SUPPLEMENTARY MATERIAL: IMPROVING LARGE-SCALE SNOW ALBEDO MODELLING USING A CLIMATOLOGY OF LIGHT-ABSORBING PARTICLE DEPOSITION

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S1 Climatological data

Figure S1 shows an example of median BC deposition from the GDFL database for a given date while an example of the GMASI snow cover product is presented on Fig. S2.

S2 Albedo simulation results

S2.1 Sodankylä forcing data

The meteorological forcing files for the Sodankylä site were built following the same methodology as Essery et al. (2016). To create these files, weather and radiation observations from the AWS at the Sodankylä research station (Finn. Met. Inst., 2018) were used. Hourly observations of surface pressure, precipitation, relative humidity and air temperature at 2 m, wind direction and speed at 10 m, and downward shortwave and longwave radiation were extracted over the 2007-2022 time period.

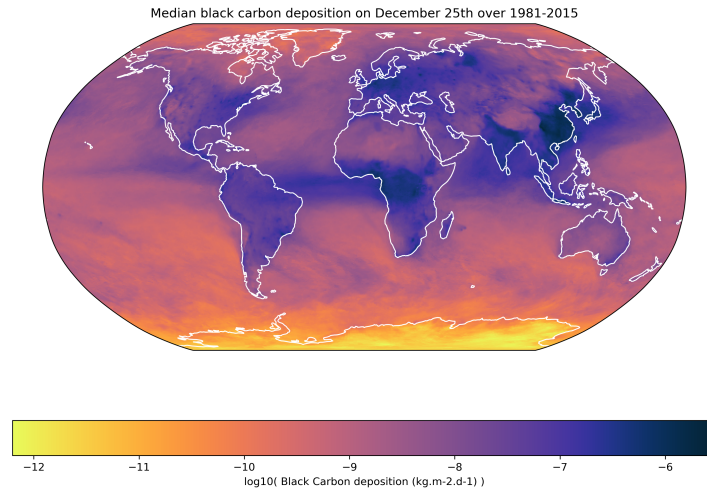
Gaps in these observations were filled using data from other sites in Northern Finland (Kittilä Kenttärova and Kittilä Lompolonvuoma, Finn. Met. Inst. (2021)). The remaining gaps after this were filled with ERA5 reanalysis data (Hersbach et al., 2020). The shortwave radiation was partitioned into direct and scattered radiation using the atmospheric model SB-DART (Ricchiazzi P. and Sowle, 1998). As radiations are measured above canopy, the correction functions proposed by Essery et al. (2016) were applied to estimate radiative fluxes at the snow surface accounting for the impact of the surrounding trees.

S2.2 Box plots

Figure S1. Map showing median BC deposition at the surface worldwide on December 25th from the GDFL database.

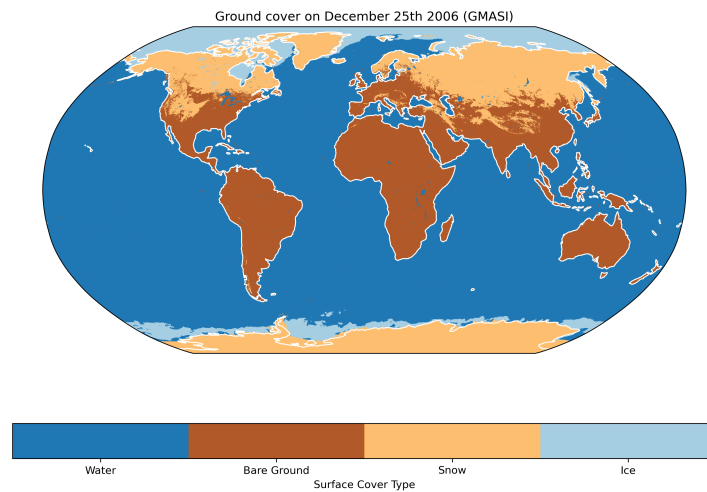



Figure S2. Map showing global surface covers taken from the GMASI product on December 25th, 2006.

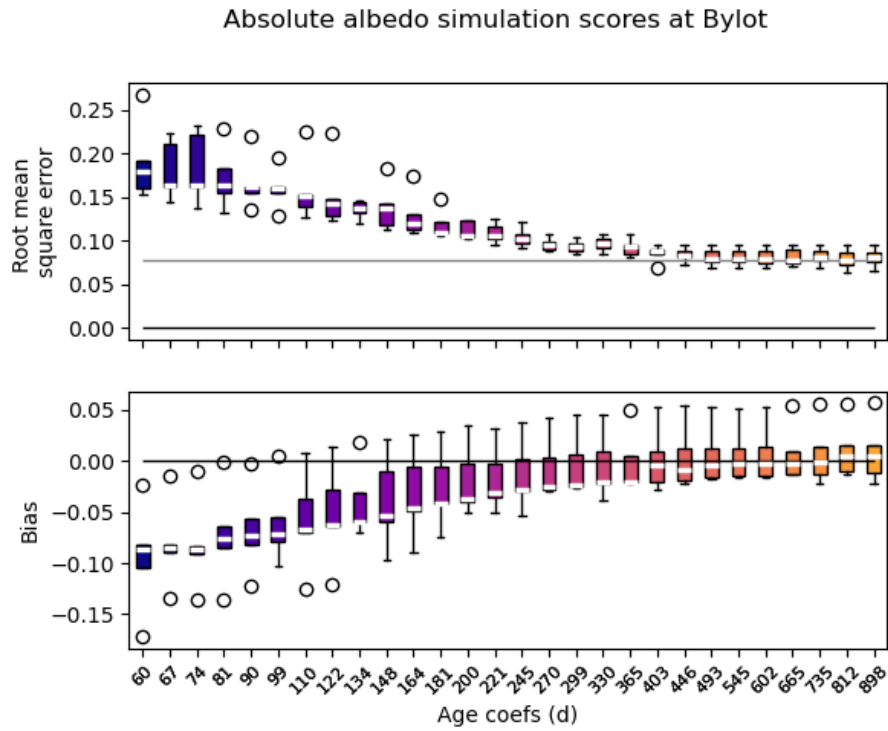



Figure S3. Box plot showing the scores at the Bylot site, in the second round of scoring. The median over the years for each γ is shown in white. The box plots show the interquartile values, and outliers are plotted as circles.

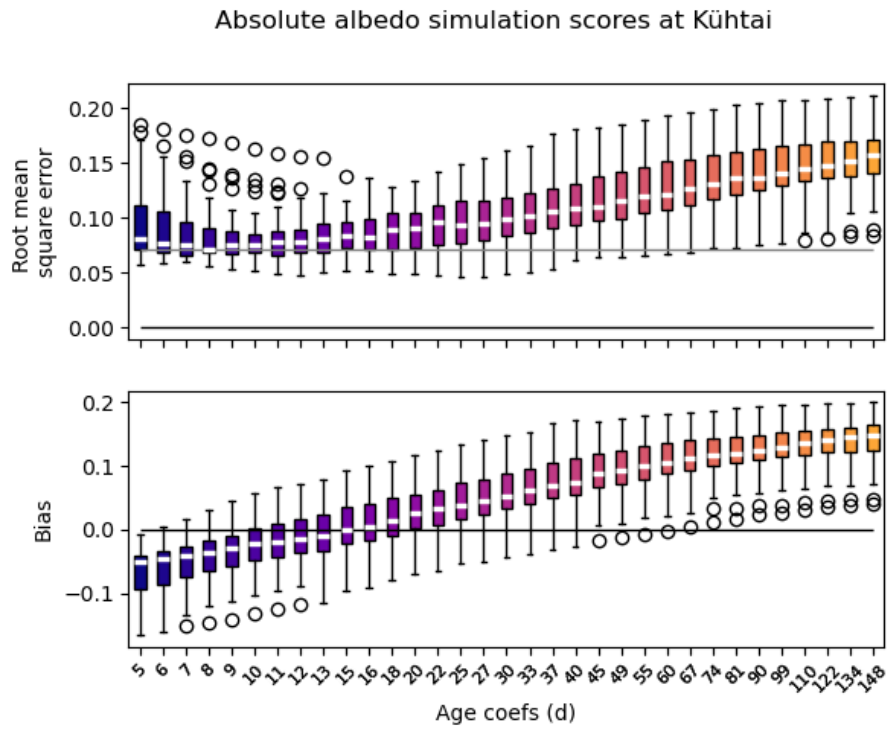



Figure S4. Box plot showing the scores at the Kühtai site, in the second round of scoring. The median over the years for each γ is shown in white. The box plots show the interquartile values, and outliers are plotted as circles.

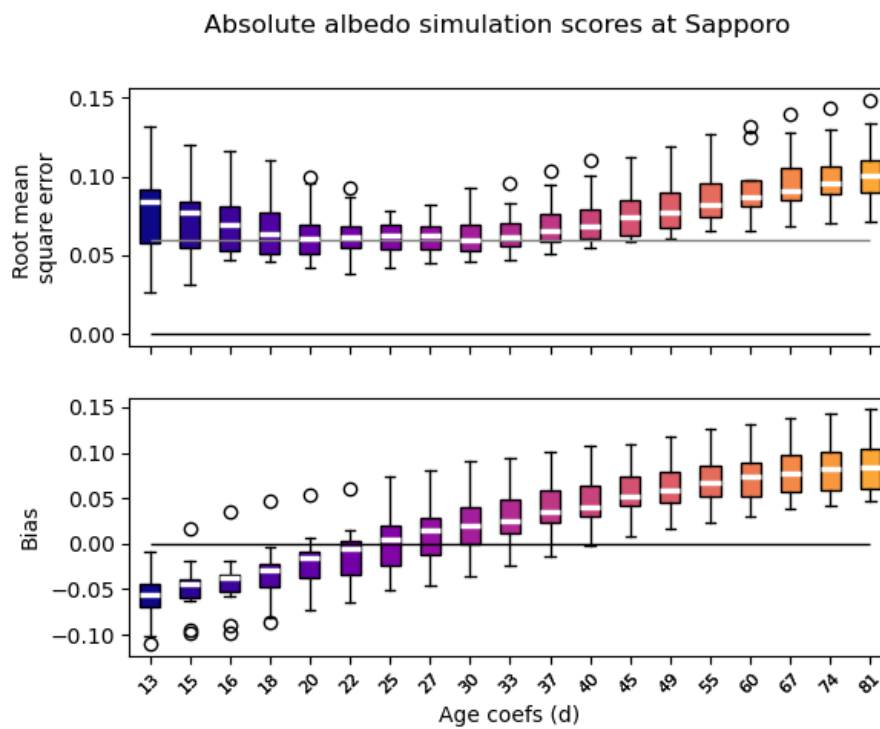



Figure S5. Box plot showing the scores at the Sapporo site, in the second round of scoring. The median over the years for each γ is shown in white. The box plots show the interquartile values, and outliers are plotted as circles.

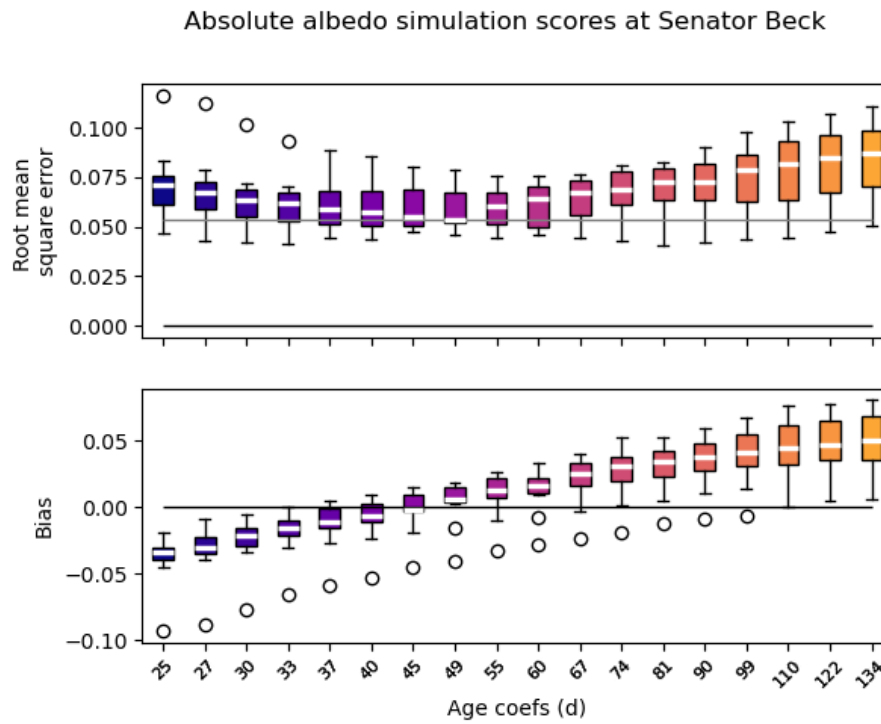



Figure S6. Box plot showing the scores at the Senator Beck site, in the second round of scoring. The median over the years for each γ is shown in white. The box plots show the interquartile values, and outliers are plotted as circles.

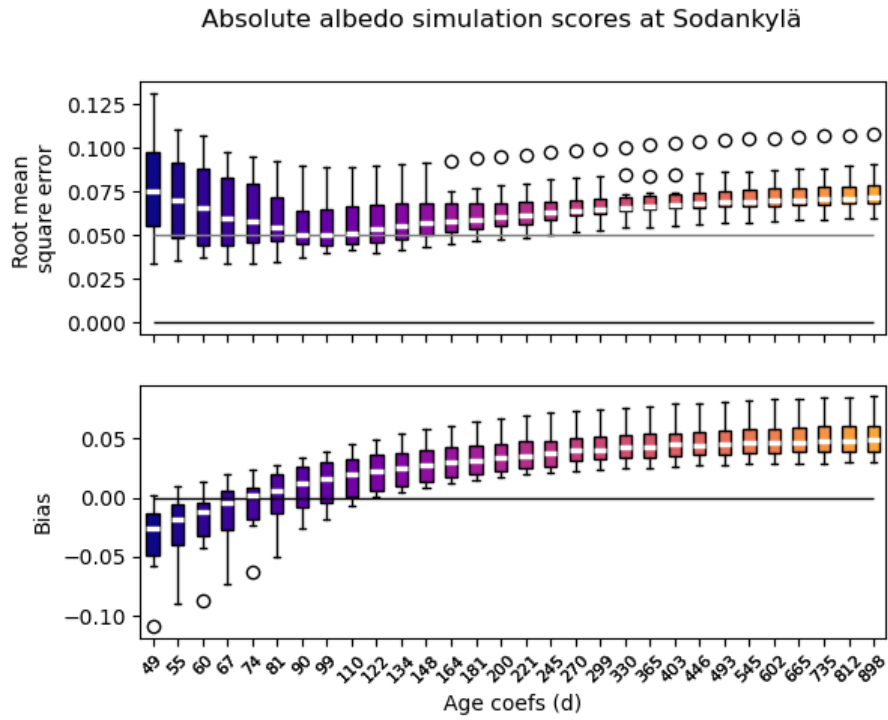



Figure S7. Box plot showing the scores at the Sodankylä site, in the second round of scoring. The median over the years for each γ is shown in white. The box plots show the interquartile values, and outliers are plotted as circles.

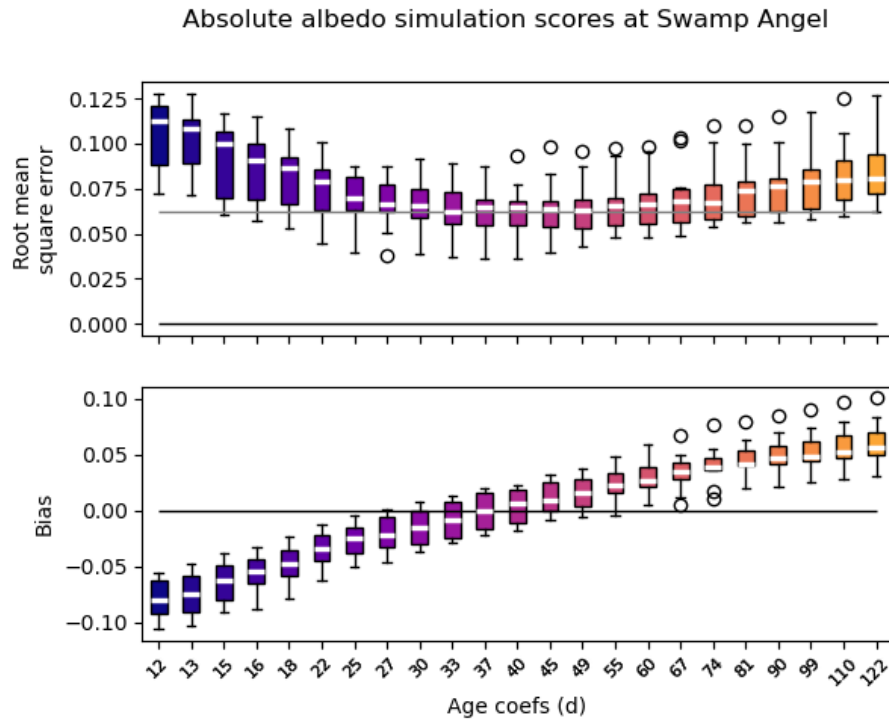



Figure S8. Box plot showing the scores at the Swamp Angel site, in the second round of scoring. The median over the years for each γ is shown in white. The box plots show the interquartile values, and outliers are plotted as circles.

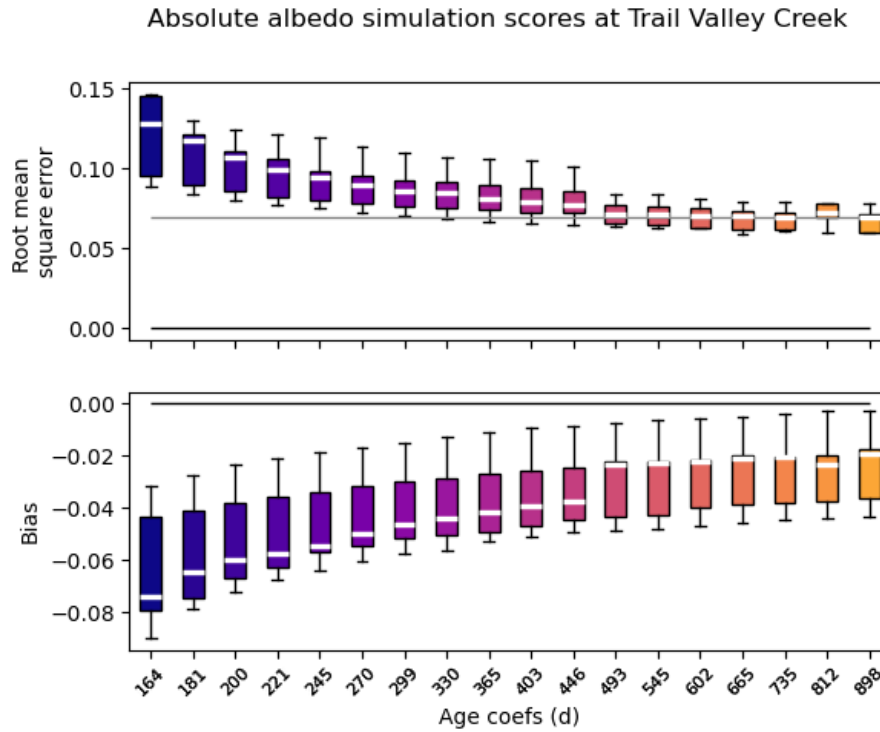



Figure S9. Box plot showing the scores at the Trail Valley Creek site, in the second round of scoring. The median over the years for each γ is shown in white. The box plots show the interquartile values, and outliers are plotted as circles.

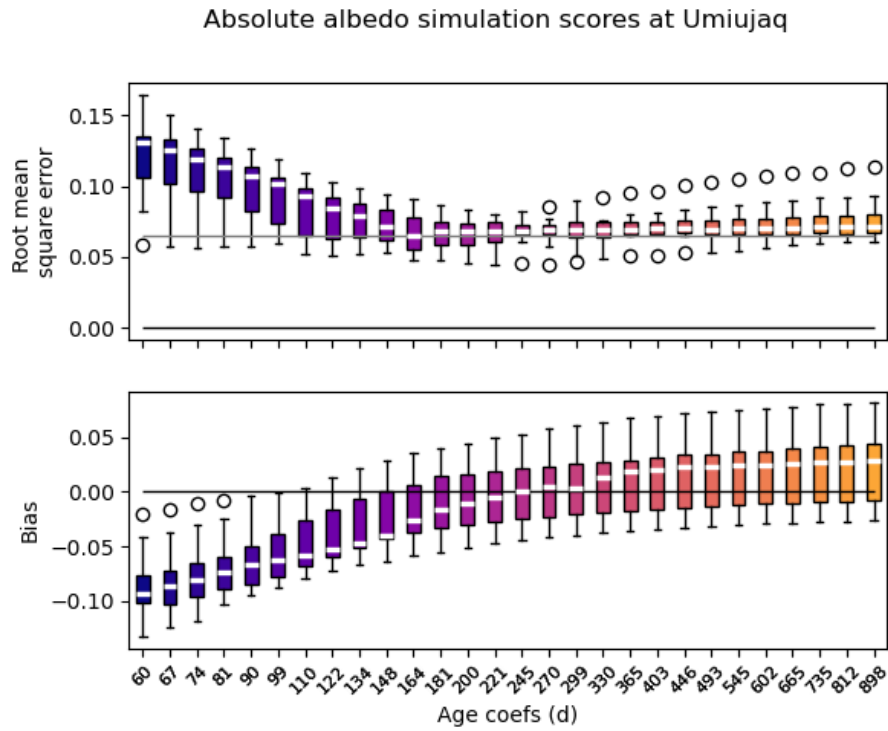



Figure S10. Box plot showing the scores at the Umiujaq site, in the second round of scoring. The median over the years for each γ is shown in white. The box plots show the interquartile values, and outliers are plotted as circles.

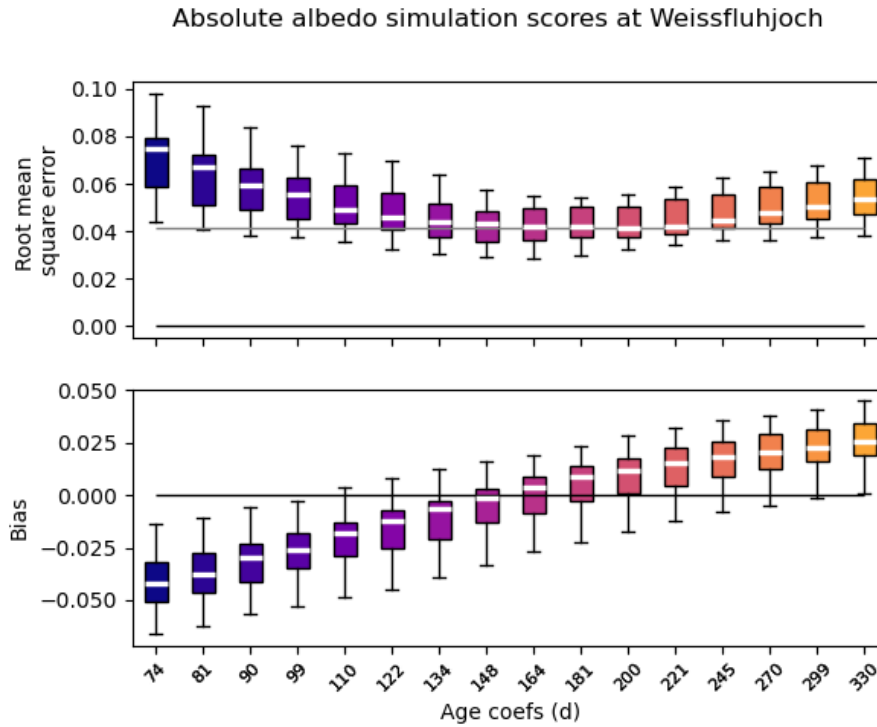



Figure S11. Box plot showing the scores at the Weissfluhjoch site, in the second round of scoring. The median over the years for each γ is shown in white. The box plots show the interquartile values, and outliers are plotted as circles.

S2.3 Choice of A_{lim}

A minimal snow age for the surface snow layer, A_{lim}, is considered to select evaluation periods when the impact of LAPs on snow albedo was significant. Table S1 shows the average number of days selected per year for the evaluation of snow albedo simulations at each of the sites considered in this study.

Table S1. Average number of days selected per year for the evaluation of snow albedo simulations at each of the sites considered in this study

Site	Days selected
Bylot	39
Col de Porte	42
Kühtai	47
Sapporo	12
Senator Beck	45
Sodankylä	30
Swamp Angel	41
Trail Valley Creek	42
Umiujaq	40
Weissfluhjoch	73

20 **References**

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