Evaluation of RAMS in the Eastern Range Dispersion Assessment System

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Presentation Outline

- Background on ERDAS
- Configuration
- Methodology
  - Objective and Subjective Components
- Objective Results
  - Surface Temperature, Moisture, and Winds
- Subjective Results
  - Sea Breeze Verification
- Summary
Background on ERDAS

- Space Launches → Emergency Response Guidance at Cape Canaveral Air Force Station

- Regional Atmospheric Modeling System (RAMS)

- AMU evaluated prototype ERDAS RAMS
  - AMU recommended changes → implemented
  - Replacement ERDAS system includes changes
Background on ERDAS

- Additional ERDAS configuration changes
  - RAMS model upgrade
  - Finer resolution on inner forecast grid
  - Full cloud microphysics

- Systematic evaluation of current ERDAS needed to validate new configuration

- Forecast tools for 45th Weather Squadron
Grid | nx | ny | nz | dx (km) | dt (s)  
--- | --- | --- | --- | --- | ---  
1  | 36 | 40 | 33 | 60 | 45  
2  | 38 | 46 | 33 | 15 | 45  
3  | 41 | 50 | 36 | 5  | 22.5  
4  | 74 | 90 | 36 | 1.25 | 7.5  

RAMS Nested Grid Configuration in ERDAS
RAMS Initialization and Forecast

- Data obtained at 0000 and 1200 UTC
  - 12-h forecast from Eta model
  - Rawinsondes, surface stations & buoys
  - Local wind towers
  - 5 local 915 MHz & 1 local 50 MHz DRWP

- Isentropic analysis using Barnes scheme
- Cold start (no technique to balance data w/ model)
- 24-h RAMS forecasts generated
- Hourly forecast output available
RAMS Operational Cycle

- Eta 12 to 36-h forecasts as boundary conditions
- Run on (3) HP-K460 (11 processors total)
- Prognostic data still available for 1-cycle failure
RAMS Evaluation Methodology

- Objective component (May – August 1999)
  - Point verification of 4-grid RAMS configuration
    » Bias, RMS Error, Standard Deviation of error
    » T, Td, Wind direction & Speed
    » All available observational data on grid 4
    » Surface land, buoy, & weather balloon sites on grids 1-3
  - Horizontal resolution experiment
    » Run RAMS with 3-grid configuration (grids 1-3 only)
    » Compare errors to 4-grid configuration
  - Eta model benchmark
    » Compare RAMS to national-scale Eta model
Methodology (cont.)

- Subjective Component (grid 4 only)
  - Central Florida east coast sea breeze (May – Aug 1999)
    » Occurrence (Doppler radar & visible satellite data)
    » Onset & propagation (13 local wind towers)
    » Compare with RAMS forecasts at 13 wind towers
13 Local Wind Towers used for Sea Breeze Verification

Kennedy Space Center

Cape Canaveral Air Force Station

Mainland Florida

Atlantic Ocean
Methodology (cont.)

- Subjective Component (grid 4 only)
  - Precipitation verification
    - Occurrence (Doppler radar 1-h rain rates)
    - Identify forecast rain (any measurable rain in model)
    - 6-zone classification scheme on grid 4 (see paper)
Objective Results: 0000 UTC 4/3-grid Cycle Temperature (°C, wind towers at 1.8 m)

Mean Obs vs. Forecast

Bias

RMS Error

Standard Deviation

Forecast Hour

Forecast Hour
0000 UTC 4/3-grid Cycle: Wind Speed (m s^{-1})
(wind towers at 16.5 m)

Mean Obs vs. Forecast

Bias

RMS Error

Standard Deviation

Forecast Hour

Forecast Hour
0000 UTC 4/3-grid Cycle: Wind Dir (deg) (wind towers at 16.5 m)

Bias: All Forecasts

RMS Error: All Forecasts

Bias: Completed Runs

RMS Error: Completed Runs

Forecast Hour

Forecast Hour
Subjective Sea Breeze Verification
(May – Aug, 0000 & 1200 UTC)

TABLE 1. Contingency table of sea breeze occurrence.

<table>
<thead>
<tr>
<th></th>
<th>Observed Sea Breeze</th>
<th>No Observed Sea Breeze</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecast Sea Breeze</td>
<td>110</td>
<td>3</td>
</tr>
<tr>
<td>Sea Breeze Not Forecast</td>
<td>6</td>
<td>16</td>
</tr>
</tbody>
</table>

Probability of Detection: 0.95  False Alarm Ratio: 0.03
Critical Success Index: 0.92  Heidke Skill Score: 0.74

TABLE 2. Sea breeze timing error statistics.

<table>
<thead>
<tr>
<th></th>
<th>0000 UTC</th>
<th>1200 UTC</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE (h)</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>RMS (h)</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>SD (h)</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Bias (h)</td>
<td>-0.2</td>
<td>0.1</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Summary

- Temp. & Dew point: Cool, dry daytime bias
  - RMS Error of 4.5 °C in 4-grid, 8 °C in 3-grid config.

- Wind Dir: 50-70° RMS error, Unbiased
  - 15-20° observational variability (Merceret 1995)
  - Largest during nighttime hours (light wind regimes)
  - Smallest error in 4-grid config. during quiescent regimes
    - Post sea breeze ~ 30°
    - 10-15° model error
  - Anomalous precipitation forecasts → Large wind errors

- Wind Speed: Positive bias in 4-grid forecasts

- RAMS: Excellent in forecasting onset and movement of central FL ECSB
Future Work

- **1999-2000 cool-season verification**
  - Cold fronts and associated precipitation
  - Low temperatures and low-level inversions

- **2000 warm-season evaluation**
  - First thunderstorm of the day
  - Additional sea breeze verification
  - Precipitation verification

- **AMU Quarterly reports:**
  
  [http://technology.ksc.nasa.gov/WWWaccess/AMU](http://technology.ksc.nasa.gov/WWWaccess/AMU)