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ACE – FTS

Atmospheric Chemistry Experiment

Level 2 data description for ACE-FTS and ACE-IMAGER version 2.2 HDF format

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	Function	Name	Signature	Date
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Table of Contents

DOCUMENT CHANGE RECORD

Issue	Rev.	Date	Change Detail
1	-	Feb. 16, 2005	First Issue of document
1	A	May 6, 2006	Minor corrections
1	B	Aug. 17, 2006	Added caveats for data use and minor corrections
1	C	Aug. 24, 2006	Updated data use recommendation table

1. Introduction and Data Description

The user is **strongly encouraged** to read the README files (produced by Chris Boone for each version of the ACE-FTS and ACE-IMAGERS retrievals and reproduced in this document) and the retrievals description paper (C. D. Boone *et al.*, "Retrievals for the Atmospheric Chemistry Experiment Fourier Transform Spectrometer", *Appl. Opt.,* 44(33) 7218-7231 (2005) which is available from http://www.ace.uwaterloo.ca/data) for more information on the ACE-FTS retrievals.

General comments on the data:

The representative location for each occultation given by the latitude, longitude and time of the 30 km tangent point (calculated geometrically). This information is given in the File Header. This value is typically used for coincidence searches. The ground track of the occultation tangent point is also provided in the Geometry Section. These values are calculated using a refraction model and the tangent heights and atmospheric densities obtained from the ACE-FTS retrievals.

In the HDF files, a fill value of -999 is used at each altitude where a retrieval is not performed. The user should be careful to distinguish fill values (-999) reported in the VMR statistical error columns from flagged values (-888). This is not a typographical error! For VMR retrievals, the profile above the highest analyzed measurement is taken as a constant times the input guess profile. These data are flagged with an error of -888 and should be treated with caution.

It should be noted that there are no errors provided for the temperature or pressure retrievals because of amount of time required to calculate them. The user is directed to the Applied Optics paper by C. D. Boone for details on how the temperature and pressure retrievals are done. A preliminary estimate of the accuracy of these retrievals is provided from the initial validation comparisons done with versions 1.0 and 2.1. In these comparisons, the ACE-FTS temperatures agree to within approximately ± 2 K with those from other satellite instruments and radiosondes, between approximately 15 and 60 km.

The ACE-FTS measurements are recorded every 2 s. This corresponds to a measurement spacing of 2-6 km which decreases at lower altitudes due to refraction. The typical altitude spacing changes with the orbital beta angle. For historical reasons, the retrieved results are interpolated onto a 1 km "grid" using a piecewise quadratic method. For ACE-FTS version 1.0, the results were reported only on the interpolated grid (every 1 km from 0.5 to 149.5 km). For versions 2.0, 2.1 and 2.2, both the "retrieval" (also called "measurement") grid and the "1 km" (or "scientific") grid profiles are available.

The ACE-FTS retrievals use line parameter information from the HITRAN 2004 database. It should be noted that the line strengths in the HITRAN 2004 database are scaled according to natural isotopic abundance. Profiles for 5 subsidiary isotopologues (H2O (181), H2O (171), H2O (162), CH4 (311), CH4 (212)) have been produced as "research" products. HDO (H2O (162) is included in the update to version 2.2. Please contact the ACE Mission Scientist (Peter Bernath; bernath@uwaterloo.ca) if you are interested in profiles for the others. For the subsidiary isotopologues, in order to obtain the actual VMR values, the user will need to scale the retrieved profile with the isotopic abundances assumed by HITRAN (www.hitran.com).

Use of *a priori* data:
For the temperature and pressure profiles, the reported values come from different sources depending on the altitude range. Below 12 km, these are fixed to meteorological data from the CMC (Canadian Meteorological Center). Between 12 km and ~120 km, pressure and temperature are retrieved. Above ~120 km, they are fixed to data from MSIS model calculations. These regions are identified by the T_fit parameter. If this is true, then the temperature and pressure have been retrieved from the measurements. In version 1.0, the T_fit parameter had values of T or F whereas in later versions these have been changed to 1 or 0. In previous versions, there was often a discontinuity between the retrieval results and the MSIS data. Version 2.2 resolves this by scaling the MSIS results above ~120 km during the retrieval process.

It should be noted that the only places that we use *a priori* profiles are the areas described above: p/T is fixed to *a priori* below 12 km and above ~120 km, and the VMR above the highest analyzed measurement for the given molecule is taken as a constant times the *a priori* (in this case, only the shape of the *a priori* profile is important). The operational retrieval employs a weighted non-linear least squares fit with appropriately bounded constraints to invert the spectral measurements and produce atmospheric profiles of pressure, temperature and constituent species. Beyond the exceptions described above, *a priori* profiles are used only as a first guess.

Version 2.2 Update (O_3 and HDO):
Those wanting to use ACE-FTS O_3 should use the data in separate version 2.2 update files instead of the results in the version 2.2 files. The update version uses microwindows only in the 10 micron region and should represent a significant improvement compared to the version 2.2 results. This change was prompted by preliminary validation comparisons, which found that the ACE-FTS ozone profiles tended to show less ozone than other satellite instruments. *Also, HDO (H2O (162)) in the version 2.2 file is incorrect, and one should only use the HDO results from the update files*.

Known issues and recommendations for data use:
The ACE Science Operations phase started on February 21, 2004. ACE measurements taken in late 2003 and early 2004 were done as part of the Satellite Commissioning phase. Occultations measured prior to January 10, 2004 were for calibration and these occultations should not be used at all. Measurements taken during the Science Commissioning period, during January and most of February 2004, generally should not be used. Since February 21, 2004, there have been a few instances where there were issues with the data and the occultations from these periods should be avoided or used with caution. For example, detector temperatures which are higher than nominal degrade the SNR performance of the ACE-FTS and this can negatively impact the retrievals.

The table below lists occultations with known issues. If you find any problems or issues with the ACE data please let the ACE Science Operations Centre know by submitting a Data Issue Report (https://databace.uwaterloo.ca/validation/data_issues_report_form.php).

Table 1: Data issues and recommendations for use.

Date Range	Occultation Number(s)	Issue Identified and Recommendation for data use
Before Janaury 10, 2004	ss1439, sr1439, ss1454	These are calibration measurements. *They should not be used at all.*
January 10 - February 2, 2004	sr2206 to ss2549	Issues with spacecraft clock. The spacecraft clock was being adjusted during this period so the timing is not reliable. *These occultations should not be used.*
February 2 - 21, 2004	ss2551 to ss2830	Command sequence macros were being adjusted. *ACE-FTS results should be treated with caution and ACE-MAESTRO results should not be used.*
February 29 – March 2, 2004	ss2968 to ss2978	Issue caused loss of attitude control and science command timeline. The ACE-FTS detector temperature was higher than nominal operating value while recovering from this event. *These occultations should be avoided.*
May 17 - 29, 2004	ss4108 to sr4281	Closed-loop offsets (for pointing at sun centroid) were set incorrectly. These measurements could have problems because of the offset issue. *These occultations should be used with caution.*
September 16 – 18, 2004	ss5909 to sr5923	Issue caused attitude control and science command timeline was disabled. The ACE-FTS detector temperature was higher than nominal operating value while recovering from this event. *These occultations should be avoided.*
March 9-12, 2006	ss13868 to ss13885	Issue caused loss of attitude control and science command timeline. The ACE-FTS detector temperature was higher than nominal operating value while recovering from this event. *These occultations should be avoided.*
August 14-17, 2006	sr16205 to ss16207	Issue caused loss of attitude control and science command timeline. The ACE-FTS detector temperature was higher than nominal operating value while recovering from this event. *These occultations should be avoided.*

2. Formatting and File Contents

General comments on the file formatting:

HDF formatted files will be used for distributing validation data and other low volumes of ACE mission data. This document describes the HDF format for level 2 ACE-FTS and ACE-IMAGER data products. These products are altitude profiles of: temperature, pressure and trace gas volume mixing ratio for ACE-FTS and atmospheric extinction at 525 and 1020 nm for ACE-IMAGER.

Naming Convention:

Each HDF file contains one type of data for (at least) one complete occultation for one instrument (for example: atmospheric profiles from ACE-FTS for ss2873). The files are named using the following naming convention:

ACE-<Instrument>_<Occultation_name>_<Process_level>_<L2_Retrieval_version>.hdf .

where:

Instrument = ACE-FTS, ACE-IMAGER

Occultation_name = sx.XXXX or sxXXXXX

sx is either ss = sunset or sr = sunrise

XXXX or XXXXX is the occultation number (either 4 or 5 digits is used)

Process_level = L2 (this document only deals with level 2 data)

L2_Retreival_version = version number for the level 2 retrieval (i.e. v2.2 or v2.2update for ACE-FTS)

File Sections and Attributes:

Each HDF file contains level 2 data for one (or more) occultation. Each occultation has information stored in File Header, Geometry, and Data sections. The File Header section contains the metadata describing the occultation measurement (what instrument used, occultation name and type, time and location of measurement and how the processing was done). The Geometry section describes the ground track of the occultation tangent point (derived from the ACE-FTS retrievals) and the location of the satellite during the occultation. The Data section(s) contain the atmospheric profile results. The formats of these sections differ for each instrument and tangent altitude grid that the profiles are given on. For ACE-FTS, the retrieved results are interpolated on to a uniform grid so profiles are provided on both the “retrieval” grid (as measured) and the interpolated altitude grid. ACE-FTS interpolated grid has a 1 km spacing (from 0.5 to 149.5 km). The ACE-IMAGER retrievals are performed on a standard 1 km grid (every 1 km from ~5.5 to 74.5 km) referred to as the “imager grid”.

Examples of the different HDF files are given in the figures below for files containing a single occultation. The ACE-FTS file contains two data sections: one for the “retrieval” grid profiles and one for the “1 km” grid profiles. Only one data section is needed in the ACE-IMAGER HDF file.

The attributes for the File Header and Geometry sections are given in Table 2 and Table 3, respectively. The attributes for each Data section type are outlined in the remaining tables: for ACE-FTS in Table 4 and for ACE-IMAGER in Table 5.

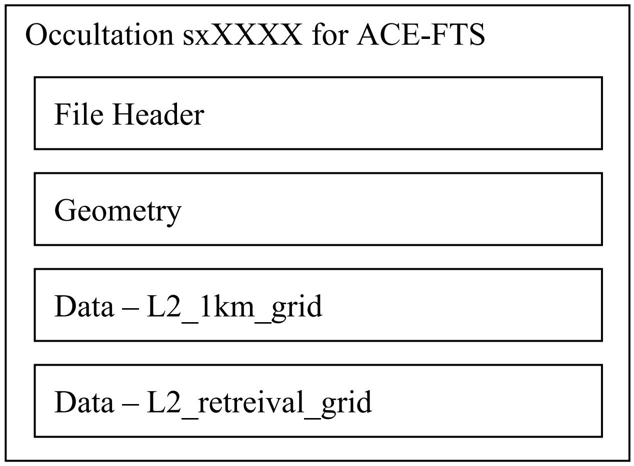

Figure 1: File sections for ACE-FTS HDF formatted data file.

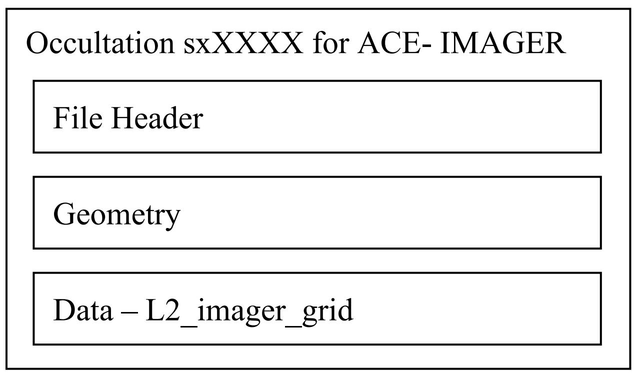

Figure 2: File sections for ACE-IMAGER HDF formatted data file.

Prepared by Kaley Walker, August 24, 2006 (kwalker@atmosp.physics.utoronto.ca).

Table 2: Attributes for File Header section.

Field name	Description	Acceptable values / units	Type
Global attributes for this section			
Instrument	Name of instrument and platform	ACE-FTS_SCISAT-1, ACE-MAESTRO_SCISAT-1, ACE-IMAGER_SCISAT-1	String
Process_level	Identify type of data by processing level (only considering level 2)	L2	String
Data_type	Description associated with Process_level	Atmospheric_profile	String
Level_1_version	Version number of level 0 to 1 processing code	1.1.0 etc for ACE-FTS and ACE-IMAGER N/A for MAESTRO	String
Level_2_version	Version number of level 1 to 2 retrieval code	1.0, 2.0, 2.2 update etc. for ACE-FTS, ACE-IMAGER and ACE-MAESTRO	String
Occultation_name	Occultation identifier using orbit number (XXXX or XXXXX) and type of occultation (sx)	sxXXXX or sxXXXXX	String
Event_type	Type of occultation (as seen from spacecraft)	sunrise, Sunset	String
Fill_value	Fill value used in array when no data is present	-999. for ACE-FTS -999. for ACE-IMAGER TBD for ACE-MAESTRO	Float
Date	Date and time of occultation 30 km tangent point (UTC)	YYYY-MM-DD hh:mm:ss.ms+00	String
Date_MJD2000	Date and time in Modified Julian Date format (gives fractional part of day)	XXXX.xxxxxx	Double
Latitude	Latitude of 30 km tangent point for occultation	Degrees (±90, N = +, S = -)	Float
Longitude	Longitude of 30 km tangent point for occultation	Degrees (±180, E = +, W = -)	Float
Beta_angle	Beta angle of occultation (at 30 km tangent point)	Degrees	Float

Table 3: Attributes for Geometry section.

Field name	Description	Acceptable values / units	Type
Independent attribute			
Tangent_height	Retrieved tangent point altitude for each ACE-FTS measurement point during the occultation	Km	Float
The following attributes are defined at each tangent altitude			
Timestamp	Date and time of measurement (UTC)	YYYY-MM-DD hh:mm:ss.ms+00	String
J2000_x	Position of SCISAT-1 spacecraft in J2000 reference frame (x, y, and z coordinates)		Float
J2000_y			Float
J2000_z			Float
TP_latitude	Latitude of measurement tangent point	Degrees (±90, N = +, S = -)	Float
TP_longitude	Longitude of measurement tangent point	Degrees (±180, E = +, W = -)	Float
SZA	Solar zenith angle of measurement point	Degrees	Float

Note:
The TP_latitude and TP_longitude provide the "ground track" of the occultation measurement. They are calculated at each ACE-FTS measurement point using a refraction model. The ACE-FTS density profiles are used as inputs to this model.

Solar zenith angle values are calculated for the retrieved tangent heights from the ACE-FTS.

Table 4: Attributes for ACE-FTS Data section. The same format is used for the 1 km (L2_1km_grid) and retrieved (L2_retreival_grid) grid sections.

In File Header section: Process_level = L2 and Instrument = ACE-FTS_SCISAT-1			
Field name	**Description**	**Acceptable values / units**	**Type**
Global attributes for this section			
z_units	Units for altitude data	Km	String
T_units	Units for temperature data	K	String
P_units	Units for pressure data	atm (1 atm = 1.01325 bar)	String
Density_units	Units for atmospheric density data	cm^{-3}	String
Species_units	Units for chemical species	ppv (parts per volume) NOT ppm or ppb	String
Independent attribute			
Z	Tangent altitude grid for retrieved parameters and species	km	Float
The following attributes are defined at each tangent altitude			
T	Temperature	K	Float
T_fit	Values indicating if temperature was retrieved from data (1) or is set to the *a priori* value (0)	0 (not fit), 1 (fit)	Integer
P	Pressure	atm (1 atm = 1.01325 bar)	Float
Density	Atmospheric density	cm^{-3}	Float
H2O	Water vapor volume mixing ratio	ppv (parts per volume)	Float
H2O_err	Statistical error for water vapor retrieval from fitting (if this value is -888, the vmr is not retrieved. It is the value obtained by scaling the *a priori* value)	Ppv	Float
: Species (or isotopologues) and statistical errors are entered as shown above in order of retrieval H2O, O3, N2O, CO, CH4, NO, NO2, HNO3, HF, HCl, OCS, N2O5, ClONO2, HCN, CH3Cl, CF4, CCl2F2, CCl3F, COF2, C2H6, C2H2, CHF2Cl, HCOOH, SF6, ClO, HO2NO2, H2O2, HOCl, H2CO, CCl4, N2, CFC-113, HCFC-142b, H2O (181), H2O (171), H2O (162), CH4 (311), CH4 (212) :			

Notes:
The isotopologues are labeled using the same convention as the HITRAN database (the Air Force Geophysics Laboratory (AFGL) shorthand notation). For example, the minor water vapor isotopologues are labeled, 181 for $H_2{}^{18}O$, 171 for $H_2{}^{17}O$ and 162 for $HD^{16}O$. Only HDO is included in the current validation dataset.

Table 5: Attributes for ACE-IMAGER Data section (L2_imager_grid).

In File Header section: Process_level = L2 and Instrument = ACE-IMAGER_SCISAT-1			
Field name	**Description**	**Acceptable values / units**	**Type**
Global attributes for this section			
z_units	Units of altitude data	Km	String
Extinction_units	Units of atmospheric extinction data	km^{-1}	String
Independent attribute			
Z	Tangent altitude grid for retrieved parameters and species	km	Float
The following attributes are defined at each tangent altitude			
VIS_Ext	Atmospheric extinction at 525 nm	km^{-1}	Float
VIS_Ext_err	Statistical error for atmospheric extinction at 525 nm from fitting	km^{-1}	Float
NIR_Ext	Atmospheric extinction at 1020 nm	km^{-1}	Float
NIR_Ext_err	Statistical error for atmospheric extinction at 1020 nm from fitting	km^{-1}	Float

3. ACE-FTS Readme Files

ACE version 2.2 O3 update
October 26, 2005

Preliminary validation efforts with ozone suggested that the ACE-FTS retrieval results showed a low bias. The ozone microwindow set consisted of a set in the 1000-1150 cm-1 range and a set in 1830-2130 cm-1 range. Upon closer inspection, it seems that the spectroscopic information in the two regions is not entirely consistent. The latter microwindow set received a higher weighting in the fitting process (because the SNR was higher in that region) and ended up dominating the fit.

A new set of ozone microwindows was selected, restricting the selection to the 980-1130 cm-1 region. The software was upgraded to allow subsidiary isotopes as interferers. Ozone isotopologues 2 and 3 were included as interfers for the updated ozone retrievals.

Tropospheric ozone results showed higher than expected variability. A method used to accelerate the retrieval process runs into trouble where there are significant baseline effects. The speedup was removed for the ozone update.

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ACE version 2.2
May 24th, 2005

Please read the readme files from versions 1.0, 2.0, and 2.1 ACE-FTS processing.

The high altitude portion (i.e., above ~90 km) should be improved in this version.

The bug for the output on the retrieval grid (i.e., the tangrid files) has been fixed. One can use either the results on the retrieval grid or the results on the 1-km grid.

The following weak molecules have been added to the processing: HOCl, H2O2, and HO2NO2. This is a testing phase for these molecules. As with ClO, averaging results from different occultations may be required.

The retrieval of subsidiary isotopologues begins with this version. Note, however, that there appears to be a problem with HDO retrievals.

A change in the VMR retrieval approach made VMR profiles more susceptible to unphysical oscillations in version 2.0. Care should be taken when comparing to the results for a single ACE occultation. However, comparisons that employ average results from several ACE occultations should not be strongly affected. This problem is not present for any other version of the ACE-FTS processing.

August 24, 2005
Problems reported for version 2.2

In occultations with elevated levels of C2H6, there was on occasion a failure of the cross-correlation approach used to align the calculated and measured spectra. With the given first guess for the C2H6 profile, the measured and calculated spectra did not look similar enough for the cross-correlation approach to work properly. This will be fixed in the next processing version by increasing the microwindow width to include lines from interfering molecules, to better constrain the cross correlation approach.

C2H2 was retrieved only for a small number of occultations. The software occasionally crashed during C2H2 retrievals, and so it was taken out of the retrieval list.

Low altitude O3 (below ~10 km) sometimes shows variability higher than expected. An approach used to speed up the processing reduced the effectiveness of the retrieval for molecules with little information content at low altitudes when there were large baseline effects (i.e., the baseline was not close to 1 and/or had a large slope). There could be problems for other molecules with low information content at low altitudes such as HNO3 or HCl (i.e., molecules with much higher VMRs in the stratosphere than in the troposphere), although this has not been investigated fully.

Some occultations exhibited errors in temperature at high altitudes (above ~90 km). The cause was compensating errors in the retrieved temperature and CO2 VMR. Be prepared to discard some occultations when working above 90 km.

Some polar winter exhibited (likely unphysical) oscillations in the retrieved pressure and temperature in the stratosphere. Note, however, that the errors should compensate and should not translate to large errors in retrieved VMRs.

In the VMR retrievals, if there are two values reported in the lowest layer in the results on the retrieval grid (the tangrid files), it is an output error. There should only be one retrieved quantity in the middle of the layer. If, for example, it reports VMR values at 9.2 and 9.8 km, the value reported at 9.2 km should be ignored, and the value reported for 9.8 km actually corresponds to the middle of the layer (9.5 km).

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ACE version 2.1
May 24th, 2005

Please read the readme files from versions 1.0 and 2.0 ACE-FTS processing.

Version 2.1 processing was only performed on a subset of the measured occultations, mostly concentrating on the Arctic measurements during January-March 2005. There was significant ice contamination on the detectors during this time period. Results for some molecules are expected to be noisier than usual, particularly HCN. ClONO2 below 18 km could also exhibit increased noise.

The results on the retrieval grid (i.e., the "tangrid" files) did not always output properly. Use the results on the 1-km grid. (Only these results were submitted to the AVDC). Note that the same issue exists for version 2.0.

ClO was added to the retrievals. This is a very weak absorber, and so it may be better to average results for several occultations with similar conditions rather than considering the results from a single occultation. There only appears to be significant ClO present during the Arctic spring occultations in this data set.

C2H2 does not appear to be processing properly.

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ACE version 2.0
January 20, 2005

Please read the ACE_readme.txt file from ACE-FTS version 1.0 processing. The setup of the output files is the same as for version 1.0, although there are more molecules. Recall the papers available for background information:

Bernath, P.F et al., Atmospheric Chemistry Experiment (ACE): mission overview, Geophys. Res. Lett., submitted (2005)

Boone, C.D. et al., Retrievals for the Atmospheric Chemistry Experiment Fourier Transform Spectrometer, Geophys. Res. Lett., submitted (2005)

Pre-prints of the papers can be found on the following Web site:
http://www.ace.uwaterloo.ca/data

In the T_fit column, 1 and 0 are used to replace T and F, respectively, from the version 1.0 output format.

Version 2.0 output files give results on both the standard 1-km grid and on the measurement grid.

For version 2.0, problems encountered when measurement spacings were less than 1 km (the altitude grid spacing) have been addressed.

A slightly improved approach is used for interpolating onto the 1-km grid for forward model calculations. In version 1.0, you could get a (maximum 0.5 km) extrapolation that would serve to slightly enhance unphysical oscillations in the results (when they were present).

For pressure/temperature retrievals below 25 km, an empirical expression with four parameters is used for pressure retrievals (instead of using a parameter for each measurement).

For P/T processing, a bug was fixed whereby during retrievals below the "crossover", P and T were fixed to the results of the retrieval above the crossover (rather than being fixed to the a priori P and T).

The software was converted to use exclusively HITRAN molecule numbering (rather than using ATMOS molecule numbering with the HITRAN 2004 linelist). A mismatch between the assumed molecule numbering and the molecule numbers in the linelist caused some issues in the troposphere (because of "phantom interferences").

The ability to retrieve subsidiary isotopologues was implemented in the software. As of January 20th, 2005, the isotopologues were not being retrieved, awaiting completion of microwindow selection. A second pass with the software will fill in the isotopologue results. Note that HDO, which was included in the regular output files for version 1.0, will now be in a separate file with all of the other subsidiary isotopologues.

Columns in the output files exist for some weak absorbers (HO2NO2, H2O2, HOCl, H2CO, and HCOOH) that are not being retrieved. They will also be retrieved on a second pass of processing, once I am comfortable with the ability to retrieve them reliably.

With a broader sample of atmospheric conditions available for evaluating microwindows, the microwindow selection was revised to avoid instances of saturation. More microwindows were added at low altitudes for several molecules to improve tropospheric results.

H2O: Microwindows changed to (1) avoid saturation experienced for some occultations, (2) avoid the 3200 cm-1 region (which was strongly impacted by detector contamination), (3) improve tropospheric retrievals, and (4) have fewer interferences in the multiple molecule retrievals

O3: The upper altitude limit of the retrieval range was increased to 95 km. Microwindow selection was redone to avoid significant interference from the 668 and 686 isotopologues and to get more microwindows in the troposphere. More windows were also added in the vicinity of the O3 concentration peak.

N2O: More microwindows at lower altitudes, particularly for the troposphere.

CO: Microwindows were adjusted improve results at low altitudes, particularly for the troposphere.

NO2: The upper altitude limit was increased, mostly to capture the enhanced high altitude NOx observed during February, 2004.

HCl: More microwindows were added, particularly at high altitudes.

COF2: Microwindows were adjusted to avoid residual solar features.
More lines were included in the retrieval.

SF6: The upper altitude limit was lowered to improve retrievals.

The following molecules have been added for version 2.0 that were not retrieved in version 1.0:

OCS, HCN, CF4, CH3Cl, C2H2, C2H6, and N2

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ACE version 1.0
September 11, 2004

Some issues to be aware of with the ACE data

In the vmr results, an entry of -999 indicates that no retrieval was performed at that altitude. At high altitudes, above the highest measurement used in the analysis for a given molecule, I include a VERY rough estimate of the molecule's vmr (it is a constant times the a priori value, with the same constant used for all altitudes above the highest analysed measurement). These data are flagged by the uncertainties being set to -888. Do not trust these results too far above the highest analyzed measurement.

Pressure and temperature values were retrieved down to no lower than 12 km (the columun labelled T_Fit indicates whether temperature was retrieved at that altitude: T for True and F for False). Below 12 km, temperature and pressure were fixed to data from the Canadian Meteorological Center.

High altitude results (above about 95 km) should be viewed with skepticism. The temperature profiles above this altitude require further work.

No provision was made for identifying occultations with significant ice contamination on the FTS detectors. Therefore, some occultations (particularly earlier ones) could experience a deterioration of results at low altitudes, some molecules worse than others.

Uncertainties provided for the vmr results are statistical errors from the fitting process (1-sigma), and do not include systematic contributions. A more detailed error budget will be determined later.

The molecule NO sometimes has extremely low absorption through the mesosphere (increasing for both higher and lower altitudes). For such occultations, the retrieved NO profile through the mesosphere will look quite ugly. The results are to be ignored when this happens.

For occultations that cut out above 10-17 km (due to clouds), the bottom-most measurement often gives results that are clearly out (presumably from the clouds affecting the measurement just before the suntracker loses lock). Simply ignore the bottom point if it looks inconsistent.

For molecules with significant interferences (e.g., N2O5 and SF6), the vmr for the highest analyzed measurement is sometimes suspiciously high. I am investigating the cause of this. If you see a sharp increase in the highest retrieved points, don't trust it.

Chris Boone

4. ACE-IMAGER Readme Files

ACE-Imager retrievals version 2.2
August 24, 2005

The preliminary approach employed for calculating transmittances for the imagers uses ACE-FTS tangent heights for altitude registration.

A rotation is applied to measured images such that the rows of the transformed image are parallel to the Earth's horizon. The transformation uses the assumed orientation of the satellite for aligning the MAESTRO input slit to the horizon (accurate to +/- 1 degree). The images are corrected for items such as dark counts and secondary images.

Transmittances are calculated only for the pixels deemed to be in the center of the ACE-FTS field of view (FOV), as determined from the pre-launch registration measurements, and post-launch checks of the registration. The results are averaged for three pixels to improve the signal-to-noise ratio. The three pixels are within the FTS FOV and are from the same row of the rotated image (and thus have the same tangent altitude).

Tangent heights are assigned to the transmittance data through the timestamps of the ACE-FTS and imager measurements. The imager data is on a finer altitude grid, and so cubic spline interpolation is used to cast the ACE-FTS tangent heights onto the imager measurement grid. An offset in timestamp is required for relating the two data sets. The timestamp for the ACE-FTS measurements corresponds to the beginning of the scan (rather than the more appropriate middle of the FTS scan), and there is the possibility of additional offsets in the timestamps. The value selected for the offset was chosen such that cloud features in the extinction profiles for the imagers matched observations from cloud spectral features in the FTS. This leads to an altitude registration (~ 1 km) problem with a small set of SAGE III measurements we had available for comparison, but internal consistency was more important, because the ACE-FTS tangent heights were used for altitude registration, and pressure and temperature from the ACE-FTS retrievals were used for calculating refraction effects.

From the transmittance data, a profile for atmospheric extinction was retrieved. The retrieval is performed on a standard 1-km grid, because the altitude spacing of imager measurements is always less than 1 km.

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