Known RCEMIP Bugs

December 10, 2024

1 Cloud Water Variables

Condensed water is cloud liquid water plus cloud ice. The details of which variables are output for $clwvi\_avg, clw\_avg, clwvi$, and clw are provided in Tables 1 and 2.

2 Relative Humidity

It was requested that relative humidity be computed with respect to liquid and ice according to each model's microphysics scheme. We caution users that models use different formulas and in particular, handle saturation in the mixed phase differently - some models have a weighted average between liquid and ice and others do not. However, each formulation should be consistent with how that model's clouds respond to and regulate relative humidity. We also caution users that some models may have calculated relative humidity with respect to liquid only - specifically, ICON-NWP-CRM, ICON-LEM-CRM, IPSL-CM6, WRF-CRM, WRF-COL-CRM, and WRF-GCM. See the section below for each model for any corrections that have been made.

3 Saturated Water Vapor Path

We caution users that the saturated water vapor path (and therefore also column relative humidity) may be biased because it depends critically on the pressure at the upper bound of the highest model level, and different models have different model tops (especially amongst the GCMs, this is less of an issue for the CRMs), and define the top of the highest model level differently.

It was requested that saturation be computed with respect to liquid and ice according to each model's microphysics scheme. We caution users that models use different formulas and in particular, handle saturation in the mixed phase differently - some models have a weighted average between liquid and ice and others do not. We also caution users that some models may have calculated saturation with respect to liquid only - specifically, CAM5-GCM, CAM6-GCM, CM1, ICON-NWP-CRM, ICON-LEM-CRM, IPSL-CM6, MESO-NH, MPAS, UCLA-CRM, WRF-CRM, WRF-COL-CRM, and WRF-GCM. See the section below for each model for any corrections that have been made.

4 Cloud Fraction

The 1D cloud fraction variable *cldfrac_avg* was specified by the RCEMIP protocol to be defined based on the output of a cloud scheme, if used by the model, or by identifying a cloud where cloud condensate is greater than $10^{-5}gg^{-1}$ or 1% of the saturation mixing ratio of water, whichever is smaller. However, it has subsequently become apparent that some models only applied the $10^{-5}gg^{-1}$ part of the threshold (See Table 3). A re-calculation of cloud fraction in the models with explicit convection for which 3D output was completed and uploaded to the swiftbrowser in May 2022. As described in more detail in the README under A-Statistics/1D, the new calculations are included in the %cfv1-cfv2-profiles.nc files, where cfv1 uses the original RCEMIP definition and cfv2 uses only a $10^{-5}gg^{-1}$ threshold. The original cloud fraction output provided by each model is cfv0 (see Table 3 for what was used in each model). For more information, see Stauffer and Wing (2022).

5 Specification of RCEMIP analytic profile

The RCEMIP protocol paper specified that `RCE_small` simulations be initialized with an analytic profile where $q_t = 10^{-11}gkg^{-1}$. The supplied Matlab code on the RCEMIP website erroneously specified this as $q_t = 10^{-11}gg^{-1} = 10^{-14}gkg^{-1}$. The code was fixed on September 2, 2020. Any simulations that used the supplied code to generate the initial sounding have this error, though it is unlikely to make any practical difference.

6 CAM5-GCM, CAM6-GCM

- ~~The CAM5-GCM-RCE_large295_2D_rsutcs.nc file is corrupted.~~ - Fixed February 7, 2020.
- The 0D variable sprw_avg and the 2D variable sprw are calculated for saturation over liquid.

7 CM1

- 2D data has one file per hour.
- The 0D variable sprw_avg and the 2D variable sprw are calculated for saturation over liquid.

8 CNRM-CM6-1

- ~~The `RCE_small` 0D files do not include '_avg' in the variable names~~ - Fixed May 13, 2019
- 1D height variable is in a separate file
- ~~The filenames have the variable name at the start of the filename rather than at the end.~~ - Fixed May 13, 2019
- The 2D files for `RCE_large300` and `RCE_large305` are missing tnfmse, hadvfmse, and vadvfmse.

- In the 1D files, cldfrac_avg is given as a % rather than a fraction; it needs to be divided by 100.
- In the `RCE_large` 1D files, hur_avg needs to be multiplied by 100.
- In the `RCE_small` 1D files, thetae_avg does not have correct values.

9 DALES/DALES-damping

- The time variable in the `RCE_small` 1D simulations is in seconds.
- The time variable in the `RCE_small_vert` 1D simulations for thetae_avg, tntrl_avg, tntrs_avg, ua_avg, and va_avg is in seconds. The time variable for the other variables is in days.
- The time variable in the `RCE_small_vert` and `RCE_small_les` 1D simulations for clw_avg and plw_avg is corrupted after day 31.
- The variables hadvfmse, vadvfmse, and tnfmsevar are corrupted in all simulations.
- All downward radiative fluxes in the textttRCE_small 0D and 2D data are negative by convention.
- The 1D data is missing an average pressure variable.
- The radiative properties of cloud ice were erroneously configured, in which the grid-box cloud fraction was set to 1 for liquid but not for ice. This bug was fixed in the DALES-damping-rad simulations.
- The temperature profiles appear incorrect above the tropopause, possibly indicating a misconfigured ozone specification (ta_avg and ta in 1D and 3D data).

10 DAM

- In `RCE_small295/0D`, the prw and rlut variables are corrupted after day 85.
- In the 1D files, hur_avg needs to be multiplied by 100.
- ~~In the 2D files, the saturated precipitable water variable name is spwr instead of sprw.~~ - Fixed April 17, 2019
- The 2D files are missing wa500 and 3D files are missing wa (the variable is present but zero).
- The 3D data is daily snapshots instead of 6-hourly.
- The values of the time dimension in the 3D variable have been corrupted (they go 0,1,2,3...31, 1, 1, 1...1, 100).

11 ECHAM6_GCM

- The 0D and 1D variables have dummy, empty latitude and longitude dimensions.
- The 1D files are missing mass fraction of precipitating ice/liquid water, equivalent potential temperature, clear-sky longwave and shortwave radiative heating rates
- In the 1D files, a different height axis is provided for each time rather than an average height vector (for plotting purposes)
- There is no output for `RCE_small` simulations.
- The experiment names (in the pseudofolder name and file names) are given as `RCE_large_$SST` rather than `RCE_large$SST`.
- The 3D variables plw and pli are missing.

12 FV3

- There is no output for `RCE_small` simulations.
- The 0D and 1D data consist of monthly averages (an average over the last 31 days of simulation).
- The 1D data is missing radiative heating tendencies.
- The hydrometeor concentrations in the 1D and 3D data are specific humidities not mass fractions.
- The formula used to calculate saturation over liquid and ice may not match that used in the FV3 model.
- The 2D data is missing the 10 m/lowest model level wind, the vertical velocity at 500 hPa, and the moist static energy terms.
- 2D data is available only as daily instantaneous output over the last 31 days of simulation (rather than hourly averages over the entire run), or for the radiative fluxes, only as monthly averages (average over the last 31 days of simulation).
- The 3D data is missing the radiative heating tendencies.
- 3D data is available only as daily instantaneous output over the last 31 days of simulation (rather than hourly).
- The x and y dimensions are given as grid_xt and grid_yt as indices (rather than distance).
- Pressure is given in hPa rather than Pa.

13 GEOS_GCM

- ~~In RCE_large300 0D file, pr_avg is listed as pr.~~ - Fixed in v2 simulations Dec 2019.
- In the 1D files, height output is provided for every hour, needs to be squeezed.
- In the 1D files, hur_avg needs to be multiplied by 100.
- ~~In RCE_large300/1D, the variable names are missing the '_avg'.~~ - Fixed in v2 simulations Dec 2019.
- 300K cli/clw nomenclature difference
- cldfrac variable in RCE_small300/1D is corrupted (O(10^{12}).
- 1D height variable is in a separate file
- The surface fluxes were configured incorrectly in the RCE_small simulations. The simulations were redone November/December 2019 with the correct configuration and uploaded as v2. The RCE_large simulations were also redone December 2019, initialized from the new RCE_small simulations, and uploaded as v2.
- ~~The RCE_large300 simulation is missing the 2D variable tas.~~ - Fixed in v2 simulations Dec 2019.
- ~~The RCE_large300 v2 simulation is missing 1D variables for cloud fraction and clear sky radiation.~~ - Fixed January 13, 2020.
- ~~The v2 simulations are missing a 1D average height variable.~~ - Fixed January 21, 2020.
- The v2 simulations are missing the 3D variables pli and plw.
- The v2 RCE_large300 is missing the 3D variable va.
- The v2 RCE_large305 is missing the 3D variable tntrl.
- The v2 RCE_large300 simulation is missing the 3D variable zg, so the 1D variable zg_avg is provided instead.

14 ICON_CRM

- The 0D and 1D variables have dummy, empty latitude and longitude dimensions.
- The RCE_large domain is configured with the long dimension in y rather than in x.
- The latitude and longitude grid vectors do not represent real latitude and longitude (that is, $1^\circ \neq 111$ km).
- cldfrac variable in ICON_LEM_CRM RCE_large 0D data only has values every 6 hours, because it was computed offline from the 6-hourly 3D output.
- There is an additional 0D file for ICON_LEM_CRM simulations that contains a version of cloud fraction using an alternate threshold value of cloud condensate.

- The ICON_LEM_CRM `RCE_large` simulations are initialized from the 3km `RCE_small` simulations rather than the 1 km ones.
- The experiment names (in the pseudofolder name and file names) are given as `RCE_large_$SST` rather than `RCE_large$SST`.
- The values of prw and rlut at day 10 in ICON_LEM_CRM simulations are corrupted and equal to 0.
- ICON_LEM_CRM 1D files are missing equivalent potential temperature.
- ICON_NWP_CRM 1D files are missing equivalent potential temperature and potential temperature
- ~~0D and 2D files are missing saturated precipitable water.~~ - Fixed October 15, 2019 for ICON_NWP. Fixed February 4, 2020 for ICON_LEM (calculated for the last 25 days with a 6 hourly time step.
- ~~ICON_NWP_CRM sprw model output at the restart time steps was wrong (every 20 days on the small domain and every 5 days on the large domain).~~ -Fixed February 4, 2020. The incorrect time steps have been set to missing and the files reuploaded.
- The surface fluxes in the 0D files should be multiplied by -1.
- ~~The ICON_NWP_CRM simulations were improperly initialized.~~ -Fixed October 8, 2019
- ~~The ICON_LEM_CRM `RCE_small_vert300` simulations had a flipped time axis in the 1D data~~ -Fixed October 1, 2019
- The variable hur_avg in the 1D files uses saturation over liquid rather than over liquid/ice. An additional output file has been added with hur_avg corrected to be over liquid/ice. This correction is performed by multiplying the 3D relative humidity output, which is relative humidity over liquid, by the saturation vapor pressure over liquid and dividing by the saturation vapor pressure over ice, whenever the temperature is below freezing. To calculate saturation vapor pressure, the Tetens equation is used following its usage in ICON. The new 1D relative humidity profiles are computed based on averages of the corrected 3D 6-hourly snapshots over the last 25 days. - Fixed June 11, 2020
- The 0D variable sprw_avg and the 2D variable sprw are calculated for saturation over liquid. Additional files were added with the values corrected to be over liquid/ice, based on calculations from the 3D data.

15 ICON_GCM

- The 0D and 1D variables have dummy, empty latitude and longitude dimensions.
- The experiment names (in the pseudofolder name and file names) are given as `RCE_large_$SST` rather than `RCE_large$SST`.
- There is no output for `RCE_small` simulations.
- The latitude variable is corrupted.

- The time array in the 2D files has some bugs (for example, time 28 is doubled).
- The 1D hur_avg variable needs to be multiplied by 100.
- Relative humidity is 0 in level 1 to 14 (above 15 km). Because of how sprw is calculated, this means that only level 15 to 47 contribute to sprw.
- The 3D variables pli, plw, and tntr are missing.
- The 3D radiative tendency variables are named as tntrl_avg and tntrs_avg ratehr than tntrl and tntrs.
- The 2D hfls and hfss fluxes are negative from the ocean to the atmosphere.

16 IPSL-CM6

- The 0D, 1D, and 2D data is daily averages instead of hourly averages.
- The `RCE_large295` and `RCE_large305` simulations are only 630 days long, and the `RCE_large300` simulation is only 660 days long.
- The 1D data is missing ua_avg, va_avg, plw_avg, pli_avg, thetae_avg, and the radiative heating rates (tntrs_avg, tntrl_avg, tntrscs_avg, tntrl_avg).
- The variable hur_avg in the 1D files uses saturation over liquid rather than over liquid/ice. An additional output file has been added with hur_avg corrected to be over liquid/ice. This correction is performed by using the Wagner and Pruss (2002) and Wagner et al. (2011) formulas to compute relative humidity over liquid when temperatures are above freezing and over ice when temperatures are below freezing, using the 1D temperature, specific humidity, and pressure data. The original relative humidity is then multiplied by the computed relative humidity over liquid/ice and divided by the relative humidity over liquid. The latter cancels with the original relative humidity, except for a residual associated with the different formulas for saturation and non-linearity in the calculation affecting the order of domain-averaging, to achieve an estimate of relative humidity over liquid/ice. - Fixed June 25, 2020
- The 0D variable clivi_avg is condensed water path (cloud liquid + ice) while the 2D variable clivi is cloud ice path. clwvi_avg and clwvi are both cloud liquid water path.
- The 3D data is missling pli and plw, and the radiative heating rates (tntrl, tntrs, tntr).
- Within the 3D data ta file, the variable is named ta_avg instead of ta.
- The time array in the 3D appears corrupted, some days are repeated.

17 MESONH

- The simulations are initialized with a single small perturbation rather than random noise.
- ~~The 0D sprw_avg and 2D sprw variables were incorrect.~~ - Fixed January 19, 2020
- The 0D variable sprw_avg and the 2D variable sprw are calculated for saturation over liquid.

- The 3D hus variable appears to be incorrect; it is much too small in the lower troposphere and it does NOT appear to simply be off by an order of magnitude.

18 MicroHH

- The 1D pressure files are from the `RCE_small_vert` simulations but are also provided in the `RCE_small_les` directory and can be used there because the variations in hydrostatic pressure are negligible.
- ~~The 0D radiative fluxes rsdt_avg, rsut_avg, and rlut_avg are incorrect - surface fluxes instead of TOA.~~ - Fixed January 11, 2020

19 MPAS

- 1D variables need to be transposed (including z).
- The 0D variable sprw_avg and the 2D variable sprw are calculated for saturation over liquid.

20 NICAM

- There is no output for `RCE_small` simulations.
- In the 1D files, cldfrac_avg is given as a % rather than a fraction; it needs to be divided by 100.
- In the 1D files, thetae_avg does not have correct values. (Tomoki Ohno added)
- ~~In the 2D files, the clear-sky radiative fluxes were mixed up.~~ - Fixed February 7, 2020
- In the 0D files, the clear-sky surface shortwave and longwave fluxes are swapped. That is, rsuscs is really rluscs and vice versa, and rsdscs is really rldscs and vice versa.

21 SAM_CRM

- The variable hus_avg in the 1D files only has values every 6 hours.
- In the 0D files in the in the `RCE_small_vert` and in the `RCE_small_les` simulations, the clear-sky variables are provided as net fluxes (rlnscs_avg and rsnscs_avg) rather than as separate upwelling and downwelling.
- ~~The variable hus_avg in the 1D files labeled specific humidity is actually mixing ratio.~~ - Fixed May 9, 2019
- ~~The variable hus in the 3D files labeled specific humidity is actually mixing ratio.~~ - Fixed April 25, 2019
- ~~0D file is missing clear sky surface upwelling shortwave flux~~ - Fixed April 17, 2019

- ~~0D Surface upwelling longwave flux incorrect~~ - Fixed August 15, 2019
- ~~0D Precipitation rate off by a factor of 86400~~ - Fixed August 15, 2019
- ~~0D Cloud water path and condensed water path off by a factor of 1000~~ - Fixed August 27, 2019
- ~~`RCE_large` 2D files missing some of the radiative fluxes~~ - Fixed October 8, 2019
- ~~`RCE_small` 2D files missing some of the radiative fluxes~~ - Fixed October 31, 2019
- `RCE_small` and `RCE_small_vert` simulations were initialized with an analytic profile with $q_t = 10^{-11} g g^{-1} = 10^{-14} g k g^{-1}$ rather than the $q_t = 10^{-11} g k g^{-1}$ specified by the protocol.
- In the 2D files, the column-integrated frozen moist static energy variable (fmse) and its tendency (tnfmse) is off by a factor of 10. The data should be multiplied by 10.
- In the `RCE_small_vert` and `RCE_small_les` 3D files, the variable names do not follow the RCEMIP convention, and QV is mixing ratio, not specific humidity.
- In the `RCE_small_vert` and `RCE_small_les` 2D files, the files for latent and sensible heat flux are named LHF and SHF, rather than hfls and hfss.
- The variable hur (relative humidity) in the 3D files appears to have been calculated incorrectly, as it has quite high supersaturation.

22 SAM_GCRM

- ~~The variable hur_avg in the 1D files uses saturation over liquid rather than over liquid/ice.~~ - Fixed June 11, 2020
- The 3D variables cli and clw have units of g/kg, rather than the units requested by the RCEMIP protocol of g/g. The units are correctly indicated in the variable attributes.
- The 3D variables tntrs and tntrl are missing (tntr is present).

23 SP-CAM, SPX-CAM

- There is no output for `RCE_small` simulations.
- 1D height variable is in a separate file
- In the 1D files, cldfrac_avg is only available as monthly means, rather than hourly averages.
- ~~In the 0D files, rlus_avg and rlds_avg are swapped (the variable listed rlus is really rlds, and vice versa).~~ - Fixed September 25, 2019
- In the 2D files, cl is only available as monthly means, rather than hourly averages.
- ~~The 1D zg_avg variable has bogus values.~~ Fixed February 4, 2020
- In the 0D files for SPX-CAM `RCE_large305`, rsus_avg is incorrect (rsds_avg has been duplicated).

24 SCALE

- The x and y grid vectors are given in units of km rather than m.
- In the `RCE_small` simulations, the average pressure variable pa_avg only has data available every 6 hours.
- The data that was available prior to October 2018 had incorrect trace gases.

25 UCLA-CRM

- ~~In the 2D files, saturation water vapor path (in the file name and variable name) is called spwr rather than sprw.~~ - Fixed April 16, 2019
- ~~In the 0D files, saturation water vapor path (in the file name and variable name) is called spwr rather than sprw.~~ - Fixed April 16, 2019
- ~~In the 1D files, the profile of precipitating water is called rain_avg rather than plw_avg (in the variable name).~~ - Fixed March 29, 2019
- ~~In the 1D files, the profile of cloud ice is called ice_avg rather than cli_avg (in the variable name).~~ - Fixed March 29, 2019
- ~~In the 1D files, the profile of precipitating ice (pli_avg) is missing, but it can be recovered by summing snow_avg, hail_avg, and graupel_avg.~~ - Fixed March 29, 2019
- ~~For the `RCE_large` simulations, the pseudofolder and file names are given as `RCE_big$SST` rather than `RCE_large$SST`.~~ - Fixed April 23, 2019
- The 1D data is missing an average pressure coordinate.
- Time is in seconds in 0D and 2D files
- In 1D files, data only has values every 6 hours.
- ~~Values of precipitation rate in 0D and 2D files were off by a factor~~ - Fixed October 28, 2019
- In the 3D files, the cli variable is instead named ice, and found in the file with ice in the filename.
- In the 3D files, the plw variable is instead named rain, and found in the file with rain in the filename.
- In the 3D files, the pli variable is missing, but can be recovered by summing the graupel, hail, and snow variables (each found in a seperate file with graupel, hail, and snow in the filename, respectively).
- The 0D variable sprw_avg and the 2D variable sprw are calculated for saturation over liquid.

26 UKMO-GA7

- In the `RCE_large`/1D files, cldfrac_avg is given as a % rather than a fraction; it needs to be divided by 100.
- In the `RCE_small`/1D files, hur_avg needs to be multiplied by 100.
- In the 1D files, height is in a separate file and has dummy empty dimensions, and has a value every hour rather than an average height vector (for plotting purposes)
- There are variable name discrepancies in the 0D and 1D data.
- In the `RCE_small`/1D files, the variable rluscs_avg is missing.
- In the `RCE_small`/0D files, the variable prw_avg is missing.
- the 2D tas file is corrupted.
- The 3D filenames follow the RCEMIP standard but within those files, the variable names do not follow the RCEMIP standard.

27 UKMOi-vn11.0

- 2D and 3D data has one file per day (labeled according to month/day).
- The 0D and 1D variables have dummy, empty latitude and longitude dimensions.
- In the `RCE_large` 1D files, thetae_avg seems to have incorrect values. (Tomoki Ohno added)
- Corrected 2D data files for UKMOi-vn11.0-CASIM/`RCE_large295` uploaded September 6, 2019.

28 WRF_COL_CRM

- ~~The variable hus_avg in the 1D files labeled specific humidity is actually mixing ratio.~~ - Fixed September 19, 2019
- ~~The variable hus in the 3D files labeled specific humidity is actually mixing ratio.~~ -Fixed September 19, 2019
- In the 0D and 2D files, the time variable is labeled as days rather than time.
- In the 2D files, the x/y variables are called west_east and south_north.
- The 1D files are missing the clear-sky shortwave and longwave radiative heating rates
- ~~The experiment names in the file names are given as `RCElarge$SST` rather than `RCE_large$SST`.~~ - Fixed September 19, 2019
- The simulations are initialized with a single small perturbation rather than random noise.
- In the `RCE_large295` simulation, the 2D data has a time array of just zeros.

- The 0D variable sprw_avg and the 2D variable sprw are calculated for saturation over liquid.
- The variable hur_avg in the 1D files and hur in the 3D files uses saturation over liquid rather than over liquid/ice. An additional output files has been added with hur_avg and hur re-calculated to be over liquid/ice. This calculation is performed by using the Wagner and Pruss (2002) and Wagner et al. (2011) formulas to compute relative humidity over liquid when temperatures are above freezing and over ice when temperatures are below freezing, using the 3D temperature, specific humidity, and pressure data. The new 1D hur_avg is then based on averaging the 3D 6-hourly snapshots over the last 25 days. - Fixed June 25, 2020

29 WRF-CRM

- The upwelling radiative fluxes are negative by convention in the 0D and 2D data.
- The dimension in the file names is lowercase 'd' instead of 'D'.
- The 0D data is missing the clear-sky radiative fluxes.
- The 1D data is missing the clear-sky radiative heating rates.
- ~~The 1D average height variable zg_avg is missing.~~ - Fixed November 21, 2019
- The 1D height variable is in a separate file with filename WRF_CRM_RCE_1d_height.nc rather the the correct filename structure.
- ~~In the `RCE_small300` simulations, it appears that the bottom half of the domain and top half of the domain are duplicate images of each other.~~ - Fixed February 13, 2020.
- The 0D variable sprw_avg and the 2D variable sprw are calculated for saturation over liquid.
- The variable hur_avg in the 1D files uses saturation over liquid rather than over liquid/ice. An additional output file has been added with hur_avg corrected to be over liquid/ice. This correction is performed by using the Wagner and Pruss (2002) and Wagner et al. (2011) formulas to compute relative humidity over liquid when temperatures are above freezing and over ice when temperatures are below freezing, using the 1D temperature, specific humidity, and pressure data. The original relative humidity is then multiplied by the computed relative humidity over liquid/ice and divided by the relative humidity over liquid. The latter cancels with the original relative humidity, except for a residual associated with the different formulas for saturation and non-linearity in the calculation affecting the order of domain-averaging, to achieve an estimate of relative humidity over liquid/ice. - Fixed June 25, 2020

30 WRF_GCM

- ~~There is no output for `RCE_small` simulations.~~ - Fixed November 1, 2019
- ~~The height variable is missing in the 1D data.~~ - Fixed September 26, 2019
- ~~Long variable names and units are missing from the file metadata.~~ - Fixed November 1, 2019

Table 1: 0D/1D Cloud Water Variables

Model	0D clwvi_avg	1D clw_avg
CAM5/CAM6/SCAM5/SCAM6	condensed water path	cloud liquid water
CM1	condensed water + rain + snow + graupel path	cloud liquid water
CNRM-CM6-1	condensed water path	cloud liquid water
DAM	condensed water path	cloud liquid water
ECHAM6_GCM	cloud liquid water path	cloud liquid water
FV3	condensed water path	cloud liquid water
GEOS	cloud liquid water path	cloud liquid water
ICON_LEM_CRM	cloud liquid water path	cloud liquid water
ICON_NWP_CRM	cloud liquid water path	cloud liquid water
ICON_GCM	cloud liquid water path	cloud liquid water
IPSL-CM6	cloud liquid water path	cloud liquid water
MESONH	cloud ice water path	cloud liquid water
MicroHH	cloud liquid water path	cloud liquid water
MPAS	condensed water path	cloud liquid water
NICAM	condensed water path	cloud liquid water
SAM_CRM	condensed water path	cloud liquid water
SAM_GCRM	condensed water path	cloud liquid water
SAM_LES	cloud liquid water path	cloud liquid water
SAM0-UNICON	condensed water path	cloud liquid water
SCALE	condensed water path	cloud liquid water
SP-CAM/SPX-CAM	cloud liquid water path	cloud liquid water
UCLA-CRM	condensed water + graupel path	cloud liquid water
UKMOi variants	condensed water path	cloud liquid water
UKMO GA7.1	condensed water path	cloud liquid water
WRF_CRM	condensed water path	cloud liquid water
WRF_COL_CRM	condensed water path	cloud liquid water
WRF_GCM	cloud liquid water path	cloud liquid water

- ~~The 1D variable hur_avg is incorrect, it is specific humidity, not relative humidity.~~ - Fixed September 26, 2019
- ~~The values for the 0D variables rlutcs_avg and rluscs_avg are identical. Both of these variables are very close (but not identical) to rlus_avg.~~ - Fixed January 31, 2020
- The 0D variable sprw_avg and the 2D variable sprw are calculated for saturation over liquid.
- The variable hur_avg in the 1D files and hur in the 3D files uses saturation over liquid rather than over liquid/ice. Additional output files have been added with hur_avg and hur re-calculated to be over liquid/ice. This calculation is performed by using the Wagner and Pruss (2002) and Wagner et al. (2011) formulas to compute relative humidity over liquid when temperatures are above freezing and over ice when temperatures are below freezing, using the 3D temperature, specific humidity, and pressure data. The new 1D hur_avg is then based on averaging the 3D 6-hourly snapshots over the last 25 days. - Fixed June 25, 2020

Table 2: 2D/3D Cloud Water Variables

Model	2D clwvi	3D clw
CAM5/CAM6/SCAM5/SCAM6	condensed water path	cloud liquid water
CM1	condensed water + rain + snow + graupel path	cloud liquid water
CNRM-CM6-1	condensed water path	cloud liquid water
DAM	condensed water path	cloud liquid water
ECHAM6_GCM	cloud liquid water path	cloud liquid water
FV3	condensed water path	cloud liquid water
GEOS	cloud liquid water path	cloud liquid water
ICON_LEM_CRM	cloud liquid water path	cloud liquid water
ICON_NWP_CRM	cloud liquid water path	cloud liquid water
ICON_GCM	cloud liquid water path	cloud liquid water
IPSL-CM6	cloud liquid water path	cloud liquid water
MESONH	cloud liquid water path	cloud liquid water
MicroHH	cloud liquid water path	cloud liquid water
MPAS	condensed water path	cloud liquid water
NICAM	condensed water path	cloud liquid water
SAM_CRM	condensed water path	cloud liquid water
SAM_GCRM	condensed water path	cloud liquid water
SAM_LES	cloud liquid water path	cloud liquid water
SAM0-UNICON	condensed water path	cloud liquid water
SCALE	condensed water path	cloud liquid water
SP-CAM/SPX-CAM	cloud liquid water path	cloud liquid water
UCLA-CRM	condensed water + graupel path	cloud liquid water
UKMOi variants	condensed water path	cloud liquid water
UKMO GA7.1	condensed water path	cloud liquid water
WRF_CRM	condensed water path	cloud liquid water
WRF_COL_CRM	condensed water path	cloud liquid water
WRF_GCM	cloud liquid water path	cloud liquid water

Table 3: Definition of cloudy point in computing 1D cldfrac_avg

Model	Cloud Condensate Threshold
CAM5/CAM6/SCAM5/SCAM6	Output from cloud scheme
CM1	Unknown
CNRM-CM6-1	Output from cloud scheme
DALES	$0gg^{-1}$
DAM	$1e^{-5}gg^{-1}$
ECHAM6_GCM	Output from cloud scheme
FV3	Unknown
GEOS	Output from cloud scheme
ICON_LEM_CRM	$\min(1e^{-5}gg^{-1},1\%q_s)$
ICON_NWP_CRM	Output from cloud scheme
ICON_GCM	Output from cloud scheme
IPSL-CM6	Output from cloud scheme
MESONH	$1e^{-5}gg^{-1}$
MicroHH	Model default
MPAS	$\min(1e^{-5}gg^{-1},1\%q_s)$
NICAM	$1e^{-5}gg^{-1}$
SAM_CRM	$\min(1e^{-5}gg^{-1},1\%q_s)$
SAM_GCRM	$\min(1e^{-5}gg^{-1},1\%q_s)$
SAM_LES	$\min(1e^{-5}gg^{-1},1\%q_s)$
SAM0-UNICON	Output from cloud scheme
SCALE	$\min(1e^{-5}gg^{-1},1\%q_s)$
SP-CAM/SPX-CAM	$1e^{-5}gg^{-1}$ within embedded CRM
UCLA-CRM	Unknown
UKMOi variants	$\min(1e^{-5}gg^{-1},1\%q_s)$
UKMO GA7.1	Output from cloud scheme
WRF_CRM	Output from cloud scheme
WRF_COL_CRM	$1e^{-5}gg^{-1}$
WRF_GCM	Output from cloud scheme