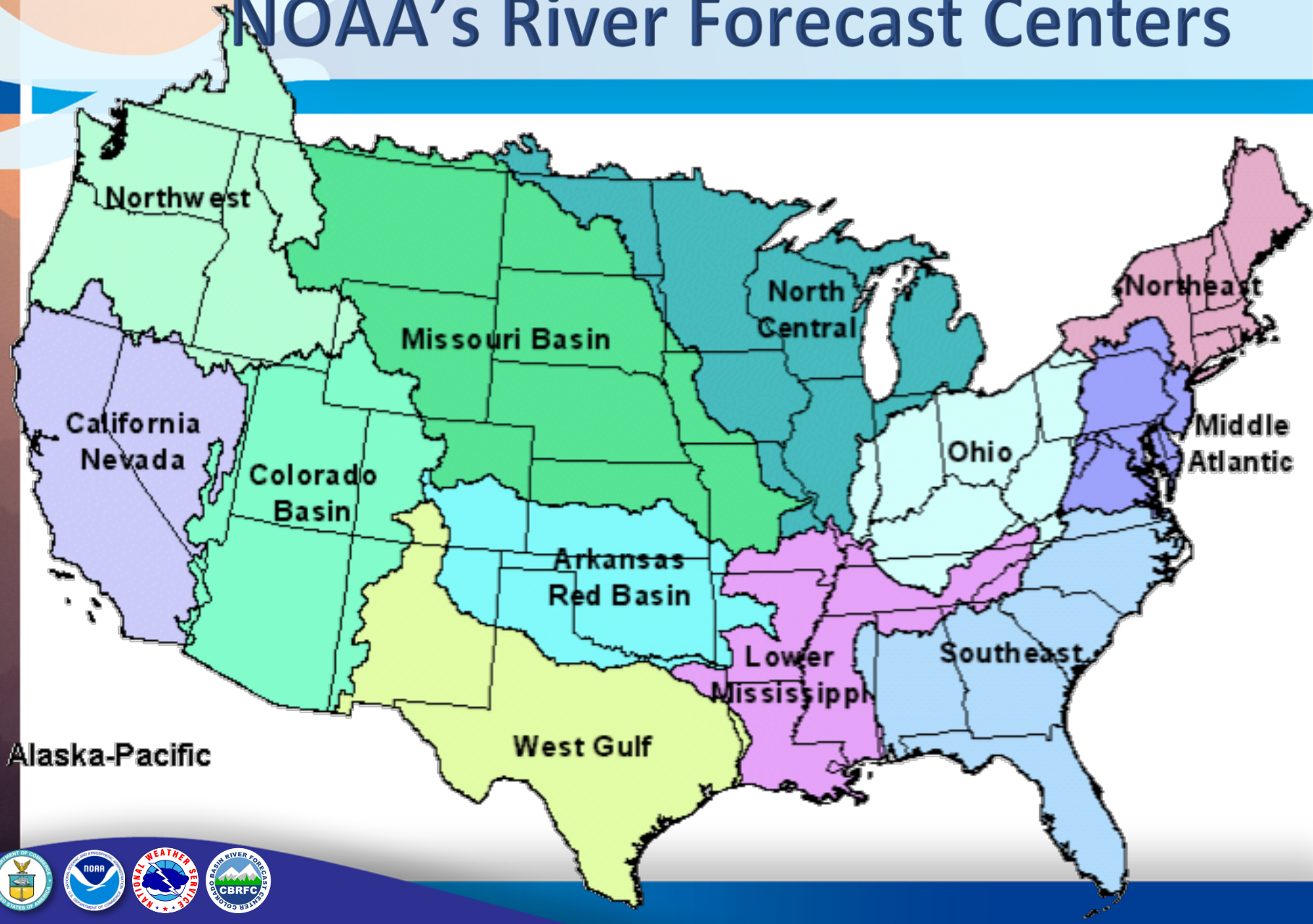
NOAA'S COLORADO BASIN RIVER FORECAST CENTER

EL NIÑO: WHAT IS IT AND THE 2015 – 2016 EVENT

Overview

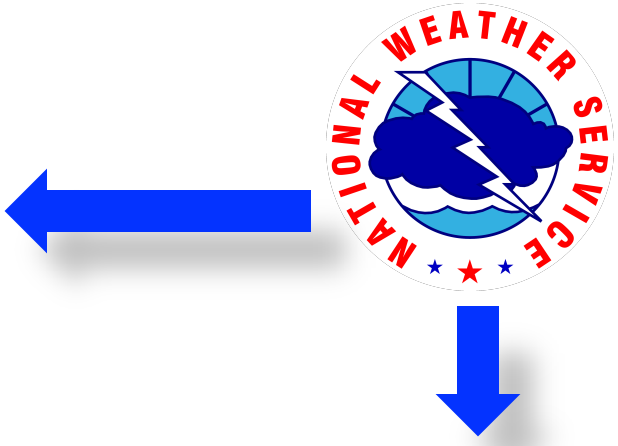
- Quick intro to the CBRFC
- What is the El Niño Southern Oscillation (ENSO)
  - What causes an El Niño (or La Niña) event?
  - Is this a teleconnection?
  - Where/What are the typical impacts?
  - What's the deal with this current El Niño event?
- How does ENSO impact the Colorado River Basin and the DLCC region?
- How does the CBRFC account for ENSO events?

NOAA's River Forecast Centers



Colorado Basin River Forecast Center

- River Forecast Centers (RFCs)
  - Support for WFOs
  - River levels and flows
  - Reservoir inflows
  - Each RFC is unique
- CBRFC
  - Seasonal Water Supply forecasts, in addition to many other products
    - Most advanced, involved
    - Reclamation is a key stakeholder
    - www.cbrfc.noaa.gov



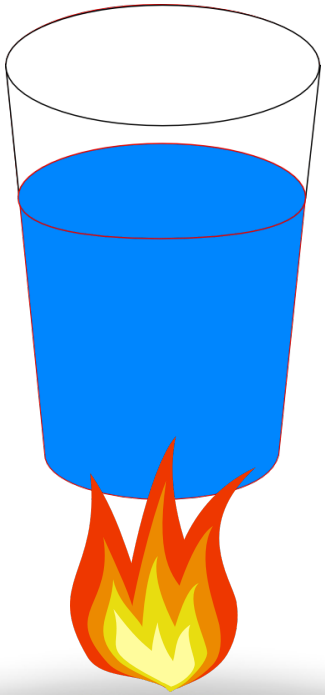
Weather Forecast Offices (WFOs)
- Everyday weather
- Extreme weather
- Warnings, watches, and advisories
- Floods, tornadoes, heat, etc…

What is ENSO?

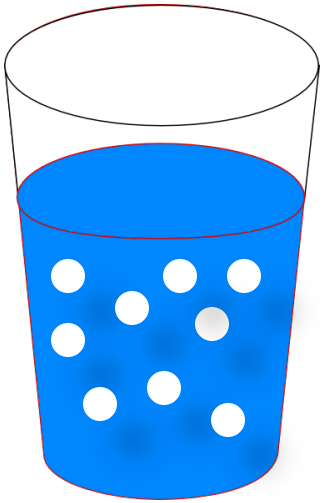
- The most influential climate pattern used in seasonal forecasting (of precipitation and temperature NOT STREAMFLOW!)
- The ENSO is a large scale phenomenon mostly identified through departures (deviations from average) in sea surface temperatures (SSTs) along the central equatorial Pacific
  - It is a coupled oceanic/atmospheric phenomenon, which means that in addition to seeing the warmer SSTs, we also need to see the atmosphere respond (what we call a weakened Walker Circulation)
  - More rainfall near the Date Line and less rainfall near Indonesia, along with anomalously westerly surface winds

What is ENSO?

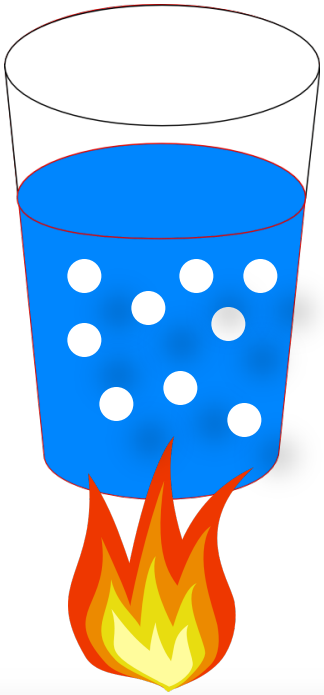
ENSO is kind of like a stove… if you pretend the ocean is your heat source and the atmosphere is what you're cooking.



Not El Niño, no atmospheric response.

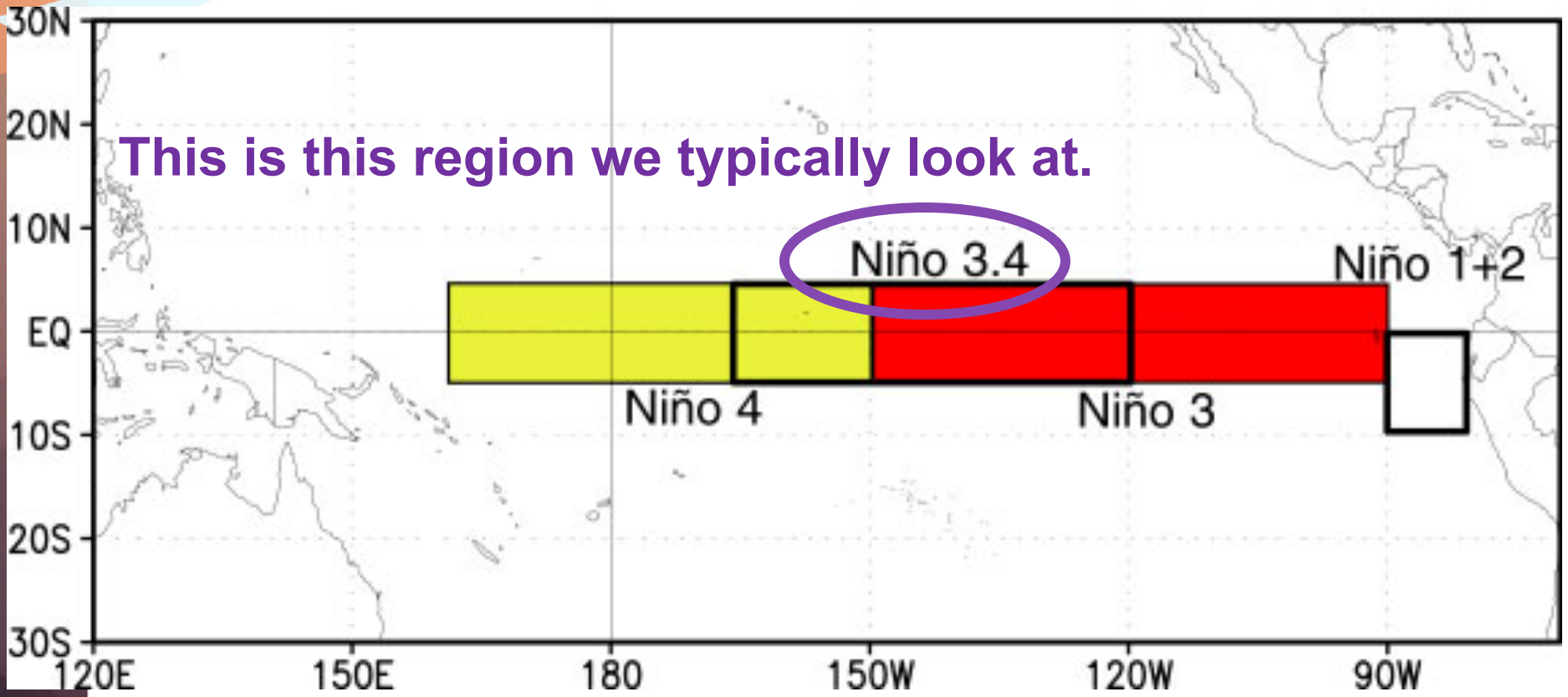


Not El Niño, no ocean driver.



El Niño!

SST Monitoring Regions



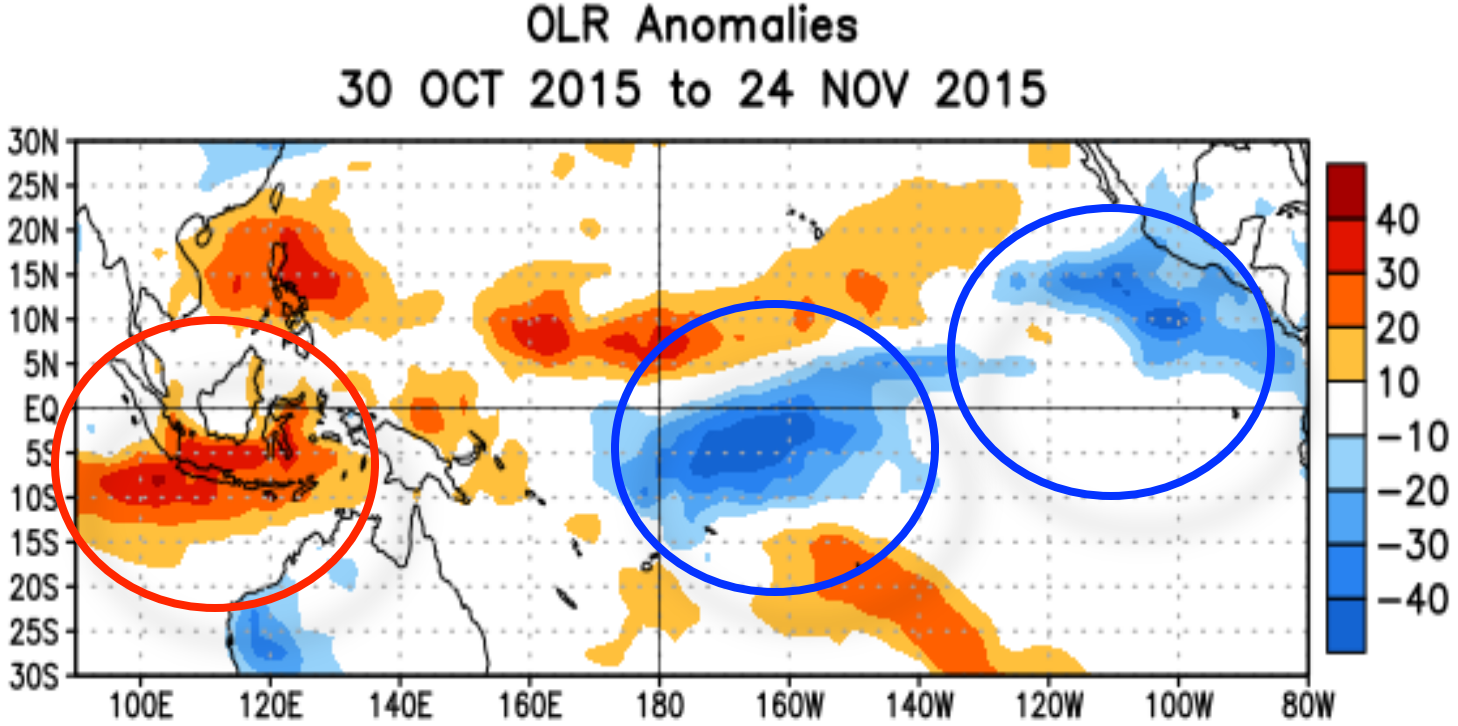
ENSO and SSTs

When departures, over a three month period, are >= 0.5°C (El Niño) or <= -0.5°C (La Niña) for 5 consecutive periods

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2002	-0.2	-0.1	0.1	0.2	0.4	0.7	0.8	0.9	1.0	1.2	1.3	1.1
2003	0.9	0.6	0.4	0	-0.2	-0.1	0.1	0.2	0.3	0.4	0.4	0.4
2004	0.3	0.2	0.1	0.1	0.2	0.3	0.5	0.7	0.7	0.7	0.7	0.7
2005	0.6	0.6	0.5	0.5	0.4	0.2	0.1	0	0	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.2	0.0	0.1	0.2	0.3	0.5	0.8	0.9	1.0
2007	0.7	0.3	0	-0.1	-0.2	-0.2	-0.3	-0.6	-0.8	-1.1	-1.2	-1.3
2008	-1.4	-1.3	-1.1	-0.9	-0.7	-0.5	-0.3	-0.2	-0.2	-0.3	-0.5	-0.7
2009	-0.8	-0.7	-0.4	-0.1	0.2	0.4	0.5	0.6	0.7	1.0	1.2	1.3
2010	1.3	1.1	0.8	0.5	0	-0.4	-0.8	-1.1	-1.3	-1.4	-1.3	-1.4
2011	-1.3	-1.1	-0.8	-0.6	-0.3	-0.2	-0.3	-0.5	-0.7	-0.9	-0.9	-0.8
2012	-0.7	-0.6	-0.5	-0.4	-0.3	-0.1	0.1	0.3	0.4	0.4	0.2	-0.2
2013	-0.4	-0.5	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3
2014	-0.5	-0.6	-0.4	-0.2	0	0	0	0	0.2	0.4	0.6	0.6
2015	0.5	0.4	0.5	0.7	0.9	1.0	1.2	1.5	1.7			

ENSO and the Atmosphere

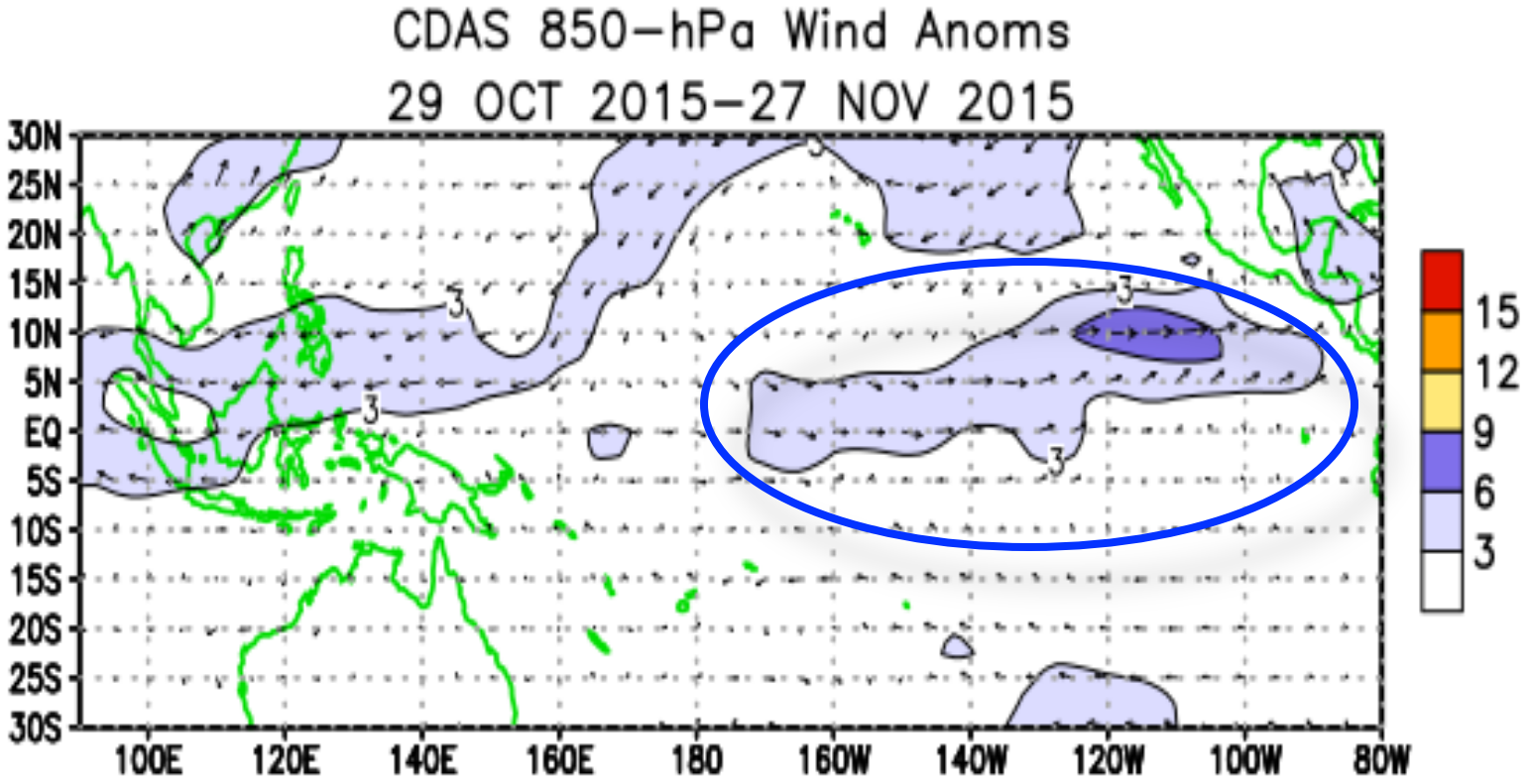
- Okay, we have the SSTs down, so what about the atmospheric side of things?



More rainfall near the date line? Check!

Less rainfall near Indonesia? Check!

ENSO and the Atmosphere

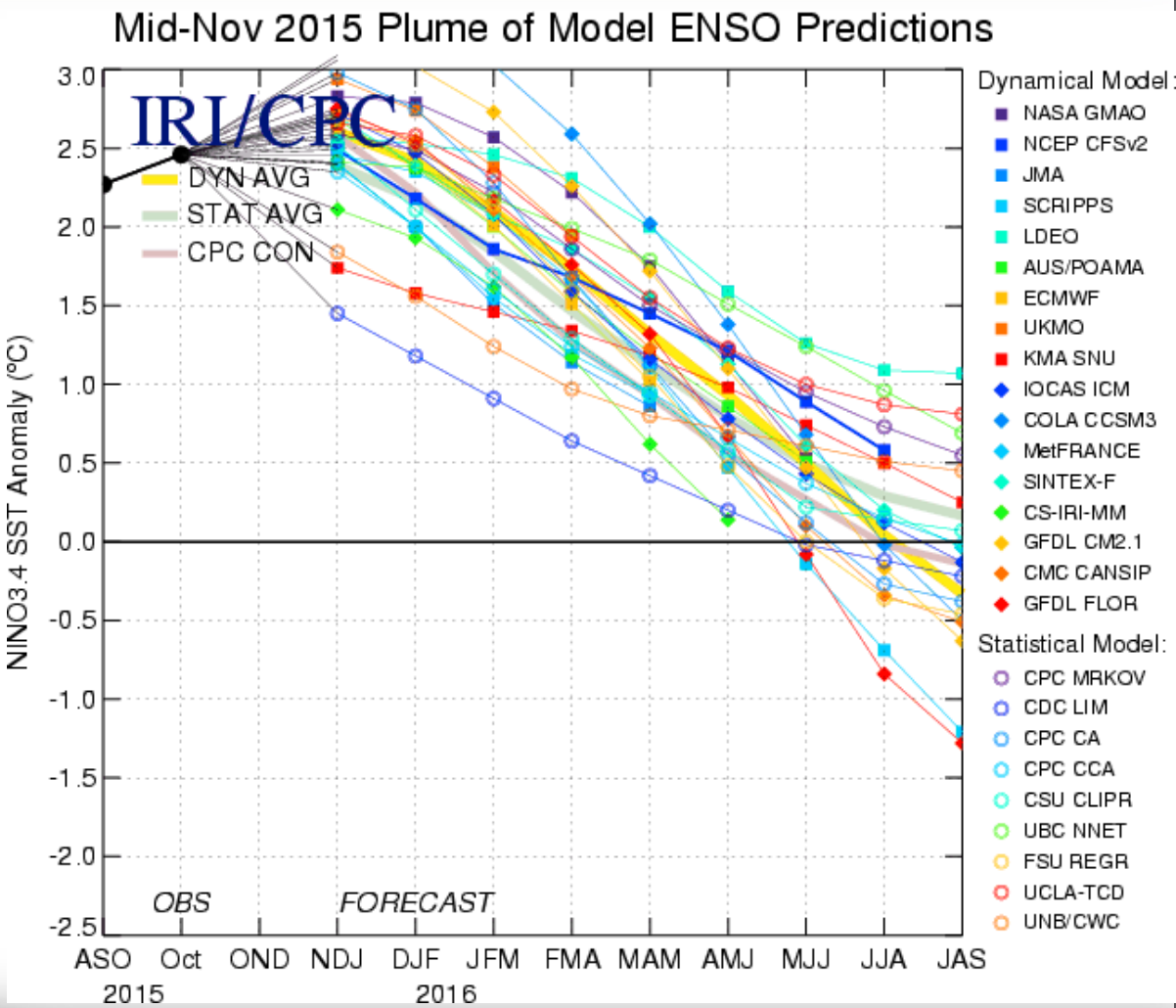


Anomalous westerly surface winds? Check!

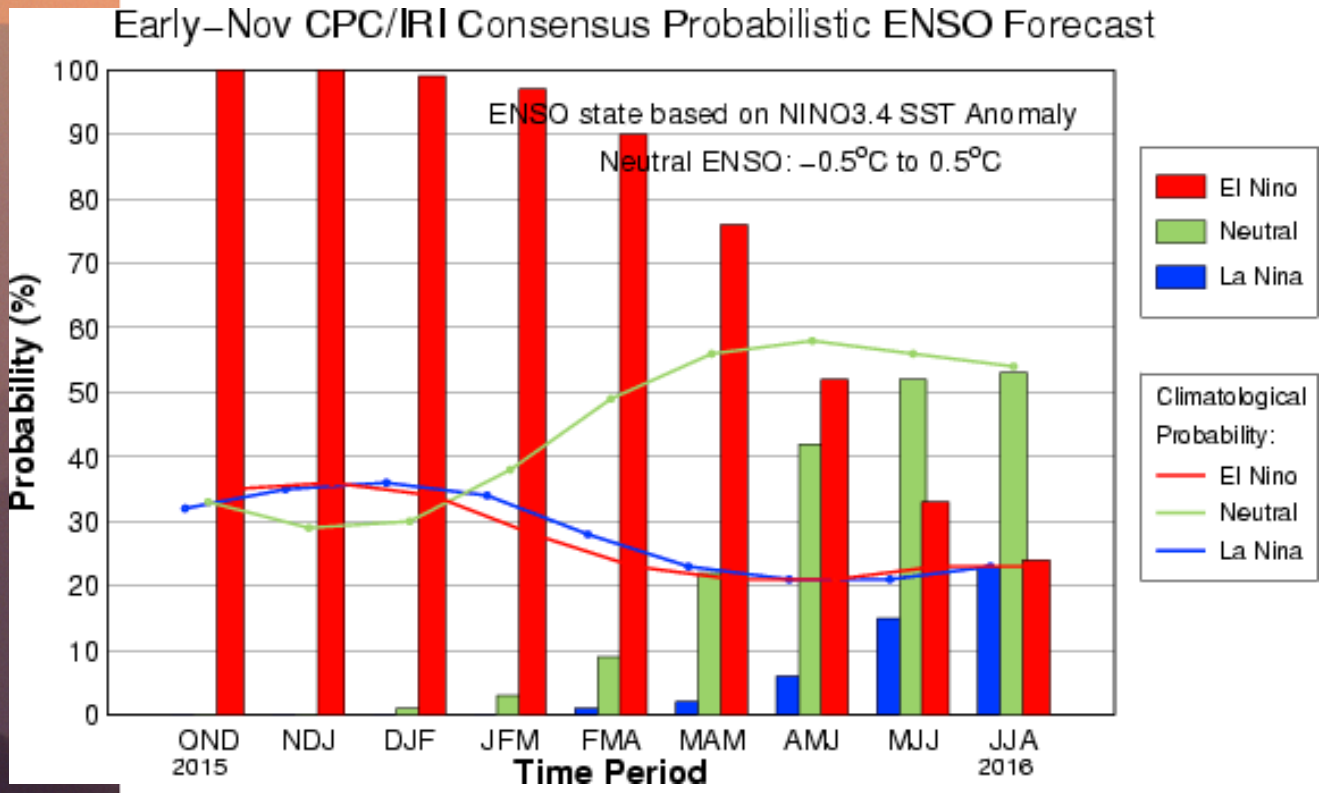
There's EVEN MORE to look at if you really want to get into it, but these are the basics.

Forecasting ENSO

- Numerous models use monthly and daily data to project ENSO conditions
- This shows the usual peak of an ENSO event in winter, declining in spring



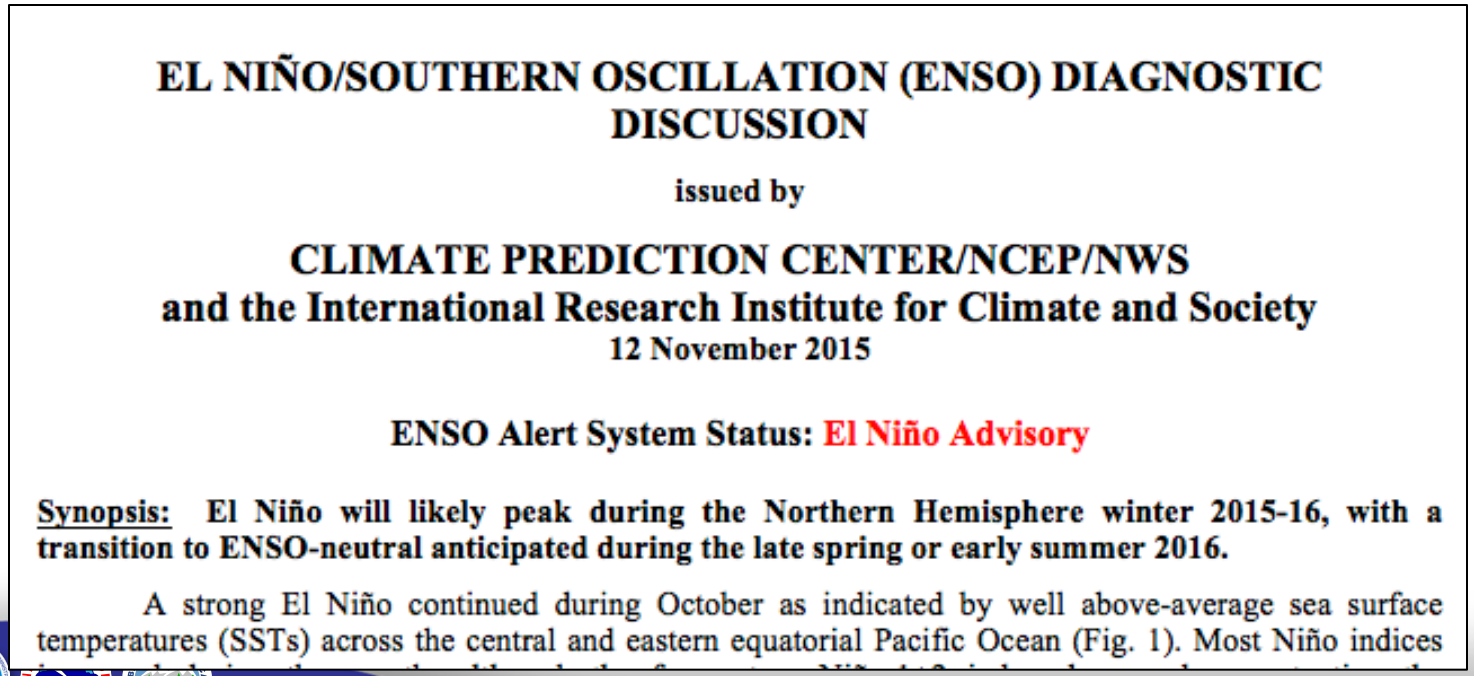
Forecasting ENSO



Once a month, forecasters get together to examine models and trends to project long-term ENSO conditions. Neutral conditions next year?

What is ENSO?

- That's a lot of stuff to keep up on!
  - It is, but luckily, there are some great NOAA resources that make it easy
  - I'll have a list at the end of the presentation



EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

issued by

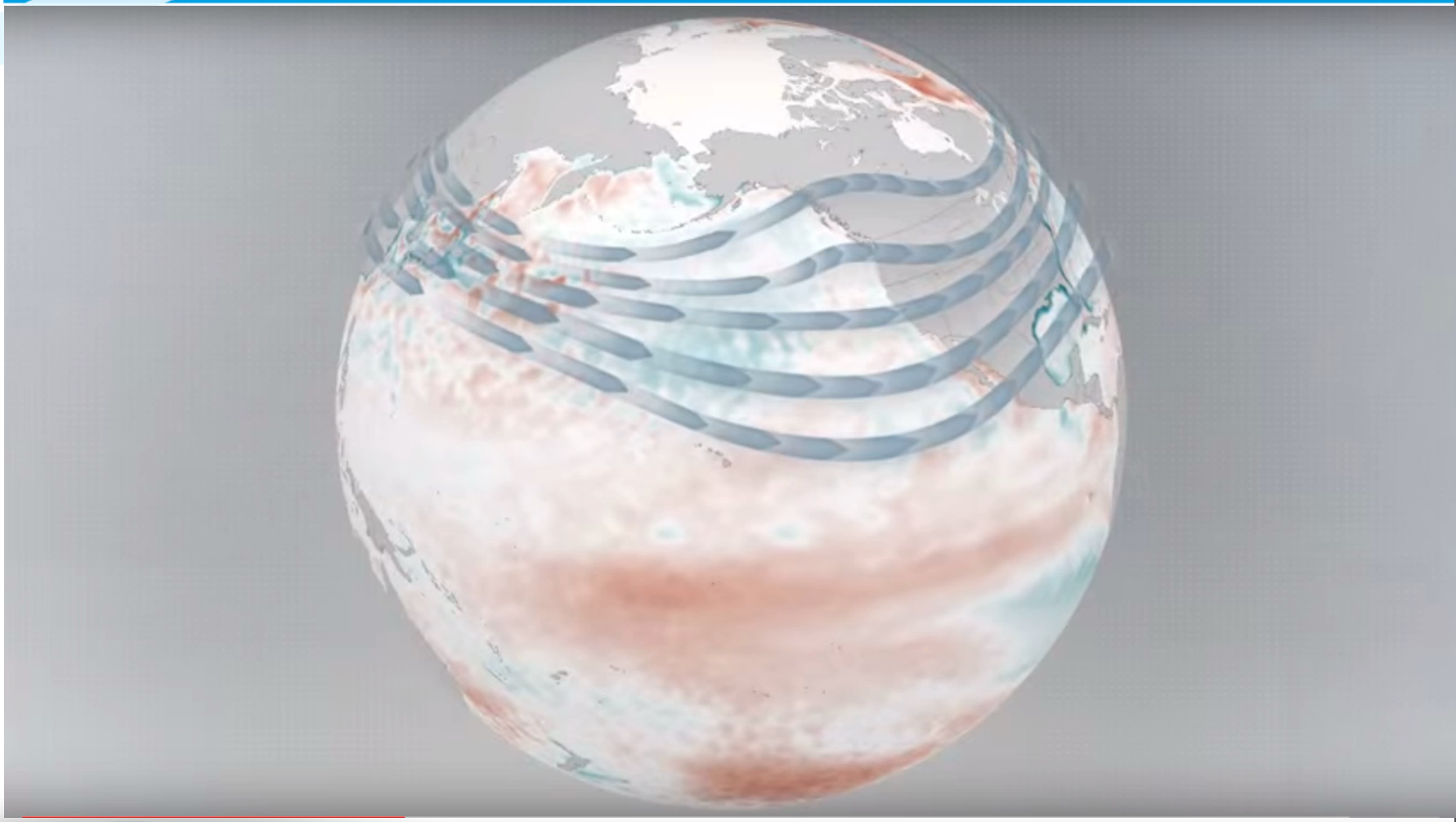
CLIMATE PREDICTION CENTER/NCEP/NWS
and the International Research Institute for Climate and Society
12 November 2015

ENSO Alert System Status: El Niño Advisory

Synopsis: El Niño will likely peak during the Northern Hemisphere winter 2015-16, with a transition to ENSO-neutral anticipated during the late spring or early summer 2016.

A strong El Niño continued during October as indicated by well above-average sea surface temperatures (SSTs) across the central and eastern equatorial Pacific Ocean (Fig. 1). Most Niño indices

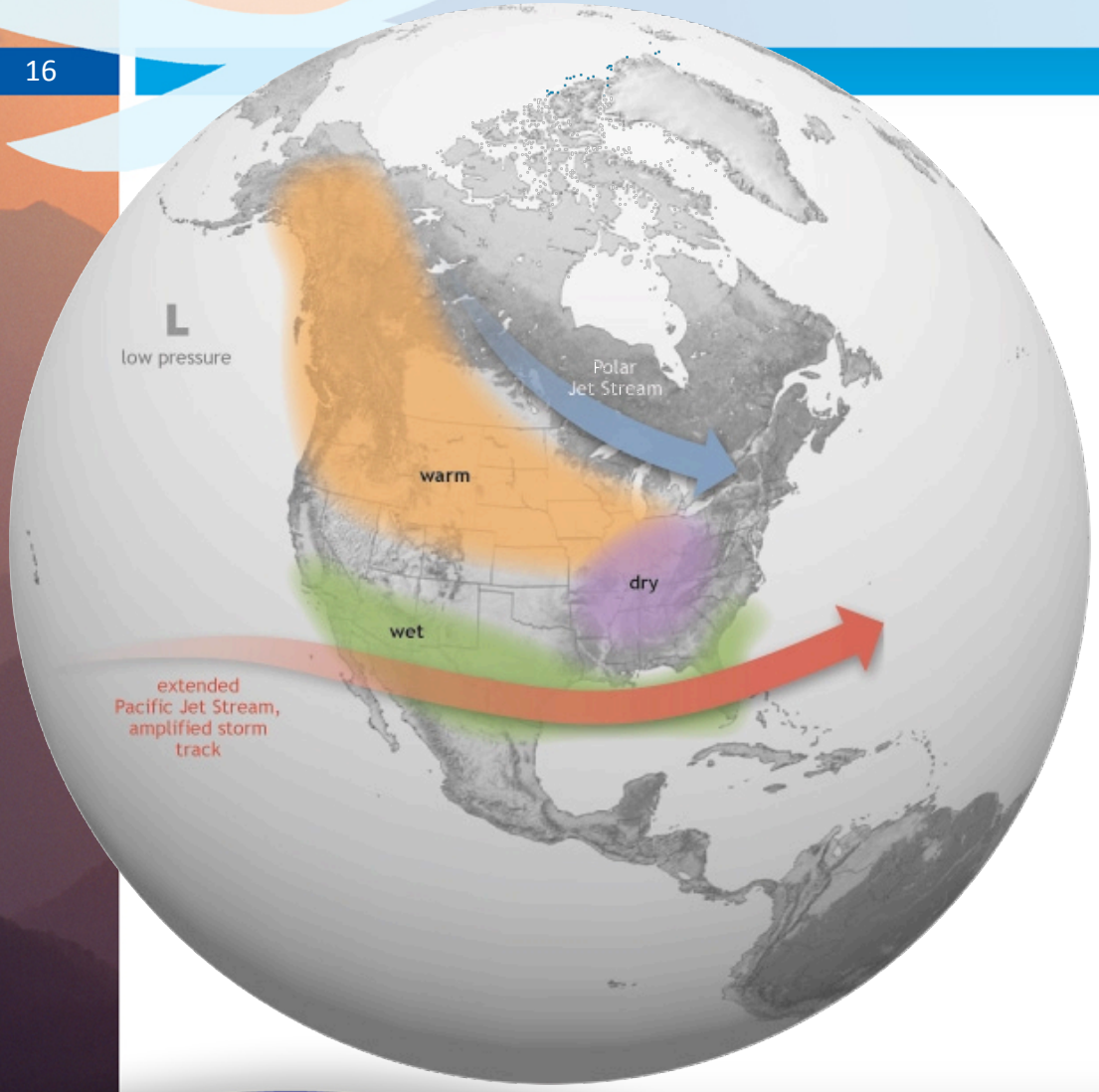
Is this a teleconnection?



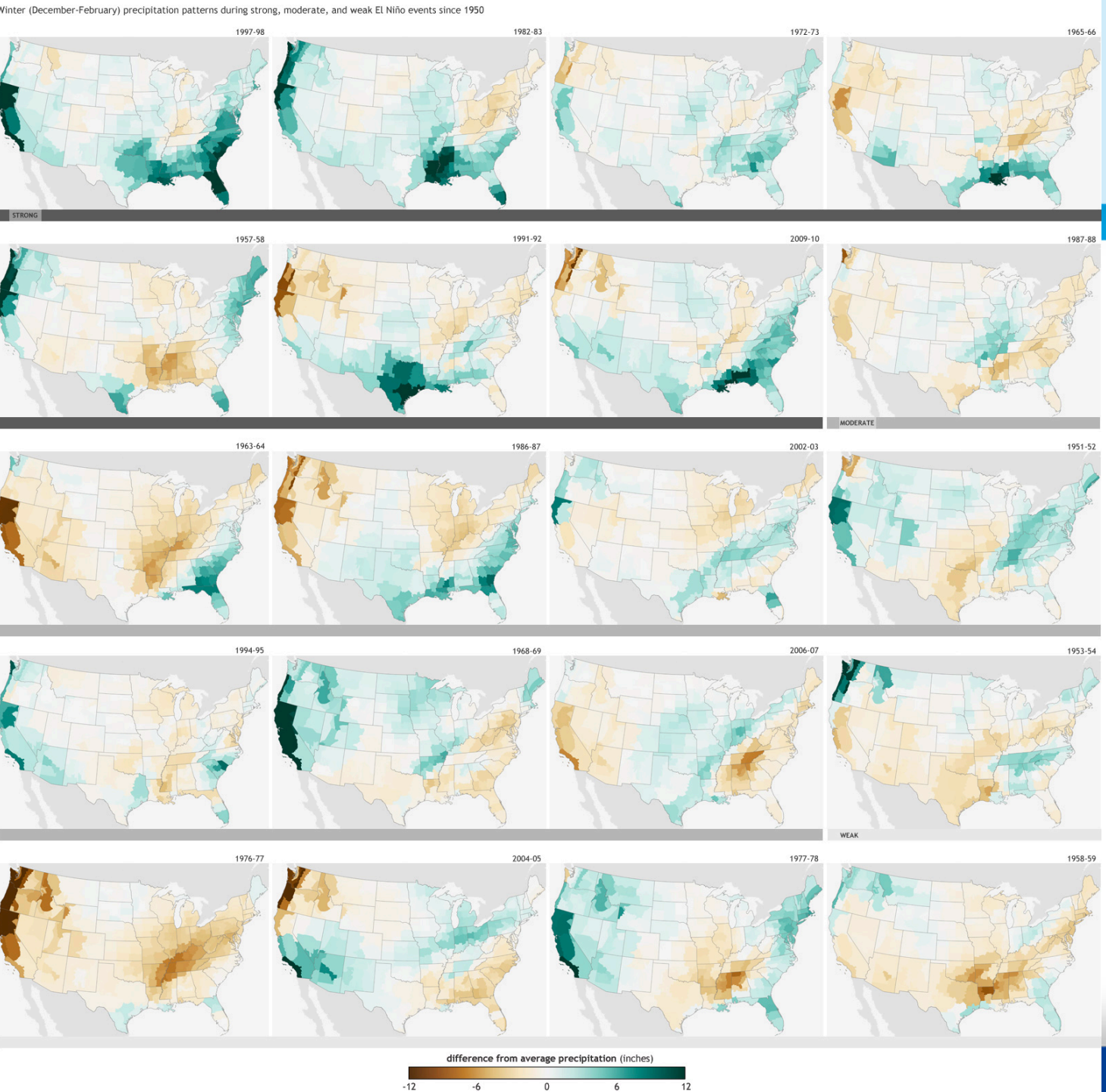
Is this a teleconnection?

- Teleconnection is a term that has been around for a while, but seems to have gained some popularity lately
- Just a fancy way of saying that one climate anomaly is related to another a long distance away (think of “tele”phone – placing a call from New York can be related to the actions of the receiver in California)
- All ENSO events are teleconnections, but not all teleconnections are ENSO events!

ENSO Impacts



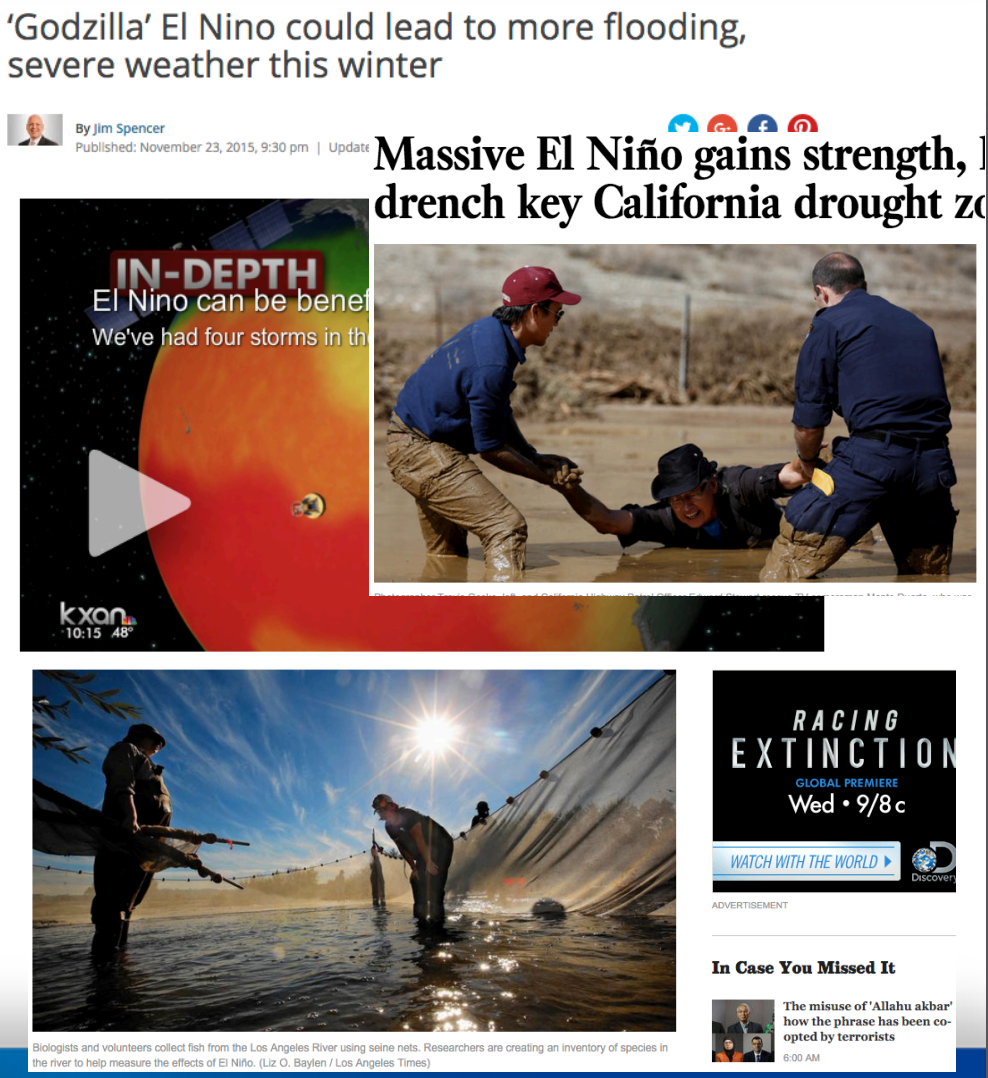
We typically look at ENSO impacts in the winter, because global atmospheric flow is more influential then. In the summer, small-scale events like thunderstorms (monsoon season!) tend to be more important.



El Niño events, regardless of strength, can vary quite a bit in the extent of their impacts. For instance, the 77-78 weak event brought wet conditions to the West, but the 65-66 strong event brought dry conditions to most of the West, including California

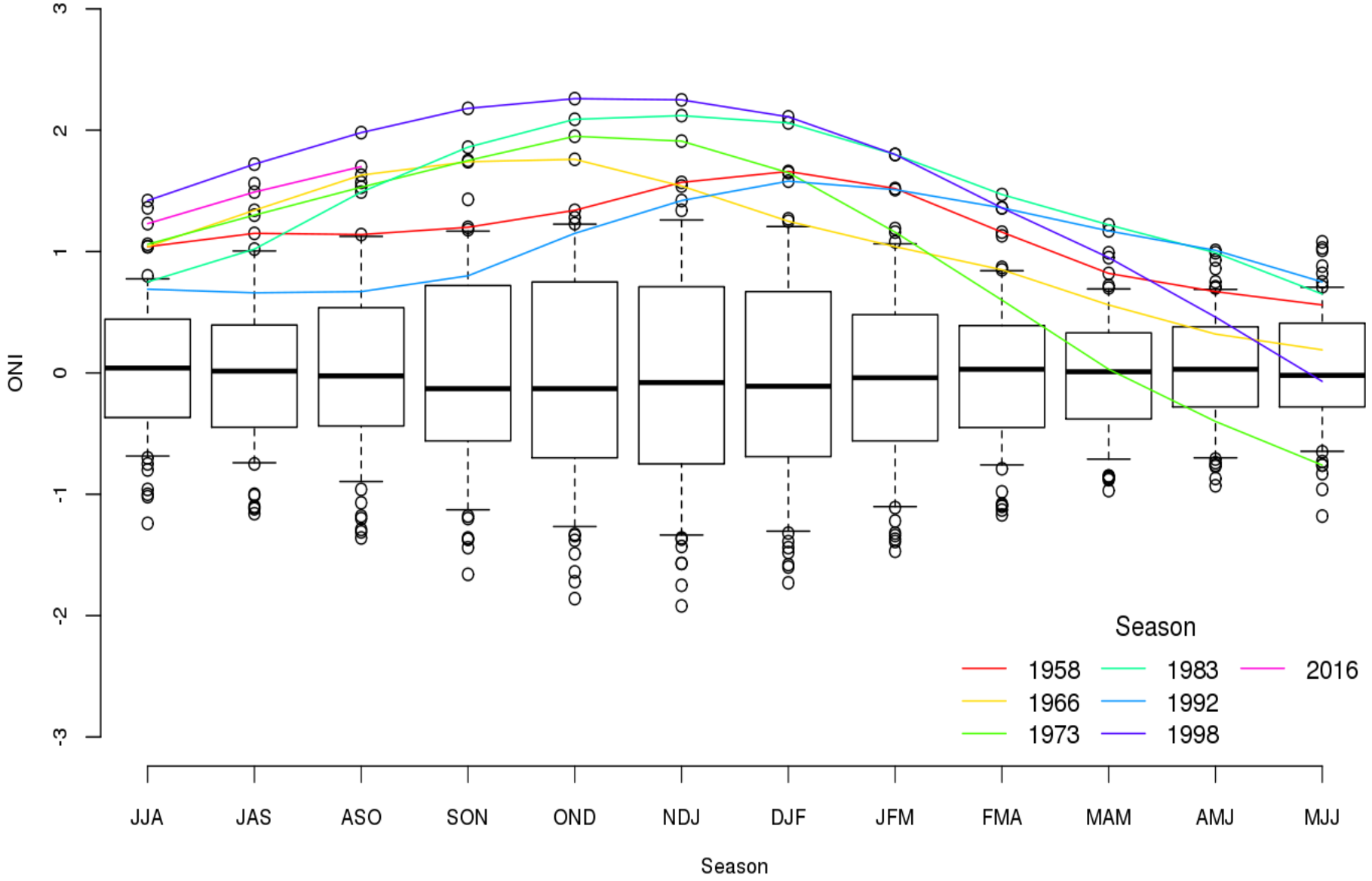
What about THIS El Niño?

- This El Niño event has received a lot of media attention due to possible impacts
  - Drought
  - Flooding
    - Extreme Precip
    - Wildfire
  - Agriculture
- And because…

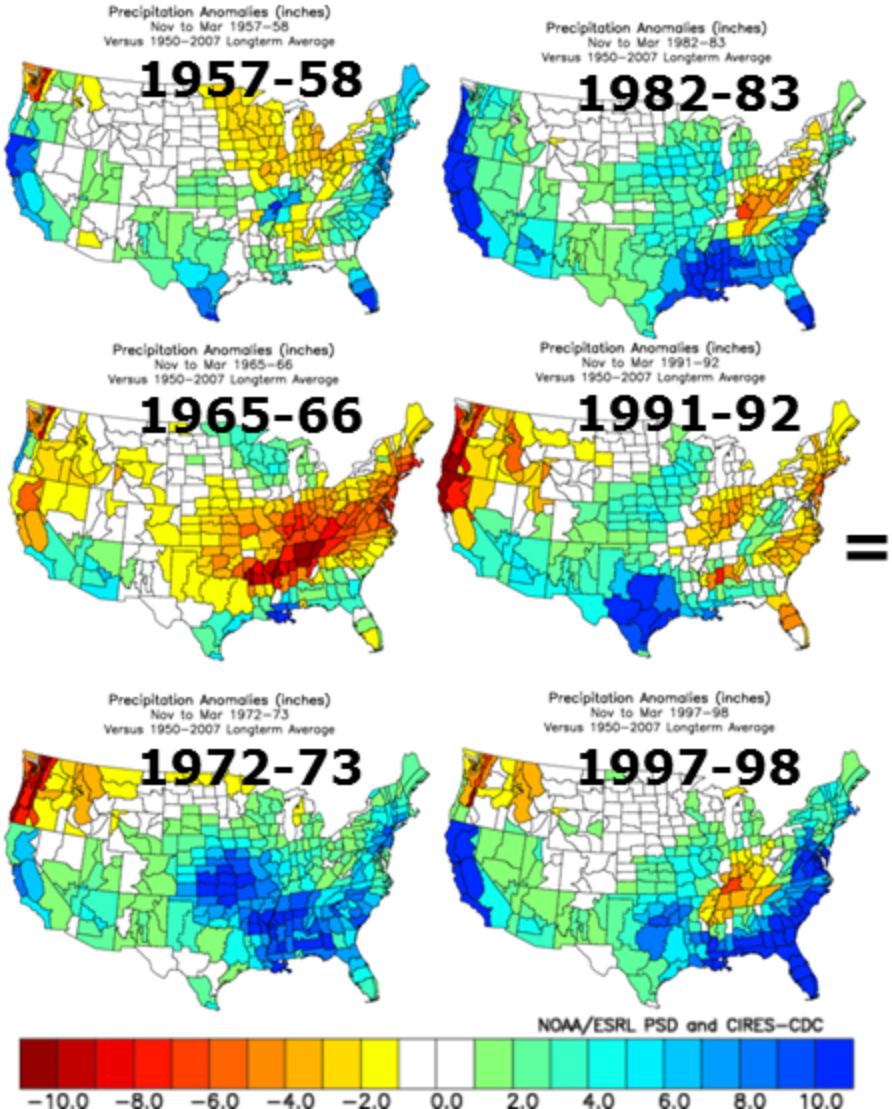


What about THIS El Niño?

- …someone thought it would be cool to call it "Godzilla El Niño." And it is kinda cool because it brings opportunities like this one along. But we don't have Godzilla El Niños, just "weak," "moderate," and "strong."
- The CPC has identified 1957-1958, 1965-1966, 1972-1973, 1982-1983, 1991-1992, and 1997-1998 as strong events


Historical Distribution of ONI values
ONI
3
2
1
0
-1
-2
-3
JJA
JAS
ASO
SON
OND
NDJ
DJF
JFM
FMA
MAM
AMJ
MJJ
Season
Season
1958
1966
1973
1983
1992
1998
2016

Precipitation Anomalies



Composite

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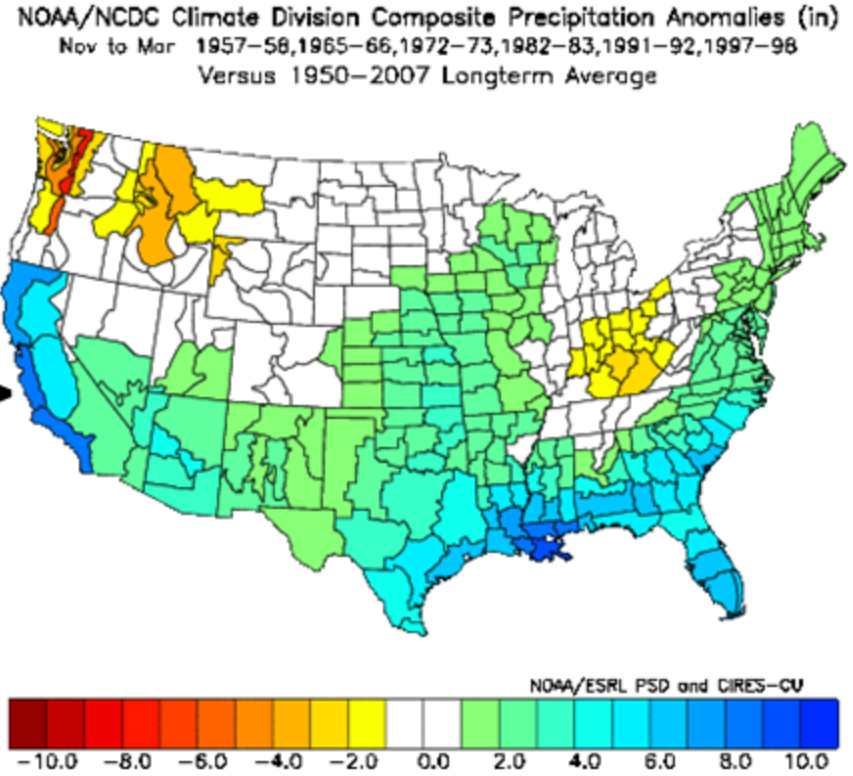
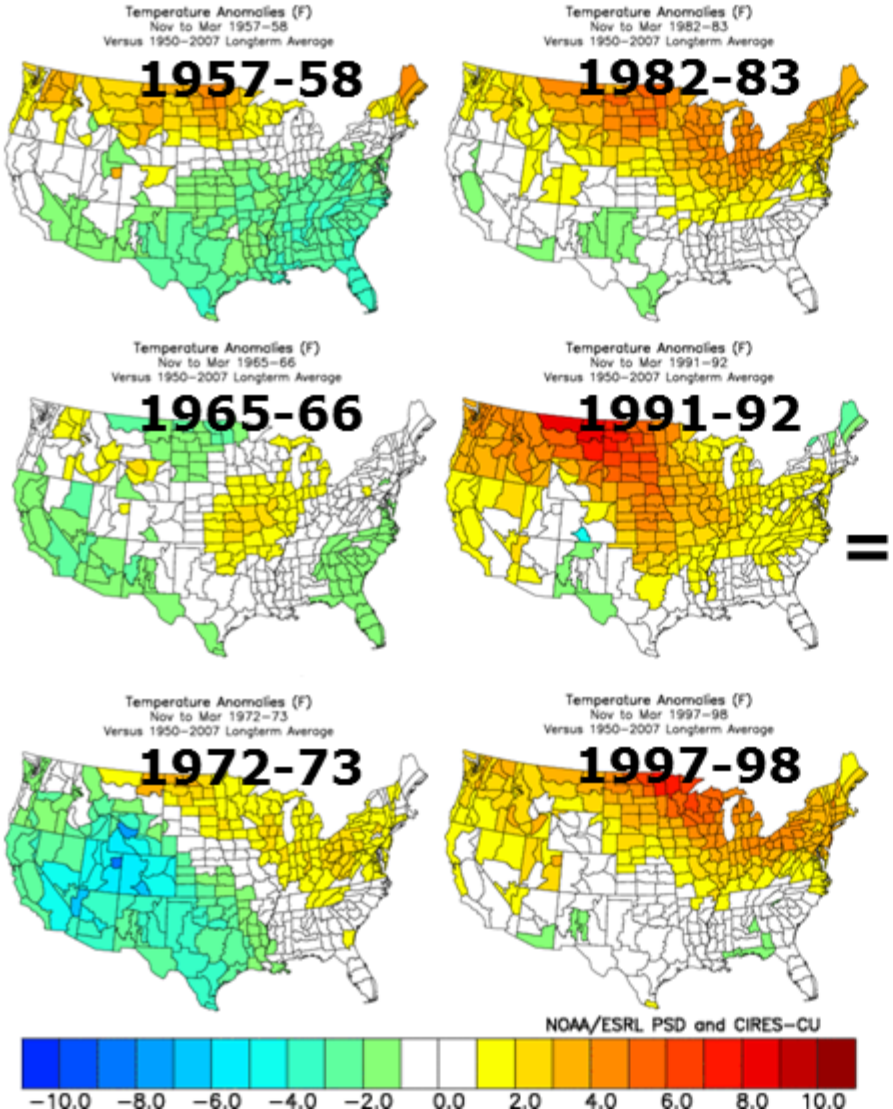


Temperature Anomalies



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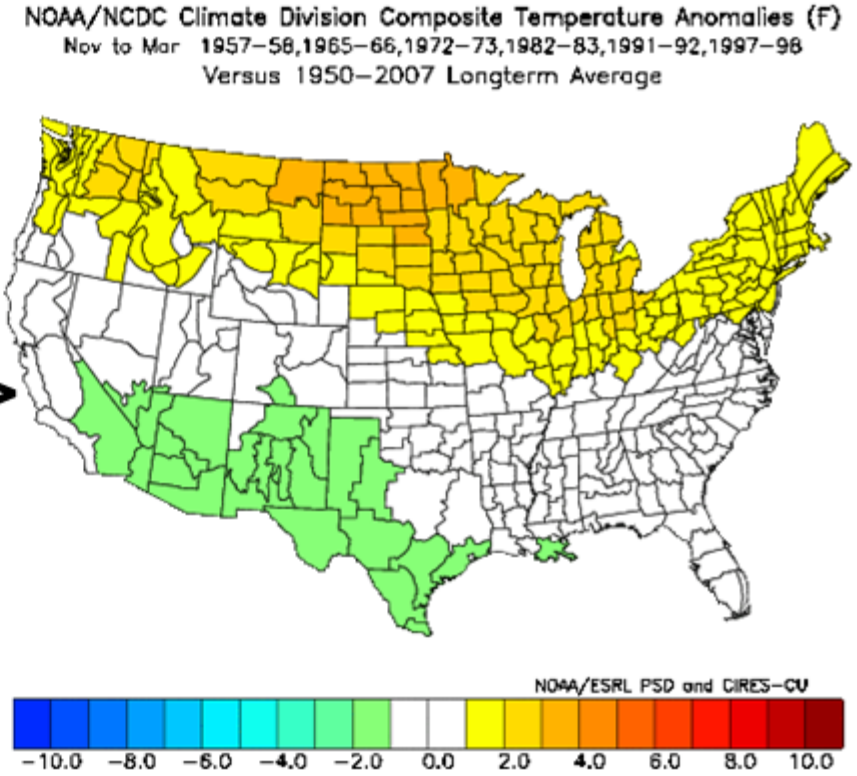
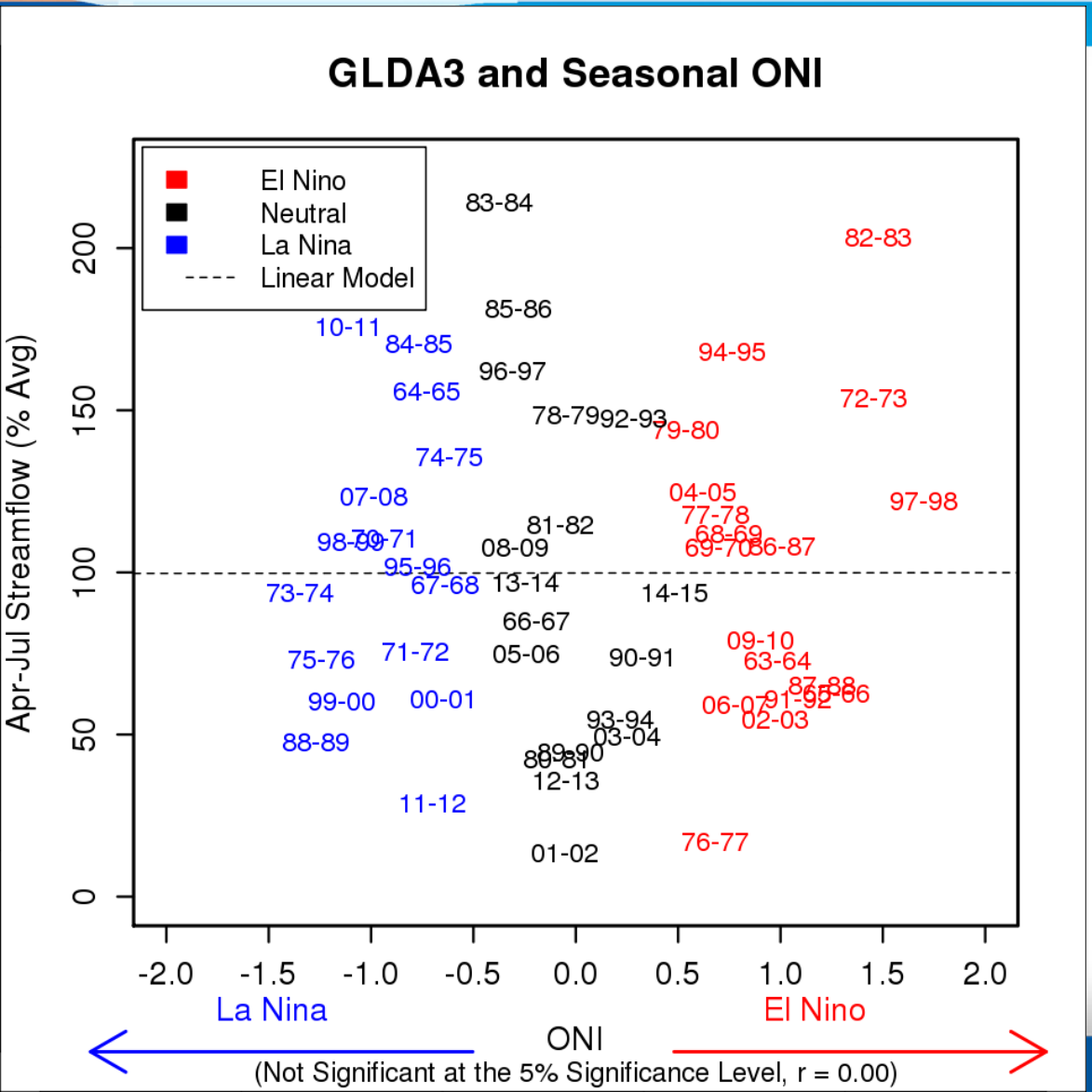
Composite



What does this mean for the Colorado River Basin and the Desert LCC?

- It is important to remember that the correlation between ENSO and most of the area in the Upper CBRFC region is not strong, and probably only applicable to the Lower Colorado Region (and DLCC region), which doesn't have as much impact on basin water supply
- Also important to remember is that the ENSO phenomenon has been correlated with precipitation, not streamflow, so antecedent conditions could still play a large role

ENSO Impacts



CPC Strong Events:

1957-1958* (pre-Powell)

1965-1966 (below avg)

1972-1973 (above avg)

1982-1983 (above avg)

1991-1992 (below avg)

1997-1998 (near avg)

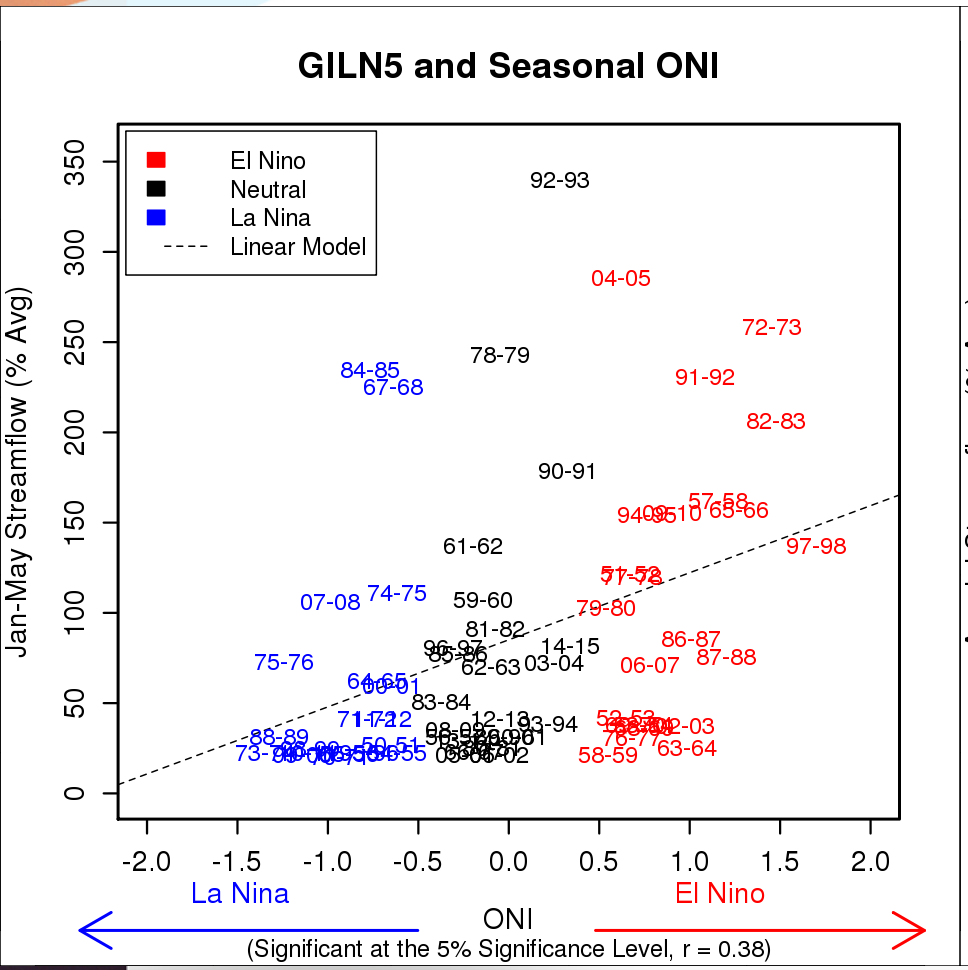
*Based on Reclamation Natural Flow, this was an above average year

ENSO Impacts in the Lower Colorado River Basin

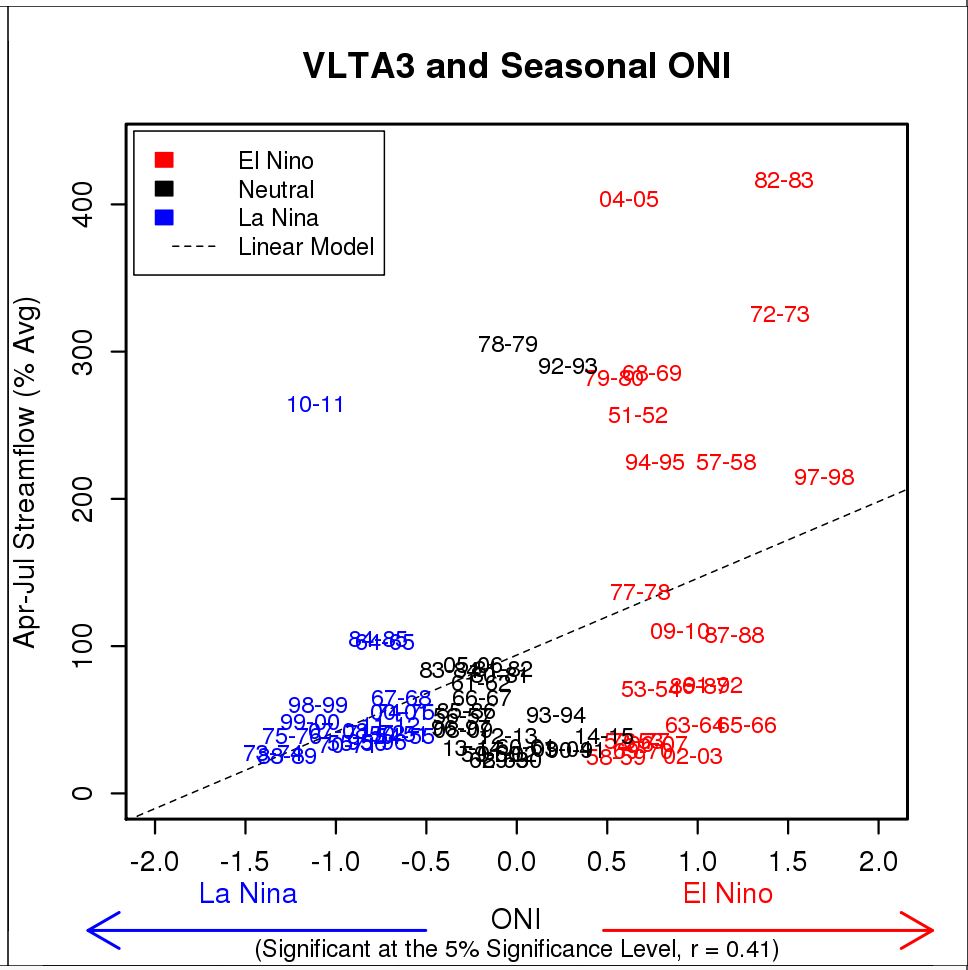
- We typically do see a statistically significant correlation between strength of an ENSO event and streamflow at forecast points in the Lower Basin, but the correlation values are low
- During El Niño (or La Niña) years, we only use historical information from El Niño and Neutral (or La Niña and Neutral) to develop our water supply forecasts in the Lower Colorado River Basin
- ENSO conditions do not impact other water supply forecasts (Upper Colorado River Basin and Great Basin areas)

More Local ENSO Impacts

Gila River

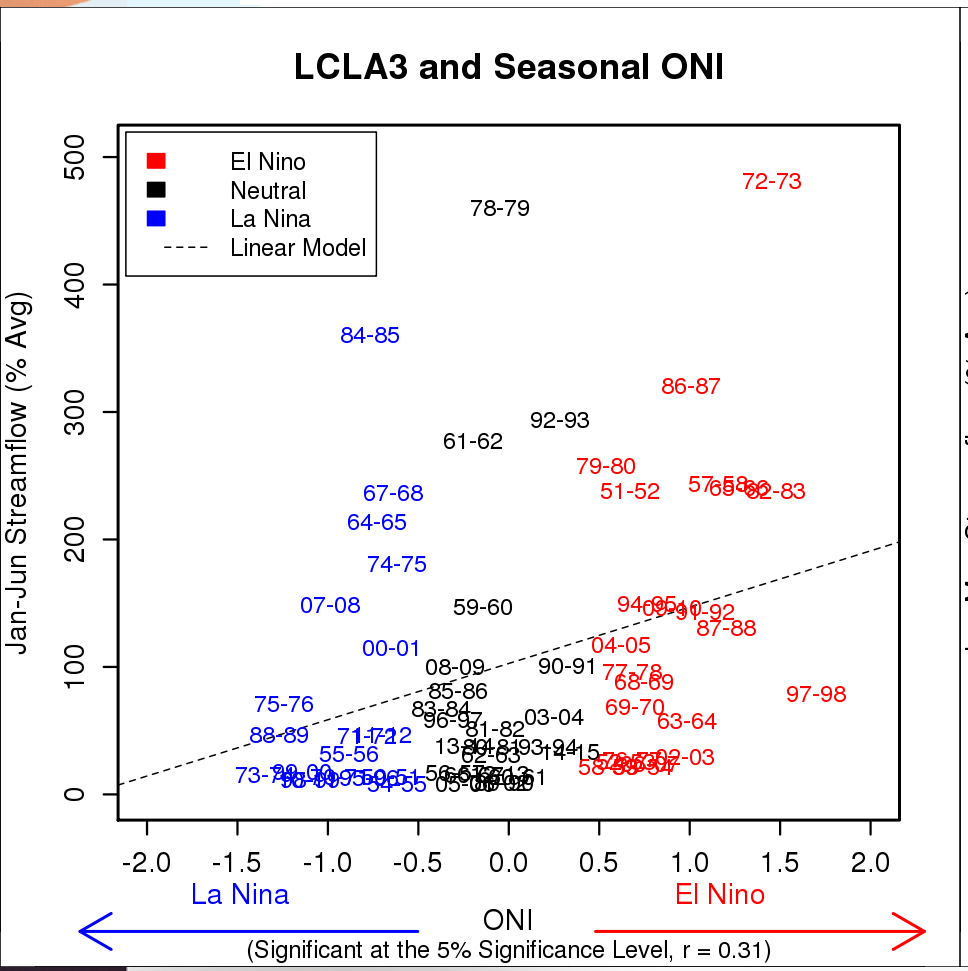


Virgin River

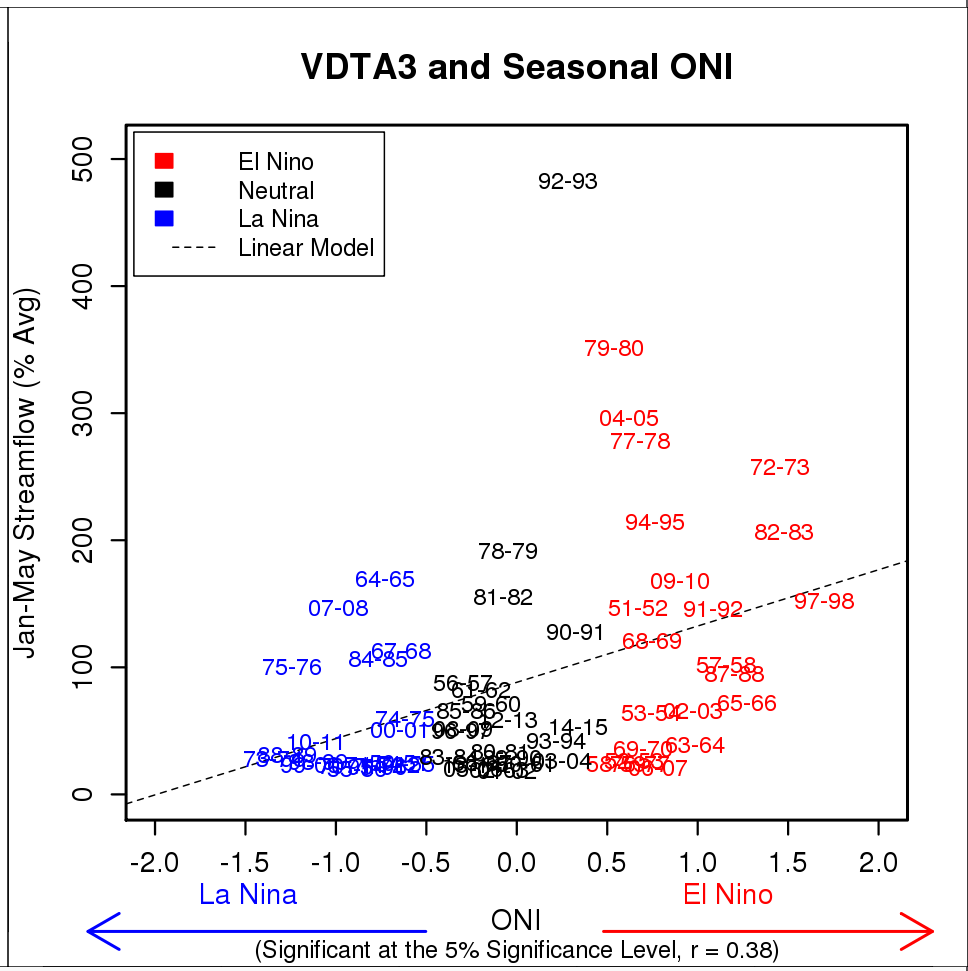


More Local ENSO Impacts

Little Colorado River



Verde River

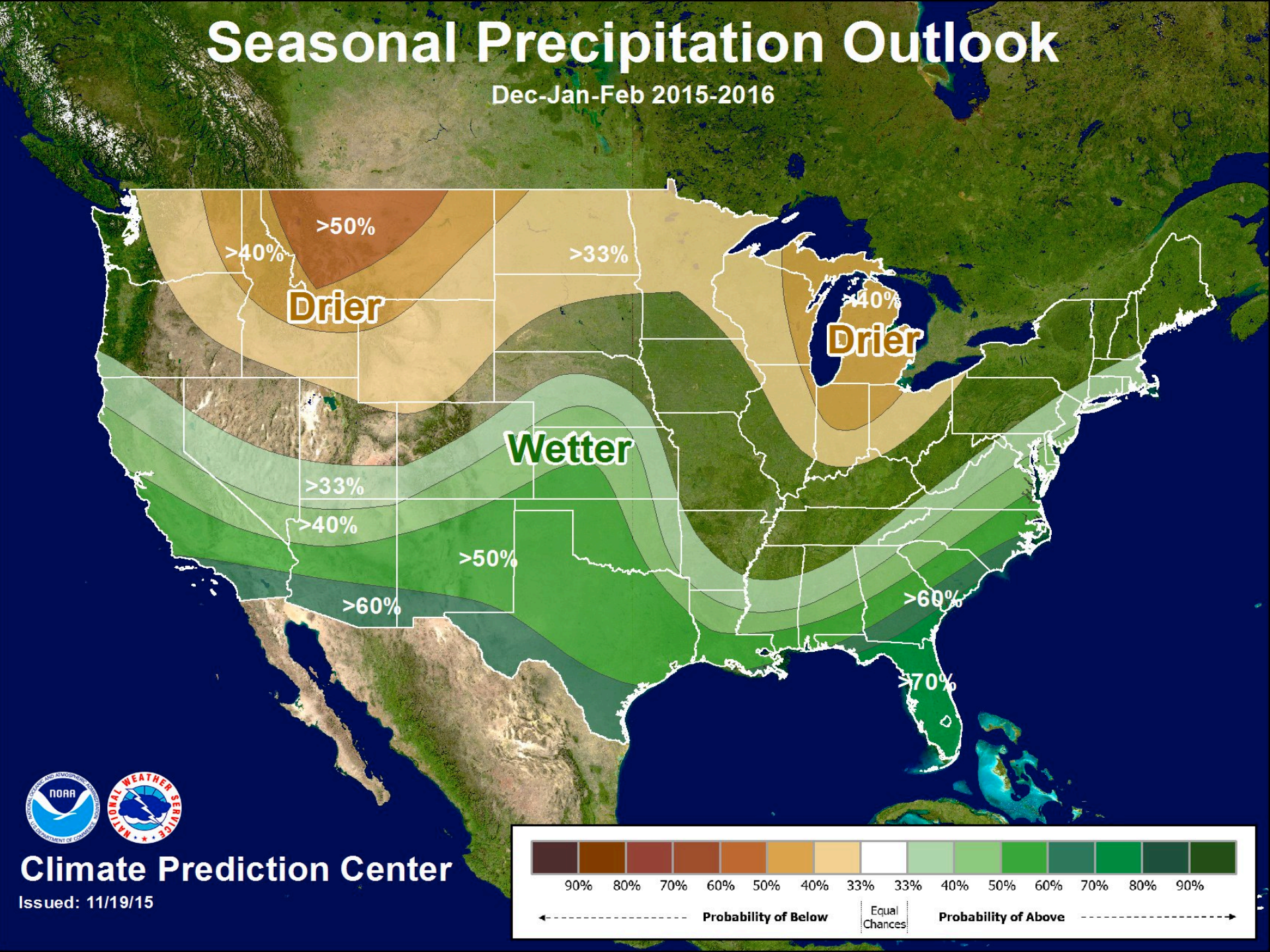


Latest Projections

- Current models are indicating that strong El Niño conditions will peak over the next month or two
- ENSO conditions will weaken through Spring, and neutral conditions are expected to be in place by late Spring
- Likely to see wetter conditions in the Lower Colorado and Desert LCC regions
- Warmer conditions in the western portion of the Lower Colorado River Basin and Desert LCC?

Seasonal Precipitation Outlook

Dec-Jan-Feb 2015-2016

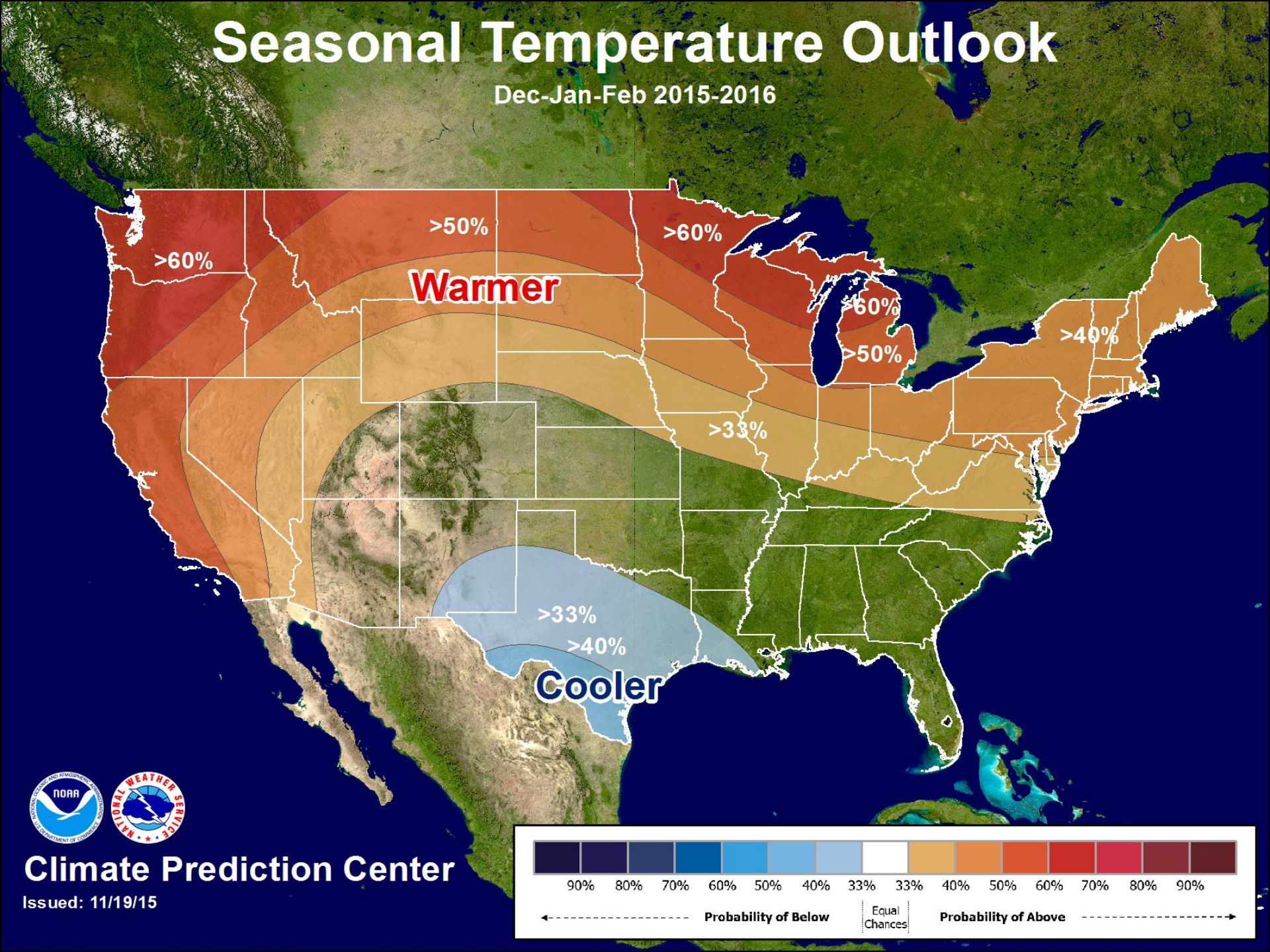


Climate Prediction Center

Issued: 11/19/15

Seasonal Temperature Outlook

Dec-Jan-Feb 2015-2016



Climate Prediction Center

Issued: 11/19/15

How can we help?

- Able to communicate physical basis for streamflow forecasts
- Provide forecasts for additional locations if needed
- Provide forecast information in a format that is most convenient for you
- We can work to develop additional products to meet your needs
  - Seriously, let us know if you need something and we will do our best to make it happen!

Useful Links

- NOAA's ENSO Blog (I really love this):
  - https://www.climate.gov/news-features/department/8443/all
- CPC's ENSO Diagnostic Discussion:
  - http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/
- Columbia University's IRI ENSO Page:
  - http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/
- CPC's Historical ONI values:
  - http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml
- CBRFC's Home Page (Us!):
  - www.cbrfc.noaa.gov

More Useful Links

- UK Met Office's ENSO summary:
  - http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks/el-nino-la-nina/ENSO-impacts
- Australia's BOM's ENSO page:
  - http://www.bom.gov.au/climate/enso/
- CLIMAS El Niño page (A NOAA RISA!):
  - http://www.climas.arizona.edu/sw-climate/el-ni%C3%B1o-southern-oscillation
- WRCC ENSO page:
  - http://www.wrcc.dri.edu/enso/enso.html

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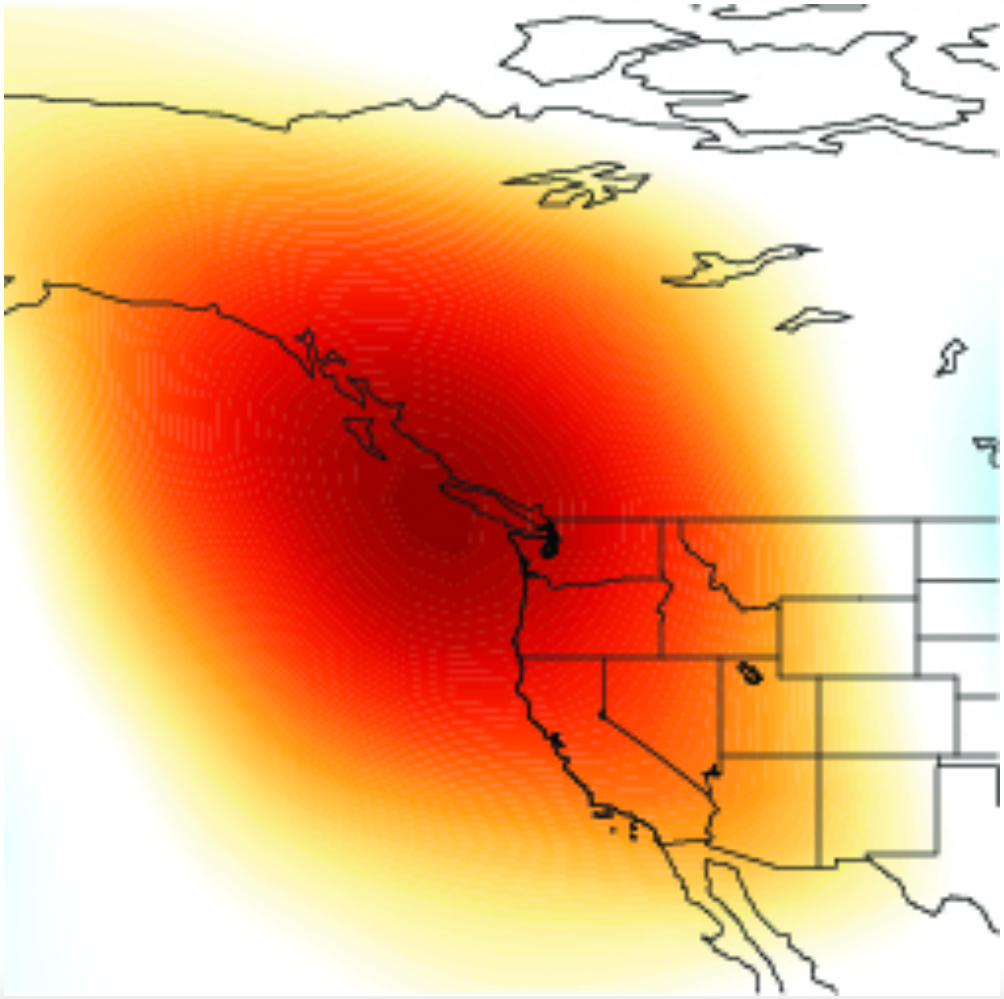
Tweet us @nwscbrfc

QUESTIONS?

Extra slides

What about the Blob?

- Another factor that makes this ENSO event unique!
- General thinking is that the warm waters off the Northwest Coast (aka “The Blob”) is a symptom of the high pressure ridge that has allowed the California drought to persist

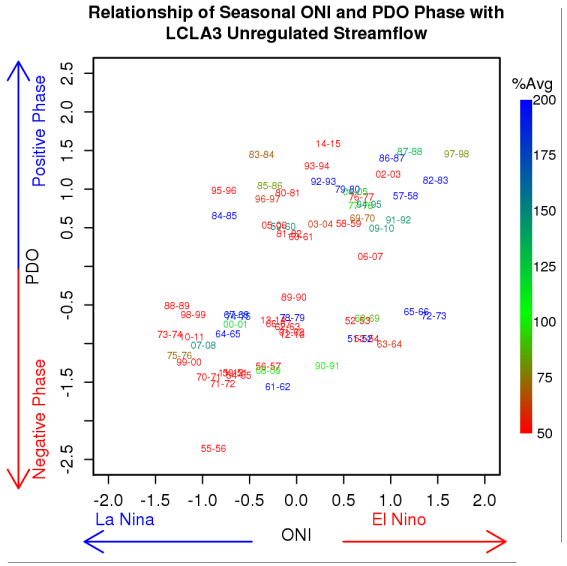


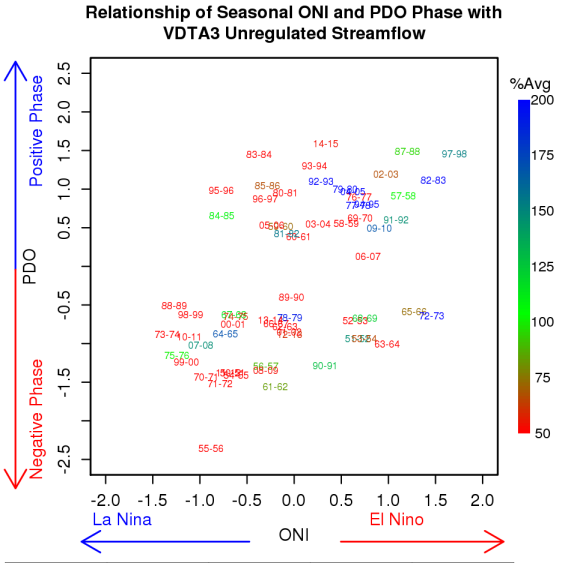
What about the Blob?

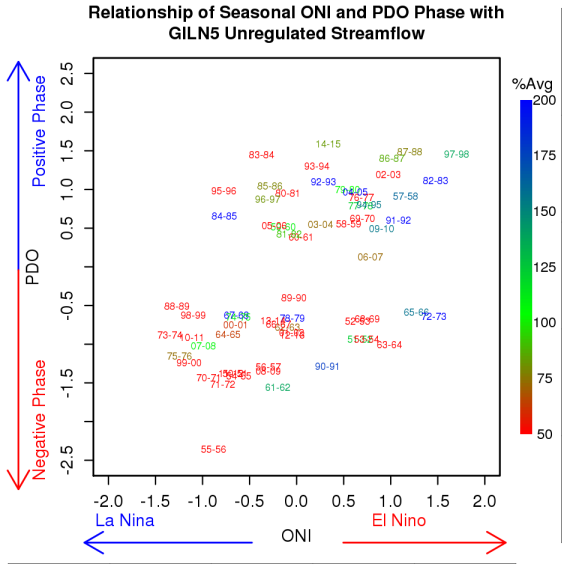
- In theory, this ENSO event should break down that ridge and the warmer water will cool back down
- I love this informative cartoon: http://www.scpr.org/news/2015/08/10/53627/el-nino-versus-the-blob-which-will-win-out-this-wi/

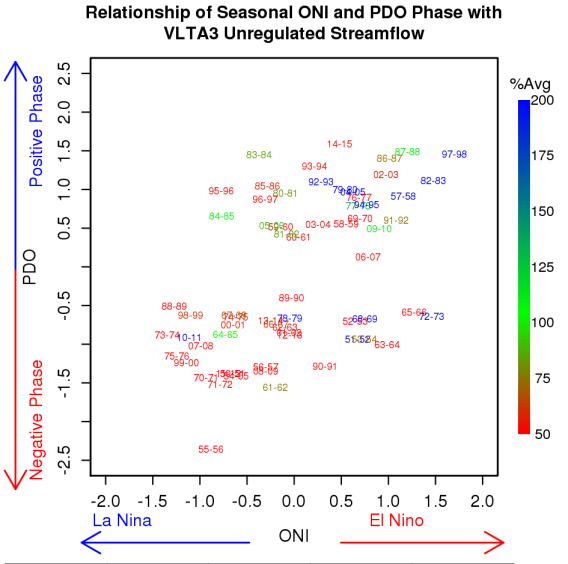
More Local ENSO Impacts

Incorporating other atmospheric teleconnections, like PDO, has not provided additional confidence.



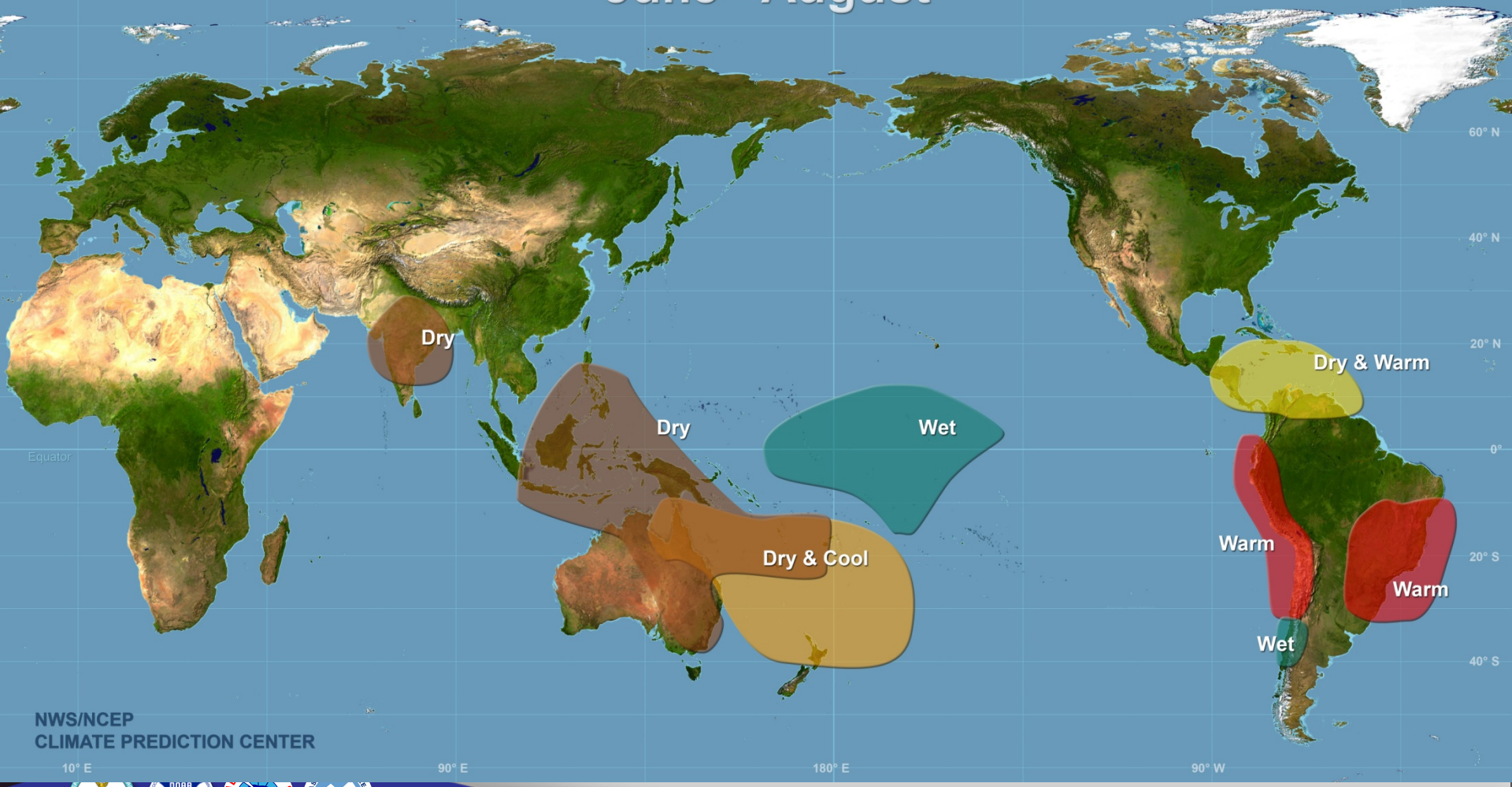






Warm Episode Relationships

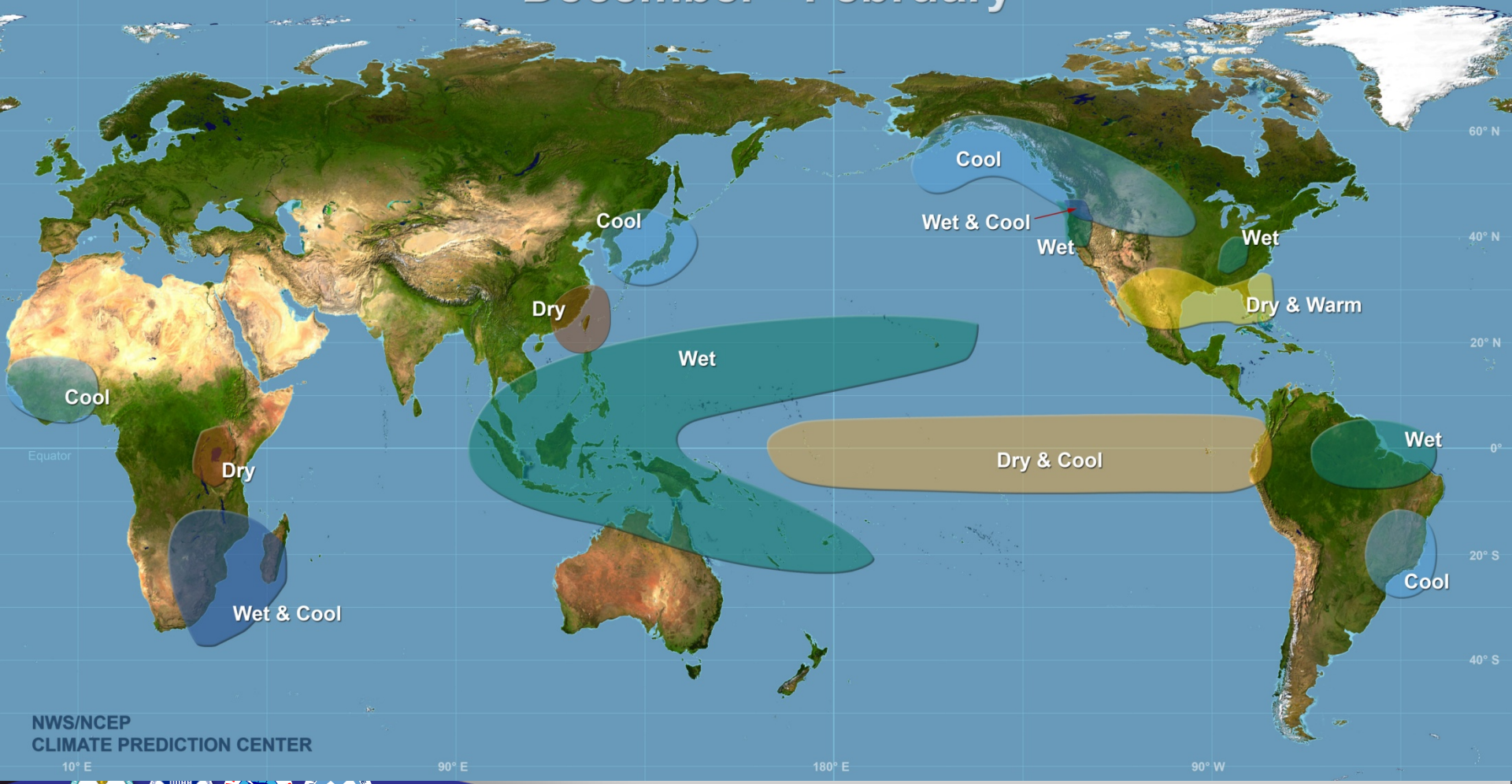
June - August



NWS/NCEP
CLIMATE PREDICTION CENTER

Cold Episode Relationships

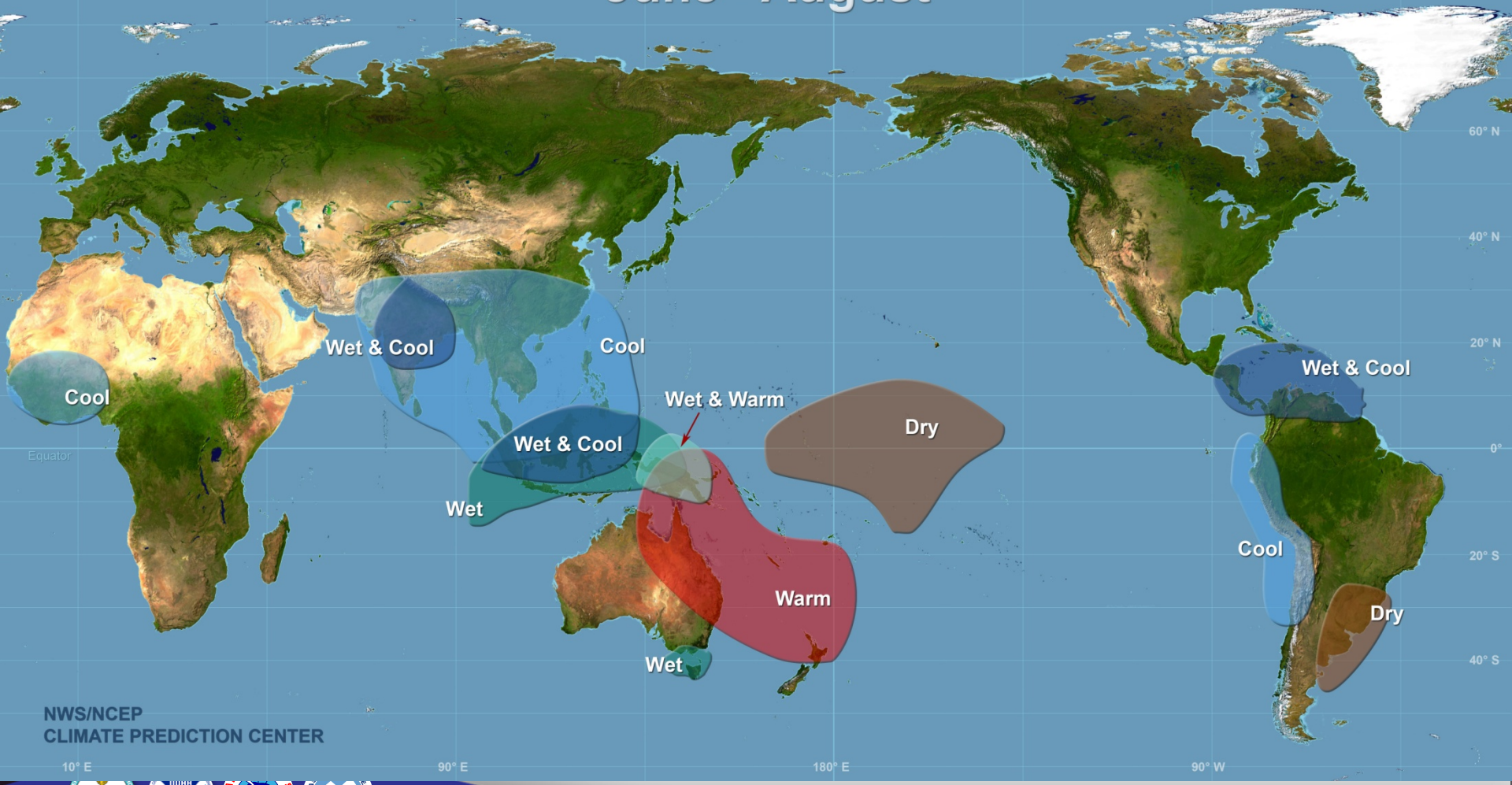
December - February



NWS/NCEP
CLIMATE PREDICTION CENTER

Cold Episode Relationships

June - August



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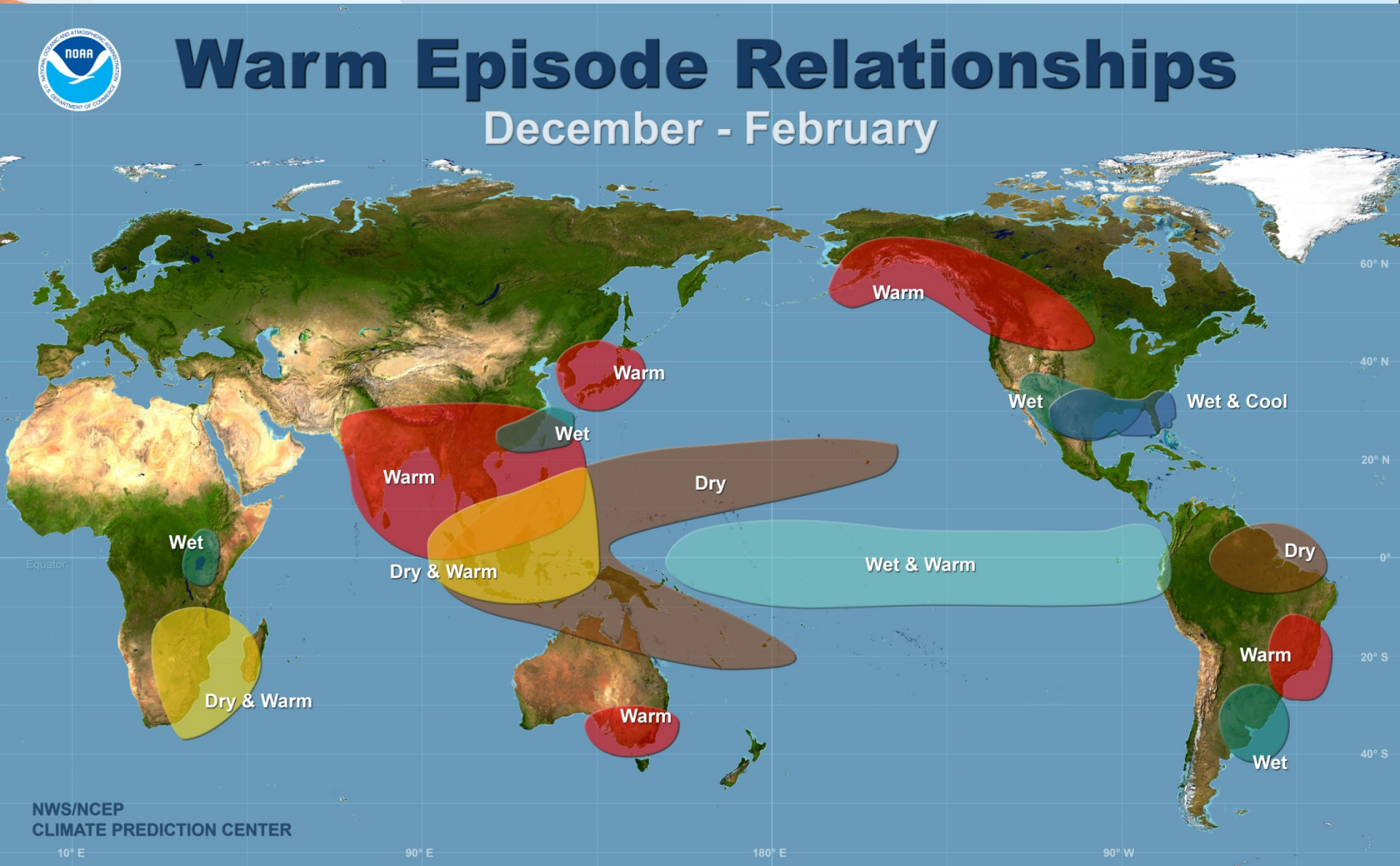
ENSO Impacts



What is ENSO?

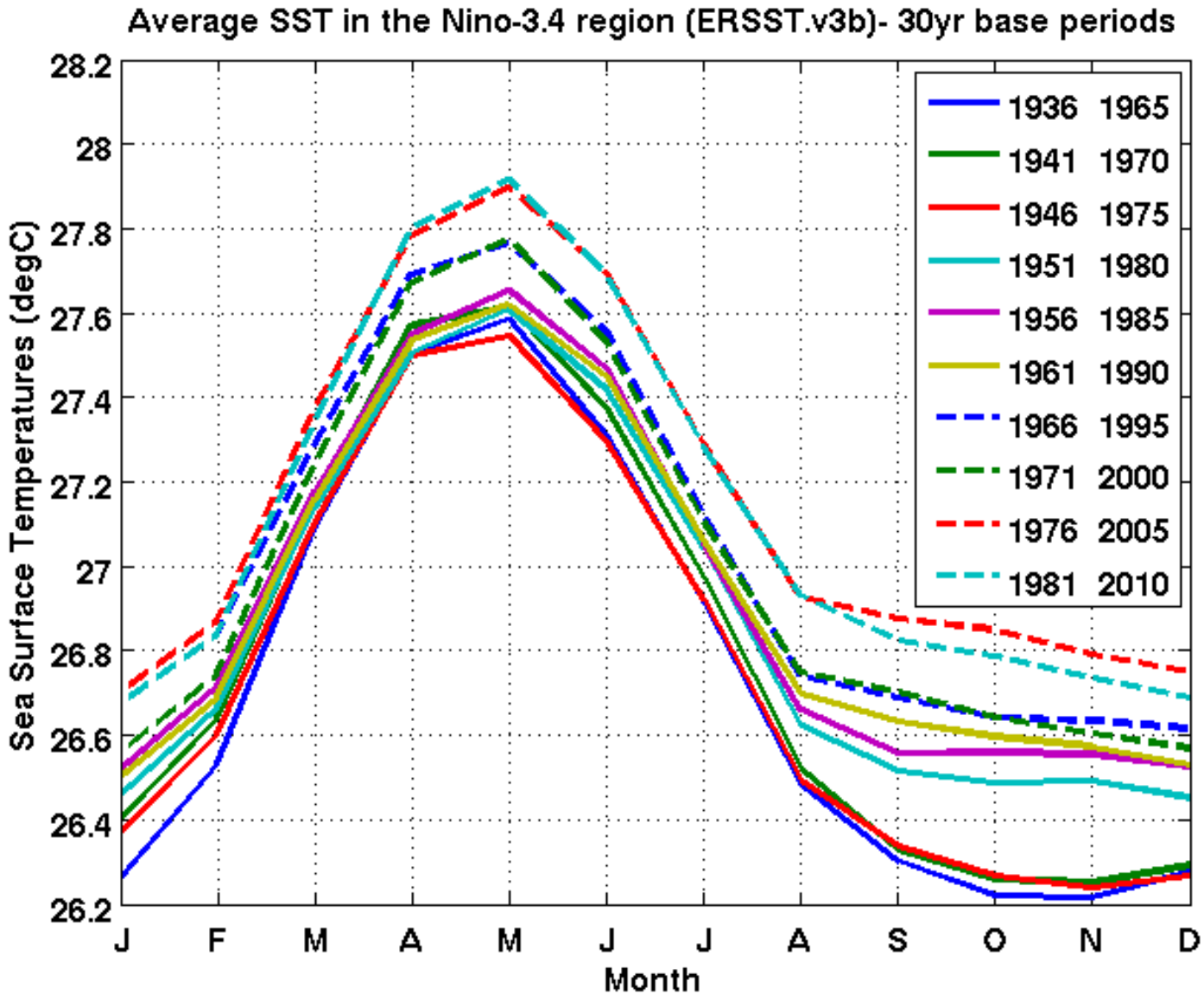
- The ENSO is a large scale phenomenon identified through departures (deviations from average) in sea surface temperatures (SSTs) along the central equatorial Pacific
  - Persistent warmer than average SSTs is an El Niño event and typically correlates with wetter winter conditions in the Lower Colorado River Basin
  - Persistent cooler than average SSTs is a La Niña event and typically correlates to drier winter conditions in the Lower Colorado River Basin
- Correlations with ENSO and other parts of the CBRFC basin are not well defined, but in the Lower Colorado River Basin it is relevant.

How do we define ENSO?

- It is important to remember that these departures are basically compared to 30-year averages updated every 10 years*
  - Important due to the impacts of climate change
  - As oceans warm, weak El Niño events may no longer qualify; cold events previously not defined as La Niña may now qualify
  - Currently using the 1981-2010 average
- AND we need to see a coupling between the atmosphere and ocean!
  - Weakened Walker Circulation
  - More rain over the Central Pacific and less rain over Indonesia

It's actually slightly more complicated than that, with departures also being developed relative to recent 5-year periods. But for most purposes, it is probably okay to use the data as derived by the most recent 30-year period. For those interested in the details please take a look at: "In Watching for El Niño and La Niña, NOAA adapts to Global Warming at: http://www.climate.gov/news-features/understanding-climate/watching-el-ni%C3%B1o-and-la-ni%C3%B1a-noaa-adapts-global-warming. Also, see "Linear trends in sea surface temperature of the tropical Pacific Ocean and Implications for the El Niño-Southern Oscillation" by L'Heureux et al. 2012 in *Climate Dynamics.

How do we define ENSO?



How do we define ENSO?

Seasonal temperature anomalies since 2000

La Niña, El Niño, neutral

relative to 1971-2000

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.6	-1.4	-1.0	-0.8	-0.6	-0.5	-0.4	-0.4	-0.4	-0.5	-0.6	-0.7
2001	-0.6	-0.5	-0.4	-0.2	-0.1	0.1	0.2	0.2	0.1	0.0	-0.1	-0.1
2002	-0.1	0.1	0.2	0.4	0.7	0.8	0.9	1.0	1.1	1.3	1.5	1.4
2003	1.2	0.9	0.5	0.1	-0.1	0.1	0.4	0.5	0.6	0.5	0.6	0.4
2004	0.4	0.3	0.2	0.2	0.3	0.5	0.7	0.8	0.9	0.8	0.8	0.8
2005	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.2	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.1	0.1	0.2	0.3	0.5	0.6	0.9	1.1	1.1
2007	0.8	0.4	0.1	-0.1	-0.1	-0.1	-0.1	-0.4	-0.7	-1.0	-1.1	-1.3
2008	-1.4	-1.4	-1.1	-0.8	-0.6	-0.4	-0.1	0.0	0.0	0.0	-0.3	-0.6
2009	-0.8	-0.7	-0.5	-0.1	0.2	0.6	0.7	0.8	0.9	1.2	1.5	1.8
2010	1.7	1.5	1.2	0.8	0.3	-0.2	-0.6	-1.0	-1.3	-1.4	-1.4	-1.4
2011	-1.3	-1.2	-0.9	-0.6	-0.2	0.0	0.0	-0.2	-0.4	-0.7	-0.8	-0.9
2012	-0.8	-0.6										

relative to 1981-2010

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.7	-1.5	-1.2	-0.9	-0.8	-0.7	-0.6	-0.5	-0.6	-0.6	-0.8	-0.8
2001	-0.7	-0.6	-0.5	-0.4	-0.2	-0.1	0.0	0.0	-0.1	-0.2	-0.3	-0.3
2002	-0.2	0.0	0.1	0.3	0.5	0.7	0.8	0.8	0.9	1.2	1.3	1.3
2003	1.1	0.8	0.4	0.0	-0.2	-0.1	0.2	0.4	0.4	0.4	0.4	0.3
2004	0.3	0.2	0.1	0.1	0.2	0.3	0.5	0.7	0.8	0.7	0.7	0.7
2005	0.6	0.4	0.3	0.3	0.3	0.3	0.2	0.1	0.0	-0.2	-0.5	-0.8
2006	-0.9	-0.7	-0.5	-0.3	0.0	0.1	0.2	0.3	0.5	0.8	1.0	1.0
2007	0.7	0.3	-0.1	-0.2	-0.3	-0.3	-0.4	-0.6	-0.8	-1.1	-1.2	-1.4
2008	-1.5	-1.5	-1.2	-0.9	-0.7	-0.5	-0.3	-0.2	-0.1	-0.2	-0.5	-0.7
2009	-0.8	-0.7	-0.5	-0.2	0.2	0.4	0.5	0.6	0.8	1.1	1.4	1.6
2010	1.6	1.3	1.0	0.6	0.1	-0.4	-0.9	-1.2	-1.4	-1.5	-1.5	-1.5
2011	-1.4	-1.2	-0.9	-0.6	-0.3	-0.2	-0.2	-0.4	-0.6	-0.8	-1.0	-1.0
2012	-0.9	-0.6	-0.5	-0.3	-0.2	0.0	0.1	0.4	0.5	0.6	0.2	-0.3

La Niñas that we didn't know we had when using the 1971-2000 average!

Blue = La Niña event

Red = El Niño event