# LAKE EYRE: THE ENSO INTEGRATOR

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Some background on the article is in - Allan, R.J., 2000: ***ENSO and climatic variability in the last 150 years.***

Chapter 1 in Diaz, H.F. and Markgraf, V., (eds), ***El Niño and the Southern Oscillation: Multiscale Variability, Global and Regional Impacts.*** Cambridge University Press, Cambridge, UK, 3-56.

***By Rob Allan, Vincent Kotwicki and David Roshier***

Links between major floodings and fillings of Lake Eyre in northern South Australia and the La Niña face of the El Niño Southern Oscillation (ENSO) phenomenon were established back in the early 1980s. Since then, there have been important advances. (see Kotwicki, 2001 at <http://www.k26.com/eyre/The_site/the_site.html>.

Today, climate scientists talk about ENSO being made up of El Niños and La Niñas, which vary in their onset, duration, magnitude and cessation. This nature results from interactions between the quasibiennial (about 2 year - QB) and lower frequency (about 3-8 year - LF) components of the 'classical' ENSO signal, and is modulated further by interactions with decadal (DEC) to multidecadal (MDEC) phenomena operating in the climate system.

By combining satellite imagery with ground based observations and hydrological models, it is now possible to build up a concise picture of the linkages between ENSO and Lake Eyre floodings. Using the Southern Oscillation Index (SOI) as a measure of ENSO, Lake Eyre floodings can be matched against the SOI since 1885 (Figure 1). Major inflows of water into Lake Eyre tend to occur at times of strong positive SOI values, which are indicative of very active La Niña events. However, this relationship is not one-to-one. Indeed, there are some instances where significant inflows into Lake Eyre occur during long periods of negative SOI, or El Niño conditions, such as in the early 1910s, 1940s and 1990s. This at first may seem incongruous given the link between El Niño events and Australian droughts, but it can be explained.

The El Niño occurrences noted above are longer lasting than the much stronger, but shorter, 1982-83 or 1997-98 events, and have been termed 'protracted' El Niño episodes. The opposite conditions, 'protracted' La Niña episodes, occurred in 1916-1918, the mid-1950s and 1970s, and since May 1998. All of these episodes may last for a number of years, as seen by the 1990-1995 'protracted' El Niño episode. However, they are not just 'classical' El Niño and La Niña events which happen to last more than the usual 18-24 months. Rather, they have been shown to occur during periods of strong interactions between 'classical' ENSO events and a decadal 'ENSO-like' signal (DEC).

To understand something about low frequency influences on 'classical' ENSO events, one must look to the patterns of anomalous (above or below average) Indo-Pacific sea surface temperatures (SSTs) which influence Australian rainfall. Figure 2 (with shadings of darker=warmer and lighter=cooler SSTs), shows SST composites during events

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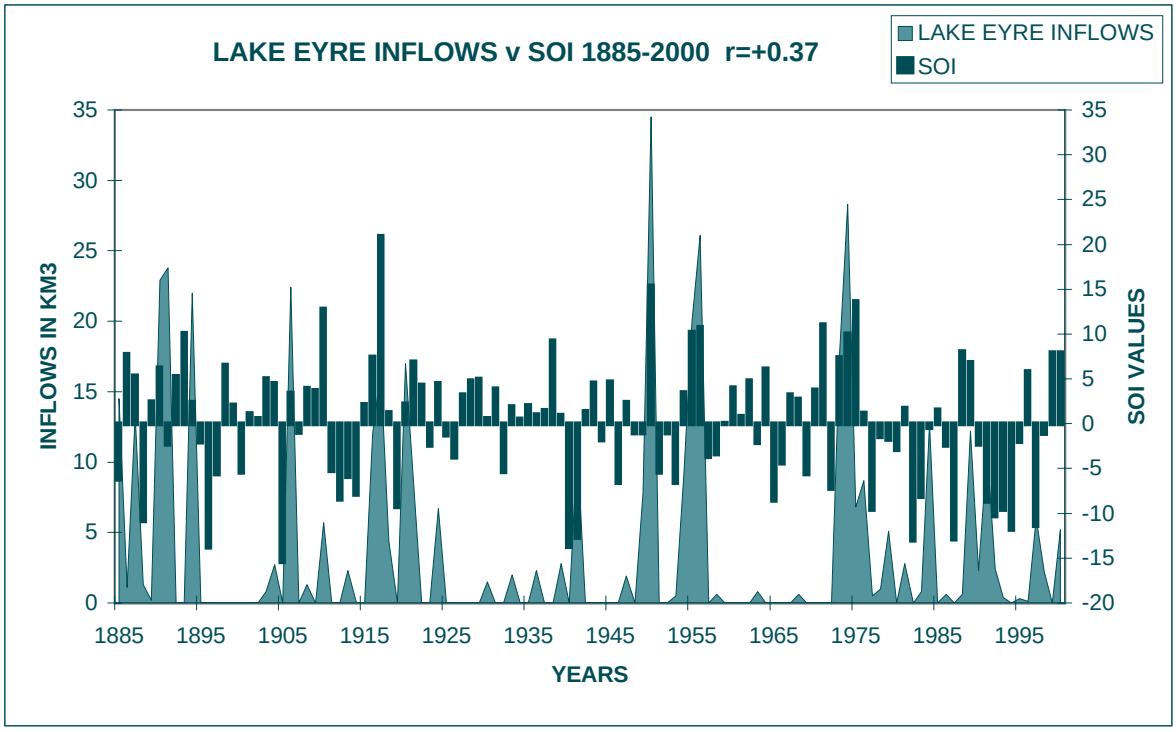
Figure 1



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and episodes in the historical record for the July-September (JAS) season. Basically, the bulk of the ENSO signal during events and episodes is concentrated in the Pacific Ocean, although the Indian Ocean basin also contains ENSO influences. However, a more intriguing picture emerges from a closer examination of Figure 2.

While the 'classical' El Niño signal on the QB and LF bands has a pronounced warm 'tongue' of SSTs that covers the eastern-central equatorial Pacific, 'protracted' El Niño episodes are marked by warmer, but weaker, SSTs with a focus in the western-central equatorial Pacific.

Over the Indian Ocean during 'classical' El Niño events on the above bands, distinct SST patterns with dipoles and tripoles of warmer and cooler waters are evident. In 'protracted' El Niño episodes, Indian Ocean SST patterns are weaker and sometimes show almost the opposite alignments. However, the 'protracted' El Niño composite is also influenced by SSTs on DEC and MDEC bands.

The DEC band has SST patterns that tend to be in-phase with those on the LF band, particularly in the Pacific, where there is a reinforcement of the warm western-central equatorial SST focus. This SST pattern causes a shift in climatic regimes which, though 'ENSO-like', can result in more regionalised impacts of wet or dry conditions that persist for a number of years. The DEC band SST pattern over the Indian Ocean also affects these impacts.

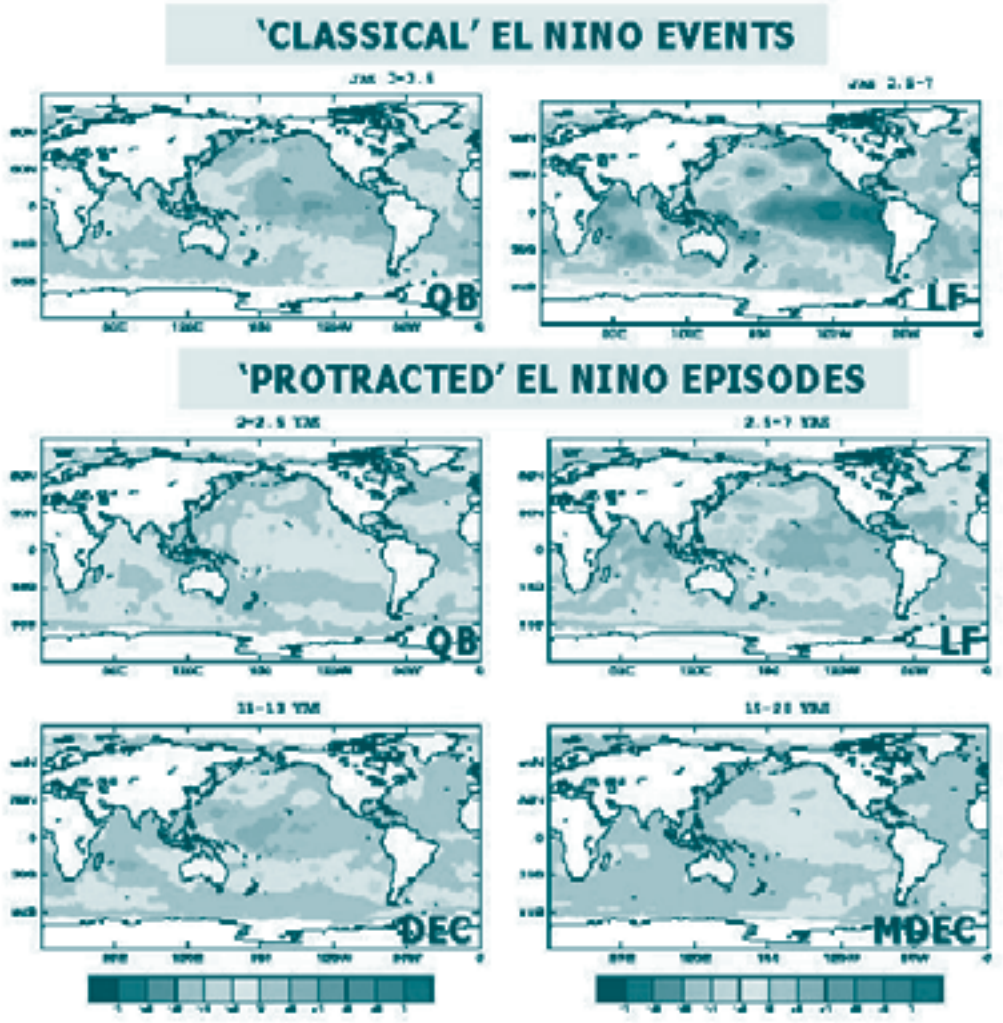


**Figure 2**

Further aspects of the above picture need to be considered. In specific 'protracted' episodes, climatic signals on the QB, LF, DEC and MDEC bands can vary to the extent that a number of permutations are possible. Periods of a month or more can develop when an episode appears to be waning, only for it to become strong again.

As it wanes, conditions in the Pacific may perhaps still favour 'protracted' El Niño conditions, while those in the Indian may be almost like a La Niña event. For Australia, this can mean extended drought in one region and major flooding events in another (eg. as in the 1990-1995 'protracted' El Niño and the 1998-present 'protracted' La Niña) during the one 'protracted' episode. Similar patterns to all of the above are found during La Niña events and episodes, but they tend to show the opposite SST structures to those in Figure 2.

Thus it is not surprising that, when matched against the SOI, Lake Eyre inflow records respond to the full range of influences on Australian rainfall patterns generated by both 'classical' ENSO events and 'protracted' ENSO episodes.

Consequently, the relationship between ENSO and Lake Eyre floodings in Figure 1 must be seen to be even more compelling, and points to Lake Eyre as indeed being a strong integrator of the entire range of ENSO types and nature.