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GEOS-Chem CO_2 Simulation: Update, Applications and Future Directions

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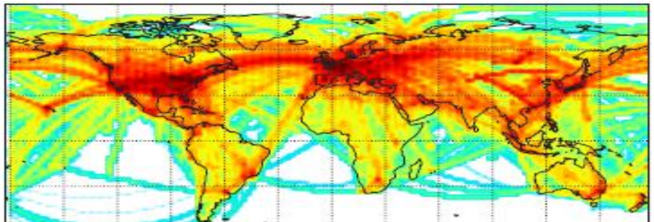
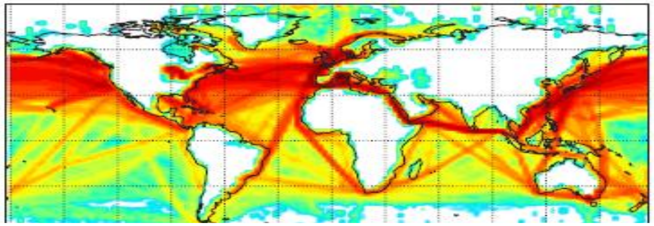
v8-03-02 CO_2 update

	CO_2 in PgC/yr in 2006
Fossil Fuels and Cement	8.23
Biomass Burning	2.16
Biofuel Burning	0.80
Ocean Flux	-1.41
Balanced Biosphere	0
Net Terrestrial Exchange	-5.29
Shipping	**0.19**
Aviation (3D)	**0.16**
Chemical Source (3D) (surface correction required)	**1.05**



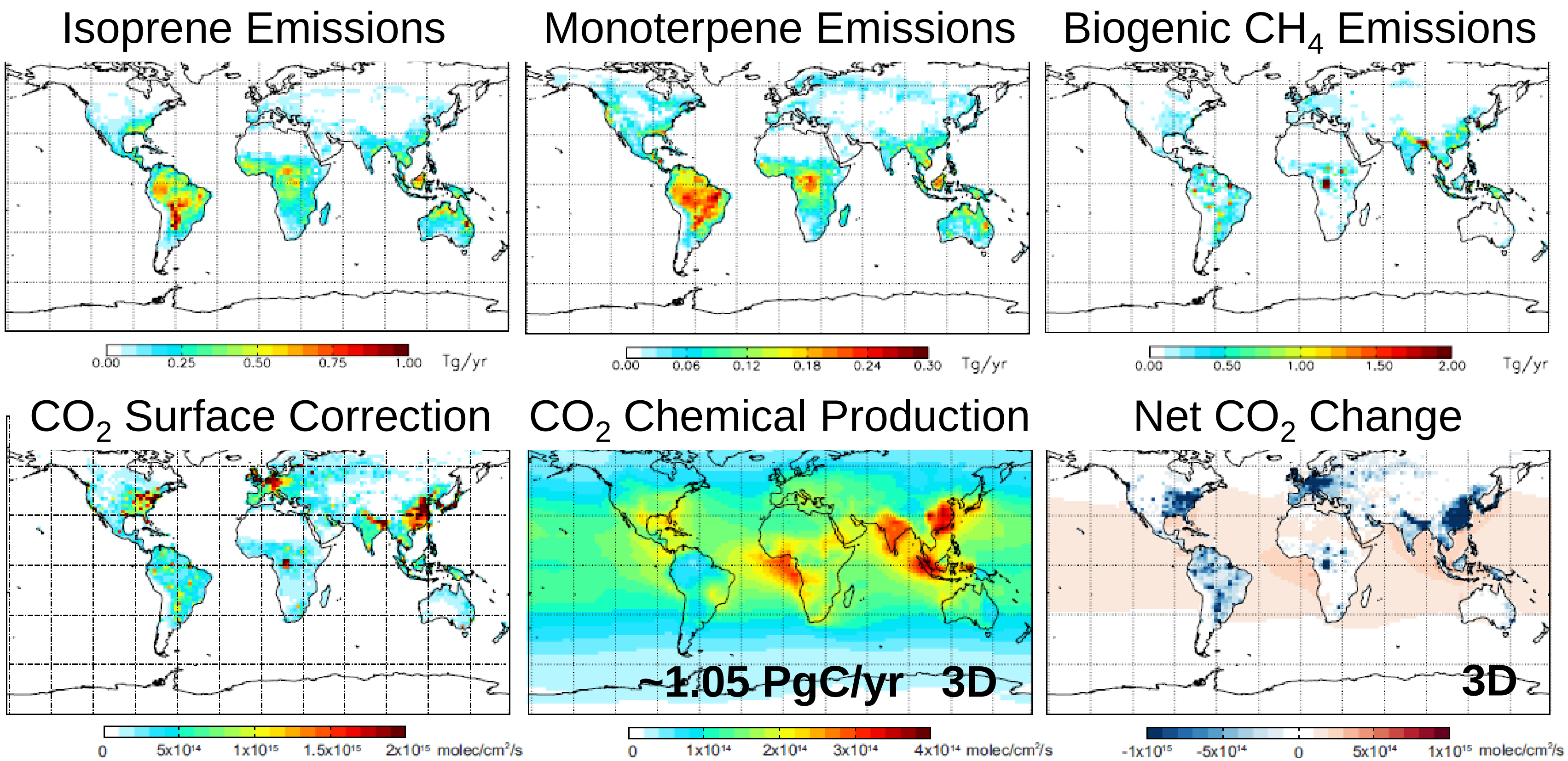
Aviation 1985-2009



Shipping (ICOADS) 1985-2006

R. Nassar, D.B.A. Jones, P. Suntharalingam, J.M. Chen, R.J. Andres, K.J. Wecht, R.M. Yantosca, S.S. Kulawik, K.W. Bowman, J.R. Worden, T. Machida, H. Matsueda (2010), ***Modeling global atmospheric CO_2 with improved emission inventories and CO_2 production from the oxidation of other carbon species,*** Geoscientific Model Development *3, 689-716.*

CO_2 from Oxidation of CO, CH_4 and Other Organics



3D representation based on CO loss rates rather than surface emission

Nassar et al. (2010) GMD inspired by Suntharalingam et al. (2005) GBC

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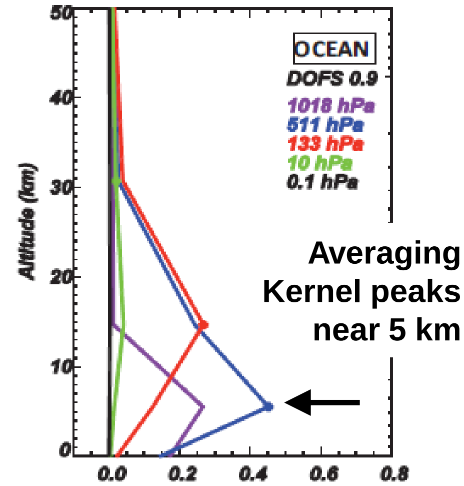
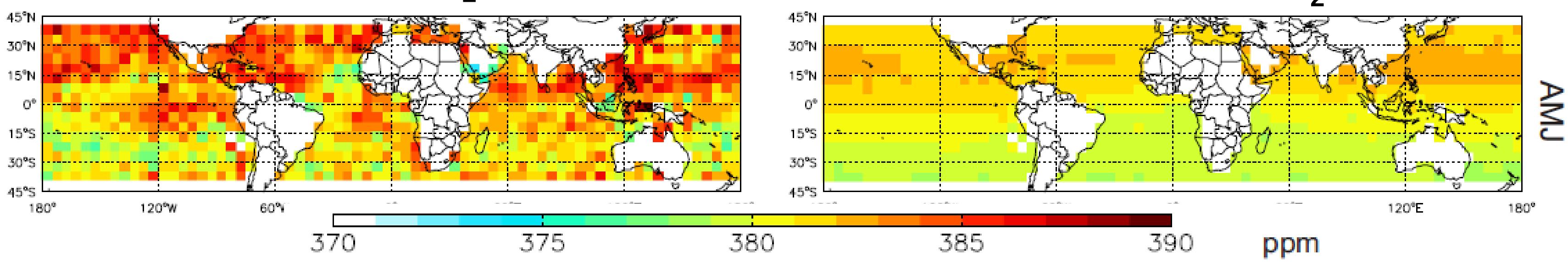
Surface Flux Inversions with TES and Flask CO_2

- Annual Bayesian inversions in 40 regions for 2006
- Sampled model at TES obs locations (ocean 40°S-40°N) and times to calculate 5°x5° monthly averages at 511 hPa
- Sampled model at 59 surface flask locations (NOAA and Environment Canada networks) to obtain monthly averages
- A priori flux uncertainties: *Baker et al.* (2006) for land, *Gruber et al.* (2009) for ocean
- Accept fossil fuel inventories and solve for “natural” fluxes (ocean, terrestrial biospheric exchange + biomass + biofuel)



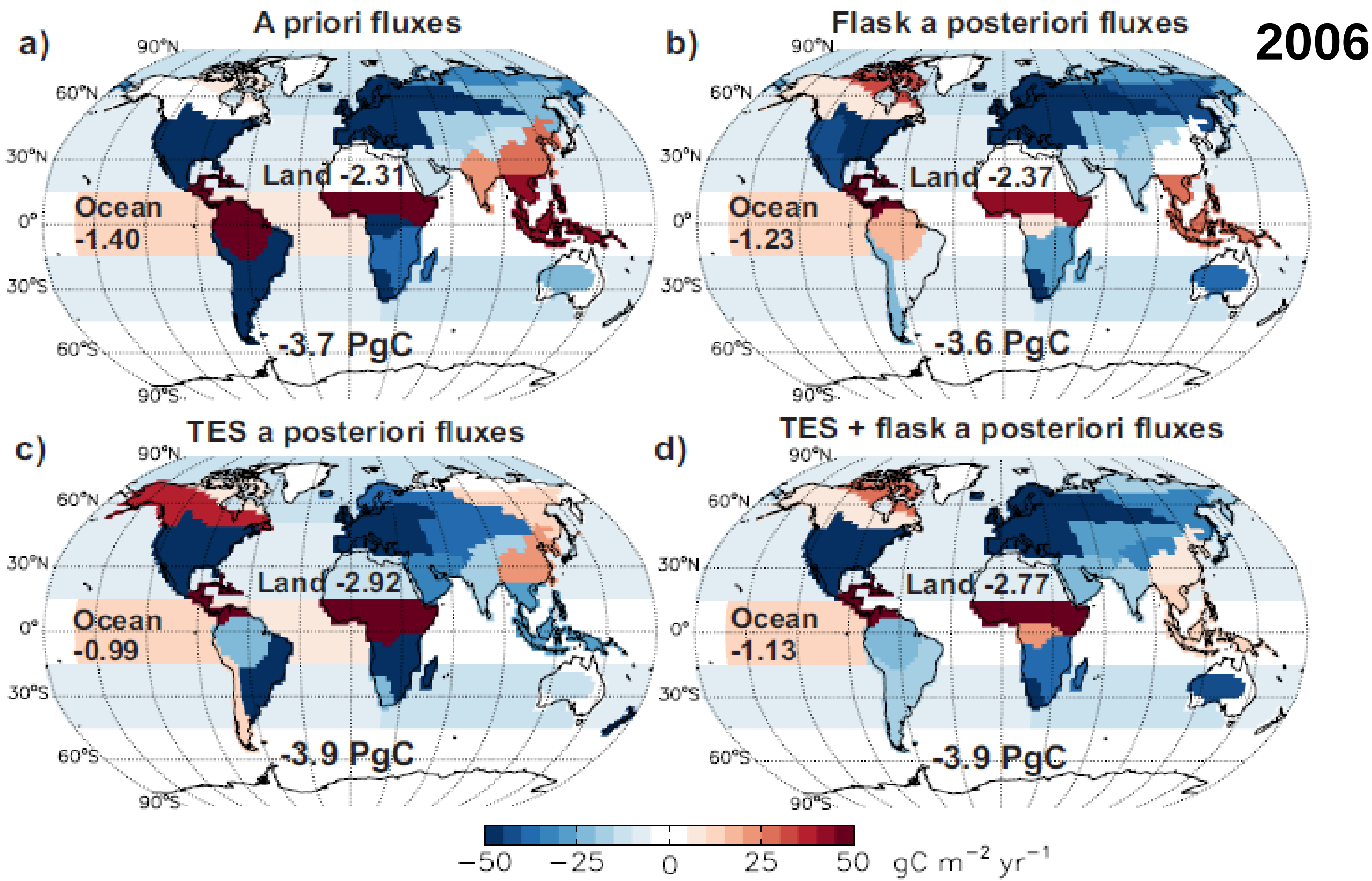
Kulawik et al. (2010) ACP

TES CO_2 **GEOS-Chem CO_2**



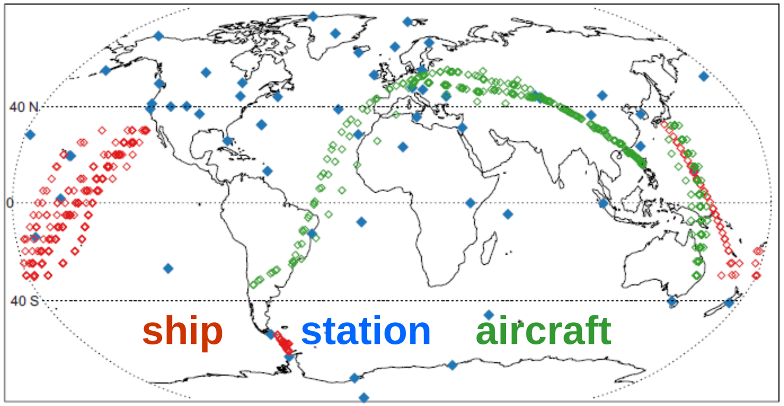
***R. Nassar**, D.B.A. Jones, S.S. Kulawik, J.R. Worden, K.W. Bowman, R.J. Andres, P. Suntharalingam, J.M. Chen, C.A.M. Brenninkmeijer, T.J. Schuck, T.J. Conway, D.E. Worthy (2011),* Inverse modeling of CO_2 sources and sinks using satellite observations of CO_2 from TES and surface flask measurements, *ACPD*, 11, 4263-4311.

CO_2 Fluxes by Combining TES and Flask data



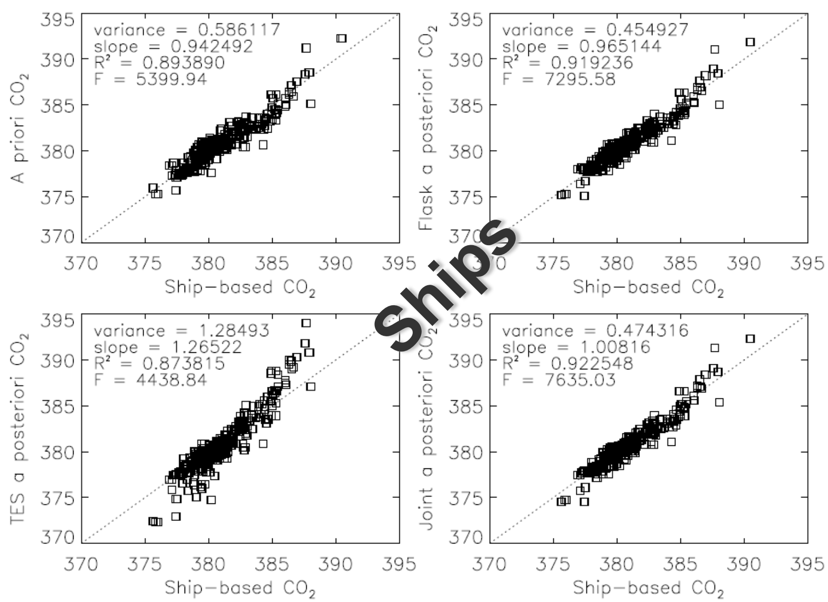
Nassar et al. (2011), ACPD, 11, 4263-4311

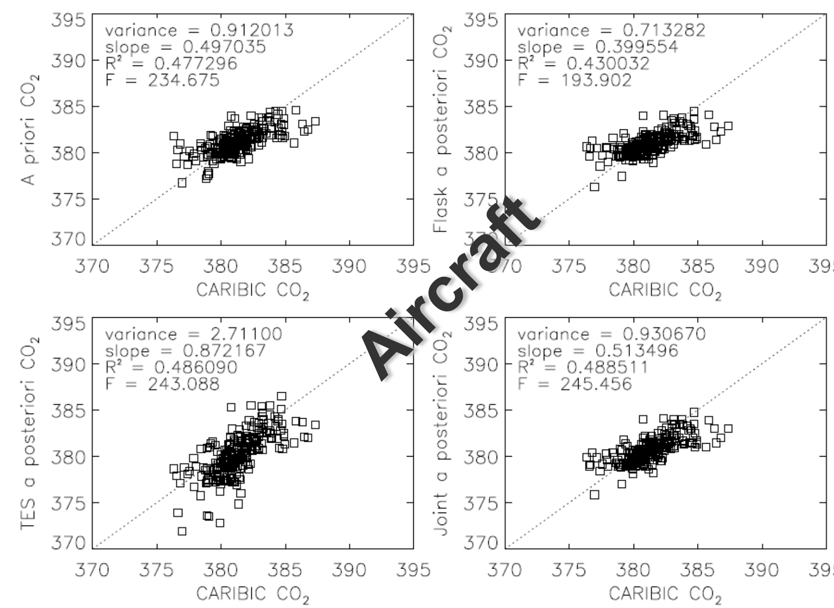
TES and Flask CO_2 are Complementary



TES and flask data together give the best agreement with independent ship (NOAA) and aircraft (CARIBIC) flask data as a result of the complementary vertical and horizontal information

Civil Aircraft for the Regular Investigation of the atmosphere Based on an Instrument Container (**CARIBIC**)





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Nassar et al. (2011), ACPD, 11, 4263-4311

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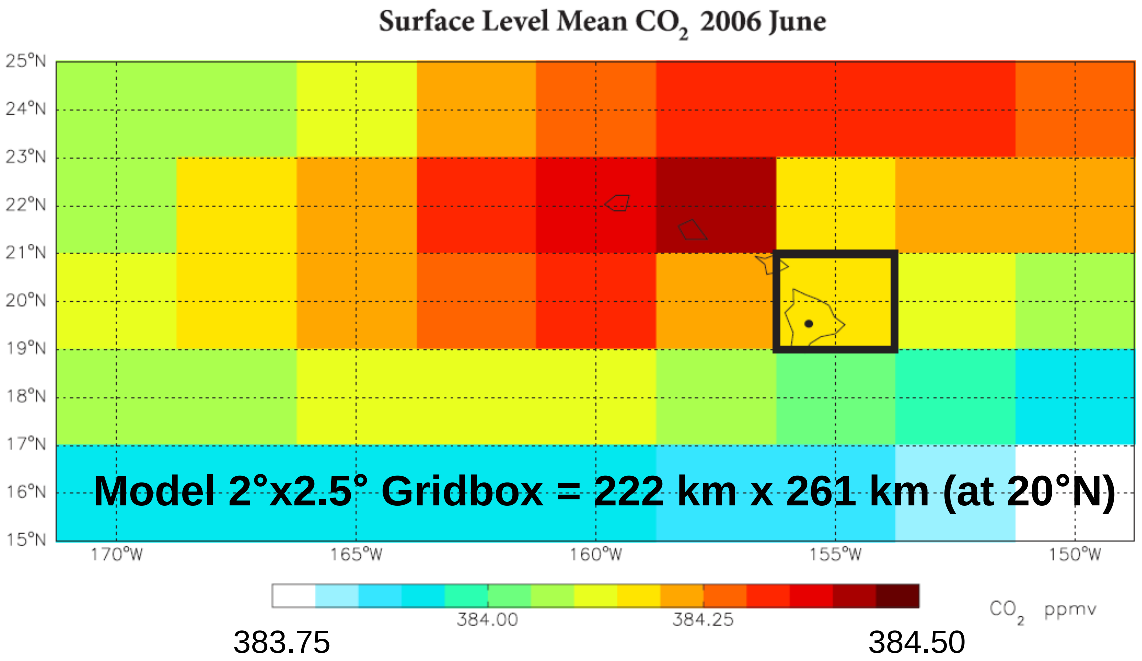
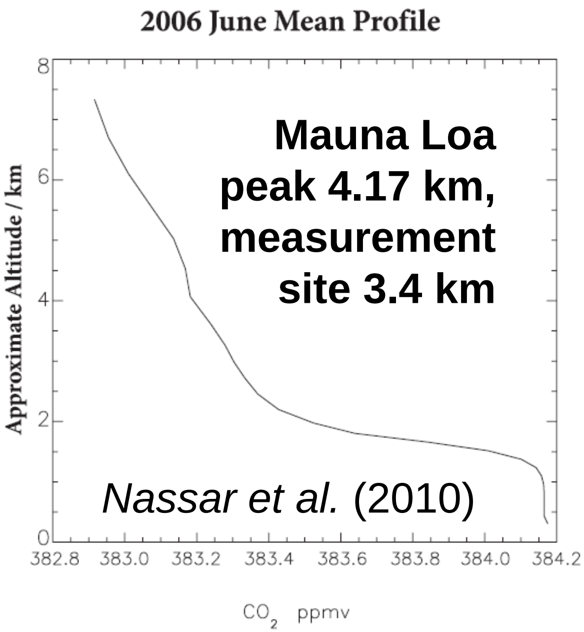
Resolution and Representativeness Errors





CO_2 flask data have precision and accuracy on the order of 0.1-0.2 ppm but it is difficult to take advantage of this due to representativeness errors

Resolution was also found to be serious limiting factor with HIPPO comparisons