El Niño-Southern Oscillation Influence on the Dust Storm Activity in Australia: Can the Past Provide an Insight into the Future?

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Background

- Australia has the largest source of airborne dust in the Southern Hemisphere with 70% of the continent classified as arid and semi-arid.
- The Australian climate (especially eastern Australian climate) is greatly influenced by the El Niño-Southern Oscillation (ENSO) phenomenon which is the strongest natural fluctuation of climate on interannual time-scales and also affects climate conditions globally by influencing a myriad of variables, such as rainfall, streamflow and surface temperature.
- ENSO is a complex interaction of atmospheric and oceanic processes and the prime driver of extreme weather events such as drought, flooding, bushfires, dust storms and tropical cyclones and up to 50% of annual rainfall variability in northern and eastern Australia is linked to ENSO (Figure 1).
- As a result increased dust storm events occur in central eastern Australia during dry El Niño phases of the Southern Oscillation.
- Large dust storm events remove millions of tonnes of fertile topsoil from inland Australia to places as far as New Zealand, New Caledonia and Antarctica (Figures 2).
- The Lake Eyre Basin, the Channel Country and the Mallee region are the main dust source region in eastern Australia (Figure 3) .

This Study

- The research project will investigate the capability in utilising measures of the ENSO phenomena in predicting dust storm activity in Australia.
- This will be achieved through major dynamical reconstructions or reanalysis of past weather and climate conditions for the past 200 years or more utilising the output from the global Atmospheric Circulation Reconstruction over the Earth (ACRE)-facilitated 20th Century Reanalysis Project (20CR) initiative to reconstruct both upper-air dynamics, surface conditions and then all major dust storm events of the past.
- The key research questions that will be addressed are:
  - What were the climatic conditions in the long-term past and have they changed?
  - Will dust storms become more prevalent and has their intensity changed through time?
  - Can the reconstruction of the past climate for the past 200 years or more including representation of upper-air dynamics and surface conditions provide an insight into the future?
  - Is there a relationship between climate change, low frequency climate variability and increased or changing dust storm activity?

Outcomes and Significance

- Australia has one of the most variable rainfall climates in the world and observational and modelling results suggest that more frequent or stronger ENSO events are possible in the future.
- Drought in Australia is probably the most economically costly climate event by reducing agricultural output and having social impacts on rural communities. Sustained drought conditions have the potential to reduce perennial vegetation cover in arid and semi-arid regions and exposing soils to increased dust storms activity in the future (Figure 4).
- Accelerated rates of dust emission from wind erosion have large implications not only on ecosystems but also for human well-being and therefore the development of a better understanding of how ENSO may affect wind erosion in arid and semi-arid landscapes is of great importance.
- The reconstruction of the ENSO history using longer-term meteorological data, reanalysis output, historical records, and other proxy data than may otherwise have been available (using the ACRE-facilitated 20CR project outputs) provides a far more lengthy and detailed global picture of past ENSO and other climate variability thereby allowing recent climate variability to be assessed from a long-term "multi-proxy" perspective.
- The resulting dataset can be used to better understand the range of past, present and future climate variability and the influence these have on the dust storm activity in Australia. In addition the information gained can provide an independent means of verifying climate model simulations.
- The scientific community is well aware that climate change is happening to some degree and Australia is already starting to experience the effects. In order to employ adaptation and mitigating measures it is also necessary to understand the underlying mechanisms responsible for climate change.

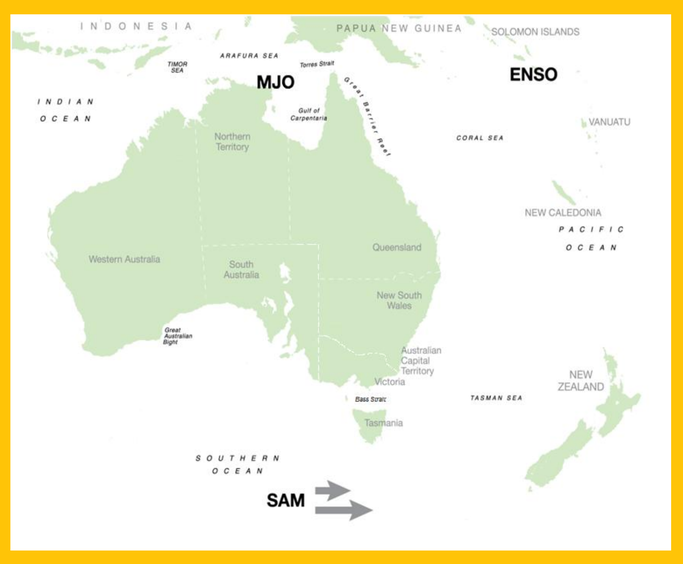

Figure 1: Schematic representation of main drivers of rainfall variability in the Australian region

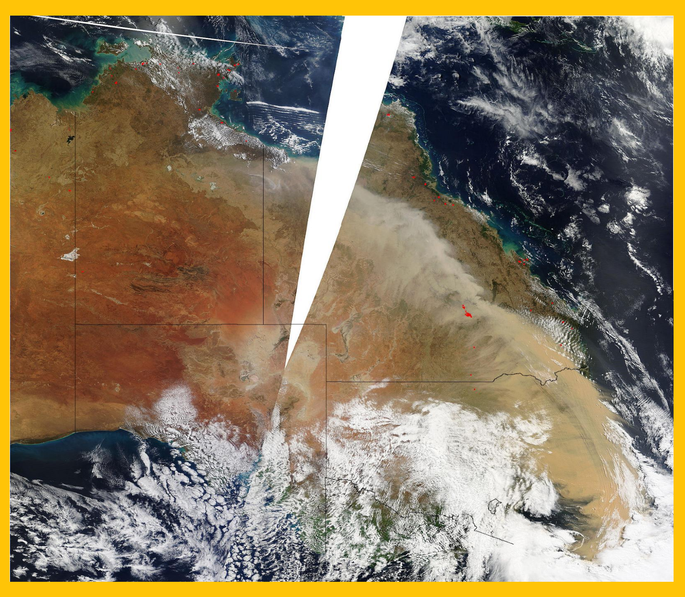

Figure 2: Satellite image of dust storm passing over eastern Australia on 23 September 2009

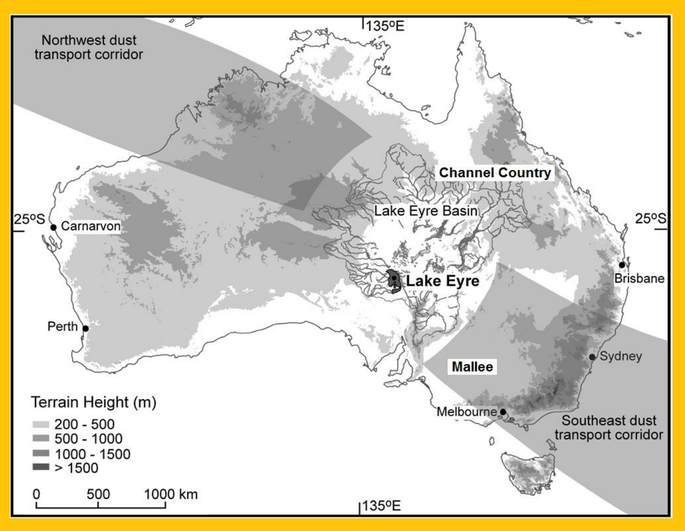

Figure 3: The location of dust source regions in eastern Australia

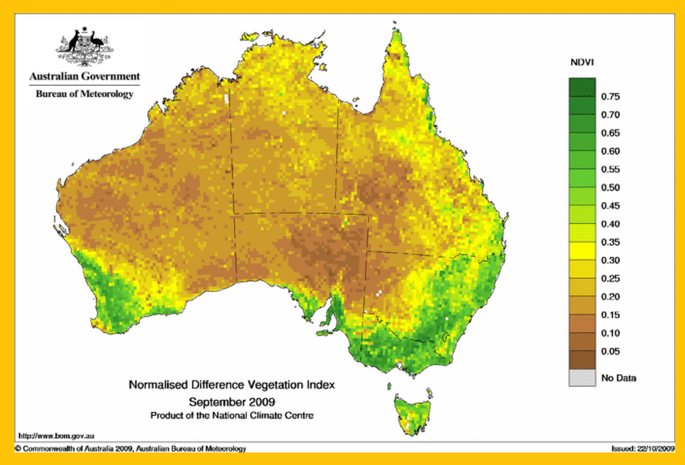

Figure 4: Normalised Difference Vegetation Index September 2009

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