Modeling to Address Open Questions on the Future of Great Lakes Climate

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What is climate modeling?

- “The world in a computer”--means of calculating an approximation of the world and creating “what if” scenarios
- Processes that are resolved follow well-known laws of physics
- Unresolved processes use parameterizations--combination of physical laws and best guesses

What do computer models tell you?

- Model's best guess at the envelope of climate.
- Many variables: air temperature, ocean temperature, wind, pressure, salinity, surface and atmospheric heat and radiation fluxes, humidity, clouds, evapotranspiration, precipitation, runoff…

What a climate model isn’t

- Weather forecast
- System with global warming explicitly built in
- Predictor of impacts

How does water vapor affect global warming?

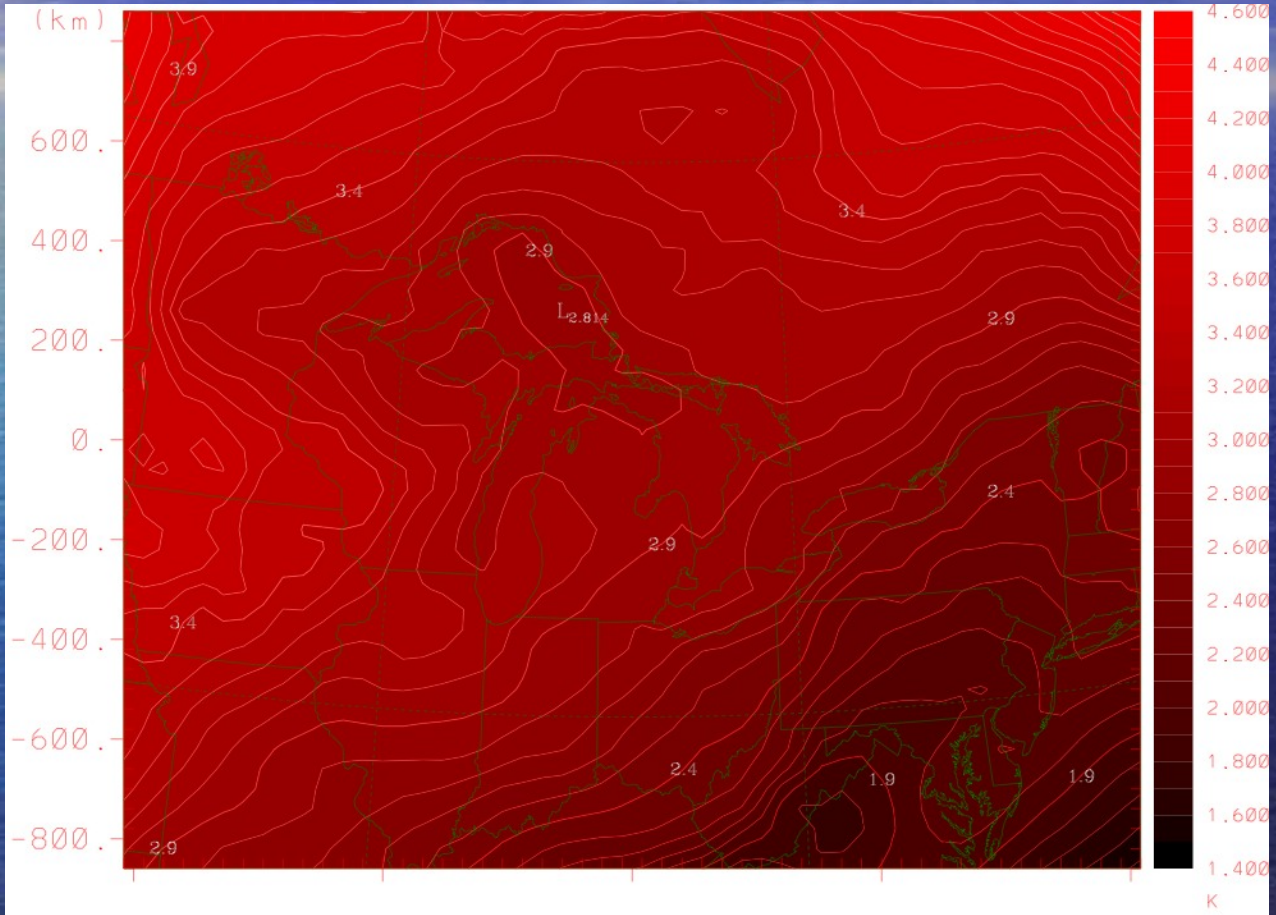
Equilibrium temperature of the earth's surface (K, Manabe and Wetherald, 1967), with fixed cloudiness

CO_2 content (ppm)	Fixed absolute humidity	Fixed relative humidity
150	289.80	286.11
300	291.05	288.39
600	292.38	290.75

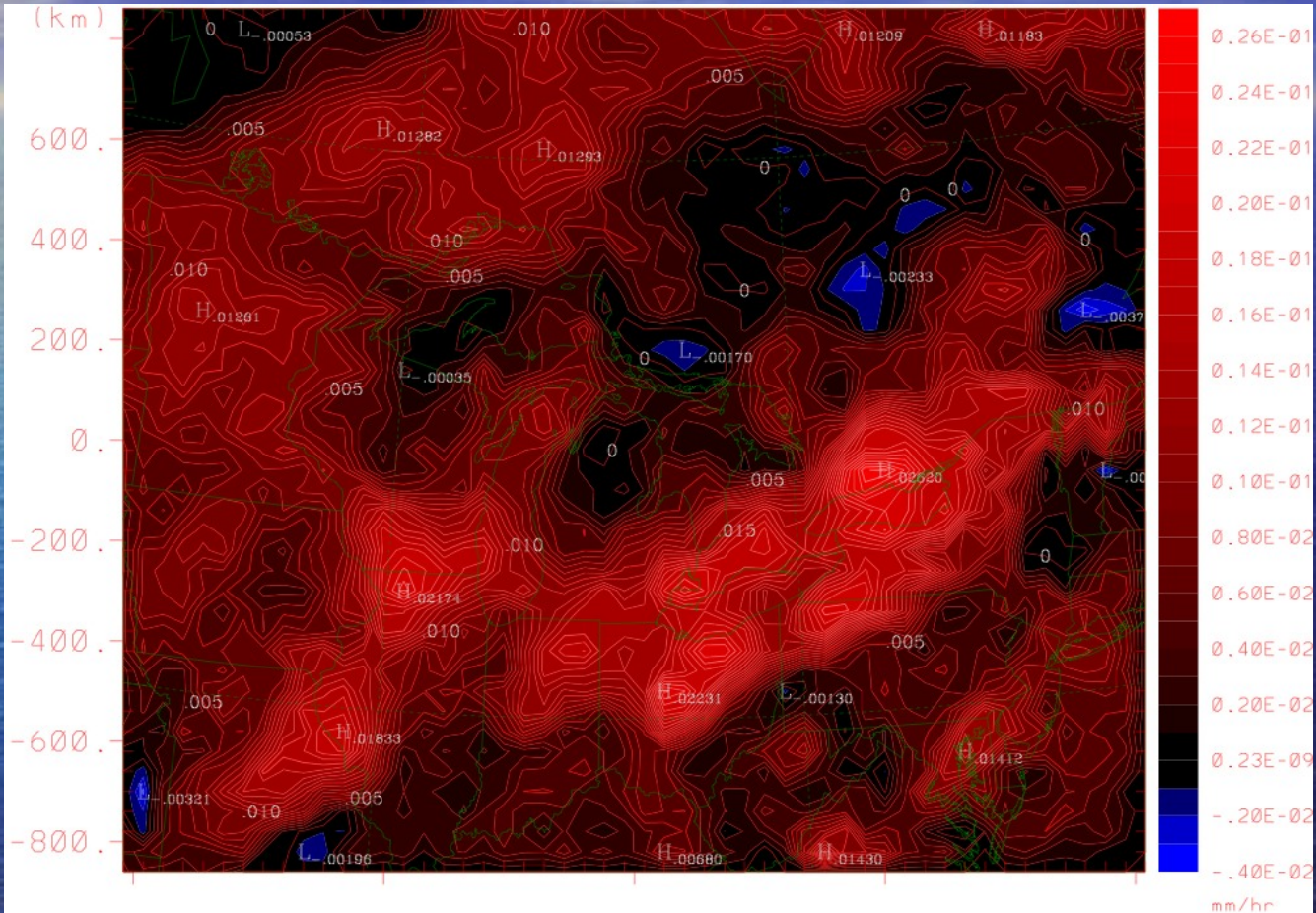
CHARM formulation

- Atmospheric model on 40 km grid encompassing entire Great Lakes basin, simulating wind, pressure, temperature, precipitation, clouds, radiation
- Fully interactive land surface hydrology
- Fully interactive array of 1-d lake column diffusion models
- Radiation and heat and moisture fluxes are the linking points
- Used input from NCAR CCSM model as boundary conditions to simulate 1997-1999 and 2067-2069, analyzed data from Sept. of 1st year to August of 3rd year

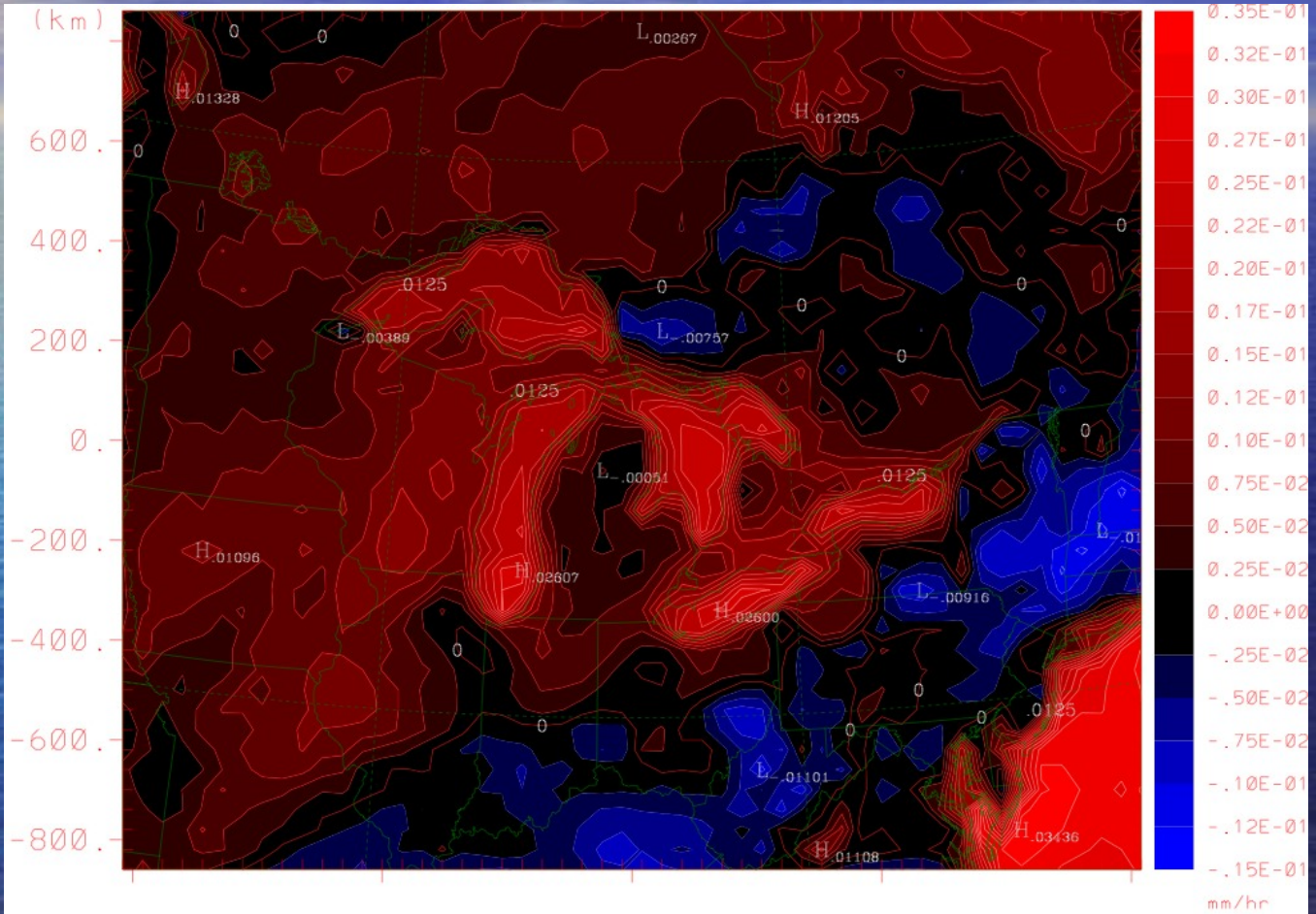
Annual Temperature 2068-1998



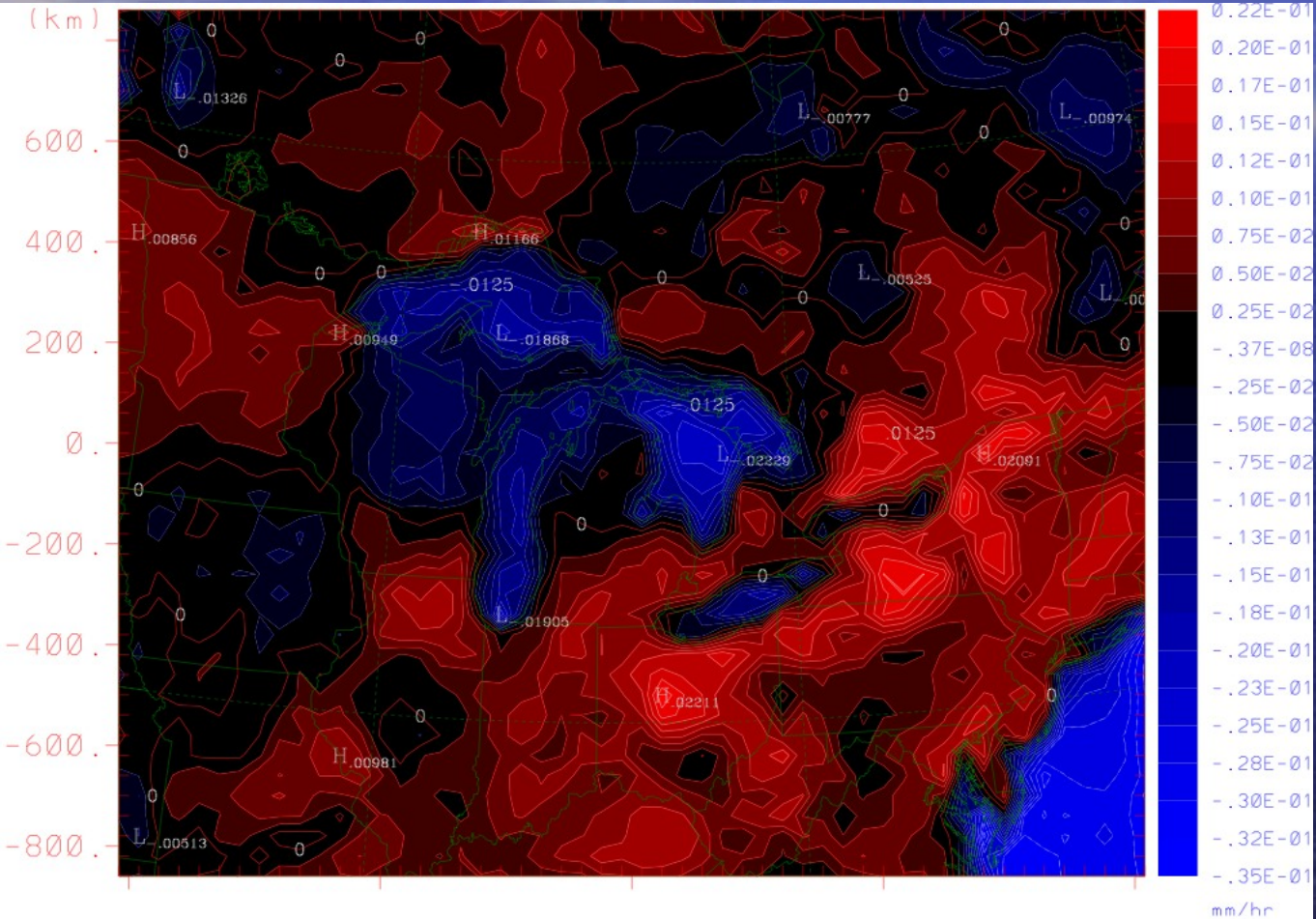
Annual Precipitation 2068-1998



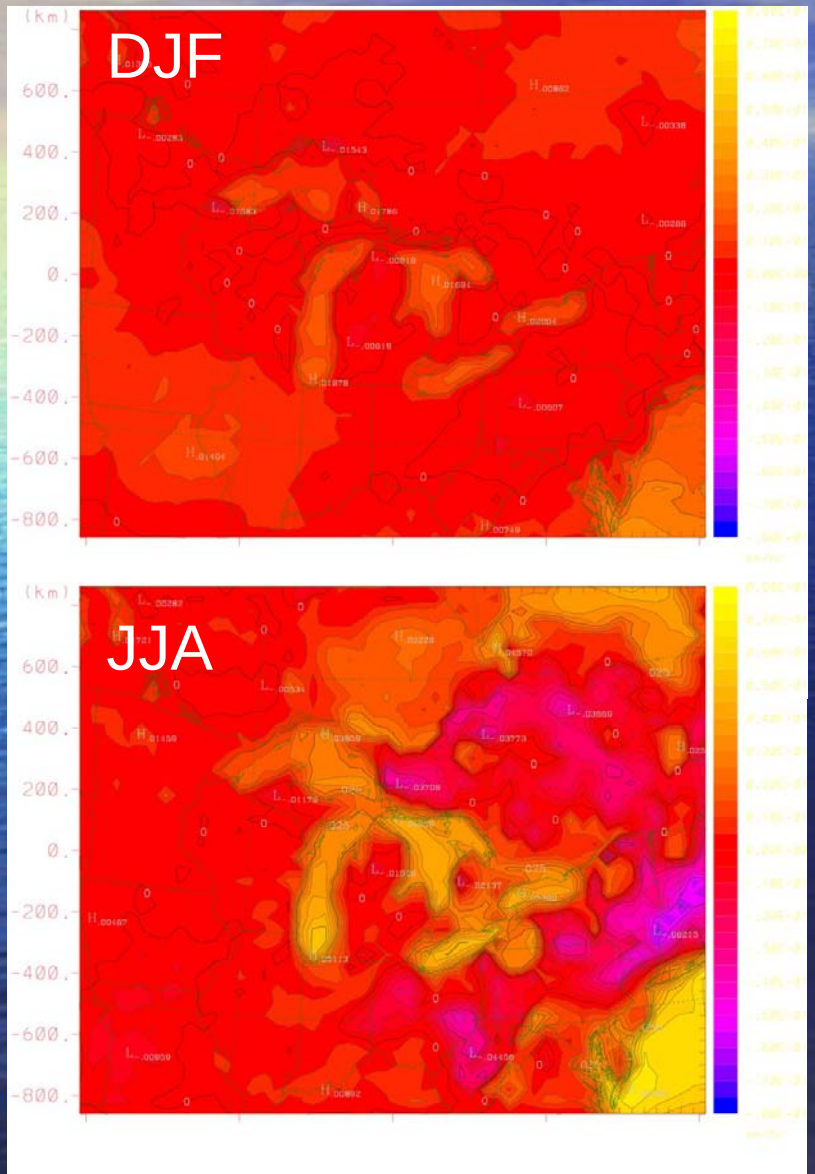
Annual Evapotranspiration 2068-1998

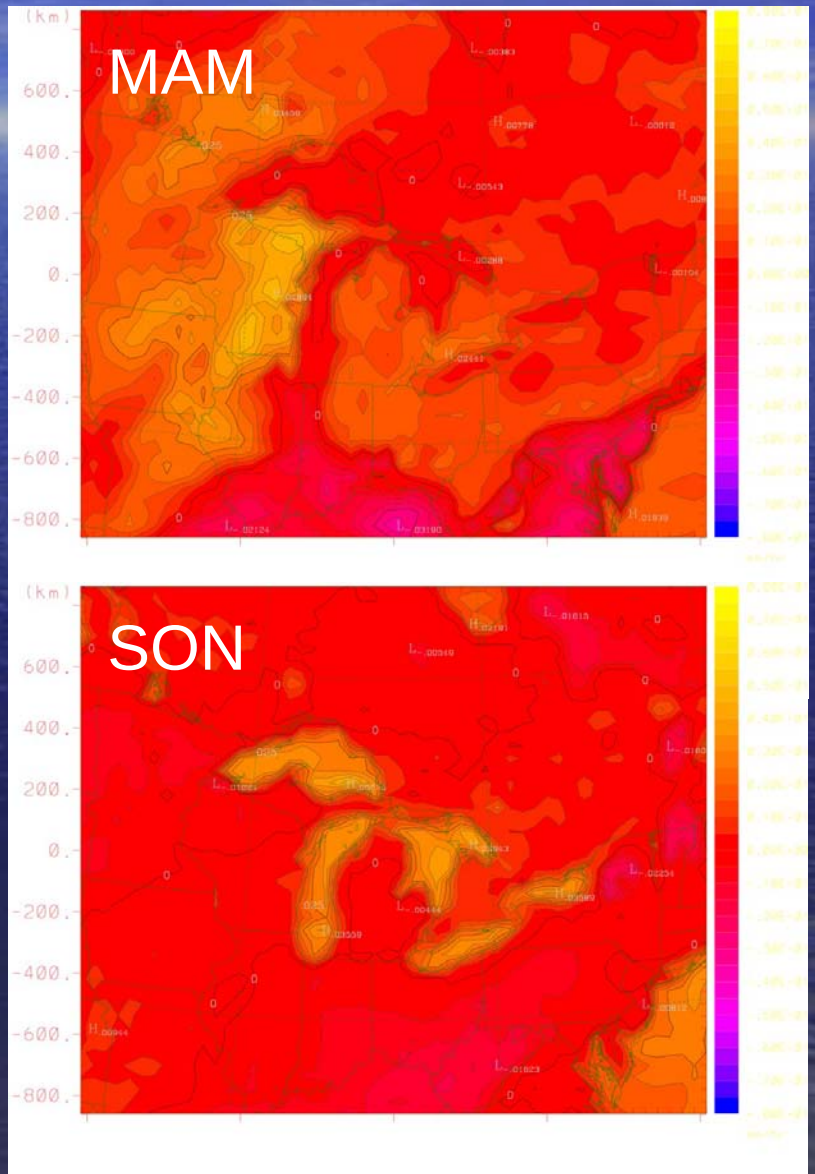


Annual P - E 2068-1998



Seasonal Evapotranspiration 2068-1998





More “what ifs” for the future

- What if there were no ice albedo feedback?
- What if ice did not insulate the water from the atmosphere?

Data resources

- Lawrence Livermore National Laboratory Climate Model Intercomparison Project esg.llnl.gov:8443/index.jsp
- Or ask me Brent.Lofgren@noaa.gov

Gaps--conflicting goals in simulating physical system

- Seamless interaction between region and global context
- Spatial detail--limits in computational power and data storage and transfer
- Length of model simulations and ensemble size
- Multi-pronged attack--computing tech., “super-ensemble”

Gaps--information transfer to impacts and stakeholders

- Increasing attention, but more needed
- Specialists convey stakeholder needs to climate modelers, facilitate public access and data transfer, and promote wise use among impacts investigators and stakeholders