CLIMATE NARRATIVE, September 2020 and as noted

Climate_Narratives may be found, https://coastwatch.pfeg.noaa.gov/elnino/coastal_conditions.html
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UNITED STATES WEST COAST AND NORTH PACIFIC

During late **September** 2020, US west coast (20-200 km offshore) satellite derived sea surface temperature (SST_S) anomaly was predominantly positive (≤2.5°C) from northern Mexico to the western Gulf of Alaska (25°-60°N). However, negative SST_S anomalies (≥ -1.5°C) occurred north of Point Conception, from 34°N to 36°N (SST_S between 13°-15°C), and off central Oregon (44°N - 45°N) where a filament of 14°-18°C surface water reached more than 300 km offshore. Filaments with SST_S ≤ 18°C reached more than 250 km westward off northern California. Coastal SST_S between 10°-12°C occurred from Washington State northward, and south to 37°N. North of 42°N positive coastal SST_S anomalies extended near-continuously across the north Pacific. South of 35°S positive coastal anomalies (≤ 2°C), with SST_S between 19°-22°C, reached 500-700 km seaward and merged into neutral SST_S anomaly, where SST_S was 20°-23°C. Two prominent north Pacific Ocean-wide zonal features were a band of generally positive SST_S anomaly (≤2.5°C) between 30°-50°N and a band of neutral to negative (≥-2°C) SST_S south of 20°N to 10°S. As in previous months, the positive anomaly was more spatially extensive in the west, extending from the northern Indian Ocean through Indonesia to the coasts of Japan, China and Russia. (5°S, 60°E-60°N, 170°E). Positive SST_S anomaly eased south of the Aleutian Island Chain but remained high in the central Gulf of Alaska and Bering Sea.
https://www.ospo.noaa.gov/Products/ocean/sst/anomaly/ https://coastwatch.pfeg.noaa.gov/elnino/coastal_conditions.html (current)
https://coastwatch.pfeg.noaa.gov https://climatereanalyzer.org/wx/DailySummary/#sstanom (current)
https://www.ospo.noaa.gov/Products/ocean/sst/contour/index.html https://psl.noaa.gov/data/gridded/data.noaa.oisst.v2.highres.html
https://www.fisheries.noaa.gov/feature-story/current-sea-surface-temperatures-eastern-bering-sea https://twitter.com/noaafisheriesak
https://www.fisheries.noaa.gov/feature-story/central-gulf-alaska-marine-heatwave-watch?utm_medium=email&utm_source=govdelivery

Sea Level Height Anomaly (SLA) analyses of the Pacific Ocean (30°S-40°N) for late **September**, showed persistent negative SLA (≥-10 cm) along the coast of North America from the equator northward beyond 40°N. South of 15°N these negative anomalies extended west to 160°E. A trough of anomaly deeper than -25 cm occurred between 10°-14°N and 120°-170°W. Another trough (≥-15 cm) occurred along the equator between 90°W and 170°W. Positive SLA was more common west of 180°E/W from the equator to 10°N and between 20°-40°N. Four areas west of 170°E, where SLA isopleths enclosed elevations greater than 15 cm, may mark vigorous heat transport in the Kuroshio Current and Kuroshio extension.
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ocean/weeklyenso_clim_81-10/wksl_anm.gif (current)

During late September, coastal areas with **surface chlorophyll-a** (chl-a) concentrations of 0.5- 2.5 mg/m^3 were seen along shore from 28°-52°N. This coastal zone of high chl-a reached more than 500 km off northern California, Oregon and reached from the Washington coast westward across the north Pacific. The coastal areas of 0.5- 2.5 mg/m^3 were generally less developed offshore central California (35°-37°N). Off southern California, ocean surface layers had generally lower concentrations (0.5- 1.5 mg/m^3). Coastal spatial patterns were generally less continuous off northern Mexico. Low chl-a oceanic water (0.05-0.09 mg/m^3) was found within 50 km of shore at 30°N.
Recent imagery is available. https://coastwatch.pfeg.noaa.gov/coastwatch/CWBrowserWW180.jsp#

https://coastwatch.pfeg.noaa.gov/elnino/coastal_conditions.html (current)

Monthly sea temperature list from shore stations and **near-shore buoys,**

The following list shows shore and nearshore water temperature measurement locations along the US west coast in decreasing latitude. Each line begins with a shore station or buoy abbreviation followed by latitude. Temperature values are in brackets with the average of available monthly values first (followed by the range and standard deviation) in parens and change from previous monthly mean. Averages for the first, second and third monthly terciles are within the second parens, followed by the multiyear monthly average, where available. Subscripts H and L show terciles containing highest and lowest monthly temperatures.

September shore and near shore temperature showed: 1) a warming trend through September, with the lowest temperatures found in the first tercile, 2) generally warmer than multi-year monthly mean temperatures, 3) temperature change from August less than 1.5°C, except at Port Orford (PrtO) where the average temperature increased 2.4°C, and 4) a range of 10°C (11.2°0-21.2°C) from Neah Bay (NeBy) to the Torry Pines Buoy (Tory).

Amphitrite Point, B.C. 48.9°N

Neah,48.5°N,124.7°W [12.1(10.0-14.6,1.0)-0.3(11.5, 11.9_{L}, 12.8_{H})11.2°C]

Cape Flattery 48.4°N

NeBy,48.4°N *[11.2(8.9-14.2, 1.3)-0.3(*10.7_{L}*, 10.8,* 12.1_{H}*)°C]*

CpEz,47.4°N,124.7°W [14.7(12.5-16.7, 1.0)-0.3(14.3_{L}, 14.4_{LH}, 15.4_{sH})13.5°C]

Cape Blanco 42.8°N

PrtO,42.7°N *[12.8(8.2-15.7,1.8)2.4(*10.7_{L}*, 12.9,* 14.6_{H}*)°C] Hi ∂*

CCty,41.7°N *[14.1 (10.2-16.7, 1.1)-0.7(*13.4_{L}*,* 14.1_{H}*,* 14.8_{H}*)°C]*

EelR,40.7°N,124.5°W [14.2(10.2-17.4, 1.9)1.5(12.3_{L}, 14.1,16.1_{H})12.7°C] Hi ∂

Point Arena 39°N

ArCv,38.9°N *[12.1(10.8-14.1, 0.8)0.0(*12.5_{LH}*,* 12.3_{L}*, 11.6)°C]*

Point Reyes 38°N

SFrn,37.8°N,122.8°W [14.6(12.1-17.3,1.0)1.3(14.0_{L}, 15.1_{LH}, 14.7)14.4°C] Hi ∂

Mtry,36.6°N *[16.1(13.4-18.7, 1.1)-0.6(*16.8_{LH}*,* 15.2_{L}*, 16.3)°C]*

Point Sur 36.3°N

PrtS,35.1° *[15.7(14.1-18.2, 0.7)0.4(*15.9_{LH}*, 15.6, 15.7)°C]*

PtCn,34.5°N,120.8°W [16.2(13.6-19.0, 1.2)1.4(16.4_{L}, 16.0,16.2_{H})°C]

Point Conception,34.4°N

SBCh,34.3°N,119.9°W [18.5(16.4-20.7, 0.7)0.7(18.7,18.3_{L}, 18.5_{LH})17.4°C]

SMca,34°N *[19.8(16.0-22.0, 1.2)0.2(*19.5_{LH}*, 19.7 20.4)°C]*

Tory,32.9°N,177.4°W [21.2 (19.4-24.9,0.7)0.4(21.7_{L}, 21.5_{H}, 20.5_{H})°C]

LaJo,32.9°N *[20.0(13.7-22.9, 2.0)1.1(*19.5_{LH}*,21.1, 19.4)°C]*

Point Loma, 32.7°N

Shore temperature measurements, taken at fixed depth below the lowest tide at NOAA **tide stations**, are in italics: *NeBy* (9443090), *PrtO* (9431647), *CCty* (9419750), *ArCv* (9416841), *Mtry* (9413450), *PrtS* (9412110), *SMca* (9410840), *LaJo* (9410230). (Numbers) lead to detailed location and station descriptions, https://tidesandcurrents.noaa.gov/stations.html?type=Physical%20Oceanography

. Near shore buoy measurement details are obtained from number designations: Neah (46087), CpEz (46041),TlMk (46089), EelR (46022), SFrn (46026), PtCn (46218), SBCh (46053),Tory (46225) . https://www.ndbc.noaa.gov/station_page.php?station=46087

EQUATORIAL AND SOUTH PACIFIC

During **September**, La Niña (cool phase ENSO) conditions intensified across the central and eastern equatorial Pacific (EP) and these are expected to continue through the northern winter. East of 150°W negative EP subsurface temperature anomalies (≥ -2.5°C) became more extensive from the surface to 200 m. Positive subsurface temperature anomalies increased below 100 m west of 150°E. The eastern EP upper 300 m heat content anomaly became more strongly negative during July and in August appeared to reach the minimum that persisted through September. Westward wind anomalies persisted over the central EP during September. Positive outgoing radiation anomalies, indicating suppressed convection and precipitation, occurred across the EP from 140°E to 180°E/W. North of 10°S negative SST_S anomalies increased in the south Pacific east of 180°E/W. Neutral and negative SST_S anomalies persisted along the South American coast from the equator to 50°S. A wide band (10°-50°S), spreading meridionally in the west, of predominately positive SST_S anomaly was seen between 130°W-135°E. Negative SST_S anomaly occurred on the south and west coasts of Australia. https://www.ospo.noaa.gov/Products/ocean/sst/anomaly/
https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf
https://coastwatch.pfeg.noaa.gov/elnino/coastal_conditions.html (current)
https://coastwatch.pfeg.noaa.gov https://climatereanalyzer.org/wx/DailySummary/#sstanom (current)
https://www.ospo.noaa.gov/Products/ocean/sst/contour/index.html https://psl.noaa.gov/data/gridded/data.noaa.oisst.v2.highres.html

Late September had predominately negative **Sea level height anomaly**(SLA) (≥-20 cm) east of 180°E/W between 30°S-30°N. These areas extended to 160°E at the equator and to the coast of Australia (145°E) at 20°S. Coastal areas of South America had increasingly negative SLA ≥ -15 cm. In the western Pacific positive SLA anomaly occurred north from 10°S across the equator into Indonesian seas.
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ocean/weeklyenso_clim_81-10/wksl_anm.gif (current)

The NOAA **Oceanic El Niño Index** (ONI) (3-month running mean of ERSST.v5 anomalies in the Nino 3.4 region) decreased during April-May-June (AMJ), MJJ, JJA and JAS to 0.0, -0.2, -0.4, -0.6, respectively, trending toward La Niña conditions.
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf
https://climatedataguide.ucar.edu/climate-data/multivariate-enso-index (alternate El Niño index)

The NOAA/PSL **Southern Oscillation Index** (SOI) values for January-September 2020 are 0.30, -0.10, -0.20, 0.30, 0.70, -0.60, 0.70, 1.8, 1.5. Positive values are associated with negative phase ENSO (La Niña). https://psl.noaa.gov/data/correlation/soi.data
https://psl.noaa.gov/site_index.html#s https://www.longpaddock.qld.gov.au/soi/

The NOAA/NCEI **Pacific Decadal Oscillation Index** (PDO), calculated from the North Pacific ERSST.v5 was -0.52, -0.75, -0.81 and -1.20 during May, June, July and August, respectively, with an increase to -1.01 for September. **PDO** and **ONI** indices are recalculated and may change through the month as data are assimilated into ERSST.v5. https://www.ncdc.noaa.gov/teleconnections/pdo/ , http://research.jisao.washington.edu/pdo/PDO.latest.txt

The **Pacific/North American Teleconnection Index** (PNA), computed from atmospheric pressure over the Pacific Ocean and North America had weakly positive daily values during September, with a monthly "Historical PNA index" of 0.59. The PNA pattern is a natural internal mode of climate variability that is strongly influenced by the El Niño/Southern Oscillation (ENSO). The positive phase of the PNA pattern tends to be associated with Pacific warm episodes (El Niño), and the negative phase tends to be associated with Pacific cold episodes (La Niña). https://www.cpc.ncep.noaa.gov/data/teledoc/pna.shtml (Historical Index) https://www.cpc.ncep.noaa.gov/data/teledoc/pna.shtml (computational alternatives).

September monthly ERD/SWFSC coastal **Upwelling Indices** (UI) remained upwelling favorable (positive) from 27°N to 39°N, but upwelling conditions appeared weaker than average from 24°N to 45°N. Daily UI values suggest lower than average upwelling favorable winds throughout September.
https://upwell.pfeg.noaa.gov/products/PFELData/upwell/monthly/table.2009
https://oceanwatch.pfeg.noaa.gov/products/PFELData/upwell/daily/p09dayac.all (see computational alternatives)
https://oceanview.pfeg.noaa.gov/products/upwelling/dnld (current)

Northwest and Washington River Discharge

Fraser River discharge, measured at Hope (130 km upriver from Vancouver, B.C.) fell to a temporary minimum of 1,900 m^3/s on 22 **September**, then increased to 2,300 m^3/s (81,200 cubic feet per second or cfs) by 30 September when the median discharge is 1,900 m^3/s. . https://wateroffice.ec.gc.ca (Station 08MF005)

The **Queets** at Clearwater, Washington was flowing at 1,730 [799/ 1192, cfs-historical median/ change from previous month as cfs in brackets]. The **Puyallup** at Puyallup was flowing at 719 [677/ -751 cfs]. **Skagit** flow was 11,900 [8,510/ 5,100 cfs] near Mount Vernon. **Stillaguamish** discharge was 503 [419/ 279 cfs] at Arlington. The **Columbia** transport was 25,700 [102,000/ -125,300 cfs] at Vancouver (tidal influence).

Oregon River Discharge

The **Columbia** at the Dalles was 124,000 [100,000/ 28,600 cfs]. The **Wilson** at Tillamook, had 250 [90/ 167 cfs] transport. At Elkton, **Umpqua** transport was 913 [1,160/ 0 cfs]. **Rogue** River flow was 1,140 [1,300/-940 cfs]] at Grants Pass and 1,410 [1,580/-880 cfs] at Agness.

California River Discharge

The **Klamath** near Klamath was transporting 2,360 [3140/ -1,040 cfs]. **Smith** River discharge was 204 [252/ -27 cfs] at Crescent City. The **Eel** at Scotia had 58 [106/ -2 cfs] transport. The **Battle Creek,** Coleman National Fish Hatchery flow was 232 [244/ 21 cfs]. **Butte Creek** at Chico had 91 [114/ -21 cfs] transport. **Sacramento** River transport was 9,060 [11,300/-2,840 cfs] at Verona and 6,930 [12,400/-11,270 cfs] at Freeport. **San Joaquin** flow was 537 [1,530/ 112 cfs] at Vernalis. **Pescadero Creek** transport was 1.0 [2.0/ 0.0 cfs] near Pescadero. **San Lorenzo** discharge was 8.8 [7.0/ 0.7 cfs] at Santa Cruz. The **Pajaro** River at Chittenden was flowing at 2.4 [4.3/ -2.4 cfs]. The **Salinas** and **Carmel Rivers** had no measurable surface flow into the ocean. The **Big Sur** River near Big Sur, discharged at 15 [14/ -3 cfs] during the final days of September.
https://droughtmonitor.unl.edu. https://waterdata.usgs.gov/ca/nwis/nwis
https://www.nwrfc.noaa.gov/water_supply/wy_summary/wy_summary.php?tab=4
https://waterdata.usgs.gov/ca/nwis/current/?type=flow https://watermonitor.gov/naww/index.php

https://www.cpc.ncep.noaa.gov/products/global_monitoring/precipitation/global_precip_accum.shtml
https://www.nwrfc.noaa.gov/water_supply/wy_summary/wy_summary.php?tab=4
https://www.wrh.noaa.gov/cnrfc/rsa_getprod.php?prod=RNORR4RSA&wfo=cnrfc&version=0

Notes for September 2020

Periods of persisting anomalously warm sea temperature (Marine Heat Waves or MHWs) have occurred with increasing frequency over the last decades. MHWs are impacting the ecosystems of the Bering Sea and Gulf of Alaska with changes that will be amplified in unpredictable ways as warming continues. On the eastern Bering Sea shelf, at depths less than 200 m, 2019 Sea Surface Temperature (SST) was near or above previous seasonal maxima recorded through the 1986-2018 period. The SST in the eastern Bering dropped to the multi-year mean in early spring of 2020, but reached 2019 levels again by June and SST remained anomalously high through September. The Gulf of Alaska (GOA) and North Pacific had MHW conditions from June 2014 to January 2017, with SST persistently 2.5°C warmer than previous multi-year means. The abundance and distribution of GOA forage fish, such as capelin (*Mallotus villosus*) and Pacific sand lance (*Ammodytes hexapterus)*, severely impacted survival and reproduction of higher tropic levels, including commercial species. During 2020 GOA SST has oscillated in and out of MHW conditions (persistently above the multi-year 90th percentile SST). MHW conditions occurred 14 July to 3 August, 14 August to 30 August and from 14 September into early October. Cooler periods during 2020 summer and fall had SSTs well above GOA multi-year means. Jordan.Watson@noaa.gov https://twitter.com/noaafisheriesak
https://www.fisheries.noaa.gov/region/alaska
https://www.fisheries.noaa.gov/feature-story/central-gulf-alaska-marine-heatwave-watch?utm_medium=email&utm_source=govdelivery

Where the NOAA Alaska Fisheries Science Center analyses for the Eastern Bering Sea and GOA are for defined for specific locations, Michael Jacox and others (*Nature* **584,** 82–86 (2020) doi.org/10.1038/s41586-020-2534-z) investigated thermal displacements as a metric characterizing MHWs (spatial shifts of SST contours). They used an observation-based global SST dataset to calculate thermal displacements for global MHWs from 1982 to 2019. Thermal displacements during MHWs vary from tens to thousands of kilometers. MHWs are comparable in magnitude to century-scale shifts inferred from warming trends and may give previews of coming physical and ecological consequences of continued warming. Also of interest at sciencemag.org, DOI: 10.1126/science.aba0690 .
https://www.nature.com/articles/s41586-020-2534-z
https://www.fisheries.noaa.gov/feature-story/ocean-heatwaves-dramatically-shift-habitats