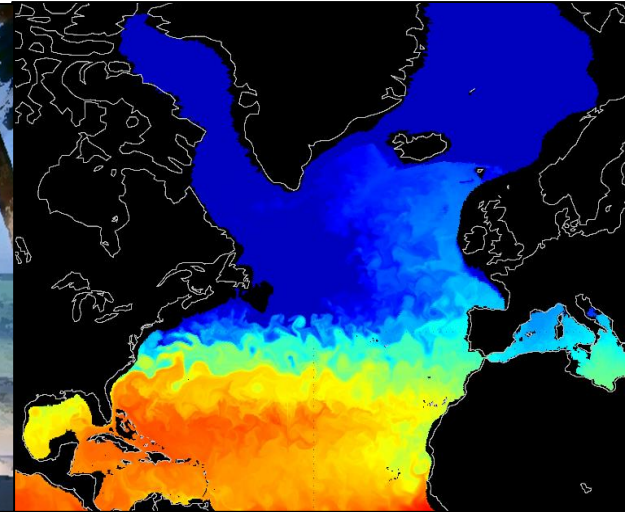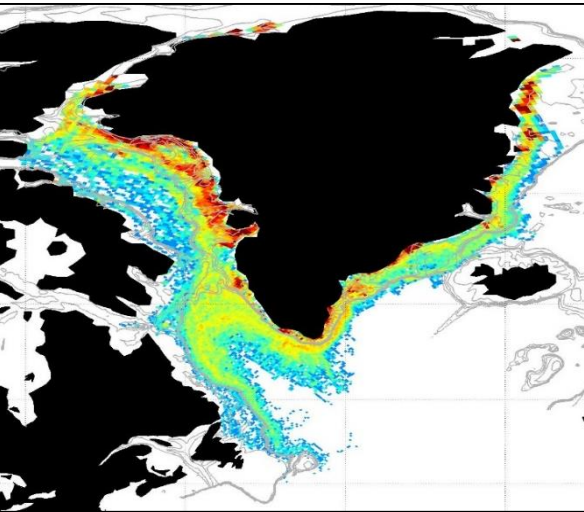Improving ocean-ice interactions
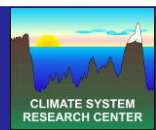# An iceberg model to simulate high-latitude freshwater forcing

Prof. Alan Condron

University of Massachusetts Amherst

Collaborators: Raymond Bradley, Jenna Hill, Peter Winsor, Rob DeConto, Dave Pollard
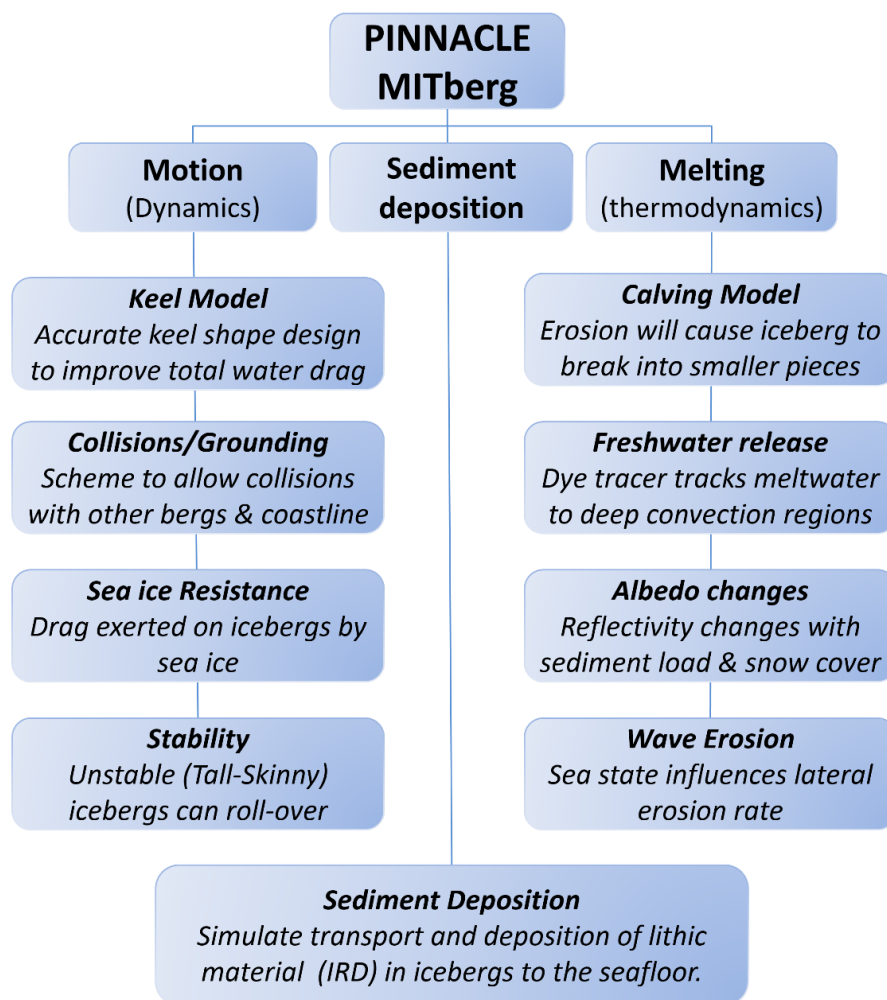
U.S. DEPARTMENT OF ENERGY

CLIMATE SYSTEM RESEARCH CENTER
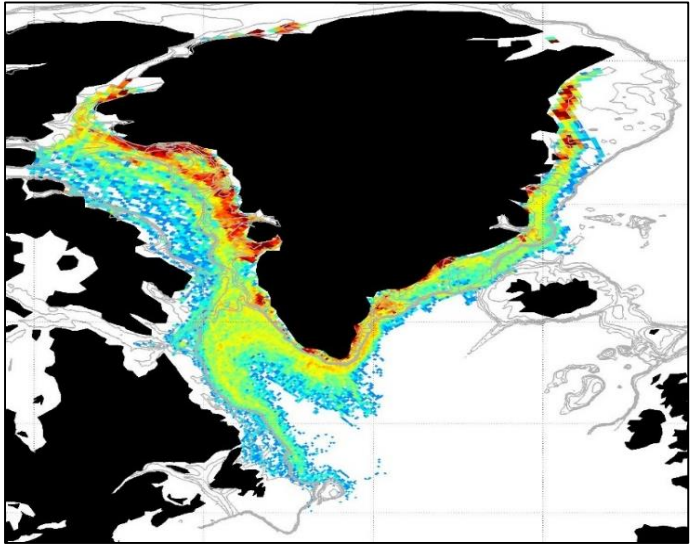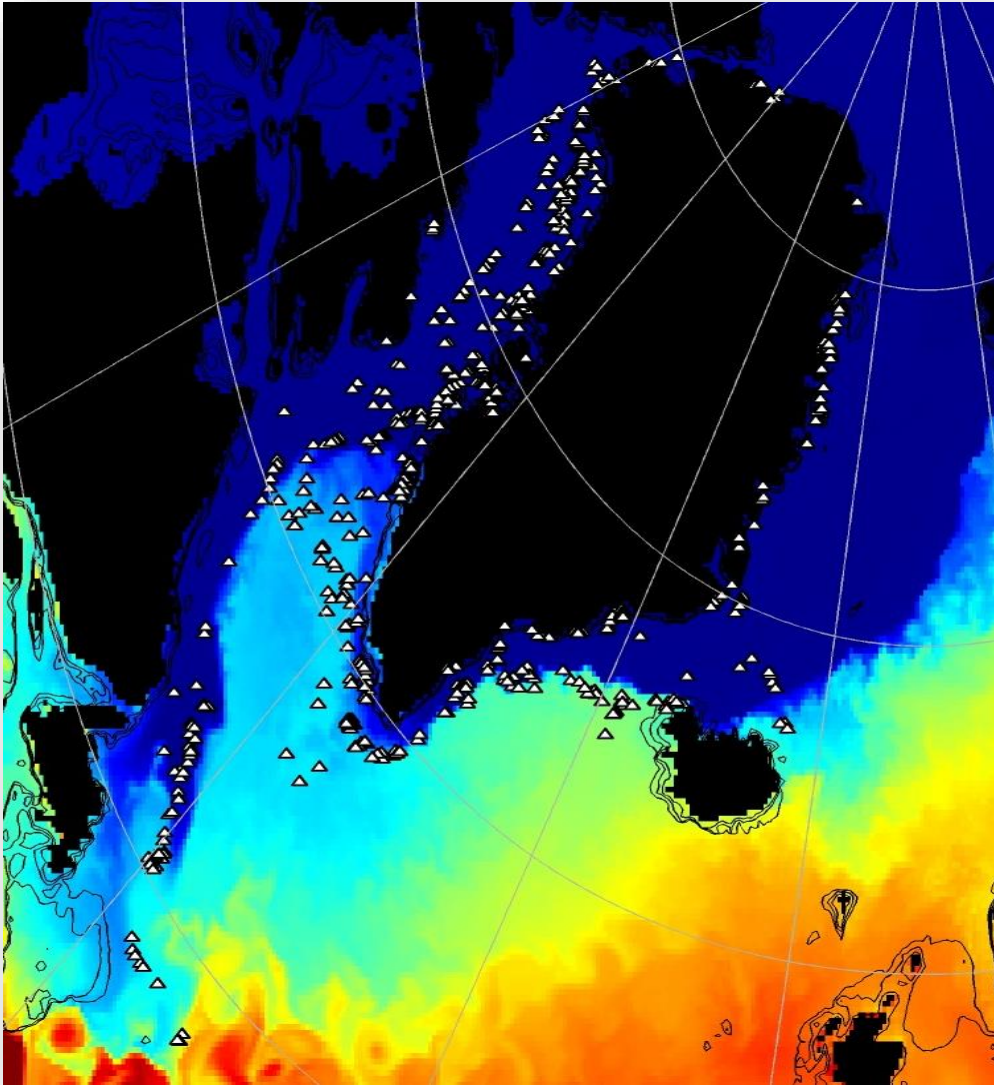
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Achievements: MITberg (PINNACLE)

- Development of a new tool/module to simulate the calving, drifting, and melt of icebergs in Earth System Models.

- Icebergs treated as lagrangian particles/floats.

- Coded (in parallel) in Fortran90

- Free to download to interested parties.

- UMass – COSIM collaboration being developed to further DOE efforts in understanding ocean-ice interactions and AMOC stability.

Funded by SciDAC: DE-FOA-0000452

PINNACLE MITberg

Motion (Dynamics)

Sediment deposition

Melting (thermodynamics)

Keel Model
Accurate keel shape design to improve total water drag

Collisions/Grounding
Scheme to allow collisions with other bergs & coastline

Sea ice Resistance
Drag exerted on icebergs by sea ice

Stability
Unstable (Tall-Skinny) icebergs can roll-over

Calving Model
Erosion will cause iceberg to break into smaller pieces

Freshwater release
Dye tracer tracks meltwater to deep convection regions

Albedo changes
Reflectivity changes with sediment load & snow cover

Wave Erosion
Sea state influences lateral erosion rate

Sediment Deposition
Simulate transport and deposition of lithic material (IRD) in icebergs to the seafloor.

Parallel h**I**gh resolutio**N** Numeric**A**l i**C**eberg mode**L**ing proj**E**ct

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Examples

Above: example iceberg density
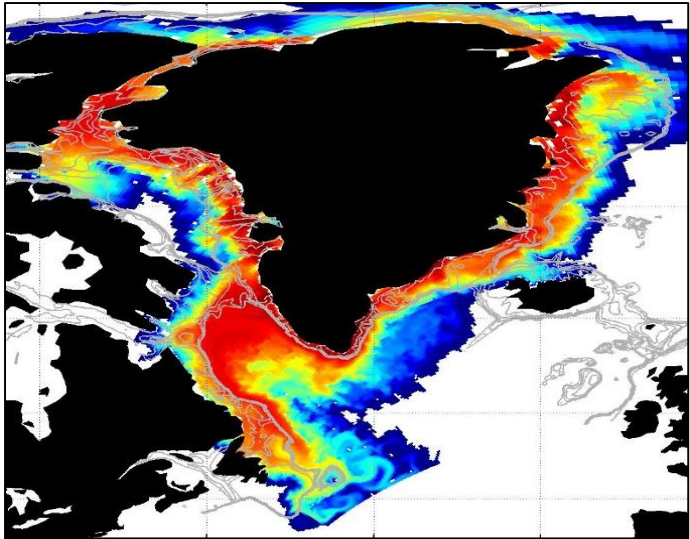
Above: Freshwater (dye tracer) release

Climate System Research Center, Geosciences

Ongoing & Future work
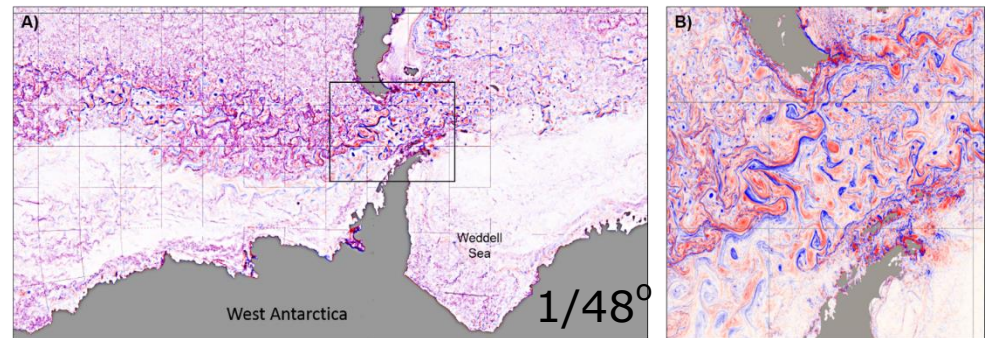
MITberg/PINNACLE will be coupled to ultra-high (up to $1/48^o$) resolution ocean model to more accurately quantify AMOC sensitivity to projected melting of Greenland and Antarctica ice sheets.
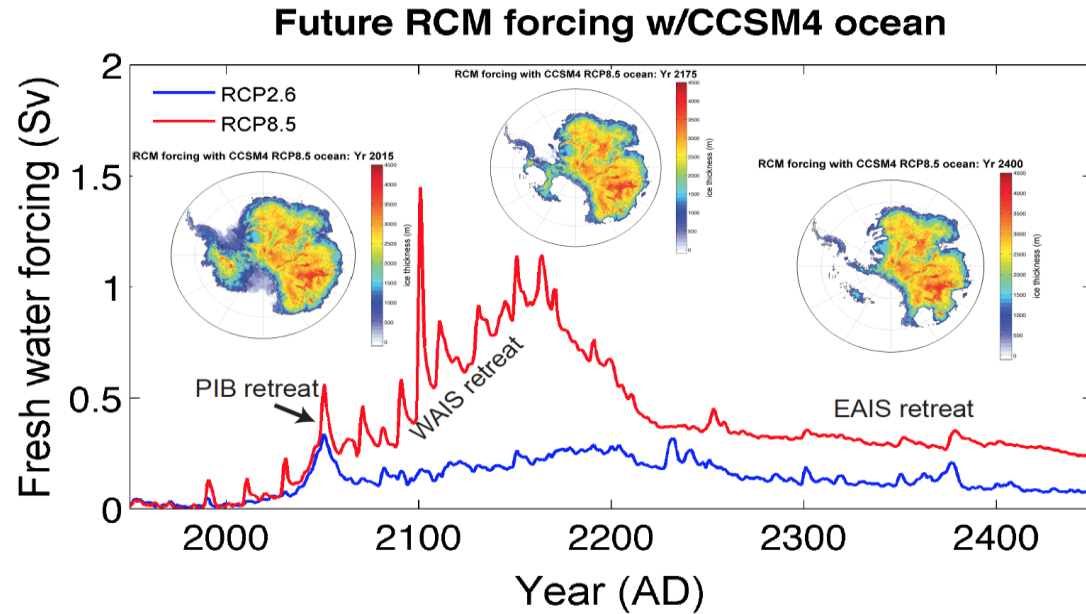
Joughin et al., (2014)

(Above) Total Antarctic freshwater runoff (simulated by ice sheet model of D. Pollard) forced with CCSM4 for RCP8.5 (red) and RCP2.6 (blue).

Quantifying climate sensitivity to freshwater forcing is essential for understanding past abrupt climate change.
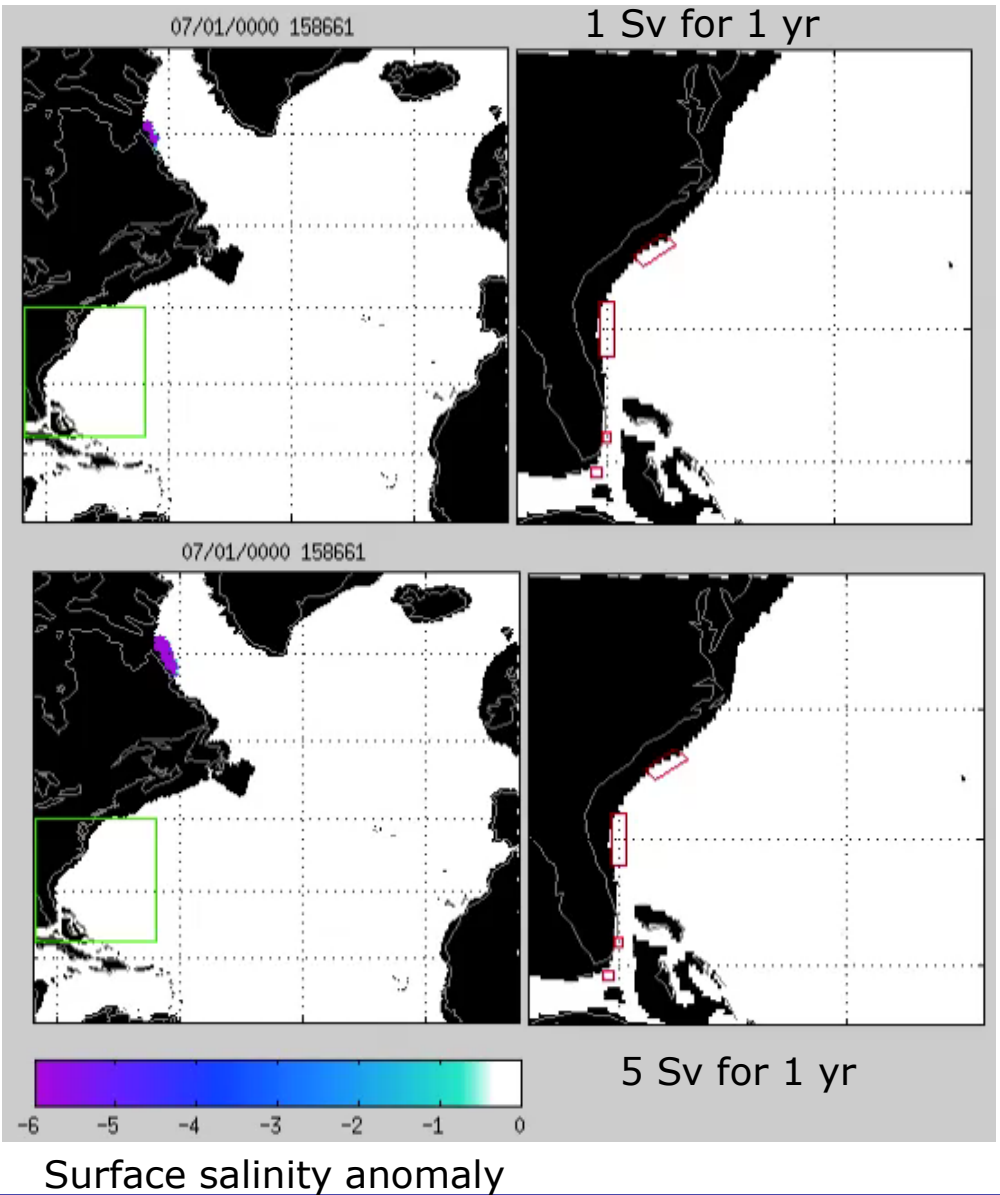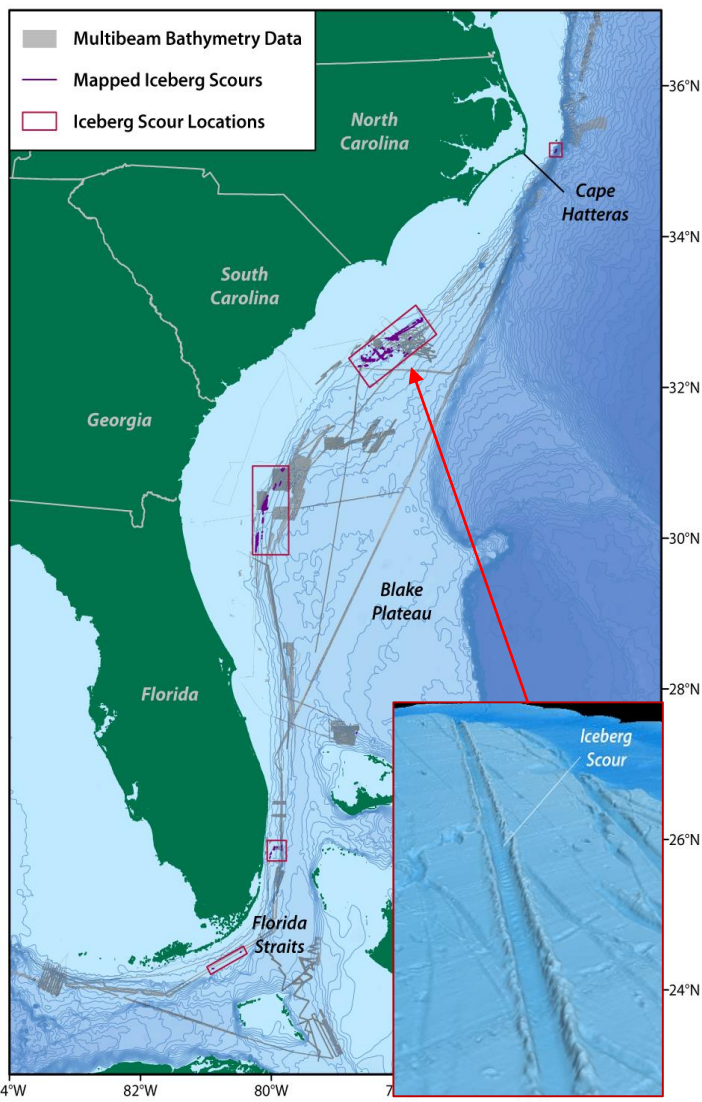

a) Glacial
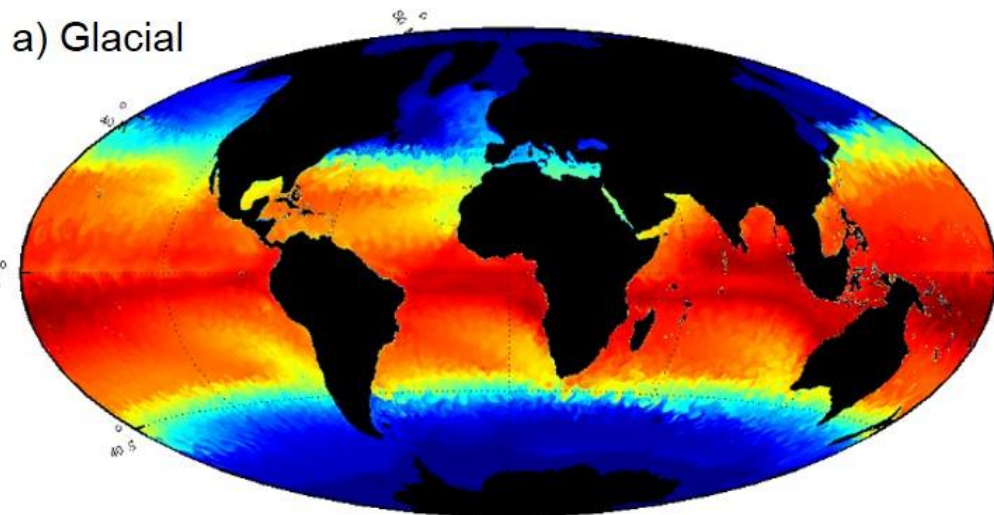
High resolution $(1/6^o)$ Last Glacial Maximum (21,000 yr ago) ocean/sea-ice/iceberg model.

~5 – 10 times higher resolution than many paleoclimate models
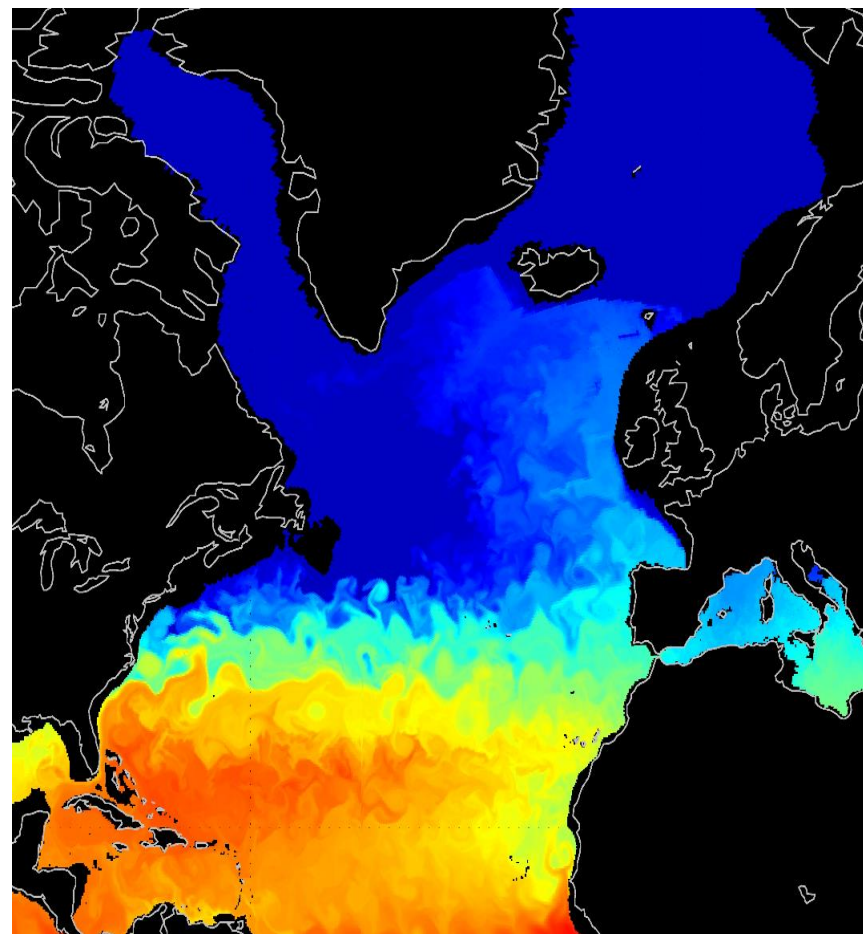
HI-PAL project
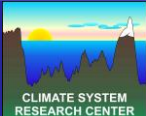
UMASS AMHERST

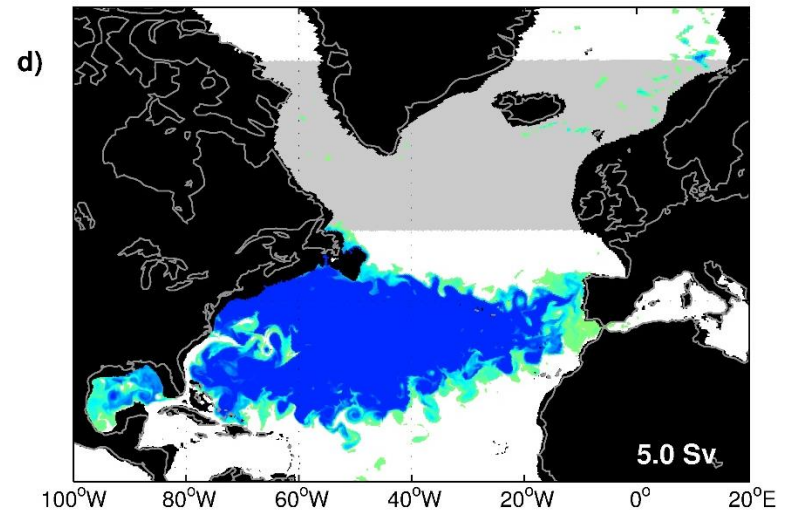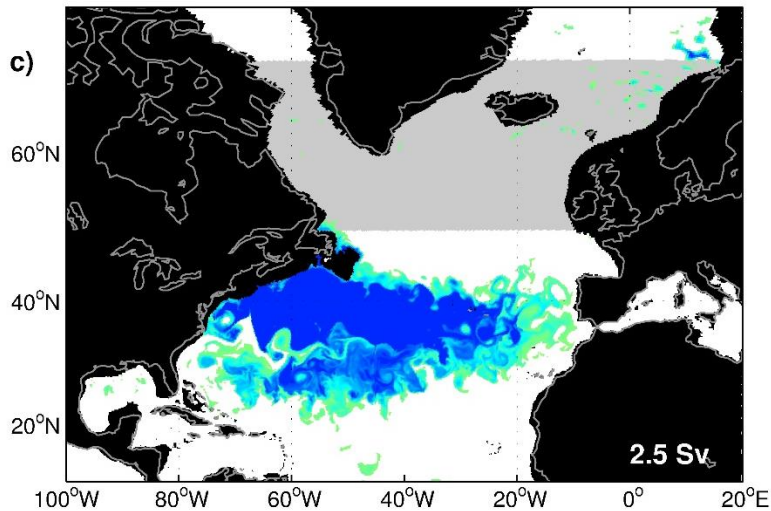# Subtropical icebergs

1 Sv for 1 yr

5 Sv for 1 yr

Surface salinity anomaly

Hill and Condron, Science (under-review)

Rethinking freshwater forcing

a) subpolar gyre / subtropical gyre — 0.5 Sv
b) 1.0 Sv
c) 2.5 Sv
d) 5.0 Sv

Hill and Condron,
Science (under-review)

surface salinity anomaly
−6 −5 −4 −3 −2 −1 0