POTENTIAL CORRELATIONS OF TROPOGRAPHY WITH TROPOSPHERIC CARBON MONOXIDE ON VENUS. C. C. C. Tsang[1] and K. McGouldrick[2], [1]Southwest Research Institute, Department of Space Studies, 1050 Walnut Street, Suite 300, Boulder, Colorado, 80302, USA (con@boulder.swri.edu), [2]University of Colorado, Laboratory for Atmospheric and Space Physics, Discovery Drive, Boulder, Colorado, 80302, USA

Introduction:

The understanding of spatial and temporal variations in tropospheric abundances of trace gases such as carbon monoxide (CO) is key to understanding the deep atmosphere of Venus. These gases are entrained in the global circulation, as well as being key ingredients to creating the sulfuric acid clouds. Long-term temporal variations of these species across Venus's disc would be provide key insights into the large-scale circulation and cloud forming processes in the troposphere. CO used as an atmospheric tracer provides the deepest probe into the atmosphere where circulation patterns can be studied.

Background:

The Venus Express spacecraft orbited Venus from April 2006 to December 2014. The Visible and Infrared Thermal Imaging Spectrometer (VIRTIS) is an imaging spectrometer that covers 0.3 to 5.0 µm. Nightside thermal emission at 2.35 µm is sensitive to CO (2-0 vibrational band) at 35 km above the surface, approximately 15 km below the lower cloud layer. Previous measurements prior to Venus Express, largely ground-based studies, have focused on the general equator-to-pole trend of CO, up to latitudes of ~60N/S [1, 2]. After arriving at Venus, Venus Express measured abundances of CO and other trace abundances systematically. Measurements by VIRTIS of the near-infrared nightside thermal emissions were conducted from April 2006 through October 2008, when the MIR channel ceased operations. Until now, this has lead to small-scale maps of CO being produced [3] and examination of correlations between CO and OCS [4, 5]. Longer term and more global studies have also been conducted. Band-ratio techniques were developed so that studies into CO over the large number of observations could be possible [6], and global synoptic picture of CO and other species could be conducted [7]. Further ground-based observations have confirmed some of these findings [8, 9].

Motivation:

However, global maps of CO as a function of latitude, longitude, local solar time, and solar time, using the full dataset from Venus Express have yet to be produced. Here, we produce the first full 2D maps of this kind over a number of years, to get as global a picture of CO at 35 km as possible, thereby allowing constraints to be placed on future general circulation models. This work is also being conducted in conjunction with a study of long-term variations of 1.73 µm thermal emission brightnesses, a proxy of cloud optical depth in the lower atmosphere, with the same data [10]. This will allow us to search for potential correlations between time varying features in the zonal wind at the cloud base, and the CO abundance lower down in the atmosphere.

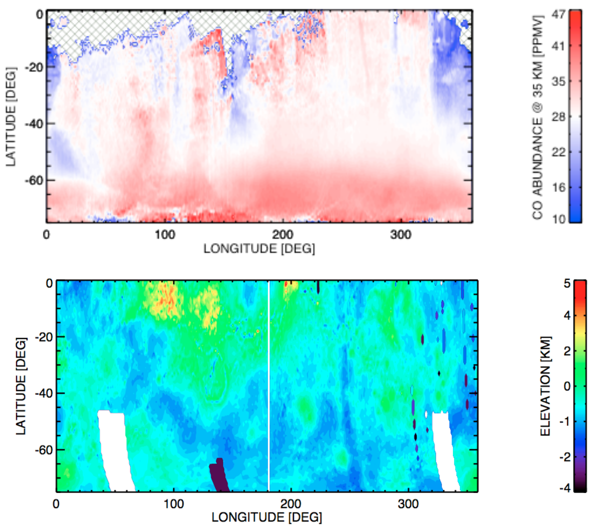
Data and Method:

We have analyzed almost 1 year of data, from April 2006 through March 2007, which includes all observations with integration times greater than 0.3 seconds. Values of radiances and CO are averaged over 1°x1° in longitude and latitude, and 1hr local time. To be conservative, we reject pixels with incidence angles less than 100 degrees, and emission angles greater than 80 degrees. We also reject values with high cloud opacity that have 2.30 µm radiances below 0.02 $W/m^2/sr/\mu m$. This produces a dataset that includes a total of 816 individual observations, spanning 255 unique days. Following a validated method [7], we derive the CO concentration by ratioing the 2.32µm flux to the 2.29 µm flux. Maps of CO, from 20°S to 75°S, as a function of latitude, longitude, local solar time and time are created.

Results:

A map of CO in local solar time during the evening and morning hemispheres is produced. Initial results indicate the evening hemisphere shows the strongest equilibrating flow of CO from pole to equator, is at 22hr. The weakest flow seems to be at 04 hr on the morning side, where the gradient is strongest. A map of CO in longitude shows the general expected equator-pole trend. However, tentative indications show a minimum at longitudes centered around 0°, which may correlate to surface topography.

A time varying nature of CO is also discovered, where on one hand, the CO gradient is completely absent in the troposphere, and on other days, the CO gradient is incredibly strong. These results need to be confirmed with further scrutiny of the data, not least because the data analyzed in this presentation only comprise approximately half of the total data available.



Conclusions:

We are in the mist of conducting a large-scale study of CO in the troposphere of Venus with 50% of the VIRTIS-MIR data analyzed. We confirm a correlation of CO with LST, and potential correlations of CO with certain planetocentric longitudes. Day to day variation of CO is also seen, as observed in previous works. Future work will confirm these observations, including the search for potential periodic features seen in the day-to-day data.

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References:

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