DICast®:
A Dynamic Integrated ForeCast System

NCAR/RAL

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The DICast® System

- An automated point weather forecast system
- Provides timely, tuned, worldwide forecasts
- Designed to emulate the human forecast process
- Applicable to a variety of forecast problems
- Uses state-of-the-art scientific and engineering principles
- Requires only modest computing systems and common data sources
- Custom data sources can add skill
Applications of DICast®

- Lay forecasts for the public
- Road Weather Forecasts
- Agricultural Soil Forecasts
- Wind Turbine Forecasts
- Solar Power Forecasts
DICast® Output and Operations

- Can produce a variety of tuned forecast variables

- Daily Max/Min Temp
- Probability of Precip
- Precip Amount and Type
- Temp & Dew point
- Wind u-, v-, speed
- Cloudiness
- Probability of Thunder
- Probability of Fog
- Visibility
- More…
DICast® Output and Operations

- Can be set up in different temporal configurations

<table>
<thead>
<tr>
<th></th>
<th>Extent</th>
<th>Resolution</th>
<th>Update Freq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Term</td>
<td>0-16 days</td>
<td>3 or 6 hours</td>
<td>3 hour</td>
</tr>
<tr>
<td>Short Term</td>
<td>0-4 days</td>
<td>1 or 3 hours</td>
<td>1 hour</td>
</tr>
<tr>
<td>Near Term</td>
<td>0-24 hrs</td>
<td>1 hour</td>
<td>1 hour</td>
</tr>
</tbody>
</table>
Can produce tuned (with observations) or interpolated forecasts for thousands of locations
Basic DICast® System Diagram

- Data Ingest
  - Forecast Module A
  - Forecast Module B
  - Forecast Module C
  - Forecast Module D
  - Forecast Module N

- Integrator
- Post Processing
- Forecast Products
Dynamic MOS

Data Ingest

Forecast Module A
Forecast Module B
Forecast Module C
Forecast Module D
Forecast Module N

Integrator

Post Processing

Forecast Products
Dynamic MOS

- Linear regression-based statistical method
- Similar to NWS MOS, but regressions built dynamically
- Can be applied to any NWP forecast model fairly easily
- Uses “default equations” if statistical model fails.
DMOS Default Equations

- Default equations are substituted whenever the statistical methods fail to produce a suitable result.
- Default equations are combinations of one or more of the regressors.
- Several regressors were designed specifically as defaults.
- Example: Surface Temp:

  - Model's Station Elevation
  - Actual Station Elevation
  - Model's Vertical Temperature Profile
  - DICAST Estimated Surface Temperature
Regression Extrapolation

**Regression**

MaxT = 35 + .13 \times CAPE

**Application**

CAPE = 2500 J

MaxT = 35 + .13 \times 2500

= 360 F

CAPE Range

0-250

Applied CAPE: 2500
Forecast Integrator

Data Ingest

Forecast Module A
Forecast Module B
Forecast Module C
Forecast Module D
Forecast Module N

Integrator

Post Processing
Forecast Products
Forecast Integrator Objectives

To combine forecasts from a set of models:

• *Discovers the “best” combination of forecast modules for a given forecast time and location.*

• *Computationally simple and robust.*

• *Can easily adapt to the addition of new modules or removal of obsolete modules.*
DICast® Forecast Integrator

• Integrated forecasts ($F$) are bias-corrected, confidence-weighted sums of the module inputs ($f_i$):

$$ F = \left( \sum c_i w_i f_i \right) / \left( \sum c_i w_i \right) + \text{Bias} $$

• Confidences ($c_i$) are determined by the forecast modules themselves.

• Weights ($w_i$) are adjusted daily in the direction of steepest descent of the error (difference between verification, $V$, and the forecast) in weight space

$$ \Delta w_i = S \left( \partial / \partial w_i \right) \{(V - F)^2\} $$
Forecast Integrator

Forecast error as function of $W_1$ & $W_2$
Post Processing

• Quality Control
  • Range Checks
  • Minimal Inter-variable comparisons
• Temporal Interpolation
• Spatial Interpolation
• Variable Derivation
• Forward Error Correction

![Graph showing temperature change over time with raw and corrected data comparison.](image-url)
Forecast Products

Data Ingest

Forecast Module A
Forecast Module B
Forecast Module C
Forecast Module D
...Forecast Module N

Integrator

Post Processing

Forecast Products
Forecast products

- Output Data Formats:
  - netCDF
  - ASCII - CSV
- Data can plug into other systems
- Decision Support
DICast® Advantages

DICast® forecasts:
- Outperform every constituent forecast module
- Outperform human beyond 12 hours
  - Based on sponsor feedback
- Are totally automated
- Are more cost effective than human generated forecasts

DICast® is scalable
- Additional sites, NWP models or new forecast variables can be easily integrated
Short Range Predictions
(0-96 hours)

Weighted average RMSE of short-term 18z temperature forecasts from 20090317 to 20090420 for all MOS sites

- 0-60 hour total average rmse for DICAST = 1.8429
- 0-60 hour total average rmse for gfs-mec = 2.3061
- 0-60 hour total average rmse for mav-mos = 2.1692
- 0-60 hour total average rmse for met-mos = 2.0774
- 0-60 hour total average rmse for nam-mec = 2.3147

Temperature

Lead Time (hour out)
Short Range Predictions
(0-96 hours)

Weighted average RMSE of short-term 18z dewpoint forecasts from 20090317–20090420 for all MOS sites

- 0–60 hour total average rmse for DICAST = 2.9611
- 0–60 hour total average rmse for gfs–mec = 2.0154
- 0–60 hour total average rmse for mav–mos = 2.7407
- 0–60 hour total average rmse for met–mos = 2.5237
- 0–60 hour total average rmse for nam–mec = 2.7145

Dew Point Temperature
Short Range Predictions (0-96 hours)

Weighted average RMSE of short-term 18z wind-speed forecasts from 20090317-20090420 for all MOS sites

- 0-60 hour total average rmse for DICAST = 1.6924
- 0-60 hour total average rmse for gfs-mec = 1.8413
- 0-60 hour total average rmse for mav-mos = 1.8055
- 0-60 hour total average rmse for met-mos = 1.8684
- 0-60 hour total average rmse for nam-mec = 1.9224

Wind Speed
Medium Range Predictions (0-10 days)

Weighted average RMSE of long-term 18z temperature forecasts from 20090310–20090413 for all MOS sites

- 0–180 hour total average rmse for DICAST = 2.8585
- 0–180 hour total average rmse for climo-fcst = 4.7321
- 0–180 hour total average rmse for gfs-mec = 8.2059
- 0–180 hour total average rmse for mex-mos = 3.2091

Temperature
Medium Range Predictions (0-10 days)

Weighted average RMSE of long-term 18z dewpoint forecasts from 20090310–20090413 for all MOS sites:

- 0–180 hour total average RMSE for DICAST = 3.6006
- 0–180 hour total average RMSE for climo–fcast = 5.688
- 0–180 hour total average RMSE for gfs–mec = 3.3366
- 0–180 hour total average RMSE for mex–mos = 3.8406

Dew Point Temperature