# Puget Sound Climate

- What is the definition of *climate*?
- What is the definition of *weather*?
  - www-k12.atmos.washington.edu/k12/grayskies/
- What environmental variables are included in each?



# Puget Sound Climate

- What is the definition of *climate*?
  - Long-term average conditions
  - Typically 50-year average or longer
  - Averages may be tabulated by month or day
- What environmental variables are included in each?
  - High, low, & average temperature
  - Precipitation (rain & snow)
  - Wind speed & direction



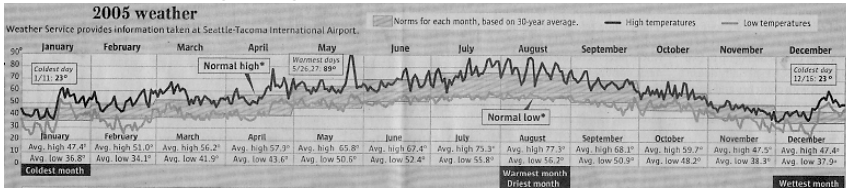
# Puget Sound Climate

- What is the definition of *weather*?
  - Short-term conditions
    - Hours, days, weeks
  - Departure of current conditions from average
- What environmental variables are included in each?
  - High, low, & average temperature
  - Precipitation (rain & snow)
  - Wind speed & direction



# Climate vs. Weather

- Difference between “normal” & “average?”
  - Variability is normal
  - Weather is seldom “average”
  - How many days in 2005 where the high = average high temperature?




Seattle Times Jan. 2 2006

# Elements of Puget Sound Climate

- What are the three “dominating controls” of the Puget Sound climate?
  - Pacific Ocean
  - Persistent high & low atmospheric pressure patterns
  - Mountains

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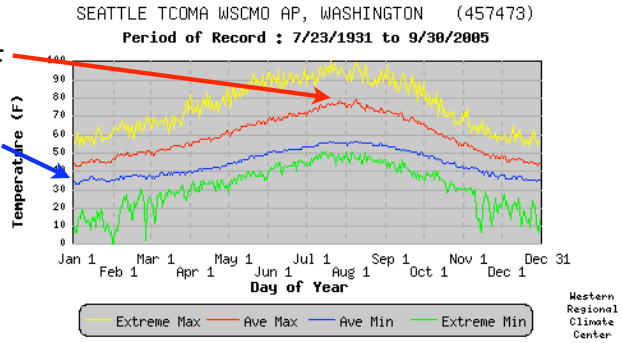
# Puget Sound Climate Control #1 - Ocean

- Pacific Ocean
  - Source of moisture to atmosphere
  - Kruckeberg calls is “Thermostat”
  - “Flywheel” perhaps more appropriate
    - Moderates air temperature
    - Water requires much more energy exchange to raise or lower temperature
    - Keeps region cooler in summer, warmer in winter

 © 2006 University of Washington

# Puget Sound Temperatures

- Moderate annual temperature cycle
- Avg. July high <80F
- Avg. Jan. low >32F

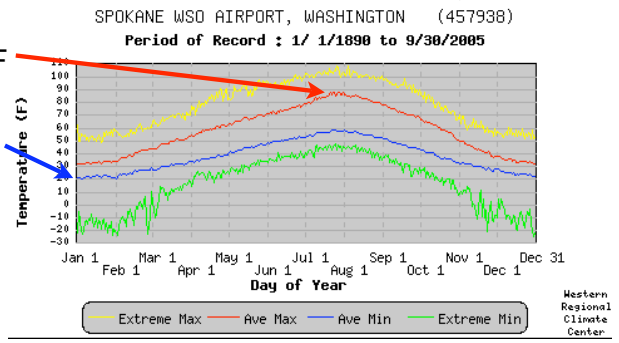



www-k12.atmos.washington.edu/k12/grayskies/Our_climate.cgi?waseat

 © 2006 University of Washington

# Spokane Temperatures

- More extreme annual temperature cycle
- Avg. July high ~90F
- Avg. Jan. low ~30F




www-k12.atmos.washington.edu/k12/grayskies/Our_climate.cgi?waspok

 © 2006 University of Washington

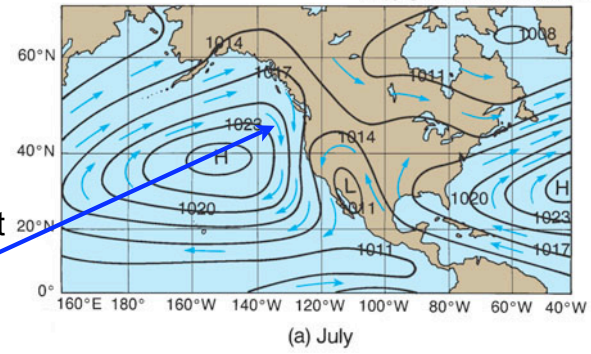
# Puget Sound Climate Control #2 - Pressure

- High & low pressure patterns
  - High pressure:
    - Sunny, warm & dry (summer)
    - Cold & clear (winter)
    - Winds from North & Northwest
  - Low pressure:
    - Cloudy, cool, & damp (all year)
    - Winds from South & Southwest



# N. Pacific Atmospheric Pressure

- Summer pressure pattern
  - High pressure dominant
  - N/NW winds along coast

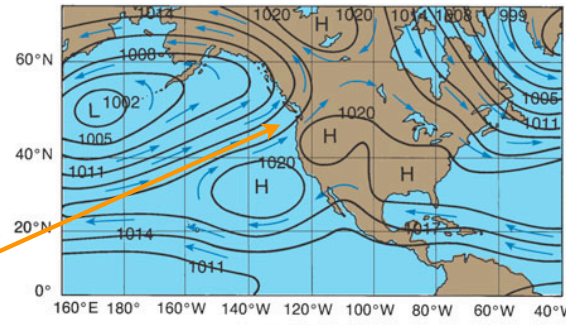


(a) July



# N. Pacific Atmospheric Pressure

- Winter pressure pattern
  - Low pressure dominant
  - S/SW winds along coast

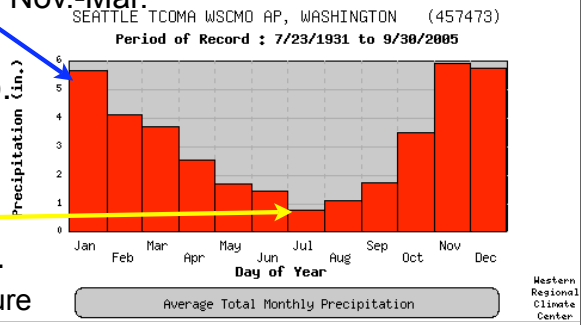


(b) January



# Puget Sound Precipitation

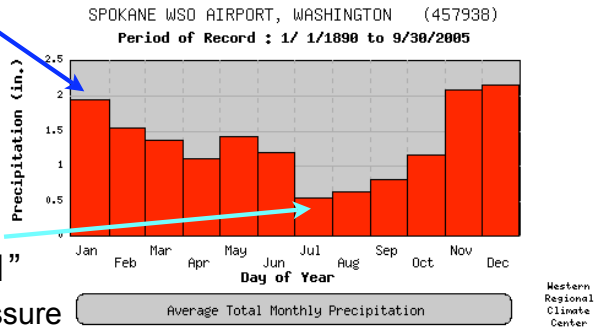
- Strong seasonal precipitation cycle
  - 2/3 of rain Nov.-Mar.
- Winter wet >5"/mo.
  - low pressure
- Summers dry <1"/mo.
  - high pressure




www-k12.atmos.washington.edu/k12/grayskies/Our_climate.cgi?waseat

# Spokane Precipitation

- Less extreme seasonal precipitation cycle
- Winters not so wet <2”
  - higher pressure
- Summers still dry <1”
  - high pressure




www-k12.atmos.washington.edu/k12/grayskies/Our_climate.cgi?waspok



# Puget Sound Climate Control #2 - Pressure

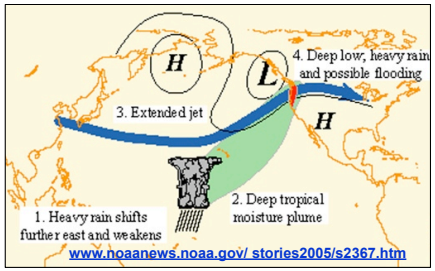
- Pressure patterns determine wind direction
  - Winds travel clockwise or counterclockwise
  - High pressure:
    - Clockwise circulation
    - Winds from North & Northwest
  - Low pressure:
    - Counterclockwise circulation
    - Winds from South & Southwest



# “Pineapple Express”

- Wind & moisture pattern directly to Puget Sound from subtropics
  - Occasional in winter
  - Warm & moist
  - Heavy rainfall
    - 1-2” per day
  - Snow melt
  - Lowland flooding

www.komotv.com/weather/ faq/pineapple_express.asp




www.noaanews.noaa.gov/ stories2005/s2367.htm



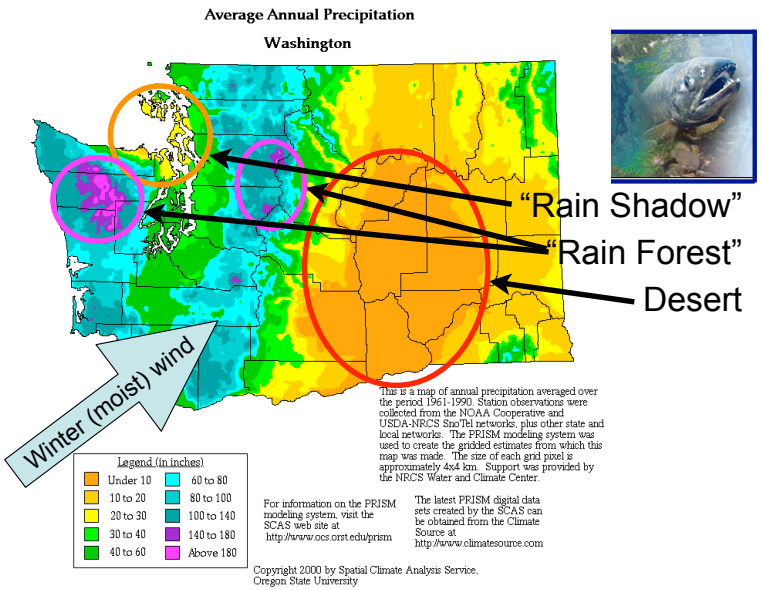
# “Pineapple Express”

- Wind & moisture pattern directly to Puget Sound from subtropics

# Puget Sound Climate Control #3 -Mountains

- Wind lifts & descends passing over mountains
  - Rising air cools
    - Moisture condenses & rain/snow falls
  - Descending air warms
    - Humidity decreases
- Prevailing winds from west
  - "Rain forest" on windward western slopes
  - "Rain shadow" east in lee of Olympics
  - Desert east in lee of Cascades





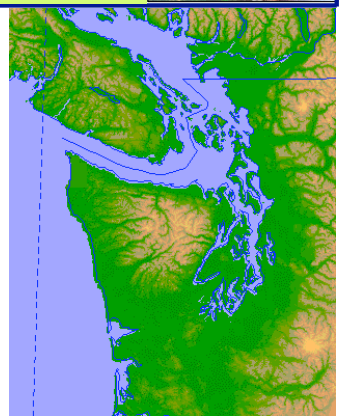

www.ocs.orst.edu/pub/maps/Precipitation/Total/States/WA/wa.gif



# Puget Sound "Convergence Zone"



- Terrain effect
  - Winds from west split around Olympic Mts.
  - Converge around King/Snohomish counties
  - Heavy rain/snow



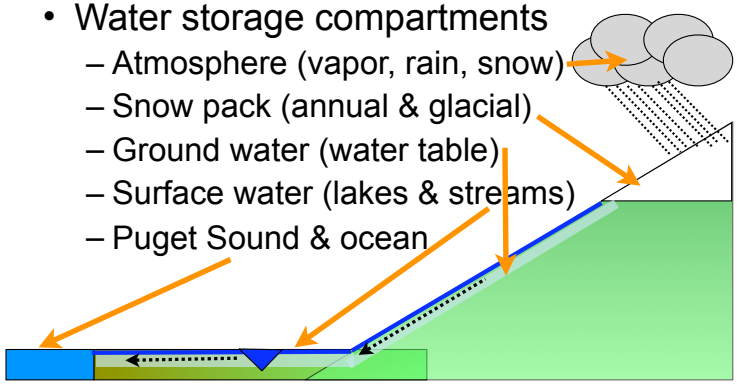
www-k12.atmos.washington.edu/k12/modules/snow/convzone.html



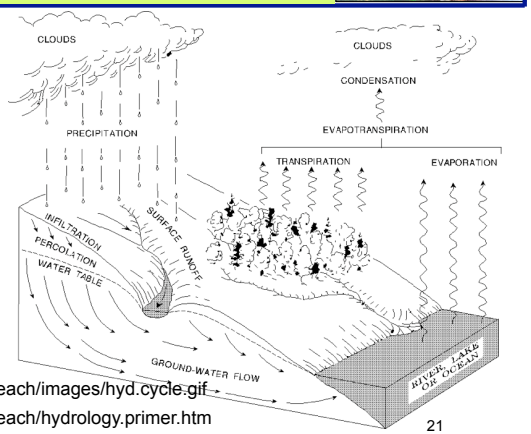
# Puget Sound Hydrologic Cycle



- Water storage compartments
  - Atmosphere (vapor, rain, snow)
  - Snow pack (annual & glacial)
  - Ground water (water table)
  - Surface water (lakes & streams)
  - Puget Sound & ocean



# Puget Sound Hydrologic Cycle




http://wa.water.usgs.gov/outreach/images/hyd.cycle.gif

http://wa.water.usgs.gov/outreach/hydrology.primer.htm



# Surface & Ground Water

- Not just what you can see in rivers, streams & lakes
  - Taken up by plants
    - Some "transpired" back to the atmosphere
  - Penetrates the soil (ground water)
    - Depends on "porosity"
    - Affected by organic & mineral content
    - Helps supply surface water
    - Exceeds supply of surface water
  - Moves downhill below and above ground



# Seasonal Cycle

- Variable from year-to-year
- Most rivers
  - High runoff in winter because of high rainfall
  - Low runoff in summer because of low rainfall
- Glacial-fed rivers
  - Secondary peak in runoff in spring
  - Snowmelt

https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?wria=07

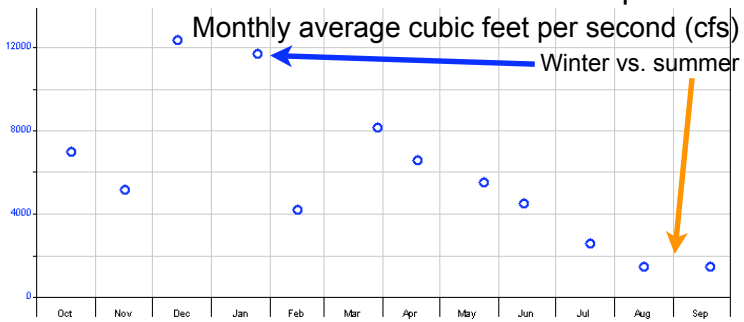


# Seasonal Cycle

Skykomish River at Monroe (WRIA 7)

Water Year 2005 Oct. 2004 - Sept. 2005

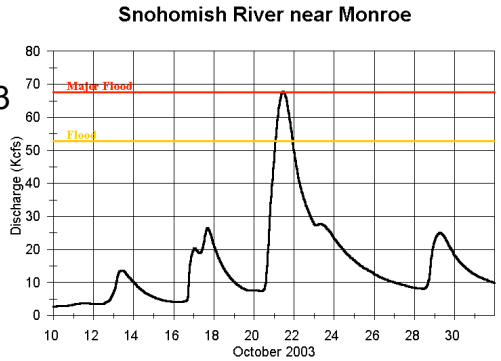
Monthly average cubic feet per second (cfs)




https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?wria=07

# Flooding

- Extreme short-term flow variations
  - Heavy rain events such as Oct. 2003
  - Can have dominant effect on monthly averages




www.nwrfc.noaa.gov/floods/oct_2003/wa_oct2003_flood.html



# Flooding

- Part of the natural landscape
  - Created flat lowland "flood plains along rivers
  - Add nutrients & soil to lowlands
  - Vital to native vegetation




# Flooding & Land Use

- Damaging to roads, buildings, etc.
- Land use aggravates flooding
  - Impermeable surfaces (pavement & buildings)
  - Removal of land cover
    - Logging & road -building
      - Trees absorb & retain water
      - Roots hold soil in place




# "Normal" Erosion

- Water moving downhill carries "land"
  - "...most massive earth-moving force known"
  - Even the purest, clearest runoff
- Several components
  - Chemicals dissolved from rock & soil
    - Inorganic & organic
  - Particles of rock & soil
    - Particle size depends on speed of flow
    - Clay, silt, sand, gravel, boulders

# "Accelerated" Erosion

- Fostered by land alteration
  - Removal of cover
  - Road-building
- Loss of soil and underlying material
  - Gullying & mass wasting

http://history.osu.edu/projects/1912/Conservation/Slaughter2.htm




# Impacts of "Accelerated" Erosion

- Loss of soil & nutrients in watershed
- Deposition of eroded material in streams & lakes
  - Fills in water bodies
    - Skokomish River, Olympic Pen.
  - Alters substrate
    - Covers natural gravel that is optimal for salmon

www.hcn.org/servlets/hcn.Article?article_id=1586