



Supplement of

Comparisons between the distributions of dust and combustion aerosols in MERRA-2, FLEXPART, and CALIPSO and implications for deposition freezing over wintertime Siberia

Lauren M. Zamora et al.

Correspondence to: Lauren M. Zamora (lauren.m.zamora@nasa.gov)

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Winter (DJF), 4-8 km

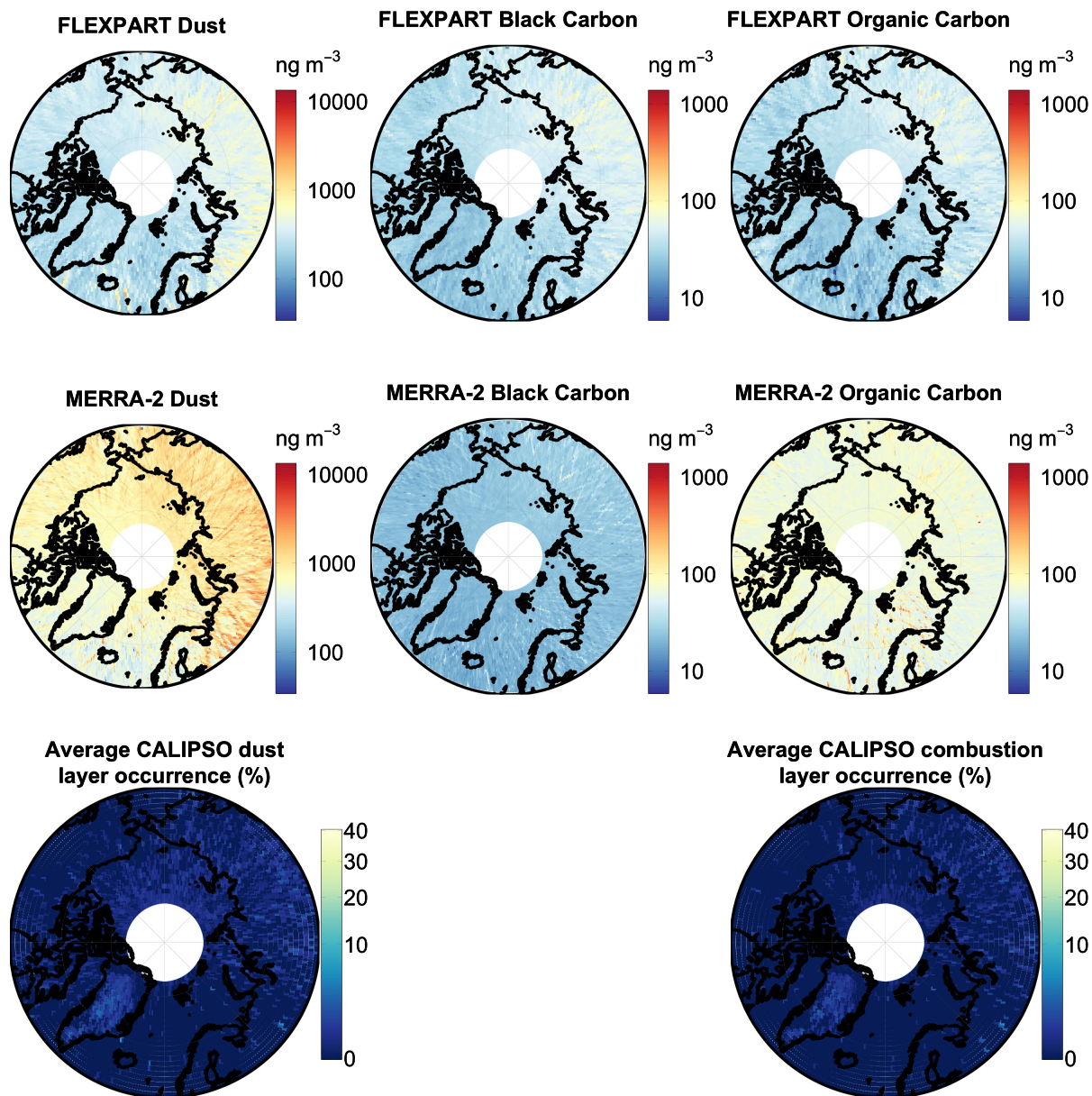


Figure S1: As in Figure 1, but for 4-8 km asl.

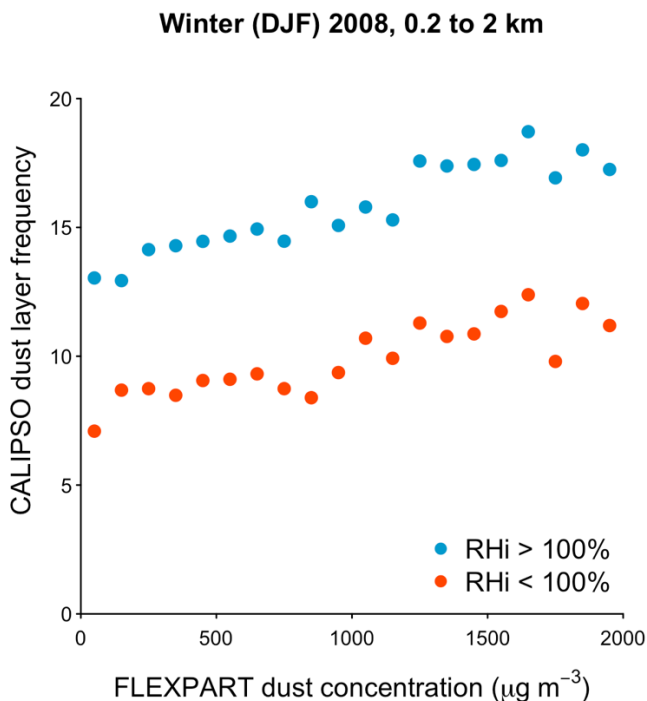
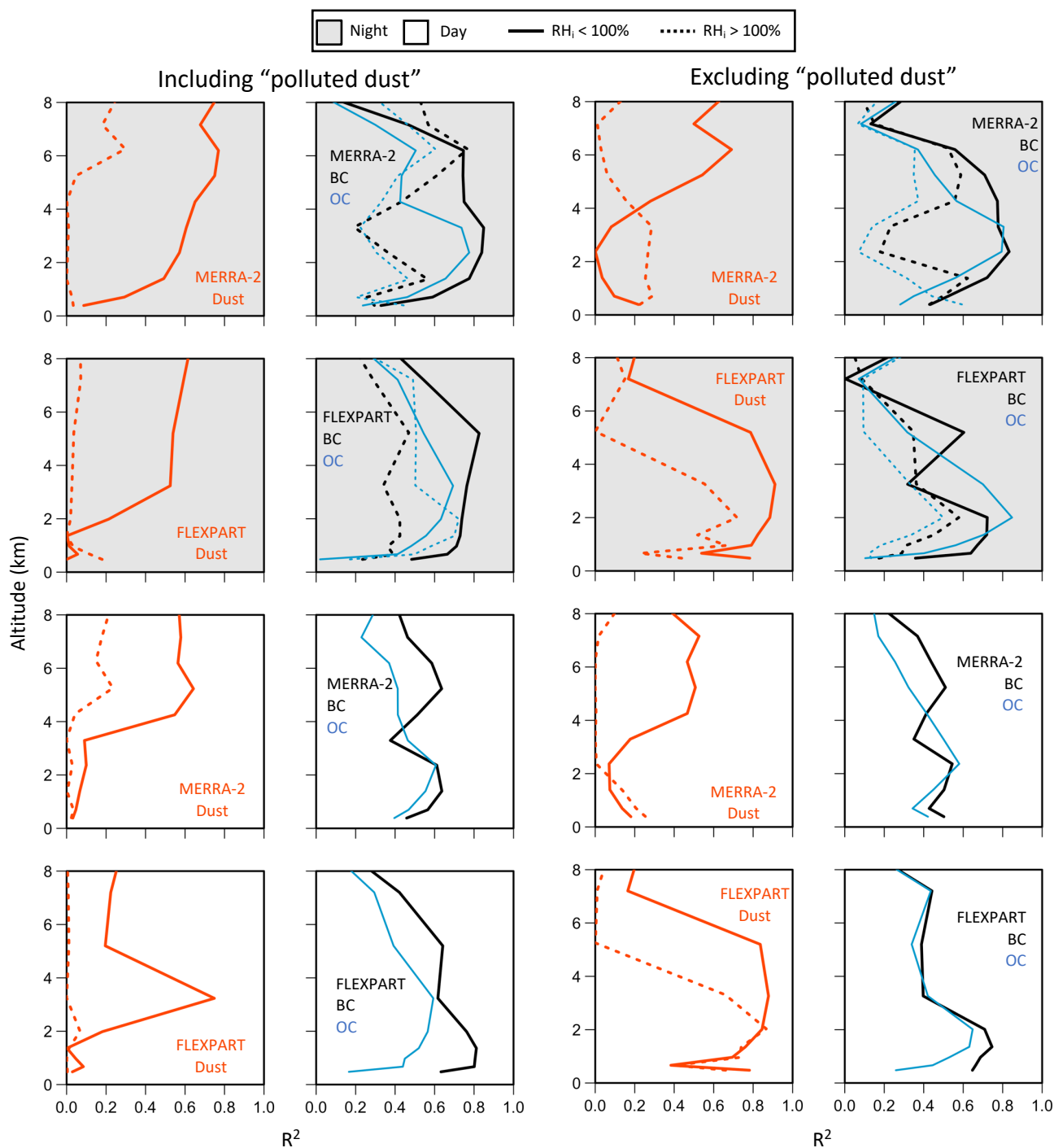


Figure S2. The average Arctic wintertime (DJF) CALIPSO dust layer frequency between 0.2 to 2 km in conditions that favor and do not favor diamond dust occurrence ($\text{RH}_i >$ and $< 100\%$, respectively).

Figure S2 methods and discussion:

For the year 2008, we compared the frequency of CALIPSO dust observations in conditions that were and were not favorable for the formation of diamond dust at different FLEXPART model dust concentrations. We found that CALIPSO reported Arctic dust layers in wintertime air masses on average $61 \pm 11\%$ more often in conditions favorable for diamond dust formation ($\text{RH}_i > 100\%$) than in conditions not favorable for diamond dust. This finding was significant (Wilcoxon rank test, $p < 7\text{e-}13$) at all dust levels tested (Fig. S2), and similar differences were also seen in the later study years as well (data not shown). Given that conditions favorable for diamond dust occur up to $\sim 60\%$ of the time near the surface during the winter (Fig. 2a), this finding suggests that up to 37% of near-surface wintertime Arctic CALIPSO mineral dust observations overall could actually be diamond dust instead of mineral dust. This result assumes that the FLEXPART model is not biased between conditions with RH_i values above and below 100%, that cloudy conditions would experience similar findings (since the current study focused on cloud-free conditions), and that these observed differences were attributable to diamond dust and not some other co-varying factor.

However, conditions favoring diamond dust occur much less frequently than 60% of the time at higher altitudes, during the summer, and over most parts of the Arctic Ocean (Fig. 2). Therefore, we believe that diamond dust is unlikely to majorly impact Arctic CALIPSO dust data at most times and places.



40 Figure S3: As in Figure 3, but based on correlations instead of the Kendall Tau method.

Difference between MERRA-2/FLEXPART and CALIPSO Z-scores

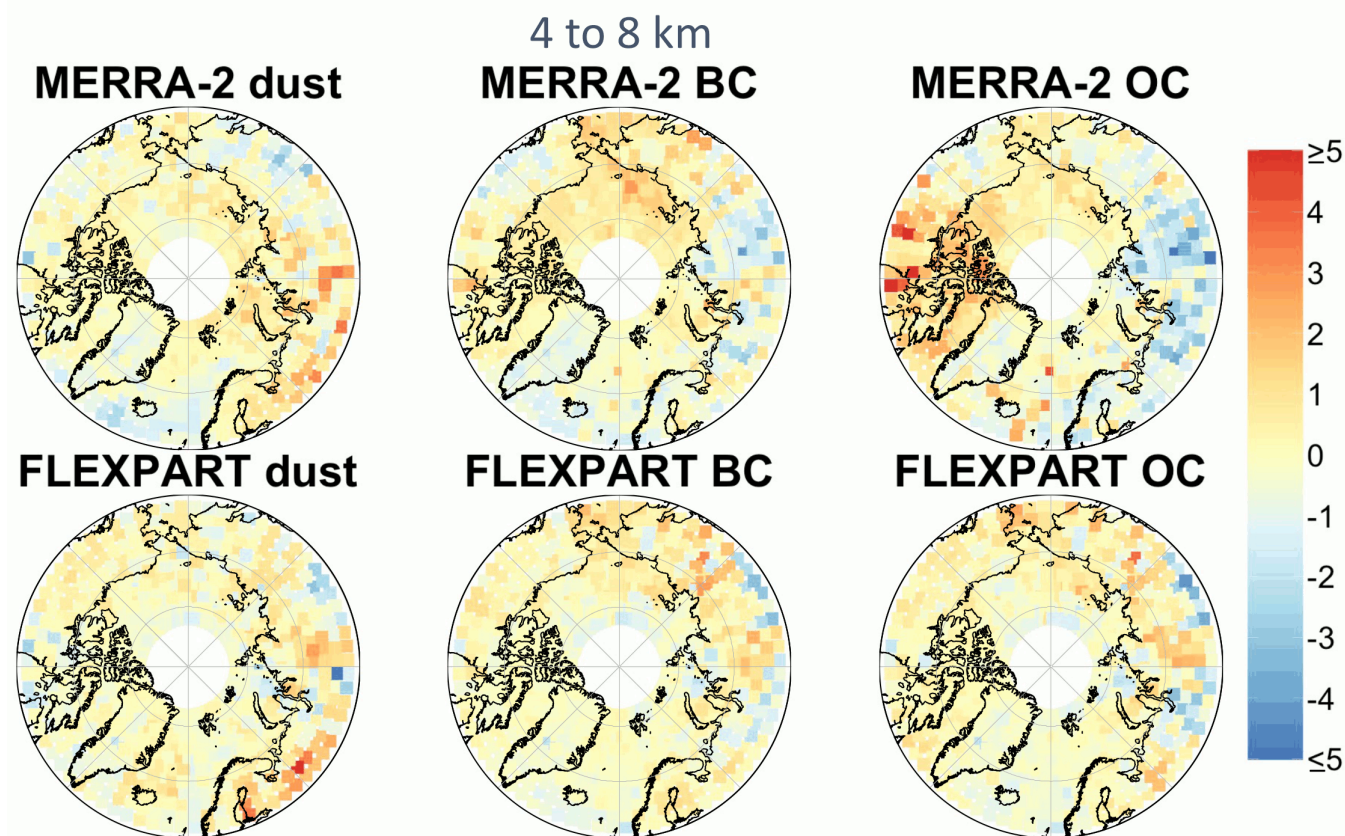


Figure S4: As in Figure 4, but for 4-8 km asl.