Typical situation

Forecast

Observation

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Traditional verification matches up points, then sums them up.

Many forecasts are more than the sums of their parts.
Pixels or Pictures?
Object verification is more like what humans do.

Objects recognize the spatial relationship between points.
## Simple example

<table>
<thead>
<tr>
<th>Observed</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Observed Grid" /></td>
<td><img src="image" alt="Forecast Grid" /></td>
</tr>
</tbody>
</table>

- **Shifted**
- **Totally wrong**

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REAL - observed

Forecast 1 – Distorted view of reality

Forecast 2 – Another distorted view of reality
REAL - observed

Forecast 1 – Distorted view of reality

Forecast 2 – Another distorted view of reality

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We can compare attributes of forecast and observations even when they are not in the same place!

- Is the object in the right place? Centroid distance = 25
- Does the size of these objects match? Area ratio = 85%
- Is the intensity within the objects similar? 50 dBZ vs 40 dBZ
This is not really a new idea . . .

Analytic cubists "analyzed" natural forms and reduced the forms into basic geometric parts on the two-dimensional picture plane.

Analytic cubism was developed between 1908 and 1912 . . .
Comparing objects can tell you things about your forecast like . . .

<table>
<thead>
<tr>
<th>This:</th>
<th>Instead of this:</th>
</tr>
</thead>
<tbody>
<tr>
<td>30% Too Big (area ratio=1.3)</td>
<td>POD = 0.35</td>
</tr>
<tr>
<td>Shifted west 1 km (centroid distance = 1km)</td>
<td>FAR = 0.7235</td>
</tr>
<tr>
<td>Rotated 15° (angle diff = 15%)</td>
<td>CSI = 0.1587</td>
</tr>
<tr>
<td>Peak Rain 1/2” too much (diff in 90th percentile of intensities = 0.5)</td>
<td></td>
</tr>
</tbody>
</table>
Verifying with objects doesn’t always make sense . . .
• In MET, object based verification is done using the MODE (Method for Object-Based Diagnostic Evaluation) tool.

  – Define objects
  – Compute attributes (e.g. area, centroid, axis angle, intensity)
  – Merge objects (e.g. thunderstorm cells merge into line)
  – Match forecast and observed objects
  – Compare attributes between matches
  – Output summary statistics
Object verification

Forecast
6 hour accumulated precip

Observed
6 hour accumulated precip
Overlaid objects

75mm threshold

- Forecast objects
- Observed object

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