**The PSD website will be unavailable starting Friday, Mar 11th 4:00pm MT through Saturday, Mar 12th at 1:00pm due to buildi
(with some limited exceptions).**

Multivariate ENSO Index (MEI)

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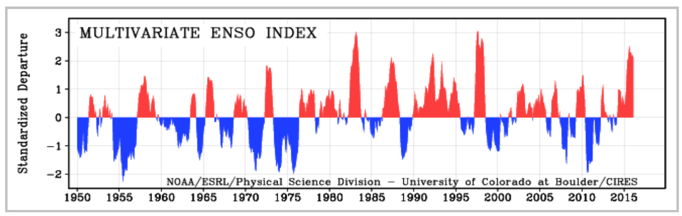

Outline for MEI webpage (updated on March 6th, 2016)

This webpage consists of seven main parts, three of which are updated every month:

1. A short description of the Multivariate ENSO Index (MEI);

2. Historic La Niña events since 1950;

3. Historic El Niño events since 1950;

4. UPDATED MEI loading maps for the latest season;

5. UPDATED MEI anomaly maps for the latest season;

6. UPDATED Discussion of recent conditions;

7. Publications and MEI data access.

El Niño/Southern Oscillation (ENSO) is the most important coupled ocean-atmosphere phenomenon to cause global climate va interannual time scales. Here we attempt to monitor ENSO by basing the Multivariate ENSO Index (MEI) on the six main obser the tropical Pacific. These six variables are: sea-level pressure (P), zonal (U) and meridional (V) components of the surface win temperature (S), surface air temperature (A), and total cloudiness fraction of the sky (C). These observations have been collect ICOADS for many years. The MEI is computed separately for each of twelve sliding bi-monthly seasons (Dec/Jan, Jan/Feb,..., N spatially filtering the individual fields into clusters (Wolter, 1987), the MEI is calculated as the first unrotated Principal Compone observed fields combined. This is accomplished by normalizing the total variance of each field first, and then performing the ext PC on the co-variance matrix of the combined fields (Wolter and Timlin, 1993). In order to keep the MEI comparable, all season standardized with respect to each season and to the 1950-93 reference period.

IMPORTANT CHANGE: The MEI used to be updated every month during the first week of the following month based on near-re
and buoy observations (courtesy of Diane Stokes at NCEP). However, this product has been discontinued as of March 2011 (IC
2-degree monthly statistics). Instead, the MEI is now being updated using ICOADS throughout its record. The main change fron
is the replacement of 'standard' trimming limits with 'enhanced' trimming limits for the period from 1994 through the current upda
slightly higher MEI values for recent El Niño events (especially 1997-98 where the increase reaches up to 0.235 standard devia
lower values for La Niña events (up to -.173 during 1995-96). The differences between old and new MEI are biggest in the 1990
of time-delayed ship data that did not enter the real-time data bank was higher than in more recent years. Nevertheless, the line
between old and new MEI for 1994 through 2010 is +0.998, confirming the robustness and stability of the MEI vis-a-vis input da
Caution should be exercised when interpreting the MEI on a month-to-month basis, since the MEI has been developed mainly fo
purposes. Negative values of the MEI represent the cold ENSO phase, a.k.a.La Niña, while positive MEI values represent the w
(El Niño).

IMPORTANT ADDITION: For those interested in MEI values before 1950, a 'sister' website has now been created that presents
MEI.ext index that extends the MEI record back to 1871, based on Hadley Centre sea-level pressure and sea surface temperatu
in a similar fashion as the current MEI. Our MEI.ext paper that looks at the full 135 year ENSO record between 1871 and 2005 i
at the International Journal of Climatology (Wolter and Timlin, 2011).

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Historic La Niña events since 1950

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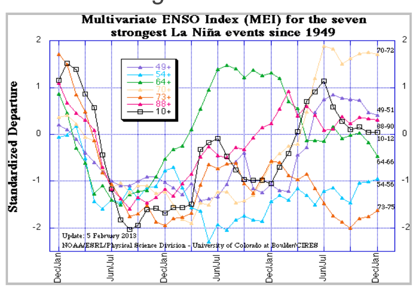

How does the 2010-12 La Niña event compare against the six previous biggest La Niña events since 1949? This figure includes
(with at least three bimonthly rankings in the top six), after replacing the slightly weaker 2007-09 event with 2010-12 (rankings a
Niña events have lasted up to and over three years since 1949, in fact, they do tend to last longer on average than El Niño ever
events included here lasted through most of 1954-56 and 1973-75. The longest event NOT included here occurred in 1999-200
the 'strong' threshold (top six rankings) just once. Click on the "Discussion" button below to find a comparison of strong 2015 El
with historic strong El Niño events.

- Discussion and comparison of recent conditions with historic La Niña events
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Historic El Niño events since 1950

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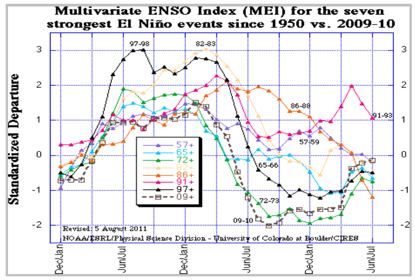

How does the 2009-10 El Niño event compare against the seven previous biggest El Niño events since 1950? This figure incluc events (with at least three bimonthly rankings in the top six), with the exception of the 2009-10 event that reached the top six ra Compared to the previous version of this figure, 1997-98 now reaches very similar peak values to the 1982-83 event, just above threshold. Click on the "Discussion" button below to find a comparison of strong 2015 El Niño conditions with the same seven hi the 2015-16(?) event is over, the comparison figure with 2015-16 will replace the current one with 2009-10.

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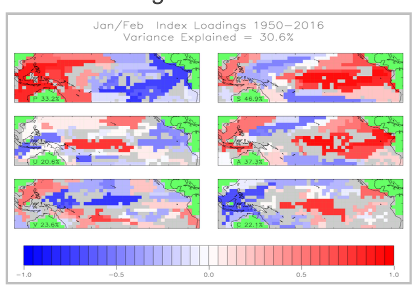
MEI loading maps for the latest season

Click to enlarge



The six loading fields show the correlations between the local anomalies and the MEI time series. Land areas as well as the Atl and flagged in green, while typically noisy regions with no coherent structures and/or lack of data are shown in grey. Each field i single capitalized letter and the explained variance for the same field in the Australian corner.

The sea level pressure (P) loadings show the familiar signature of the Southern Oscillation: high pressure anomalies in the wes anomalies in the east correspond to positive MEI values, or El Niño-like conditions. Consistent with P, U has positive loadings al of the Equator, corresponding to westerly anomalies near the dateline. Negative loadings over Indonesia and east of Australia a Galapagos indicate easterly anomalies during El Niño. The meridional wind field (V) features high negative loadings north of the the southward shift of the ITCZ so common during El Niño-like conditions, juxtaposed with high positive loadings northeast of A anomalies during El Niño).

Both sea (S) and air (A) surface temperature fields exhibit the typical ENSO signature of a wedge of positive loadings stretching and South American coast to the dateline, or warm anomalies during an El Niño event. They are flanked by a horse-shoe patter loadings (cold anomalies during El Niño) to its north- and soutwest. At the same time, total cloudiness (C) tends to be increased equatorial Pacific, juxtaposed with decreased cloudiness from north of Australia to the Philippines.

The MEI continues its retreat from its peak explained variance two months earlier (now down to 30.6%) of all six fields in the tro 30N to 30S. This is 1% higher than 12 months ago, and 1% lower than 18 years ago during the last extra strong El Niño, showi of the reduction in ENSO activity during the first decade of this century. Although the temperature components dominate the ME of their possible variance, even P, V, as well as U and C join in with about a third, almost a quarter, and twice with more than a f explained variance, respectively. The loading patterns shown here resemble the seasonal composite anomaly fields of Year 1 in

Carpenter (1982).

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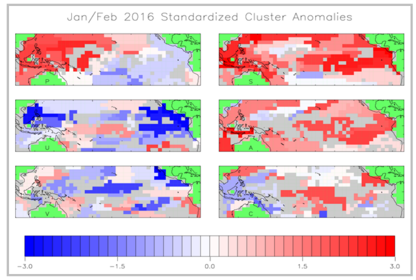
MEI anomaly maps for the latest season

Click to enlarge



With the MEI indicating continuing strong El Niño conditions, one can find a long list of key anomalies in the MEI component fiel
equal one standard deviation, or one sigma (compare to loadings figure). Every one of them flags El Niño rather than La Niña c

Significant positive anomalies (coinciding with high positive loadings) indicate very high sea level pressure anomalies (P) from t
down to Australia, strong westerly anomalies (U) near the equatorial dateline, strong southerly anomalies (V) east of Australia,
surface (S) and air temperatures (A) anomalies over the central and eastern equatorial Pacific, strongly enhanced cloudiness (C
equatorial Pacific. Significant negative anomalies (coinciding with high negative loadings) flag low sea level pressure (P) near T
easterly anomalies (U) both over Indonesia and west of Galapagos, strong northerly wind anomalies (V) over the northern centr
Pacific, and reduced cloudiness (C) over the western tropical Pacific. The biggest change compared to last month is the signific
anomalous southerly flow anomalies east of Australia, strengthened northerly anomalies north of the Equator, both of which stre
cloudiness in the equatorial Pacific to two standard deviations. Thus, all six fields are showing key anomalies at or beyond plus/
deviations, a feat only accomplished once before during this event, during its peak season of August-September 2015.

Go to the discussion below for more information on the current situation.

If you prefer to look at anomaly maps without the clustering filter (which is most limiting for the cloudiness field), check out the c
our map room.

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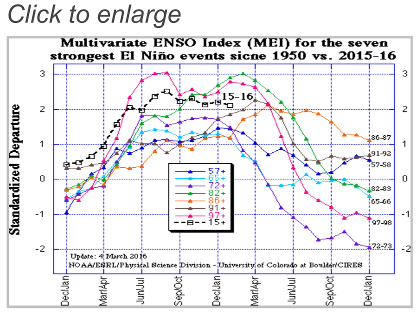
Discussion and comparison of recent conditions with historic El Niño co

Click to enlarge



In the context of strong El Niño conditions since March-April 2015, this section features a comparison figure with the classic set events during the MEI period of record.

Compared to last month, the updated (January-February) MEI has decreased slightly (by 0.08) to +2.12, continuing at the 3rd h falling further behind 1983 and 1998, compared to earlier this season. However, the August-September 2015 value of +2.53 ren highest overall at any time of year since 1950. The evolution of the 2015-16 El Niño is now slightly more similar to 1965-66 than monitored by the MEI. This means that the odds of having a second peak in late winter/early spring have collapsed to zero.

Looking at the nearest 6 rankings (+2/-4) in this season gives us three 'analogues' already identified four months ago: 1972-73, 1997-98, plus 1957-58 and 1991-92 from last month, and 2009-10 as a new entry. Three of these six analogues evolved into La later ('73-74, '98-99, and '10-11), one of them ended up neutral ('83-84), and two hung onto weak El Niño conditions ('58-59 anc for a few months running, La Niña is more likely than climatological odds a year from now, but it is by no means a guaranteed o Meanwhile, strong El Niño conditions (top 10% ranking) are quite likely through March-April (four of the top six cases remained while general El Niño rankings (top 30%) are still more likely than not (four out of six) through May-June, in the MEI sense.

Positive SST anomalies cover the eastern equatorial Pacific, all the way from just west of the dateline to the South American co latest weekly SST map. This includes anomalies above +2C from about 110-170W, but no +3C anomalies within that 'warm ton clearly a reduction in amplitude compared to earlier updates this season.

For an alternate interpretation of the current situation, I recommend reading the NOAA ENSO Advisory which represents the off recent Climate Prediction Center opinion on this subject. In its latest update (February 11th, 2016), strong El Niño conditions we were expected to transition to ENSO-neutral by late boreal spring or early summer. I may disagree with the timing a little, but the tends to transition faster than the MEI in similar situations such as 1998.

There are a number of ENSO indices that are kept up-to-date on the web. Several of these are tracked at the NCEP website tha updated around the same time as the MEI, just in time for this go-around. Unless otherwise noted, I refer to the OISSTv2 anoma discussion, they tend to be bigger than the ERSSTv4 anomalies that are currently used by CPC. Since October 2014, Niño regi around +0.5C, but rose steadily from April 2015 onwards, reaching +1.3C in June, 2.1C in August, peaking at 2.95C in Novemb steadily since then, to +2.8C in December, +2.6C in January, and +2.4C in February. The November 2015 value appears to be t record for any month since 1982, exceeding December 1997 (2.7C) and January 1983 (2.8C). The ERSST4 version kept the No anomaly quite a bit lower (+2.37C), also a new record, if only by 0.04C. For some unknown reason, the ERSST4 Niño 3.4 anom dropped by 0.17C since then, keeping the most recent anomaly higher than in either 1983 or 1998 during February. For compar SST crested at +2.93C in November and dropped to +2.85C in December, +2.58C in January, followed by a rapid decline in Feb Note that this decline still allowed for the average SST to peak at +28.36C in this region, the highest for this event. In any case, anomalies were quite a bit lower than what was recorded in December 1997 or January 1983 (by 0.7C and 0.4C, respectively). SST alone, the current event appears to have been more powerful at its peak than based on the MEI (or Niño 3 SST).

For extended Tahiti-Darwin SOI data back to 1876, and timely monthly updates, check the Australian Bureau of Meteorology we has often been out of sync with other ENSO indices in the last decade, including a jump to +10 (+1 sigma) in April 2010 that wa other ENSO index in announcing La Niña conditions. In 2015, its value varied from +1 in February (neutral ENSO conditions) do up again to -4 in April, and back down below -10 from May through October, reaching -20 both in August and October. The runn average peaked in June-October (-16.5), which was the lowest since early 1998. However, the November and December 2015 considerably (-5 and -9), only to rebound back to -20 in January and February, somewhat akin to what happened from late 1997 This also serves as a reminder that this index is noisier from month to month than any other ENSO index.

An even longer Tahiti-Darwin SOI (back to 1866) is maintained at the Climate Research Unit of the University of East Anglia we less frequent updates, with the last one to include data through all of 2015. Extended SST-based ENSO data can be found at th Washington-JISAO website, which is now more than five years behind current conditions.

Stay tuned for the next update by April 9th (probably earlier) to see where the MEI will be heading next. El Niño conditions are g persist for at least a few more months, but clearly weaker than in 1983 or 1998 for this index. Typical El Niño impacts will be sup PDO conditions that have endured since January 2014, reaching record levels from December 2014 through February 2015. Da ENSO status can be found at the TAO/TRITON website, showing at least some recent signs of life in terms of westerly anomalie equatorial dateline after about a month or more of almost none.

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MEI data access and publications

You can find the numerical values of the MEI timeseries under this link, and historic ranks under this related link.

If you have trouble getting the data, please contact me under (Klaus.Wolter@noaa.gov)

You are welcome to use any of the figures or data from the MEI websites, but proper acknowledgment would be appreciated. Pl (Wolter and Timlin, 1993, 1998) papers below (available online as pdf files), and/or this webpage.

In order to access and compare the MEI.ext against the MEI, go here.

Publications

- Rasmusson, E.G., and T.H. Carpenter, 1982: Variations in tropical sea surface temperature and surface wind fields asso Southern Oscillation/El Niño. *Mon. Wea. Rev.*, **110**, 354-384. Available from the AMS.
- Wolter, K., 1987: The Southern Oscillation in surface circulation and climate over the tropical Atlantic, Eastern Pacific, an as captured by cluster analysis. *J. Climate Appl. Meteor.*, **26**, 540-558. Available from the AMS.
- Wolter, K., and M.S. Timlin, 1993: Monitoring ENSO in COADS with a seasonally adjusted principal component index. *Pr Climate Diagnostics Workshop*, Norman, OK, NOAA/NMC/CAC, NSSL, Oklahoma Clim. Survey, CIMMS and the School of Oklahoma, 52-57. Download PDF.
- Wolter, K., and M. S. Timlin, 1998: Measuring the strength of ENSO events - how does 1997/98 rank? *Weather,* **53,** 315- PDF.
- Wolter, K., and M. S. Timlin, 2011: El Niño/Southern Oscillation behaviour since 1871 as diagnosed in an extended multi index (MEI.ext). *Intl. J. Climatology*, **31**, 14pp., 1074-1087. Available from Wiley Online Library.

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