How Dust Shapes Ecosystems: The Past, Present, and Future

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With many contributions from
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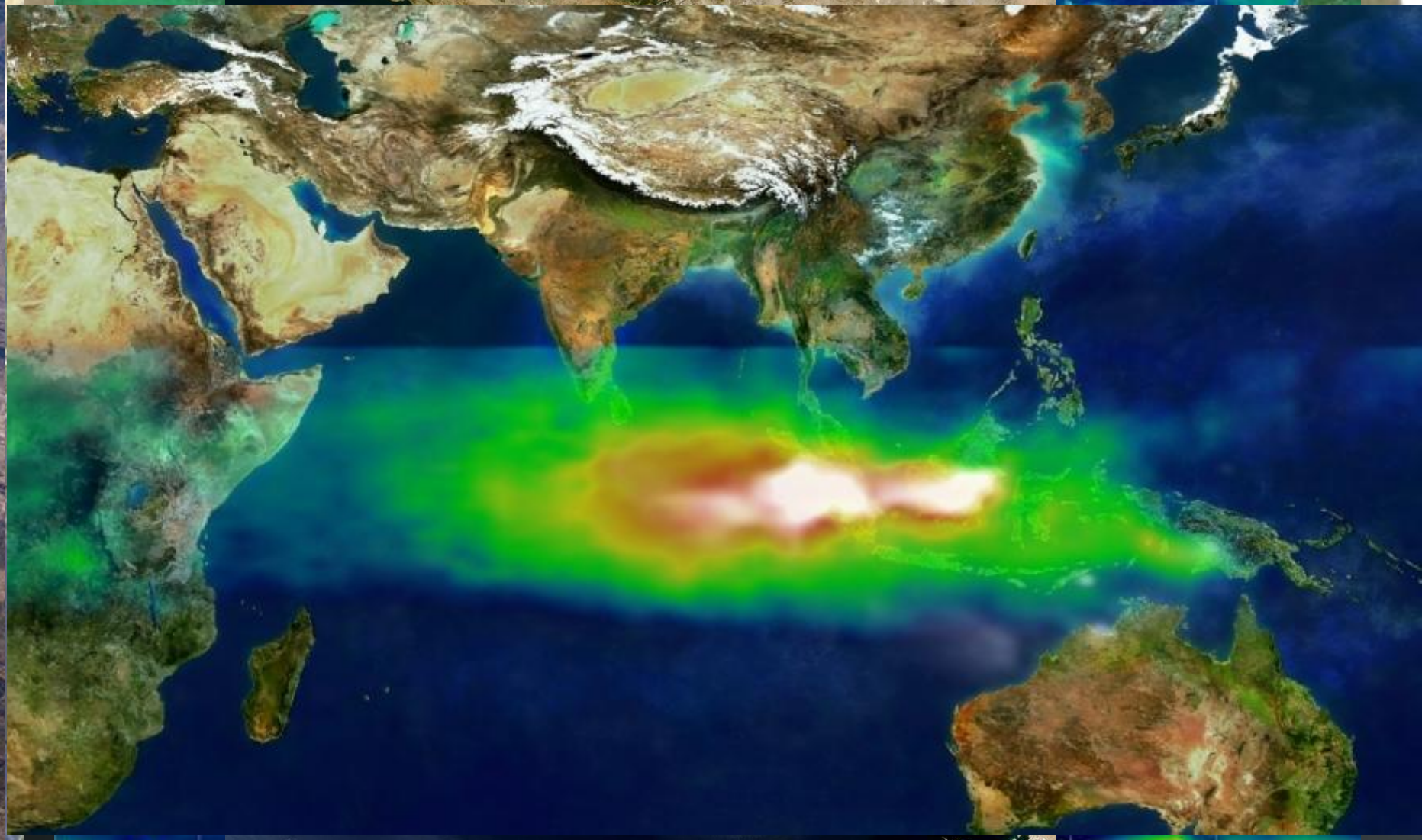
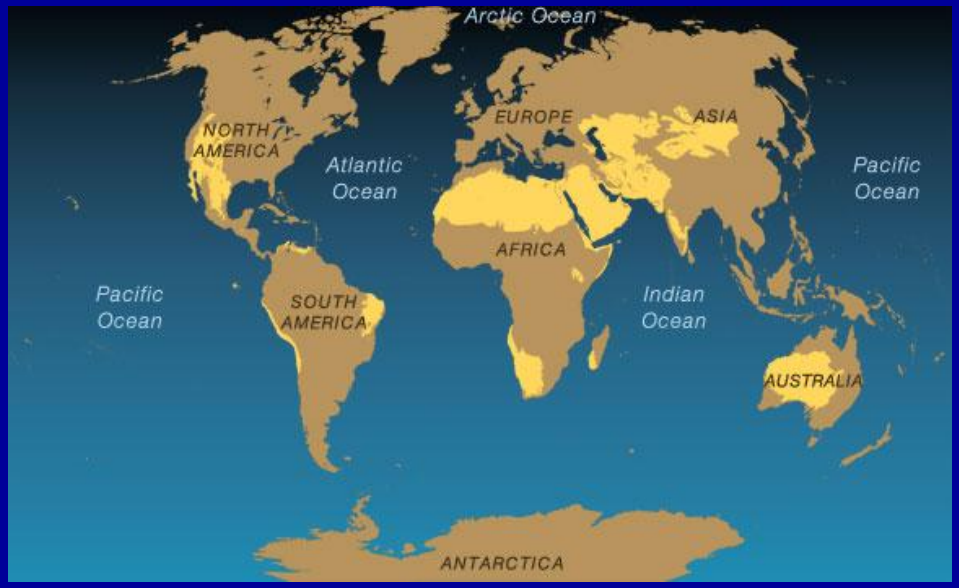
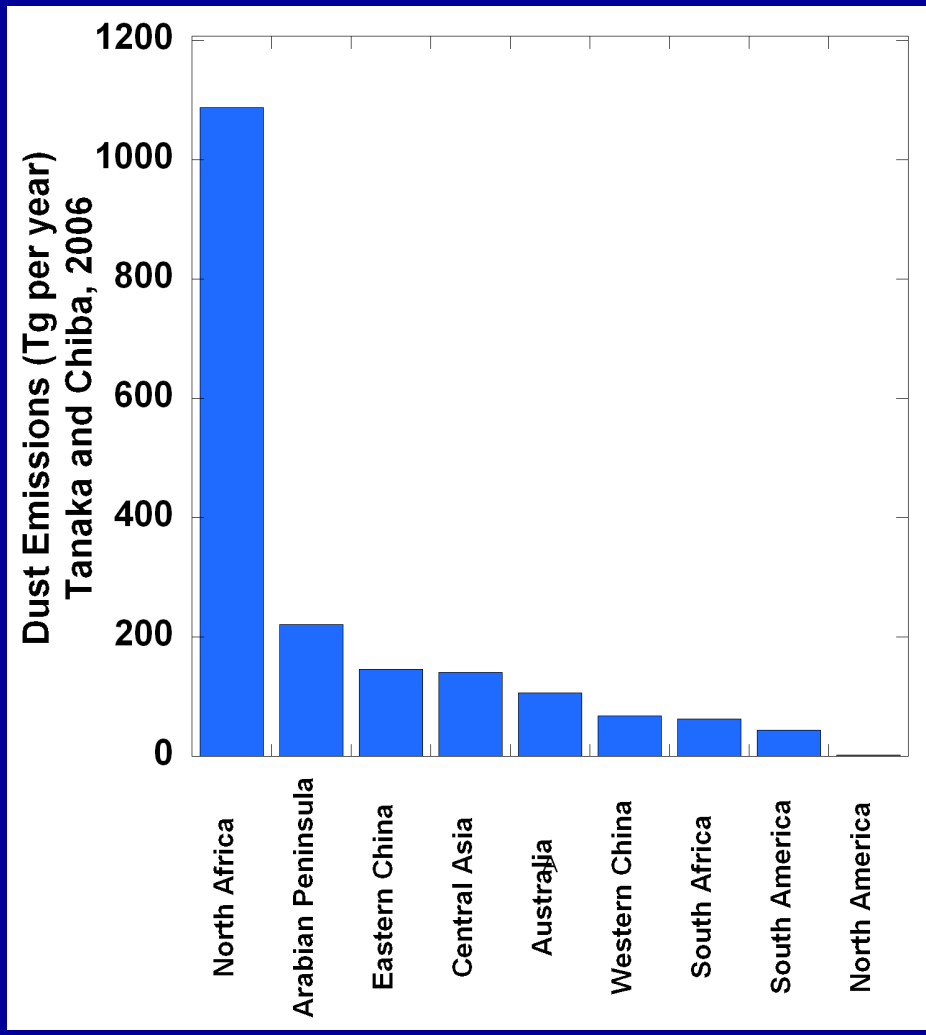

April 8, 2001
Earth Probe TOMS
0.0
Aerosol Index

Global Dust Sources (today)



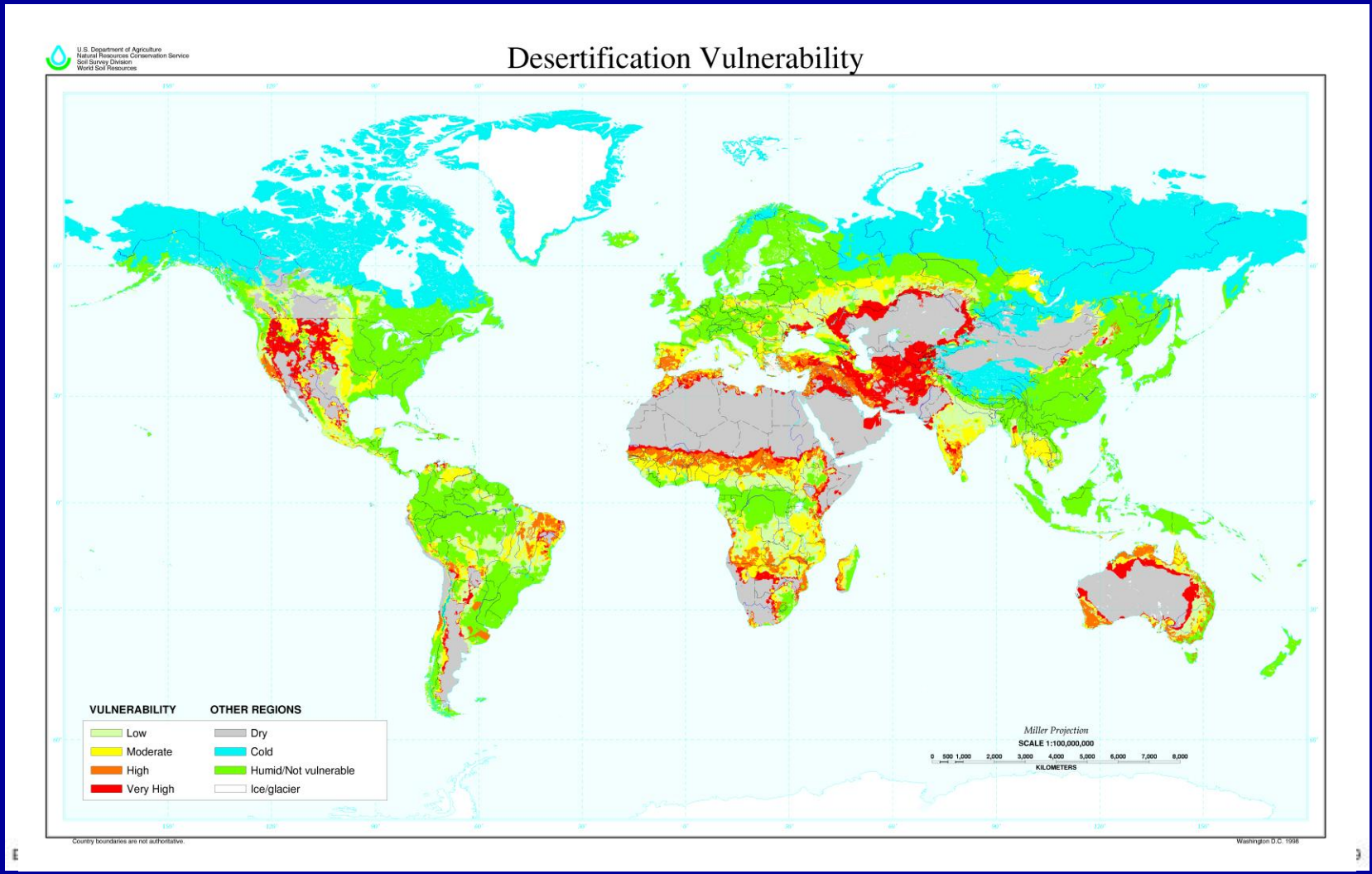


Climate impacts still important (and highly uncertain)!

Human health and disease

Significant ecological implications!

Ecological Connectivity and Climate Change

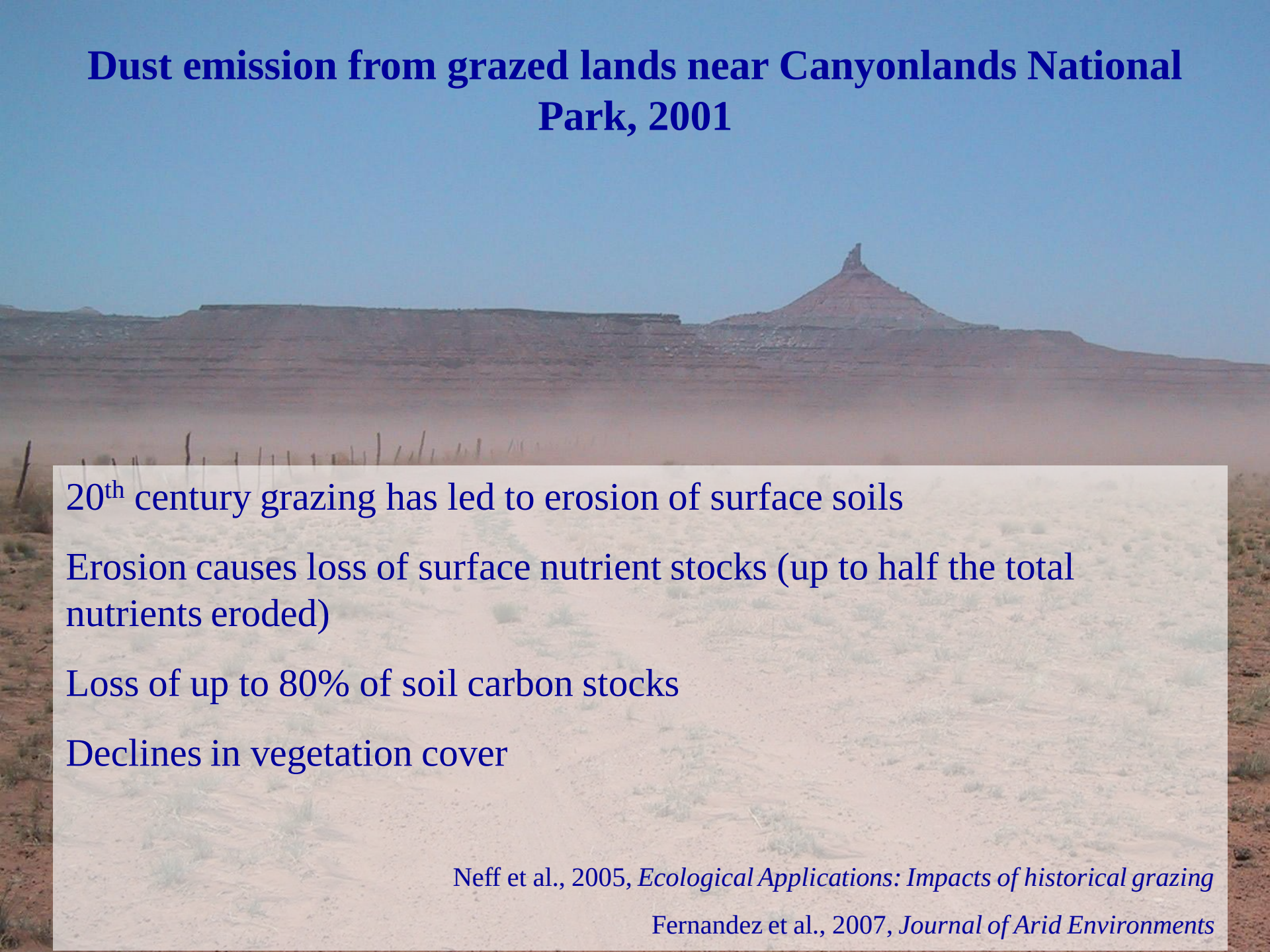


Modern Dust

http://www.weru.ksu.edu/new_weru/multimedia/dustbowl/dustbowlpics.html

Dust storm near Canyonlands National Park, 2004

Dust emission from grazed lands near Canyonlands National Park, 2001



20th century grazing has led to erosion of surface soils

Erosion causes loss of surface nutrient stocks (up to half the total nutrients eroded)

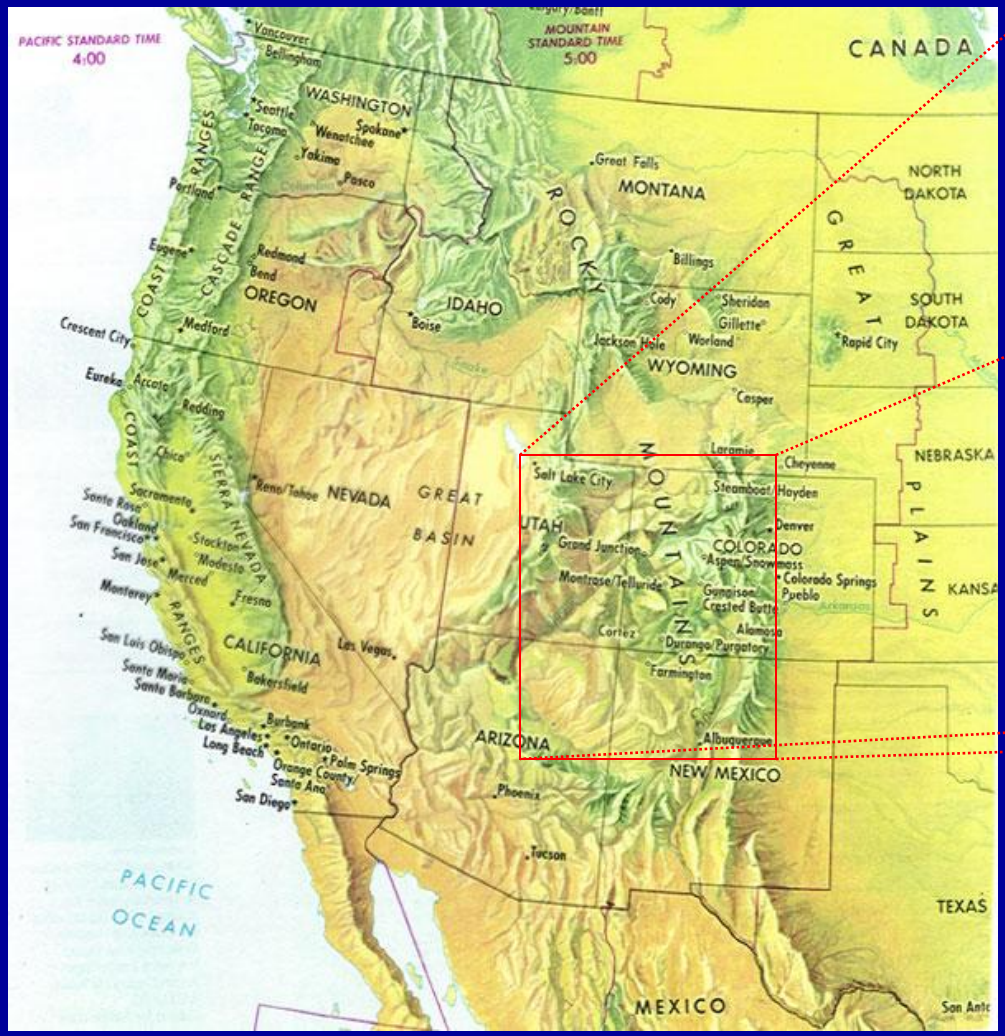
Loss of up to 80% of soil carbon stocks

Declines in vegetation cover

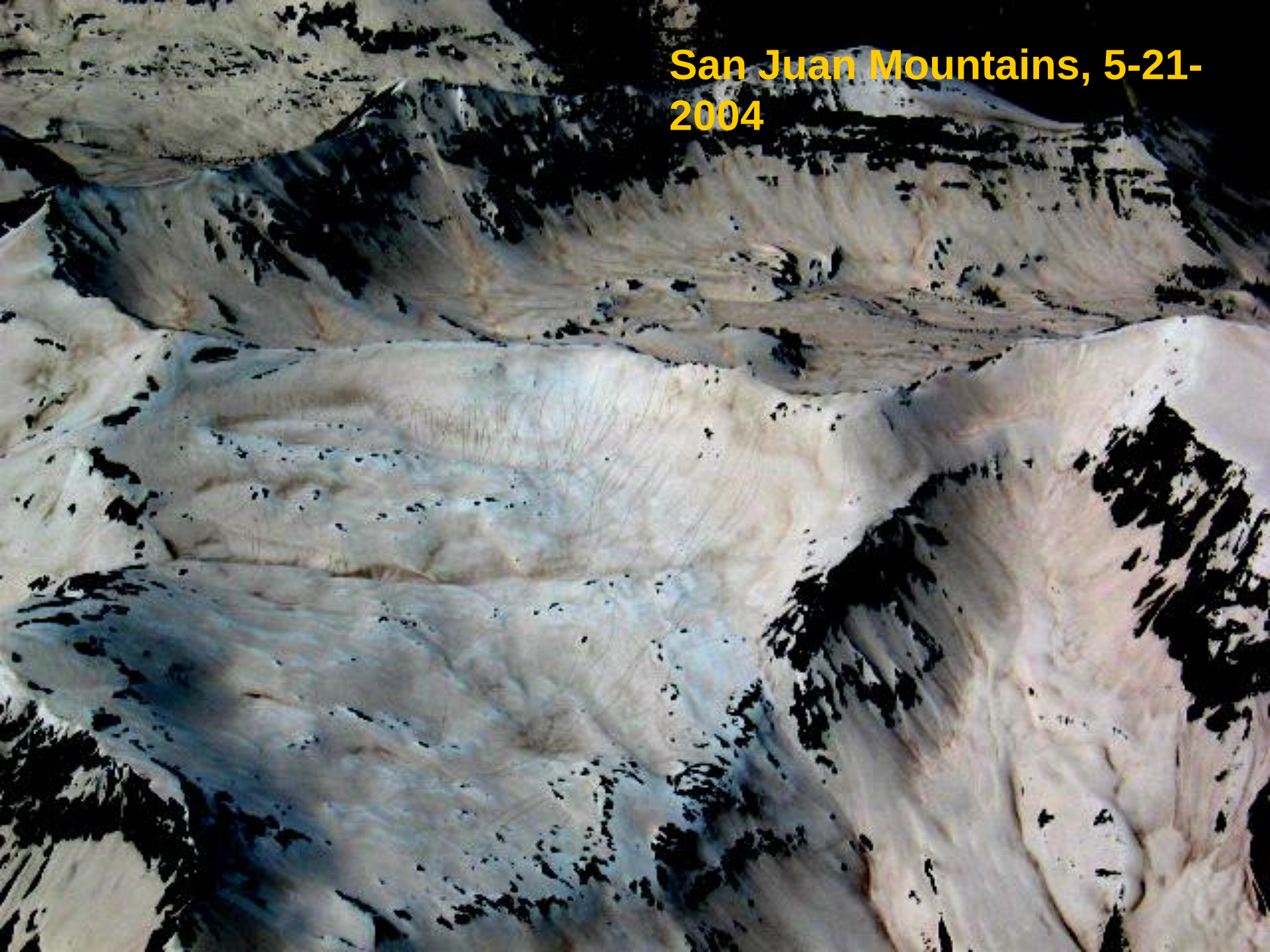
Neff et al., 2005, *Ecological Applications: Impacts of historical grazing*

Fernandez et al., 2007, *Journal of Arid Environments*

Deserts to Mountains – Continental Scale Ecology

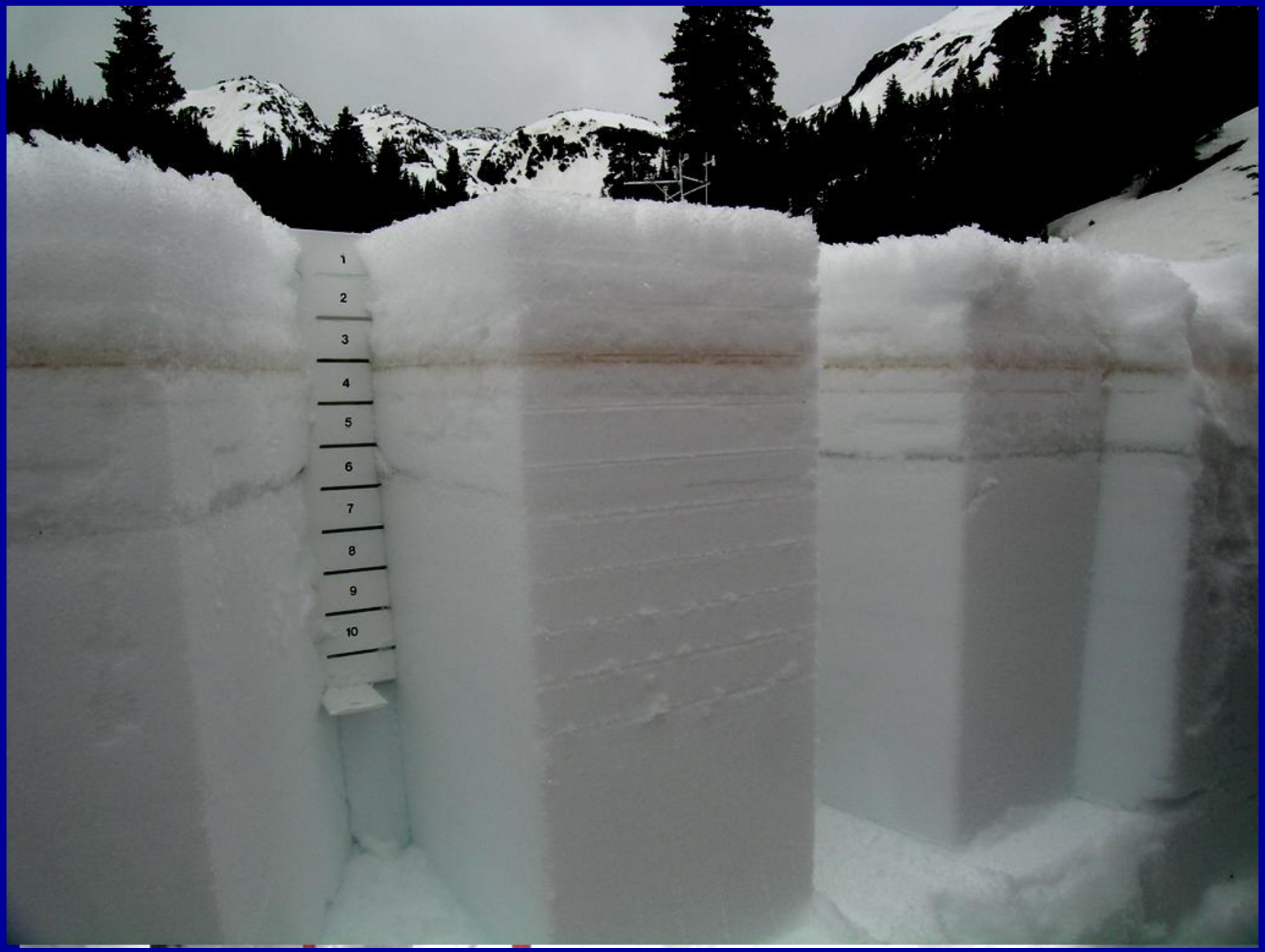


Niwot Ridge LTER

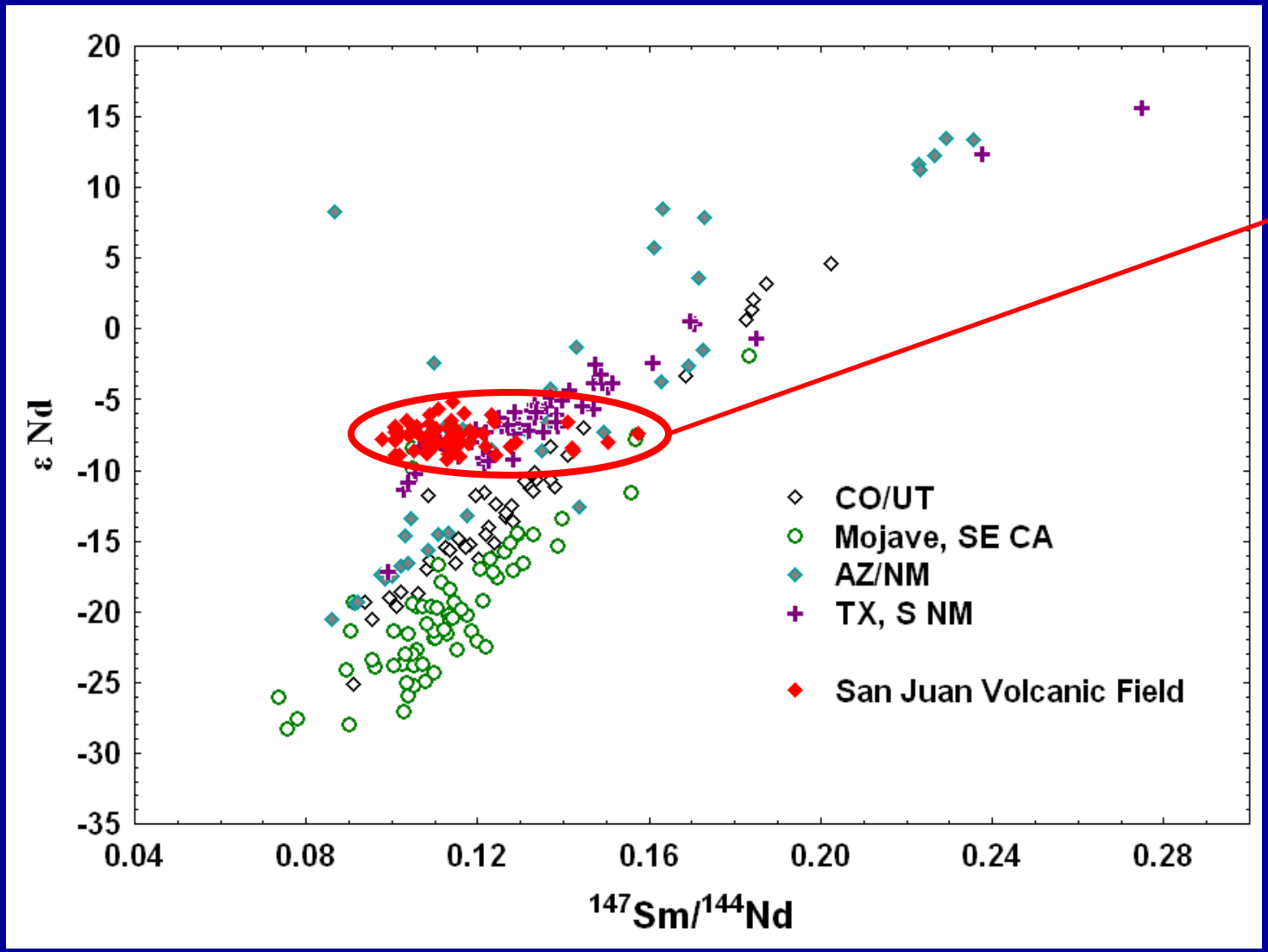

San Juan Mountains, 5-21-2004

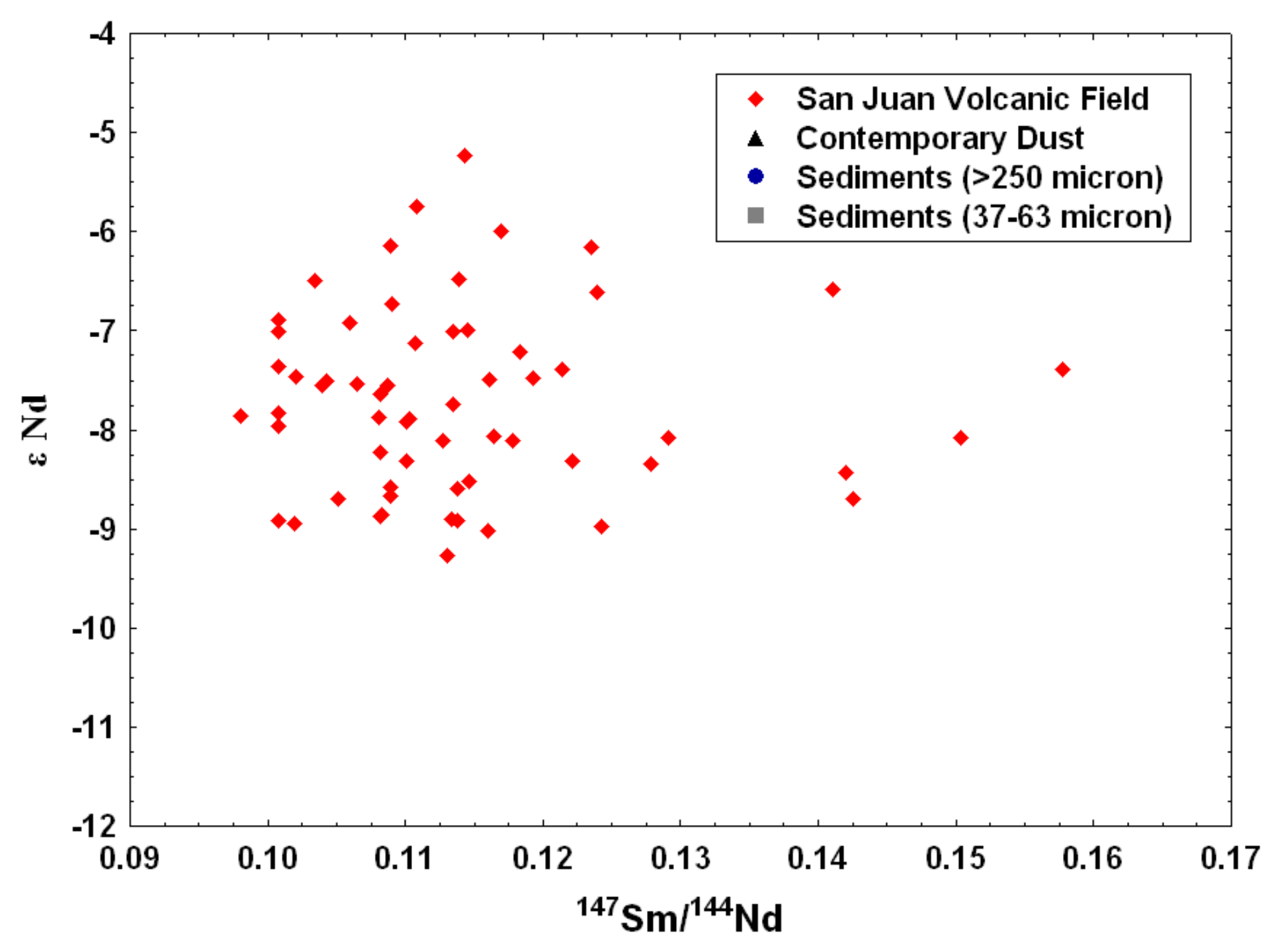
Have humans impacted dust fall to this region?

Collecting Dust



Sources and properties of dust vs. bedrock




San Juan Volcanic Field
Contemporary Dust
Sediments (>250 micron)
Sediments (37-63 micron)
ε Nd
-4
-5
-6
-7
-8
-9
-10
-11
-12
0.09
0.10
0.11
0.12
0.13
0.14
0.15
0.16
0.17
147Sm/144Nd

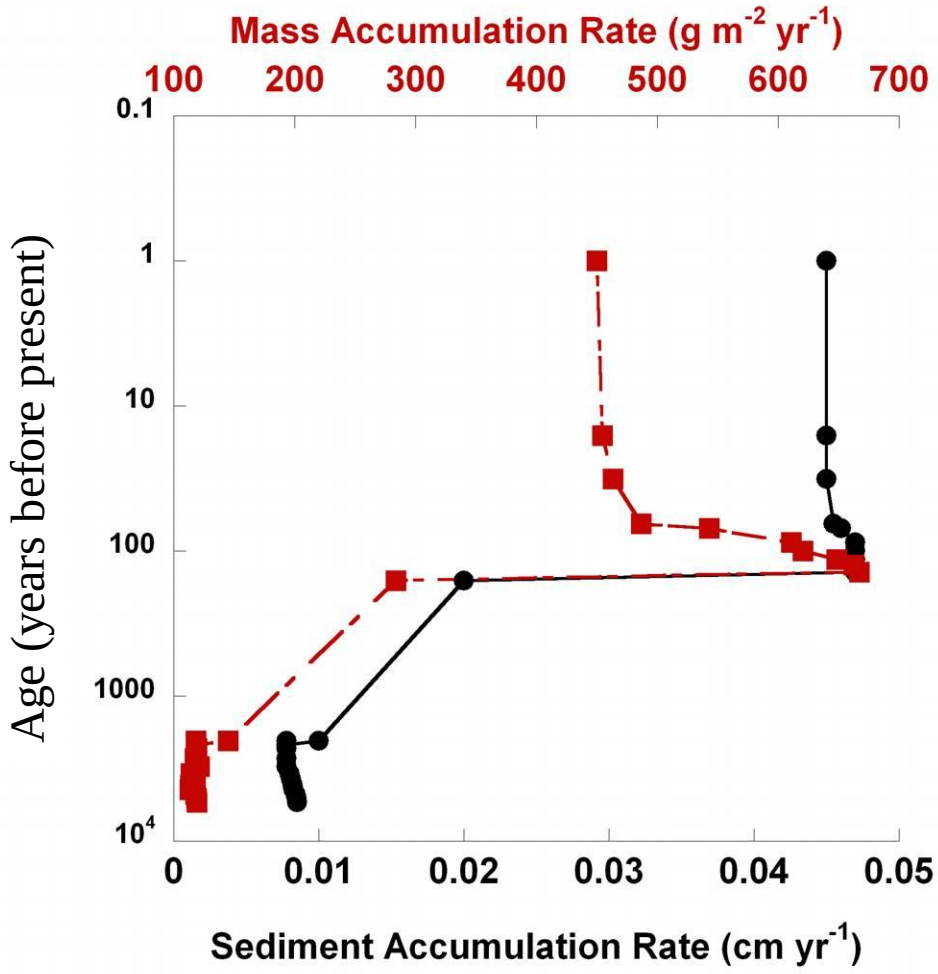
Sediment Age Model

^{210}Pb for past ~150 years

^{14}C of Terrestrial macrofossils for older material

A history of dust

Neff et al., Nature Geosciences 2008



Pacific Railway Act – 1862

Taylor Grazing Act - 1934

Land Use Change in the Western US

1870 – 4.1 million beef cattle and 4.8 million sheep

Taylor Grazing Districts in 1937 (Bureau of Land Management)

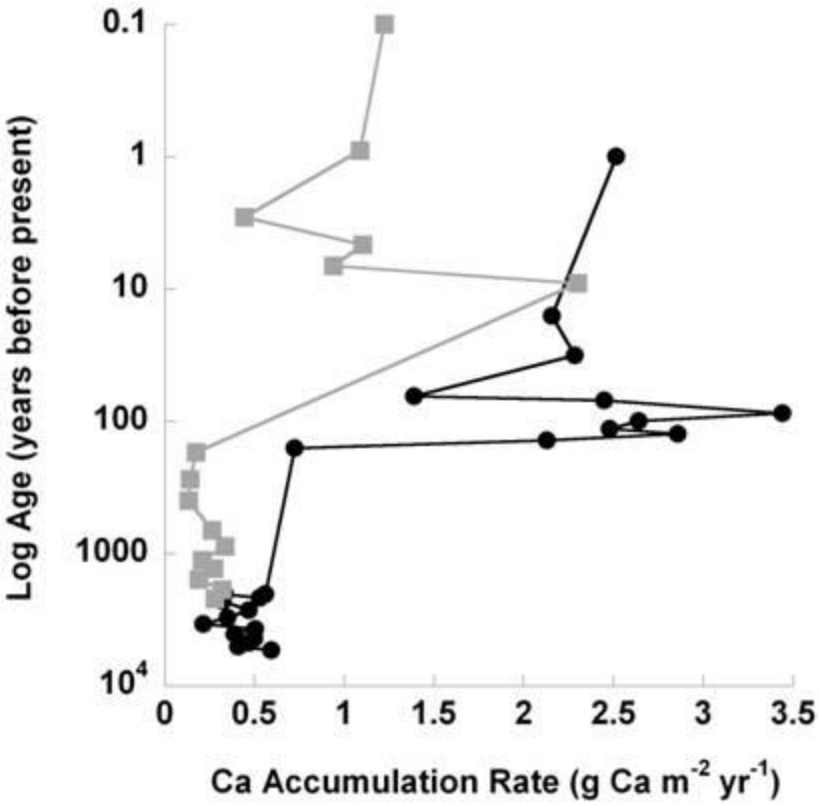
1900 – 19.6 million beef cattle and 25.1 million sheep

1920s/1930s – severely degraded rangelands over large parts of the Western US

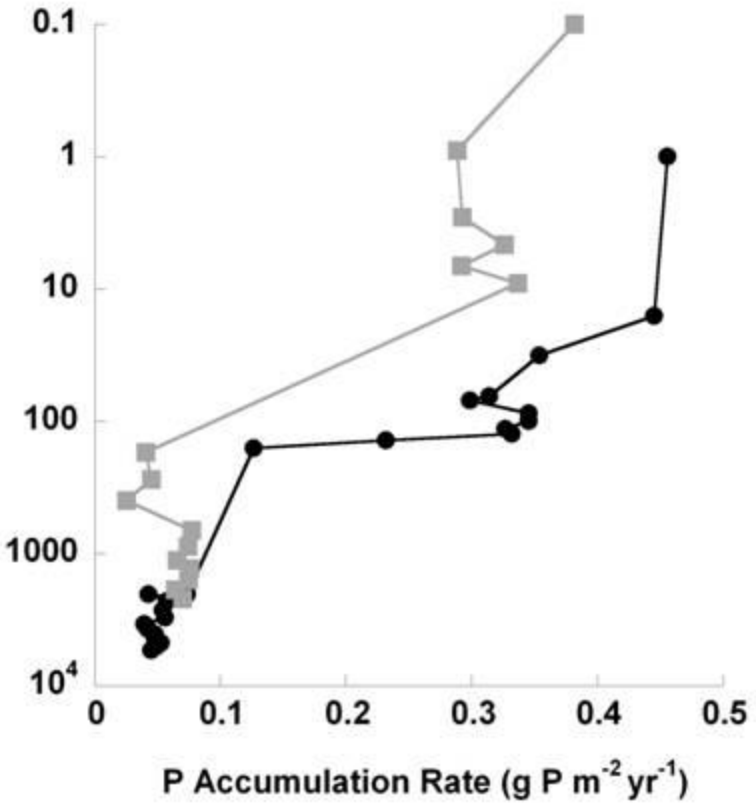
1934 Taylor Grazing Act passed by congress

Changing dust loads = changing element fluxes

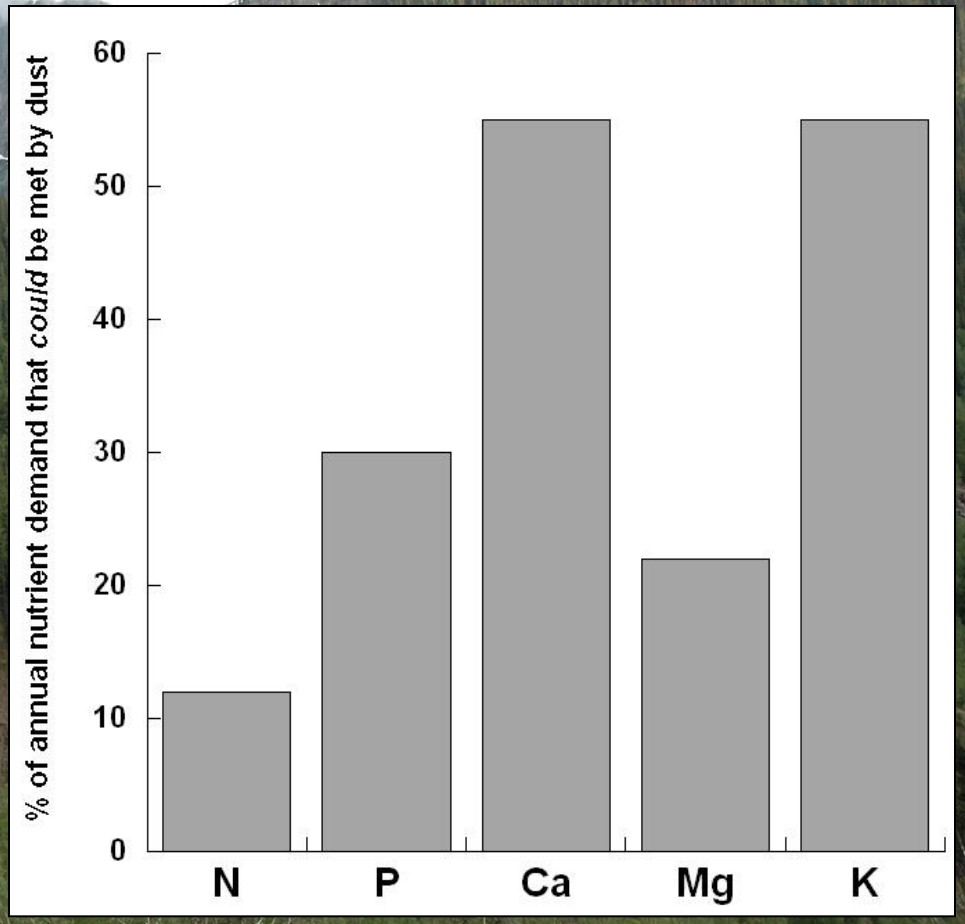
5-6 X increase in Ca deposition



5-7 X increase in P deposition



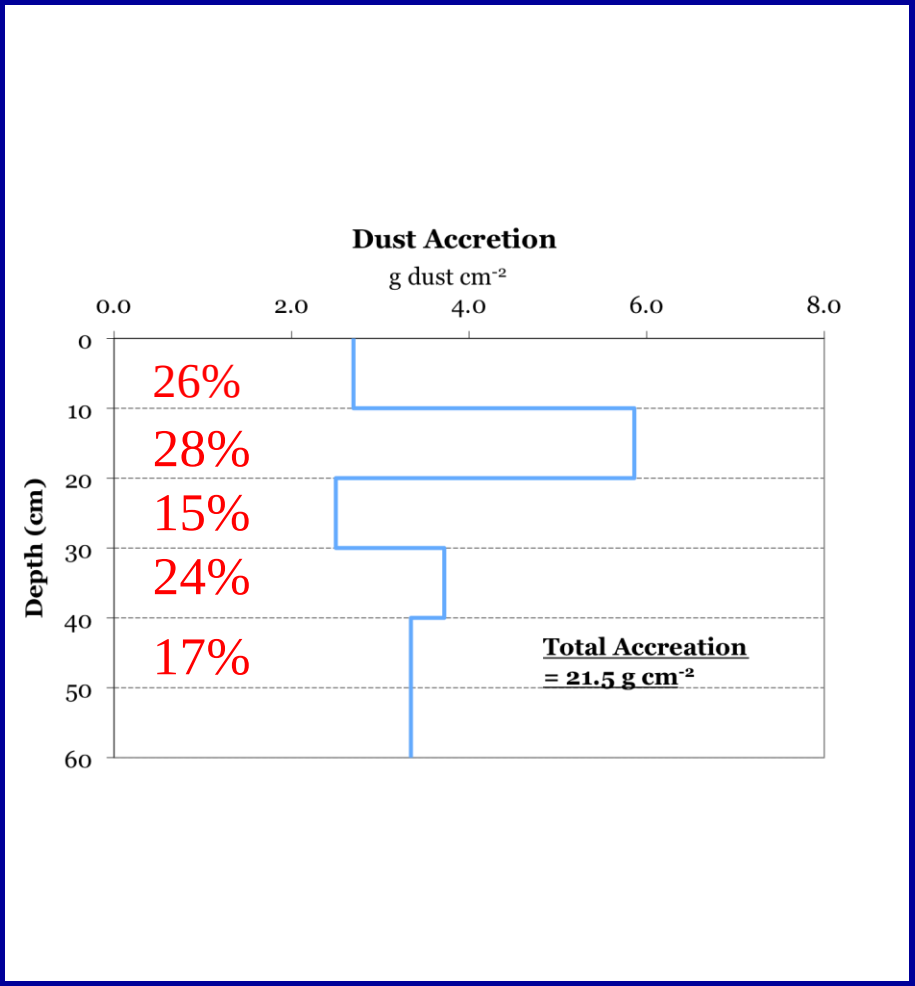
Dust impacts on Vegetation



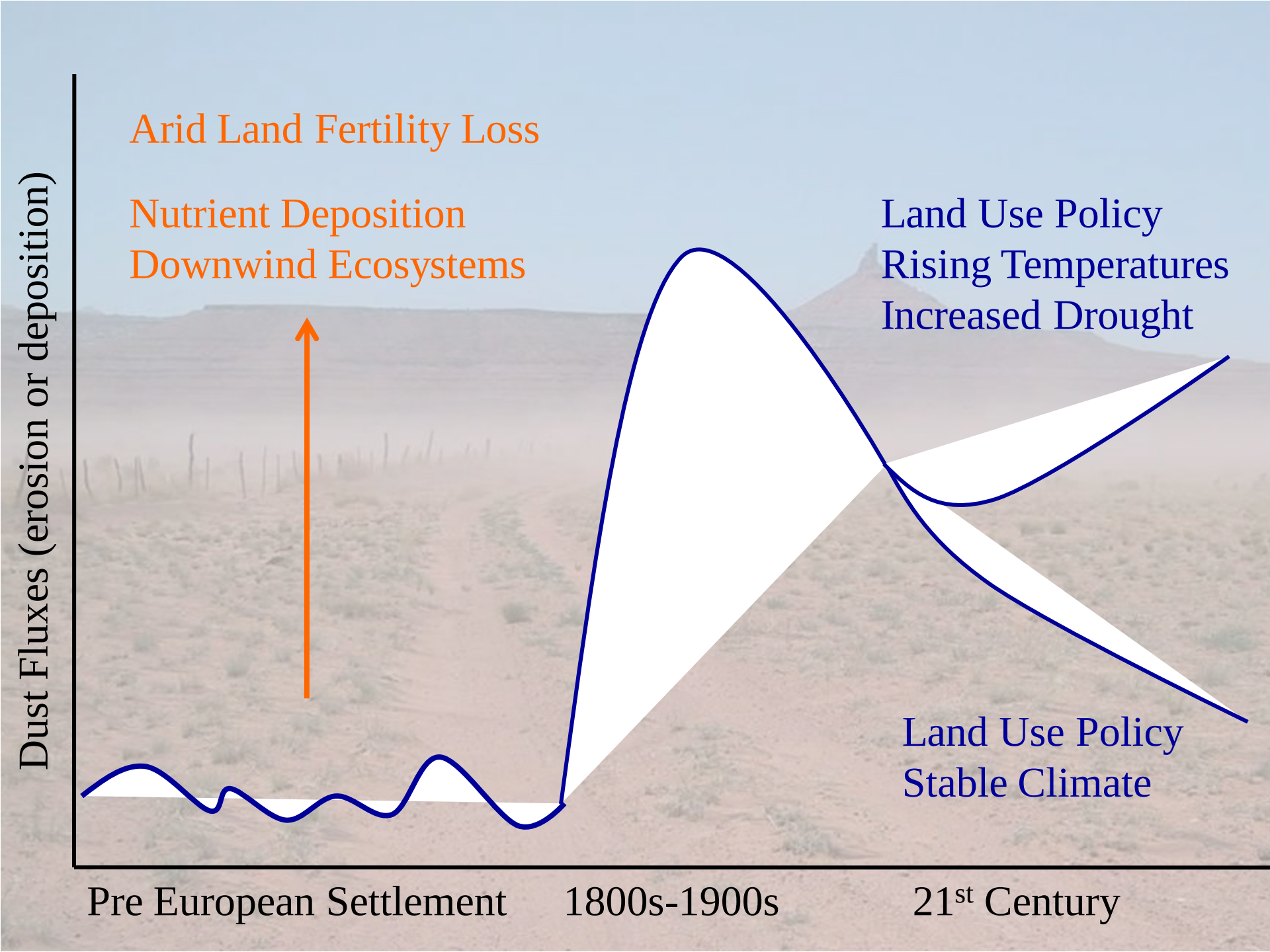
Castle and Neff, In Press *Ecosystems*

Castle et al., in prep

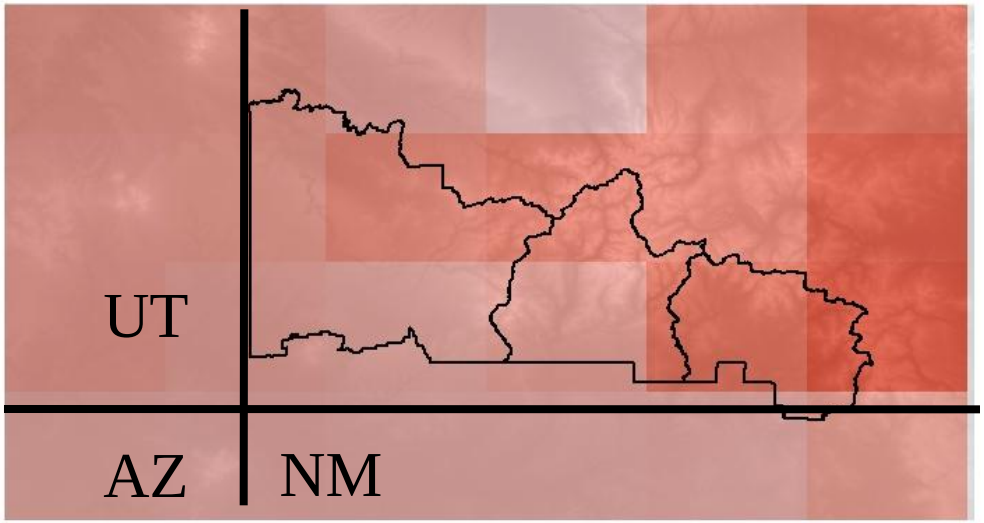
Dust to Soil



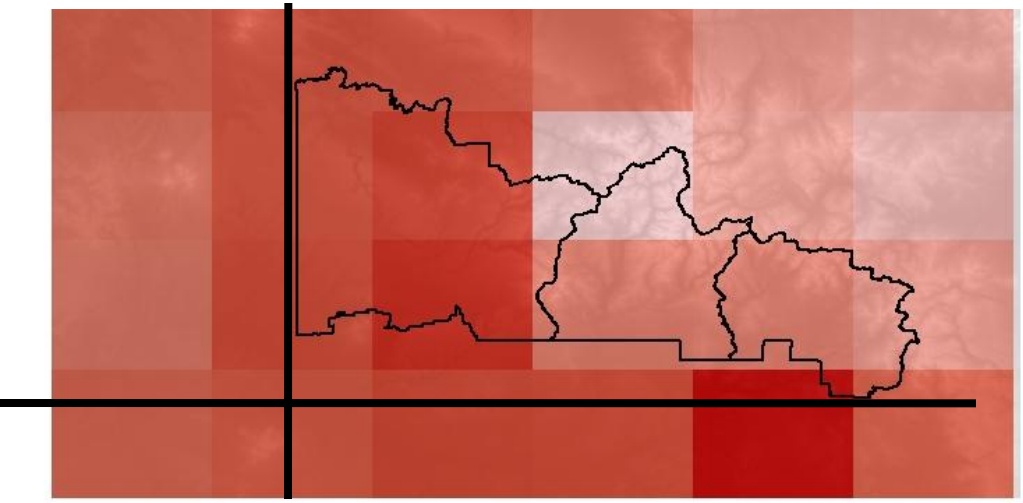
Lawrence et al. in prep


Arid Land Fertility Loss
Nutrient Deposition
Downwind Ecosystems
Land Use Policy
Rising Temperatures
Increased Drought
Land Use Policy
Stable Climate
Dust Fluxes (erosion or deposition)
Pre European Settlement
1800s-1900s
21st Century

Summer Temperatures 2066-2070



Winter Temperatures 2066-2070

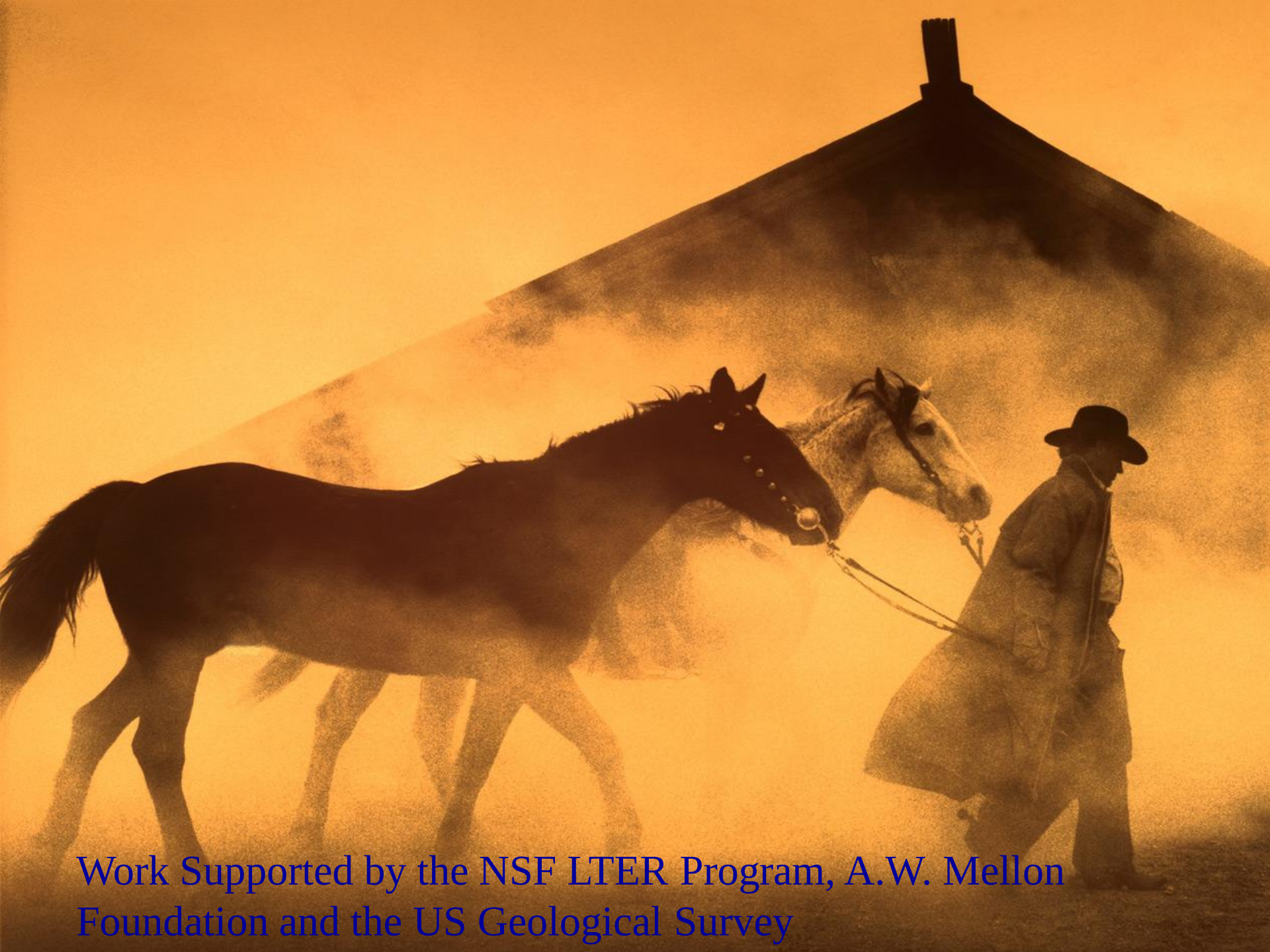


Temperature Change NCAR NARCCAP Simulations (GFDL model)

Relative to 2001-2006 in degrees C

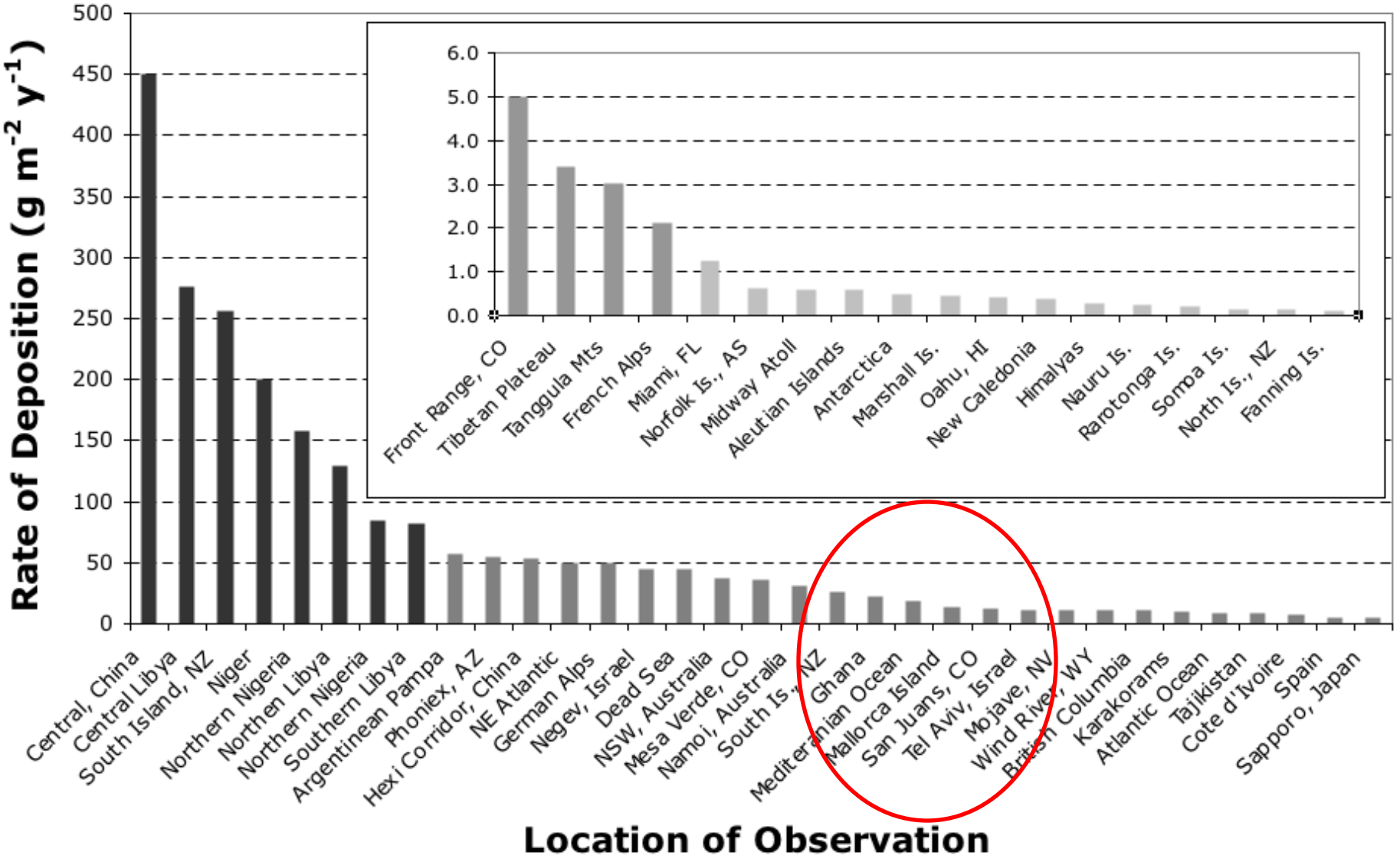
Change in temp

	High : 5.0	9 F
	Low : 1.0	1.8 F



Work Supported by the NSF LTER Program, A.W. Mellon Foundation and the US Geological Survey

Eolian Deposition Across Spatial Scales



Lawrence & Neff, *In Review*, Chemical Geology