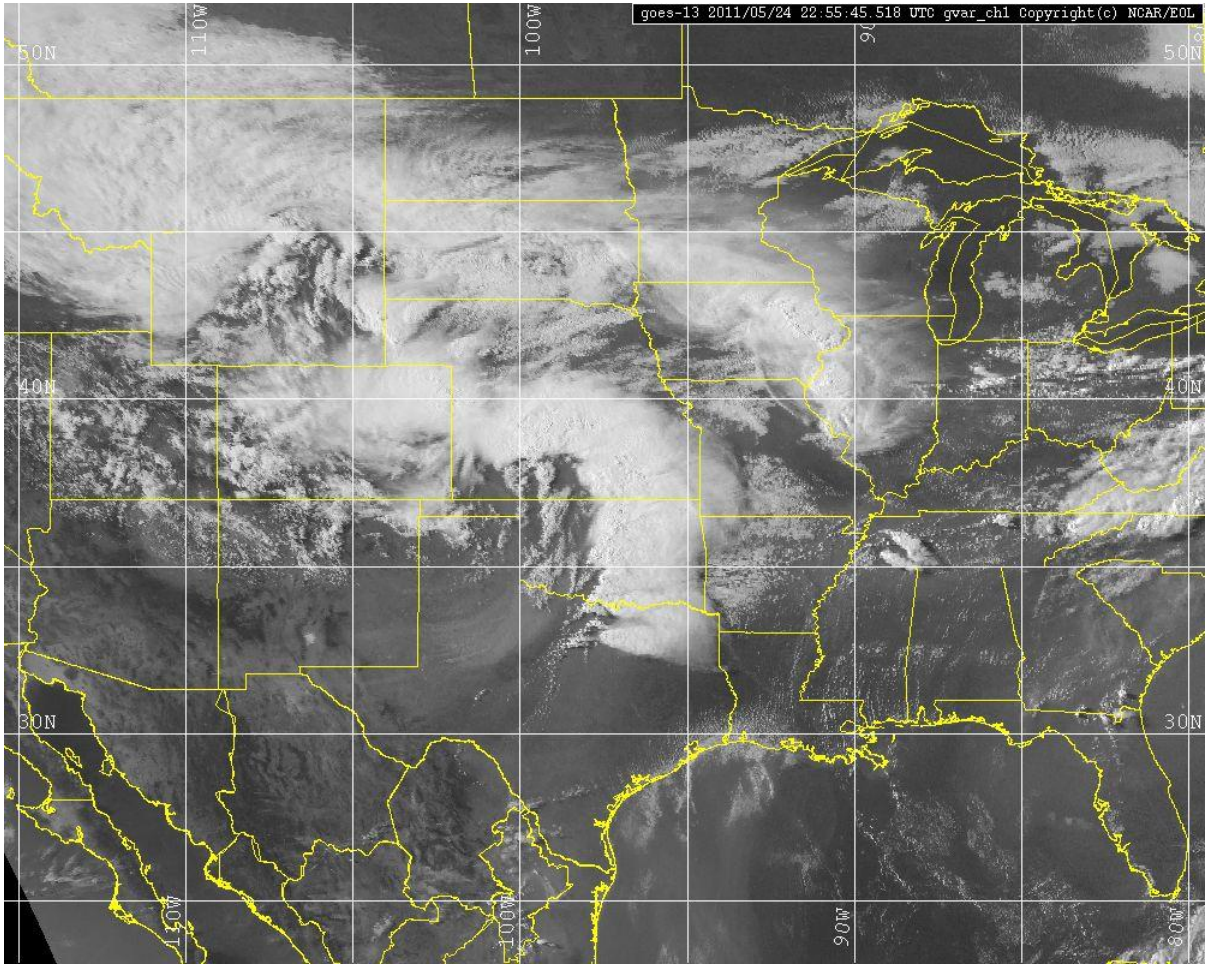
Forecasting/Nowcasting for DC3:



Morris Weisman NCAR/NESL/MMM

(DC3 Workshop 21-22 February, 2012)

….a host of high-resolution explicit convective forecasts and chemical forecasts will be available….

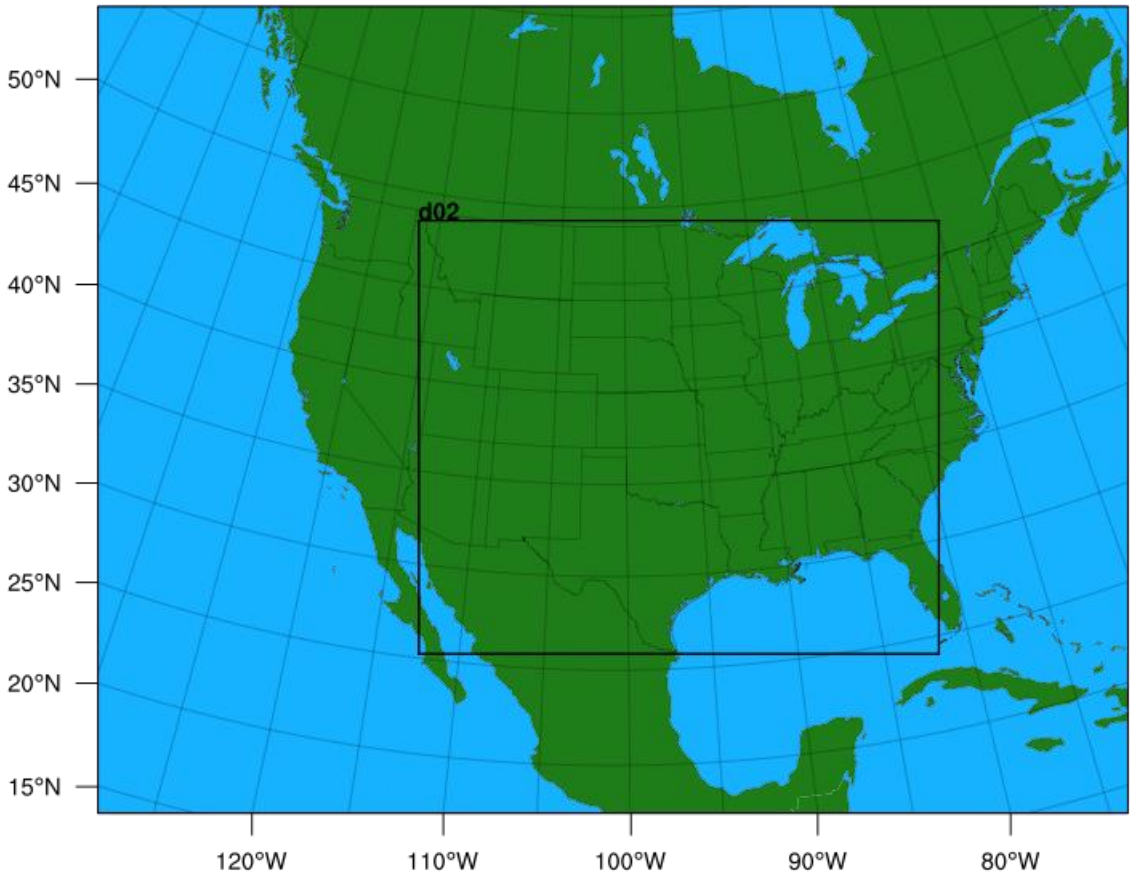
Name	Run time	Update time	Time available to community	Observations used
3 km WRF-ARW Weather & tracer forecasts	2 48-hr sims run daily	00Z 12Z	13Z = 0800 CDT 01Z = 2000 CDT	
3 km WRF TTU Weather forecasts	4 60-hr sims run daily	00Z, 06Z, 12Z, 18Z	10-13Z = 0500-0800 CDT	
4 km WRF NSSL Weather forecasts	1 36-hr sim run daily	00Z		
FLEXPART Particle dispersion model Trajectory forecasts in UT	1 48-hr run after flight completes	~02Z		Aircraft lat & lon GFS winds
0.5x0.6° MOZART Chemical forecasts	1 5-day run	00Z	14Z = 0900 CDT	

Also: A statistical-based decision making tool: Hans Verlinde and Arthur Small

WRF-ARW Forecasts for DC3: 01 May-30 June 2012

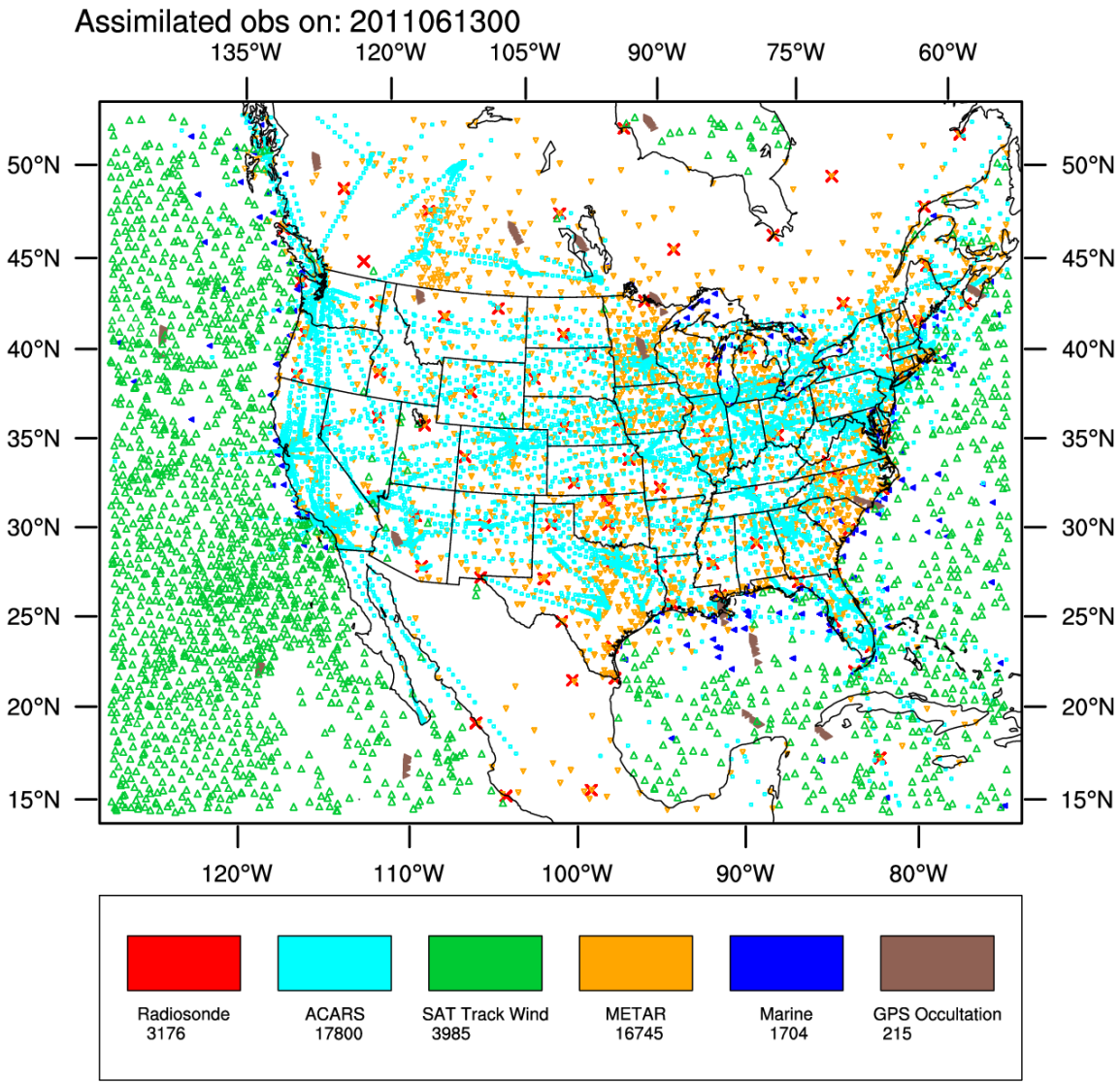
*48 h 3 km forecasts initialized at 00 and 12 UTC using DART analyses

DART:
*50 members at 15 km grid resolution
*Member with closest normalized fit to ensemble mean selected for IC/BC for 3 km forecast
*GFS forecast BC for outer domain
*MYJ PBL, Thompson Micro.



NESL

Assimilated Observation Types



<u>MADIS sourced:</u>
Radiosonde U,V,T,Td,Alt.
METAR U,V,T,Td,Alt.
MARINE U,V,T,Td,Alt.
ACARS U,V,T,Td

<u>SSEC sourced:</u>
SAT cloud track winds: U,V

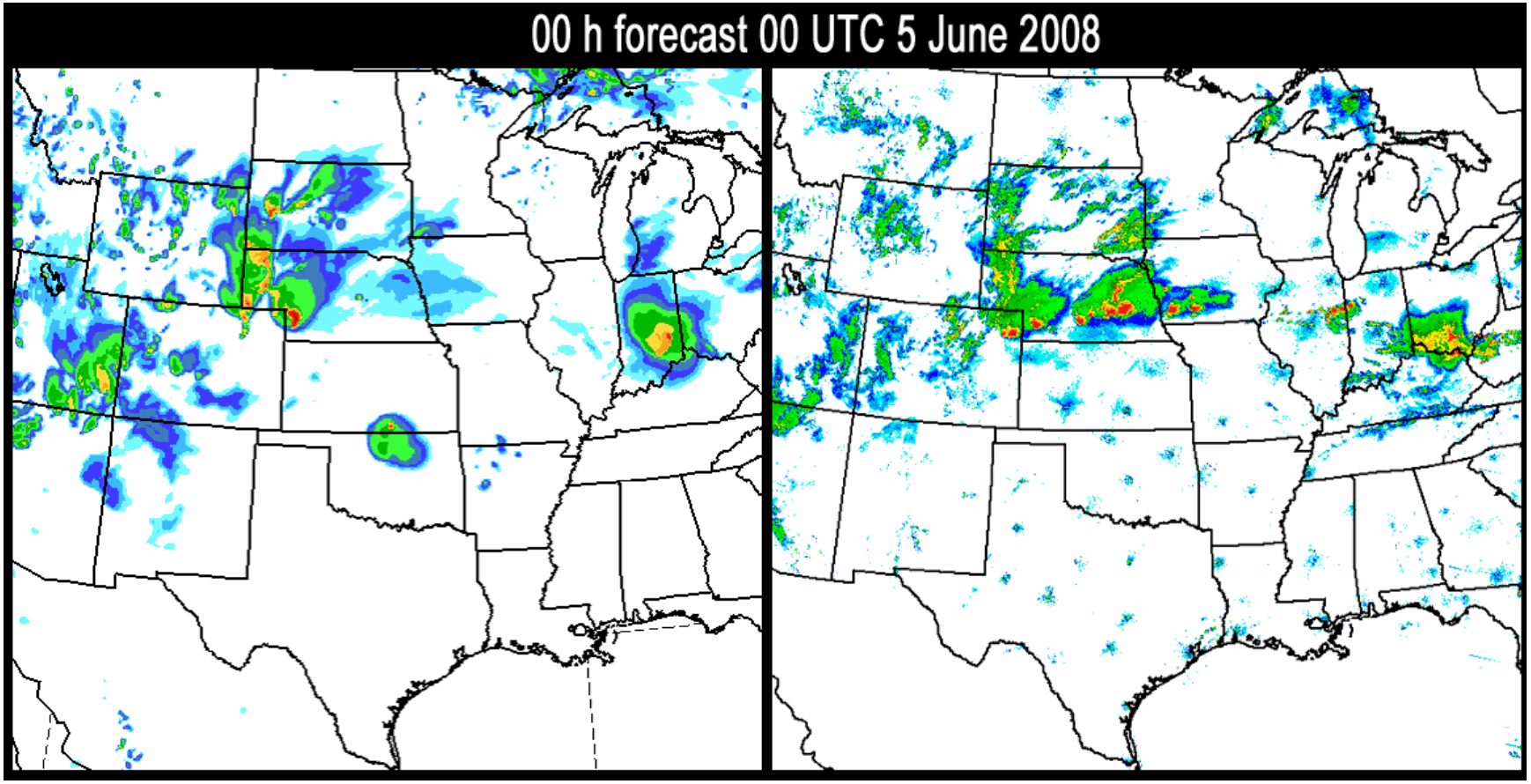
<u>COSMIC sourced:</u>
GPS occultation

~ 40k obs, 4x daily

3 km ARW Forecast: 06/05/08

ARW Reflectivity

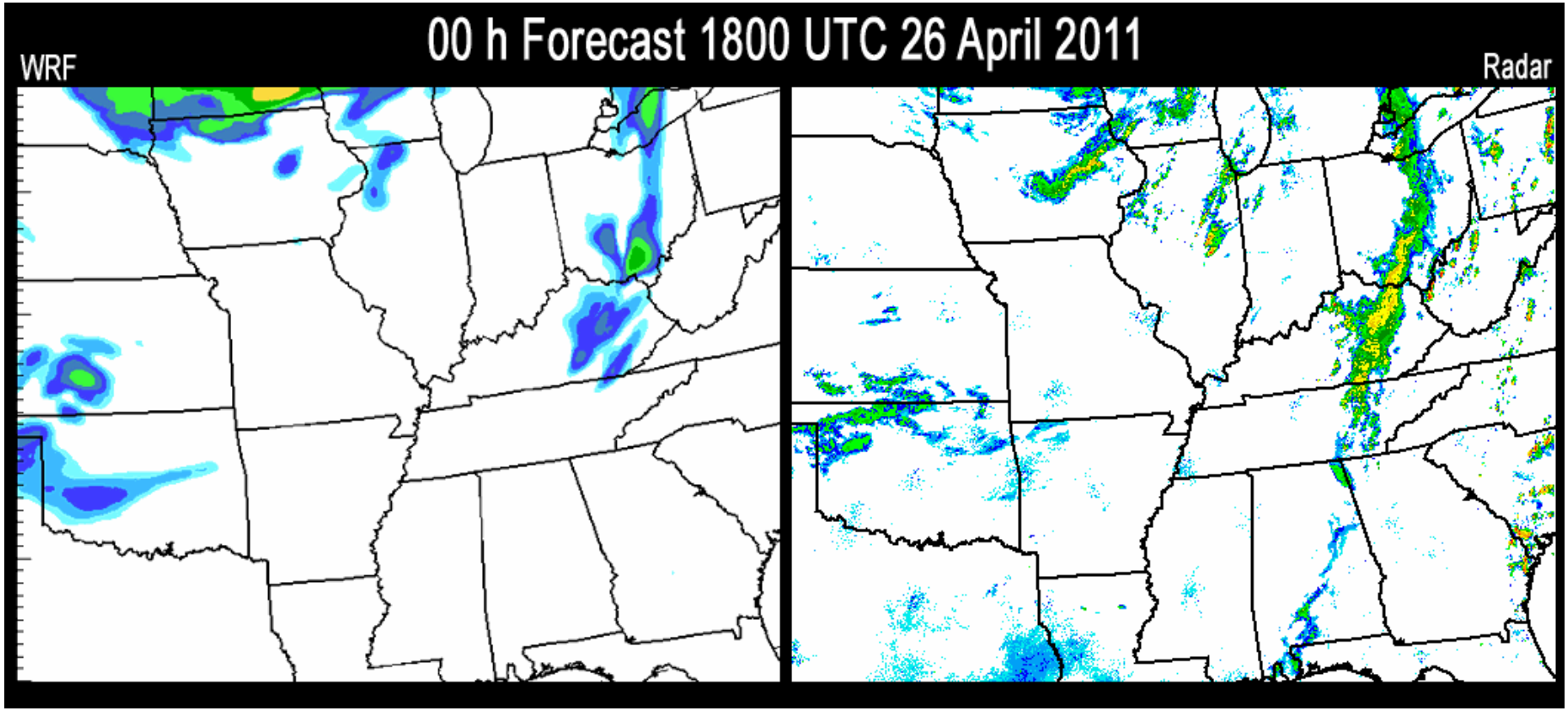
Observed Reflectivity



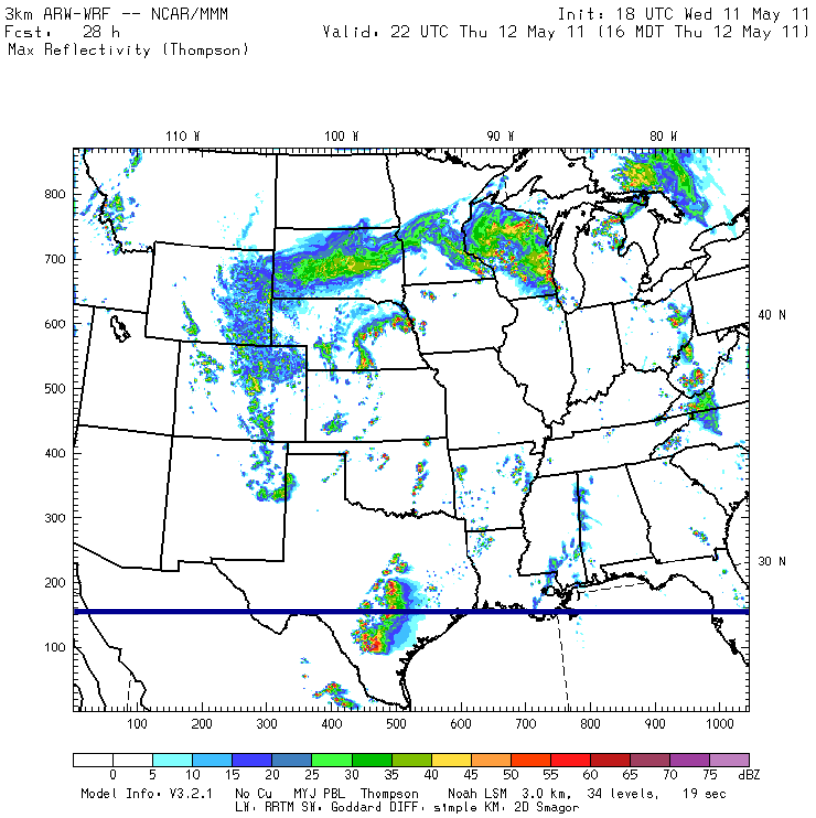
3 km ARW Forecast: 04/26/11

ARW Reflectivity

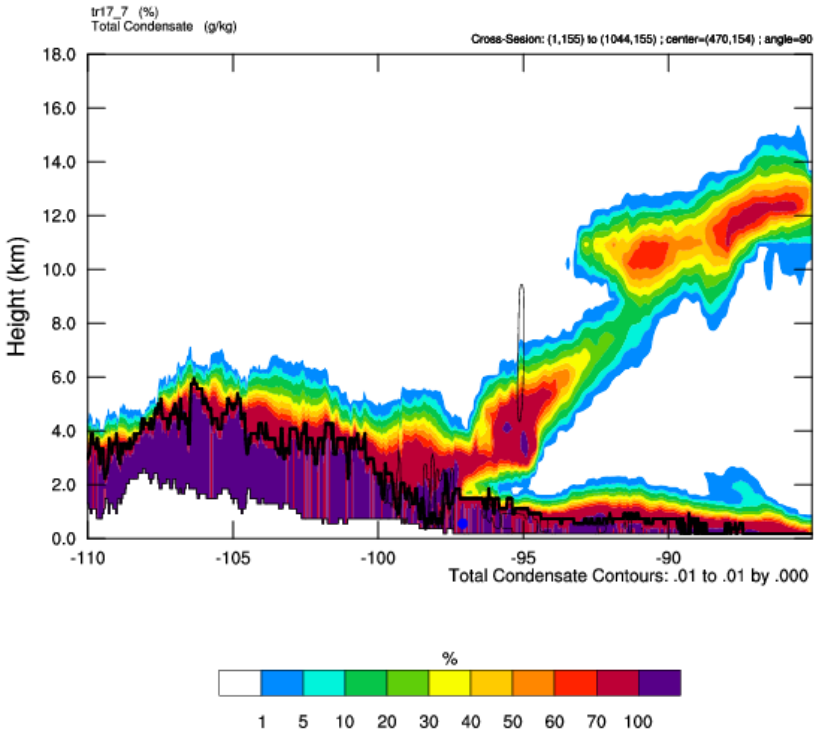
Observed Reflectivity



- Boundary Layer (BL) tracer = 1 between surface and PBL height every time step



2200 May 11, 2011 WRF



BL tracer (color) vertical cross section
PBL height (thick black line)

8 Tracers Used:

1 Universal BL Tracer

2 Colorado BL tracers

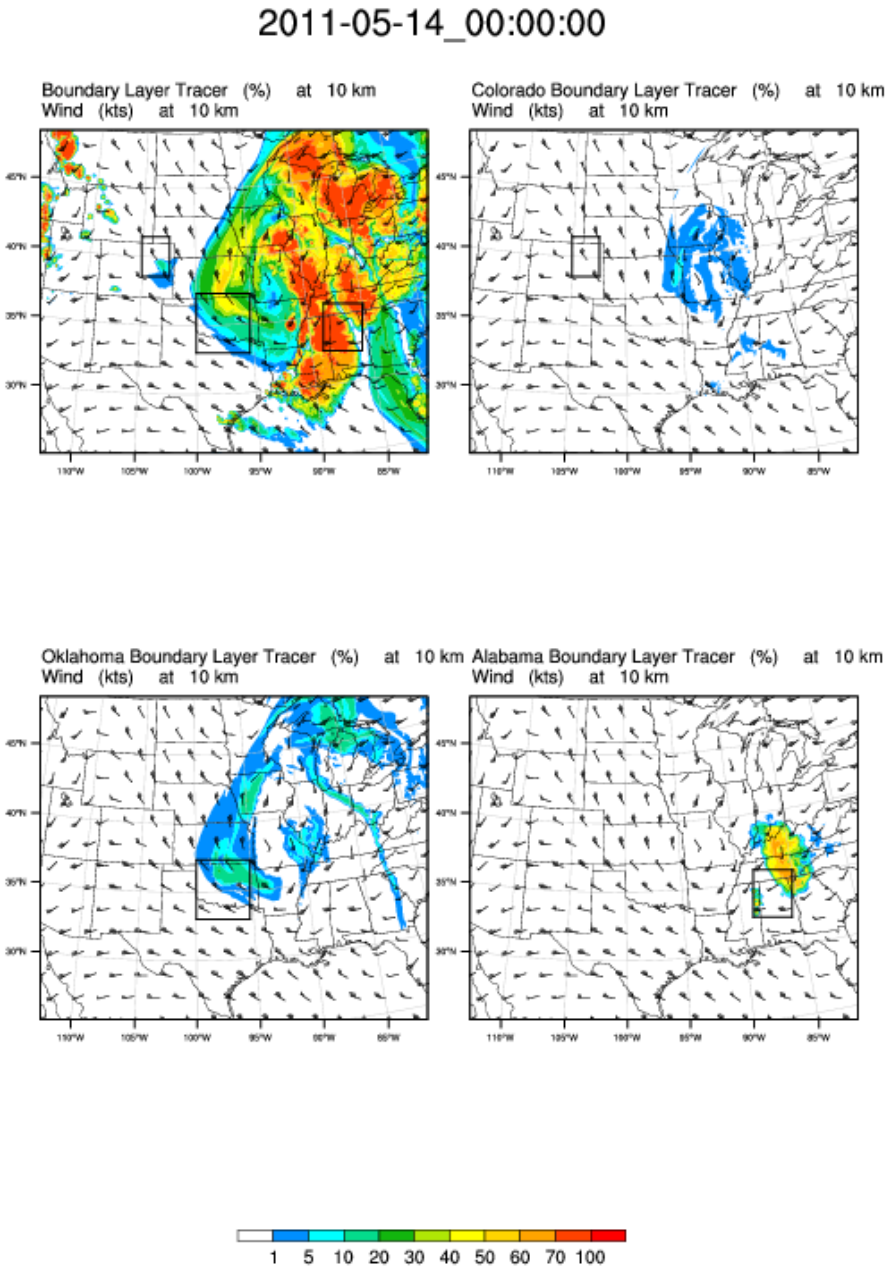
2 Oklahoma BL tracers

2 Alabama BL tracers

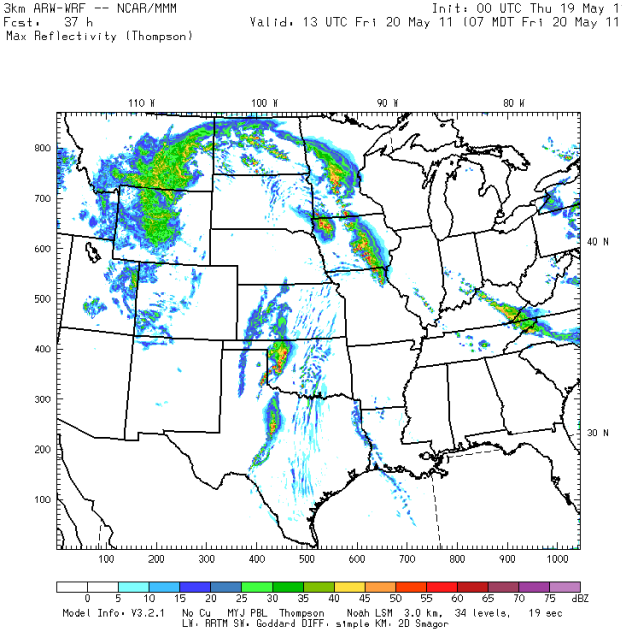
1 Lightning NOx tracer

Two types of tracers
1) Passive tracer
2) Decaying tracer with time scale of 1 day

→ Age of Air



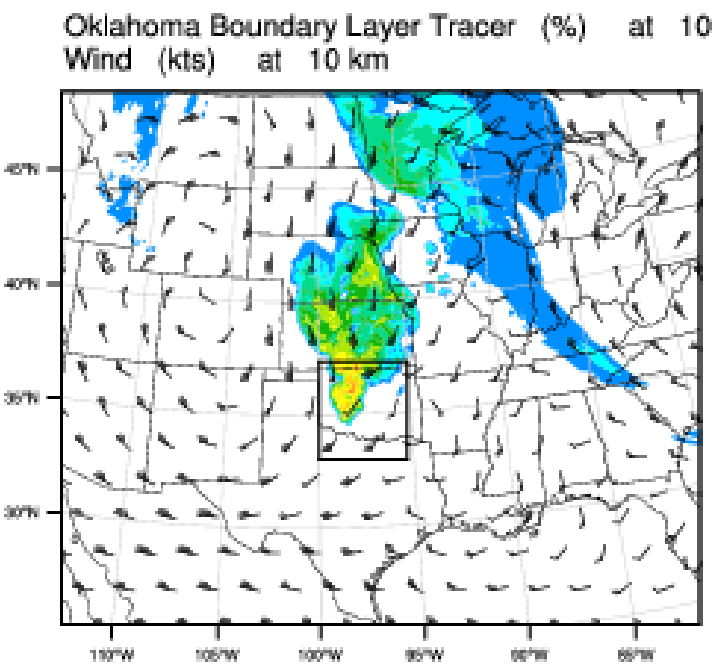
Model radar reflectivity (dBZ)
13 UTC 20 May (08 CDT)

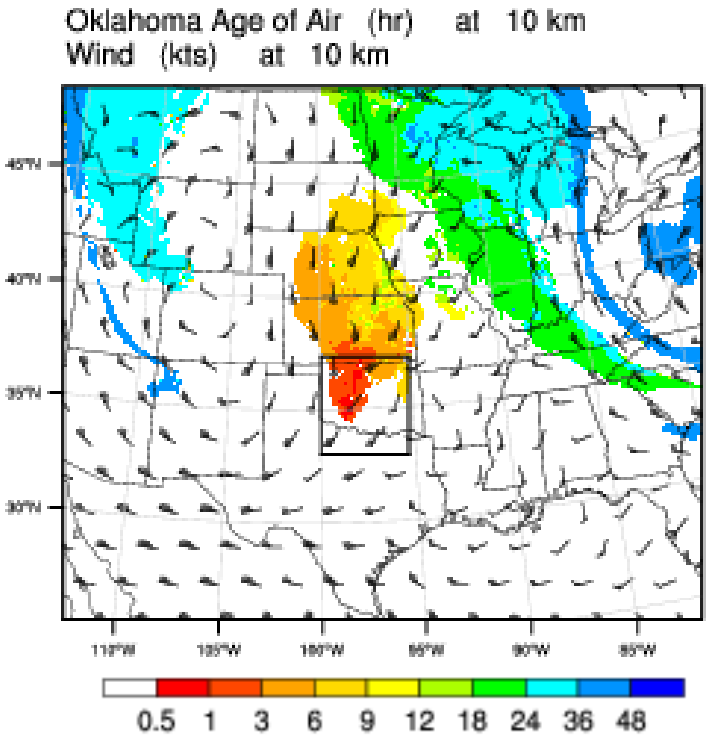


Two types of tracers

1) Passive tracer
2) Decaying tracer with time scale of 1 day

19 UTC 20 May (14 CDT)
(initialized 00 UTC)

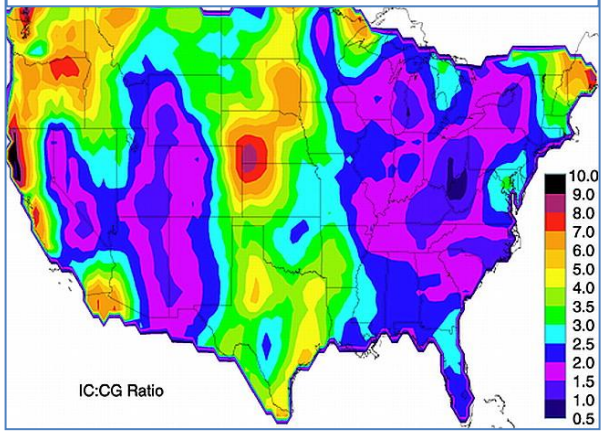




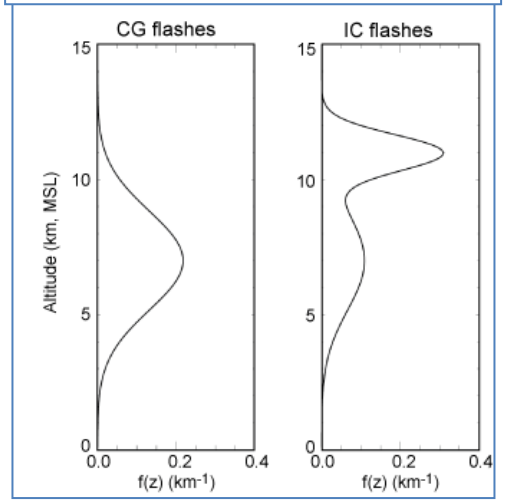
Kristin Cummings (UMD), Ken Pickering (NASA/GSFC), Mary Barth (NCAR)

- Lightning NO_x tracer
  - Lightning flashes predicted by maximum updraft speed (Price and Rind, 1992) within a "tile" of the domain
  - Intracloud to cloud-to-ground flash ratio is based on climatology (Boccippio et al., 2001)
  - Location of NO source is within 20 dBZ region, following DeCaria et al. (2000) vertical distribution
  - Produce 500moles NO/flash
  - Transported by winds
  - First-order decay rate

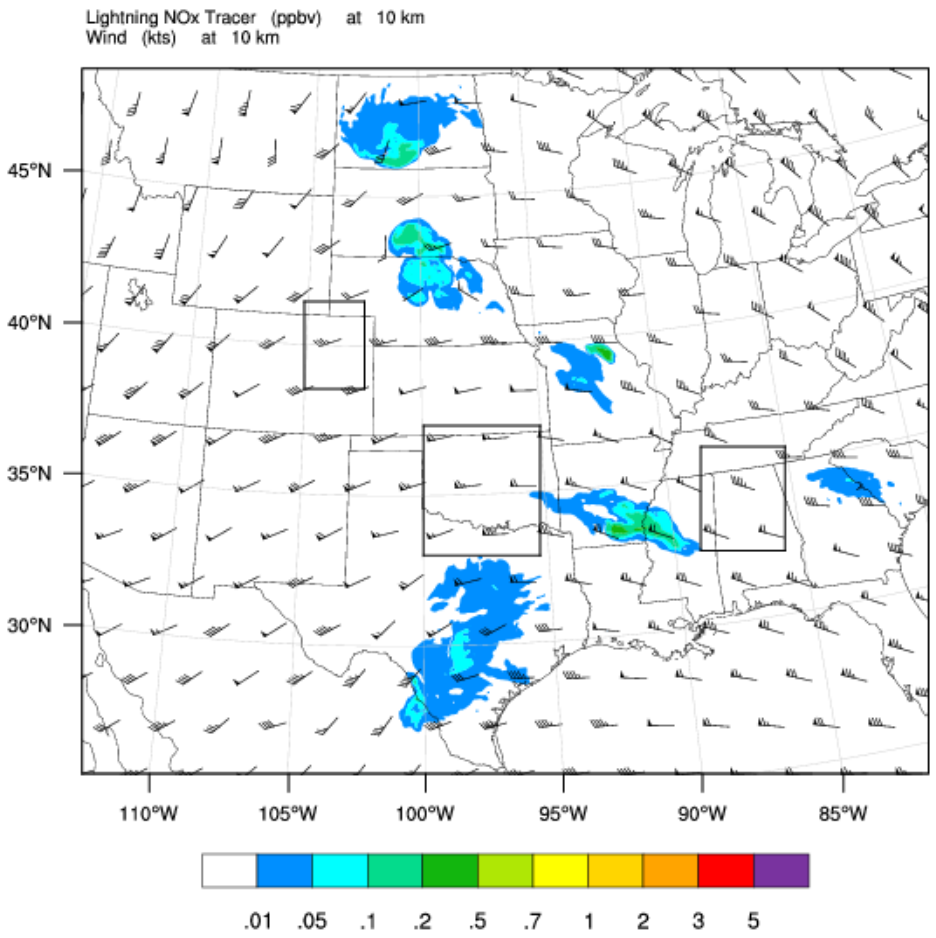
IC to CG Ratio (Boccippio et al., 2001)



Vertical Distribution of NO Source (DeCaria et al., 2000)



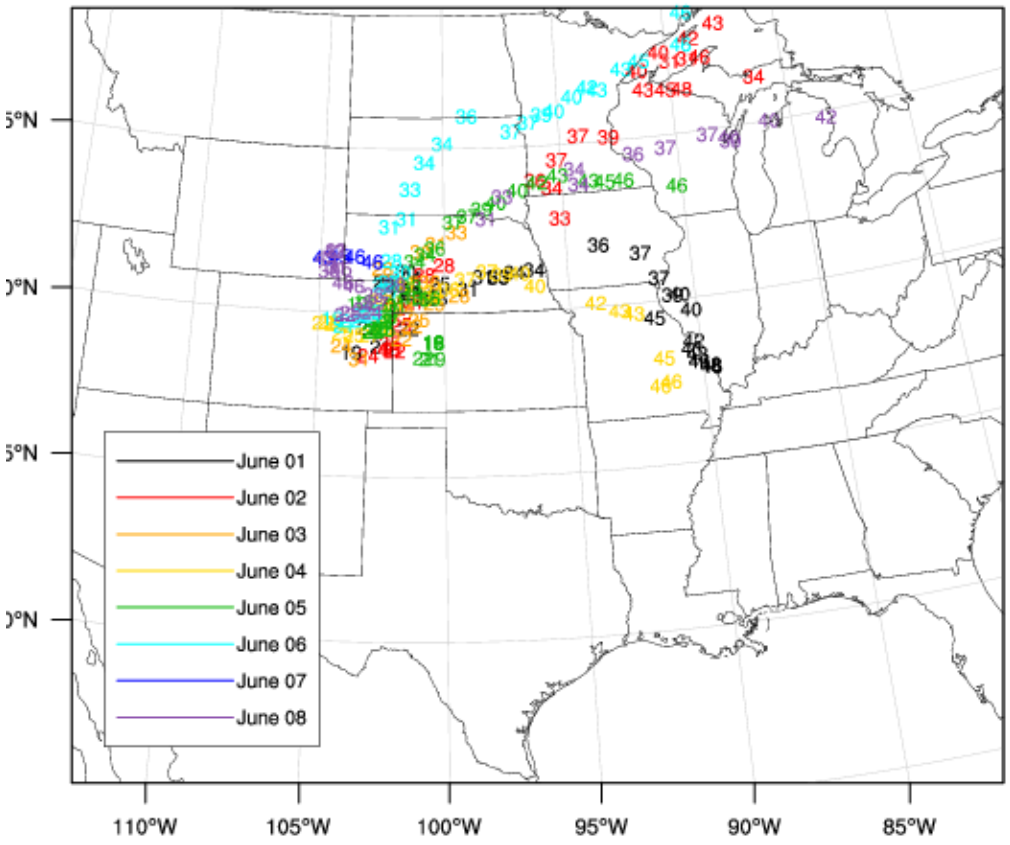
Example of LNO_x Tracer Forecast from DC3 Test Flights



- LNO_x tracer provides information about LNO_x plume:
  - Magnitude
  - Location
  - Depth
- LNO_x tracer output will be used in flight planning

Estimate of where air goes from NE Colorado region June 1-8, 2011 analyzed

…..via tracking maximum boundary layer tracer at 10 km

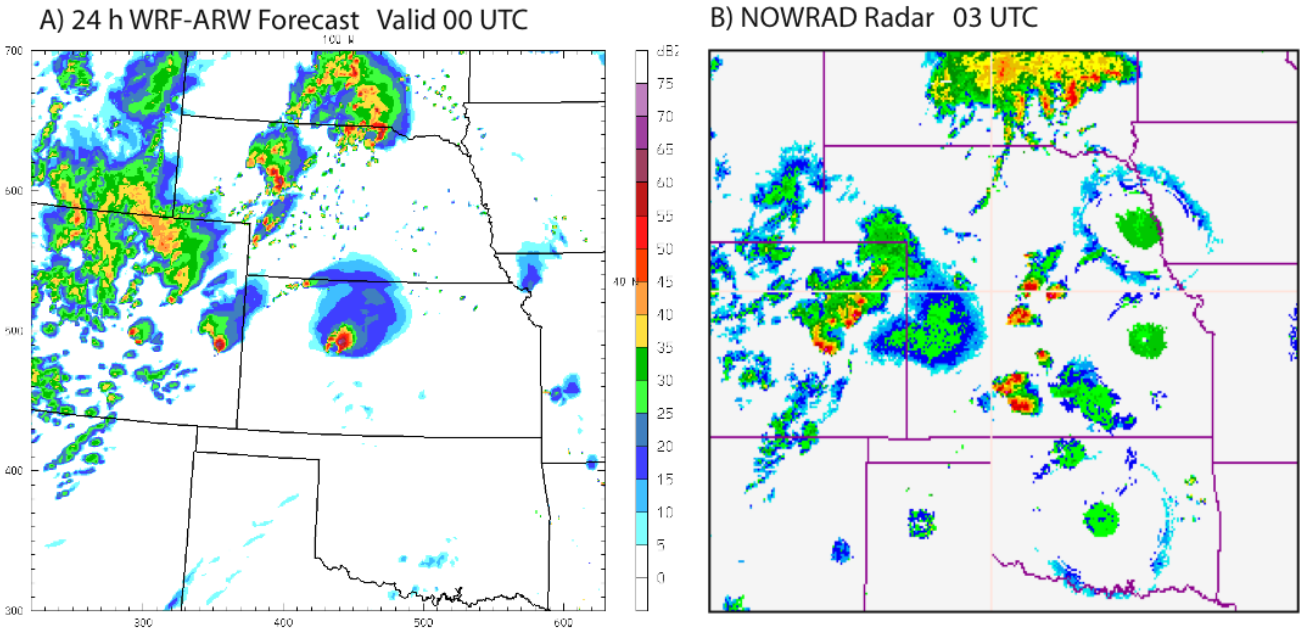


Colors are dates; numbers are hour since start of simulation

Predictability of Convective Storms:

Greensburg, KS Tornado 05 May 2007

24 h - 3 km WRF-ARW Forecast

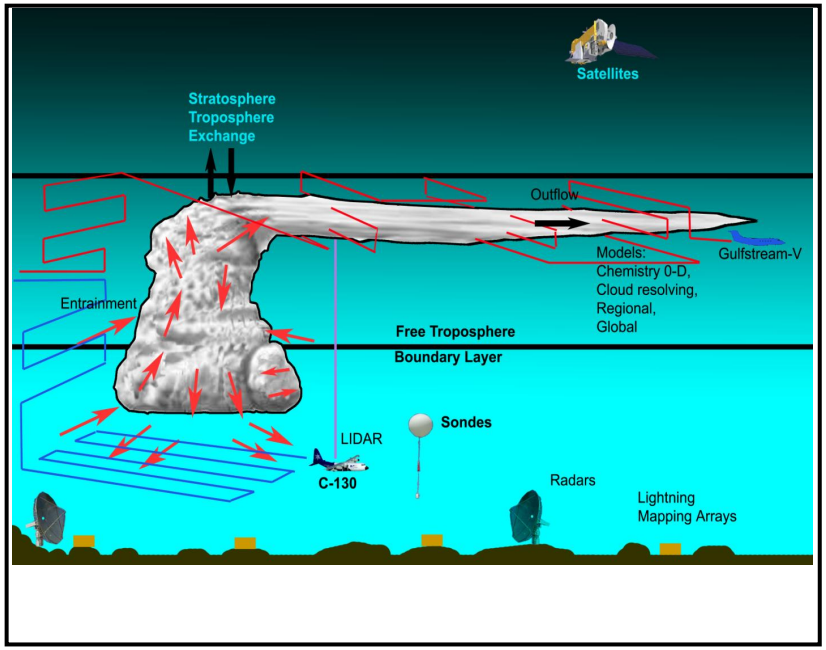


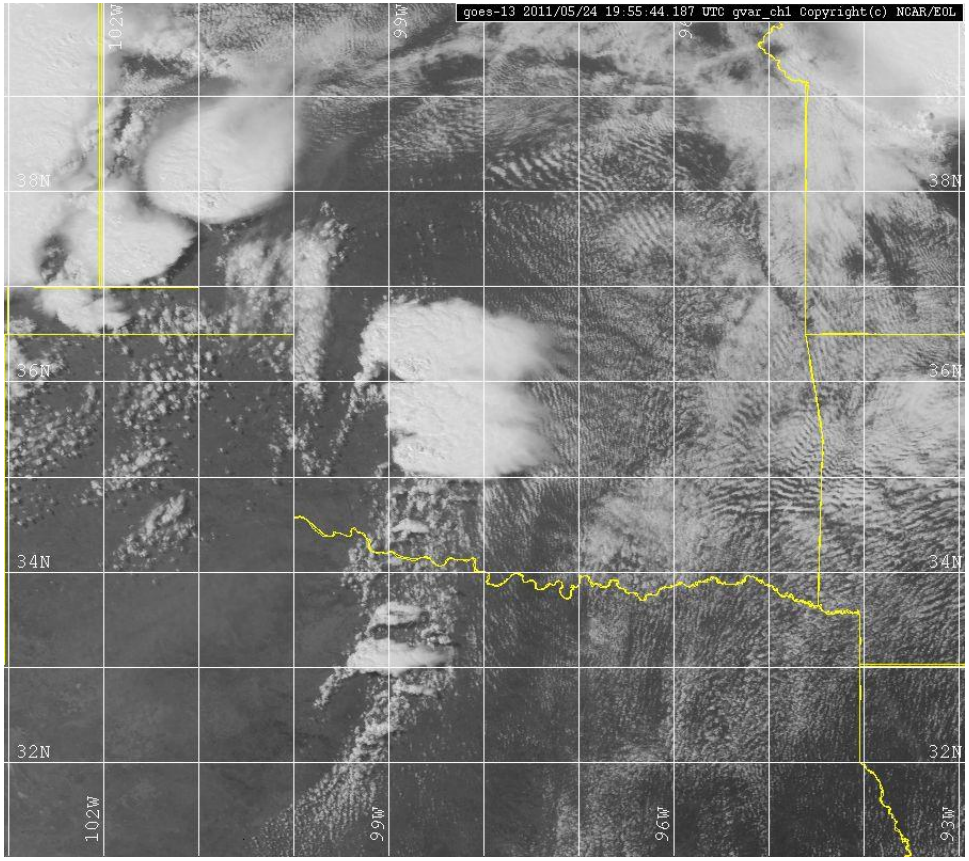
Observed Radar

What can we hope for in DC3?

*24-36 h forecasts: +/- 2 hrs, +/- 150 km

*6-18 h forecasts: just a bit better? (need good nowcasting support!!!!!!)

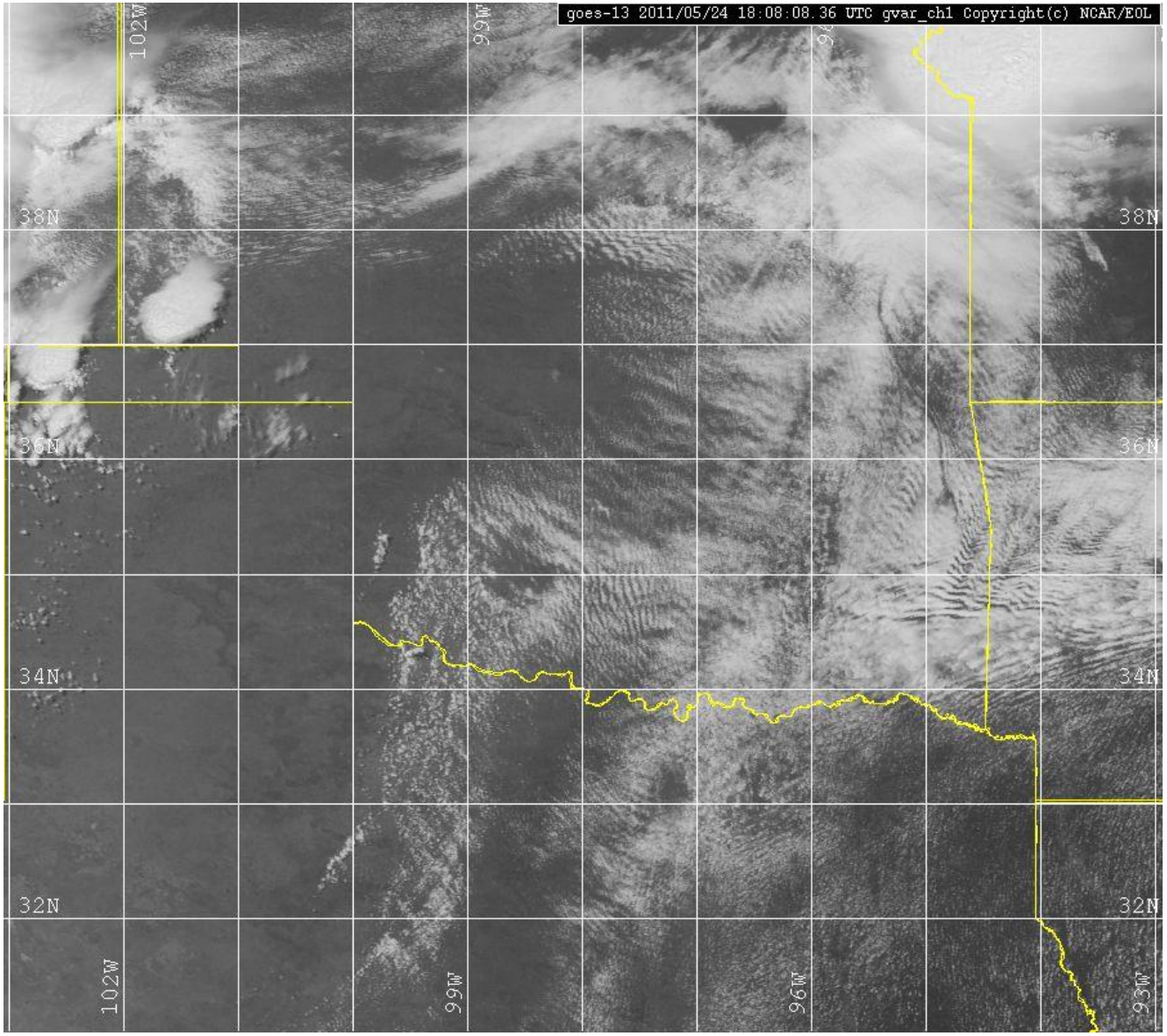




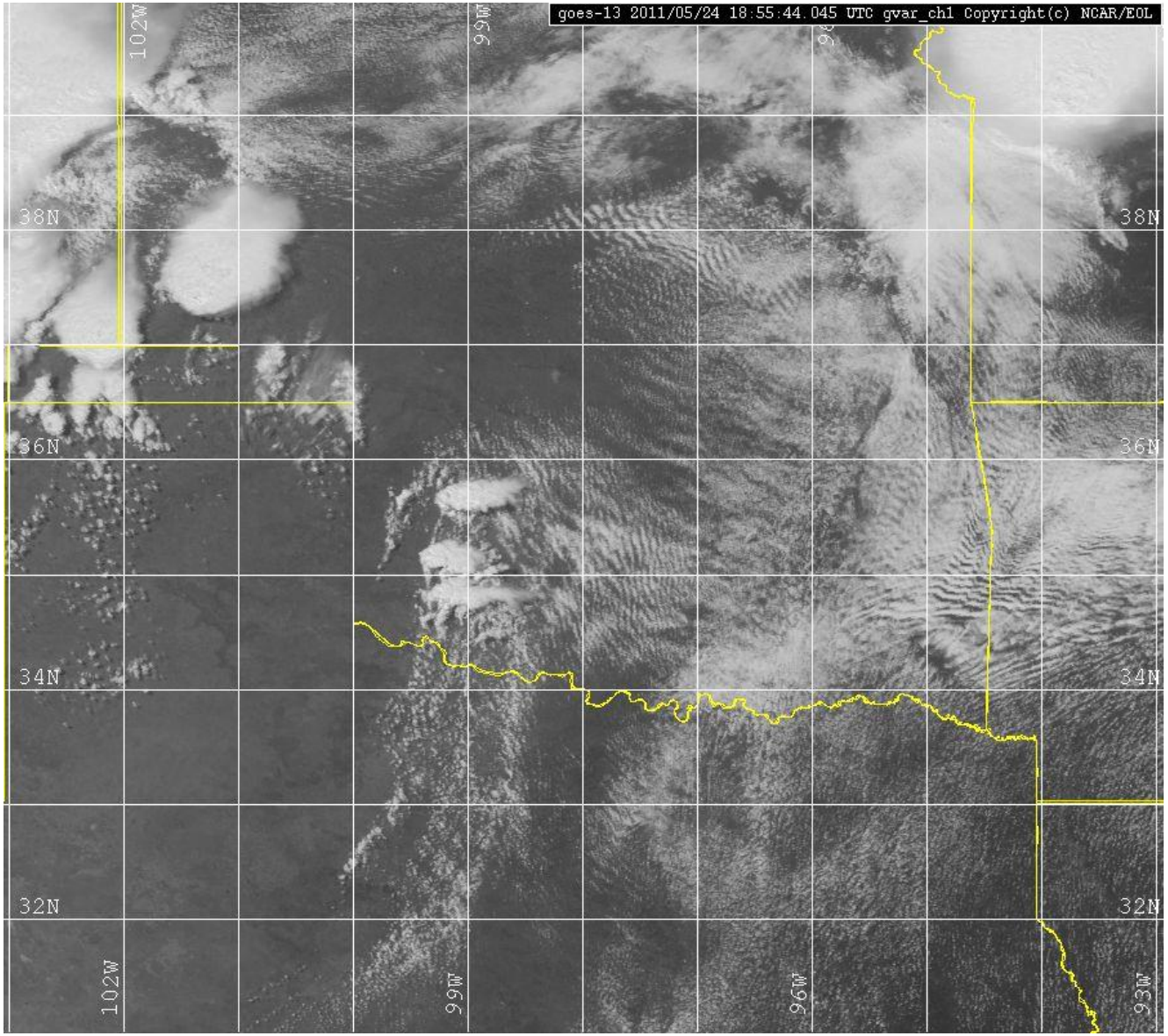
Isolated Convection: easy to fly, difficult to forecast

Widespread Convection: easier to forecast, more difficult to fly

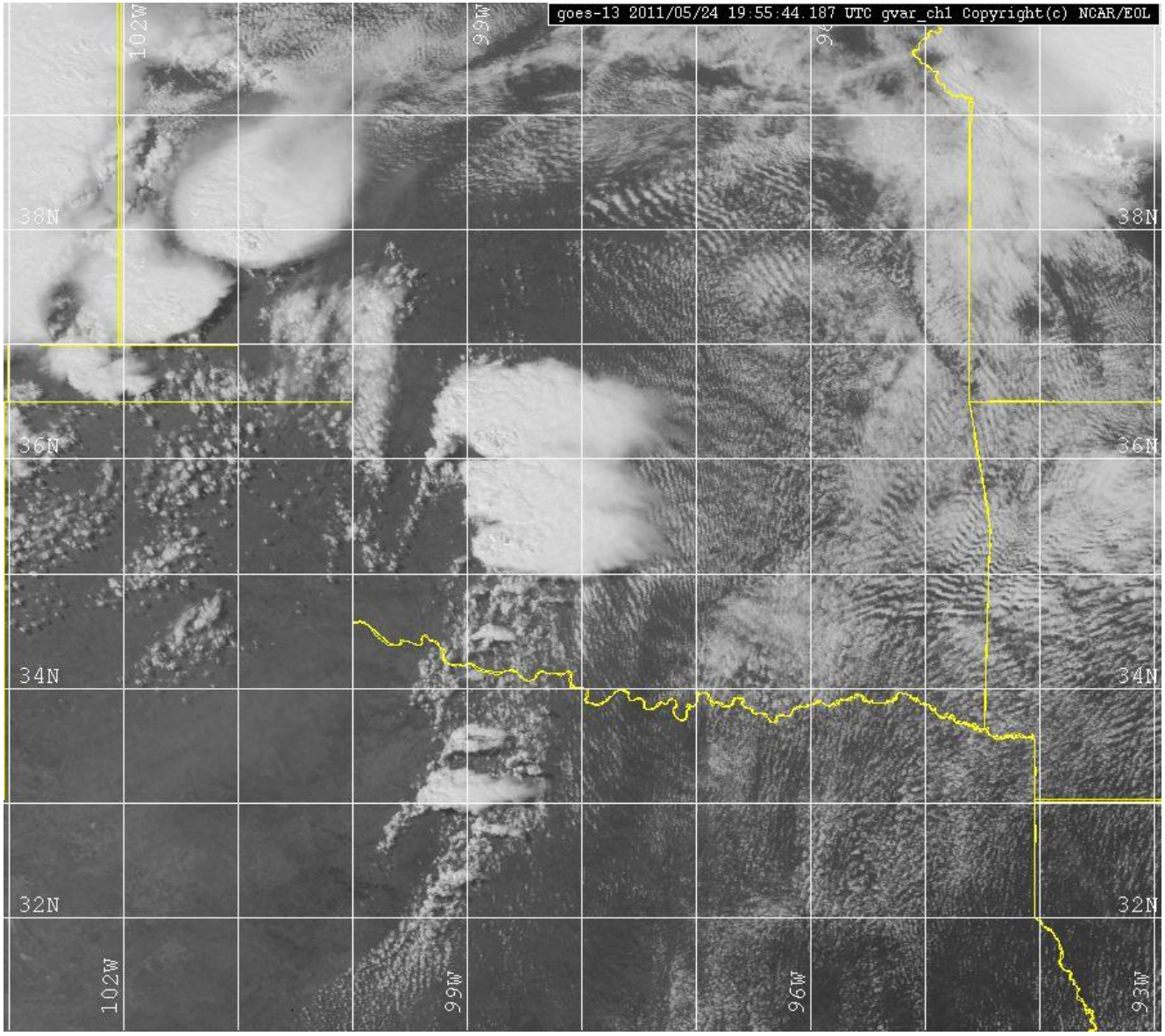
05/24/2011
18 UTC



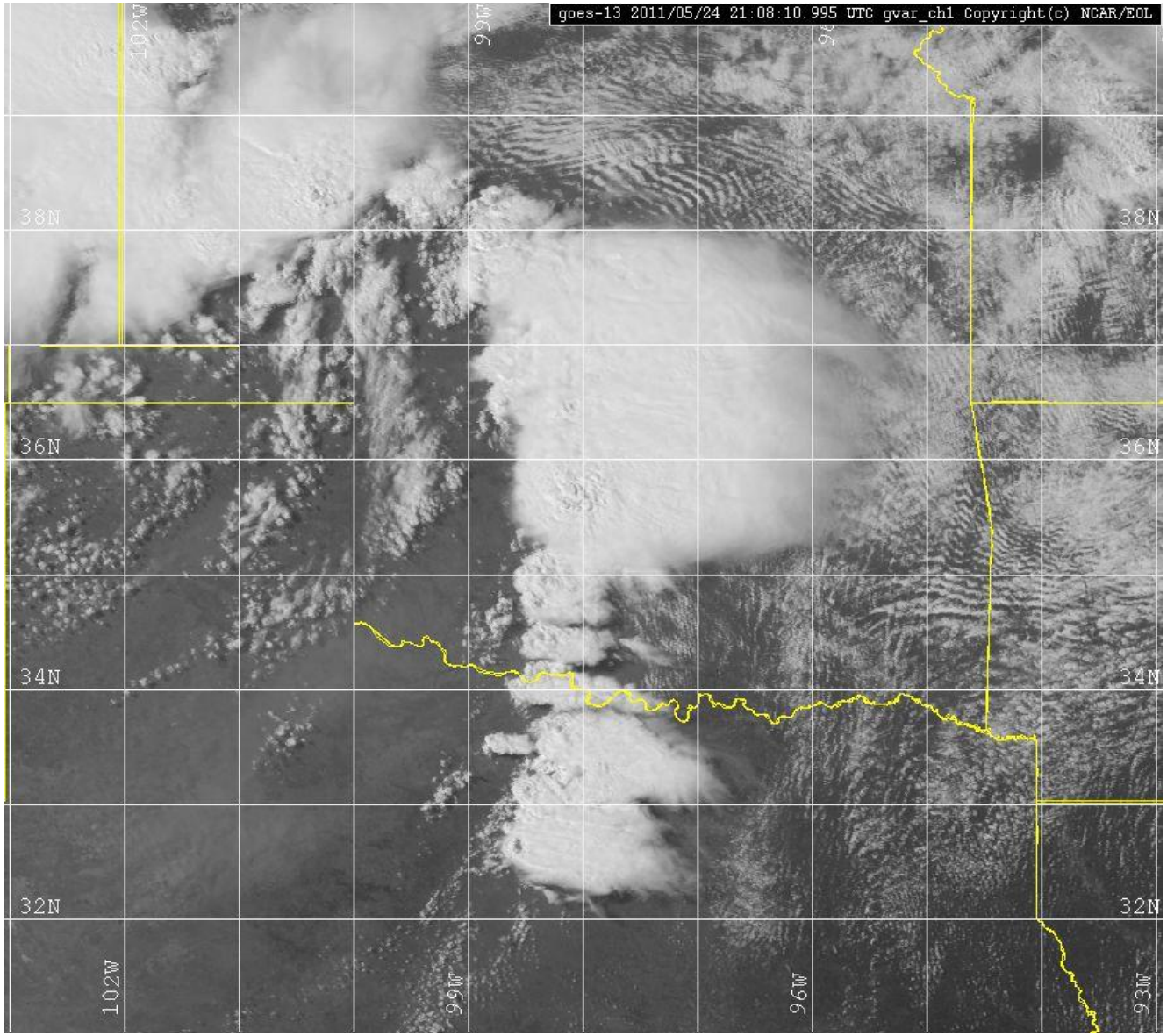
05/24/2011
19 UTC



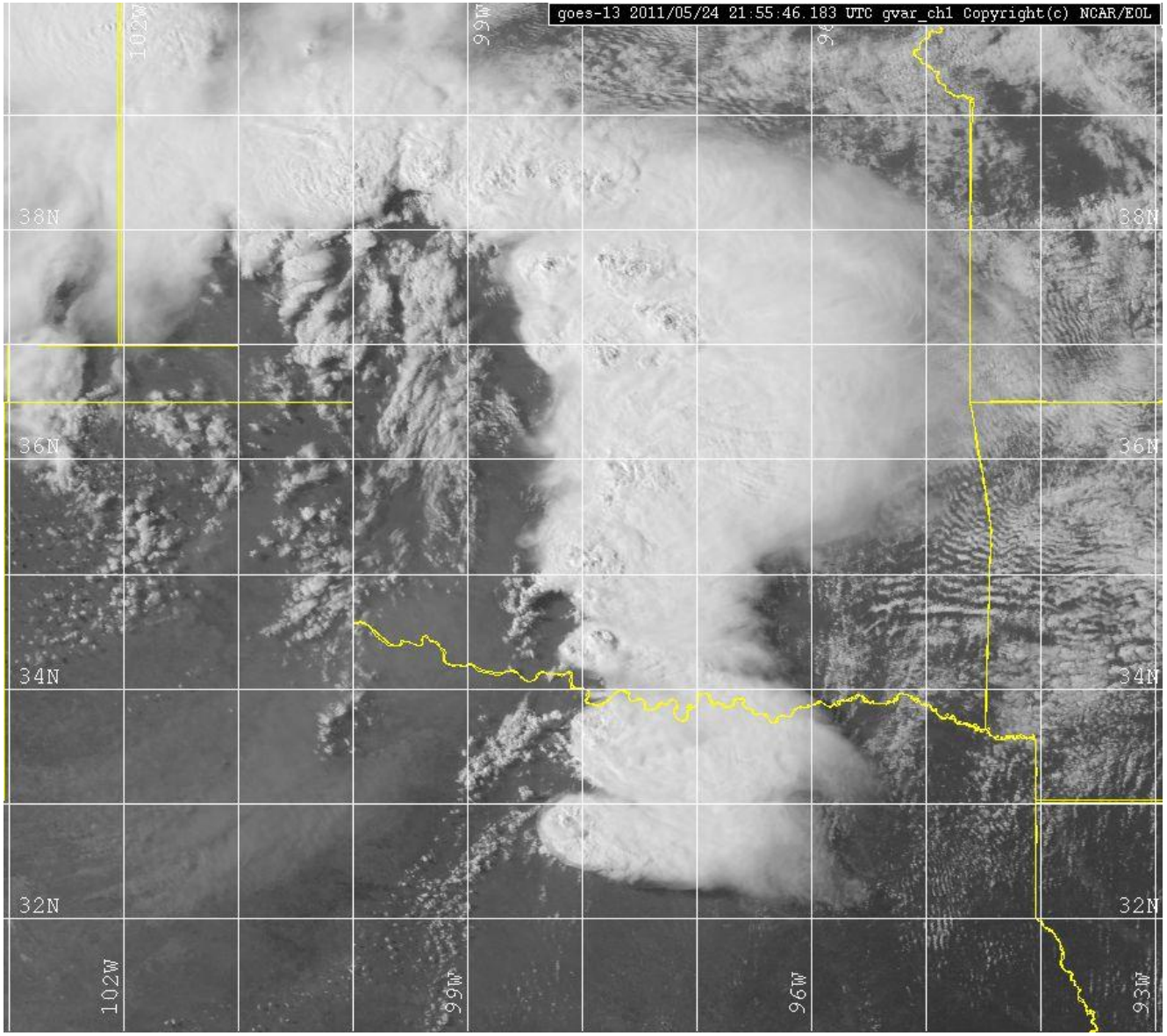
05/24/2011
20 UTC



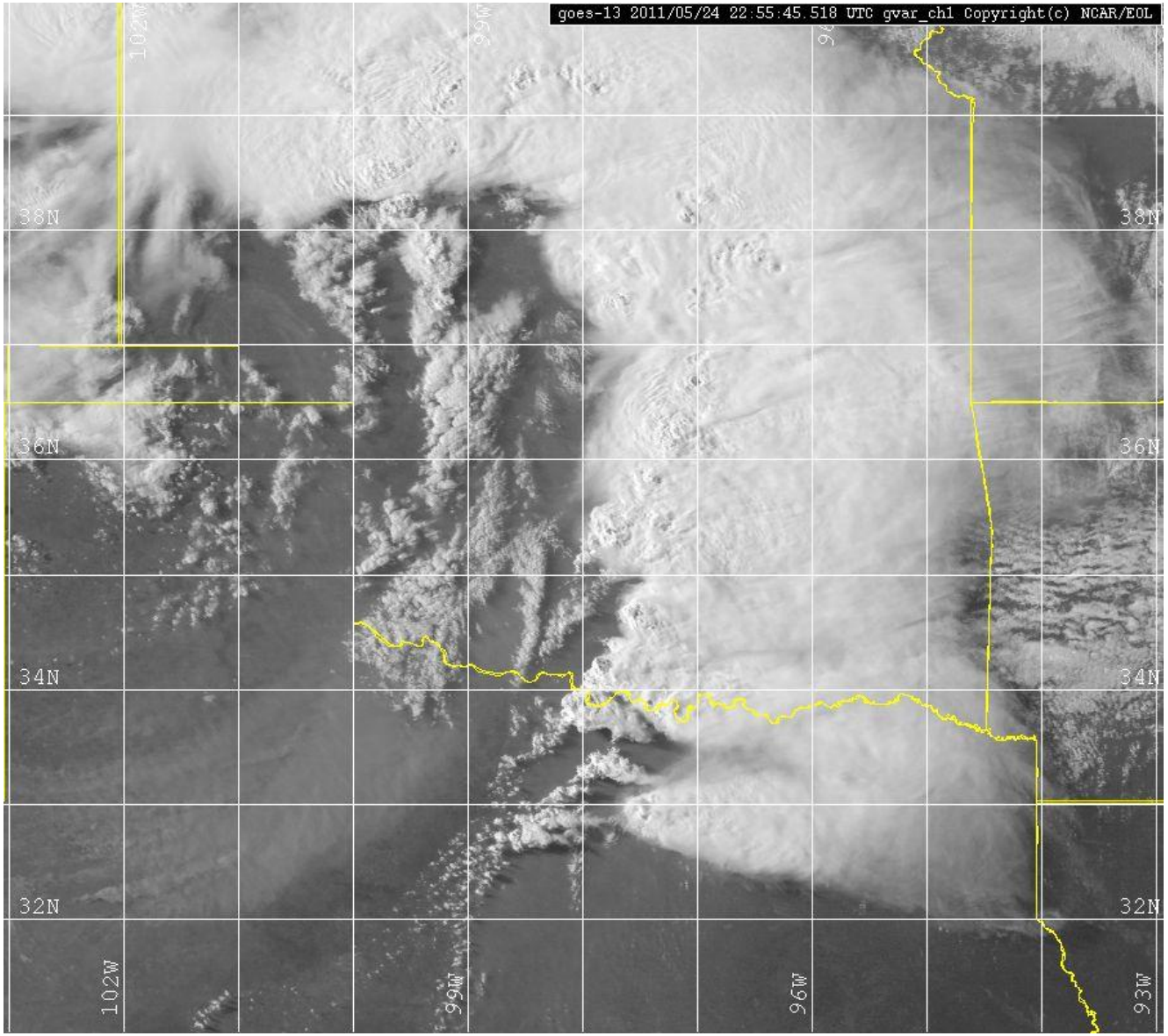
05/24/2011
21 UTC



05/24/2011
22 UTC



05/24/2011
23 UTC



*Need to work through a variety of forecast/weather scenarios to help with decision-making

DC3 Forecast/Nowcast Plans:

Forecasting Team: provides day 1, 2, 3… forecast guidance for DC3 planning/decision making….presents morning briefing/afternoon updates etc.

Lead Forecasters: Morris Weisman, Craig Schwartz (May 22-June 10)

Regional Forecasters: Don Burgess (OK), Russ Schumacher (CSU), Lamont Bain (AL)

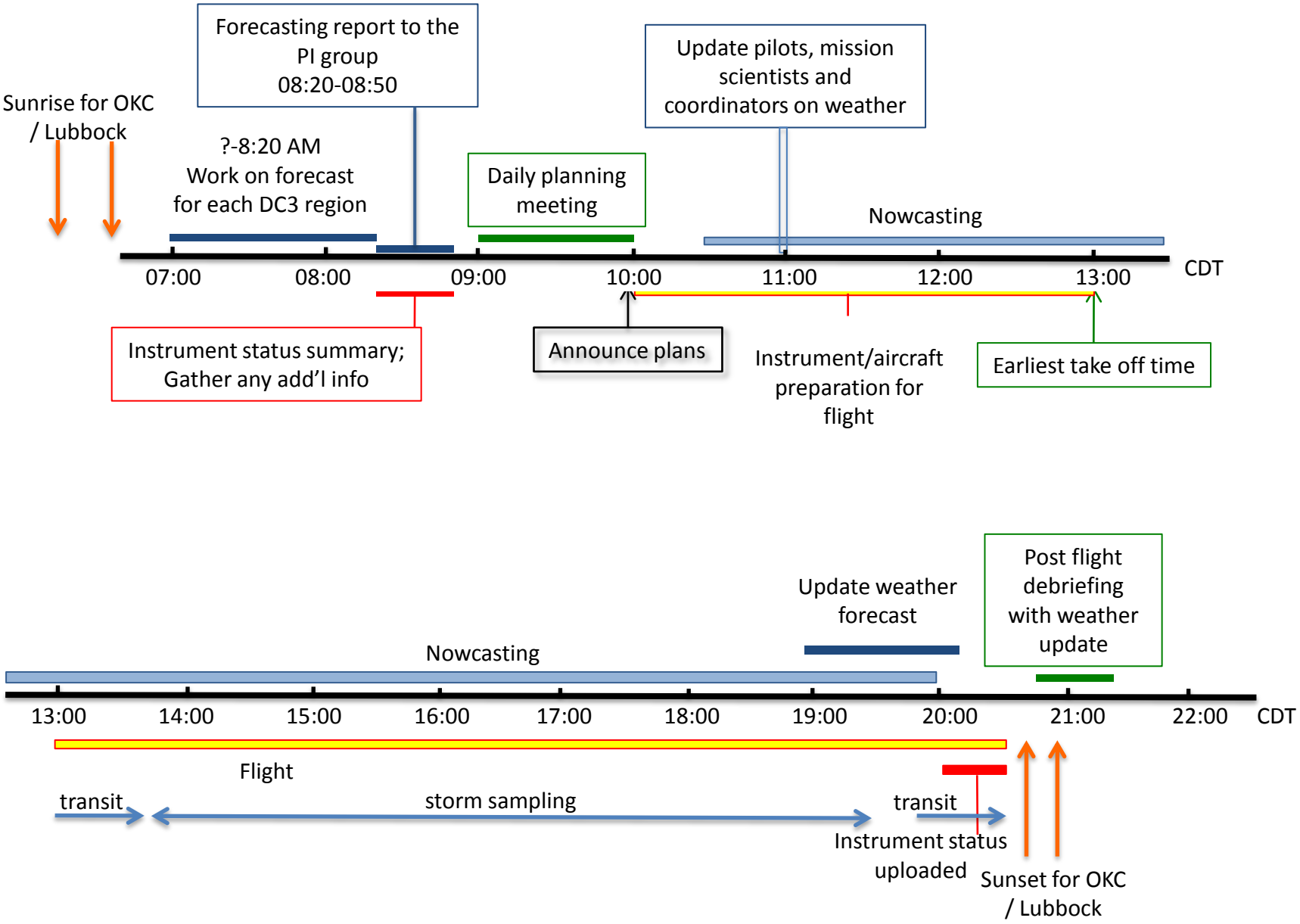
Nowcasting Team (Salina): monitors weather and provide updates/guidance for aircraft/ground crew operations as needed…works directly with Operations Director, PI's, etc.

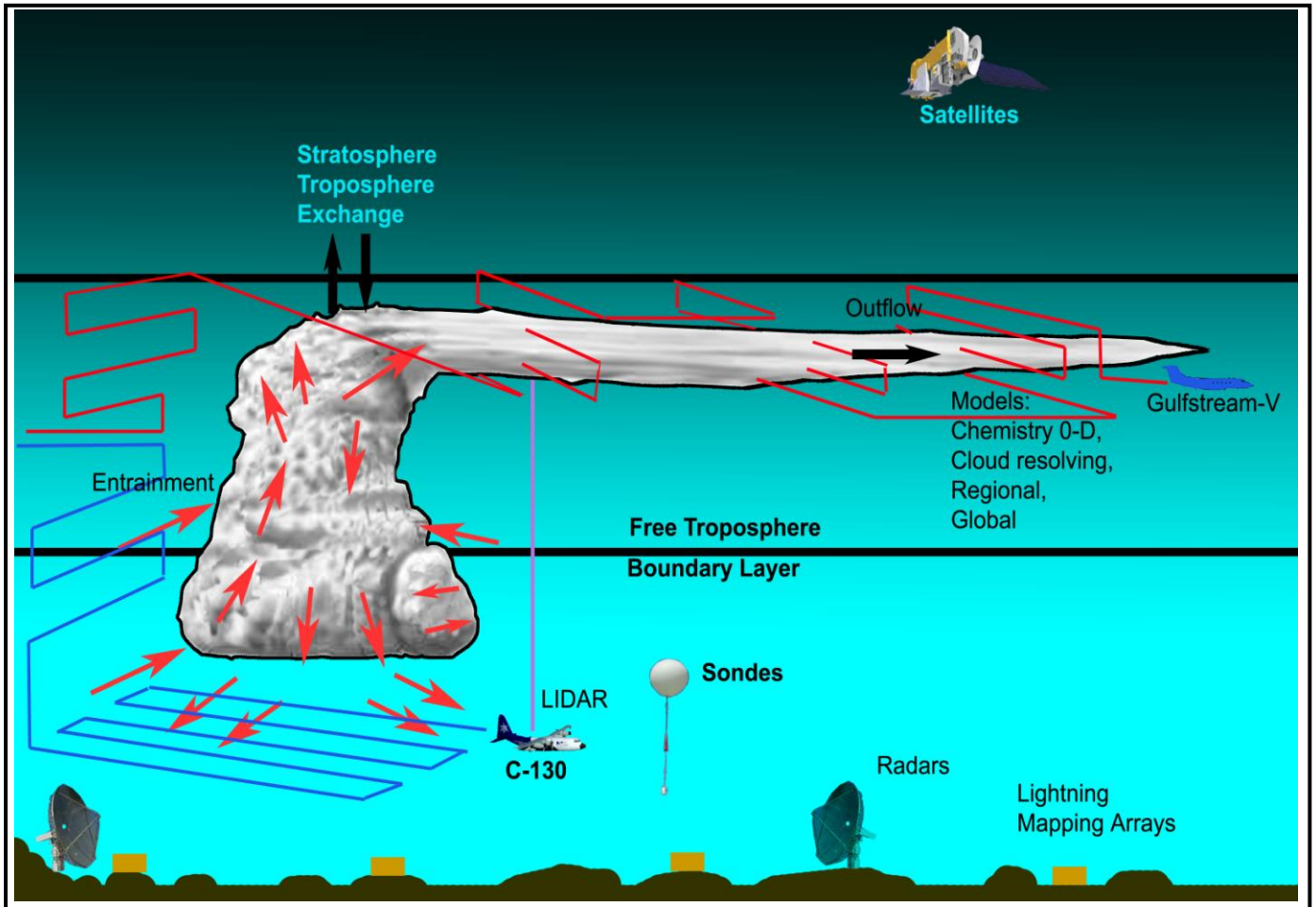
Oklahoma/Texas: Pat Hyland, Eric Bruning/Stephanie Weiss, Patrick Marsh

Alabama: ?

Colorado: ?

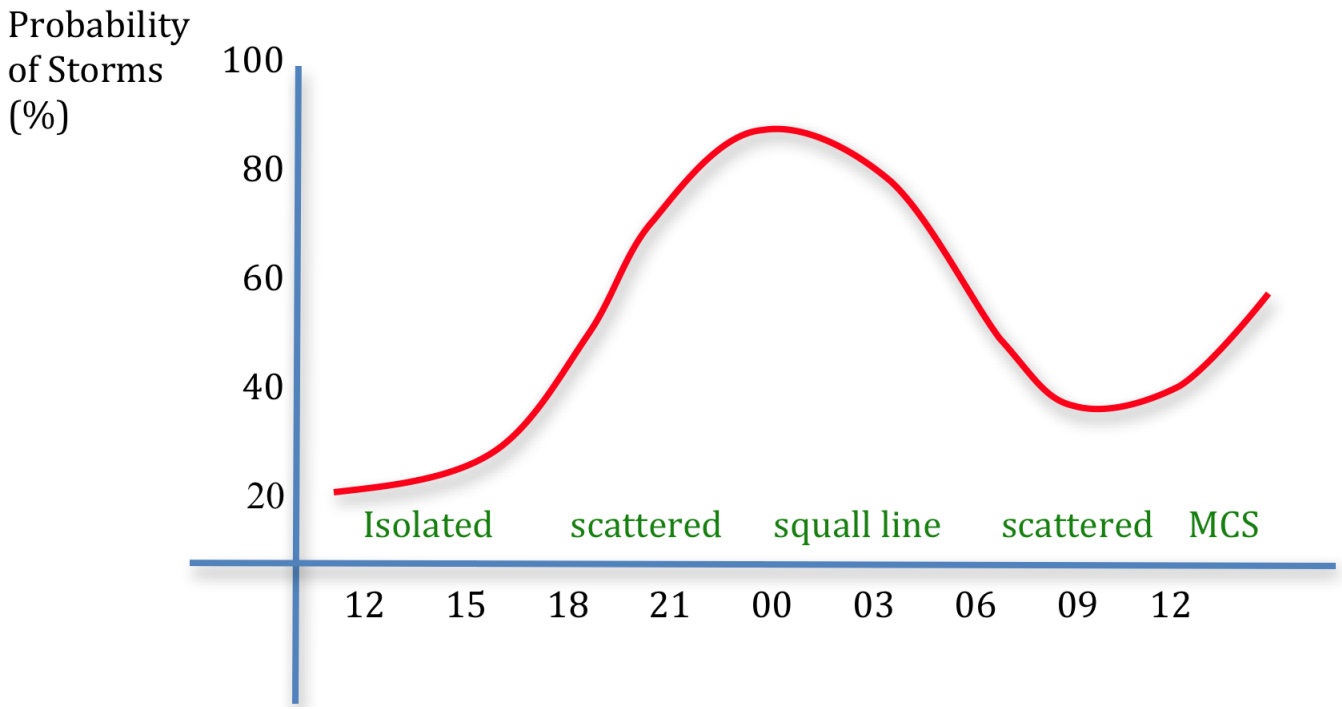
DC3 Daily schedule for active storm in Oklahoma flight day
no flight the following day




Satellites
Stratosphere
Troposphere
Exchange
Outflow
Models:
Chemistry 0-D,
Cloud resolving,
Regional,
Global
Gulfstream-V
Entrainment
Free Troposphere
Boundary Layer
Sondes
LIDAR
C-130
Radars
Lightning
Mapping Arrays

Summary:

We need additional nowcast support in Salina…….


Probability of Storms (%)
100
80
60
40
20
Isolated
scattered
squall line
scattered
MCS
12
15
18
21
00
03
06
09
12

Specific duties of the Nowcaster:

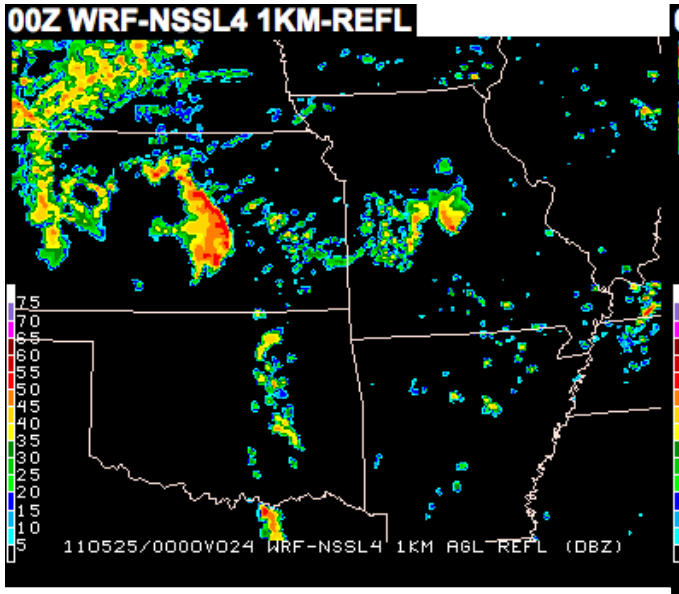
1) Prior to aircraft operations and during ferry, update on-board science and mission coordinator, and ground-based mission scientist on the evolving weather scenario, including expected timing and location of convective initiation.
2) During flights, monitor evolving convection, including storm intensity, motion, storm-relative winds, lightning activity, cloud/anvil tops, etc. This includes closely monitoring the target storm once a target has been chosen, as well as nearby storms that could impact ongoing observations or that might be targeted subsequently.
3) Specific to sampling in the Oklahoma region where mobile radars will be deployed, the nowcasting should begin as soon as the radars depart from the Oklahoma operations base.

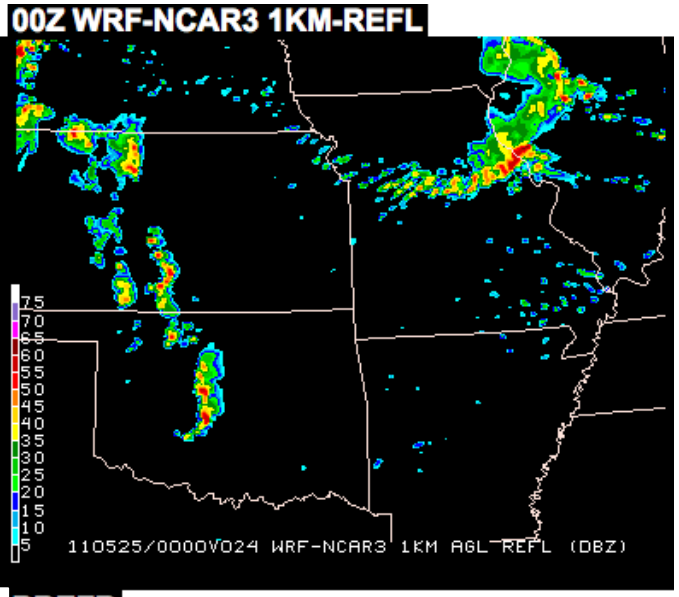
Specific forecasting questions to consider:

1. Will there be convection within the given domains today?
2. When will the convection initiate?
3. How strong/deep will the convection be (max updrafts, cloud tops, etc.)
4. What will be the primary convective mode at onset (e.g., isolated, scattered, supercellular, squall line)?
5. How will the convective mode evolve during the observation period (e.g., isolated cells growing upscale into squall line…. etc.)?
6. Where will the convection and/or convective outflows be the following day?
7. What is the potential for lightning?
8. What are the projections for aircraft turbulence?
9. What is the anticipated height of the tropopause?

05/25/11 0000 UTC

NSSL
4 km
NAM
WSM6

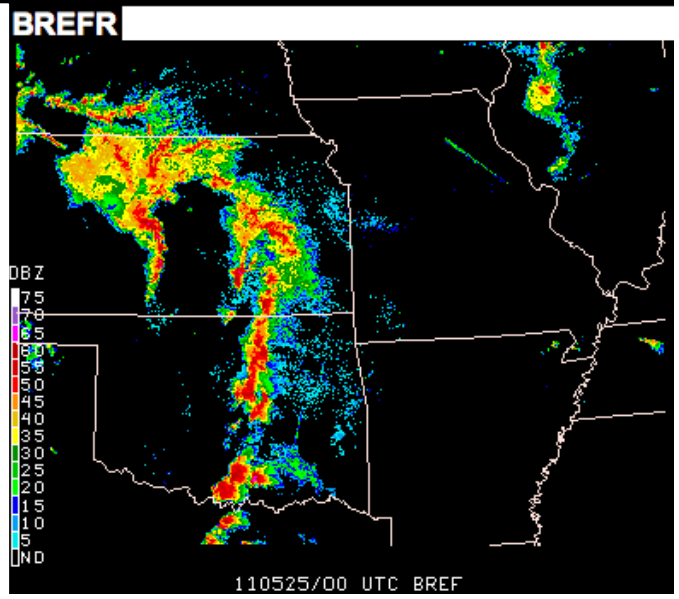




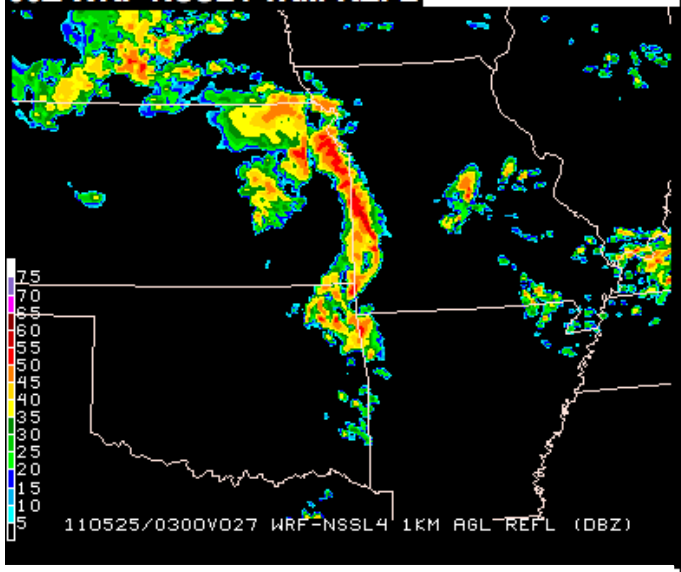
NCAR
3 km
DART
Thomp

24 h Forecasts

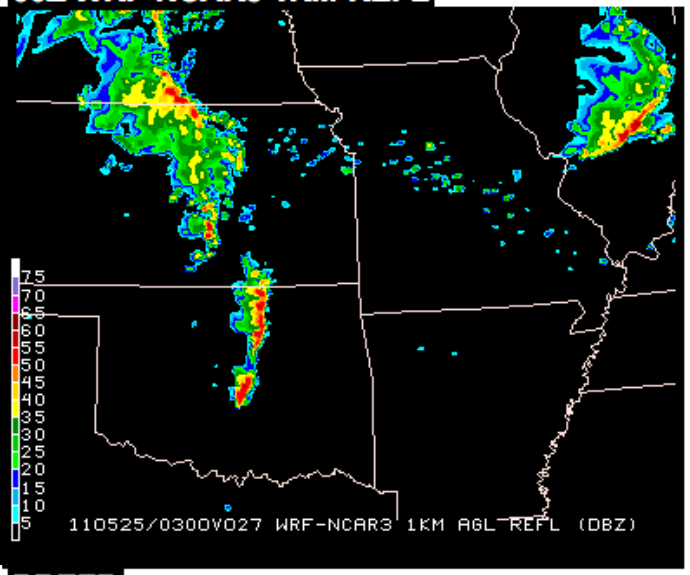
1 km Observed
Reflectivity



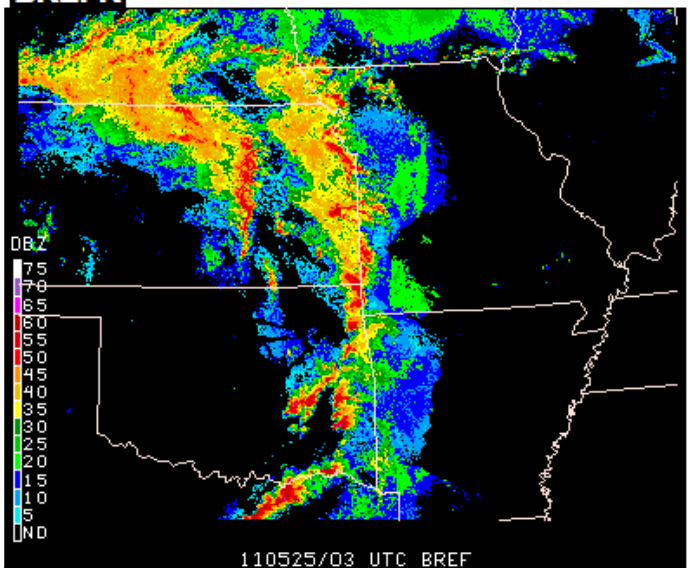
00Z WRF-NSSL4 1KM-REFL



00Z WRF-NCAR3 1KM-REFL



BREFR



8 tracers included

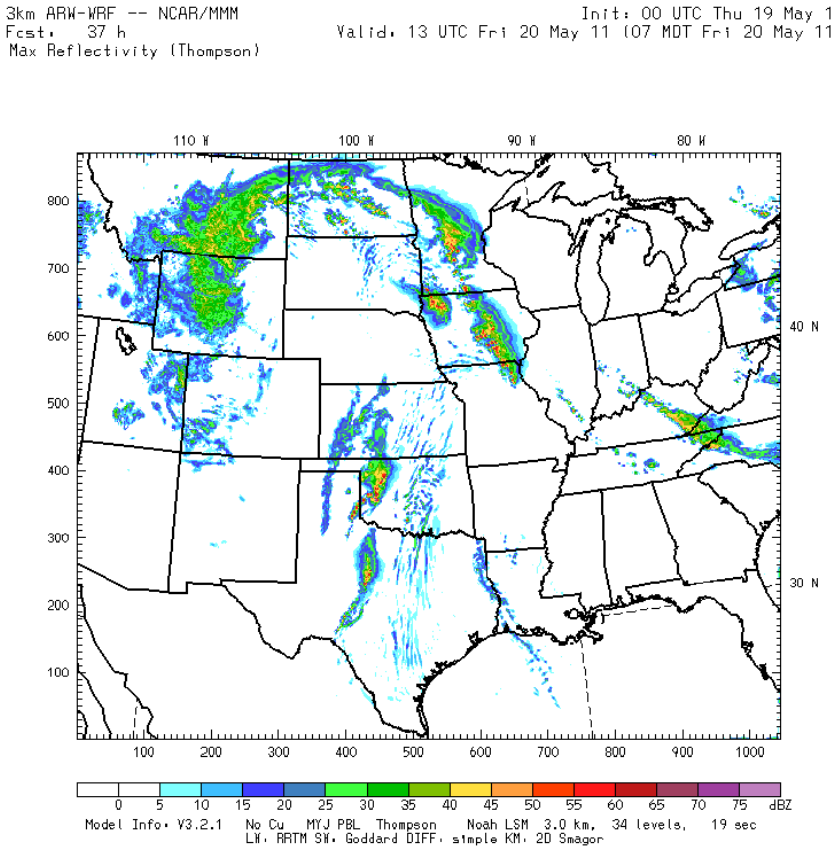
tracers 2,3 4,5 6,7

- 2 Colorado BL tracers
- 2 Oklahoma BL tracers
- 2 Alabama BL tracers

Two types of tracers

1) Passive tracer
2) Decaying tracer with time scale of 1 day

→ Age of Air

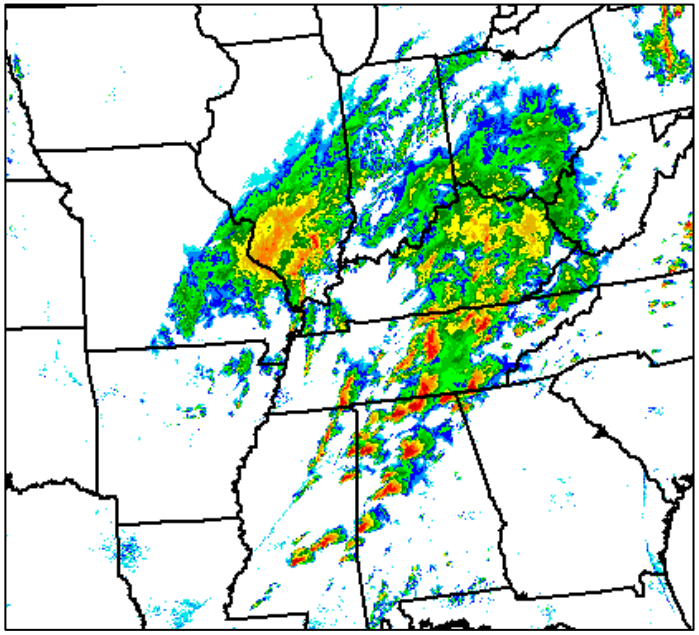


Model radar reflectivity (dBZ)
13 UTC 20 May (08 CDT)

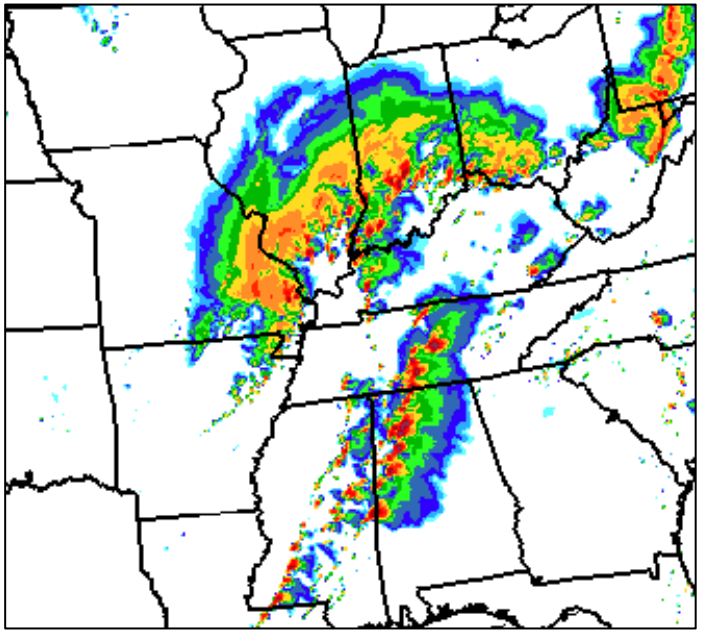
The Impact of WRF-DART Analyses on 3 km Explicit Convective Forecasts During the 2011 Spring Season

M. Weisman, W. Wang, K. Manning, G. Romine; NCAR/MMM

(12th WRF Workshop: June 20-24 2011)



Radar 22 UTC



3 km ARW 4 h Forecast

Tornado Outbreak: 04/27/11

Lightning NO_x (LNO_x) Tracer for the DC3 Cloud-Resolved WRF Forecasts

Kristin Cummings (UMD), Ken Pickering (NASA/GSFC), Mary Barth (NCAR)

- **Three flash rate parameterization schemes (FRPS) running on-line in NCAR WRF cloud-resolving (3-km resolution) forecast model:**
  - **Estimate total flash rates from predicted storm variables:**
  - **Cloud-top height, maximum vertical velocity, updraft volume**
  - **Use IC/CG ratios based on *Boccippio et al. (2001)* climatology**

- **One FRPS will be selected for use in injecting LNOx into the model**

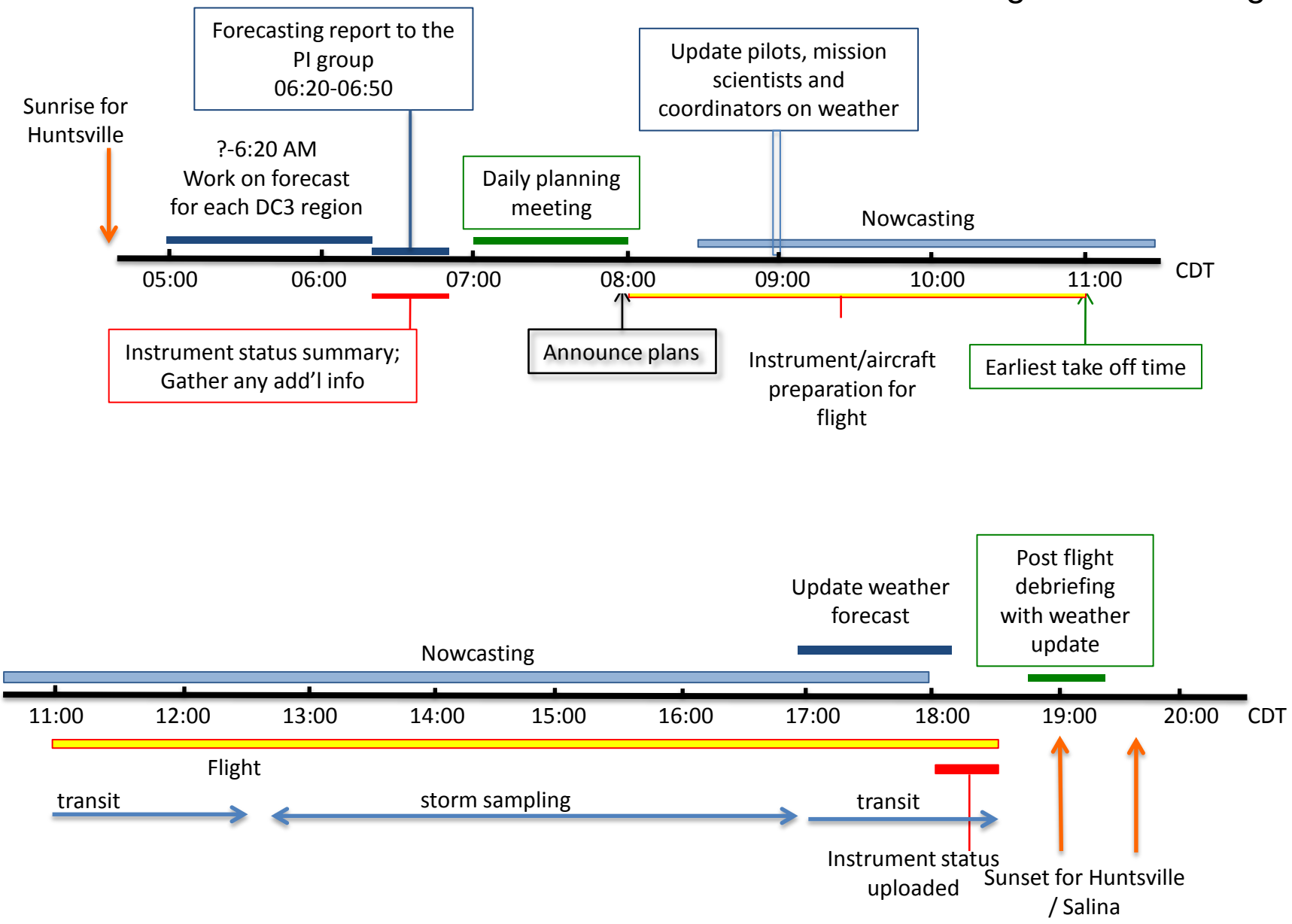
- **Assumes 500 moles NO per IC and CG flash *(Ott et al., 2010)***

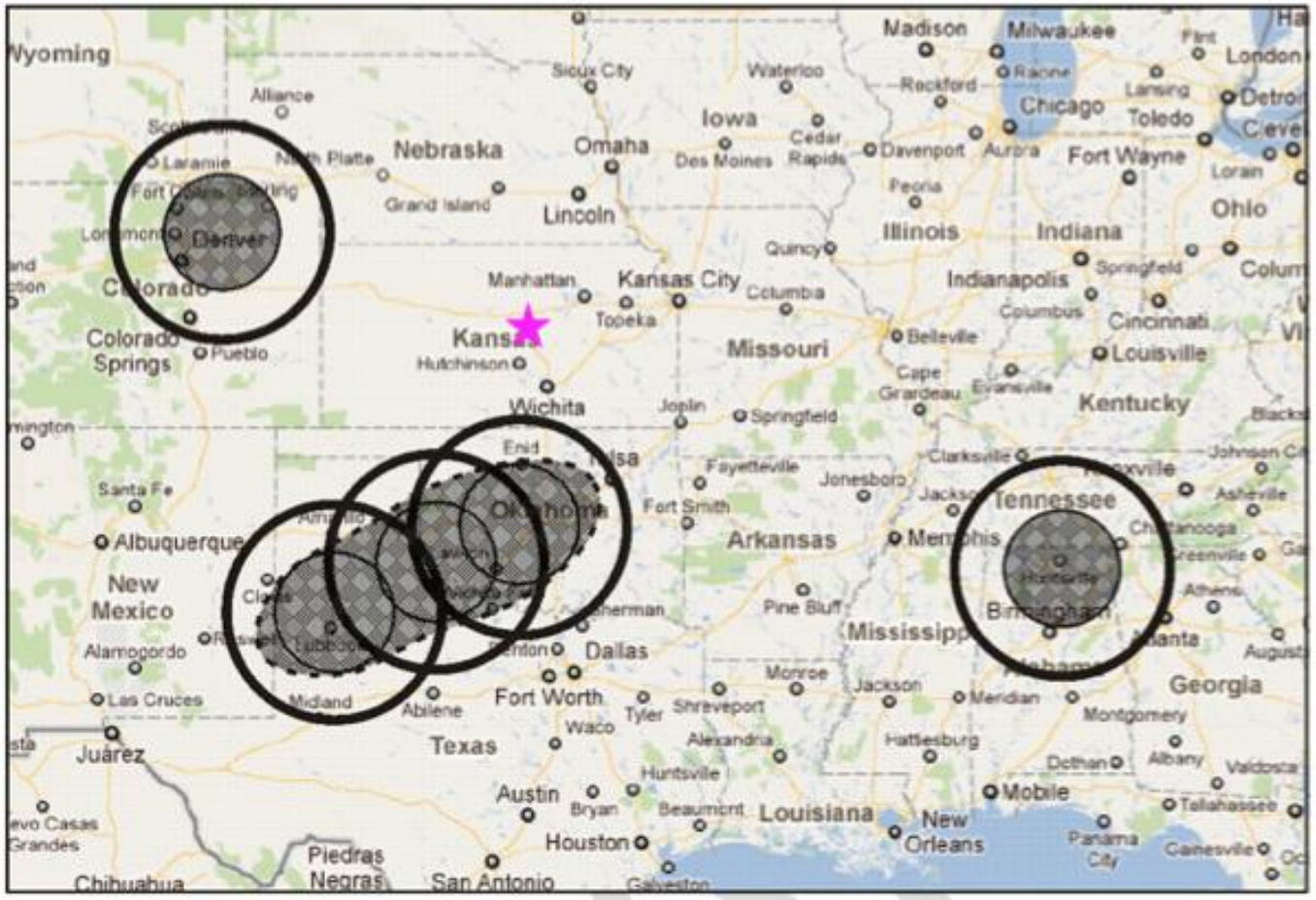
- **Assumes Gaussian vertical distributions of IC (bimodal) and CG (single mode) NO production based on typical lightning flash channel distributions. Lightning channels set to maximize at -15C (CG and IC) and -45C (IC).**

- **Horizontal placement of LNOx within the 20 dBZ contour**

- **LNOx decay based on altitude-dependent e-folding lifetimes (ranging from 1 day in PBL to 5 days in upper troposphere)**

DC3 Daily schedule for active storm in Alabama flight day
no flight the following day




Wyoming
Alliance
Nebraska
Omaha
Lincoln
Grand Island
North Platte
Laramie
Denver
Colorado
Colorado Springs
Pueblo
Sioux City
Waterloo
Iowa
Des Moines
Cedar Rapids
Davenport
Madison
Milwaukee
Rockford
Racine
Chicago
Aurora
Lansing
Toledo
Fort Wayne
Peoria
Illinois
Indiana
Ohio
Quincy
Indianapolis
Springfield
Columbus
Cincinnati
Louisville
Belleville
Cape Girardeau
Evansville
Kentucky
Missouri
Columbia
Kansas City
Topeka
Manhattan
Hutchinson
Wichita
Joplin
Springfield
Enid
Tulsa
Oklahoma
Fayetteville
Fort Smith
Jonesboro
Arkansas
Memphis
Tennessee
Clarksville
Jackson
Asheville
Chattanooga
Greenville
Athens
Birmingham
Georgia
Atlanta
Augusta
Mississippi
Pine Bluff
Monroe
Jackson
Meridian
Montgomery
Hattiesburg
Dothan
Albany
Valdosta
Tallahassee
Gainesville
Mobile
Louisiana
New Orleans
Panama City
Santa Fe
Albuquerque
New Mexico
Alamogordo
Las Cruces
Juárez
Clovis
Roswell
Lubbock
Midland
Abilene
Sherman
Denton
Dallas
Fort Worth
Waco
Tyler
Shreveport
Alexandria
Texas
Austin
Bryan
Beaumont
Huntsville
Houston
San Antonio
Galveston
Piedras Negras
Chihuahua
Nuevo Casas Grandes