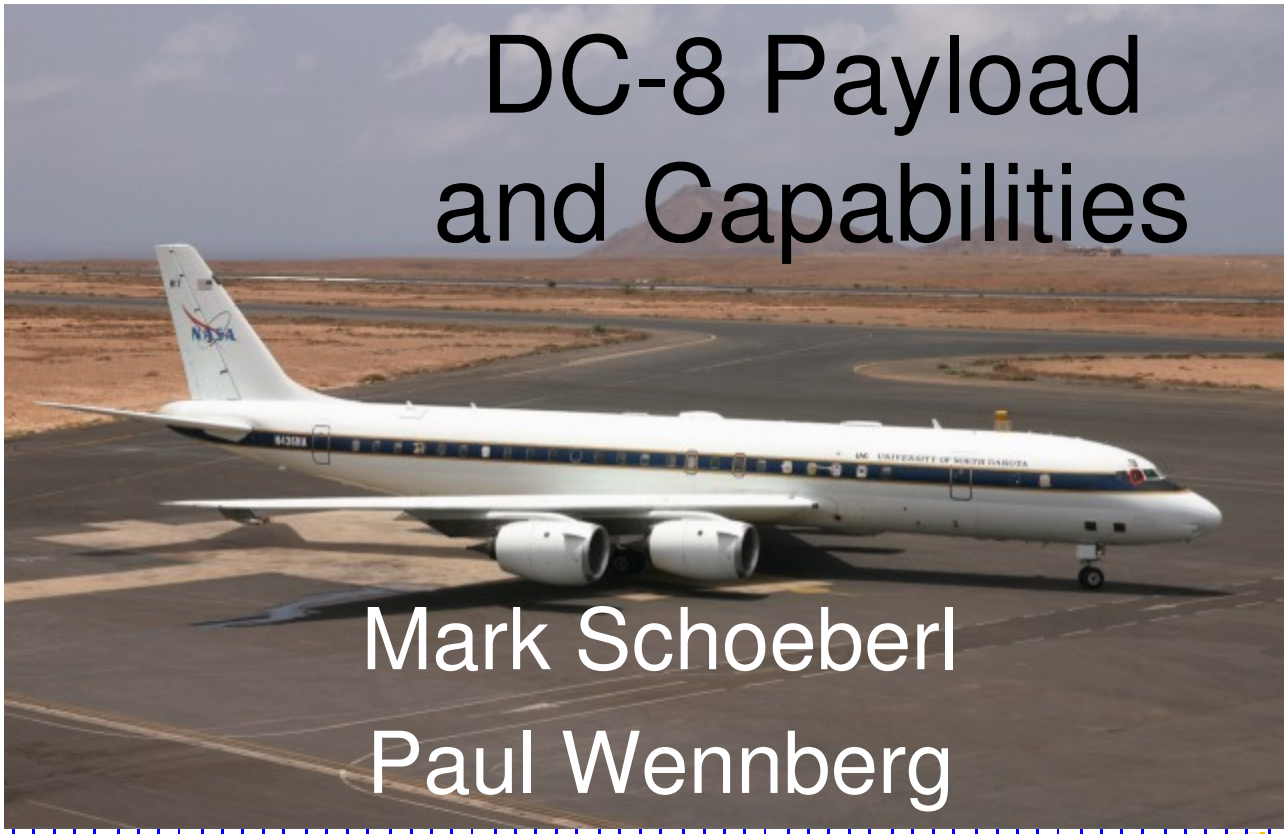
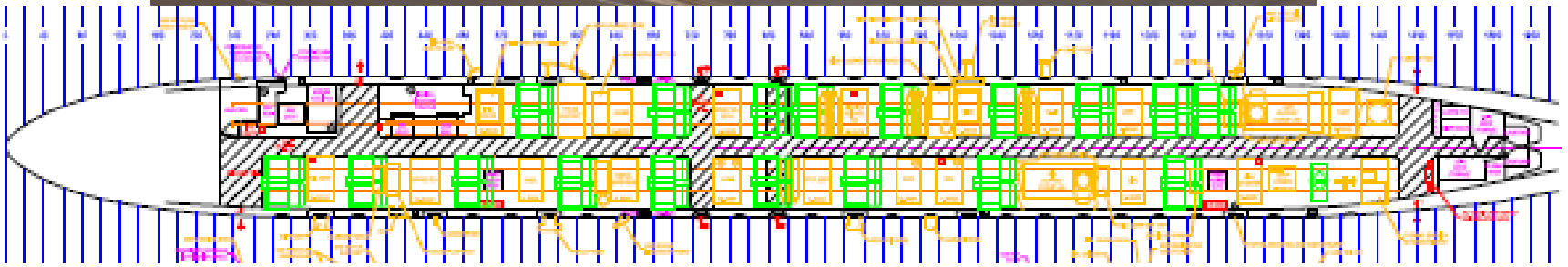
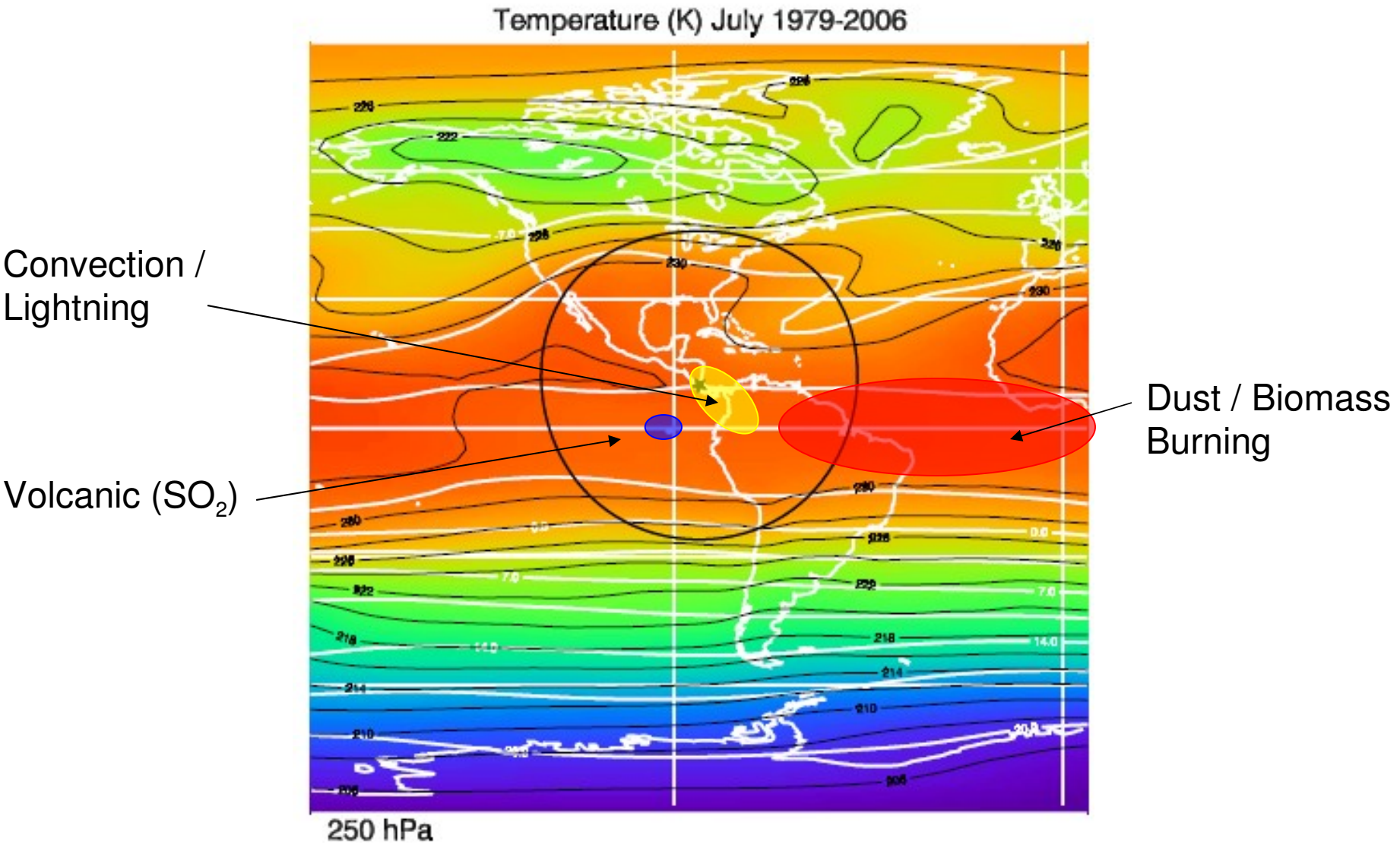
DC-8 Payload and Capabilities



Mark Schoeberl
Paul Wennberg




Temperature (K) July 1979-2006
Convection / Lightning
Volcanic (SO_2)
Dust / Biomass Burning
250 hPa

DC-8 Instruments

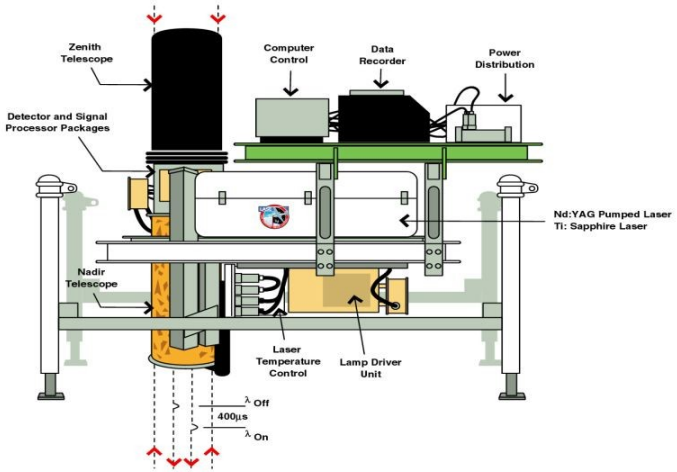
Measurement	Instrument Name	PI	type
Aerosol Composition	PALMS	D. Murphy	In Situ
Aerosol Microphysics	LARGE	B. Anderson	In Situ
Cloud Particles	2DS, CPI	P. Lawson	In Situ
Cloud Particles	RICE, PIP, CAPS, CVI	A. Heymsfield & C. Twohey	In Situ
T soundings	Dropsondes	M. Kurylo	Remote (sort of)
T & P	MMS	P. Bui	In Situ
Ozone	FastOz	M. Avery	In Situ
CO2	MACDONNA	S. Vay	In Situ
Acids and Organic peroxides	CIMS	J. Crounse	In Situ
HDO	IRIS	H.J. Jost	In Situ
NOx & PAN	TD-LIF	R. Cohen	In Situ
Many Gases	WAS	D. Blake	In Situ
HNO3	SAGA	J. Dibb	In Situ
H2O, CO,CH4, N2O	DACOM, DLH	G. Diskin	In Situ
Ozone, Aerosols, cloud heights	DIAL (up-down lidar)	E. Browell	Remote
H2O, Aerosols, cloud heights	LASE (up-down lidar)	E. Browell	Remote
Clouds	APR-2 (nadir radar)	E. Smith	Remote
Overhead Ozone Column	CAFS	R. Shetter	Remote
Solar Spectral Irradiance	SSFR	P. Pilewskie	Remote
Broadband solar and IR	BBIRR	A. Bucholtz	Remote

Payload

H_2O vapor

- In situ
  - H_2O mixing ratio: **DLH** (Diskin). Open path TDL.
  - HDO/H_2O: **IRIS** (Jost). TDL spectrometer.

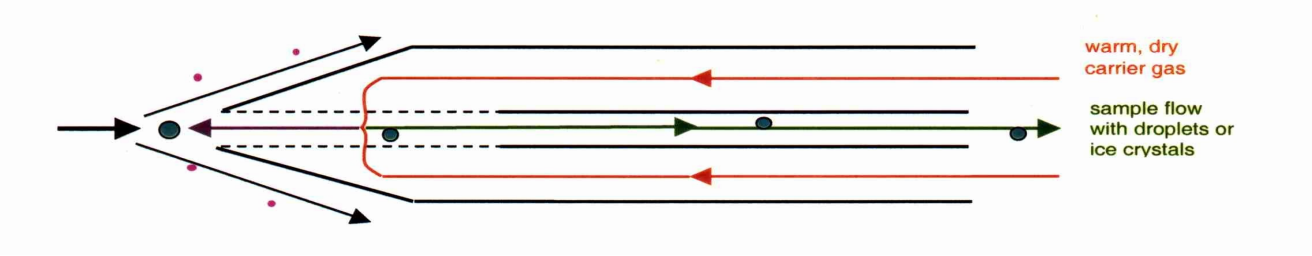
- Remote
  - **LASE** (Browell) Up-down 815 nm water LIDAR.



Payload

Cloud Particles

- In situ (Heymsfield, Twohey, and Lawson)
  - Particle size distribution and images (**2D-S**) and 256 gray levels (**CPI**). Derived products: extinction, particle concentration, ice water content and particle shape. (**CAPS**) size distribution from 1-1000 μm.
  - Rosemount Icing Detector (**RICE**) measures the rate of ice riming in supercooled liquid and mixed clouds.
  - High volume precipitation spectrometer (**PIP**) measures large (>1500 μm particles).
  - **CVI** measures total liquid and ice water content.



Payload

Cloud Particles

- Remote (Browell and Smith)
  - **LASE** up-down LIDAR measures extinction at 815 nm. Can derive cirrus cloud optical properties. Cloud heights.
  - **DIAL** up-down LIDAR measures extinction in UV, vis, and near-IR. Cloud heights. Cirrus optical properties.
  - **APR-2** (13.4 & 35.6 GHz RADAR). Makes simultaneous measurements of multiple rainfall parameters, including co-polarized and cross-polarized reflectivity and vertical Doppler velocities of rainfall and snowfall.

Payload

Aerosol

- In situ (Anderson, Murphy, Dibb)
  - **LARGE** measures aerosol number, size, and optical properties, total and non-volatile aerosol number density, dry aerosol size distribution from 0.01 to 10 μm, total and submicron aerosol absorption coefficients at 470, 535, and 670 nm, total and submicron aerosol scattering coefficients at 550 nm, and total scattering and hemispheric backscattering coefficients at 400, 550 and 700 nm. Derives Aerosol size statistics (mode, number and mass mean diameters, etc.), aerosol surface area and mass loading, aerosol extinction, single scattering albedo, and angstrom coefficients.
  - **PALMS** is a single particle aerosol mass spectrometer that will measure aerosol composition. Will be used in coordination with the CVI for determination of cloud condensation nuclei composition.
  - **SAGA** measures fine aerosol sulfate; bulk aerosol collected onto filters for analysis in the laboratory for soluble ions (e.g. K^+) and the radionuclide tracers ^{7}Be and ^{210}Pb.

Payload

Aerosol

- Remote (Browell)
  - **LASE** (up-down LIDAR) measures extinction at 815 nm.
  - **DIAL** (up-down LIDAR) measures extinction in UV, vis, and near-IR. Aerosol extinction, depolarization, size.

Payload

Long-lived tracers

- In Situ
  - **DACOM** (Diskin) measures CO, N_2O, CH_4
  - **MACDONNA (Vay) measures CO_2**
  - **CIMS** (Crounse) measures HCN
  - **WAS** (Blake) measures many tracers

Ethane	CCl3F (CFC-11)	CH3Br
Ethyne	CCl2F2 (CFC-12)	OCS
Propane	CCl4	CBrClF2 (H-1211)
n-Butane	CCl2FCClF2 (CFC-113)	
i-Butane	CClF2CClF2 (CFC-114)	
Benzene	CH3Cl	
	CH2Cl2	
	CHCl3	
	CH3CCl3	
	CH2FCF3 (HFC-134a)	
	CH3CCl2F (HCFC-141b)	
	C2Cl4	
	CH3CClF2 (HCFC-142b)	
	CHClF2 (HCFC-22)	

Payload

Photochemistry

- In Situ
  - **FastOz** (Avery) measures O_3
  - **TD-LIF** (Cohen) measures NO, NO_2, Nitrates, PAN
  - **CIMS** (Crounse) measures peroxides, gas-phase acids and SO_2
  - **SAGA** (Dibb) measures nitric acid
  - **WAS** (Blake) measures short-lived sulfur and halogen containing organics.

DMS	Ethene	3-Methylpentane	OCS
Ethyne	Benzene	Methyl Nitrate	CCl2FCClF2 (CFC-113)
Propane	Toluene	Ethyl Nitrate	CClF2CClF2 (CFC-114)
Propene	*o*-Ethyltoluene	1-Propyl Nitrate	CH3Cl
n-Butane	*m*-Ethyltoluene	2-Propyl Nitrate	CH2Cl2
i-Butane	*p*-Ethyltoluene	2-Butyl Nitrate	CHCl3
1-Butene	1,2,4-Trimethylbenzene	2-Pentyl Nitrate	CCl4
cis-2-Butene	1,3,5-Trimethylbenzene	3-Pentyl Nitrate	CH3CCl3
trans-2-Butene	*o*-Xylene	CH2FCF3 (HFC-134a)	C2HCl3
1,3-Butadiene	*m*-Xylene	CH3CCl2F (HCFC-141b)	C2Cl4
n-Pentane	*p*-Xylene	CH3CClF2 (HCFC-142b)	CH3**Br**
i-Pentane	Ethylbenzene	CHClF2 (HCFC-22)	CH2**Br2**
Isoprene	α-Pinene	C**Br**ClF2 (H-1211)	CH**Br3**
n-Hexane	β-Pinene	1,2-DCE	CH3I

Payload

Photochemistry & Radiation

- Remote
  - **DIAL** (Browell) measures ozone.
  - **CAFS** (Shetter) measures actinic flux
  - **SSFR** (Pilewskie) measures solar spectral irradiance
  - **BBIRR** (Bucholtz) measures broadband solar and IR

Validation

- Vertical profiles of HNO_3, NO_2, AOD, H_2O and HDO, CO, O_3 (SO_2) by both LIDAR and in situ profiling (clear air). Be aware of opportunities to profile 'hot spots' in field of view of satellite (e.g. volcanoes, cities).
  - TES, MLS, AIRS, etc.
- Along track measurements of CO, HNO_3, H_2O, HDO.
  - TES, MLS, AIRS, etc
- RADAR profiling of cloud and heating rates.
  - Cloudsat, etc.

Cloud Physics

- Measuring the ice crystal size distributions in the lower parts of anvil cirrus.
  - Understanding precipitation process, radiative properties of anvil cirrus. Crystal habit measurements (CPI) are needed for radar remote-sensing retrieval algorithms.
- Observing the microphysical properties (e.g. number and size of ice crystals; amount of liquid water near thehomogeneous freezing level (-38 C); number of droplets) in the updraft cores of benign, isolated, maritime convective systems? Obviously needs to be carefully studied and planned to address feasibility and safety.
  - What is the nature of deep convection microphysics: heterogeneous ice nucleation at T > -38 C, activation of droplets on aerosols entrained into the plume, size and shape of precipitating ice crystals.
- Remote-sensing of thin cirrus near the tropopause.
  - Defining occurrence frequencies and cloud structures would be provide insight into formation and evolution of these systems.

Cloud/Aerosol/Chemistry Interaction

- Characterize the influence of lightning on NO_x levels and ozone production.
  - Profiles of NOx with DC8 (and WB57) in the enviroment around convective systems provide key test of estimates of NOx production by lightning.
- Observe trace gases below and in the outflow of convective events.
  - Can we obtain closure on the transport of gases and aerosols?
- Observe trace gases (with different atmospheric lifetimes) in outflow.
  - Do we understand the chemical evolution of the trace gases in the outflow? Observe interaction of CN, ICN, and cloud.
- Observe the chemical composition of CN and ICN.
  - How are the nuclei that form ICN different from the CN they are formed by?
- Observe the stage and structure of convective clouds that we overfly to support analysis and modeling of these clouds.
  - Potential aerosol effects on precipitation is a hot objective; knowing about the precipitation and its vertical structure is requirement to actually address this question in credible way.
- Measure profiles of aerosol size distribution in the vicinity of developing cloud systems.

Stratospheric Boundary Condition

- Characterize the outflow of convection for short and long-lived chemicals and of aerosols of importance for stratospheric processes.
  - What is the concentration of short lived halogens in the outflow.
  - Are their significant amounts of short-lived sulfur containing compounds in the outflow?
  - Are new particles formed and what is their composition?