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Long term estimates of Australian dust flux into New Zealand: The use of modern analogues to assess the sensitivity of dust to environmental change using trace-element calibrated ^{210}Pb as a monitor

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Long travelled dust can be used as an excellent proxy for paleoenvironmental conditions such as the degree of aridity in dust source areas, changes in wind strength and dust transport pathways in response to changing synoptic circulation patterns. In addition, long travelled dust may also serve as a useful indicator of medium term climate variability triggered by phenomena such as ENSO. However, in order for dust and dust deposits to be used in this way it is necessary that the controls on dust transport and deposition, and the sensitivity of dust emissions to climate variability are understood.

Few long term modern analogues of long range dust transport exist. This is the case for the Australia-New Zealand region, where the deposition of Australian dust has been reported periodically in New Zealand over the last 100 years, eg Marshall (1903), Knight *et al*. (1995), McGowan *et al*. (2000). These studies have provided valuable information on the mechanisms of dust transport, but have not investigated the relationship between climate variability and inter-regional dust transport.

In this study we present a 12 year record (March 1989 to February 2001) of Australian dust flux from the west coast of the South Island, New Zealand, constructed using weekly average atmospheric ^{210}Pb records. Dusts collected from New Zealand glaciers were found to contain a mixture of local and long range Australian mate-

rial based on novel binary and tertiary mixing models of their ultra trace element chemistries. Trace element characteristics allowed the provenance of the long range dust component to within $<$ 200 km of their Australian sources. ^{210}Pb analyses of these dusts show that activity is related to the percentage of Australian dust in a linear fashion. However, ^{210}Pb activities of Australian dust collected in New Zealand were orders of magnitude greater than those measured in the alluvial sediments of the dust source areas, and were also highly enriched in ^{210}Pb compared to dusts collected in Australia. Atmospheric dust therefore scavenges ^{210}Pb from the atmosphere and can be used as an effective tracer of long-range dust transport. As a result, we use historical atmospheric ^{210}Pb flux records to develop the first record of long range Australian dust flux in New Zealand.

Results show that the average Australian dust concentration in New Zealand is 5.3 μg m^{-3}. There is a clear seasonality with the highest concentrations occurring in autumn-winter, preceding Australia's major dust storm season, which occurs in winter-spring. We propose that while meteorological factors control the occurrence of major dust storms, the availability of sediment in source areas is a major control on Australian dust flux in New Zealand. Dust flux is greatest after the summer floods when transport of extremely fine grained material occurs immediately after floodwaters recede. This is followed by transport of larger particles in the more spectacular winter-spring dust storms.

These results provide new information on the characteristics and seasonality of dust transport in the Australian region. Importantly they show dust emissions act as a sensitive proxy to source area conditions such as sediment supply, moisture, and synoptic circulation patterns. Results also attest to the value of dust as a paleoenvironmental proxy within geologic archives.

References:

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