Real or Fake? Follow-ups on Signatures Observed on US Radar Composites

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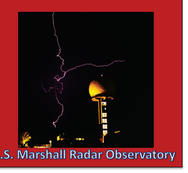


At the last conference, we presented **some results from the analysis of 16+ years of US radar composites** and showcased the value of such analysis to investigate new or unexpected signatures.
Three unexpected results were presented: **- a possible convection minimum in summer afternoons in the Mississippi Valley**
- a signature of the effect of cities on convection
- a possible difference between weekday and weekend precipitation maximized downwind of the industrial North East
Additional work was performed on these three unexpected results to determine their basis and their statistical significance: **are these signatures real, or are we the victim of limited data sampling?**

A. Mississippi Valley Convection Minimum

Claim:

Void of convection over the Mississippi Valley that occurs in the afternoon in the middle of summer is hypothesized to be caused by orography (valley vs. Ozarks) or by land use / land cover changes (agriculture vs. forest).

Update:

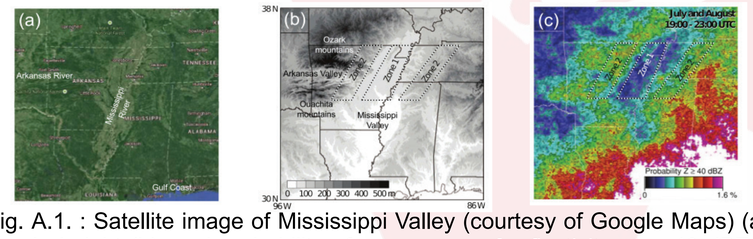


Fig. A.1. : Satellite image of Mississippi Valley (courtesy of Google Maps) (a), terrain height (b), and probability of occurrence of reflectivity over 40 dBZ in mid-afternoon (19 – 23 UTC) in July and August derived from the US radar composites.

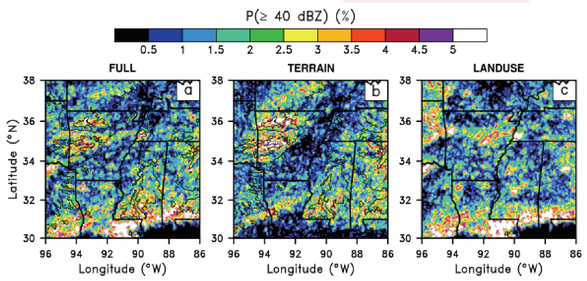
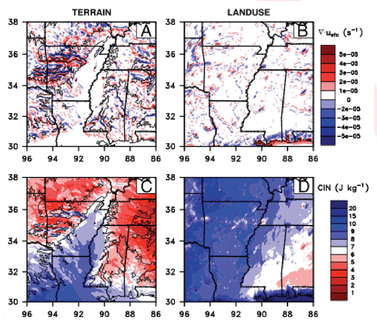


Fig. A.2. : Frequency of model simulated radar reflectivity exceeding 40 dBZ between 19-23 UTC including terrain and land use (a), terrain only (b), and land use only (c) in synoptically quiet conditions.

Fig. A.3. : Average surface based convergence for terrain only (a) and land use only (b) simulations and mean-layer (0 – 500 m AGL) CIN for terrain only (c) and land use only (d) simulations.



Conclusion:

Real

The data signature is very clear, and numerical simulations show that the weak orography around the valley leads to reduced stability and triggers convection preferably in these areas compared to the valley itself.

Ref.: Kirshbaum, Fabry, and Cazenave, 2016: The Mississippi Valley Convection Minimum on Summer Afternoons: Observations and Dsimulations, MWR, in Review

B. Effect of Cities on Convection

Claim:

Urban areas are hypothesized to have an influence on convection either by the land cover change or by the urban heat effect compared to the surrounding rural area, which would cause an increase in convection downwind for the urban area.

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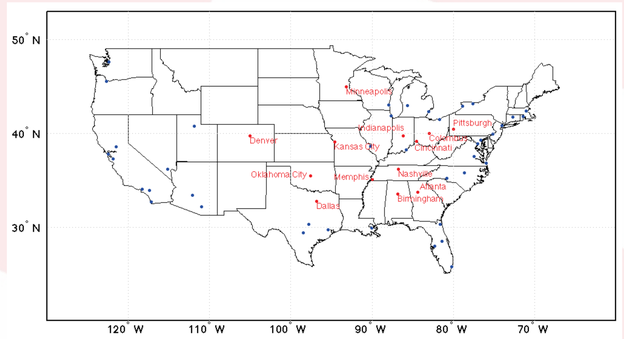


Fig. B.1. : Location of cities than have at least 1 million inhabitants from the 2010 USA Census (53 cities) in the contiguous USA (in blue dots) and a list of "selected" cities (in red dots) that have no blockage or ground echoes and are more than 200 km away from either the ocean or the Great Lakes.

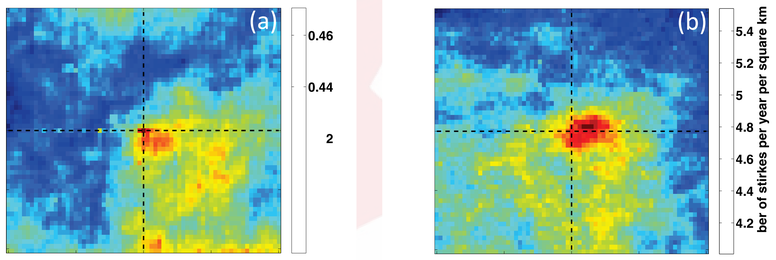


Fig. B.2. : Composite signature around the selected cities for probabilities of radar echoes above 40 dBZ (a) and number lightning strikes per year per square km (b) around the city center for the summer period (May – August).

Conclusion:

Probably Real

While it is very difficult to identify for certain the signature of individual cities and the mechanism for their impact, the combination of data from 13 cities show a weak but definite fingerprint on both radar and lightning data over a ~25*20 km area slightly downwind of the city, compatible with its expected local impact. Significance calculations are however difficult to make.

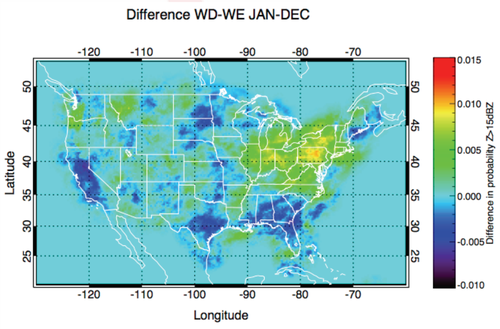
C. Weekday-Weekend Precipitation Difference

Claim:

A clear peak in weekday precipitation (or a clear minimum in weekend precipitation) is observed downwind of the industrial North-East. This is possibly because of the effect of increased aerosols during weekdays on precipitation.

Update:

Fig. C.1. : Difference in probability of echoes greater than 15 dBZ between weekdays and weekends. In the industrial North-East, a potentially significant difference is observed.



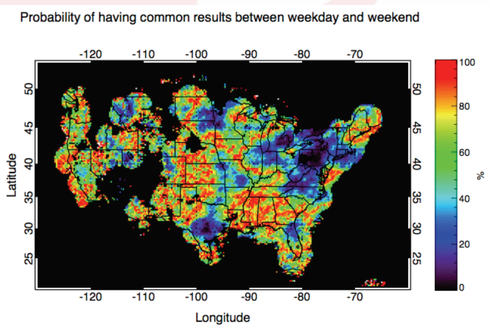


Fig. C.2. : Probability that the difference in week-day and week-end echoes are due to chance.

A resampling experiment was perform using 7-day blocks not aligned on weekdays or weekends.

Though the probability that the difference in the North-East is due to chance may be low, the resampling experiment shows that the size of the area where such low probabilities are observed is expected based on chance alone.

Conclusion:

Probably Fake

Though the 16 years data shows a ~15% difference between the probability of precipitation on a weekday than on a weekend, data resampling experiments suggest that such large differences can be obtained by natural variability and are not yet significant enough to be declared a reality.

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