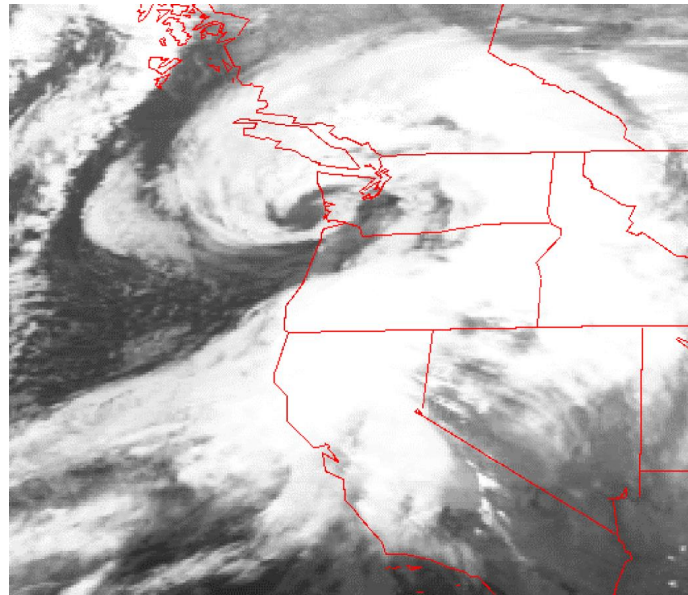


The Impacts of Climate Change on Northwest Windstorms

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Atmospheric Sciences
University of
Washington



Although the Pacific Northwest does not experience tropical storms or hurricanes, we do experience very strong Pacific cyclones, with winds equal to category two or three hurricanes



1993 Inauguration Day Storm

The Thunderbird



Native Americans knew about NW windstorms and had several legends regarding their origin.



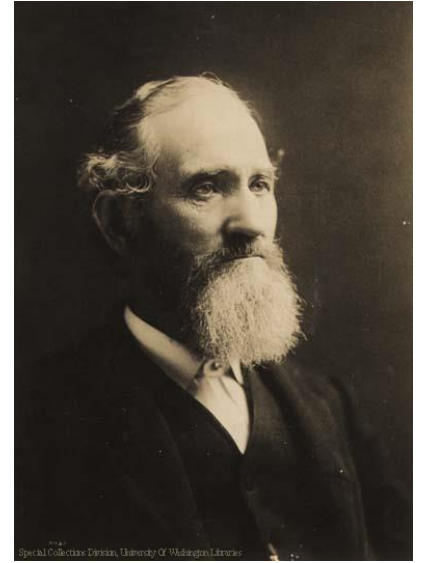
**John Meares,
1788, off of
Cape
Flattery of the
Olympics**



The force of southerly storms was evident to every eye; large and extensive woods being laid flat by their power, the branches forming one long line to the North West, intermingled with the roots of innumerable trees, which have been torn from their beds and helped to mark the furious course of their tempests.

Early Settlers

- As European settlers learned that Northwest windstorms were a force to be reckoned with.
- In 1875, Seattle pioneer Arthur Denny noted "a strong gale, which threw down considerable timber and overturned light structures, such as sheds and outbuildings."



Arthur Denny



Seattle

Big Trees: NW Storm Force Multiplier

A minor
windstorm
Easter Sunday,
April 97

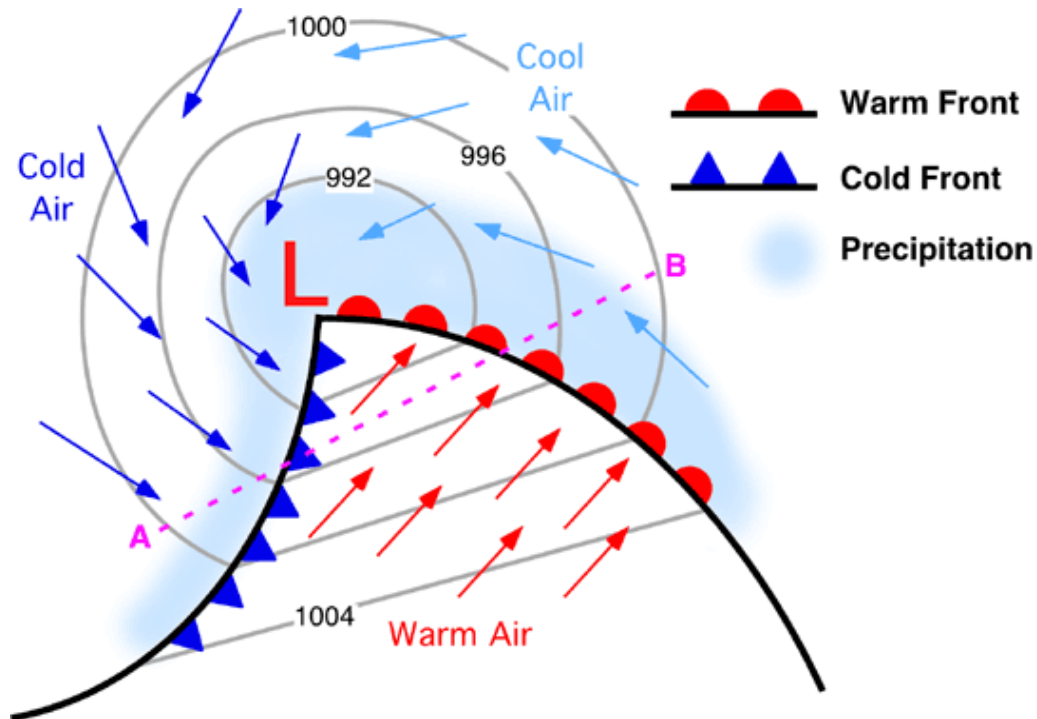


Compared to this...

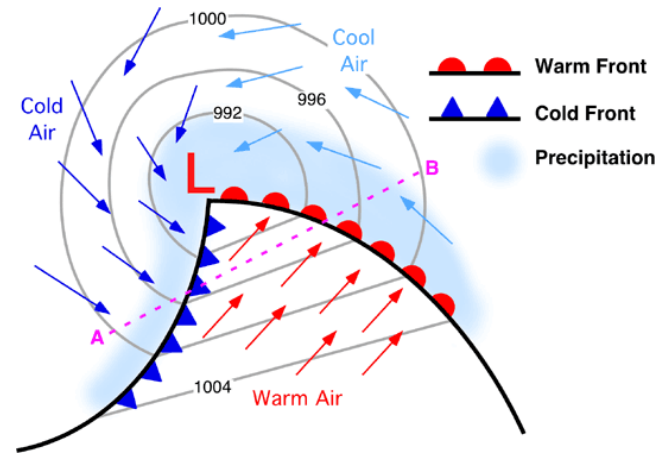


Most Northwest Windstorms are Produced by Midlatitude Cyclones with low central pressures

- A cyclone is an area of low pressure around which air circulates in a counterclockwise direction (in the northern hemisphere)

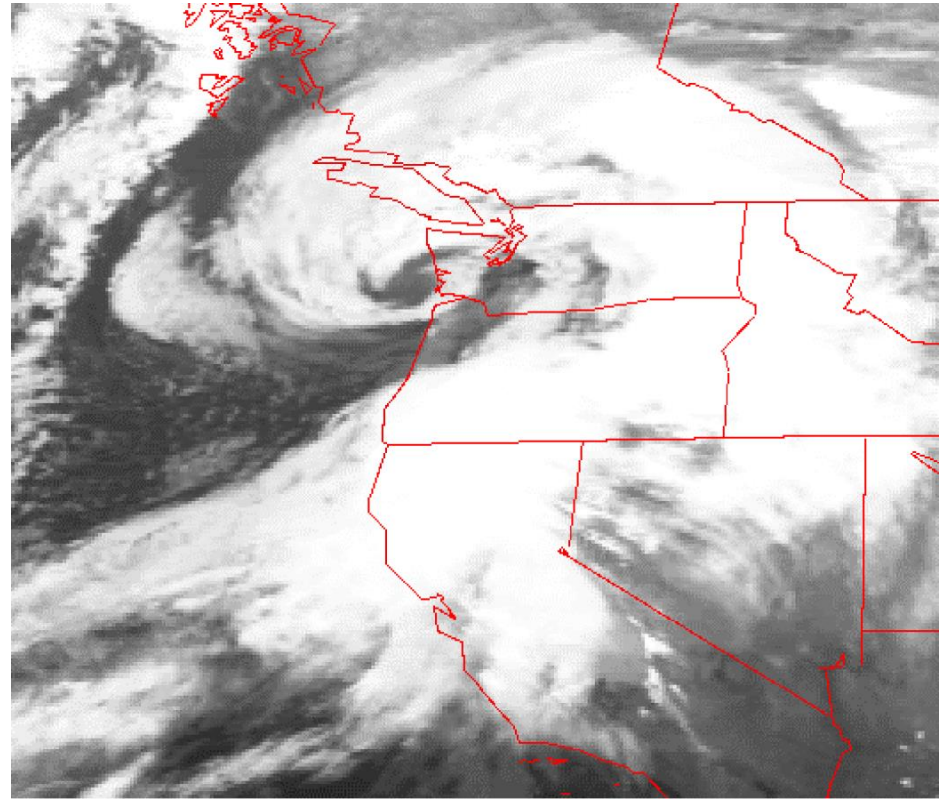


Midlatitude Cyclones

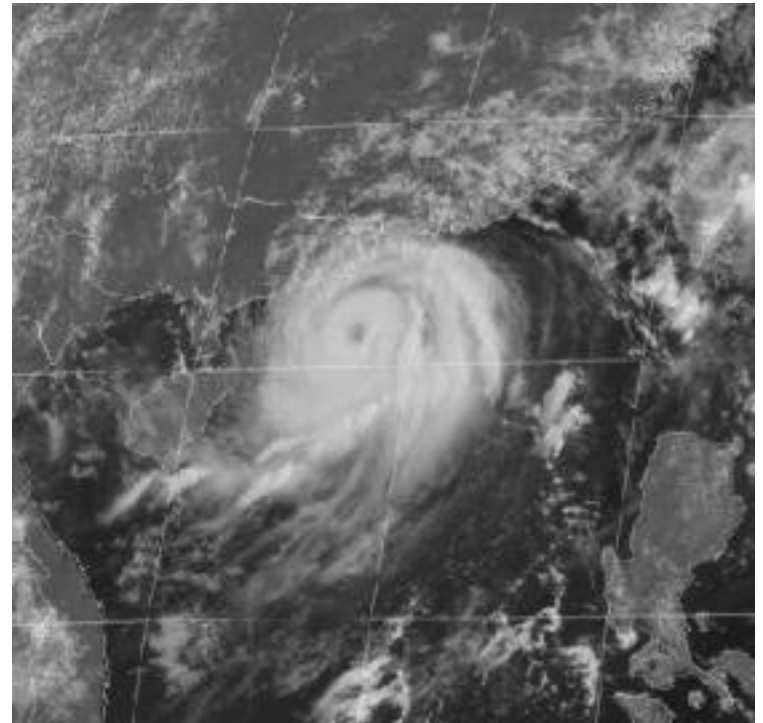


- The lower the central pressure the stronger the winds.
- Typical winter low 990-1000 hPa. Moderate windstorms 980-990 hPa. Strong ones, 950-980hPa
- Deep lows have strong pressure gradients, which result in the strong winds.

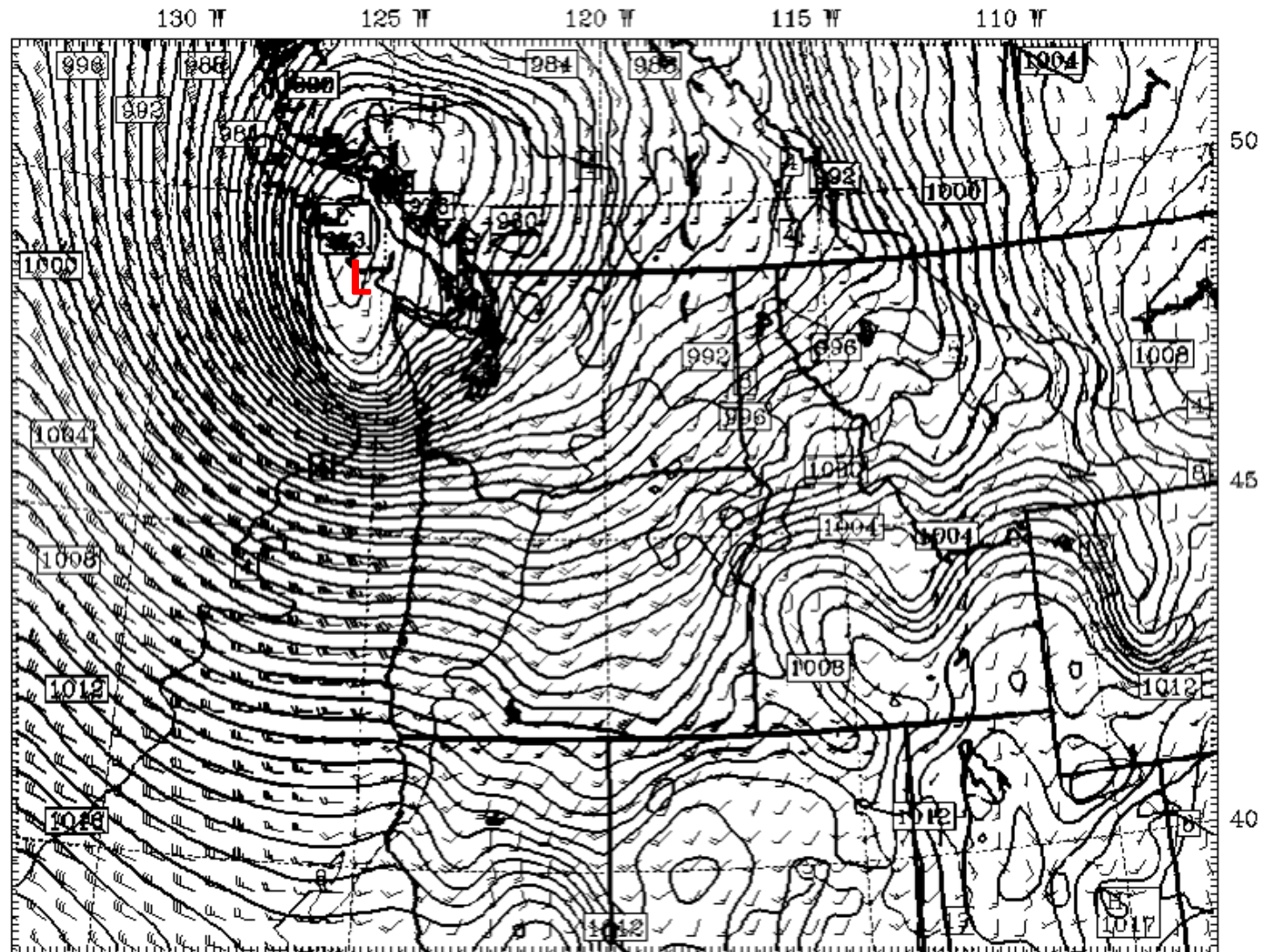
Weather Satellites Imagery of Our Storms Reveal The Huge Scale of Our Major Storms



Tropical Cyclones: Much Smaller



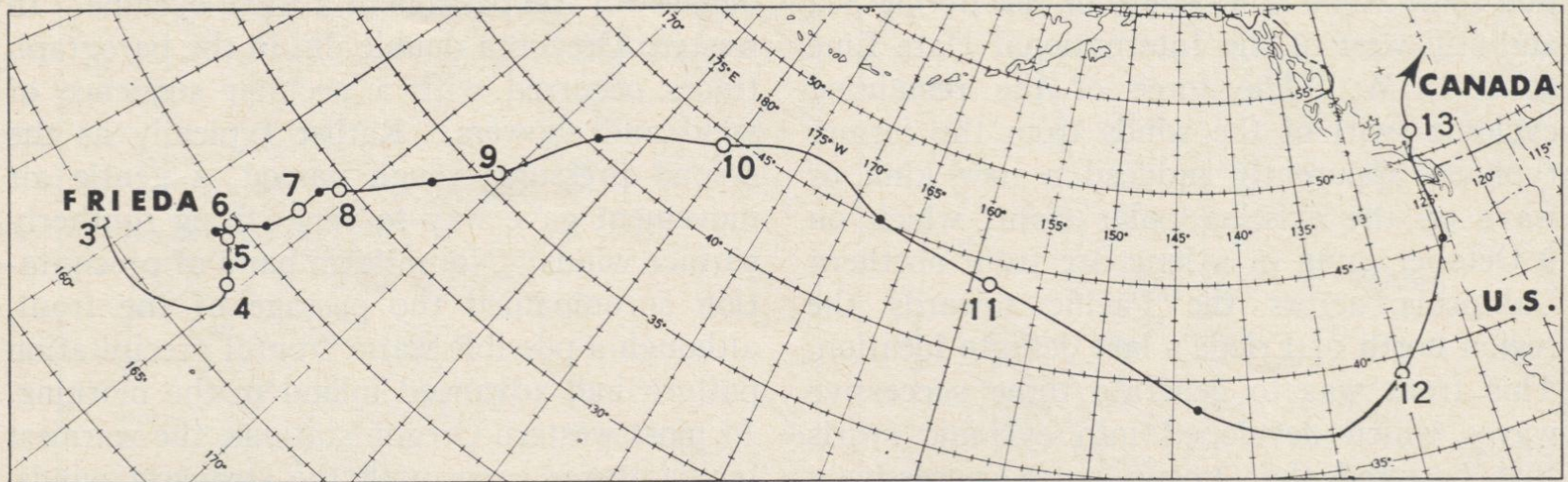
Pressure Pattern Associated with the Chanukah Eve Storm Of December 15, 2006



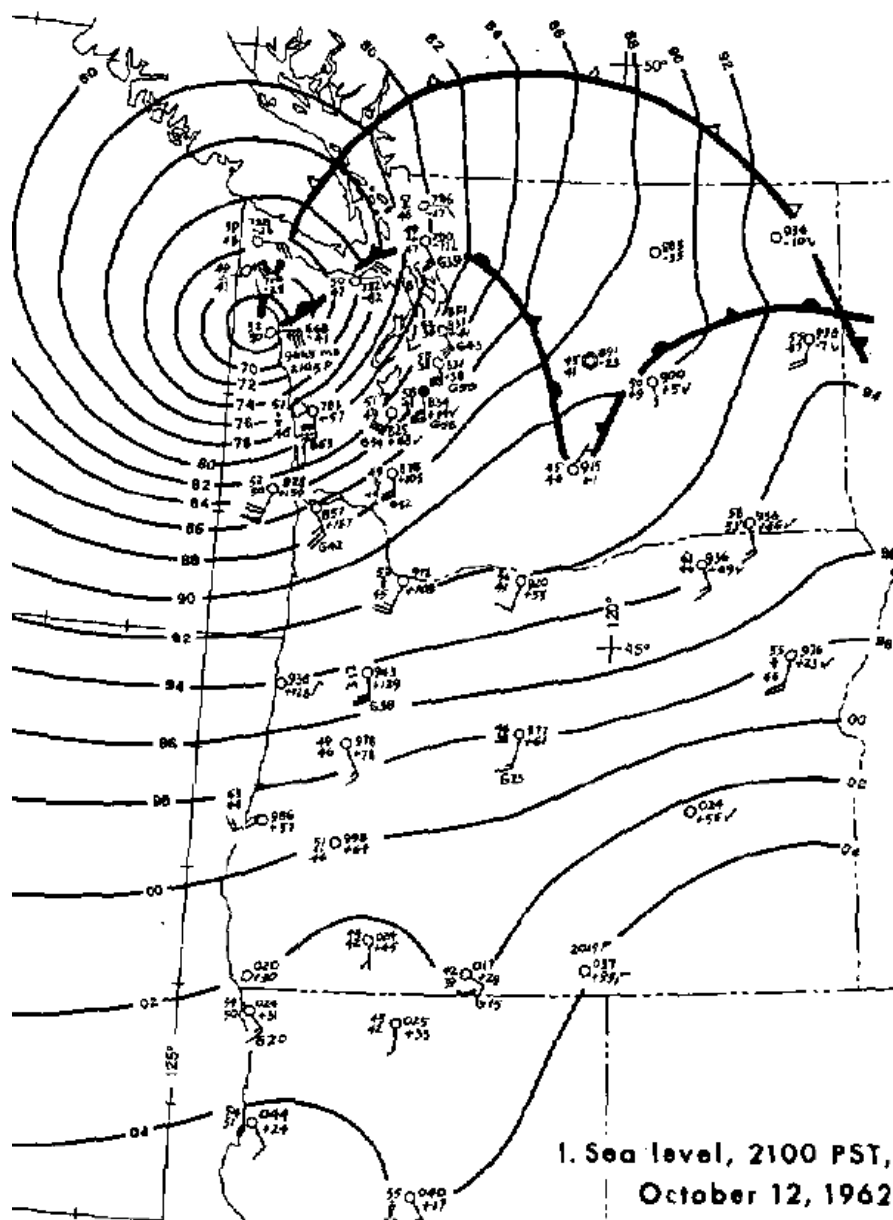
The Most Extreme Northwest Windstorm: The Columbus Day Windstorm of 12 October 1962



Began as Typhoon Frieda and then moved northward and transformed into a midlatitude cyclone.



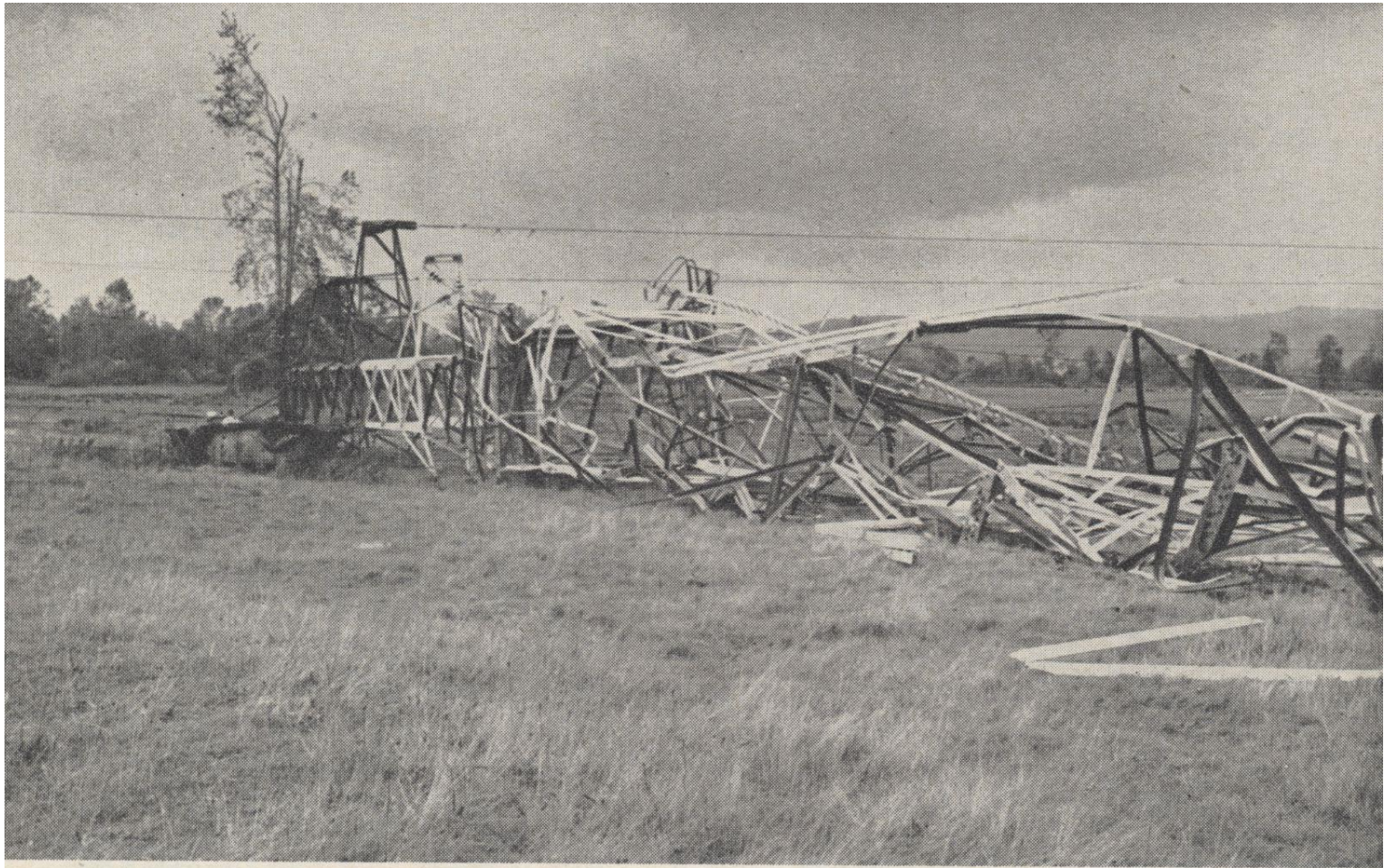
Track of ex-typhoon Frieda across the North Pacific Ocean. Open circles show the 0400 PST position on date shown. Closed circles the 1600 PST position. USWB chart.



Columbus Day Storm

- The most damaging windstorm to strike the Pacific Northwest in 150 years.
- An area from northern California to southern British Columbia experienced **hurricane-force winds**, massive treefalls, and power outages.
- In Oregon and Washington, 46 died and 317 required hospitalization as a result of the storm.





The toppled tower carrying 115,000-volt cables at Barlow Point, two miles west of Longview Bridge on the Columbia River. Bonneville Power Administration photo.

Max Winds
(mph)

Columbus Day
Storm 1962

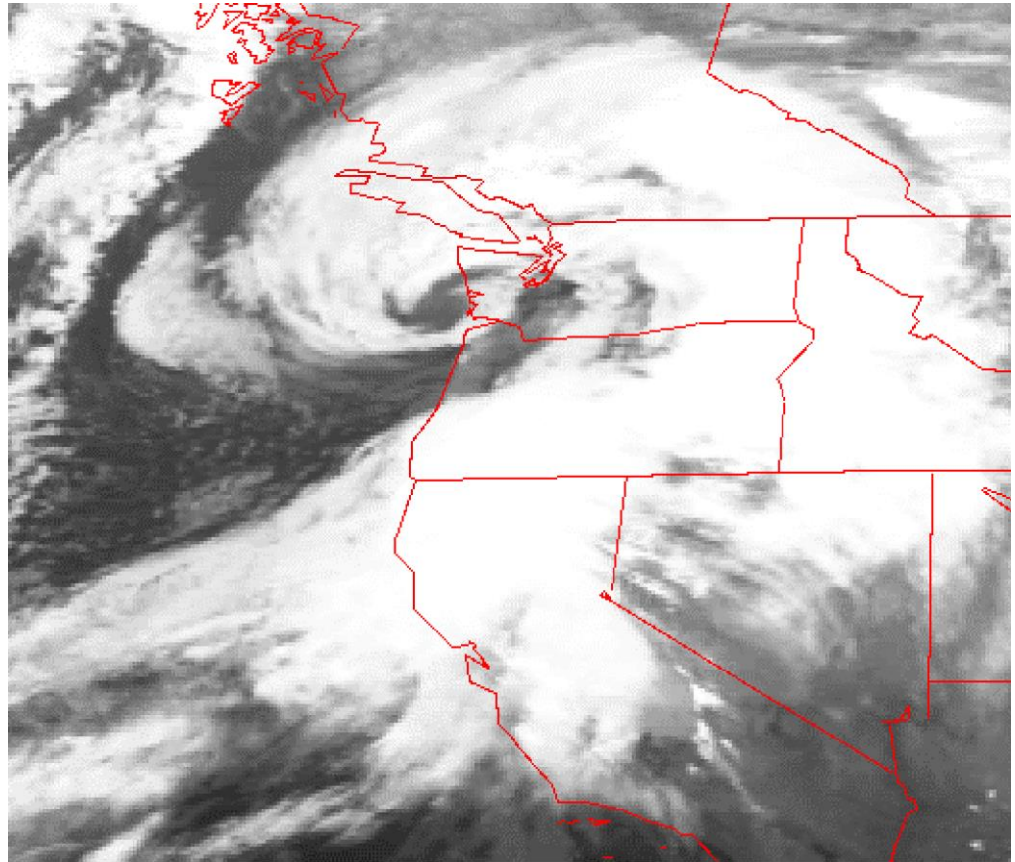


Columbus Day 1962: At Cape Blanco there were 150 mph with gusts to 179! Strongest winds on bluffs and windward slopes of coastal orography



More Recent Storms

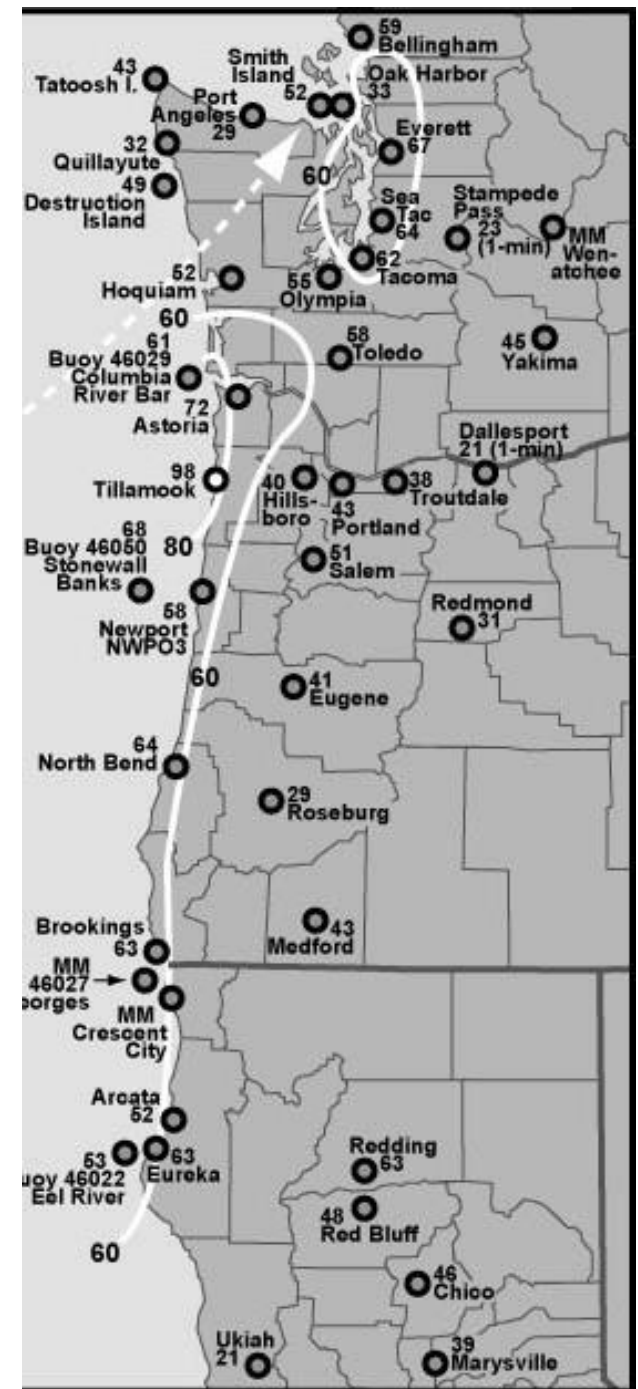
**Inauguration
Day
Storm
January 20,
1993**



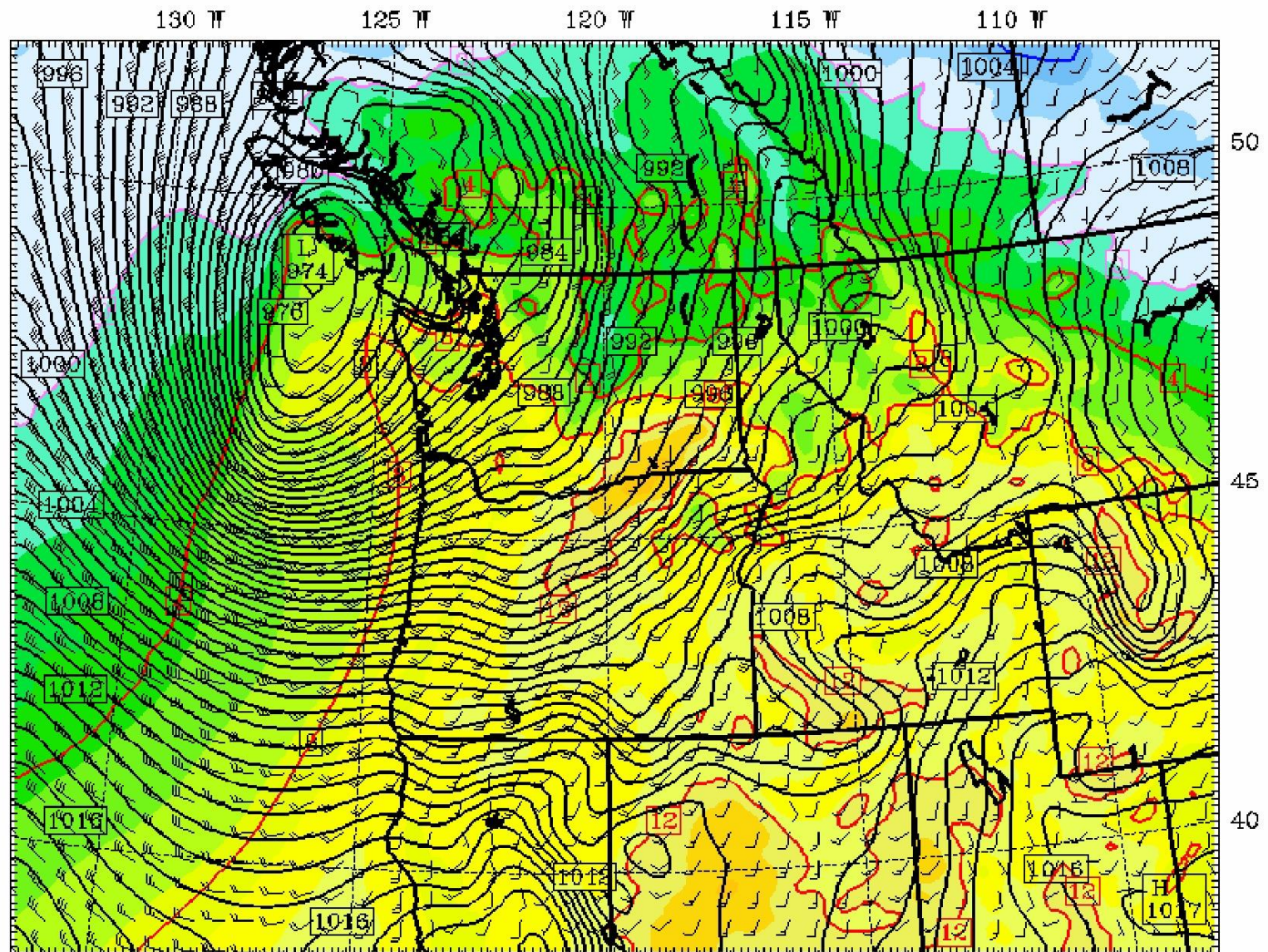


The first major windstorm to be highly skillfully forecast....

Winds of over 100 mph were observed at exposed sites in the coastal mountains and the Cascades, with speeds exceeding 80 mph along the coast and in the interior of western Washington.



Chanukah Eve Storm of Dec. 2006



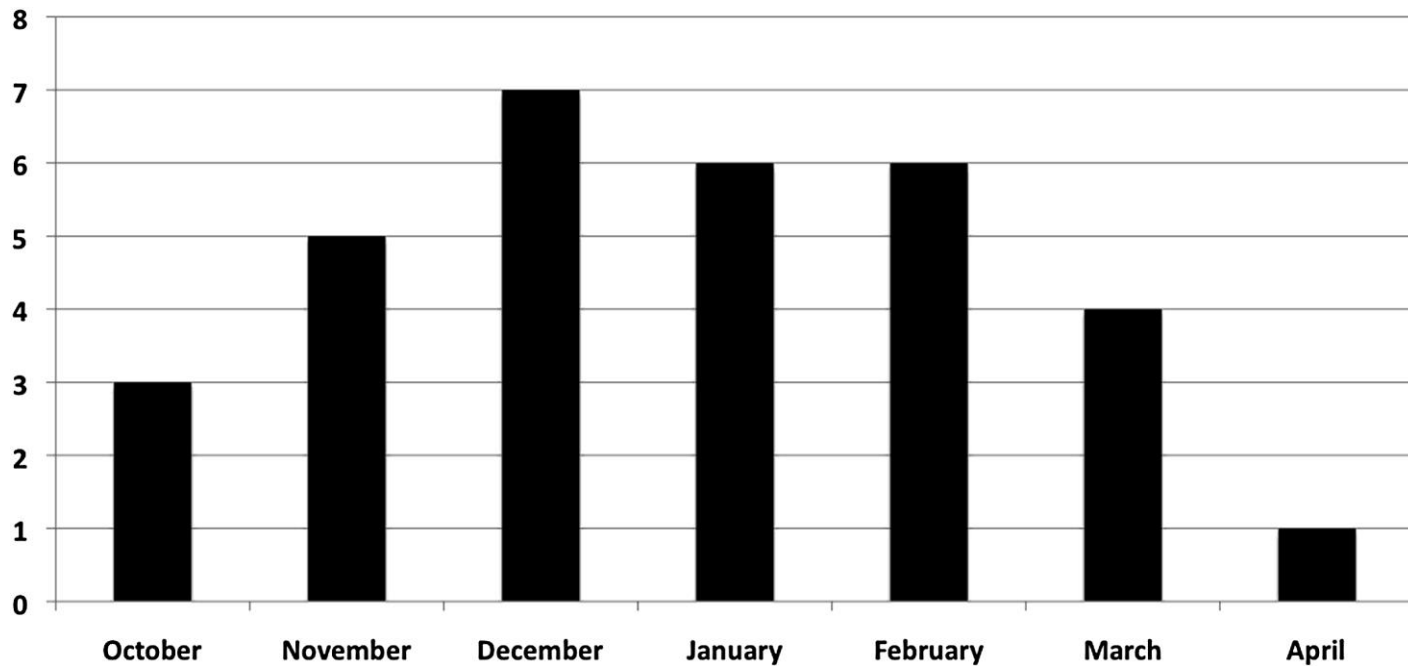
- Winds gusted to 90 mph along the coast, 80 mph in the eastern Strait of Juan de Fuca, and 70 mph over the Puget Sound lowlands.
- In the Cascades, winds reached 100 mph at Sunrise on Mt. Rainier and 113 mph at Chinook Pass.



Pacific Cyclone Key Facts

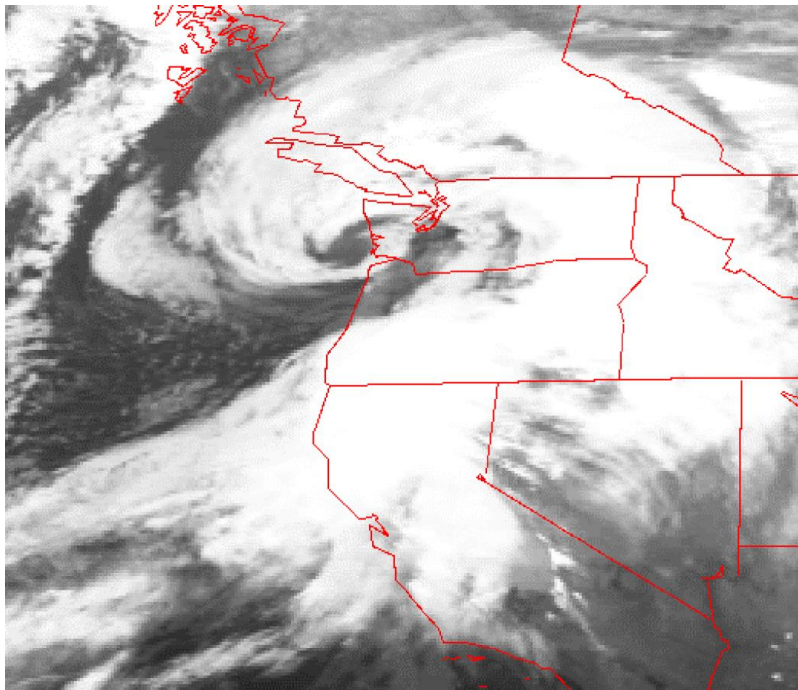
- Each year, typically get several storms with winds gusting to 30-50 mph.
- Every year, a storm reaching roughly 50-70 mph.
- Every ten years, 70-90 mph
- Every 30-50 years, 90+ in exposed locations.

A Winter Season Phenomenon



Northwest Windstorms and Global Warming

- Will there be more of them?
- Will they become more intense?



The Inauguration Day Storm
1993

Northwest Windstorms

- The best science suggests that there will **not** be an increasing trend.
- But first, what has been the trend over the past half-century?



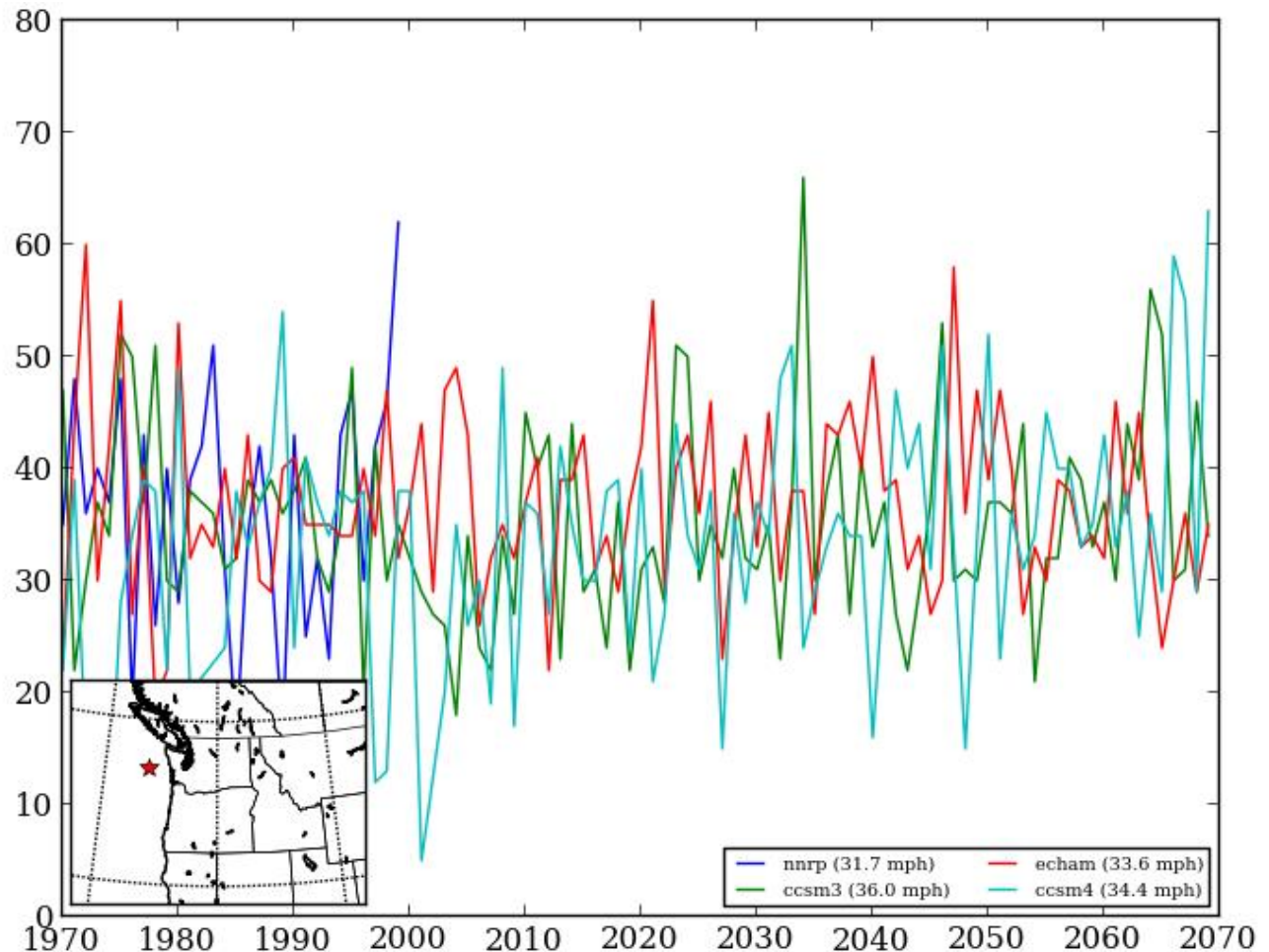
Seattle City Light sponsored study

- Started with global climate models
- Used regional, high-resolution models to look at local impacts.

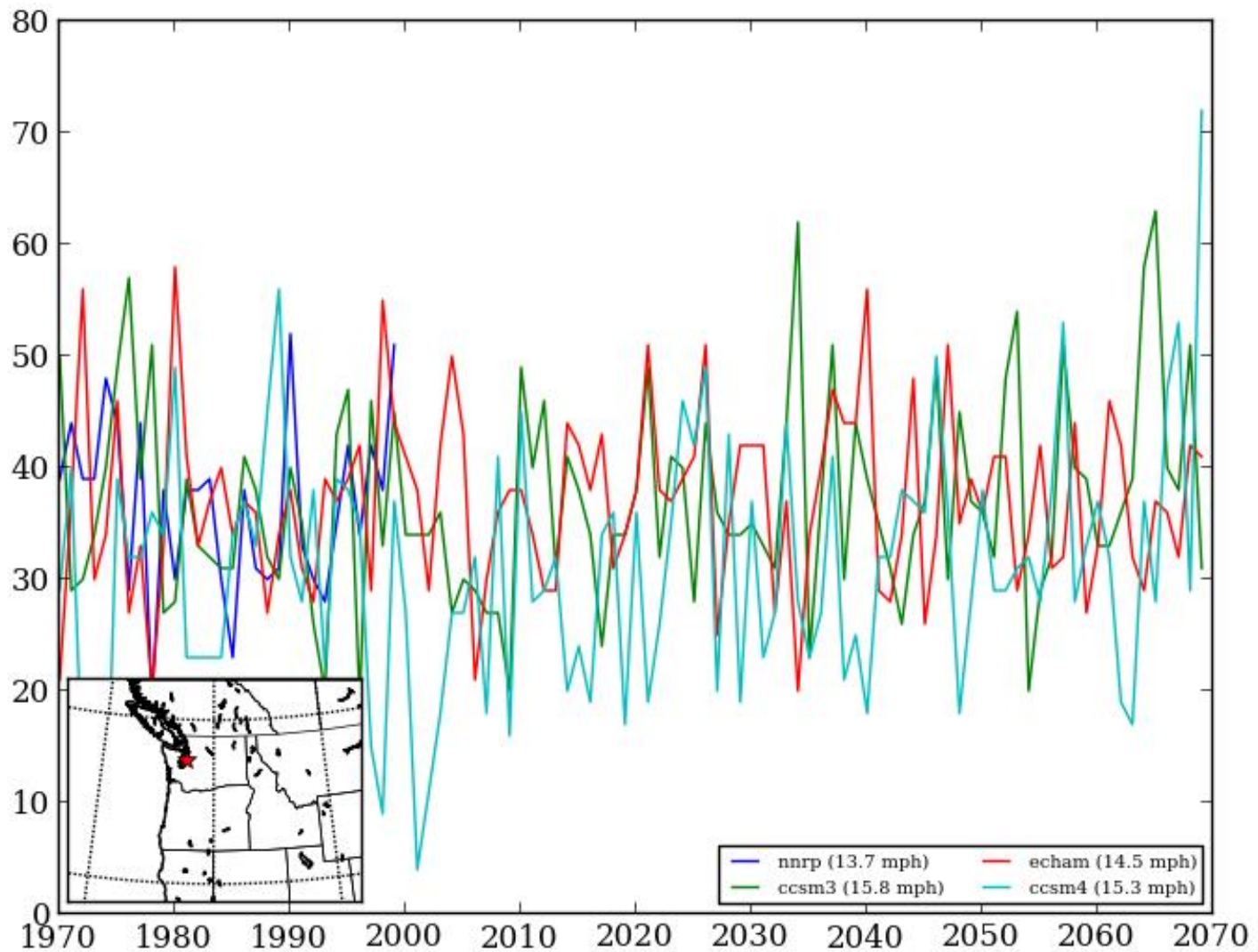


Number of times above 90 percentile for 1970-2000 (DJF)

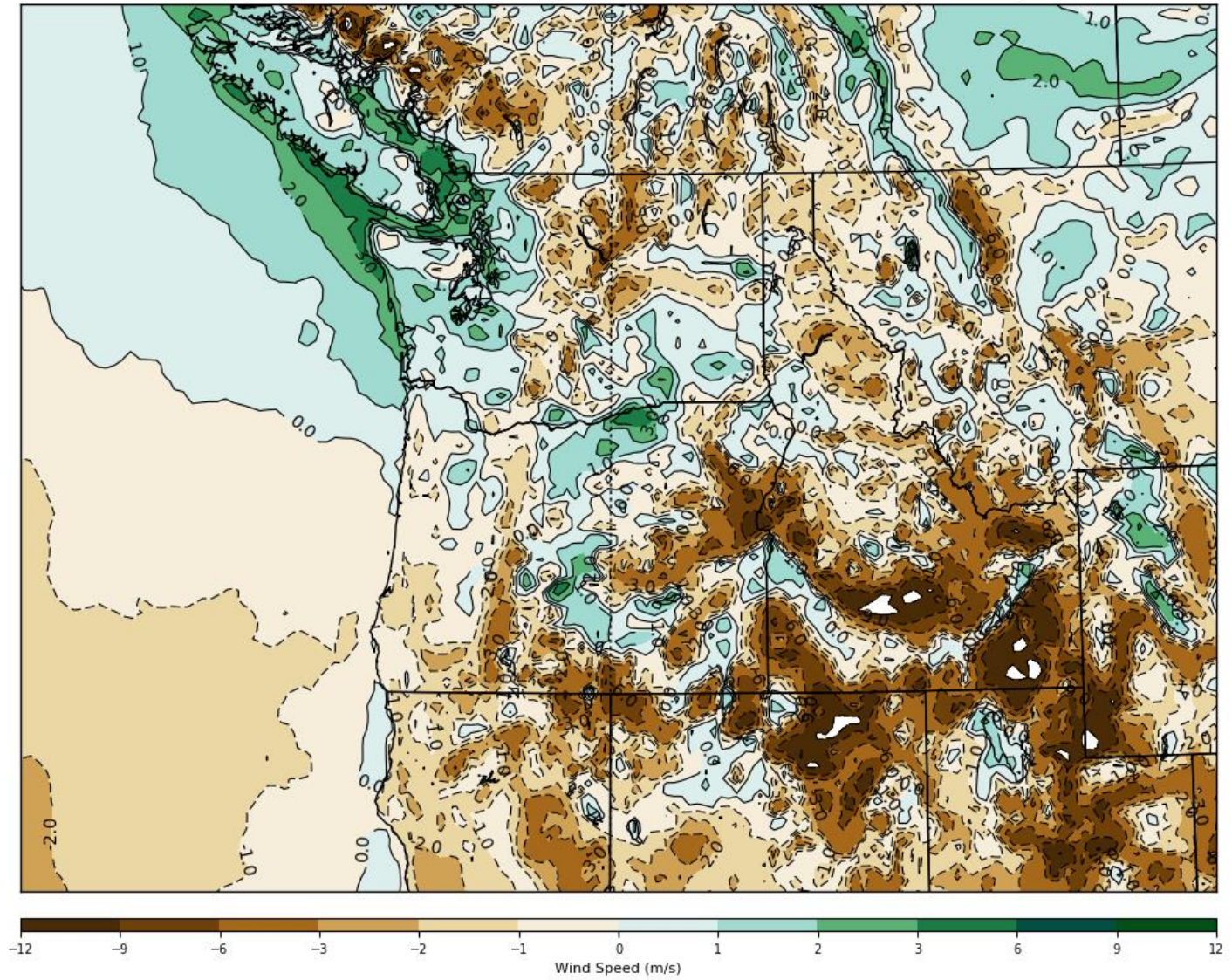
**Just
offshore of
Washington
Coast**



Seattle



Dec-Jan-Feb Average Maximum Wind Speed Difference (m/s), (2070 - 2099) - (1970 - 2000)



Why **SHOULD** we expect Northwest windstorms to change?

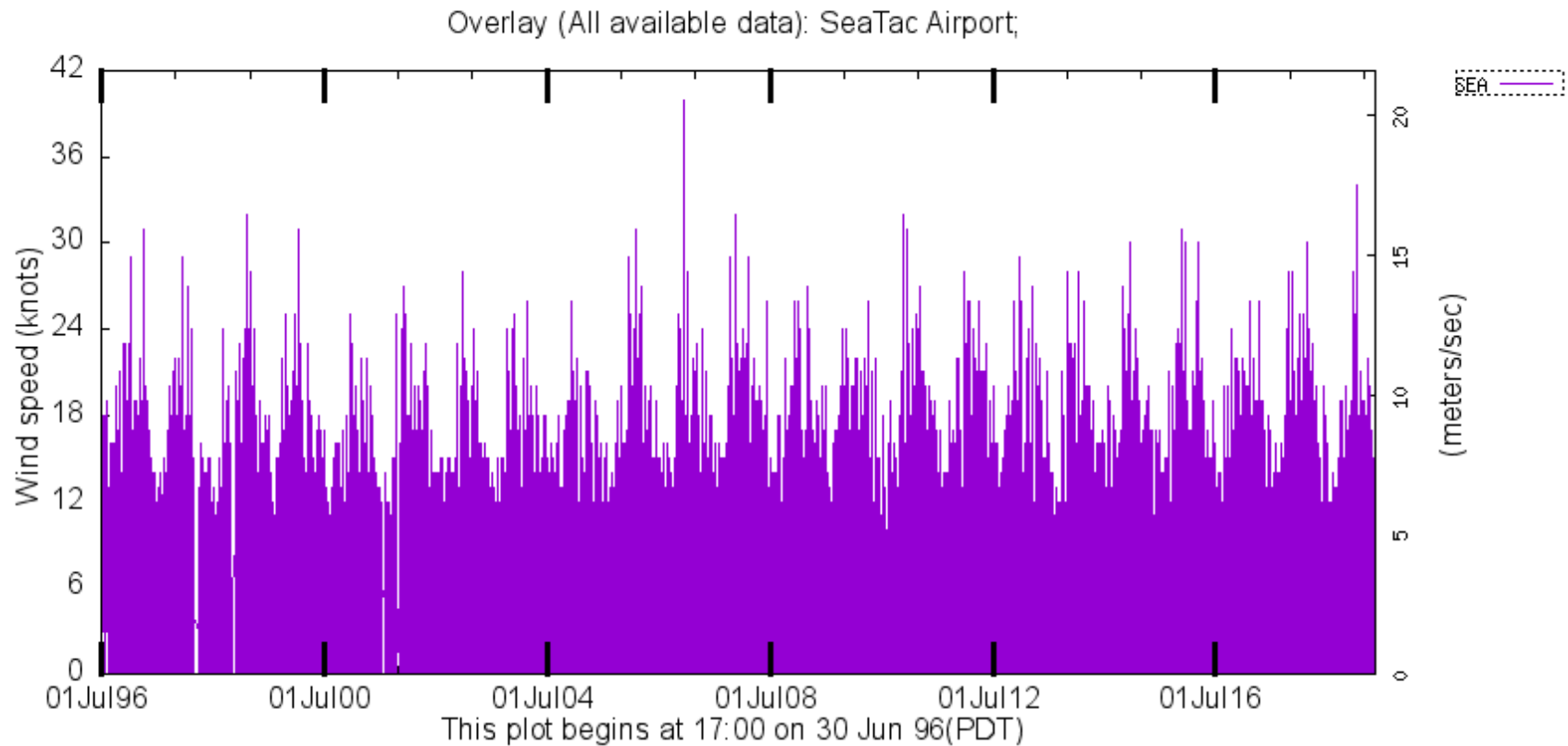
- Their energy source is the jet stream and the strong horizontal temperature gradients associated with it.
- Most global climate models suggest that the temperature gradients will weaken at low levels as the Arctic heats up more than the poles.
- But the temperature gradient increases in upper troposphere.

Hurricanes hitting the Northwest under Global Warming?

Forget it, even a warmed eastern Pacific will be far too cold.



Observed Trend at Sea-Tac



**Damaging Winds Can Also
Be Produced in other Ways**

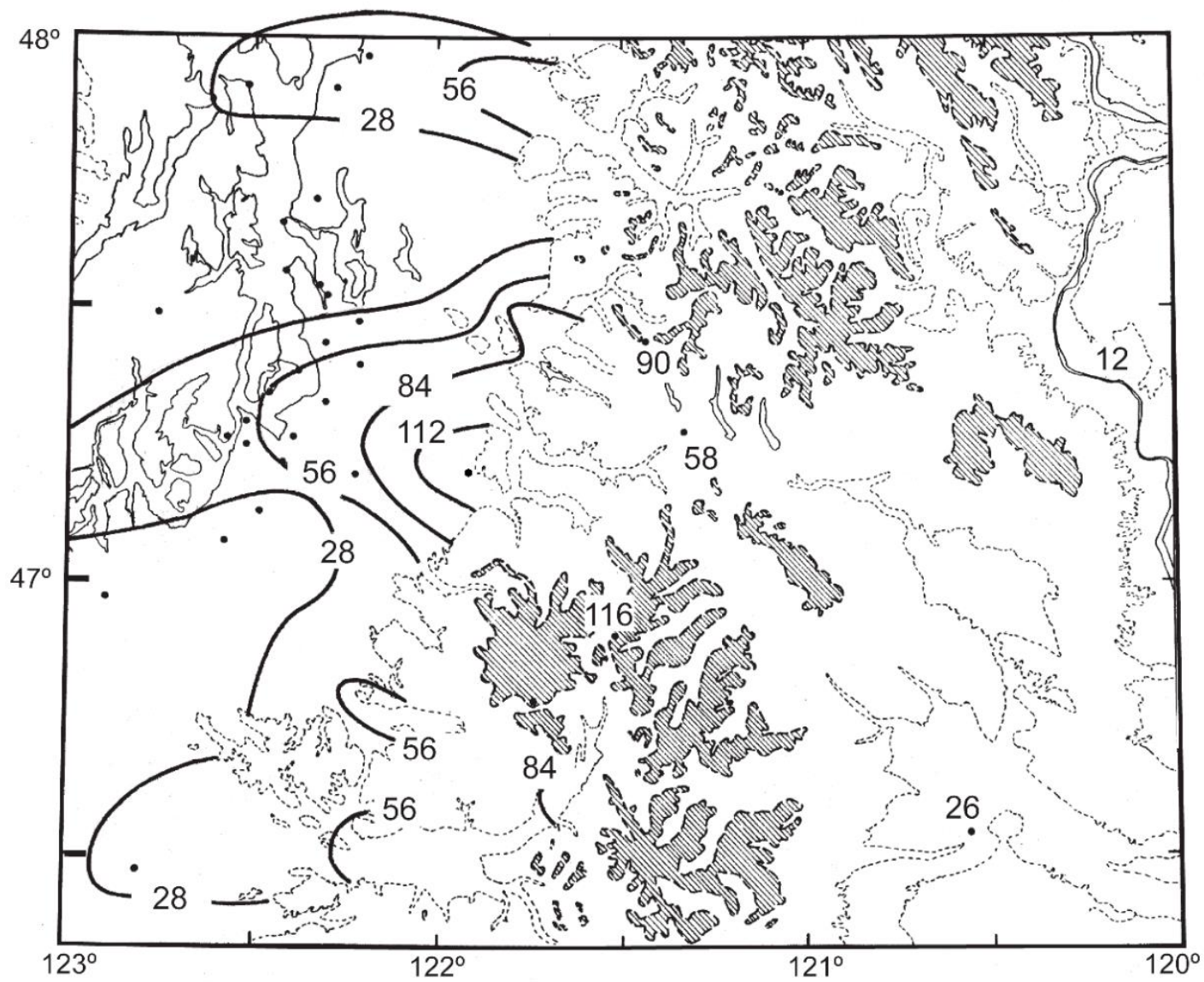
Gaps in Our Terran Produce
Strong Wins.

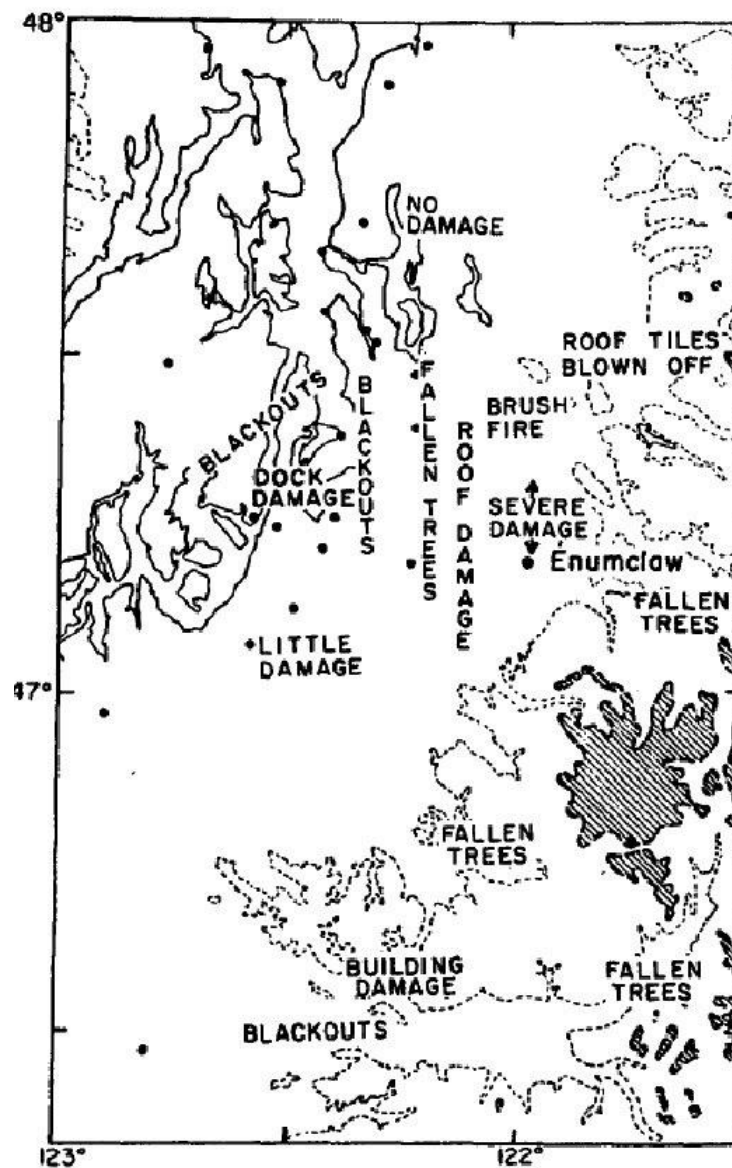
Enumclaw and nearby foothills locations can experience severe windstorms...while calm winds occur a dozen miles away

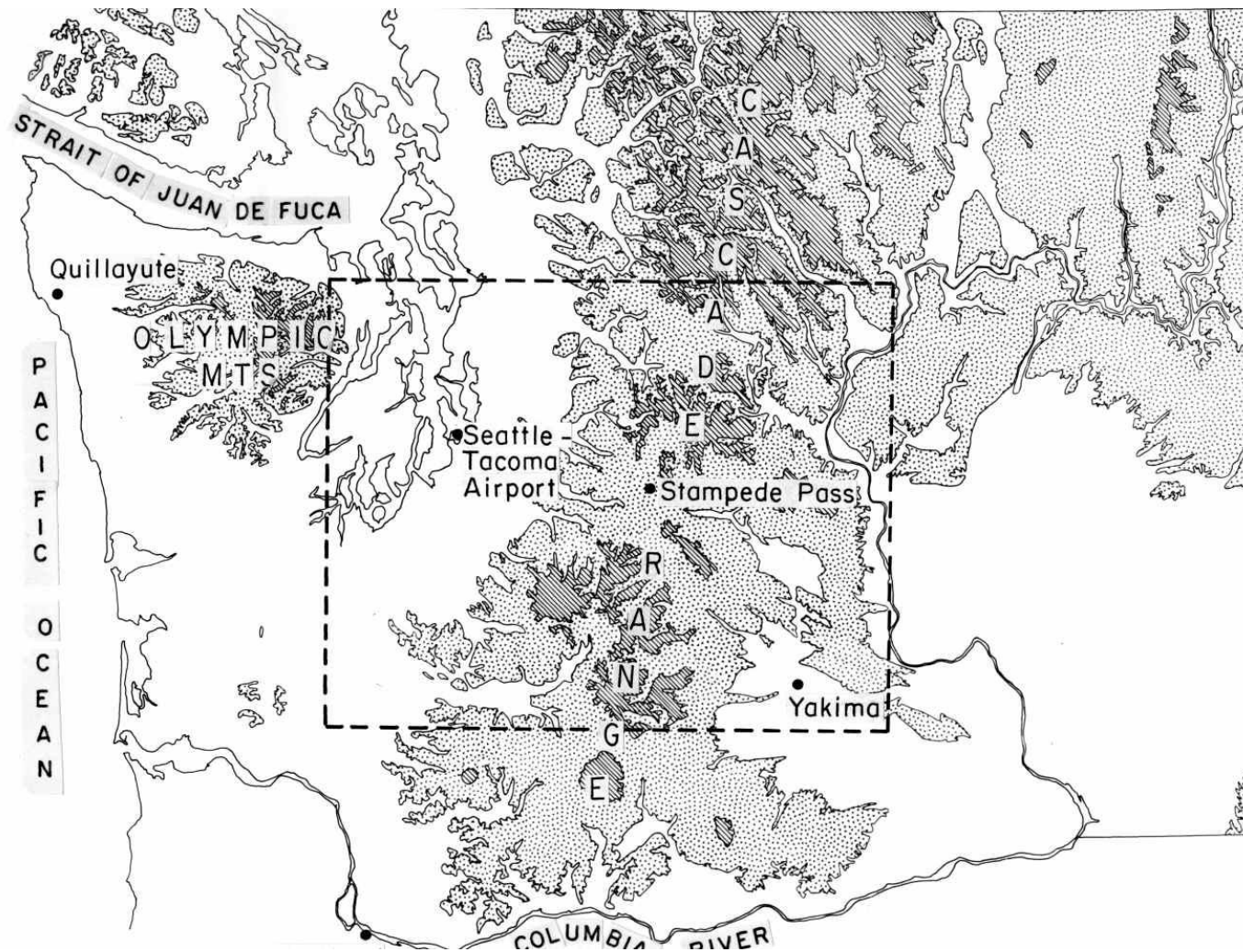


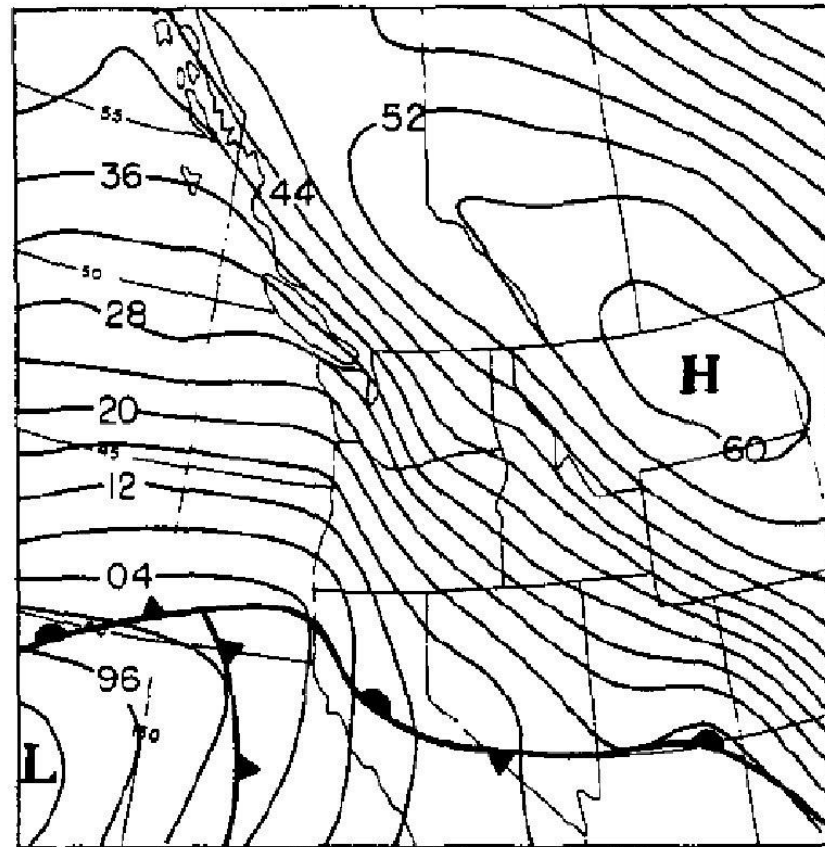
Winds over 118 mph
December 24, 1983

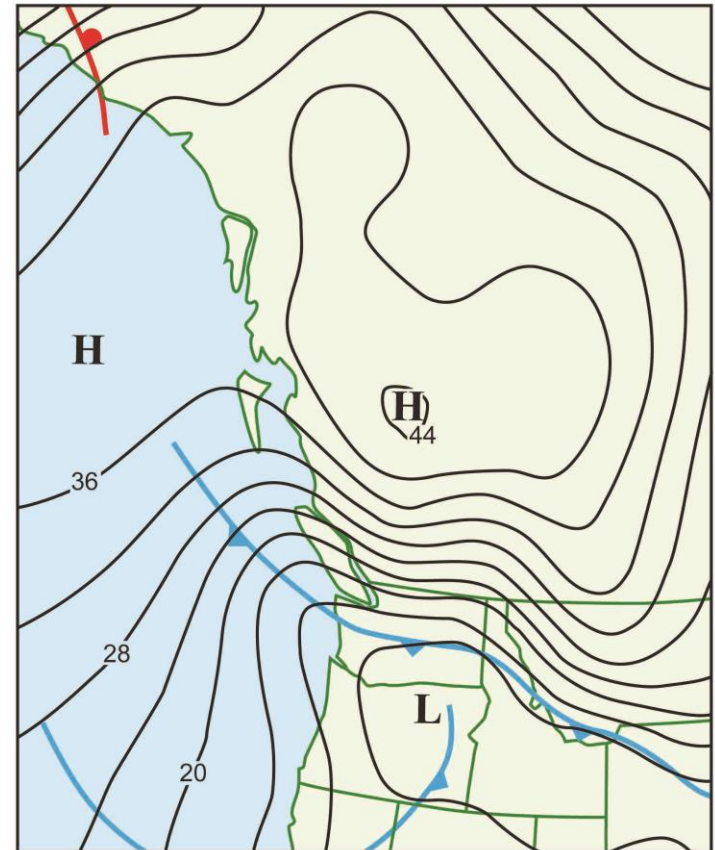
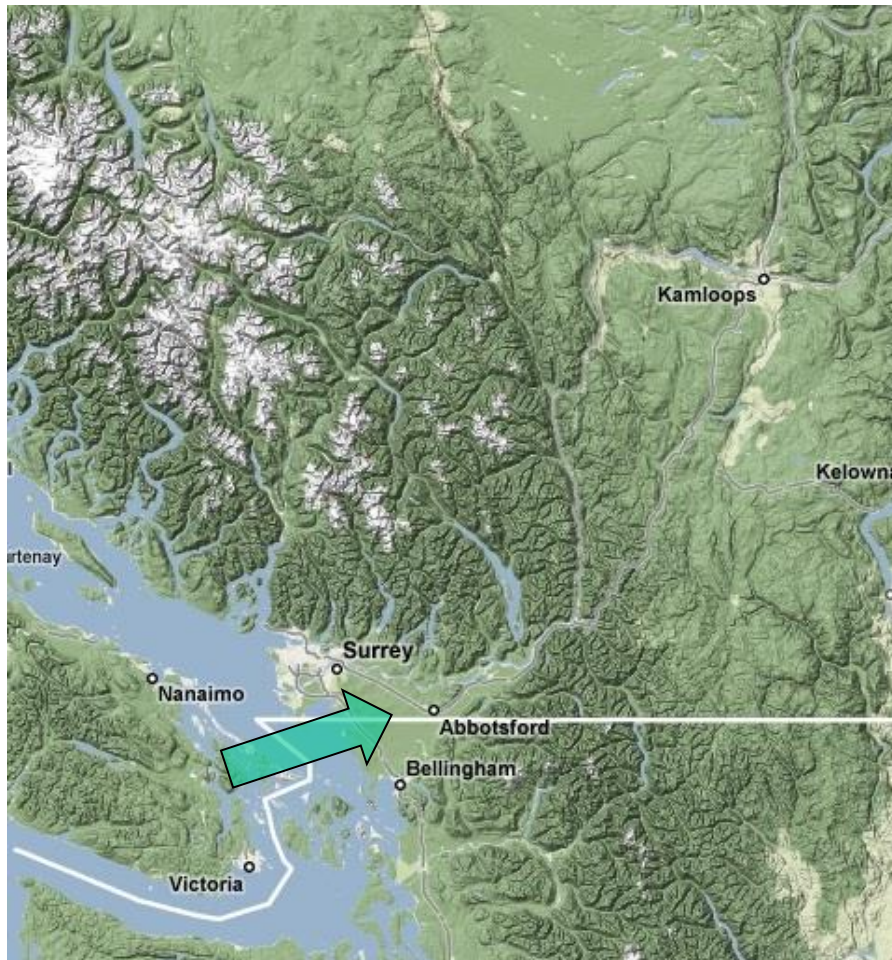


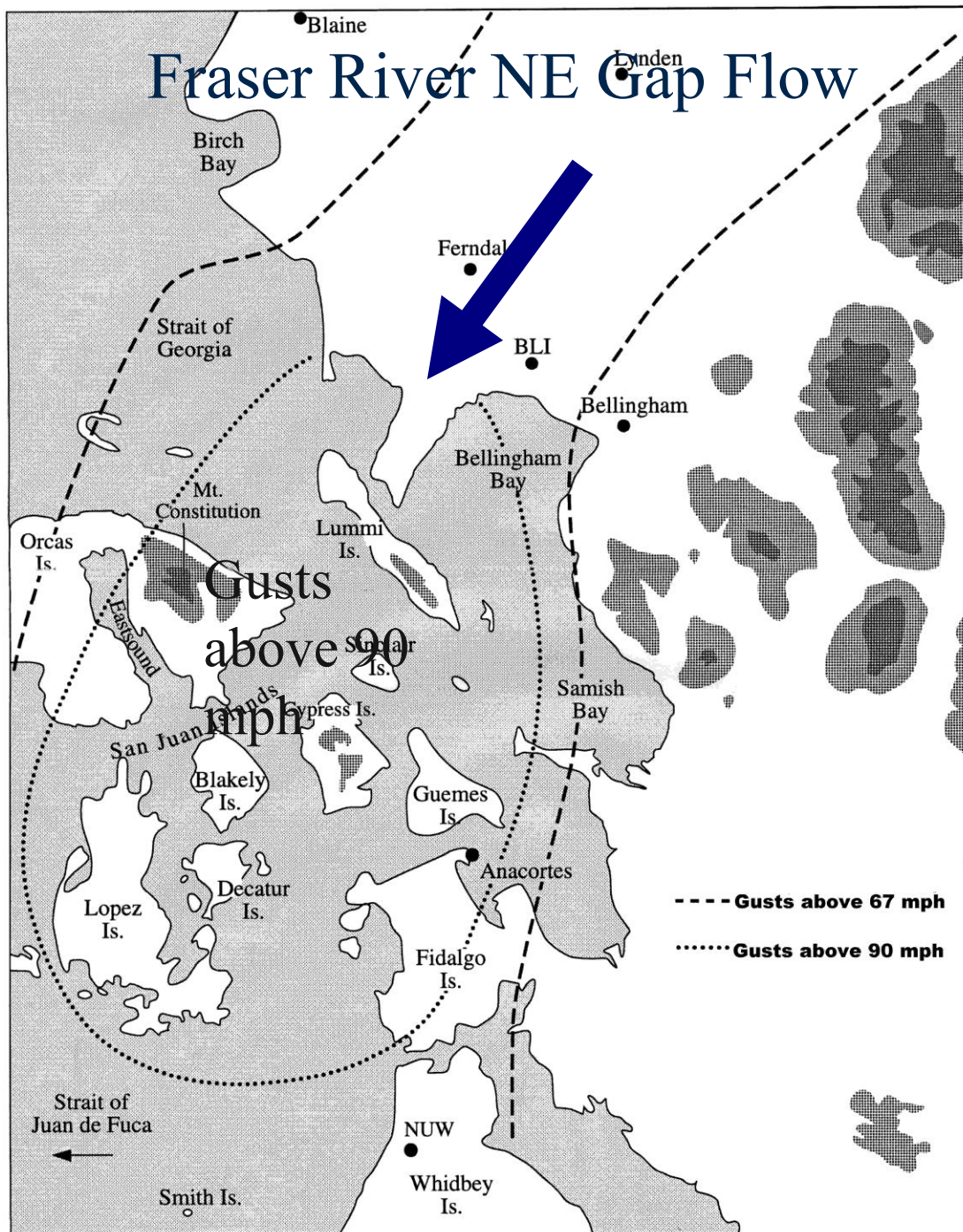












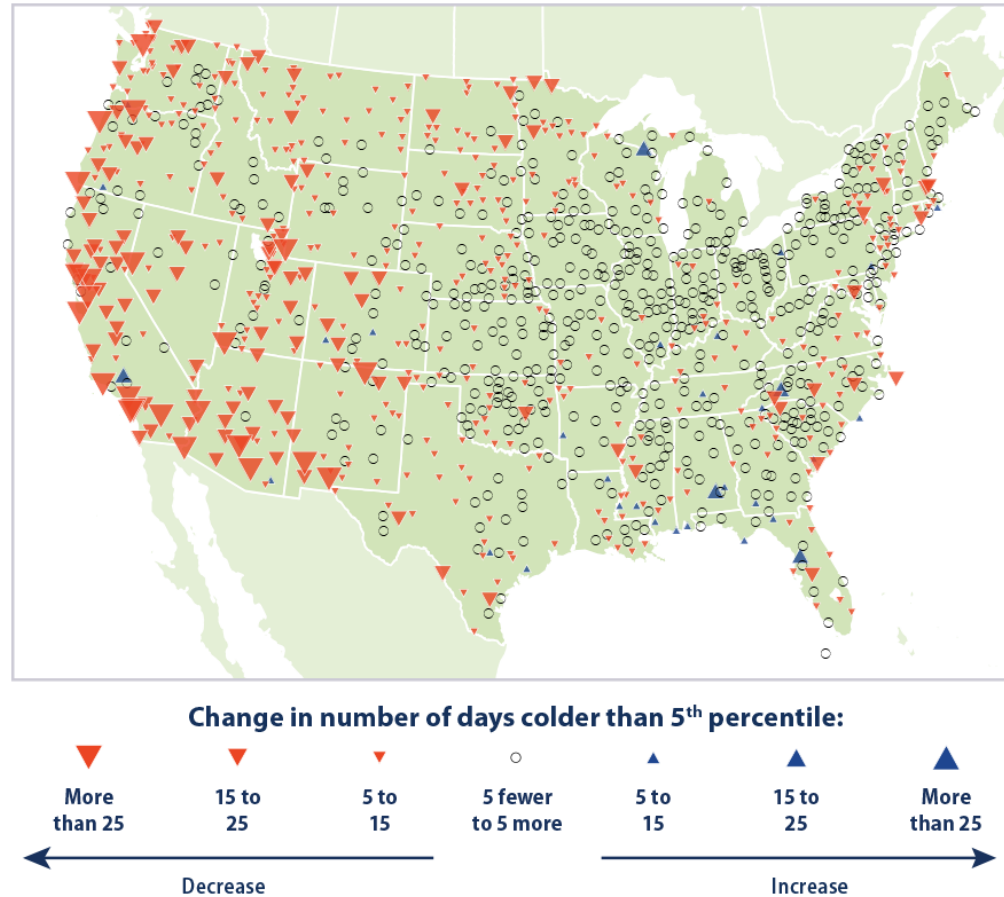
Max Winds, 28
Dec. 1990



What will Global Warming Do to Strong Gap Winds?

- Probably weaken them
- Cold air in the interior of the continent results in higher pressure that can help drive gap winds
- Global warming is lessening the severity of the cold air in the interior.
- Less strong offshore flow in gaps during winter.

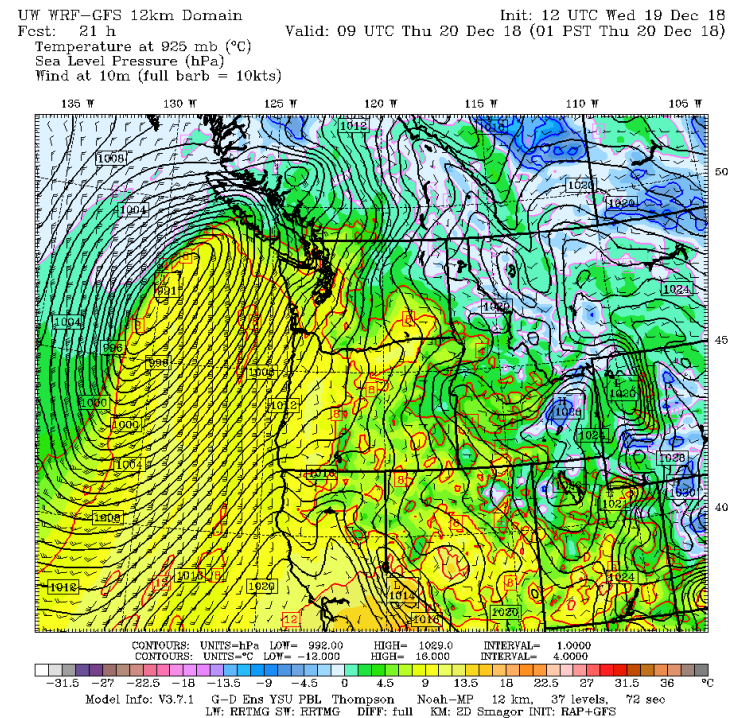
Cold Wave Trends



The U.S. Environmental Protection Agency did a study of the trend of cold wave days from 1948 to 2015

An Aside: Forecasting of Northwest Windstorms is MUCH Better

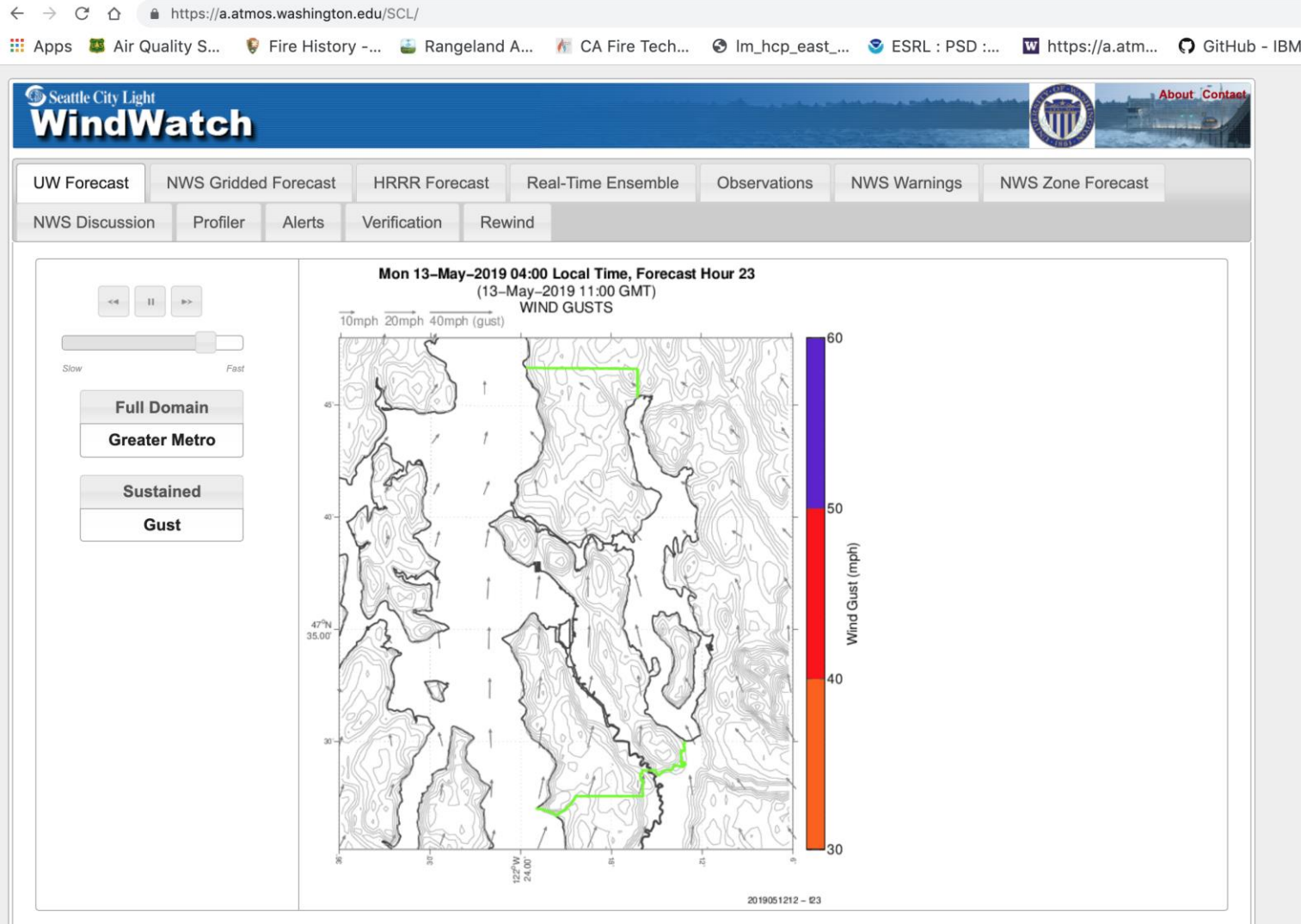
- Better forecast models
- Satellite data around the globe
- Higher resolution and more.
- Before ~1993 we got most wrong. Today, most correct days in advance.



Forecasts Need to Be Used Better in Construction



Seattle WindWatch



Bottom Line

- There is no reason to expect increased extreme winds over the region under global warming.
- Weather forecasting skill has improved, which can be useful for protecting construction and buildings in place.