Usable Science II:
The Potential Use and Misuse of El Niño Information in North America

31 October - 3 November 1994

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Dedication

This report is dedicated to the memory of **Gordon McKay**, a scientist whose career was devoted to an improved understanding of atmospheric processes for the benefit of humanity.

Contents

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Introduction

El Niño and Society

There is considerable and growing interest in the progress that has been made since the earliest decades of this century with regard to research and understanding of El Niño-Southern Oscillation events, popularly referred to as El Niño. Research in this area began at the turn of the twentieth century with Sir Gilbert Walker's research on the Southern Oscillation, a seesaw of pressure systems across the equatorial Pacific Ocean, centered on Darwin (Australia) and Tahiti. He also identified, through a variety of statistical measures, linkages over relatively large distances, called teleconnections, between seemingly unrelated climate anomalies.

Along the coast of western South America, people had been aware of sea surface temperature changes that disrupted ecological processes, such as fish and guano-bird population dynamics. That awareness stems at least back to the early 1800s.

Jacob Bjerknes in the mid-1960s identified the physical mechanisms that linked these two phenomena --- El Niño and the Southern Oscillation. Before then, these physical processes had been treated separately. Since the mid-1960s, the research community involved in long-range forecasting has shown a constantly, if not exponentially, increasing interest in ENSO events and their teleconnections.

In 1986, a research team within the forecast community went public with an El Niño forecast in 1986, much to the chagrin of fellow researchers. Fellow researchers opposed making research forecasts public because of the uncertainties in their scientific knowledge

about the phenomenon. Yet, the initial public forecast proved to be a correct one and received a great deal of attention from science reporters. By the end of the 1980s, several groups had followed suit by issuing their forecasts of ENSO. As various groups, using a variety of modeling, observational and statistical techniques, would become aware of the possibility of the onset of a warm event, they would issue forecasts; a climate applications group in NOAA's National Weather Service issues a forecast in the form of an ENSO advisory.

Considerable insight into air-sea interactions in the equatorial and extratropical regions has been gained. First of all, the ENSO events of the 1980s and early 1990s have been the most intensively observed and assessed to date. And, secondly, through the efforts of researchers involved in an international, decade-long (1985 to 1994) research and field program called TOGA (Tropical Ocean-Global Atmosphere), our understanding of ENSO has greatly improved. The end of the TOGA program is likely to be followed by another decadal-scale related research effort on interannual variability in the mid-latitude region, called GOALS (Global-Ocean-Atmosphere-Land System).

In light of recent gains in scientific knowledge of air-sea interaction in the Pacific Ocean (eg, ENSO), it is clearly time for the social science research community to become more deeply engaged in efforts to enhance the utility of existing scientific information about ENSO events by focusing not only on the physical processes of ENSO but on identifying those groups in societies in North America that can use ENSO-related information to enrich their decisionmaking capabilities with respect to their climate-sensitive activities.

Several scientific researchers have identified possible linkages between weather anomalies in North America and the occurrence of ENSO events in the central and eastern equatorial Pacific. While they do not necessarily agree with the linkages (called teleconnections) proposed by other researchers, there is an identifiable set of anomalies in North America that can provide useful information to the user community.

By user community, we are referring to both actual users of ENSO and teleconnection information (including forecasts) and potential users. The former are those who are already aware of either El Nino, the Southern Oscillation or ENSO and its possible impacts on their activities in North America or elsewhere (e.g., farming, fishing, manufacturing, transporting, human health). The latter group --- potential users --- are those whose activities could benefit from the use of such scientific information, if they were to be shown how ENSO events can affect their activities and how to use ENSO-related information in their decisionmaking processes. Awareness of and belief in the potential value of ENSO information are important first steps toward converting potential users into actual ones.

Those who write about ENSO research findings, such as science writers and reporters (among other media specialists), need to be convinced that ENSO forecasts have value for their geographic or functional regions, either directly or indirectly. The media are not only consumers of information about ENSO, but they are the potential educators of the public, including policymakers. In essence they are *the* creators of actual users, converting their potential into reality. But the media that reports on scientific research activities are faced with numerous constraints not the least of which is a focus on regional and local weather-related issues. Aside from providing general interest stories with the generic information on ENSO, they await more certainty in ENSO teleconnections research and they want it to be focused on the communities that they serve. For example, Californians want to know what an ENSO means for them, drought or floods; New Englanders want to know what it means for their region, more hurricanes or less; the Gulf states are also concerned with the possibility of increased flooding from Texas to Florida; the Pacific Northwest states are concerned about wintertime precipitation shortfalls; the Canadian Prairie farmers want to know about ENSO, for agricultural production purposes; and so forth. Each of these regional interests is not necessarily captured in the interests of other regions. This is a variation of NIMBY (Not In My Back Yard): I am not interested in writing stories about climate-related phenomena that are not directly affecting my back yard.

Users' Perceptions

The following chart was devised, based on information provided by the potential users of ENSO information in their discussion papers. The chart depicts the overriding concern about climate-related information of his or her company or agency, specific concerns, and the potential value to that specific segment of the user community of improved ENSO-related information. The information on the chart should also be treated as anecdotal information. Similar information for a variety of potential users of ENSO information and forecasts could be, however, gathered in a systematic way, providing greater insights to the ENSO research community about users' perceptions of their needs. Such information would also serve as a good starting point for meaningful dialogue between producers of ENSO-related information and the potential users of that information.

Chart of Users' ENSO-Related Concerns

User (Potential/Actual)	Overriding Primary Concern	Specific Concerns	Perceived Potential Use or Savings	Remarks
Canadian Wheat Board	Grain yield, production and quality forecasting on the global scale with a focus on Canada (regional and global)	• Big production savings in major foreign markets • Need 3–6 months reliable forecast • What kind of summer or growing season are we likely to have? • Need to know the size, quality, and any hazardous risks to the crop as soon as possible	• Improved early warning system for North American spring rains • La Niña drought forecasting • To assist Canadian Wheat Board in its marketing functions to maintain a competitive edge for CWB wheat in the world marketplace • Advance ENSO forecast (of warm winters) would be of great planning value to companies in the heating business	• Focus is also on US corn belt • Weather forecasts can drive the grain market • Make forecast products user-friendly • End users tend to be skeptical of forecasts • Need forecast that is precise in its prediction of ENSO's onset and decay • Warm winters in the Canadian Prairies with ENSO • Figuring out what causes the PNA blocking is a multi-billion-dollar business
Chiquita Brands, Inc.	Banana production and shipment	• Long range (30/60/90 days) precipitation forecast • Wind forecast • Mesoscale forecasts	• Fruit quality improvement, e.g., disease control (sigatoka), early warning of disease • Production volume vs. marketing demands • Replanting needs and preparedness • Identification of alternative fruit supply • Ship scheduling and chartering	• 4–6 month lead time about ENSO onset for the Ecuador/Peru coast • Better precipitation forecast, as ENSO builds up
California Water Resources	• Water supply forecasting (including snowmelt runoff) six months in advance • Flood forecasting on major northern California rivers (hours in advance) • State's droughts and floods	• Most crop planting decisions are made in February when hydrological uncertainties are still very large • No good relationship seen between ENSO and California winter season precipitation. Some ENSO years are wet, others are dry	• 15-month forecast (about Feb/Mar/Apr) could not affect the amount of reservoir carryover to a possible second dry year • 7-year forecast would enable water people to build facilities, adjust market infrastructure to fit oncoming drought or flood	• Forecasts are used by water project operators to schedule reservoir operations and water system deliveries (preliminary forecast in December and updated each month) • Two long-range forecast value thresholds: (a) reliable wet season (or rest of wet season through to April 1), (b) reliable forecasts out to 7 years

User (Potential/Actual)	Overriding Primary Concern	Specific Concerns	Perceived Potential Use or Savings	Remarks
California Water Resources, continued				• A good monthly forecast by December 1 of future precipitation out into the future by 4 to 5 months • Major adjustments occur in February when 60–65% of precipitation accumulation occurs • At this point, shift to reliable forecast of subsequent wet season (15-month forecast). This affects the amount of reservoir carryover to be saved for possible second dry year
Upper Colorado River Commission	Regional droughts and regional floods	• Agricultural crops (type and planting) to match water supply • Structural concerns • When reservoirs are full or near-full, the amount/timing of precipitation is very important in a forecast • The accuracy and timing (monthly volume) of runoffs are critical	• Could save investment in seed, fuel, labor with sufficient long-range prediction • Advanced flood warning allows temporary protection measures (sandbags and Gabian basket structure) to minimize structural damage to diversion and conveyance facilities • If ENSO can unlock mysteries of runoff cycles, then there will be an enhanced operation of Colorado River system • Can ENSO info improve what we know of any of the 3 streamflow components (1) snow on the ground, (2) rain in the bucket, (3) moisture in the soil	• Upper basin devoid of major storage facilities and relies on runoff (site specific) • Poor (low precipitation) forecast can mean loss of hydropower generation and damage to spillway tunnels and to riverine environment in Grand Canyon
Hydro-Quebec	Electric power production	Energy load and inflows are related to climate	• Reduce annual energy surplus's standard of deviation of 10% of supply • 1% decrease of standard deviation of the energy supply for next 10 years could save $20 million	• Demand for electricity is highest when streamflow is lowest (winter); therefore we need reservoirs • Water inflows limit annual energy output • Need confidence limits with forecasts

User (Potential/Actual)	Overriding Primary Concern	Specific Concerns	Perceived Potential Use or Savings	Remarks
Newspapers	The need for better information on ENSO teleconnections with California (especially northern California)	• Regional drought (multiyear) • With ENSO, weather could go either way, either droughts or floods • Science is still confused: can't warn people of drought or flood in California, therefore what value is it? • Need for accurate, user-friendly consumer product	With improved regional accurate prediction of ENSO, California media would be a welcomed audience	• Climate and weather are big news in California • Competition for scarce water • California weather and climate are governed by Pacific and by ENSO • Heavy rains in southern California lead to flooding, but no rain in northern California leads to drought • Media needs access and accuracy from science community • Interest in ENSO research and forecast is parochial • Make ENSO information "news you can use"; bring it closer to home. Readership is increasingly urban
Insurance	• National prevention of loss of life and injuries • National weather-related concern of property–casualty companies is dramatic increase in losses to residential and commercial structures	• Public safety and early warning • Loss to structures against wind, hail, freezing • Insurance companies need a year's advanced lead time • Need a clear understanding of link between severe weather and El Niño	• Forecast of hurricane a few days ahead will not affect amount of insurance in force • Limit the marketing of insurance needs in an area where long-range forecast predicts severe weather • Better climate forecasts would allow insurance companies to evaluate their individual rate-level requirements • Improve building codes • Insurance company could plan to increase or decrease exposure, depending on outlook • Purchase more or less reinsurance depending on the forecast • Companies could hedge risks	• Short-term forecasts valuable for early warning to prevent death and injuries, but do not reduce insured property loss • Costs rising due to population increase along coasts • Weakened enforcement of building codes • Failure to develop hail-resistant roofing • Building in forested areas • Lack of insulation in freeze-prone areas • Rates for structures are based almost solely on their fire characteristics with little consideration given to severe weather vulnerabilities

User (Potential/Actual)	Overriding Primary Concern	Specific Concerns	Perceived Potential Use or Savings	Remarks
Federal Emergency Management Agency (FEMA)	• National reduction of loss of life and property from all types of hazards, natural and technological • Nationally cut by half the loss of life and property damage due to natural disasters by 2020	• Droughts, floods, freezes, blizzards • Concern about weather-related information such as El Niño for (1) public safety, (2) early warning, (3) fire control, (4) impact assessment • To provide more lead time for mitigation and response actions	Federal Insurance Administration (FIA) can sell a 7- or 8-year term ENSO flood insurance policy	• The unexpected happens • FEMA needs new, better user-friendly, weather-related information, data, and study methodology
Office of Foreign Disaster Assistance (OFDA), US Agency for International Development	Global disaster early warning	• Ability to respond in timely way to complex emergency of drought and flood, therefore, timing and amount of precipitation and frequency of tropical storms is needed • Demand for disaster relief far exceeds available resources • Need region-specific information related to ENSO teleconnections	• Provision of valuable early warning system linked to ENSO forecasts for prevention, mitigation, and preparedness of droughts, floods, storms, pests • Reduced vulnerability with good ENSO forecast • Useful for preparedness, relief planning: longer-term preparedness and vulnerability reduction	• Cost of natural disasters exceeds official development assistance • Early warning needs to be linked to effective action

Users' Needs

Various segments of the user community clearly have ideas of what they believe they need from ENSO researchers in general and forecasters, specifically. Some of these stated needs were identified in the discussion papers presented at the workshop and are listed below. Like the information on the preceding chart, the following list of needs should be treated as anecdotal information. It does not represent an attempt to identify a comprehensive list of needs of the user community.

Forecasters' Needs from Users

- *users need to let forecasters know what critical climate information they need for their sectors or activities*
- *need to establish credibility of forecast*
- *science programs need to be more concerned about commercial interest needs (i.e., users' needs)*
- *need a better idea of what the "use of info" means*
- *bridge communication gap between scientists and end users*
- *research community must reach out to educate government officials about reliance on ENSO forecasts*
- *scientific research must show more societal benefits*
- *need to integrate health sector into forecast application centers*
- *identify NOAA's responsibility to provide relevant ENSO info to users*
- *need to know decision processes to heighten the value of ENSO info*
- *need to know regional intervening factors affecting forecast of ENSO*
- *identify factors that affect the impacts of El Niño at the local level*

Users' Needs from Forecasters

- *there needs to be an evaluation of CAC's forecast products by its users*
- *need to give the ownership of the ENSO forecast to those who are most at risk*
- *need to know the point at which ENSO "locks in"*
- *decisionmakers need scientific info that is less uncertain, more perfect, more complete*
- *need 4-6 month lead time for South and Central America*
- *better precipitation prediction for parts of Ecuador before and during El Niño*
- *Reliability of (a) magnitude and (b) timing of precipitation*
- *accurate and timely runoff information*
- *forecast accuracy of runoff even for average conditions*
- *need a forecast that is specific as possible to local conditions*
- *need a more reliable forecast with a 3 to 6 month lead time*
- *need to know the reliability of forecasts*
- *need more precision in prediction of the onset and decay of an ENSO event*
- *need to be better alerted by ENSO researchers*
- *need one year lead time*

- *better lead time*
- *need accuracy in forecasting magnitude/intensity, duration and potential impacts areas*
- *need longer lead times for ENSO events*
- *forecast community must deliver "product" to users*
- *there is a need for teleconnection information at the mesoscale*
- *forecast which can accurately predict the regional impacts of El Niño*
- *forecast for regional hazards*
- *need an ENSO forecast that is region-specific, provides estimates of magnitude and the degree of certainty of occurrence*
- *need to know regional forecasts of ENSO impacts*
- *user-friendly explanations of El Niño and teleconnections*
- *need user friendly forecast products*
- *need info on the type of growing season in the summer in North America*

Users' Needs from Users

- *to what extent should ENSO info be considered as proprietary*
- *need to improve early warning for public safety*
- *users must investigate ways in which they can better use ENSO forecast*
- *need user friendly info*
- *need to identify ENSO once it has definitely started*
- *need to realize that forecasting ENSO can only be of value if combined with better resource management*
- *forecasters need to be realistic about claims of what they can provide*
- *need case studies of the successful use of ENSO info; need unsuccessful cases also*
- *need closer interactions between researchers and user (include users in program planning)*
- *need ENSO info for early warning systems for humanitarian efforts abroad*
- *better contact and communication between producers of forecasts and users*
- *need to search for and improve understanding of second order impacts of ENSO (pests, diseases, rodents)*
- *need a high correlation between ENSO and impacts*
- *need to know the size, quality and risk to the crop ASAP*
- *farmers need to know ENSO impacts around the globe vis a vis his/her sector or activity*
- *need local or regional ENSO info*
- *need to sort out ENSO linkages from other factors that influence salmon stocks*
- *need media coverage of successes to develop the support for a decisionmakers' decision.*
- *identify winners/losers in the use of ENSO info*
- *case studies of the use or non-use of ENSO info*
- *need to identify the role of the media in forecast dissemination and interpretation*
- *need to know the role of anecdotal information*
- *need user friendly info*
- *need to look at media's role as either (a) descriptive ENSO stories, or (b) explanatory, or (c) predictive*
- *case studies of actual use/non-use of ENSO info*
- *forecast must be user friendly*
- *need to improve early warning system for North American spring rains*

Forecasters' Needs from Forecasters

- *forecast community needs to demonstrate successes of its use*
- *scientific community must generally agree with forecast*
- *need to improve the reliability of ENSO-related scientific information*
- *need to identify when a forecast is no longer reliable*
- *need to overcome the "predictability gap"*
- *need improved skill in forecasting ENSO onset and demise and teleconnections*
- *need to overcome the 'spring barrier'*
- *identify areas to be affected by El Niño*
- *identify El Niño effects*
- *need information for Atlantic and Pacific coast*
- *need to use only sound statistical relationships*
- *need to identify regional impacts*
- *need to know how to combine climate and weather info*
- *need to know changes scientists see in prediction models in the next five years*
- *need to know the linkage between ENSO and QBO*
- *need better data for empirical research*
- *improved scientific understanding of ENSO*
- *need to improve ENSO predictability*
- *need to overcome basic hurdles: lead time and reliable data*
- *need a better comparison between warm and cold events*
- *need more scientific research on ENSO*
- *need a clear understanding of the link between severe weather and El Niño*
- *more research*
- *need to maintain long-term monitoring efforts*
- *better understanding of the causes of yield variability*
- *need to understand the local setting at the time of ENSO*
- *need to know better the PNA/ENSO link*
- *look at the effects of climate change on ENSO's frequency and intensity*
- *more research on climate change and ENSO*

The North American ENSO Applications Workshop

The Workshop on *Usable Science II: The Use and Misuse of ENSO Information in North America* was held in Boulder, Colorado, 31 October to 3 November 1994. It was designed to bring together climate impacts researchers, weather-sensitive industry representatives, physical scientists concerned with ENSO (El Niño/Southern Oscillation), media specialists and policymakers. The overriding goal of the workshop was to foster interaction between the producers of ENSO-related scientific information and the potential users of that information.

In addition to fostering discussion among these groups of interest, workshop organizers asked participants to prepare in advance of the meeting discussion papers that raised their concerns about ENSO forecasts or about what kinds of information that they needed for their activities from the ENSO research and forecast communities. These papers served as starting points for discussion and not for presentation.

In order to focus discussion on specific issues, some of the participants were asked to make presentations in order to stimulate discussion. The Workshop Agenda which follows identifies the issues that were discussed. A record of all of the discussion sessions throughout the meeting were put together into one section. Several recurrent themes were identified, and almost all of the points made in the discussion sessions were clustered under one of those themes. These are presented in the Summary Section. It is very important to note at the outset of this report that the workshop discussion sessions were designed to focus, not on the successes in the forecast system, but on identifying problems from the perspective of potential and actual users related to forecasting ENSO events and using ENSO forecasts. It is important to keep this in mind when reading the Summary of Workshop Discussions.

It became clear at the workshop that there were different, sometimes opposing, perceptions on the reliability of El Niño forecasts for local and regional level decisionmaking. While there are several views in the scientific and popular literature about how El Niño events in the equatorial Pacific affect weather patterns in various parts of North America, for most of them there is little consensus for a variety of reasons. One is that not all researchers use the same "objective" criteria for determining the onset of El Niño. Some favor monitoring the Southern Oscillation, while others favor monitoring sea surface temperatures, and so forth. There are also some differences of opinion within the scientific community about what constitutes the onset of an El Niño.

It became clear at the workshop that interest in the ENSO phenomenon has sharply increased since the onset of an event in 1991, an event that had been correctly forecast some months in advance by a few groups. Federal emergency managers, tropical fruit producers,

insurance companies, humanitarian assistance agencies, water resources planners, and agricultural commodities interests have developed a healthy respect for and interest in El Niño.

Important concerns were raised for discussion, such as the following: To what extent is the increasing level of public interest in the use of El Niño forecasts appropriate to our present-day level of scientific understanding about the phemenon? Who has the responsibility to help the attentive public in determining the use such information? Who specifically are the potential users of El Niño information, including forecasts, to whom we constantly hear references?

While there are several locations around the globe where El Niño's impacts can be clearly shown to occur (i.e., Peru, Australia, Indonesia, India, Vietnam, Brazil), the strength and reliability of teleconnections to North American weather patterns remain less clear. Nevertheless, it is not difficult to show how information about ENSO events and their proposed North American teleconnections does provide decisionmakers in various sectors of society with enough information to "hedge their bets."

In 1966, when he was on the verge of identifying linkages between sea surface temperature changes and sea level pressure changes in the equatorial Pacific Ocean, Bjerknes made the following projection:

> *Although this primary triggering may remain obscure, a close watch of the temperature anomalies arising over the eastern tropical Pacific is likely to play an important part in future seasonal forecasting of climate anomalies over North America, and even over Europe.**

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*J. Bjerknes, 1966: A possible response of the atmospheric Hadley calculations to equatorial anomalies of ocean temperatures. *Tellus*, 18(4), 820-829.

Glossary of Terms

Some scientists use El Niño and ENSO interchangeably. Others use the phrase "warm event" to describe a warming of the surface waters in the central and eastern equatorial Pacific, and "cold event" to denote the opposite phase of the Southern Oscillation. The glossary which follows is provided to help the reader sort out these concepts.

El Niño is a term originally used to describe the appearance of warm (surface) water from time to time in the eastern equatorial Pacific region along the coasts of Peru and Ecuador. It was once suggested that minor El Niño events occurred about every two to three years and major ones about every eight to 11 years. Today, scientists note that El Niño has a return period of four to five years. When an El Niño event occurs, it often lasts from 12 to 18 months.

La Niña refers to the appearance of colder-than-average sea surface temperatures (SSTs) in the central or eastern equatorial Pacific region (the opposite to conditions during El Niño). Many scientists do not like the use of the term and prefer to call it a cold event (described below).

A **warm event** refers to the anomalous warming of SSTs in the central and eastern equatorial Pacific. This term is being used to avoid confusion over the use of other terms like ENSO and El Niño. A warming in the regions mentioned is accompanied by a relative cooling in the western equatorial Pacific.

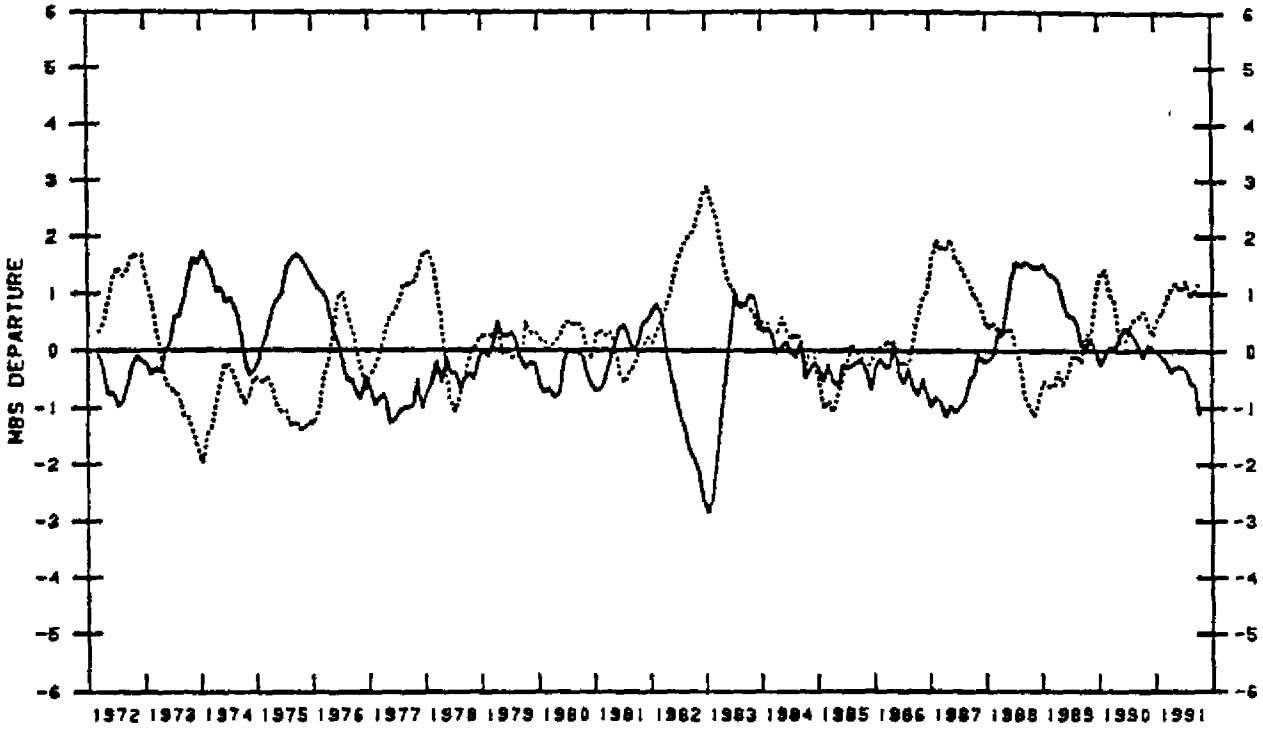
A **cold event** is one where the SSTs become anomalously colder compared to the long-term average for the central and eastern equatorial region. (It is the opposite of a warm event in that region.) It has been referred to in the past as anti-El Niño and, more recently, as La Niña. La Niña, however, unlike the restrictive view of El Niño, is applied to Pacific basinwide phenomena.

The **Southern Oscillation** is a see-saw of atmospheric mass (pressure) between the Pacific and Indo-Australian areas. For example, when the pressure is low in the South Pacific high pressure cell and high over Indonesia and Australia, the Pacific trade winds weaken, upwelling of cool water on the Pacific equator and along the Peruvian coast weakens or stops, and SSTs increase in these areas where the upwelling weakens.

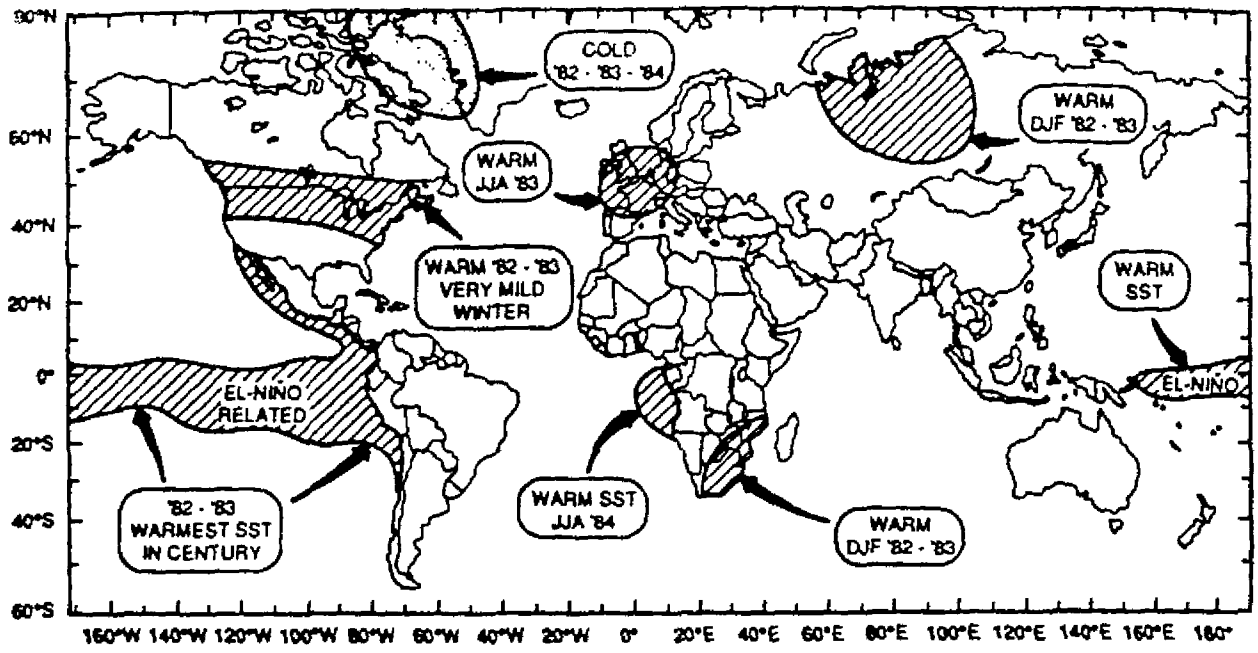
The **Southern Oscillation Index (SOI)** has been developed to monitor the Southern Oscillation using the difference between sea level pressures at Darwin, Australia, and Tahiti, although other stations have sometimes been used. Large negative values of the SOI indicate a warm event, and large positive values indicate a cold event (also referred to as La Niña). It is important to note that there is not a one-to-one correspondence between the occurrence of Southern Oscillation events and El Niño events, using the spatially restrictive original definition of El Niño.

ENSO is the term currently used by scientists to describe the full range of the Southern Oscillation that includes both SST increases (a warming) as well as SST decreases (a cooling) when compared to a long-term average. It has sometimes been used by scientists to relate only to the broader view of El Niño or the warm events, the warming of SSTs in the central and eastern equatorial Pacific. The acronym, ENSO, is composed of El Niño-Southern Oscillation, where El Niño is the oceanic component and the Southern Oscillation is the atmospheric component of the phenomenon. The broader definition of El Niño has sometimes been used interchangeably with ENSO, because ENSO is less well known in the popular electronic and printed media.

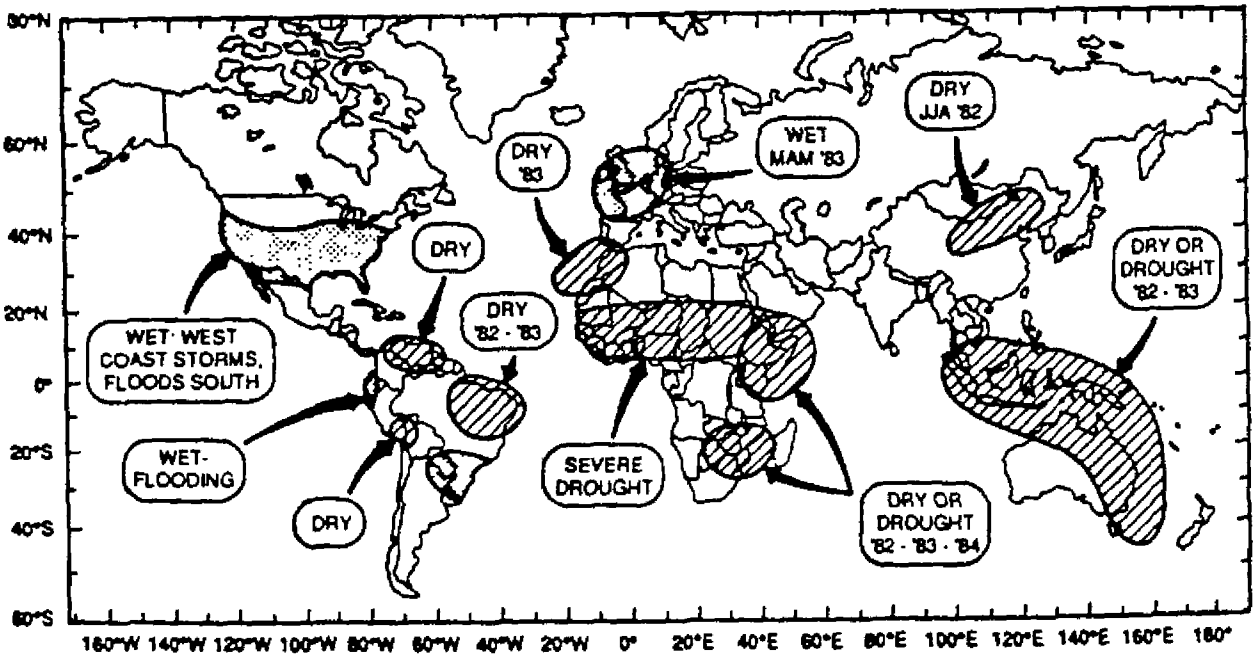
Teleconnections can be defined as atmospheric interactions between widely separated regions. They have been identified through statistical correlations (in space and time). Some of these correlations have been used to generate hypotheses about geophysical processes related to teleconnections. Most countries in the world are, or should be, interested in this aspect of the Southern Oscillation. Some examples are provided in the following maps.



Five-month running mean of the sea level pressure anomalies at Darwin (dashed) and Tahiti (solid) (Climate Analysis Center, 1991: *Climate Diagnostics Bulletin*, November. Washington, DC: US Department of Commerce.



Selected extreme temperature events that persisted for a season or longer in the 1982-84 period. (WMO, 1984: *The Global Climate System: A Critical Review of the Climate System During 1982-1984*. Geneva: WMO.)



Selected extreme continental precipitation (wet and dry areas) that persisted for a season or longer in the 1982-84 period (WMO, 1984: see above.)

Agenda
ENSO/North American Applications Workshop
31 October - 3 November 1994
Hotel Boulderado, Boulder, Colorado

Sunday, October 30, 1994

Arrival

Day 1: *Monday, October 31*

8:45 am	Welcome to meeting
9:30-10:00	Round-the-Table introductions
10:00-10:30	Break
10:30-11:00	What El Niño is What the Southern Oscillation is
11:00-11:30	What El Niño does (globally)
11:30-12:15	El Niño linkages to North America
12:15-1:30	Lunch
1:30-2:00	The use of ENSO information in hurricane forecasting
2:00-2:30	What can forecasters provide today?
2:30-3:00	What might forecasters be able to provide us in the next several years?
3:00-3:30	Break
3:30-4:00	What would users like to obtain from the ENSO research and forecast communities?
4:00-4:30	What about the impacts of the cold phase events?
4:30-5:00	Summary

Day 2: *Tuesday, November 1*

9:00-9:30am	What do we mean by "use" of ENSO information? What weather/climate information do North American users use now?

9:30-10:15 Who are the users —in theory and in practice?

10:15-10:45 Break

10:45-11:30 Can we identify and measure the value of ENSO information (including forecasts)?

11:30-12:15 The use of ENSO information in Australian agriculture

12:15-1:30 Lunch

1:30-3:00 Potential uses of El Niño information

1. OFDA (Dilley)
2. US/WAB (Strommen)
3. Canadian Wheat Board (Garnett)
4. Chiquita Brands International (Caid)
5. Salmon (Miller)

3:00-3:30 Break

3:30-5:00
6. Health (Epstein)
7. Hydro (Bisson)
8. Insurance (Roth)
9. Fires (Robinson)

Day 3: *Wednesday, November 2*

8:30-9:15am Problems with forecasts in general: who has them, and when; probability; and usability

9:15-10:15 The use of ENSO information and forecasts

Successful:	*Missed*:
1. 1986-87	1. Quinn-Wyrtki (1975)
2. 1991-92	2. 1982-83
3. Australia	3. Handler (1983)
	4. ENSO forecasts (1990-1993)

10:15-10:45 Break

10:45-12:15 Is the science "ready" (i.e., mature enough) for us to generate interest among potential North American users of ENSO information? How can we tell whether it is "ready"?

12:15-1:30 Lunch

1:30-2:15 Does ENSO provide the right kind information to "hedge our bets"?

2:15-3:00 What institutional and other opportunities/constraints exist that foster or restrict the use of ENSO information in decisionmaking?

3:00-3:30 Break

3:30-4:30 Media as creator and educator of ENSO users; as a consumer of ENSO information

Day 4: *Thursday, November 3*

8:30-9:30am What are ENSO researchers' needs, if any, from the user community? What are ENSO users' needs from the ENSO forecasters?

9:30-10:15 ENSO and climate change

10:15-10:45 Break

10:45-11:30 Recommendations toward a *Plan of Action* for ENSO information awareness in North America and need for integral multidisciplinary involvement

11:30-12:15 Where do we go from here?

12:15-1:30 Lunch and Adjourn

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