JUNE 2021 HEAT WAVE

Nick Bond
Office of the Washington State Climatologist
Cooperative Institute for Climate, Ocean, and Ecosystem Studies
University of Washington
16 November 2021
Strange Passions!
Haunting Terror!
Guilty Love!

heat wave

starring
ALEX NICOL
HILLARY BROOKE

with SIDNEY JAMES · SUSAN STEPHEN · PAUL CARPENTER

Produced by Anthony Hinds · Directed by Ken Hughes
Screenplay by Ken Hughes · Based on his novel "High Wray"
A HAMMER PRODUCTION · A LIPPERT PICTURES PRESENTATION
The ‘heat dome’

Occurs when the atmosphere traps hot ocean air like a lid or cap.

1. In summer, the jet stream (which moves the air) shifts northward.

2. Hot and stagnant air expands upwards.

3. Strong and high-pressure atmospheric conditions combine with influences from La Niña act like a dome or cap.

4. In a process known as convection, hot air attempts to escape but high pressure pushes it back down.

5. Under the dome, the air sinks and compresses, releasing more heat.

6. As winds move the hot air east, the jet stream traps the air where it sinks, resulting in heat waves.

Source: NOAA/US/Canada medias, experts

Temperature forecasts (darker color = hotter)

Heat dome also blocks out clouds, which provide some relief from the sun’s heat.

The hotter the temperature is, the stronger the heat dome gets, and vice versa.
Historical Analysis of Pacific Northwest Heat Waves


- Nighttime events increasing in the region; no trend in daytime
- Similarities in synoptic pattern for both (e.g., ridge at 500 mb)
- Some differences: ridge more important for getting days hot while higher precipitable water accounts for hot nights
Composite of Past Events

Bumbaco et al. (2013)

**500 mb Height Anomalies**

**850 mb Temperature Anomalies**
Departure from Normal Average Minimum Temperature (°F)
6/21/2021 - 7/20/2021

Generated 7/21/2021 at HPRCC using provisional data.
Was an all-time high temperature record set in WA state this summer?
Considerably higher dewpoints in irrigated regions of eastern WA, with implications for heat stress on humans.
Human Health Impacts

- OR: 116 fatalities (Oregonlive.com; 7 July)

- WA: 138 fatalities (WA Dept. of Health/Marnie Boardman)

- BC: 526! Fatalities (Provincial Coroner’s Service by CBC; 1 Nov)

- District 10 (AK, ID, OR, WA): 2,779 Heat-related emergency department visits during 25-30 June (CDC; 16 July). This number of visits is 69 times higher than the same period in 2019, which lacked a heat advisory.
NW Raspberry Harvest down 30% due to Heat Wave

Smith, Buck (ECY) <JSMI461@ecy.wa.gov>
to Jeff, Jaclyn, Jon, Megan, Sheryl, me, Karin, Scott, Brent, Robin, Marilyn, Amy, Nicholas, Chris, Tyler, Benjamin, Kasey

FYI – Photos of red raspberry and blueberry heat damage.
• With this assumption and combining the results from the analysis of climate models and weather observations, an event, defined as daily maximum temperatures (TXx) in the heatwave region, as rare as 1 in a 1000 years would have been at least 150 times rarer without human-induced climate change.

• Also, this heatwave was about 2°C hotter than it would have been if it had occurred at the beginning of the industrial revolution (when global mean temperatures were 1.2°C cooler than today).

• Looking into the future, in a world with 2°C of global warming (0.8°C warmer than today which at current emission levels would be reached as early as the 2040s), this event would have been another degree hotter. An event like this – currently estimated to occur only once every 1000 years, would occur roughly every 5 to 10 years in that future world with 2°C of global warming.
Year Range
1895 - 2021

Variable Selection
Maximum Temperature

Time Frame
Summer (JJA)

Trend Range
Per Decade

Trend
- 0 +

Significant (S)
Not Significant (NS)
Insufficient Data (I)

Add to Graph
None
Average
Statewide Average
Trend Line

Trend Data (°F Per Decade)

ID
+ 0.12

MT
+ 0.2

OR
+ 0.23

WA
+ 0.09

Summer (JJA) Maximum Temperature 1895-2020

WA Statewide

Station Data Source: NOAA’s U.S. Historical Climatology Network version 2.5.5.20210712

Statewide Data Source: NOAA’s US Climate Division Dataset (nClimDiv)

https://climate.washington.edu/climate-data/trendanalysisapp/
Number of Hot Days (Diablo Dam 90+ F, Spokane 95+ F)
Climate Change Time of Emergence for the Pacific Northwest

When is the earliest change expected, for temperature metrics?
Number of daytime heat waves (3 consecutive days with max temperature > historical 99th%ile),
Northwest Precipitation
June–July

1901–2000 Mean: 2.45 in
Soil Moisture Percentile
2021/07/01
from Miralles et al. (NYAS, 2018)
Physics of Heat Waves (Zeppetello & Battisti (2020))

• Daily temperatures are related to insolation and temperature advection
• Longer-term (e.g., monthly) fluctuations in temperature are related to extended periods of anomalous precipitation
• “Extremely hot” days concentrated during the hottest months on record

• How well do precipitation-induced monthly temperature fluctuations account for short-term heat waves in WA & OR?
Final Remarks

• By one measure, the heat wave of 2021 was on the order of a 1000-year event for the Pacific NW, and based on accepted methods involving extreme events, it was made much more likely by climate change.

• Mean summer temperatures (especially minimums) are rising

• Summer precipitation has decreased over the last few decades

• If early summer precipitation continues to decline we will likely experience a higher frequency of extreme heat waves
Questions?

• OWSC website: [www.climate.washington.edu](http://www.climate.washington.edu)
• email: [climate@atmos.washington.edu](mailto:climate@atmos.washington.edu)
• Newsletter: [www.climate.washington.edu/newsletter](http://www.climate.washington.edu/newsletter)

• phone: 206-543-3145 (Karin)
• phone: 206-525-7363 (Nick)
Yearly Number of Days with Extreme Minimum Temperatures
Olympia Airport

Number of Days with Extreme Minimums

#<20F

#>58F

Yearly Number of Days with Extreme Minimum Temperatures

Ritzville

Number of Days with Extreme Minimums

- #<15F
- #>60F

[Graph showing the number of days with extreme minimum temperatures for Ritzville from 1910 to 2010.]