

Supporting Information for

**Extreme North American heatwaves in 1941 and 2021 drove
widespread but contrasting impacts**

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Introduction

This supporting information provides text, figures, and tables to contextualize and add details to the methods and results presented in the main paper.

Text S1. On weather forecasts in 1941

The accuracy of weather forecasts varied during the 1941 heatwave. For example, in Seattle, forecasts consistently underestimated maximum daily temperatures during the heatwave¹ but overpredicted temperatures in the five days before and after the heatwave. Between July 13 – 18, 1941, the reported forecast underestimated observed temperatures by an average of 10.2 °F (5.7 °C) with the greatest difference on July 15, when the forecast predicted 78 °F (25.6 °C) but actual temperatures reached 97 °F (36.1 °C). In central and eastern North America, forecasts in several cities accurately predicted the onset of the heatwave, but underestimated its persistence and severity². In Winnipeg, MB on July 19, it was forecasted that the heatwave was travelling eastward, and two days later, Winnipeg reached its maximum temperature of 95 °F (35.0 °C). However, Winnipeg forecasters inaccurately predicted on three consecutive days that cooler weather would arrive the next day². Forecasts for Windsor, ON on July 23 predicted that the heatwave was imminent and would last until July 26³; however, maximum daily temperatures were at least 90 °F (32.2 °C) until July 31.

References

1. “Cooler Weather By Slow Freight.” *The Seattle Daily Times*. 17 July 1941, Page 4.
2. “Weather Man’s ‘Cooler’ Just Makes People Hotter.” *The Winnipeg Tribune*. 24 July 1941, Page 13.
3. “Heat Wave Is Predicted.” *The Windsor Daily Star*. 23 July 1941, Page 13.

Table S1. A summary of newspaper article themes and categories, along with category descriptions and example headlines.

Theme	Category	Description	Example Headline
Weather	Weather forecast	Predictions of future weather, or comparisons to prior predictions	“Break in heat wave tomorrow” (Seattle Daily Times; July 16, 1941)
	Weather data	Quantitative meteorological observations (e.g. daily tables)	“State Swelters; Mercury at 100” (The Bend Bulletin; July 15, 1941)
	Weather description	Description of heatwave or other meteorological phenomena	“Mercury Rising in London Area” (The Windsor Daily Star; July 23, 1941)
	Weather record	Record-breaking meteorological observation, or observations put in context of past records	“Mercury Hits Record Level” (Kamloops Sentinel; July 17, 1941)
	Pre-heatwave weather	Description of seasonal conditions or weather events that occurred prior to the heatwave	“Crops Benefitting From Increased Rainfall Here” (Saskatoon Star-Phoenix; July 9, 1941)
Natural systems	Forestry	Related to forests or the lumber industry	“Closure of Forests in Operation / Period of Continued Drought Forces Action to Protect Timber / Effective Last Night” (Nanaimo Free Press; July 17, 1941)
	Wildfire	Forest fires and grass fires in natural areas	“Lightning Starts Hundreds of Fires / Rangers Battling Blazes on Coast” (The Vancouver Sun; July 18, 1941)
	Fire (non-wildfire)	Fires in urban or built environments (e.g. house fires)	“Fire Damages School” (Saskatoon Star-Phoenix; July 24, 1941)
	Hydrology	Related to natural hydrological systems (e.g. rivers, lakes, glaciers)	“Melting Glacier Floods Pemberton” (The Vancouver Sun; July 21, 1941)
	Animals	Experiences and behaviours of non-livestock animals (e.g. fish, pets)	“Even Trout Seek Depth in Heat Wave” (The Vancouver Sun; July 18, 1941)
	Tides	Related to or mentions of the tides during the heatwave	“No Long Runouts / Tidewaters Kind to Bathers” (The Vancouver Daily Province; July 17, 1941)
Food and water systems	Consumptive water use	Related to human water use, including municipal water, irrigation, and dams	“City Water Fails After Hottest Day” (The Calgary Herald; July 19, 1941)
	Crops	Related to cultivated plants	“Heat Does Crop Damage Up To 70 Percent” (The Winnipeg Tribune; July 21, 1941)
	Livestock	Related to domesticated animals in agricultural settings, including production of dairy products	“Crisis Looms! Calling All Cows! Ice Cream Supply Low; Heat Slows Bovines, Refrigeration” (The Vancouver Sun; July 17, 1941)

Human health	Mortality, direct	Death due to heat exposure	"Heat kills man" (The Windsor Daily Star; July 25, 1941)
	Mortality, indirect	Death due to heat-moderated behaviour (e.g. drowning)	"Drowns in Willamette... [11-year-old] was drowned while trying to keep cool in the Willamette river near the Wheatland ferry yesterday" (The Bend Bulletin; July 16, 1941)
	Drowning, other	Death due to drowning, but not directly attributed to the heatwave	"Bank Manager is Drowned Trying to Rescue Young Son" (The Globe and Mail; July 26, 1941)
	Mortality, other	Non-drowning death during heatwave, but not directly attributed to heatwave	"Umpire Dies in Exhibition Game" (The Bend Bulletin; July 21, 1941)
	Morbidity and injury, direct	Morbidity or injury due to heat exposure (e.g. heat prostration)	"All of East an Inferno / Collapses Numerous All Over Canada and U. S." (The Windsor Daily Star; July 28, 1941)
	Morbidity and injury, indirect	Morbidity or injury due to heat-moderated behaviour	"Girl Injured Helping Fight Forest Fire" (Nanaimo Free Press; July 14, 1941)
	Morbidity and injury, other	Other relevant examples of morbidity and injury (e.g. near-fatalities)	"Quesnel Girl Nearly Drowns at Mud Lake" (The Cariboo Observer; July 19, 1941)
Critical infrastructure	Infrastructure	Heatwave impacts on the built environment, including buildings, bridges, and roads	"Traffic Disrupted / Heat Moves Concrete Slabs On Highway" (The Vancouver Daily Province; July 17, 1941)
	Transportation	Related to the mobility of people	"Sunny Weather Attracts Many to Seba Beach / Week-end Visitors Throng Cottages at Lake Resort / Arrive by Motor" (Edmonton Journal; July 24, 1941)
	Housing	Heatwave impacts on people in dwellings	"Under Roof of Stars / Heat-Harassed, Hundreds Throng Parks ... The upper rooms of almost every home were simply unbearable" (The Vancouver Daily Province; July 18, 1941)
	Industry	Related to business or sales (e.g. icemakers, ice cream vendors)	"Ice Dealers Hit New Highs in Heat" (The Vancouver Daily Province; July 19, 1941)
	Trade	Related to the transportation of goods	"Lemon Shortage Is Caused By Prolonged Heat Wave... 'People want lemons and it takes about seven or eight days to complete a shipment.'" (The Seattle Daily Times; July 17, 1941)

Social infrastructure and services	Public service announcements	Communications to raise public awareness about policy or to influence behaviour	"More than ever before, Britain needs British Columbia lumber! Prevent forest fires" (Prince George Citizen; July 24, 1941)
	Sports and recreation	Related to either heatwave impacts on athletics/recreation, or activities chosen because of the heatwave (e.g. popularity of beaches, swimming pools)	"It Sure Was Hot / City's Beach Records Smashed / Warmest day of the Year Drives Populace Outdoors" (The Vancouver Daily Province; July 15, 1941)
	Crime	Reported relationships between crime and the heatwave, including the judicial system	"Woodpile Robbed in This Weather / Perspiring Thieves Steal Fan, Icebox" (The Vancouver Sun; July 17, 1941)
	Recommendations and advice	Suggested actions for managing the heatwave (e.g. cooling, cooking, and health tips)	"Hats For Protection Against Hot Sun Urged" (The Regina Leader-Post; July 21, 1941)
	Behaviour	Related to how and why people either do or do not modify their actions based on the weather conditions (e.g. sleeping outside)	"Too Warm on Farms / Bulkley Valley Haymakers Lay Off in Mid-Day – 100 Above" (The Prince Rupert Daily News; July 18, 1941)
Narrative	Relative perspective	Perspectives that centre on the heatwave in relation to somewhere else (e.g. tourists commenting on how the heat compares to where they are from)	"Vancouver Visitors Say Climate is Wonderful in Spite of Heat" (The Vancouver Daily Province; July 16, 1941)
	Framing	Heatwave used as a narrative tool to frame or discuss non-heatwave topics	"A Cooling Thought – State Mint Industry Booming" (The Seattle Daily Times; July 18, 1941)
Conflict	Conflict	Relationships between the heatwave and World War II	"More Than Ever Before, Britain Needs British Columbia Lumber! Prevent Forest Fires" (Prince George Citizen; July 24, 1941)
	Advertisements	Advertisements or advertorials that use heat as a framing device	"Beat The Heat With Sunshine Krispy Crackers" (The Seattle Daily Times; July 13, 1941)

Table S2. A summary of newspaper publications used in this study.

Publication Title	Publication City	Dates Used	Publication Frequency	Source	Number of Issues	Number of Pages
Victoria Daily Times	Victoria, Canada	July 8 – 28, 1941	Daily (except Sundays)	BC Historical Newspapers	18	343
Nanaimo Free Press	Nanaimo, Canada	July 8 – 28, 1941	Daily (except Sundays)	Newspapers.com	18	114
The Vancouver Daily Province	Vancouver, Canada	July 8 – 28, 1941	Daily (except Sundays)	BC Historical Newspapers	18	586
Vancouver Sun	Vancouver, Canada	July 8 – 28, 1941	Daily (except Sundays)	BC Historical Newspapers	18	522
The Seattle Daily Times	Seattle, USA	July 8 – 28, 1941	Daily	Seattle Daily Times Web Archives	21	782
The Nome Nugget	Nome, USA	July 9 – 28, 1941	Monday / Wednesday / Friday	Library of Congress Chronicling America	9	36
The Daily Alaska Empire	Juneau, USA	July 8 – 28, 1941	Daily (except Sundays)	Library of Congress Chronicling America	18	142
The Bend Bulletin	Bend, USA	July 8 – 28, 1941	Daily (except Sundays)	Google Newspaper Archive	18	148
The Interior News	Smithers, Canada	July 9 – 30, 1941	Weekly (on Wednesdays)	Newspapers.com	4	18
The Similkameen Star	Princeton, Canada	July 10 – 31, 1941	Weekly (on Thursdays)	BC Historical Newspapers	4	18
The Daily News	Prince Rupert, Canada	July 8 – 28, 1941	Daily (except Sundays)	The Prince Rupert Newspaper Archive	18	74
Kamloops Sentinel	Kamloops, Canada	July 10 – 31, 1941	Weekly (on Thursdays)	NewsHound (Thompson-Nicola Region)	4	52

Prince George Citizen	Prince George, Canada	July 10 – 31, 1941	Weekly (on Thursdays)	Prince George Newspapers	4	32
The Cariboo Observer	Quesnel, Canada	July 12 – Aug 2, 1941	Weekly (on Saturdays)	Newspapers.com	4	18
The Whitehorse Star	Whitehorse, Canada	July 11 – Aug 1, 1941	Weely (on Fridays)	Newspapers.com	4	32
The Herald-Tribune	Grande Prairie, Canada	July 10 – 31, 1941	Weekly (on Thursdays)	University of Calgary Digital Collections	4	26
Nelson Daily News	Nelson, Canada	July 8 – 28, 1941	Daily (except Sundays; missing July 18)	BC Historical Newspapers	17	180
The Calgary Herald	Calgary, Canada	July 8 – 28, 1941	Daily (except Sundays)	Proquest	18	375
Edmonton Journal	Edmonton, Canada	July 8 – 28, 1941	Daily (except Sundays)	Proquest	18	362
Saskatoon Star-Phoenix	Saskatoon, Canada	July 8 – 28, 1941	Daily (except Sundays)	Proquest	18	345
The Leader-Post	Regina, Canada	July 8 – 28, 1941	Daily (except Sundays)	Proquest	18	386
The Winnipeg Tribune	Winnipeg, Canada	July 8 – 31, 1941	Daily (except Sundays)	Newspapers.com	21	501
Minneapolis Morning Tribune	Minneapolis, USA	July 8 – 31, 1941	Daily (except Sundays)	Newspapers.com	21	358
The Windsor Daily Star	Windsor, Canada	July 8 – 31, 1941	Daily (except Sundays)	Proquest	21	670
The Globe and Mail	Toronto, Canada	July 8 – 31, 1941	Daily (except Sundays)	Proquest	21	472

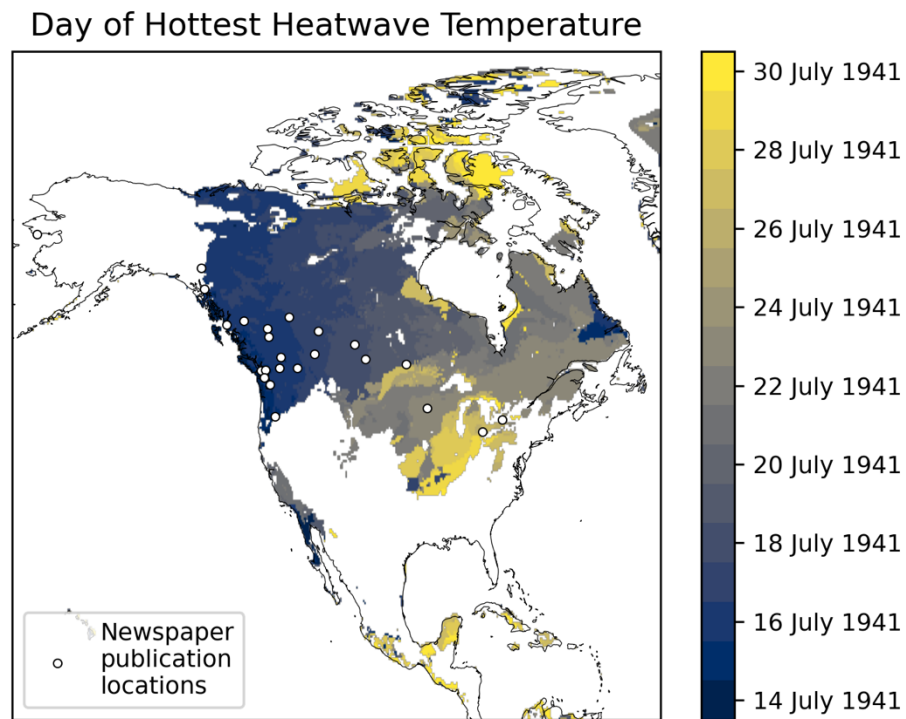


Figure S1. The day of hottest July temperature recorded after the onset of the heatwave, for grid cells where temperature anomalies were positive on average from July 13 – 31. Data is from ERA5 climate reanalysis at 0.25° x 0.25° resolution.

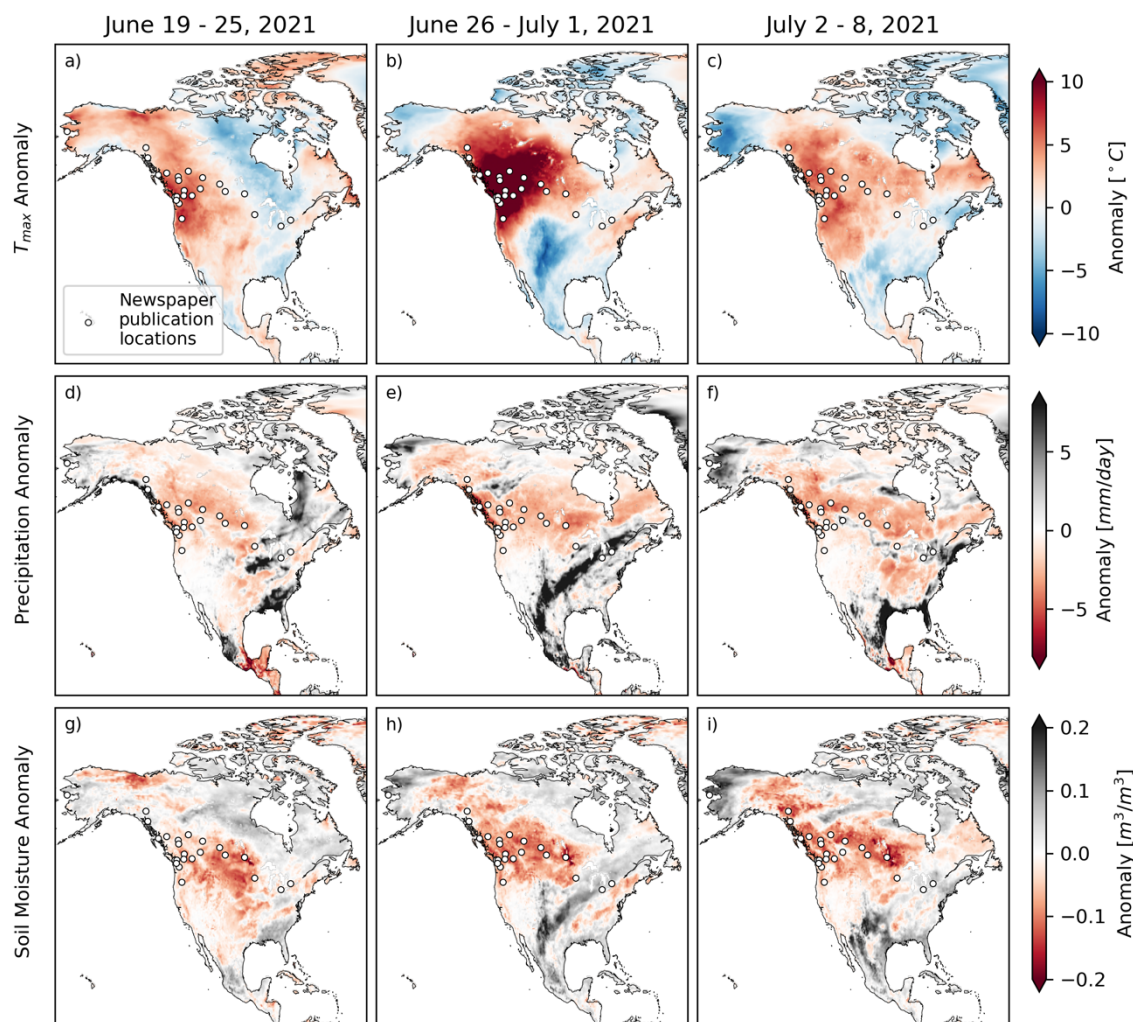


Figure S2. Weekly mean anomalies of a) – c) daily maximum temperature, d) – f) daily total precipitation, and g) – i) soil moisture in the top 7 cm of the soil column, from ERA5 reanalysis, for periods before, during, and after the 2021 heatwave. Anomalies are calculated relative to the 1990 – 2019 climatology.

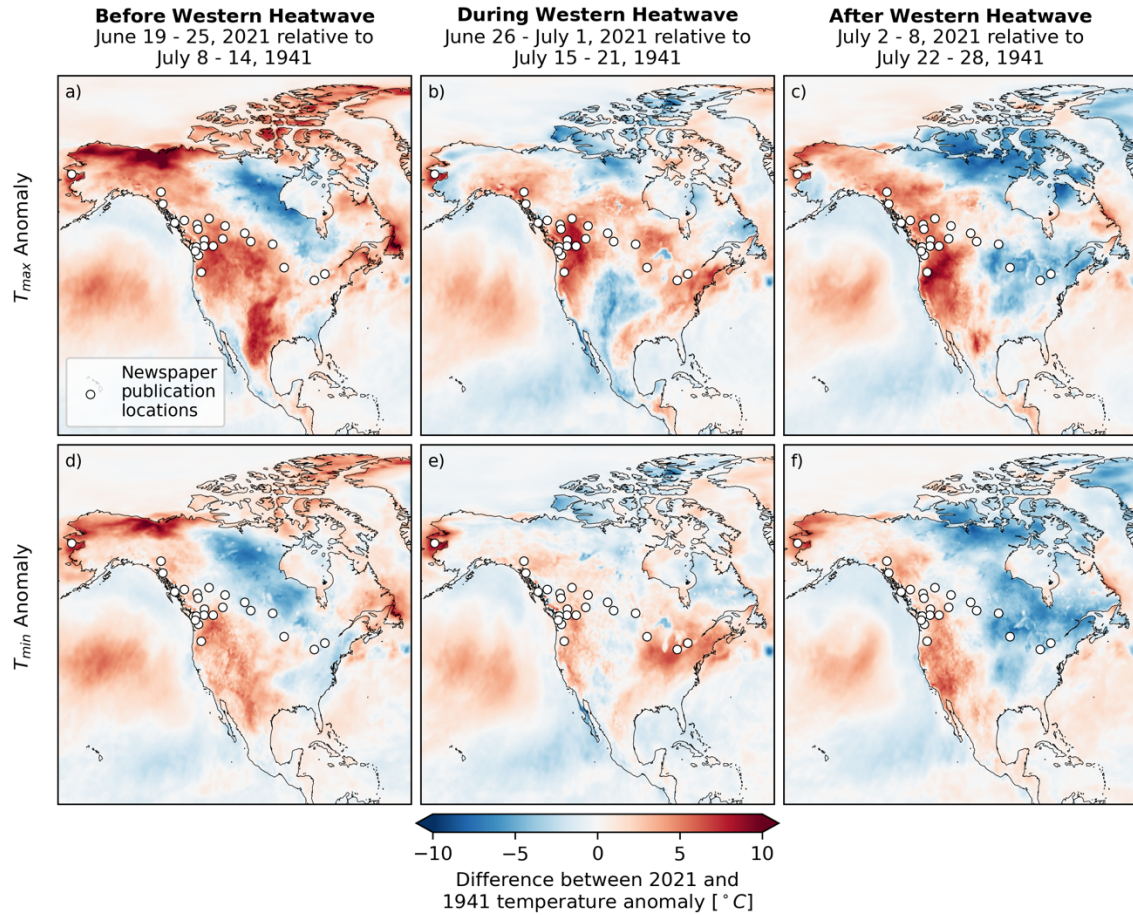


Figure S3. The difference between a) – c) maximum temperature anomalies, and d) – f) minimum temperature anomalies, between the 2021 heatwave and the 1941 heatwave. Positive (red) values indicate where temperatures were more anomalously hot during 2021, whereas negative (blue) values indicate where temperatures were more anomalously hot during 1941. 1941 temperature anomalies are calculated relative to 1940 – 1969 climatology, and 2021 temperature anomalies are calculated relative to 1990 – 2019 climatology. We show results for the week prior to the heatwaves’ peaks in Western North America (left column), during the week when temperatures peaked in Western North America (middle column), and during the week after temperatures peaked in Western North America (right column).

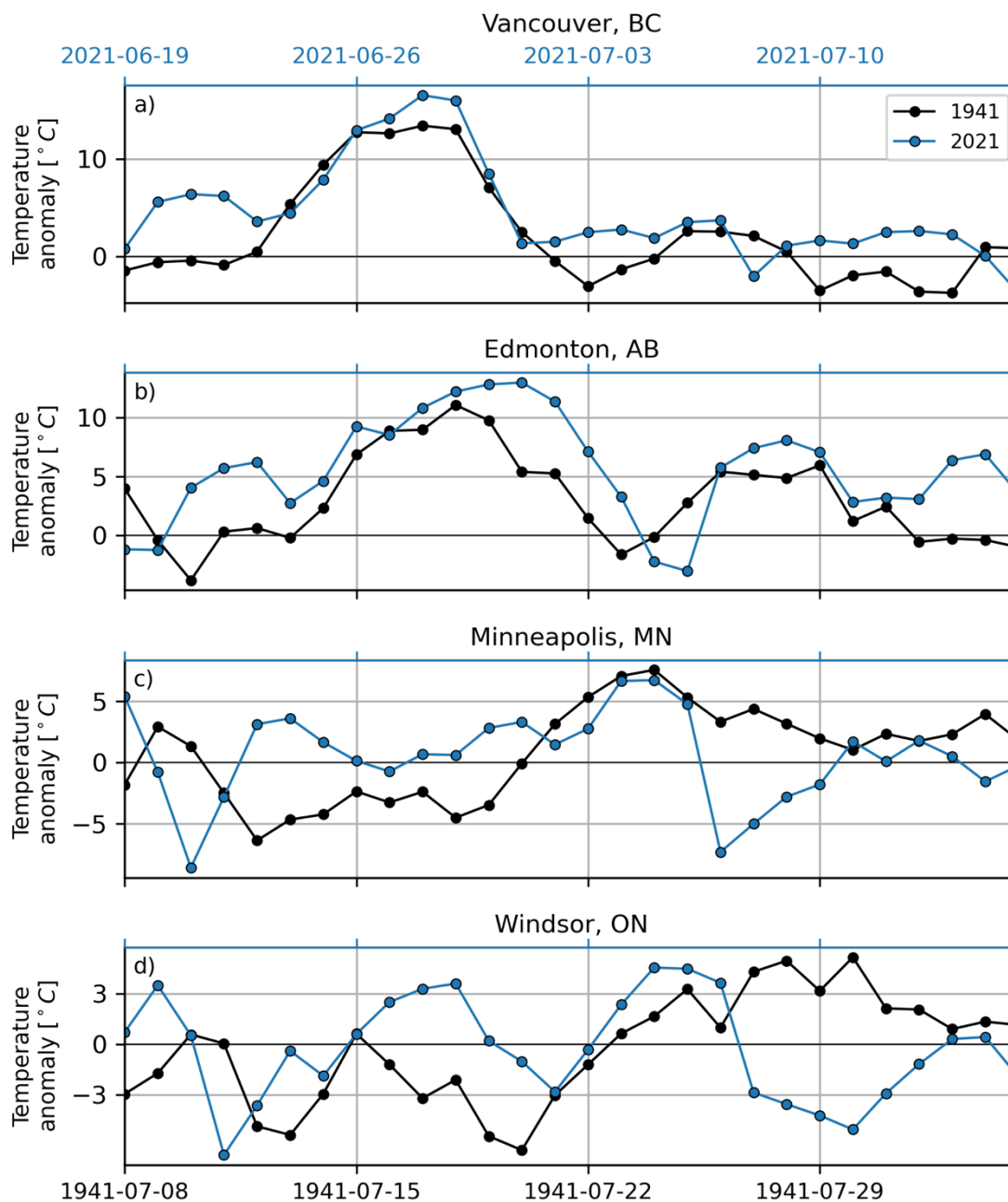


Figure S4. Daily maximum temperature anomalies from ERA5 climate reanalysis for the 1941 heatwave (black) and the 2021 heatwave (blue), for a) Vancouver, BC, located on the west coast; b) Edmonton , AB, located east of the Canadian Rocky Mountains; c) Minneapolis, MN, located in the US Midwest; and d) Windsor, ON, located in Southern Ontario. 1941 temperature anomalies are calculated relative to

1940 – 1969 climatology, and 2021 temperature anomalies are calculated relative to 1990 – 2019 climatology. Both heatwaves were most anomalously hot in Western North America (a and b) and both heatwaves extended into Eastern North America; however, the 1941 heatwave persisted in Eastern North American whereas the 2021 heatwave ended abruptly (c and d).

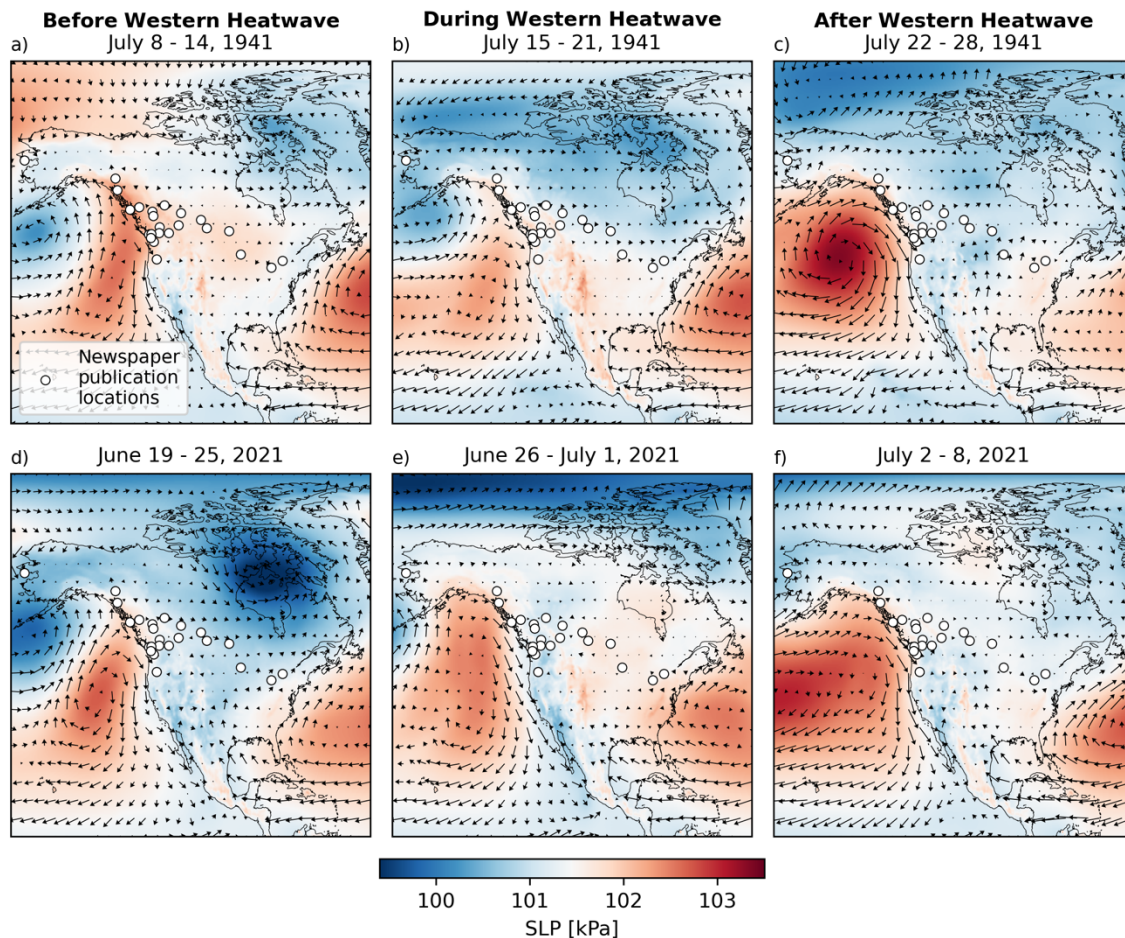


Figure S5. Weekly mean values of mean sea level pressure and 10m wind vectors from ERA5 reanalysis, for a) – c) the 1941 heatwave, and d) – f) the 2021 heatwave. We show results for the week prior to the heatwaves’ peaks in Western North America (left column), during the week when temperatures peaked in Western North America (middle column), and during the week after temperatures peaked in Western North America (right column). During the week after temperatures peaked in Western North America (right column), southerly winds from the Gulf of Mexico to the US Midwest were relatively stronger in 1941 (c) than in 2021 (f).