Variability in the distribution of ozone over land and marine regions in the Indian region

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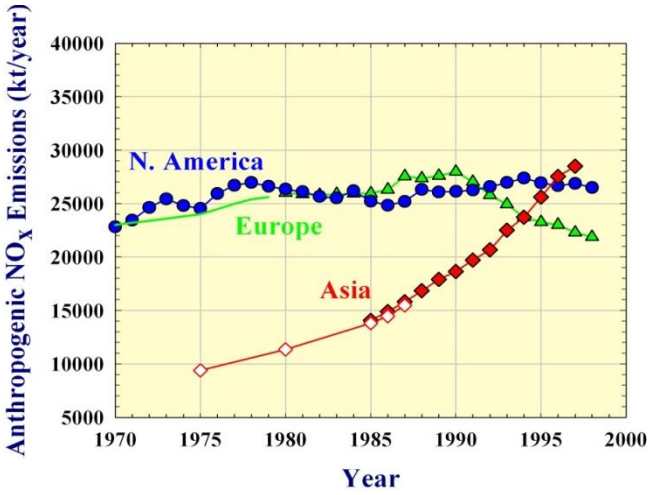
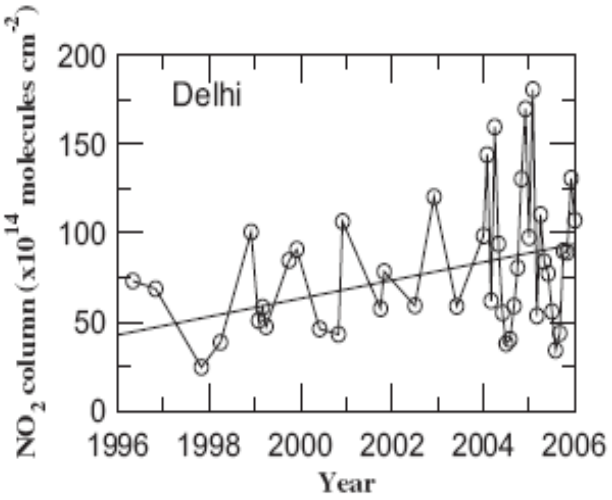
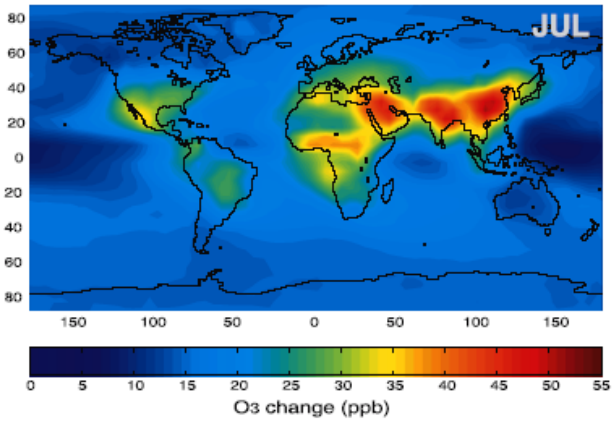
Current focus of tropospheric research is on chemistry-climate interactions especially over the Asian region



Akimoto (2003) Science



Sheel et al., AE, 2010

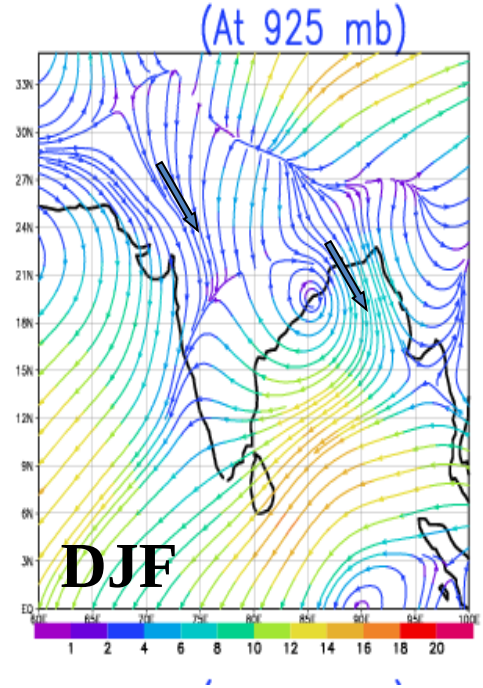


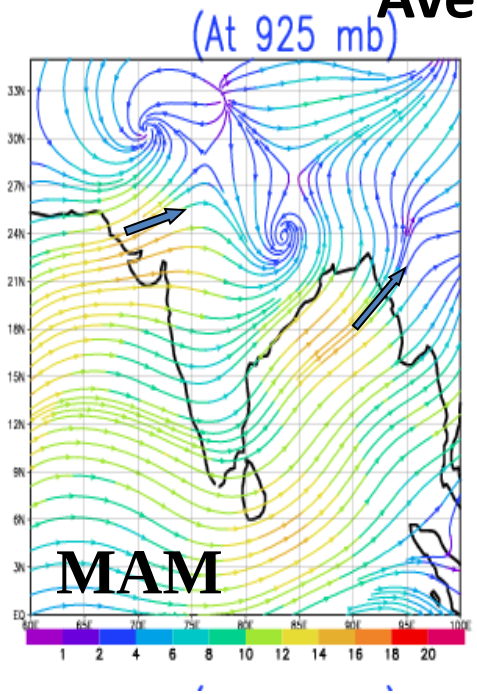
Monthly mean surface ozone increase from 2000 to 2100 based on average results of 10 models.
Prather et al., JGR 2003

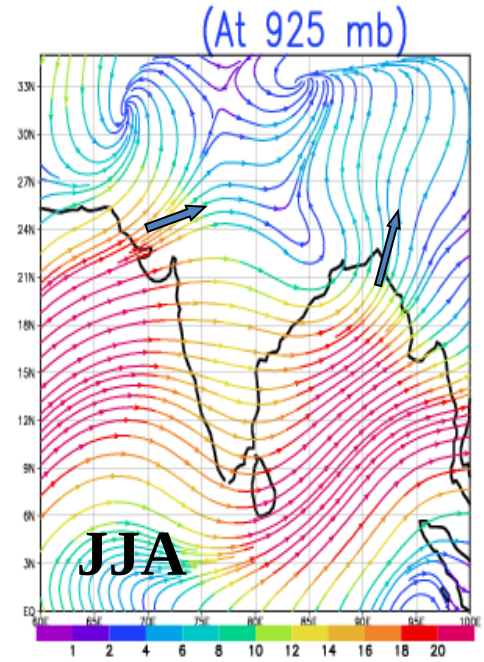
NOx emissions during 1990-2020 (Gg NO_2/yr), *Streets et al. JGR 2003*

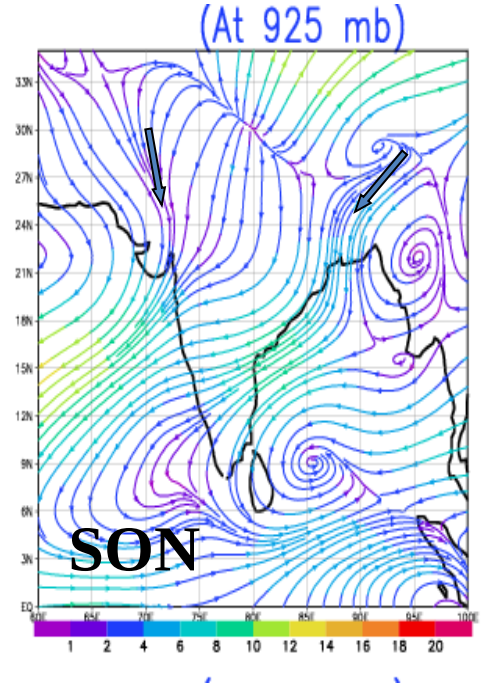
	1990	2000	2010	2020
China	8273	13719	21906	32364
India	3481	5615	10842	22824

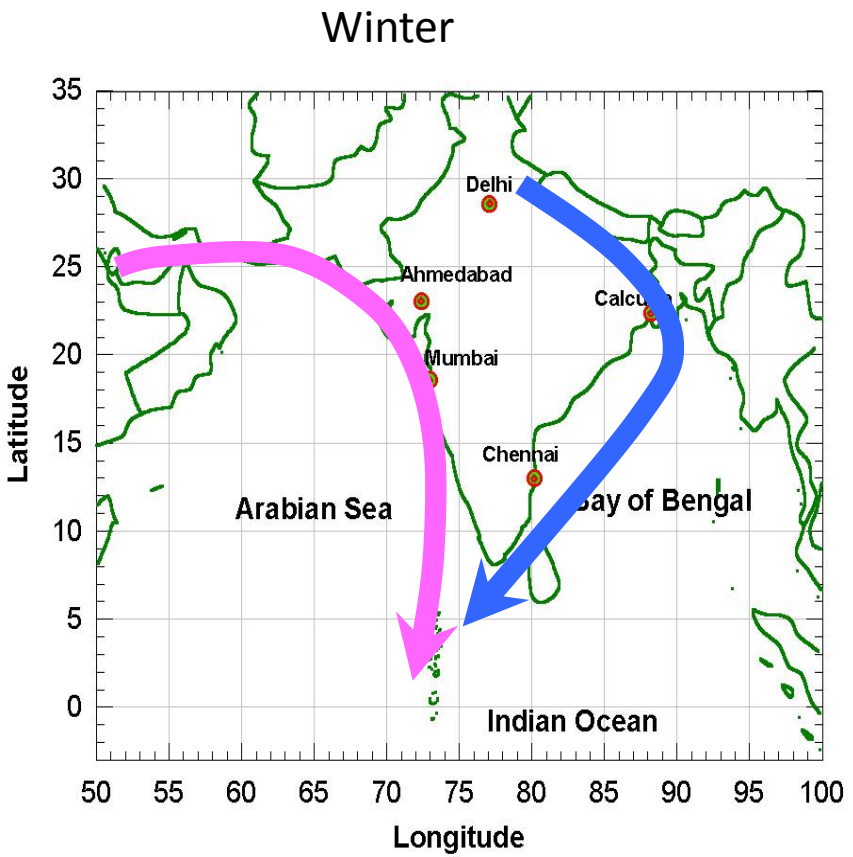
Average Seasonal Wind Streamlines



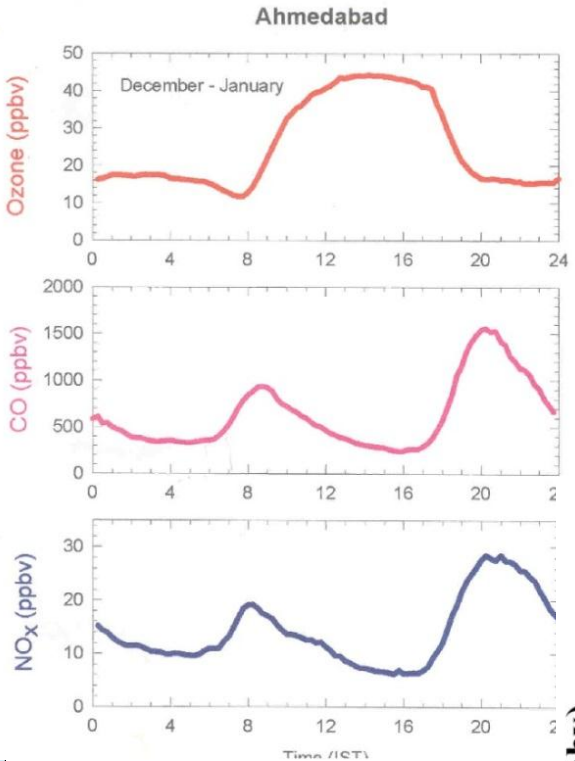


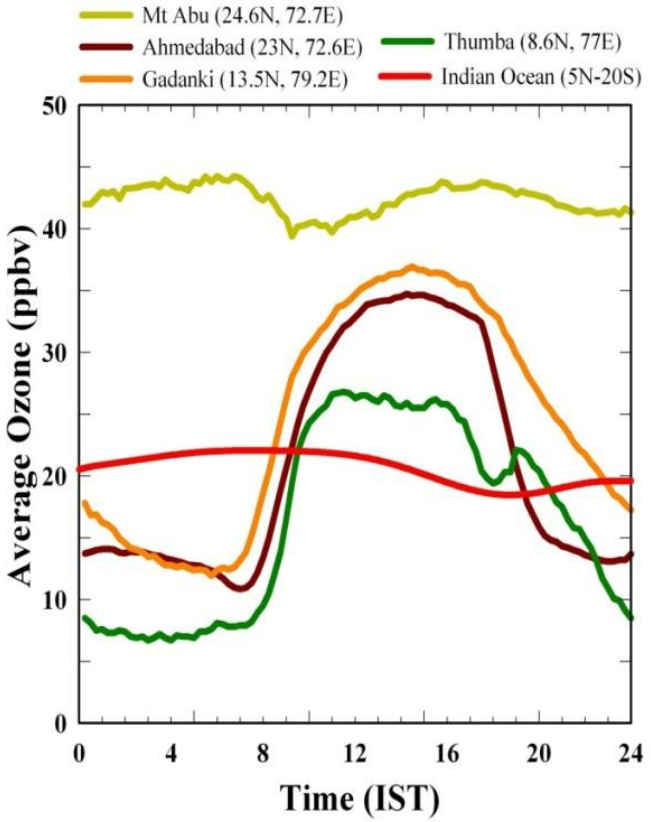




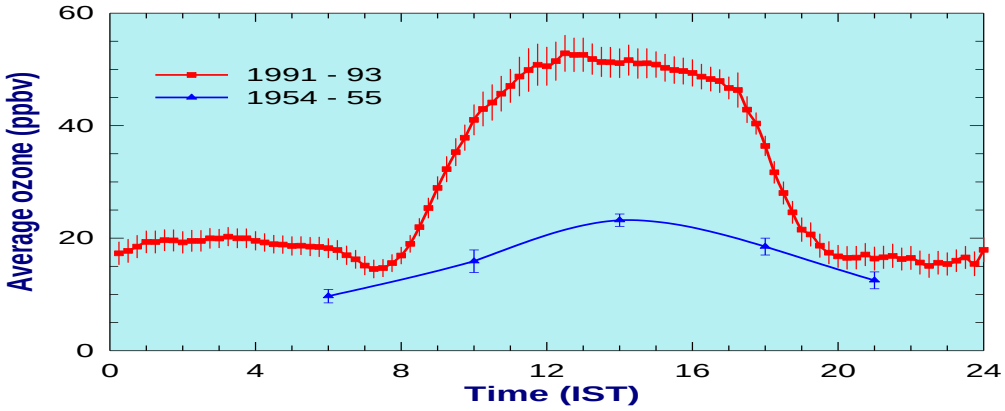


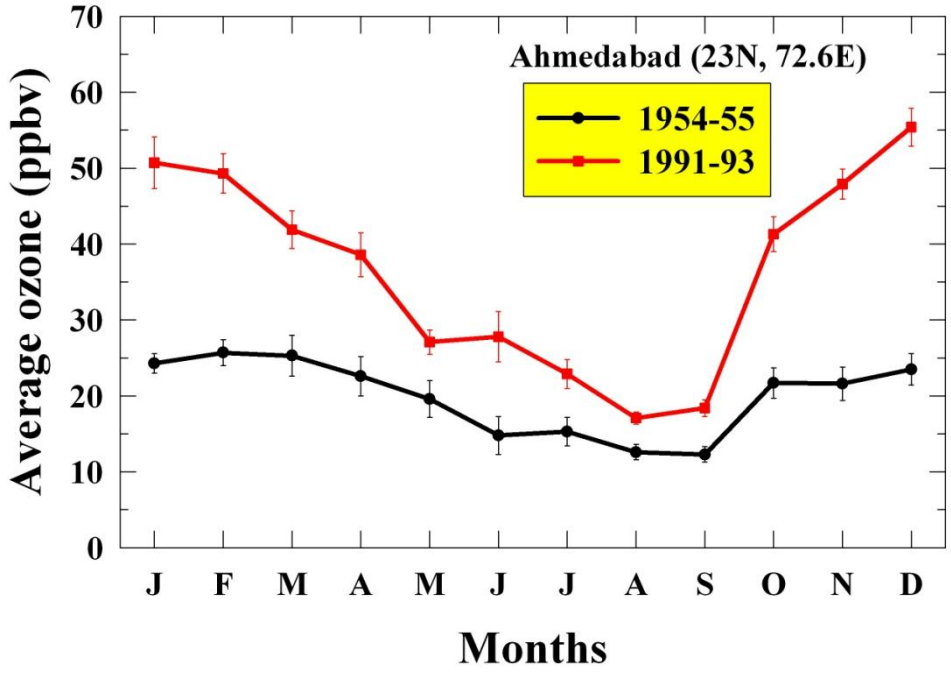
Study of ozone and related trace gases at Ahmedabad





Surface ozone at Ahmedabad– Longterm Trends

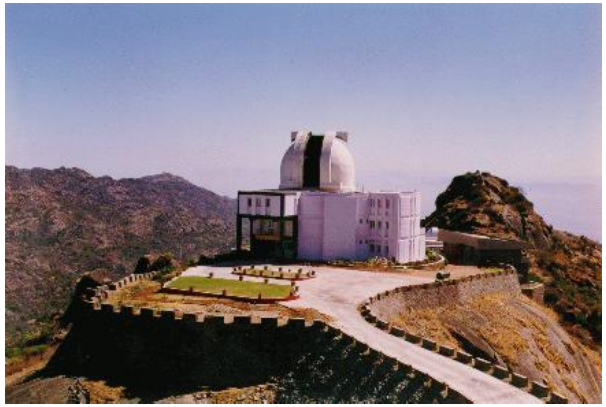


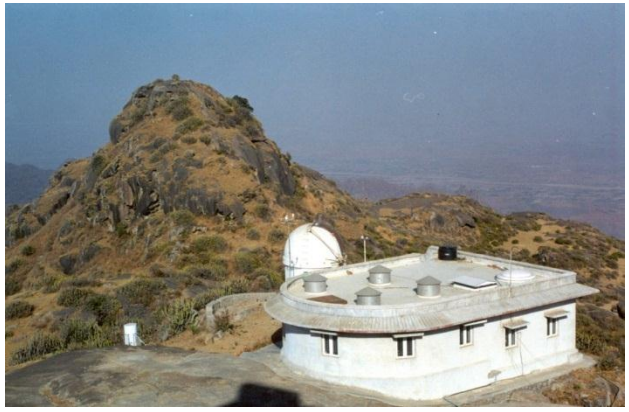


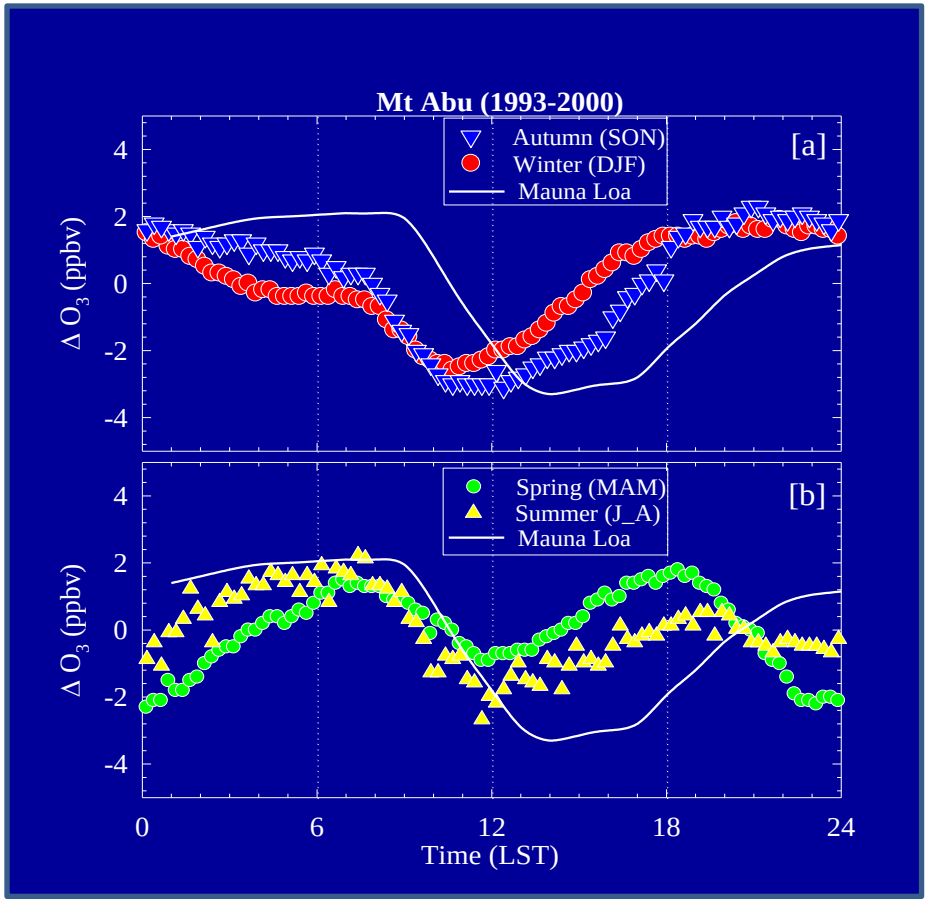
Average ozone mixing ratio increased from 14.7 ppbv during 1954-55 to 25.3 ppbv during 1991-93, resulting in a linear increase of ~ 1.4%/year

Naja and Lal, GRL , 1996

Diurnal variation of ozone at Mt. Abu (24.6N, 72.7E, 1680m amsl)







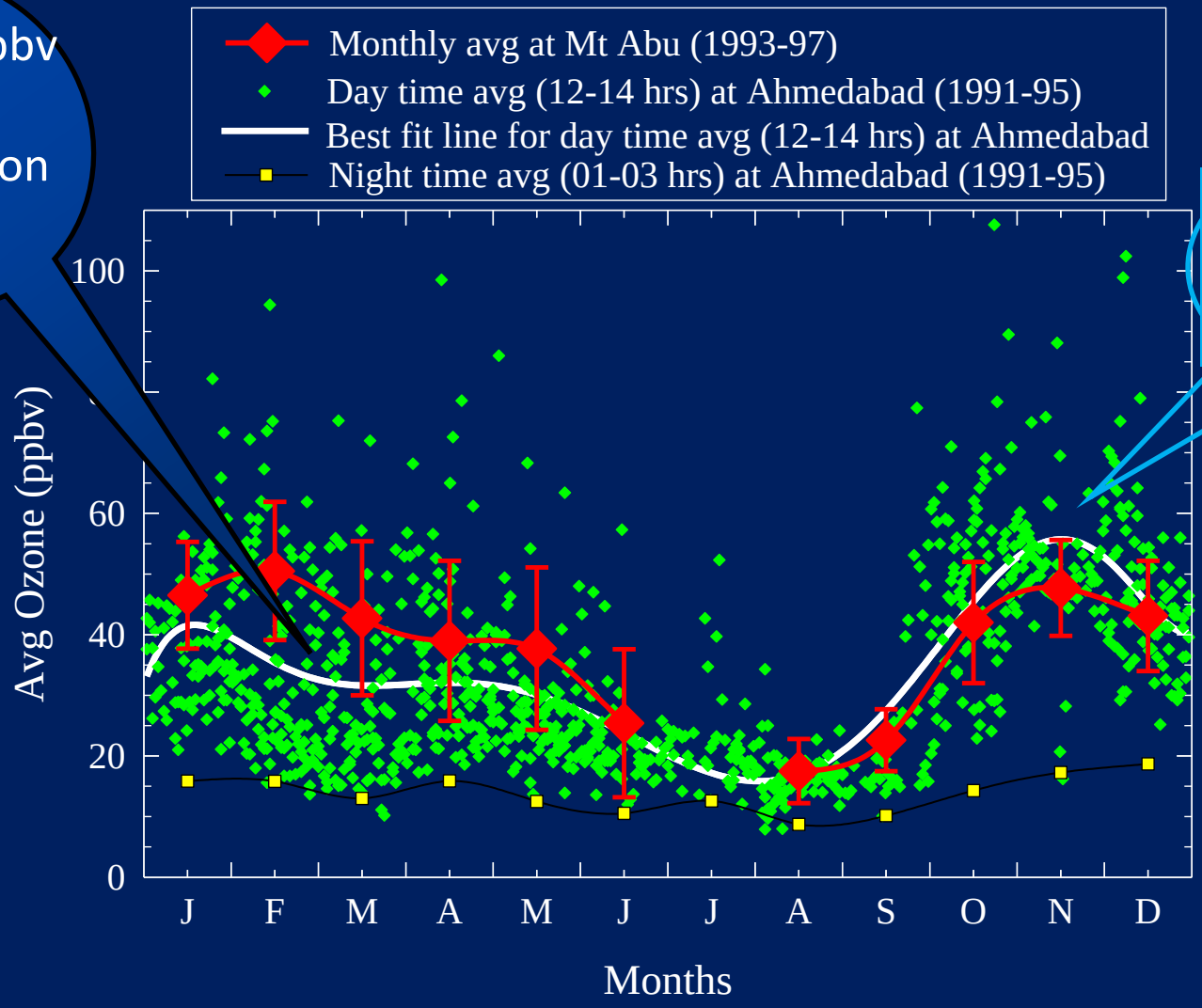
Autumn and Winter : Winds from north

Spring and Summer : Winds from south-west and south

Naja et al., AE 2003

Regional and Local effects

~ 12-15 ppbv
Regional
Contribution



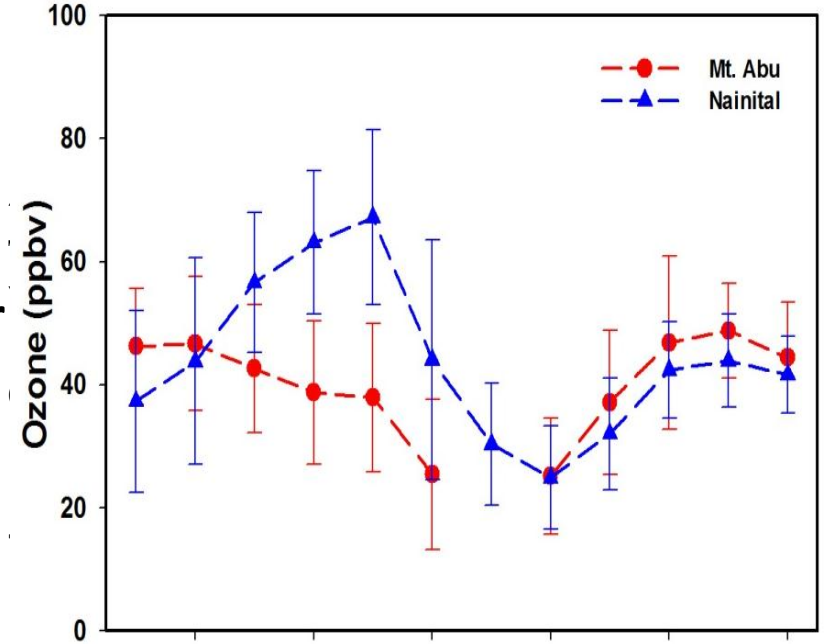
~ 5-10 ppbv
Local (Amd)
Contribution

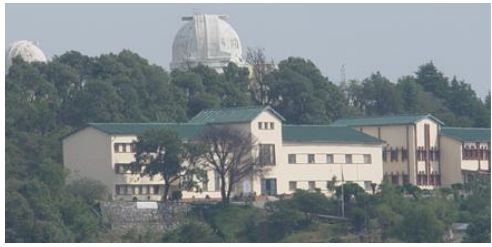
Ozone at Mt. Abu (24.6N, 72.7E) and Nainital (29.4N,79.4E)

Maximum ozone :

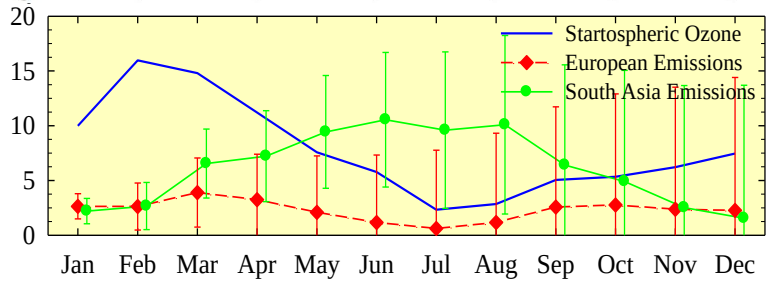
Mt. Abu - Autumn/Winter

Nainital - Spring/Summer





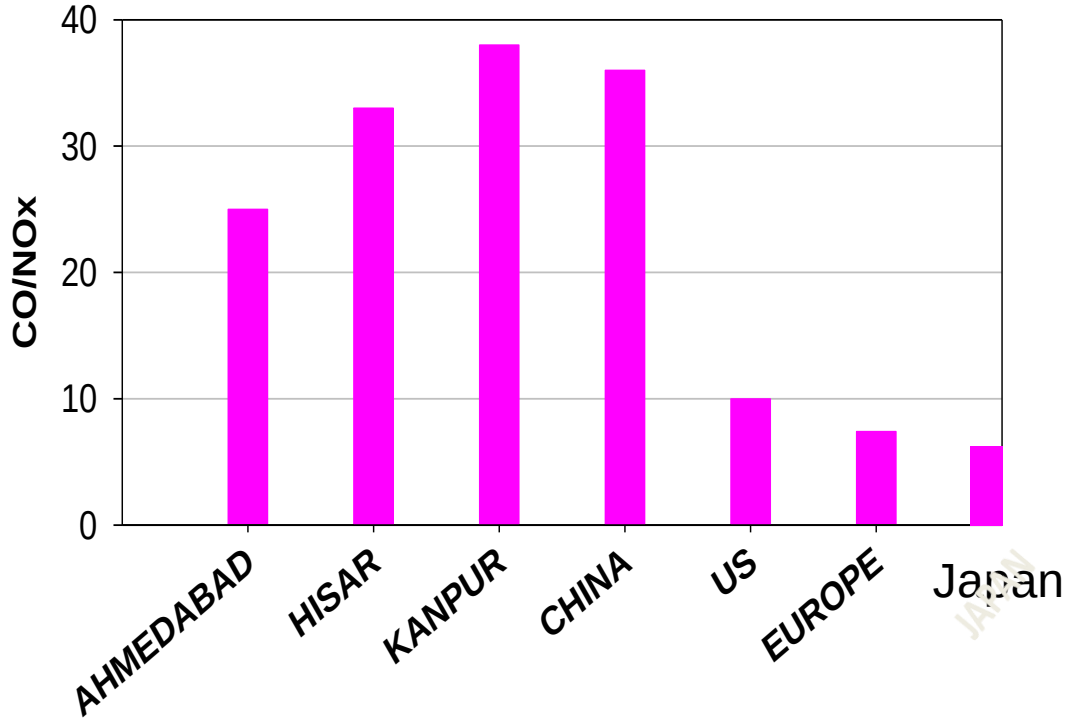
Model derived contributions (in ppbv) for Nainital .



Variations and levels of ozone and related trace gases are different over different parts of India suggesting diverse regional emission sources

Kumar et al., JGR, 2010

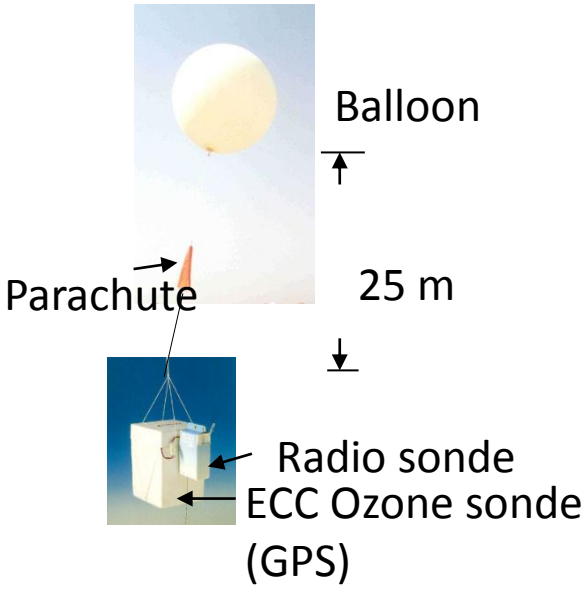
CO-NOx Relation

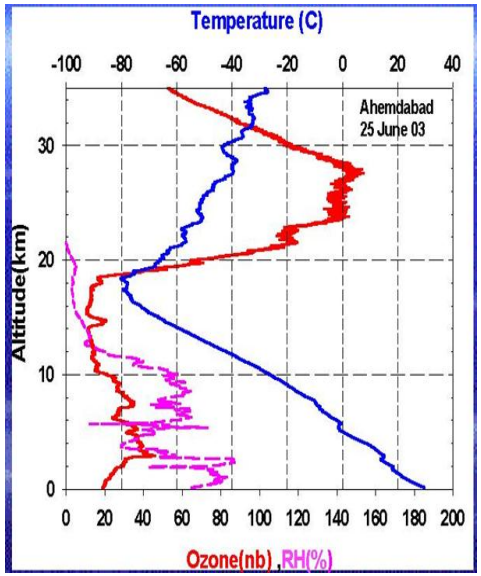


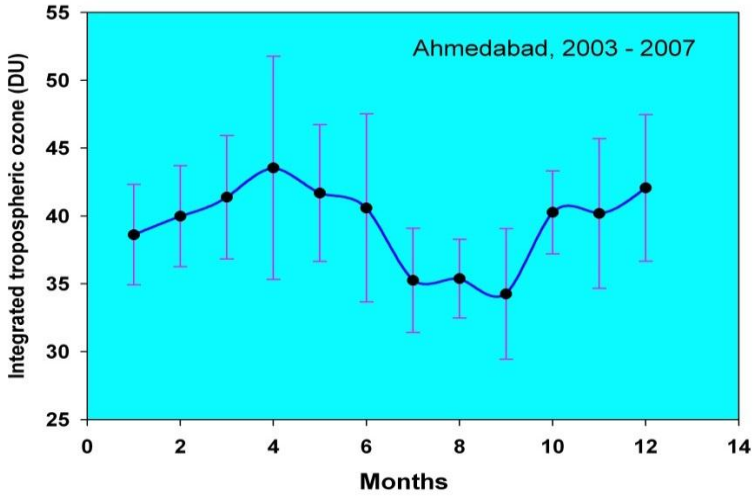
The slope (ΔCO/ΔNOx) is related to primary emission sources of these species. In high temperature combustion processes (e.g., use of fossil fuel in vehicles and power plants) these slope values are lower than those emitted from biofuel and biomass burning

These results indicate that emission from biofuel combustion and biomass burning play major role in the observed distributions of various trace gases in India.

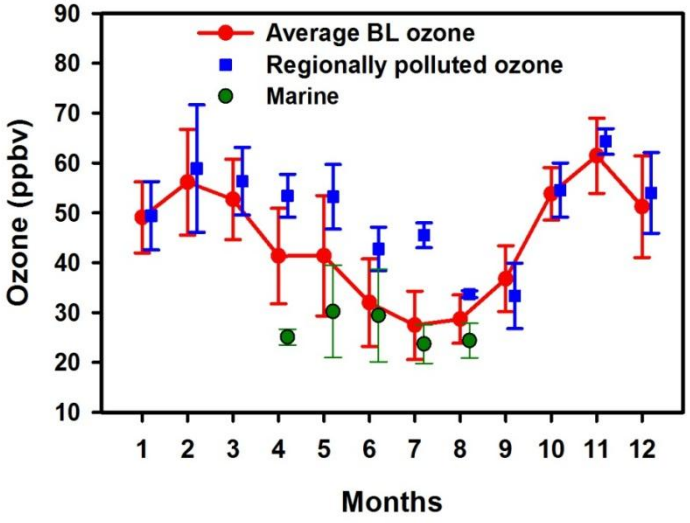
Vertical distribution of ozone over Ahmedabad (June 2003- July 2007)

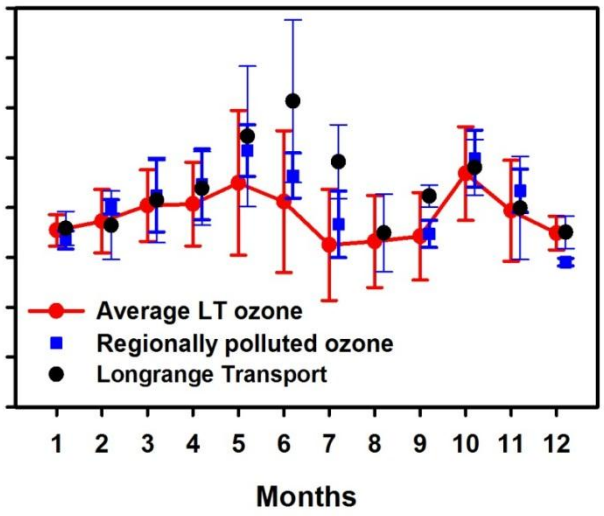






Total ~ 80 balloon flights





Effects of :

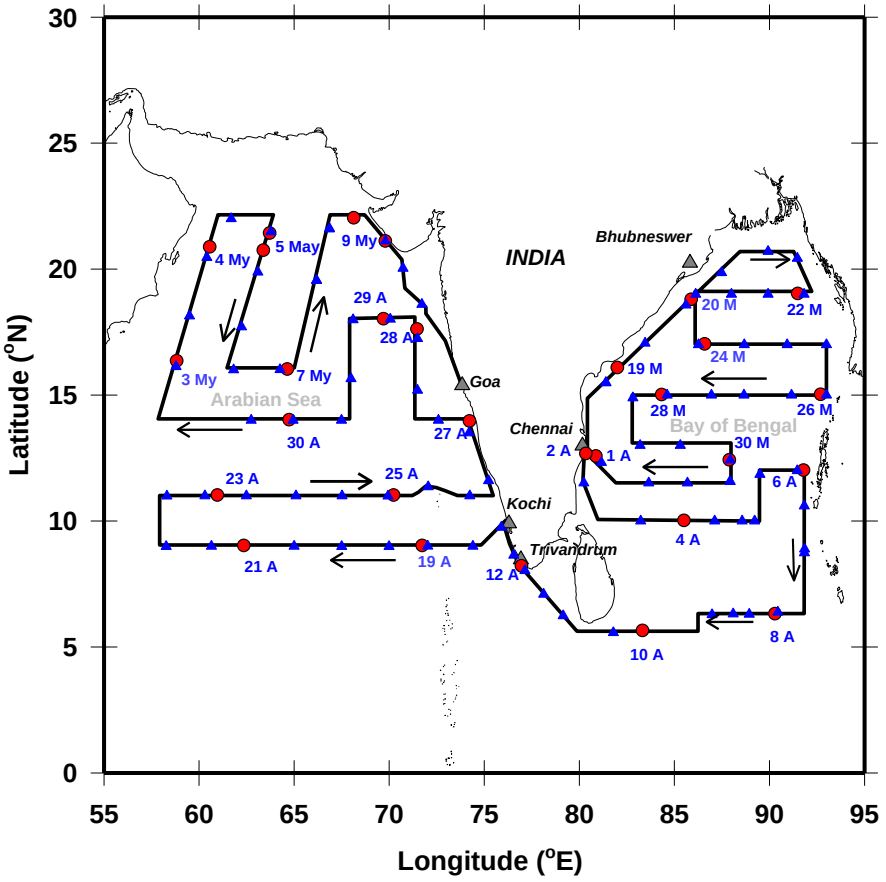
Regional Pollution -
Spring and summer seasons

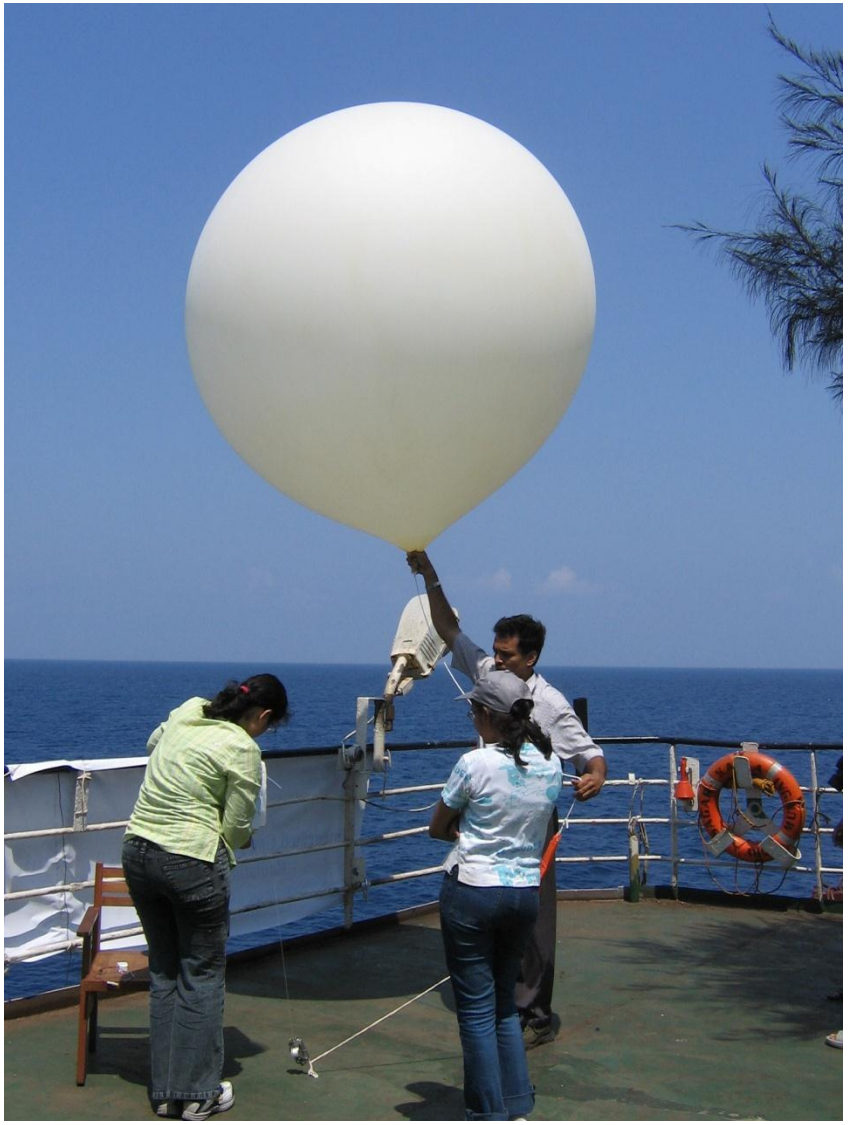
Longrange Transport –
Spring season in the free troposphere

Marine -
Monsoon season in the BL

Study of ozone and meteorological parameters over Bay of Bengal (BoB) and Arabian Sea (AS)

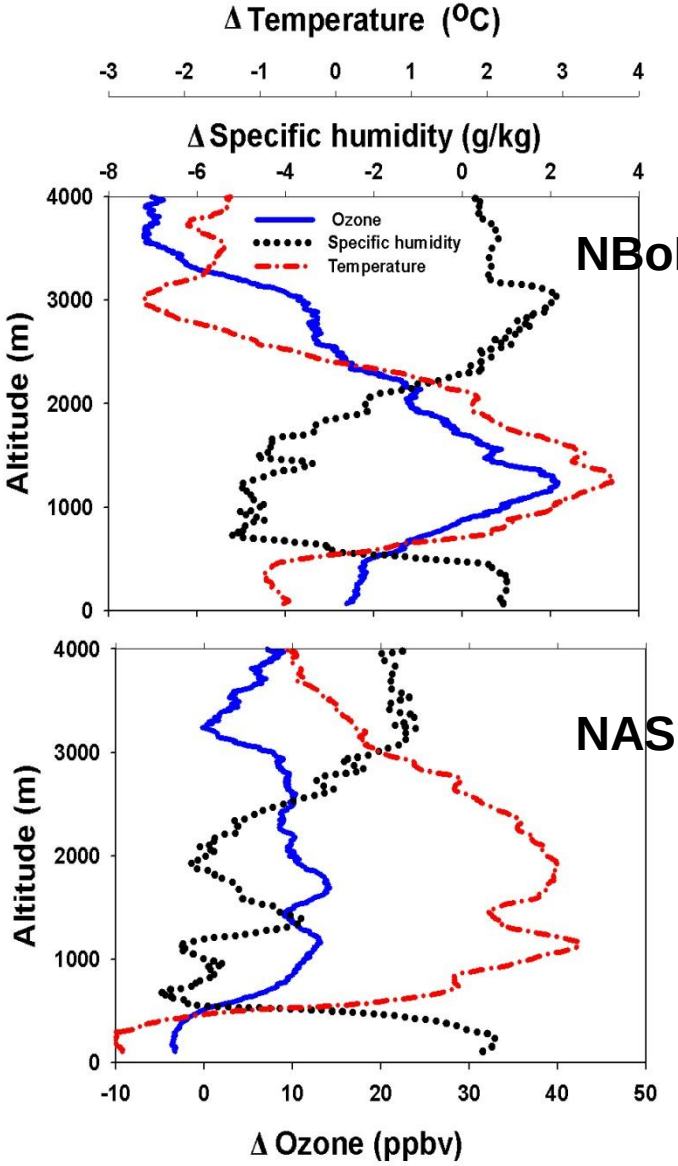
Integrated Campaign for Aerosols, gases and Radiation Budget (ICARB)

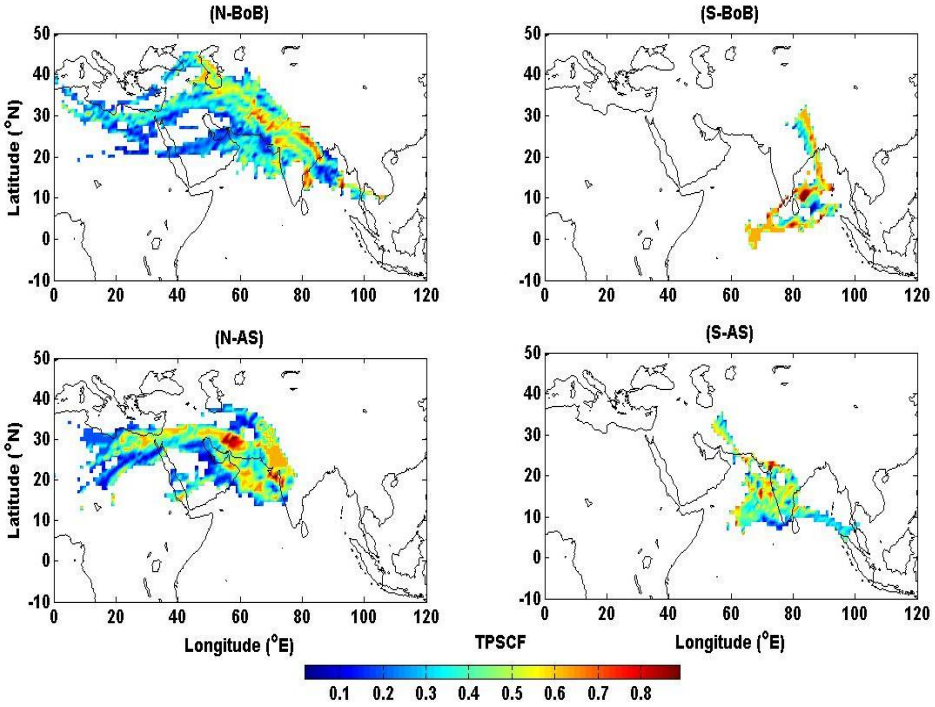




- Bay of Bengal (18 March to 13 April,06)
- Arabian Sea (18 April to 11 May,06)
- 29 Ozone and radio sondes

Intrusion of land plume over North Bay of Bengal (N-BoB) and North Arabian Sea (N-AS)- ICARB 2006





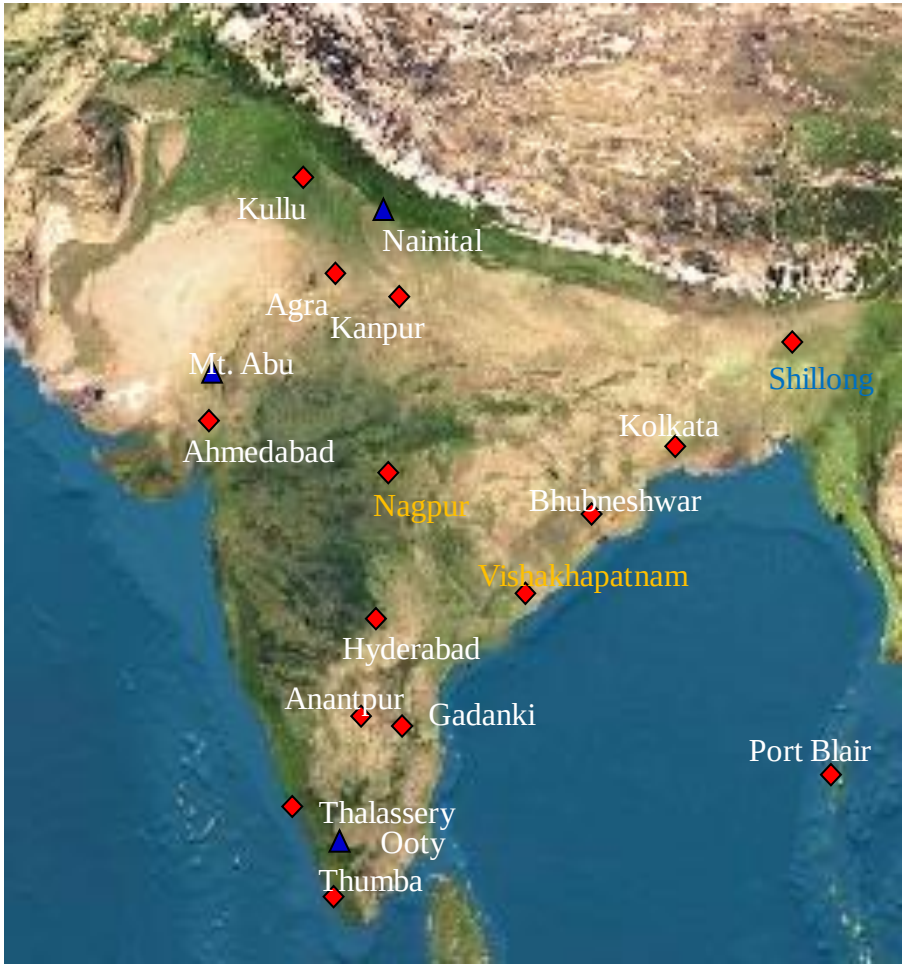
Potential Source Contribution Function (PSCF) analysis

Transport of ozone rich layer (60-90 ppbv) over N-BoB attributed to advection of air from Indo-Gangetic Plain.

Srivastava et al., JGR (in press)

Measurements of ozone and related trace gases in different regions :

A network of environmental observatories in India under ISRO GBP



Nainital
29.4N,79.4E
~2.0 km

Mt. Abu
24.6N,72.6E
~1.7 km

Ooty
11.4N,76.7E
~ 2.5 km

Summary :

- Tropical Asian region - a natural photochemical laboratory.
- Chemical changes are occurring due to rapid industrialization and economic growth.
- Emission characteristics and transport pathways differ from region to region and from season to season.
- Surrounding marine regions affected by transport for the continental polluted air.
- There is a need for understanding types of emission sources, their budgets and chemical and transport processes for predicting future changes in this region.

Thanks for your attention