

APPENDIX B

Maps of Climate and Hydrologic Change for Major Puget Sound Watersheds: Basin average projections

This appendix contains maps of historical and projected changes in climate and hydrology, averaged over the major watersheds in Puget Sound. As a complement to the watershed averages, Appendix C includes maps showing the full-resolution climate and hydrologic projections. Results are included for the following two datasets:

- ***Integrated Scenarios for the Future Northwest Environment.*** The current set of projections, developed by Mote et al. in 2015,¹ which stem from the newer 2013 IPCC report,² and
- ***The Pacific Northwest Hydroclimate Scenarios Project.*** A previous set of projections, developed by Hamlet et al. in 2010,³ which are based on the climate projections used in the IPCC's 2007 report.⁴

The global climate model projections that form the basis of these two datasets stem from the current and previous generations of the Coupled Model Intercomparison Project ("CMIP", see Section 1). The previous projections originate from the CMIP3 archive, while the current projections come from the newer CMIP5 archive.^{5,6} Each CMIP experiment is associated with a different set of greenhouse gas scenarios.^A For simplicity, each figure is labeled with the CMIP experiment on which it is based ("CMIP3" or "CMIP5"), as well as the name(s) of the greenhouse gas scenarios that are the basis of the projections shown in each figure (e.g. "Moderate (A1B)", or "Low (RCP 4.5)").

Projections are included for the following climate and hydrologic variables:

Figures 1a, b:	Average Winter Temperature
Figures 2a, b:	Average Summer Temperature
Figures 3a, b:	Growing Degree Days
Figures 4a, b:	Extreme high daytime temperatures
Figures 5a, b:	Extreme low nighttime temperatures
Figures 6a, b:	Total Winter Precipitation
Figures 7a, b:	Total Summer Precipitation
Figures 8a, b:	Max 24-hour Precipitation
Figures 9a, b:	Summer Water Deficit
Figures 10a, b:	April 1 st Snow Water Equivalent (SWE)
Figures 11a, b:	Annual Maximum Snow Water Equivalent (SWE)
Figures 12a, b:	Ratio of max SWE to Oct-Mar Precipitation

^A Greenhouse gas scenarios were developed by climate modeling centers for use in modeling global and regional climate impacts. These are described in the text as follows: "very low" refers to the RCP 2.6 scenario; "low" refers to RCP 4.5 or SRES B1; "moderate" refers to RCP 6.0 or SRES A1B; and "high" refers to RCP 8.5, SRES A2, or SRES A1FI – descriptors are based on cumulative emissions by 2100 for each scenario. See Section 1 for more details.

Figures 13a, b:	Length of the Snow Season
Figures 14a, b:	Summer Runoff
Figures 15a, b:	Winter Runoff
Figures 16a, b:	Peak daily streamflow, 2-year Event
Figures 17a, b:	Peak daily streamflow, 10-year Event
Figures 18a, b:	Peak daily streamflow, 50-year Event
Figures 19a, b:	Peak daily streamflow, 100-year Event
Figures 20a, b:	Minimum 7-day streamflow, 2-year Event
Figures 21a, b:	Minimum 7-day streamflow, 10-year Event

Other maps and figures, for example showing averages over smaller sub-basins to each watershed, are available upon request.

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- 1 Mote, P. W., Rupp, D. E., Abatzoglou, J. T., Hegewisch, K. C., Nijssen, B., Lettenmaier, D. P., Stumbaugh, M., Lee, S.-Y., & Bachelet, D., 2015. Integrated Scenarios for the Future Northwest Environment. Version if relevant. USGS ScienceBase. Data set accessed 2015-03-02 at <https://www.sciencebase.gov/catalog/item/5006eb9de4b0abf7ce733f5c>
 - 2 (IPCC) Intergovernmental Panel on Climate Change. 2013. *Working Group 1, Summary for Policymakers*. Available at: http://www.climatechange2013.org/images/uploads/WGIAR5-SPM_Approved27Sep2013.pdf
 - 3 Hamlet, A.F. et al., 2013. An overview of the Columbia Basin Climate Change Scenarios Project: Approach, methods, and summary of key results. *Atmosphere-Ocean* 51(4): 392-415. doi: 10.1080/07055900.2013.819555
 - 4 (IPCC) Intergovernmental Panel on Climate Change. 2007. *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
 - 5 Taylor, K. E. et al., 2012. An overview of CMIP5 and the experiment design. *Bulletin of the American Meteorological Society*, 93(4), 485-498, doi:10.1175/BAMS-D-11-00094.1
 - 6 Knutti, R. et al., 2013. Climate model genealogy: Generation CMIP5 and how we got there. *Geophys. Res. Lett*, 40, 1194-1199, doi:10.1002/grl.50256

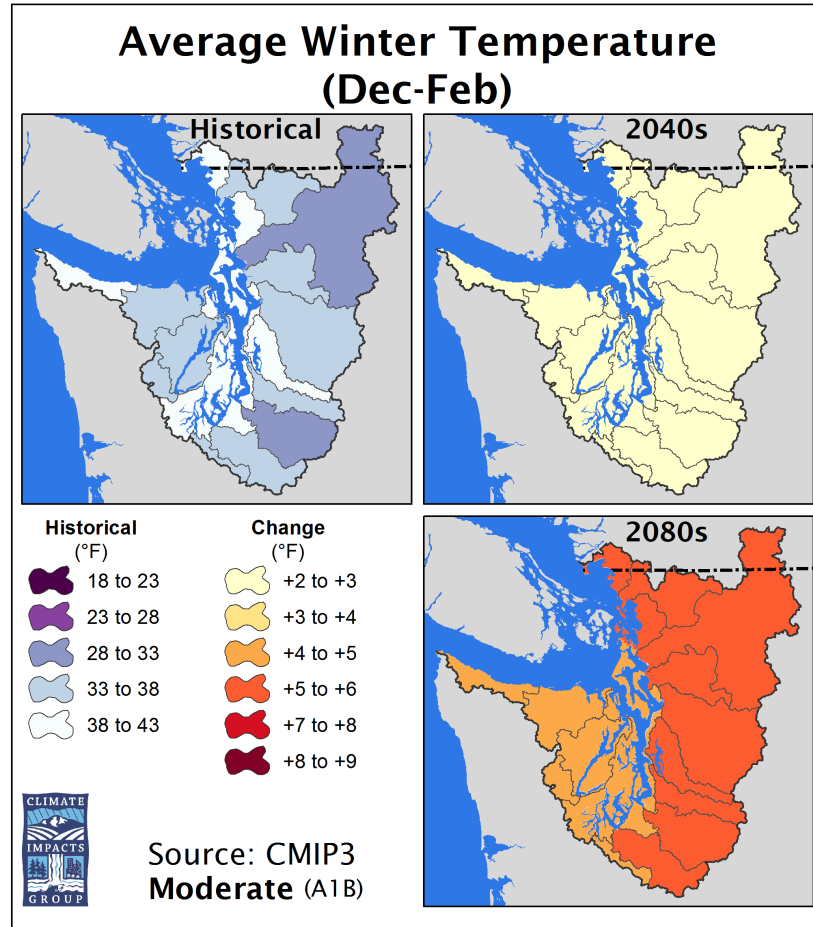


Figure 1a. Average Winter Temperature, previous projections. Maps show the historical and projected change in average winter (December–February) temperature, in °F. Maps compare watershed averages for historical conditions (1970–1999) and the projected change for ten global models. Two time periods are considered: the 2040s (2030–2059) and the 2080s (2070–2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark blue shading on the historical map indicates areas with the lowest average winter temperature. Projected increases in average winter temperature are depicted by the yellow to red shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

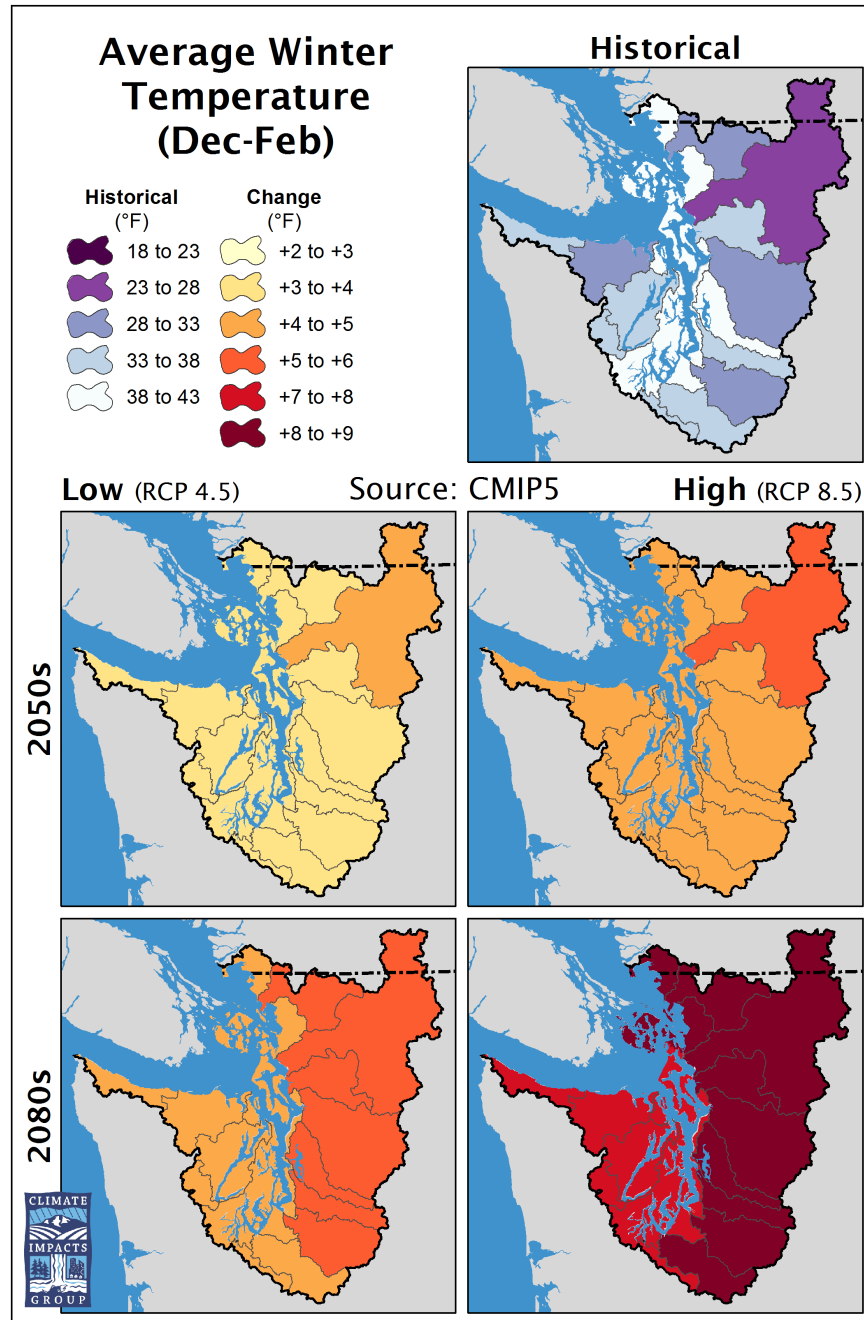


Figure 1b. Average Winter Temperature, newer projections. As in Figure 1a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

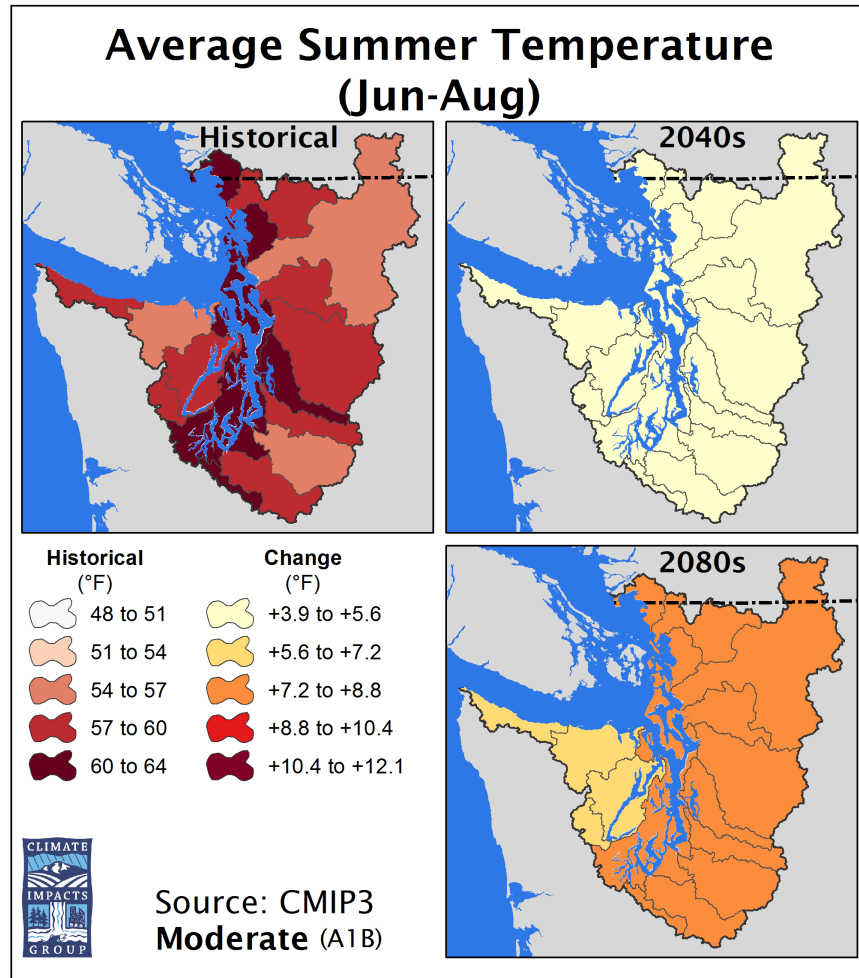


Figure 2a. Average Summer Temperature, previous projections. Maps show the historical and projected change in average summer (June–August) temperature, in °F. The figure compares watershed averages for historical conditions (1970–1999) and the projected change for ten global models. Two time periods are considered: the 2040s (2030–2059) and the 2080s (2070–2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark red shading on the historical map indicates areas with the highest average summer temperature. Projected increases in average winter temperature are depicted by the yellow to red shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

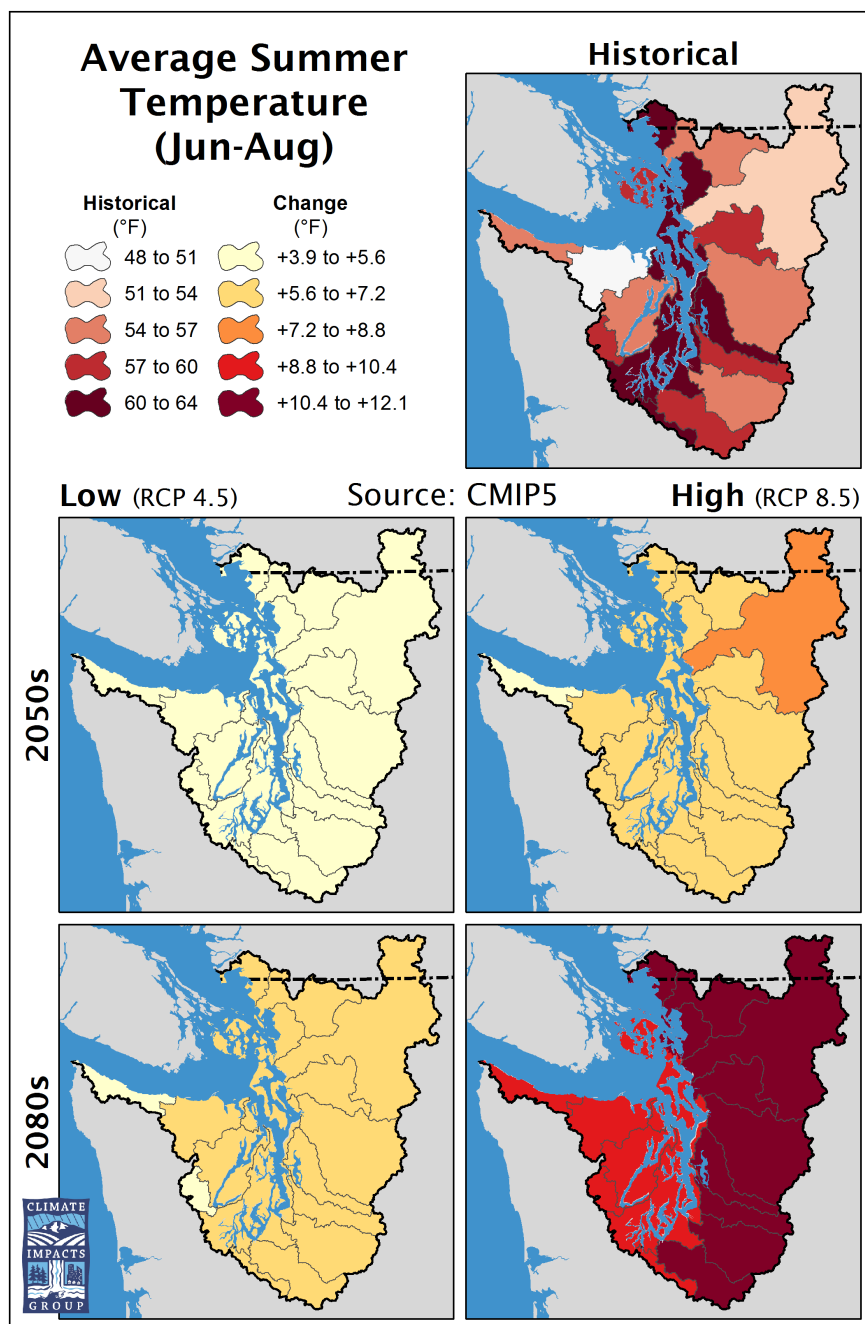


Figure 2b. Average Summer Temperature, newer projections. As in Figure 2a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

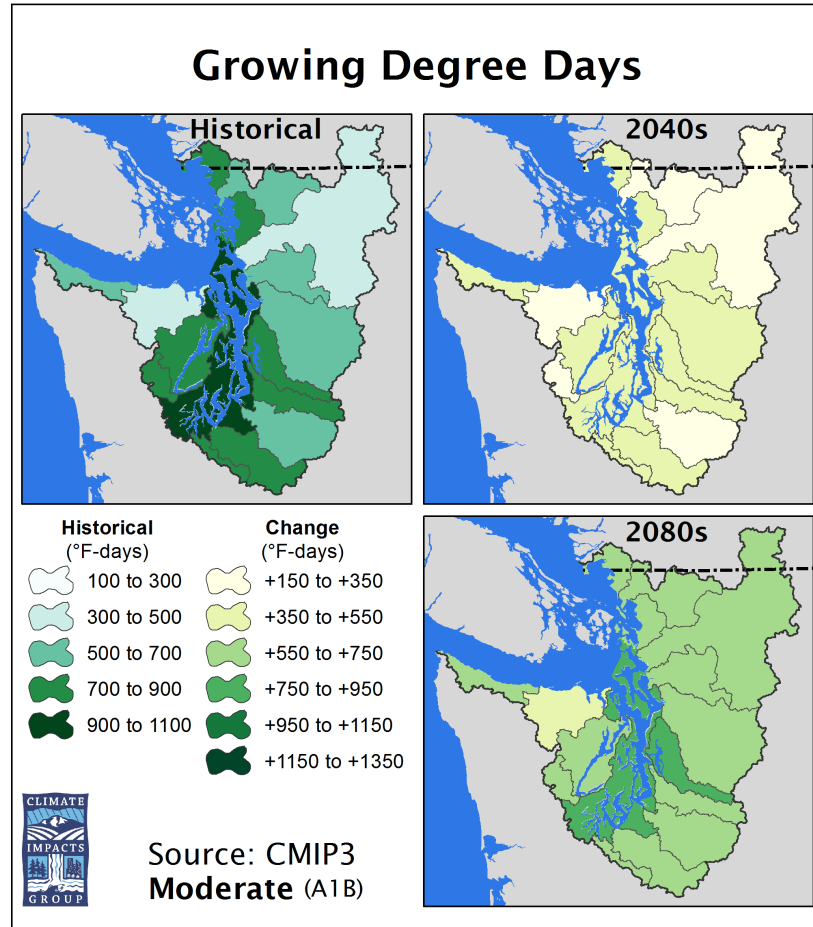


Figure 3a. Growing Degree Days, previous projections. Maps show the historical and projected growing degree days (GDD), a measure of heat accumulation in plants, which measures the cumulative seasonal warming above a base temperature of 50°F. The figure compares watershed averages for historical conditions (1970-1999) and the projected change for ten global models, all in units of °F-days. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark green shading on the historical map indicates areas with the highest average GDD. Projected increases in growing degree days are depicted by the beige to dark green shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

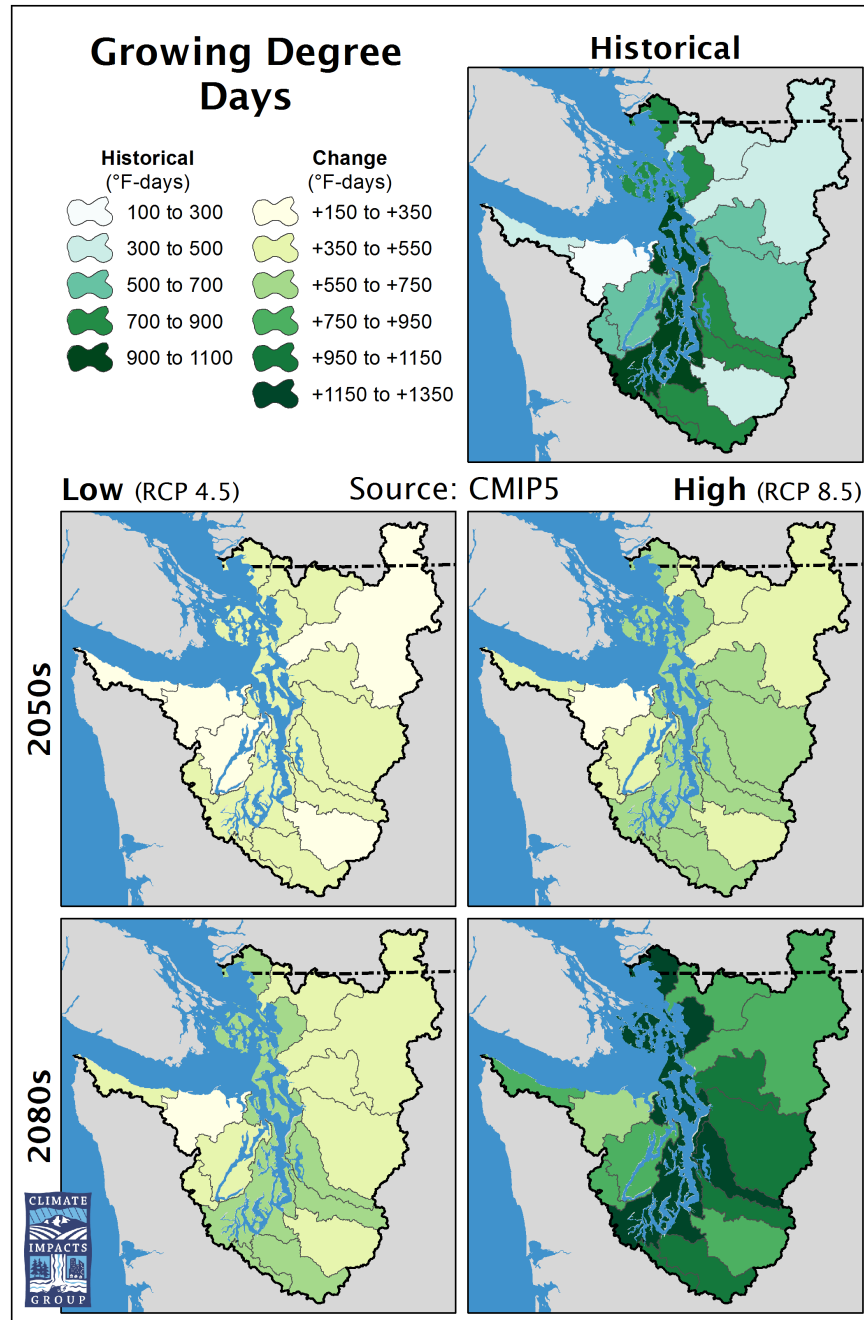


Figure 3b. Growing Degree Days, newer projections. As in Figure 3a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹*

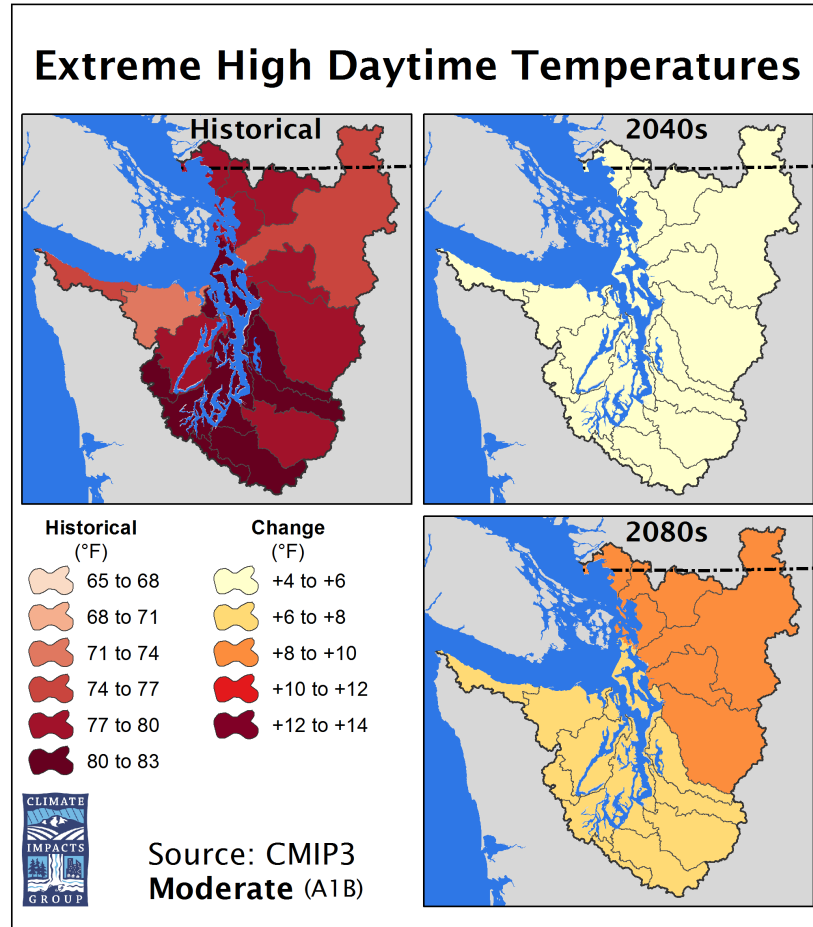


Figure 4a. Extreme high daytime temperatures, previous projections. Maps show the historical and projected change in extreme high daytime temperatures, in °F. The “extreme high” temperature is defined as the 95th percentile of daily maximum temperatures occurring in each year. The figure compares watershed averages for historical conditions (1970-1999) and the projected change for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark red shading on the historical map indicates areas with the warmest extreme high daytime temperatures. Projected increases in extreme high daytime temperatures are depicted by the yellow to red shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

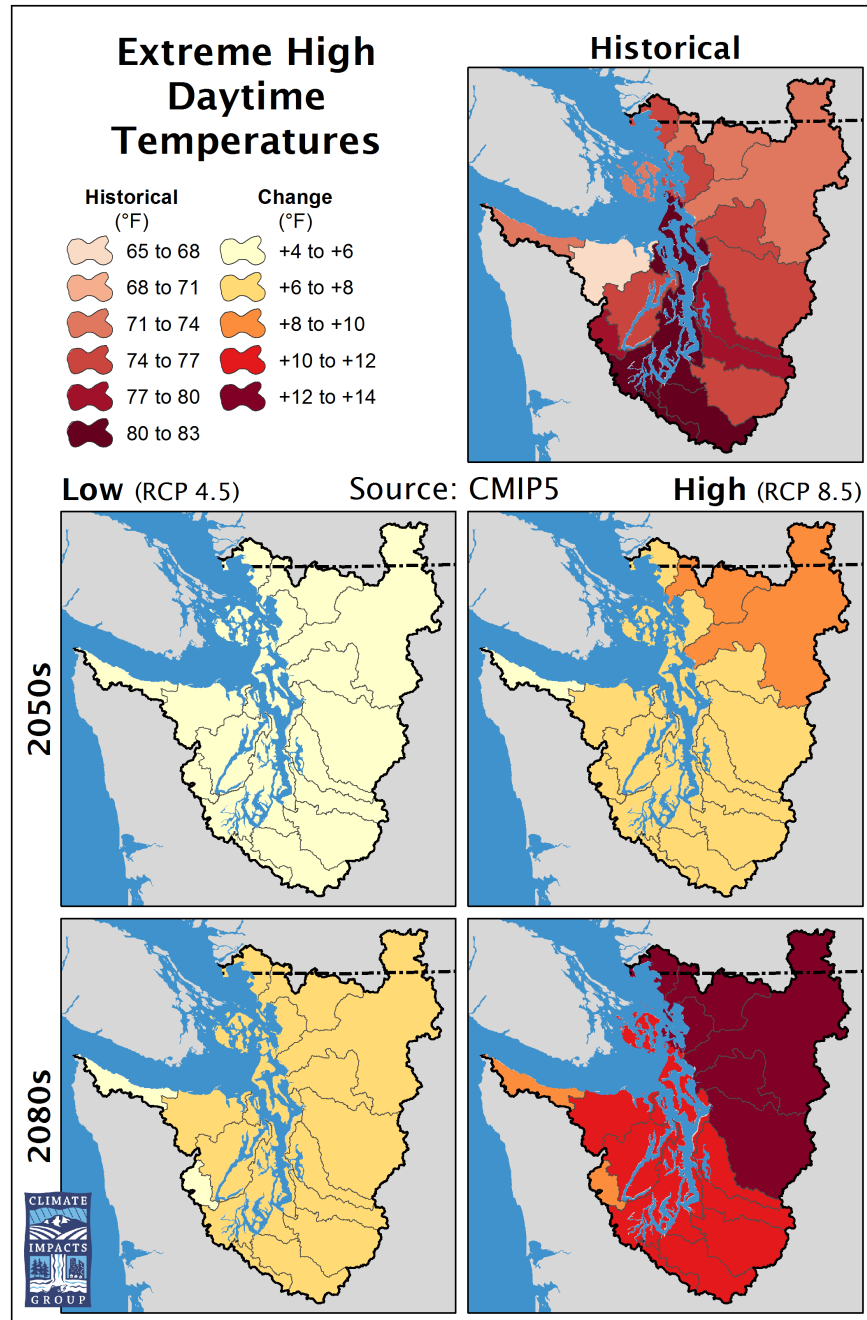


Figure 4b. Extreme high daytime temperatures, newer projections. As in Figure 4a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

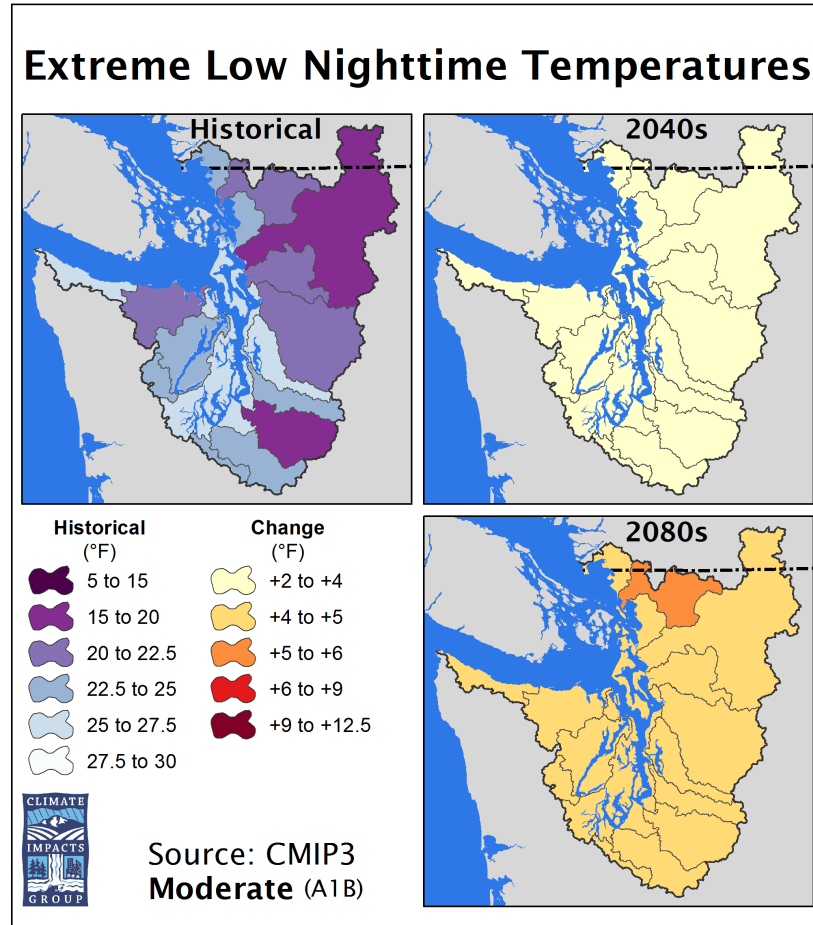


Figure 5a. Extreme low nighttime temperatures, previous projections. Maps show the historical and projected change in extreme low nighttime temperatures, in °F. The “extreme low” temperature is defined as the 5th percentile of daily minimum temperatures occurring in each year. The figure compares watershed averages for historical conditions (1970-1999) and the projected change for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark purple shading on the historical map indicates areas with the lowest extreme low nighttime temperatures. Projected increases in extreme low nighttime temperatures are depicted by the yellow to red shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

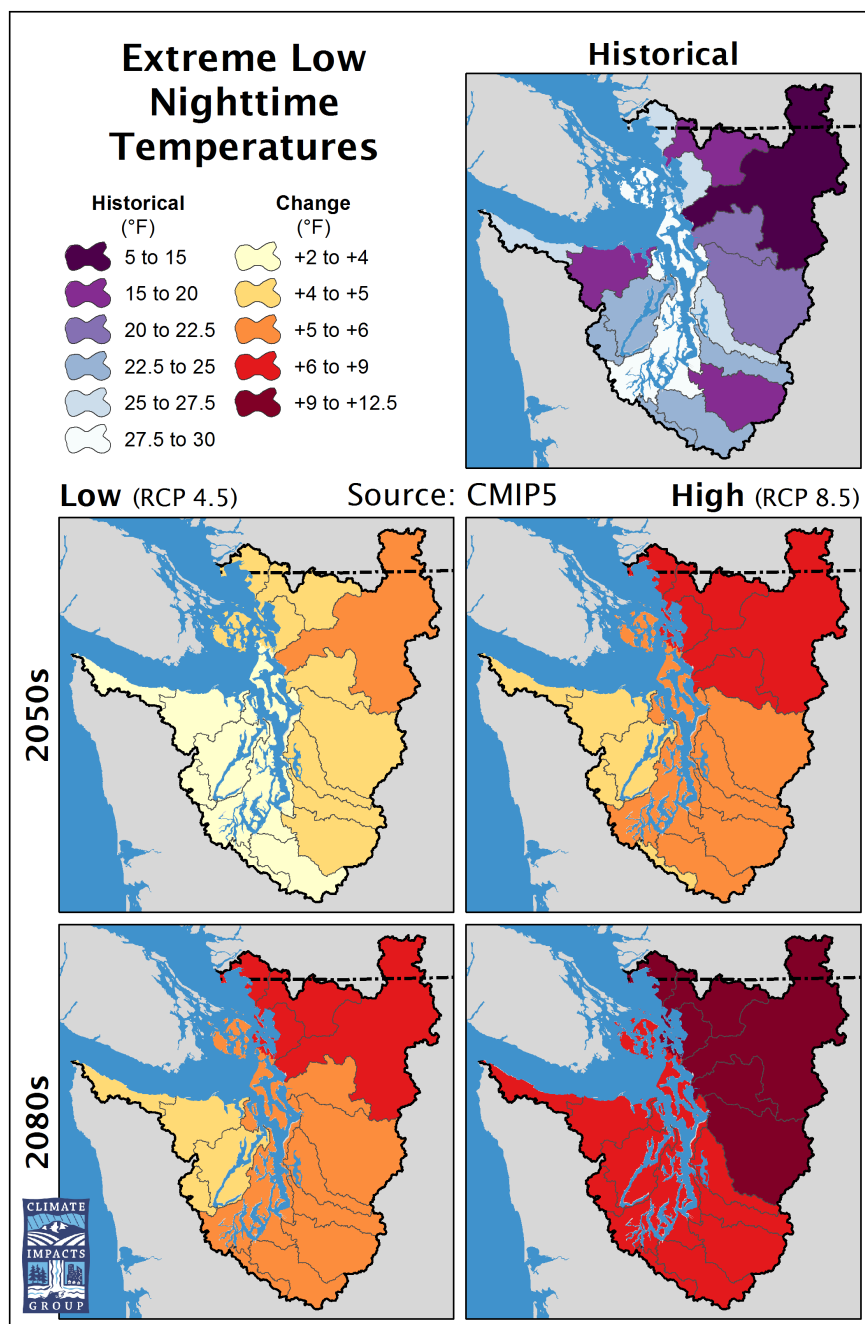


Figure 5b. Extreme low nighttime temperatures, newer projections. As in Figure 5a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

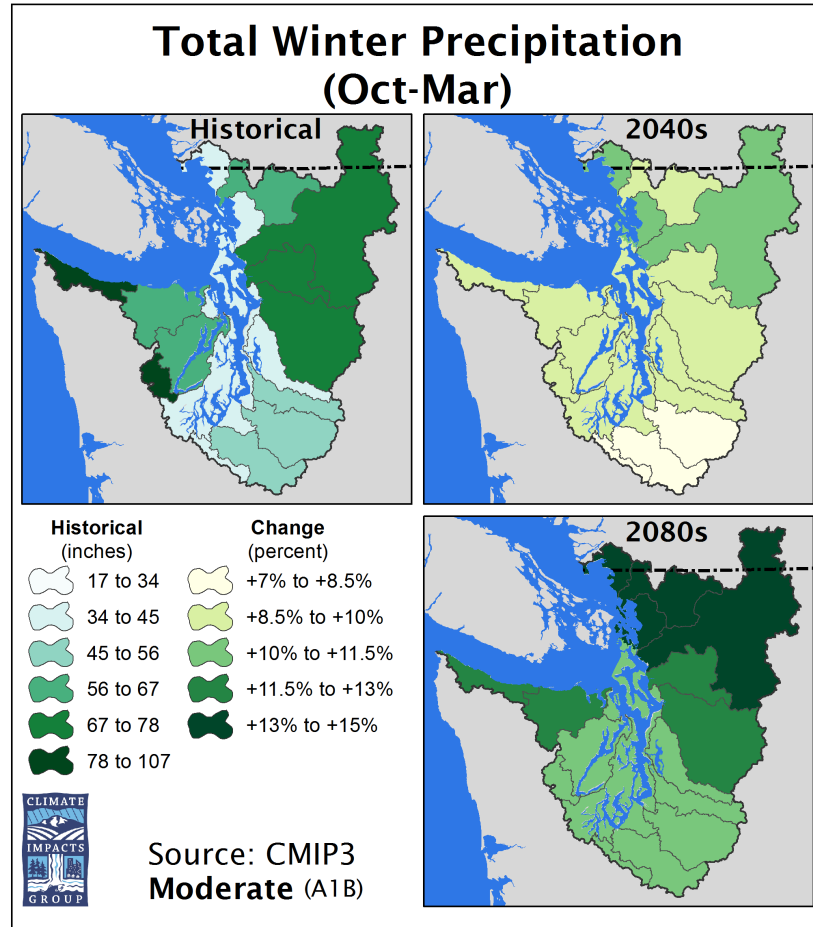


Figure 6a. Total winter precipitation, previous projections. Maps show the historical and projected total winter (October–March) precipitation. The figure compares watershed averages for historical conditions (1970–1999, in inches) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030–2059) and the 2080s (2070–2099), based on a moderate greenhouse gas scenario (A1B). Dark green shading on the historical map indicates areas that have received highest levels of total winter precipitation in Puget Sound. Projected changes are depicted by the light to dark green shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

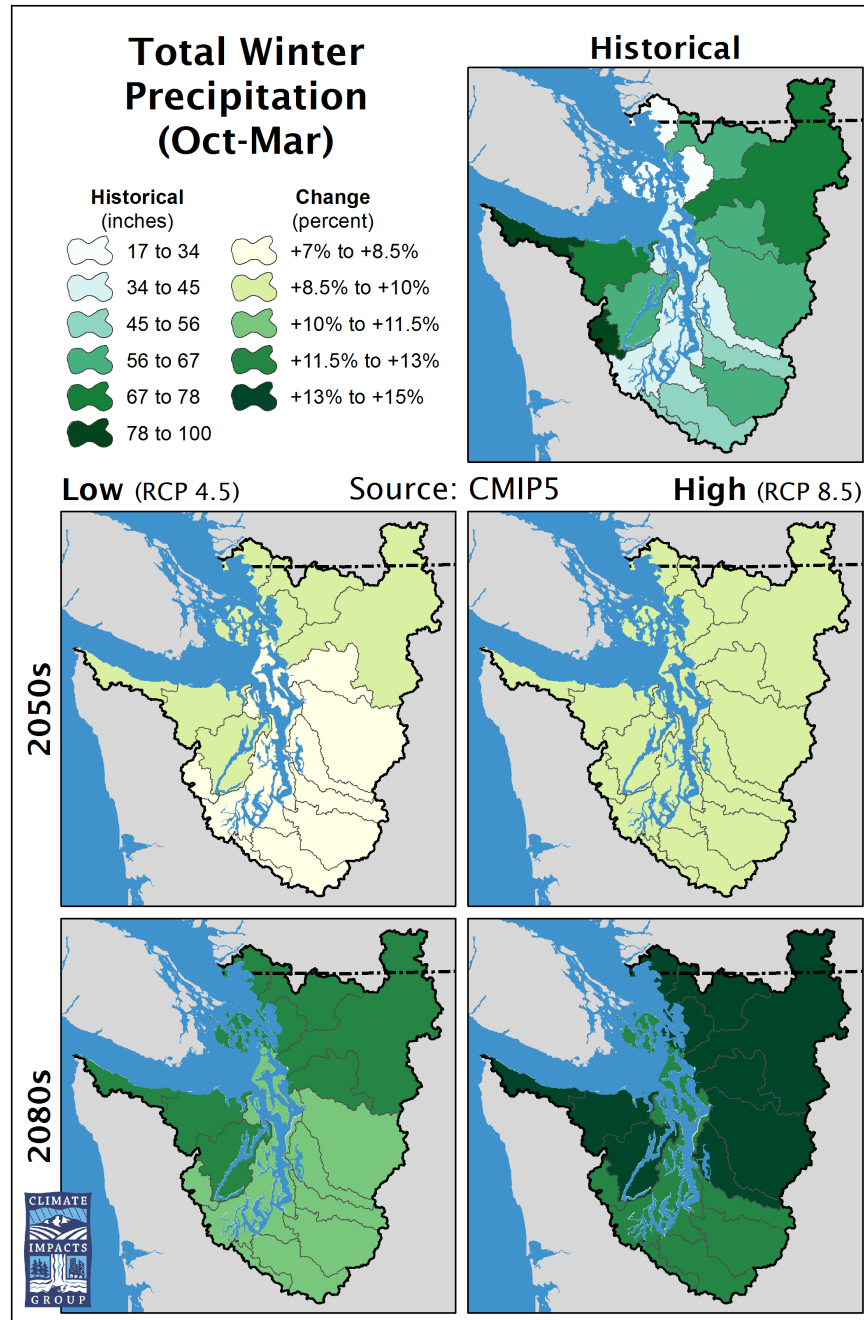


Figure 6b. Total winter precipitation, newer projections. As in Figure 6a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

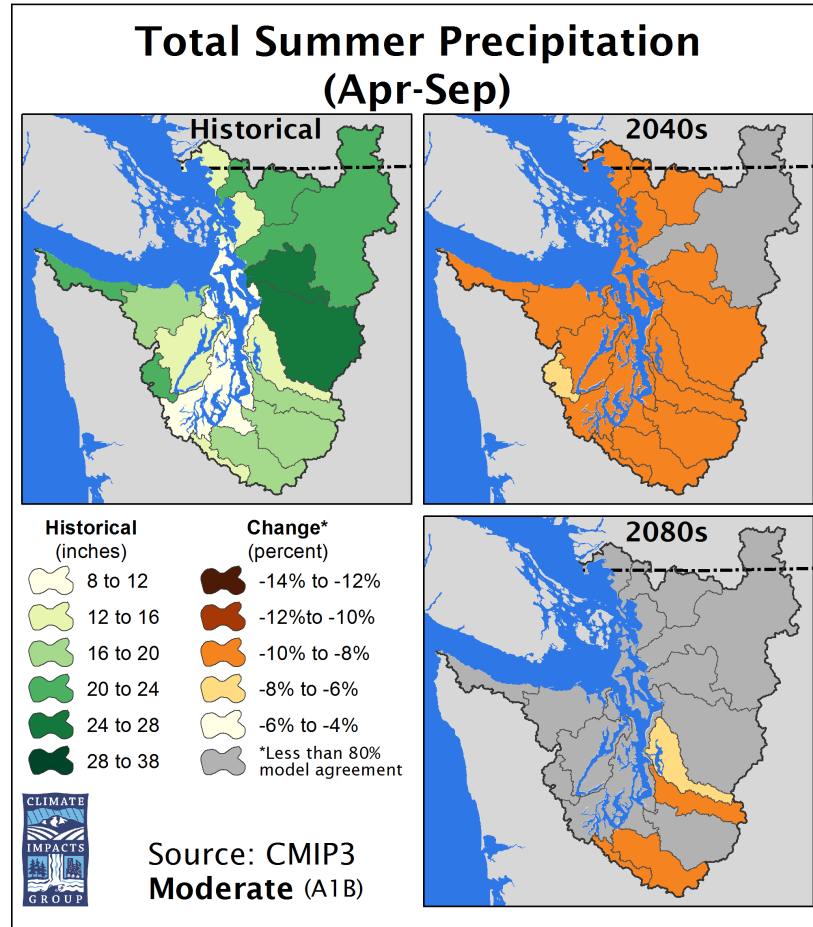


Figure 7a. Total summer precipitation, previous projections. Maps show the historical and projected total summer (April-September) precipitation. The figure compares watershed averages for historical conditions (1970-1999, in inches) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark green shading on the historical map indicates areas that have received highest levels of summer precipitation in Puget Sound. Projected changes are depicted by the yellow to red shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

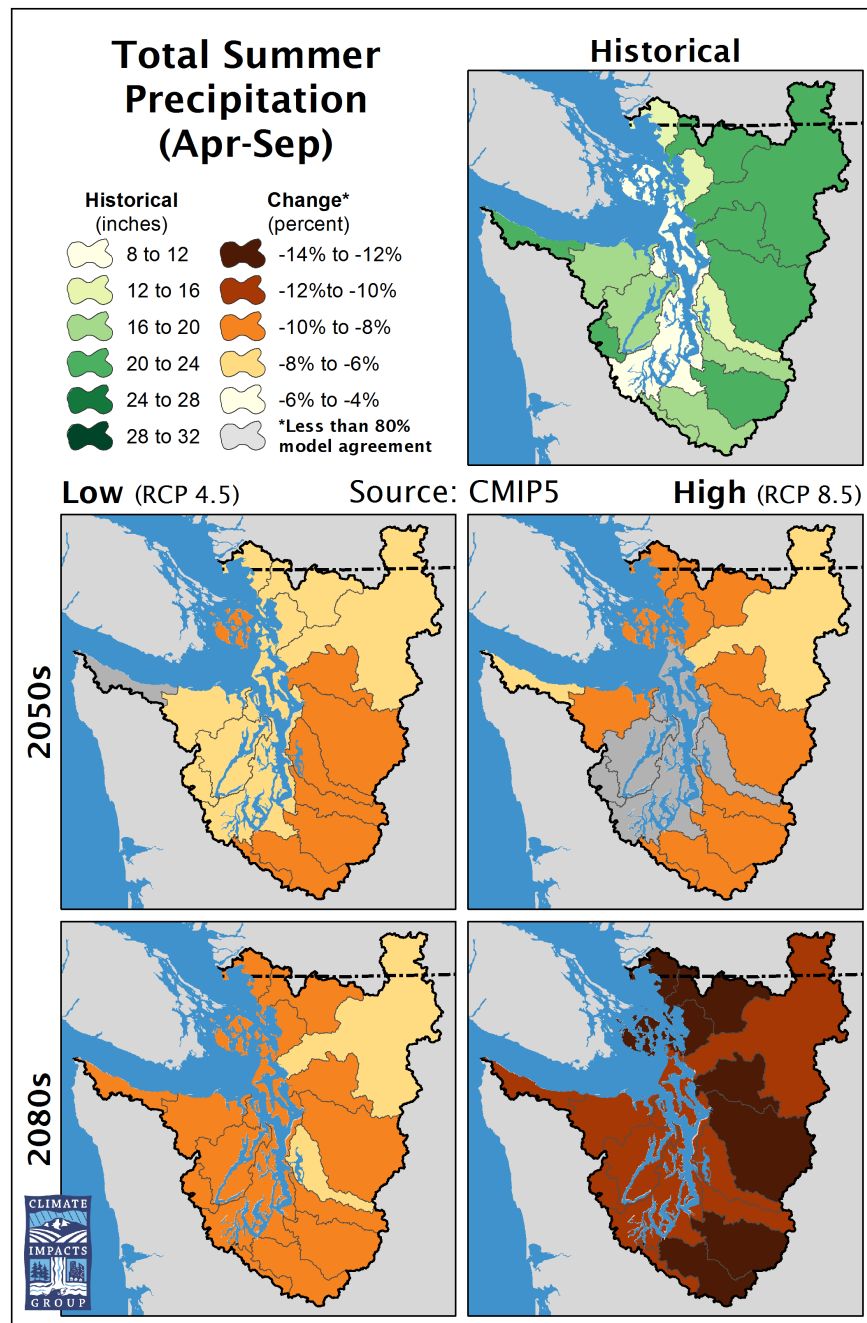


Figure 7b. Total summer precipitation, newer projections. As in Figure 7a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

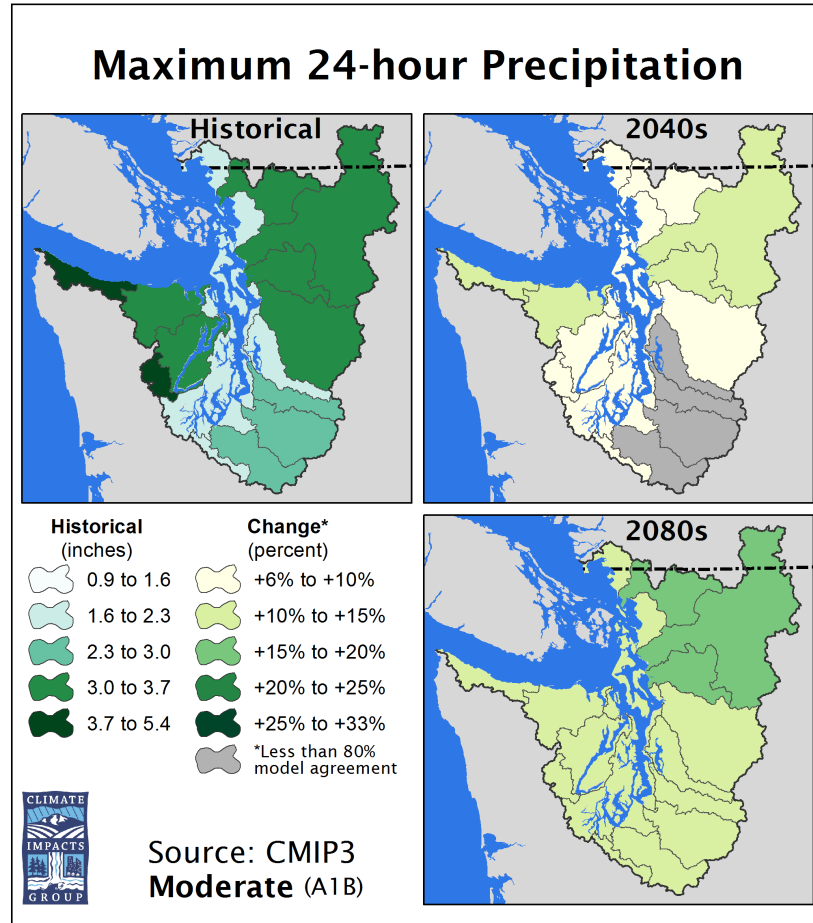


Figure 8a. Maximum 24-hour precipitation, previous projections. Maps show the maximum daily precipitation for Puget Sound watersheds. The figure compares watershed averages for historical conditions (1970-1999, in inches) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark green shading on the historical map indicates areas that have received highest levels of maximum daily precipitation in Puget Sound. Projected changes are depicted by the light to dark green shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

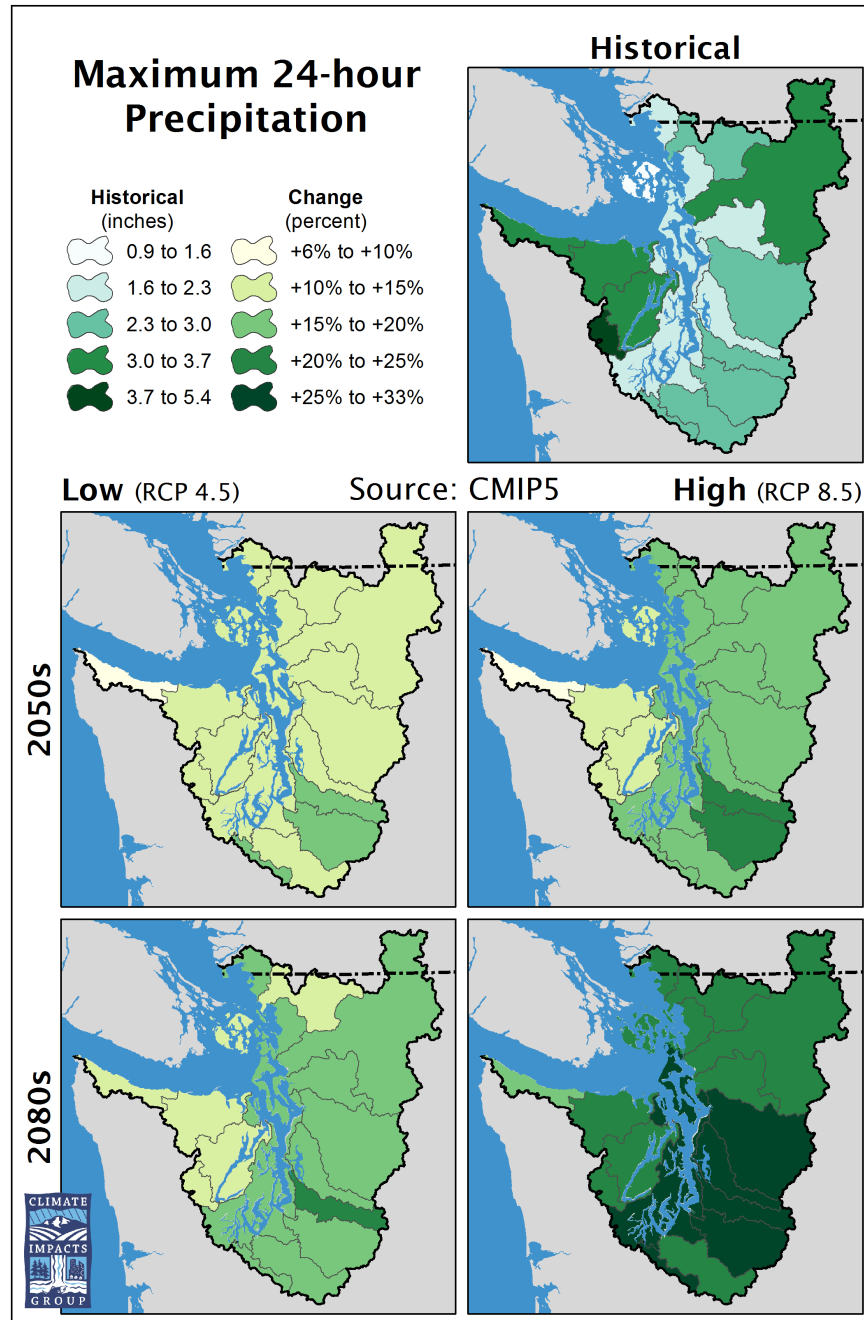


Figure 8b. Maximum 24-hour precipitation, newer projections. As in Figure 8a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

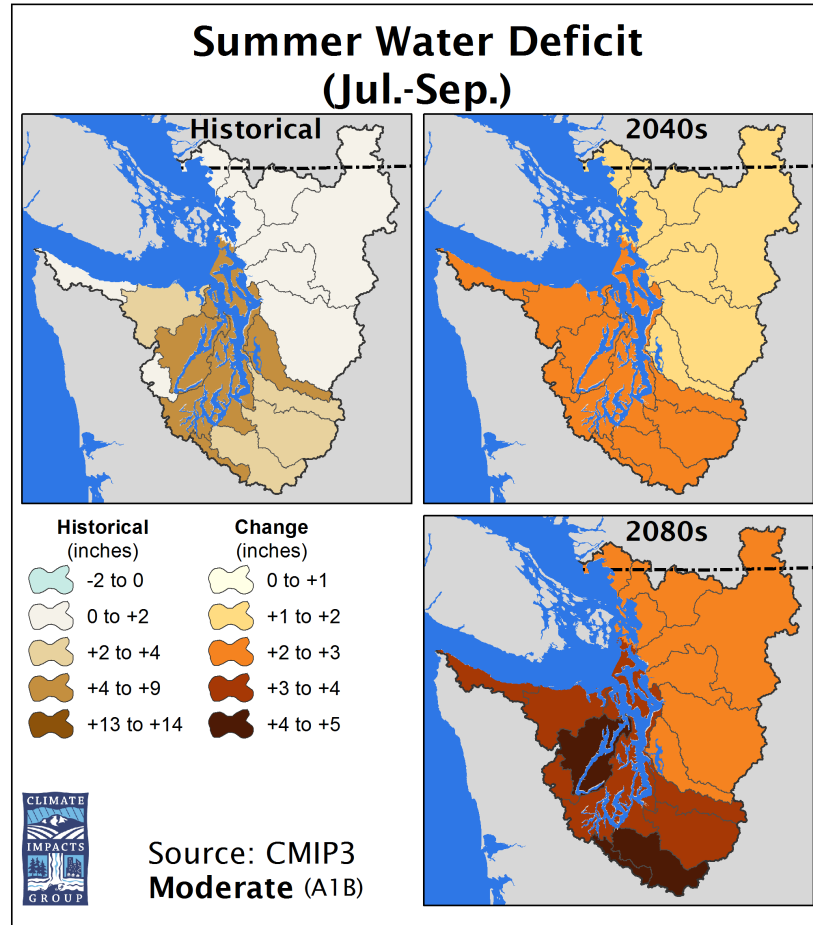


Figure 9a. Summer Water Deficit, previous projections. Maps show the historical and projected summer (July-September) water deficit, based on the amount of soil moisture available relative to atmospheric demand for water via evaporation, either from water bodies or vegetation. Maps compare watershed averages for historical conditions (1970-1999) and the projected change for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Teal shading indicates areas where water availability exceeds water demand. Light to dark brown shading indicates areas where a positive water deficit occurs, that is, regions where water demands exceed soil water availability. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

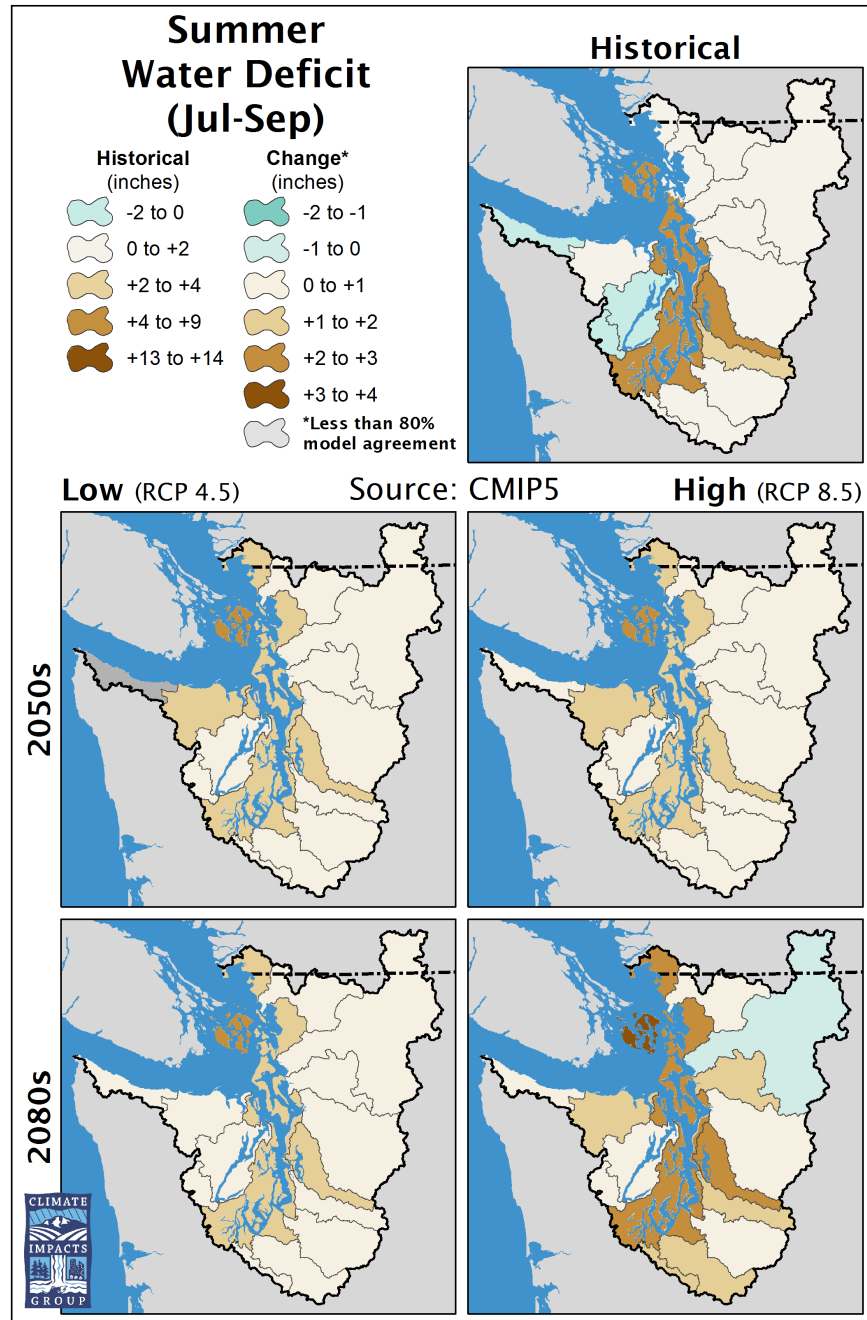


Figure 9b. Summer Water Deficit, newer projections. As in Figure 9a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹*

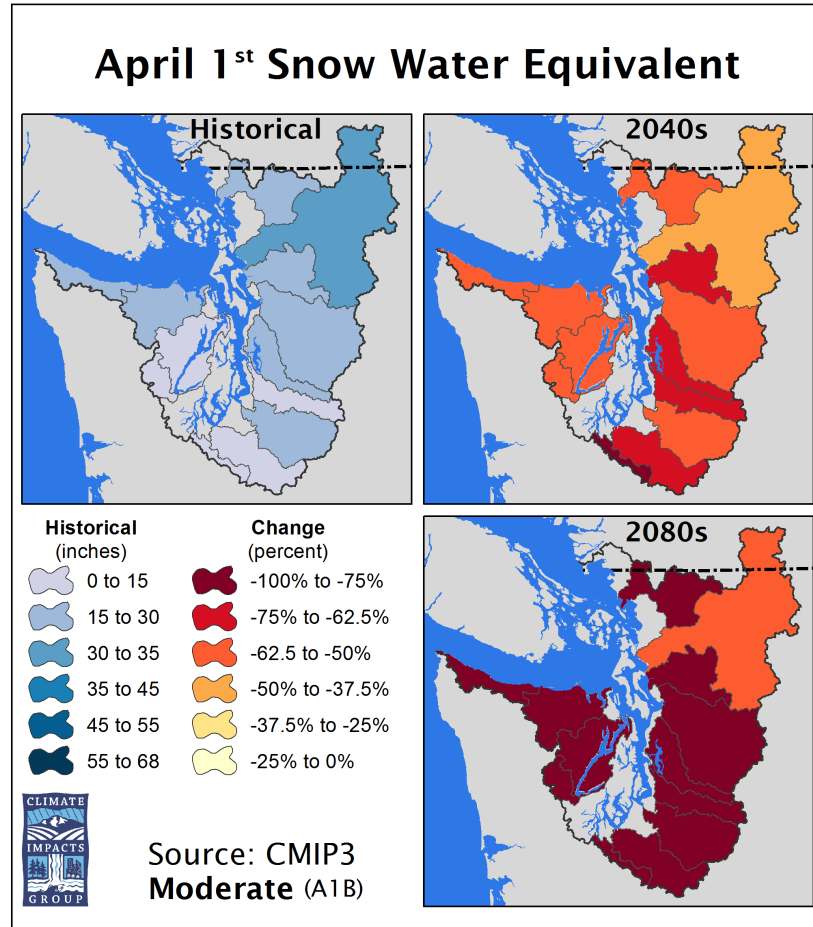


Figure 10a. April 1st Snow Water Equivalent, previous projections. Maps show the historical and projected April 1st snow water equivalent (SWE), a measure of the total amount of water contained in the snowpack. The figure compares watershed averages for historical conditions (1970-1999, in inches) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds with an average historical April 1st SWE of at least 0.4 inch. White to dark blue shading on the historical map indicates areas which received highest levels of April 1st snow water equivalent in Puget Sound. Projected decreases in snow water equivalent are depicted by the yellow to red shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

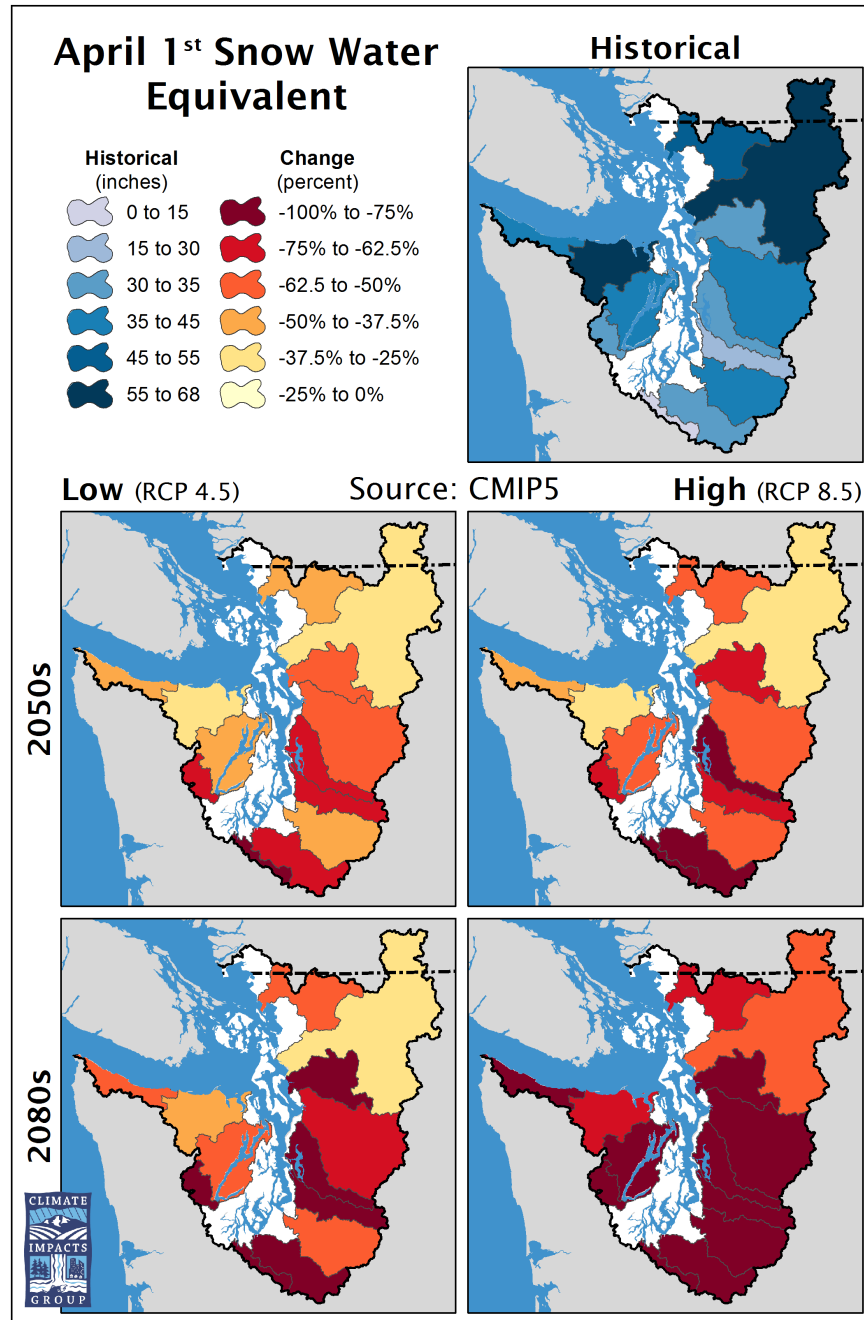


Figure 10b. April 1st Snow Water Equivalent, newer projections. As in Figure 10a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹*

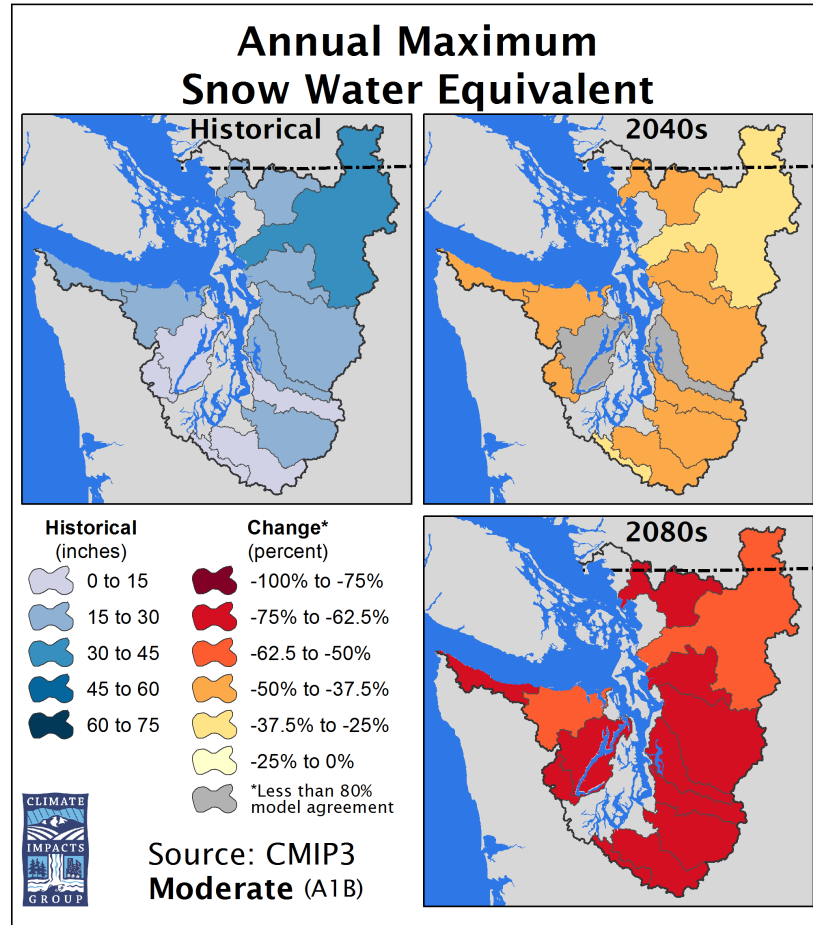


Figure 11a. Annual Maximum Snow Water Equivalent, previous projections. Maps show the historical and projected annual maximum snow water equivalent (SWE), a measure of the total amount of water contained in the snowpack. The figure compares watershed averages for historical conditions (1970-1999, in inches) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds with an average historical April 1st SWE of at least 0.4 inch, and for which at least 8 out of the 10 models agree on the direction of change. White to dark blue shading on the historical map indicates areas which received highest levels of April 1st snow water equivalent in Puget Sound. Projected decreases in snow water equivalent are depicted by the yellow to red shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

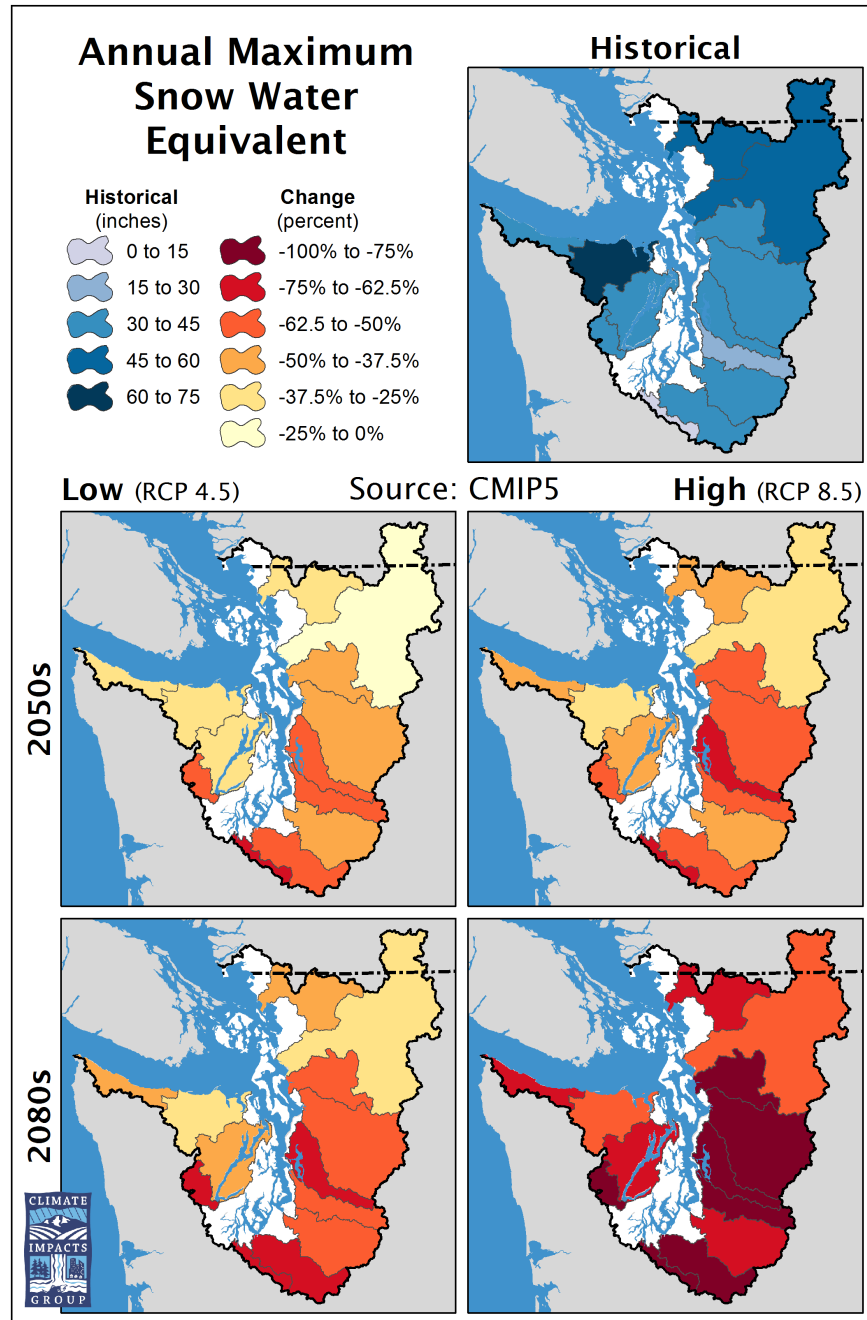


Figure 11b. Annual Maximum Snow Water Equivalent, newer projections. As in Figure 11a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

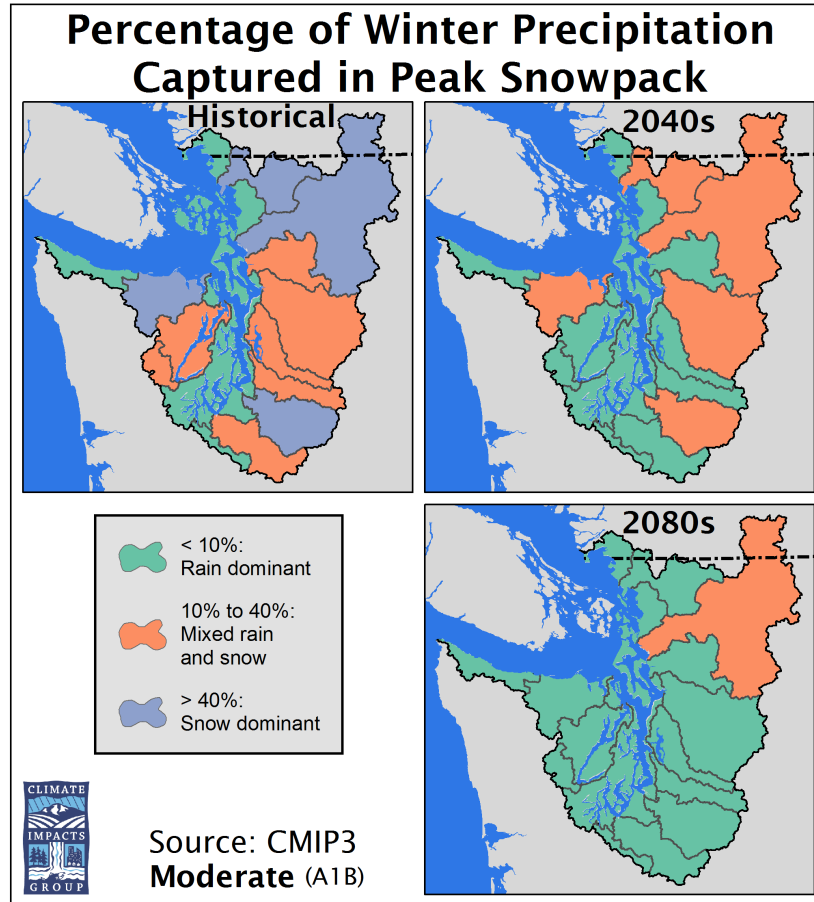


Figure 12a. Percentage of Winter Precipitation Captured in Peak Snowpack, previous projections. Maps show the historical and projected percentage of winter (October-March) precipitation that is retained in the annual maximum snow water equivalent (SWE). The figure compares watershed averages for historical conditions (1970-1999) to the conditions projected by the average of ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Green shading in the maps indicates warm ("rain-dominant") watersheds, which retain less than 10% of winter precipitation as snow. Blue indicates cold ("snow-dominant") watersheds, that is, cold basins that retain more than 40% of their winter precipitation as snow. The most sensitive basins to warming are the watersheds that are near the current snowline ("mixed rain and snow"), shown in red. Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³

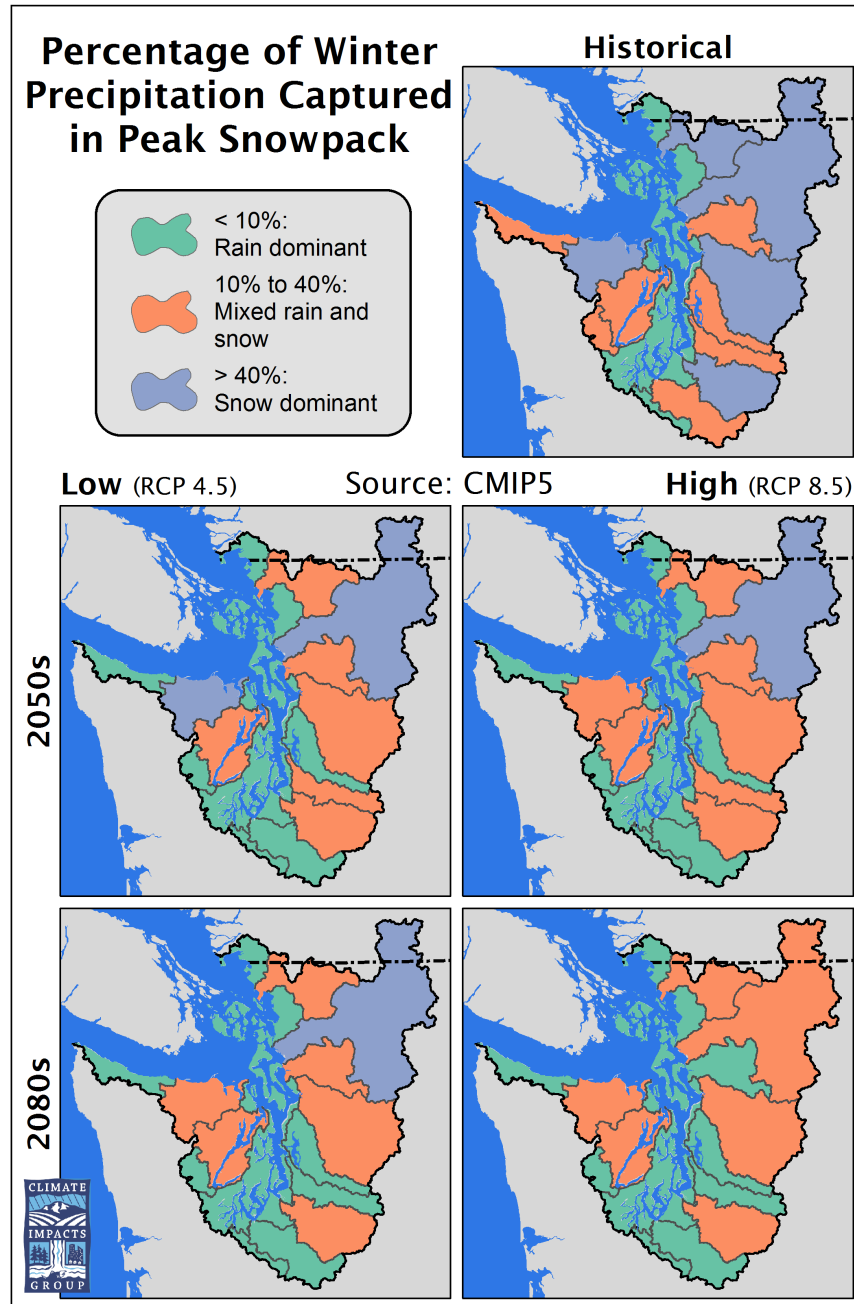


Figure 12b. Percentage of Winter Precipitation Captured in Peak Snowpack, newer projections. As in Figure 12a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

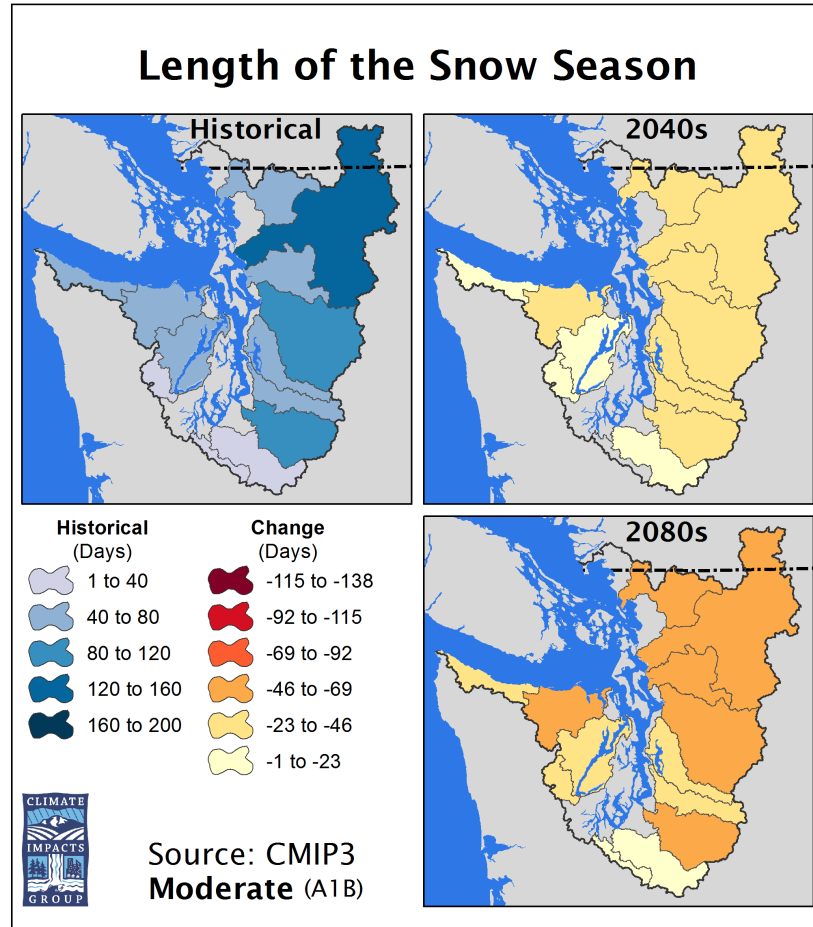


Figure 13a. Length of the Snow Season, previous projections. Maps show the historical and projected change in the length of the snow season, defined as the number of days between the date of 10% accumulation and 90% melt, relative to annual maximum snow water equivalent (see Figures 11a and 11b). The figure compares watershed averages for historical conditions (1970-1999, in inches) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds with an average historical April 1st SWE of at least 0.4 inch, and for which at least 8 out of the 10 models agree on the direction of change. White to dark blue shading on the historical map indicates areas which received highest levels of April 1st snow water equivalent in Puget Sound. Projected decreases in snow water equivalent are depicted by the yellow to red shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

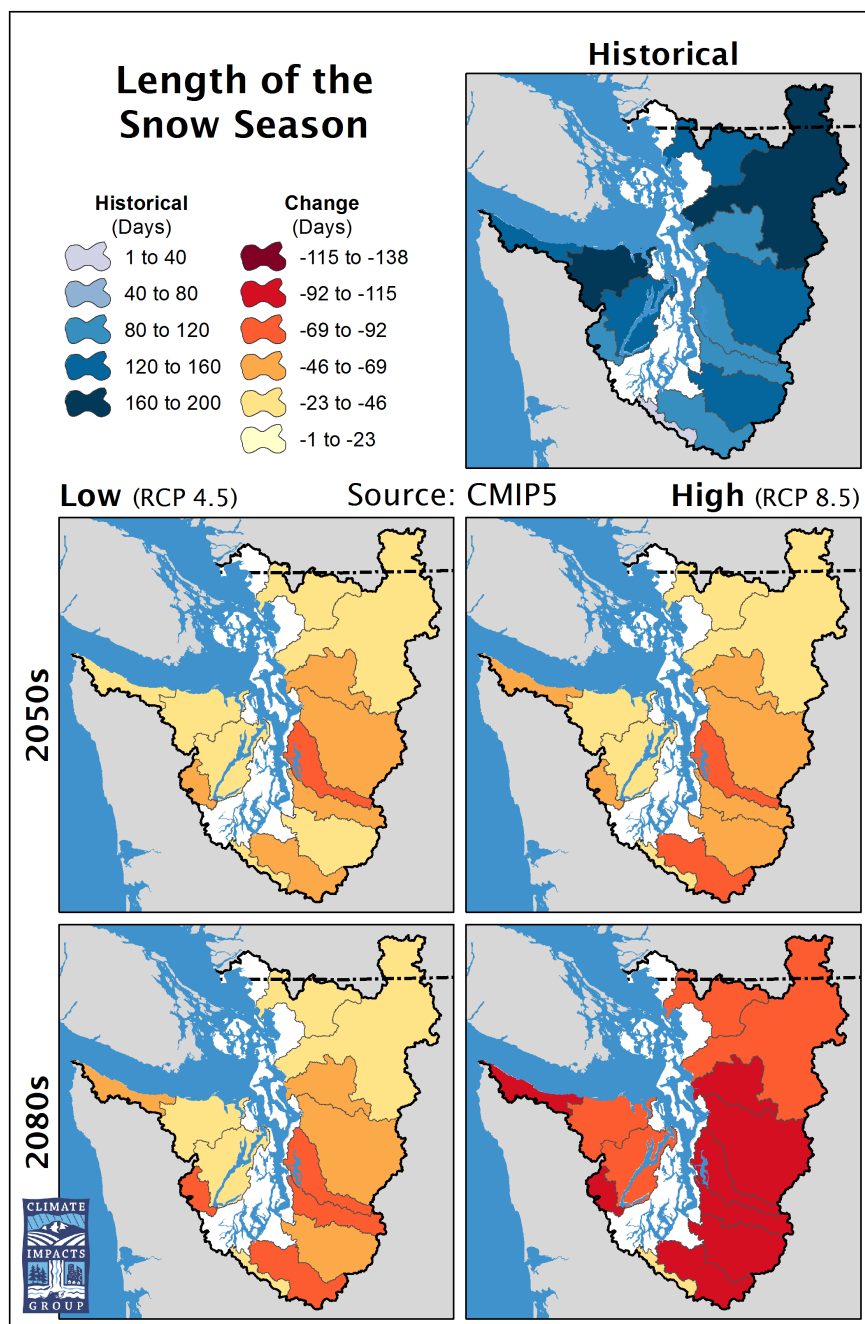


Figure 13b. Length of the Snow Season, newer projections. As in Figure 13a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

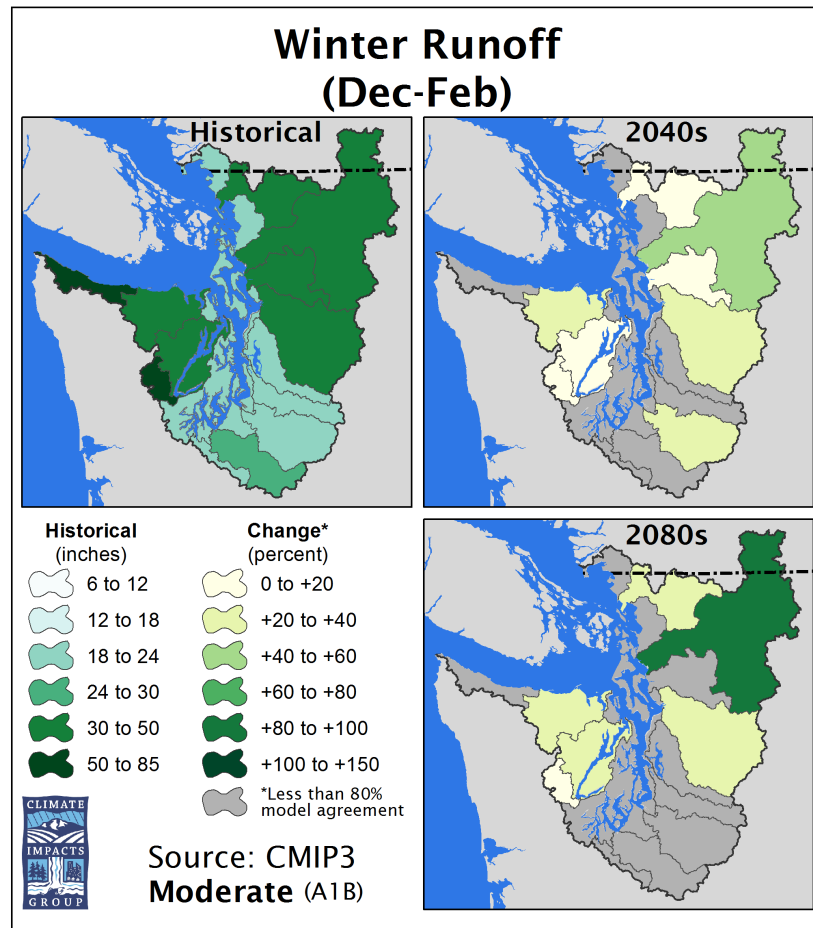


Figure 14a. Winter runoff, previous projections. Maps show the historical and projected total summer (December-February) runoff. This includes any overland water flows in addition to subsurface runoff in shallow groundwater. The figure compares watershed averages for historical conditions (1970-1999, in inches) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Dark green shading on the historical map indicates areas that have received highest levels of total winter precipitation in Puget Sound. Projected changes are depicted by the light to dark green shading. Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³

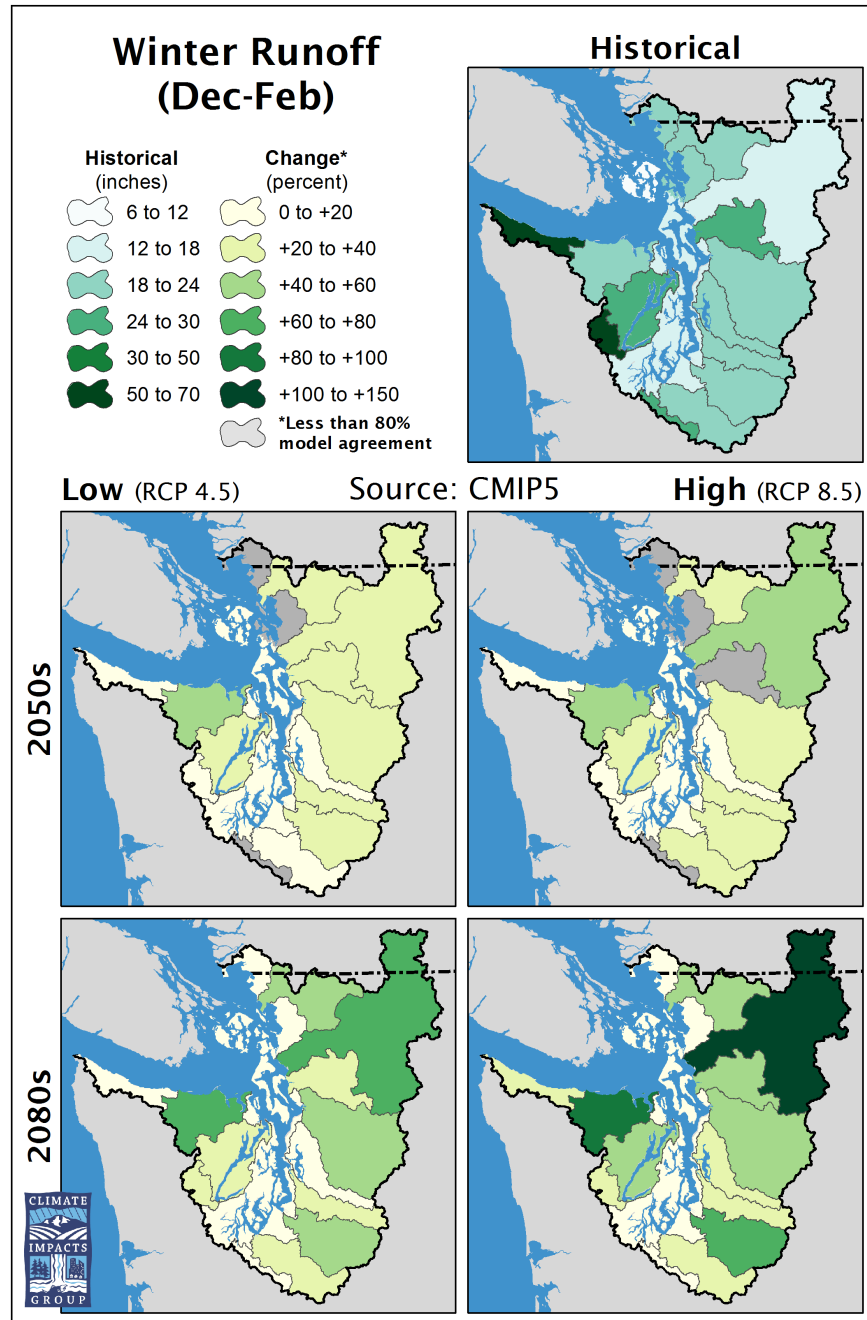


Figure 14b. Winter runoff, newer projections. As in Figure 14a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

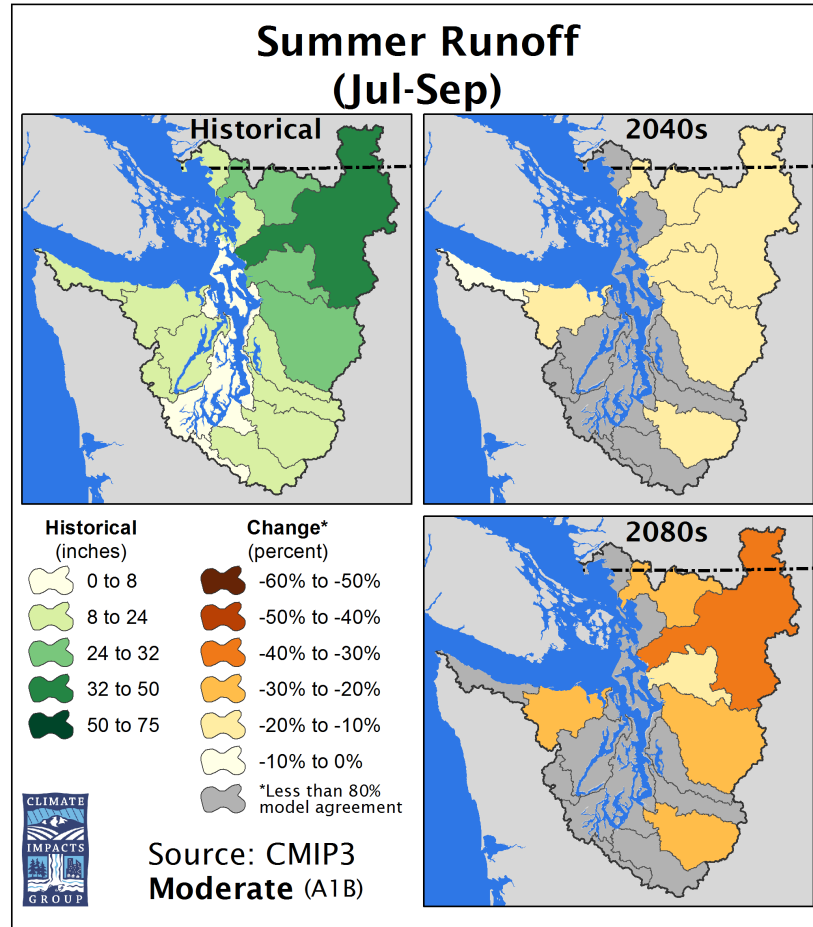


Figure 15a. Summer runoff, previous projections. Maps show the historical and projected total summer (July-September) runoff. This includes any overland water flows in addition to subsurface runoff in shallow groundwater. The figure compares watershed averages for historical conditions (1970-1999, in inches) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Dark green shading on the historical map indicates areas that have received highest streamflow in Puget Sound. Projected changes are depicted by the yellow to red shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

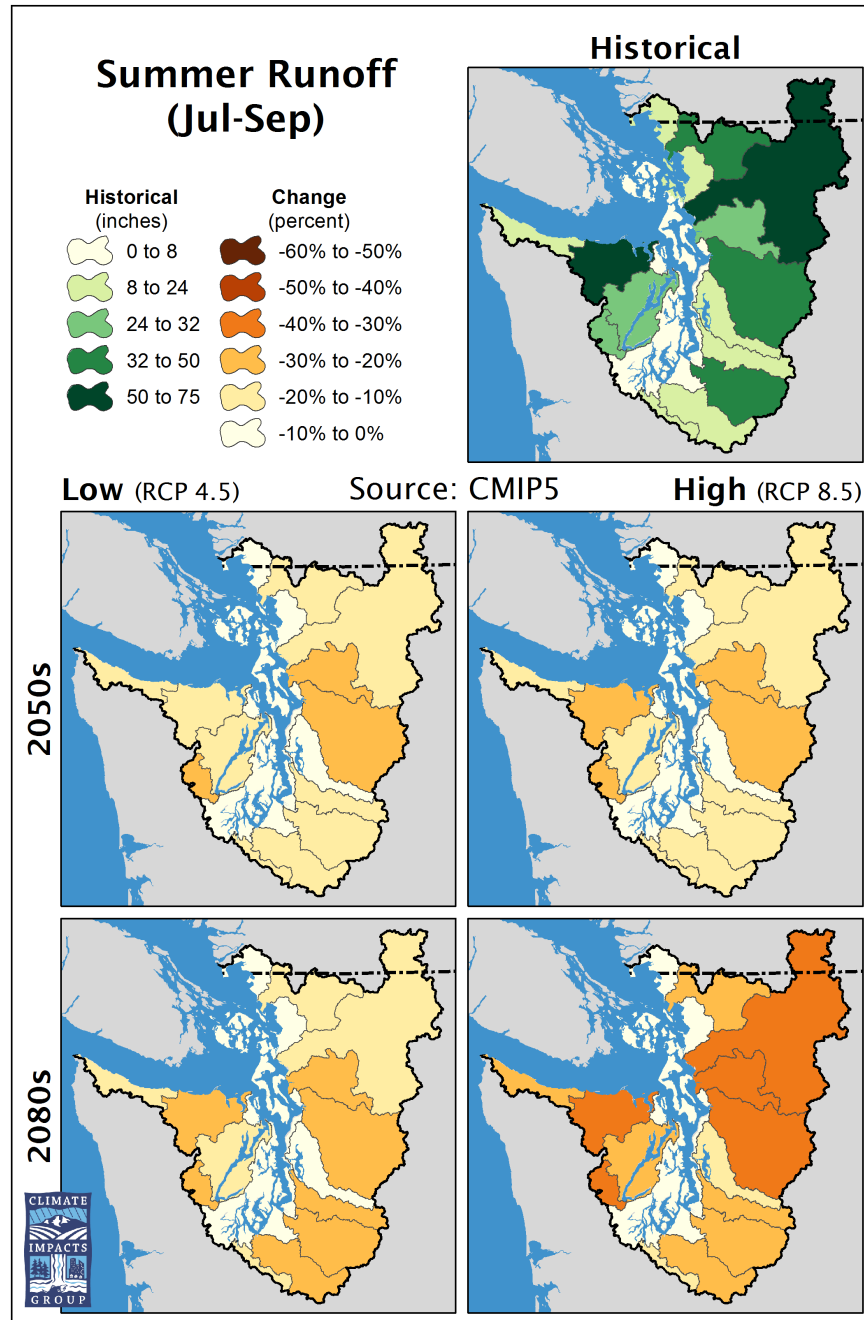


Figure 15b. Summer runoff, newer projections. As in Figure 15a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

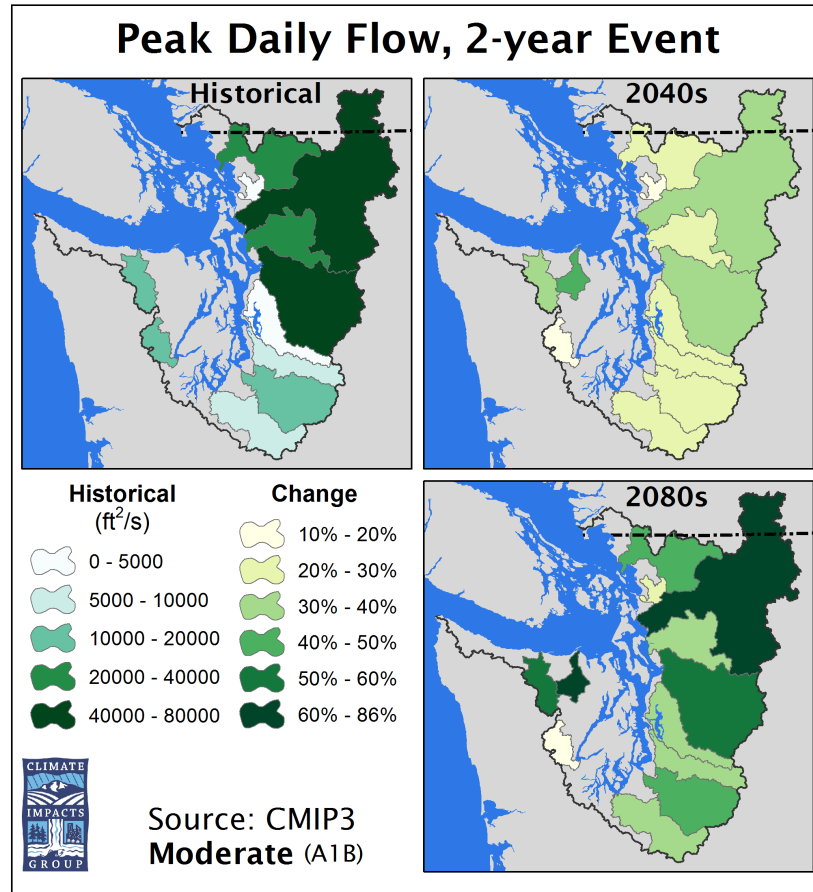


Figure 16a. Peak daily streamflow, 2-year event, previous projections. Maps show the historical and projected change in the peak daily streamflow volume with a 2-year return interval (50% annual chance of exceedance). Daily streamflow for each watershed was assessed at the mouth of each river. The figure includes a map of historical conditions (1970-1999, in ft³/s) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark green shading on the historical map indicates areas that have the greatest flows historically. Projected changes are depicted by the yellow to green shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

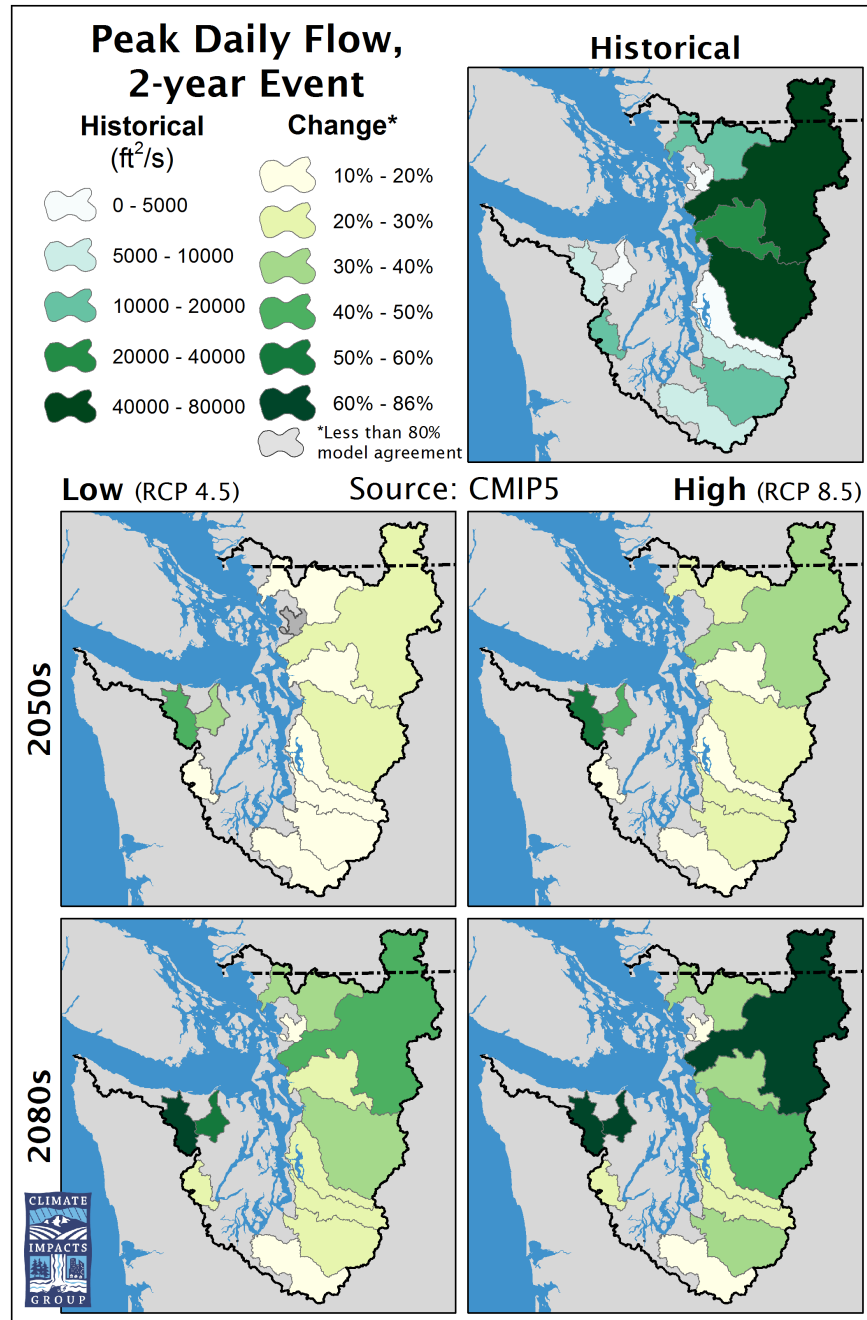


Figure 16b. Peak daily streamflow, 2-year event, newer projections. As in Figure 16a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

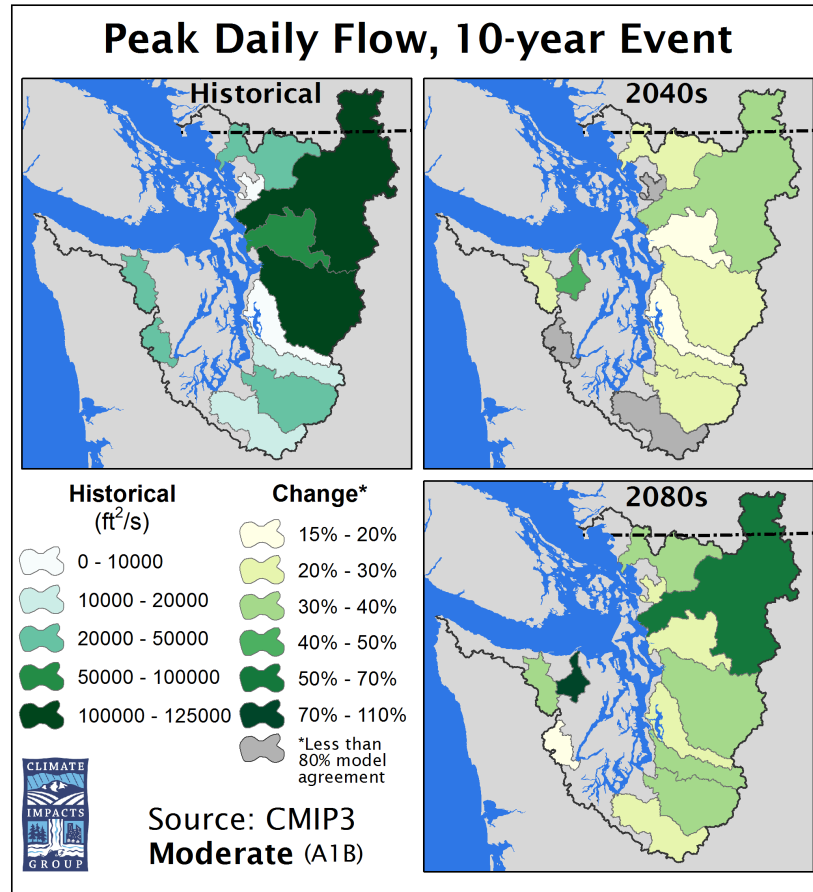


Figure 17a. Peak daily streamflow, 10-year event, previous projections. Maps show the historical and projected change in the peak daily streamflow volume with a 10-year return interval (10% annual chance of exceedance). Daily streamflow for each watershed was assessed at the mouth of each river. The figure includes a map of historical conditions (1970-1999, in ft³/s) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark green shading on the historical map indicates areas that have the greatest flows historically. Projected changes are depicted by the yellow to green shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

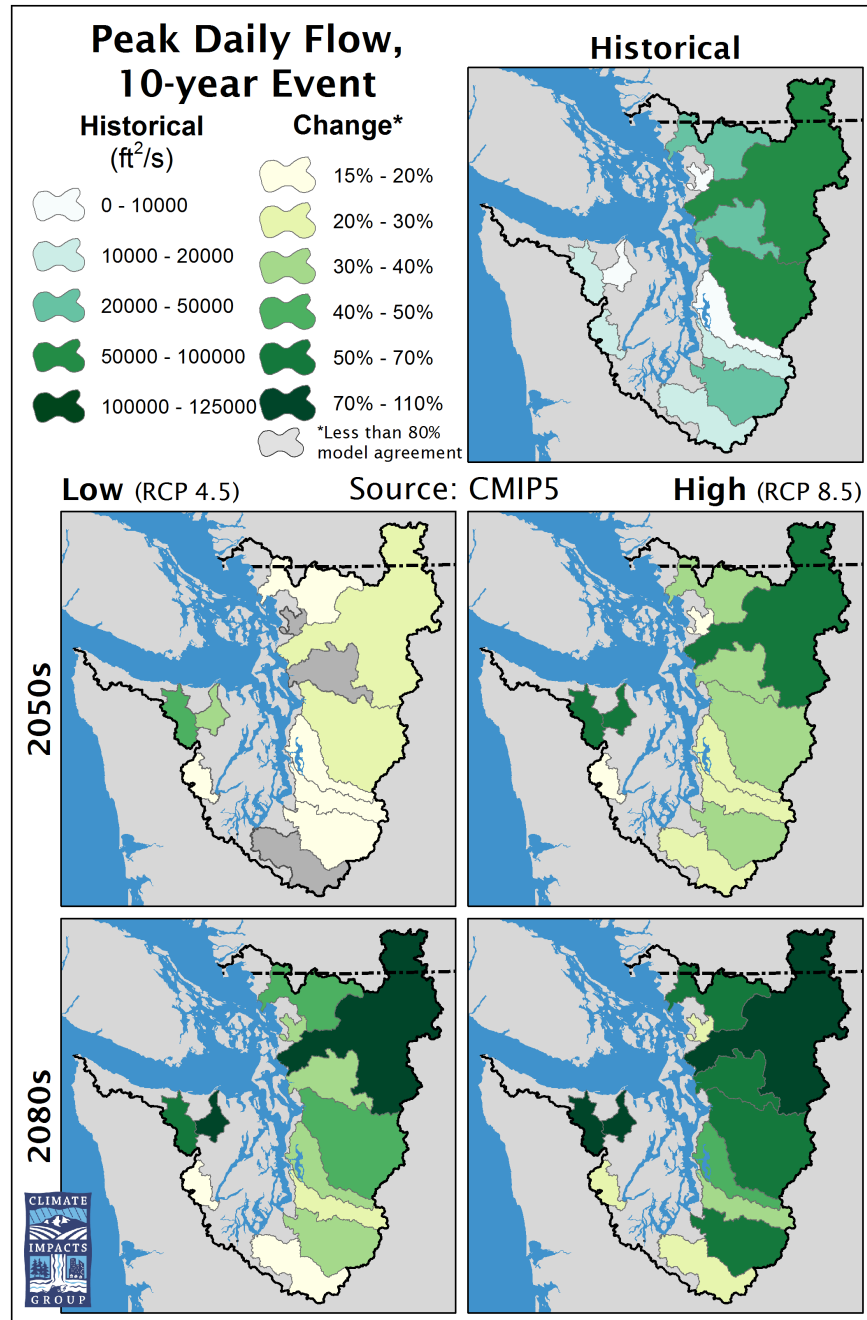


Figure 17b. Peak daily streamflow, 10-year event, newer projections. As in Figure 17a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

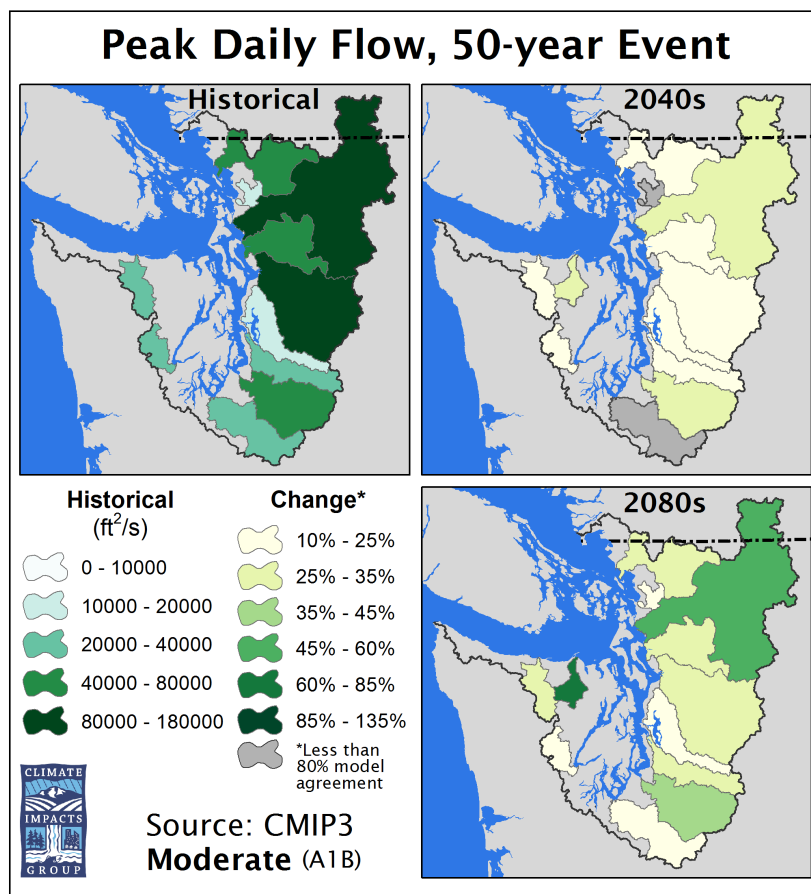


Figure 18a. Peak daily streamflow, 50-year event, previous projections.

Maps show the historical and projected change in the peak daily streamflow volume with a 50-year return interval (2% annual chance of exceedance). Daily streamflow for each watershed was assessed at the mouth of each river. The figure includes a map of historical conditions (1970-1999, in ft³/s) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark green shading on the historical map indicates areas that have the greatest flows historically. Projected changes are depicted by the yellow to green shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

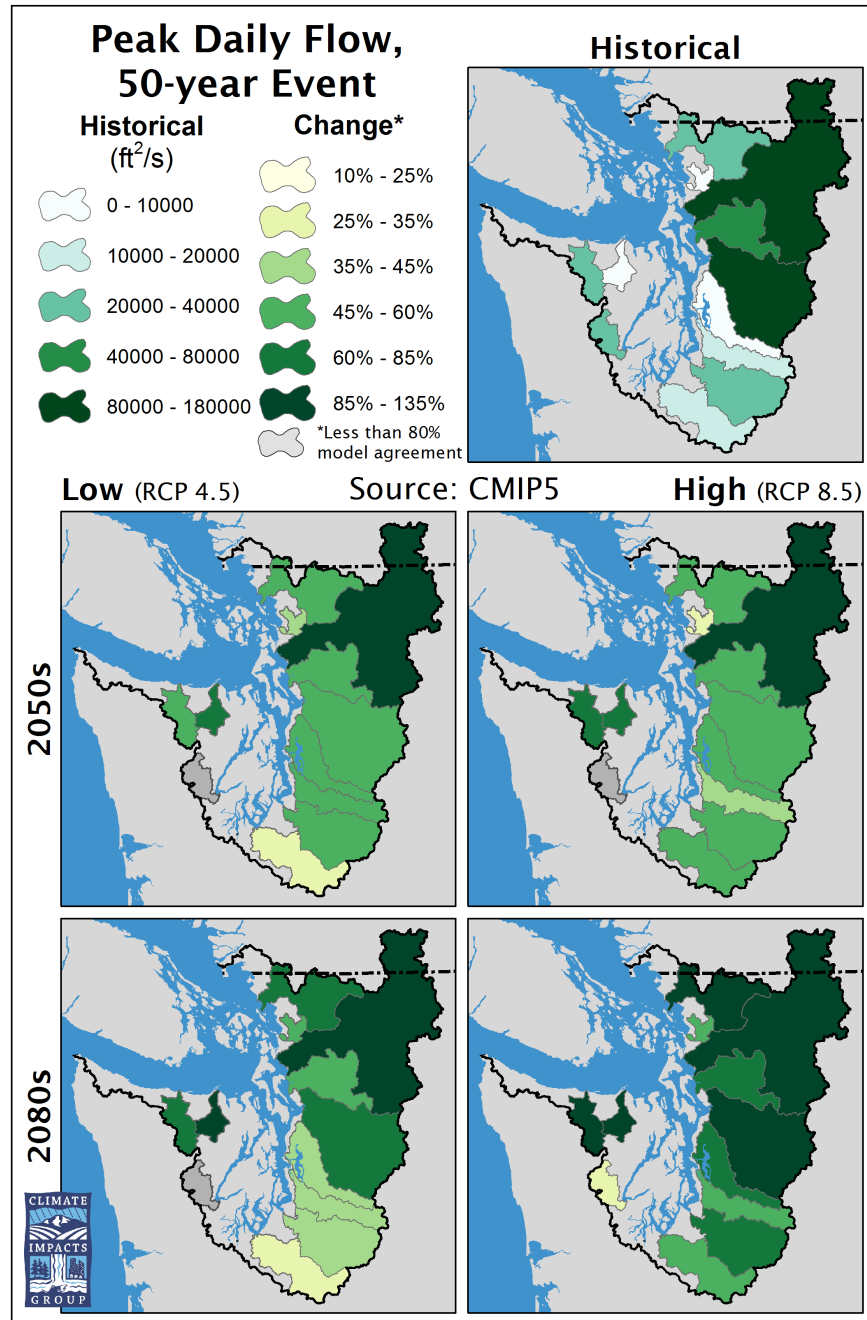


Figure 18b. Peak daily streamflow, 50-year event, newer projections. As in Figure 18a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

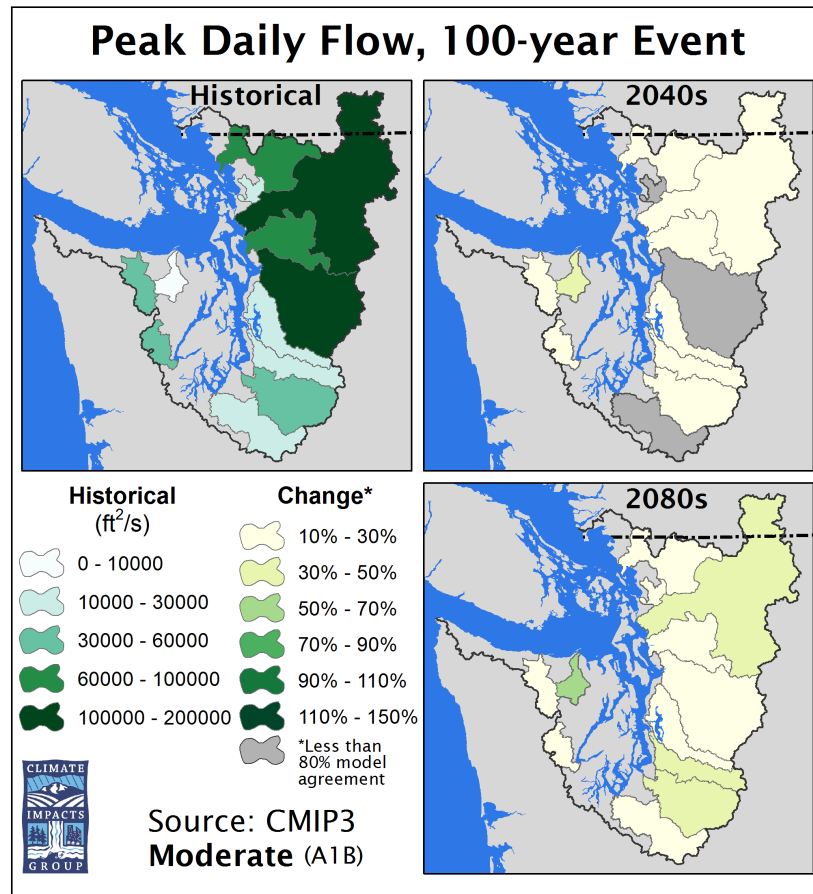


Figure 19a. Peak daily streamflow, 100-year event, previous projections. Maps show the historical and projected change in the peak daily streamflow volume with a 100-year return interval (1% annual chance of exceedance). Daily streamflow for each watershed was assessed at the mouth of each river. The figure includes a map of historical conditions (1970-1999, in ft³/s) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark green shading on the historical map indicates areas that have the greatest flows historically. Projected changes are depicted by the yellow to green shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

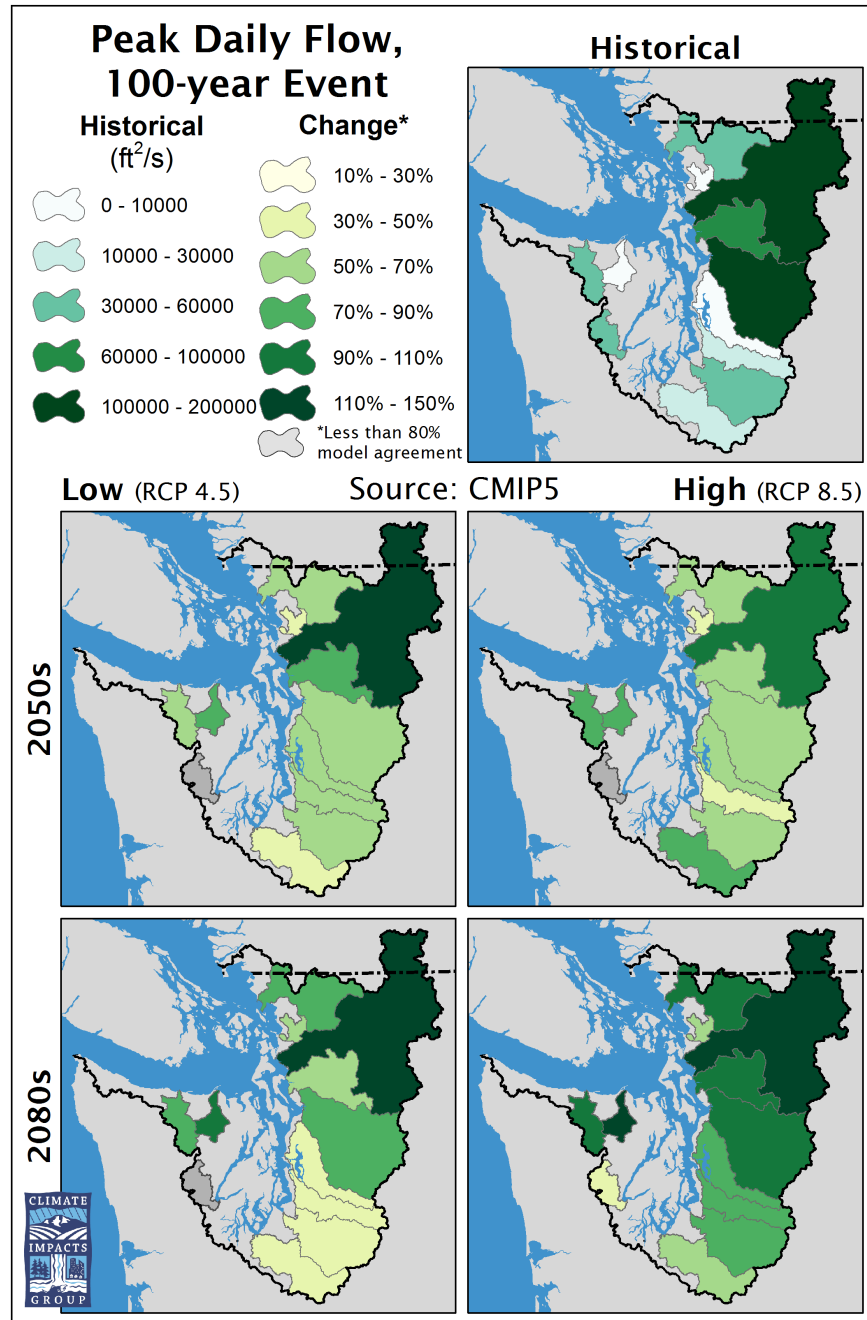


Figure 19b. Peak daily streamflow, 100-year event, newer projections. As in Figure 19a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

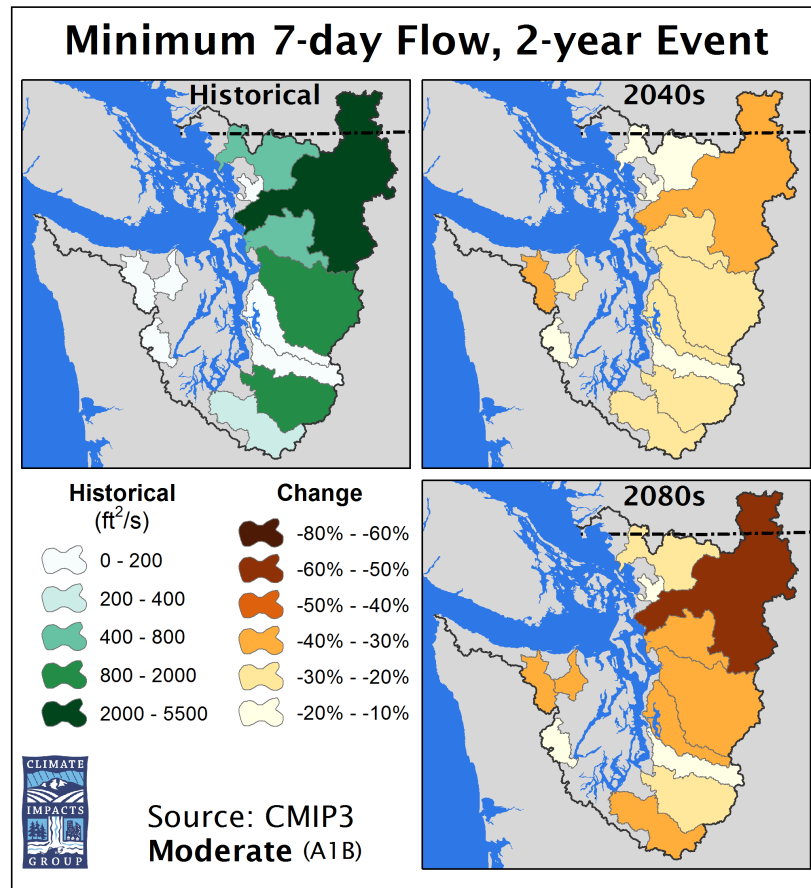


Figure 20a. Minimum 7-day streamflow, 2-year event, previous projections. Maps show the historical and projected change in the annual minimum 7-day streamflow volume with a 2-year return interval (50% annual chance of exceedance). Weekly (7-day) streamflow for each watershed was assessed at the mouth of each river. The figure includes a map of historical conditions (1970-1999, in ft³/s) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark green shading on the historical map indicates areas that have the greatest flows historically. Projected changes are depicted by the yellow to black shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

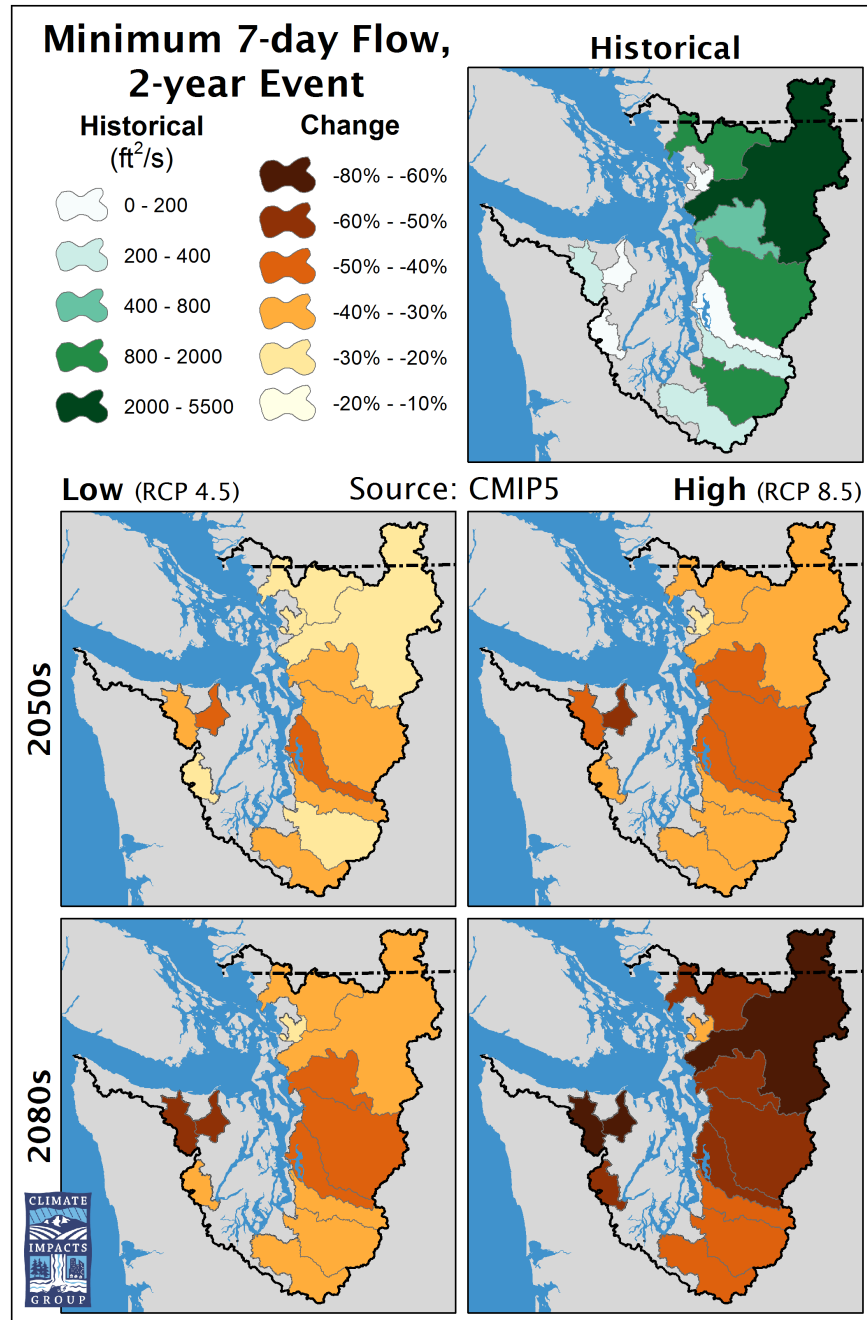


Figure 20b. Minimum 7-day streamflow, 2-year event, newer projections. As in Figure 20a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹

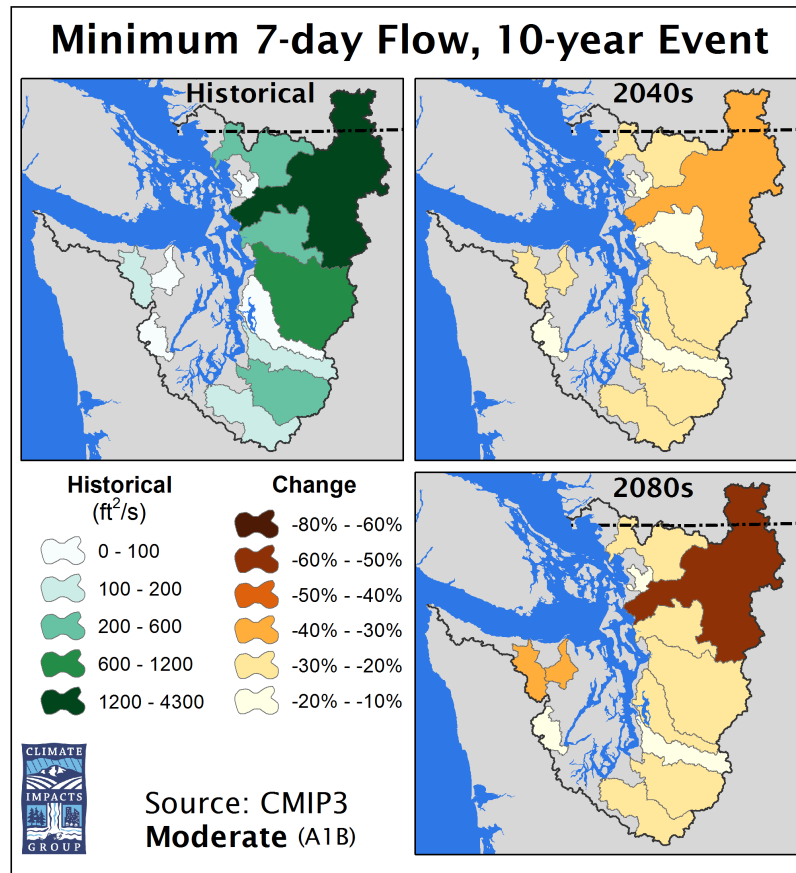


Figure 21a. Minimum 7-day streamflow, 10-year event, previous projections. Maps show the historical and projected change in the annual minimum 7-day streamflow volume with a 10-year return interval (10% annual chance of exceedance). Weekly (7-day) streamflow for each watershed was assessed at the mouth of each river. The figure includes a map of historical conditions (1970-1999, in ft³/s) and the projected change (in percent) for ten global models. Two time periods are considered: the 2040s (2030-2059) and the 2080s (2070-2099), based on a moderate greenhouse gas scenario (A1B). Results are only shown for watersheds for which at least 8 out of the 10 models agree on the direction of change. Dark green shading on the historical map indicates areas that have the greatest flows historically. Projected changes are depicted by the yellow to black shading. *Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP3 projections used in the IPCC 2007⁴ report. Data source: Hamlet et al. 2013.³*

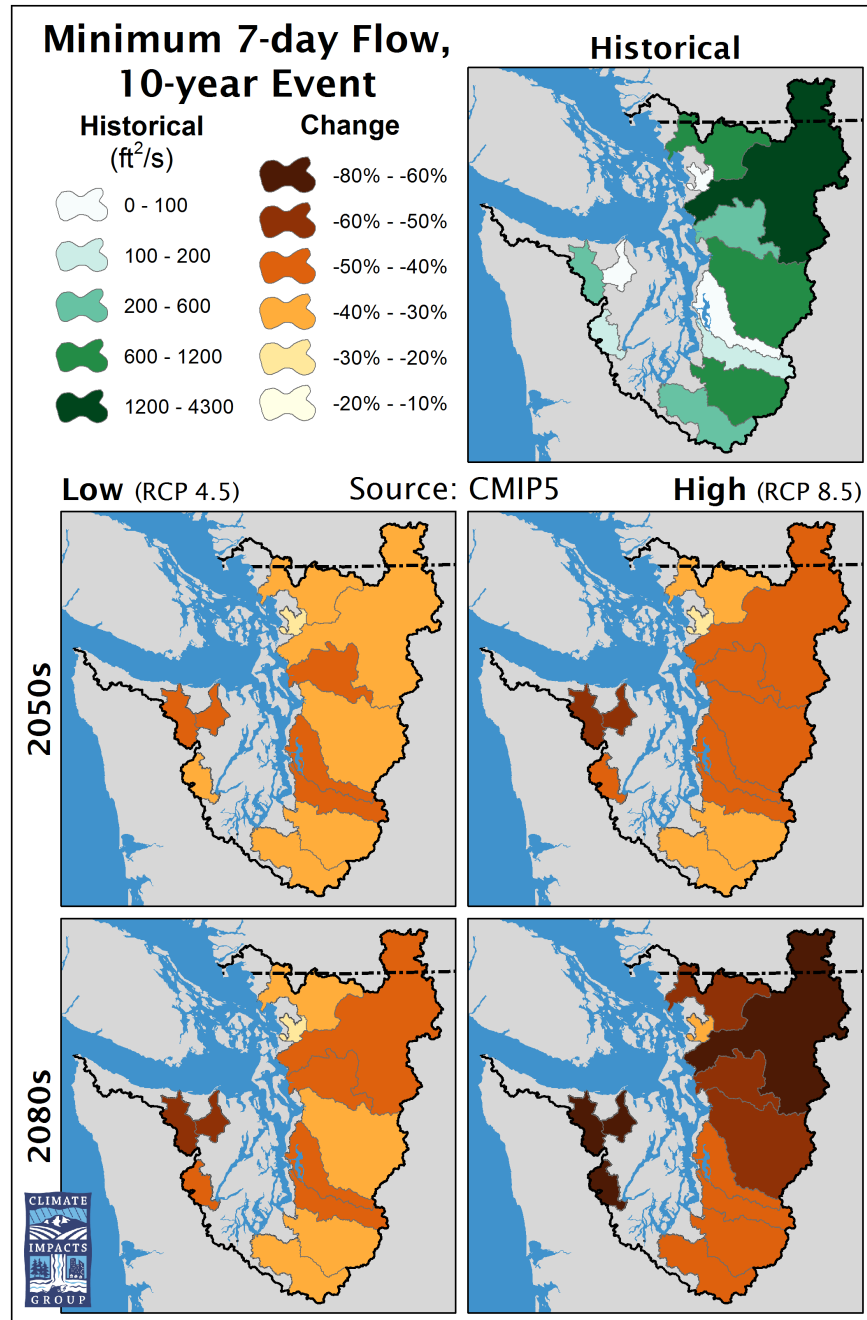


Figure 21b. Minimum 7-day streamflow, 10-year event, newer projections. As in Figure 21a, except showing results from the current generation of climate model projections. Instead of the 2040s, mid-century projections are shown for the 2050s (2040-2069), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5). Figure created by Robert Norheim, Climate Impacts Group, based on the CMIP5 projections used in the IPCC 2013² report. Data source: Mote et al. 2015.¹