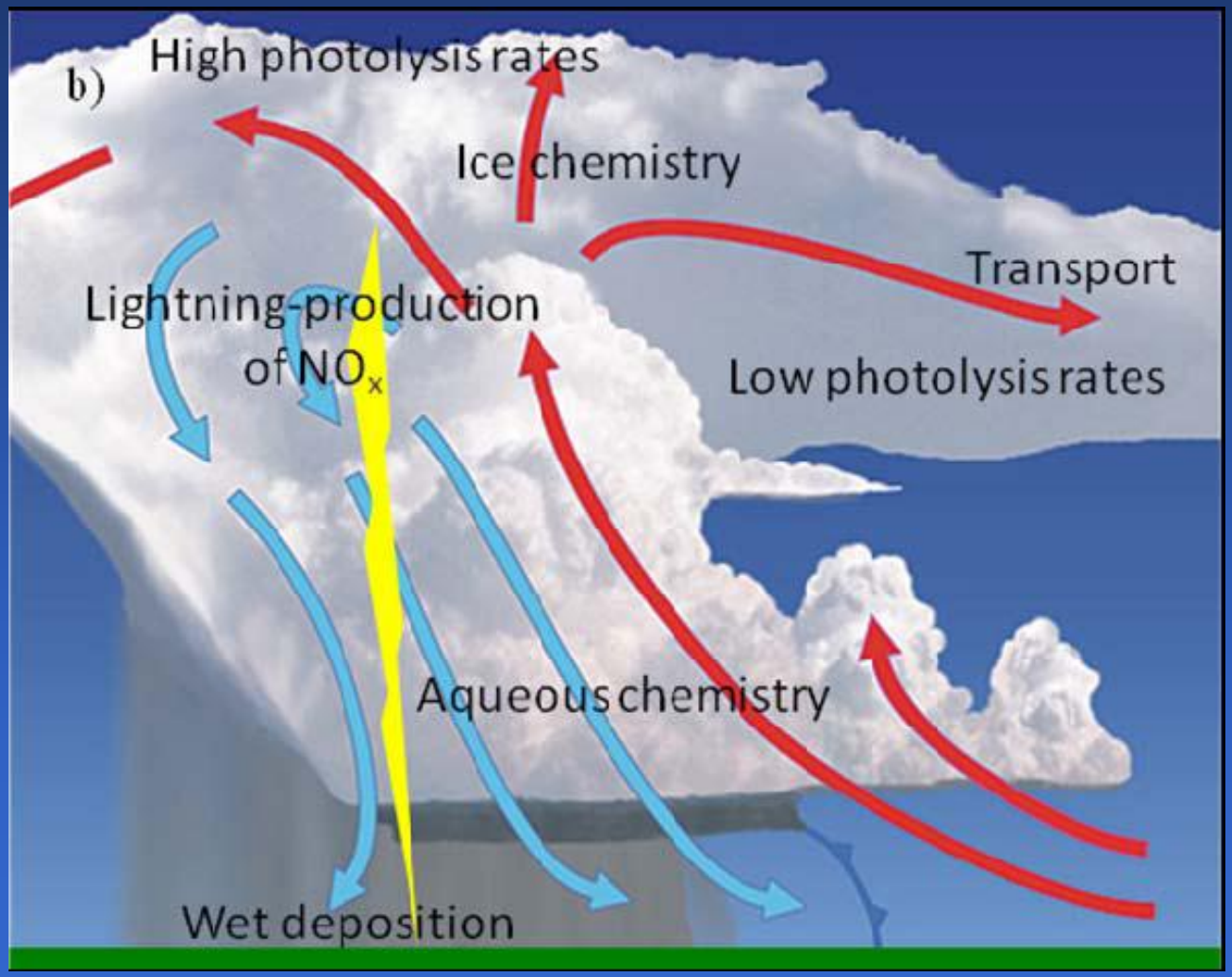
Deep Convective Clouds and Chemistry (DC3) Field Program



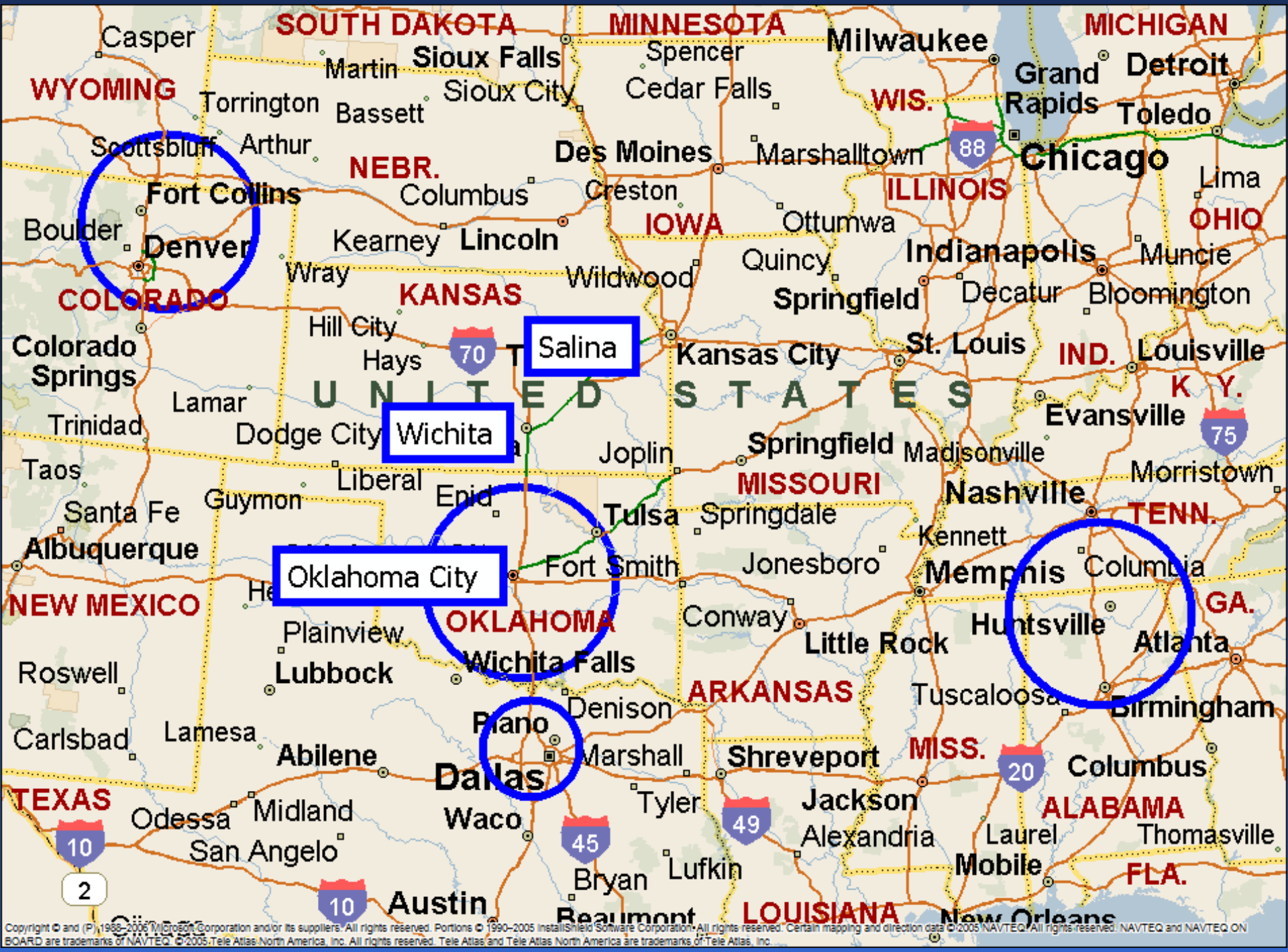
Primary Goals of DC3

- Quantify and characterize the convective transport of fresh chemical emissions and water to the upper troposphere within the first few hours of active convection. Requires investigating:
  - Storm dynamics and physics
  - Lightning and its production of nitrogen oxides
  - Cloud hydrometeor effects on scavenging of species, surface emission variability, and chemistry of anvil

- Quantify the changes in chemistry and composition in the upper troposphere, focusing on 12-24 hours after deep convection and during seasonal transition of chemical composition of the upper troposphere

Lightning-Specific Hypotheses

- The contribution of lightning to NOx in the anvil and upper troposphere depends on overall flash rates and aggregate channel lengths at heights from the melting level to the uppermost region of the convective core
- On average, the amount of NOx produced by a CG flash is roughly equivalent to the amount produced by an IC flash
- Flash rates are proportional to the volume of updrafts > 10 m/s at -10° to -40°C and to the storm echo volume of graupel
- CG occurrence usually follows the occurrence of precipitation in the 0° to -10°C layer and is inhibited in storms with little precipitation
- Flashes whose vertical polarity is inverted from the usual polarity are favored in storms in which a large fraction of the adiabatic liquid water profile is realized as cloud liquid in the mixed phase region



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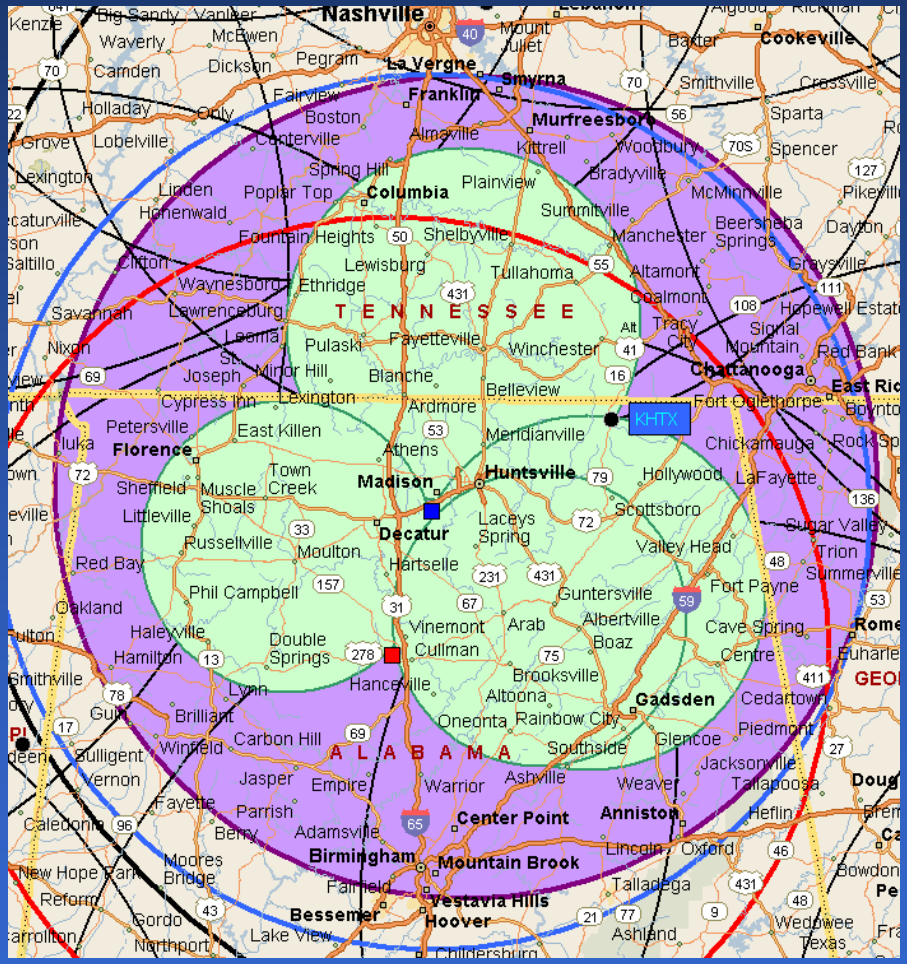
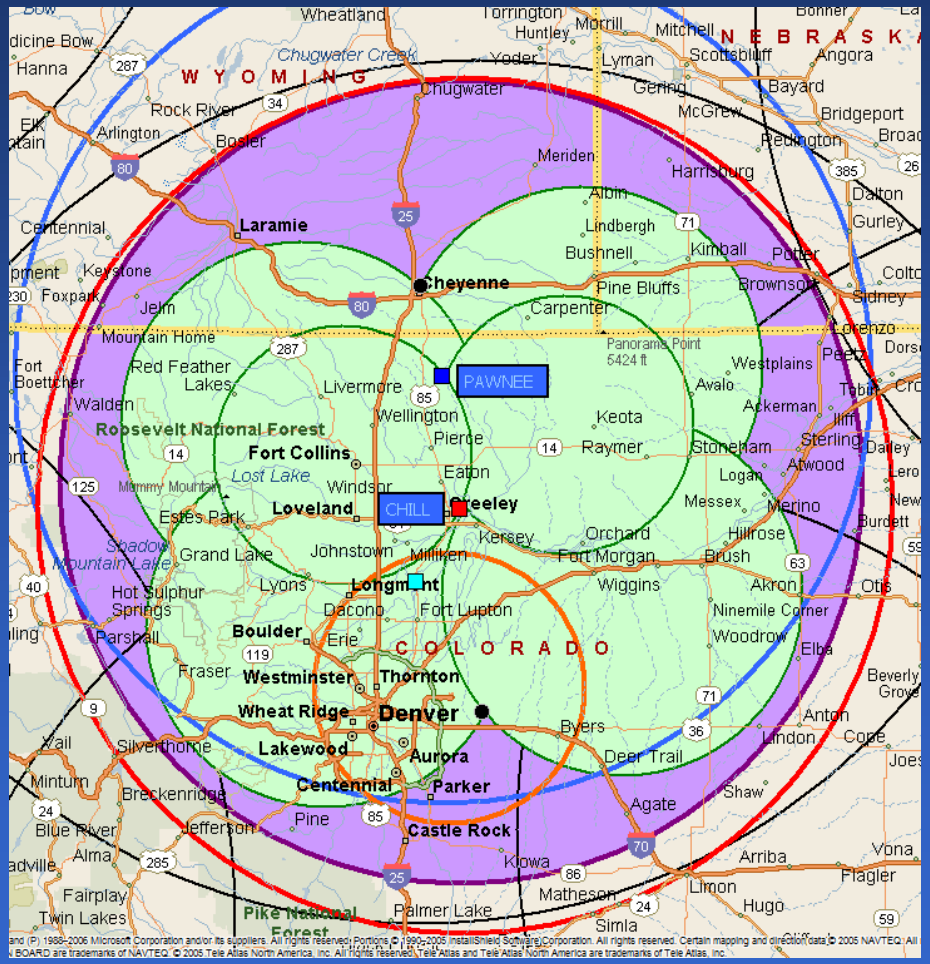
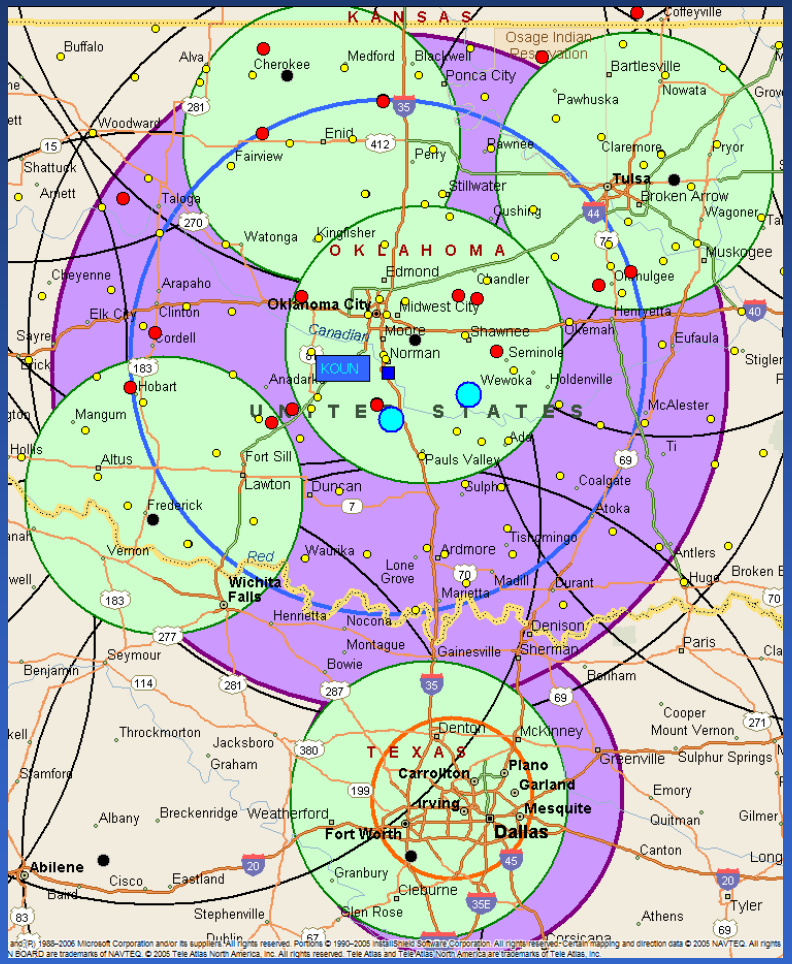
Northern Alabama



Colorado


W Y O M I N G
N E B R A S K A
C O L O R A D O
Chugwater Creek
Chugwater
Wheatland
Torrington
Huntley
Morrill
Mitchell
Scottsbluff
Angora
Bayard
Bridgeport
Lyman
Gering
McGrew
Yoder
Rock River
Arlington
Bosler
Meriden
Harrisburg
Albin
Lindbergh
Bushnell
Kimball
Pine Bluffs
Carpenter
Laramie
Cheyenne
Centennial
Keystone
Foxpark
Jelm
Mountain Home
Red Feather Lakes
Livermore
Wellington
PAWNEE
Panorama Point 5424 ft
Westplains
Avalo
Ackerman
Keota
Pierce
Raymer
Stoneham
Sterling
Atwood
Logan
Messex
Merino
Roosevelt National Forest
Fort Collins
Lost Lake
Mummy Mountain
Windsor
Eaton
Loveland
CHILL
Greeley
Estes Park
Kersey
Orchard
Hillrose
Brush
Fort Morgan
Grand Lake
Johnstown
Milliken
Shadow Mountain Lake
Lyons
Longmont
Wiggins
Akron
Hot Sulphur Springs
Dacono
Fort Lupton
Ninemile Corner
Parshall
Boulder
Erie
Woodrow
Elba
Fraser
Westminster
Thornton
Wheat Ridge
Denver
Byers
Anton
Vail
Silverthorne
Lakewood
Aurora
Deer Trail
Lindon
Minturn
Breckenridge
Centennial
Parker
Shaw
Agate
Blue River
Jefferson
Pine
Castle Rock
Alma
Kiowa
Arriba
Vona
Flagler
Fairplay
Twin Lakes
Pike National Forest
Palmer Lake
Matheson
Limon
Hugo
Simla

Oklahoma


KANSAS
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TEXAS
UNITED STATES
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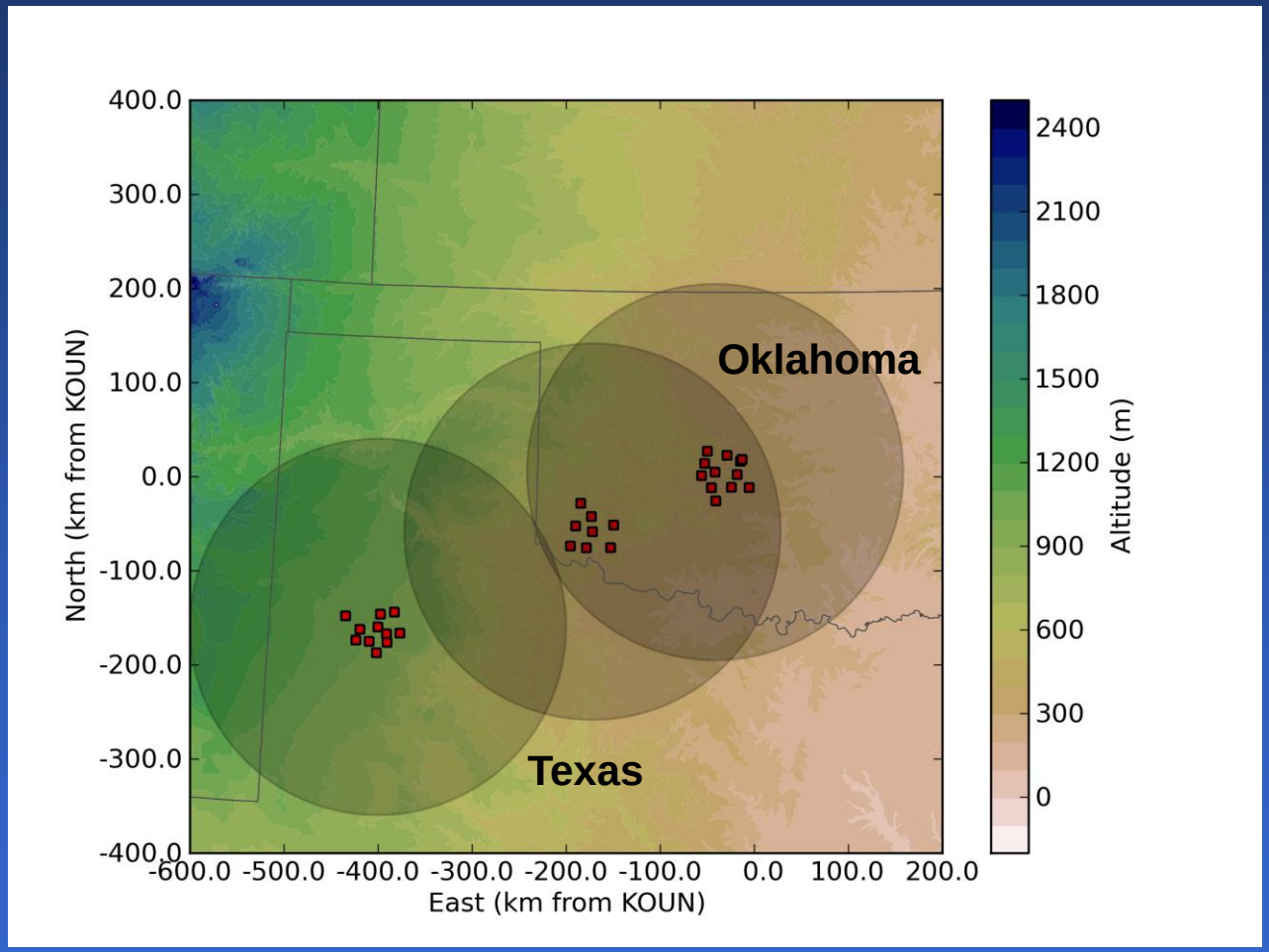
Medford
Blackwell
Ponca City
Osage Indian Reservation
Bartlesville
Nowata
Pawhuska
Woodward
Enid
Fairview
Perry
Pawnee
Claremore
Pryor
Shattuck
Arnett
Tulsa
Broken Arrow
Stillwater
Cushing
Wagoner
Taloga
Watonga
Kingfisher
Muskogee
Cheyenne
Arapaho
Edmond
Guthrie
Okmulgee
Elk City
Clinton
Oklahoma City
Midwest City
Henryetta
Sayre
Cordell
Canadian
Moore
Shawnee
Okemah
Eufaula
Norman
Seminole
Hobart
Anadarko
Wewoka
Holdenville
Mangum
McAlester
Altus
Fort Sill
Pauls Valley
Ada
Lawton
Duncan
Sulphur
Coalgate
Frederick
Atoka
Vernon
Red
Waurika
Ardmore
Tishomingo
Lone Grove
Madill
Durant
Wichita Falls
Marietta
Henrietta
Nocona
Denison
Montague
Gainesville
Sherman
Seymour
Bowie
Paris
Benjamin
Bonham
Throckmorton
Jacksboro
Denton
McKinney
Cooper
Mount Vernon
Graham
Carrollton
Plano
Garland
Greenville
Sulphur Springs
Stamford
Irving
Mesquite
Emory
Albany
Breckenridge
Weatherford
Fort Worth
Dallas
Quitman
Gilmer
Abilene
Canton
Granbury
Cisco
Eastland
Cleburne
Glen Rose
Tyler
Stephenville
Athens
Dublin
Corsicana
KOUN

Planned OK-LMA and WT-LMA



Planned Facilities

Table 2. Ground-based platforms and facilities to be used in DC3.

Facility	Product	Sponsor	Required for Goals:
NE Colorado			
CSU-CHILL, Pawnee, NEXRAD radars	Winds, precipitation, hydrometeor identification	♦NSF, NOAA	1
3-D lightning mapping array (LMA) (fixed and mobile)	Lightning location, geometry	NSF	1
Sondes (MGAUS)	T, P, RH	NSF	1
Rainwater samples	Rainwater composition	NSF	1
NOAA Platteville observations	Rainfall, wind profiles	NOAA	1
Mobile hail & rainwater collector	Hydrometeor amount and composition	NCAR	1
Central Oklahoma			
Oklahoma LMA (plus mobile)	Lightning location, geometry	OU, NSSL	1
KOUN, PAR, NEXRAD, SMART-R and X-band mobile radars	Wind, precipitation, hydrometeor identification	OU, NSSL, NOAA	1
Sondes	Winds, T, P, RH, electric field, precipitation	NSSL, NSF	1
ARM sites	Solar radiation, wind profiles, CO_2 flux, aerosols, cloud properties, aerosol profiles, surface winds, sondes	DOE	1
Oklahoma Mesonet	Wind field & thermodynamic grid	OCS	1
Rainwater samples	Rainwater composition	NSF	1
Northern Alabama			
Radars (ARMOR, KHTX, MAX, Redstone)	Winds, precipitation, hydrometeor identification	UAH, NASA, NOAA, Redstone	1
MIPS mobile	Wind profiles, water vapor, cloud water, virtual T, electric field	UAH	1
Sondes	Winds, T, P, RH, O_3, precipitation	UAH, Redstone, NSF	1
M3V vehicle	Surface meteorology, rain water samples	UAH	
Mobile sounding unit	Winds, T, P, RH, O_3, electric field, precipitation	UAH (Redstone), NSF	1
Rainwater samples	Rainwater composition	NSF	1
Alabama LMA (plus mobile)	Lightning location, geometry	NASA-MSFC	1
Northern Alabama Electric Field Change Network	Lightning physics, energetics	UAH	1

♦ Sponsor acronyms: NSF: National Science Foundation; NOAA: National Oceanic and Atmospheric Administration; NCAR: National Center for Atmospheric Research; OU: University of Oklahoma; NSSL: National Severe Storms Laboratory; DOE: Department of Energy; OCS: Oklahoma Climatological Survey; UAH: University of Alabama-Huntsville; MSFC: Marshall Space Flight Center.

Typical Flight Patterns

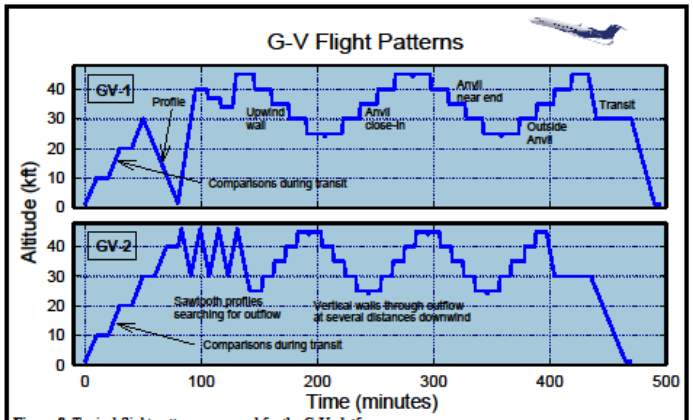


Figure 8. Typical flight patterns proposed for the G-V platform.

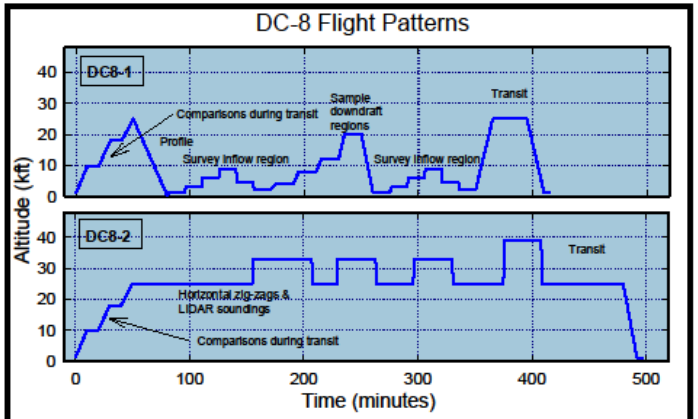


Figure 9. Typical flight patterns proposed for the DC-8 aircraft.