Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS) next planned mission of the NASA Tropospheric Chemistry Program

ARCTAS to be conducted in spring and summer 2008 (two phases) as part of the POLARCAT program during the International Polar Year (IPY)

ARCTAS STRATEGY: use aircraft to increase value of satellite data for models of arctic atmospheric composition and climate

Satellites: CALIPSO, Cloudsat, MODIS, MISR, TES, OMI, HIRDLS, MLS, AIRS, MOPITT
- Aerosol optical depth, properties
- CO, ozone, BrO, NO₂, HCHO

Aircraft: DC-8, J-31, B-200
- Detailed in situ chemical and aerosol measurements
- Remote sensing of ozone, aerosol, surface properties

Models: CTMs, GCMs, ESMs
- Source-receptor relationships for Arctic pollution
- Effects of boreal forest fires
- Aerosol radiative forcing
- Arctic chemistry

Data assimilation
Diagnostic studies
Retrieval algorithm development & validation
Correlative information
Model error characterization

Two 1-mo deployments: April and July 2008
ARCTAS Science Theme 1: winter/spring long-range transport of pollution to the Arctic

European influence

Satellite capabilities:
- CO (TES, AIRS, MOPITT)
- O$_3$ (TES)
- aerosol (CALIPSO, MODIS, MISR)

Aircraft added value:
- detailed chemical composition
- tracers of sources
- vertical information

What are the transport pathways for different pollutants?
What are the contributions from different source regions, the source-receptor relationships?
What is the interannual variability (e.g., Arctic Oscillation)?

J. Worden, JPL
ARCTAS Science Theme 2: Boreal forest fires

Fire trend over past decade

CALIPSO view of fire plume

MISR injection height

A. Soja, LaRC

C. Trepte, LaRC

R. Kahn, JPL

Satellite capabilities:

- plume layers (CALIPSO)
- injection heights (MISR)
- aerosols (MODIS, MISR, OMI)
- CO (TES, AIRS, MOPITT, MLS)

Aircraft added value:

- detailed chemical composition
- aerosol properties
- pyroconvective outflow

• What is the chemical composition & evolution of the fire plumes?
• What are their aerosol optical properties, how do these evolve?
• What are the injection heights, what are the implications for transport & chemistry?
ARCTIC Science Theme 3: Aerosol radiative forcing

**CALIPSO clouds and smoke**

**Arctic haze**

**MISR true-color fire plume**

**Satellite capabilities:**
- UV/Vis/IR reflectances (Cloudsat, MODIS, MISR, OMI)
- multi-angle sensing (MISR)
- lidar (CALIPSO)

**Aircraft added value:**
- detailed in situ aerosol characterization
- remote sensing of radiances, fluxes
- BRDF of surface

- What is the regional radiative forcing from Arctic haze, fire plumes?
- How does this forcing evolve during plume aging?
- What are the major sources of soot to the Arctic?
- What is the effect of deposited soot on ice albedo?
ARCTAS Science Theme 4: Chemical processes

Ozone, Hg depletion events  OMI tropospheric BrO  TES tropospheric ozone

- What is the HO\textsubscript{x}/NO\textsubscript{x} chemistry in the Arctic?
- What drives halogen radical chemistry in the Arctic, what is its regional extent?
- What are the regional implications of halogen chemistry for ozone and mercury?
- How does stratosphere-troposphere exchange affect tropospheric ozone in the Arctic?

Satellite capabilities:
- Ozone (TES, OMI/MLS)
- BrO (OMI)
- strat-trop exchange (HIRDLS)
- CO (TES, AIRS, MOPITT)

Aircraft added value:
- detailed chemical characterization, constraints on photochemical models
- validation of OMI tropospheric BrO
- HO\textsubscript{x} measurement intercomparison
AIRCRAFT PLATFORMS, PAYLOADS

DC-8: major in situ platform
Ceiling 37 kft, range 4000 nmi, endurance 9 h
Payload: $O_3$, $H_2O$, CO, CO$_2$, CH$_4$, NO$_x$ and HO$_x$ chemistry, BrO, halogen reservoirs, mercury, NMVOCs, halocarbons, SO$_2$. HCN/CH$_3$CN, actinic fluxes, aerosol mass and number concentrations, aerosol physical and optical properties, remote ozone and aerosol

J-31: major aerosol remote sensing platform
Ceiling 26 kft, range 800 nmi, endurance 5 h
Payload: optical depth, radiative flux, radiance spectra

B-200: major CALIPSO validation platform
Ceiling 32 kft, range 800 nmi, endurance 3.5 h
Payload: High Spectral Resolution Lidar (HSRL)
POTENTIAL ARCTAS BASES AND NOMINAL DC-8 RANGES

Anchorage
Fairbanks
Churchill
Winnipeg
Kiruna (spring)
Iqaluit
Thule
Yakutsk
DC-8 FLIGHT STRATEGIES

Lidar remote sensing:
- mapping of pollution plumes
- satellite validation

Process studies:
- photochemistry
- plume evolution
- transport mechanisms

Satellite validation

Characterization of emissions, surface uptake

Air mass characterization
- global and regional chemical budgets
- long-range transport