Understanding Climate Scenarios and Adaptation Planning

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Agenda

- CEA Background
- What drives our current climate?
- Overview of climate models and information
- Adaptation Planning
- Insurance implications
- National floodplain mapping
- Questions/Discussion

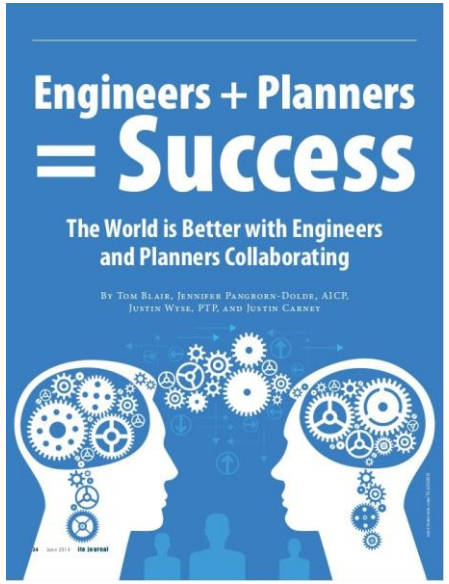
Who is CEA?

- Consulting Engineers of Alberta formed as a non-profit organization in 1978.
- 1993 Consulting Engineers of Alberta Act was proclaimed by the Alberta Legislature.
- Support consulting engineers services in Alberta to various client groups.
- 90+ member companies representing over 9,000 employees in the province.
- CEA promotes quality based selection of Consultants

Why is Climate Change Important to Engineers and Planners?

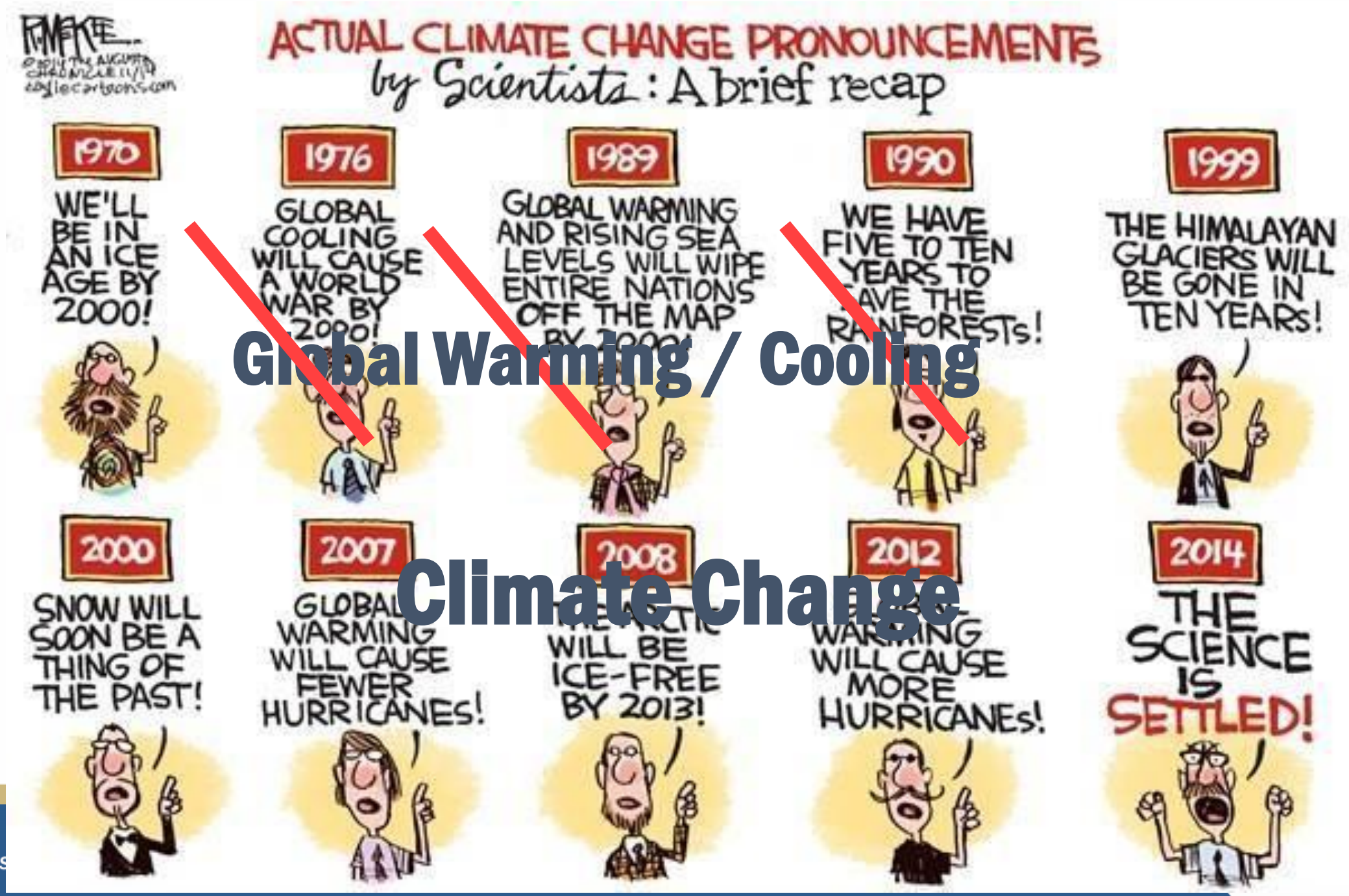
- The climate has always been changing, but evidence suggests an increased rate of change
- The vulnerability of infrastructure and communities to climate change is increasingly visible to policymakers, planners and engineers
- All industries are working to raise awareness about potential impacts of climate change
- Future activities will benefit from increased resilience to a range of potential future climate patterns
- Quality based selection can help define climate changes scope needs in future projects

The Future of Climate Change…



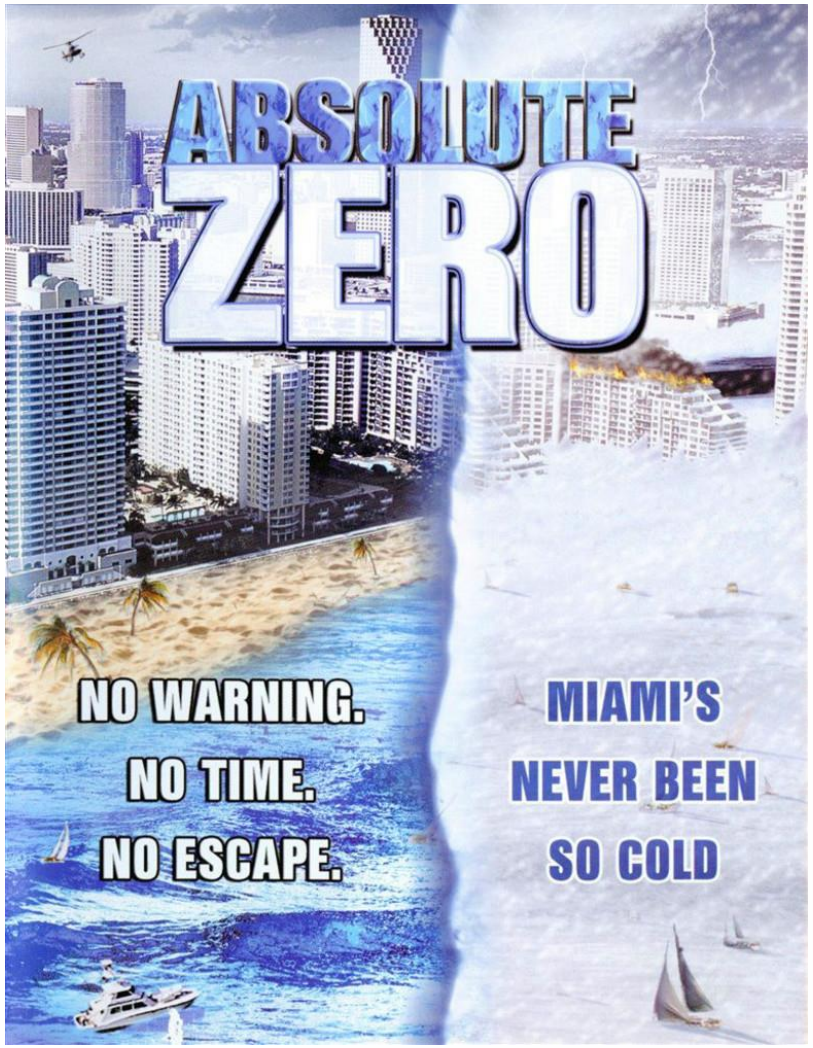
Suzan Lapp, PhD

May 3, 2016



Global Warming / Cooling

Climate Change


ABSOLUTE
ZERO
NO WARNING.
NO TIME.
NO ESCAPE.
MIAMI'S
NEVER BEEN
SO COLD

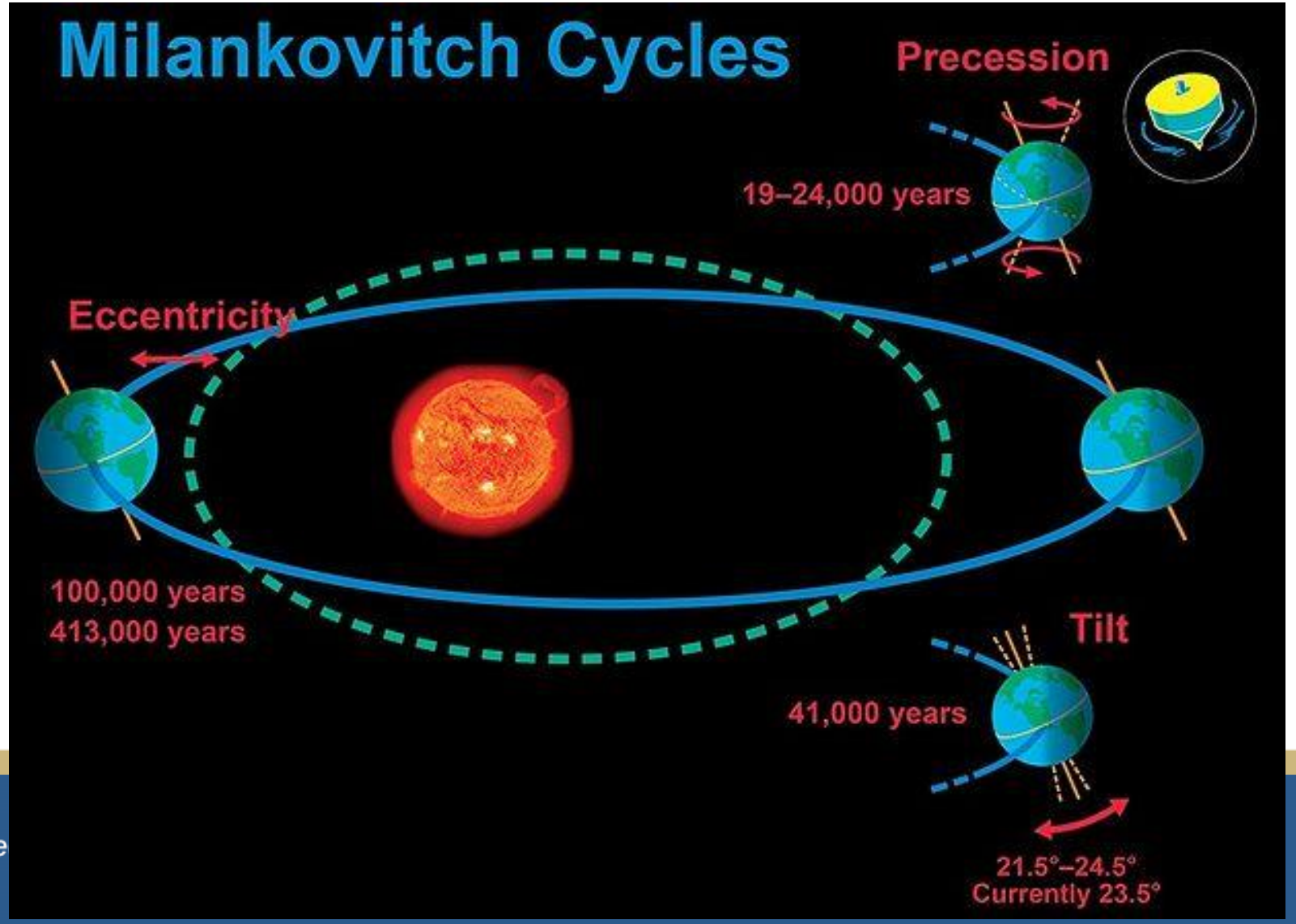

THE DAY AFTER
TOMORROW


FROM
VISIONARY DIRECTOR
BONG JOON HO
SNOWPIERCER
FIGHT
YOUR
WAY
TO THE
FRONT
CHRIS EVANS
SONG KANG HO
TILDA SWINTON
JAMIE BELL
OCTAVIA SPENCER
JOHN HURT
ED HARRIS
SCREEN STORY BY BONG JOON HO
SCREENPLAY BY BONG JOON HO AND KELLY MASTERSON

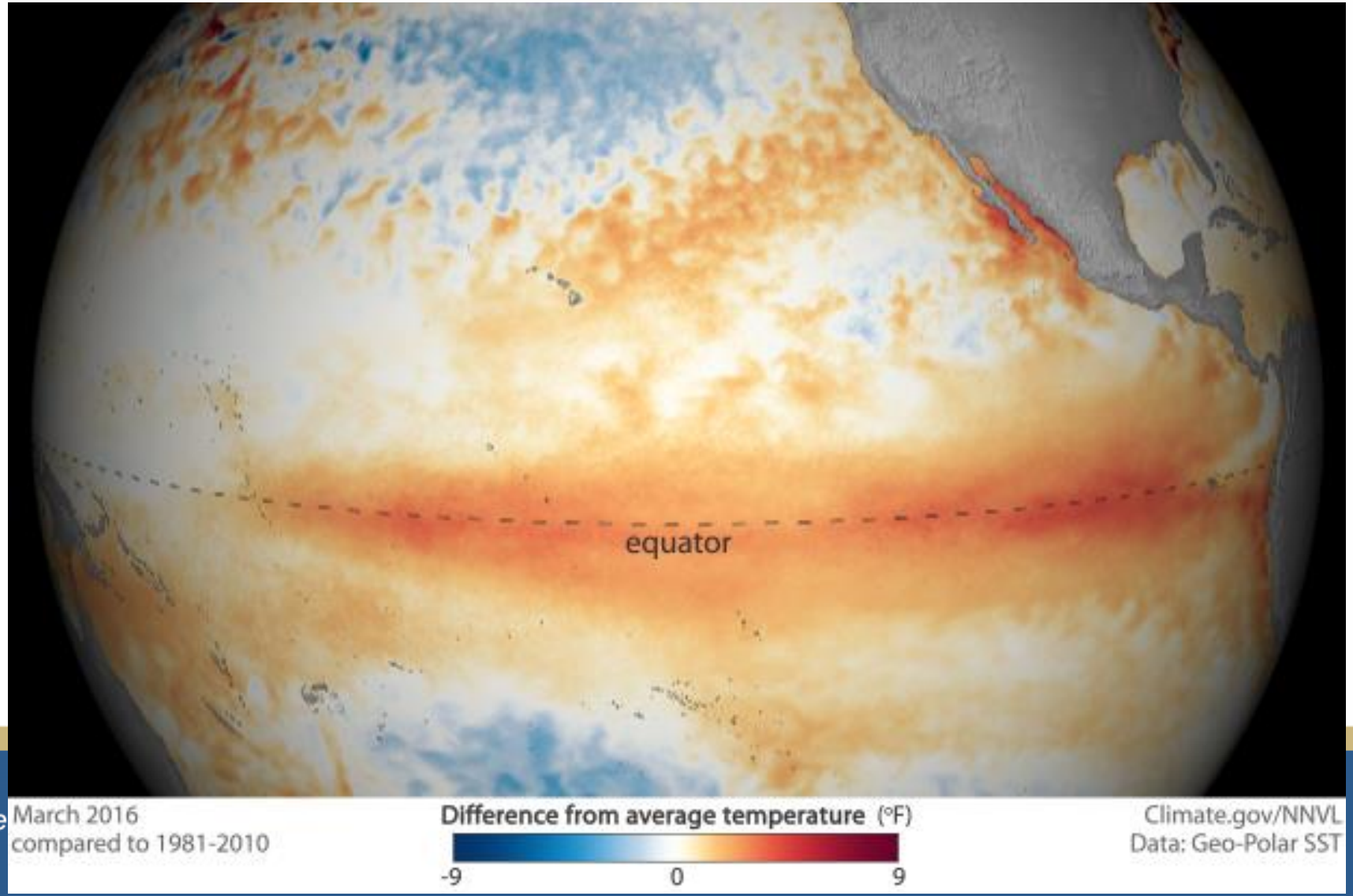
Past/Current Climate – A Step Back

Natural Climate Cycles

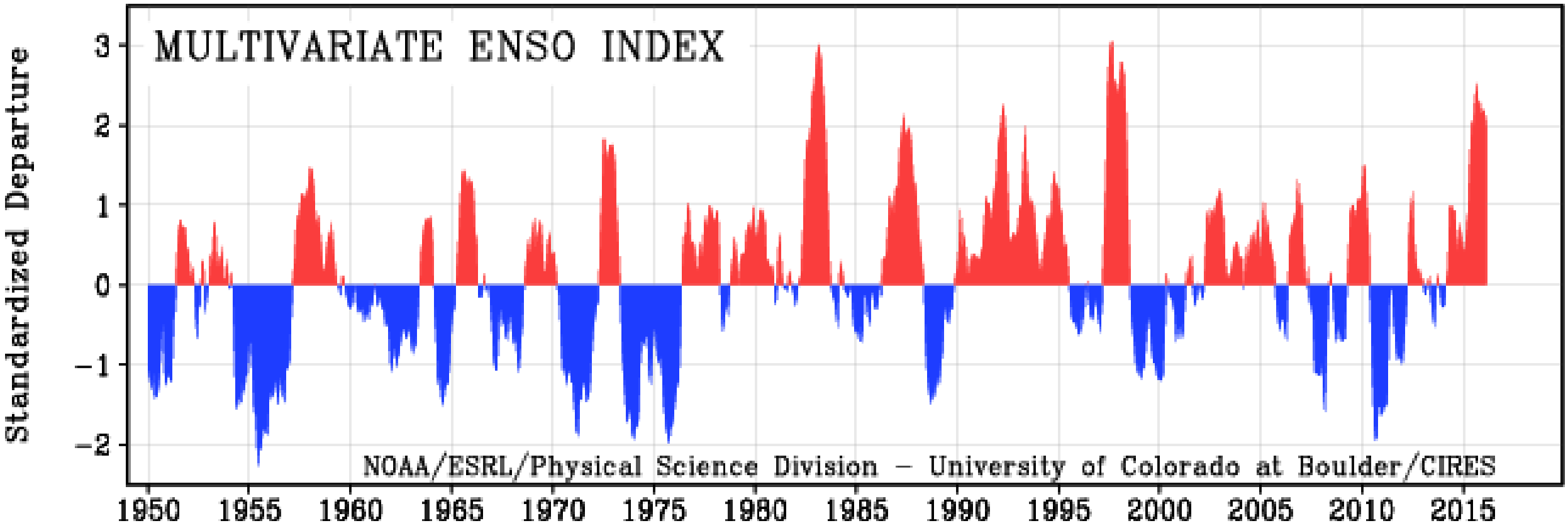
these three cycles combine to affect the amount of solar heat that's incident on the Earth's surface and subsequently influence climatic patterns



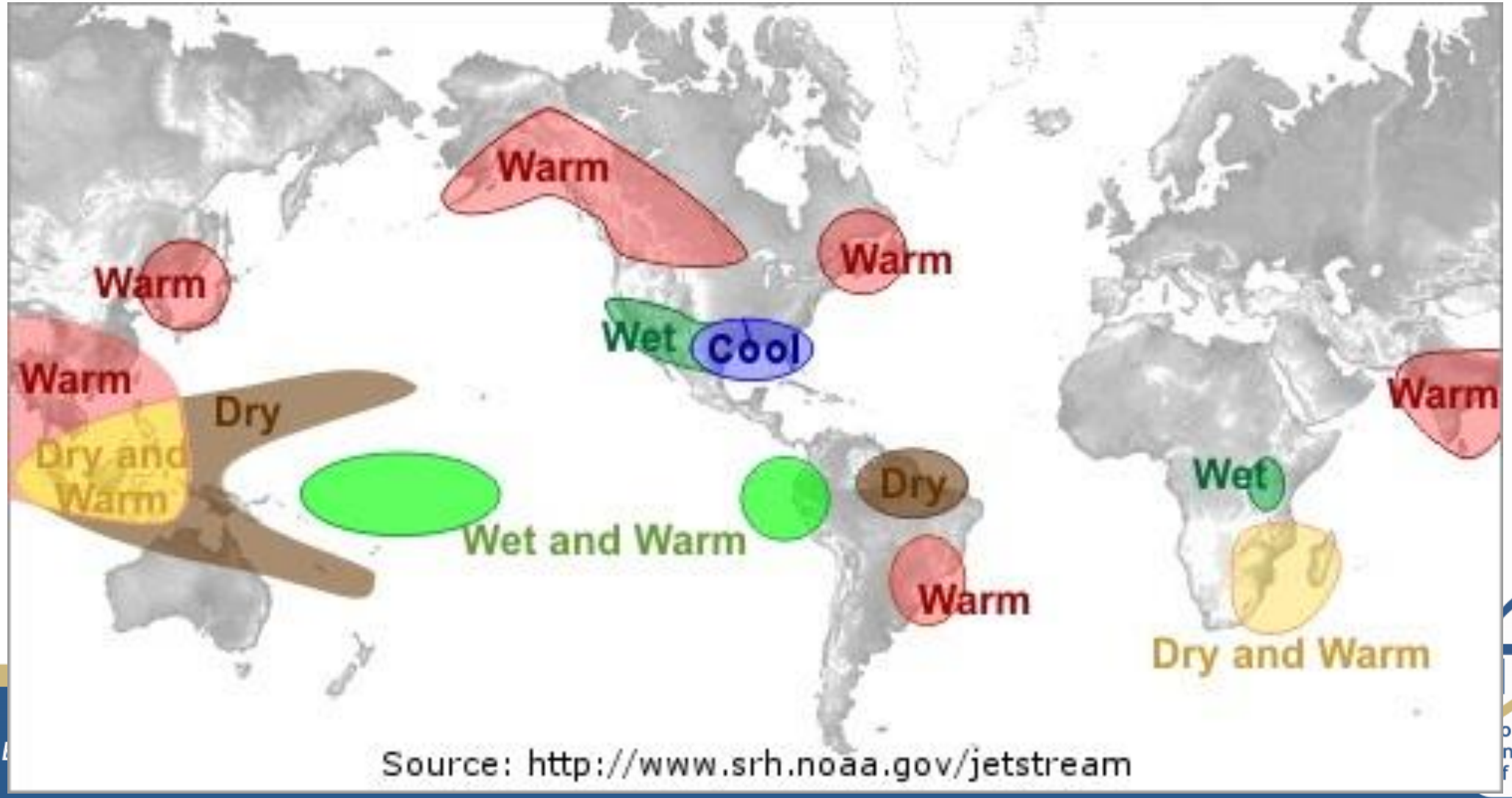
ENSO and PDO (Pacific Ocean SST)



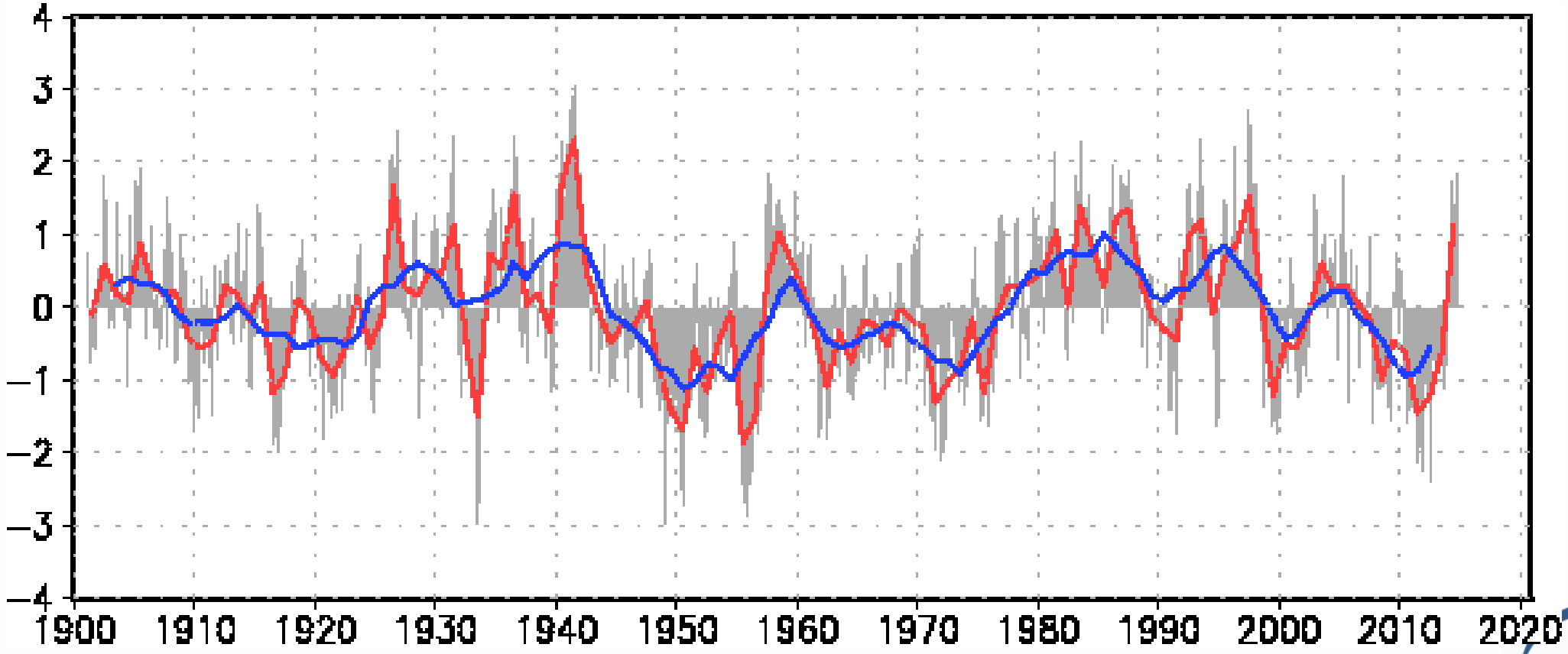
ENSO – El Nino / La Nina



El Nino Typical Impacts



Pacific Decadal Oscillation (PDO)



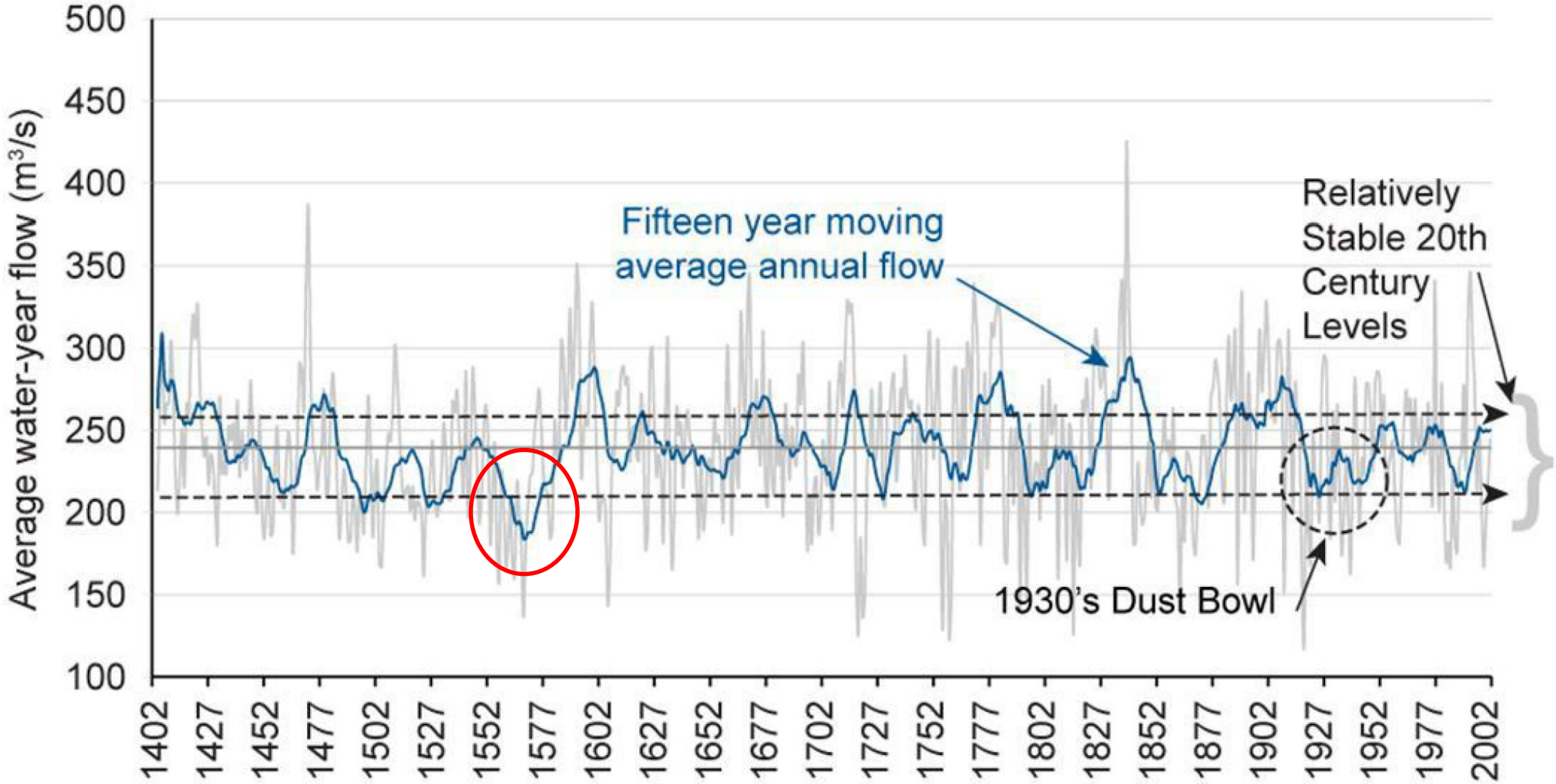
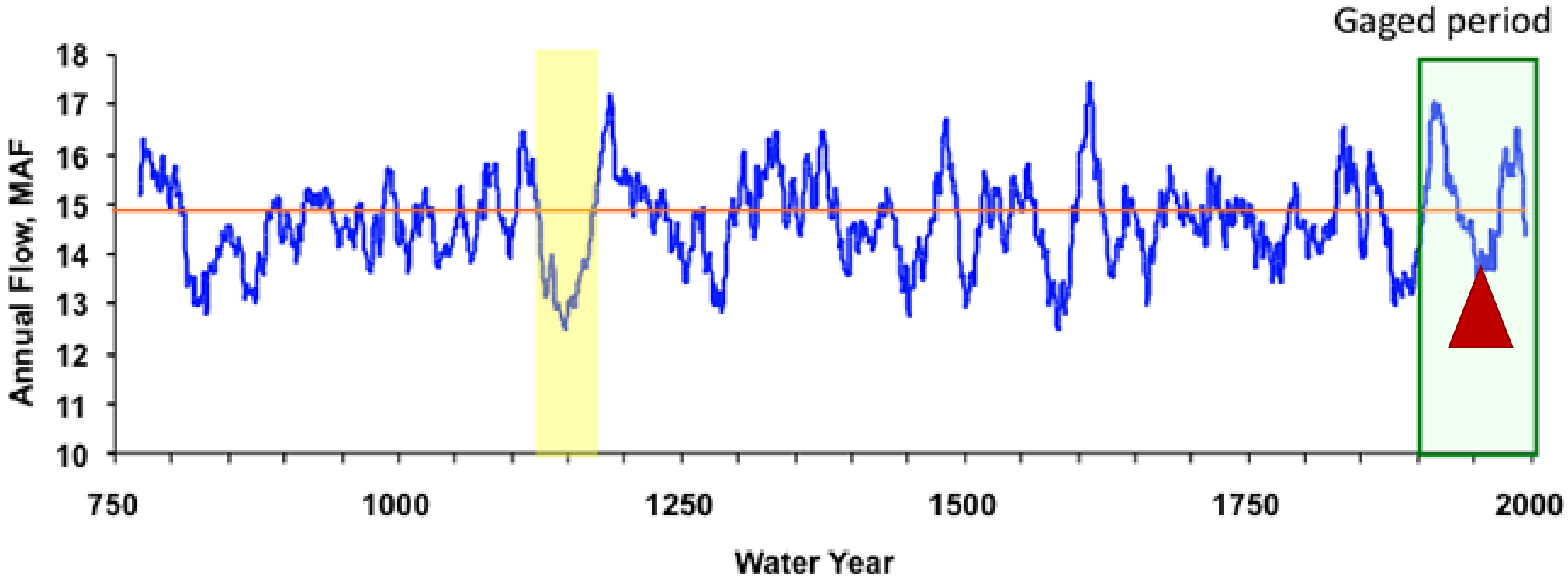


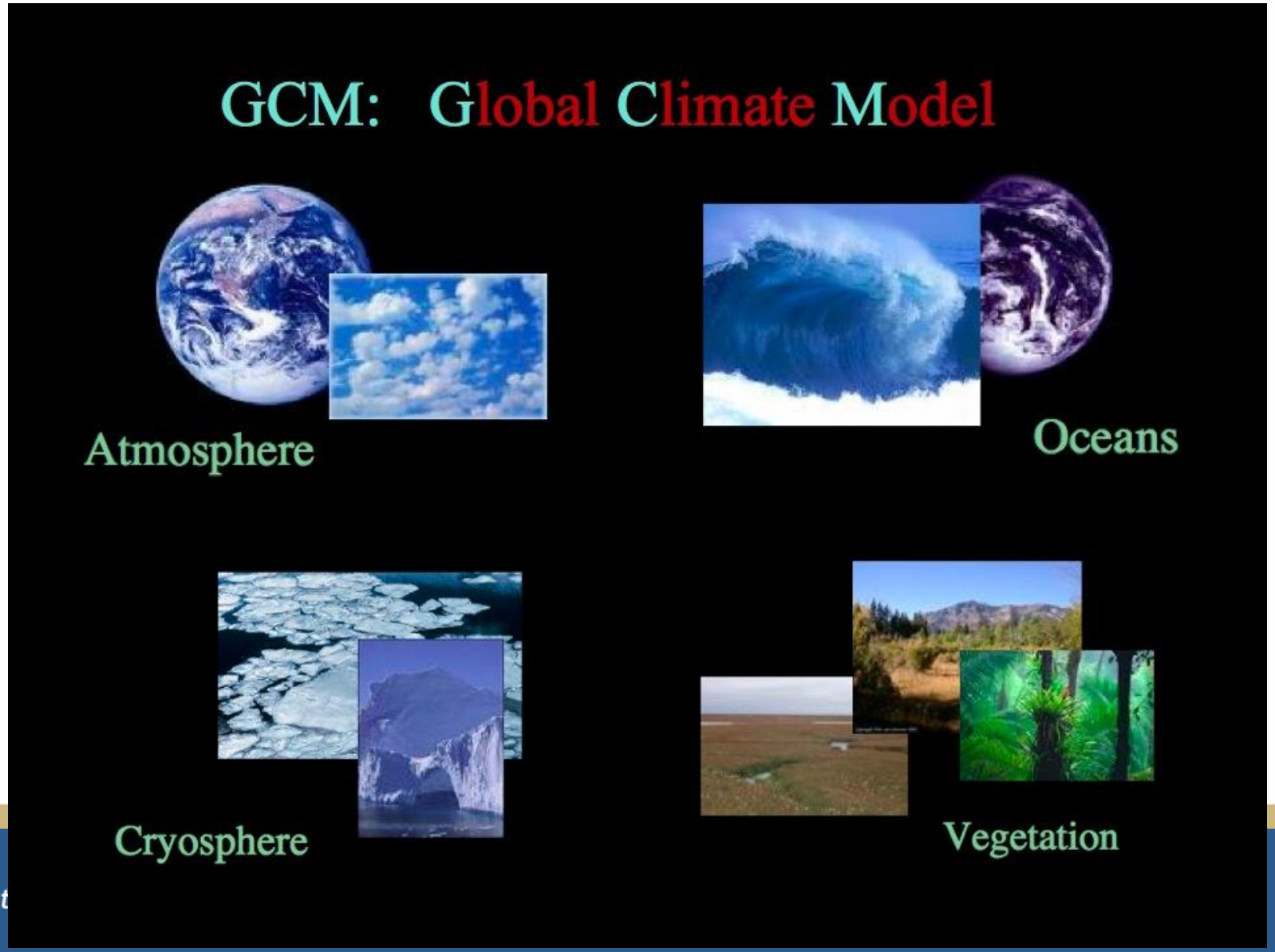
Figure 1: South Saskatchewan River Basin flows (Bow + Oldman)

Source: Axelson et al., 2009

Streamflow Colorado River at Lees Ferry, Az



Global Climate Models (GCM)



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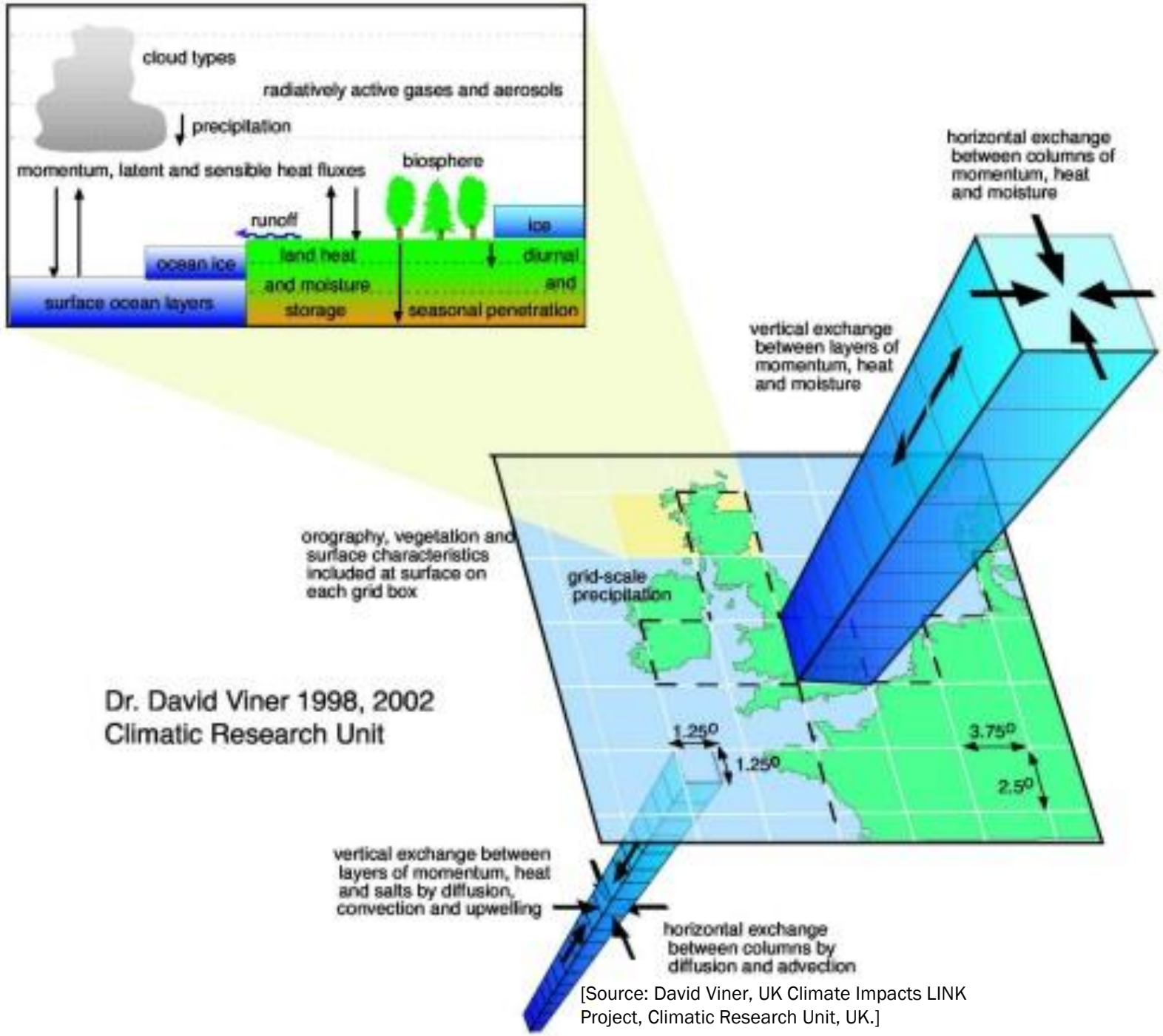
"... are the only credible tools currently available for simulating the response of the global climate system to increasing greenhouse gas concentrations" (IPCC-TGCIA, 1999)

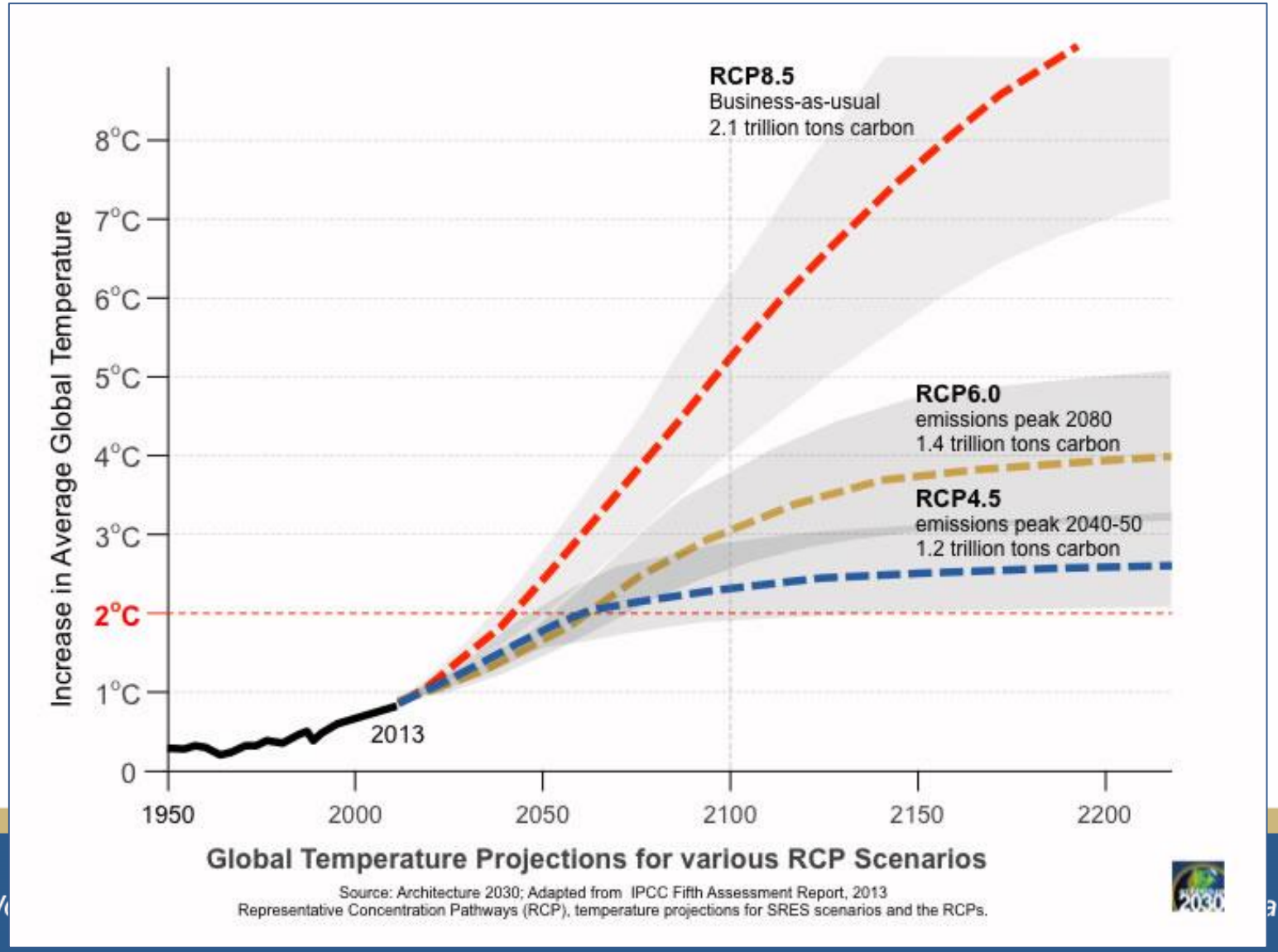


[Source: David Viner, UK Climate Impacts LINK Project, Climatic Research Unit, UK.]

GCM Data – AR5 (2014)

Modeling Center	Model	Institution
BCC	BCC-CSM1.1 BCC-CSM1.1(m)	Beijing Climate Center, China Meteorological Administration
CCCma	CanAM4 CanCM4 CanESM2	Canadian Centre for Climate Modelling and Analysis
CMCC	CMCC-CESM CMCC-CM CMCC-CMS	Centro Euro-Mediterraneo per I Cambiamenti Climatici
CNRM-CERFACS	CNRM-CM5	Centre National de Recherches Meteorologiques / Centre Europeen de Recherche et Formation Avancees en Calcul Scientifiq
CNRM-CERFACS	CNRM-CM5-2	Centre National de Recherches Meteorologiques / Centre Europeen de Recherche et Formation Avancees en Calcul Scientifiq
COLA and NCEP	CFSv2-2011	Center for Ocean-Land-Atmosphere Studies and National Centers for Environmental Prediction
CSIRO-BOM	ACCESS1.0 ACCESS1.3	CSIRO (Commonwealth Scientific and Industrial Research Organisation, Australia), and BOM (Bureau of Meteorology, Austral
CSIRO-QCCCE	CSIRO-Mk3.6.0	Commonwealth Scientific and Industrial Research Organisation in collaboration with the Queensland Climate Change Centre o Excellence
EC-EARTH	EC-EARTH	EC-EARTH consortium
FIO	FIO-ESM	The First Institute of Oceanography, SOA, China
GCESS	BNU-ESM	College of Global Change and Earth System Science, Beijing Normal University
INM	INM-CM4	Institute for Numerical Mathematics
IPSL	IPSL-CM5A-LR IPSL-CM5A-MR IPSL-CM5B-LR	Institut Pierre-Simon Laplace
LASG-CESS	FGOALS-g2	LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences; and CESS, Tsinghua University
LASG-IAP	FGOALS-gl FGOALS-s2	LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences
MIROC	MIROC4h MIROC5	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan A for Marine-Earth Science and Technology
MIROC	MIROC-ESM MIROC-ESM-CHEM	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies
MOHC (additional realizations by INPE)	HadCM3 HadCM3Q HadGEM2-A HadGEM2-CC HadGEM2-ES	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais)
MPI-M	MPI-ESM-LR MPI-ESM-MR MPI-ESM-P	Max Planck Institute for Meteorology (MPI-M)
MRI	MRI-AGCM3.2H MRI-AGCM3.2S	Meteorological Research Institute

Representative Concentration Pathways – RCPs



Scenarios

Moss et al. 2010

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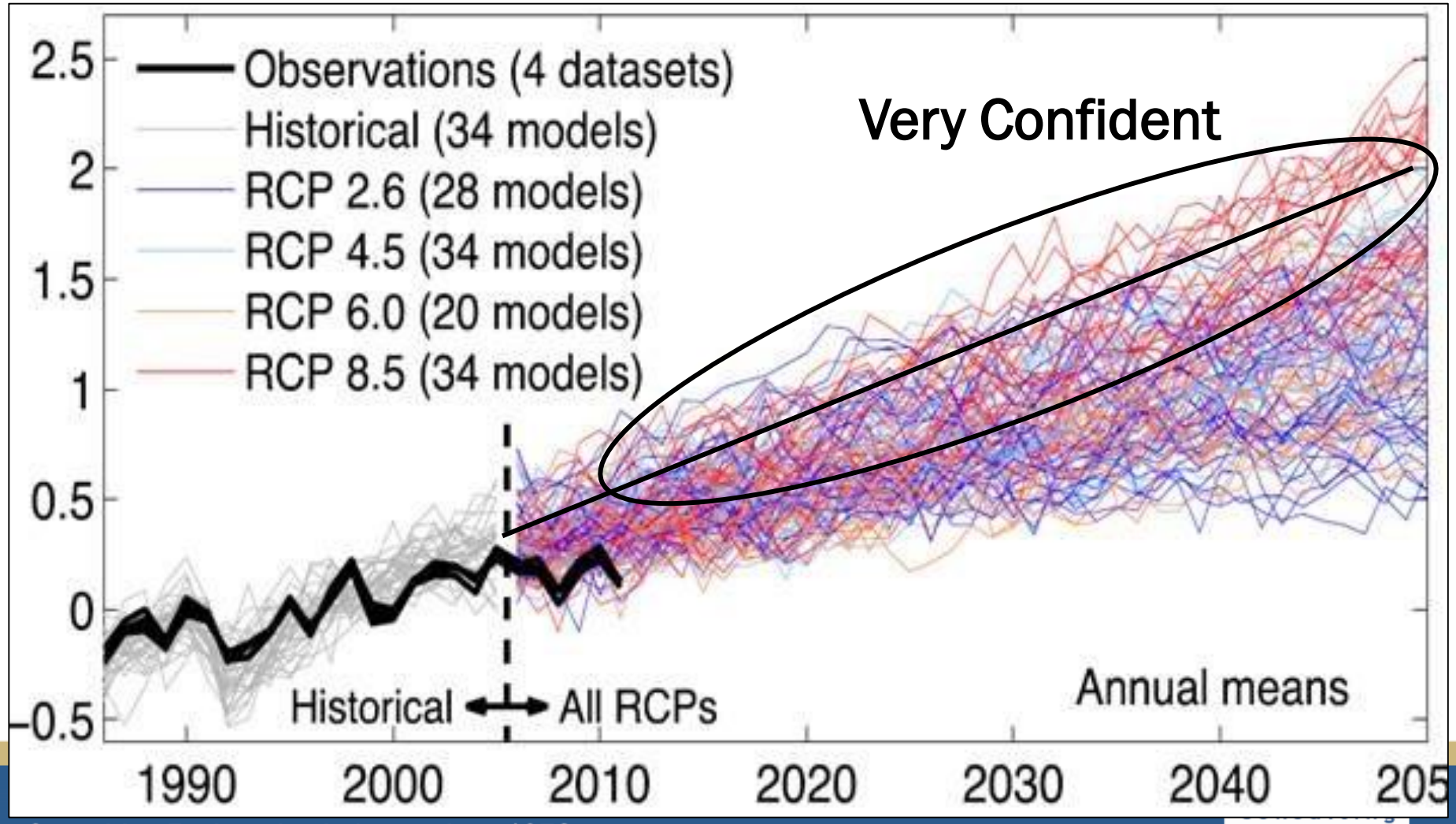
Dealing with Uncertainty….

GCM?
Scenario?
Years?



[Source: IPCC WGI Summary for Policymakers]

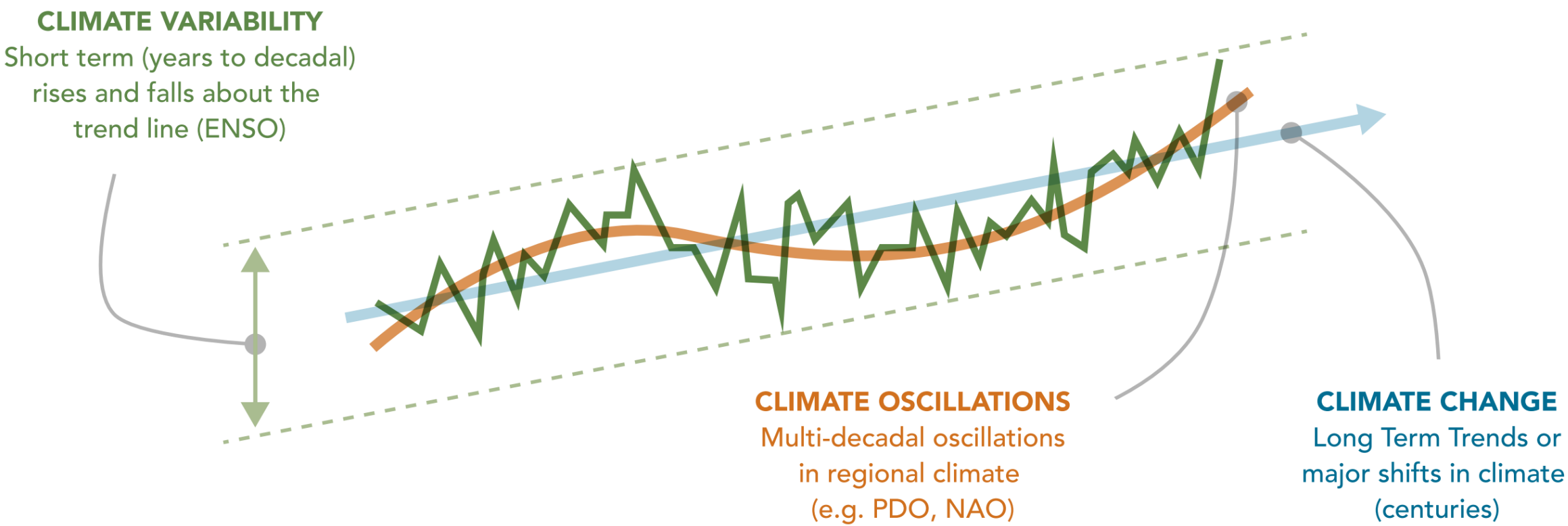
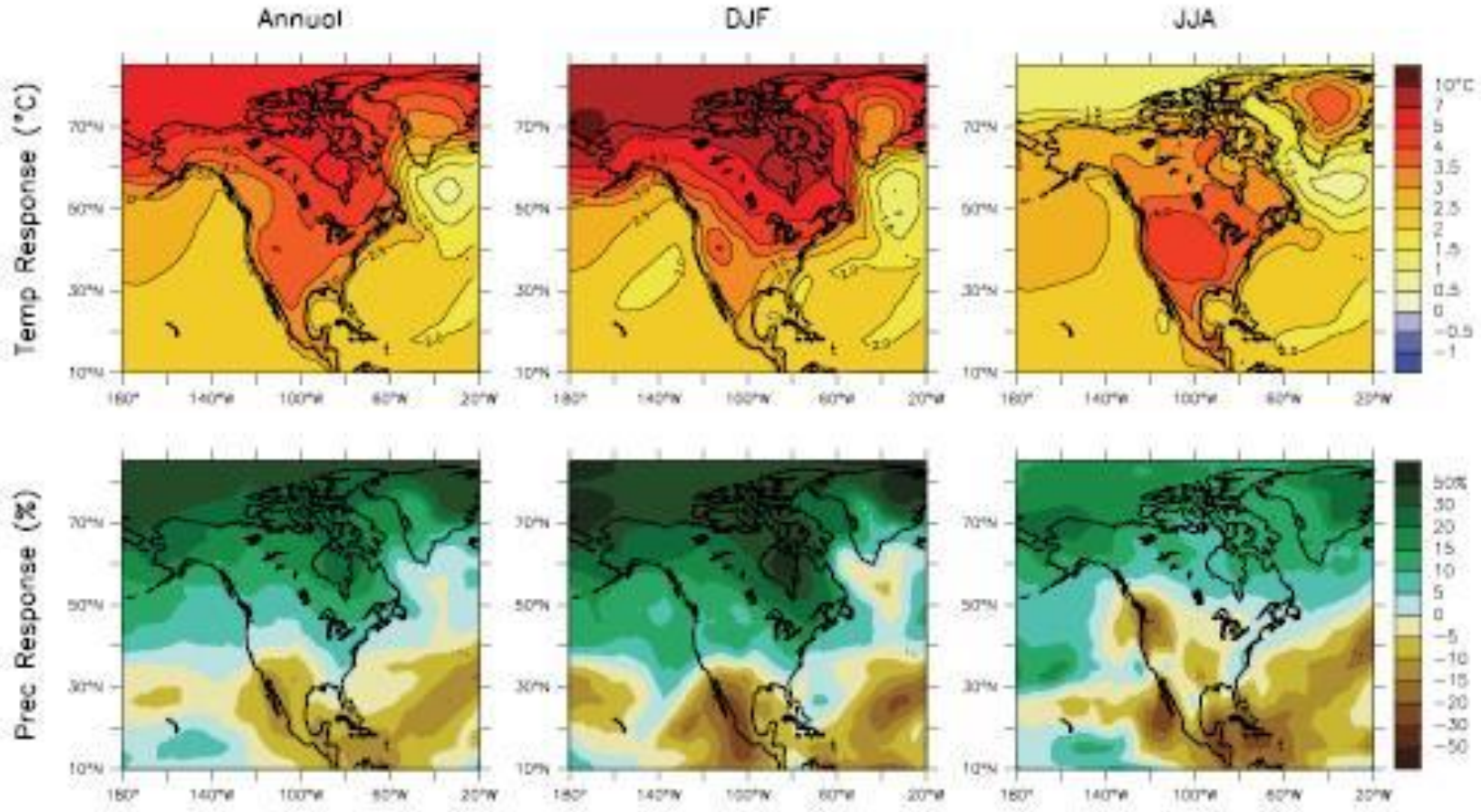


FIGURE 3. CLIMATE VARIABILITY, OSCILLATIONS & CHANGE

Diagram showing difference between climate variability, oscillations, and climate change. Adapted from original, courtesy of Pacific Climate Impacts Consortium, www.pacificclimate.org

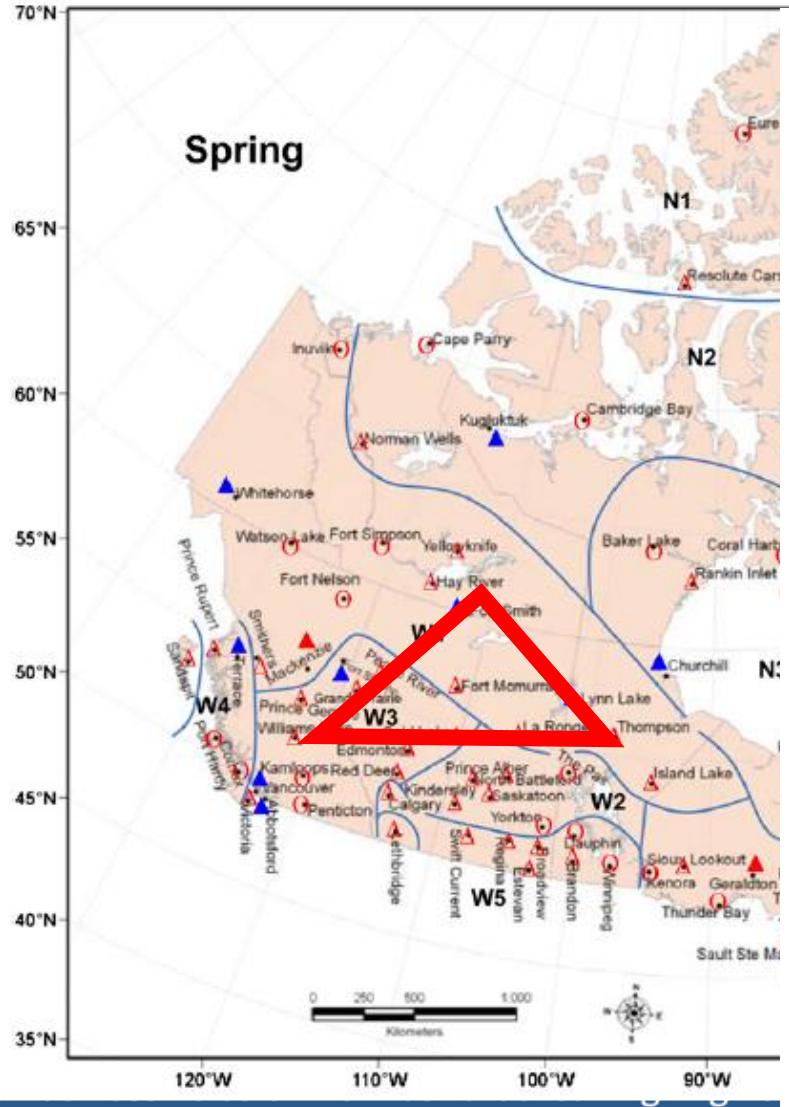
Projected Climate Changes

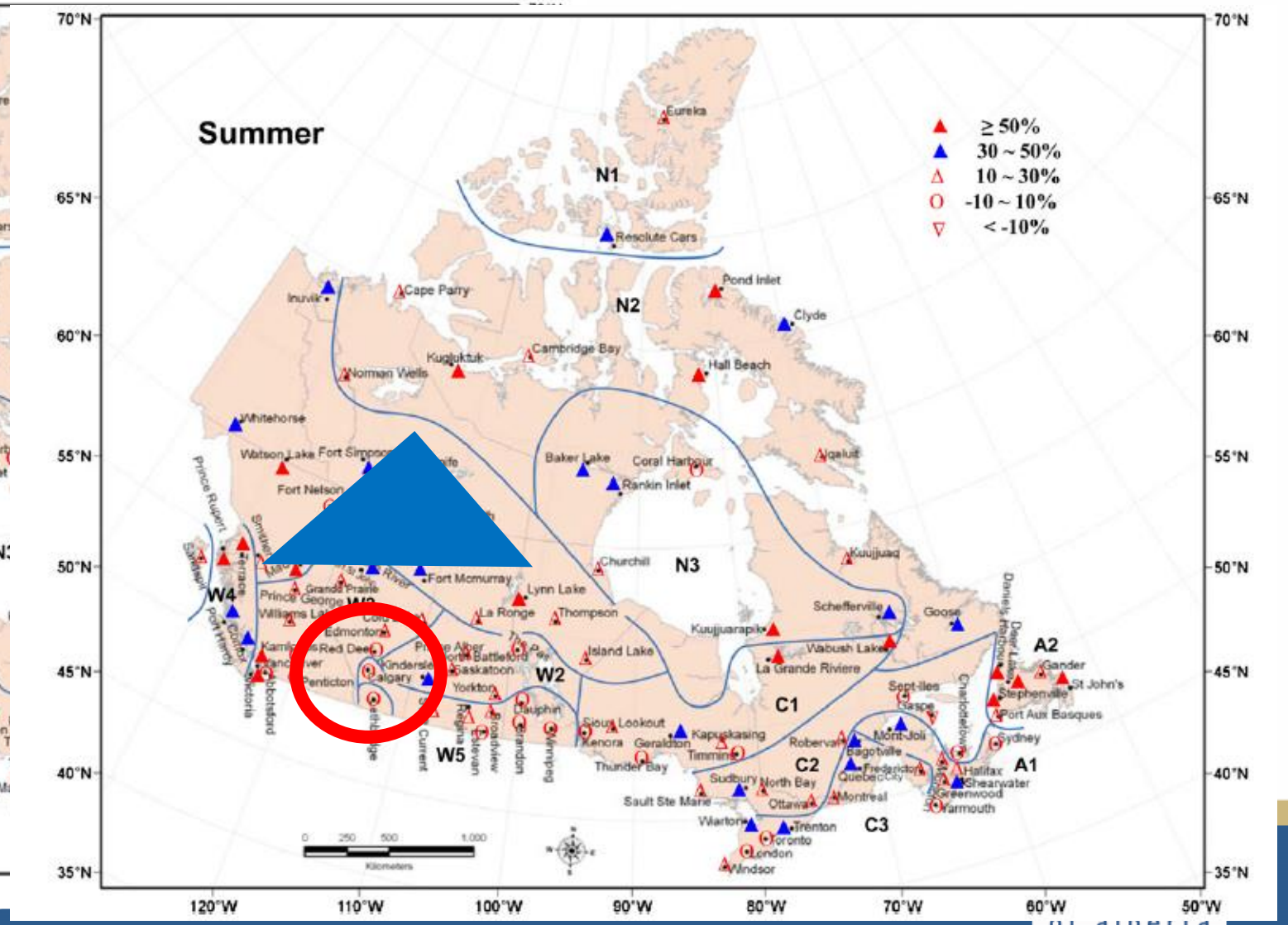
Temperature and Precipitation (2100)



Increased Extremes

Wind Speed


Spring
N1
N2
W3
W4
W5
W2
Resolute Cars
Cape Parry
Inuvik
Kugluktuk
Cambridge Bay
Norman Wells
Whitehorse
Fort Nelson
Yellowknife
Hay River
Baker Lake
Churchill
Fort Mcmurray
Lynn Lake
La Ronge
Thompson
Island Lake
Edmonton
Kamloops
Red Deer
Prince Albert
Saskatoon
Kindersley
Calgary
Penticton
Yorkton
Dauphin
Brandon
Winnipeg
Sioux Lookout
Kenora
Geraldton
Thunder Bay
Sault Ste Ma
Prince Rupert
Terrace
Prince George
Williams Lake
Vancouver
Victoria
Abbotsford
Lethbridge
Swift Current
Regina
Estevan
Broadview
70°N
65°N
60°N
55°N
50°N
45°N
40°N
35°N
120°W
110°W
100°W
90°W


Summer
≥ 50%
30 ~ 50%
10 ~ 30%
-10 ~ 10%
< -10%
N1
N2
N3
W4
W5
W2
C1
C2
C3
A1
A2
Resolute Cars
Eureka
Cape Parry
Inuvik
Kugluktuk
Cambridge Bay
Norman Wells
Pond Inlet
Clyde
Hall Beach
Whitehorse
Fort Nelson
Baker Lake
Coral Harbour
Rankin Inlet
Iqaluit
Churchill
Fort Mcmurray
Lynn Lake
La Ronge
Thompson
Island Lake
Kuujjuaq
Kuujjuarapik
Schefferville
Goose
Wabush Lake
La Grande Rivière
Sept-Îles
Gaspé
Mont-Joli
Bagotville
Fredericton
Quebec City
Montreal
Ottawa
Sudbury
North Bay
Timmins
Kapuskasing
Robervale
Sault Ste Marie
Wiarton
Toronto
London
Windsor
Trenton
Halifax
Shearwater
Greenwood
Yarmouth
Sydney
Port Aux Basques
Gander
St John's
Stephenville
Edmonton
Kamloops
Red Deer
Prince Albert
Saskatoon
Kindersley
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Penticton
Yorkton
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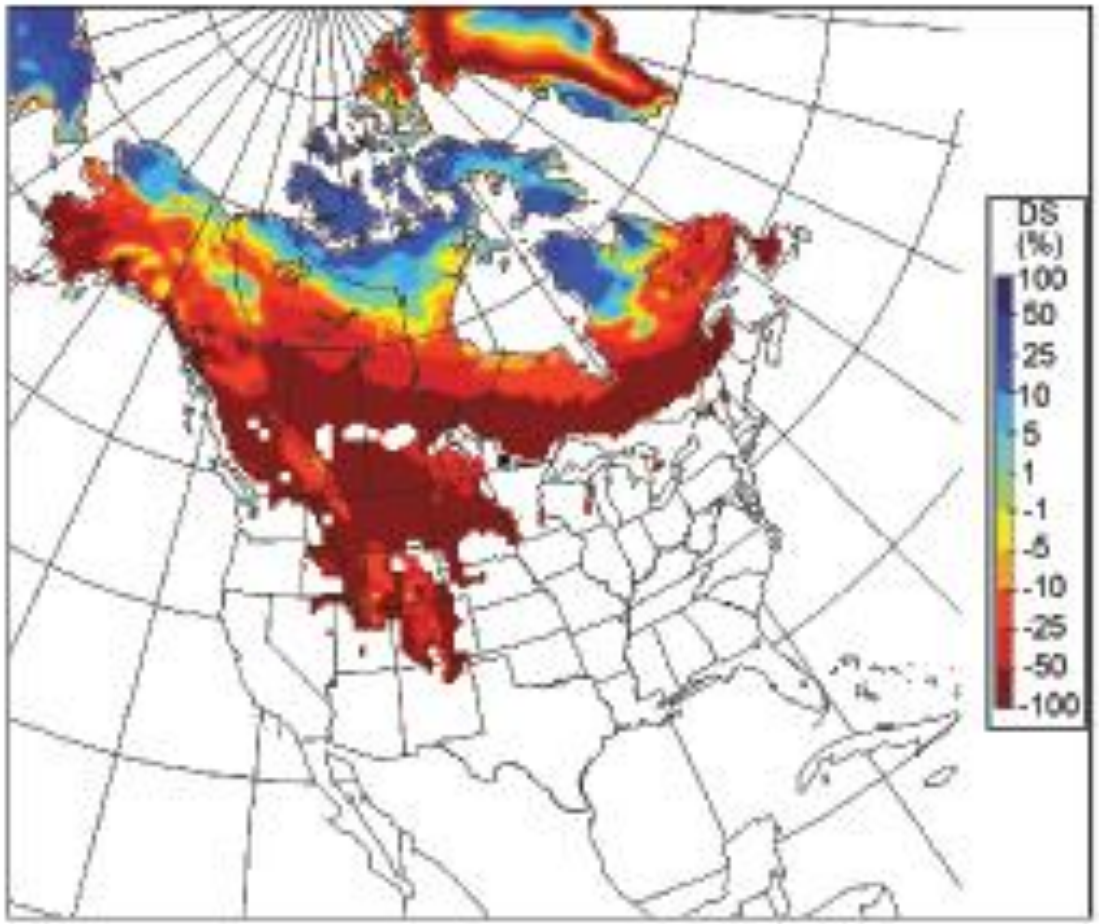
70°N
65°N
60°N
55°N
50°N
45°N
40°N
35°N
120°W
110°W
100°W
90°W
80°W
70°W
60°W
50°W

Snow Pack Changes (2050's)



⬆ ppt

+

⬆ temp

= rain not snow

Runoff Changes – what about timing?

projected changes in runoff by the end of the 21st century

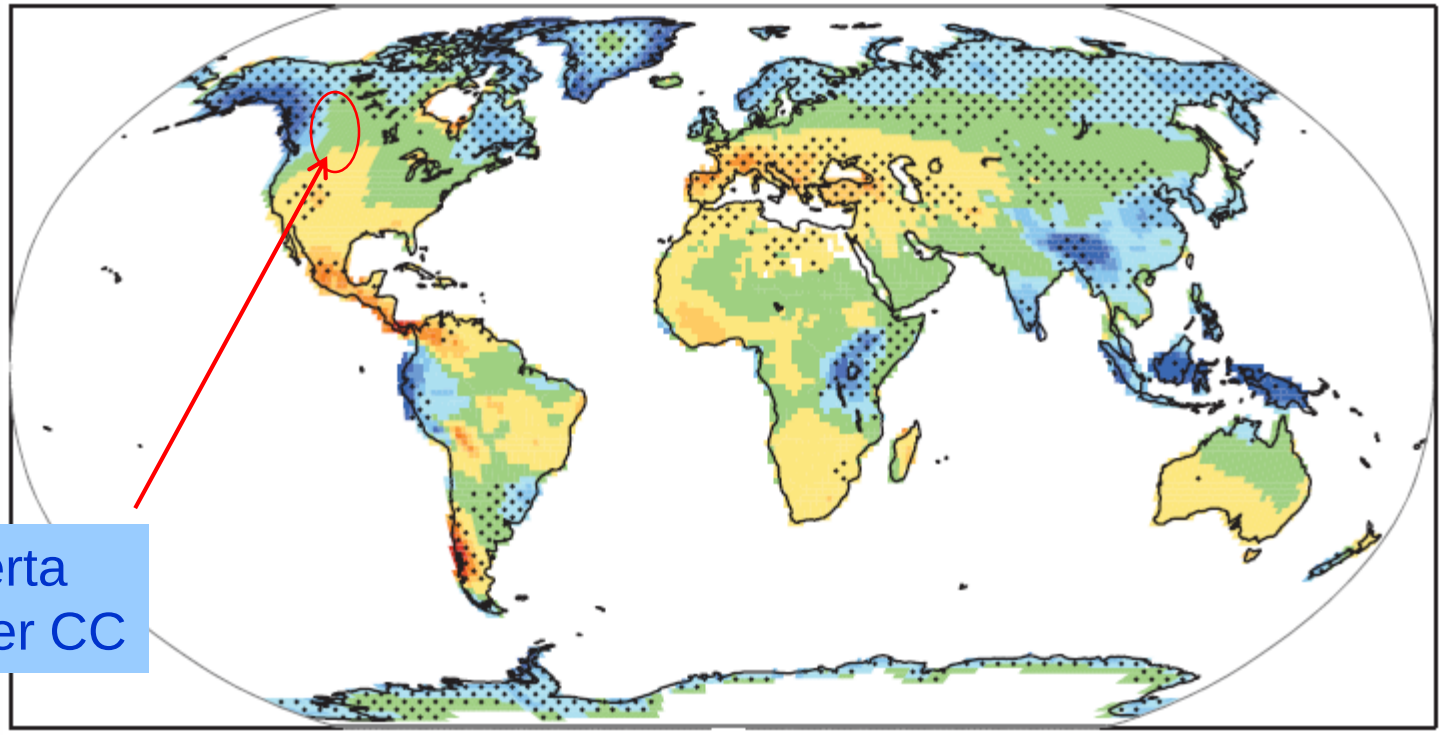


Fig. 10.12 IPCC 4. Multi-model mean changes in runoff (mm/day). Changes are annual means for the SRES A1B scenario for the period 2080 to 2099 relative to 1980 to 1999.

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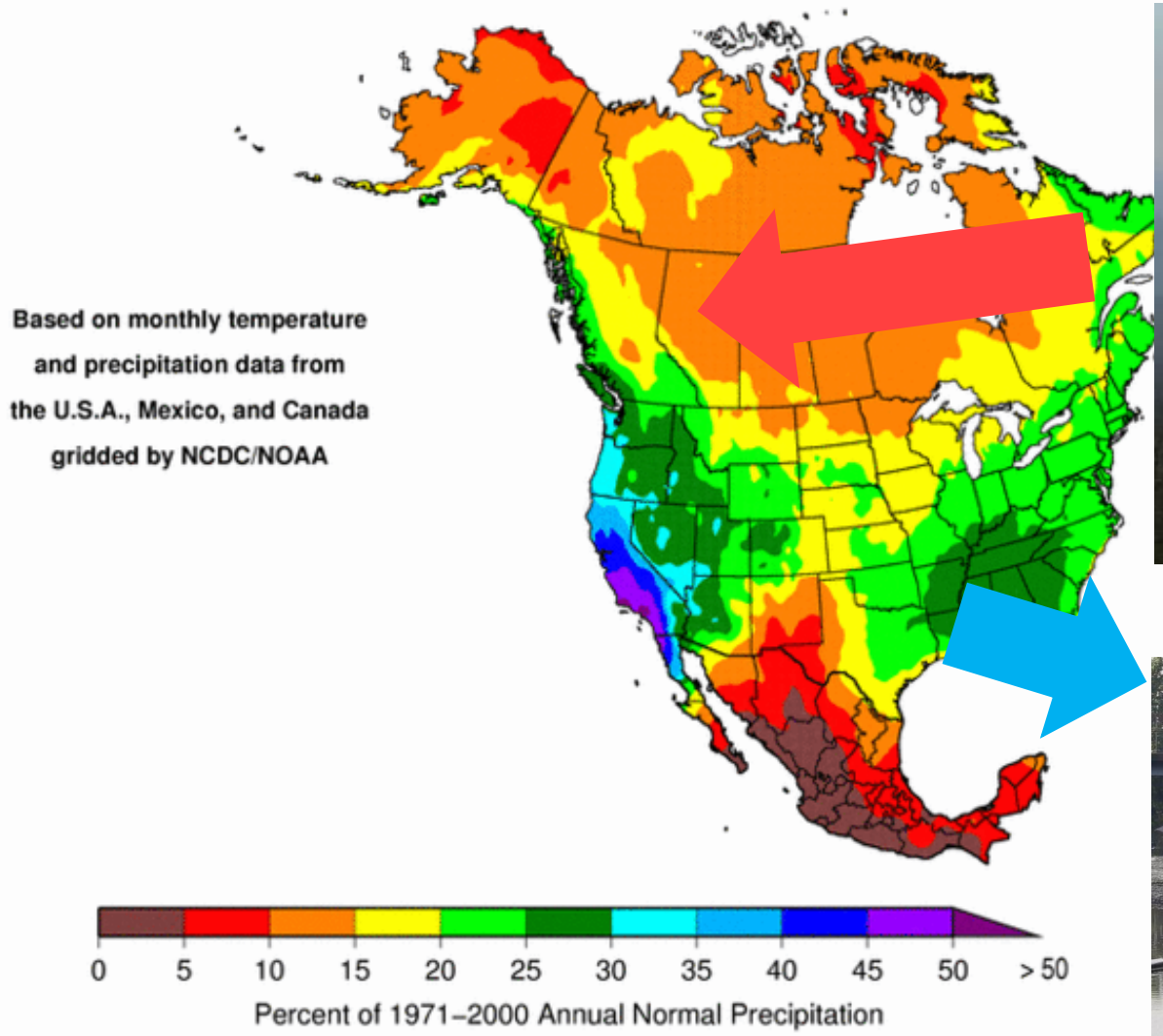
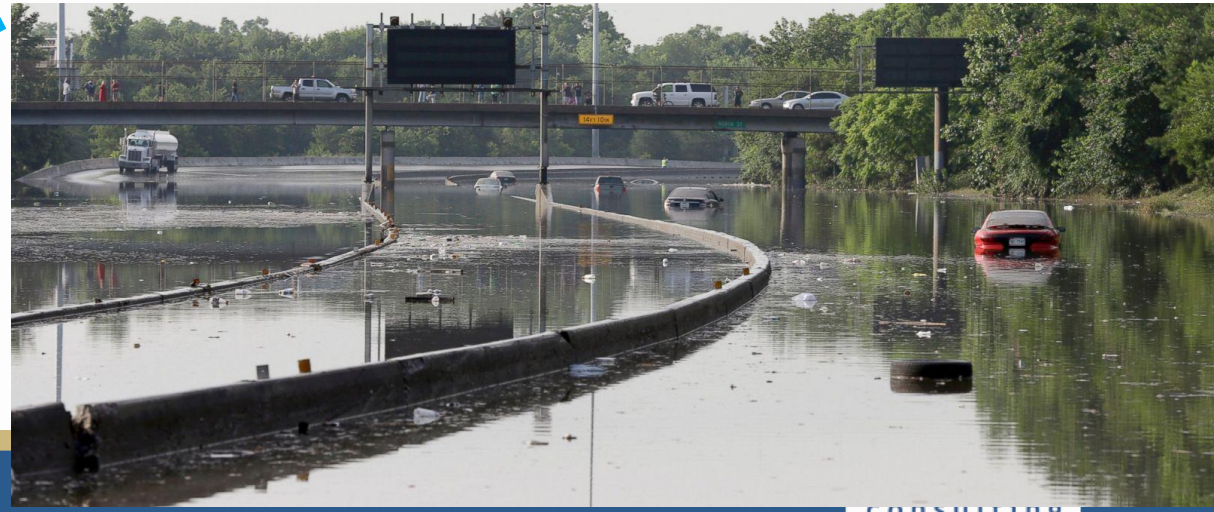
Percent of Annual Normal Precipitation, February to April





Increased hot/dry conditions

- Improved crop productivity
  - Economic opportunities
- Plant/livestock stress may increase
- Industrial/commercial/residential/agricultural water demands exhaust summer water supplies (reservoir, ponds)
- Wildfire increase in frequency and intensity
  - Wildfire Management Plans
  - Evaluate staffing and distribution of forest protection staff and resources

Longer dry season

- Advanced freshet (earlier spring runoff)
  - Decline in late spring/summer flows leading to water shortages
- Storage reservoir demand increased
  - Evaluate winter/spring runoff (supply) with respect to irrigation, water storage requirements, and conservation programs
- Water use restrictions
  - Drought Management Plans

Increased runoff and potential flooding

- Flooding increase in frequency and magnitude where already an issue
  - Consider managed retreat and abandonment of frequently flooded land
  - Identify key community assets, e.g. hospitals, schools, natural parks that could be vulnerable to flooding
- Seasonal water quality may be reduced
  - Drinking water treatment systems
- Stream bank erosion and high river flows may cause increased strain on dikes and other flood protection infrastructure and crossings (bridges)
  - Vulnerability assessments (John's talk)
- Storm water design may not be adequate

Why think different? Why adapt?

- Current infrastructure based historical climate data
- Assumption that the climate was stationary
- Reduce vulnerability

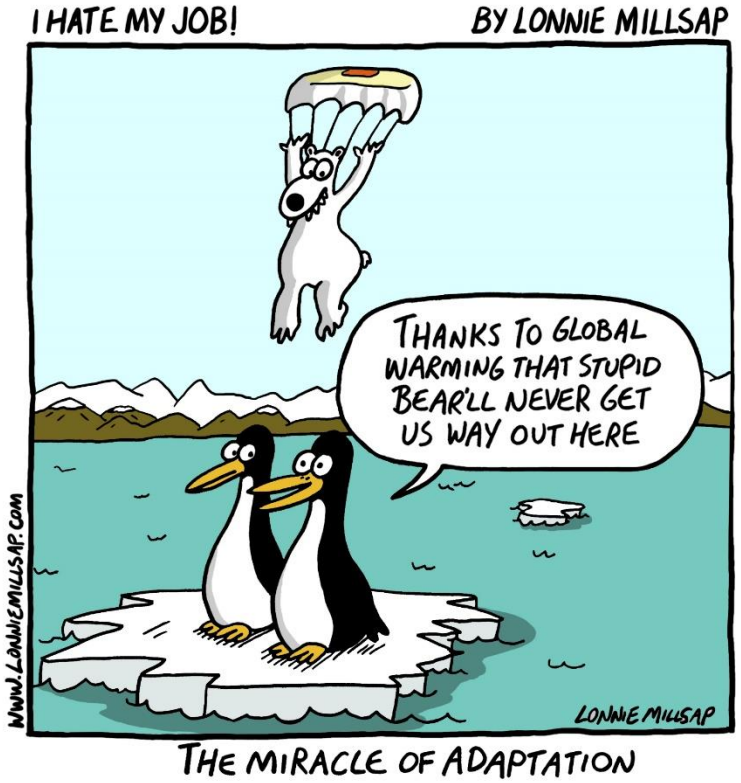
OCP – Bylaws - Guidelines

- Riparian widths
- Floodplain bylaws
- Zoning bylaws
  - Building requirements: wind, size of footprint
- Hillside Guidelines
  - Drainage concerns/slumping/cut and fills

Resource Planners

- What will this do to habitat? Sensitive areas? Recreation?
- Agriculture – Crops/irrigation requirements
- Appropriate land uses

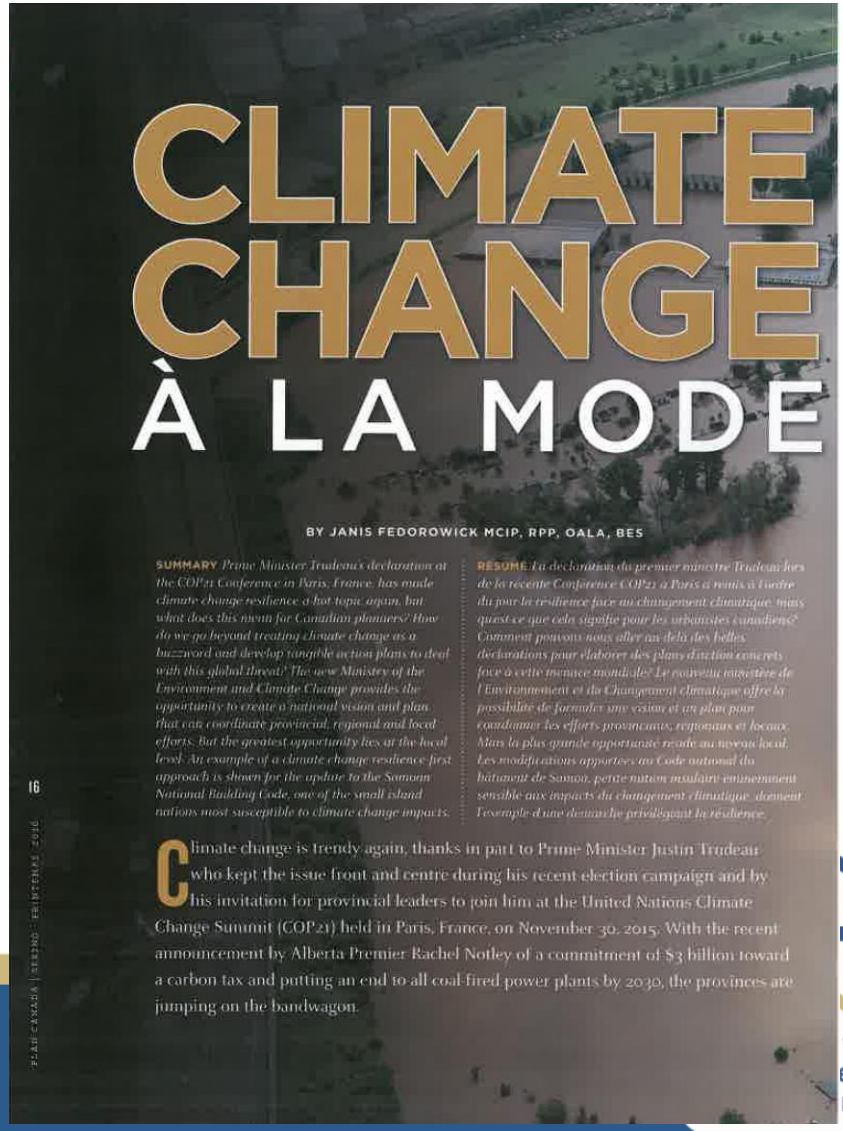
Adaptation Assessment Examples



Resilience: First Planning in Action Process

Framework – impacts to solutions

1. List expected climate-change impacts according to the biogeographical zone
2. Categorize impacts according to its cause
3. Solutions to offset the impact
    1. Legislation
    2. Programs
    3. Updates



Edmonton Example – Resiliency

Region of Concern

- Alberta Capital Region
  - Rural farming, parkland – new housing development - and North Sask River valley – downtown Edmonton core

Expected Impact

- Forest Fires – Alberta Capital Region
  - Settlements
  - Evacuations
  - Transmission lines
  - Bridges, roads
  - Homes, facilities
  - Air pollution

Causes

- Increase Temp; changed ppt pattern;
- Low flows in North Saskatchewan
- Seasonal water supplies (ponds, etc.)

Legislation/ programs

- FireSmart
- Capital Region Emergency Preparedness Partnership (C-REPP)

Updates

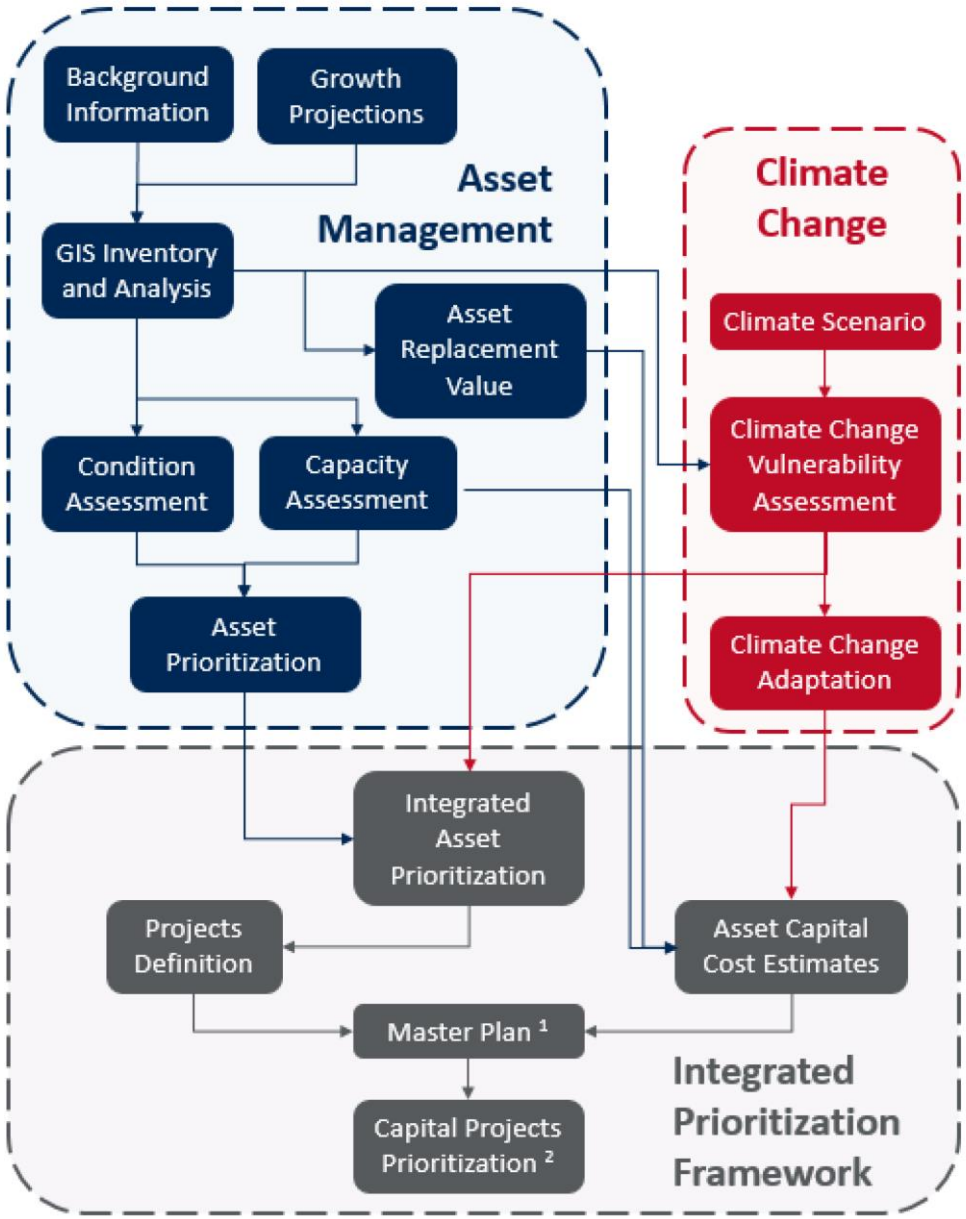
- Evacuation plans
- Emergency public warning system
- Selective logging
- Fire barriers
- Redundancy
- New setbacks

Asset Management

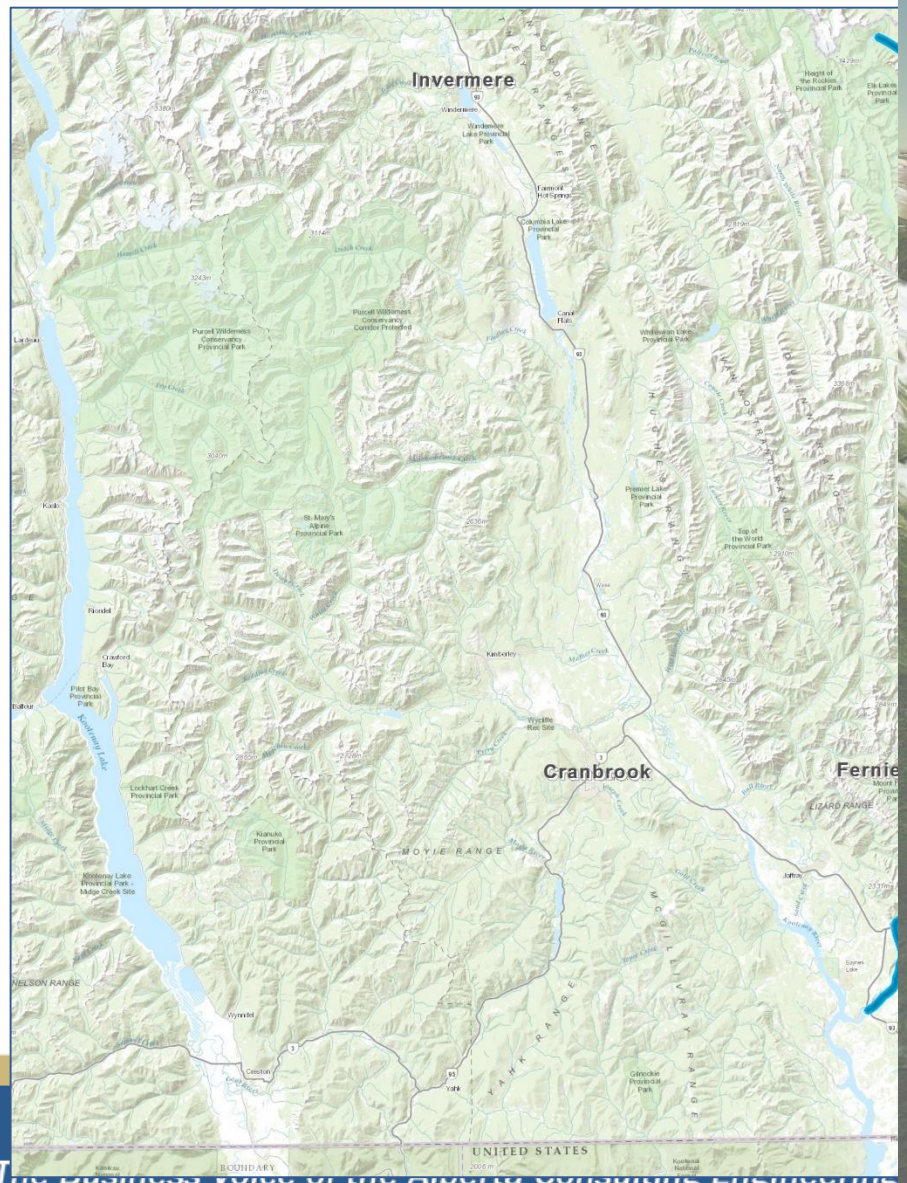
IAMA
INFRASTRUCTURE ASSET MANAGEMENT ALBERTA

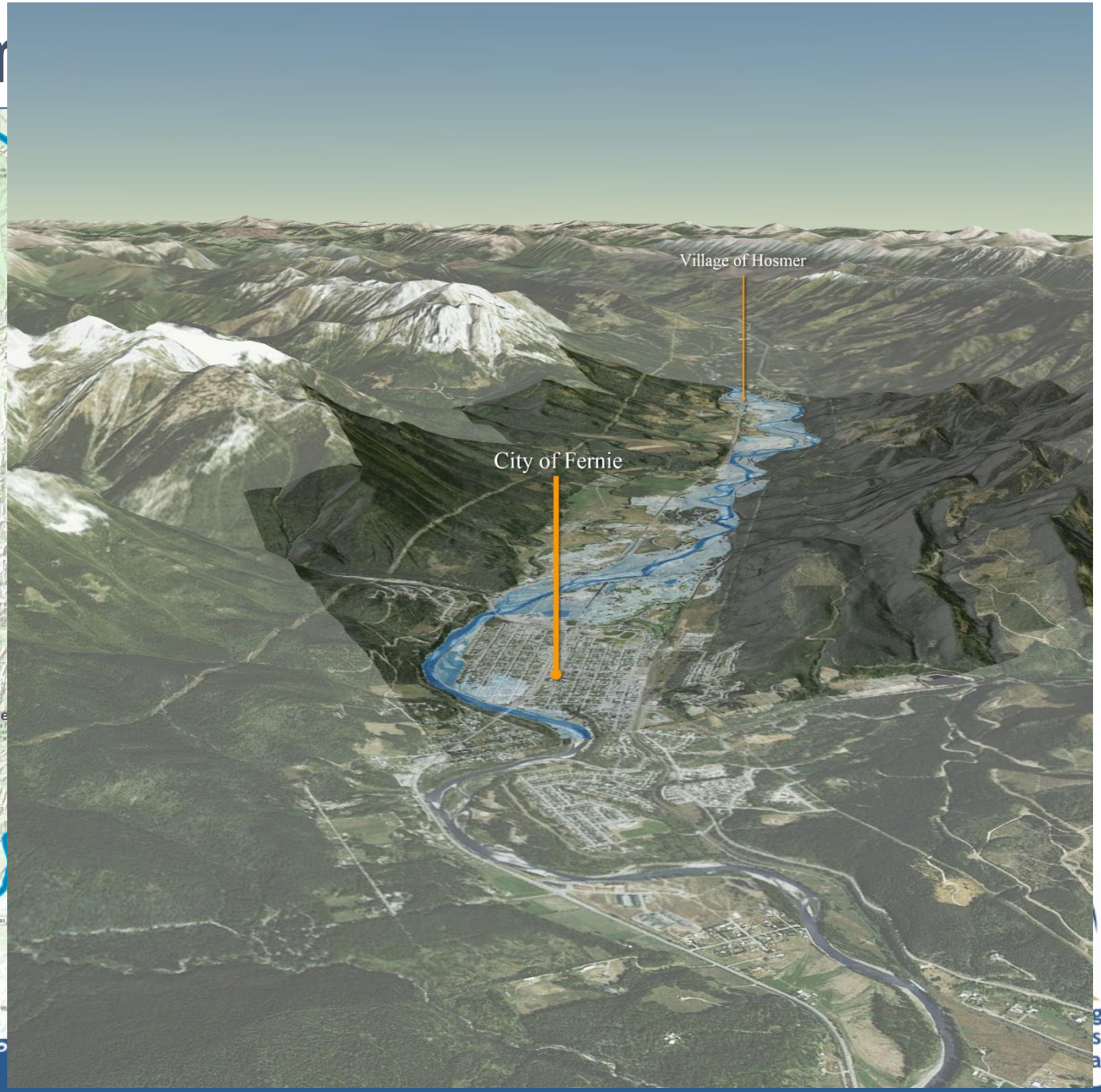
AM & CC

Figure 1 - General Asset Management & Climate Change Integration Process



Elk River Flooding Exam






1995 Event
1:200 Year
Event
2013 Event
Google
Imagery ©2016 DigitalGlobe, Province of British Columbia, RDCO, RDNO

Climate Change + Cumulative Effects

- Human development compounded by climate change
- Social + Environment + Economic Impacts

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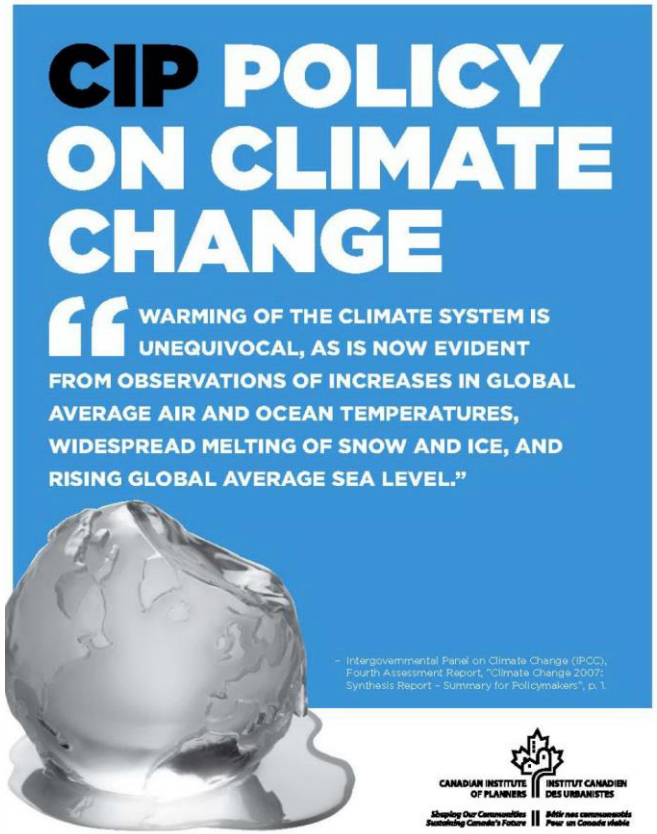
What is the communities willingness to do something?

- Find a leader
- Slow and steady = progress
- Identify opportunities
- Acknowledge that climate changes
- Identify time periods



Questions

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