Data documentation

E3SMv2 model output from the following simulations ("cases") are described in this document:

- v2_F2010_nc00_bgt_A (62 MB)
- v2_F2010_nc00_inst_6hr (80 GB)
- v2_F2010_nc00_freq (8.6 GB)
- v2_F2010_nc00_cdncf09_bgt_A_sub01 (234 GB)
- v2_F2010_nc00_cdncf09_bgt_B_sub01 (386 GB)

The simulations were conducted using the F2010 configuration ("compset") at the ne30pg2_oECv3 horizonal resolution with 72 vertical grid layers in the atmosphere. All tunable parameters were set to their default values except the lower bound of the in-cloud cloud droplet number concentration (CDNC) was turned off. All simulations documented here are bit-for-bit identical in terms of the simulated climate. Different simulations were run for different lengths and wrote out different variables. Variable names starting with cnd01_, cnd02_ etc. are output from the online analysis tool CondiDiag (Wan et al., 2022, DOI: 10.5194/gmd-15-3205-2022).

Point of contact

Hui Wan, Pacific Northwest National Laboratory

Case "v2_F2010_nc00_bgt_A"

Overview

- One-year simulation with monthly mean output.
- · Purpose: global budget analyses for cloud droplet mass and number in stratiform and shallow convective clouds.
- Conditional sampling: none (i.e., all time steps were included in time average).

Output variables

Changes (increments) per 30-minute time step (or 5-minute substep) of the vertically integrated grid box mean cloud droplet mass mixing ratio (CLDLIQ) and number mixing ratio (NUMLIQ).

Variable naming convention:

- cnd01_CLDLIQ_v_<process_label>_inc for cloud droplet mass;
- cnd01_NUMLIQ_v_<process_label>_inc for cloud droplet number.

Process labels and explanation:

Label	Processes
DYNEND	Resolved transport (i.e., large-scale advection)
SHCU	Deep convection
CLUBB0[1-6]	CLUBB in the 1st to 6th substeps, respectively, of the cloud macrophysics-microphysics loop
ACTDIAG0[1- 6]	Cloud droplet nucleation, evaporation, and mixing in the 1st to 6th substeps, respectively, of the cloud macrophysics-microphysics loop
CLDMIC0[1-6]	Cloud microphysics in the 1st to 6th substeps, respectively, of the cloud macrophysics-microphysics loop
CUDET0[1-6]	Deep convection detrainment applied during the 1st to 6th substeps, respectively, of the cloud macrophysics-microphysics loop
NDG	All calculations in the "after-coupling" parameterization group (subroutine tphysac) in the E3SMv2 atmosphere model

12 files in total. 5.2 MB per file. File names follow the pattern v2_F2010_nc00_bgt_A.eam.h1.2010-<mm>.nc where <mm> goes from 01 to 12.

Case "v2_F2010_nc00_inst_6hr"

Overview

- One-year simulation with 6-hourly instantaneous output.
- 30 days (120 time slices) per file. 4 months of spin-up also included in this archive.
- Purpose: instantaneous output of atmospheric state variables for interactive data exploration.
- Conditional sampling: none.

Output variables

Variable name	Explanation
LANDFRAC	Land fraction in grid box. Unitless.
CLDLOW	Vertically integrated low-level cloud fraction. Unitless.
CLDTOT	Vertically integrated total cloud fraction. Unitless.
cnd01_ALST_ACTDIAG01	Liquid cloud fraction of the stratiform and shallow convective clouds. Unitless.
cnd01_AST_ACTDIAG01	Total (liquid and ice) cloud fraction of the stratiform and shallow convective clouds. Unitless.
cnd01_CLDLIQ_ACTDIAG01	Grid box mean cloud droplet mass mixing ratio. Unit: kg/kg.
cnd01_NUMLIQ_ACTDIAG01	Grid box mean cloud droplet number mixing ratio. Unit: 1/kg.
cnd01_CDMC_ACTDIAG01	In-cloud mean droplet mass concentration (zero if cndo1_CLDLIQ_ACTDIAGo1 < 1E-18 kg/kg). Unit: kg/m3
cnd01_CDNC_ACTDIAG01	In-cloud mean droplet number concentration (zero if cndo1_CLDLIQ_ACTDIAGO1 < 1E-18 kg/kg). Unit: 1/m3
cnd01_CCN3_ACTDIAG01	Cloud condensation nuclei number concentration at 0.1% supersaturation. Unit: 1/cm3
cnd01_LHF_ACTDIAG01	Latent heat flux at the Earth's surface. Unit: W/m2
cnd01_SHF_ACTDIAG01	Sensible heat flux at the Earth's surface. Unit: W/m2

Files

File Size	File Name
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2009-09-01-00000.nc
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2009-10-01-00000.nc
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2009-10-31-00000.nc
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2009-11-30-00000.nc
5.0G	v2_F2010_nco0_inst_6hr.eam.ho.2009-12-30-00000.nc
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2010-01-29-00000.nc
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2010-02-28-00000.nc
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2010-03-30-00000.nc
5.0G	v2_F2010_nco0_inst_6hr.eam.h0.2010-04-29-00000.nc
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2010-05-29-00000.nc
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2010-06-28-00000.nc

File Size	File Name
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2010-07-28-00000.nc
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2010-08-27-00000.nc
5.0G	v2_F2010_nco0_inst_6hr.eam.ho.2010-09-26-00000.nc
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2010-10-26-00000.nc
5.0G	v2_F2010_nc00_inst_6hr.eam.h0.2010-11-25-00000.nc
1.2G	v2_F2010_nc00_inst_6hr.eam.h0.2010-12-25-00000.nc

Case "v2_F2010_nc00_freq"

Overview

- 10-year simulation with montly mean output.
- Purpose: to diagnose the frequency of occurrence of ultra-low CDNCs (i.e., concentrations lower than 10/cm3).
- Conditional sampling: on.

Key variables in each file

Variable name	Explanation
<pre>cnd01_CLDLIQ_flag</pre>	Fractional frequency of occurrence of the condition "CLDLIQ > 1E-18 kg/kg". Unitless.
cnd02_CDNCqsml_flag	$\label{eq:condition} Fractional frequency of occurrence of the condition ``CDNC = 0.01-9.99/cm3 and CLDLIQ > 1E-18 \ kg/kg''. Unitless.$
cnd03_CLDLIQ_flag	Fractional frequency of occurrence of the condition "CLDLIQ > 1E-8 kg/kg". Unitless.
cnd04_CDNCq1m8_flag	Fractional frequency of occurrence of the condition "CDNC = 0.01–9.99/cm3 and CLDLIQ > 1E-8 kg/kg". Unitless.
cnd05_CLDLIQ_flag	Fractional frequency of occurrence of the condition "CLDLIQ > 2E-5 kg/kg". Unitless.
cnd06_CDNCq2m5_flag	Fractional frequency of occurrence of the condition "CDNC = 0.01–9.99/cm3 and CLDLIQ > 2E-5 kg/kg". Unitless.

Files

120 files in total (10 years times 12 months per year). 73 MB per file. File names follow the pattern v2_F2010_nc00_freq.eam.h1.<yyyy>-<mm>.nc where <yyyy> goes from 2010 to 2019 and <mm> goes from 01 to 12.

Case "v2_F2010_nc00_cdncf09_bgt_A_sub01"

Overview

- Ten-year simulation with monthly mean output.
- Purpose: for ultra-low CDNCs occurring with cloud fractions higher than 0.9, diagnose the cloud droplet mass and number tendencies (process rates) corresponding to the major groups of resolved and parameterized physical processes at the E3SMv2 atmosphere model's "physics driver" level.
- Conditional sampling: on.

Output variables

Changes (increments) per 30-minute time step (or 5-minute substep) in the grid box mean cloud droplet mass mixing ratio (CLDLIQ) and number mixing ratio (NUMLIQ) of various physical processes and under different sampling conditions (see below). The fractional frequency of occurrence of the conditions and the land fraction in each model grid box (LANDFRAC) are also included.

- cnd0[1-6]_CLDLIQ_<process_label>_inc for cloud droplet mass;
- cnd0[1-6]_NUMLIQ_<process_label>_inc for cloud droplet number.

Process labels and explanation:

Label	Processes
DYNEND	Resolved transport (i.e., large-scale advection)
SHCU	Deep convection
CLUBB0[1-6]	CLUBB in the 1st to 6th substeps, respectively, of the cloud macrophysics-microphysics loop
ACTDIAG0[1- 6]	Cloud droplet nucleation, evaporation, and mixing in the 1st to 6th substeps, respectively, of the cloud macrophysics-microphysics loop
CLDMIC0[1-6]	Cloud microphysics in the 1st to 6th substeps, respectively, of the cloud macrophysics-microphysics loop
CUDET0[1-6]	Deep convection detrainment applied during the 1st to 6th substeps, respectively, of the cloud macrophysics-microphysics loop
NDG	All calculations in the "after-coupling" parameterization group (subroutine tphysac) in the E3SMv2 atmosphere model

Sampling conditions:

Label	Output variable for freq. of occurrence	Condition
cnd01	<pre>cnd01_CDNCfl09_flag</pre>	ALST > 0.9 and CDNC = 0.01–9.99/cm3
cnd02	cnd02_CDNCfl09_flag	ALST > 0.9 and CDNC = 30–50/cm3
cnd03	cnd03_CDNCfl09_flag	ALST > 0.9 and CDNC > 50/cm3
Label	Output variable for freq. of occurrence	Condition
Label cnd04	Output variable for freq. of occurrence cnd04_CDNCfs09_flag	Condition AST > 0.9 and CDNC = 0.01–9.99/cm3
Label cnd04 cnd05	Output variable for freq. of occurrence cnd04_CDNCfs09_flag cnd05_CDNCfs09_flag	Condition AST > 0.9 and CDNC = 0.01-9.99/cm3 AST > 0.9 and CDNC = 30-50/cm3

Files

cnd06

120 files in total (10 years times 12 months per year). 2.0 GB per file. File names follow the pattern v2_F2010_nc00_cdncf09_bgt_A_sub01.eam.h1.
<yyyy>-<mm>.nc where <yyyy> goes from 2010 to 2019 and <mm> goes from 01 to 12.

AST > 0.9 and CDNC > 50/cm3

Case "v2_F2010_nc00_cdncf09_bgt_B_sub01"

Overview

• Ten-year simulation with monthly mean output.

cnd06_CDNCfs09_flag

- Purpose: for ultra-low CDNCs occurring with cloud fractions higher than 0.9, diagnose cloud droplet number tendencies of the processes represented in the parameterization of droplet nucleation, evaporation, and mixing; also diagnose various features of the atmosphere state relevant for the parameterization.
- Conditional sampling: on.

Output variables

• Tendencies of the grid box mean cloud droplet number mixing ratio (NUMLIQ).

• Features of the atmosphere state.

These variables were sampled and written out for different sampling conditions (see below). The fractional frequency of occurrence of the conditions and the land fraction in each grid box (LANDFRAC) are also included in the data files.

Variable naming convention: cnd0[1-6]_<QoI>_ACTDIAG0[1-6]

- cnd[1-6] is the identifier for the sampling conditions, which are the same as in the "v2_F2010_nc00_cdncf09_bgt_A_sub01" case described above.
- ACTDIAG0 [1-6] is the identifier for the 5-minute substeps in the cloud macrophysics-microphysics substepping loop within each 30-minute "physics time step" in the E3SMv2 atmosphere model.

Monitored quantities of interest (QoI's) – (1) process rates:

QoI short name	Explanation
NDROPMIX	Grid box mean cloud droplet number tendency due to turbulent mixing. Unit: 1/kg/s
NSRCNACT	Grid box mean cloud droplet number tendency due to cloud-base nucleation. Unit: 1/kg/s
NSRCGROW	Grid box mean cloud droplet number tendency associated with cloud fraction increase. Unit: 1/kg/s
NSRCSHRK	Grid box mean cloud droplet number tendency associated with cloud fraction decrease. Unit: 1/kg/s
NSRCNCLR	Grid box mean cloud droplet number tendency due to assumed evaporation that ensures droplet number is zero if cloud fraction is zero before the calculation of turbulent mixing. Unit: 1/kg/s
NSRCEVAP	Grid box mean cloud droplet number tendency due to evaporation of droplets detrained to clear air by turbulence. Unit: 1/kg/s

Monitored quantities of interest (QoI's) – (2) features of the atmosphere state:

QoI short name	Explanation
ALST	Liquid cloud fraction of the stratiform and shallow convective clouds. Unitless.
AST	Total (liquid and ice) cloud fraction of the stratiform and shallow convective clouds. Unitless.
CCN3	Cloud condensation nuclei number concentration at 0.1% supersaturation. Unit: 1/cm3
CFBGRID	Fractional area of cloud base in the current grid box. Unitless.
NDROPW	Characteristic updraft velocity used in aerosol activation calculation, with an assumed minimum value of 0.1 m/s. Unit: m/s
NDROPWSUB	Standard deviation of the sub-grid vertical velocity (from the turbulence parameterization, bounded with a maximum value of 10 m/s). Unit: m/s
SKWZT	Skewness of the sub-grid vertical velocoty (from the turbulence parameterization). Unitless.

Files

120 files in total (10 years times 12 months per year). 3.3 GB per file. File names follow the pattern v2_F2010_nc00_cdncf09_bgt_B_sub01.eam.h1.