Evaluating Satellite CO_2 Measurements using Coarse-grid Coastal Comparisons

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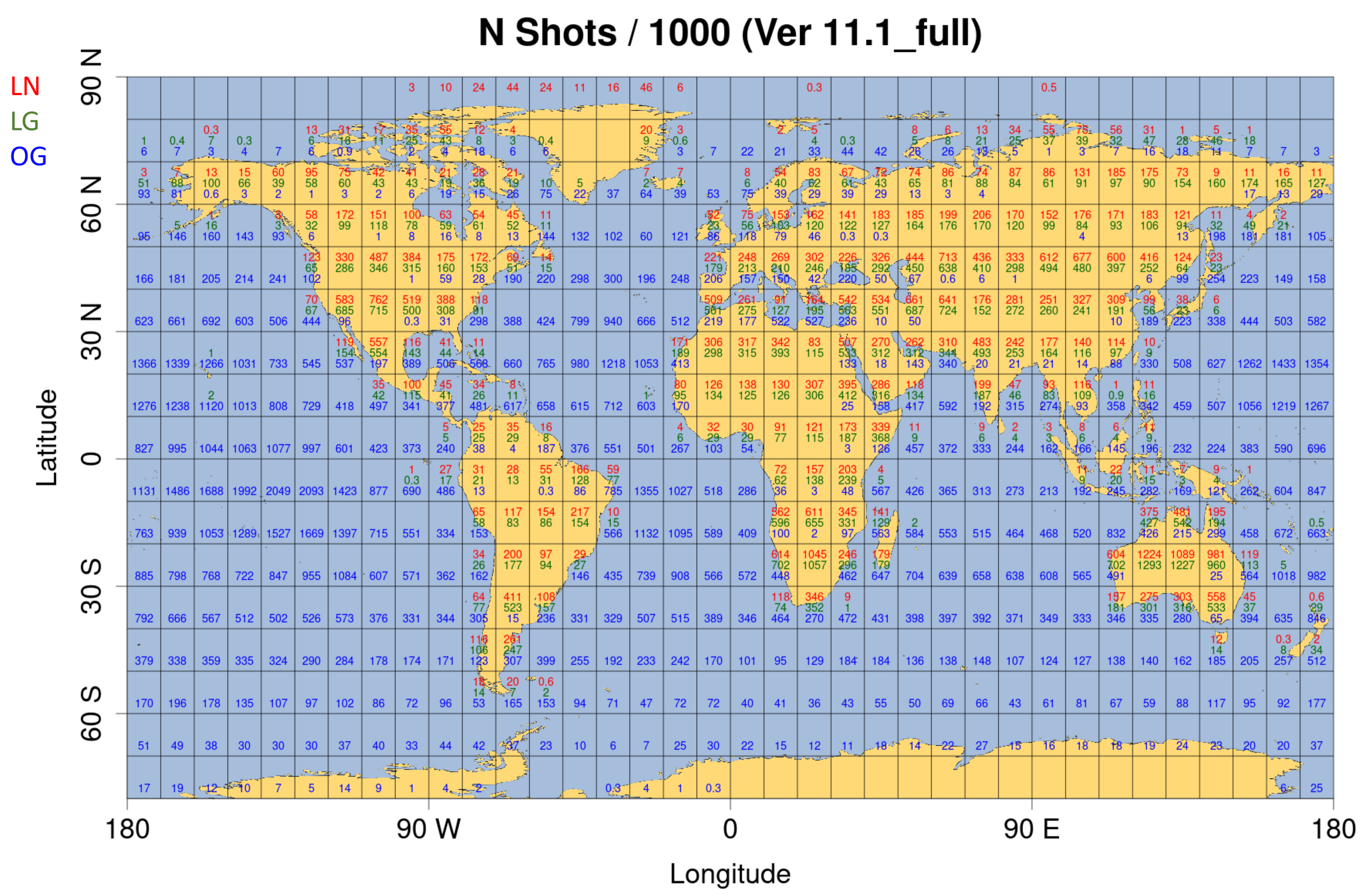
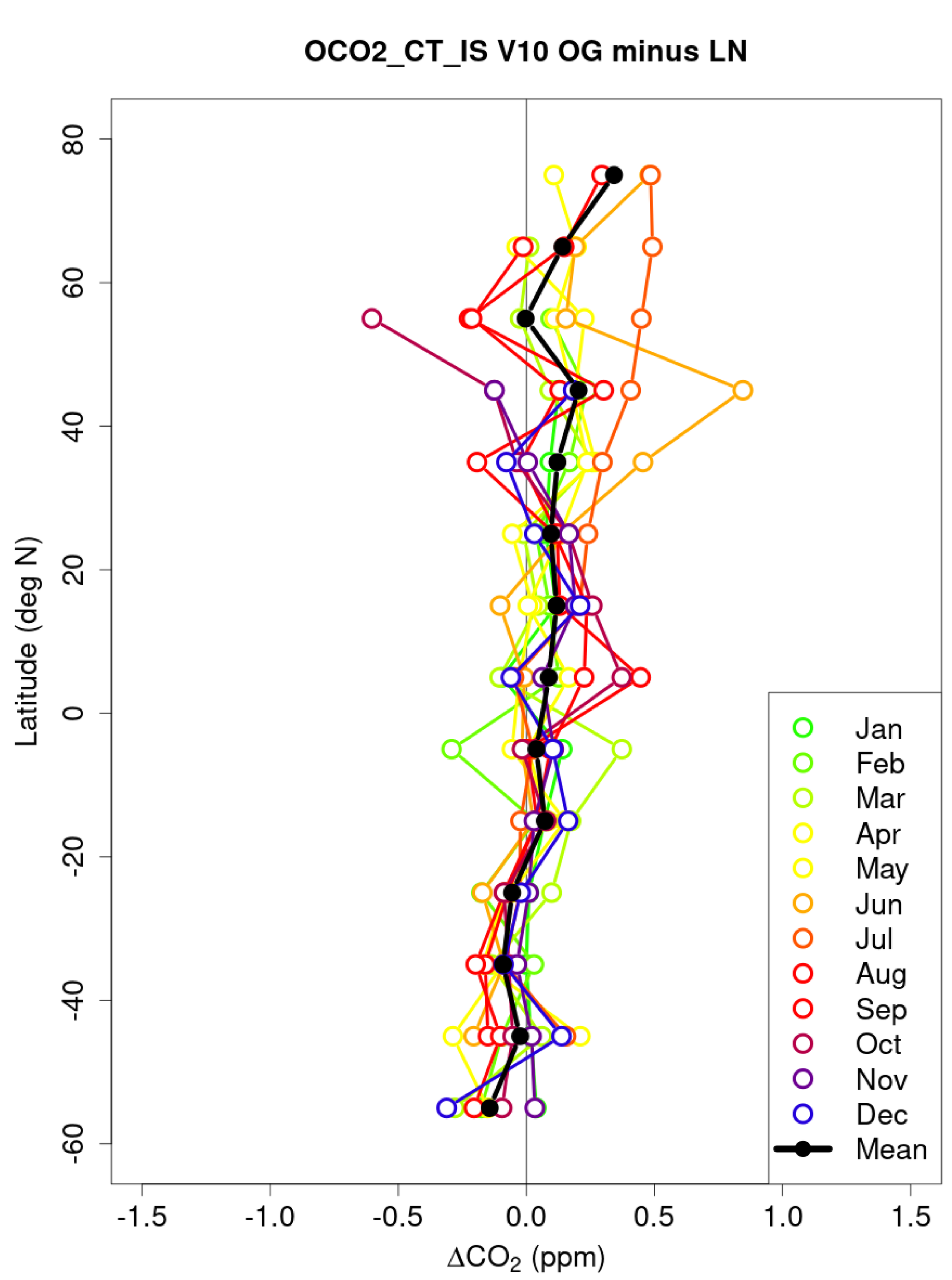
Overview: We track relative XCO2 biases between the different observing modes of OCO-2 and OCO-3 as a function of latitude and time of year by comparing observations in overlapping 10-degree latitude by 10-degree longitude boxes. Similar calculations on matching posterior concentrations output from the OCO-2 V10 MIP global atmospheric transport models show that these differences are expected to be very small.

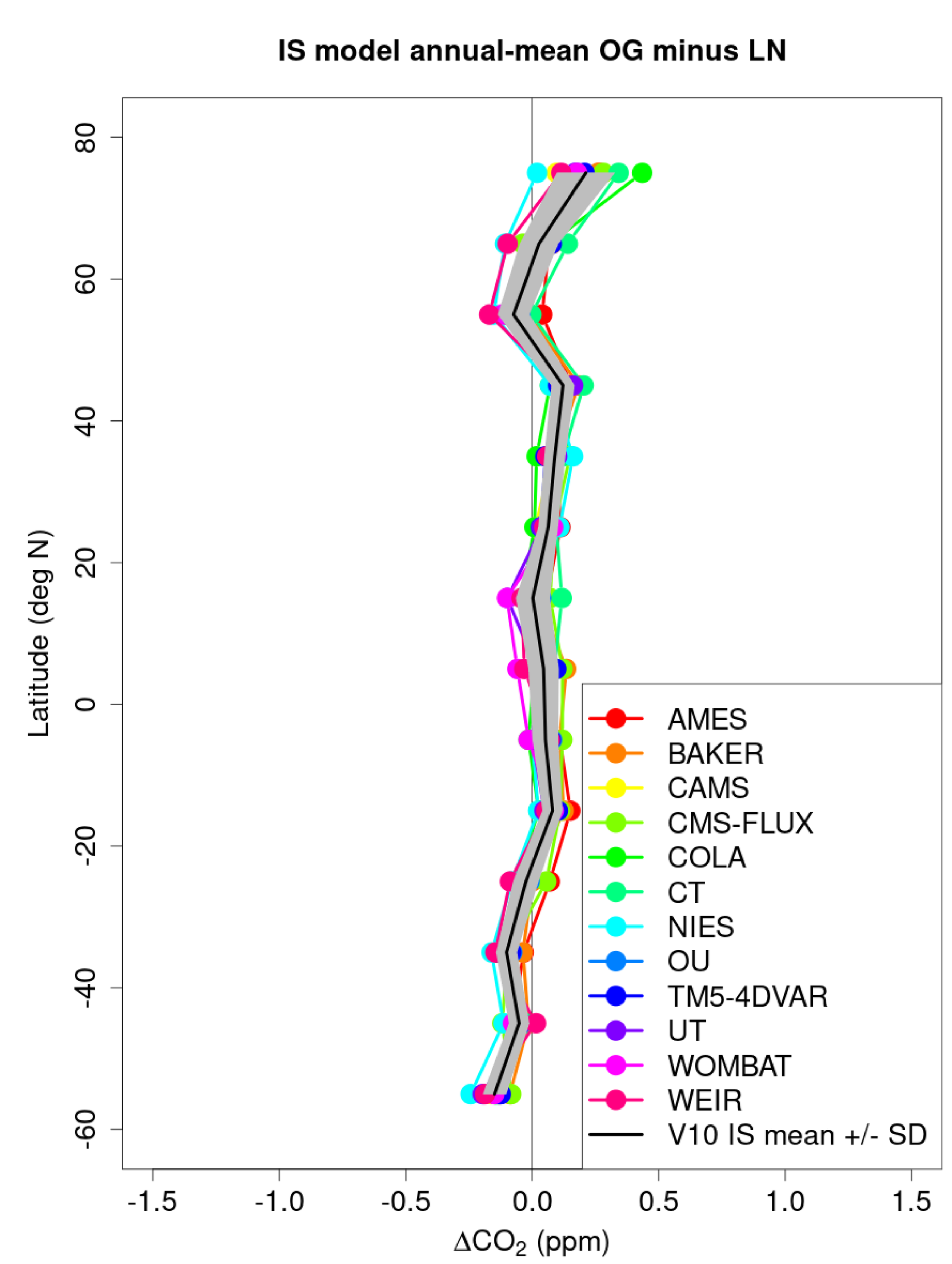


Map showing the total number of OCO-2 V11.1 soundings (/1000, 2015-22) for OG (blue), LN (red), and LG (green).

Recipe:

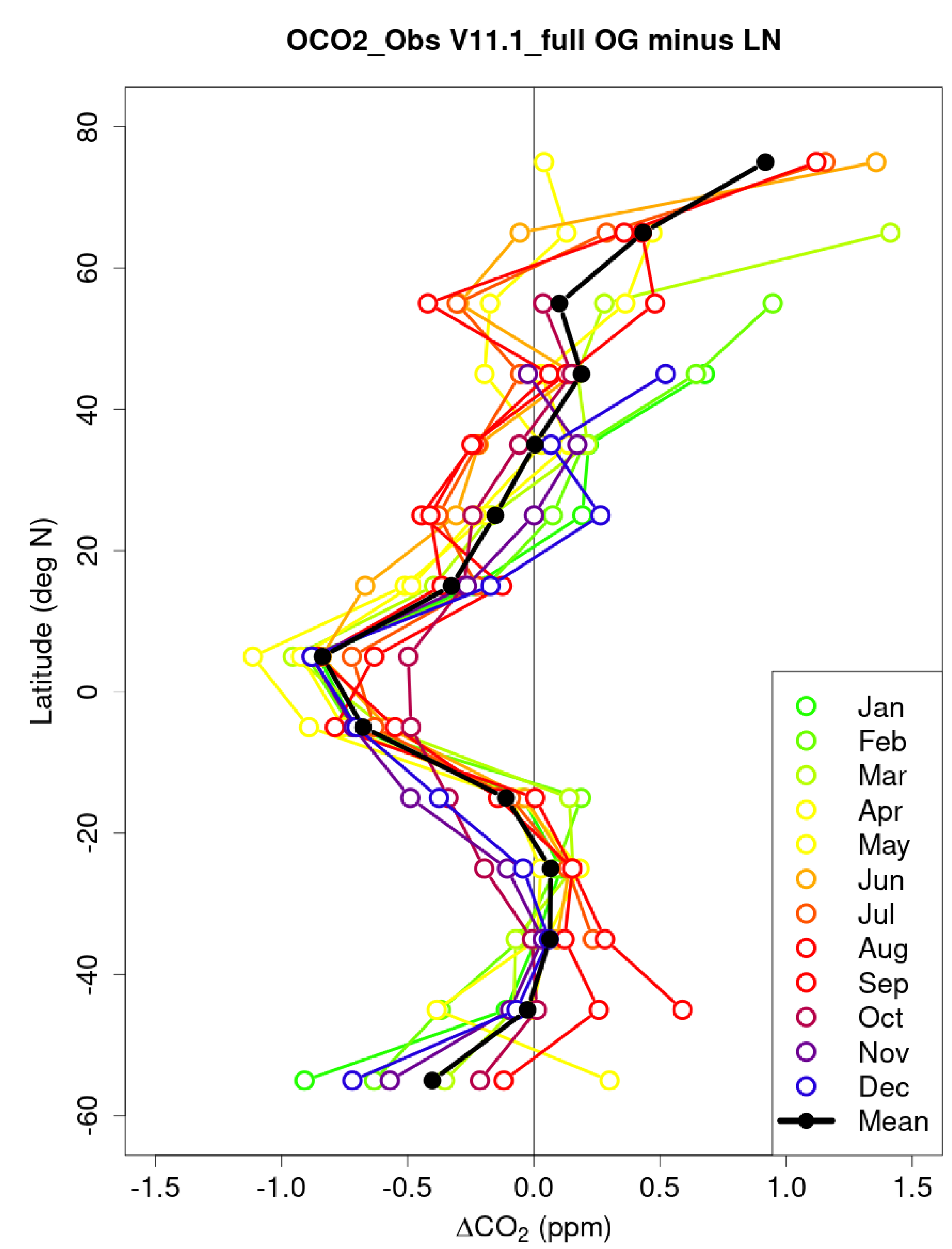
1. read in 10-sec XCO2 file for a satellite and version
2. filter for quality flag = 0
3. bin average 10-sec XCO2 by 10 degrees lat/lon, month, and observing mode (LN, LG, or OG)
4. bin sum total shots by same 10 degrees lat/lon, month, and observing mode
5. filter bins for sum(total shots) > 250
6. subtract OG-LN for each common grid box and month containing data for each
7. calculate zonal mean monthly differences
8. calculate annual means by latitude
9. do the identical analysis on all OCO-2 V10 MIP IS experiment co-samples to use as a reference

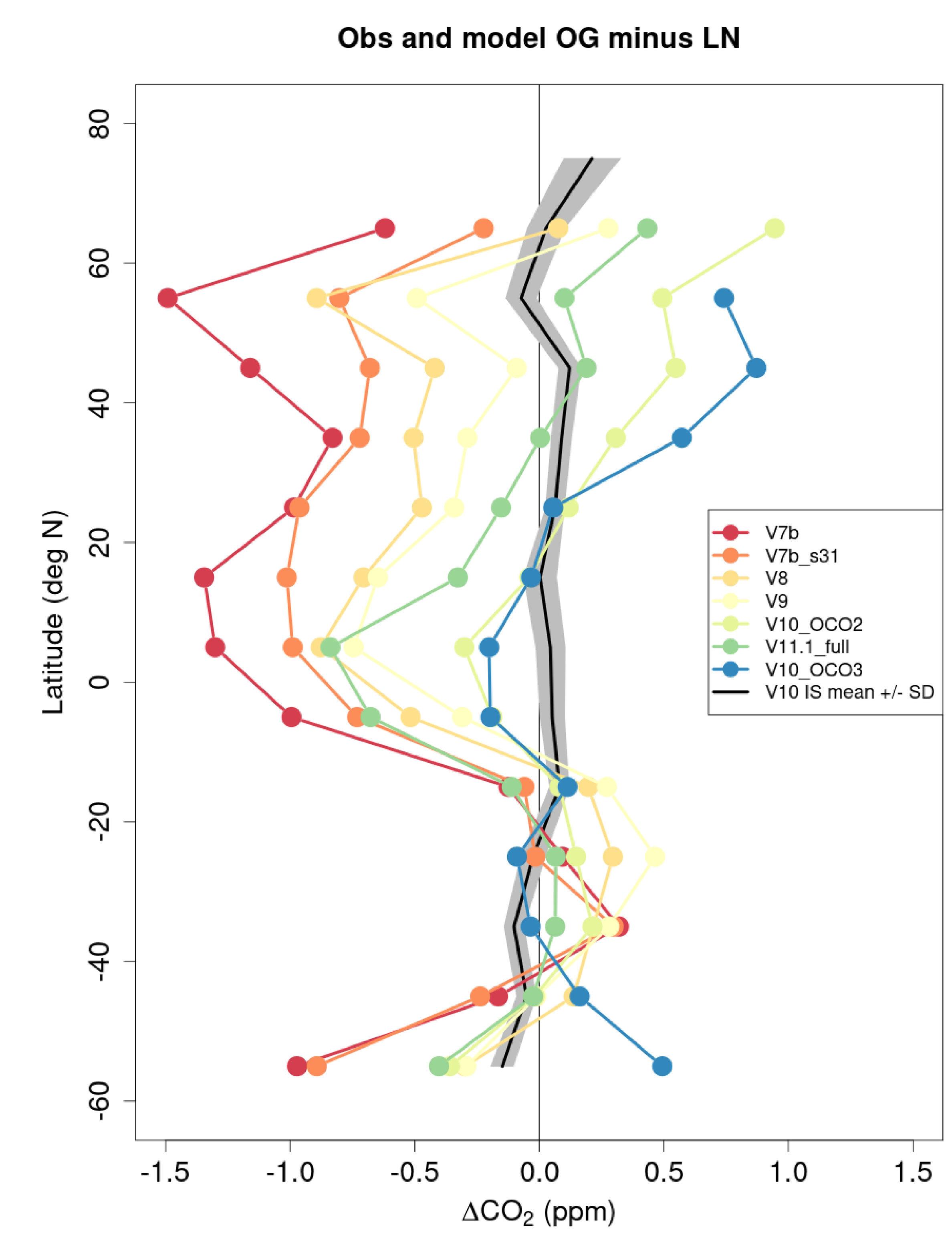




Expected OG-LN differences based on a single in situ inversion model by month (CT IS, left) and for all IS inversion model annual means (right). The black annual mean line and shading in the right panel here serves as a reference in the far upper right plot.

Observed OG-LN differences for OCO-2 V11.1 by month (left) and for all OCO-2 and OCO-3 version annual means (right). The black line in the left panel is the same as the green line in the right panel.





Results: OCO-2 v11.1 exhibits annual-mean ocean glint (OG) minus land nadir (LN) relative biases of -0.8 ppm (OG lower than LN) within 10 degrees of the Equator and +0.5 to +1.0 ppm (OG higher than LN) at high northern latitudes in summer. Starting with OCO-2 v7, with northern hemisphere OG-LN differences larger than -1.0 ppm, each version of OCO-2 through v10 has shown a steady reduction in OG-LN relative biases. OCO-2 v11.1 reduced OG-LN relative biases with respect to v10 at high latitudes at the expense of greater biases at the Equator. OCO-3 v10 relative OG-LN differences are very similar to those of OCO-2 v10, suggesting a common set of causes.