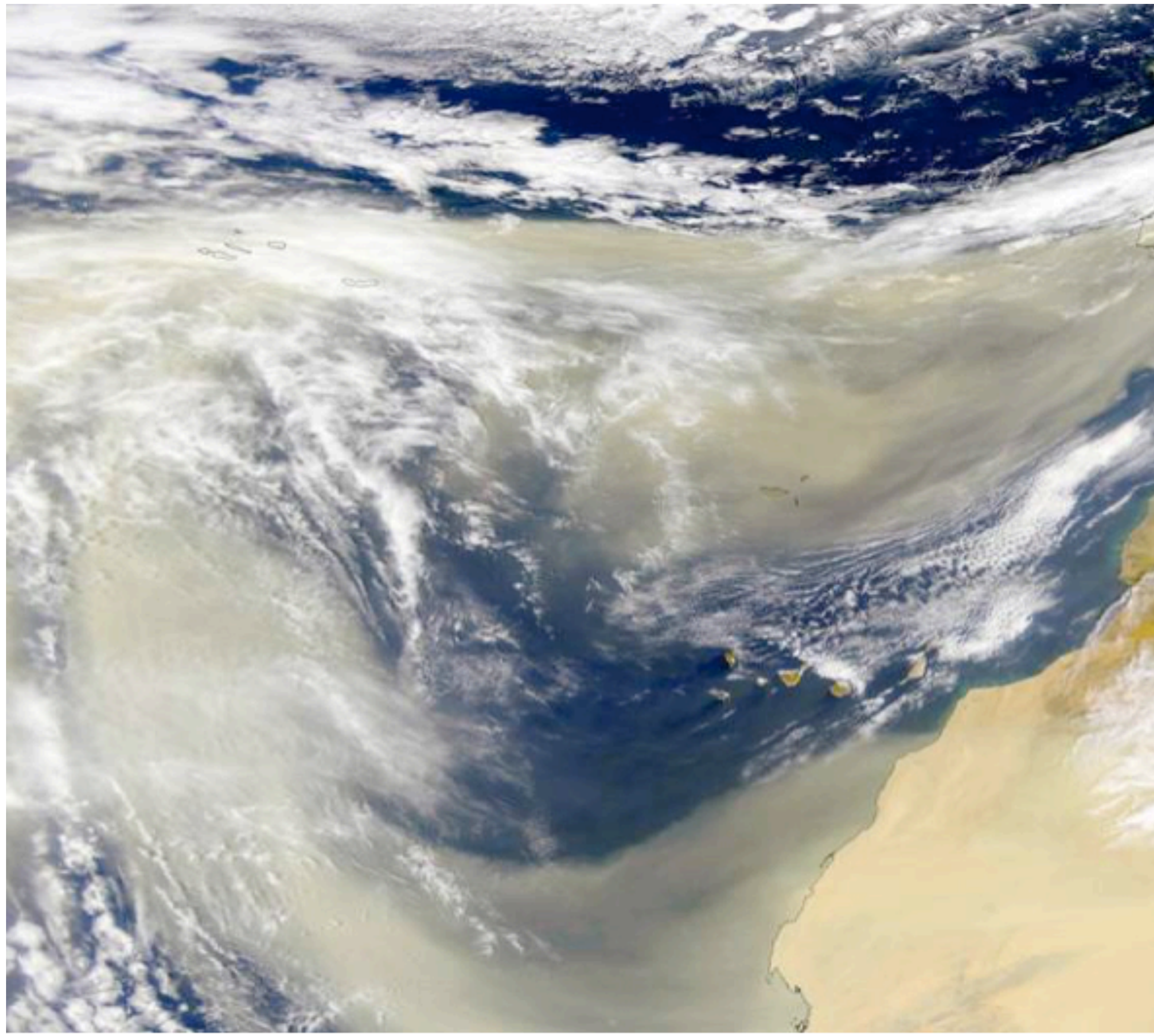
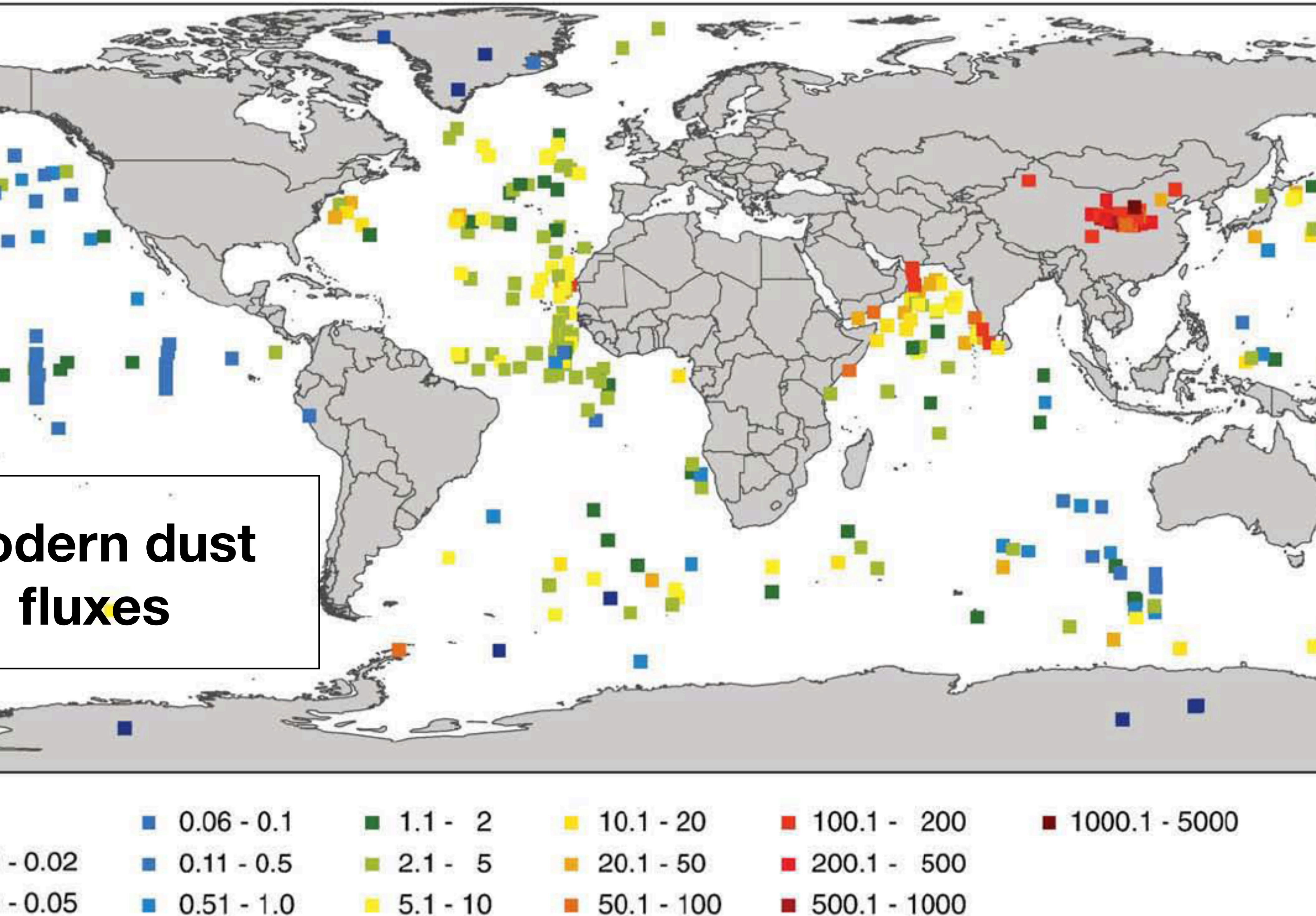
The role of marine sediments in understanding the dust cycle

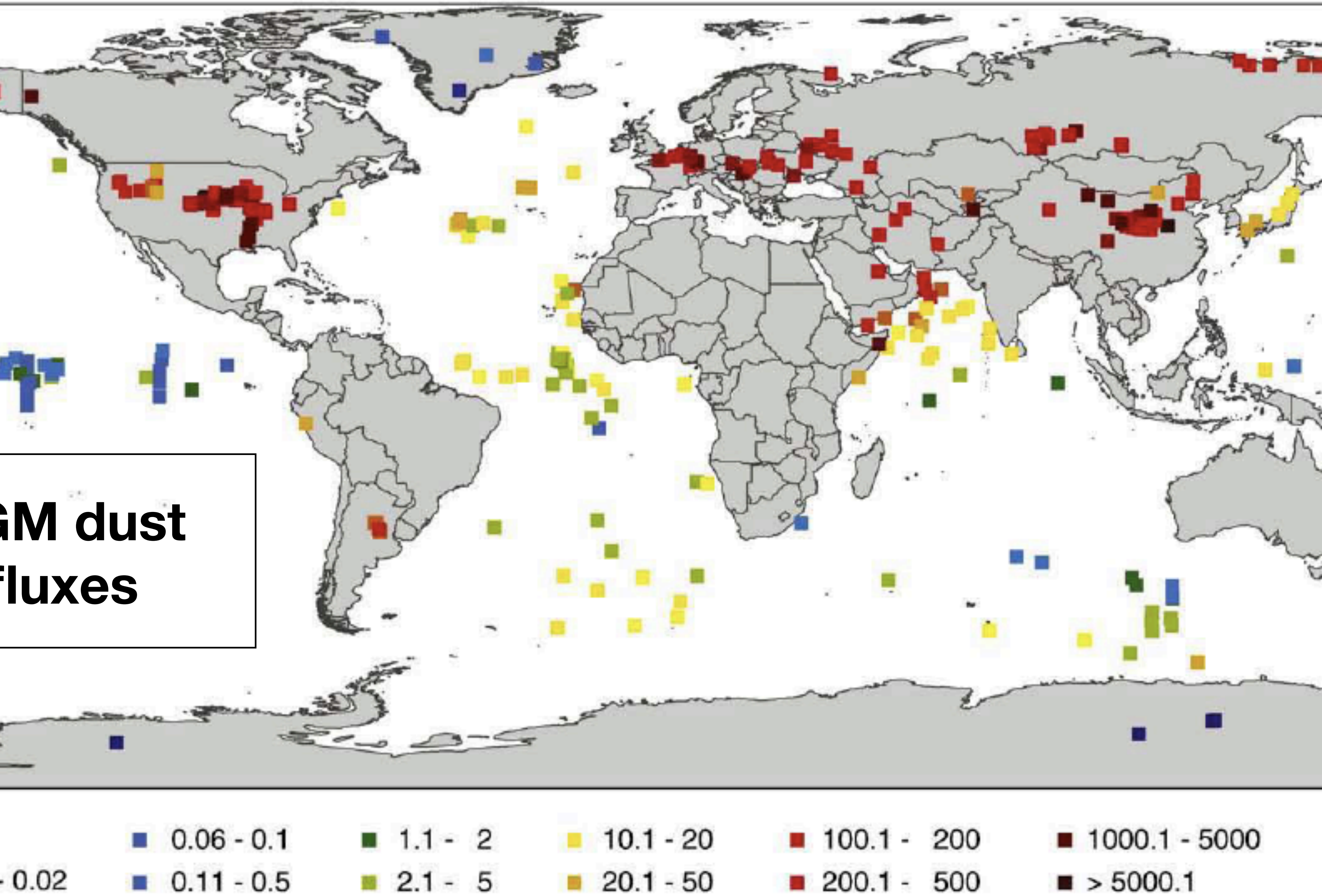


McGee

rmining “modern” (Late Holocene) dust fluxes



onstructing LGM dust fluxes



series

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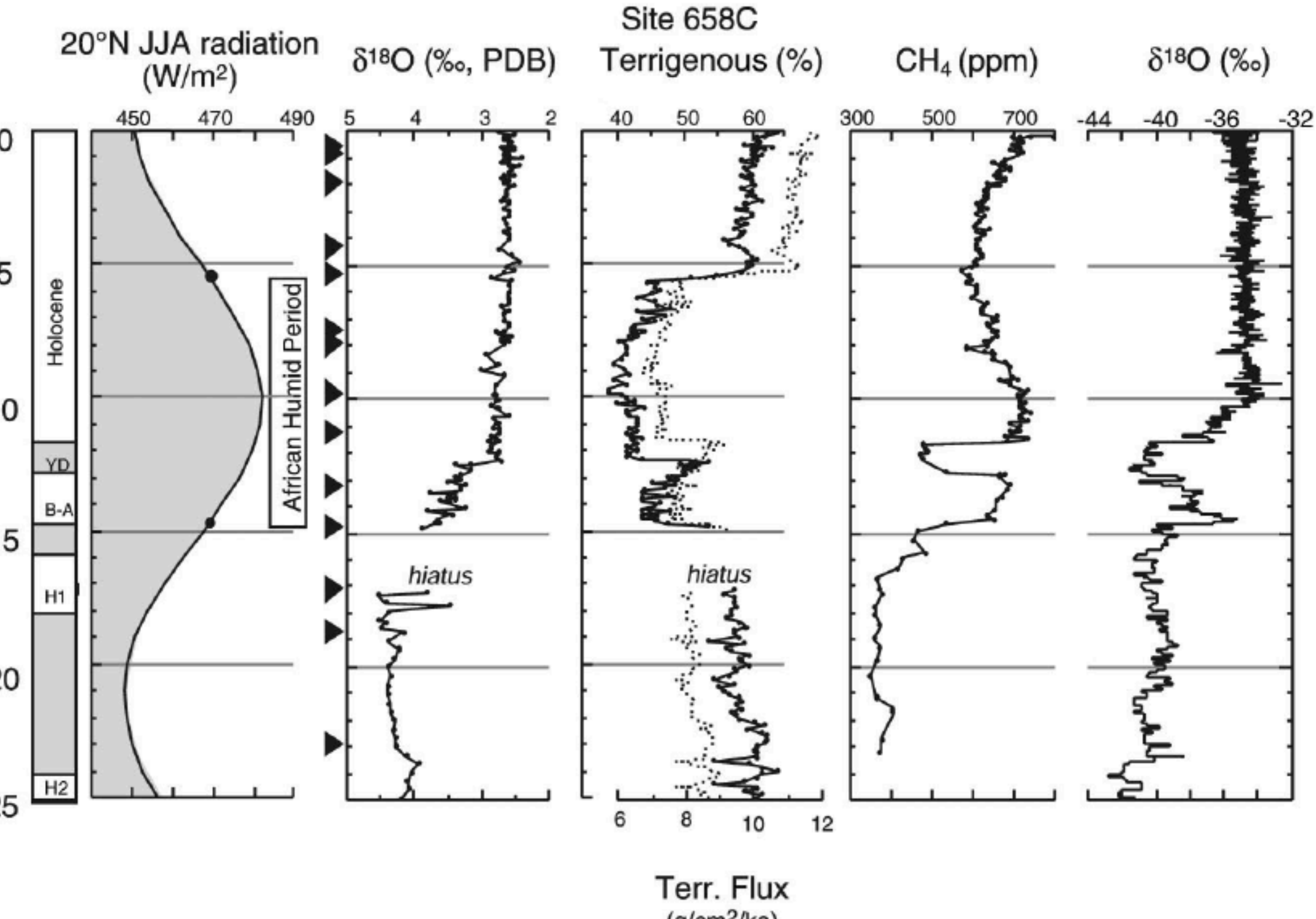
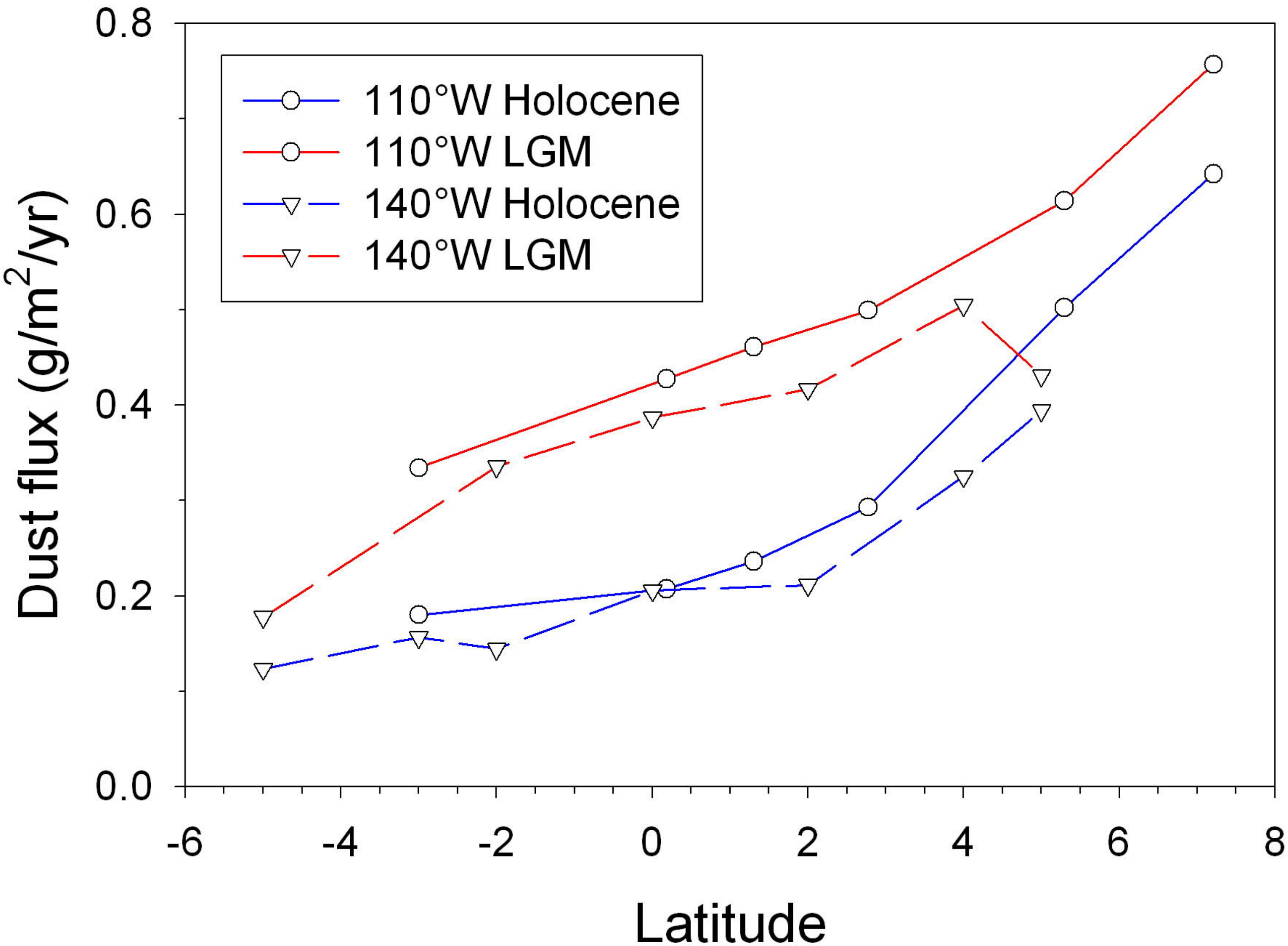


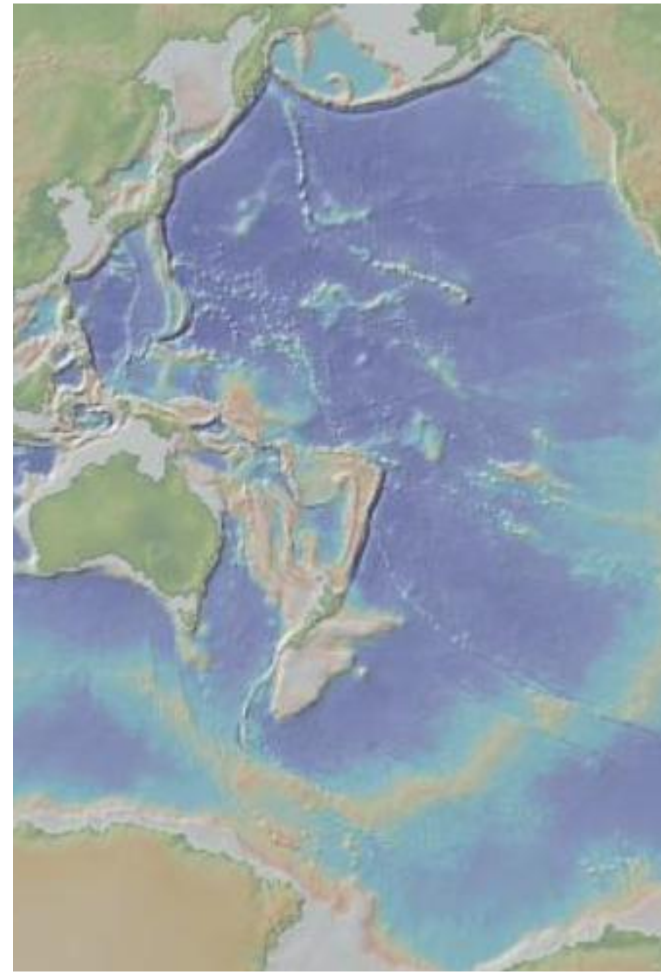


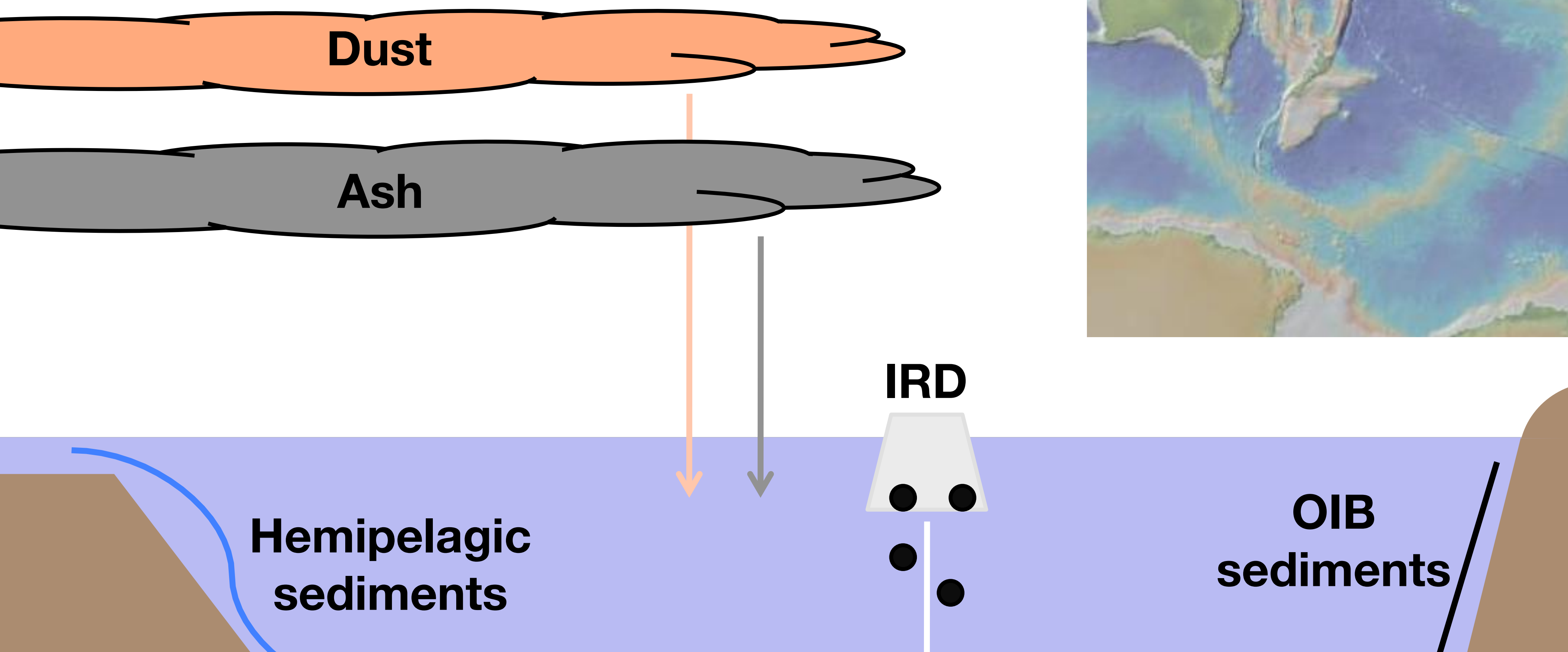
110°W Holocene
110°W LGM
140°W Holocene
140°W LGM
Dust flux (g/m2/yr)
0.0
0.2
0.4
0.6
0.8
-6
-4
-2
0
2
4
6
8
Latitude

rmining dust fluxes in marine sediments

nge:

uishing dust from other components of the detrital
n





minantly dust

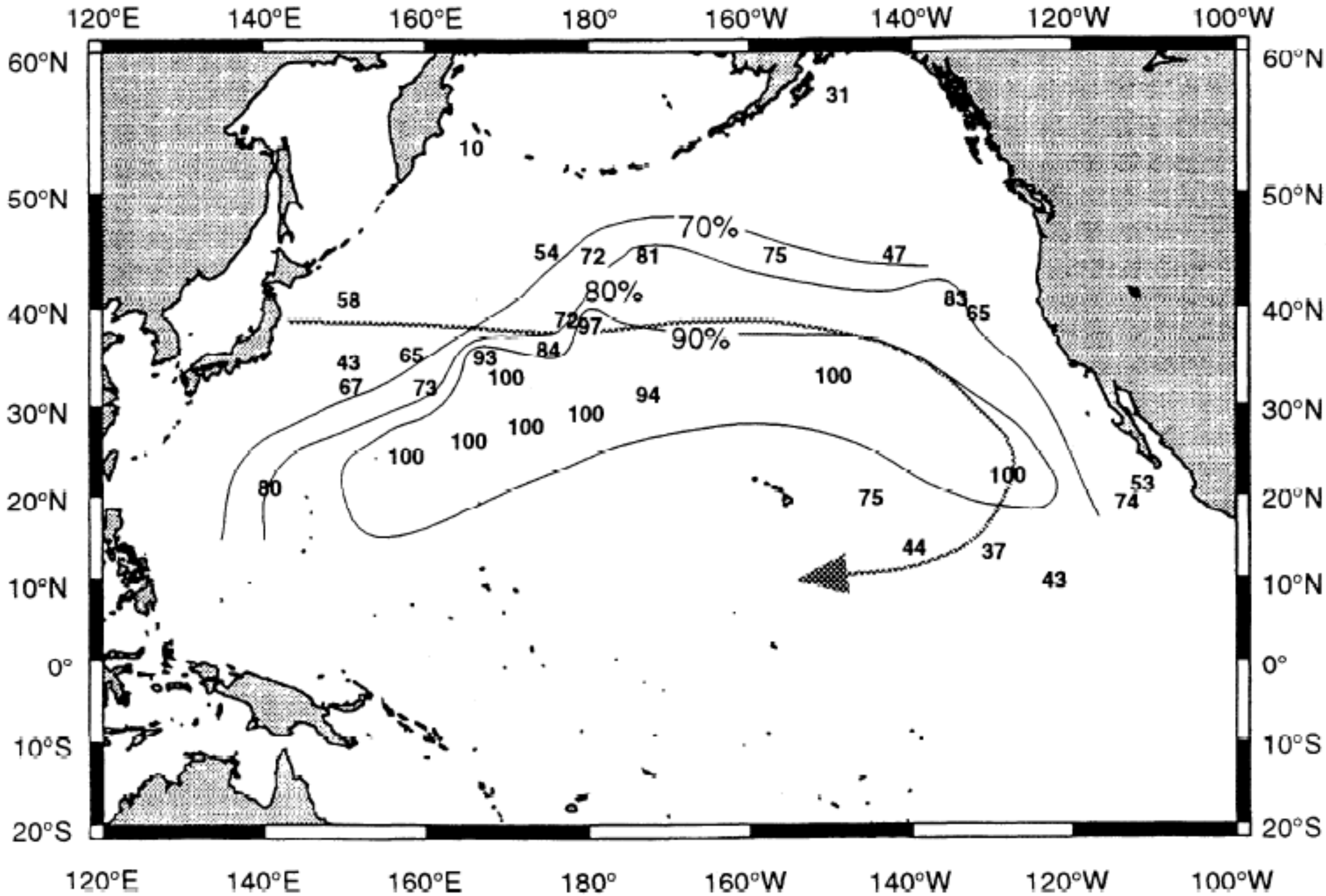
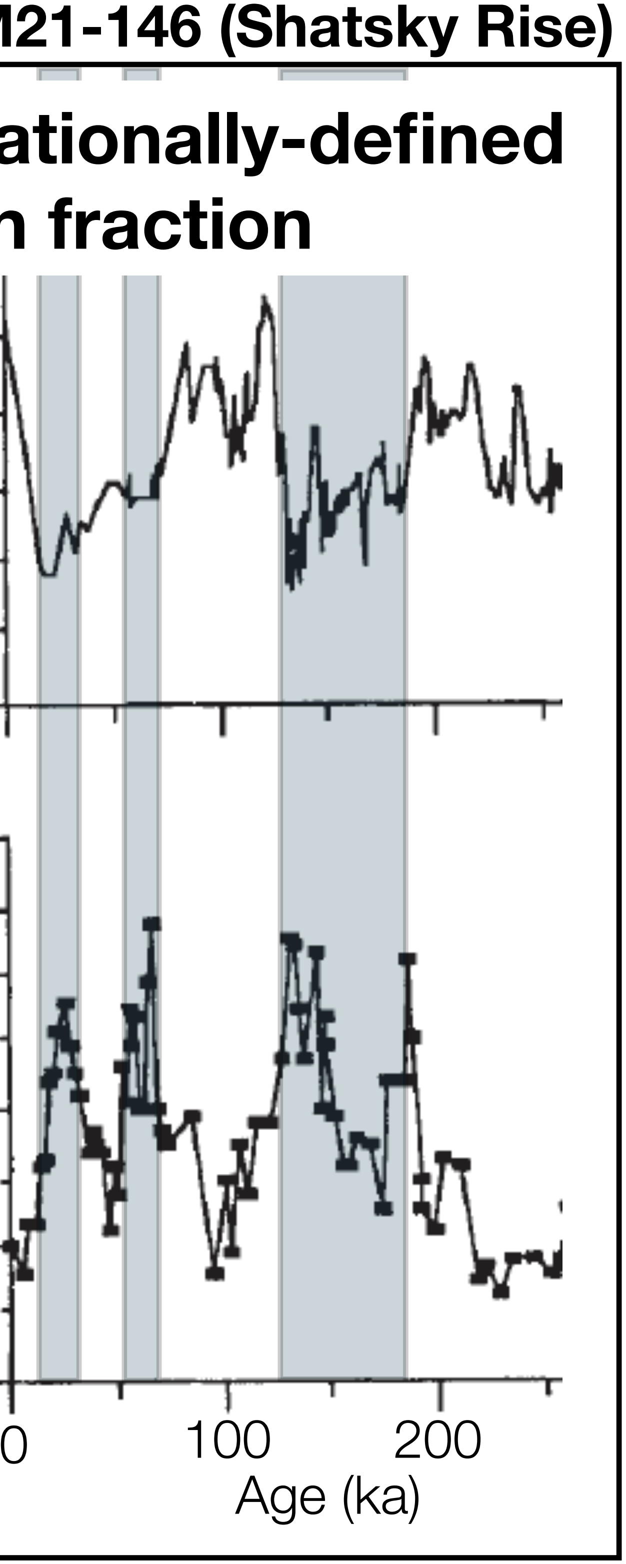
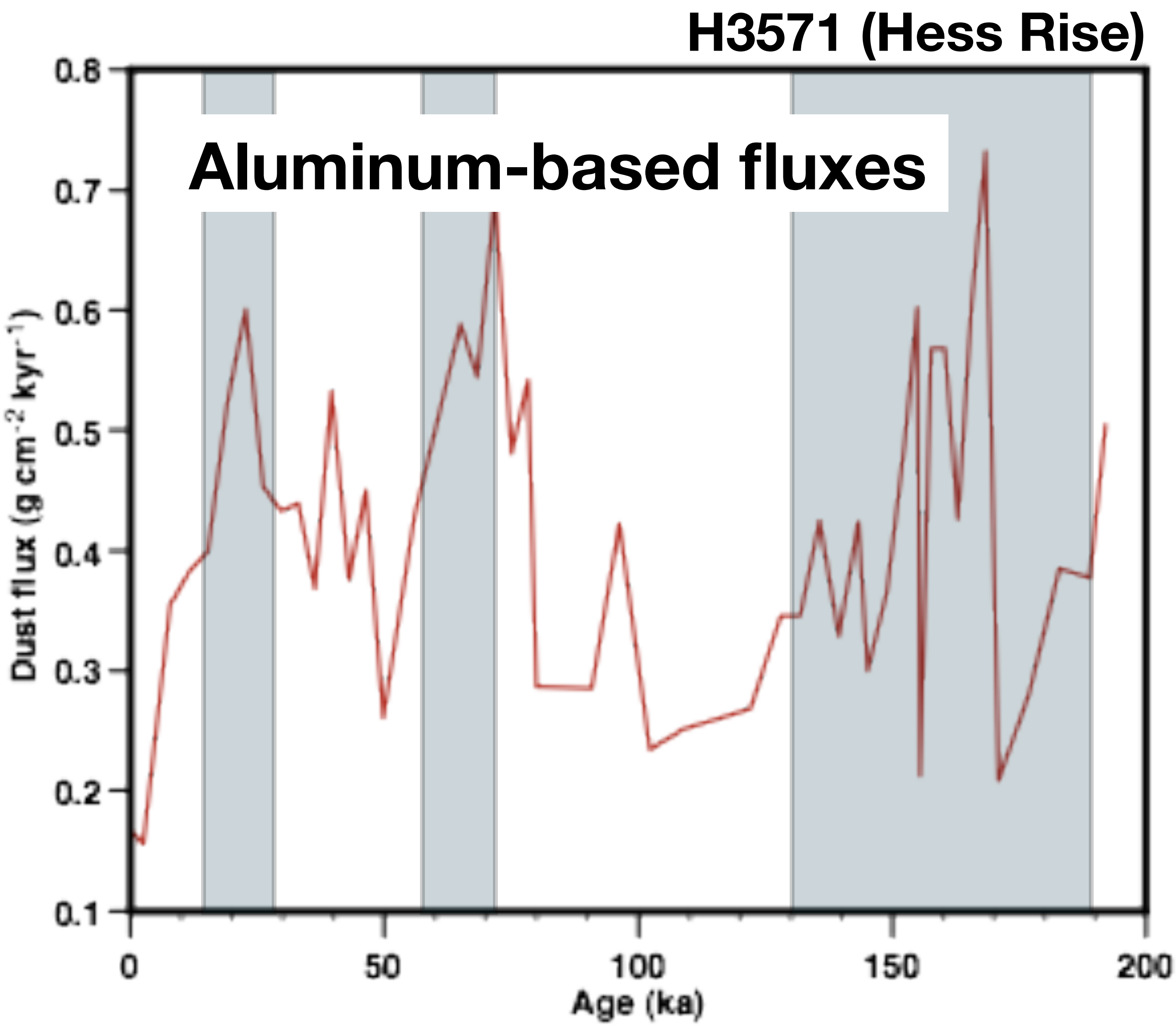
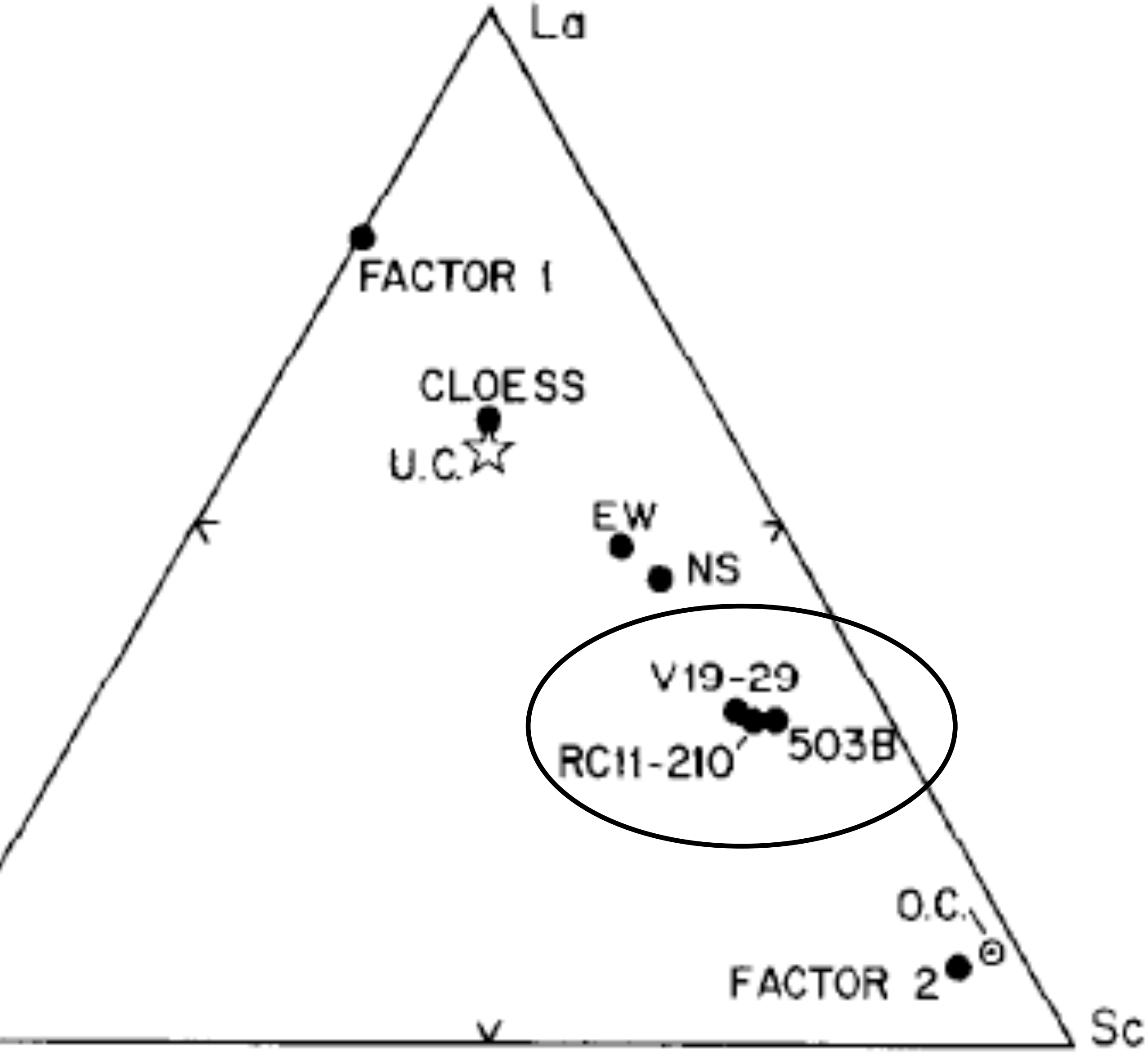


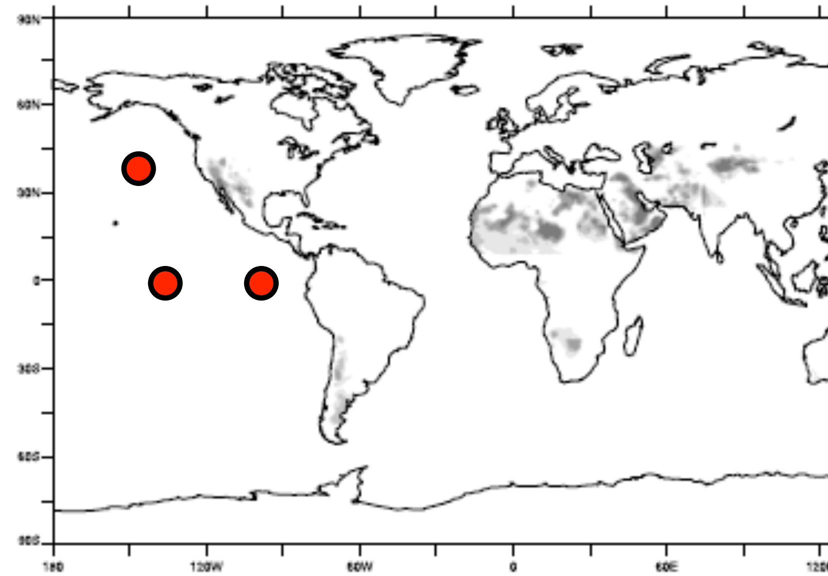
Figure 6. Spatial distribution of percent eolian crustal material content in PACSUR samples based on model 3 (4.2-μm loess size fraction and average K-K volcanics). The percent eolian crustal material in each sample is denoted by a small number centered on each sample's position. The approximate track of Asian dust storms is marked by the shaded arrow [*Merrill*, 1989]. The highest eolian transport to the ocean is at about 40°N in the



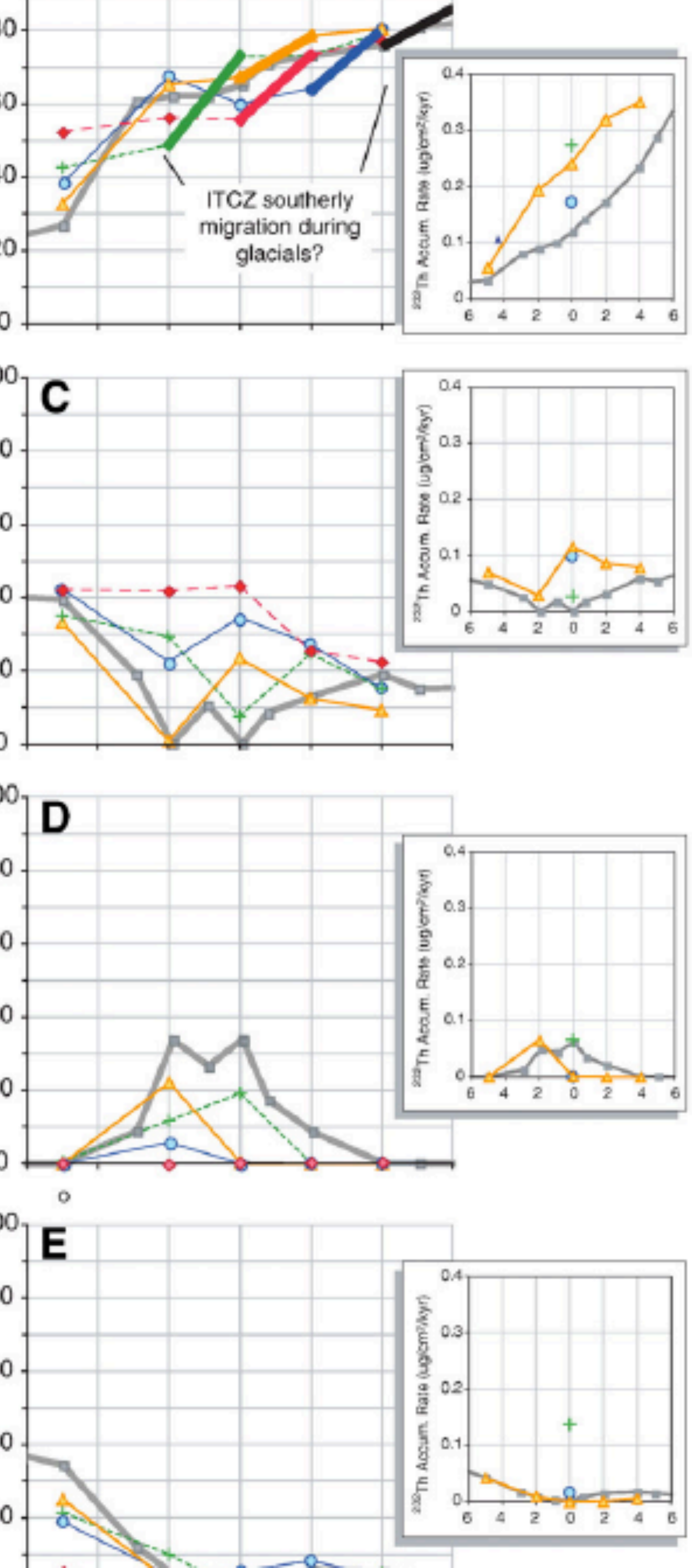
North Pacific (East Asian dust)







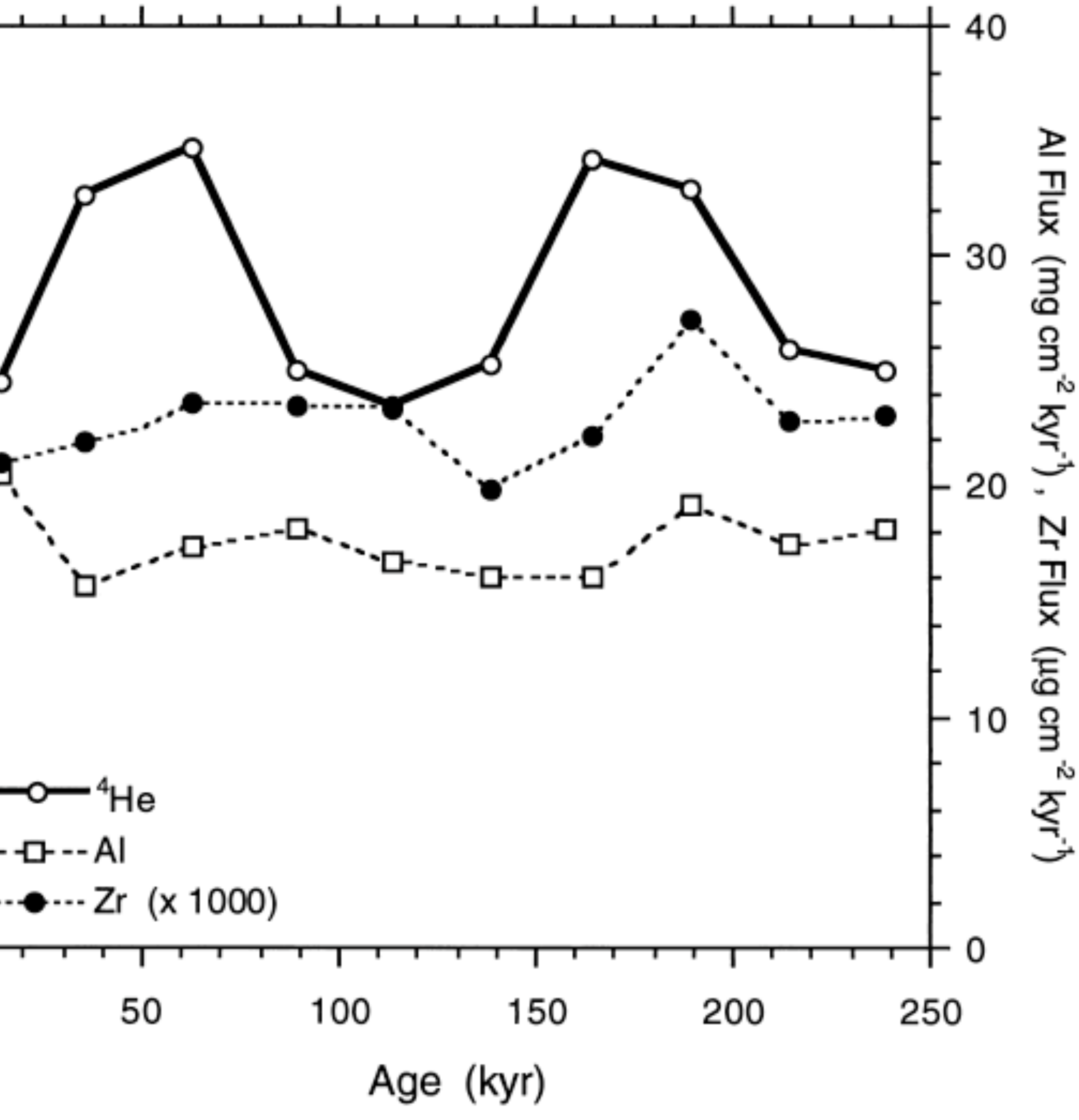
uatorial Pacific sediments: a mixture of material simila
Chinese loess and other material (mafic volcanics?)



Andesitic ash and long-travelled equatorial undercurrent detritus be significant contributors as we

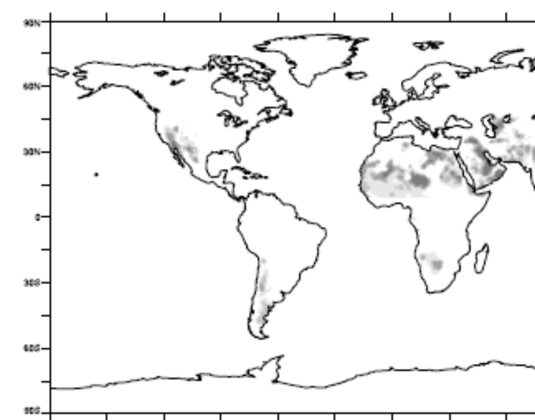
al components using **geochemical** differences

Equatorial Pacific

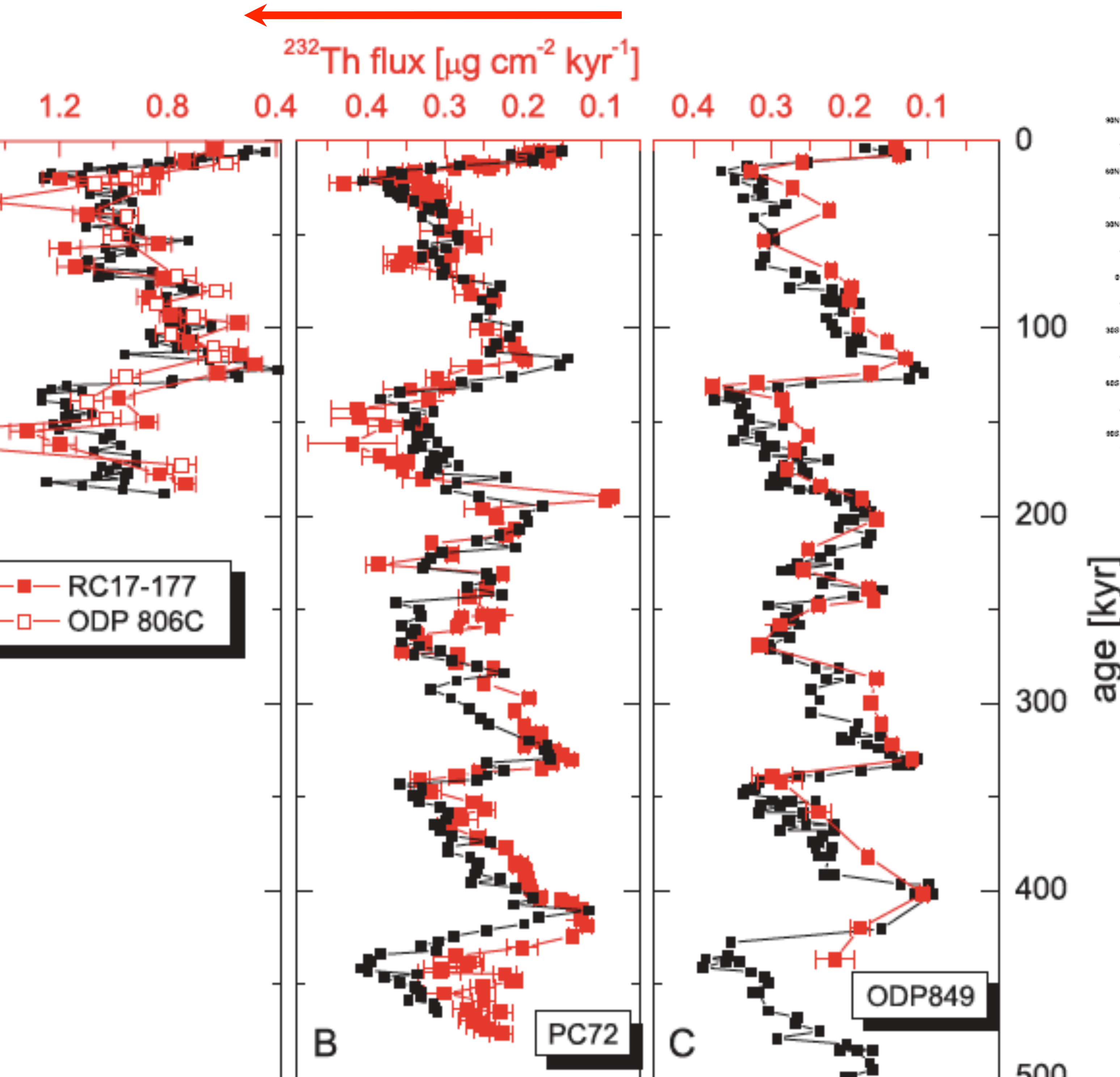


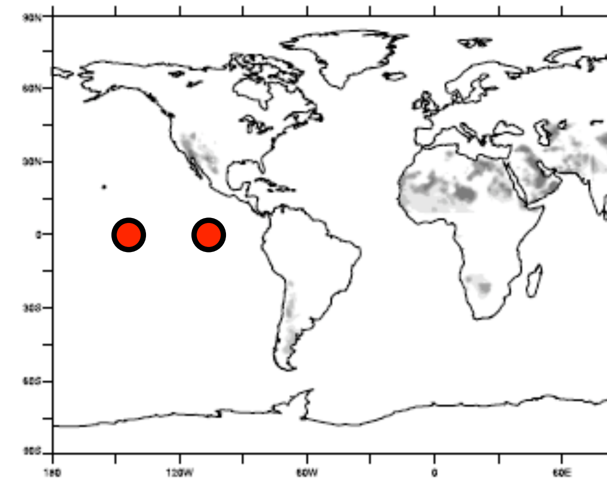
<u>Examples:</u>

^{232}Th, ^{4}He



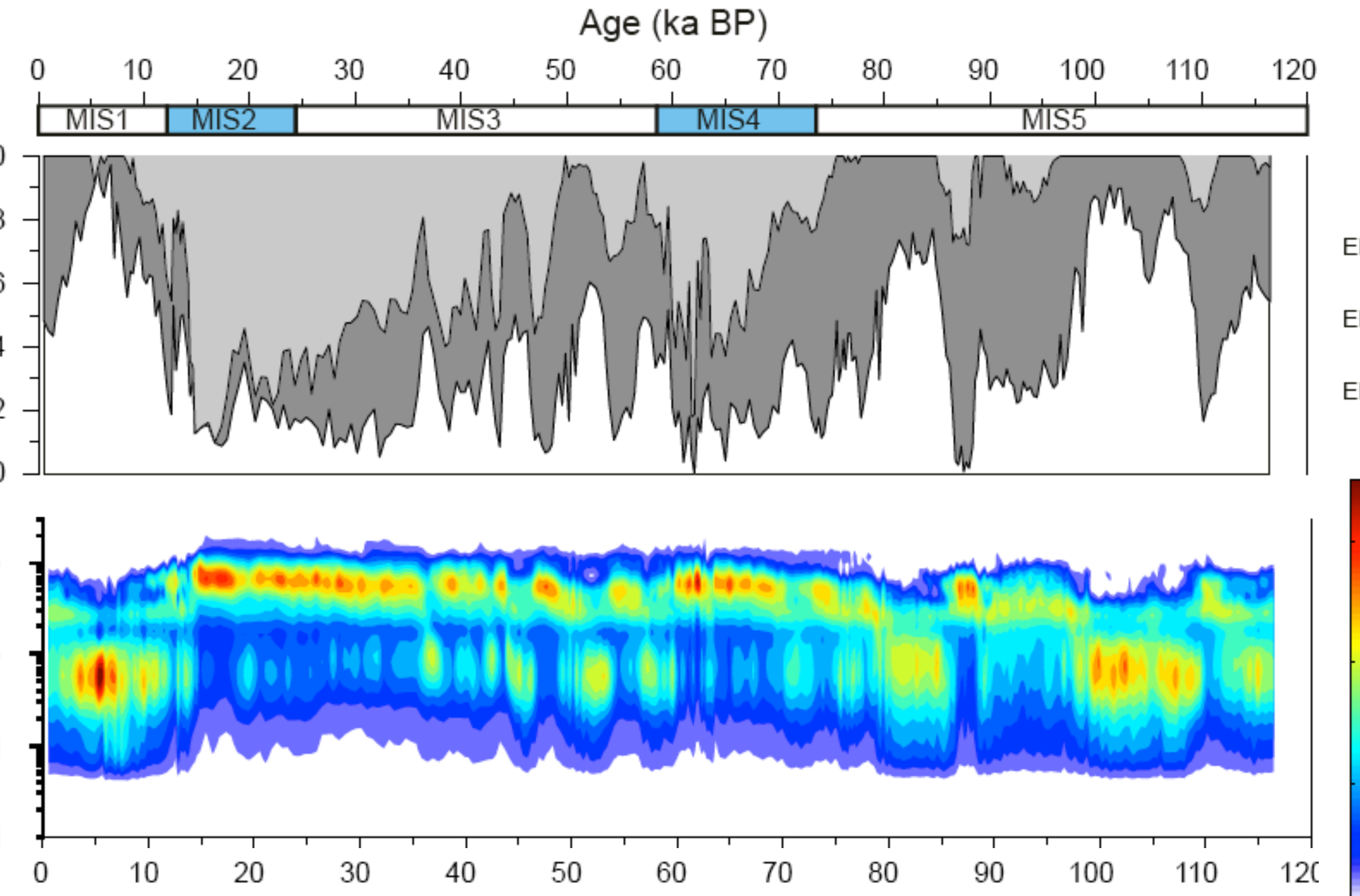
as a dust proxy



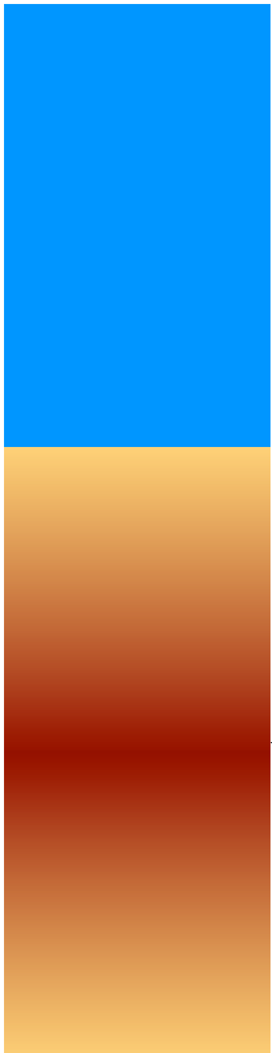


Equatorial Pa

al components using **grain size** differences



ng from concentrations to fluxes



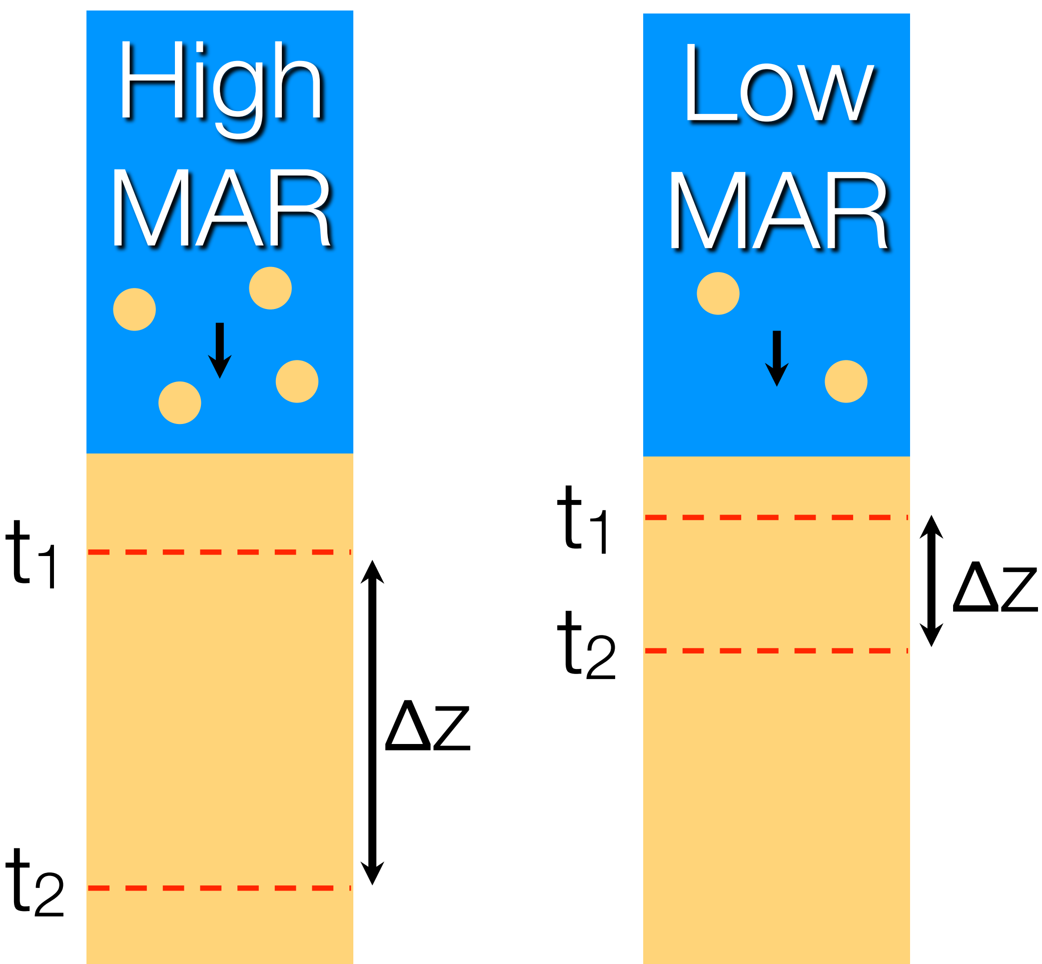
Dust MAR = Total MAR x [dust]

MAR = mass accumulation rate
[ ] = concentration

Increase in dust flux or decrease in biogenic sediment f

culating mass accumulation rates (MARs)

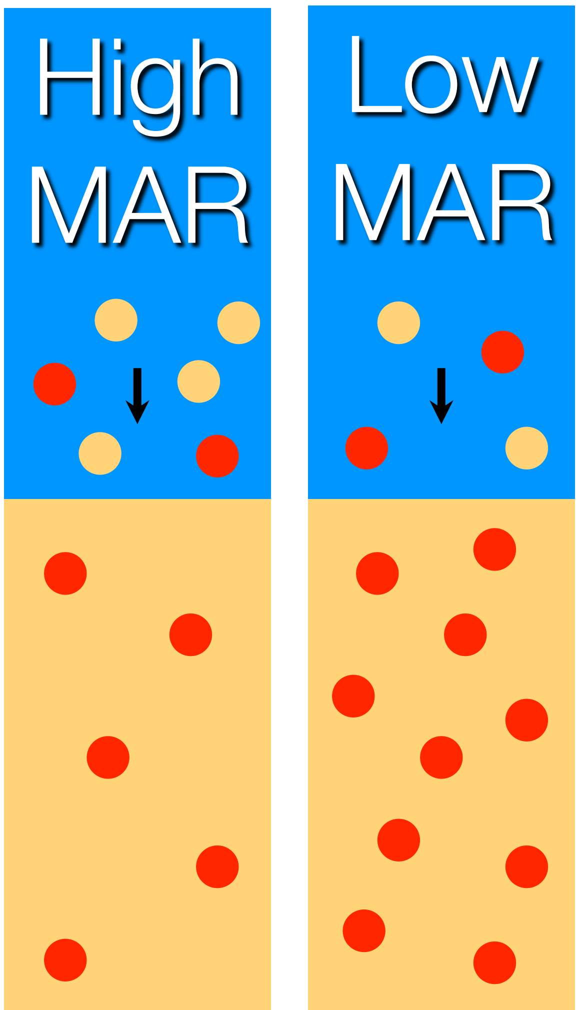
1. Age model approach



$$MAR = \frac{\rho \cdot \Delta z}{\Delta t}$$

ulating MARs:

Constant flux proxy normalization



$$MAR = \frac{f_{CFP}}{[CFP]}$$

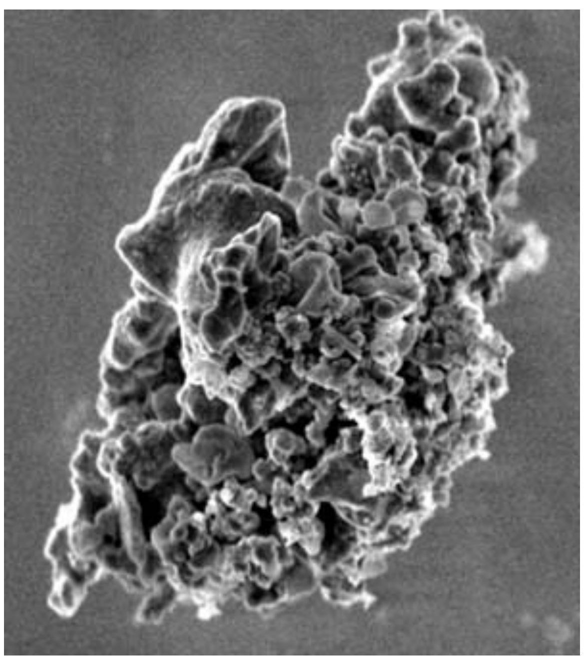
Largely insensitive to age model errors

"Instantaneous" fluxes at each sample depth nstant flux proxies

^{3}He

elivered by interplanetary
st particles (IDPs)

P ^{3}He flux ~constant in
e late Quaternary



^{230}Th

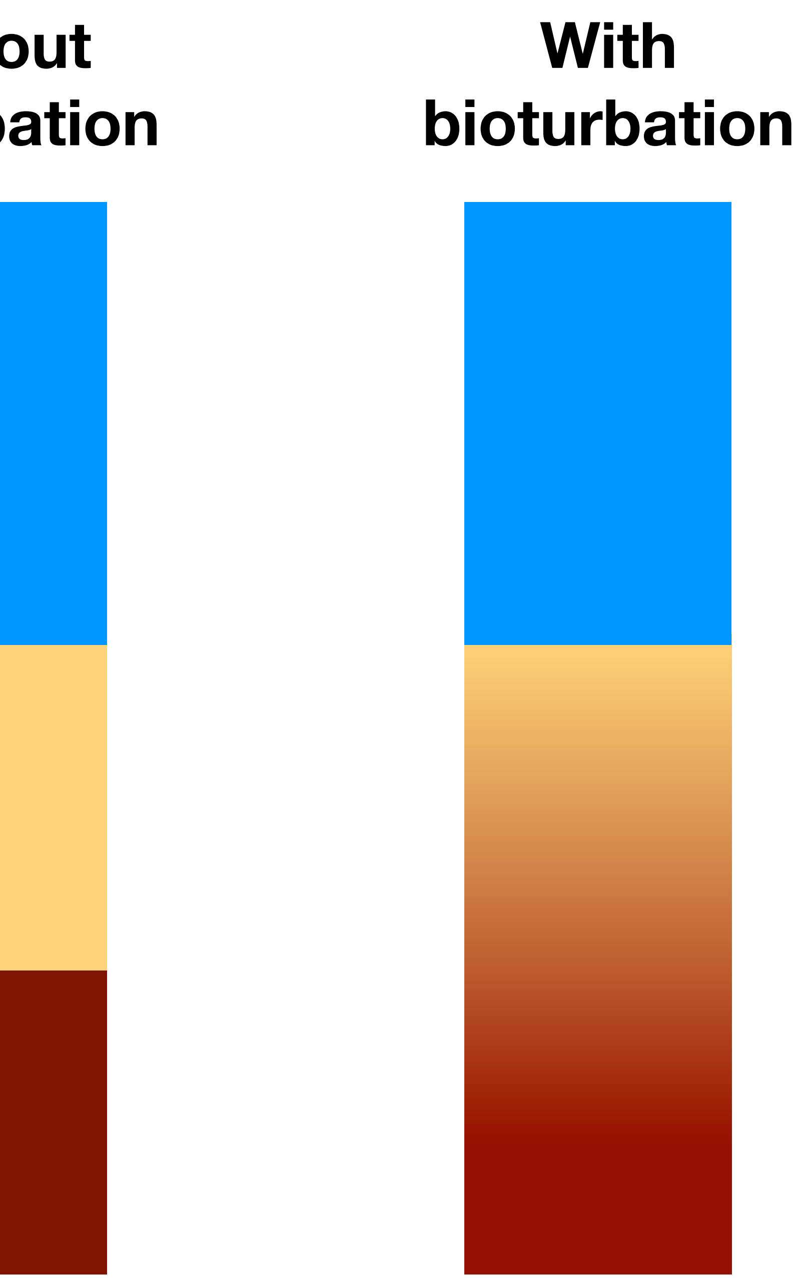
Produced by ^{234}U decay in the water column

Short residence time in the ocean (decades)

Flux to seafloor ~ production rate in overlying water column

Halflife = 75.7 kyr

urbation limits resolution



Average open-ocean sedimentation rate: 1-2 cm/kyr.

Average bioturbation depth: 5-10 cm.

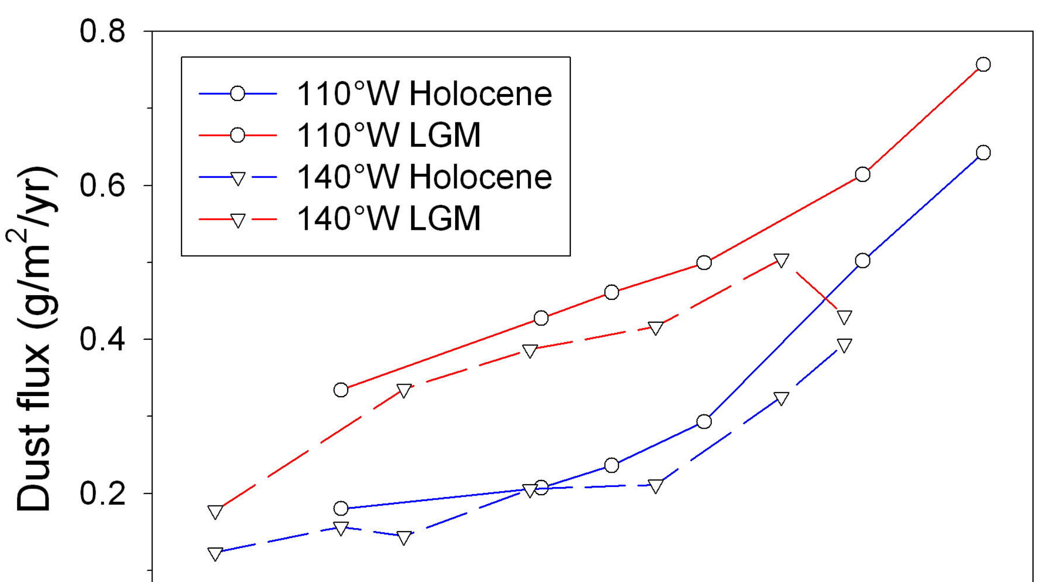
In average sediments, bioturbation thus smooths signal over 2-10 kyr intervals.

ırbation can:

limit our ability to observe abrupt or short-lived dust
lux changes

decrease dust flux differences in time (e.g., LGM-
Holocene differences)

produce mixes of modern and older sediments at the
core top (if it is preserved during coring)



ects for higher-resolution marine records

ntinental margin cores in places where eolian and fluvial diments differ by grain size or geochemistry (e.g., North ican margin, northwest Pacific).

en-ocean cores with good carbonate preservation ually seamounts) (e.g., Shatsky Rise, Hess Rise)

ft deposits probably not an option.

tions to ask about marine dust records

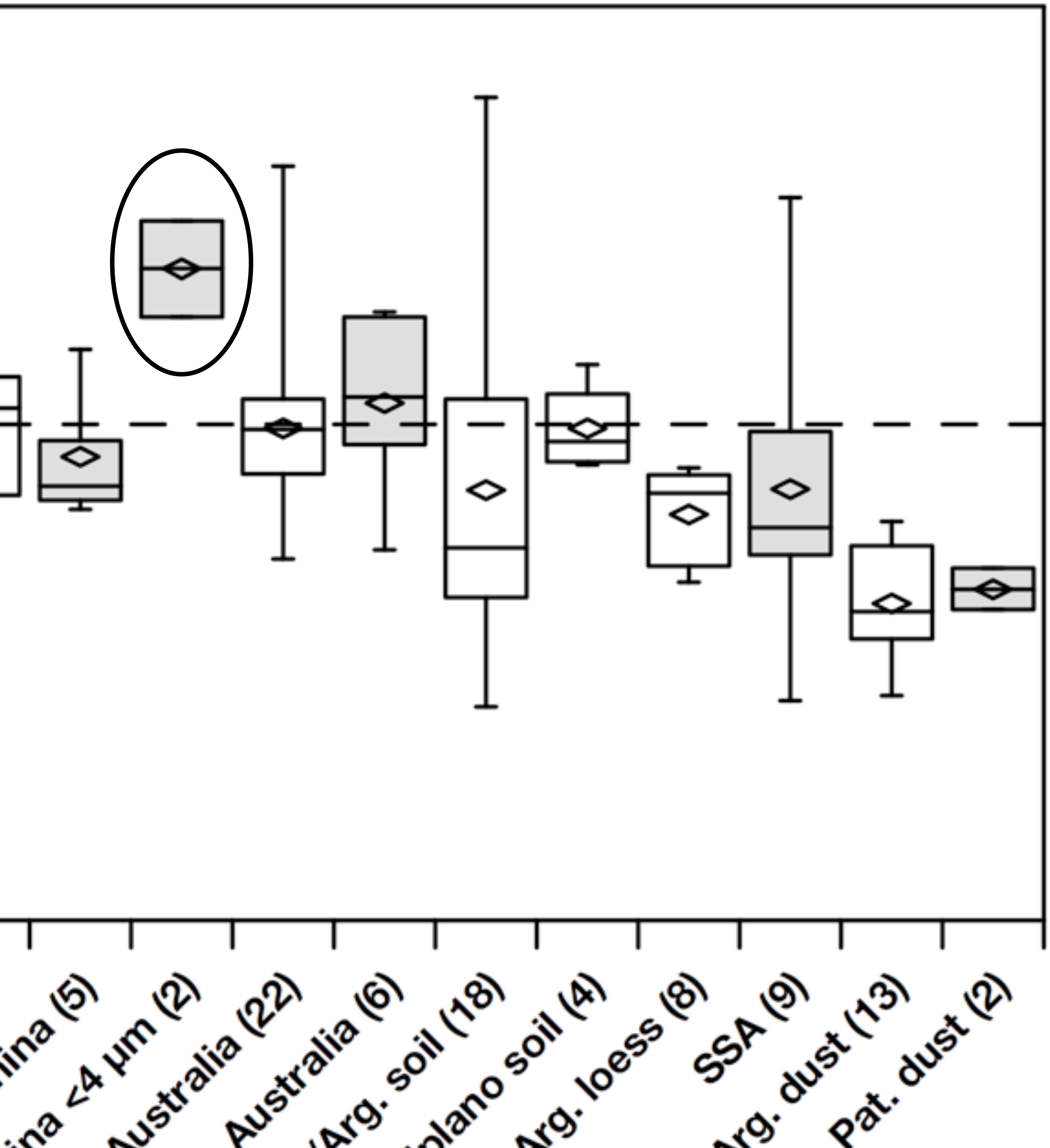
w was dust distinguished from other detrital components?

w were fluxes calculated?

hat are errors on absolute ages in the age model?

hat effects does bioturbation have on the record?

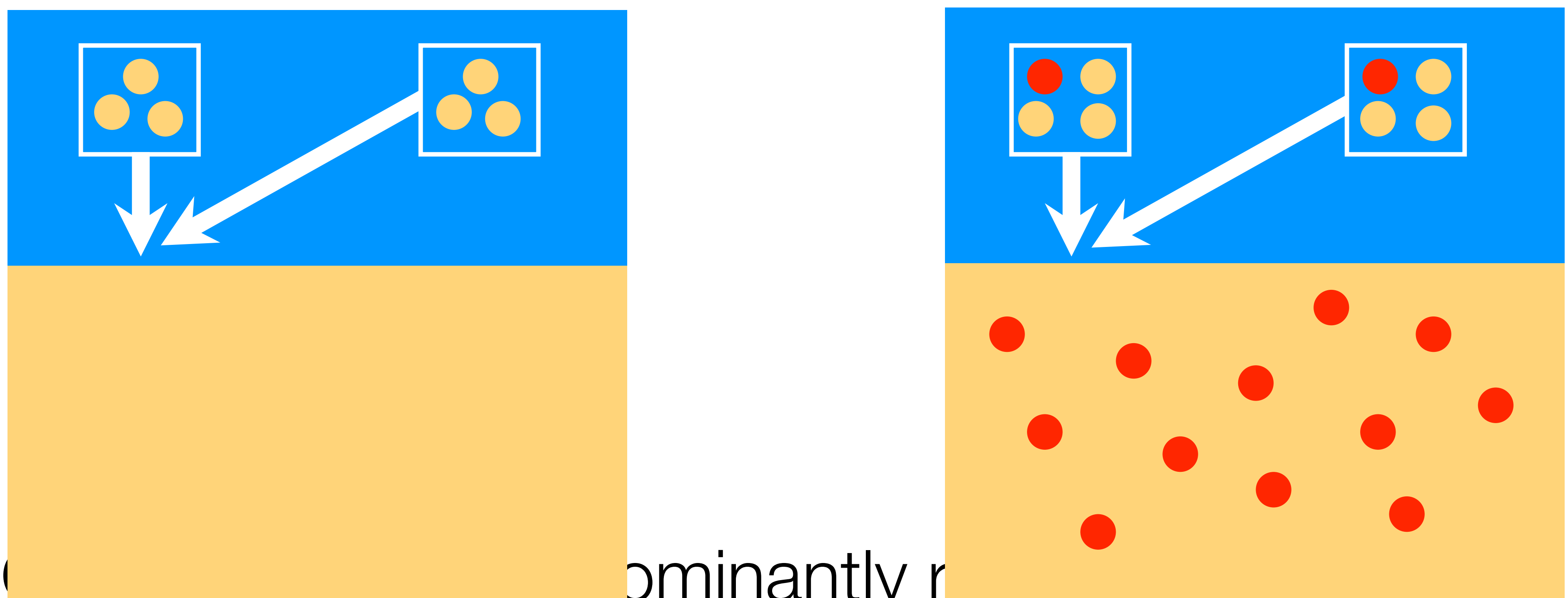
offers quantitative dust flux estimates



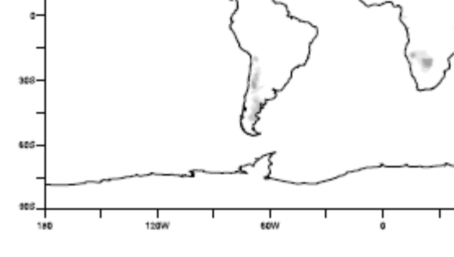
^{232}Th concentrations
UCC average in mos
source areas, but m
up to 50% higher in
fraction

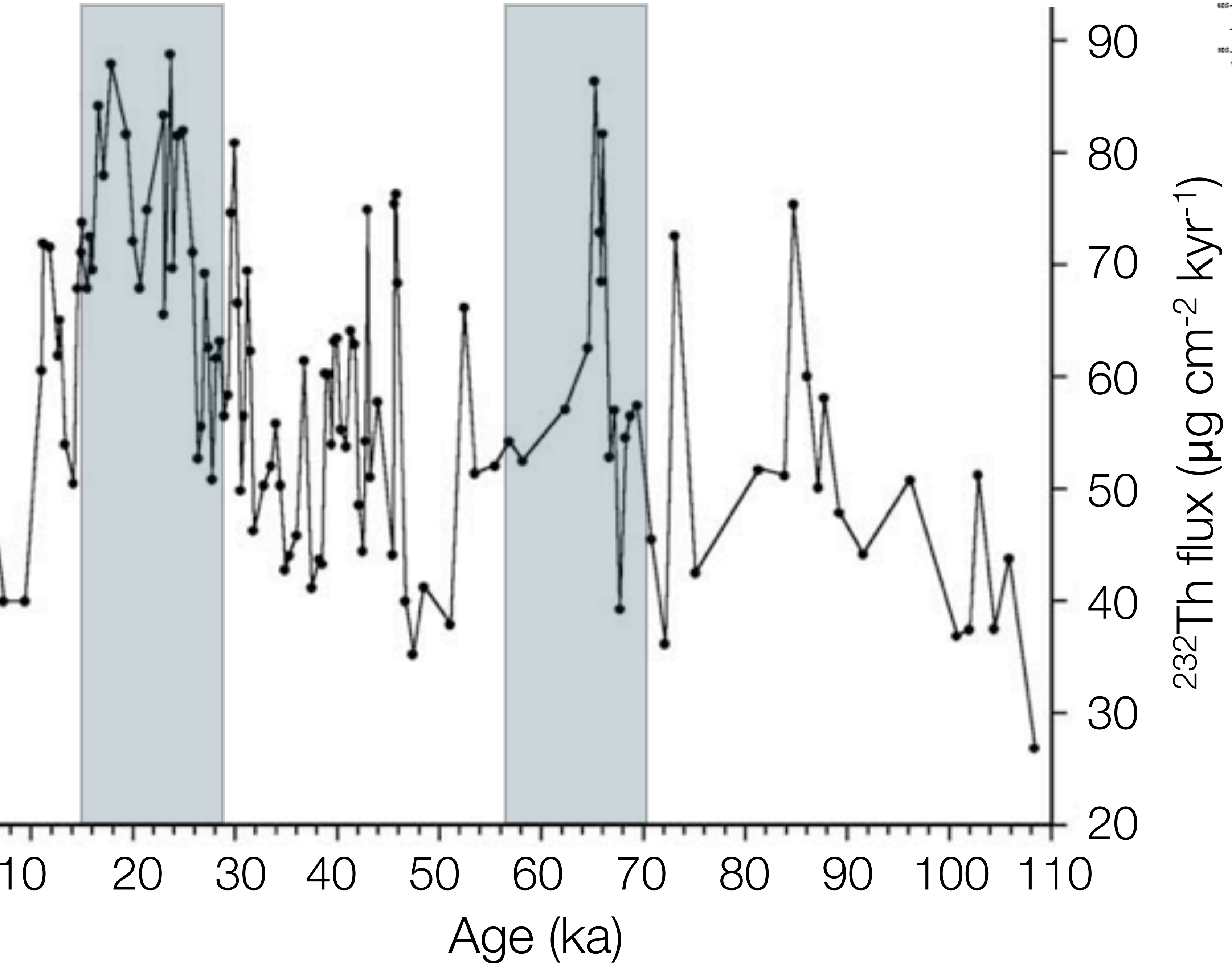
cts of lateral sediment advection (“focusing”)

- Age model-based MARs reflect all sediment additions (vertical and lateral)



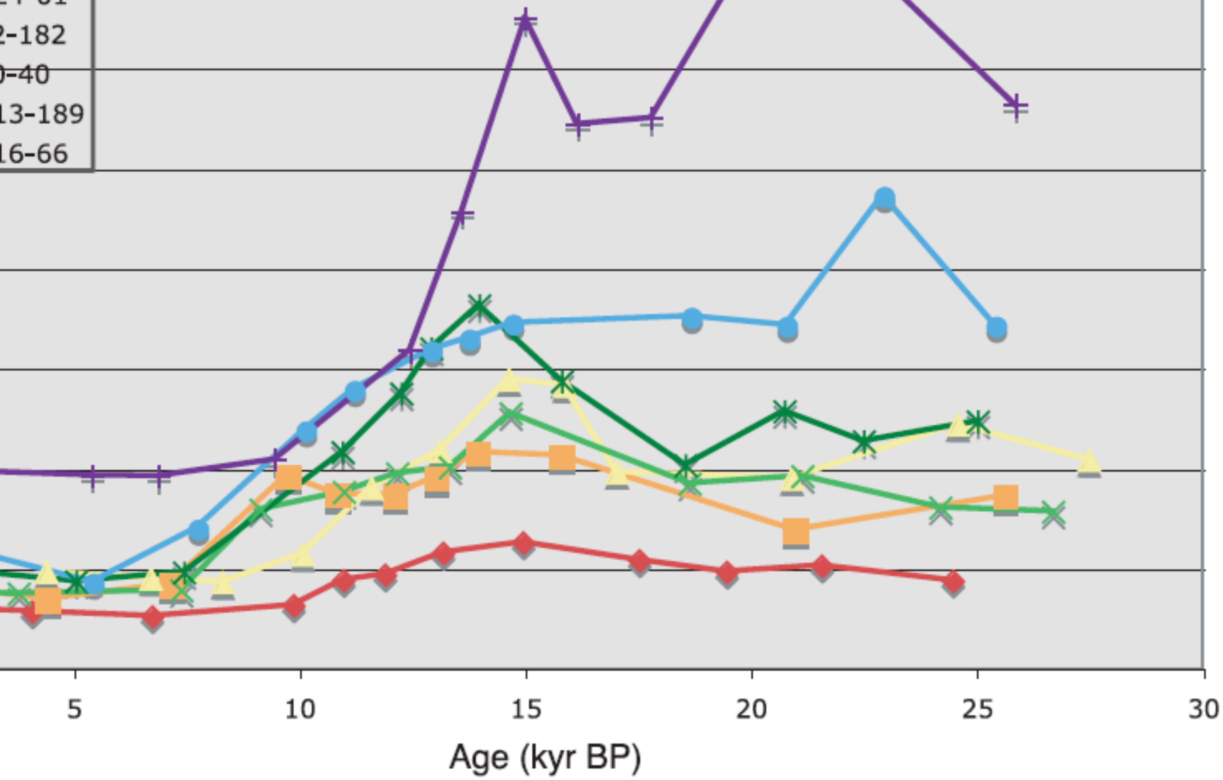
- ominantly r
  sedimentation (“rain rates”)

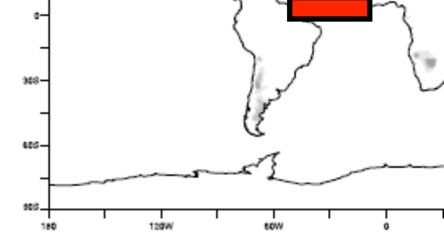




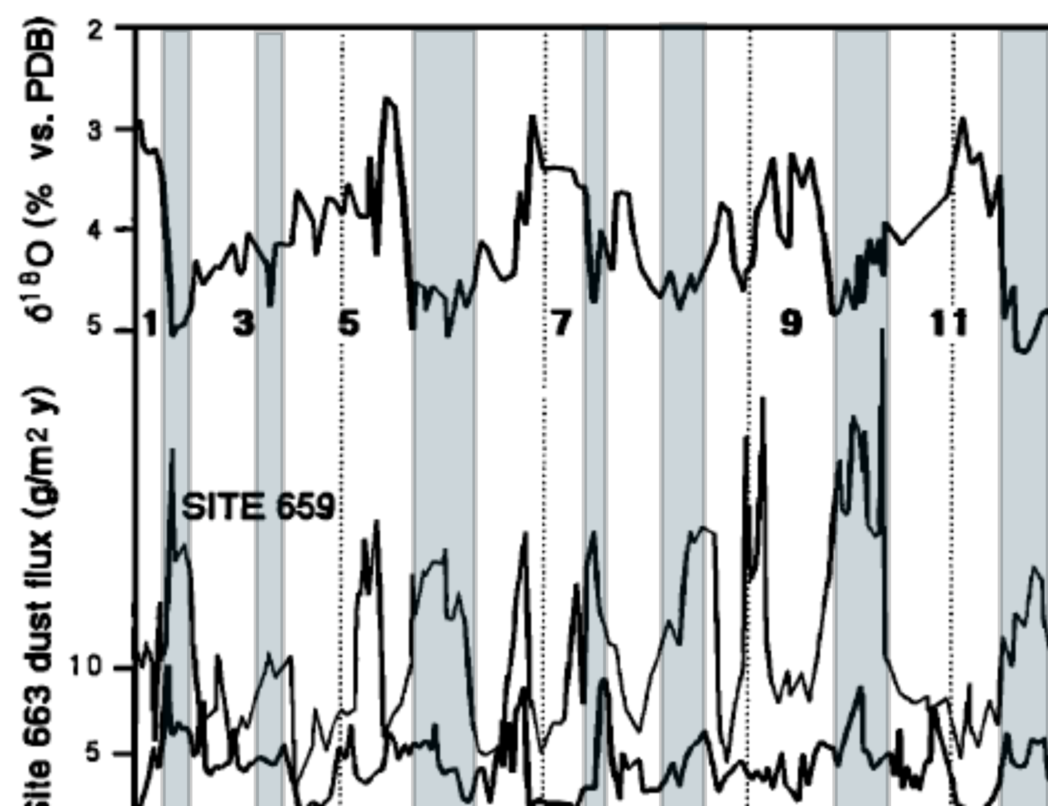
90
80
70
60
50
40
30
20
10
20
30
40
50
60
70
80
90
100
110
Age (ka)
232Th flux (μg cm-2 kyr-1)

rabian Sea

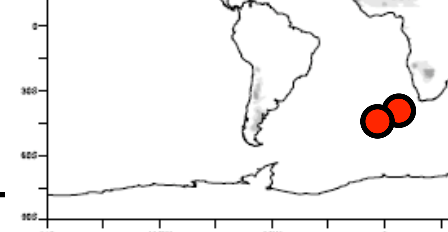


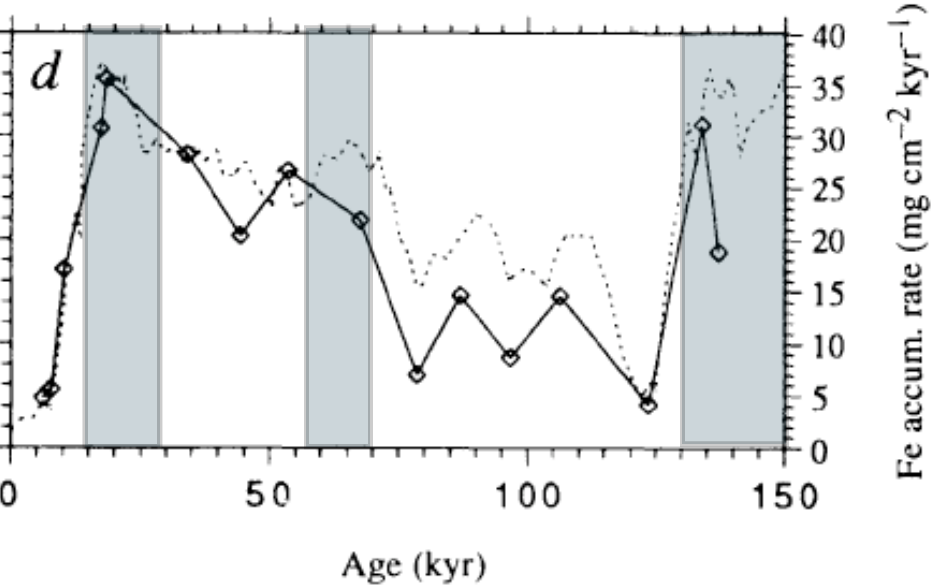


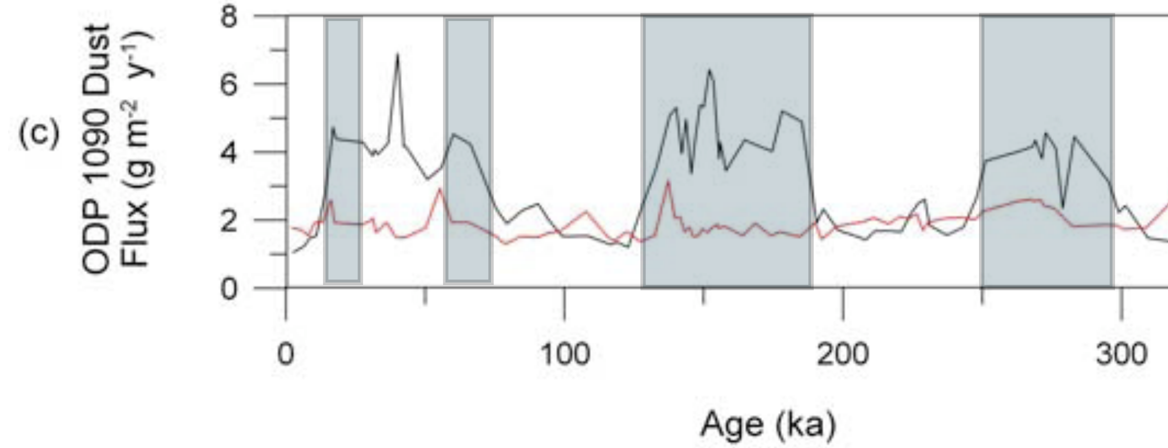
atorial and North
ical Atlantic
th Africa)



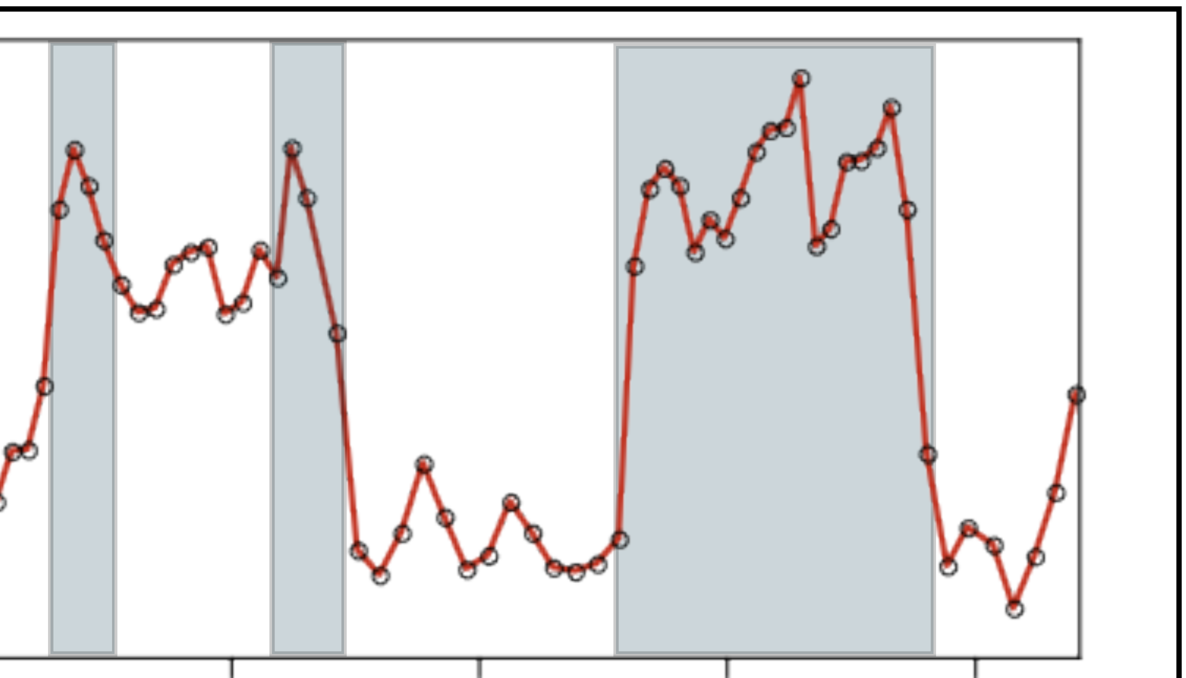
n Atlantic (Southern South America)







an Sea (Australia)



rmining dust fluxes in marine sediments

nge 1:
uishing dust from other
nents of the detrital
n

pelagic

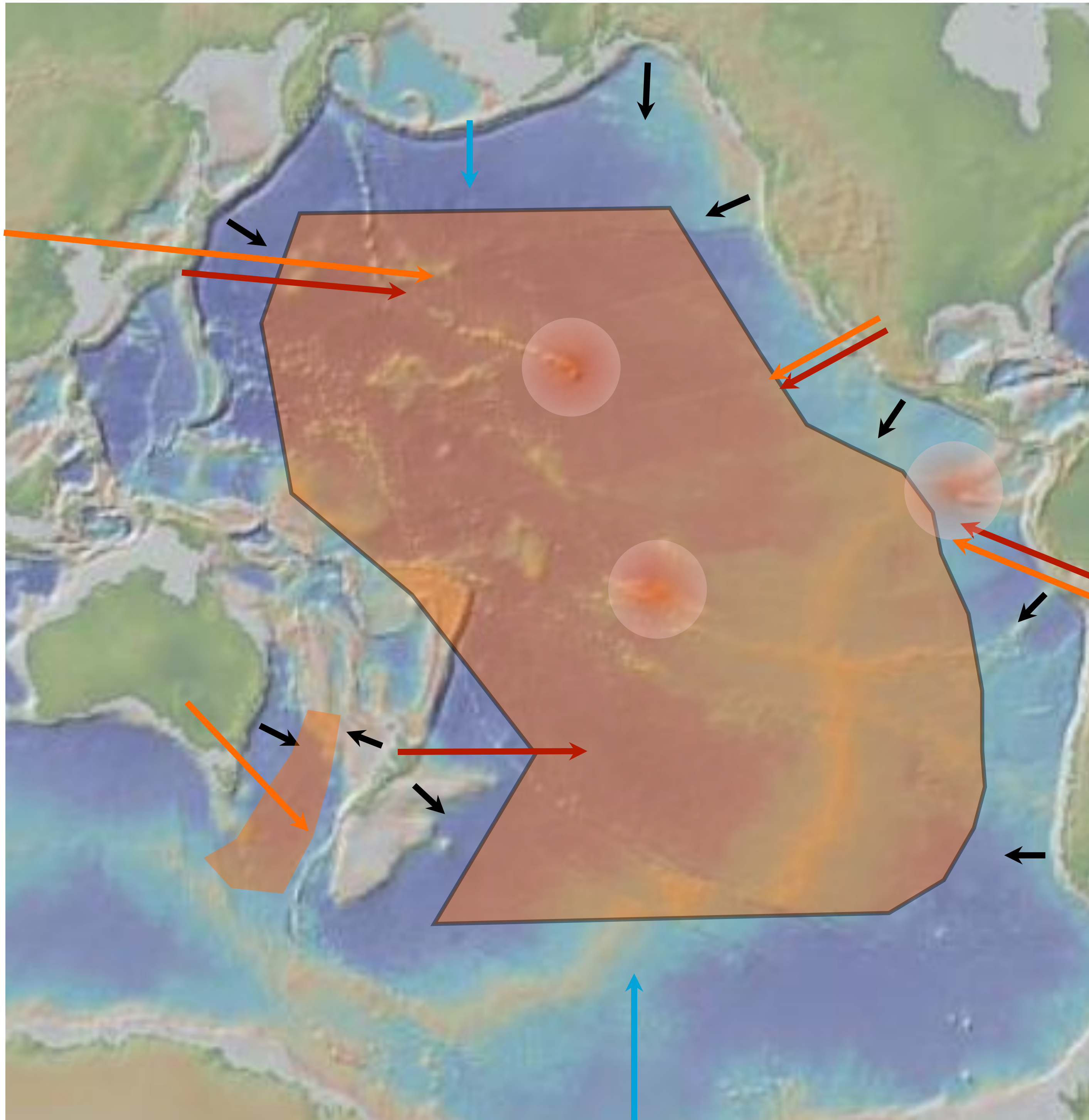
fted detritus

nic ash and sediments

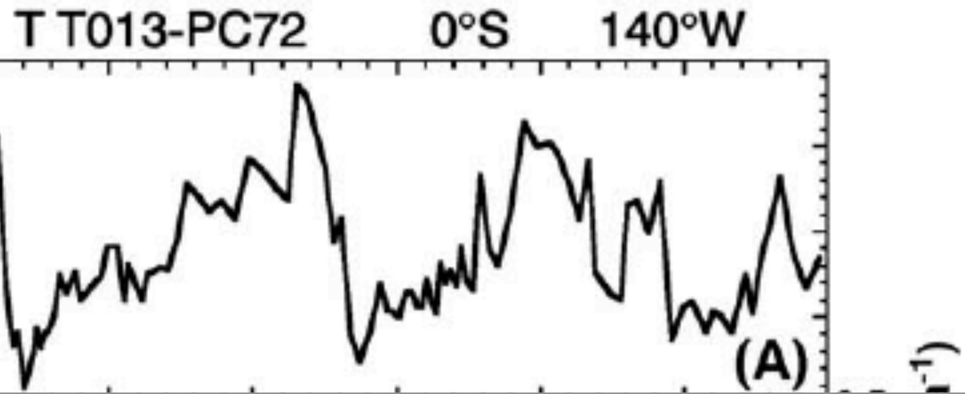
dust

gy 1:
n-ocean settings outside
belt

geochemical proxies
are minimal in volcanic
aminants



al components using **geochemical** differences



^{232}Th concentrations:
~10 ppm in UCC, loess
≤1 ppm in basalts