Western North America Extreme Heat

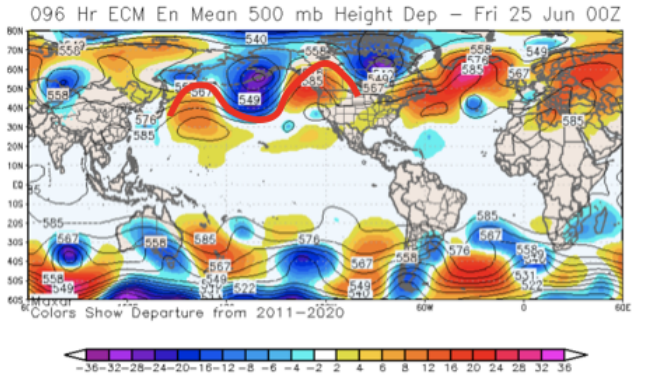
Over the days of 25 June - 29 June 2021, there was extreme heat in western North America

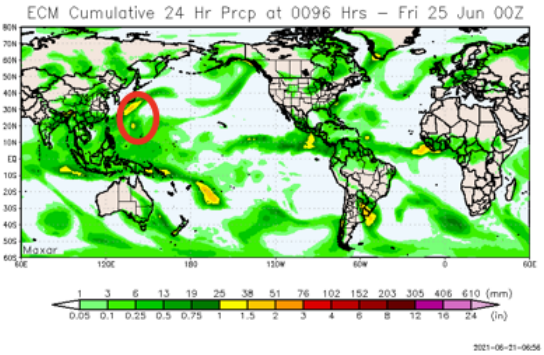
The US states of Washington and Oregon as well as the Canadian Province of British Columbia achieved all time record maximum temperatures - in some cases more than 8C higher than any previously recorded temperature at the site. An unofficial list of all the new all time record maximum temperatures in this event, courtesy of the "coolwx" website run by Dr. Robert Hart of Florida State University, is shown later on this page.

Below is a commentary on this event. Many of the charts, below, come from a US list-serve.

COMMENTS ON LARGE SCALE FEATURES

This first image, provided by Dr Paul Roundy at the University of Albany, shows what the early predictors were for this event.

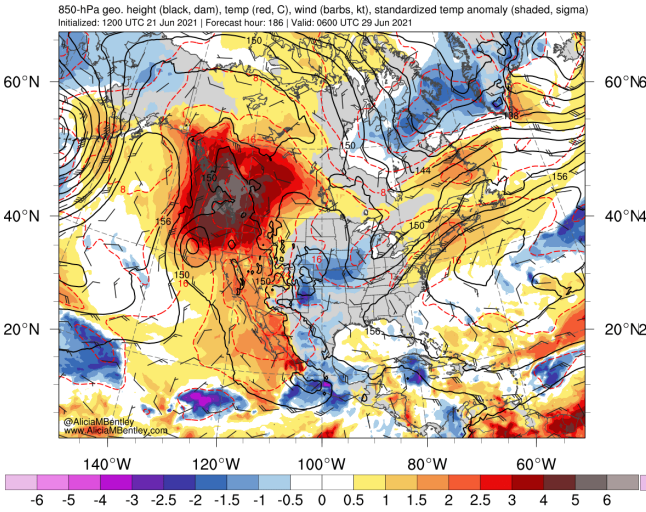


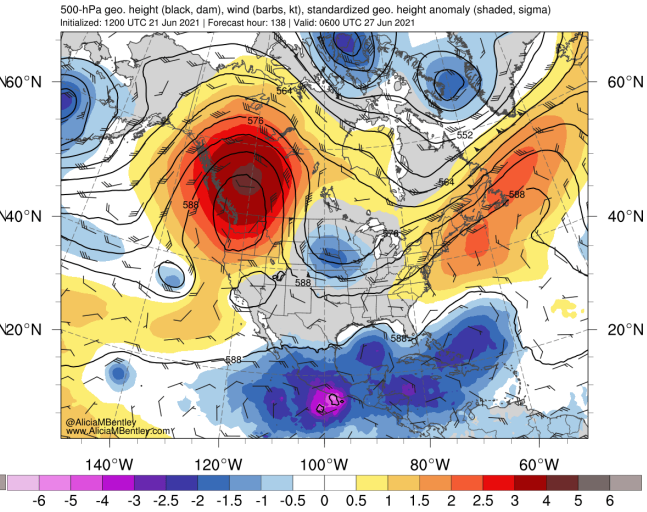


Red ellipse highlights the region of forcing by heavy rainfall. The models show the wave train amplifying in response to the forcing.

Dr Roundy noted: "Heavy precip over the West Pacific, associated with tropical depression 6 and along a front near and east of Japan appear to amplify a North Pacific wave train that favors the NW US/Western Canadian ridge at the time."

Other models shared this early prediction of the event. Dr Cliff Mass, at the University of Washington, shared these plots from Dr Alicia Bentley (NOAA) web site. They show the GFS ensemble standardized anomalies, for which height anomalies were in excess of 3 standard deviations above normal for the location in question:

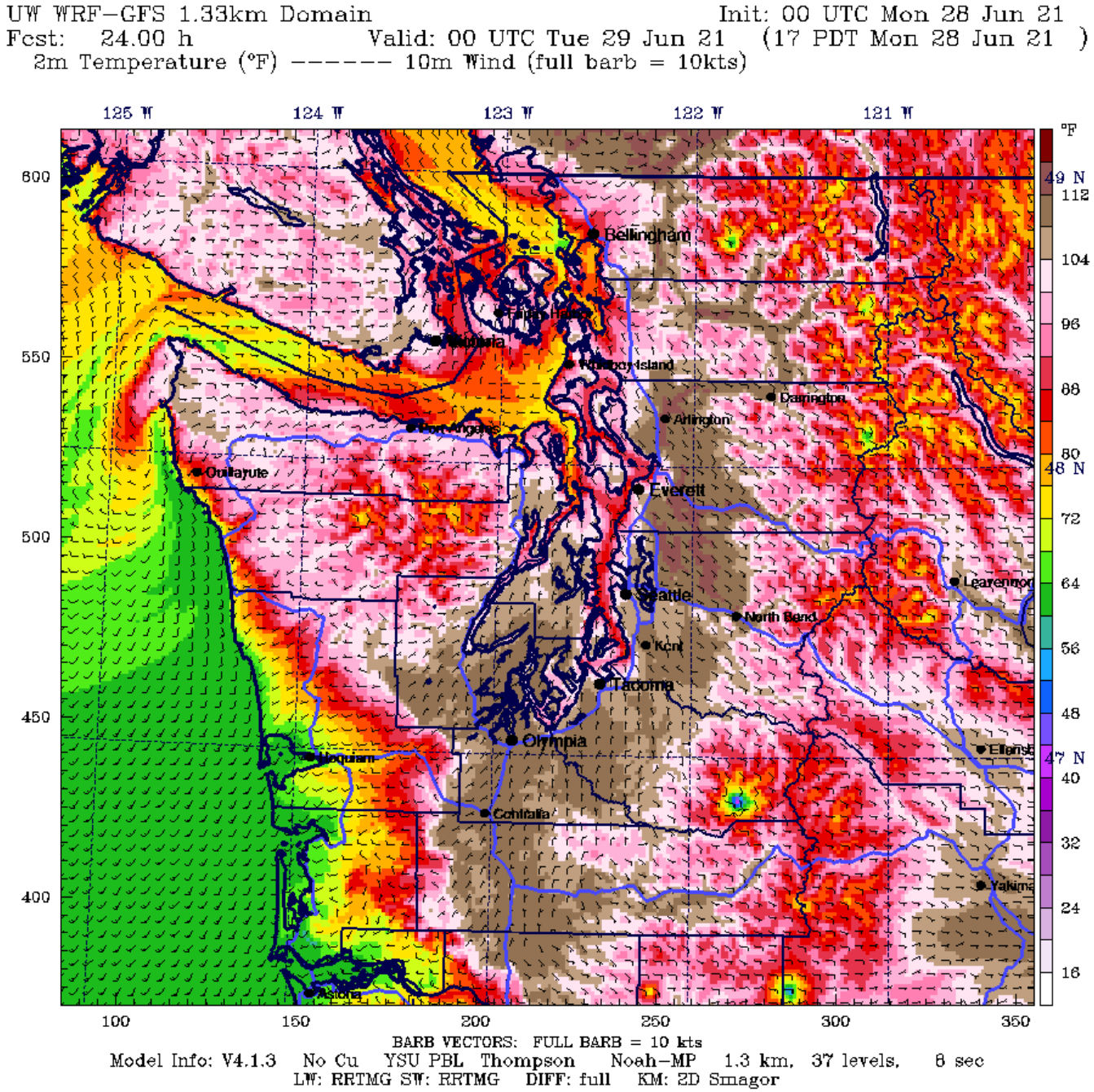




Some discussion that took place prior to the event. From Paul Wolyn:
"The GFS and EC have southeast flow at 850mb over the OR and WA. Could the southeast flow advect the heating from the elevated mixed layer over central Oregon into the PDX and maybe the SEA area? Much of central Oregon is at 4000 to 5000 feet MSL. I wonder if this could be contributing to the extreme temperatures in the model runs. It could be the "perfect" combination of many factors leading to the extreme heat."

COMMENTS ON LOCAL FEATURES

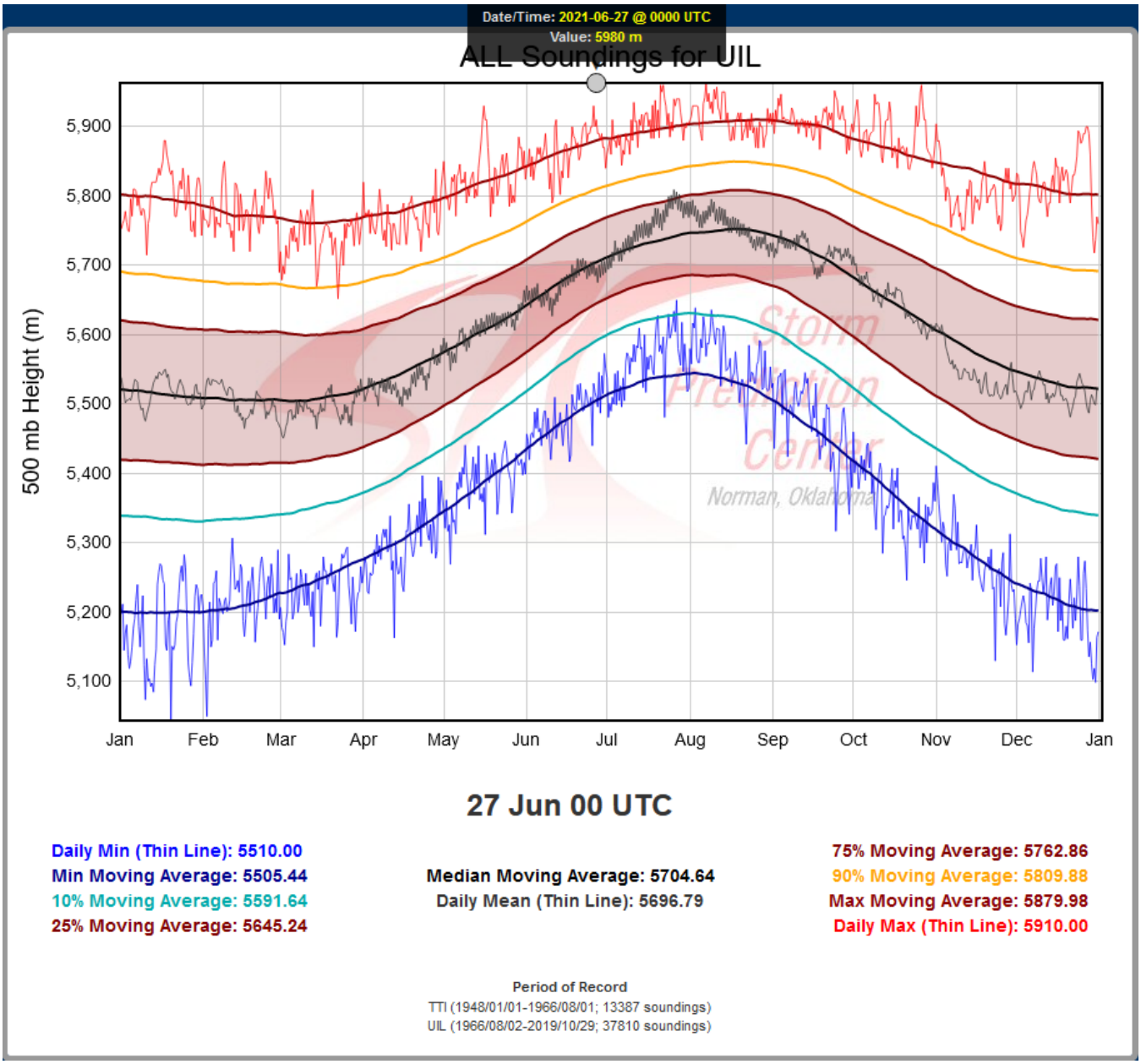
Higher resolution models, such as the WRF run at the University of Washington, added details to this picture:



This extreme heat event was predicted well in advance. At that time, as what was being predicted was something that had not been seen before, there was plenty of conversation about if this was indeed real - or some sort of model error. It did turn out to be true.

COMMENTS ON OBSERVED WEATHER

First - the observed 500mb height from Quilayutte, WA, USA, and the historical soundings for that site:



27 Jun 00 UTC

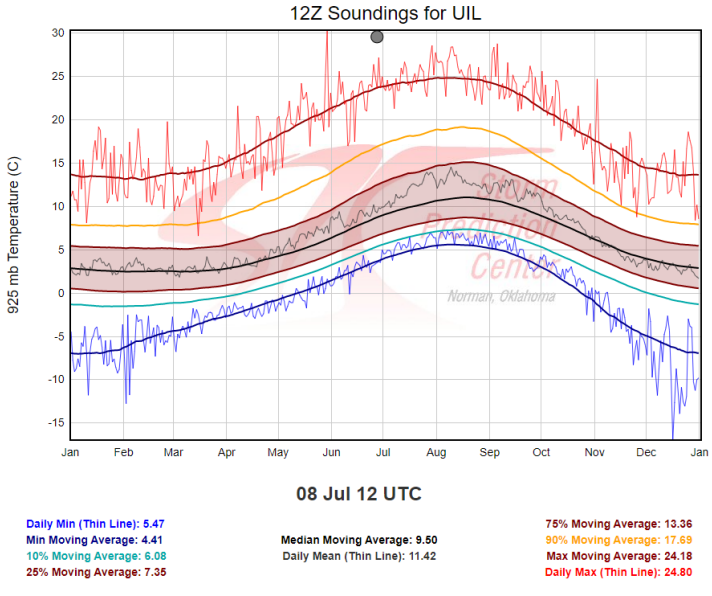
Daily Min (Thin Line): 5510.00
Min Moving Average: 5505.44
10% Moving Average: 5591.64
25% Moving Average: 5645.24

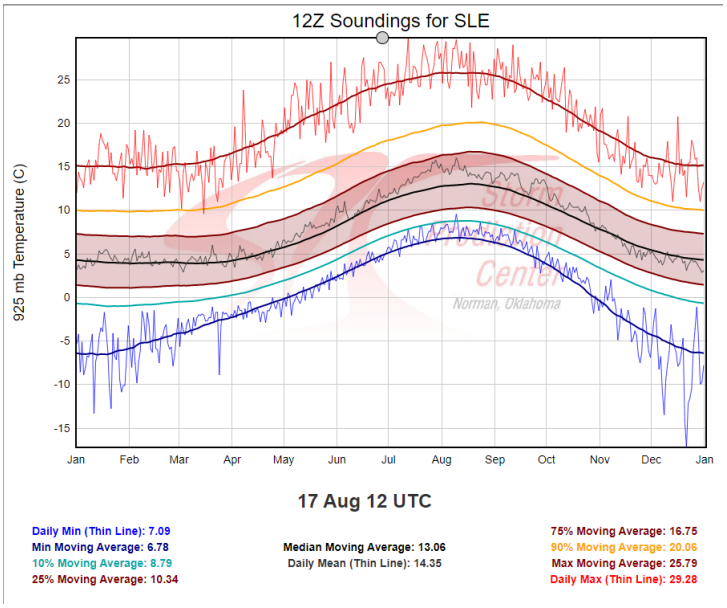
Median Moving Average: 5704.64
Daily Mean (Thin Line): 5696.79

75% Moving Average: 5762.86
90% Moving Average: 5809.88
Max Moving Average: 5879.98
Daily Max (Thin Line): 5910.00

Period of Record
TTI (1948/01/01-1966/08/01; 13387 soundings)
UIL (1966/08/02-2019/10/29; 37810 soundings)

In addition, 925mb temperatures were close to, if not, greatest ever observed, both at Quillayute, WA, and Salem, OR





In British Columbia, Canada, records were also set. From Greg West: "The headliner is Lytton, BC, ...in the lee of the Coast Range, extremely dry climate, often the hottest location in BC, and Canada. Our old national record was 45.0C set in Saskatchewan in 1937. Lytton's old all time record was 44.4 in 1941. On Sunday they hit 46.6. Then on Monday they hit 47.9. Tuesday they peaked at 49.6 (that can be rounded to 50C?). I'm really completely dumbfounded. Breaking the old all time record by more than 5C, a month from the hottest time of the year, and 3 days in a row."

An unofficial list of all the new all time record maximum temperatures in this event, courtesy of the "coolwx" website run by Dr. Robert Hart of Florida State University. Some of the new all time record temperatures are more than 8C greater than the previously highest temperature ever recorded at the sites.

LEGEND OF UNOFFICIAL RECORDS:

	Daily Close	Daily Tied	Daily Broken	Monthly Tied/Broken	All-time Tied/Broken
HIGH RECORD	##.#	##.#	##.#	##.#	##.#
LOW RECORD	##.#	##.#	##.#	##.#	##.#

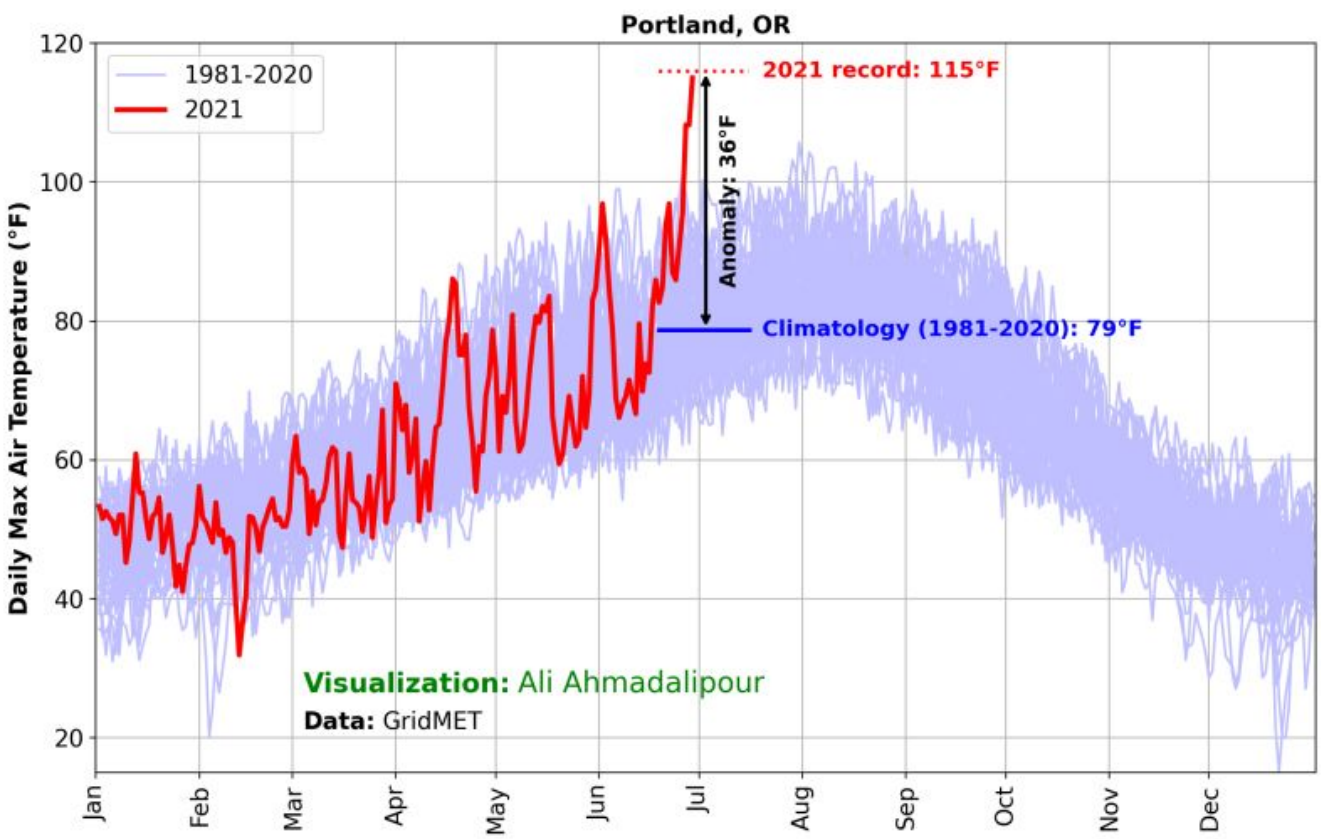
Table Units: [Fahrenheit | Celsius]

ID	City	Country	Current Temp & Trend (°F)	Unofficial Daily / Monthly / Alltime Record (°F)	Margin of Unofficial Daily Record (°F)	Database Length (years)	ID
KRNT	Renton, WA	United States	108.0 ▼	90.9 (1995) 95.0 (2017) 105.1 (2009)	+17.1	35	KRNT
KTTD	Portland, OR	United States	115.0	98.1 (2003) 102.9 (1992) 108.0 (1981)	+16.9	54	KTTD
CYXX	Abbotsford, B. C.	Canada	107.6	91.4 (2008) 94.5 (1982) 100.4 (2009)	+16.2	44	CYXX
CWLM	Victoria	Canada	101.3 ▼	85.3 (2008) 90.1 (2004) 95.5 (2004)	+16.0	40	CWLM
KSHN	Shelton, WA	United States	109.0	93.9 (2008) 97.0 (2017) 104.0 (2009)	+15.1	45	KSHN
KOLM	Olympia, WA	United States	109.0 ▲	93.9 (2008) 98.1 (2017) 104.0 (1981)	+15.1	73	KOLM
CYYJ	Victoria Int. Airport, B. C.	Canada	102.2	87.8 (1995) 92.3 (2003) 97.3 (2007)	+14.4	43	CYYJ
CYQZ	Quesnel Airport	Canada	105.8 ▲	91.4 (1987) 93.7 (2006) 97.7 (2007)	+14.4	44	CYQZ
CYQU	Grande Prairie, Alta.	Canada	100.4 ▲	86.0 (2008) 90.1 (2006) 96.1 (2006)	+14.4	45	CYQU
KGRF	Fort Lewis, WA	United States	109.6	95.4 (2008) 96.8 (2017) 103.1 (2009)	+14.2	58	KGRF
KPWT	Bremerton National, WA	United States	108.0 ▼	93.9 (1987) 96.1 (2017) 104.0 (2009)	+14.1	48	KPWT
KPDX	Portland, OR	United States	114.1	100.0 (2008) 102.4 (1942) 107.2 (1942)	+14.1	82	KPDX
KTCM	Tacoma / McChord AFB, WA	United States	109.0	95.0 (1951) 99.0 (1955) 104.4 (2009)	+14.0	81	KTCM
KUAO	Aurora, OR	United States	114.1 ▲	100.9 (2008) 102.0 (2008) 108.0 (2009)	+13.2	39	KUAO
KSEA	Seattle, WA	United States	105.1 ▲	92.3 (1951) 96.4 (1955) 102.9 (2009)	+12.8	73	KSEA
CYZY	Mackenzie, B. C.	Canada	98.6 ▼	86.0 (2015) 89.6 (2018) 95.0 (2007)	+12.6	44	CYZY
CYXS	Prince George, B. C.	Canada	100.4 ▲	87.8 (1987) 93.0 (1958) 96.8 (1983)	+12.6	54	CYXS
CYCQ	Chetwynd Airport	Canada	98.6	86.0 (2015) 87.8 (2006) 95.0 (2006)	+12.6	37	CYCQ
CYCD	Nanaimo Airport	Canada	104.0	91.4 (1987) 93.2 (1987) 98.6 (2009)	+12.6	44	CYCD
CYAZ	Tofino Airport	Canada	95.0	82.4 (1995) 87.8 (2003) 91.0 (1981)	+12.6	56	CYAZ
KHIO	Portland, OR	United States	113.0 ▲	100.9 (2008) 102.0 (2006) 108.0 (1988)	+12.1	43	KHIO
CWSK	Squamish Airport, B. C	Canada	105.4 ▼	93.7 (2015) 96.8 (2009) 100.8 (2017)	+11.7	35	CWSK
CYWL	Williams Lake, B. C.	Canada	100.4	88.9 (2015) 92.5 (2017) 97.9 (1988)	+11.5	44	CYWL

KLMT	Klamath Falls, OR	United States	102.9	91.9 (2015) 102.9 (1985) 102.9 (1985)	+11.0	61	KLMT
CYHE	Hope, B. C.	Canada	104.0	93.0 (2015) 94.1 (2003) 102.2 (1981)	+11.0	44	CYHE
CYXJ	Fort St John, B. C.	Canada	96.8	86.0 (2015) 88.7 (2018) 93.2 (1981)	+10.8	46	CYXJ
CWLY	Lytton, B. C.	Canada	114.8	104.0 (2008) 104.0 (2008) 107.6 (1981)	+10.8	47	CWLY
CYKA	Kamloops, B. C.	Canada	113.0 ▲	102.4 (2015) 102.4 (2008) 105.4 (2018)	+10.6	43	CYKA
CYQQ	Comox, B. C.	Canada	98.6 ▲	88.2 (2015) 93.2 (2018) 95.4 (2009)	+10.4	54	CYQQ
CYYD	Smithers, B. C.	Canada	96.8 ▲	86.5 (2015) 93.6 (2004) 96.8 (2009)	+10.3	46	CYYD
CYHI	Holman Island Airport	Canada	84.2	73.9 (1982) 78.8 (2012) 82.0 (1976)	+10.3	63	CYHI
KDLS	The Dalles, OR	United States	117.0 ▼	107.1 (2008) 108.0 (2015) 111.6 (1998)	+9.9	66	KDLS
KBFI	Seattle, WA	United States	102.9	93.4 (1951) 99.3 (1955) 105.1 (2009)	+9.5	69	KBFI
KBLI	Bellingham, WA	United States	97.0 ▼	88.0 (1995) 91.0 (1955) 96.1 (2009)	+9.0	66	KBLI
CYZH	Slave Lake, Alta	Canada	95.0 ▲	86.0 (1979) 89.2 (2002) 94.8 (1998)	+9.0	47	CYZH
CYYF	Penticton, B. C.	Canada	107.6	98.6 (2008) 100.0 (2008) 104.0 (1979)	+9.0	43	CYYF
CYQH	Watson Lake, Y. T.	Canada	91.4 ▲	82.4 (1998) 91.4 (2004) 93.6 (1983)	+9.0	51	CYQH
CYET	Edson, Alta.	Canada	95.0 ▼	86.0 (2015) 88.9 (2002) 92.5 (2006)	+9.0	44	CYET
CYBL	Campbell River Airport	Canada	100.4	91.4 (2015) 93.2 (2018) 96.8 (2009)	+9.0	44	CYBL
CWME	Cathedral Point	Canada	91.4 ▲	82.4 (2015) 89.6 (2004) 89.8 (2017)	+9.0	36	CWME
CWPZ	Burns Lake CS , B. C.	Canada	95.9 ▼	87.3 (2015) 96.1 (2004) 96.1 (2004)	+8.6	42	CWPZ
KTIW	Tacoma, WA	United States	104.0	95.9 (1995) 95.9 (1995) 102.9 (2009)	+8.0	38	KTIW
KRDM	Redmond, OR	United States	108.0 ▼	100.0 (2008) 102.0 (2017) 106.0 (2008)	+8.0	77	KRDM
KAAT	Alturas, CA	United States	102.9	95.0 (2016) 123.8 (1984) 129.2 (1984)	+7.9	38	KAAT
CYXT	Terrace, B. C.	Canada	95.0	87.6 (2015) 97.7 (2004) 99.1 (2009)	+7.4	43	CYXT
KLGD	La Grande, OR	United States	104.0 ▲	96.8 (2003) 98.6 (2003) 108.0 (2018)	+7.2	37	KLGD
CYZU	Whitecourt, Alta.	Canada	93.2	86.0 (2015) 89.2 (1992) 94.5 (2006)	+7.2	42	CYZU
CYZT	Port Hardy, B. C.	Canada	84.2 ▼	77.0 (2013) 86.0 (2004) 92.1 (1983)	+7.2	46	CYZT
CYPE	Peace River, Alta.	Canada	96.8	89.6 (2015) 91.4 (1982) 95.0 (1981)	+7.2	43	CYPE
CWSW	Sparwood / Elk Valley	Canada	95.0	87.8 (2015) 95.0 (2015) 98.6 (2018)	+7.2	40	CWSW
CYVR	Vancouver Intl., BC	Canada	89.6 ▲	82.4 (1995) 86.4 (2002) 93.9 (2009)	+7.1	46	CYVR
KCLM	Port Angeles, WA	United States	97.0	90.0 (1987) 91.0 (2015) 93.9 (2016)	+7.0	40	KCLM
CWZG	Banff	Canada	96.4	89.4 (2015) 91.4 (2003) 95.0 (2005)	+7.0	44	CWZG
KSIY	Montague, CA	United States	105.1 ▲	99.0 (2015) 109.9 (1992) 109.9 (1992)	+6.0	62	KSIY

KPAE	Everett, WA	United States	100.0 ▲	93.9 (1995) 97.0 (1995) 100.0 (2020)	+6.0	73	KPAE
CWEZ	Saturna Island	Canada	88.5 ▲	82.4 (2003) 96.8 (1985) 96.8 (1985)	+6.0	38	CWEZ
CWLB	Lac La Biche, Alta.	Canada	90.1	84.2 (2008) 93.2 (2002) 94.5 (1990)	+5.8	41	CWLB
CYYC	Calgary International, Alta.	Canada	93.2	87.4 (2015) 92.3 (2002) 97.7 (2018)	+5.8	53	CYYC
CYED	Edmonton Namao Alta.	Canada	93.2 ▼	87.6 (2015) 93.4 (2002) 96.8 (1998)	+5.6	57	CYED
CYCG	Castlegar Airport	Canada	105.8	100.4 (2008) 102.2 (2015) 104.0 (2018)	+5.3	44	CYCG
CYZP	Sandspit, B. C.	Canada	77.0 ▲	72.3 (1987) 78.6 (1987) 82.4 (1996)	+4.7	52	CYZP
CWJV	Vernon, B. C.	Canada	107.2 ▲	102.7 (2015) 102.7 (2015) 104.0 (1994)	+4.5	43	CWJV
KPDT	Pendleton, OR	United States	113.0 ▲	109.0 (2015) 109.0 (2015) 111.9 (1961)	+4.0	83	KPDT
KSMP	Stampede Pass, WA	United States	93.9 ▼	90.0 (2008) 90.0 (2008) 102.0 (2004)	+3.9	72	KSMP
CYCP	Blue River, B. C.	Canada	100.4 ▼	96.6 (2015) 96.8 (2015) 98.6 (1979)	+3.8	44	CYCP
CWRM	Rocky House	Canada	89.4	85.6 (2008) 104.0 (1983) 104.0 (1983)	+3.8	44	CWRM
KTRK	Truckee-Tahoe, CA	United States	91.4	87.8 (2013) 95.0 (1973) 97.0 (1973)	+3.6	48	KTRK

Many all time records were set. Additionally, the temperatures were substantially warmer than what is normal for these locations. Below shows the high temperature in Portland, Oregon, being 36 degrees F (20C) above normal.



SOCIETAL IMPACTS

WA, OR, and BC are all usually cool and cloudy. Houses are built with large, south facing windows, to maximize sunlight into houses. Less than half of houses have air conditioning. In short: WA, OR, and BC houses are all built to the past climatology of the area, and the heat they got was very far from that climatology. One approach taken was to board up windows. In contrast to an incoming tropical cyclone, in which the boarding up is to prevent glass from breaking, here, it was to block out the sun and try to keep in the cool air. Dale Durran, University of Washington: "One thing I did to prepare for the heat was buy some 4'x8' sheets of 1/4" foam core and use them to block the direct sunlight in several windows. Below is a photo of one row of such blocked windows. I'm going to save these for really cold days too — they have to have an R value above most window coverings and work particularly well on the sloped glass."

In addition, other bits of infrastructure were not up to the challenge. From Ronald Miller, National Weather Service Spokane, WA:
"The utility company in Spokane has instituted 'rolling blackouts' for the past two days, affecting about 24,000 customers for 3-4 hours during the hottest part of the day. The news article explained that the outages were not due to lack of supply (Washington dams generate a LOT of electricity, some of which is routinely shipped south), but rather the local city grid. The substations were overheating due to demand and had to be taken offline."
The news article in question: https://www.spokesman.com/stories/2021/jun/28/avista-asks-customers-to-conserve-energy-as-heat-s/

SUMMARY THOUGHTS

There is much more to be added to this page, but these things are of note:

#1 - There were numerous all time high temperature records set.

#2 - The combination of retrograding ridge in the western United States and the Rossby Wave train coming from the west Pacific both worked to make this event possible, and both were well predicted

#3 - Higher resolution models gave even greater details on the location of the extreme heat.

#4 - This was a high impact event. Temperatures were 20-25C above normal, in summer. The locations impacted were not built for this heat. As the climate of the earth changes, more events like this - where the weather is something never before experienced, and not something a community is prepared for - will likely happen.

ECMWF Edit

This event has also been added to the Severe Event Catalogue for further analysis: 202106 - Heatwave - N.America