Consolidated Storm Prediction for Aviation (CoSPA) Overview

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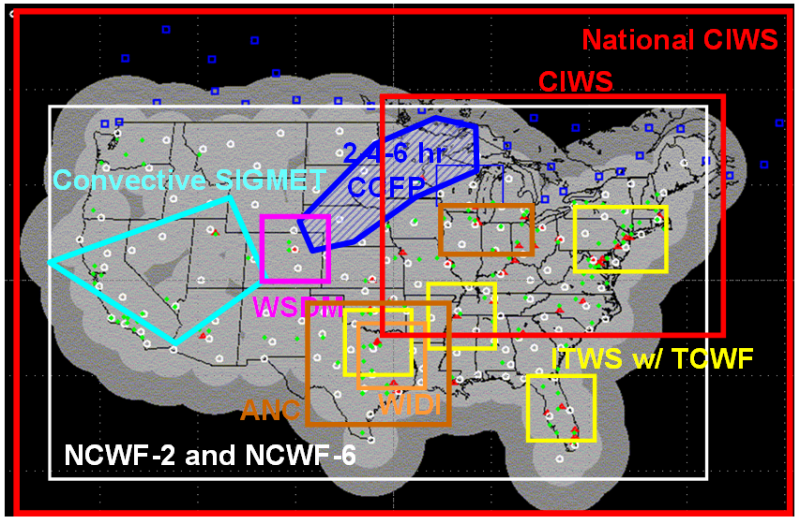
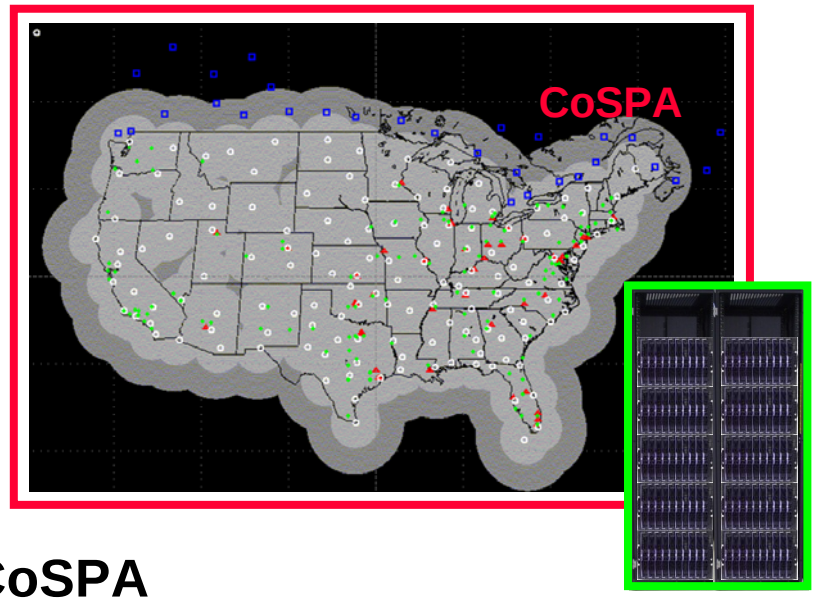
27 September 2007

FAA NextGen Thrusts

- **Implement research aimed at improving observation, forecasts, and weather suitable for use by ATM, and flight deck decision support tools**
- **Implement technologies which allow user access without user detailed knowledge of source or unique/proprietary interfaces**
- **Implement standardized development and implementation methods which allow for rapid update of capabilities**
- **Develop the authoritative weather data repository—known as the 4-dimensional data cube—which will provide net-centric access by system users to consistent, tactical- and strategic-level weather information**
  - Use of SWIM for core services
  - CoSPA forecasts to be available via the cube
- **Implement the NextGen Initial Operating Capability leveraging technologies from the research, commercial vendor and other Government sources**

Inception of CoSPA

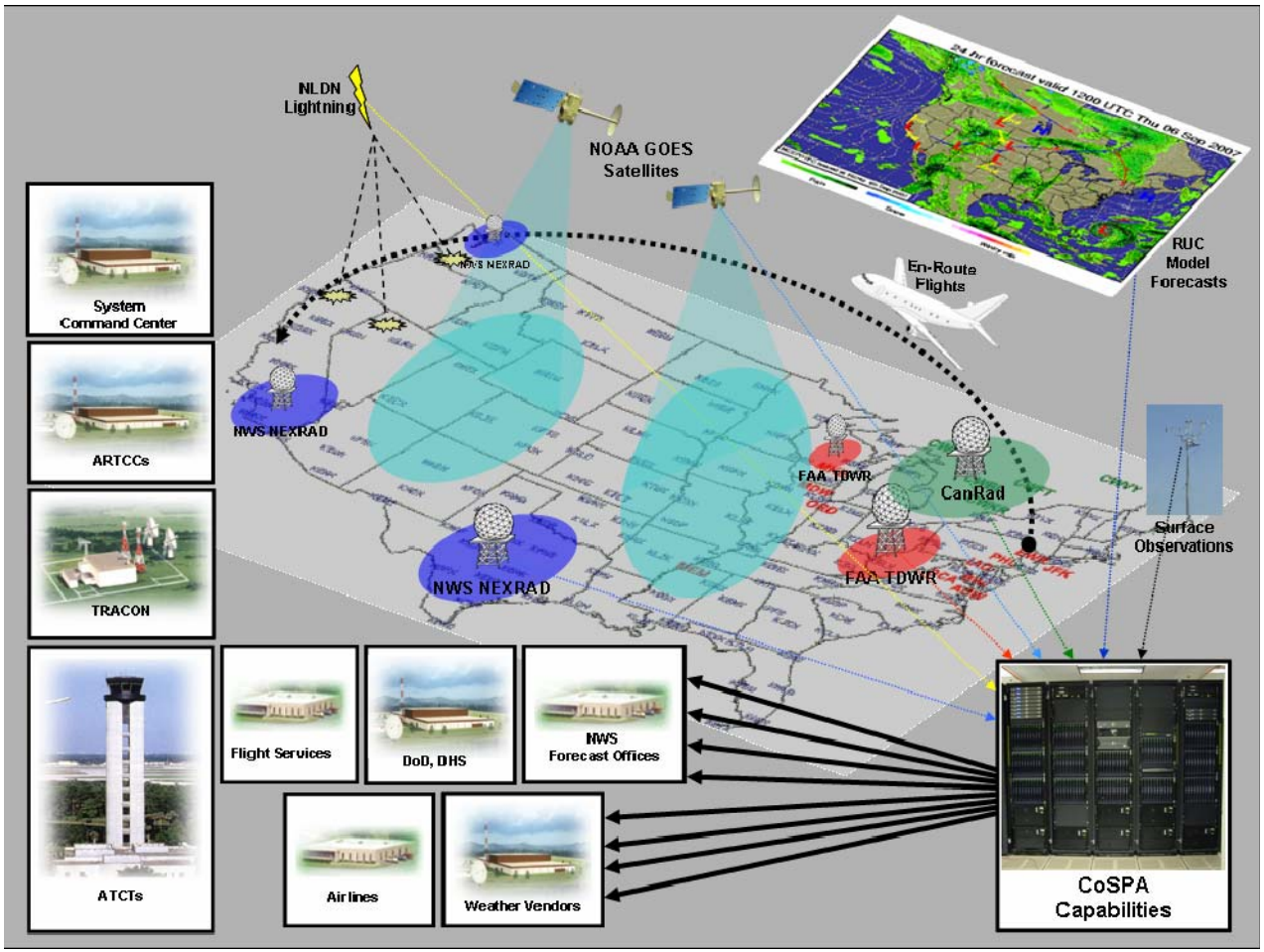




- **Current Storm Forecast Situation**
  - Multiple forecast systems
  - Diverse resolution, coverage, generation algorithms and display
  - Uncoordinated leveraging of FAA and NWS assets

- **CoSPA**
  - **Support NextGen goals**
  - **FAA-oriented**
    - **Enroute & Terminal**
    - **Winter & Summer**
  - **Network enabled**
  - **Standardized format and access**
  - **Common situational awareness**

CoSPA Circa 2012



- **CONUS Integrated Sensor Mosaics**
  - 1 km resolution, 2.5 min update
  - Precip (VIL and Surface), Echo Tops, G&D Trends, Winter Precip, etc…
    - E.g., Turbulence, Ceiling and Visibility, Gust Fronts, etc.
- **Animated Forecast Loops**
  - 0-2 hr
    - 5 min interval; 5 min update rate; 1 km res
  - 2-8 hr
    - 15-60 min interval; 1-3 hr update rate; 2-4 km res
- **Forecast Products (all 0- 8 hr)**
  - Deterministic Forecasts
    - Precip, Echo Tops, etc
    - Used in Summer and Winter
  - Probabilistic Forecasts
    - Convection, *Snow, Pilot-Weather Avoidance Fields, etc
  - Surface Fronts
    - 15 min update rate
  - Performance Results

* Permits “snow – mix – rain” Winter Forecast

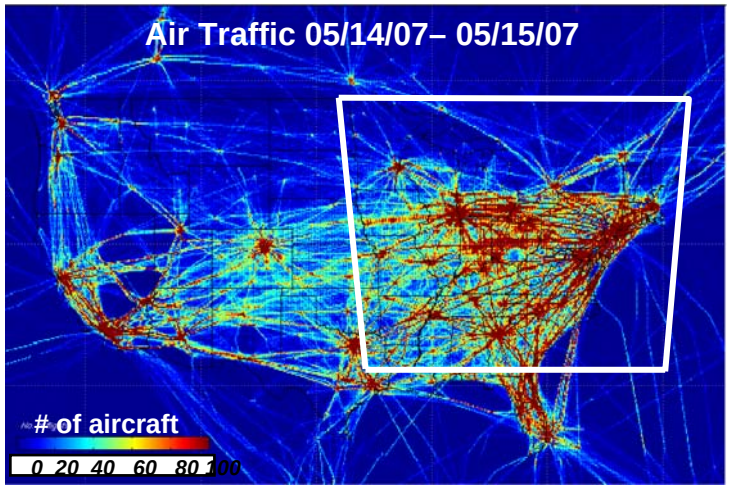
FY08 CoSPA Planned Activities

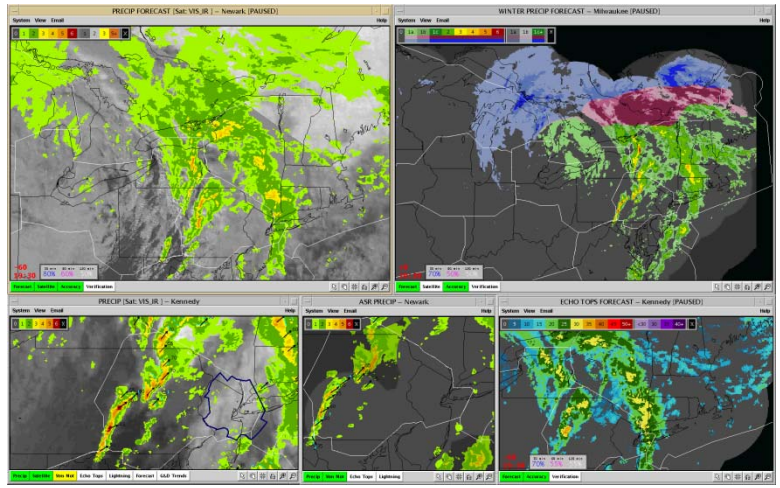
- **0-2 hr Forecasts – CONUS coverage**
  - VIL and Echo Tops forecasts by June
  - Winterized Precip (snow-mix-rain) by September
  - Improved motion vectors and advection out to 6 hrs
- **2-6 hr Forecast debut**
  - Integrated with 0-2 hr forecast presentation
  - Blending of advected and numerical model forecasts
  - High resolution numerical model simulations (3-4 km)
  - Experiment with translation into WAF ("weather avoidance fields")
- **Planned improvements in 0-2 hr forecast**
  - Satellite contribution to convective initiation
  - Optimized feature detectors for storm initiation, growth
  - Improved echo tops decay trends for coupling with DSS

Tactical Forecast Highlights

- **0-2 Forecast Demonstration**
  - Spring 07 Release: 0-2 Hour Forecast
  - Spring 08 Release: CONUS coverage
    - Redesign, recode and documentation
- **Research Efforts**
- **System Engineering**
  - CoSPA Collaboration NNEW/SWIM Teams
  - Collaborating to develop software development standards

Tactical Forecasts: CIWS Benefits

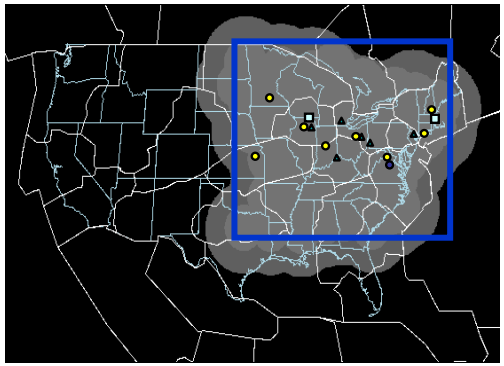




- **Real-time delivery of experimental products to users**
  - **Heavily-exercised demonstration system**
  - **Tactical uses of CIWS have been robust**
  - **Good jumping off point (platform and user community) for Co-SPA testing**
- **Customer feedback drives research**
  - **Address users' traffic flow management problems**
  - **Aggressively apply *new* products/technology**
  - **Provide constructive criticism and identifying beneficial uses**
- **Documented Benefits**
  - **http://www.ll.mit.edu/AviationWeather/WW-11317_ExecSummary_Final.pdf**
- **Making a difference every day!**
  - **"CIWS has changed the way we do business" - ZDC STMC**

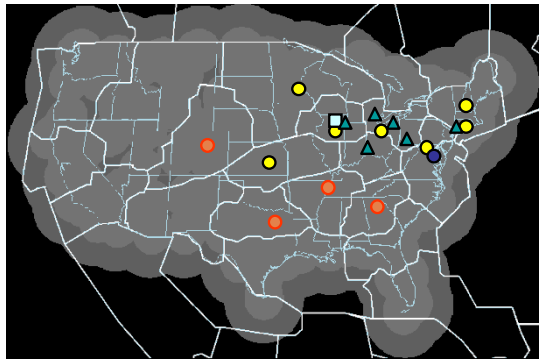
Forecast Demonstration

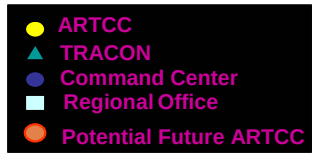
Spring 2007



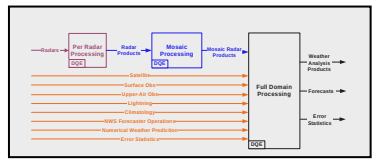
- **Improved Convective Initiation**
- **Stability Mask**
- **Scoring Upgrades**
- **Weather Type Upgrades**
- **Data Quality Upgrades**
- **NOAA STMAS Integration**
- **Redesigned Playback System**

Summer 2008





- **Expand to CONUS**
  - VIL and Echo Tops forecasts by June. Winterized Precip (snow-mix-rain) by September
  - Improved motion vectors and advection out to 6 hrs
- **Redesign System** →
  - Parallel Architecture



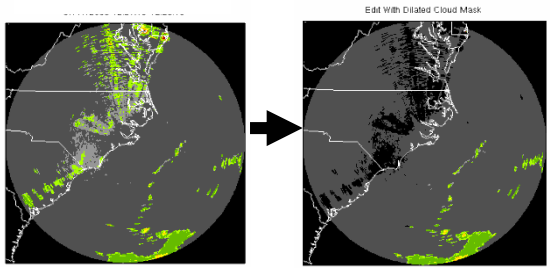
- **Total Recode**
- **Adopt Industry Software Standards**
- **Inline Documentation (Doxygen)** →
- **Integrate new AWRP technology**

- **CIWS is leveraging the efforts of CoSPA forecast improvements to support ATO-R operations**
- **We plan to develop an Open System Architecture with 'plug and play' and NNEW/SWIM data dissemination capabilities**

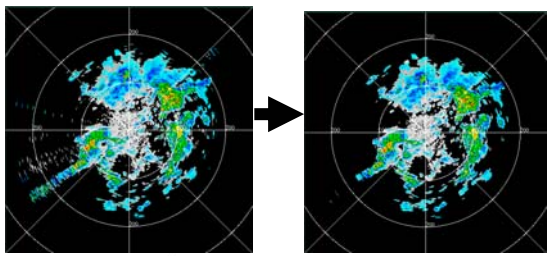
Research Efforts

Data Quality Editing

Satellite Based



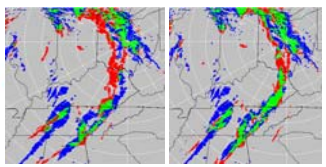
Spike and Speckle Removal



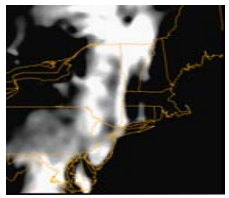
Motion

Ref

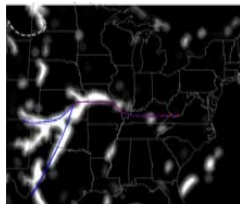
Input



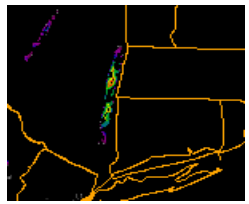
Stability Mask



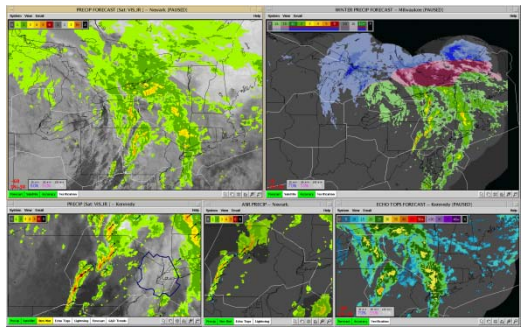
Front Detection



Convective Initiation



Improved System

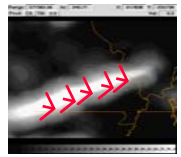


Motion Data Fusion

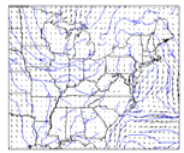
Envelope

Cell

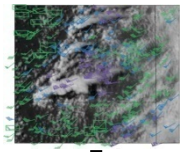
Front Motion

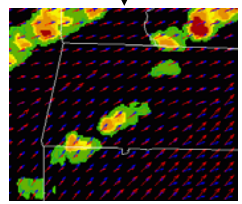


NWP Winds



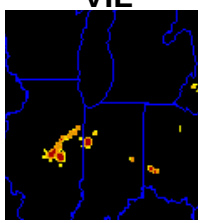
Satellite Winds



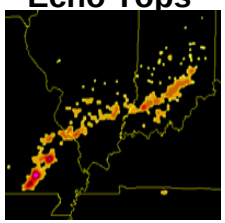


Lightning Proxy

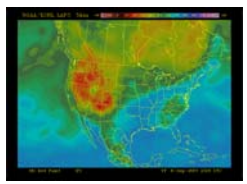
VIL



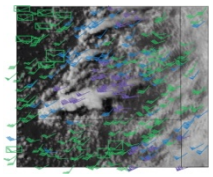
Echo Tops



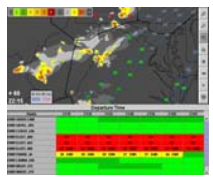
STMAS



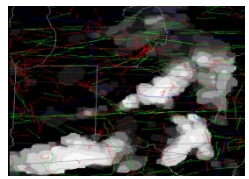
NASA ASAP



RAPT



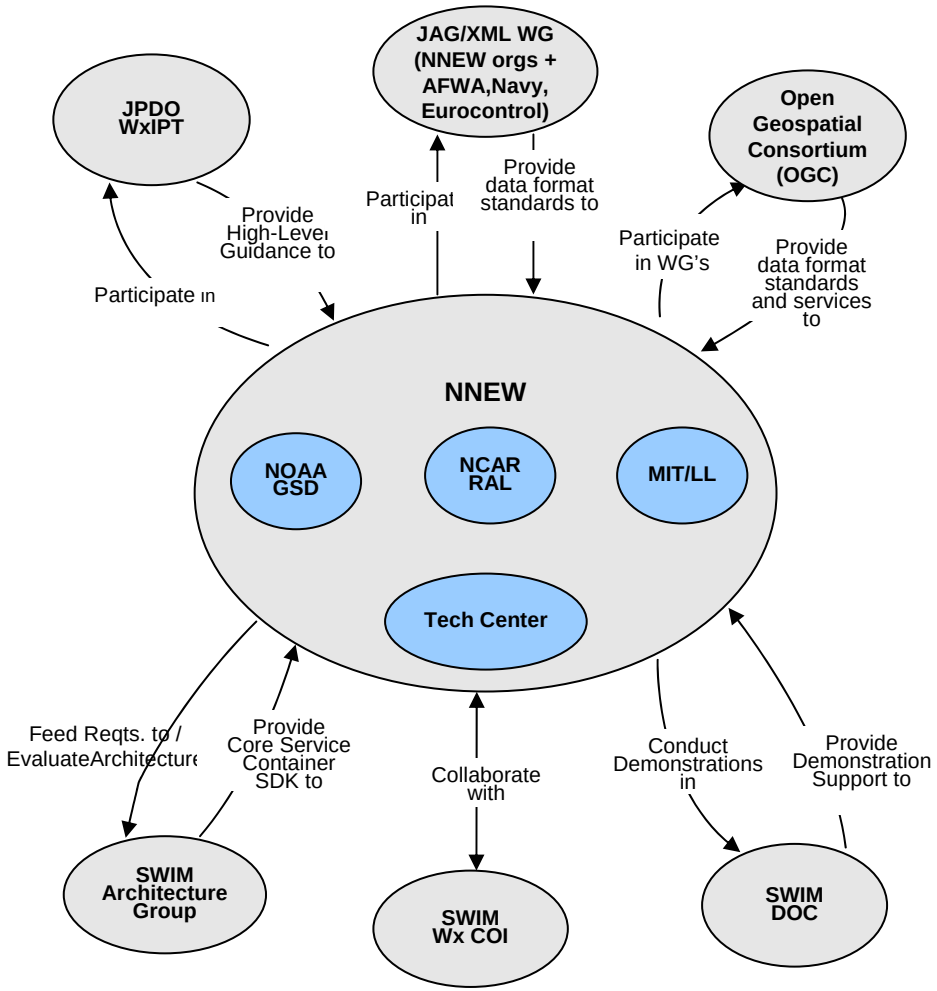
Weather Avoidance



System Engineering

NextGen Network-Enabled Weather (NNEW)

Organizational Relationships



Target Data Formats and Data Dissemination Services

Data Formats

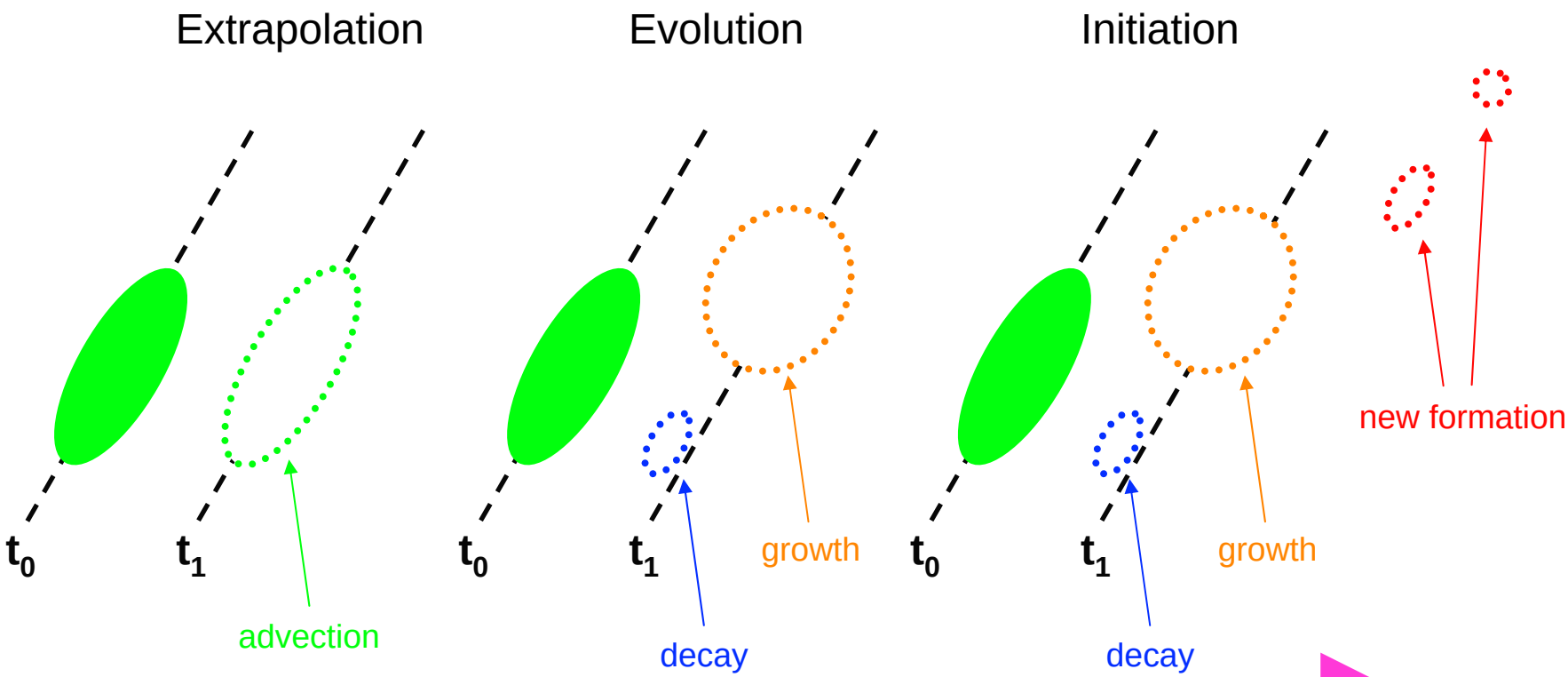
- NetCDF4/HDF5 for gridded data products
- XML for non-gridded products
- ISO data model foundational components

Data Dissemination Services

- OGC Sensor & Data Discovery catalog
- OGC Web Coverage Service (gridded data)
- OGC Web Feature Service (non-gridded data)
- JMBL/JET Node

- CoSPA is collaborating with NNEW/SWIM
- CoSPA will adopt NNEW/SWIM as it evolves
  - Writing data adapters to convert native formats to/from NetCDF4/HDF5.
  - LDM used for data dissemination in the meantime
- MITLL, NCAR and NOAA-GSL FAA project teams are collaborating to develop software development standards

Strategic Storm Forecasting — Prediction Issues

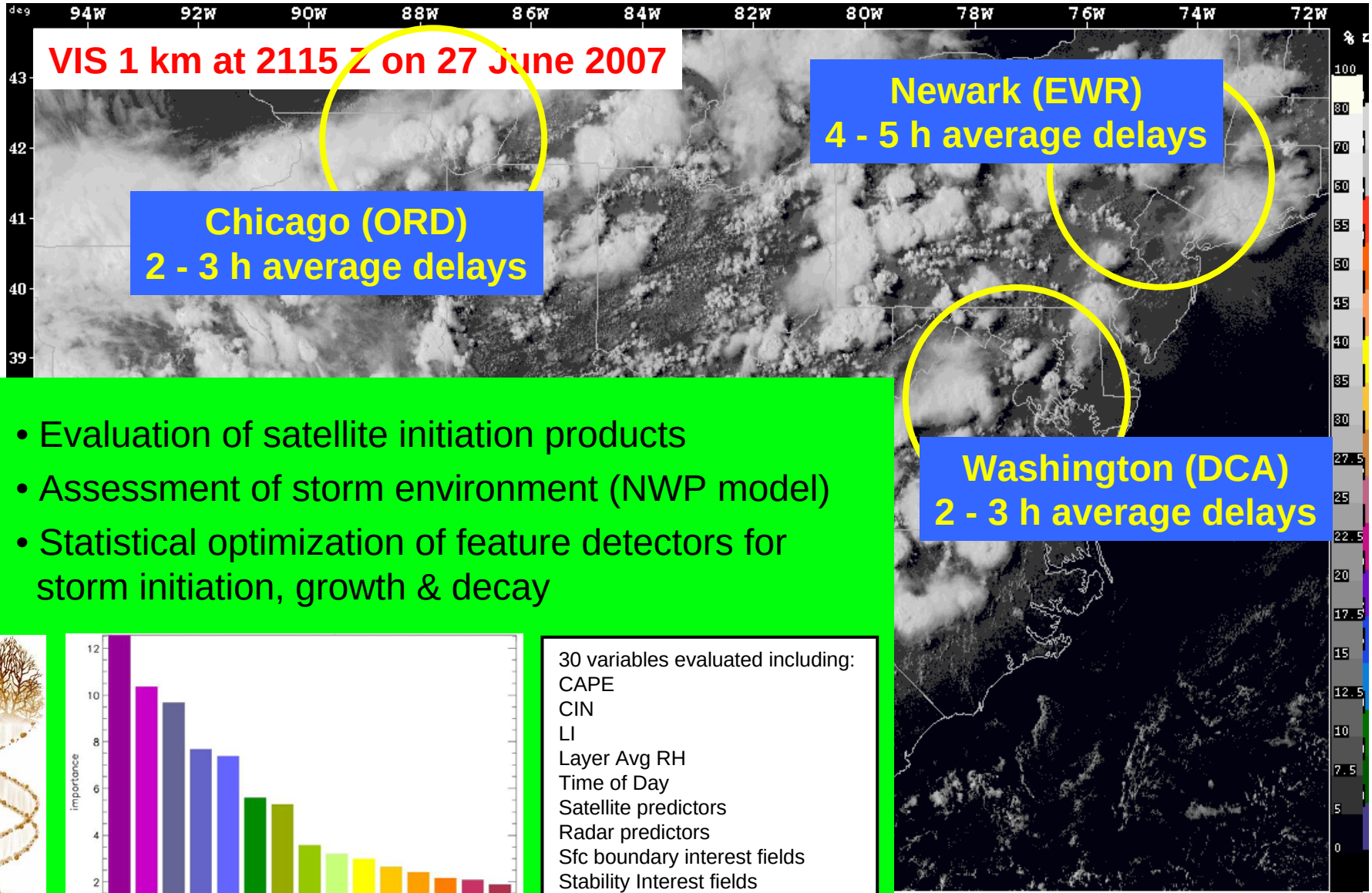


Relative importance increases with forecast length

Increasing role of numerical weather prediction

Uncertainty increases with forecast length

Importance of Capturing Storm Initiation

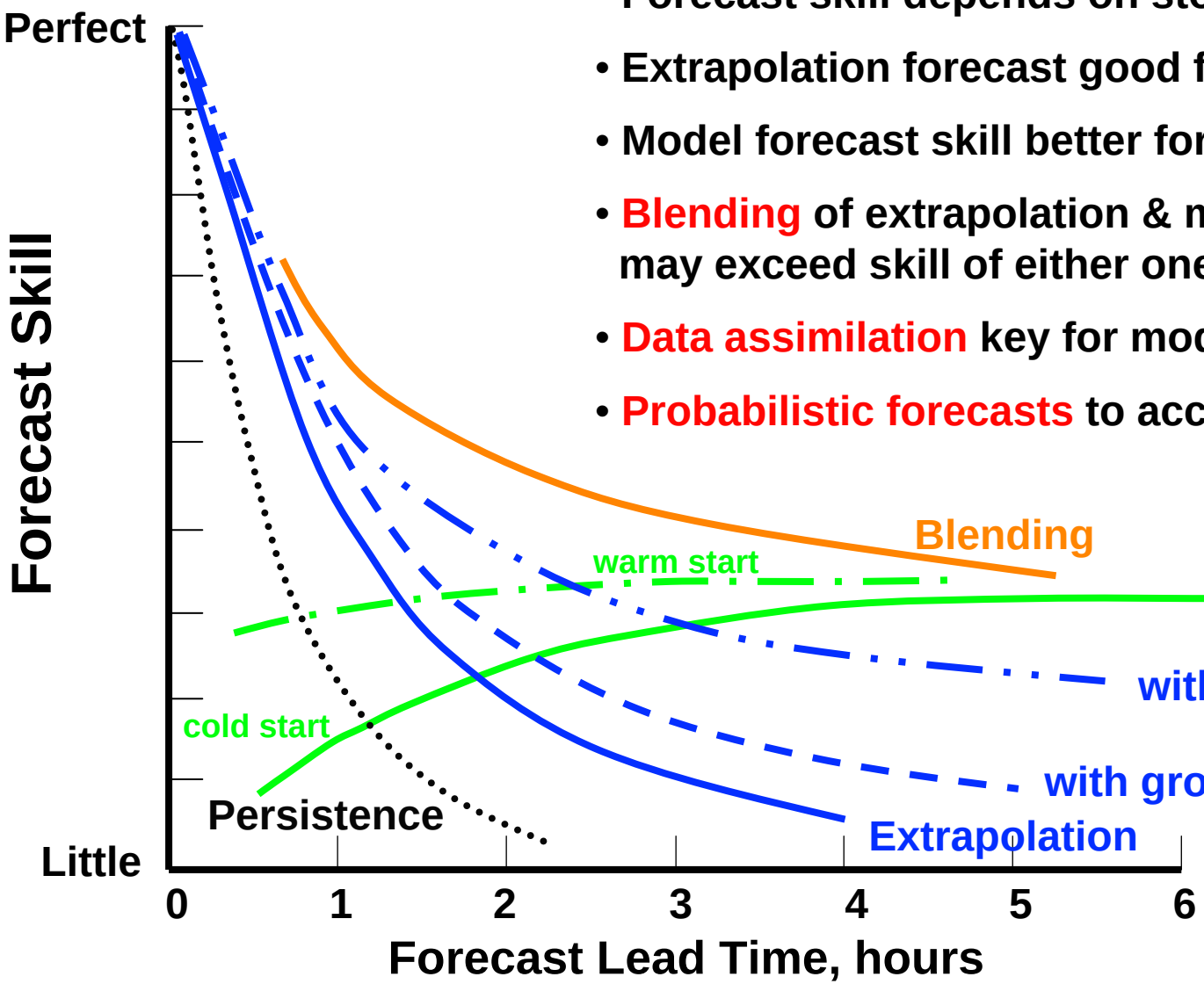


- Evaluation of satellite initiation products
- Assessment of storm environment (NWP model)
- Statistical optimization of feature detectors for storm initiation, growth & decay

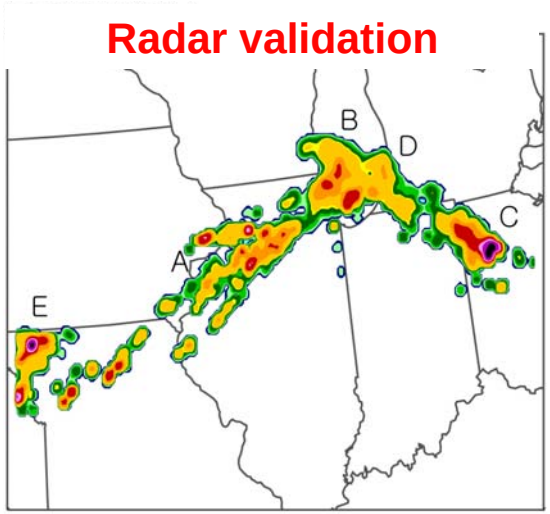
30 variables evaluated including:
CAPE
CIN
LI
Layer Avg RH
Time of Day
Satellite predictors
Radar predictors
Sfc boundary interest fields
Stability Interest fields
…

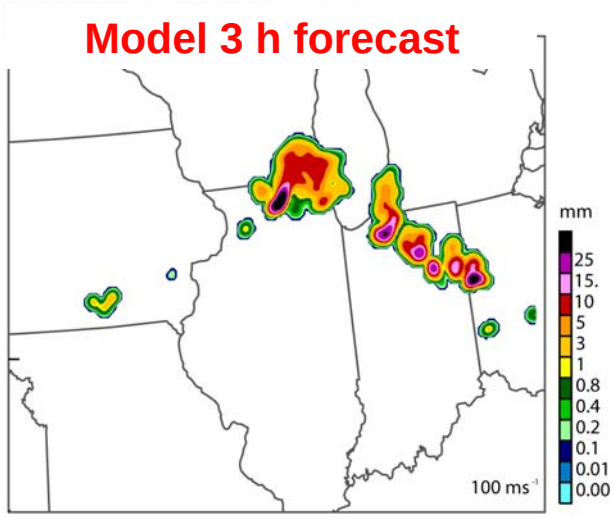
Progress Toward Improved Forecast Skill

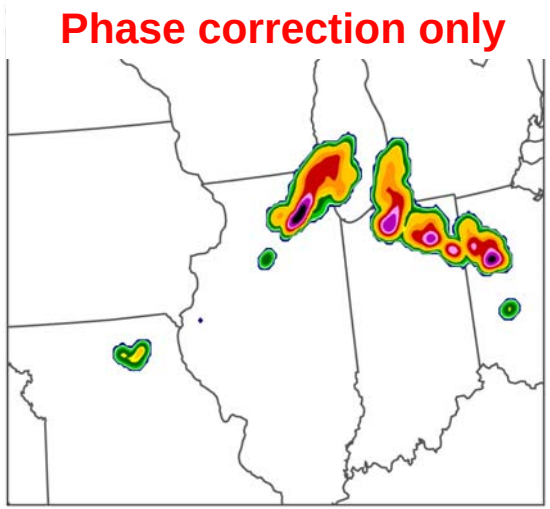
- Forecast skill depends on storm type
- Extrapolation forecast good for short lead times
- Model forecast skill better for longer lead times
- **Blending** of extrapolation & model forecasts may exceed skill of either one
- **Data assimilation** key for model initialization
- **Probabilistic forecasts** to account for uncertainty

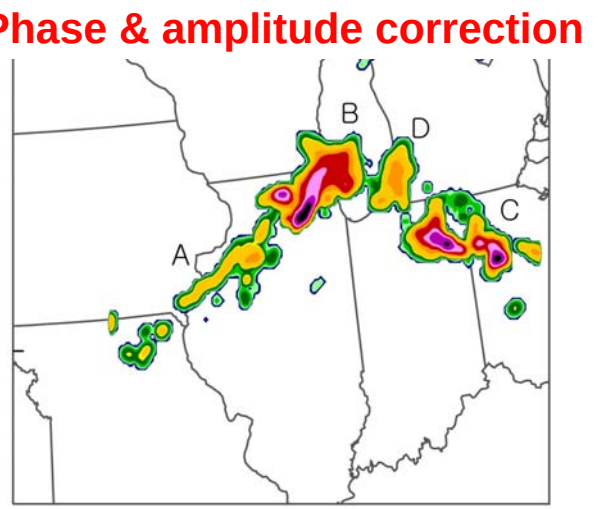


Blending of Extrapolation & Model Forecasts

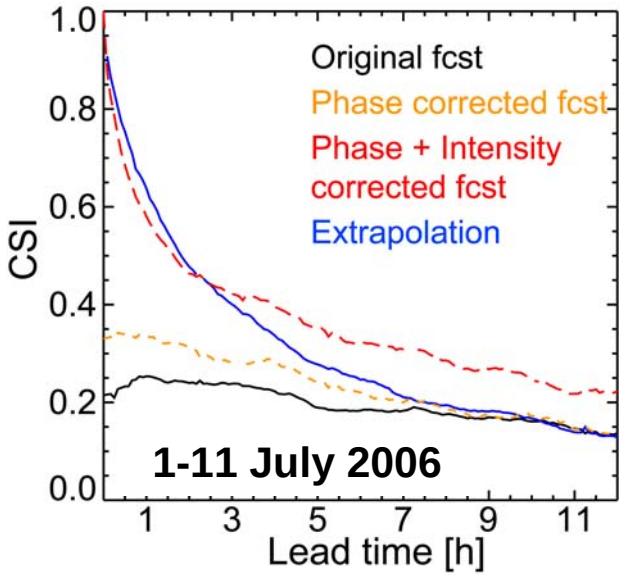








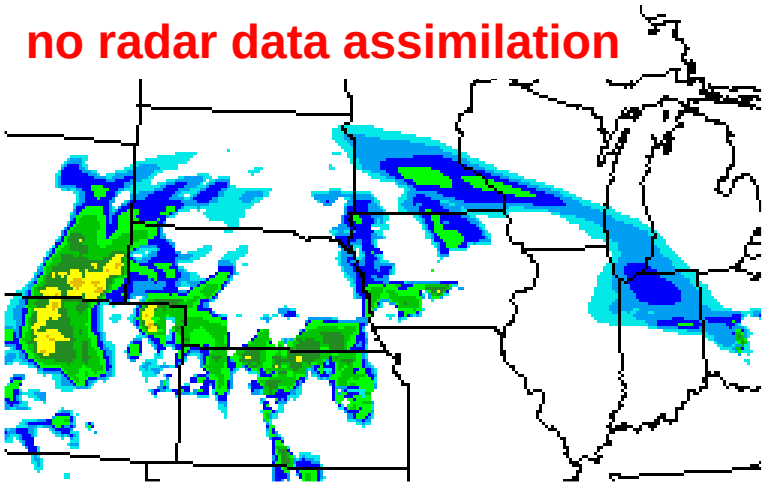
- Evaluation of various blending techniques
- Modular combinations of extrapolation & model
- Considering recent past performance



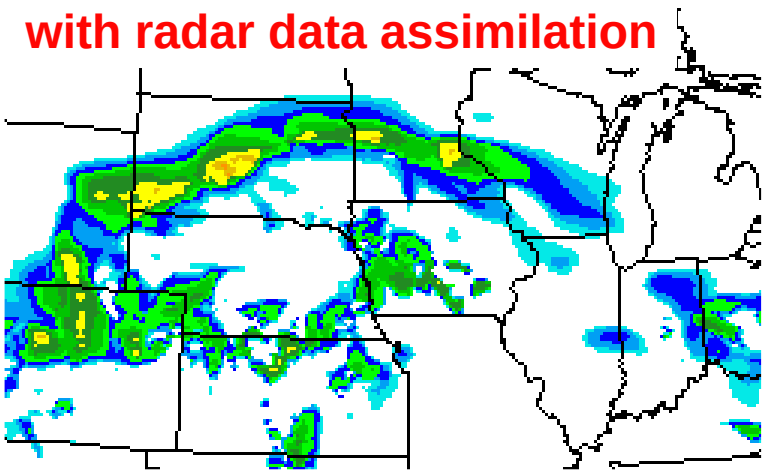
Data Assimilation & Modeling

RUC 3 h forecast valid for 00Z on 25 March 2007

no radar data assimilation



with radar data assimilation



- **Rapid Update Cycle (RUC) model with radar data assimilation operational at NCEP by January 2008**
- **Various model physics upgrades**
- **WRF-based Rapid Refresh (RR) to replace RUC by 2009**
- **Northeast High-Resolution RR (HRRR), 3 km, 12 h forecast, 1-3 h cycling**
- **Ensemble RR (6 members) by 2012**
- **NCAR & GSD collaboration on R&D**

radar at 00Z on 25 March 2007