# Second GABLS experiment

*Instructions for participating modelers*

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## Introduction

This case is taken from the CASES-99 experiment (Poulos et al, 2002). It was previously simulated by Steeneveld et al. (2005), in which they focused on the energy balance at the surface. The case is chosen with the purpose to study the diurnal cycle. The geographical location for the experiment, Kansas US, is covered with prairie grassland and the area is relatively flat with some minor topography. Here, we have chosen to start the simulation at 19 UTC (14 LT) on October 22, 1999 (Julian day 295) and a simulation time of 59 hours.

The background geostrophic wind is in this period from the northern sector and it is weakening somewhat in combination with some subsidence during the second day. To control the simulations, the goal is to keep the constraining conditions as "simple" as possible, i.e. the surface temperature is prescribed, the surface water content and the pressure gradient are both kept constant during the simulation. However, the ambition is to keep the forcing conditions similar enough to the real conditions making it possible to compare the model results with the observations, but the main aim is to inter-compare the various models performance. There are many observations taken during the campaign (see http://www.joss.ucar.edu/cases99/) that gives opportunity to compare many aspects of the model results with observations as well as with themselves.

## Model setup

- Vertical domain: Minimum 4000 m, preferably log-linearly distributed gridpoints with the first point close to the ground O (1 m) and at least 100m resolution close to the model top. Optionally, if models have a specific operational grid this may also be used.
- Time-step – in accordance with the vertical resolution used.
- Radiation scheme turned off.
- Latitude: 37.6º N
- Longitude: -96.7º E
- Surface pressure: 972 hPa (The location is at 436 m a.s.l.)
- Surface roughness length: $z_0$=0.03 m
- Surface temperature roughness: $z_T=z_0/10$
- Surface condition: u, v=0 at $z_0$
- Geostrophic wind constant with height and time $u_g$=3 $ms^{-1}$, $v_g$= –9 $ms^{-1}$
- Large scale synoptic divergence *from hour 40 (i.e. 16:00LT, October 23)* resulting in w=-0.005 *z/1000 $ms^{-1}$ for $z \leq 1000$ m and w=-0.005 $ms^{-1}$ for $z > 1000$ m

- Initial profiles of temperature and specific humidity:

| Θ (K) | q (kg kg$^{-1}$) | z (m) |
|---|---|---|
| 288 | 0.0025 | 0 |
| 286 | 0.0025 | 200 |
| 286 | 0.0025 | 850 |
| 288 | 0.0025 | 900 |
| 292 | 0.0005 | 1000 |
| 300 | 0.0030 | 2000 |
| 310 | 0.0020 | 3500 |
| 312 | 0.0015 | 4000 |

- The skin temperature in degrees Celsius is given by (t is local time +24 or 48):

  if ($t \leq 17.4$)

  T=-10-25*cos(t*0.22+0.2)

  elseif (t >17.4 & $t \leq$ 30)

  T=-0.54*t+15.2

  elseif (t>30. & $t \leq 41.9$)

  T=-7-25*cos(t*0.21+1.8)

  elseif (t>41.9 & $t \leq 53.3$)

  T= -0.37*t+18;

  elseif (t>53.3 & $t \leq 65.6$)

  T=-4-25*cos(t*0.22+2.5)

  elseif (t>65.6)

  T=4.4

  end

- The latent heat flux at the surface is 2.5% of its potential value
- TKE should be initialized with $0.5*(1-z/800)$ for $0 \leq z \leq 800m$ and the model minimum value above that
- Other constants (if required): gravitational acceleration g=9.81 ms$^{-2}$; reference temperature $\theta_0$= 283.15K; reference pressure $p_0$=1000 hPa

**Results**

For participating models we ask for result files written in ASCII format. The first file should contain the vertical profiles of the mean variables for each hour of simulation. The file should be named "mean_" followed by the acronym of your model ending with ".dat". The data should be presented as in the table below with all hours right after each other, one profile per hour.

mean_"acronym".dat

| z (m) | P (hPa) | T (K) | θ (K) | q (kg kg$^{-1}$) | u (ms$^{-1}$) | v (ms$^{-1}$) | w (ms$^{-1}$) |
|---|---|---|---|---|---|---|---|
| (T=0) $z_1$ … $z_{MAX}$ | $P_1$ … $P_{MAX}$ | | | | | | |
| (T=1) $z_1$ … $z_{MAX}$ | | | | | | | |
| … | | | | | | | |
| (T=$T_{MAX}$) $z_1$ … $z_{MAX}$ | | | | | | | |

The second file should contain the vertical profiles of turbulence statistics. This file should be named "turb_" followed by the acronym of your model and ending with ".dat". The data should be presented as in the table below with all hours right after each other, one profile per hour.

turb_"acronym".dat

| z (m) | TKE (m$^2$s$^{-2}$) | u'$^2$ (m$^2$s$^{-2}$) | v'$^2$ (m$^2$s$^{-2}$) | w'$^2$ (m$^2$s$^{-2}$) | θ'$^2$ (K$^2$) | w'θ' (ms$^{-1}$K) | w'$^3$/( w'$^2$)$^{3/2}$ |
|---|---|---|---|---|---|---|---|

The next file should contain vertical profiles of the eddy coefficients and the vertical fluxes of momentum, heat and water vapor. The file should be named flux_"acronym".dat and be reported in the same way as in the previous files.

flux_"acronym".dat

| z (m) | $K_m$ (m$^2$s$^{-1}$) | $K_h$ (m$^2$s$^{-1}$) | u'w' (m$^2$s$^{-2}$) | v'w' (m$^2$s$^{-2}$) | w'θ' (ms$^{-1}$K) | w'q' (ms$^{-1}$ kg kg$^{-1}$) |
|---|---|---|---|---|---|---|

The fourth file should contain the budget terms of the TKE equation for each hour all right after each hour as in the other files. This file should be named budget_"acronym".dat.

budget_"acronym".dat

| z (m) | Shear (m$^2$s$^{-3}$) | Buoyancy (m$^2$s$^{-3}$) | Total transport (m$^2$s$^{-3}$) | Dissipation (m$^2$s$^{-3}$) |
|---|---|---|---|---|

The surface values of the following parameters should be given every 5 minutes for the entire simulation. The time should be given in hours of simulation time in units of hours and fractions thereof. This file should also be in ASCII format and named with the model acronym in it according to surf_"acronym.dat".

surf_"acronym".dat

| Simulation time (h) | Monin-Obukhov length L (m) | BLH (m) | Friction velocity ($ms^{-1}$) | $w'\theta'$ ($ms^{-1}K$) | $w'q'$ ($ms^{-1}$ kg $kg^{-1}$) |
|---|---|---|---|---|---|

The boundary layer height reported here should be the height, where the value of $\sqrt{(uw^2 + vw^2)}$ falls to 95% of its surface value, divided by 0.95.

A file containing information on the model should also be submitted. The file should contain information of the closure, the grid, timestep, etc. A main reference for the model should be given and a contact person for the simulation. Any deviations or problems with the result files could be commented on in this file as well.

**Submission**

We look forward to receive model results from you submitted to gunilla@misu.su.se before August 15, 2005. The first results will be presented on the upcoming workshop in the Netherlands, September 19-21, 2005.

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**References**

Poulus, G.S., and Coauthors, 2002: CASES-99: A comprehensive investigation of the stable nocturnal boundary layer. *Bull. Amer. Meteor. Soc.,* **83,** 555–581.

Steeneveld, G.J., B.J.H. van de Wiel and A.A.M. Holtslag, 2005: Modelling three archetypes of the nocturnal boundary layer for CASES-99. Submitted to *Journal of Atmospheric Sciences.*