PACIFIC CLIMATE IMPACTS CONSORTIUM

PCIC UPDATE SEPTEMBER 2015

METRO VANCOUVER CLIMATE EXTREMES PROJECTIONS

When we think of anthropogenic climate change, we might first think of changes to the global average temperature or precipitation over several decades. However, though climate change is a global phenomenon, it is felt regionally, and while anthropogenic greenhouse gas emissions are changing the average values of temperature and precipitation over long periods of time, they are also shaping climate extremes. These include things like the number of very warm and very cold days and nights, the maximum values of temperature and precipitation, and growing season length. Potential future changes to regional climate extremes are of great interest to anyone involved in planning as they have potential impacts that span from water availability, sewage treatment and infrastructure, to tourism and ecosystem services. As part of our ongoing work to address climate change adaptation in the Georgia Basin, PCIC is making use of high-resolution statistical downscaling to shed light on potential future changes to climate extremes in the region.

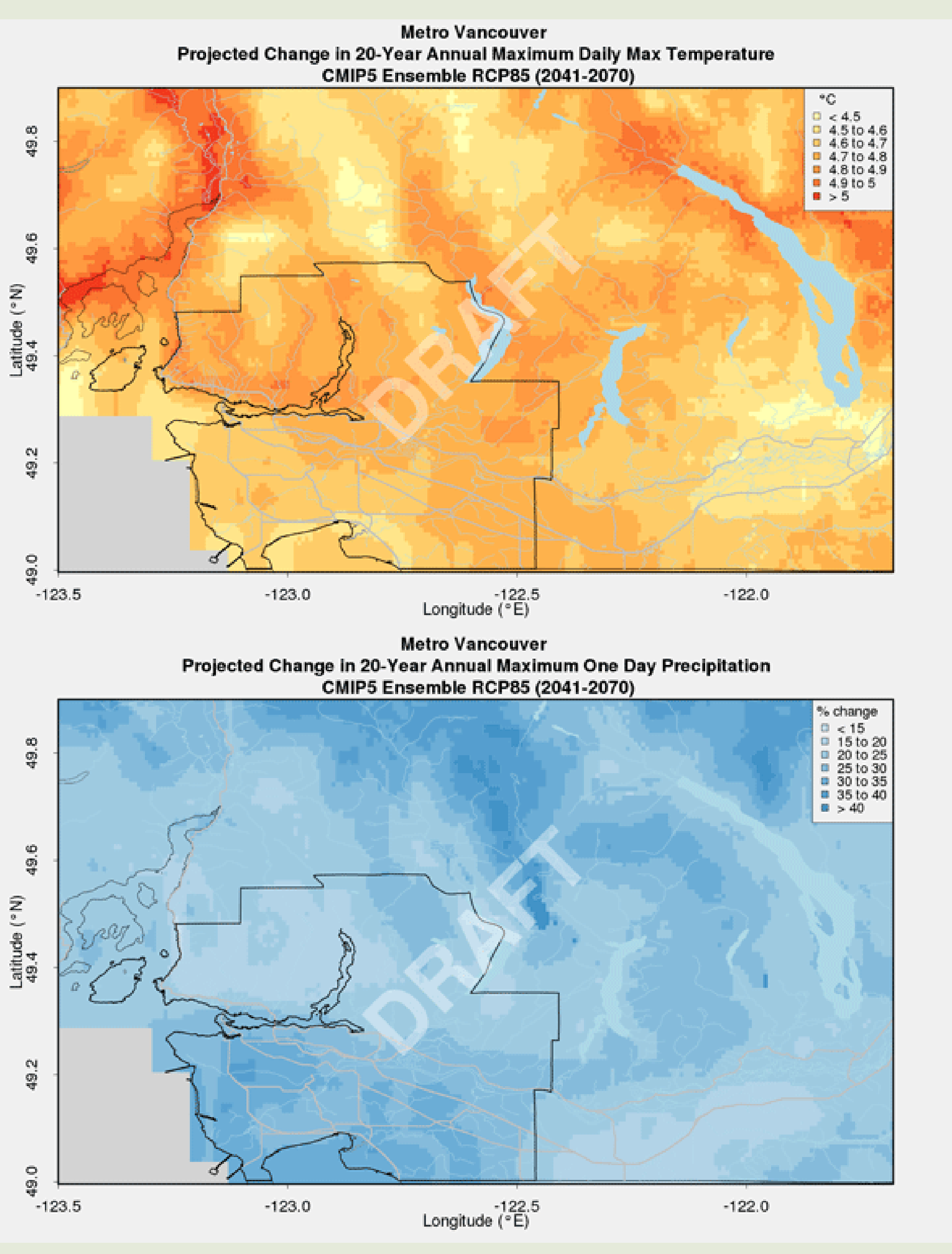

Figure 1: Projected changes in 20-year return period events for the warmest daily maximum temperature of the year and the heaviest one day precipitation amount of the year, for the Metro Vancouver region. These are downscaled from an ensemble of global climate models participating in the Fifth Phase of the Coupled Model Intercomparison Project (CMIP5). These projections are for the 2041-2070 period as compared to the 1971-2000 period and assume large greenhouse gas emissions (RCP8.5).

Prior to this work, all of the information available on projected changes to extremes for Metro Vancouver came in the form of regional averages from regional climate models with a resolution of 50 kilometres. The new projections have a ten kilometre resolution and some variables can be visualised down to 800 metres, using elevation corrections from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). This method, also used to evaluate projected changes to climate extremes in Whistler (see the second article in this newsletter) is the first combined use of ten kilometre resolution, downscaled climate projections with historical climatologies obtained from the PRISM data set. Some general results from this work are as follows. Compared to the climate over the 1971-2000 period, extreme temperatures so warm that in the past they would be exceeded on average only once every 20 years (about 32°C to 35°C) are projected to occur on average more than twice as often in Metro Vancouver in the 2050s. Rainfall in the region is also projected to increase, by 21% on very wet days and by 28% on extremely wet days. Extreme precipitation events (so intense than in the past they would be exceeded on average only once every 20 years) are projected to occur on average three times as often in Metro Vancouver (Figure 1).

For the next step in this project, we are consulting with different groups interested in climate change to gather input on which climate extremes indices to focus on analysing.

WHISTLER CLIMATE EXTREMES PROJECTIONS

PCIC researchers have recently completed climate projections for the Whistler area. This is the first time that regional climate projections have been made explicitly for the Whistler region which, given its small area and complex topography, made analysis of local climate change more difficult. The analysis for Whistler uses the same data set as the projections for Metro Vancouver (see the first article in this newsletter). These combine downscaled ten kilometre climate projections with information from PRISM. Incorporating high-resolution observations (800 metre scale) from PRISM enables better representation of topographic effects in the climate projections, which is necessary in mountainous regions such as Whistler.

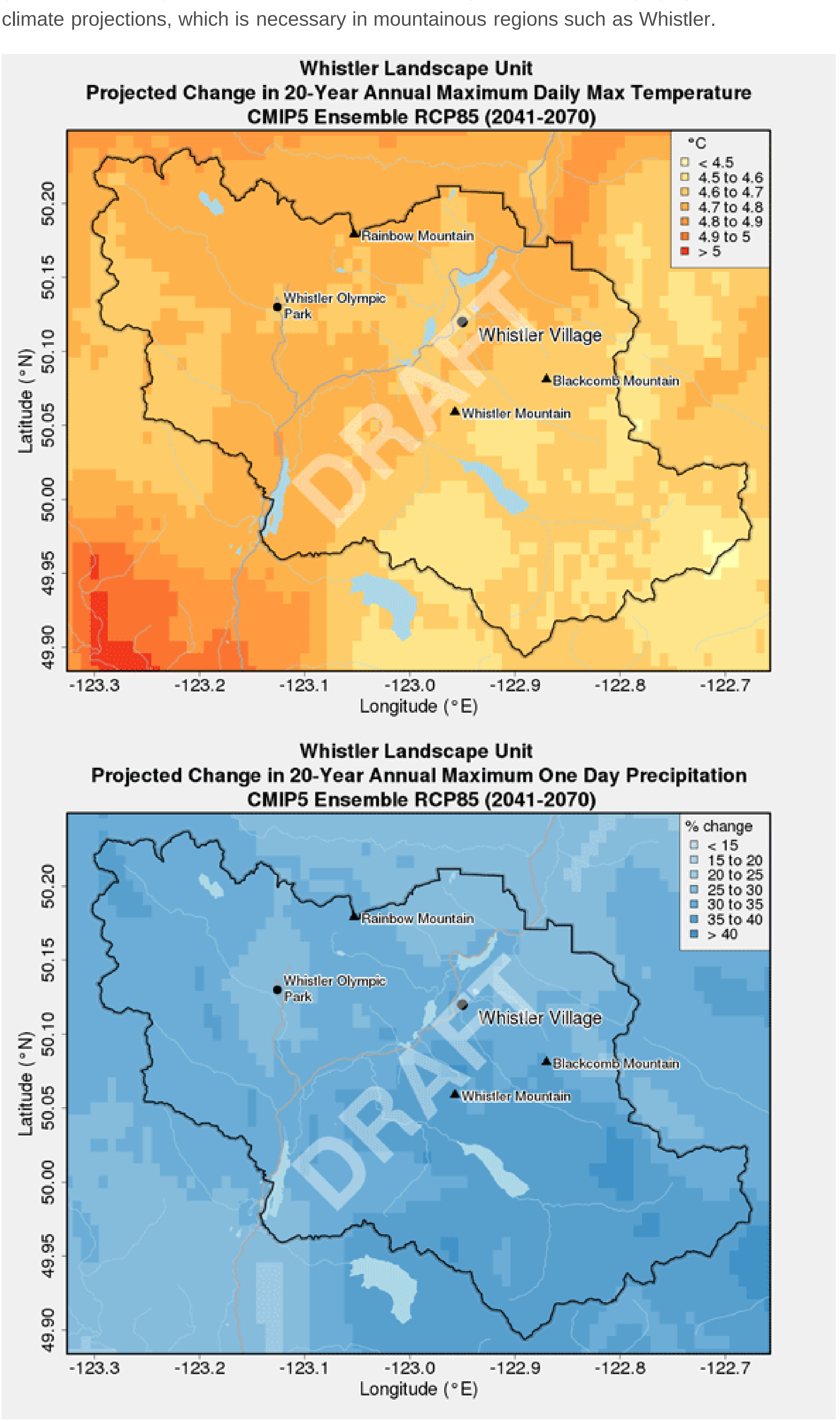

Figure 2: Projected changes in 20-year return period events for the warmest daily maximum temperature of the year and the heaviest one day precipitation amount of the year for the Whistler region. These are downscaled from an ensemble of global climate models participating in CMIP5. These projections are for the 2041-2070 period as compared to the 1971-2000 period and assume large greenhouse gas emissions (RCP8.5).

While expert opinion was that projections would show warmer summers, wetter winters and a lower snowpack for the region, PCIC has been able to provide greater detail to inform specific planning and priorities. PCIC researchers have found that precipitation projections are strongly seasonally dependent, with projected increases of 7% in winter and declines of up to 16% in summer. Minimum temperatures, which are relevant for snow levels, are projected to increase by three to four degrees by the 2050s. Additionally, while in the past all seasons except summer had average minimum temperatures below zero, by the 2050s both spring and fall minimum temperatures are projected to exceed zero degrees Celsius on average.

In terms of annually averaged values, maximum five-day precipitation amounts are projected to increase in magnitude between 8-12% in Winter, Spring, and Fall, but decline by 7% in summer, by the 2050s as compared to the 1971-2000 period. Warming is seen in the hottest day of the year for the region, which is projected to increase from its value of 25°C in the past to 29°C in the 2050s. Following suit, the coldest day of the year is also projected to warm, increasing from -19°C to -14°C over the same period.

Precipitation events that are so large in magnitude that they only happened once every 20-years in the past are projected to increase in magnitude by 36% (for daily accumulations) in the 2050s. Similarly, the temperature during those events that are so hot that they only occur once every twenty years is projected to warm by 4.6°C (Figure 2)."

Because snow levels are of significant interest to stakeholders in Whistler, projected changes in snowpack were also examined using the VIC hydrologic model, which was previously run by PCIC's hydrology group. Projected snowpack levels for three elevations display declining amounts throughout the 21st century with the lowest elevations declining by half by 2100. Both spring and fall minimum temperatures are projected to increase by 3°C and move from their past values which were below freezing, to 0°C for spring and 2°C for fall. This is accompanied by a reduction in the number of frost days (days with a minimum temperature below 0°C) from 212 per year in the past to 159 per year in the future.

This work is also an instance of mitigation and adaptation being considered simultaneously. For instance, during the initial meeting in which PCIC delivered a presentation on future climate projections for BC and some preliminary results for Whistler, the mitigation committee noticed immediately that their energy retrofit initiatives should consider future heating and cooling demand.

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE TECHNICAL CIRCULAR

Figure 3: The Subcommittee for Engineering Adaptation for Climate Change meet in Vancouver.

As the climate continues to change, it presents a unique set of challenges to infrastructure and design projects. In an effort to help with planning and adaptation, PCIC has provided projected climate change scenarios, including analyses of climate extremes indices and case studies, to the BC Ministry of Transportation and Infrastructure. In particular, PCIC has collaborated on several case studies involving vulnerability assessments to specific sections of BC highways following recent failures due to extreme events (for example Bella Coola flooding in 2012). Following from this, the Subcommittee for Engineering Adaptation for Climate Change (SEACC) was formed in order to provide opinions on a Province-wide requirement for design projects in the province to consider the effects of climate change. The committee's work has come together in the form of a technical circular outlining adaptation considerations for the design of transportation infrastructure for the Ministry of Transportation and Infrastructure.

The next step to help ensure that BC's infrastructure will be resilient to the effects of climate change is the creation of a set of guidance documents to help engineers make use of climate change information. The SEACC is now working with the Association for Professional Engineers and Geoscientists of British Columbia on these documents.

ON THE RECENT STORMS

Beginning on August 27th, record-breaking storms struck coastal BC. In this article, PCIC Climatologist Dr. Faron Anslow shares his thoughts on these storms, ties them to global meteorological phenomena and places them into their broader historical context.

Following a long, hot summer, the end of August saw the west coast of BC battered by the strongest windstorm ever recorded in the region, leaving half a million BC residents without power. Leading up to the storms were the ongoing El Niño, a region of warm surface water in the eastern tropical Pacific, combined with generally much warmer than normal sea surface temperatures in the north east Pacific that, combined, have created conditions allowing greater than normal amounts of water vapour to reside in the atmosphere above the central and eastern tropical Pacific Ocean. On the weather side of the coin, when tropical systems become incorporated into the higher latitude storm tracks, they sometimes have the effect of amplifying the wave patterns in the atmosphere. The so-called super typhoon Atsani previously over the western Pacific near Japan, moved into the midlatitudes around the 24th of August and did just that. Soon thereafter the high pressure that had been providing our clear skies and warm summer was pushed south and west while a deep, low pressure trough sagged just off our coast. As this was happening, the passage of several hurricanes near Hawaii (Kilo, Ignacio, and Jimena) helped to move tropical moisture further north. The sagging trough was able to tap into moisture from those hurricanes and convey it to our coast. Embedded in this stream was a very strong storm that broke numerous records for wind speed, air pressure, and power outages when it hit the morning of Saturday, August 29th. In addition to the wind, the storm was very wet, resulting in rainfall totals above 100 mm in some locations. Quickly on the heels of this storm, another tropical moisture stream impacted our coast on the 30th and 31st. Weather forecasts indicate that as much as 250 mm of rain may have fallen on the North Shore mountains of the lower mainland over the three-day period ending early on the first of September. August went out with a bang!

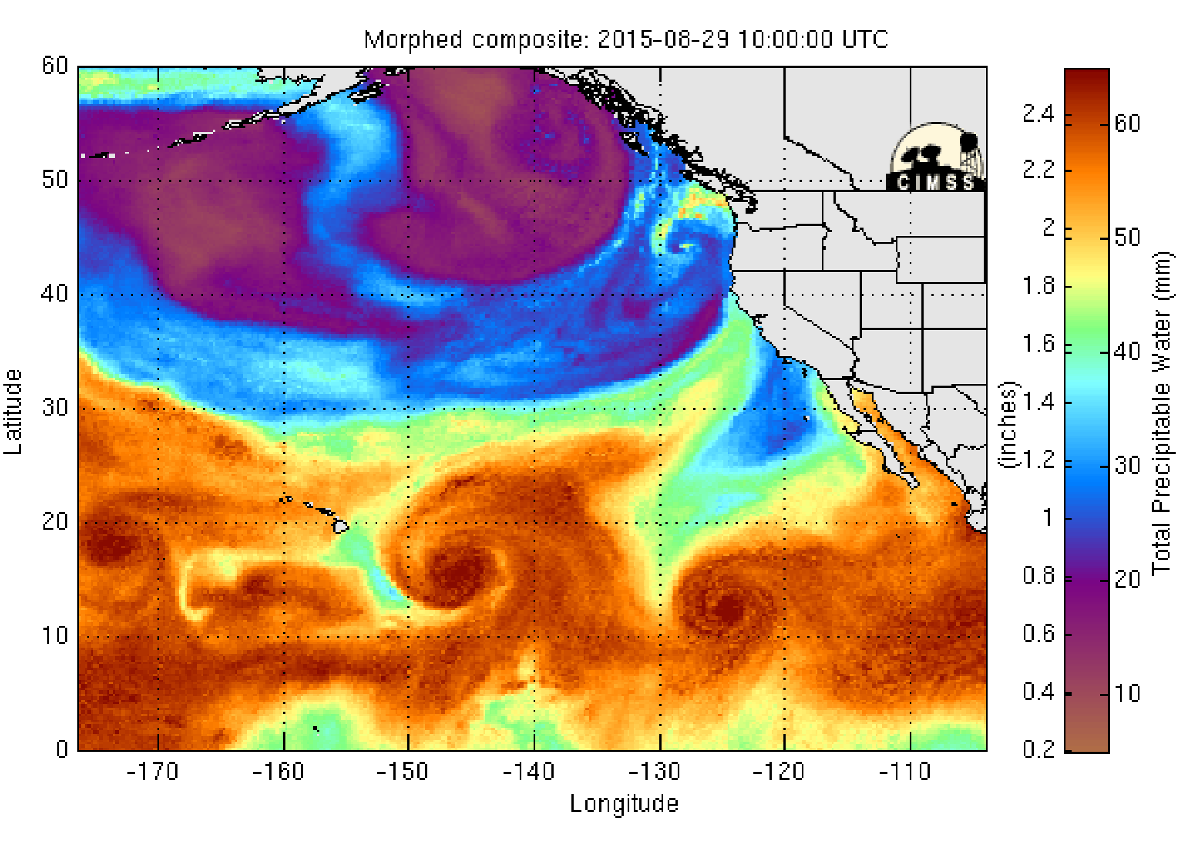

Figure 2: This image depicts the amount of water vapour in the atmosphere across the eastern Pacific Ocean at 3 AM Pacific Daylight Time, derived from satellite measurements. Just off the coast of Oregon, the tight spiral of warm and cool colours indicates the intensifying storm that would impact the province several hours later. The orange and yellow colours to the north of the storm centre indicate very moist air. In the tropics, the hurricanes Kilo, Ignacio, and Jimena are shown as yellow-orange spirals to the south west and and south east of Hawaii. Image courtesy of the University of Wisconsin's Cooperative Institute for Meteorological Satellite Studies; accessed on 8 September, 2015.

Although the storm of the 29th was very strong, the influence of hurricane remnant rainfall events or simply the occurrence of heavy rainfall in late summer is not unique to 2015. In fact, some of the heaviest precipitation events occur in the late summer and early fall on the west coast of BC. These events are often the result of abundant tropical moisture available at the highest latitudes of the entire year. As fall wanes into winter, that moisture retreats southward and is less accessible to our weather systems. For a heavy rainfall event to occur in August, all that is needed is a strong enough storm to bring moisture north and drive it against our mountains with strong winds. As the air is pressed against the mountains, it rises, cools and cannot hold as much moisture, leading to precipitation. The sequence of events resulting from a very active Pacific hurricane and typhoon season enabled this to occur a bit early this year and gave us a good soaking when we are used to basking in sunshine.

PCIC WELCOMES NEW LEAD, PLANNING AND OPERATIONS

PCIC is very pleased to extend a warm welcome to Kathy Veldhoen. Kathy has recently joined PCIC's team as Lead, Planning and Operations, bringing strong experience in financial, operational and project management. Prior to joining PCIC she held various management and executive roles with the University of Victoria's industry liaison office, with primary responsibility for all financial and operational functions, including management of the University's patent portfolio and related license agreements. She holds a Chartered Professional Accountant, Certified Management Accountant designation. Kathy also has national and international experience as a research associate and laboratory manager in the fields of visual neurobiology and oncology, as well having worked in various roles in the legal sector.

LAUNCH OF THE 2015-2016 PACIFIC CLIMATE SEMINAR SERIES

We are excited to announce that the joint PCIC-Pacific Institute for Climate Solutions Pacific Climate Seminar Series for 2015-2016 will be starting with a talk delivered by Professor Robert Gifford on September 16th, at 3:30 in Room 002 of University House 1. The description for this talk is below.

By now, most people understand that we have been burning too much carbon. Many of these same people are not taking significant action to decrease their emissions of carbon dioxide and other greenhouse gases. There is a big gap between climate change concern and climate change action. What accounts for this gap between beliefs and behaviours? What prevents people from adopting more climate friendly habits and choices? In this talk UVic's Dr. Robert Gifford will discuss the many psychological barriers to climate change action.

See here for more information.

RECENT PAPERS AUTHORED BY PCIC STAFF

Seiler, C. and **F.W. Zwiers**, 2015: How will climate change affect explosive cyclones in the extratropics of the Northern Hemisphere? *Climate Dynamics* (in press), doi:10.1007/s00382-015-2791-y.

Kim, Y.H., S.K. Min , X. Zhang, **F. Zwiers**, L.V. Alexander, M.G. Donat and Y.S. Tung, 2015: Attribution of extreme temperature changes during 1951–2010. *Climate Dynamics*, doi:10.1007/s00382-015-2674-2.

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