GeoCarb Level 3/4 Algorithm Updates

Lesley Ott[1], Brad Weir[1,2], Sourish Basu[1,3]

[1]NASA GSFC, Global Modeling and Assimilation Office
[2]Morgan State University
[3]Earth System Science Interdisciplinary Center, University of Maryland

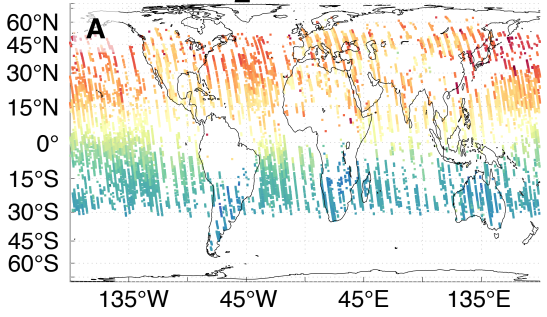
GeoCarb Level 3 Algorithm Leverages Techniques developed for OCO

For OCO-2: Gap-filled 50-km XCO_2 fields (daily and monthly)
Produced by assimilating bias-corrected L2 OCO-2 data into the GEOS Constituent Data Assimilation System (CoDAS)

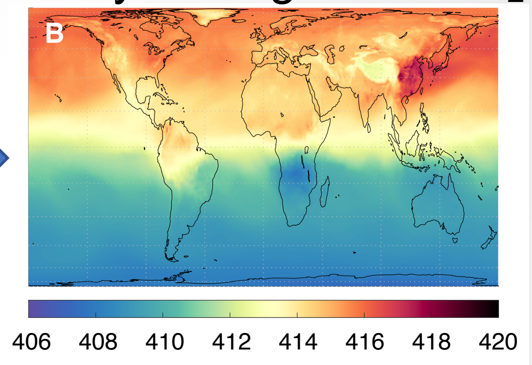
When OCO-2 data are unavailable, gaps are filled using:

- All previous good quality OCO-2 retrievals
- MERRA-2 wind and atmospheric transport fields
- Observationally-informed, low latency flux package that includes information from:
    - ODIAC (previous years)
    - CASA-GFED NEE (previous years)
    - NOAA *in situ* growth rate (previous years + forecast using SST information)
    - QFED fires (NRT)

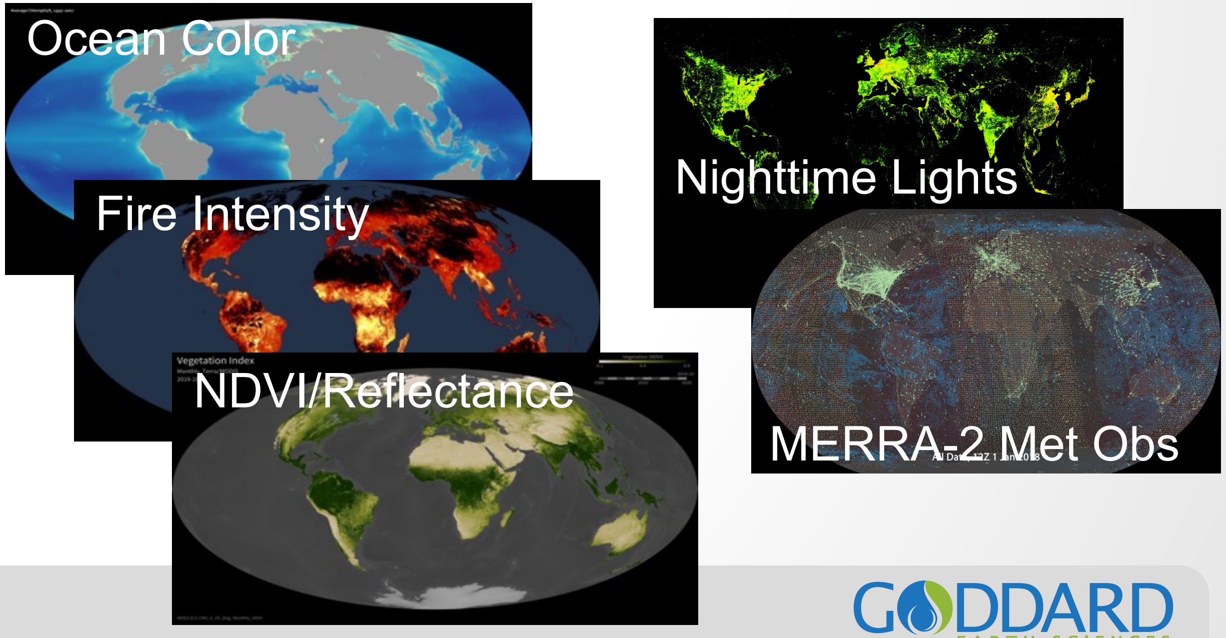
16 days of cloud-screened OCO-2 XCO_2 – 4/1-16/2020



16-day average L3 XCO_2

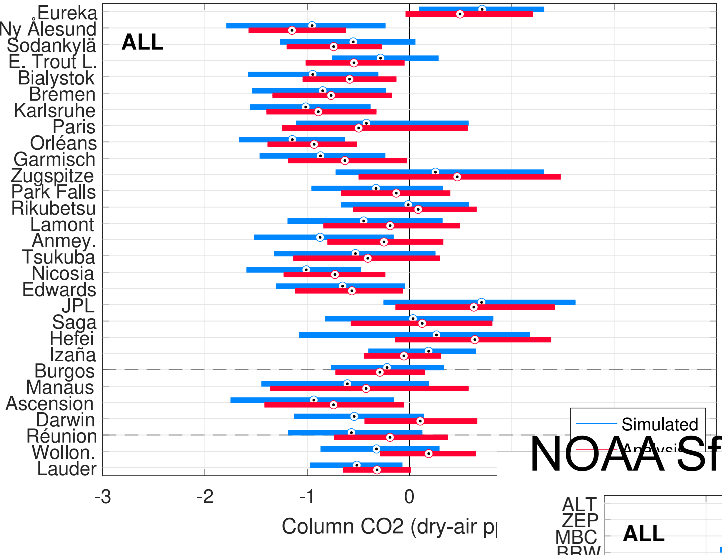


Complementary observations



Data assimilation approach facilitates rigorous benchmarking against independent data

TCCON Obs – Ana, Obs – Sim



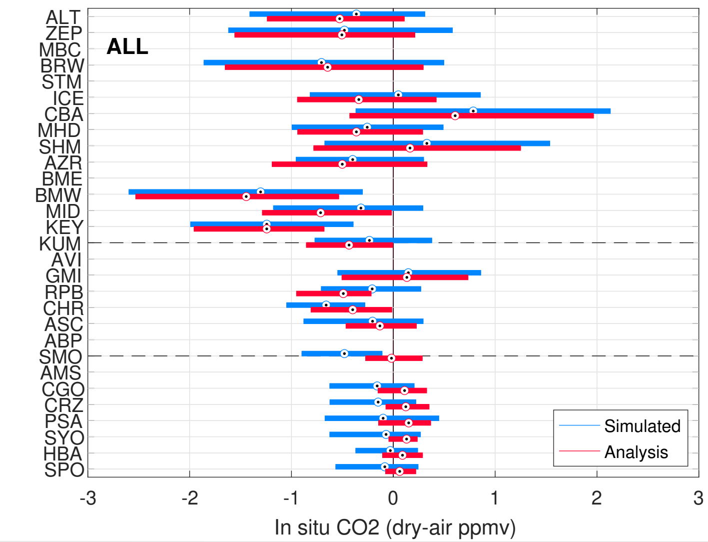
Extensive evaluation against:

- TCCON network
- NOAA surface stations
- NOAA and NASA aircraft campaign data

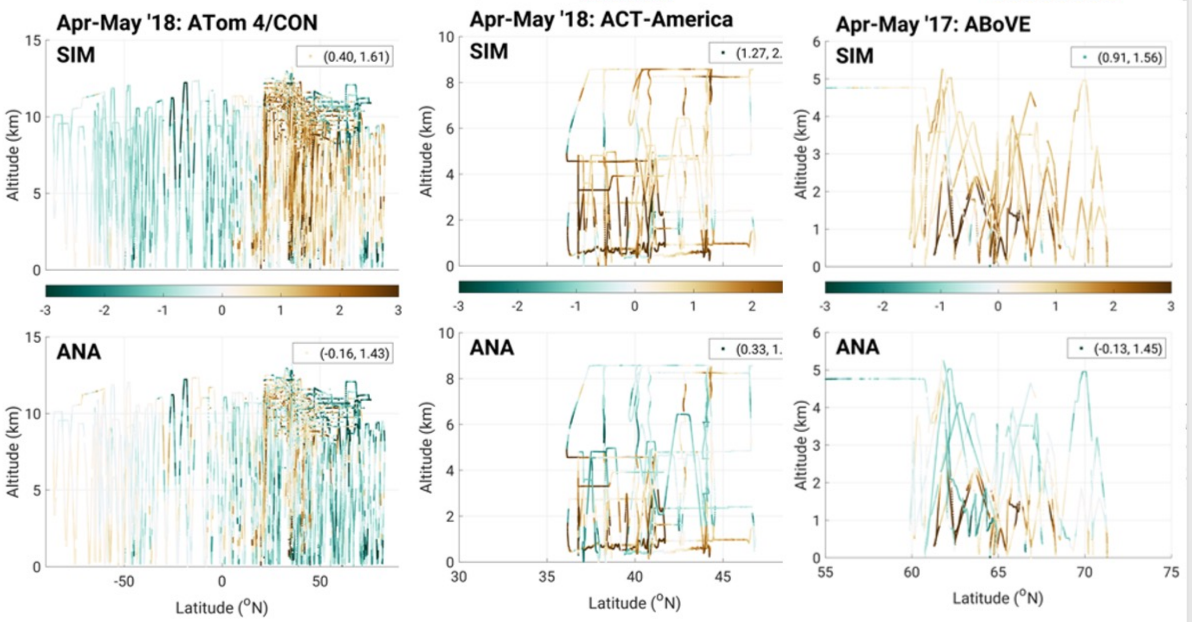
Comparisons through 2020 included in GEOS OCO L3 User's Guide with updates provided via GMAO's page

Automated benchmarking package can run to support GeoCarb monitoring, QC efforts

NOAA Sfc. Obs – Ana, Obs – Sim

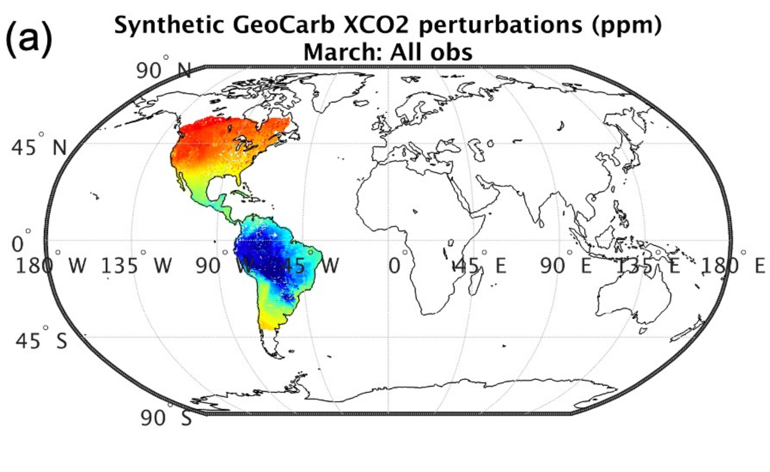


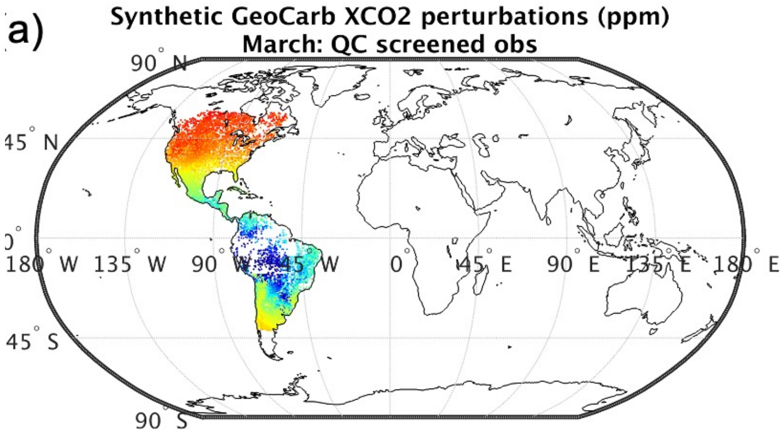
Example comparisons against ATøM, ACT-America, and ABoVE

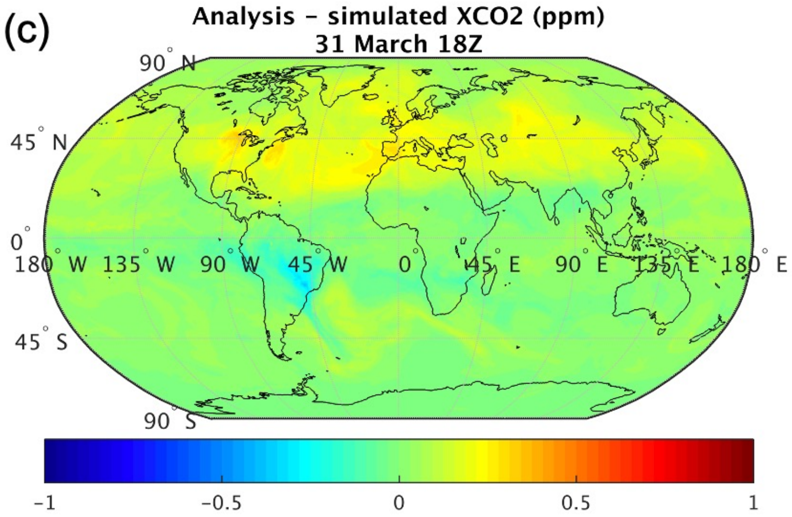


<u>High-quality 3D fields also provide BCs to higher res regional models</u>

L3 Algorithm Application to GeoCarb Data







CO_2: Demonstrated with synthetic data to evaluate impact of data loss due to clouds in the Amazon

CO: System developed with MOPITT data, not yet tested with GeoCarb synthetic data

CH_4: TROPOMI data processing automated, but data quality issues prevent meaningful analysis of assimilation, tuning

Next step is testing with GOSAT data, awaiting improvements in TROPOMI data

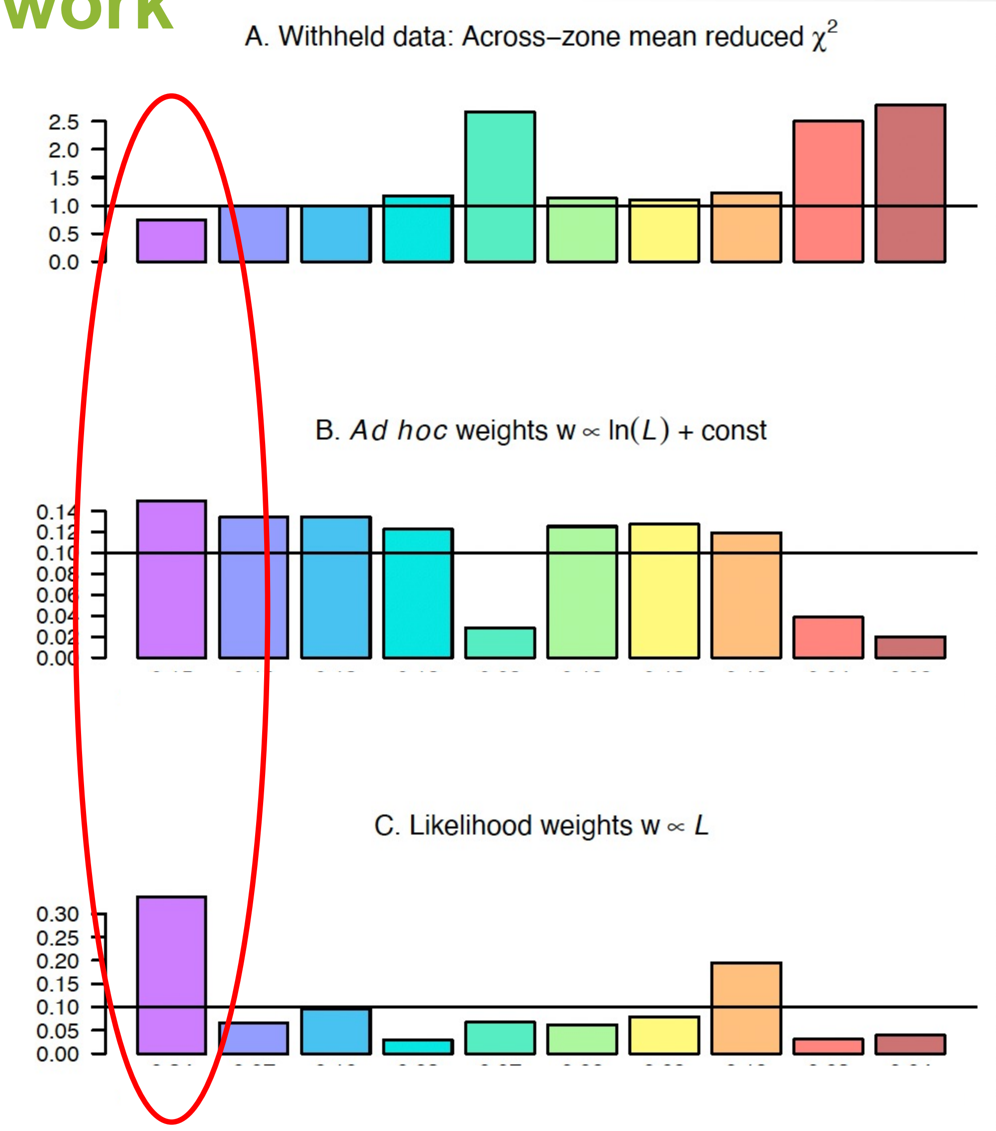
GeoCarb Level 4 Algorithm Leverages Techniques applied to GOSAT/OCO, *in situ* network

For OCO/*in situ*: Global, 2x3 degree resolution

Produced using the TM5-4DVAR system developed by Sourish Basu (shares legacy with OU TM5 system)

Extensive comparison against other inverse systems from OCO-MIP:
- Example of χ^2 compared to withheld in situ data (top plot)
- Examples of model weighting approaches (bottom two plots)

In development – ability to run with both IFS/GEOS meteorology for improved uncertainty characterization



Future Work: L4 algorithm application to GeoCarb

- L4 Application to CO_2 – expected to be straightforward given OCO heritage
- L4 Application to CH_4 – run with in situ only, plan to test with TROPOMI or GOSAT data
- Would like to test both L3 and L4 algorithms with simulated GeoCarb ‘day in the life’ data to better understand data volume, performance at different target resolutions – ideally upgrading to finer resolution than for OCO products

Remaining challenges/points for discussion

- What data to combine with GeoCarb for L3 and L4?
- What subset is appropriate for GeoCarb data?
- Connection to regional modeling, data assimilation efforts