

Aerosol Atmospheric Interactions in the Asian Region

Atmospheric dust: a significant scavenger of SO_2

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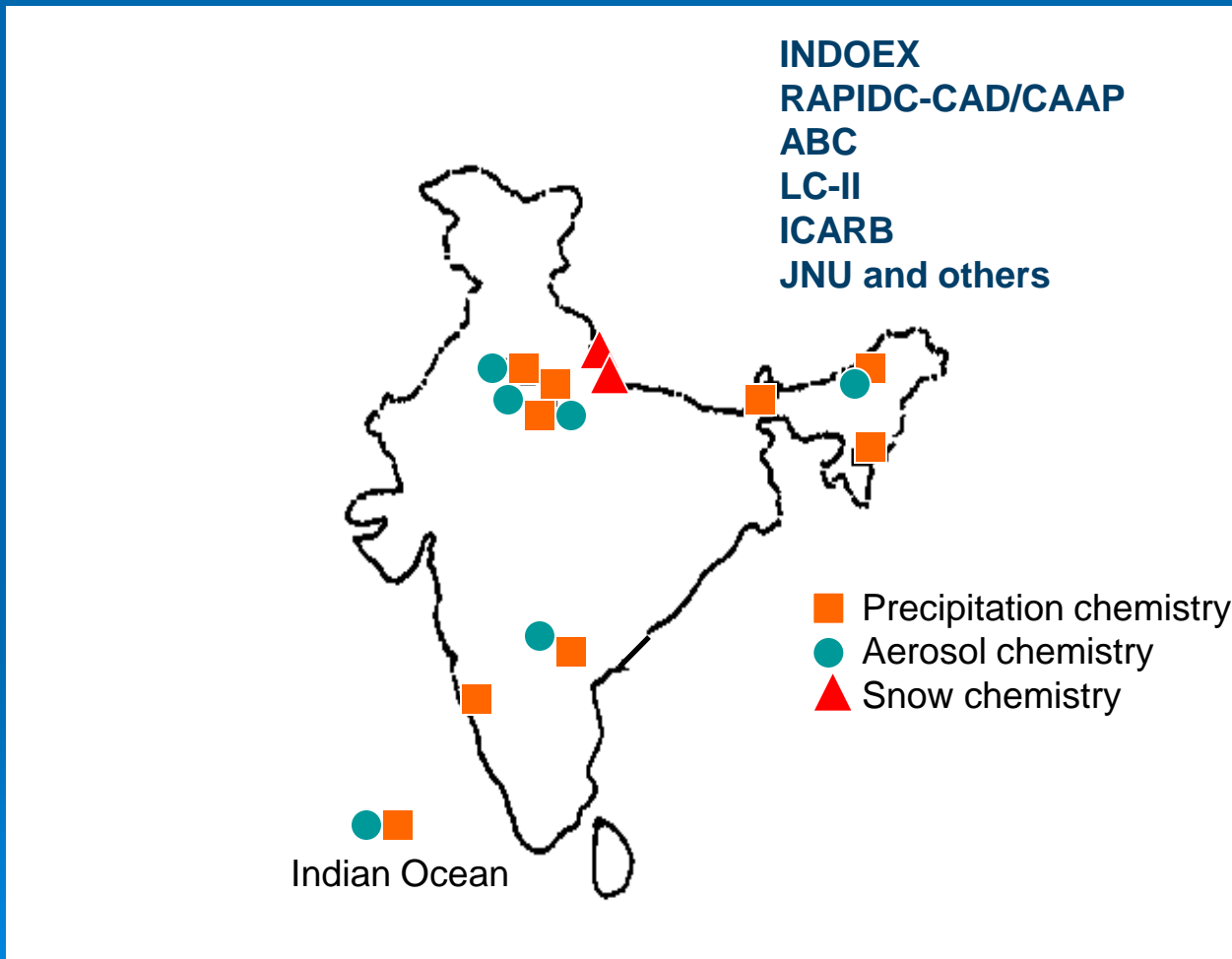
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Sites investigated



Sources of Air Pollution in Asia

Industries



Transport



Biomass Burning
Forest fire
Agriculture waste



Domestic cooking/ heating



Natural Sources

- Sea salt
- Soil dust
- Volcanoes
- Forest fires

Anthropogenic Sources

- Industries
- Vehicular traffic
- Power Plants
- Biomass Burning
- Agriculture

Emissions



**SO₂, NO_x,
Aerosols**
CO₂, CO,
N₂O, CFCs,
Organics

Ozone Depletion

Global Warming

Acidification

Deposition
to Ecosystem



Wet

Rain

Snow

Fog

In-cloud

Below Cloud

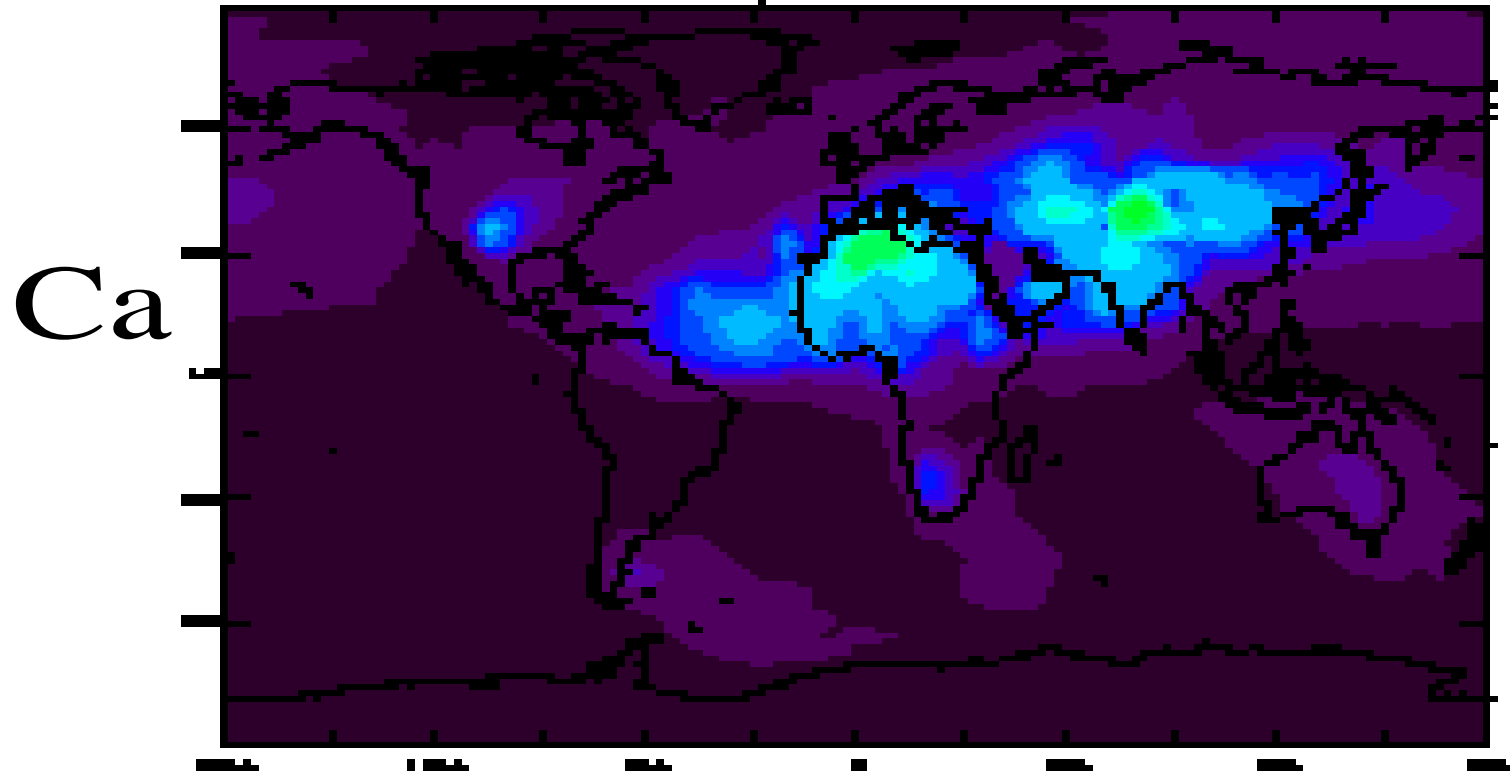
Dry

Dustfall

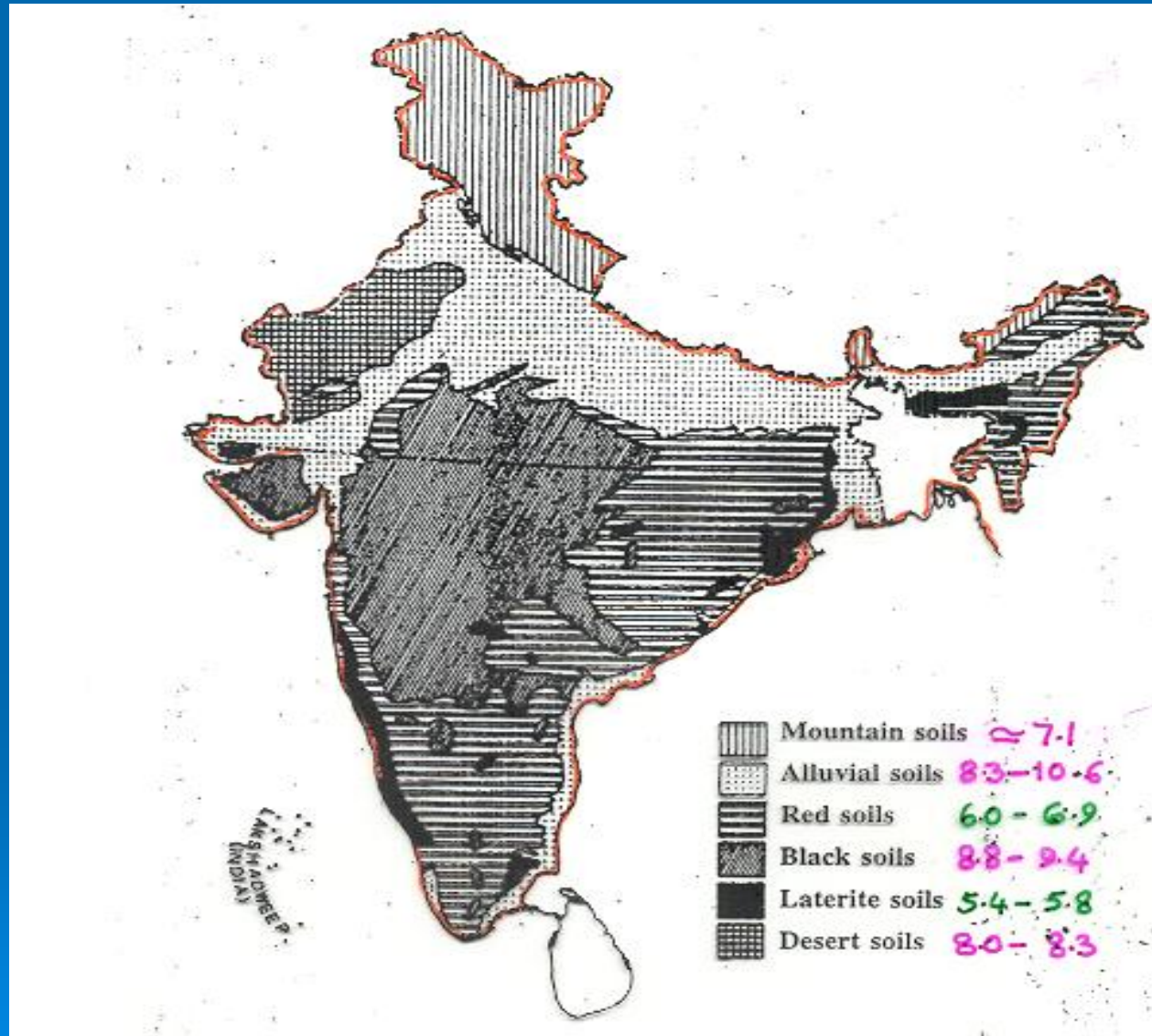
**Deposition of
gases on surfaces**

Important Factor Affecting Gaseous Concentrations

Ca deposition distribution



Soil types in India- High pH



pH of Rain Water at Indian Sites



Site	pH
Kodaikanal	6.1
Pune	6.5
Allahabad	7.1
Nagpur	6.3
Delhi	6.3
Mohanbari	6.4
Darjiling	6.4
Srinagar	7.0
Hyderabad	6.7
Jodhpur	8.3
Agra	7.1

Mean and median of concentration (in $\mu\text{eq l}^{-1}$) for four categories of stations in India.



	Na^+	NH_4^+	K^+	Mg^{2+}	Ca^{2+}	Cl^-	NO_3^-	nss SO_4^{2-}	HCO_3^- (calc)	pH
Rural	55	12	15	40	105	49	25	21	54	6.5
Sub-urban	79	15	11	51	121	82	15	21	40	6.7
Urban	76	22	11	36	105	80	36	34	37	6.4
Industrial	38	26	8	28	89	38	21	85	33	6.1

Very high Ca, nss SO_4 , HCO_3 and pH

Chemical composition of soil

<i>Components</i>	<i>Conc.</i> <i>(g eq/tonne)</i>
<i>pH</i> 	6.4
<i>Ca</i> 	31
<i>K</i>	3
<i>Mg</i>	5
Na	7
<i>SO4</i>	4
<i>NO3</i>	3
<i>Cl</i>	4

Dustfall rates ($\text{mg m}^{-2} \text{d}^{-1}$) of major ions

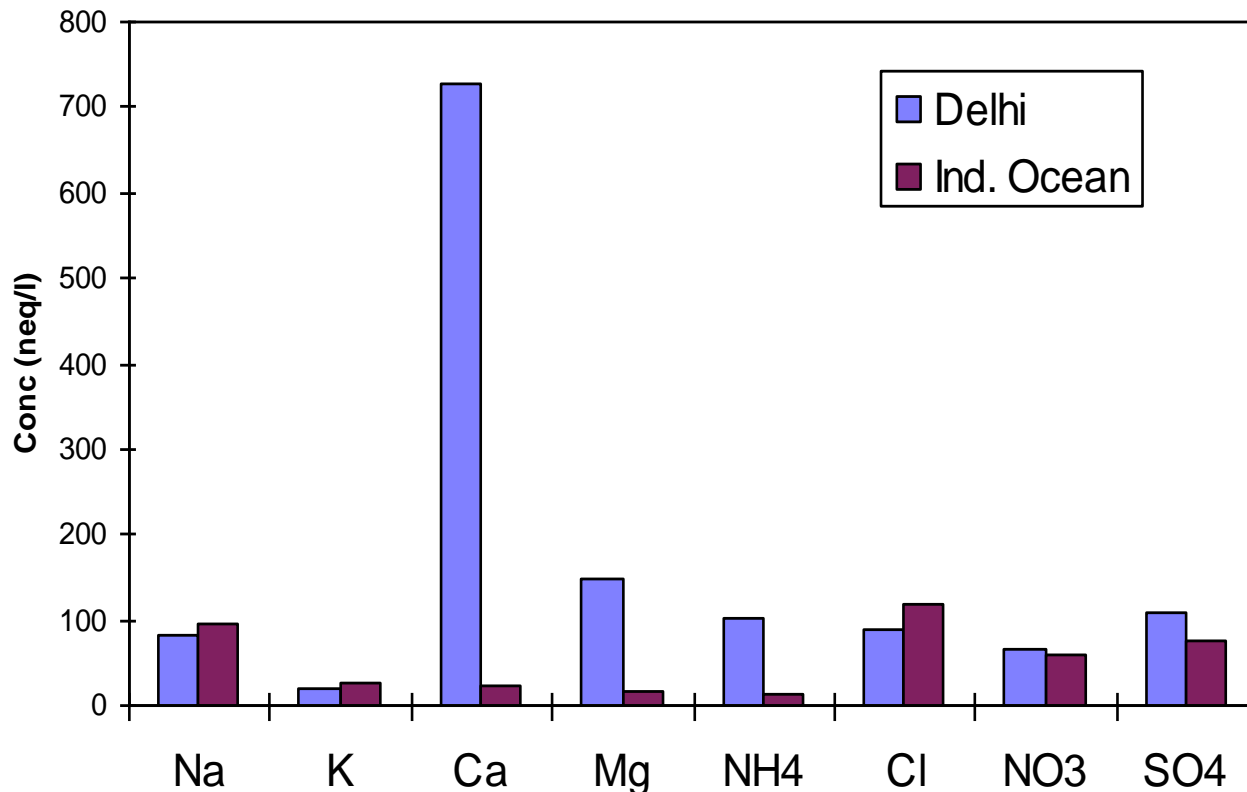
<i>Ca</i> 	<u>1.81</u>
<i>K</i>	0.92
<i>Na</i>	0.19
<i>Mg</i>	0.49
<i>NH₄</i>	0.19
<i>Cl</i>	1.06
<i>NO₃</i>	0.64
<i>SO₄</i> 	<u>1.54</u>

SO₄ DD rates are increased

Due to SO₂ Oxidation onto
CaCO₃ particles

Water soluble components of SPM at Delhi and over Indian Ocean

Water soluble components

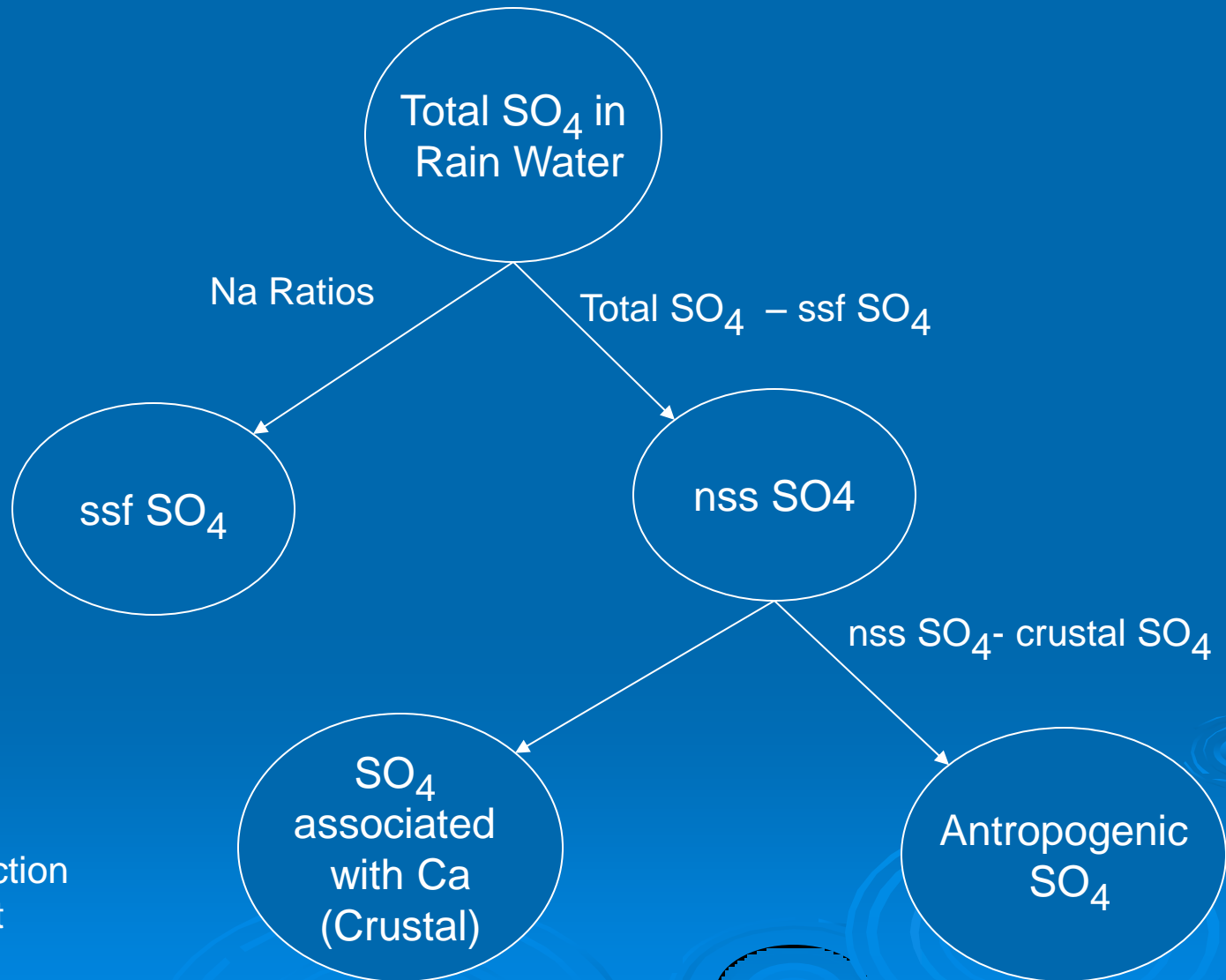


SO₄/Ca ratio

Delhi 0.1

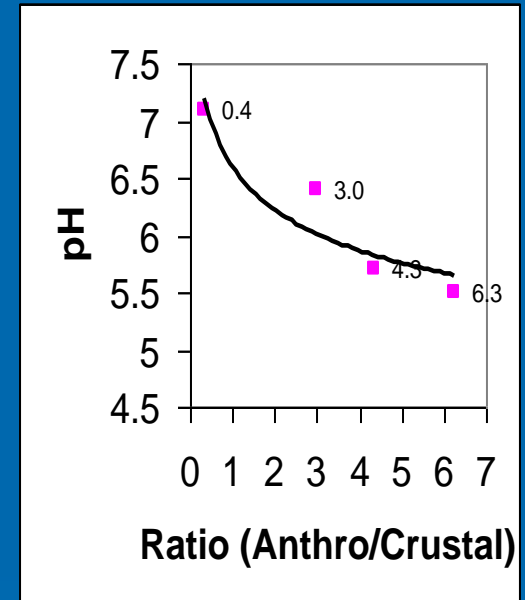
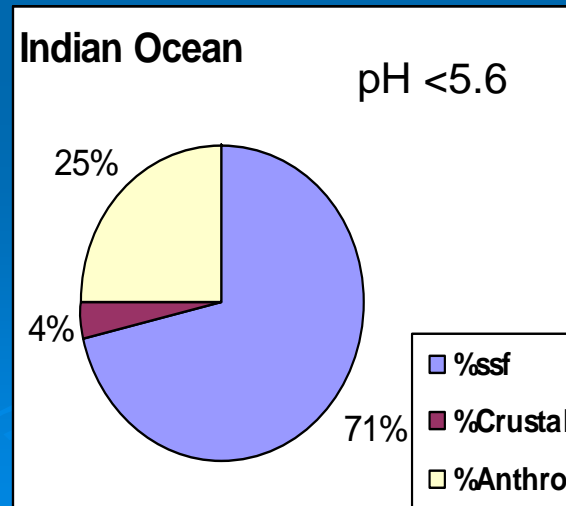
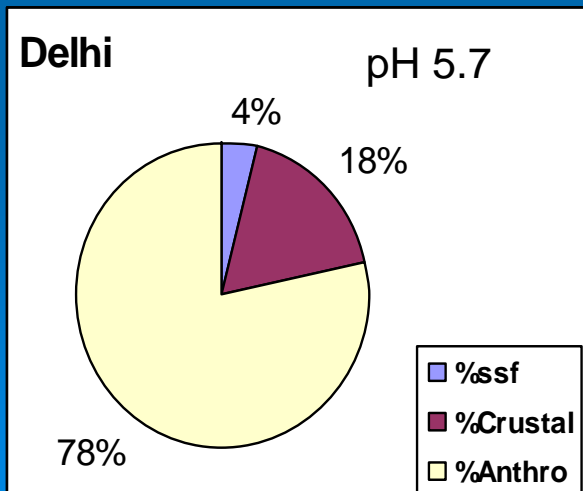
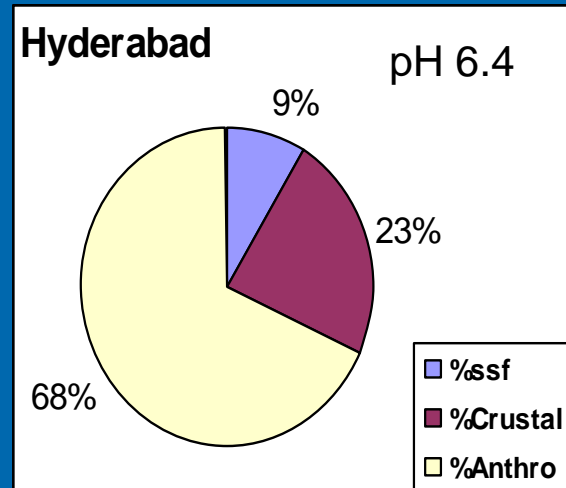
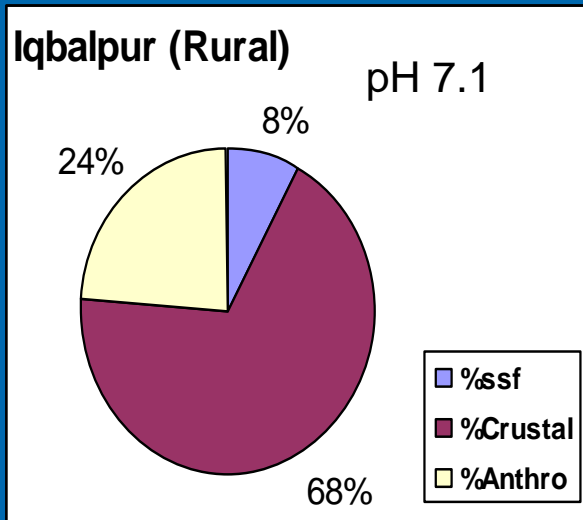
I.O. 3.0

Steps for SO₄ differentiation

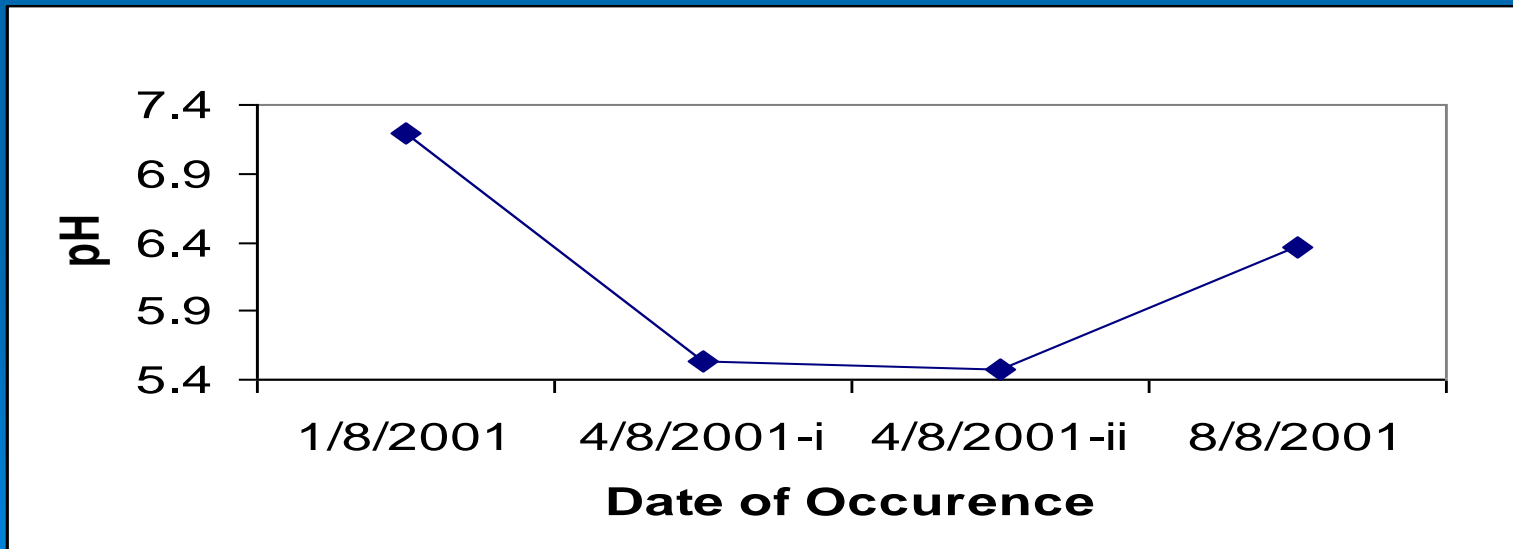
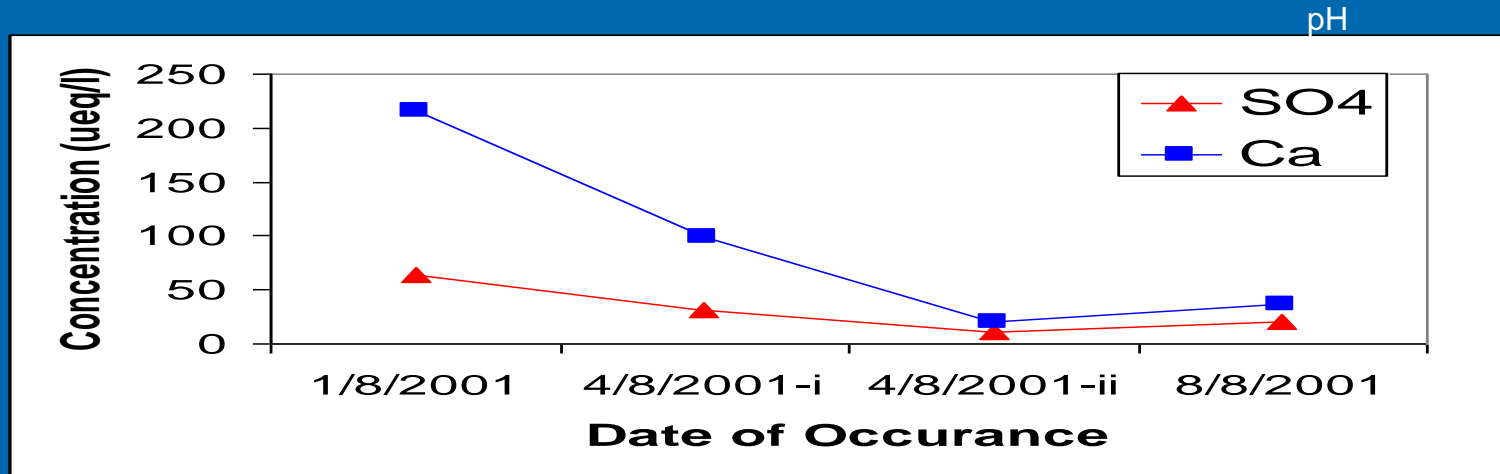


Ssf = Sea salt fraction
Nss= non-sea salt

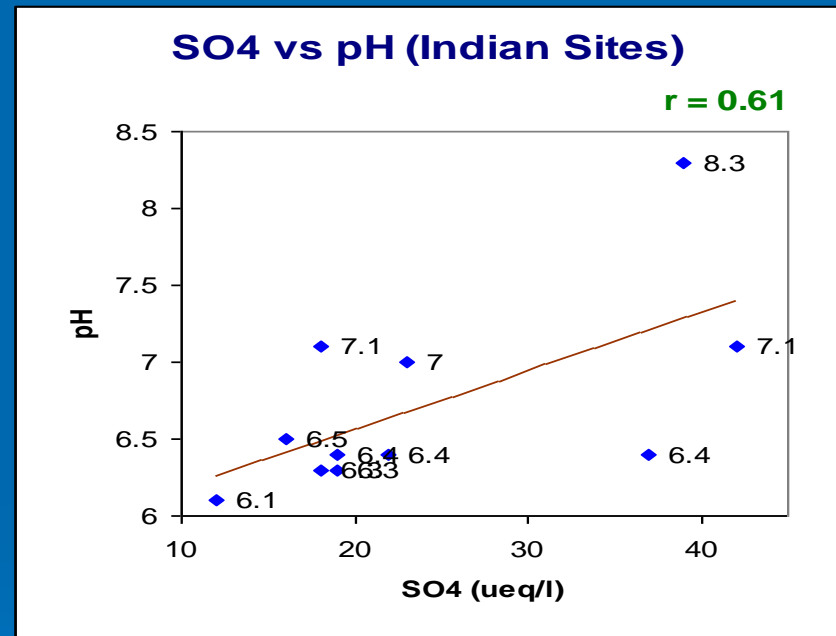
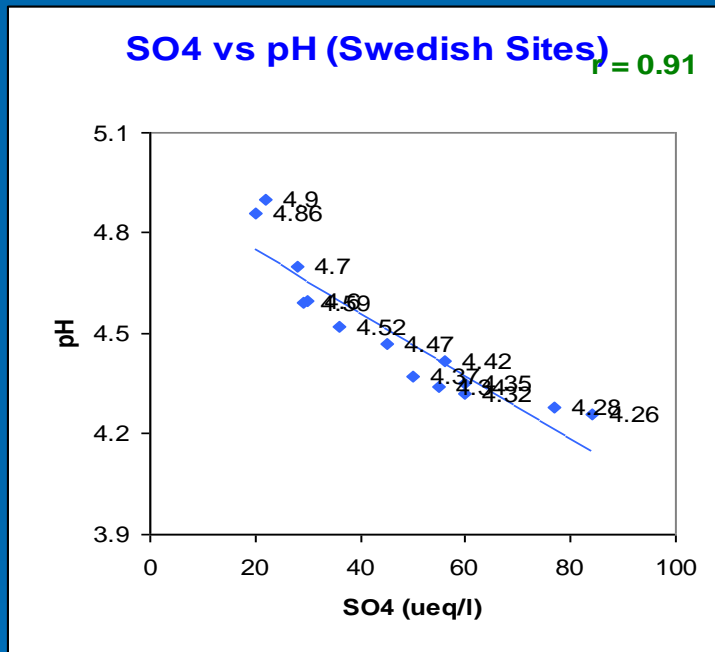
Sulphate source differentiation



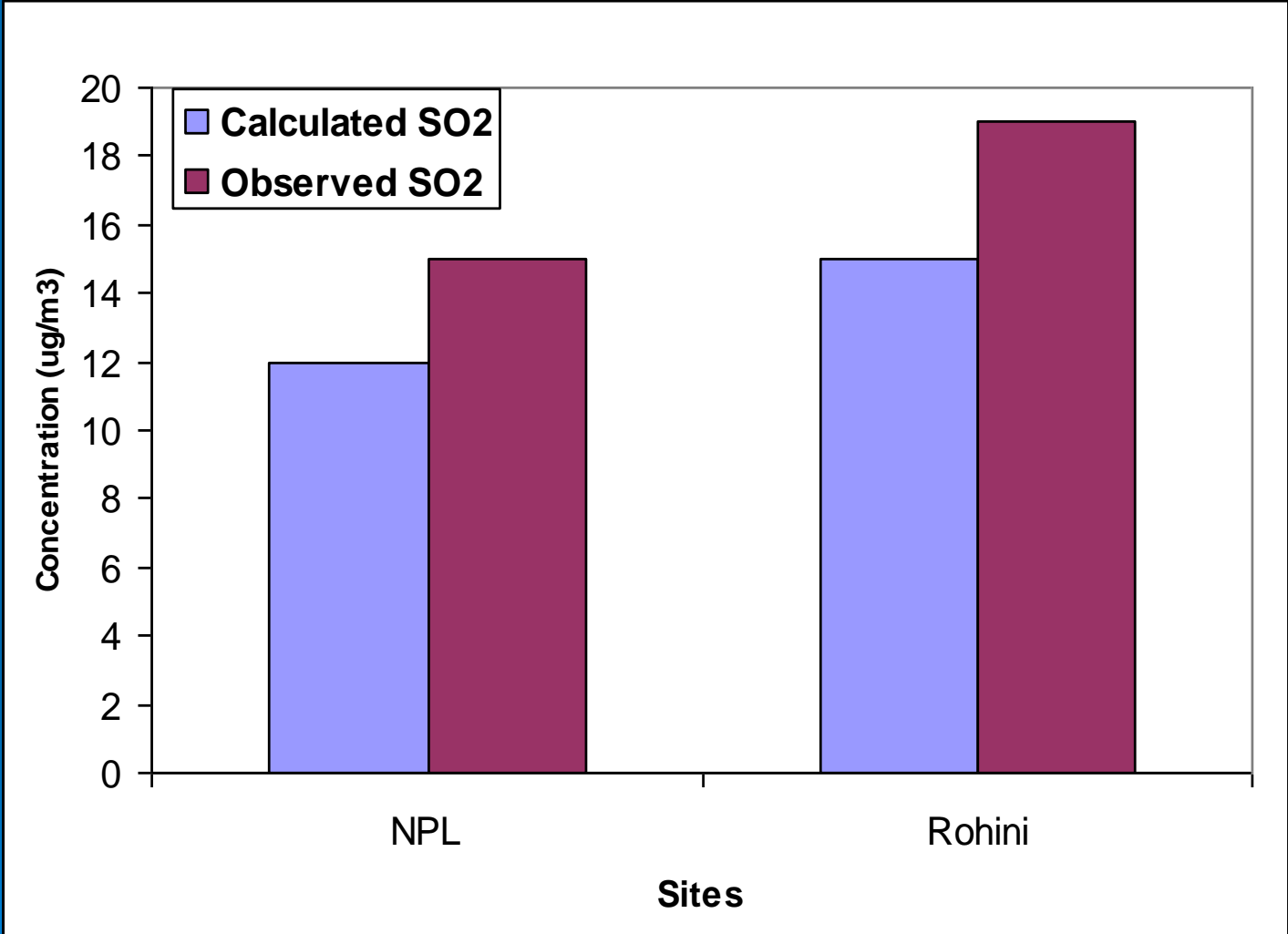
Removal of Calcium Sulphate in India



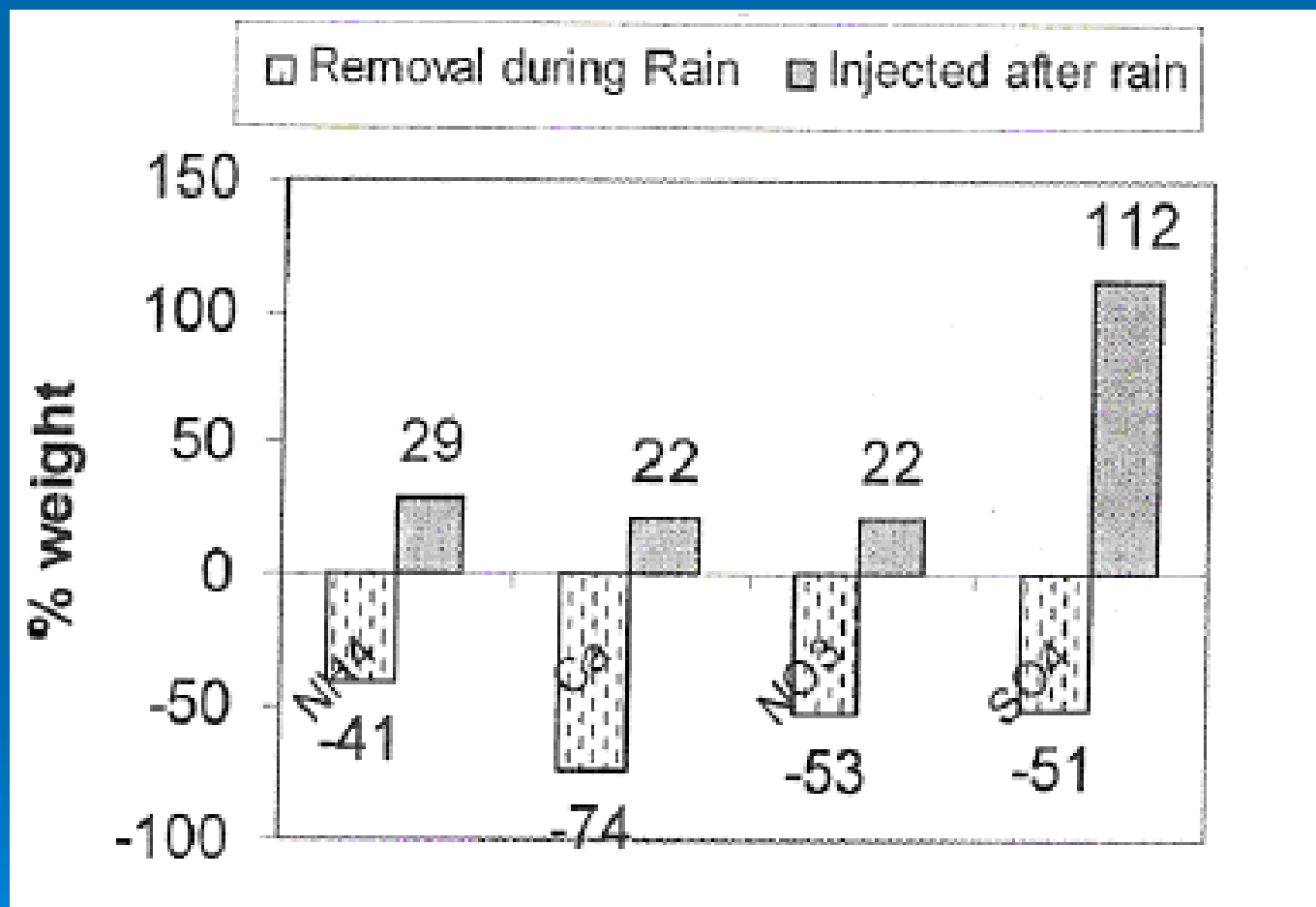
Variation of pH and nss SO₄ (Europe and India)



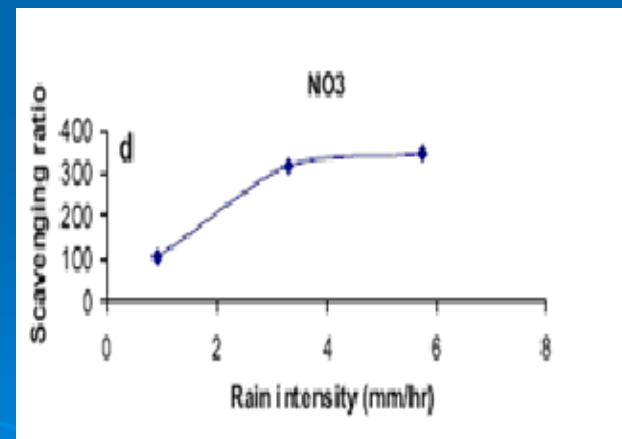
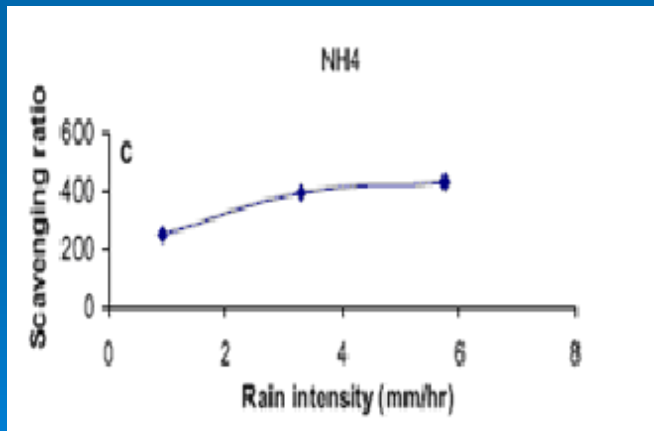
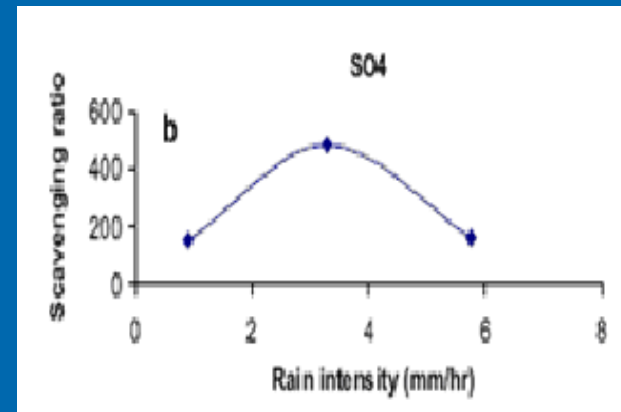
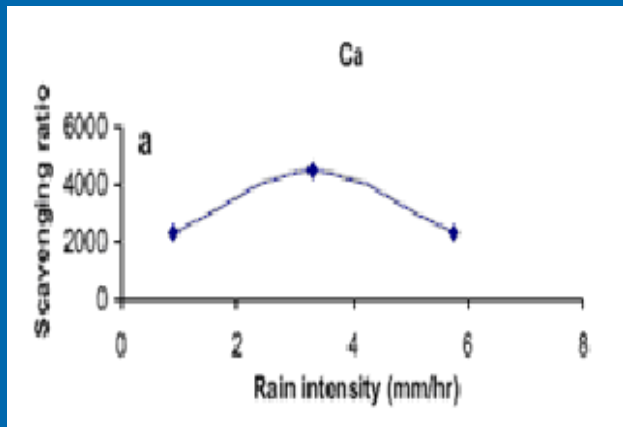
Europe- at high nss SO₄, pH is very low **India-** Even at higher nss SO₄ levels, pH is higher

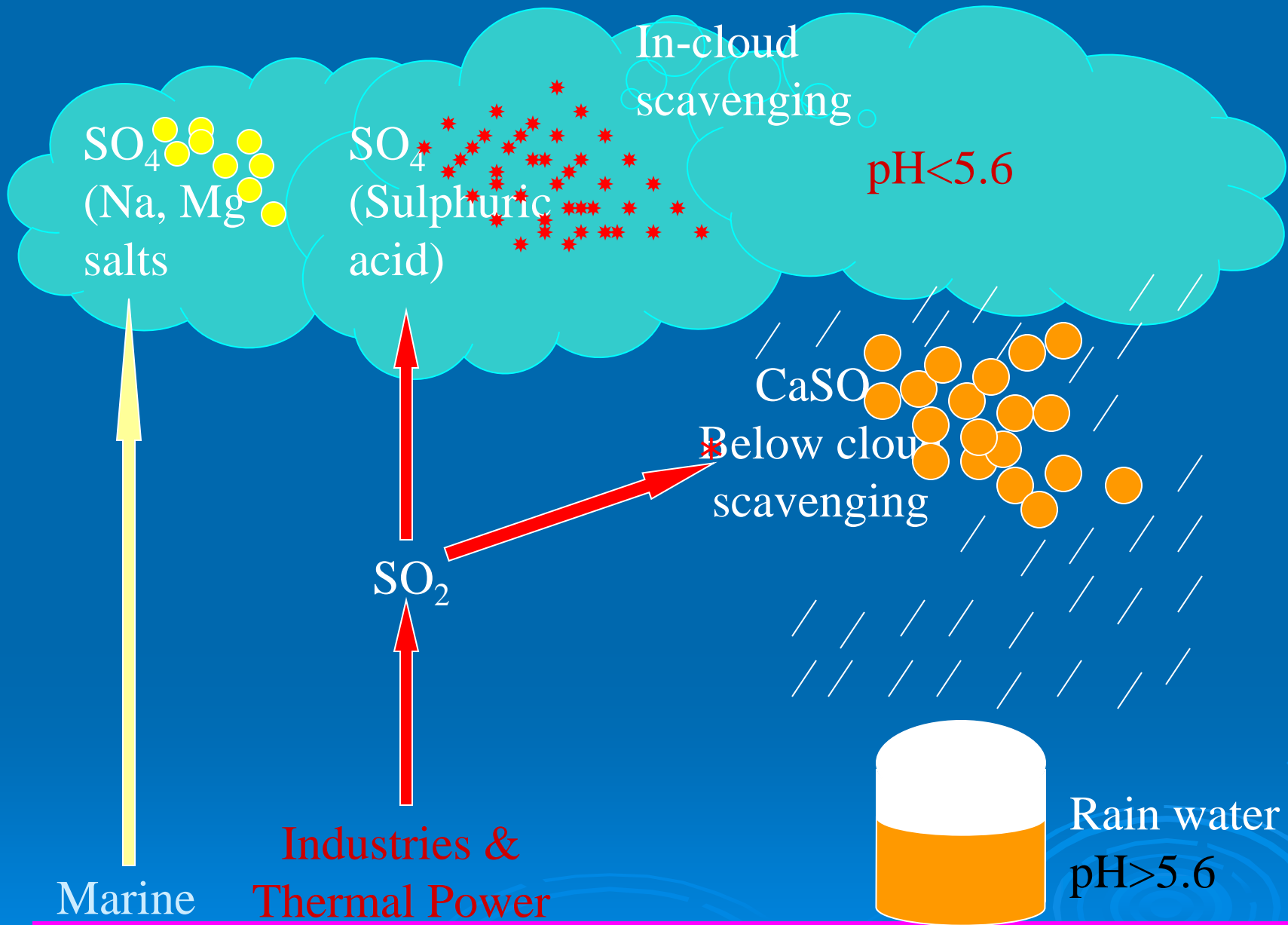


Percent removal of major ions during rain event and injection after rain event



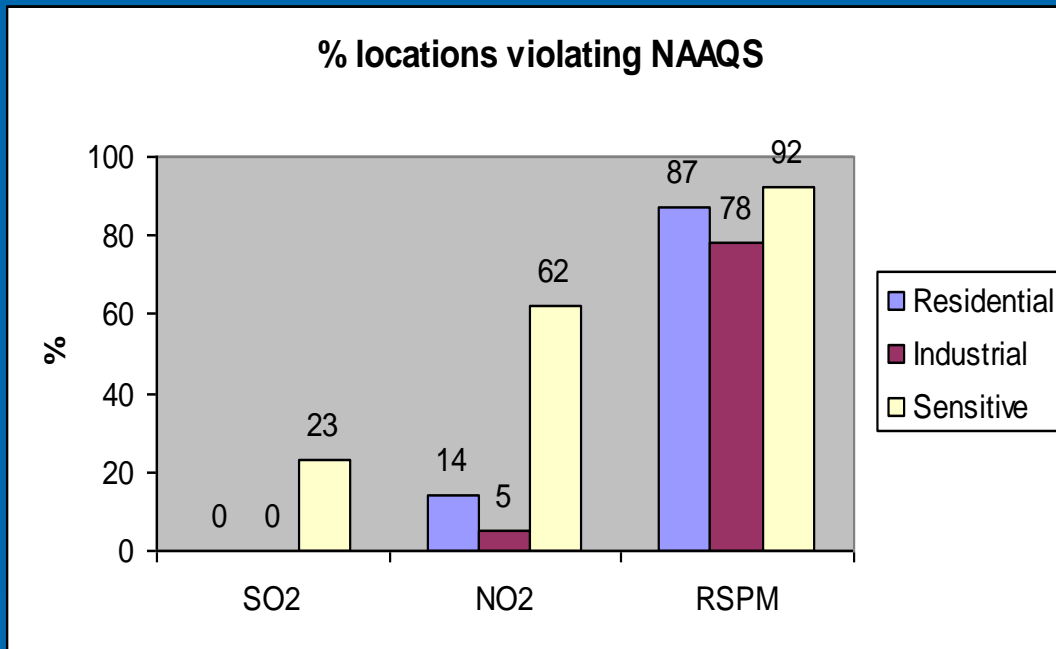
Scavenging ratios vs. rain intensity





Air quality in India

% of locations violating NAAQS in 2008



SO2 is mostly well within NAAQS limits

NO2 moderately crossing the NAAQS

SPM and RSPM mostly higher than NAAQS

(Source: NAAQMS/33/2009-10 (CPCB))

Annual NAAQS during 2008

Pollutant	Industrial (ug/m3)	Residential (ug/m3)	Sensitive (ug/m3)
SO2	80	60	15
NO2	80	60	15
RSPM	120	60	50

Summary

- Atmospheric soil-dust is an important constituent of the atmosphere in India and part of China which buffers the acidity.
- Estimation of dust component and its equivalent SO_4 aerosols calculations will help in validating models and in estimating radiative forcing in Asian region.
- There is a need to conduct studies on mixed aerosols having soil-dust and carbon soot for dust regions.
- Similar to SO_2 , behavior of other gases in dusty regions needs to be investigated.

30K 551



Save the Planet

