



Supplement of

The day-to-day co-variability between mineral dust and cloud glaciation: a proxy for heterogeneous freezing

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For figures S.1 to S.14:

- a) Time average at -15°C (averaged in a 12 K range), 2007-2010.
- b) Time-zonal average, 2007-2010.
- c) Zonal average at -15°C (averaged in a 12 K range), 2007-2010.

S 1-S 3: Frequency phase ratio (FPR) variables.

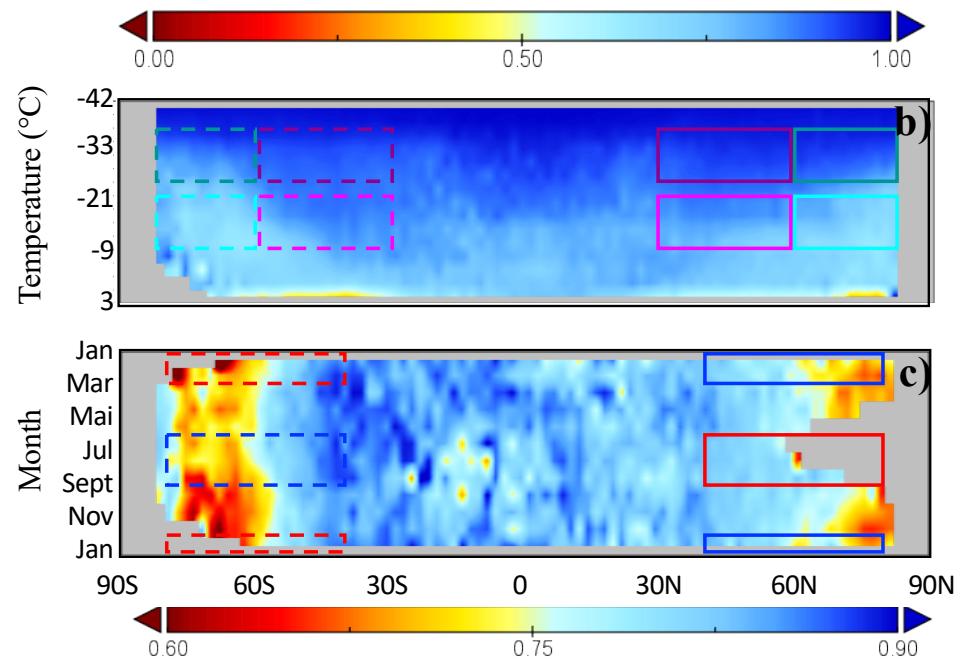
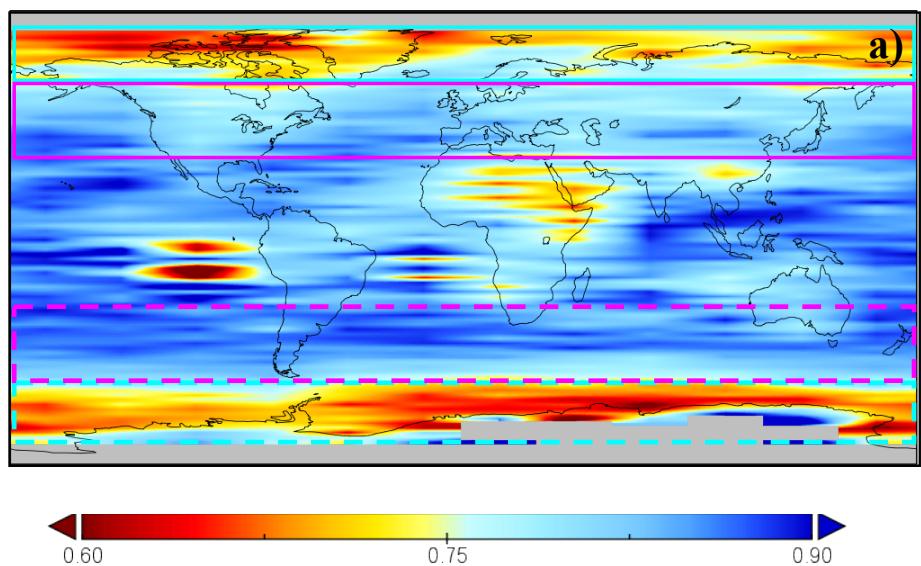
S 4-S.7: Dust aerosol data from MACC reanalysis.

S.8-S.9: Cloud volume fraction of all and stratiform clouds (CALIPSO-GOCCP).

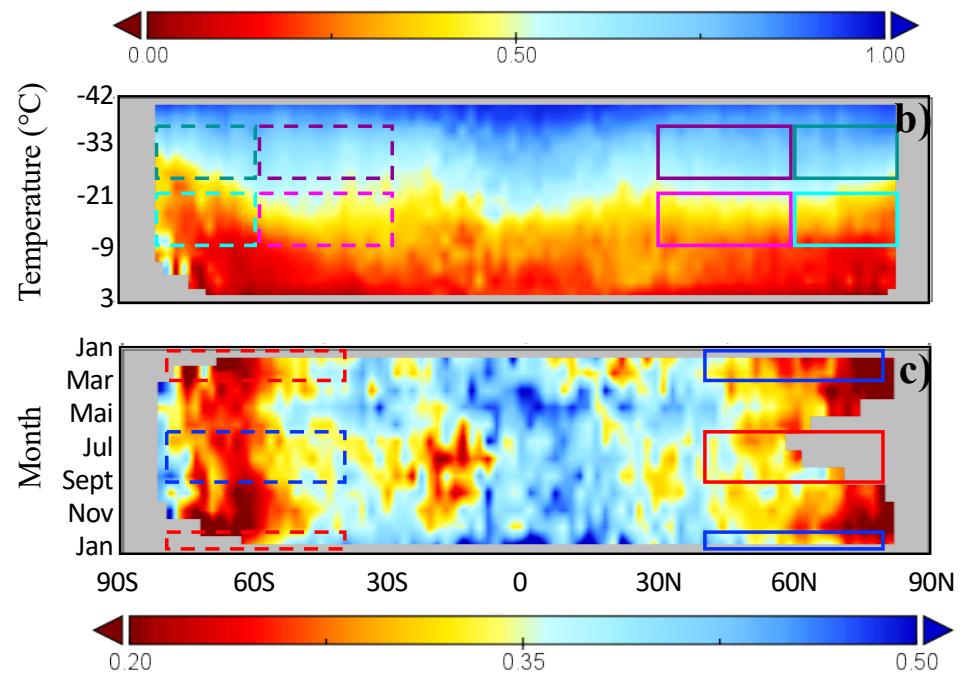
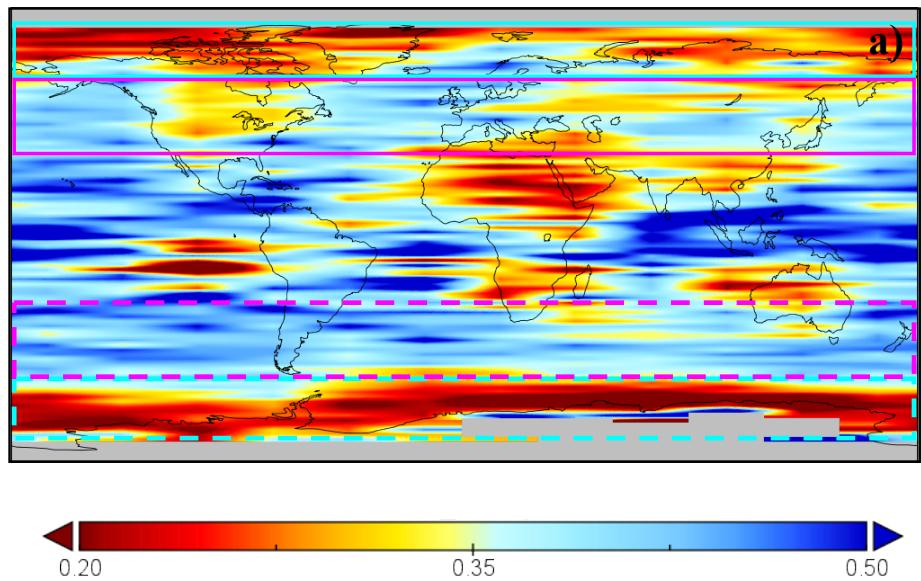
S.10-S.13: Vertical velocity (MACC), relative humidity (ERA-Interim),
isotherm height and temperature (ECMWF-AUX).

S.14-S.16: Sample size distribution.

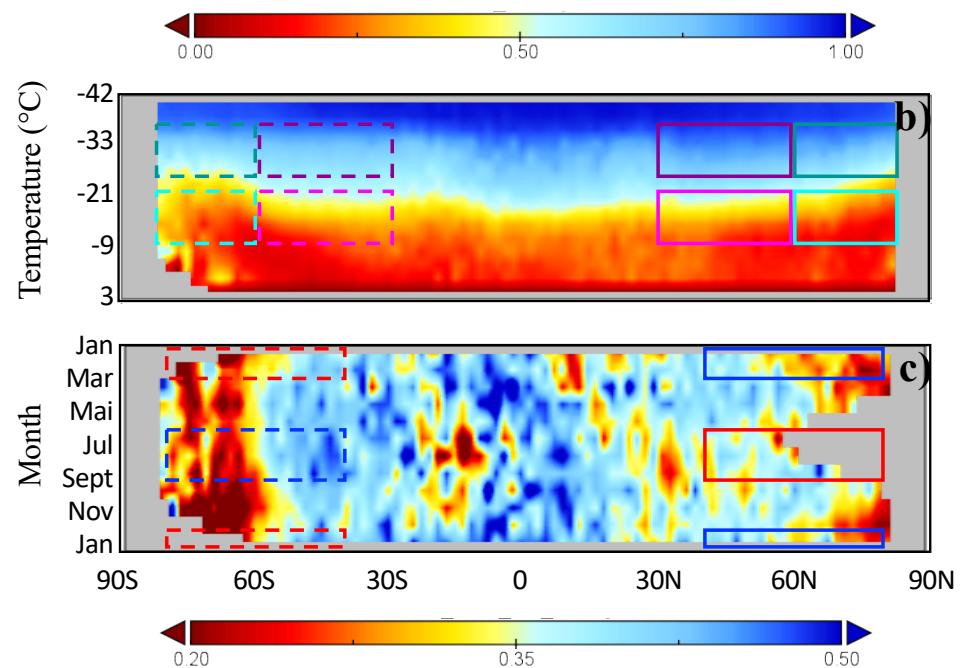
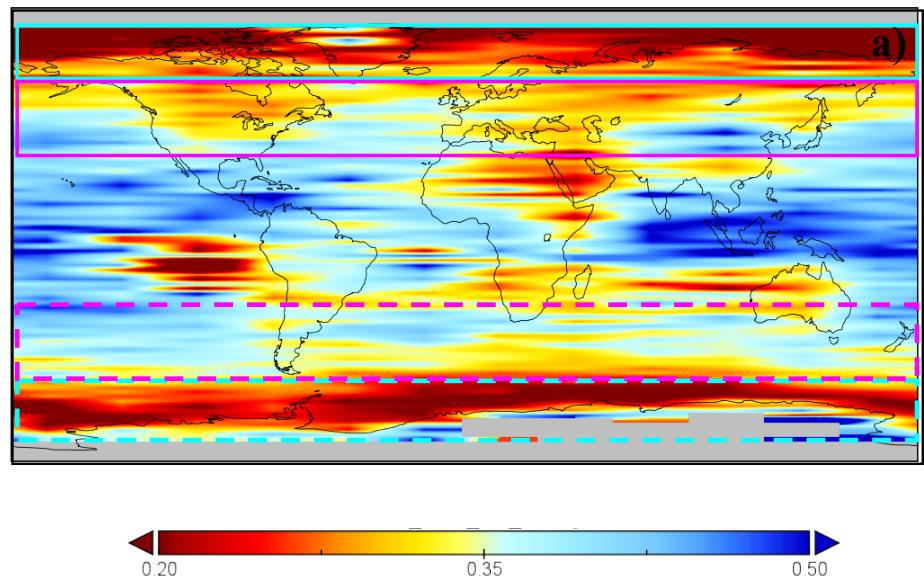
S.17-S.20: Day-to-day dust-ice statistics without meteorological constrains.



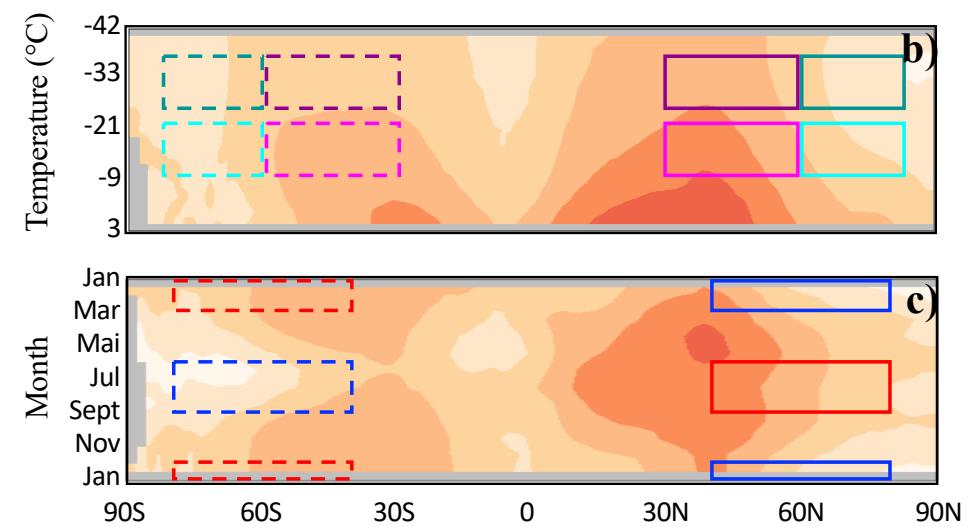
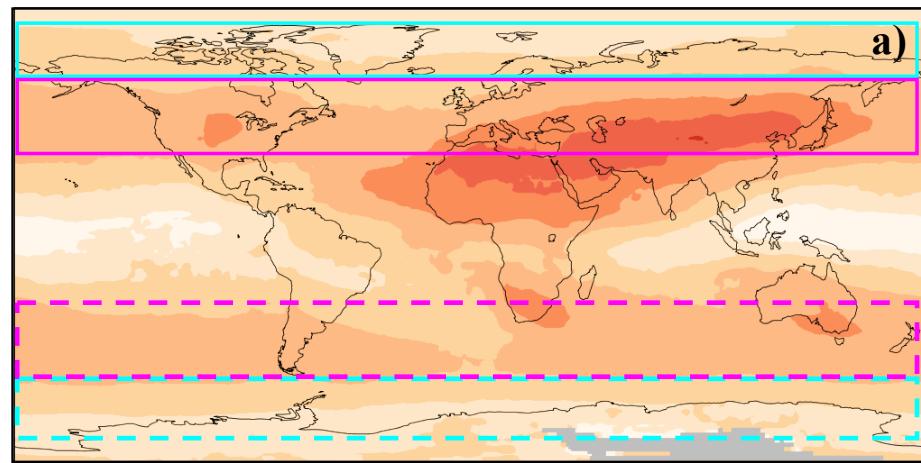
S1. $\text{FPR}_{\text{DARDAR}} [\%]$



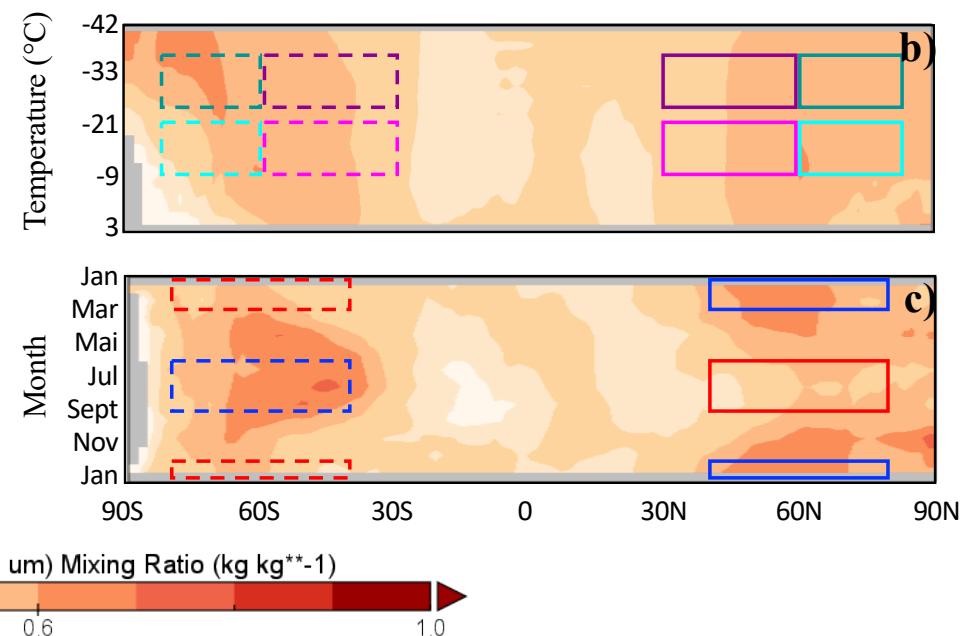
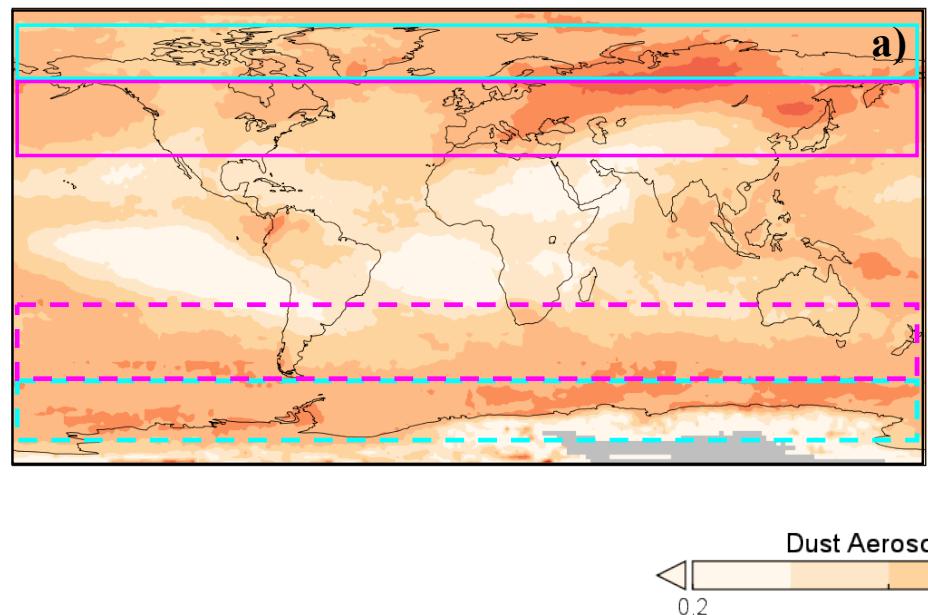
S2. FPR_{ALT_{DARDAR}} [%]



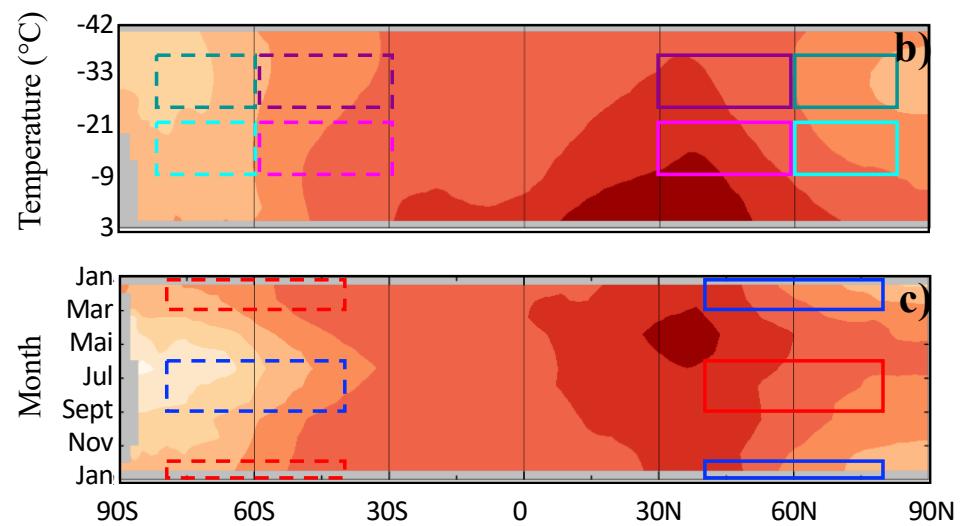
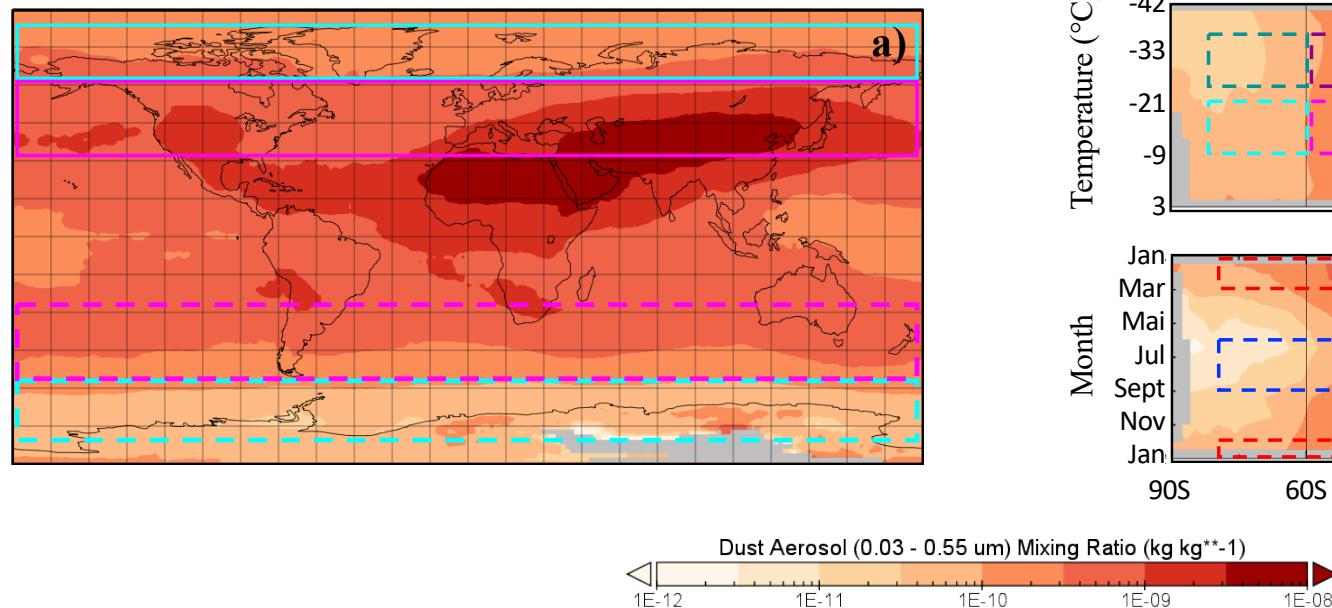
S3. $\text{FPR}_{\text{GOCCP}} [\%]$



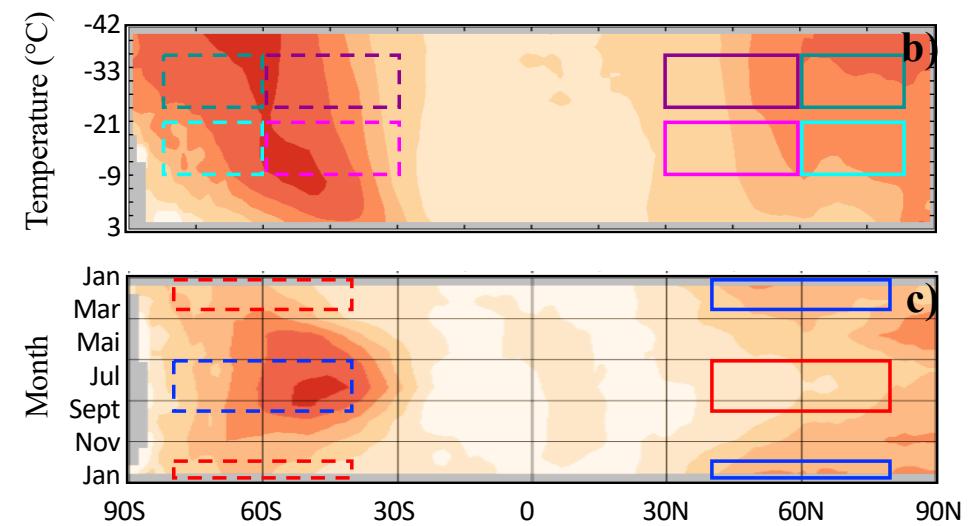
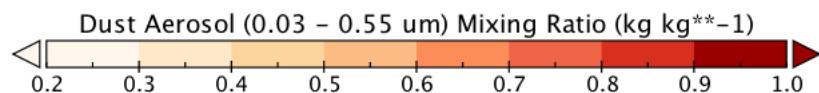
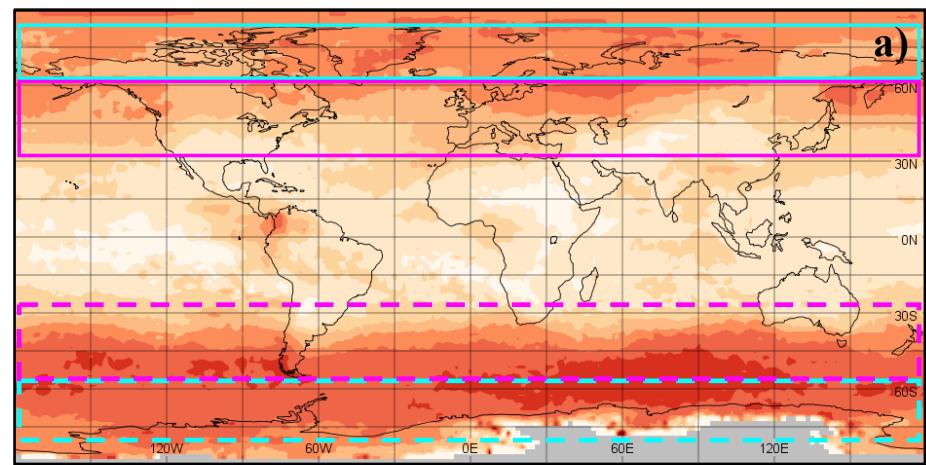
S4. MACC coarse dust [kg/kg].



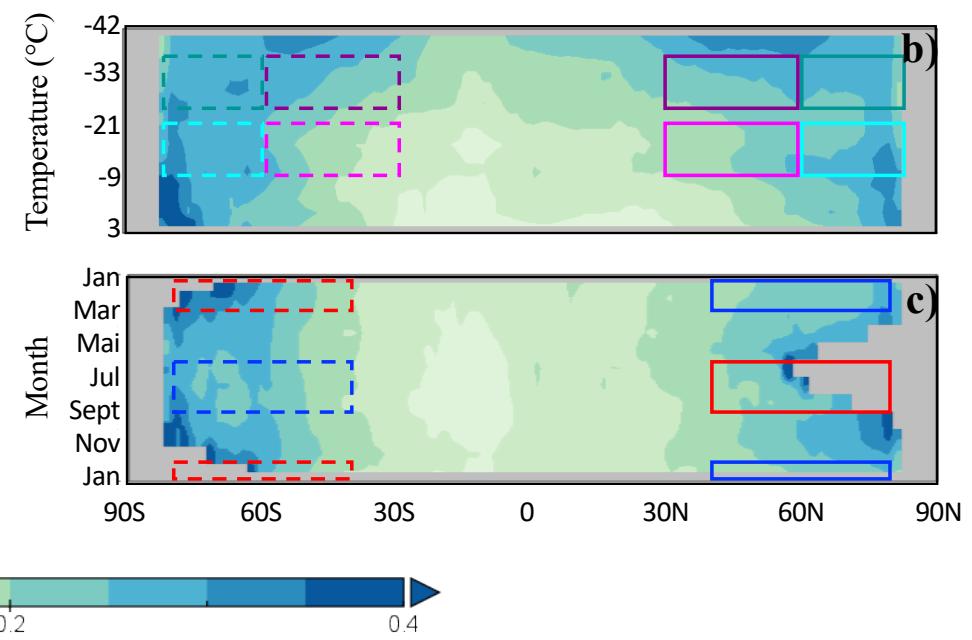
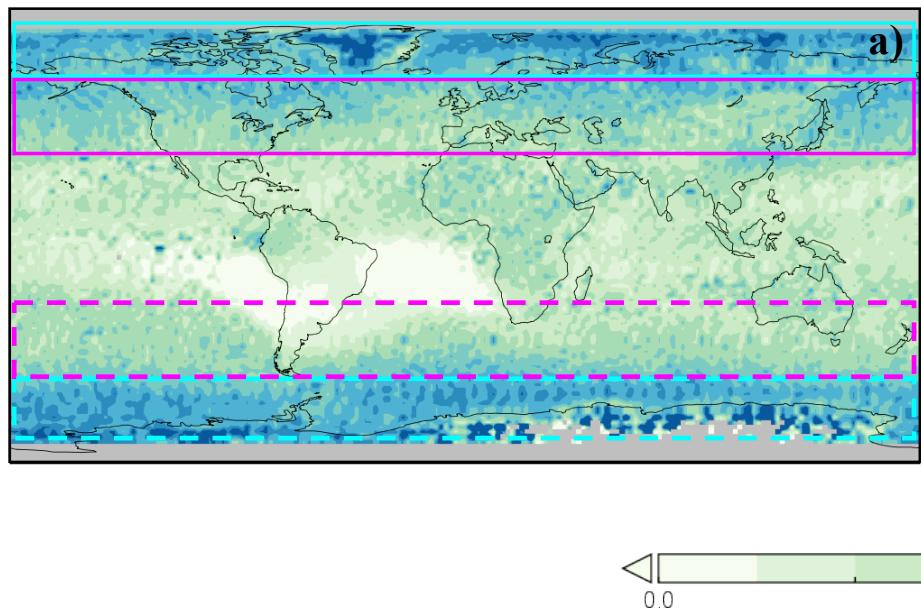
S5. Standard deviation of coarse log (dust) MACC [$\log(\text{kg/kg})$].



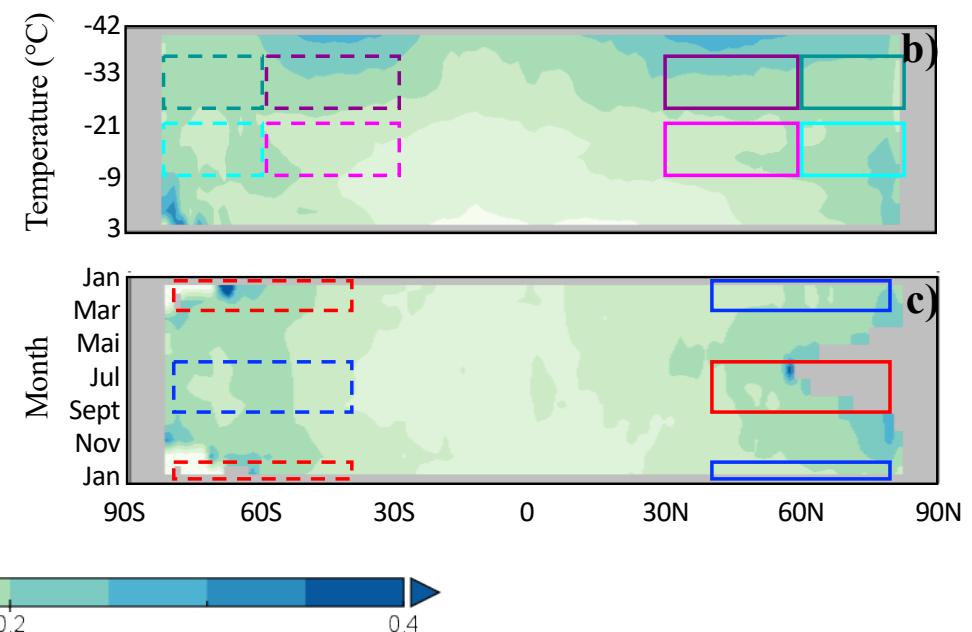
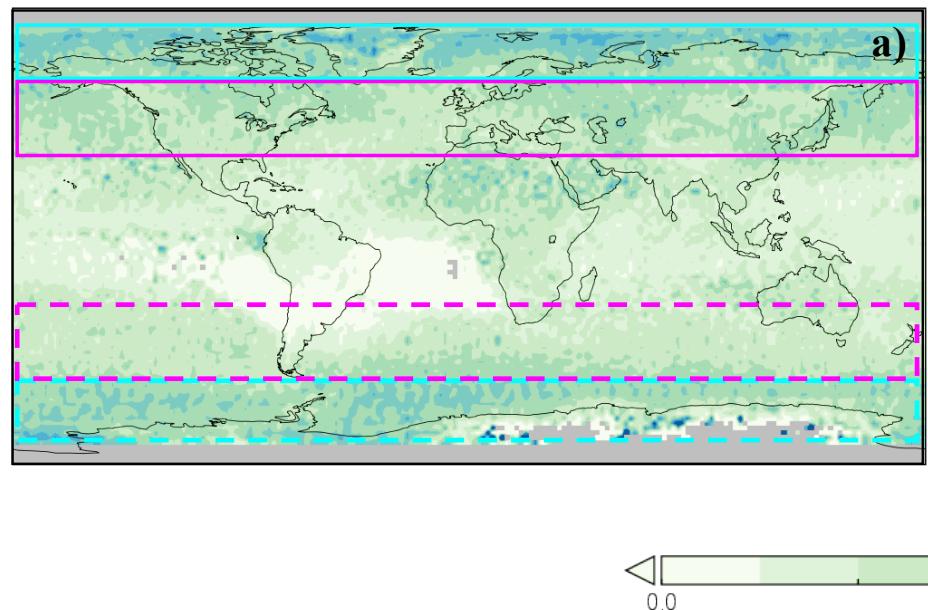
S6. MACC fine dust [kg/kg].



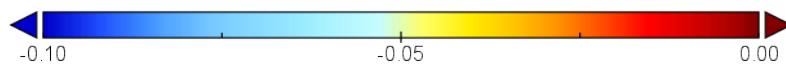
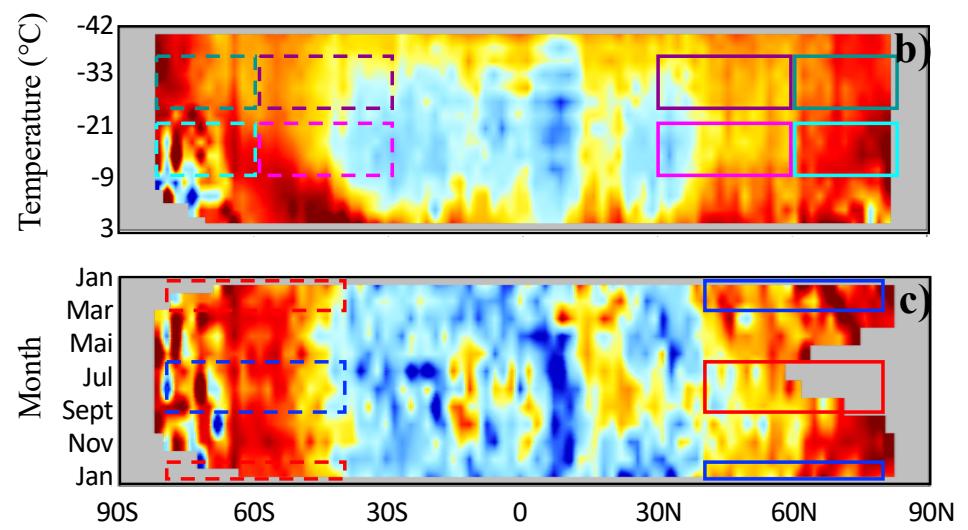
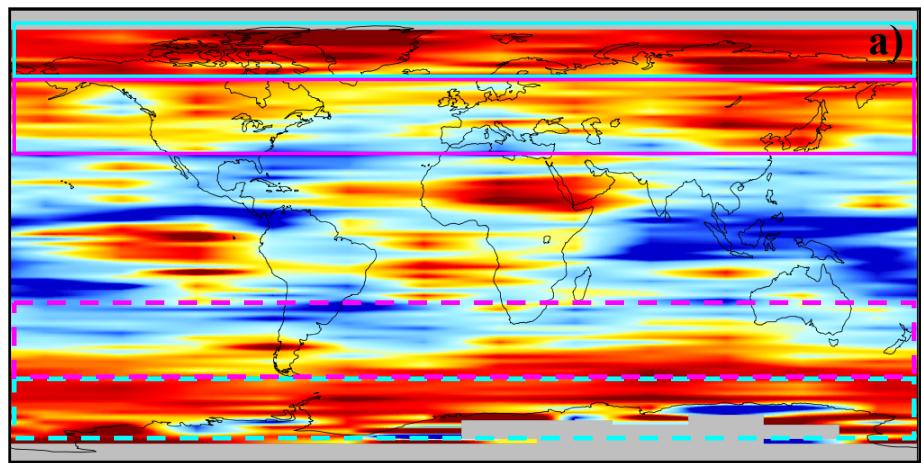
S7. Standard deviation of fine log (dust) MACC [$\log(\text{kg}/\text{kg})$].



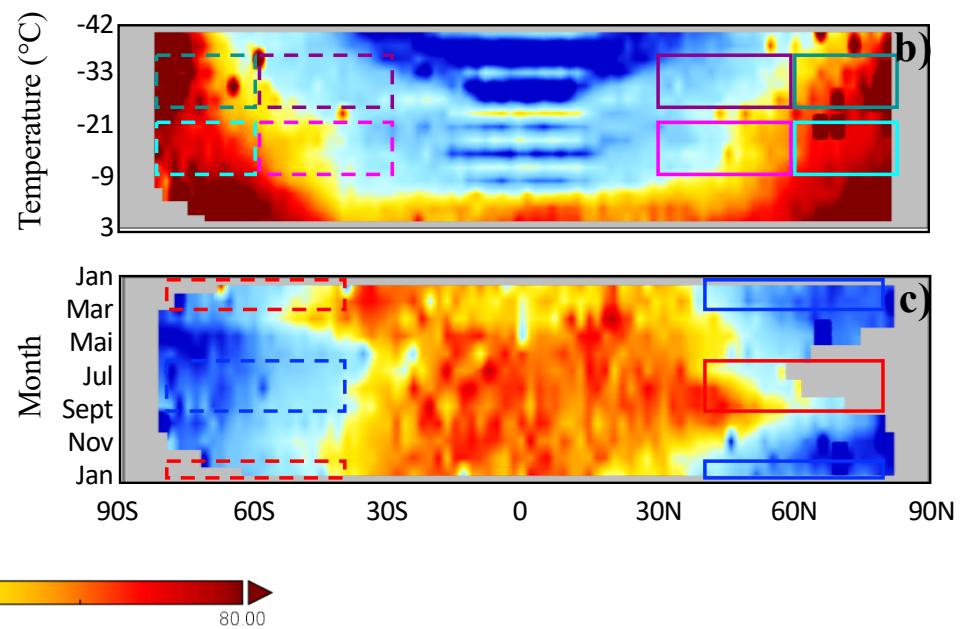
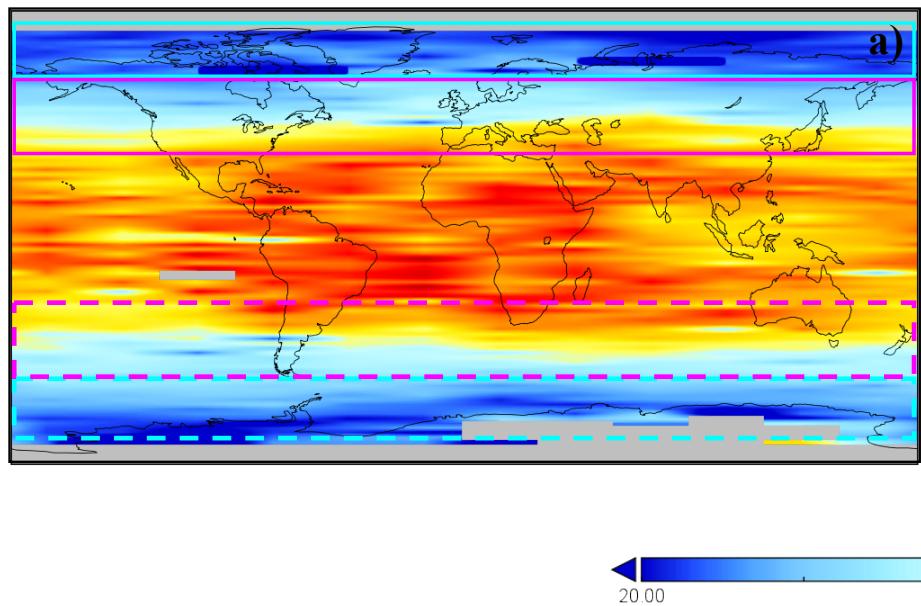
S8. Cloud volume fraction [%].



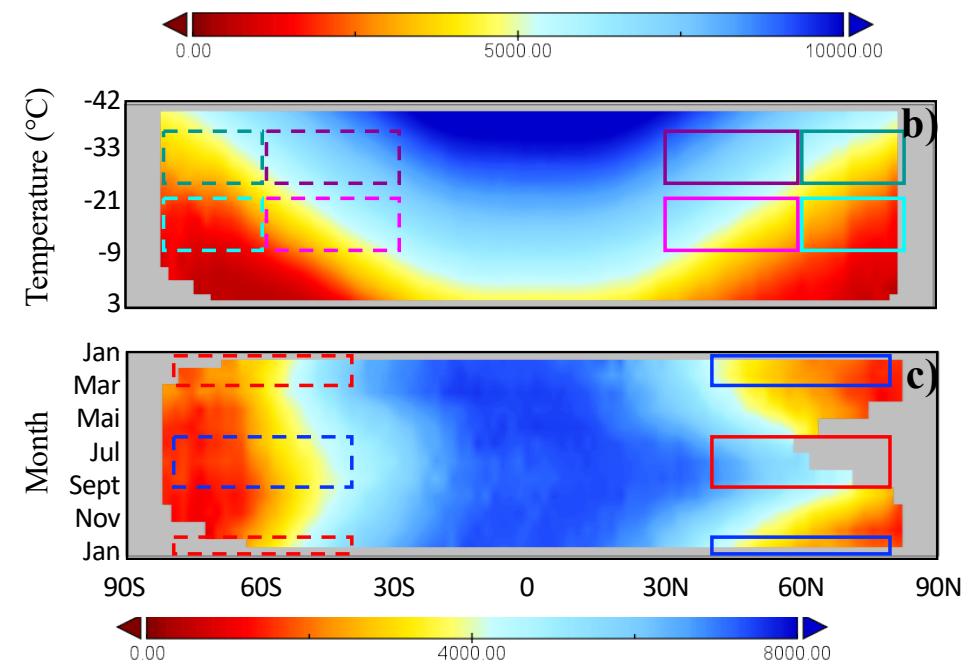
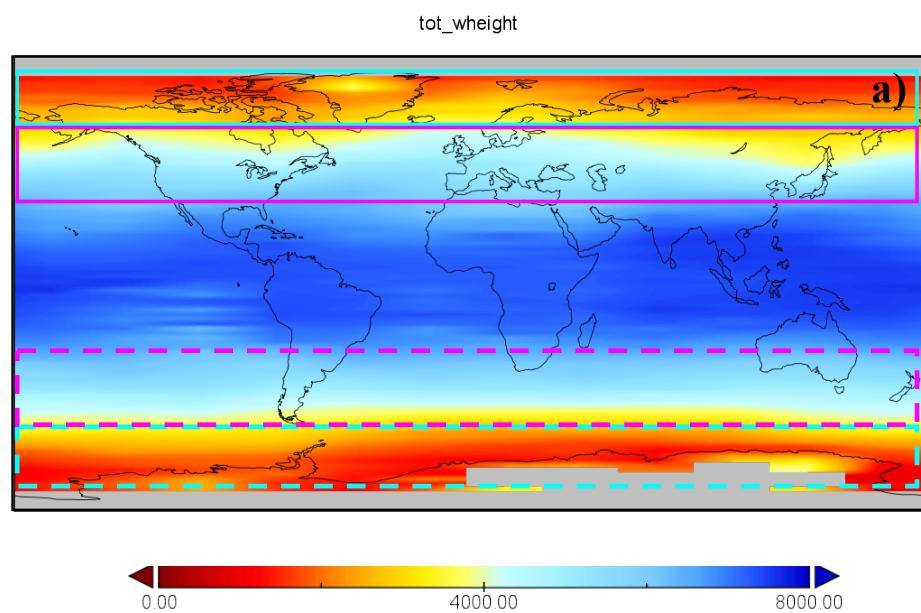
S9. Stratiform cloud volume fraction [%].



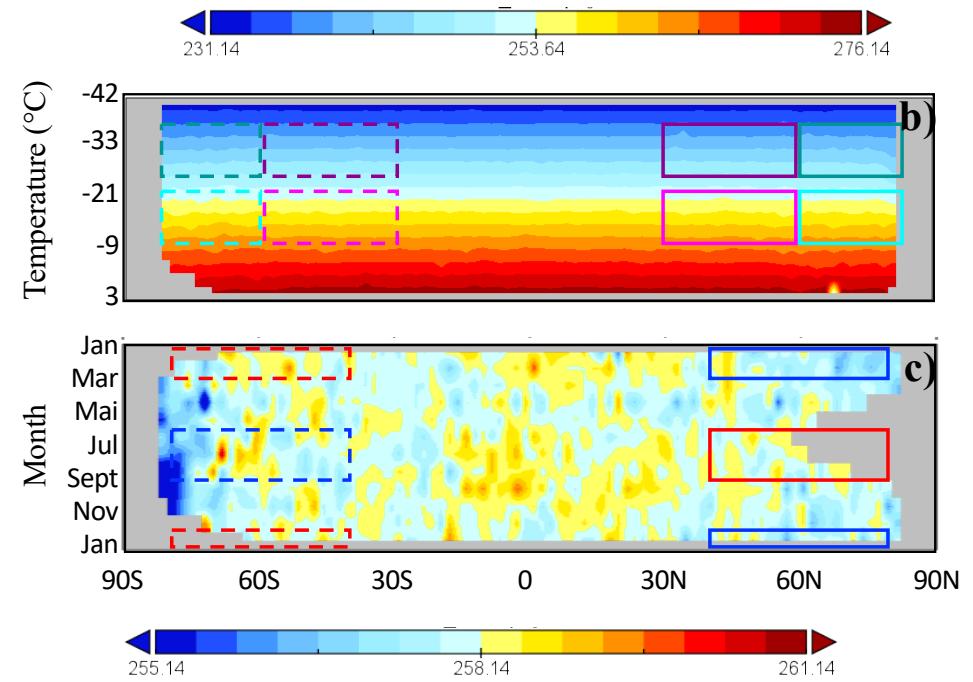
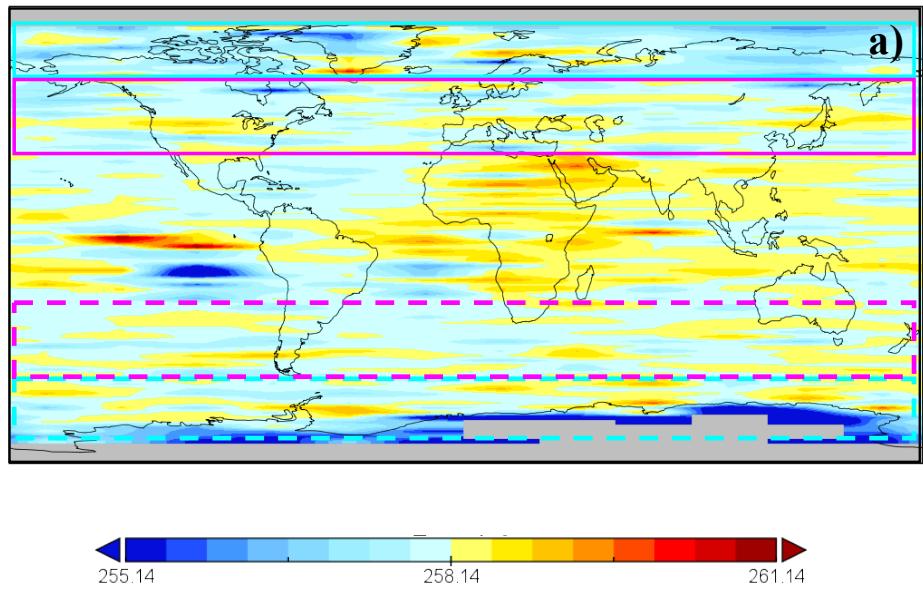
S10. MACC vertical velocity [Pa/s] for stratiform clouds.



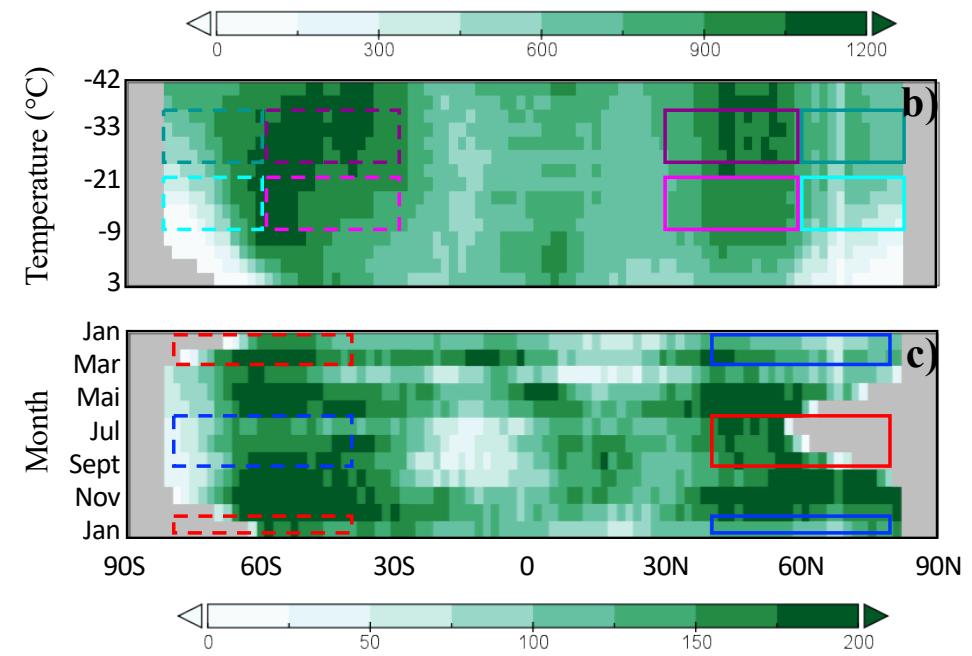
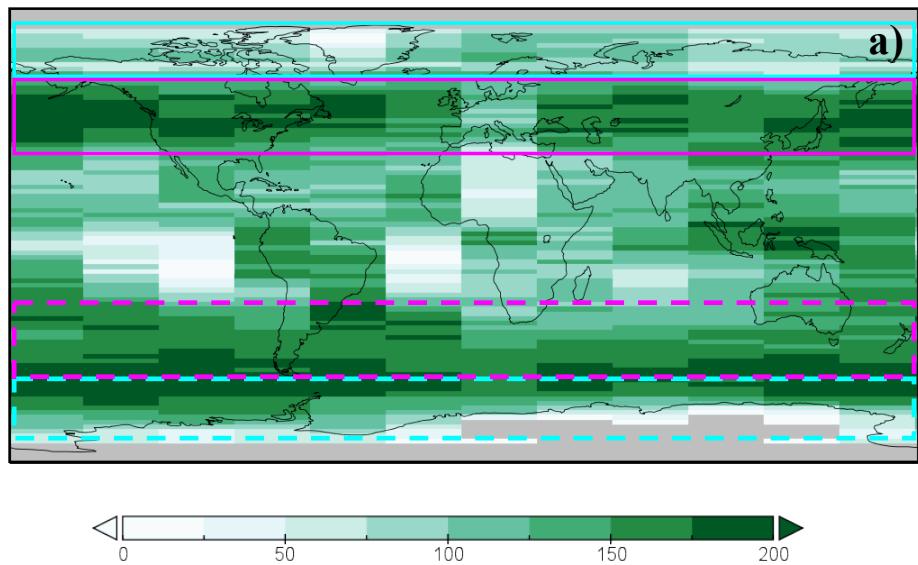
S11. MACC relative humidity [%] for stratiform clouds.



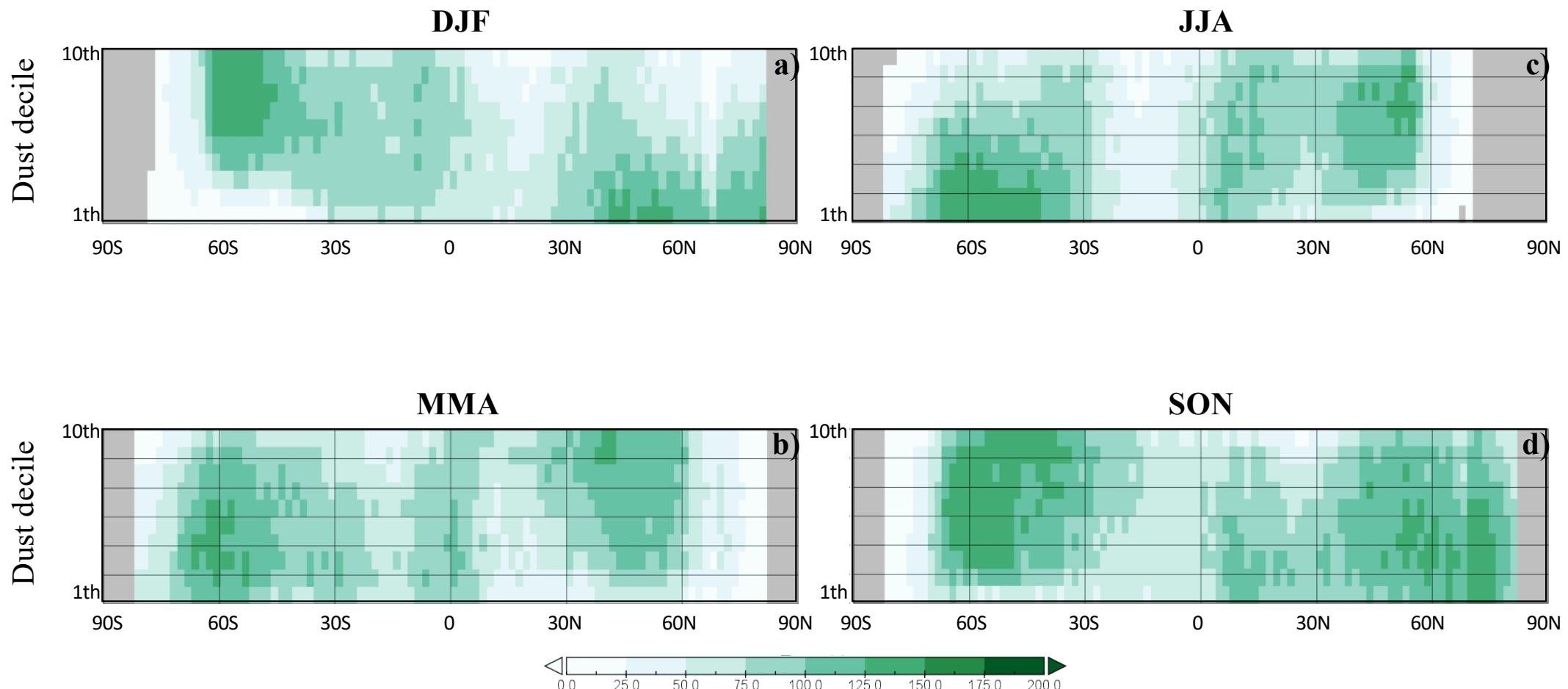
S12. ECMWF-AUX isotherm height [m] for stratiform clouds.



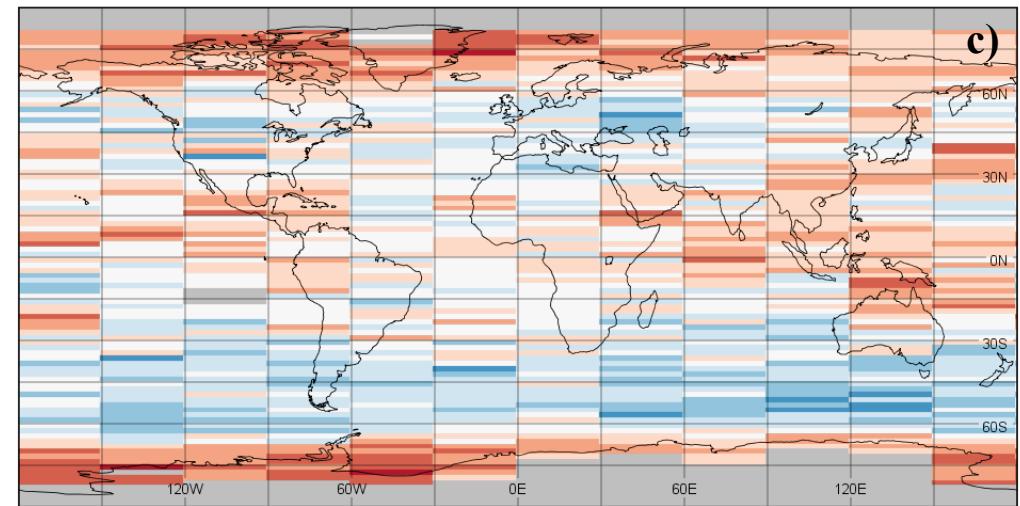
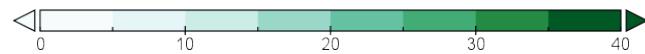
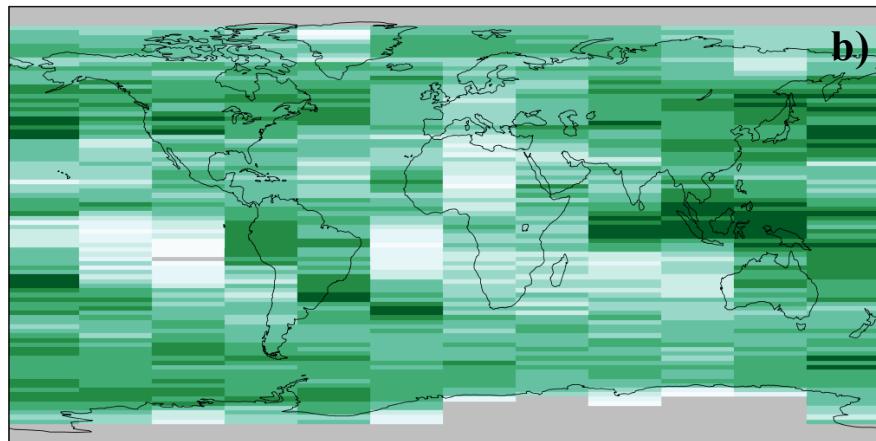
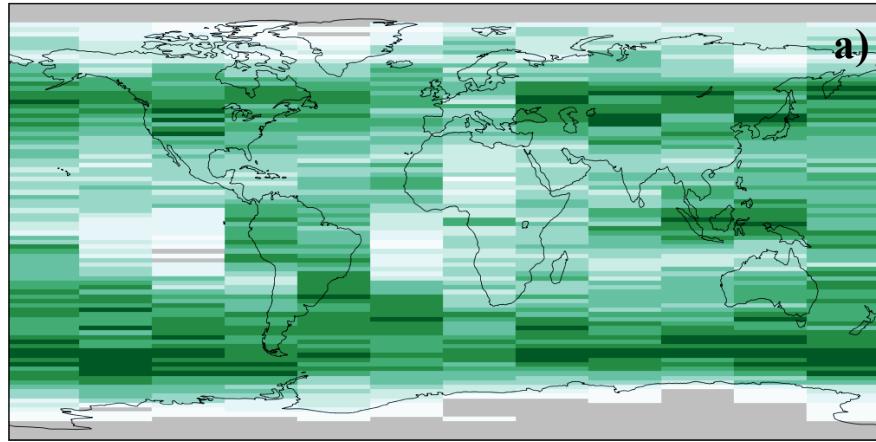
S13. ECMWF-AUX temperature [K] for stratiform clouds.



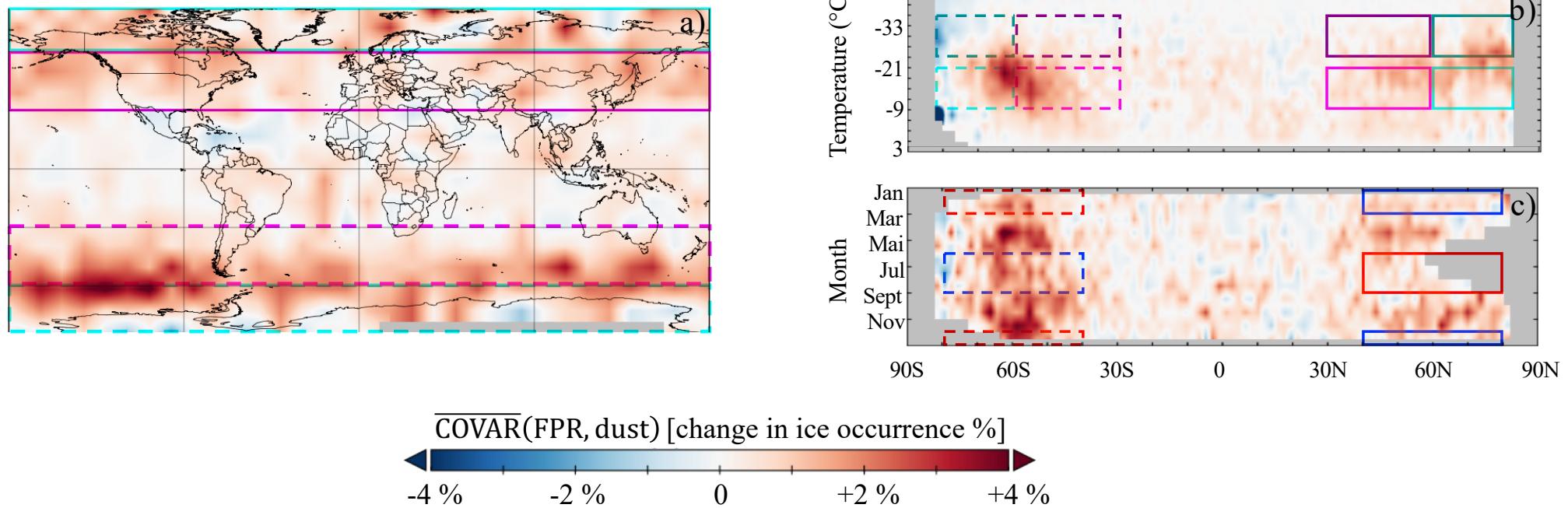
S14. Sample size of stratiform clouds [#gridboxes(month, dust decile, temperature, latitude, longitude)].



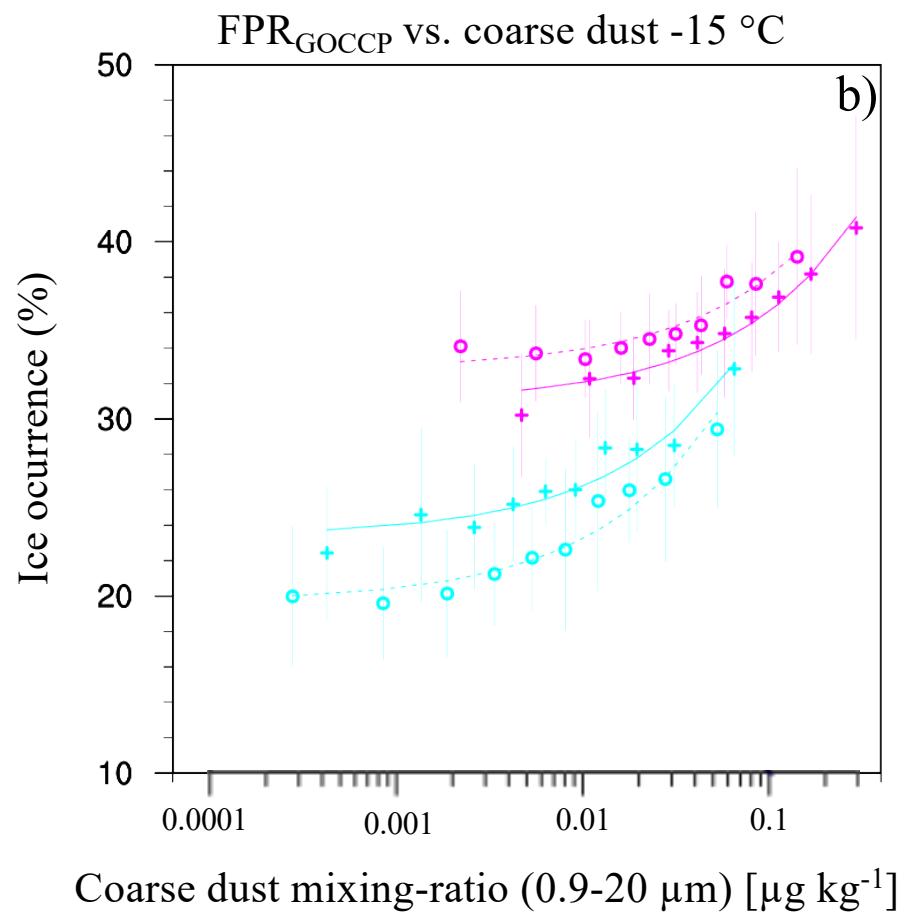
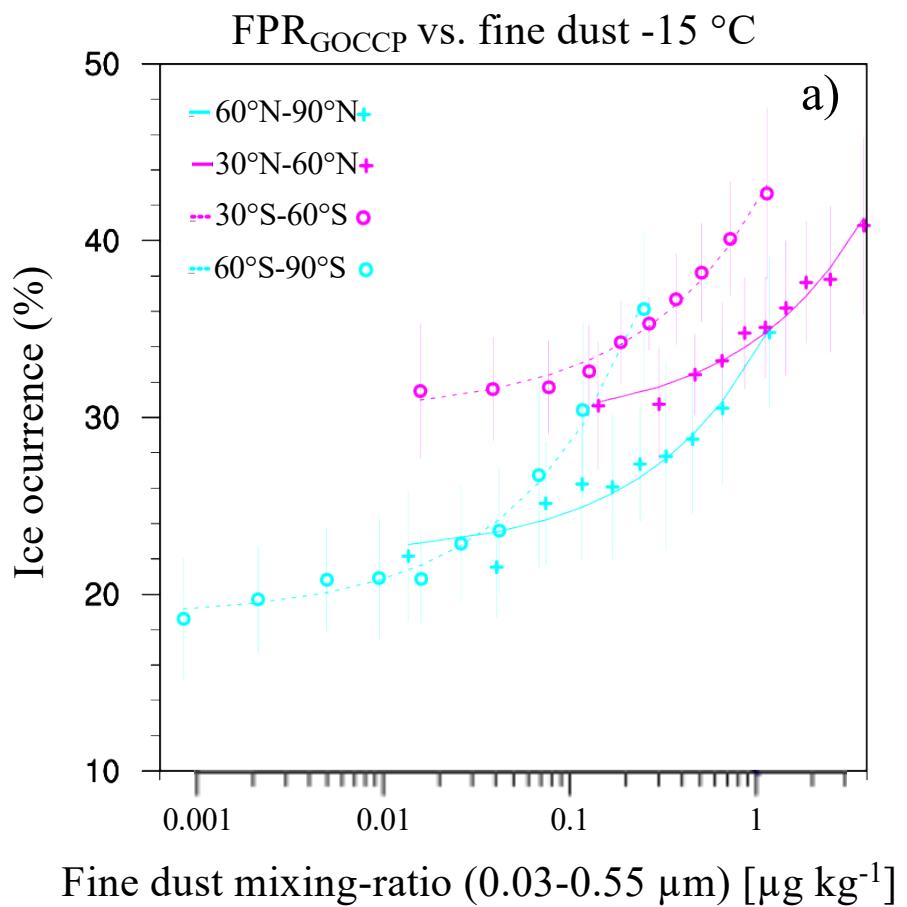
S15. Sample size of stratiform clouds [<#gridboxes(month, dust decile, temperature, latitude, longitude)] for different seasons.



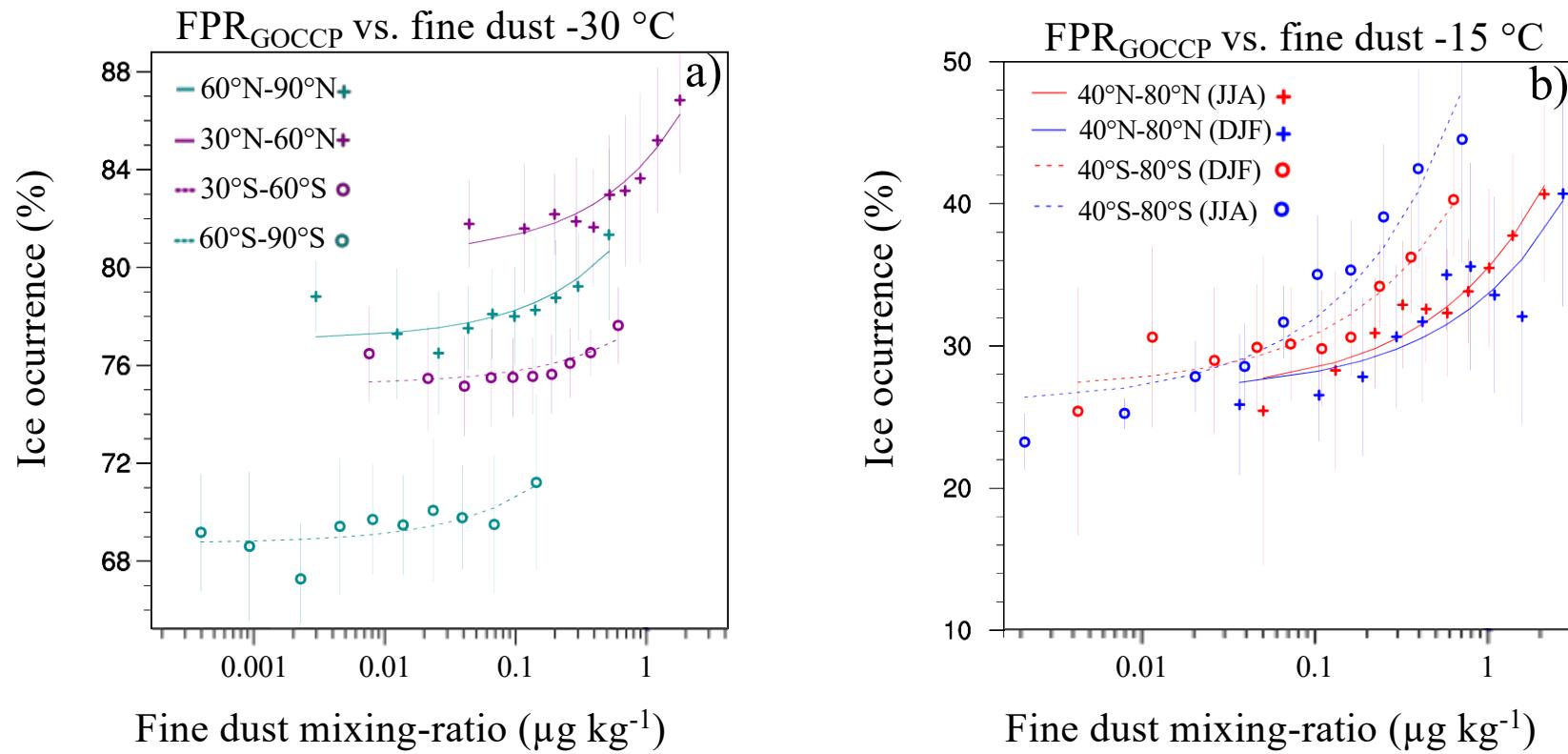
S16. Sample size for a) highest fine dust decile b) lowest fine dust decile. c) difference between highest and lowest decile.



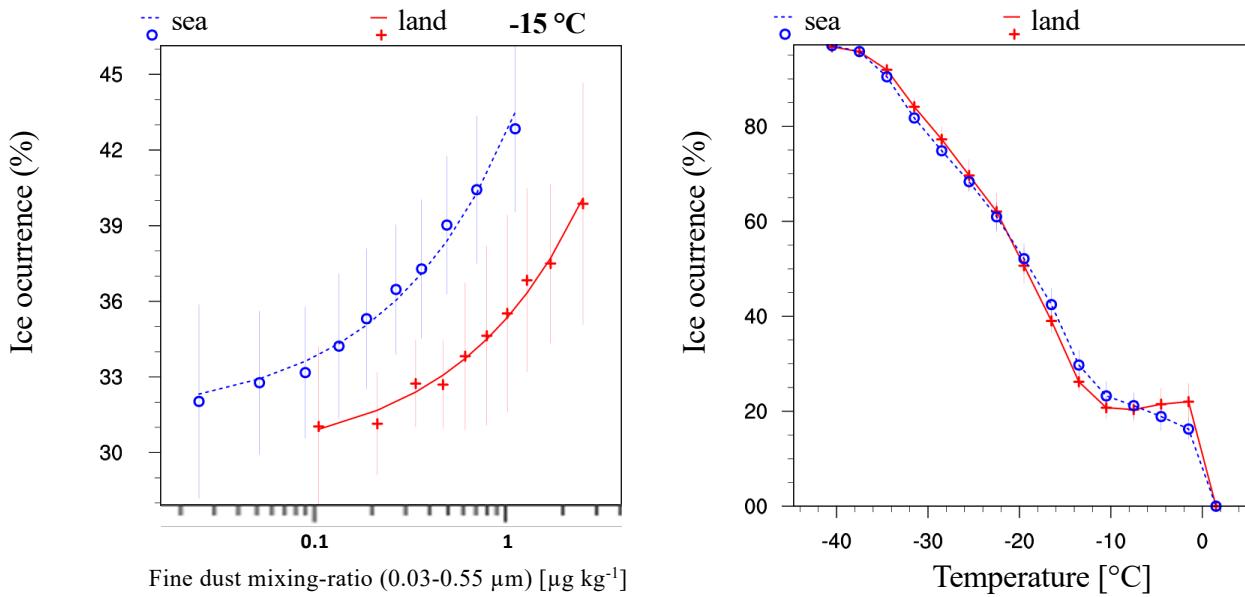
S17. Day-to-day covariance of fine dust mixing-ratio (MACC) and FPR_{GOCCP} 2007-2010. The covariance is normalized by the fine dust standard deviation. a) Time mean covariance between 12 monthly covariance values at -15°C (averaged in a 12 K range). b) Time-zonal mean covariance. c) Monthly-zonal mean covariance at -15°C. Red colours denote a high correlation between day-to-day fine dust and ice occurrence. The colour and pattern of the boxes corresponds to the regression lines in S 18 and S 19.



S18. Average cloud phase for the mid-latitude and high-latitude bands for -15 °C (range -21 °C to -9 °C) in the period 2007-2010. The horizontal axis corresponds to the different time deciles (day-to-day variability) of fine (a) and coarse (b) dust mixing-ratio (MACC), calculated for each each 3°C temperature bin and gridbox ($1.875^\circ \times 1.875^\circ$) and averaged along each 12 °C temperature range and latitude band ($30^\circ \times 360^\circ$). The vertical bars are positioned at each dust decile and show the mean zonal standard deviation within each latitude band. The lines represent the linear regressions ($FPR = A \cdot m^{2/3} + FPR_0$). Only stratiform and non-precipitating clouds were included.



S 19. Same as Fig 7.a but for a) -30°C (range -36°C to -24°C) and b) winter (blue) and summer (red) seasons for the $40\text{--}80^{\circ}\text{N/S}$ latitude bands.



S 20. Average sea/land cloud phase (CALIPSO-GOCCP) a) at -15 °C (range -21 °C to -9 °C) against the MACC deciles of fine dust mixing ratio and b) against temperature for 2007-2010. The vertical lines correspond to the standard deviation between a) Longitudes and b) Months of the year.