The nocturnal boundary layer height at Bucharest-Baneasa: lidar measurements versus modelled values

D. Dobrovolschi, V. Ristici, Anca Ristici, Rodica Sandu, C. Rada, F. Nicodim, B. Lucaschi
National Meteorological Administration, Bucharest, Romania,

RAIDO

norway grants

INNOVATION NORWAY

norway grants

4th OTEM, 19-21 October 2010,
Cluj-Napoca

- The PBL (daytime and nocturnal)
- The importance of the PBL height h
- Methods to determine h
- The lidar of The National Meteorological Administration
- An example: February 18th, 2009 Bucharest

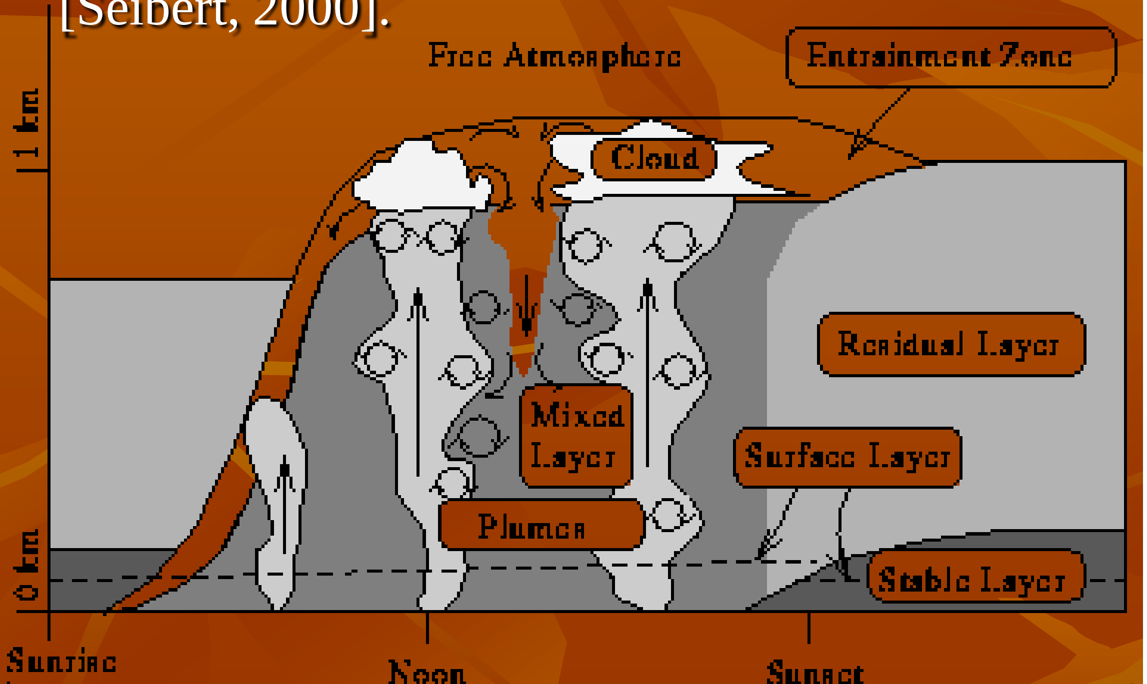
The PBL (daytime and nocturnal)

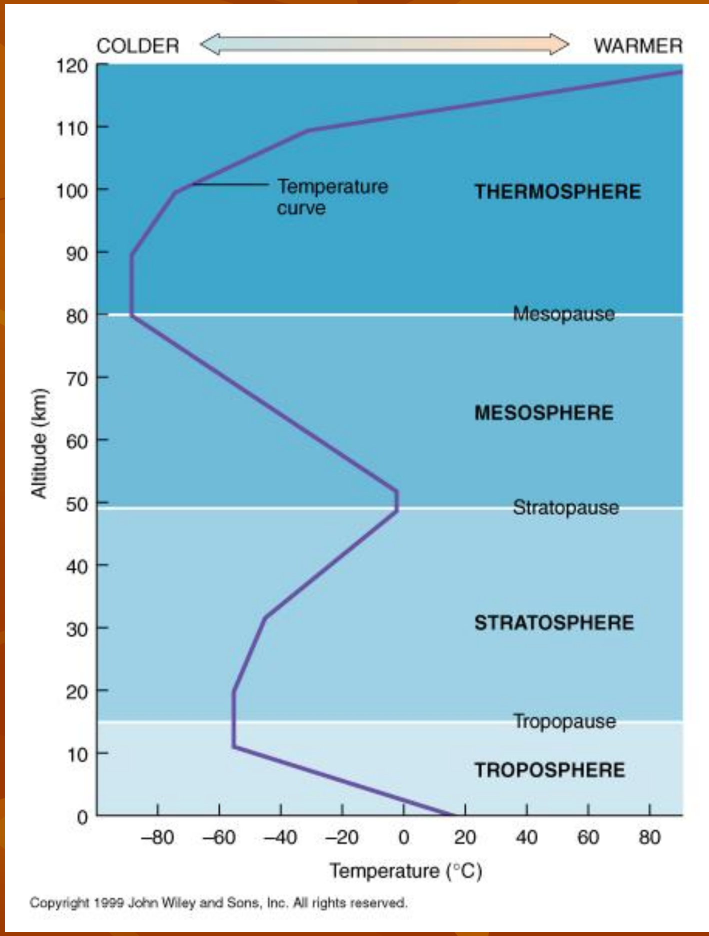
- the part of the troposphere that is

-directly influenced by the presence of the earth's surface, and

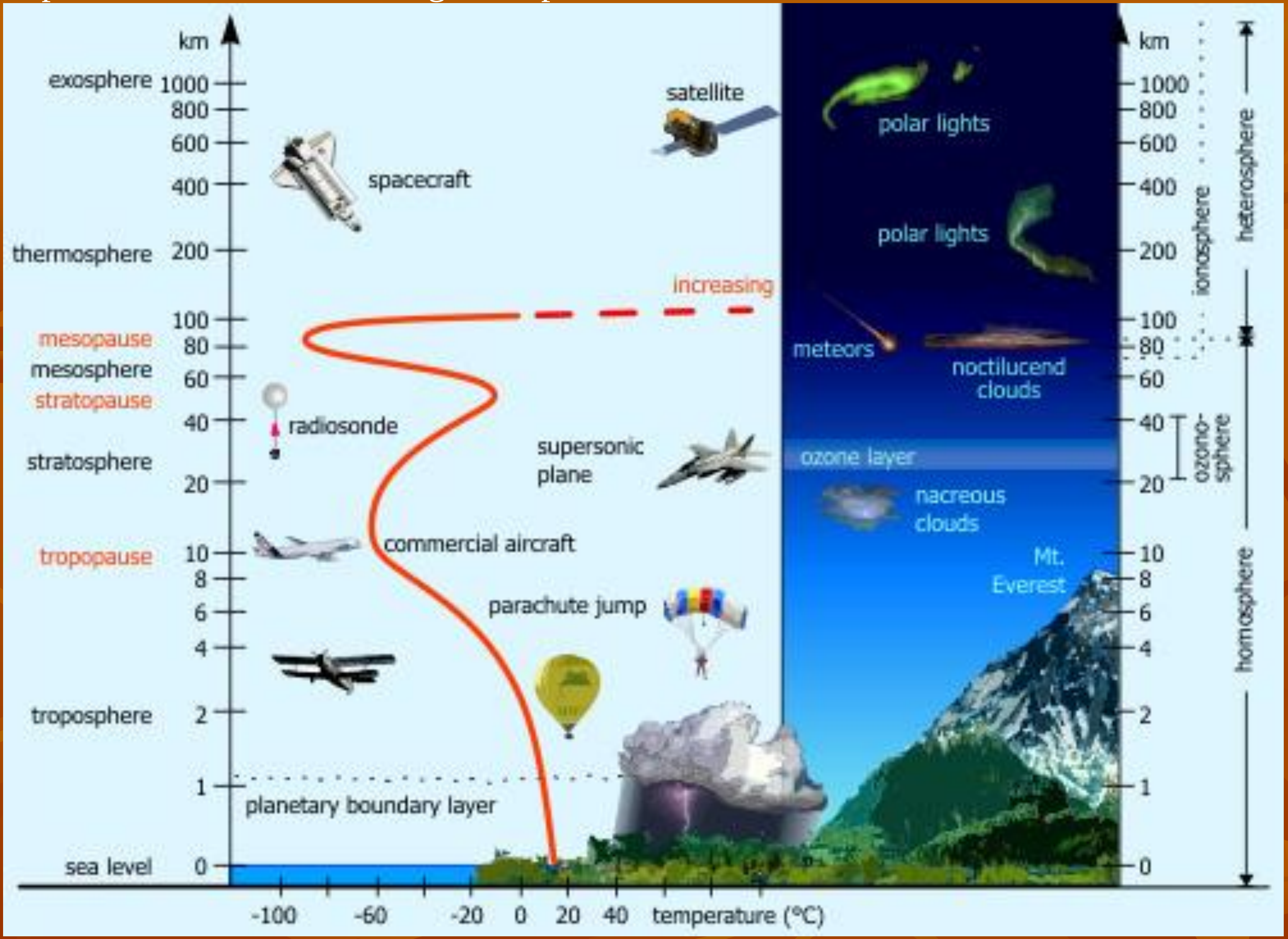
-responds to surface forcings with a time scale of about an hour or less [Stull, 1988];

-vertical dispersion within about an hour [Seibert, 2000].





http://www.nairaland.com/nigeria/topic-421464.64.html



- NBL: The boundary layer from sunset to sunrise;
- It is often a stable layer, which forms when the solar heating ends and the radiative cooling and surface friction stabilize the lowest part of the PBL. Above that, the remnants of the daytime CBL form a residual layer.
- The nocturnal boundary layer may also be convective when cold air advects over a warm surface.

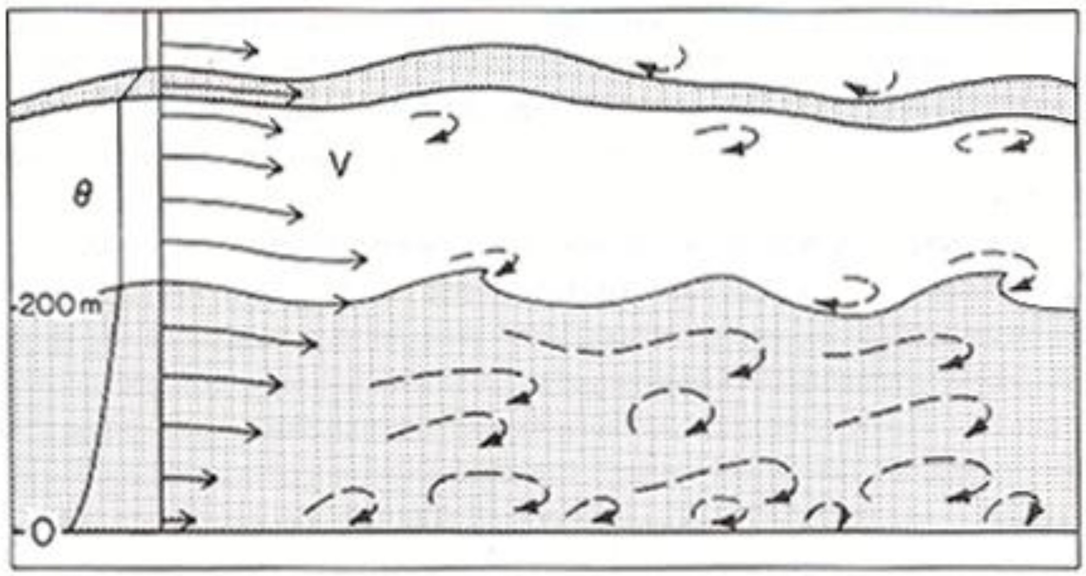
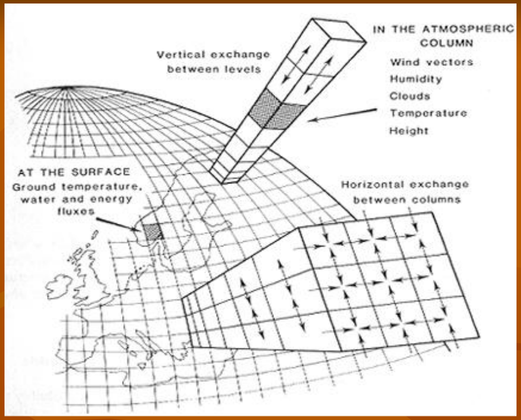
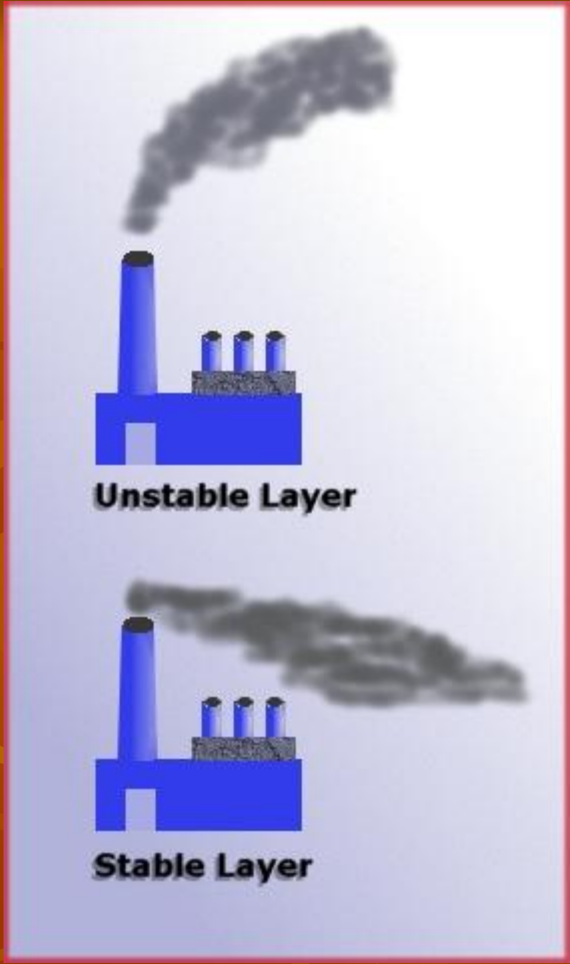


FIG. 1.5. Schematic of stable boundary layer flow showing eddy structure, waves, and elevated inversion layer (from Wyngaard, 1990).

- The PBL height *h* is important for parameterizing the PBL in large-scale atmospheric circulation models and air pollution dispersion models.





- The dispersion of pollutants

during stable stratification (e.g. during the nighttime) is strongly affected by *h*:
if the effective pollutant source height is smaller than *h*, then *h* is the upper limit up to where pollutants spread. Since at night *h* can be smaller than 100 m, this may result in very high concentrations near the ground that seriously affect human health.

Methods to determine h

-from profile measurements
---radiosoundings
---remote sounding systems (lidars, sodars, wind profilers)
-from parameterizations and models
---diagnostic or prognostic equations

Under stable conditions

Diagnostic equations:

$$h = a_1 u_* / f$$

$$z_m = c_m (u_* / f)$$

$$c_m = 0.25$$

a_1 is 0.07-0.3
with 0.3 for neutral conditions

Prognostic equations:

$$\frac{dh}{dt} = \frac{h_e - h}{\tau_e}$$

Properties of lidar as a remote sensing tool (Geraint Vaughan, Manchester)

Advantages

- Good height and time resolution
- Backscattered signals readily interpreted
- May be mounted on trailers or aircraft for mobile operation
- No distorsion of the flow

Disadvantages

- Affected by cloud (light can't get through)
- Background light is a problem during daytime
- Systems to observe the stratosphere tend to be expensive and large
- Precise alignment must be maintained

Elastic micro lidar
at the Natl Met Admin

-Used for research
-based on a 3D astronomic telescope configuration (Cassegrain, 20 cm) with a solid state micropulse laser (Nd: YAG at 532 nm , 3μJ / 7Khz) for the transmitter and a PhotonCounting Module Detection for the receiver part.

An example: February 18th, 2009 Bucharest

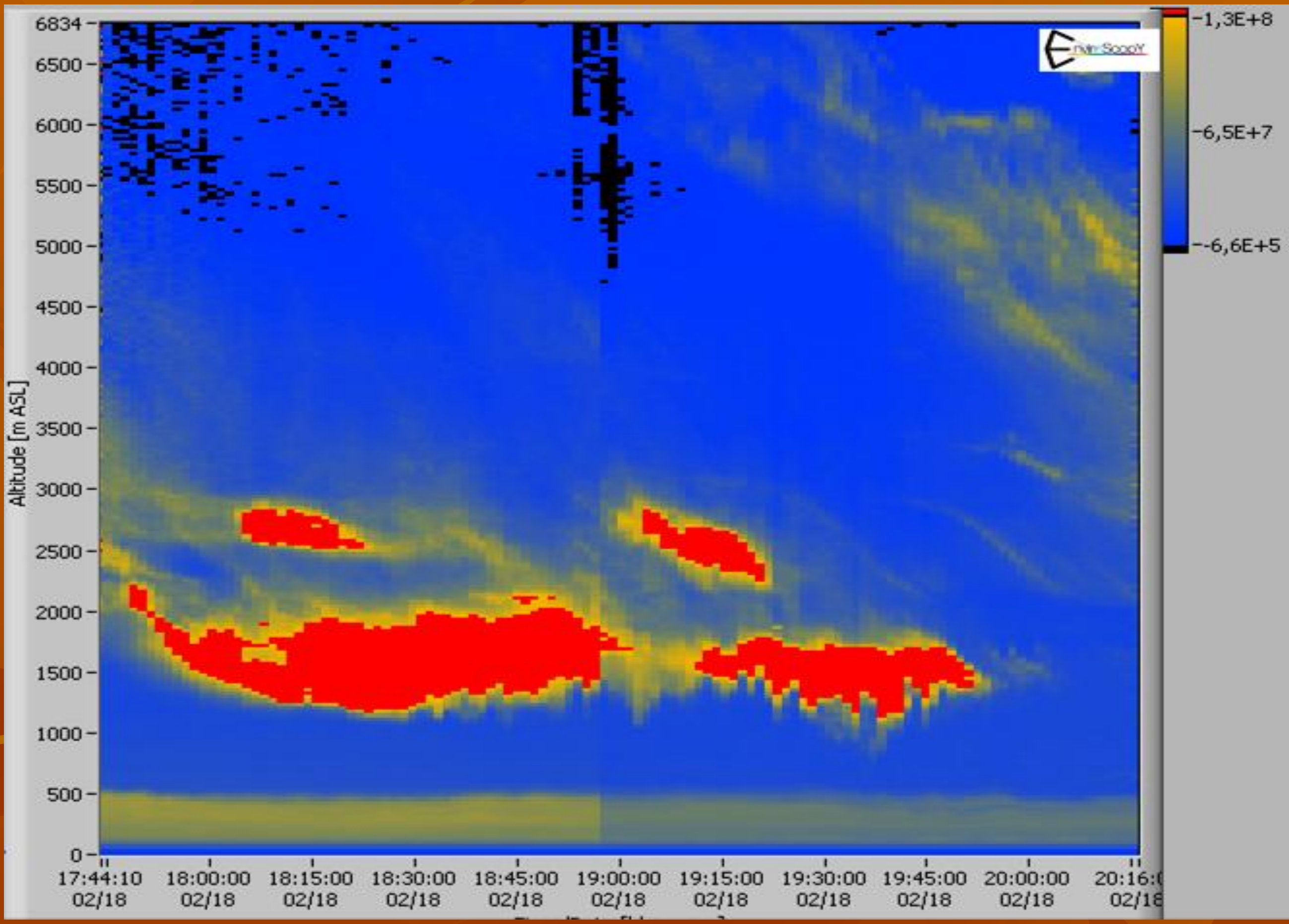
OML model:

u* = 0.1 m/s
u*/f = 1000 m

$$z_m = c_m (u_* / f)$$

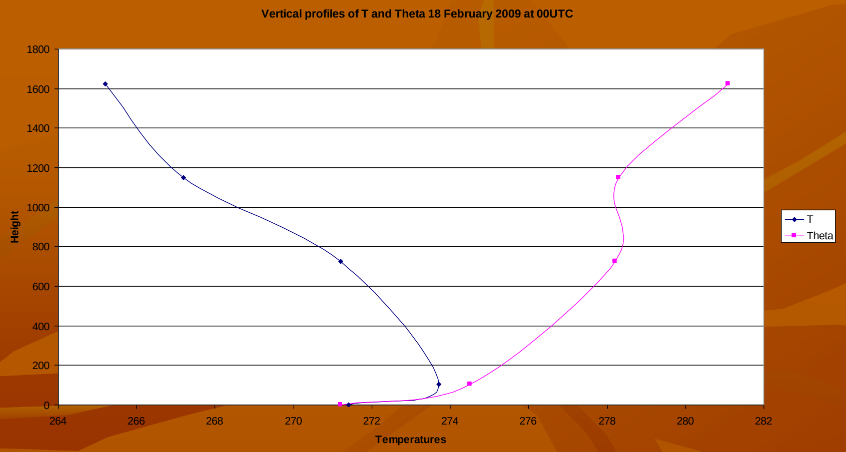
Z_mech=250 m

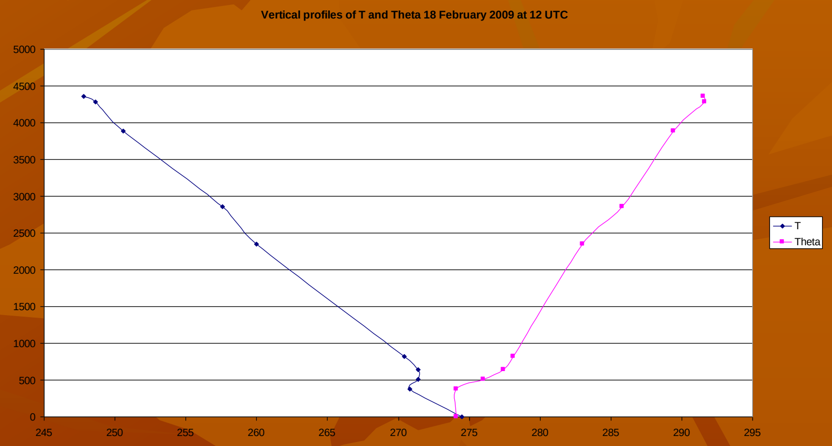
Z_lid = 150 m
L = 50 m
Z_mix=min{z_mech, z_lid}

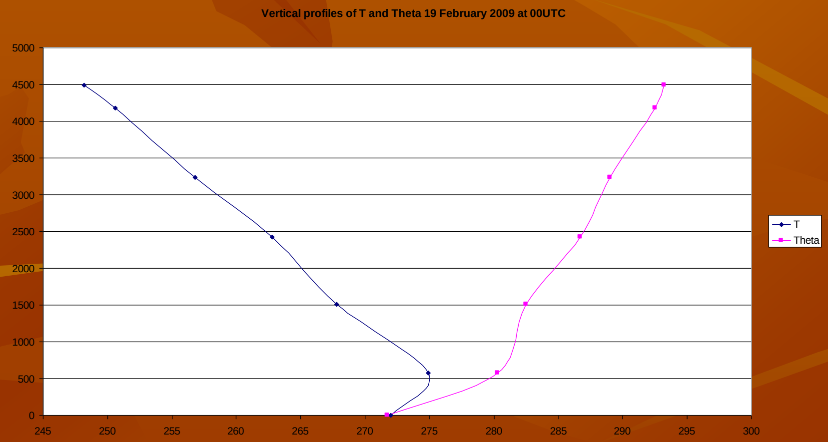


(Lu*/f)1/2 = 223.6 m

(30 L)-1 + (f / (0.35 u*))-1 = 284 m


Vertical profiles of T and Theta 18 February 2009 at 00UTC
Height
Temperatures
T
Theta

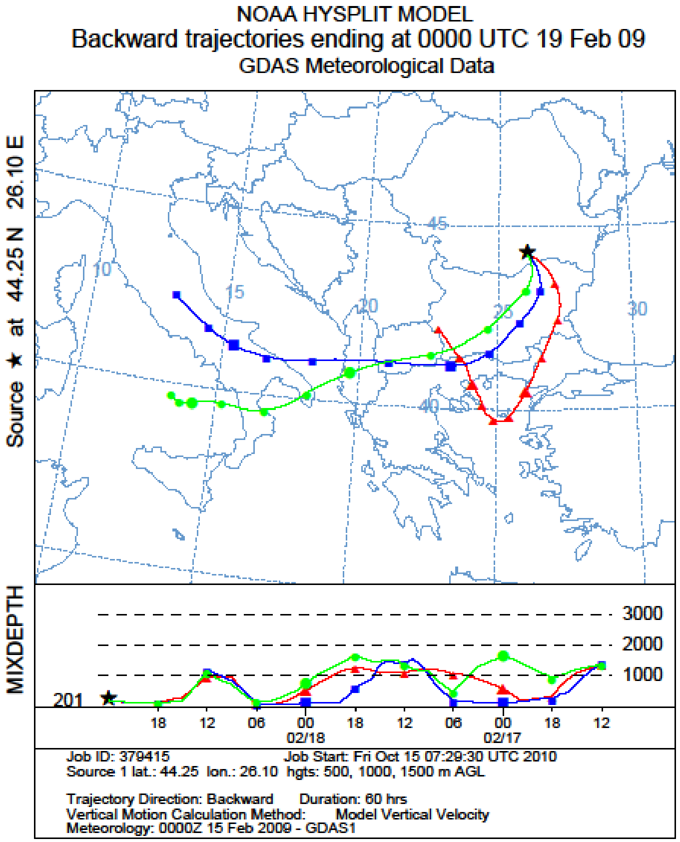

Vertical profiles of T and Theta 18 February 2009 at 12 UTC
T
Theta

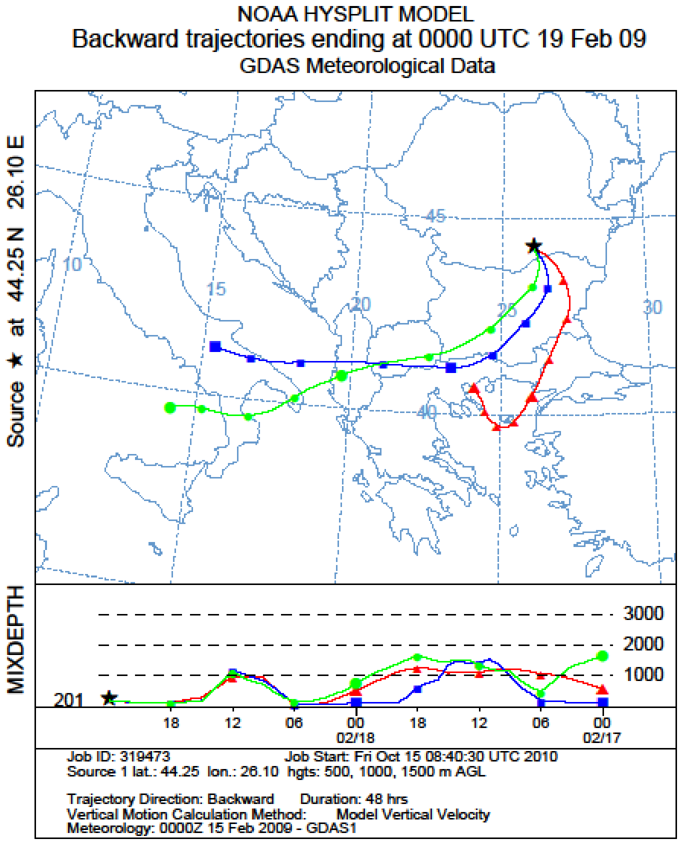

Vertical profiles of T and Theta 19 February 2009 at 00UTC
T
Theta

60 hrs backward

Red -500m
Blue -1000m
Green-1500m

48 hrs backward





The authors acknowledge the kind support of RADO (Romanian Atmospheric Research 3D Observatory) consortium and Innovation Norway.

"**Oliviers avec les Alpilles dans le fond**" de Vincent Van Gogh (1889)