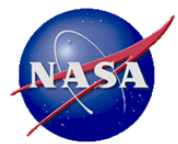


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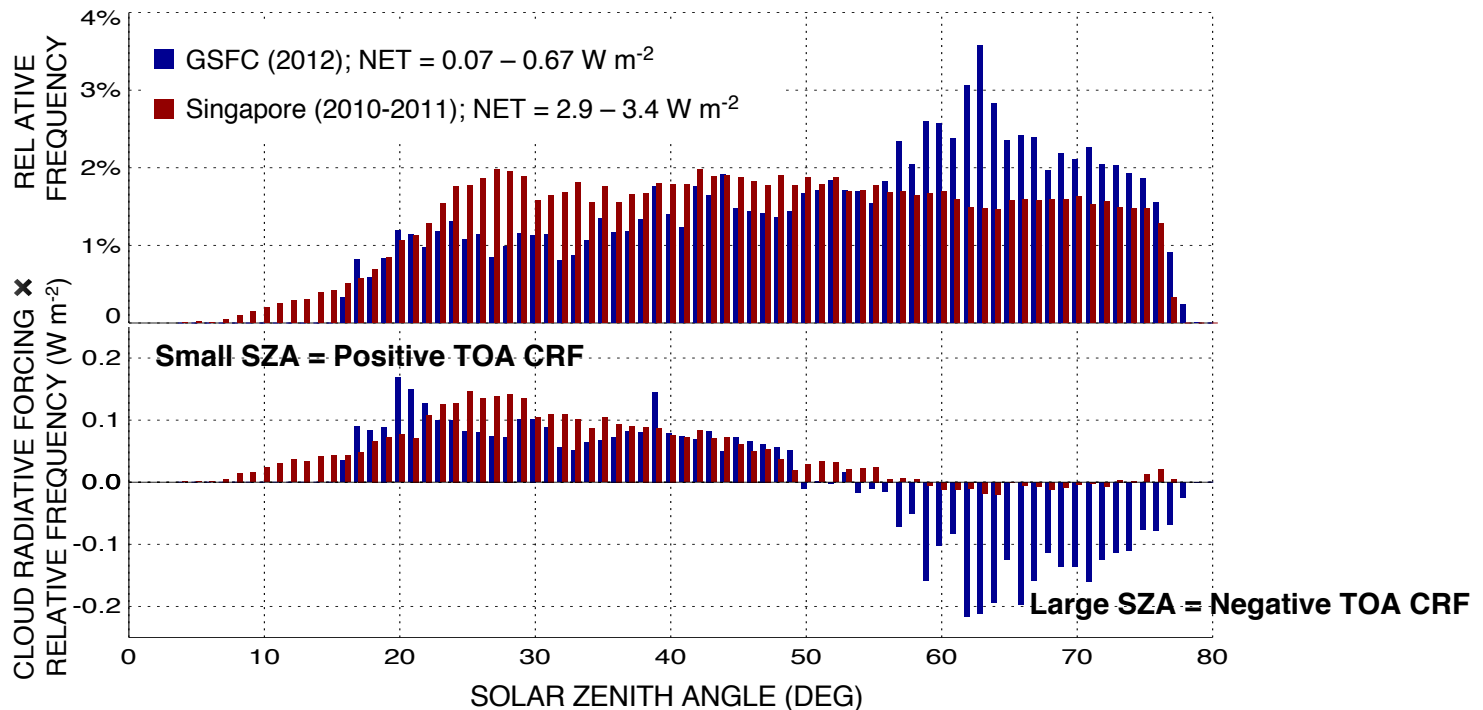
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Daytime Top-of-the-Atmosphere Cirrus Cloud Radiative Forcing Properties at Singapore

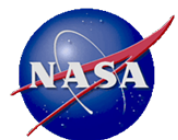


S. Lolli Code 612/JCET, NASA GSFC, J. R. Campbell, NRL, E. J. Welton Code 612, J. R. Lewis Code 612/JCET et al., 2017



Cirrus clouds are the most commonly found cloud in the atmosphere (40-60% global frequencies, 70% in tropical regions). Optically-thin cirrus clouds (optical depths < 0.3; COD) represent roughly half of all such occurrence, making a significant component of cirrus **impossible to resolve with passive satellite sensors alone** and why ground-based lidar networks like MPLNET are optimal to conduct this study.

While all clouds warm the atmosphere at night, during **daytime cirrus are the lone cloud genus that can readily act as to both warm and cool the underlying atmosphere**, depending on their varying physical properties. Results from this study support the open hypothesis of an **hemispheric gradient in cirrus cloud daytime TOA CRF globally, varying from positive near the equator** (as shown at Singapore) **to neutral in the midlatitudes** (as shown at GSFC) and **presumably negative approaching the non-ice-covered poles**.



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References:

Lolli, S., J.R. Campbell, J.R. Lewis, Y. Gu, J.W. Marquis, B.N. Chew, S. Liew, S.V. Salinas, and E.J. Welton, 2017: Daytime Top-of-the-Atmosphere Cirrus Cloud Radiative Forcing Properties at Singapore. *J. Appl. Meteor. Climatol.*, **56**, 1249–1257, <https://doi.org/10.1175/JAMC-D-16-0262.1>
Campbell, J. R., S. Lolli, J. R. Lewis, Y. Gu, and E. J. Welton, 2016: Daytime cirrus cloud top-of-atmosphere radiative forcing properties at a midlatitude site and their global consequence. *J. Appl. Meteor. Climatol.*, **55**, 1667–1679, <https://doi.org/10.1175/JAMC-D-15-0217.1>

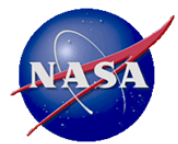
Data Sources: NASA Micro Pulse Lidar Network (MPLNET: <https://mplnet.gsfc.nasa.gov/data>). We credit the excellent work performed by MPLNET staff. Cloud-Aerosol Lidar with Orthogonal Polarizations (CALIOP) Level 2 Cloud Profile Data (https://eosweb.larc.nasa.gov/project/calipso/calipso_table)

Technical Description of Figures:

Graphic: Shown in the figure is a comparison of the frequency-normalized daytime top-of-the-atmosphere (TOA) cloud radiative forcing (CRF) estimates over land solved as a function of solar zenith angle (SZA) at GSFC and Singapore, including relative occurrence frequency. More warming (positive TOA CRF) occurs at Singapore; whereas near-neutral TOA CRF occurs at the midlatitude GSFC site. Daytime TOA CRF is estimated using lidar ratios of 20 sr and 30 sr to estimate the cloud optical depth (COD), in order to cover all the variability. Cirrus cloud relative occurrence exponentially increases with decreasing COD, consistent with other studies. TOA CRF values normalized by these occurrence rates reflect distributions where the most significant forcing effect is proportioned accordingly toward clouds with lower COD. Relative daytime TOA CRF over land at Singapore varied between 2.858 and 3.370 W m^{-2} (20 and 30 sr, respectively) in 2010 and 3.078 and 3.329 W m^{-2} in 2011. Since Singapore is an island situated within the larger Maritime Continent archipelago, over water estimates of TOA CRF are calculated between -0.094 and 0.541 W m^{-2} in 2010 (30 and 20 sr, respectively) and -0.598 and 0.433 W m^{-2} in 2011; the difference being the impact of lower surface albedo over water that suppresses the relative solar forcing component within the net solutions. Satellite-based observations from CALIOP show 80% regional cirrus occurrence near Singapore. Normalizing the results by approximately 1.3, the TOA CRF estimates for Singapore become 2.198–2.592 W m^{-2} in 2010 and 2.368–2.561 W m^{-2} in 2011 over land, and -0.072 – 0.416 W m^{-2} in 2010 and -0.460 – 0.333 W m^{-2} in 2011 over water.

Scientific significance, societal relevance, and relationships to future missions: The study follows a midlatitude study of 2012 MPLNET cirrus cloud TOA radiative properties. The novelty in isolating daytime cirrus cloud TOA CRF comes from cirrus being the only genus that can readily induce both positive and/or negative daytime TOA CRF depending on their physical characteristics. By categorizing the frequency-normalized daytime TOA CRF versus the Solar Zenith Angle and Cloud Top Height, Campbell et al. (2016) hypothesize a meridional hemispheric gradient in daytime TOA CRF, varying from positive at the equator, neutral in the midlatitudes, and negative near the non-ice-covered (i.e., summer) poles. Results from Singapore are consistent with the existence of such a gradient, with one fundamental exception: the significance of overland versus overwater albedos leads to complimentary zonal forcing gradients, a component that Campbell et al. (2016) did not recognize. This occurs as the solar component of daytime TOA CRF is suppressed relative to overland conditions, which leads to significantly lower net values overall. **This study thus demonstrates the compelling likelihood that much of the global oceans are subject to negative daytime TOA CRF, presuming the forcing sign changes meridionally at lower latitudes than believed likely over land.** Though the net TOA CRF associated with any single cirrus cloud is often on the order of 1 W m^{-2} , their impact on global radiation is grounded in the long-term aggregate, since they are nearly an order of magnitude more common than most liquid cloud genera that induce significantly greater TOA CRF.

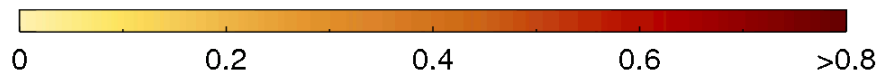
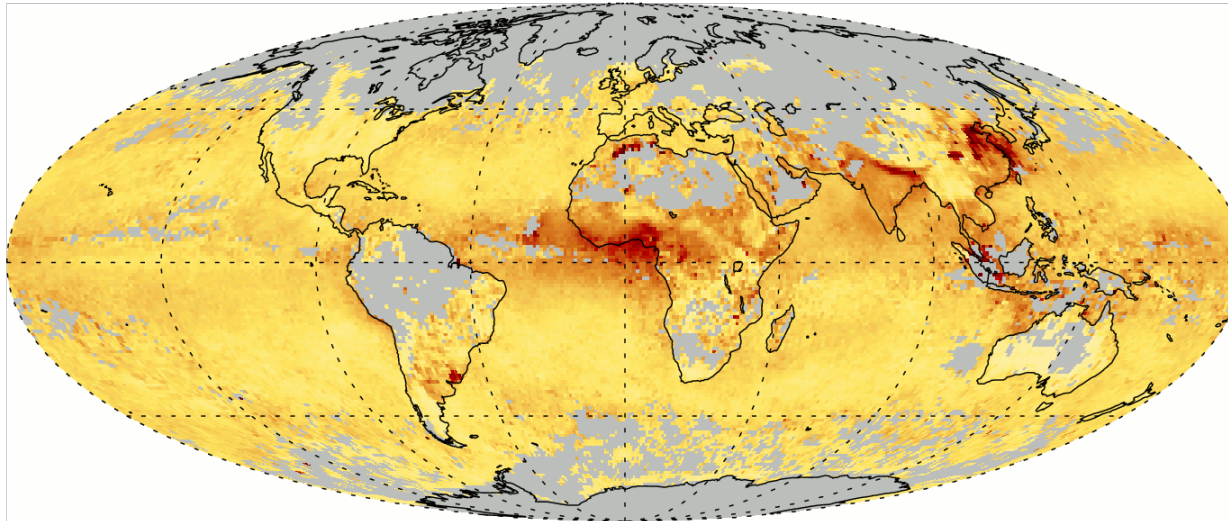
The NASA MPLNET shares an extremely rich measurement database that spans for almost two decades for some observational stations. For this reason, a multi-site and multi-year analysis of MPLNET data will bring critical new understanding of daytime/diurnal cirrus radiative impact in the climate budget. This characterization will permit better parameterization of cirrus cloud radiative behavior to improve both forecast and climate models.



Towards a 40-year aerosol record: first near-global (land and ocean) demonstration data set from the AVHRRs

N. C. Hsu (613), A. M. Sayer (613/USRA), J. Lee (613/ESSIC)

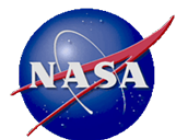
NOAA18 AVHRR Deep Blue 550 nm AOD, 200601



Animation (available at <https://atmospheres.gsfc.nasa.gov/science/>) of monthly mean AVHRR-derived aerosol optical depth (AOD) for 2006-2011.

The AVHRR satellite instruments have been used to study the Earth since the 1980s. While AVHRR-based aerosol optical depth (AOD) data sets exist over oceans, data over land have been lacking, causing an important gap in air quality and climate applications. We adapted our mature Deep Blue and Satellite Ocean Aerosol Retrieval algorithms, previously applied to SeaWiFS, MODIS, and VIIRS, to work with AVHRR data.

This provides, for the first time, near-global land and ocean aerosol data from the AVHRRs. This work has the potential to generate a 40-year long-term consistent time series.



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References:

This highlight covers two papers:

Hsu, N. C., J. Lee, A. M. Sayer, N. Carletta, S.-H. Chen, C. J. Tucker, B. N. Holben, and S.-C. Tsay (2017), Retrieving near-global aerosol loading over land and ocean from AVHRR, *J. Geophys. Res. Atmos.*, 122, doi:10.1002/2017JD026932.

Sayer, A. M., N. C. Hsu, J. Lee, N. Carletta, S.-H. Chen, and A. Smirnov (2017), Evaluation of NASA Deep Blue/SOAR aerosol retrieval algorithms applied to AVHRR measurements, *J. Geophys. Res. Atmos.*, 122, doi:10.1002/2017JD026934.

The importance of the research was also recognized by AGU, who highlighted the two articles with a joint Research Spotlight in EOS magazine:

<https://eos.org/research-spotlights/new-data-record-extends-history-of-global-air-pollution>

Data Sources: AVHRR, MODIS, AERONET.

Technical Description of Figure/Animation:

This animation shows a time series of the monthly average aerosol optical depth (AOD), a measure of the loading of particles such as desert dust and smoke in the atmosphere. Warmer colors indicate more aerosol loading; prominent features include Saharan dust, wildfire smoke in South America, central Africa, and south-eastern Asia and industrial haze in southern and eastern Asia.

Data are shown as monthly aggregates at 1 degree resolution (although source instantaneous retrievals are approximately 0.1 degree). Grid cells in grey have insufficient sampling during a month due to e.g. clouds, polar night, or unsuitable surface conditions such as snow/ice cover.

The time series was created using measurements from the AVHRR sensor aboard the NOAA18 satellite, for a six-year period (2006-2011).

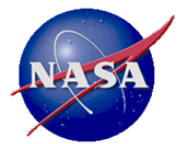
Our approach is an extension of our SeaWiFS and MODIS aerosol algorithms. Extensive comparisons have also been performed between the AOD retrieved from the AVHRR instruments on NOAA 14 and 18 with ground-truth AERONET and ship-based data, revealing a high quality of performance. As a demonstration, we have also made available multiple years of the AVHRR Deep Blue aerosol products from NOAA 11, 14, and 18 (cf.

<https://deepblue.gsfc.nasa.gov> and <https://portal.nccs.nasa.gov/datashare/AVHRRDeepBlue/>).

Scientific significance, societal relevance, and relationships to future missions:

Now approaching 40 years in length, the AVHRRs represent the longest single-sensor-type data record suitable for retrieving aerosol properties.

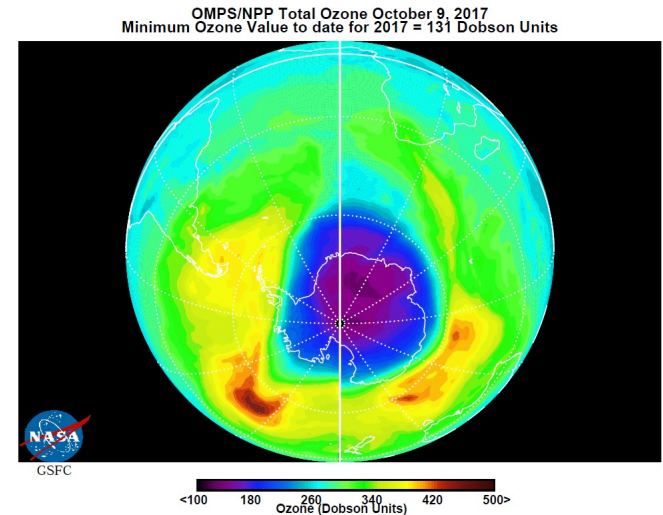
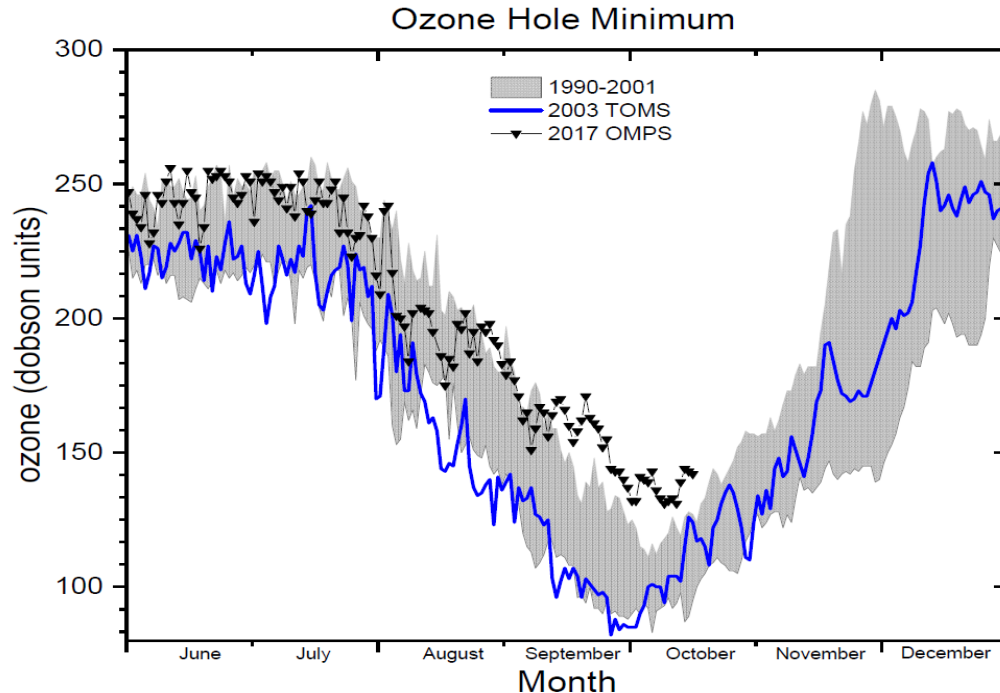
Importantly, they cover the two decades prior to the EOS record; this earlier time period (from 1981 to 2000) is particularly important for understanding changes in the levels of aerosol loading over Asia, where a large fraction of global economic growth over the past several decades has occurred. The years of overlap with EOS provide important opportunities for cross-calibration and comparison against these new sensor types. Previously, AVHRR data had been used to retrieve aerosols over ocean but data over land were sparse or absent entirely. We demonstrated a new approach to quantitatively retrieve, for the first time, this much needed aerosol information from AVHRR over land and ocean on a global scale. Our work therefore fills a crucial observational gap for air quality and climate studies, roughly doubling the available data record length.



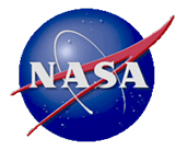
Ozone Hole 2017: the Low is High

R. McPeters¹ and C. Seftor²,

¹Code 614, NASA/GSFC, ²SSAI



The Antarctic Ozone hole was not very deep in 2017. Minimum ozone measured by the Suomi NPP OMPS Total Column Mapper on October 9th was 131 Dobson Units, a higher low than we have seen since the 1980's. Is this a sign of ozone recovery or just unusual dynamics in the south polar region?



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References:

N. Kramarova, E. Nash, P. Newman, P. K. Bhartia, R. McPeters, D. Rault, C. Seftor, P. Q. Xu, and G. Labow, Measuring the Antarctic ozone hole with the new Ozone Mapping and Profiler Suite (OMPS), *Atmos. Chem & Phys. Discuss.*, 14, 2353-2361, doi:10.5194/acp-14-2353-2014, 2014.

Data Sources:

The Suomi NPP Ozone Mapping and Profiler Suite (OMPS), total column mapper. Maps the ozone hole each year continuing the observations of the Aura OMI (2004-present) and the TOMS series (Nimbus 7 TOMS 1979-1993, and Earth Probe TOMS, 1996-2006).

Technical Description of Figures:

Fig 1: Daily minimum ozone in the south polar region for 2017 is compared with the very low ozone measured by Earth Probe TOMS in 2003. The shaded region shows the range observed between 1990 and 2001 when ozone destruction was near maximum.

Fig 2: Minimum ozone of 131 Dobson Units was observed on October 9th this year, about a week later than usual.

Scientific significance, societal relevance, and relationships to future missions:

The surprise of the extreme low ozone observed in the Antarctic in the 1980's led directly to the Montreal Protocol and a NASA emphasis on understanding stratospheric ozone. NASA's TOMS ozone mapping instruments were used to monitor the development of the ozone hole each year. Research showed that high levels of chlorine from CFCs led to very low ozone in the 1990-2001 period. While we now expect an ozone recovery as stratospheric chlorine levels drop, the dynamics of the polar vortex can strongly affect the development of the ozone hole, and an injection of volcanic aerosols can intensify the development. While the higher "low ozone" observed in the ozone hole in 2017 may be a sign of recovery, careful observations and analysis are required to make such a conclusion.