THE IMPACT OF MOPITT DATA ON TROPOSPHERIC CHEMISTRY

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1. INTRODUCTION

The launch of the Measurement Of Pollutants In The Troposphere (MOPITT) experiment on the EOS Terra spacecraft ushered in a new era in tropospheric chemistry. MOPITT measures the tropospheric concentrations of carbon monoxide (CO) from 80°S to 80°N. Prior to MOPITT, a few shuttle missions with the Measurement of Air Pollution from Satellites (MAPS) experiment flew 4 times on the space shuttle [1]. This provided the first brief global measurements of tropospheric column CO, and indications that the CO distribution was more complex than believed.

CO is produced by the incomplete combustion from natural and anthropogenic sources, as well as the oxidation of methane and other organic gases. CO is present in the troposphere with mixing ratios of ~ 60 parts per billion by volume (ppbv) in the relatively clean Southern Hemisphere to ≥ 300ppbv in polluted situations in the Northern Hemisphere.

2. MOPITT OBSERVATIONS OF SOURCES AND VARIABILITY

With MOPITT it became possible for the first time to observe the global distribution of a major pollutant gas with important roles in tropospheric chemistry with relevance to climate effects. Ten years of these data have provided comprehensive looks at the time variations of the horizontal and vertical distributions of this gas, showing its annual and inter-annual variations. From this an understanding of the processes that create and maintain these distributions of CO has been greatly

improved. The existence of these data have also led to the development of a wider understanding of the products of remote sensing by the user community. Interactions with models have also led to new ways of improving the recovery of information from them.

A first review of the annual variations of CO shows a number of regularly occurring major events. From December until March, fires in Africa south of the Sahara occur, releasing significant amounts of CO into the atmosphere at low latitudes. It becomes entrained in the tropical easterlies, and plumes of high CO can be tracked across the Atlantic, and often across northern South America into the Eastern Pacific [2].

March and April are also months in which there are large sources, from anthropogenic and biomass burning, in Southeast Asia. Plumes from these sources regularly cross the Pacific and reach the West Coast of North America, where they can impact local air quality [3].

During the northern winter the CO concentrations in the Northern Hemisphere are considerably higher than those in the Southern Hemisphere, reflecting the larger anthropogenic sources there, and longer lifetimes. In northern summer, when temperatures and therefore water vapor are higher, and there is more sunlight, more hydroxyl radical (OH) is created. The OH reacts to remove CO, resulting in the CO concentrations being similar in the two hemispheres.

Beginning in August, there are many fires in the Congo region in Africa, continuing into the autumn. Burning in the Amazon region begins slightly later. Some of the CO plumes from Africa again are carried across the South Atlantic. However, most of the African plumes, joined by air from South America, flow southward and eastward, in the mid-latitude westerly's. Some of the longest-lived plumes can be identified from these sources, as they flow across the Indian Ocean, Australia, past New Zealand, and back to southern South America [4].

In addition to these regular sources, it is now appreciated that the largest variability can be caused by irregular sources. A prime example of these is the fires in the Indonesian region that are related to El Nino-Southern Oscillation (ENSO) changes. Another example is boreal fires- fires at high northern

latitudes in Siberia, Alaska or Canada that can produce large amounts of CO. (Alaskan fires in 2004 are calculated to have emitted as much as anthropogenic emissions in the continental U.S.,[5])

3. DATA ASSIMILATION AND ESTIMATION OF SOURCE STRENGTHS

The advent of MOPITT data has spurred the use of data assimilation techniques, in order to allow numerical chemical transport models (CTM's) to fill in details that are not immediately available in the MOPITT retrievals. With their ability to provide data at all locations and at uniform times, they readily lead to illustrative animations of the data and readily understandable visualization of transports and pollutant events.

A more scientifically important role of data assimilation is in the estimation of the strengths and locations of CO sources. By adjusting these, in conjunction with an inversion algorithm and a CTM, it is possible to obtain a "top down" estimate of sources, which generally are significant improvements on ground-based "bottoms up" estimates. An important further advance has been the use of adjoint models of the CTM's, to allow determination of source regions with much improved spatial resolution, down to the model resolution [6].

4. COMBINING NIR WITH TIR SIGNALS

The present MOPITT data version, V4, relies on the 4.7mm emission, in the thermal infrared (TIR). Recent work has shown that it is also possible to incorporate the reflected solar signal in the near infrared (NIR) at 2.2 mm [7]. The reflected signal provides considerable additional information on CO concentrations at the surface, although is only available in daytime over land. Combining them will improve estimates of emissions from urban regions. It will also reduce the dependence of the inverse modeling of sources on the models representation of the mixing between the boundary layer and the free troposphere. This will also make the surface source estimates of more value for improving models of CO_2 sources.

5. REFERENCES

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