Effects of climate variability on hydrological processes in Marmot Creek: Approach and Challenges

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Introduction

* Effect of variability in climate on the water balance is very important in basin hydrology
* The water balance is governed by the major hydrological processes operating in a basin, which are influenced by climate
* Harder and Pomeroy show that Marmot Creek hydrology is changing, but do not show causal links with basin hydrology
* Need to explain how climate variability is affecting hydrological processes, water balance and ultimately streamflow

Objectives

* Overall objective is to relate changes in hydrological processes over a basin and their effect on stream flow to climate variability
* Two main objectives:

1. Model the processes governing the water balance over the last 50 years.
2. Describe changes in the water balance in relation to variability in the basin's climate.

CRHM

* Cold Regions Hydrological Model
* Modelling platform which can be used to simulate hydrological processes
  * Precipitation phase and redistribution
  * Evapotranspiration
  * Snow sublimation
  * Snowmelt
  * Change in storage
  * Runoff

Methodology – Data Set

* Meteorological data set from the 1960's to the 1980's and more recent data set (2005-2013) for calculating hydrological processes

* Data includes:
  * Precipitation
  * Air temperature
  * Wind speed
  * Relative humidity

Methodology – Data Set

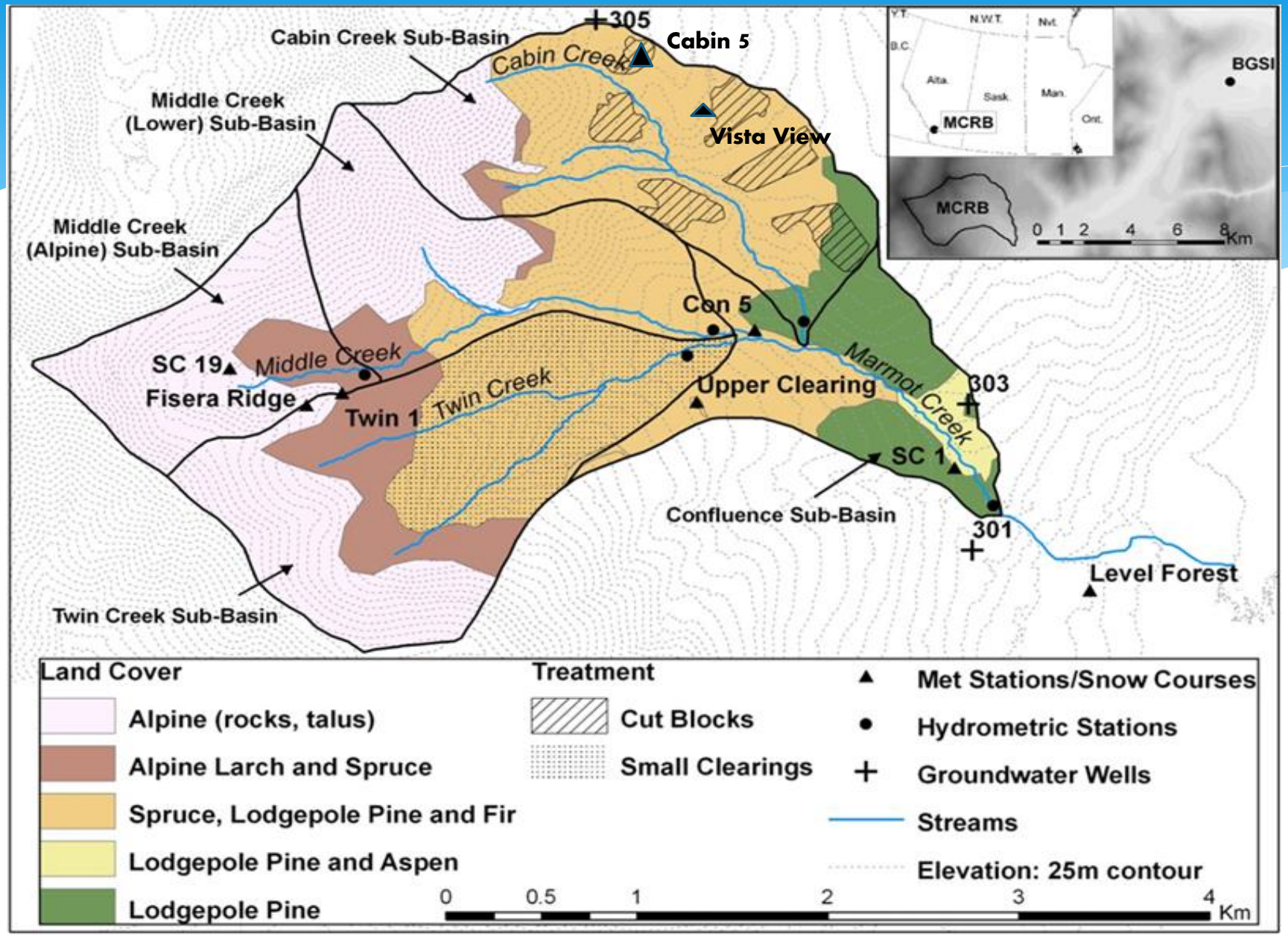
* Three stages of data:
  * Historical data (1962-1987) includes scanned data from Alberta Forestry that is daily, as well as hourly, depending on the meteorological site and time
  * The Gap (1987-2004) – no meteorological data collected in the basin
  * Current data (2005-2013) including Fisera ridge, Upper clearing/forest, Vista view, etc..
    * Hourly measurements that form a tested and modelled data set
  * Also streamflow measurements from Water Survey Canada at the outlet of the basin that run consistently from 1960's to 2012

Historical Data

* Historical data ranging from 1962-1987
* Three main stations: Twin 1, Confluence 5, Cabin 5
* Hourly data recorded for
  * Temperature
  * Relative Humidity
  * Wind
* Daily recorded data for
  * Temperature (Max/Min)
  * Relative Humidity (Max/Min)
  * Precipitation
  * Wind (Daily Average)

Current Data

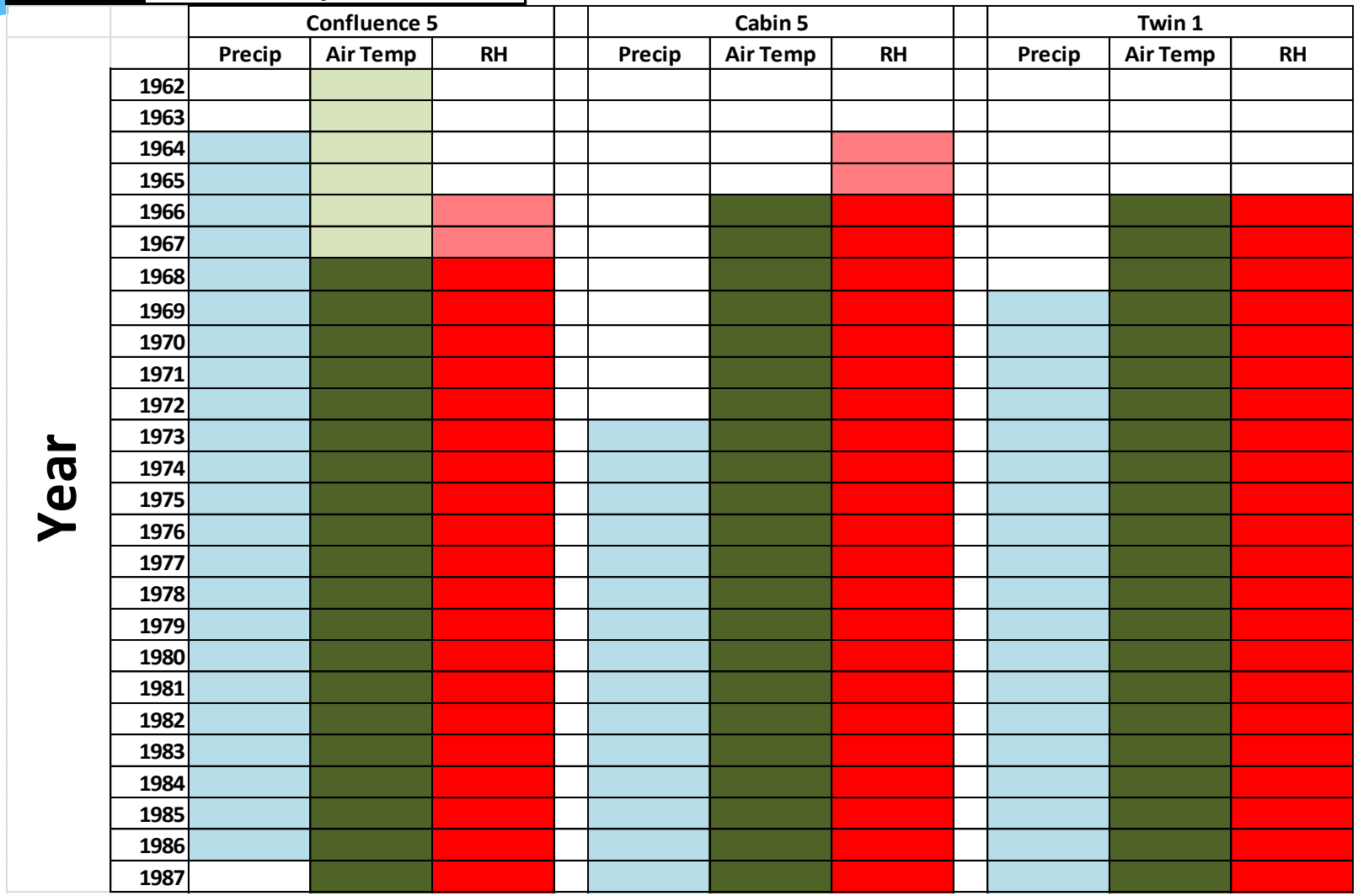
* Current data ranging from 2005-2013
* Comparable stations to historical data include: Fisera Ridge, Upper Clearing and Vista View
* Hourly recorded data for
  * Temperature
  * Relative humidity
  * Precipitation
  * Wind
  * Incoming short wave radiation


305
Cabin Creek Sub-Basin
Cabin Creek
Cabin 5
Middle Creek
(Lower) Sub-Basin
Vista View
Middle Creek
(Alpine) Sub-Basin
Con 5
SC 19
Middle Creek
Fisera Ridge
Twin 1
Twin Creek
Upper Clearing
Marmot Creek
303
SC 1
Confluence Sub-Basin
301
Level Forest
Twin Creek Sub-Basin
Y.T.
N.W.T.
Nvt.
B.C.
Alta.
Sask.
Man.
Ont.
MCRB
BGSI
MCRB
0 1 2 4 6 8 Km
Land Cover
Alpine (rocks, talus)
Alpine Larch and Spruce
Spruce, Lodgepole Pine and Fir
Lodgepole Pine and Aspen
Lodgepole Pine
Treatment
Cut Blocks
Small Clearings
Met Stations/Snow Courses
Hydrometric Stations
Groundwater Wells
Streams
Elevation: 25m contour
0 0.5 1 2 3 4 Km

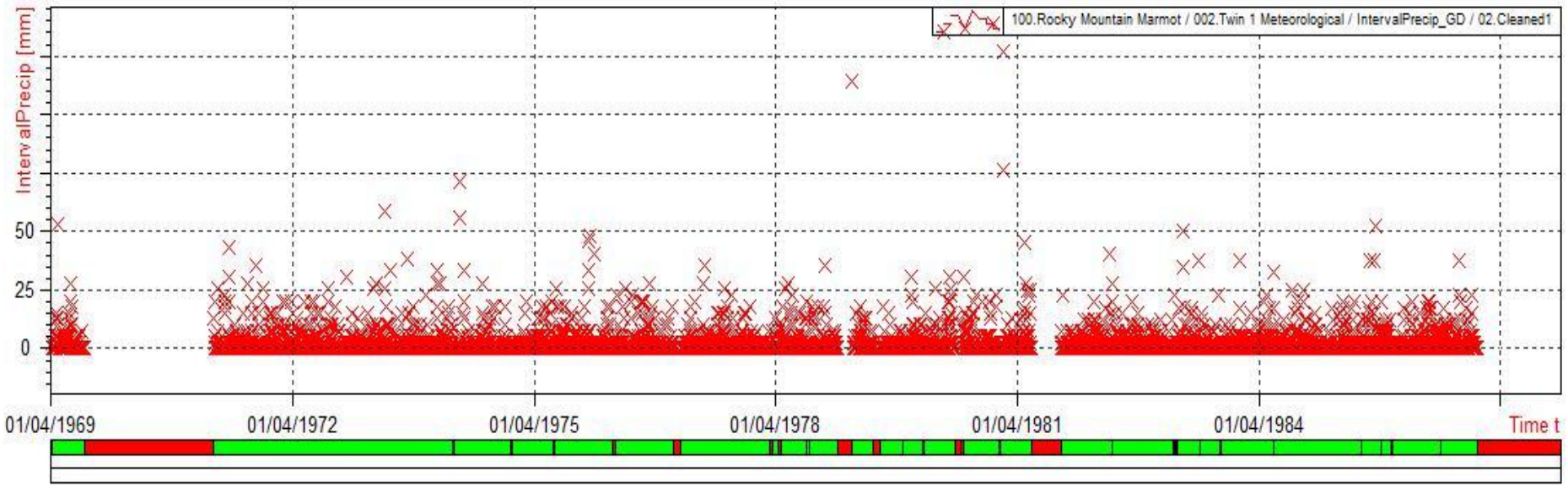
Historical Data

* Precipitation, air temperature and relative humidity: daily to hourly

	Shaded = Daily data
	Solid = Hourly data



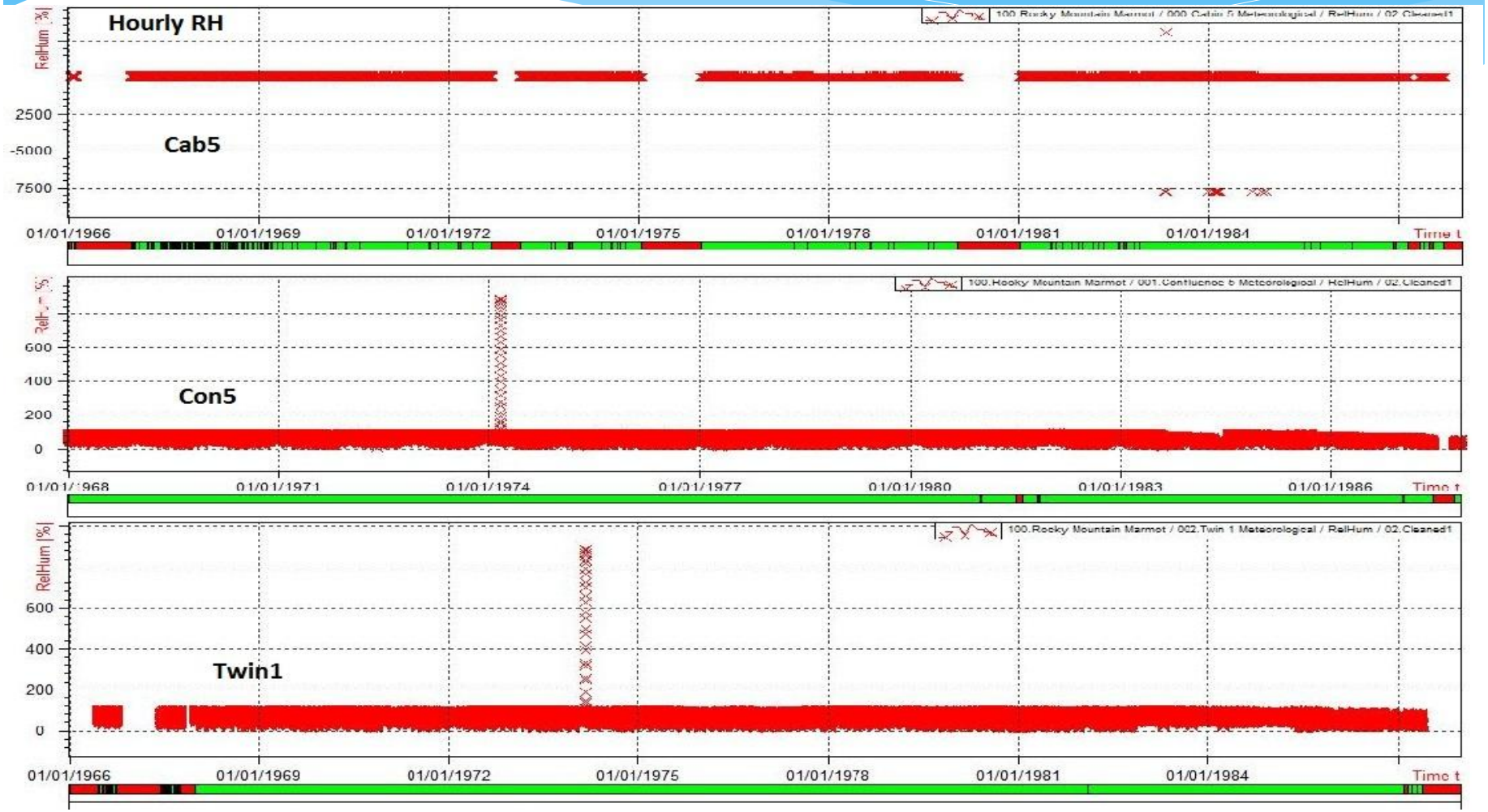
Twin 1 – Daily Precipitation



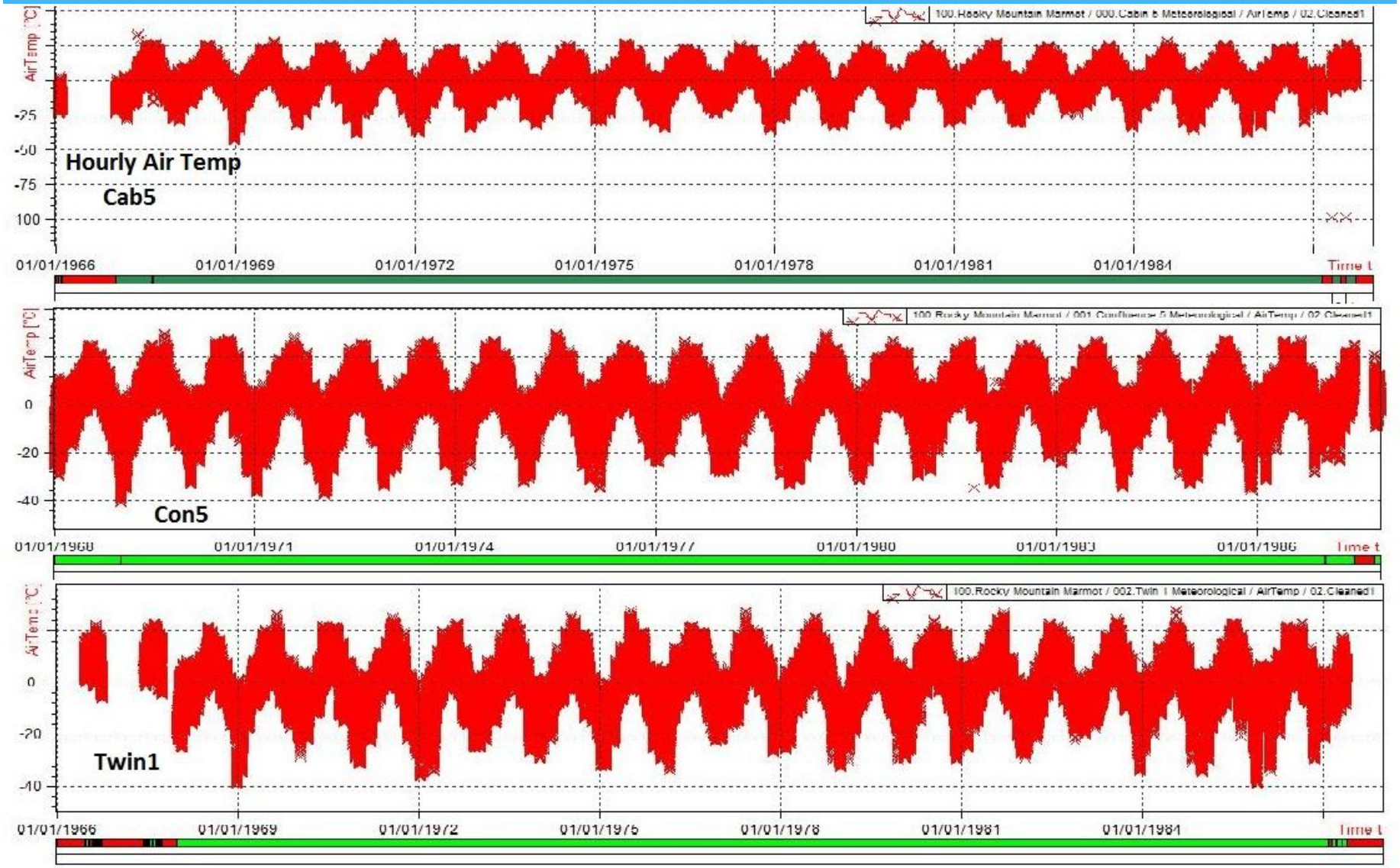
Daily Precipitation

Daily Precip

Hourly Relative Humidity



Hourly Air Temperature



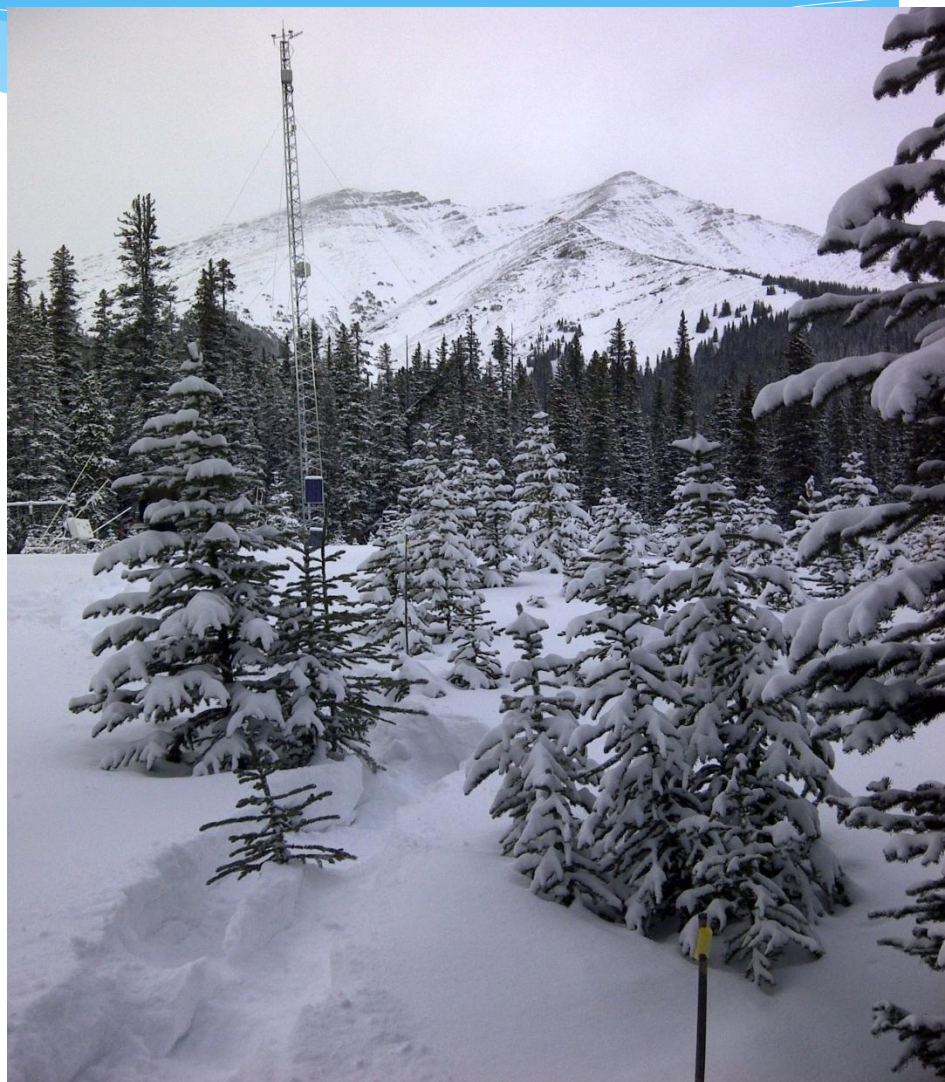
Historical Data

* Hourly and daily wind data

		Con 5	Cabin 5	Twin 1		Twin 12
		Hourly	Hourly	Hourly	Daily	Daily
Year	1962					
	1963					
	1964					
	1965					
	1966					
	1967					
	1968					
	1969					
	1970					
	1971					
	1972					
	1973					
	1974					
	1975					
	1976					
	1977					
	1978					
	1979					
	1980					
	1981					
	1982					
	1983					
	1984					
	1985					
	1986					
	1987					

Historical Data - Gap Filling

* Within the recorded years there are gaps of varying size to infill
* Regression equations between stations can be used for temperature and vapour pressure infilling
* Seasonal lapse rates to extrapolate precipitation



Historical Wind Data

* Challenge lies with the lack of hourly wind data as CRHM requires this for various modules such as blowing snow
* For infilling use regression equations between hourly wind observations for three main sites Con 5, Cabin 5, Twin 1 for period between 82-87
* Simulate hydrological processes using CRHM:
  * Using in-filled hourly wind data
  * Using a daily mean derived from hourly wind observations
* Determine the errors induced by lack of hourly wind observations
* Apply results to 60's and 70's

No Mans Land

* Period of 17 years between the historical and current data sets (1987-2004) with no data inside basin
* Time spent gathering data from neighbouring sites:
  * Nakiska ridge top – adjacent mountain ridge
  * Boundary ranger station – across highway from basin

Safety Precautions

* Always uncertainty in running a model
* Uncertainty is related to the amount and quality of data
* Working with a large amount of data with varying amounts of infill
* Major risk being that changes in basin behaviour are actually disguised changes in uncertainty
* On the same thought- our best available method at studying this time period for Marmot Creek

Thank you for your time. Questions?