MOPITT V3 Level 2 Data Quality Summary

The following information applies to MOPITT level 2 (L2) data, Version 3 (V3; L2V5.5.1)
September 4, 2002

CO Profiles and Total columns

Carbon monoxide (CO) mixing ratio profiles are retrieved on the 6 standard MOPITT pressure levels: 850, 700, 500, 350, 250, 150 hPa, and at the surface, for global clear sky measurements. CO total columns are calculated from a 35 level representation of the profiles employed by the retrieval forward model using the corresponding temperature and surface pressure fields from the NCEP archived history tapes. The horizontal footprint of each MOPITT retrieval is 22 km by 22 km. The contents of Level 2 (MOP02) files are given in the MOPITT File Spec on the NCAR MOPITT Data Description page.

Estimated errors

For CO vertical profiles, estimated errors are available in the error field (2nd element) of the "CO Mixing Ratio" and "Retrieval Bottom CO Mixing Ratio" variables of the MOP02-files. These values depend on the smoothing error, model parameter error, forward model error, and error due to instrument noise (Rodgers, 1995). The major error is expected to be due to smoothing error. Additional specification of the retrieval errors can be found in the "Retrieval Error Covariance Matrix" variable. At 500 hPa, the retrieval uncertainties are approximately 20% in the tropics and at mid-latitudes, and 30-40% at high latitudes.

Missing data when surface pressure < 850 mb

For the 'standard' case (p_sfc > 850 mb), there are 7 valid levels in the retrieved profile, and the retrieved error covariance matrix C_x is a symmetric 7 by 7 matrix. In the level 2 product, only the 21 independent off-diagonal elements in the upper right triangular section of C_x are reported. This is called the 'covariance vector.' The 21 elements are reported in the following order: First the six off-diagonal elements of the first row, then the five off-diagonal elements of the second row, and so on, finally ending with the single off-diagonal element in the sixth row. (The first row and column represent the surface level, and the last row and column represent 150 mb).

For the case where 700 mb < p_sfc < 850 mb, the surface level moves to the second row and column of C_x. In this case, the first row and column of C_x is populated by the value 0. Rows 3-7 and columns 3-7 have the same meaning as for the standard case. A total of 21 elements are still reported in the 'covariance vector.' However, in this case, the first six elements of the covariance vector (representing the 'missing' 850 mb level) will all be 0. The next five elements describe the covariances between the surface level and the five fixed levels. For cases where there are even more missing levels (e.g., p_sfc < 700 mb), the surface level always skips down to replace the missing level closest to p_sfc.

For the vertical profile mixing ratios, the values at the standard rertrieval levels that are greater than the surface pressure will be reported as "nodata" (-9999).

Cloud detection

The location of cloud is determined using a combination of information from MOPITT radiances and the MODIS Cloud Mask, providing retrievals at all latitudes. A Cloud Description flag is provided in MOPITT level-2 products for each pixel. When both MOPITT radiances and MODIS cloud mask are used and agree the Cloud Description is 2. When MODIS cloud mask states clear for a pixel and MOPITT radiances indicate cloudy the pixel is treated as clear and the Cloud Description is 3. In the case that MODIS cloud mask is not available, only MOPITT radiances are used. Cloud Description is 0 if both MOPITT thermal and solar channels are used for cloud detection, and 1 if only thermal radiances are used. Poleward of 65N/S only MODIS cloud mask is used and the Cloud Description is 5.

A major advantage of V3 MOPITT cloud detection is to recover the pixels over low cloud that MOPITT radiance is not sensitive to. When a pixel is identified as clear (from MOPITT radiances) and MODIS cloud mask classifies it as cloudy, additional tests are used. These tests identify low cloud based on MODIS cloud test flags. A Cloud Description 4 is assigned when MOPITT CO retrieval over low cloud is provided.

Data Interpretation

Averaging Kernels. The averaging kernels for each retrieval can be calculated from the retrieval covariance matrix and the a priori profile and a priori covariance matrix. Averaging kernels indicate the sensitivity of the retrievals to different levels of the atmosphere, and must be examined in order to properly interpret the retrieved data. A detailed description of the calculation and use of averaging kernels is available at the NCAR MOPITT Data page.

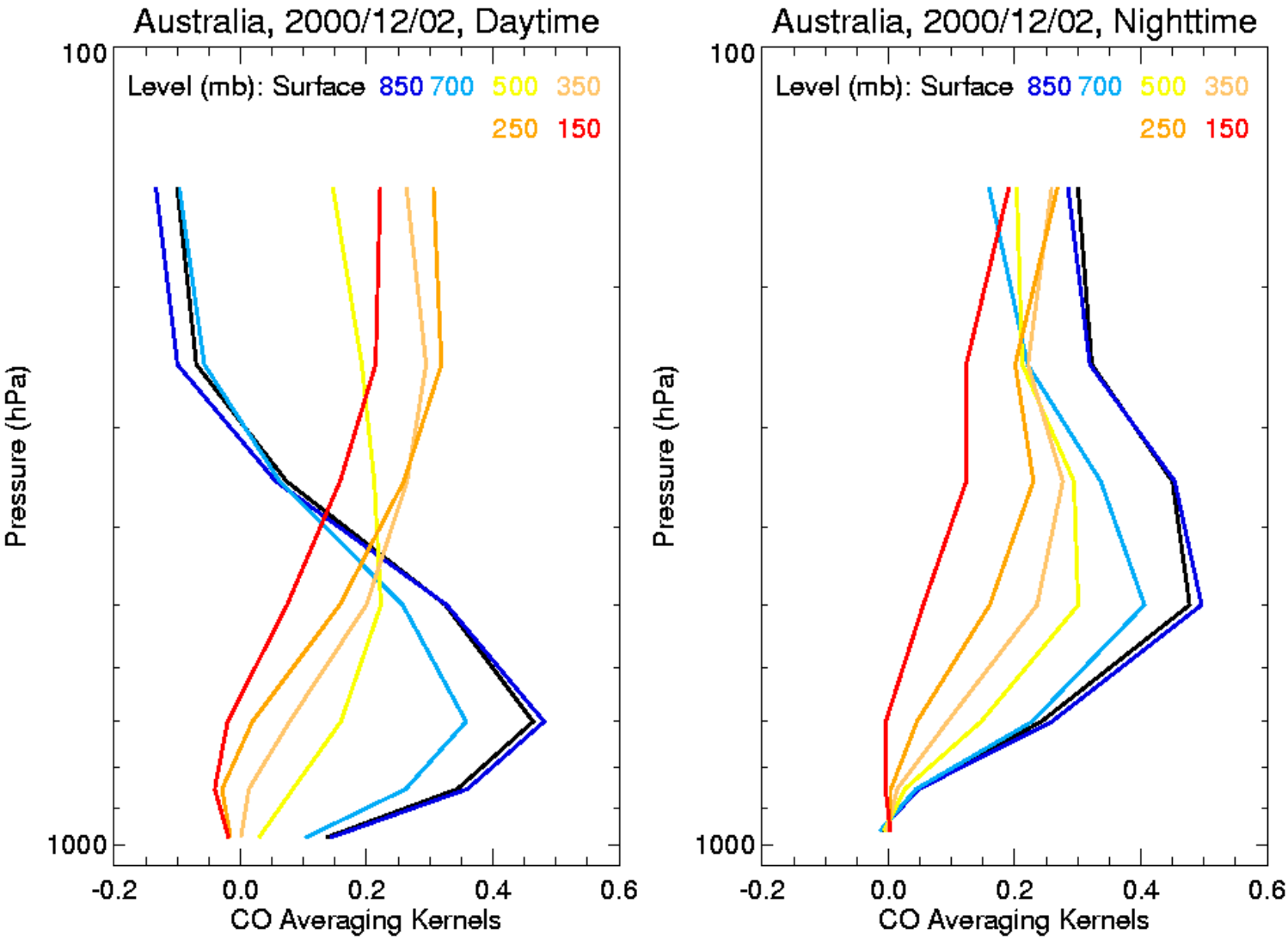
A priori fraction. The variables "CO Mixing Ratio Percent Apriori" and "Retrieval Bottom CO Mixing Ratio Percent Apriori" give the fraction of information in each retrieval that came from the a priori. This variable indicates how much the actual measurement contributed to the final retrieval. It is recommended to filter out data with a very high fraction a priori, with a limit appropriate for the specific study.

Lower bounds. CO profiles that have values of 5 ppbv should not be used as that is an indication that the retrieval did not converge properly and is not reasonable. In addition, retrieved profiles with values below about 40 ppbv at 500 hPa should be treated with caution.

High latitude data. Retrievals south of 65S and north of 65N should be used with caution. The a priori fraction provides a valuable measure of the reliability of retrievals in this region. However, even retrievals with a low a priori fraction, may produce erroneous retrievals due to errors in cloud detection, and due to difficulties in performing retrievals over icy surfaces.

Day-Night and Land-Ocean differences. Due to the sensitivity of the retrievals to surface temperature, differences between day and night will appear in retrievals over land. The averaging kernels show how the sensitivity to CO in the lower troposphere is reduced over cold surfaces. At land-ocean boundaries, similar differences can be seen. These differences should not be interpreted as changes in the atmospheric concentration of CO, but are due solely to the change in sensitivity of the measurement over different surfaces.

Example over Australia



Validation

MOPITT CO mixing ratios have been validated with numerous aircraft profiles measured by Paul Novelli at NOAA/CMDL, as well as with independent campaigns, such as SAFARI-2000 and TRACE-P. Validation results for V3 retrievals indicate MOPITT CO mixing ratios are slightly high, with approximately 10-20 ppbv bias at 700 hPa and <5 ppbv at 250 hPa. See MOPITT Validation of MOPITT CO mixing ratio and column retrievals for additional information.

CH4 Total Columns

Methane (CH4) retrievals are not available in this data version.