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Weather and Coastal Conditions

DEPARTMENT OF ECOLOGY State of Washington

2011 - Monthly	***R**ecent marine weather and coastal conditions*
2011 - Summary	***A** yearly review of atmospheric and oceanic conditions*
Figure Explanation	***F**igure Explanation and data sources*

"Boundary conditions play an important role for water quality in Puget Sound and our coastal Bays

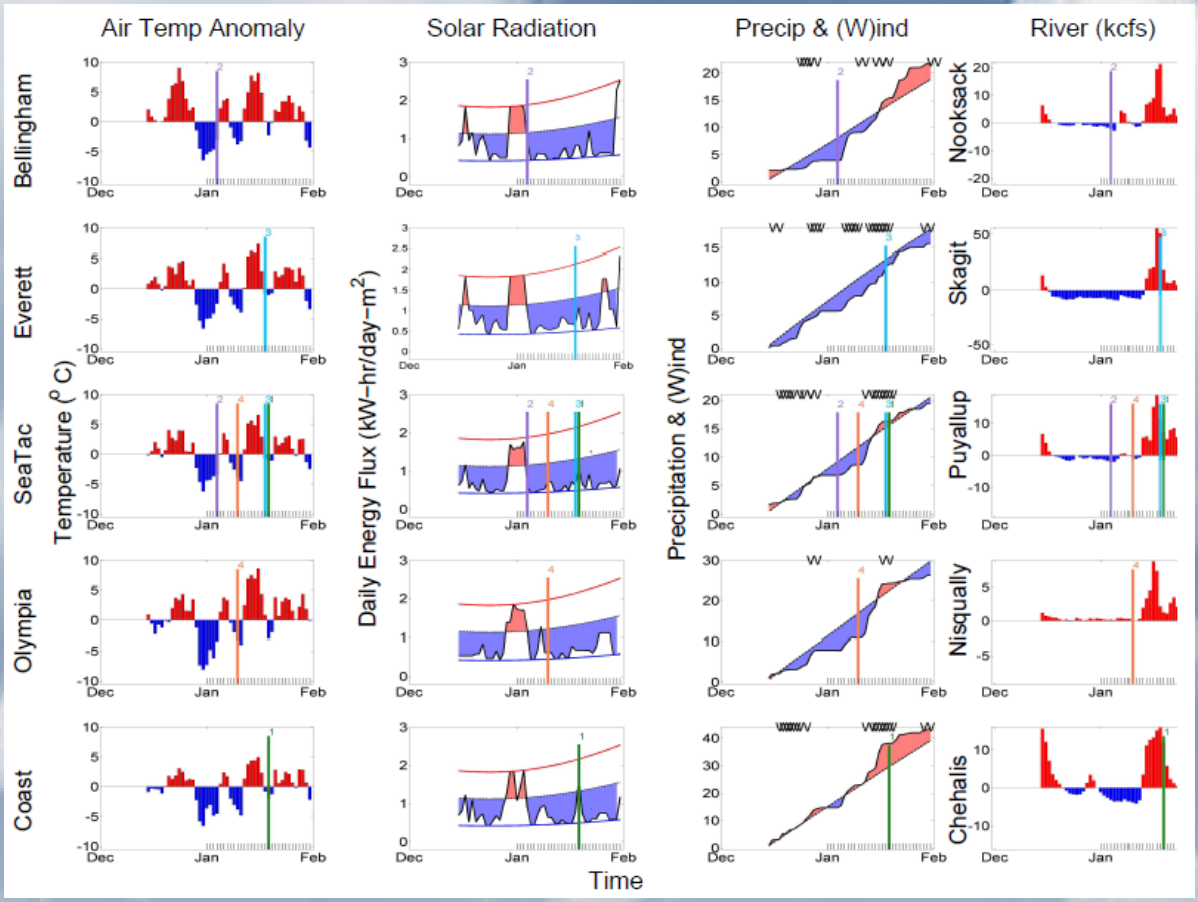
Note: Weather data for this presentation are summarized from external sources.
www-k12.atmos.washington.edu/k12/grayskies/nw_weather.html

(●) Weather ( ) Coastal conditions

Meteorological conditions typically explain up to half of the variance in observed marine variables (Moore et al. 2008), particularly in shallower waters like those of South Puget Sound. The specific conditions prevalent during the past two weeks, from north to south, are shown below.

Summary:

January 2011 began sunny, drier and colder than normal throughout Western Washington. Within a week it became consistently overcast, and precipitation/river flow both became higher than normal during the second half of the month. Wind was either weak and from the north, or stronger and from the SE-SW. Air temperatures flip-flopped from colder-than-normal to warmer-than-normal.



Moore et al. 2008. Local and large-scale climate forcing of Puget Sound oceanographic properties on seasonal to interdecadal timescales. Limnol. Oceanogr., 53(5), 1746–1758

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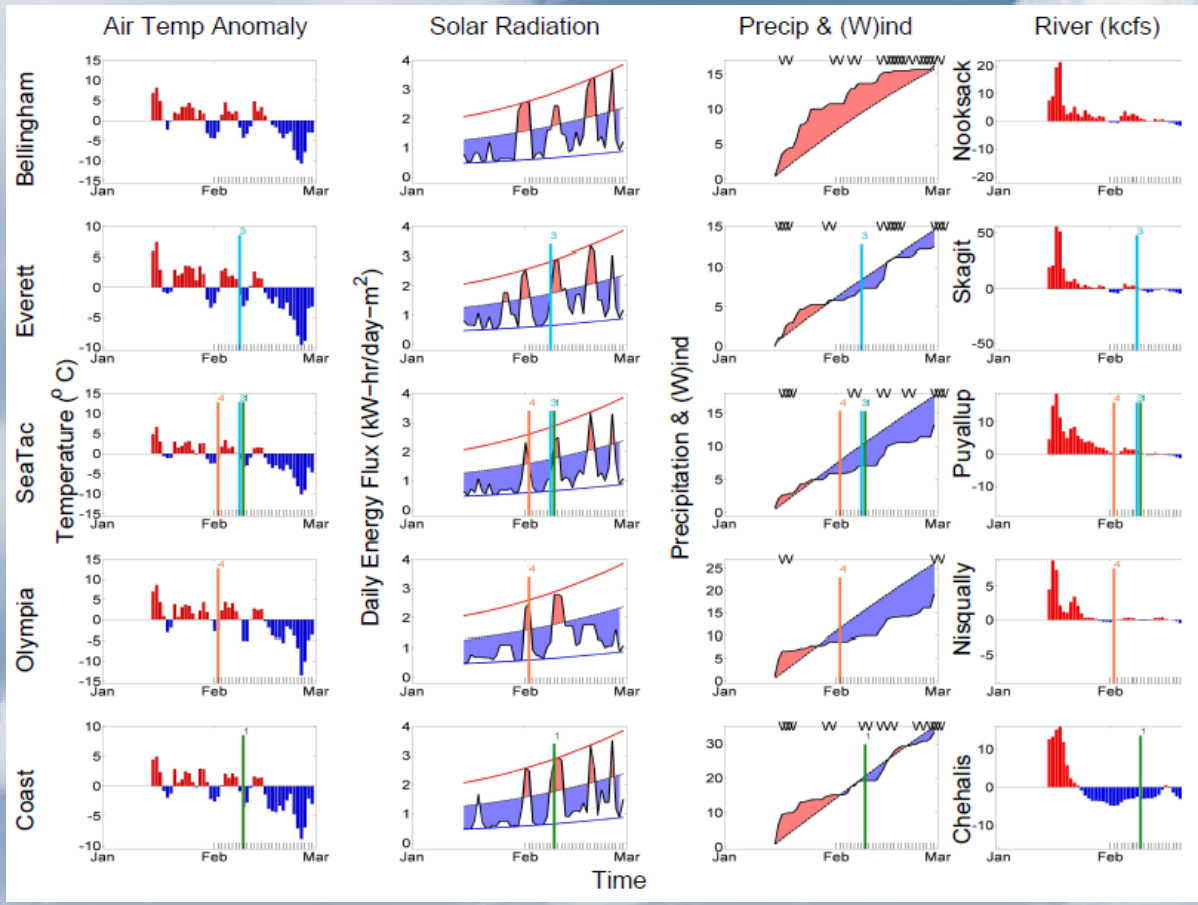
Summary:

February started warm, cloudy, and dry except in the extreme north where it rained. The second half of the month became quite cold and featured a sea-level snowstorm that began on the 23rd. River flow was at or below normal with the colder weather. South Sound and the Coast flights occurred during brief sunny periods; Central Sound flight was after a cloudy period.



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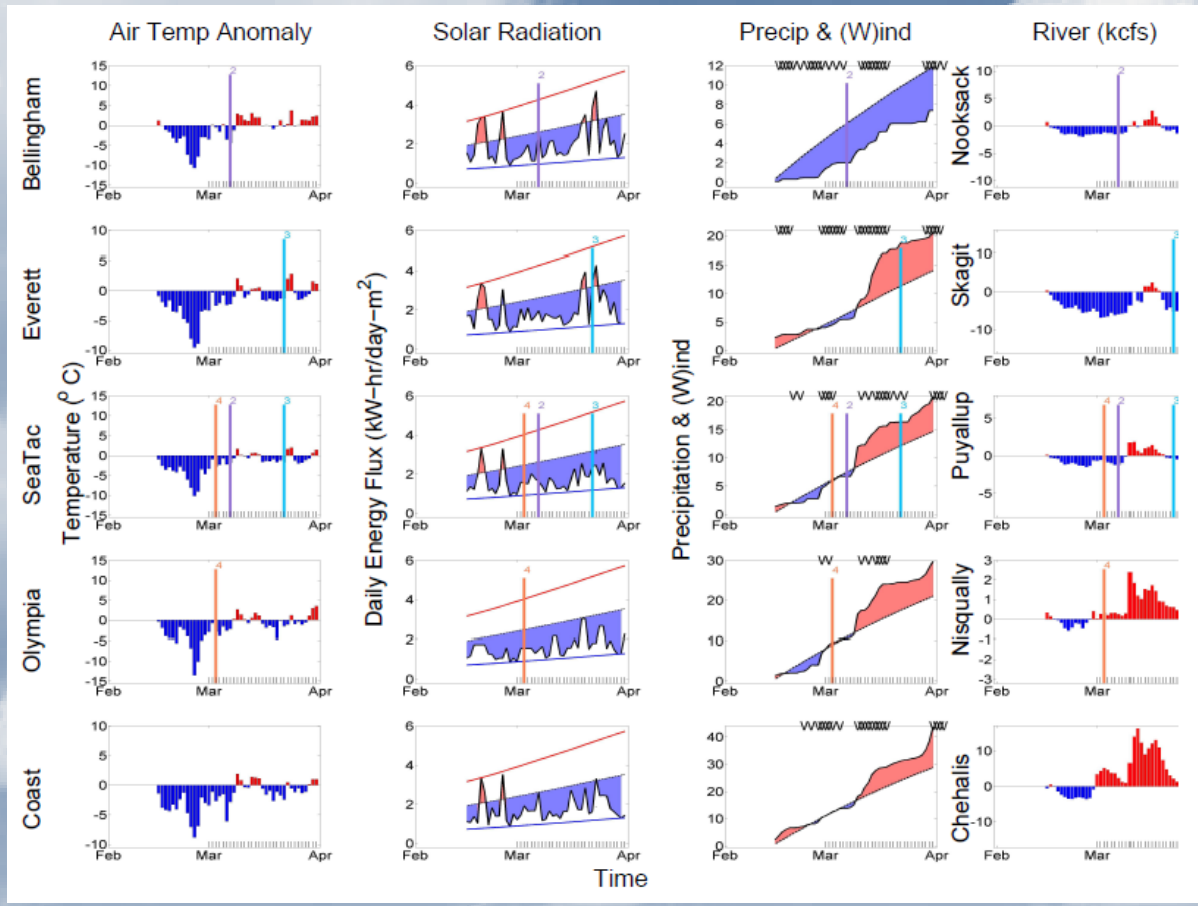
Summary:

March was cloudy and wet everywhere around Western Washington, except toward the extreme north (either that, or there was something wrong with the ASOS rain gauge in Bellingham). Although the first week of March was near normal by many metrics, heavy rain accompanied strong southerly winds after mid month. River flows were above normal in the south and on the coast, but below normal to the north. MF2&4 followed cold cloudy periods, and MF3 had scant sun and cool conditions.



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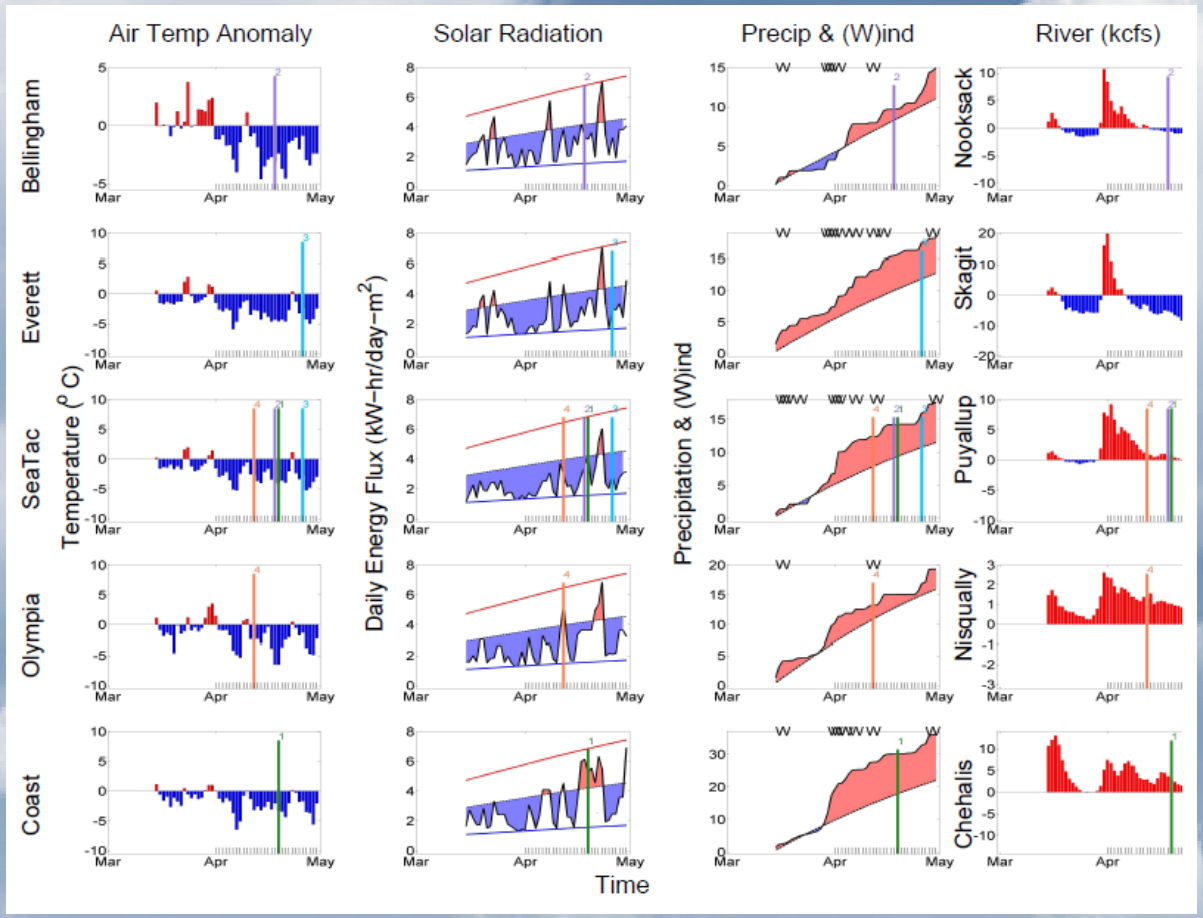
Summary:

April 2011 was cold, cloudy, and wet across Western Washington. The wind was predominantly out of the south with numerous passing storms. The few "bright spots" were on the 12th (MF4) and for a period around 22-24th, which might have helped blooms on the coast (MF1). General light energy and length-of-day may have helped in other areas. I expect a general delayed onset of spring blooms, cold water temperatures throughout, and low salinities in South Sound and on the Coast. Salinities could be higher to the north due to the lower river flow (precipitation bound up in snow, no doubt).



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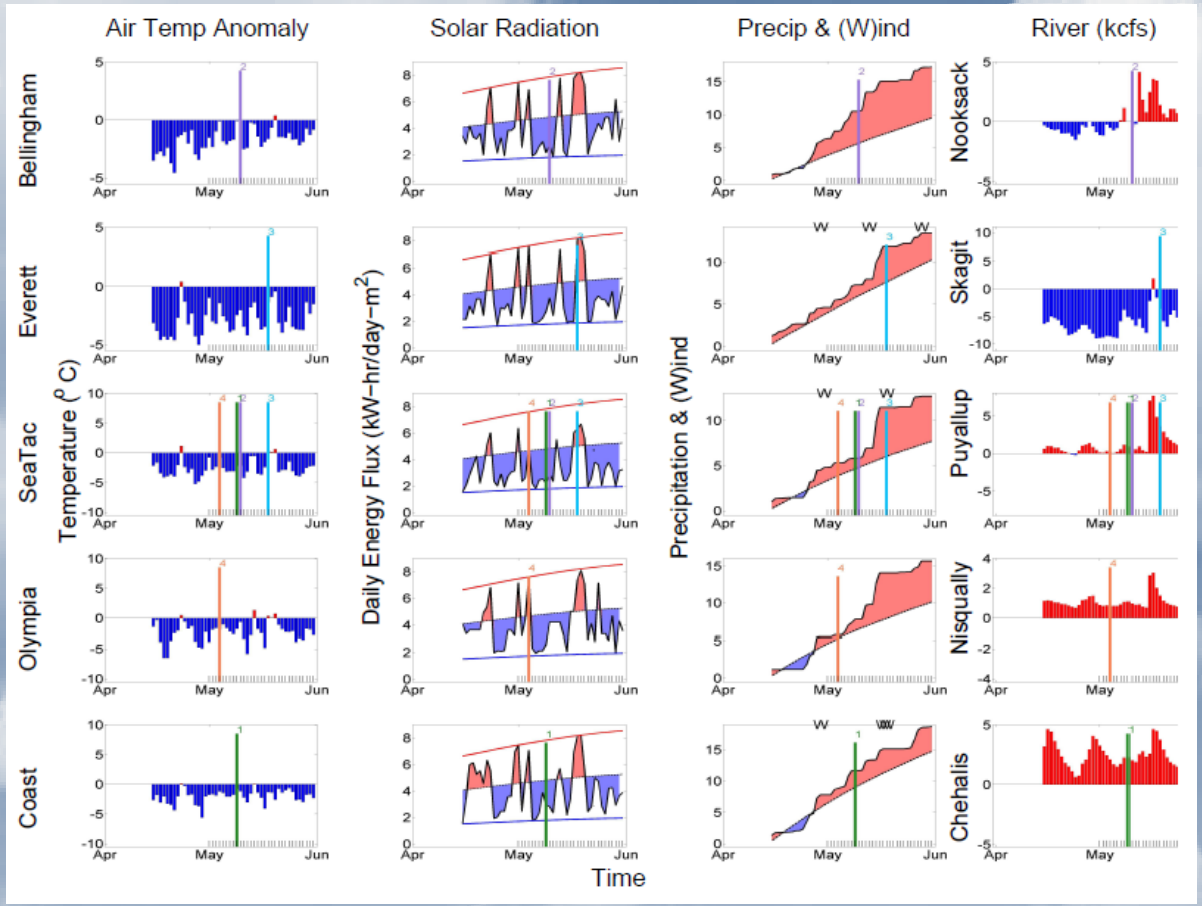
Summary:

May was unusually cool and wet throughout Western Washington. Heavy rains occurred on 14 May 2011 in the Puget Sound region, with a brief sunny respite around the 17-18th (MF3 - Central Sound). MF4 - South Sound likewise occurred during a small sun break, but MF1 and MF2 were during cloudy periods. River flow increased to above-normal during the second half of the month, except on the Skagit that remained below normal. The weather predicts cool surface temperatures, lower salinities (except for perhaps MF3), and higher chlorophylls on MF3 & 4.



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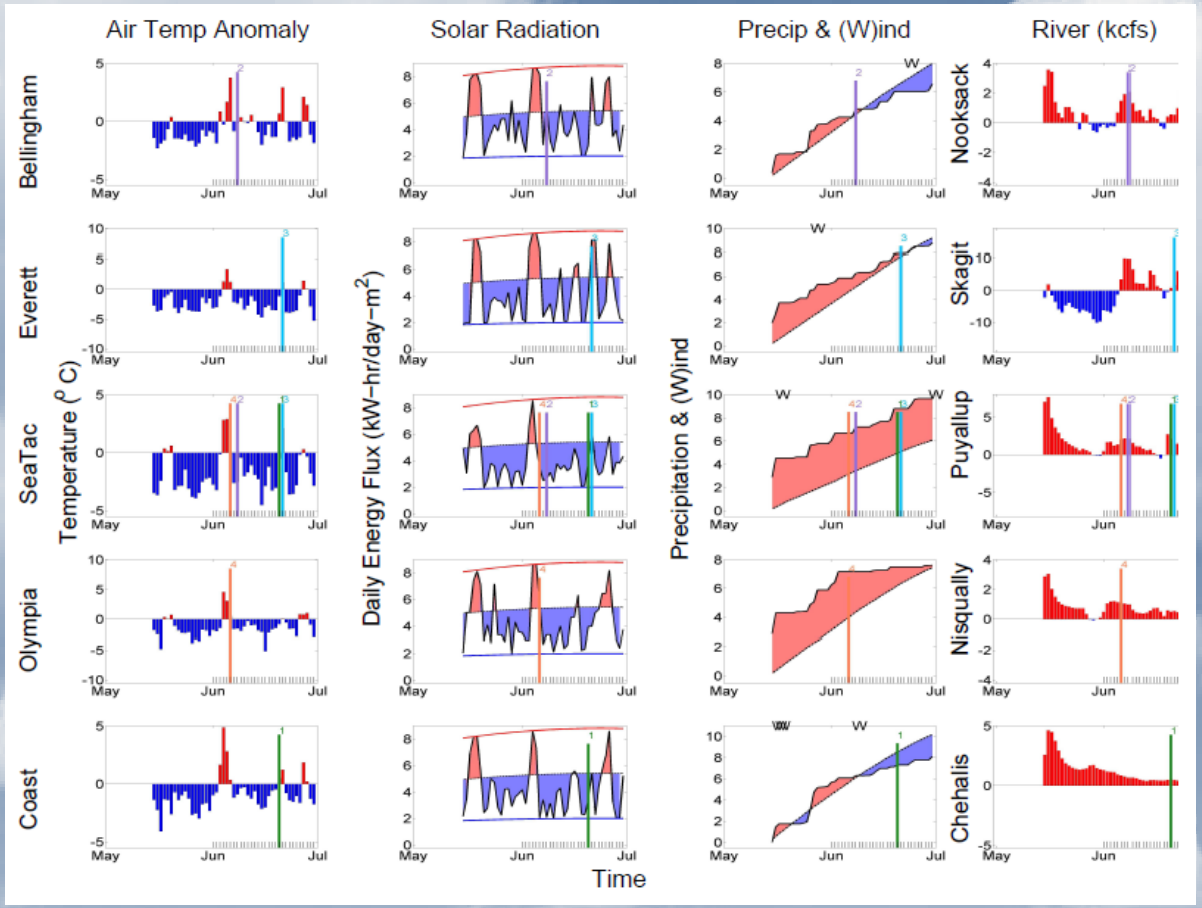
Summary:

After a cool stormy start, Western WA enjoyed a several-day period of warm and sunny weather beginning around 4 June. The remainder of the month was unseasonably cool and wetter in the Central to South Puget Sound regions than up north or on the coast. Winds were predominantly from the WSW on the coast, SW in Olympia, working around to the S and SE to the north.



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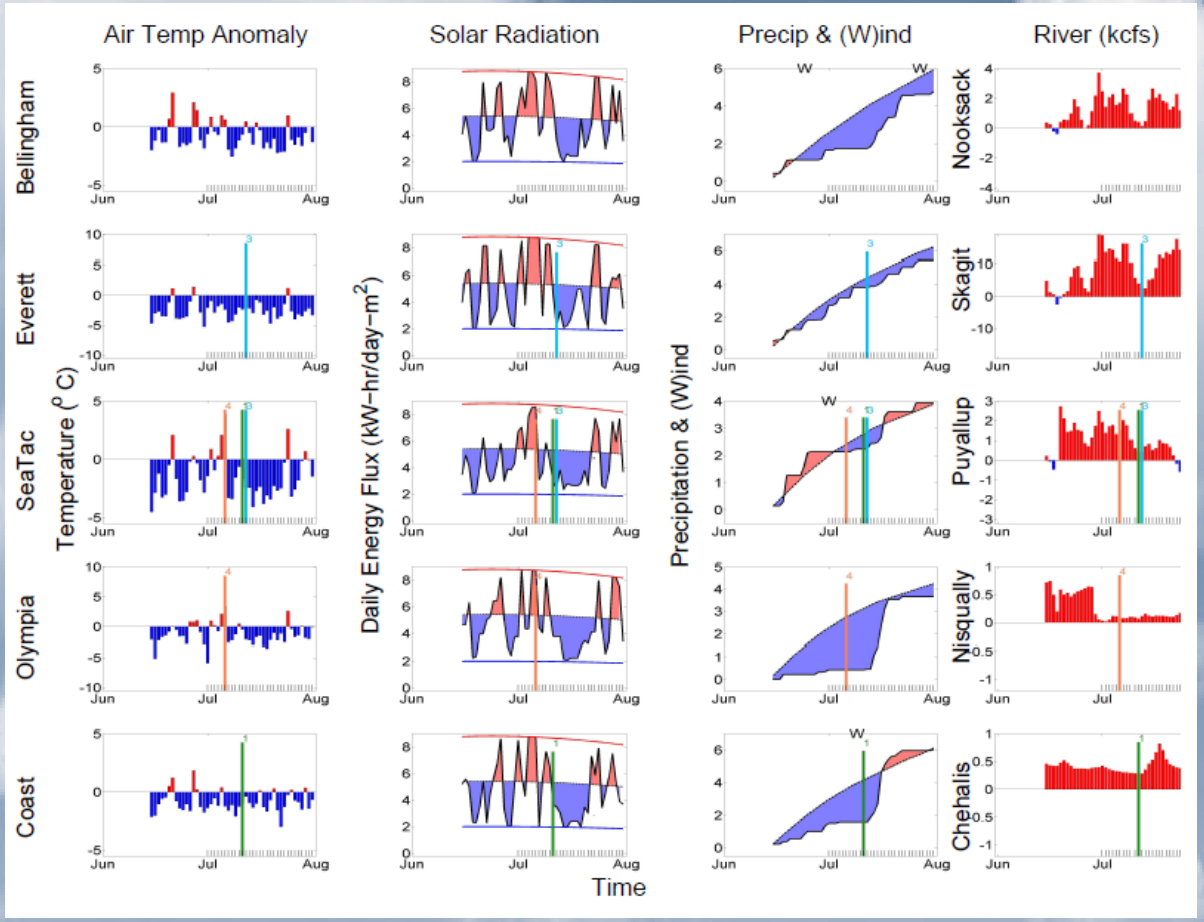
Summary:

After a few days of warmer weather, Western WA reverted to a continuing pattern of cooler-than-normal (and cloudy) conditions. Rainfall was below average in South Sound and north of Everett, and above normal at the end of July on the Coast and in Central Sound.



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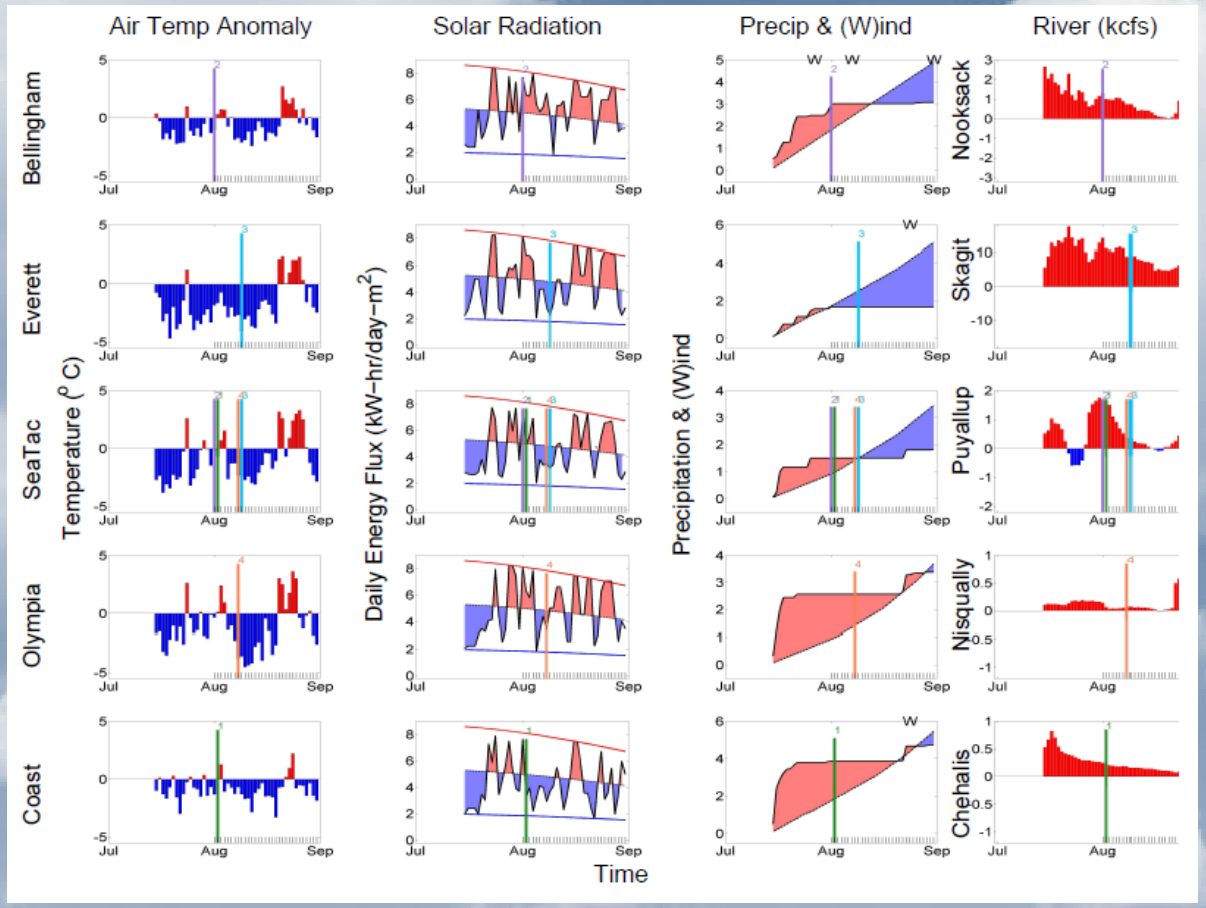
Summary:

Pattern of cooler-than-normal (and cloudy) conditions persisted until later in the month. It was dryer in Central and North Sound and wet in the South Sound and the Coast with a decreasing precipitation trend everywhere. River flows returned to normal by the end of August but were high in the beginning. Unusual southerly winds persisted.



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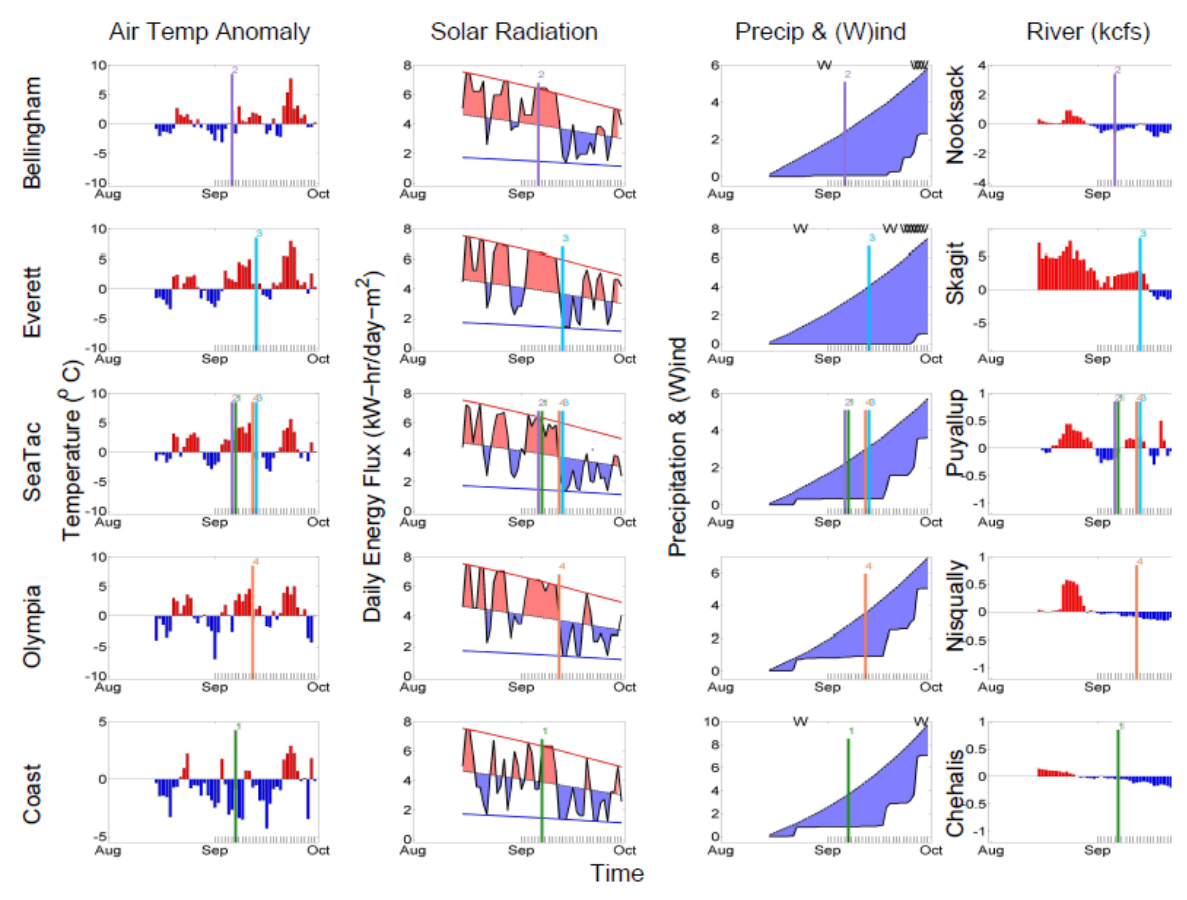
Summary:

Air temperatures were finally above normal, after a cool summer, except on the Coast where it remained chilly.

Sunlight was also abundant during the first part of the month.

Rivers: Coastal, southern, and extreme northern rivers have been trending lower than normal, but those in Central Sound were higher midmonth.

Winds have been predominantly from the north during the first half of the month, and from the south during the second half.



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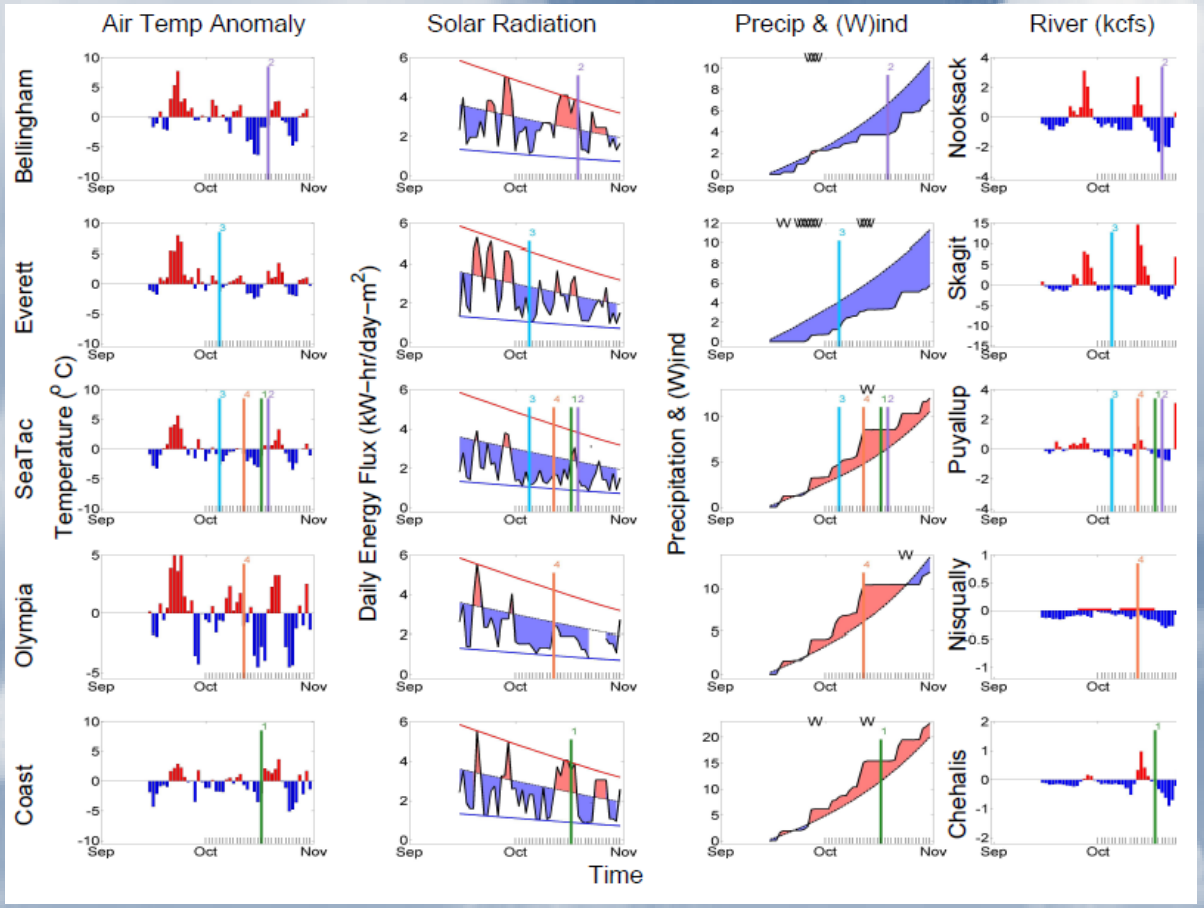
Summary:

Air temperatures during the past few days have been cooler than average, with warm afternoons but colder nights. **Sunlight** has been stronger to the north and on the coast.

Coastal and northern rivers started below normal, went above normal in the middle of the month, and then returned below normal toward the end of the month. Salinity should be lower on flights after the storm (everything but central sound), but there may have also been a significant import of fresh surface coastal water due to downwelling (e.g., from the Columbia River).



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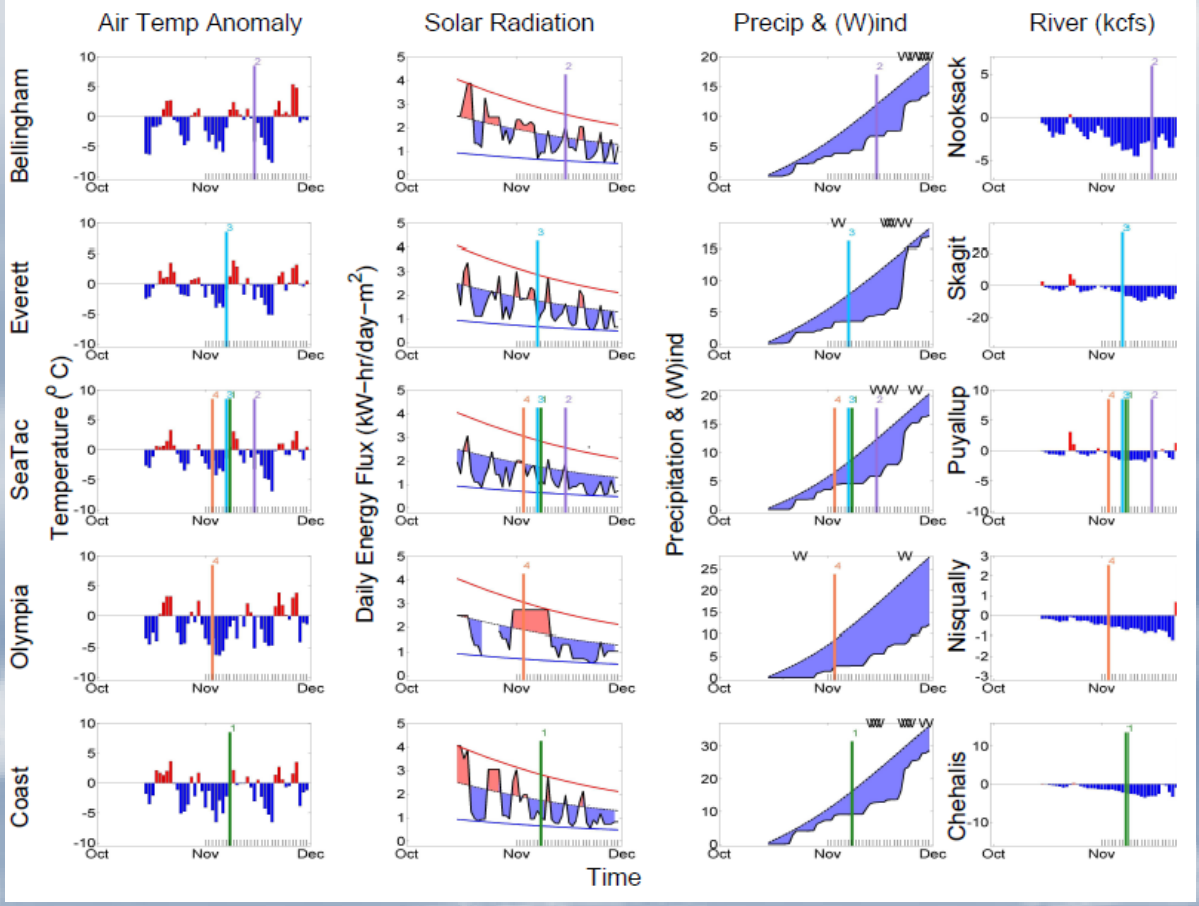
Summary:

The first 20 days of November were drier than normal with low river flows throughout Western Washington and the last 10 days were wetter than normal. Olympia and the Coast had more sunny periods than further to the north. Air temperatures fluctuated with a week of cool, a week of warm, another week of cool, and finally a week of warmer than normal conditions.



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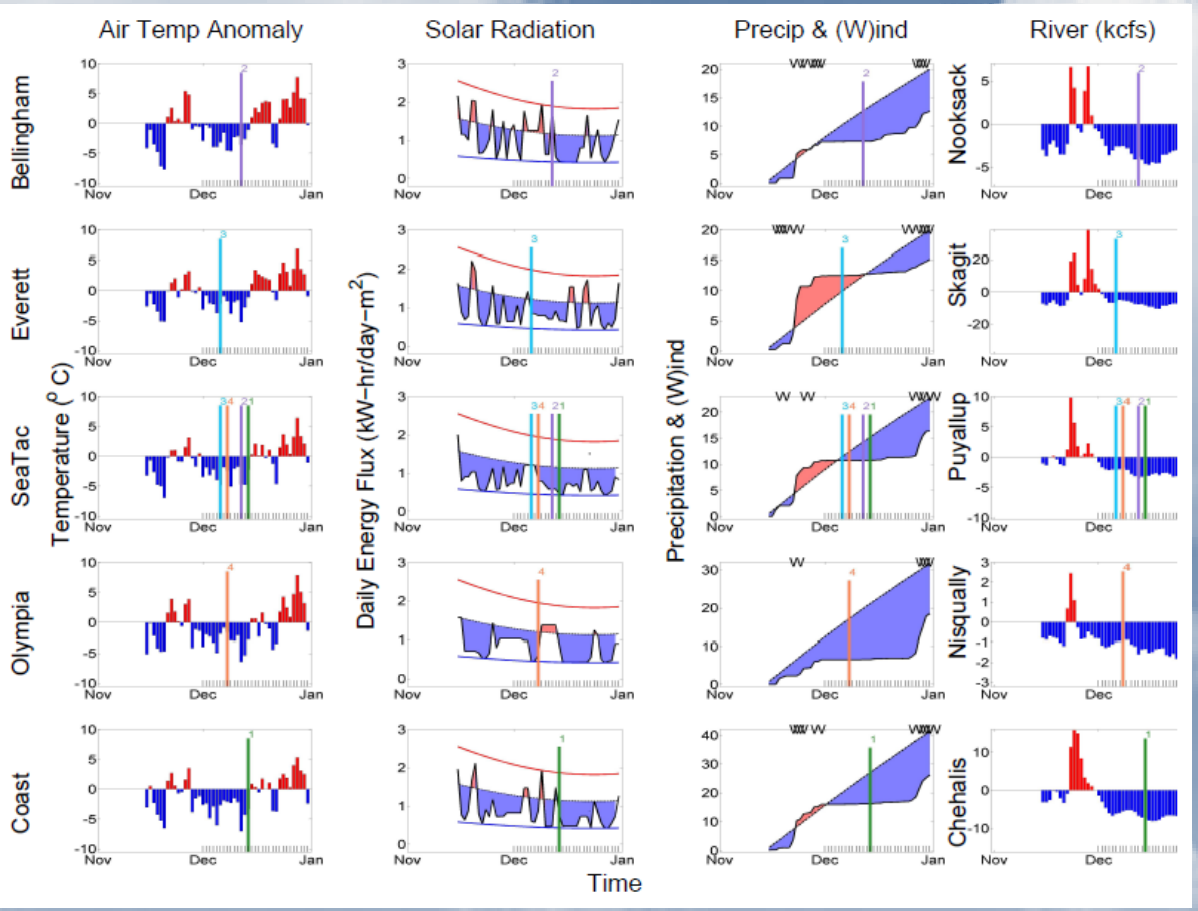
Summary:

Air temperatures were colder during the first half of December and warmer during the second half. Solar radiation was generally low, but there was some sunlight during the cold period of early December that may have affected all flights except South Sound (MF4). Precipitation was significantly below normal except in the Central Sound (MF3) and rivers were also running below normal until the final 4-5 days of the month when the wind also picked up.



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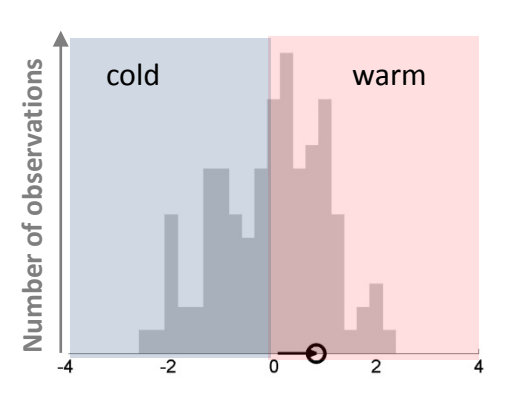
Pacific Decadal Oscillation

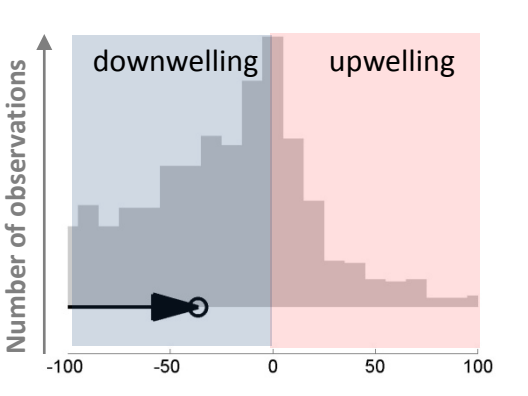
Pacific Decadal Oscillation (PDO) indices are derived from observed Pacific Sea Surface Temperature and Sea Level Pressure and are dimensionless; they are available monthly back to 1900. Unlike El Niño indices, a positive value indicates a warm-phase. The arrow shows a trend from the prior month.

January PDO Index scores are predominantly neutral over all years. For January, 2011 PDO Index scores are slightly positive showing a warming trend from the prior month.



Histogram of PDO Index scores

Upwelling Index



Histogram of Upwelling Index scores

Typically January has downwelling. January 2011 had downwelling but with a trend toward less downwelling.

The NOAA Pacific Fisheries Environmental Laboratory Upwelling Index (PFEL) is positive for upwelling, and negative for downwelling conditions. The histogram shows all values of the current month in the historical record since 1967. The arrow shows a trend from the prior month.

Pacific Decadal Oscillation

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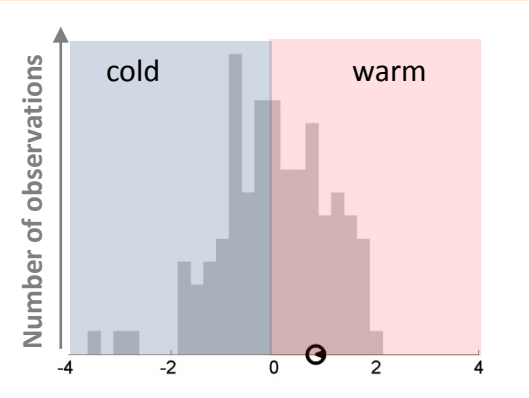
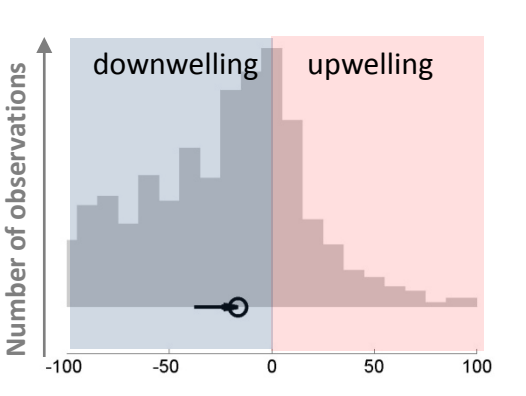
February PDO Index scores are predominantly neutral over all years. For February, 2011 PDO Index scores are slightly positive with a very slight warming trend from the prior month.



Histogram of PDO Index scores

Upwelling Index



Histogram of Upwelling Index scores

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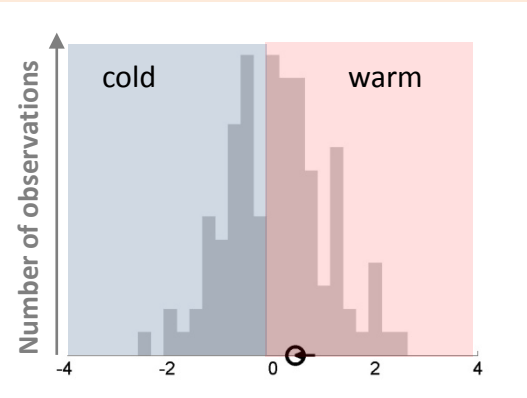
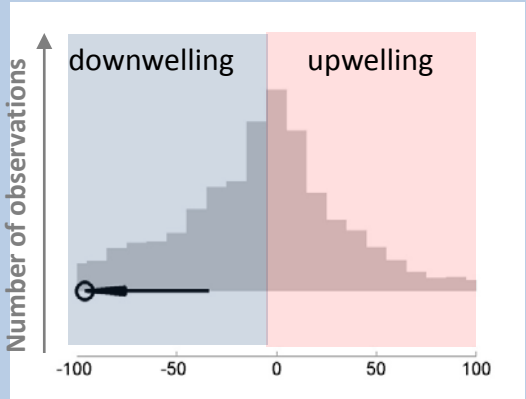
March PDO Index scores are predominantly neutral over all years. For March, 2011 PDO Index scores are slightly positive with a very slight cooling trend from the prior month.



Histogram of PDO Index scores

Upwelling Index



Histogram of Upwelling Index scores

Typically March has a fairly even distribution of upwelling and downwelling. March 2011 had downwelling with a trend toward much greater downwelling.

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Pacific Decadal Oscillation

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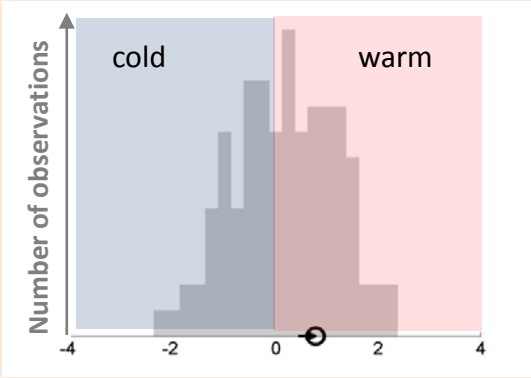
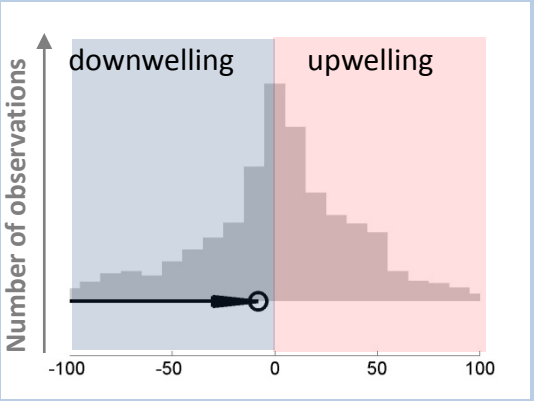
April PDO Index scores are predominantly neutral over all years. For April, 2011 PDO Index scores are slightly positive with a very slight cooling trend from the prior month.



Histogram of PDO Index scores

Upwelling Index



Histogram of Upwelling Index scores

Typically April has a fairly even distribution of upwelling and downwelling. April 2011 had downwelling with a trend toward neutrality.

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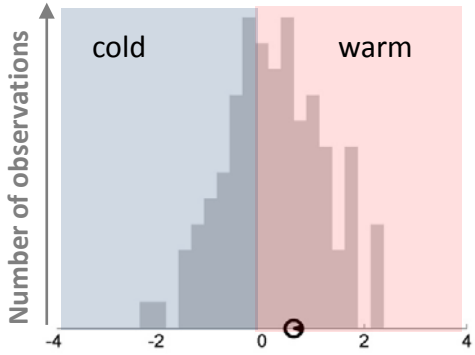
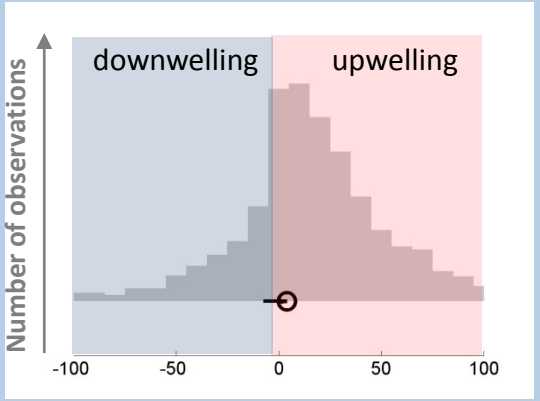
May PDO Index scores are predominantly neutral over all years. For May, 2011 PDO Index scores are slightly positive with a very slight warming from the prior month.



Histogram of PDO Index scores

Upwelling Index



Histogram of Upwelling Index scores

Typically May has upwelling. May 2011 had neutral conditions with a trend toward upwelling.

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Pacific Decadal Oscillation

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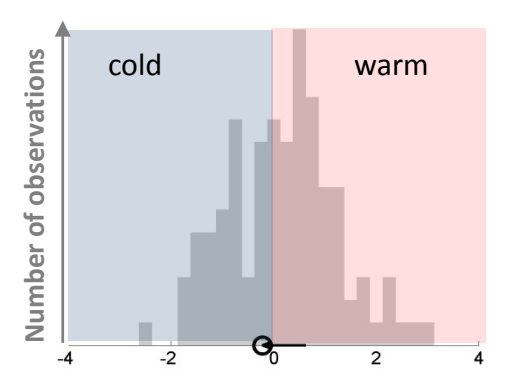
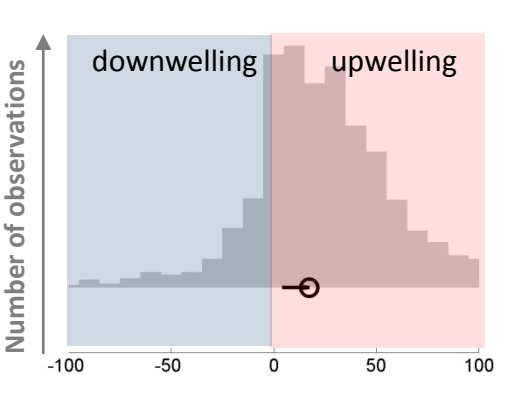
June PDO Index scores are predominantly neutral over all years. For June, 2011 PDO Index scores are neutral with a slight cooling from the prior month.



Histogram of PDO Index scores

Upwelling Index



Histogram of Upwelling Index scores

Typically June has upwelling. June 2011 had slight upwelling conditions with a trend toward increased upwelling.

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Pacific Decadal Oscillation

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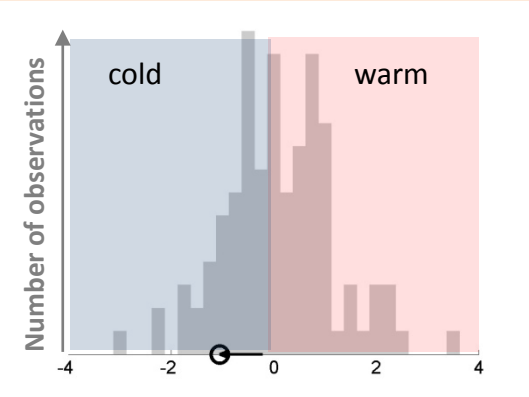
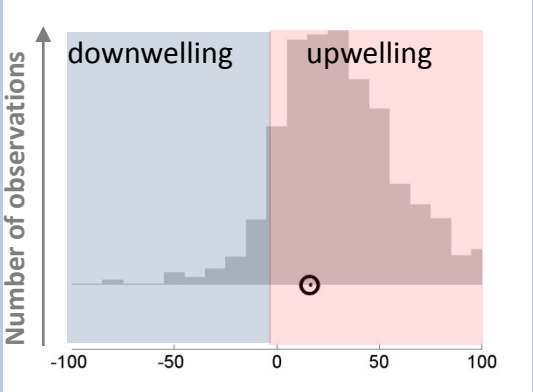
July PDO Index scores are predominantly neutral over all years. For July, 2011 PDO Index scores are cool with a cooling trend from the prior month.



Histogram of PDO Index scores

Upwelling Index



Histogram of Upwelling Index scores

Typically July has upwelling. July 2011 had slight upwelling conditions with very little trend.

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Pacific Decadal Oscillation

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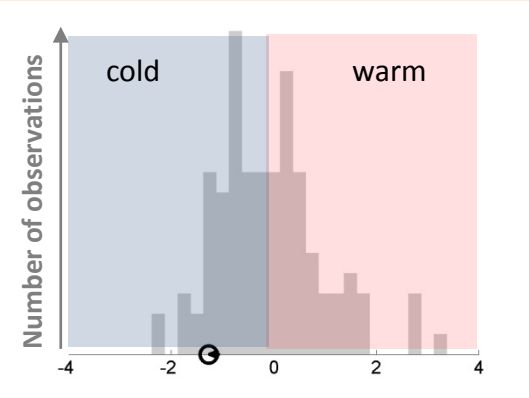
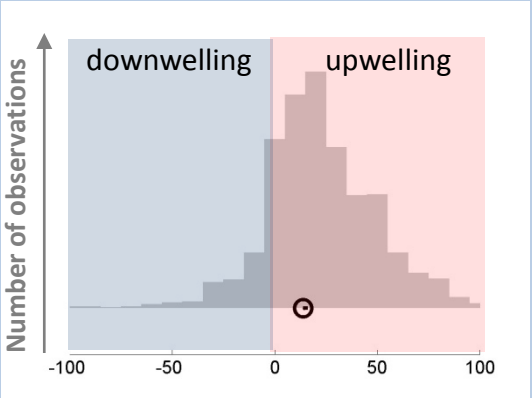
August PDO Index scores are predominantly neutral over all years. For August, 2011 PDO Index scores are cool but with a very slight warming trend from the prior month.



Histogram of PDO Index scores

Upwelling Index



Histogram of Upwelling Index scores

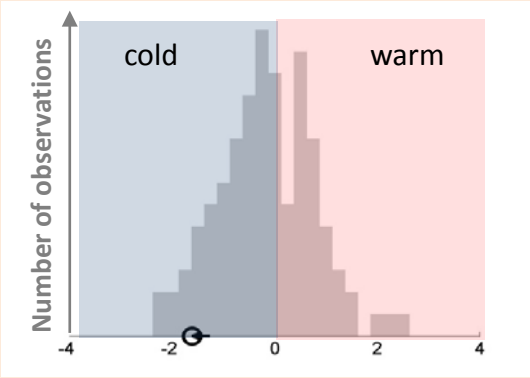
Typically August has strong upwelling. August2011 had only slight upwelling conditions with a trend toward slightly increased upwelling.

The NOAA Pacific Fisheries Environmental Laboratory Upwelling Index (PFEL) is positive for upwelling, and negative for downwelling conditions. The histogram shows all values of the current month in the historical record since 1967. The arrow shows a trend from the prior month.

Pacific Decadal Oscillation

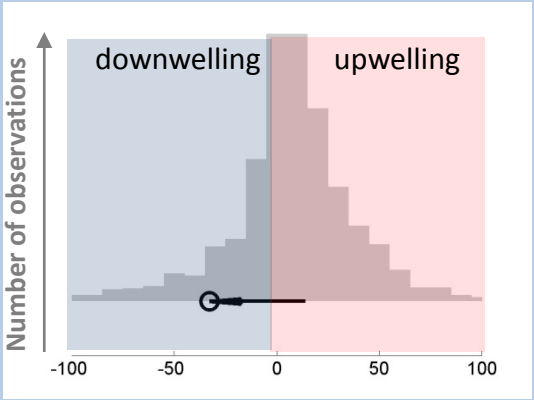
Pacific Decadal Oscillation (PDO) indices are derived from observed Pacific Sea Surface Temperature and Sea Level Pressure and are dimensionless; they are available monthly back to 1900. Unlike El Niño indices, a positive value indicates a warm-phase. The arrow shows a trend from the prior month.

September PDO Index scores are predominantly neutral over all years. This September scores were very cool with a continuing cooling trend.



Histogram of PDO Index scores

Upwelling Index



Histogram of Upwelling Index scores

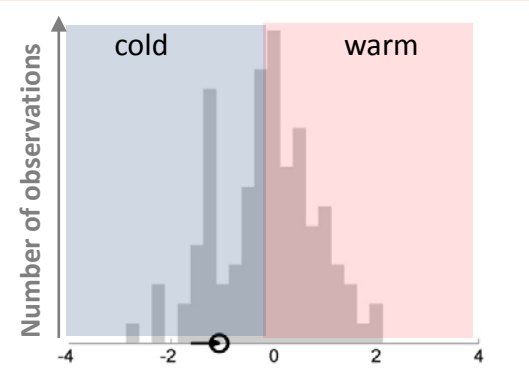
Typically September has positive upwelling, indicated by the peak in historic values above zero. September 2011 had much stronger downwelling than other years with a trend toward increased downwelling from the month before.

The NOAA Pacific Fisheries Environmental Laboratory Upwelling Index (PFEL) is positive for upwelling, and negative for downwelling conditions. The histogram shows all values of the current month in the historical record since 1967. The arrow shows a trend from the prior month.

Pacific Decadal Oscillation

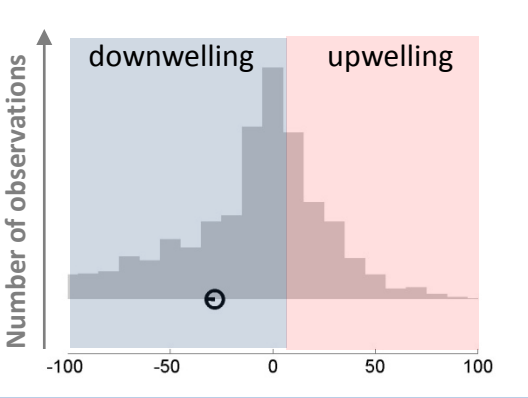
Pacific Decadal Oscillation (PDO) indices are derived from observed Pacific Sea Surface Temperature and Sea Level Pressure and are dimensionless; they are available monthly back to 1900. Unlike El Niño indices, a positive value indicates a warm-phase. The arrow shows a trend from the prior month.

For October PDO Index scores are predominantly neutral over all years. For October 2011 scores were very cool with a weak warming trend



Histogram of PDO Index scores

Upwelling Index



Histogram of Upwelling Index scores

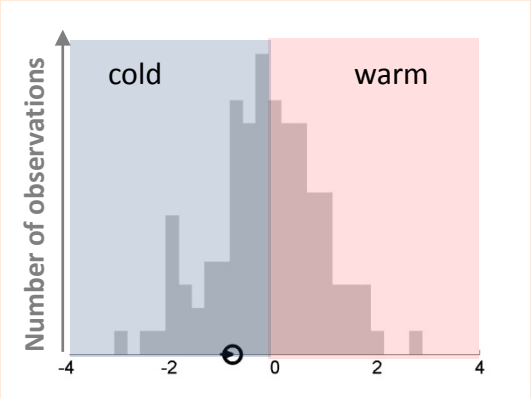
Typically October data have upwelling neutral conditions. Downwelling dominated in October. Implying that waters from the ocean should be lower in salinity

The NOAA Pacific Fisheries Environmental Laboratory Upwelling Index (PFEL) is positive for upwelling, and negative for downwelling conditions. The histogram shows all values of the current month in the historical record since 1967. The arrow shows a trend from the prior month.

Pacific Decadal Oscillation

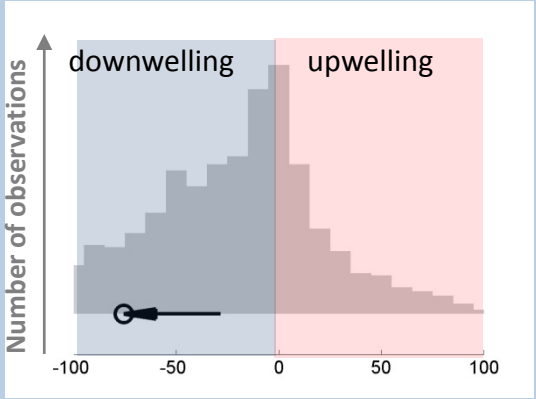
Pacific Decadal Oscillation (PDO) indices are derived from observed Pacific Sea Surface Temperature and Sea Level Pressure and are dimensionless; they are available monthly back to 1900. Unlike El Niño indices, a positive value indicates a warm-phase. The arrow shows a trend from the prior month.

November PDO Index scores are predominantly neutral over all years. For November , 2011 PDO Index scores are predominantly cool with a weak warming trend.



Histogram of PDO Index scores

Upwelling Index



Histogram of Upwelling Index scores

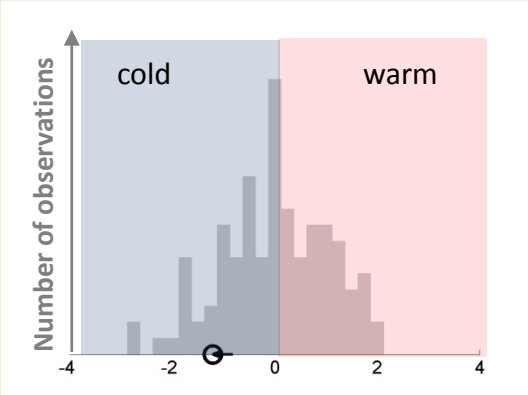
Typically November data have downwelling-favorable conditions. Downwelling dominated in November, with an increasing downwelling trend, implying that waters incoming from the ocean should be lower in salinity.

The NOAA Pacific Fisheries Environmental Laboratory Upwelling Index (PFEL) is positive for upwelling, and negative for downwelling conditions. The histogram shows all values of the current month in the historical record since 1967. The arrow shows a trend from the prior month.

Pacific Decadal Oscillation

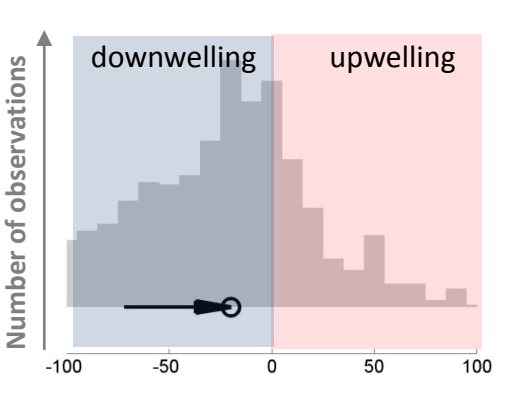
Pacific Decadal Oscillation (PDO) indices are derived from observed Pacific Sea Surface Temperature and Sea Level Pressure and are dimensionless; they are available monthly back to 1900. Unlike El Niño indices, a positive value indicates a warm-phase. The arrow shows a trend from the prior month.

December PDO Index scores are predominantly neutral over all years. For December, 2011 PDO Index scores are predominantly cool with a weak cooling trend from the prior month.



Histogram of PDO Index scores

Upwelling Index



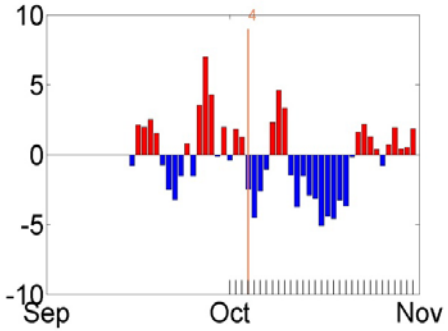
Histogram of Upwelling Index scores

Typically December data have downwelling-favorable conditions. Downwelling dominated in December, but with a decreasing downwelling trend.

The NOAA Pacific Fisheries Environmental Laboratory Upwelling Index (PFEL) is positive for upwelling, and negative for downwelling conditions. The histogram shows all values of the current month in the historical record since 1967. The arrow shows a trend from the prior month.

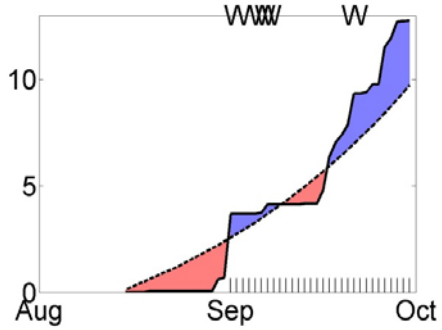
◉ **Weather** ○ **Coastal conditions**

Anomalies in Air Temperature



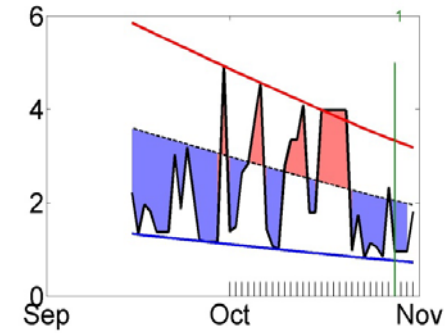
Departure of daily mean temperature from 30+ year climatology; red for warmer than normal, blue for cooler than normal.

Anomalies in Cumulative Precipitation



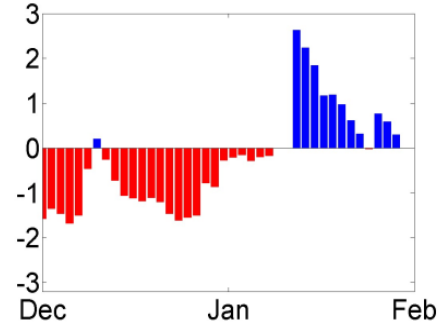
Anomalies (red=less blue=more) in cumulative daily precipitation compared against a seasonally expected precipitation curve (dotted black).

Anomalies in Solar Energy



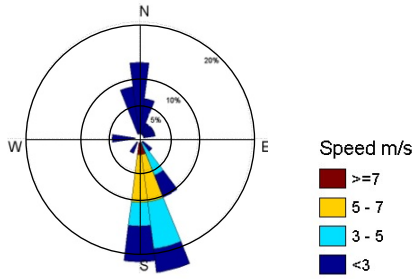
Solar energy anomalies (red=positive, blue negative) in relation to expected seasonal values (black). A seasonal envelope is given as colored lines.

Anomalies in River Flow



Anomalies in daily mean river flow. Lower-than-normal river flows are plotted in red, and higher-than-normal flows are plotted in blue.

Wind Compass Rose

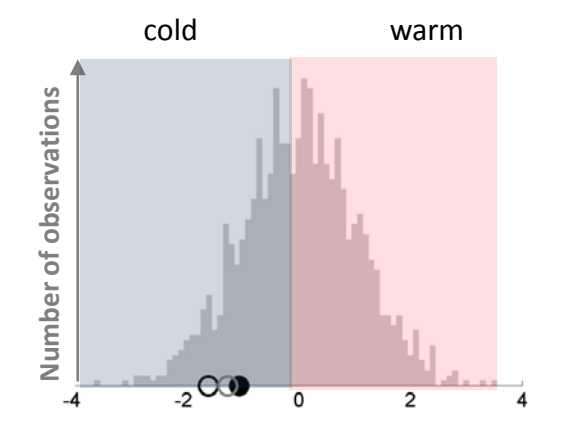


The radius of the circles (black) shows the percentage of observations in a given month. The radius of each sector is proportional to the frequency of the wind blowing from a particular direction. The largest sector indicated the predominant wind direction of the last month.

Superimposed on each sector is the relative intensities of the wind coming from a particular direction. Warmer colors indicate stronger winds, cooler colors indicate weaker winds. Strong winds tend to occur less frequently than weaker winds. This can be used in the geometry of the sectors. The area of each sector becomes smaller towards the tip (center of graphic), the frequency is scaled to the area of the sector. Less frequent but strong winds are therefore plotted at the tip of each sector.

Weather Coastal conditions

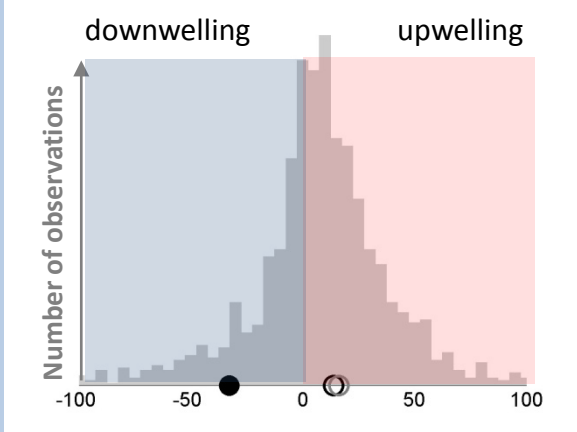
Pacific Decadal Oscillation



Histogram of PDO Index scores

Pacific Decadal Oscillation (PDO) indices are derived from observed Pacific Sea Surface Temperature (SST) and Sea Level Pressure (SLP) and are dimensionless; they are available monthly back to 1900. Unlike El Niño indices, a positive value indicates a warm-phase. The solid dot shows the current month, the hollow black dot shows the previous month, and the hollow gray dot is from two months ago.

Upwelling Index

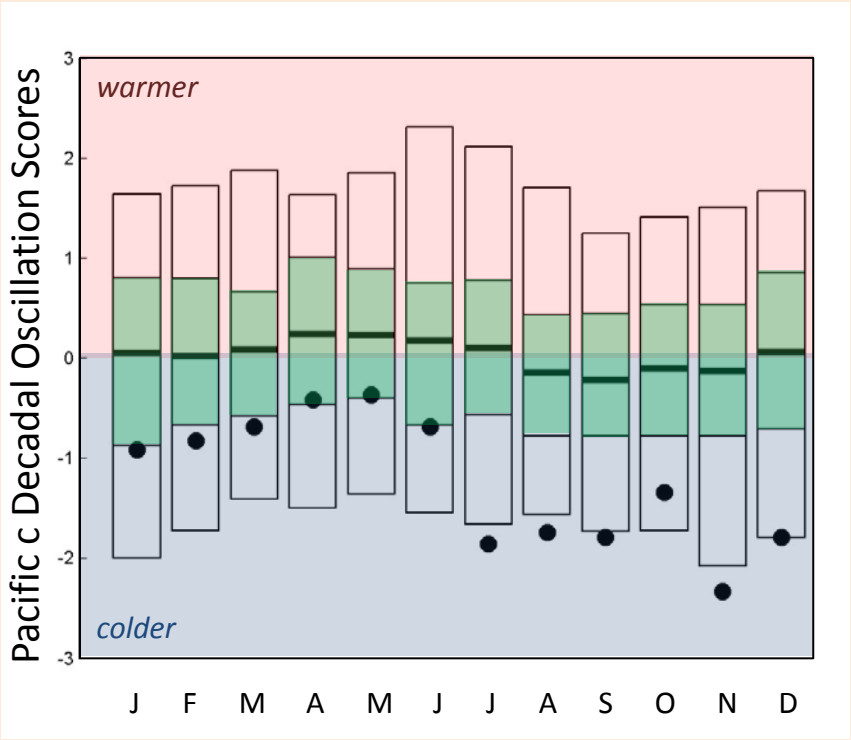


Histogram of Upwelling Index scores

The NOAA Pacific Fisheries Environmental Laboratory Upwelling Index (PFEL) is positive for upwelling of deeper ocean water, which is caused by northerly winds in the PNW, and negative for downwelling conditions. The histogram shows all values in the historical record since 1967 for the current month. The solid dot shows the current month, the hollow black dot shows the previous month, and the hollow gray dot is from two months ago.

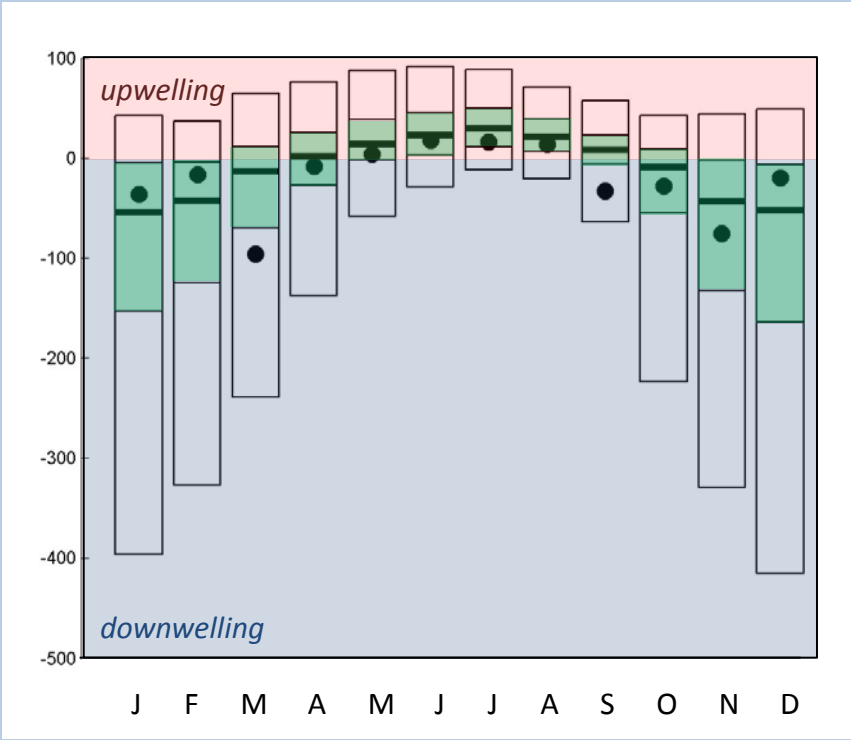
Weather Coastal conditions

Monthly Pacific Decadal Oscillation and Anomalies



Sea surface temperatures were lower than expected for 2011 falling below median expected values for all months. Significantly lower temperature falling below the IQR of historic observations were observed past June and continued through into the winter

Monthly Upwelling Index and Anomalies



Upwelling generally fell below expected median historic values but well within expected historic ranges. Exceptions to this pattern were January and February and December 2011 where upwelling was slightly higher but within expected ranges. Exceptional strong downwelling occurred in May and September

◉ **Weather** ○ **Coastal conditions**

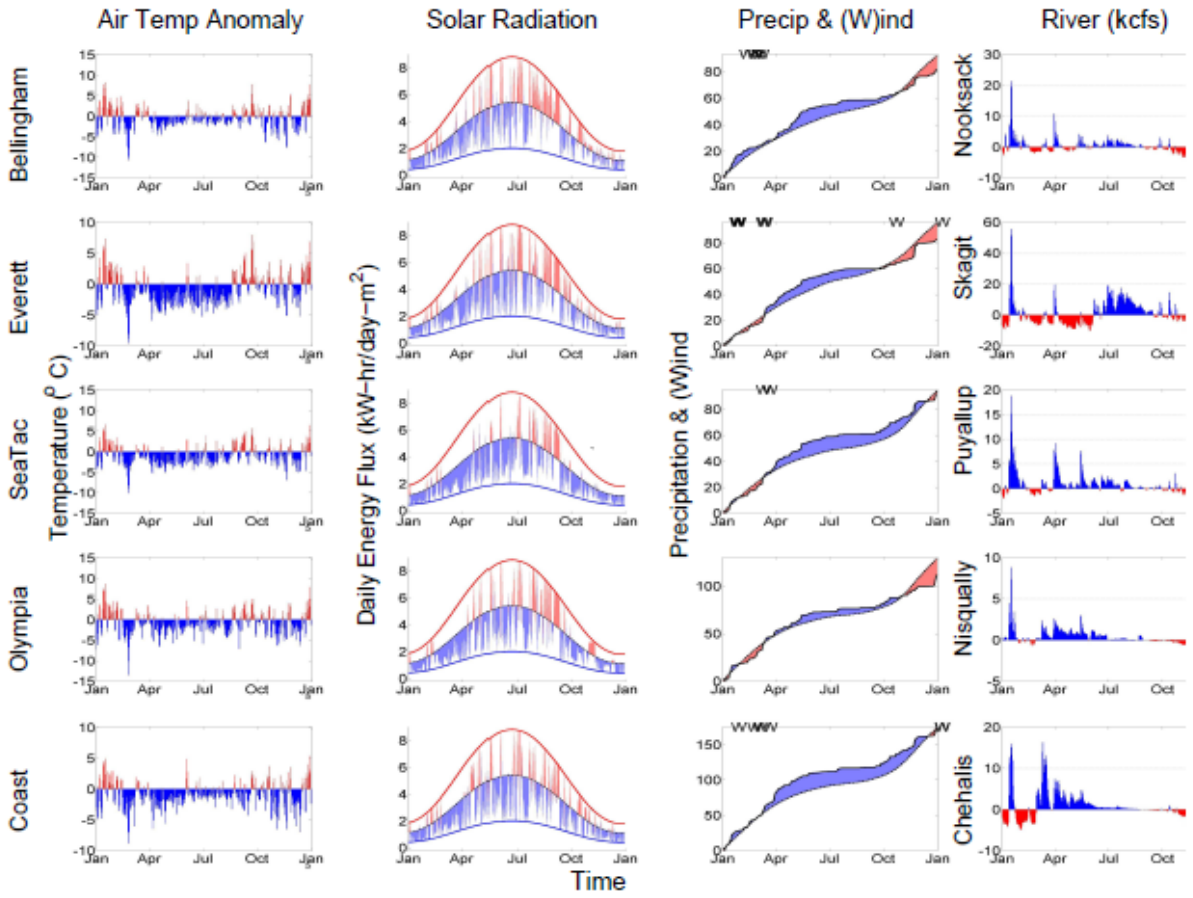
Meteorological conditions typically explain up to half of the variance in observed marine variables (Moore et al. 2008), particularly in shallower waters like those of South Puget Sound. The specific conditions prevalent during the past two weeks, from north to south, are shown below.

Summary:

Air temperatures were generally below normal with the exceptions of late-January to February and late-August to September.

Rivers were generally above normal to the south during the first half of the year, and above normal to the north from late-June to September.

Wind events were more significant in the spring of 2011 than in the fall.

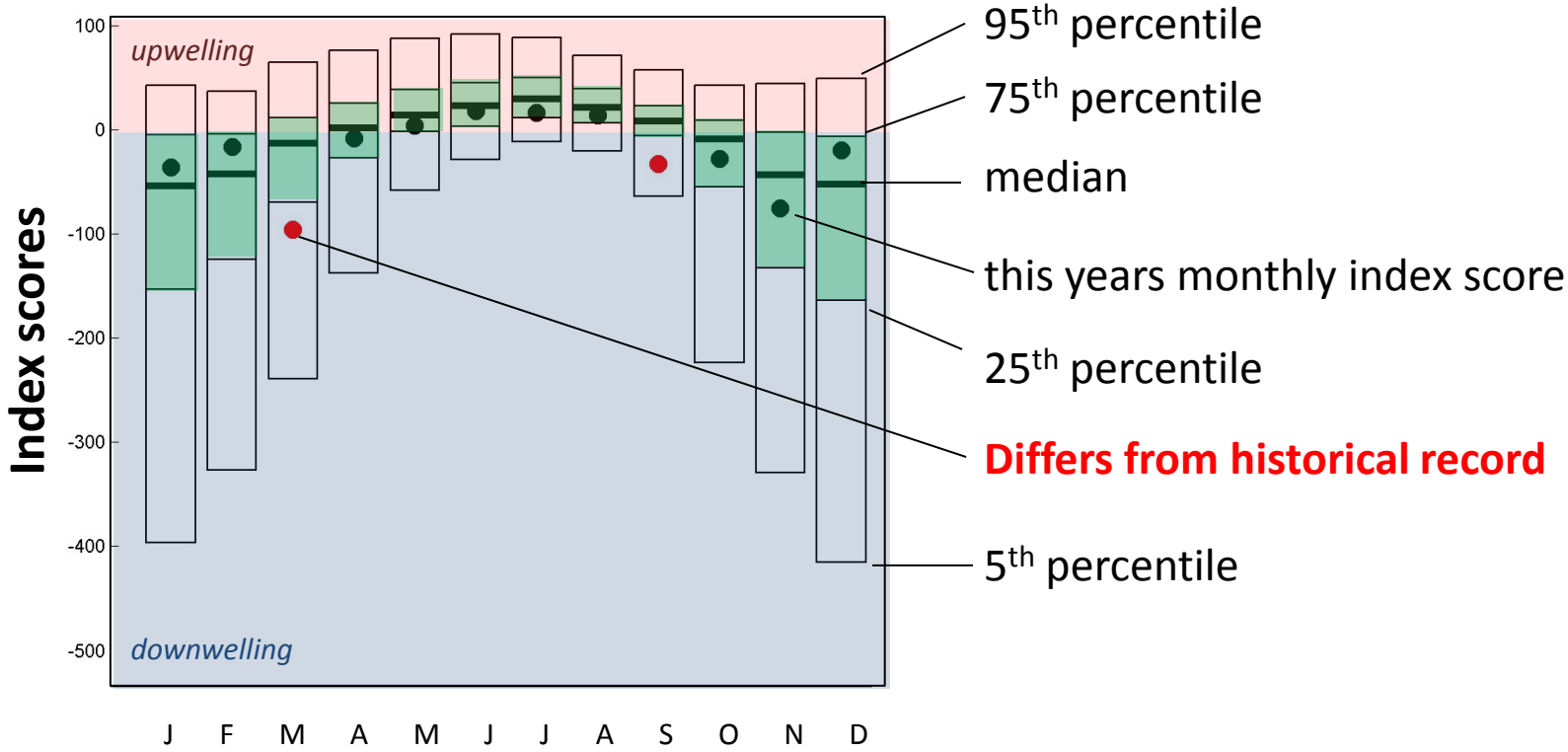


ECOLOGY State of Washington

Moore et al. 2008. Local and large-scale climate forcing of Puget Sound oceanographic properties on seasonal to interdecadal timescales. Limnol. Oceanogr., 53(5), 1746–1758

○ Weather ◉ Coastal conditions

Monthly Index Scores and Anomalies



Comment: Monthly values of the coastal upwelling index at 48°N and 125°W (filled circles). Median historical values are depicted by the solid black lines the green area represents the interquartile range of observations for each month. The larger box surrounding the median and interquartile range represents the 5th (lower) and 95th (upper) percentiles.