Regional Climate Modeling for Water Resources Projection

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My overarching attitude

I’m a science geek.
Start with the bedrock understanding of climate change.
Use truth before hype; it also suggests action.
Regional impacts inherently have greater uncertainty than global temperature.
One good way of decreasing uncertainty is decreasing greenhouse gases.
I like the recent *Rolling Stone* article by Al Gore.
Previously Assumed Chain of Causality

GHGs

Air temp (maybe precip)

All else
Regional climate modeling approach

Regional coupled modeling including GCM-based large-scale atmosphere and regional lake-land-air interactions

Other examples applied specifically to the Laurentian Great Lakes include MacKay and Seglenieks (2013), Bennington et al. (2014), Gula and Peltier (2013), Music (2011)
Coupled Hydrosphere-Atmosphere Research Model (CHARM)

Based on Regional Atmospheric Modeling System (RAMS)
40 km grid, with domain reaching into the Great Plains, Hudson Bay, Atlantic Ocean, and near the Gulf of Mexico
24 vertical levels up to 17 km

Array (on the same horizontal grid) of 1-dimensional lake column models based on Hostetler and Bartlein 1990

LEAF3 formulation of land surface

Mellor-Yamada level 2.5 atmospheric boundary layer

Driven by a simulation of the Canadian CRCM3 with SRES A2 scenario GHG concentrations (CMIP3 version)
Winter air temperatures

Observed

Modeled
Winter precipitation

Observed

Modeled
Winter (DJF) temperatures

1982

2057-1982
Winter (DJF) precip rate

1982

2057-1982

mm d⁻¹

mm d⁻¹
Summer (JJA) temperatures

1982

2057-1982

deg C

deg C

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Summer precipitation

1982

2057-1982
Precipitation minus evapotranspiration—2057 minus 1982
Seasonal cycle of lake surface temperature

Lake Superior

Lake Michigan

Lake Erie

0 5 10 15 20 25

J F M A M J J A S O N D

deg C

0 5 10 15 20 25 30

J F M A M J J A S O N D

deg C

1982 2056

1982 2056

1982 2056
Water temperature (deg C) vs. depth (m)—central L. Michigan

- Feb
- Apr
- Jun
- Aug
- Oct
- Dec

1971 vs. 2062
February ice thickness (m)

1982

2056
Net basin supply, past and future

Superior

Michigan

Erie
Summary

Increased air temperatures
Mostly increased precipitation
Reduced ice cover
Net increase in P – E
Increased water temperatures and altered seasonal stratification
Plans

More modeling
Increase range of physical processes included
Increase range of impacts considered