High-Latitude Anticyclonic Rossby Wave Breaking and High-Latitude Heat Waves over Parts of the Northern Hemisphere during Late June 2021

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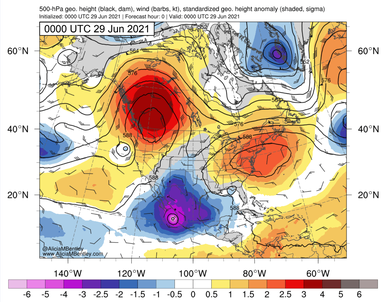
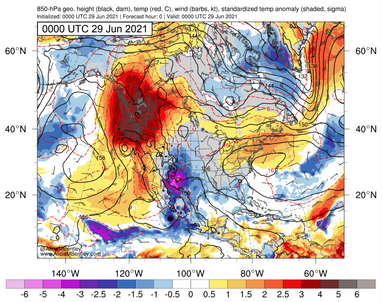
1) Purpose

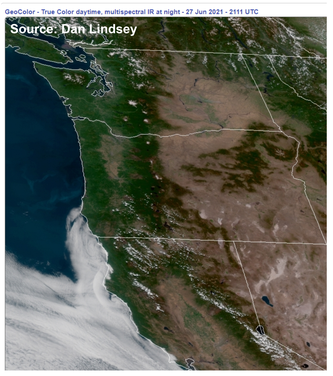
- Illustrate upstream flow conditions over the North Pacific (NPAC) that contributed to the Pacific Northwest heat wave of late June 2021.
- Document the evolution of the large-scale flow pattern over the eastern NPAC and western North America during the heat wave.
- Link the Pacific Northwest heat wave to a subsequent high-latitude Eurasian heat wave.

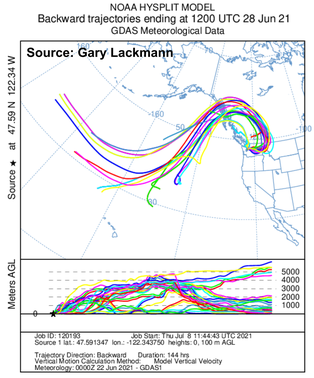
2) Overview

- Illustrate the Pacific Northwest heat wave via selected standardized anomaly maps valid 0000 UTC 29 June 2021 (source: Alicia Bentley).

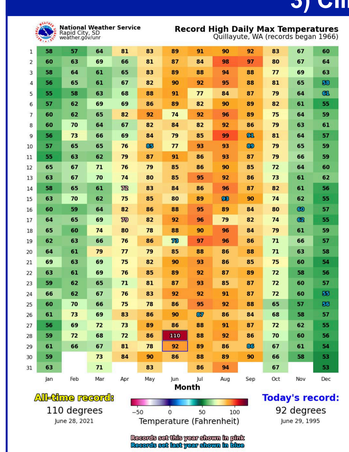






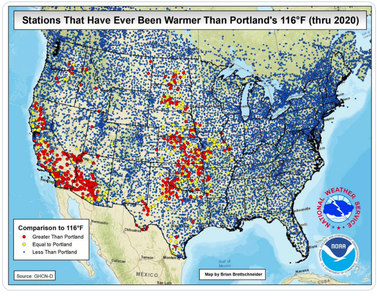


3) Climate Context



- Unprecedented heat in the Pacific Northwest: Quillayute, WA, reached 110°F (43.3°C) on 28 June. Previous monthly record was 92°F (33.3°C).

Now that Portland has reached 116°F, here's an updated map showing which of the stations in the U.S. climate record have ever recorded 116°F or greater (thru 2020).



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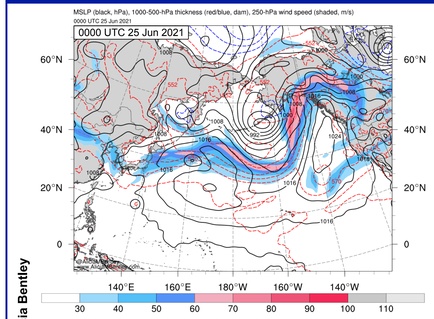
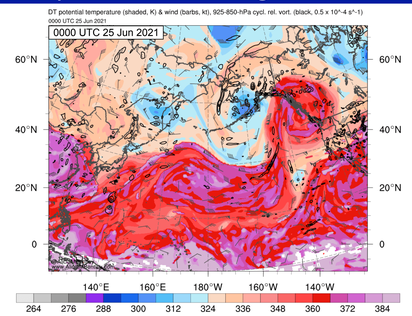
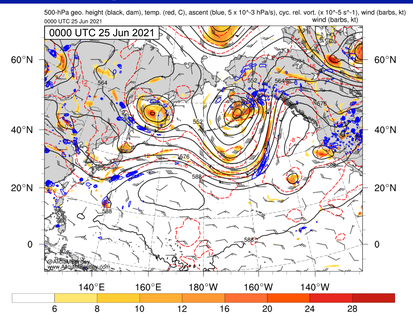
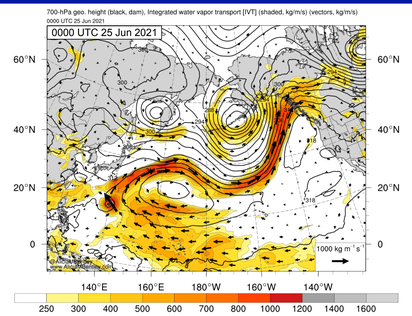
4) North Pacific Large-Scale Flow Pattern Perspective: 25–27 June 2021

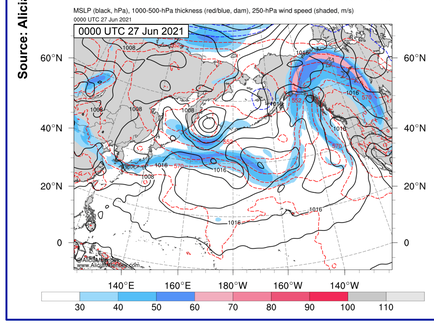
Source: Alicia Bentley

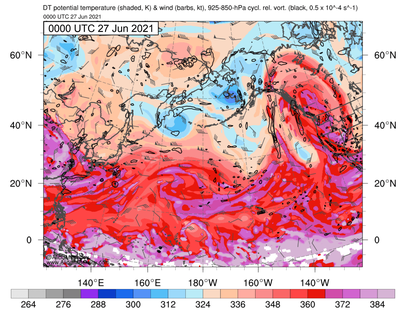


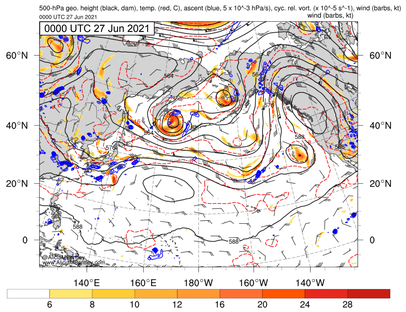


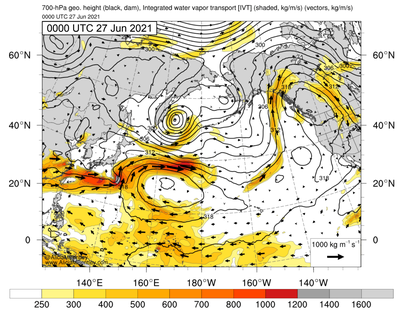




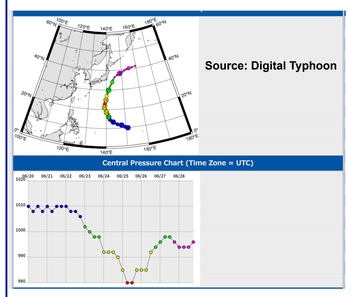


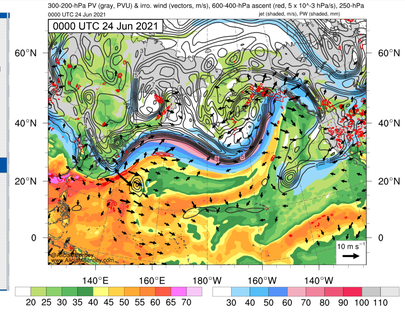






5) Did TC Champi Contribute to Downstream Baroclinic Development Prior to the Pacific Northwest Heat Wave?





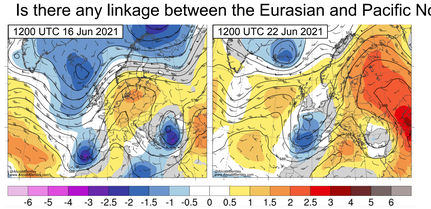
- Little evidence for significant negative PV advection by the irrotational wind in the upper troposphere downstream of TC Champi.
- Better evidence that tropical moisture advection contributed to deep cyclogenesis in the Gulf of Alaska and downstream ridge amplification.

6) Conclusions

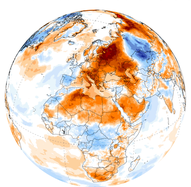
- Downstream baroclinic development (DBD) occurs across the NPAC during late June 2021.
- Strong cyclogenesis in the Gulf of Alaska fueled by tropical moisture induces strong ridge amplification over western Canada.
- Pacific Northwest experiences a deep ESE (offshore) flow equatorward of the western Canada ridge.
- Combination of a strong ridge to the north and an offshore trough drives a hot and dry downslope offshore flow.
- An extremely hot, subsidence-warmed air mass (30°C at 850 hPa) supports widespread record-breaking temperatures.

7) Postscript

- Is there any linkage between the Eurasian and Pacific Northwest heat waves of late June 2021?

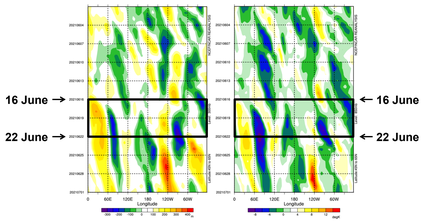


Standardized 500-hPa geopotential height anomaly (σ; shaded), and 500-hPa geopotential height (dam; black) and wind (kt; flags and barbs). Source: Alicia Bentley.

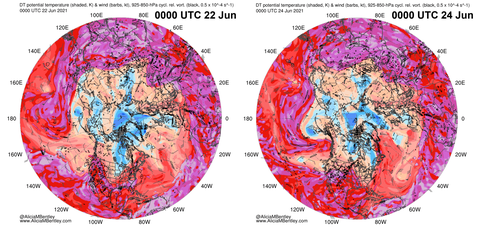


CFSR 2-m temperature anomalies on 23 June 2021 (source: Climate Reanalyzer).

Surface temperature anomaly (°C) during 18–25 June 2021 (source: NASA Observatory).



Hovmöller diagrams (45–65°N) of (left) anomalous 300-hPa geopotential height (m) and (right) anomalous 850-hPa temperature (K) during 1 June–1 July 2021.



8) Postscript Conclusions

- DBD occurs across the NH during the latter half of June 2021.
- Whether or not TC Champi's interaction with the NPAC jet stream induces further DBD is still an open question.
- Hovmöller analyses are inconclusive as to whether the June 2021 Eurasian and Pacific Northwest heat waves are linked.
- NH dynamic tropopause analyses suggest, but *do not* prove, that the Eurasian and Pacific Northwest heat waves may be linked.