

Introduction

The Pacific Northwest region of the United States and Canada recently experienced two exceptionally extreme and devastating weather events within a year of each other.

- 1) September 2020: An high wind event rapidly spread several large wildfires across Washington, Oregon, and California.
- 2) June 2021: A record shattering deadly heat wave affected Oregon, Washington, British Columbia, and Alberta.

September 2020

- On September 7, 2020 an extreme Rossby Wave Breaking event occurred over the western US, forming an omega blocking pattern.
- Daily record high 500 hPa geopotential heights occurred one day prior to daily record low heights.
- Extremely strong and dry easterly winds over Washington and Oregon resulted in the rapid spread of several large wildfires and urban fires.
- Blocking ridge following event resulted in a prolonged period of air stagnation and hazardous smoke across much of the West.

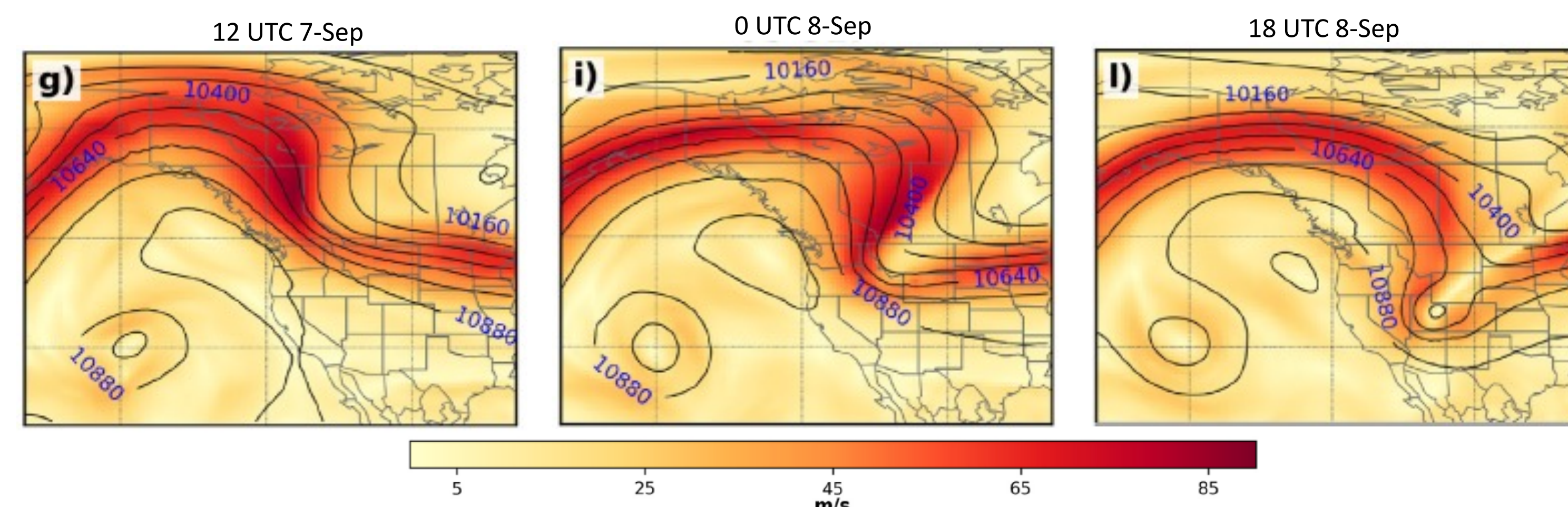


Fig 1. 300 hPa wind and geopotential height.

A large Omega block developed in the upper troposphere. Areas on the east side of the ridge experienced the most dramatic impacts including record breaking offshore winds in Washington and Oregon and snow in the Rocky Mountains.

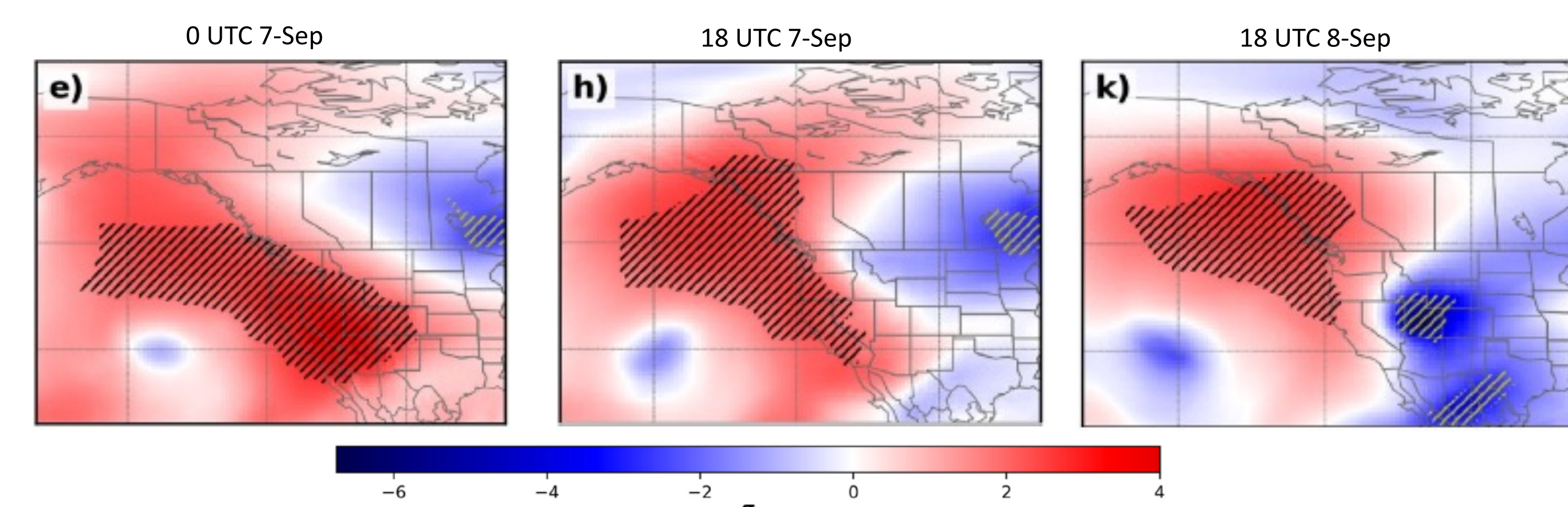


Fig 2. 500 hPa height anomalies in units of standard deviation. Hatching over red shades indicates a record high value for the date and hatching over blue indicates a record low value for the date.

Grid cells over and around Utah had record high 500 hPa geopotential height one day prior to record low 500 hPa geopotential height.

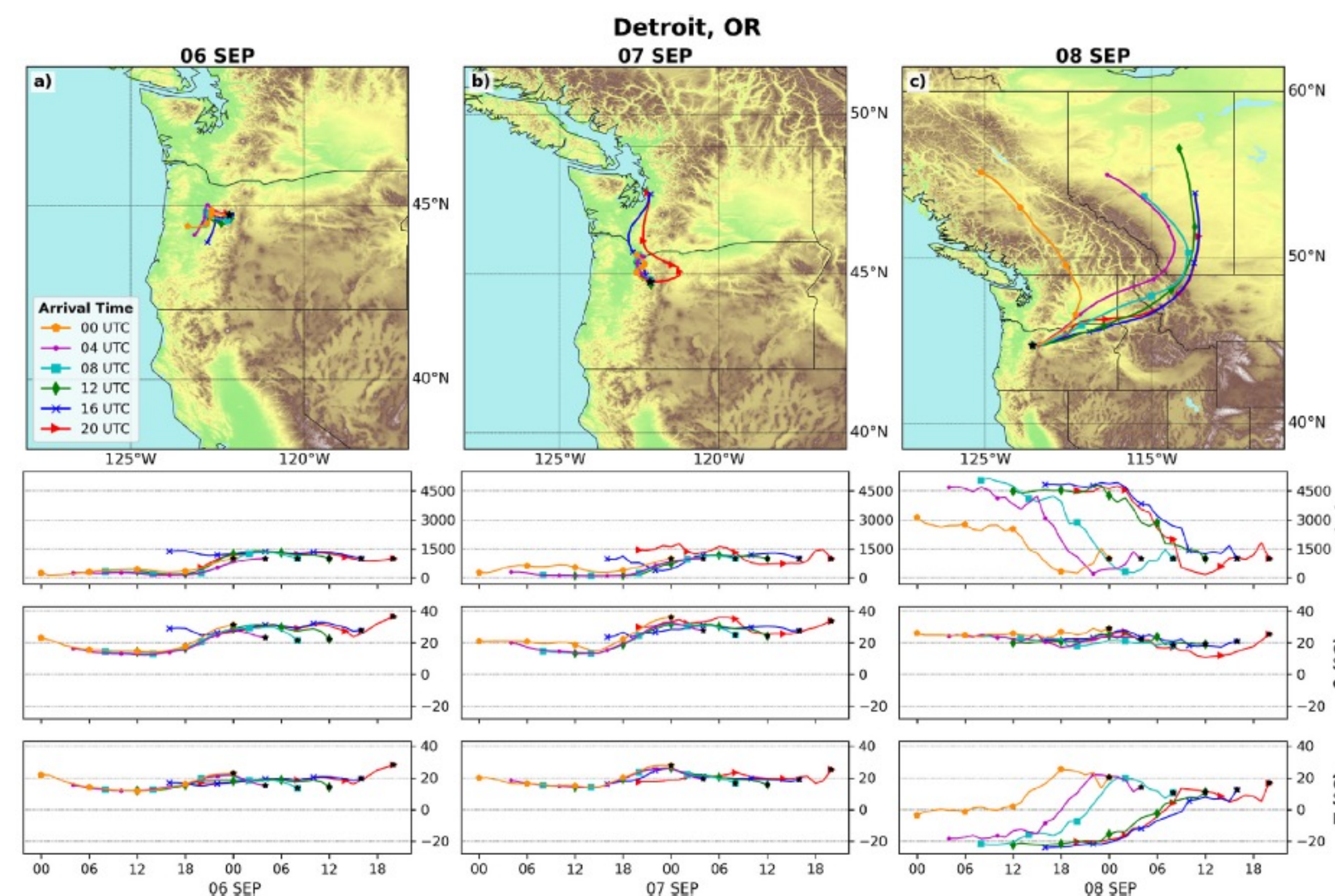
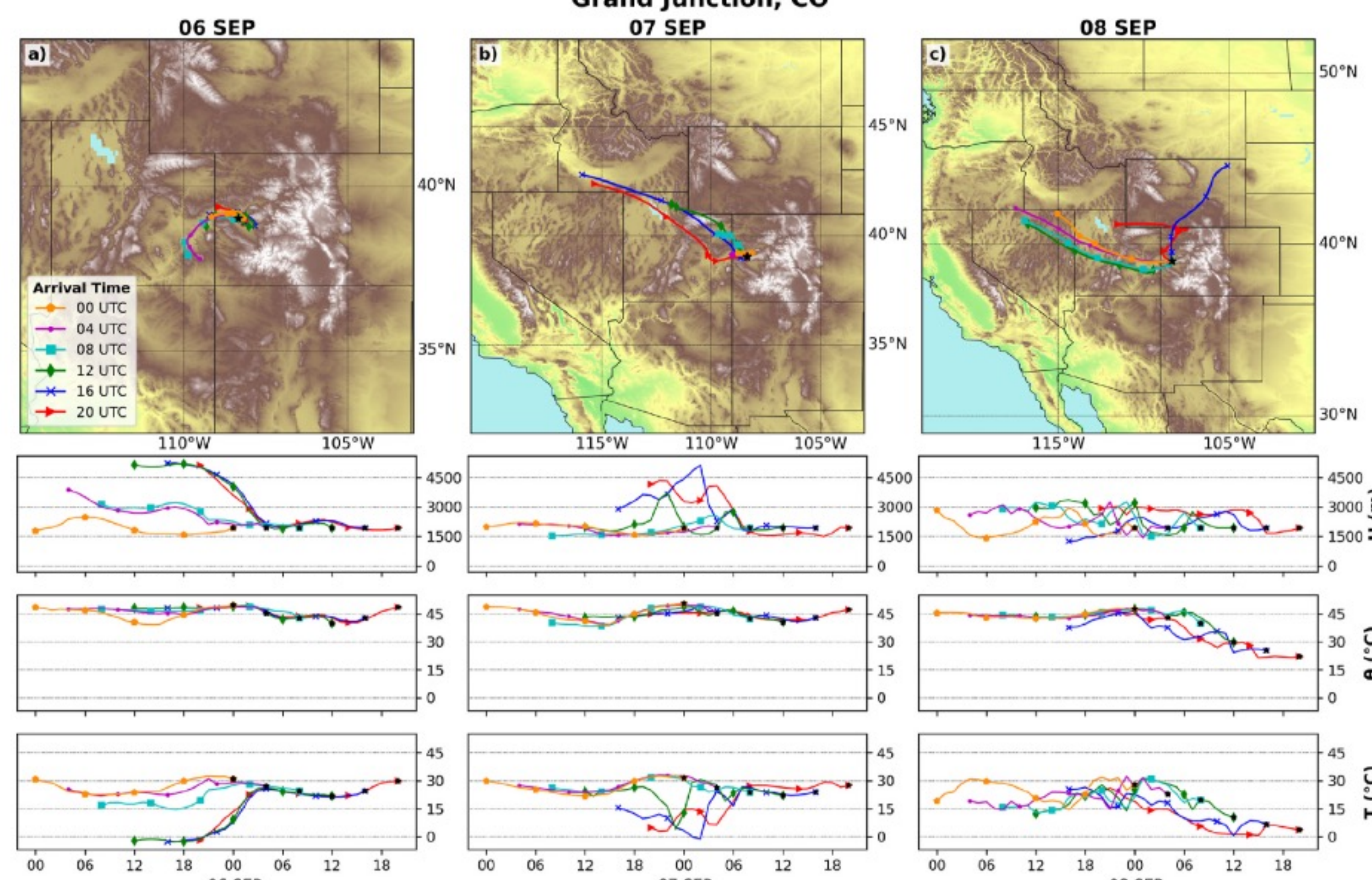


Figure 3. Air parcel back trajectories for Detroit, OR where devastating wildfires occurred. Trajectories are color-coded by UTC hour of the day.

A rapid shift from light winds and warm air to strong easterly winds and cooler air occurred between the 7th and the 8th. Air parcels on the 8th were over 4500 meters above sea level 24 hours prior to arriving in Detroit, warming adiabatically as they descended, and holding very little moisture.



While dry easterly winds fueled large wildfires in the Northwest, dramatic cooling occurred in the Rocky Mountains. Air parcels cooled enroute to Grand Junction during the 8th, likely due to evaporational cooling and melting snow flakes.

A large Rossby Wave Break and formation of a large blocking pattern resulted in rapid and drastic weather changes across the western US in early September, 2020. Results included record breaking winds, destructive wildfires, record 24-hour temperature changes, and early season snowfall.

Russell, E. N., P. C. Loikith, J. Done, I. Ajibade, and C. Lower, 2024: The meteorology and impacts of the September 2020 Western United States extreme weather event. *Weather and Climate Extremes*, <https://doi.org/10.1016/j.wace.2024.100647>.

June 2021

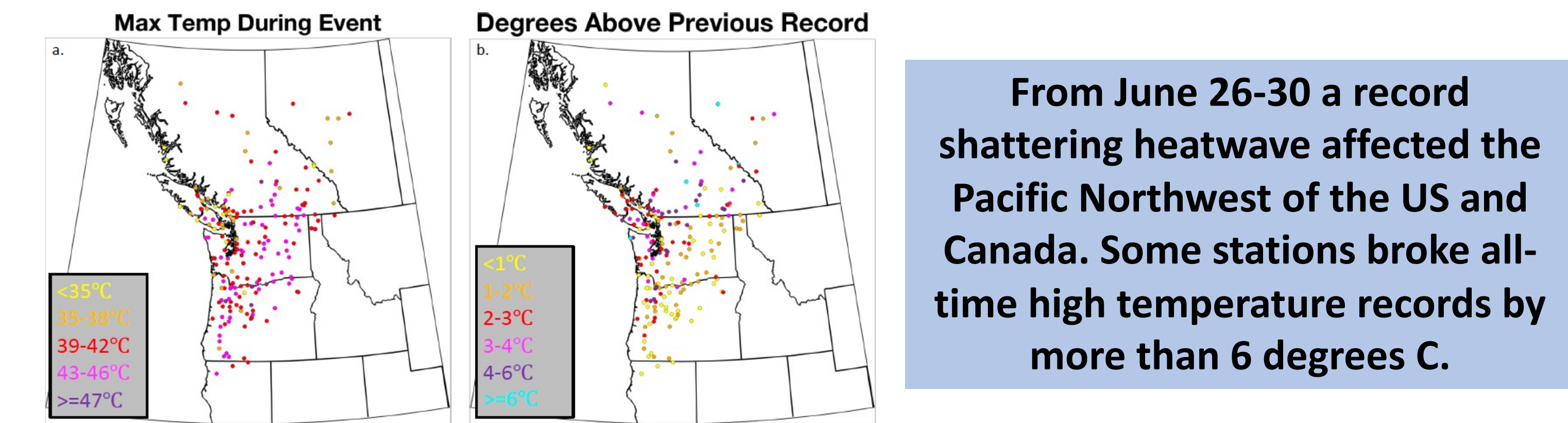


Figure 5. Temperature records during 2021 heat wave. Only stations that tied or exceeded their previous all-time record are shown.

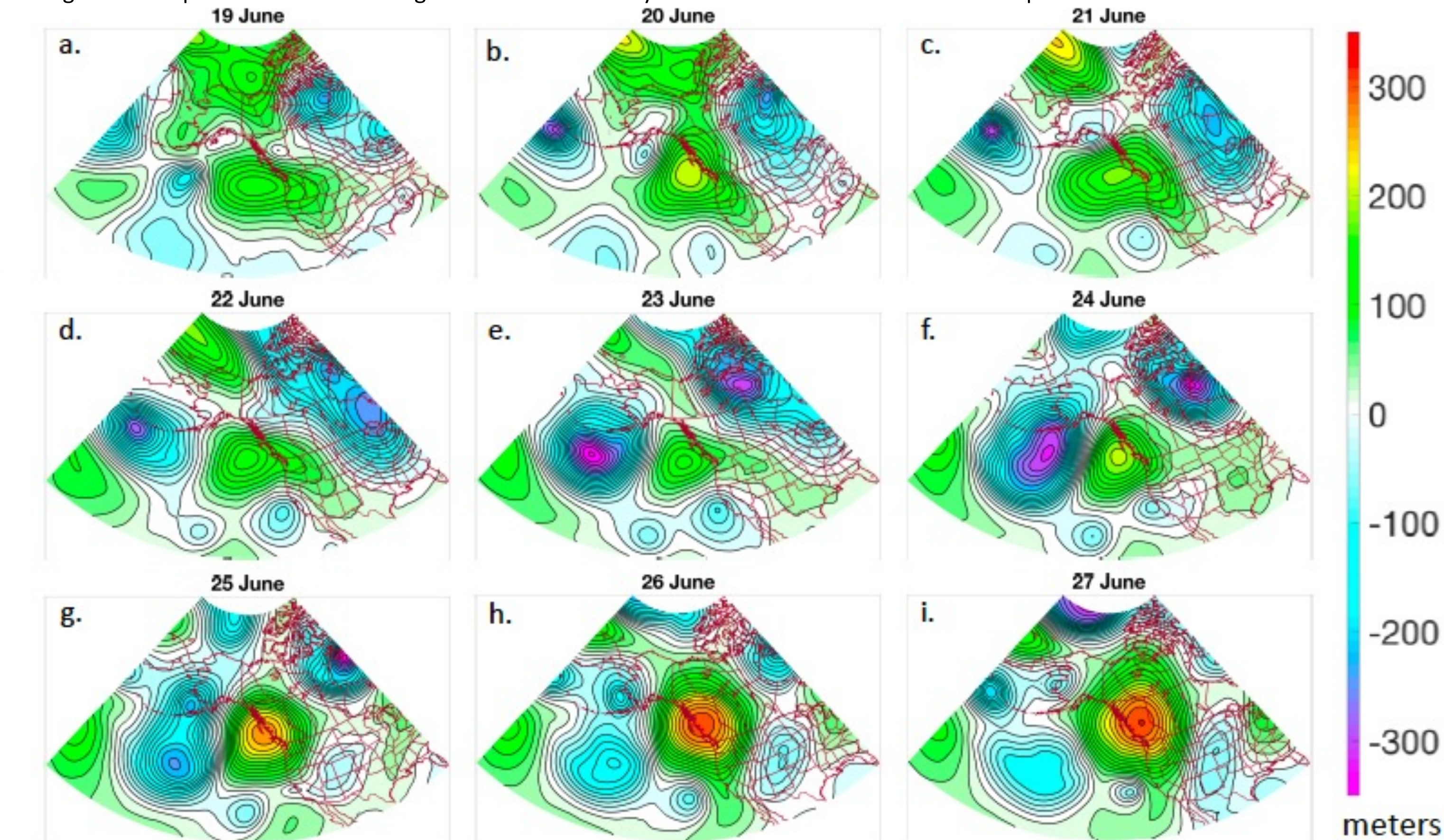


Figure 6. 500 hPa geopotential height anomalies for days leading up to the June 2021 heatwave.

A blocking ridge of upper-level high pressure rapidly strengthened from June 24-26. 500 hPa geopotential height anomalies were record high and 500 hPa zonal anomalies were record high for meteorological summer.

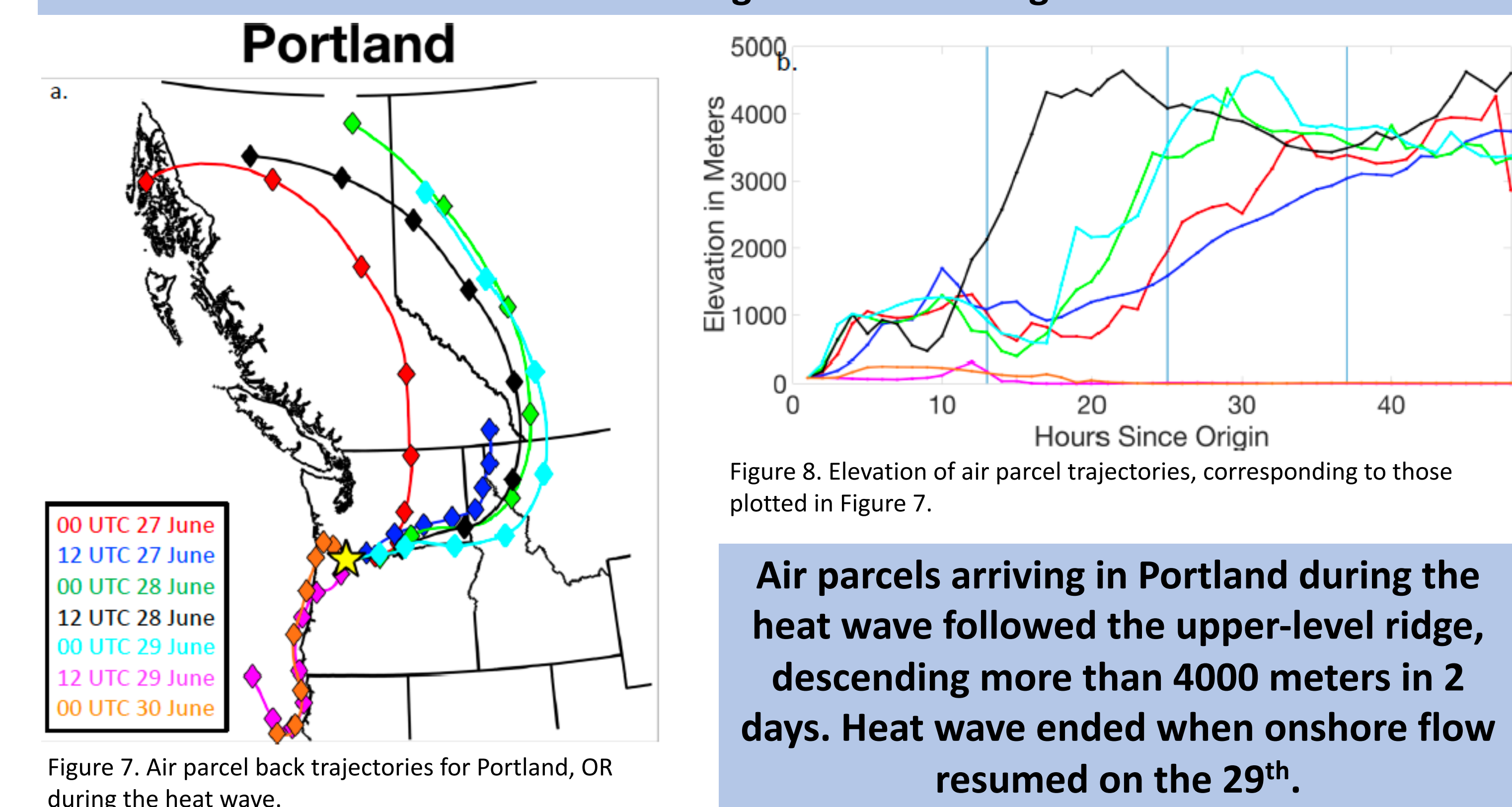


Figure 7. Air parcel back trajectories for Portland, OR during the heat wave.

Air parcels arriving in Portland during the heat wave followed the upper-level ridge, descending more than 4000 meters in 2 days. Heat wave ended when onshore flow resumed on the 29th.

Like the September 2020 event, the June 2021 heat wave was associated with a record breaking 500 hPa ridge and a distinct blocking pattern. Synoptic pattern facilitated anomalous flow leading to a multi-day period of record shattering heat.

Loikith, P. C., and D. A. Kalashnikov, 2023: Meteorological Analysis of the Pacific Northwest June 2021 Heat Wave. *Monthly Weather Review*, **151**, 1303-1319, <https://doi.org/10.1175/MWR-D-22-0284.1>.