Tracer transport differences: Challenges and implications for flux inversions

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Transport differences

Even when using identical surface fluxes and initial conditions, the GEOS GCM and TM-5 CTM produce fields of CO_2 with noticeable differences in the zonal & monthly mean structure.

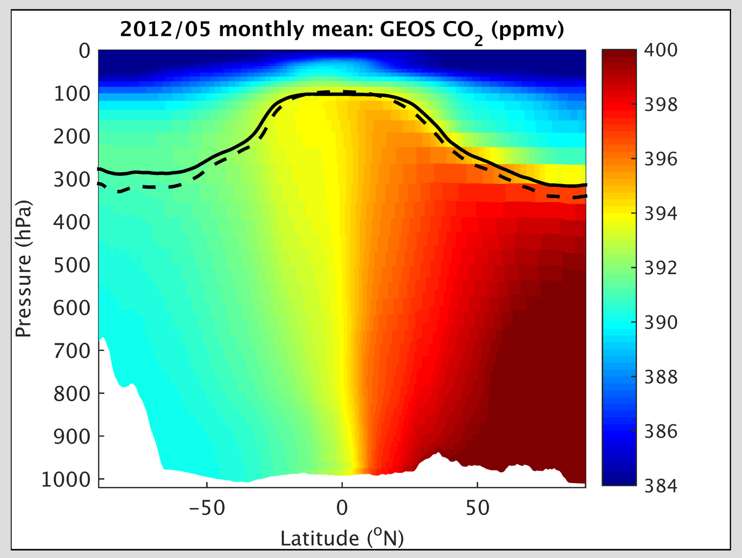


Fig 1. Zonal mean GEOS predicted values for May 2012.

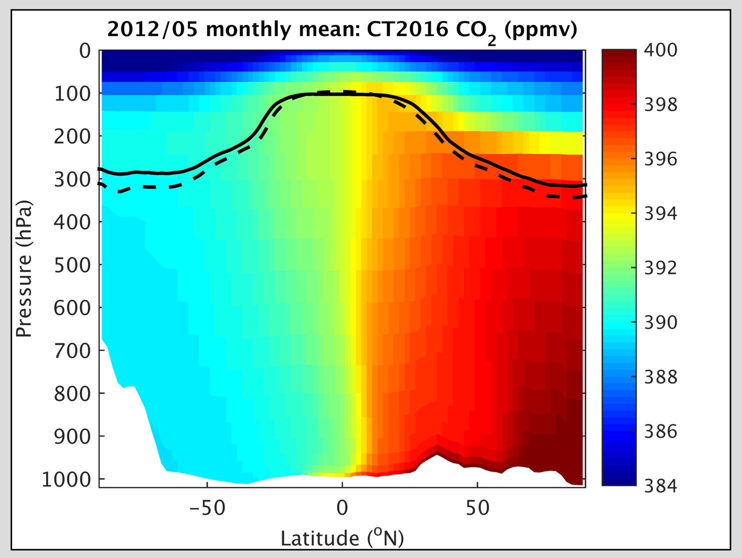


Fig 2. Zonal mean TM-5 predicted values for May 2012.

The NASA GMAO analysis system blends observations (top) with GEOS model predictions (bottom) to estimate the full 3D state of CO_2 every 3 hours (middle).

These differences have coherent regional and seasonal patterns that are great enough to be aliased onto the surface fluxes inferred from an inversion of atmospheric measurements.

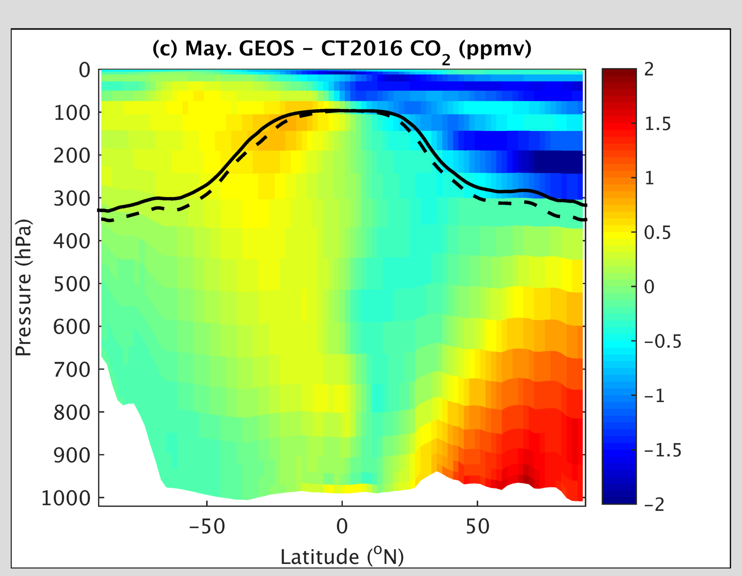


Fig 3. Difference between GEOS and TM-5 predicted values.

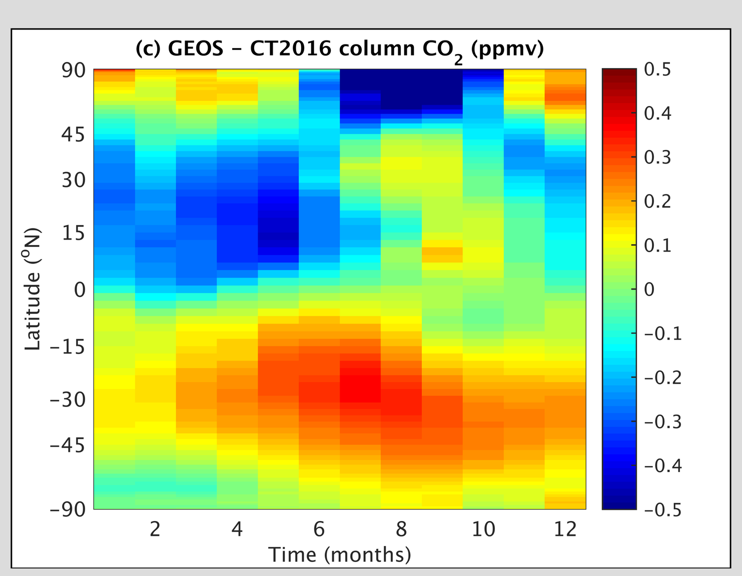
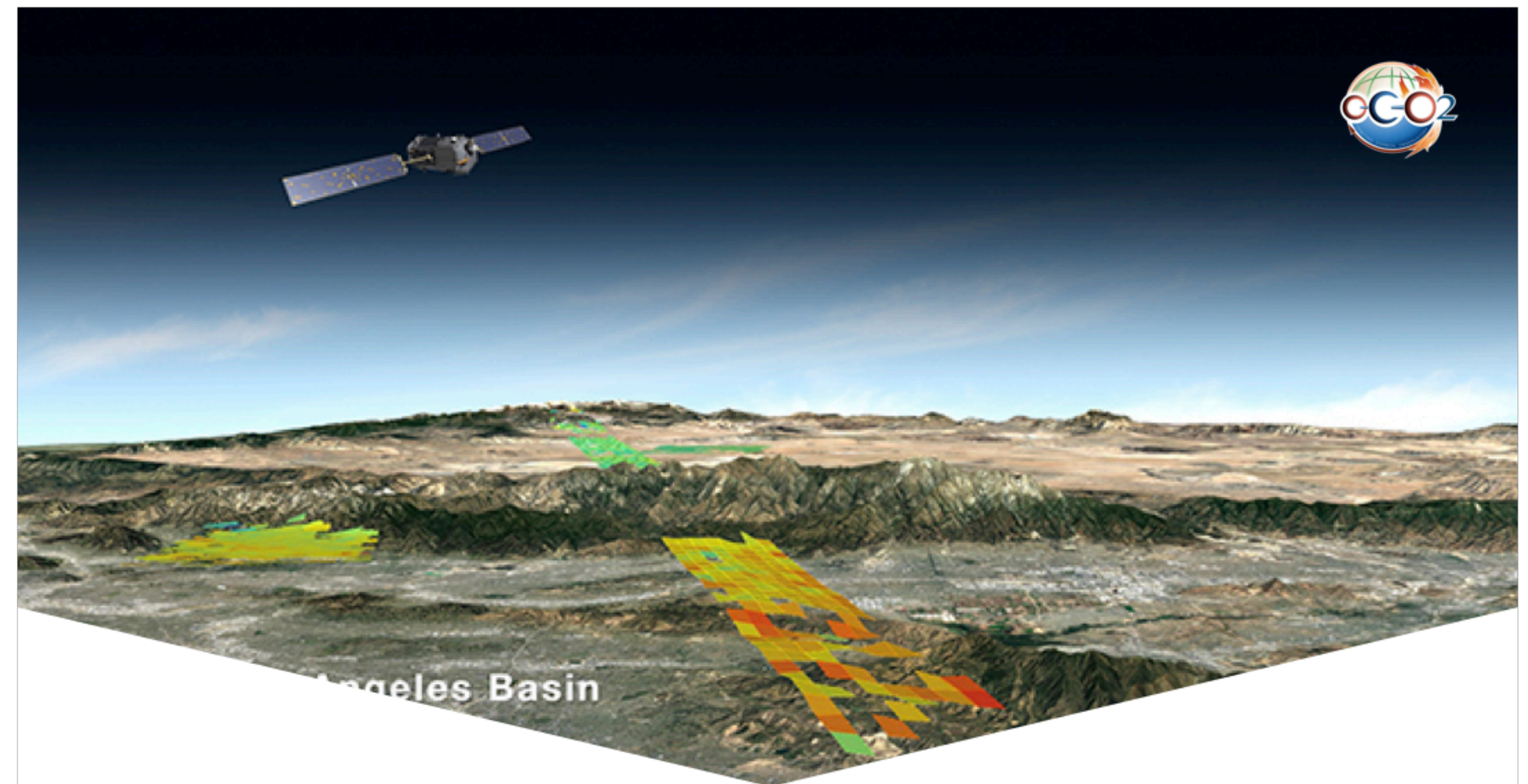
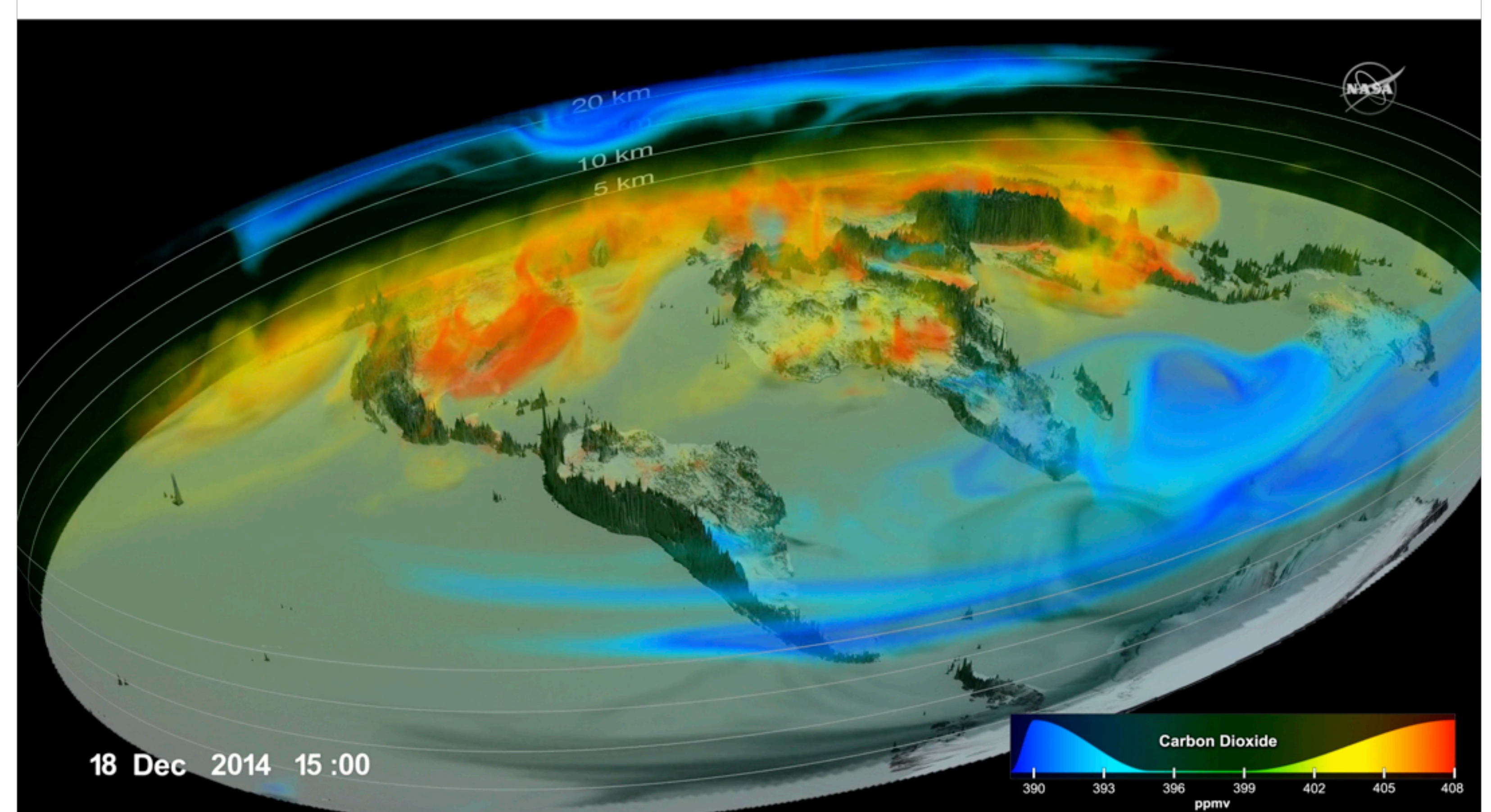
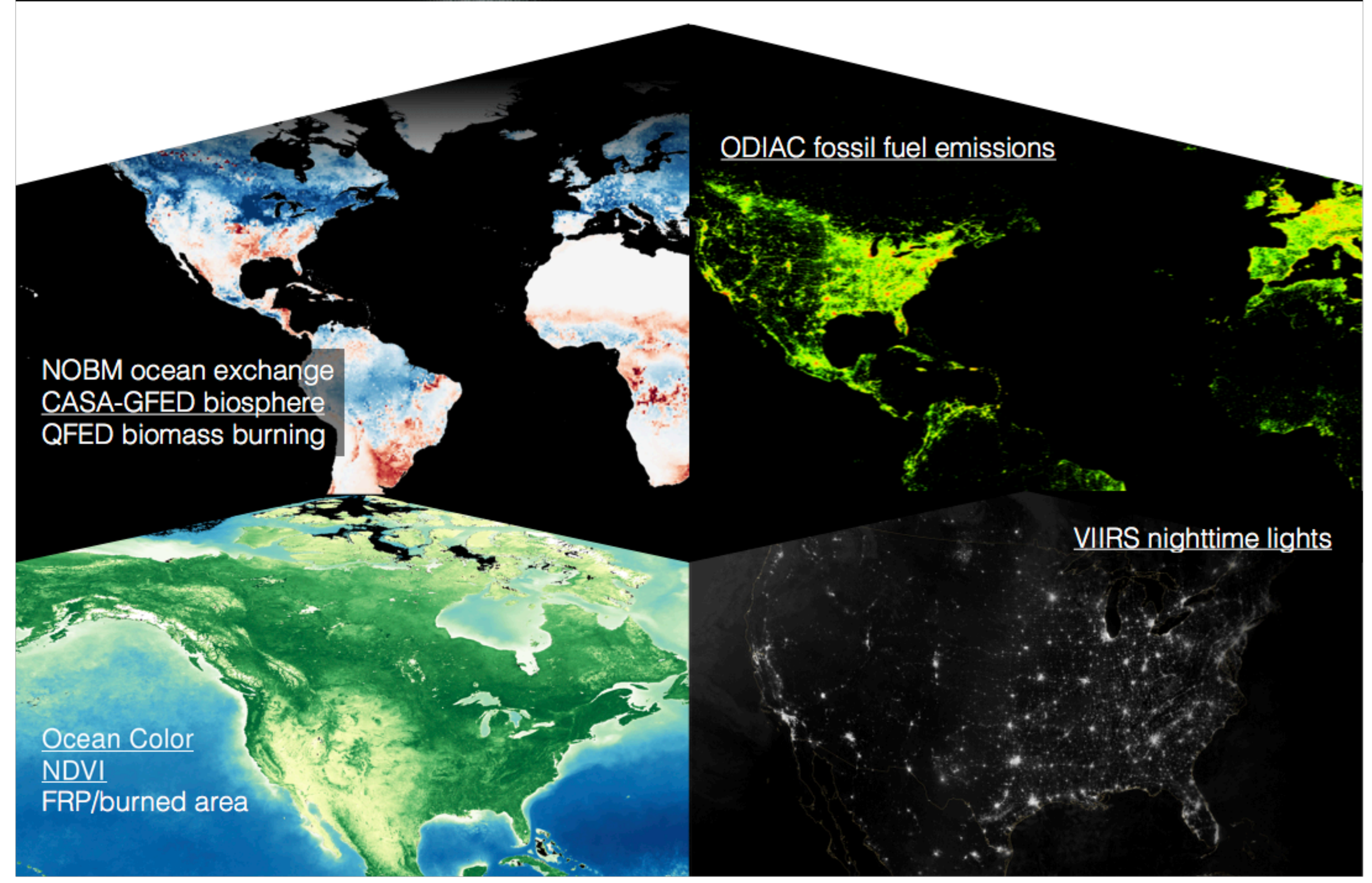


Fig 4. Hovmöller plot of the zonal and monthly mean differences of the average-column CO_2 (XCO_2) from GEOS and TM-5.







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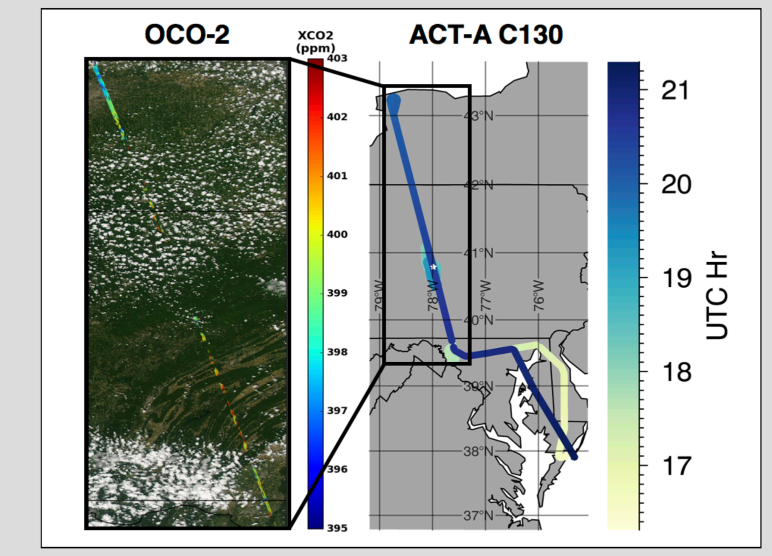

Fig 1. OCO-2 overpass and ACT flight path for 27 July 2016.

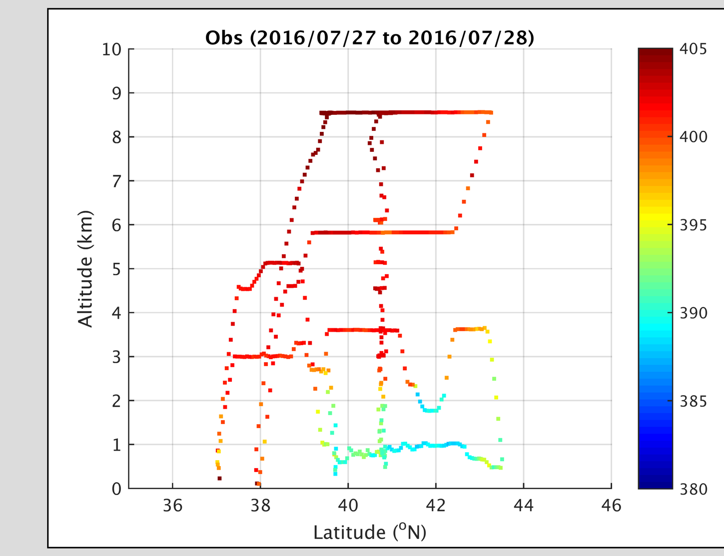

Fig 2. Measured CO_2 from ACT aircraft.

Aircraft-based analysis

What do measurements from the ACT-America campaign say about potential transport errors in the GEOS model?

Here, we assimilate data from 1 day into GEOS and compare the results to an OCO-2 overpass. **The assimilation indicates that the GEOS model PBL was too high.** Overall, the mean difference with OCO-2 v7b is reduced from 0.59 ppm to 0.28 ppm. Further analysis is needed to make general conclusions about transport error.

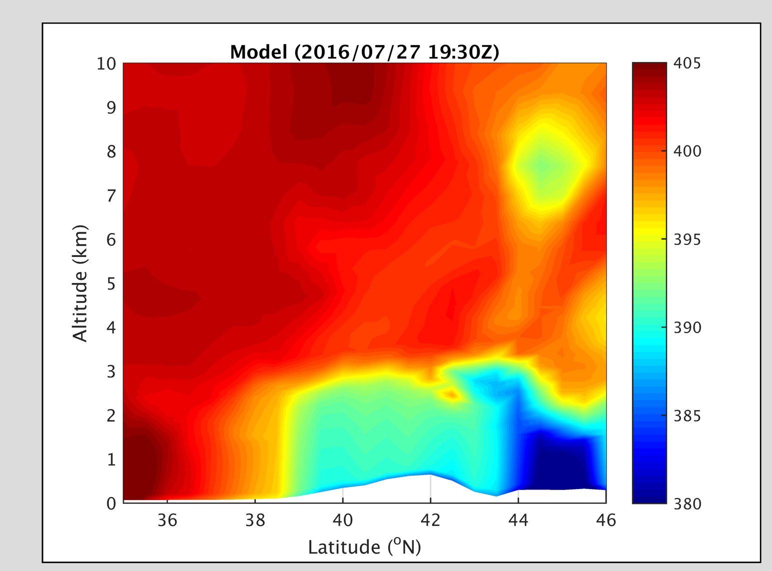

Fig 3. GEOS forecasted values before assimilation.

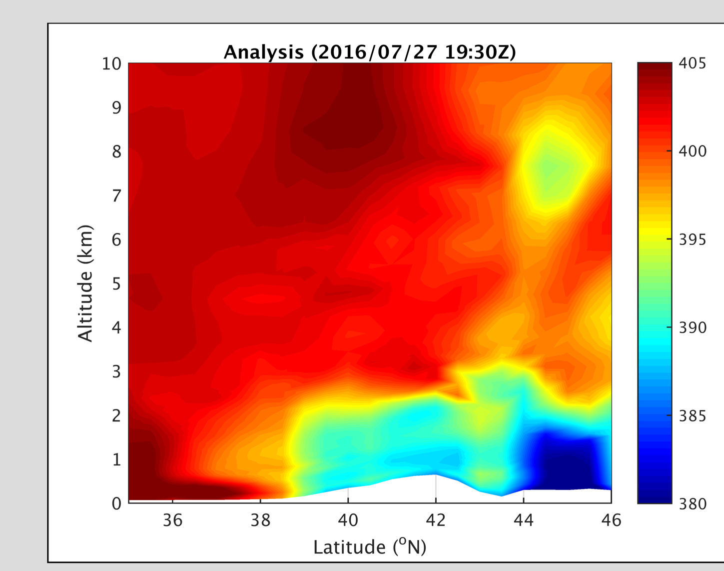

Fig 4. Curtain for aircraft data assimilated into the GEOS model. Note the decrease in PBL height over 39° to 42°N from Fig 3.

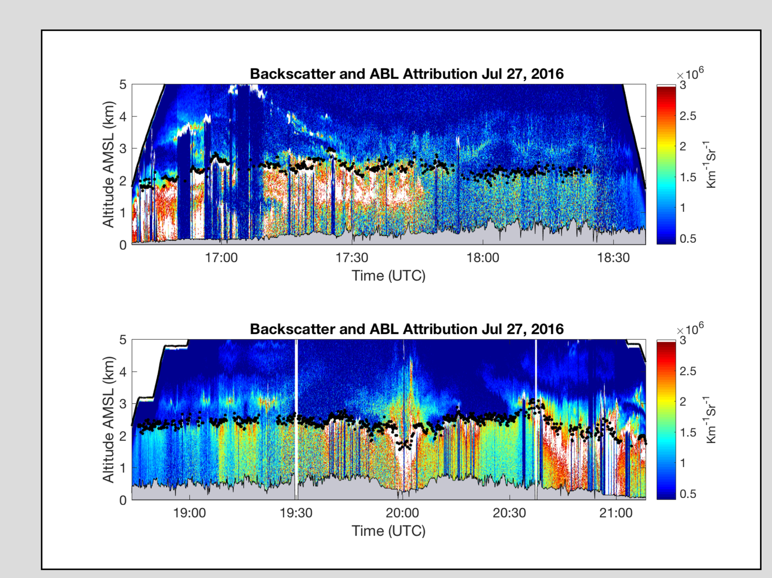

Fig 5. PBL height determined from Cloud Physics Lidar measurements. These heights are closer to those from Fig 4.

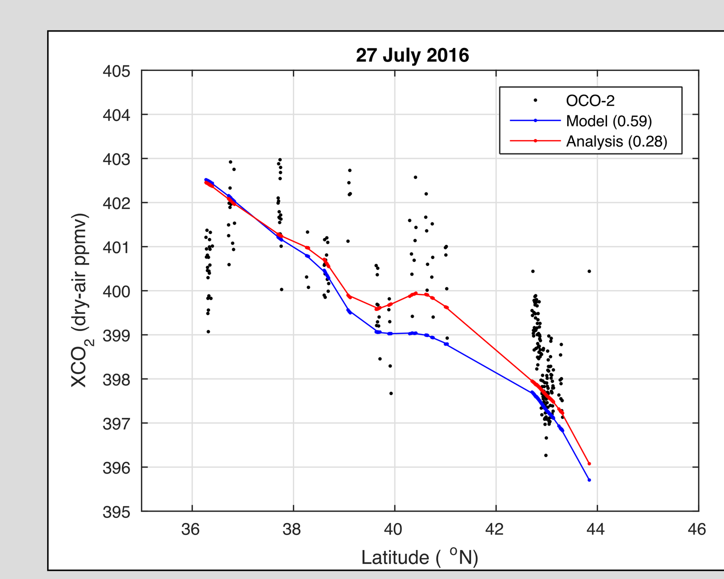

Fig 6. Comparisons to column CO_2 (XCO_2) from OCO-2 v7b. The analysis decreases the bias from 0.59 ppm to 0.28 ppm.

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