Optimizing the Impact of GOES Sounder Products in Very-short-range Forecasts - Recent Results and Future Plans

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BACKGROUND

What are we trying to improve?

Short-range forecasts of timing / location of severe thunderstorms - especially hard-to-forecast, isolated summer-time convection

Basic questions addressed here include:

1 - What are NearCasts?

2 - How can forecasters use NearCasts to improve forecaster awareness and reduce false alarms?

3 - Can GOES sounder data be incorporated to improve short-range forecasts of the Pre-Convection Environment ?

What are NearCasts?

NearCasts are 1-9 hour forecasts specifically designed to monitor conditions where hazardous weather will (or will not) form.

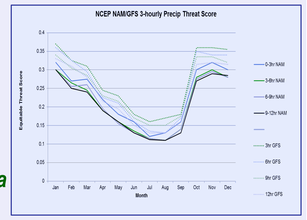
NearCasts :

- *Add a forecast component to GOES observation*
- *Are available within minutes of observation times,*
- *Are frequently updated (hourly or sub-hourly), and*
- *Are Data-Driven - use observations more than traditional NWP products*

Note: GOES NearCasts use high-density observations of Moisture and Temp obtained over land that are not used in any operational NWP system

What are we trying to correct?

- *Poor precipitation forecast accuracy in short-range NWP (especially in summer), a time when GOES IR soundings are least impacted by clouds*
- *Time lags in providing NWP guidance updates*
- *Under-utilization of GEO satellite moisture data over land in NWP and subjective forecasting*
- *Excessive smoothing of mesoscale moisture patterns in NWP data assimilation*



- *Lack of IR satellite information about convective environments after storms begins*
- *Provide forecasters with objective, observation-based tools to detect and monitor the pre-convective environments 1-9 hours in advance*

NearCasts Transform GOES Observations into Forecasts

- **NearCasts use hourly updated projections of GOES soundings over land to *fill the 'information voids'* between 0-1 hour Nowcasts and longer-range NWP guidance**
- **NearCasts *include implicate fusion with NWP products* by using the most recent GFS forecasts as 'first guess' fields for the hourly updated GOES temperature/moisture retrievals.** *Note: GOES sounder products are not likely to be used in ANY operational NWP for many years*
- **NearCasts of the pre-convective environment are *not affected by errors caused by convective 'parameterization' in NWP models***
- **NearCast output can be fused with and enhance short-range mesoscale NWP and ensemble forecasts by *providing hourly-updated real-time validation, reinforcing good forecasts, reducing false alarms & adding data-driven information about the timing and location of convection* during the next 6-9 hours**

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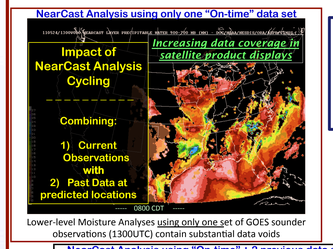
RECENT ACCOMPLISHMENTS

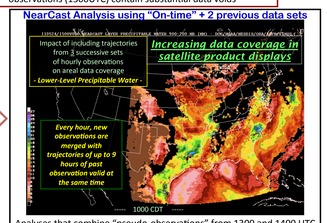
Forecaster evaluations of NearCasts from HWT / AWC in 2011 included:

1. **Want information about dynamic triggering** *(underway)*
2. **Extend forecast length** *(increased from 6 to 9 hours)*
3. **Clouds can limit the usefulness of product** *(Extended analysis cycling using past data has helped – Discussed Below)*
4. **Nearcast fields (especially tendencies) were most useful for diagnosing initial growth and coverage**
5. **Nearcasts most valuable when used in conjunction with observations and other model data (both where convection *will* and *will not* occur)**
   - *Useful in updating/verifying NWP guidance (and NWP skill only ~15% in summer)*

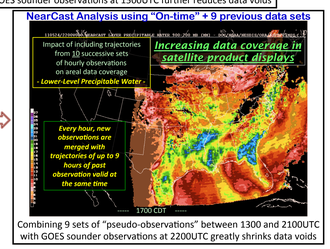
Forecasters needed more education, training and experience with new products and help interpreting analyses and combined NearCast parameters



Lower-level Moisture Analyses using only one set of GOES sounder observations (1300UTC) contain substantial data voids

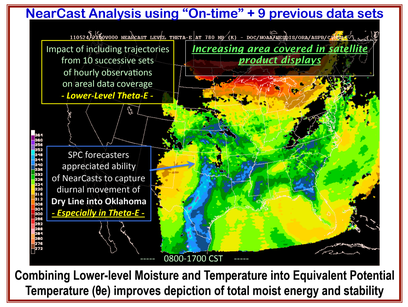


Analyses that combine "pseudo-observations" from 1300 and 1400 UTC with GOES sounder observations at 1500UTC further reduces data voids



Combining 9 sets of "pseudo-observations" between 1300 and 2100UTC with GOES sounder observations at 2200UTC greatly shrinks data voids

NearCasts analyses improve areal coverage of GOES observations by including data from up to 10 previous observation times



Combining Lower-level Moisture and Temperature into Equivalent Potential Temperature (θe) improves depiction of total moist energy and stability

Using Equivalent Potential Temperature (θ e) to improves NearCast products by:

1) Monitoring combined lower-level moisture/ temperature sources and

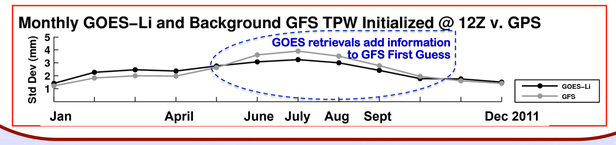
2) Better defining Convective Destabilization processes

Evaluating the quality of the input GOES retrievals

(Comparing GOES Total Precipitable Water and NCEP GFS retrieval First-Guess fields using surface GPS observations as truth)

Assuring that the GOES data provide information beyond that already in the models

- **GOES TPW data have a wet bias** *(which will be removed in future NearCasts)*
  - *Worst at time of day when GFS has highest precipitation bias*
- **GOES TPW data show substantial improvement over First Guess:**
  1) In warm months (when NWP precipitation skill is worst) and
  2) Using 06Z, 12Z and 18Z GFS guess fields



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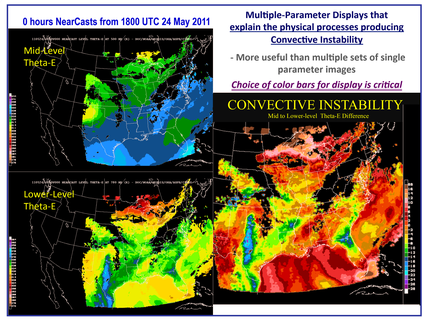
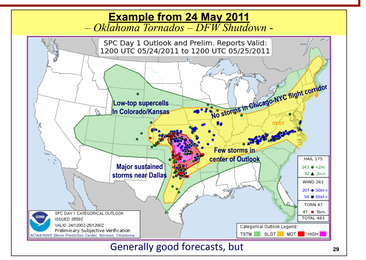
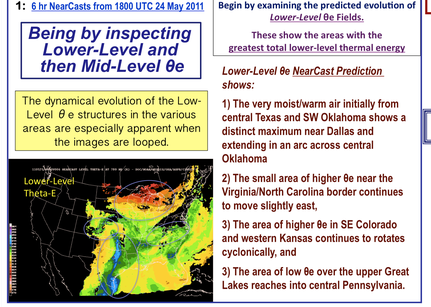
Case Study and Training – 24 May 2011

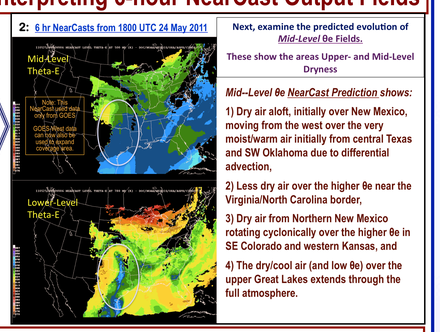


← Initial Conditions from 1800 UTC and Severe Weather Observations ↓



Interpreting 6-hour NearCast Output Fields

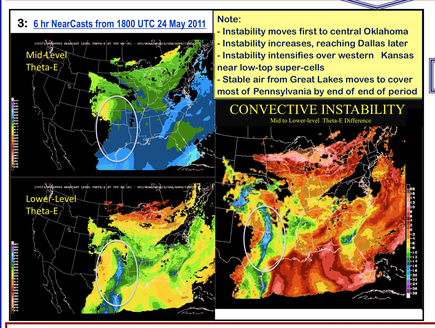




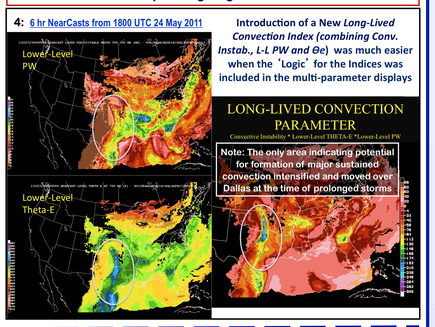
To help identify areas where differential advection is forcing upper-level dry/cool air to override lower-level warm/moist air, the fields can be subtracted to determine the Deep-Layer Convective Instability (a "Modified LI", with an unstable threshold of -4°)

GOES/SEVIRI observe this well !

Note: The Instability well only be released in areas where Low-level lifting is also present



Finally, a "Long-Lived Convection Index" has been introduced to isolate areas where:
1) Convection is likely to form rapidly, and
2) Ample low-level warm & especially moist air can sustain prolonged growth



Example shows that NearCasts provided real-time information about timing, location, intensity and longevity of convection 6-9 hours in advance.

See Examples on Laptop for more Detail and Cases

CURRENT AND FUTURE PLANS

☑ **Continue efforts to use POES data to remove GOES biases**

- *Initial tests using AIRS retrievals showed larger errors and bias variability over land than GOES*
- *GPS/TPW now providing primary bias correction data - Other AIRS/IASI retrievals being considered*

☑ **Converting NearCasting model to Isentropic Coordinates**

- *Adds lifting/sinking information in adiabatic flow (appropriate for clear-air GOES IR Retrievals)*
- *Improves synergy between weighting function peaks and model configuration*
- *Provides more levels of information needed for additional output parameters (e.g., CAPE, CINH)*

☑ **Provide Objective Verifications** *(and participate in new PG activities)*

- *Use parameters relevant to specific forecast problems (e.g., SPC, AWC, HPC, OPC)*
- *First need to remove diurnal variations in biases to make results meaningful*

☑ **Improve Synergy with other GOES-R Projects**

- *Include NearCasts in Convective Initiation products and SEVIRI applications*