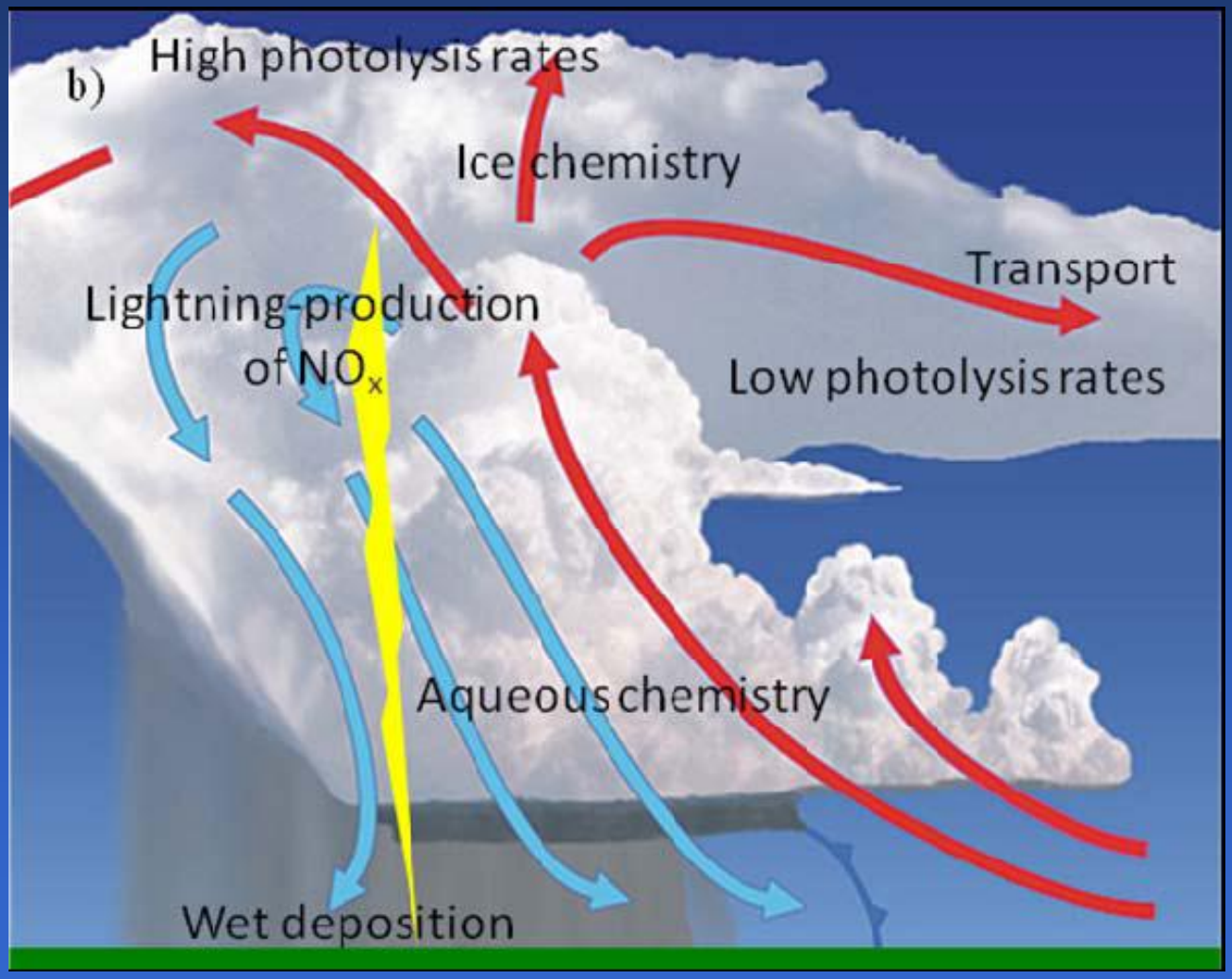
Deep Convective Clouds and Chemistry (DC3) Field Program



Primary Goals of DC3

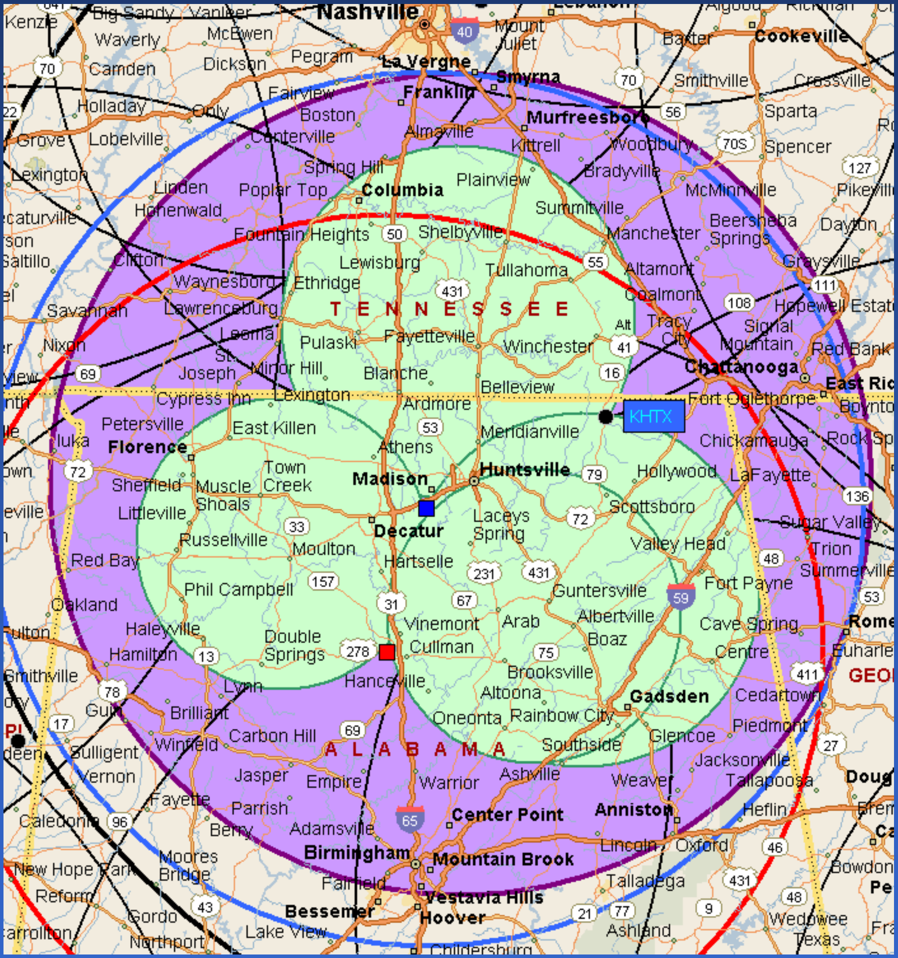
- **Quantify and characterize the convective transport of fresh chemical emissions and water to the upper troposphere within the first few hours of active convection. Requires investigating:**
  - **Storm dynamics and physics**
  - **Lightning and its production of nitrogen oxides**
  - **Cloud hydrometeor 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**

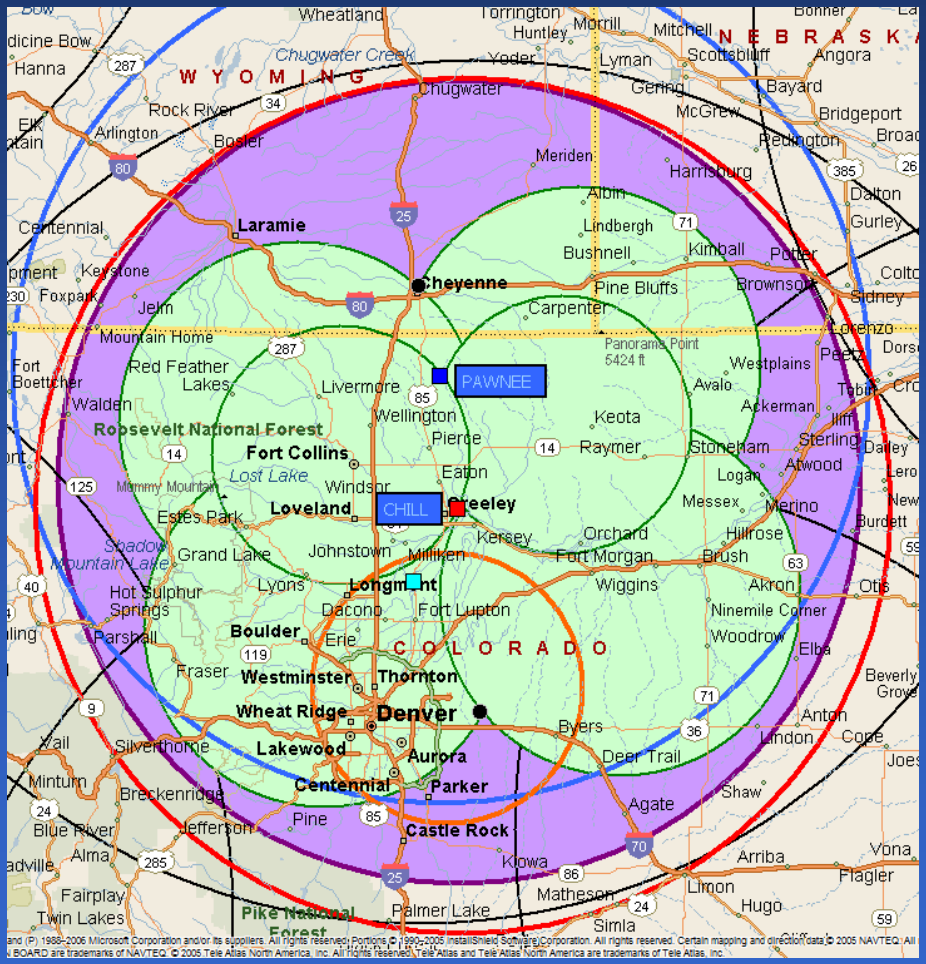
Lightning-Specific Hypotheses

- 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

Northern Alabama



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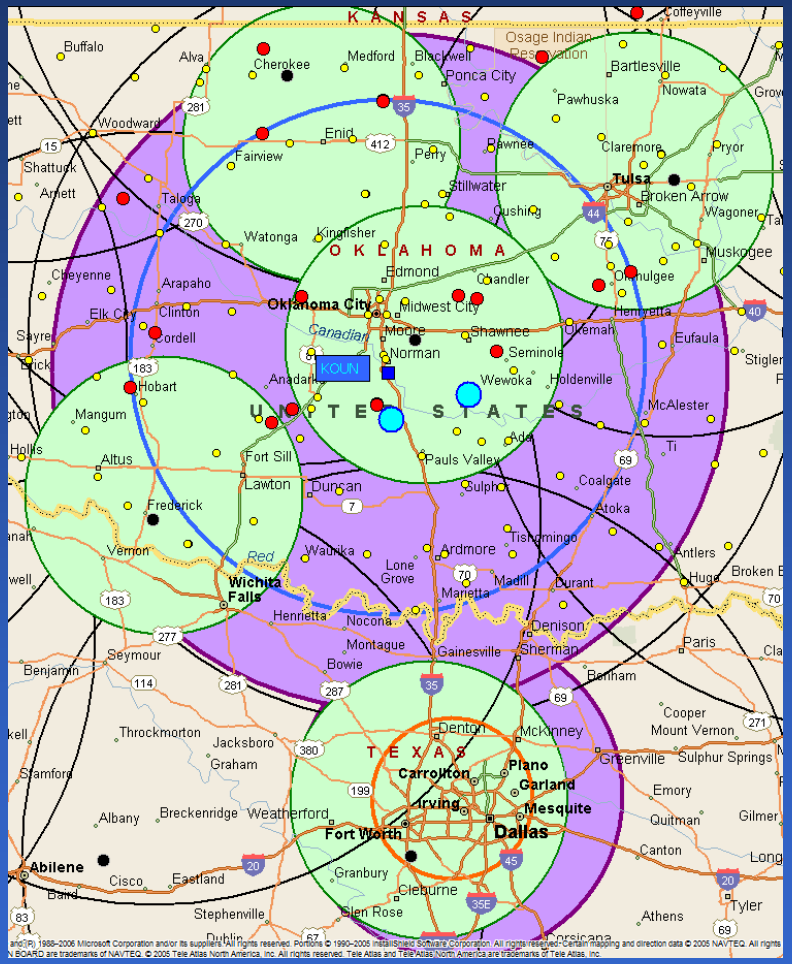
Torrington
Huntley
Morrill
Mitchell
NEBRASKA
Chugwater Creek
Yoder
Lyman
Scottsbluff
Angora
Hanna
WYOMING
Chugwater
Gering
Bayard
Rock River
Arlington
Bosler
McGrew
Bridgeport
Meriden
Harrisburg
Albin
Centennial
Laramie
Lindbergh
Bushnell
Kimball
Gurley
Keystone
Foxpark
Cheyenne
Pine Bluffs
Brownson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

Oklahoma


KANSAS
Coffeyville
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Cherokee
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
OKLAHOMA
Muskogee
Edmond
Guthrie
Cheyenne
Arapaho
Oklahoma City
Midwest City
Elk City
Clinton
Henryetta
Canadian
Moore
Shawnee
Okemah
Eufaula
Sayre
Cordell
Norman
Seminole
KOUN
Wewoka
Holdenville
Hobart
Anadarko
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Mangum
Ada
Hollis
Altus
Fort Sill
Pauls Valley
Lawton
Duncan
Coalgate
Frederick
Sulphur
Atoka
Tishomingo
Vernon
Red
Waurika
Ardmore
Lone Grove
Madill
Durant
Wichita Falls
Marietta
Henrietta
Nocona
Denison
Montague
Gainesville
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Paris
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Bowie
Benjamin
Bonham
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Jacksboro
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Stamford
Carrollton
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Garland
Irving
Mesquite
Emory
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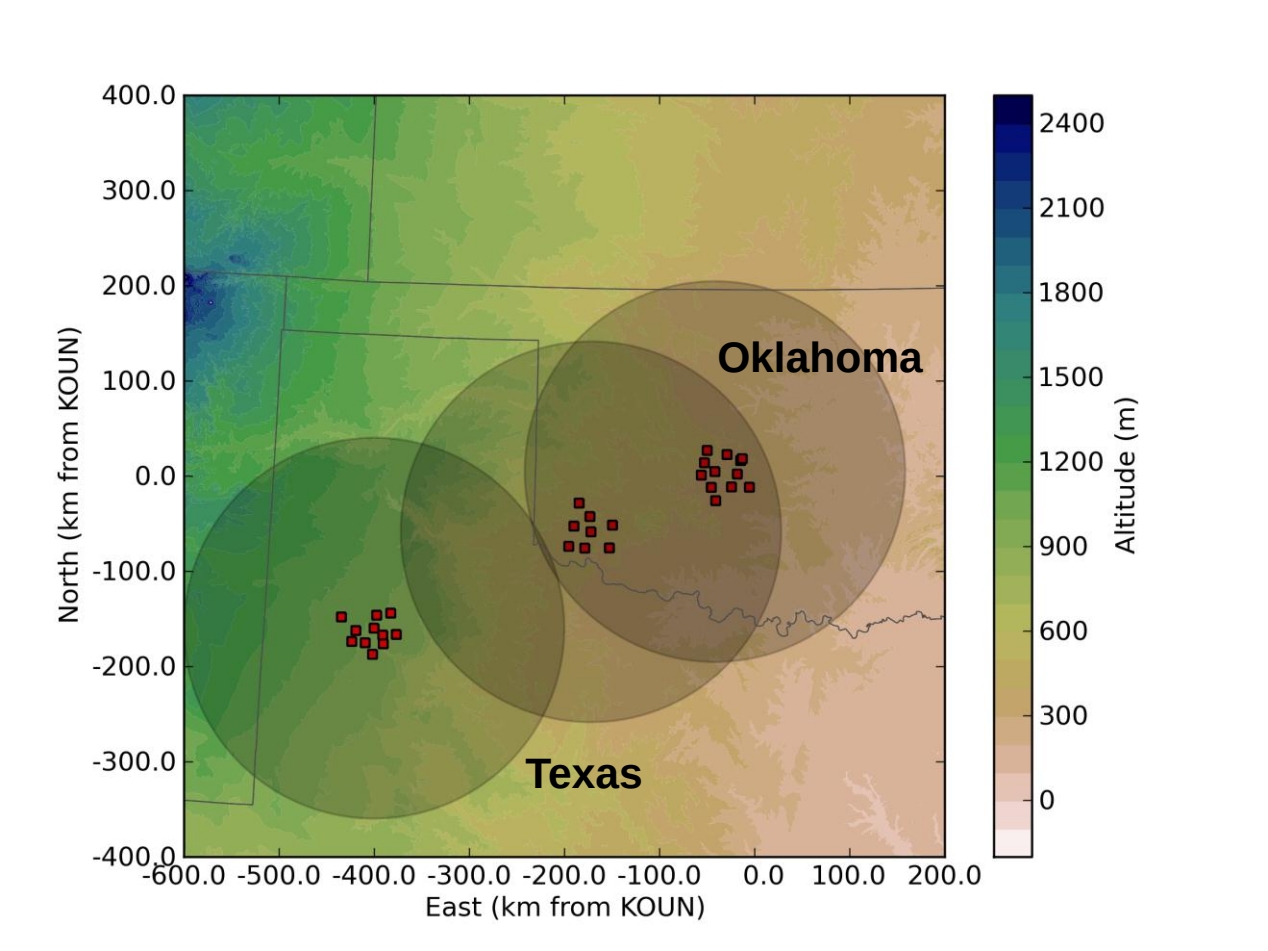
Quitman
Gilmer
Abilene
Granbury
Canton
Cisco
Eastland
Cleburne
Baird
Glen Rose
Tyler
Stephenville
Athens
Dublin
Corsicana

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

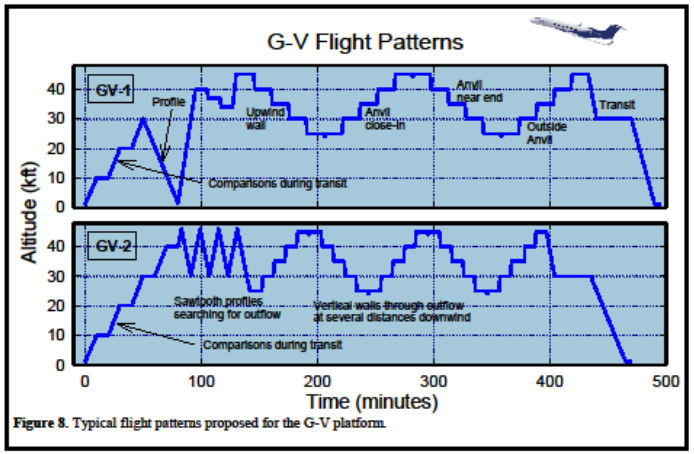


Figure 8. Typical flight patterns proposed for the G-V platform.

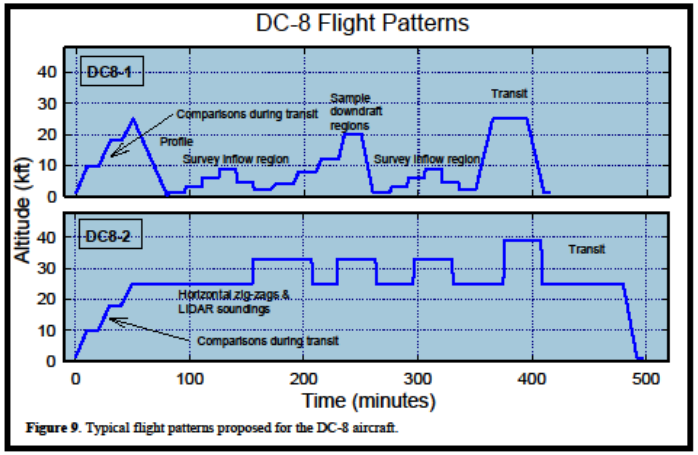


Figure 9. Typical flight patterns proposed for the DC-8 aircraft.