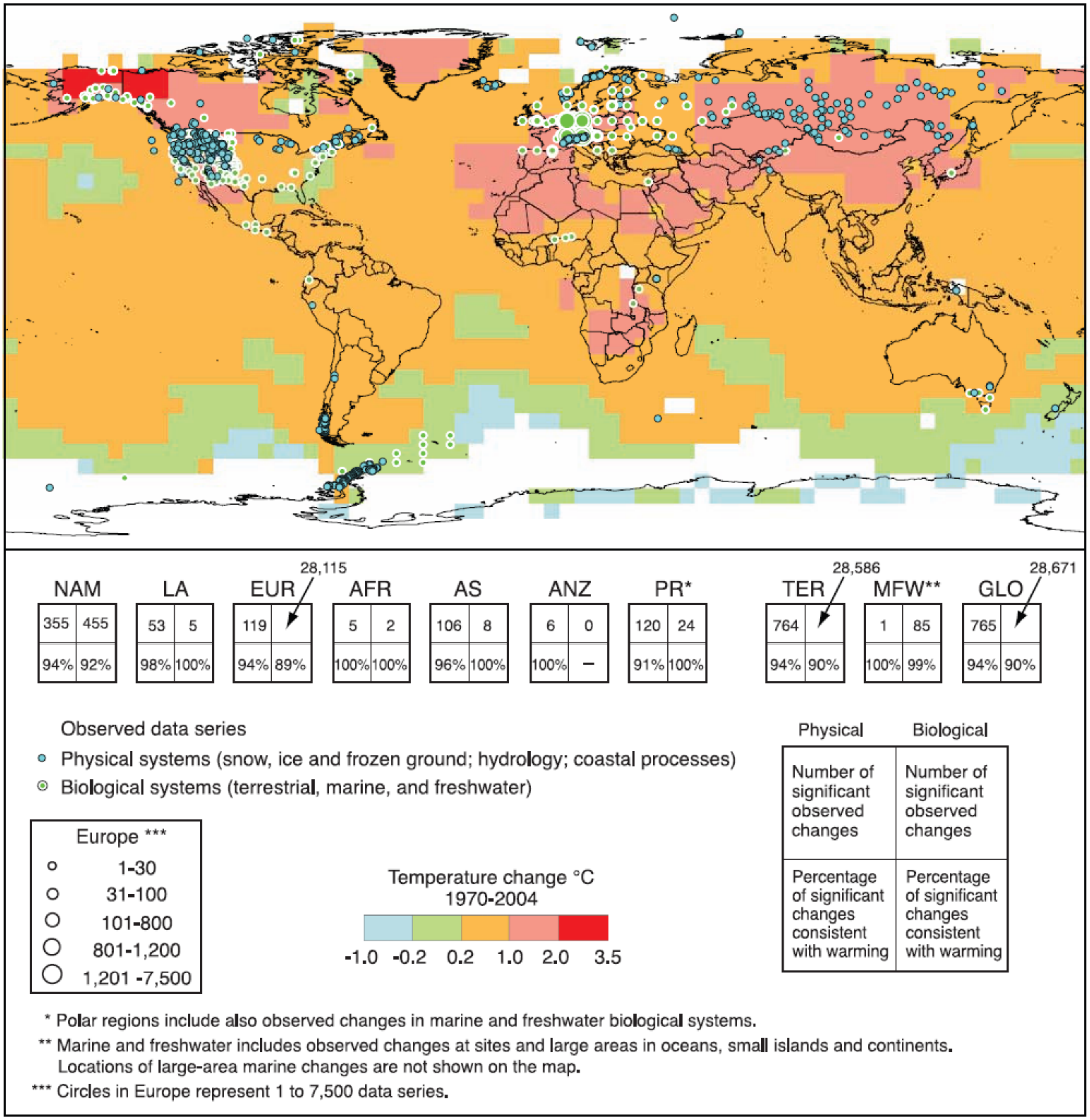
Future Scenarios of Climate Change: The challenges we face

Dr. David Sauchyn, Universidad de Regina-Canadá

With thanks to: Prof. Melitta Fiebig Wittmaack, ULS

22 de Abril, 2009, La Serena, Chile

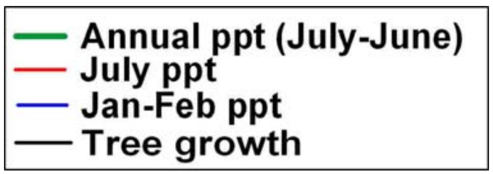

28,115
28,586
28,671
NAM
355 455
94% 92%
LA
53 5
98% 100%
EUR
119
94% 89%
AFR
5 2
100% 100%
AS
106 8
96% 100%
ANZ
6 0
100% –
PR*
120 24
91% 100%
TER
764
94% 90%
MFW**
1 85
100% 99%
GLO
765
94% 90%
Observed data series
Physical systems (snow, ice and frozen ground; hydrology; coastal processes)
Biological systems (terrestrial, marine, and freshwater)
Physical
Biological
Number of significant observed changes
Number of significant observed changes
Percentage of significant changes consistent with warming
Percentage of significant changes consistent with warming
Europe ***
1-30
31-100
101-800
801-1,200
1,201 -7,500
Temperature change °C
1970-2004
-1.0
-0.2
0.2
1.0
2.0
3.5
* Polar regions include also observed changes in marine and freshwater biological systems.
** Marine and freshwater includes observed changes at sites and large areas in oceans, small islands and continents. Locations of large-area marine changes are not shown on the map.
*** Circles in Europe represent 1 to 7,500 data series.

(IPCC 2007)

Seasonal precipitation, ENSO and tree growth response, SSRB

▲ Response to summer

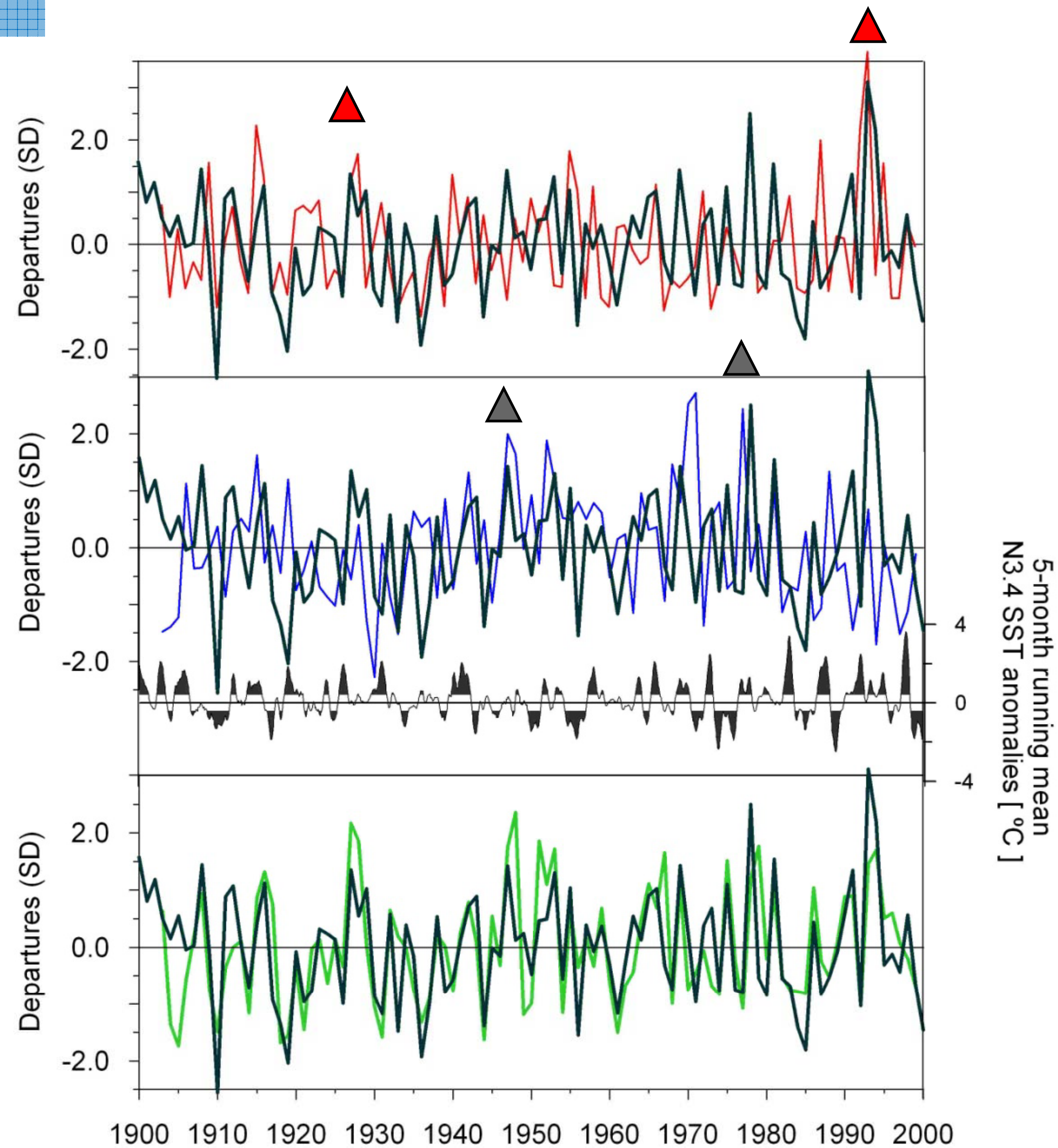
▲ Response to winter



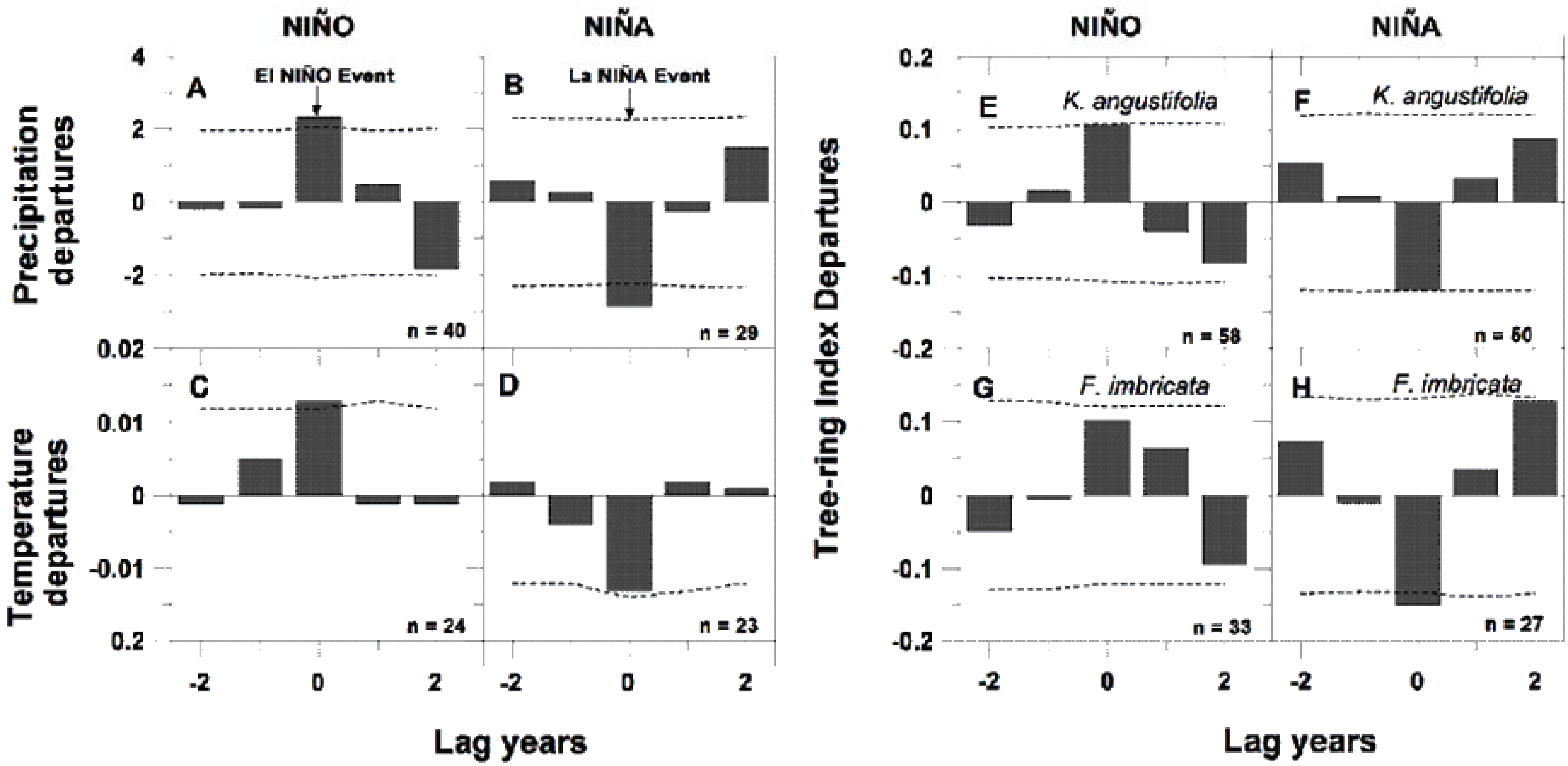
r = .67

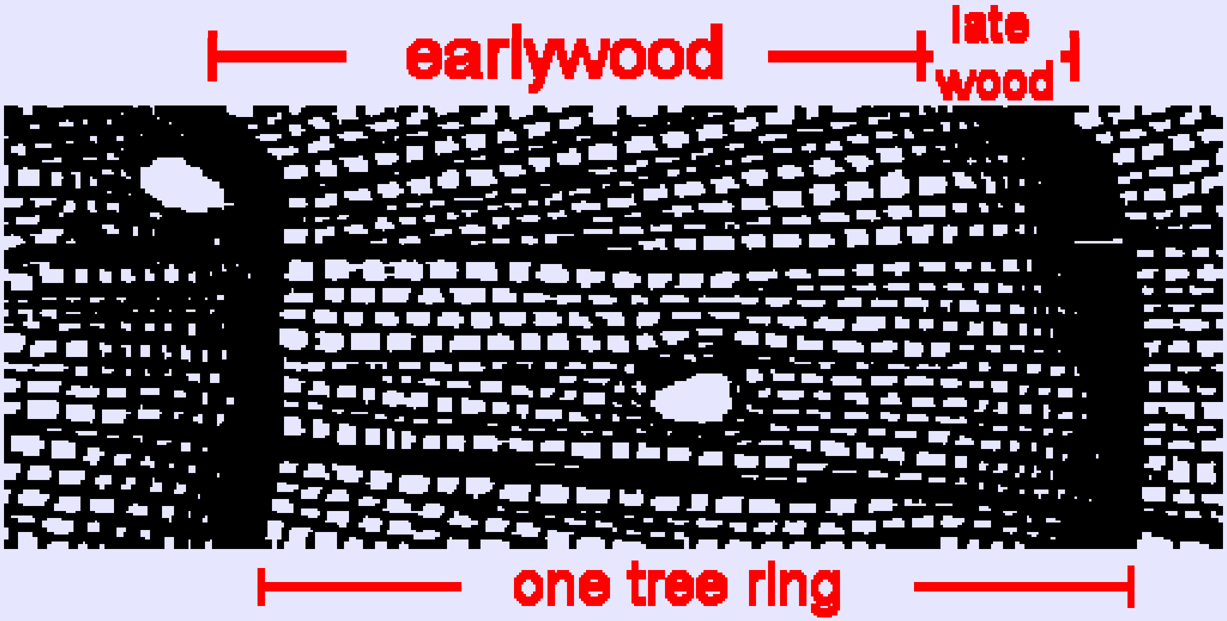
El Niño→ winter (-); summer (+)

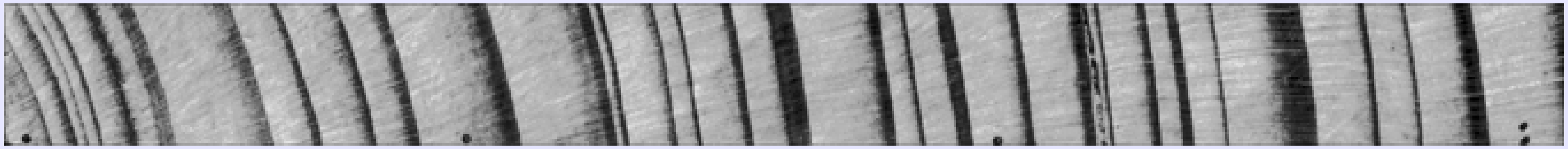
La Niña→ winter (+); summer (-)



Region IV Dendrochronology – ENSO signal

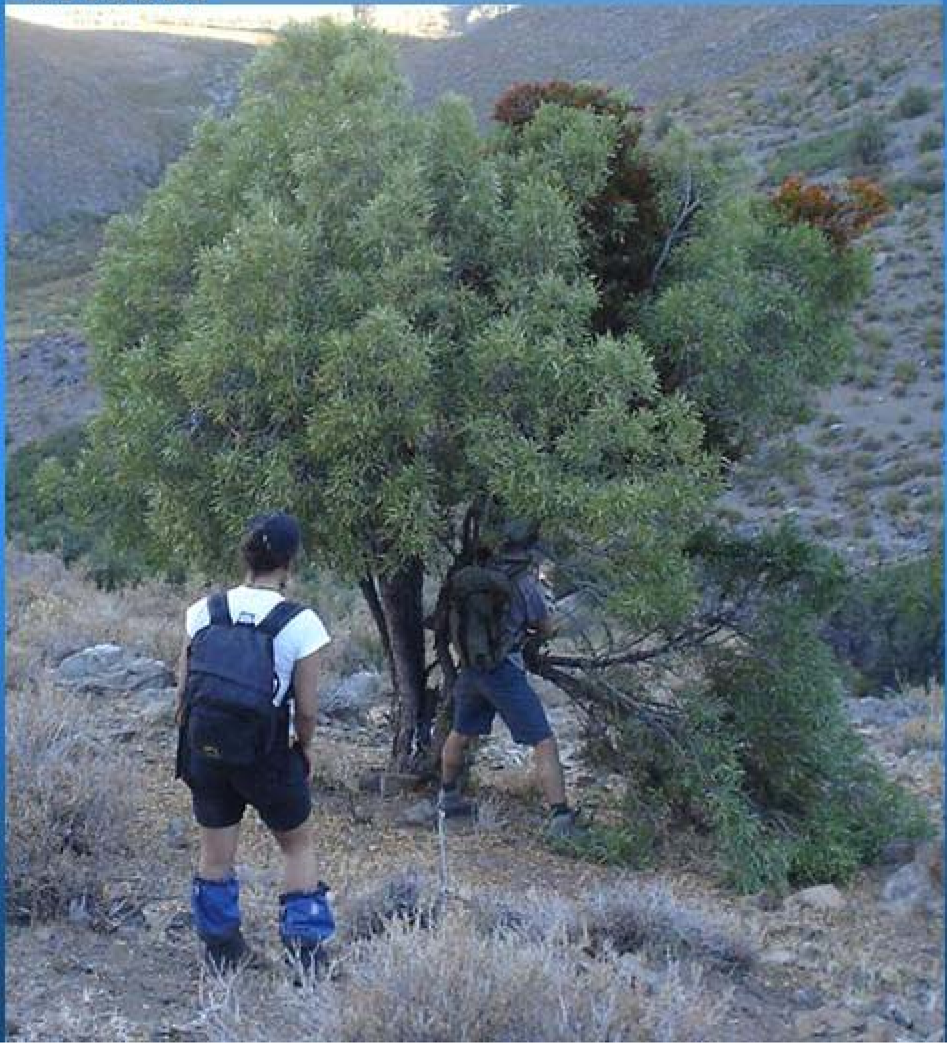



earlywood
late
wood
one tree ring



Kageneckia's site

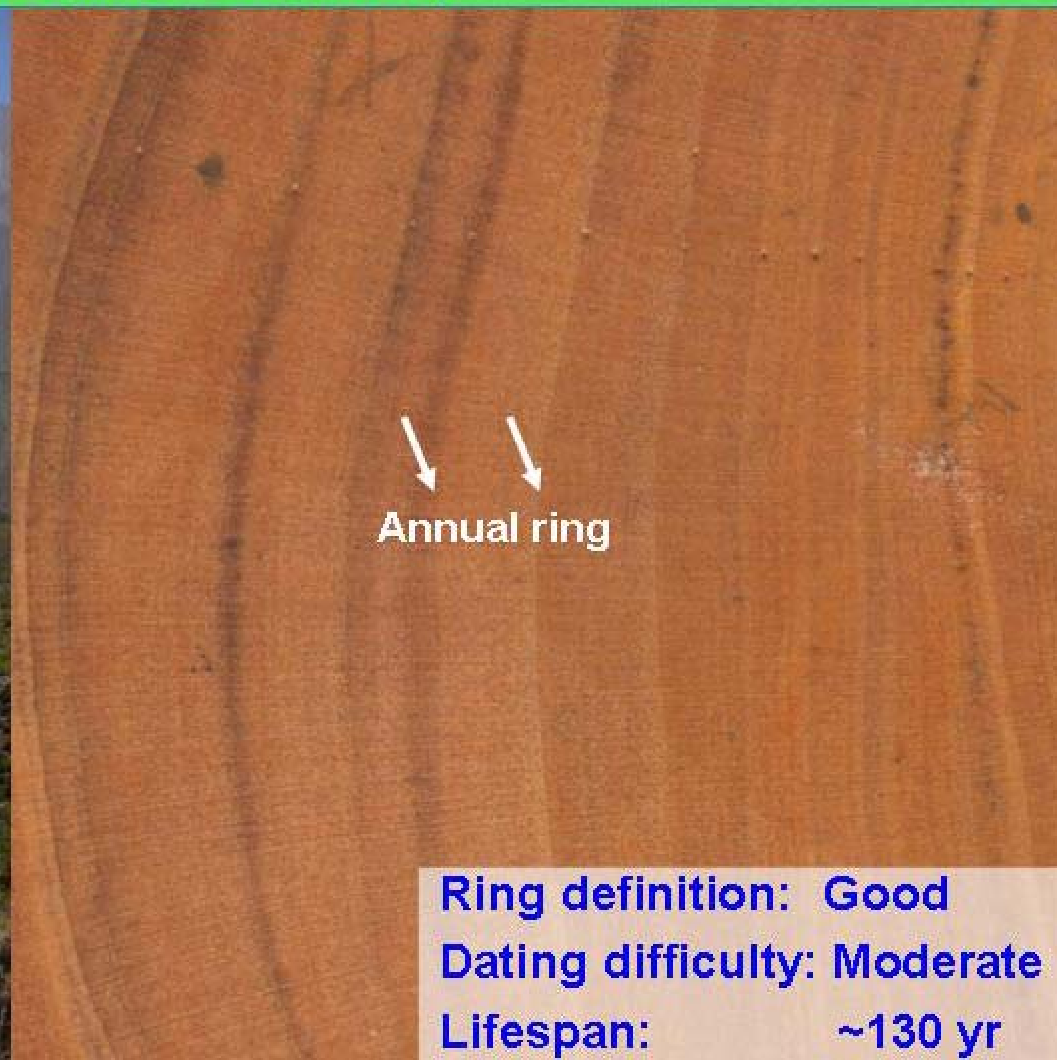
Sampling of living branches to solve crossdating problems found in the last decades



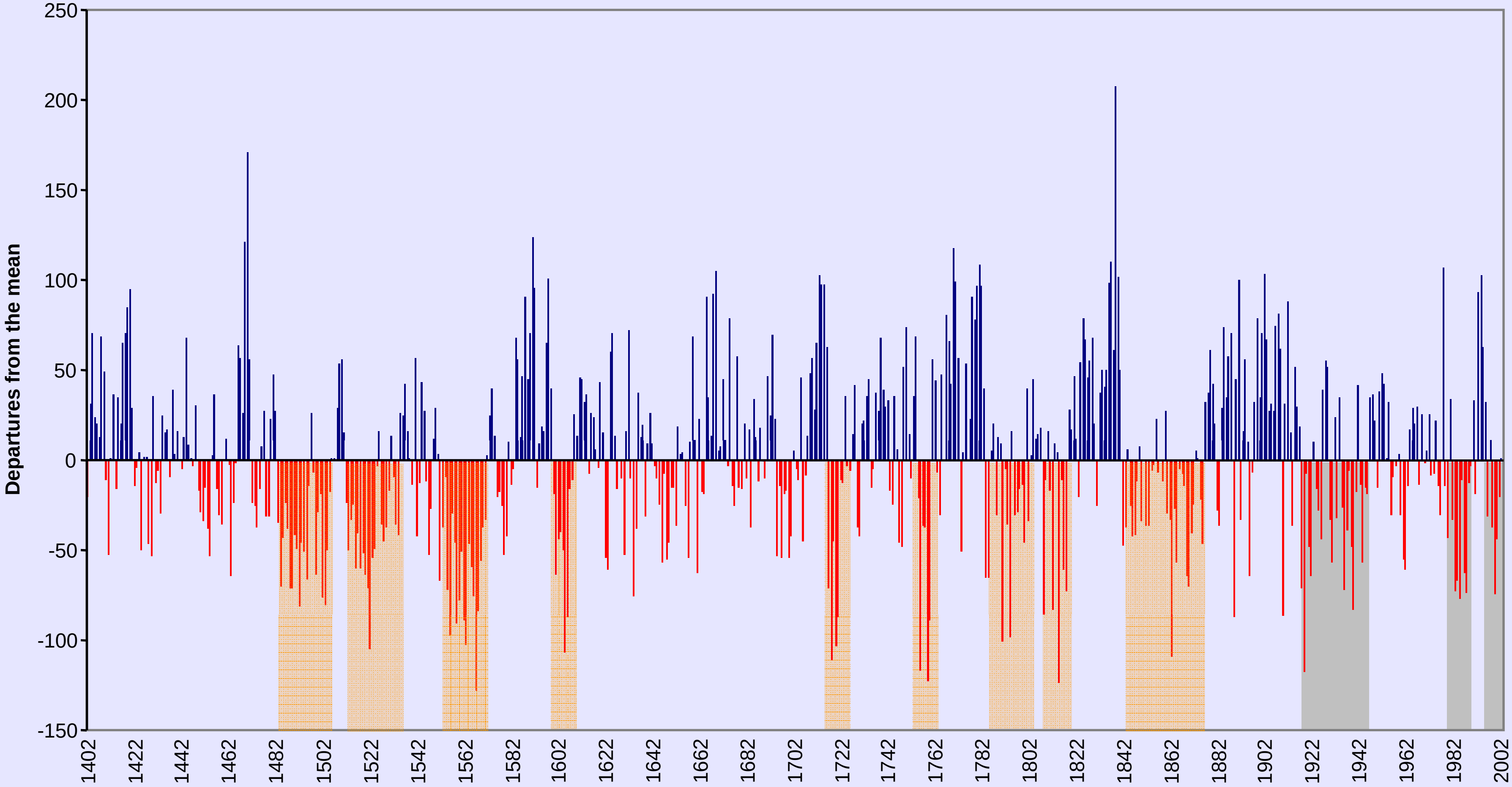
Sampling of old dead wood to extend the chronology into the past

Wood and Tree-rings

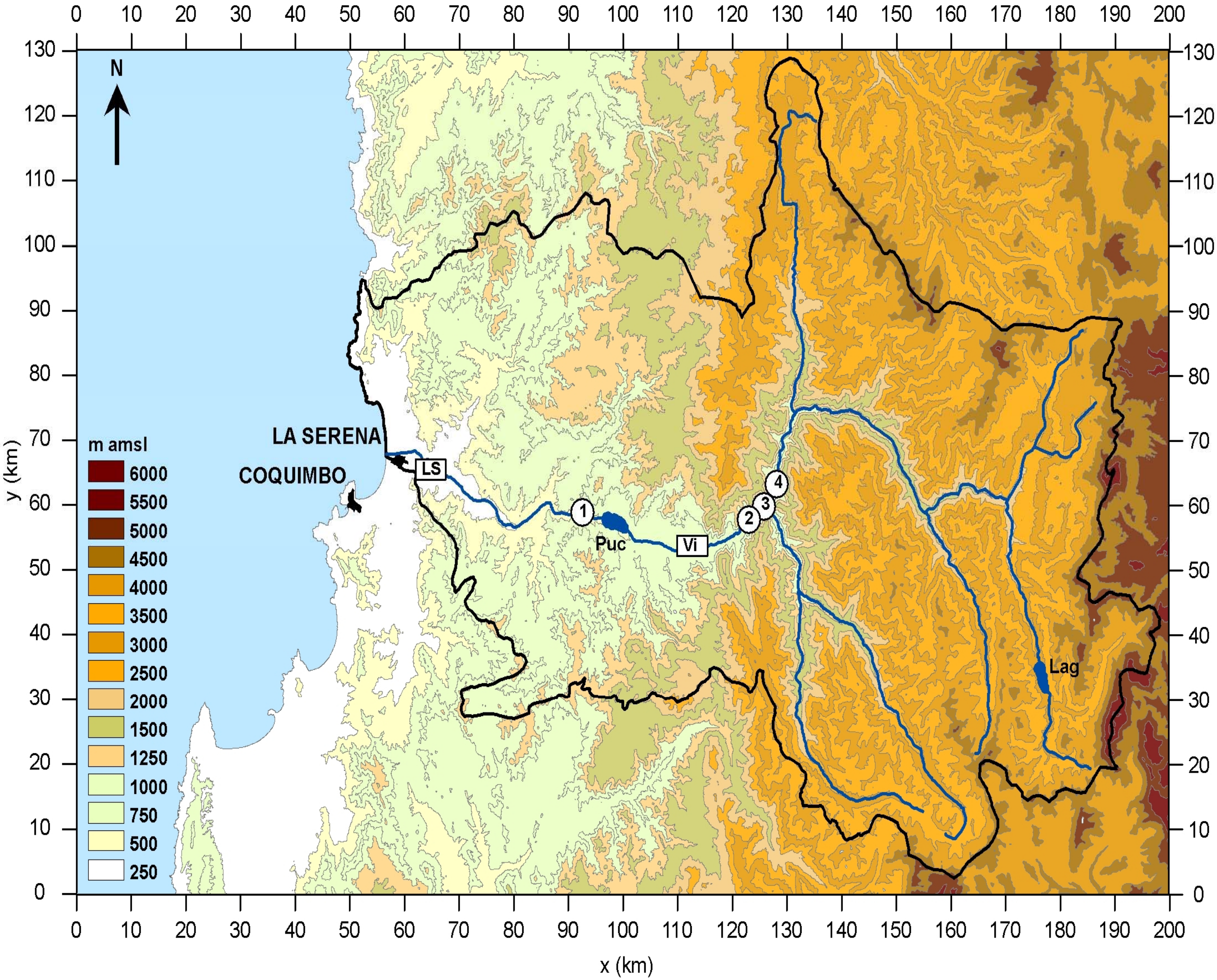
Kageneckia angustifolia
(Pulpica – Small tree)




South Saskatchewan River at Medicine Hat, 1402-2004



Axelson and Sauchyn, In Press



N
LA SERENA
COQUIMBO
LS
Puc
Vi
Lag
1
2
3
4
m amsl
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1250
1000
750
500
250
y (km)
x (km)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200

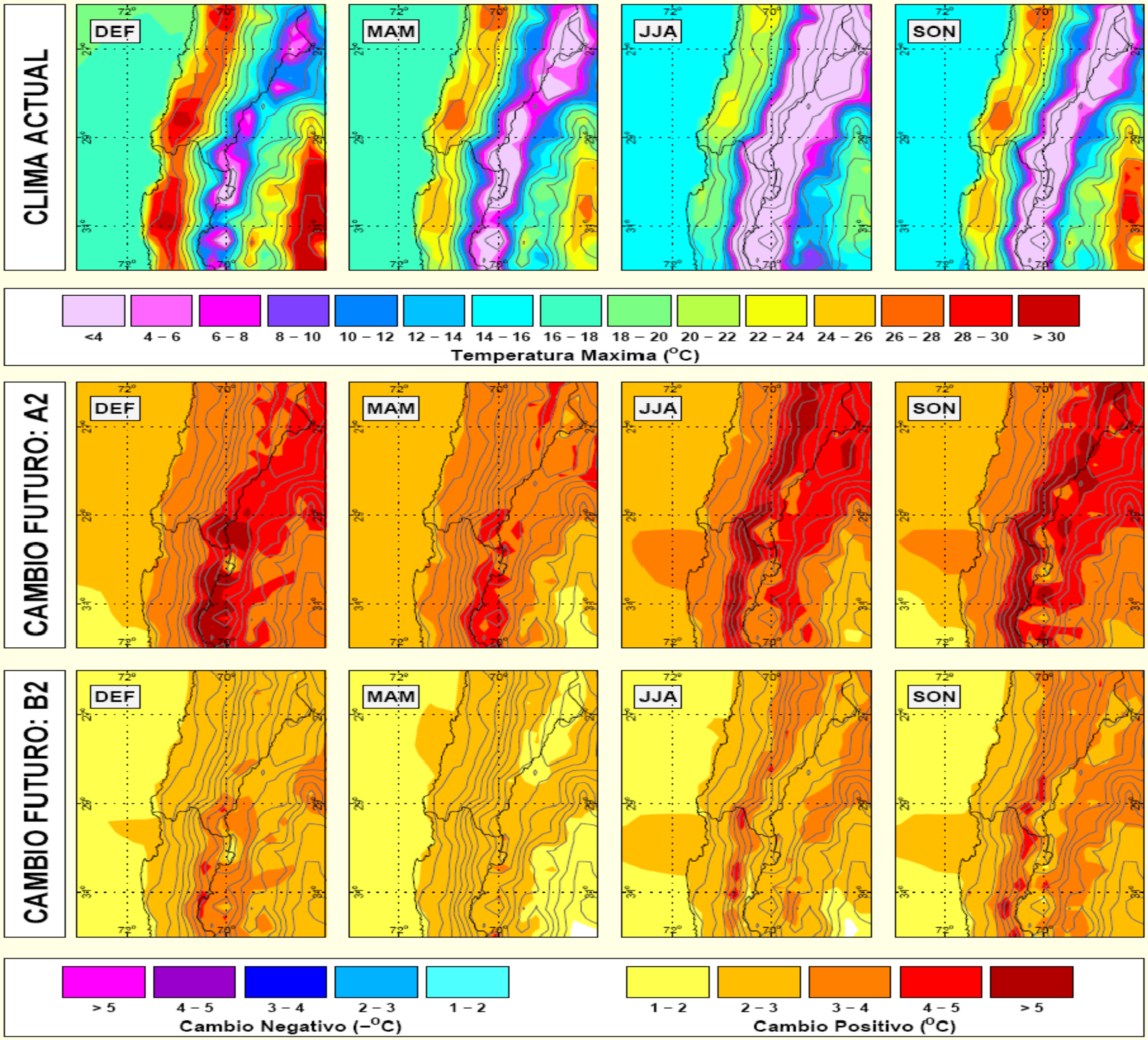
Climate change scenarios for the Norte Chico region (include the ERB), for the period 2070-2100

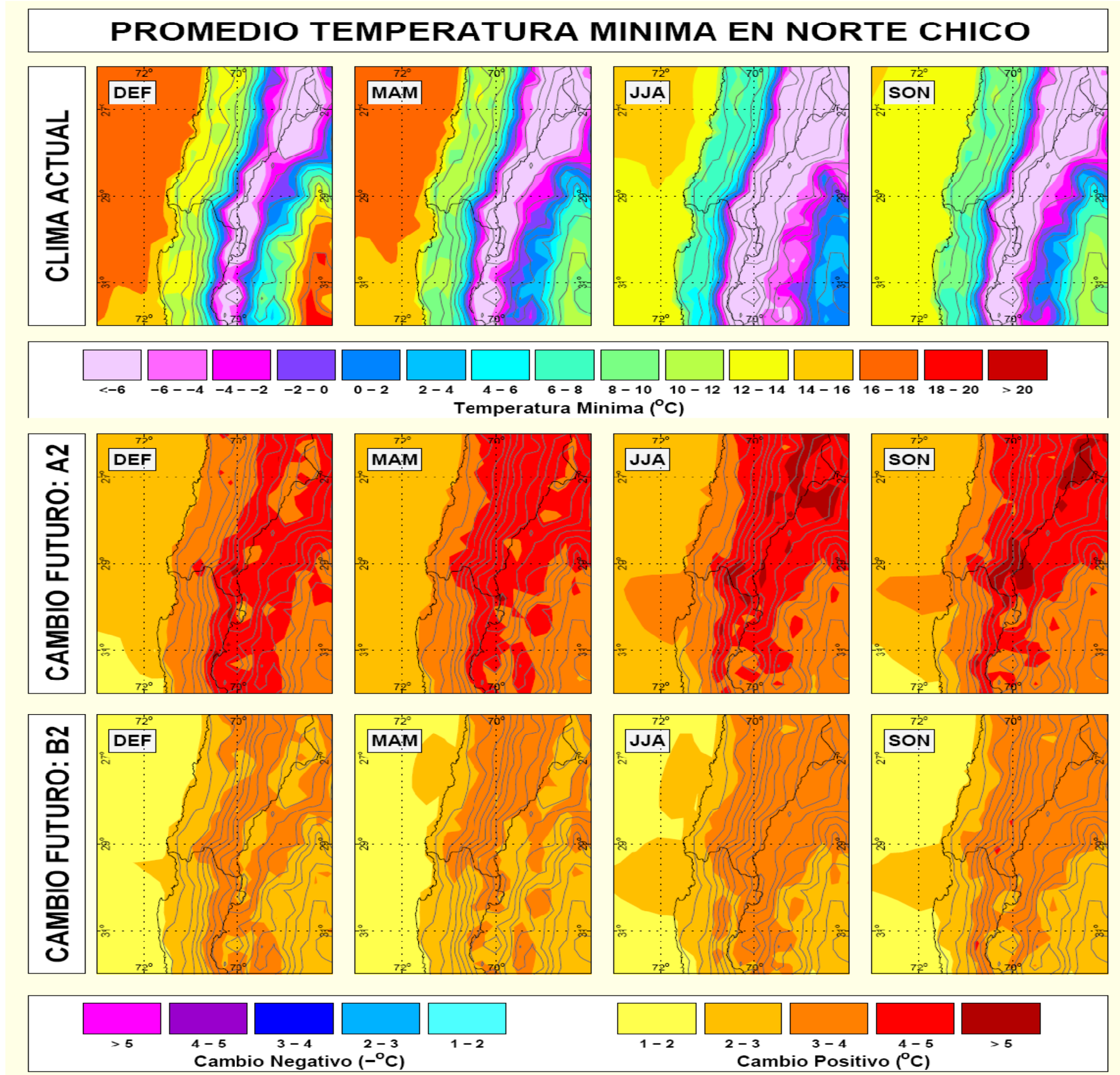
Department of Geophysics of the University of Chile (CONAMA 2008)

• important changes in temperature and in precipitation

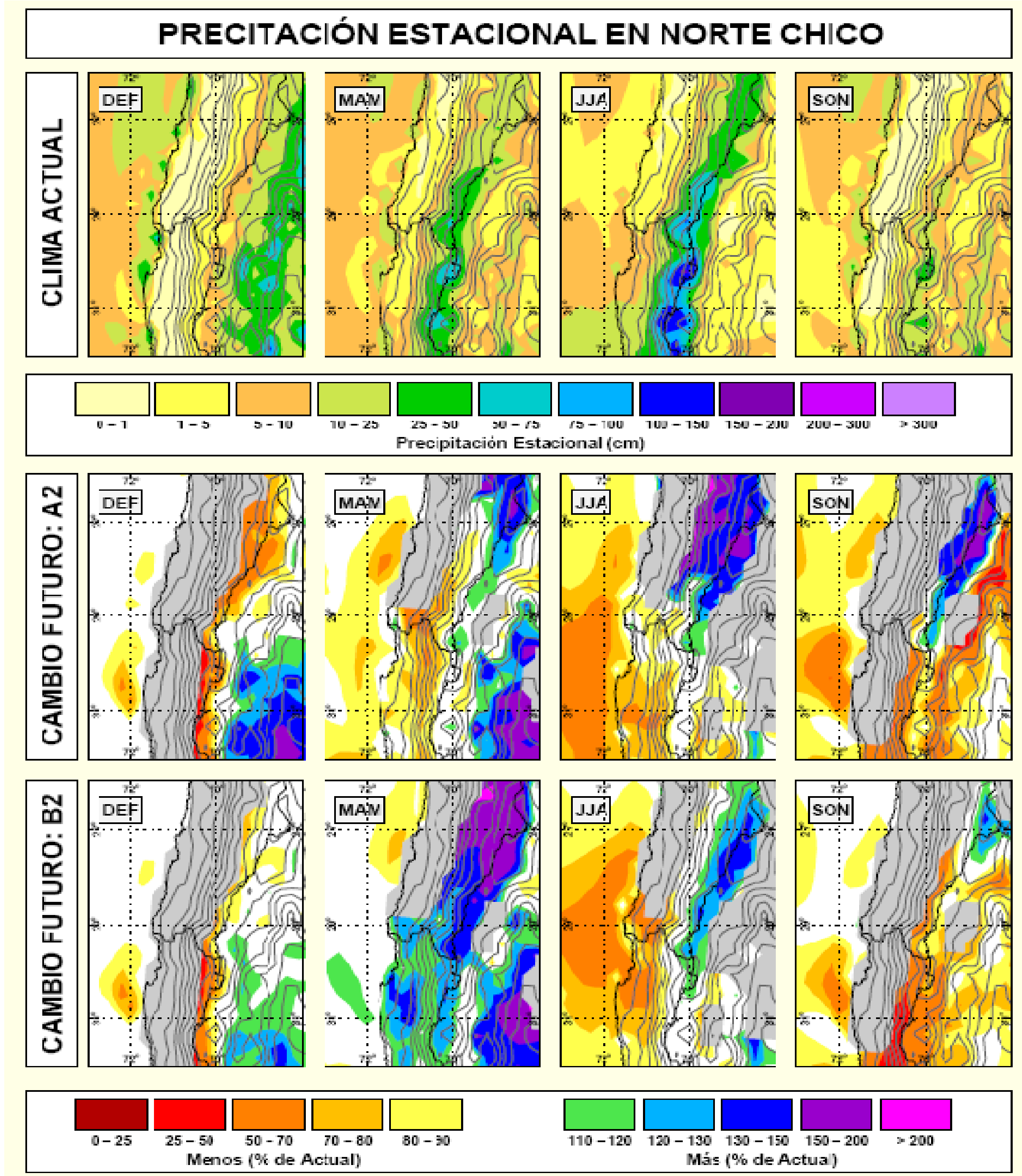
• the water resources will be affected because
  - the isotherm 0ºC will be several meters higher and so the Andean area with capacity to storage snow between the seasons will be smaller (this affects the agricultural irrigation capacity in summer and autumn)
  - in wintertime in some areas precipitation will decrease

PROMEDIO TEMPERATURA MAXIMA EN NORTE CHICO





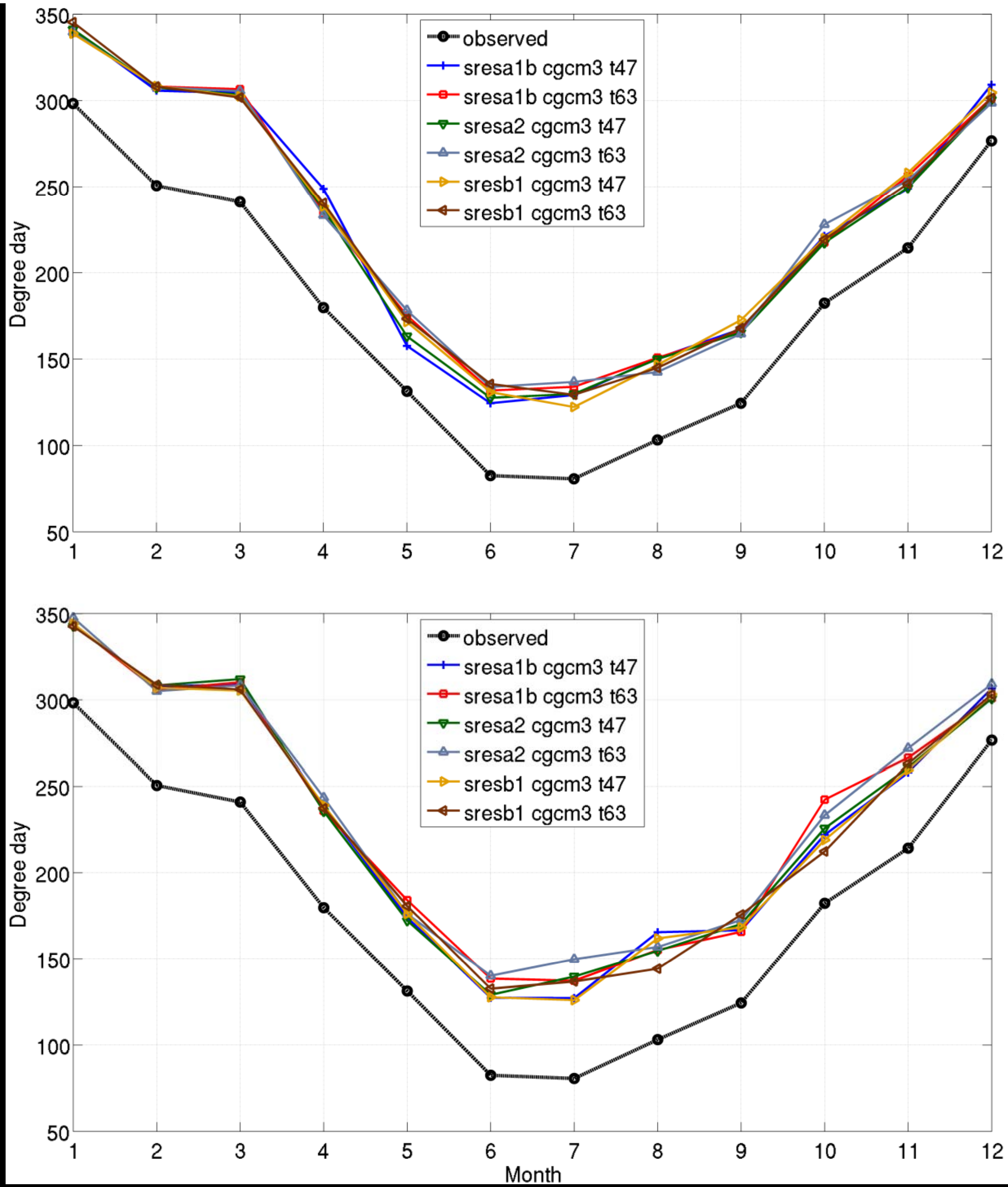
PROMEDIO TEMPERATURA MINIMA EN NORTE CHICO
CLIMA ACTUAL
DEF
MAM
JJA
SON
<−6
−6 − −4
−4 − −2
−2 − 0
0 − 2
2 − 4
4 − 6
6 − 8
8 − 10
10 − 12
12 − 14
14 − 16
16 − 18
18 − 20
> 20
Temperatura Minima (°C)
CAMBIO FUTURO: A2
CAMBIO FUTURO: B2
> 5
4 − 5
3 − 4
2 − 3
1 − 2
Cambio Negativo (−°C)
1 − 2
2 − 3
3 − 4
4 − 5
> 5
Cambio Positivo (°C)


PRECITACIÓN ESTACIONAL EN NORTE CHICO
CLIMA ACTUAL
DEF
MAM
JJA
SON
0 – 1
1 – 5
5 – 10
10 – 25
25 – 50
50 – 75
75 – 100
100 – 150
150 – 200
200 – 300
> 300
Precipitación Estacional (cm)
CAMBIO FUTURO: A2
CAMBIO FUTURO: B2
0 – 25
25 – 50
50 – 70
70 – 80
80 – 90
Menos (% de Actual)
110 – 120
120 – 130
130 – 150
150 – 200
> 200
Más (% de Actual)

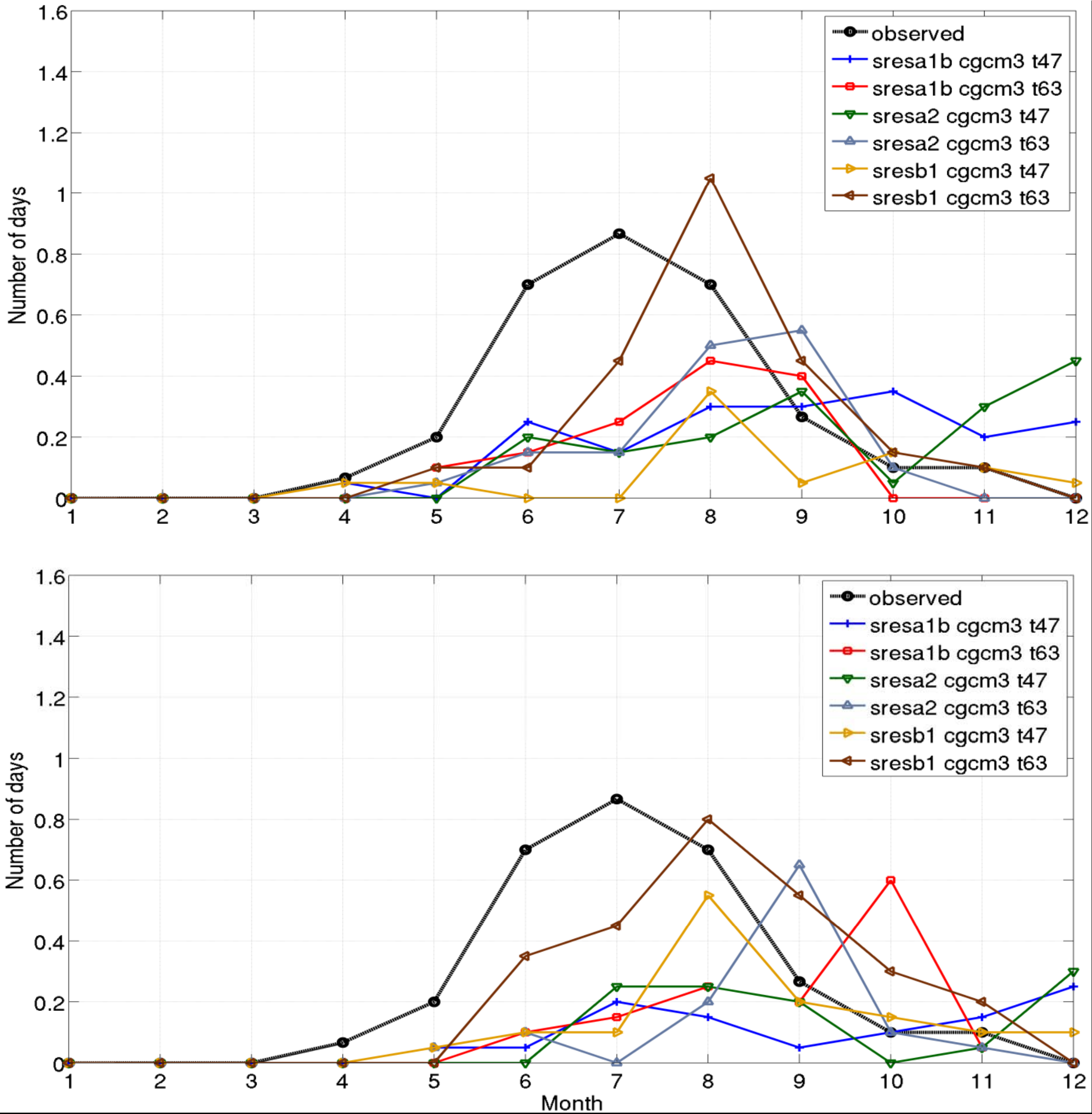
Modeling scenarios of local impact of climate change in ERB

Statistical downscaling realized by the Chilean IACC team for the area of Vicuña

- Global models : CGCM1, CGCM2, CGCM3
- Stochastical wheather generator LARS
- Observed time serie: 1960-1990
- Emission scenarios: A2 y B2
- Output periods: 2011-2030, 2046-2065, 2070-2100
- Outputs: almost all climate indexes of the ETCCDI (Expert Team on Climate Change Detection and Indices)



Monthly averaged degree day index (temperature higher than 10°C). The black dotted line corresponds to the observed data at Vicuña for the period 1960-1990 and the other lines corresponds to results calculated with LARS for different emission scenarios, for the periods 2011-2030 (above) and 2046-2065 (below).



Monthly averaged number of days with daily precipitation amounts higher or equal than 10 mm. The black dotted line corresponds to the observed data at Vicuña for the period 1960-1990 and the other lines corresponds to results calculated with LARS for different emission scenarios, for the period 2011-2030 (above) and 2046-2065 (below)

An increase in stream flow could be only temporary, due to permafrost and glacier melting. This conclusion is alarming because the loss of valuable water resources stored in the form of snow, permafrost and glaciers can result in environmental and socio-economic crises.

There will be not only threats, but also opportunities: some new agriculture products can be introduced in the ERB. . . . as long as there is enough water !!!

As a consequence of higher temperatures, evapotranspiration will increase and so the demand for water for agriculture activities.

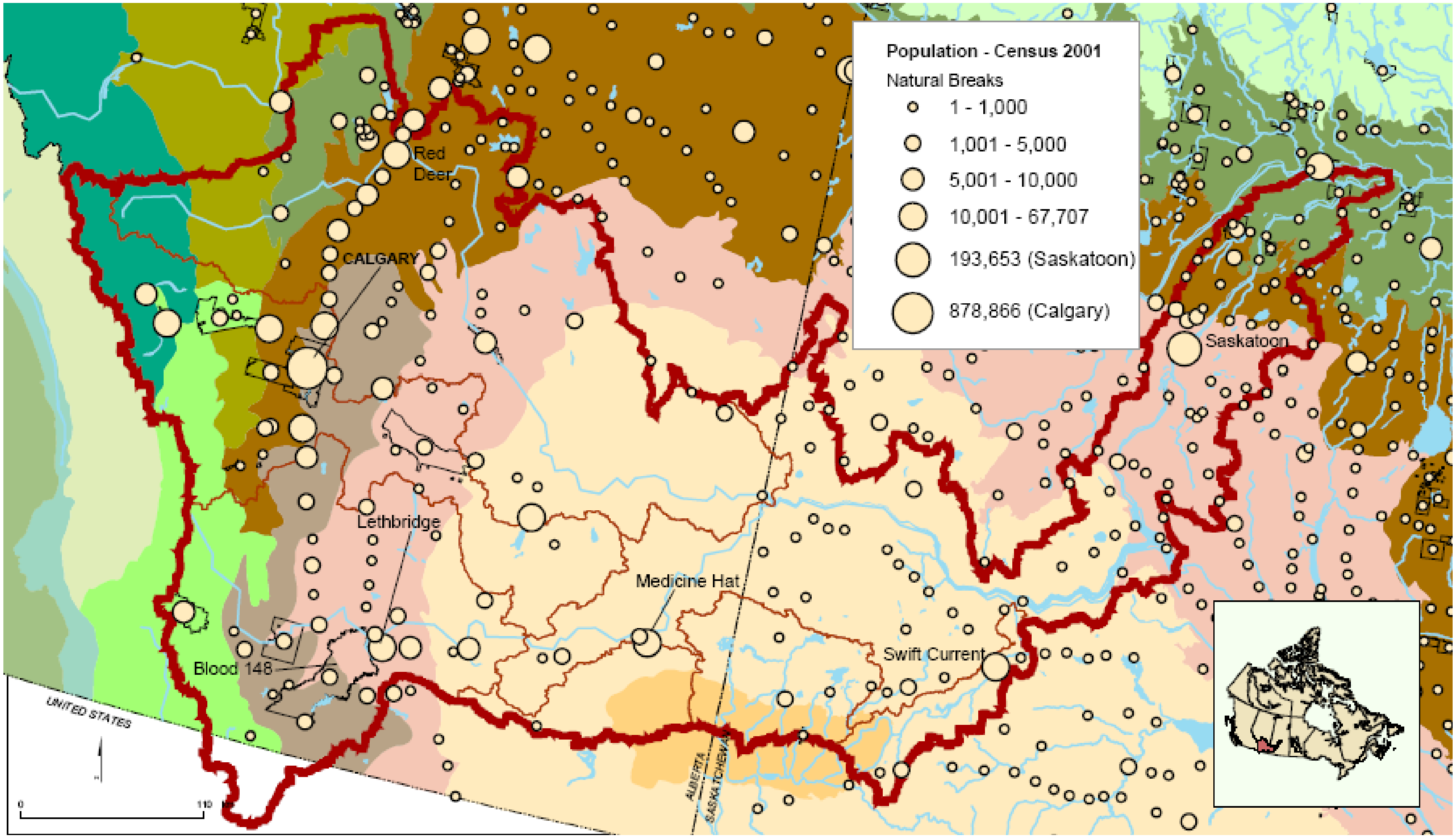
A decrease in chilling hours reduces the diversity of fruit species that could potentially be cultivated in the ERB. The decrease of frosty days will have a positive impact because it will reduce the vulnerability of special crops, e. g., papayas,, avocados, etc.

Temperatures higher than 30ºC have negative effects in the photosynthesis process of all the fruit trees cultivated in the ERB.

The increase of the degree-day index will allow earlier harvesting and higher prices for the grapes, but also lower fruit quality and an increase in insect plagues

Ecoregions in the South Saskatchewan River Basin.

(Map prepared for the IACC project - November 2005)



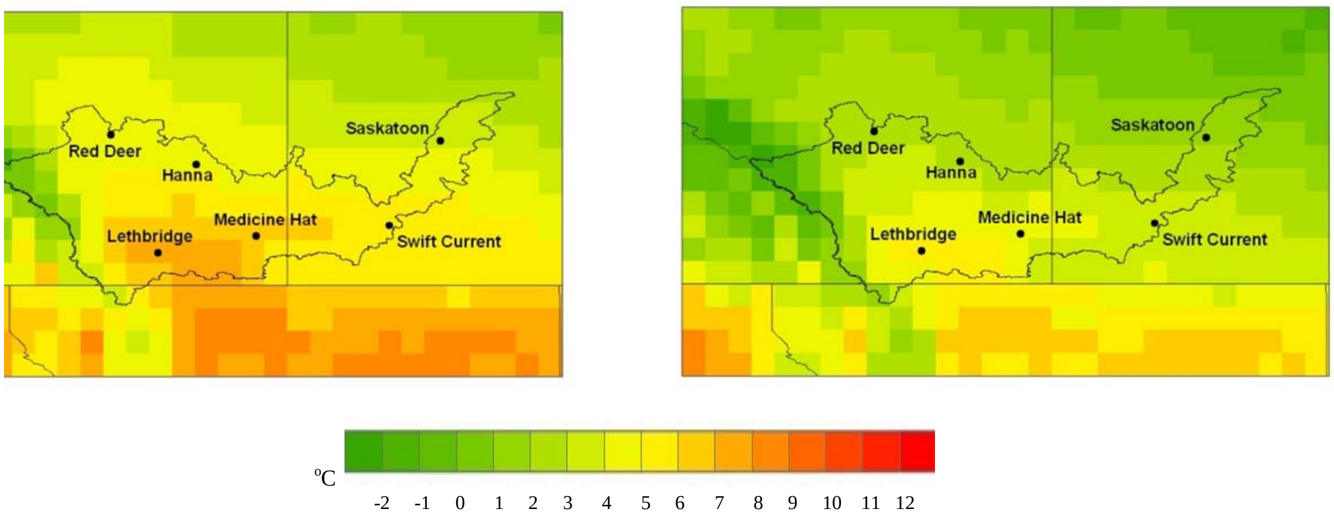
Ecoregions

- Aspen Parkland
- Boreal Transition
- Columbia Mountains and Highlands
- Cypress Upland
- Eastern Continental Ranges
- Fescue Grassland
- Mid-Boreal Uplands
- Mixed Grassland
- Moist Mixed Grassland
- Northern Continental Divide
- Southern Rocky Mountain Trench
- Western Alberta Upland
- Western Continental Ranges

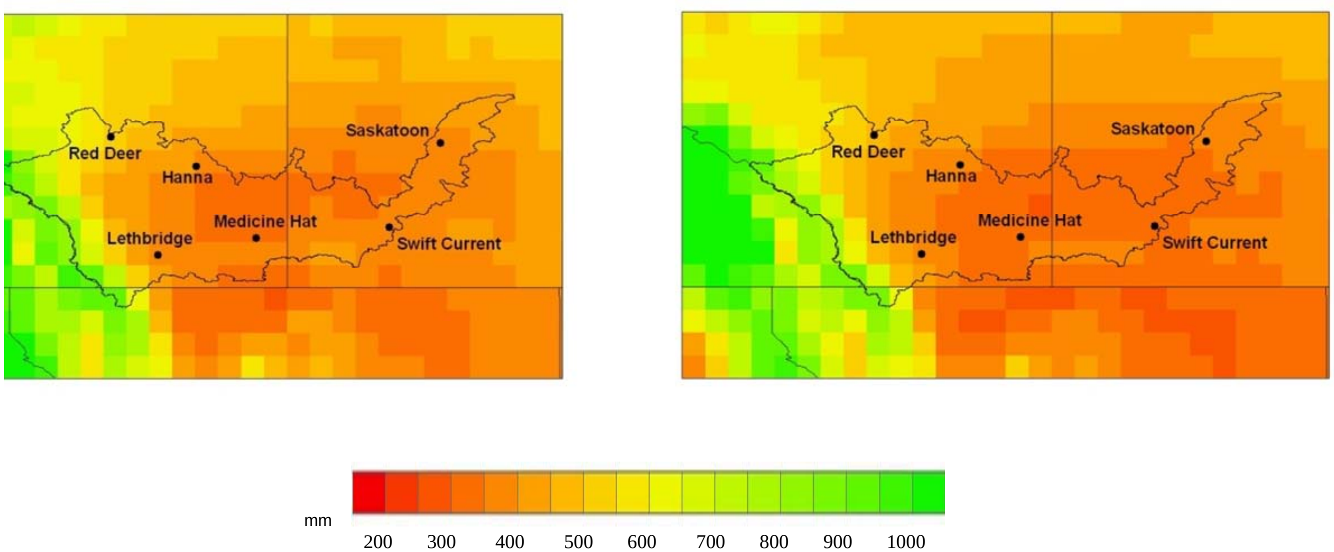
- SSRB
- Indian Reserve

Median scenarios derived from the Canadian Global Climate Model and greenhouse gas emission scenario B1(2).

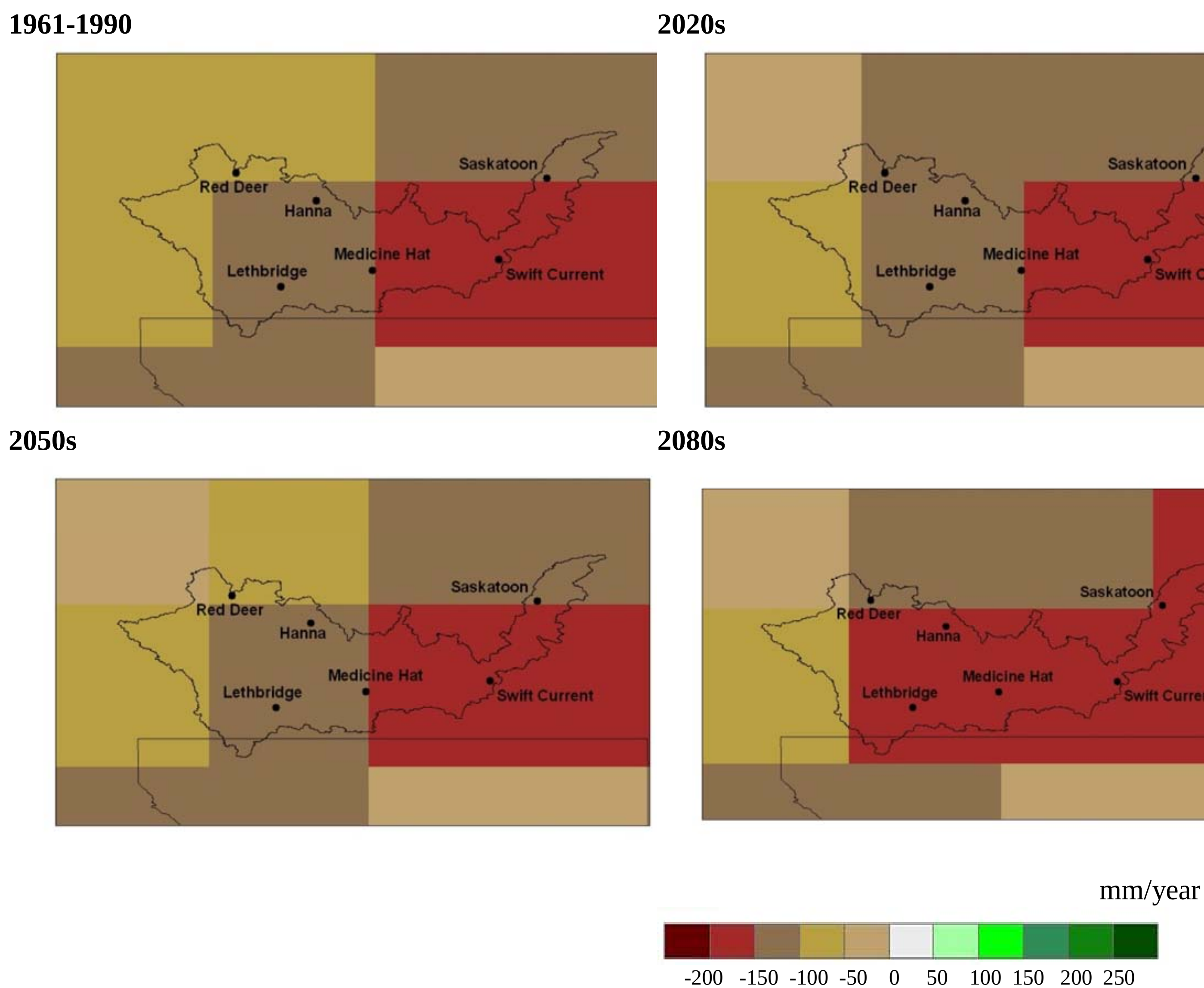
.1/T47 B1(2) (median) **Annual Temperature – 2050s** **1961-1990**



.1/T47 B1(2) (median) **Annual Precipitation – 2050s** **1961-1990**



Median scenarios of May-June-July P-PET for the 1961-1990, 2020s, 2050s and 2080s, from CGCM3.1/T47 B1(2).



We are losing the advantage of a cold winter

Major ecological changes are expected.

One of the most certain projections is that extra water will be available in winter and spring, while summers generally will be drier

There will be greater variation in water and climate

Both drought and unusually wet years could occur with greater frequency and severity

Most impacts are adverse because we are not presently adapted to the larger range of climate conditions projected

Resources and communities are sensitive to climate variability

The net impacts of climate change are not clear; they depend on rates of climate change and adaptation strategies

The impacts of climate change will depend on how well we adapt and how much adaptation is required

Adaptation: adjustments in practices, processes, or structures of systems to projected or actual changes of climate (IPCC, 2001).