Supplementary Information For

Assessing acetone for the GISS ModelE2.1 Earth system model

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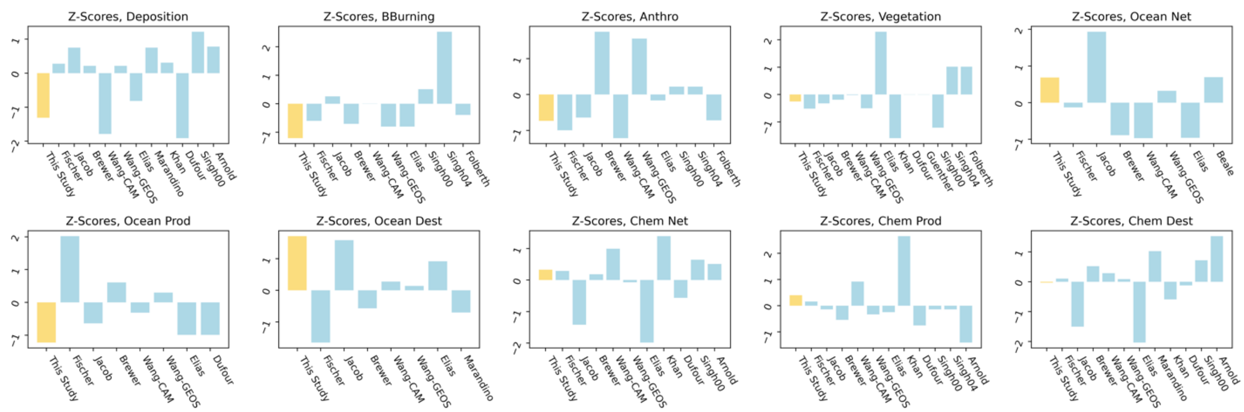


Figure S1. The data recorded in the literature was used to determine a mean for each budget flux value, and the distance from that mean for each paper was expressed as a z-score. The papers that contributed to determining the mean are in light blue, and the Baseline model's z-score is highlighted in yellow.

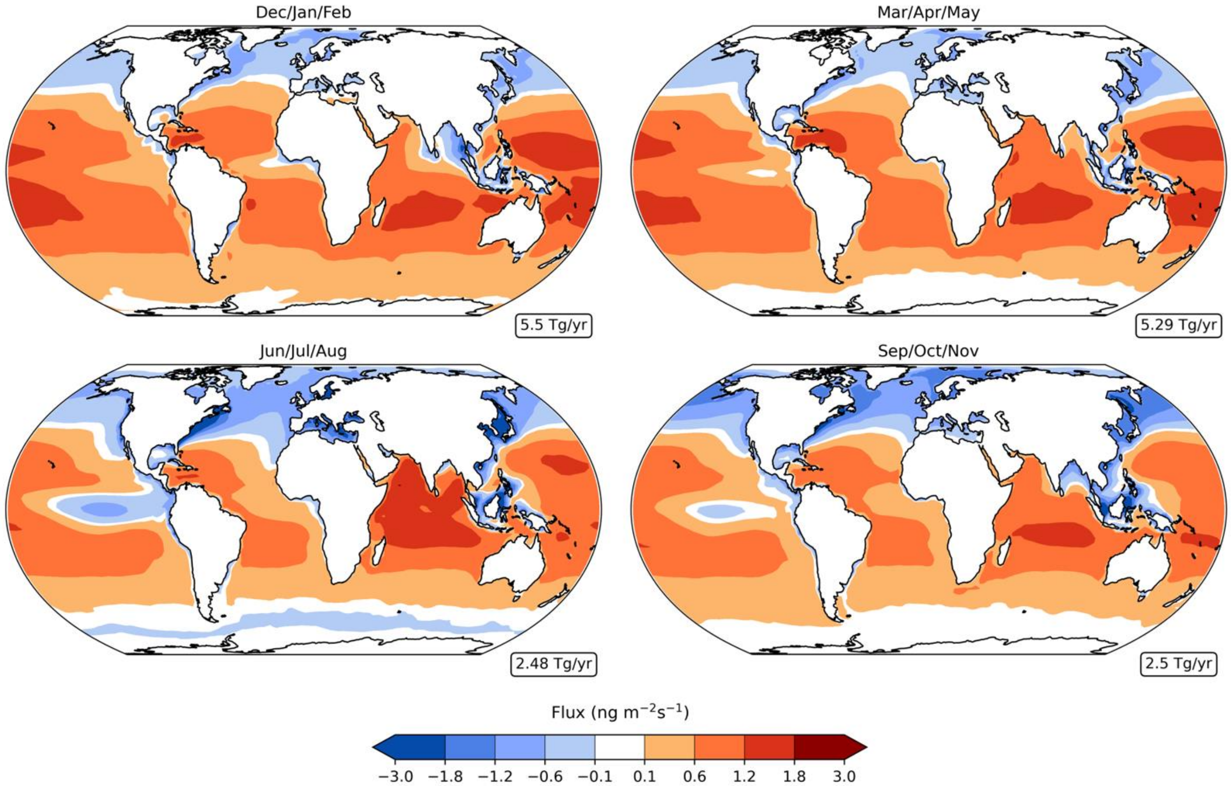


Figure S2. Net oceanic acetone fluxes in the Baseline simulation for for December-February (top left), March-May (top right), June-August (bottom left), and September-November (bottom right), with red indicating a net source and blue indicating a net sink. Nonlinear colorbars are used to better differentiate the details in the map. The weighted global means of the net ocean fluxes are shown in boxes on the lower right.

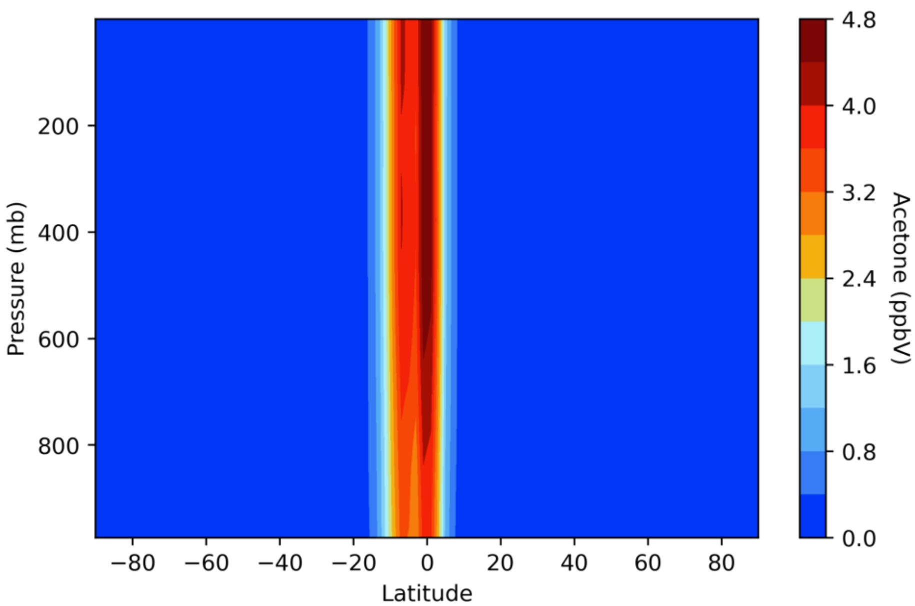


Figure S3. Vertical distribution of acetone air mixing ratios across latitudes in the previous acetone scheme. Here, acetone is derived from the zonal mean of isoprene.

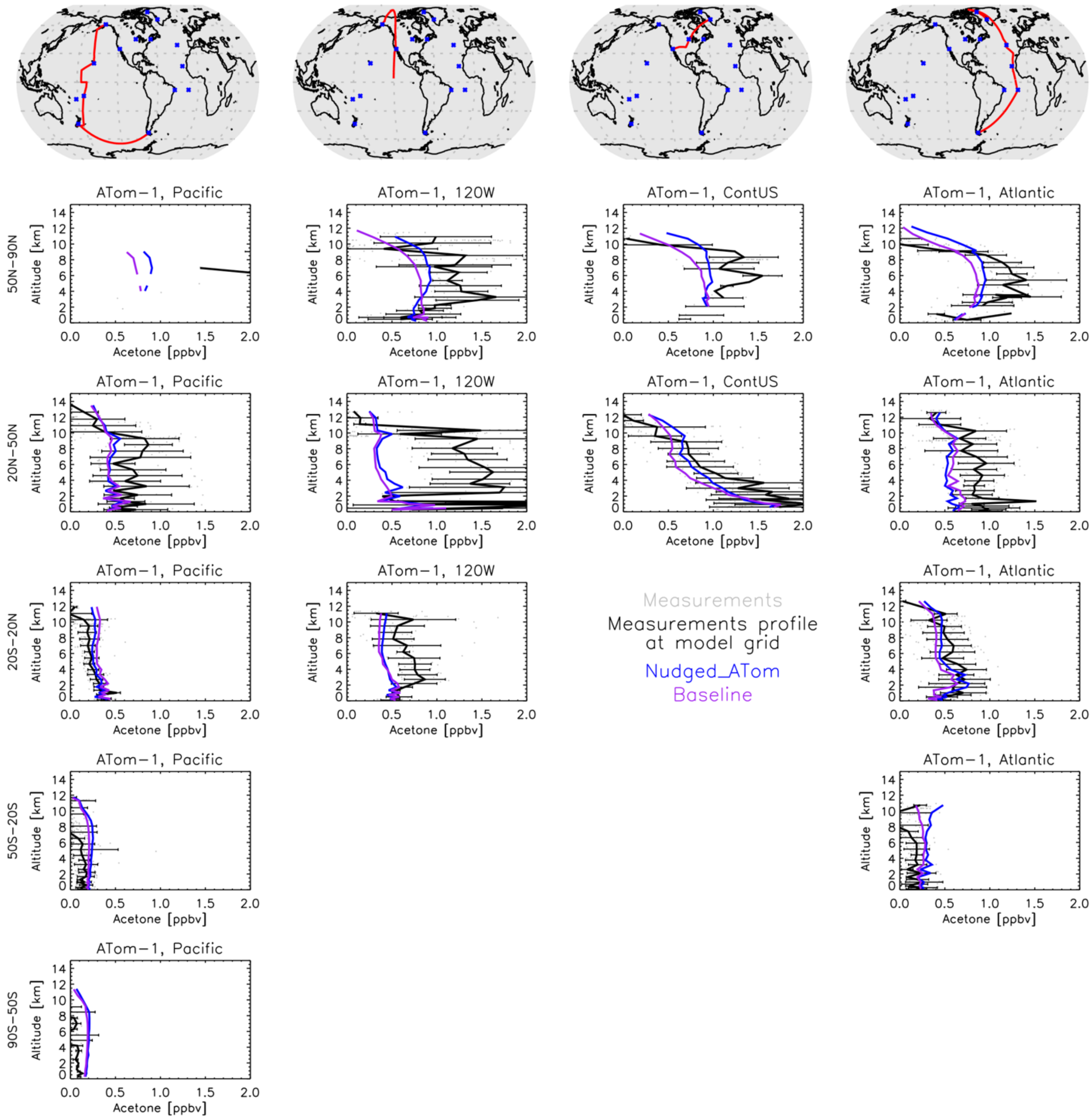


Figure S4. Comparison between the GISS ModelE2.1 simulations (Baseline in purple and Nudged_ATom in blue) and the ATom-1 field measurements (July-August 2016). Individual data points are shown with grey dots, and their average values are shown in black, with error bars representing the one-sigma range of the averages.

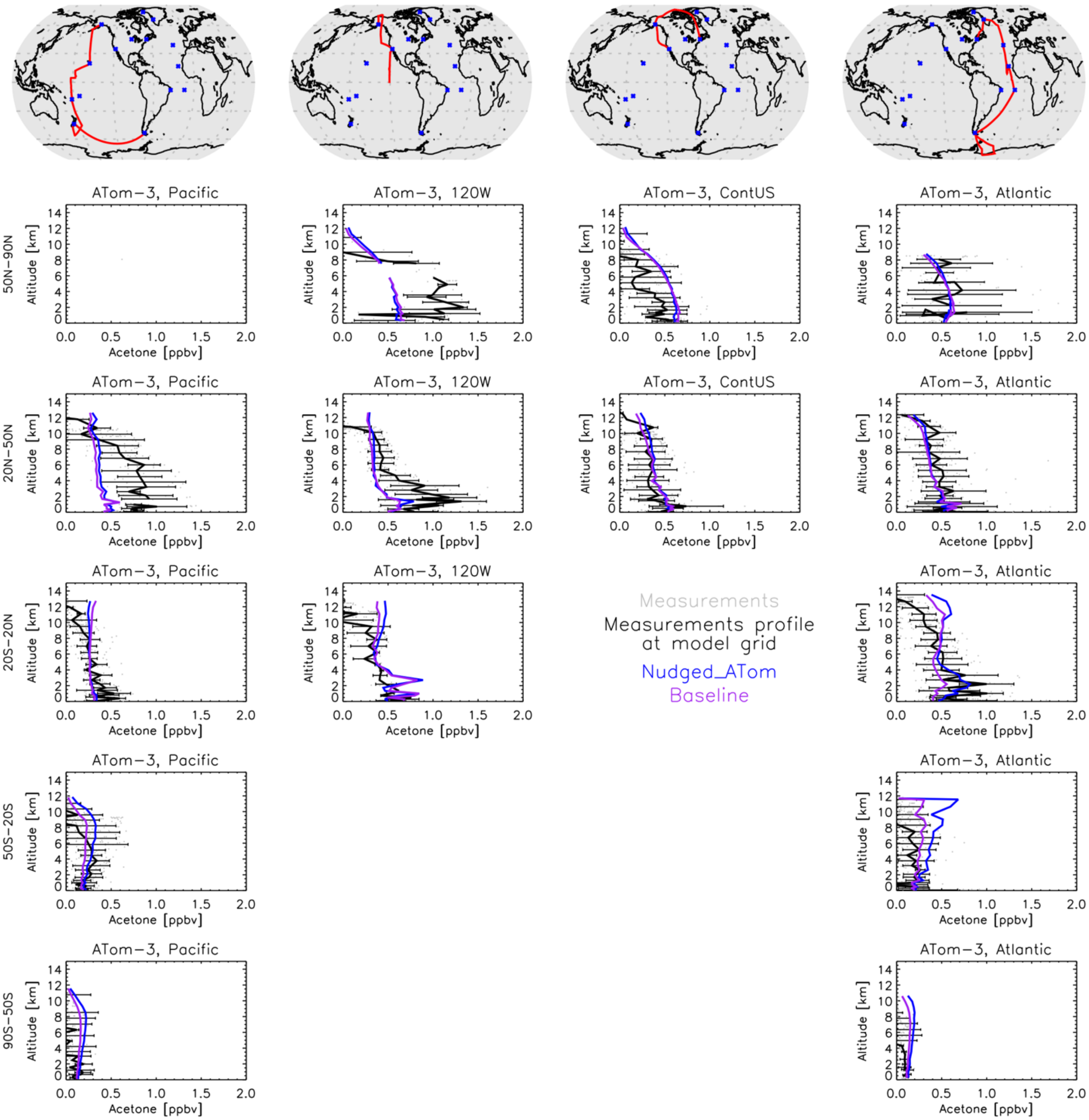


Figure S5. Same as Figure S4, for the ATom-3 field measurements (September-October 2017).

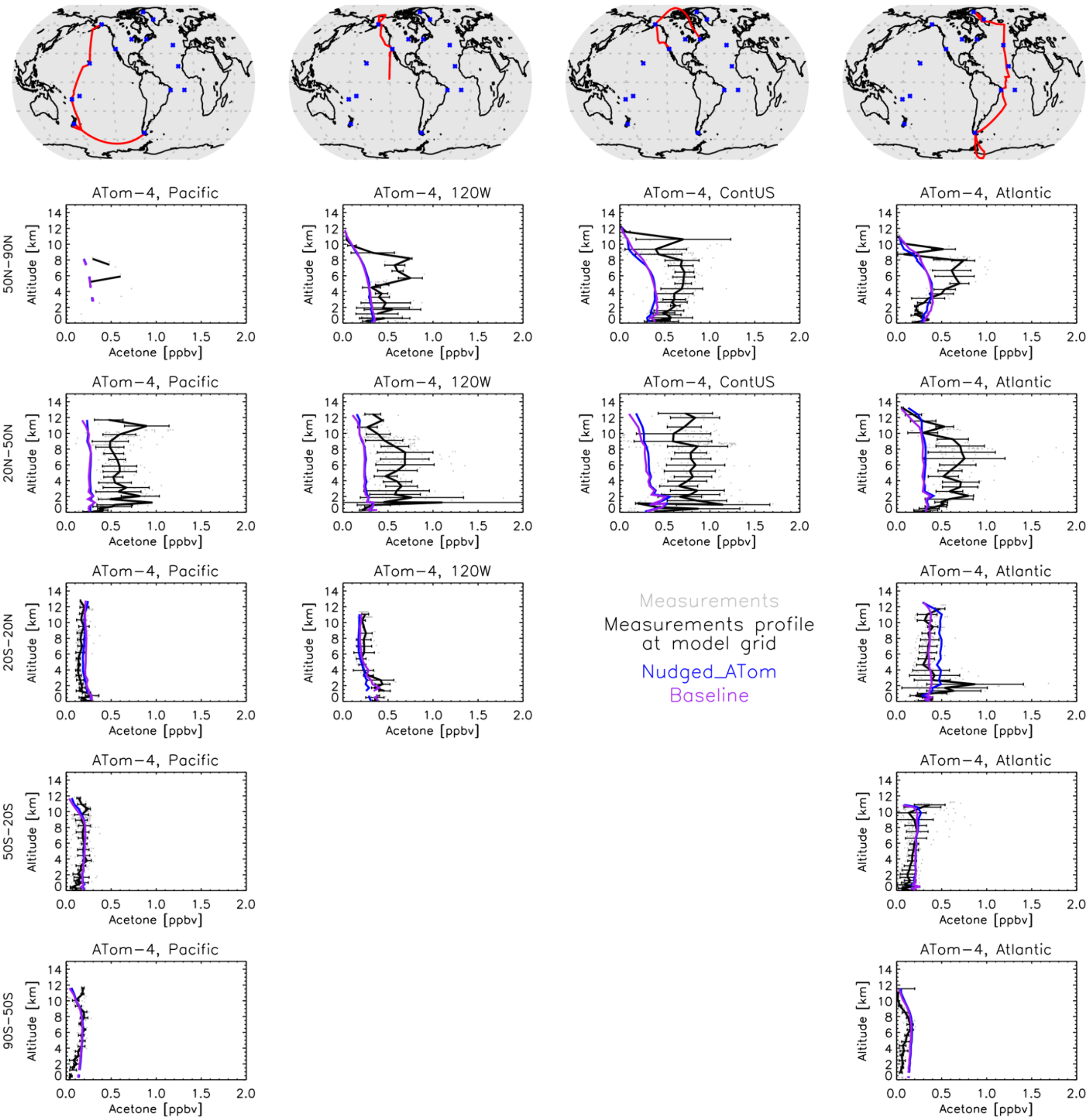


Figure S6. Same as Figure S4, for the ATom-4 field measurements (April-May 2018).

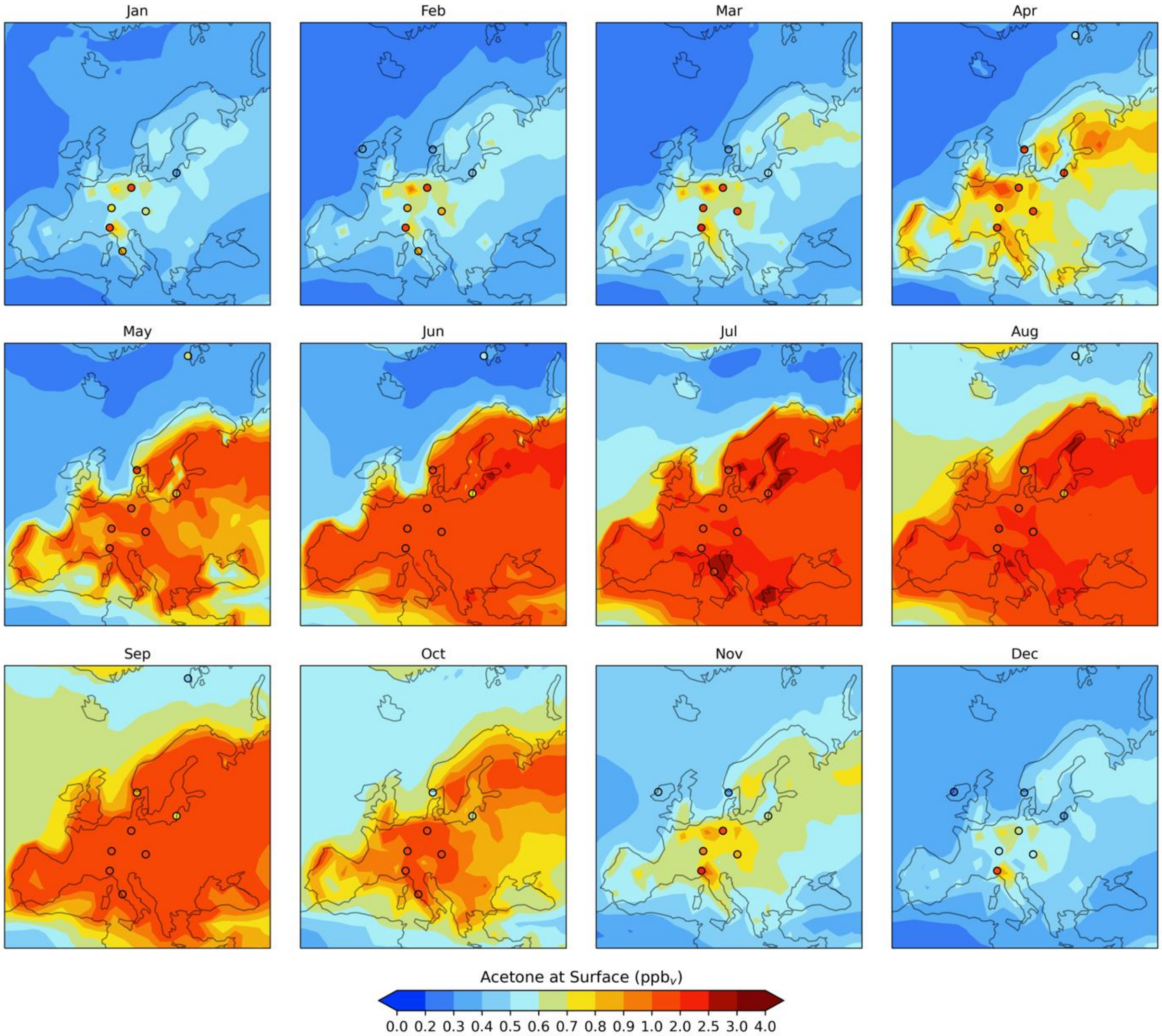


Figure S7. GISS ModelE2.1 spatial distribution of annual mean acetone at surface for the Baseline simulation in Europe over twelve months. Filled circles represent data from field measurements from Solberg et al., (1996). A nonlinear colorbar is used to better differentiate the details in the map.

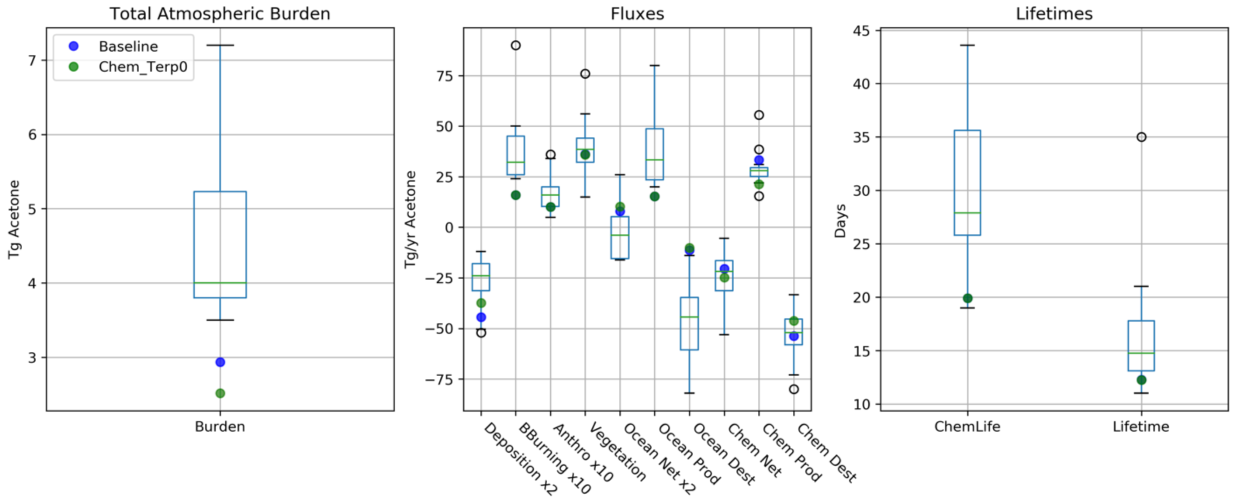


Figure S8. Total atmospheric burden, fluxes, and lifetimes of acetone from the literature (shown in boxes and whiskers with outliers as open circles), and values from GISS ModelE2.1 Baseline simulation (solid blue circles) and Chem_Terp0 sensitivity study (green circles).

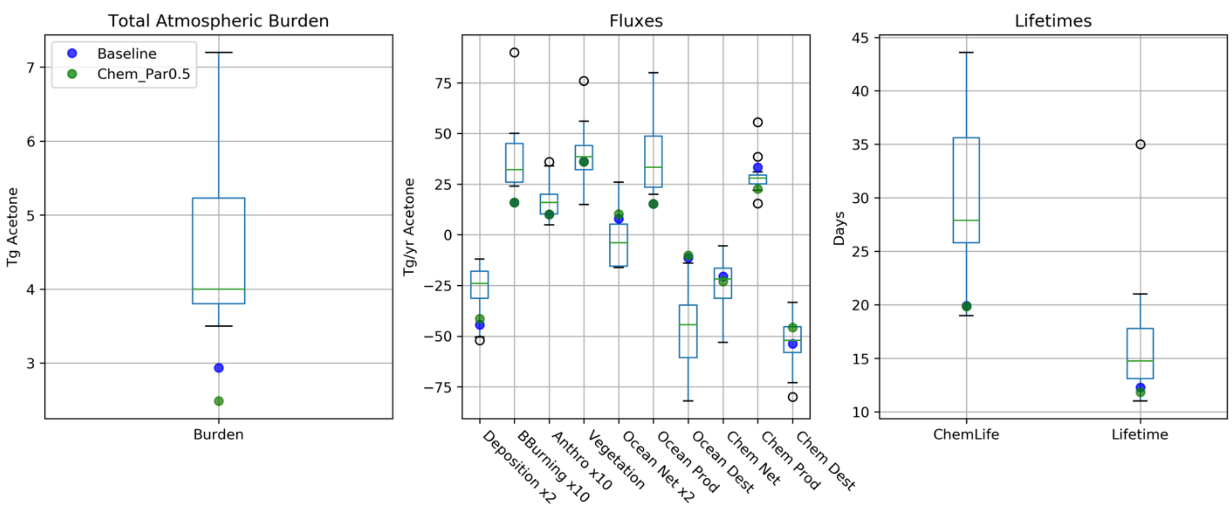


Figure S9. Same as Figure S8, for the Chem_Par0.5 sensitivity study.

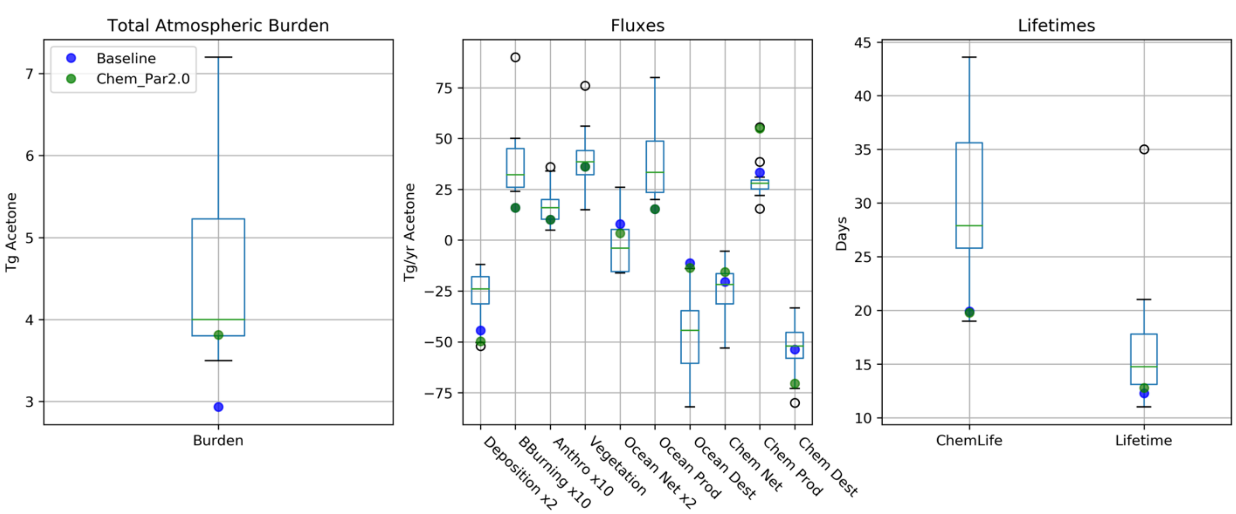


Figure S10. Same as Figure S8, for the Chem_Par2.0 sensitivity study.

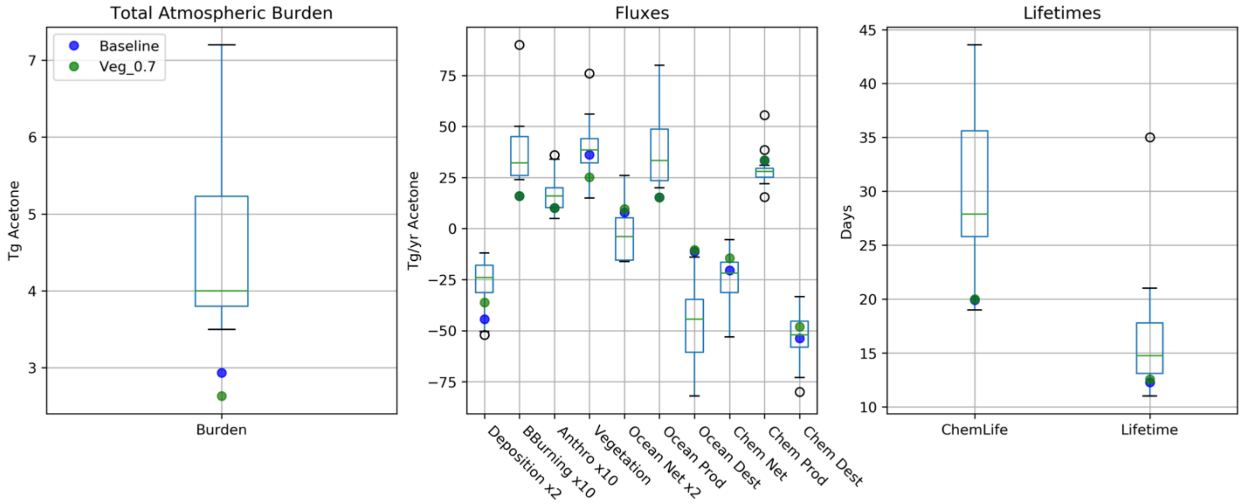


Figure S11. Same as Figure S8, for the Veg_0.7 sensitivity study.

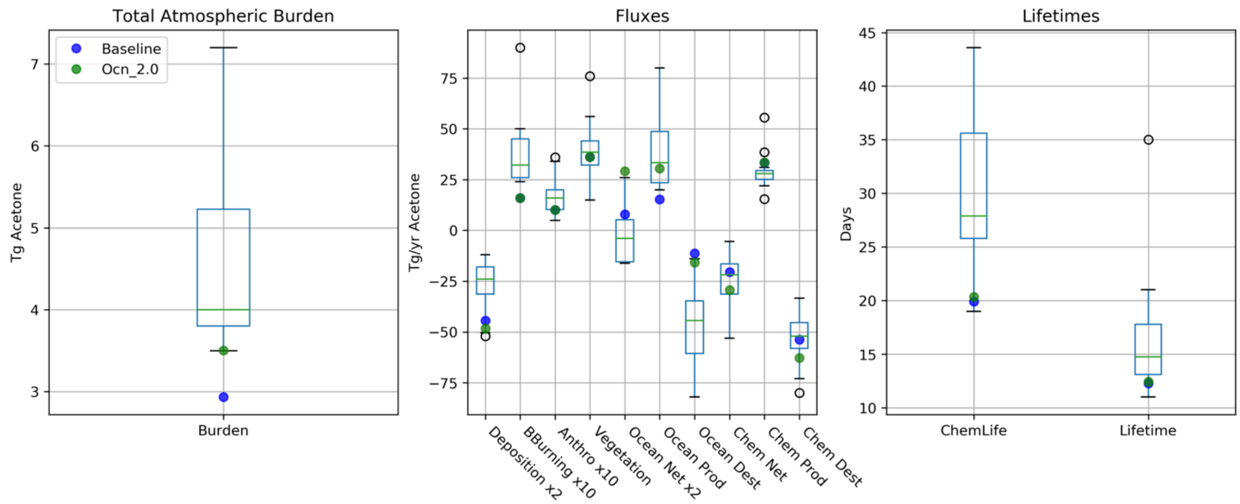


Figure S12. Same as Figure S8, for the Ocn_2.0 sensitivity study.

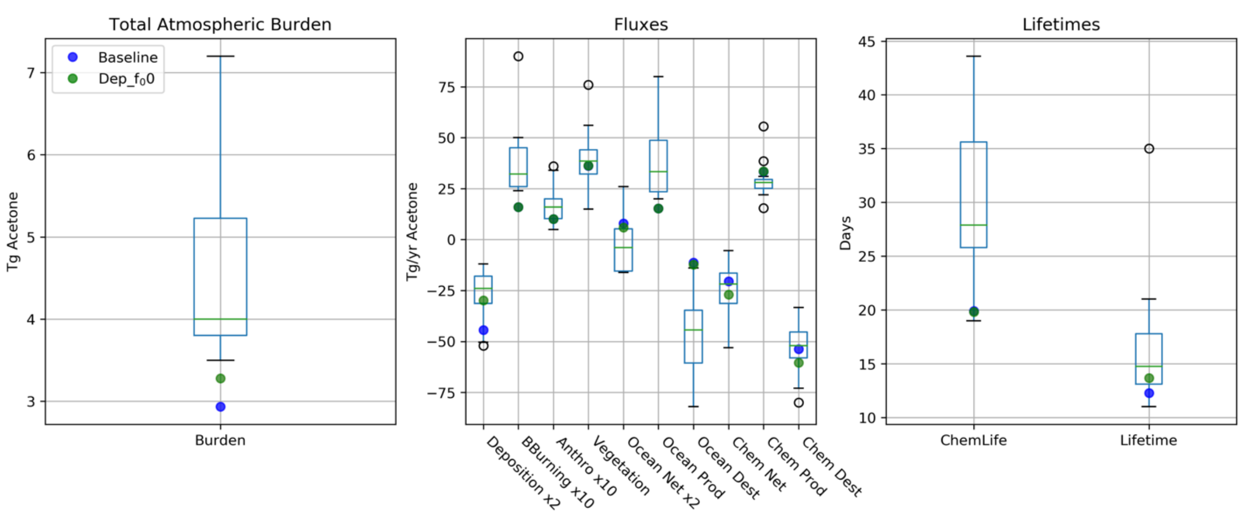


Figure S13. Same as Figure S8, for the Dep_f$_0$0 sensitivity study.

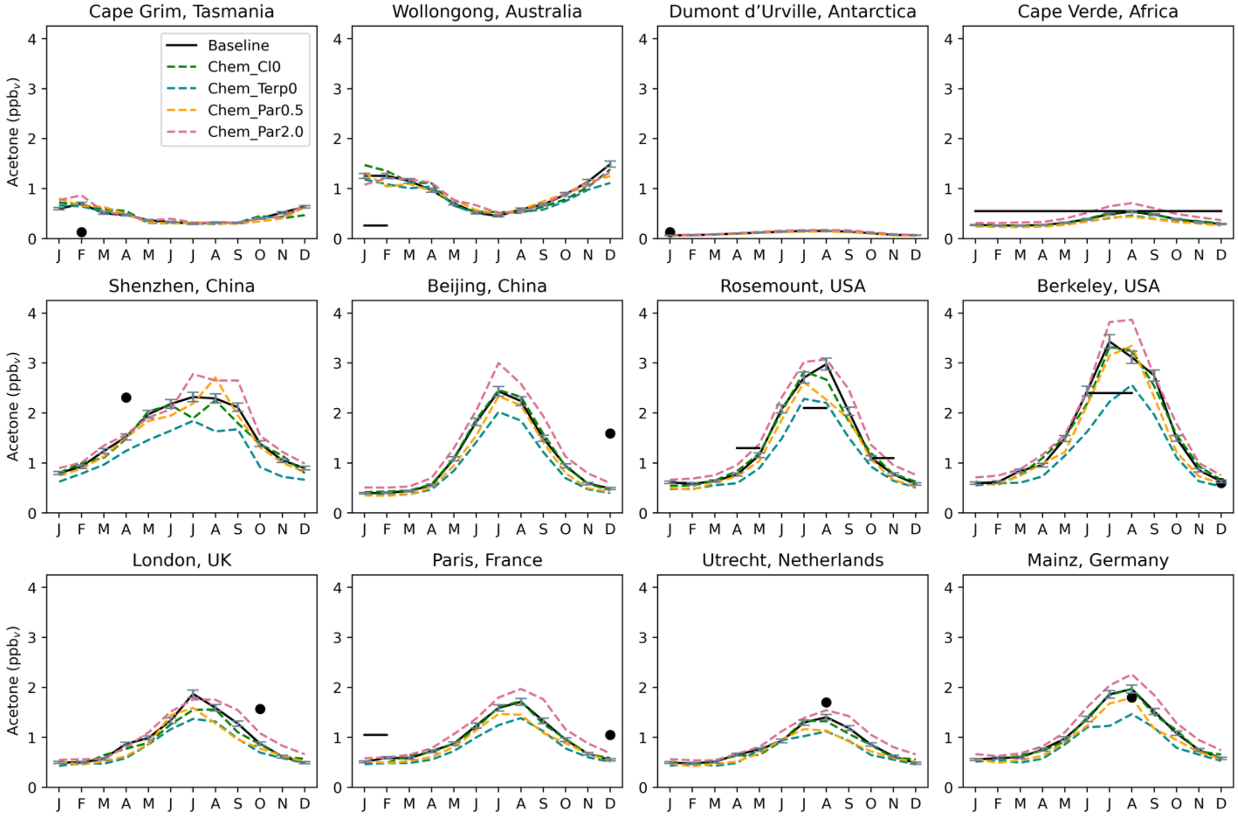


Figure S14. Acetone over twelve months for various sites that do not have enough measurements to resolve seasonality (Australia, Antarctica, Africa, Asia, Europe, North America) with the chemistry sensitivity studies added. The modelled estimates are overlaid with monthly (solid circles) or seasonal (solid lines) field measurements, as found in the literature. The sensitivity studies include removing the acetone + chlorine reaction (green line), removing the production of acetone from terpenes (blue line), halving the yield of acetone from paraffin (orange line), and doubling the yield of acetone from paraffin (pink line).

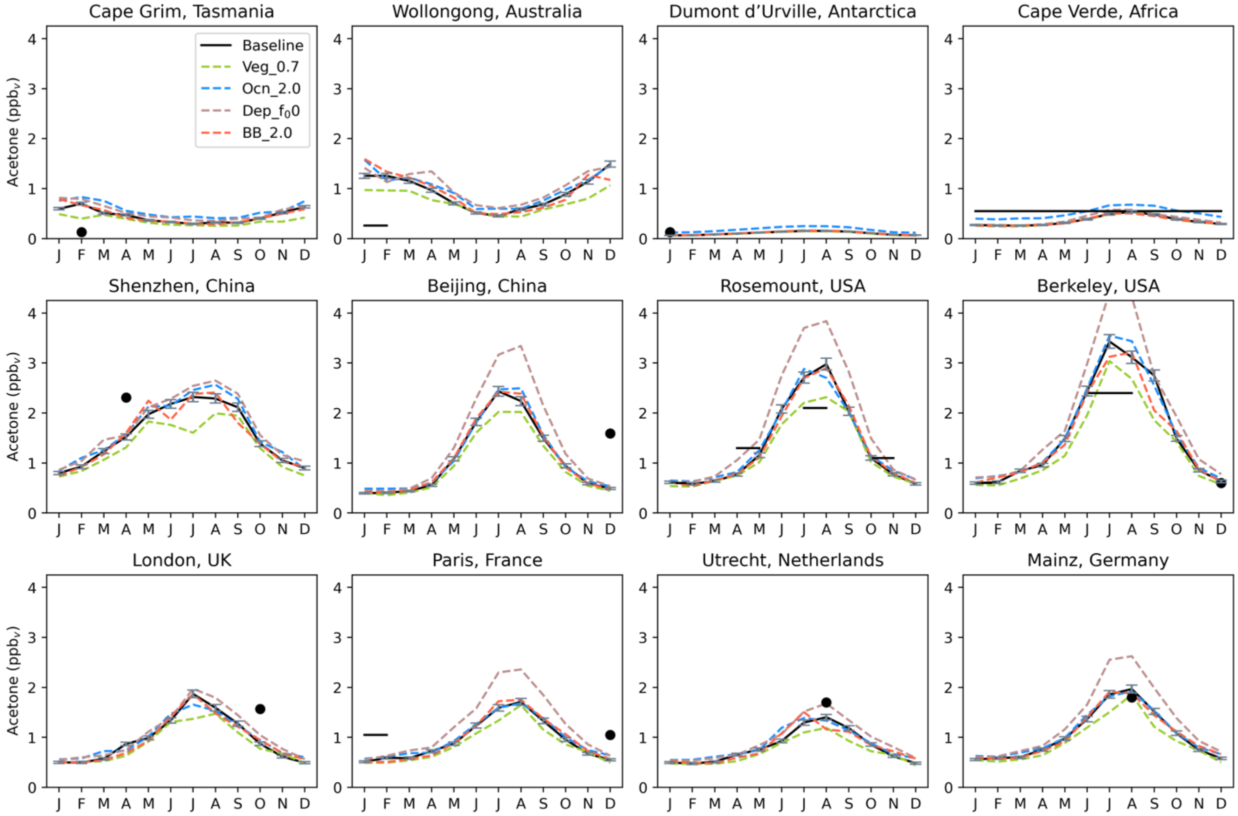


Figure S15. Same as Figure S14, with the terrestrial and oceanic sensitivity studies added. The sensitivity studies include reducing vegetation emissions to 0.7 acetone from MEGAN (light green line), doubling ocean acetone concentration (blue line), changing the reactivity factor for deposition (brown line), and doubling biomass burning emissions (orange line).

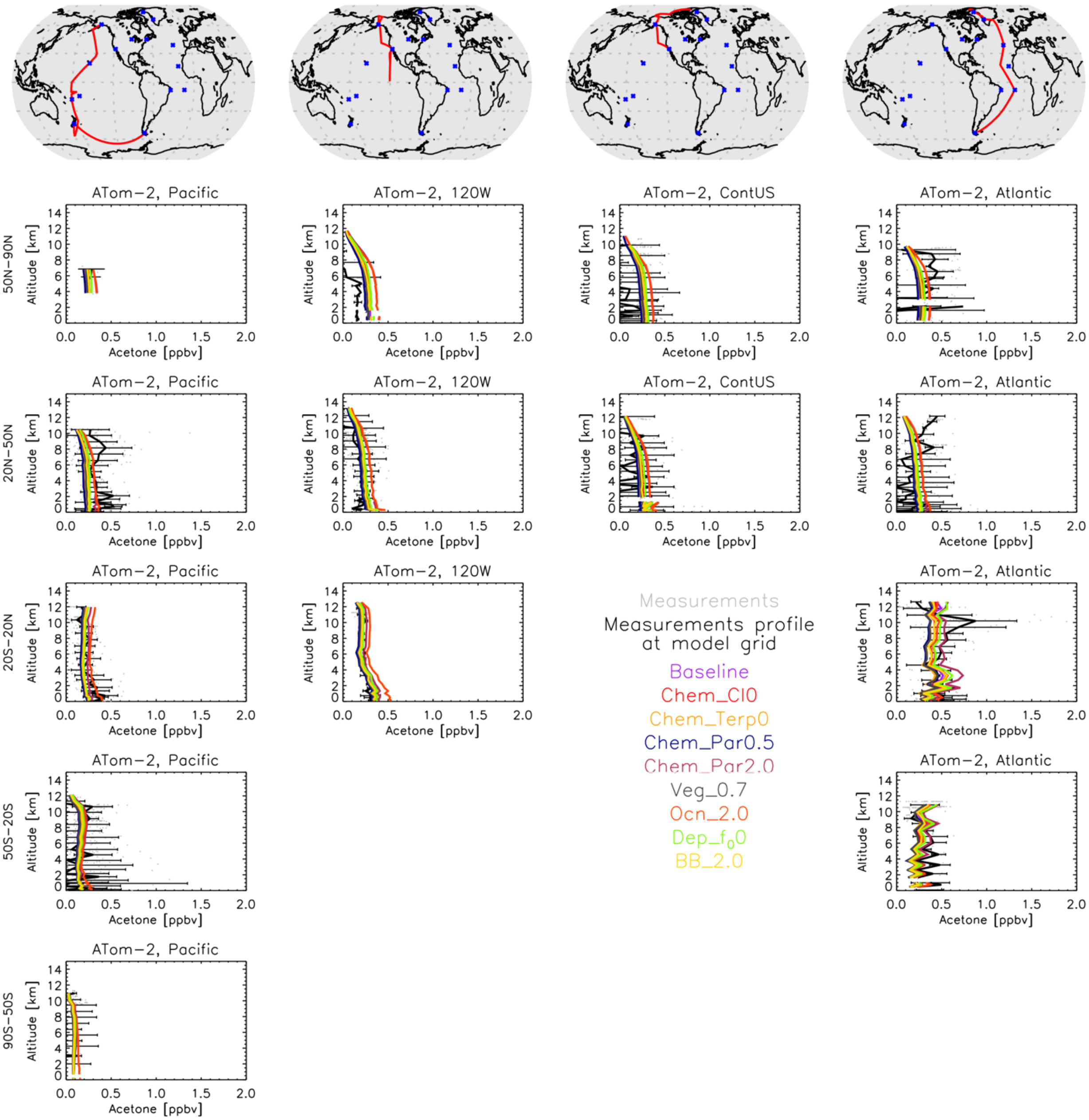


Figure S16. A comparison between the GISS ModelE2.1 sensitivity simulations and the ATom-2 aircraft measurements (January-February 2017). Note that all sensitivities are to be compared against the Baseline simulation.

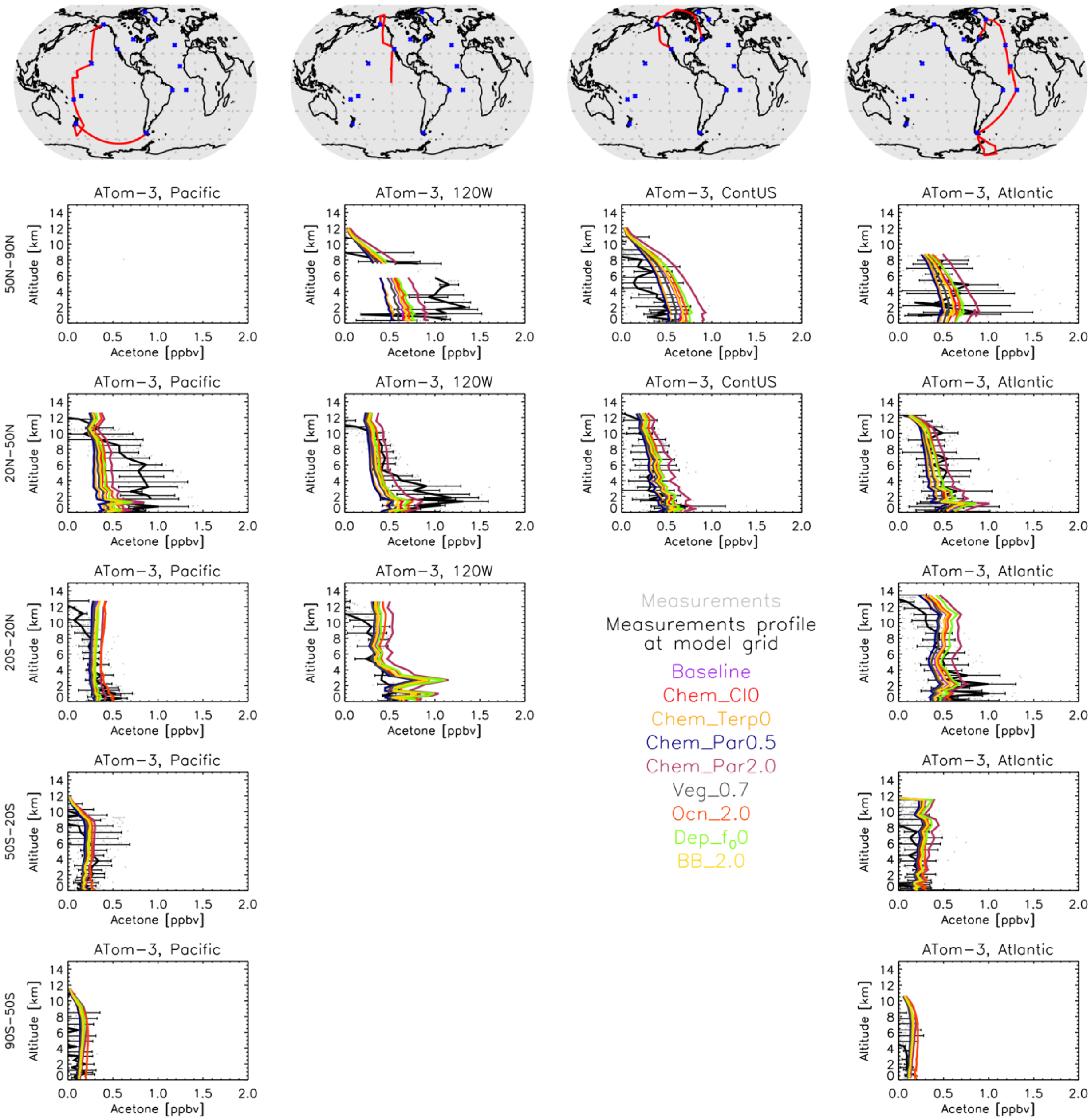
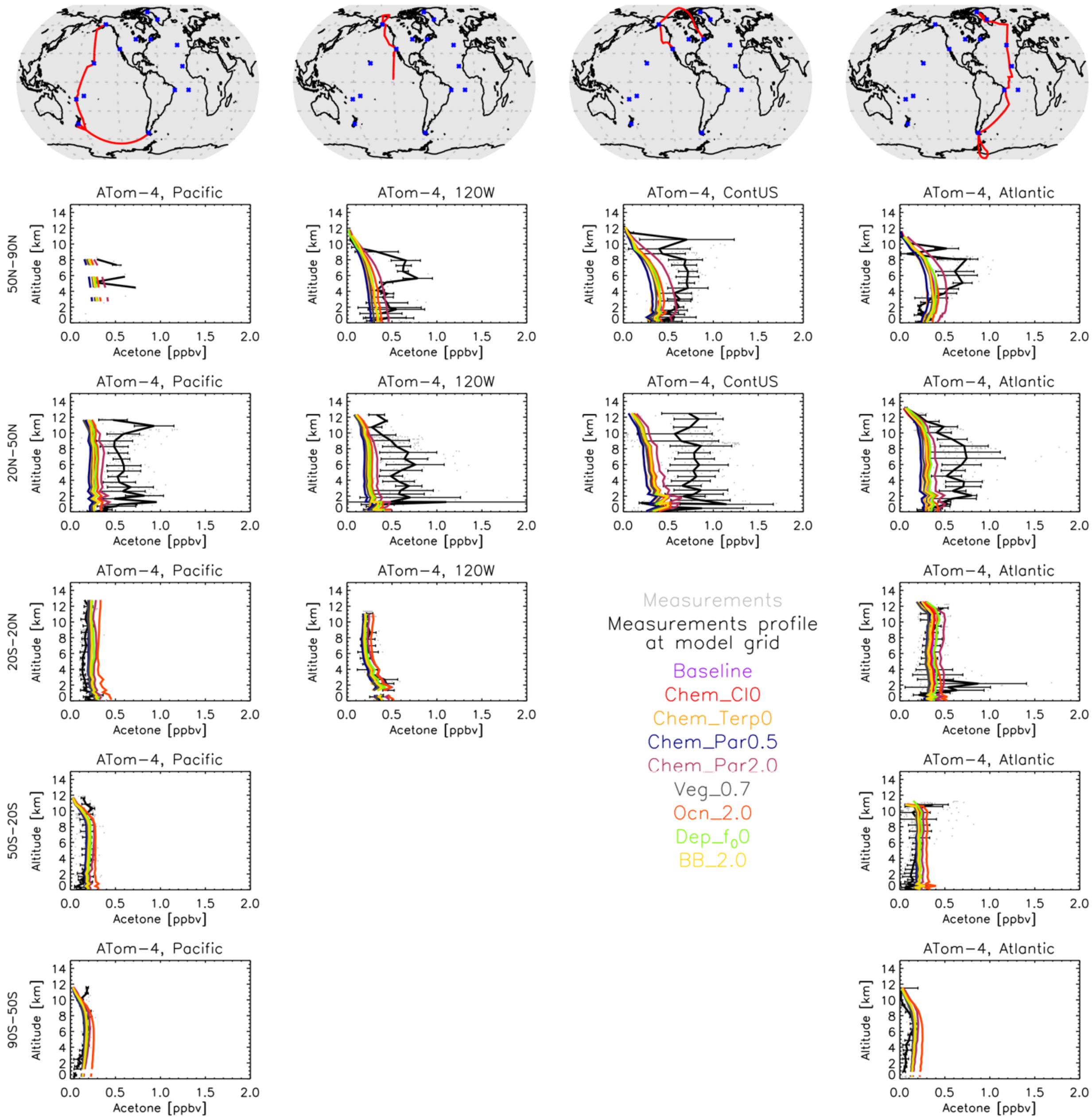


Figure S17. Same as Figure S16, for the ATom-3 field measurements (September-October 2017).



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86 **Figure S18.** Same as Figure S16, for the ATom-4 field measurements (April-May 2018).