Introduction

- Stratospheric ozone absorbs ultraviolet radiation from the sun, but surface ozone is a pollutant.
- Tropospheric ozone concentrations are influenced by advection, stratospheric influences, photochemical production, biomass burning, and other anthropogenic sources.
- Ozone concentrations should be low in the tropics, especially over oceans.
- Pollution in the southern Atlantic is enhanced by biomass burning in southern Africa.

Figure 1 (right). Ozone in the Atmosphere. Image courtesy NASA.

- Seasonal biomass burning leads to a large increase in ozone in the southern Atlantic.
- To what extent does biomass burning affect tropical ozone values?

Goal & Methods

- Ozone sondes were launched at Ascension Island and Natal from 1998 - 2009.
- We cluster ozone profile using self-organising maps (SOMs) and compare the cluster maps to meteorology.
- We hypothesize that ozone sondes will cluster according to influences from meteorology and anthropogenic sources.
- Comparing clusters with the meteorology and seasonality should lead to insight on the major influences of tropical ozone.

Figure 3 (top right). A yearly cycle of ozone at Ascension Island taken from the 4x4 SOM. Influences from biomass burning are apparent. Row 1 shows the individual SOM nodes (cyan) and the ozone profile imaged row 2 shows the seasonality of the profiles. Row 3 shows the stability and row 4 shows the 7-day back trajectory clusters ending over Ascension Island at an altitude of 2.5 kilometers.

Problem

- Fire counts from MODIS in 2005 from January to August. Image courtesy NASA.
- Fires counts and smoke in Angola and the Democratic Republic of the Congo. Image courtesy NASA.

Analysis

- In March, April, May (MAM) same values at Ascension Island are above average. As the year progresses to June, July, August (JJA), increased stability and flow mainly from the African continent leads to increased ozone at Ascension Island. The main burning season in southern Africa is in September, October, November (SON). This is when ozone at Ascension Island is significantly increased from the mean. The pronounced atmospheric stability in this season leads to the large vertical ozone gradient seen above about 1.5 kilometers. Al so flow patterns during this time of year have Ascension Island downwind of the African continent.

Figure 14 (left). The influence of conversion on ozone seen at Natal. Row 1 shows two different SOM nodes from the 4x4 Natal SOM where the node on the left shows significantly lower ozone than the mean and the node on the right shows significantly higher ozone than the mean. Row 2 shows the corresponding average outgoing longwave radiation (OLR) corresponding to each day that went into the nodes. OLR data was provided by National Centers for Environmental Protection (NCEP) reanalysis. OLR is significantly lower at Natal corresponding to the lower ozone case, suggesting conversion is vertically mixing ozone.

Conclusions

- Self-organising maps are an effective way to cluster ozone profile and link ozone profile cluster to meteorological phenomena.
- Ascension Island ozone profiles are influenced by seasonal biomass burning and convective mixing. Also, atmospheric stability plays an important role.
- Self-organising maps pick out a yearly cycle of ozone at Ascension Island.
- Ozone over Natal shows influence from seasonal convection.
- Results from self-organising maps can be used to improve regional and global chemical transport models.

Acknowledgments

This research was supported by an Earth and Environmental Systems Institute (EES) Environmental Scholar fund through The Pennsylvania State University and National Aeronautics and Space Administration (NASA). SHADOZ grant NNX01AA25G for which M.J. Kurylo and K.W. Jucks are thanked. We are grateful for the years of excellent sounding data from Russell Yen (Ascension Island) Naeem M. Paus Lane, and Francisco Duflo (INPE, Brazil). Conversations with Christopher Nowicki were exceptionally helpful. We would like to thank Greg Garner, David Dougherty, Doug Martin, Caroline Noreille, Ryan Mauller, Hamish Halliday, Wilfred Balschov, and Sonya Miller for their company and insight. For more information on SHADOZ go to http://tropos.gefir.nasa.gov/shadoz.

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