A Great Lakes Regional Focus on Global Climate Change

(Advertised title: What Changes Are Predicted?)

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“Our Moral Footprint”

“Larger changes, however, could have unforeseeable effects within the global ecosystem. In that case, we would have to ask ourselves whether human life would be possible. Because so much uncertainty still reigns, a great deal of humility and circumspection is called for.”

-Vaclav Havel, *New York Times*, Sep. 27, 2007

Northern Hemisphere Temperature Change

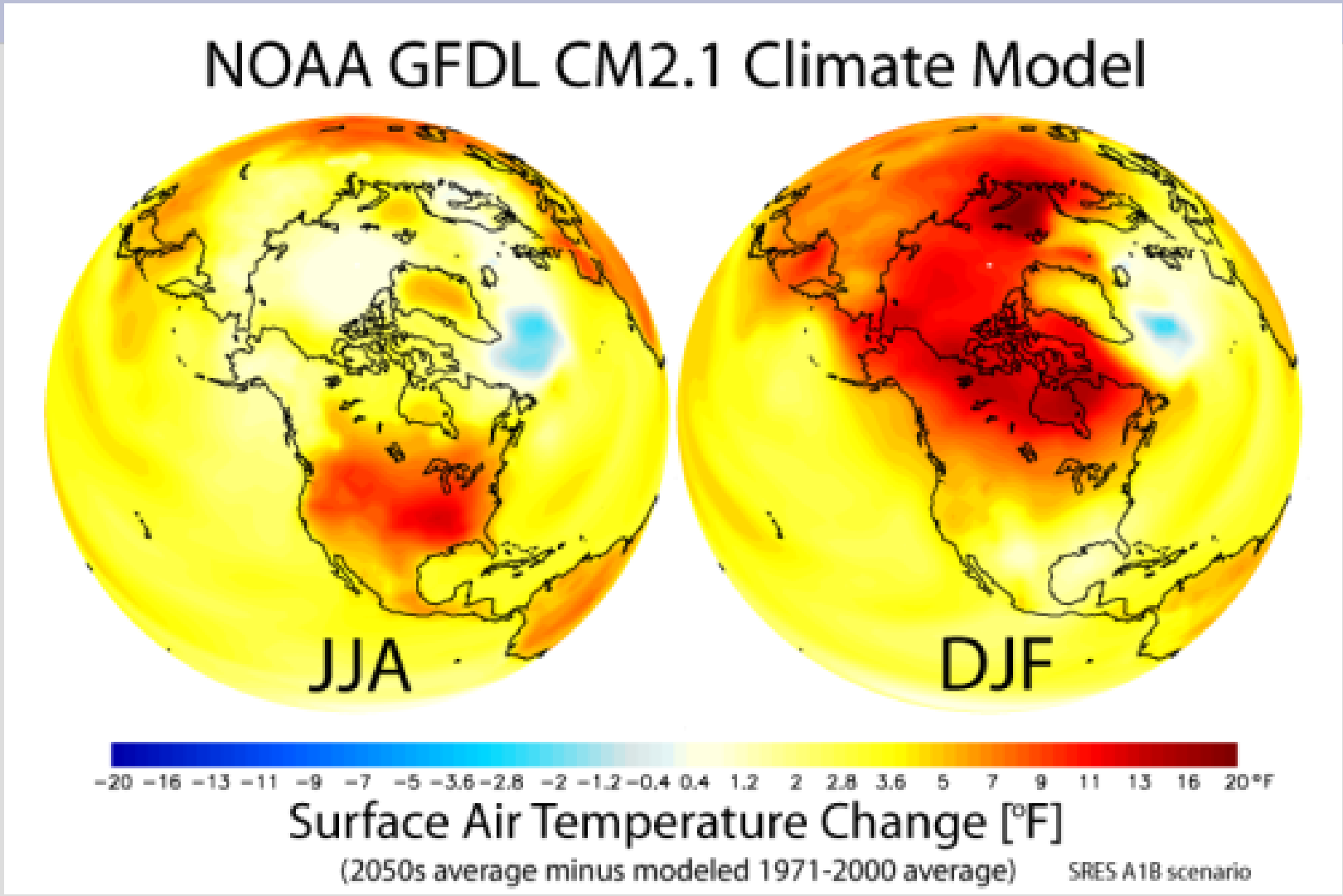
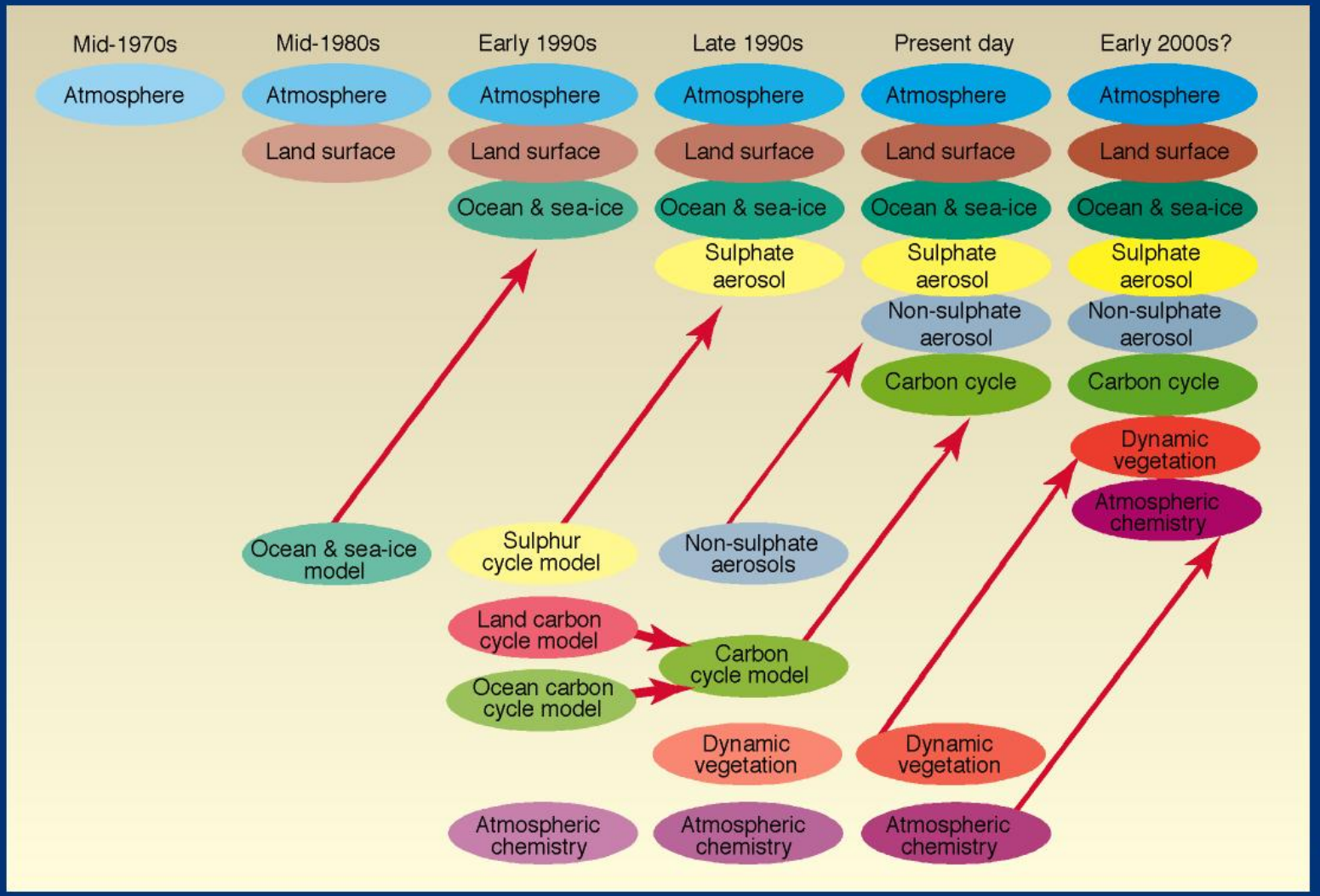


Figure courtesy GFDL

The development of climate models, past, present and future

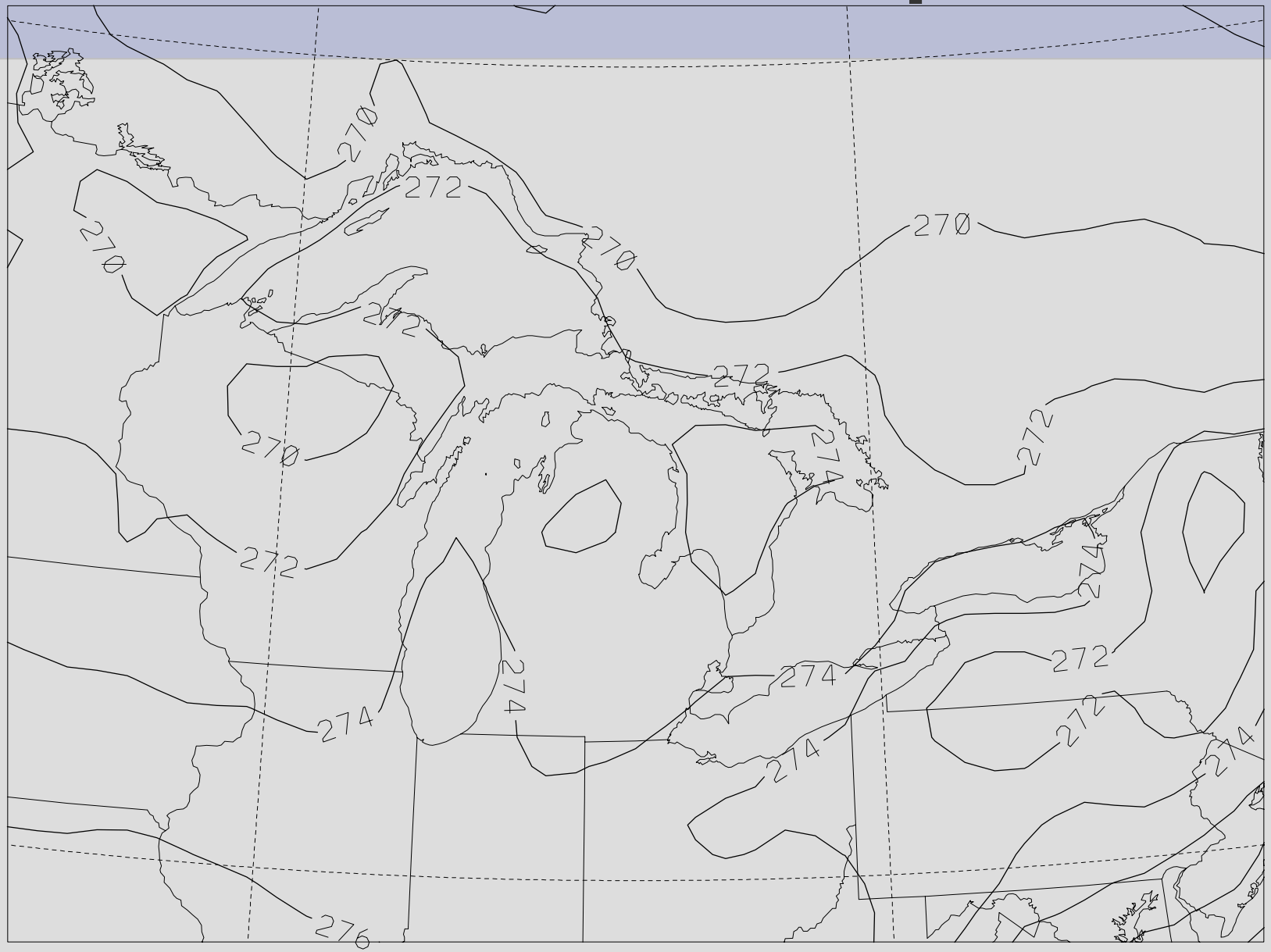


WG1 - TS BOX 3
FIGURE 1

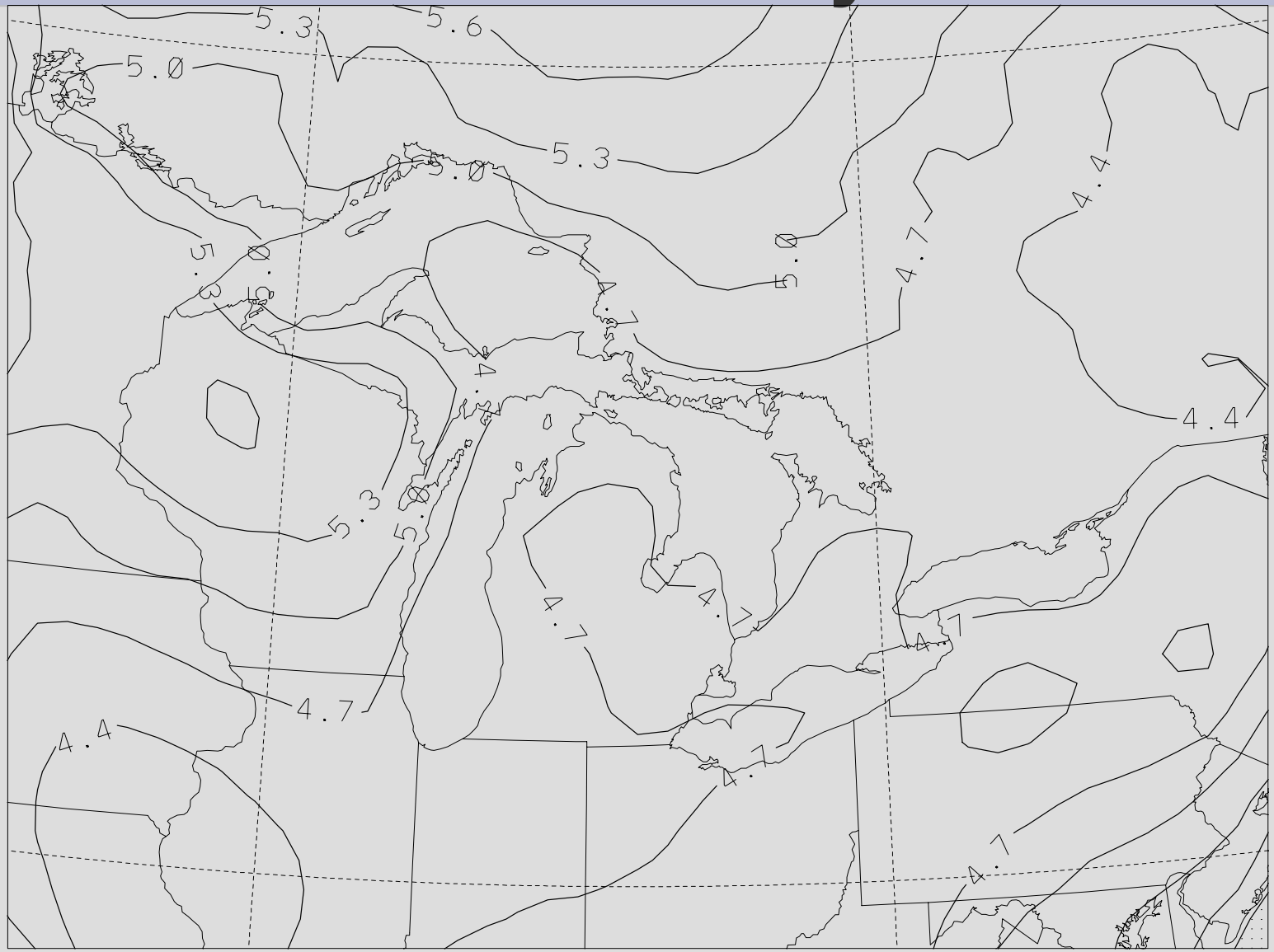
So what?—Main Categories of Impact on the Great Lakes

- Temperature/thermal structure—suitability of different species and communities, timing of overturning, tourism
- Ice cover—winter habitat, navigation
- Water level—littoral and wetland habitat, shipping, shoreline property

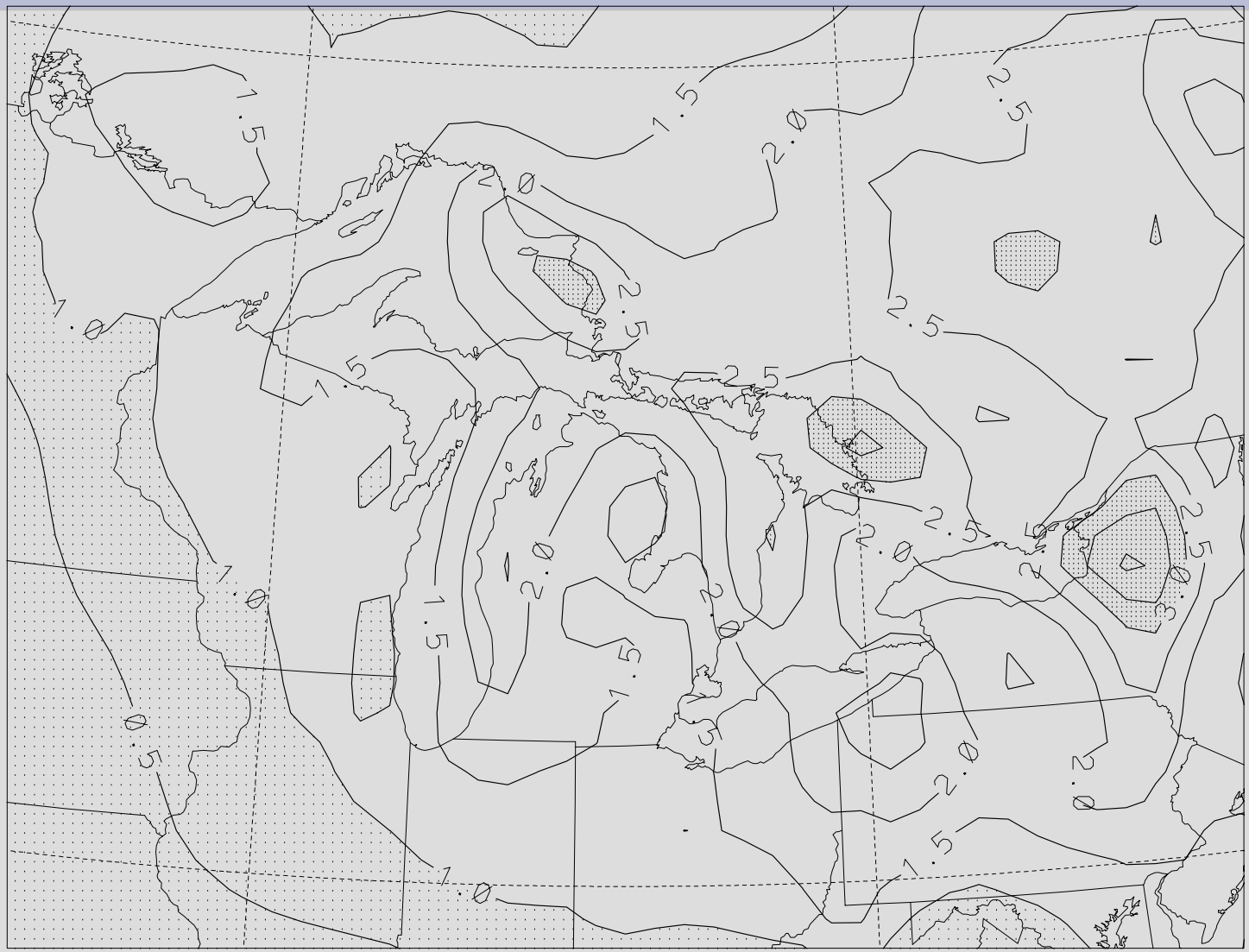
Current winter temperature



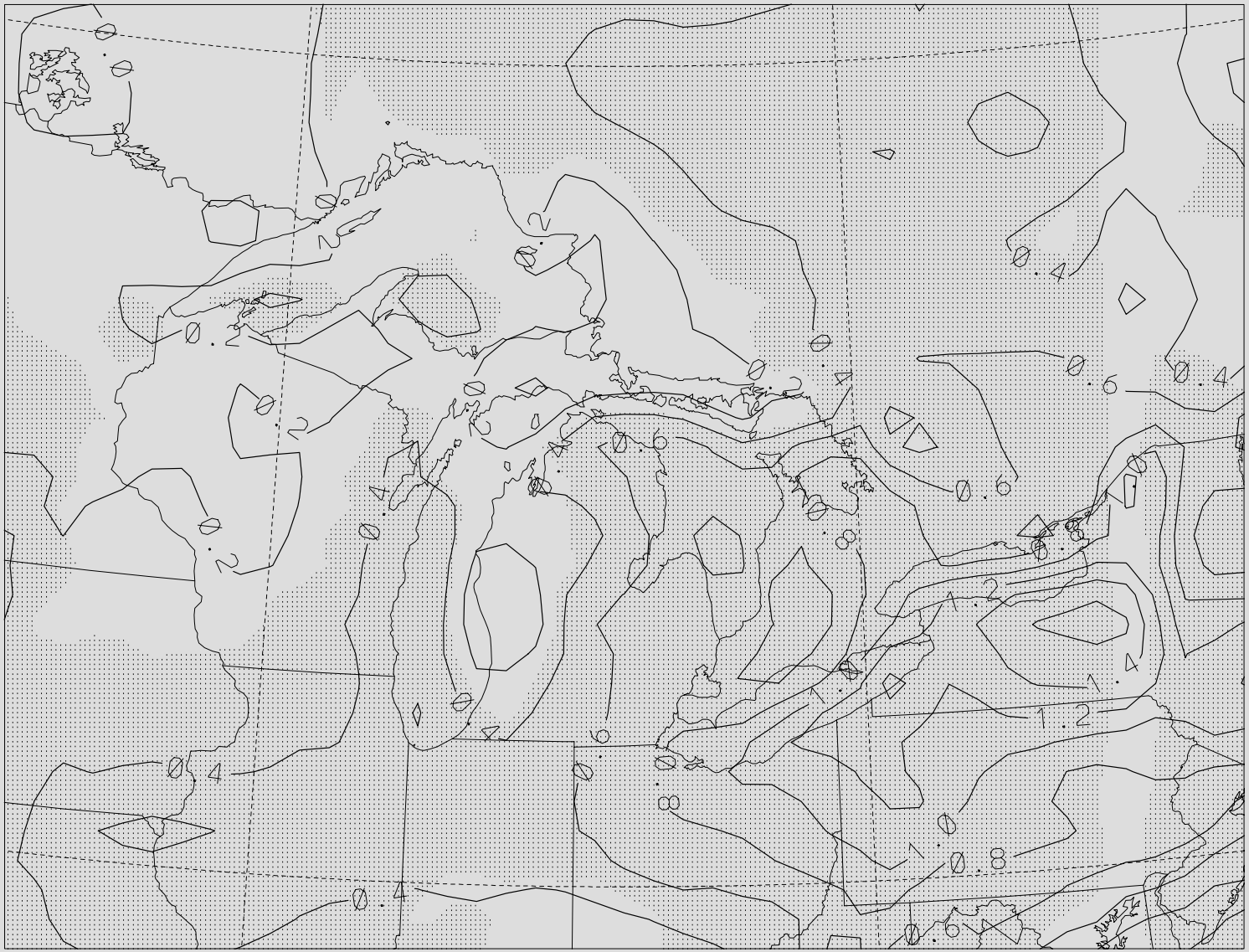
Projected Temperature Change in 21st Century



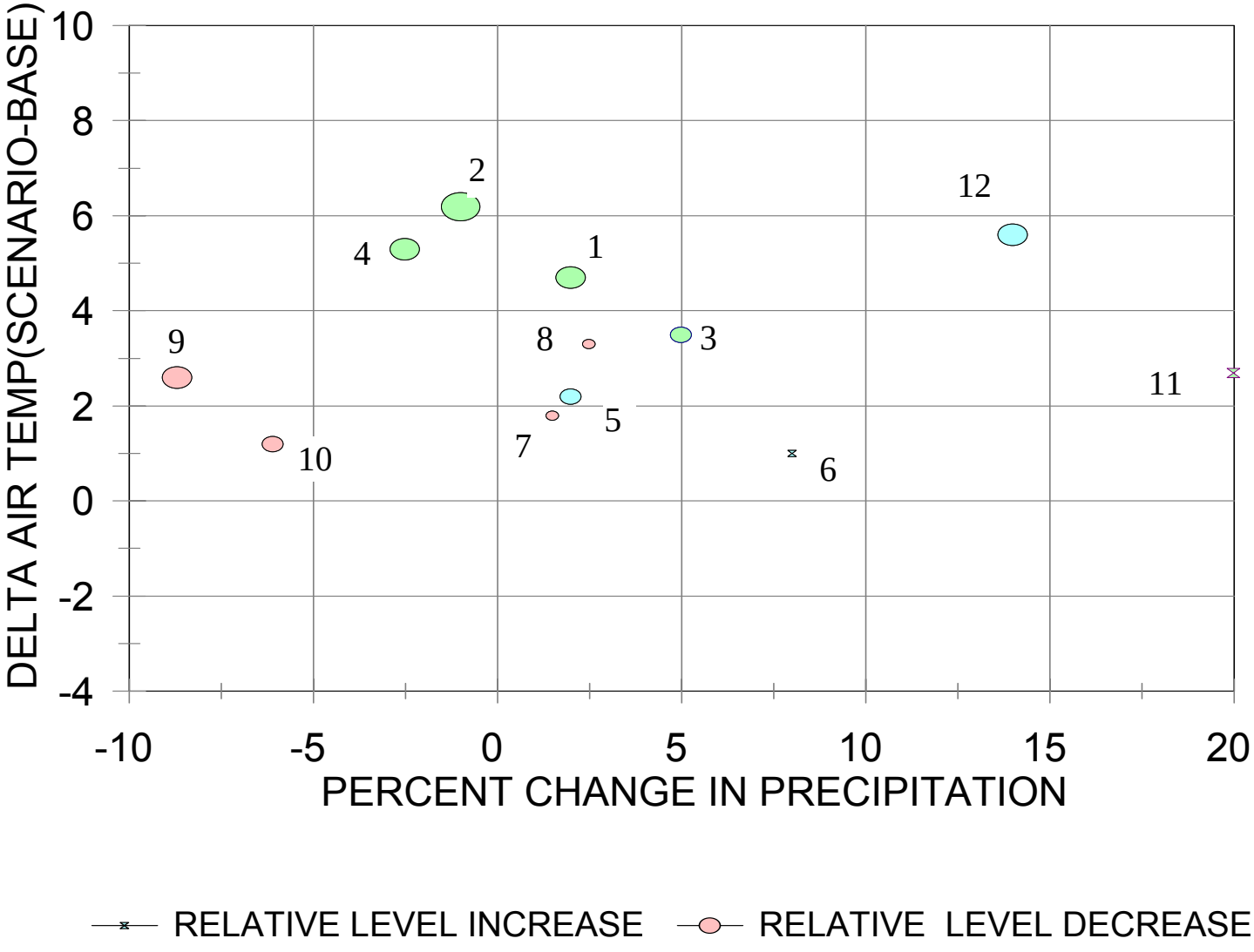
Simulated Winter Precipitation



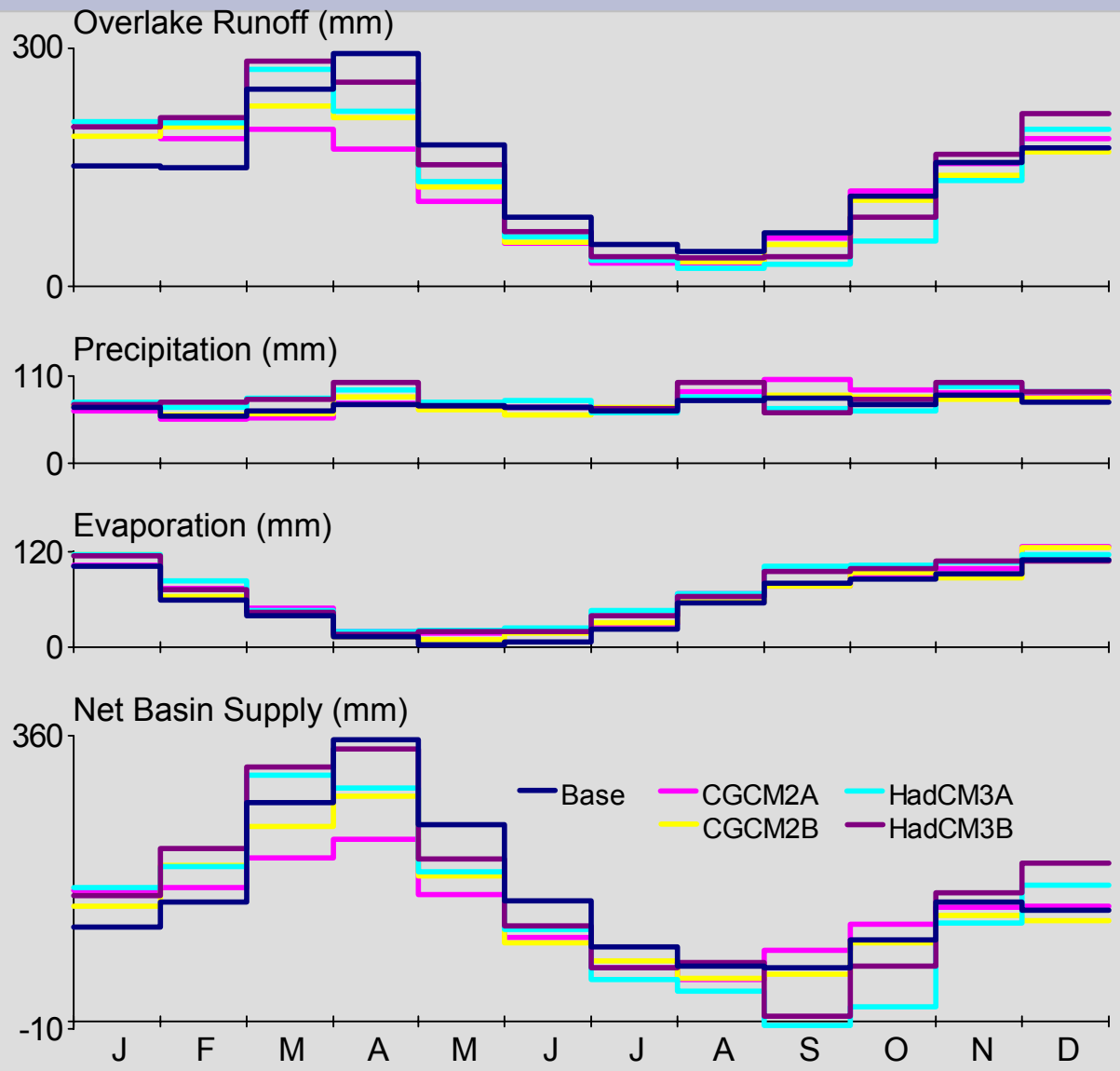
Projected 21st Century Change in Winter Precipitation



GCM-to-lake level analysis



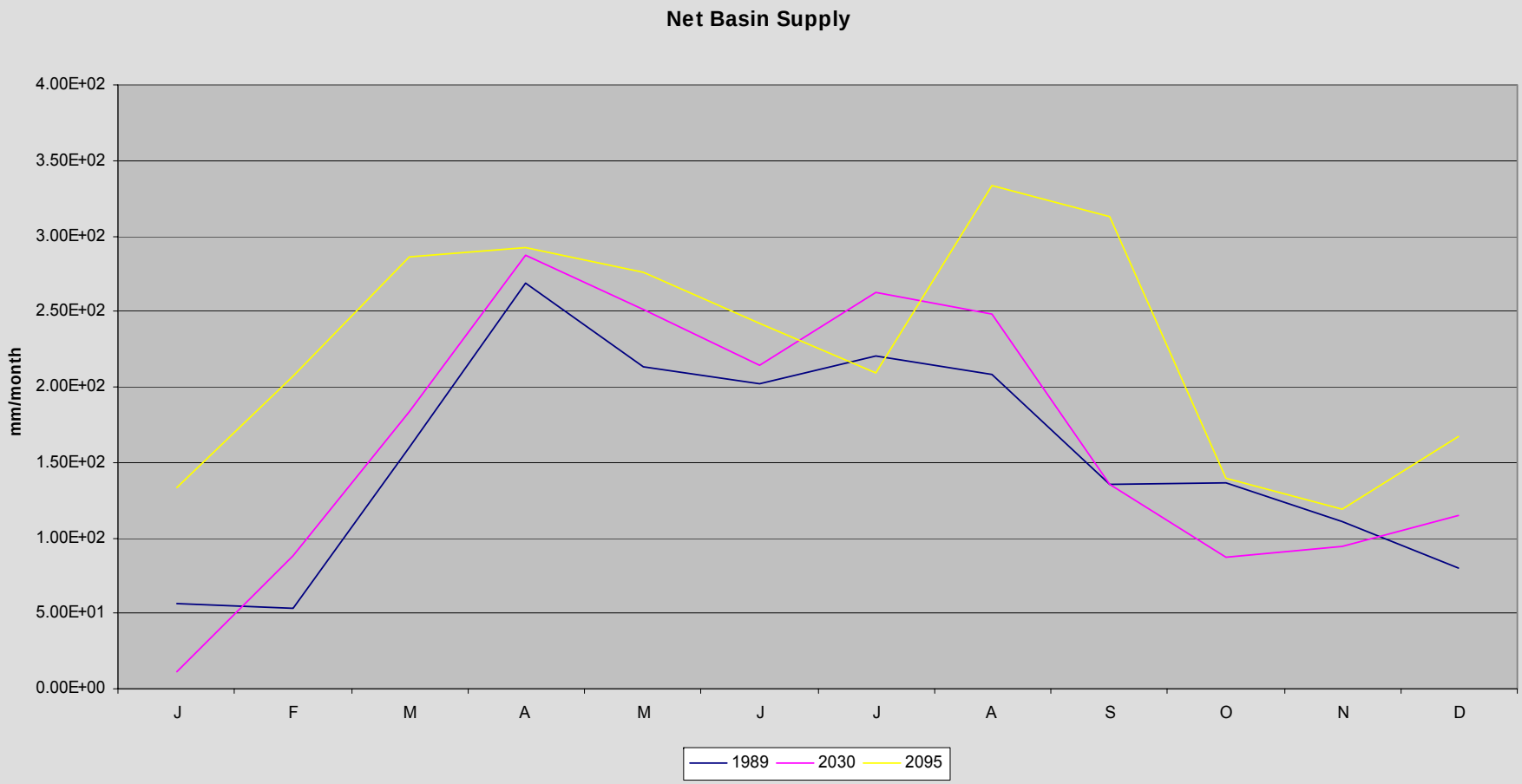
GCM-to-NBS analysis



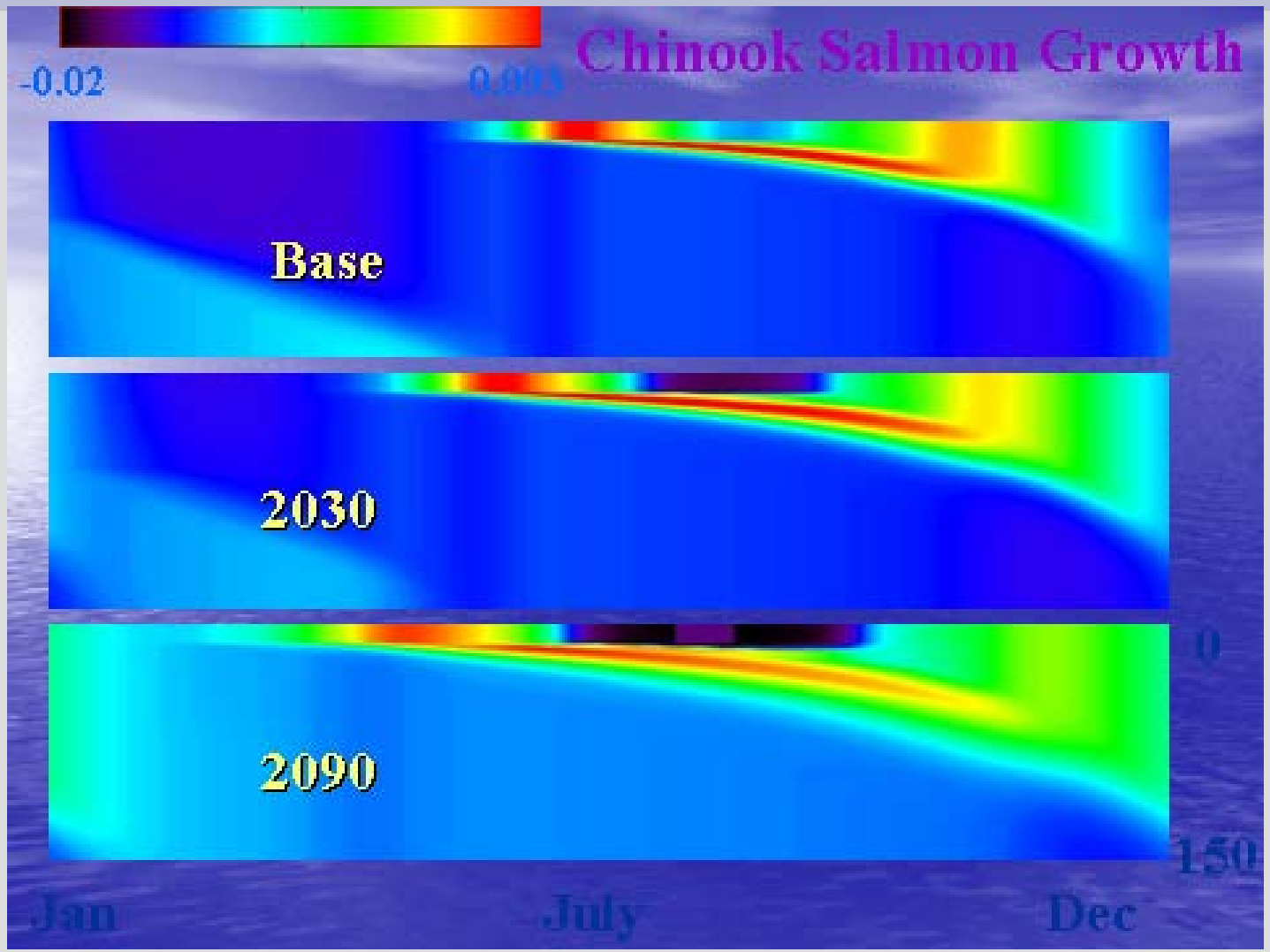
Tom Croley,

2003

CHARM RCM analysis



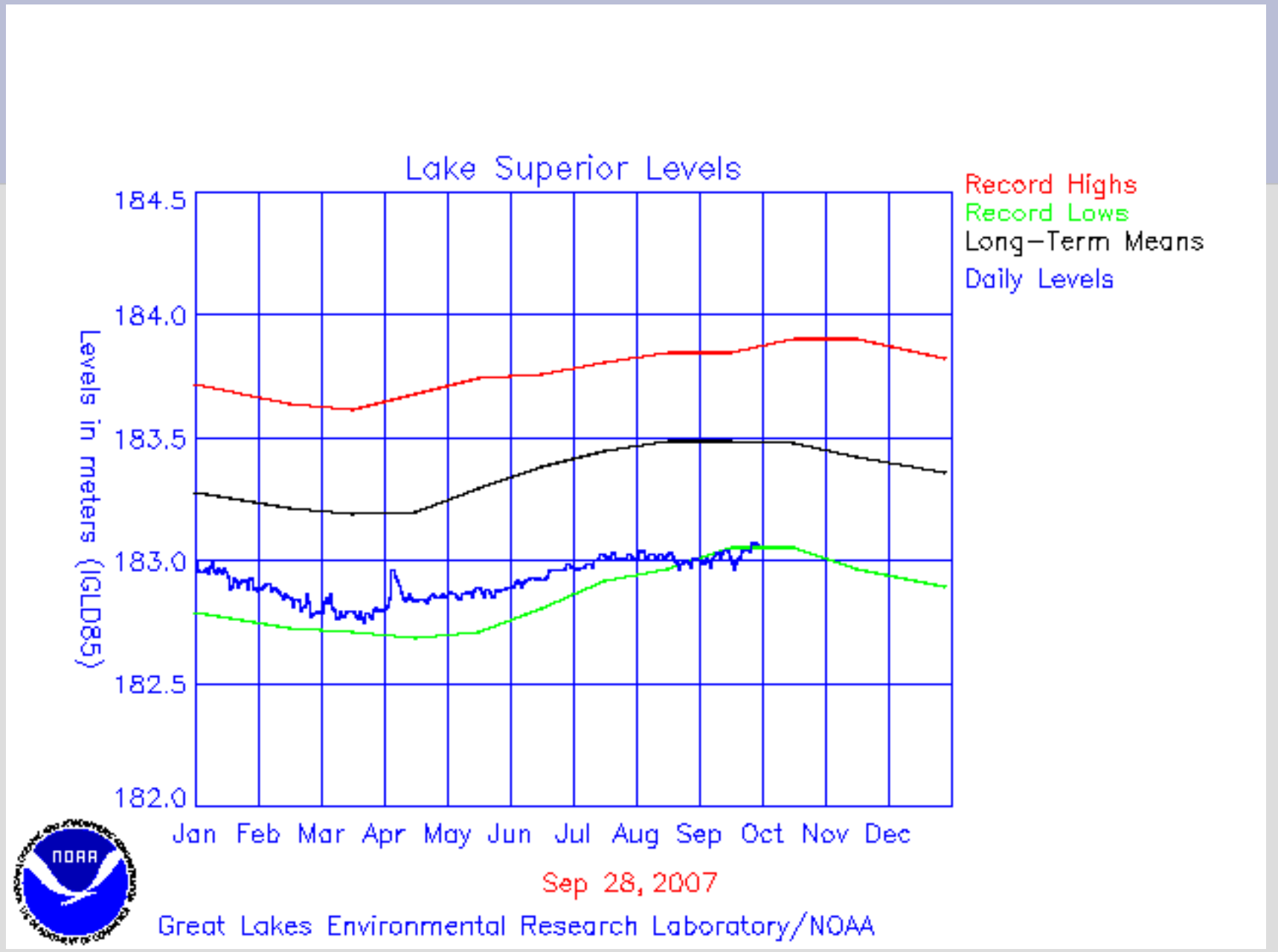
Consequences for Fish Growth

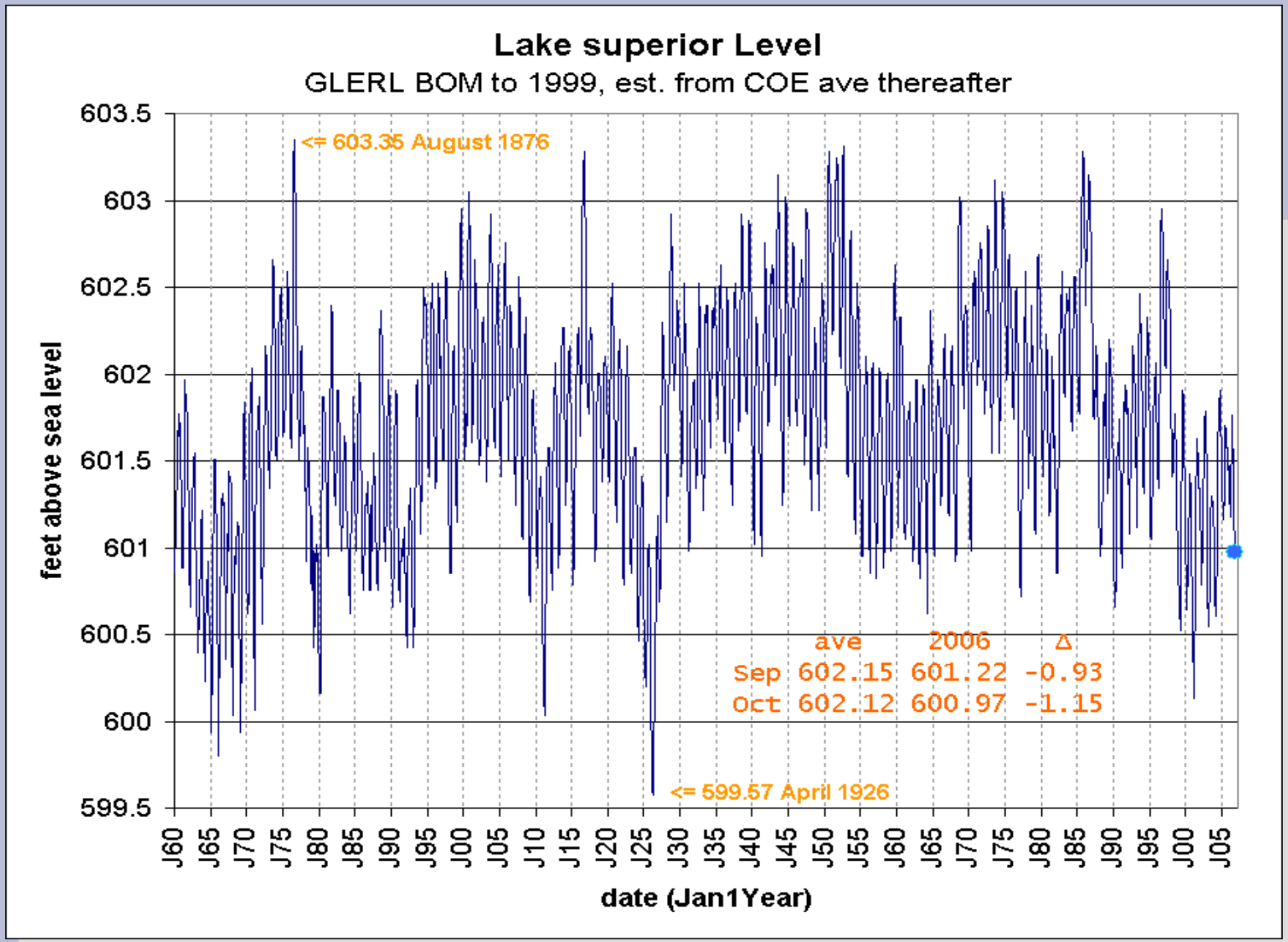


Brandt et al. 2002

A Note on Variability

Human causes vs. natural variability is not an either-or question


Lake Superior Levels
Record Highs
Record Lows
Long-Term Means
Daily Levels
Levels in meters (IGLD85)
184.5
184.0
183.5
183.0
182.5
182.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Sep 28, 2007
Great Lakes Environmental Research Laboratory/NOAA


Lake superior Level
GLERL BOM to 1999, est. from COE ave thereafter
<= 603.35 August 1876
<= 599.57 April 1926
ave 2006 Δ
Sep 602.15 601.22 -0.93
Oct 602.12 600.97 -1.15
feet above sea level
603.5
603
602.5
602
601.5
601
600.5
600
599.5
J60 J65 J70 J75 J80 J85 J90 J95 J00 J05 J10 J15 J20 J25 J30 J35 J40 J45 J50 J55 J60 J65 J70 J75 J80 J85 J90 J95 J00 J05
date (Jan1Year)

New Results—Austin and Colman (2007)

- Increase in summer maximum water temperature of Lake Superior (1979-2006) is greater than increase in air temperature
- Ice albedo feedback
- Summer stratification has the effect of reducing effective thermal capacity

Solid Conclusions

- Increased temperature—air and lake
- Shift in timing of overturning and stratification
- Reduced ice
- Eventual possibility of no ice and monomictic lake
- Seasonality of runoff—reduced magnitude of annual variation and shift in timing

Less Secure Conclusions

- Likely drop in net basin supply and lake levels
- Wind mixing
- Anoxic zone

Thanks for your attention.

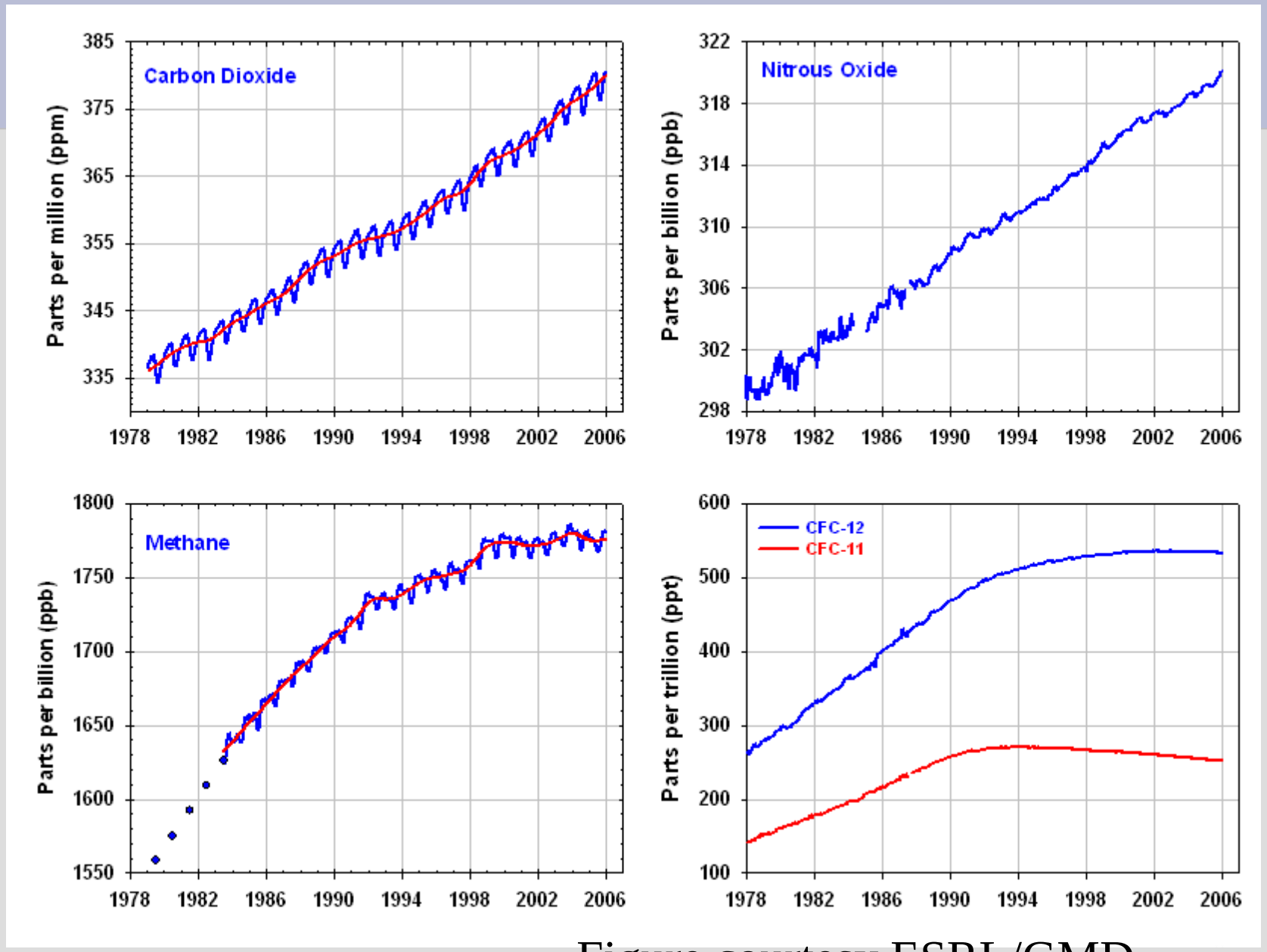


Figure courtesy ESRL/GMD

The Bottom-Line Reason

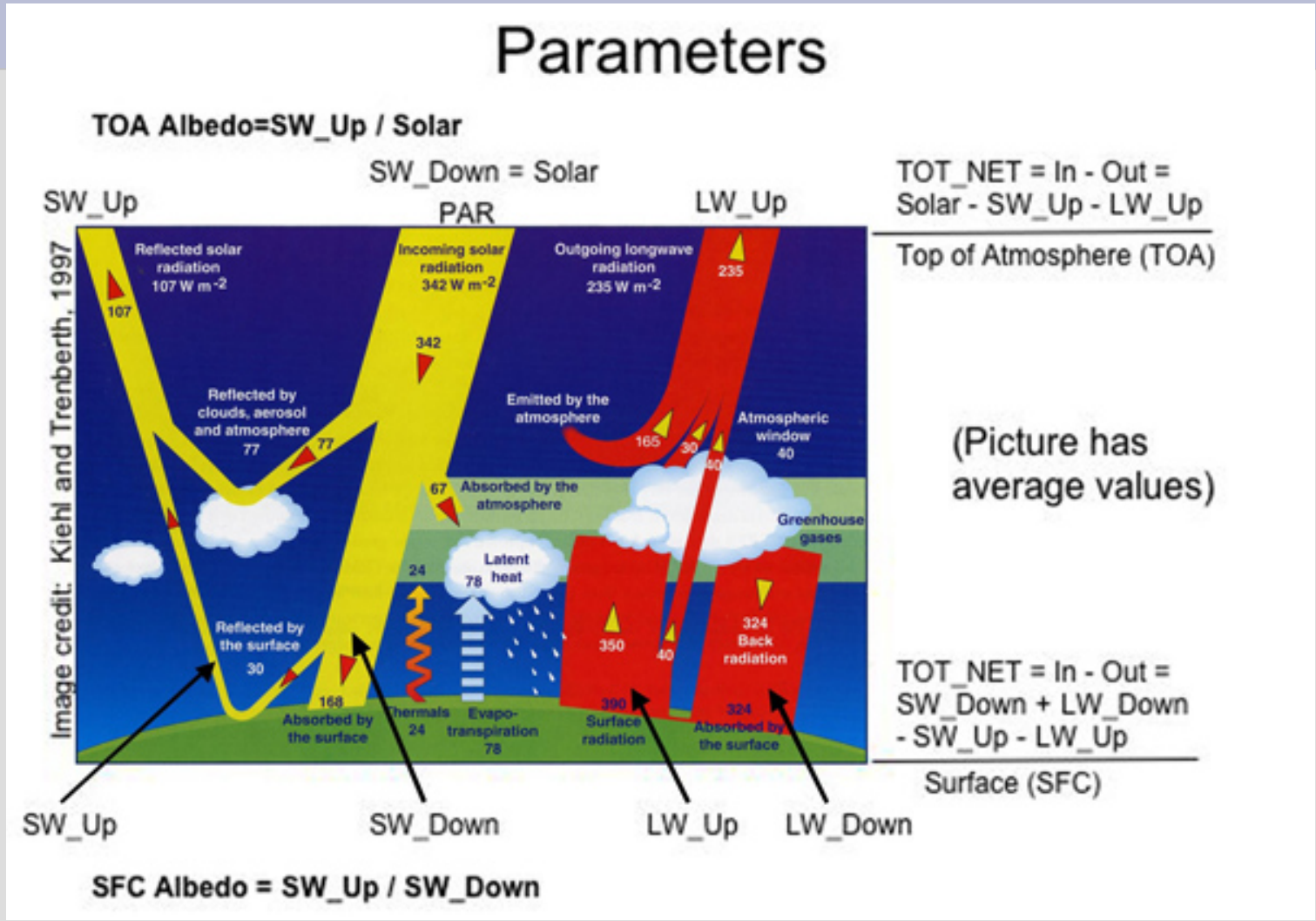
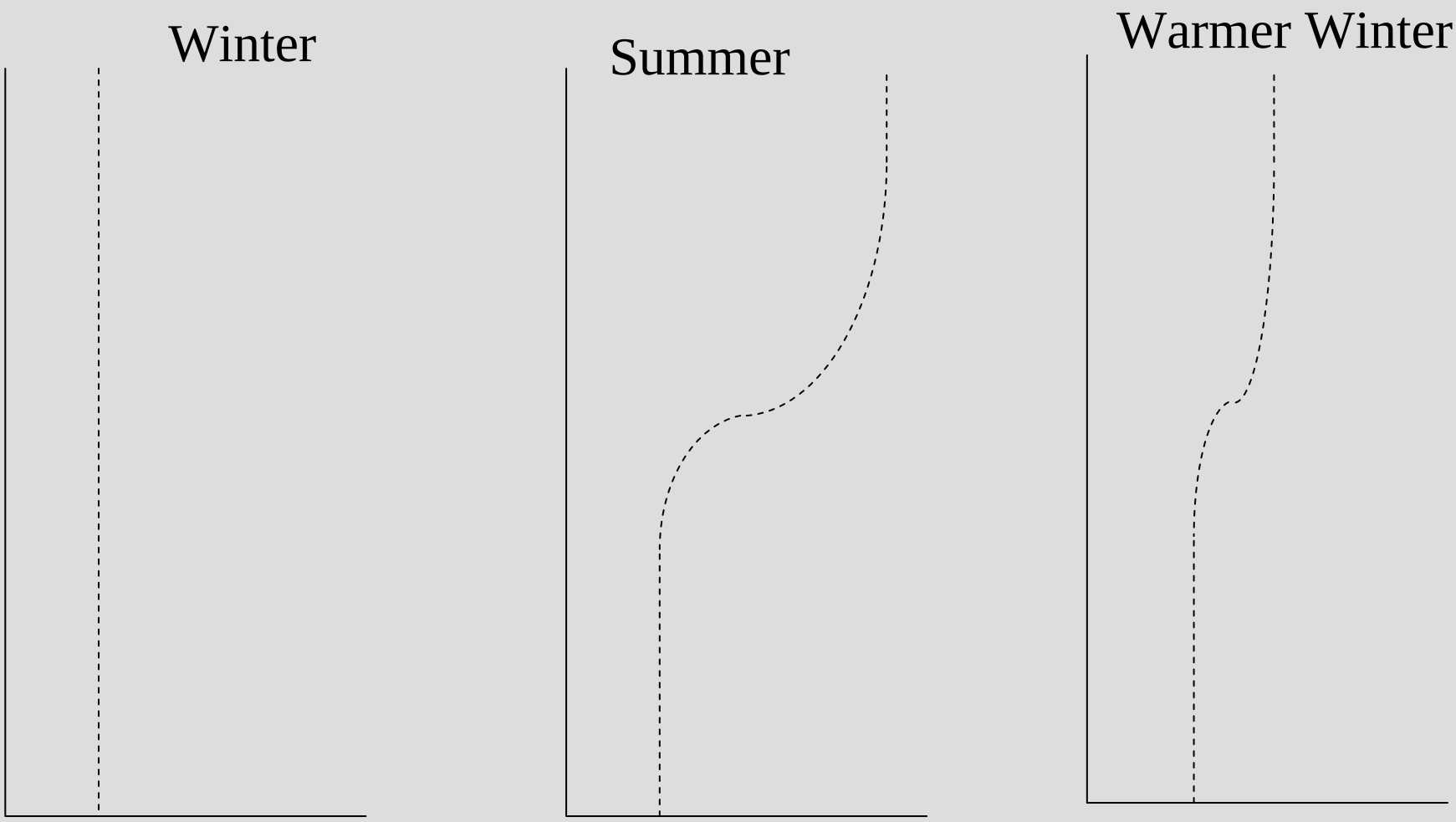


Figure courtesy eosweb.nasa.gov

Great Lakes Thermal Capacity—More than Land, Less than Ocean

- Maximum density of freshwater above freezing, saltwater below
- Mean depth of Lake Superior 148 m, world oceans 3,711 m
- Latitudinal extent of Lake Michigan 41.5° to 46° N, world ocean ~79° S to 90° N
- Lakes have outlets; oceans do not

Monomictic + Interannual Variability



Variability

- Changes in variability likely, but character and quantity less certain than mean changes
- Short-term variability—storm intensity and frequency, can affect runoff-ET partitioning
- Long-term variability—seasonal to decadal, create cumulative effects on lake storage, finest resolution models will not capture this