ACTIVITY El Niño and La Niña Web Based Activities

MSC Issues and Topics	http://www.msc-smc.ec.gc.ca/issues_e.cfm
Canadian El Niño page	http://www.msc-smc.ec.gc.ca/elnino/index_e.cfm
Canadian La Niña page	http://www.msc-smc.ec.gc.ca/lanina/index_e.cfm
NOAA El Nino page	http://www.pmel.noaa.gov/tao/elnino/nino-home.html

The **El Niño Theme Pages** will help you explore the workings of the tropical Pacific marine environment. Stretching nearly one-third of the way around the globe and covering a fifth of the Earth's surface, the tropical Pacific is a coupled ocean/atmosphere system that makes its presence known far beyond its boundaries. Its influence on world-wide weather and climate can lead to major ecological, societal, and economic disruptions. Occurrence of *El Niño* every two to seven years and the less frequent *La Niña* demonstrate that there are swings in ocean/atmosphere conditions, weather, and climate which operate on other than annual timetables.

With the ***El Niño* Theme Pages,** you can investigate and compare ocean and atmospheric conditions that occur during *El Niño* and *La Niña* with long-term average conditions.

The Tropical Pacific During long-term Average Conditions

Examine the **El Niño Theme Pages** where you will find the questions "What is *El Niño*?" and "What is *La Niña*?" Click on these to help you identify the correct answers in the statements below.

1. The winds in the equatorial Pacific Ocean during long-term average conditions blow toward the [**(*east*) (*west*)**] and the wind speed is [**(*higher*) (*lower*)**] in the Eastern Pacific than in the western Pacific.
2. During long-term average conditions in the equatorial Pacific Ocean, surface water flows towards the [**(*east*) (*west*)**]
3. The highest sea surface temperatures (SSTs) during long-term average conditions occur in the [**(eastern) (western)**] tropical Pacific. This SST pattern is caused by relatively strong Trade Winds pushing sun-warmed surface water [**(*eastward*) (*westward*)**] as evidenced by the direction of surface currents.

4. Strong Trade Winds also cause the warm surface waters to pile up in the western tropical Pacific so that the sea surface height in the western Pacific is [**(*lower*) (*higher*)**] than in the eastern Pacific. Transport of surface water to the west also causes the thermocline (the transition zone between warm surface water and cold deep water) to be [**(*deeper*) (*shallower*)**] in the eastern Pacific than in the western Pacific.

5. Warm surface water transported by the wind away from the South American coast is replaced by cold water rising from below in a process called *upwelling*. Upwelling of cold deeper water results in relatively [**(*high*) (*low*)**] SSTs in the eastern Pacific compared to the western Pacific.

6. Cold surface water cools the air above it, which leads to increases in the surface air pressure. Warm surface water adds heat and water vapour to the atmosphere, lowering surface air pressure. These effects result in tropical surface air pressure being [**(*highest*) (*lowest*)**] in the eastern Pacific and [**(*highest*) (*lowest*)**] in the western Pacific.

7. Whenever air pressure changes over distance, a force will act on air to move it from where the pressure is relatively high to where pressure is relatively low. The Trade Winds blow from east to the west because from east to west the surface air pressure [**(*increases*) (*decreases*)**].

8. Rainfall in the tropical Pacific is also related to SST patterns. There are reasons for this relationship. The higher the SST, the greater the rate of evaporation of seawater and the more vigorous is atmospheric convention. Consequently, during long-term average conditions, rainfall is greatest in the [**(*western*) (*eastern*)**] Pacific where SSTs are [**(*highest*) (*lowest*)**].

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The Tropical Pacific During El Niño and La Niña

While no two *El Niño* or *La Niña* episodes are exactly alike, all of them exhibit most of the characteristics described in the **El Niño Theme Pages**.

1. During long-term average conditions, the surface air pressure in the central Pacific is higher than to the west. During *El Niño*, the surface air pressure to the west is [**(*higher*) (*lower*)**] than in the central Pacific. During *La Niña*, the surface air pressure to the west is [**(*higher*) (*lower*)**] than in the central Pacific. This seesaw pattern of pressure variation is called the *Southern Oscillation*.
2. In response to changes in the air pressure pattern across the tropical Pacific, the speed of the Trade Winds decreases (and wind directions can reverse, especially in the western Pacific). No longer being pushed toward and piled up in the western Pacific, the warm surface water reverses flow direction. This causes SSTs in the eastern tropical Pacific to be [**(*higher*) (*lower*)**] than long-term average values. Conversely, the surface water currents during ***La Niña*** flow toward the [**(*east*) (*west*)**].
3. In response to surface currents, sea surface heights in the eastern tropical Pacific are [**(*higher*) (*lower*)**] than long-term average levels during *El Niño* events. At the same time, the arrival of the warmer water causes the surface warm-water layer to thicken during *El Niño*. Evidence of this is the [**(*shallower*) (*deeper*)**] depth of the thermocline compared to long-term average conditions.
4. In response to surface currents, sea surface heights in the eastern tropical Pacific are [**(*higher*) (*lower*)**] than long-term average levels during *La Niña* events. At the same time, the arrival of the warmer water causes the surface warm-water layer to thicken during *La Niña*. Evidence of this is the [**(*shallower*) (*deeper*)**] depth of the thermocline compared to long-term average conditions.
5. Differences between existing conditions and long-term average conditions are called *anomalies*. If readings are higher than the respective long-term averages

the anomalies are positive. If values are lower, the anomalies are negative. In the eastern tropical Pacific during *El Niño*, the SST anomaly is [**(*negative*) (*positive*)**], the sea-surface height anomaly is [**(*negative*) (*positive*)**], the surface air pressure anomaly is [**(*negative*) (*positive*)**], and the rainfall anomaly is [(***negative***) (***positive***)].

6. Differences between existing conditions and long-term average conditions are called *anomalies*. If readings are higher than the respective long-term averages the anomalies are positive. If values are lower, the anomalies are negative. In the eastern tropical Pacific during La Niña , the SST anomaly is [**(*negative*) (*positive*)**], the sea-surface height anomaly is [**(*negative*) (*positive*)**], the surface air pressure anomaly is [**(*negative*) (*positive*)**], and the rainfall anomaly is [**(*negative*) (*positive*)**].

7. Continue your investigations of the tropical Pacific ocean/atmosphere system by predicting how the changes shown by the **El Niño Theme Page** might impact people living along the Peruvian coast and on the island nations of the western tropical Pacific. Return back to the **El Niño Theme Page** to study the potential impacts of El Niño in those areas and else where, including Canada.

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Canadian Winter Climate Prediction

1. Using the **Canadian El Niño** or **La Niña web pages** or the maps at the end of this section that show average temperature and precipitation changes that occur during *El Niño* and *La Niña* conditions, give a forecast for the winter for the following Canadian cities ***assuming that a La Niña will be occurring in the tropical Pacific.***

Example:

If a La Niña occurs this winter Churchill, Manitoba should experience temperatures about <u>two degrees colder</u> than normal but with <u>less snowfall</u> than normal.

1.	**Vancouver**	**11.**	**Montreal**
2.	**Victoria**	**12.**	**Fredericton**
3.	**Edmonton**	**13.**	**Halifax**
4.	**Calgary**	**14.**	**St. John's**
5.	**Regina**	**15.**	**Yellowknife**
6.	**Winnipeg**	**16.**	**Whitehorse**
7.	**Thunder Bay**	**17.**	**Iqaluit**
8.	**Toronto**	**18.**	**Prince George**
9.	**Ottawa**	**19.**	**Kelowna**
10.	**Quebec City**		

2. Write a forecast for your hometown for the upcoming winter.

   First, using the **Canadian El Niño** or **La Niña web pages** find out if one of these tropical events is expected to be occurring in the upcoming winter. Second, using the maps at the end of this section that show average temperature and precipitation changes that occur during *El Niño* and *La Niña* conditions, to give a forecast for the winter for your hometown. Try some of the other Canadian cities listed above to see if there are any differences.

EXTENSIONS

1. Satellites provide us with a unique view of the Earth's oceans. Imagery acquired by various sensors aboard these space platforms reveal broad-scale circulation patterns that can be seen in their entirety. Describe how each of the following remote sensors could be used to track the progress of *El Niño* and *La Niña*:

   a) infrared (IR) sensors that measure sea surface temperatures,

   b) altimeters that monitor sea-surface height, and

   c) ocean colour sensors that observe visible light reflecting from pigments such as chlorophyll in phytoplankton.

2. Not all observations of ocean conditions can be obtained remotely by sensors aboard satellites. Some measurements must be made "in situ", that is, by instruments actually in the water. Describe how each of the following unmanned platforms could be used to track the progress of *El Niño* and *La Niña*:

   a) tide gauge stations that measure the height of local sea level,

   b) moored buoys that monitor surface winds and water temperatures at several levels below the ocean surface, and

   c) drifting buoys that observe the motion and temperature of surface ocean water.

3. One of the best sources of data on ocean/atmosphere conditions are the sensors and scientists aboard oceanographic research ships. What are some of the advantages and disadvantages of using these resources to monitor *El Niño* and *La Niña*?

4. Reliable data obtained from remote and direct sensors help describe the existing conditions in the tropical Pacific. These data are now being used by scientists to develop realistic numerical models of the coupled ocean and atmosphere. Computers that are programmed with these models can project future states of the tropical ocean/atmosphere and foresee a future *El Niño* and *La Niña*. What might be the value of such predictions?

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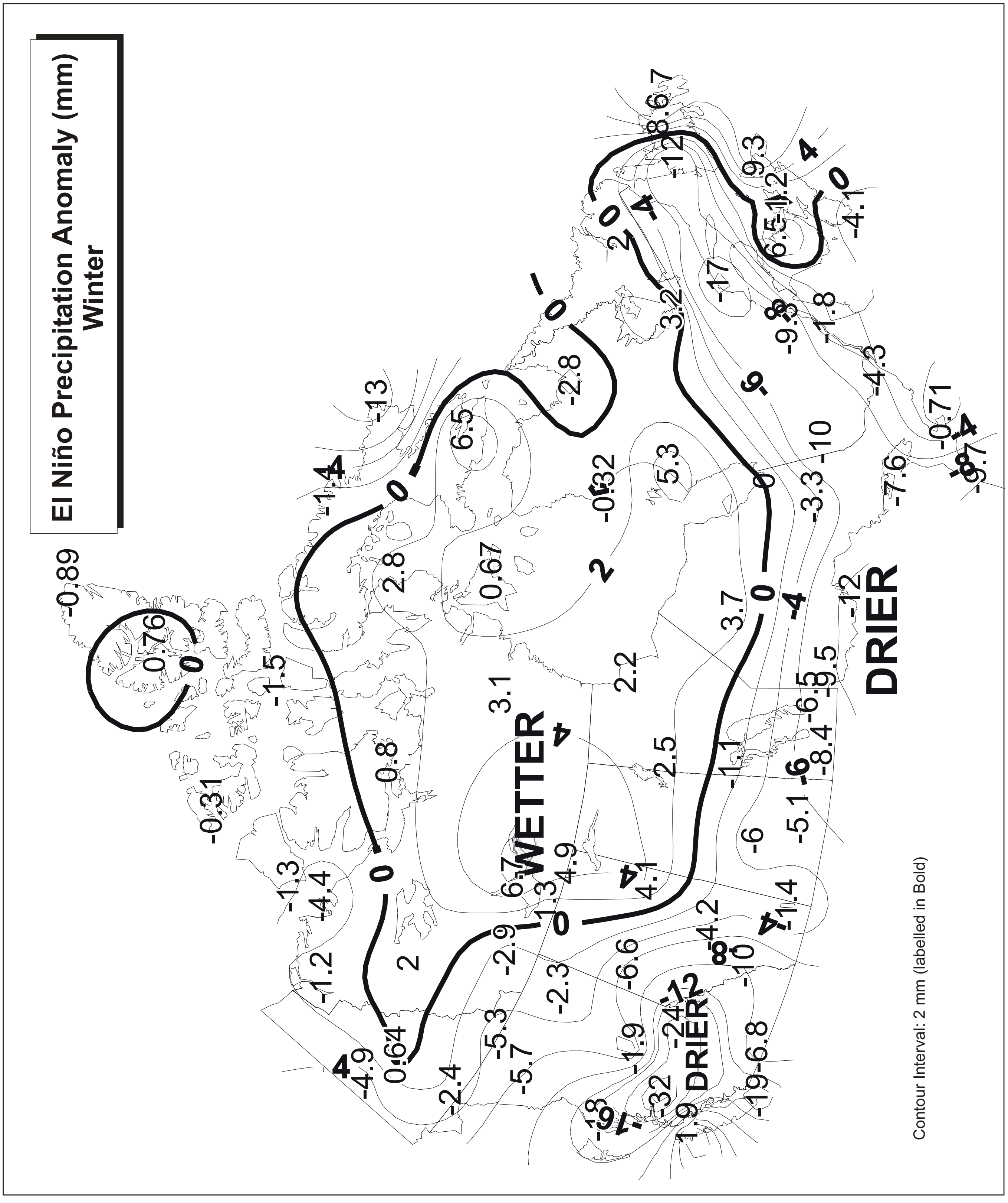

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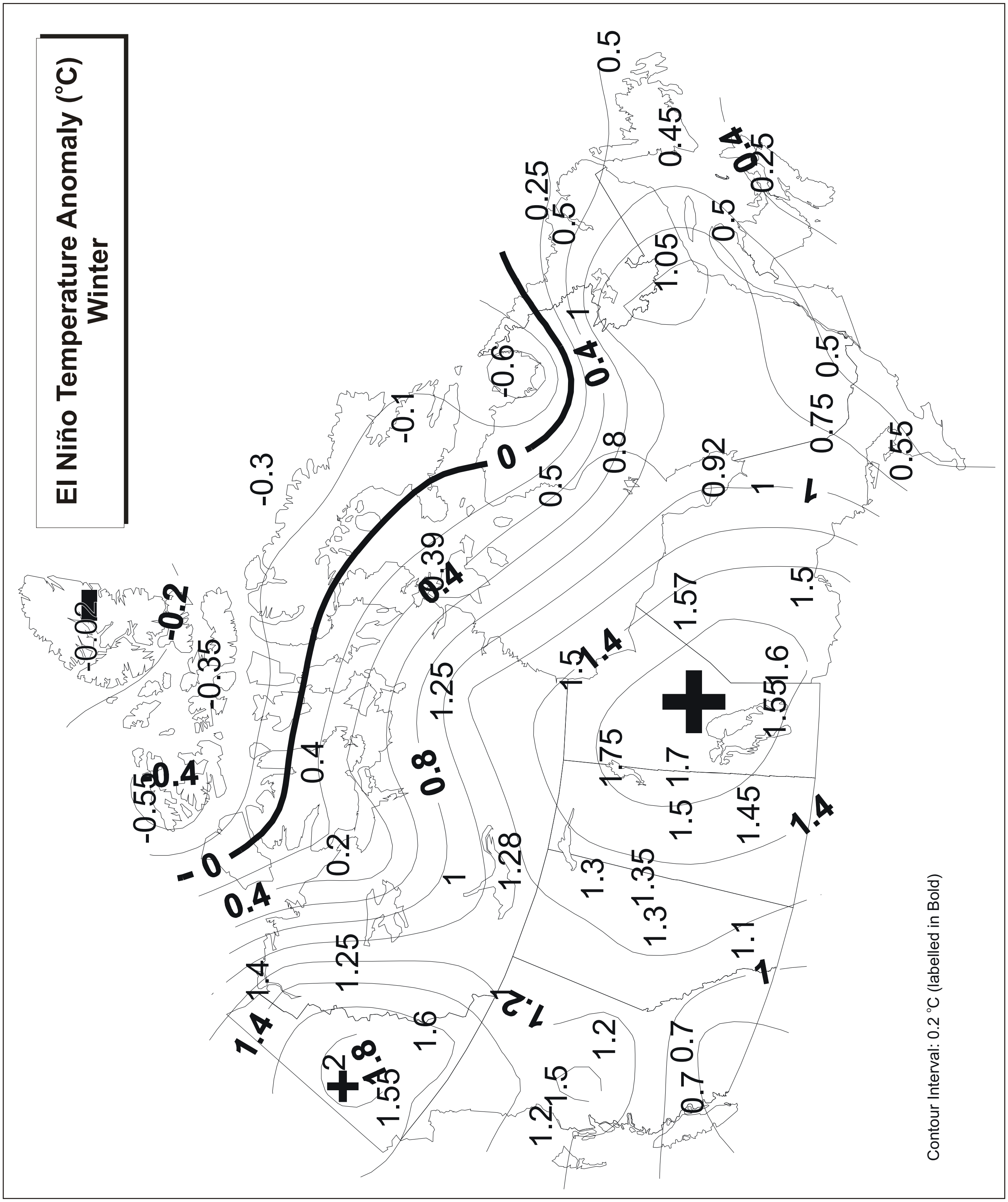

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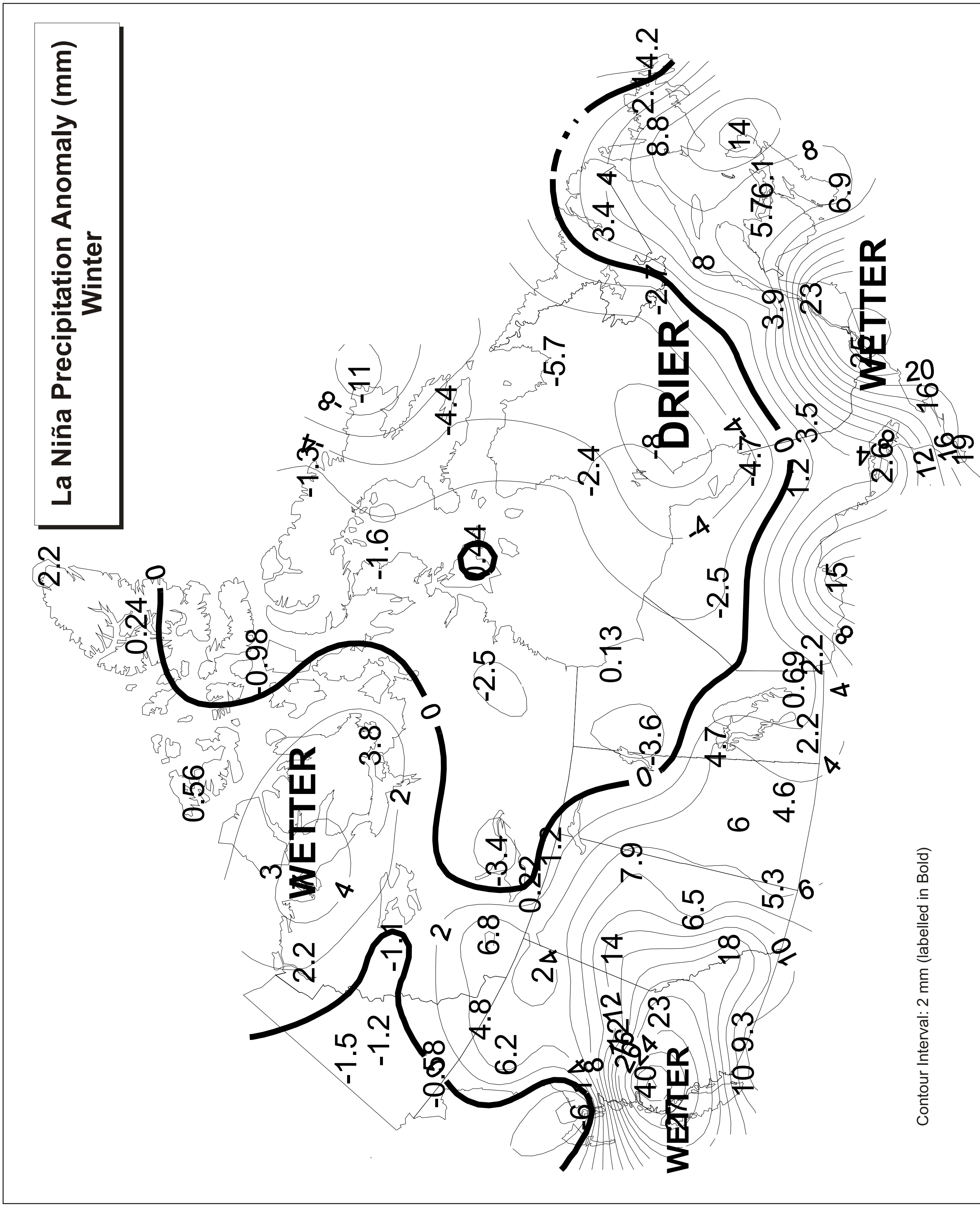

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