ENSO Prediction

Michelle L'Heureux
NOAA Climate Prediction Center (CPC)

Key input from: Michael Tippett (Columbia), Emily Becker (CIMAS/Miami), Tom Di Liberto (NOAA CPO), Nathaniel Johnson (NOAA GFDL), Rebecca Lindsey (NOAA CPO), Tony Barnston (retired)

3rd Summer School on Theory Mechanisms and Hierarchical Modeling of Climate Dynamics
Trieste, Italy
21 July 2022

Outline

(1) ENSO history + Why Do We Predict ENSO?

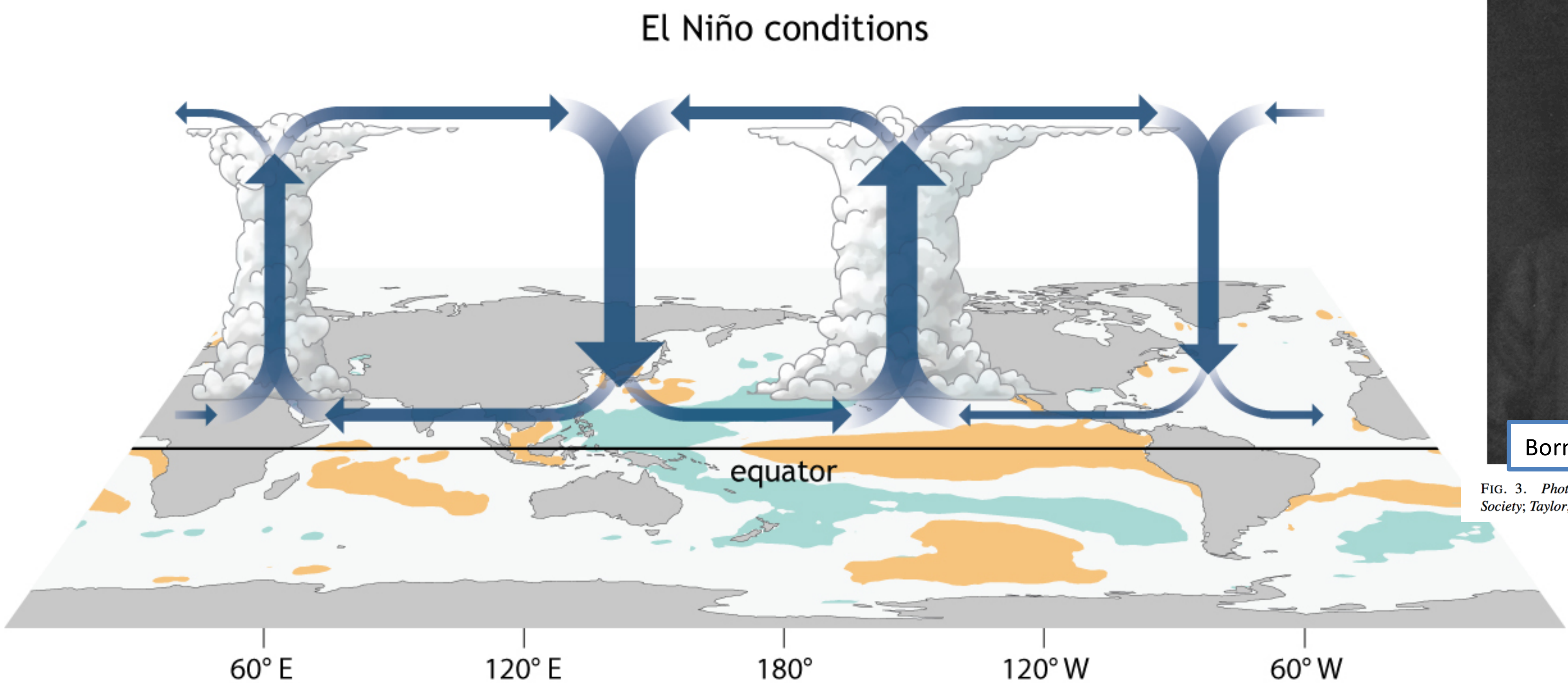
(2) Observing ENSO at NOAA

(3) How do we make ENSO Forecasts?

(4) How do we verify ENSO Forecasts?

(5) Challenges in ENSO prediction

History of ENSO



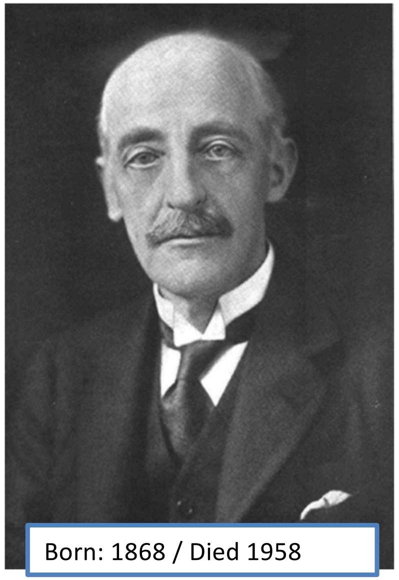


FIG. 3. *Photograph of Sir Gilbert T. Walker (source: Royal Society; Taylor, 1962).*

In his efforts to predict the Indian Monsoon, Gilbert Walker discovered the **Southern Oscillation**, a large-scale pattern in sea level pressure that spans the Indian and Pacific Oceans (published in 1924).

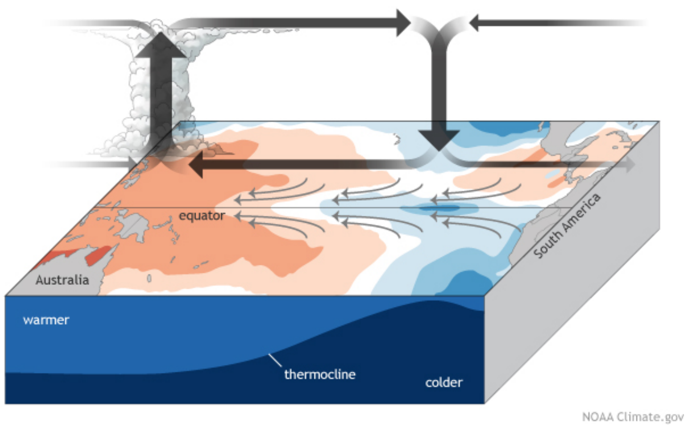
“As recently as the 1960s, the Southern Oscillation was still largely dismissed as a climate curiosity” (Rasmusson, 1991).

https://www.climate.gov/news-features/blogs/enso/walker-circulation-ensos-atmospheric-buddy

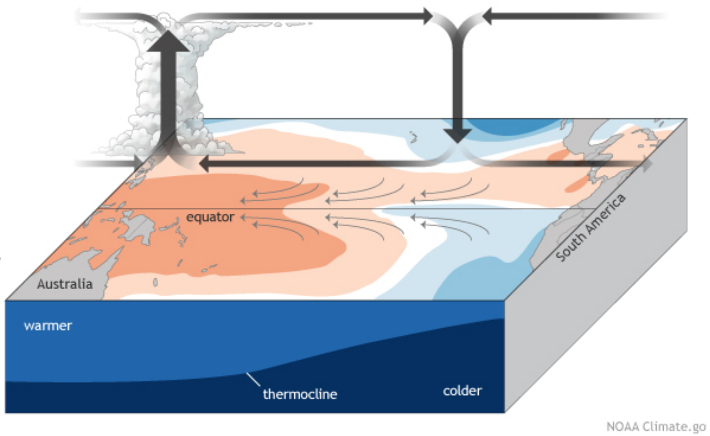
Bjerknes Feedback

Jacob Bjerknes (1969) came along and realized that the ocean-atmosphere were coupled. There is *positive feedback* between **Sea Surface Temperature (SST)** and the **circulation** across the tropical Pacific Ocean.

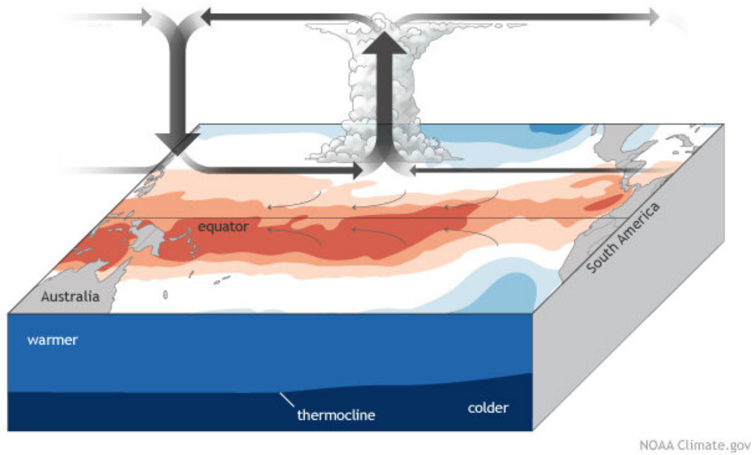
La Niña



ENSO-Neutral

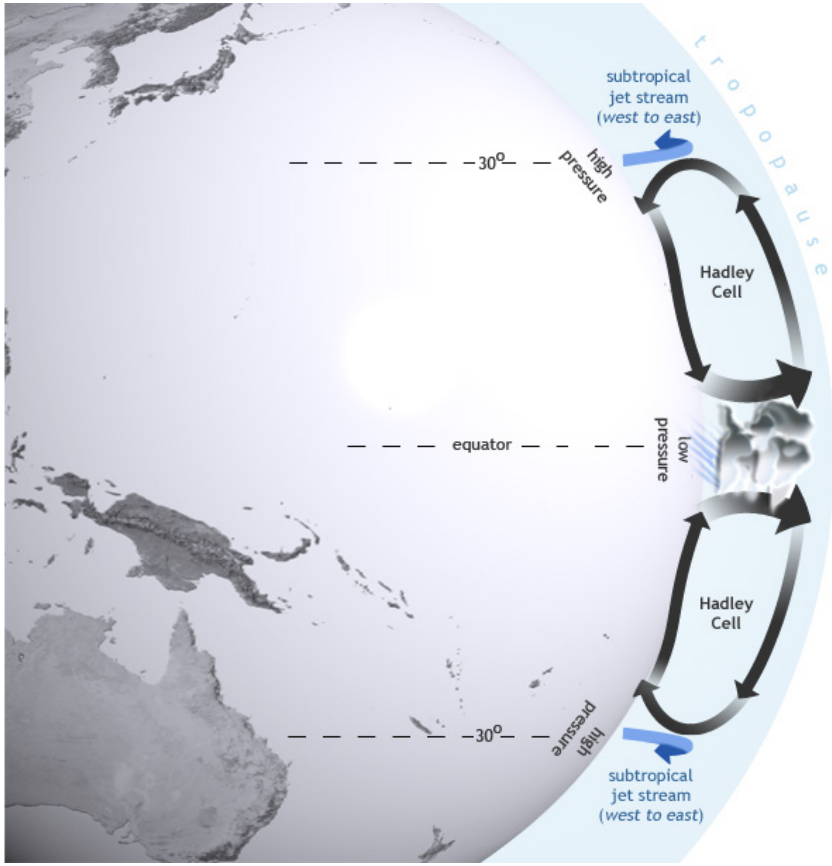


El Niño

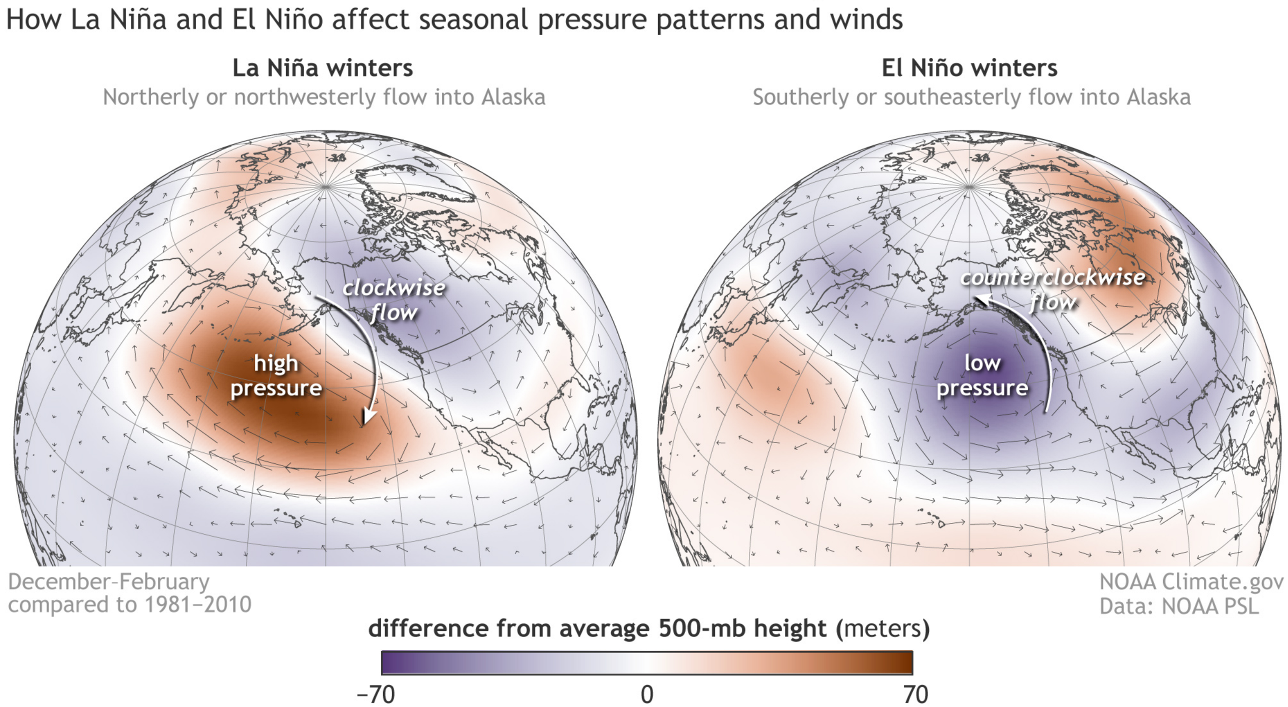


https://www.climate.gov/news-features/blogs/enso/rise-el-niño-and-la-niña

Why Do We Care About ENSO?

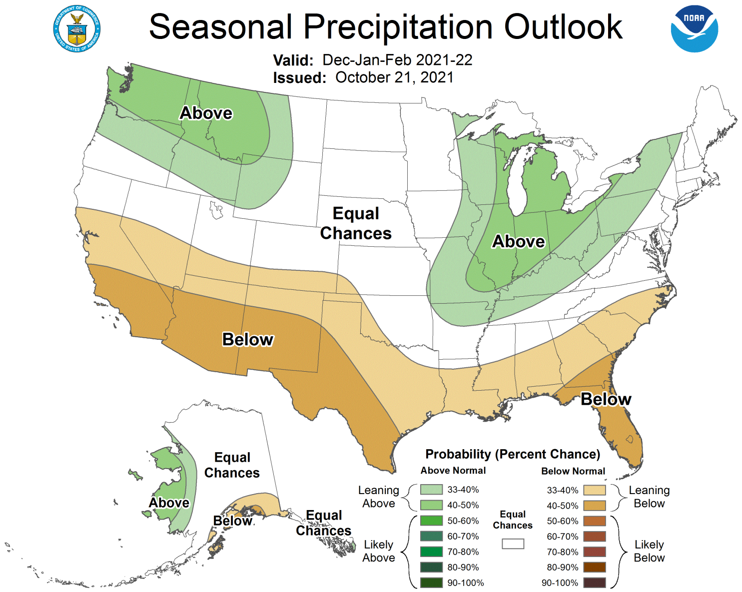


Horel and Wallace (1981)

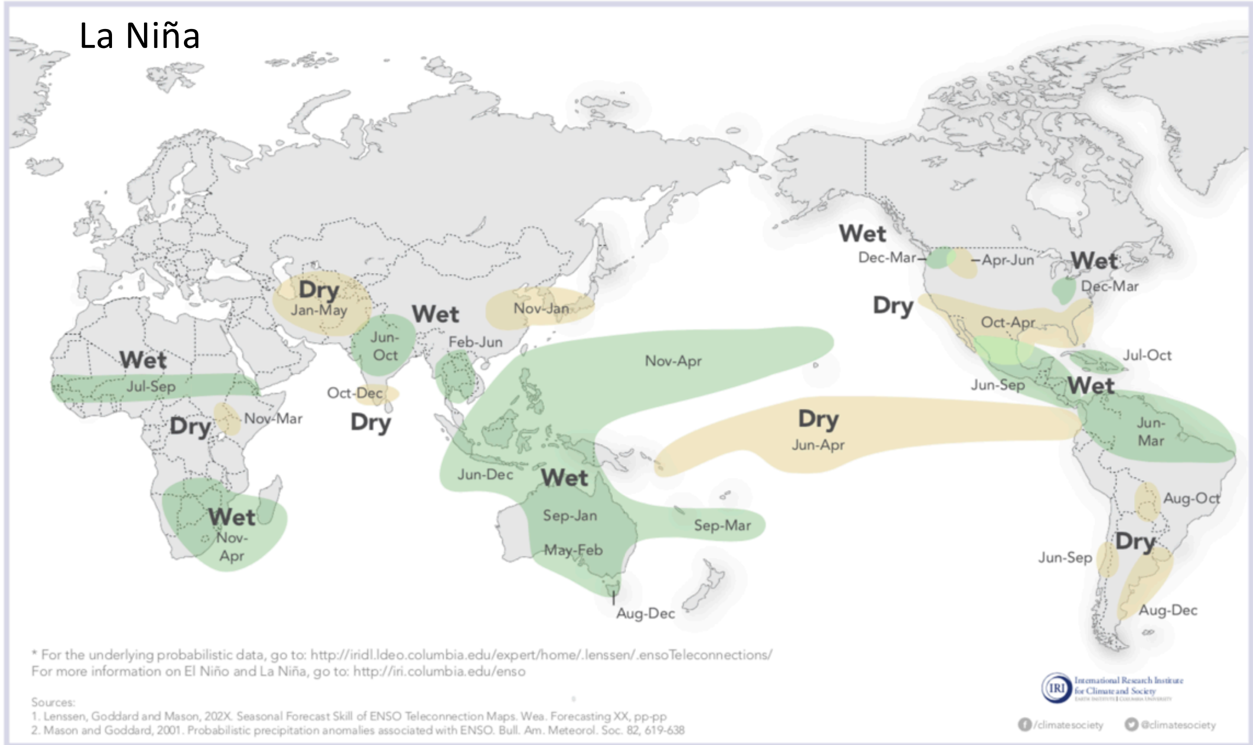


ENSO helps us to make Subseasonal-to-Seasonal Predictions

NOAA CPC Precipitation Outlook for December 2021 - February 2022



https://www.cpc.ncep.noaa.gov/products/predictions/long_range/



Lenssen, N. J. L., L. Goddard, and S. Mason (2020), Seasonal Forecast Skill of ENSO Teleconnection Maps. *Wea. Forecasting*.

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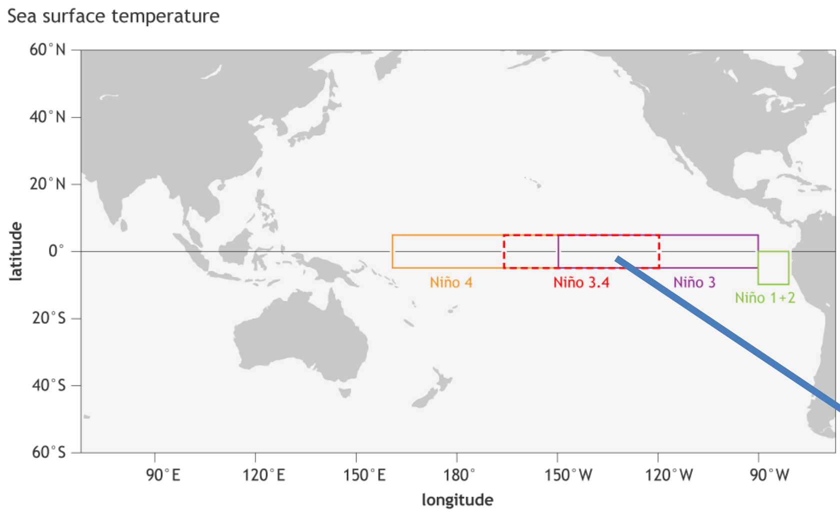
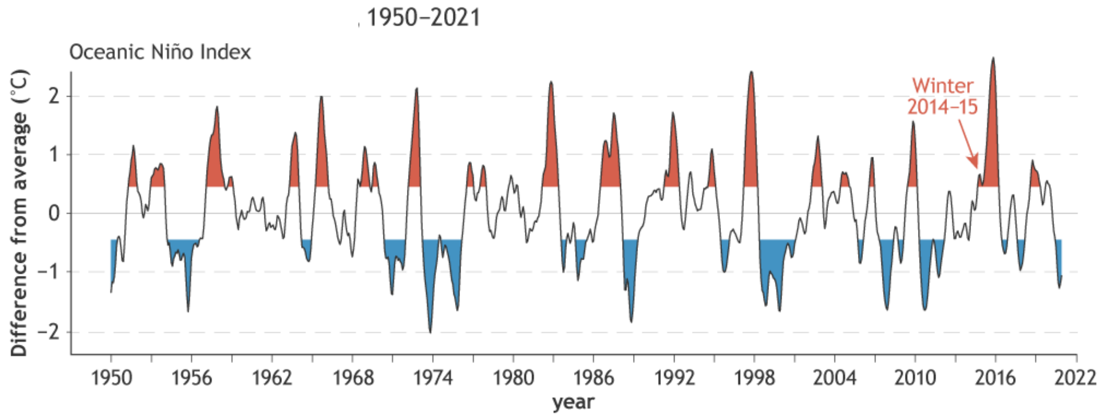
ENSO Monitoring: Niño-3.4 Sea Surface Temperature (SST) Index

3-month running average values in Niño3.4 is called the <u>Oceanic Niño Index</u> (ONI)



An index (time series) is created by averaging sea surface temperature in the Niño3.4 box and subtracting out the seasonal cycle.



Well correlated (coupled) with atmospheric variables over the tropical Pacific Ocean. Atmospheric variables are noisier than oceanic ones.

NOAA uses a high quality historical SST dataset for comparisons, ERSSTv5.

Barnston, A. G., Chelliah, M., & Goldenberg, S. B. (1997). Documentation of a highly ENSO-related SST region in the equatorial pacific: Research note. *Atmos.-Ocean*, *35*(3), 367-383.

NOAA's Official Definition is based on the Oceanic Niño Index (ONI)
(table shows 1950-present)

Cold & Warm Episodes by Season

Notice: This page is updated automatically on the first Thursday of each month. Because of the high frequency filter applied to the ERSSTv5 data (Huang et al. 2017, J.Climate), ONI values may change up to two months after the initial "real time" value is posted. Therefore, the most recent ONI values should be considered an estimate.

DESCRIPTION: Warm (red) and cold (blue) periods based on a threshold of +/- 0.5^{o}C for the Oceanic Niño Index (ONI) [3 month running mean of ERSST.v5 SST anomalies in the Niño 3.4 region (5^{o}N-5^{o}S, 120^o-170^{o}W)], based on centered 30-year base periods updated every 5 years.

Uses ERSSTv5 data

For historical purposes, periods of below and above normal SSTs are colored in blue and red when the threshold is met for a minimum of 5 consecutive overlapping seasons. The ONI is one measure of the El Niño-Southern Oscillation, and other indices can confirm whether features consistent with a coupled ocean-atmosphere phenomenon accompanied these periods.

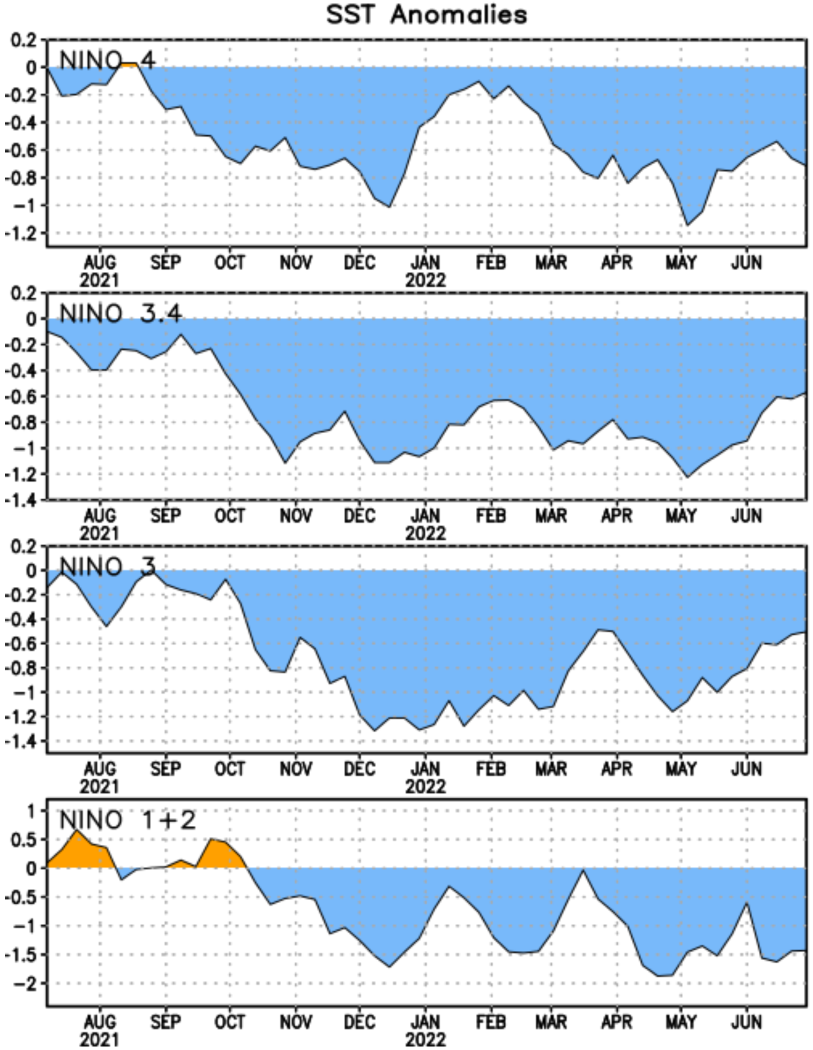
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
1950	-1.5	-1.3	-1.2	-1.2	-1.1	-0.9	-0.5	-0.4	-0.4	-0.4	-0.6	-0.8
1951	-0.8	-0.5	-0.2	0.2	0.4	0.6	0.7	0.9	1.0	1.2	1.0	0.8
1952	0.5	0.4	0.3	0.3	0.2	0.0	-0.1	0.0	0.2	0.1	0.0	0.1
1953	0.4	0.6	0.6	0.7	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8
1954	0.8	0.5	0.0	-0.4	-0.5	-0.5	-0.6	-0.8	-0.9	-0.8	-0.7	-0.7
1955	-0.7	-0.6	-0.7	-0.8	-0.8	-0.7	-0.7	-0.7	-1.1	-1.4	-1.7	-1.5
1956	-1.1	-0.8	-0.6	-0.5	-0.5	-0.5	-0.6	-0.6	-0.5	-0.4	-0.4	-0.4
1957	-0.2	0.1	0.4	0.7	0.9	1.1	1.3	1.3	1.3	1.4	1.5	1.7
1958	1.8	1.7	1.3	0.9	0.7	0.6	0.6	0.4	0.4	0.4	0.5	0.6
1959	0.6	0.6	0.5	0.3	0.2	-0.1	-0.2	-0.3	-0.1	0.0	0.0	0.0
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
1960	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.1	0.2	0.3	0.2	0.1	0.1
1961	0.0	0.0	0.0	0.1	0.2	0.3	0.1	-0.1	-0.3	-0.3	-0.2	-0.2
1962	-0.2	-0.2	-0.2	-0.3	-0.3	-0.2	0.0	-0.1	-0.1	-0.2	-0.3	-0.4
1963	-0.4	-0.2	0.2	0.3	0.3	0.5	0.9	1.1	1.2	1.3	1.4	1.3
1964	1.1	0.6	0.1	-0.3	-0.6	-0.6	-0.6	-0.7	-0.8	-0.8	-0.8	-0.8
1965	-0.6	-0.3	-0.1	0.2	0.5	0.8	1.2	1.5	1.9	2.0	2.0	1.7
1966	1.4	1.2	1.0	0.7	0.4	0.2	0.2	0.1	-0.1	-0.1	-0.2	-0.3
1967	-0.4	-0.5	-0.5	-0.4	-0.2	0.0	0.0	-0.2	-0.3	-0.4	-0.3	-0.4
1968	-0.6	-0.7	-0.6	-0.4	0.0	0.3	0.6	0.5	0.4	0.5	0.7	1.0
1969	1.1	1.1	0.9	0.8	0.6	0.4	0.4	0.5	0.8	0.9	0.8	0.6

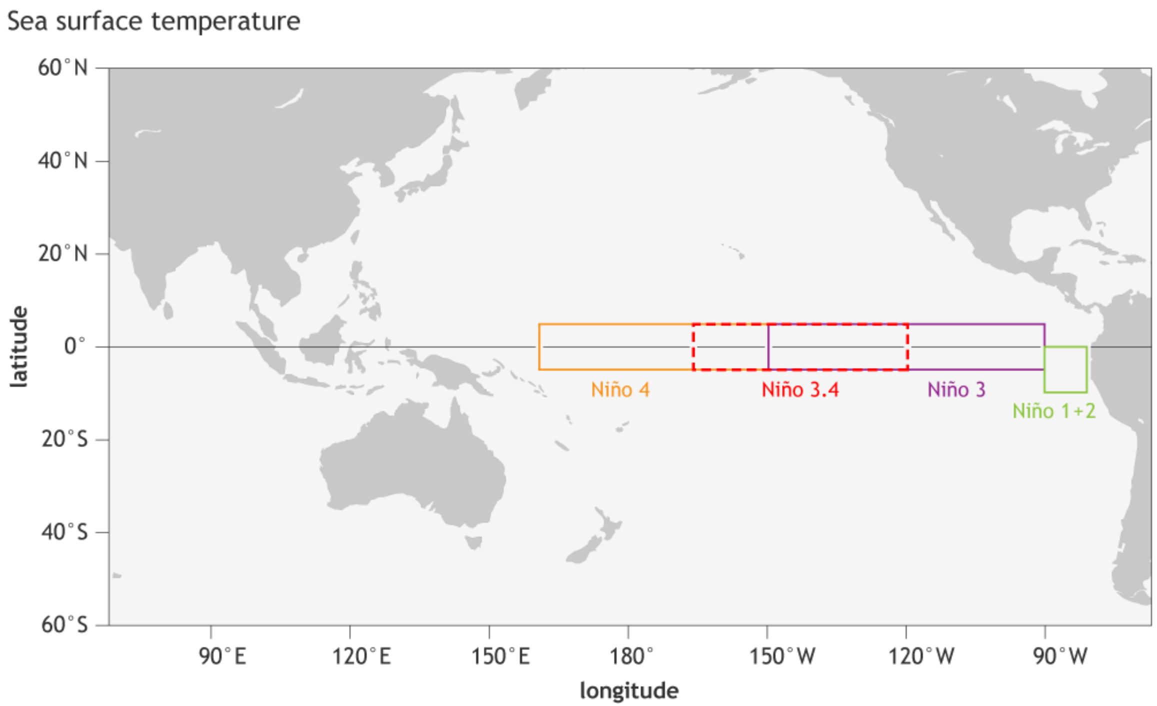
El Niño Episode:
>= 0.45°C for at least 5 consecutive seasons

La Niña Episode:
<= -0.45°C for at least 5 consecutive seasons

https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

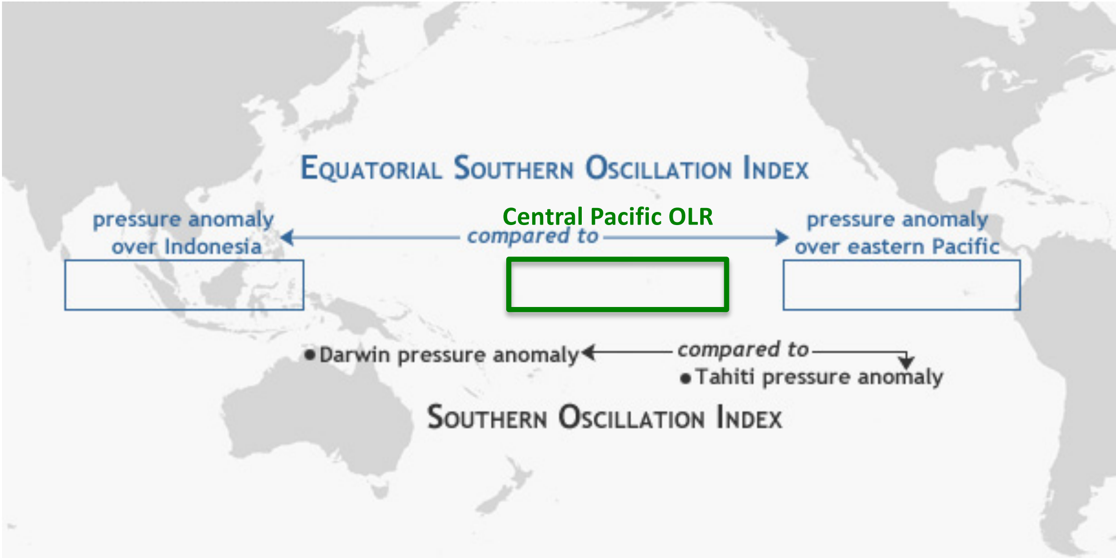
Other SST (Niño) index regions are monitored as well

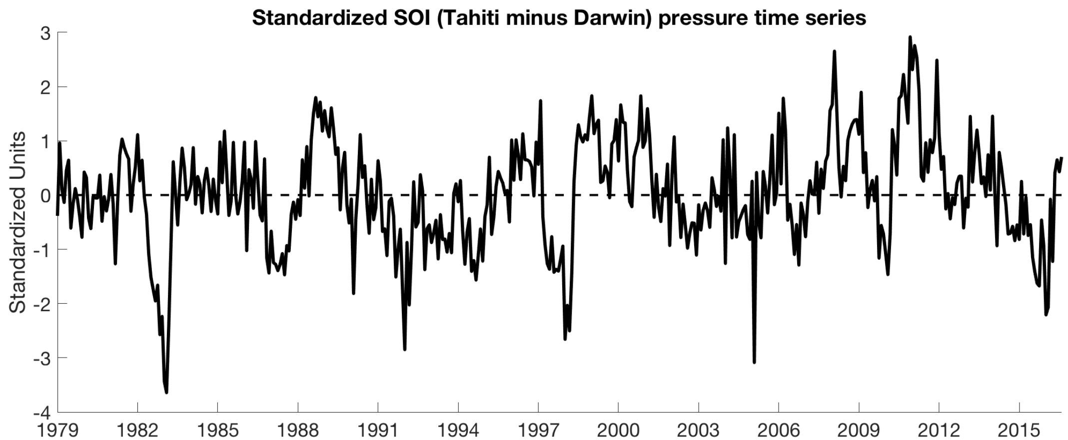




Weekly ENSO briefing updates every Monday (or Tuesday if holiday):
https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf

Atmospheric Indices to Monitor ENSO





You can download most of these ENSO indices in text/ascii format here: http://www.cpc.ncep.noaa.gov/data/indices/

On the 2nd Thursday of each month, we update
(1) the ***status*** of ENSO (where are we now?) and (2) the ***forecast***

EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

issued by
CLIMATE PREDICTION CENTER/NCEP/NWS
and the International Research Institute for Climate and Society

14 July 2022

The ENSO Alert System is simultaneously updated

ENSO Alert System Status: La Niña Advisory

Synopsis: **La Niña is favored to continue through 2022 with the odds for La Niña decreasing into the Northern Hemisphere late summer (60% chance in July-September 2022) before increasing through the Northern Hemisphere fall and early winter 2022 (62-66% chance).**

During June, below-average sea surface temperatures (SSTs) weakened across most of the central and eastern equatorial Pacific Ocean with SSTs returning to near-average in the east-central Pacific [Fig. 1], as reflected by the Niño indices, which ranged from -0.4°C to -1.2°C during the past week [Fig. 2]. Subsurface temperatures anomalies averaged between 180°-100°W and 0-300m depth were weakly positive in June [Fig. 3]. Below-average subsurface temperatures persisted near the surface to ~75m depth in the eastern equatorial Pacific Ocean, with above-average temperatures at depth (~100 to 200m) in the western and central Pacific Ocean [Fig. 4]. Low-level easterly wind anomalies prevailed in the western and central equatorial Pacific, while upper-level westerly wind anomalies continued over most of the equatorial Pacific. Convection remained suppressed over the western and central Pacific and enhanced over Indonesia [Fig. 5]. Overall, the coupled ocean-atmosphere system was consistent with La Niña conditions.

The most recent IRI/CPC plume average for the Niño-3.4 SST index now forecasts La Niña to persist into the Northern Hemisphere winter 2022-23 [Fig. 6]. The forecaster consensus also predicts La Niña to persist during the remainder of 2022, with odds for La Niña remaining at 60% or greater through early winter. Lowest odds occur during the next few months with a 60% chance of La Niña and a 39% chance of ENSO-neutral during July-September 2022. Subsequently, chances of La Niña increase slightly during the fall and early winter. In summary, La Niña is favored to continue through 2022 with the odds for La Niña decreasing into the Northern Hemisphere late summer (60% chance in July-September 2022) before increasing through the Northern Hemisphere fall and early winter 2022 (62-66% chance; click CPC/IRI consensus forecast for the chances in each 3-month period).

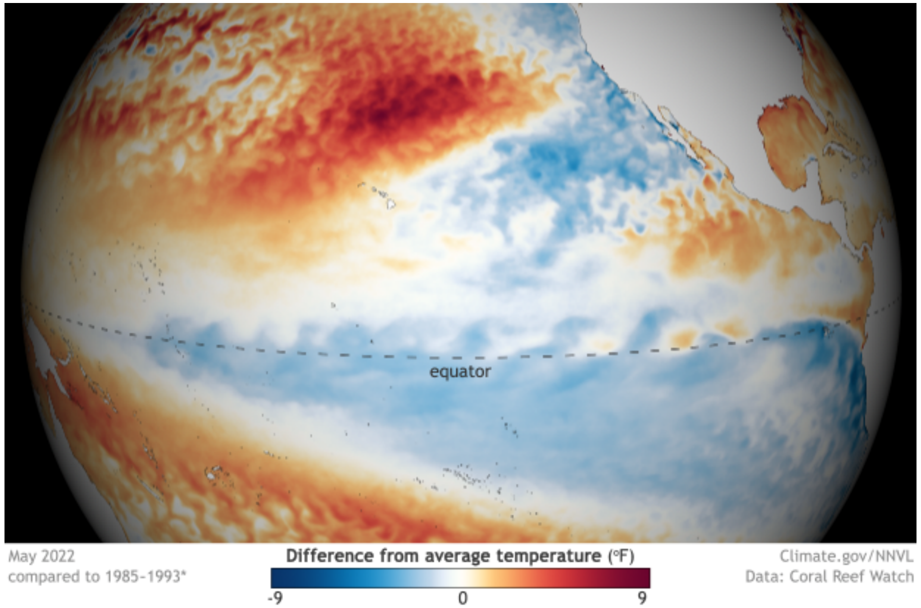
This discussion is a consolidated effort of the National Oceanic and Atmospheric Administration (NOAA), NOAA's National Weather Service, and their funded institutions. Oceanic and atmospheric conditions are updated weekly on the Climate Prediction Center web site (El Niño/La Niña Current Conditions and Expert Discussions). Additional perspectives and analysis are also available in an ENSO blog. A probabilistic strength forecast is available here. The next ENSO Diagnostics Discussion is scheduled for 11 August 2022.

To receive an e-mail notification when the monthly ENSO Diagnostic Discussions are released, please send an e-mail message to: ncep.list.enso-update@noaa.gov.

Climate Prediction Center
5830 University Research Court
College Park, Maryland 20740

https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/

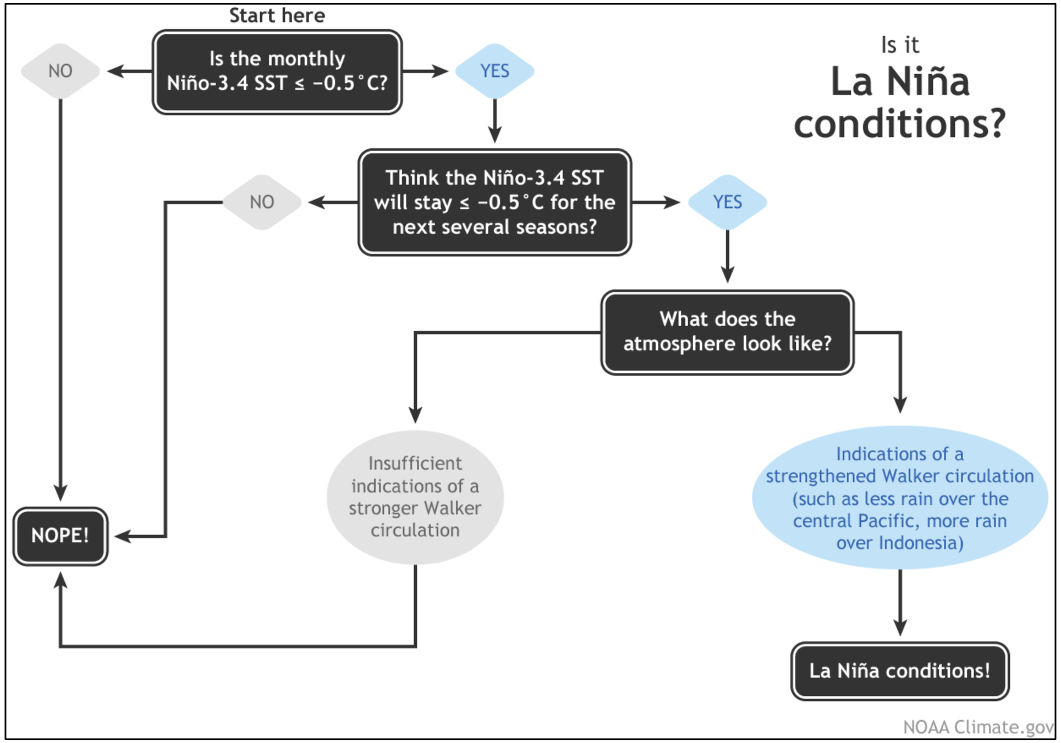
ENSO Alert System



https://www.climate.gov/maps-data/data-snapshots

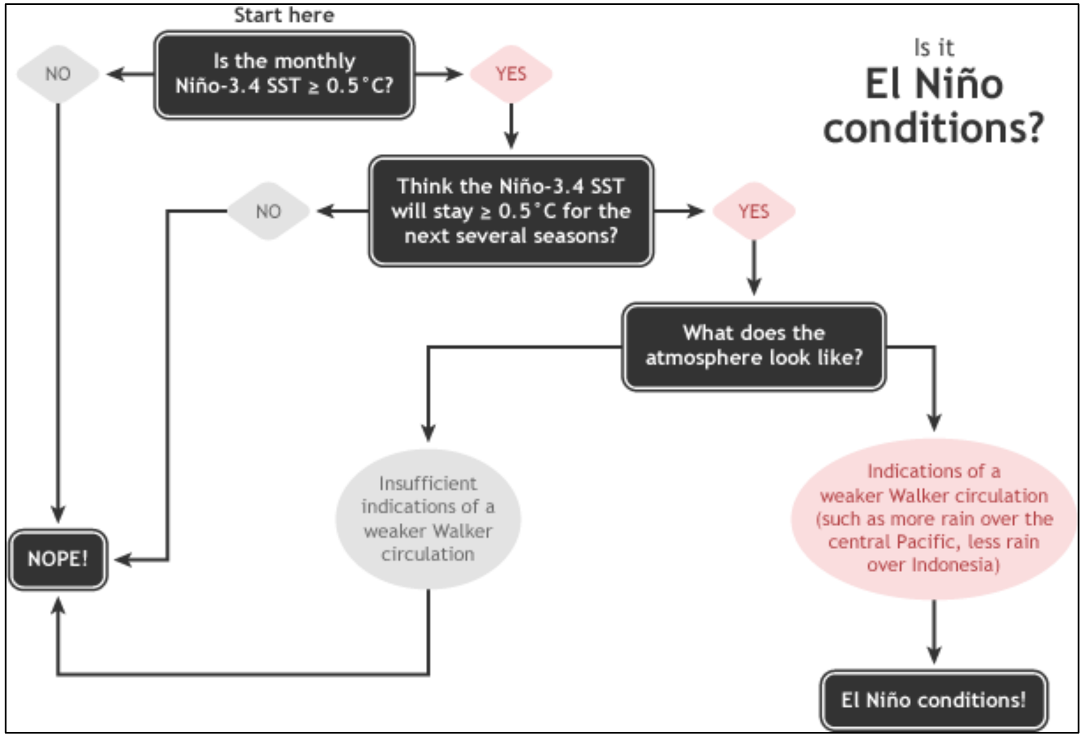
- **Watch***:* Issued when conditions are favorable for the development of El Niño or La Niña conditions within the next six months.
- **Advisory***:* Issued when El Niño or La Niña conditions are observed and expected to continue.
- **Final advisory**: Issued after El Niño or La Niña conditions have ended.
- **Not Active:** ENSO Alert System is not active. Neither El Niño nor La Niña are observed or expected in coming 6 months.

How Do We Decide Status of ENSO in Real-Time?



*Note that **the forecast** is part of our ENSO status.*
Our official definition is for 5 overlapping seasons (ONI).

We are not going to wait until after 5 seasons have qualified to declare an El Niño or La Niña event.



We Also Update an ENSO Blog Twice a Month

One post is associated with the monthly ENSO Diagnostics Discussion release.

Other post will cover ENSO-related topics or other climate phenomena.

Index/summary page that organizes past blog articles (goes back to May 2014):

https://www.climate.gov/news-features/blogs/enso/index-page-enso-blog-posts

Tons of useful graphics for your presentations!

ENSO BLOG

A blog about monitoring and forecasting El Niño, La Niña, and their impacts.

DISCLAIMER

The ENSO blog is written, edited, and moderated by Michelle L'Heureux (NOAA Climate Prediction Center), Emily Becker (University of Miami/CIMAS), Nat Johnson (NOAA Geophysical Fluid Dynamics Laboratory), and Tom DiLiberto and Rebecca Lindsey (contractors to NOAA Climate Program Office), with periodic guest contributors.

Ideas and explanations found in these posts should be attributed to the ENSO blog team, and not to NOAA (the agency) itself. These are blog posts, not official agency communications; if you quote from these posts or from the comments section, you should attribute the quoted material to the blogger or commenter, not to NOAA, CPC, or Climate.gov.

LATEST BLOGS

Variable Walks In Our Climate Forest

October 2021 ENSO update: La Niña is here!

ENSO as a climate conductor for global crop yields

ENSO and Climate Change: What does the new IPCC

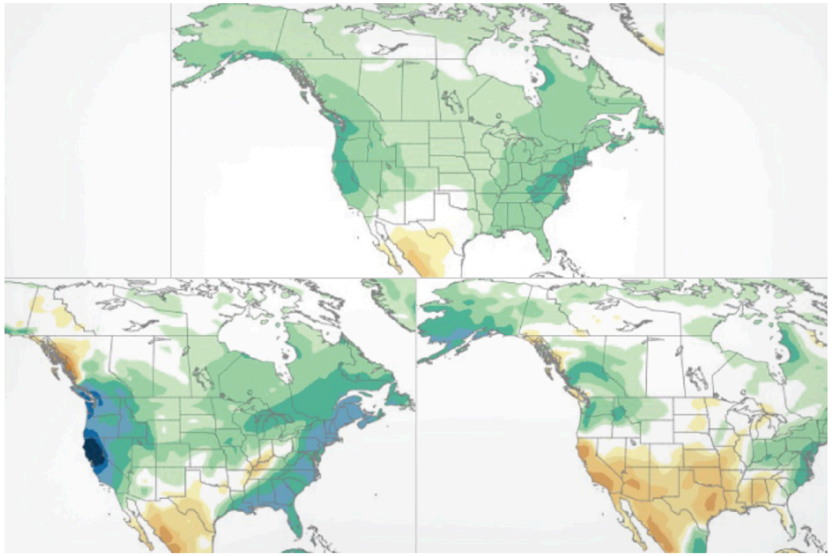
ENSO Blog

Sort by blog: ENSO | Items per page: 10 | Sort by Date: Descending | Apply

ENSO BLOG | OCTOBER 28, 2021 | COMMENTS: 2

Variable Walks In Our Climate Forest

BY MICHELLE L'HEUREUX



When the climate doesn't behave like we expect, whether it's for an individual season or for several decades, we often hear scientists blaming internal variability. Scientists use this term a lot (even on Twitter) and I've noticed that I usually obtain a few blank faces

https://www.climate.gov/news-features/department/enso-blog or just google "ENSO Blog"

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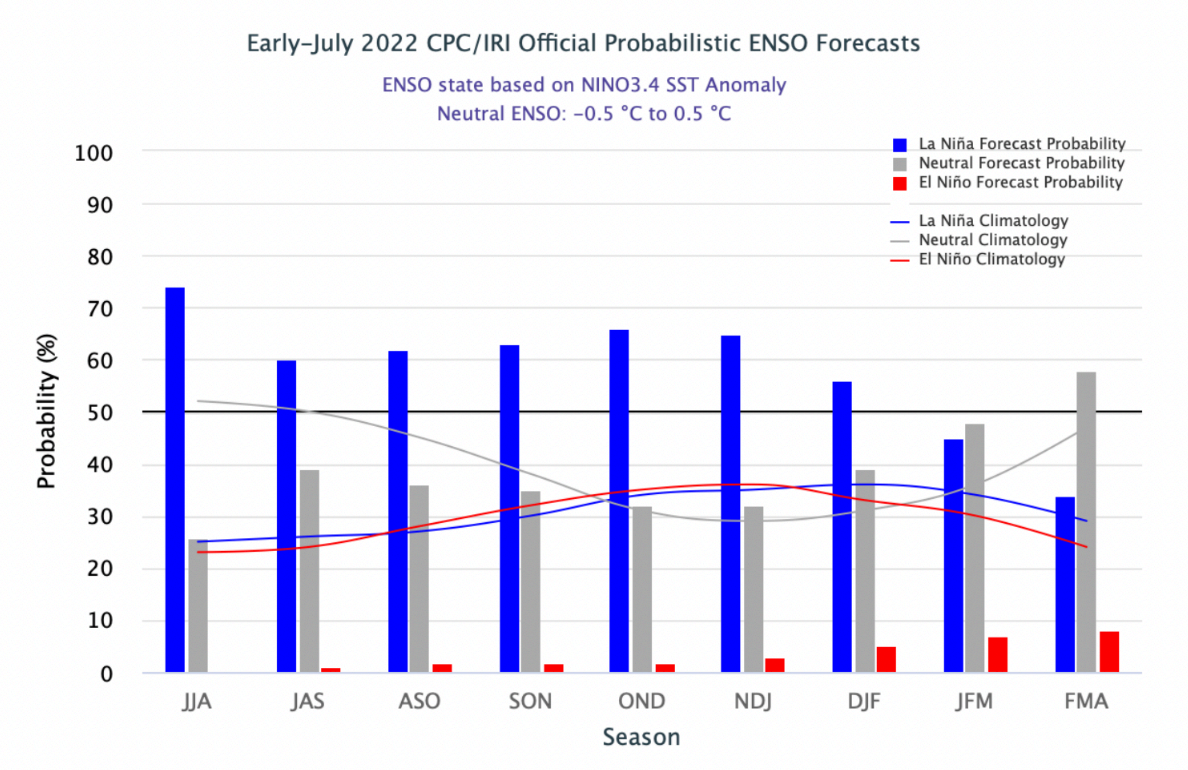
Predicting ENSO at NOAA

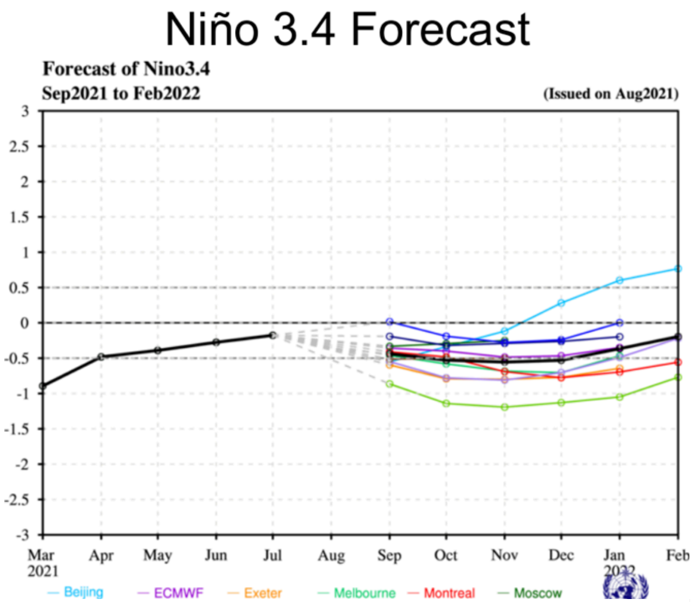
- A ***team-based*** effort. Size has varied from 8 to 13 CPC/IRI scientists who dedicate a few hours each month to construct a prediction.
- On their own, each forecaster is responsible for weighing the evidence and providing forecasts of the Niño3.4 index for the following nine overlapping seasons. We combine those forecasts.
- The outlook is provided in the form of probabilities (% chance) because there is a lot of ***uncertainty*** in seasonal climate prediction

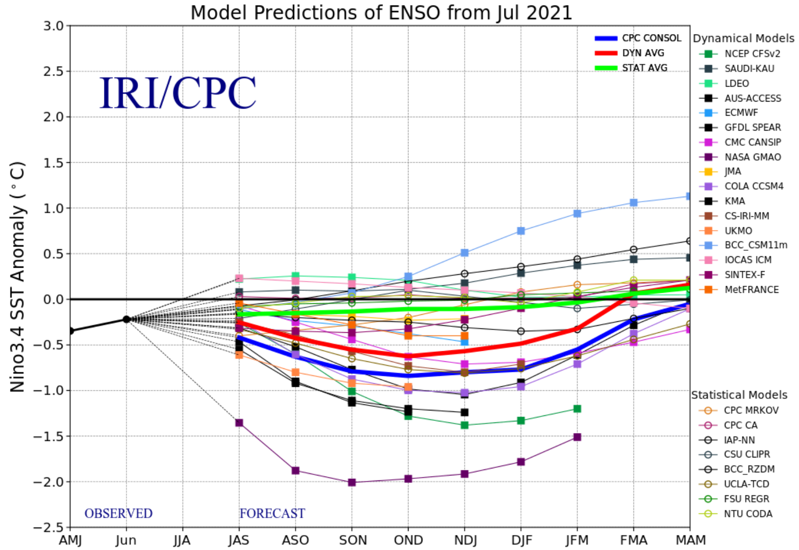


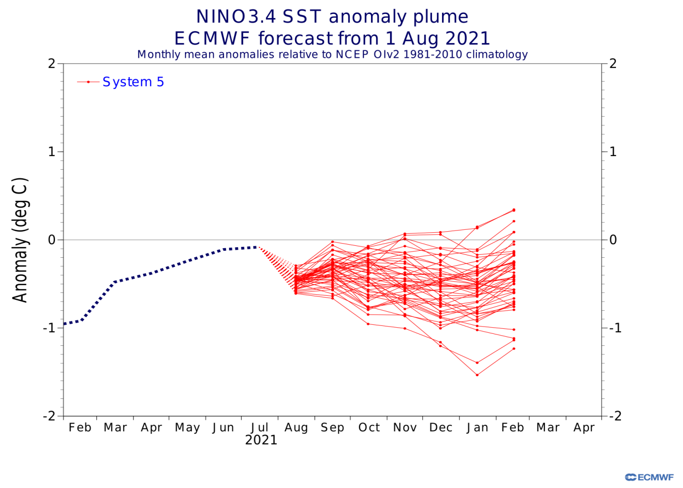
Verification is based on the ERSSTv5 Niño-3.4 index (ONI table of historical events)

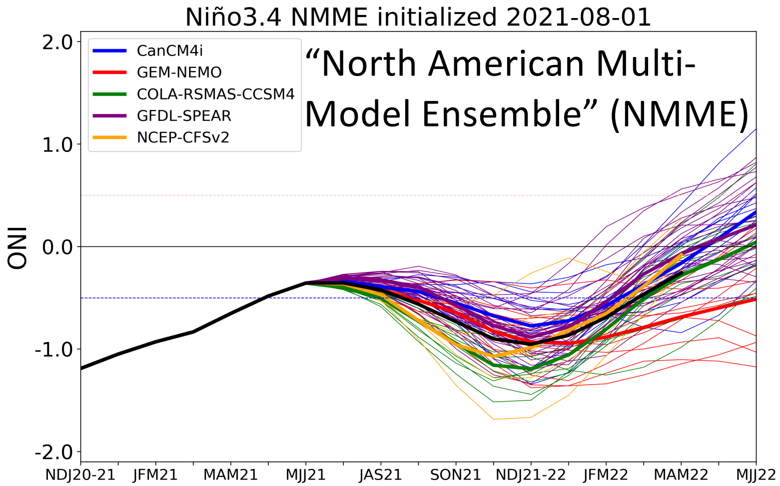
-0.5°C/+0.5°C thresholds

When Making Forecasts We Have ***Many*** Initialized Climate Models To Consider.







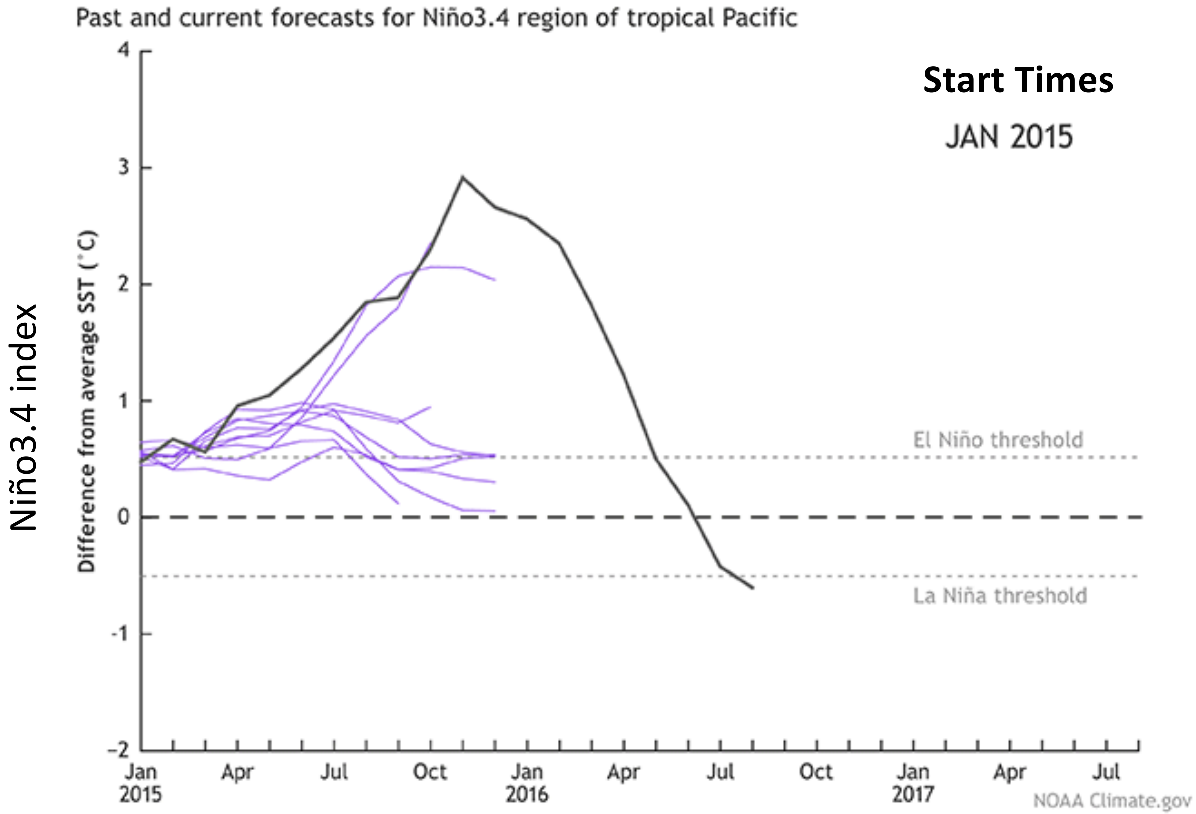


Why Not Just Pick One Model Set/Statistical Correction and Just Use It?

probabilities for ENSO strength outlooks. However, it quickly becomes controversial which model or set of models should be relied upon, and even then, selecting a method to develop the probabilities from the selected model is also not trivial.[1] Putting this issue aside, addressing the question of whether objective

[1] One might hope that someday the scientific community settles on a single, all-encompassing forecast strategy, but until such a day, forecasters will desire the flexibility to consider multiple forecast inputs. Model developers and statisticians enable this approach by continually creating updated model(s) and new forecast tools. At any given time, there are several model suites and combinations that are favored by forecasters over others, but these evolve and get supplanted by other methods over time. So, the role of forecasters is often akin to the role of jurors, facing multiple lines of evidence and a requirement to come up with the most defensible judgment possible.

https://journals.ametsoc.org/view/journals/wefo/34/1/waf-d-18-0126_1.xml



Purple lines are NMME ensemble averages from each model

Black line is the Niño3.4 observation

A lot of moving parts when making or verifying forecasts!

(1) Start Times: When was the forecast made?
(2) Target Times: When is the forecast valid? What dates are you forecasting?
(3) Lead Times: The interval or difference between the Start Time and the Target Time.

Before you Forecast or Verify (or Grade) a forecast, YOU MUST KNOW:

(1) **Start Times**: The date(s) when the forecast was initialized. When did you make the forecast?

(2) **Target Times**: The dates(s) when the forecast is valid. What dates are you forecasting?

(3) **Lead Time**: The interval or difference between the Start Time and the Target Time.

(4) **Which variable**: What quantity are you forecasting? Niño3.4 index?

(5) **What is the averaging period**? Are you forecasting a day? A month? A season (3 month average)?

(6) Which **observational dataset** are you going to use to verify the forecast?

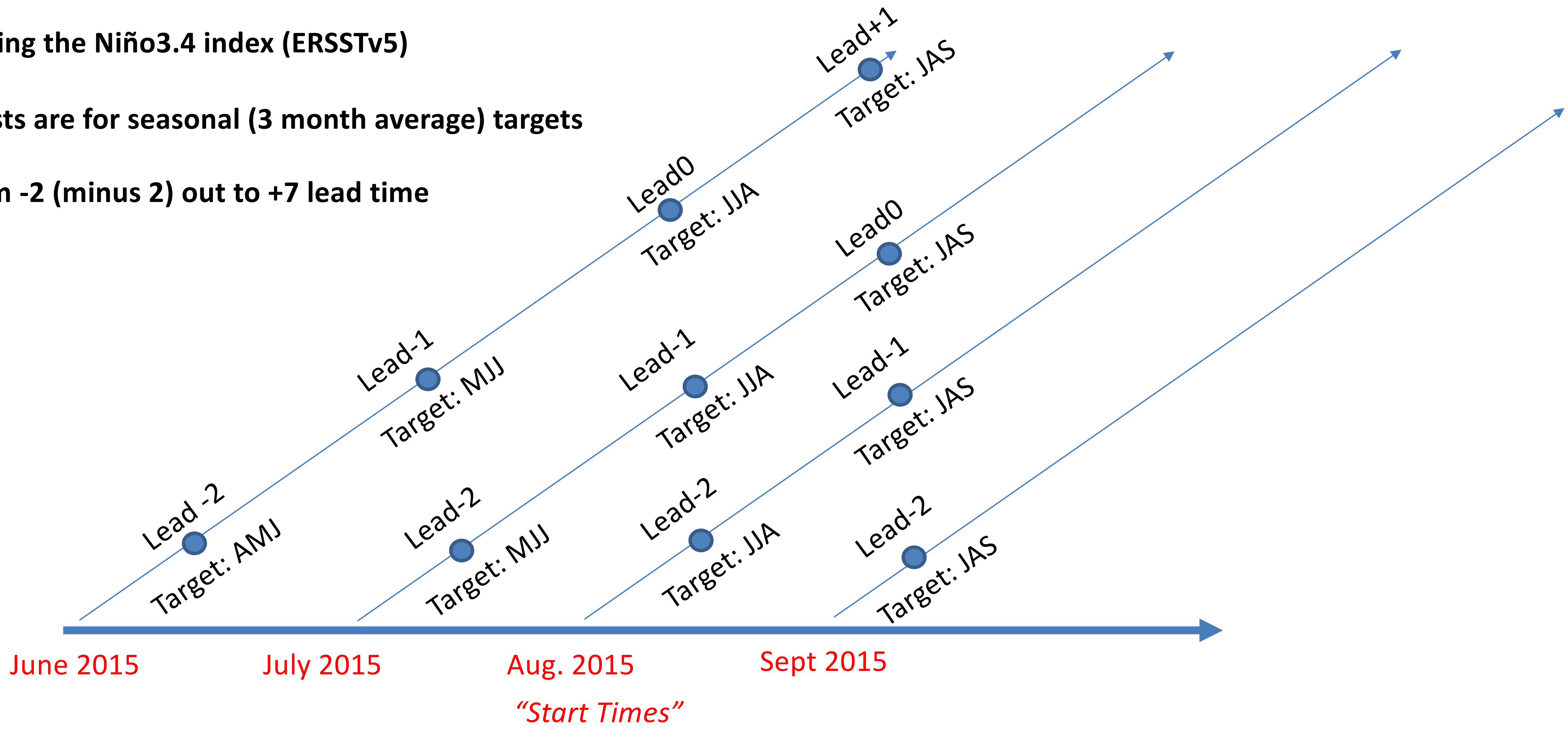
No Hand Waving!

How Our Official ENSO Forecasts are Organized

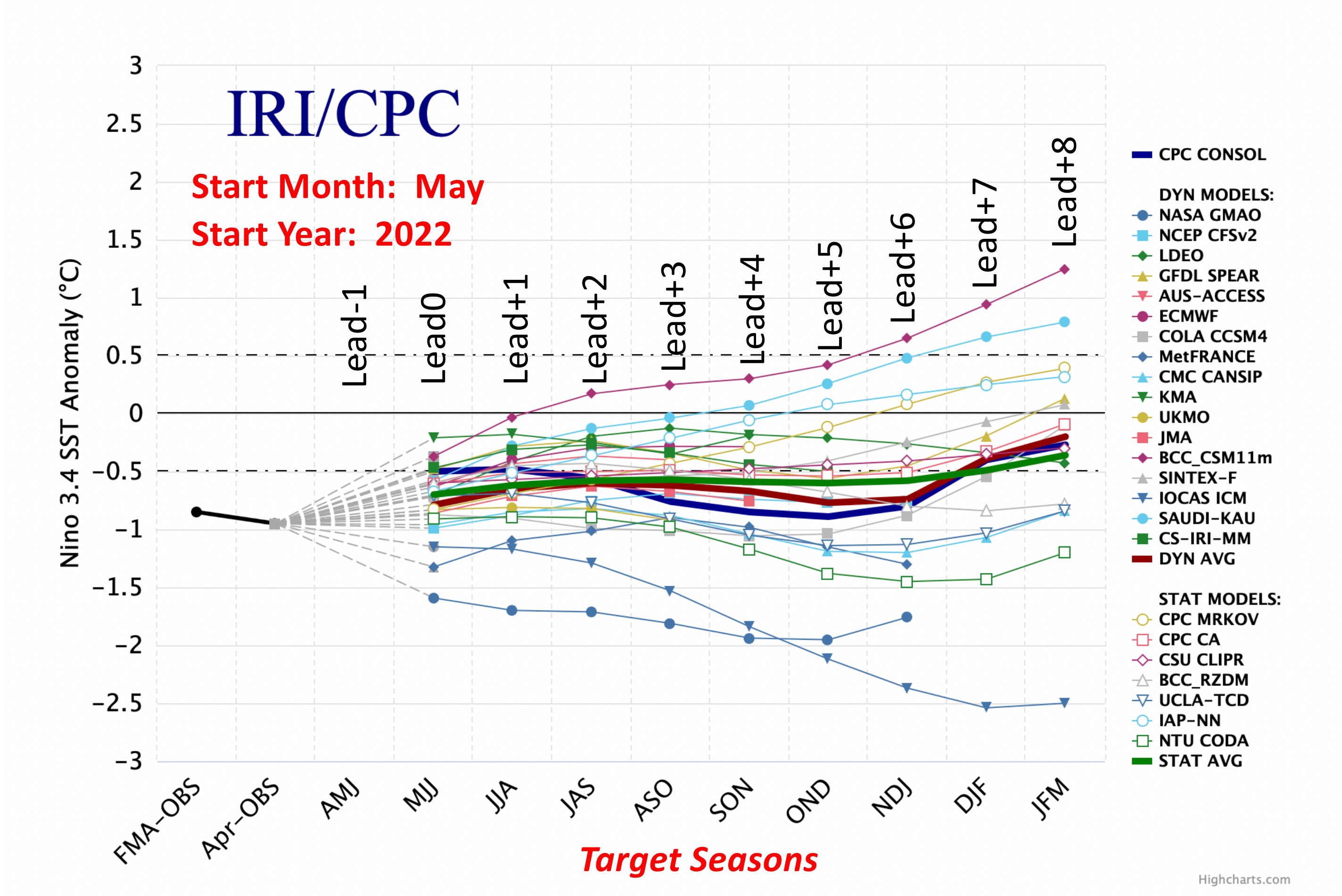
Predicting the Niño3.4 index (ERSSTv5)

Forecasts are for seasonal (3 month average) targets

Go from -2 (minus 2) out to +7 lead time



IRI Plume of Niño3.4 (ENSO) Forecasts for One Start Time

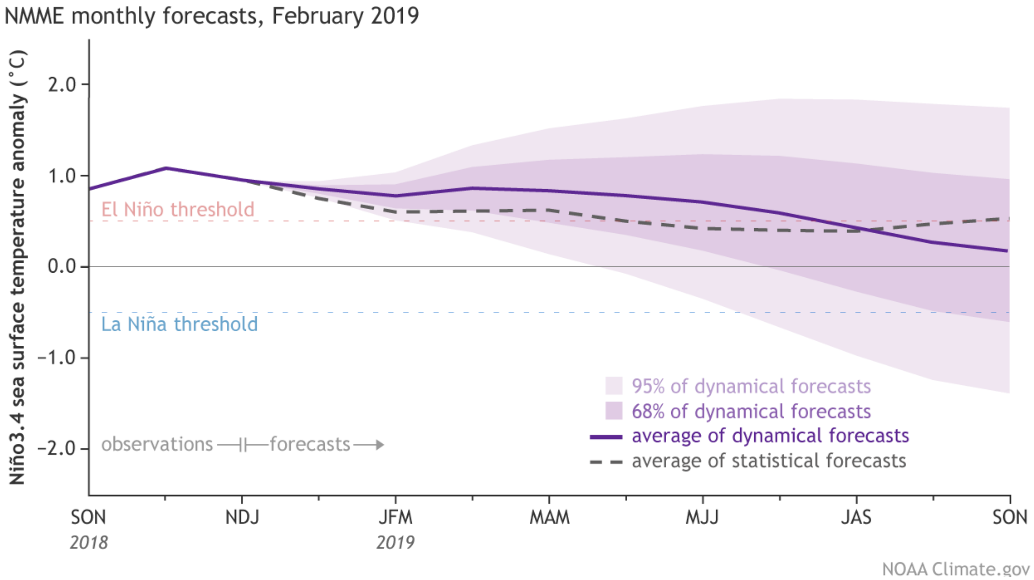


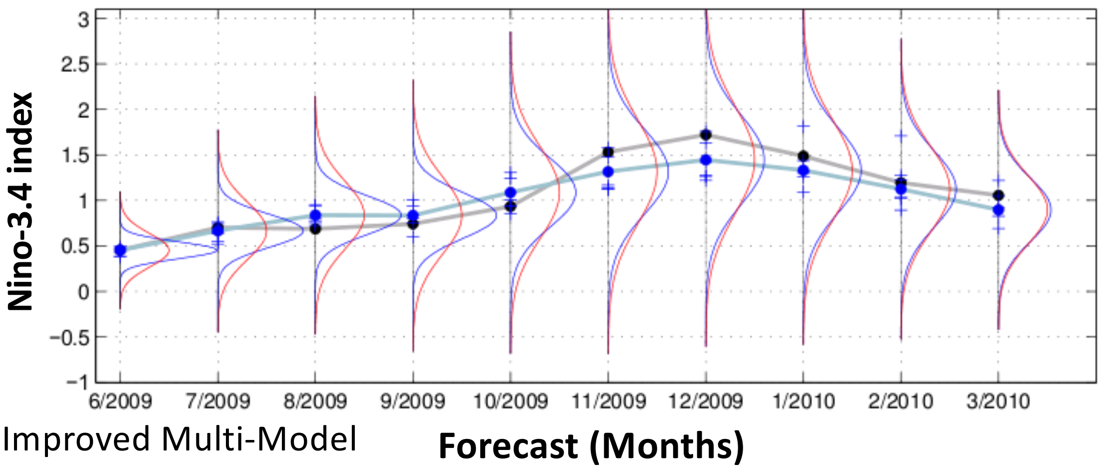
https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table

Why are multi-model ensembles considered in forecasting?

- Extremely unlikely one model would predict every variable, every location, and every timescale better than another model.
- Can leverage the strengths of each model by averaging them together (can also weight certain models over others if you have a *good* reason to do so).
- A multimodel hindcast outperforms a single-model hindcast of the same ensemble size (Hagedorn et al., 2005).
- For Niño3.4, skill advantage of multi-model approach (compared to individual models) is substantially greater than simply increasing ensemble size and is consistent with the *addition of new signals* (DelSole et al., 2014).

Forecast ensembles can be used to calculate a distribution and probabilities of future outcomes





Barnston et al., 2015 “Toward an Improved Multi-Model ENSO Prediction”

A distribution allows us to make an ENSO strengths forecast

ENSO Strengths

This table shows the forecast probability (%) of Niño-3.4 index exceeding a certain threshold (in degrees Celsius).
For negative thresholds, the table shows the probability (%) of a Niño-3.4 index value that is less than (more negative) that value.
For positive thresholds, the table shows the probability (%) of a Niño-3.4 index value that is greater than (more positive) that value.
This tool supports the official ENSO Diagnostic discussion updated on the 2nd Thursday of each month.

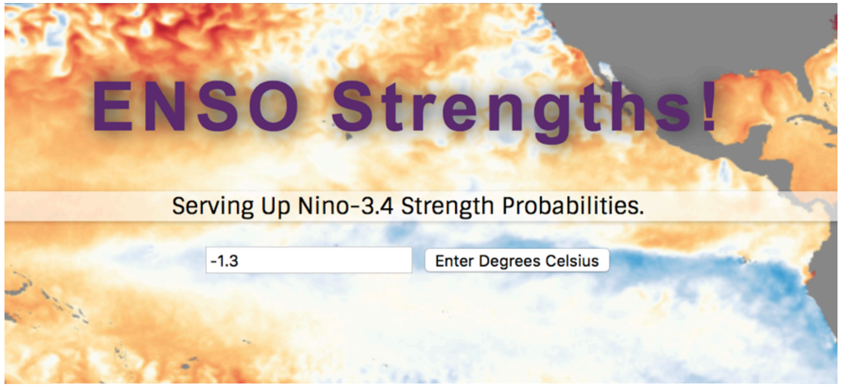
Target	< -1.5°C	< -1.0°C	< -0.5°C	> 0.5°C	> 1.0°C	> 1.5°C
JJA	~0	12	74	~0	~0	~0
JAS	2	17	60	1	~0	~0
ASO	4	23	62	2	~0	~0
SON	6	27	63	2	~0	~0
OND	9	32	66	2	~0	~0
NDJ	10	32	65	3	~0	~0
DJF	6	25	56	5	1	~0
JFM	3	16	45	7	1	~0
FMA	1	8	34	8	1	~0
	< -1.5°C	< -1.0°C	< -0.5°C	> 0.5°C	> 1.0°C	> 1.5°C

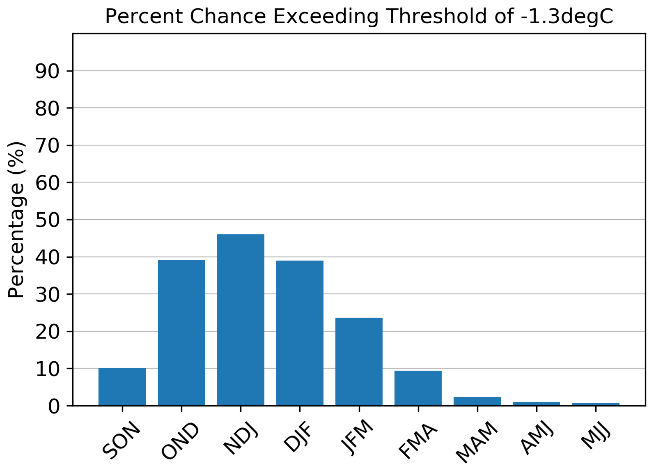
For example, for the upcoming November-January season, there is a 32% chance of Niño-3.4 index less than -1.0°C.

https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/strengths/index.php

Because Tables are Ugly and Thresholds are Arbitrary:

Aiming to create tool to type in *any* Niño-3.4 index value and obtain the % chance it will be stronger than that value*





** Some day the IT department at the National Centers for Environmental Prediction (NCEP) may permit this tool on the web.*

L'Heureux M.L., M.K. Tippett, K. Takahashi, A.G. Barnston, E.J. Becker, G.D. Bell, T.E. Di Liberto, J. Gottschalck, M.S. Halpert, Z.-Z. Hu, N.C. Johnson, Y. Xue, W. Wang (2019): Strength Outlooks for the El Niño-Southern Oscillation. *Weather Forecast.*, 34, 165-175.

Outline

(1) ENSO history + Why Do We Predict ENSO?

(2) Observing ENSO at NOAA

(3) How do we make ENSO Forecasts?

(4) How do we verify ENSO Forecasts?

(5) Challenges in ENSO prediction

How Accurate are ENSO Predictions?

Prediction Skill asks how well do the **observations** and your **prediction** match up?

Different from ***Predictability***, which asks whether there are certain conditions that result in a shift from the climatological probability. This is often estimated using model ensembles.
Recent article: https://www.climate.gov/news-features/blogs/enso/what-predictability

Different Ways to Measure Prediction Skill:

(1) **Deterministic: evaluate a non-probabilistic forecast, like a member or an ensemble mean, against the observations**
Examples: Anomaly correlation (AC), error, hit/miss rates, Heidke Skill score, Mean squared error skill score

Barnston, A.G., M.K. Tippett, M. Ranganathan, M. L'Heureux (2019): Deterministic skill of ENSO predictions from the North American Multimodel Ensemble. *Clim Dyn.,* doi: 10.1007/s00382-017-3603-3.

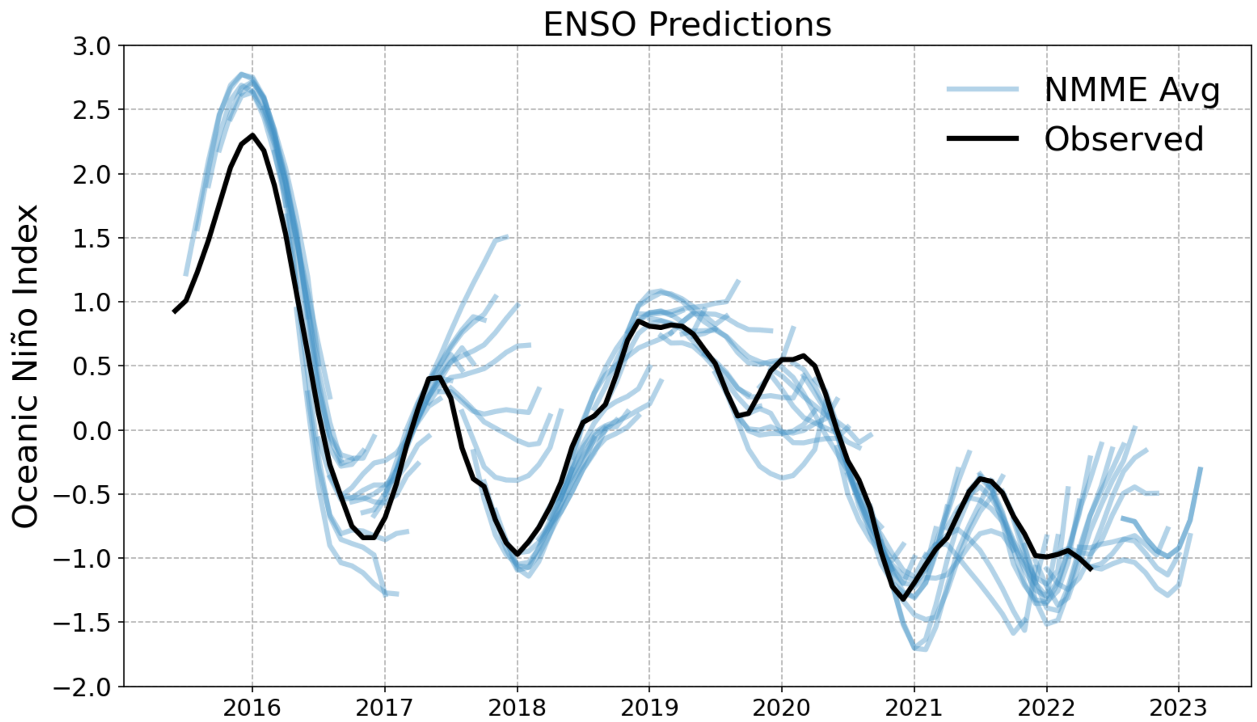
(2) Probabilistic: evaluate the multi-member ensemble against the observations
Examples: Brier Skill Score (BSS), Reliability/Attributes diagram, Ranked Probability Skill Score (RPSS), Rank Histogram, Logarithmic Skill Score/Ignorance

Tippett, M.K., M. Ranganathan, M. L'Heureux, A. Barnston, T. DelSole (2019): Assessing probabilistic predictions of ENSO phase and intensity from the North American Multimodel Ensemble. *Clim Dyn.* doi:10.1007/s00382-017-3721-y.

That's A Lot of Verification Metrics. Which One Should I Use?

Really depends on the question you're asking. Each have their plusses and minuses.
Are you dealing with ensembles/uncertainty? Then try to use some probabilistic metrics as well.

Start Simple. Maybe a diagram that shows all forecast trajectories next to the observations. Any interesting features?



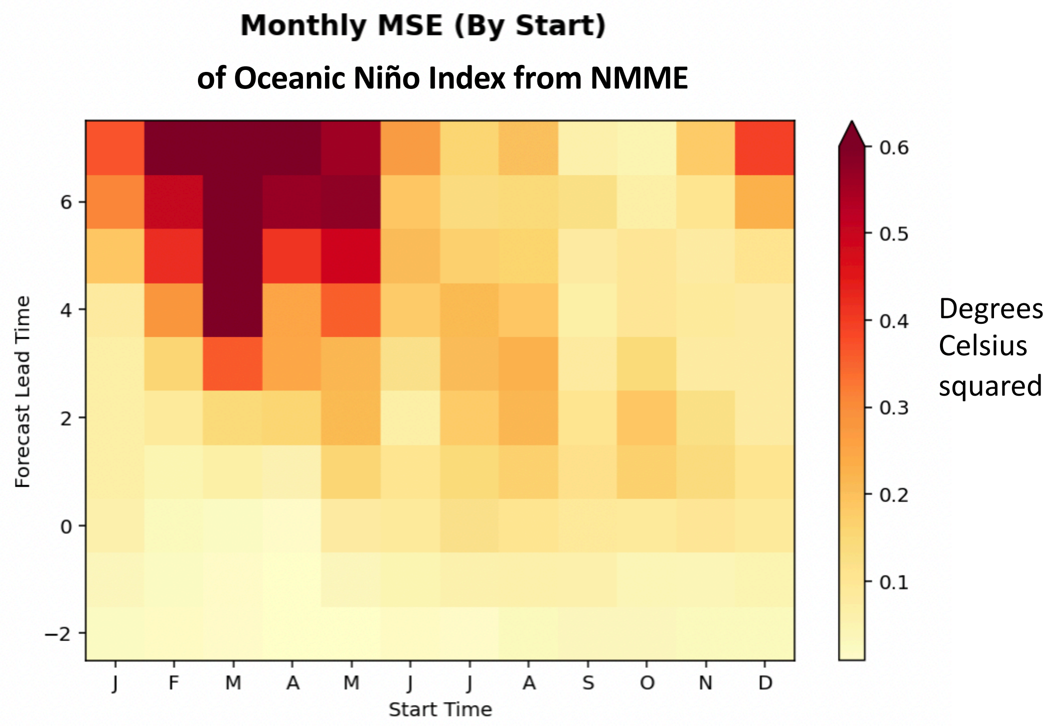
That's A Lot of Verification Metrics. Which One Should I Use?

I like to start with Mean Squared Error (this slide) and Anomaly Correlation (next slide). They reveal different types of errors.

$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2.$$

Y = forecast

$\hat{Y}_i$ = observations



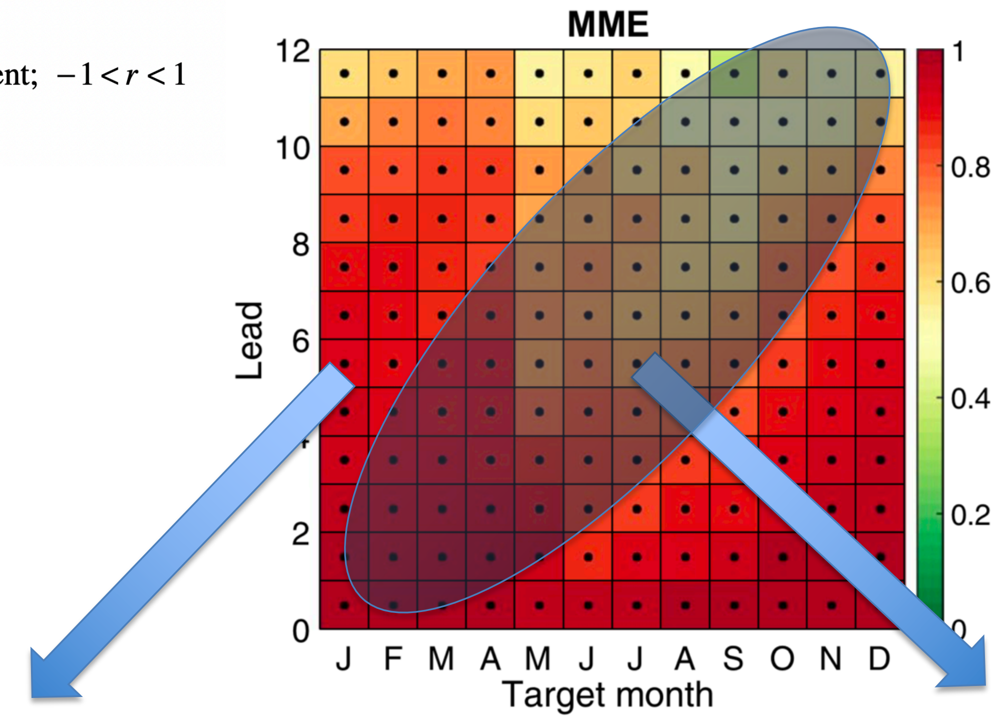
"Spring Prediction Barrier"

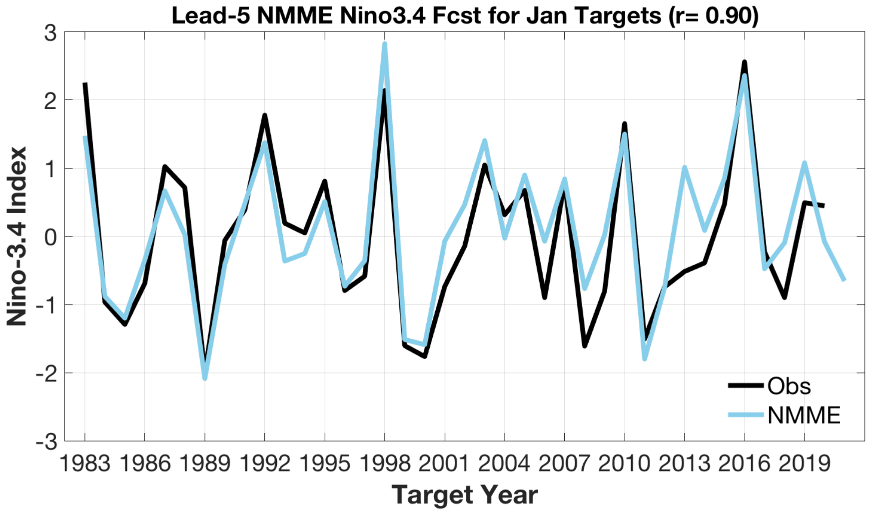
Forecasts made early in the year tend to have larger errors or less skill.

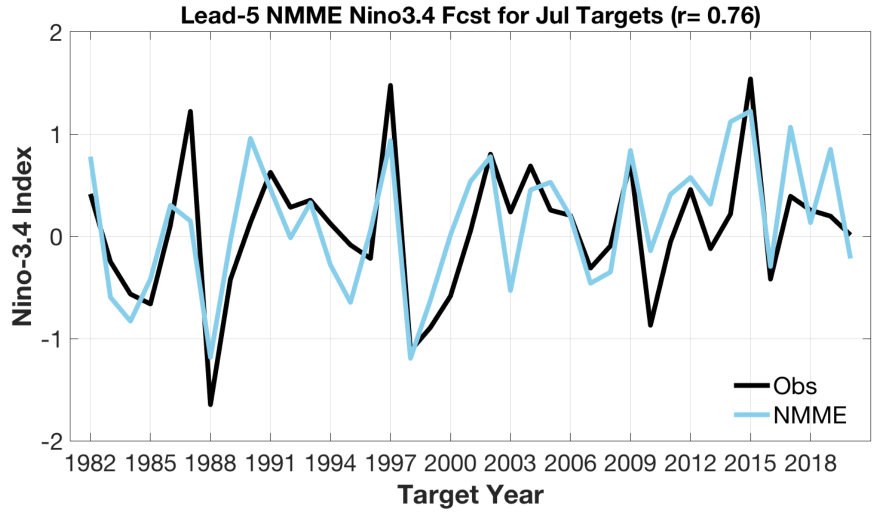
$$r = \frac{\overline{x'y'}}{\sigma_x \sigma_y} = \text{the correlation coefficient;} \quad -1 < r < 1$$

Correlation coefficient (r)
Colorbar varies
from…
No skill r=0 (green)
to
perfect skill r=1 (red)

"Spring Prediction Barrier"





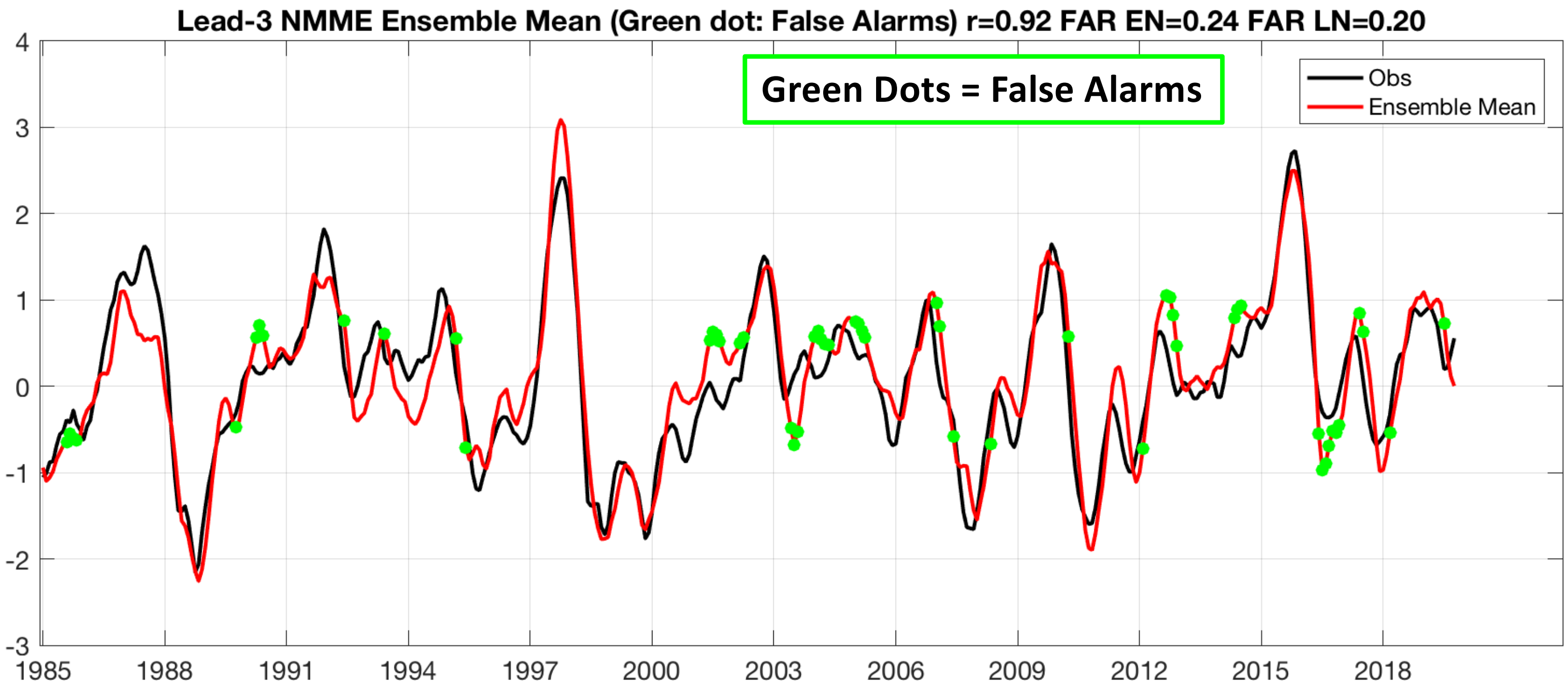


Skill with correlations (r) around 0.9? That's impressive!

But, correlation is an *average* measure. Can mask some fairly big busts due to El Niño and La Niña threshold requirements (+0.5°C/-0.5°C in Niño3.4 index).

False Alarms are cases when an ENSO event was predicted and then it did not happen. Forecasters (and the public) are especially sensitive to these situations (for example, 2014-15)

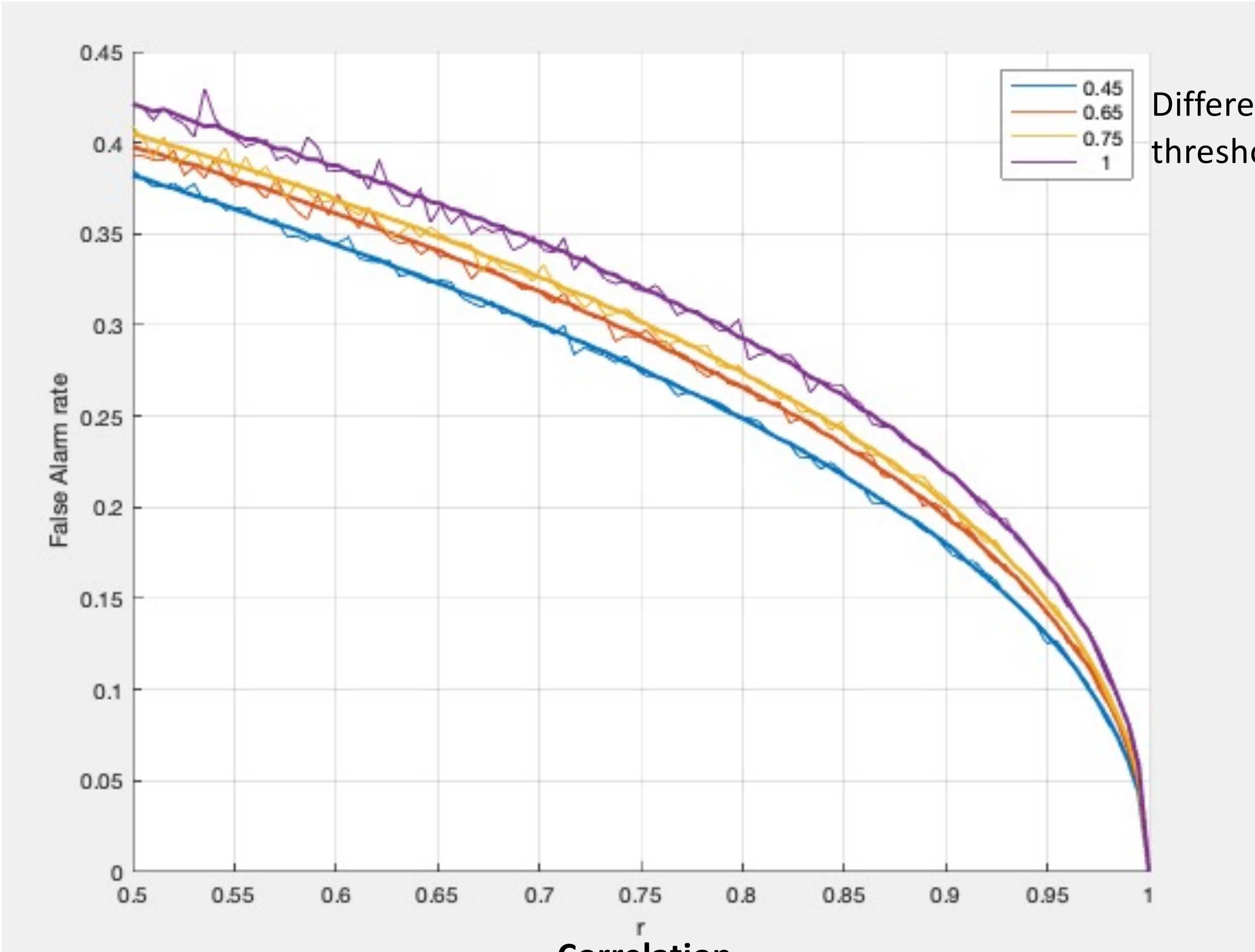
What does r ~0.9 look like in terms of El Niño and La Niña False Alarms in the NMME?



False Alarms Relate To Correlation For A Joint Gaussian Distribution

(insight/figure from Mike Tippett)

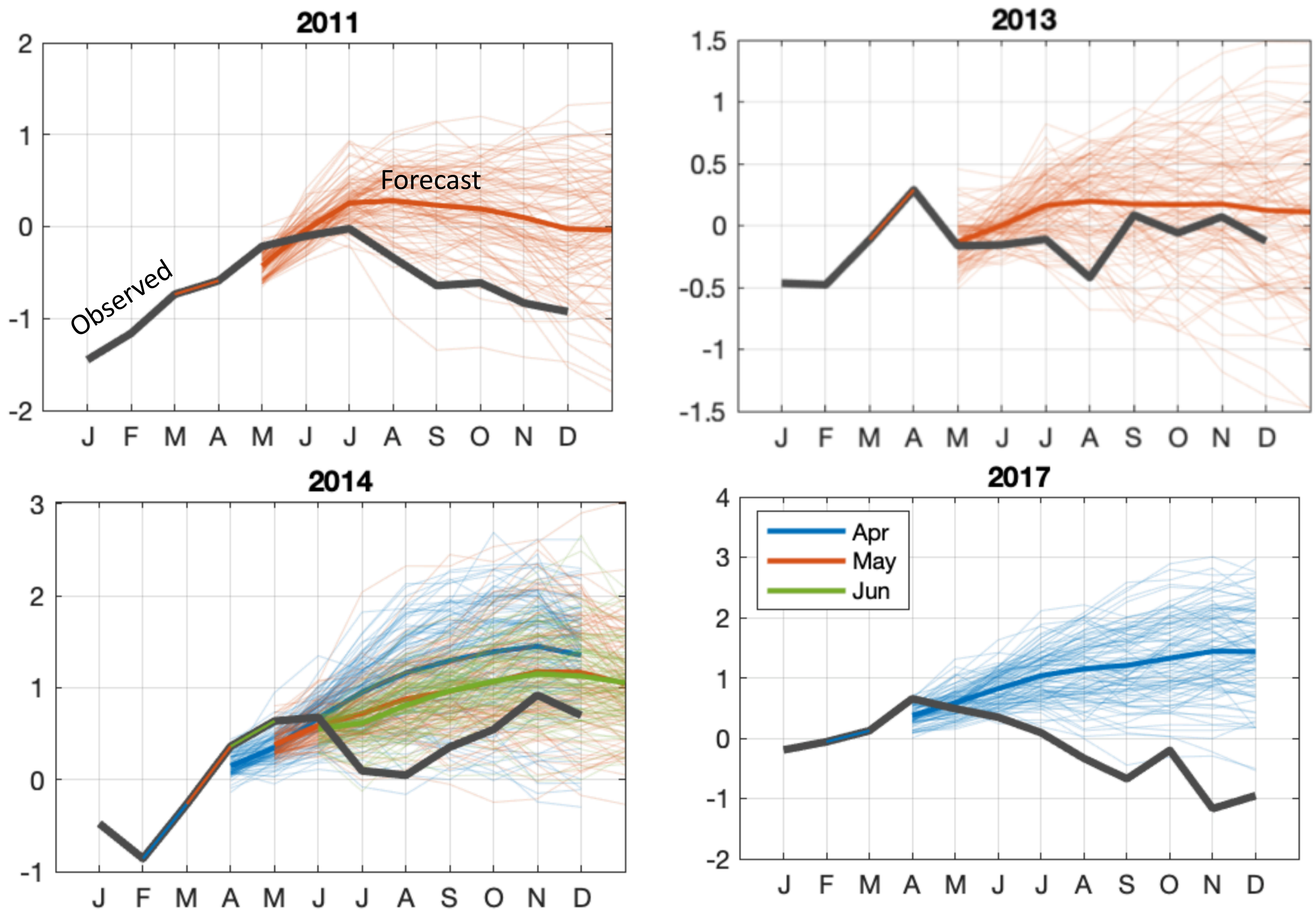
False Alarm Rate



Different Niño3.4 thresholds

Correlation

Boreal Spring is a tough Time to Predict ENSO: Recent False Alarms



Tippett, M. K., M.L., L'Heureux, Becker, E. J., & Kumar, A. (2020). Excessive momentum and false alarms in late-spring ENSO forecasts. *Geophysical Research Letters*, 47, e2020GL087008.

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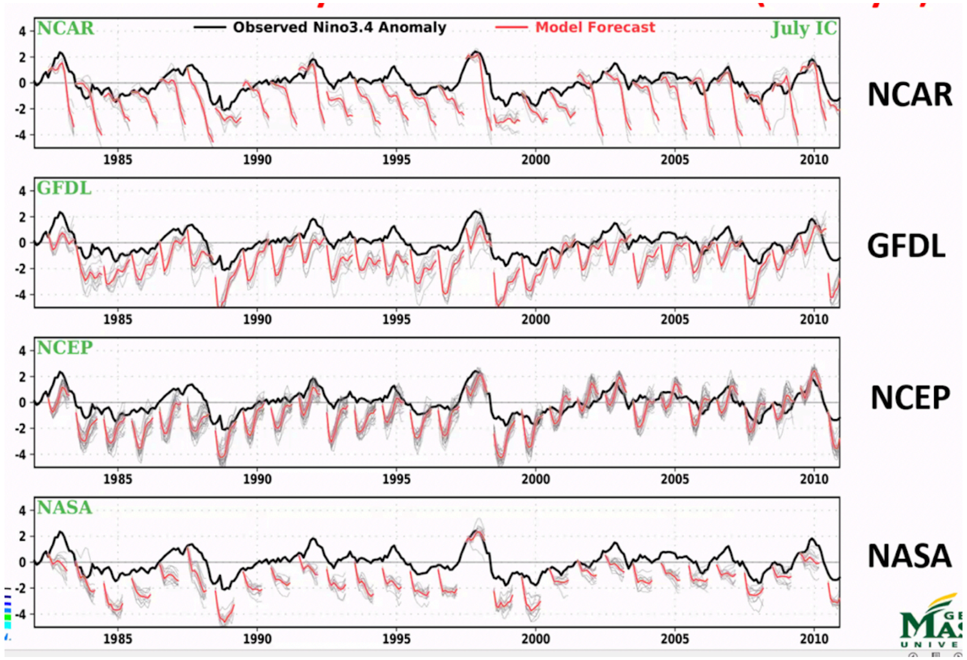
Model Niño3.4 index relative to Observed Climatology



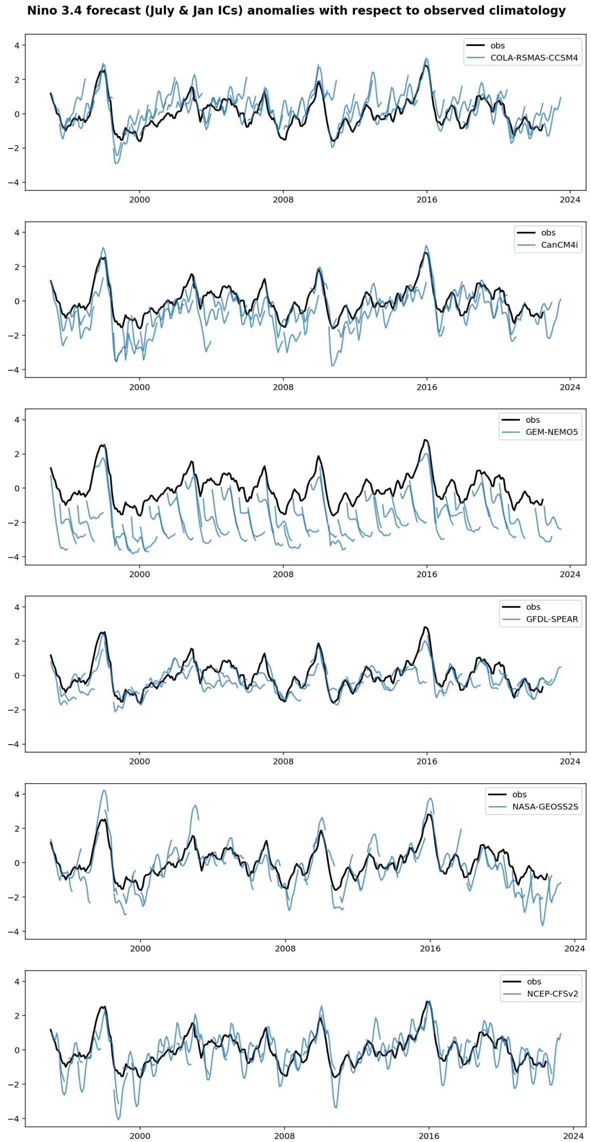
NCAR

GFDL

NCEP

NASA

From earlier this week…

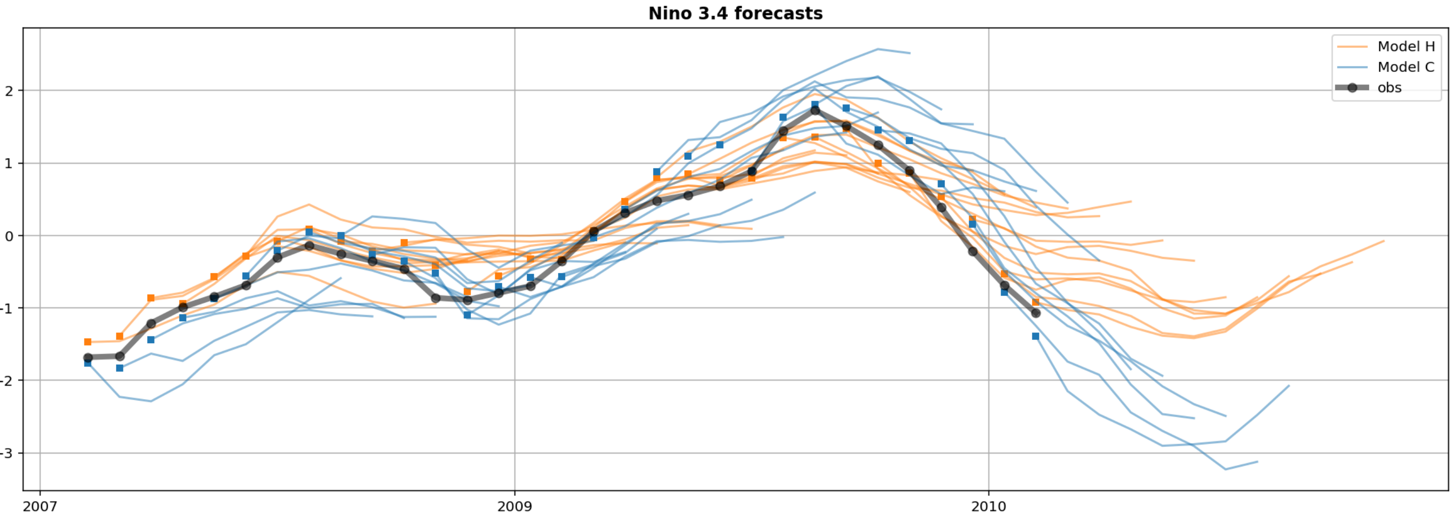


An update using current NMME models by M. Tippett

A Difference Between Reforecasts And "Real-Time" Model Predictions

Reforecasts

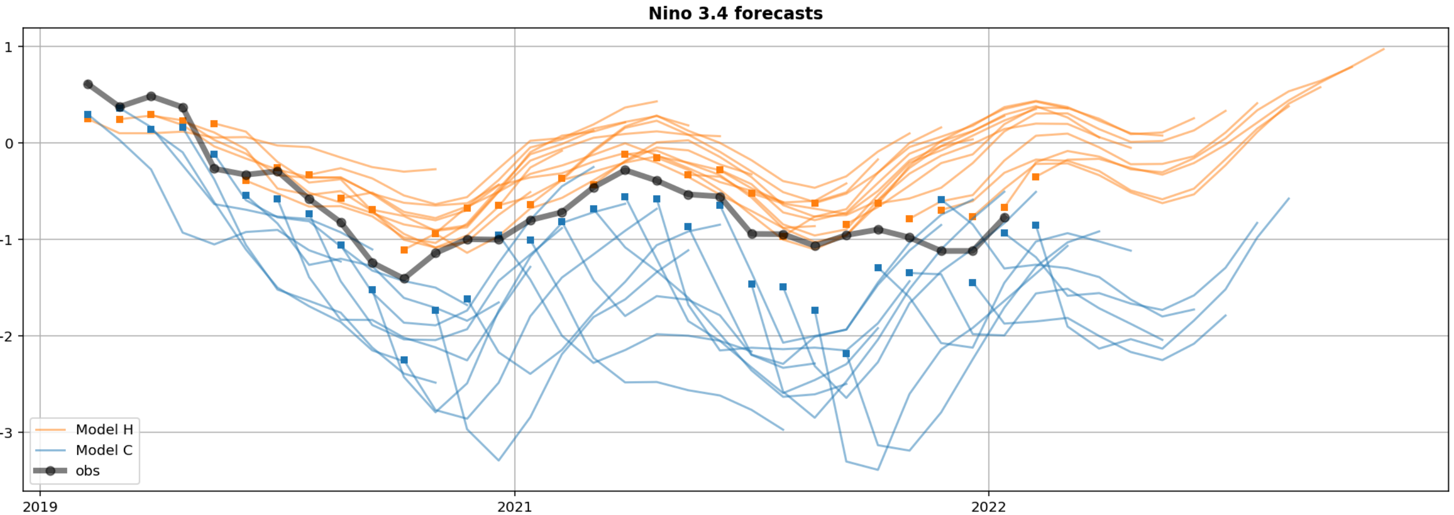
"Model forecasts look pretty good!"



Note: in forecasting, we remove the model's lead dependent climatology when we compute anomalies

Real Time

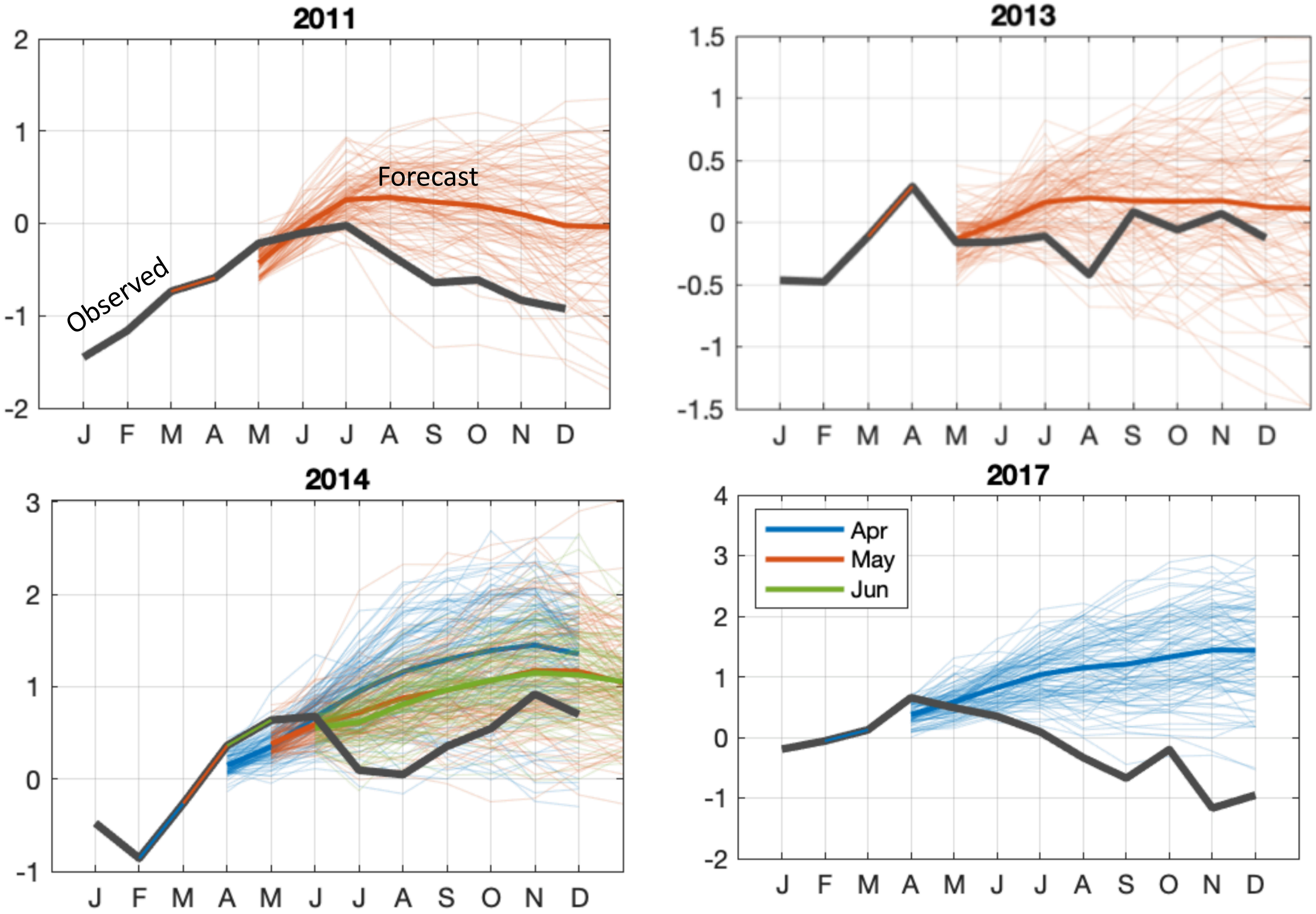
"Go Home, you look drunk."



The problems here likely stems from shifts in the reforecast to real time system.

Figures by Mike Tippett

4 of 9 Springtime False Alarms in the ~40 year record have occurred since 2010 (predictions too warm)



Tippett, M. K., M.L., L'Heureux, Becker, E. J., & Kumar, A. (2020). Excessive momentum and false alarms in late-spring ENSO forecasts. *Geophysical Research Letters*, 47, e2020GL087008.

Prediction challenges associated with errors in linear trends of tropical Pacific sea surface temperature

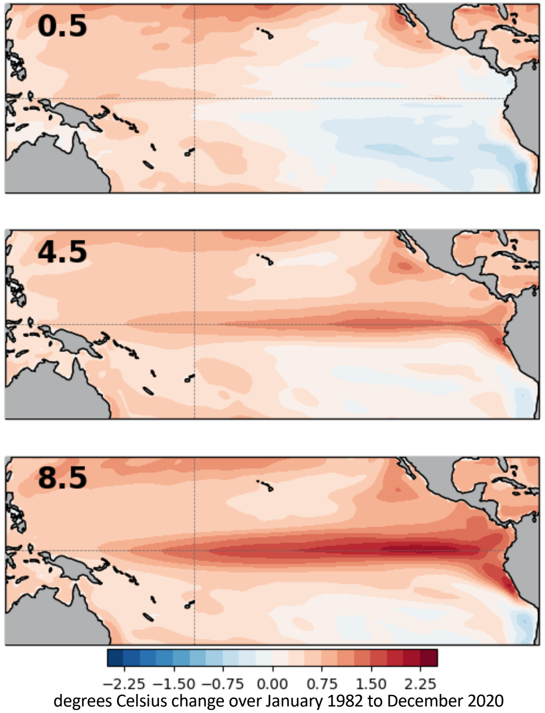
SST trends in initialized climate model forecasts are **<u>more positive</u>** than observed trends across the tropical Pacific Ocean. This appears to be associated with an increase in El Niño False Alarms.

Trend in an NMME model

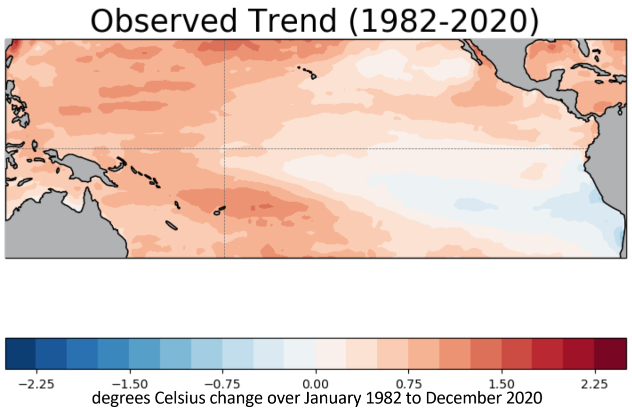
0.5-mth lead time

4.5-mth lead time

8.5-mth lead time



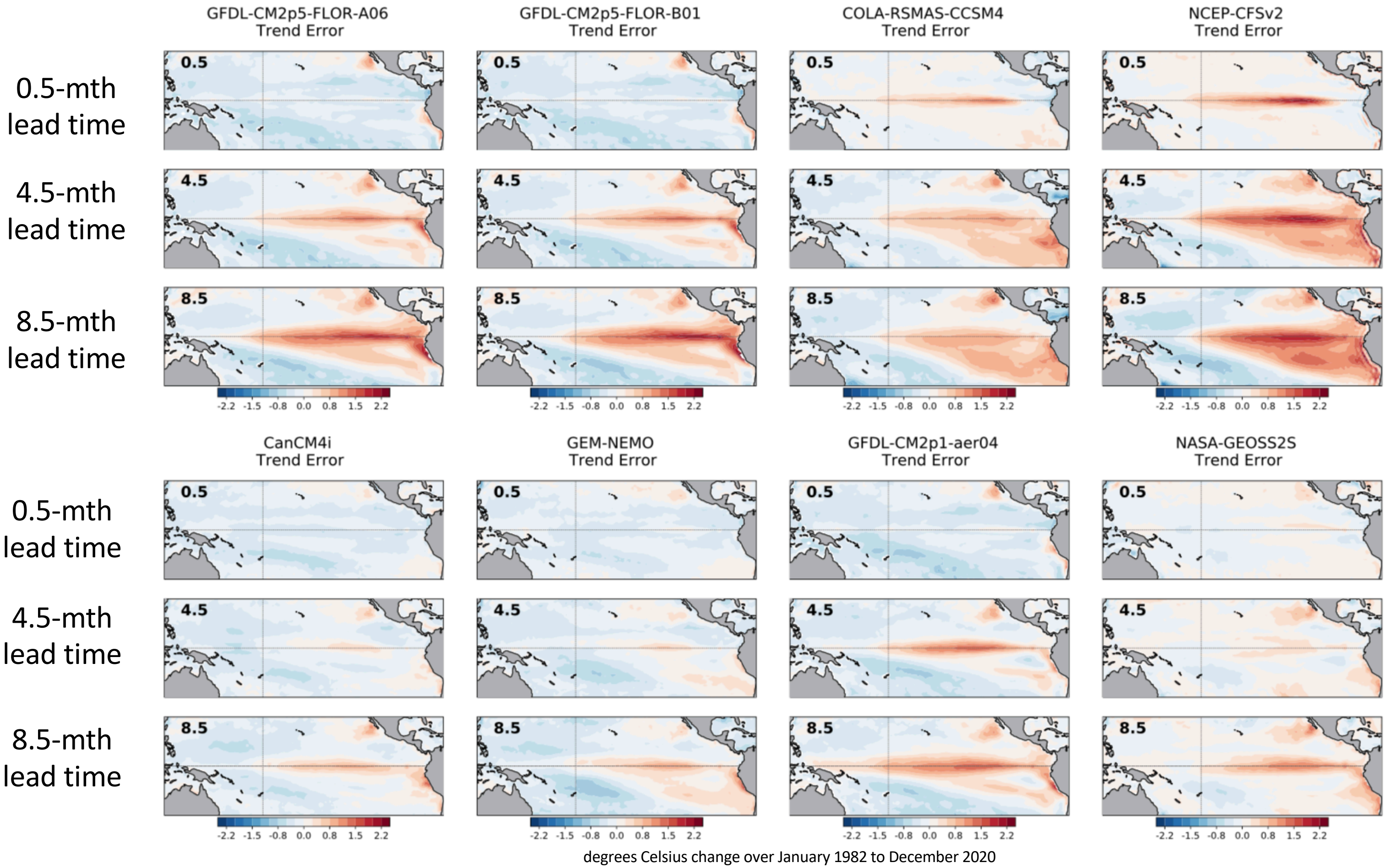
Should look like



Open-Access Publication:
L'Heureux, M.L., Tippett, M. K., Wang, W. (2022). Prediction Challenges from Errors in Tropical Sea Surface Temperature Trends. *Front. clim*. https://doi.org/10.3389/fclim.2022.837483

Linear Trend Error (forecast minus the observations) is too positive in the eastern Pacific Ocean. Most evident by the ~4.5-month lead and beyond.

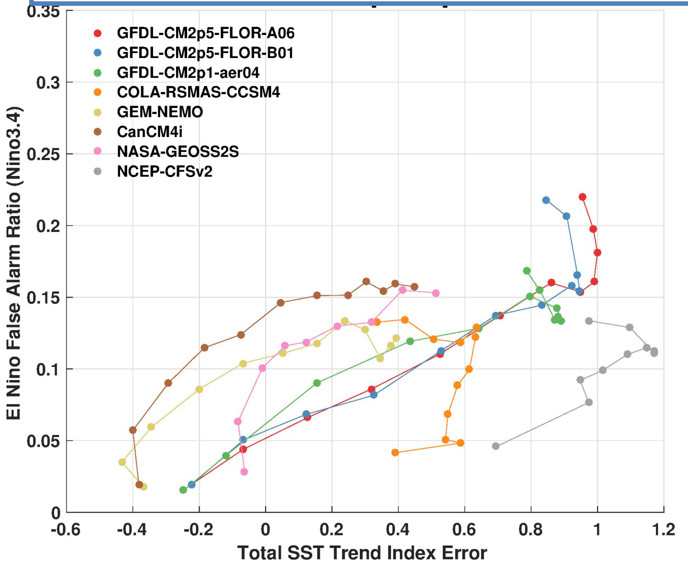
~40 year linear trend (1982-2020) is computed separately for each forecast lead time and model in the NMME.



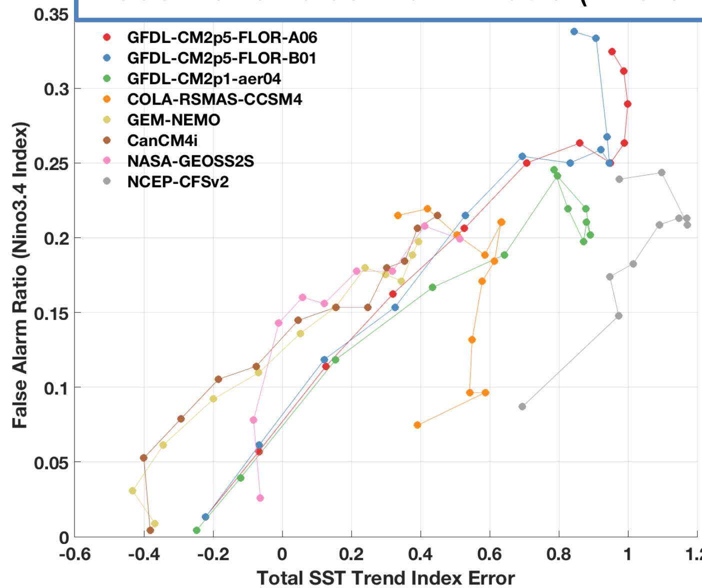
CFSv2 and CCSM4 have known initialization errors which manifest as SST trend error at short lead times (see 0.5-month).

El Niño False Alarm Ratio has increased in the last half of the record

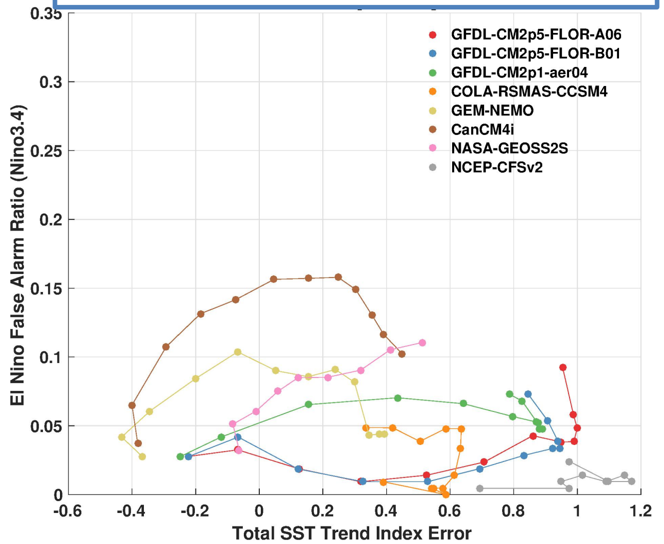
1982-2020 False Alarm Ratio (r=0.62)



2000-2020 False Alarm Ratio (r= 0.82)



1982-1999 False Alarm Ratio (r=-0.34)



Summary

- The El Niño-Southern Oscillation (ENSO) is a *coupled* climate phenomenon, which helps us to predict subseasonal-to-seasonal climate variability around the world.

- There are a lot of products and tools to help you monitor and predict ENSO variability.

- Many different ways to verify a forecast. In prediction, even large positive correlations are associated with false alarms or “busts.” The public is sensitive to these!

- Spring prediction barrier continues to bedevil climate forecasters.

- Real-time is a much different beast than reforecasting (humans notice and adjust).

- El Niño false alarms have occurred more frequently in recent years. SST trend errors may partially explain an increase in false alarms.

ENSO discussion is updated on the 2nd Thursday of every month right here:
https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/

Climate.gov ENSO Blog updated twice a month. **Just Google "ENSO Blog"**
https://www.climate.gov/news-features/department/enso-blog

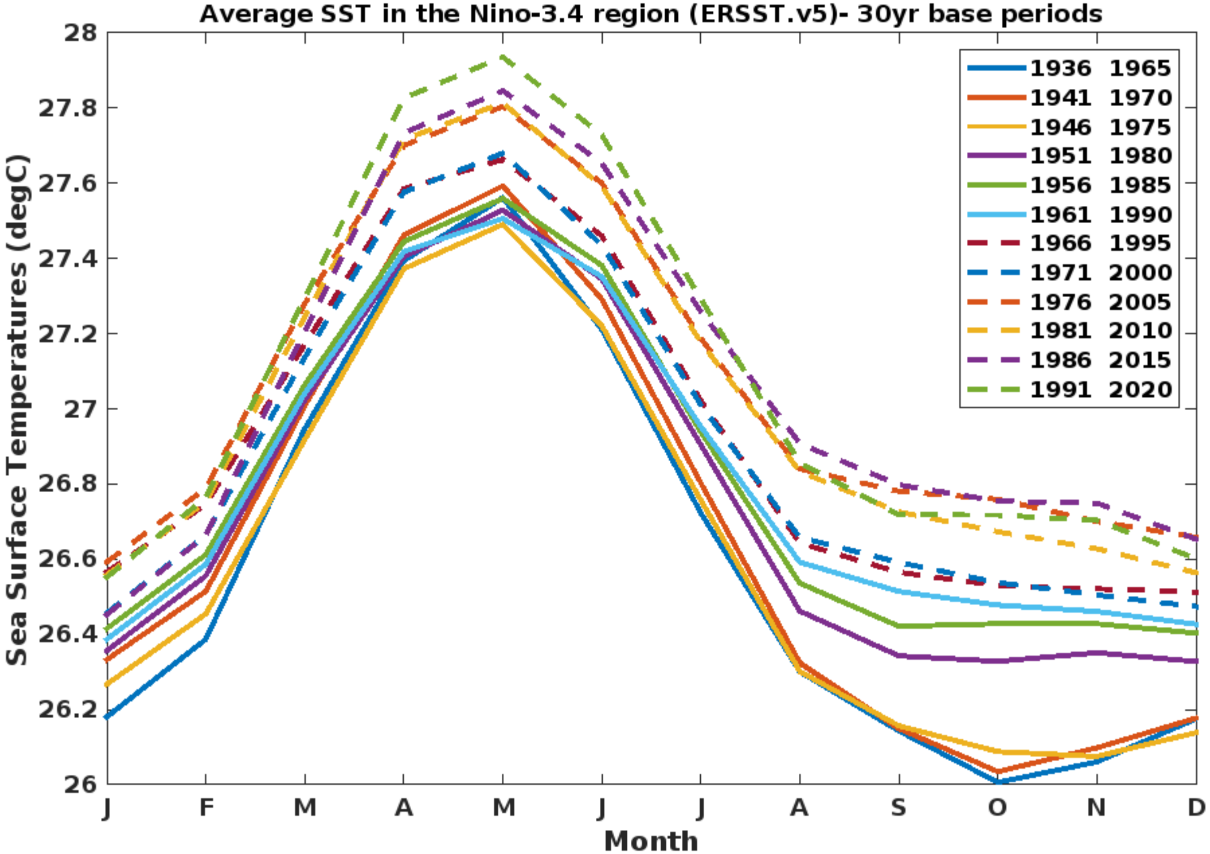
Can also follow us here:

@NWSCPC and @NOAAClimate on Twitter
@NWSCPC and @NOAAClimateGov on Facebook

If interested in being notified via email of a new ENSO update (it's just one email per month) please send an email to**: ncep.list.enso-update@noaa.gov**

Additional Slides

Climatology associated with the Oceanic Niño Index (ONI) values are updated every 5 years



- ONI values going back to 2006 were updated with the 1991-2020 base period.
- Prior to 2006, ONI values are adjusted by older (fixed) 30 year base periods.