

From Global to Local: Climate Change in the Lake Superior Basin

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Making a Great Lake Superior
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Duluth, MN

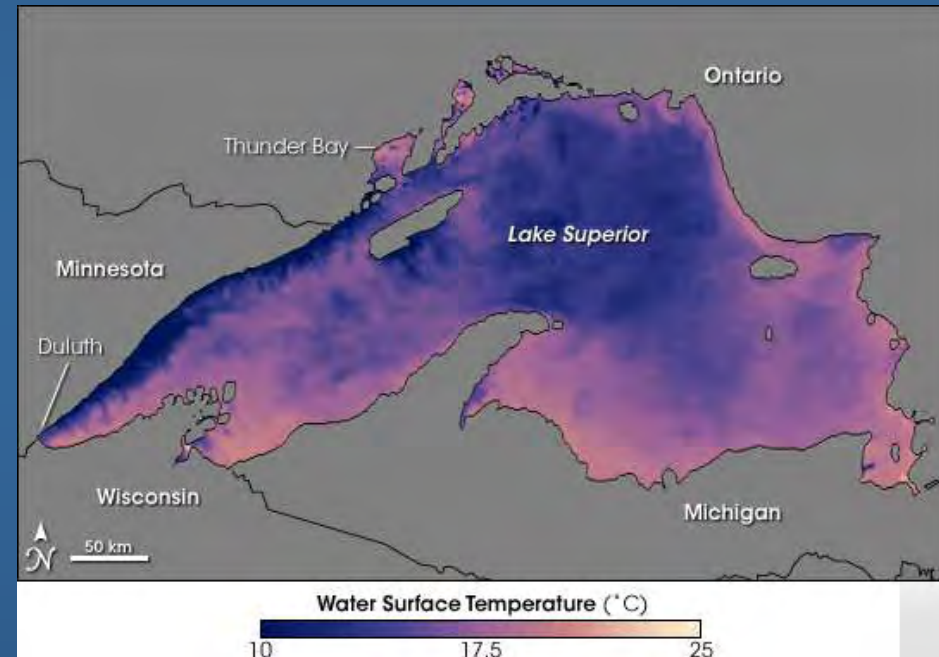


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Outline of today's talk:

- “Big Picture” – Intergovernmental Panel on Climate Change (IPCC)
- What does climate change mean for the Lake Superior Basin?
 - Climate scenarios
 - Hydrology
 - Ecosystems

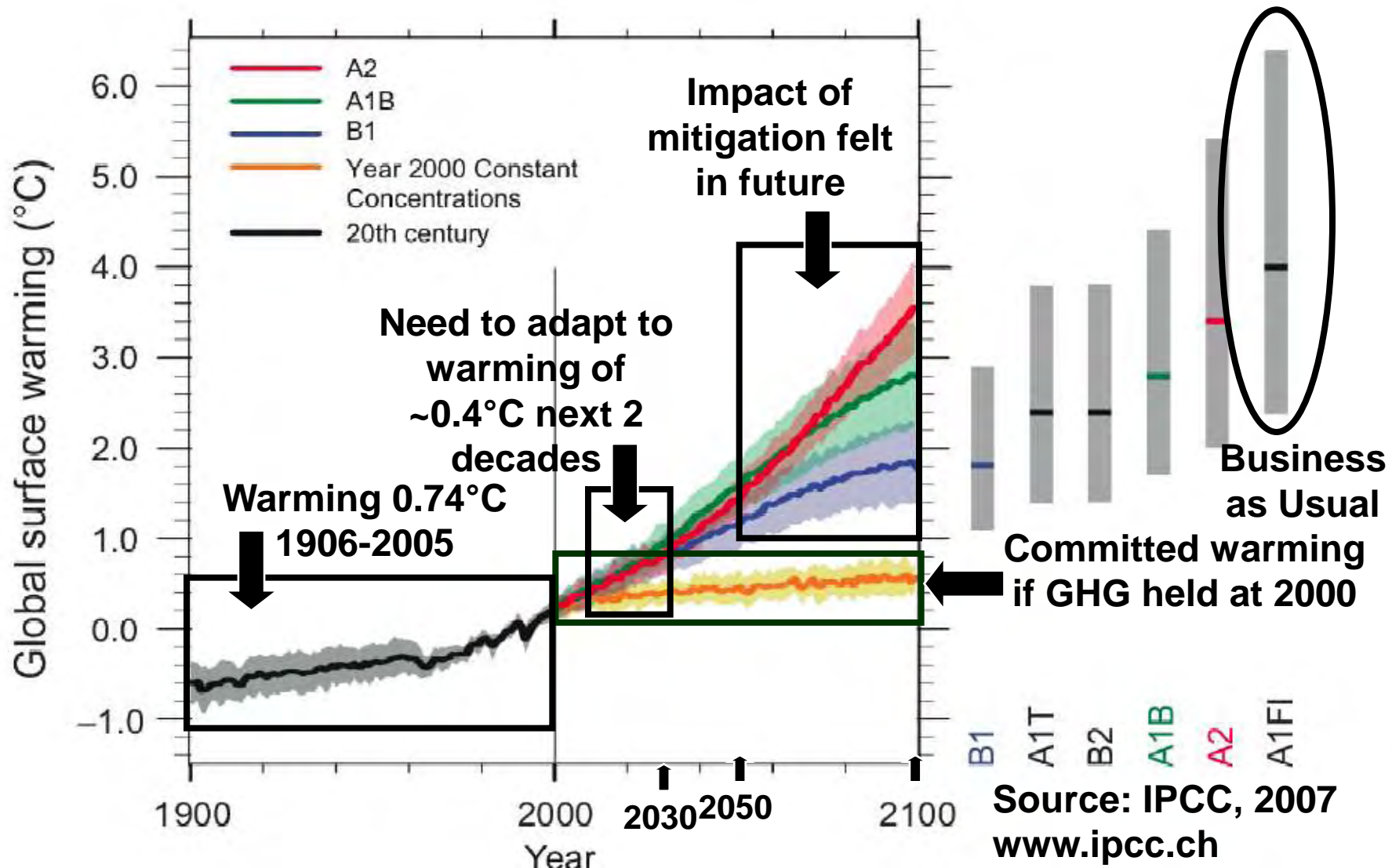


**Lake Superior on
August 2, 2007**

“Warming of the climate system is unequivocal...” IPCC 2007

- Global annual temperature +0.74°C – 1906 to 2005
- Detecting changes in natural systems: snow, ice, & phenology
- Warming by 2100:
 - globally 1.8°C to 4.0°C depends on emission scenarios (best estimates)
- Balanced response to climate change:
 - **Mitigation** – reduce emissions & increase sinks of greenhouse gases to halt/prevent climate change
 - change light bulbs to cap & trade program
 - **Adaptation** – respond to impacts of changing climate - moderate harm or exploit beneficial opportunities
 - water conservation to integrated water strategy

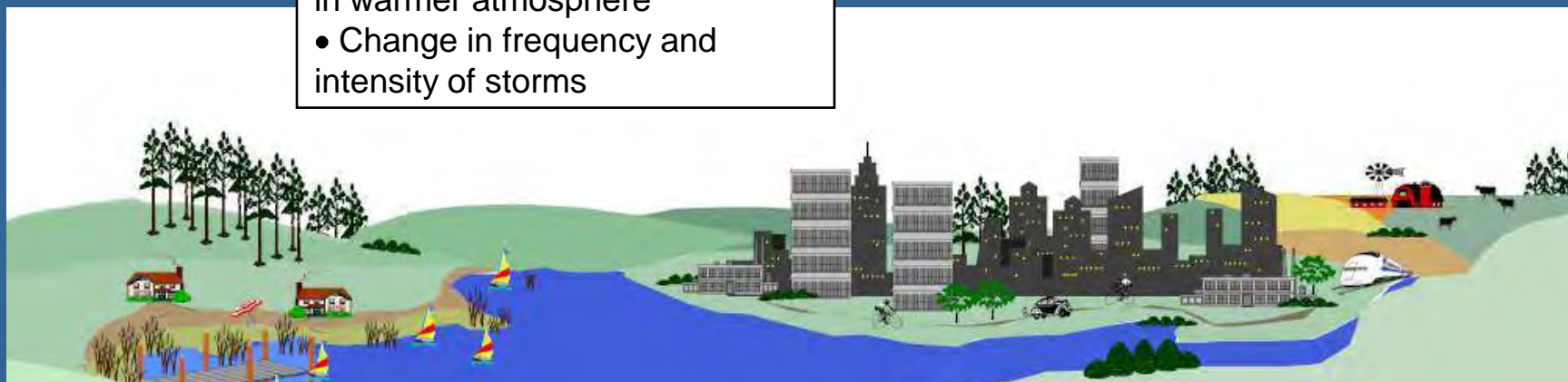
We need to adapt (and mitigate)...



Projected changes in climate for the Great Lakes Basin (✓ observed)

Airshed Effects:

- ✓ Increase in air temperatures
- ✓ Increase in precipitable water in warmer atmosphere
- Change in frequency and intensity of storms



Nearshore Effects:

- ✓ Increase in water temperature
- Increase in evaporation

Inlake Effects:

- ✓ Increase in water temperature
- Higher evaporative losses from lakes
- ✓ Less ice cover (shorter duration)

Watershed Effects:

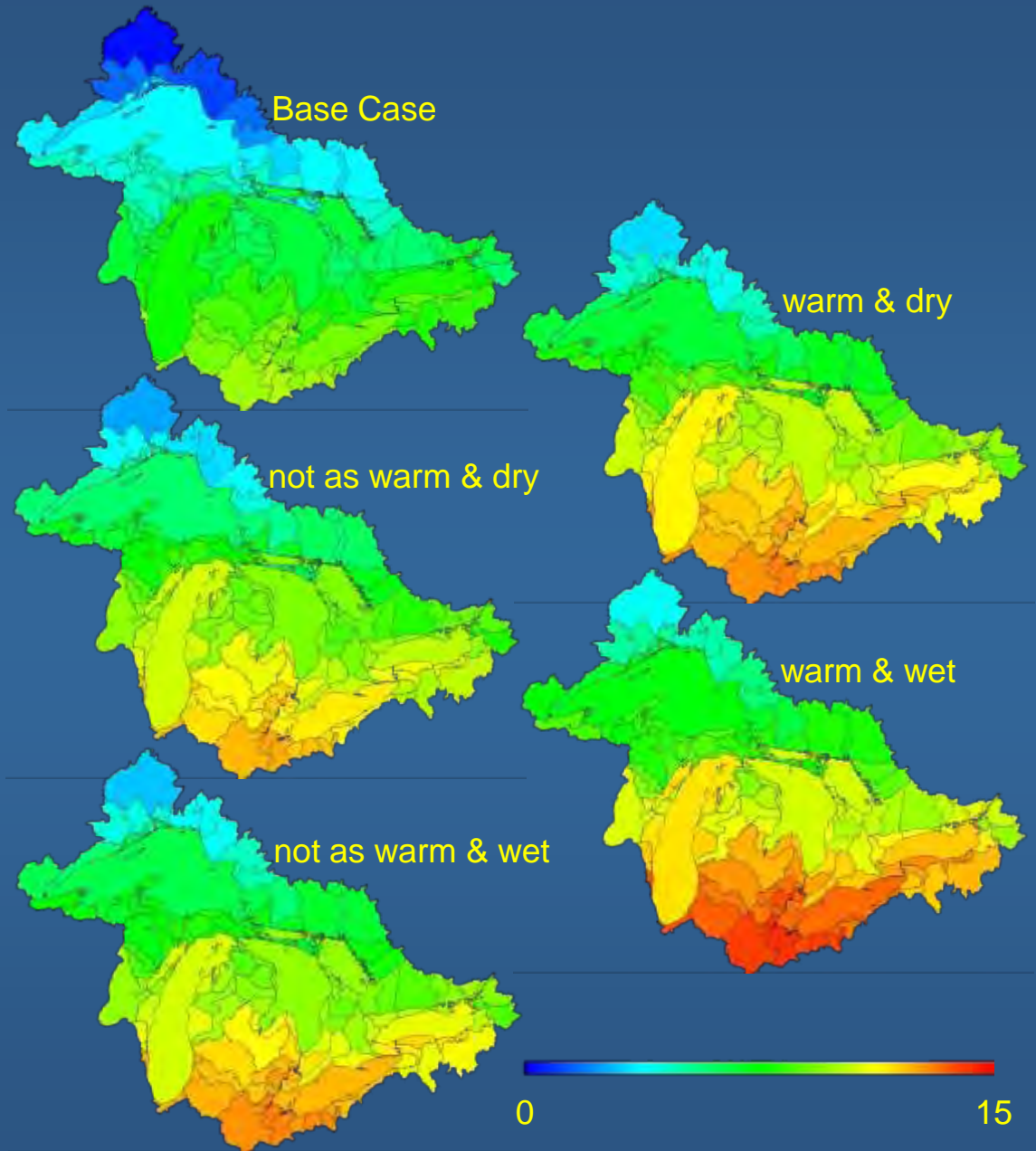
- ✓ Warmer air temperatures
- ✓ More precipitation (decreases in key seasons)
- Less winter precipitation as snowfall and more rain
- ✓ Less snowpack
- ✓ More intense precipitation events
- Increase in evapotranspiration

Great Lakes Basin Climate Change Scenarios: temperature (T-°C) & precipitation change (P-%) for 2050s relative to 1961-1990

GCM	ANNUAL		WINTER (DJF)	SPRING (MAM)	SUMMER (JJA)	FALL (SON)
HadCM3 A1FI Warm & Wet	T	+3.99	+3.09	+3.57	+4.44	+4.07
	P	+10.33	+21.52	+19.18	+3.06	+4.67
CGCM2 A21 Warm & Dry	T	+3.24	+4.32	+3.26	+3.17	+2.21
	P	+1.40	+4.38	+4.39	-1.60	+1.28
HadCM3 B22 Not so Warm & Wet	T	+2.84	+3.33	+2.35	+3.08	+2.60
	P	+12.51	+20.81	+19.93	+7.70	+8.00
CGCM2 B23 Not so Warm & Dry	T	+2.24	+3.17	+2.57	+2.32	+1.60
	P	+2.84	+5.33	+6.60	+0.10	+1.35

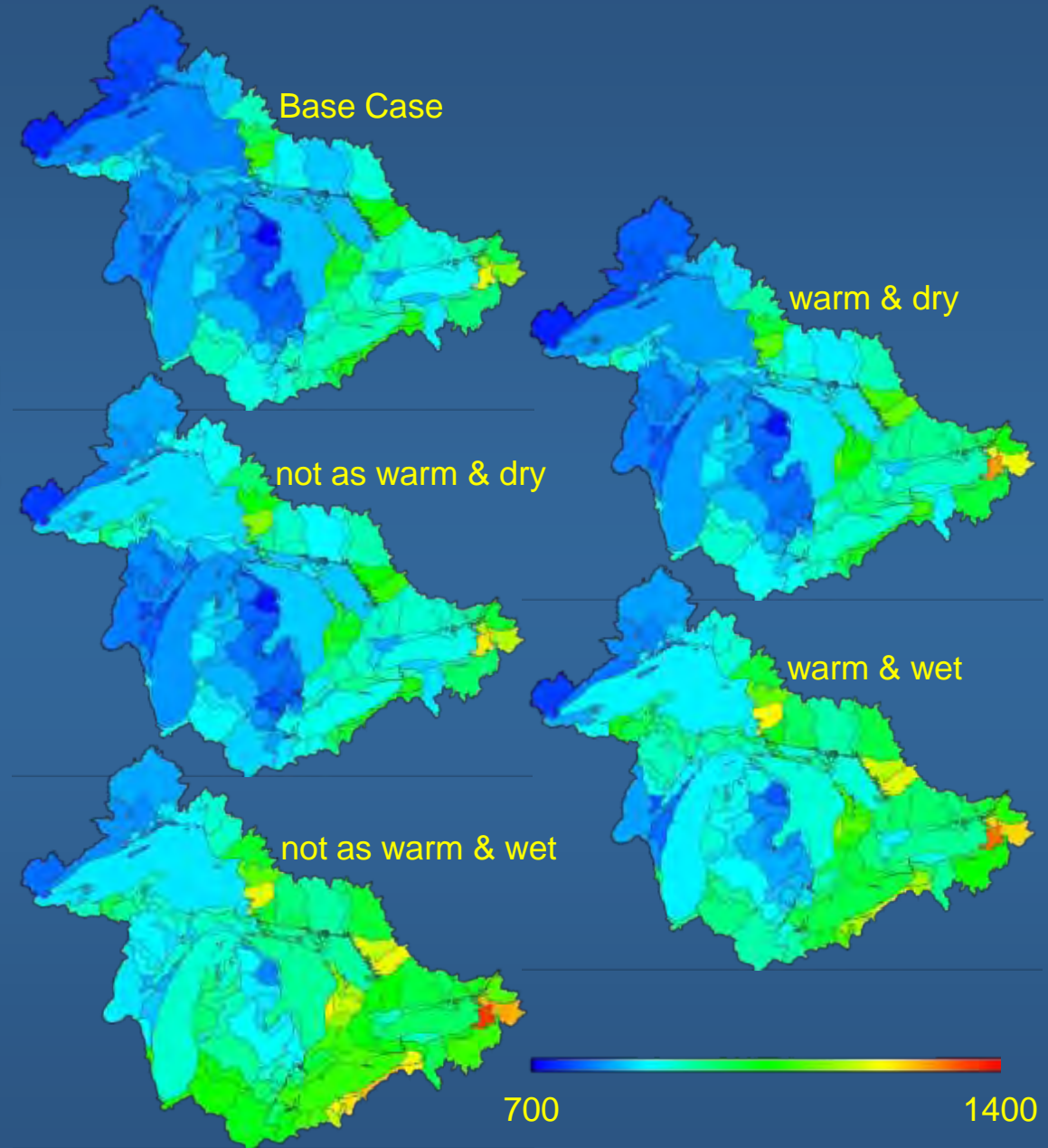
Annual average air temperature (°C)
Base case & 2050s

Source: Croley, GLERL



Annual total
precipitation (mm)
Base case & 2050s

Source: Croley, GLERL

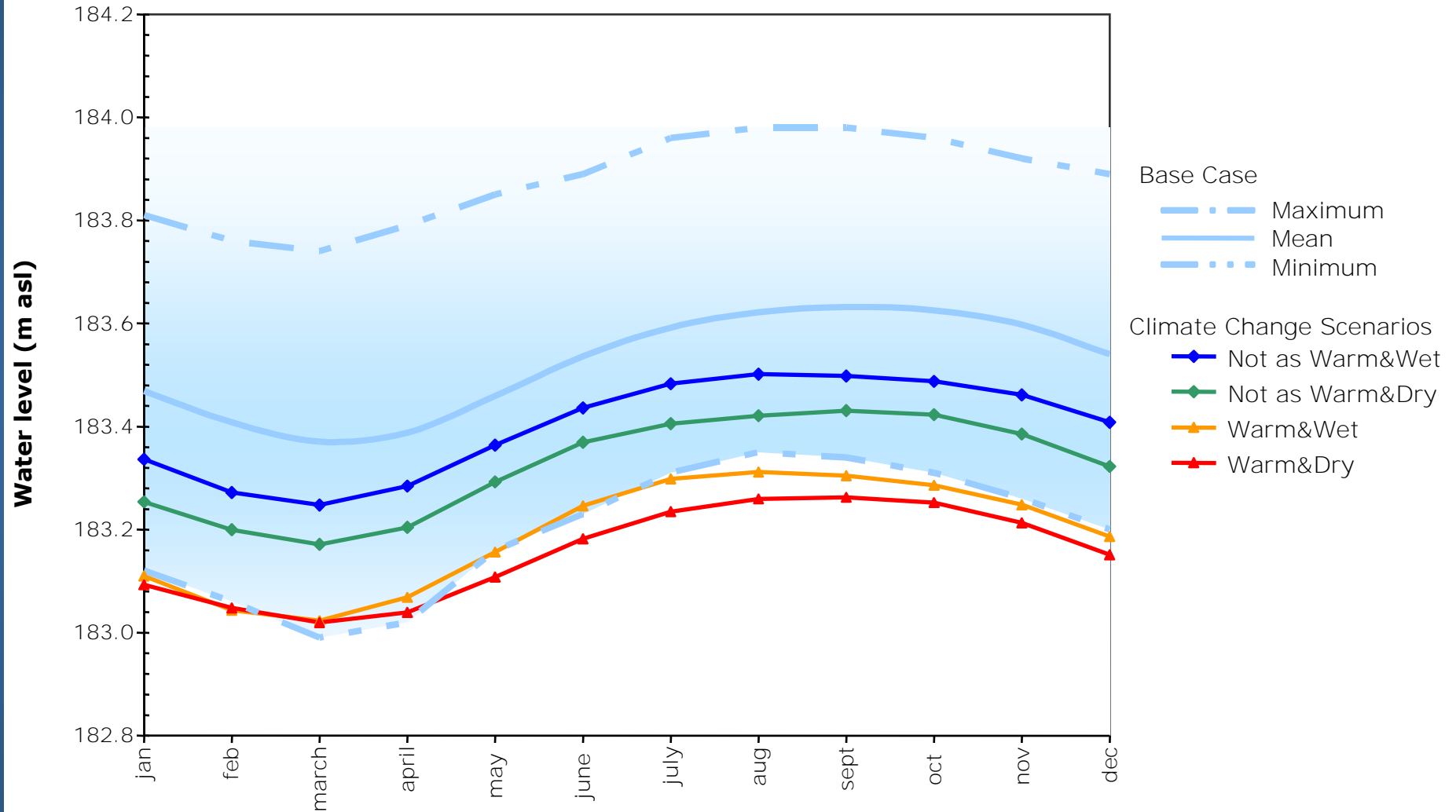


Lake Superior – Hydrologic impacts

	BASE CASE	WARM & DRY	NOT-AS WARM & DRY	WARM & WET	NOT-AS WARM & WET
LAKE OUTFLOW STATISTICS (m³/s)					
Annual Mean	2334	1865 (-20%)	2194 (-6%)	1914 (-18%)	2128 (-9%)
CHANGE OF LAKE LEVEL FROM BASE CASE (cm)					
Annual		-36	-20	-33	-12
Winter		-38	-21	-36	-13
Spring		-35	-18	-32	-11
Summer		-36	-18	-30	-11
Autumn		-38	-21	-34	-14

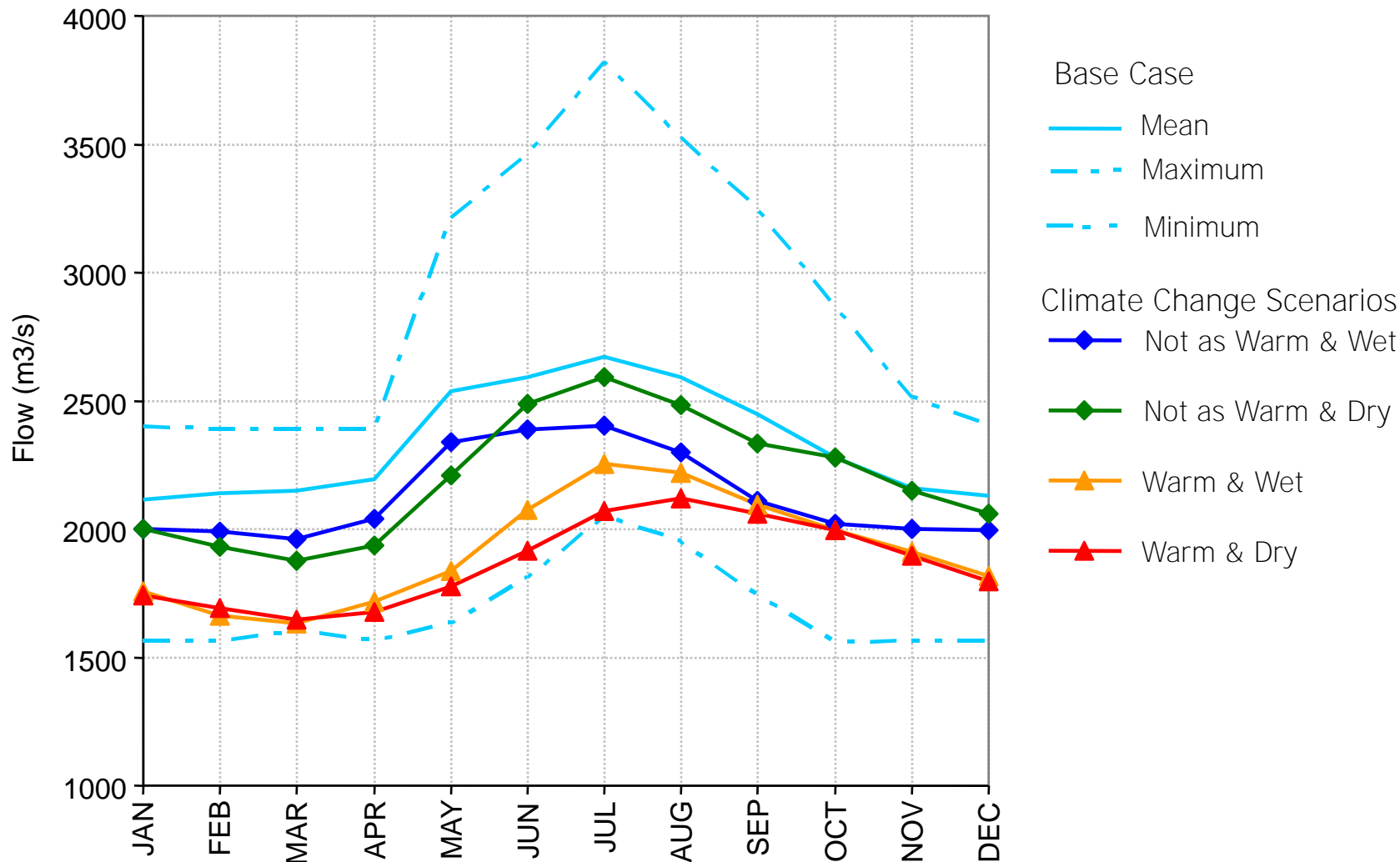
Source: Fay & Fan, Environment Canada

Lake Superior - Water Level Scenarios

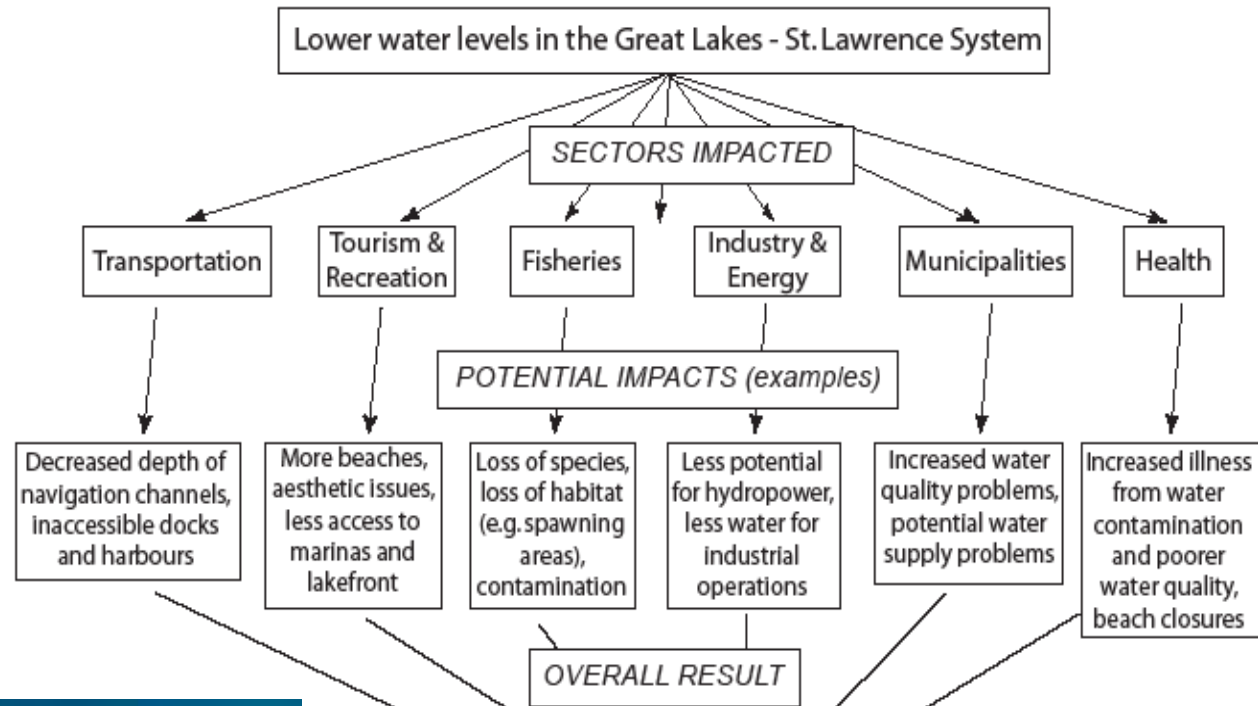


Source: Fay & Fan, Environment Canada

Lake Superior - Flow Scenarios



Inter-connected impacts ...



Supply-demand mismatches and issues of apportionment among:

- sectors
- levels of government
- jurisdictions (e.g. provinces/states, Canada/U.S)
- economic uses and ecosystem needs
- upstream and downstream interests



Disturbance from pests, diseases and fire intensify ...

- Longer growing season & drier soils affect terrestrial ecosystems
- Extended period of high fire risk & large increases in area burned
- Disrupt ecosystem services – wildlife habitat



Changes in fish & wildlife populations

- Temperature and precipitation thresholds change
 - Ranges expand north e.g., L. Superior and zebra mussel?
- Poorer water quality – e.g., water temperature & dissolved oxygen
- Changes in food sources (or timing of availability)
- Rare & endangered, endemic & migrating species vulnerable



Climate change is a challenge and an opportunity ...

- Climate is changing
 - Past climate no longer reliable guide to the future
- Many projected impacts more extreme versions of what already experiencing locally
 - exacerbate local management concerns and affect policy and programs
- How can we “mainstream” climate change information into decision-making?
 - Planning informed/guided by climate scenarios & monitoring
 - “No regrets” adaptations