Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 132 (2018) 1857–1865

Procedia Computer Science

www.elsevier.com/locate/procedia

International Conference on Computational Intelligence and Data Science (ICCIDS 2018)

Effect of Aerosols on Ocean Parameters in India by Using Satellite Data

S. N. Palve, [a]P.D.Nemade, [b], S.D.Ghude,[c]

[a] *DYPIT, Pimpri,University of Pune,, India 411018*
[b] *S.B. PatilCollege of Engineering. Indapur,Pune 411018, India[c]IITM,, Pune 411038,India*

Abstract

The rapid industrial and economic development in India leads to high level of pollution in environment. Due to increased level of aerosols oceans are warming. This paper highlights on aerosols effect on sea surface wind and sea surface temperature by using remote sensing data.The windplays important role in Aerosol Optical Depth (AOD) and radiative forcing and is analyzed using National Centers for Environmental Prediction (NCEP) monthly wind data. The radiative forcing observed is much higher and up to 60% of total AOD during summer monsoon. SeaSurface Temperature (SST) is another important parameter in ocean atmosphere system and a key variable in coupling the atmosphere and ocean. The SST has changed during the change of atmospheric pattern and it plays an important role in aerosols mechanism. The study observed that during summer monsoon SST over the South Eastern Tropical Indian Ocean (SETIO) much higher than Western Tropical Indian Ocean (WTIO) and it plays important role in aerosols mechanism.

© 2018 The Authors. Published by Elsevier Ltd.
This is an open access article under the CC BY-NC-ND license (https://creativecommons.org/licenses/by-nc-nd/3.0/)
Peer-review under responsibility of the scientific committee of the International Conference on Computational Intelligence and Data Science (ICCIDS 2018).

Keywords: Aerosols, MODIS, SST, Climate Change, Atmosphere

Corresponding author: sandippalve@hotmail.com

1877-0509 © 2018 The Authors. Published by Elsevier Ltd.
This is an open access article under the CC BY-NC-ND license (https://creativecommons.org/licenses/by-nc-nd/3.0/)
Peer-review under responsibility of the scientific committee of the International Conference on Computational Intelligence and Data Science (ICCIDS 2018).
10.1016/j.procs.2018.05.130

1. Introduction

Rapid industrialisation plus urbanization in India consumes more energy which includes coal, petroleum products, biomass burning and nuclear power [1].These products cause high level of air pollution in clean environment. Dissipations of climate and weather seriously effect on ecosystem, human health and overall impact on society [2]. The direct plus indirect effect of aerosols results in prime role in climate system [3]. During last two decades, several investigations have clearly proved the importance of aerosols to the Earth's radiation budget [4].The anthropogenic aerosols are more predominant over natural aerosols, globally and regionally [5].The atmospheric heating and pressure gradient mainly causes due to overall impact of aerosols which effects on precipitation [6, 7].Oceans which cover more than 70 % surface of earth and important source of water regulating the climate and distribute the heat and salt equally [8, 9].This paper aims to explore role of aerosols on ocean features over the Indian peninsula. Sea surface wind and Sea Surface Temperature (SST)are important variables for coupling atmosphere and ocean. The role of sea surface wind introduce on Aerosol Optical Depth (AOD) noted that. The increasing wind speed over Arabian Sea and nearby Indian Ocean associated with summer monsoon season in India causes mainly due to AOD and sea surface wind. SST is an important and prime component of climate change relates other parameters such as heat content and rainfall [10].The problem of aerosol is becoming more acute due to abundant of air pollution in natural environment [11] and their interaction with monsoonal activities [12].

2 MODIS AOD data

MODIS (Moderate Resolution Imaging Spectroradiometer) on board Terra and Aqua launched in 1999 has a spatial resolution 1°× 1° covers entire globe within 24 hours. [13]. Data observations during July shown in Figure 1(*a*) indicate that AOD is very high over the Arabian Sea and North West coast. AOD values reach up to 0.6 towards west coast of the Arabian Desert. The northern part of India falls under high aerosols loading due to urbanisation and industrialisation, where AOD observed > 0.6 (Figure 1 (b)). In the monsoon season some data are missing out due to presence of clouds.The dust aerosols transported from Thar Desert which is situatedatNorth-western partof the country, accumulated over Indo Gangetic plane. Therich contents of aerosolsextendedup to 30° Ndue to prevailing masses of air over the ocean.AOD deceases to the small amountless than 0.2 towards, south of 10°-5°N.The large AOD also observed over Bay of Bengal but not like that of ArabianSea. The Arabian Sea, Bay of Bengal and south coast during September 2014 (Figure1(*c*)) indicate less aerosol loading (>0.2). The dynamic and invariable nature of AOD over the Indian landmass shown in frequency distribution curve (Figure 2(*a*)-(*c*)).The increasing AOD observed over North eastern and Indo Gangetic Parts of the country. The unequal distribution of monsoonal rainfall over the India due to increasing aerosols loading causes serious draught conditions and reduces agricultural production.

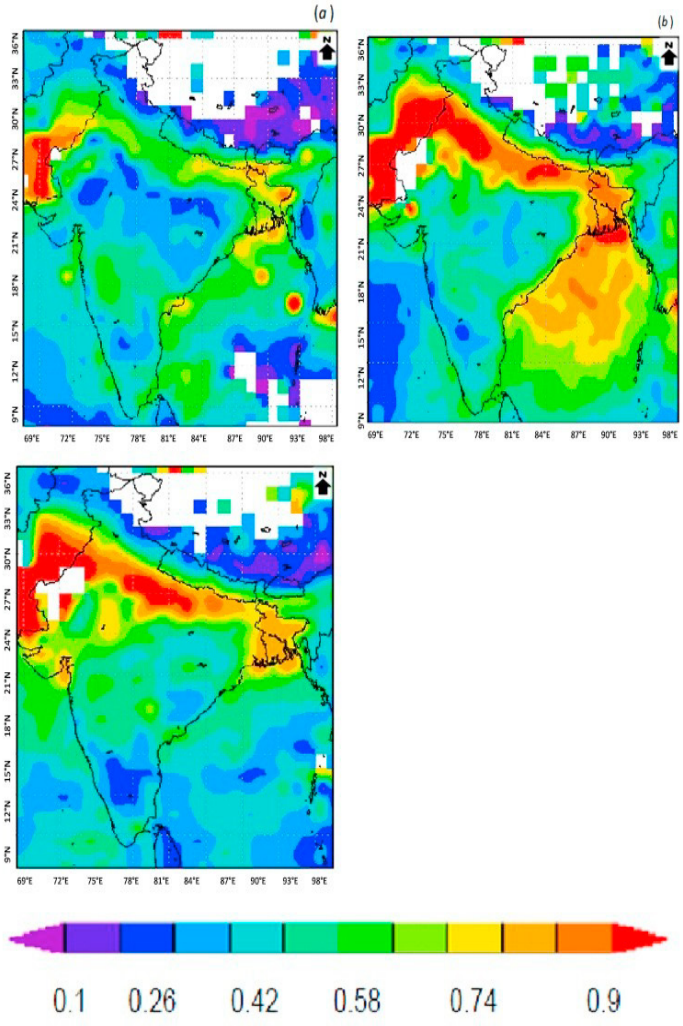

Figure1 MODIS AOD over the India during July-September 2014

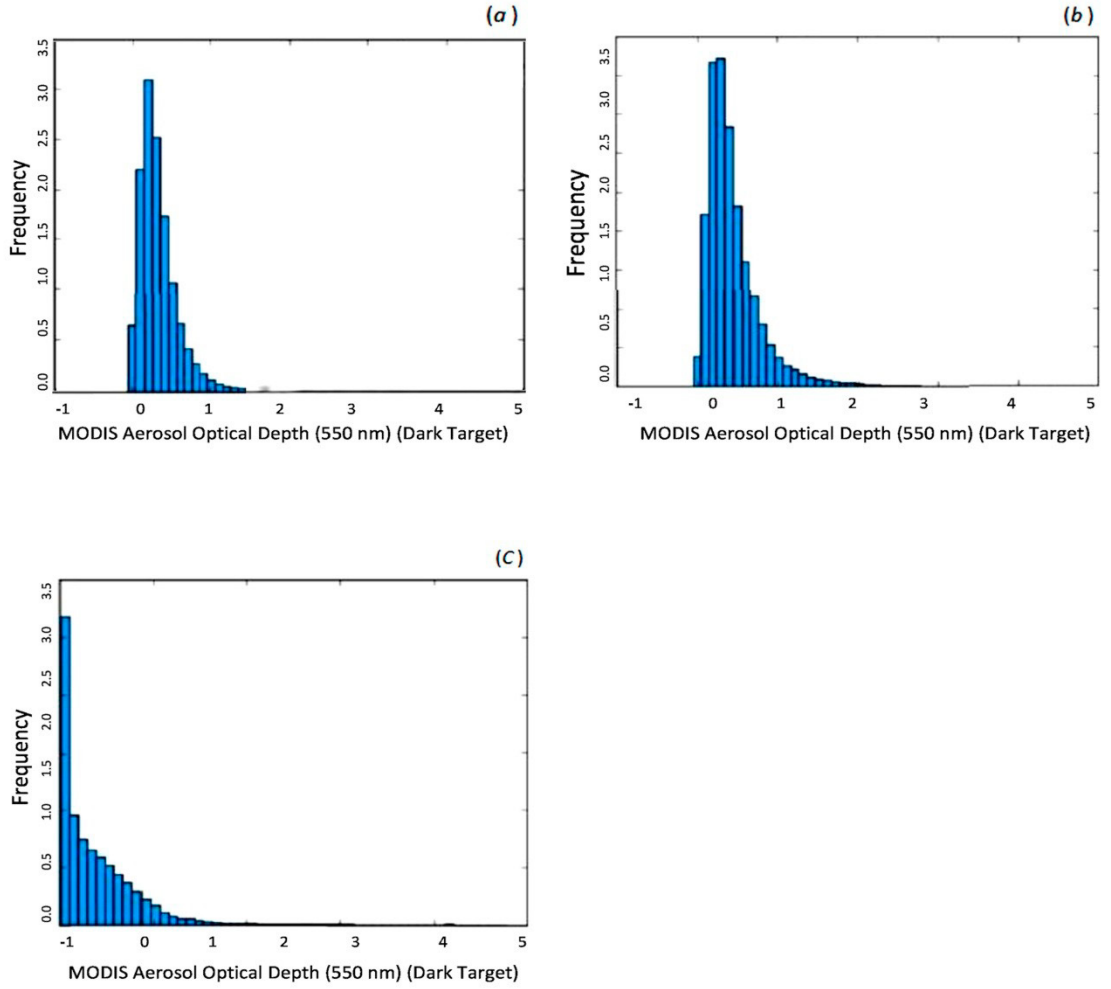

Figure2 Frequency distribution curve of AOD during July-September 2014

3. Sea-surface wind and AOD observations over the ocean

To monitor aerosols globallyit'simportant to us knowing the changes ofradiation flux. The natural aerosols, sea salt scatter the solar radiation and their forcing causes the cooling effect globally. The radiative properties of the atmosphere alter due to changes in aerosols composition with change in sea surface wind [14]. In this study observations of AOD over the Arabian Sea during July-September are shown in Figure 3. The study observed that during Indian summer monsoon (July-September) wind has a predominant effect on AOD and radiative forcing over the Arabian Sea [15].

Following equation is used over the Tropical Indian Ocean with respect to AOD and wind speed. $\tau_a = \tau_o \exp(bU)$

Where τ_o is the AOD at 0 wind speed and b is a constant intended to (0.12 for 500 nm, 0.17for850nmand0.18for1020nm)and the observed wind speed is U[14]. Wind patterns during July-September 2014 are shown in Figure 4.OvertheBayofBengal the average wind speed is 10 m s^{-1}except over the eastern part of Arabian Sea which is approximately 8 m s^{-1}.

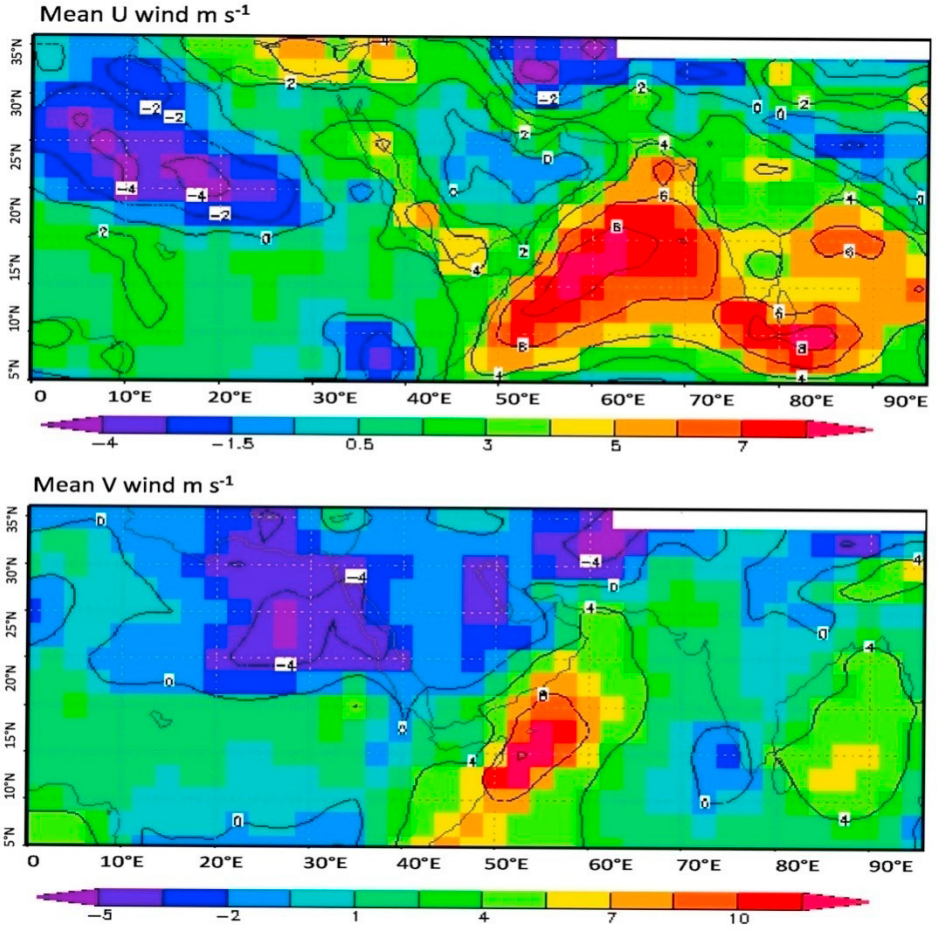

Figure 3 Surface wind pattern averaged for July-September 2014

During the summermonsoonextreme wind and Low Level Jet (LLJ) at an altitude of 1.5 km (850 hPa) observed over the Arabian Sea and west coast of India. So considering value 0.17 for 850 nm and average 10 m s^{-1}speed of wind value of $\tau_a$obtained is 0.27. This value is much higher and up to 60 % of total AOD. The study revealed that total aerosol loading is more than 50 % due to strong sea surface wind during the ISM (Indian Summer Monsoon).

4. Sea Surface Temperature (SST) affecting on Tropical Indian Ocean

SST is an important parameter and a key variable in coupling the atmosphere and ocean. SST is considered to be essential parameter for estimating the world climate [16] and most important for World Meteorological Organization. SST is collected routinely from ships, moored and drifting buoys, but these sources lack temporal and spatial density. The advent of satellites has been revolutionized the ocean observation, providing high spatial and temporal resolution. SST is important in various research activities, such as climate research, weather forecasting etc. The importance of daily SST over the tropical Indian Ocean has been increasingly recognized [17].When mineral aerosols are transported over the oceans, they can influence the energy balance nearby the sea surface. The study reveals that changes in dust concentrations correlate with those in SST.The regional variation of aerosols can account for 69% of the recent upward trend in SST over the northern tropical Atlantic Ocean [18].

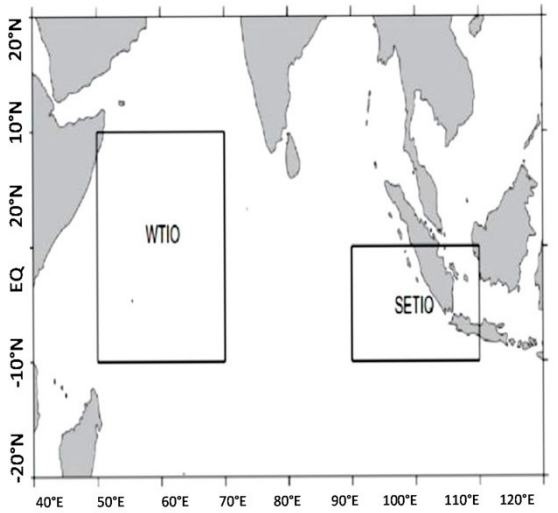

Figure 4 Western and South Eastern Tropical Indian Ocean source (Saji et al. 1999)

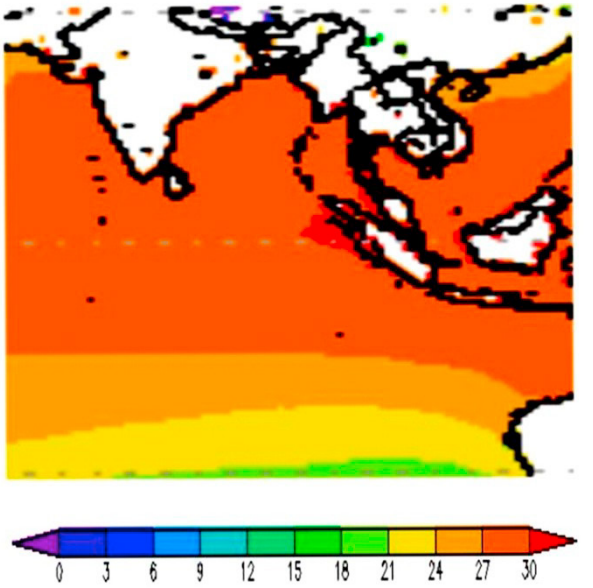

Figure 5 Sea Surface Temperatures at 9 km average during July-September 2014

The Asian summer monsoon likely to affect due to Sea Surface Temperature and dust induced aerosols [19]. The study of SST and climate parameter found that Indian Ocean Dipole (IOD) discovered from the Tropical Indian Ocean (TIO) [20] shown in (Figure 4). The intensity of IOD also governs by Western Tropical Indian Ocean (WTIO) and South Eastern Tropical Indian Ocean (SETIO) shown in the Figure 5. The negative IOD and positive IOD creates a major influence on climate near the Indian Ocean and its surroundings area. In the tropical continent, variability of air pollutants mainly occurred due to major effects of El Ninoand La Nina [21].SST probability density curves averaged during July-September 2014(Figure 6) in association with climatological factors created to examine

the annual variability. The studyreveals that the variability of SST over WTIO and SETIO was dynamic and strong in nature. The geophysical quantities govern the non-linear law which generates the spatiotemporal variability [22].The study observed that during May-September 2014 Sea Surface Temperature over the SETIO is much higher than WTIO. It is manifested that SST would have changed during the change of atmospheric pattern and it plays an important role in aerosols mechanism.

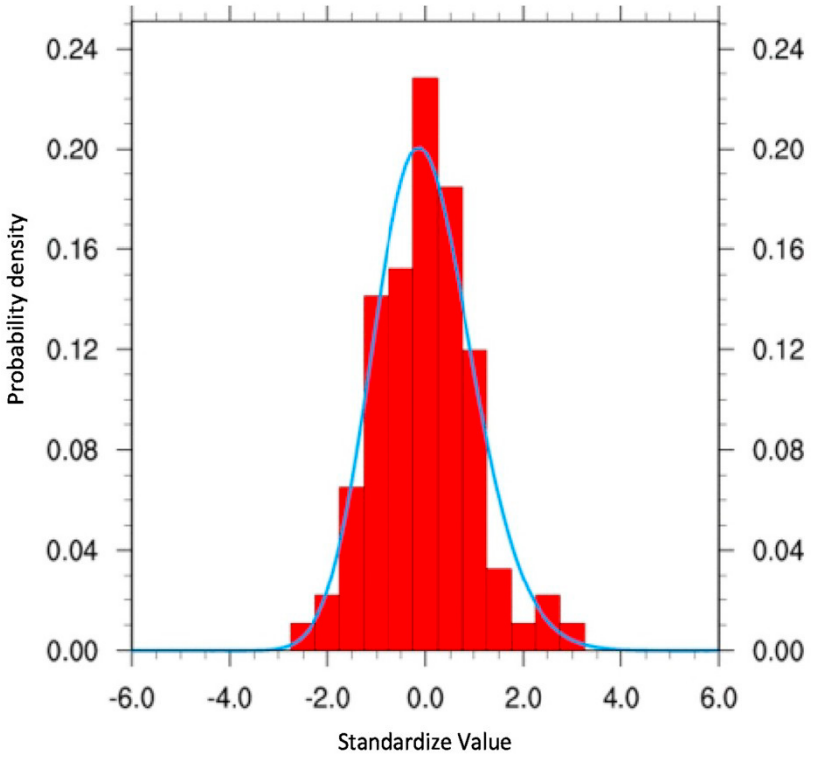

Figure 6 Probability density curves for SST during July-September2014

5. Conclusions

The study concludes the following aspects which influence the aerosols effect on ocean parameters in India.The increased population and human influence observed the correlation between Sea Surface Wind, Sea Surface Temperature and its associated parameters.The Indian summer monsoon during July-September 2014 strongly exhibited due to wind and aerosols forcing observedover the Arabian Sea. Negative and positive IOD have major influence on climate near the Indian Ocean and its surroundings area. The variability of air pollutants mainly occurred due to major El Nino and La Nina effects. SST over the SETIO is much higher than WTIO and it would have changed during the change of atmospheric pattern and it plays an important role in aerosols mechanism.

Acknowledgements
The authors are thanks to the principal DYPIT, Pimpri, University of Pune India and Director of the IITM, Pune India for motivation during the work.

References

[1]Ghude SD, Kulkarni PS, Kulkarni SH, Fadnavis S, Van Der RJ. (2011) "Temporal variation of urban NOx concentration in India during the past decade as observed from space."*International Journal of Remote Sensing***32:** 849-861.

[2]Kondratyev KY, Varotsos CA. (1995) "Atmospheric ozone variability in the context of global change."*International Journal of Remote Sensing***16:** 1851-1881.

[3]Craknell AP, Varotsos CA. (2007) "The IPCC Fourth Assessment Report and fiftieth anniversary of Sputnik."*Environmental Science and Pollution Research***14:** 384-387.

[4]Kondratyev KY, Varotsos CA. (1996) "Global total ozone dynamics: impact on surface solar ultraviolet radiation variability and ecosystems."*Environmental Science and Pollution Research***3:** 205-209.

[5] Kaufman YJ, Boucher O, Chin M, Remer LA, Takemura T. (2005) "Aerosol anthropogenic component estimated from satellite data."*Geophysical Research Letter***32:** L17804.

[6] Lau KM, Kim KM. (2006) "Observational relationships between aerosol and Asian monsoon rainfall and circulation."*Geophysical Research Letter***33:** L21810.

[7] IPCC.(2007) "The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change." (Cambridge,UK:Cambridge University Press).

[8] Murphy DM, Solomon S, Portmann RW, Rosenlof KH, Forster PM, Wong T. (2009) "An observationally based energy balance for the Earth since 1950."*Journal of Geophysical Research***114:**doi: 10.1029/2009JD012105.

[9] Palmer MD, McNeall DJ, Dunstone NJ. (2011) "Importance of The Deep Ocean for Estimating Decadal Changes in Earth's Radiation Balance."*Geophysical Research Letters***38:**doi: 10.1029/2011GL047835.

[10] Walker, Bliss EW. (1932) "World Weather V."*Memoirs of the Royal Meteorological Society***4:** 36.

[11] Lau KM, Kim KM, Hsu CN, Holben BN. (2009) "Possible influence of Air Pollution, dust- and sandstorms on the Indian monsoon."*WMO Bulletin***58:** 22-30.

[12]Ramanathan V, Ramana M. (2005) "Persistent widespread and strongly absorbing haze over the Himalayan foothills and the Indo-Gangetic Plain."*Pure and Applied Physics***162:** 1609-1626.

[13] Remer L, Kaufmen Y. (2005) "The MODIS aerosol algorithm, product and Validation."*Journal of Atmospheric Sciences* **62:** 947-973.

[14]Satheesh SK. (2002) "Aerosol radiative forcing over tropical Indian Ocean: modulation by sea-surface winds."*Current Science***82:** 310-316.

[15]Satheesh SK, Moorthy KK. (2005) "Radiative effects of natural aerosols: a review."*Atmospheric Environment***39:** 2089-2110.

[16]Donlon C, Casey KS, Robinson IS, Gentemann CL, Reynolds RW, Barton I, Arino O, Stark J,Rayner N, Le BorgneP,Poulter D, Vazquez-Cuervo J, Armstrong E, BeggsH,Llewellyn-Jones D, MinnettPJ,Merchant C J, Evans R. (2009) "The GODAE High Resolution Sea Surface Temperature Pilot Project."*Oceanography* **22:** 34-45.

[17]Sengupta D, Goswami BN, Senan R. (2001) "Coherent intraseasonal oscillations of ocean and atmosphere during the Asian summer monsoon."*Geophysical Research Letter***28:**doi: 10.1029/2001GL013587.

[18] Evan Amato T, et al. (2009) "North Atlantic Ocean Temperature Anomalies the Role of Aerosols in the Evolution of Tropical North Atlantic Ocean Temperature Anomalies."*Science***324:** 778.

[19] Miller RL, Perlwitz J, Tegen I. (2004) "Modeling Arabian dust mobilization during the Asian summer monsoon:The effect of prescribed versus calculated SST."*Geophysical Research Letter***31:**doi: 10.1029/2004GL020669.

[20]Saji NH, Goswami BN, Vinayachandran, Yamagata T. (1999) "A dipole mode in the tropical Indian Ocean."*Nature* **401:** 360-363.

[21] Chandra S, Ziemke JR, Schoeberl MR, Froidevaux L, Read WG, Levelt PF, Bhartia PK. (2004) "Effects of the 2004 El Niño on tropospheric ozone and water vapour." *Geophysical Research Letter***34:**doi: 10.1029/2006GL028779.

[22]Varotsos C, Cartalis C, Vlamakis A, Tzanis C, Keramitsoglou I.(2004)"The long-term coupling between column ozone and tropopause properties."*Journal of Climate***17:** 3843-3854.