Estimate of the Global Carbon Monoxide Budget Derived From MOPITT Data

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Introduction

Carbon monoxide (CO) influences the oxidizing capacity of the troposphere as the major sink of the OH radical. Thus it is very important to have an accurate estimate of the atmospheric CO budget. It is well known that CO concentrations are higher in the northern hemisphere than in the southern hemisphere (fig.1 A). However, another important source of CO is biomass burning, much of which takes place in the southern tropics. Figure 1 B) also shows that Indonesia is another very significant source. Many of these fires are fueled by peat that smoulders and has a high carbon content.

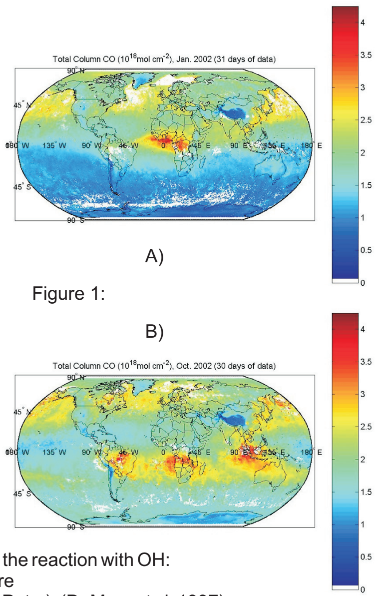

Figure 1:

Method

- ➔ Losses were calculated for the reaction with OH:
  L = k * [OH] [CO], where
  k = 1.5e-13 * (1 + 0.6 * Patm). (DeMore et al. 1997)
- ➔ Reference profiles of OH and air density were used from the model of Anderson et al. (1986)
- ➔ The total loss was estimated by integrating the loss rate over the month
- ➔ Net-change in CO amount was calculated between successive months.
- ➔ The sum of the net change and the losses within one month equals the emission.
  Source (CO) = Net Change (CO) + OH Losses (CO)
- ➔ Monthly values were added up to give the annual budget.

References

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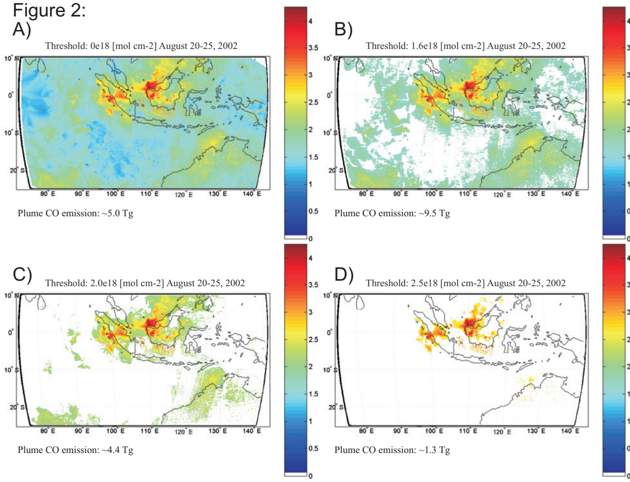
Estimate of global budget

Reference	Total Sources [Tg/yr]	OH reaction sink [Tg/yr]
[1]Logan et al. 1981	2736	
[2]Allen et al. 1996	2039	
[3]SAR 1996	1800-2700	1500-2700
[4]Hauglustaine et al.1998	2100	1920
[5]Khalil et al. 1999	2500	
[6]Bergamasschi et al. 2000	2860	
[7]TAR 2001	2780	
MOPITT	1900-2230	1890-2185

Emissions in Indonesia 2002

- Region: 10°N to 25°S and 75°W to 141°W (see also fig. 2)
- assume changes due to transport to be small
- combine CO columns and vmr into 6-day bins
- interpolate columns and vmr on regular grid (0.1° resolution) to compensate for missing data points.
- filter data with threshold (as given in figure 3)
- only grid cells exceeding threshold are populated
- define populated grid points as being within the plume
- multiply populated grid cell by its area and sum
- calculate amount, net change and losses as described in 'Method'

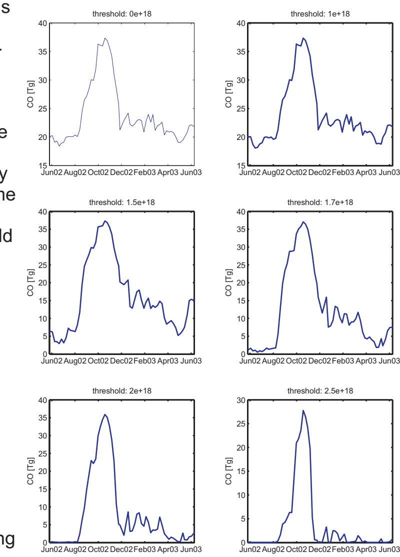
Figure 2:



An example of the plume size variation for different thresholds is given in figure 2. Shown are MOPITT CO column measurements for August 20-25, 2002. In fig. 2 A (threshold of 0) all values of CO are included within the plume and the plume 'area' coincides with the box. With increasing thresholds only areas associated with the plume are taken into account (B,C). Further increasing the threshold (D) will underestimate the plume size.

Figure 3 shows the time evolution of the CO amounts within the plume for different threshold values. For lower thresholds, the total CO assigned to the plume starts with a positive offset. It decreases with increasing threshold. Ideally the plume should correspond to a threshold so that there is no offset before or after the burning period.

Figure 3:



The emission remains relatively unchanged between 1.5-1.7x10e^{18} molecule cm^{-2}, indicating that the nominal threshold for a realistic estimate of the plume lies in this range. For this value the estimated CO emission appears to be ~66 Tg.

Conclusion

CO Budget:

- Emissions of 1900 - 2230 Tg/year (with OH as primary sink)
- Near the lower end of earlier budget estimates
- Inclusion of ground deposition as additional sink would increase emissions to values quite similar to an earlier estimates.

Estimated CO emissions in Indonesia (2002):

- 66 Tg CO between August 1 and December 5.
- This is about half of the emissions estimated for the fires in 1997.

Acknowledgements

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