TITLE: A Statistical Evaluation and Comparison of VISSR Atmospheric Sounder (VAS) Data

RESEARCH INVESTIGATOR:

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SIGNIFICANT ACCOMPLISHMENTS:

An evaluation of VAS sounding data has been completed for one of the AVE/VAS field experiment periods. Three satellite sounding data setswere available for analysis on 6 March 1982 at five time periods (1100 GMT, 1430 GMT, 1730 GMT, 2030 GMT, and 2330 GMT). Three-hourly mesoscale rawinsonde observations were available over central Texas and Oklahoma with supporting three-hourly synoptic scale observations from the standard NWS network in the central part of the United States. In order to account for the temporal and spatial discrepancies between the VAS and rawinsonde soundings, special procedures were followed. The rawinsonde data were adjusted to a common hour of release where the new observation time corresponded to the satellite scan time. Both the satellite and rawinsonde observations of the basic atmospheric parameters (T, Td, and Z) were objectively analyzed to a uniform grid maintaining the same mesoscale structure in each data set. A detailed evaluation of the performance of each retrieval algorithm in producing accurate and representative soundings was performed using statistical parameters such as the mean, standard deviation, and root-mean-square of the difference fields for each parameter and grid level. Horizontal structure was also qualitatively evaluated by examining atmospheric features on constant pressure surfaces. An analysis of the vertical structure of the atmosphere was also performed by looking at co-located and grid mean vertical profiles of both the satellite and rawinsonde data sets. A few highlights of these results are presented below.

Table 1. indicates the mean difference and standard deviations of the differences between the rawinsonde and satellite gridded fields (RAO-SAT) for the composite of all five times. Time composite results are often misleading since biases and errors can cancel out to produce small composite results. In this investigation, large biases occured at several time periods, but are not accurately portrayed in the composite results shown below. Despite this problem, the composite results present some very interesting conclusions. Mean temperature differences between the satellite and rawinsonde data sets indicate a considerable warm bias in the composite results. The statistical scheme (Lee, et al., 1983) and the physical scheme (Smith 1970) indicate a bias which is maximized in the mid-troposphere whereas the modified physical scheme (Smith, 1983) a larger low level warm bias. Despite these bias differences, the standard deviation of the temperature differences are quite similar from one data set to another and fairly consistent in the vertical. Mean dew point temper-

Regression (GSFC)

PARAMETERS

Pressure Levels	T (°C)		TD (°C)		PW (mm)		Z (m)		Thick. (m)		Grad T (°C/100km)		Grad Z (m/100km)	
100	0.6	0 7	---		---		-24 9	25 4	*		0 2	0.6	6.2	23.0
150	-0 2	0 7	---		---		·27 3	26 6	*		0 3	0.6	0.5	27 0
200	1.6	0 9	---		---		·36 8	27 3	19 2	17.4	0 3	0.8	-3.2	29 0
250	0.4	2.0	---		---		-44 1	27 7	*		0 1	1.0	-0.7	29 0
300	0.0	1 8	---		---		·43 6	30.9	*		0.3	1 2	4.0	28 0
350	·1 6	1 1	9 1	8.1	---		·37 4	31 2	*		-0 3	1.0	6.4	24 0
400	·1 6	1 4	1 2	4 8	---		·32 2	28.0	-27 3	16.0	0.5	1.4	5.0	19 0
450	·2.4	1 9	·1 1	3.1	---		·25 2	23 2	*		1 2	1.4	1 3	15 0
500	·2 4	1 9	·0.8	2.4	---		·16.9	18 3	*		1.0	1 3	-1 7	12 0
550	·1 7	1 6	·1 4	3.3	---		·11 2	15.0	*		0.7	1 1	-3.5	10.0
600	-0.6	1 2	·0.4	4 3	---		-8.4	12 2	·8 5	11.8	0 2	0.9	-4.5	8.7
650	0.2	1 1	·1 1	4.4	---		·7 8	10.2	*		0 1	0.7	-4.4	7.7
700	0.3	0 9	-1 5	3.3	---		·8.4	8.6	*		0.1	0.8	-3.8	7 0
750	0 9	1 0	·1.6	2.4	---		·9 8	7.8	*		0 3	0.9	-3.0	6 7
800	0.3	1 3	0 7	1 7	---		-11 2	7 1	1 7	5 7	0.4	0.8	-1 5	6 6
850	·1 5	1 3	1 4	1 5	---		·10.1	6 4	*		-0 1	0.7	-0.0	6 3
900	·3 2	1 3	1 5	1 4	---		·5 7	6 1			0.0	0.8	0.0	5 6
SFC	0 4	1 4	1 0	2 3	0.6	0 9	---				0 5	0.9	---	

Physical (GRVASR)

PARAMETERS

Pressure Levels	T (°C)		TD (°C)		PW (mm)		Z (m)	
100	·2 4	1 1	---		...		-61 0	27 0
150	·0 2	1 0	---		---		-44 0	23 0
200	·0.1	1 3	---		---		-46 0	22 0
250	·1 3	1 4	---		---		-42 0	21 0
300	·1 7	1.6	---		---		·31.0	21 0
350	·2 2	0 9	5.4	4.6	---		·19 0	20.0
400	·1 7	1 4	4.0	3 6	---		·13.0	13.0
450	-2.0	1 7	·0.8	4.8	---		·6 9	15.0
500	·1 7	1 6	·2.4	4.6	---		·0.5	12.0
550	·1 2	1 3	·4 4	5.0	---		2 4	12.0
600	-0.6	1 1	·3 8	5.4	---		4.6	11.0
650	0.3	1 0	·4 8	5.9	---		4.9	9 2
700	0.4	1 1	·5.9	5.5	---		4.2	7 9
750	0.8	1 1	·6 5	4 8	---		3.0	7.2
800	0.5	1 0	·4.0	4 1	---		2 1	7 2
850	-0 3	1 5	·2.0	2 3	---		4 3	6.8
900	-0.5	1.4	1 3	1 4	---		6.5	5 7
SFC	0 7	1.0	1 7	2 4	·1 0	1 6	---	

Modified Physical (VSOUND)

PARAMETERS

Pressure Levels	T (°C)		TD (°C)		PW (mm)		Z (m)		Thick. (m)		Grad T (°C/100km)		Grad Z (m/100km)	
100	0.0	0.9	---		---		·13.0	27 1	*		0.4	0 7	7 4	21.0
150	·0.1	0.7	---		---		·12 6	26.1	*		0.2	0.7	3 4	24.0
200	0 4	1 3	---		---		·14 5	24.2	17.7	17.4	0.5	0 8	0 7	23.0
250	0 4	1 1	---		---		·15.8	23.7	*		0.9	0 8	3.4	23.0
300	-0 6	1 7	---		---		·15.9	21 2	*		0 3	1 0	8 9	22.0
350	·0.4	1 1	---		---		·12 8	19 9	*		0.1	0.8	11 0	18.0
400	-0.1	1 4	1 1	5.1	---		·11 3	18 7	·34.5	14.4	0 7	1 2	7 9	16.0
450	-0.0	1 9	-0.2	4.3	---		·10 9	15.6	*		1 3	1 2	3.0	12.0
500	-0.3	1.9	0.9	4.8	---		·10.5	13 0	*		1 2	1 1	·1.0	10.0
550	-0.7	1 2	-1.3	5.0	---		-9 2	12 8	*		0 8	0.9	-3.2	8 7
600	-0.9	1 0	-1.7	4 2	---		·7 1	11 4	0.6	10.1	0 3	0.8	-4.0	7 5
650	1 2	0 9	-2.9	4 8	---		-4 5	10.1	*		0.2	0 7	-3.3	6.8
700	1 3	1 2	-4.1	5 3	---		·1 9	8.1	*		0.1	0.9	-1 7	5.8
750	·1 3	1 3	-4.4	5.1	---		0 7	6 4	*		0.3	0.9	0 5	4.8
800	·1 0	1 3	-4.4	4.0	---		3.0	5.0	5.8	6 6	0.3	0.9	2 6	4.2
850	0.1	1 3	-2.2	3.4	---		3.9	4 3	*		0.1	1 0	4.5	4 1
900	0.8	0.8	-0.3	2.1	---		3 0	5 1			0 3	0.7	4.1	4.6
SFC	-0.6	1 8	0.1	1.4	-0.6	1 2	...				0 7	0.8	---	
			1.5	2.4										

Table 1. Mean difference and standard deviations of the difference between rawinsonde and satellite gridded fields (Rao-Sat) for basic and derived parameters and for a composite of five times on 6 March 1982. Each Table represents the results for a different satellite retrieval scheme as labeled.

ature differences indicate large moist biases (RAO-SAT < 0) for the physical scheme in the lower and middle troposphere with magnitudes exceeding 5 °C near 700mb. The regression and modified physical schemes do not indicate such bias extremes in the composite results although at individual time periods (not shown) values can become quite large. The standard dew point deviations for all three satellite data sets are similar with values of about 2 °C in the lowest layers and 4-5 °C in the middle layers. Total precipitable water values also indicates that the physical schemes are both moist biased with standard deviations greater than 1.2mm while the regression scheme is some what dry biased.

Additional comparisonns for derived parameters of thickness, and the temperature and height gradients were calculated for the regression and modified physical schemes. Thickness comparisons for the two satellite data sets with the rawinsonde data are similar with mean thickness difference values about 30m too high in the 500-250mb layer. Standard thickness deviations both increase with decreasing pressure from the surface up to 100mb. Temperature gradient statistics indaicate that for the most part, the satellite soundings produce weaker thermal gradients with largest mean differences and standard deviations occuring in the middle and upper troposphere. Height gradient calculations indicate a weakened gradient in the upper levels but also a stronger height gradient in the lower levels. Futher analyses indicate that these stronger gradients occur where the rawinsonde fields indicate a weak gradient and the satellite error represented by the standard deviations significantly dominate the analyzed fields.

CURRENT AND FUTURE WORK:

Current efforts involve completing a rough draft of these findings for a journal article. The article will present a complete look at all three of the VAS sounding data sets for 6 March 1982. It is expected that this manuscript will be ready for submission this summer. Future plans at this time include further evaluations of VAS sounding data for the 24-25 April 1982 case. Soundings produced using a modified physical retrieval scheme are available at five times during the AVE/VAS experiment day.

PUBLICATIONS SINCE JUNE 1983:

1. A statistical evaluation and comparison of VISSR Atmospheric Sounder (VAS) data and corresponding rawinsonde measurements. NASA Technical Memorandom (in press), Marshall Space Flight Center, Huntsville, 1984
2. A statistical evaluation and comparison of VISSR Atmospheric Sounder (VAS) data and corresponding rawinsonde measurements. Preprints Satellite Meteorology/Remote Sensing & Appl. Conf., in press, AMS, Boston, June 1984.
3. MSFC special network statisical evalustion. (with Greg Wilson), VAS Demonstration Final Report, NASA Ref. Publ., in press, Goddard Space Flight Center, Greenbelt, Md., 1984.

References

Lee, T., D. Chesters, and A. Mostek, 1983: The impact of conventional surface data upon VAS regression retrievals in the lower troposphere. J. Appl. Meteor., 22, 1853-1874.

Smith, W. L., 1970: Iterative solution to the radiative transfer equation for the temperature and absorbing gas profile of an atmosphere. Appl. Opt., 9, 1993-1999.

Smith, W. L., 1983: The retrieval of atmospheric profiles from VAS geostationary radiance observations. J. Atmos. Sci., 40, 2025-2035.