Air Quality Monitoring

- IMD in collaboration with IITM operates network of air quality monitoring systems in Delhi, Mumbai, Pune and Ahmedabad.
- Air Quality parameters monitored are PM10, PM2.5, O_3, CO, Nox, BTX, SO_2, NH_3, UV-Index and Weather Parameters.

Dr Harsh Vardhan, Hon'ble Union Minister of Earth Sciences unveiling a state-of-the-art Air Quality Monitoring Station at Chandani Chowk in Delhi
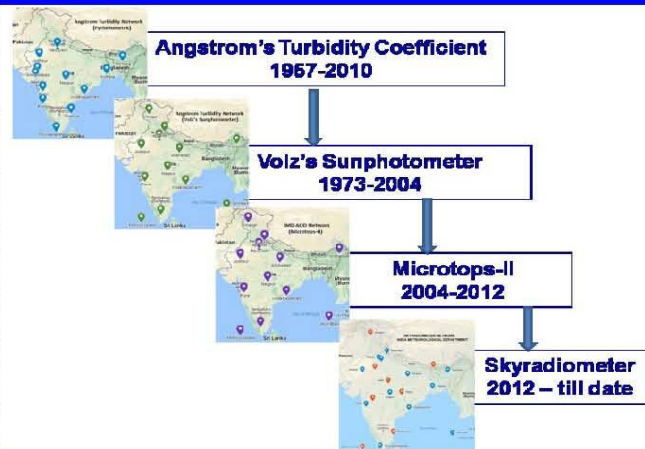
International and National Collaborations

- ❑ IMD contributes in the field of atmospheric environment to the World Meteorological Organization (WMO) Global Atmosphere Watch (GAW) programme. IMD contributes Ozone, Precipitation Chemistry, Aerosol and Solar Radiation data to WMO world data centers.
- ❑ Cooperation agreement in the field of Atmospheric Environment between IMD and Finnish Meteorological Institute (FMI) was signed in the presence of Hon'ble President of India in 2014. The air quality forecast models and aerosol research activities are in progress under this collaboration.
- ❑ EMRC, IMD provides specific services to Ministry of Environment and Forest & Climate Change and other Government Agencies in the assessment of air pollution impacts.
- ❑ Collaboration with Skynet, Tokyo, Japan on aerosol research.
- ❑ Indo-Russian Cooperation Programme with Roshydromet on Study of atmospheric Ozone, aerosols and UV-radiation.
- ❑ Collaboration with several Universities/Institutions in India on Environment Monitoring and Research.

Chronology of Ozone Monitoring in IMD

1928-29	First Ozone Observations at Kodaikanal as part of Dobson's worldwide Total Ozone Measurements
1940	IMD acquired First Dobson Spectrophotometer
1950s	IMD established Dobson Spectrophotometer Network; Delhi(1955), Srinagar (1955), Kodaikanal (1957), Varanasi (1963), Pune (1973)
1962	Indian balloon-borne electrochemical Ozonesonde developed at Instrument Division, IMD, Pune
1970	First Indian Surface Ozone Recorder developed at Instrument Division, IMD, Pune
1980s	First Ozonesonde Observations during 1982-83 expedition and Dobson observations in 1987 at Dakshin Gangotri, Antarctic
1990s	Brewer Spectrophotometers Network establioshed; New Delhi (1994), Kodaikanal (1994), Maitri, Antarctica (1994), Pune (2005)
2010s	Ozone Observations from INSAT-3D (2013) and INSAT-3DR (2016)
2015	Ozone Observations started at Bharati, Antarctica

IMD's participation in WMO/GAW Dobson International Intercomparison; Belsk / Poland (1974), Boulder / USA (1977), Melbourne / Australia (1984), Tsukuba / Japan (1996, 2006), Irene / South Africa (2019)

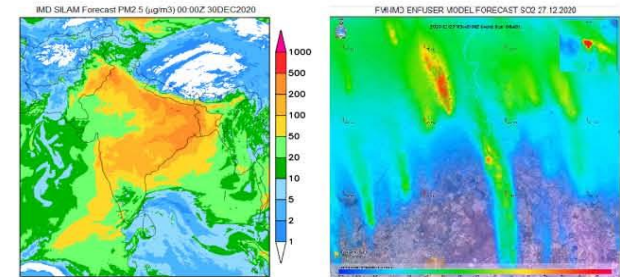## Chronology of Aerosol Monitoring in IMD

Angstrom's Turbidity Coefficient 1957-2010

Volz's Sunphotometer 1973-2004

Microtops-II 2004-2012

Skyradiometer 2012 – till date

https://ews.tropmet.res.in/
https://nwp.imd.gov.in/silam_imd.php

Environment Monitoring and Research Centre
India Meteorological Department
Ministry of Earth Sciences

Ambient Air Quality Monitoring
⇒ PM10, PM2.5, O_3, CO, NOx, BTX, SO_2, NH_3

Air Quality Forecasting Services
⇒ From Regional Scale to Urban Street Scale
⇒ 3-days forecast and outlook for next 7-days
⇒ forecast of non-local fire contribution
⇒ AQ Forecast Models
→SILAM
→WRF-Chem
→ENFUSER
→NCUM Dust

Environmental Monitoring
⇒ Ozone
⇒ Aerosol Optical Properties
⇒ Black Carbon Aerosol
⇒ Precipitation Chemistry
⇒ Aerosol Chemistry
⇒ Trace Gases
⇒ Greenhouse Gases
⇒ Solar Radiation

Ozone Monitoring

Ozone Centre of IMD is designated as secondary regional ozone centre for Regional Association II (Asia) of World Meteorological Organization. The centre maintains a network of ozone monitoring stations including Maitri and Bharati in Antarctica. Following atmospheric Ozone components are measured currently:

- Surface Ozone at 10 stations
- Vertical Distribution 2 ozonesonde stations)
- Total Columnar ozone 2 Dobson stations
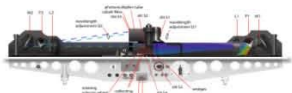
Dobson Spectrophotomter

Precipitation and Aerosol Chemistry

- Precipitation Chemistry (major Cations, Anions, pH and Conductivity) monitoring through a network of 11 stations since 1970s.
- State-of-art Precipitation Chemistry Laboratory at IMD, Pune equipped with:
  - ❑ Ion-chromatograph
  - ❑ UV-VIS Spectrophotometer
  - ❑ Atomic Absorption Spectrophotometer
  - ❑ pH and Conductivity Meter
  - ❑ Ultra-pure De-ionized Water Plant
- High Volume Samplers for PM10, PM2.5 and Total Suspended Particulate Matter sample collection at Delhi, Ranichauri, Pune and Varanasi.
- Analysis of filter papers for chemical characterization of aerosols.
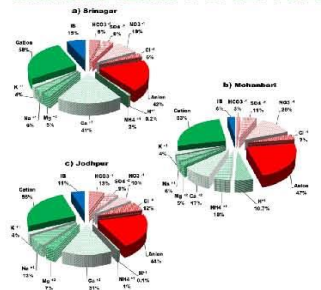
Aerosol Monitoring

Sun-Skyradiometer Network for Aerosol Optical Properties Monitoring

- Spectral Aerosol Optical Depth
- Angström exponent
- Single Scattering Albedo
- Aerosol Size Distribution
- Asymmetry Parameter
- Columnar Water Vapor
- Complex Refractive Index
- Aerosol Radiative Forcing

Black Carbon Aerosol

- Equivalent BC Aerosol Concentration
- Biomass Burning BC Concentration
- Fossil Fuel BC Concentration
- Spectral Absorption Coefficient

Satellite based Environment Monitoring

- **Aerosol Optical Depth – INSAT-3D/3DR, MODIS**
- **Total Column Ozone –INSAT-3D/3DR**
- **Fire Counts – MODIS, SUOMI NPP VIIRS**
- **Dust Transport – SEVIRI, INSAT-3D/3DR**
- **Total columns of O_3, SO_2, CO, NO_2 -TROPOMI**

INSAT-3D AOD
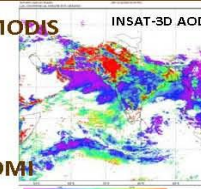
Background Environment Monitoring at Ranichauri, Uttarakhand

- **Black Carbon Aerosol**
- **Skyradiometer**
- **Differential Mobility Particle Sizer**
- **Condensation Particle Counter**
- **Aerodynamic Particle Sizer**
- **Nephelometer**
- **Solar Radiation**
- **Precipitation Chemistry**
- **GNSS**
- **High Volume Air Sampler (SPM, PM10, PM2.5)**
- **Greenhouse Gases Monitoring**

Air Quality Forecasting

The AQ-EWS has been developed under the aegis of Ministry of Earth Sciences, jointly by India Meteorological Department, Indian Institute of Tropical Meteorology and National Centre for Medium-Range Weather Forecasting.

Air Quality Early Warning System (AQ-EWS)	
Observations	Satellite based AOD, Fire Counts
	In-situ Air Quality Data (DPCC, CPCB, SPCBs, IMD,IITM)
Weather Forecast Modelling	GFS (12 km) WRF (3km)
Air Quality Modelling	WRF-Chem (10km, 2km, 400m), SILAM (3km), NCUM Dust Model (17km), ENFUSER (30m)
Air Quality Forecasting	3-days Forecast for PM10, PM2.5, CO, O_3, NO_2, SO_2, Fire and Dust Contribution
Warning Products Generated	Visualization and Animations of Weather and Air Quality parameters, Forecast Bulletin
Information Dissemination	Website https://ews.tropmet.res.in Email and Whatsapp to Pollution Control Authorities and registered users, media

## Operational Air Quality Forecast Models of IMD

System for Integrated modeLling of Atmospheric coMposition (SILAM)

- Hourly AQ Forecast of pollutants PM10, PM2.5, O_3, CO, NOx, SO_2 for 72 hours.
- Domain: 60-100E, 0-40N, 3km x3km grid, 15 hybrid layers up to ~10km (~270hpa).
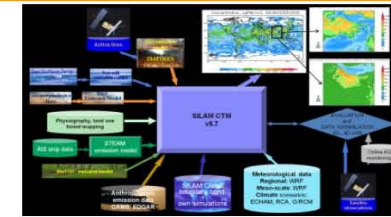
ENvironmental information FUsion SERvice (ENFUSER)

- Hourly AQ Forecast of (PM10, PM2.5, O_3, CO, NOx, SO_2 and other species) for 72 hours.
- Domain: Delhi (28.362N-28.86N, 76.901E - 77.56E)
- Spatial Resolution – 30m
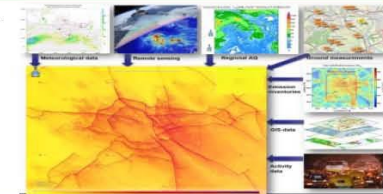
Other Forecast Products

- Air Quality Forecast using IITM WRF-Chem
- NCMRWF NCUM Dust Forecast
- HYSPLIT Backward and Forward Trajectories.
- Mixing Height and Ventilation Index from IMD GFS
- Meteogram and EPSgram