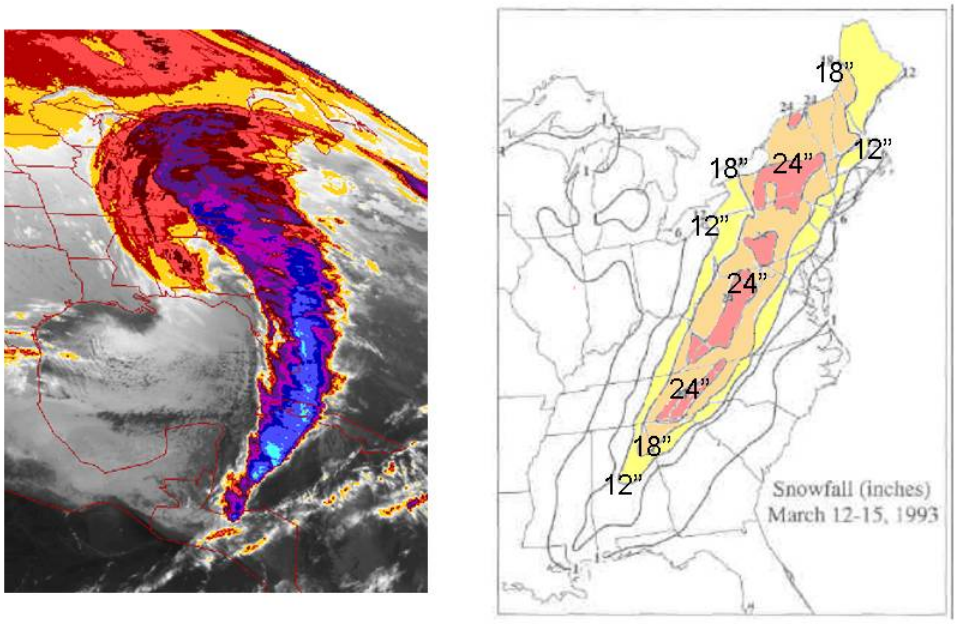
SNOWFALL ANOMALIES IN RECENT DECADES – DRIVEN IN PART BY MULTIDECADAL OCEAN CYCLES

By Joseph D'Aleo, CCM, Fellow of the AMS

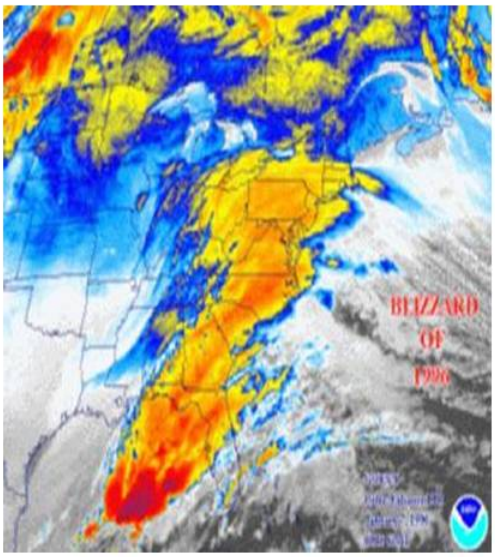
The 1990s and early 2000s had some very interesting snow years with the focus shifting around the country in response to changes in the oceans.

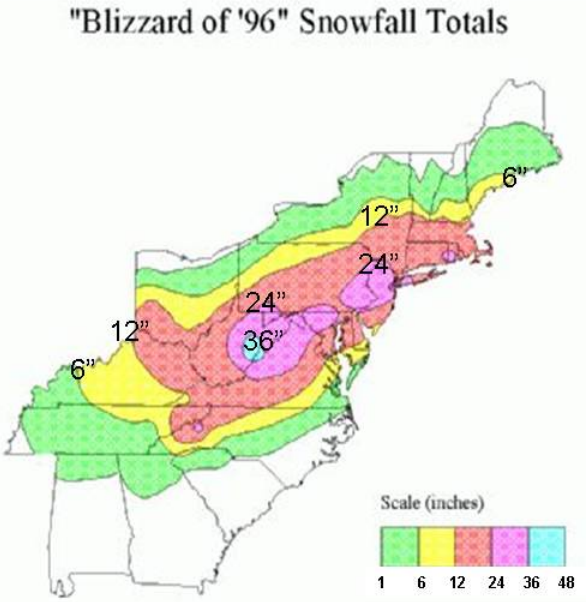
It started in March of 1993, when the "Storm of the Century" brought heavy snowfall (1 up to 4 feet) from Alabama to New York and New England (2-4 feet) with losses that totaled $7.6 billion and approximately 270 deaths.



"Storm of the Century" March 1993 hits entire eastern seaboard with tornadoes, high winds, and heavy snows (2-4 feet); $6.3-7.6 billion damage/costs; approximately 270 deaths.

Then in January of 1996, the "Blizzard of '96" deposited again 1-4 feet of snow over the Appalachians, Mid-Atlantic, and Northeast; followed by severe flooding in parts of same area due to rain and snowmelt inflicting approximately $3.5 billion damage and 187 deaths.





"Blizzard of '96" January 1996. Very heavy snowstorm (1-4 feet) over Appalachians, Mid-Atlantic, and Northeast; followed by severe flooding in parts of same area due to rain and snowmelt; approximately $3.5 billion damage/costs; 187 deaths.

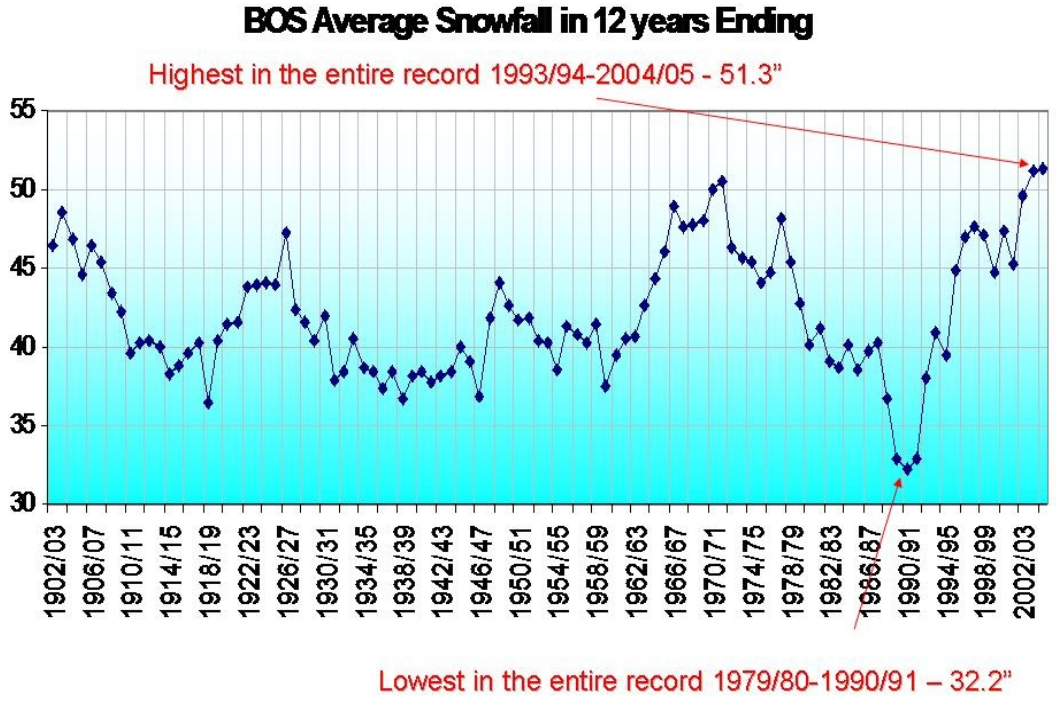
That winter, the snows started early and never stopped coming. All-time seasonal snowfall records were set in dozens of cities in the east and central states including Boston (107.6" or 286% of normal), New York City (75.6 inches of 276% of normal), Philadelphia (63.1 inches or 303% or normal) and Baltimore, MD (63.5 inches or 303% of normal)

THE LOCATIONS WHERE 1995/96 SNOWFALL EXCEEDED ALL-TIME RECORDS			
Station	**Total**	**Norm**	**%Norm**
Marquette, MI	**250.8**	**129.0**	**194%**
Sault Ste. Marie, MI	**216.3**	**115.5**	**187%**
Blue Hill Observatory, MA	**143.8**	**59.6**	**241%**
Elkins, WV	**136.6**	**76.3**	**179%**
Duluth, MN	**135.4**	**78.2**	**173%**
Binghamton, NY	**133.4**	**82.9**	**161%**
Worcester, MA	**132.9**	**68.5**	**194%**
International Falls, MN	**116.0**	**64.2**	**181%**
Windsor Locks, CT	**115.2**	**48.0**	**240%**
Boston, MA	**107.6**	**41.7**	**258%**
Providence, RI	**106.1**	**36.1**	**294%**
Charleston, WV	**105.9**	**32.6**	**325%**
Mansfield, OH	**90.5**	**41.8**	**217%**
Williamsport, PA	**87.7**	**41.8**	**210%**

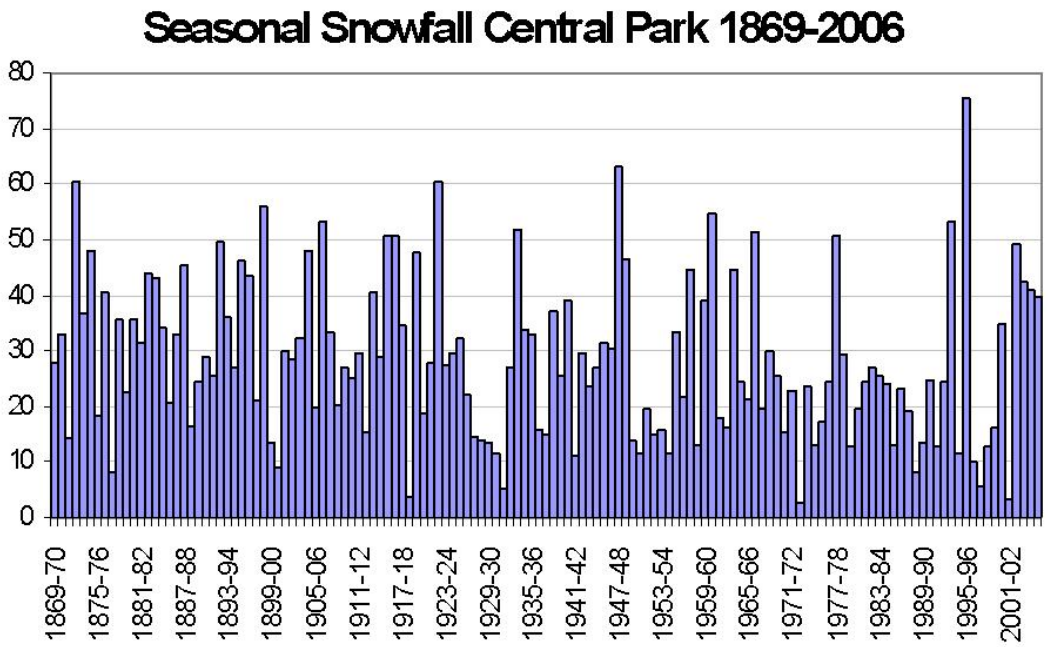
Newark, NJ	**78.4**	**27.5**	**285%**
Bridgeport, CT	**76.8**	**25.6**	**300%**
N.Y.- Central Park, NY	**75.6**	**28.4**	**266%**
N.Y.- JFK Airport, NY	**69.0**	**23.0**	**300%**
Philadelphia, PA	**63.1**	**20.8**	**303%**
Jackson, KY	**62.7**	**21.9**	**286%**
Baltimore, MD	**62.5**	**20.6**	**303%**
Dulles Airport, VA	**61.9**	**22.5**	**275%**
Lynchburg, VA	**56.8**	**17.9**	**317%**
National Airport, VA	**46.0**	**16.4**	**280%**

In the last few years, all time single storm records were shattered in the northeast cities. Just this last winter, on February 11-12th 2006 a blizzard set new all-time snowstorm record for Central Park in New York City with 26.9 inches. On February 17-18, 2003, a snowstorm set new all-time snowfall record for Boston with 27.5 inches. Another blizzard on January 24-25 2005 brought 22.5" at Boston's Logan Airport, along with high winds, 6 foot drifts and bitterly cold temperatures. Many measurements however near Logan were 27-28" and the storm was compared by many to the blizzard of '78.

Despite the IPCC claim in their 4th Assessment that cities with winter average temperatures near 32F are seeing less snowfall and more rainfall, this is not the case in the eastern United States. Boston has an average winter temperature of 32F. Boston since 1992/93 had had 5 years that rank among the top 12 snowiest winters in over 130 years of record, including numbers 1, 3, 5, 7 and 12th. If you do a running mean of average snowfall over dozen years, the period from 1993/94 through 2004/05 for Boston, the average is the highest in the entire record dating back to the 1880s.



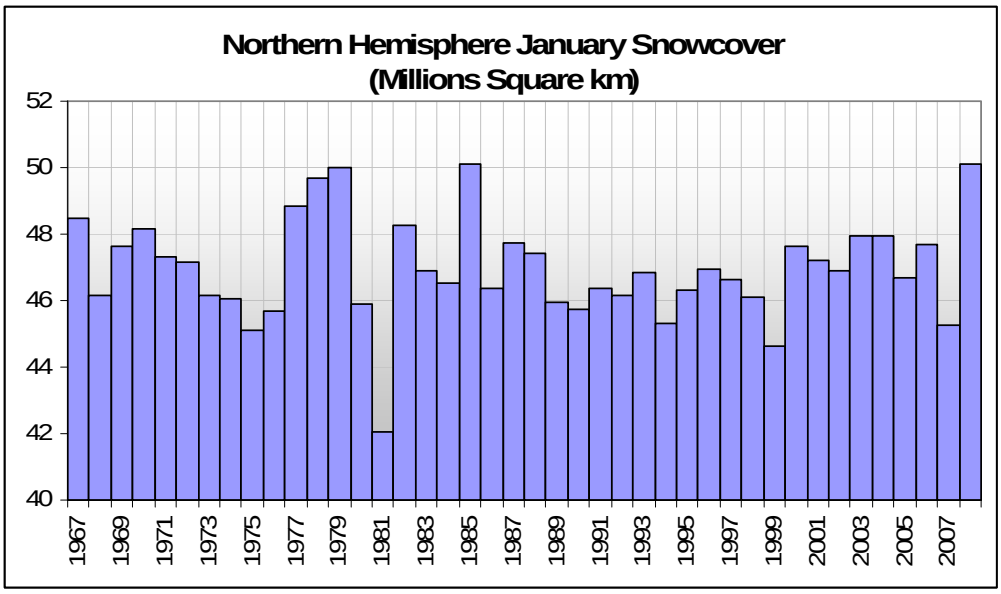
New York City (with annual snowfall data back to 1869) has an average January temperature (their coldest month) of 32F. New York City for the first time EVER, had four successive years with over 40 inches of snow the last four winters. Its four-year running mean is the highest its entire 137 year record.



New York's Central Park had 40" of snow for four straight years for the first time since records began in 1869. $ year running mean also was the highest in the record

NOT JUST A LOCAL PHENOMENON

This past January the Northern Hemispheric snowcover was the greatest in the record (since 1967).

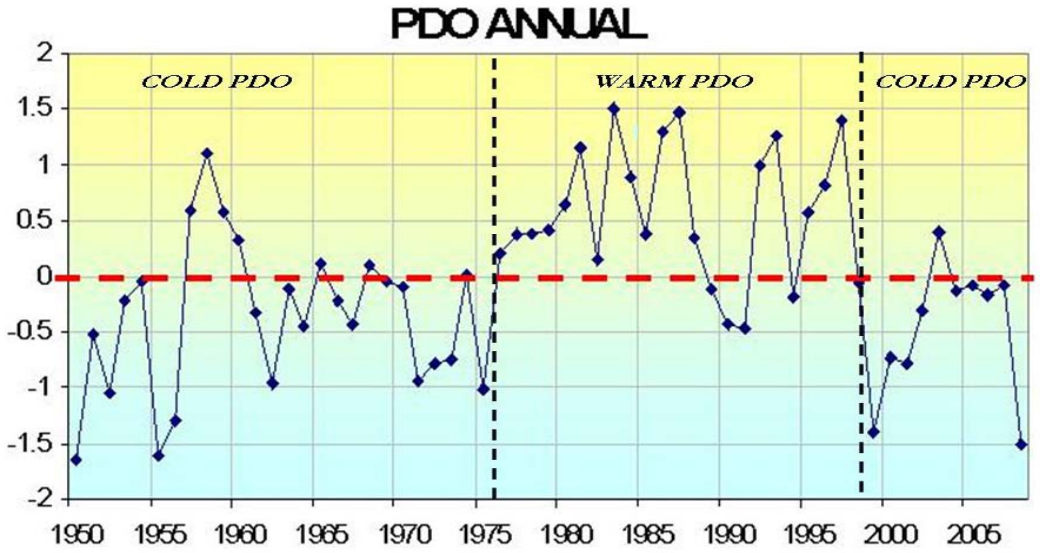


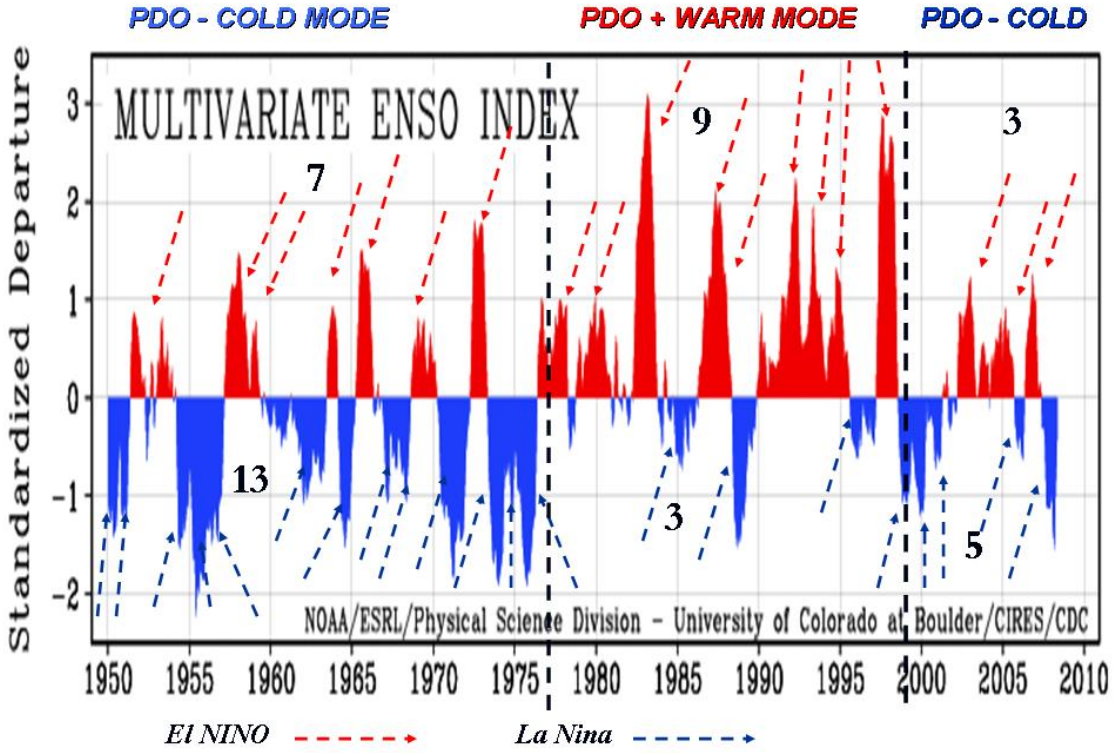
The recent winters were major snow winters in parts of both hemispheres. See story earlier posted here and this one here.

WHAT IS BEHIND THIS SNOWFALL BLITZ?

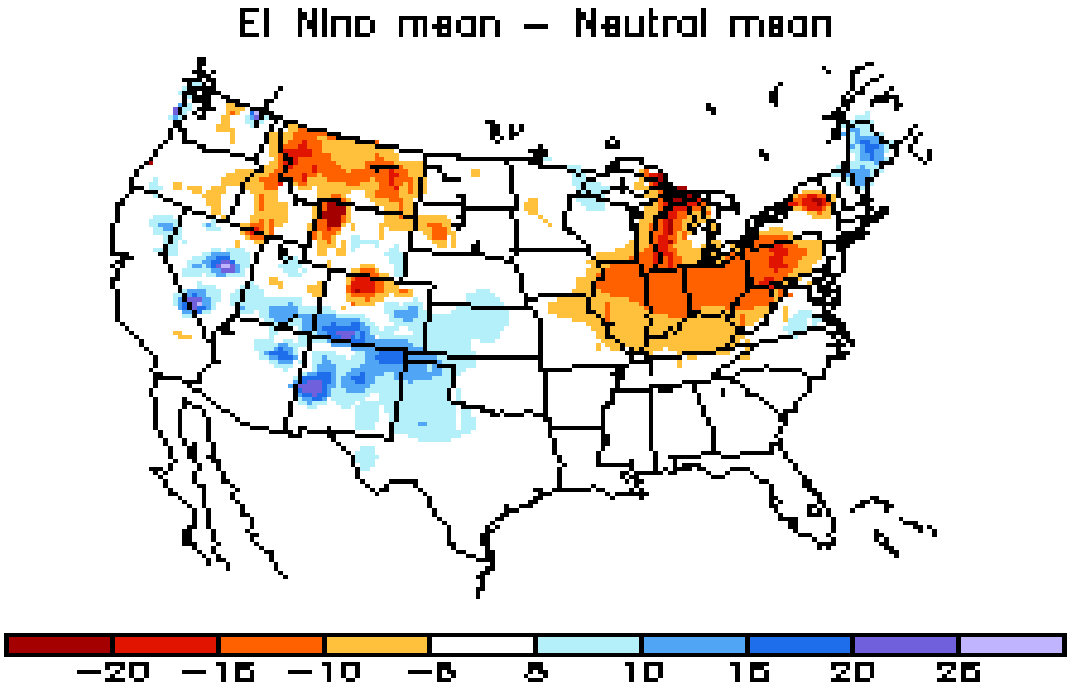
Snowfall here in the Northeast and across much of the Hemisphere relate to decadal scale cycles in the Pacific, Atlantic and Arctic.

When the Pacific Decadal Oscillation flipped from its cold to warm mode in the Great Pacific Climate Shift in 1977, El Nino frequency increased. In the warm mode, more El Ninos are favored (two to one over La Ninas), and when they are weak to moderate this often translates into less snow in the Pacific Northwest but heavy snows in the southwest, southern Rockies and Plains and in the southern and east coastal United States.



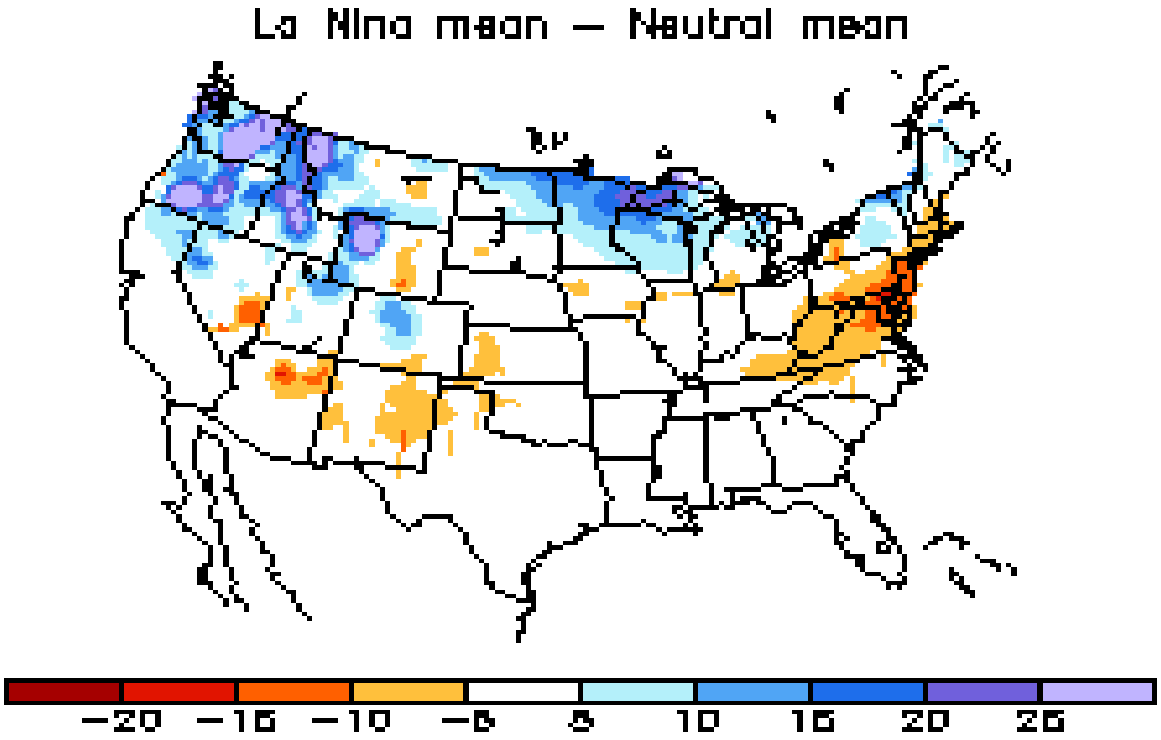

PDO - COLD MODE
PDO + WARM MODE
PDO - COLD
MULTIVARIATE ENSO INDEX
Standardized Departure
7
9
3
13
3
5
NOAA/ESRL/Physical Science Division - University of Colorado at Boulder/CIRES/CDC
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010
El NINO
La Nina


El Nino Winters
Active southern storm track
Heavy snowstorms if weak



La Ninas show northern storm tracks and heavy snows across the Pacific Northwest, Rockies, Upper Midwest, Northern Plains, Great Lakes and far northeast.

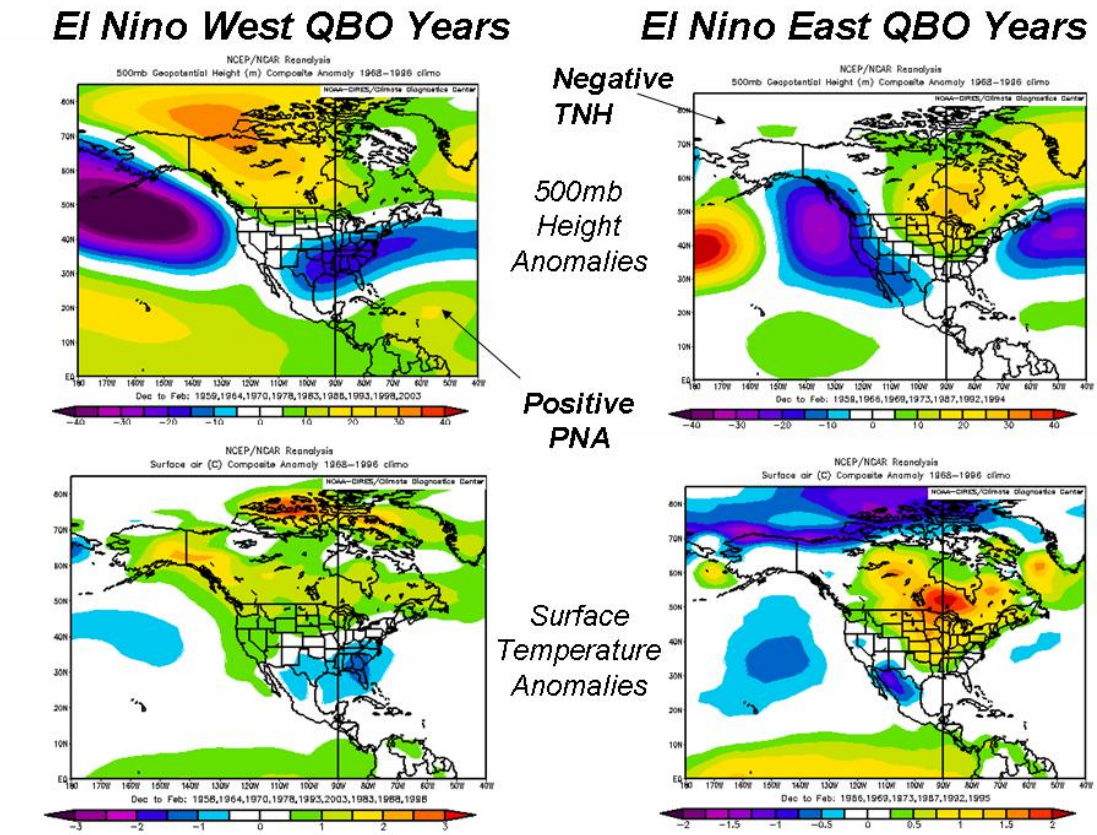

La Nina Winters
Active northern
storm tracks

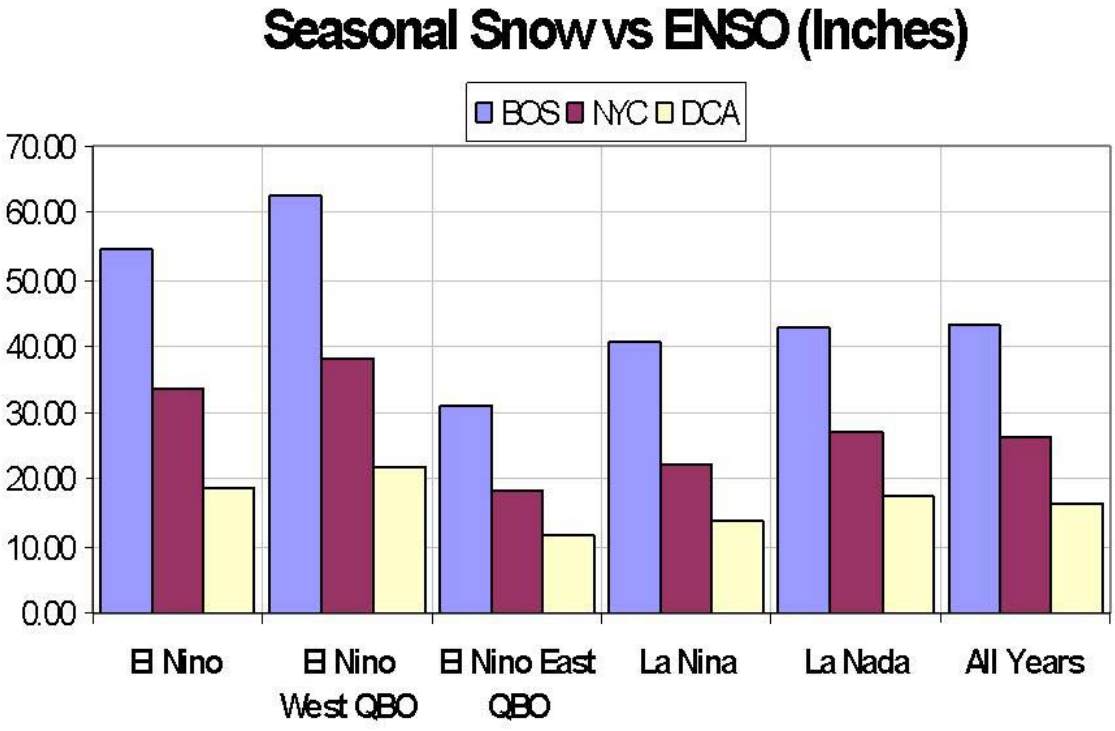


DIFFERENT ENSO FLAVORS

CPC research in the late 1980s by Livesey, Barnston and Halpert showed how a west QBO El Nino favors the positive PNA pattern with an eastern trough which predisposes the east to east coast storms vut with a different pattern in east years.

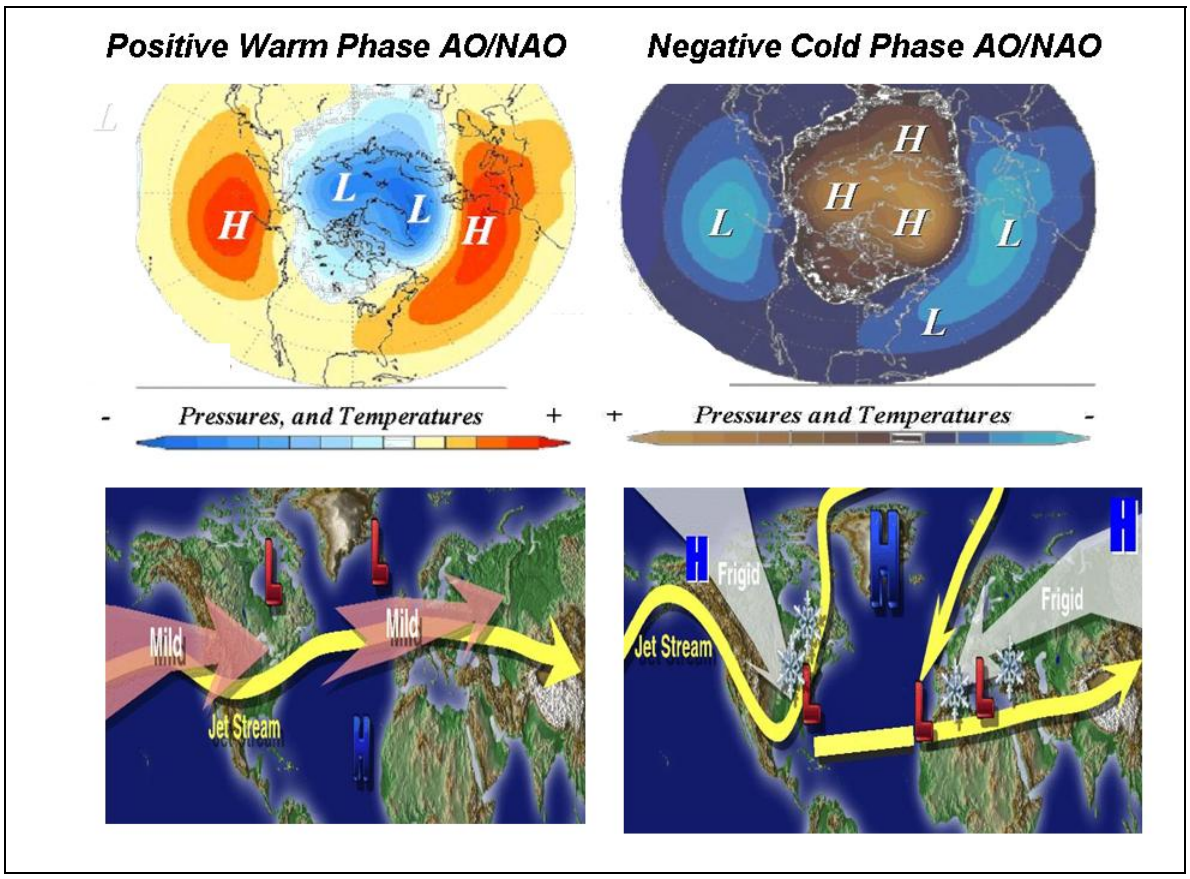
Indeed 2/3rds of the top dozen heaviest snow years since the 1870s for Boston were El Nino West QBO seasons. Snowfall is also heaviest in DCA and NYC in most all but the stronger El Nino west years. We had a cluster of El Nino West years from 1977/78, 1972/83, 1987/88, 1992/93, 1993/94. 1997/98, 2002/03, 2004/05.





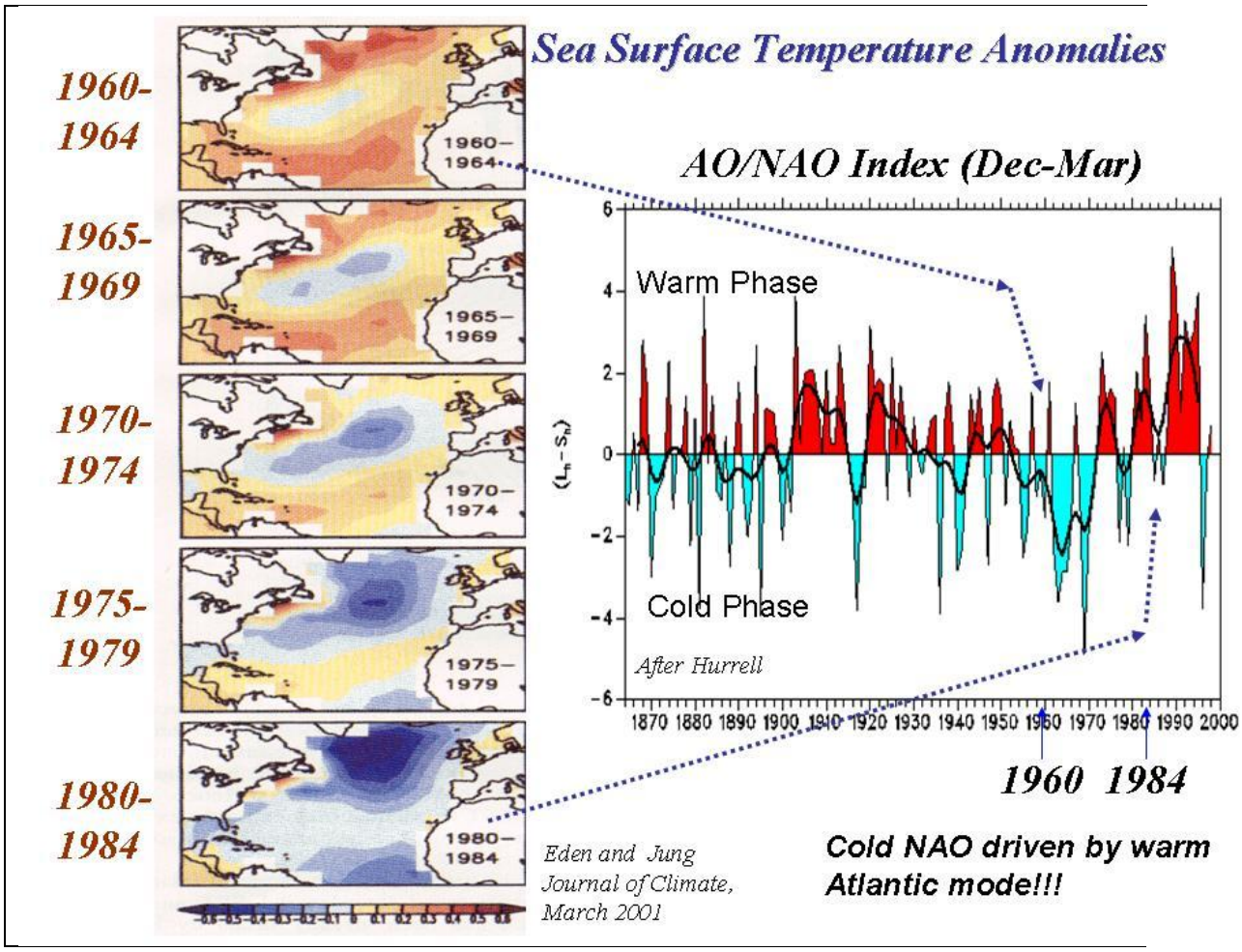
THE ROLE OF THE NORTH ATLANTIC OSCILLATION

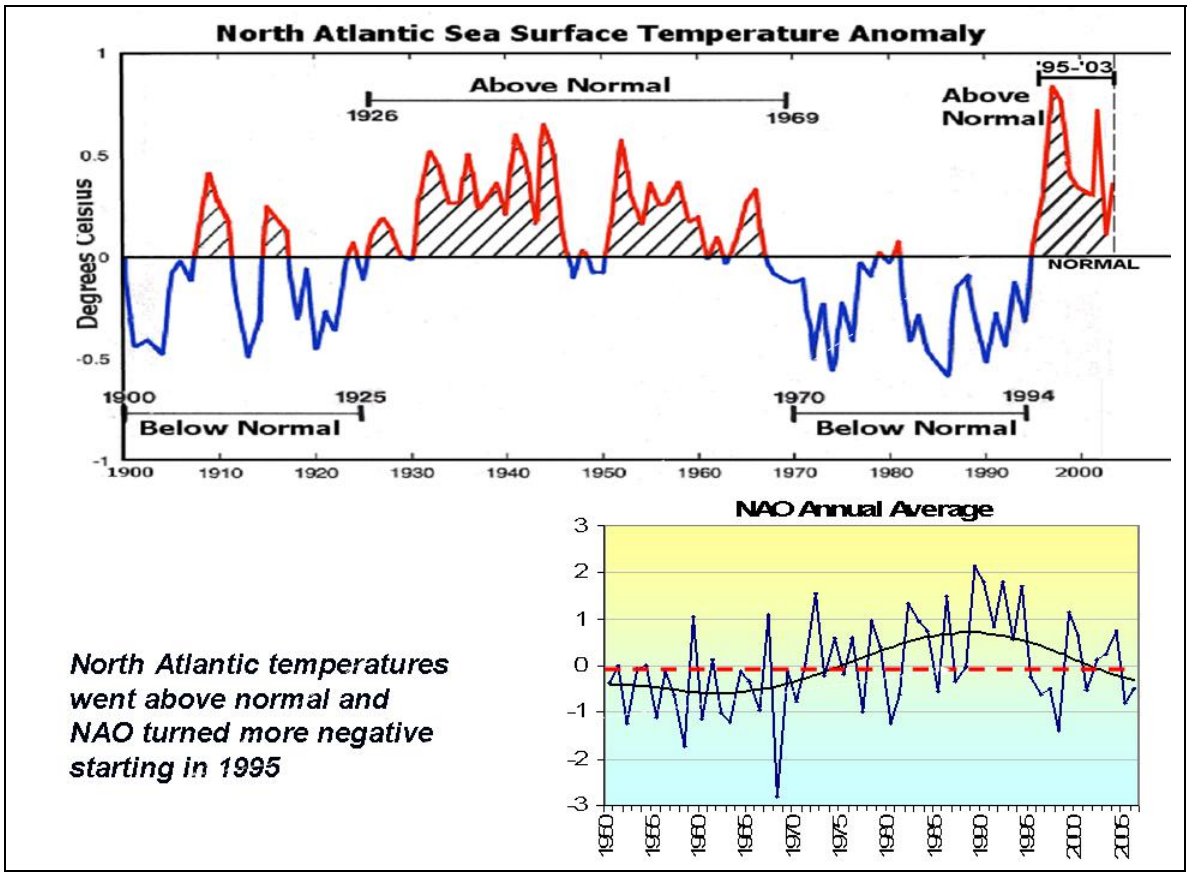
Also important to the snow increases has been a shift of two atmospheric oscillations which generally operate in tandem, the North Atlantic Oscillation (NAO) and Arctic Oscillations (AO). These oscillations have significant control over the weather pattern including winter storm tracks and temperatures in both Europe and the eastern United States.



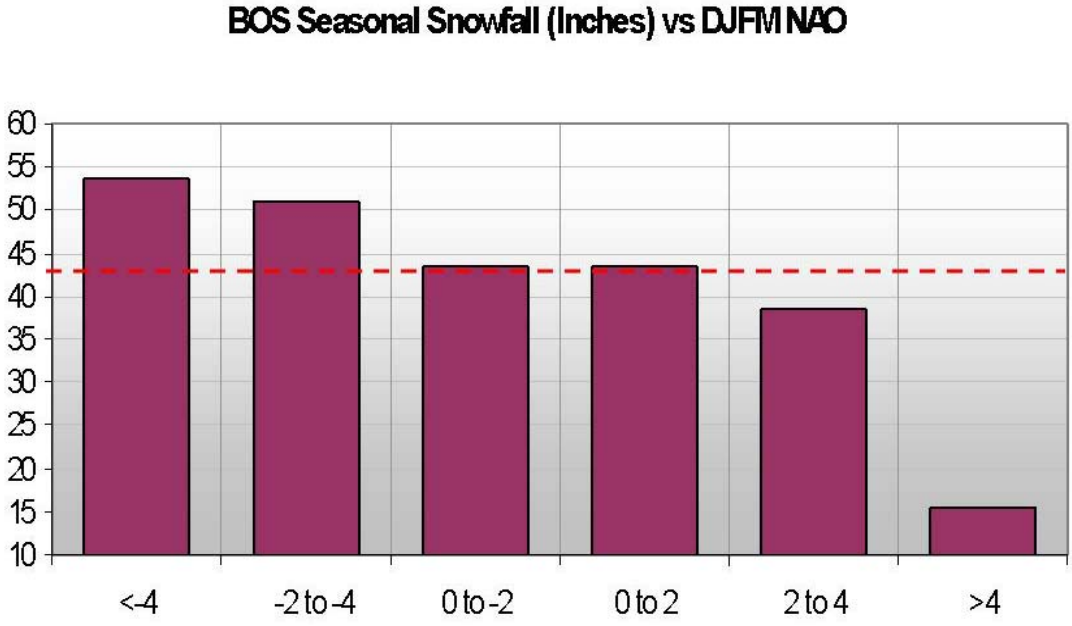
Since the middle 1990s, these oscillations have more often been in the phase that favors cold and snow (the negative or 'cold' phases) in both Europe and the eastern United States. Like the PDO, the NAO and AO tend to be predominantly in one mode in the other for decades at a time.

The same Atlantic Multidecadal Oscillation that controls the frequency of hurricanes is responsible for the NAO/AO decadal tendencies. When the Atlantic is cold, the AO and NAO TEND towards the positive state, when the Atlantic is warm on the other hand, the NAO/AO TEND to be often negative. This means high latitude blocking and enhanced coastal storm activity in the United States and Mediterranean storms that bring snows to Europe.


Sea Surface Temperature Anomalies
1960-1964
1965-1969
1970-1974
1975-1979
1980-1984
1960–1964
1965–1969
1970–1974
1975–1979
1980–1984
AO/NAO Index (Dec-Mar)
Warm Phase
Cold Phase
After Hurrell
1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000
1960 1984
Eden and Jung
Journal of Climate,
March 2001
Cold NAO driven by warm Atlantic mode!!!

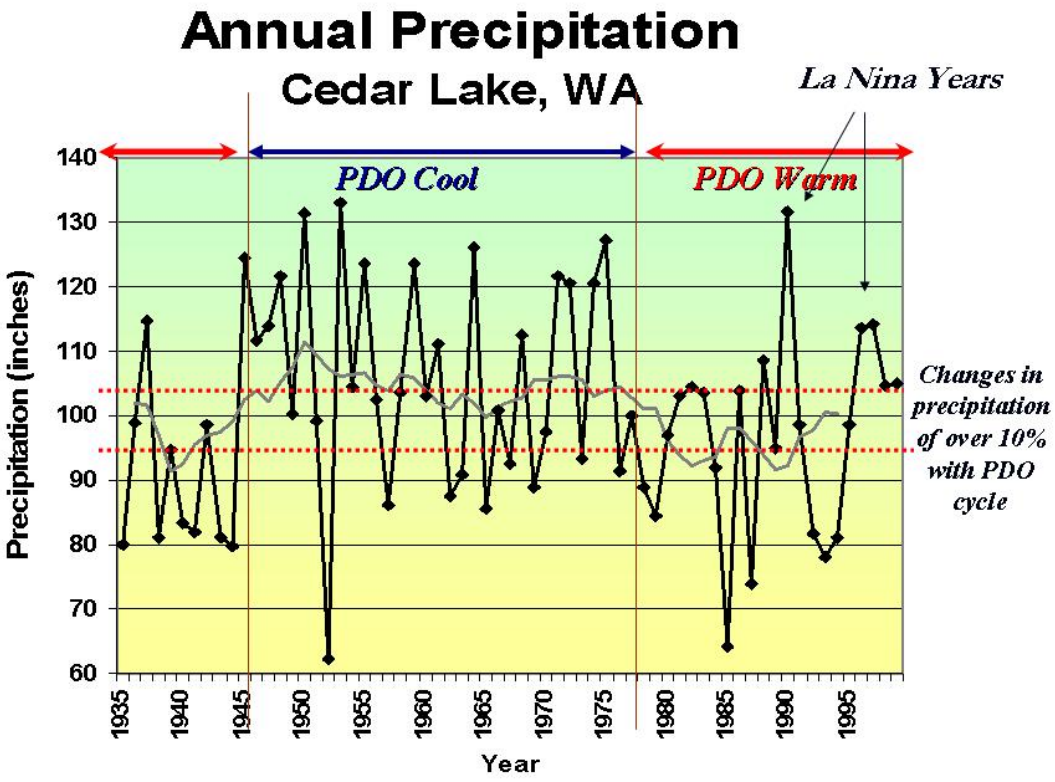


When the NAO is negative, snowstorms are more frequent in the eastern United States (nor'easters). Seasons when the NAO is predominantly negative tend to be snowier than seasons when they are positive. We had significantly negative NAO years in the winters of 1995/96, 2000/01, 2002/03.



MEANWHILE LESS SNOW IN THE NORTHWEST

As mentioned El Ninos cause a shift south of the storm tracks, more snows for the southwest mountains and southern Rockies and less snow for the Pacific Northwest and mountains of southwest Canada across the Northern Rockies. The positive (warm) PDO favors less precipitation (most occurs in the cold season so less snow) in the Pacific Northwest and Northern Rockies.



Now you might recall however that in 1999/2000 that Mt. Baker in Washington set a new world record for seasonal snowfall. That broke the record set in 1971/72.

New World Seasonal Snowfall

- The Mt. Baker Ski Area in northwestern Washington State reported 1,140 inches of snowfall for the 1998-'99 snowfall season ending June 30, 1999. This was a new world record for seasonal snowfall.
- The previous U.S. and world seasonal snowfall record was 1,122 inches in the 1971-1972 snowfall season at the Paradise Ranger Station on Mt. Rainer, also in Washington State and about 150 miles south of Mt. Baker.

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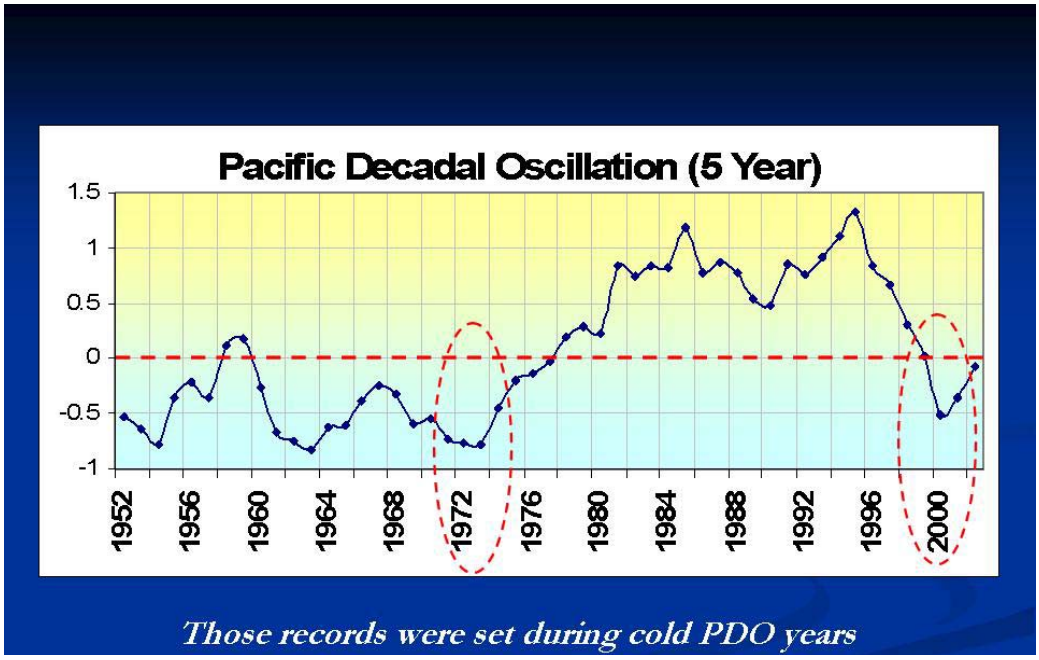
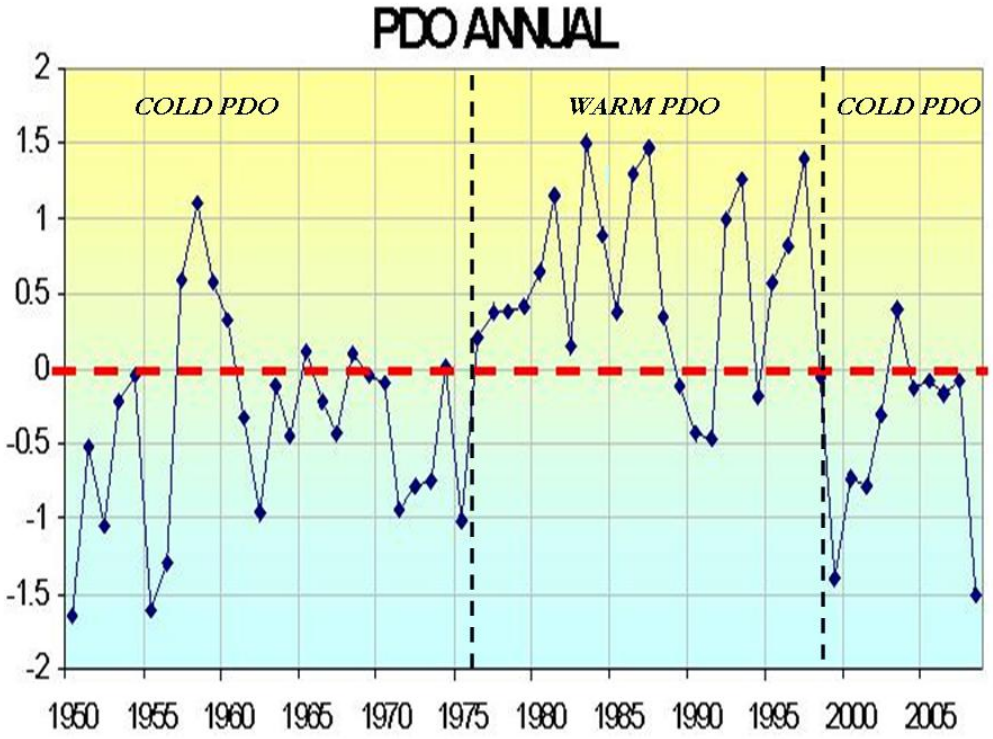
In the late 1990s the PDO reverted back negative for a few years, back to the state it was in 1971/72, when the prior record had been set. A significant three year La Nina shifted the storm track north targeting the Pacific Northwest.



The PDO bounced positive again with the El Nino of 2002/02. The Pacific Northwest even experienced unusual drought conditions with this rebound. It dropped slightly negative then accelerated down.



In 2006/07, a blockbuster summer followed by the highest number of winter visitors since 9/11 have combined to give Whistler in British Columbia its best year on record, according to Tourism Whistler. Mother Nature helped by delivering a record-breaking snowfall last November which continued to accumulate to more than 14 metres (46 feet) over the winter -- more than 40 per cent above the average.

Bill Steffen of WOOD-TV posted this note last spring about the western snows last winter. Across almost all of North America, this has been the best, or one of the best seasons ever for those who love snow. Practically every ski area from Alaska across Canada in the Western U.S. - the Midwest and New England saw plenty of snow; some places reporting all-time record snow. Michael Berry, President of the National Ski Areas Assn. told the AP that “This could very well be a record year”. Brundage Ski Area in Idaho received another 10 inches of snow and they’ll be open a THIRD bonus weekend into early May. This is the first time they have ever had lift service into May. This has been their 2nd snowiest winter ever with 422” so far.

Alyeska, Alaska has picked up 826” of snow this winter! On the summit, they still have 198” of snow on the ground. Timberline in Oregon plans on skiing through the summer on Mt. Hood. They are taking ski camp reservations for early August! They’ve had 780” of snow this winter and still have 237” of snow on the ground at the lodge, where the AM

temperature is 20 degrees F. Whistler-Blackcomb in British Columbia is offering skiing into June. They've had 389" of snow this winter with a base of 94". The Alta Ski Area in Utah has had 673" of snow this season. The Snowbird Resort in Utah says they'll be open "through Memorial Day and maybe beyond!"

In the Oregon Cascades, the snow was so heavy, roofs were collapsing. In Steamboat Springs, CO, over 100 inches fell in every winter month for the first time ever and set a new record for seasonal snowfall with 450 inches with weeks more to go. Rendevous Bowl which has a 33 year average of 320 inches, had 566 inches as of March 25.

Madison, Wisconsin blew away there all-time snow record 100.4 inches of snowing exceeding their old record by 33%! New seasonal snowfall records were set in Michigan in places like Ann Arbor, in Ohio where Youngstown had well over 100 inches, 52" above normal and for the winter (December through February) for Burlington, VT and Concord, NH, Caribou, Maine. Most of the big cities in southern Canada also had all-time record snowfall.

What will this winter bring. We will provide an outlook soon. It is not a straightforward as some recent years. Meanwhile see the Old Farmer's Almanac, where I authored a story this year and where the forecaster sees a snowy and cold winter for many.