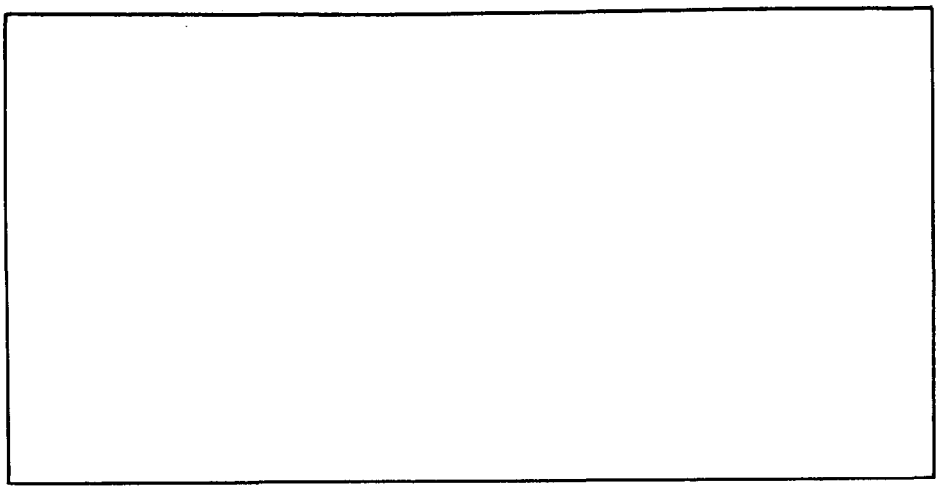
E72-10200
CR-129066

"Made available under NASA sponsorship in the interest of early and wide dissemination of Earth Resources Survey Program information and without liability for any use made thereof."



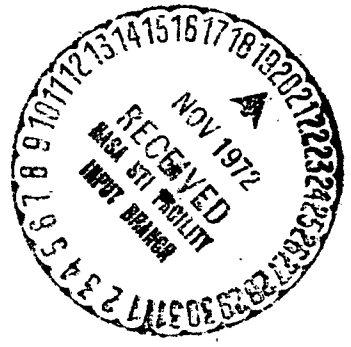
SCIENCE APPLICATIONS INCORPORATED

(E72-10200) DETERMINATION OF AEROSOL CONTENT IN THE ATMOSPHERE FROM ERTS-1 DATA Progress Report, 7 Sep. - 6 Nov. 1972 C.B. Ludwig, et al (Science Applications, Inc.) 7 Nov. 1972 11 p

N73-11298

Unclas

CSCL 04A G3/13 00200



SAI-72-589-LJ

DETERMINIATION OF AEROSOL CONTENT IN THE ATMOSPHERE FROM ERTS-1 DATA

Progress Report No. 1

Contract No.: NAS5-21860

Period Covered: 7 September to 6 November 1972

Proposal Number: 245

GSFC ID Number: P135

Principal Investigator: Dr. C. B. Ludwig

Author: Dr. M. Griggs

Prepared for:

Goddard Space Flight Center

7 November 1972

ACCOMPLISHMENTS

The first two-month period of this contract included Phase I - Data Analysis Preparation and the start of Phase II - Preliminary Data Analysis.

PHASE I - DATA ANALYSIS PREPARATION

Software Development

The development of the computer program necessary to read the bulk processed digital tapes was initiated. It was found that the sample tape output did not correspond with the sample print. This problem was discussed with NASA personnel at the User Support and Services, who agreed that incorrect sample data were apparently sent to us. New sample data are expected by November 15, 1972.

NASA Aircraft Flights

Arrangements have been made with NASA-Houston for an aircraft flight at 2000 ft altitude at the SAI-1 test site at the Salton Sea on December 12, 1972, coincident with the ERTS-1 overpass. Aircraft data in the MSS channels will be provided on digital tape and photographic positives and negatives. The areas to be covered by the aircraft are indicated in Fig. 1. An alternate site has been arranged at San Diego on December 13, 1972, in the event that conditions are unsuitable at the Salton Sea on December 12, 1972, and is shown in Fig. 2.

Ground-based observations of the aerosol optical thickness will be made with the Volz photometer and the Exotech radiometer, at the time of the aircraft flight.

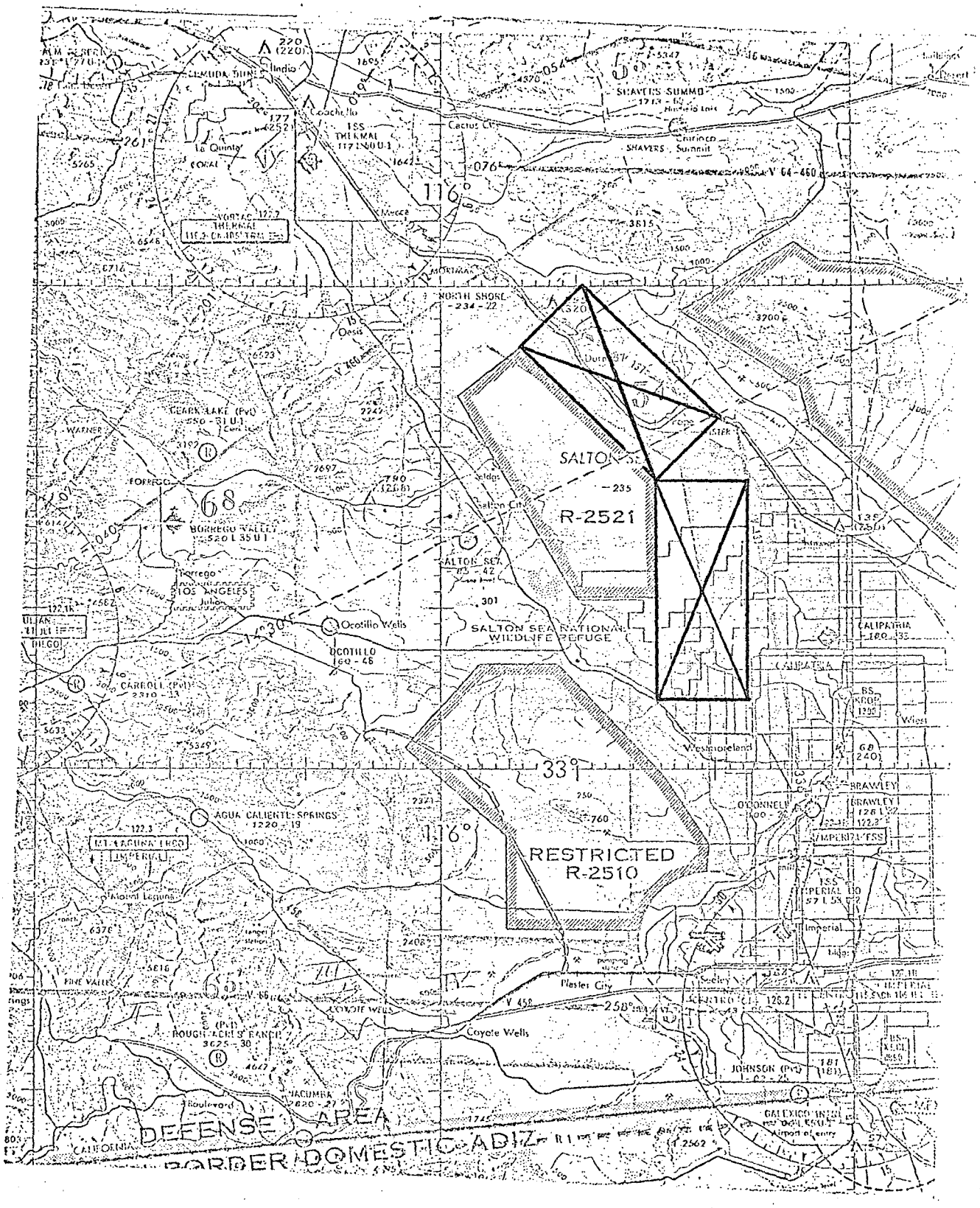

SALTON SEA
R-2521
RESTRICTED
R-2510
SALTON SEA NATIONAL WILDLIFE REFUGE
DEFENSE AREA
BORDER DOMESTIC ADIZ
Coachella
Indio
La Quinta
Mecca
Oasis
Thermal
Coachella
Borrego Valley
Ocotillo Wells
Agua Caliente Springs
Mt. Laguna
Coyote Wells
Plaster City
Brawley
Calipatria
Imperial
Westmoreland
Niland
Johnson
Gale Xico Int'l
Rough Acres Ranch
Clark Lake
Carroll
Ocotillo
Shavers Summit
North Shore
Los Angeles
Julian
Warner
Borrego
Jacumba
Boulevard
Fine Valley
Mount Laguna
Imperial
Calexico
Wiest
Shavers
Summit
Chiriaco
Cactus City
Desert Center
Johnson
Gale Xico Int'l
Airport of entry
Boulevard
Jacumba

Fig. 2. San Diego Aircraft Flight Coverage (Square with diagonals drawn in).

Reproduced from best available copy.

After the data of this flight have been analyzed, a second aircraft flight will be scheduled for the Salton Sea, or for San Diego, probably in February 1973.

Theoretical Analysis

The contrast relationship previously developed, and shown in Eq. 1 has been further investigated.

$$f(\tau) = A'\left(C_o/C_R - 1\right) \tag{1}$$

where

$$f(\tau) = \frac{R(\tau, 0)}{R(\tau, 1) - R(\tau, 0)}$$

and

A' = the background reflectivity

C_o = the inherent contrast

C_R = the apparent contrast

τ = the total vertical optical thickness

$R(\tau, A)$ = the reflected radiance at reflectivity A and optical thickness τ.

The unpublished and published aircraft data of Scripps Institute of Oceanography were reviewed, and found to be not useful for this program. The aircraft flights described in these reports have been made at low altitudes (5000 m or less) and reflected radiances as a function of wavelength and sun angle over land and water were not measured.

A literature search was made to determine the availability of other data. Work by M. J. Mazurowski and D. R. Sink, J. Opt. Soc. Am. 55, 26 (1965) on the attenuation of photographic contrast by the atmosphere as a function of wavelength and altitude is not suitable since they apparently did not consider the effects due to the variation of sun angle.

The theoretical data of R. S. Fraser, J. Opt. Soc. Am. 54, 289 (1964) were converted to the format of Eq. 1, and compared with the data of Plass and Kattawar, Appl. Opt. 7, 1129 (1968); 9, 1122 (1970). The comparison is shown in Fig. 3. It is seen that the general shapes of the curves are similar, although the absolute values disagree. This is due to the different model assumptions.

In order to calculate the inherent contrast of the Salton Sea and desert, it is necessary to know the variation of the reflectivities of the water and desert. The reflectivity of sand depends on the composition of the sand and on the sun angle, and according to the data of K. L. Coulson, et al., J. Geophys. Res. 70, 4601 (1965); Appl. Opt. 5, 905 (1966), it cannot be readily calculated. The radiance reflected from water is more readily calculated (J. I. Gordon and P. V. Church, Appl. Opt. 5, 919 (1966)), but varies with wind speed and suspended matter in the water.

Thus, due to the shortcomings of available data and theory it is planned to rely mainly on the satellite, aircraft and ground-truth measurements to determine an empirical relationship between the optical thickness and contrast attenuation.

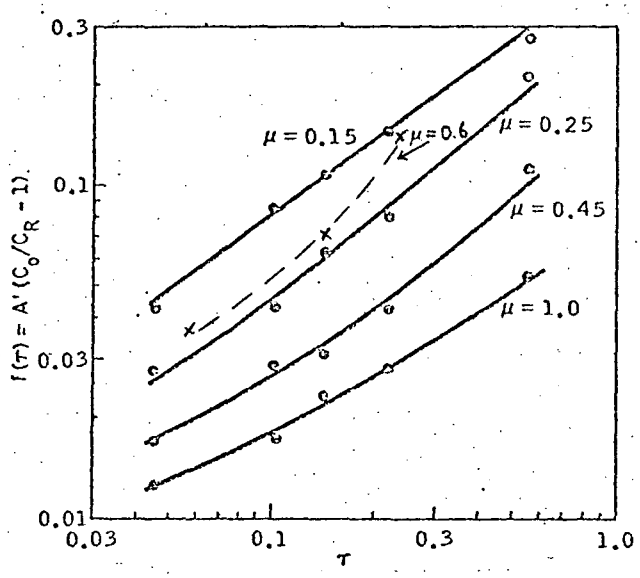


Fig. 3. Function of $f(\tau) = A'(C_O/C_R-1)$ versus τ for several values of sun zenith angle, θ, ($\mu = \cos\theta$).

o——o Plass and Kattawar

x— —x Fraser ($\mu = 0.6$)

Future Plans

In the next reporting period it is planned to further investigate the contrast relationship, and to make the ground-truth measurements in conjunction with the aircraft measurements. The ERTS-1 photographic data will be further analyzed when the calibration data is received.

PHASE II - PRELIMINARY DATA ANALYSIS

ERTS-1 data were first received on October 24, 1972, and on November 3, 1972. Both sets of photographic prints and negatives were incomplete. No digital tapes have yet been received.

A preliminary analysis of the first set of data for the Salton Sea area on August 26, 1972, has been made with a densitometer. However, due to the lack of calibration data for the grey scale, the data have not been reduced to radiances in order to investigate the contrast attenuation.

Significant Results

There are no significant results to report in this period.

Problems

The incorrect sample data for the digital tapes originally sent to us has delayed the development of the computer program required to read the tapes. However, digital tapes of real ERTS-1 data have not yet been received.

The lack of a grey scale calibration for the photographic data has delayed detailed analysis of the photographic data already received.

The Exotech ERTS radiometer required for our ground-truth observations has not been received. It was ordered in June, and delivery promised for mid-August. The latest estimated shipment date is November 13, 1972. This instrument is required to supplement the Volz photometer, particularly in conjunction with the aircraft flights.

Standing Order Change

A change was made in our standing order on October 10, 1972, to obtain data for our two test sites for all satellite overpasses. A copy of the standing order form change is attached.

Principal Investigator Change

A request has been made, October 7, 1972, to NASA Headquarters to make Dr. Michael Griggs the Principal Investigator on this program in place of Dr. Claus Ludwig, who will soon be involved as Program Manager on a contract from NASA Langley Research Center to develop satellite measurements of air pollution. Dr. Ludwig would continue as a co-investigator on this program.

Miscellaneous

The scientific monitor of this program, Dr. R. S. Fraser visited Science Applications, Inc., on October 25, 1972, to discuss the accomplishments and status of this program.

ERTS 1 STANDING ORDER FORM

(See Instructions on Back)

DATE Oct 10th 1972

GSFC ID NUMBER PR 135

PRINCIPAL INVESTIGATOR Dr C.B. LUDWIG

TELEPHONE NO. (714) 459-0211 ☐ NEW

SHIP TO: Dr M. GRIGGS

(NAME)

SCIENCE APPLICATIONS INC

(AGENCY)

P.O. BOX 2351

(STREET)

LA JOLLA (CITY) CA (STATE) 92037 (ZIP)

☐ ADDITION

☒ CHANGE

☐ DELETION

CATALOGS DESIRED

STANDARD ☒ U.S. ☐ NON-U.S.

DCS ☐

MICROFILM ☐ U.S. ☐ NON-U.S.

☐ CHECK IF ADDRESS IS NEW

NDPF USE ONLY

D

N

ID

DTM

TM

TM APP

AREA NUMBER	GEOGRAPHIC POINTS		CLOUD COVER %	QUALITY	COVERAGE PERIOD		PROD		TICK MARK	QUANTITY	RBV BANDS			MSS BANDS				DELETE
	LATITUDE	LONGITUDE			START DATE	STOP DATE	TYPE	FORMAT			1	2	3	1	2	3	4	
TO	33° 20'N	115° 50'W	20		080172	072673		P		1				X	X	X	X	
								T		1				X	X	X	X	
FROM	33° 20'N	115° 50'W	20		080172	083172		P		1				X	X	X	X	
					100172	103172		T		1				X	X	X	X	
					010173	013173												

GSFC 37-3 (7/72)

INVESTIGATOR'S COPY