Tutorial of NICAM-DC for DCMIP2016 on Yellowstone

Version 2.0

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Note

This document is a tutorial of NICAM-DC for DCMIP2016. Procedures for three ideal experiments are explained assuming the Yellowstone environment. NICAM-DC is the dynamical core package, which is a part of NICAM full model. The development of NICAM with full physics has been co-developed mainly by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Atmosphere and Ocean Research Institute (AORI) at The University of Tokyo, and RIKEN / Advanced Institute for Computational Science (AICS). A reference paper for NICAM is Tomita and Satoh (2004), Satoh et al. (2008). See also NICAM.jp (`http://nicam.jp/`). This distribution package (NICAM-DC) is released for the purpose of widespread use of NICAM. The license is according to BSD 2 Clause. Have lots of fun!

- Explanations are based on bash environment below. In the tcsh environment, use "setenv" command instead of "export". (e.g. `> setenv NICAM_SYS "Yellowstone"`)
- A symbol of "`>`" means execution of commands in the console.
- Gothic means output from standard output.
- ${TOP} means `/glade/[your-working-dir]/nicamdc`
- ${SHARE} means `/glade/p/work/ryuji/public`

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1 Quick Start

1.1 Extend a tar file

Copy a tar file to the disc space of scratch or work.

```
> cp nicamdc.20160606.tgz /grade/[your-working-dir]/
> cd /grade/[your-working-dir]/
> tar zxvf nicamdc.20160606.tgz
```

By this command, a new directly of nicamdc is created, and contents are extended into the directly.

* The tar file name would be changed by source code update.

1.2 Preparing Environment

Set machine environmental parameters.

```
> module load ncl
> module load cdo/1.6.3
> module load mkl/10.3.11
```

* You can check the loaded libraries by "module list" command.
* Intel compiler, MPI, and netcdf are loaded as default sets.

Set NICAM environmental parameters.

```
> export NICAM_SYS="Yellowstone"
> export ENABLE_NETCDF="T"
```

* NICAM setting parameters are described in Makedef file, which is stored in `${TOP}/sysdep`. The `NICAM_SYS` parameter specifies the Makedef file.
* In other machines, the parameter `NICAM_SYS` should be changed to suitable one, for example "`Linux64-gnu-ompi`" in GNU compiler with openMPI on Linux x86-64.

Recommendation
To keep above settings, edit ".tcshrc" or ".bashrc".

1.3 Compile

Change directly to test case directly, for example,

```
> cd ${TOP}/test/case/DCMIP2016-11
```

Table 1: Corresponding test cases

teat case name in NICAM	test case type
DCMIP2016-11	moist baroclinic wave test (161)
DCMIP2016-12	idealized tropical cyclone test (162)
DCMIP2016-13	supercell test (163)

In the $TOP/test/case, a lot of test cases sets are prepared. In those, the cases for DCMIP2016 are shown in Table 1.
Compile the program using make command.

```
> make -j 4
```

When the compile is finished correctly, a "`nhm_driver`" is created in the current directly, which is an executable binary of NICAM.

* The number of -j option is a number of parallel compile processes. To reduce elapsed time of compile, you can specify the number as more than two. We recommend 2 8 for the -j option.

1.4 Run experiments

To run the model, type "make run", and then the job script is displayed in standard output. Hit "q" to quit.

```
> make run
#! /bin/bash -x
#------------------------------------------------------------------------
#
# for NCAR Yellowstone (IBM iDataPlex Sandybridge)
#
#------------------------------------------------------------------------
#BSUB -a poe                  # set parallel operating environment
#BSUB -P SCIS0006             # project code
#BSUB -J nicamdc              # job name
#BSUB -W 00:10                # wall-clock time (hrs:mins)
#BSUB -n 10                   # number of tasks in job
#BSUB -R "span[ptile=10]"     # run four MPI tasks per node
#BSUB -q regular              # queue
#BSUB -e errors.%J.nicamdc    # error file name
#BSUB -o output.%J.nicamdc    # output file name
```

If the job script is OK, submit a job to the machine.

```
> bsub < run.sh
```

Caution : Do not miss the symbol "<".

You can check the status of your jobs by "bjobs" command.

```
> bjobs
JOBID  USER  STAT QUEUE    FROM_HOST   EXEC_HOST   JOB_NAME SUBMIT_TIME
159420 ryuji RUN  regular  yslogin3-ib 10*ys0531-i nicamdc  Jun  7 02:24
```

* To see detail status, do "bjobs -l".
* For detail, see `https://www2.cisl.ucar.edu/resources/computational-systems/yellowstone/using-computing-resources/running-jobs/platform-lsf-job-script-examples`

1.5 Post process

After finish of test run, create the lat-lon grid data from the original icosahedral grid data. Before submit a job of post process, edit `ico2ll_netcdf.sh` following your experimental settings.

```
> vi ico2ll_netcdf.sh

[at Line 22]
# User Settings
# ------------------------------------------------------------------

glev=5          # g-level of original grid
case=161        # test case number
out_intev='day' # output interval (format: "1hr", "6hr", "day", "100s")
```

If the job script is OK, submit a job to the machine.

```
> bsub < ico2ll_netcdf.sh
```

The netcdf format data such as "`nicam.161.200.L30.interp_latlon.nc`" is created by an "ico2ll" post-process program.

1.6 Ploting

In the DCMIP2016, NCL scripts are preparing to plot results for each experiments. The script use as below.

```
> ncl < ncl_script.161
```

Caution : Do not miss the symbol "<".

* "ncview" and "grads" is also available to quick check.
* NCL scripts (only given by LOC) are in ${SHARE}/plots.

2 Change Model Configurations

Terms

- g-level (grid level): number of grid level, this is a number of subdivision times from the original icosahedron.
- r-level (region level): level of management groups. When r-level = 0, the management groups are ten groups. So, the number of available maximum MPI processes is ten.

2.1 Change Test Case

In this section, configurations are explained here to run three experiments in DCMIP2016. NICAM-DC has already configuration sets for three test cases in the directory of ${TOP}/test/case. At the first step, use these sets.

2.1.1 preparing directory

Change to the directory of target case. If you want to run test case 162, change to $TOP/test/case/DCMIP2016-12/. After that, make a directory. The directory of gl05rl00z30pe40 already may exists, we assume create it newly.

```
> mkdir gl05rl00z30pe40
> cd gl05rl00z30pe40/
```

Copy Makefile and configuration file from another directory of DCMIP2016 to the new direcotory, for example DCMIP2016-11.

```
> cp ../../DCMIP2016-11/gl05rl00z30pe10/Makefile ./
> cp ../../DCMIP2016-11/gl05rl00z30pe10/nhm_driver.cnf ./
```

2.1.2 Edit configuration file: nhm_driver.cnf

edit for test case 161: moist baroclinic wave

(symbols "<--" means changed parameters)

```
> vi nhm_driver.cnf
 * snip *

 &RUNCONFPARAM
   RUNNAME        = 'DCMIP2016-11',      <--
   NDIFF_LOCATION = 'IN_LARGE_STEP2',
   THUBURN_LIM    = .true.,
   EIN_TYPE       = 'SIMPLE',
   RAIN_TYPE      = "WARM",
   AF_TYPE        = 'DCMIP2016',
  /

 * snip *

 &DYCORETESTPARAM
   init_type   = 'Jablonowski-Moist',    <--
   test_case   = '1',                    <--
   chemtracer  = .true.,                 <--
   prs_rebuild = .false.,
```

```
 /

* snip *

&FORCING_DCMIP_PARAM
  SET_DCMIP2016_11 = .true.,            <--
 /

* snip *
```

Note

- "RUNNAME" should be specified as "DCMIP2016-11".
- "init_type" should be specified as "Jablonowski-Moist".
- "test_case" can be choose from 1 6.
  case 1: perturbation: exponential / with moisture
  case 2: perturbation: stream function / with moisture
  case 3: perturbation: exponential / without moisture
  case 4: perturbation: stream function / without moisture
  case 5: no perturbation / with moisture
  case 6: no perturbation / without moisture
- `FORCING_DCMIP_PARAM` should be specified as "`SET_DCMIP2016_11 = .true.`".
- "step" in `NMHISD` should be changed following required history output interval as described in DCMIP2016 Test Case Document.
- items of history output variables, which specified by "NMHIST", should be added following the requirement in DCMIP2016 Test Case Document.
- "small_planet_factor" in CNSTPARAM should be set as 1.

edit for test case 162: ideal tropical cyclone

(symbols "<--" means changed parameters)

```
> vi nhm_driver.cnf
 * snip *

 &RUNCONFPARAM
   RUNNAME        = 'DCMIP2016-12',      <--
   NDIFF_LOCATION = 'IN_LARGE_STEP2',
   THUBURN_LIM    = .true.,
   EIN_TYPE       = 'SIMPLE',
   RAIN_TYPE      = "WARM",
   AF_TYPE        = 'DCMIP2016',
  /

 * snip *

 &DYCORETESTPARAM
   init_type   = 'Tropical-Cyclone',     <--
  /

 * snip *
```

```
&FORCING_DCMIP_PARAM
  SET_DCMIP2016_12 = .true.,            <--
 /

* snip *
```

Note

- "RUNNAME" should be specified as "DCMIP2016-12".
- "init_type" should be specified as "Tropical-Cyclone".
- `FORCING_DCMIP_PARAM` should be specified as "`SET_DCMIP2016_12 = .true.`".
- "step" in `NMHISD` should be changed following required history output interval as described in DCMIP2016 Test Case Document.
- items of history output variables, which specified by "NMHIST", should be added following the requirement in DCMIP2016 Test Case Document.
- "small_planet_factor" in CNSTPARAM should be set as 1.

edit for test case 163: supercell

(symbols "<--" means changed parameters)

```
> vi nhm_driver.cnf
 * snip *

 &RUNCONFPARAM
   RUNNAME        = 'DCMIP2016-13',      <--
   NDIFF_LOCATION = 'IN_LARGE_STEP2',
   THUBURN_LIM    = .true.,
   EIN_TYPE       = 'SIMPLE',
   RAIN_TYPE      = "WARM",
   AF_TYPE        = 'DCMIP2016',
  /

 * snip *

 &DYCORETESTPARAM
   init_type   = 'Supercell',            <--
   test_case   = '1',                    <--
  /

 * snip *

 &FORCING_DCMIP_PARAM
   SET_DCMIP2016_13 = .true.,            <--
  /

 * snip *
```

Note

- "RUNNAME" should be specified as "DCMIP2016-13".

- "init_type" should be specified as "Supercell".
- "test_case" can be choose from 1 6.
  case 1: with initial perturbation
  case 2: without initial perturbation
- `FORCING_DCMIP_PARAM` should be specified as "`SET_DCMIP2016_13 = .true.`".
- "step" in `NMHISD` should be changed following required history output interval as described in DCMIP2016 Test Case Document.
- items of history output variables, which specified by "NMHIST", should be added following the requirement in DCMIP2016 Test Case Document.
- "small_planet_factor" in CNSTPARAM should be set as 120.
- "earth_angvel" in CNSTPARAM should be set as 0.

After above edit, you can run the experiment by the same manner in Section 1.4.

```
> make run
> bsub < run.sh
```

2.2 Change Physics Schemes

Default settings for each test cases in DCMIP2016 is set in the pre-existing configuration file. You can change these settings as you like. Note that we have not yet checked all the combinations of physics schemes for all test cases.

use Large scale condensation instead of kessler

The default setting for cloud microphysics is Kessler scheme. To use Large scale condensation (Reed and Jablonowski (2012) precip scheme), add "`SET_DCMIP2016_LSC`" with true sign. An example for test case 161 is shown below.
(symbols "`<--`" means changed parameters)

```
> vi nhm_driver.cnf
 * snip *

 &FORCING_DCMIP_PARAM
   SET_DCMIP2016_11 = .true.,
   SET_DCMIP2016_LSC = .true.,      <--
  /

 * snip *
```

no cloud physics

To run without any cloud physics, add "`SET_DCMIP2016_DRY`" with true sign. An example for test case 161 is shown below.
(symbols "`<--`" means changed parameters)

```
> vi nhm_driver.cnf
 * snip *

 &FORCING_DCMIP_PARAM
   SET_DCMIP2016_11 = .true.,
   SET_DCMIP2016_DRY = .true.,      <--
  /
```

```
 * snip *
```

use George Bryan PBL

The default setting for PBL scheme is Reed and Jablonowski (2012). To use George Bryan PBL, add "SM_PBL_Bryan" with true sign. This option is available only for Tropical cyclone case (162). An example is shown below.

(symbols "<--" means changed parameters)

```
> vi nhm_driver.cnf
 * snip *

 &FORCING_DCMIP_PARAM
   SET_DCMIP2016_12 = .true.,
   SM_PBL_Bryan     = .true.,      <--
  /

 * snip *
```

no physics

To run any physics scheme, specify "NONE" to the parameter of AF_TYPE in RUNCONFPARAM. An example for test case 161 is shown below.

(symbols "<--" means changed parameters)

```
> vi nhm_driver.cnf
 * snip *

 &RUNCONFPARAM
   RUNNAME        = 'DCMIP2016-11',
   NDIFF_LOCATION = 'IN_LARGE_STEP2',
   THUBURN_LIM    = .true.,
   EIN_TYPE       = 'SIMPLE',
   RAIN_TYPE      = "WARM",
   AF_TYPE        = 'NONE',       <--
  /

 * snip *
```

2.3 Increase MPI processes

To reduce elasped time of the model execution, we can increase number of MPI processes. For example, edit to change to use 40 MPI processes with g-level 5 in test case 161.

To increase MPI processes up to 40, r-level should be rised from 0 to 1 because the upper limit of processes in r-level 0 is 10 processes.

2.3.1 preparing directory

We assume in $TOP/test/case/DCMIP2016-11/

```
> mkdir gl05rl01z30pe40    <-- r-level is 1
> cd gl05rl01z30pe40/
```

Copy Makefile and configuration file to new direcotory.

```
> cp ../gl05rl00z30pe10/Makefile ./
> cp ../gl05rl00z30pe10/nhm_driver.cnf ./
```

2.3.2 Edit Makefile

(symbols "<--" means changed parameters)
On the Lines from 17 to 21, edit parameters.

```
> vi Makefile
 glevel = 5
 rlevel = 1      <--
 nmpi   = 40     <--
 zlayer = 30
 vgrid  = vgrid30_stretch_30km_dcmip2016.dat
```

2.3.3 Edit configuration file: nhm_driver.cnf

(symbols "<--" means changed parameters)

```
> vi nhm_driver.cnf
 * snip *
 &ADMPARAM
   glevel      = 5,
   rlevel      = 1,                    <--
   vlayer      = 30,
   rgnmngfname = "rl01-prc40.info",     <--
  /

 &GRDPARAM
   hgrid_io_mode = "ADVANCED",
   hgrid_fname   = "boundary_GL05RL01",  <--
   VGRID_fname   = "vgrid30_stretch_30km_dcmip2016.dat",
   vgrid_scheme  = "LINEAR",
   topo_fname    = "NONE",
  /

 * snip *

 &RESTARTPARAM
   input_io_mode     = 'IDEAL',
   output_io_mode    = 'ADVANCED',
   output_basename   = 'restart_all_GL05RL01z30', <--
   restart_layername = 'ZSALL32_DCMIP16',
  /
```

After above edit, you can run the experiment by the same manner in Section 1.4.

```
> make run
> bsub < run.sh
```

2.4 Change grid spacing

This is an example to change grid spacing of g-level 6 (approxi. 120 km) with 40 MPI processes in test case 161. When horizontal grid space is changed, some additional settings should be changed,

for example, interval of time integration (DTL), maximum number of time steps (LSTEP_MAX), numerical filter parameters, and output interval of history data.

2.4.1 preparing directory

We assume in $TOP/test/case/DCMIP2016-11/

```
> mkdir gl06rl01z30pe40  <-- g-level is 6, and r-level is 1
> cd gl06rl01z30pe40/
```

Copy Makefile and configuration file to new direcotory.

```
> cp ../gl05rl00z30pe10/Makefile ./
> cp ../gl05rl00z30pe10/nhm_driver.cnf ./
```

2.4.2 Edit Makefile

(symbols "<--" means changed parameters)
On the Lines from 17 to 21, edit parameters.

```
> vi Makefile
 glevel = 6      <--
 rlevel = 1      <--
 nmpi   = 40     <--
 zlayer = 30
 vgrid  = vgrid30_stretch_30km_dcmip2016.dat
```

2.4.3 Edit configuration file: nhm_driver.cnf

A guideline of changing interval of time integration (DTL) is
take 1/2 of DTL by one up of g-level.
A guideline of changing numerical filter parameters is
take 1/8 of coefficient value by one up of g-level.

(symbols "<--" means changed parameters)

```
> vi nhm_driver.cnf
 * snip *
 &ADMPARAM
   glevel      = 6,                    <--
   rlevel      = 1,                    <--
   vlayer      = 30,
   rgnmngfname = "rl01-prc40.info",    <--
  /

 &GRDPARAM
   hgrid_io_mode = "ADVANCED",
   hgrid_fname   = "boundary_GL06RL01",  <--
   VGRID_fname   = "vgrid30_stretch_30km_dcmip2016.dat",
   vgrid_scheme  = "LINEAR",
   topo_fname    = "NONE",
  /

 &TIMEPARAM
   DTL         = 300.D0,     <--
```

```
  INTEG_TYPE  = "RK3",
  LSTEP_MAX   = 4320,       <--
  start_date  = 0000,1,1,0,0,0
 /

* snip *

&RESTARTPARAM
  input_io_mode     = 'IDEAL',
  output_io_mode    = 'ADVANCED',
  output_basename   = 'restart_all_GL06RL01z30', <--
  restart_layername = 'ZSALL32_DCMIP16',
 /

* snip *

&NUMFILTERPARAM
  lap_order_hdiff   = 2,
  hdiff_type        = 'NONLINEAR1',
  Kh_coef_maxlim    = 1.500D+16,    <--
  Kh_coef_minlim    = 1.500D+15,    <--
  ZD_hdiff_nl       = 20000.D0,
  divdamp_type      = 'DIRECT',
  lap_order_divdamp = 2,
  alpha_d           = 1.50D15,      <--
  gamma_h_lap1      = 0.0D0,
  ZD                = 40000.D0,
  alpha_r           = 0.0D0,
 /

* snip *

&NMHISD
  output_io_mode   = 'ADVANCED' ,
  histall_fname    = 'history'  ,
  hist3D_layername = 'ZSDEF30_DCMIP16',
  NO_VINTRPL       = .false.    ,
  output_type      = 'SNAPSHOT' ,
  step             = 288        ,    <--
  doout_step0      = .true.     ,
 /
```

After above edit, you can run the experiment by the same manner in Section 1.4.

```
> make run
> bsub < run.sh
```

3 Requested Test Cases in DCMIP2016

The requested test cases are summarized in this section. Take care to test settings, because a part of test cases is not described in the Test Case Document.

3.1 Moist Baroclinic Wave

In the moist baroclinic wave, two types of tests are requested.

3.1.1 common settings

- default horizontal resolution: 1 degree.
- vertical grid arrangement: 30 levels (stretched) with 120m resolution in the lowest model level. The model cap should be between 30km and 50km.

3.1.2 case: 161

- employ Kessler precipitation
- employ surface fluxes (test = 1)
- employ boundary layer
- no RJ2012_precip
- employ Terminator physics

3.1.3 case: 161-preciponly

- employ Kessler precipitation
- no surface fluxes
- no boundary layer
- no RJ2012_precip
- employ Terminator physics

3.1.4 output variables

- daily frequency
- 3D param: Qv, Qc, Qr, U, V, W, Theta, T, P (or Rho)
- 2D param: surface pressure, instantaneous precip 6-hourly averaged precip.
- Additional 2D diagnostics are required for the Terminator test, as described in the test case document.

3.2 Tropical Cyclone

In the tropical cyclone, two types of tests are requested.

3.2.1 common settings

- employ Kessler precipitation
- employ Reed-Jablonowski simple physics enable
- employ surface fluxes (test = 1)
- no RJ2012_precip
- vertical levels setting is same with the baroclinic wave test.
- required horiz. grid spacing = 1.0 and 0.5 deg. (optionally 0.25 degree)

3.2.2 case: 162-rjpbl

- employ RJ2012 PBL (default PBL in simple physics)

3.2.3 case: 162-bryanpbl

- employ Bryan TC PBL

3.2.4 output variables

- 6 hours interval
- default horiz. grid space: 1 degree (encourage groups to try a 0.25).
- 3D param: Qv, Qc, Qr, U, V, W. Theta, T, P (or Rho).
- 2D param: surface pressure instantaneous 6-hourly, instantaneous precip 6-hourly averaged precip.

3.3 Supercell

3.3.1 case: 163

- employ Kessler physics
- no RJ2012_precip
- no surface fluxes
- default resolution = 1 degree.
- vertical levels: 40 levs (500m vertical grid spacing, uniformly spaced)
- model top: 20 km

3.3.2 case: 162-bryanpbl

- employ Bryan TC PBL

3.3.3 output variables

- default output interval: 5 minutes
- 3D Qv, Qc, Qr, U, V, W, Theta, plus at least one of Phi, T, Tv, Rh*o or P*).
- 2D surface pressure and instantaneous and 5-minute averaged precipitation.

4 Appendix: Configuration Parameters

columns of example show settings of test case 161 in g-level 5.

Table 2: ADMPARAM (Model Administration Parameters)

parameters	example	kind	description
glevel	5	int	number of g-level
rlevel	0	int	number of r-level
vlayer	30	int	number of vertical layers
rgnmngfname	"rl00-prc10.info"	char	name of region management file

Table 3: GRDPARAM (Grid Setting Parameters)

parameters	example	kind	description
`hgrid_io_mode`	"ADVANCED"	char	IO mode of horizontal grid file
`hgrid_fname`	"`boundary_GL05RL00`"	char	name of horizontal grid file
`VGRID_fname`	"`vgrid30_stretch_30km_dcmip2016.dat`"	char	name of vertical grid file
`vgrid_scheme`	"LINEAR"	char	IO mode of vertical grid file
`topo_fname`	"NONE"	char	name of topography file

Table 4: TIMEPARAM (Time Integration Setting Parameters)

parameters	example	kind	description
DTL	600.D0	real	interval of time step (s)
`INTEG_TYPE`	"RK3"	char	time integration scheme
`LSTEP_MAX`	2160	int	time integration steps
`start_date`	0000,1,1,0,0,0	int (array)	date of initial time

Table 5: RUNCONFPARAM (Common Configurations)

parameters	example	kind	description
RUNNAME	'DCMIP2016-11'	char	name of run case
NDIFF_LOCATION	'IN_LARGE_STEP2'	char	setting of numerical diffusion
THUBURN_LIM	.true.	logical	use of the limiter
EIN_TYPE	'SIMPLE'	char	evaluation type of internal energy
RAIN_TYPE	'WARM'	char	date of initial time
CHEM_TYPE	'PASSIVE'	char	chemical tracer type
AF_TYPE	'DCMIP2016'	char	type of forcing (physics step)

Table 6: CHEMVARPARAM (Chemical Tracer Settings)

parameters	example	kind	description
CHEM_TRC_vmax	2	int	maximum number of chemical tracers

Table 7: BSSTATEPARAM (Basic (reference) State Parameters)

parameters	example	kind	description
ref_type	'NOBASE'	char	type of reference state

Table 8: RESTARTPARAM (Initialize/Restart Setting Parameters)

parameters	example	kind	description
input_io_mode	'IDEAL'	char	IO mode of input file (for initialize)
output_io_mode	'ADVANCED'	char	IO mode of output file (for restart)
output_basename	'restart_all_GL05RL00z30'	char	name of output file
restart_layername	'ZSALL32_DCMIP16'	char	name of vertical lev. info. file for restart

Table 9: DYCORETESTPARAM (Dynamical-core Test Parameters)

parameters	example	kind	description
init_type	'Jablonowski-Moist'	char	test case name
test_case	'1'	char	test case number (not DCMIP test case number)
chemtracer	.true.	logical	switch of chemical tracer
prs_rebuild	.false.	logical	switch of initial pressure re-calculation

Table 10: FORCING_PARAM (Forcing (Physics) Setting Parameters)

parameters	example	kind	description
NEGATIVE_FIXER	.true.	logical	switch of negative fixer
UPDATE_TOT_DENS	.false.	logical	switch of total density update

Table 11: FORCING_DCMIP_PARAM (DCMIP2016 Physics Setting)

parameters	example	kind	description
SET_DCMIP2016_11	.true.	logical	physics set for test 161 (exclusive use)
SET_DCMIP2016_12	.false.	logical	physics set for test 162 (exclusive use)
SET_DCMIP2016_13	.false.	logical	physics set for test 163 (exclusive use)

Table 12: CNSTPARAM (Constant Parameters)

parameters	default	kind	description
earth_radius	6.37122D+6	real	radius of the earth (m)
earth_angvel	7.292D-5	real	angular velocity of the earth (s-1)
small_planet_factor	1.D0	real	small planet facter (X)
earth_gravity	9.80616D0	real	gravity acceleration (m s-2)
gas_cnst	287.0D0	real	ideal gas constant for dry air (J kg-1 K-1)
specific_heat_pre	1004.5D0	real	specific heat capacity at constant pressure (J kg-1 K-1)

Table 13: NUMFILTERPARAM (Numerical Filter Settings)

parameters	default	kind	description
lap_order_hdiff	2	int	order of horizontal diffusion
hdiff_type	'NONLINEAR1'	char	horizontal diffusion type
Kh_coef_maxlim	1.200D+17	real	maximum limit of Kh coefficient (for Non-Linear)
Kh_coef_minlim	1.200D+16	real	minimum limit of Kh coefficient (for Non-Linear)
ZD_hdiff_nl	20000.D0	real	effective bottom level of horiz. diff. (for Non-Linear)
divdamp_type	'DIRECT'	char	divergence dumping type
lap_order_divdamp	2	int	order of divergence dumping
alpha_d	1.20D16	real	specific value of coefficient for divergence dumping

Table 14: EMBUDGETPARAM (Budget Monitoring Parameters)

parameters	example	kind	description
MNT_ON	.true.	logical	switch of monitoring
MNT_INTV	72	int	monitoring interval (steps)

Table 15: NMHISD (Common History Output Parameters)

parameters	default	kind	description
output_io_mode	'ADVANCED'	char	IO mode of history output file
histall_fname	'history'	char	name of history output file
hist3D_layername	'ZSDEF30_DCMIP16'	char	name of vertical lev. info. file for history
NO_VINTRPL	.false.	logical	switch of vertical interpolation
output_type	'SNAPSHOT'	char	output value type (snapshot or average)
step	72	int	output interval (steps)
doout_step0	.true.	logical	switch of output initial condition

Table 16: NMHIST (Settings of History Output Items)

parameters	example	kind	description
item	'ml_u'	char	name of output variable in the model
file	'u'	char	name of output variable in the file
ktype	'3D'	char	dimension type of output variable