DDH

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MUSC working week, Helsinki, 29 November – 2 December 2011

Sofia, 16-19 May 2006

Outlook

1. A short overview of DDH
2. Conservation equation
3. Horizontal and time averaging
4. Output file
5. Namelists
6. DDH toolbox
7. Adding new entries
8. Examples

1. A short owerview of DDH

- Horizontal and time integration of model equation, term by term
- Horizontal domain for integration is defined by user through namelist. There are three kinds of domains: global, zonal and local. For LAM users local one is interesting.
- Output at times independant from historical files output times. This is controled by namelist too.
- Output in LFA files.
- Further calculations and visualization is provided by DDH toolbox.

2. Conservation equation

- DDH is based on model equations in flux form

$$\frac{\partial}{\partial t}\left(\chi \frac{\partial p}{\partial \eta}\right) = -\nabla_{\eta} \cdot \left(\chi v \frac{\partial p}{\partial \eta}\right) - \frac{\partial}{\partial \eta}\left(\chi \dot{\eta} \frac{\partial p}{\partial \eta}\right) + S_d \frac{\partial p}{\partial \eta} - g \frac{\partial F}{\partial \eta} - gS \frac{\partial G}{\partial \eta}$$

(1) (2) (3) (4) (5)

1. Horizontal divergence
2. Vertical divergence
3. Adiabatic source (pressure gradient force,…)
4. Divergence of physical fluxes (turbulence, microphysics, …)
5. Tendencies due to physical parameterizations

No physical tendencies!

2. Conservation equation *(cont.)*

$$\chi : 1, \vec{v}, q_{v}, q_{l}, q_{n}, k, c_{p}T, \vec{M}, s$$

$(k$: kinetic energy; s : entropy; $\vec{M}$: angular momentum $)$

Vertical discretization of conservation equation:

$$\frac{\partial}{\partial t}\left(\chi\delta p\right) = -\nabla_{\eta}\cdot\left(\chi V\delta p\right) - \delta\left(\chi\dot{\eta}\frac{\partial p}{\partial \eta}\right) + S_{d}\delta p - g\delta\delta \quad - gS \;\delta G$$

$$\delta\xi_{l} = \xi_{\bar{l}} - \xi_{\bar{l}-1}$$

3.Horizontal and time averaging

Horizontal average

$$\frac{\partial}{\partial t}\left(\overline{\chi\frac{\partial p}{\partial \eta}}^{H}\right) = -\overline{\nabla_{\eta}\cdot\left(\chi v\frac{\partial p}{\partial \eta}\right)}^{H} - \frac{\partial}{\partial \eta}\left(\overline{\chi\dot{\eta}\frac{\partial p}{\partial \eta}}^{H}\right) + \overline{S_d\frac{\partial p}{\partial \eta}}^{H} - g\frac{\partial \overline{F}^{H}}{\partial \eta} - \overline{gS\frac{\partial G}{\partial \eta}}^{H}$$

Time average

$$\overline{\chi\frac{\partial p}{\partial \eta}}^{H}\Big|_{t=n\cdot\Delta t} - \overline{\chi\frac{\partial p}{\partial \eta}}^{H}\Big|_{t=0} =$$

$$-\overline{\overline{\nabla_{\eta}\cdot\left(\chi v\frac{\partial p}{\partial \eta}\right)}^{H}}^{t} - \frac{\partial}{\partial \eta}\left(\overline{\overline{\chi\dot{\eta}\frac{\partial p}{\partial \eta}}^{H}}^{t}\right) + \overline{\overline{S_d\frac{\partial p}{\partial \eta}}^{H}}^{t} - g\frac{\partial \overline{\overline{F}^{H}}^{t}}{\partial \eta} - \overline{\overline{gS\frac{\partial G}{\partial \eta}}^{H}}^{t}$$

Values under averaging operators are saved in DDH output files.

4. Output file

4.1. Classification of terms in DDH

1. Variables: $\frac{1}{g}\chi\delta p$
2. Dynamical tendencies: $\frac{\delta t}{g}\nabla_{\eta}\cdot\left(\chi V\delta p\right)$ and $\frac{\delta t}{g}S_{d}\delta p$
3. Dynamical fluxes: $\frac{\delta t}{g}\chi\dot{\eta}\frac{\partial p}{\partial \eta}$
4. Physical fluxes: $\delta t\cdot F$
5. Physical tendencies: $gS\ \delta G$

Full levels: variables and tendencies

Half levels: fluxes

4.2. Output files structure

Descriptions:

date, output time, number of output values, number of levels, logical keys, numbers describing data, descriptions of domains, …

Data:

- variables at time 0 and t
- Dynamical tendencies
- Dynamical fluxes
- Physical fluxes
- Physical tendencies

4.3 Output file's data names

nnntvvssssssssss

- nnn: number of domain
- t: data type (Variable,Tendency,Fflux,Soil)
- vv: variable
  - PP: pressure
  - QV: specific ratio for water vapor
  - UU, VV: velocity components
  - KK: kinetic energy
  - CT: enthalpy
  - ...
- ssssssssss: description
  - DIVFLUHOR: horizontal div. term
  - TUR: TURBULENCE

4.4. Format and names of output files

Format: lfa

Name:

- Global domain: DHFGLeeee+nnnn
- Zonal bands: DHFZOeeee+nnnn
- User defined: DHFDLeeee+nnnn

eeee: experiment name

nnnn: ouput time

5. Namelists

&NAMDDH

- LFLEXDIA: new data flow
- LHDGLB, LHDZON, LHDDOP : global, zonal and limited domain, one must be TRUE
- LHDHKS : budgets of mas, energy, momentum, relative humidity, soil budget
- LHDMCI: budget of kinetic momentum
- LHDENT: budget of entalpy
- LHDPRG, LHDPRZ , LHDPRD: printing for global, zonal and limited domain
- LHDEFG, LHDEFZ, LHDEFD: saving in fille for global, zonal and limited domain
- LHDLIST: more output from DDH at run time

5. Namelists

&NAMDDH

BDEDDH(1, domain number): domain type,

BDEDDH(2, domain number): virtual plain,

Domain type 1, point given with indices:

BDEDDH(3, domain number), index in X direction

BDEDDH(4, domain number), index in Y direction

Domain type 4, point given with geografical coordinates

BDEDDH(3, domain number), index in X direction

BDEDDH(4, domain number), index in Y direction

Domain type 2, quadrilateral domain; points 1 to 4 in clockwise direction

BDEDDH(3, domain number): 1. point, longitude

BDEDDH(4, domain number), 1. point, latitude

BDEDDH(5, domain number): 2. point, longitude

BDEDDH(6, domain number) ,2 . point, latitude

BDEDDH(7, domain number), 3. point, longitude

BDEDDH(8, domain number), 3. point, latitude

BDEDDH(9, domain number), 4. point, longitude

BDEDDH(10, domain number), 4. point, latitude

Domain type 3, rectangular domain; points 1 to 4 in clockwise direction

BDEDDH(3, domain number): 1. point, longitude

BDEDDH(4, domain number), 1. point, latitude

BDEDDH(5, domain number): 3. point, longitude

BDEDDH(6, domain number) ,3 . point, latitude

5. Namelists

&NAMCT0

1. way: output eachn n-th timestep
   NFRDHFD=n and NDHFDTS(0)=0

2. way: output at arbitrary timesteps
   NFRDHFD=n, NDHFDTS(0)= number of output times and
   NDHFDTS(i)=pi. Autput after N*pi timesteps

2. way: output at arbitrary hour
   NFRDHFD=n, NDHFDTS(0)= - number of output times and
   NDHFDTS(i)=-pi. Autput after N*pi hour

5. Namelists

Important small detail:

```
 &NAMOPH
   LINC=.FALSE.,
```

If this is not done the number at the end of the output file will be hour.
Within one hour there can be more ddh outputs and they will be saved in
files having the same bumber at the end. Corrant output will overwrite preceding one.

6. DDH toolbox

ddhr

- Gives some basic information about ddh file

  ddhr file_name

lfaedit

- Opens ddh lfa file in text editor

  extract EDITOR=name of the editor

  lfaedit file_name

ddht

- Does many tasks on one or two ddh files. Opsions are:

  SOMME_PONDEREE, SOMME_CONTIGUE, DIFFE_EXP_REFE, DIFFE_EC2_EC1, DIFFE_PONDEREE, SEPAR_PR_COMPL, MOY_VERTIC, MOY_HORIZ, INTERPOL, EXTRAIT_DOMAIN, EXTRAIT_NIVEAUX, CALC

- ddht -cEXTRAIT_DOMAIN -1f1 -sresul -E1

6. DDH toolbox

ddhi

- Extracts from the ddh file fields listed in the list file. For each field produces two ASCII FILES *.doc and *.dta file with descriptions and data needed for Ploting.

  Ddhi file_name -l list_file

  list_file: file with the list of field names

  -list eqample:

  VQV1

  VCTV1

ddhb

- Extract budget for one variable out of ddh file for one domain.

  export DDHI_LIST=conversion_list_file

  export DDHB_BPS=ddh_budget_list_file_name

  ddhb -v variable_symbol –i ddh_file

  variable_symbol: UU, VV, QV, QC,...

7. Adding new entries

SUBROUTINE ADD_FIELD_3D(PMAT,CDNAME,CDFLUX,CDMOD,LDINST,LDDH)

PMAT: array with new ddh entry

CDNAME: name of new entry

CDFLUX: type of entry; F','V','T' if flux,variable or tendency

LDINST: TRUE if instantaneous field

LDDH: TRUE to stor into ddh files

In the subroutine where you want take a new entry put

USE DDH_MIX

Call this subroutine there where new entry is calculated, at the end of calculation.

In subroutine CPPHDDH there is:

USE DDH_MIX,ONLY :ADD_FIELD_3D

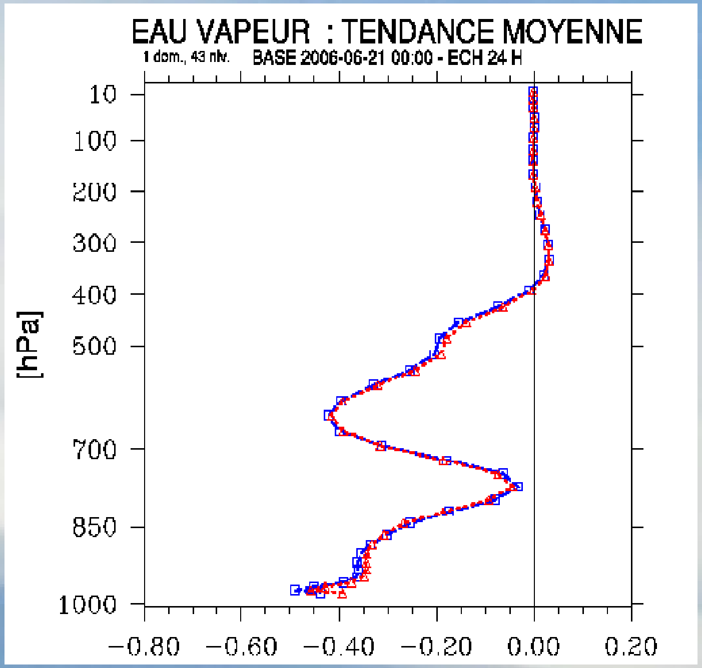
and

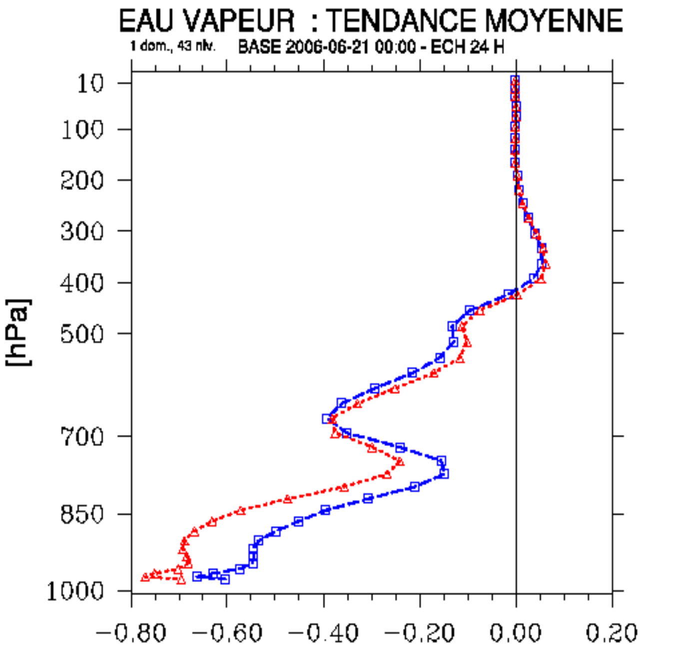
CALL ADD_FIELD_3D(PDIFTQN,'FQNTUR','F','ARP',.TRUE.,.TRUE.)

and many other such calls for physival fluxes and tendencies.

8. Examples

Doina Banciu: Validation and tuning of prognostic convection inside 3MT





Water vapour tendency for two entrainment rates for 21.062006, 00+24 h:
ALARO without 3MT part (left) and with 3MT (right);
GCVNU=1.e-05,
red - TENTR=2.5e-06, TENTRX=8.e-05 (actual setting),
blue - TENTR=5e-06, TENTRX=16e-05,

8. Examples

Water vapor budget, by JM Piriou