# Supplementary Information: The aerosol-cyclone indirect effect in observations and high-resolution simulations

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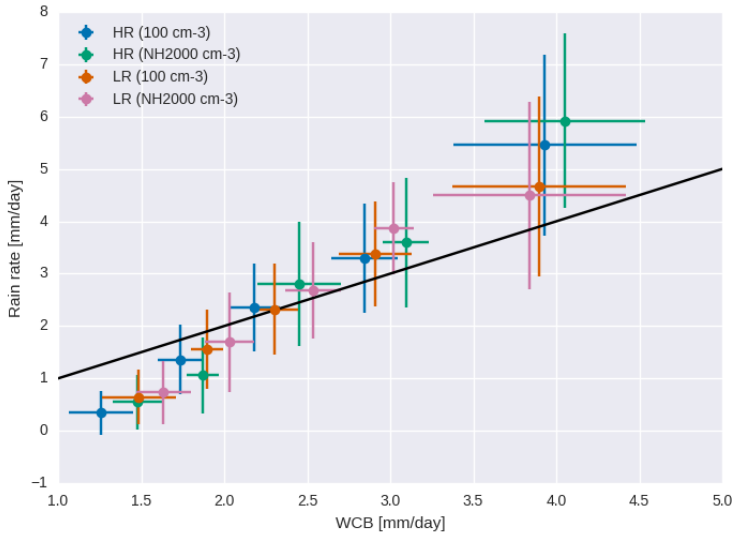


**Fig. S 1 Rain rate in the UM versus warm conveyor belt (WCB) flux (predicted from the UM water vapor path (WVP) and wind speed within 2000 km of the cyclone center). Model resolution is noted in the legend. GCM-surrogate resolution is denoted LR and convection-permitting resolution is denoted HR. Two simulations are contrasted. A low aerosol control with 100 cm$^{-3}$ accumulation aerosol near the surface and a high aerosol experiment where accumulation mode aerosol is increased to 2000 cm$^{-3}$ between 30°-60°N. A one to one relationship between rain rate and the WCB flux is shown as a solid black line.**

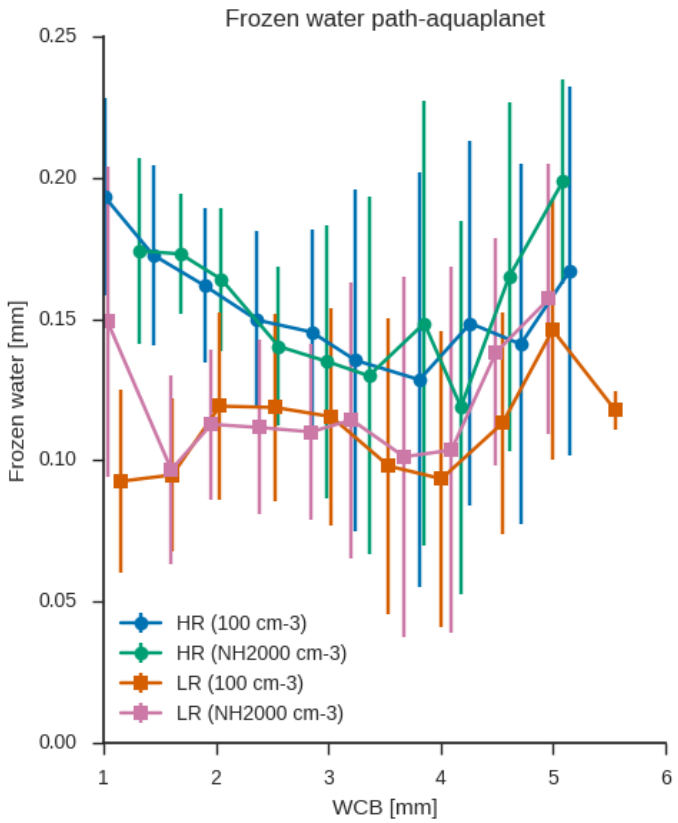


**Fig. S 2 As in Fig. 1a, but showing cyclone-mean frozen water path.**

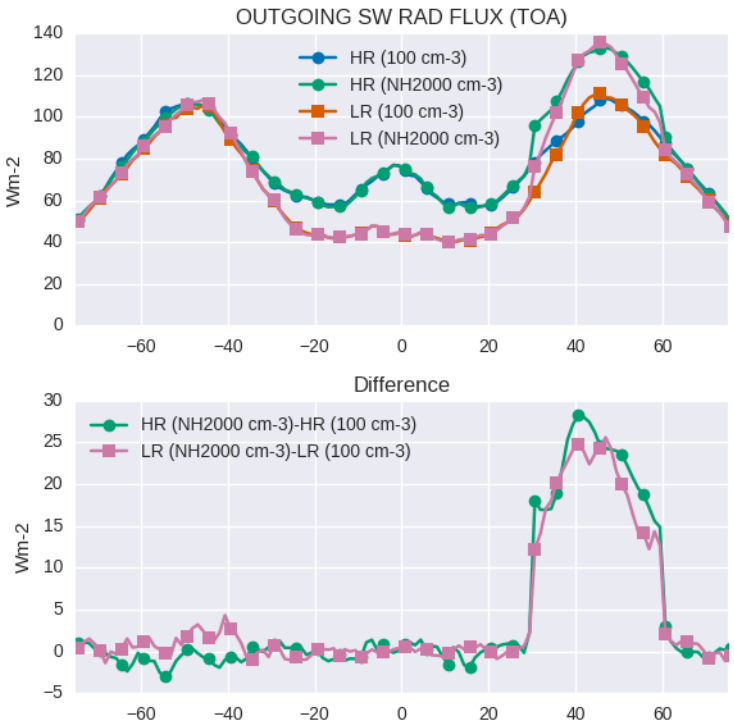


**Fig. S 3 The zonal mean shortwave (SW) radiative flux to space averaged over the duration of the simulations in the convection-permitting (HR) and GCM-surrogate (LR) simulations at low and high aerosol concentration. Differences between low and high aerosol simulations are shown in the bottom plot.**

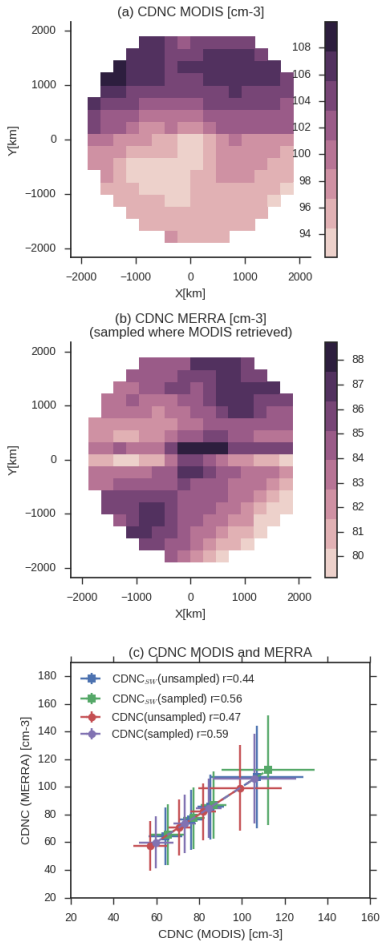


**Fig. S 4 (a) As in Fig. 2, but using CDNC retrieved by MODIS. (b) As in Fig. 2, but sampled so that failed retrievals from MODIS are not used in calculation of the mean composite. (c) The CDNC from MERRA2 binned by MODIS CDNC. Both the cyclone-mean CDNC and $CDNC_{SW}$ are shown. CDNC (and $CDNC_{SW}$) from MERRA2 is calculated when all data is used and when it is sampled to correspond to MODIS. The correlation between the CDNC (and $CDNC_{SW}$) from MODIS and from MERRA2 for all cyclones in the observational record is noted in the legend. Error bars show one standard deviation over each bin.**

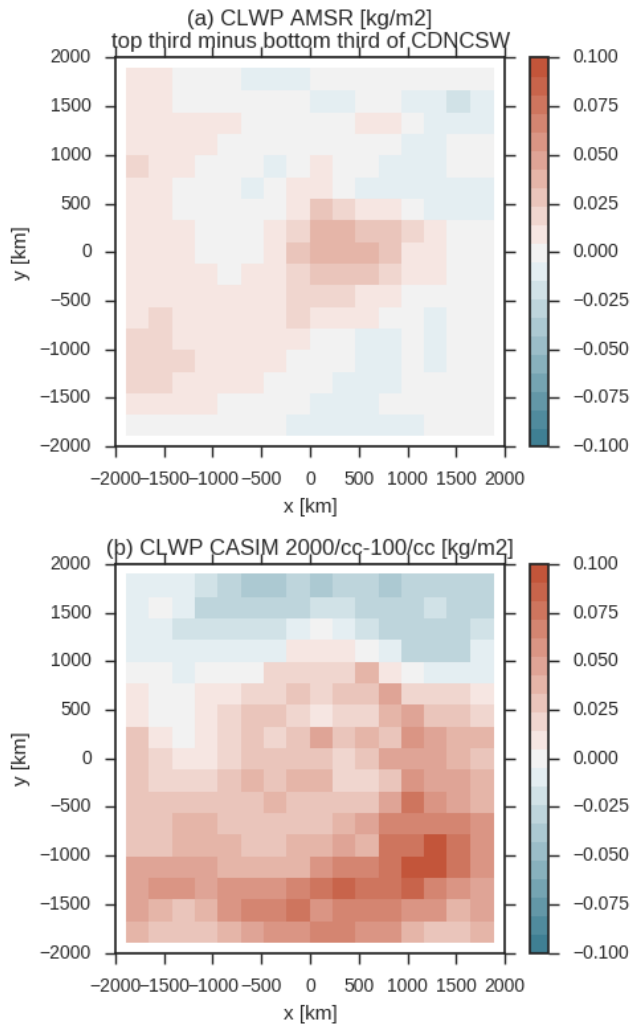


**Fig. S 5 Differences in CLWP composited around cyclone centers for (a) observations and (b) CASIM high resolution aquaplanet. The differences are high minus low aerosol. In the observations this corresponds to the top and bottom third of all observed $CDNC_{SW}$. In the aquaplanet this corresponds to the 2000 $cm^{-3}$ and 100 $cm^{-3}$ aerosol at the surface.**

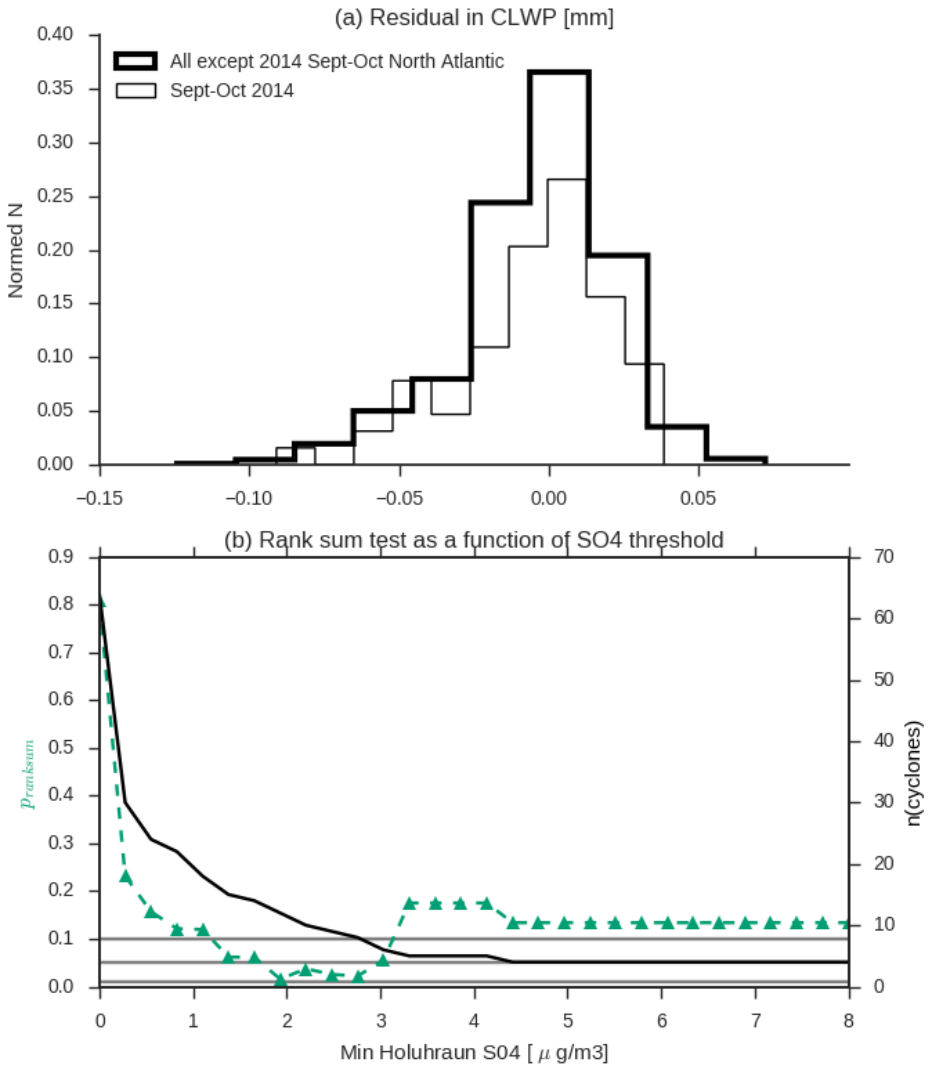


**Fig. S 6 (a) Residuals in AMSR-observed CLWP relative to the prediction from Eq. 1 in the North Atlantic during September and October 2014 (separated into eruption and non-eruption years). To stratify the cyclones during September and October 2014 into cyclones that have and have not interacted with the volcanic the minimum meaningful volcanic sulfate aerosol mass near the surface (100-900m) in the southwest quadrant each cyclone must be decided upon. The p-value of a two-sided rank-sum test comparing North Atlantic cyclones during September and October 2014 to September and October for the remaining years in the observational record is shown in (b). The ordinate shows increasing minimum volcanic sulfate for a cyclone to be considered as interacting with the volcanic plume. The black line shows the number of cyclones with a volcanic sulfate in excess of that value. P=0.1, 0.05, and 0.01 are shown as grey lines.**