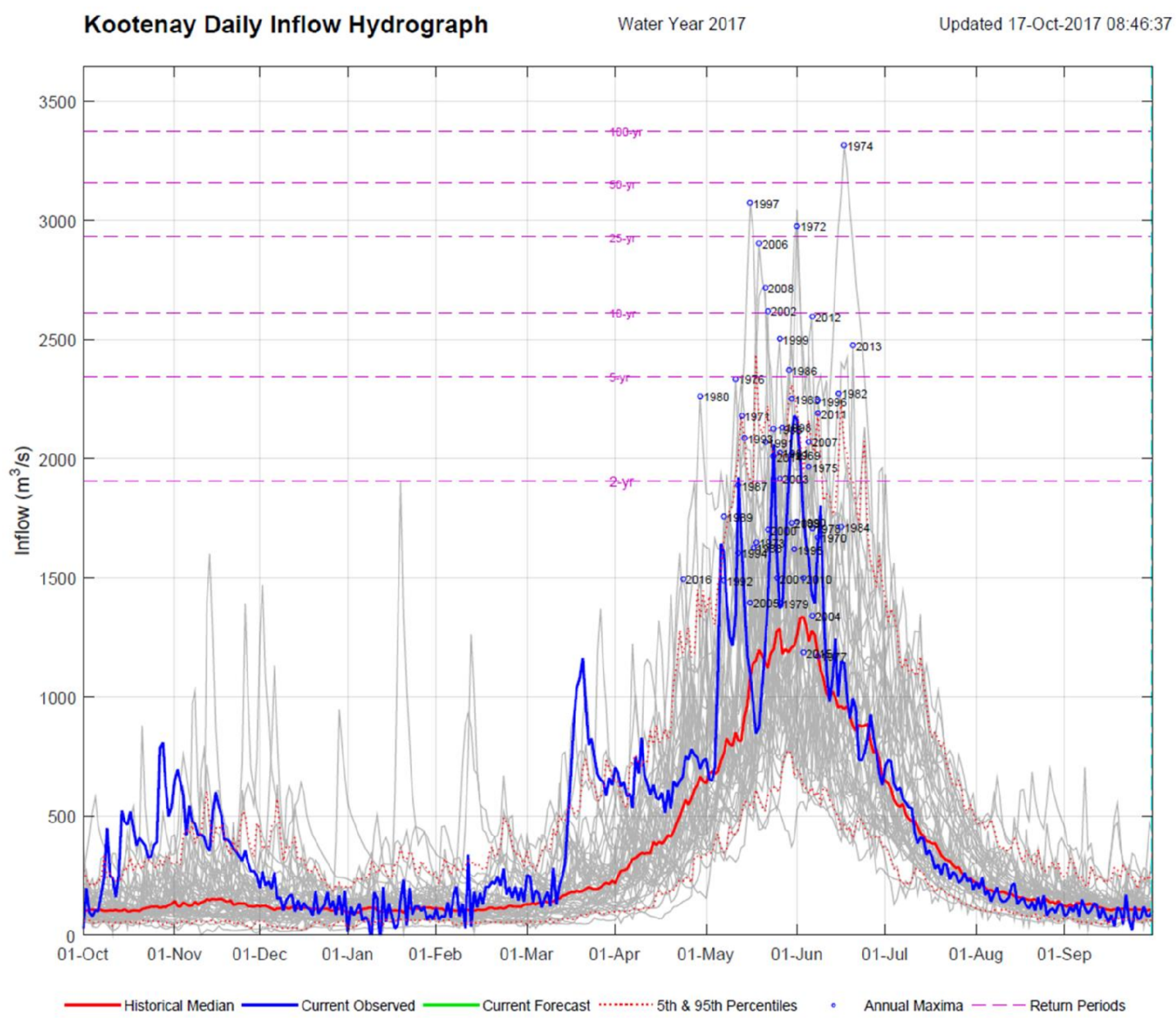
Water Year 2017



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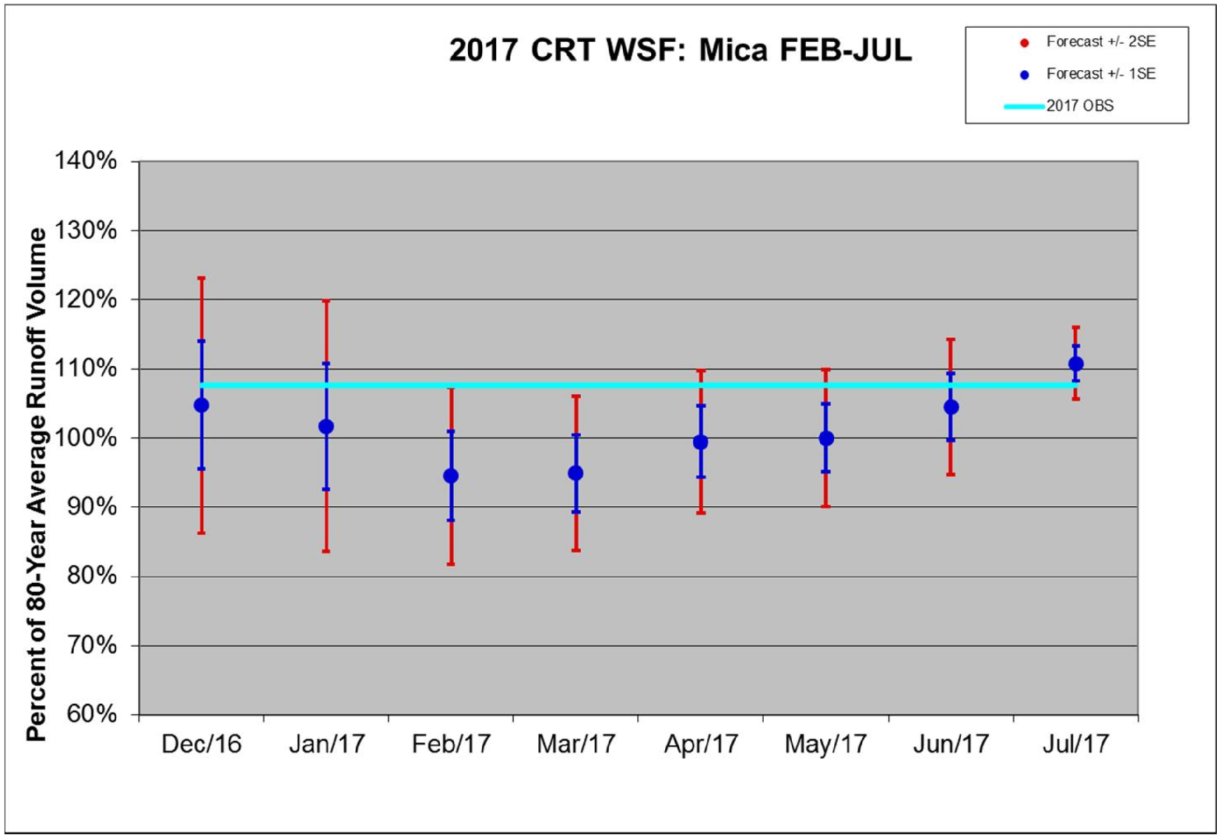
Mica – prediction uncertainty



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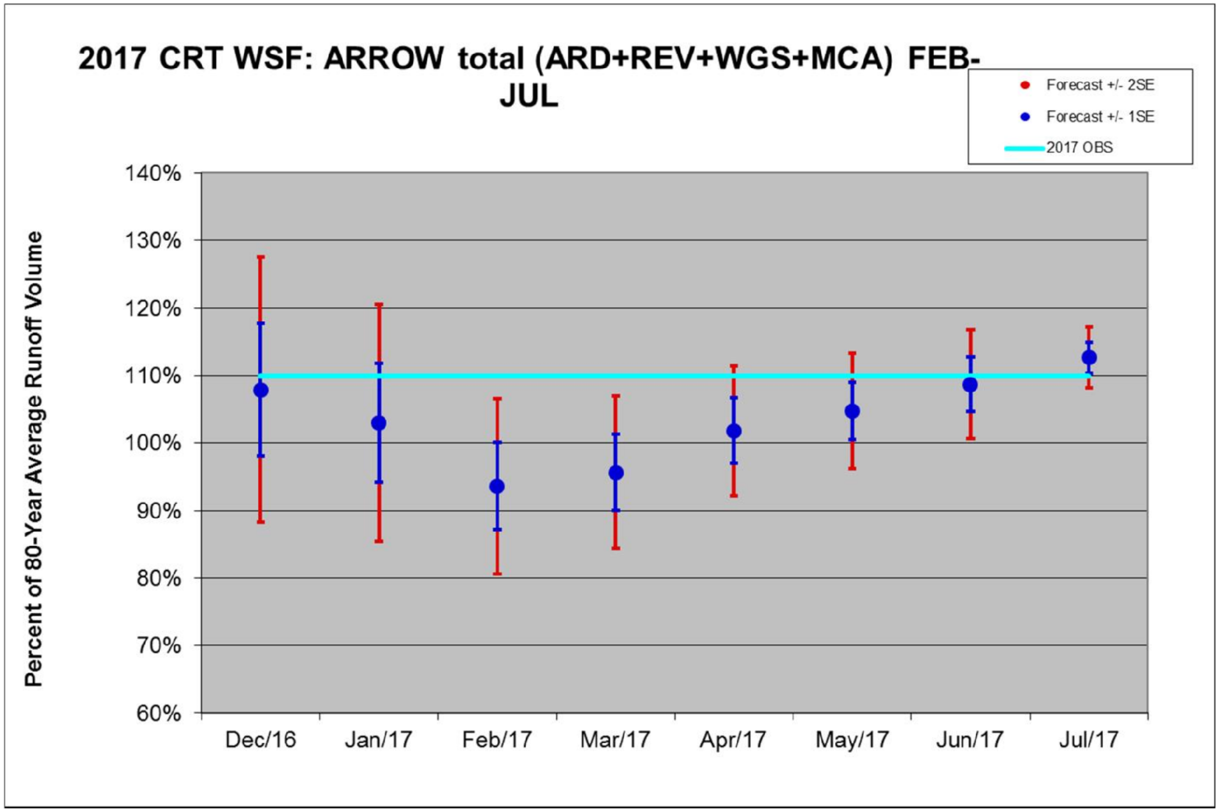
Arrow -prediction uncertainty



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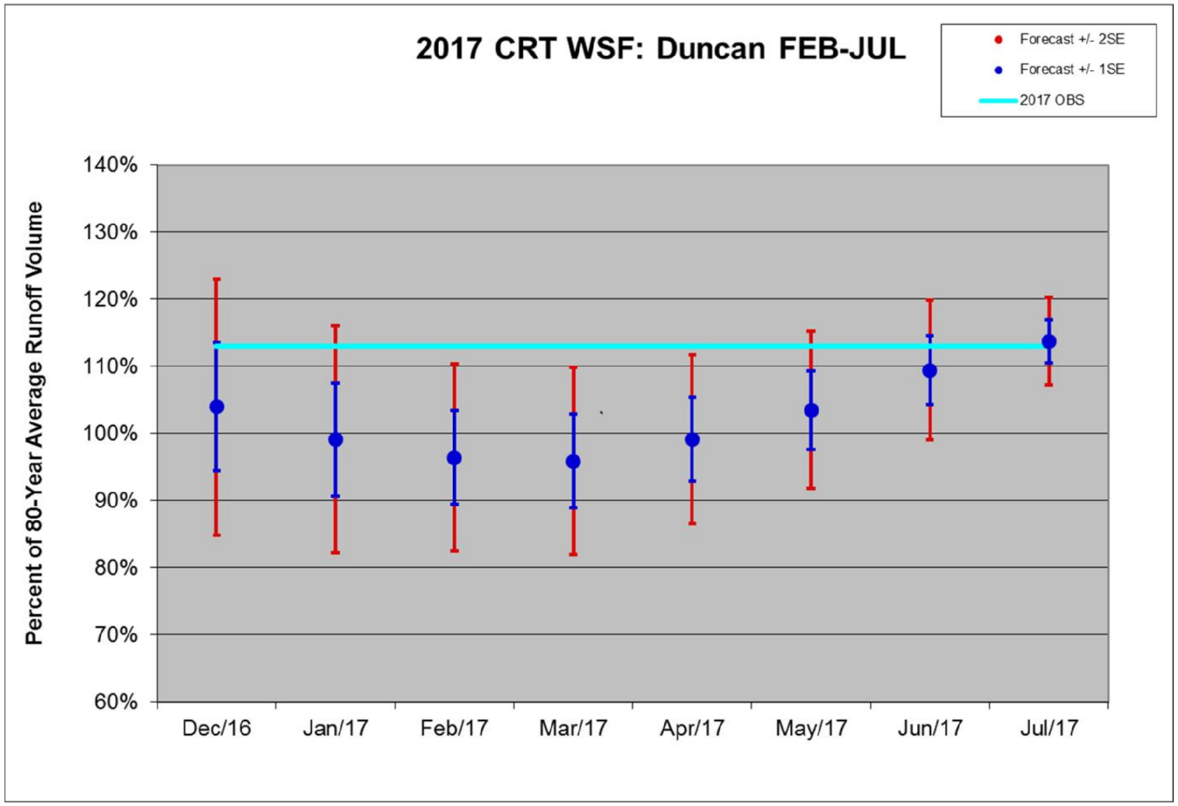
Duncan



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Updated Statistical forecast equations

Adam Gobena did all the work

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Motivation

- Request came from CRT staff to update prediction errors
- Last update in 2006 (using 1966-2002 data)
- Over 10 years of new data since then

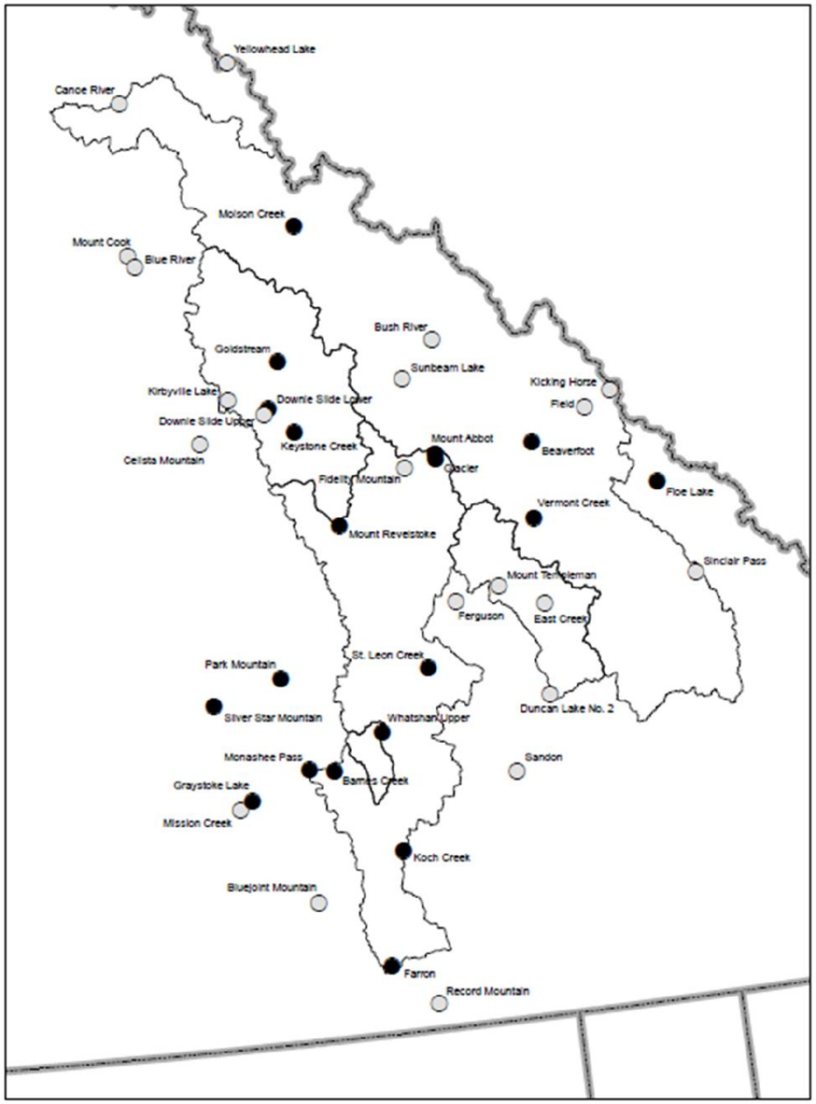
Methodology and data

- Broadly similar to the last update
- PCR methodology for predictor selection
- Training period: 1984-2015
- The training period incorporates recent observed hydroclimatic variability and hence the updated CVSE gives a more realistic picture of the predictive uncertainty.

Predictors

- Precipitation (fall, winter, summer)
- Snow (SWE, winter conditional precipitation)
- Antecedent inflow
- Climate indices (ENSO)
- Summer temperature

Snow monitoring stations used in PCR



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Main differences to previous equations

- Snowpack data are incorporated in the January model
- The December and January models incorporate equations for the Jan-Jul volume instead of Feb-Jul and hence will negate using climatological mean for the month of January
- The standard errors of the new models are generally higher than those of the previous models during early to mid-season forecast dates (increase in predictive uncertainty with the addition of recent climate data)
- Predictor sets selected for the new models produce lower standard errors than the predictor sets used in VoDCa (using the same training period)

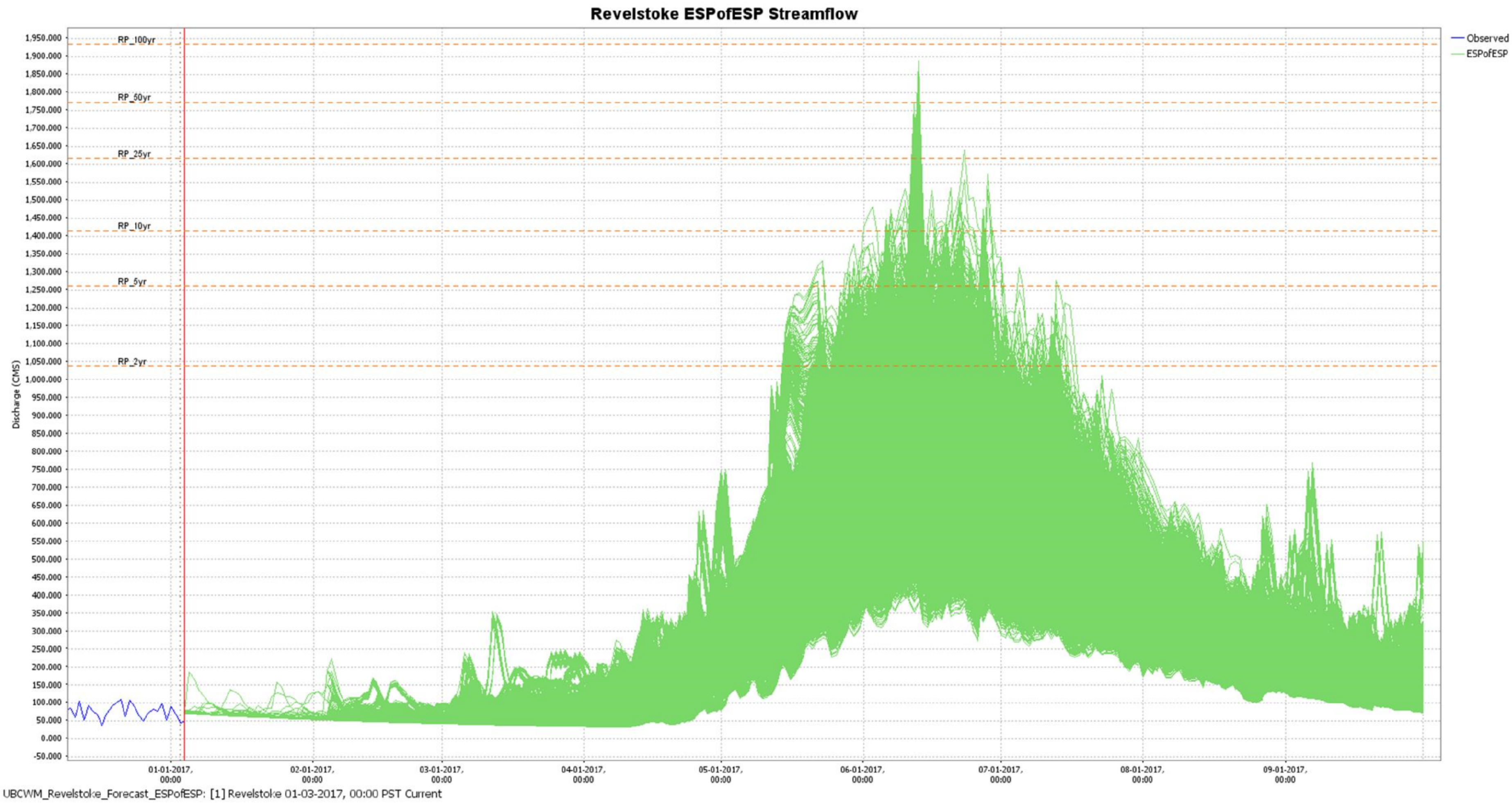
Statistical Forecast Parameters: Mica_Dam

Predictor	Input Data			REG Coef	Forecast: Res. Feb-Sep			REG Coef	Forecast: Res. Jan-Jul			REG Coef	Forecast: Res. Apr-Aug		
	Actual	Normal	%Normal		Actual	Normal	DIFF (%)		Actual	Normal	DIFF (%)		Actual	Normal	DIFF (%)
SWE2APR st1: 2A11	0.0	0.0	-	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
SWE2APR st2: 2A14	0.0	0.0	-	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
SWE2APR st3: 2A19	0.0	0.0	-	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
SWE2APR st4: 2A21P	0.0	0.0	-	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
SWE2APR st5: 2C14P	0.0	0.0	-	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
SWEMAY st1: 2A11	0.0	0.0	-	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
SWEMAY st2: 2A14	0.0	0.0	-	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
SWEMAY st3 2A21P	0.0	0.0	-	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
SWEMAY st4: 2C14P	0.0	0.0	-	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
WCP st1: GRP	234.6	193.8	121.1	4.215	988.9	816.8	1.1	3.183	746.8	616.8	1.1	3.755	881.0	727.6	1.1
WP st1: RGR	203.4	197.9	102.8	4.447	904.5	880.0	0.2	3.358	683.0	664.5	0.2	3.961	805.7	783.8	0.2
WP st2: WGE	45.6	47.7	95.7	9.771	445.6	465.7	-0.1	7.378	336.4	351.6	-0.1	8.704	396.9	414.8	-0.1
SP st1: YCP	0.0	0.0	-	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
ST st1: FID	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
PREVT st1: FID	0.0	-3.5	3.5	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
PREVT st2: WGE	1.7	1.0	0.7	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
OCTP st1: RAD	41.8	27.2	153.4	17.146	715.8	466.5	1.6	12.946	540.5	352.3	1.6	15.274	637.7	415.6	1.6
OCTP st2: RGR	172.4	138.2	124.7	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
3mQ st1: Mica	2560.8	2681.1	95.5	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
PREVQ st1: Mica	467.8	512.1	91.3	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.0
CI st1: SOI	0.6	0.0	0.6	159.818	99.9	0.4	0.6	120.672	75.4	0.3	0.6	142.365	89.0	0.4	0.7
INTERCEPT				*12899.8*				*9832.8*				*11203.4*			
CVSE				*1475.8*				*1361.9*				*1393.2*			
TOTAL					**16054.6**	15529.3			**12214.9**	11818.3			**14013.6**	13545.6	
TOTAL AS % NORMAL FC					**103.4**	100.0	**3.4**		**103.4**		**3.4**		**103.5**		**3.5**

Variable definitions
SWE2APR: 1st of month SWE up to Apr 1st
SWEMAY: 1st of May SWE
WCP: Accumulated winter conditional precip until Apr 1st
WP: Accumulated winter precip from Nov 1st to Mar 31st
SP: Accumulated summer precip from Apr 1st to Jul 31st
PREVP: Previous month total precip
ST: Mean of monthly max temp from Apr 1st to Jul 31st
PREVT: Previous month monthly max temp
OCTP: October precip
3mQ: Cummulative inflow volume for last 3 months
PREVQ: Previous month's inflow volume
CI: Climate index Jun-Sep average

What we are up to....

ESP of ESP



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ESP of ESP

ESP	subtyp	jan	feb
ESP orig		1970	1970
		1971	1971
		1972	1972
ESP feb	M(ember)1	1970	1970
	M2	1970	1971
	M3	1970	1972
	M1	1971	1970
	M2	1971	1971
	M3	1971	1972
	M1	1972	1970
	M2	1972	1971
	M3	1972	1972
ESP mar	M1	1970	1970
	M2	1970	1970
	M3	1970	1970
	M1	1971	1971
	M2	1971	1971
	M3	1971	1971
	M1	1972	1972
	M2	1972	1972
	M3	1972	1972
ESP apr	M1	1970	1970
	M2	1970	1970
	M3	1970	1970
	M1	1971	1971
	M2	1971	1971
	M3	1971	1971
	M1	1972	1972
	M2	1972	1972
	M3	1972	1972
ESP may	M1	1970	1970
	M2	1970	1970
	M3	1970	1970
	M1	1971	1971
	M2	1971	1971
	M3	1971	1971
	M1	1972	1972
	M2	1972	1972
	M3	1972	1972
ESP jun	M1	1970	1970
	M2	1970	1970
	M3	1970	1970
	M1	1971	1971
	M2	1971	1971
	M3	1971	1971
	M1	1972	1972
	M2	1972	1972
	M3	1972	1972

Seasonal forecast for Revelstoke

Remainder of Feb - Sep Runoff Volume (Mil. Cu. M)

	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP
MIN	4730	4596	4430	4118	2855	1685	848	270
10%	5296	5143	4936	4667	3571	1922	962	329
MEAN	6003	5870	5698	5336	4194	2440	1151	429
50%	5868	5745	5462	5161	4003	2397	1106	422
90%	6843	6702	6525	6235	5071	3141	1483	598
MAX	8082	7969	7747	7471	6448	3805	1720	661
STD	636	637	635	655	710	458	198	88
NORM	6290	6189	6052	5667	4443	2681	1253	443

Monthly Runoff Volume (Mil. Cu. M)

FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP
111	104	177	823	1170	811	536	270
112	122	234	907	1406	916	561	329
133	172	361	1143	1754	1289	721	429
126	163	365	1140	1692	1266	689	422
170	245	496	1412	2095	1664	944	598
227	309	561	1606	2643	2086	1196	661
23	45	89	184	310	284	146	88
101	136	386	1224	1762	1428	810	443

Remainder of Feb - Sep Runoff Volume (Percent of Normals)

	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP
MIN	75	74	73	73	64	63	68	61
10%	84	83	82	82	80	72	77	74
MEAN	95	95	94	94	94	91	92	97
50%	93	93	90	91	90	89	88	95
90%	109	108	108	110	114	117	118	135
MAX	128	129	128	132	145	142	137	149
STD	10	10	10	12	16	17	16	20

Monthly Runoff Volume (Percent of Normals)

FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP
109	76	46	67	66	57	66	61
111	90	61	74	80	64	69	74
131	126	94	93	100	90	89	97
124	120	95	93	96	89	85	95
168	180	128	115	119	116	116	135
223	226	146	131	150	146	148	149
23	33	23	15	18	20	18	20

Remainder of Feb - Sep Runoff Volume (Mil. Cu. M)

	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP
MIN	4298	4175	4015	3718	2650	1575	738	253
10%	5373	5243	5086	4721	3545	1992	963	323
MEAN	6142	6008	5835	5469	4295	2482	1154	421
50%	6089	5950	5775	5403	4240	2442	1130	411
90%	6989	6854	6673	6315	5106	3012	1381	540
MAX	8720	8602	8378	8103	7068	4246	2007	787
STD	638	638	633	631	623	403	171	83
NORM	6290	6189	6052	5667	4443	2681	1253	443

Remainder of Feb - Sep Runoff Volume (Percent of Normals)

	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP
MIN	68	68	66	66	60	59	59	57
10%	85	85	84	83	80	74	77	73
MEAN	98	97	96	96	97	93	92	95
50%	97	96	95	95	95	91	90	93
90%	111	111	110	111	115	112	110	122
MAX	139	139	138	143	159	158	160	178
STD	10	10	10	11	14	15	14	19

Online Resources

WSF Web Archive

(b) (4) [redacted]

Hydrology website:

(b) (4) [redacted]

Hydrology FAQs:

(b) (4) [redacted]

Water pages (Observations, Forecasts, Watershed Atlas)

(b) (4) [redacted]

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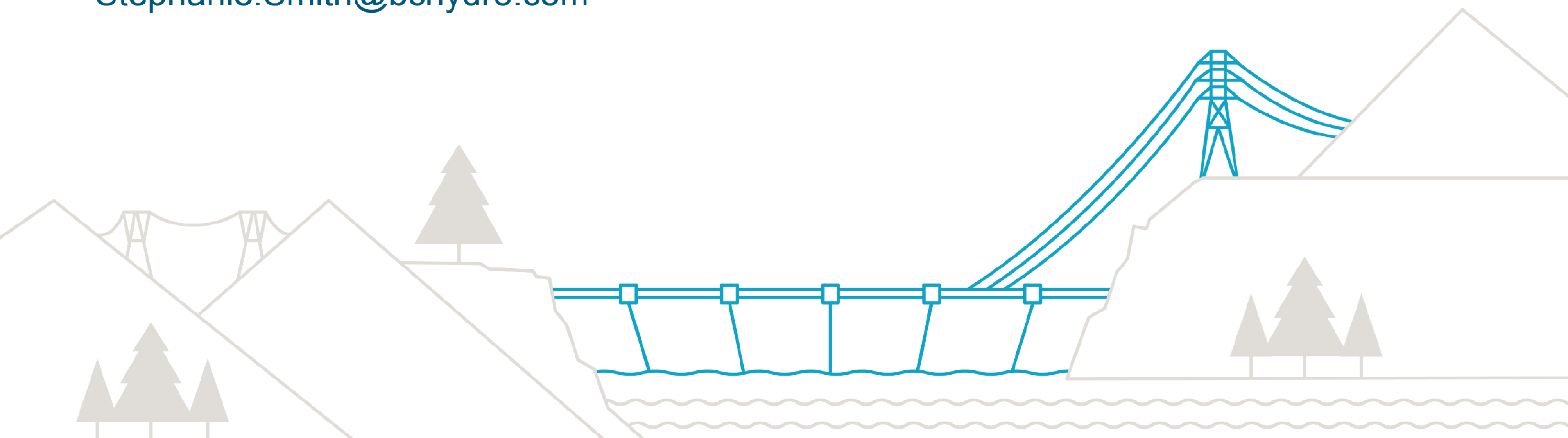
BC Hydro / PCIC 2016-18 Climate Change Work plans

Stephanie.Smith@bchydro.com



May 20, 2016

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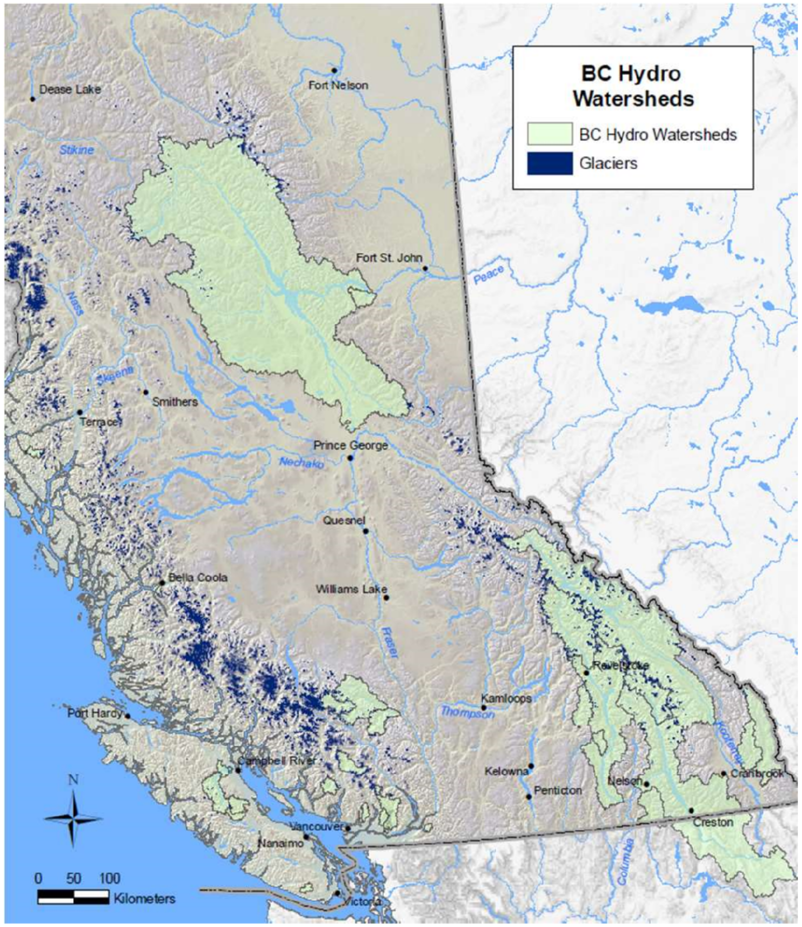
Overview – Climate Change assessment



- Why?
- Who?
- How?
- What's New?
- Where do we go from here?

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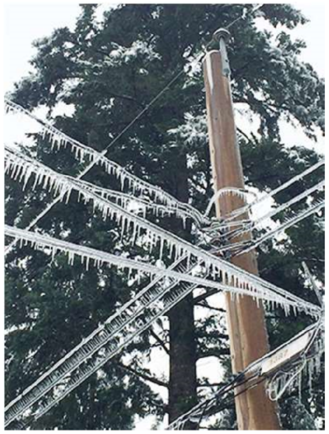
What does it mean to be a climate-resilient business?



Understand your risks and vulnerabilities

Involve your stakeholders (internal/external)

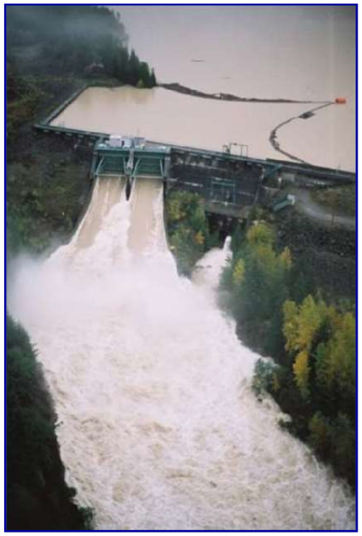
Start with highest impact areas

Leverage and share resources (government / academic / industry associations)

Build local capacity / innovation

Adapt existing tools / practices

Take advantage of times of renewal



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Understanding the Science

Through Research Partnerships

Pacific Climate Impacts Consortium

Formed in 2007 as a consortium of researchers, provincial and federal government, and industry to build capacity within British Columbia for understanding climate change and its impact in BC

- Funded by endowment from BC Government, research agreements with BC Hydro and other partners, federal grants

Western Canadian Cryospheric Network

- Federal research grant
- Small contribution from BC Hydro for focused study on Columbia glaciers

Natural Resources Canada Adaptation Platform

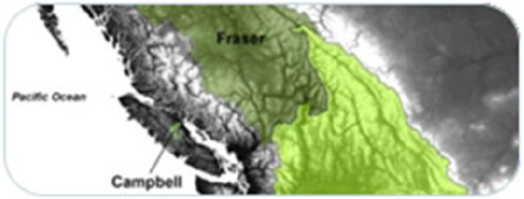
- **BC Electricity Demand Assessment**

PACIFIC CLIMATE IMPACTS CONSORTIUM

WC²N WESTERN CANADIAN CRYOSPHERIC NETWORK

Canada

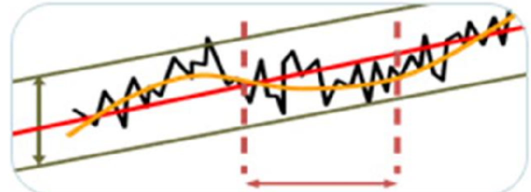
Pacific Climate Impacts Consortium



HYDROLOGIC IMPACTS

The Hydrologic Impacts theme is concerned with estimating the effects of climate variability and change on water resources using downscaled global climate models and hydrologic models.

READ MORE



REGIONAL CLIMATE IMPACTS

The Regional Climate Impacts theme stresses the need to explain and interpret the potential impacts of global climate variability and change at the regional and community scale.

READ MORE

CLIMATE ANALYSIS AND MONITORING

The Climate Analysis and Monitoring theme addresses the need for accurate historical and near real-time climate data.

READ MORE

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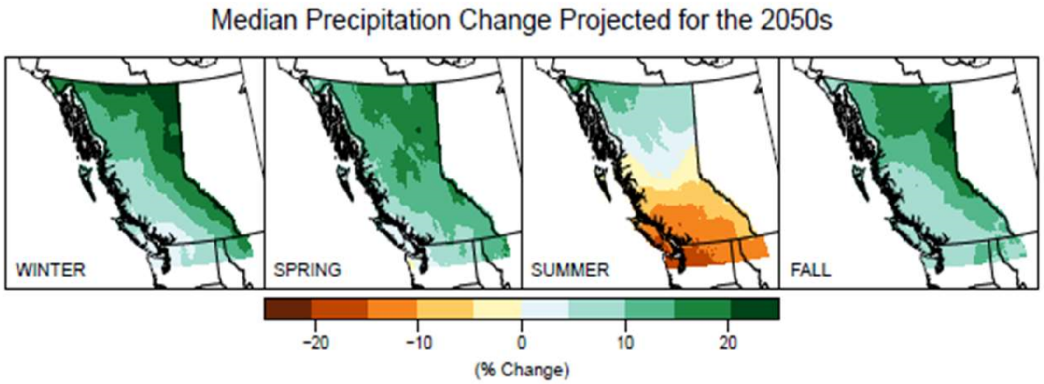
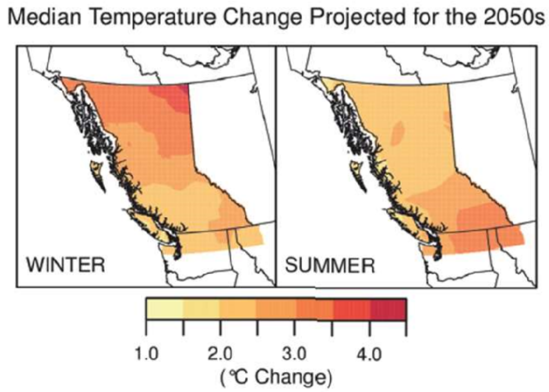
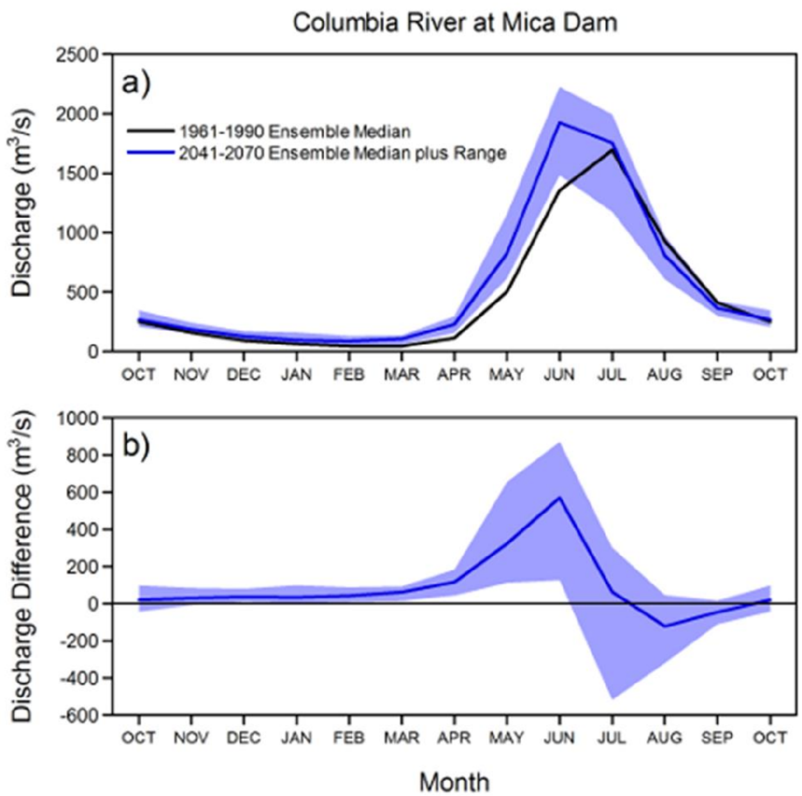
www.pacificclimate.org

Hydrologic Impacts – 2010 Results







- By 2050:
  - 1.4 – 3.7 °C increase in mean temperature
  - 0 – 18% increase in annual precipitation
  - Modest increase in annual water supply
  - Significant change in timing of runoff

- By 2100:
  - 44 – 100% loss of glaciers in Upper Columbia River

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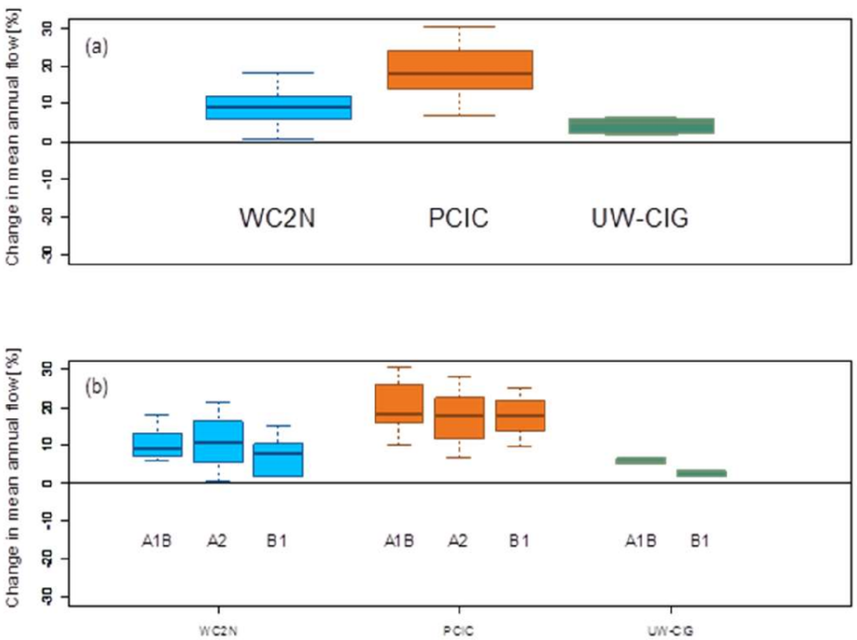
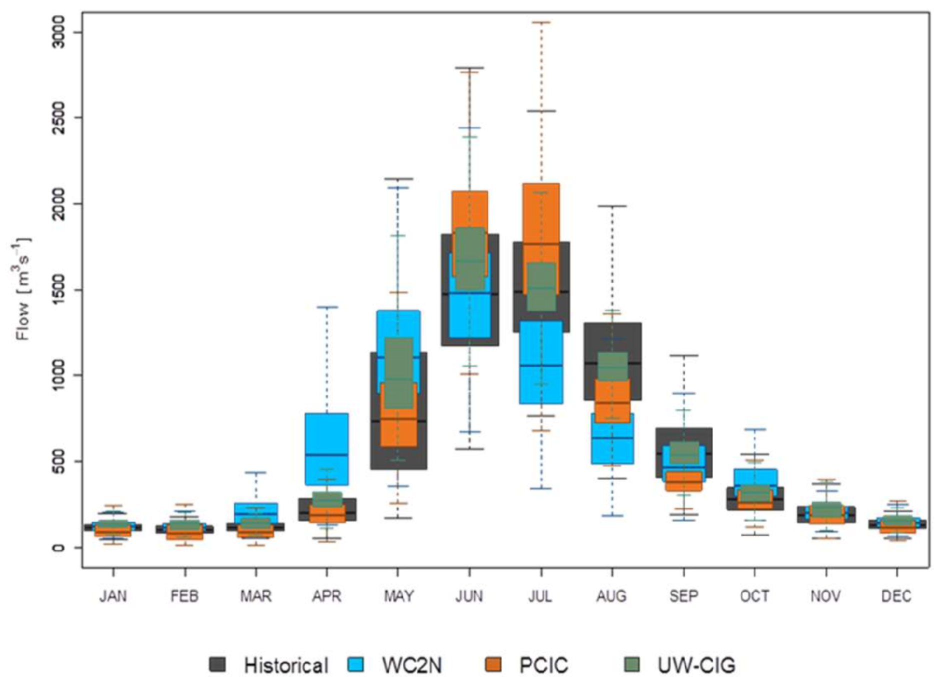
Multi Model comparison (2010)

Example: Multi-Agency ensemble of Mica flow projections





Study	P	Q	ET	Icemelt
WC2N	9%	7%	2%	0%
PCIC	8%	17%	**-9%**	0%
UW-CIG	n/a	4%	n/a	n/a

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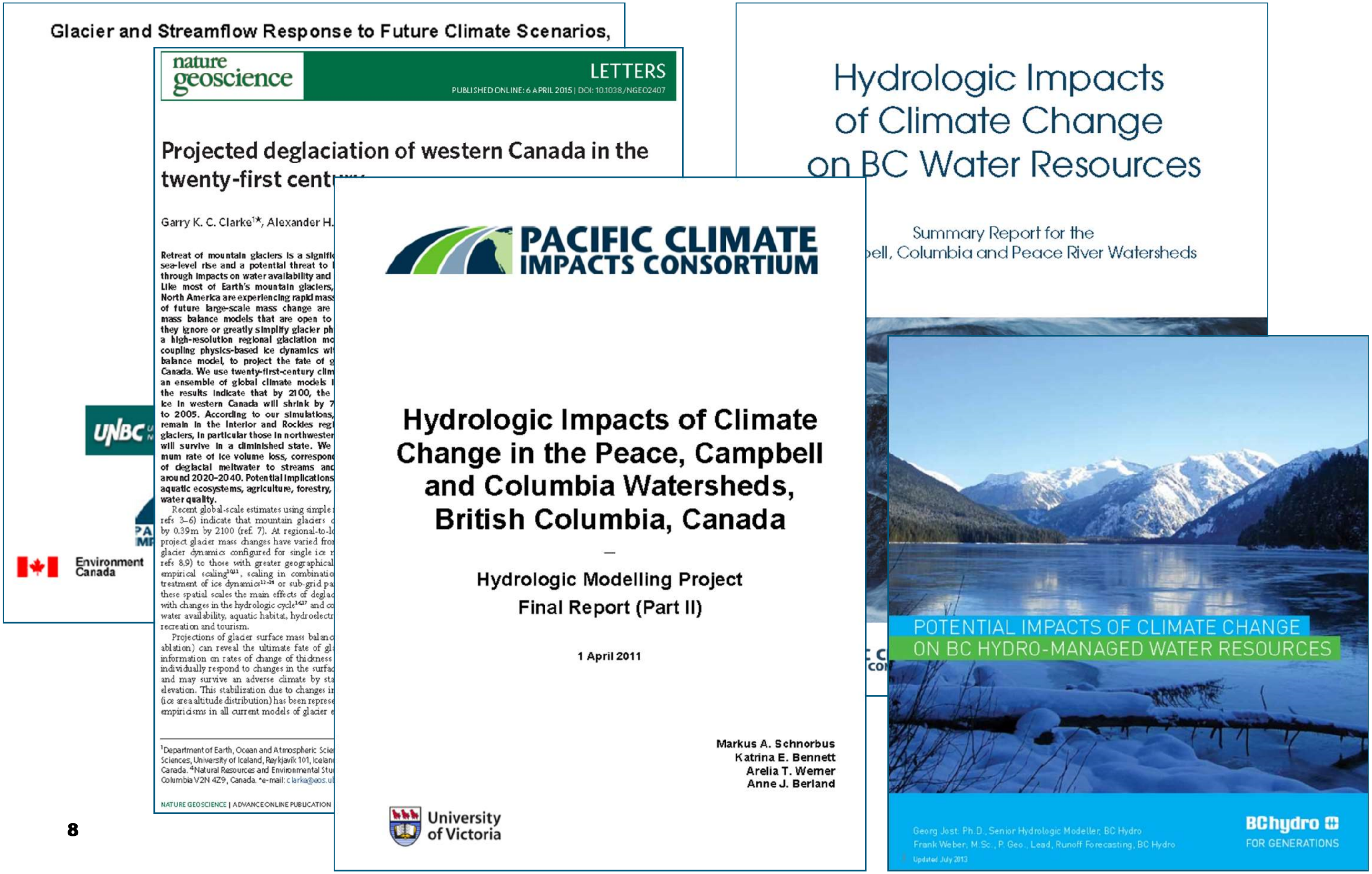
Results & Reports



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PCIC 2016- 2018 Work plan

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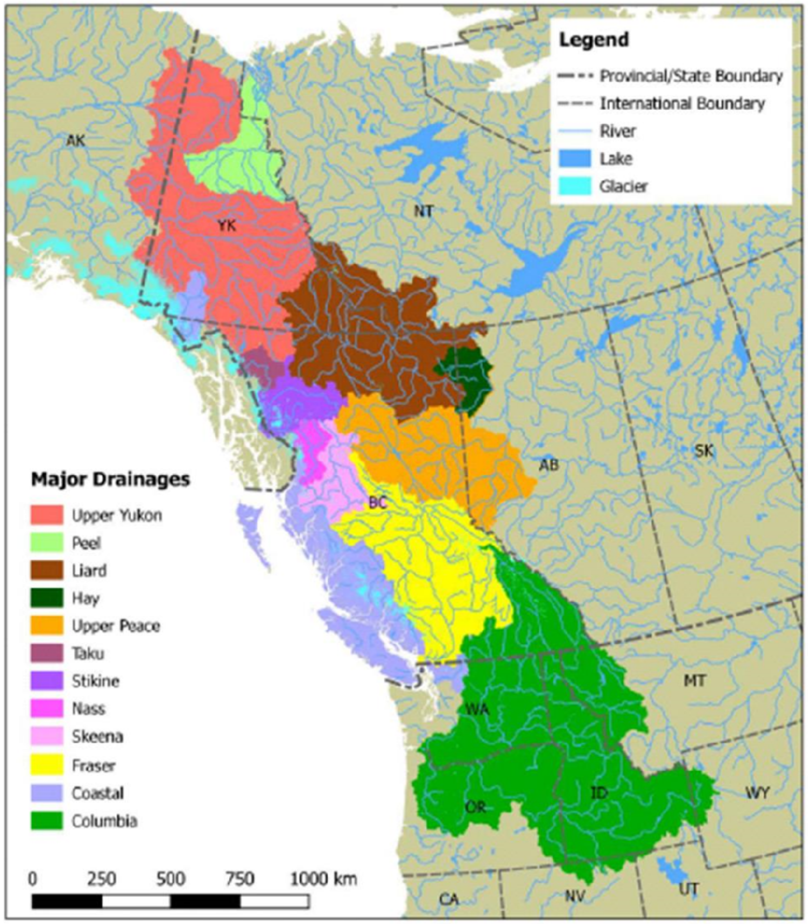
Study Area



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University of Victoria

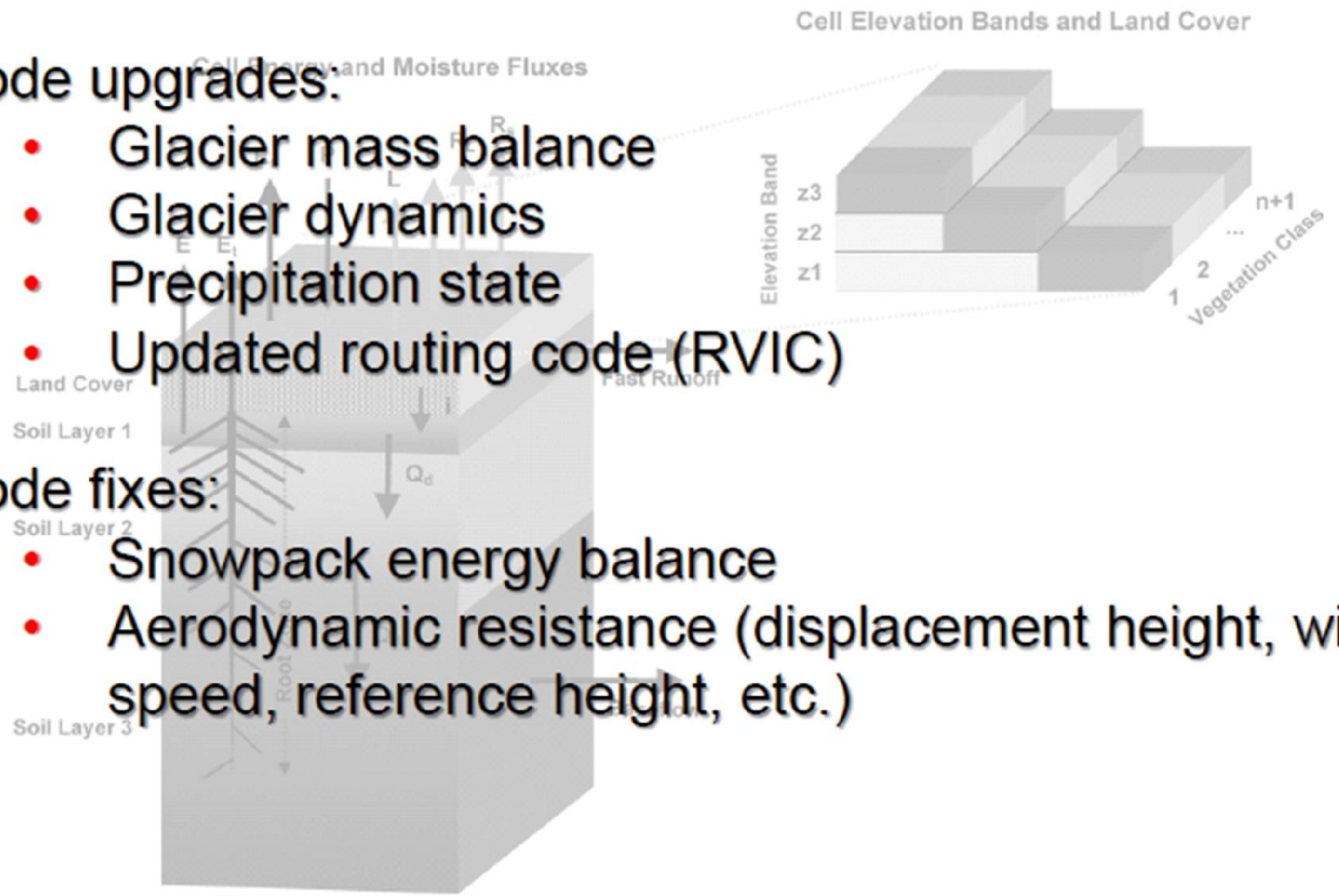
VIC Updates

Code upgrades:

- Glacier mass balance
- Glacier dynamics
- Precipitation state
- Updated routing code (RVIC)

Code fixes:

- Snowpack energy balance
- Aerodynamic resistance (displacement height, wind speed, reference height, etc.)



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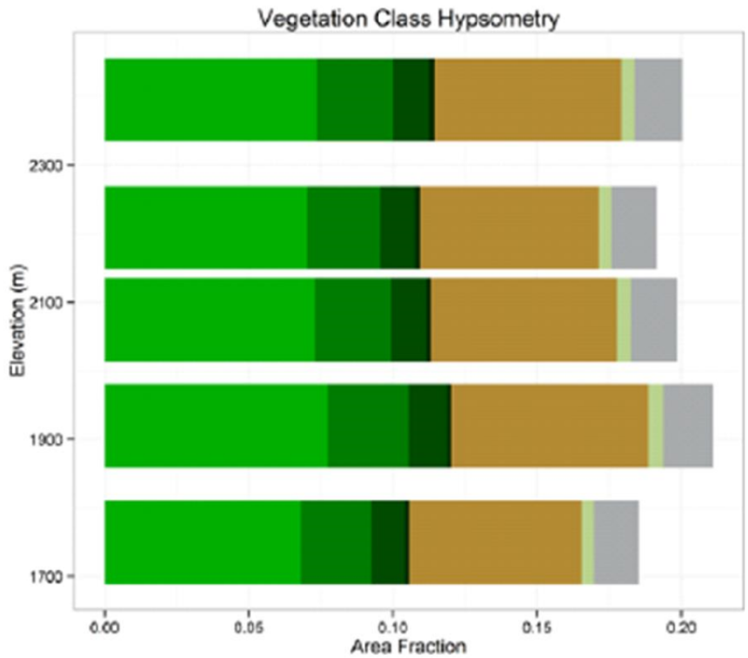
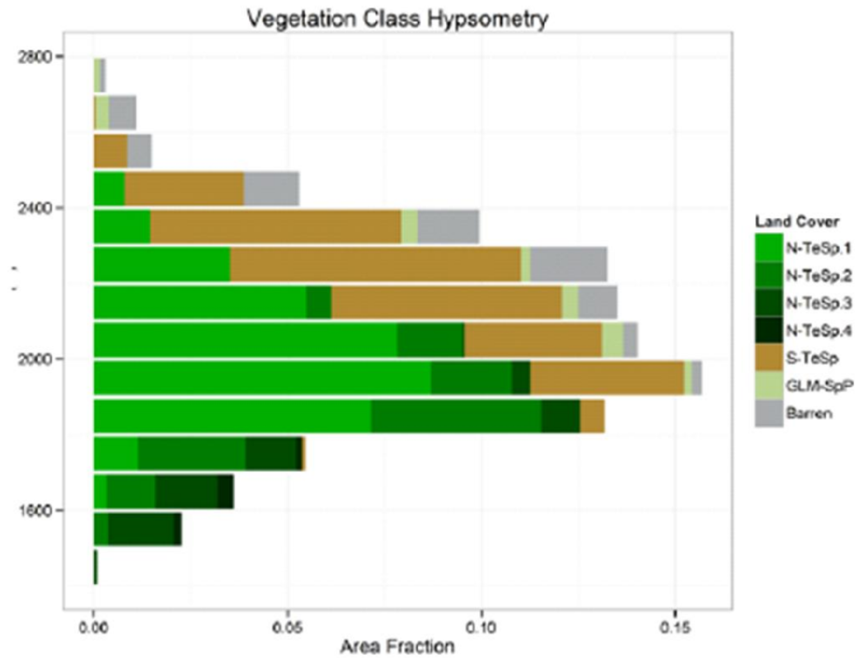
Hydrologic Response Units (HRUs)

Bull River near Wardner, BC

Original w/ Tiles
500-m Bands



Updated w/ HRUs
100-m Bands



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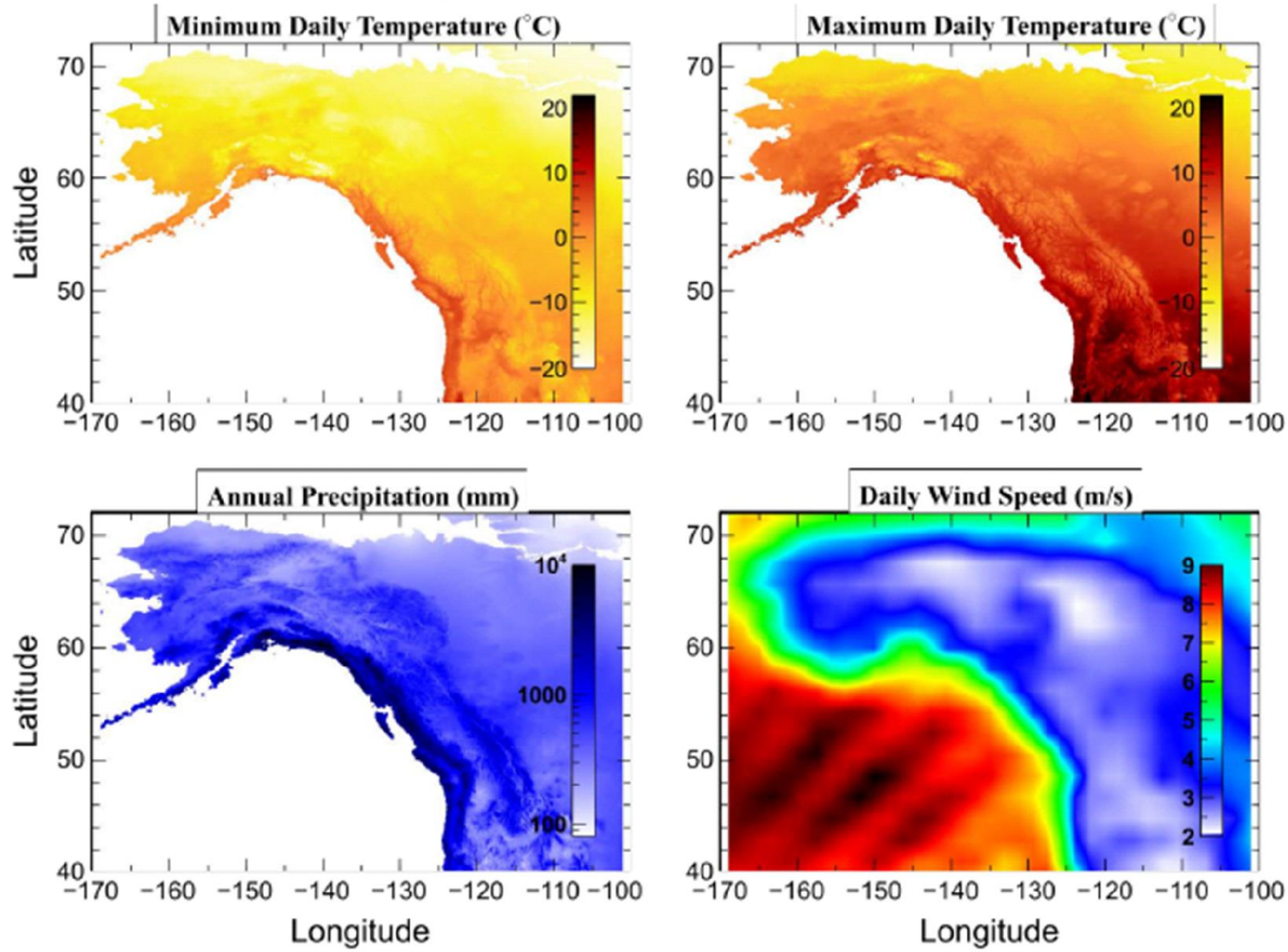
Meteorological Forcing

1971 to 2000 Climatology



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