Auto-Nowcast System

Tom Saxen (July) – Huaqing Cai (Aug)
National Center for Atmospheric Research

Summer 2006 ATEC Forecaster Conference

Photo courtesy of Greg Thompson
Overview:

Introductory comments on the ANC system.

Discussion on how the ANC system works.

Role of the human in the ANC system.

Future plans.
What is the NCAR Auto-nowcast System?

It’s an automated, data fusion system that weights and combines all available data sets to produce short-term 0-1 hr nowcasts of thunderstorm initiation, growth and decay.

Primary focus of this presentation will be on the *initiation* forecasting capabilities since the hope is to provide this sort of capabilities at all ranges (except CRTC, sorry Craig) in the next few years.
**System Forecast Output**

**Initiation Likelihood Forecast**

**Blue Regions** - Little chance of storm development

**Green Regions** - Moderate likelihood

**Red Regions** - Areas of forecast initiation

**Combined Forecast**

**Extrapolation And Trending**

** Initiation Forecasts **
What is the difference between the ANC system and the MRRD (Multiple Regional Radar Display)/AN-Lite?

The MRRD/AN-Lite system is primarily a radar data display system with limited forecasting capabilities, providing simply 60 minute extrapolation forecast (both TREC motion vectors and TITAN storm motions).

The MRRD/AN-Lite system also utilizes NIDS data as it’s primary source of radar data, which is less than ideal. The ANC system utilizes the full beam to beam (or Level II radar data).
What ranges have what system?

<table>
<thead>
<tr>
<th></th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATC</td>
<td>MRRD/AN-Lite (with Level II radar data)</td>
</tr>
<tr>
<td>CRTC</td>
<td>None</td>
</tr>
<tr>
<td>DPG</td>
<td>MRRD/AN-Lite (with Level II radar data)</td>
</tr>
<tr>
<td>EPG</td>
<td>MRRD/AN-Lite</td>
</tr>
<tr>
<td>RTTC</td>
<td>MRRD/AN-Lite</td>
</tr>
<tr>
<td>WSMR</td>
<td>Full ANC system</td>
</tr>
<tr>
<td>YPG</td>
<td>MRRD/AN-Lite</td>
</tr>
</tbody>
</table>
What makes the Auto-nowcast System different from other thunderstorm nowcasting systems?

Most operational systems for generating analyses and short-period nowcasts of rainfall and other weather parameters rely on the presence of already existing storms. I.e. they are primarily extrapolation based systems.
Data Sets
- Radar
- WSR-88D
- Satellite
- Mesonet
- Profiler
- Sounding
- Numerical Model
- Lightning

Forecaster Input

Analysis Algorithms

Predictor Fields

Final Prediction

Fuzzy Logic Algorithm
- Membership functions
- weights
- Combined likelihood field
Separate sets of forecast logic for different types of convective regimes.
Predictor Fields used for Initiation Likelihood Forecast

- **Environmental conditions (RUC or RT-FDDA)**
  - Frontal likelihood
  - Layered stability
  - CAPE (max between 900 and 700 mb)
  - CIN (mean value between 975 and 900 mb)
  - Mean 875 to 725 mb Relative Humidity

- **Boundary-layer**
  - Convergence
  - LI (based on METARS)
  - Vertical velocity along boundary (maxW)
  - Boundary-relative steering flow
  - New storm development along boundary

- **Clouds**
  - Clear or Cumulus
  - Vertical develop as observed by drop in IR temps
Flow Chart for the Auto-Nowcaster System

Data Sets
- Radar
- WSR-88D
- Satellite
- Mesonet
- Profiler
- Sounding
- Numerical Model
- Lightning

Forecaster Input

Analysis Algorithms

Predictor Fields

Fuzzy Logic Algorithm
- Membership functions
- weights
- Combined likelihood field

Final Prediction
Example of fuzzy logic
Predictor Field 1

Convergence line

Lifting Zone

Membership Function

Likelihood

Yes

No

Lifting Zone

0

.5

Likelihood

.5

NCAR
Predictor Field 2

Convergence

Membership Function

Likelihood

Convergence

Likelihood

.1

.2

.3

.1

.2
Predictor Field 3

Membership Function

Cumulus cloud type

Likelihood

-1

0

1

.8

.4

-.5

-1

Likelihood

-.5

-.5

.4

-.5
Likelihood 1

Likelihood 2

Likelihood 3

Weight 1

Weight 2

Weight 3

\[ \sum \]

Final combined likelihood of initiation
<table>
<thead>
<tr>
<th></th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boundary Collision:</td>
<td>0.12</td>
</tr>
<tr>
<td>Sat_Clear:</td>
<td>0.40</td>
</tr>
<tr>
<td>Lake:</td>
<td>0.10</td>
</tr>
</tbody>
</table>

**Initiation Levels:**

- 0.70 => Init 1
- 0.90 => Init 2
- 1.20 => Init 3
System Forecast Output

Initiation Likelihood Forecast

**Blue Regions** - Little chance of storm development

**Green Regions** - Moderate likelihood

**Red Regions** - Areas of forecast initiation

Combined Forecast

Extrapolation And Trending

Initiation Forecasts
Why do we need a forecaster in the loop??
(or rather over the loop)

- **Forecasters see the larger picture**
  - Conceptual Models
  - Ignore bad data points
  - Understand limitations of NWP and observations
- **Set current convective regime so appropriate forecast logic is utilized**
- **Input significant surface convergence features (cold fronts, dry lines, gust fronts, etc.)**
Entering a convergence boundary in real time is as simple as this demonstration!
Forecaster Tools: Boundary Entry
Future Plans:  
Transition to Probabilistic Forecast Product

- Idea is to transition the ANC forecast products to a probabilistic product.

- Goal is to implement this within the WSMR ANC system for next summer (2007).
Transitioning ANC Forecasts to Probabilities

**Current Initiation Interest Field**

- **Reds**: Initiation expected
- **Greens**: Regions of moderate likelihood
- **Blues**: No initiation is expected

**Current Final Forecast Field**

- **Blue areas**: Initiation regions
- **Yellow/Orange/Reds**: Growth/Decay Fcst
Transitioning ANC Forecasts to Probabilities

Example possible probabilistic final forecast field

- Includes both initiation and growth/decay information.
- Warmer colors represent higher probabilities of convection.
- Still need to finalize these methods and also calibrate the probabilities.

Verification reflectivities (> 35 dBZ) are overlaid.
Future Plans: 
Testing Enhancements at Other Ranges

• Would like to test the ANC-like capabilities at a range or possibly two.

• Idea is to utilize model data with other local data sets to produce an initiation likelihood field.

• Timeline for this is still not clear.
Future Plans:

0-6 hour Convective Weather Forecast Product

• New effort in underway in the convective weather group to develop a 0-6 hour convective weather product.

• Idea is to merge ANC-like capabilities with numerical model output to produce these forecasts.

• The Army test ranges would be ideal candidates for these systems due to access to high quality meso-scale models and ANC-like capabilities.
1-6 hr Probability Forecasts

**Extrapolation**

Fcst Valid Times: 1600 – 2200 UTC by 60 min

**RUC Convective Probabilities**

Fcst Valid Times: 1600 – 2200 UTC by 120 min

Radar Data 1400- 1600 UTC by 30 min
1-6 hr Merged Probability Forecast – Linear summation

WSI: 1400-1600 UTC by 30 min; Fcst: 1600 – 2200 UTC by 60 min
Questions/Discussion.....