Composite Climatology of Florida Summer Thunderstorms

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ABSTRACT

In an attempt to produce an objective climatology of peninsular Florida thunderstorms that does not suffer from observer bias, we composited 9088 hours of high-resolution manually digitized radar (MDR) data and 28 days of daytime satellite imagery. Both indicated maximum activity over the southwestern corner of the peninsula. Radar shows much higher frequencies than are found in other studies, but this is due in part to the method of data collection. We then decomposed the MDR data into Principal Components (PC) to isolate independent spatial and temporal patterns. The most important pattern had a strong diurnal component that was very congruent with coastline geography. Additional important PCs generate the most likely daily regime.

A temporal analysis of the daily march of the radar PC composites over the area of highest activity indicates two discrete diurnal maxima. Over southwestern south Florida (near Flamingo), activity peaks sharply around 2000 UTC. There is another discrete peak in activity approximately 200 km to the northwest two hours later.

Satellite composites also demonstrated that deep cumulonimbus activity over south Florida on undisturbed summer days is strongly focused by the peninsula.

In a statistical analysis at the synoptic scale, interdiurnal variability in the radar PCs is more related to variation at the 850 mb level than variation at the surface.

1. Introduction

The summer thunderstorm regime in Florida has been a prime target of scientific investigation since Byers and Rodebush (1948) initially related afternoon sea breezes and thunderstorm development. Gentry and Moore (1954) and Frank et al. (1967) corroborated the early work with analogous investigations of nighttime land breezes over the nearby oceans. In a radar-based multiple case study, Blanchard and Lopez (1985) recently demonstrated the link between several subjectively determined individual convective patterns and their synoptic fields.

Pielke (1974) established the first three-dimensional model of peninsular Florida flow, and also concluded that the sea breeze circulations are the dominant mode of thunderstorm control under undisturbed conditions. Aspects of his model calculations were verified by on-site instrumentation work of Ulanski and Garstang (1978), as well as by dynamic analyses of Burpee (1979). Cooper et al. (1982) found, again with on-site instrumentation, that peninsular sea-breeze convergence initiated convection, but that subsequent thunderstorm activity was amplified primarily by downdrafts from the original convection.

Krietzberg (1976) and Pielke (1976, 1982) suggested that complimentary use of a remotely sensed (i.e. “objective”) mesoscale climatology and a mesoscale numerical model could provide a substantial improvement in short-range forecasts of terrain-induced mesoscale systems. This improvement is particularly likely because surface forcing varies little from day-to-day during Florida’s warm season. The surface weather pattern is therefore primarily a function of a few synoptic situations.

In this paper we provide a new climatology, based upon approximately 10 000 hours of Manually Digitized Radar (MDR) data. Our research in this area adds to that of Blanchard and Lopez (1985) by using a much more extensive input dataset (approximately 20 times more observations) that allows for objective determination of the discrete convective patterns. We also add
satellite composite imagery that generally corroborates the radar analyses.

Observer-based climatologies of Florida peninsula thunderstorms suffer from density and quality, as noted in Michaels (1985). That work, which applied only to seasonal patterns, did find the expected peninsular maximum, with most of the variation about the mean [expressed by the first Principal Component (PC)] occurring over south Florida, as would be expected from the earlier dynamic work of Pielke (1974). However, analyses of the available data from the National Climatic Data Center produced only rather gross results because of problems with station density and data reliability (see Michaels, 1985). Also, note that the operational definition of a thunderstorm ("thunder heard") results in larger areas of observed activity than the region covered by important thunderstorm-related weather: strong winds, heavy rain, and hail.

The objective of this paper is to produce a more comprehensive peninsular Florida summer thunderstorm climatology, using composites based upon the longest available time series of best-resolution MDR return. The MDR composites are then compared to a more limited set of satellite composites. Temporal variation in the radar composites is then related to synoptic-scale variability.

Our overall approach measures the strength of the synoptic-scale signal in determining the distribution of mesoscale radar return patterns, and provides some verification of the MDR patterns through visible satellite imagery.

2. Data sources and analyses

a. Radar composites

We analyzed 10 025 hours of $47.6 \times 47.6$ km gridcell MDR data for June–August 1978–82, from a data tape supplied by Roy Jenne of NCAR. The data were previously flagged for missing or inappropriate values; as a result, 84% (or 9088 h) had simultaneous and complete records for all gridcells. We first describe the mean pattern, and then disaggregate the dataset into PCs that display the principal spatial modes of departure from the mean. We then temporally composite each of the PCs into discrete diurnal thunderstorm patterns.

Our thunderstorm criterion was a Video Integrator and Processor (VIP) brightness of three, which has been used by Reap and Foster (1979) as a general indicator of thunder activity in their objective thunder probability forecast work. Our range was 150 gridcells over and surrounding the Florida peninsula. The radar sites, surface, and upper-air stations are shown in Fig. 1.

While the MDR data are of sufficient utility to initialize large-area objective forecast models such as the Model Output Statistics (MOS), they overestimate the coverage of previously mentioned important weather effects associated with thunderstorms. MOS is a primarily empirical forecast technique based upon the historical distribution of output from the multilevel objective prognostic models. However, the radar data is certainly more dense and of better quality than the human observer–based set noted in Michaels (1985).

The overestimation bias results in part from the way the data were initially collected. If 20% of the area within each cell is covered by any type of return, the cell is considered active. When that criterion is met, the highest VIP return observed within the cell is recorded as the MDR value. Thus, while it is quite unlikely, a single radar gate (approximately 1 km$^2$) showing intense (level 6) activity results in that level being recorded for the entire cell.

In this study, when a VIP brightness of three or greater was encountered in a given hour, a 1 was recorded for that gridcell; zeroes were recorded for returns 0–2. Descriptive statistics were then aggregated and plotted with the NCAR graphics package. The MDR cells were superimposed upon the background map, and individual values were assumed to be at the center of each cell. The mean value, shown in Fig. 2, is the fraction of the 9088 h ($\times 100$) in which the VIP criterion was exceeded.

Based upon the MDR data, the mean hourly value is as high as 15% of the observed hours over the southwestern Peninsular areas near Flamingo and Cape Romano. This does not mean that the significant weather associated with thunderstorms is observed that frequently. However, given the relative size of convective
and grid cells, it seems likely that this figure is more representative of the percent of time the classical definition of thunderstorm ("thunder heard") is fulfilled. Another maximum appears in the Cedar Key area north of Tampa Bay. All of the high mean values are displaced west of the peninsular axis, because climatically prevailing southeasterlies exert an effect on the position of the sea breeze fronts.

A companion analysis (Fig. 3) calculates the percent of days (rather than hours) in which high MDR values are observed. As many as 84% of the summer (June–August) days display MDR echoes of three or greater along the southwestern coast. In this representation, the hourly maxima apparent in Fig. 2 are concentrated over a smaller area of southwestern Florida. The implication is that there are more hours of activity over the extreme southwestern tip (near Flamingo) but that the daily likelihood is greater midway between there and Cape Romano.

We decomposed the hourly radar data into principal components using standard analytical techniques that have been detailed extensively in the atmospheric science literature (see Kutzbach, 1967, and Hayden and Smith, 1982, for appropriate examples). Our PC analysis was calculated from the correlation matrix.

This technique is highly efficient at determining the spatial correlation structure of atmospheric data. In this case, we use it to determine the most likely daily patterns of MDR echoes indicative of thunderstorm activity.

The model equation used was

\[ PC_1 = \sum_{i=1}^{150} \alpha_i F_i; \quad PC_2 = \sum_{i=1}^{150} \alpha_i' F_i; \text{ etc.,} \]

where \( PC_1 \) refers to the first PC and \( PC_2 \) the second, etc. The \( F_i \) are the hourly frequencies of MDR return of 3.0 or greater, and the \( \alpha_i \) are the linear multipliers for each of the 150 gridcells that resolve the data into the PC representation.

The prime objective was to isolate statistically independent spatial patterns of convection that could then describe the daily march of convective activity across the peninsula. A second objective was to compare the MDR patterns to those observed from GOES geostationary satellite imagery. Additionally, we statistically related the radar patterns to synoptic-scale empirical models.

Other nonorthogonal techniques (which can maximize explained variance within each function by relaxation of the independence criterion) may be more appropriate for different types of meteorological problems; see Richman (1981) and Walsh et al. (1982) for pertinent discussions. However, because one of our ultimate objectives was to relate these patterns statistically...
TABLE 1. Summary statistics for the MDR PCs. The first 35 are significant,* according both to the Overland and Preisendorfer (1982) criterion and the Scree Test (for eigenvalue < 1.0).

<table>
<thead>
<tr>
<th>PC</th>
<th>Percent variance explained</th>
<th>Cumulative percent variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.16</td>
<td>10.16</td>
</tr>
<tr>
<td>2</td>
<td>3.94</td>
<td>14.10</td>
</tr>
<tr>
<td>3</td>
<td>3.16</td>
<td>17.27</td>
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<tr>
<td>4</td>
<td>2.80</td>
<td>20.07</td>
</tr>
<tr>
<td>5</td>
<td>2.46</td>
<td>22.53</td>
</tr>
<tr>
<td>6</td>
<td>2.13</td>
<td>24.66</td>
</tr>
<tr>
<td>7</td>
<td>1.95</td>
<td>26.60</td>
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<tr>
<td>8</td>
<td>1.59</td>
<td>28.20</td>
</tr>
<tr>
<td>9</td>
<td>1.51</td>
<td>29.71</td>
</tr>
<tr>
<td>10</td>
<td>1.40</td>
<td>31.11</td>
</tr>
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</tr>
<tr>
<td>35</td>
<td>0.68</td>
<td>53.96</td>
</tr>
</tbody>
</table>

* The first 35 PCs have eigenvalues > 1.0 and also exceed the 0.05 level significance criterion of Overland and Preisendorfer (1982), based upon a logarithmic extrapolation of their published test.

to surrounding synoptic fields, we felt that the interpretation would be more straightforward if the dependent variables were independent of one another.

We tested the PCs for statistical significance with the Monte Carlo–based table of Overland and Preisendorfer (1982), after extrapolating to the very large sample size ($n = 9088$) with a logarithmic function. The published version of the test only applies to the 0.05 significance level.

The null hypothesis associated with this test is that the input data are spatially uncorrelated; i.e., there is no correlation between the 150 gridcells. Clearly, the dimensions of much of the organized Florida convection are greater than our gridcell size, so that the Overland and Preisendorfer test conveniently discriminates between PCs that realistically describe convective patterns and those that do not.

Another criterion often used to assess the statistical significance of a PC is whether or not the value of the associated eigenvalue exceeds 1.0, sometimes called the “Scree Test.” See Cohen (1983) for application to a climatological problem. Under the criterion, the variation explained by each PC is greater than the average variation explained by a raw input variable. This is informally similar to the discrimination made by the Overland and Preisendorfer test in this case.

Both tests indicated that the first 35 PCs were significant, with a total explained correlation structure of 54% of the radar data. However, we note that the logarithmic extrapolation of the Overland and Preisendorfer (1982) test is at best approximate, so that the apparent congruence between it and the Scree Test may only be by chance. Descriptive statistics are given in Table 1.

Maximum values of PC1 (Fig. 4) are concentrated over the peninsula, with the gradient especially congruent with coastline geometry. For example, the maximum is displaced towards the inland direction in the coastal bend between Cedar Key and Tampa, and also at Tampa Bay. Seaward displacement is also noted around Cape Romano, immediately southwest of the peninsular maximum. Isopleths also bend inland around Lake Okeechobee, mimicking the effect of that body of water as represented in the numerical model study of Pielke (1974). Inserted into Fig. 4 is the average value for each hour, indicating a discrete maximum in PC1 at 2000 UTC.

Note that our hourly values are approximately one-half hour after the standard observing period, which takes place nearer to the half hour. Thus our indicated maximum at 2000 UTC is actually closer to 1930 UTC.

High values imply above-mean activity in the regions where each PC is most positive. As shown in the insert, the value of PC1 begins a rapid rise around 1500 UTC (1100 EDT) followed by a rapid decline to neutral conditions (i.e., no “recognition” of this pattern) at 0100 UTC. The major bloom of activity related to this PC takes place over the entire peninsular axis quite suddenly between 1700 and 2000 UTC. The reverse pattern, below normal numbers over the peninsula (reflected by the most negative numbers in the hourly plot), is strongest from 0300 to 1400 UTC.

In PC2 (Fig. 5), the major oscillation is north–south along the axis of the peninsula, implying a tendency for an out-of-phase oscillation between the north and south halves of the peninsula. Its temporal behavior, also shown in Fig. 5, is substantially different from PC1; here the afternoon maximum is extremely sharp, and is shifted two hours earlier. At 2000 UTC, when PC1 reaches its highest value, PC2 is near zero. The reverse takes place at night. During most of the time that PC1 is most negative—implying suppressed activity over the peninsula—PC2 is again near zero. PC2 reaches its lowest values near 0000 UTC. This component’s behavior is reflective of the most likely daily march of convective activity, in which activity begins in the southeast and propagates northwesterward. It is unlikely that the entire peninsula experiences simultaneous activity.

PCs 3–5 are presented in Figs. 6, 7 and 8; as component order increases, physical interpretation becomes more speculative.

Taken as a composite, the most significant components efficiently describe the likely diurnal march of convection over south Florida. The initial afternoon bloom takes place quite suddenly between 1700 and 1800 UTC (PC2) over the midline of the southern extremity of the peninsula. This is followed by the displacement to the southwestern coast between 1800 and 2100 UTC seen in PC3. Note that the weightings plotted spatially in Fig. 8 (PC3) are negative, indicating above-mean activity when the amplitude of the component, shown in the temporal plot, is negative. This occurs only slightly before the major peninsular bloom
Fig. 4. First PC of MDR data (×100), and mean hourly value.

Fig. 5. As in Fig. 4 except for second PC.
Fig. 6. As in Fig. 4 except for third PC.

Fig. 7. As in Fig. 4 except for fourth PC.
(1900 to approximately 2200 UTC) of PC1. Finally, the center of activity shifts further to the northwest from 2000 to 2300 UTC (PC4). The most negative values of PC3 background the entire afternoon with suppressed activity over the surrounding water from 1700 to 2200 UTC; also included is a small coastal strip from Miami to Cape Romano. The temporal composite of the five most important PCs is shown in Fig. 9.

In that figure, the regions are demarcated by calculations based on characteristics of the PCs. The time is that at which the mean value of each of the associated PCs is 90% or more of its maximum range, and the space domain is where the values for gridcell coefficients [the $a_i$ from Eq. (1)] exceed 90% or more of the total range of all of the coefficients for that PC. This also applies in the negative sense if the $a_i$ are negative and the hourly mean values are also near their minimum.

b. Satellite composites

Preferential areas for deep cumulonimbus convection can also be described by composite satellite imagery. Unfortunately, only a limited number of cases could be evaluated because of expenses associated with the compositing of satellite data.

The satellite data used to make the composite images were collected from GOES-East by the Colorado State University Atmospheric Science Department's Direct Readout Satellite Earth Station (DRSES). The data were received and stored on magnetic tape for 28 synoptically undisturbed days during the summer (1 June–31 August) of 1983.

Data were collected every other hour from 1300 to 2300 UTC. Visible images were archived at 0.81 km$^2$ equatorial resolution and infrared at 12.9 km$^2$. Florida resolutions are approximately 10% larger.

The collected raw images were first sectorized into one image which centered on, and only included, south Florida and associated offshore waters. The sectorized images were then visually reevaluated to a standard position by landmark (lakes, coastlines, etc.) background.

Images were then reclassified with techniques similar to those described in Weaver and Kelly (1982) and Klett et al. (1985), as well as the bispectral method of Reynolds et al. (1978), which extracts information from both the infrared and visible ranges to create one reclassified image. The three resulting reclassifications (deep convection, developing cumulus, and low clouds) are extensively described in McQueen (1985). The first classification applies to this paper.

For deep convection, we used both cloud top temperatures ($CT$) from the infrared, and brightness count
The objective was to determine if there was enough information at the synoptic scale to reproduce the major MDR PCs empirically in the absence of an intervening mesoscale model.

The predictor variables were divided into several groups: 1) surface wind vectors and pressure from all stations; 2) 850 mb wind vectors and heights from all stations; 3) a combination of 1) and 2); 4) wind vectors over south Florida; and 5) the pressure difference down the length of the peninsula. The first three were PC-based in an attempt to reduce the number of possible predictors, while the last two used nontransformed data directly in a multiple regression.

The PC models used to reduce the number of predictors were of the form

**Model 1**

\[ PC_{j}(\text{sfc}) = \sum_{i=1}^{5} \alpha_i X_i(\text{sfc}) \]  

**Model 2**

\[ PC_{j}(850) = \sum_{i=1}^{5} \alpha'_i X'_i(850) \]  

**Model 3**

\[ PC_{j}(\text{comb}) = \sum_{i=1}^{5} \alpha_i X_i(\text{sfc}) + \sum_{i=1}^{5} \alpha'_i X'_i(850) \]  

where PC$_j$ refers to each $j$th PC, which is a linear combination of its weighting ($\alpha_i$ or $\alpha'_i$) and the input data ($X_i$). The $X_i$ included the following: surface pressure, $u$ and $v$ wind vectors (model 1); 850 mb height, $u$ and $v$ wind vectors (model 2), and the combination of input to models 1 and 2 (model 3). In each, the summation is over the five surface and/or 850 mb sites. The PCs of $u$, $v$, the surface pressure or the 850 mb heights were calculated simultaneously.

Subsequent regression models tested the hypothesis that daily fluctuations in the strength of the most important MDR PCs should be significantly related, in an empirical fashion, to the synoptic-scale variables.

The hypotheses to be tested can be summarized as:

1) the MDR PCs were significantly related to fluctuations in the overall peninsular 850 mb height, surface pressure, and wind vector fields,

2) the MDR PCs were related to daily fluctuations in the surface wind fields over the southern portion of the peninsula, and

3) they were related to the pressure gradient down the length of the peninsula.

The regression models were of the form:

**Models 1–3**

\[ \hat{Y} = K + \sum_{i=1}^{5} \beta_i PC_i + \sum_{i=1}^{5} \beta'_i PC_i^2 \]  

**Model 4**

\[ \hat{Y} = K + \sum_{i=1}^{5} \beta_i U_i + \sum_{i=1}^{5} \beta'_i V_i \]  

c. MDR composites and synoptic-scale winds

We then attempted to determine the degree to which the various MDR PCs could be related to synoptic-scale 850 mb and surface wind fields. The stations used are shown in Fig. 1.
Fig. 10. Time series of the evolution of satellite-sensed convective composites for all undisturbed days. Monochrome chart refers to percent of hours that the deep convection criteria are met. (a) 1700 UTC; (b) 1900 UTC; (c) 2100 UTC; (d) 2300 UTC.

Model 5

\[ \hat{Y} = K + \beta_1 \Delta P_i + \beta_1' \Delta P_i^2 \]  

where \( Y \) is the regression fit value of an individual MDR component, expressed as a function of \( K \), the regression constant, and the remaining variables on the right-hand sides. \( K, \beta_1 \), and \( \beta_1' \), of course, have different values in each model. For models 1–3, the predictor PC

In each case, we attempted to predict the midafternoon (2000 UTC) value of the MDR PCs using the morning (1200 UTC) surface and 850 mb data. Separate regression models were calculated for each of the first three MDR PCs. The final regression equation for each model was determined with a standard backwards elimination procedure, as described in Draper and Smith (1981). The PCs that remained in the final equation were significant at the 0.95 level. Representative model statistics are presented in Tables 2–6. The tables detail the dependent MDR PCs and the independent predictor PCs. Their predictor’s square is included where appropriate. Summary statistics include multiple correlation (\( R \)), the calculated F-ratio, and the significance of that value.

While there were statistically significant associations in all five models, correlation in models 4 and 5 are
Table 2. Statistical summary for model 1: First three MDR PCs vs surface wind vector and pressure PCs.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variables</th>
<th>Summary statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDR PC 1</td>
<td>SFC PCs, 2.3, 4, 5, 6, 8, 10^2</td>
<td>F = 7.32, R = 0.3390, Sig. level = 0.0999</td>
</tr>
<tr>
<td>MDR PC 2</td>
<td>SFC PCs, 1.7, 3</td>
<td>F = 22.51, R = 0.3805, Sig. level = 0.0999</td>
</tr>
<tr>
<td>MDR PC 3</td>
<td>SFC PCs, 1.2, 3, 8, 10^2</td>
<td>F = 15.70, R = 0.4006, Sig. level = 0.0999</td>
</tr>
</tbody>
</table>

Table 4. Statistical summary for model 3: First three MDR PCs vs surface and 850 mb wind vector and pressure PCs.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variables</th>
<th>Summary statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDR PC 1</td>
<td>SFC PCs, 1.2, 3, 4, 5, 6</td>
<td>F = 7.85, R = 0.4411, Sig. level = 0.0999</td>
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<tr>
<td>MDR PC 2</td>
<td>SFC PCs, 3.7, 10^2</td>
<td>F = 14.42, R = 0.5411, Sig. level = 0.0999</td>
</tr>
<tr>
<td>MDR PC 3</td>
<td>SFC PCs, 2.4, 8, 10^2</td>
<td>F = 15.53, R = 0.5476, Sig. level = 0.0999</td>
</tr>
</tbody>
</table>

Insula, indicates almost daily summer occurrence. However, R-values ranging between 0.34 and 0.55 in the first three models indicate some promise as forecast aids; they should be able to predict whether or not a given MDR component will be above or below normal on a given day.

Note that the correlation between the 850 mb variables and the radar PCs (model 2) is higher than it is for the surface variables (model 1). Further, when the two levels are combined (model 3), the increase in information contributed over the 850 mb level is much less than would have been contributed if the two levels provided independent forecast information.

3. Discussion and conclusions

An analysis of 450 summer days of MDR data provides an objective basis for an expanded peninsular Florida thunderstorm climatology, subject to the restrictions noted above.

The maximum frequency of radar-induced thunderstorm activity, near the southwestern tip of the pen-insula, indicates almost daily summer occurrence. However, the procedure used to generate the MDR data can overestimate spatial coverage of the individual thunderstorm cells. Thus, these frequencies refer more to the classical definition of thunderstorm ("thunder heard") than to the distribution of significant storm-related weather.

The PC analysis of the radar data economically indicates the most likely daily march of convection over south Florida. Convection tends to begin around 1800 UTC near the midpoint of a triangle bounded by Cape Romano, Miami, and Flamingo and then migrates west-northwest from 1900 to 2100 UTC before settling on the west coast near Fort Meyers from 2100 to 2200 UTC.

Table 3. Statistical summary for model 2: First three MDR PCs vs 850 mb wind vector and pressure PCs.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variables</th>
<th>Summary statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDR PC 1</td>
<td>850 mb PCs, 1.2, 3, 4, 8, 10^2, 3^2</td>
<td>F = 8.45, R = 0.3824, Sig. level = 0.0999</td>
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<tr>
<td>MDR PC 2</td>
<td>850 mb PCs, 1.3, 4, 5, 3^2, 4^2</td>
<td>F = 11.67, R = 0.4132, Sig. level = 0.0999</td>
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<tr>
<td>MDR PC 3</td>
<td>850 mb PCs, 1.2, 3, 5, 7, 3^2</td>
<td>F = 24.00, R = 0.5156, Sig. level = 0.0999</td>
</tr>
</tbody>
</table>

Table 5. Statistical summary for model 4: First three MDR PCs vs surface wind vectors at Key West (EYW) and Palm Beach (PBI).

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variables</th>
<th>Summary statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDR PC 1</td>
<td>u, PBI, v, EYW</td>
<td>F = 15.25, R = 0.2716, Sig. level = 0.0999</td>
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<tr>
<td>MDR PC 2</td>
<td>u, PBI, EYW</td>
<td>F = 14.15, R = 0.3592, Sig. level = 0.0999</td>
</tr>
<tr>
<td>MDR PC 3</td>
<td>u, PBI</td>
<td>F = 29.63, R = 0.2576, Sig. level = 0.0999</td>
</tr>
</tbody>
</table>
The statistically most important PC is the peninsular bloom of convection around 2000 UTC. Spatial analyses indicate that this pattern is highly congruent with mesoscale geographic features, including coastline conformation and Lake Okeechobee. Satellite composites of thunder activity, although generated from a much more limited dataset, corroborate the more extensive MDR analysis. Variation in the radar patterns—and the associated convective regime—can be related at the synoptic scale, primarily to the 850 mb height and wind fields. At that scale, the surface does not contribute as much information.

Our results objectively demonstrate the dominance of recurrent convective patterns over south Florida, even at scales as small as local coastline variation. Thus it seems likely that mesoscale dynamic and empirical analyses of these patterns will result in a quantitative improvement of our understanding, and our ability, to forecast local convection in such an environment.

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