Environmental Research Letters

COMMENT

Comment on ‘Drought variability in the eastern Australia and New Zealand summer drought atlas (ANZDA, CE 1500-2012) modulated by the Interdecadal Pacific Oscillation’

Tessa R Vance¹,², Jason L Roberts¹,², Chris T Plummer³, Anthony S Kiem⁴ and Tas D van Ommen¹,²

¹ Antarctic Climate & Ecosystems Cooperative Research Centre, University of Tasmania, Hobart, Tasmania, 7001, Australia
² Australian Antarctic Division, Kingston, Tasmania, 7050, Australia
³ Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, 7001, Australia
⁴ Centre for Water, Climate and Land (CWCL), Faculty of Science and Information Technology, University of Newcastle, Callaghan, NSW, 2308, Australia
⁵ Author to whom any correspondence should be addressed. E-mail: tessa.vance@utas.edu.au

Keywords: Law Dome, interdecadal Pacific oscillation, drought, ANZDA

Abstract

The study of (Palmer et al 2015 Environ. Res. Lett. 10 124002) details a spatial reconstruction of drought across eastern Australia and New Zealand over the last 500 years. The authors used a global 0.5° by 0.5° gridded network of the self-calibrating Palmer drought severity index (scPDSI) spanning 1901–2012 as the basis for a nested point-by-point regression to reconstruct austral summer (DJF) scPDSI for this region. Their study used 176 tree rings from New Zealand, Indonesia and Australia, and one coral record from the Great Barrier Reef. In their paper Palmer et al (2015) compared three publically available proxy records and reconstructions derived from the Law Dome ice core (East Antarctica) to their reconstructed scPDSI. These were the LD summer sea salt (LDsss) series, which is a proxy for Western Pacific sea surface temperature and subtropical eastern Australian rainfall (Vance et al 2013 J. Clim. 26 710–25, 2015 Geophys. Res. Lett. 42 129–37, Tozer et al 2016 Hydrol. Earth Syst. Sci. 20 1703–17), and two Interdecadal Pacific Oscillation (IPO) reconstructions produced using two independent methods, namely the Piece-wise Linear Fit (PLF) and Decision Tree (DT) series (Vance et al 2015 Geophys. Res. Lett. 42 129–37, 2016 Clim. Past 12 595–610). We show that the treatment of the Law Dome LDsss record and the PLF and DT IPO reconstructions mis-characterizes both the utility and targets of the three records.

Introduction

We argue that the analysis of Palmer et al (2015) mischaracterizes the skill of our Interdecadal Pacific Oscillation (IPO) reconstructions. It does this by correlating austral summer (DJF and DJFM) and annual (May–June) instrumental indices of the IPO (Power et al 1999 and Henley et al 2015) with our 13 years smoothed PLF and DT-median reconstructions (see table 1(b) in Palmer et al 2015). Clearly, the different temporal resolutions of the correlated series mean our 13 years smoothed reconstructions will be unable to capture variance in seasonal or annual indices; correspondingly, the squared Pearson correlation coefficient (RSQ) values presented are low, leading to the conclusion that the ANZDA EOF1 is more strongly related to the IPO than the Vance et al (2015) PLF and DT reconstructions. Unfortunately, readers of the Palmer et al (2015) paper are likely to be unaware that the RSQ values have been calculated using smoothed reconstructions against seasonal/annual instrumental data. Our IPO reconstructions were developed with the decadal-scale band as the target and are in actual fact highly skillful in the decadal scale band that defines the IPO (Vance et al 2015).

Additionally, Palmer et al (2015) compute correlations between the LDsss series and indices that do not particularly make sense—for example, against IPO indices. We have not used or published the LDsss
Table 1. Pearson r-squared (RSQ) values from table 1(b), Palmer et al (2015) for 1902–1975 (publically available datasets may have been updated/changed slightly, hence small differences in some cases). Note that we have not tried to recalculate the ANZDA EOF1 values.

| 1902–1975 | Niño 34 dJF | IPO dJF | TPI dJF | LDsss | PLF | DT-median | ANZDA |
|-----------|-------------|---------|---------|-------|-----|-----------|-------|
| Niño 34 dJF | 0.656       | 0.846   | 0.131   | 0.011 | 0.015 |          |       |
| IPO dJF    | 0.801       | 0.096   | 0.115   | 0.510 | 0.151 | 0.639    |       |
| TPI dJF    |             |         | [0.453; 0.563] | [0.607; 0.669]  |       |          |       |
| Niño 34 dJFM | 0.125**    | 0.108** | [0.491; 0.594]** | [0.627; 0.753]** | 0.946 | 0.946    |       |
| ANZDA EOF1 |             |         | [0.557; 0.706]** | [0.627; 0.832]** | 0.000 | 0.000    |       |

* indicates values correlated against extended seasonal (dJFM) or annual series. Italics show instances of statistical incompatibility, where publically available 13 years Guassian smoothed Law Dome IPO reconstructions (PLF and DT-median) were correlated against seasonal timeseries in Palmer et al (2015). Bold values beside the italicized original values from Palmer et al (2015) show the correct (smoothed) RSQ values, with ranges in brackets showing bootstrapped 95% confidence intervals (CI), taking into account autocorrelation of the series. Underlined values show instances where the LDsss series (which is not an IPO proxy) has been correlated against an IPO index or reconstruction.

Table 2. Full instrumental record Pearson RSQ values (1878–2003 to avoid end effects in smoothed series). Bold type again shows smoothed Law Dome IPO reconstructions with bootstrapped 95% CI (bracketed ranges). Note that CI ranges between tables 1 and 2 largely overlap (except for IPO dJFM correlated against PLF and DT). Given the increase in effective degrees of freedom, the slightly lower values do not signify a meaningful difference in significance or variance explained over the full instrumental period. Thus, the Law Dome IPO reconstructions are robust across the full instrumental record. We also calculated RSQ values over 1902–2003 and again showed no significant difference (data not shown), indicating the significance of the Law Dome IPO reconstructions do not decline after 1975 and are robust regardless of time interval used.

| 1878–2003 | Niño 34 dJF | IPO dJF | TPI dJF | LDsss | PLF | DT-median | ANZDA |
|-----------|-------------|---------|---------|-------|-----|-----------|-------|
| Niño 34 dJF | 0.721       | 0.877   | 0.059   | 0.390 | 0.534 |          |       |
| IPO dJF    | 0.830       | 0.430   | [0.341; 0.437] | [0.503; 0.566]  |       |          |       |
| TPI dJF    |             |         | [0.200; 0.632] | [0.331; 0.781]  |       |          |       |
| LDsss      | 0.059**     | 0.488   | 0.547   | [0.444; 0.637]** | 0.947 |          |       |
| PLF        |             | [0.471; 0.504]** | [0.444; 0.637]** | [0.947; 0.947]  |       |          |       |
| DT-median  | 0.635       | 0.657   | 0.720   | [0.576; 0.687]** | [0.549; 0.834]** |          |       |
| ANZDA EOF1 |             |         | [0.947; 0.947] | [0.947; 0.947]  |       |          |       |

series as an IPO proxy, and suggest that the resulting low RSQ values presented in Palmer et al (2015) are unsurprising and have no bearing on the utility of the LDsss series as a Western Pacific sea surface temperature (SST)/eastern Australian rainfall proxy. Our published work about the LDsss series details significant relationships with SST in the Western Pacific and with eastern subtropical Australian rainfall (Cai et al 2010, Vance et al 2013, 2015, Tozer et al 2016), not with the IPO. Western Pacific SSTs are particularly associated with rainfall variability in eastern Australia during winter/spring (not summer) (www.bom.gov.au/climate/updates/articles/a008-el-nino-and-australia.shtml, Gallant et al 2012). The relationship between the Western Pacific and Law Dome also occurs during austral winter/spring, as would be expected with a developing ENSO-related wavetrain in the SW Pacific, which is then transmitted to higher latitudes by astral summer (Karoly 1989, Mo and Paegle 2001) and appears as a signal in the summer sea salt concentrations (LDsss series) in snowfall at Law Dome. This stronger relationship between LDsss and the Western Pacific and Australian rainfall should have been mentioned, rather than just presenting a low RSQ value with Niño 3.4 SST from outside of the SST season described as being important for mechanistic reasons in Vance et al (2013).

To illustrate these issues, we provide two tables. Table 1 reproduces the RSQ values from table 1(b) of Palmer et al (2015) using publically available indices, and augments this with correctly computed, decadally smoothed targets. We have italicized or underlined...
values that we argue mischaracterize our records or artificially suppress correlations. In addition, we provide table 2, which shows Pearson RSQ values for the Law Dome IPO reconstructions/LDss proxy over the full instrumental period which demonstrates that the Law Dome IPO reconstructions are robust and remain highly skillful over the full instrumental era.

Methods

IPO Indices—HADISST monthly data was obtained directly from Chris Folland (UK Met Office) in 2014. This data was used to calculate dJF/dJFM and annual (May–June) records. TPI IPO (HADISST) monthly data obtained from Ben Henley, as part of Henley et al (2015), and also calculated to seasonal and annual as above. Niño 3.4 seasonal (dJF and dJFM) produced from monthly data downloaded from KNMI Climate Explorer.

Calculation of correlation values with bootstrap confidence intervals (CIs)—the method of Olafsdottir and Mudelsee (2014) was used for the calculation of correlation values and associated bootstrap CIs. This method accounts for autocorrelation in the time series when computing correlations. The correlation result is significant at 95% if the 95% CI does not span zero.

References

Cai W, van Rensh P, Cowan T and Sullivan A 2010 Asymmetry in ENSO teleconnection with regional rainfall, its multidecadal variability, and impact J. Clim. 23 4944–55

Gallant A J E, Kiern A S, Verdon-Kidd D C, Stone R C and Karoly D J 2012 Understanding hydroclimate processes in the Murray-Darling Basin for natural resources management Hydrol. Earth Syst. Sci. 16 2049–68

Henley B J, Geoghegan J, Karoly D J, Power S, Kennedy J and Folland C K 2013 A tripoole index for the Interdecadal Pacific Oscillation Clim. Dyn. 45 3077–90

Karoly D 1989 Southern hemisphere circulation features associated with El Niño-Southern Oscillation events J. Clim. 2 1239–52

Mo K C and Paegle J N 2001 The Pacific-South American modes and their downstream effects Int. J. Climatol. 21 1211–29

Olafsdottir K B and Mudelsee M 2014 More accurate, calibrated bootstrap confidence intervals for estimating the correlation between two timeseries Math. Geosci. 46 411–27

Palmer J G, Cook E R, Turner C S M, Allen K, Fenwick P, Cook B L, O’Donnell A, Lough J, Grierson P and Baker P 2015 Drought variability in the eastern Australia and New Zealand summer drought atlas (ANZDA, CE 1500–2012) modulated by the Interdecadal Pacific Oscillation Environ. Res. Lett. 10 124002

Power S, Casey T, Folland C, Colman A and Mehta V 1999 Interdecadal modulation of the impact of ENSO on Australia Clim. Dyn. 15 319–24

Tozer C, Vance T R, Roberts J L, Kiern A S, Curran M A J and Moy A D 2016 An ice core derived 1013-year catchment-scale annual rainfall reconstruction in subtropical eastern Australia Hydrol. Earth Syst. Sci. 20 1703–17

Vance T R, van Ommen T D, Curran M A J, Plummer C T and Moy A D 2013 A millennial proxy record of ENSO and Eastern Australian rainfall from the Law Dome ice core, East Antarctica J. Clim. 26 710–25

Vance T R, Roberts J L, Plummer C T, Kiern A S and van Ommen T D 2015 Interdecadal Pacific variability and eastern Australian megadroughts over the last millennium Geophys. Res. Lett. 42 129–37

Vance T R et al 2016 Optimal site selection for a high-resolution ice core record in East Antarctica Clim. Past 12 595–610