Subject: initial vs restart files for CAM
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Date: 5/9/13 1:15 PM
To: Jeffrey Anderson <jla@ucar.edu>, kevin <raeder@ucar.edu>

Hi Jeff,

a couple weeks ago you requested a list of all the differences
between CAM initial and restart files. Here's what I've been
able to figure out for the FV core, CAM4 and CAM5.
CAM4 and CAM5 use the same initial files.

I copied sibling files from Nancy's 6hour coupled assim run:
cp /glade/scratch/nancy/cesm_hybrid_6h
/run/cesm_hybrid_6h.cam_0001.i.2004-01-16-43200.nc caminput.nc
cp /glade/scratch/nancy/cesm_hybrid_6h
/run/cesm_hybrid_6h.cam_0001.r.2004-01-16-43200.nc restart.r.nc

The initial file has a smaller number of fields (37 vs ~130).
The restart file has no meta data, so I can't use it to make connections
    between fields if the names are not the same.
The fields that are common between the 2 files are listed below, along with
comments about
    whether they have any meaningful "contents",
    a corresponding field in the "restart" file, and
    maximum differences between those fields ("restart_diffs").

Current state fields:
        double PS(time, lat, lon) ;
                PS:units = "Pa" ;
                PS:long_name = "Surface pressure" ;
                PS:contents = non-0
                PS:restart = PS (and scaled virtual potential temperature)
                PS:restart_diffs = O(e+3)
        double Q(time, lev, lat, lon) ;
                Q:units = "kg/kg" ;
                Q:long_name = "Specific humidity" ;
                Q:contents = non-0
                Q:restart = Q (and scaled virtual potential temperature)
                Q:restart_diffs = O(e-2)
        double US(time, lev, slat, lon) ;
                US:units = "m/s" ;
                US:long_name = "Zonal wind, staggered" ;
                US:contents = non-0
                US:restart = U but it is the staggered field,
                                    with an extra latitude (S pole) padded with 0s
                US:restart_diffs = O(30)
        double VS(time, lev, lat, slon) ;
                VS:units = "m/s" ;
                VS:long_name = "Meridional wind, staggered" ;
                VS:contents = non-0
                VS:restart = V but it is the staggered field,
                VS:restart_diffs = O(30)

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        double CLDICE(time, lev, lat, lon) ;
                CLDICE:units = "kg/kg" ;
                CLDICE:long_name = "Grid box averaged cloud ice amount" ;
                CLDICE:contents =  non-0
                CLDICE:restart =  CLDICE
                CLDICE:restart_diffs =  O(e-4)
        double CLDLIQ(time, lev, lat, lon) ;
                CLDLIQ:units = "kg/kg" ;
                CLDLIQ:long_name = "Grid box averaged cloud liquid amount" ;
                CLDLIQ:contents =  non-0
                CLDLIQ:restart =  CLDLIQ
                CLDLIQ:restart_diffs =  O(e-4)
        double T(time, lev, lat, lon) ;
                T:units = "K" ;
                T:long_name = "Temperature" ;
                T:contents =  non-0
                T:restart  ~  PT ("scaled virtual potential temperature")
                T:restart_diffs = ?
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In addition, the rest of the in-common fields have non-0 differences:
   DMS   dimethyl sulfide?
   H2O2  hydrogen peroxide
   H2SO4 sulfuric acid
   SO2   sulfur dioxide
(I'd have to guess what the following are, or dig in the code, since the metadata
are not helpful.)
   NUMICE, NUMLIQ, SOAG,
   bc_a1,  dst_a1, dst_a3,
   ncl_a1, ncl_a2, ncl_a3,
   num_a1, num_a2, num_a3,
   pom_a1,
   so4_a1, so4_a2, so4_a3,
   soa_a1, soa_a2,
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Notes:

The restart file temperature, PT, is a scaled virtual potential temperature.
The conversions between that quantity and the actual temperature will be found
in the dp_coupling code.  I haven't looked into the details of that, but will
if I should.

Overall, from Brian Eaton, "it appears that the initial file and restart file
contain the same model state.  This makes sense to me because Jerry Olson spent
years trying to make the initial file look like a restart file."
But when I generate the differences between the fields, which the 2 files have
in common, all of them have differences.  The important ones, at least, have large
differences: PS O(10 hPa), US,VS O(30 m/s), Q O(10 g/kg), T impossible to say.
Since the restarts have been carefully constructed to contain the model state
which allows seamless continuations, it must be that the initial files are
"wrong".
Jerry says "I can't recall exactly why restarts and IC files don't match
except to say that snapshots of the state may be captured at different times
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      in the model cycle for the 2 files."
He uses the restart files for CAPT now, not the initial files.

The restart file has 'U' and 'V', which implies non-staggered grids,
but Brian Eaton says "in fact the staggered velocity components
are being written to the restart file. ... I'm going to guess that it's possible
to write these fields to arrays that have the same dimensions as the cell
centered arrays by making use of longitude wrap and pole point constraints."

The S pole of U is all 0s; added as padding.  The north pole of U never existed.
lon(1,:) are different than lon(288,:), so I'll assume that V is simply the VS.

Kevin
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