SUbsonic aircraft Contrail & Clouds Effects Special Study (SUCCESS) Langley DAAC Project/Campaign Document

Summary:

SUCCESS is a NASA field program using scientifically instrumented aircraft and ground based measurements to investigate the effects of subsonic aircraft on contrails, cirrus clouds and atmospheric chemistry. The experiment is cosponsored by NASA's Subsonic Assessment Program and the Radiation Sciences Program which are part of the overall Aeronautics and Mission to Planet Earth Programs, respectively. SUCCESS has well over a hundred direct participants from several NASA Centers, other agencies, universities and private research companies.

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1. Project/Campaign Overview:

The SUCCESS project was conducted from the Kansas State University airport facilities in Salina, Kansas from April 8, 1996 until May 10, 1996, with an extension from May 10 until May 15, 1996 at NASA's Ames Research Center in Moffett Field, Ca.

SUCCESS had several objectives:

- to better determine the radiative properties of cirrus clouds and of contrails so that satellite observations can more reliably measure their impact on the Earth's radiation budget.
- to determine how cirrus clouds form, whether the exhaust from subsonic aircraft presently affects the formation of cirrus clouds, and if the exhaust does affect the clouds whether the changes induced are of climatological significance.
- to develop and test several new instruments.
- to better determine the characteristics of gaseous and particulate exhaust products from subsonic aircraft and their evolution in the region near the aircraft.

In order to achieve these experimental objectives the NASA DC-8, and T-39 aircraft were used as *in situ* sampling platforms. The NASA ER-2 aircraft was also employed as a remote sensing platform. The NASA 757 was used as a source aircraft for studies of contrails and exhaust. Table 1 lists the flights that were made by these aircraft.

Table 1: SUMMARY OF SUCCESS FLIGHTS

Date	DC-8	ER-2	T-39	757	CART*	Purpose
4/4		X				Test flight

4/8		X				Ferry flight
4/10	X					Test flight at Ames
4/11			X			Transit flight
4/13	X	X			X	DC-8 transit and contrails, ER-2 Cart site for clear sky Radiation
4/15	X	X	X		X	Coordination practice, near field sampling and clear sky radiation
4/16	X	X	X		X	Near field sampling by T-39 Cirrus profiling by DC-8 radiation observations of contrails and cirrus by ER-2
4/18	X		X		Xe	Near field sampling without contrails. DC-8 sampled supercooled water cloud.
4/20	X	X	X		Xe,o	T-39 inst. test flight. ER-2 and DC-8 observed cirrus clouds with multiple vertical profiles.
4/21	X	X			X	Vertical profiling of Cirrus clouds observed from the top. Contrail sampling by DC-8. Studies of convective clouds
4/23		X				ER-2 overflew wave clouds
4/24	X		X		X	T-39 did near field sampling of DC-8 exhaust. DC-8 did vertical profile in cirrus.
4/26		X	X			T-39 followed commercial aircraft, ER-2 did satellite underflight.
4/27	X	X	X		Xe,o	DC-8 sampled contrail of T-39, and profiled cirrus that were observed by the ER-2
4/29	X		X		X	DC-8 profiled stratus clouds at CART site for radar calibration. T-39 sampled DC-8 exhaust.
4/30	X		X	X		DC-8 studied wave cloud and practiced finding 757 exhaust. T-39 sampled 757 exhaust.
5/2	X	X				ER-2 and DC-8 studied wave cloud over Boulder.
5/3	X	X	X	X	Xe	Sampling of 757 contrail by the DC-8 and T-39.
5/4	X	X	X	X	Xe,o	Sampling of the 757 contrail by the DC-8 and T-39.
5/7	X	X	X	X		Sample persistent contrails over Nebraska
5/8	X	X	X			study convection, T-39 studies DC-8 exhaust.
5/10	X	X	X			transit to Ames or Langley
5/12	X	X				Persistent contrail.
5/15	X	X				Cirrus over water.
Total Flight hours	19 110	18 85	15	4	11	

*e=Egret, o=Twin otter

Many of the flights were made over the Department of Energy's Climate and Radiation Testbed (CART) site in Northern Oklahoma, where a suite of ground based remote sensing instruments was located. The DOE also operated an Egret and a Twin Otter aircraft, mostly using remote sensing instruments. The flight dates over the CART site, and those on which the Egret or Otter flew, are also noted in Table 1.

Table 2 list the targets of the various flights, as planned and as flown. Meteorological opportunities were found for most of the planned missions in the vicinity of Salina, Kansas. However, the cirrus-over-water flight could not be done from Salina, but instead was done over the Pacific Ocean using Ames Research Center as a base of operations. Although a diurnal chemistry flight was attempted, weather conditions prevented it from being done. That was the only objective for which a research flight was not completed. Most of the instruments functioned for the majority of the mission.

Table 2: SUMMARY OF FLIGHT OBJECTIVES DURING SUCCESS

Missions	**Flights Proposed**	**Flights Flown**
Contrails	3	6
Cirrus	2	7 (+1 stratus)
Lenticular Clouds	2	2
Cirrus over water	2	2
Near Field	3	3 (757) (parts of 11)
Second Priority Missions:		
Outflow from Convective Clouds	2	2
Diurnal Chemistry in Clear Skies	-	0
Clear sky aerosols	-	many

There were a large number of interesting science results from the SUCCESS project. Although it is too early to determine if every question posed for SUCCESS was answered, it is clear that considerable progress was made.

A great deal was learned about the radiative properties of cirrus clouds and contrails. A number of multiple-aircraft flights were made, with aircraft making radiative as well as *in situ* measurements over the well-instrumented CART site. Several coincident flights with satellite overpasses were made. The most complete set of ice cloud particle size distributions and cloud optical properties to data were obtained, which should help resolve long-standing debates about the role of small particles in ice cloud radiative properties, and the shape of the scattering phase function for ice particles of various shapes. Numerous flights were made in which vertical profiles of cloud properties were obtained, and several flights were performed which helped to calibrate ground-based and aircraft-based remote sensing instruments.

Much data were obtained which should shed light on the formation mechanisms of cirrus clouds and contrails. Supersaturations at which ice nucleation occurs were measured which will aid in the prediction of ice formation, and contrails were observed at temperatures where existing theories did not predict their occurrence so new theories may be needed. The first extensive measurements of ice nuclei (IN), cloud condensation nuclei (CCN), and condensation nuclei (CN) concentrations as well as compositions in the upper troposphere were made. The swelling and pre-activation of aerosols providing insight into the nucleation process were observed, the scavenging of aerosols by ice crystals were observed, and data on the (surprising) composition of the aerosols in the upper troposphere over the US were collected. Much evidence was found for significant mixing between the surface and upper troposphere, and possibly on the alterations of aerosol properties which occur in convective cloud systems. Also observed was a number of interesting dynamical phenomena associated with the tropopause.

One goal was to develop and test a series of new instruments. Each of the new instruments on the DC-8 performed very well. A new suite of instruments for gas phase chemistry, aerosol chemistry and microphysics is now available to the community. In addition, numerous instrument intercomparisons were performed (e.g., 5 independent air temperature measurements, 4 independent water vapor measurements, as well as multiple CN, ice water content, IN and particle size measurements). These intercomparisons indicated not only good agreement in some cases, but revealed problems with some measurements previously thought to be reliable.

The goal of obtaining new Near Field data was clearly met and exceeded. Both gas and particle data were obtained from very close to the engine (< 50m) to far from the aircraft (>10 km) for a variety of aircraft. Data were obtained in persistent and not- persistent contrails, in exhaust which did not form a contrail, at a variety of altitudes and for fuels with a large range of sulfur contents. Unique data on concentrations of sulfur, nitrogen, and odd- hydrogen species, as well as on particles were obtained. Numerous emission indices were determined for a variety of aircraft and flight conditions.

Name of Project/Campaign:

SUbsonic aircraft Contrail & Clouds Effects Special Study (SUCCESS)

Project/Campaign Introduction:

See Project/Campaign Overview.

Project/Campaign Mission Objectives:

SUCCESS has several objectives.

- To better determine the radiative properties of cirrus clouds and of contrails so that satellite observations can better determine their impact on Earth's radiation budget.
- To determine how cirrus clouds form, whether the exhaust from subsonic aircraft presently affects the formation of cirrus clouds, and if the exhaust does affect the clouds whether the changes induced are of climatological significance.
- To pave the way for future studies by developing and testing several new instruments.
- To better determine the characteristics of gaseous and particulate exhaust products from subsonic aircraft and their evolution in the region near the aircraft.

Discipline(s):

Cloud Microphysics
Aerosol Properties
Atmospheric Chemistry
Meteorology and Dynamic Radiation
Remoting Sensing

Geographic Region(s):

During the SUCCESS field deployment, all three aircraft were based in Salina, Kansas. A series of flights, averaging one every other day during this period, was made mainly near the Department of Energy's Clouds and Radiation Testbed site (CART) located in Northern Oklahoma, and Southern Kansas. During this same time period an extensive set of ground based measurements were made by the DOE, which was also operating several aircraft in the area to better understand the radiative properties of the atmosphere. Additional flights were made over the Rocky Mountains, to investigate wave clouds. Flights were also made over the Gulf of Mexico to utilize an oceanic background for remote sensing measurements.

- Area of operation
- More information is available on the SUCCESS Homepage.

Detailed Project/Campaign Description:

See Project/Campaign Overview.

2. Data Availability:

Two data sets are currently available from the Langley DAAC.

Data Type(s):

- University of Utah PDL in ASCII format with associated images.
- VHS videotapes from forward and aft cameras aboard DC-8 and T-39 aircraft.

Input/Output Media:

Data were transitioned to the Langley DAAC via electronic means. Video data was transferred on VHS videotape. Data are distributed from the Langley DAAC via ftp. Video data is distributed on VHS video. The remaining data sets are archived at the SUCCESS Archive at Ames Research Center.

Proprietary Status:

There is no proprietary status for the data sets currently on-line at the Langley DAAC.

3. Data Access:

Data Center Location:

Langley DAAC User and Data Services Office
NASA Langley Research Center
Mail Stop 157D
Hampton, Virginia 23681-2199
USA
Telephone: (757) 864-8656
FAX: (757) 864-8807
E-mail: support-asdc@earthdata.nasa.gov

Contact Information:

For data sets listed in Section 2:

Langley DAAC User and Data Services Office
NASA Langley Research Center
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USA
Telephone: (757) 864-8656
FAX: (757) 864-8807
E-mail: support-asdc@earthdata.nasa.gov

For access to the SUCCESS archive, contact:

Steve Gaines
Ames Research Center
Mail Stop 245-5
Building N245, Room 139
Moffett Field, CA 94035-1000
Telephone: (415) 604-4546
FAX: (415) 604-3625
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Associated Costs:

There is no cost associated with this data.

4. Principal Investigator Information:

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6. References:

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7. Glossary and Acronyms:

EOSDIS Acronyms (PDF).

10baseT - 10 Mbits/sec Baseband Twisted pair (ethernet)
AEAP - The NASA Atmospheric Effects of Aviation Project
ARC - NASA Ames Research Center
ARM - Atmospheric Radiation Measurement
ARP - Address Resolution Protocol
ASCII - American Standard Code for Information Interchange
ATHOS - Airborne Tropospheric Hydrogen Oxides Sensor
ATC - Air Traffic Control
AUI - Attachment Unit Interface [networking]
CART - Cloud and Radiation Testbed
CCD - Charged Coupled Device
CCN - Cloud Condensation Nuclei
CFD - Continuous Flow Detector
CLS - Cloud Lidar System [ER-2]
CSU - Colorado State University
CVI - Counterflow Virtual Impactor
DACOM - Differential Absorption, CO Measurement
DASI - Digital Array Scanned Interferometer
DLH - Diode Laser Hygrometer
DNS - Domain Name System/Server
DOE - Department of Energy
DSU - Data Service Unit
DRI - Desert Research Institute
ESE - Earth Science Enterprise (formerly Mission to Planet Earth)
ESPO - ARC Earth Science Project Office
ESSC - Earth System Science Center (Penn State Univ)
ETL - NOAA Environmental Technology Lab
FAA - Federal Aviation Administration
FIRE - First ISSCP Regional Experiment
FSSP - Forward Scattering Spectrometer Probe
FTP - File Transfer Protocol
GIF - Graphics Interchange Format
GSFC - Goddard Space Flight Center
HIS - High Resolution Interferometer Sounder [ER-2]
HTTP - Hyper-Text Transfer Protocol
IFO - Intensive Field Operations
ISCCP - International Satellite Cloud Climatology Project
JEMS - Jet Exhaust Mass Spectrometer
JPEG - Joint Photographic Experts Group
JPL - Jet Propulsion Lab
KSU - Kansas State University
LaRC - NASA Langley Research Center
LIDAR - LIght raDAR
MAS - MODIS Airborne Simulator [ER-2]
MASP - Multiangle Aerosol Spectrometer Probe
MASS - Mobile Aerosol Sampling System [DC-8]
MAU - Media Attachment Unit [networking]
MCIDAS - Man Computer Interactive Data Access System
MIR - Microwave Imaging Radiometer [ER-2]
MMS - Meteorological Measurement System
MODIS - Moderate Resolution Imaging Spectroradiometer [ER-2]
MPEG - Moving Pictures Expert Group
MPT - MultiPort Transceiver [networking]
MSFC - NASA Marshall Space Flight Center
MTP - Microwave Temperature Profiler [DC-8]
NASA - National Aeronautics & Space Administration
NCAR - National Center for Atmospheric Research
NCSA - National Center for Supercomputer Applications
NFS - Network File System
NIC - Network Interface Card / Network Information Center
NSI - NASA Science Internet
NSIPO - NSI Project Office
NSSDC - NASA Space Science Data Center
PCMCIA - Personal Computer Memory Card International Association
PCASP - Passive Cavity Aerosol Spectrometer
PDL - Polarization Diversity Lidar
PING - Packet Internet Groper [networking]
PSCN - Program Support Communication Network
PSU - Pennsylvania State University
RAMS - Radiation Measurement System [ER-2]
RPA - Remotely Piloted Aircraft
SASS - Subsonic Assessment
SIO - Scripps Institute of Oceanography
SLN - Salina KS airport
SMTP - Simple Mail Transfer Protocol
SPFR - Spectral Flux Radiometer
SQE - Signal Quality Error
SRB - Surface Radiation Budget
SRI - Stanford Research Institute
SSEC - Space Sciences Engineering Center (Univ of Wisconsin)
SUCCESS - SUbsonic Contrails and Clouds Effects Special Study
TRACE - Tropospheric Aerosol Characterization Experiment
TSCC - Tilt Scan CCD Camera
UARS - Upper Atmosphere Research Satellite
UAV - Upper Atmosphere Vehicle / Unmanned Aerial Vechicle
UMR - University of Missouri at Rolla
UNH - University of New Hampshire
UTP - Unshielded Twisted Pair [networking]
USAF - United States Air Force
VIPS - Video Ice particle Sampler

8. Document Information:

- **Document Revision Date:** December 19, 1997; July 1999
- **Document Review Date:** December 19, 1997
- **Document Project Reference:** SUCCESS Homepage
- **Document ID:**
- **Document Curator:** Langley DAAC User and Data Services Office
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