HydroPredict' 2010

Coupling statistical and dynamical methods for spatial downscaling of precipitation

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1. Background (1)

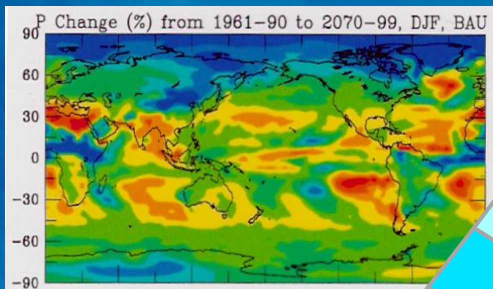
- The Intergovernmental Panel on Climate Change (IPCC) stated that the yearly mean precipitation is very likely to increase in Canada with increases predicted in winter and spring combined with decreases in summer (IPCC, 2007).

- General Circulation Models (GCMs) have been developed to simulate the present climate and predict future climate change.

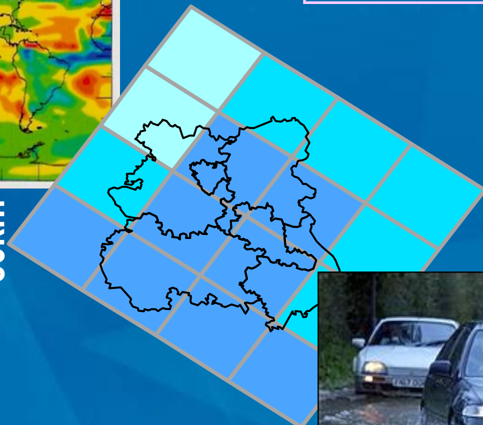
1. Background (2)

Impact models require …

150km

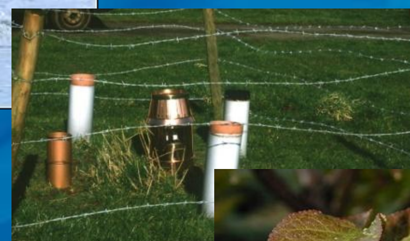


50km



10km

1m



Point

General Circulation Models supply…

1. Background (3)

Hence, downscaling techniques have been developed to address this **scale problem**:

- Regional Climate Models (RCMs) - “dynamical downscaling”

- Empirical/Statistical Models - “statistical downscaling (SD)”

✓ Transfer function (TF)

✓ Weather typing (WT)

✓ Weather generator (WG)

2. Objectives

Downscaling

1

Assess the improvement in SD using RCM variables as predictors over GCM;

2

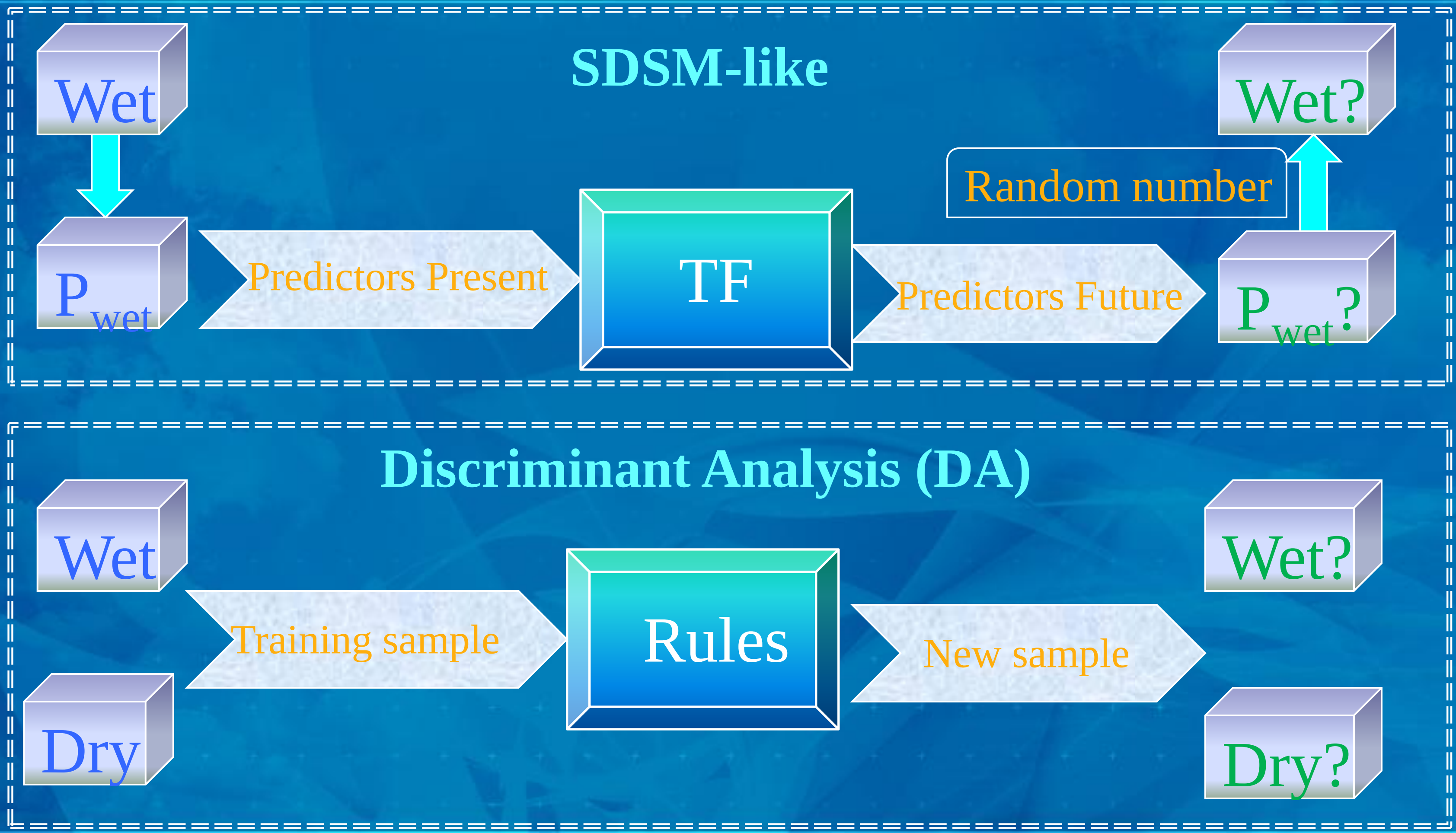
Assess the efficiency of a weather typing approach in downscaling precipitation;

3. Methodologies

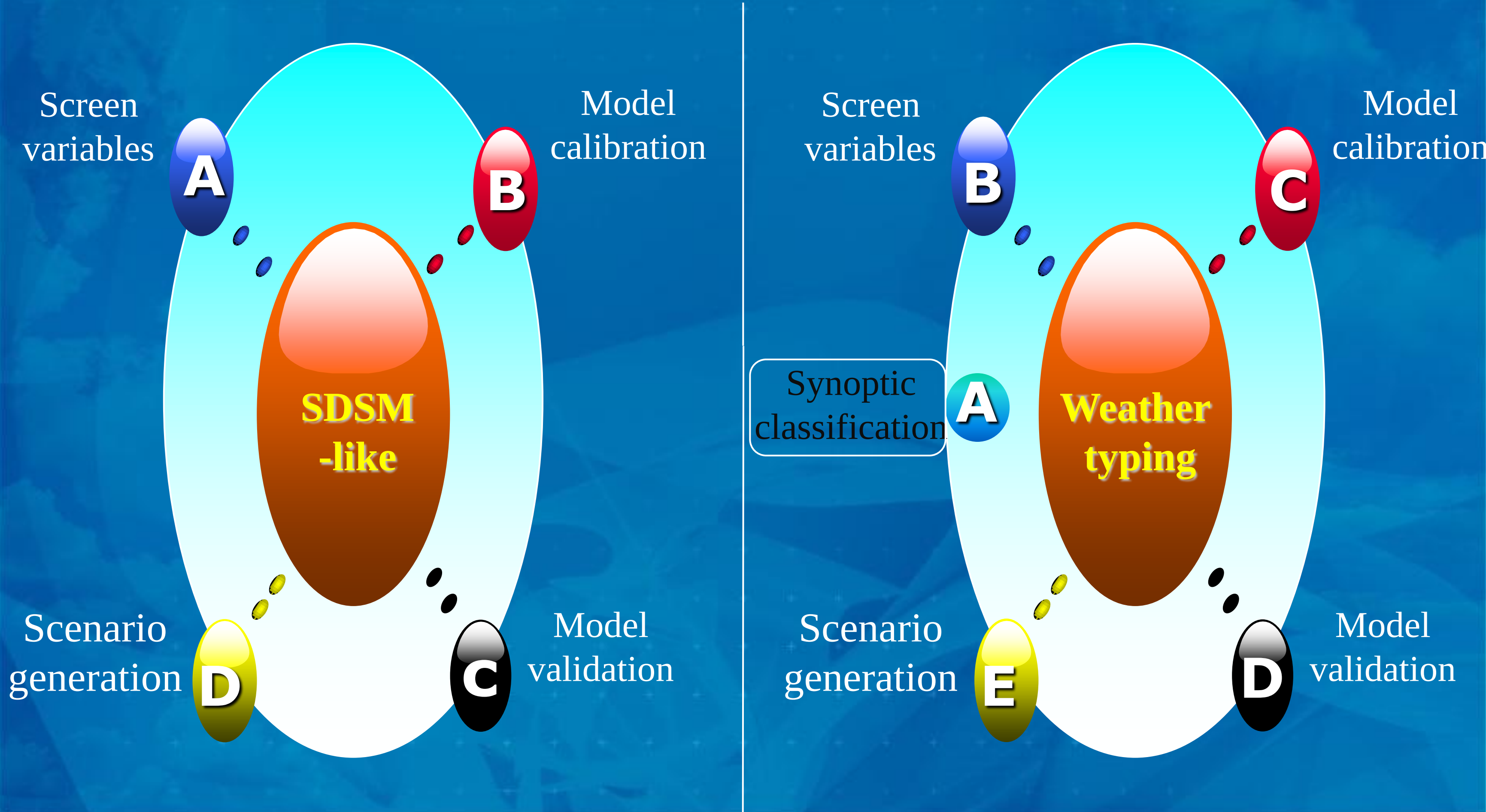
Downscaling

- Precip occurr
  - 1. Transfer function approach (SDSM-like)
  - 2. Discriminant Analysis (DA)
- Precip amount
  - 1. Transfer function approach (SDSM-like)
  - 2. Weather typing approach (WT)

3.1 Precipitation Occurrence



3.2 Precipitation amount



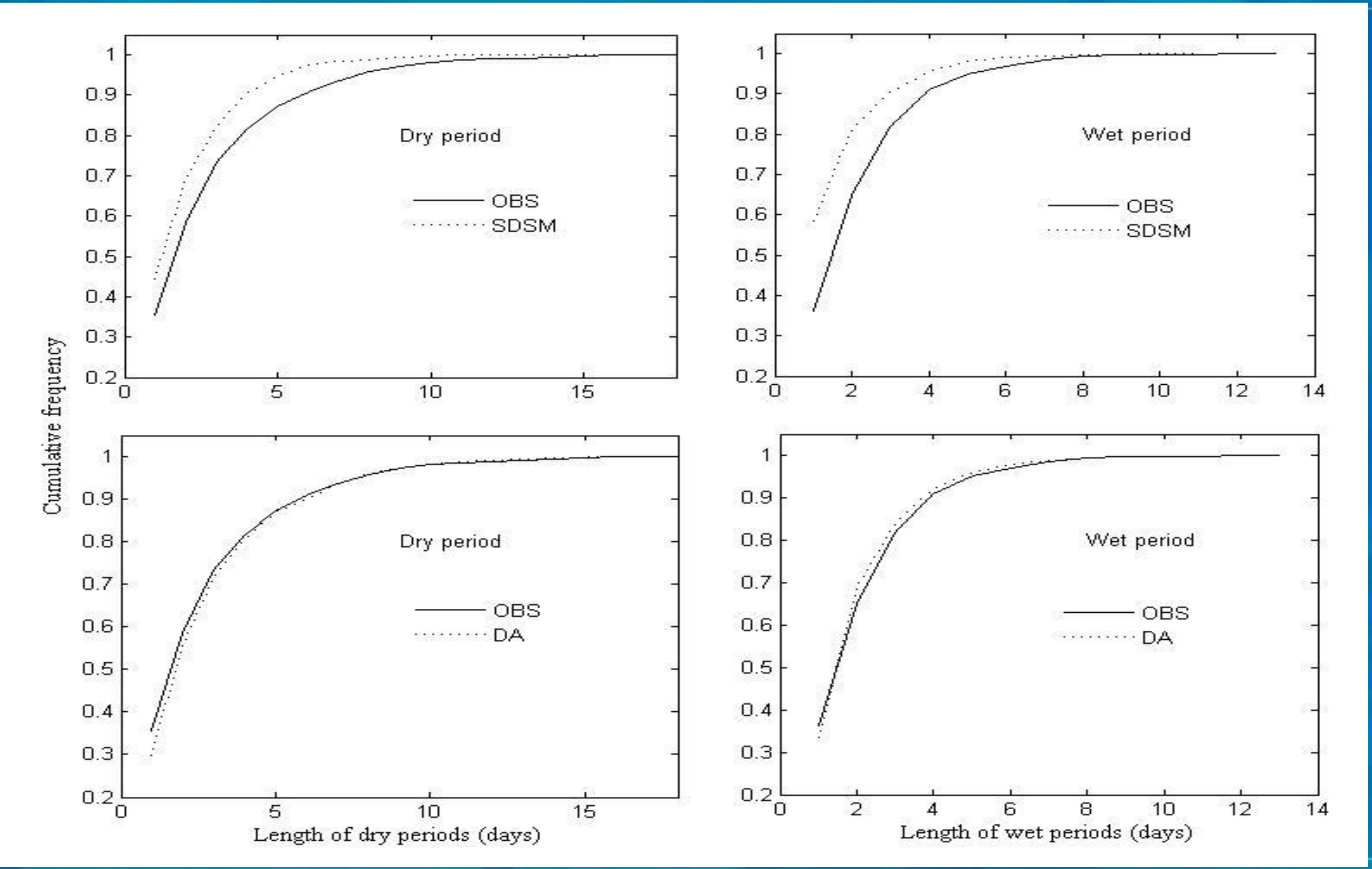
3.3 Validation

Three Stations: Svir219, Svir293, Svir689

Time periods: 1970-1984 (Calibration);
1985-1999 (Validation)

Diagnostics:
1. Frequency distribution of dry and wet periods;
2. Successful rates of identified wet and dry days;
3. Mean and standard deviation of daily precipitation;
4. Explained variance

4. Results (1)



Cumulative frequency
Dry period
OBS
SDSM
Wet period
OBS
SDSM
Dry period
OBS
DA
Wet period
OBS
DA
Length of dry periods (days)
Length of wet periods (days)

4. Results (2)

Station	Source	SDSM		Discriminant Analysis	
		NCEP_ variable	CRCM_ variable	NCEP_ variable	CRCM_ variable
	Total days	5475			
Svir219	obs_wet_day	2400			
	pre_wet_day	2320	2356	2347	2340
	cor_wet_day	42.8%	43.8%	66.3%	72.0%
	cor_dry_day	58.0%	56.1%	75.4%	80.1%
Svir293	obs_wet_day	2452			
	pre_wet_day	2379	2435	2432	2362
	cor_wet_day	43.6%	45.1%	68.5%	74.8%
	cor_dry_day	56.6%	56.0%	75.1%	82.5%
Svir689	obs_wet_day	1818			
	pre_wet_day	1824	1757	2248	1926
	cor_wet_day	33.3%	32.4%	70.1%	71.9%
	cor_dry_day	66.7%	28.1%	73.4%	83.1%

4. Results (3)

Station	Season	Mean				Standard deviation			
		Observed	SDSM_NCEP	SDSM_CRCM	WT_CRCM	Observed	SDSM_NCEP	SDSM_CRCM	WT_CRCM
Sivr219	Spring	4.2	2.8	3.4	3.4	4.7	2.0	3.7	3.5
	Summer	5.7	3.6	3.8	3.7	6.6	2.3	3.0	3.1
	Autumn	4.6	3.0	3.6	3.6	6.0	2.4	4.5	4.6
	Winter	3.3	2.2	2.7	2.7	4.0	1.4	3.4	3.5
Svir293	Spring	3.5	2.7	3.0	3.0	4.7	2.3	3.8	3.5
	Summer	5.0	3.5	3.5	3.5	6.3	2.5	2.8	3.0
	Autumn	4.4	3.1	3.5	3.5	6.1	2.9	4.3	4.3
	Winter	2.8	2.1	2.4	2.5	3.5	1.5	3.5	3.4
Svir689	Spring	4.9	3.1	3.5	3.5	5.7	1.8	3.7	3.7
	Summer	6.1	3.5	3.6	3.4	8.1	1.6	2.2	2.0
	Autumn	5.2	3.5	3.9	3.9	7.0	2.4	4.4	4.6
	Winter	3.6	2.6	2.8	2.8	4.6	2.1	3.5	3.6
MRE(%)		--	-32.3	-24.0	-24.0	--	-61.5	-32.4	-32.3

4. Results (4)

Station	Season	Explained variance (%) of calibration			Explained variance (%) of validation		
		SDSM_ NCEP	SDSM_ CRCM	WT CRCM	SDSM_ NCEP	SDSM_ CRCM	WT_ CRCM
Sivr219	Spring	21.8	45.3	45.6	15.7	31.3	31.8
	Summer	18.7	30.8	31.8	12.3	17.1	15.0
	Autumn	24.6	36.5	39.1	23.8	54.8	51.0
	Winter	28.0	45.3	46.7	20.9	31.9	33.1
Svir293	Spring	26.8	47.4	49.3	25.3	47.0	45.6
	Summer	20.4	31.5	36.4	16.6	23.7	26.7
	Autumn	24.0	37.1	38.4	29.2	58.4	57.8
	Winter	26.4	53.8	52.6	28.5	41.5	48.3
Sir689	Spring	16.0	39.9	43.3	13.8	21.7	20.6
	Summer	7.9	12.4	11.8	8.1	8.3	9.7
	Autumn	21.9	33.4	35.2	21.4	49.8	46.6
	Winter	25.5	46.9	45.9	22.9	47.7	45.7
Mean		21.8	38.4	39.7	19.9	36.1	36.0

5. Conclusions (1)

- Both the SDSM-like and DA-based models reproduced the percentage of wet days, while the wet and dry statuses for each day were poorly downscaled by both approaches. But the DA-based model was much better the SDSM-like model.

- Both the mean and standard deviations were markedly underestimated for the two approaches tested, due to the explained variances are consistent less than 50%.

5. Conclusions (2)

- Despite the added complexity, the weather typing approach was not better at downscaling precipitation than approaches without classification.

- Using CRCM variables as predictors rather than NCEP data improved the wet and dry day predictions and also resulted in a much-improved explained variance for precipitation amount. However, the explained variance was always less than 50% overall.

Thank you!