AVDC TES Lite products user's guide

Disclaimer. This is a beta product intended to simplify TES data usage including data / model and data/data comparisons. This product can be used for science analysis as each data product is fully characterized. However, this initial Lite product should be considered a "beta" release as it is possible that there are post-processing artifacts in the products. Please report any issues to Susan Kulawik (susan.kulawik@jpl.nasa.gov).

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Abstract. The TES Lite products are meant to facilitate use of TES data by end users by (1) aggregating product resultsby month (no averaging is applied), (2) reducing data dimensionality to the retrieved pressure levels, which results in a minimal reduction of information but reduces data sizes by 1/3 to 1/10, (3) applying known corrections quantified through validation campaigns (4) combining data from ancillary files and multipleTES product files that are needed for science analysis (particularly for CH_4 and HDO), and (5) removing fields that are not typically used. For example, the HDO product also includes the H_2O product; it contains the recommended bias correction for HDO, results are mapped to 18 pressures, and the averaging kernel and error covariances are packed together from the H_2O, HDO, and ancillary individual product files into full matrices for easier use by modelers and for science analysis. The products include the mapping matrix to relate the reduced-size retrieval vectors, covariances, and averaging kernels back to the TES forward model pressure grid to support cross-comparison between products and models. NH_3 and CH_4 contain "Representative Tropospheric VMR" (RTVMR) fields (Payne et al., 2009) that map the full profile to levels that are most representative of the atmosphere based on the altitude dependent sensitivity of the estimate. Similarly to the TES L2 products, indexing is consistent across species, with fill and bad results interspersed with good data. Always check speciesRetrievalQuality is 1 (and o3_ccurve_qa is 1 for O3) to select good data.

1. Downloading

Lite data can be downloaded from the website for a few files at a time or in batch from commands from Christian Retscher. For example, to get all TES lite data:
wget -r -m -e robots=off -nH --no-parent --cut-dirs=4 --reject ".html*" 'http://avdc.gsfc.nasa.gov/pub/data/satellite/Aura/TES/V005/'*
To get TES CO2 lite data only:
wget -r -m -e robots=off -nH --no-parent --cut-dirs=4 --reject ".html*" 'http://avdc.gsfc.nasa.gov/pub/data/satellite/Aura/TES/V005/CO2/'*

2. Lite products levels:

CH4 (includes N2O): 25 levels
CO: 14 levels
CO2: 14 levels
HDO (includes H2O): 34 levels (17 each for H2O and HDO)
H2O: 17 levels
NH3: 14 levels
O3: 25 levels
TATM (atmospheric temperature): 27 levels

Information on TES L2 products can be found in the **TES user's guide:** **http://eosweb.larc.nasa.gov/PRODOCS/tes/UsersGuide/TES_L2_Data_Users_Guide.pdf.** Information specific toLite products is included here.

3. General notes

For good quality, select SpeciesRetrievalQuality == 1 (and O3_CCURVE_QA == 1, for ozone). "SPECIES" vector has retrieval results which is on "PRESSURE" pressure grid or "ALTITUDE" altitude grid (in meters). Time can be determined by "YEARFLOAT" which is the fraction of the year that has passed (e.g. 2010.3421) or "TIME" which is the tai time (# of seconds since January 1, 1993). GLOBALSURVEY == 1 means it is a global survey. If 0, it is a special observation. "RUN" gives run ID for each entry. This can be checked against the TES data calendar for more description and individual plots.

4. Specifics for particular Lite products

CO2: The averaging kernel and errors are corrected as indicated by Kulawik et al., 2012.The averaging kernel is corrected to reflect the actual sensitivity. The observation error is increased by a factor of 1.5 (this also affects the total error). There are 3 bias terms included in the product: bias2010, biasSpatial, and biasTimeDependent, all with units ppm. The bias-corrected value is species + (bias2010 + biasSpatial + biasTimeDependent) in VMR. The species field is bias corrected using the above equation and the original_species field is not. The CarbonTracker fields, ct_pressure, ct_co2, ct_latitude, ct_longitude, and ct_yearfloat, are the closest CarbonTracker matches from CT2011oi. ncep_temperature is the closest NCEP temperature at the following pressures: 1000,900,800,700,600,500,400,300,200,100,10 hPa. [For SIPS: I would like to include these fields. Is it OK or not? These are used for validation.]

HDO-H2O: The HDO (17 levels) and H2O (17 levels) results are stacked into one 34-level vector. The fill is put in at the front of each species, so HDO always starts at index 0 and H2O always starts at index 17. Corresponding to this 34-level result, the averaging kernel, observation error, measurement error, and total error for the off diagonal blocks are obtained from the ancillary products and stacked into 34x34 matrices to give the complete errors and sensitivity for the HDO-H2O results. HDO is bias corrected by the equation $\ln(\boldsymbol{HDO}_{\boldsymbol{corrected}}) = \ln(\boldsymbol{HDO}_{\boldsymbol{original}}) - \mathbf{A}_{\mathrm{DD}}\delta_{bias}$, where A_{DD} is the HDO

sub-block of the averaging kernel, and $\delta_{bias} = 0.00019 \times Pressure - 0.067$ from the surface to 316.227 hPa and 0 above 316.227 hPa (updated in lite v08)

For the averagingkernel (AK): there are 4 sub-blocks of the matrix [0,0], [1,0], [0,1], and [1,1]. Subblock [0,0] ranges from indices ns to 16, and subblock [1,1] ranges from indices 17+ns to 33, where ns are the # of fill values for H2O or HDO.

[0,0] block is the HDO AK
[1,1] block is H2O AK
[1,0] block is HDO_H2OAVERAGINGKERNEL
[0,1] block is H2O_HDOAVERAGINGKERNEL

For each error matrix:

[0,0] block is the HDO error matrix
[1,1] block is H2O error matrix
[1,0] block is the HDO_H2O*COVARIANCE error matrix from the ancillary file
[0,1] block is TRANSPOSE(HDO_H2O*COVARIANCE) error matrix from the ancillary file

NH3 This adds in a new quality flag, removing (by setting quality to bad) cases where the IG was set incorrectly (based on updates which will be in v006).Adds in the following RTVMR fields:

rtvmr: size 2 x n RTVMR value(s)
rtvmrPressure: size 2 x n: peak pressure for the RTVMR value(s)
rtvmrPressureBoundUpper: size 2 x n: bounding fwhm pressure
rtvmrPressureBoundLower: size 2 x n: bounding fwhm pressure
rtvmrErroTtotal: size 2 x n: sqrt(diagonal(RTVMR error matrix))
rtvmrErrorMeasurement: size 2 x n sqrt(diagonal(RTVMR meas error))
rtvmrErrorObservation: size 2 x n sqrt(diagonal(RTVMR obs. error))
rtvmrMap: 5 x #levels x n: map used for RTVMR
rtvmrPressureMap: 5 x n: pressures used for RTVMR map

Note that the rtmvrmap can be used to transform any field into the RTVMR qualitites; where index 1 is the RTVMR quantity (starting at index 0) for a 4-level transform, and index 1 and 2 are the RTVMR quantities for a 5-level transform.

CH4. We use N2O (which does not vary significantly in the Troposphere) to correct CH4 results, so N2O information is included in the Lite product. We include CH4 corrected by the N2O result (Worden et al., 2012). We also include all the RTVMR fields described in the NH3 section.

constraintVector_N2O: for v005, updated to v006 N2O climatology
species_N2O: N2O results with new constraint vector swapped in
original_species_N2O
original_constraintVector_N2O
averagingKernel_N2O
observationErrorCovariance_N2O

species_N2Ocorrected: CH4 corrected using the equation:
species_N2Ocorrected = EXP(ALOG(species +
ALOG(constraintVector_N2O) – species_N2O))
variabilitych4_qa = standard deviation of CH4 below 200 mb / mean of CH4 below 200 mb
variabilityN2O_qa = standard deviation of N2O below 350 mb / mean of N2O below 350 mb
stratosphere_qa = fraction of the sensitivity in the stratosphere for the 562 hPa level.

5. Version update log

Version v02: July, 2012

Prepend "grid_" to variables that define dimensions in netcdf file. Change levels variables to have actual pressures. Grid variable names are now: grid_pressure_fm, grid_pressure, grid_pressure_composite (HDO only), and grid_targets (just an index array counting # of targets)

Add two variables to NH3 file:

Thermalcontrastinitial = surface temperature – lowest atmospheric temperature

Thermalcontrast: same, except from retrieved values

For HDO, check that water value below 200 mb initial values are > 1e-16, and value is not more than 1000x times larger than the level below it. If these conditions are not met, then speciesretrievalqualityis set to 0 for this case.

For CH4 add stratosphere_qa, which is fraction of the sensitivity in the stratosphere for the 562 hPa level.

Added H2O lite product. (H2O is also found in the HDO lite product).

Version v03: August, 2012 (L2v005_Litev003)

Update levels to include retrieval levels close to the surface pressure

NH3 and CH4 RTVMR updates: update RTVMR indexing to be fill-first when applicable.

Fix an indexing bug in H2O, CO, O3, TATM lite products that caused a fraction of targets to be skipped and a fraction of targets to be included twice

Version v04: September, 2012 (L2v005_Litev004)

Update grid pressure value to be consistent with target pressures

All v5 data processed after 2005

CO2 added fields for matching CarbonTracker values (version CT2011):
ct_pressure, ct_co2, ct_latitude, ct_longitude, ct_yearfloat

Version v05: September, 2012 (L2v005_Litev005): complete TES dataset for GS

Updated CH4 RTVMR to use the corrected CH4 results and move original results to original_species, and put N2O corrected CH4 values into "species". The N2O prior is now corrected by the formal R13 climatology.

Version v06: November, 2012 (L2v005_Litev06): complete TES dataset

Complete TES dataset (through present)

Updated HDO files: add separate entries for H2O and HDO profile values. Intersperse fill rather than putting fill all at the front. So HDO always starts at index 0 and H2O always starts at index 17.

Added fields ct_co2, ct_co2_ak, ct_pressure, etc. to TES CO2 products. These are the CT2011 CO2 fields matching TES locations. Ct_co2_ak has the TES observation operator applied and is on TES pressure levels. Other quantities are on the CT2011 native pressure grid. Added fields for bias correction: bias_global, bias_time, bias_2010, bias_spatial to represent bias corrections from the different sources for each observation. Added ncep_temperature and ncep_pressure with matching NCEP temperature values.

Version v07: Sept, 2013 (L2v005_Litev07): complete TES v5 dataset.

Updates for CO2 fields to set species to corrected CO2 values and CarbonTracker fields to CT2011oi.

Version v08: Sept, 2013 (L2v006_Litev08):

HDO bias updated (see HDO section). HDO: take out fields HDO and H2O. Use the stacked "species" field to get HDO and H2O. Add field HDO_H2O, which is a duplicate of field species.

Add species CH3OH and HCOOH which have same fields as NH3 (v006 TES output only).

O3IRK update mapping to fix NaN's

Change YYYYMMDD variable to *not* contain day fraction

Add UT_Hour which, combined with YYYYMMDD above creates complete time.

6. References

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