Confirmation of carbon monoxide transport over West Africa

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Citation: AIP Conference Proceedings **2043**, 020022 (2018); doi: 10.1063/1.5080041
View online: https://doi.org/10.1063/1.5080041
View Table of Contents: http://aip.scitation.org/toc/apc/2043/1
Published by the American Institute of Physics

Confirmation of carbon monoxide transport over West Africa

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Abstract. This research is to estimate the carbon prints in the atmosphere West Africa. The imageries was from Measurement of Pollution in the Troposphere (MOPITT). The minima carbon monoxide (CO) concentration can be as low as 100ppvb and can be as high as 400ppbv between November to February every year. However, the increase of CO has increased between 2016 and 2017 by 140%. Hence, the recent invasion of black carbon over the oil rich region of Nigeria in February 2017 can be explained. The poor air quality is responsible for the death of approximately 3 million people each year via acute respiratory diseases, cardiovascular diseases, and lung cancer.

INTRODUCTION

The multiplication of illegal refineries in the region has significantly increased the carbon print over the region. In 2003 (January 31), images from the Multi-angle Imaging SpectroRadiometer (MISR) showed an extensive smoke from fires burning throughout Nigeria and north central Africa. In 2004, the Measurement of Pollution in the Troposphere (MOPITT) imageries showed the widespread carbon monoxide into the atmosphere of West Africa. More recently, carbon particulates covered one of the commercial cities from the oil rich region of Nigeria i.e. Niger-Delta. This shows that carbon particulates over Nigeria has been exceeded and have an extensive effect on the West African region.

Pollution is the introduction of a contaminant into the environment. It is created mostly by human actions, but can also be a result of natural disasters. Pollutants, the components of pollution, can be either foreign substances/energies or naturally occurring contaminants. Pollution is often classed as point source or non-point source pollution [1,2].

Aerosols are suspension of small liquid or solid particles in air or gas. The sources of aerosols include vehicles exhaust (soot/black carbon, organics), industrial emissions (soot/black carbon, sulphate, organics, metals and nitrate), construction and agriculture emission (soot/black carbon, nitrate and soil), sea-spray (salt), biomass and fires (soot/black carbon, nitrate and organics) [3]. The general characteristic of any type of aerosol particles are its heterogeneous structure, that is, their different sizes, shapes and stoichiometry. There are two major types of

The 6th International Conference on Science & Engineering in Mathematics, Chemistry and Physics
AIP Conf. Proc. 2043, 020022-1–020022-4; https://doi.org/10.1063/1.5080041
Published by AIP Publishing. 978-0-7354-1769-4/$30.00

aerosols; natural and man-made or anthropogenic aerosol. Aerosols sizes range from nanometers to tens of micrometers. Soot/black carbon is common to gas flaring, illegal refineries emission, automobile emission e.t.c. The danger of soot/black carbon is majorly respiratory and cardiovascular diseases.

In this paper, we seek to confirm the level of carbon prints over the West Africa. Also, we wish to affirm the speed of the carbon particulates over West Africa. This would help to prevent natural disaster in the future.

METHODOLOGY

This research focused on West Africa. The imageries adopted for this study was collected from the Measurement of Pollution in the Troposphere (MOPITT). The explanations of the imageries were done using the West African regional scale dispersion model (WASDM). WASDM have successfully described the relationship between aerosols (soot/black carbon) and the West African climate system. The model was validated by the aerosols loading of over fifty towns and cities in West Africa [4,5]. One of the solution of the general WASDM is shown below:

$$C(x,y,z) = a^2 \mathrm{b}\cos(\frac{\mathrm{n}\pi}{2}x + \alpha)\cos(\frac{\mathrm{n}\pi}{2}y + \beta)\exp(-\frac{V_z}{k_z}\, z) \tag{1}$$

V_z is the wind velocity (m/s), C(x,y,z) is the mean concentration of diffusing pollutants of diffusing substance at a point (x,y,z) [kg/m^3], K_z is the eddy diffusivities in the direction of the z- axis [m^2/s], , a is known as the atmospheric/decay/growth constant, α and β is the phase difference, n is tuning constant, b is the multiplier constant.

RESULTS AND DISCUSSION

The major climatic zone of West Africa stretches across five latitudinal zones of 5° each namely zones 0 - 5°N, 5 ° N - 10°N, 10 °N - 15°N, 15 ° N - 20°N and 20 ° N - 25°N. West Africa (WA) has tropical climate though the far northern portion of West Africa is arid and stretches into the Sahara desert. However, the main pollution from the arid region of WA is dust. The four different climatic zones in West Africa are Sahelian zone, Sudano-Sahelian zone, Sudanian zone and Guinean zone. The thick CO concentration over West Africa was very high (>400ppbv). The CO volume decreased in February, 2016. This is because atmospheric circulation pattern in the four zones is controlled by some salient factors like African Easterly Jet (AEJ), Intertropical Convergence Zone (ITCZ), Intertropical Discontinuity (ITD), associated heat low (HL), Subtropical Jet (STJ), troughs and cyclonic centers associated with African Easterly Waves (AEW) and Tropical Easterly Jet (TEJ).

In October 2016, The CO imprint over the last year by 140%. This result is quite high. Hence, we monitored some selected days in January, 2017. The sharp CO transport is in agreement with our model that when particulates do not decay in the micro scale, four levels of change are expected as the wind increases at 10 m/s, 20 m/s, 26 m/s and 30 m/s. The numerical prediction hence shows that like the aerosols, carbon monoxide could also travel 15 km - 17 km within an hour under the set condition [6].

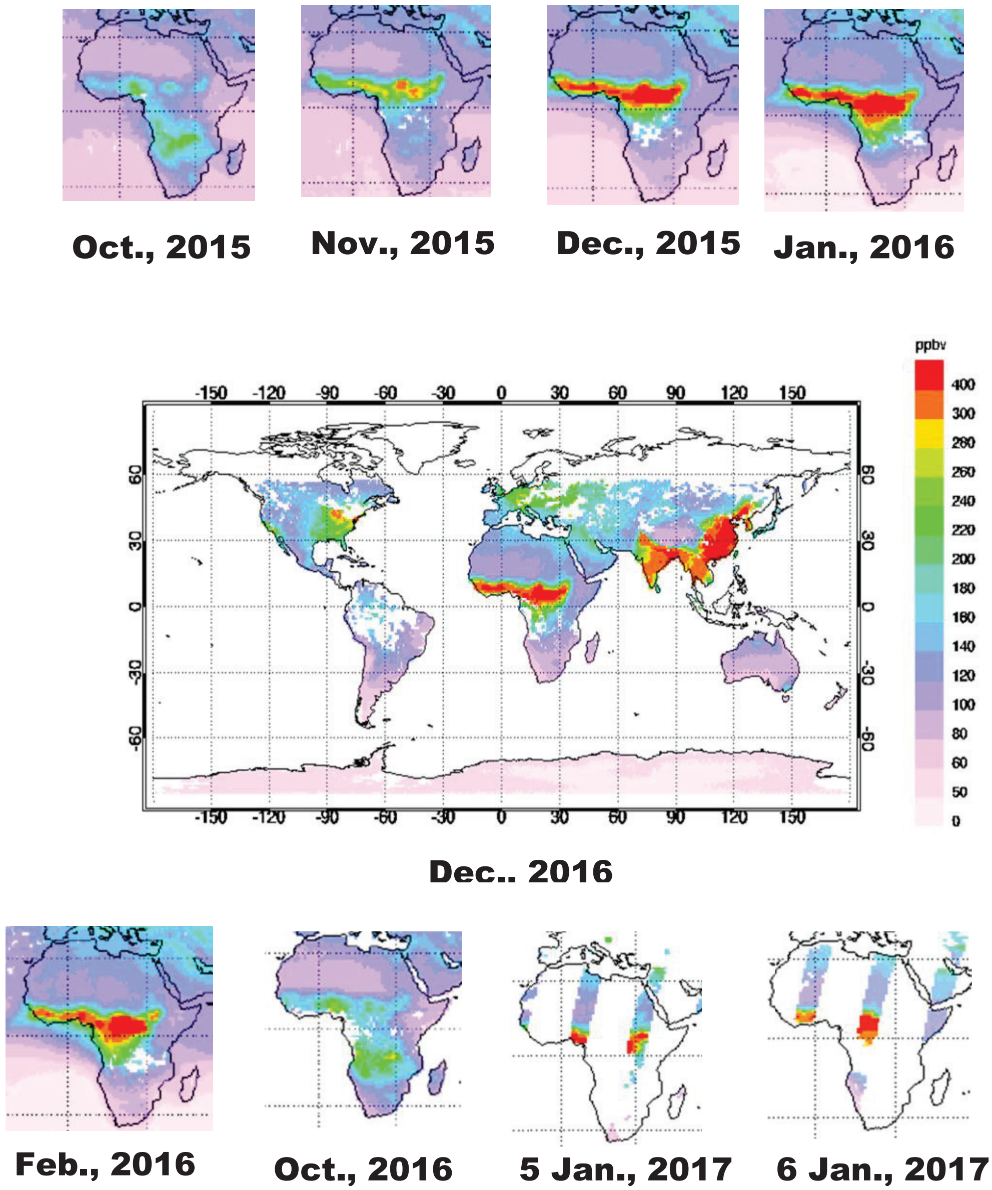

FIGURE 1. Satellite imageries for monitoring carbon monoxide in West Africa

CONCLUSION

The movement of atmospheric pollution between continents attracts increasing attention. The lifetime of carbon monoxide depends on the climate system which is able to reduce or increase carbon monoxide by 140%. The carbon print over West Africa is triggered from Nigeria and travel fast. This confirms the earlier calculation done in the WASDM for particulate transport over micro and macro scale.

ACKNOWLEDGMENTS

The authors appreciate Covenant University for partial sponsorship. The authors acknowledge the use of NASA dataset for the research. Emetere M.E. enjoys partial funding as Senior Research Associate at University of Johannesburg.

REFERENCES

1. M.E. Emetere, M.L. Akinyemi, & O. Akinojo, "*Theoretical Aid for Improving Measuring Instruments Efficiency within the Meteorological Space of Lagos-Nigeria*", 2015 PIAMSEE: AIP Conference Proceedings 1705, 020054 (2015)
2. M.E. Emetere, M.L. Akinyemi, & S. E. Sanni, "*Verification of Aerosols Loading Over Kano: A Theoretical Estimation via Mathematical Rudiments*," Lecture Notes in Engineering and Computer Science: Proceedings of The World Congress on Engineering, 29 June - 1 July, 2016, London, U.K., pp802-806 (2016a)
3. W.Y. Sun, K.J.S. Yang, & N.H. Lin, "*Numerical simulations of asian dust-aerosols and regional impacts on weather and climate- Part II: PRCM-dust model simulation*". Aerosol and Air Quality Research, 13: 1641–1654. (2013).
4. M.E. Emetere, T. J. Oluwafemi, T. Akinlusi, M. C. Allen, and E. C Ama, "*Developing a Mathematical Mobile App: A Case Study of an Environmental Model*" Lecture Notes in Engineering and Computer Science: Proceedings of The World Congress on Engineering and Computer Science, 19 October - 21 October, 2016, San Francisco, U.SA., pp150-153 (2016b).
5. Emetere, M.E., Onyechekwa, L., Tunji-Olayeni, P. "*Effect of aerosols loading and retention on surface temperature in the DJF months*". Journal of Physics: Conference Series, 852 (1), art. no. 012010, . DOI: 10.1088/1742-6596/852/1/012010 (2017).
6. M. E. Emetere, "*Analytical studies on aerosols transport over micro and macro scale settings of West Africa*". Environ. Eng. Res. https://doi.org/10.4491/eer.2016.080 ((2017).