#436

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METEOROLOGICAL, EPHEM, RAT DATA ARCH 79-013A-01A

ESAC-00044

BETA AEROSOL NO. DEN ARCH TAPE 79-013A-01B

(Version)

Table of Contents

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1. INTRODUCTION:

The documentation for this data set was originally on paper, kept in NSSDC's Data Set Catalogs (DSCs). The paper documentation in the Data Set Catalogs have been made into digital images, and then collected into a single PDF file for each Data Set Catalog. The inventory information in these DSCs is current as of July 1, 2004. This inventory information is now no longer maintained in the DSCs, but is now managed in the inventory part of the NSSDC information system. The information existing in the DSCs is now not needed for locating the data files, but we did not remove that inventory information.

The offline tape datasets have now been migrated from the original magnetic tape to Archival Information Packages (AIP's).

A prior restoration may have been done on data sets, if a requestor of this data set has questions; they should send an inquiry to the request office to see if additional information exists.

2. ERRATA/CHANGE LOG:

NOTE: Changes are made in a text box, and will show up that way when displayed on screen with a PDF reader.

When printing, special settings may be required to make the text box appear on the printed output.

Version	Date	Person	Page	Description of Change
01				
02				

3 LINKS TO RELEVANT INFORMATION IN THE ONLINE NSSDC INFORMATION SYSTEM:

http://nssdc.gsfc.nasa.gov/nmc/

[NOTE: This link will take you to the main page of the NSSDC Master Catalog. There you will be able to perform searches to find additional information]

4. CATALOG MATERIALS:

a. Associated Documents To find associated documents you will need to know the document ID number and then click here. http://nssdcftp.gsfc.nasa.gov/miscellaneous/documents/

b. Core Catalog Materials

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METEOROLOGICAL, EPHEM, RAW DATA ARCH

79-013A-01A ESAC-00044

This data set has been restored. There was originally 238 Binary 9-Track, 1600 BPI tapes. There are 20 restored tapes. The DR and DS tapes are 9-track, 6250 BPI. The tapes were created on a CDC computer. The DR and DS numbers along with the corresponding D numbers and the time spans are as follows:

DR#	DS#	D#	FILES	TIME SPAN
DR00140	DS00140	D42920	1-117	03/05/79 - 03/08/79
		D42921	118-211	03/09/79 - 03/12/79
		D42922	212-292	03/13/79 - 03/16/79
		D42923	293-410	03/17/79 - 03/20/79
		D42924	411-518	03/25/79 - 03/28/79
DR00141	DS00141	D42926	1-119	04/01/79 - 04/04/79
		D42927	120-240	04/05/79 - 04/08/79
		D42928	241-351	04/09/79 - 04/12/79
		D42929	352-470	04/13/79 - 04/16/79
DR00142	DS00142	D42930	1-119	04/17/79 - 04/20/79
		D42931	120-238	04/21/79 - 04/24/79
		D42932	239-357	04/25/79 - 04/28/79
		D42934	358-430	05/24/79 - 05/29/79
DR00143	DS00143	D42935	1-89	05/29/79 - 05/31/79
		D42936	90-208	06/01/79 - 06/04/79
		D42937	209-326	06/05/79 - 06/08/79
		D42938	327-408	06/09/79 - 06/13/79
		D42939	409-442	06/19/79 - 06/28/79
		D42940	443-480	07/01/79 - 07/04/79
DR00144	DS00144	D42941	1-36	07/15/79 - 07/18/79
		D42942	37-82	07/19/79 - 07/22/79
		D42943	83-119	07/23/79 - 07/25/79
		D42944	120-155	08/02/79 - 08/06/79
		D42945	156-208	08/06/79 - 08/09/79
		D42946	209-265	08/10/79 - 08/13/79
		D42947	266-319	08/15/79 - 08/17/79
		D42948	320-352	08/18/79 - 08/21/79
		D42949	353-408	08/22/79 - 08/25/79
		D42950	409-468	08/26/79 - 08/29/79
		D42951	469-488	08/30/79 - 08/31/79
		D42952	489-523	09/13/79 - 09/17/79
		D42953	524-566	09/18/79 - 09/26/79
		D42954	567-615	09/27/79 - 09/30/79
		D42955	616-671	10/01/79 - 10/04/79
		D42956	672-713	10/05/79 - 10/08/79
		D42957	714-752	10/09/79 - 10/12/79

* F351-354 were 0 block - tape was recreated w/ those files

New file 351 is missing record(s) at the beginning.

DR#	DS#	D#	FILES	TIME SPAN
DR00145	DS00145	D42959	1-38	10/17/79 - 10/20/79
		D42960	39-77	10/21/79 - 10/25/79
		D42961	78-103	10/26/79 - 10/29/79
DR00146	DS00146	D42962	1-59	11/21/79 - 11/24/79
		D42963	60-119	11/25/79 - 11/28/79
		D42964	120-149	11/29/79 - 11/30/79
		D42965	150-201	12/05/79 - 12/08/79
		D42966	202-259	12/09/79 - 12/12/79
		D42967	260-318	12/13/79 - 12/16/79
		D42968	319-376	12/17/79 - 12/20/79
		D46070	377-473	02/21/79 - 02/24/79
		D46071	474-586	02/25/79 - 02/28/79
		D46072	587-703	03/01/79 - 03/04/79
DR00147	DS00147	D46073	1-115	03/21/79 - 03/24/79
		D46074	116-199	03/29/79 - 03/31/79
		D46075	200-258	04/29/79 - 04/30/79
		D46076	259-377	05/01/79 - 05/04/79
		D46077	378-494	05/05/79 - 05/08/79
DR00148	DS00148	D46078	1-119	05/09/79 - 05/12/79
		D46084	120-232	05/13/79 - 05/16/79
		D46080	233-278	05/16/79 - 05/17/79
		D46081	279-360	06/09/79 - 06/13/79
		D46082	361-375	06/29/79 - 06/30/79
DR00149	DS00149	D46083	1-30	07/05/79 - 07/09/79
		D46079	31-36	07/10/79 - 07/14/79
		D46085	37-88	09/01/79 - 09/04/79
		D46086	89-146	09/05/79 - 09/08/79
		D46087	147-198	09/09/79 - 09/12/79
		D46088	199-224	10/30/79 - 10/31/79
		D46089	225-246	11/01/79 - 11/04/79
		D46090	247-273	11/05/79 - 11/20/79
		D46091	274-330	12/01/79 - 12/04/79
		D46092	331-389	12/21/79 - 12/24/79
		D46093	390-438	12/25/79 - 12/28/79
		D46094	439-480	12/29/79 - 12/31/79
		D46641	481-531	01/01/80 - 01/04/80
		D46642	532-586	01/05/80 - 01/08/80
		D46643	587-639	01/09/80 - 01/12/80
		D46644	640-655	01/13/80 - 01/14/80
		D46645	656-677	01/27/80 - 01/28/80
		D46646	678-722	01/29/80 - 01/31/80
DR00150	DS00150	D46647	1-60	02/01/80 - 02/04/80
		D46648	61-119	02/05/80 - 02/08/80
		D46649	120-178	02/09/80 - 02/12/80
		D46650	179-237	02/13/80 - 02/16/80
		D46651	238-296	02/17/80 - 02/20/80
		D46652	297-356	02/21/80 - 02/24/80
		D46653	357-416	02/25/80 - 02/28/80

DR#	DS#	D#	FILES	TIME SPAN
DR00151	DS00151	D46654	1-14	02/29/80 - 03/01/80
		D46655	15-72	03/01/80 - 03/04/80
		D46656	73-132	03/05/80 - 03/08/80
		D46657	133-185	03/09/80 - 03/13/80
		D46658	186-244	03/13/80 - 03/16/80
		D46659	245-303	03/17/80 - 03/20/80
		D46660	304-347	03/21/80 - 03/24/80
		D46661	348-348	03/25/80 - 03/25/80
		D46662	349-387	04/08/80 - 04/10/80
		D46663	388-446	04/11/80 - 04/14/80
		D46664	447-505	04/15/80 - 04/18/80
		D46665	506-565	04/19/80 - 04/22/80
		D46666	566-625	04/23/80 - 04/26/80
		D46667	626-663	04/27/80 - 04/29/80
		D46668	664-707	05/09/80 - 05/12/80
		D46669	708-767	05/13/80 - 05/16/80
DR00152	DS00152	D46670	1-60	05/17/80 - 05/20/80
		D46671	61-120	05/21/80 - 05/24/80
		D46672	121-178	05/25/80 - 05/28/80
		D46673	179-223	05/29/80 - 05/31/80
		D46674	224-279	06/01/80 - 06/04/80
		D46675	280-338	06/05/80 - 06/08/80
		D46676	339-398	06/09/80 - 06/12/80
		D46677	399-458	06/13/80 - 06/16/80
		D46678	459-518	06/17/80 - 06/20/80
		D46679	519-577	06/21/80 - 06/24/80
		D46680	578-636	06/25/80 - 06/28/80
		D46681	637-666	06/29/80 - 06/30/80
		D46682	667-727	07/01/80 - 07/04/80
		D46683	728-772	07/05/80 - 07/20/80
		D46684	773-832	07/21/80 - 07/24/80
		D46685	833-892	07/25/80 - 07/28/80
		D46686	893-937	07/29/80 - 07/31/80
DR00153	DS00153	D46687	1-59	08/01/80 - 08/04/80
		D46688	60-119	08/05/80 - 08/08/80
		D46689	120-179	08/09/80 - 08/12/80
		D46690	180-239	08/13/80 - 08/16/80
		D46691	240-299	08/17/80 - 08/20/80
		D46692	300-359	08/21/80 - 08/24/80
		D46693	360-419	08/25/80 - 08/28/80
		D46694	420-464	08/29/80 - 09/01/80
		D46695	465-523	09/01/80 - 09/04/80
		D46696	524-583	09/05/80 - 09/08/80
		D46697	584-642	09/09/80 - 09/12/80
		D46698	643-695	09/13/80 - 09/16/80
DR00154	DS00154	D46699	1-60	09/17/80 - 09/20/80
		D46700	61-120	09/21/80 - 09/24/80
		D46701	121-180	09/25/80 - 09/28/80
		D46702	181-209	09/29/80 - 09/30/80
		D46703	210-269	10/01/80 - 10/04/80
		D46704	270-327	10/05/80 - 10/08/80

DR#	DS#	D#	FILES	TIME SPAN
DR00154 (cont.)		D46705	328-383	10/09/80 - 10/12/80
		D46706	384-442	10/13/80 - 10/17/80
		D46707	443-501	10/17/80 - 10/20/80
		D46708	502-516	10/31/80 - 10/31/80
		D46709	517-576	11/01/80 - 11/04/80
		D46710	577-636	11/05/80 - 11/08/80
		D46711	637-696	11/09/80 - 11/12/80
		D46712	697-756	11/13/80 - 11/16/80
		D46713	757-815	11/17/80 - 11/20/80
DR00155	DS00155	D46714	1-60	11/21/80 - 11/24/80
		D46715	61-120	11/25/80 - 11/28/80
		D46716	121-147	11/29/80 - 11/30/80
		D46717	148-206	12/01/80 - 12/04/80
		D46718	207-265	12/05/80 - 12/08/80
		D46719	266-321	12/09/80 - 12/12/80
		D46720	322-381	12/13/80 - 12/16/80
		D46721	382-438	12/17/80 - 12/20/80
		D46722	439-496	12/21/80 - 12/24/80
		D58566	497-553	01/09/81 - 01/12/81
		D58567	554-613	01/13/81 - 01/16/81
		D58568	614-673	01/17/81 - 01/20/81
		D58569	674-733	01/21/81 - 01/24/81
		D58570	734-793	01/25/81 - 01/28/81
		D58571	794-838	01/29/81 - 01/31/81
		D58572	839-897	02/01/81 - 02/05/81
		D58573	898-954	02/05/81 - 02/08/81
DR00156	DS00156	D58574	1-60	02/09/81 - 02/12/81
		D58575	61-120	02/13/81 - 02/16/81
		D58576	121-180	02/17/81 - 02/20/81
		D58577	181-235	02/21/81 - 02/24/81
		D58578	236-293	02/25/81 - 02/28/81
		D58579	294-349	03/01/81 - 03/04/81
		D58580	350-374	03/05/81 - 03/06/81
		D58581	375-417	03/17/81 - 03/20/81
		D58582	418-477	03/21/81 - 03/24/81
		D58583	478-537	03/25/81 - 03/28/81
		D58584	538-582	03/29/81 - 03/31/81
		D58585	583-642	04/01/81 - 04/04/81
		D58586	643-702	04/05/81 - 04/08/81
DR00157	DS00157	D58587	1-53	04/09/81 - 04/12/81
		D58588	54-113	04/21/81 - 04/24/81
		D58589	114-173	04/25/81 - 04/28/81
		D58590	174-203	04/29/81 - 04/30/81
		D58591	204-263	05/01/81 - 05/04/81
		D58592	264-314	05/05/81 - 05/08/81
		D58593	315-372	05/09/81 - 05/12/81
		D58594	373-430	05/13/81 - 05/16/81
		D58595	431-489	05/17/81 - 05/20/81
		D58596	490-547	05/21/81 - 05/24/81
		D58597	548-605	05/25/81 - 05/28/81
		D58598	606-616	05/29/81 - 05/30/81
		D58599	617-676	06/05/81 - 06/08/81
		D58600	677-735	06/09/81 - 06/12/81
		D58601	736-808	06/13/81 - 06/30/81
		D58602	809-823	06/30/81 - 06/30/81
		D58603	824-883	07/01/81 - 07/04/81

DR#	DS#	D#	FILES	TIME SPAN
DR00158	DS00158	D58604	1-75	07/05/81 - 07/06/81
		D58605	76-150	07/10/81 - 07/14/81
		D58606	151-205	07/15/81 - 07/18/81
		D58607	206-256	07/19/81 - 07/22/81
		D58608	257-312	07/23/81 - 07/26/81
		D58609	313-372	07/27/81 - 07/30/81
		D58610	373-384	07/31/81 - 07/31/81
		D58611	385-442	08/01/81 - 08/04/81
		D58612	443-492	08/05/81 - 08/09/81
		D58613	493-501	08/09/81 - 08/10/81
		D58614	502-520	08/15/81 - 08/16/81
		D58615	521-580	08/17/81 - 08/20/81
		D58616	581-640	08/21/81 - 08/24/81
		D58617	641-682	08/25/81 - 08/27/81
		D58618	683-697	09/04/81 - 09/04/81
		D58619	698-757	09/05/81 - 09/08/81
		D58620	758-816	09/09/81 - 09/12/81
		D58621	817-876	09/13/81 - 09/16/81
		D58622	877-935	09/17/81 - 09/20/81
DR00159	DS00159	D58623	1-60	09/21/81 - 09/24/81
		D58624	61-120	09/25/81 - 09/28/81
		D58625	121-150	09/29/81 - 09/30/81
		D58626	151-164	10/01/81 - 10/04/81
		D58627	165-167	10/12/81 - 10/12/81
		D58628	168-224	10/13/81 - 10/16/81
		D58629	225-284	10/17/81 - 10/20/81
		D58630	285-343	10/21/81 - 10/24/81
		D58631	344-403	10/25/81 - 10/28/81
		D58632	404-448	10/29/81 - 10/31/81
		D58633	449-505	11/01/81 - 11/04/81
		D58634	506-563	11/05/81 - 11/08/81
		D58635	564-621	11/09/81 - 11/12/81
		D58636	622-680	11/13/81 - 11/16/81
		D58637	681-707	11/17/81 - 11/18/81

REQ. AGENT	RAND #	ACQ. AGENT
DAD	V0014 195	RNH

SAGE

METEROLOGICAL, EPHEM, RAW DATA ARCH

79-013A-01A

This data set catalog consists of 233 data tapes. The tapes are 9 track, 1600 BPI, binary and multi-filed. The tapes were created on a CDC computer. Time spans and number of files are as follows:

list not in T/S order

D#	FILES	TIME SPAN
D-42920	117	03/05/79 - 03/08/79
D-42921	94	03/09/79 - 03/12/79
D-42922	81	03/13/79 - 03/16/79
D-42923	118	03/17/79 - 03/20/79
D-42924	108	03/25/79 - 03/28/79
D-42926	119	04/01/79 - 04/04/79
D-42927	121	04/05/79 - 04/08/79
D-42928	111	04/09/79 - 04/12/79
D-42929	119	04/13/79 - 04/16/79
D-42930	119	04/17/79 - 04/20/79
D-42931	119	04/21/79 - 04/24/79
D-42932	119	04/25/79 - 04/28/79
D-42934	73	05/24/79 - 05/29 79
D-42935	89	05/29/79 - 05/31/79
D-42936	119	06/01/79 - 06/04/79
D-42937	118	06/05/79 - 06/08/79
D-42938	82	06/09/79 - 06/13/79
D-42939	34	06/19/79 - 06/28/79
D-42940	38	07/01/79 - 07/04/79
D-42941	36	07/15/79 - 07/18/79
D-42942	46	07/19/79 - 07/22/79
D-42943	37	07/23/79 - 07/25/79
D-42944	36	08/02/79 - 08/06/79
D-42945	53	08/06/79 - 08/09/79
D-42946	57	08/10/79 - 08/13/79
D-42947	54	08/15/79 - 08/17/79
D-42948	37	08/18/79 - 08/21/79
D-42949	56	08/22/79 - 08/25/79
D-42950	50	08/26/79 - 08/29/79
D-42951	30	08/30/79 - 08/31/79
D-42952	35	09/13/79 - 09/17/79
D-42953	43	09/18/79 - 09/26/79
D-42954	49	09/27/79 - 09/30/79
D-42955	56	10/01/79 - 10/04/79
D-42956	42	10/05/79 - 10/08/79
D-42957	39	10/09/79 - 10/12/79
D-42958	42	10/13/79 - 10/16/79

D-42959	38	10/17/79 - 10/20/79
D-42960	39	10/21/79 - 10/25/79
D-42961	26	10/26/79 - 10/29/79
D-42962	59	11/21/79 - 11/24/79
D-42963	60	11/25/79 - 11/28/79
D-42964	30	11/29/79 - 11/30/79
D-42965	52	12/05/79 - 12/08/79
D-42966	58	12/09/79 - 12/12/79
D-42967	59	12/13/79 - 12/16/79
D-42968	58	12/17/79 - 12/20/79
D-46070	97	02/21/79 - 02/24/79
D-46071	113	02/25/79 - 02/28/79
D-46072	117	03/01/79 - 03/04/79
D-46073	115	03/21/79 - 03/24/79
D-46074	84	03/29/79 - 03/31/79
D-46075	59	04/29/79 - 04/30/79
D-46076	119	05/01/79 - 05/04/79
D-46077	117	05/05/79 - 05/08/79
D-46078	119	05/09/79 - 05/12/79
D-46084	113	05/13/79 - 05/16/79
D-46080	46	05/16/79 - 05/17/79
D-46081	82	06/09/79 - 06/13/79
D-46082	15	06/29/79 - 06/30/79
D-46083	30	07/05/79 - 07/09/79
D-46079	6	07/10/79 - 07/14/79
D-46085	52	09/01/79 - 09/04/79
D-46086	58	09/05/79 - 09/08/79
D-46087	52	09/09/79 - 09/12/79
D-46088	26	10/30/79 - 10/31/79
D-46089	22	11/01/79 - 11/04/79
D-46090	27	11/05/79 - 11/20/79
D-46091	57	12/01/79 - 12/04/79
D-46092	59	12/21/79 - 12/24/79
D-46093	49	12/25/79 - 12/28/79
D-46094	42	12/29/79 - 12/31/79
D-46641	51	01/01/80 - 01/04/80
D-46642	55	01/05/80 - 01/08/80
D-46643	53	01/09/80 - 01/12/80
D-46644	16	01/13/80 - 01/14/80
D-46645	22	01/27/80 - 01/28/80
D-46646	45	01/29 80 - 01/31/80
D-46647	60	02/01/80 - 02/04/80
D-46648	59	02/05/80 - 02/08/80
D-46649	59	02/09/80 - 02/12/80
D-46650	59	02/13/80 - 02/16/80
D-46651	59	02/17/80 - 02/20/80
D-46652	60	02/21/80 - 02/24/80
D-46653	60	02/25/80 - 02/28/80
D-46654	14	02/29/80
D-46655	58	03/01/80 - 03/04/80
D-46656	60	03/05/80 - 03/08/80
D-46657	53	03/09/80 - 03/13/80
D-46658	59	03/13/80 - 03/16/80
D-46659	59	03/17/80 - 03/20/80
D-46660	44	03/21/80 - 03/24/80

D-46661	1	03/25/80
D-46662	39	04/08/80 - 04/10/80
D-46663	59	04/11/80 - 04/14/80
D-46664	59	04/15/80 - 04/18/80
D-46665	60	04/19/80 - 04/22/80
D-46666	60	04/23/80 - 04/26/80
D-46667	38	04/27/80 - 04/29/80
D-46668	44	05/09/80 - 05/12/80
D-46669	60	05/13/80 - 05/16/80
D-46670	60	05/17/80 - 05/20/80
D-46671	60	05/21/80 - 05/24/80
D-46672	58	05/25/80 - 05/28/80
D-46673	45	05/29/80 - 05/31/80
D-46674	56	06/01/80 - 06/04/80
D-46675	59	06/05/80 - 06/08/80
D-46676	60	06/09/80 - 06/12/80
D-46677	60	06/13/80 - 06/16/80
D-46678	60	06/17/80 - 06/20/80
D-46679	59	06/21/80 - 06/24/80
D-46680	59	06/25/80 - 06/28/80
D-46681	30	06/29/80 - 06/30/80
D-46682	61	07/01/80 - 07/04/80
D-46683	45	07/05/80 - 07/20/80
D-46684	60	07/21/80 - 07/24/80
D-46685	60	07/25/80 - 07/28/80
D-46686	45	07/29/80 - 07/31/80
D-46687	59	08/01/80 - 08/04/80
D-46688	60	08/05/80 - 08/08/80
D-46689	60	08/09/80 - 08/12/80
D-46690	60	08/13/80 - 08/16/80
D-46691	60	08/17/80 - 08/20/80
D-46692	60	08/21/80 - 08/24/80
D-46693	60	08/25/80 - 08/28/80
D-46694	45	08/29/80 - 09/01/80
D-46695	59	09/01/80 - 09/04/80
D-46696	60	09/05/80 - 09/08/80
D-46697	59	09/09/80 - 09/12/80
D-46698	53	09/13/80 - 09/16/80
D-46699	60	09/17/80 - 09/20/80
D-46700	60	09/21/80 - 09/24/80
D-46701	60	09/25/80 - 09/28/80
D-46702	29	09/29/80 - 09/30/80
D-46703	60	10/01/80 - 10/04/80
D-46704	58	10/05/80 - 10/08/80
D-46705	56	10/09/80 - 10/12/80
D-46706	59	10/13/80 - 10/17/80
D-46707	59	10/17/80 - 10/20/80
D-46708	15	10/31/80
D-46709	60	11/01/80 - 11/04/80
D-46710	60	11/05/80 - 11/08/80
D-46711	60	11/09/80 - 11/12/80
D-46712	60	11/13/80 - 11/16/80
D-46713	59	11/17/80 - 11/20/80
D-46714	60	11/21/80 - 11/24/80
D-46715	60	11/25/80 - 11/28/80
D-46716	27	11/29/80 - 11/30/80

D-46717	59	12/01/80 - 12/04/80
D-46718	59	12/05/80 - 12/08/80
D-46719	56	12/09/80 - 12/12/80
D-46720	60	12/13/80 - 12/16/80
D-46721	57	12/17/80 - 12/20/80
D-46722	58	12/21/80 - 12/24/80
D-58566	57	01/09/81 - 01/12/81
D-58567	60	01/13/81 - 01/16/81
D-58568	60	01/17/80 - 01/20/81
D-58569	60	01/21/81 - 01/24/81
D-58570	60	01/25/81 - 01/28/81
D-58571	45	01/29/81 - 01/31/81
D-58572	59	02/01/81 - 02/05/81
D-58573	57	02/05/81 - 02/08/81
D-58574	60	02/09/81 - 02/12/81
D-58575	60	02/13/81 - 02/16/81
D-58576	60	02/17/81 - 02/20/81
D-58577	55	02/21/81 - 02/24/81
D-58578	58	02/25/81 - 02/28/81
D-58579	56	03/01/81 - 03/04/81
D-58580	25	03/05/81 - 03/06/81
D-58581	43	03/17/81 - 03/20/81
D-58582	60	03/21/81 - 03/24/81
D-58583	60	03/25/81 - 03/28/81
D-58584	45	03/29/81 - 03/31/81
D-58585	60	04/01/81 - 04/04/81
D-58586	60	04/05/81 - 04/08/81
D-58587	53	04/09/81 - 04/12/81
D-58588	60	04/21/81 - 04/24/81
D-58589	60	04/25/81 - 04/28/81
D-58590	30	04/29/81 - 04/30/81
D-58591	60	05/01/81 - 05/04/81
D-58592	51	05/05/81 - 05/08/81
D-58593	58	05/09/81 - 05/12/81
D-58594	58	05/13/81 - 05/16/81
D-58595	59	05/17/81 - 05/20/81
D-58596	58	05/21/81 - 05/24/81
D-58597	58	05/25/81 - 05/28/81
D-58598	11	05/29/81 - 05/30/81
D-58599	60	06/05/81 - 06/08/81
D-58600	59	06/09/81 - 06/12/81
D-58601	73	06/13/81 - 06/30/81
D-58602	15	06/30/81
D-58603	60	07/01/81 - 07/04/81
D-58604	75	07/05/81 - 07/06/81
D-58605	75	07/10/81 - 07/14/81
D-58606	55	07/15/81 - 07/18/81
D-58607	51	07/19/81 - 07/22/81
D-58608	56	07/23/81 - 07/26/81
D-58609	60	07/27/81 - 07/30/81
D-58610	12	07/31/81
D-58611	58	08/01/81 - 08/04/81
D-58612	50	08/05/81 - 08/09/81
D-58613	9	08/09/81 - 08/10/81
D-58614	19	08/15/81 - 08/16/81

D-58615	60	08/17/81 - 08/20/81
D-58616	60	08/21/81 - 08/24/81
D-58617	42	08/25/81 - 08/27/81
D-58618	15	09/04/81 -
D-58619	60	09/05/81 - 09/08/81
D-58620	59	09/09/81 - 09/12/81
D-58621	60	09/13/81 - 09/16/81
D-58622	59	09/17/81 - 09/20/81
D-58623	60	09/21/81 - 09/24/81
D-58624	60	09/25/81 - 09/28/81
D-58625	30	09/29/81 - 09/30/81
D-58626	14	10/01/81 - 10/04/81
D-58627	3	10/12/81
D-58628	57	10/13/81 - 10/16/81
D-58629	60	10/17/81 - 10/20/81
D-58630	59	10/21/81 - 10/24/81
D-58631	60	10/25/81 - 10/28/81
D-58632	45	10/29/81 - 10/31/81
D-58633	57	11/01/81 - 11/04/81
D-58634	58	11/05/81 - 11/08/81
D-58635	58	11/09/81 - 11/12/81
D-58636	59	11/13/81 - 11/16/81
D-58637	27	11/17/81 - 11/18/81

SAGE MERDAT

(STRATOSPHERIC AEROSOL AND GAS EXPERIMENT METEOROLOGICAL, EPHEMERIS, RAW DATA ARCHIVAL TAPE)

USER's GUIDE

To replace copy mailed earlier — lost or damaged during microfilming. See dup copy after the BANAT User's Guide!

REVISED 24 January 1980

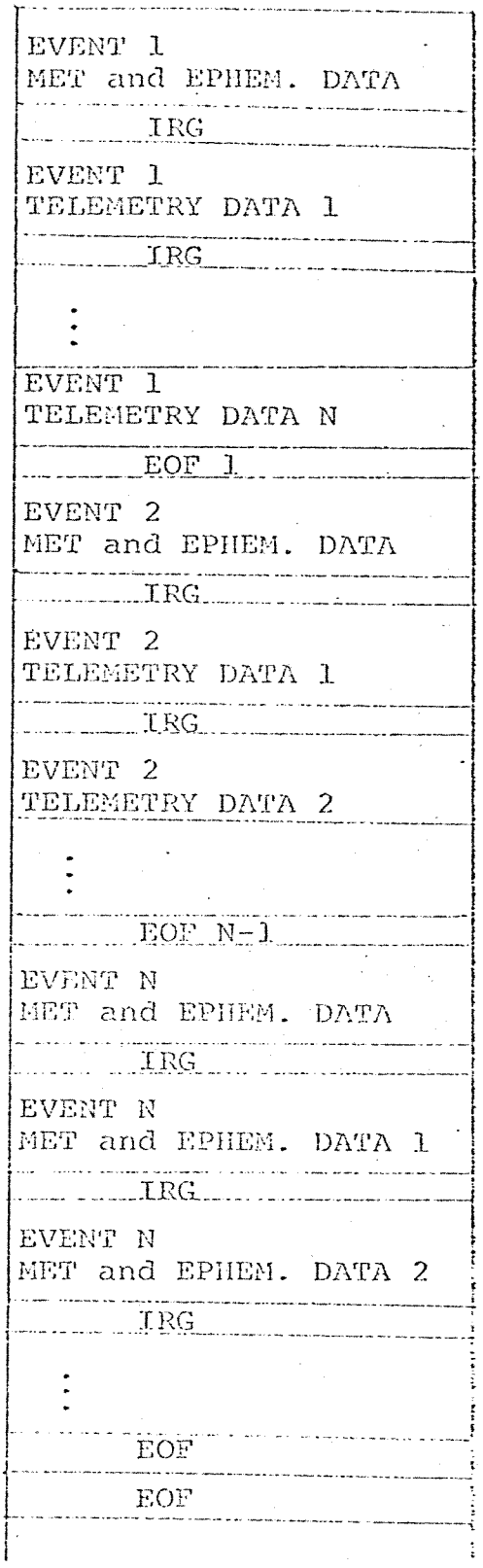
William A. Barnett Jr.

MERDAT TAPE CHARACTERISTICS

AND DATA ORGANIZATION

This data is on 9-track, 1600 CPI, unlabled magnetic tape in fixed length 616 CDC word (60 BIT) binary records. Each SAGE event is comprised of one record of Meteorological and Ephemeris data (combined) plus ten or more consecutive four second telemetry data records followed by an end-of-file mark. The last event will be followed by two end-of-file marks or end of tape. The number of records and number of events will vary. There will be no padding of missing telemetry data, however, MET and/or EPHEMERIS data dropout will result in zero fill of the appropriate words in record 1 of each file.

MERDAT GROSS FORMAT



MERDAT MET AND EPHEMERIS

DETAIL DESCRIPTION

The first 616 CDC word record in each file will contain the following:

MET DATA

CDC WORD #	DESCRIPTION	CDC INTERNAL FORMAT
1	Satellite Code	A9
2	Instrument	A6
3	Year	I4
4	Month	I2
5	Day	I2
6	Hour	I2
7	Minute	I2
8	Second	I2
9	Latitude	A6
10	Longitude	A7
11	Event Type	A7
12	No. Events in Day	I2
13	This Event No. in Day	I2
* 14-32	Temperature Deg K or 9999.	Real
* 33-51	Temp. Error Deg K or 999.	Real
* 52-70	Altitude in Meters or 99999.	Real
* 71-89	Density g/m^3 or 99999.	Real
* 90-108	Density Error $(\frac{\text{Temp. Err}}{\text{Temp.}})$ or 999.	Real

* The first 18 values correspond to fixed pressure levels in millibars:
1000,850,700,500,400,300,250,200,150,100,70,50,30,
10,5,2,1,0.4

The 19th value is derived at the variable tropopause pressure.

MERDAT MET AND EPHEMERIS DETAIL
DESCRIPTION (cont.)

EPHEMERIS DATA

CDC Word #			
	Description (All CDC Floating Point Words)		
109	Date of 1st EPH point (YYMMDD.0)		
110	No. days since Jan. 0 of year (DDD.0)		
111	Seconds of Day (SSSSS.S)		
112	Time interval between Eph. points (seconds)		
113	X	Position	(DUL)
114	Y	Vector	(DUL)
115	Z	1	(DUL)
116	VX	Velocity	(DUL/DUT)
117	VY	Vector	(DUL/DUT)
118	VZ	1	(DUL/DUT)
119-412	49 Additional vector component sets like 113-118		
413	Time of 1st Eph. point in this record (DUT)		
414	Time interval between Eph. points (DUT)		
415	Epoch time (centidays since 0 Hr. Sept. 18, 1957) (DUT)		
416	Greenwich hour angle at epoch time (radians)		
417-615	Repeat of 109-307 for next available Eph. set		
616	Twelve bit one's complement add checksum with end-around carry		

SAGE TELEMETRY DATA

DETAIL DESCRIPTION

Each physical record contains 4 seconds of SAGE data. (32 minor frames with Goddard Space Flight Center GMT tags and quality estimate codes.)

Minor Frame Gross Format (1 MF = 1152 BITS)

A. Telemetry Minor Frame - See GSFC document (included) Data Reduction Notes for Heat Capacity Mapping Mission (HCMM) and Stratosphere and Aerosol Gas Experiment (SAGE). BITS 1-1024

B. A/D FLAGS BITS 1025-1036 (Figure 1)

C. DAY BITS 1037-1045
MSEC OF DAY BITS 1046-1072

D. TELOPS COUNTERS (Figure 2)

E. TELOPS FLAGS (FIGURE 3)

F. FILL/EDIT FLAGS (FIGURE 4)

G. Twelve bit one's complement add checksum with end-around carry. (Supplied by LaRC in the last word (616) of each record and not read from the GSFC SAGE Experimenter Tape).

MISC.

1.) Events contained on MERDAT have been edited for slow scan quantity only.
2.) MET data missing single measurements are filled with 9's.
3.) DUL refers to DOD unit of length. 10,000 km = 1 DUL.
4.) DUT refers to DOD unit of time 864 sec = 1 centiday = 1 DUT.

F5	F6	F7	F8	F9	F10	F11	F12	SPARE	SPARE	P_{35}	P_{27}

GLOSSARY

F5 = BIT SLIPPAGE	F10 = LOS FLAG
F6 = INPUT DATA TERMINATION	F11 = "QUICK-LOOK" DATA
F7 = BIT ERRORS IN FSW	F12 = SPARE
F8 = FRAME SYNC NOT RECOGNIZED	P_{35} = PARITY ON 35 BITS OF TIME
F9 = AOS FLAG.	P_{27} = PARITY ON 27 BITS MSEC

Figure 1 | Analog-to-Digital Flags

Figure 2 | TELOPS Counters

ITEM DESCRIPTION	STATE	BIT(S) (R TO L)
COUNT OF INPUT FRAMES	0–262,143	1–18
FRAME COUNT ERROR	0–31	19–23
SPARE	0	24
UNCORRECTED TELEMETRY MODE WORD (ONLY IF MODE WORD CORRECTED)	0–255	25–32

Figure 3 TELOPS Preedit Flags

BIT NUMBER (L TO R)	DESCRIPTION
1	DECODING FRAME SUSPECT
2	PARTIAL FRAME (PADDED)
3	MODE ERROR
4	MODIFIED FRAME
5	FRAME IMMD AFTER DATA GAP
6	FRAME COUNT ERROR
7	SPARE
8	POSITIVE S/C ERROR
9	NEGATIVE S/C ERROR
10	POSITIVE UTC ERROR
11	NEGATIVE UTC ERROR
12	FRAME COUNT JUMP
13	SPARE
14	POSITIVE S/C JUMP
15	NEGATIVE S/C JUMP
16	POSITIVE UTC JUMP
17	NEGATIVE UTC JUMP
18	ILLEGAL UTC FROM G/STA
19	QUESTIONABLE FRAME COUNTER
20	SUBCOM II ERROR (SYNC)
21	SUBCOM III ERROR (COUNTER)
22	VERIFIED MODE CHANGE
23	FRACTION START
24	FRACTION END
25	DATA POINT OUTSIDE OF FRACTIONS
26	QUESTIONABLE S/C CLOCK
27	QUESTIONABLE UTC VALUE
28	SPARE
29--32	COUNT FRAME SYNC BIT ERRORS BY P.E.

Figure 4 Edit Flag Identification (AEM-B)

DESCRIPTION	STATUS	BIT (R TO L)
FRAME COUNTER VERIFIED	0	1
FRAME COUNTER CORRECTION	1	
SPACECRAFT CLOCK VERIFIED	0	2
SPACECRAFT CLOCK CORRECTION	1	
COMMAND CLOCK VERIFIED	0	3
COMMAND CLOCK CORRECTION	1	
COMMAND CLOCK STABLE	0	4
COMMAND CLOCK RESET	1	
COMMAND REPLICA VERIFIED	0	5
COMMAND REPLICA ERROR	1	
SPACECRAFT ID VERIFIED	0	6
SPACECRAFT ID CORRECTION	1	
PCM FORMAT VERIFIED	0	7
PCM FORMAT CORRECTION	1	
PCM FORMAT CONTINUOUS	0	8
PCM FORMAT CHANGE	1	
UTC ACCEPTABLE	0	9
UTC QUESTIONABLE	1	
UTC INTERPOLATED	0	10
UTC EXTRAPOLATED	1	
CONTINUOUS GROUND TIME	0	11
GROUND TIME DISCONTINUITY	1	
DATA CONTINUOUS	0	12
LOSS OF FRAME SYNC	1	
TELEMETRY DATA PRESENT	0	13
FILL DATA PRESENT	1	
DATA QUALITY GOOD	0	14
SUSPECT DATA	1	
SEGMENT INCOMPLETE	0	15
SEGMENT TERMINATION	1	
COMMAND CLOCK VERIFIED	0	16
COMMAND CLOCK UNVERIFIED	1	

Inversion of stratospheric aerosol and gaseous constituents from spacecraft solar extinction data in the 0.38–1.0-μm wavelength region

W. P. Chu and M. P. McCormick

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Inversion of stratospheric aerosol and gaseous constituents from spacecraft solar extinction data in the 0.38–1.0-μm wavelength region

W. P. Chu and M. P. McCormick

Inversion techniques for the retrieval of stratospheric aerosol, ozone, neutral density, and nitrogen dioxide vertical profiles from numerically simulated spacecraft solar extinction measurements have been analyzed. The analysis is applied toward the space flight mission of the Stratospheric Aerosol and Gas Experiment (SAGE), which will be flown on the Applications Explorer Mission B (AEM-B) spacecraft. The instrument has four radiometric channels located at selected intervals in the 0.38–1.0-μm wavelength range. The expected retrieval accuracies are determined from inverting simulated data with various experimental errors included. The results from this analysis assuming a horizontally homogeneous atmosphere indicate that aerosol, ozone, and neutral density vertical profiles can be retrieved to an accuracy better than 10% with about 1-km vertical resolution over most of the stratosphere. The results also show that nitrogen dioxide can be inverted to an accuracy of about 25% in the 25–38-km altitude range. In addition, the effects of horizontally inhomogeneous distributions of aerosol and ozone on the retrieval accuracies are analyzed based on a simple inhomogeneous model of the atmosphere and found that there is only a small perturbation on the inversion accuracies.

Introduction

The minor constituents in the upper atmosphere, such as aerosols and ozone, have received great attention in recent years because of concerns over their roles in affecting the global environment with subsequent alteration of activities in the biosphere. With mankind's increasing activities in both the stratosphere and troposphere, and naturally occurring events such as volcanic eruptions, large changes in stratospheric aerosol and/or ozone loading could be induced directly or indirectly through various photochemical reactions. A realistic assessment of this problem is still not possible due to the lack of information on the distribution, chemistry, and dynamics of most of the constituents in our atmosphere. Global monitoring of ozone has been carried out by different instruments on-board spacecrafts since the early part of this decade. Monitoring of stratospheric aerosols will begin with the Nimbus-G satellite in 1978 using data from Stratospheric Aerosol Measurement II (SAM II), which will cover the near-polar high-latitude region of the globe.[1] Another mission, the Stratospheric Aerosol and Gas Experiment (SAGE), will begin global monitoring of stratospheric aerosols and ozone with the Application Explorer Mission-B (AEM-B) satellite in 1979.[1]

In this paper we shall discuss a possible data retrieval technique for SAGE. The SAGE instrument has four radiometric channels centered at 1.0-μm, 0.6-μm, 0.45 μm, and 0.385-μm wavelength. The 1.0-μm channel is sensitive primarily to aerosol scattering. The 0.6-μm channel is located at the peak of the ozone Chappius absorption band for providing an ozone measurement. The 0.45-μm and 0.385-μm channels will provide information on nitrogen dioxide and aerosol short wavelength scattering properties. The experimental approach is solar occultation as viewed from an orbiting spacecraft. Each radiometric channel has a field of view (FOV) of 0.5-min of arc. which will provide atmospheric vertical resolution of approximately half km altitude. The radiometer will track the solar disk during each sunrise and sunset event in order to produce atmospheric extinction profiles at the four wavelengths down to cloud top vertical altitudes or approximately below 10 km.

The accuracy of the inference of aerosol and other gaseous constituent vertical distributions from the SAGE four channel radiometric data depends to a large extent on the accuracy of the measurement by the instrument. The understanding of the measuremental errors will dictate the proper inversion method to be used with the experimental data. In this paper, we will

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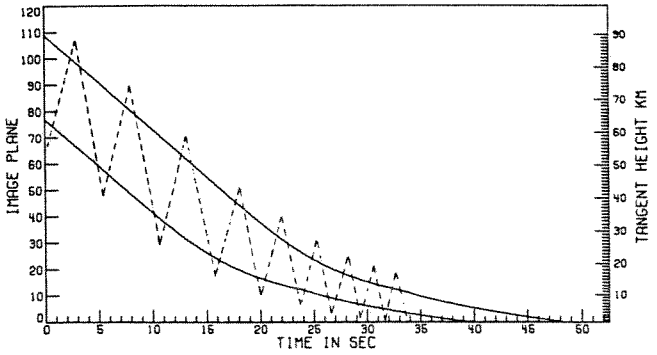

Fig. 1. Data acquisition mode for solar extinction experiment during a sunset event. The solid lines denote top and bottom of solar disk. The zig-zag dashed line shows the data taking sequence.

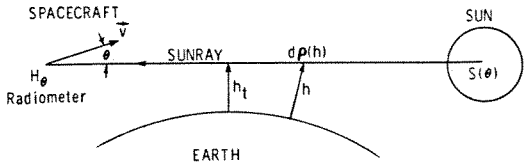

Fig. 2. Experimental geometry for solar extinction measurement.

describe a data reduction procedure for minimization of experimental errors based on a detailed simulation of the measurement sequence. An efficient and accurate inversion method will then be used for the retrieval of all the constituent vertical profiles.

The effects of horizontally inhomogeneous distributions of the constituent vertical profiles are also investigated based on available data of their global distributions. A simple horizontally inhomogeneous model of stratospheric aerosol and ozone will be used to estimate this perturbation on the retrieval accuracies.

Description of the Experiment

The data acquisition mode for the SAGE radiometer is illustrated in Fig. 1. The two solid lines denote, respectively, the image position of the top and bottom of the solar disk during a sunset event as viewed from the spacecraft platform. The gradual shrinking of the vertical sun shape image is due to atmospheric refraction. A ray trace technique based on Snell's law has been used to compute this effect.[2] The left vertical ordinate denotes relative angle measured from the spacecraft coordinate system in min of arc, while the right vertical ordinate denotes the corresponding vertical tangent altitude. The horizontal abscissa denotes event time in seconds corresponding to a sunset event in which the sun-satellite vector lies in the spacecraft's orbital plane. During a typical data taking sequence, the radiometer vertically scans the solar disk up and down with respect to earth's horizon. This is represented by the dashed line in the figure. The nominal scan rate will be 15 min of arc/sec. For a spacecraft sunrise event, the data taking mode is similar with the time sequence reversed. The radiometric data from each channel will be sampled at a rate of 64 samples/sec and will be digitized to 12 bits.

Simulation of Experimental Data

In order to determine the inversion accuracy for the SAGE solar extinction experiment, a detailed understanding of the various experimental errors and their effects on the retrieval of atmospheric constituent profiles will be required. This type of analysis can serve the purpose of guiding the design of the experiment and assessing the success of the experimental approach. There are two types of experimental errors associated with the SAGE measurement. The first type of error is the usual random noise associated with each measurement. The second type is the so-called pointing error, which is uniquely associated with solar extinction measurements. This error arises from the uncertainty in assigning to each measurement the viewing direction of the instrument with respect to both the atmosphere and the solar position and is caused by several different factors such as inaccurate spacecraft ephemeris data, errors in scanning and tracking of the instrument, and spacecraft drift due to residual angular momentum. To appreciate the magnitude of this error, let us assume the spacecraft ephemeris data are off by 1 sec. With the sun's vertical motion of about 3-km/sec as viewed from the spacecraft platform, this will correspond to an altitude offset error of 3 km.

The simulation of the experiment is based on the experimental geometry as illustrated in Fig. 2. The atmosphere is assumed to be spherically symmetric. The effects due to a horizontally inhomogeneous atmosphere will be considered in a later section. The radiometer is situated on the circularly orbiting satellite with velocity V. Each instantaneous view angle θ measured from V will define a unique tangent altitude h_t for the sun ray. In the inertial frame fixed on the spacecraft with the sun approximately at infinity, the instantaneous irradiance H_λ measured by the instrument at centered wavelength λ and time t is given as

$$H_\lambda(t) = \int_{\Delta\lambda}\int_{\Delta\Omega} F_\lambda(\theta,\phi)S_\lambda(\theta,\phi,t)T_\lambda(\theta)d\Omega d\lambda, \qquad (1)$$

where $F_\lambda(\theta,\phi)$ is the radiometer's field of view function, ϕ is the azimuthal angle, Ω is the solid angle, $T_\lambda(\theta)$ is the transmission of the atmosphere as a function of view angle θ, and $S_\lambda(\theta,\phi,t)$ is the extraterrestrial solar radiance profile for wavelength λ. In order to account for atmospheric refraction effects on the solar radiance distribution as described in Fig. 1, an atmospheric refracted solar radiance distribution has to be used in Eq. (1).

Using the Bouguer law, the transmission function $T_\lambda(\theta)$, with the change of variable from θ to h_t, is given by

$$T_\lambda(h_t) = \mathrm{Exp} - [\int \beta_\lambda(h)d\rho_\lambda(h)], \qquad (2)$$

where $\beta_\lambda(h)$ is the total extinction coefficient of the atmosphere vs altitude h for wavelength λ, and $\rho_\lambda(h)$ is the sun ray optical pathlength. The integral is evaluated from the spacecraft position through the atmosphere at h_t to the sun. For SAGE with spectral channels located within the spectral range of 0.38–1.0

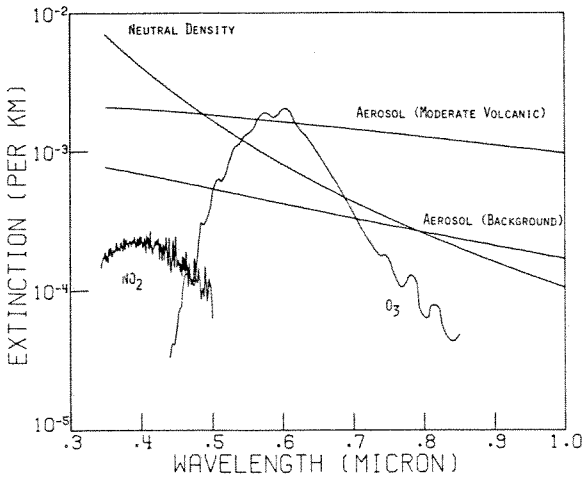

Fig. 3. Extinction contributions from Rayleigh, aerosol, O_3, and NO_2 vs wavelength from 0.35 μm to 1.0 μm at an altitude of 18 km.

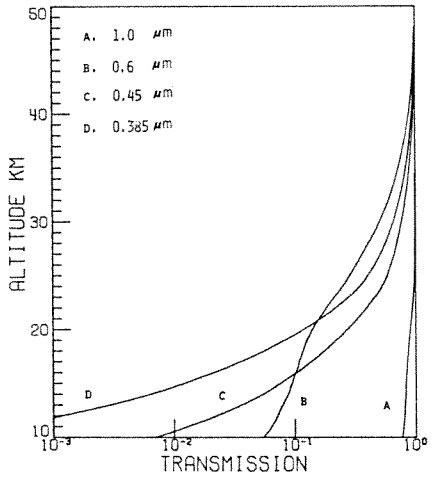

Fig. 4. Atmospheric transmission vs tangent altitude at the four wavelengths for solar extinction geometry.

μm, the total extinction coefficient β_λ at each altitude is composed of contributions from

$$\beta_\lambda = \beta_{ND}(\lambda) + \beta_{O_3}(\lambda) + \beta_{NO_2}(\lambda) + \beta_a(\lambda), \quad (3)$$

where $\beta_{ND}(\lambda)$ is the extinction coefficient at λ for neutral atmospheric density (Rayleigh scattering); $\beta_{O_3}(\lambda)$, $\beta_{NO_2}(\lambda)$, and $\beta_a(\lambda)$ are, respectively, ozone, nitrogen dioxide, and aerosol extinction coefficients at wavelength λ. The Rayleigh scattering term is described by the well-known inverse fourth power law dependence on wavelength. For the gaseous constituents, ozone and nitrogen dioxide, the extinction coefficient is equal to the product of number density and the absorption cross section at the specific wavelength. The aerosol extinction coefficient is a function of aerosol size distribution, shape, and index of refraction. For homogeneous spherical aerosol particles, the extinction coefficient is given by the following equation[3]:

$$\beta_a(\lambda) = \int_0^\infty \sigma(n,r,\lambda)N(r)dr, \quad (4)$$

where $N(r)$ is the size distribution function for aerosol particles, $\sigma(n,r,\lambda)$ is the extinction cross section at λ for particle with index of refraction n and radius r. The extinction cross section $\sigma(n,r,\lambda)$ can be computed from Mie theory for homogeneous spherical particles.[4] Figure 3 shows extinction contributions from each atmospheric constituent vs wavelength at an altitude of 18 km. The ozone number density is assumed to be $4 \times 10^{12}/cm^3$, NO_2 number density is assumed to be $3 \times 10^9/cm^3$. Two aerosol extinction models are shown in the figure corresponding to a background model and a moderate volcanic model. Both aerosol models are computed from Rosen's log normal size distribution with refractive index of 1.43 corresponding to composition of 75% H_2SO_4 and 25% H_2O.[5] The background model assumes a modal radius r_g of 0.0725 μm and a spread σ_g of 1.86, while the moderate volcanic model assumes a modal radius r_g of 0.097 μm and a spread σ_g of 2.02. The total aerosol number density in both models is assumed to be $10/cm^3$.

Before proceeding to the simulation of the experimental data, different models of the atmosphere have to be constructed. We computed the atmospheric transmission profiles at the four SAGE wavelengths by dividing the atmosphere into homogeneous spherical shells of 0.15-km thickness. The optical pathlength through each layer is computed from the ray trace method properly taking atmospheric refraction into account. Different sets of aerosol, ozone, and nitrogen dioxide vertical profiles are then used to construct transmission vs tangent altitude profiles at the four wavelengths. Figure 4 illustrates typical computational results showing atmospheric transmission vs tangent altitude profiles at the four wavelengths. The vertical distribution for each constituent used in computing these transmission profiles is shown in Fig. 5 in terms of extinction profiles at a given wavelength. The neu-

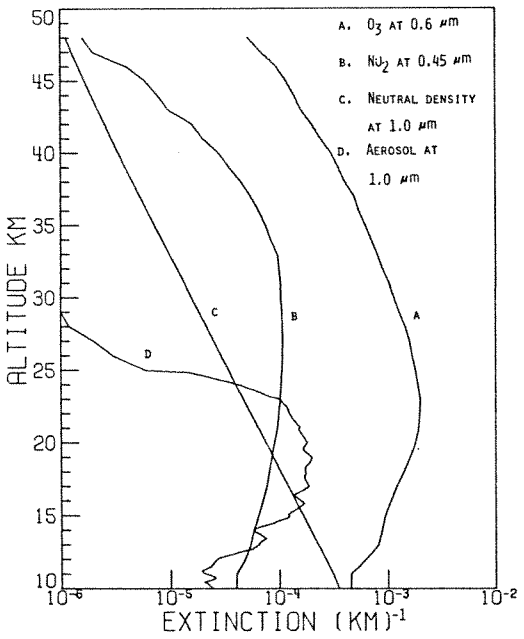

Fig. 5. Vertical extinction profiles for Rayleigh, aerosol, O_3, and NO_2.

tral density and the ozone extinction profiles are computed from the 1976 Standard Atmosphere.[6] The nitrogen dioxide extinction profile is computed from Concorde measurements,[7] and the aerosol vertical profile is computed from a typical dustsonde measurement in the 1972 period.[8] The optical model for the aerosol used in the calculation is the same as illustrated in Fig. 3 for the background aerosol model.

The actual simulation of the experimental data is derived based on Eq. (1) together with the experimental sequence as illustrated in Fig. 1. We have assumed that the spectral bandpass for each radiometric channel is sufficiently narrow so that a single wavelength representation for each channel can be justified. Since the field of view of the instrument, which is 0.5 min of arc, is much smaller than the angular extent of the solar disk, we made the approximation of replacing $F_\lambda(\theta,\phi)$ in Eq. (1) with the line spread function of the instrument to calculate the measured irradiance. The line spread function is determined from instrument specification for the SAGE experiment.[1] Pointing errors associated with the instrument in the form of scan rate fluctuations are then incorporated into the simulation. Moreover, for each measured irradiance, random noise with a fixed maximum magnitude representative of the worst case instrument errors is added. Each simulated measurement is then quantized to 12 bits. Figure 6 shows a typical simulated data set for the 1.0-μm channel during a sunset event. The simulation begins when the suntop is situated at a 92-km tangent altitude. The solar limb darkening profiles used in all the simulations have been tabulated by Allen.[9]

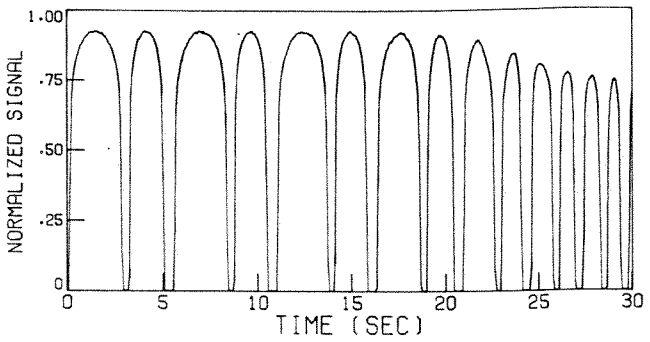

Fig. 6. Simulated experimental data for solar extinction measurement at 1.0-μm wavelength.

Reduction of Measured Data to Transmission Profiles of the Atmosphere

The reduction of measured data from the SAGE four radiometric channels, such as those illustrated in Fig. 6, is accomplished through the following procedure. First, each measured irradiance is related to view angle with respect to the earth's atmosphere in terms of tangent altitude and with respect to the solar disk in terms of position on the limb darkening curve. This relationship in principle can be established through a calculation with the spacecraft and solar ephemeris data. Accurate determination of this relationship for all measured data during a complete sunrise or sunset event, however, will be difficult due to the atmospheric refraction effects and the pointing uncertainty of the instrument. We have developed, therefore, an iterative method to establish this relationship through a fitting of the measured sun shapes to the computed sun shapes. In this method, the function $\Phi(h_r)$, which is the sum of squares of the time differences between the measured sun edge crossing time and the computed sun edge crossing time with reference altitude h_r, is minimized.

$$\Phi(h_r) = \sum_{i=1}^{n} [\Delta t_i^{(m)} - \Delta t_i^{(c)}(h_r) - 2\delta t]^2, \tag{5}$$

where $\Delta t_i^{(m)}$ is the measured sun edge crossing time for the ith scan, $\Delta t_i^{(c)}(h_r)$ is the computed sun edge crossing time for the ith scan with reference altitude h_r, and δt is the sun edge spreading time which is determined by the amount of edge smear produced by the imaging optics and by the intensity threshold level selected for the definition of sun edge. The iterative process begins by making an initial guess of the reference altitude $h_r^{(o)}$ to compute the function $\Phi(h_r)$. The following equation is then used for the update of h_r:

$$h_r^{(k+1)} = h_r^{(k)} + c \sum_i [\Delta t_i^{(m)} - \Delta t_i^{(c)}(h_r) - 2\delta t], \tag{6}$$

where the superscript k is the iteration number, and c is a positive scaling constant to control the speed of convergence of the iteration. The absolute magnitude of c is proportional to the scan rate and is determined by trial and error. The iteration stops when a minimum of the function $\Phi(h_r)$ has been located. The iterative procedure described above has been applied to simulated experimental data with a range of pointing error, and the iteration always converges to within 0.2 km of the true reference altitude in about ten iterations.

The second step in the data reduction procedure is to utilize the self-calibrating property of this type of measurement by making the first few high-altitude scans of the solar disk where the atmospheric extinction is assumed to be zero as the extraterrestrial solar limb darkening profiles. Atmospheric transmittance values for each subsequent measured irradiance are then determined by forming the ratio with the calibrated limb profile at the proper solar limb position. This generates a large number of transmittance values for each wavelength at different tangent altitudes. In order to facilitate the inversion and to minimize the random noise effect, the transmission data are grouped into predetermined altitude steps. The arithmetic mean of the transmittance values within each altitude step is then taken as the representative average transmittance for the particular layer. In this study, we have divided the atmosphere into 80 homogeneous layers from 10 km to 50 km with thickness of 0.5 km. The improvement in the signal-to-noise level based on this averaging process

can be demonstrated with simulated events as illustrated in Fig. 7 where the sunset event of Fig. 6 is used. Instrumental errors of 0.5% random noise on each measurement and 0.5-min of arc/sec scan rate error were introduced into the simulation sequence. These simulated irradiance data are then reduced by first establishing a best fit reference altitude from the sun shape measurements. Subsequently, all irradiance data are normalized to the first scan limb profile to determine the atmospheric transmittance values. Figure 7(A) shows the percentage error associated with the reduced transmittance from each measurement as a function of tangent altitude for the 1.0-μm wavelength channel. Figure 7(B) shows the percentage error associated with the mean transmittance values after averaging the reduced transmittance values within each 0.5-km altitude step. Generally, a significant improvement of signal-to-noise level can be achieved through this simple reduction process.

Inversion of Transmission Profile to Extinction Profile for each Constituent

The inversion of the mean transmittance profiles at the four wavelengths to extinction profile for each constituent is based on inverting the integral equation as described by Eq. (2). Rewriting Eq. (2) in terms of optical thickness $\tau_\lambda(h_t)$, where $\tau_\lambda(h_t) = \ln[1/T_\lambda(h_t)]$, we have

$$\tau_\lambda(h_t) = \int \beta_\lambda(h) d\rho_\lambda(h). \tag{7}$$

The integral can be approximated with a sum over N discrete atmospheric layers with each layer having an averaged extinction coefficient $\beta_j(\lambda)$. Equation (7) can then be replaced by a system of linear equations

$$\tau_i(\lambda) = \sum_{j=i}^{N} \beta_j(\lambda)\rho_{ij} \qquad \text{for } i = 1,2,\ldots m, \tag{8}$$

where ρ_{ij} is the sunray's pathlength in the jth layer with its tangent height at the ith layer, and $\beta_j(\lambda)$ is the averaged atmospheric extinction coefficient for the jth layer at wavelength λ. $\beta_j(\lambda)$ can be separated into contributions from each constitutent as described by Eq. (3). Combining Eqs. (8) and (3), we have

$$\tau_i(\lambda) = \sum_{j=i}^{N} \rho_{ij}[\beta_{\mathrm{ND}}(\lambda) + \beta_{\mathrm{O_3}}(\lambda) + \beta_{\mathrm{NO_2}}(\lambda) + \beta_a(\lambda)]_j \tag{9}$$

$$\text{for } i = 1,2,\ldots m.$$

Equation (9) describes four coupled systems of linear equations corresponding to the 1.0 μm, 0.6-μm, 0.45-μm, and 0.385-μm SAGE wavelength measurements. Due to the constraint on the number of wavelength measurements available from the instrument, it is only possible to retrieve a maximum of four independent sets of vertical constituent profiles. It is well known that nitrogen dioxide distribution in the atmosphere peaks at 30 km, while aerosol peaks at 15–20 km with negligible contribution above 25 km. To make full use of the spatial separation of aerosol and NO_2 vertical distributions in the atmosphere, we are inverting the NO_2 vertical profile above 25 km while inverting a two parameter model for the aerosol layer below 25 km.

There are two approaches for the inversion of multiwavelength transmittance profiles into extinction profiles for each contributing constituent. The first approach is based on two successive steps of inversion.[10] In the first step, Eq. (8) is inverted independently at each wavelength channel to give total extinction coefficients vs tangent altitude profiles. Then in the second step, the inverted total extinction coefficients for all wavelength channels are used at each altitude to invert the contribution from each constituent. The inversion stops when the complete altitude range has been covered. There are inherent difficulties associated with this type of inversion approach. First, the input to the second inversion step is by itself an inverted quantity. Estimating the uncertainty associated with this input for the second inversion process would be difficult, and either an overestimation or underestimation on this uncertainty is undesirable and will affect the final inversion results. Second, this approach does not provide enough flexibility to incorporate a vertical smoothing constraint on the retrieved constituent profiles.

The second approach is a direct one-step inversion from the multiwavelength transmittance profiles to

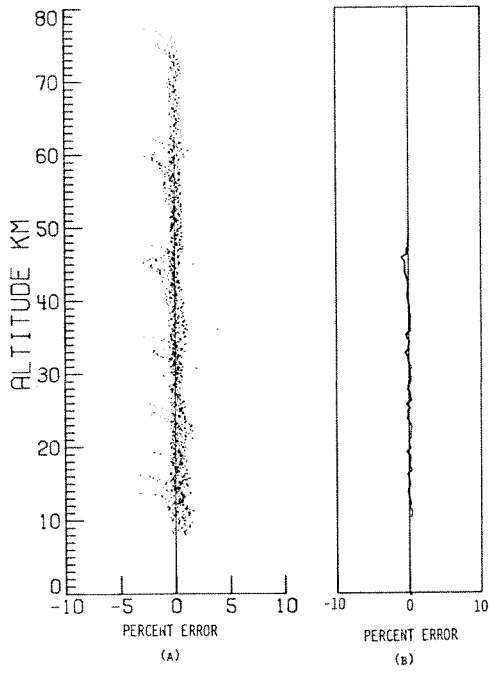

Fig. 7. (a) Percent error of transmittance value associated with each simulated data point for the solar extinction measurement. (b) Percent error of mean transmittance values obtained from averaging data points over 0.5-km altitude steps.

each constituent vertical profile. We have developed this inversion approach based on the consideration that each wavelength channel is most sensitive selectively to an individual constituent. Figure 8 illustrates this point by showing the ratio profiles of $\beta_a/\beta_{\text{total}}$ at 1.0 μm, $\beta_{O_3}/\beta_{\text{total}}$ at 0.6 μm, $\beta_{ND}/\beta_{\text{total}}$ at 0.385 μm, $\beta_a/\beta_{\text{total}}$ at 0.45 μm, and $\beta_{NO_2}/\beta_{\text{total}}$ at 0.45 μm. The atmospheric model used in Fig. 8 is the same as illustrated in Fig. 5. It is obvious that the contributions by aerosol, ozone, and neutral density are heavily weighted at the 1.0-μm, 0.6-μm, and 0.385-μm wavelengths, respectively, with a variable contribution from nitrogen dioxide and aerosol at the 0.45-μm wavelength. This consideration leads us to formulate an iterative approach in which each constituent is inverted at the wavelength channel which is most sensitive to its contribution. A set of initial-guess constituent profiles is first selected. The inversion process begins, for example, at the 1.0-μm wavelength channel by computing the initial aerosol optical thickness $\tau_{ai}^{(0)}$ at 1.0 μm:

$$\tau_{ai}^{(0)} = \tau_i^m - \sum_{j=i}^{N} \rho_{ij}[\beta_{ND}^{(0)} + \beta_{O_3}^{(0)} + \beta_{NO_2}^{(0)}]_j, \tag{10}$$

where τ_i^m is the measured total optical depth at 1.0 μm, $\beta_{ND}^{(0)}$, $\beta_{O_3}^{(0)}$, and $\beta_{NO_2}^{(0)}$ are, respectively, the initial-guess profile for neutral density, ozone, and NO_2. The first update of the aerosol extinction profile $\beta_a^{(1)}$ at 1.0 μm is then inverted from the following equation:

$$\tau_{ai}^{(0)} = \sum_{j=i}^{N} \rho_{ij}\beta_{aj}. \tag{11}$$

In this study, Eq. (11) is inverted with Twomey's modification of Chahine's nonlinear relaxation method.[11] The iterative equation in this case

$$\beta_{aj}^{(1)} = \beta_{aj}^{(0)} \left| \left\{ 1 + \left[\frac{\tau_{ai}^{(0)}}{\sum_{j=i}^{N} \rho_{ij}\beta_{aj}^{(0)}} - 1 \right] \frac{\rho_{ij}}{\rho_{ii}} \right\} \right|, \tag{12}$$

where $\beta_{aj}^{(0)}$ is the initial-guess profile for aerosol extinction at 1.0 μm. The absolute value sign in Eq. (12) is to insure a positive solution. Each $\tau_{ai}^{(0)}$ value is used to update the aerosol extinction $\beta_{aj}^{(0)}$ at the j-level connected by the matrix element ρ_{ij}. The matrix ρ_{ij} is sharply peaked at the diagonal and slowly decreasing toward the off-diagonal elements. It is found that by truncating the weighting factor ρ_{ij}/ρ_{ii} to levels close to the diagonal insures the stability of the inversion. This will at the same time provide sufficient smoothing on the retrieved vertical profile. In this work, the weighting factor ρ_{ij}/ρ_{ii} is truncated at 4 km above the diagonal element. After the first updated aerosol profile has been obtained, the inversion process proceeds on to the 0.6-μm wavelength. An updated ozone profile can be calculated with Eq. (12) using the first updated aerosol profile together with the initial profiles for other constituents. The process is continued at 0.45 μm and then at the 0.385-μm wavelength. A complete set of updated constituent profiles is obtained in this manner. The inversion process then repeats itself starting at the 1.0-μm wavelength. This iterative cycle

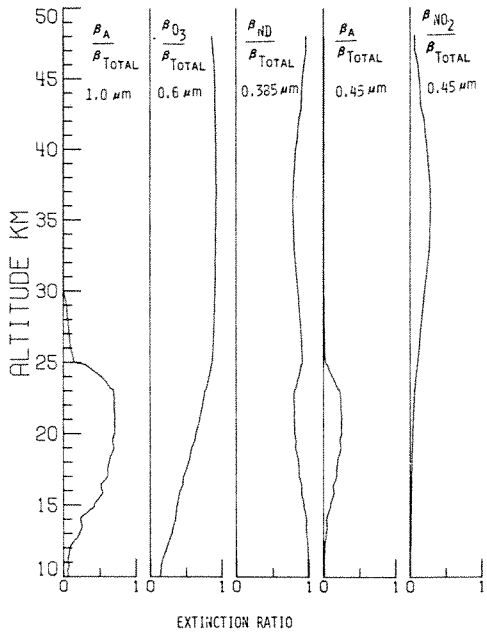

Fig. 8. Vertical profiles of extinction ratio at the four wavelengths

will continue until a certain convergence criterion has been met. We have used a convergence criterion based on the absolute value of the residual between the computed transmittance value and the measurement at each atmospheric level to be less than or equal to the standard deviation associated with the mean transmittance value deduced from the radiometric data. After the convergence criterion is satisfied for all the atmospheric levels in each wavelength channel, the iteration stops. It is found that the inverted solutions show no dependence on the initial-guess profiles, however, the speed of convergence does depend on how closely the shape of the initial guesses and the actual profiles correspond.

Inversion Results for a Horizontally Homogeneous Atmosphere

The data reduction scheme and the inversion approach described above have been applied to simulated experimental data assuming various amounts of experimental error. Figure 9 shows a set of typical inversion results for each constituent extinction profile. The input profiles which are identical to those shown in Fig. 5 are denoted by solid lines. The background aerosol model illustrated in Fig. 3 has been assumed. Experimental errors consisting of a random noise of 0.5% and scan rate error of 0.5 min of arc/sec have been included in the simulation process. These error levels correspond to twice the worst-case expected performance of the SAGE instrument. Ten independent simulations, reductions, and inversions have been performed on the same input profiles. The bars represent one standard deviation in the inverted mean profiles for the ten simulations. In the inversion calculations, a

linear relationship between aerosol extinction coefficient and wavelength has been assumed. This assumption is not strictly correct, but the errors introduced in the retrieval of ozone and neutral density profiles are sufficiently small due to the small aerosol contributions in the 0.6-μm and the 0.385-μm wavelength regions. The inversion results indicated that a vertical ozone extinction profile at 0.6 μm can be retrieved to an accuracy of about 10% between 12 km and 42 km with better accuracy at the peak of the profile. The neutral density vertical profile can be retrieved to a few percent accuracy from 10 km to approximately 40 km. Aerosol vertical extinction profiles at 1.0 μm and 0.45 μm can be retrieved to about 10% accuracy between 13 km and 24 km, extending over the full altitude range of the stratospheric aerosol layer. Nitrogen dioxide vertical extinction profile at 0.45 μm can be retrieved to an accuracy of about 25% between 25 km and 38 km. The vertical resolution achievable is approximatly 1 km. The accuracy of retrieving O_3, NO_2, and ND above 40 km can be improved by increasing the altitude interval over which the data are averaged with, of course, a concomitant loss of vertical resolution. Simulations and inversions have also been performed on different sets of input profiles. For input ozone profiles showing fine-scale vertical structures, the inversion results show similar retrieval accuracy over the altitude range from 12 km to 42 km. For different input aerosol profiles ranging from moderate volcanic profiles with a corresponding aerosol optical model to background-level profiles showing extinction peaks at various altitudes between 14 km and 22 km corresponding to profiles observed at different latitude regions on the globe, the inversion results at 1.0 μm and 0.45 μm generally show about 10% accuracy over the full altitude range of the aerosol layer. For nitrogen dioxide input profiles showing a high level of concentration such as those reported by Brewer,[12] a small bias error within the altitude range from 10 km to 20 km could be introduced in the retrieved ozone profile and aerosol profile at 0.45 μm. This bias error arises from neglecting the nitrogen dioxide contribution within this altitude region and, therefore, can be minimized by including a mean NO_2 profile at this region in the inversion.

Effects of Horizontally Inhomogeneous Aerosol and Ozone Distributions

The assumption of spherically symmetric geometry in our modeling of the atmospheric parameters for the solar extinction measurements is only an approximation. Vertical distributions of atmospheric variables over different latitudes or longitudes on the globe generally show variations due to atmospheric dynamical and chemical effects. Since the inversion method discussed here implicitly assumed a spherically symmetric atmosphere, effects due to horizontally inhomogeneous distributions of the atmospheric constituents can be considered as a source of error for the inversion process. In this section, the data retrieval method that was discussed previously will be applied to a simple horizontally inhomogeneous atmospheric model in order to assess this type of perturbation on the retrieval accuracies.

The four atmospheric constituents—neutral density, aerosol, ozone, and nitrogen dioxide—all show certain degrees of horizontal inhomogeneity. Variations of

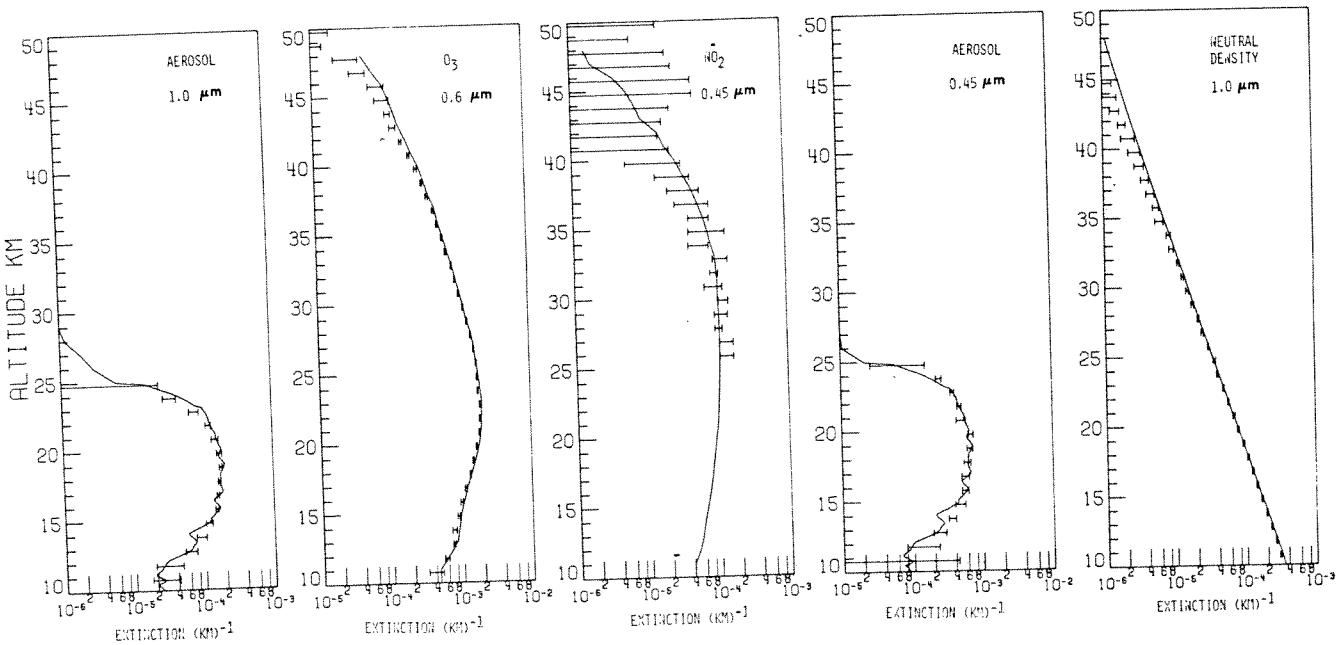

Fig. 9. Inversion results from the four wavelength solar extinction data. Error bars denote one standard deviation from the mean of ten independent simulations and inversions.

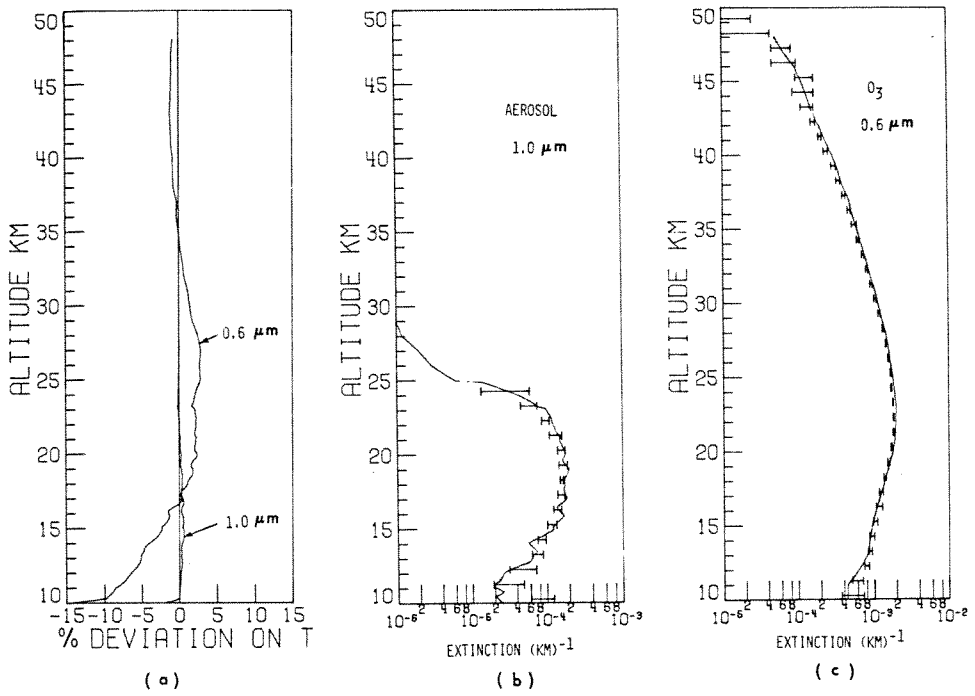

Fig. 10. (a) Percent deviations of transmission profiles for the inhomogeneous atmospheric model to the homogeneous model for 1.0-μm and 0.6-μm wavelengths. (b), (c) Inversion results from the inhomogeneous atmospheric model for aerosol extinction at 1.0 μm and ozone extinction at 0.6 μm.

atmospheric vertical density profiles are generally small over the approximate 300-km horizontal pathlength for SAGE. Aerosol spatial distributions can be more variable, especially during the period of initial volcanic injection and dispersion. Lidar measurements of stratospheric aerosol vertical profiles have shown that during the first 3 months after a large volcanic eruption whose effluents penetrate the stratosphere, that large variations in aerosol vertical distribution were consistently observed. Subsequently, a quasi-steady-state distribution is reached showing a rather smooth vertical profile which persists for a long period of time.[13] Lidar data have also shown horizontal homogeneity over hundreds of kilometers during these times which are representative of the normal background aerosol. No observational data currently exist on the horizontal distribution of stratospheric aerosol during the initial dispersion phase (first 3 months) after a volcanic injection event. Global aerosol and ozone distribution data at different seasons have been obtained from both balloon and satellite measurements.[14,15] No observational data currently exist on the global distribution of nitrogen dioxide. Extinction contributions from nitrogen dioxide in the visible spectrum are usually small, however, and the horizontal variation will be neglected in this analysis. In our modeling of the inhomogeneous atmosphere, therefore, we will only consider the horizontally inhomogeneous distributions of aerosol and ozone.

The vertical distribution of aerosol and ozone will be described in terms of mixing ratios profiles $M(h,x)$, where h is the vertical altitude and x is measured along the horizon in earth-center-degree (equivalent to degree latitude or longitude). The mixing ratio profile is considered here because it is this quantity which is conserved in atmospheric transport processes that do not involve mixing. Moreover, aerosol vertical mixing ratio profiles near polar and equatorial regions have been observed to vary as a simple shift in altitude with respect to tropopause height.[14] We model the horizontal inhomogeneity of aerosol and ozone distributions by assuming that the constant mixing ratio levels are all parallel lines with a horizontal gradient $K = \partial h/\partial x$. To extend this assumption over the entire altitude range of the stratosphere would be a worst case consideration. The horizontal variations of the mixing ratio profile $M(h,x)$ in this case are described by the following equation:

$$M(h,x) = M[h + K(x - x_0), x_0], \tag{13}$$

where x_0 is the horizontal tangent coordinate of the experimental geometry, and $M(h,x_0)$ is the vertical mixing ratio profile at x_0. Typical values of K deduced from inspection of latitudinal cross-sectional charts for both aerosol and ozone distributions vary from 0.2 km per degree lattitude near polar and equatorial regions to a maximum of 1.0 km per degree latitude at midlatitudes near the jet stream region.[14,15]

In order to analyze the difference between a horizontally inhomogeneous and homogeneous atmospheric model, the atmospheric transmission profiles at different wavelengths for the two models are computed. Figure 10(a) shows the percentage difference between the two calculated transmission profiles at wavelengths of 1.0 μm and 0.6 μm. The vertical profiles for each constituent are the same as those shown in Fig. 5, and they are identical at the horizontal tangent coordinate x_0 for the two models. For the horizontally inhomogeneous model, the aerosol and ozone mixing ratio profiles were computed directly as β_a/β_{ND} and β_{O_3}/β_{ND}, re-

spectively, with K equal to 1.0 km per degree angle for both profiles. The resultant differences of the two transmission profiles which are equivalent to a "noise" term added in the inversion are either less than or equal to the total instrumental noise level as shown in Fig. 7. By including this level of modeling noise in the simulation, one can conclude that the inversion results should not be perturbed to a large extent. This conclusion is confirmed by the inversion results for aerosol at 1.0 μm and ozone at 0.6 μm as illustrated in Figs. 10(b) and 10(c), respectively. As for Fig. 9, ten independent simulations, reductions, and inversions have been performed on the horizontally inhomogeneous atmospheric model including the same level of experimental errors as discussed previously. The inverted results denoted by error bars of one standard deviation are shown superimposed on the input profiles (solid lines) at the tangent coordinate. Comparison with Fig. 9 shows that the perturbation on inversion accuracies due to horizontal inhomogeneity is small. Inverted results for neutral density, nitrogen dioxide, and aerosol extinction at 0.45 μm are also similar to the results shown in Fig. 9. Additional analysis with K values less than 1.0 km per degree produced proportionally smaller differences.

Effects of a horizontally inhomogeneous atmosphere with aerosol and ozone profiles showing more vertical structure have also been analyzed. Typical results are illustrated in Fig. 11. A moderate volcanic aerosol profile[16] and an ozone profile with additional vertical structure were used as inputs in the simulations with K equal to 1.0 km per degree. The accuracies of the inversion results are approximately the same as those illustrated in Fig. 9 and 10.

Conclusions

This paper has demonstrated that simulated solar occultation data from the four channel SAGE instrument can be inverted to produce aerosol, ozone, neutral density, and nitrogen dioxide vertical extinction profiles in the stratosphere. A data reduction scheme has been developed to reduce the multiwavelength radiometric data into atmospheric transmittance profiles. An iterative inversion approach is then used to retrieve all the constituent vertical profiles directly from the multiwavelength transmittance profiles with the assumption of a horizontally homogeneous atmosphere. Based on simulations of the experimental events including various instrumental error sources and 1-km height resolution it is found that ozone vertical extinction profiles between 12 km and 42 km can be retrieved to an accuracy of about 10% with much better accuracy at the ozone peak, neutral density profiles can be retrieved to a few percent accuracy up to about 40 km, aerosol extinction profiles at 1.0 μm and 0.45 μm can be retrieved to about 10% accuracy over the full altitude range of the stratospheric aerosol layer, and nitrogen dioxide extinction profiles at 0.45 μm can be retrieved to about 25% accuracy from 25 km to 38 km. Accuracies above 40 km can be improved by vertical smoothing, i.e., averaging over larger height intervals.

The effects of horizontally inhomogeneous distri-

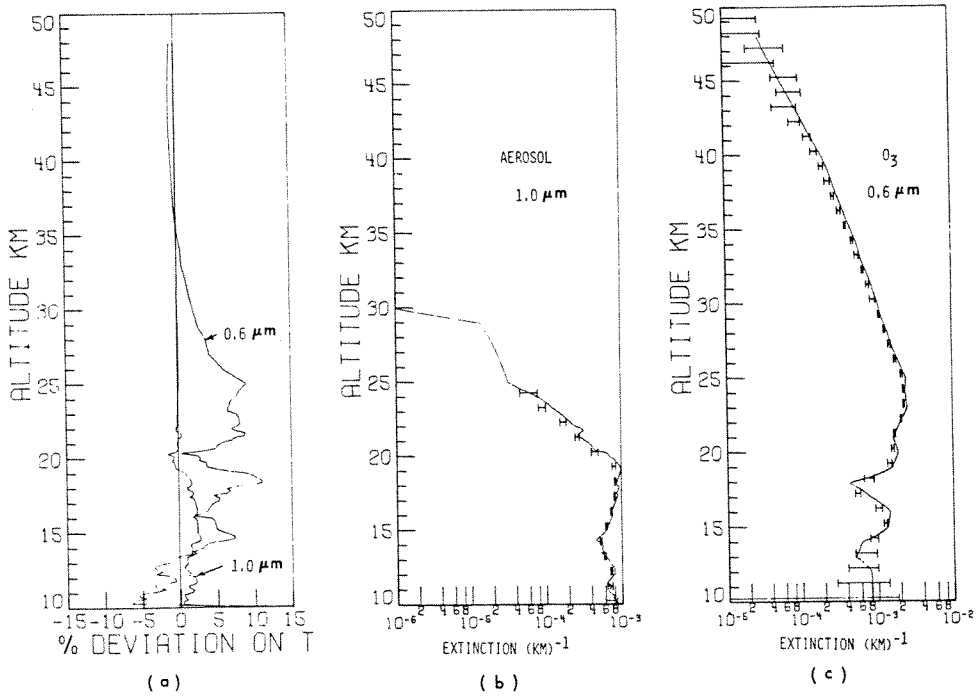

Fig. 11. Same as Fig. 10 with different aerosol and ozone vertical profiles.

butions of aerosol and ozone on the retrieval accuracies have also been analyzed. A simple one parameter model describing the horizontal variations of aerosol and ozone profiles was constructed based on global observational data. Inversion results obtained from the inhomogeneous atmospheric model indicate that the perturbation on the retrieval accuracies is small for a greater than typical amount of horizontal inhomogeneity exhibited in the atmosphere.

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Application Explorer Mission 2 (AEM 2) - Stratospheric Aerosol and Gas Experiment (SAGE)

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ABSTRACT:

The objective of the Stratospheric Aerosol and Gas Experiment (SAGE) is to determine the spatial distribution of stratospheric aerosols and ozone on a global scale. Specific objectives are -- (1) to develop a satellite-based remote sensing technique for stratospheric aerosols and ozone, (2) to map aerosol and ozone concentrations on a time scale shorter than major stratospheric changes, (3) to locate stratospheric aerosol and ozone sources and sinks, (4) to monitor circulation and transfer phenomena, (5) to observe hemispheric differences, and (6) to investigate the optical properties of aerosols and assess their effects on global climate. The SAGE instrument consists of a telescope and a spectrometer subassembly which separates and measures the attenuation of solar radiation at four wavelengths (.38, .45, .6, and 1.0 micrometers) during solar occultation. As the spacecraft emerges from the earth's shadow, the sensor scans the earth's atmosphere from the horizon up, and measures the attenuation of solar radiation in different atmospheric height layers. This procedure is repeated during spacecraft sunset. Two vertical scannings are obtained during each orbit, with each scan requiring approximately 1 min of time to cover the atmosphere above the troposphere. The instrument has a field of view of approximately 0.5 arc minutes which results in atmospheric height resolution of less than 1 km.

SUMMARY:

The AEM 2 spacecraft was launched February 18, 1979. Eight months of instrument data have been collected to date and are currently being merged with spacecraft ephemeris and meteorological data for routine data processing. Correlative observations have also been made at several sites and preliminary data analysis indicates excellent comparison with the coincident satellite observations. A complete error analysis of the satellite data is underway as part of the data validation required prior to archival.

During the period April 14-20, 1979, volcano La Soufrière erupted in the Caribbean area. A volcanic plume was observed to penetrate into the stratosphere by an aircraft laser radar while performing ground-truth measurements for SAGE sensor. Immediately after the volcanic eruption, the SAGE sensor was able to map the eruption region in latitude and longitude, and obtain information on the strength and spatial distribution of the injection. These data are currently being analyzed to determine the spreading of the volcanic plume and its influence on stratospheric aerosol loading.

The spacecraft, since June 11, 1979, has experienced a general degradation in the battery resulting in low power capacity. The instrument module continues to work extremely well when adequate power is available for operation but approximately 50% data loss has been experienced.

JOURNAL PUBLICATIONS:

1. Chu, W. P. and M. P. McCormick, 1979: Inversion of Stratospheric Aerosol and Gaseous Constituents From Spacecraft Solar Extinction Data in the 0.38-1.0 μm Wavelength Region. Appl. Opt., 18, 1404-1413.

2. McCormick, M. P., P. Hamill, T. J. Pepin, W. P. Chu, T. J. Swissler, and L. R. McMaster, 1979: Satellite Studies of the Stratospheric Aerosol. Bull. Am. Met. Soc., 60.

3. Russell, P. B., Editor 1979: SAGE Ground Truth Plan - Correlative Measurements for the Stratospheric Aerosol and Gas Experiment (SAGE) on the AEM-B Satellite. NASA TM 80076.

4. West, S., 1979: The Best Read Volcano. Science News, 115, 314-318.

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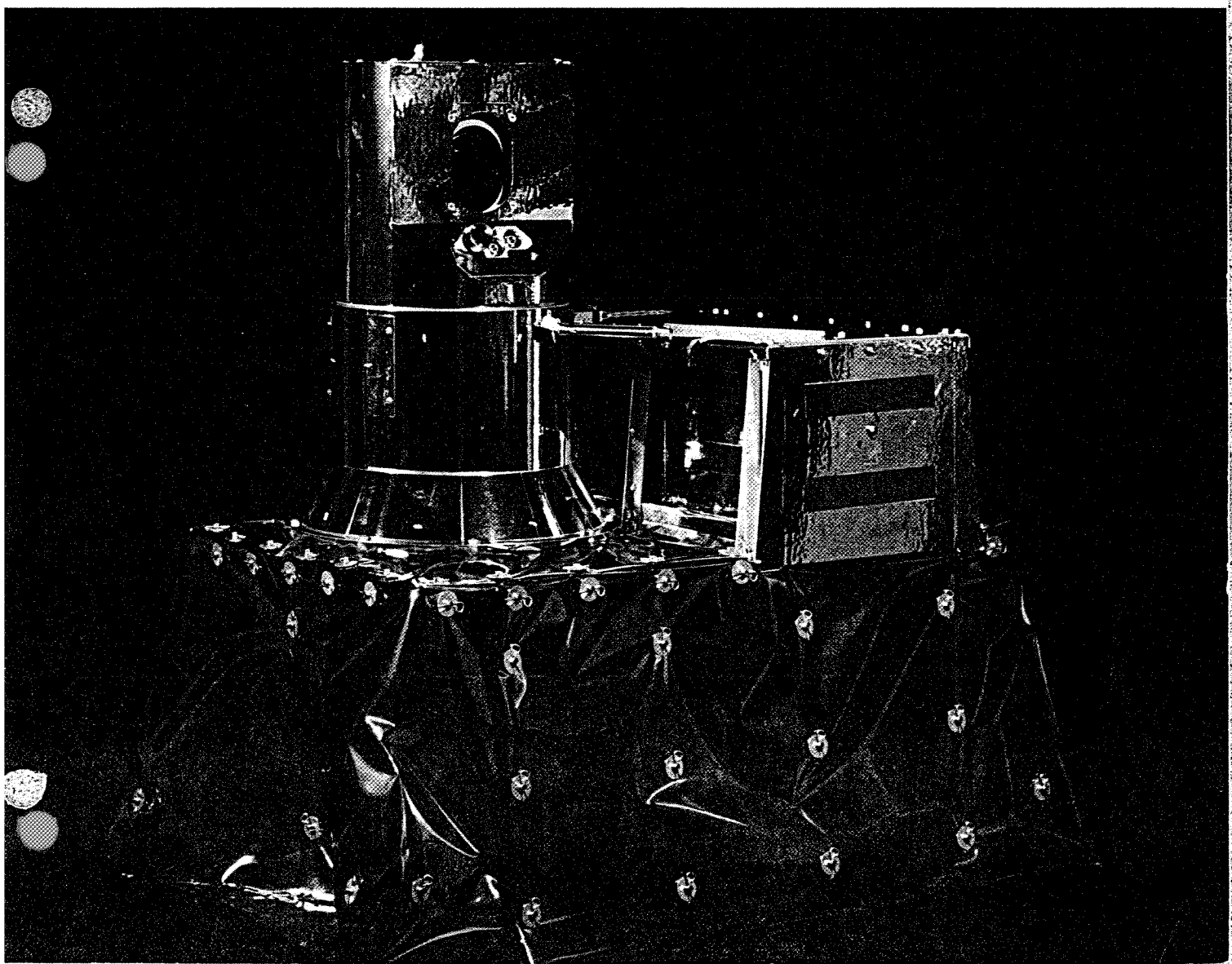

Cover Photograph: Picture of the flight model of the Stratospheric Aerosol and Gas Experiment (SAGE) presently flying on the Applications Explorer Mission II spacecraft. SAGE, built by the Ball Aerospace Systems Division for the NASA Langley Research Center and launched in February 1979, is a four spectral-channel sensor measuring profiles of stratospheric aerosols and ozone. For more details, see the article by McCormick *et al.*, which begins on page 1038.

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Satellite Studies of the Stratospheric Aerosol

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Abstract

The potential climatological and environmental importance of the stratospheric aerosol layer has prompted great interest in measuring the properties of this aerosol. In this paper we report on two recently deployed NASA satellite systems (SAM II and SAGE) that are monitoring the stratospheric aerosol. The satellite orbits are such that nearly global coverage is obtained. The instruments mounted in the spacecraft are sun photometers that measure solar intensity at specific wavelengths as it is moderated by atmospheric particulates and gases during each sunrise and sunset encountered by the satellites. The data obtained are "inverted" to yield vertical aerosol and gaseous (primarily ozone) extinction profiles with 1 km vertical resolution. Thus, latitudinal, longitudinal, and temporal variations in the aerosol layer can be evaluated. The satellite systems are being validated by a series of ground truth experiments using airborne and ground lidar, balloon-borne dustsondes, aircraft-mounted impactors, and other correlative sensors. We describe the SAM II and SAGE satellite systems, instrument characteristics, and mode of operation; outline the methodology of the experiments; and describe the ground truth experiments. We present preliminary results from these measurements.

1. Introduction

Nearly 20 years ago Junge *et al.* (1961) carried out a series of measurements on the aerosol content of air in the upper troposphere and lower stratosphere using balloon-borne particle counters. They found that the total number of particles per milligram of air decreases with altitude, but that just above the tropopause there is a substantial increase in the concentration of large particles in a region several kilometers thick. This layer of large particles is called the stratospheric aerosol or, sometimes, the Junge layer. It might be noted, however, that the existence of a stratospheric particulate veil was postulated much earlier. In fact, for centuries scientists have been speculating that the brilliant sunsets commonly observed after volcanic eruptions are due to volcanic dust injected into the stratosphere. But the measurements by Junge and subsequent investigators provided the first quantitative information on the properties of the stratospheric particles. Thus, we now know that the "large" particles exist in a well-defined layer in the lower stratosphere from slightly above the tropopause to less than 30 km, that they are distributed in size primarily between 0.1 and 1.0 μm diameter in either a unimodal or polymodal size distribution, that they are probably primarily composed of an impure solution of sulfuric acid and water, that they are quite numerous shortly after violent volcanic eruptions, and that the number density slowly decays with an *e*-folding time of about 1 year (McCormick *et al.*, 1978). Excellent reviews of the characteristics of stratospheric aerosols exist in the literature (Junge *et al.*, 1961; Rosen, 1969; Cadle and Grams, 1975; and Toon and Pollack, 1976).

Besides causing colorful twilights, the stratospheric aerosol may both affect weather by being a source of high-altitude cloud condensation nuclei and exert an important influence on climate by modulating the flux of incoming solar radiation and outgoing long wavelength earth radiation (Hansen *et al.*, 1978). For example, it is believed that the eruption of the volcano Tambora in the Dutch East Indies in 1815 (Stommel and Stommel, 1979; Toon and Pollack, 1977) had a significant impact on global weather patterns. In Europe, 1816 was called a "year without a summer" and record low summer temperatures were recorded in New England and elsewhere. The resultant crop damage led to high prices for food and even famines in parts of Britain, France, and Germany.

If we are to expand our knowledge of the stratospheric aerosol, the question arises regarding the best way to measure its properties. In his early work, Junge used impactors and supersaturation chambers carried aloft by balloons, which allowed him to measure total particle number densities. In this country, a group at the University of Wyoming (J. Rosen, D. Hofmann, and T. Pepin) are making stratospheric measurements with balloon-borne optical counters (dustsondes) that allow for differentiation between particles of radius >0.25 μm and particles of radius >0.15 μm. Rosen and coworkers have probably made in situ profile measurements of the stratospheric aerosol at more different geographic locations than any other group. The data they have compiled and published are the most comprehensive description of the latitudinal and vertical distribution of the aerosol layer to date. Rosen's work also includes a measurement of the boiling point of the stratospheric particles, showing it to be consistent with that of a 75% sulfuric acid and 25% water solution (Rosen, 1971).

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Another technique for studying the aerosol layer is by analyzing backscattered laser light. Some of the earliest work with this technique was carried out by G. W. Grams, now at Georgia Institute of Technology, and G. Fiocco, now at the University of Rome (Fiocco and Grams, 1966). Presently, a number of investigators are studying the stratospheric aerosol with lidar systems. Among these investigators are P. B. Russell at SRI International, M. P. McCormick's group at the NASA Langley Research Center (LaRC), and non-U.S. groups such as those of M. Hirono in Japan, J. Blamont in France, R. Reiter in Germany, B. R. Clemesha in Brazil, and V. Zuyev in the Soviet Union.

Other methods presently used for measuring the properties of the stratospheric aerosol include the wire impactors flown on a U-2 aircraft by N. Farlow at the NASA Ames Research Center, a quartz crystal microbalance impactor flown by D. C. Woods of NASA LaRC, a polar nephelometer flown by G. W. Grams, and a filter impactor flown by A. Lazrus of the National Center for Atmospheric Research.

All of these techniques (except for the airborne systems) give only a localized picture of the stratospheric aerosol. By patching together the results of a large number of measurements distributed in time and space, one can draw a sketchy picture of the geographic and temporal characteristics of the aerosol layer. However, it is not yet known whether or not the aerosol layer exhibits any systematic longitudinal variations, nor is it known whether or not there is a residual nonvolcanic component to the layer that is maintained by gas and particulate diffusion from the troposphere followed by particle growth in the stratosphere. The size distribution and composition of the particles are still uncertain and the radiative properties of the layer are poorly determined.

The last volcanic eruption to inject a significant amount of matter into the stratosphere was Volcán de Fuego (14.5°N), which exploded in mid-October 1974. Stratospheric particles attributable to this volcano were observed at mid-latitudes (37.1°N) on 26 November 1974 (McCormick *et al.*, 1978). The latitudinal spread of the volcanic veil would have been very interesting to observe since it is an excellent tracer for stratospheric latitudinal diffusion. This information is essential in the development of models to evaluate the spread of volcanic dust and in formulating models to determine the climatic impact of volcanoes. The effects of Fuego on climate have not been well evaluated, but Hansen *et al.* (1978), using a 1-dimensional radiative convective model, showed that Agung, which erupted on Bali in 1963, caused a significant average global tropospheric cooling of a few tenths of a degree. This calculated result agrees well with available data on global temperature fluctuations during the 1963-67 period (Newell and Weare, 1976).

Studies of the spread of a volcanic veil would also shed light on the question as to whether the post-volcanic layer consists of particles injected directly into the stratosphere or if secondary particle formation and growth is a significant process.

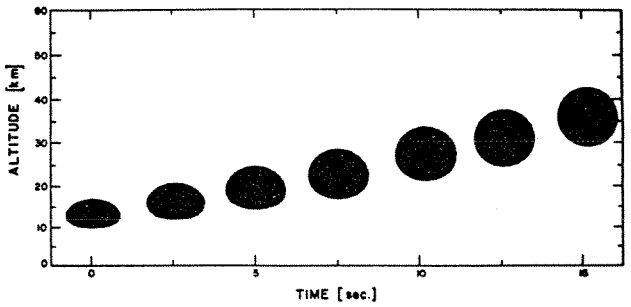

FIG. 1. Sunrise as observed during the Apollo-Soyuz Test Project (Rev. 95, 100°E, 43°S). Note the flattening of the solar disk near the horizon due to refraction.

A capability to monitor the aerosol layer in a continuous manner over a wide geographic area has not been available until very recently. In the remainder of this article we describe two new satellite systems that will yield a nearly continuous time coverage of the aerosol layer over most of the surface of the earth.

2. SAM II and SAGE

During the 1975 Apollo-Soyuz Test Project one of the experiments carried on Apollo was the Stratospheric Aerosol Measurement (SAM). The SAM instrument was a lensless single spectral channel sun photometer, which the astronauts pointed at the sun during two satellite sunrises and two satellite sunsets and with which they obtained measurements of the solar intensity in a band centered at 0.83 μm wavelength during these events (Pepin *et al.*, 1977). A series of photographs of the sun rising over the horizon, as observed from Apollo, is shown in Fig. 1, where one notes the interesting optical phenomenon of the apparent flattening of the solar disk due to atmospheric refraction. When the sun's rays reach the satellite they have traversed a portion of the atmosphere and, as described below, the attenuation of the sunlight due to scattering by aerosol particles gives information on the aerosol properties. To interpret these data, however, the effects of refraction must be understood and included in the inversion calculations.

Once the SAM experiment demonstrated the feasibility of the approach, the SAM II and the Stratospheric Aerosol and Gas Experiment (SAGE) programs were developed by NASA with the collaboration of Science Teams drawn from the scientific community.[3]

[3] Science Team for SAM II: M. P. McCormick (leader), NASA-LaRC; G. W. Grams, Georgia Institute of Technology; B. M. Herman, University of Arizona; T. J. Pepin, University of Wyoming; and P. B. Russell, SRI International. Science Team for SAGE: all of the above and, in addition, D. M. Cunnold, Massachusetts Institute of Technology; D. E. Miller, British Meteorological Office; D. G. Murcray, University of Denver; W. G. Planet, National Environmental Satellite Service; and R. A. Craig (deceased), Florida State University.

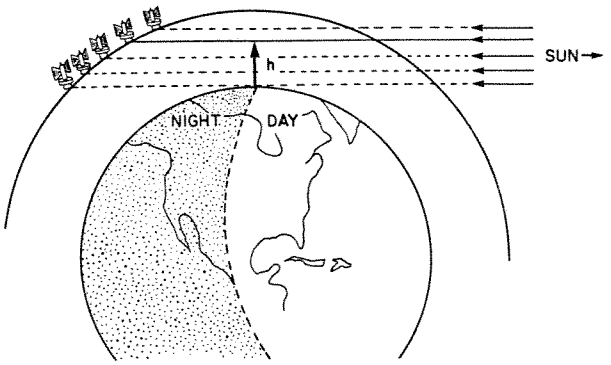

FIG. 2. A sunset as viewed by the Nimbus-7 satellite. The instrument starts to scan the solar disk at a tangent height (h) of about 350 km, and follows it down until the sun disappears. Note that different layers of the atmosphere are successively sampled during the event.

The instruments are, essentially, satellite-mounted sun photometers designed to measure solar intensity profiles during each sunrise and sunset event encountered by the unmanned satellite as it orbits the earth. Since the satellite orbital period is roughly 1½ h, there are approximately 30 sampling opportunities per day (15 sunrises and 15 sunsets) for each instrument. These events occur at different latitudes and longitudes, depending on orbital parameters. Tailoring the satellite orbit for optimal coverage can give a nearly global picture of the stratospheric aerosol. This will be illustrated later for SAM II and SAGE. Longitudinal and latitudinal variations as well as seasonal and short period temporal variations in the layer can then be determined.

Additionally, the data can be utilized to study aerosol sources and sinks in the stratosphere, aerosol transport, aerosol radiative and climatological implications, the effects of sudden warmings, the injection of particulate matter into the stratosphere through the intertropical convergence zone (ITCZ), and, possibly, the development and dispersion of volcanic veils. Furthermore, the experiments will be useful in studies of mesospheric aerosols, noctilucent and nacreous clouds, and thin cirrus clouds near the tropopause. There will also be occasions under cloudless conditions when information on tropospheric aerosols will be obtained.

Figure 2 illustrates the geometrical constraints on the system, showing how the satellite measures solar intensity at different altitudes during a single sunset event. Note that the path of a ray of light from the sun to the satellite successively passes through different air masses, depending on the orbital position of the satellite. The effects of refraction illustrated in Fig. 1 are not shown in Fig. 2. The "tangent height" h is the vertical distance from the surface at the ray tangent. During a typical event, measurements are taken from a tangent height of 350 km, where there is no atmospheric attenuation, to the surface or until the sun is obscured by clouds. The technique, therefore, is partially self-calibrating since the instrument measures unattenuated sunlight before each sunset and after each sunrise.

SAM II was launched 24 October 1978 on the Nimbus 7 satellite. The payload incorporates several other experiments, including sensors to determine the earth radiation budget; concentrations of various atmospheric trace gases including ozone, H_2O, CH_4, CO, NO_x, and HNO_3; pictures of cloud coverage; and other measurements.

The Stratospheric Aerosol and Gas Experiment (SAGE) was launched 18 February 1979 on a dedicated Applications Explorer Mission (AEM-B) satellite. It is providing measurements of scattering due to aerosols and molecules, as well as absorption due to ozone and nitrogen dioxide. This paper addresses only the aerosol measurements.

An important component of these satellite measuring programs is the associated validation or "ground truth" experiments (Russell *et al.*, 1978; Russell, 1978). These experiments, which are considered in more detail in Section 4, are a concerted study of the stratospheric aerosol utilizing nearly all the techniques presently available. A variety of individual experiments sample the aerosol in the same air mass that is being simultaneously monitored by the satellite. It is felt that these collaborative efforts alone will lead to significant new insights into the properties and nature of the aerosol layer.

3. Satellite and instrument characteristics

As mentioned above, the SAM II instrument is mounted on the Nimbus 7 satellite (Fig. 3). This satellite is in a

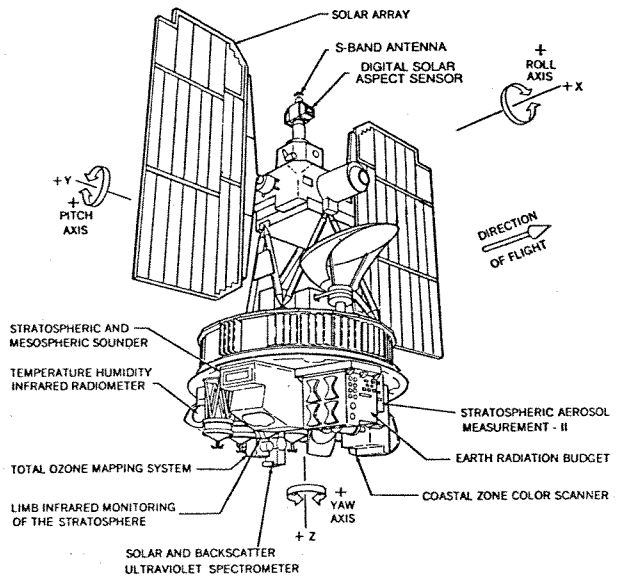

FIG. 3. Nimbus-7 Observatory. The SAM II instrument is mounted on the base of the satellite along with several other atmospheric measurement systems.

TABLE 1. SAM II geographic coverage (Northern Hemisphere, April–June 1979).

Latitude (°N.)	Longitude (°E.)								
	0–40	40–80	80–120	120–160	160–200	200–240	240–280	280–320	320–360
79–77	15*	13	14	14	14	13	14	14	13
77–75	12	15	13	15	13	15	12	14	15
75–73	13	11	13	12	13	11	14	12	12
73–71	10	12	10	11	10	11	10	12	11
71–69	13	11	14	11	13	12	13	12	12
69–67	10	12	9	12	10	11	11	11	11
67–65	15	15	16	15	15	16	15	15	16
65–63	51	52	50	51	50	51	50	52	51

* Number of sunsets or aerosol profiles retrieved between these latitude and longitude bands during the April–June time period.

nearly circular, retrograde orbit with inclination of 99° and orbital altitude of 955 km. The orbit is high-noon sun-synchronous, that is, each equatorial crossing occurs either at 12:00 noon or midnight, local time. The orbital period is 104 min. The satellite encounters sunsets in the polar regions (64°–80°N) of the northern hemisphere and sunrises in the polar regions (64°–80°S) of the Southern Hemisphere. Table 1 illustrates the geographical coverage obtained by SAM II during a typical three-month period.

The SAGE instrument is mounted on a dedicated AEM-B satellite (Fig. 4) with orbit inclined at 55°, an apogee of 660 km, a perigee of 548 km, and period of 96.8 min. This highly precessing orbit provides aerosol profiles distributed around the earth between 79°N and 79°S (depending on the season). Figure 5 gives an idea of the breadth of geographic coverage of the data obtained from SAGE. Indicated in Fig. 5 are the tangent points of the sunrise and sunset events encountered by SAGE during a single month.

The SAM II instrument, a one-spectral channel sun photometer, is illustrated in Fig. 6. The passband, centered at a wavelength of 1 μm, is in a region of the spectrum where absorption by atmospheric gases is negligible. Consequently any attenuation of sunlight is due to scattering by aerosol particles and by molecules (Rayleigh scattering).

In operation, the instrument is activated just before a sunrise or sunset. When the wide field-of-view sun presence sensor indicates a sun intensity of at least 5% relative to the unattenuated sun, the instrument searches for the sun in azimuth. When the sun is nulled to within ± 1 arc minute the scan mirror (Fig. 6, right) "fast" scans (3° s^{-1}) in elevation until the sun is acquired. The mirror then "slow" scans vertically across the face of the sun at a rate of 0.25° s^{-1}, reversing itself each time a sun limb crossing occurs. Light from the sun is reflected by the scan mirror to the entrance of a small Cassegrainian telescope. The entrance window of the telescope passes light of wavelength greater than 0.9 μm. A circular aperture placed at the image plane of the telescope serves to define the instrument's instantaneous field of view to be 0.01°, providing an atmospheric vertical resolution on the horizon of approximately $\frac{1}{2}$ km altitude. The output

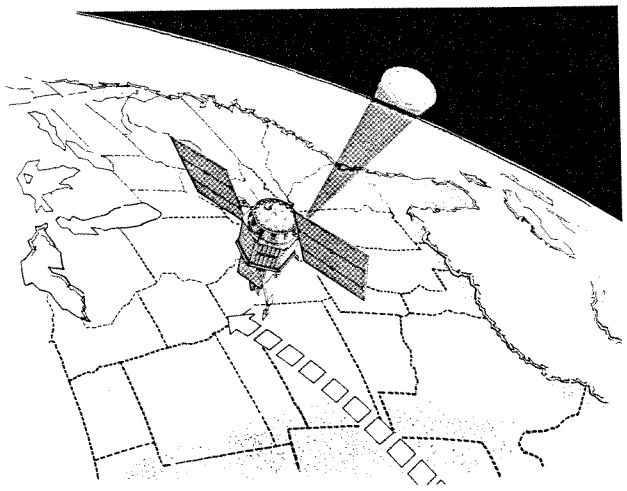

FIG. 4. The Stratospheric Aerosol and Gas Experiment (SAGE) is mounted on a dedicated Applications Explorer Mission Satellite. The orbit of the satellite allows for viewing sunrise and sunset events in the range of latitudes from 79°N to 79°S.

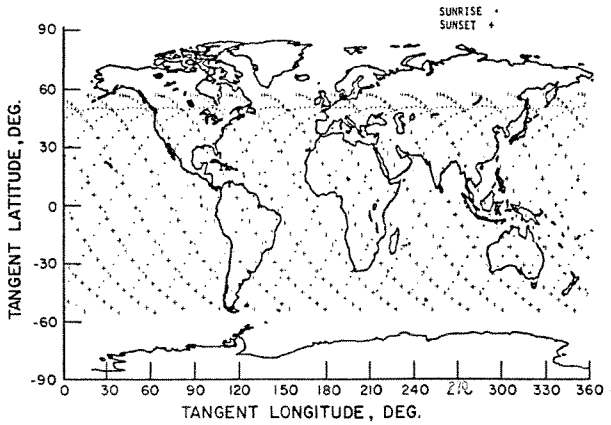

FIG. 5. SAGE sunrise and sunset tangent locations for February 1979. Successive events are shifted slightly in longitude and latitude. The + symbols represent sunsets and the · symbols represent sunrises.

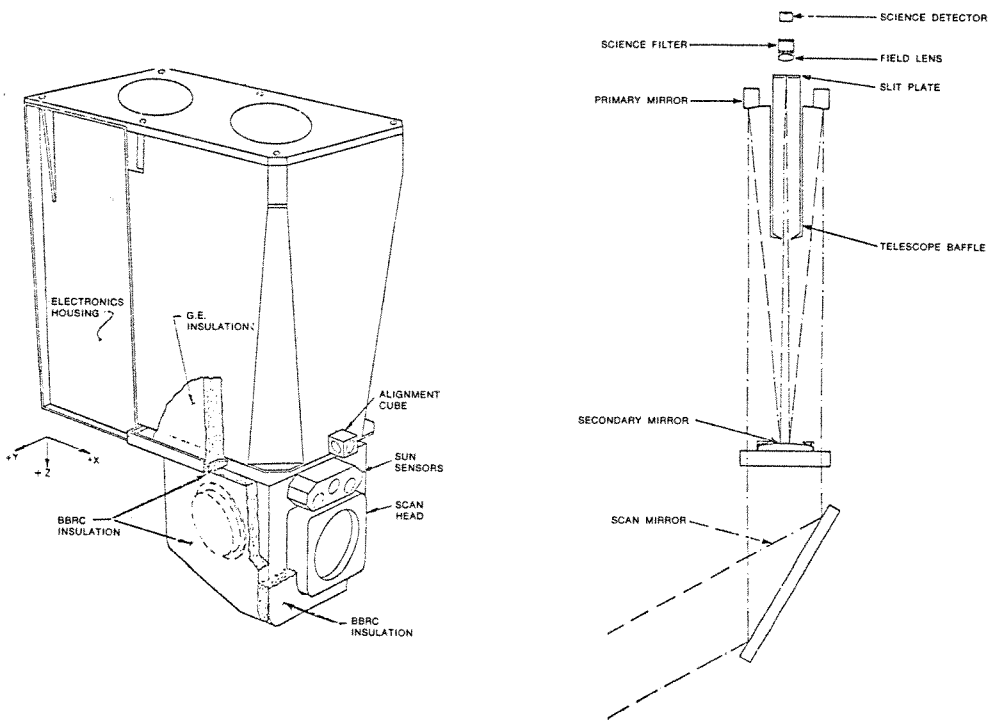

FIG. 6. The SAM II instrument mounted on the interface structure (left). The SAM II optical system (right).

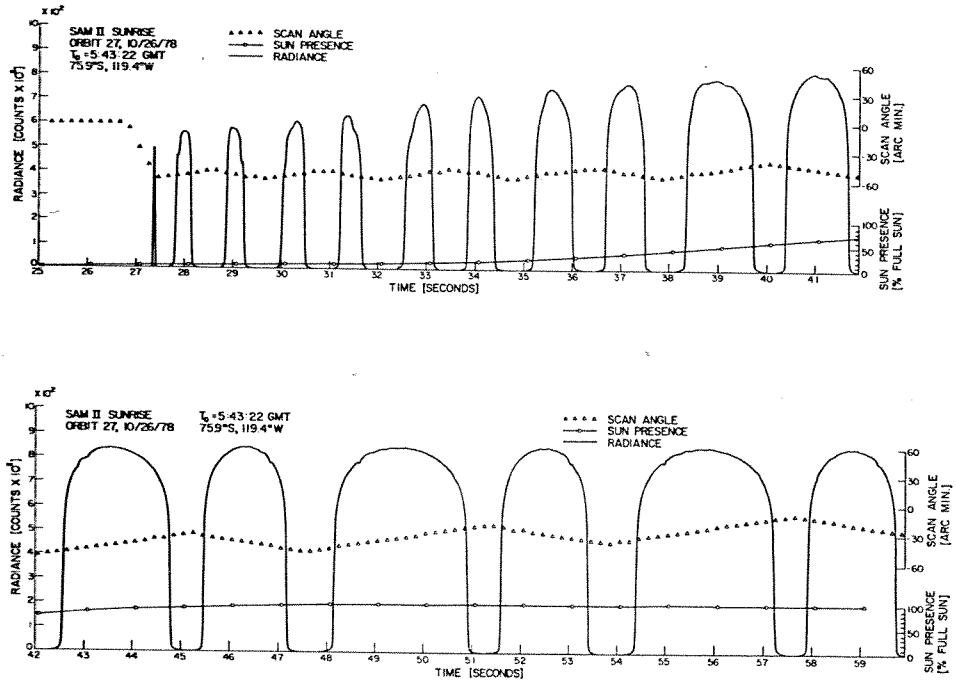

FIG. 7. A SAM II solar sunrise scan taken on 26 October 1978 during the 27th orbit of Nimbus 7. The latitude is 75.9°S. The ordinate (in counts) is directly proportional to the light intensity received by the pin photodiode, and the abscissa (in seconds from beginning of the scan) can be interpreted to give the tangent height, h. For description of features see text.

of the telescope is directed through a broadband interference filter that rejects all but the 1 μm wavelength ($\pm$0.02 μm) passband to a photodiode detector. The output of the photodiode is digitized at a rate of 50 samples per second, recorded, and telemetered back to earth where the intensity of received light for each scan across the sun can be reconstructed.

An example of the radiance data is presented in Fig. 7, which shows plots of raw data obtained during a sunrise observed on the 27th SAM II orbit. The scans are alternately upscans and downscans after solar acquisition. Thus, the scan centered at $t = 28$ s is an upscan. The bottom of the sun is encountered at about $t = 27.8$ s corresponding to a tangent height above the earth's surface of about $h = 5$ km. The dip in the radiance near the lower edge of the sun is due to a tropospheric cloud layer. This cloud shows up again on the next scan (at $t = 29.2$). The features near the top of the scans between 30 and 33 s are attributable to the stratospheric aerosol layer. At times $t = 39$, 41, and 43 the dips in the radiance curve may be due to nacreous clouds in the antarctic (the altitude of these features is about 25 km). Finally, it is interesting to note the narrow dip at $t = 46.8$ s, which shows up again at 48.7 s, 53 s, and 55 s. This repeating feature independent of the earth's atmosphere is a sunspot.

Also given on the same plot are the angle of the scan mirror and the integrated signal from the sun presence sensor. It should be kept in mind that Fig. 7 is a plot of total solar intensity received by the instrument as it scans the sun.

Once the intensity (I) has been determined as a function of tangent height (h), the transmission (T) can be obtained from $T = I/I_0$ where I_0 is the unattenuated intensity (obtained from scans taken at $h \gtrsim 350$ km). Then, via inversion techniques described in Chu and McCormick (1979), the transmission profiles are "inverted" to obtain the extinction (attenuation per unit distance) as a function of altitude. Since the contribution due to molecular scattering can, in principle, be calculated, it is possible to determine the extinction caused by aerosol particles. Then, using model results or best estimates for particle size distribution and index of refraction, one can evaluate the aerosol number density as a function of altitude.

The errors associated with calculating the molecular density depend on the temperature and pressure errors in the rawinsonde measurement or the difference between the actual values of these parameters and any model atmosphere that is used. The errors in retrieving the aerosol profile also depend on aerosol loading, i.e., the relative aerosol-to-molecular extinction at a given altitude and instrument uncertainties. Below approximately 25 km the total error in the retrieved aerosol extinction coefficient is typically $\leq$10% in regions where aerosol extinction exceeds molecular extinction by 50%. This means that even under background or nonvolcanic conditions the extinction due to the stratospheric particles can be measured to within 10% accuracy.

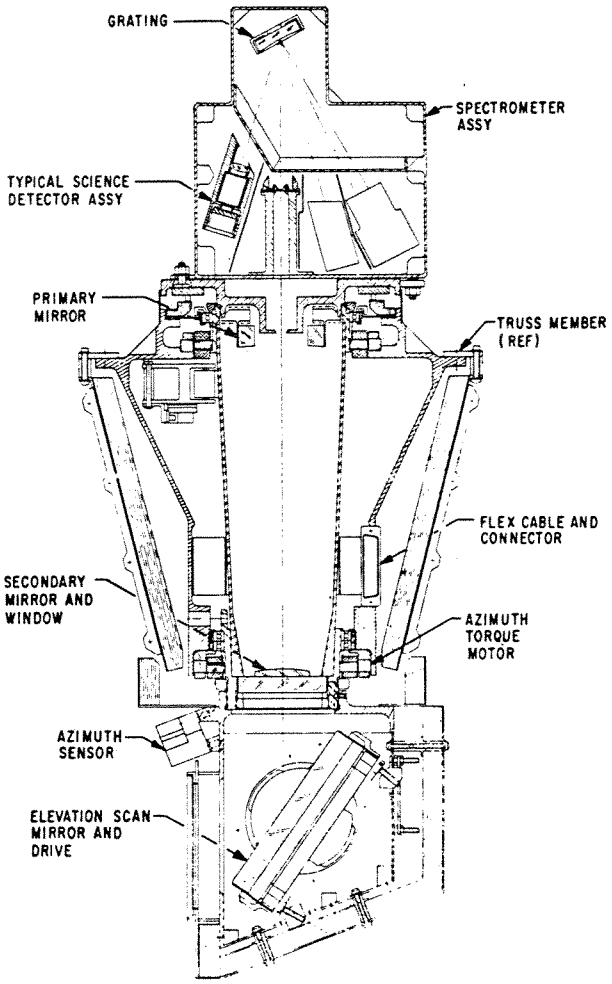

FIG. 8. The SAGE sensor assembly.

SAGE measurements during sunrise and sunset events are very similar to those of SAM II. But, as mentioned above, the SAGE orbit is tailored to complement the SAM II geographical coverage. The SAGE instrument is also somewhat more complex, being a four-channel sun photometer as illustrated in Fig. 8. For SAGE, spectral discrimination is achieved by using a holographic diffraction grating that disperses the different wavelengths in different directions. By placing four sensors at appropriate positions with respect to the grating, it is possible to measure light centered at wavelengths 0.385, 0.45, 0.60, and 1.0 μm. Intensity measurements from these channels can be inverted to obtain profiles of aerosol extinction as well as extinction profiles that can be interpreted to give concentrations of ozone, nitrogen dioxide, and total molecular density. The ozone measurements by SAGE will give accurate, highly spatially resolved ozone profiles from the tropopause to 45 km. Thus, the measurements include the altitude region (35–45 km) where large ozone concentration changes due to the effects of anthropogenic chlorofluoromethane emissions are postulated to take place (Stief *et al.*, 1978). In

addition, the simultaneous measurements of aerosols and ozone will help to determine if aerosol radiative effects influence ozone photochemistry or if there are any other coupled effects, e.g., heterogeneous surface chemistry.

4. The ground truth experiments

The ground truth or validation experiments are an integral part of the SAM II and SAGE projects (Russell *et al.*, 1978; Russell, 1978). These consist of a coordinated set of experiments in which aerosol content and other properties of a given air mass are measured with a variety of different instruments. The results are designed not only to corroborate results of the satellite measurements, but are also intended to independently produce a large body of scientifically significant information. The ground truth experiment sites for SAM II and SAGE are: Sondrestrom, Greenland (November 1978); White Sands, N.Mex. (March 1979); Natal, Brazil (April 1979); Poker Flat, Alaska (July 1979); and Wallops Island (April, June, and October 1979). A practice comparative experiment was carried out at Laramie, Wyo. (September 1978). Other associated experiments will be carried out in Japan, England, Germany, Belgium, France, Australia, and the Soviet Union by participating ground truth experiment teams.

The ground truth experiments are not all the same, and the scientific components will vary. Nevertheless, a good idea of the general type of activities carried out is obtained by considering the Sondrestrom ground truth experiment performed 20–25 November 1978.

Participating in the experiment were personnel from NASA LaRC, NASA Wallops Flight Center, SRI International, Georgia Institute of Technology, NCAR, the University of Wyoming, and NOAA National Weather Service.

The orbit of Nimbus 7 was such that during this period the SAM II instrument made four measurements of the air mass over Greenland. As the satellite passed overhead, the NASA P-3 airborne lidar system studied the aerosol content of the same air mass from below, over the height range from 8–30 km. This required flying the aircraft along the flight paths shown in Fig. 9. At the same time, the NCAR Sabreliner was flying in the stratosphere (tropopause to 15 km), sampling the aerosol with a quartz crystal microbalance impactor and a polar nephelometer. Finally, dustsondes were launched by the University of Wyoming group, measuring concentrations of aerosols in two different size groups over the height range from ground level to 28 km.

All of the experiments were performed without significant problems. The P-3 and Sabreliner flew missions daily from 22–25 November. Dustsondes were launched on 22 and 23 November. In addition, several weather balloons (radiosondes) were launched each day.

Interestingly, during the Natal, Brazil ground truth experiment, there was a large eruption of Soufrière on St. Vincent. The P-3 aircraft studied the volcanic plume with airborne lidar and the quartz crystal microbalance, and SAGE made a number of measurements of the air mass in the general vicinity of the volcano. A more complete description is presented in a recent article in *Science News* (West, 1979).

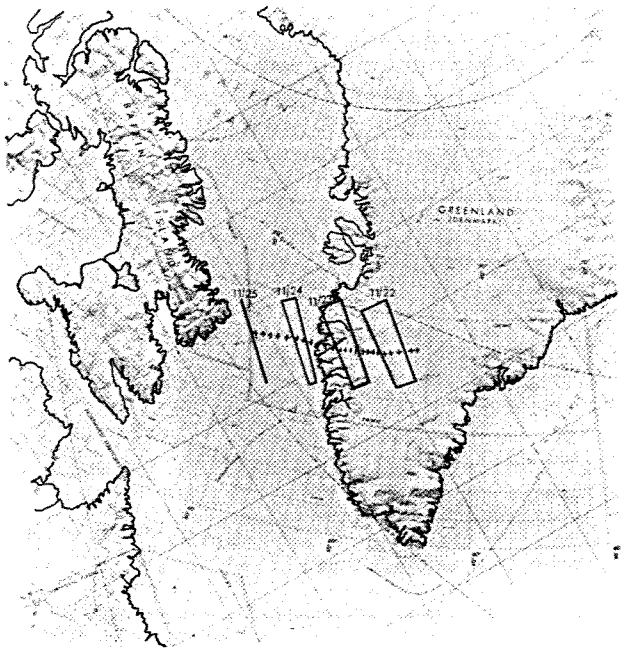

FIG. 9. Flight paths of the P-3 aircraft on 22–25 November 1978 during the SAM II Ground Truth Experiment at Sondrestrom. The dashed lines are projections to the ground of the portion of the atmosphere sampled by the SAM II system during four sunset events. The satellite encountered these events at the same time the airborne lidar on the P-3 was observing the aerosol layer from below. The crosses represent a projection of the SAM II profiles on the surface of the Earth.

5. Data

The SAM II and SAGE missions and the associated ground truth experiments will generate a large amount of data that will be processed and made available to the scientific community. The data processing involves merging the data from the satellite sensor with meteorological data to carry out inversions and develop a set of products that include derived aerosol extinction profiles, modeled aerosol number densities, atmospheric molecular extinction coefficients, and total extinction ratios as a function of altitude for each sunrise and sunset event. Additionally, SAGE data will include ozone, nitrogen dioxide, and total molecular concentrations. All of this information will be archived on magnetic tapes and on microfilm.

Display products from the data analysis consist of profiles, cross sections, maps, and time histories. As an example, the SAM II display products are listed in Table 2. SAGE data products will be similar but with the addition of O_3 and NO_2.

Table 2. SAM II display products.

Title of display products	Frequency	No./Year
Profiles		
Solar irradiance vs time (sunrise/sunset)	Daily	730
Solar irradiance vs altitude		
0–40 km (sunrise/sunset)	Daily	730
40–160 km (sunrise/sunset)	Daily	730
Aerosol coef. of extinction vs altitude		
(0–40 km (sunrise/sunset)	Daily	730
(40–160 km (sunrise/sunset)	Daily	730
Total extinction ratio		
0–40 km (sunrise/sunset)	Daily	730
40–160 km (sunrise/sunset)	Daily	730
6 day avg.—aerosol coef. of ext. vs altitude	1/6 Days	61
Contours		
Long. cross sections of aerosol coef. of ext. vs altitude	1/6 Days	61
Aerosol no. density vs altitude	1/6 Days	61
Total ext. ratio vs altitude	1/6 Days	61
Lat. cross sections aerosol coef. of ext. vs altitude	36/Quarterly	144
Aerosol no. density vs altitude	36/Quarterly	144
Total ext. ratio vs altitude	36/Quarterly	144
Maps		
Aerosol coef. of ext.	14/Quarterly	56
Aerosol no. density	14/Quarterly	56
Total ext. ratio	14/Quarterly	56
Integrated no. density	3/Quarterly	12
Optical depth	3/Quarterly	12
Time histories		
Optical depth from given altitude	15/Quarterly	60
Alt. and peak ext. ratio	2/Quarterly	8

The raw data tapes as well as the products of the data processing, including the ground truth and supporting measurement data, will be archived at the National Space Sciences Data Center at NASA Goddard Space Flight Center, Greenbelt, Md. Additionally, the ozone data products from SAGE will be archived at the World Ozone Data Center, Toronto, Canada. Archiving of the raw radiance has begun. The processed products will be archived beginning in the fall of 1979. Requests for data should be made to the archival center.

6. Preliminary results and conclusions

Preliminary results from SAM II and SAGE indicate that the instruments are performing optimally. Radiance data show stratospheric aerosol concentrations at high latitudes consistent with background levels predicted by models and in agreement with recent lidar observations of the layer (McCormick *et al.*, 1978). Interestingly, a number of measurements actually give aerosol data well down into the lower troposphere, indicating that some information on tropospheric aerosol content will be obtained. It is also interesting to note that results from the first few SAM II orbits show that the arctic (fall hemisphere) aerosol extends to higher altitudes than does the aerosol layer over the antarctic (spring hemisphere). The data also indicate that the peak aerosol layer over the antarctic gives a greater extinction than the arctic aerosol. This result may be related to a seasonal variation of the aerosol or may indicate a hemispheric difference in the concentration or size distribution of the aerosol particles. It is important to caution the reader that these results are preliminary and based on quick analyses of a small amount of data; we mention them here only to illustrate the kind of information that will be obtained from the satellite projects.

In conclusion, these two satellite systems are expected to give, for the first time, a near-continuous global monitoring of the particulate matter in the upper atmosphere. This information is of fundamental importance in formulating and corroborating radiative models and in evaluating the effects of anthropogenically-produced perturbations of the stratospheric aerosol. Furthermore, as stated earlier, the results obtained should shed light on the questions of aerosol formation and sources and sinks of aerosol particles in the stratosphere, as well as on the properties and characteristics of noctilucent and nacreous clouds.

Future plans for monitoring stratospheric aerosols and gases include the development of SAGE II, which will be flown on a shuttle-launched spacecraft, and of a downward-looking active-probing instrument (shuttle lidar) to map both stratospheric and tropospheric aerosol profiles.

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FIRST EVENT (FILE) HAS NO MET DATA - ZERO FILLED

YEAR	MON	DD	HR:MM:SS.SSS	DAY OF YEAR	DT ZERO MET	DT MET	EPH DT	LAST TYPE EV	EVENT-FILE	EVNT LENGTH	CUM. REC. TOTAL
79		00	00:29:14.313	60.02030455	0	39	9999		1	56	56
79	MAR	01	01:29:36.314	60.06222586	-2	49	60	SUN SE	2	33	89
79	MAR	01	02:06: 2.314	60.08752678	0	36	36	SUN RI	3	56	145
79	MAR	01	03:06:24.317	60.12944811	-2	46	60	SUN SE	4	33	178
79	MAR	01	03:42:41.323	60.15464494	0	32	36	SUN RI	5	57	235
79	MAR	01	04:43:10.333	60.19664737	-2	43	60	SUN SE	6	36	271
79	MAR	01	05:19:29.338	60.22186734	0	29	36	SUN RI	7	58	329
79	MAR	01	06:20: 2.348	60.26391606	-2	40	60	SUN SE	8	34	363
79	MAR	01	06:56:18.326	60.28910100	0	26	36	SUN RI	9	58	421
79	MAR	01	07:56:50.326	60.33113803	-2	36	60	SUN SE	10	36	457
79	MAR	01	08:33:14.325	60.35641580	0	23	36	SUN RI	11	56	513
79	MAR	01	09:33:38.325	60.39836024	-2	33	60	SUN SE	12	35	548
79	MAR	01	10:09:54.324	60.42354542	0	19	36	SUN RI	13	57	605
79	MAR	01	11:10:26.324	60.46558245	-2	30	60	SUN SE	14	36	641
79	MAR	01	11:46:37.324	60.49070977	0	16	36	SUN RI	15	58	699
79	MAR	01	12:47:15.323	60.53281624	-2	27	60	SUN SE	16	33	732
79	MAR	01	13:23:30.323	60.55798985	0	13	36	SUN RI	17	57	789
79	MAR	01	14:24: 4.322	60.60005002	-2	24	60	SUN SE	18	36	825
79	MAR	01	15:00:14.322	60.62516576	0	10	36	SUN RI	19	58	883
79	MAR	01	16:00:50.321	60.66724909	-2	20	60	SUN SE	20	34	917
79	MAR	01	16:37: 2.321	60.69238797	0	7	36	SUN RI	21	57	974
79	MAR	01	17:37:41.320	60.73450602	-2	17	60	SUN SE	22	36	1010
79	MAR	01	18:13:50.320	60.75961019	0	53	36	SUN RI	23	57	1067
79	MAR	01	19:14:30.320	60.80173981	-2	14	60	SUN SE	24	33	1100
79	MAR	01	19:50:34.319	60.82678610	0	50	36	SUN RI	25	57	1157
79	MAR	01	20:51:18.319	60.86896203	-2	11	60	SUN SE	26	33	1190
79	MAR	01	21:27:22.318	60.89400831	0	47	36	SUN RI	27	57	1247
79	MAR	01	22:28: 6.318	60.93618424	-2	8	60	SUN SE	28	36	1283
79	MAR	01	23:04: 9.322	60.96121900	0	44	36	SUN RI	29	58	1341

YEAR	MON	DD	HR:MM:SS.SSS	DAY OF YEAR	DT MET	DT EPH	DTLAST	TYPE EV	EVENT-FILE	EVNT LENGTH	CUM. REC. TOTAL
79	MAR	02	00:04:55.329	61.00341816	-2	54	60	SUN SE	30	36	1377
79	MAR	02	00:40:54.337	61.02840668	0	40	35	SUN RI	31	58	1435
79	MAR	02	01:41:42.337	61.07062890	-2	51	60	SUN SE	32	34	1469
79	MAR	02	02:17:46.337	61.09567520	0	37	36	SUN RI	33	57	1526
79	MAR	02	03:18:33.338	61.13788586	-2	48	60	SUN SE	34	36	1562
79	MAR	02	03:54:30.338	61.16285113	0	34	35	SUN RI	35	71	1633
79	MAR	02	05:31:20.339	61.23009652	0	31	96	SUN RI	36	57	1690
79	MAR	02	06:32: 9.340	61.27233032	-2	42	60	SUN SE	37	37	1727
79	MAR	02	07:08:10.340	61.29734190	0	28	36	SUN RI	38	57	1784
79	MAR	02	08:09: 1.340	61.33959884	-2	39	60	SUN SE	39	33	1817
79	MAR	02	08:44:50.341	61.36447154	0	24	35	SUN RI	40	58	1875
79	MAR	02	09:45:46.341	61.40678635	-2	35	60	SUN SE	41	37	1912
79	MAR	02	10:21:38.342	61.43169377	0	21	35	SUN RI	42	58	1970
79	MAR	02	11:22:38.342	61.47405488	-2	32	61	SUN SE	43	37	2007
79	MAR	02	11:58:27.342	61.49892757	0	18	35	SUN RI	44	57	2064
79	MAR	02	12:59:26.343	61.54127712	-2	29	60	SUN SE	45	36	2100
79	MAR	02	13:35:10.343	61.56609193	0	15	35	SUN RI	46	58	2158
79	MAR	02	14:36:14.344	61.60849935	-2	26	61	SUN SE	47	37	2195
79	MAR	02	15:12: 6.344	61.63340676	0	12	35	SUN RI	48	56	2251
79	MAR	02	16:13: 2.345	61.67572159	-2	23	60	SUN SE	49	35	2286
79	MAR	02	16:48:46.345	61.70053640	0	8	35	SUN RI	50	57	2343
79	MAR	02	17:49:54.345	61.74299010	-2	19	61	SUN SE	51	36	2379
79	MAR	02	18:25:29.346	61.76770076	0	5	35	SUN RI	52	59	2438
79	MAR	02	19:26:41.346	61.81020076	-2	16	61	SUN SE	53	37	2475
79	MAR	02	20:02:20.346	61.83495771	0	52	35	SUN RI	54	58	2533
79	MAR	02	21:03:31.347	61.87744615	-2	13	61	SUN SE	55	36	2569
79	MAR	02	21:39: 7.347	61.90216837	0	49	35	SUN RI	56	58	2627
79	MAR	02	22:40:18.348	61.94465681	-2	10	61	SUN SE	57	37	2664
79	MAR	02	23:15:54.348	61.96937903	0	45	35	SUN RI	58	56	2720

YEAR	MON	DD	HR:MM:SS.SSS	DAY OF YEAR	DT MET	DT EPH	DTLAST	TYPE EV	EVENT-FILE	EVNT LENGTH	CUM. REC. TOTAL
79	MAR	03	00:17: 7.347	62.01189059	-2	7	61	SUN SE	59	36	2756
79	MAR	03	00:52:42.349	62.03660126	0	42	35	SUN RI	60	57	2813
79	MAR	03	01:53:58.353	62.07914760	-2	53	61	SUN SE	61	37	2850
79	MAR	03	02:29:30.356	62.10382356	0	39	35	SUN RI	62	56	2906
79	MAR	03	03:30:46.360	62.14636991	-2	50	61	SUN SE	63	35	2941
79	MAR	03	04:06:18.363	62.17104587	0	36	35	SUN RI	64	56	2997
79	MAR	03	05:07:38.355	62.21363837	-2	47	61	SUN SE	65	35	3032
79	MAR	03	05:43:11.355	62.23832587	0	33	35	SUN RI	66	55	3087
79	MAR	03	06:44:26.356	62.28086060	-2	44	61	SUN SE	67	37	3124
79	MAR	03	07:19:50.357	62.30544395	0	29	35	SUN RI	68	57	3181
79	MAR	03	08:21:14.358	62.34808285	-2	41	61	SUN SE	69	35	3216
79	MAR	03	08:56:34.359	62.37261990	0	26	35	SUN RI	70	58	3274
79	MAR	03	09:58: 4.360	62.41532824	-2	38	61	SUN SE	71	37	3311
79	MAR	03	10:33:26.361	62.43988844	0	23	35	SUN RI	72	57	3368
79	MAR	03	11:34:54.362	62.48257363	-2	34	61	SUN SE	73	38	3406
79	MAR	03	12:10:14.363	62.50711068	0	20	35	SUN RI	74	56	3462
79	MAR	03	13:11:41.364	62.54978431	-2	31	61	SUN SE	75	38	3500
79	MAR	03	13:47: 1.365	62.57432135	0	17	35	SUN RI	76	56	3556
79	MAR	03	14:48:31.366	62.61702970	-2	28	61	SUN SE	77	35	3591
79	MAR	03	15:23:50.367	62.64155517	0	13	35	SUN RI	78	56	3647
79	MAR	03	16:25:21.368	62.68427509	-2	25	61	SUN SE	79	35	3682
79	MAR	03	17:00:30.369	62.70868483	0	10	35	SUN RI	80	57	3739
79	MAR	03	18:02: 9.370	62.75149734	-2	22	61	SUN SE	81	38	3777
79	MAR	03	18:37:18.371	62.77590707	0	7	35	SUN RI	82	57	3834
79	MAR	03	19:39: 2.477	62.81877867	-2	19	61	SUN SE	83	37	3871
79	MAR	03	20:14: 6.477	62.84313052	0	54	35	SUN RI	84	57	3928
79	MAR	03	21:15:50.477	62.88600089	-2	15	61	SUN SE	85	35	3963
79	MAR	03	21:50:50.477	62.91030645	0	50	35	SUN RI	86	58	4021
79	MAR	03	22:52:38.395	62.95322216	-2	12	61	SUN SE	87	36	4057
79	MAR	03	23:27:46.412	62.97762051	0	47	35	SUN RI	88	56	4113

YEAR	MON	DD	HR:MM:SS.SSS	DAY OF YEAR	DT MET	DT EPH	DTLAST	TYPE EV	EVENT-FILE	EVNT LENGTH	CUM. REC. TOTAL
79	MAR	04	01:04:30.459	63.04479698	0	44	96	SUN RI	89	57	4170
79	MAR	04	02:06:18.375	63.08771267	-2	6	61	SUN SE	90	38	4208
79	MAR	04	02:41:18.376	63.11201824	0	41	35	SUN RI	91	56	4264
79	MAR	04	03:43:10.377	63.15498122	-2	53	61	SUN SE	92	35	4299
79	MAR	04	04:21: 5.377	63.18131223	3	41	37	SUN RI	93	12	4311
79	MAR	04	05:19:59.378	63.22221502	-2	49	58	SUN SE	94	38	4349
79	MAR	04	05:54:54.379	63.24646272	0	34	34	SUN RI	95	57	4406
79	MAR	04	06:56:46.380	63.28942569	-2	46	61	SUN SE	96	38	4444
79	MAR	04	07:31:38.381	63.31363867	0	31	34	SUN RI	97	57	4501
79	MAR	04	08:33:38.382	63.35669424	-2	43	62	SUN SE	98	35	4536
79	MAR	04	09:08:26.382	63.38086090	0	48	34	SUN RI	99	57	4593
79	MAR	04	10:10:27.383	63.42392804	-2	10	62	SUN SE	100	38	4631
79	MAR	04	10:45:10.384	63.44803685	0	45	34	SUN RI	101	58	4689
79	MAR	04	11:47:18.472	63.49118602	-2	7	62	SUN SE	102	39	4728
79	MAR	04	12:22: 2.472	63.51530639	0	42	34	SUN RI	103	57	4785
79	MAR	04	13:24: 6.472	63.55840824	-2	54	62	SUN SE	104	39	4824
79	MAR	04	13:58:50.472	63.58252861	0	38	34	SUN RI	105	56	4880
79	MAR	04	15:00:58.386	63.62567576	-2	50	62	SUN SE	106	35	4915
79	MAR	04	15:35:41.387	63.64978457	0	35	34	SUN RI	107	55	4970
79	MAR	04	16:37:46.389	63.69289802	-2	47	62	SUN SE	108	37	5007
79	MAR	04	17:12:26.390	63.71697211	0	32	34	SUN RI	109	55	5062
79	MAR	04	18:14:38.190	63.76016424	-2	44	62	SUN SE	110	39	5101
79	MAR	04	18:49: 2.221	63.78405348	0	29	34	SUN RI	111	58	5159
79	MAR	04	19:51:26.279	63.82738749	-2	41	62	SUN SE	112	39	5198
79	MAR	04	20:25:54.310	63.85132303	0	25	34	SUN RI	113	57	5255
79	MAR	04	21:28:18.367	63.89465703	-2	38	62	SUN SE	114	36	5291
79	MAR	04	22:02:44.399	63.91856943	0	22	34	SUN RI	115	57	5348
79	MAR	04	23:05: 7.456	63.96189185	-2	35	62	SUN SE	116	37	5385
79	MAR	04	23:39:30.395	63.98576846	0	19	34	SUN RI	117	57	5442

Phone # FTS 827-

YEAR	MON	DD	HR:MM:SS.SSS	DAY OF YEAR	DT MET	DT EPH	DTLAST TYPE EV	EVENT-FILE	EVNT LENGTH	CUM. REC. TOTAL
79	MAR	05	00:41:57.395	64.02913652	-2	31	9999 SUN SE	1	39	39
79	MAR	05	01:16:18.395	64.05299068	0	16	34 SUN RI	2	56	95
79	MAR	05	02:18:45.396	64.09635875	-2	28	62 SUN SE	3	37	132
79	MAR	05	02:53:10.396	64.12025921	0	13	34 SUN RI	4	55	187
79	MAR	05	03:55:37.397	64.16362728	-2	25	62 SUN SE	5	36	223
79	MAR	05	04:29:54.398	64.18743516	0	9	34 SUN RI	6	56	279
79	MAR	05	05:32:26.398	64.23086109	-2	22	62 SUN SE	7	38	317

MINUTES

EVENT START

TIME FROM MET. TEMPERATURE PROFILE TO EVENT START

TIME FROM 1ST EPHEMERIS DATA TO EVENT START

Time From Last event

OF 4 SECOND RECORDS/FILE

YEAR	MON	DD	HR:MM:SS.SSS	DAY OF YEAR	DT MET	DT EPH	DTLAST	TYPE EV	EVENT-FILE	EVNT LENGTH	CUM. REC. TOTAL
79	MAR	05	00:00: 0.000	0.	9999	9999	9999	SUN RI	8	55	372

THIS IS AN EVENT OF DOUBTFUL QUALITY. PROBABLY
DUE TO TELEMETRY LOSS (THE TIME GAP IS ABOUT EQUAL TO 2 ORBI

YEAR	MON	DD	HR:MM:SS.SSS	DAY OF YEAR	DT MET	DT EPH	DTLAST	TYPE EV	EVENT-FILE	EVNT LENGTH	CUM. REC. TOTAL
79	MAR	05	08:46:10.401	64.36539816	-2	16	9999	SUN SE	9	35	407
79	MAR	05	09:20:10.402	64.38900928	0	50	34	SUN RI	10	57	464
79	MAR	05	10:22:57.402	64.43260882	-2	12	62	SUN SE	11	36	500
79	MAR	05	10:57: 9.403	64.45635883	0	47	34	SUN RI	12	54	554
79	MAR	05	11:59:49.404	64.49987736	-2	9	62	SUN SE	13	40	594
79	MAR	05	12:33:54.404	64.52354634	0	43	34	SUN RI	14	55	649
79	MAR	05	13:36:37.405	64.56709959	-2	6	62	SUN SE	15	38	687
79	MAR	05	14:10:41.405	64.59075700	0	40	34	SUN RI	16	56	743
79	MAR	05	15:13:30.406	64.63437970	-2	53	62	SUN SE	17	36	779
79	MAR	05	15:47:30.407	64.65799082	0	37	34	SUN RI	18	55	834
79	MAR	05	16:50:22.408	64.70164824	-2	50	62	SUN SE	19	39	873
79	MAR	05	17:24:14.408	64.72516676	0	34	33	SUN RI	20	55	928
79	MAR	05	18:27:10.409	64.76887047	-2	47	62	SUN SE	21	41	969
79	MAR	05	19:00:58.409	64.79234270	0	30	33	SUN RI	22	56	1025
79	MAR	05	20:04: 2.410	64.83613900	-2	44	63	SUN SE	23	37	1062
79	MAR	05	20:37:50.411	64.85961124	0	27	33	SUN RI	24	55	1117
79	MAR	05	21:40:54.411	64.90340753	-2	40	63	SUN SE	25	36	1153
79	MAR	05	22:14:34.412	64.92678718	0	24	33	SUN RI	26	56	1209
79	MAR	05	23:17:42.413	64.97062978	-2	37	63	SUN SE	27	37	1246
79	MAR	05	23:51:26.413	64.99405571	0	21	33	SUN RI	28	56	1302

YEAR	MON	DD	HR:MM:SS.SSS	DAY OF YEAR	DT MET	DT EPH	DTLAST	TYPE EV	EVENT-FILE	EVNT LENGTH	CUM. REC. TOTAL
79	MAR	06	00:54:34.415	65.03789832	-2	34	63	SUN SE	29	41	1343
79	MAR	06	01:28:14.415	65.06127795	0	18	33	SUN RI	30	53	1396
79	MAR	06	02:31:26.416	65.10516685	-2	31	63	SUN SE	31	37	1433
79	MAR	06	03:04:54.417	65.12840760	0	14	33	SUN RI	32	57	1490
79	MAR	06	04:08:14.417	65.17238909	-2	28	63	SUN SE	33	41	1531
79	MAR	06	04:41:46.418	65.19567613	0	11	33	SUN RI	34	56	1587
79	MAR	06	05:45: 6.418	65.23965762	-2	25	63	SUN SE	35	40	1627
79	MAR	06	06:18:42.419	65.26299096	0	8	33	SUN RI	36	54	1681
79	MAR	06	07:21:58.420	65.30692616	-2	21	63	SUN SE	37	39	1720
79	MAR	06	07:55:18.420	65.33007431	0	5	33	SUN RI	38	57	1777
79	MAR	06	08:58:48.421	65.37417154	-2	18	63	SUN SE	39	37	1814
79	MAR	06	09:32:14.421	65.39738913	0	52	33	SUN RI	40	55	1869
79	MAR	06	10:35:38.422	65.44141692	-2	15	63	SUN SE	41	37	1906
79	MAR	06	11:09: 2.422	65.46461137	0	49	33	SUN RI	42	55	1961
79	MAR	06	12:12:30.423	65.50868545	-2	12	63	SUN SE	43	37	1998
79	MAR	06	12:45:46.424	65.53178731	0	45	33	SUN RI	44	56	2054
79	MAR	06	13:49:22.424	65.57595398	-2	9	63	SUN SE	45	37	2091
79	MAR	06	14:22:38.425	65.59905584	0	42	33	SUN RI	46	55	2146
79	MAR	06	15:26:11.425	65.64318779	-2	6	63	SUN SE	47	38	2184
79	MAR	06	15:59:22.426	65.66623178	0	39	33	SUN RI	48	55	2239
79	MAR	06	17:03: 2.427	65.71044476	-2	53	63	SUN SE	49	38	2277
79	MAR	06	17:36: 6.427	65.73340772	0	36	33	SUN RI	50	56	2333
79	MAR	06	18:39:53.428	65.77770171	-2	49	63	SUN SE	51	42	2375
79	MAR	06	19:12:51.428	65.80059523	0	32	32	SUN RI	52	57	2432
79	MAR	06	20:16:46.429	65.84498182	-2	46	63	SUN SE	53	41	2473
79	MAR	06	20:49:42.429	65.86785219	0	29	32	SUN RI	54	55	2528
79	MAR	06	21:53:38.430	65.91225035	-2	43	63	SUN SE	55	37	2565
79	MAR	06	22:26:34.430	65.93512072	0	26	32	SUN RI	56	55	2620
79	MAR	06	23:30:30.431	65.97951888	-2	40	63	SUN SE	57	38	2658

YEAR	MON	DD	HR:MM:SS.SSS	DAY OF YEAR	DT MET	DT EPH	DTLAST	TYPE EV	EVENT-FILE	EVNT LENGTH	CUM. REC. TOTAL
79	MAR	07	00:03:22.433	66.00234297	0	23	32	SUN RI	58	54	2712
79	MAR	07	01:07:18.433	66.04674112	-3	37	63	SUN SE	59	39	2751
79	MAR	07	01:40: 2.433	66.06947260	0	20	32	SUN RI	60	56	2807
79	MAR	07	02:44:10.434	66.11400965	-3	34	64	SUN SE	61	42	2849
79	MAR	07	03:16:54.434	66.13674113	0	16	32	SUN RI	62	55	2904
79	MAR	07	04:21: 1.435	66.18126661	-3	31	64	SUN SE	63	41	2945
79	MAR	07	04:53:42.437	66.20396339	0	13	32	SUN RI	64	56	3001
79	MAR	07	05:57:53.449	66.24853529	-3	27	64	SUN SE	65	42	3043
79	MAR	07	06:30:30.455	66.27118582	0	10	32	SUN RI	66	56	3099
79	MAR	07	07:34:45.467	66.31580402	-3	24	64	SUN SE	67	38	3137
79	MAR	07	08:07:26.473	66.33850084	0	7	32	SUN RI	68	54	3191
79	MAR	07	09:11:37.425	66.38307205	-3	21	64	SUN SE	69	39	3230
79	MAR	07	09:44:14.427	66.40572253	0	54	32	SUN RI	70	54	3284
79	MAR	07	10:48:30.432	66.45035222	-3	18	64	SUN SE	71	38	3322
79	MAR	07	11:20:58.434	66.47289854	0	50	32	SUN RI	72	55	3377
79	MAR	07	12:25:22.438	66.51762081	-3	15	64	SUN SE	73	38	3415
79	MAR	07	12:57:46.441	66.54012084	0	47	32	SUN RI	74	55	3470
79	MAR	07	14:02:14.443	66.58488939	-3	12	64	SUN SE	75	38	3508
79	MAR	07	14:34:30.444	66.60729681	0	44	32	SUN RI	76	56	3564
79	MAR	07	15:39: 2.445	66.65211163	-3	9	64	SUN SE	77	42	3606
79	MAR	07	16:11:15.445	66.67448432	0	41	32	SUN RI	78	56	3662
79	MAR	07	17:15:53.446	66.71936859	-3	5	64	SUN SE	79	41	3703
79	MAR	07	17:48: 8.446	66.74176442	0	38	32	SUN RI	80	55	3758
79	MAR	07	18:52:46.447	66.78664869	-3	52	64	SUN SE	81	42	3800
79	MAR	07	19:24:50.448	66.80891722	0	34	32	SUN RI	82	57	3857
79	MAR	07	20:29:38.449	66.85391723	-3	49	64	SUN SE	83	40	3897
79	MAR	07	21:01:40.449	66.87616260	0	31	32	SUN RI	84	56	3953
79	MAR	07	22:06:29.450	66.92117419	-3	46	64	SUN SE	85	39	3992
79	MAR	07	22:38:30.451	66.94340800	0	28	32	SUN RI	86	56	4048
79	MAR	07	23:43:22.451	66.98845429	-3	43	64	SUN SE	87	42	4090

YEAR	MON	DD	HR:MM:SS.SSS	DAY OF YEAR	DT MET	DT EPH	DTLAST	TYPE EV	EVENT-FILE	EVNT LENGTH	CUM. REC. TOTAL
79	MAR	08	00:15:22.451	67.01067652	0	25	32	SUN RI	88	55	4145
79	MAR	08	01:20:14.452	67.05572282	-3	40	64	SUN SE	89	44	4189
79	MAR	08	01:52:10.452	67.07789875	0	22	31	SUN RI	90	55	4244
79	MAR	08	02:57: 6.453	67.12299135	-3	37	64	SUN SE	91	44	4288
79	MAR	08	03:28:54.453	67.14507469	0	18	31	SUN RI	92	56	4344
79	MAR	08	04:33:58.454	67.19025988	-3	33	65	SUN SE	93	44	4388
79	MAR	08	05:05:46.454	67.21234322	0	15	31	SUN RI	94	55	4443
79	MAR	08	06:10:50.455	67.25752841	-3	30	65	SUN SE	95	40	4483
79	MAR	08	06:42:38.456	67.27961176	0	12	31	SUN RI	96	55	4538
79	MAR	08	07:47:45.456	67.32483167	-3	27	65	SUN SE	97	39	4577
79	MAR	08	08:19:30.457	67.34688029	0	9	31	SUN RI	98	54	4631
79	MAR	08	09:24:37.458	67.39210021	-3	24	65	SUN SE	99	40	4671
79	MAR	08	09:56:18.458	67.41410252	0	6	31	SUN RI	100	54	4725
79	MAR	08	11:01:30.459	67.45938031	-3	21	65	SUN SE	101	39	4764
79	MAR	08	11:32:54.459	67.48118587	0	52	31	SUN RI	102	57	4821
79	MAR	08	12:38:22.460	67.52664884	-3	18	65	SUN SE	103	42	4863
79	MAR	08	13:09:54.460	67.54854699	0	49	31	SUN RI	104	54	4917
79	MAR	08	14:15:14.461	67.59391737	-3	15	65	SUN SE	105	40	4957
79	MAR	08	14:46:42.462	67.61576924	0	46	31	SUN RI	106	54	5011
79	MAR	08	15:52: 6.462	67.66118590	-3	12	65	SUN SE	107	40	5051
79	MAR	08	16:23:30.463	67.68299147	0	43	31	SUN RI	108	54	5105
79	MAR	08	17:28:58.464	67.72845444	-3	8	65	SUN SE	109	40	5145
79	MAR	08	18:00:14.464	67.75016741	0	40	31	SUN RI	110	55	5200
79	MAR	08	19:05:52.465	67.79574612	-3	5	65	SUN SE	111	40	5240
79	MAR	08	19:37: 6.465	67.81743594	0	37	31	SUN RI	112	55	5295
79	MAR	08	20:42:42.466	67.86299150	-3	52	65	SUN SE	113	44	5339
79	MAR	08	21:13:50.466	67.88461188	0	33	31	SUN RI	114	56	5395
79	MAR	08	22:19:33.467	67.93024846	-3	49	65	SUN SE	115	42	5437
79	MAR	08	22:50:38.468	67.95183412	0	30	31	SUN RI	116	56	5493
79	MAR	08	23:56:30.468	67.99757486	-3	46	65	SUN SE	117	41	5534

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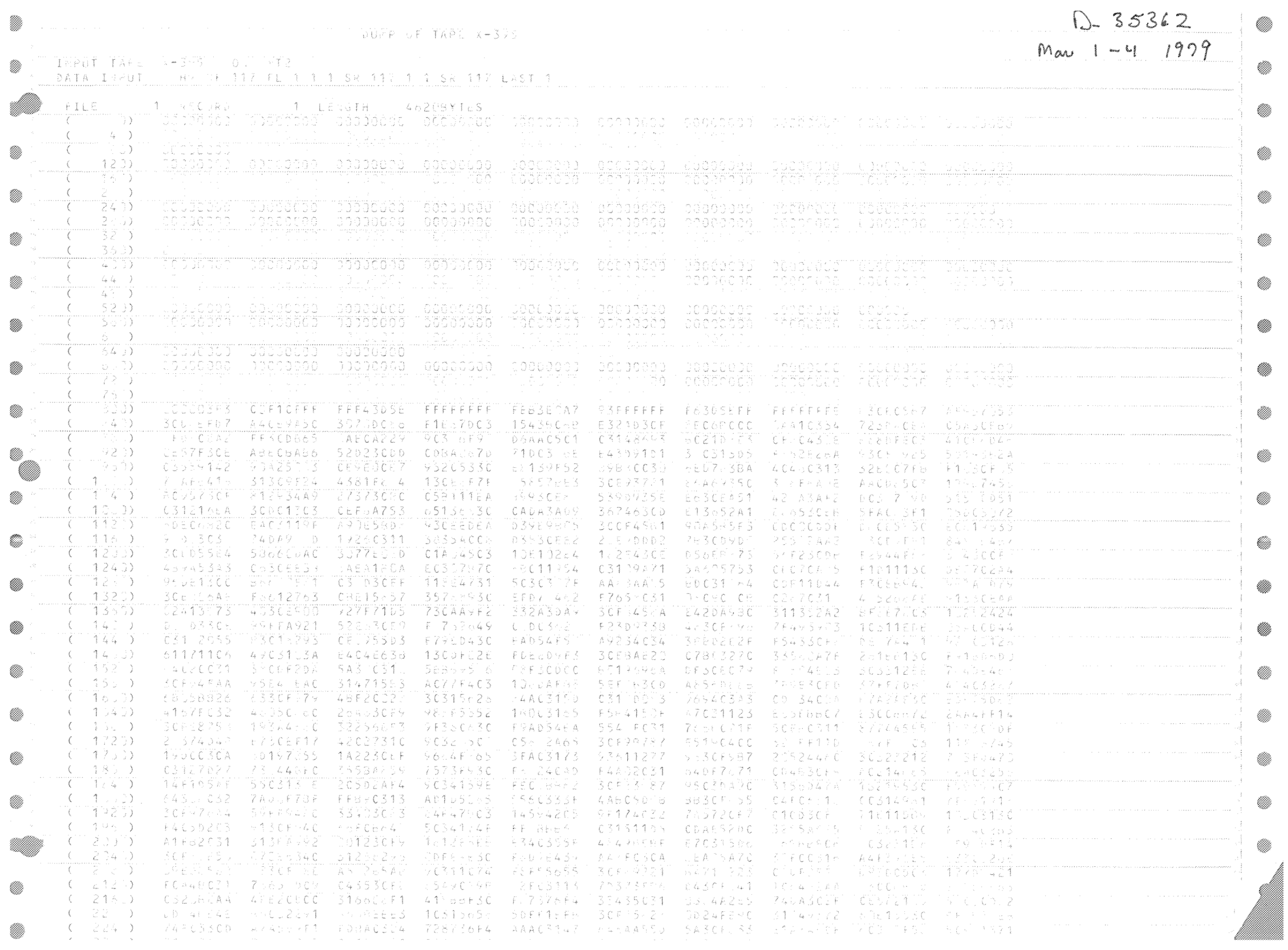
DUMP OF TAPE X-375

INPUT TAPE X-375 O. NT2
DATA INPUT MX CH 117 FL 1 1 1 SR 111 1 1 SR 117 LAST 1

FILE 1 RECORD 1 LENGTH 4620 BYTES



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(  23x )  4EC.nC2   ?91.wx5C   .  F.3CEC   5DC.DFC5   4C?3CF8?   94C?F?F?   AEC3344?   7.AC?2?9   2C511F..   1F??.A?A
(  24  )  3CE8E27   2?1?W11?C   5 .?7CA5   1114?13C   F?5DAAC1   11D.53CE   9?1DE?C1   .ACCE341   3C.11EC5   ??A?C114
(  244 )  1B7A25C1   C?3CE?E9A   7E2?2D16   6C3D7?DD   ?EA3?BFB   3CEA51AC   1CBEFEF3   C.A??C2?   .?2.2?C3   32L?723.
(  24? )  C9o?CC31   D?AC317C   24F?3CED   FF13S19?   1F?C3??7   EC?E52?A2   FC3CF?3A   ?.A53???   ?C?E?.52   ?.??2?.F
(  252 )  3C?C5?B5   ?E3114AC   31..47?D   FD1?533C   ED54E8?B   DD?CCC3.   7?444EC1   A4CE3C?.   1?CF?5?C   E?5?CEC?
(  256 )  ?0E722F5   A?3CF?A2   A5217E49   CC3.??F6   ?49-3.44   3C?C4C?C   AC?.  EDC   3 ?A3?CF   ?755.93C   0?F.A5d0
(  260 )  ?D0C?3CE   D434E1?A   E8D?3CC3   D6A3.524   .E?C3?7.   61??CA7?   1?3CEBD7   5C?2?D4C   ?C3C?B?.   ?1;??.?F
(  264 )  3CDB?EFE   1?3CAE?3   CEE.E5AE   ?235.?3C   CCD13134   ?FC3?C53   7557F13C   ?C?553CE   .3A?C2F24   D?4C?.?D
(  268 )  C5FF?42C   F?3CD911   .?D6414C   D3CEECAE   F3?3?FFF   3CD?5?71   F?71A?AC   ?.?2E2FC   ?24C?E?C   ?AE?.?C1
(  272 )  ?C?.?8C31   ?J?B?6?DB   C?C?3CC?   32E?2A6C   ?AA3CEF7   7?7EC?61   CC3CD?4A   D4F3?C?3   3C3.?11?   5?D3E?F?
(  276 )  3CE?4.AE   ??EEC?2C   3106E?5?   4144C13C   C?.35D?.?   ?AA5A3CE   ?.D9?9252   C?BE3CDC   2?C?4???   ?2?C?A?.
(  280 )  ED?C342E   3A3CE34F   5F1E?.3F   4C51.E3E   E11AAD.E   3CACC?54   F2CF4?53   CF?4F??.   1E=C47?C   DFFF?C??
(  284 )  C2?EDC33   6F3FED14   .AE13CDE   AAFC13CD   A14C3116   ?4C?91?5   DFC3?137   9?1FDF1.   13CF.?C2   4?F4?1A?
(  288 )  3CDFC3B7   DDDFA?2C   3D?EFF?3   BEF?453C   DCA?243?   ?D.C7C31   1FBFD?99   795?C342   3F?.317F   ?7C3CF?D
(  292 )  FD4?AC?4   F?3CE?BB   8?ADA4CE   9C3.?F?.   4D3?94A4   3CDA9?52   F?95F9AC   3?24E?.?   ?E4?71C3   341F??.?
(  296 )  5?7.B3CF   .EA41F.3   D4EA3CE9   8BD1F426   CD?C3.?7   9D?3FA?9   .A3CD.?D   4DE3F.??   1C3134F?   CA5?.F.4
(  300 )  C327?63?   ?7?67?03   CF?.5415   77?.CF23C   EA51EA46   38D61C3.   7251A?03   4D1C3CCC   ?4CA1157   F?E.C314
(  304 )  ?341A1?.   ?7C32525   ??.EE1D9   53CF922?   13F321C9   3CE3.D?7   E?.?72D?C   3C749AF7   ?E.F?73E   C?.15?.D
(  308 )  5?1.A3E3   ?F4.?4E3   .E2C3CC?   E3?E3?E3   ?D13E3?F   427FFFFF   F33D1AD?   A.?A2?CA   ?3E3C?F1   DFFF1FF4
(  312 )  3C5F3FFF   FFFFFE83   ?4?5FFFF   FFFFF43D   5FFFFFFF   FFFE?C31   407D2F4F   15F.C322   C.?2AD4?   .C5?CF?3
(  316 )  .7A?C3E?   AC3CEF?C   ?D4?F?E1?   2C3.7776   5??.CF27   3CF.?B?1   D46?F24C   315AE32A   14?F3?C3   25?.?4C1
(  320 )  ?ECD13CF   4348DE5?   CA?13CEC   5F?.?553   463C3.?A   E27?C?94   A?C3?4B7   2.CAE2C4   0C31?.F7   ?A?.C?F?
(  324 )  C31?1?C?   ?B2.52A3   CF?2EE93   15?3F?3C   ECF?5?AC   1?55?C3.   ?EDA1334   ?97.C34?   ?D.53?.1   ?.2?3122
(  328 )  A?F.2?CF   F5C315F6   ?133?A3?   43CF?1F9   22134EF?   3CFD7D?C   5?5?3F2C   31?6?33F   F5?F?5C3   3.FC5.33
(  332 )  5E2?EC32   ?DD?FC?6   4A3CC314   E72AD.?D   3F?5CF?D   6?.E4DGA   C45CEDF7   AE?54DF?   3C3113E?   ?4?F?5?5
(  336 )  C3329E?2   FFDA3CDC   3220?CF9   9AE.45C3   13E354?D   1?2193CF   .E417911   4 ?B3CEE   ?31 2D?7   D.CC311?
(  340 )  ?B4A?A?A   ?RC?272C   7F?F1E42   6C324D6E   F7711?D?   C312EC4.   DAFA7?13   CF.B?3?.   .5?5?45C   EF?.?1?4
(  344 )  5EC?2C31   27ACE472   33AFC325   144FF?14   ?5DC32?E   DCADC?DB   BAC31202   F5?EF?RD   C3CF.?31   5C7.?4?C
(  348 )  .3CEF.C11   1.?.413C   31348?C3   3CE654C3   23?7727C   5?EADC33   212?F2?3   ?AEEC311   2?.?52F3   F1.3CF.4
(  352 )  4F?E?73C   2A3CEF4?   FC?15?A9   7C31423?   E4BF33EF   C321.?.7   ?F..AD.C   33657F9F   25?2AFC3   1??2?5C3
(  356 )  124C?3C?   FFC3D?F?   .5A63CFF   75D?B1EA   4F2C315?   B475ACBC   2?C317?C   1.?2C9?D   FC?454F?   C2FF?A53
(  360 )  C3J?D1?1   ?.D4?443   CEF5D9BF   2B?A2D3C   EF9259?3   0C144C31   5FE.CA?A   CAD2C31?   ?CE3E432   >?B?C5?7E
(  364 )  ?EE141E?   ?AC3.77D   .53DB?15   E3CEEAFE   3E41D.FA   3CFF9F?3   5?07C4?C   31?FCF?.   7?>?2?C3   1??.?7?F
(  368 )  4E?C43CA   D4E2CE23   5C4?C3.7   317?RFF5   ?6C3CED?   .3?2AF49   F33CFF9A   .??F?C37   C52.?E..   C?.1C111
(  372 )  C31+?C?E   02?731C3   CBF4CF32   09C?94C3   ?6EF3E5E   9ACEA3CE   ?22F?413   C?D?.3C?F   .51C14E?   ?12C?222
(  375 )  ?5?4?3A   F2C314?D   A?423943   93CCBF14   ?3C?545?4   C3?3B?4E   FC3525F3   C?C47?D?   C?5?2C3C   .F5F.455
(  3?? )  5?n?1C3?   45EFC34E   3.?EC313   4AFC??A2   CA23C?.1   7?E3?.3D   EAC3.?87   D.?77E?C.   ?3C?F5F?   ??.?.?F?
(  3.4 )  3CEF2?F1   2AF?BDDC   32699A?C   F1?A1?C3   12?5A593   2?C2553D   A2E3.154   4?.?C5.?   ?52..C?.   ?7?3CE?5
(  3?? )  ?1S?4D4?   F?3CE?E4   .?1326421   FC331C3D   FDEF152F   C311CE?1   D?A43?.3   CDC3?E24   E1?.FCC3   ?D4.A?C5
(  392 )  3.?.?3CE   ?.?F4?E?   ?81?3CEE   ?E239524   A.2C33?5   51?F.C5C   1FC31155   FA.5E?C3   13CDE3A?   ?CE4C1EC
(  396 )  C3.?3870   CEF.5?23   CE3?2.?D   F.4?223C   EE2?A84?   4?RD2C34   ?242A3DF   ?C?RC3?.   CCE?1C7?   4??.?F?1
(  400 )  403.071A   3EC3?A32   BD5C47CD   ?3CDE9FC   BE2?D5?4   3CEDB3FD   4DF21E?C   3?17C5E3   ?CC.CCFC3   1?D?FA42
(  4?4 )  3CCB?3C?   ?.323C3?   ?4?7C3D?   377?2?4A   E?63CDC?   A?1?CD72   433CED3C   0C?D?EEB   ?3C?.?F75   CD?.?=145
(  4?8 )  C3.7F3D4   F1?CD?23   CE?E?A1?   .1C?37C3   ?4?A7D?   81?9E3CD   A2?E?52F   4DF?3CEC   9F?.FF32   3.FFCC?2
(  412 )  E4CF46?2   D1C307CA   3972?4?D   43C?AC3?   4A?3S3DF   C3?3?0?F   E2?D1273   CCFB?145   4.??1ESC   F?FF1?51
(  416 )  77C?C3CC   DD?C172?   EF41C3C7   A75F?7?F   ?423C?E?   2DE51395   3FC3?6?4   2?71F??.   23CCEDC7   27.?45E?
(  42? )  3C??5279   F2E141D?   CD?3E.?3   C?1FCDC3   .Z?D??4D   ACAD?3CE   C?5CC C2   E?55C3.?   E23?17D2   ?CC.?CFCA
(  424 )  ?D?F?D?   A?3CEA??   ?4.E?FA?   63CDB?.9   .45531??   C3.??C9?   CED?.?7A   ?5A?.FC3   .?E.A5?3
(  428 )  .57FC3C?   CC4??C?C   AA?53CE?   D4C5A?BB   BD63CDD3   A??3?47E5   2?C3.774   C2?3.61F   C3CEEB31   .F?BC4??
(  432 )  C3.?2C33   3527?BAC   353?0?40   45F1723C   E?B33A?3   9?5AF3CD   FE3?C8FA   ?E1?C3?7   7A?5F?35   4?.?3CEB4
(  436 )  FF53.CED   .?C3.777   ?47F383C   ?C34.3BA   D?E21?F?   3CE.?BAC   4FC?E5.3   C??.11CD   4E.173C3   .?.15?.
(  440 )  361.3F3C?   E?5?5733   5.?1?3?7   CC2?53?C   FFCC3336   A?5.C.H.   5C3CDF?2   .?C24?2.   C5CF?.5?   F.?4?.F7
(  444 )  C3?7?51C   ?R4.D?C3   CEF4ECCE   4A44?FC3   1?533EC1   1?04FC32   ?62?L4B?   3F513C?C   BC4F2?A4   ?7?3CFAF
(  448 )  F.2?4?2?   3.C3?7E?   3AA?4A?8   C?CE?H?A   3DFF?FD6   C3111F1D   .1F1C?2C   3251?3?4   ??A?.?3C   ?AF?3A4?
(  452 )  4F4?ESCE   ME?TFFA?   ?422C3?7   ?8?3CF.   ?6?.?DAC?   CAC511F?   1?F?E?1?   CC?2?5?A   ?7C.?8?1
(  456 )  3C?.E7C?   12?723?3   CECCF?.5   2EB?21C3   1?JEF?C?   .EBA53CF   .2AE8?91   E1?1C?12   FF4C.?C?   .?1C?2?A
(  460 )  C?S?442F   ?.3CC?0A   3?:2?153   1C?.?0?C   3?0?3?F3
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```
FILE     1  R-C-RD      5?  LE?.TH   402 ?YTES
(      )  ?2  D?.      ?  3?.3   ?2 5E      0F?F9   7C42C?1   .  ?.3?2   .  3.5?3      3DC14   FFF?.      2  5.3
(   4?)  ?3?.5F??   1AC121+?   ?????????   ?2?3?9?3   CD2?5?3?   D1?2CC.?   CCC?DE?C   ?3?3?1?3   ?C?3E5F..   ?61F?4?3
(    ?)  .?7F2?   ?2?03?03   ?02?5E?3   3?.?2?3F   7D?E44.?   ?2?3?F?3   ?D3?5E?3   .?7F3?4?   ?D?.?.4?   ?3.?3?F3
(   12 )  ?.5?   .?5E2?2E   .?11?.1E   ?.2?   .   A2?4   .   .   ?C?   FF.?D?   .  ?.3   ?2.?E?   1.?2??
(   16?)  7F2?CA?3   .2?3?2?3   ?3?3?E?3   ?.?3?C14   F.F?   .   .   3   3   3   2.5?   1C.?14?   .   .   3   3
```

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(  360)  00305D00  7D24A541  00700210  03002002  02E50000  EFC03FFF  797E2E00  00002072  F03F5DC2  72E20043
(  400)  9BA01140  8F02F002  003E5E00  A03E229E  211E211E  21231200  1A2A....  ....DA..  ..F.5DC3
(  440)  0F2A5DC0  D30DB1F9  7A2C09F..  .5.3.3.3  03.5D0..  ..3DC14  A.98..  3.2..2  F.3.5DC.  7F1214AF
(  480)  D0000075  03033003  03315D00  01020000  00000E70  C3C02003  0D3C5E00  77CC77AC  C0EC07E3  03003003
(  520)  003.5D..  .5FFA1FF  707E02C.  03..3C.2  ..C3.3C.  4AF01030  90002203  03020002  03005D00  ..3AE29E
(  560)  211F.11E  21A...  .A27...  ....  91.DE..  .3..3C.3  ..3.5E.C  .4.DEFF9  A3E2C09.  ..F.7C.3
(  600)  0D2A5C00  0203DC14  C01A3000  03003003  0D305D00  FFC4214B  FFC40000  02003003  C0C.5E..  1.2...3.
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(  680)  ..3.5E..  67..2331  A3A1A4D.  2..33.3  03.5D0C.  ..3B229E  .211E.1E  221D0...  .A2.....  ........
(  720)  93FFD0..  ..2..3.3  ..33.5E0  .5.DB7F9  7D7EC92.  ..2..3.3  ..32.5E.  ....3DC14  3.1.F...  .2..3.3
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(  800)  0F4A7E30  .2..5.03  ..03.5E0.  FB729996  7A7E2130  03003003  00205E00  0F3B0031  A05F.E3C  02A03003
(  840)  0A3.5E0.  A..3B229E  .211E01E  229A0.00  .A24.0..  ....A0.3  9107D6.0  2..35.3  02.5E..  ..1.D7F9
(  880)  6D7DC1D0  03003003  00305D00  0003DC14  527E8D0C  02003003  00305D00  FFC4214B  ....  ..3..3.3
(  920)  00305D30  01020C00  00000E70  03003003  00305D00  7B7D00AB  00BA7030  02002003  F03C5D00  20001163
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( 1240)  ...DDF0.  02003003  00205E00  7D3A7BA1  00FF76A0  02003003  00205E00  CFD397..  7A7F0035  03F03003
( 1280)  ..2.5E..  CB9559..  96FF8E3C  92..3.C3  03.5D0..  ..3B229E  .221E.1E  24.E....  .A20....  ........
( 12C0)  04003000  03003003  30303F00  .2.DB7FA  74740727  2..3.3.3  02.5E...  ....3DC14  ....  .2.3.3
( 1300)  00C30D00  C7736.14B  00000000  02003003  00205D00  01020000  00000DF0  03002002  .02.5E00  7D24.542
( 1340)  0A0A7987  ..3..3C3  .02.5E.0  EEC284FF  7F7E77A.  03002002  00205E00  23520C43  9.C.1040  03C02002
( 1380)  ..3.5D..  .13B229E  .221E.1E  25700...  .A2.....  ........  21..DE..  3..3.3..  .03.5D0.  .3.DC7FA
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( 1440)  7E7EF.5.  03..3003  .03.5D0C  4AF0.13.  92..2292  .3..3.3.  .02.5D..  ..3B229E  .211E.1E  25C.....
( 1480)  0A2F0C00  ........  91..D0..  .3..3.03  03.5D0..  .4.DB7FA  93.7C65.  ..3.3..2  ..3.5D0.  ...5DC14
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( 1600)  ..2.5D..  7B729496  7D7E.13.  02..3..3  02.5E...  .44..31  965F.E3.  02..3..3  .02.5E..  ..3.229E
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( 1700)  ..2.5E..  ..32..35  9.AA1.4.  2..3..3.  03.5D0..  .3B229E  221F.11E  26FF....  .A3C.10..  ........
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( 17C0)  ..20C34.  .3..2002  .02.5D..  bAA711FF  7C7E5D1.  03..2002  .03.5D07  1.49.038  9A2E029.  .3..2.2.
( 1800)  ..5D....  .3A2295E  .221E01E  277C....  A33.10..  ........  91..D6..  .3..3.3.  .03.5D0.  .DE7F8.
( 1840)  7C42C4D0  03003002  00205D00  0003DC14  FFFF8000  02002002  C03C5D00  1AC12146  0C.CC0A0  22.03303
( 1880)  ..3.5E..  1.2.....  .0DDD9B  03002002  .03.5D30  7D1F7400  0C917F10  03002002  .02.5D30  3.42.35F
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( 1900)  CA340C00  .0010C0C  FF000600  03002002  .03.5E0C  C1C0F7FB  7F2DC45.  3..3..3.  03.5E0.  ..3DC14
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( 19C0)  2E1F.E3.  .3..3C.5  .2.5D...  .3B229E  221E.1E  2.7e....  .A35.10.  ....4...  ........  ........
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( 1A40)  00300000  0C0C0300  03000000  00F00000  E0C00C00  00C00C00  03000000  E0C00C03  C0C00000  24000300
( 1A80)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1AC0)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1B00)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1B40)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1B80)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1BC0)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1C00)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1C40)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1C80)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
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( 1D00)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1D40)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1D80)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1DC0)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1E00)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1E40)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1E80)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1EC0)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
( 1F00)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
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( 1FC0)  ........  ........  ........  ........  ........  ........  ........  ........  ........  ........
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( 304 )) 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
( 3[illegible] )) 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
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( 428 )) 1
( 432 )) 00000000 00000000 00000000 00000000
( 436 )) 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
( 44[illegible] )) [illegible] 00000000 00000000 00000000
( 444 )) 1
( 448 )) 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
( 452 )) 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
( 456 )) [illegible]
( 460 )) 1 D6 1F

      FILE   INPUT    DATA RECORDS    MAX.        READ ERROR SUMMARY           INPUT RETRIES
             RECS.       INPUT        SIZE     PERM  ZERO L.E.  SHORT  UNDEF.   RECS.  TOTALS
        1      56        57           462                  5        7              5      7

FILE   117  RECORD      1  LENGTH    462BYTES
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(   4 )) [illegible] 1 [illegible]2 [illegible] [illegible]14 B[illegible]EF72 EE6DB60B 5CAE3EE1 14DE[illegible]DB5 [illegible]522
(   8 )) 6D00D000 0000000 1E [illegible] 1E3D[illegible]3 0 307FD 307F5
(  12 )) 3D7[illegible]7000 00000003 07DE0000 0000003D 70900000 00000367 00000000 00003E70 E0000000 00C307DF
(  16 )) [illegible] 307E00 [illegible] 307E[illegible] [illegible] 3D70F[illegible] 00000003 07DE0000 0000003D 7[illegible]
(  20 )) 300 9C30[illegible] 3DD9 C30 [illegible] 3D09C 3C [illegible] 3DD9C3 C[illegible] [illegible]E70S
(  24 )) 3010C000 00000003 01000000 0000003D 10000000 00000301 00000000 00003B10 [illegible] 3010
(  2[illegible] )) 00000000 00301000 00000000 03D10000 00000000 3010000[illegible] 00000003 01000000 [illegible]0000030 1[illegible]000
(  32 )) 301 3010 3010 13D9F9C 3D9F9C
(  36 )) 3D9F9C00 000[illegible]003 09F9C[illegible] 3D 2C 307 AA 3DFA [illegible] 3DEAF
(  40 )) 00000000 003DCADE 00000000 03DCCF20 00000000 3DD4540 00000003 DD46A[illegible]D [illegible]0000030 DA[illegible]
(  44 )) 3DD CADC [illegible]3DDF 4[illegible] 3DF[illegible]C 7C [illegible] 3DE4D[illegible] [illegible] 03DE[illegible]7E [illegible]
(  48 )) 3DEF 72 3 [illegible] C34F[illegible] 3E 3C34F 3E C34F[illegible] 3F[illegible]C [illegible]4F[illegible] [illegible]CF0
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(  56 )) CCCCC3D[illegible] F0CCCCCC CCC33[illegible]C 5F333333 3323D[illegible]C F3333333 32307E[illegible]4 CCCCCCCC [illegible]7F FFFFFFFF
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hw23 mm39 20 1979 3 mon pg-4

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(F8)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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(118)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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(128)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(130)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(138)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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D-35363
3/5/79 - 3/8/79

DUMP OF TAPE X-597

INPUT TAPE X-597 ON NT1
DATA INPUT 1/2 OF 117 FL 1 2 2 SR 117 1 2 SK 117 LAST 2

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(90)	55555555523	2516 5523 5555	5555				11173	446		173 4417
(144)	0000000000000	1730 4320 0000	0000 173	413	1722776			172744		1727
(192)	72000000000	0700017278720	0000000000000	1727642000000	000000001727	612000000000	0000173547 03	000000000000
(24)	173547036	0 0 1735	47 36 0 0000	0 0001735470 3	6031000 0 0	173547036000	0000 0001735	47 36 0 0 3000
(288)	173547 3	65	173547036 30	1727	614	1722500		172255
(336)	000000001722	500000000000	0000172250 00	0000000000000	172250000000	000000001722	500000000000	0000172250 0
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(432)	7634 0	17317634	0000 0 0	17317634 000	000 0001731	7634 0 0	0 0 17317634	0
(480)	173176340000	000000001731	763400000000	0000172340 0		1727456 0	1732	5774
(528)	0000173360136	0000000000000	173450014000	000000001734	733440000000	000017354571	200 0000 0000	173552644000
(576)	0 0 1735	6 40 0 0 0	0 0 17356755	6 0 0 0	173 4 436 00	0 0 001740	60 0476 000000	0000174000 04
(624)	76	174 0 0 476	0 0 174	6 0 476 0	0 174 6 64	76 0 0 0	174 6 0 476	0 174
(672)	6036476000000	0000174036064	760000000000	1735775040 0	000000001732	450200000000	0000173240 02	0000000000000
(72)	173360 3140 3	140 3140 21731	500 140 3140 31	4603173142 11	777777777777	1730 6 33777 7	777777771730	500 7314 0 3140 3
(768)	140 2173 4732	3140 3140 3145	172770 377777	777777771727	541463146314	631417557346	24154 0 0 2	175573462415
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(912)	4 0 0 0 0 0	0 0 0 172140 0	0 0 0 0 0 0	172140 0 0 0 0	0 0 0 0 0 0	4 0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0
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(3648)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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(3792)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(3840)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(3888)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(3936)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(3984)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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(384)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(432)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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(576)	33e[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(624)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(672)	055201413007	300051724000	001132200060	004000600060	302003054030	051637054360	200J10001000	140014J60400
(72)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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(1056)	[illegible]	357241673[illegible]	2[illegible]	[illegible]	336003733e31	2e5237[illegible]	740014001400	140014070400
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(1152)	424[illegible]	140014001400	140734000141	140007076724	563300040004	0003J00301[illegible]	[illegible]	1142374[illegible]
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(1536)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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(2208)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(2256)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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(2400)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(2448)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(2496)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(2544)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(2592)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(2640)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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(144)	0000000000000	1735434000000	1000000001730	414000000000	000017304000	000000000000	1727743000000	000000001727		
(192)	72	1727672	0000	1727642	0000001727	614	1727612			
(240)	1727636		1727	602	172772		1727752	173 411		
(288)	000017304160	000000000000	173041100000	000000001727	610000000000	000017224000	000000000000	172240000000		
(336)		1722	4	17224000	172240000000	1722	4	000017224000		
(384)			1722400	1722	4	172241	17224 0	1722		
(432)	400000000000	000017224000	000003000000	172240000000	000000001722	600000000000	000017234 00	000000001000		
(480)	172344000000	000003001723	000003000000	000017234000	000000000000	1726500000	000000001732	5712000000000		
(528)	17356122		17345000 4	0000001734	7334400	017354573	00	173556600		
(576)	000000001735	6047000000000	0 17356755	4	173047443	173o 4437		17365 27		
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(768)	1402173 4732	3146314631145	172776377777	777777771727	537631463146	3145172670571	4031406314063	17205 4 0314		
(816)	0314031217 5	6012172732 3	6556172374 5	075341217265	172270702430	5e0507431721	5204 0111264	57 017205121		
(864)	727 2436 5576	17174152 541	711735431727	53 031463146	3145172 40	0 1721	172 40	172		
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(1104)	777777777753	606213313314	066475356060	327217045113	0477171 05345	045016473536	171651234202	77 0 4256 01		
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(12)	171 5e023 3 13	277731140 61	257113671327	6713 61 652	16463 552141	6 6227211563	75 757345	277716437514		
(1248)	024717164347	35004414 743	171654057203	1074 66 61	32451 4 55	56e1 0 1 43	2 1 77532 4	0 0255 02151		
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(1344)	752410321 137	0 3 7507542	331140 7e0 6	255 435 2466	7453171506 1	7131370 312	171654115173	72407 355062		
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(1584)	15463004770	0 0670334 316	01624 26060	2325340044 0	464317144 1	0014422245 1	171657755 5	5 5 6 52 04		
(1632)	125741251537	0775 03 03611	527054756225	171240111275	2650477676 0	231446770745	145617134 24	7611 5 03 557		
(1680)	171657725463	1124031 65066	2671124 35677	5 16 6 3575	25016 334204	171355574 5	65 3741 0 0 0	231757132751		
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SAGE
03/29/79
-04/01/79

DUMP OF TAPE DIN1

INPUT TAPE DIN1 ON MT4
DATA INPUT H9 NF 114 FL 1 1 1 SR 114 1 1 SR 114 LAST 1

1979 3 29

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(1280)	0896C3CD	9D3492FA	BFE03CBD	A5DF6137	7693CED5	37506A81	CE3CF8EB	B5BA34CD	3C305CBB	6E30BA6C
(1320)	C336FBF0	88507EE3	CCF58A54	D44CCF3C	99281732	97D733CE	D243E416	3C9A3CF9	08F99604	4D6C305C
(1360)	3FDF0EC7	E0C333C7	242BB90A	B3CCAFBF	58C49E76	C346EBB5	AB9A1993	CECE6E64	BAFD713C	F91C7FDC
(1400)	A6C97C30	5C746CD5	DB02C330	A0C496E0	B483CBD2	A6CAFFE9	A2C335CB	920CBFE7	03CEC9BB	4B1BAA5B
(1440)	3CF92637	7806B5CC	305D5851	B0D32AC3	26C6119B	D0D8A3CA	8A48DC31	445AC330	2C390A51	8913CEC4
(1480)	2FF6FFC7	143CF926	19CBDC43	DC305EEA	11DA3252	C3254639	83DB051C	356F1C78	AF1BB3C3	254EE808
(1520)	C05FD3CE	BDD2A9C9	AC143CF9	1C2AB961	75EC3061	278221C5	C5C323D2	6A76F3CE	FC342A7B	2103F19C
(1560)	C3229320	8AE09213	CEB6AA7C	BD62973C	F9087879	401DBC30	640DCA04	CCAAC322	6C20430F	3D2C334F
(1600)	3F71880B	51C317F2	D676020D	53CEAEBF	59F3BDE8	3CF8EB1B	8AF1A61C	30679969	ABA59FC3	2114CB2E
(1640)	49DE8C33	0A164C7B	AFF0C316	A4B17D3C	D853CEA6	19F1C91F	FB3CF8C4	368060CD	1C306BC6	35F50954
(1680)	C317E6E3	5192139C	326304F2	0BBE73C3	15608266	1C2653CE	9CC3B2DD	9C443CF8	93F5DE7E	E03C3070
(1720)	8F7396E5	72C3174C	309ACE08	0C3241B0	A431A3DB	C314279E	F96F0633	CE92C6BE	9C7D1F3C	F85A8FDA
(1760)	48D78C30	75EFC4EE	68CEC316	BAE95C16	041C3221	30A662F4	F6C312FB	50805E25	13CE882D	DEEDE182
(1800)	3CF81844	1CDB7A5C	307BE143	A5D067C3	1633A03E	C2F91C32	01A684D4	7F51C311	DCD27234	8503CDFA
(1840)	08F495F6	4A3CEF9A	B6EE5E86	AC3104BA	DD418533	C315B6DC	B32CD78C	31719951	E823E4C3	10CD514F
(1880)	EDD943CD	E2AD1024	9E9C3CEE	F44F25D2	01FC3112	BA92145A	F2C31545	1BA9A55A	DC3162FA	211CADE3
(1920)	C307E6F4	C0844FE3	CDCA6108	80E9EF3C	EE3E0534	CC4DAC31	21B2AC11	8050C314	DECEDE6B	540C3155
(1960)	04AAE012	5DC3076F	D32082DF	63CDB13E	C46FDAC5	3CED789D	AB98FE2C	31319340	8426B8C3	14845BBE
(2000)	B17FAC31	47C72E45	571EC307	01C050B5	FA23CD97	60FF912F	7C3CECA4	EC8A5FF8	BC31424B	88C8878D
(2040)	C314361C	142B8A7C	313B4F2F	8D12FFC3	069D2F4A	ECCB83CC	F9C65ECD	F28E3CEB	C3D467AE	BF8C3153
(2080)	C9E871B5	51C313F4	5D663C31	7C312FA9	6A72AFA5	C3064289	11064513	CCC3C2CE	D41BB43C	EAD64582
(2120)	99822C31	65FC1430	AE51C313	BF60708D	A2DC3124	E1BBACEE	10C305F2	2C455BD0	13CC8CF0	7A32A741
(2160)	3CE9DD3C	D20AD93C	3178CF09	E00827C3	1397594A	E9578C31	1B032487	E5D5C305	AC6CCDB5	6A63CBAB
(2200)	12A8BC3B	E13CE8D9	C2FF4018	5C32185E	4E9749C7	C3137C6E	54BDC7CC	311217B3	B65FC6C3	05719385
(2240)	D516B3C9	EE3F1566	CA053CDF	99D6C784	682C3240	109A9D98	47C3136E	BA20488E	4C310A28	90012EDE

D-58637
SAGE
11/17/81 - 11/18/81

DUMP OF TAPE DIN637

INPUT TAPE DIN637 ON TU1
DATA INPUT H9 NF 27 SR 1 1 1 SR 27 1 1

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FILE 1 RECORD 1 LENGTH 4620BYTES

(0)	0453660A	DR6D86D4	C11C5B6D	B6DB6D00	00000000	007BD000	00000000	000B0000	00000000	01100000
(40)	00000000	00000000	00000000	80000000	0000002E	B5F82F74	EB6DB6DB	5D7DEBE3	16DB6D4D	53AD4C55
(80)	2DB6D000	00000000	001E0000	00000000	0013D88F	80000000	003D88C0	00000000	03D88800	00000000
(120)	3D880800	00000003	D7F50000	0000003D	7E400000	000003D7	DC000000	0003D7D	70000000	0003D7D8
(160)	00000000	003D7D70	00000000	03D7D400	00000000	3D7D7000	00000003	D7D90000	0000003D	7E100000
(200)	000003D7	E6000000	00003D7F	00000000	0003D7F5	00000000	003D7FE0	00000000	03D7D800	00000000
(240)	3D1C0000	00000003	01C00000	0000003D	1C000000	000003D1	C0000000	0000D1C	00000000	0003D1C0
(280)	00000000	003D1C00	00000000	03D1C000	00000000	3D1C0000	00000003	D1C00000	0000003D	18000000
(320)	00003D1	80000000	00003D1C	00000000	0003D1C0	00000000	003D2C00	00000000	03D38000	00000000
(360)	3D390000	00000003	D3C00000	0000003D	2C000000	000003D6	B4000000	00003DAB	46000000	0003DBBC
(400)	A0000000	003DCR00	00000000	03DCE370	00000000	3DD90FC0	00000003	DDA3B800	0000003D	DB9E8000
(440)	0000030D	D6600000	00003DDF	EA400000	0003DE90	C8000000	003DEA13	C0000000	03DEBAB4	00000000
(480)	3DEF34E0	00000003	DF8B8900	0000003D	FA470000	000003DF	B7F80000	00003DFD	24800000	0003DDB7
(520)	94000000	003DA97C	00000000	03DA8440	00000000	3D9E0266	66666653	D9A97333	3333323D	98E33333
(560)	33332308	E5333333	3323D8C	5F333333	3323D8A2	0CCCCCCC	CC3D7F1E	66666666	53D7A1FF	FFFFFFFF
(600)	3DEE5FFF	FFFFFFF3	D6A20A3D	70A3D53D	5C0A3D70	A3D6E3D3	F7AE147A	E1443D2F	25604189	36B3D1B9
(640)	CAC08312	673D0860	4189374B	53CF8C71	0CB295E6	3D8A54CC	CCCCCCC3	D0800000	0000003D	08000000
(680)	000003D0	80000000	00003D08	00000000	0003D080	00000000	003D0800	00000000	03D08000	00000000
(720)	3D080000	00000003	D0800000	0000003D	08000000	000003D0	80000000	00003D08	00000000	0003D080
(760)	00000000	003D0800	00000000	03D1C000	00000000	3D1C0000	00000003	D2800000	0000003D	2A000000
(800)	00000301	C0000000	00003E3C	6068FFFF	FF43D89F	FFFFFFFF	F33E0A40	FFFFFFFF	63D5EFFF	FFFFFFEB
(840)	C31324CC	4BCEE283	CDC10662	4931E8C3	07611F7E	4FCC6C34	14146715	BA47C306	0802541D	7C7C3248
(880)	68C83604	2AC3130A	F94F12C0	53CD9458	44926700	C30732D0	51EC4D1C	347829EE	3CBFD5C3	05DEA666
(920)	71F7EC32	6A465A55	D037C312	FF16419A	9453CCCE	151E81DD	E3C3070D	FF5464FD	9C3672D6	A4C0E5C3
(960)	C305C038	94F950DC	33197826	C5B06FC3	13012C56	DD9393CB	E5388508	9C03C306	F2D13C3A	31F3CA82
(1000)	9D00243B	13C305AC	D4CF526F	EC335F4A	EB379650	C3131136	044E8E33	C9B542AF	ADA634C3	06E1628D
(1040)	CA7233CB	A58B371C	03D8C305	A489C24E	2FFC344B	76D2391F	B0C3132F	1F5BF9B8	AC347538	4327586C
(1080)	C306D9C2	96F1C753	CC848204	387082C3	05A75C74	54F48C36	63FE9E27	07DDC313	5AC5BF12	CD8C335E
(1120)	DA4AC0D8	58C306DB	F84D178F	73CCB5A8	50132545	C305B544	AE7C2A33	CACD377D	E98027C3	1393F87A
(1160)	7BF8AC33	03C51A52	15A1C306	E7FFEA2A	4553CCE6	05A313B5	30C305CE	31327142	83CBF3B7	6C1196C5
(1200)	C313DA78	9FAF445C	3254DF00	E89EFDC3	06FDCB60	0CC503CD	8AB3C8EE	1331C305	F20524B8	F613CCBF
(1240)	DFB49986	BCC3142D	F9BA8567	7C322892	A89727CD	C3071D42	843F5693	CDA1CEC3	8FA607C3	06209A19
(1280)	9D33F3CD	828899F4	9636C314	8E21B08D	2FEC317E	9671DB71	2BC30746	4311B8AA	63CDB83B	BDA566A1
(1320)	C3065B8E	6B0D3A23	CDA4940E	3652CFC3	14FA8969	BB749C31	696E10FE	D245C307	78A0D8C0	2E23CDCD
(1360)	E388C95F	43C3069D	36A4A0BD	63CDC5EE	C2DEACDF	C31572BC	EF7E323C	3154E6D7	D0978FC3	07B425E7
(1400)	08EC63CD	E2AF7A98	704CC306	EABC836C	0243CDE6	75EC3D1C	48C315F6	3C1A4FE1	8C314116	C74E9583
(1440)	C307F892	BAF37033	CDF689E7	18E1A6C3	07420048	AA1913CE	8303C291	4D3AC316	847ADEF3	D6DC312E
(1480)	13225E80	01C3108B	3CFD9267	93CE84AE	F7437E3E	C307A2A8	0045EA03	CE924136	05E883C3	171CE1F7
(1520)	AAD9AC31	1BF05D5E	2429C311	35EE95FB	CEA3CE8D	8BE3DBE6	F1C31018	A2C979A6	93CEA0E3	3FD14B09
(1560)	C317BECF	526576FC	310AC204	6B2C2EC3	11F084E8	18AB83CE	95D24FA6	D7DAC310	FD2036F8	EAC3CEAE
(1600)	DA6315DD	4CC320D3	2D936072	CC307D4D	558E2F51	C312BA39	C831B933	CE9D7969	7A1D64C3	11F1DED8
(1640)	AD07A3CE	BC17C6F9	A85EC322	39053C45	CF2C3075	C5EA85DC	BDC31392	36CD33A2	A3CEA478	E4A45C13
(1680)	C312F5E2	64FBCC33	CEC88D2F	859015C3	23ADA89D	E427CC30	6ED2F3A2	1E5BC314	77963FAB	5F43CEAA
(1720)	C9245B25	FCC31408	1FE30A09	B3CED42D	2A73FF46	C3252F8A	5D5BF3DC	30687C0A	6AEDE4C3	156963D3
(1760)	9590F3CE	B0632BC0	903CC315	277C9378	BC93CEDE	EB07BD4C	45C326BD	0E9D9853	7C3062C8	26ED63F4
(1800)	C3166690	BB86C513	CEB540C2	E8CB09C3	1652CED0	953853CE	E8BB0360	0CDAC330	A9188155	338C305D
(1840)	BC9A52C2	DBC3176E	35784825	93CEB9EC	5B885D0B	C31788DF	A05A6A93	CEF1922F	865631C3	33E89D75
(1880)	80FE3C30	5961FD1A	406AC320	FE21E870	DA43CEBC	B12D5966	CCC32190	D65E1E49	F3CEF966	95AF68FE
(1920)	C337352F	661F2D6C	3055BA3D	7A3306C3	2330172F	FD3283CE	BF3B349B	FB86C324	20466066	BC33CF80
(1960)	17A03A9D	A1C34516	833D4BDF	9C3052CA	842F1F8B	C3256FEE	CF711CD3	CEC0F73C	9ECD82C3	26BD5BF7
(2000)	020133CF	82F2219B	8DA6C357	9CEBE987	DB4C3050	9639400A	FDC327BB	3C6A15AF	13CEC1E2	E30CA890
(2040)	C332CAA2	DC76DC53	CF853F64	0519BA3C	9A2BCCAA	9587EC30	4F1FFE52	ECE0C334	1F0B53E2	FFB3CEC1
(2080)	FC90E9E5	50C34055	4F4B3B2D	83CF86FC	8C3B288C	3CB944AD	5AD5DF7C	304E69A9	85FF66C3	41A91378
(2120)	066B83CE	C143C40E	1156C356	540FA883	3823CF88	27584864	433CBFF4	559262DF	6C304E74	43ACB107
(2160)	C356475E	261C4EB3	CEBF889D	5876943C	AC0F9457	464A83CF	88BE24E9	36983CCB	4950DD4B	CCDC304F
(2200)	4003B83E	2F3CA947	2E4537C3	13CE8D5C	2F7808D4	3CC87162	A4327EA3	CF88BFDD	52FF783C	CE8C2B1C
(2240)	AB010C30	50CC4FBF	61623CBE	1E6D2C61	62D3CEBA	307DC678	453CCDD7	95269C1F	93CF882C	18D57A26