Pronounced Changes in Water Vapor, Ozone and Meteorological Parameters Associated with Dust Storms Using Multi Sensor

Ramesh P. Singh, A.K. Prasad, Ritesh Gautam and Menas Kafatos

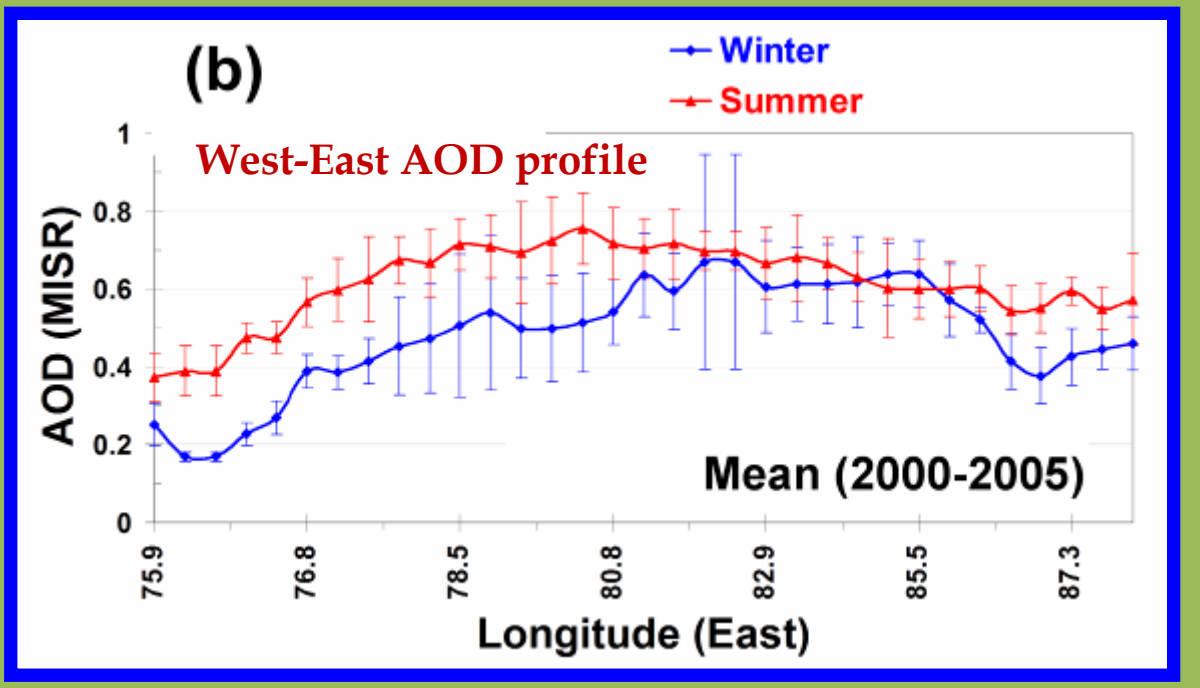
Center for Earth Observing and Space Research

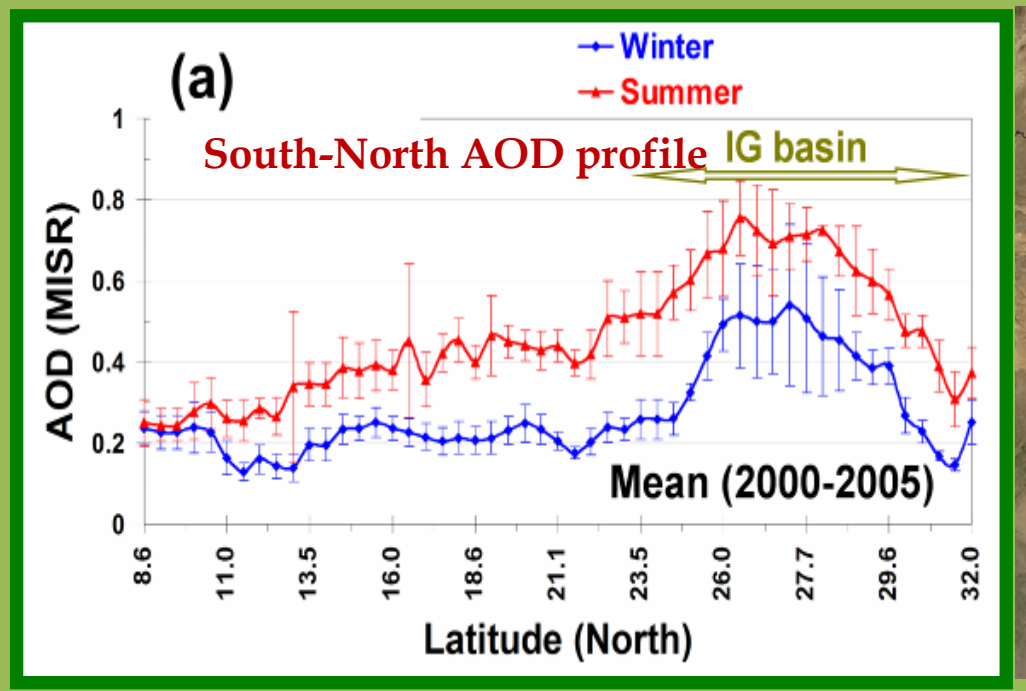
George Mason University

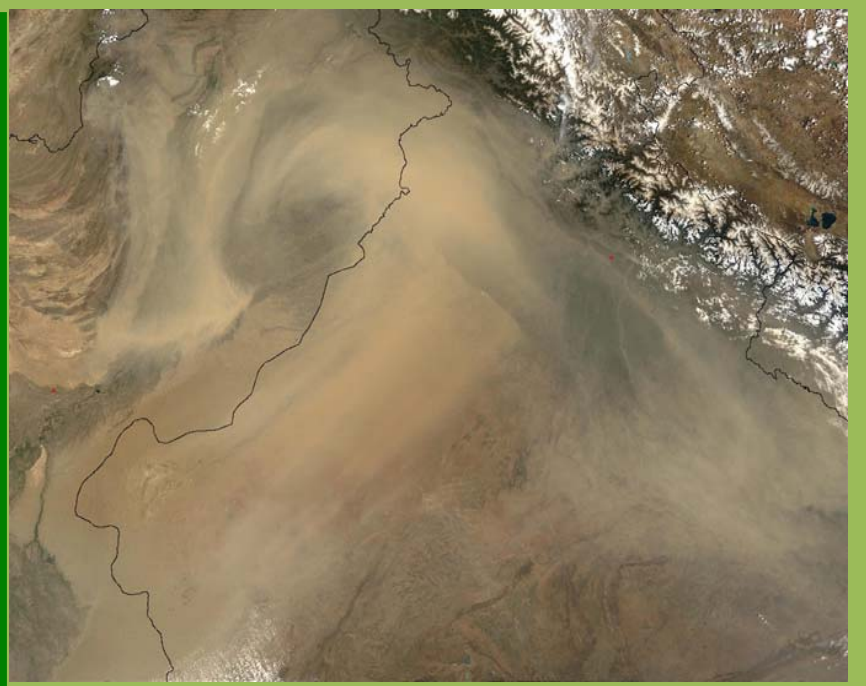
Fairfax, VA, USA

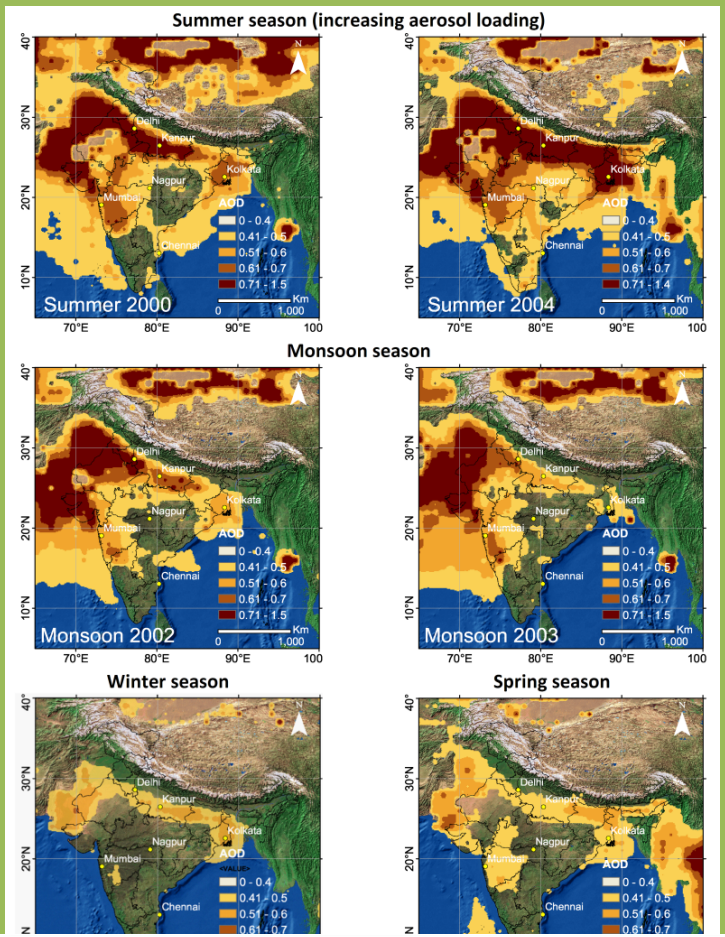
rsingh3@gmu.edu

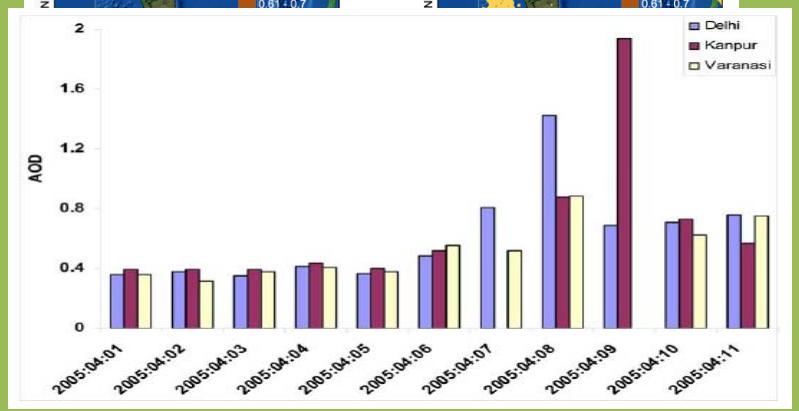

(d)
A-B
A'-B'
A''-B'
Cities
IG (Ganga) basin
A
A''
A'
B
B'
Delhi
Kanpur
Kolkata
Nagpur
Mumbai
Chennai
Profile path
Km
0
1,100
70°E
80°E
90°E
30°N
20°N
10°N

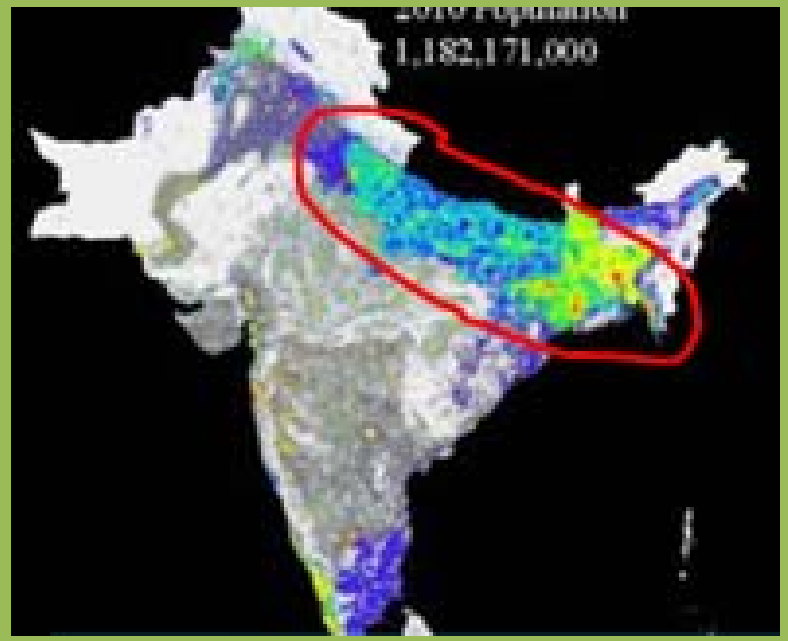

(b)
Winter
Summer
West-East AOD profile
AOD (MISR)
Mean (2000-2005)
Longitude (East)
75.9
76.8
78.5
80.8
82.9
85.5
87.3


(a)
Winter
Summer
South-North AOD profile
IG basin
AOD (MISR)
Mean (2000-2005)
Latitude (North)
8.6
11.0
13.5
16.0
18.6
21.1
23.5
26.0
27.7
29.6
32.0




Summer season (increasing aerosol loading)
Summer 2000
Summer 2004
Monsoon season
Monsoon 2002
Monsoon 2003
Winter season
Spring season
AOD
0 - 0.4
0.41 - 0.5
0.51 - 0.6
0.61 - 0.7
0.71 - 1.5
Km
0
1,000
Delhi
Kanpur
Nagpur
Kolkata
Mumbai
Chennai
70°E
80°E
90°E
100
10°N
20°N
30°N
40°


Delhi
Kanpur
Varanasi
AOD
2
1.6
1.2
0.8
0.4
0
2005-04-01
2005-04-02
2005-04-03
2005-04-04
2005-04-05
2005-04-06
2005-04-07
2005-04-08
2005-04-09
2005-04-10
2005-04-11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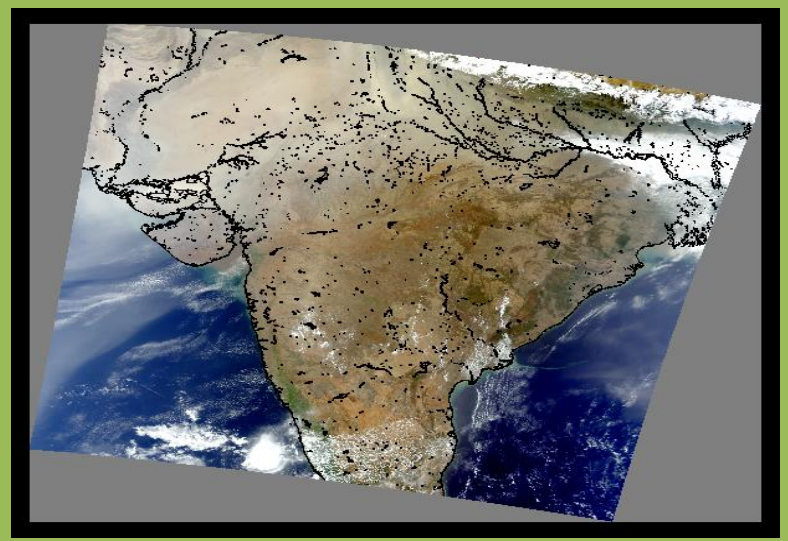
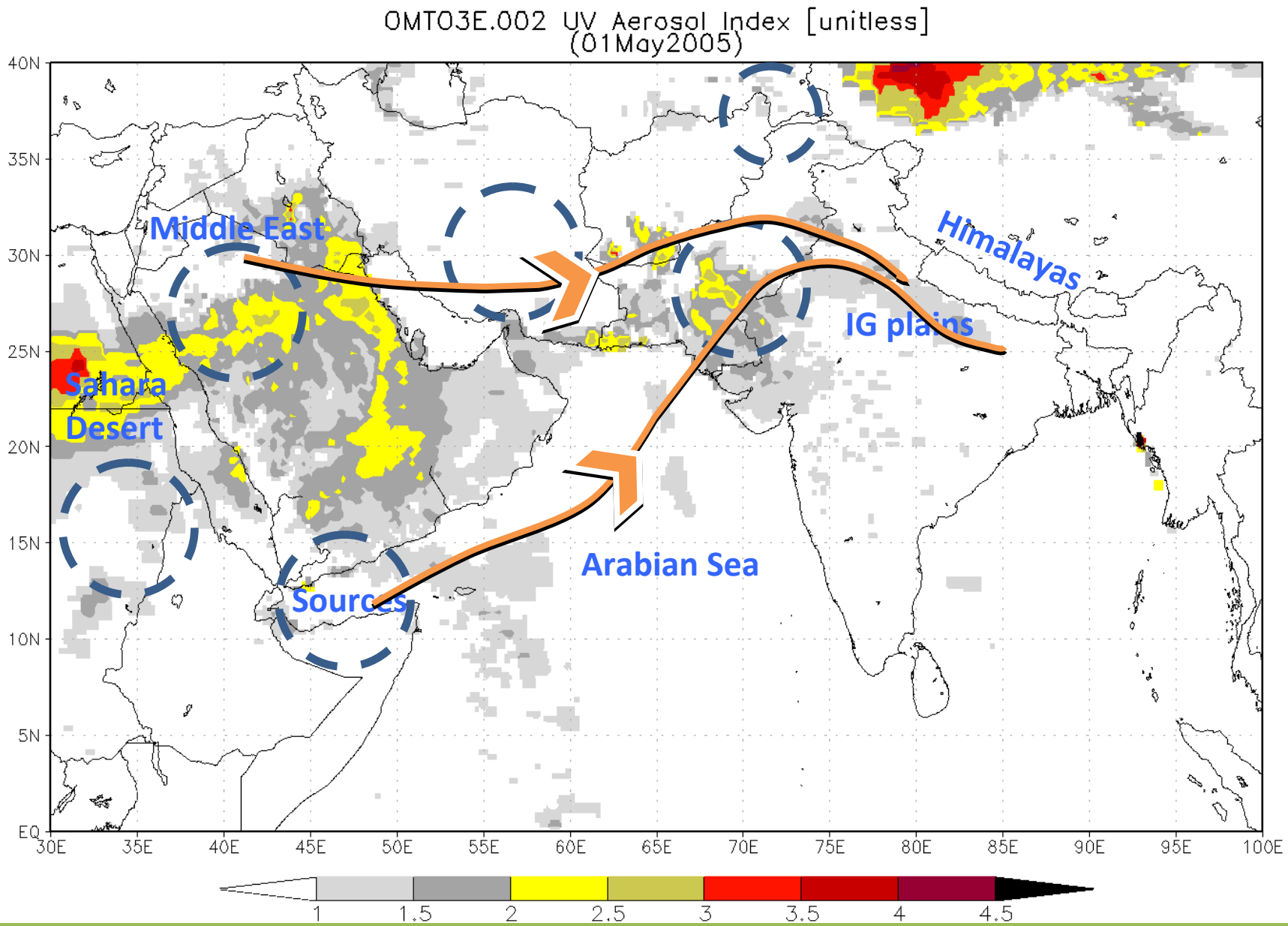
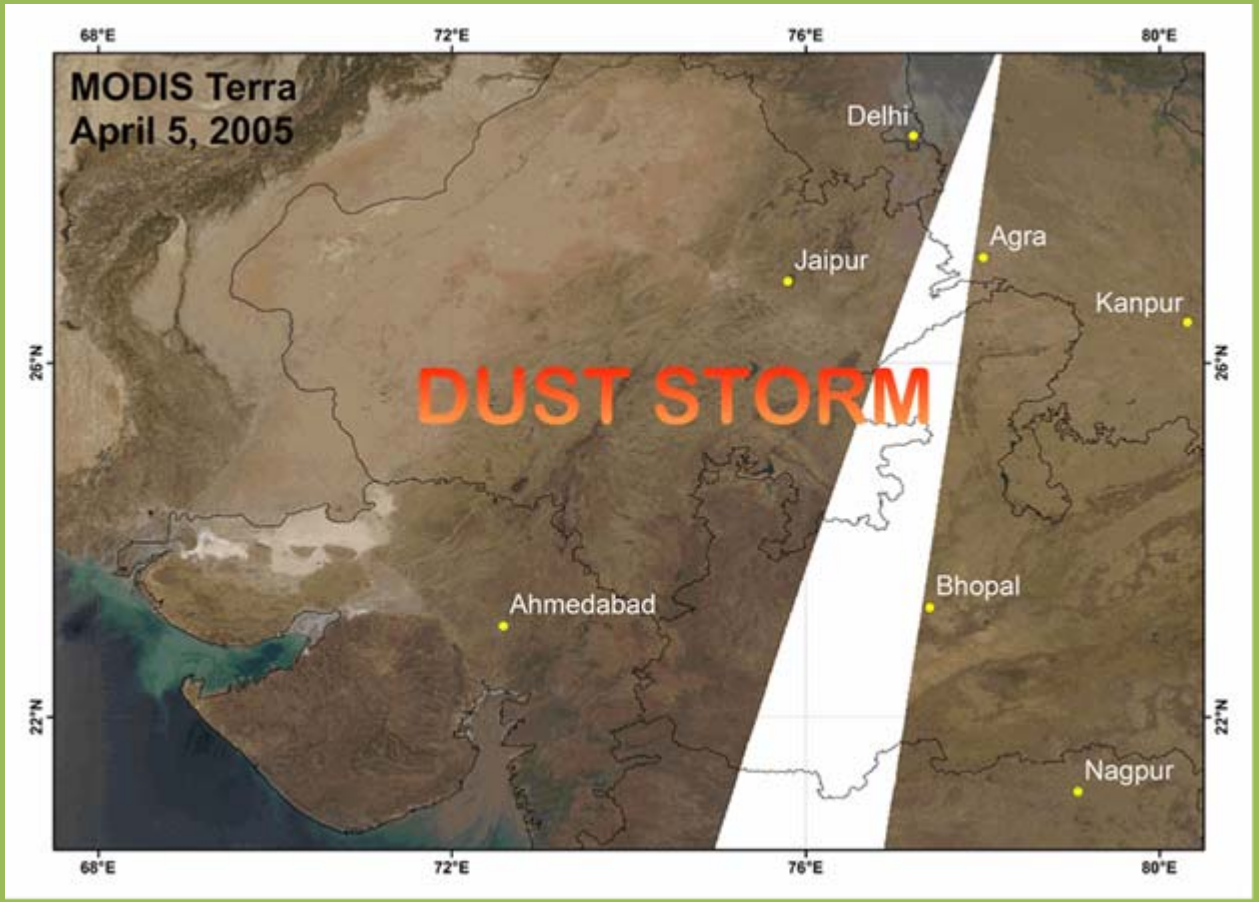


Dust storms (May 7-8-9, 2005)

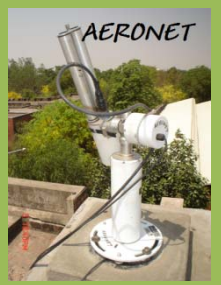


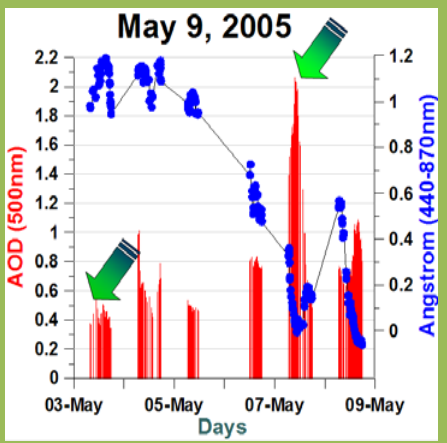
Dust Storms

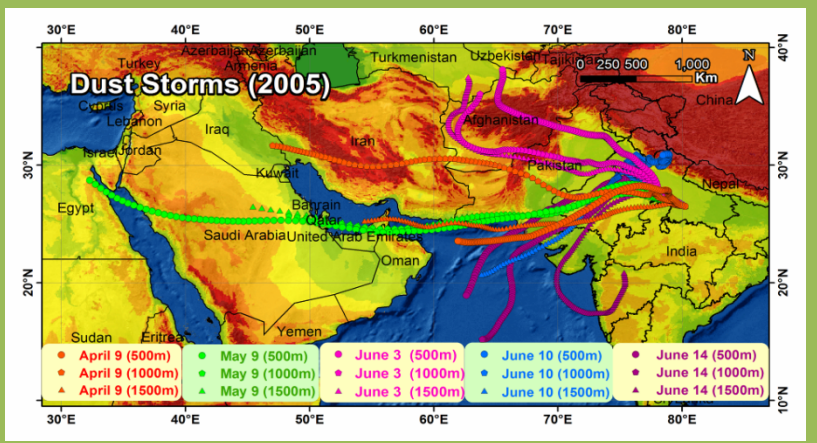
Satellite (daily)
MODIS Terra and Aqua)



Ground based
CIMEL
Sun-photometer

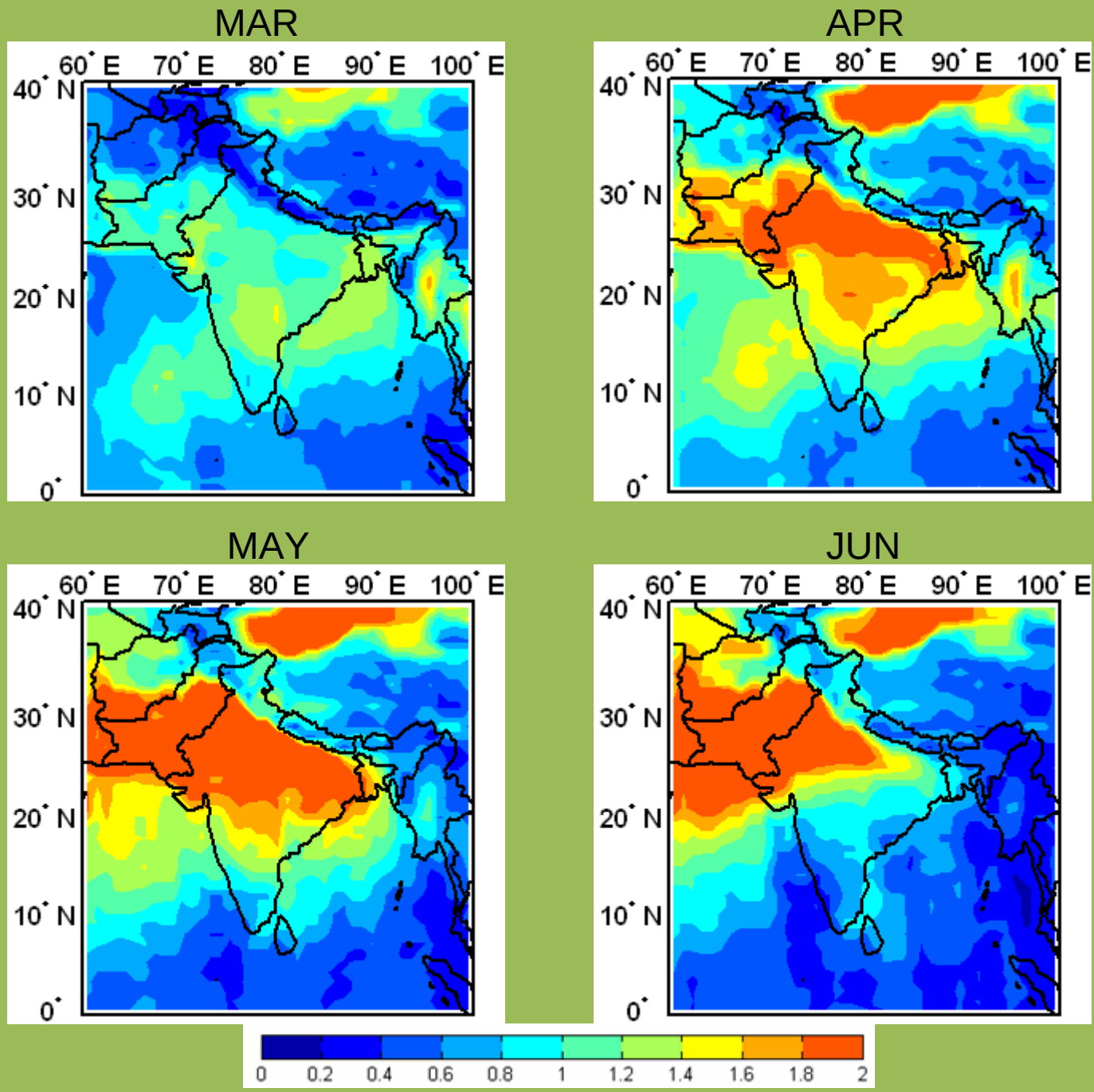




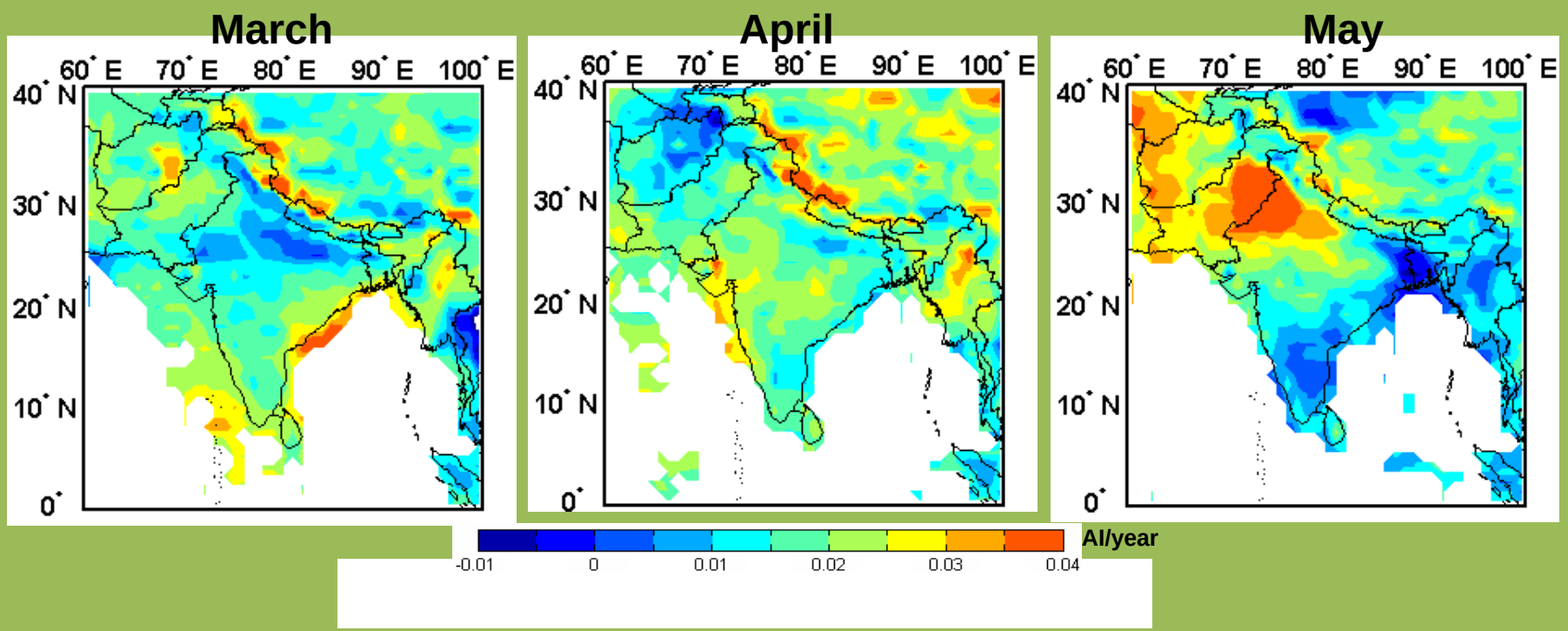


Climatology
TOMS AI

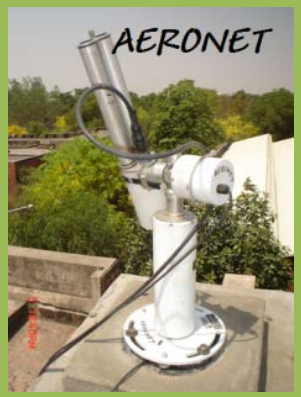
1997-2004

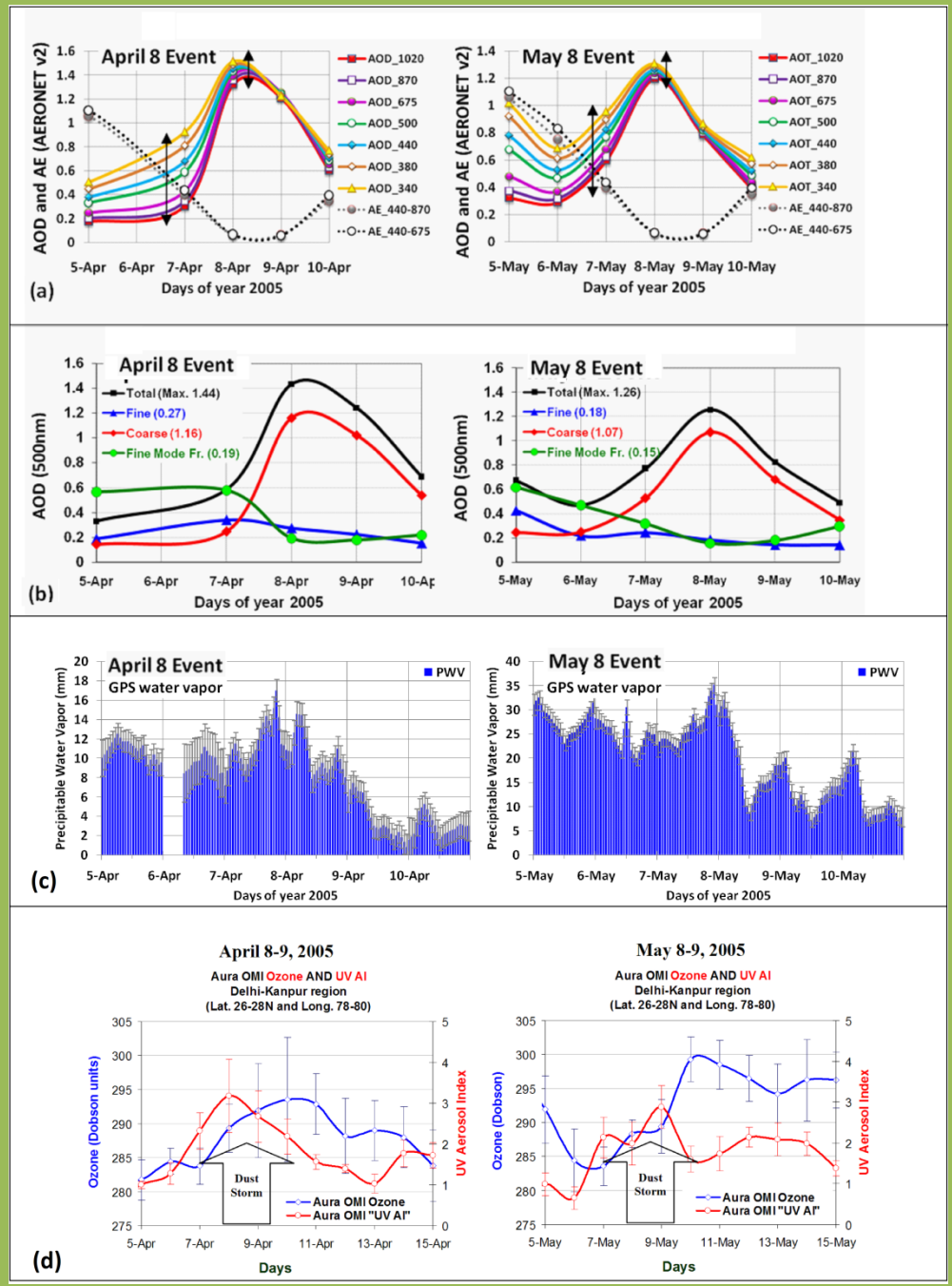


TOMS AI Trend 1979-2001

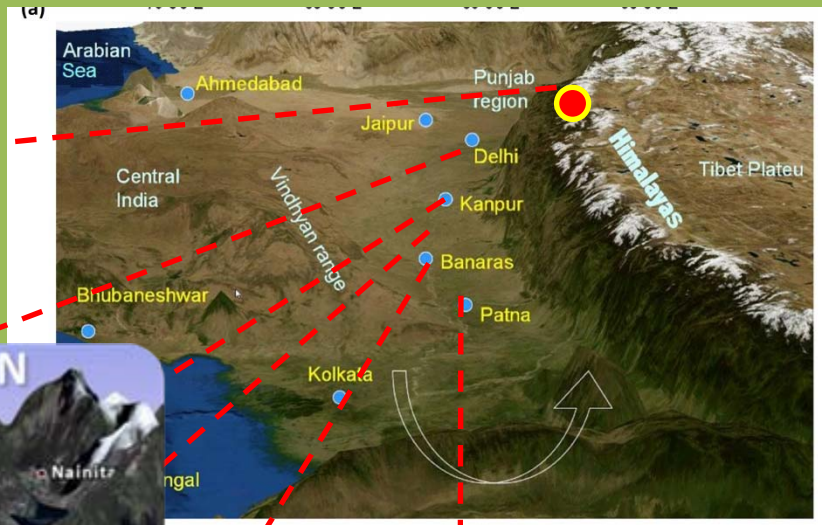


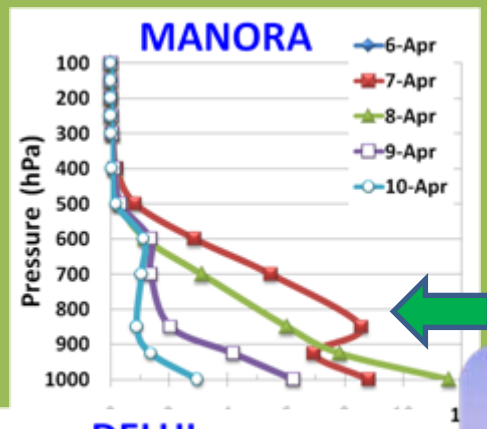
AERONET

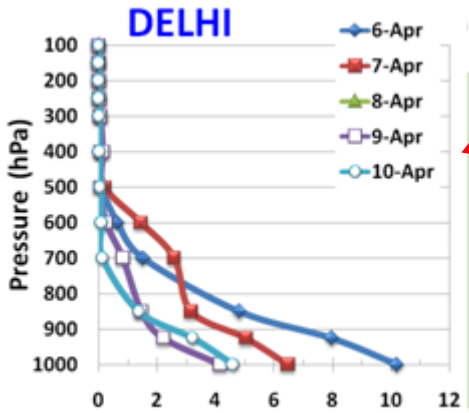

AERONET

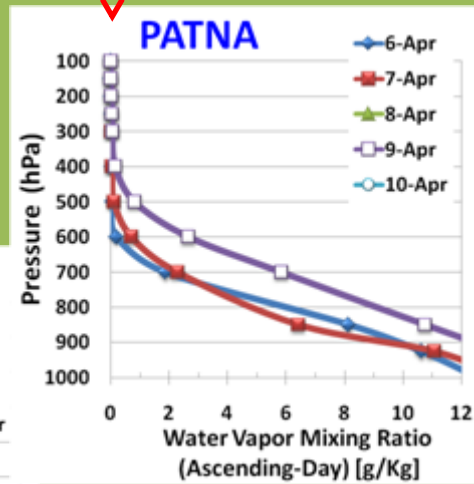

April 8 Event
May 8 Event
AOD and AE (AERONET v2)
AOD_1020
AOD_870
AOD_675
AOD_500
AOD_440
AOD_380
AOD_340
AE_440-870
AE_440-675
AOT_1020
AOT_870
AOT_675
AOT_500
AOT_440
AOT_380
AOT_340
Days of year 2005
(a)
AOD (500nm)
Total (Max. 1.44)
Fine (0.27)
Coarse (1.16)
Fine Mode Fr. (0.19)
Total (Max. 1.26)
Fine (0.18)
Coarse (1.07)
Fine Mode Fr. (0.15)
(b)
GPS water vapor
PWV
Precipitable Water Vapor (mm)
(c)
April 8-9, 2005
May 8-9, 2005
Aura OMI Ozone AND UV AI
Delhi-Kanpur region
(Lat. 26-28N and Long. 78-80)
Ozone (Dobson units)
Ozone (Dobson)
UV Aerosol Index
Dust Storm
Aura OMI Ozone
Aura OMI "UV AI"
Days
(d)

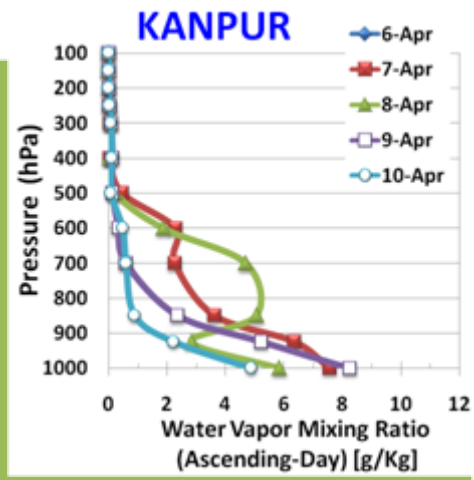
Dust storm and AIRS – Water Vapor Mixing Ratio (g/Kg)

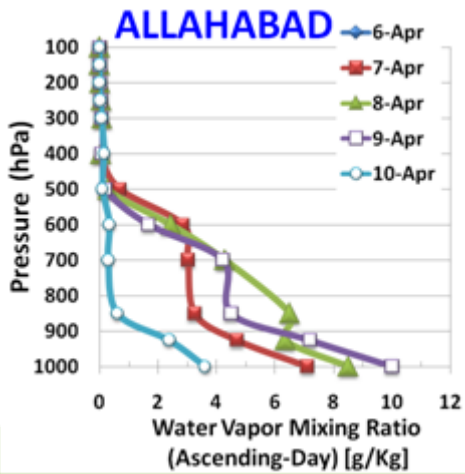


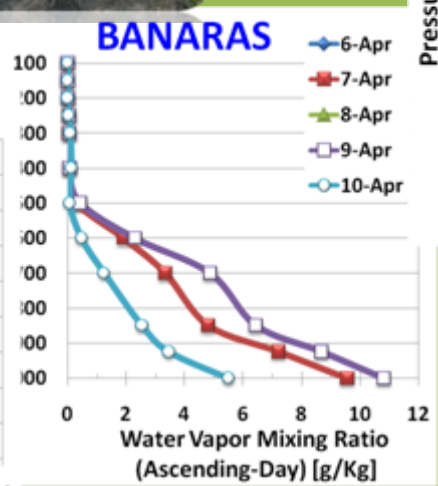








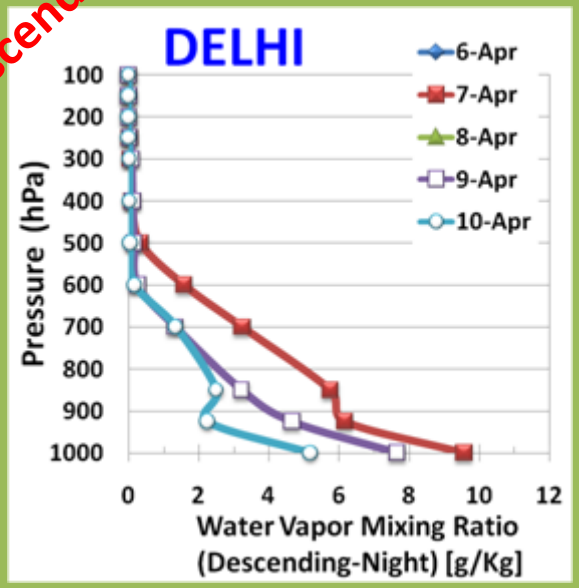


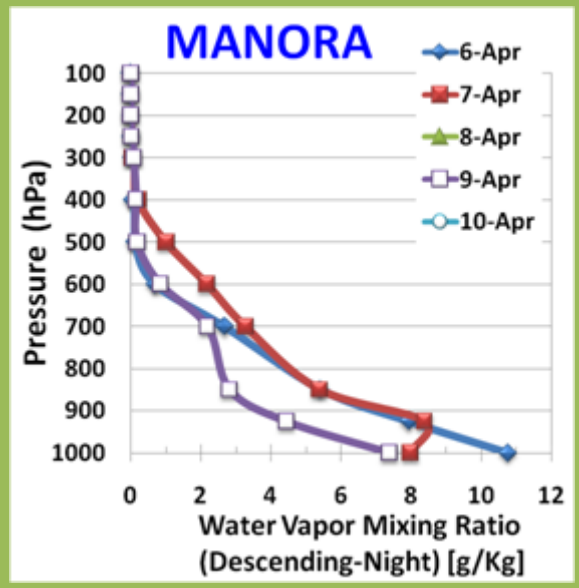


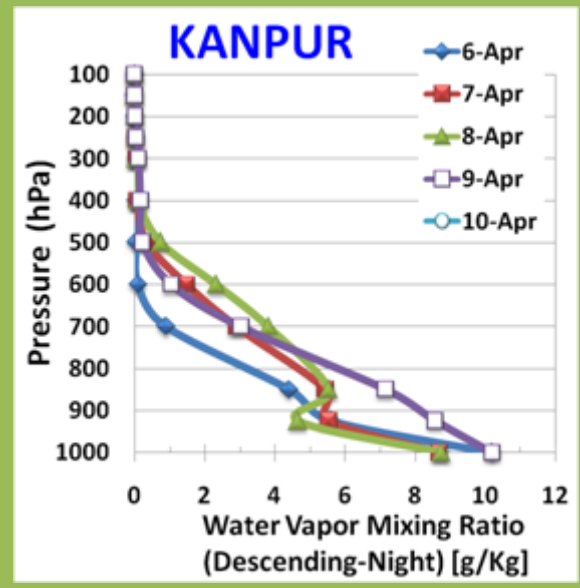
Ascending - Day

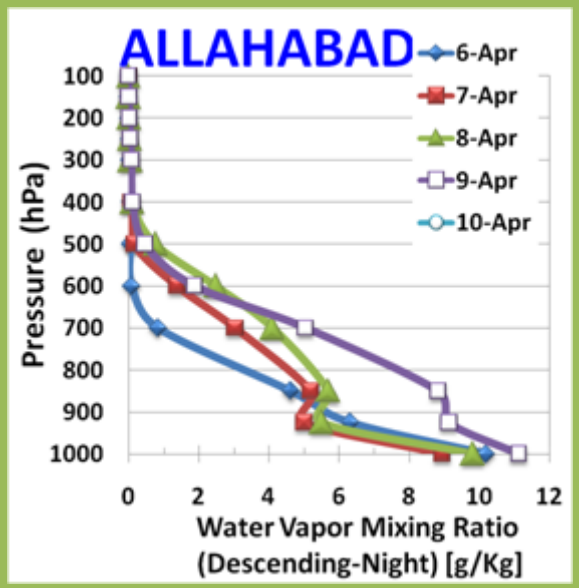
Descending - Night

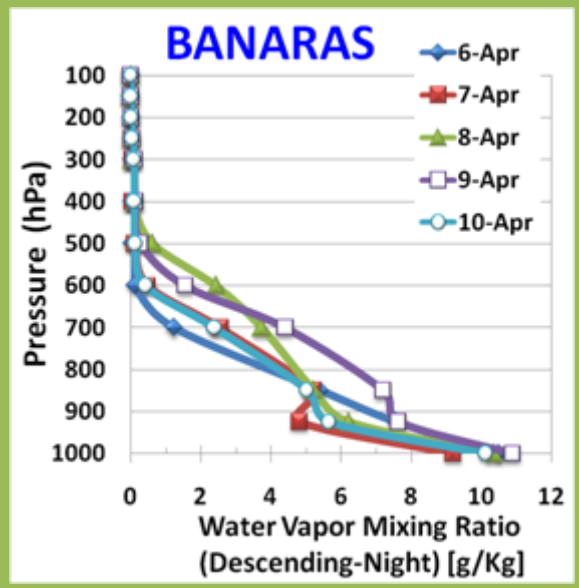
AIRS – Water Vapor Mixing Ratio (g/Kg)

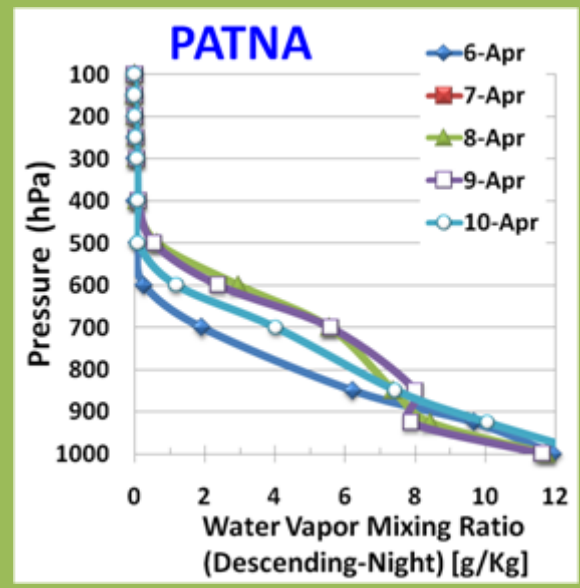






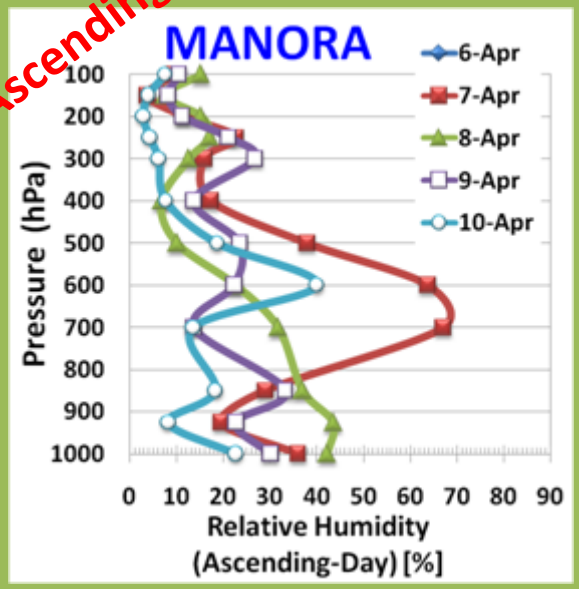


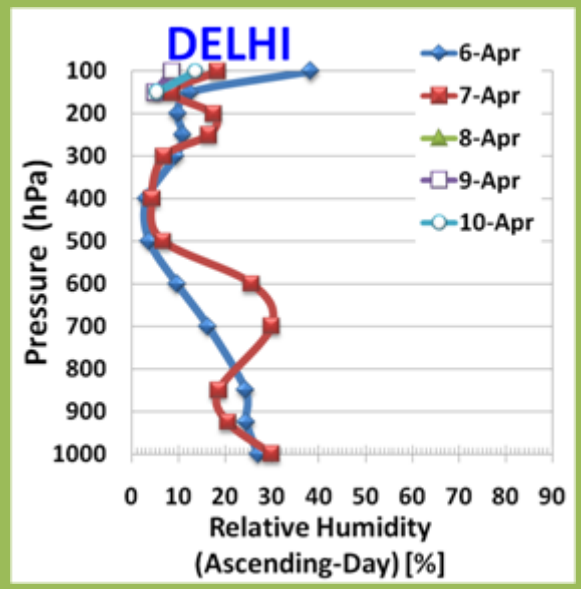


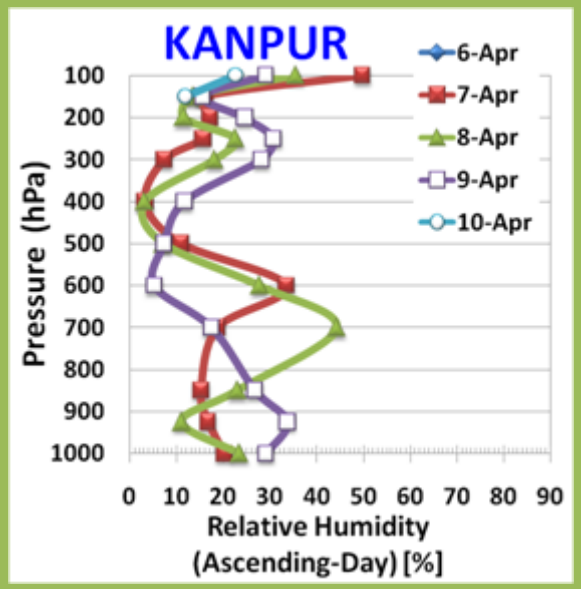


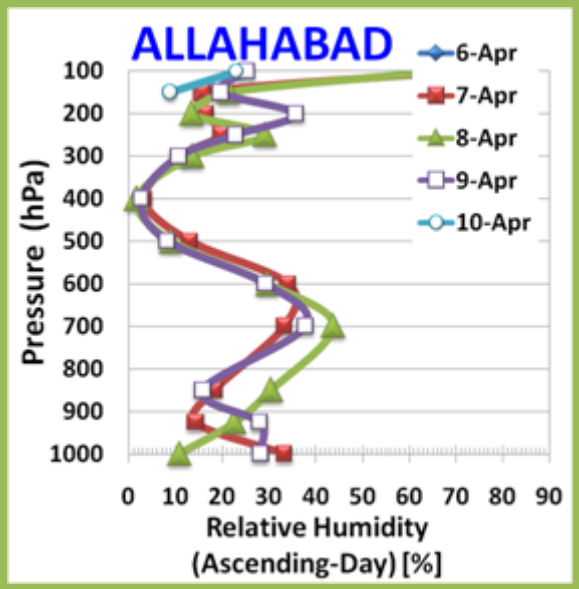
AIRS – Relative Humidity (%)

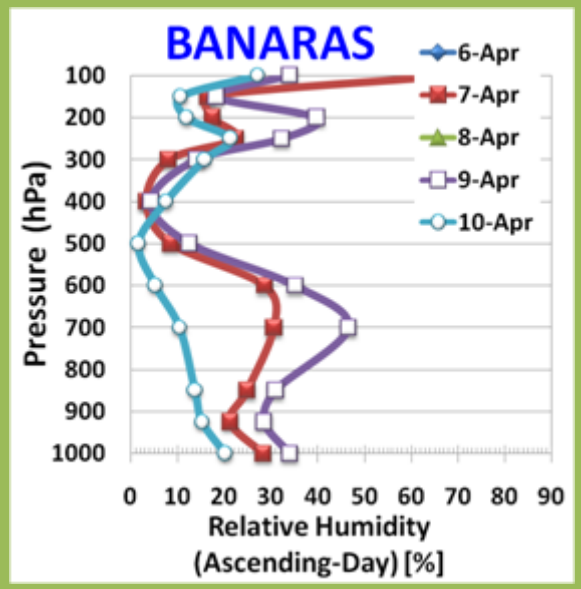
Ascending - Day

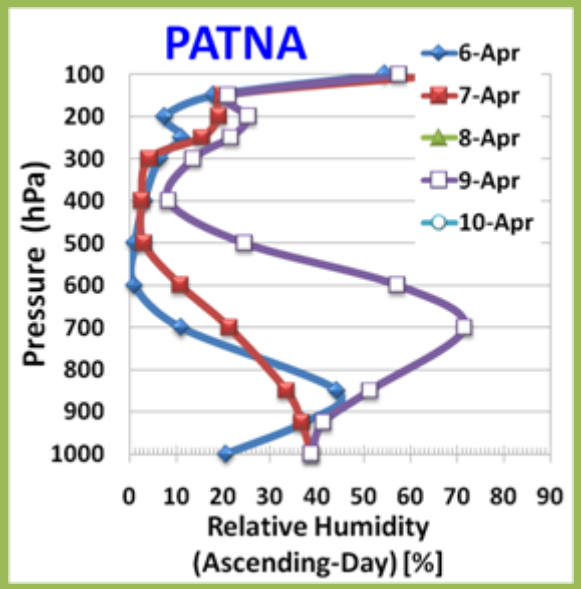






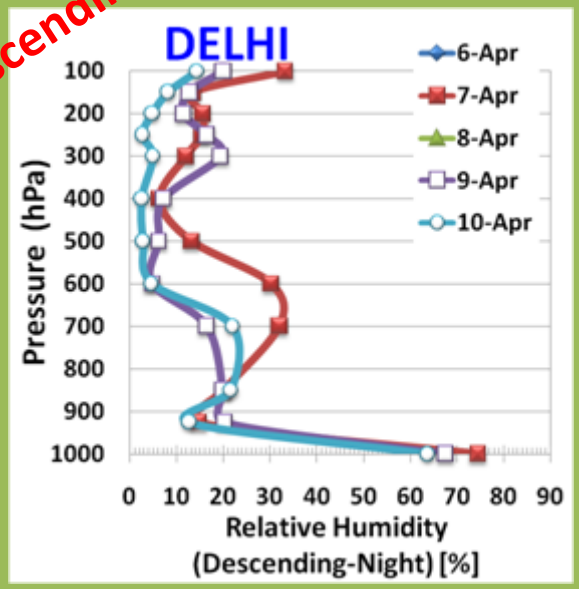


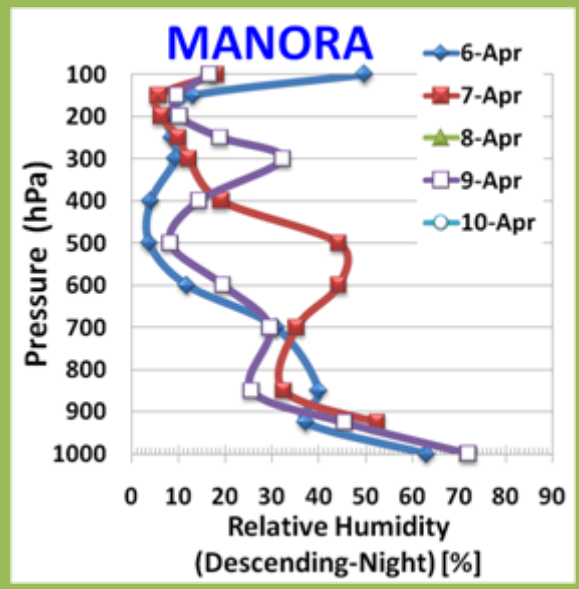


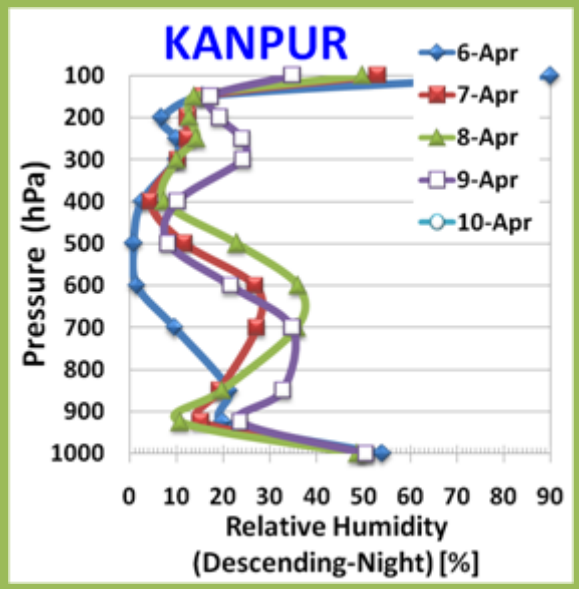


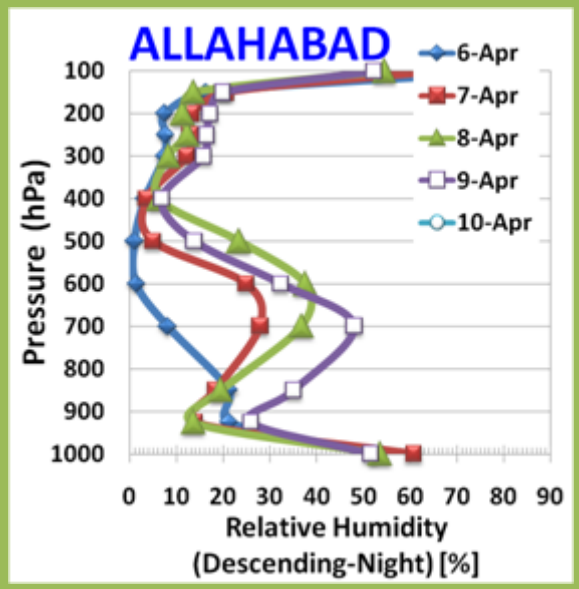
Descending - Night

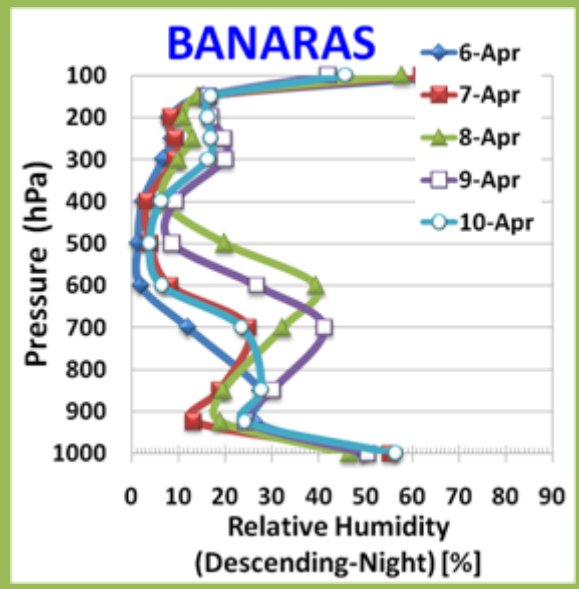
AIRS – Relative Humidity (%)

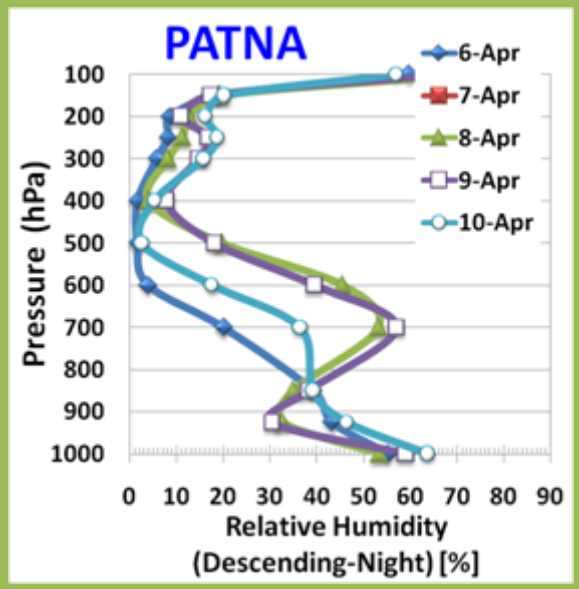






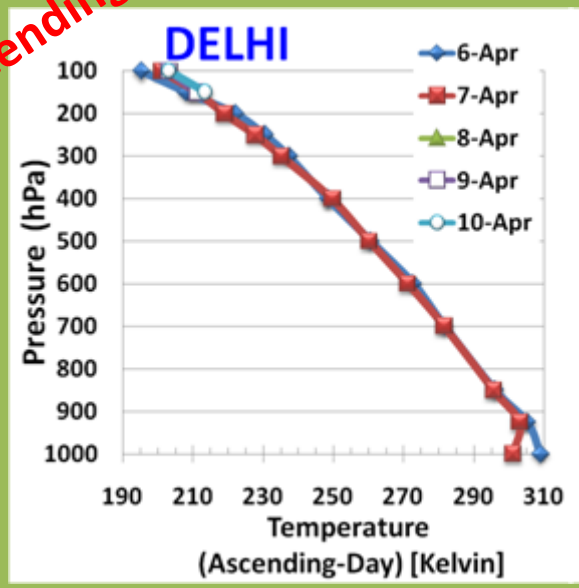


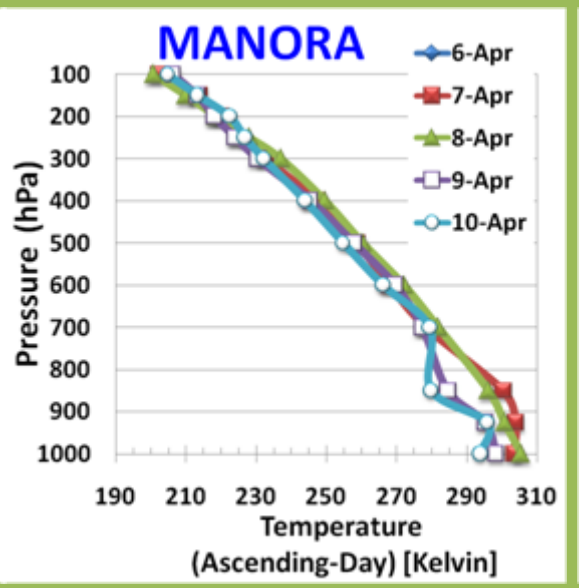


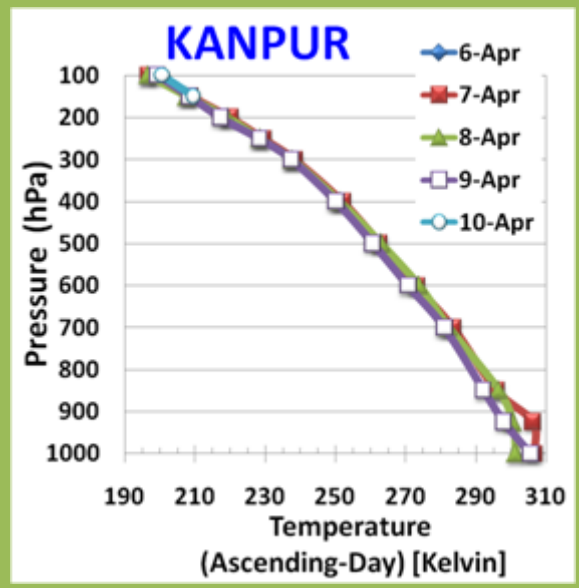


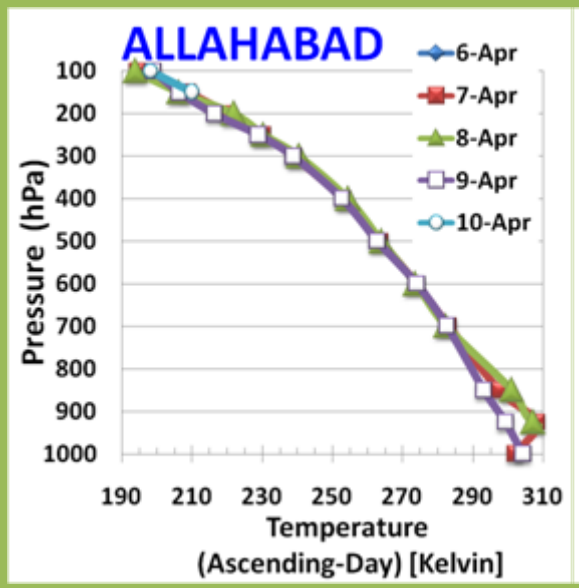
AIRS – Temperature (Kelvin)

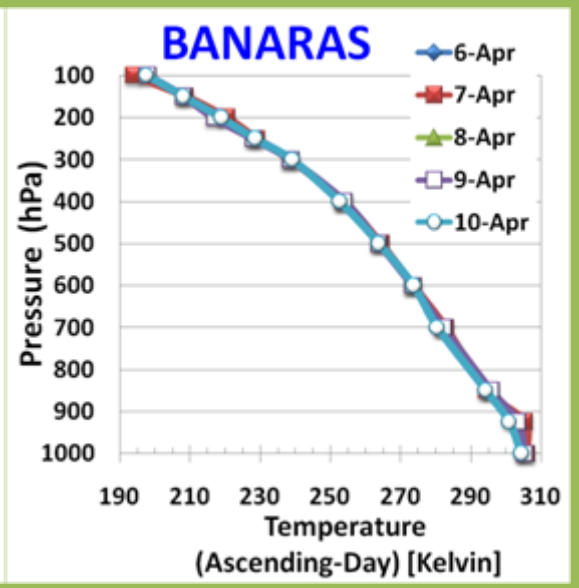
Ascending - Day

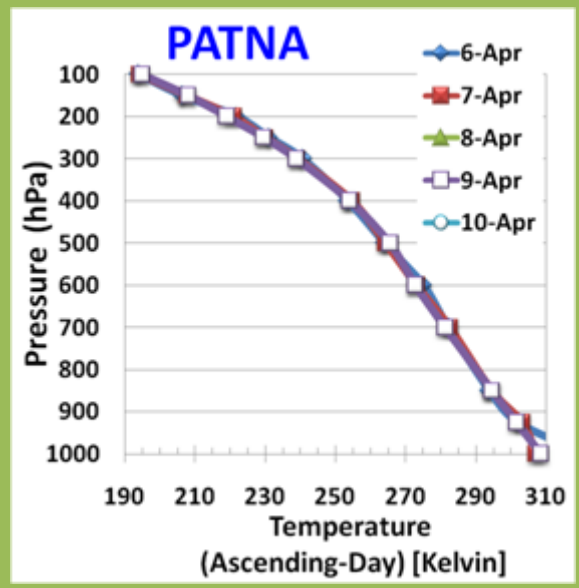






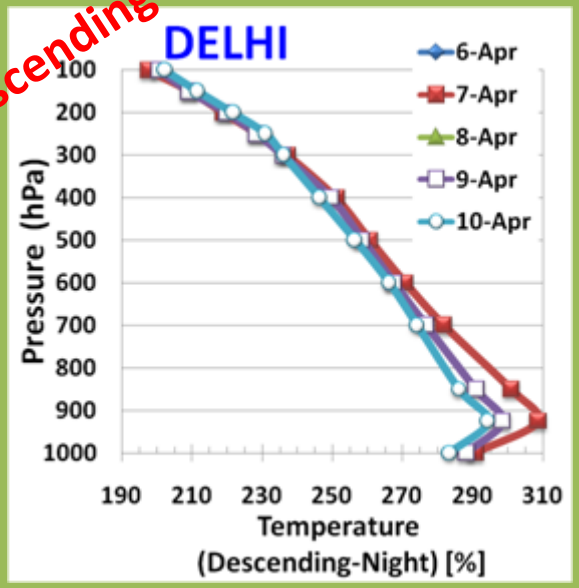


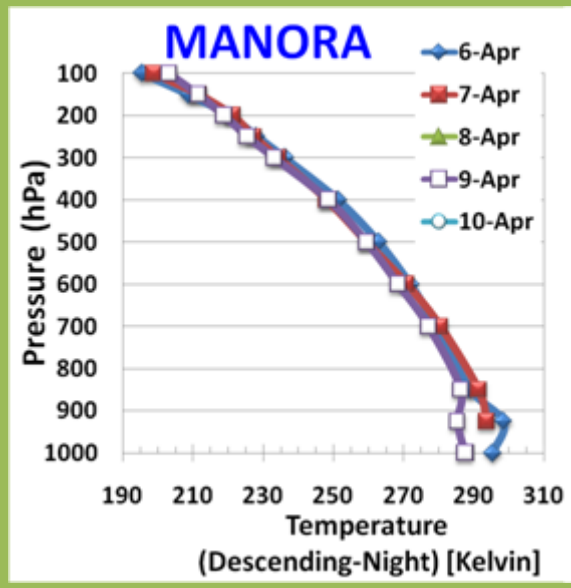


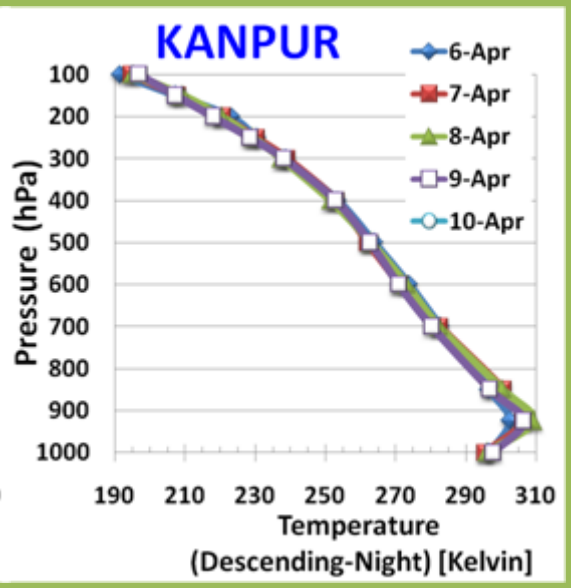


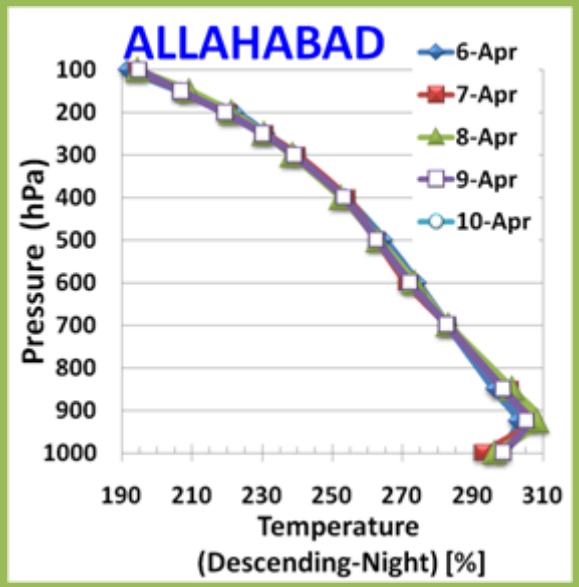
AIRS – Temperature (Kelvin)

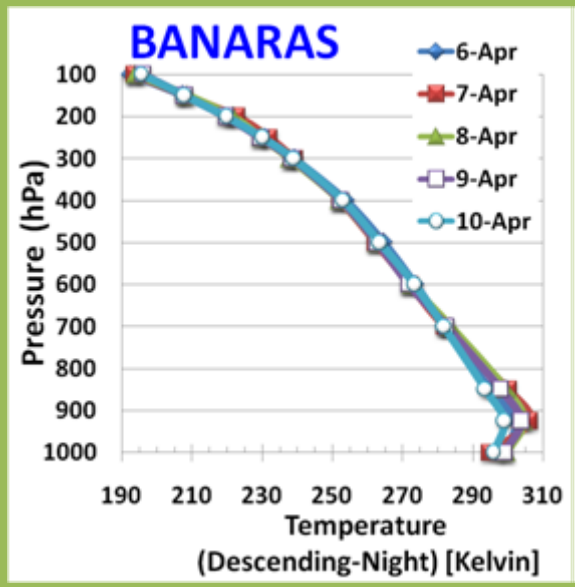
Descending - Night

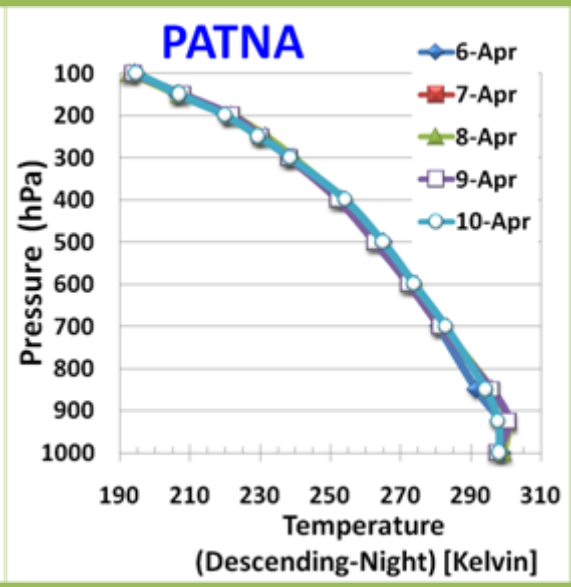


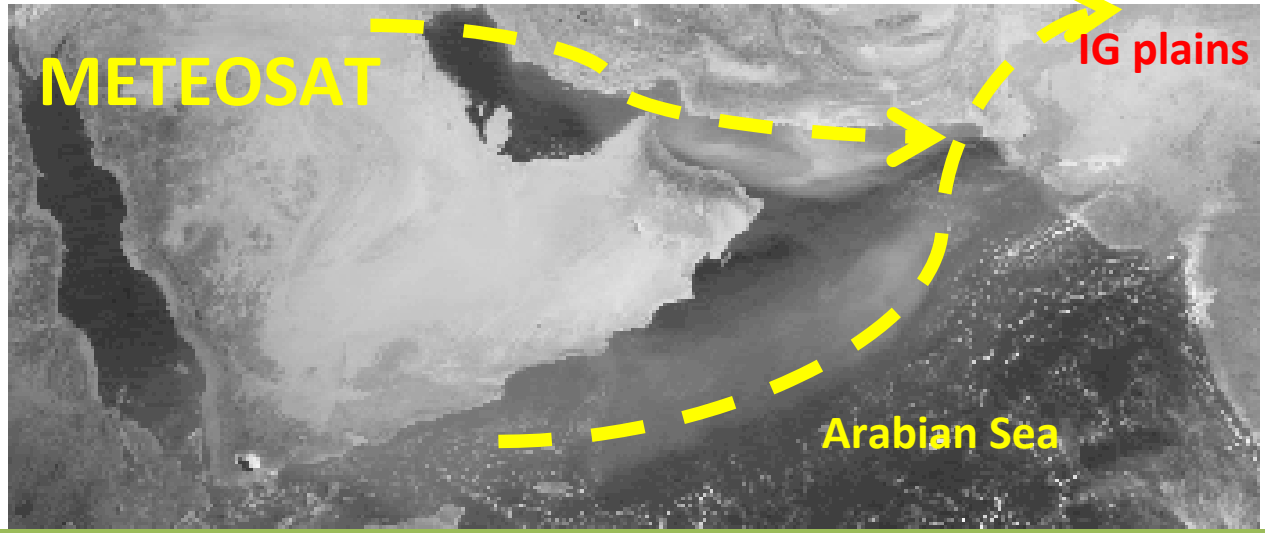






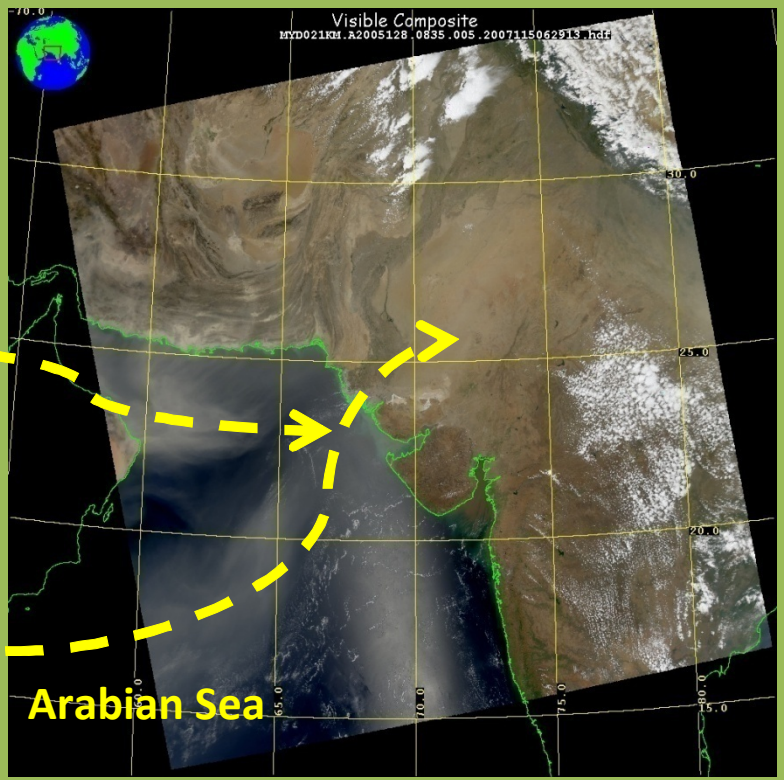


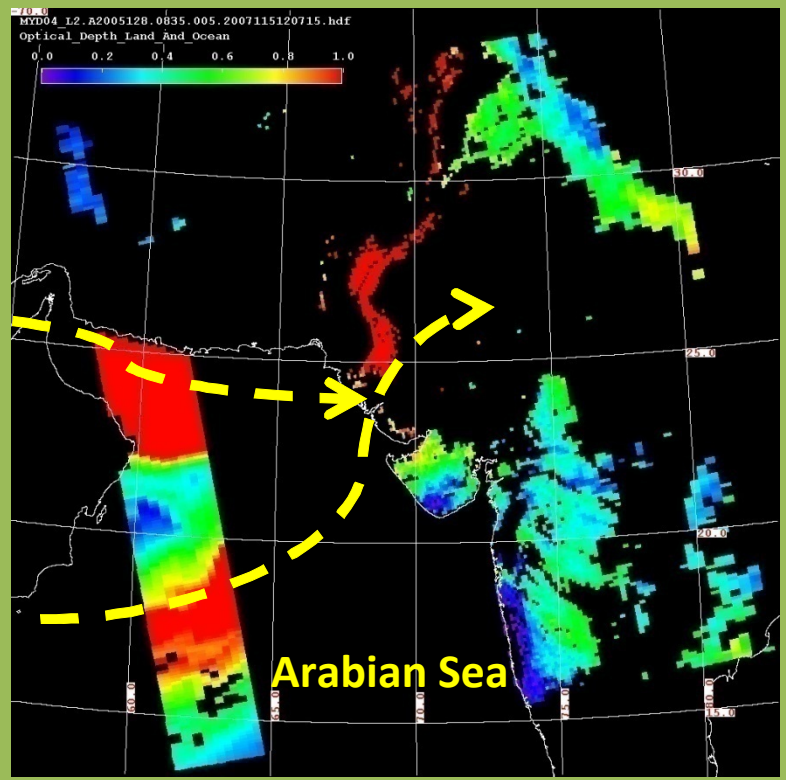




Path of Dust storm

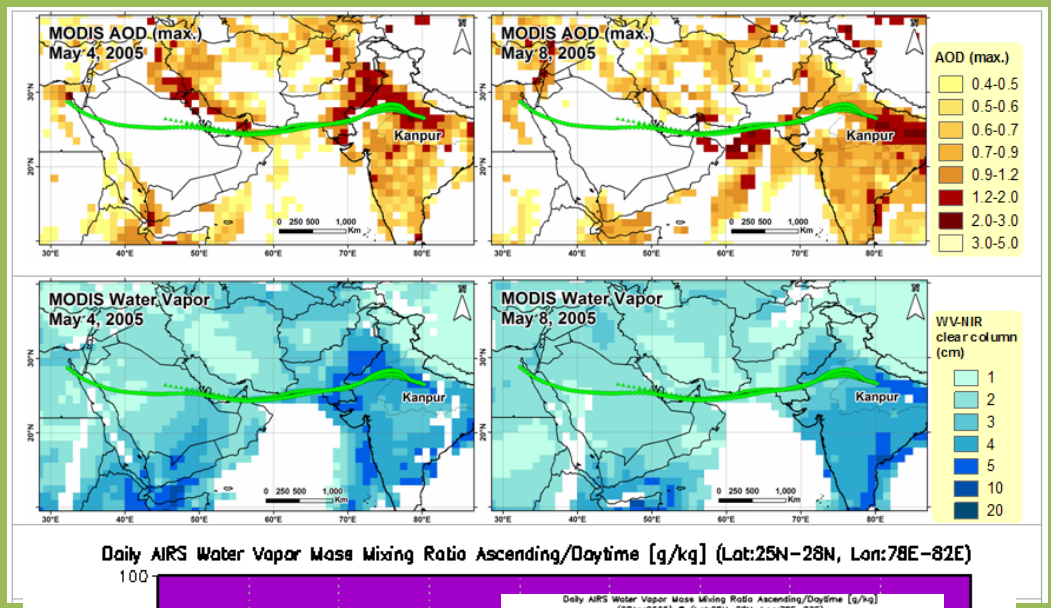
May 8, 2005

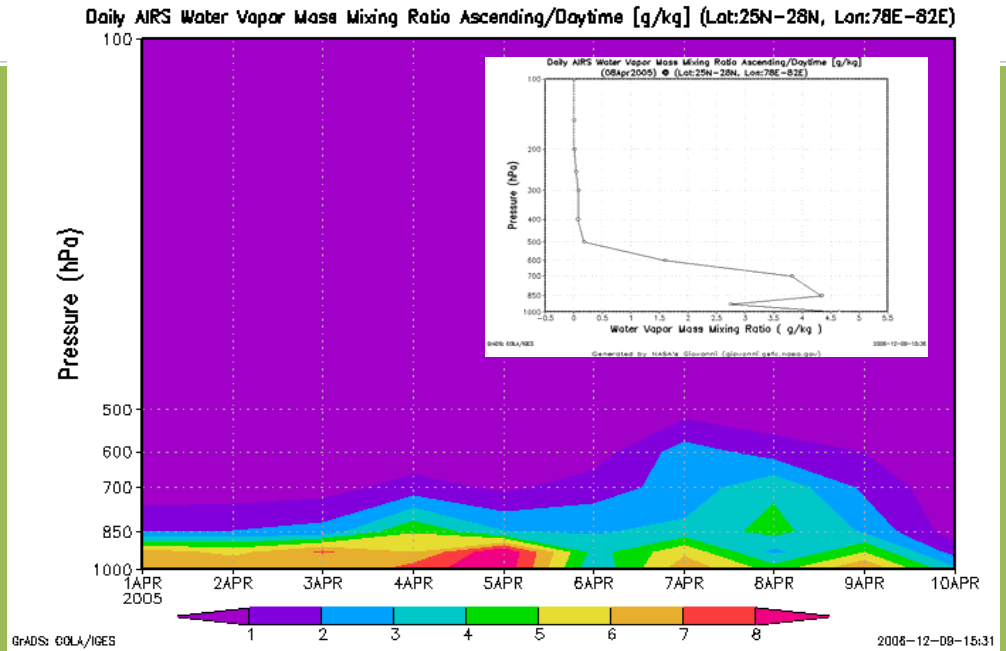


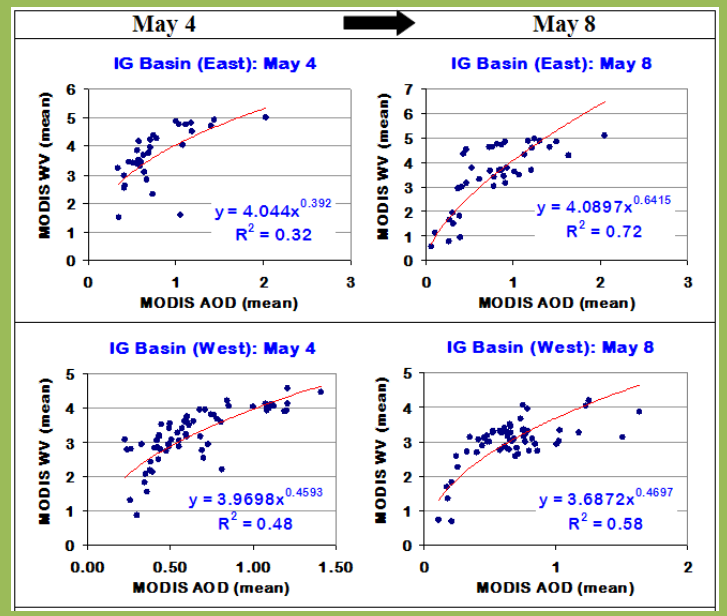


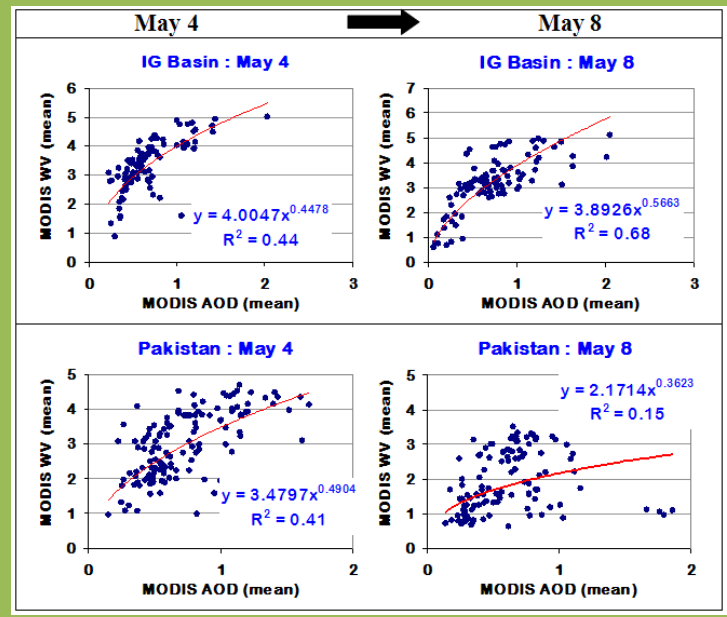
Dust storms: Association of water vapor with high AOD (Dust)

Maximum AOD (550nm) | **Mean Water vapor (cm) NIR-CC**

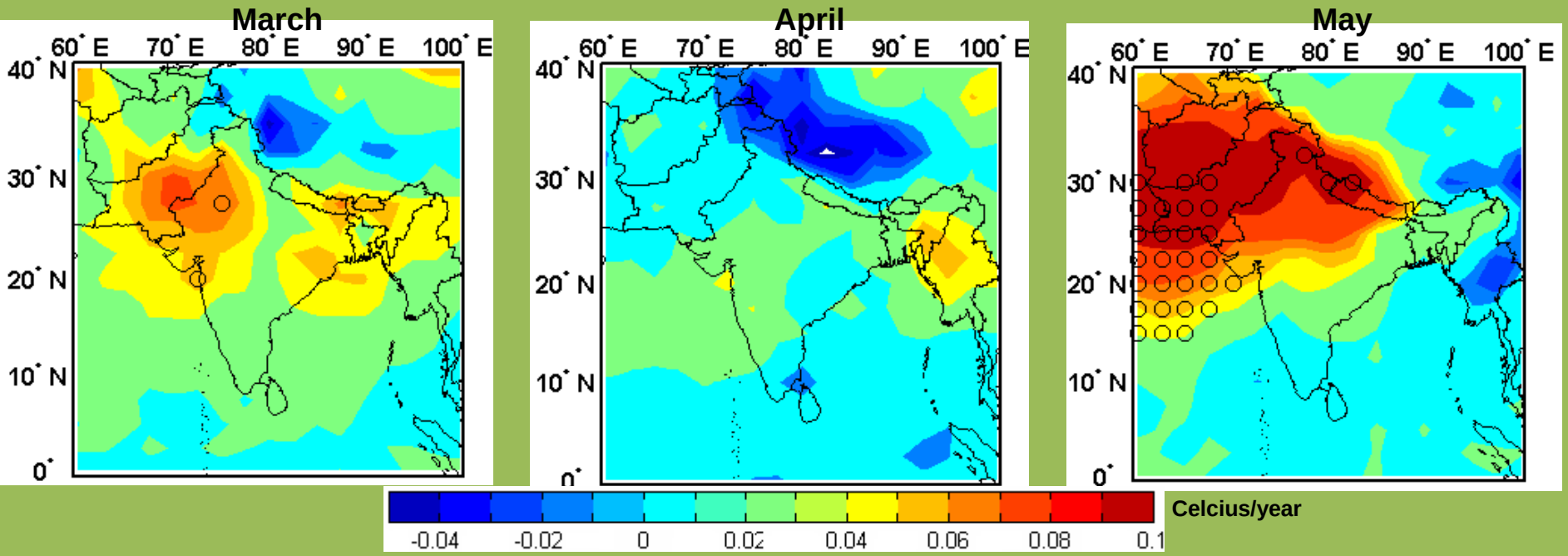






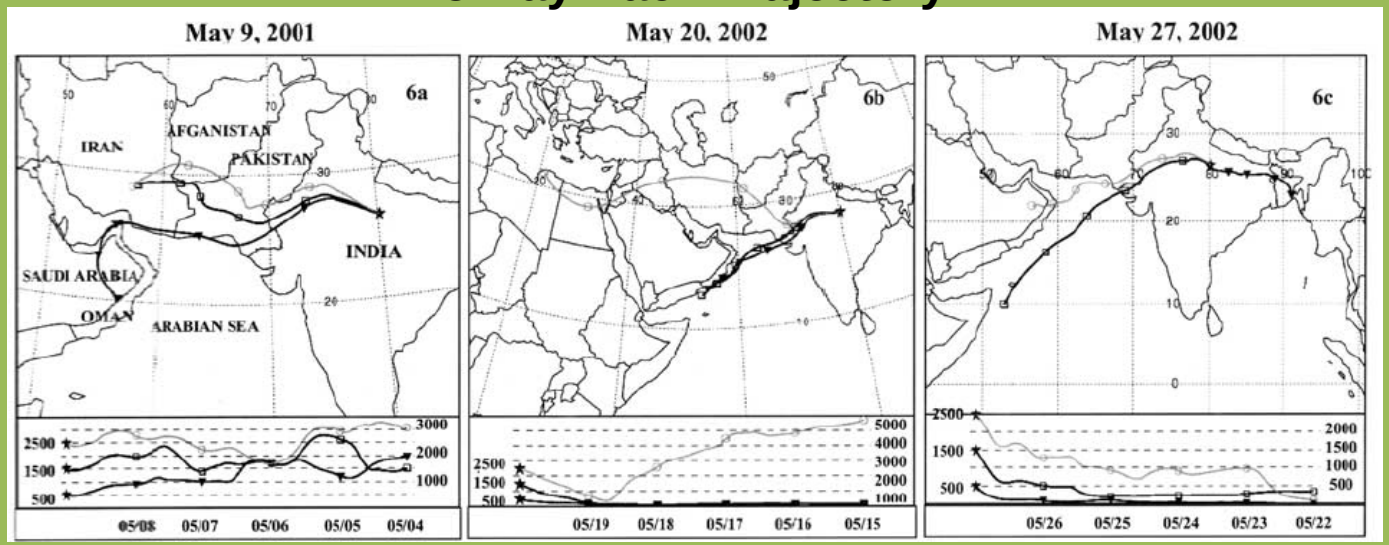


MSU mid-Trop. Temperature Trend (1979-2001)



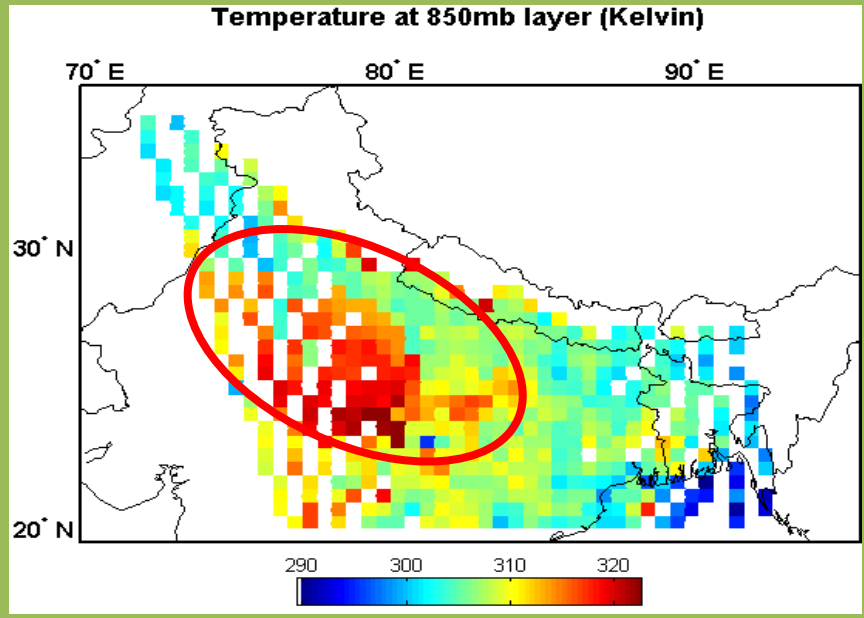
*Black circles show regions where trend is significant at 95% confidence interval.

5-Day Back Trajectory

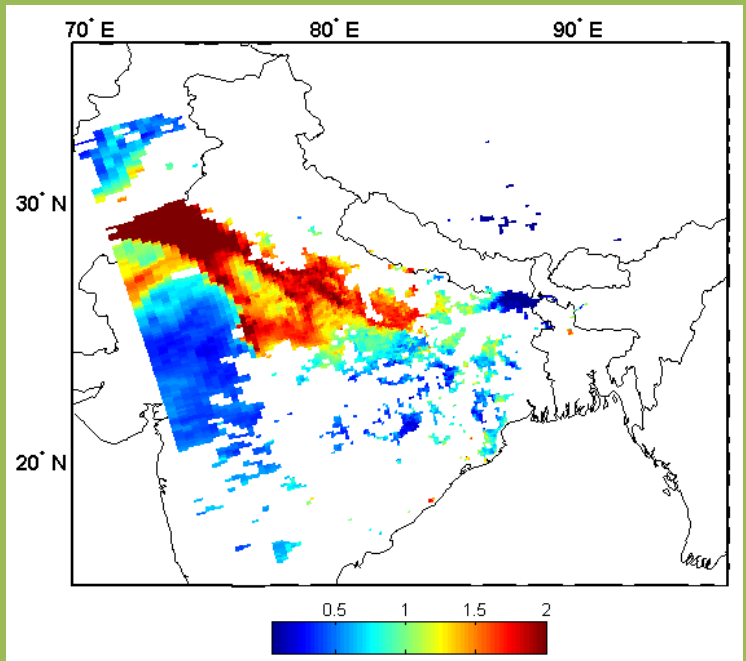


Aqua MODIS, June 10, 2005

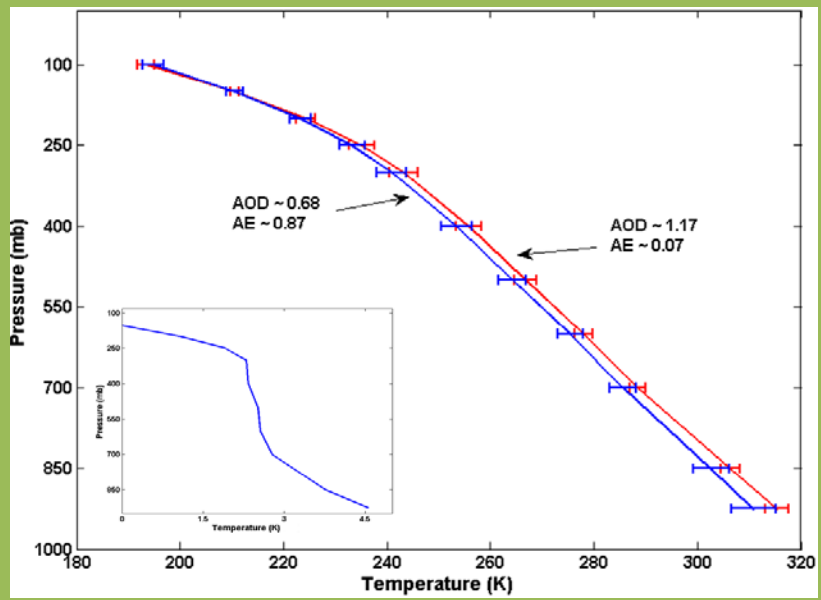
AIRS, June 10, 2005

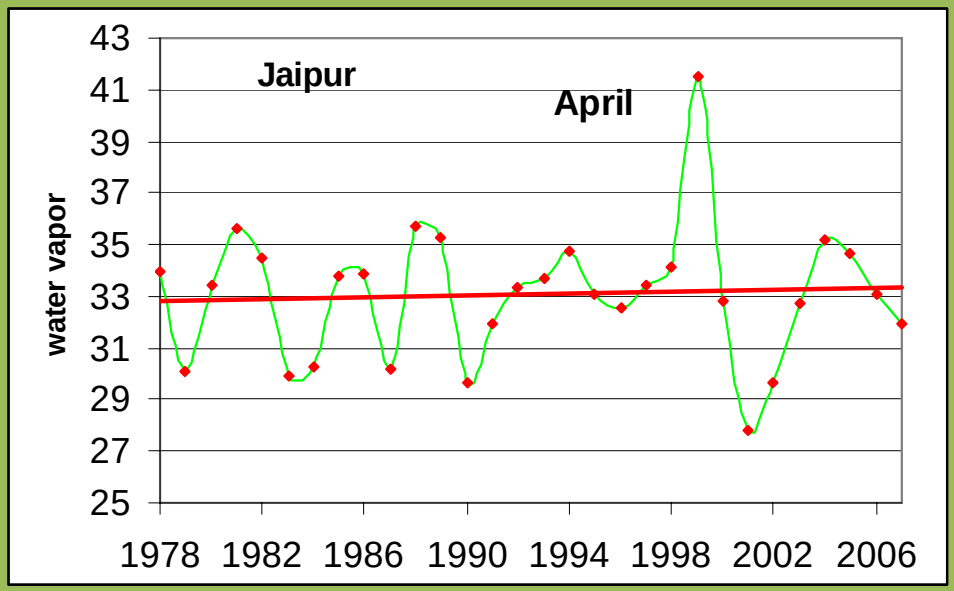


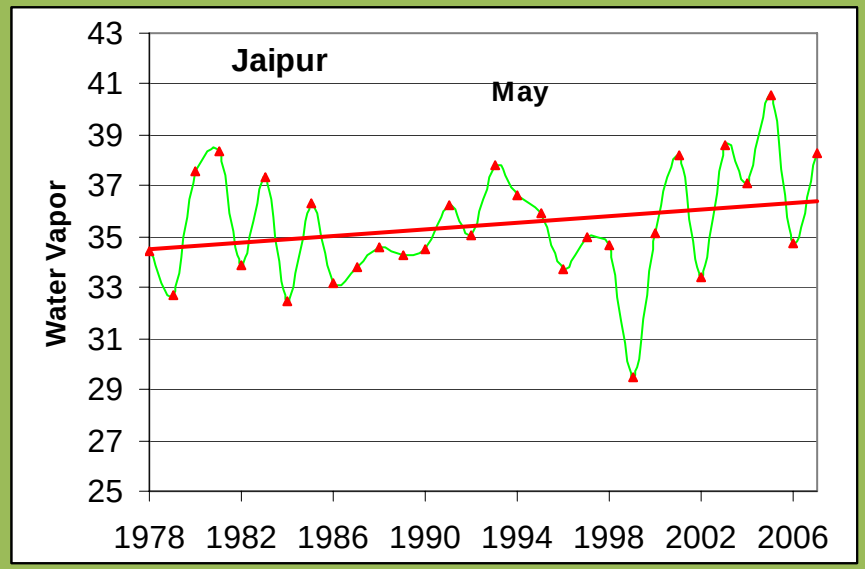
MODIS Deep Blue AOD Retrieval

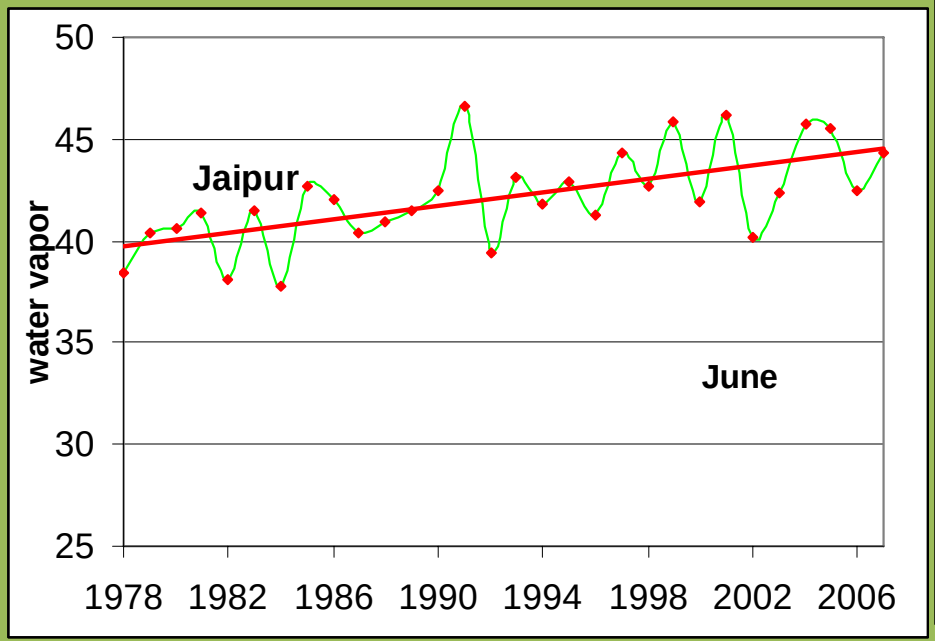


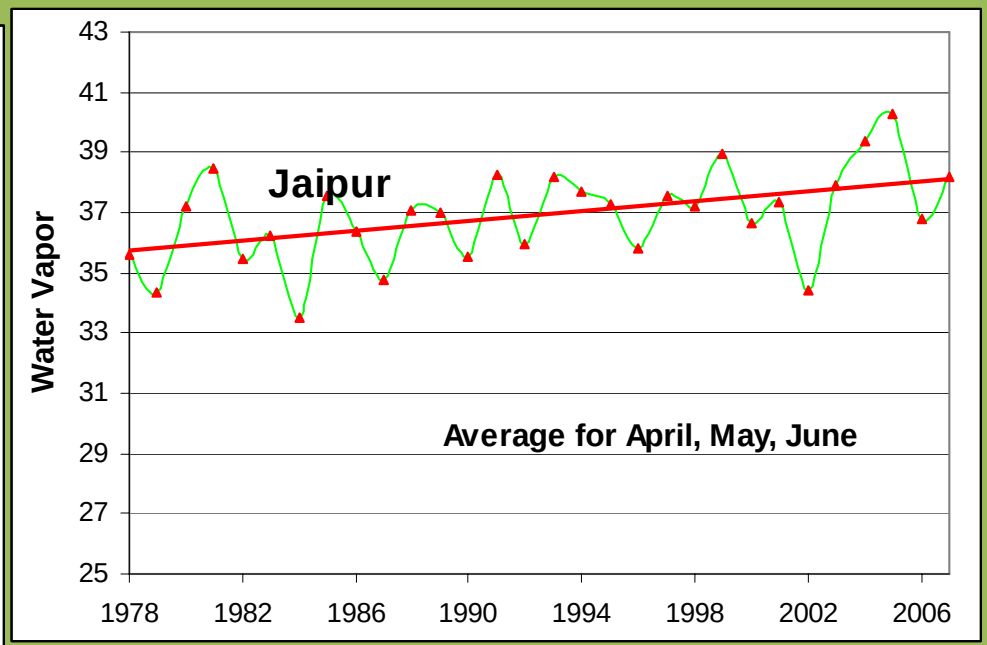
AIRS Temperature Profiles




Jaipur
April
water vapor
43
41
39
37
35
33
31
29
27
25
1978 1982 1986 1990 1994 1998 2002 2006

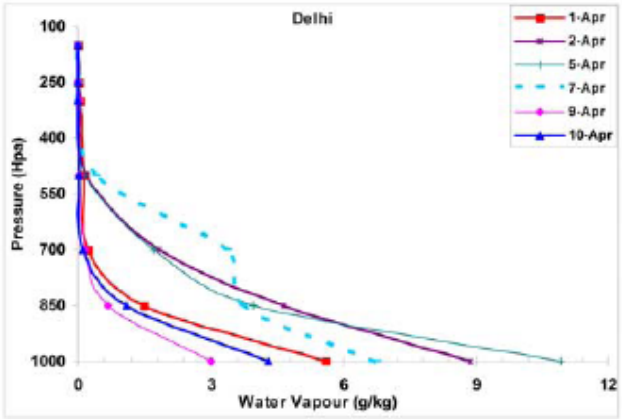

Jaipur
May
Water Vapor
43
41
39
37
35
33
31
29
27
25
1978 1982 1986 1990 1994 1998 2002 2006

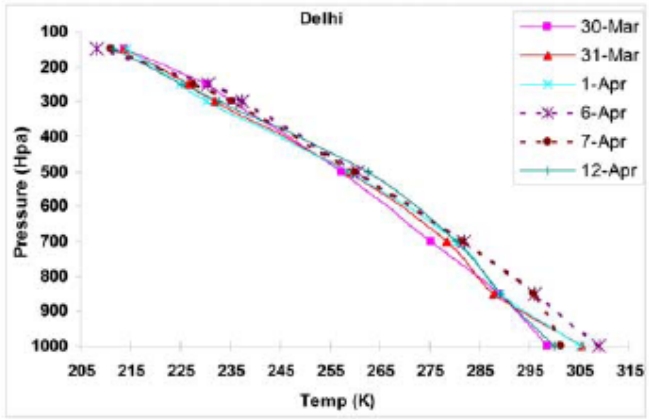

Jaipur
June
water vapor
50
45
40
35
30
25
1978 1982 1986 1990 1994 1998 2002 2006

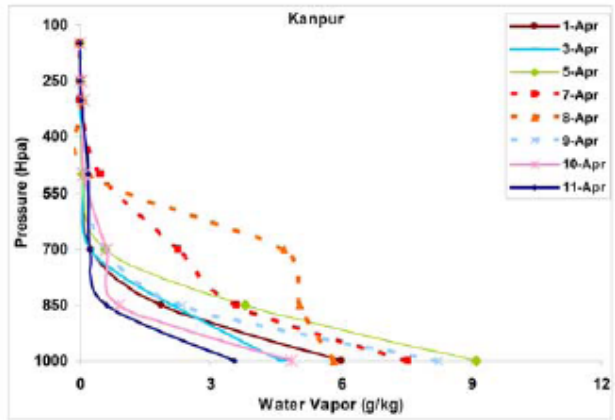

Jaipur
Average for April, May, June
Water Vapor
43
41
39
37
35
33
31
29
27
25
1978 1982 1986 1990 1994 1998 2002 2006

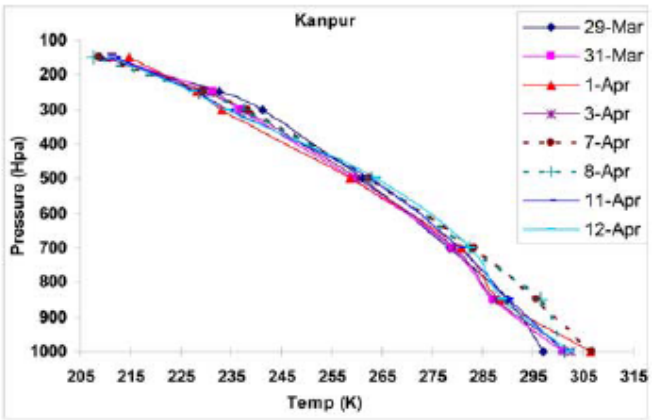
(a) Water vapor mass mixing ratio

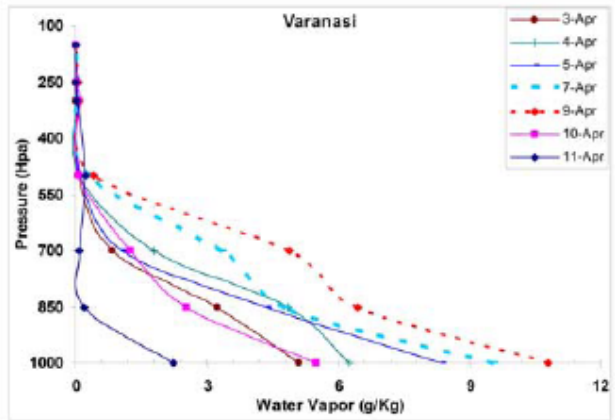
(b) Temperature

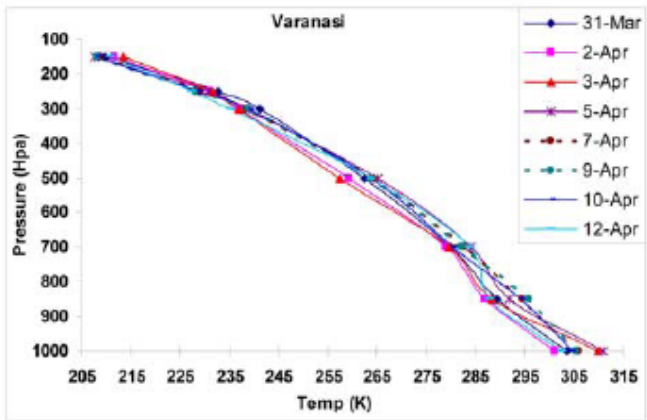


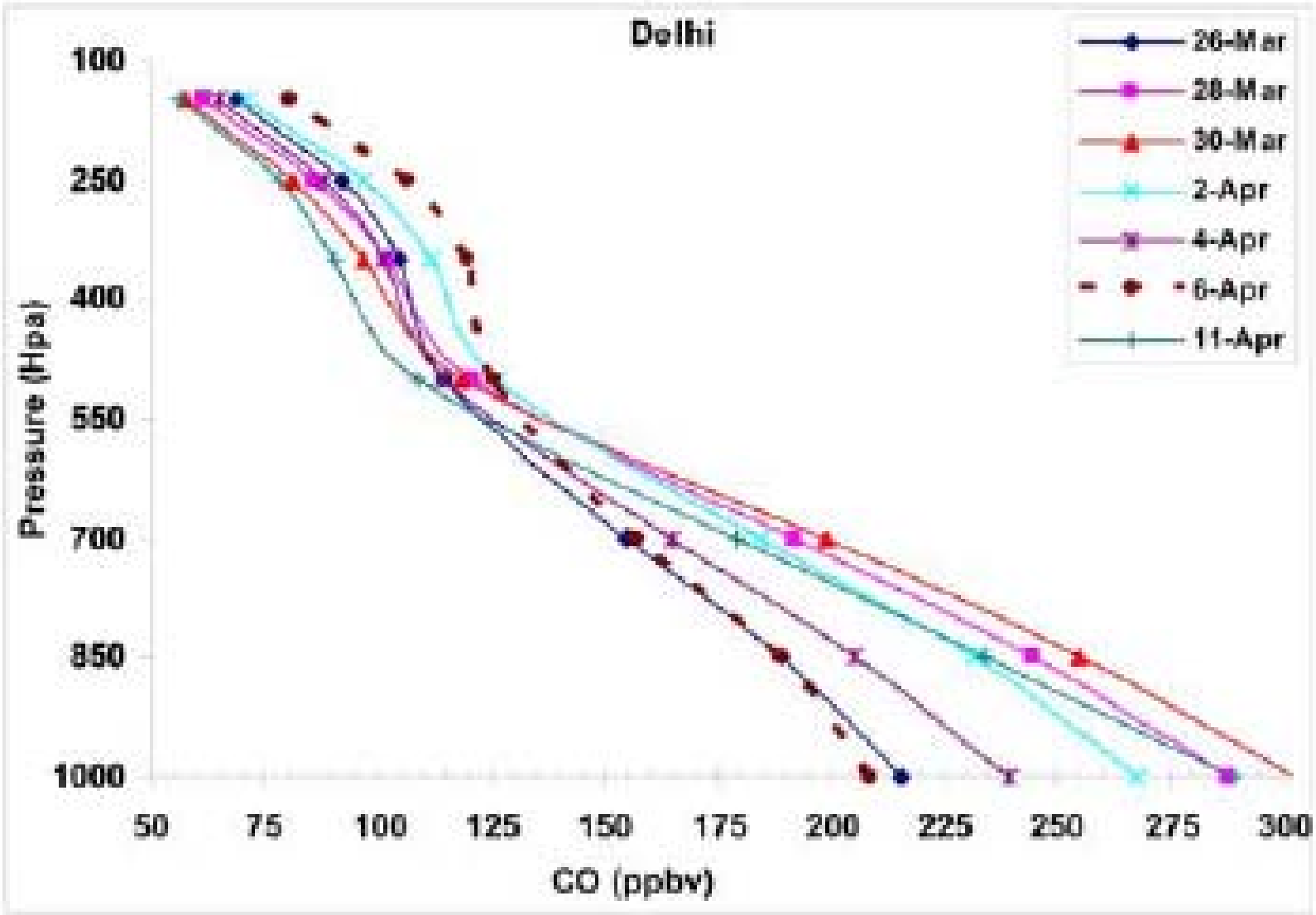











Delhi
26-Mar
28-Mar
30-Mar
2-Apr
4-Apr
6-Apr
11-Apr
Pressure (Hpa)
100
250
400
550
700
850
1000
50
75
100
125
150
175
200
225
250
275
300
CO (ppbv)

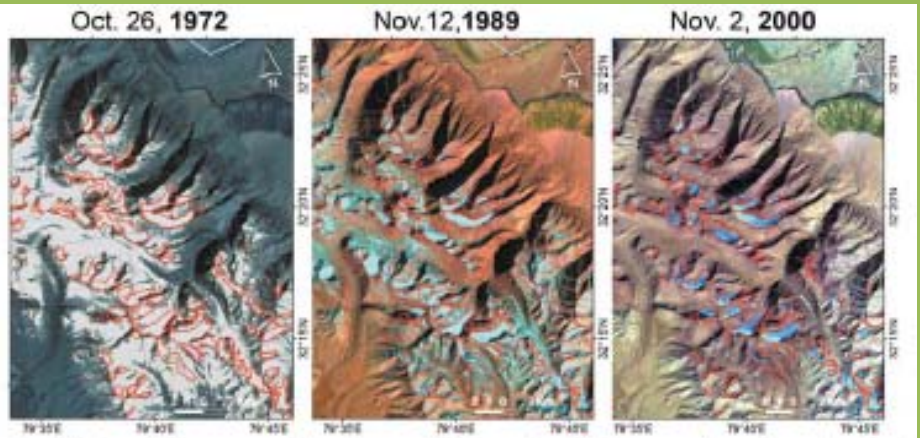


Fig. 1. Change in the snow and glacier cover in the western Himalayan region as shown in Landsat multispectral scanner (1972), thematic mapper (1989), and Enhanced Thematic Mapper Plus (2000) images. Areas outlined in red indicate information from the GLIMS database.

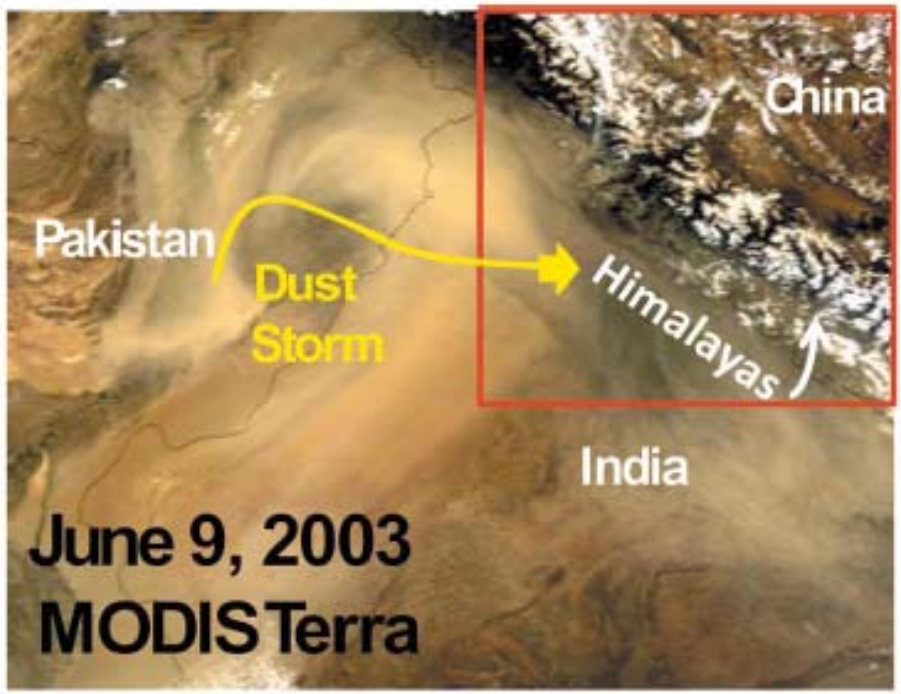


Fig. 2. Dust storms reach up to snow and glacier of Himalayas (box outlined in red) as visible in this 9 June 2003 MODIS Terra image obtained from the MODIS Web site (http://modis.gsfc.nasa.gov/).

Conclusion

- **Multi sensor data shows enhancement of water vapor, total ozone column, CO and pronounced changes in meteorological parameters associated with dust storms.**

- **The warming of troposphere is found that could be associated with the increasing trend of water vapor and CO associated with dust events.**

- **Use of Sounders data will be useful in understanding all atmospheric and meteorological parameters associated with dust events and understanding of the changes in RF.**

Thank You

International TOVS Study Conference, 16th, ITSC-16, Angra dos Reis, Brazil, 7-13 May 2008. Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2008.