

Aura CO profiles generated by combining TES and MLS measurements

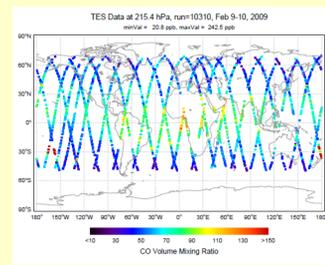
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Jet Propulsion Laboratory, Pasadena, CA for Aura Science Meeting, Sept 27-30, 2010, Boulder CO

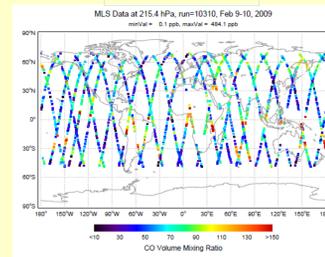
1. Description

We describe the algorithm, the processing procedures, and prototyping results for producing Aura CO profiles using TES and MLS measurements. TES and MLS instrument are both on the Aura satellite, and their CO profile retrievals are sensitive respectively to lower-mid troposphere for TES and upper troposphere and above for MLS. TES nadir and MLS limb locations can be paired **within 6-8 min and less than 220km**. Optimally combining the radiance measurements from the two instruments improves the vertical resolution and coverage of the retrieved CO profiles. This new Aura CO profile product will provide unique data sets to studies on tropospheric transport of air pollutants and troposphere-stratospheric exchange processes.

TES V005

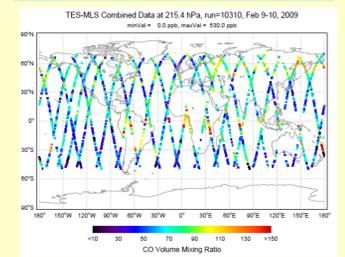


MLS V3.3

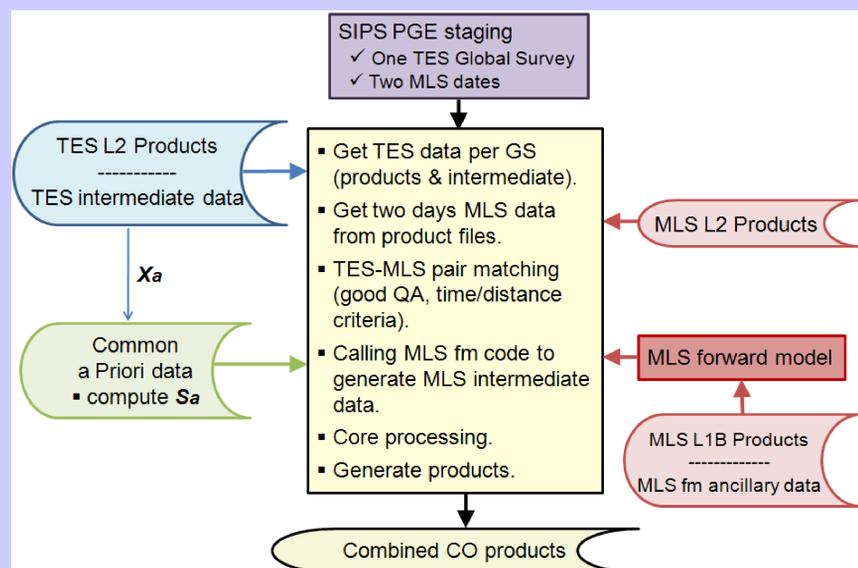


Example: CO Volume Mixing Ratio at 215 hPa, Feb 9-10, 2009

TES-MLS Combined



2. Processing



3. Algorithm

Optimal combination: $\hat{x}_t = x_{a_com} + \hat{S}_t \left[K_{TES}^T S_{y_TES}^{-1} (y_{TES} - FM_{TES}(x_{a_com})) + K_{MLS}^T S_{y_MLS}^{-1} (y_{MLS} - FM_{MLS}(x_{a_com})) \right]$

The total error and averaging kernel:

$$\hat{S}_t = \left(K_{TES}^T S_{y_TES}^{-1} K_{TES} + K_{MLS}^T S_{y_MLS}^{-1} K_{MLS} + S_{a_com_constraint}^{-1} \right)^{-1}$$

$$A = \hat{S}_t \left(K_{TES}^T S_{y_TES}^{-1} K_{TES} + K_{MLS}^T S_{y_MLS}^{-1} K_{MLS} \right)$$

Assumption: $FM_{TES}(x_{ret}) = FM_{TES}(x_a) + K_{TES}(x_{ret} - x_a)$

The final equation:

$$\hat{x}_t = x_{a_com} + \hat{S}_t \left[K_{TES}^T S_{y_TES}^{-1} (y_{TES} - FM_{TES}(x_{ret_TES})) + K_{TES}^T S_{y_TES}^{-1} K_{TES} (x_{ret_TES} - x_{a_com}) + K_{MLS}^T S_{y_MLS}^{-1} (y_{MLS} - FM_{MLS}(x_{a_com})) \right]$$

Terms:

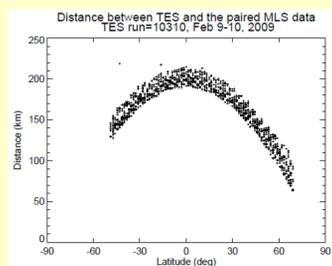
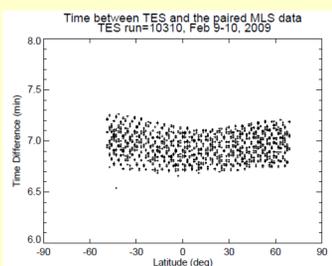
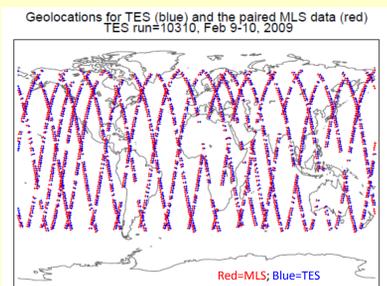
- x_{a_com} : x_{ret_TES} : common a Priori profile and TES retrieved profile.
- y_a, S_{y_a} : measurement spectra and measurement noise.
- FM_* and K_* : model spectra and Jacobian.
- S_a : common constraint.

4. TES and MLS Data Matching.

Combined-product file granule: per TES GS.

Data matching:

- Identify the two MLS days (data files) for the give TES GS.
- Loop over all TES scenes with good QA in CO retrieval.
- For a given TES scene, find MLS profiles within 6-8min of TES and good MLS QA for CO retrieval.
- For those identified above, find the MLS profile closest to TES location.
- Remove those TES-MLS pairs > 220 km due to QA absent data in both instrument.



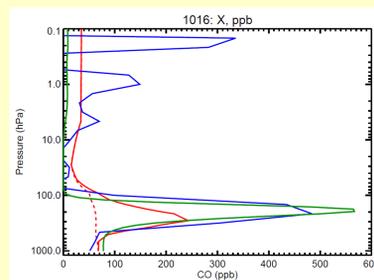
5. Prototyping Example.

Status:

- MLS team is building the fast forward model to be used for computing radiance residual and Jacobians.
- TES team is defining the database for storing 'intermediate data' to be produced in the new version processing (V005).
- Prototyping of the combination is in progress, including examining the effects of TES and MLS terms and the common constraint.
- Data validation will be defined following existing works for validating TES and MLS CO products.

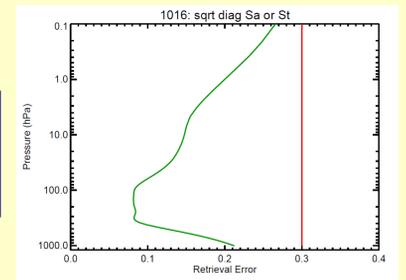
CO profiles for a scene with enhanced CO due to Australia fire:

- TES retrieval and X_a .
- MLS retrieval
- Combined profile



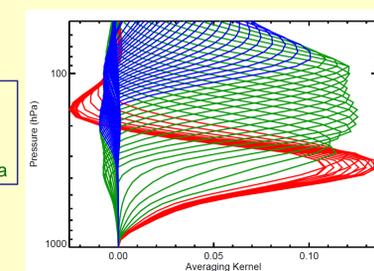
Retrieval Errors:

- a Priori (sqrt of diag S_a).
- Combined (sqrt of diag S_t).



Averaging Kernel:

- Pres > 316 hPa
- Pres < 68 hPa
- 68 hPa < Pres < 316 hPa



DOF of combined CO for surface - 50 hPa. Note TES DOFs are < 2.

