Regional Empirical Seasonal Climate Predictions in Western Canada

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Trevor Murdock, Rick Lee, and Dave Rodenhuis
Pacific Climate Impacts Consortium
University of Victoria

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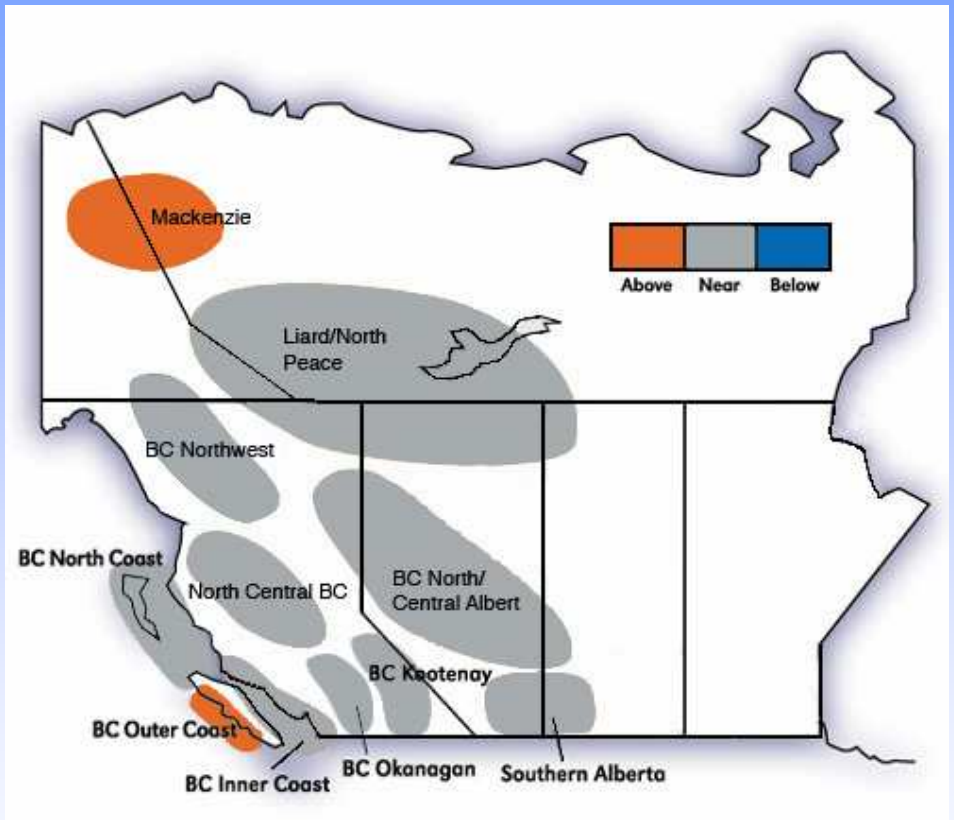
Outline

- Introduction – user needs
- Methodology
- Results: Temperature
- Winter 2006-07 forecast
- Future directions

Motivation

- Assessment of Objective Seasonal Climate Predictions
  - UVic expert & users workshop (1995)
  - attended trade shows, marketing
  - carried out case studies and developed client-specific predictions
- Users
  - disappointment in skill
  - discrepancy in resolution
  - deficiency in utility
- "Skill" (A,B,C)
  - Accuracy
  - Bias
  - Consistency
- Regional Empirical Prediction method developed 1996-1999

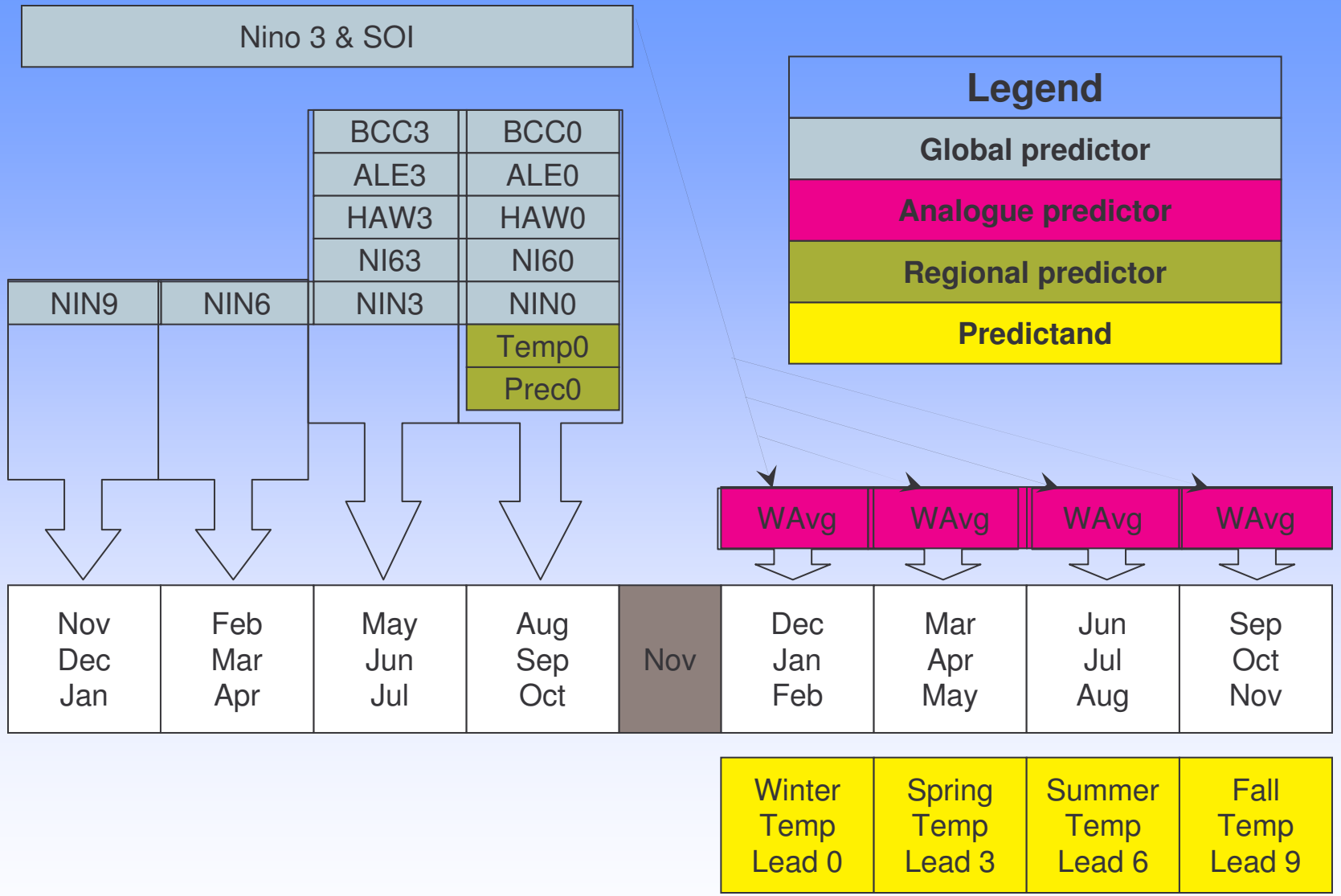
Target regions in Western Canada



Predictors

1. global predictors: Pacific SSTs
2. regional predictors: antecedent T & P
3. analogue predictor: weighted composite ENSO response

Predictors and Predictands e.g. November prediction



Derived Predictands

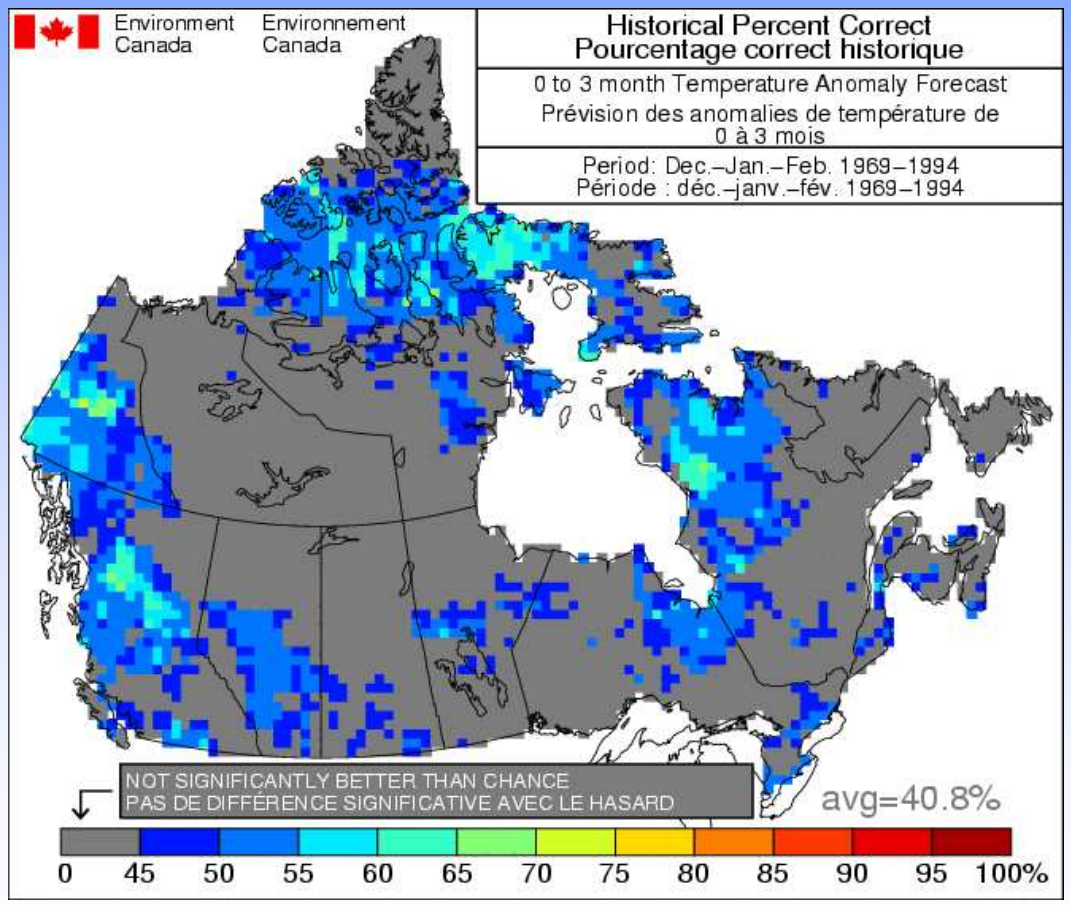
- Experimental approach for dozens of parameters
  - number of days of rainfall above .2 mm, 5 mm, 10 mm, 25 mm
  - greatest one-day snowfall, number of days of snowfall above thresholds, number of days with snow depth above thresholds
  - extreme max/min temperature, number of days with frost, number of days with temperature below –10C, frost free season
  - various degree days, sunshine, visibility, wind, relative humidity, soil moisture
  - number of days with freezing rain, thunderstorms, hail, fog, haze
- Most parameters have inadequate skill although some show promise in certain regions for certain times of year

Cross-validation (1953-1992)

Target Region	REP RMS error (ºC)	REP Skill (% correct)	EC Skill (% correct)
1. BC Inner Coast	1.15	42.5	45
2. BC Outer Coast	0.95	**52.5**	45
3. BC North Coast	1.23	**55**	NS
4. BC North Central	2.51	42.5	65
5. Okanagan	1.51	55	59
6. Kootenay	1.43	**57.5**	NS
7. BC North-Central Alberta	2.70	**60**	47
8. Southern Alberta	2.86	47.5	50
9. Northwest BC	3.16	47.5	50
10. Liard/North Peace	2.21	**52.5**	NS
11. Mackenzie	1.95	**50**	NS

Historical Skill (cross validated)

MSC National Operational Forecast
(winter season; zero leadtime)



REP Skill … as a function of Lead Time (Winter Season; Kootenay Region)

Lead Time (months)	REP RMS error (°C)	REP Skill (% correct)	EC Skill (% correct)
0	1.43	57.5	NS
1	1.45	52.5	--
2	1.42	60.0	--
3	1.26	57.5	47.5
4	1.49	60.0	--
5	1.62	60.0	--
6	1.61	57.5	NS

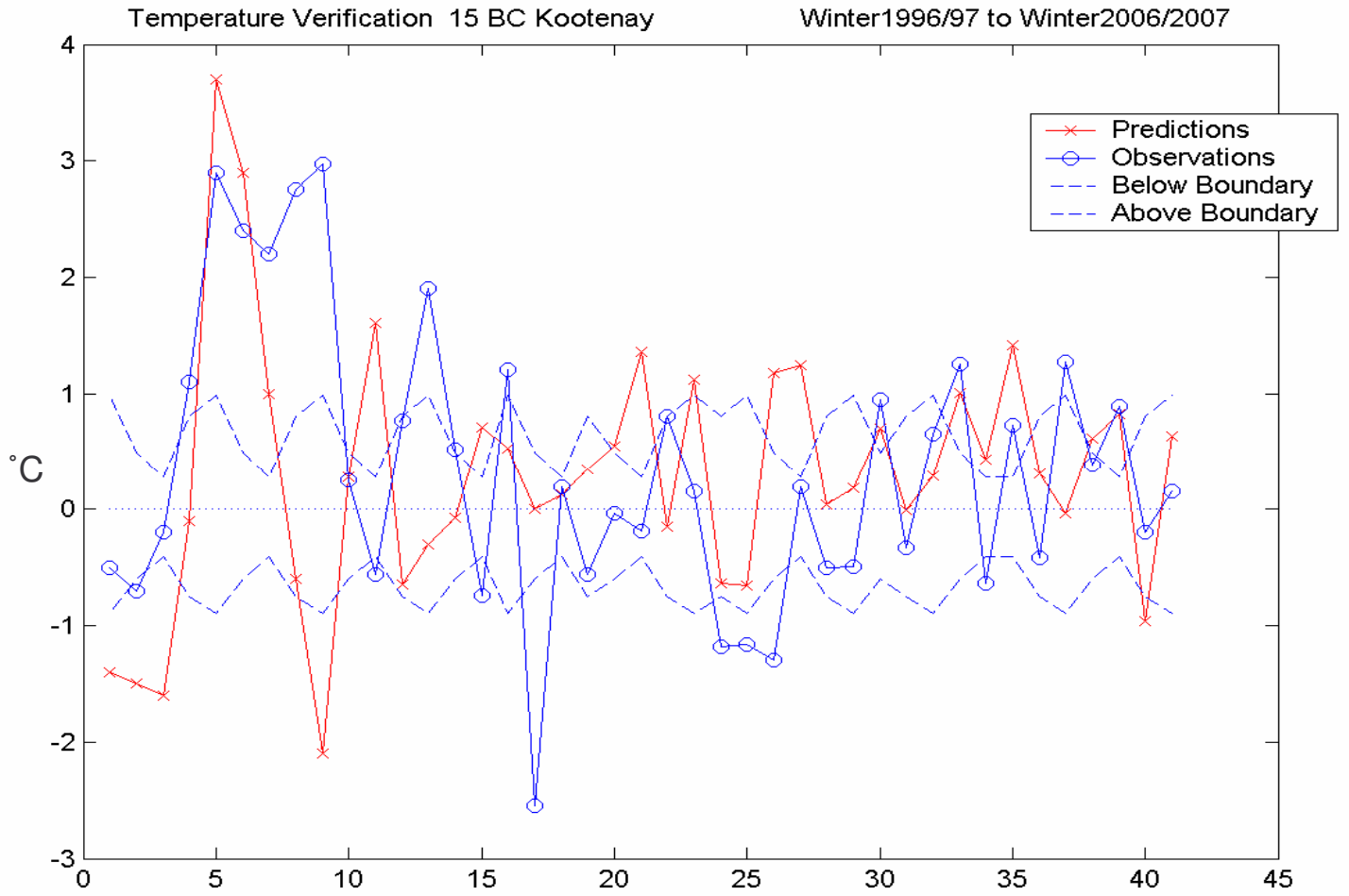
Verification

1996 - 2006; zero leadtime only; Winter season

Target Region	REP Skill % correct	1961-1990 Climatology % correct	Heidke Skill Score	EC Skill % correct
1. BC Inner Coast	18	18	-0.23	
2. BC Outer Coast	**22**	11	-0.17	
3. BC North Coast	**60**	40	**0.4**	
4. BC North Central	**40**	20	**0.1**	
5. Okanagan	**45**	36	**0.18**	
6. Kootenay	36	45	**0.04**	
7. BC North-Central Alberta	55	55	**0.33**	
8. Southern Alberta	**36**	9	**0.04**	
9. Northwest BC	**50**	10	**0.25**	
10. Liard/North Peace	**30**	10	-0.05	
11. Mackenzie	**30**	10	-0.05	
Average all regions	**36**	21	**0.04**	

Verification Example

All seasons: Kootenay Region



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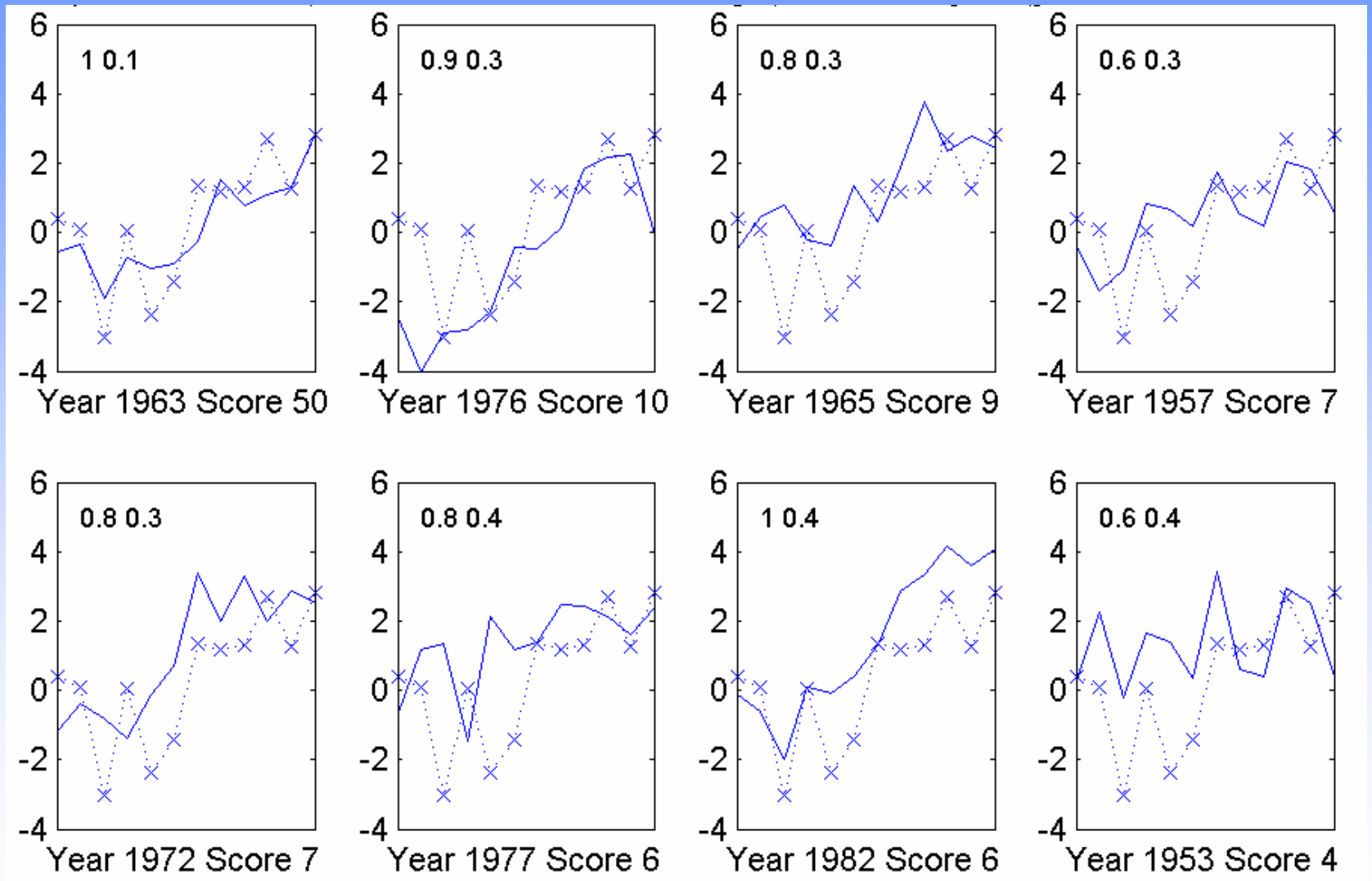
Analogue example (data to Oct 2006)



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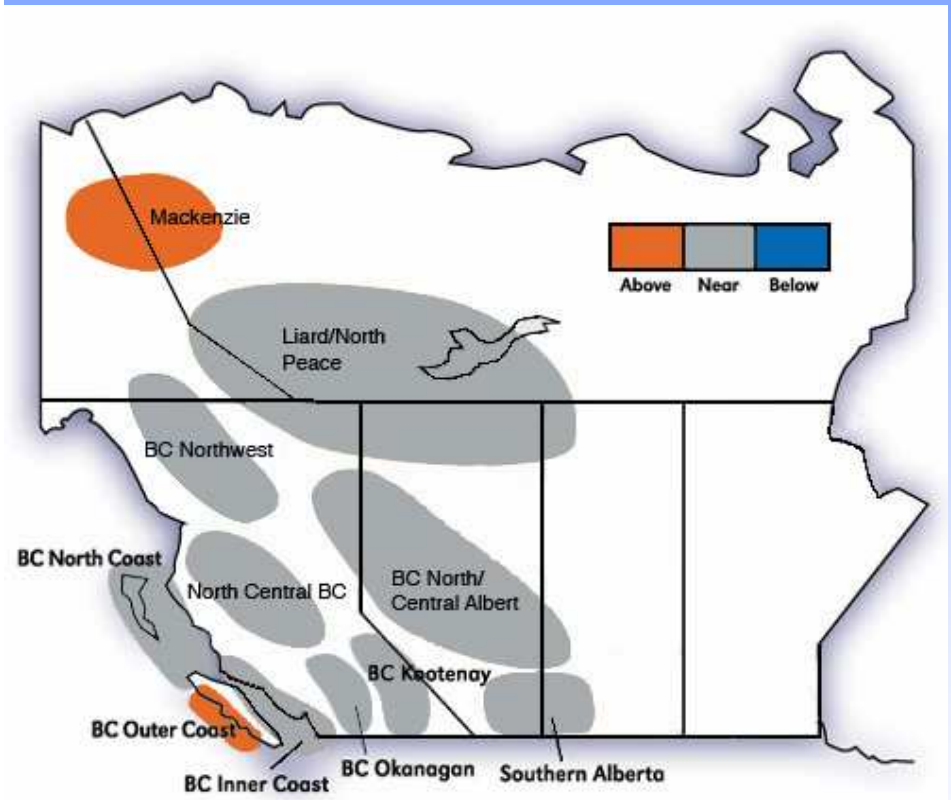
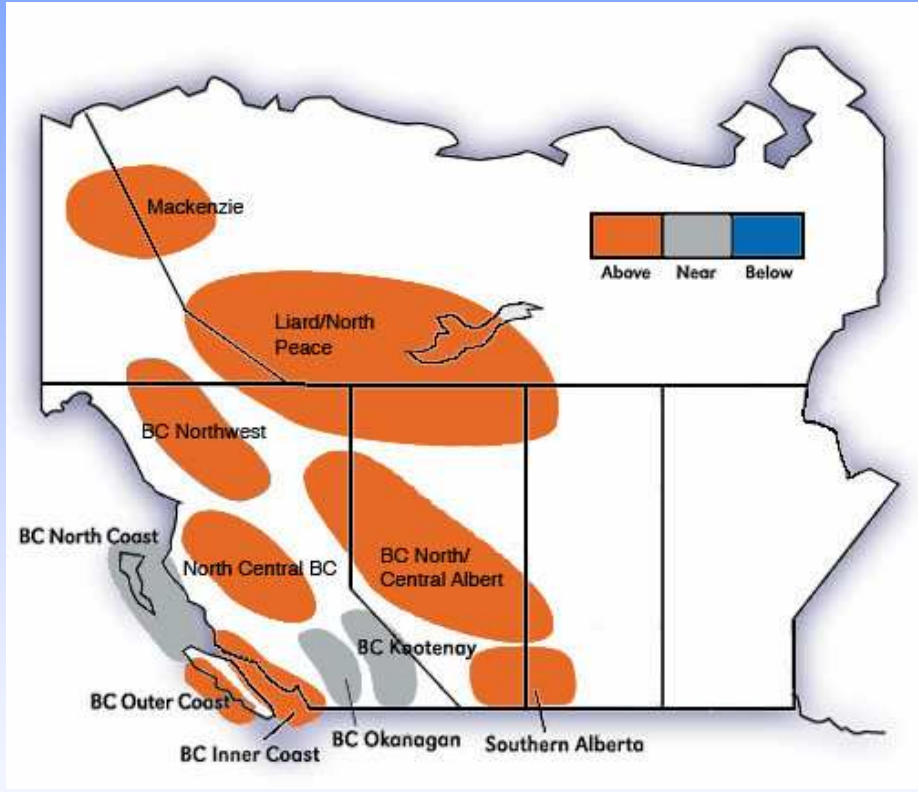
Winter 2006-07

REP Prediction



Observations



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Summary

- Commercial product (1996-2006): no business case
- Determination of user needs
- *Disappointment* in skill remains - a gap between what is needed and what can be delivered
  - *Accuracy* – temperature comparable to national predictions
  - *Bias* – verification shows evidence of need to address bias
  - *Consistency* – forced
- REP addressed to some degree
  - *discrepancy* in resolution – regional targets
  - *deficiency* in utility – derived predictands

Where do we go from here?

- Objective is to improve adaptation to climate change and variability
- Complete seasonal evaluation of REP by comparison with the EC cross-validation and (stricter?) verification
- Analysis of predictors chosen and derived predictand skill
- Focus on climate prediction in the PNW of North America
- User needs for skill (A, B, C), resolution, and utility

Thank You

For more information
tmurdock@uvic.ca

August prediction of # of days with snowfall above 5 cm in winter (DJF)

Confidence in prediction skill
* 99 Very Strong Confidence
\+ 95 Strong Confidence
x 90 Moderate Confidence
o 80 Use Climatology
c <80 Use Climatology

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November prediction of # of days with thunderstorms in winter (DJF)

Confidence in prediction skill
* 99 Very Strong Confidence
\+ 95 Strong Confidence
x 90 Moderate Confidence
o 80 Use Climatology
c <80 Use Climatology

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Regional Empirical Prediction method (REP)

- Analogue multiple linear regression for seasonal Temperature and Precipitation
- Each multiple linear regression is determined *independently* for each region 0-11 months before each season
- Regions chosen with consistent *historical ENSO response* and relatively consistent climatology
  - original regions different for Temp and Precip
  - choosing consistent regions → reduction in Precip skill
- *Derived* parameters
- Automated iterative statistical selection of predictors
- Commercial product 96-06 *Canadian Institute for Climate Studies*

Global & regional predictors

- Pacific SSTs
  - chosen by expert knowledge (Rick Lee) to measure ENSO signal and PNA teleconnection to mid-latitudes
    - BC Coast 50N 130W
    - Aleutian Low 40N 170W
    - Hawaii 30N 165W
    - Nino6 0N 145E
    - Nino3.4 (5S-5N; 170W-120W)
- Antecedent Temperature and Precipitation anomalies
  - last 3 months' observations
  - persistent effects of natural variability

Analogue Predictor

- Analogue ENSO years (WAVG)
  - linear combination of SOI and Nino3
  - PCA= a*SOI + b*Nino3, where the coefficients a=-.9343$^{o}C^{-1}$ and b=0.3564 are based on the first principal component of the covariance
  - analyzed for past 12 months and all historical years ending in the same month
  - correlation and RMSE used to determine score of similarity of analogue year to current year (more weight given to last 4 months)
  - observed Temperature response following the analogue year is weighted according to score
  - composite response itself used as a predictor (could also be used directly as a prediction itself; much less skill than MLR)

To update predictions

- update the training period dataset (currently only to 1993)
- address bias and climate change trends
- focus on value-added by comparing/contrasting with other predictions
- *derived* parameters potentially more relevant but less viable as an operational package