Natural terrestrial aerosol sources

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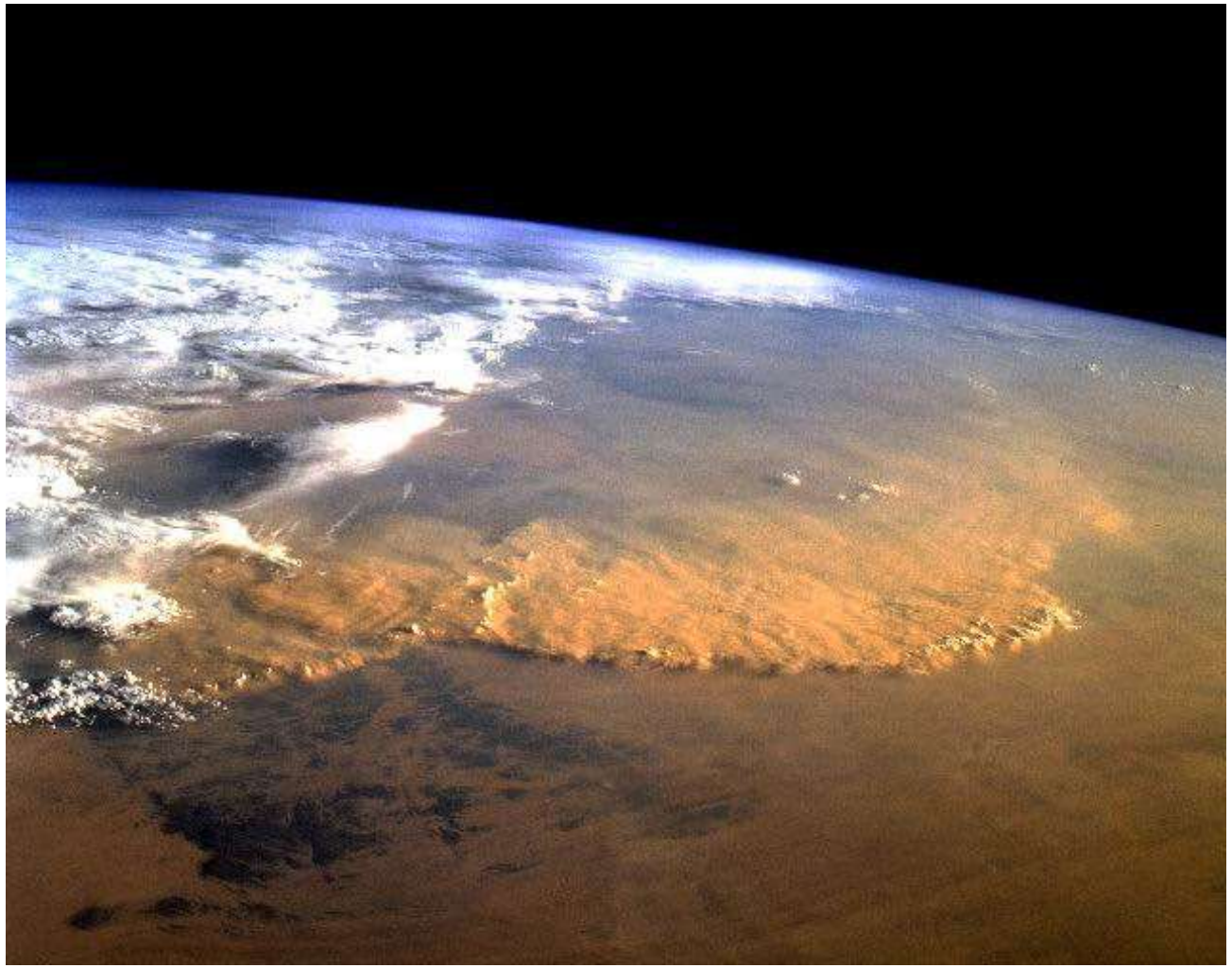
NIWA

Mineral dust as an aerosol source

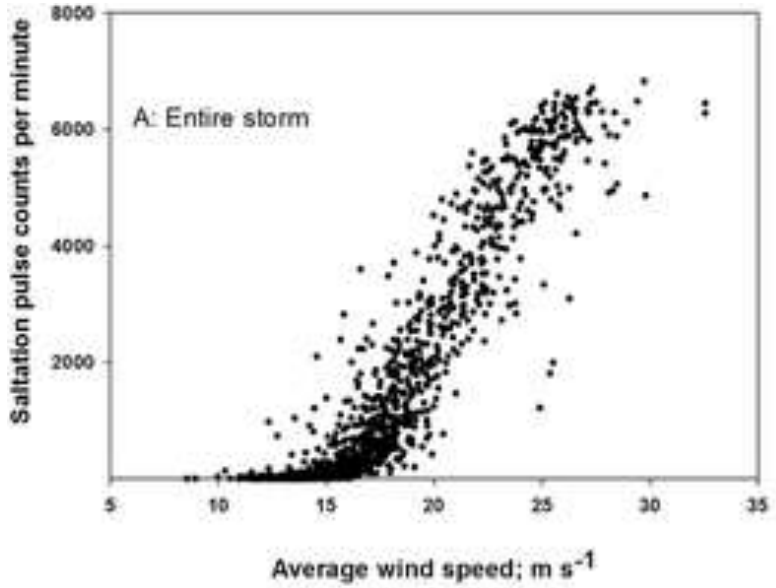
Sources	Emission Tg yr^{-1},	Lower limit Tg yr^{-1}	Upper limit Tg yr^{-1}	Column burden mg m^{-2}	Contribu on to Optical depth
Natural					
Primary					
Soil dust	1500	100	2000	32.2	0.023
Sea-salt	1300	300	10000	7	0.003
Volcanic dust	33	25	300	0.7	0.001
Biological debris	50	3	150	1.1	0.002
Secondary					
Sulphates	150	85	1100	2.8	0.014
Organics	55	15	200	2.1	0.011
Nitrates	30	15	700	0.5	0.001
Total Natural	3118	543	14450	46.4	0.055
Anthropogenic					
Primary					
Industrial dust	100	10	170	2.1	0.004
Black carbon	20	3	150	0.6	0.006
Secondary					
Sulphates	140	70	375	3.8	0.019
Biomass burning (w/o BC)	90	60	150	3.4	0.017
Nitrates	40	23	65	0.8	0.002
Organic matter	10	5	90	0.4	0.002
Total Anthropogenic	400	171	1000	11.1	0.05
Total	**3518**	**714**	**15450**	**57.5**	**0.105**
Anthropogenic fraction (%)	11	24	6	19	48

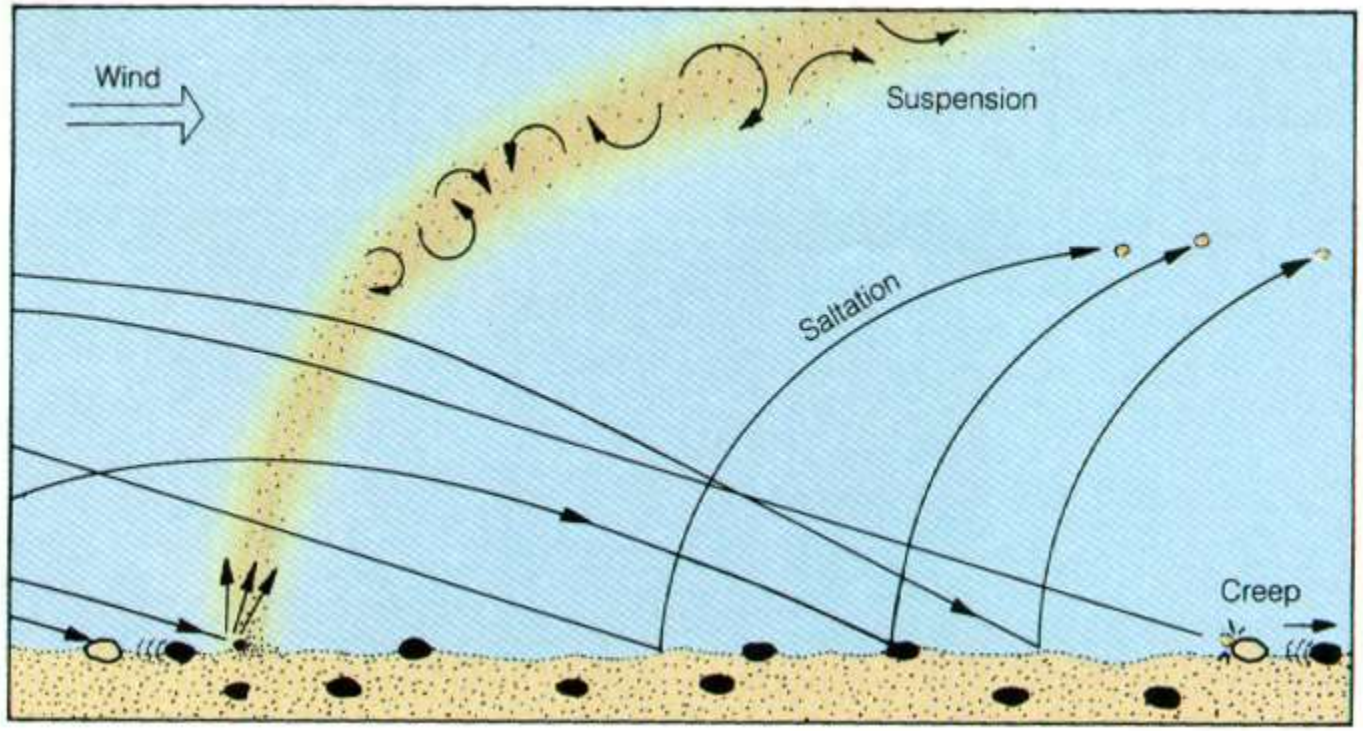


Duststorm impacts

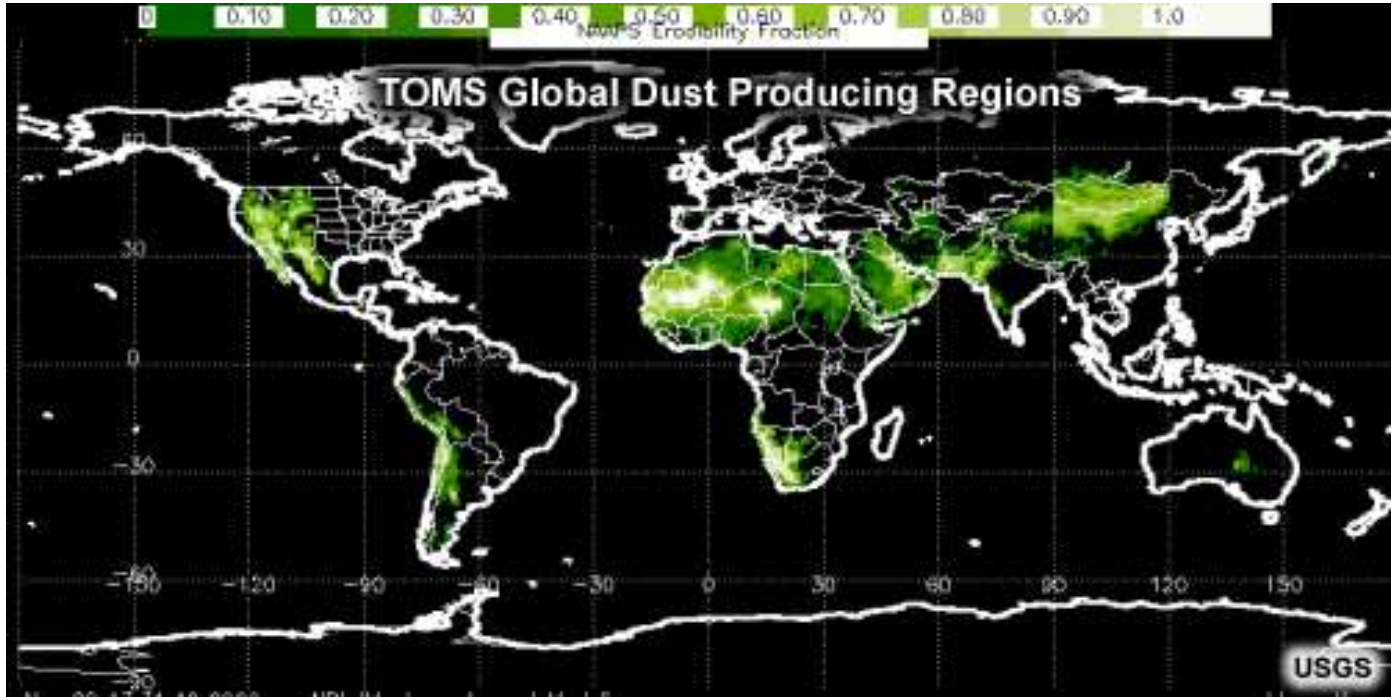
Saltation

- Pre-requisites:
  - Sand
  - Wind
- Constraints:
  - Dust reservoir/supply
  - Crust/moisture





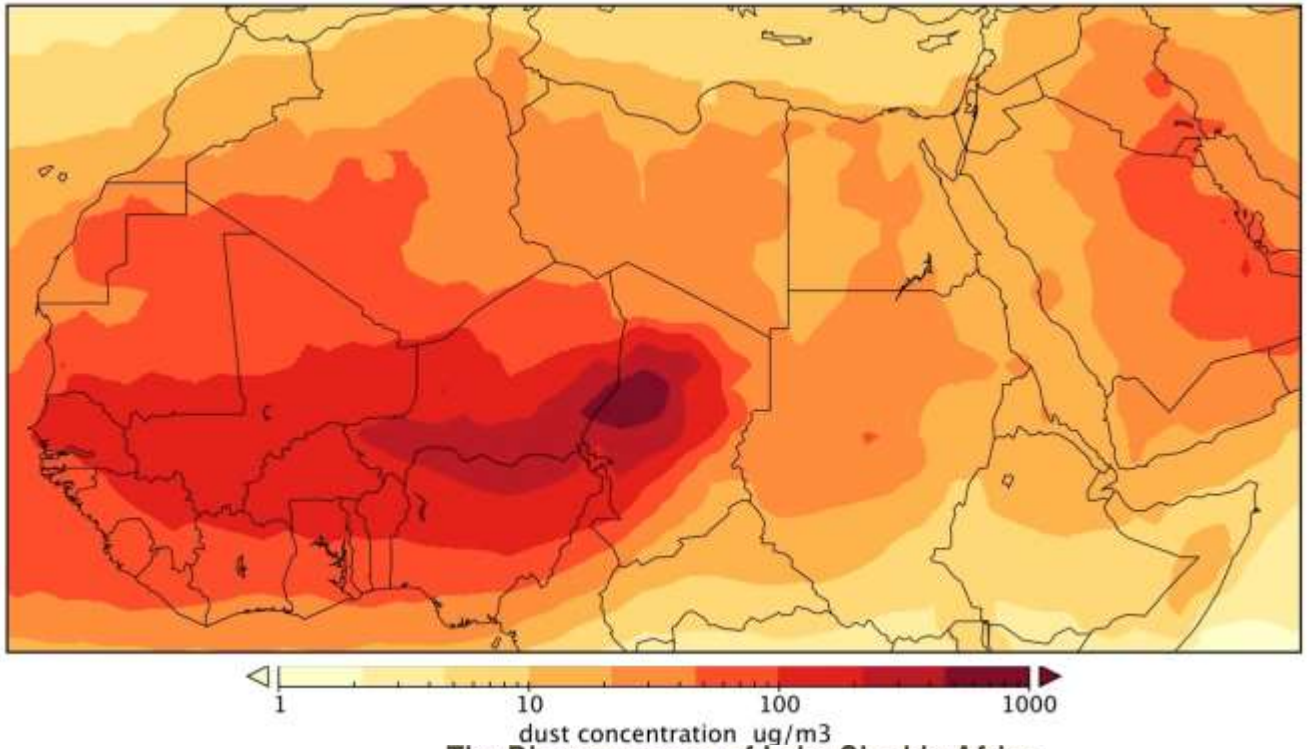
Source areas



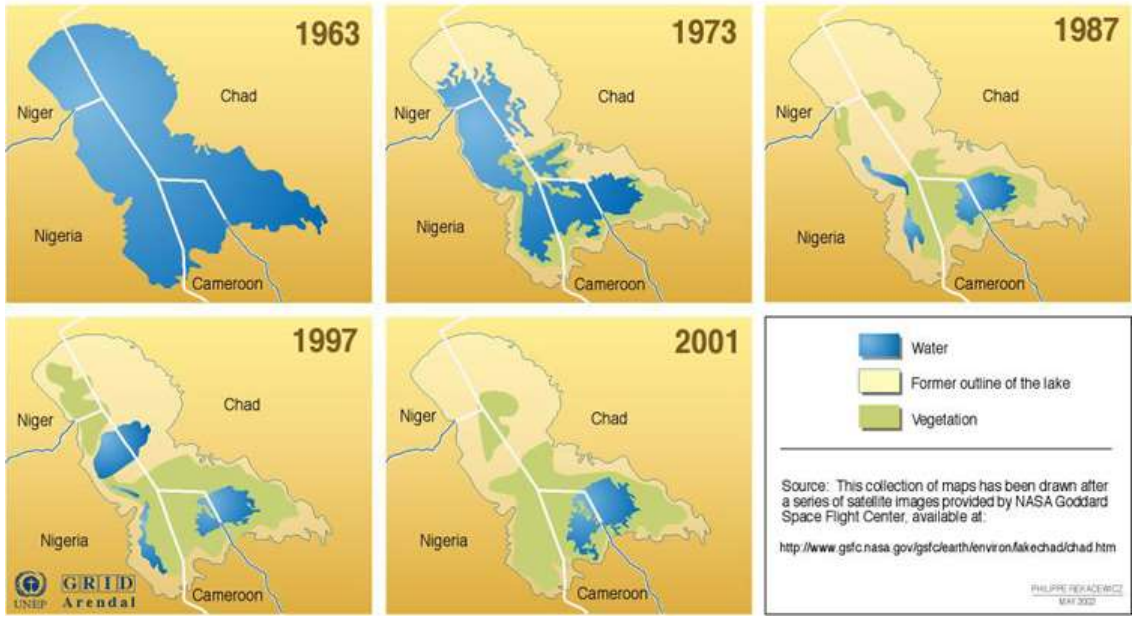
- Topographic lows exposed to the wind
- 200 – 250 mm rainfall to adjacent highlands (more leads to vegetation growth and soil formation)
- Alluvial deposits, intermittent/ephemeral flooding

- Largest sources are most remote
- Nearby sand source

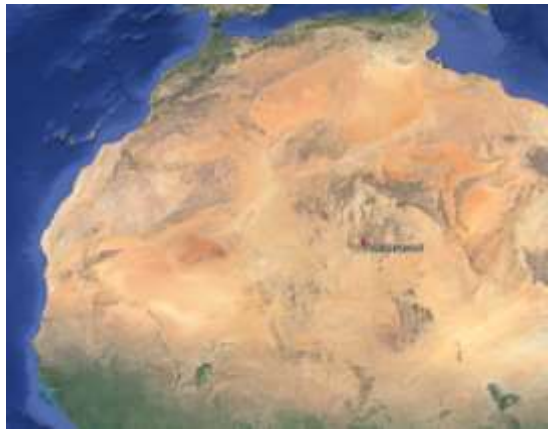
The Bodele depression, Chad

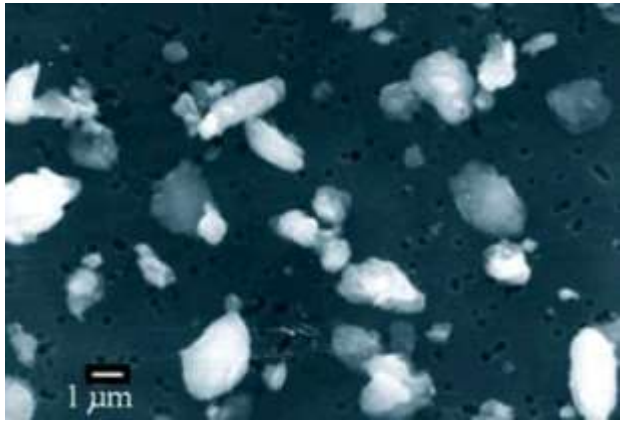


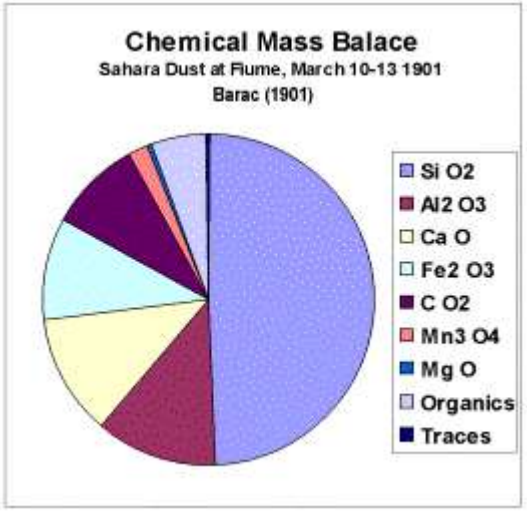
The Disappearance of Lake Chad in Africa

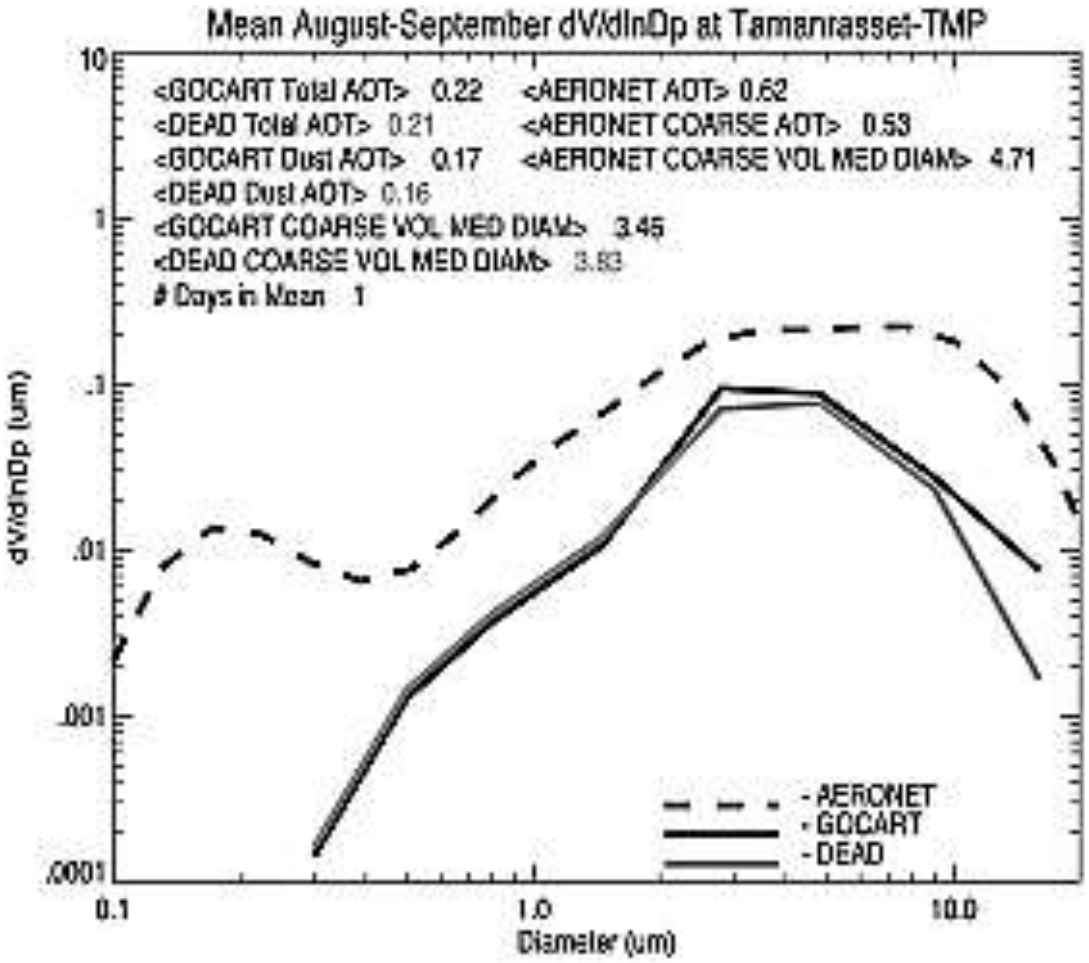


Observing desert dust aerosol

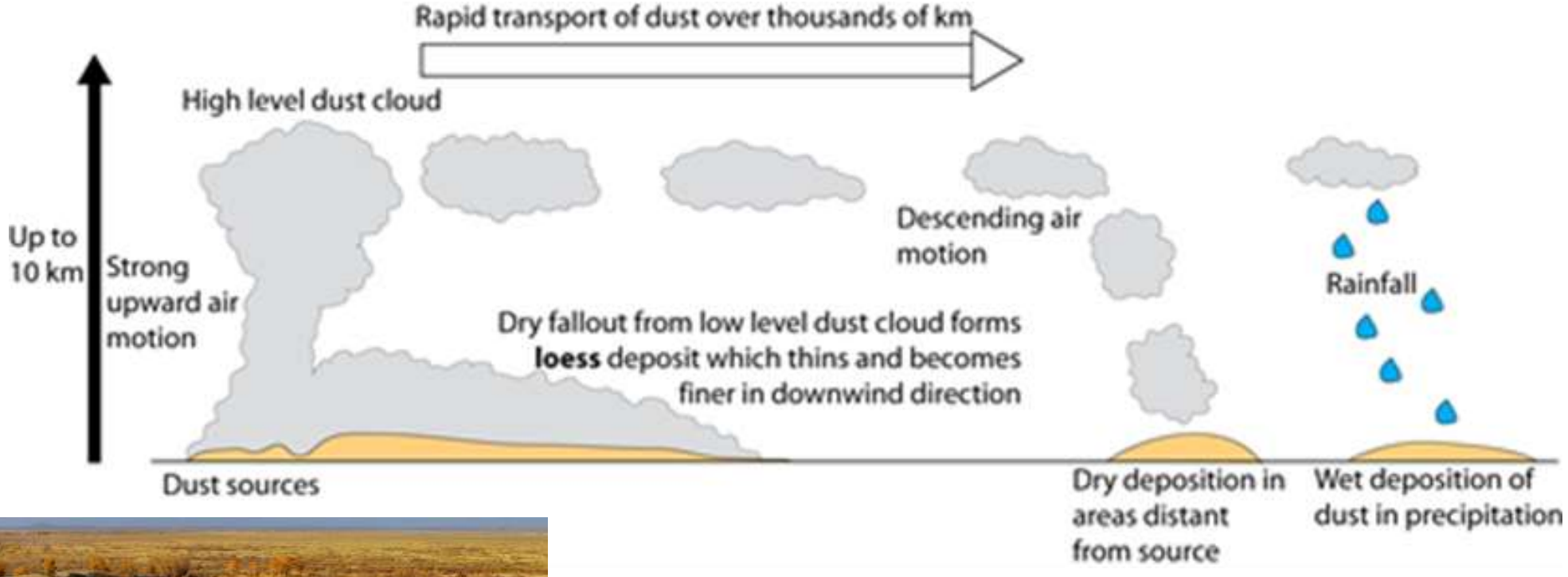








Short-range transport



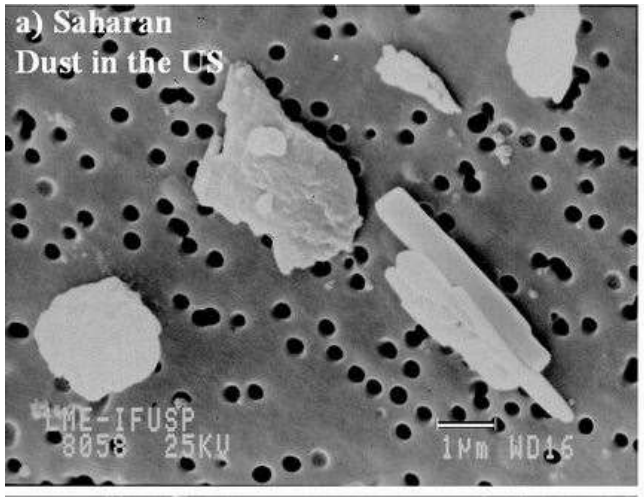
- Dunes are not significant dust sources due to absence of saltating sand – they represent locations where winds are locally reduced, hence deposition dominates

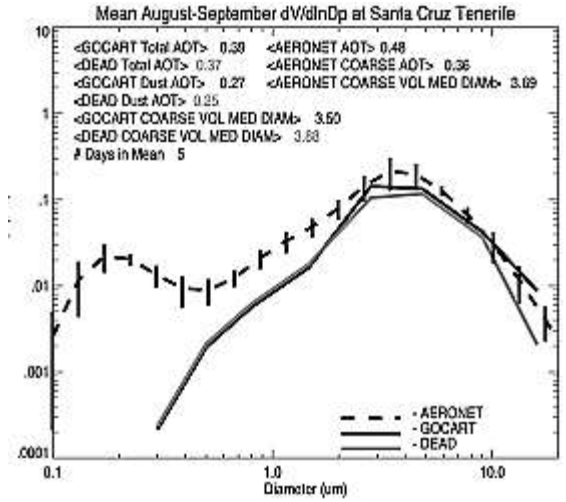
Loess

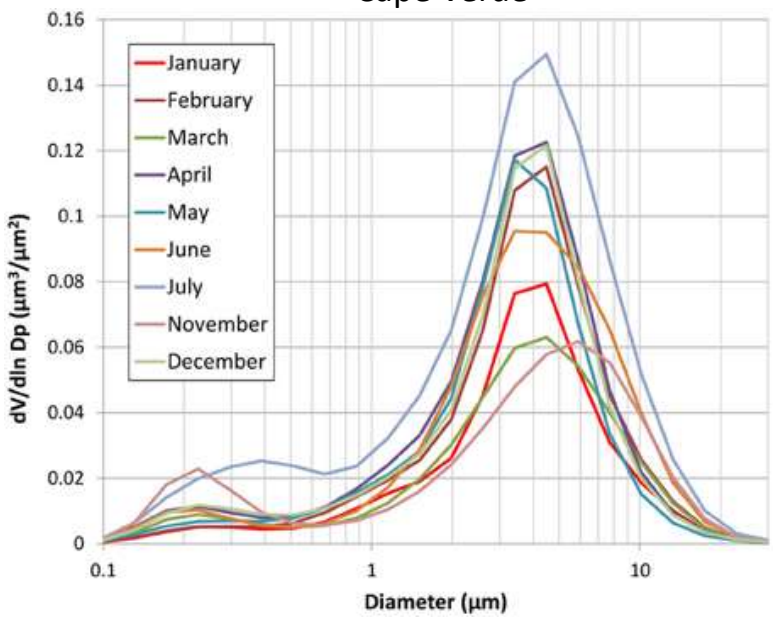
- Deposits of resuspended dust
- Absence of sand to initiate saltation
- Animal and agricultural activity loosens dust allowing easy resuspension

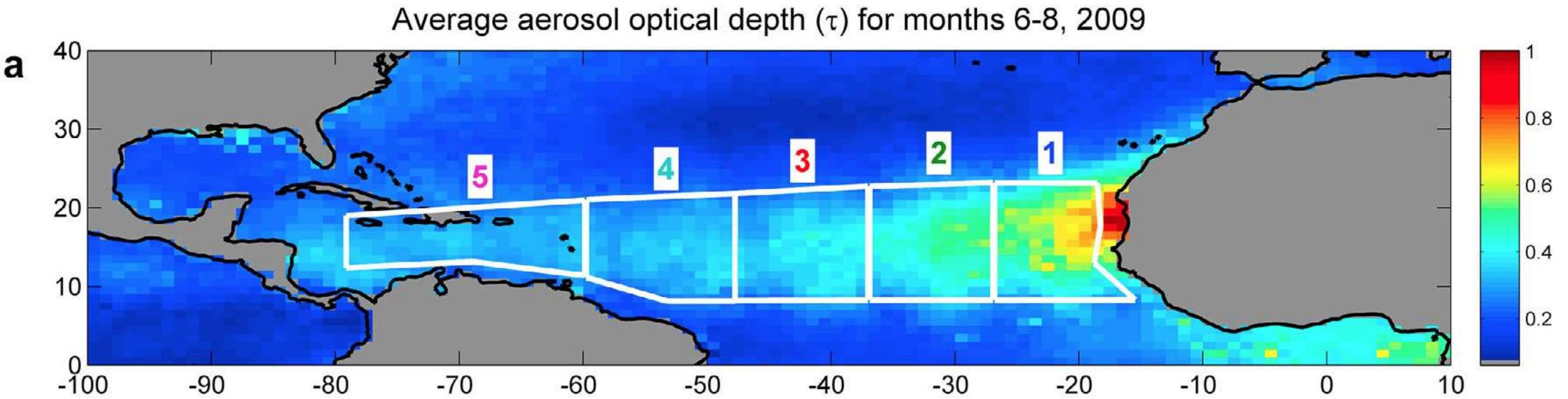
Dust (mineral aerosols)
- diameter size: 2-300 μm
- main material: sand, silt, clay
- includes essential trace metals such as Fe
- consists of insoluble and soluble fractions

Long-range transport

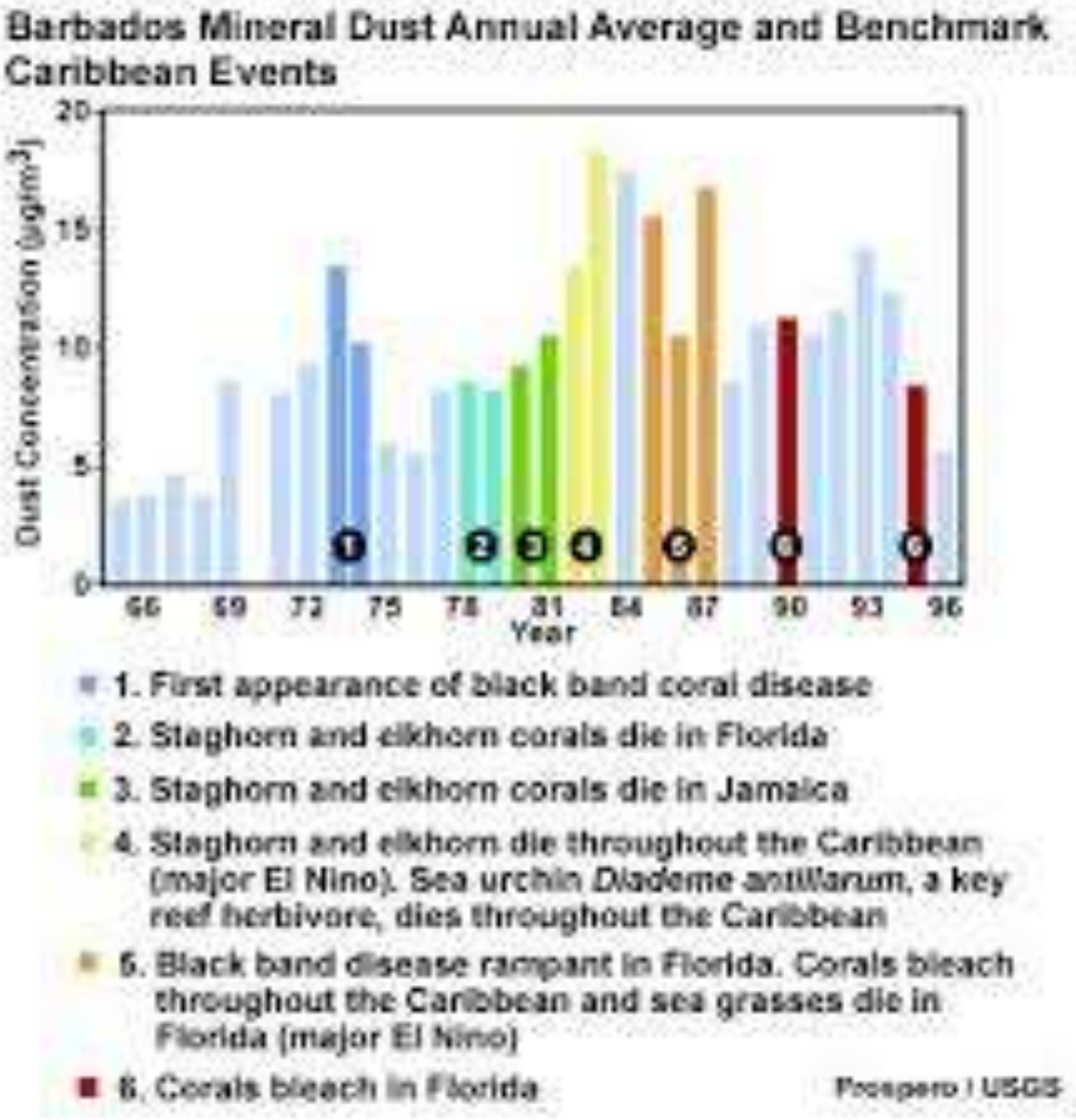


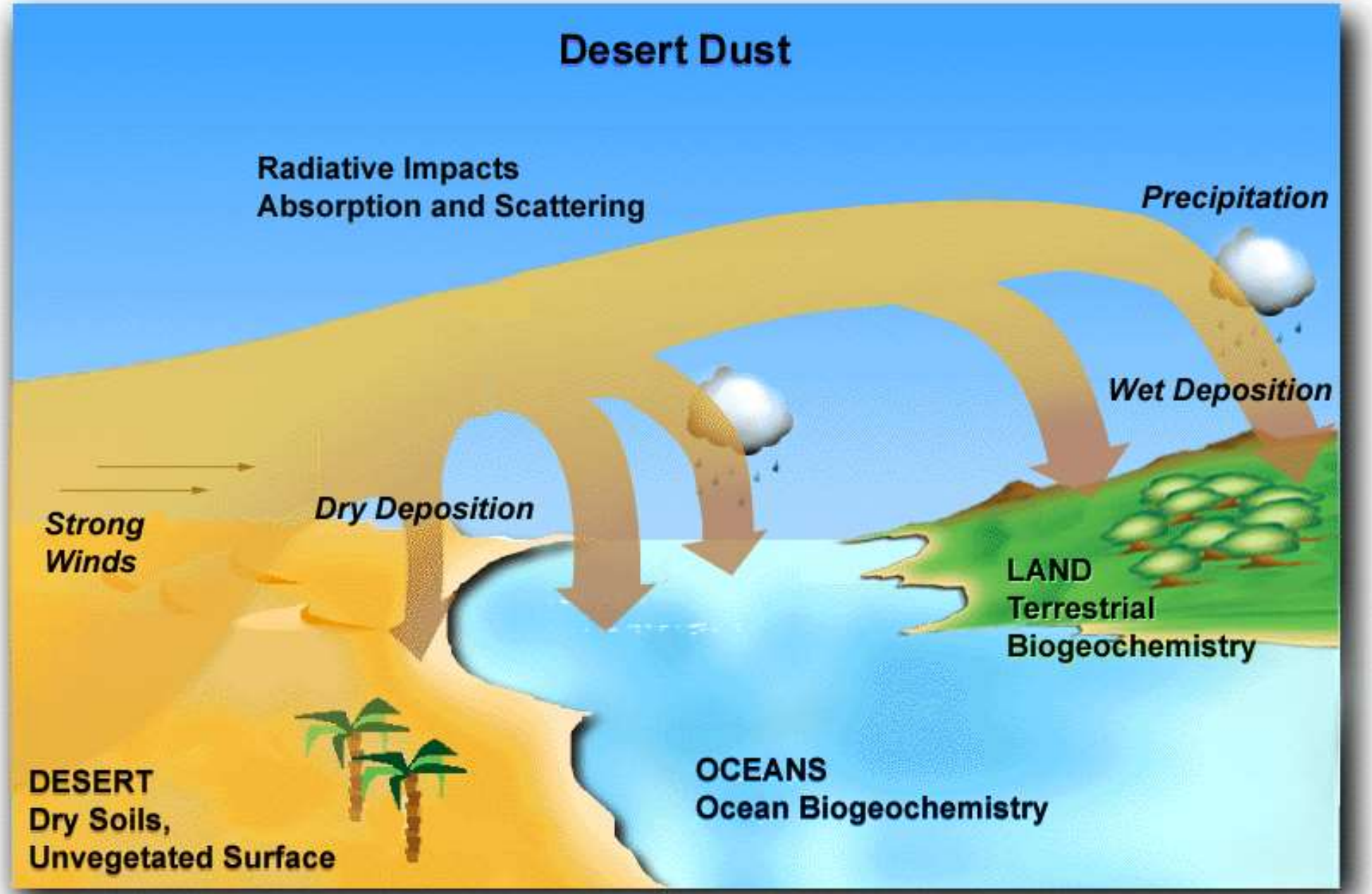






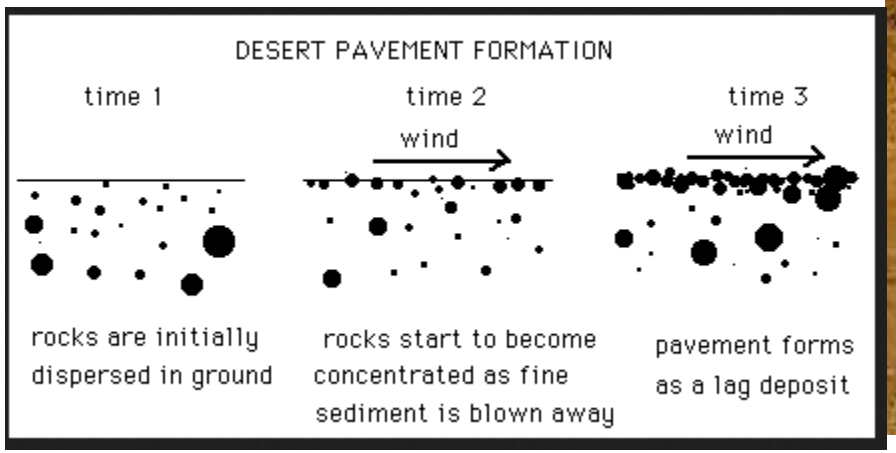
Long-range impacts



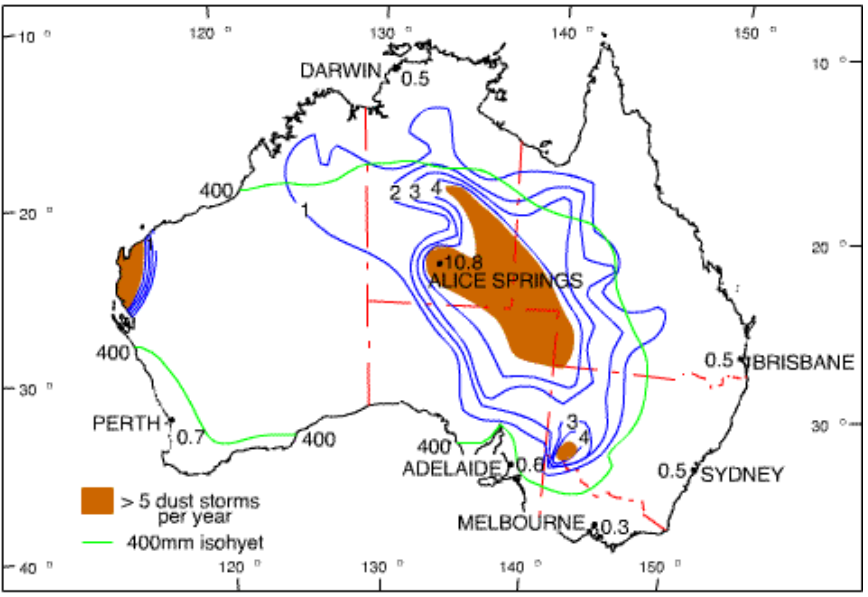

Desert Dust
Radiative Impacts
Absorption and Scattering
Precipitation
Wet Deposition
Dry Deposition
Strong
Winds
LAND
Terrestrial
Biogeochemistry
DESERT
Dry Soils,
Unvegetated Surface
OCEANS
Ocean Biogeochemistry

The Australian source

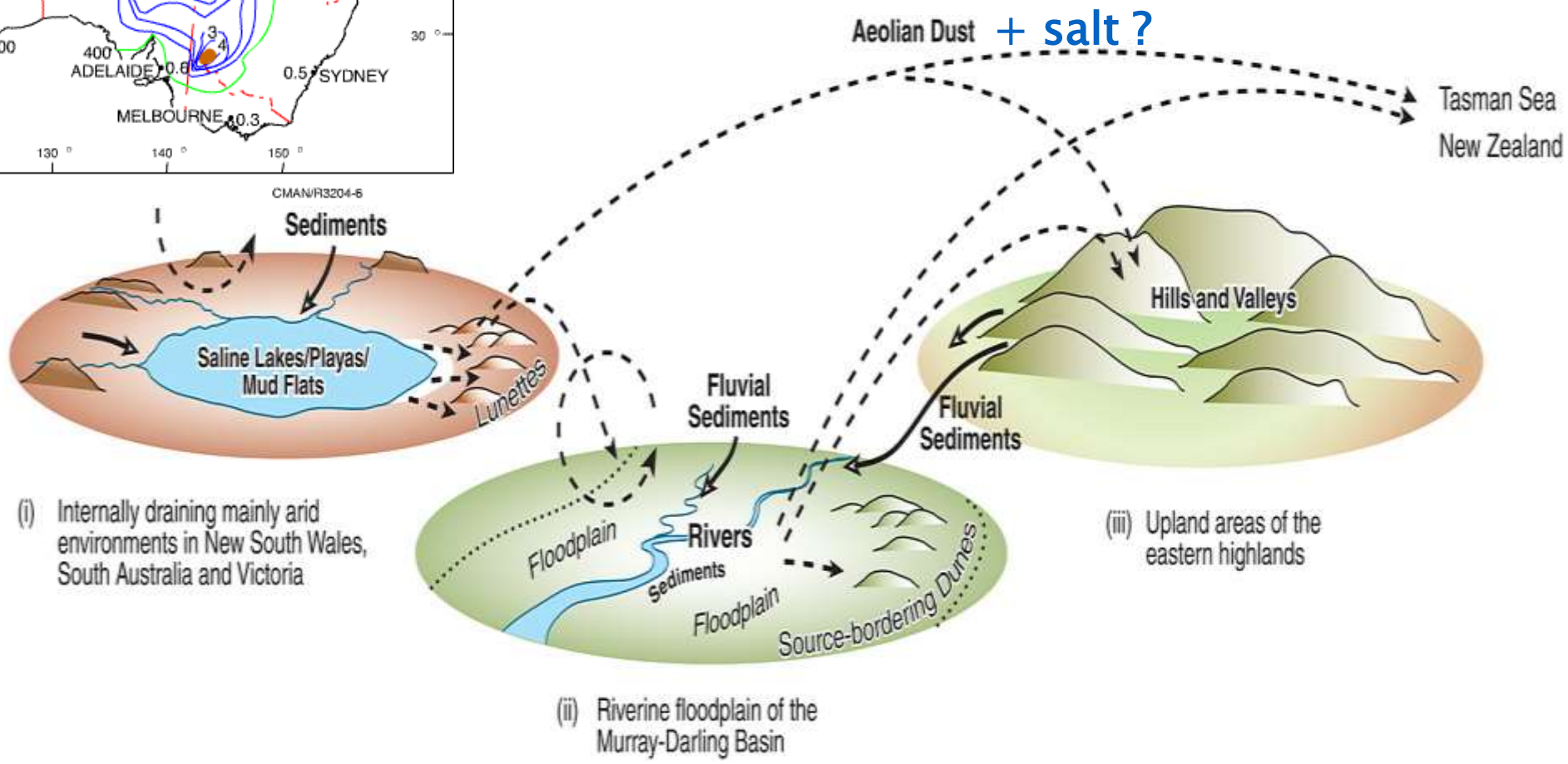
- Dust deposits already deflated
- Stony surface
- Limited erosion

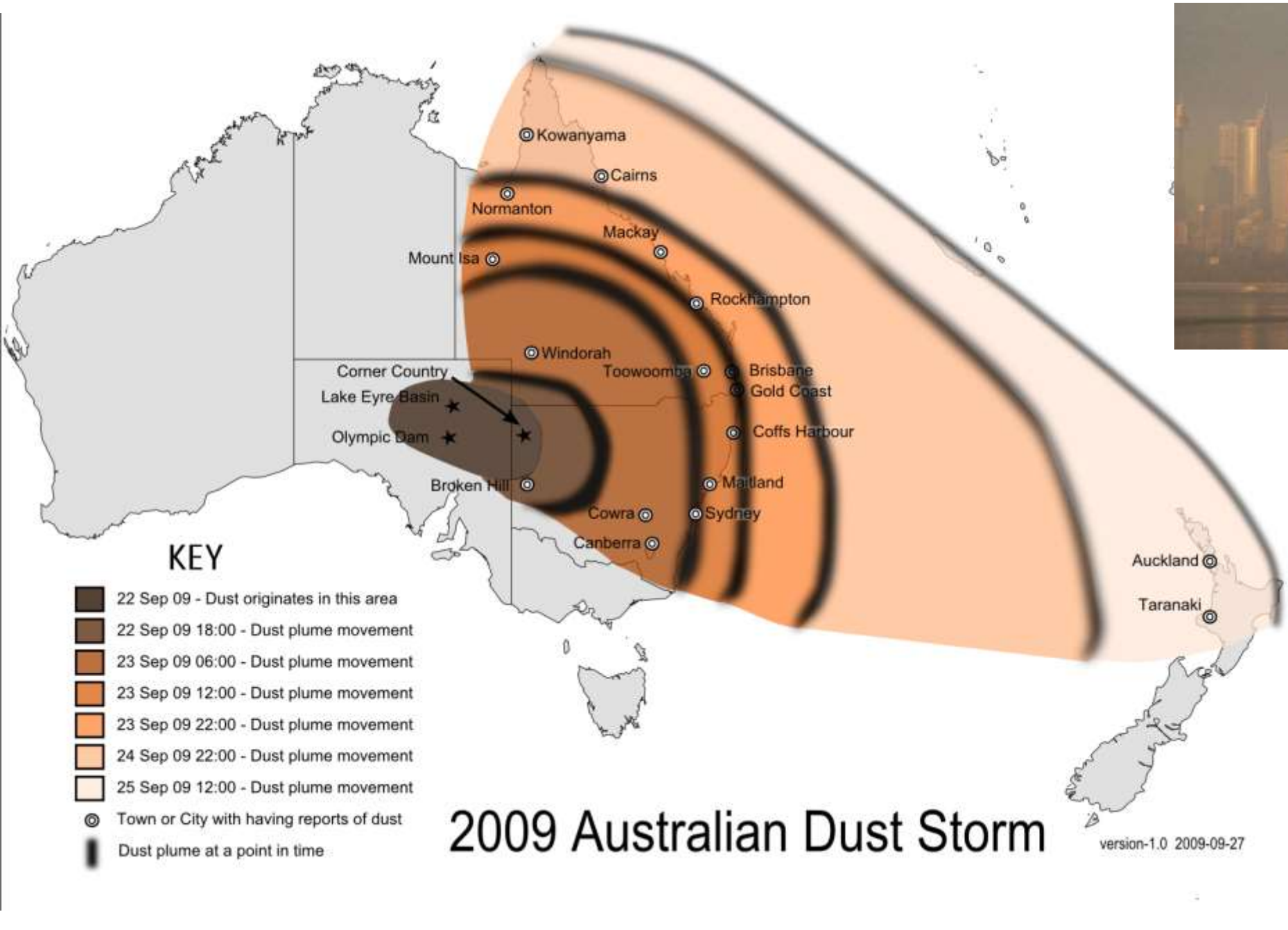


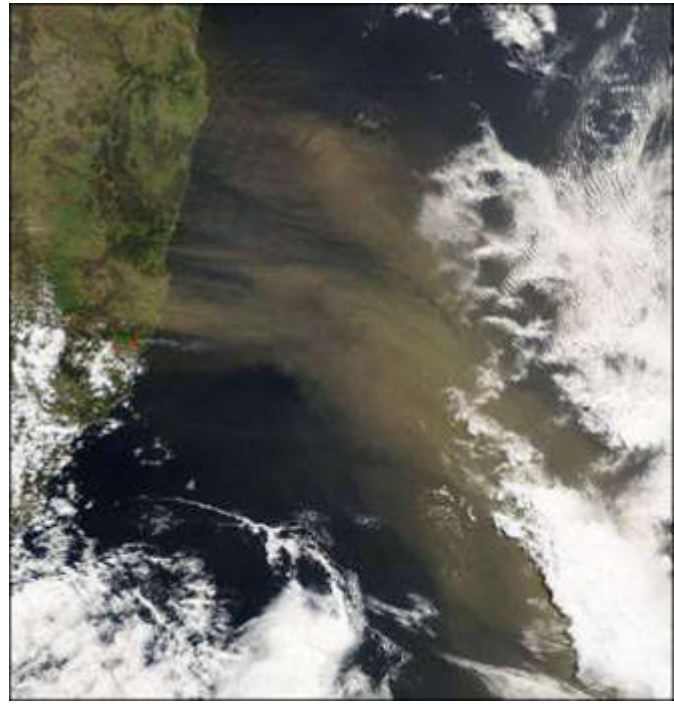
Dust sources & transportation in Australia



CMAN/R3204-6

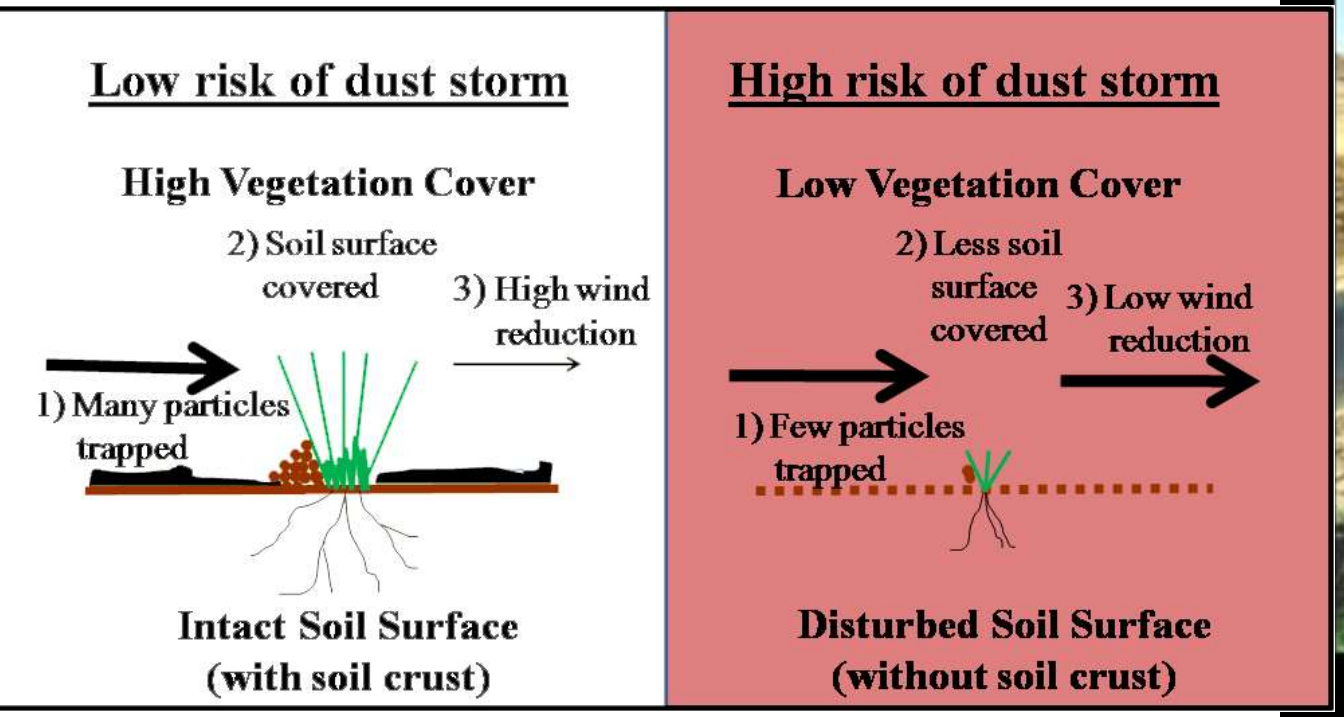



Kowanyama
Cairns
Normanton
Mackay
Mount Isa
Rockhampton
Windorah
Corner Country
Toowoomba
Brisbane
Gold Coast
Lake Eyre Basin
Olympic Dam
Coffs Harbour
Broken Hill
Maitland
Cowra
Sydney
Canberra
Auckland
Taranaki
KEY
22 Sep 09 - Dust originates in this area
22 Sep 09 18:00 - Dust plume movement
23 Sep 09 06:00 - Dust plume movement
23 Sep 09 12:00 - Dust plume movement
23 Sep 09 22:00 - Dust plume movement
24 Sep 09 22:00 - Dust plume movement
25 Sep 09 12:00 - Dust plume movement
Town or City with having reports of dust
Dust plume at a point in time
2009 Australian Dust Storm
version-1.0 2009-09-27

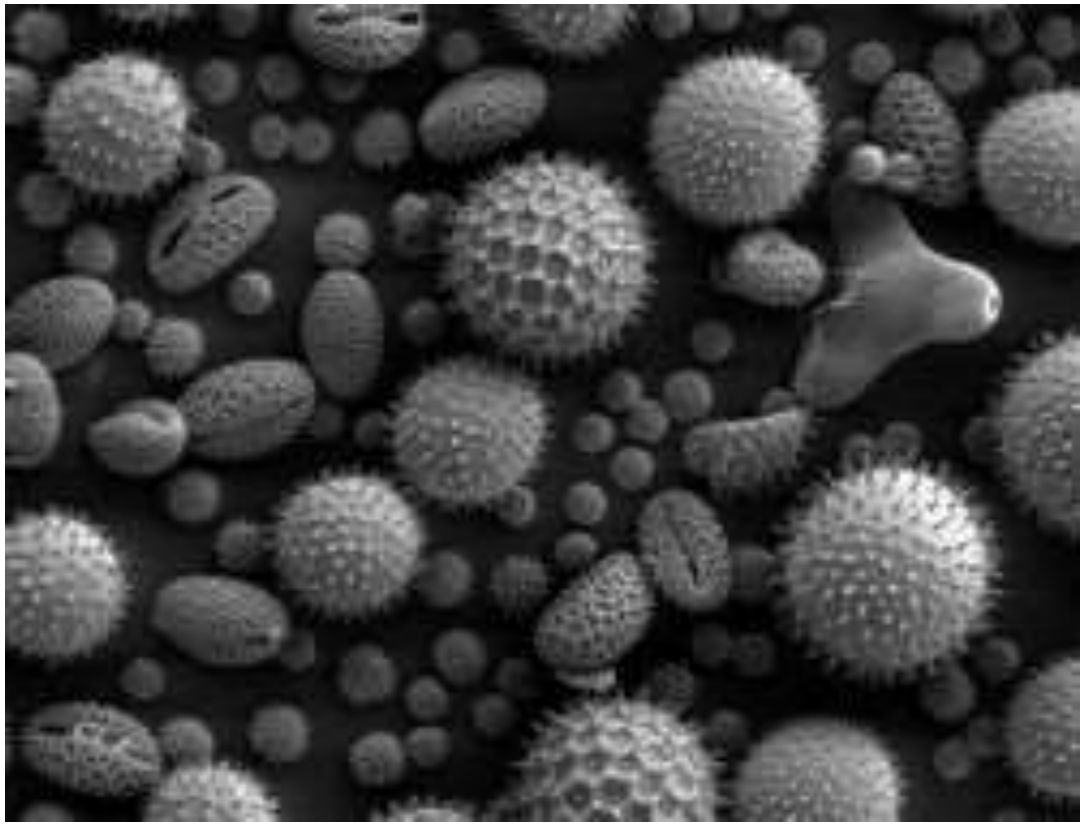


Crust disturbance

Land and climate change



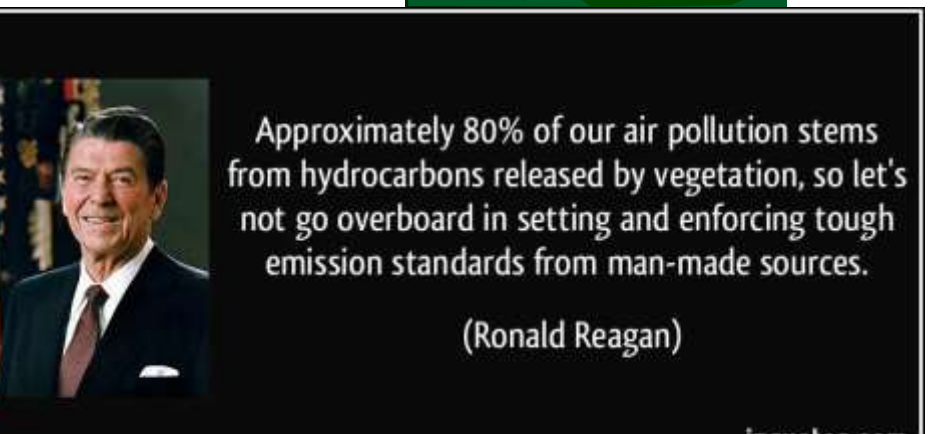
Bioaerosol

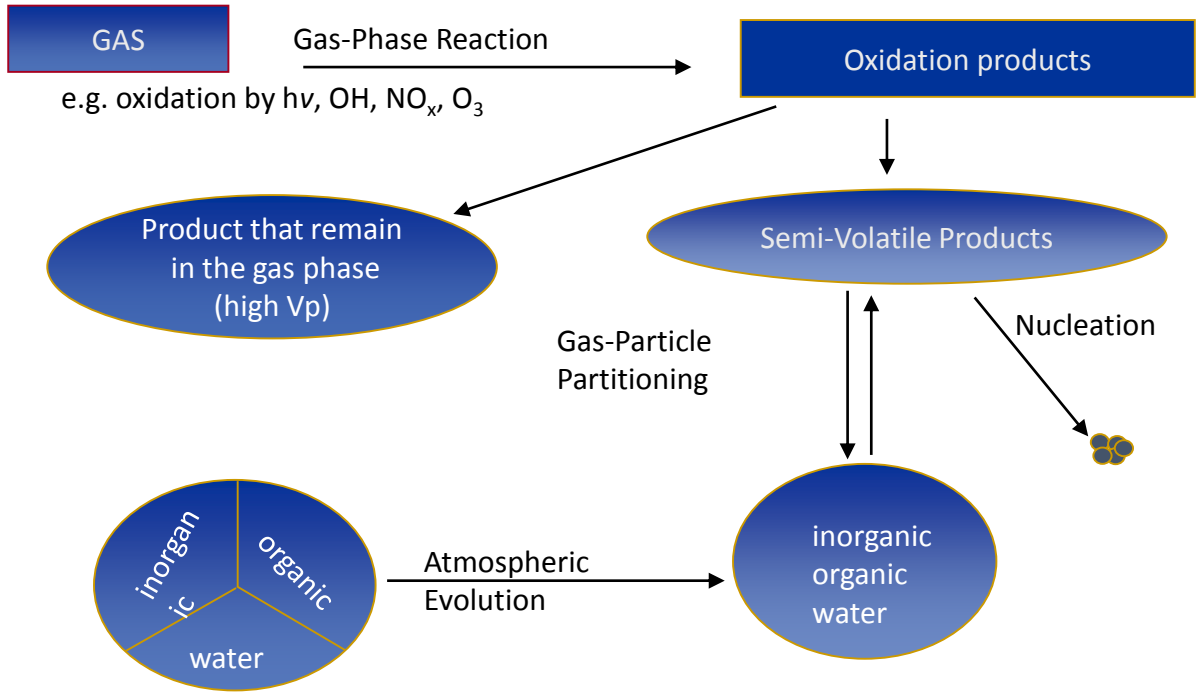


Pollen and dander

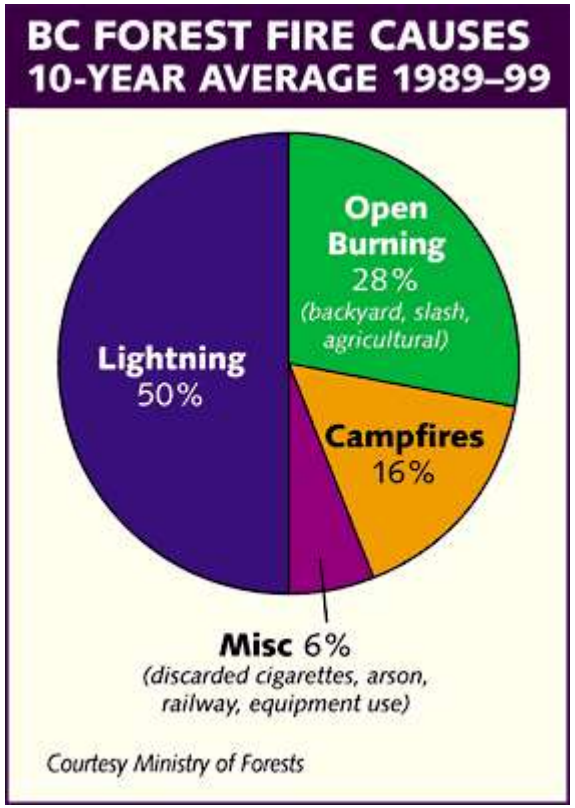
Vegetation sources of aerosol

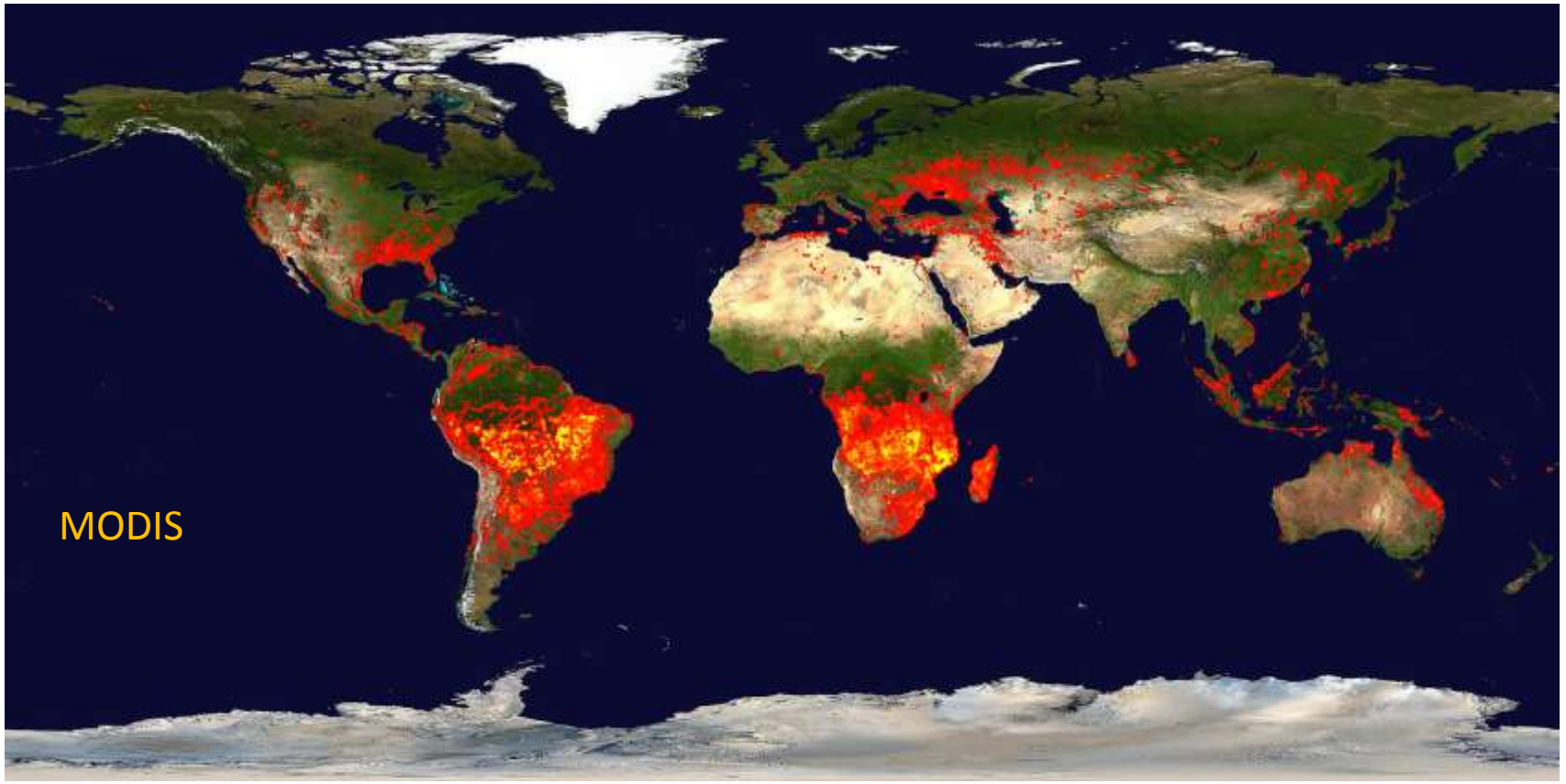
- Secondary aerosol from biogenic VOCs producing fine particles (?)

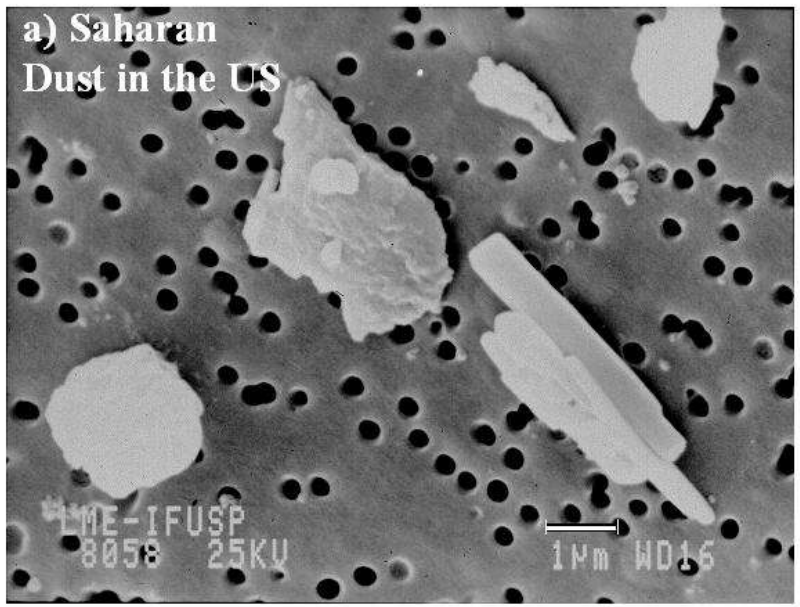


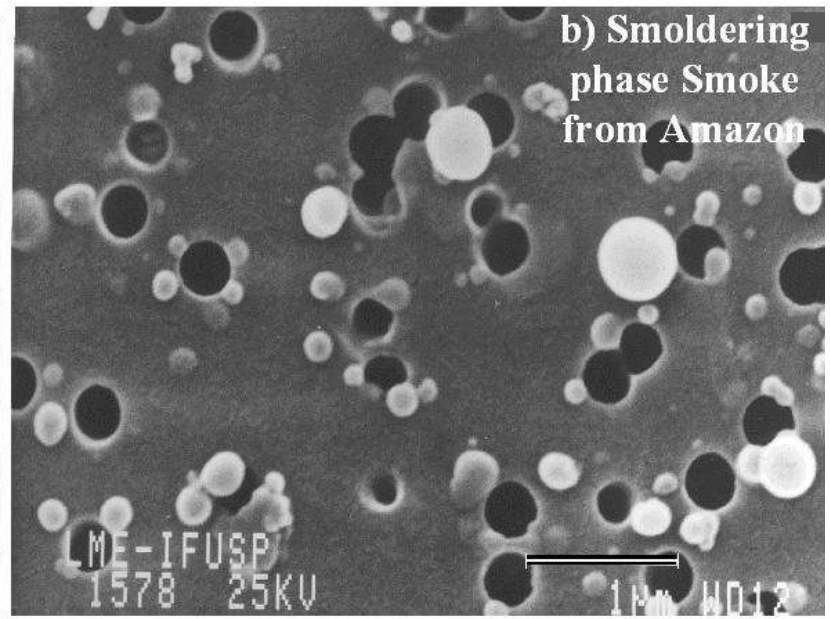


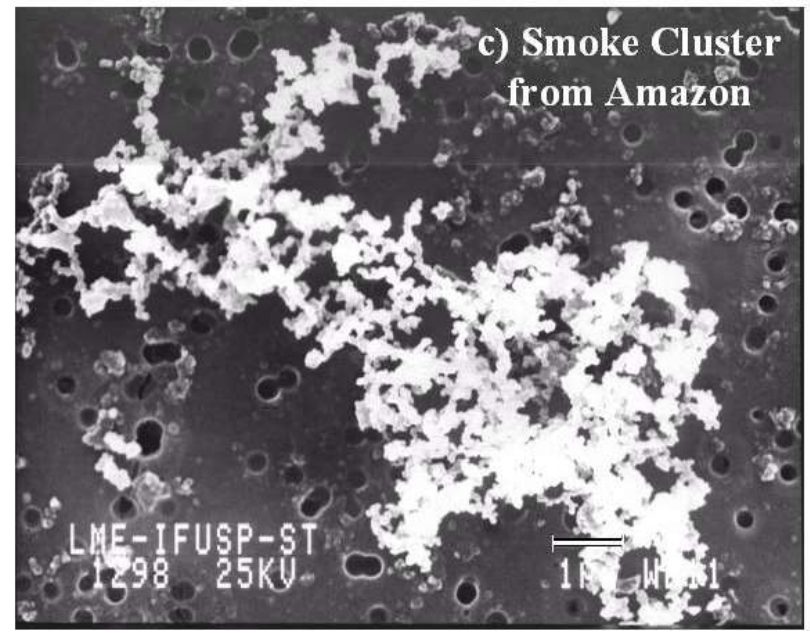
Wildfires


BC FOREST FIRE CAUSES
10-YEAR AVERAGE 1989–99
Open Burning 28% (backyard, slash, agricultural)
Lightning 50%
Campfires 16%
Misc 6% (discarded cigarettes, arson, railway, equipment use)
Courtesy Ministry of Forests

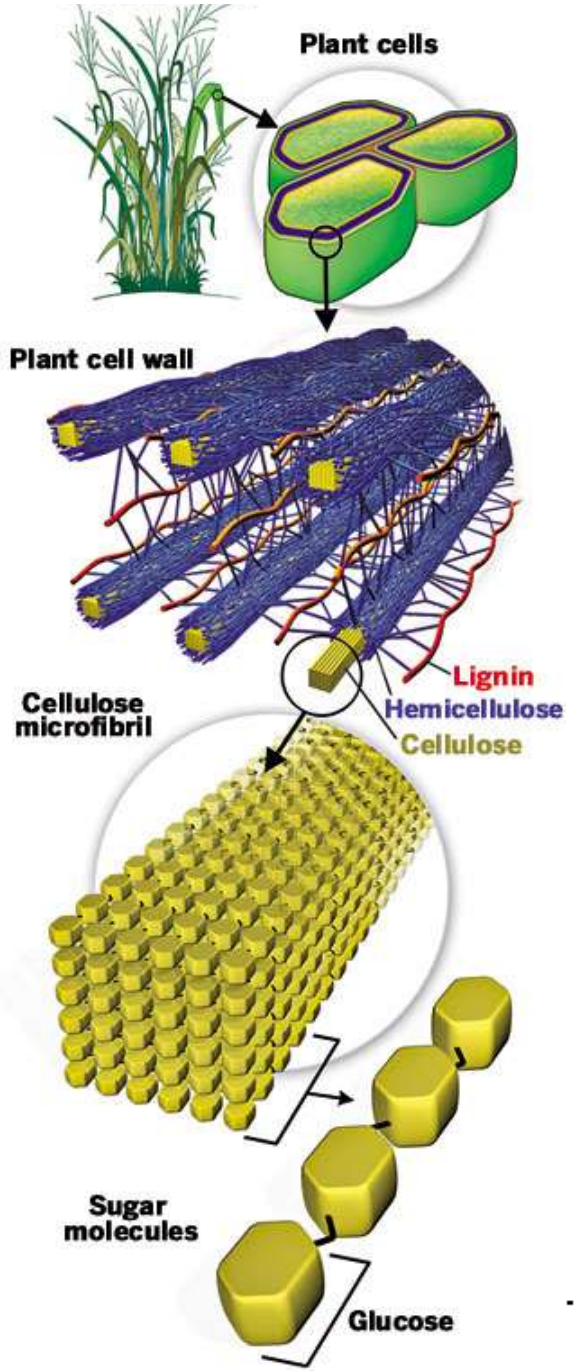

MODIS

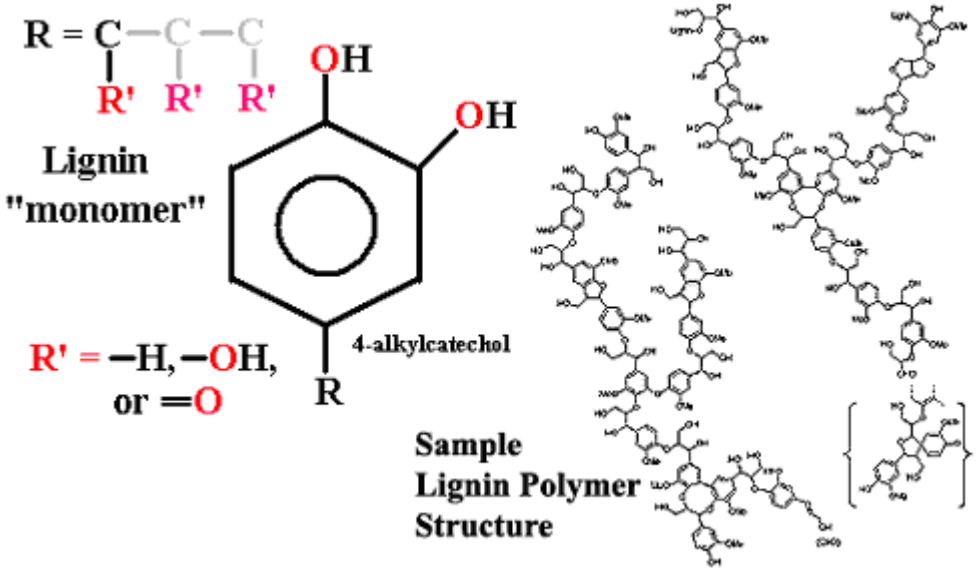

a) Saharan
Dust in the US
LME-IFUSP
8058 25KV
1Mm WD16

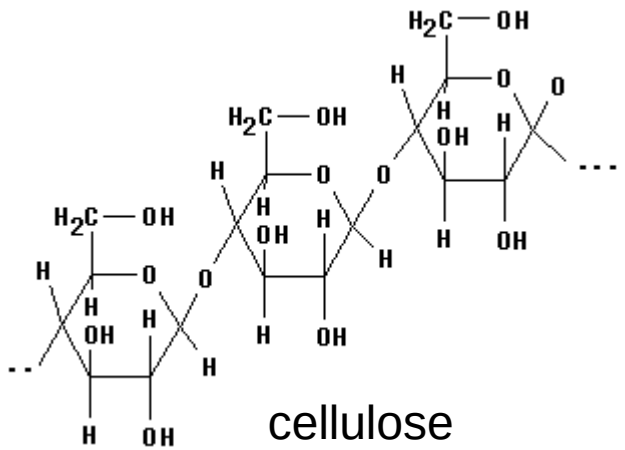

b) Smoldering
phase Smoke
from Amazon
LME-IFUSP
1578 25KV

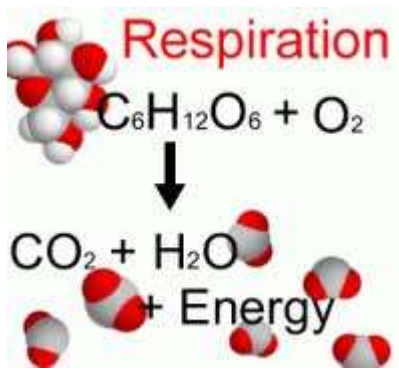

c) Smoke Cluster
from Amazon
LME-IFUSP-ST
1298 25KV

Burning biomass









Formation of soot from wood burning

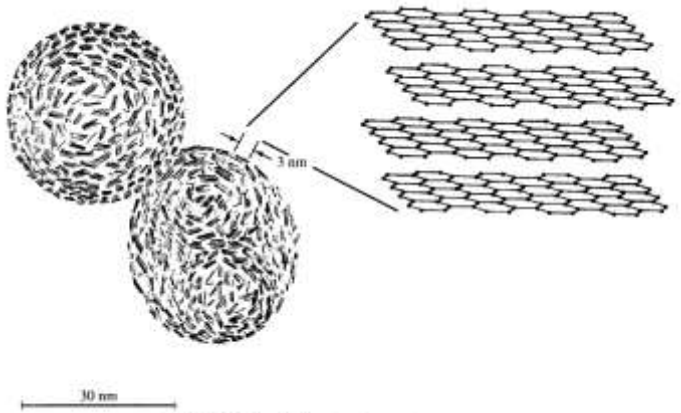
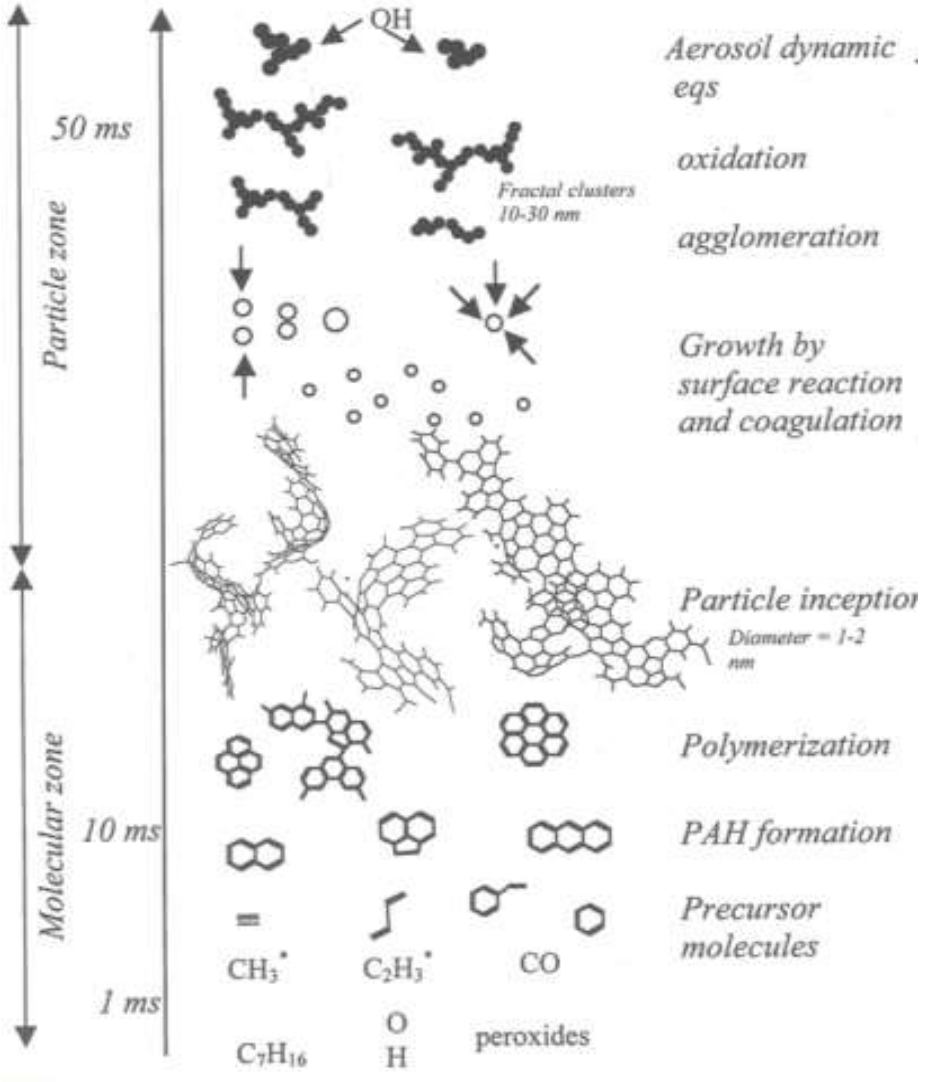


FIGURE 13.1 Schematic of soot microstructure.



soot – "elemental carbon"

- formed in flames
- little spectral dependence
- carbon-only

"brown carbon":

- sugars
- alcohols
- aromatics
- di/tri acids
- ketoacids
- hydroxyacids

Natural dust sources of NZ origin