GABLS3 LES INTERCOMPARISON
Case Description (Revised: October 6, 2008)

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Location:
Cabauw, The Netherlands (51.9711^{o} N, 4.9267^{o} E)

Period:
00 UTC July 2, 2006 – 09 UTC July 2, 2006

Domain:
800 m $\times$ 800 m $\times$ 800 m

Grid:
Please report simulation results from multiple grid resolutions. At least one of the resolutions should be 6.25 m (i.e., 128^3 points). Other resolutions (coarser or finer) are at the modelers' discretion.

Please keep the grids isotropic, i.e., $\Delta x = \Delta y = \Delta z$. However, if you anticipate that your LES code will perform better utilizing an aspect ratio of less than one (i.e., $\Delta z/\Delta x = \Delta z/\Delta y < 1$), then please submit ***additional*** runs using optimal anisotropic grids.

Damping Layer (if used):
Lower limit around 550-600 m

Surface Roughness:
z_o = 0.15 m

z_{oT} and z_{oQ} are not needed since 0.25 m potential temperature and specific humidity are prescribed (see below).

Lower Boundary Conditions:

Monin-Obukhov Similarity

If feasible, please use: $\Psi_M = \Psi_H = \Psi_Q = -5z/L$ for stably stratified conditions. [L: Obukhov length]

During the LES runs, the surface sensible heat flux should be estimated using the prescribed 0.25 m potential temperature ($\Theta_{0.25}$) and the model's lowest level (z_1) potential temperature ($\Theta(z_1)$) values as follows (or, using its local variant):

$$\langle w'\theta'\rangle_{surface} = \frac{u_*\kappa[\theta_{0.25} - \theta(z_1)]}{ln\left(\frac{z_1}{0.25}\right) - \Psi_H\left(\frac{z_1}{L}\right) + \Psi_H\left(\frac{0.25}{L}\right)}$$

Similar approach should be followed for the surface latent heat flux estimation.

Table 1. Surface pressure, 0.25 m potential temperature and 0.25 m specific humidity

Time (UTC)	P_0 (hPa)	$\Theta_{0.25}$ (K)	$Q_{0.25}$ (Kg/Kg)
0	1022.1	291.28	0.0100
1	1022.0	290.34	0.0099
2	1022.0	289.45	0.0100
3	1021.8	288.62	0.0099
4	1021.9	288.43	0.0099
5	1022.1	289.95	0.0104
6	1022.3	292.38	0.0109
7	1022.3	294.16	0.0113
8	1022.3	296.55	0.0121
9	1022.2	298.45	0.0129

Interpolate P_0, $\Theta_{0.25}$ and $Q_{0.25}$ linearly in time. Time series plots of $\Theta_{0.25}$ and $Q_{0.25}$ are provided at: http://www.atmo.ttu.edu/basu/GABLS3/Figures.html

Upper Boundary Condition:

Free slip, w = 0

Inversion strength (if used): 0.0029 K/m

Lateral Boundary Condition:

Periodic

Initial Conditions (00 UTC July 2, 2006):

Table 2. Initial velocity profiles

Z (m)	U (ms^{-1})	V (ms^{-1})
10	-3.35	-0.04
20	-4.31	0.08
40	-6.13	0.32
80	-9.00	0.90
140	-11.48	3.50
200	-10.16	5.58
203	-10.08	5.57
257	-9.15	5.47
308	-8.75	5.54
310	-8.74	5.55
363	-8.57	5.64
408	-8.46	5.64
426	-8.41	5.61
465	-8.23	5.47
520	-7.82	5.10
541	-7.60	4.90
575	-7.17	4.53
635	-6.22	3.76
657	-5.82	3.47
694	-5.14	3.00
715	-4.77	2.76
749	-4.19	2.46
772	-3.86	2.34
801	-3.54	2.31
830	-3.37	2.46

Table 3. Initial potential temperature and specific humidity profiles

Z (m)	P (hPa)	Θ (K)	Q (Kg/Kg)
10	1020.91	292.72	0.0098
20	1019.73	293.02	0.0097
40	1017.37	293.41	0.0096
80	1012.67	294.30	0.0096
140	1005.67	295.68	0.0092
200	998.74	297.35	0.0089
203	998.50	297.35	0.0089
257	992.40	297.51	0.0089
308	986.60	297.66	0.0089
363	980.40	297.81	0.0089
408	975.40	297.94	0.0089
465	969.00	298.11	0.0089
520	962.80	298.27	0.0088
575	956.70	298.42	0.0088
635	950.20	298.60	0.0088
694	943.70	298.77	0.0088
749	937.80	298.93	0.0088
801	932.10	299.08	0.0088
854	926.40	299.23	0.0087

Initial Perturbations:

Initial SGS TKE field (if required): $TKE_{SGS} = 0.15\left(1-\frac{z}{200}\right)^2$ m^2/s^2 for $z \leq 200$.

For u and v fields, use $N\left(0{,}0.2\left(1-\frac{z}{200}\right)^2\right)$ [i.e., Gaussian random numbers with zero-mean and variance = $0.2\left(1-\frac{z}{200}\right)^2$] as initial perturbations for $z \leq 200$.

For Θ field, use $N(0{,}0.1)$ as initial perturbations for $z \leq 200$.

Geostrophic Forcings:

Table 4. Surface geostrophic wind

Time	Ugeo	Vgeo
(UTC)	(ms^{-1})	(ms^{-1})
20060701 23:00	-6.5	4.5
20060702 03:00	-5.0	4.5
20060702 06:00	-5.0	4.5
20060702 12:00	-6.5	2.5

Geostrophic wind profiles

Interpolate the surface geostrophic forcing linearly in time. Subsequently, at each time step, interpolate between the surface geostrophic wind linearly to Ugeo = -2.0 and Vgeo = 2.0 ms^{-1} at 2000 m.
Time-height plots of Ugeo and Vgeo are provided at:
http://www.atmo.ttu.edu/basu/GABLS3/Figures.html

Large-scale Advection:

Tendencies are prescribed constant in the column z = 200-800 m. Below 200 m apply a linear interpolation to zero at 0 m.

Sign convention: $\frac{\partial \emptyset}{\partial t} = \cdots + Large\_Scale\_Advection$ [For any variable $\emptyset$]

Table 5. Horizontal wind dynamic tendency (200-800 m)

Time	Uadv	Vadv
(UTC)	(ms^{-2})	(ms^{-2})
20060701 23:00	5.0 E-4	0.0 E-4
20060702 03:00	5.0 E-4	0.0 E-4
20060702 03:00	0.0 E-4	0.0 E-4
20060702 12:00	0.0 E-4	0.0 E-4

Table 6. Potential temperature dynamic tendency (200-800 m)

Time	Θadv
(UTC)	(Ks^{-1})
20060701 12:00	-2.5 E-5
20060702 01:00	-2.5 E-5
20060702 01:00	7.5 E-5
20060702 06:00	7.5 E-5
20060702 06:00	0.0 E-5
20060702 12:00	0.0 E-5

Table 7. Specific humidity dynamic tendency (200-800 m)

Time	Qadv
(UTC)	(Kg/kg/s)
20060702 00:00	0.0 E-8
20060702 02:00	0.0 E-8
20060702 02:00	-8.0 E-8
20060702 05:00	-8.0 E-8
20060702 05:00	0.0 E-8
20060702 12:00	0.0 E-8

Interpolate the large-scale advection forcings linearly in time.

Required Output:

Format: formatted ascii or netcdf. We will use Matlab to read these data files and synthesize the results.

Mean Profiles

Variables: z , U, V, Θ, and Q

Spatial averaging: horizontal plane-averaging

Temporal averaging: NONE

Output interval: every 5 min starting 00:05 UTC

Filename: mean_N.fmt [fmt: file extension; N = 1 for 00:05 UTC, N = 2 for 00:10 UTC and so on].

File structure (formatted ascii):

z	U	V	Θ	Q
x	x	x	x	x
x	x	x	x	x

In the case of netcdf, the files should contain the variables appropriately as 'z', 'U', 'V' etc.

Variance Profiles

Variables: z, σ_u^2, σ_v^2, σ_w^2, σ_θ^2, σ_q^2, and TKE_{SGS}

Spatial averaging: horizontal plane-averaging

Temporal averaging: NONE

Output interval: every 5 min starting 00:05 UTC

Filename: variance_N.fmt [fmt: file extension; N = 1 for 00:05 UTC, N = 2 for 00:10 UTC and so on].

File structure (formatted ascii):

z	σ_u^2	σ_v^2	σ_w^2	σ_θ^2	σ_q^2	TKE_{SGS}
x	x	x	x	x	x	x
x	x	x	x	x	x	x

In the case of netcdf, the files should contain the variables appropriately as ‘z’, ‘sigu’, ‘sigv’ etc.

Flux Profiles

Variables:	z, $\langle u'w' \rangle$, $\langle v'w' \rangle$, $\langle u'v' \rangle$, $\langle w'\theta' \rangle$, $\langle w'q' \rangle$, $\langle u'w' \rangle_{SGS}$ (or, τ_{xz}), $\langle v'w' \rangle_{SGS}$, $\langle u'v' \rangle_{SGS}$, $\langle w'\theta' \rangle_{SGS}$, and $\langle w'q' \rangle_{SGS}$
Spatial averaging:	horizontal plane-averaging
Temporal averaging:	NONE
Output interval:	every 5 min starting 00:05 UTC
Filename:	flux_N.fmt [fmt: file extension; N = 1 for 00:05 UTC, N = 2 for 00:10 UTC and so on].

File structure (formatted ascii):

z	$\langle u'w' \rangle$	$\langle v'w' \rangle$	$\langle u'v' \rangle$	$\langle w'\theta' \rangle$	$\langle w'q' \rangle$	$\langle u'w' \rangle_{SGS}$	$\langle v'w' \rangle_{SGS}$	$\langle u'v' \rangle_{SGS}$	$\langle w'\theta' \rangle_{SGS}$	$\langle w'q' \rangle_{SGS}$
x	x	x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x	x	x

In the case of netcdf, the files should contain the variables appropriately as ‘z’, ‘uw’, ‘wqsgs’ etc.

3D Snapshots (ScienceQ: spectral analysis, flow visualization)

Variables:	x, y, z, u, v, w, θ, and q
Spatial averaging:	NONE
Temporal averaging:	NONE
Output interval:	every 1 hr starting 03 UTC

Filename: 3D_N.fmt [fmt: file extension; N = 1 for 03:00 UTC, N = 2 for 04:00 UTC and so on].

File structure (formatted ascii):

x	y	z	u	v	w	θ	q
x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x

In the case of netcdf, the files should contain the variables appropriately as ‘x’, ‘y’, ‘z’, ‘u’, etc.

Surface Time Series

Variables: $\langle u'w' \rangle_{surface}$, $\langle v'w' \rangle_{surface}$, $\langle w'\theta' \rangle_{surface}$, $\langle w'q' \rangle_{surface}$

Spatial averaging: horizontal plane-averaging

Temporal averaging: NONE

Output interval: every 10 s starting 00:00:10 UTC

Filename: surface.fmt [fmt: file extension].

File structure (formatted ascii):

time (s)	$\langle u'w' \rangle_{surface}$	$\langle v'w' \rangle_{surface}$	$\langle w'\theta' \rangle_{surface}$	$\langle w'q' \rangle_{surface}$
10	x	x	x	x
20	x	x	x	x

Time Series (ScienceQ: turbulence bursting)

Variables: u, v, w, θ, q, and TKE_{SGS}

Spatial averaging: NONE

Temporal averaging: NONE

Output interval: every 10 s starting 00:00:10 UTC

Filename: timeseries_Z.fmt [fmt: file extension; Z: height in m – closest to 10, 25, 50, 100, 200 m ‘only’].

File structure (formatted ascii):

Example: For timeseries_50.dat -> output u, v, w, θ, q, and TKE_{SGS} from (nx/2, ny/2, z ~50 m).

time (s)	u	v	w	θ	q	TKE_{SGS}
10	x	x	x	x	x	x
20	x	x	x	x	x	x