AIRDAS

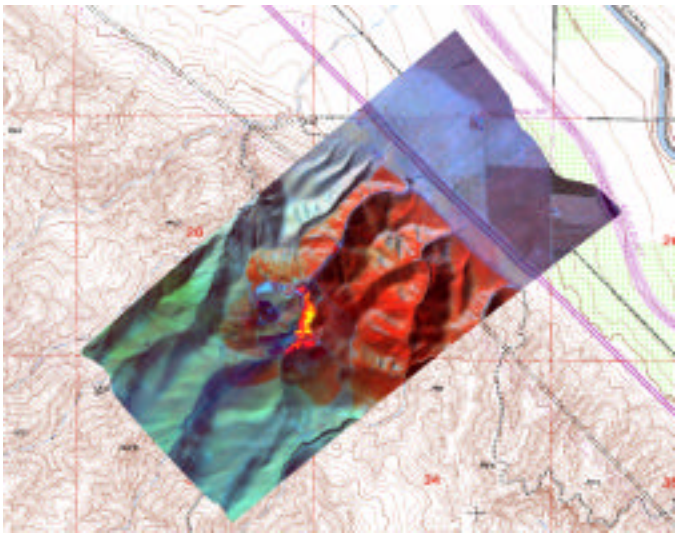
Airborne Infrared Disaster Assessment System

The Airborne Infrared Disaster Assessment System (AIRDAS) is a four channel scanning instrument designed and built at NASA- Ames Research Center, Moffett Field, California. The scanner was designed to fill a critical gap in airborne instrumentation of wildland fires and other natural and man-induced disasters. The initial elements of the instrument were designed and funded through the Ames Basic Research Council's, Director's Discretionary Fund and the U.S. Forest Service, Fire Research Lab. In configuring the system, Ames scientists and engineers focused on specific design criteria which would enable the scanner to be a valuable research instrument as well as a cost-effective applications support scanner.

These criteria included:

- Make the total system self contained and portable, incorporating position and altitude sensing, data display and recording, and full scanner controls in a single station.
- Rapid integration and deployment on various small aircraft to reduce operating costs.
- Develop a real-time telemetry interface allowing for timely information flow to ground-based fire and disaster managers.
- Incorporate detectors configured to support hazard research and management, fuel condition assessment, vegetation stress management, and actual fire and high temperature measurements.
- Utilize off-the-shelf components to reduce costs and allow duplicity of system construction.

These criteria have led to the development and deployment of a unique instrument capable of overcoming some of the design limitations of other scanning or photographic systems. AIRDAS is the only instrument capable of resolving high temperature profiles associated with intense wildfires or volcanic flow features, allowing for accurate mensuration of fire intensities.

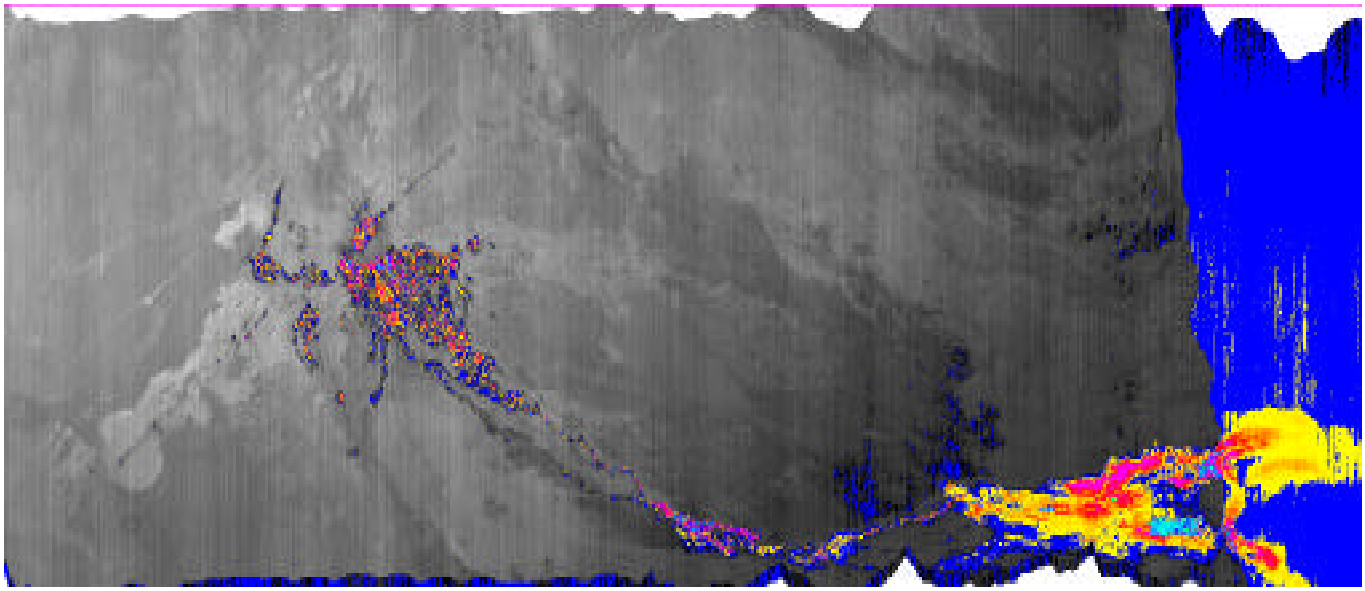


AIRDAS Scanner Data: *This image was acquired at 12:11 P.M. (local time) over the Patterson, California tire dump fire on 5 October 1999 from the USFSe Piper Navajo twin-engine aircraft operating at 4200 feet AGL. The data was geo-corrected and overlain on the Solyo, CA. 7.5' Digital Raster Graphic (DRG) map. The variations in burn intensity can be seen in this data composed of the non-filtered channel 4 thermal (red), channel 2, mid-IR (green), and channel 1, visible (blue).*

Background

The AIRDAS scanner was conceived, designed and constructed by the following NASA-Ames organizations: the Ecosystems Science and Technology Branch (Code SGE), the Airborne Sensor Facility (Code SG), and the Electronics Systems Branch (Code FES). During the past twenty years, the development of scanner technology at Ames has allowed us to simplify and compartmentalize many system features, and overcome technology limitations. Limitations of previous remote sensing scanner systems, including the ability to spectrally penetrate smoke plumes and define minute temperature variations in intense wildfires, has been overcome in the design characteristics of the AIRDAS. These innovations have included the integration of non-linear pre-

amplifiers for the thermal infrared bands.



AIRDAS Scanner Data: *The AIRDAS is truly a multi-faceted airborne disaster assessment tool capable of operating day or night as this imagery shows. This data is derived from a thermal infrared (5.5 – 13.0 μm) wavelength image collected in the vicinity of Makaopuhi Crater on the island of Hawaii. The image was collected in conjunction with the NASA ERAST Pathfinder Program on 11 March 1998 at 10:30 PM (Hawaii Standard Time) from 8,000 feet AGL using the AIRDAS scanner onboard the USFS Navajo aircraft. This image is a 13 mile run from craters to ocean (northwest to southeast; ocean at far right) with a swath width of 4.2 miles. Spatial resolution is 20 feet. Coolest to warmest surface and subsurface temperature ranges have been color-coded from blue to red. This imagery demonstrates the utility of the AIRDAS scanner for distinguishing subtle temperature variations, allowing for analysis of hazardous conditions such as these subsurface volcanic flows.*

System Configuration

The AIRDAS scanning system is designed to be easily incorporated in small to large aircraft by one person. On a compatible airframe, full system integration time is minimal. The total system is self contained, requiring a minimum of integration tools and power requirements other than incorporation of a GPS antenna and an Airphone antenna. The system requires a 7 inch x 14 inch open aerial photo or scanner port with enough room for the control rack and the operator. At present, the scanner has been integrated on a number of airframes including the USFS Navajo, the NASA Learjet 23, the NASA C-130B, , the NCAR King-Air, a Brazilian Learjet 35, and a NAVY P-3 Orion. The system can be transported overland or can be integrated onto an airframe when and where needed.

System Composition

Power Requirements:	28V DC @20 amps
Weight, Head:	80 pounds
Rack:	190 pounds
Total:	270 pounds

Scanner Port Size:	8in. x 14in.
System Composition:	Pentium I 233 Mz System
	Non-linear Detector Amps
	16-bit Digitizer
	Dichroic filters
	Trimble TN2000 GPS
	2-axis gyro stabilizer
	Removable Hard Drive
	Real-Time Video Monitor

AIRDAS Data Characteristics

The AIRDAS 4-channel scanner is designed to collect digital information in four spectral bands of the EM spectrum. Channel 1 acquires data from the visible "red" segment of the spectrum, channel 2 from the near-infrared portion , channel 3 from the mid-infrared portion, and channel 4 from the thermal infrared portion of the EM spectrum. Each of these spectral regions provides useful ecosystem information. In the case of fire analysis, the visible band (Channel 1) allows for determination, extent and movement of the smoke plume, as well as distinguishing surface cultural and vegetative features. Channel 2 allows for the analysis of vegetative composition as well as very hot fire fronts, while still penetrating the associated smoke plume. Channel 3 is specifically designed for analysis of distinct fire temperatures while penetrating the associated smoke column. Channel 4 is designed to collect thermal data on earth background temperatures and on the lower temperature soil heating conditions behind fire fronts. When Channel three has a narrow band-pass filter installed, there is minimal Channel 4 response. The system has been calibrated for high temperature calculation without saturation to over 650_C.

AIRDAS Channel	Wavelength _m
1	0.64 - 0.71
2	1.57 - 1.70
3	3.75 - 4.05
4	5.50 - 13.0

*Channels 3 & 4 are filterable

Sensor/Aircraft Parameters:

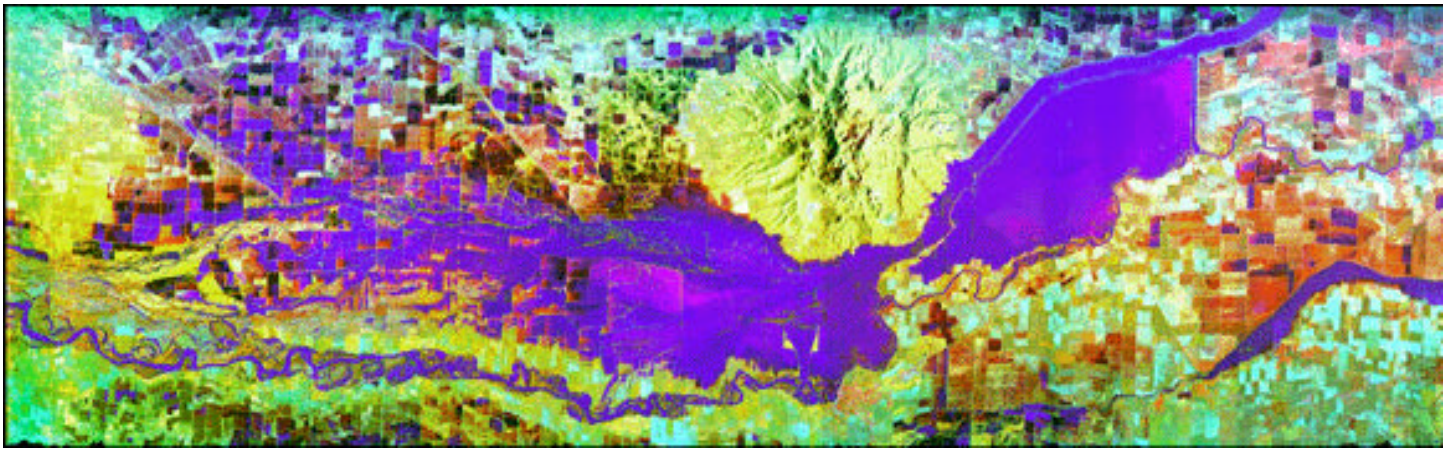
FOV:	108 degrees
IFOV:	2.62 milliradians
Scan Rate:	5 - 23 scans/second
Digitized Swath Width:	720 pixels
Spatial Resolution:	26 ft. at 10,000 feet

Airframe Compatibility:

UAV ALTUS U.S.F.S. Piper Navajo

NCAR King Air Lear Jet (Model 23 and 35)

NASA C-130B P-3 Orion



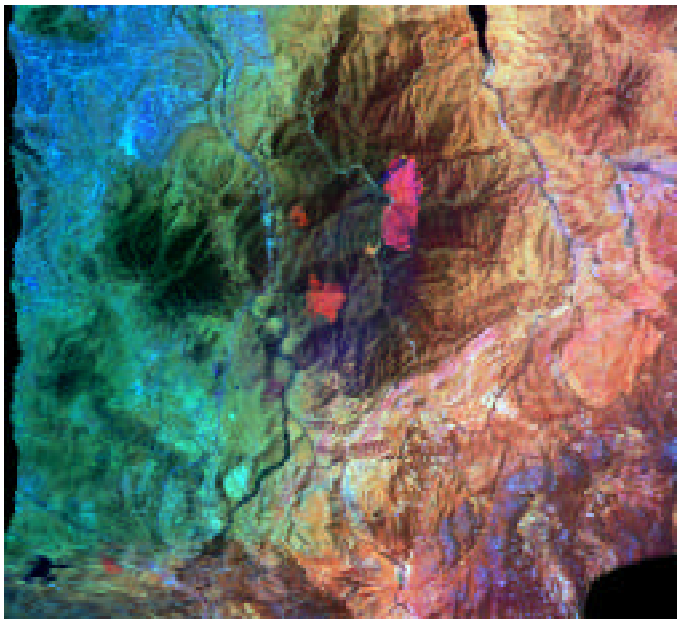
AIRDAS Scanner Data: *This thermal (5.50 – 13.0 μm), reflected IR (1.57 – 1.70 μm), and visible (0.64 – 0.71 μm) wavelength image was acquired on the afternoon of 7 January 1997 from 30,000 feet AGL aboard the NASA-Ames Lear jet. . The image was acquired over the Sacramento River Valley of Northern California during flooding caused by massive rainfall and a warming trend, prompting early snowmelt in the mountains surrounding the drainage basin. Spatial resolution is approximately 80 feet (24 meters); image*

dimensions are: cross-track - approximately 16 miles, scan-direction (along-track) - approximately 75 miles. This data set exhibits the AIRDAS instrument's versatility in hazard assessment and rapid deployment for emergency mitigation efforts.

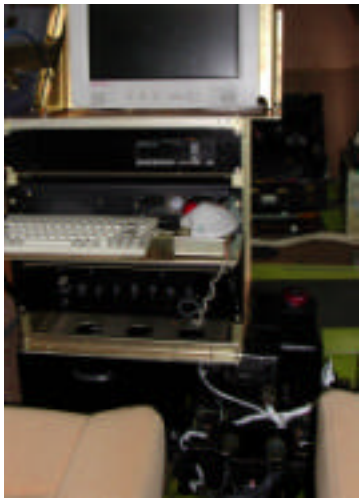
Archiving and Real-Time Dissemination

The AIRDAS data is collected on Exabyte 8mm data storage tapes from a 8500 device. Data retrieval software, developed for UNIX machines, includes correction for aircraft scanner roll and a scan angle correction program. Information collected and stored as part of each scanline header data includes the time of collection (GMT), aircraft attitude (pitch/roll), aircraft speed and direction, and the GPS coordinates of the airframe.

Real-time data downlink capabilities include the incorporation of an Airphone system on the airframe, delivering a wireless data link to a remote computer site for analysis of single band imagery, shortly after collection. That downlink is being refined to allow the distribution of multi-band image data.



AIRDAS Scanner Data: *This image was acquired over the Otay California fire (near San Diego) on 30 April 1996. The data set was acquired from the NASA Lear jet from an altitude of 33,000 feet. This data is composed of the non-filtered channel 4, thermal (red), channel 2, mid-IR (green), and channel 1, visible (blue). The regions of warmer surface ash can be seen in shades of red.*



AIRDAS Scanner System: *The AIRDAS scanner mounted in the USFS Navajo aircraft. The scanhead is located over the belly hatch (lower right) and the NERA telemetry anntennea is mounted in the aircraft window (left side).*

Data Collection and Accessibility

Further information concerning utilizing the scanner for new data collection or archived data sets can be obtained by contacting the following personnel at the address and phone number below:

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Code SGE, M.S. 242-4
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Moffett Field, CA. 94035-1000
(650) 604-6565 or 604-5232
Fax: (650) 604-4680
Email: vambrosia@mail.arc.nasa.gov or
jbrass@mail.arc.nasa.gov

AIRDAS information can be viewed at:
http://geo.arc.nasa.gov/sge/

Information concerning system engineering or airframe integration can be obtained by contacting:

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