ABSTRACT

Ozone ($O_3$) produced in the troposphere plays a vital role in the radiative and chemical processes of the atmosphere due to its strong oxidizing capability. Subsequently, surface $O_3$ is one of the ideal trace gases present in the troposphere which can modulate the chemistry to a larger extent. Being a prominent greenhouse gas and a good tracer with fairly small lifetime, the variation in the abundance of ground level $O_3$ is an ideal method to explore the photochemistry and dynamics of the atmosphere. The chemistry that leads to tropospheric $O_3$ formation is generally initiated by the photolysis of NO$_2$. In the presence of solar radiation, NO$_2$ photolysis produces NO and atomic oxygen and this atomic oxygen reacts with O$_2$ to produce O$_3$. The conversion of NO to NO$_2$ without $O_3$ occurs through a combination of the reaction cycles of hydroxyl (OH) or peroxyl radicals (HO$_2$). In these cycles, OH radicals are converted to HO$_2$ or RO$_2$, through their reaction with CO or hydrocarbons. The increasing trends in ground level $O_3$ in the urban and rural areas of industrialized regions are strongly linked to the changes in anthropogenic emissions of $O_3$ precursors and revealed that its key role in imparting global warming and subsequent climate changes. Over the last few decades, several studies have revealed that background $O_3$ in the troposphere has almost doubled that compared to the pre-industrial era. In order to explore surface $O_3$ chemistry and its transport at Kannur, a tropical coastal site in the state of Kerala, continuous observations have been going on since 2009 at Kannur University with the support of ISRO-GBP (AT-CTM) programme. This thesis is focused on the observations on the variations of ground level $O_3$ mixing ratio and its precursors at Kannur (11.9°N and 75.4°E, 5m asl), in north Kerala confined in the coastal belt of Arabian Sea and Western Ghats. In order to discuss the objectivity effectively, the thesis is divided into seven chapters. In the following paragraphs, the highlights of each chapter are discussed. A brief explanation on air pollution, climate change, radiative forcing, importance of $O_3$ study, previous work done in globe and India about surface $O_3$ variability and its impact on air quality and climate change is discussed in Chapter 1. Photochemistry of surface $O_3$, details about observational site, general meteorology and various experimental techniques used for the study is discussed in chapter 2. Chapter 3 mainly deals with the temporal variations of $O_3$ at Kannur University Campus during 2009 November to 2011 December. Weekend effect of $O_3$ at Kannur town and diurnal variation of $O_3$ at Ooty, a free tropospheric hill station in Western Ghats region is also discussed. Chapter 4 deals with the temporal variations of NO$_x$, CH$_4$ and NMHCS at Kannur University campus. Analysis and chemical coupling of $O_3$ with oxides of nitrogen is also presented. Organic analysis of vapour samples collected at the observational site and air trajectory analysis is also discussed in this chapter. Chapter 5 focused on the influence of solar eclipse on surface $O_3$, NO, NO$_2$ and meteorological parameters at Kannur. Further, the observed variation in $O_3$ is validated with NCAR Master Mechanism Photochemical Box model. Chapter 6 covers a detailed study of impact of fireworks on the ambient air quality during fire cracker episode (Vishu festival) in 2010 and 2011 at Kannur University Campus. Night time $O_3$ production and the detection of various hazardous organic species both in vapour and particle phase in the ambient air due to intense flash of fire crackers discussed in detailed. Chapter 7 provides an overall summary and conclusions of the results obtained in this work.
Some of the important results in the thesis have been published in the peer reviewed journals as given below:


Nishanth, T., Satheesh Kumar, M.K., Valsaraj, K.T., 2012. Analysis of ground level O\textsubscript{3} and NO\textsubscript{x} measured at Kannur, India. Earth Science Climate change, doi:10.4172/2157-7617.1000111


Nishanth, T., Praseed, K.M., Satheesh Kumar, M.K., 2011. Solar eclipse-induced variations in solar flux, j(NO2) and surface ozone at Kannur, India, Meteorology Atmospheric Physics. 113, 67–73. DOI 10.1007/s00703-011-0141-0


Nishanth, T., Satheesh Kumar, M.K., 2010. Measurement of surface ozone and its precursor NO\textsubscript{X} over urban and rural locations in Kannur- a tropical coastal site in India. Indian Journal of Science and Technology, 3(12), 1198-1201.

National and International conference proceedings/presentation

Nishanth. T., Satheesh Kumar, M.K., Impact of fireworks on the regional air quality at Kannur, India. Proc. 39\textsuperscript{th} COSPAR Scientific Assembly, Mysore, India, July 2012

Nishanth. T., Satheesh Kumar, M.K., Impact of O\textsubscript{3}, NO\textsubscript{x}, CH\textsubscript{4} and NMHC on ambient air quality at Kannur. Proc. 17\textsuperscript{th} National Space Science Symposium (NSSS) of ISRO, SV University, Tirupati, February 2012.

Participated in the international workshop on Asian Greenhouses gases at PRL Ahmedabad, organized by Asian Pollution Network and JAMSTEC, Japan. September, 2011.

Nishanth. T., Praseed, K.M., Satheesh Kumar, M.K., Spectral variation of total column aerosol optical depth over Kannur, a tropical coastal site in India. Proc. National conference on Advances in atmospheric Sciences Weather Prediction & Climate Change (ARWPCC-2011), SV University, Tirupati, March 2011


Nishanth. T., Satheesh Kumar, M.K., Seasonal variation of NO$_x$ along the coastal belt of Arabian Sea using satellite data. Proc.38$^{th}$ COSPAR scientific assembly, Bremen, Germany, July 2010.


Nishanth. T., Satheesh Kumar, M.K., Diurnal variation of surface ozone and its precursor NO$_x$ in the urban and rural location in Kannur. Proc. National seminar on atmospheric aerosols in inducing climate changes, Sir Syed College Taliparamba,
March 2010.

Nishanth. T., Satheesh Kumar, M.K., Trend analysis of tropospheric NO$_2$ along the coastal belt of Arabian Sea using satellite data. Proc. 16$^{th}$ National Space Science Symposium (NSSS) of ISRO, Saurashtra University, Rajkot, February 2010.