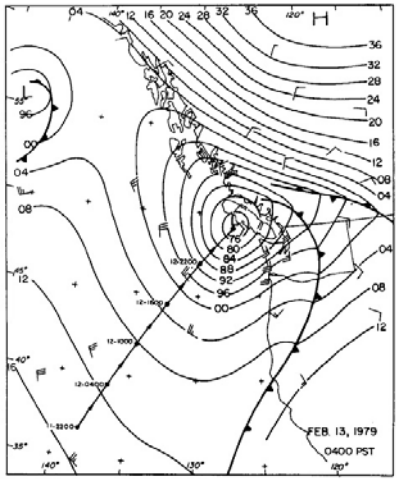
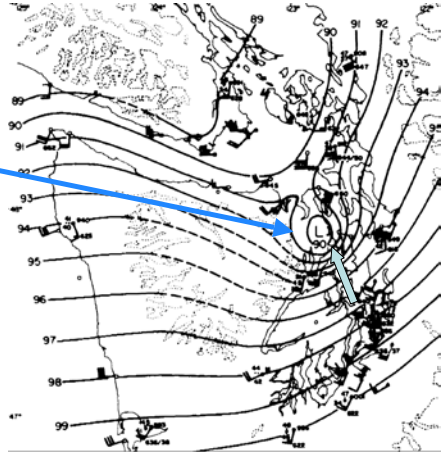
The Hood Canal Storm



The Hood Canal Storm
February 13 1979

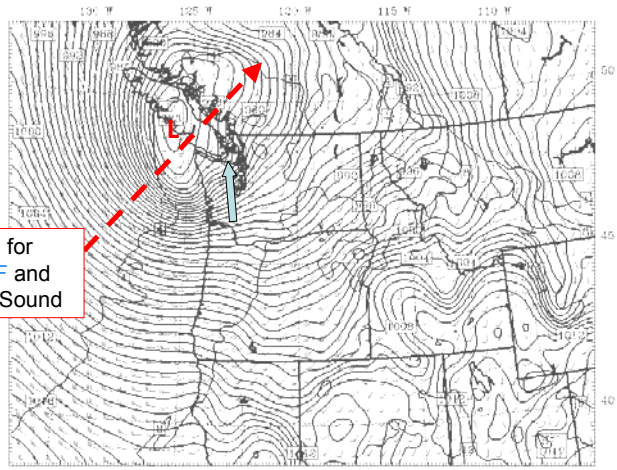
A Meso Low generated in the lee of the Olympics caused a very strong northward PGF in the south Puget Sound and very strong winds



Map created by Professor Richard Reed

Winds over 110 mph destroyed the Hood Canal Bridge
Cost to replace: over 100 million dollars

Chanukah Eve Storm: 18-h forecast for 10 PM December 14, 2006



Path of Low for maximum PGF and winds in Puget Sound

Mercer Island, December 15, 2006

Photo Courtesy of Wolf Read

The damage was extraordinary—made far worse by the heavy precipitation of the previous month.

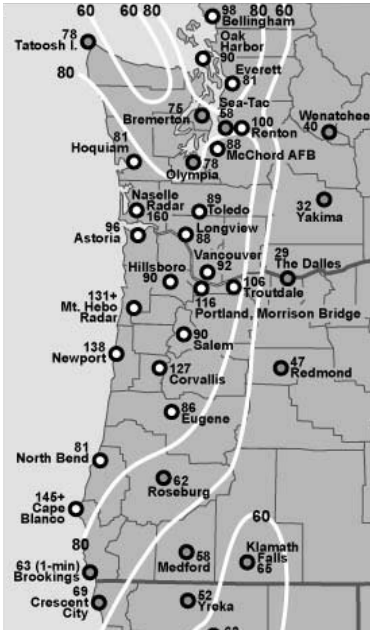
The Most Extreme Northwest Windstorm: The Columbus Day Windstorm of 12 October 1962

Bellingham, WA

Max Winds (mph)

Columbus Day Storm 1962

Graphic courtesy of Wolf Read

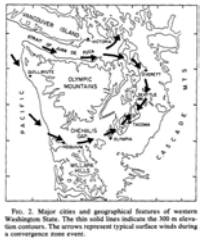


Interesting Local Weather

- Wind Storms:
  - Flows along gaps in mountains
  - Flows in Puget Sound
- Puget Sound Convergence Zone
- Pineapple Express
- Marine Push
- Puget Sound Diurnal Sea Breeze

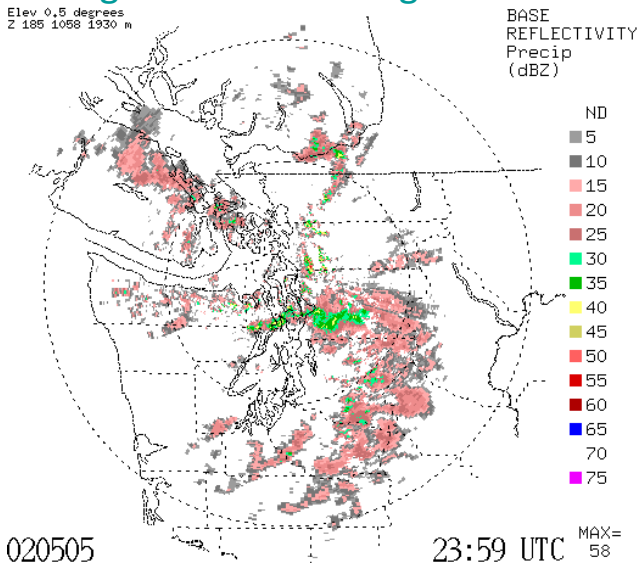
Cartoon of a Puget Sound Convergence Zone Event

Near surface air flowing around the Olympic Mts (down the St. of Juan de Fuca and up Puget Sound) converge somewhere on the lee side of the Olympics: in Puget Sound



Puget Sound Convergence Zone

Puget Sound Convergence Zone



Puget Sound Convergence Zone

- Happens after a cold front passes Puget Sound
  - Recall that the upper level cold front lags the surface front. Hence, most unstable air is *after* front passes Puget Sound
- Happens in winter and spring
  - because the wind direction in is more likely to be westerly in these seasons

Puget Sound Convergence Zone

Typical Situation
A cold front is approaching from the NW.

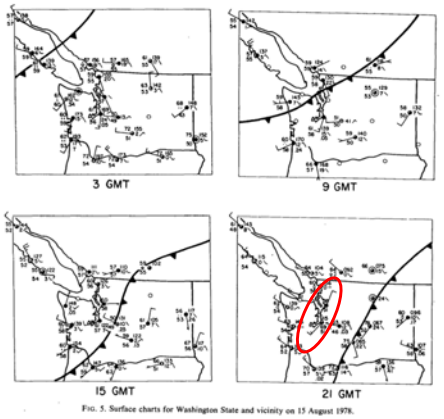


Fig. 5. Surface charts for Washington State and vicinity on 15 August 1978.

When the cold front reaches Puget Sound, the PGF forces air down the SJF and up Puget Sound

C Mass 1981

A Puget Sound Covergence Zone usually produces a narrow east-west band of moderate to heavy rain or snow that can last for several hours

Puget Sound Convergence Zone

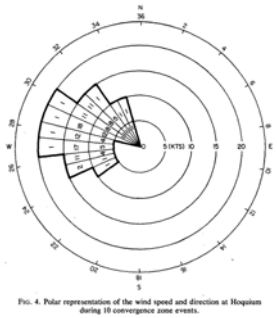


Fig. 4. Polar representation of the wind speed and direction at Hoquiam during 10 convergence zone events.

C Mass 1981

PS Convergence Zones only happen when the wind along the Washington coast is from the west or northwest (air needs to flow around both sides for the Olympic Mts for it to converge again over Puget Sound)

Interesting Local Weather

- Wind Storms:
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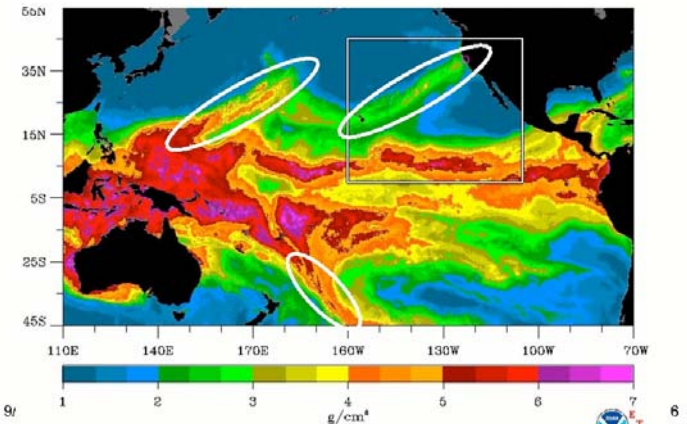
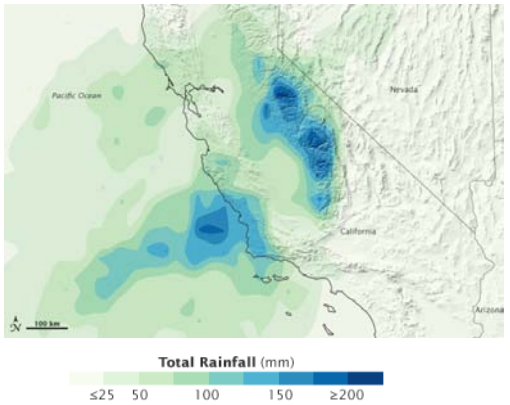
“Pineapple Express”

A relatively narrow current of warm, moist air from the subtropics…often starting near or just north of Hawaii. Also called “atmospheric rivers”.

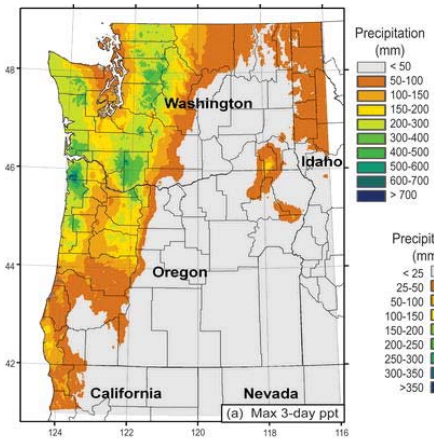


A Recent Devastating Pineapple Express: December 18-20, 2010

http://www.atmos.washington.edu/~ovens/loops/wxloop.cgi?sat_500_archive+start+2010121812+end+2010122112+interval+3h



Another Famous Pineapple Express 6-9 November 2006

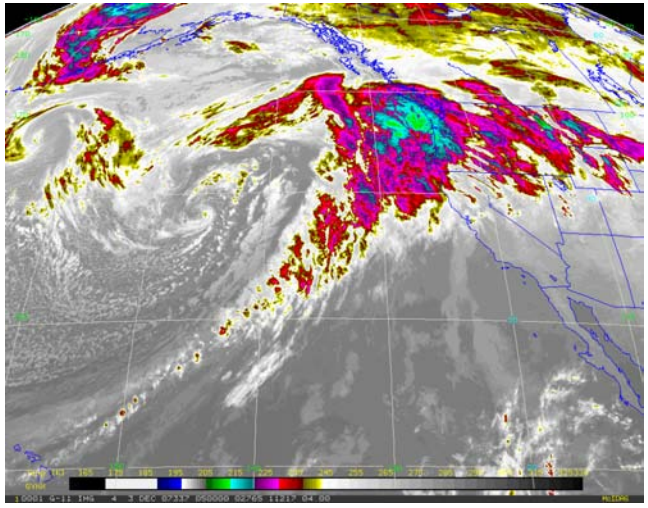


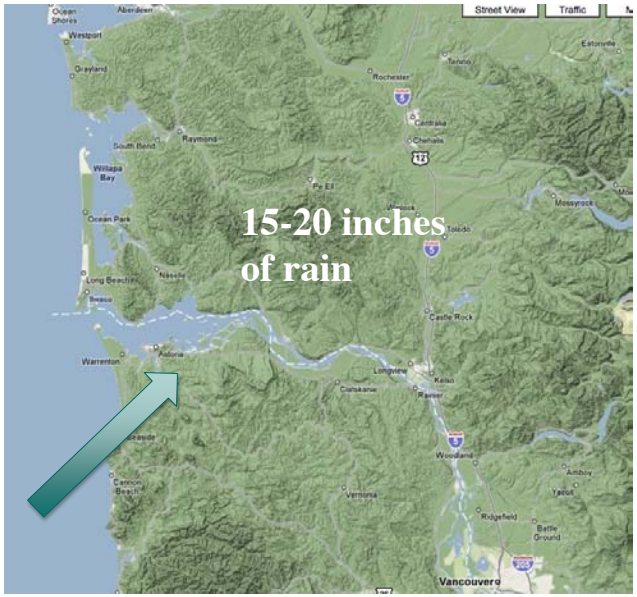
Dark Green: about 20 inches of rain in four days

Mount Rainier National Park 18 inches in 36 hr (Nov 8, 2006)

Mt. Rainier damage

… and another
December 2-3, 2007

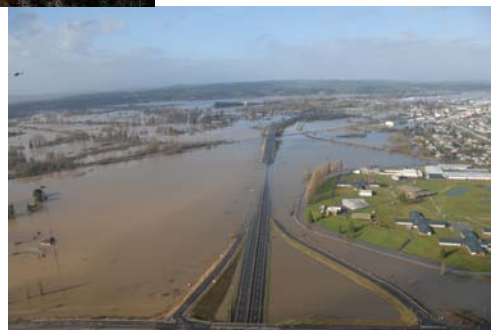


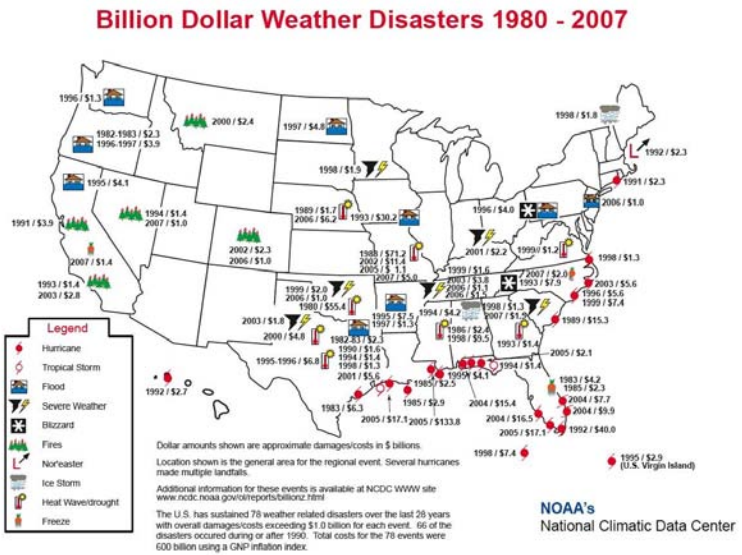


Dec. 3, 2007
20 inches in two days
over coastal terrain of SW Washington

Pictures courtesy of WSDOT

The results: massive landslides and river flooding





Interesting Local Weather

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Marine Push Composite Temperature Evolution

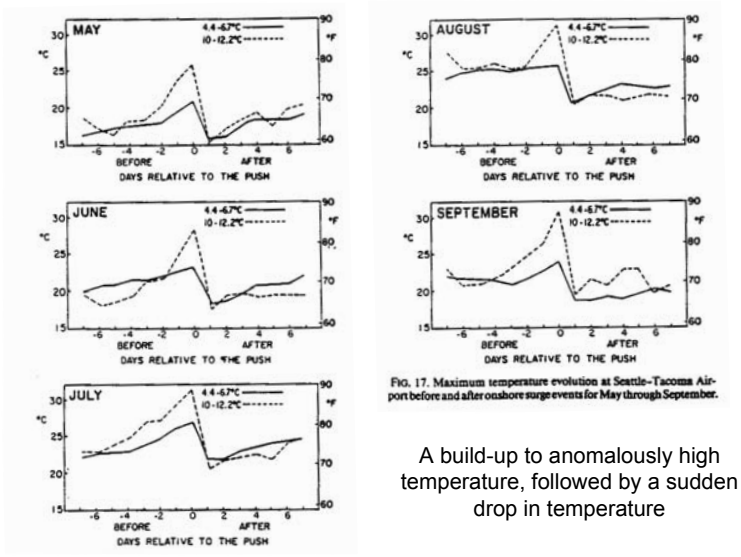


FIG. 17. Maximum temperature evolution at Seattle–Tacoma Airport before and after onshore surge events for May through September.

A build-up to anomalously high temperature, followed by a sudden drop in temperature

How often do they happen?

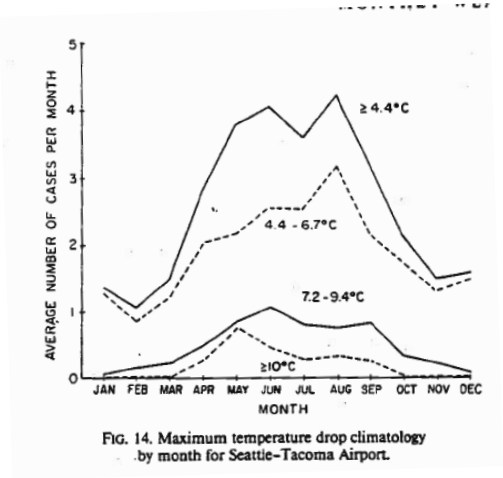


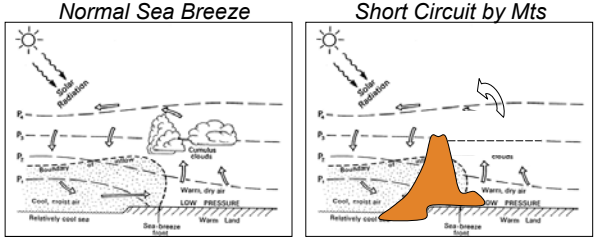
FIG. 14. Maximum temperature drop climatology by month for Seattle–Tacoma Airport.

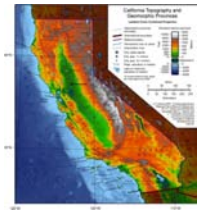
About four times per month in the summer

Marine Push: Summary Notes

- Heat low builds up in Northern California causing a sea breeze that is short circuited by coastal mountains

Normal Sea Breeze *Short Circuit by Mts*



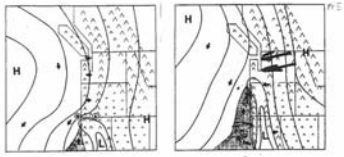


- Subsidence offshore builds a saturated tongue of air (cloudy) in the boundary layer (up to 800m) that is trapped to the coast
- The northward extent of the cold cloudy air along the coast is anchored by the strong heat low in the northern end of the Central Valley, CA (which produces large subsidence offshore)

Evolution of a Marine Push

Time t_1

Heat Low builds in Central Valley

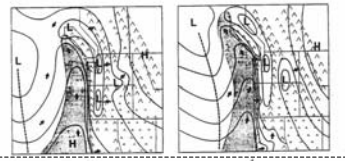


t_2

Subsidence offshore keeps air trapped near surface -> clouds and fog develop

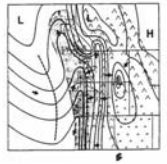
t_3

Midlevel trough approaches coast causing cold moist air to surge northward along the coast



t_4

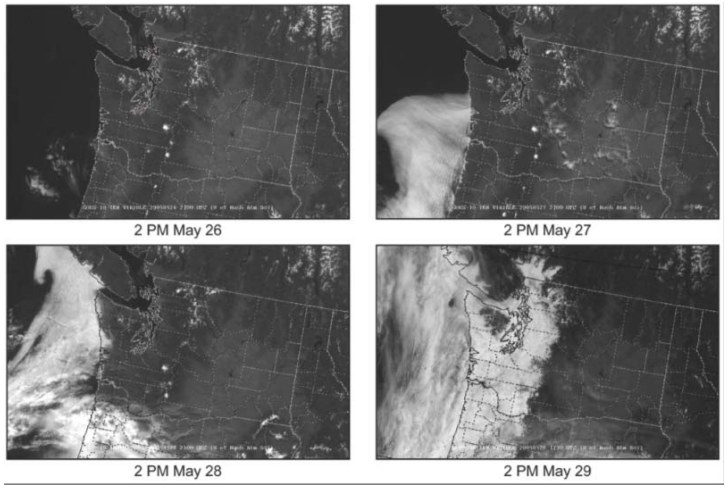
Cold moist air moving northward along the coast



t_5

Surface flow continues to flow northward, trapped along coast. Marine air leaks into Puget Sound in mountain gaps and through the St. of Juan de Fuca

Satellite view of a Marine Push



2 PM May 26 2 PM May 27

2 PM May 28 2 PM May 29

Marine Push: Summary Notes

- Heat low builds up in Northern California causing a sea breeze that is blocked by Coastal Mts.
  - Subsidence offshore builds a saturated tongue of air (cloudy) in the boundary layer (up to 800m) that is trapped to the coast
- A weak upper level trough comes to the coast and “tweaks” the boundary layer
  - Air surges poleward along the coast (trapped by coastal mountains)
- Gaps in the coastal mountains (Chehalis Gap; Str. Of Juan de Fuca) let cold marine air and clouds *flood* into Puget lowlands
  - Our spring and summer air conditioner
- Same thing happens elsewhere
  - on the east coast of Australia, where cold moist air moves equatorward (Southerly Buster)
  - On the west coast of Southern Africa, where warm moist air moves poleward

Interesting Local Weather

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Puget Sound Sea Breeze (summer)

Local Time

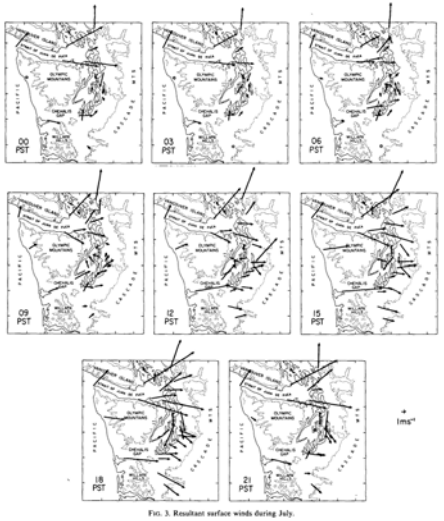

Fig. 3. Resultant surface winds during July.

Climatological Near Surface Daily Wind Velocity

C Mass 1982

Near Surface Daily Wind Velocity (July)

Local Time

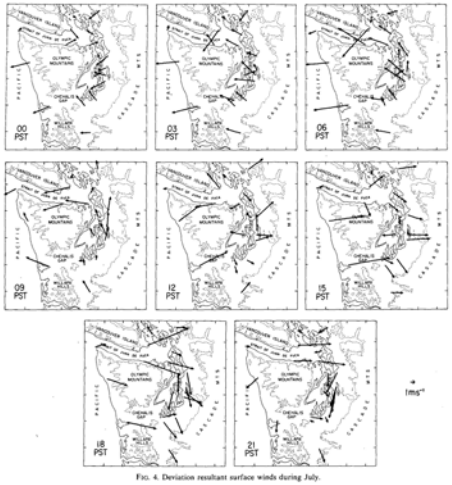

Fig. 4. Deviation resultant surface winds during July.

Departure from the daily average

C Mass 1982