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Diagnostics for TES Initial Observations

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Abstract

Metrics for data quality of observations are analyzed with respect to several parameters determined from Level 2 processing. Data quality parameters include retrieval success, mean residuals, RMS residuals, number of degrees of freedom of data and a set of frequency scale parameters (calscale). We present and discuss initial data quality information from these observations. Overall success for these initial observations is excellent with nearly 100% of data processed through Level 2 for the special observations and over 90% for the global survey.

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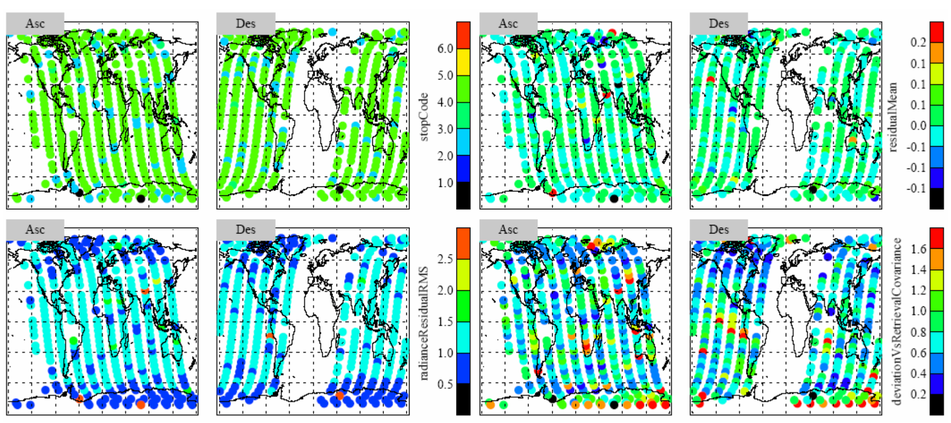
Special Observations and Global Survey Runs Done and Processed

We report on 1656 nadir scenes comprising data from 4 special surveys and one global survey. Profiles retrieved were: atmospheric temperature, water vapor, methane, and carbon monoxide. This is 95% of the total nadir scenes acquired during these runs. We report on the results from these five separate data acquisition runs comprising two types of instrument data acquisition modes:
Global Survey for 9/20/04
Special Observations, transect step & stare: 9/21 crossing over Ascension Island (AI I) and again 10/11 (AI II), 9/22/04 crossing over Natal (Natal I), Brazil, 10/20 over Natal (Natal II), 10/21 AVE support (AVE) over the Gulf of Mexico, Caribbean, and Texas.

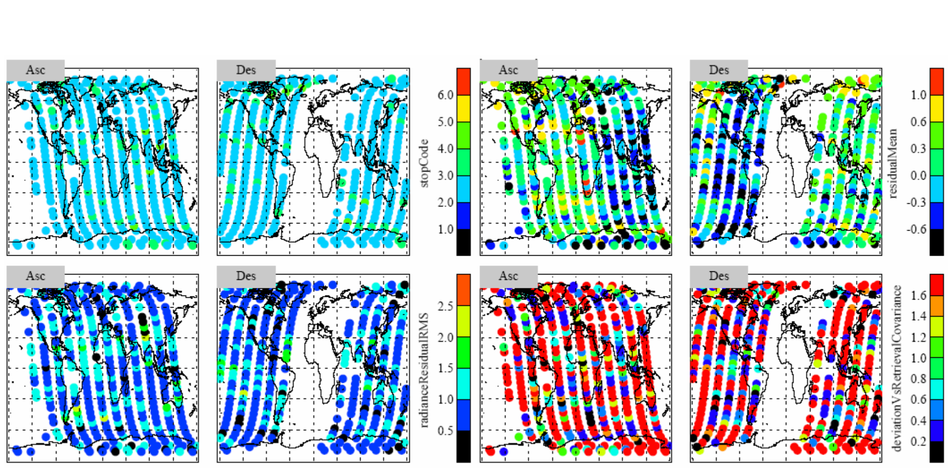
Consistency of Retrievals

Below and to the right, for the global survey performed on 9/20/04, are plots of stop code, residual mean, residual rms, and deviation vs. retrieval covariance. Overall consistency is summarized at a glance by the uniformity of the plots themselves. Outliers for further investigation are apparent by colors significantly off the “green” of the median values.

Ozone

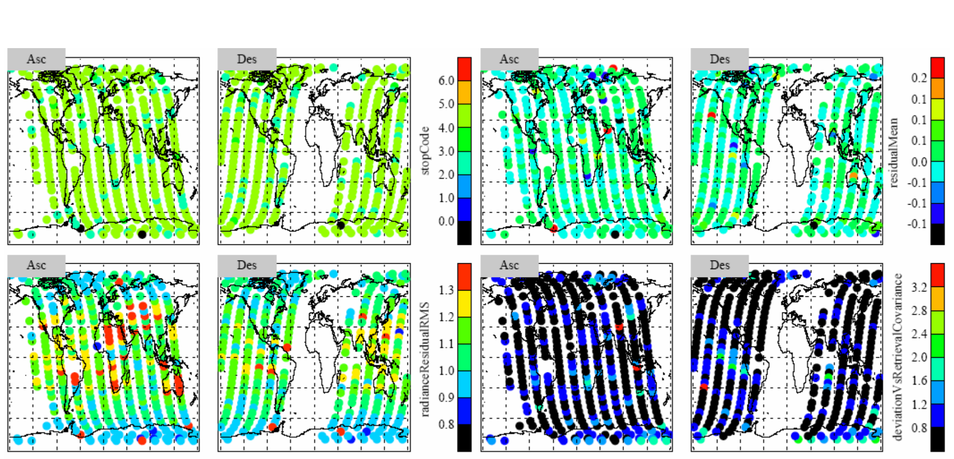


Methane

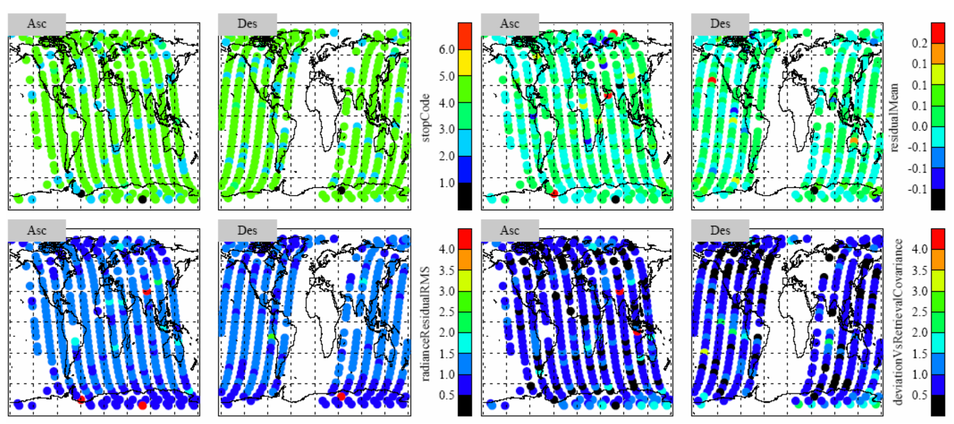


Along with the calibration frequency parameter set these metrics form the basis for a quality assurance process. Stop code provides basic information on retrieval convergence. Possible acceptable convergence criteria: the residual has reached a value within a tolerance, and the residual change is below a threshold. Additional outcomes include max number of iterations of the solver hit and failed. Failed retrievals are flagged for further processing by the science algorithm team at JPL. Residual mean is the overall average difference between data and model. Residual RMS is the root mean square error after subtracting the mean. Deviation vs. the retrieval covariance is the root mean square difference of the retrieved profile and the initial guess, which is based on GMAO data.

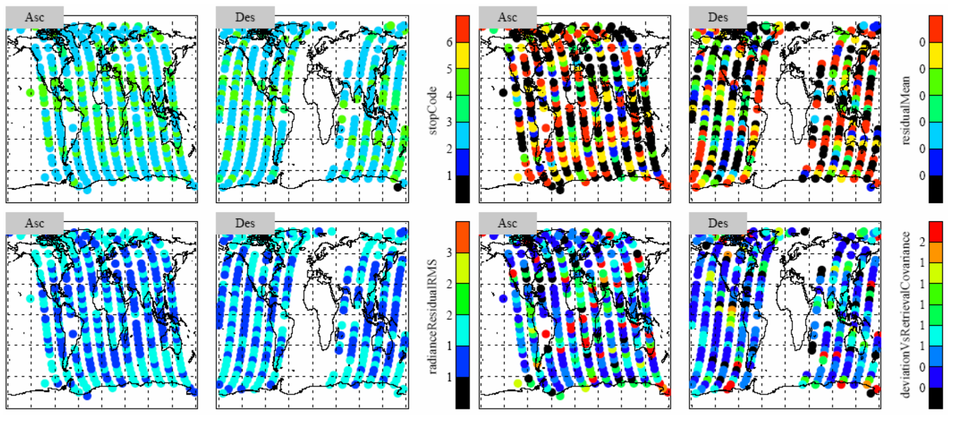
Atmospheric Temperature



Water



Carbon Monoxide



Quality Assurance of TES Data for Initial Observations

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Degrees of Freedom of Signal

The five sets of surveys total 1752 total nadir target scenes, with 1656 processed up to Level 2, obtaining temperature, water, ozone, methane, and carbon monoxide profiles. The four special observations were performed as transects across only a part of an orbit. Averages of the number of degrees of freedom of signal (DOF) were done for each survey and for each survey by latitudinal bands to begin assembling data for statistical analysis of overall performance. Averaging for the global survey, which covers all latitudinal bands (2 polar, 2 mid-lat, equatorial) was done for each: ±90° - ± 60°, ± 60° - ± 30°, -30 - 30. Averages by data set for each species are in Table I. Table II presents Degrees of Freedom of Signal for Atmospheric Temperature in latitudinal bands for the data and Table III has this information for O3. DOF is an important quantity to track as it is this quantity that most accurately represents the amount of information provided in the retreived profiles.

Table I: Average Degrees of Freedom of Signal for Retrievals

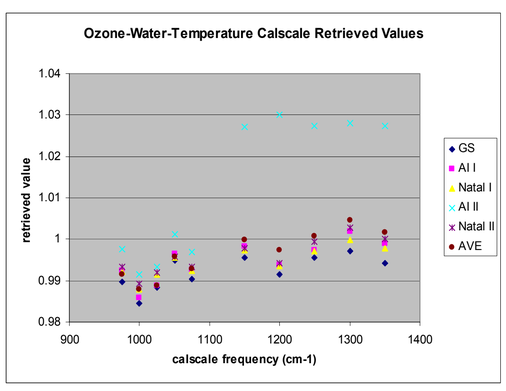
Run/Species	Atmos. Temp.	Water Vapor	Ozone	Methane	Carbon Monoxide
Global Survey 9/20/04	5.3	2.4	3.3	>0.1	1.2
AI	5.4	2.9	3.5	>0.1	1.2
Natal I	5.3	2.8	3.4	>0.1	1.2
Natal II	4.9	2.6	3.1	>0.1	1.1
AVE	5.0	2.5	3.1	>0.1	1.1

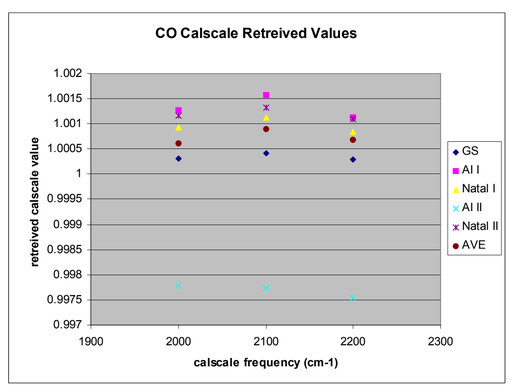
Table II: Average DOF of Signal for Atmospheric Temperature by Latitude Band

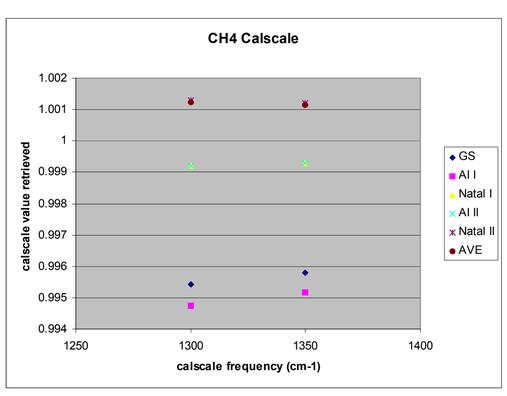
Run/Lat Band	-90° – -60°	-60° – -30°	-30° – 30°	30° – 60°	60° – 90°
Global Survey	4.0	5.2	6.3	5.4	4.6
AI I		4.4	5.5	5.5	
Natal I			5.2	5.8	
Natal II		4.0	4.9	5.5	
AVE			5.8	4.3	4.3

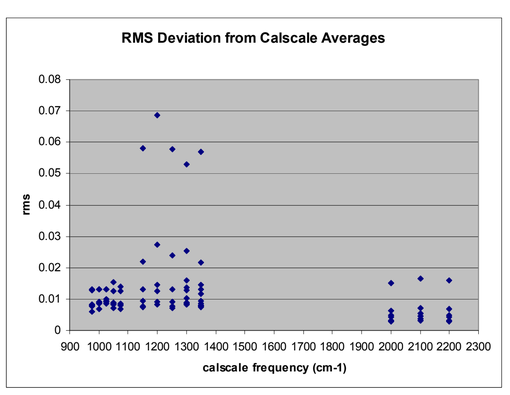
Table III: Average DOF of Signal for Ozone by Latitude Band

Run/Lat Band	-90° – -60°	-60° – -30°	-30° – 30°	30° – 60°	60° – 90°
Global Sruvey	2.7	3.3	3.7	3.4	3.0
AI I		3.2	3.5	3.6	
Natal I			3.4	3.5	
NatalII		3.0	3.0	3.5	
AVE			3.4	2.8	2.8

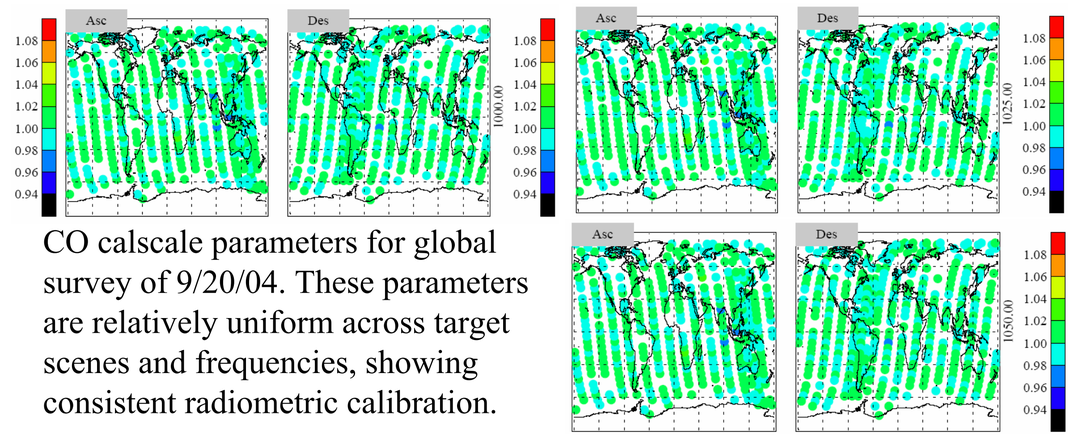




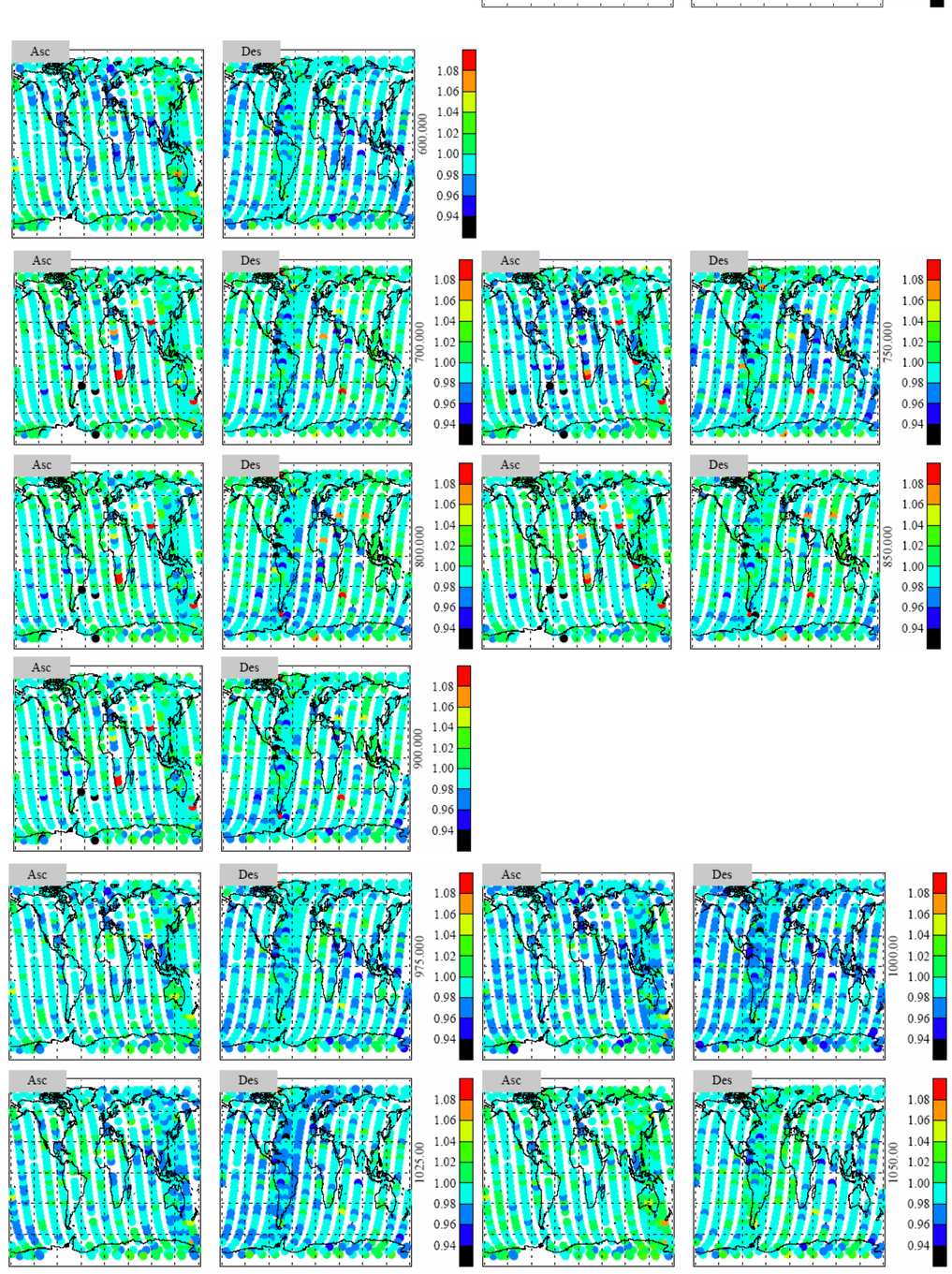




Calscale Parameters



CO calscale parameters for global survey of 9/20/04. These parameters are relatively uniform across target scenes and frequencies, showing consistent radiometric calibration.



Ozone calscale parameters for global survey of 9/20/04. These parameters are relatively uniform across target scenes and frequencies. One point where the calscale parameter does get large is in several panels is at the southern tip of Africa (red dots), another is in northern India indicating the difficulty of calculating land emissivities.

To the left are the plots of the retrieved values for the calscale parameters used in the combined retrieval of temp. water and ozone, CH4, and CO. Calscale parameters are used to adjust Level 2 forward model radiances in frequency ranges of 25-100 cm-1 as a compensation to systematic errors in the L1B calibrated radiances. As can be seen the values for different data sets track each other. Important information on the instrument performance can be gained from comparison of the retrieved values over time. From the data shown here it can be seen that the average values at each frequency have less than 1% deviation. This overall consistency is seen in the plot of the RMS deviations for all the parameter (lower right corner plot). These results are in excellent agreement with the direct radiance comparisons performed between TES, AIRS and S-HIS. The anomalously high values for the Natal II data needs to be investigated.

Overall Status of Nadir Retrievals

The Ground Data System and TES Algorithm Team have processed over 95% of the data through Level 2

- Residual means are small – systematic error from Level 1 processing can be accounted for
- Residual rms typically close to 1 indicating residuals are at noise level
- The number of degrees of freedom for signal for temperature, water, ozone, and carbon monoxide mean that significant information for these important atmospheric quantities is available from TES
- Calscale parameters provide an excellent tool for understanding radiance calibration and are in agreement with excellent TES – AIRS - S-HIS radiance comparisons. Further analysis of the calscale parameters over time will provide additional information on systematic errors in frequency calibration and on stability of the calibration
- Time, orbit, and latitudinal dependencies will need to be tracked to be better understood

http://tes/jpl/nasa/gov

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