Global Ocean Monitoring: Recent Evolution, Current Status, and Predictions

Prepared by

Climate Prediction Center, NCEP/NOAA

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http://www.cpc.ncep.noaa.gov/products/GODAS/

This project, to deliver real-time ocean monitoring products, is implemented by CPC in cooperation with NOAA's Global Ocean Monitoring and Observing Program (GOMO)

Outline

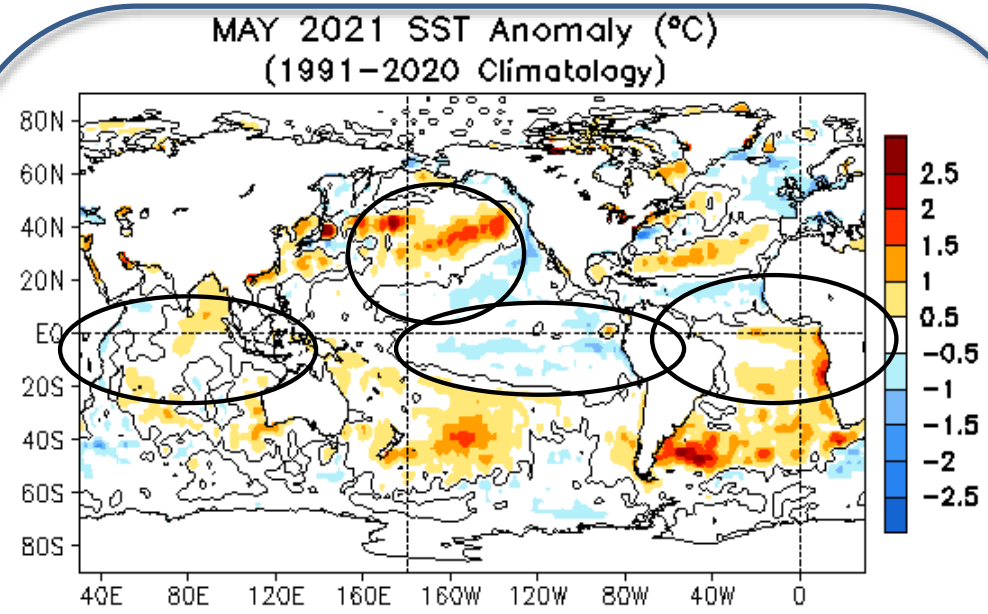
- Overview
- Recent highlights
  - Pacific/Arctic Ocean
  - Indian Ocean
  - Atlantic Ocean
- Global SST Anomaly Predictions

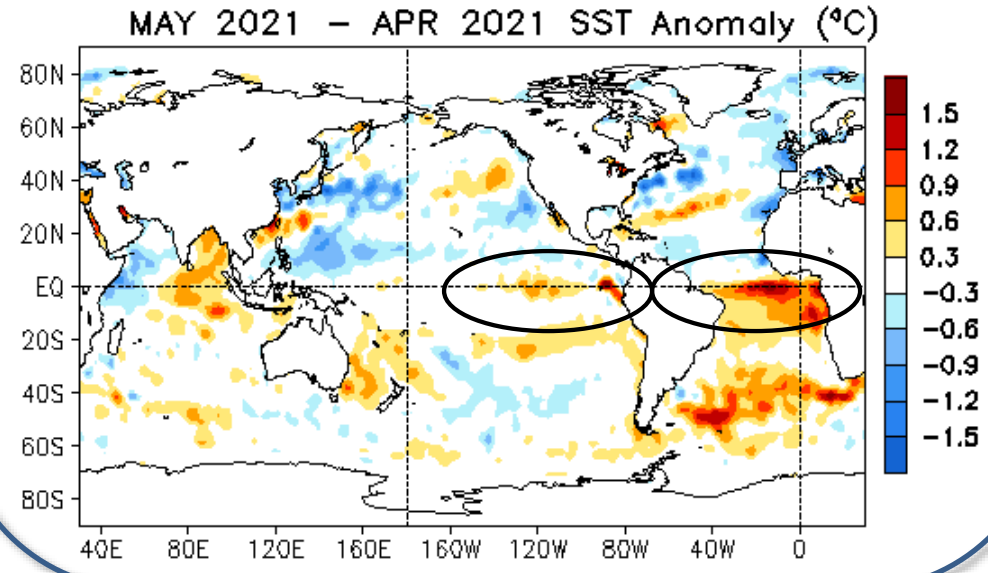
Overview

- Pacific Ocean
  - NOAA "ENSO Diagnostic Discussion" on 10 Jun 2021 stated *"ENSO-neutral is favored through the Northern Hemisphere summer (78% chance for the June-August season) and fall (50% chance for the September-November season)."*
  - La Niña conditions ended with Niño3.4 = -0.34^{o}C in May 2021.
  - The negative phase of PDO has persisted since Jan 2020 with PDOI = -1.5 in May 2021.
- Indian Ocean
  - SSTAs were small in the tropical Indian Ocean in May 2021.
- Atlantic Ocean
  - Positive SSTA tendencies were observed in the equatorial Atlantic Ocean, which were associated with the potential development of Atlantic Niño in May 2021.
  - NAO was in a negative phase in May 2021 with NAOI= -1.1.
  - In May 20th, 2021, CPC predicted another above-normal Atlantic hurricane season with a 60% chance of an above-normal season, a 30% chance of a near-normal season, and a 10% chance of a below-normal season.
- Arctic Ocean
  - The pace of ice loss in May 2021 was slower than average, leading to only the 9th lowest May extent during the satellite data record.
  - With ICs in May 2021, NCEP/CPC predicted a below-normal sea ice extent during summer and autumn 2021.

Global Oceans

Global SST Anomaly (°C) and Anomaly Tendency



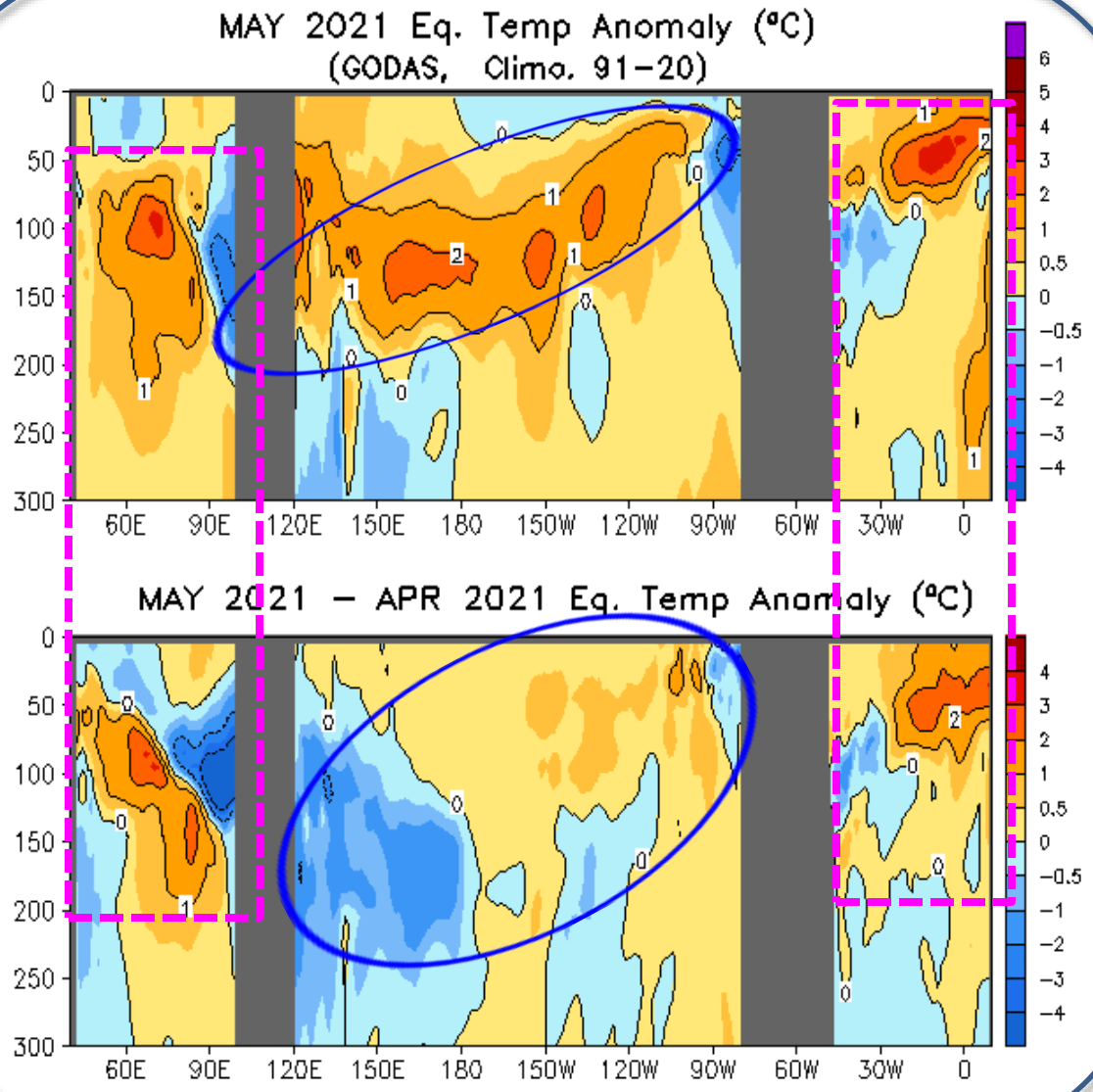


- SSTAs were small in the tropical Pacific.
- Positive SSTAs were evident in the NE Pacific.
- Positive SSTAs were present in the tropical Atlantic Ocean and along the African coast (Benguela Niño region).
- SSTAs were small in the tropical Indian Ocean.

- Positive SSTA tendencies were present in the eastern equatorial Pacific.
- Positive SSTA tendencies were observed in the equatorial Atlantic Ocean, leading to a potential development of Atlantic Niño.

Sea surface temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1991-2020 base period means.

Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2°S-2°N

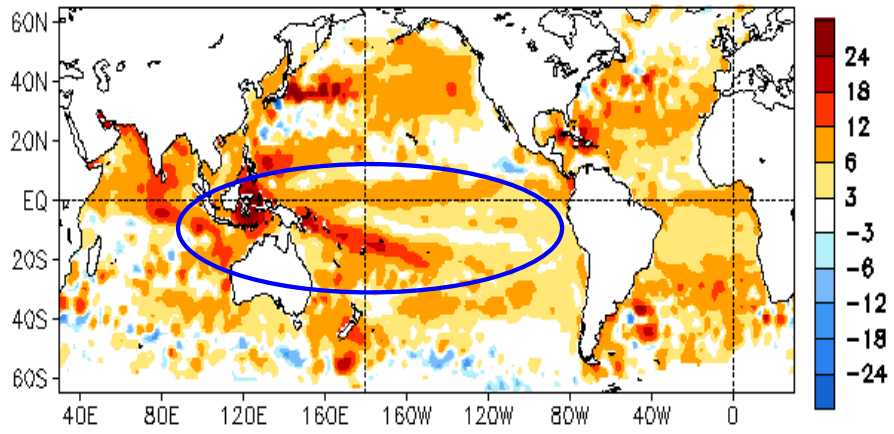


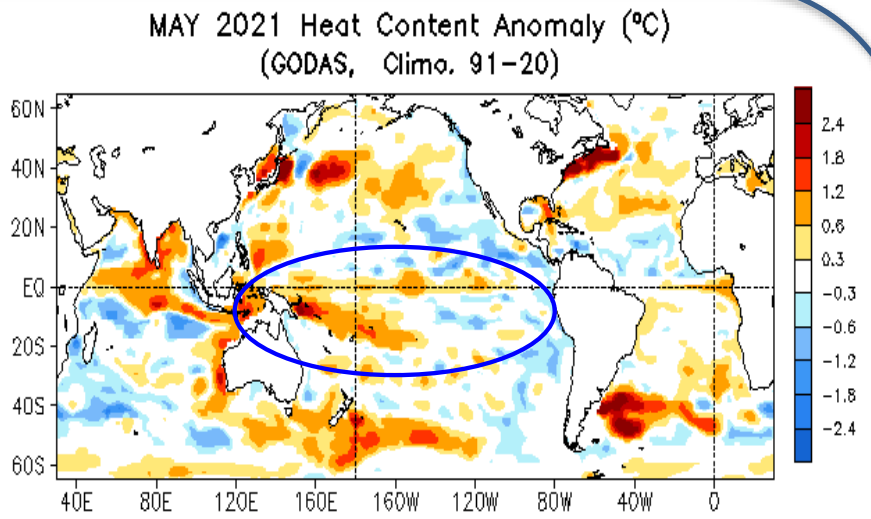
- Positive subsurface ocean anomalies dominated along the thermocline in the equatorial Pacific.
- Positive anomalies were observed in the central and eastern Atlantic Ocean, associated with the potential development of an Atlantic Niño.
- The dipole pattern at 50-200m was reversed in the Indian Ocean.

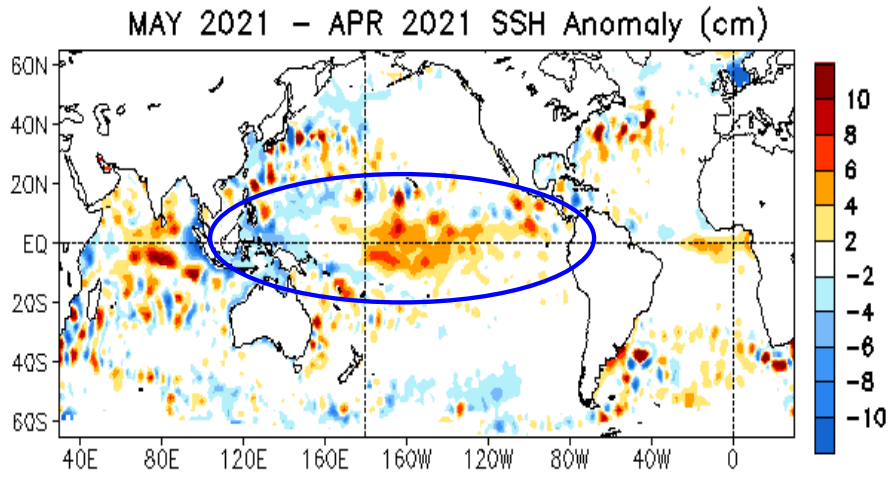
- Temperature anomaly tendency was positive (negative) along the thermocline in the eastern (western) Pacific, implying an eastward propagation of the positive anomalies.

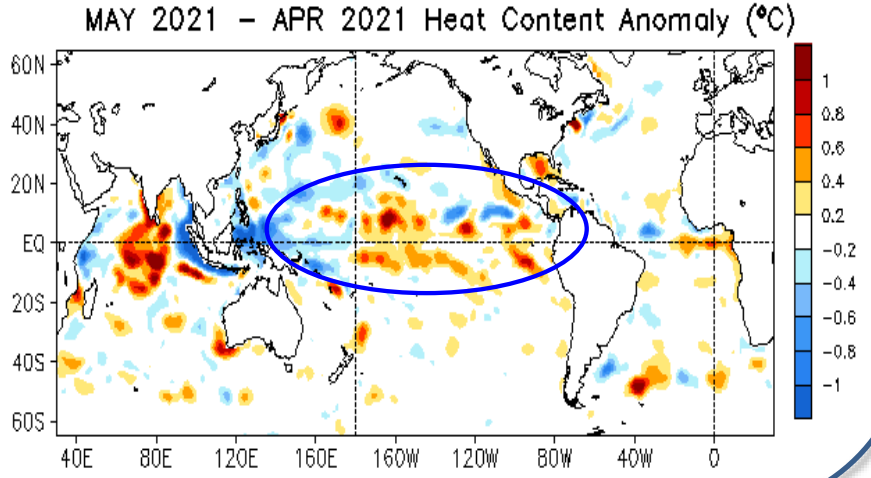
Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data is from the NCEP's global ocean data assimilation system. Anomalies are departures from the 1991-2020 base period means.

Global SSH and HC300 Anomaly & Anomaly Tendency





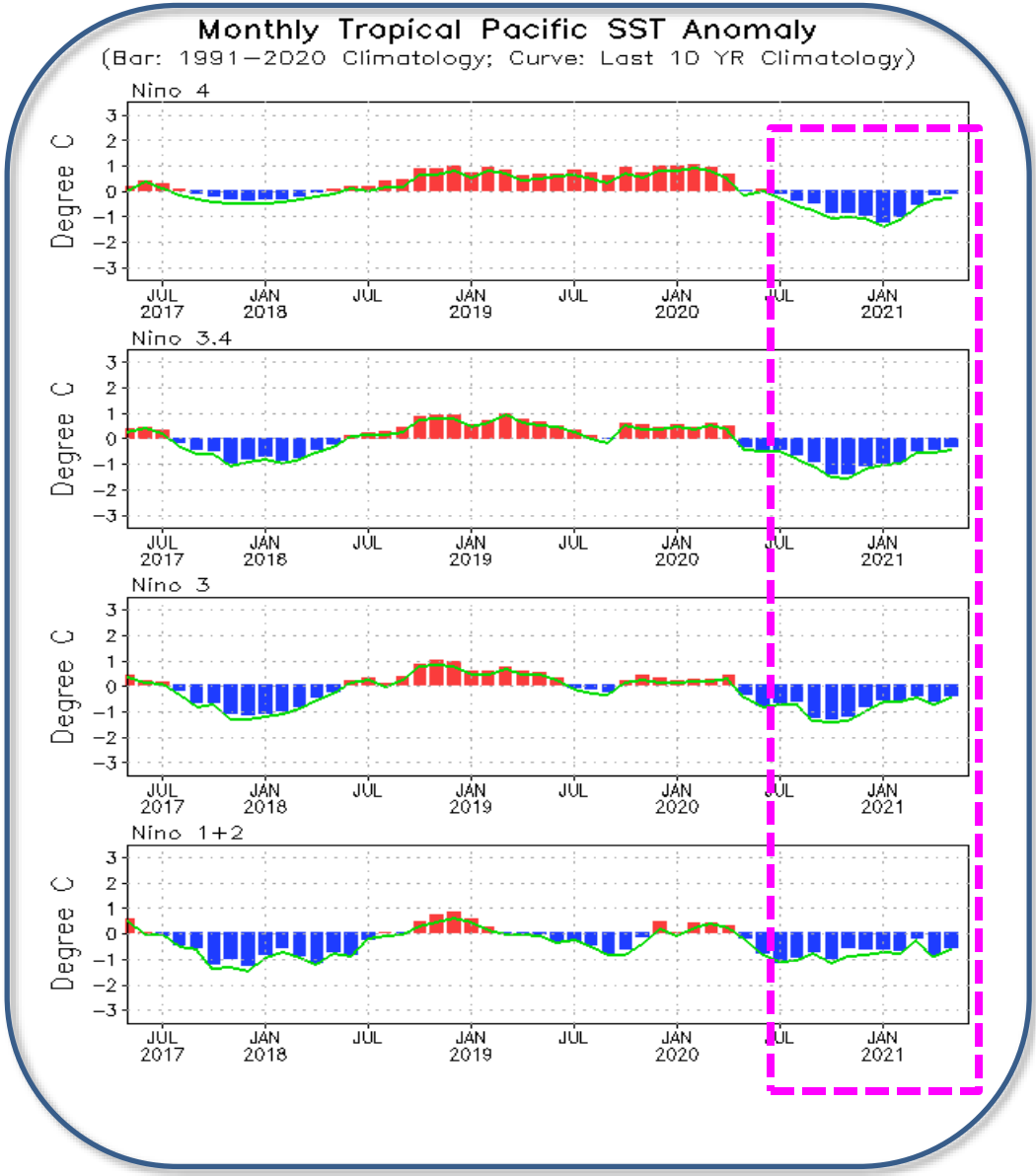


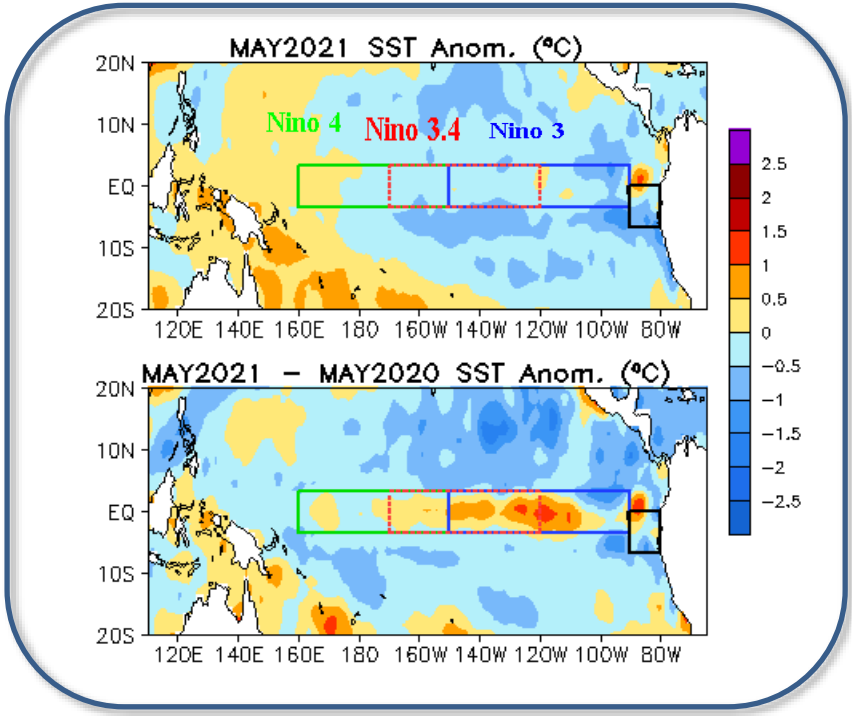


- The SSHA pattern was overall consistent with the HC300A pattern, but with a significant trend component in SSHA.
- Small anomalies were present in the tropical Pacific.
- Anomaly tendencies: Positive in the east-central tropical Pacific; negative in the western tropical Pacific, consistent with the subsurface ocean temperature anomaly tendency (the previous slide).

Tropical Pacific Ocean and ENSO Conditions

Evolution of Pacific Niño SST Indices





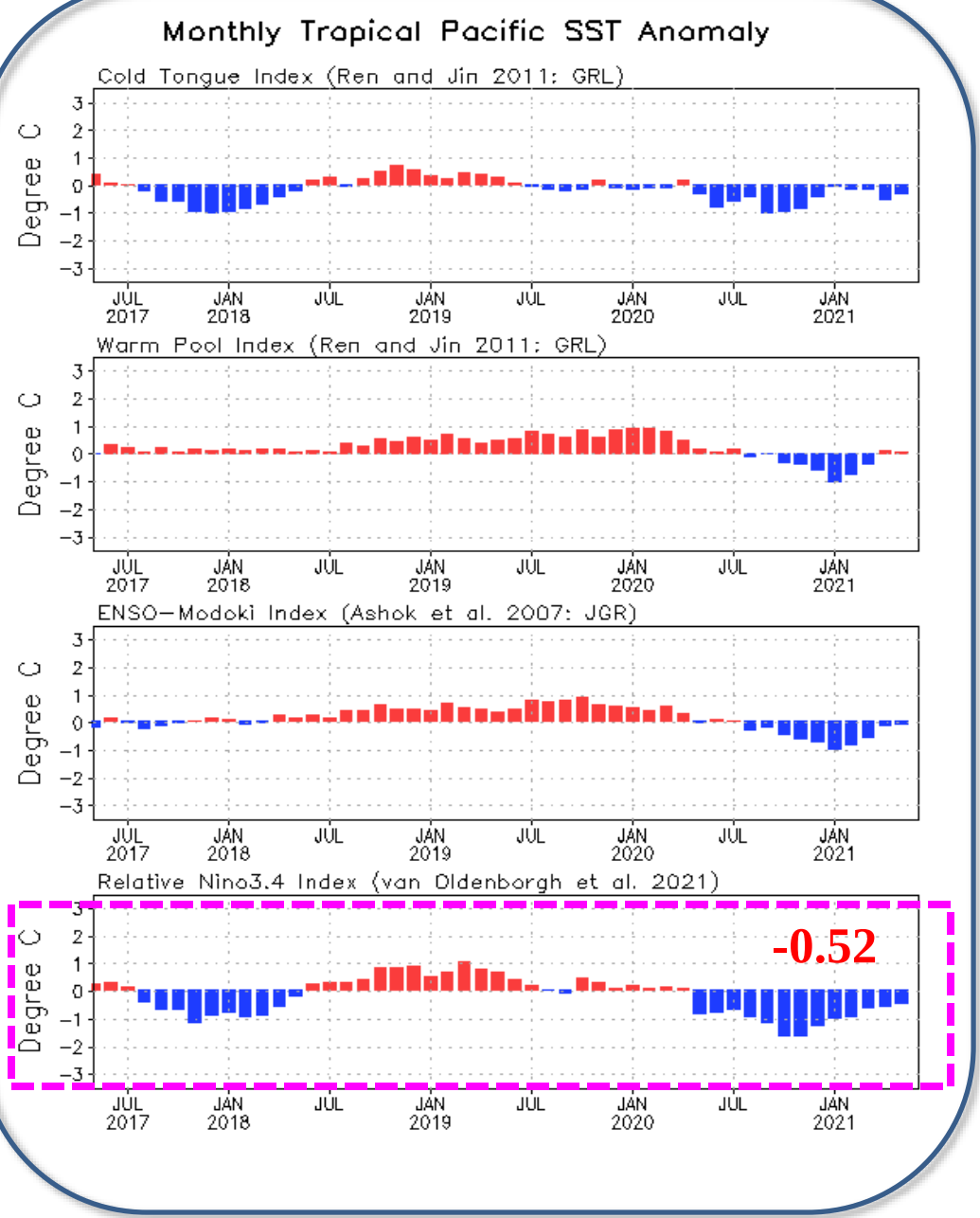
- All Niño indices weakened with Niño3.4 = -0.34°C in May 2021.

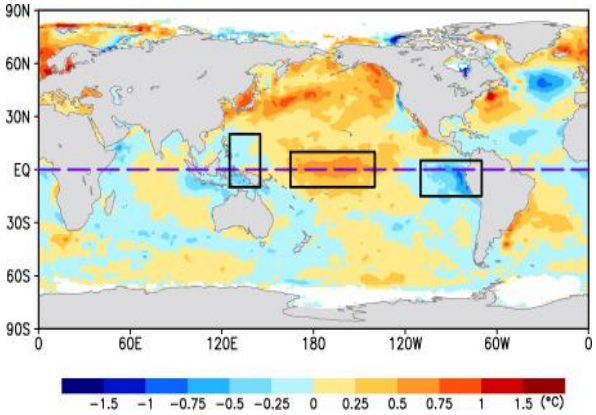
- Compared with May2020, the central and eastern equatorial Pacific was warmer in May 2021.

- The indices may have slight differences if based on different SST products.

Niño region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1991-2020 base period means.

Evolution of Pacific Niño SST Indices

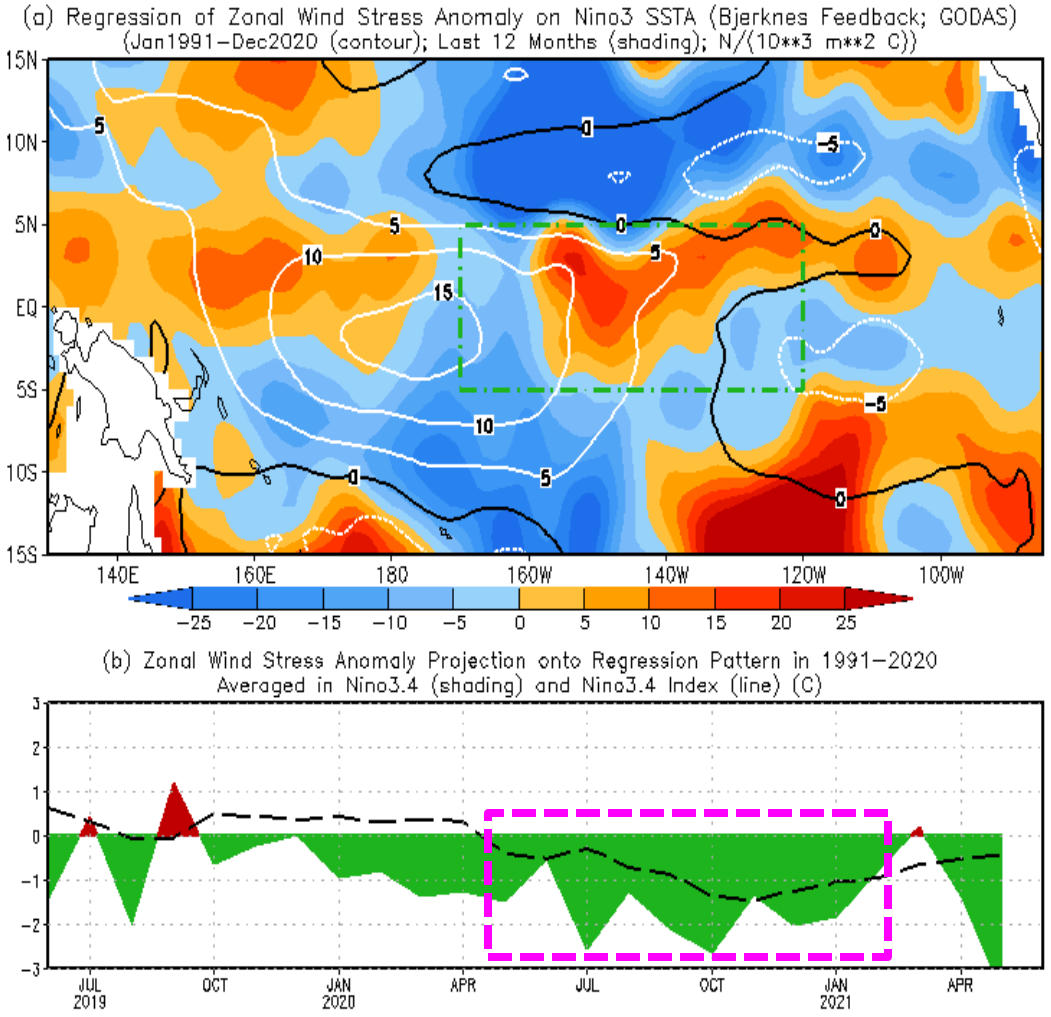




- Relative Niño3.4 index is now included in ENSO monitoring, which is defined as the conventional Niño3.4 index minus the SSTA averaged in the whole tropics (0°-360°, 20°S-20°N), in order to remove the global warming signal. Also, to have the same variability as the conventional Niño3.4 index, the relative Niño3.4 index is renormalized (van Oldenborgh et al. 2021: ERL, 10.1088/1748-9326/abe9ed).

Relative Niño3.4 data updated monthly at:

https://www.cpc.ncep.noaa.gov/data/indices/RONI.ascii.txt

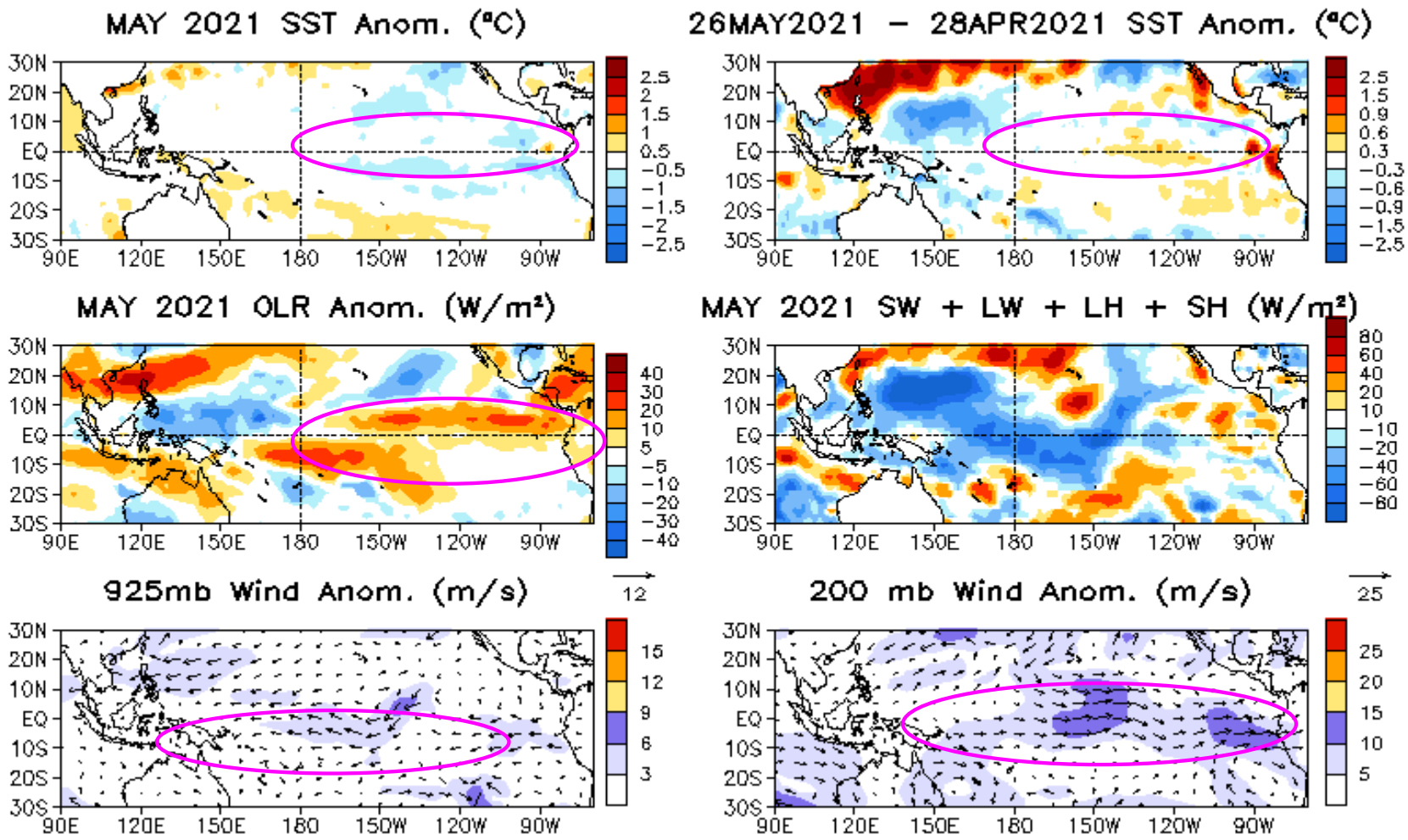


- According to the atmospheric BJ and Niño3.4 indices, the coupling associated 2020/21 La Niña started since May 2020, weakened since Mar 2021.

*According to Lloyd et al. (2009), the wind-SST interaction can be approximately measured by the linear regression coefficient "α(x,y)" of zonal wind stress anomaly "τx(x,y,t)" at every grid point "(x,y)" regressed against the Niño3 SSTA then averaged over the Niño region, which was also called Bjerknes feedback by Lloyd et al. (2009) or atmospheric Bjerknes feedback by Bellenger et al. (2014). The linear regression is expressed as: τx(x,y,t)=α(x,y)*Niño3(t)+R(x,y,t); where, "R(x,y,t)" represents the residual.*

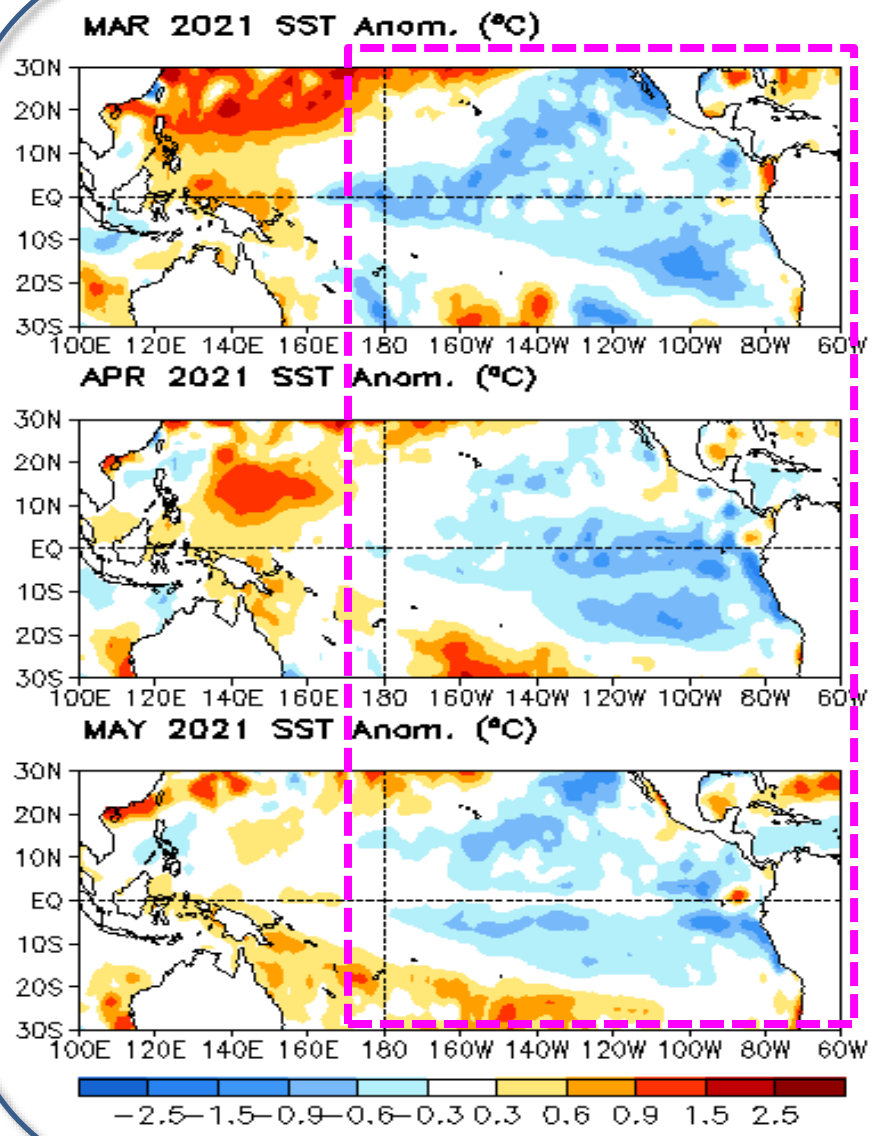
Lloyd, et al., 2009: 10.1175/JCLI-D-11-00178.1.
Bellenger, et al. 2014: 10.1007/s00382-013-1783-z,
LI et al. 2019: 10.1175/JCLI-D-18-0209.1.

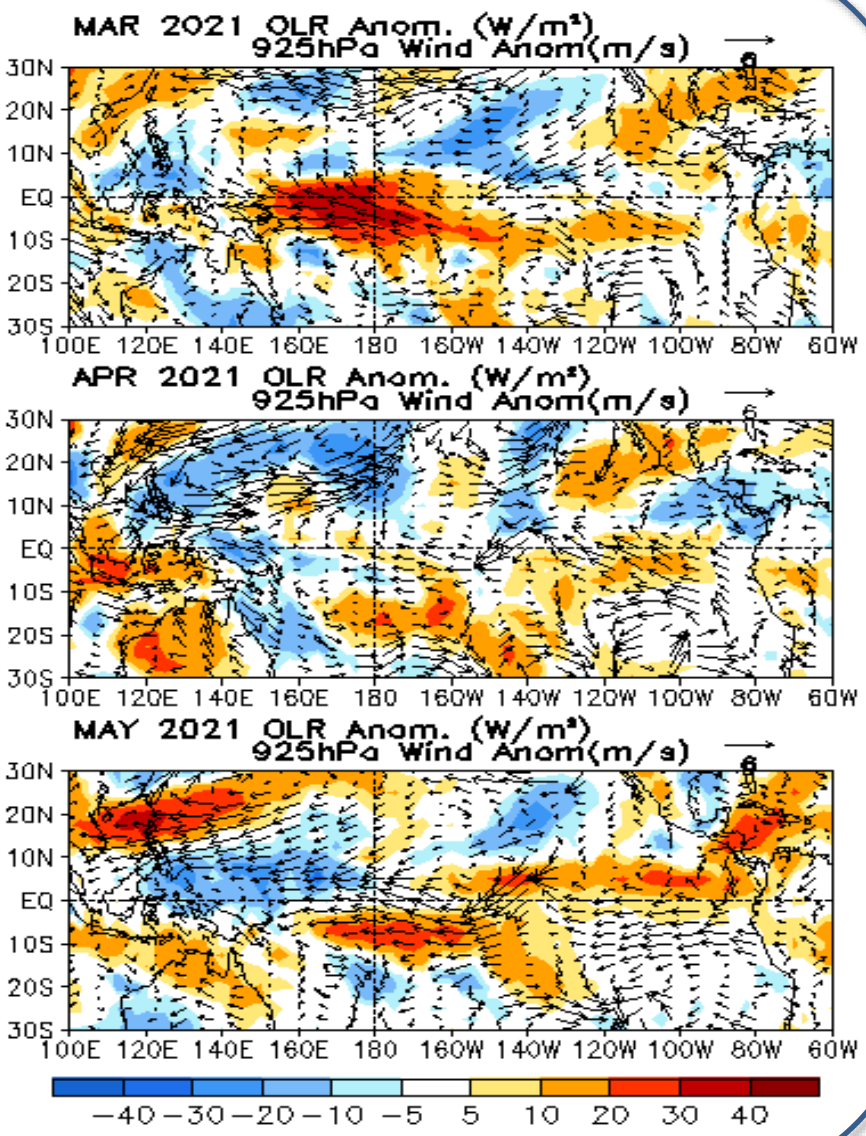
Tropical Pacific: SSTA, SSTA Trend, OLR, heat flux, uv925 & uv200 anomalies



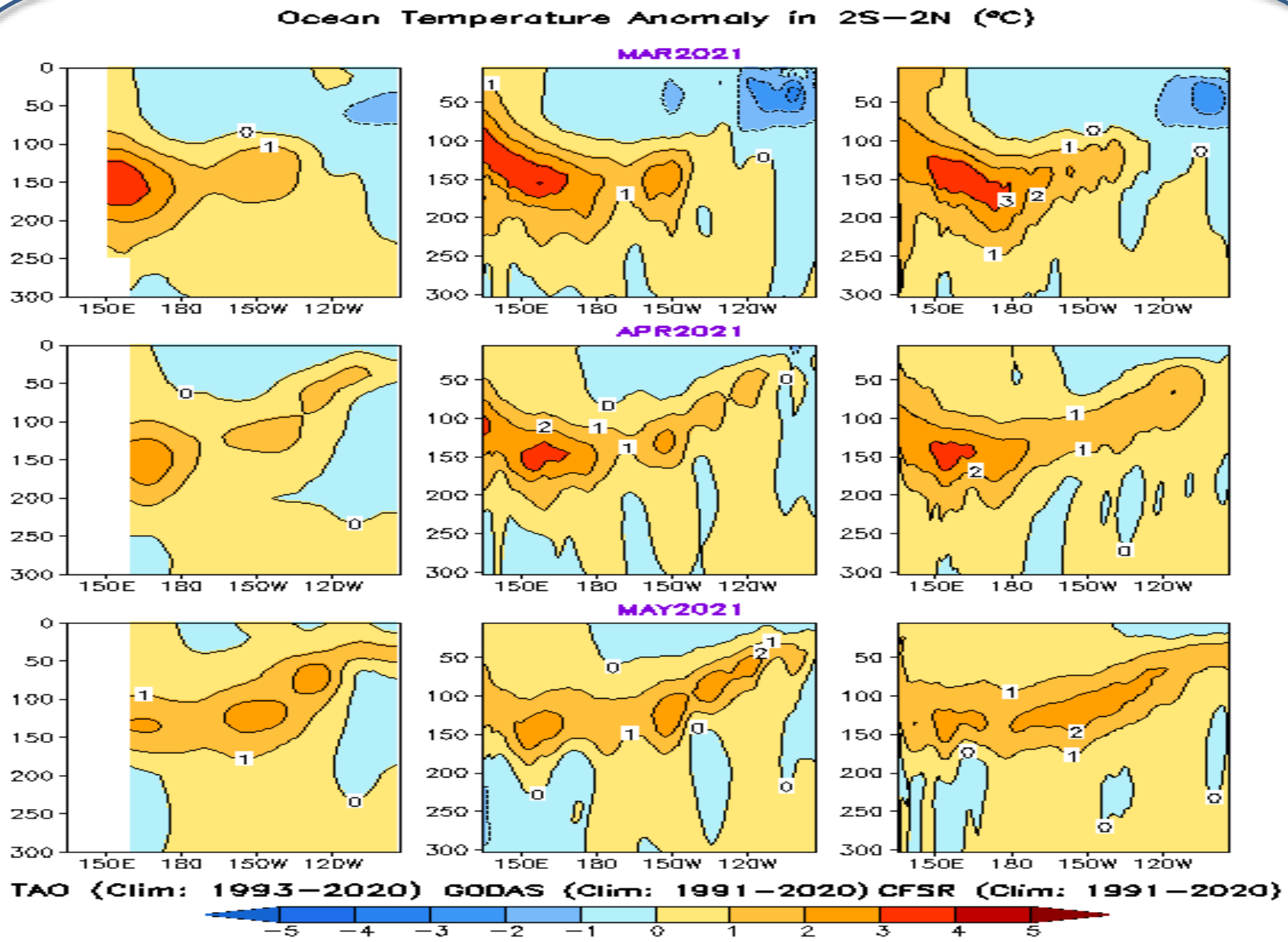
Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right; positive means heat into the ocean), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, winds and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1991-2020 base period means.

Latest 3-month Tropical Pacific SST , OLR, & uv925 anomalies

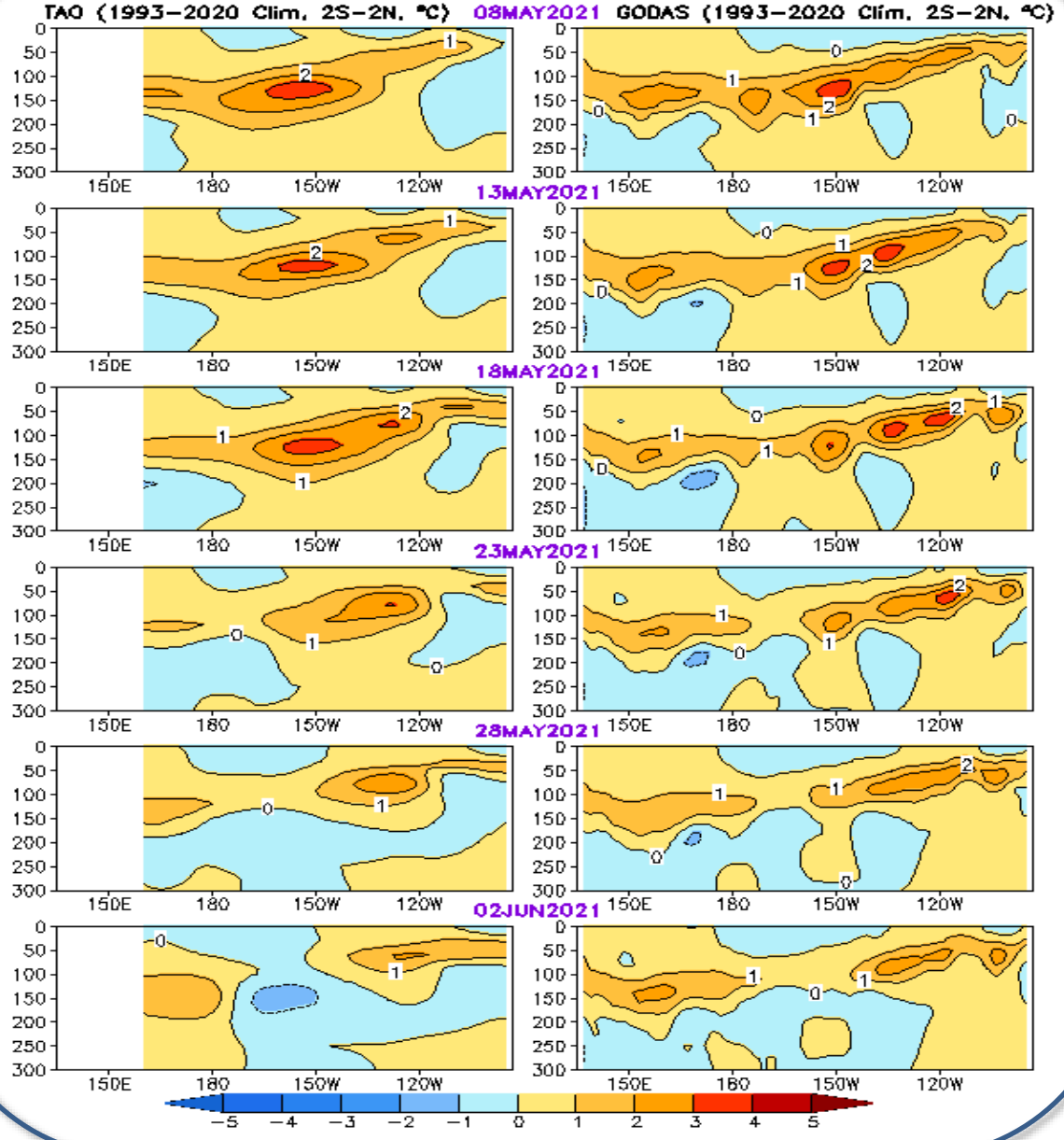




Latest 3-month subsurface temperature anomaly along the Equator

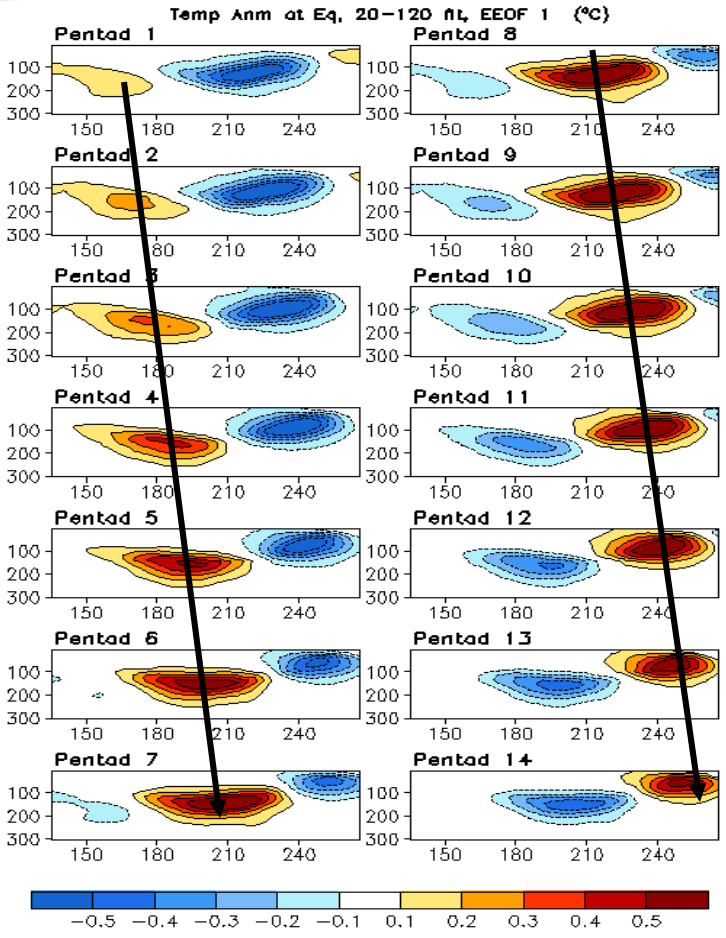


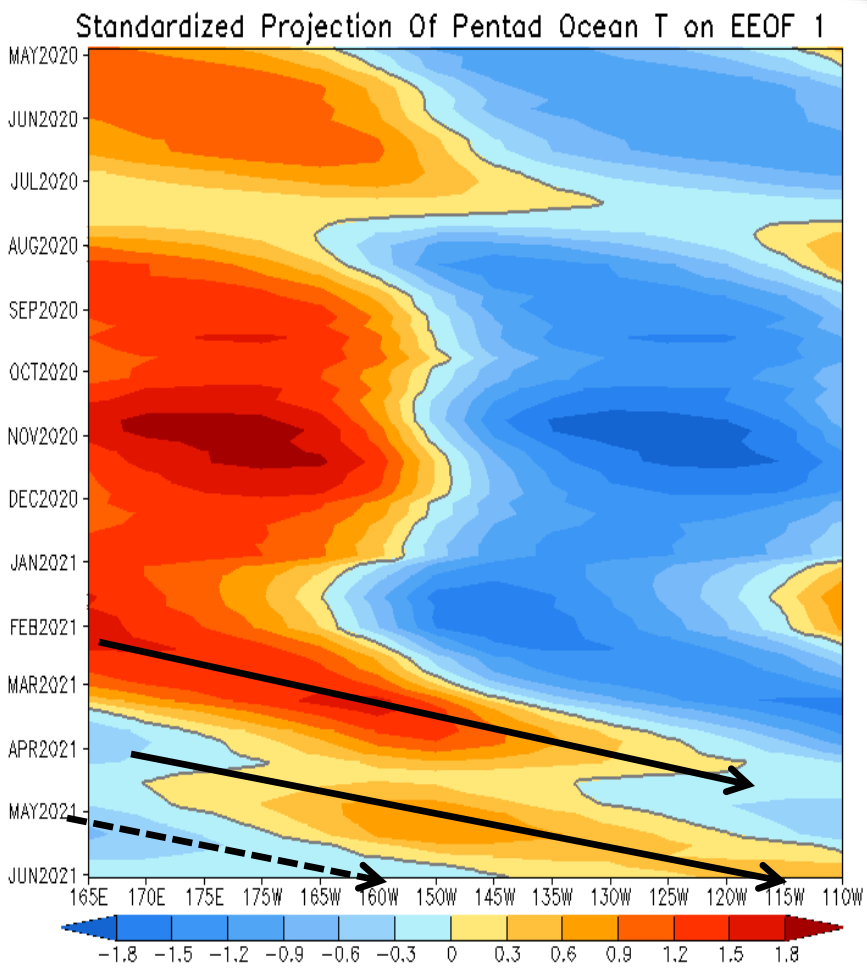
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly



- Positive ocean temperature anomalies along the thermocline in the Pacific weakened in May 2021.
- The features of the ocean temperature anomalies were similar between GODAS (model based) and TAO (objective) analysis.

Oceanic Kelvin Wave (OKW) Index

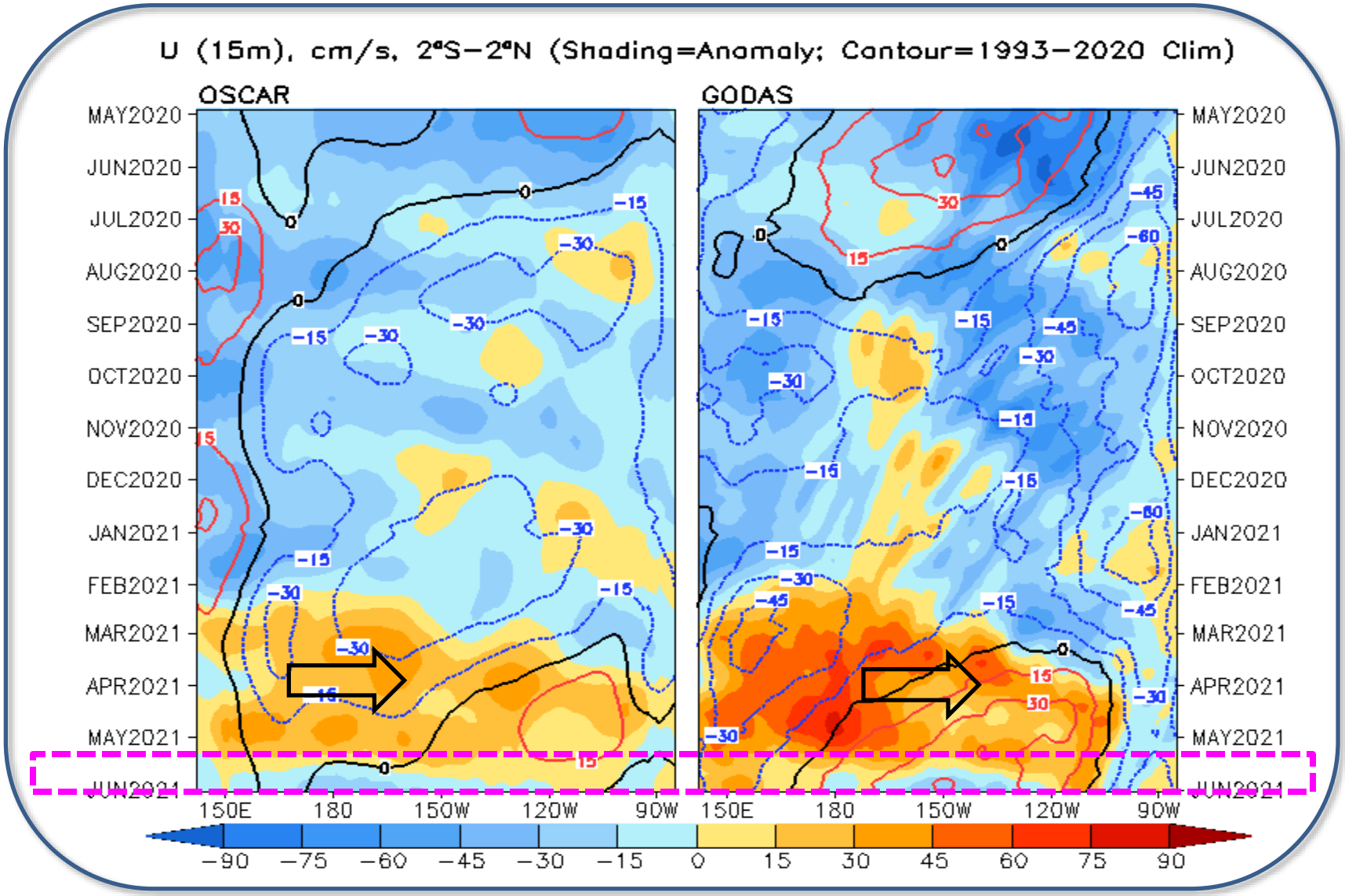




- Two weak downwelling Kelvin waves were initiated in Feb and Apr 2021, respectively, consisting with the weakening of La Niña.

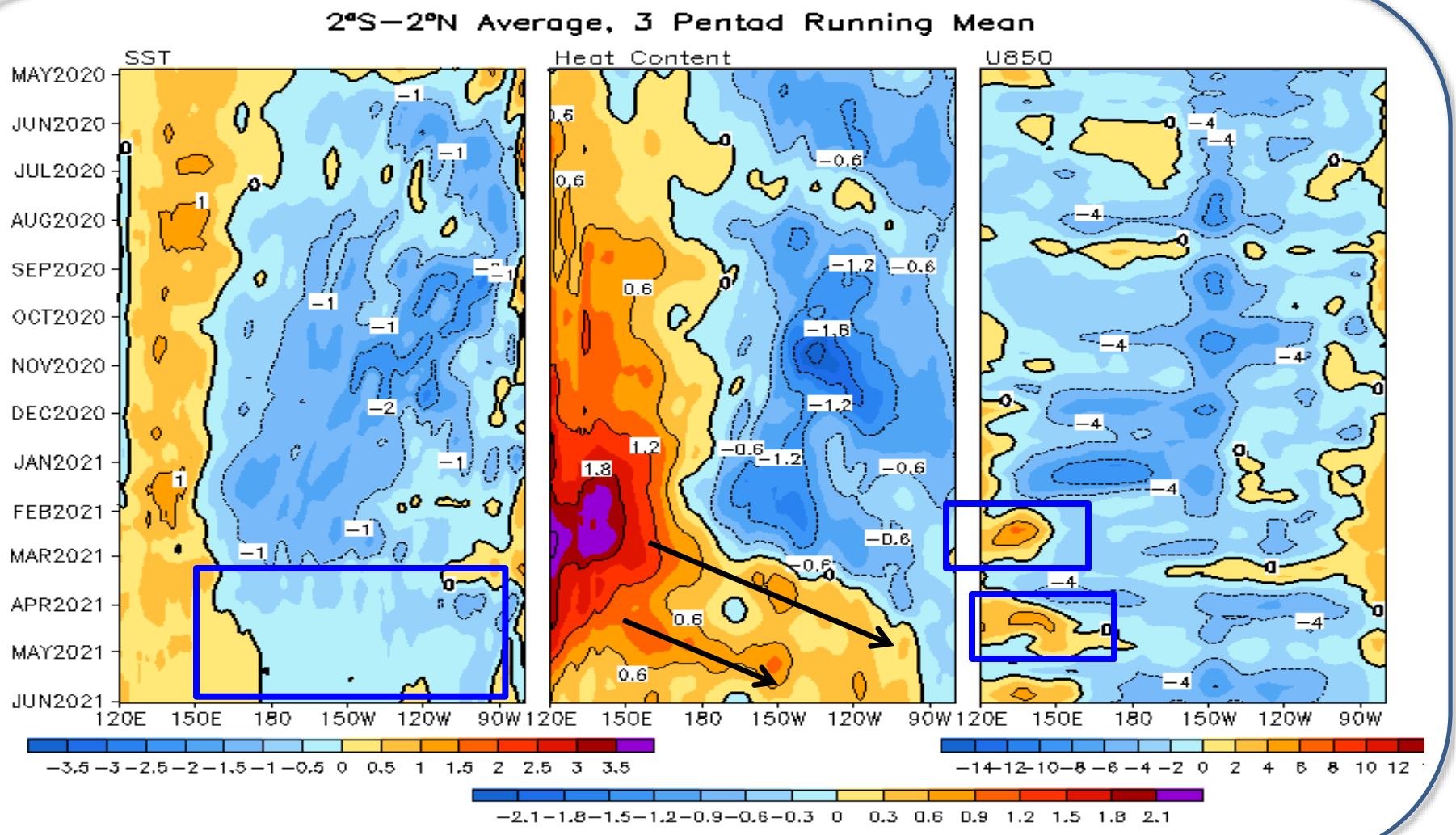
(OKW index is defined as standardized projections of total anomalies onto the 14 patterns of Extended EOF1 of equatorial temperature anomalies (Seo and Xue , GRL, 2005).)

Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- Anomalous eastward currents emerged in the western & central equatorial Pacific in both OSCAR and GODAS in Feb-Apr 2021.
- Anomalous westward currents were observed in May 2021.

Equatorial Pacific SST (°C), HC300 (°C), u850 (m/s) Anomalies

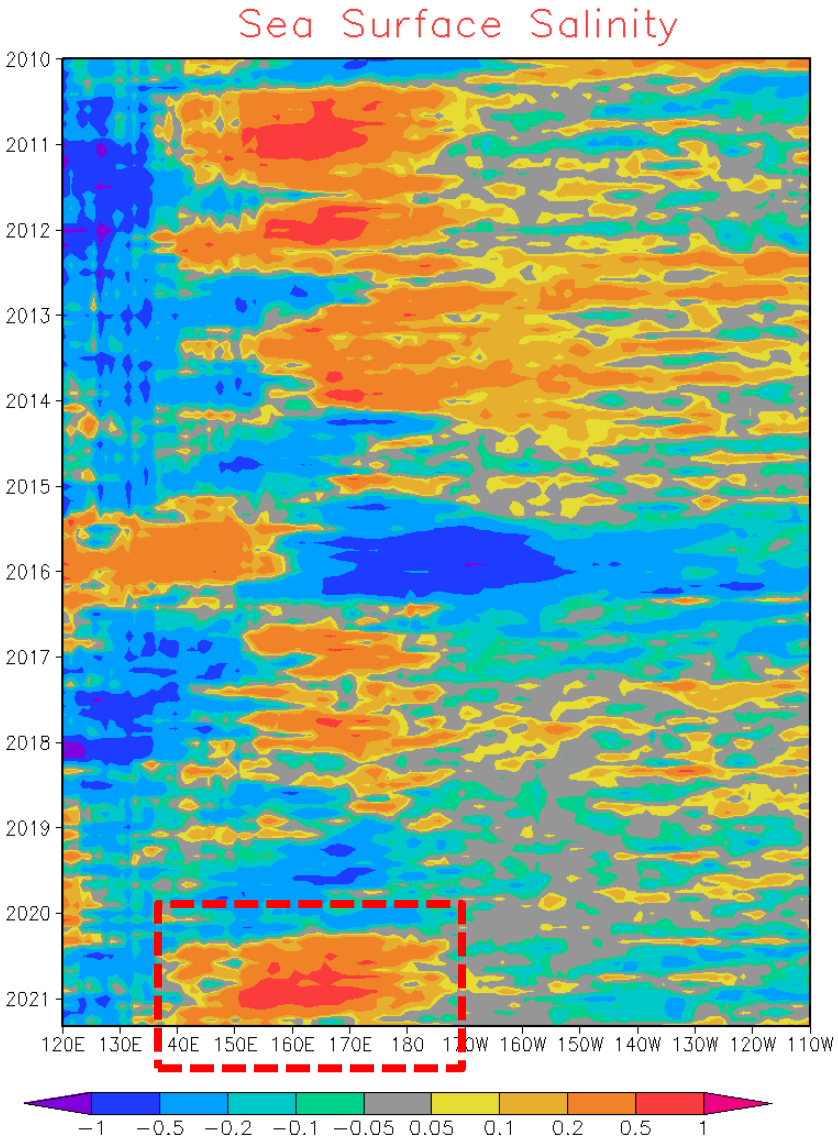


- Both the negative SSTAs and positive HC anomalies weakened in May 2021.

Monthly SSS Anomaly Evolution over Equatorial Pacific

NOTE: Since June 2015, the BASS SSS is from in situ, SMOS and SMAP; before June 2015,The BASS SSS is from in situ, SMOS and Aquarius.

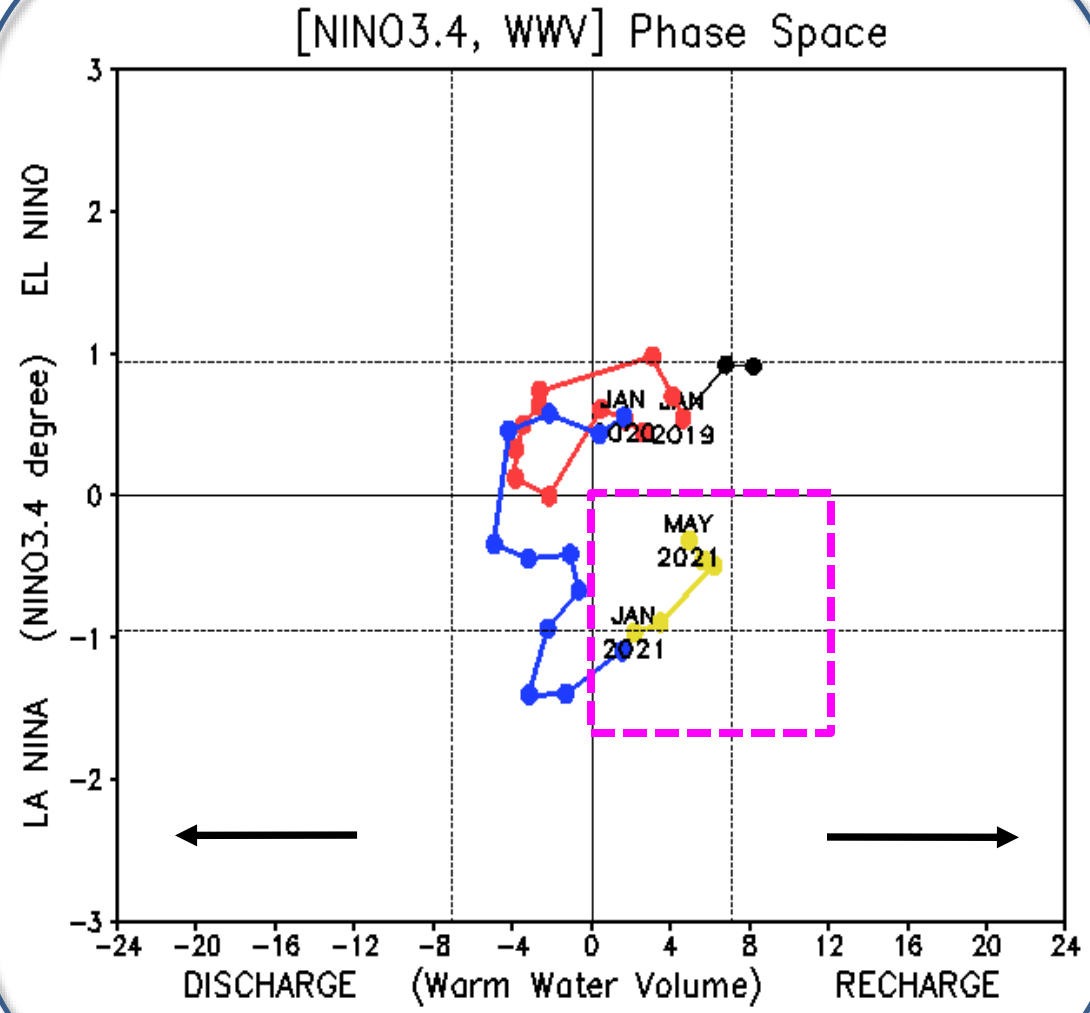
- Hovemoller diagram for equatorial SSS anomaly **(5° S-5° N);**
- In the equatorial Pacific Ocean, west of 140° E, negative SSS signal continues; positive SSS signal also continues between 140° E and 170° W; while negative SSS signal likely becomes weaker or changes to neutral east of 160° W.



Warm Water Volume (WWV) and Niño3.4 Anomalies

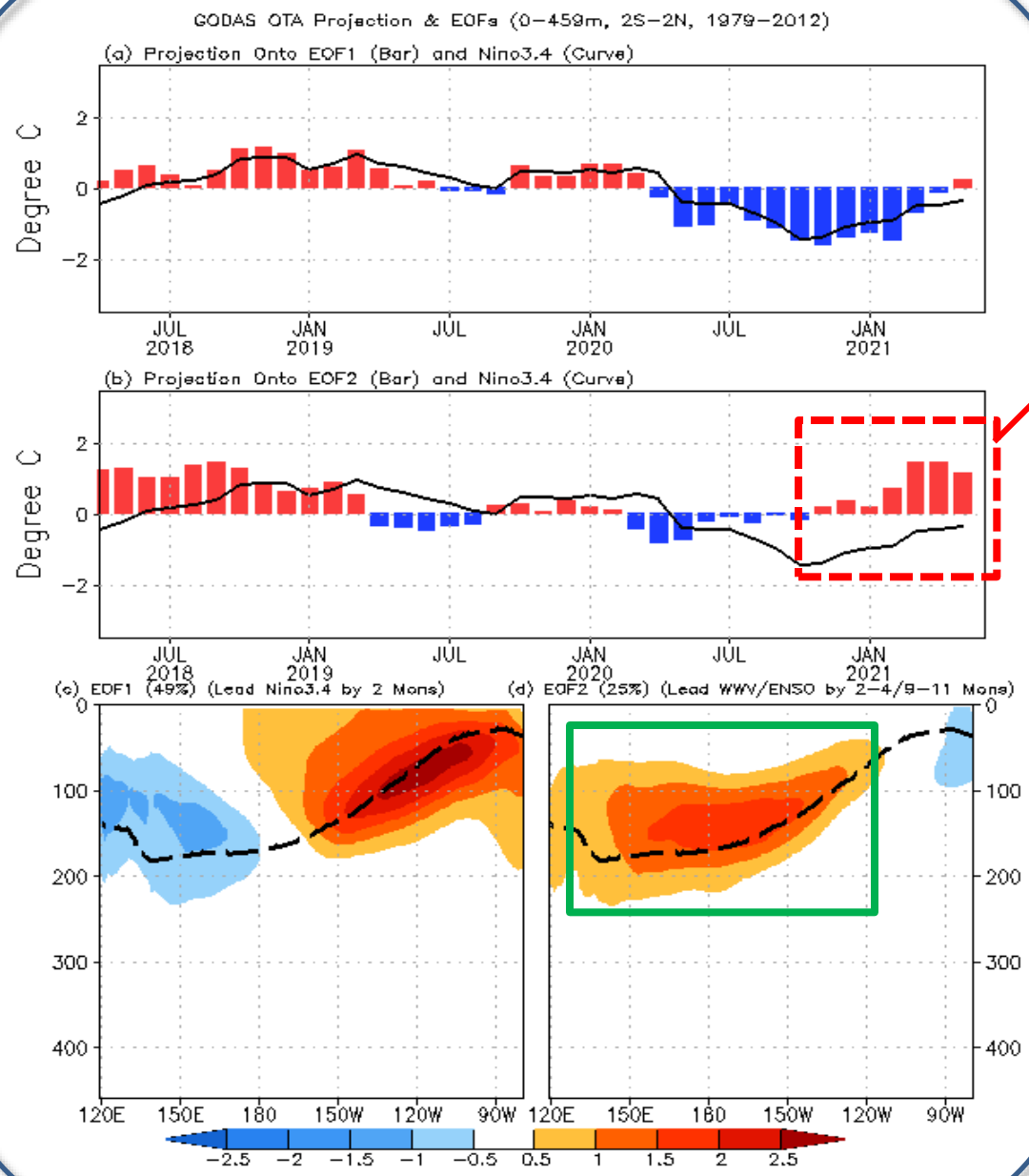
- Equatorial Warm Water Volume (WWV) has been in a recharge phase since Dec 2020.

-As WWV is intimately linked to ENSO variability (Wyrtki 1985; Jin 1997), it is useful to monitor ENSO in a phase space of WWV and Niño3.4 (Kessler 2002).
- Increase (decrease) of WWV indicates recharge (discharge) of the equatorial oceanic heat content.



Phase diagram of Warm Water Volume (WWV) and Niño3.4 indices. WWV is the average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN] calculated with the NCEP's GODAS. Anomalies are departures from the 1991-2020 base period means.

Equatorial Sub-surface Ocean Temperature Monitoring

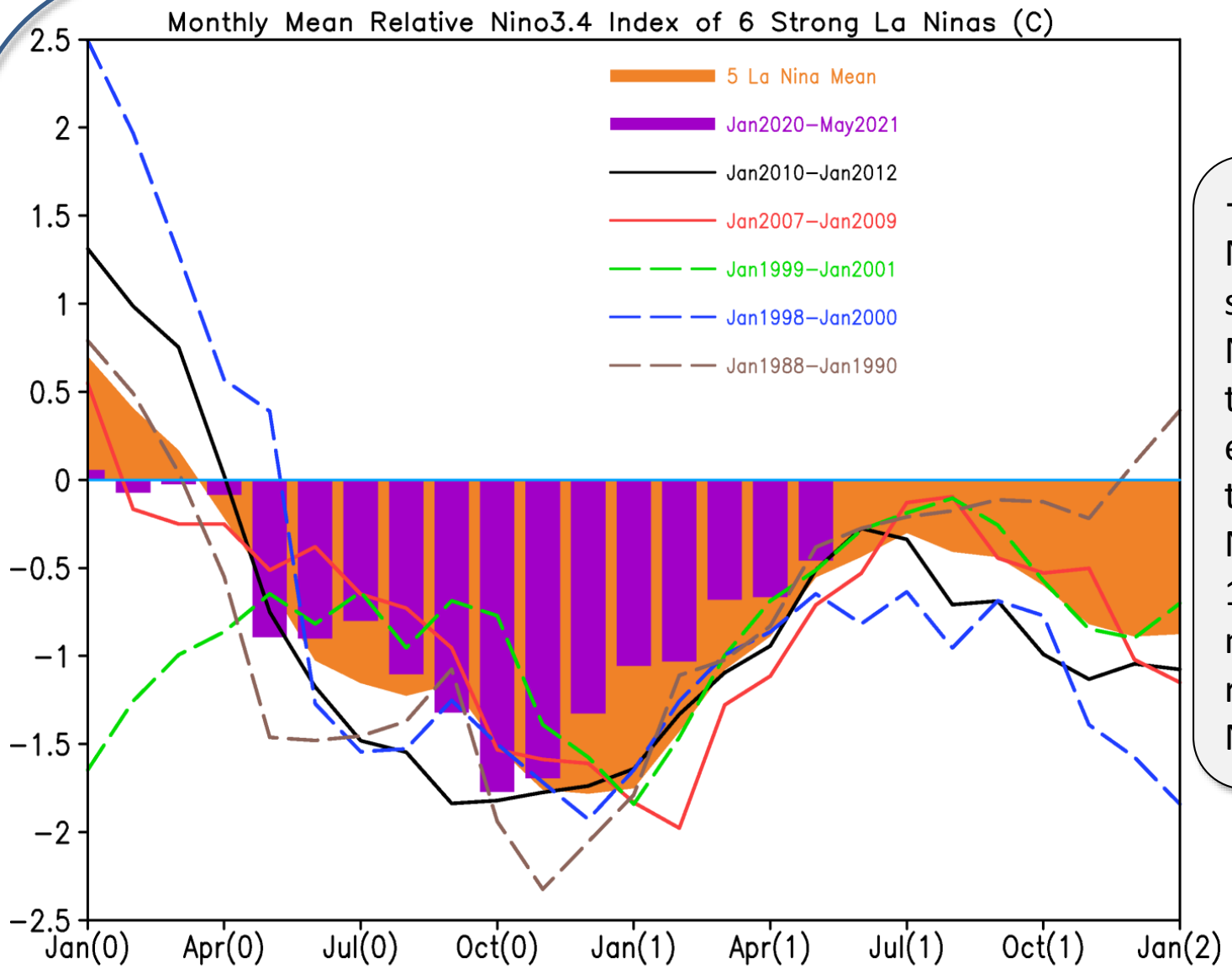


- The equatorial Pacific has been in a recharge phase since Nov 2020.

- Projection of ocean temperature anomalies onto EOF1 and EOF2; EOF1: Tilt/dipole mode (ENSO peak phase); EOF2: WWV mode.

- Recharge/discharge oscillation (ENSO transition phase); Recharge process: heat transport from outside of equator to equator; Negative -> positive phase of ENSO

- For details, see: Kumar & Hu (2014) DOI: 10.1007/s00382-013-1721-0.

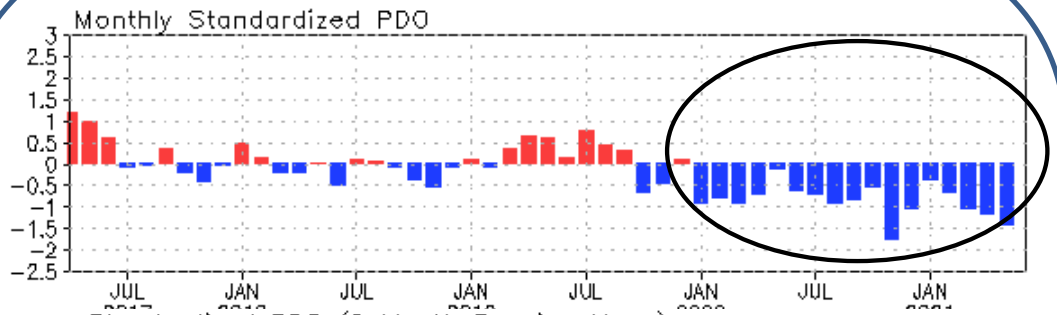


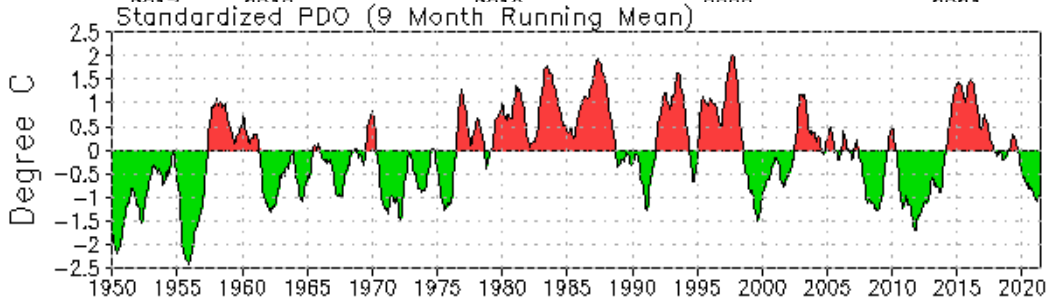
- 2020/21 La Niña ranks 6th strongest La Niña and it is the weakest event among the strong La Niñas since 1982 based on monthly mean relative Niño3.4.

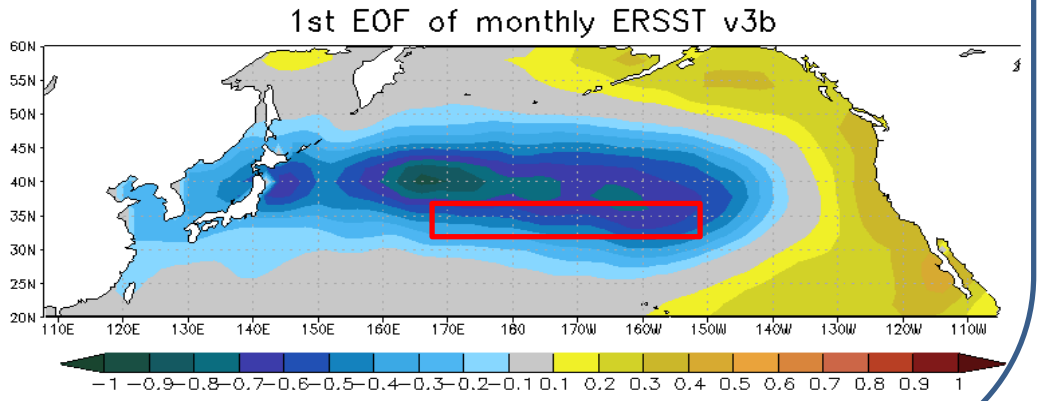
Relative Niño3.4 Index: (van Oldenborgh et al. 2021: ERL, 10.1088/1748-9326/abe9ed)

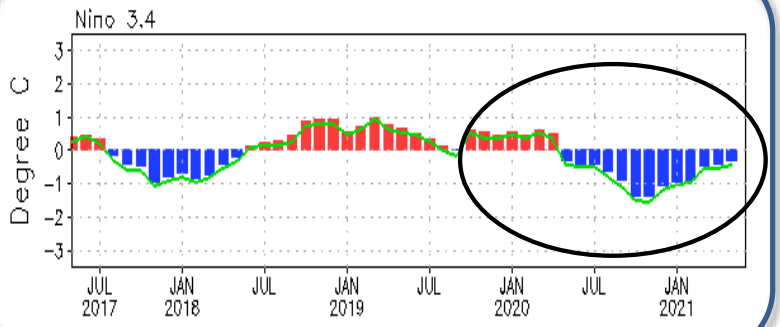
North Pacific & Arctic Oceans

Pacific Decadal Oscillation (PDO) Index







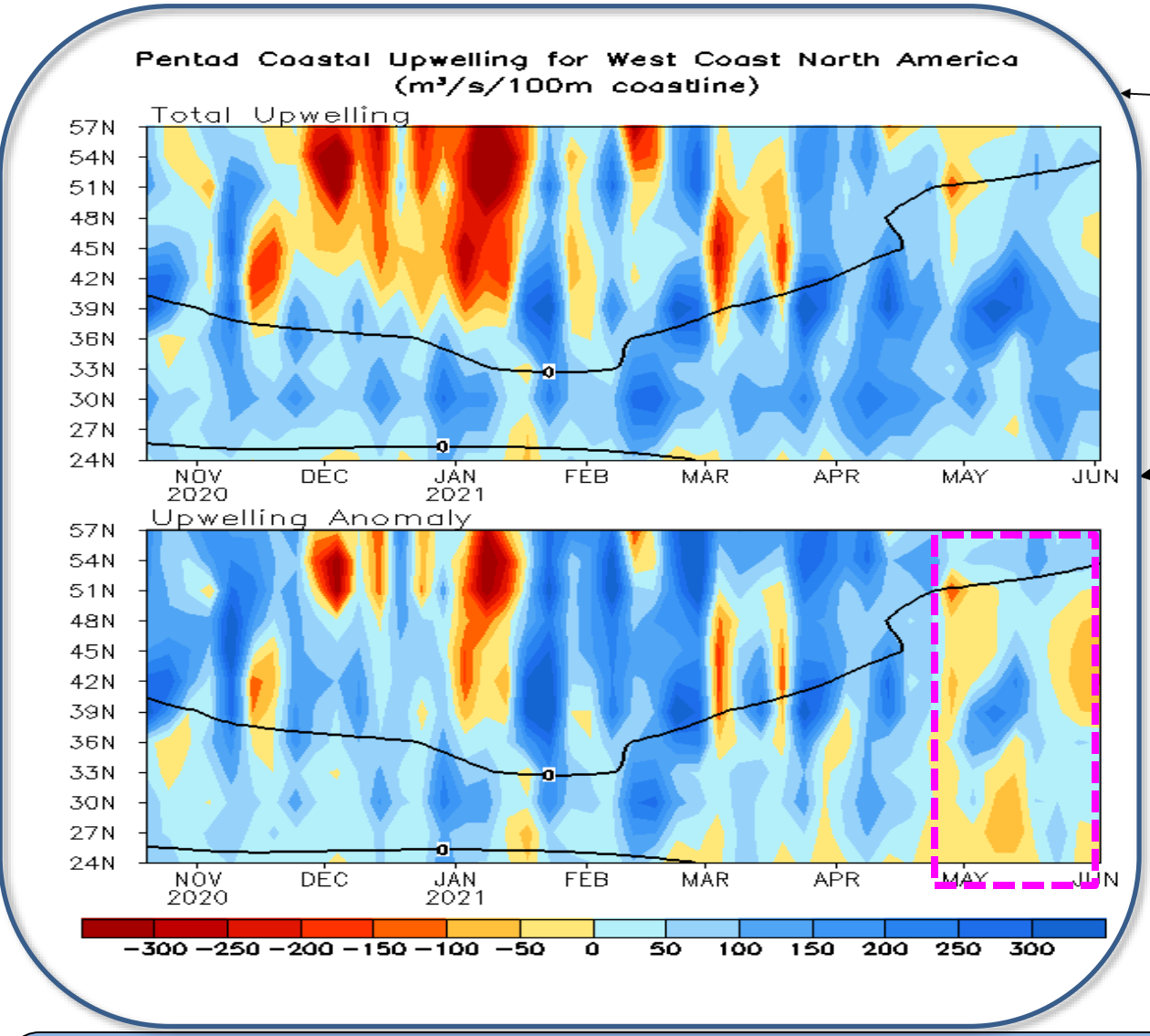


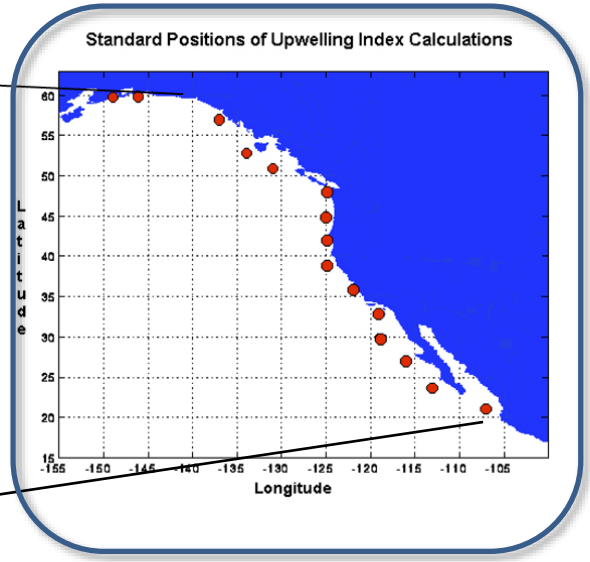
- The negative phase of PDO has persisted since Jan 2020 with PDOI = -1.5 in May 2021.

- Statistically, ENSO leads PDO by 3-4 months, through teleconnection via atmospheric bridge, with El Niño (La Niña) associated with positive (negative) PDO Index.

• PDO is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly SST anomalies onto the 1st EOF pattern.
• The PDO index differs slightly from that of JISAO, which uses a blend of UKMET and OIv1 and OIv2 SST.

North America Western Coastal Upwelling

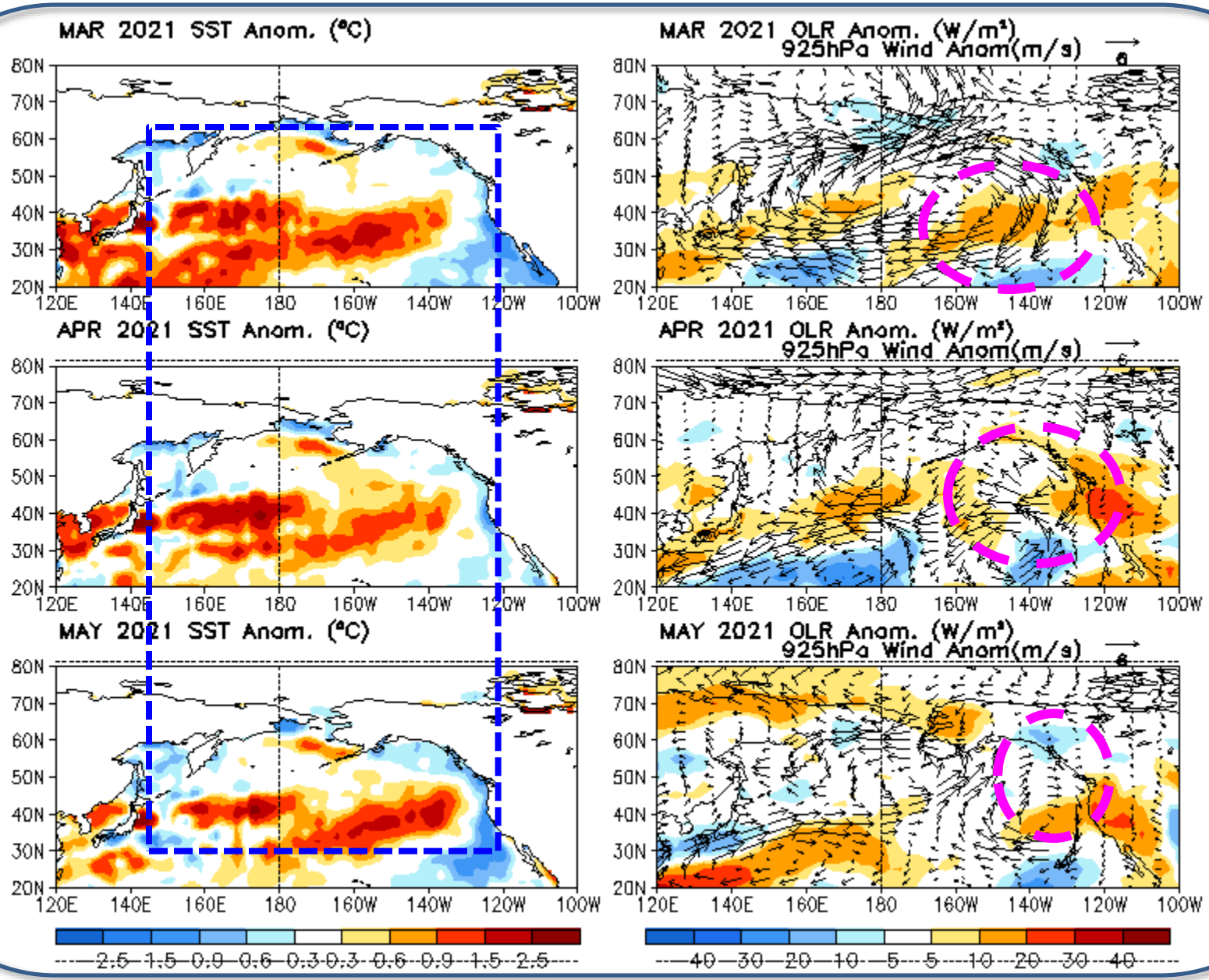




- Both coastal anomalous upwelling and downwelling were present in May 2021.

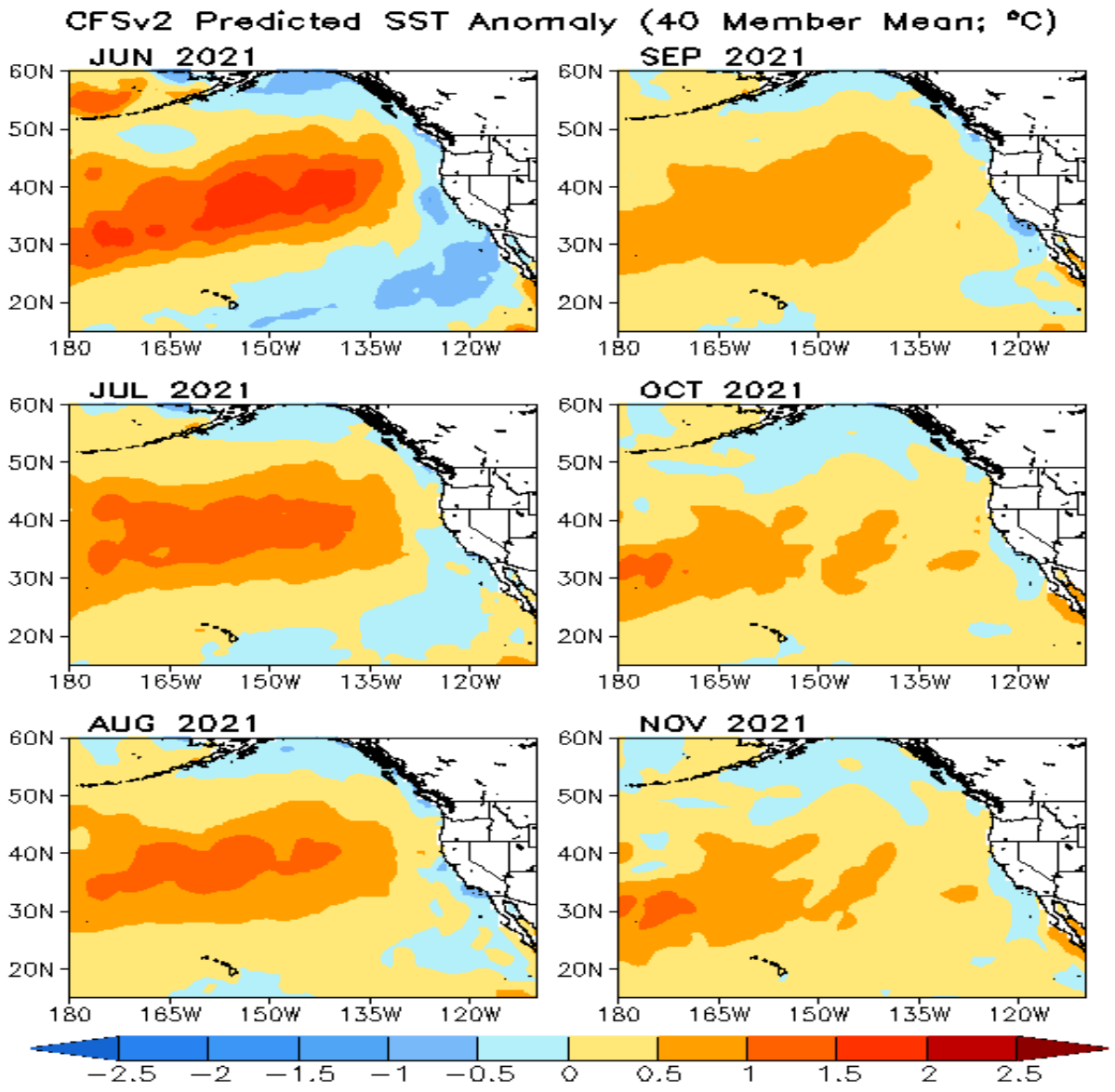
(top) Total and (bottom) anomalous upwelling indices at the 15 standard locations for the western coast of North America. derived from the vertical velocity of the NCEP's GODAS and are calculated as integrated vertical volume transport at 50-meter depth from each location to its nearest coast point ($m^3/s/100m$ coastline). Anomalies are departures from the 1991-2020 base period pentad means.
- Area below (above) black line indicates climatological upwelling (downwelling) season.
- Climatologically upwelling season progresses from March to July along the west coast of North America from 36ºN to 57ºN.

Latest 3-month North Pacific SST, OLR & uv925 anomalies



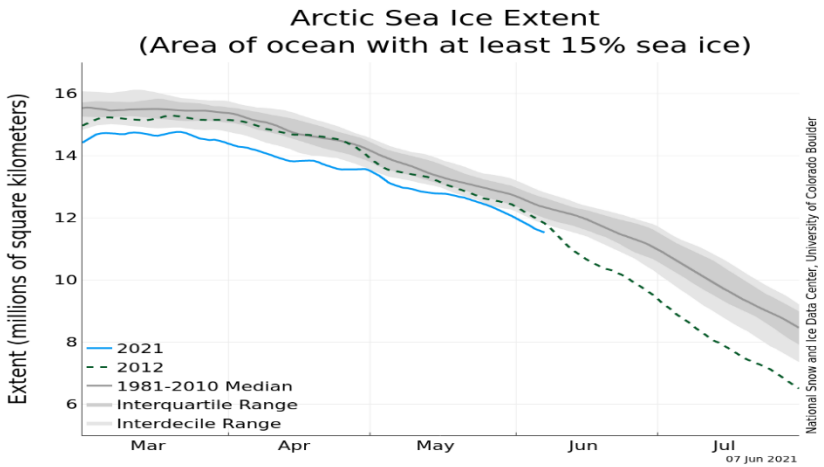
Data source: NCEP/NCAR Reanalysis 1

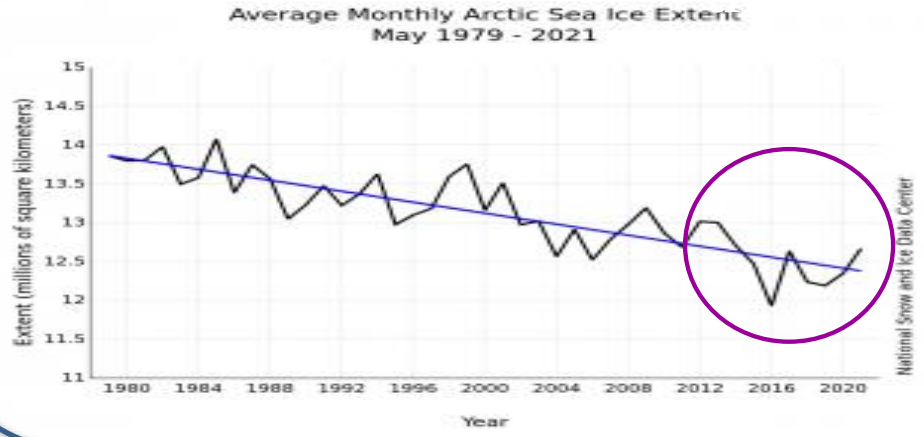
CFSv2 NE Pacific Marine Heatwave Predictions

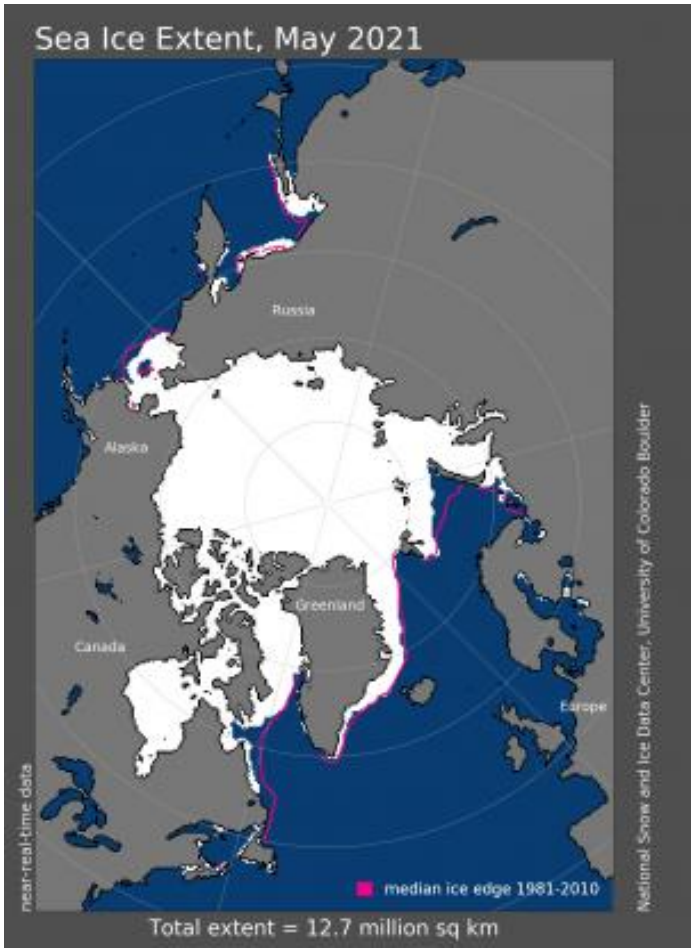


- Latest CFSv2 predictions suggest that the current warm state will weaken in the next 6 months.

Arctic Sea Ice; NSIDC (http://nsidc.org/arcticseaicenews/index.html)

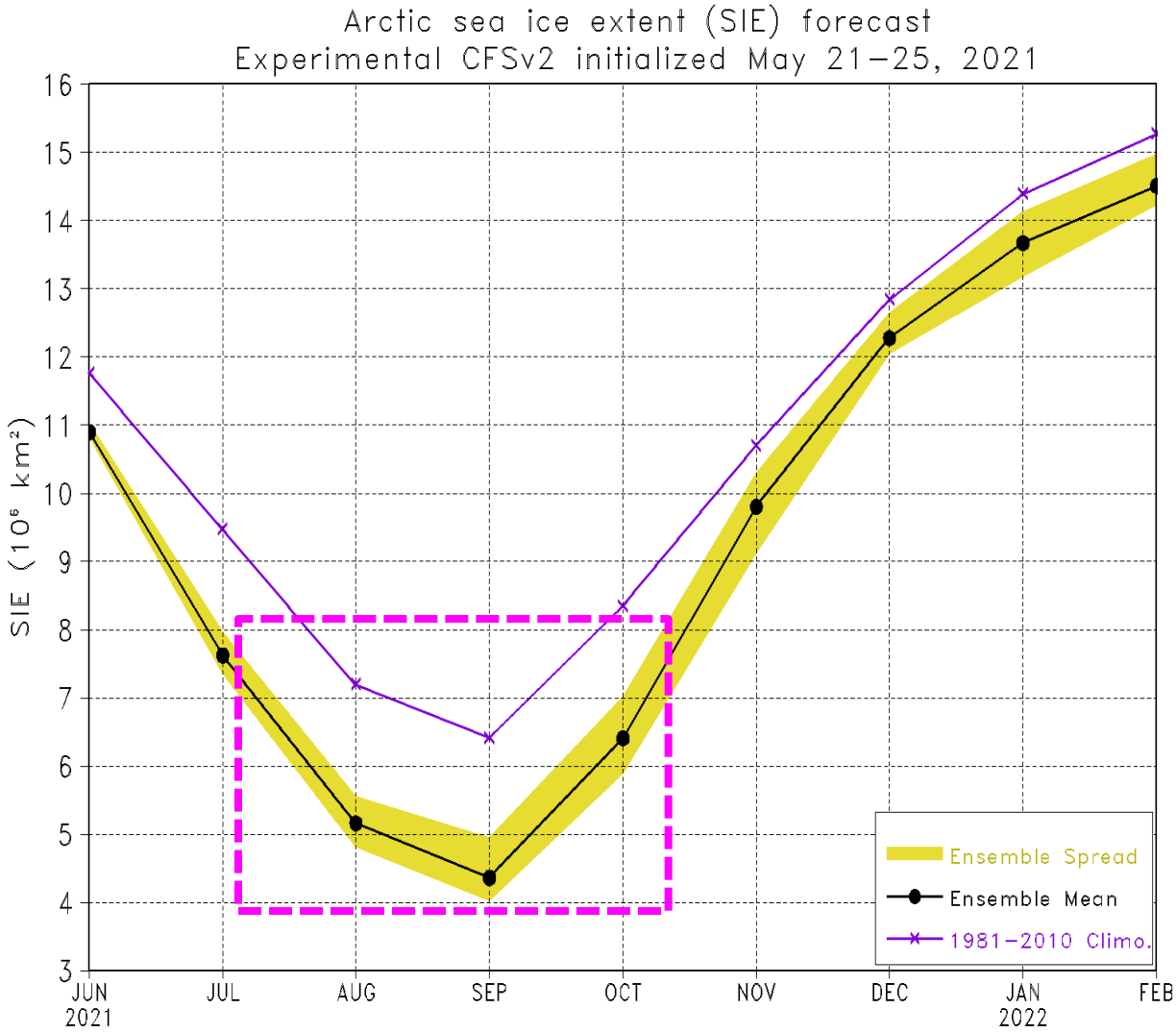






- The pace of ice loss in May 2021 was slower than average, leading to only the 9th lowest May extent during the satellite data record.
- Through 2021, the linear rate of decline for May sea ice extent is 2.7 percent per decade.

NCEP/CPC Arctic Sea Ice Extent Forecasts

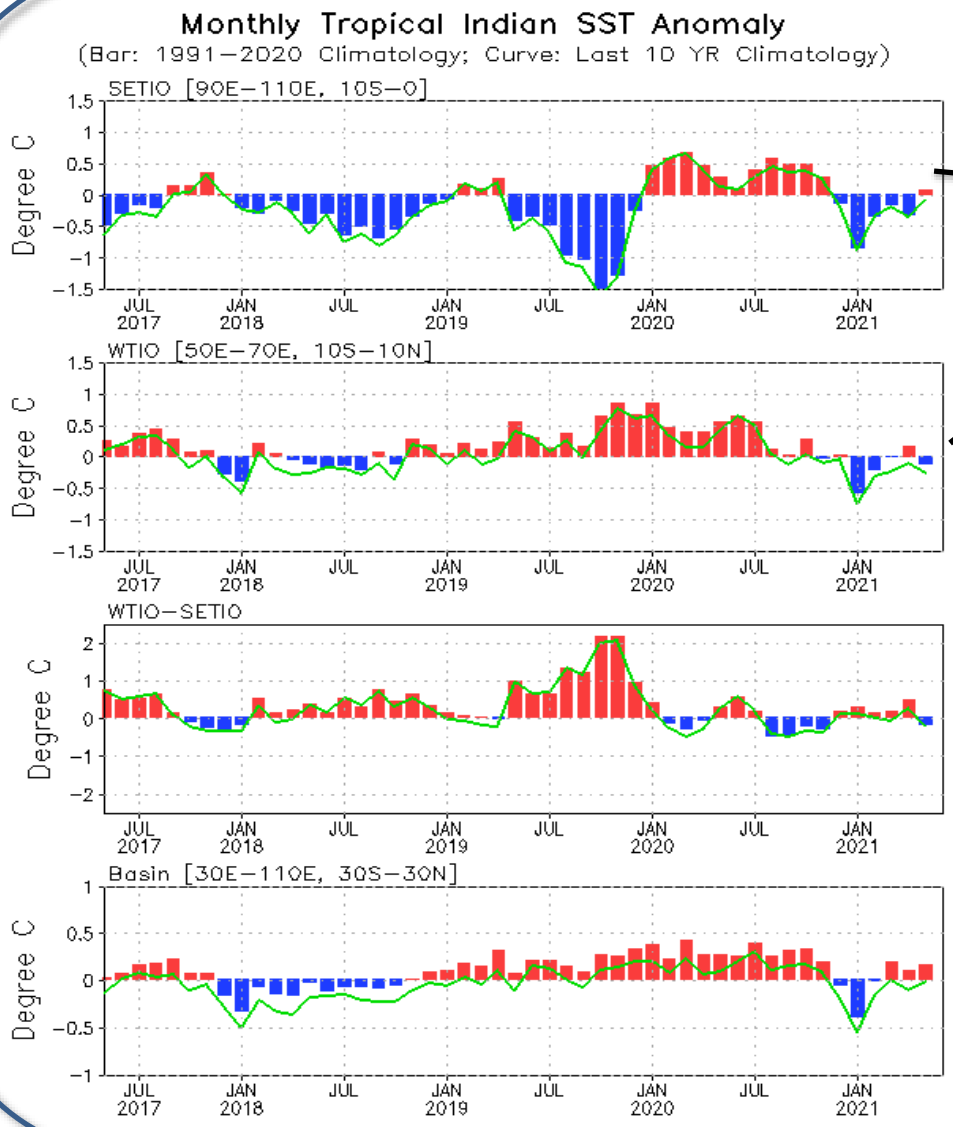


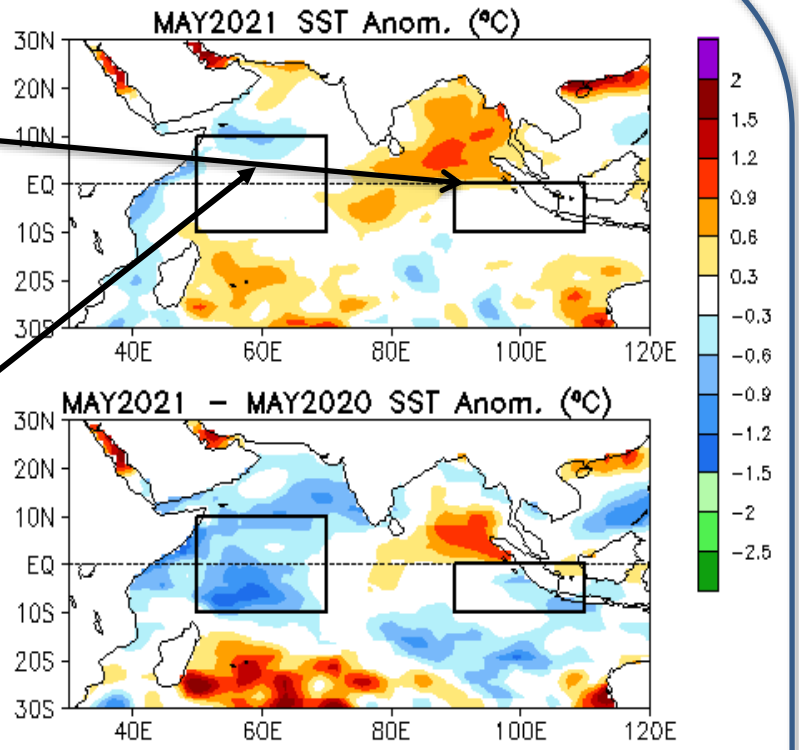
For ICs in May 2021, NCEP/CPC predicted a below-normal sea ice extent.

https://www.cpc.ncep.noaa.gov/products/people/wwang/seaice_seasonal/index.html

Indian Ocean

Evolution of Indian Ocean SST Indices

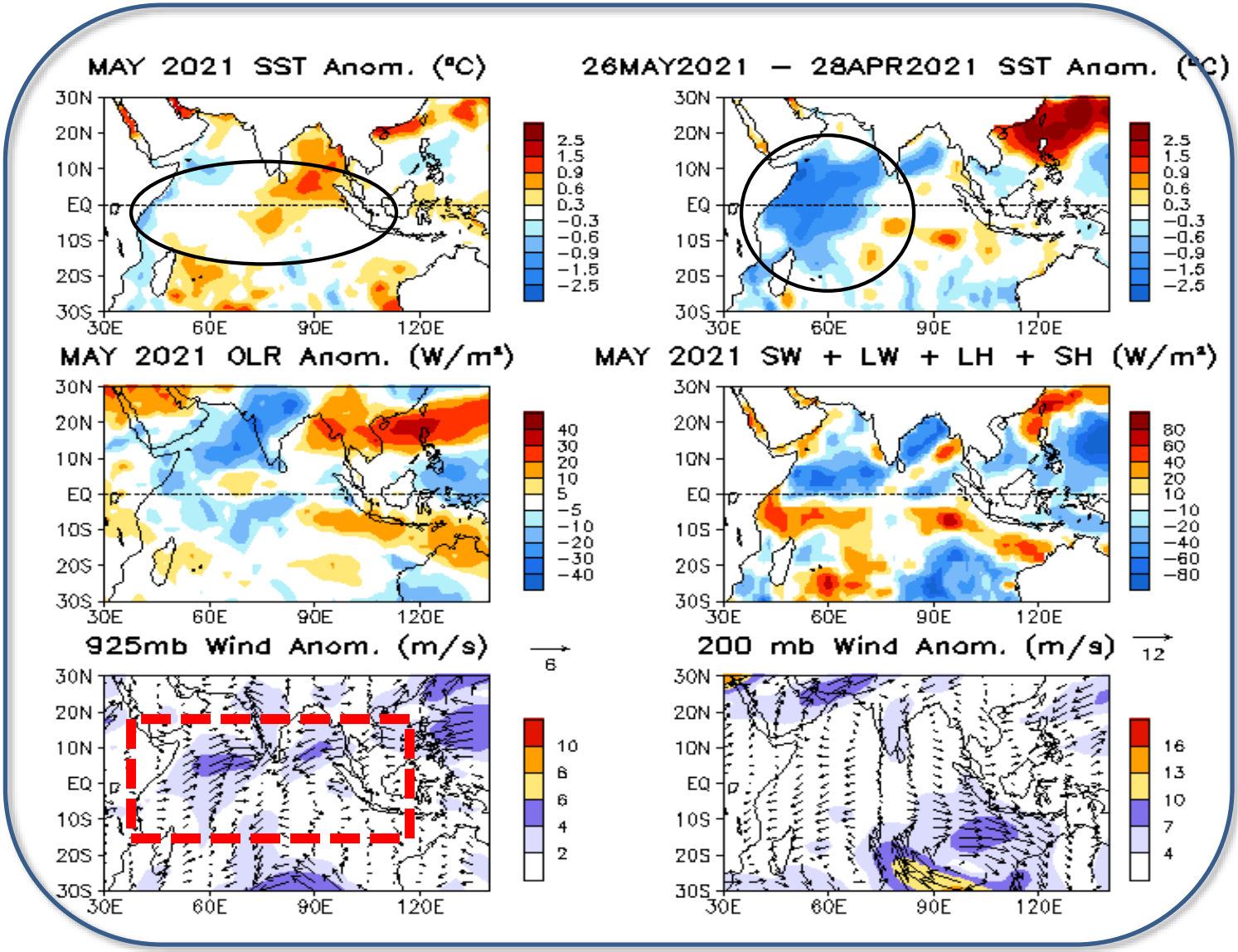




- Overall, SSTAs were small in the tropical Indian Ocean in May 2021.

Indian Ocean Dipole region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (OC) for the SETIO [90ºE-110ºE, 10ºS-0] and WTIO [50ºE-70ºE, 10ºS-10ºN] regions, and Dipole Mode Index, defined as differences between WTIO and SETIO. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1991-2020 base period means.

Tropical Indian: SSTA, SSTA Trend, OLR, heat flux uv925-mb & uv200 anomalies

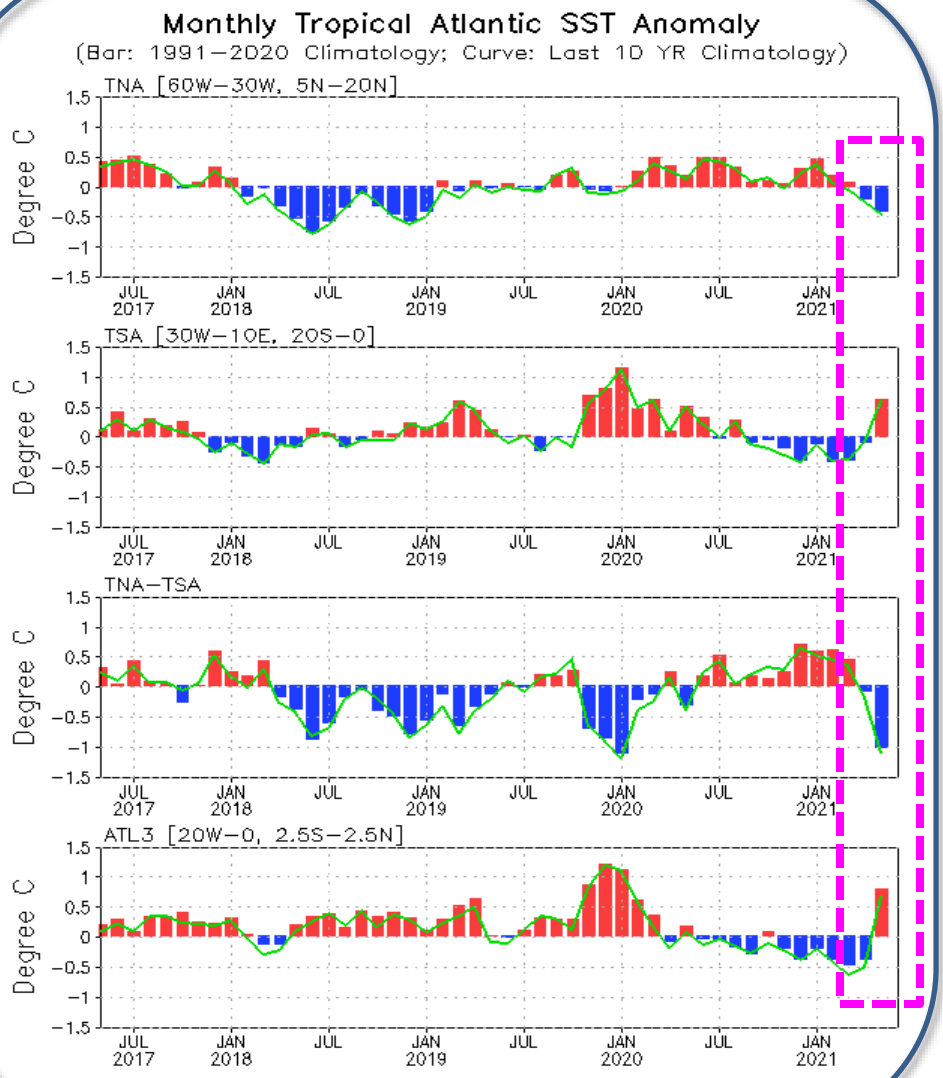


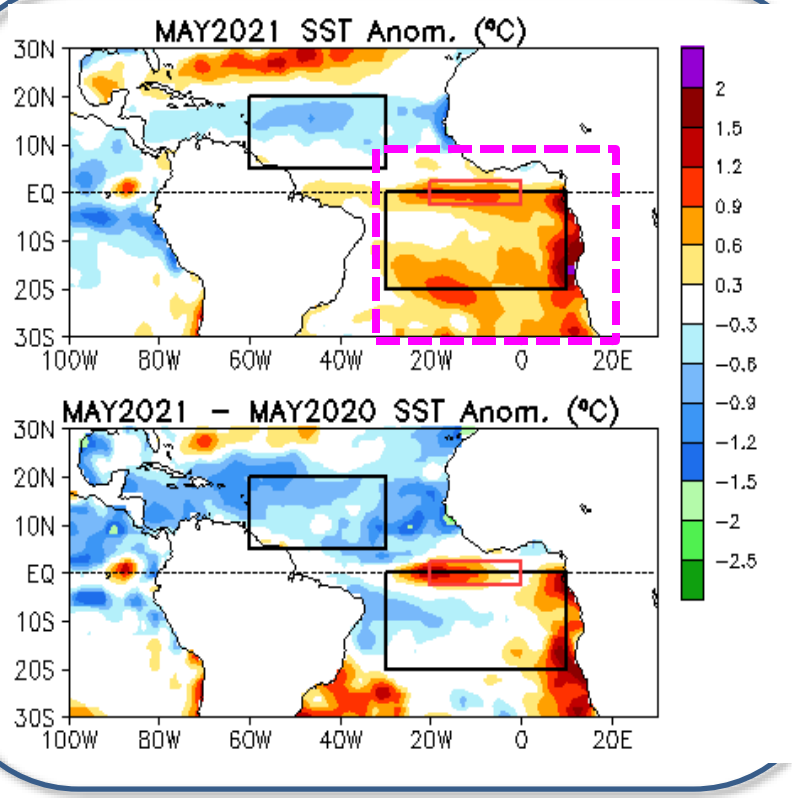
- SSTAs were small and the tendencies were negative in the western tropical Indian Ocean.

SSTAs (top-left), SSTA tendency (top-right), OLR anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, winds and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1991-2020 base period means.

Tropical and North Atlantic Ocean

Evolution of Tropical Atlantic SST Indices

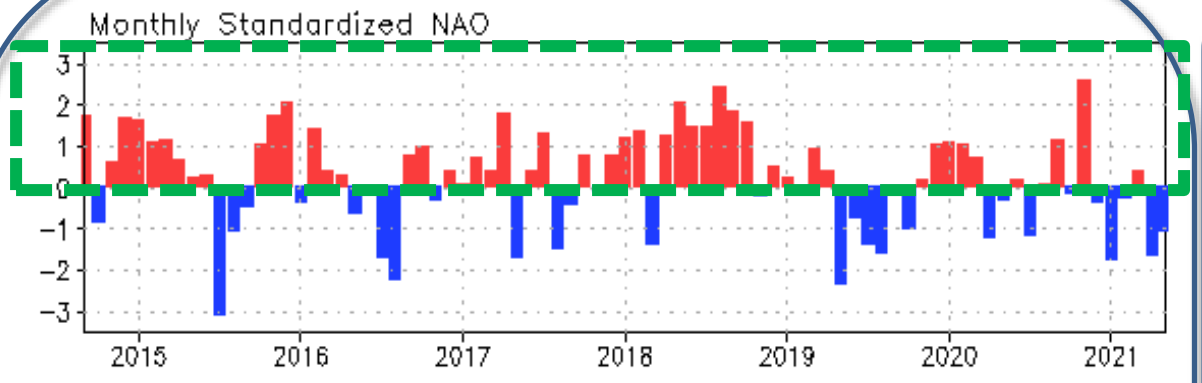


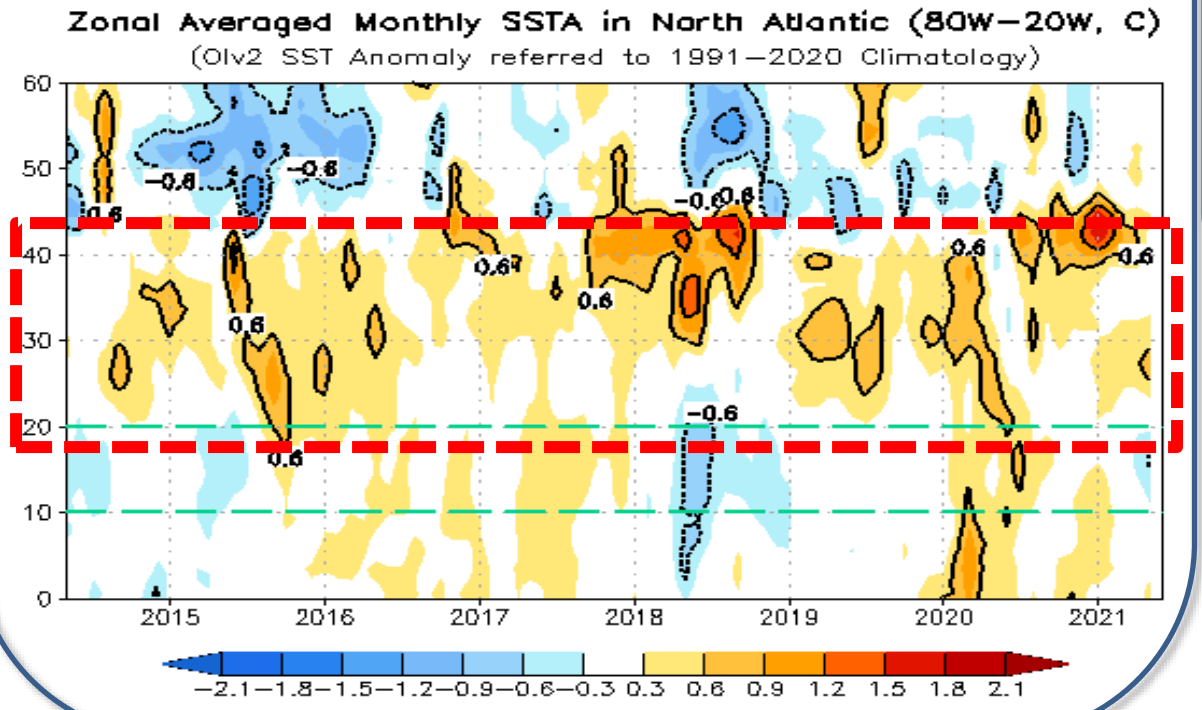


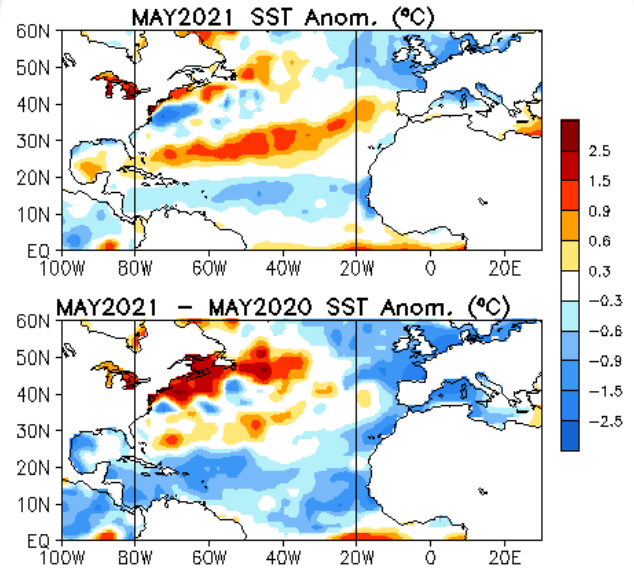
- A strong negative phase of the dipole index was observed in May 2021.
- Benguela Niño-like SSTA was observed, which may trigger the Atlantic Niño-like SSTA development in May 2021 (Hu & Huang 2007: 10.1175/JCLI4189.1; Illig et al. 2020: 10.1029/2019JC016003).

Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (^{O}C) for the TNA [60^{O}W-30^{O}W, 5ºN-20^{O}N], TSA [30^{O}W-10^{O}E, 20^{O}S-0] and ATL3 [20^{O}W-0, 2.5^{O}S-2.5^{O}N] regions, and Meridional Gradient Index, defined as differences between TNA and TSA. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1991-2020 base period means.

NAO and SST Anomaly in North Atlantic



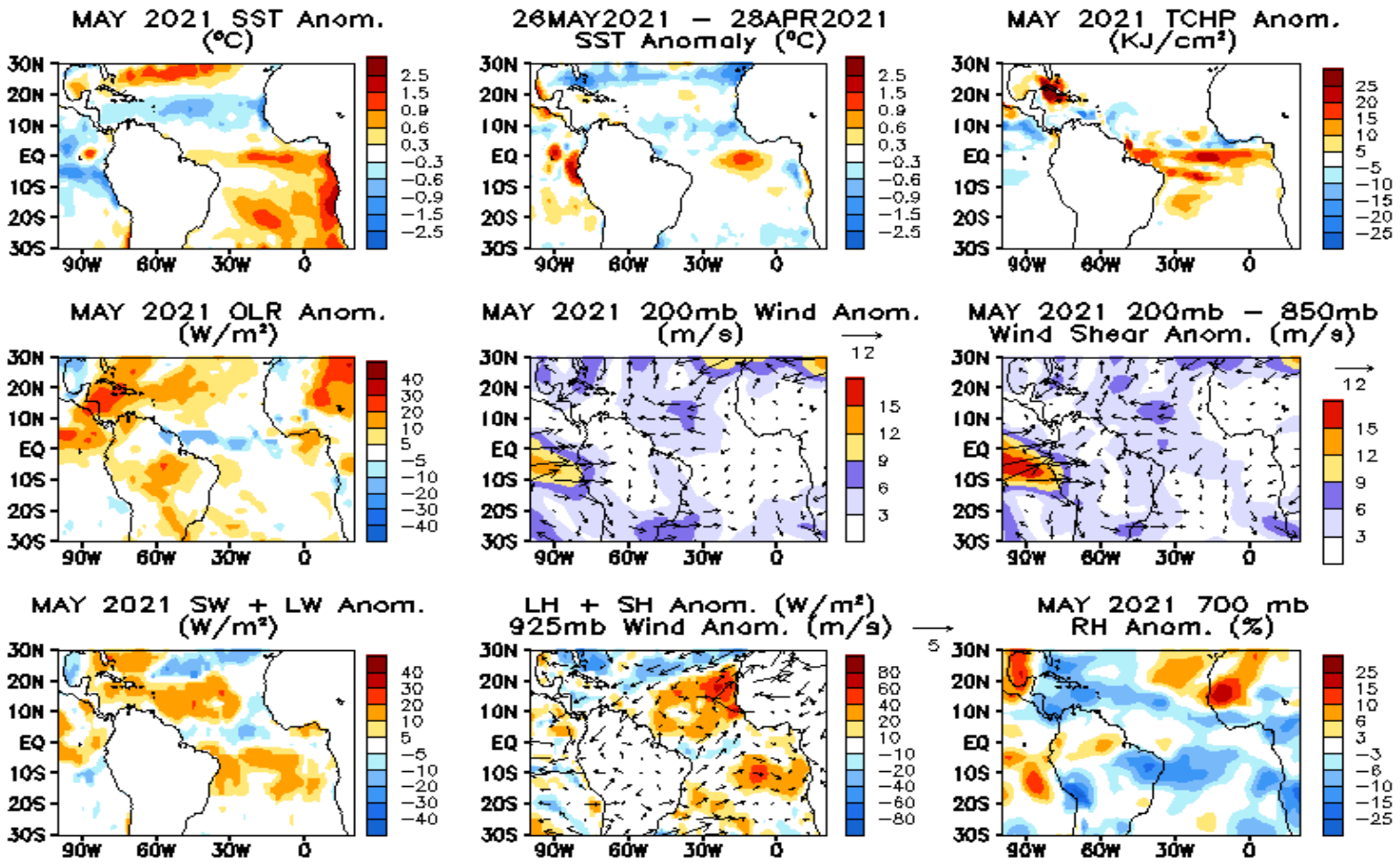




- NAO was in a negative phase in May 2021 with NAOI= -1.1.
- The prolonged positive SSTAs in the middle latitudes were evident, due to the domination of the positive phase of NAO during the last 5-6 years.

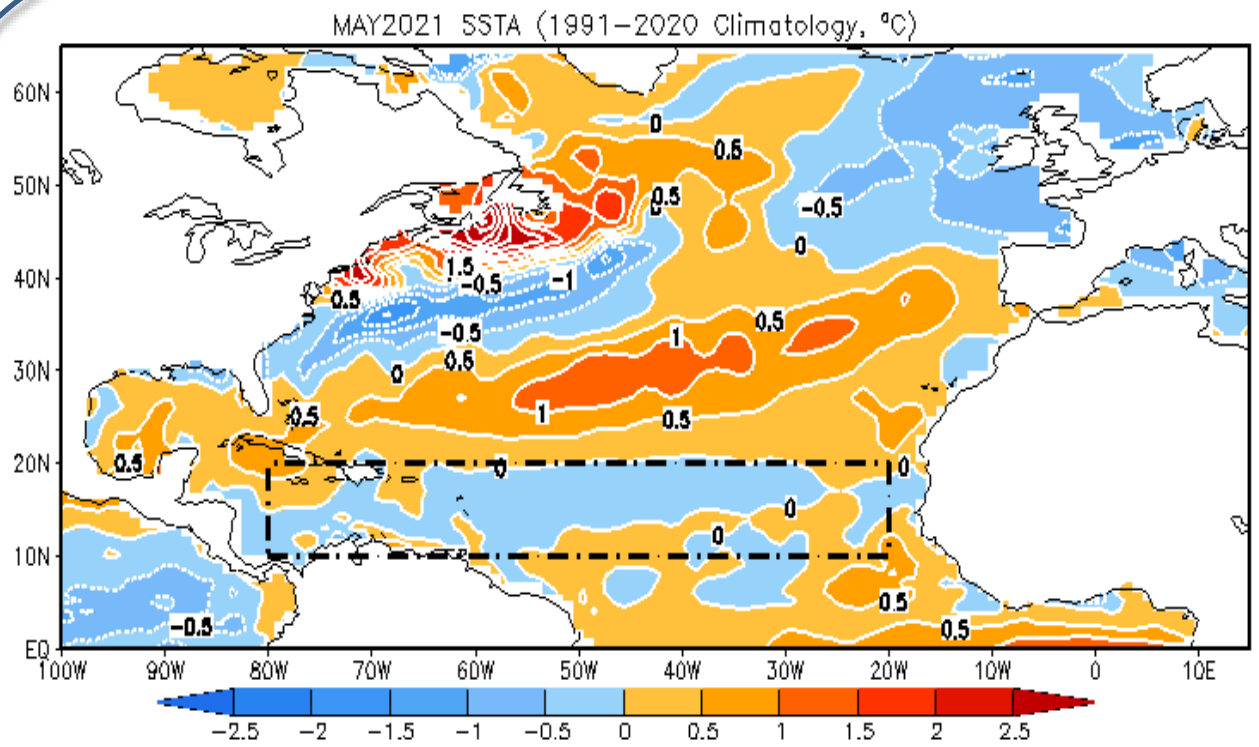
Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20^{O}N-90^{O}N (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80ºW and 20ºW (bottom). SST are derived from the NCEP OI SST analysis, and anomalies are departures from the 1991-2020 base period means.

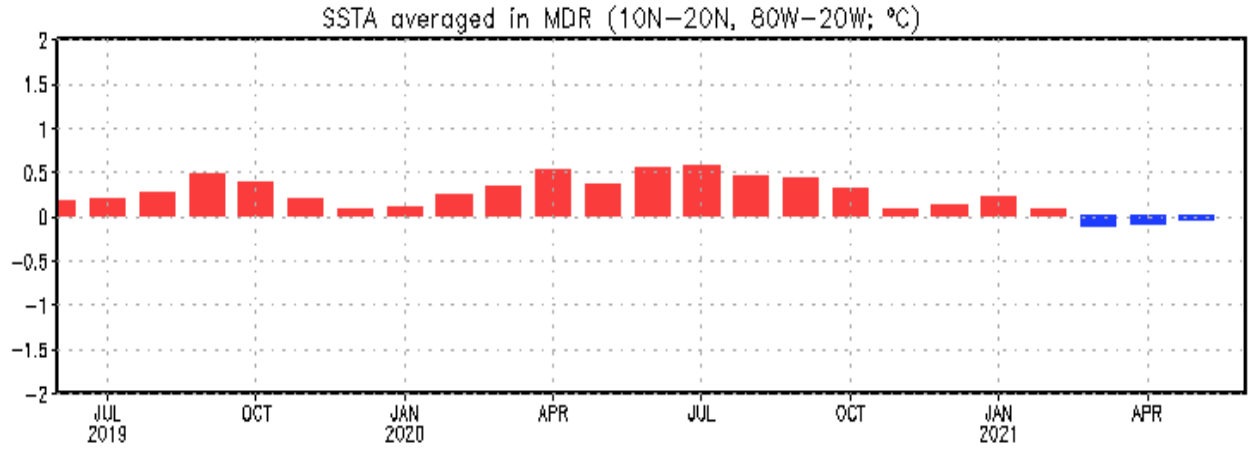
Tropical Atlantic Ocean: SSTA, SSTA Tend, TCHP, OLR, UV200, UV200-UV850, Heat Flux Anomalies



Top Row: SSTA (left; OI SST), SSTA tendency (central), Tropical Cyclone Heat Potential anomaly (right; GODAS).
Middle row: OLR (left; NOAA 18 AVHRR IR), UV200 (central; NCEP CDAS), UV200-UV850 (right; NCEP CDAS) anomalies.
Bottom row: SW+LW (left), LH+SH (central), Relative humidity at 700 hPa (right; NCEP CDAS) anomalies.
Anomalies are departures from the 1991-2020 base period means.

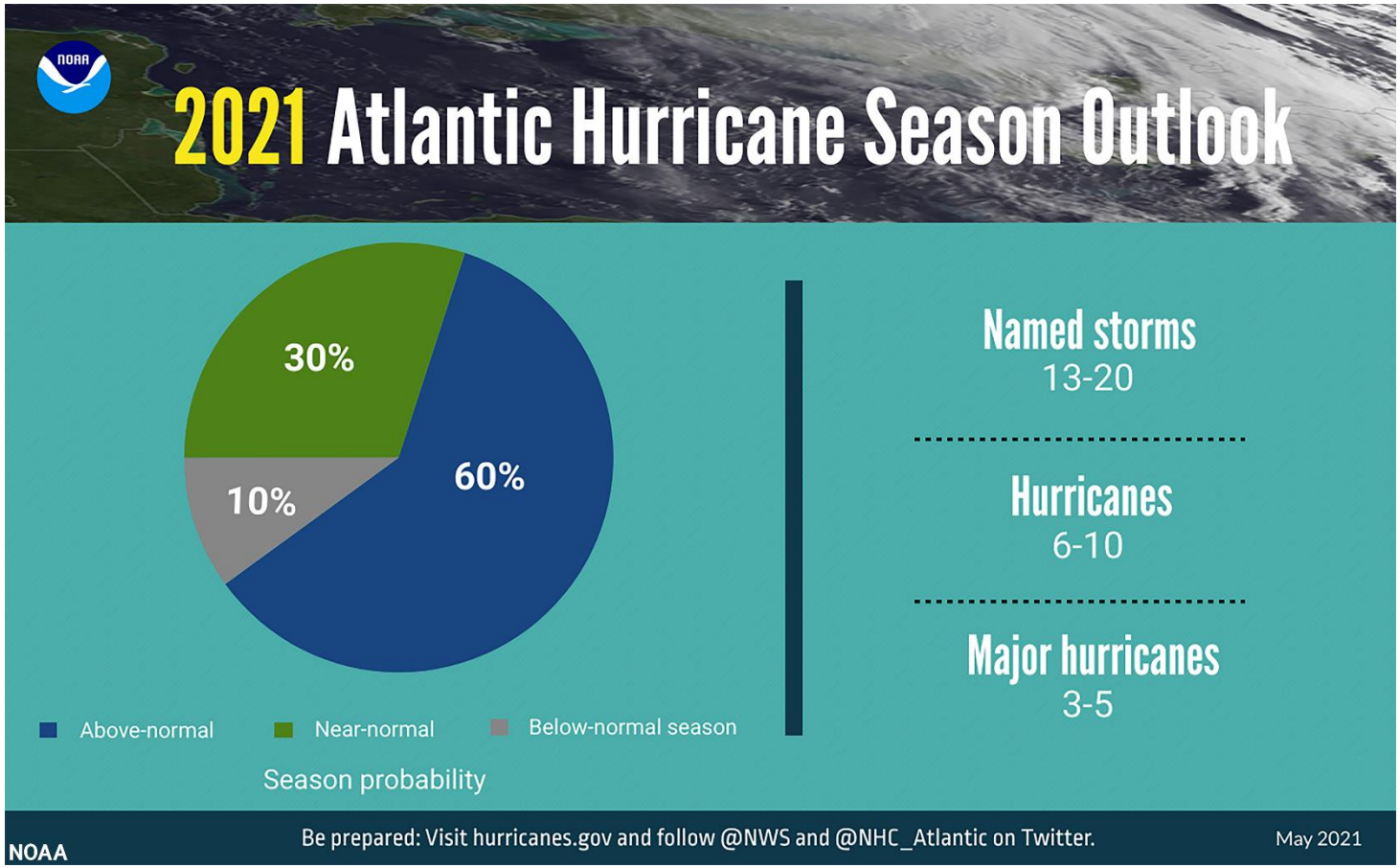
SSTAs in the North Atlantic & MDR





- SST in MDR was below average during the last three months.

2021 Atlantic Hurricane Season Outlook



- May 20, 2021: NOAA's CPC predicted another above-normal Atlantic hurricane season with a 60% chance of an above-normal season, a 30% chance of a near-normal season, and a 10% chance of a below-normal season.
- However, experts do not anticipate the historic level of storm activity seen in 2020.

(https://www.noaa.gov/media-release/noaa-predicts-another-active-atlantic-hurricane-season)

2021 Atlantic Hurricane Season Outlook

- "ENSO-neutral and La Niña support the conditions associated with the ongoing high-activity era."

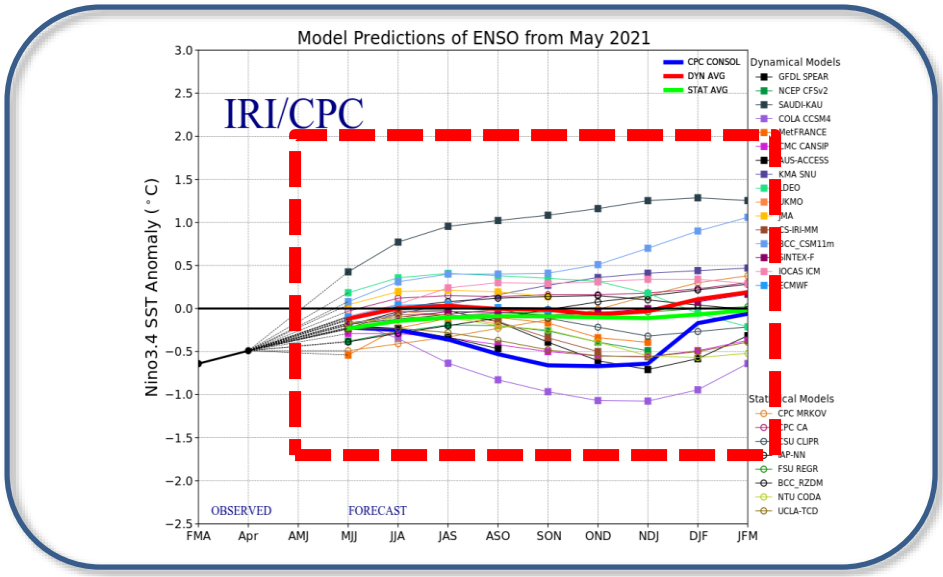
- "Predicted warmer-than-average sea surface temperatures in the tropical Atlantic Ocean and Caribbean Sea, weaker tropical Atlantic trade winds, and an enhanced west African monsoon will likely be factors in this year's overall activity."

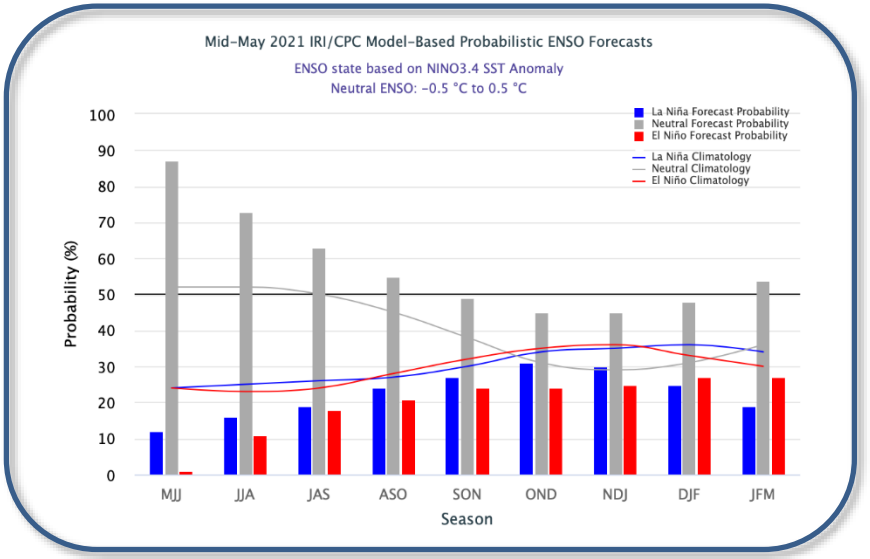
- "Although NOAA scientists don't expect this season to be as busy as last year, it only takes one storm to devastate a community, …"

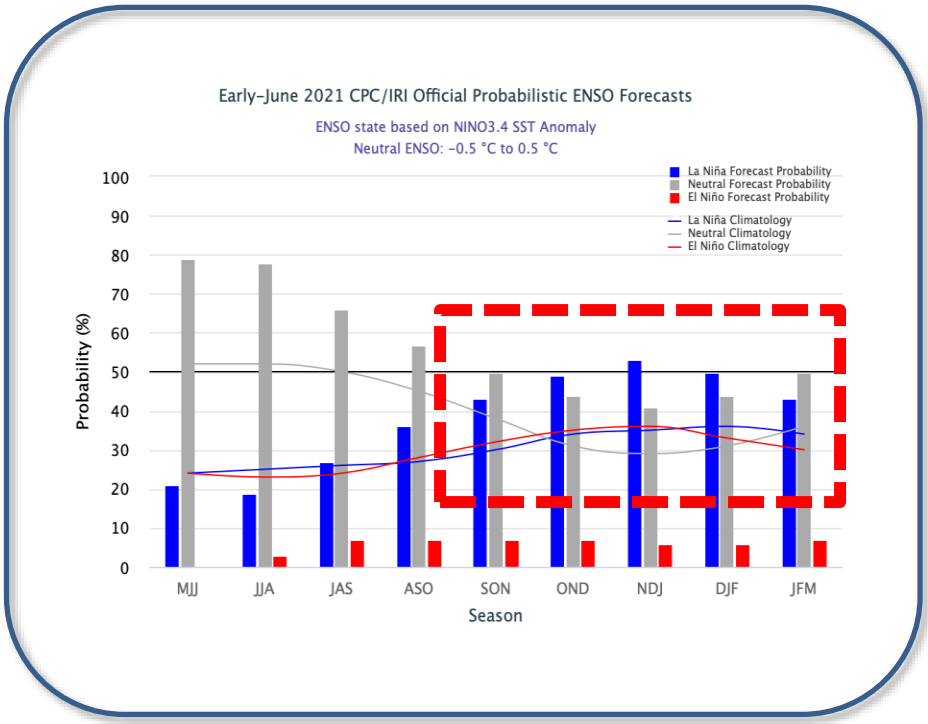
(https://www.noaa.gov/media-release/noaa-predicts-another-active-atlantic-hurricane-season)

ENSO and Global SST Predictions

IRI/CPC Niño3.4 Forecast

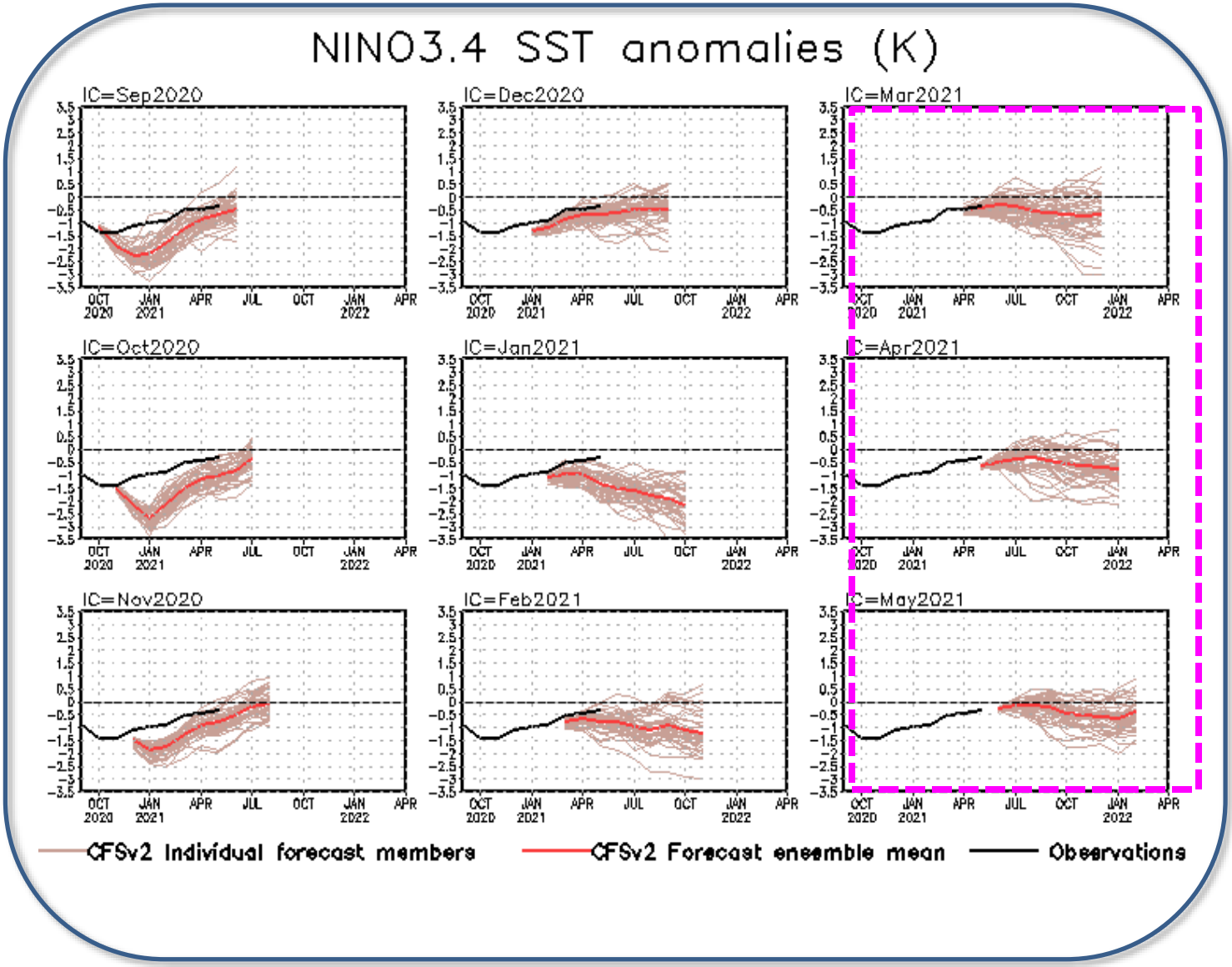






- **ENSO Alert System Status: La Niña Advisory Issued on 10 Jun 2021**
- <u>Synopsis:</u> *ENSO-neutral is favored through the Northern Hemisphere summer (78% chance for the June-August season) and fall (50% chance for the September-November season).*

CFSv2 Niño3.4 SST Predictions

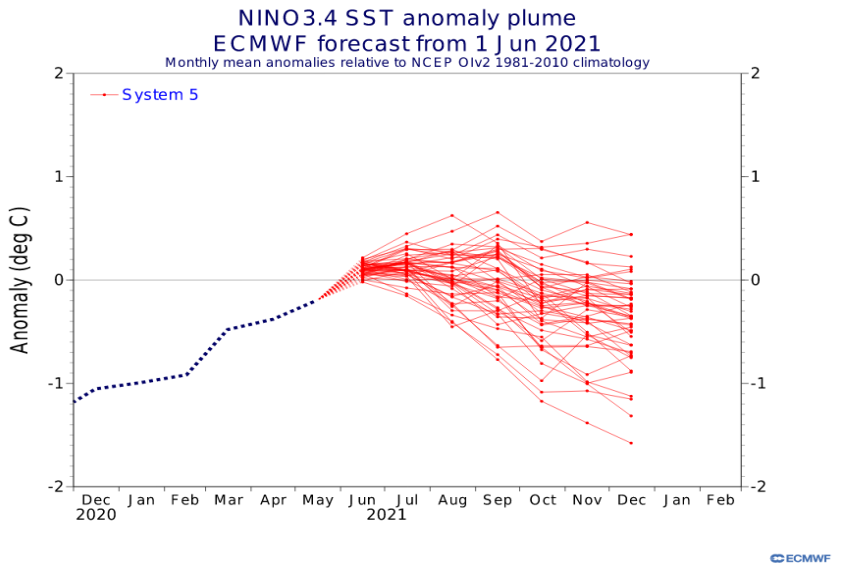


- Latest CFSv2 predictions call for below-normal SSTs in the 2nd half of 2021.

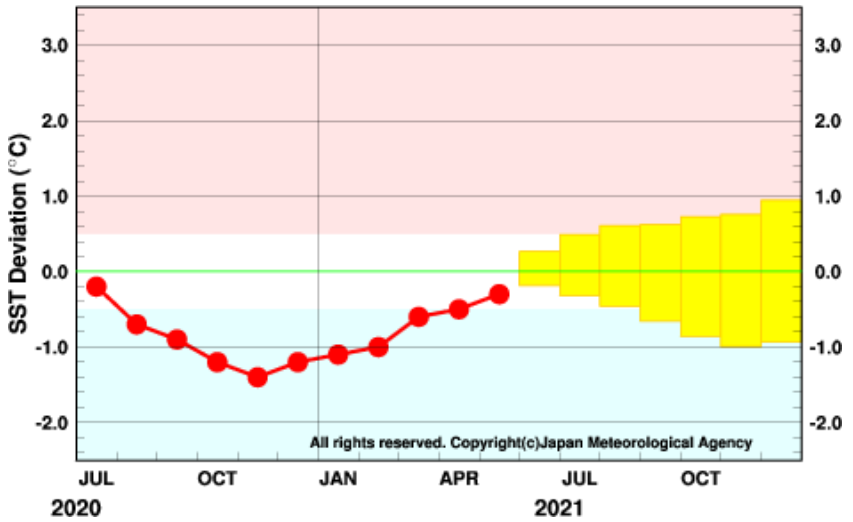
CFS Niño3.4 SST prediction from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1991-2020 base period means.

Individual Model Niño3.4 Forecasts

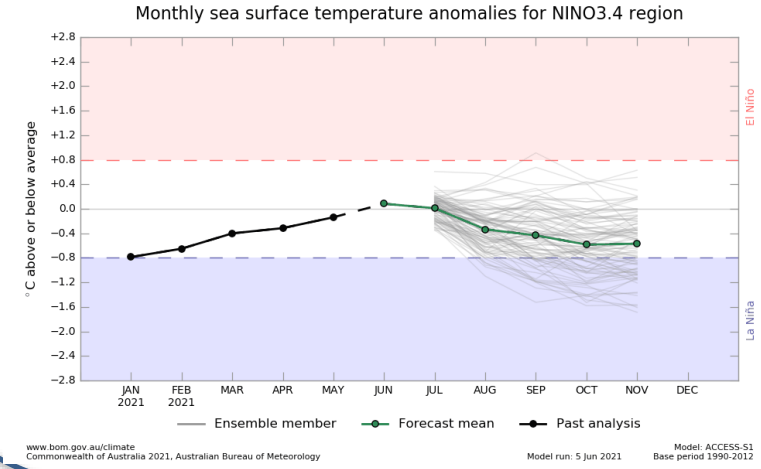
EC: IC= 01 June, 2021



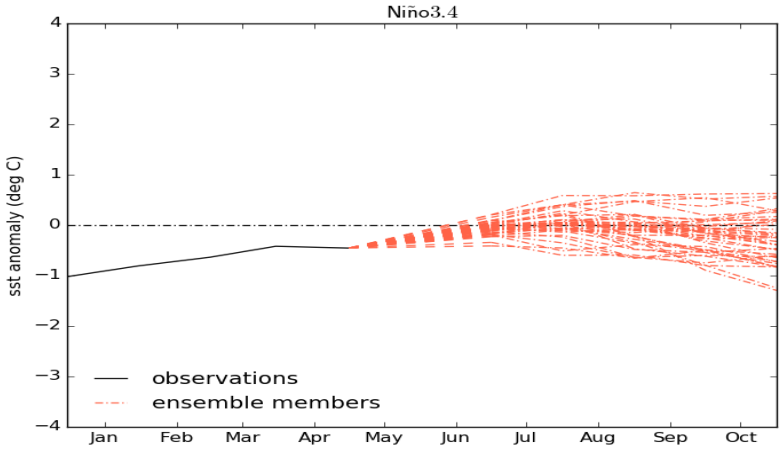
JMA: Updated 10 June, 2021



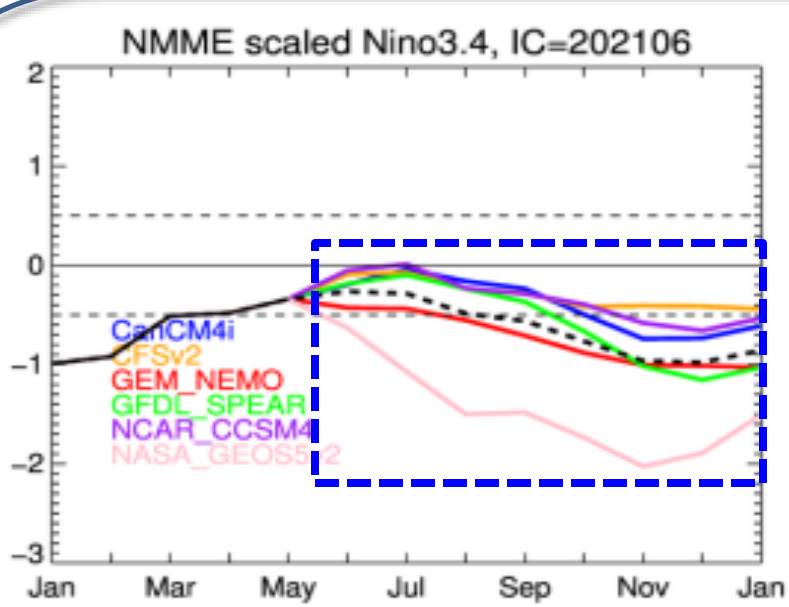
BOM: Updated 05 June, 2021

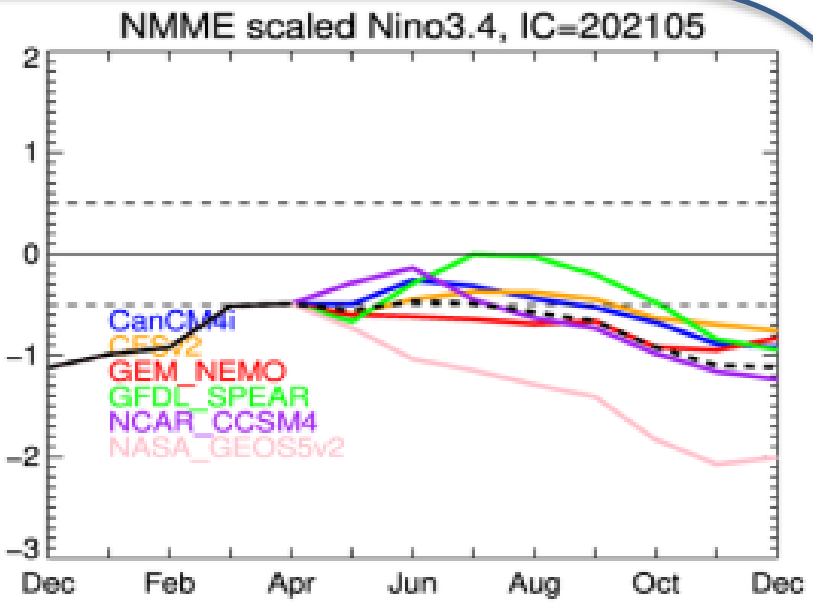


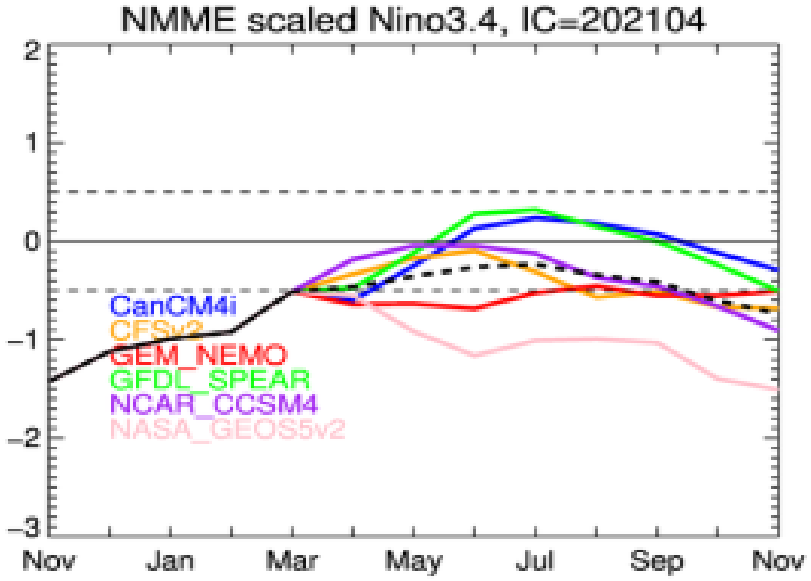
UKMO: Updated 11 May, 2021

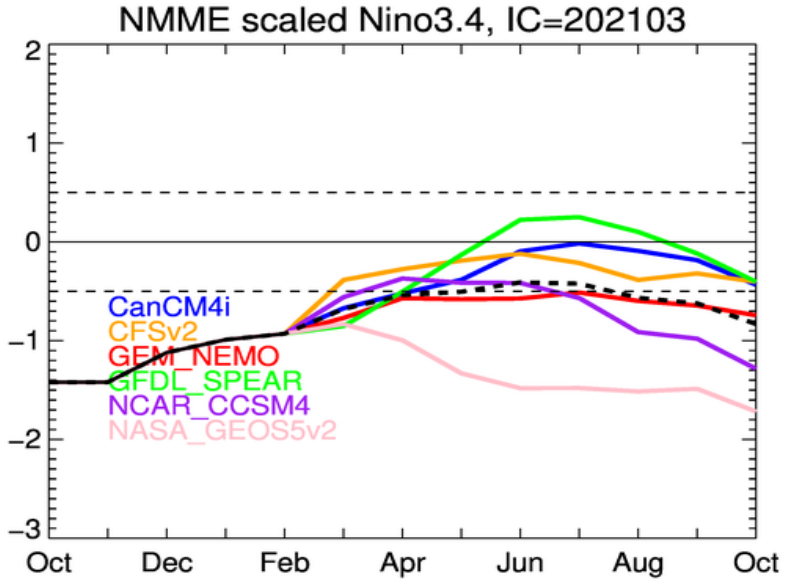


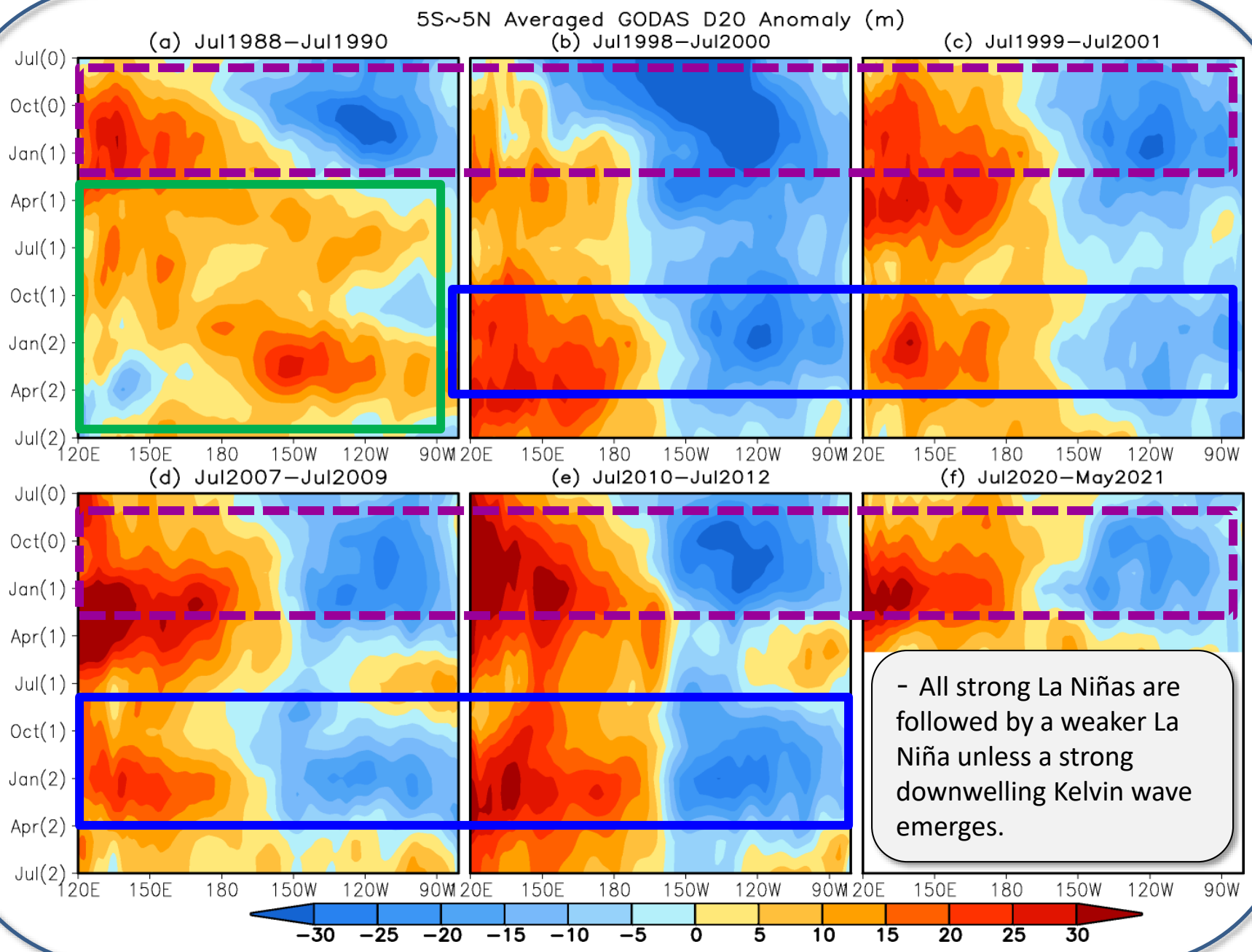
NMME forecasts with the latest 4-month initial conditions



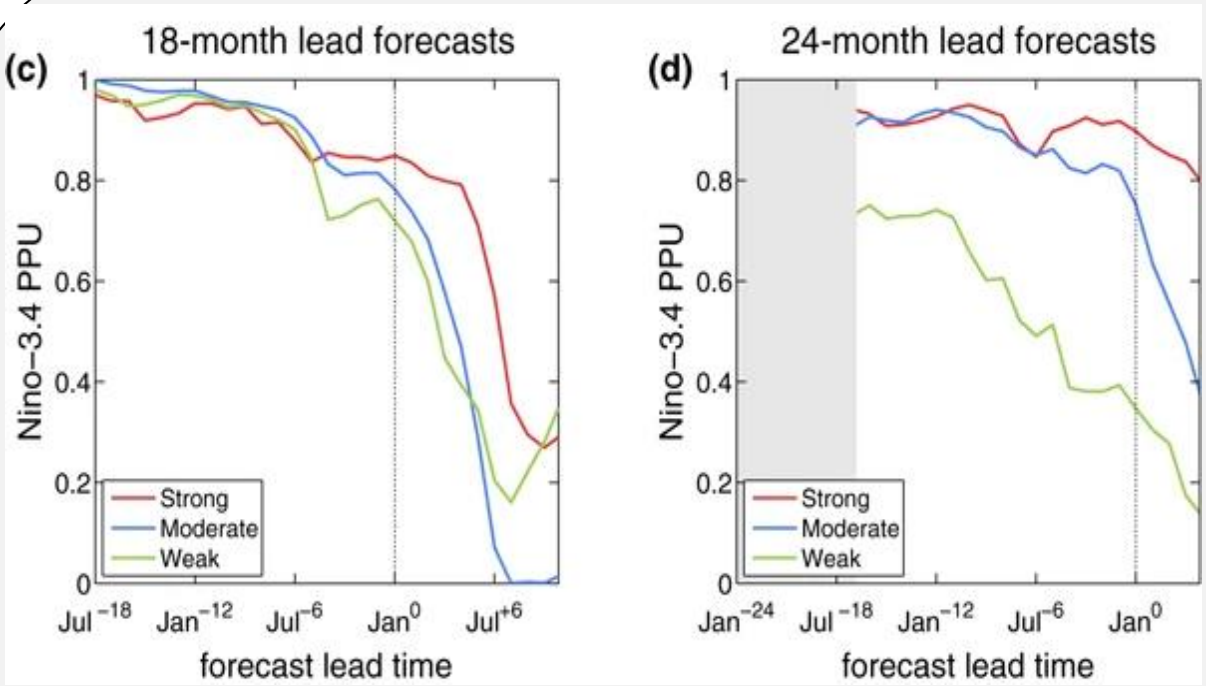







5S~5N Averaged GODAS D20 Anomaly (m)
(a) Jul1988–Jul1990
(b) Jul1998–Jul2000
(c) Jul1999–Jul2001
(d) Jul2007–Jul2009
(e) Jul2010–Jul2012
(f) Jul2020–May2021
Jul(0)
Oct(0)
Jan(1)
Apr(1)
Jul(1)
Oct(1)
Jan(2)
Apr(2)
Jul(2)
120E
150E
180
150W
120W
90W
- All strong La Niñas are followed by a weaker La Niña unless a strong downwelling Kelvin wave emerges.
−30
−25
−20
−15
−10
−5
0
5
10
15
20
25
30

2-year La Nina may be predictable 18 to 24 months in advance



IC: -WWV

IC: El Nino

- A 1800-year long control simulation of CESM1 & forecasts with the perfect model approach.
- A strong thermocline discharge or a strong El Niño can lead to La Niña conditions that last 2 years (2-year LN).

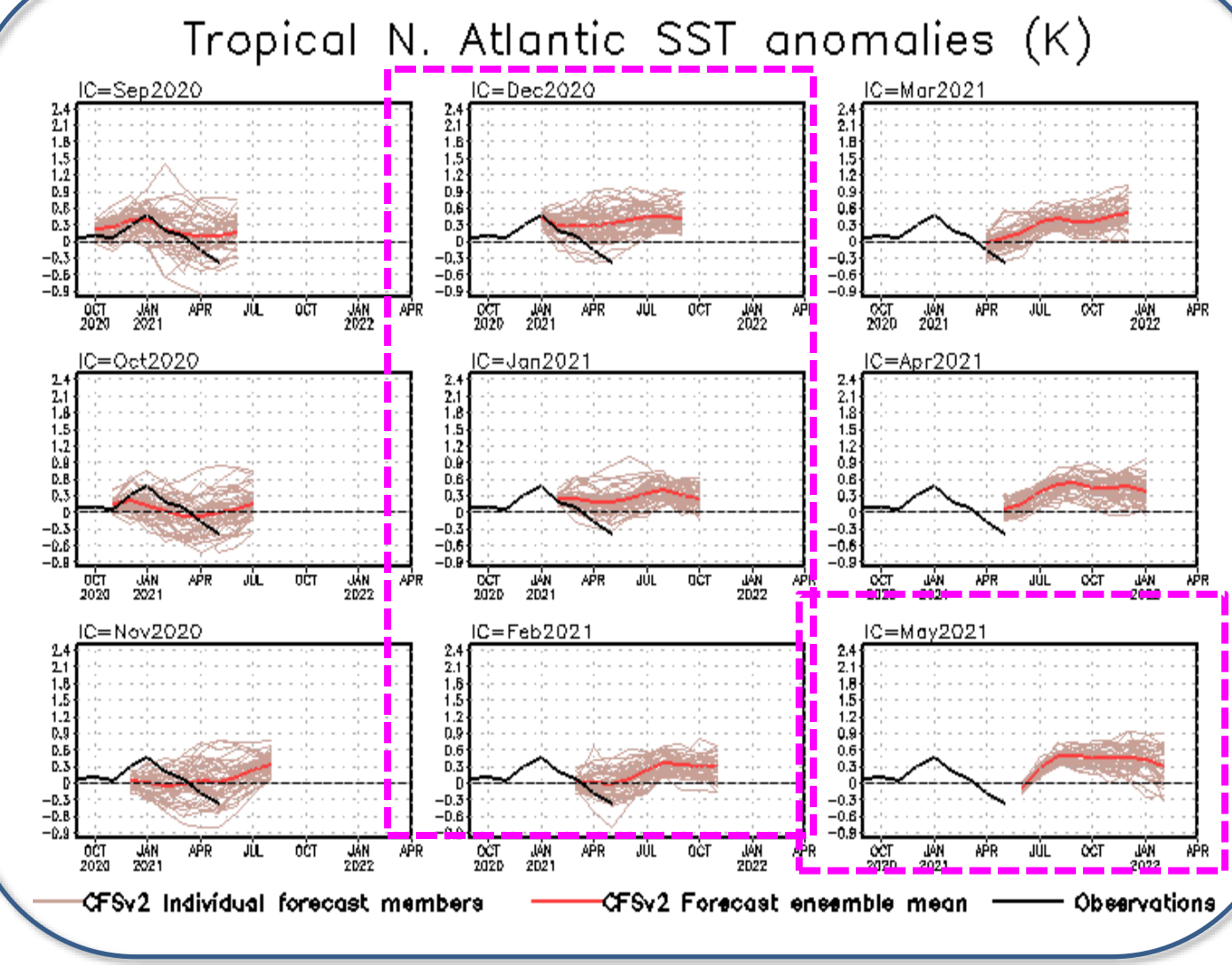
- Forecasts initialized with strong thermocline discharge or strong peak El Niño amplitude show higher predictability than those with initial conditions of weaker magnitude.
- **2-year La Nina may be predictable 18 to 24 months in advance under *specific* initial conditions.**

Temporal evolution of potential prediction utility (PPU) of the Nino-3.4 index for "***perfect CESM1***" in forecasts initialized a during the discharge phase (c) and at the peak of the preceding El Niño event (d). The dashed black line indicates January of the second year (Jan0).

2019	**0.7**	**0.7**	**0.7**	**0.7**	**0.5**	**0.5**	0.3	0.1	0.2	0.3	0.5	0.5
Year	**DJF**	**JFM**	**FMA**	**MAM**	**AMJ**	**MJJ**	**JJA**	**JAS**	**ASO**	**SON**	**OND**	**NDJ**
2020	0.5	0.5	0.4	0.2	-0.1	-0.3	-0.4	**-0.6**	**-0.9**	**-1.2**	**-1.3**	**-1.2**
2021	**-1.0**	**-0.9**	**-0.8**	**-0.7**								

DiNezio, et al, 2017: Predictability of 2-year La Niña events in a coupled general circulation model. Clim. Dyn., 49, 4237–4261.

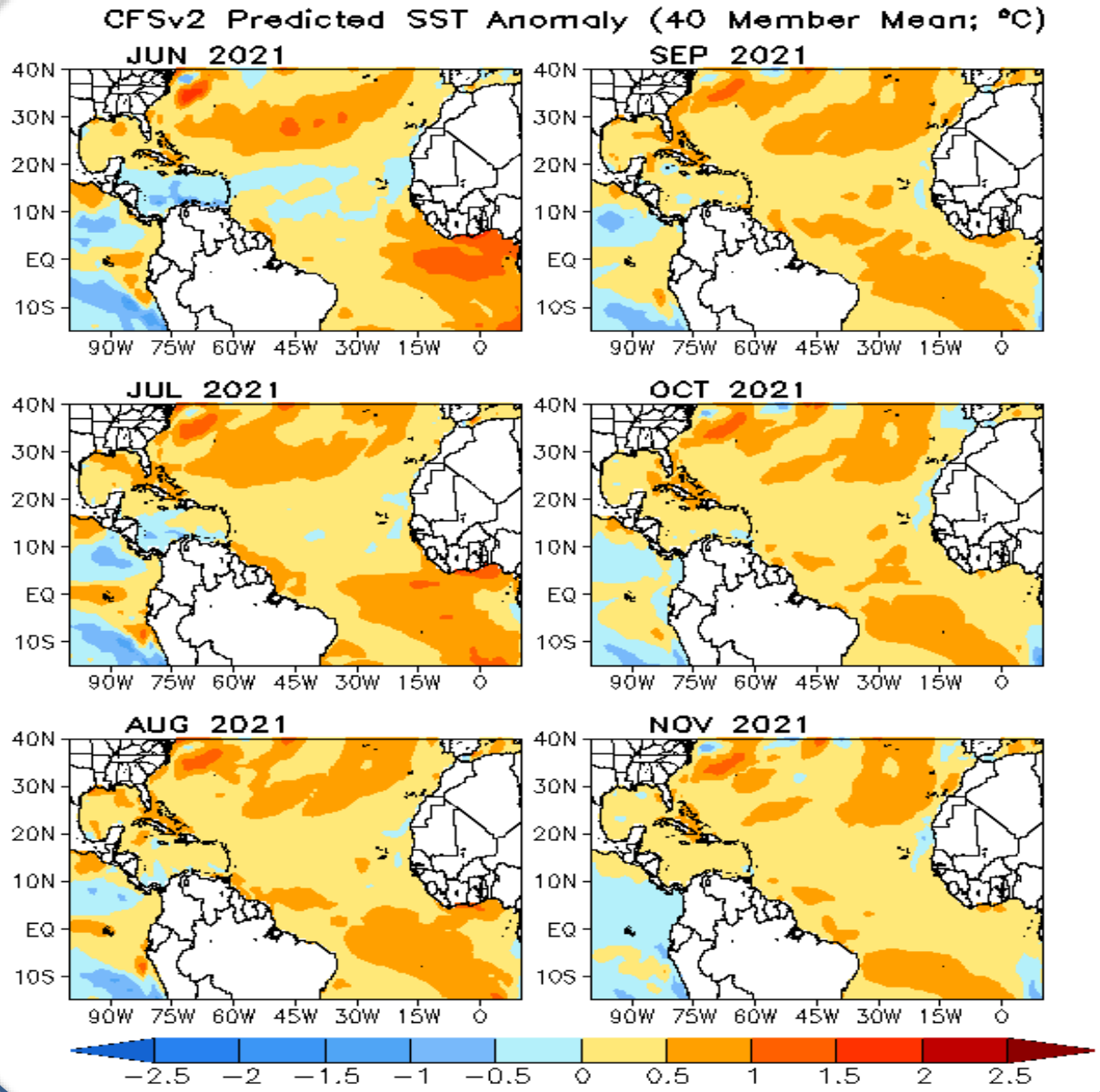
CFSv2 Tropical North Atlantic (TNA) SST Predictions



- Latest CFSv2 predictions call for above normal SSTs in the tropical N. Atlantic in 2021 hurricane season.
- There are warm biases with ICs in Dec 2020-Feb 2021.

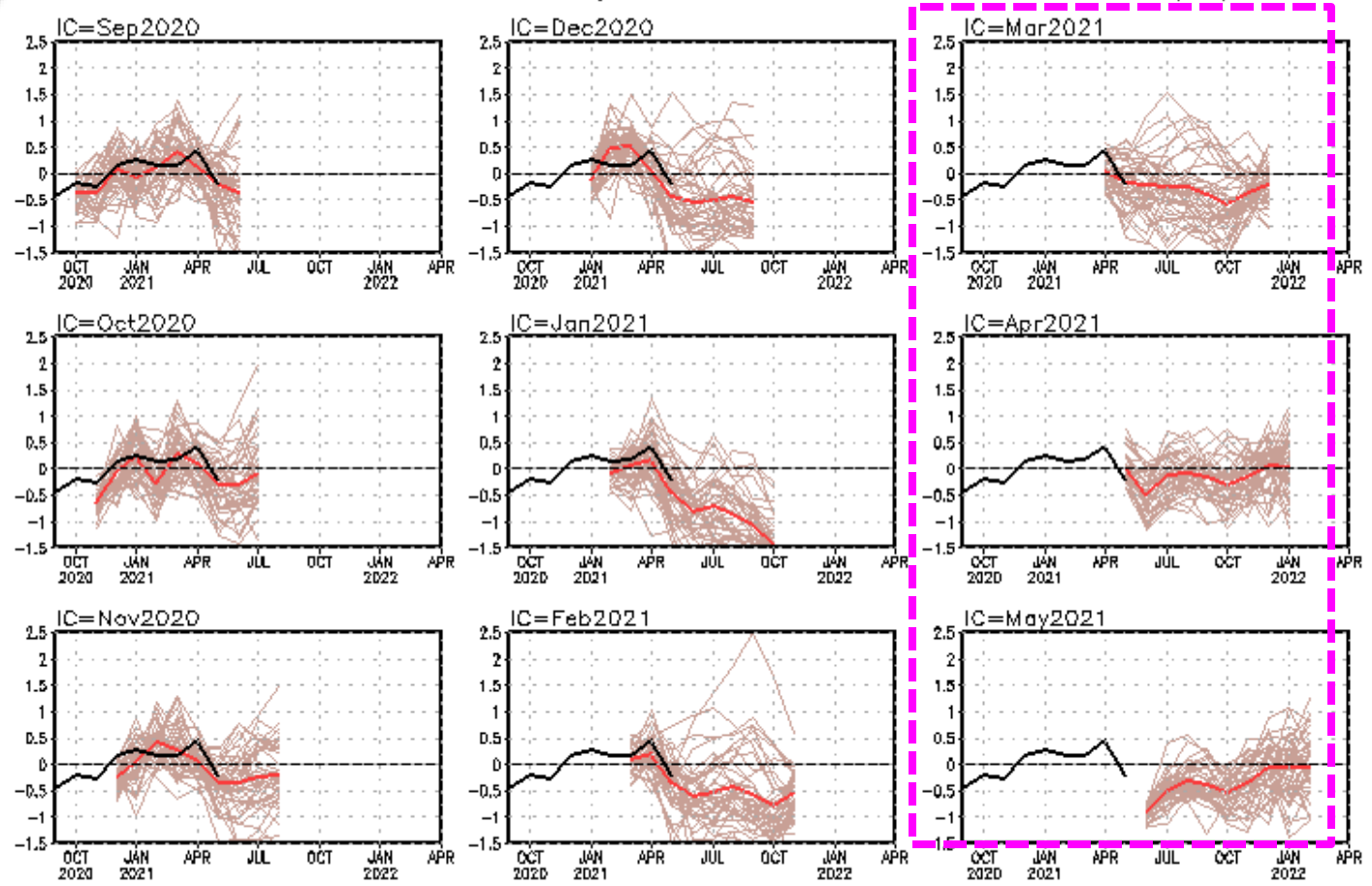
CFS Tropical North Atlantic (TNA) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1991-2020 base period means. TNA is the SST anomaly averaged in the region of [60oW-30oW, 5oN-20oN].

CFSv2 Atlantic SSTA Predictions



- Latest CFSv2 predictions call above-normal SST in the tropical Atlantic in the next 6 months (2021 hurricane season).

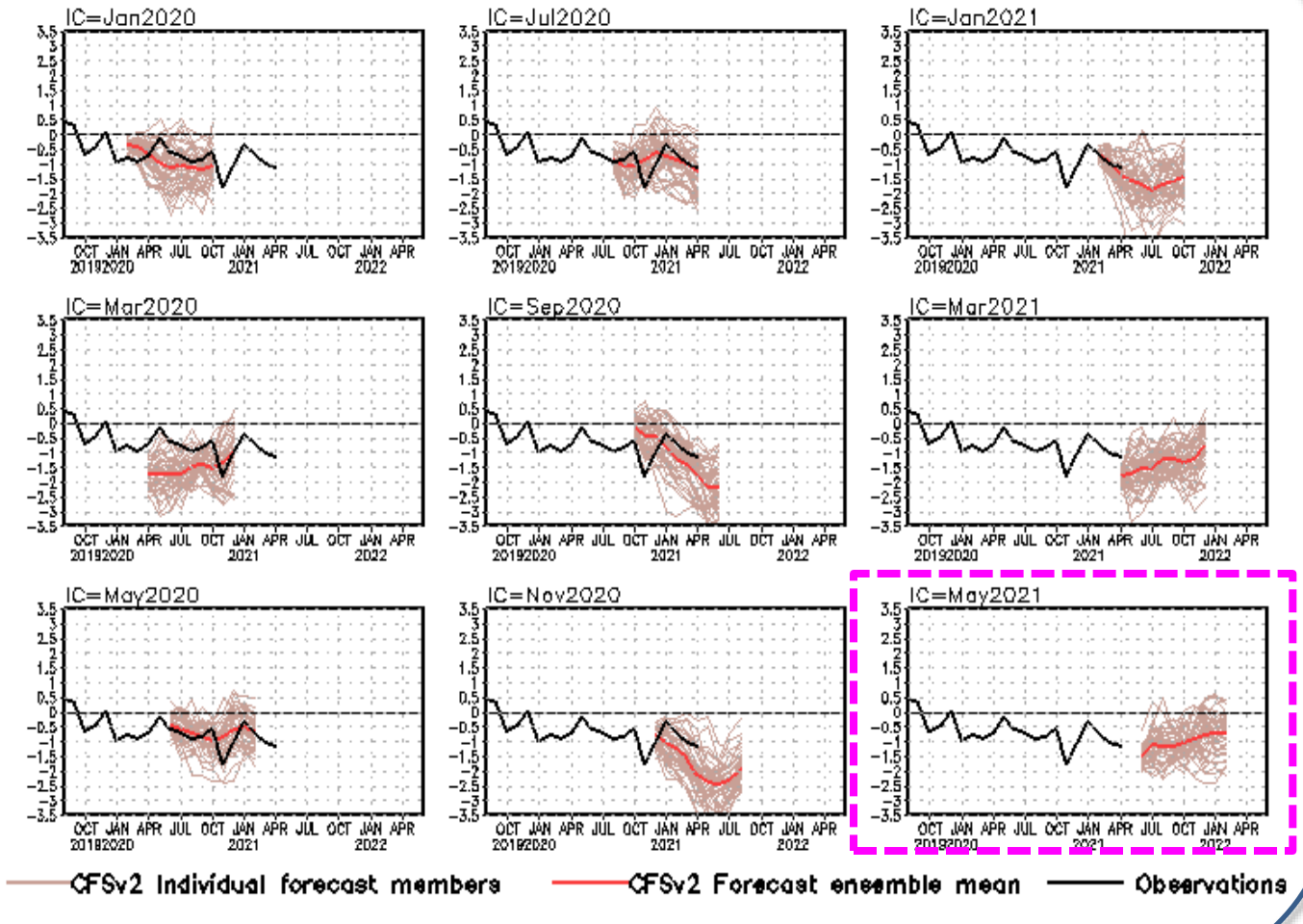
CFSv2 DMI SST Predictions



- Latest CFSv2 predicts a negative phase of IOD in 2021.

CFS Dipole Model Index (DMI) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). The hindcast climatology for 1981-2006 was removed, and replaced by corresponding observation climatology for the same period. Anomalies were computed with respect to the 1991-2020 base period means.

CFSv2 Pacific Decadal Oscillation (PDO) Index Predictions



- CFSv2 predicts a negative phase of PDO in the coming seasons.

CFS Pacific Decadal Oscillation (PDO) index predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1991-2020 base period means. PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110°E-100°W, 20°N-60°N]. CFS PDO index is the standardized projection of CFS SST forecast anomalies onto the PDO EOF pattern.

Acknowledgements

- Drs. Arun Kumar, Caihong Wen, and Jieshun Zhu: reviewed PPT, and provided insightful suggestions and comments

- Drs. Li Ren and Pingping Xie provided the BASS/CMORPH/CFSR EVAP package

- Dr. Wanqiu Wang provided the sea ice forecasts and maintained the CFSv2 forecast archive

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Jieshun.Zhu@noaa.gov

Zeng-Zhen.Hu@noaa.gov

Data Sources (climatology is for 1991-2020)

- **Weekly Optimal Interpolation SST (OI SST) version 2 (Reynolds et al. 2002)**
- **Extended Reconstructed SST (ERSST) v5 (Huang et al. 2017)**
- **Blended Analysis of Surface Salinity (BASS) (Xie et al. 2014)**
- **CMORPH precipitation (Xie et al. 2017)**
- **CFSR evaporation adjusted to OAFlux (Xie and Ren 2018)**
- **NCEP CDAS winds, surface radiation and heat fluxes (Kalnay et al. 1996)**
- **NESDIS Outgoing Long-wave Radiation (Liebmann and Smith 1996)**
- **NCEP's GODAS temperature, heat content, currents (Behringer and Xue 2004)**
- **Aviso altimetry sea surface height from CMEMS**
- **Ocean Surface Current Analyses – Realtime (OSCAR)**
- **In situ data objective analyses (IPRC, Scripps, EN4.2.1, PMEL TAO)**
- **Operational Ocean Reanalysis Intercomparison Project**

  http://www.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html

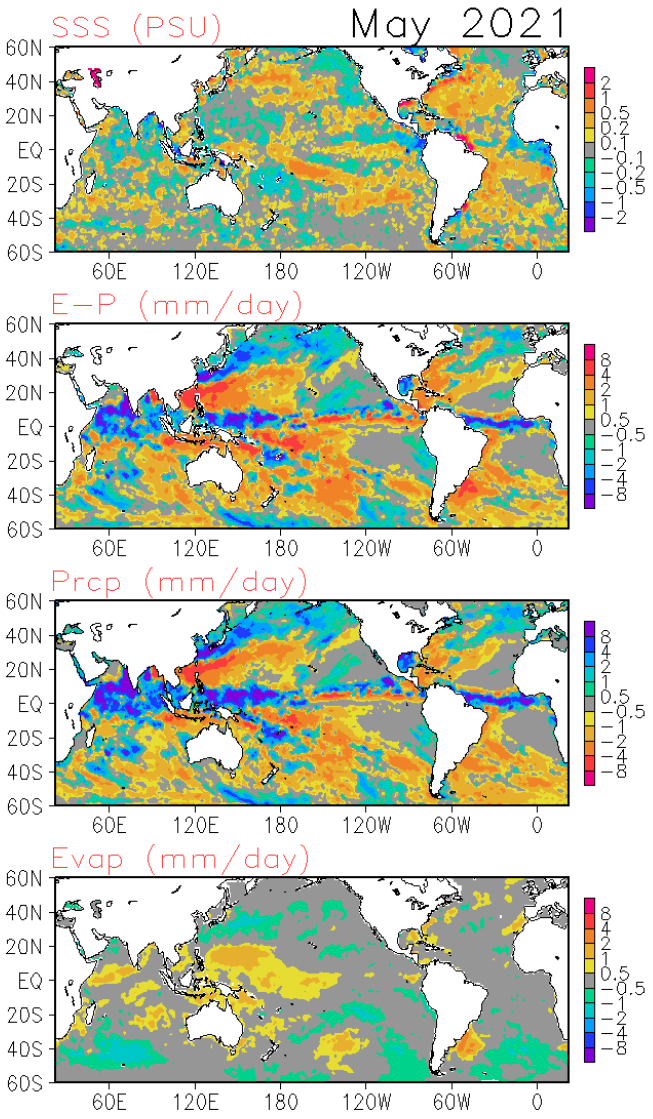
  http://www.cpc.ncep.noaa.gov/products/GODAS/multiora93_body.html

Backup Slides

Global Sea Surface Salinity (SSS): Anomaly for May 2021

New Update: The NCEI SST data used in the quality control procedure has been updated to version 2.1 since May 2020;

Positive SSS anomaly still continues in the western equatorial Pacific Ocean and SPCZ region. Positive SSS anomaly along the Equatorial Pacific Ocean east of date line continues. Also, positive SSS anomaly in the central N. Pacific Ocean between 20° N and 40° N continues. Positive SSS anomaly is persistent between equator and 40° N in the North Atlantic Ocean. Negative SSS anomaly appears in the Indian Ocean north of Equator, which is likely cause by increased precipitation.



SSS : Blended Analysis of Surface Salinity (BASS) V0.Z

(a CPC-NESDIS/NODC-NESDIS/STAR joint effort)

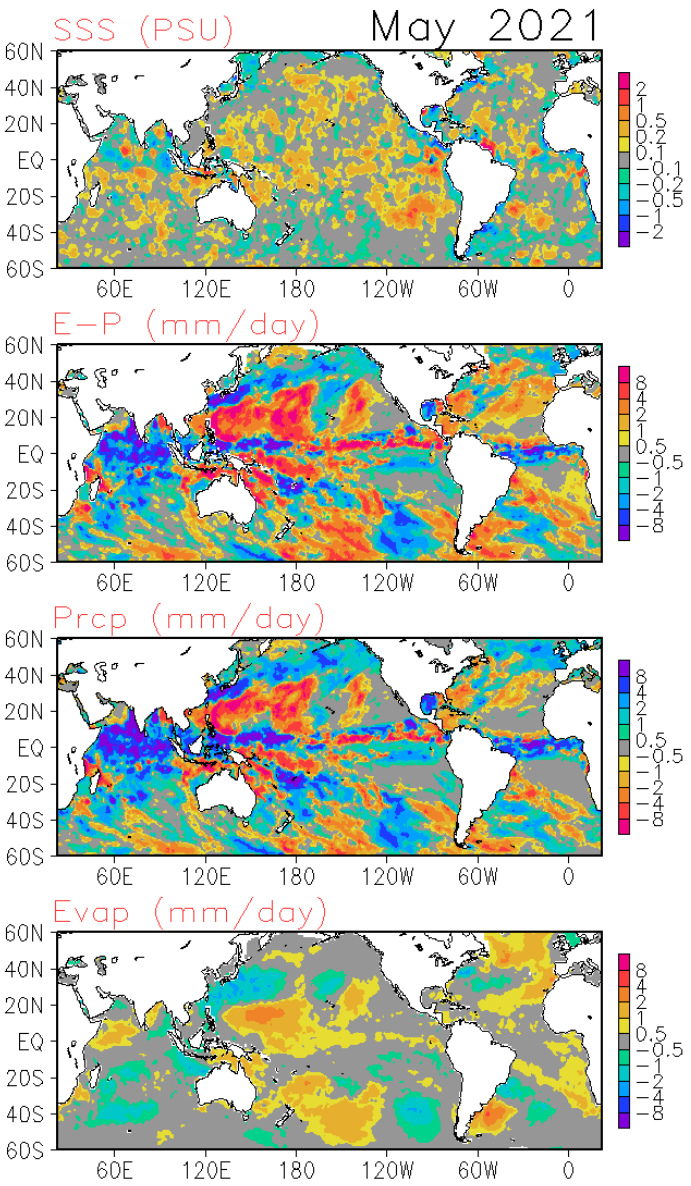
ftp.cpc.ncep.noaa.gov/precip/BASS

Precipitation: CMORPH adjusted satellite precipitation estimates

Evaporation: Adjusted CFS Reanalysis

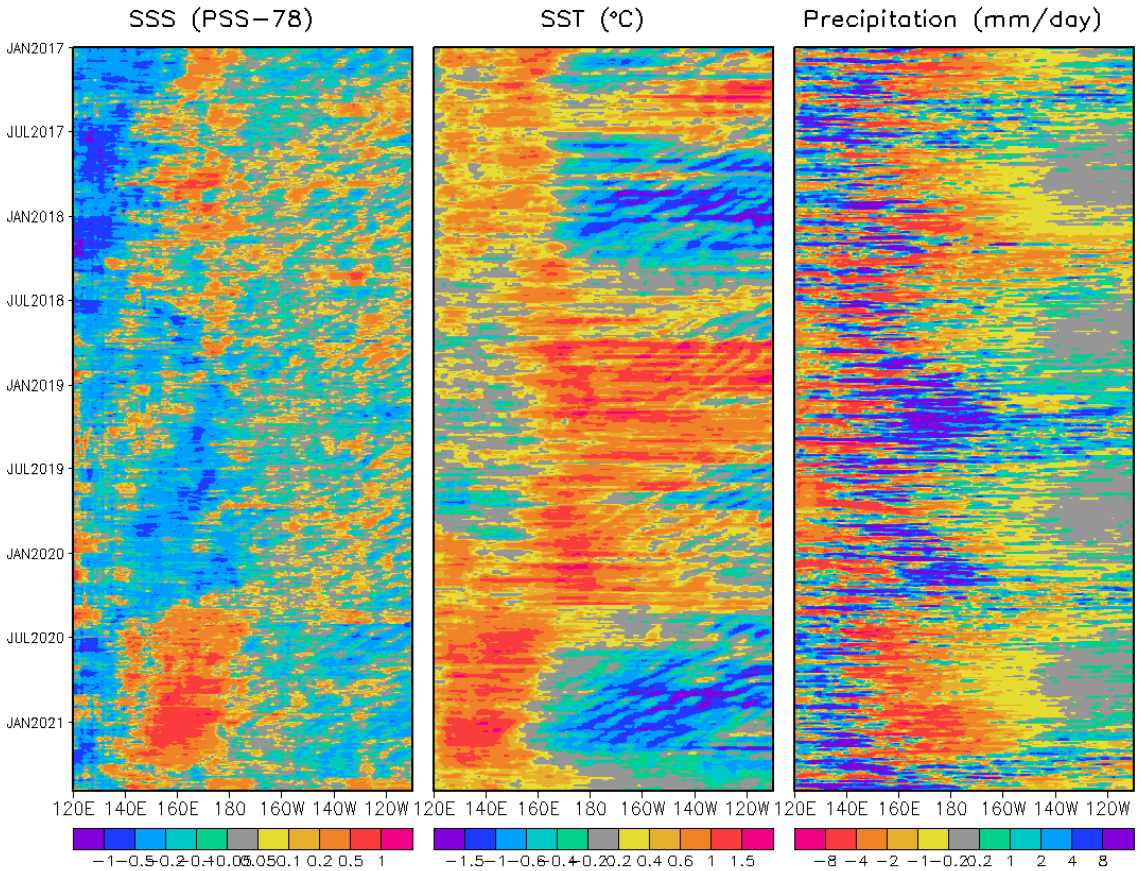
Global Sea Surface Salinity (SSS): Tendency for May 2021

Compared with last month, SSS continues increasing in most of the area of the N. Pacific between equator and 40° N. SSS also increases in the North Atlantic Ocean between Equator and 40° N. In the equatorial Atlantic Ocean, the SSS continues increasing along the equator which is likely due to reduced precipitation. SSS decreases in the Indian Ocean in most areas north of equator.

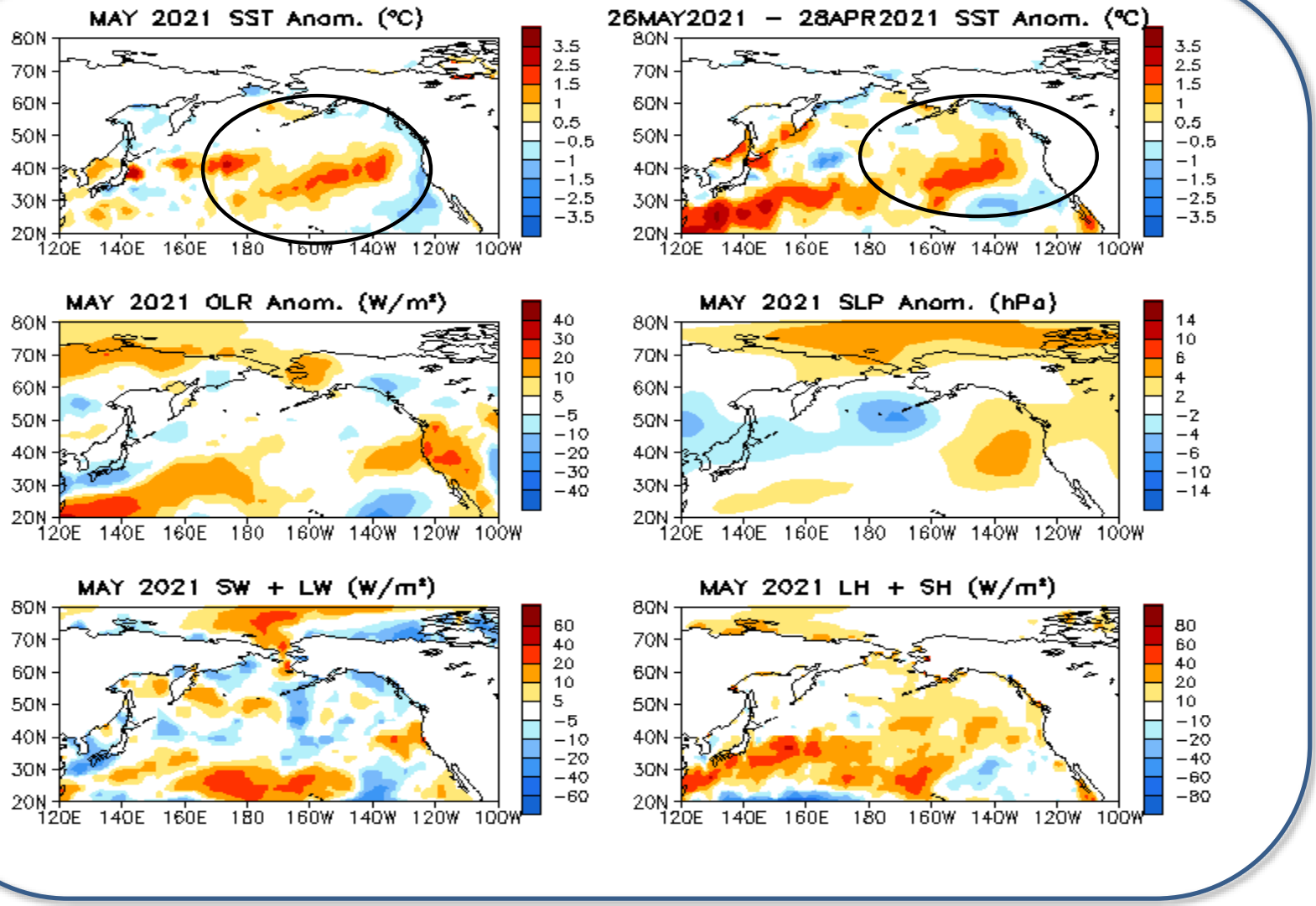


Pentad SSS Anomaly Evolution over Equatorial Pacific

Figure caption:
Hovemoller diagram for equatorial (5° S-5° N) 5-day mean SSS, SST and precipitation anomalies. The climatology for SSS is Levitus 1994 climatology. The SST data used here is the OISST V2 AVHRR only daily dataset with its climatology being calculated from 1985 to 2010. The precipitation data used here is the adjusted CMORPH dataset with its climatology being calculated from 1999 to 2013.

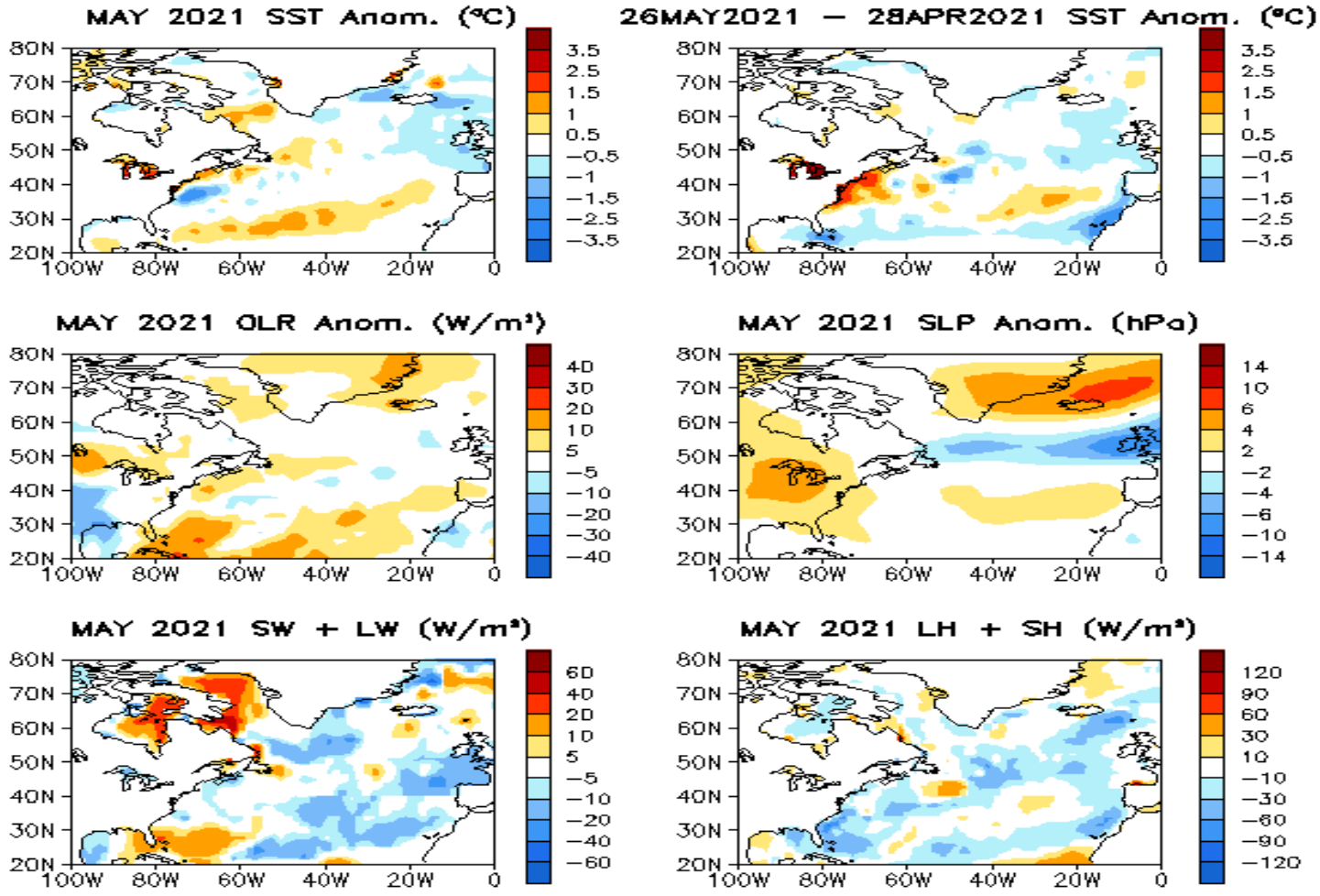


North Pacific & Arctic Ocean: SSTA, SSTA Trend, OLR, SLP, Heat Flux Anomalies

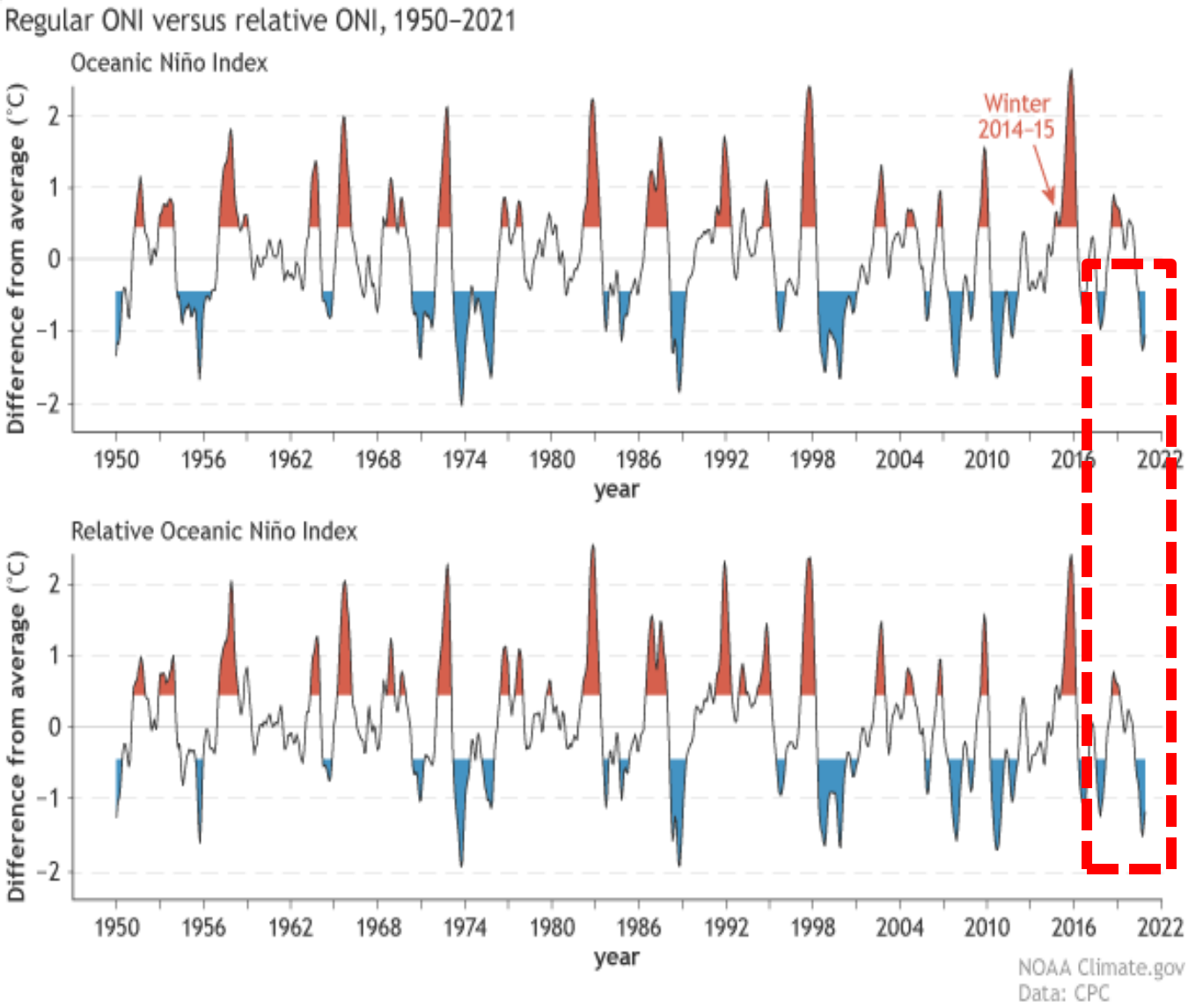


Sea surface temperature (top-left; NCEP OI SST Analysis), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) (middle-left; NOAA 18 AVHRR IR), sea surface pressure (middle-right; NCEP CDAS), sum of net surface short- and long-wave radiation (bottom-left; positive means heat into the ocean; NCEP CDAS), sum of latent and sensible heat flux (bottom-right; positive means heat into the ocean; NCEP CDAS). Anomalies are departures from the 1991-2020 base period means.

North Atlantic Ocean: SSTA, SSTA Trend, OLR, SLP, Heat Flux Anomalies

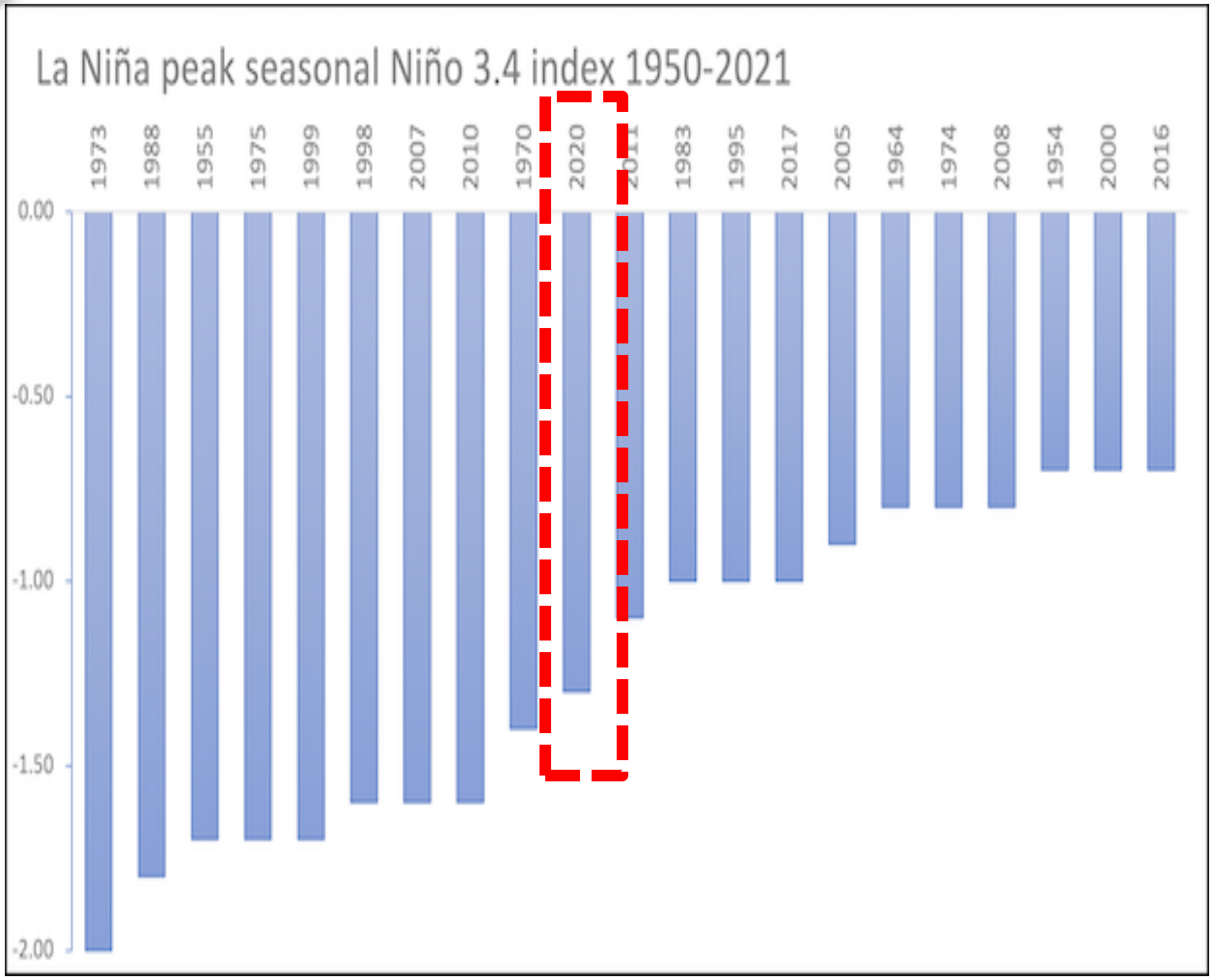


Sea surface temperature (top-left; NCEP OI SST Analysis), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) (middle-left; NOAA 18 AVHRR IR), sea surface pressure (middle-right; NCEP CDAS), sum of net surface short- and long-wave radiation (bottom-left; positive means heat into the ocean; NCEP CDAS), sum of latent and sensible heat flux (bottom-right; positive means heat into the ocean; NCEP CDAS). Anomalies are departures from the 1991-2020 base period means.



- With the relative Niño3.4 index, the strength of 2020/21 La Niña increased slightly, compared with the Niño3.4 index.

https://www.climate.gov/news-features/blogs/enso/enso-running-fever-or-it-global-warming

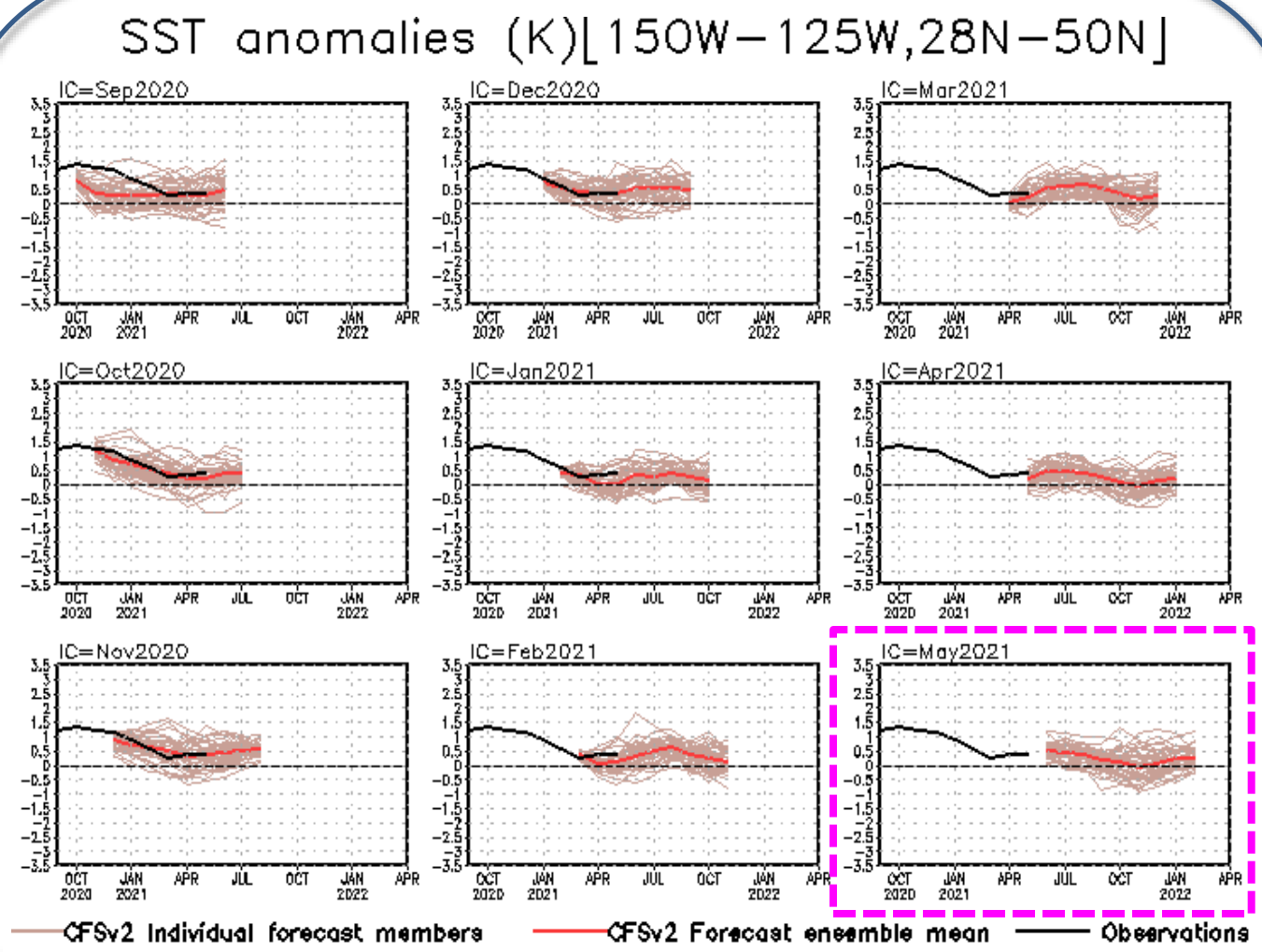


- 2020/21 La Niña ranks 10th strongest La Niña event since 1950 based on 3-month mean Niño3.4.

Peak seasonal (3-month-average) sea surface temperature anomalies in the ENSO 3.4 region for all La Niña events since 1950. The year label is the first year of the event; e.g., "2020" is the "2020–21" La Niña.

https://www.climate.gov/news-features/blogs/enso/april-2021-enso-update-spring-triathlon

CFSv2 NE Pacific Marine Heatwave Index Predictions



- Latest CFSv2 predictions call weakening of the positive SSTAs in the NE Pacific in 2021.

CFS NE Pacific SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1991-2020 base period means.