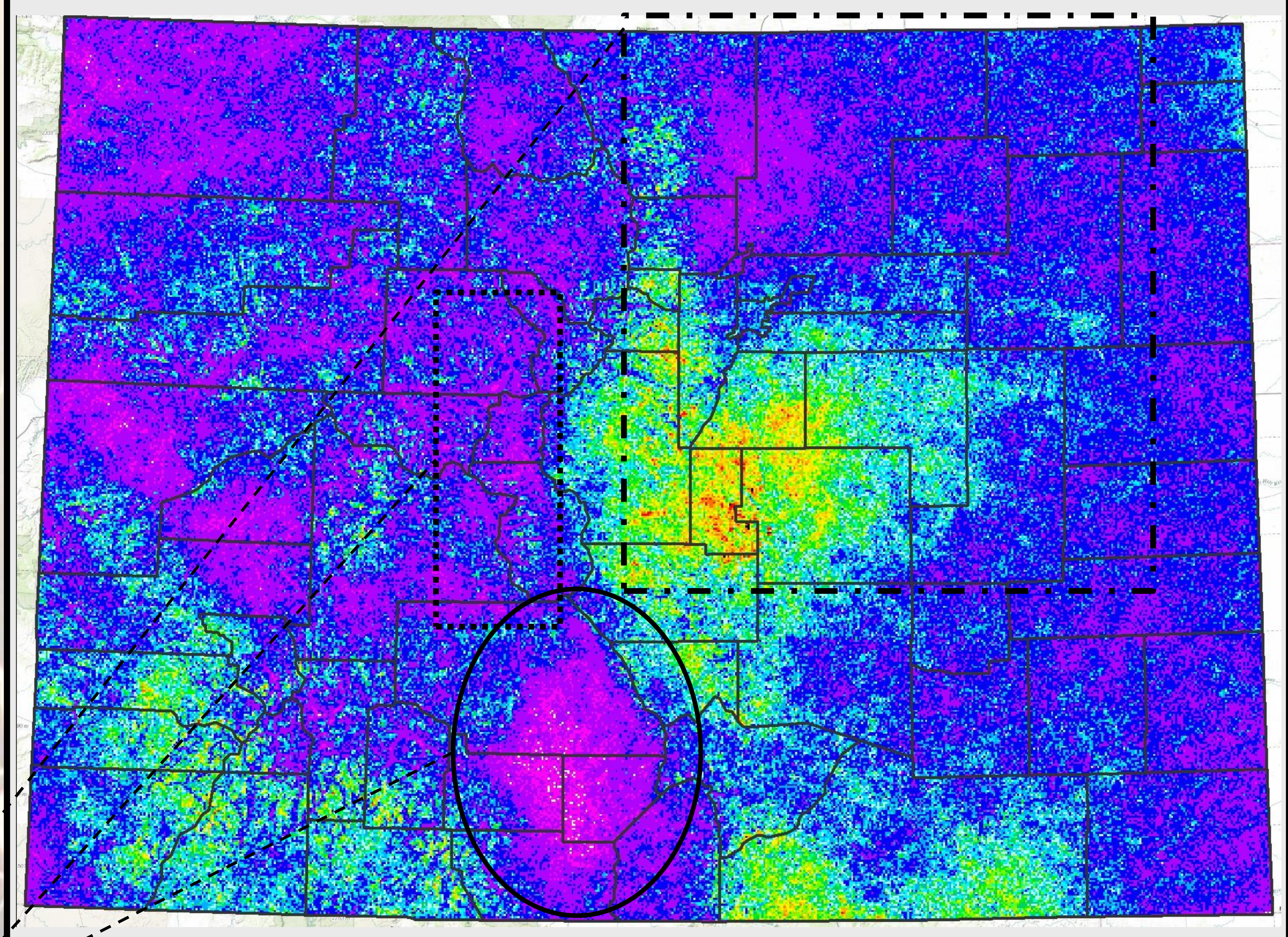


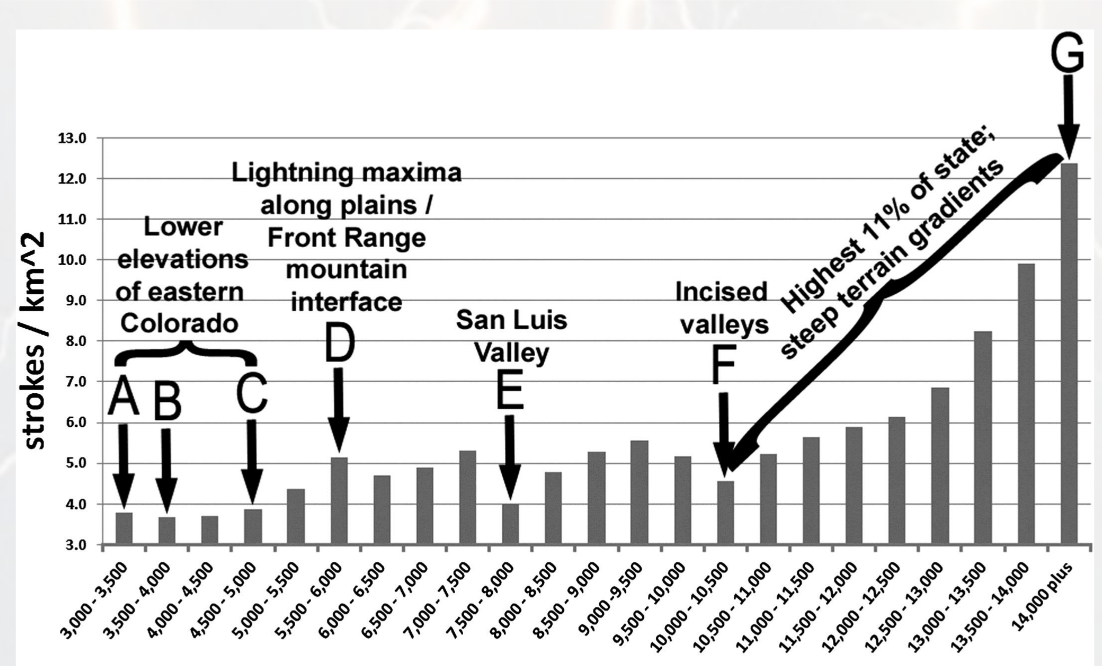


Colorado Topography



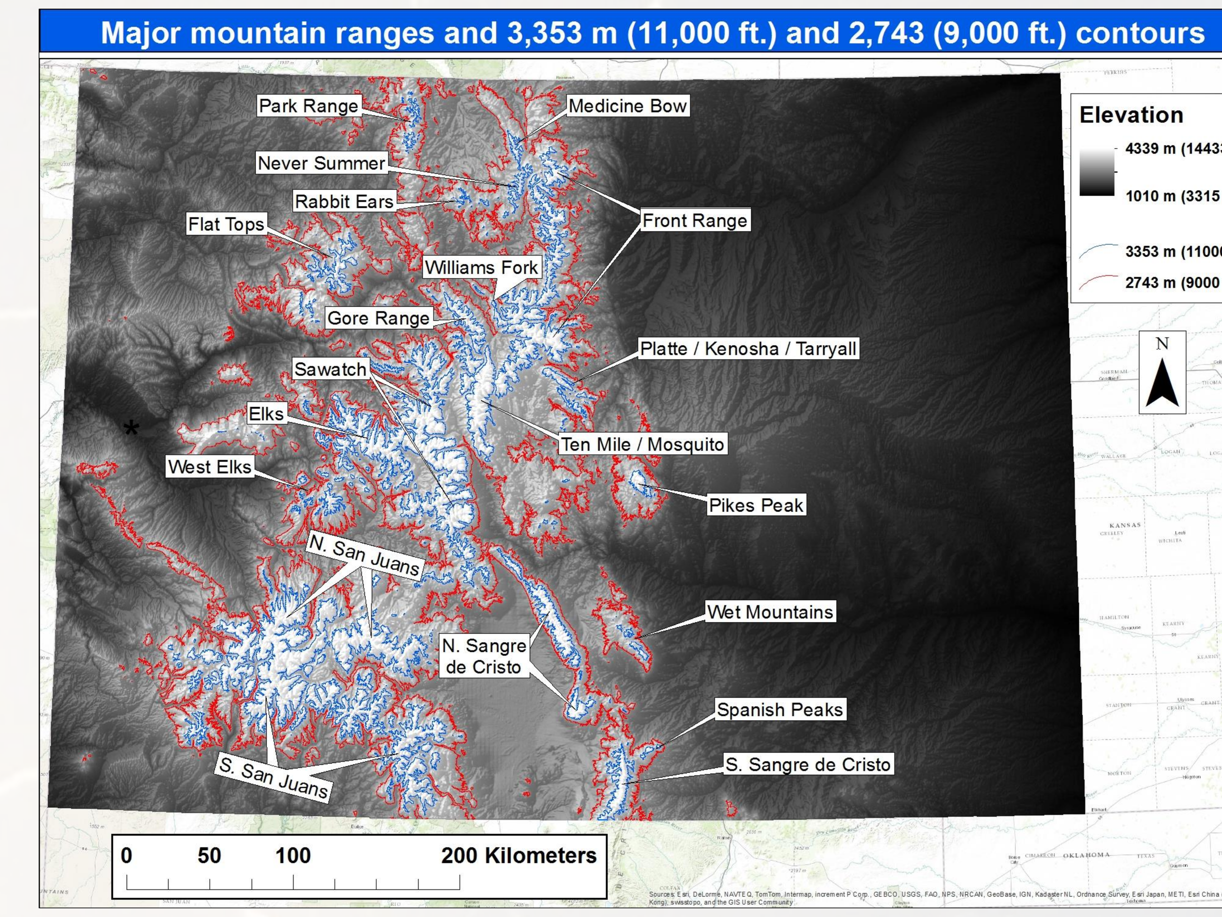
Average annual strokes / km^2, 1 April - 31 October, 2003 - 2012



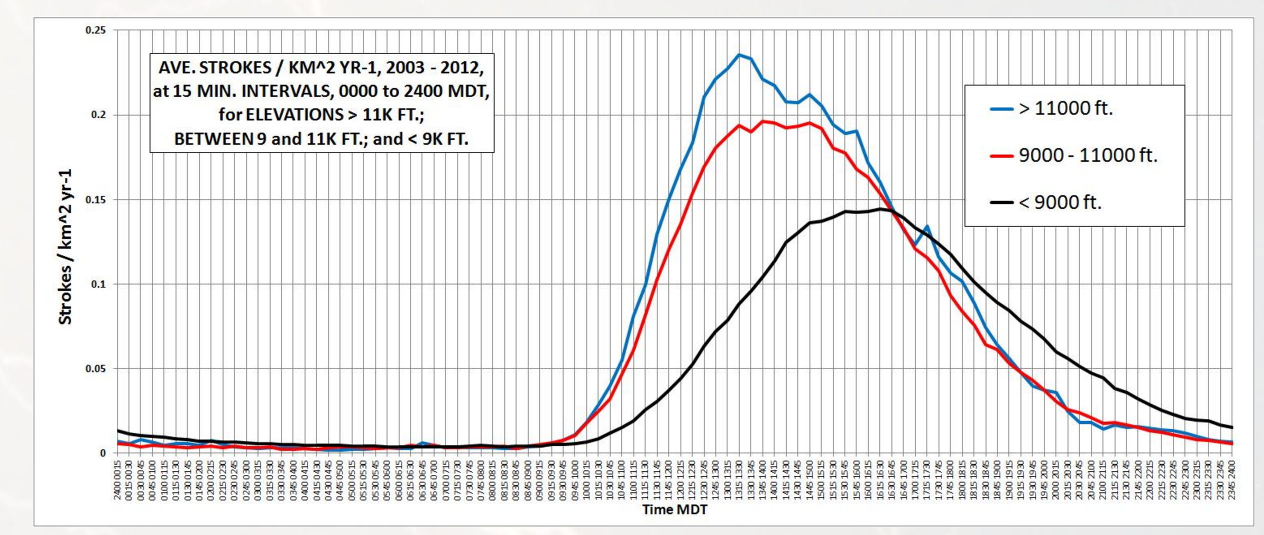


Areas below 3,048 m (10,000 ft.) show a fluctuating relationship between elevation and CG density while areas above 3,048 m (10,000 ft.) are characterized by an overall increase in stroke density. A strong positive relationship exists between terrain elevation and CG density only in the highest 11% of the State's area that extends from 3048 m (10,000 ft.) to 4,399 m (14,433 ft.). In this elevation range, stroke densities increase from 4.6 km^2 yr^{-1} above 3,048 m (10,000 ft.) to 6.1 km^2 yr^{-1} at 3734 m (12,250 ft.), then sharply increase and reach a maximum of >12 km^2 yr^{-1} at elevations above 4,267 m (14,000 ft.). These results corroborate the work of Cummins (2012) and Bourscheidt et al. (2009) who attribute high flash densities to regions with steep slope gradients. Cummins (2012) also proposes that high flash densities are linked to areas with high turbulence driven by high surface roughness and areas with variations in the surface electrical boundary conditions.

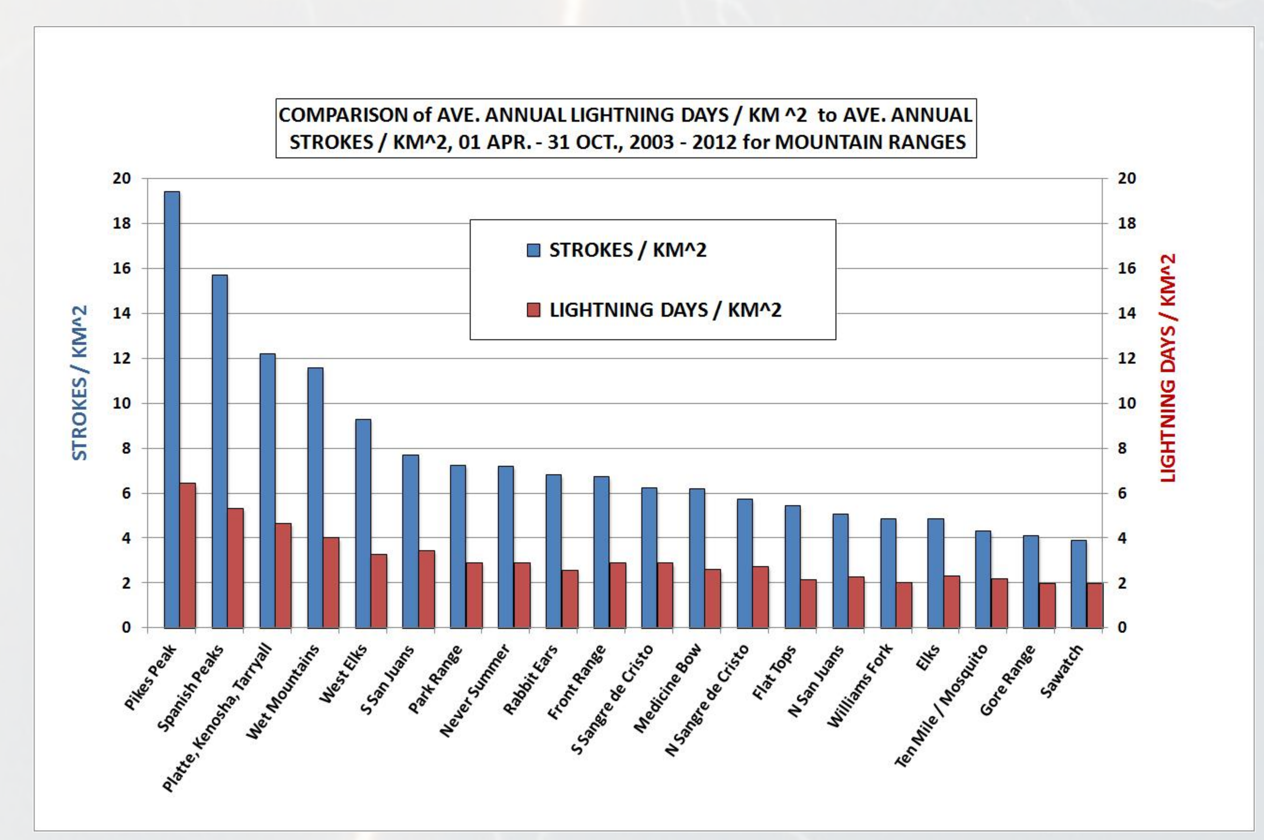
Major mountain ranges and 3,353 m (11,000 ft.) and 2,743 (9,000 ft.) contours



Colorado Mountain Ranges; 11 kft, 9 kft



Ground stroke density in 15 minute intervals for elevations above 11 kft, 9 kft and 11 kft and below 9 kft. High mountain areas ramp up rapidly and reach a peak around 1330 MDT. Lower elevations the stroke densities occur later in the day.



This chart shows average “lightning” days for the mountain ranges above 11,000 ft. Note that even though the interior high elevation mountains (i.e., Sawatch Range) do not see much overall CG lightning, they still see CG lightning on a frequent “day-to-day” basis.

- Cummins, K. 2012: On The Relationship Between Terrain Variations and LLS-Derived Lightning Parameters. 2012 International Conference on Lightning Protection (ICLP), Vienna, Austria.
- Bourscheidt, V., Pinto, O, Naccarato, K., and I Pinto, 2009: The influence of topography on the cloud-to-ground lightning density in South Brazil, *Atmospheric Research,* vol. **91**, no. 2-4, Feb, 2009, pp. 508-513.
- Szoke, E. J. and M. L. Weisman, J.M. Brown, F. Caracena and T. W. Schlatter, 1984: A subsynoptic analysis of the Denver tornadoes of 1981. *Mon. Wea. Rev.* **112**, 790-808.