Mean state and variability in a suite of forced global ocean-ice simulations: the interannual Coordinated Ocean-ice Reference Experiments (CORE-II)

Hypothesis: forward models forced with same interannual varying data will result in similar simulations. Perform a direct comparison with internanual varying observational record (and syntheses???).

Introduction

--reasons for global ocean-ice simulations (very short!)
- -summary of points made in CORE-I paper, such as
- -support synthesis efforts
- -support coupled climate model efforts
- -support mechanistic interpretation of observational record
- -support efforts towards decadal prediction
- -initialization

--reasons to be careful interpreting global ocean-ice simulations (very short!)
-much as in CORE-I paper, such as
-feedbacks corrupted, which makes the sensitivies often quite distinct from fully coupled climate models.
-difficulties with atmospheric state, such as short and error-prone observational record and the need to recycle the forcing a few times in order to reach a quasi-steady state.
-emphasize the need to be careful with the questions asked with the simulations. Not all questions of climate are accessible to a CORE-IAF approach. May need fully coupled.

--reasons for comparison efforts (very short!)
-enhanced robustness of simulation results
-provide feedback to data sets
-it is an iterative process whereby data and models are mutually questioned and modified. But need more than one model in order to test robustness of the changes. Should not tune dataset for just one model framework.

--focus of this paper
-introduce the interannual CORE approach, which is very similar to CORE-I, except now run through a few cycles of CORE-IAF using as weak salinity restoring as seen feasible.
-illustrate a suite of diagnostics/metrics to help assess the integrity of the simulations.
-address the hypotheses mentioned above.
-provide some enhanced focus on questions of North Atlantic decadal variability.

CORE-IAF

--Brief detail the protocol
-summarize main features of Large and Yeager (2009), with enhancements based on use of a seasonally varying river runoff from Dai and Trenberth.
-recommend CFC-11 and CFC-12
-initial conditions based on observations (specify what is done)
-restoring to SSS observations (specify what is done)
-review issues related to salinity restoring; summarize much of the literature, including CORE-I paper as well as other papers that point to importance of high latitude precip (Claus' points).
-summarize the key points of CORE, which is global ocean-ice with no temperature restoring, and salinity restoring as weak as feasible to obtain a solution worthy of comparing to observational record. IAF calls for roughly 5 repeating cycles of the 1948-2007 dataset.
-mention that the issue of salinity restoring remains a topic that can be dependent on the individual models.
-point to CORE-I appendices for extra details, such as use of bulk forcing

Spin-up behaviour of CORE-IAF simulations (show last 4+1 cycles)

Purpose is to illustrate the spin-up / drift over 4+1 cycles of CORE-IAF forcing, and to illustrate the transition from 2007 to 1948.

-global, and by basin, horizontal mean temp and salinity relative to initial conditions
-Hovmoller of global, Indo-Pacific, and Atlantic-Arctic poleward heat transport
-time series monthly mean for
AMOC (26.5N and 41N and 30S, max over full depth, monthly mean),
PDO, subpolar gyre index,
nino3, Drake Passage, Indonesian
Throughflow, Denmark Strait, Bering Strait, Florida Strait,
others
-time series for global mean heat and fresh water entering the ocean surface
-time series of global integrated heat and global integrated salt in full liquid ocean
-northern hemisphere and southern hemisphere monthly average sea ice area, and volume.
-global and basin SSH time series

-look at the last two cycles, and should be repeatable/no drift in order to take this particular diagnostic seriously (Treguier to clarify this point).
-volumes of water masses, plottings in T/S bins (Nurser)

1988-2007 time mean diagnostics (this is best time for forcing)

-poleward heat transport: global, Atlantic, Indo-Pacific
-poleward fresh water transport: global, Atlantic, Indo-Pacific
-SST, SSS, SSH, MLD (wintertime and summertime mean; Nurser and Large) relative to observations (Reynolds, WOA, Nijler, CORE-I or Scripps mld?)
-overturning (global, Atlantic-Arctic, Indo-Pac) depth and sigma-2 space
-zonal mean temp and salinity relative to observations (either PHC2 or PHC3 is fine)
-map of total heat flux entering ocean
-map of P-E+R entering ocean, absent the flux from restoring/correction
-map of restoring/correction salt flux converted to an implied water flux.
-Drange will suggest sea ice northern and southern hemisphere average annual cycle of sea ice area and volume
-Drange will provide maps of northern and southern hemisphere winter/summer sea ice concentration and thickness

variability defined with respect to 1988-2007 mean

-standard deviations of annual mean SST, SSS, SSH, overturning streamfunction (depth and density by basin)
-MLD std somehow defined according to winter convective mixing (Drange)
-tropical thermocline std (across all basins)
-tropical cells (Drange)
-T14C depth standard deviation (Griffies)
-outcropping std (Drange)
-propagation of information (Large)
-upper ocean heat content anomaly (Marsland)
-thermosteric and halosteric sea level (Drange)

Trends and changes over

-Comparison with observed trends (Treguier)
-look for shifts in Atlantic and Pacific to define the time mean minus the time mean.
-SST, SSS, SSH
-zonal mean temp and salinity
-others?

Case studies for North Atlantic

-GSA (Drange)
-Curry and McCartney index for SSH difference in Atlantic (Drange)
-illustrate the ability to do more than show and tell with CORE-IAF by focusing on a few specific questions about North Atlantic decadal variability
-changes in subpolar gyre surrounding 1995 event
-why do all models (do they all?) show increase in AMOC over instrumental record?

Case studies for Indian Ocean (Claus)

-warming of Northern Indian ocean (Treguier); zonal mean slice
-SSH as in Claus' talk

Case study for Pacific (Large)

-did ocean respond to regime shift?
-how consistent are the models?

Southern ocean

-Can we look at Drake Passage transport in CORE-II?
-AAIW changes (Treguier)

Arctic Ocean (Drange)

-Sea ice changes
-warming post 2000 due to Atlantic warming?
-freshening post 1950

Illustration of sensitivities

-changes to precip suggested by Claus: are more than a few models showing similar sensitivity?
-changes in zonal wind trend in Southern Ocean suggested by Hiro; do a few models show similar sensitivity?
-helps to understand mechanisms for certain phenomena.
-more general discussion of the role that CORE-II plays in helping feedback on the development of atmospheric states to force the ocean-ice models.

Appendices

-numerics and physics of each contributing model or synthesis

-topography maps or tables of areas/depths in key regions (Drange, Treguier)

-details of how each model implemented the CORE-IAF protocol
-SSS restoring time scale?

-SSS restoring under ice?
-SSS restoring in disconnected inland seas?
-SSS restoring removed global mean?
-SSS restoring implemented as a salt flux or implied water flux?
-details of initial ocean and sea ice state
-any other relevant details

-table summarizing the model diagnostics and metrics used in the paper