Qingdao to San Francisco – Weather and Current Brief

Fig 1: Overall Great Circle Route from Qingdao to San Francisco
(ARCS Chart 4008: A Planning Chart for the North Pacific Ocean, issued 10/8/2006)

The overall route (*figure 1)* shows the idealised great circle passage. This does not take into account meteorological or oceanographic conditions.

1. Qingdao to Kyushu – the Yellow Sea

1.1 Physical Routing

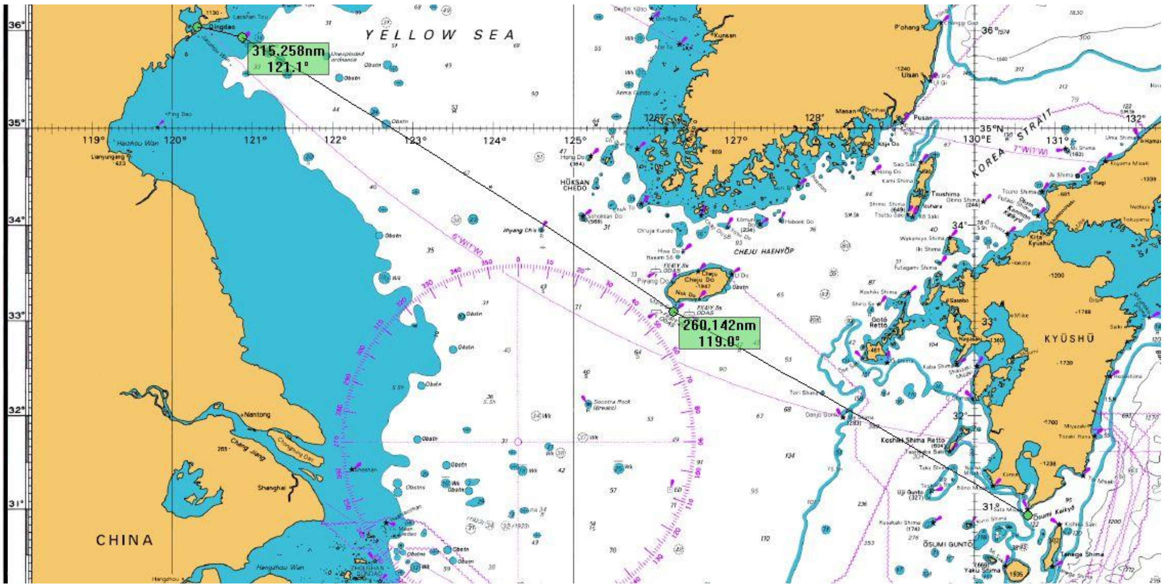


Fig 1.2.: Qingdao to Kyushu
(ARCS chart 4509: Western portion of Japan, issued 8/5/2008)

Once clear of the Chinese coast there are few navigational hazards and these are well charted. For most of the Yellow Sea until the 200m edge of the continental shelf the major hazard is other shipping, particularly fishing vessels and their gear. The area is politically sensitive, and it is essential to know of any restrictions or tensions in the area. This information will no doubt be easily obtained from the Chinese authorities in Qingdao.

1.2 Currents

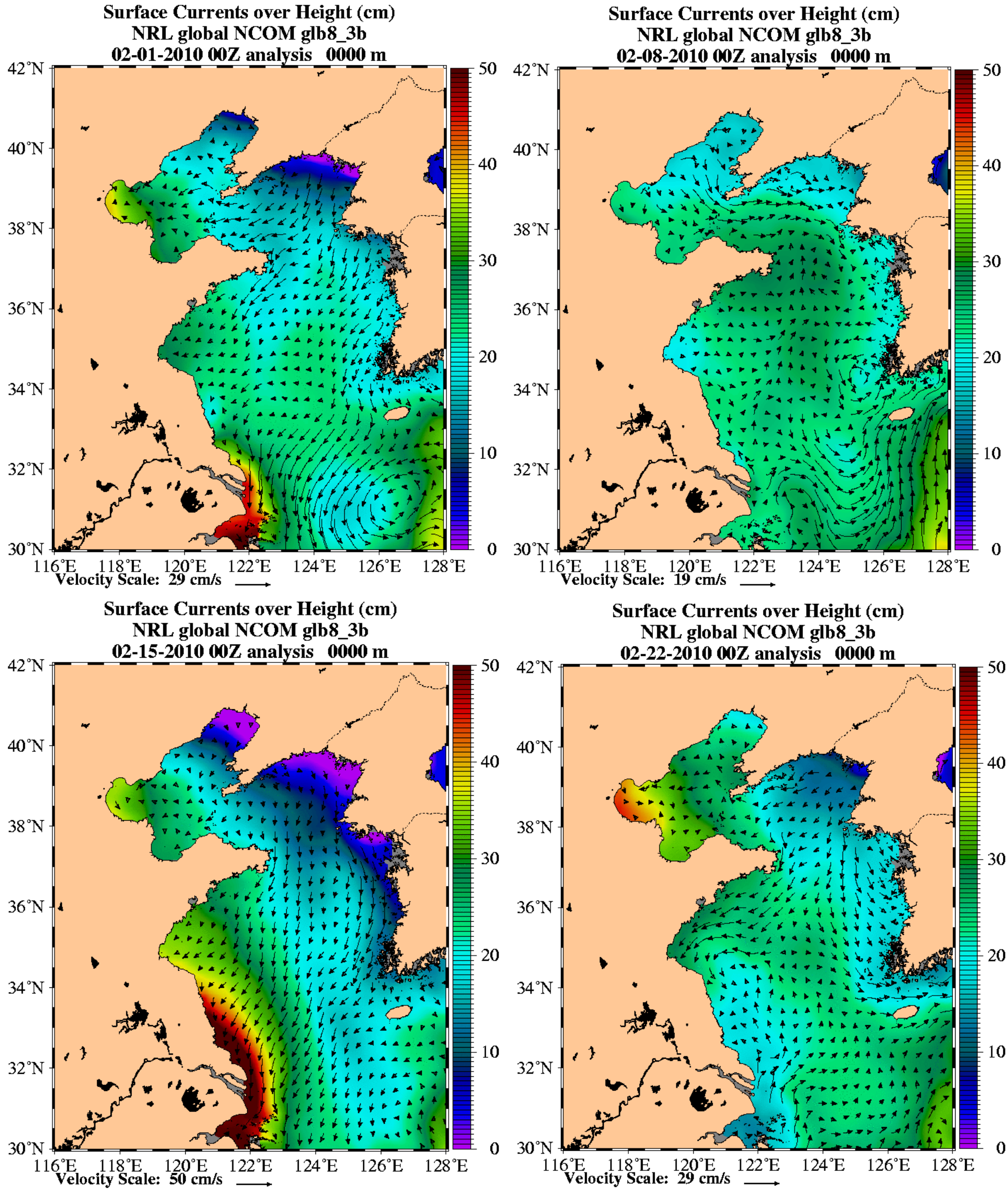


Fig 1.3: surface currents over sea surface height for February 1st, 8th, 15th and 22nd, 2010 (http://www7320.nrlssc.navy.mil/global_ncom/Links/cssh_list_yes.html)

As the previous month's surface current data shows (*figure 1.3)*, the surface currents are not particularly constant, and are basically driven by the surface winds. They cannot be used to plan for a particular current advantage – it all depends on Neptune's mood at the time.

2. Sata Misaki to Nojima Saki – along the Southern Japanese Coastline

2.1 Physical Routing

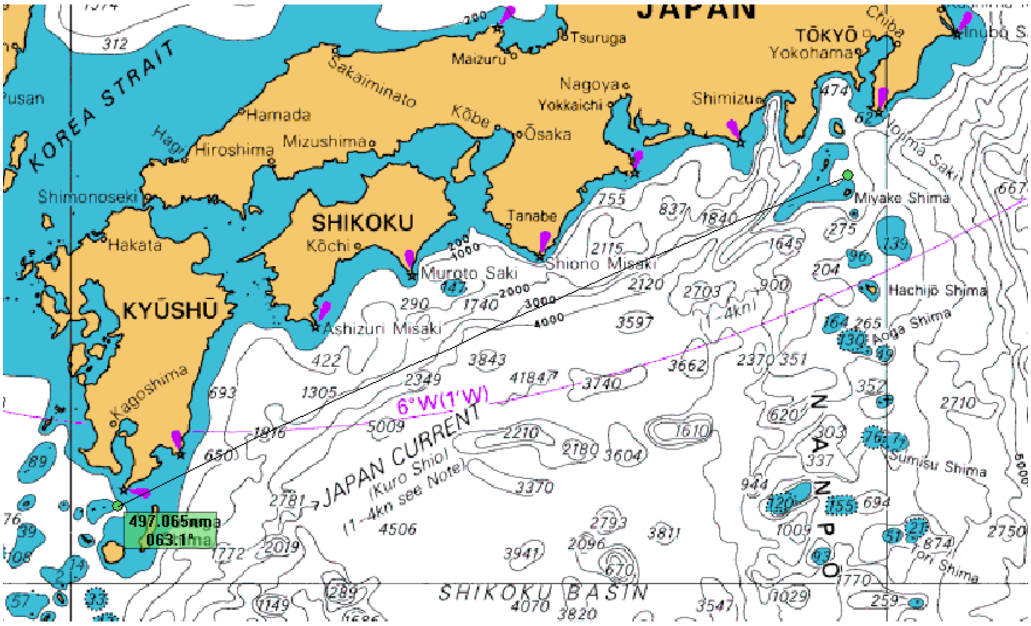


Fig 2.1: along the Japanese coastline
(ARCS chart 4052: North Pacific Ocean Southwestern Part, issued 8/5/2008)

There are no major navigational hazards for most of the section (*figure 2.1)*, except for strong currents around headlands and significant commercial shipping. The island of Tanega Shima (30^{o} 40'N, 131^{o} E) is Japan's space program's launch site.

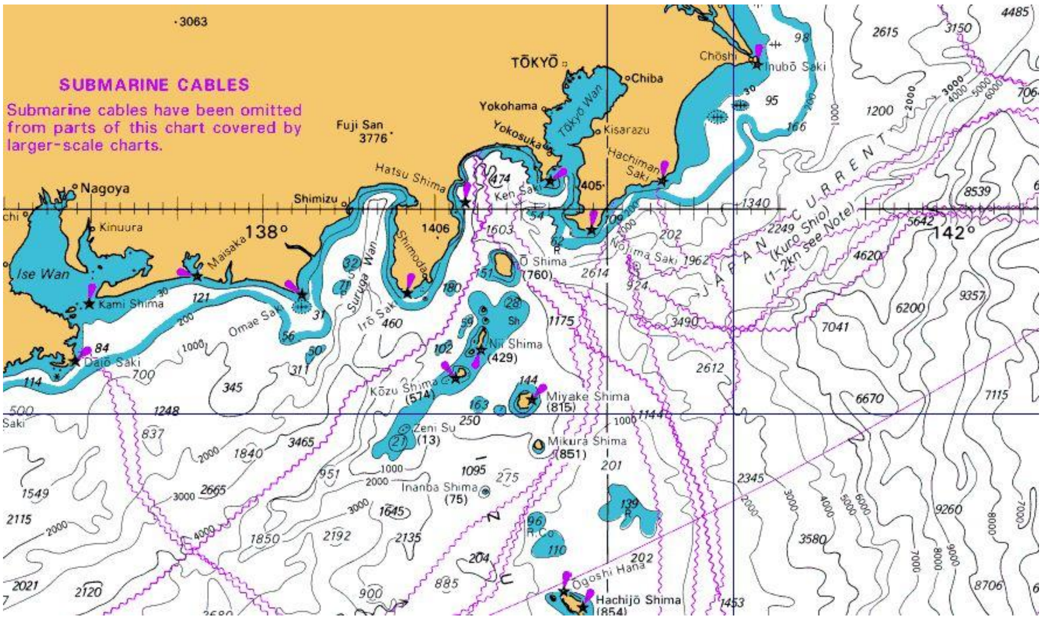


Fig 2.2: detail showing the islands south of Tokyo Wan
(ARCS chart 4510: Eastern Portion of Japan, issued 8/5/2008)

The islands south of Tokyo Wan (*figure 2.2)* require careful navigation, as the large change in depth, strong currents and frequent high winds cause sea states that can be "nasty, brutish and short" (Hobbes, 1651).

2.2 Currents

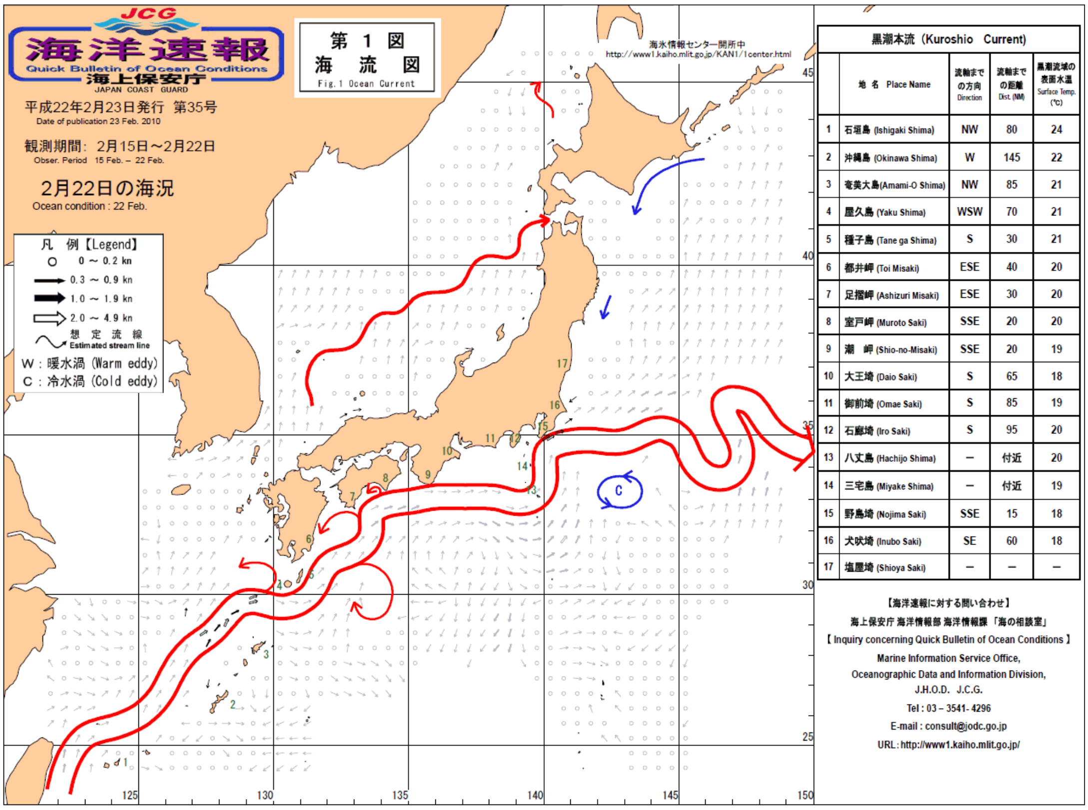


Fig 2.3: the Kuro Shio current, 22nd February 2010
(Courtesy of JAPAN COAST GUARD, HYDROGRAPHIC AND OCEANOGRAPHIC DEPARTMENT. http://www1.kaiho.mlit.go.jp/KANKYO/KAIYO/qboc/index_E.html)

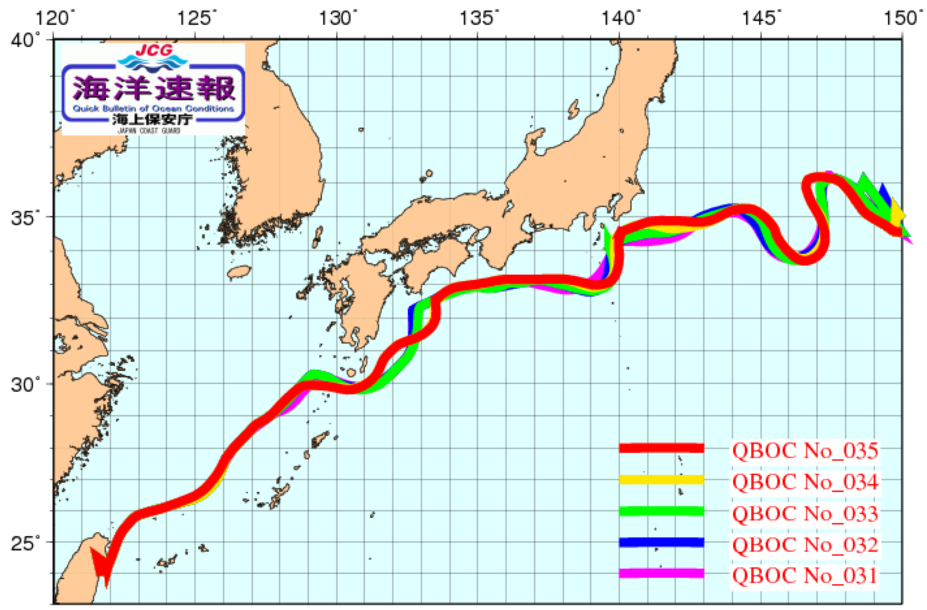


Fig 2.4: composite Kuro Shio current tracks from 17th to 22nd February 2010
(Courtesy of JAPAN COAST GUARD, HYDROGRAPHIC AND OCEANOGRAPHIC DEPARTMENT. http://www1.kaiho.mlit.go.jp/KANKYO/KAIYO/qboc/5current/5current.html)

The surface current along the south coast of Japan (*figures 2.3 and 2.4)* is the Kuro Shio, or Black Snake. This is the strongest part of the Pacific's Western Boundary Current, and is of great navigational significance (see *UKHO Admiralty Sailing Directions 41, 42A, 42B and 42C, the Japan Pilots,* for detailed information). This is of most use in the first half of the leg, where the direct route coincides with the strongest current along the continental shelf, and going through the islands south of Tokyo Wan, where it can be a bit like being on a cork coming out of a bottle of fizz, with up to 4kts in the channels between the islands. If there is a strong easterly or south easterly, however, the sea state will be brutal in the relatively shallow, confined channels.

2010 is a weak El Nino year (*Appendix A)*. This does not seem to affect the path of the Kuro Shio past the Japanese coast. See

http://www7320.nrlssc.navy.mil/global_ncom/krs.html

for archives of this data – the general trend is the same, with no obvious difference in eddy size or location. The previous weak El Nino year was September 2006 to early 2007.

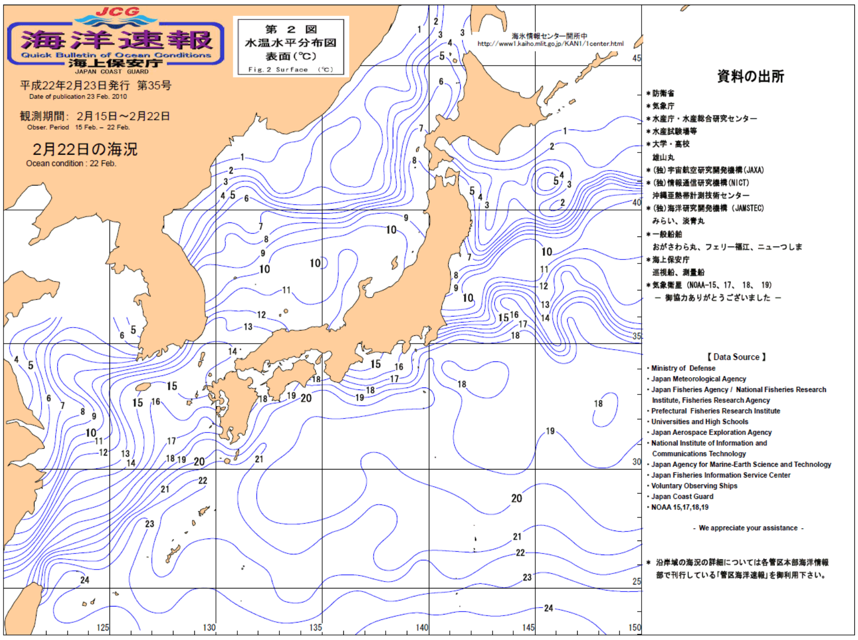


Fig 2.5: sea surface currents in the Yellow Sea and around Japan, 22nd February 2010 (Courtesy of JAPAN COAST GUARD, HYDROGRAPHIC AND OCEANOGRAPHIC DEPARTMENT. http://www1.kaiho.mlit.go.jp/KANKYO/KAIYO/qboc/index_E.html)

The sea surface temperature (*figure 2.5)* shows that the SST is a good proxy for surface current. For further research, it is interesting to look at the 100m and 200m temperature profiles available from the Japan Oceanographic Data Center (JODC) at

http://www1.kaiho.mlit.go.jp/KANKYO/KAIYO/qboc/index_E.html

which clearly show the surface current following the area of greatest temperature gradient.

3. Japan to San Francisco

3.1 Physical Routing

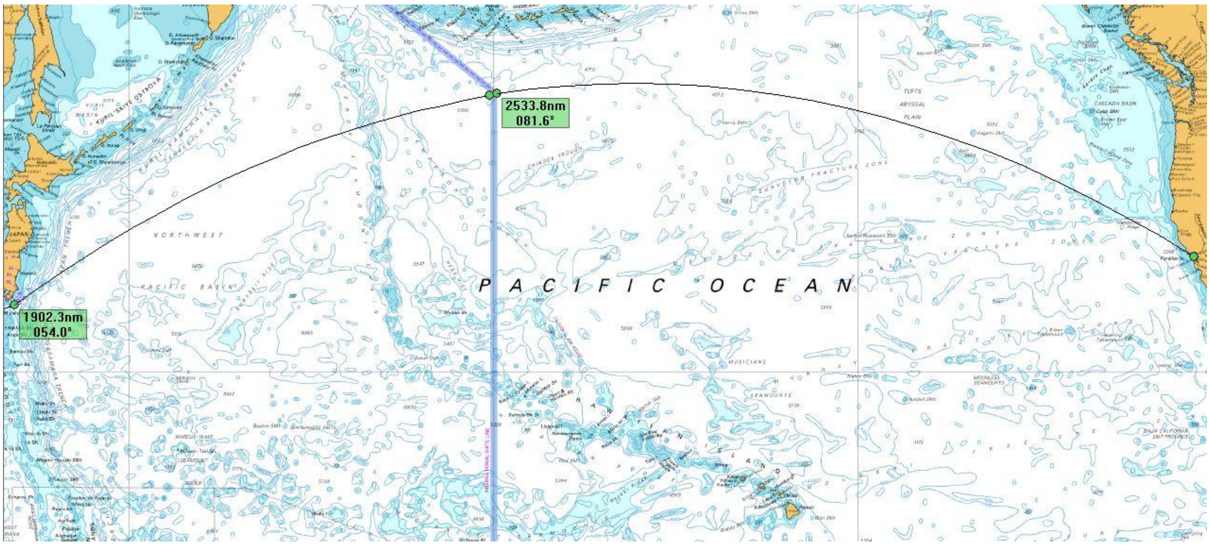


Fig 3.1: along the Japanese coastline
(ARCS chart 4008: A Planning Chart for the North Pacific Ocean, issued 10/8/2006)

Apart from the islands off the coast of Japan (*figure 2.2)* and the ones off the coast of California *(figure 3.2)* there is about 4500 miles of ocean (*figure 3.1).* This great circle route does not take into account any meteorological or oceanographic considerations, which will be covered later.

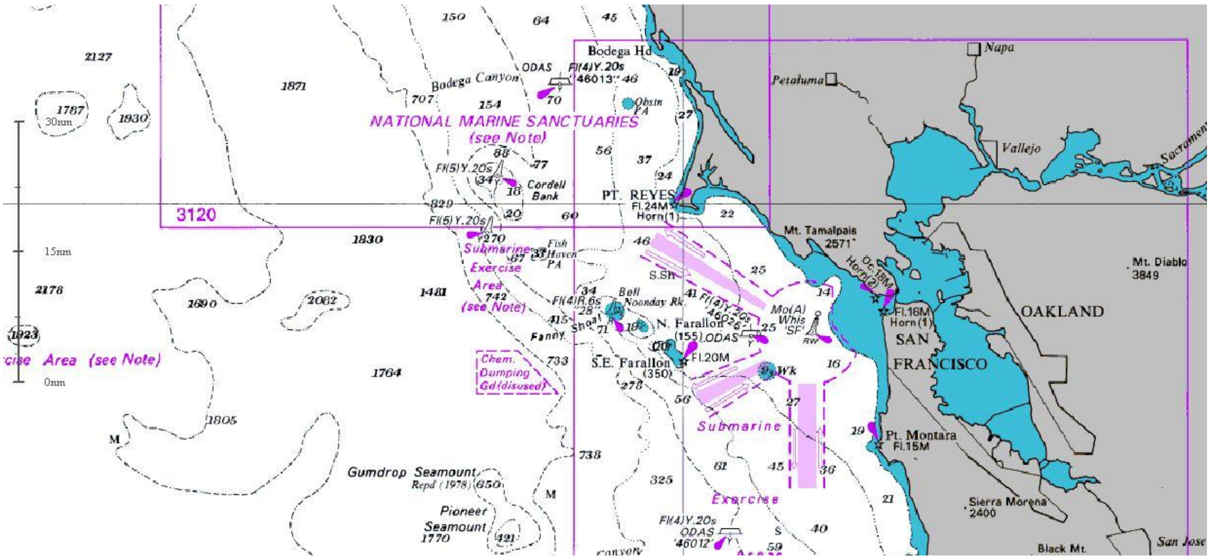


Fig 3.2: landfall in California
(ARCS chart 2530: San Diego Bay to Cape Mendocino, issued 8/5/2008)

The approaches to San Francisco are relatively straightforward, but take note of several traffic separation schemes, maritime sanctuaries and submarine exercise areas.

3.2 Currents

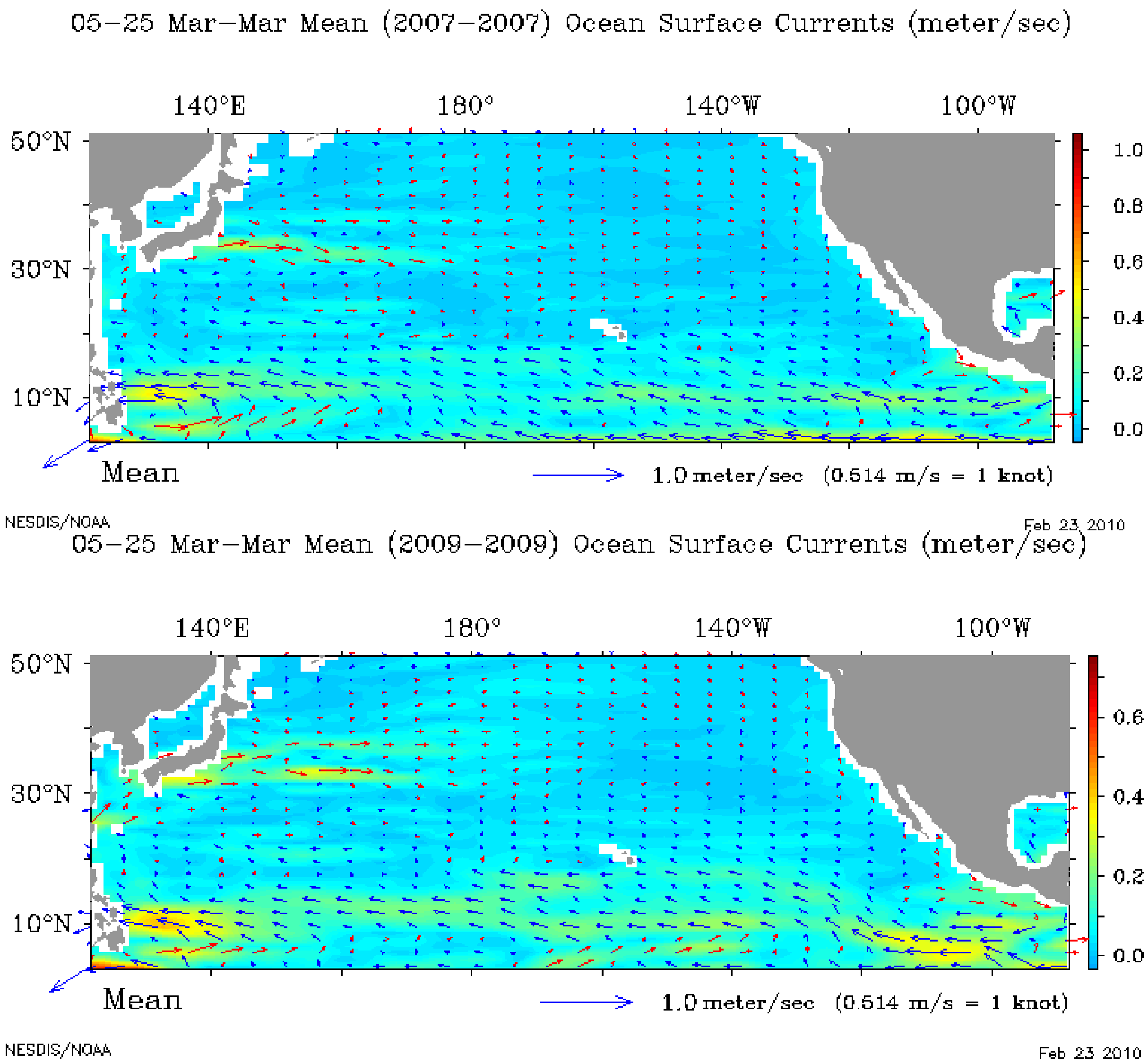


Fig 3.3: North Pacific Currents, averaged for March 2007 and March 2009 (Courtesy of NOAA. http://www.oscar.noaa.gov/datadisplay/index.html)

March 2007 was during a weak El Nino event (*Appendix A)*, and the averaged currents from that period are not very different to those from March 2009 (*figure 3.3).* Once the Kuro Shio has been left behind there is nothing apart from the general North Pacific circulation. The sea temperature is a useful proxy for whether the yacht is still in the current or not (*figure 3.4).*

The California Current (*figure 3.5)* extends nearly 300 miles off the coast, and gives a general flow parallel to the coast of about 0.3 knots southwards (see *Admiralty Sailing Directions, NP 8, "Pacific Coasts of Central America and United States Pilot"*).

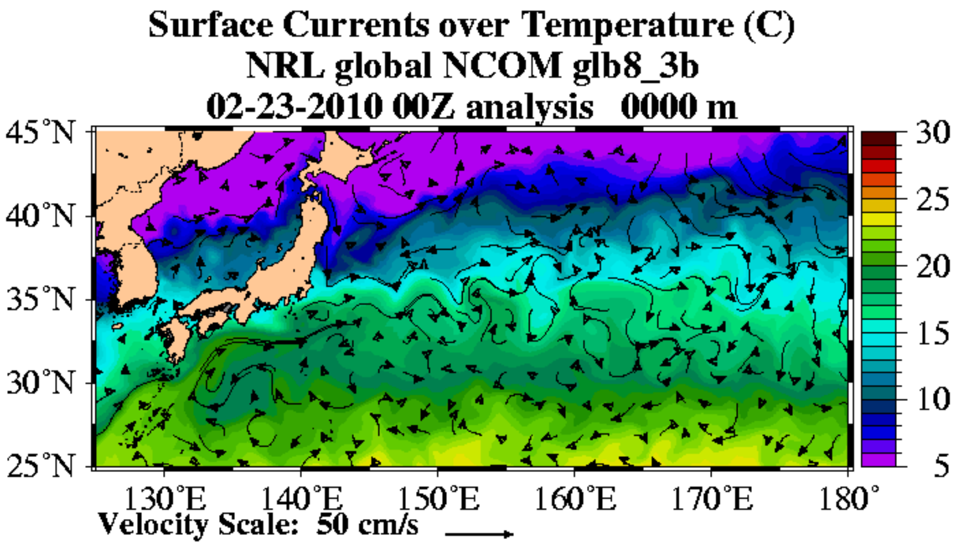


Fig 3.4: surface current on top of SST
(Courtesy of the Naval Research Laboratory.
http://www7320.nrlssc.navy.mil/global_ncom/krs.html)

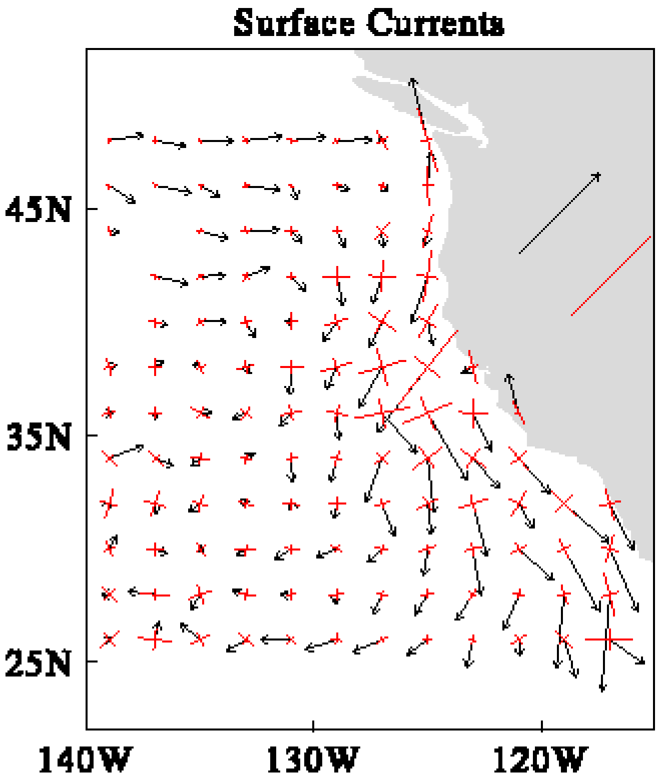


Fig 3.5: mean 15m depth current, black arrows equal 0.3kts. The size of the red crossbars signifies the variability of this (taken from Miller et al, 1999)

4. Weather Conditions

The route, weather-wise, can be split into 3 main sections:
(i) Qingdao to the eastern end of Japan, where it's effectively a coastal race with little scope available in the way of weather tactics;
(ii) Japan to the International Date Line (IDL) – the north west Pacific, which is dominated by the passage of powerful low pressure systems;
(iii) the IDL to California – the north east Pacific, which is dominated by the eastern Pacific High and the lows running to the north of it.

4.1. Qingdao to the eastern end of Japan

The Yellow Sea at this time of year will generally have either a northerly driven between the Mongolian High and a developing low near Japan, or an easterly (plus or minus a couple of points) coming from a wide ridge extending over Korea and Japan. Right now the forecast for March 2nd 2010 is for the former (*figure 4.1)*, but that is a long way away.

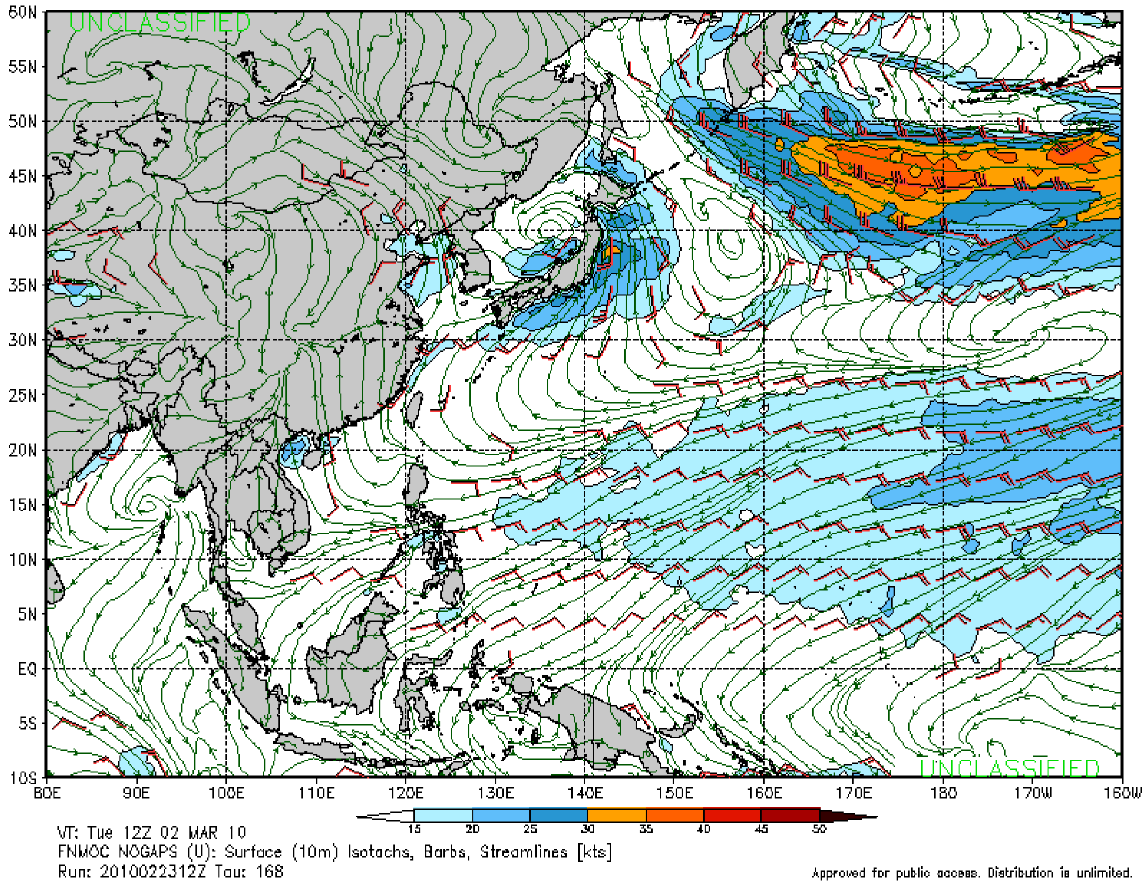


Fig. 4.1: 168 hour surface streamline forecast, 2nd March 2010. (Courtesy of Fleet Numerical Meteorology and Oceanography Center, https://www.fnmoc.navy.mil/wxmap_cgi/cgi-bin/wxmap_DOD_area.cgi?area=ngp_tropwpac&set=Tropical)

Along the south coast of Japan the wind is very much dependent on the position of the nearest low. As this is the area where the lows usually develop, really strong winds tend to occur only at the eastern end of the leg (*figure 4.2)*. This streamline image shows a strong front right at the SE corner of Japan, with SW 35 to 40 knots before the front veering to NNE 25 to 30 knots after it. This is common, and combined with a steeply rising seabed and the Kuro Shio current (*section 2)* can be rather challenging.

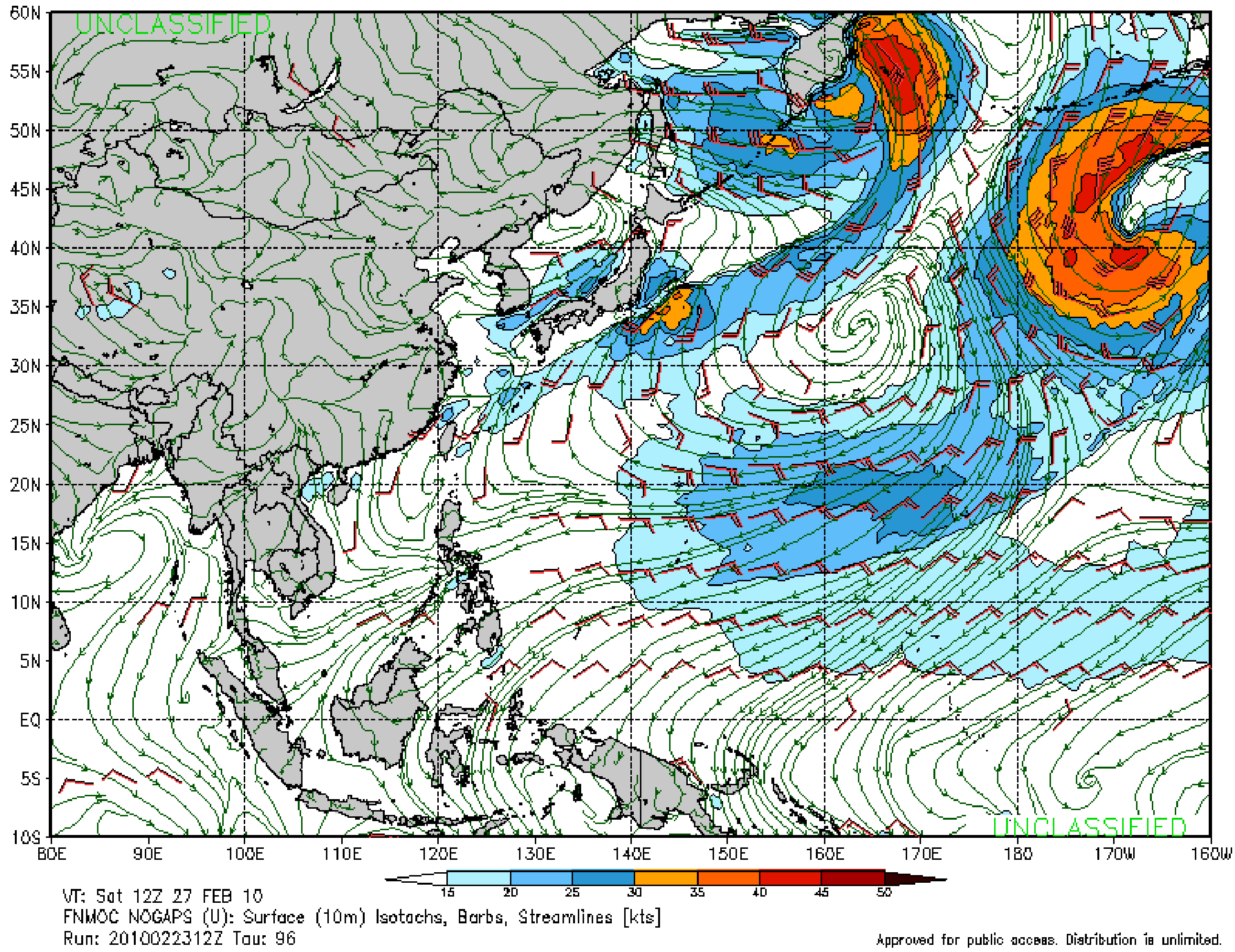


Fig. 4.2: 96 hour surface streamline forecast, 27th February 2010. (Courtesy of Fleet Numerical Meteorology and Oceanography Center, https://www.fnmoc.navy.mil/wxmap_cgi/cgi-bin/wxmap_DOD_area.cgi?area=ngp_tropwpac&set=Tropical)

4.2 Japan to the International Date Line – the North West Pacific

The high pressure system in the NW Pacific is more fragmented than that in the NE Pacific, and tends to be cells that emanate from the Mongolian high and are moved around by the lows developing in the area (*figure 4.3).*

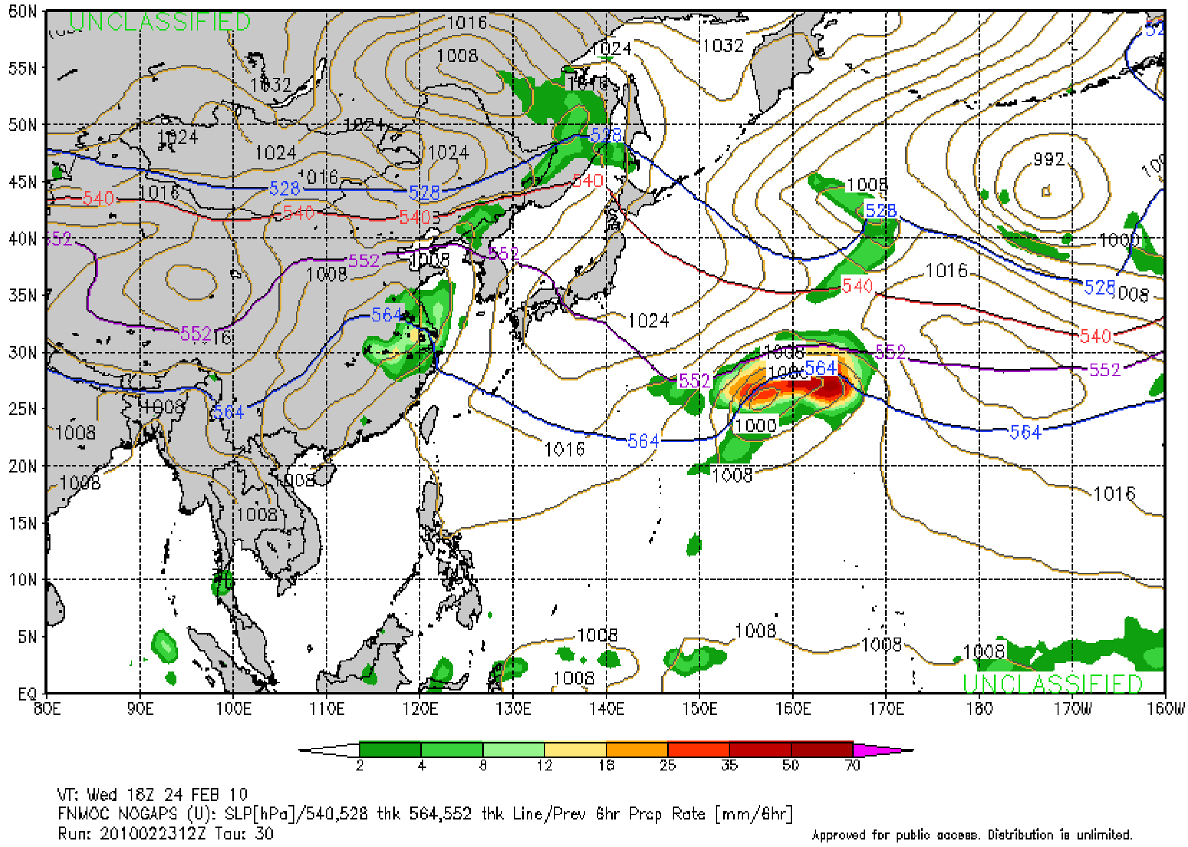


Fig. 4.3: 30 hour surface level pressure forecast, 24th February 2010. (Courtesy of Fleet Numerical Meteorology and Oceanography Center, https://www.fnmoc.navy.mil/wxmap_cgi/cgi-bin/wxmap_DOD_area.cgi?area=ngp_tropwpac&set=Tropical)

The significant weather systems are the lows that generate near Japan before moving NE towards the Aleutians and Alaska. The path of the centres of the lows (ominously called the "storm track") generally follows to the north of the upper level jet stream,which can be best seen on the 500 hPa streamline plots (for example *figure 4.4).* The band of strong 100 knot plus winds is clearly centred at about 43^{o}N, which gives a good idea of the general location of the storm track.

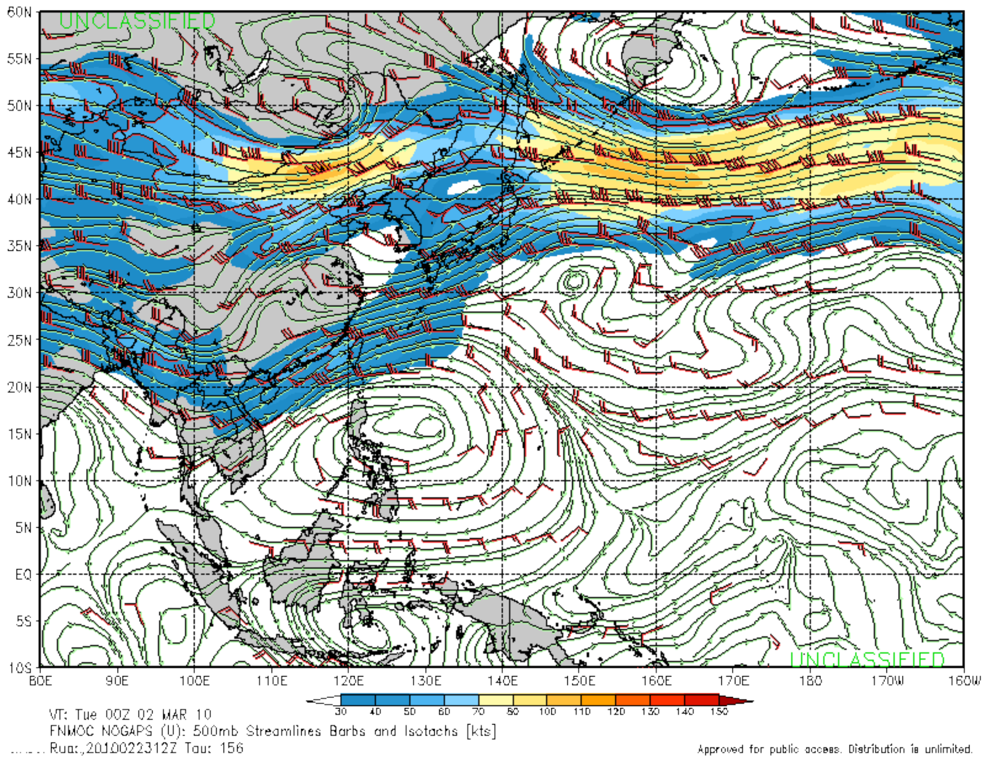


Fig. 4.4: 168 hour 500 hPa streamline forecast, 2nd March 2010. (Courtesy of Fleet Numerical Meteorology and Oceanography Center, https://www.fnmoc.navy.mil/wxmap_cgi/cgi-bin/wxmap_DOD_area.cgi?area=ngp_tropwpac&set=Tropical)

However, occasionally the jet stream dips south (*figure 4.4).* The small area of low pressure at about 26°N 157°E (*figure 4.3)* moves under this until it pops out to the left of the jet exit region 36 hours later (*figures 4.5 and 4.6).* Broadly speaking in the northern hemisphere, the areas to the right of the jet entry area (i.e. the start of the 100 knot plus area) and to the left of the jet exit area (the end of the 100 knot plus area) are areas where the upper level winds diverge. This effectively sucks more air up from the surface, causing the low pressure system to “spin up” and possibly reach storm force. The good thing about them is that they occur in the middle of the largest stretch of deep, clear water on the planet so there is plenty of sea room. They should be treated with caution, and from experience even hove to a Clipper 68 will still make 4 knots in roughly the right direction in 55 knots of wind.

These lows will generally cross the IDL at about 38° to 45°N, and are not the norm – they are well forecast, both on GRIB and SATC, so there is usually ample time to at least start heading away from the strongest areas.

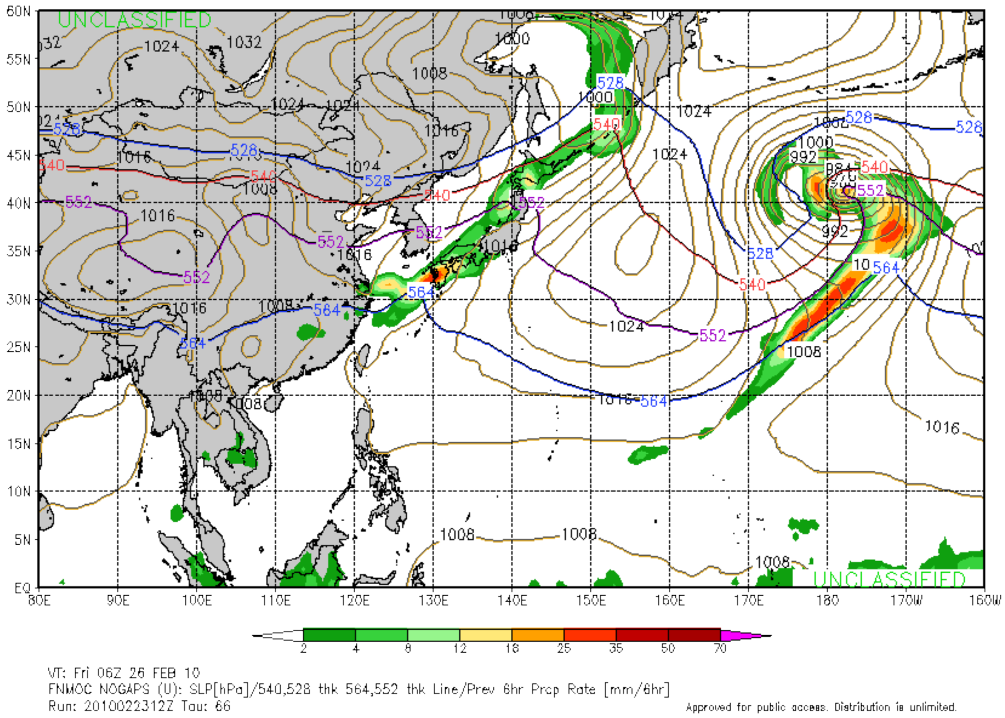


Fig. 4.5: 66 hour surface level pressure forecast, 26th February 2010. (Courtesy of Fleet Numerical Meteorology and Oceanography Center, https://www.fnmoc.navy.mil/wxmap_cgi/cgi-bin/wxmap_DOD_area.cgi?area=ngp_tropwpac&set=Tropical)

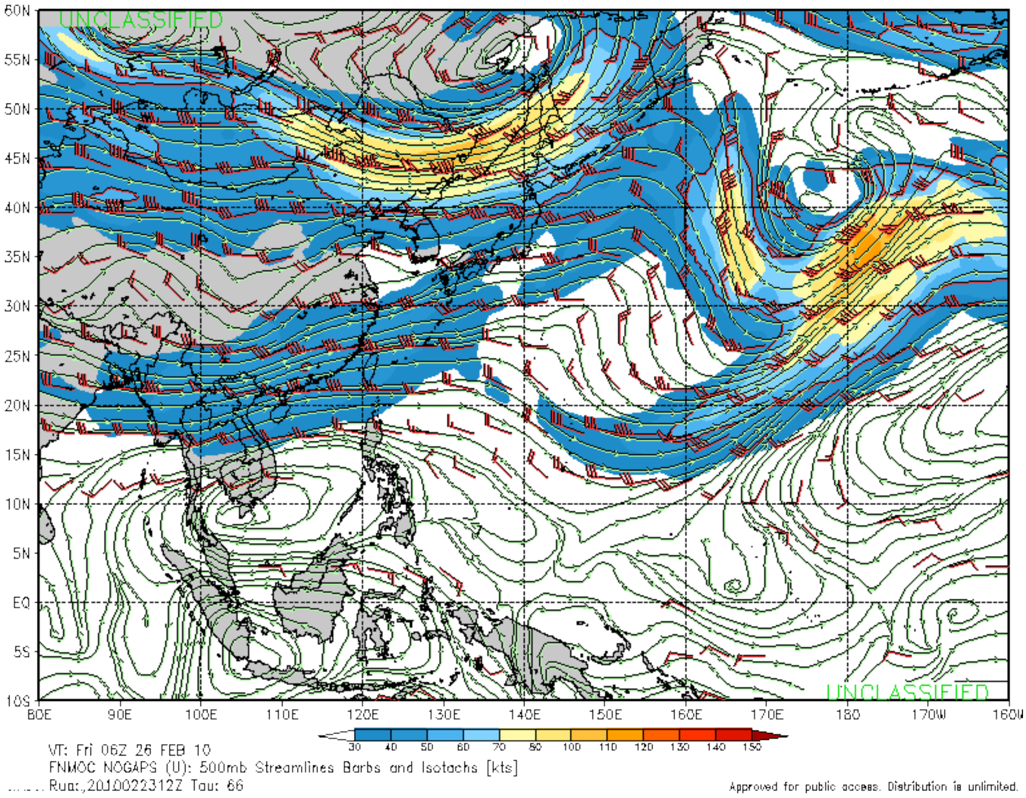


Fig. 4.6: 66 hour 500 hPa streamline forecast, 26th February 2010. (Courtesy of Fleet Numerical Meteorology and Oceanography Center, https://www.fnmoc.navy.mil/wxmap_cgi/cgi-bin/wxmap_DOD_area.cgi?area=ngp_tropwpac&set=Tropical)

4.3 The International Date Line to California – the North East Pacific

There is still a lot of water to be covered from here on in, but the good news is that the low pressure systems have mostly peaked either just before or just after the IDL. The E Pacific high is much more stable, and even the largest lows tend to merely change its shape rather than brush it aside. The strongest lows, as described previously, may trail fronts down that almost, but not quite, split the high (*figure 4.7).* These transitions from one high pressure cell to another need to be watched carefully, as it is possible to end up with no wind at all if the yacht is too far south directly in the dip between the two cells. The wind down the western seaboard of the United States is entirely dependent on the position of the high – if it has been pushed south by a low it is possible to take a more direct, more southerly route in to San Francisco.

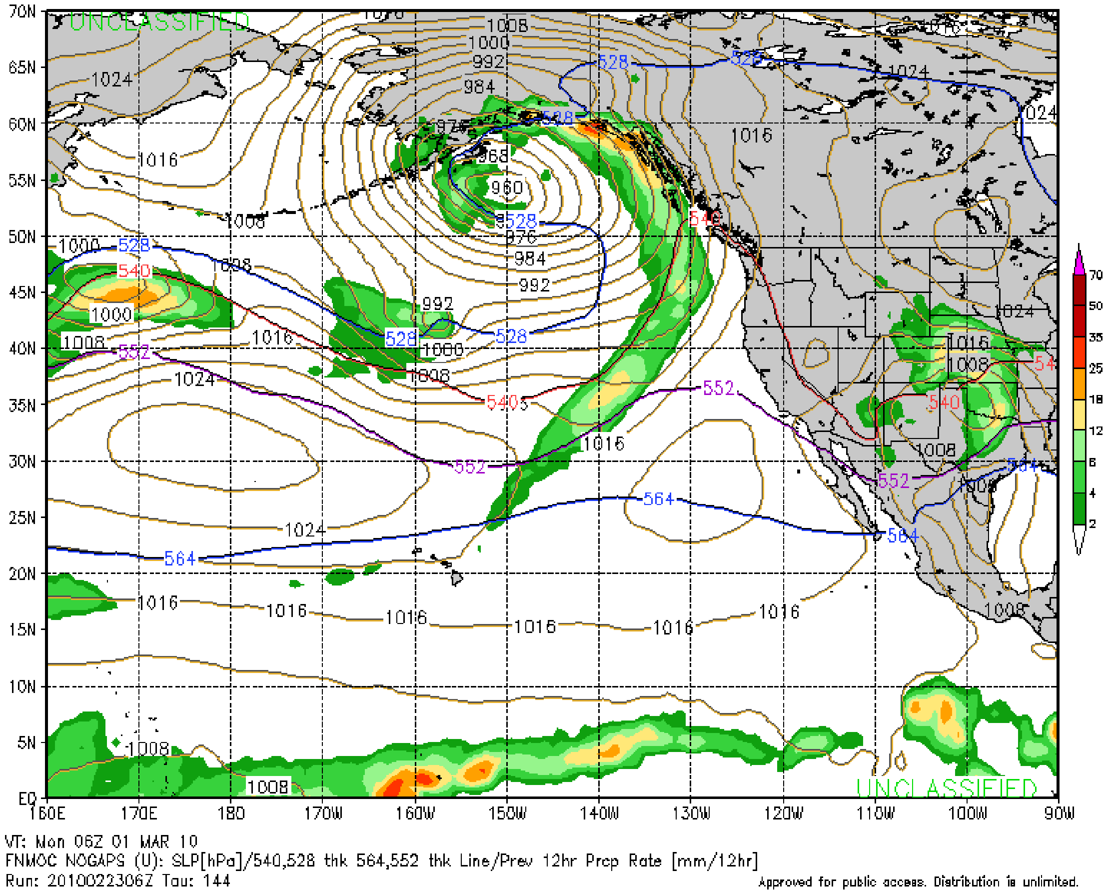


Fig. 4.7: 144 hour surface level pressure forecast, 1st March 2010. (Courtesy of Fleet Numerical Meteorology and Oceanography Center, https://www.fnmoc.navy.mil/wxmap_cgi/cgi-bin/wxmap_DOD_area.cgi?area=ngp_epac&set=Core)

5. Routing Recommendations

Through the Yellow Sea there is not much more to do other than point at the SW corner of Japan and sail as fast as possible, taking care to avoid Cheju Do and other small islands (which are well marked). Along the south coast of Japan finding the Kuro Shio current is key, and the Japan Coast Guard charts for that are the best information to use. The islands to the south of Tokyo Wan cause a funneling effect of the current, which can be very useful. Once into the open Pacific the current fans out rapidly, so the choice of route now depends mostly on the meteorological situation. The traditional sailing route across the Pacific at this time of year cut the IDL at about 42^{o}N and went due east from there until the winds allowed passage southwards to San Francisco (UKHO, 1987). Looking at the low pressure system movement this is entirely sensible, with a recommended IDL crossing point of between 41^{o} and 42^{o}N. From there, sail as close to the great circle route to San Francisco as possible, taking particular care not to stray too far into the high pressure system to the south.

It seems appropriate for this race brief to finish with the quote at the start of that most excellent publication, Ocean Passages for the World:

"Oh God be good to me, Thy sea is so wide and my ship is so small"

(Breton fisherman's prayer)

Appendix A: the El Nino Southern Oscillation

This entirely natural oscillation is well described in the following article reproduced from the NOAA website (http://www.pmel.noaa.gov/tao/elnino/el-nino-story.html). The very small but important diagram that explains the whole thing is expanded here (*figure A.1*).

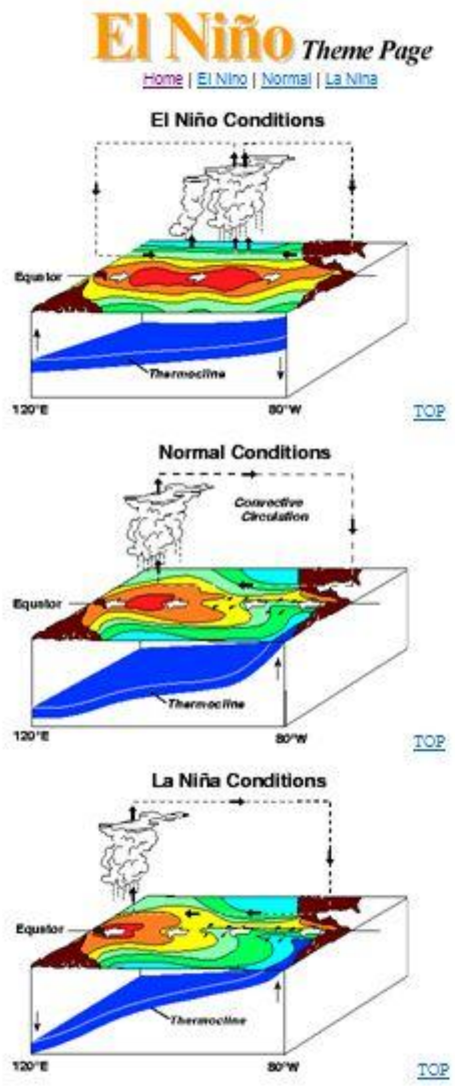
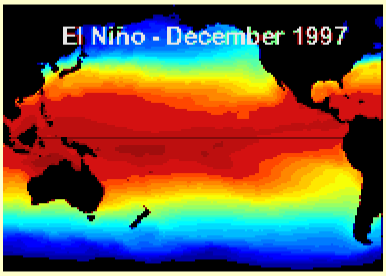


Fig A.1: diagram showing how the change in SST distribution affects convection activity over the central Pacific during El Nino and La Nina episodes (NOAA)



El Niño is characterized by unusually warm ocean temperatures in the Equatorial Pacific, as opposed to La Niña, which characterized by unusually cold ocean temperatures in the Equatorial Pacific. El Niño is an oscillation of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe.

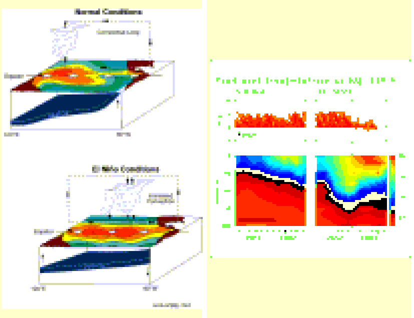
Among these consequences are increased rainfall across the southern tier of the US and in Peru, which has caused destructive flooding, and drought in the West Pacific, sometimes associated with devastating brush fires in Australia. Observations of conditions in the tropical Pacific are considered essential for the prediction of short term (a few months to 1 year) climate variations.

To provide necessary data, NOAA operates a network of buoys which measure temperature, currents and winds in the equatorial band. These buoys daily transmit data which are available to researchers and forecasters around the world in real time.

In normal, non-El Niño conditions (top panel of schematic diagram), the trade winds blow towards the west across the tropical Pacific. These winds pile up warm surface water in the west Pacific, so that the sea surface is about 1/2 meter higher at Indonesia than at Ecuador.

Read more on:
Recognizing an El Niño
El Niño animations
Recent El Niños
Selected references
Related sites:
What is La Niña?
Children of the Tropics: El Niño and La Niña.
Today's El Niño and La Niña information ***Updated daily!***
Sites in Spanish and Portuguese language

Click for full size image (will open a new browser window)



(a) **(b)**

(a) Schematic diagram of normal El Niño conditions in the Pacific Ocean, and (b) temperature on the Equator at 110W

The sea surface temperature is about 8 degrees C higher in the west, with cool temperatures off South America, due to an upwelling of cold water from deeper levels. This cold water is nutrient-rich, supporting high levels of primary productivity, diverse marine ecosystems, and major fisheries. Rainfall is found in rising air over the warmest water, and the east Pacific is relatively dry. The observations at 110 W (left diagram of 110 W conditions) show that the cool water (below about 17 degrees C, the black band in these plots) is within 50m of the surface.

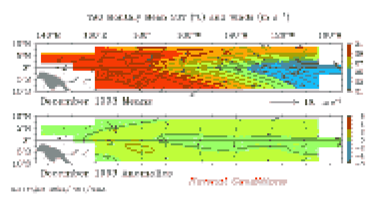
During El Niño (bottom panel of the schematic diagram), the trade winds relax in the central and western Pacific leading to a depression of the thermocline in the eastern Pacific, and an elevation of the thermocline in the west. The observations at 110W show, for example, that during 1982-1983, the 17-degree isotherm dropped to about 150m depth. This reduced the efficiency of upwelling to cool the surface and cut off the supply of nutrient rich thermocline water to the euphotic zone. The result was a rise in sea surface temperature and a drastic decline in primary productivity, the latter of which adversely affected higher trophic levels of the food chain, including commercial fisheries in this region. The weakening of easterly tradewinds during El Niño is evident in this figure as well. Rainfall follows the warm water eastward, with associated flooding in

Peru and drought in Indonesia and Australia. The eastward displacement of the atmospheric heat source overlaying the warmest water results in large changes in the global atmospheric circulation, which in turn force changes in weather in regions far removed from the tropical Pacific.

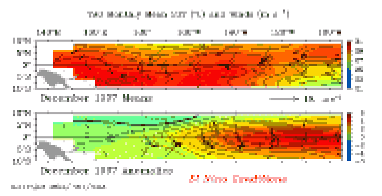
Recognizing El Niño

El Niño can be seen in Sea Surface Temperature in the Equatorial Pacific Ocean

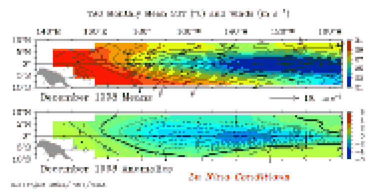
El Niño can be seen in measurements of the sea surface temperature, such as those shown above, which were made from the TAO Array of moored buoys. In December 1993, the sea surface temperatures and the winds were near normal, with warm water in the Western Pacific Ocean (in red on the top panel of December 1993 plot), and cool water, called the "cold tongue" in the Eastern Pacific Ocean (in green on the top panel of the December 1993 plot). The winds in the Western Pacific are very weak (see the arrows pointing in the direction the wind is blowing towards), and the winds in the Eastern Pacific are blowing towards the west (towards Indonesia). The bottom panel of the December 1993 plot shows anomalies, the way the sea surface temperature and wind differs from a normal December. In this plot, the anomalies are very small (yellow/green), indicating a normal December. December 1997 was near the peak of a strong El Niño year. In December 1997, the warm water (red in the top panel of the December 1997 plot) has spread from the western Pacific Ocean towards the east (in the direction of South America), the "cold tongue" (green colour in the top panel of the December 1997 plot) has weakened, and the winds in the western Pacific, usually weak, are blowing strongly towards the east, pushing the warm water eastward. The anomalies show clearly that the water in the centre of Pacific Ocean is much warmer (red) than in a normal December.



Normal Conditions - December 1993



El Niño (warm) Conditions - December 1997



La Niña (cold) Conditions - December 1998

Also see the entire Pacific Ocean

December 1998 was a strong La Niña (cold) event. The cold tongue (blue) is cooler than usual by about 3° Centigrade. The cold La Niña events sometimes (but not always) follow El Niño events.

Animation of El Niño

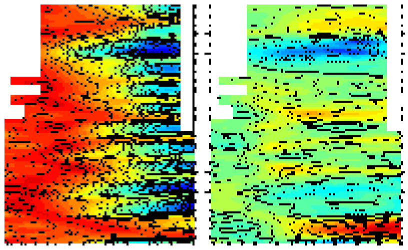
Animation of physical processes allow scientists to better understand El Niño

If you have an MPEG animation viewer, and sufficient memory, you can view an animation of El Niño which shows the changes in monthly sea surface temperature in the tropical Pacific Ocean. The animation is about 1 Megabyte in size. As you view this animation, you will see the warm water spreading from the western Pacific to the eastern Pacific during 1997. The bottom panel in the animation, labelled anomalies, shows how much the sea surface temperature for each month is different from the long term average for that month. The red colour in the anomalies plot indicates that the temperature of the water is much warmer than is normal for that month. Blue colour indicates that the water is much cooler than is normal for that month

Recent El Niños

Several recent El Niños can be seen in Pacific Sea Surface Temperature representations

Click for full size image (will open a new browser window)



Mean and anomalies of sea surface temperature from 1986 to the present, showing El Niños in 1986-1987, 1991-1992, 1993, 1994 and 1997

In the left hand panel, you see the sea surface temperature at the Equator in the Pacific Ocean (Indonesia is towards the left, South America is towards the right). Time is increasing downwards from 1986 at the top of the plot, to the present, at the bottom of the plot. The first thing to note is the blue "scallops" on the right of the plot, in the eastern Pacific. These indicate the cool water typically observed in the Eastern Pacific (called the "cold tongue"). Cold tongue temperatures vary seasonally, being warmest in the northern hemisphere springtime and coolest in the northern hemisphere fall. The red colour on the left is the warm pool of water typically observed in the western Pacific Ocean. El Niño is an exaggeration of the usual seasonal cycle. During the El Niño in 1986-1987, you can see the warm water (red) penetrating eastward in the Spring of 1987. There is another El Niño in 1991-1992, and you can see the warm water penetrating towards the east in the northern hemisphere spring of 1992. The El Niño in 1997-1998 is a very strong El Niño. El Niño years are easier to see in the anomalies on the right hand panel. The anomalies show how much the sea surface temperature is different from the usual value for each month. Water temperatures significantly warmer than the norm are shown in red, and water temperatures cooler than the norm are shown in blue.

Information on the names El Niño and La Niña

El Niño was originally recognized by fisherman off the coast of South America as the appearance of unusually warm water in the Pacific ocean, occurring near the beginning of the year. El Niño means The Little Boy or Christ child in Spanish. This name was used for the tendency of the phenomenon to arrive around Christmas.

La Niña means The Little Girl. La Niña is sometimes called El Viejo, anti-El Niño, or simply "a cold event" or "a cold episode". El Niño is often called "a warm event".

There has been a confusing range of uses for the terms El Niño, La Niña and ENSO by

In the right-hand plot of sea surface temperature anomalies, it is very easy to see El Niños, with water warmer than usual (red) in the eastern Pacific, during in 1986-1987, 1991-1992, 1993, 1994 and 1997-1998. Notice the very cool water (blue), in the Eastern Pacific, in 1988-1989. This is a strong La Niña, which occurs after some (but not all) El Niño years. 1995-1996 was a weaker La Niña year. It is unusual for El Niños to occur in such rapid succession, as has been the case during 1990-1994.

both the scientific community and the general public, which is clarified in this web page on definitions of the terms ENSO, Southern Oscillation Index, El Niño and La Niña. Also interesting is the Web page: Where did the name El Niño come from?

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Credits and Acknowledgements | TAO Diagrams

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