NearCasting Convective Destabilization using Objective Tolls which Optimize the Impact of Sequences of GOES Moisture Products

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BACKGROUND

NearCasts: FILLING THE GAP between observation-based Nowcasts and later-arriving NWP

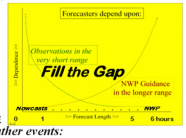
Basic premises - NearCasting Models Should:

Update/Enhance NWP guidance:
- Be Fast (valid 0-6 hrs in advance)
- Be run frequently
  - *Can avoid 'computational stability' issues of longer-range NWP*

Use all available data quickly:
- "Draw closely" to good data
  - *Avoid 'analysis smoothing' issues of longer-range NWP – keep data extremes*

Be useful in anticipating rapidly developing weather events:
- "Perishable" guidance products – need rapid delivery
  - *Avoid 'computational resources' issues of longer-range NWP*
  - *Run Locally? – Few resources needed beyond comms, user training*

Focus on the "pre-storm environment"
- *Short-range forecasts of timing and locations of severe thunderstorms*
- *Especially hard-to-forecast, isolated summer-time convection*

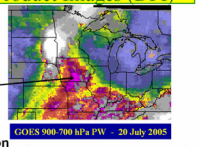


Goals:
- *Increase the length of time that forecasters can make good use of frequent, quality GOES observations to supplement NWP guidance in 1-6 hour forecasts*
- *Provide objective tools to help them do this*

A Specific Objective: Expand the benefits of valuable *Moisture Information* contained in GOES Sounder Derived Product Images (DPI)

GOES Sounder products images already are available to forecasters

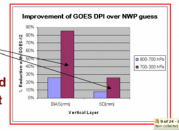
Products currently available include:
- *Total column Precipitable Water (TPW)*
- *3-layers Precipitable Water (PW)*
- *Stability Indices, . . .*

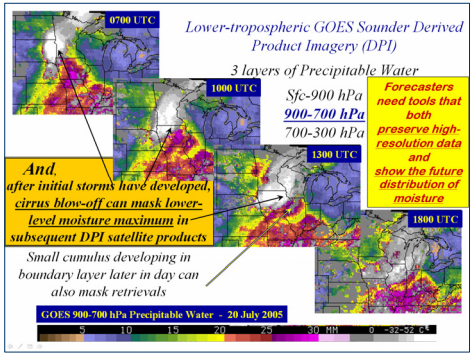


DPI Strengths and Current Limitations

+ **Image Displays speed comprehension of information in GOES soundings, and**
+ **Data Improve upon Model First Guess.**

but
- **Products used *only* as observations, and**
- **Currently have no predictive component**
  - *Data not used in current NWP models*





What are the benefits of a Lagrangian NearCasting approach?

Extending a proven diagnostic approach to prediction

- **It is Quick** – *and these forecasts are VERY parishable*

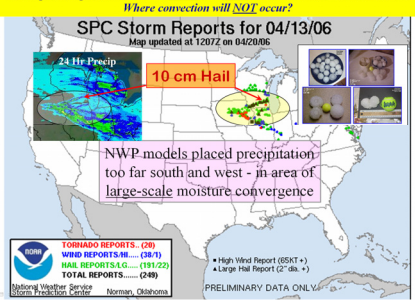
DATA DRIVEN

- **Data are used directly - no 'analysis smoothing'**
  - *Retains observed maxima and minima and extreme gradients*
- **Variable Spatial resolution**
  - *Automatically adjusts to available data density*
- **GOES products can be projected forward at full resolution**
  - *NearCast products exist even after clouds form and subsequent IR observations are no longer available*
- **New data are added at time observed**
  - *NearCasts updated as soon as GOES sounder products are available*
  - *Data combined over multiple observation times*

CASE STUDY

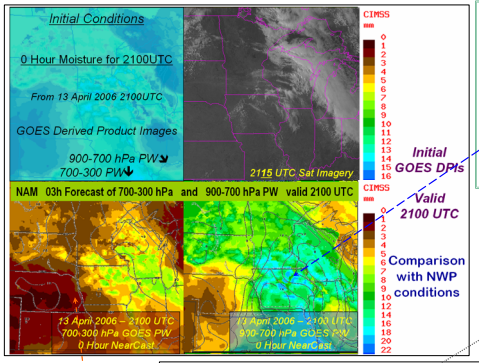
A case study was conducted for the hail storm event of 13 April 2006 that caused major property damage across southern Wisconsin

The important questions are both where and when severe convection will occur, and Where convection will NOT occur?



Progression of convective system requires *development and release of convective instability*, whereby differential advection first forces low-level moisture to be overtaken by subsiding dry air aloft and then have the convective instability released in areas of low-level lifting

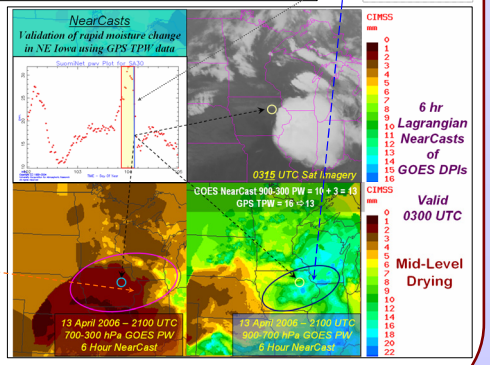
NearCast Model Results



NearCast transports low-level Moisture initially over NE Iowa ENE^ly into So WI in 6 hr

Rapid increase and decrease of TPW over NE IA validated by GPS TPW reports

Simulaneously, NearCast transports leading edge of mid-level Dryness initially over SE Nebraska more rapidly easterward into So WI due to differential wind direction and speed shears



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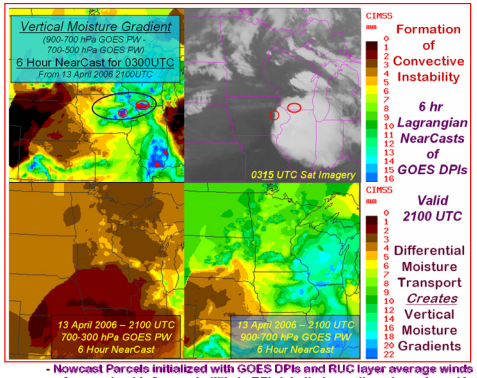
Nearcast of Convective Destabilization

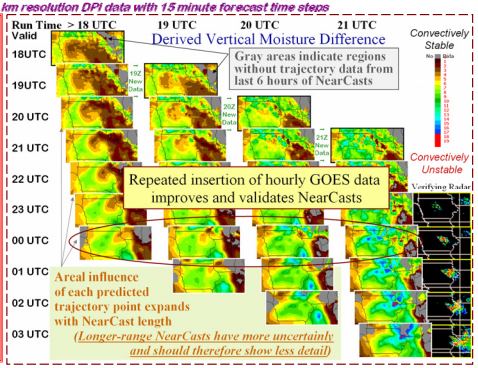
Coincident ENE transport of low-level moisture and East-ward transport of leading edge of mid-level dryness in 6-hr Lagrangian NearCasts created isolated areas of convective instability when and where convection developed



Accuracy of GOES data and dynamical approach allows NearCasts to isolate areas of Convective Destabilization several hours in advance and independently of NWP convective parameterizations

- **Nowcast Parcels initialized with GOES DPIs and RUC layer average winds**
  - *Approach adds forecast utility to DPI data that are otherwise not used in NWP*
  - **Trajectory approach:**
    - **Retains tight gradients in DPI moisture data**
    - **Includes dynamical wind adjustments**
    - ***Is very efficient***
    - ***Uses full 10 km resolution DPI data with 15 minute forecast time steps***

Frequent updates of GOES data and speed of NearCast trajectory approach fosters repeated updating of products – improving input data and validating previous runs



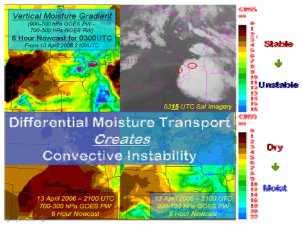
Summary – An Objective Lagrangian NearCasting Model

- **Quick and minimal resources needed**
- **Can be used 'stand-alone' or to 'update' other NWP guidance**

DATA DRIVEN at the MESOSCALE

- **Data can be inserted (combined) directly retaining resolution and extremes**
- **NearCasts retain *useful* maxima and minima – image cycling preserves old data**

Forecast Images agree with storm formations and provide accurate/timely guidance



Goals met:
- *Provides objective tool to increase the length of time that forecasters can make good use of detailed GOES moisture data in their short range forecasts (augment smoother NWP output)*
- *Expands value of GOES moisture products from observations to short-range forecasting tools*
- *Testing planned in NWS offices*