Spatio-Temporal Evolution of Aerosols in the Atlantic Ocean

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Keywords: aerosol size distribution; ocean research expedition; Atlantic Ocean, mineral dust, air mass

Abstract

Aerosol distribution dynamics over large range transport remain uncertain, even though particle size distributions are an intrinsic component of global and regional prediction and forecast models. In the Tropical Atlantic Ocean, these processes are further complicated by the synoptic weather phenomena in the region. Furthermore, in this area there is a considerable influx of aerosols from biomass burning activities and mineral dust aerosols from the African continent. This research performs statistical analysis of particle size distributions measured in-situ in the Atlantic Ocean, in order to gain a further understanding of the spatial and temporal evolution of aerosols in the Tropical Atlantic Ocean.

1. Introduction

The African continent is the major emitter of mineral dust into the atmosphere, and a considerable contributor of aerosols resulting from biomass burning activities. Nonetheless, the distribution dynamics involved in the long range transportation of aerosols has not yet been comprehended due to the lack of in-situ measurements. In the global scale, the region of North Africa and Central Asia is denominated the Dust Belt, as shown in Figure 1 (Prospero et al, 2002, Gottwald et al. 2006) due to the location of major deserts and basins, which combined generate the most mineral dust into the atmosphere. Furthermore, more of these aerosols are deposited into the Atlantic Ocean than into any other ocean basin.

The specific characteristics of the aerosol distribution during the voyage from its origin in North Africa to their final destinations in the American continent and the Atlantic Ocean are not known and remain without validation (Mahowald et al., 2014). Due to the enormity of the region, the procurement of continuous in-situ data is not feasible in this area of the Atlantic Ocean (Guereque, 2012). For this purpose, the Aerosol and Ocean Science Expeditions (AEROSE) were conducted on a yearly basis from 2004 through 2013.

AEROSE is a research campaign designed to obtain in-situ aerosols along different routes over the Atlantic Ocean over nine years (Nalli et al. 2011). The main purpose of

this intensive research campaign has been to obtain a variety of in-situ properties of aerosols including physical, biological, and chemical measurements to analyze and study the transport of aerosols from Africa across the Atlantic Ocean (Morris et al. 2006).

Understanding aerosol size distribution is key in determining aerosol optical properties given that aerosol size affects particle behavior and properties, such as volume, mass, and velocity [Hinds, 1999]. Additionally, air mass origin and wind-speeds also affect particle size distributions (Freutel et al., 2013). For this purpose, this research is to determine the contribution that aerosols have in atmospheric processes over the Atlantic Ocean.

To achieve this, the spatio-temporal distribution of the physical properties of aerosols using in-situ measurements obtained over a period of 30 days in the Atlantic Ocean have been computed. This study presents statistical analysis of downstream aerosol number size distributions (ANSD), and generates a correlation between number densities at receptor sites to their corresponding source regions, with the purpose of understanding the relationship between downstream ANSD and the upstream source region. The outcome is a classification air masses based on their source region.

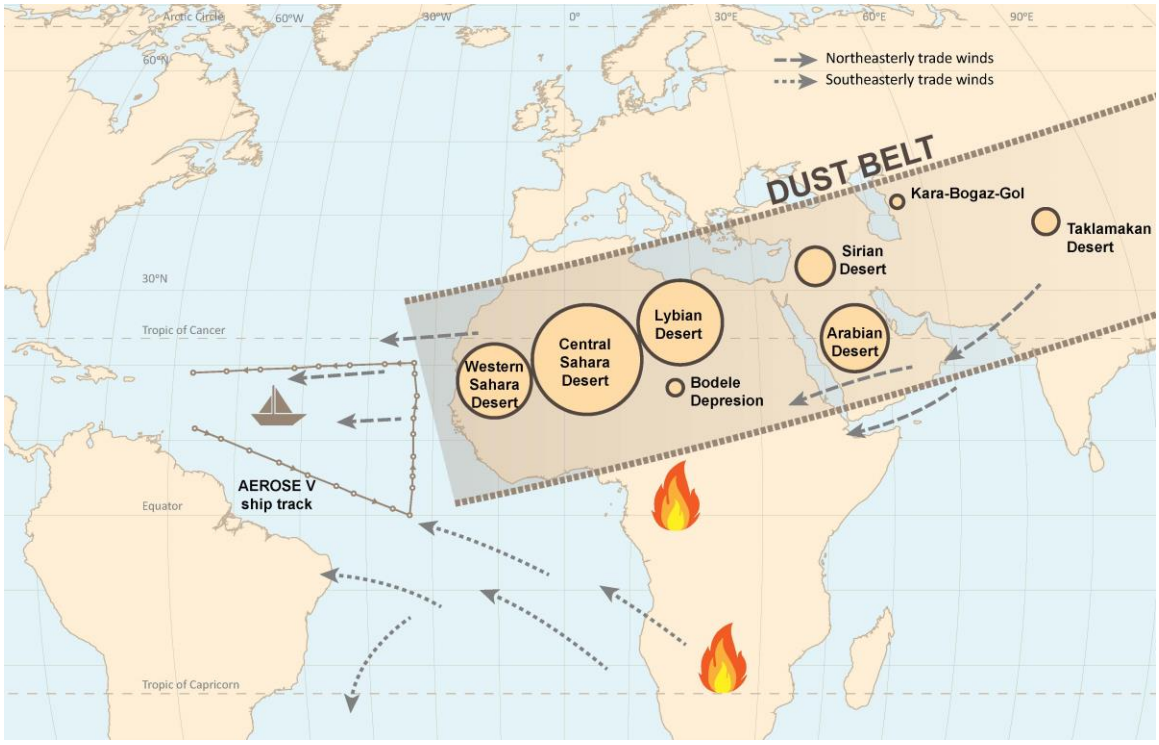

Figure 1. Illustration depicting factors influencing the research area, based on Prospero et al. 2002, and Gottwald et al. 2006.

2. Acknowledgements

This material is based upon research supported by the National Oceanic and Atmospheric Administration, Educational Partnership Program, U.S. Department of Commerce, under Agreement No. NA11SEC4810003.

AEROSE is the trans-Atlantic AERosols and Ocean Science Expeditions. AEROSE is supported primarily by NOAA through the Educational Partnership Program via

Cooperative Agreement NA11SEC4810003. Additional support is provided by NOAA NESDIS STAR. The AEROSE science team is also acknowledged for providing data analysis and access to metadata generated from the campaigns. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

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3. References

Freutel F, Schneider J, Drewnick F, von der Weiden-Reinmüller SL, Crippa M, Prévôt ASH, Baltensperger U, Poulain L, Wiedensohler A, Sciare J, Sarda-Estève R, Burkhart JF, Eckhardt S, Stohl A, Gros V, Colomb A, Michoud V, Doussin JF, Borbon A, Haeffelin M, Morille Y, Beekmann M, and Borrmann S, 2013 Aerosol particle measurements at three stationary sites in the megacity of Paris during summer 2009: meteorology and air mass origin dominate aerosol particle com- position and size distribution. *Atmos. Chem. Phys*., 13, 933–959, doi:10.5194/acp-13-933-2013, 2013

Gottwald M, Bovensmann H, Lichtenberg G, Noel S, von Bargen A, Slijkhuis S, Piters A, Hoogeveen R, von Savigny C, Buchwitz M, Kokhanovsky A, Richter A, Rozanov A, Holzer-Popp T, Bramstedt K, Lambert JC, Skupin J, Wittrock F, Schrijver H, Burrows JP, 2006. SCIAMACHY, Monitoring the Changing Earth's Atmosphere; Published by DLR

Guereque, M. (2012), "Analysis of aerosol particle size distributions observed during AEROSE V campaign". *ETD Collection for University of Texas, El Paso*. Paper AAI1513105. http://digitalcommons.utep.edu/dissertations/AAI1513105

Hinds WC, 1999, Aerosol Technology: Properties, Behavior, and Measurement of Airborne Particles, John Wiley and Sons, Inc., New York, 483 pp.

Mahowald, N, Albani S, Kok JF, Engelstaeder S, Scanza R, Ward DS, and Flanner MG, 2014 The size distribution of desert dust aerosols and its impact on the Earth system, *Aeolian Re-search*, in press, doi:10.1016/j.aeolia.2013.09.002, 2014

Morris V, Clemente-Colon P, Nalli N, Joseph E, Armstrong R, Detres Y, Goldberg M, P.J. Minnett PJ, Lumpkin R, 2006, Measuring Trans-Atlantic Aerosol Transport From Africa. *EOS*, Dec 12, 565-566

Nalli N, Joseph E, Morris V, Barnet C, Wolf W, D. Wolfe, Minnett P, Szczodrak M, Izaguirre M, Lumpkin R, Xie H, Smirnov A, King T, J. Wei J, 2011, Multi-year observations of the tropical Atlantic atmosphere: Multidisciplinary applications of the NOAA Aerosols and Ocean Science Expeditions (AEROSE). *Bulletin of the American Meteorological Society (BAMS)*, 92(6), 765-789 June

Prospero, JM, Ginoux P, Torres O, Nicholson SE, and Gill T, Environmental characterization of global sources of atmospheric soil dust identified with the NIMBUS 7 Total Ozone Mapping Spectrometer (TOMS) absorbing aerosol product. *Reviews of Geophysics*, 40(1), 1002, doi:10.1029/2000RG000095.