Meteorological Driver for CTM

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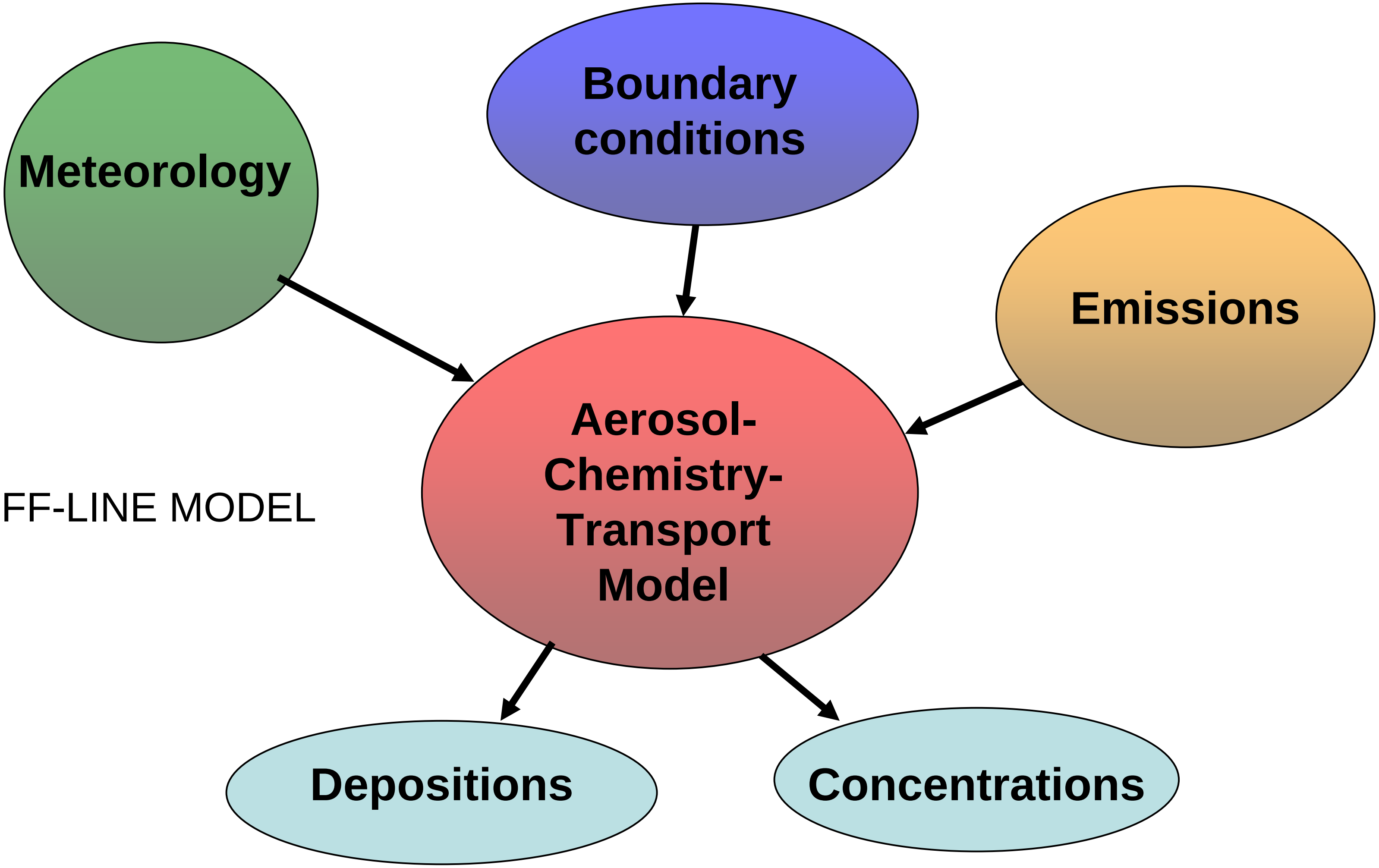
Model-System



OFF-LINE MODEL

Chemical Transport Models

LARGE and URBAN SCALE:

- 3D-CTM REM/CALGRID (RCG)

URBAN/LOCAL SCALE:

- 3D-CTM MICRO-CALGRID FOR MULTIPLE STREET CANYONS
- 2D-STREET MODEL CPB FOR A SINGLE STREET CANYON
- PARTICLE MODEL

aims

- Presentation of meteorological fields for long term modeling and diagnostics:
- large scales (Europe)
- Urban/regional scales (e.g. Berlin/Brandenburg)
- Street canyon (e.g. Berlin)

General Procedure

Iterative diagnostic procedure:

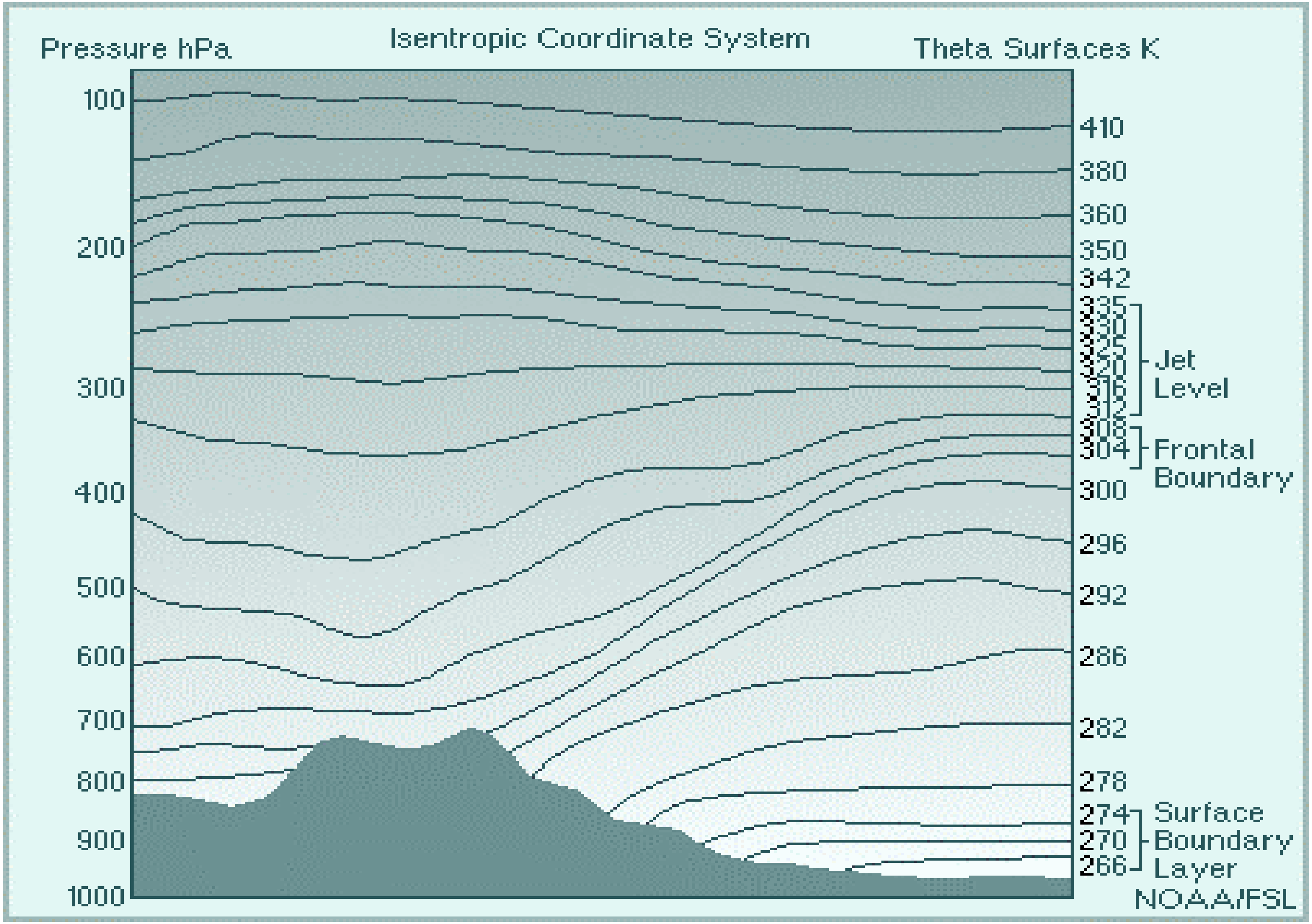
Use of observations: problem is resolution by network

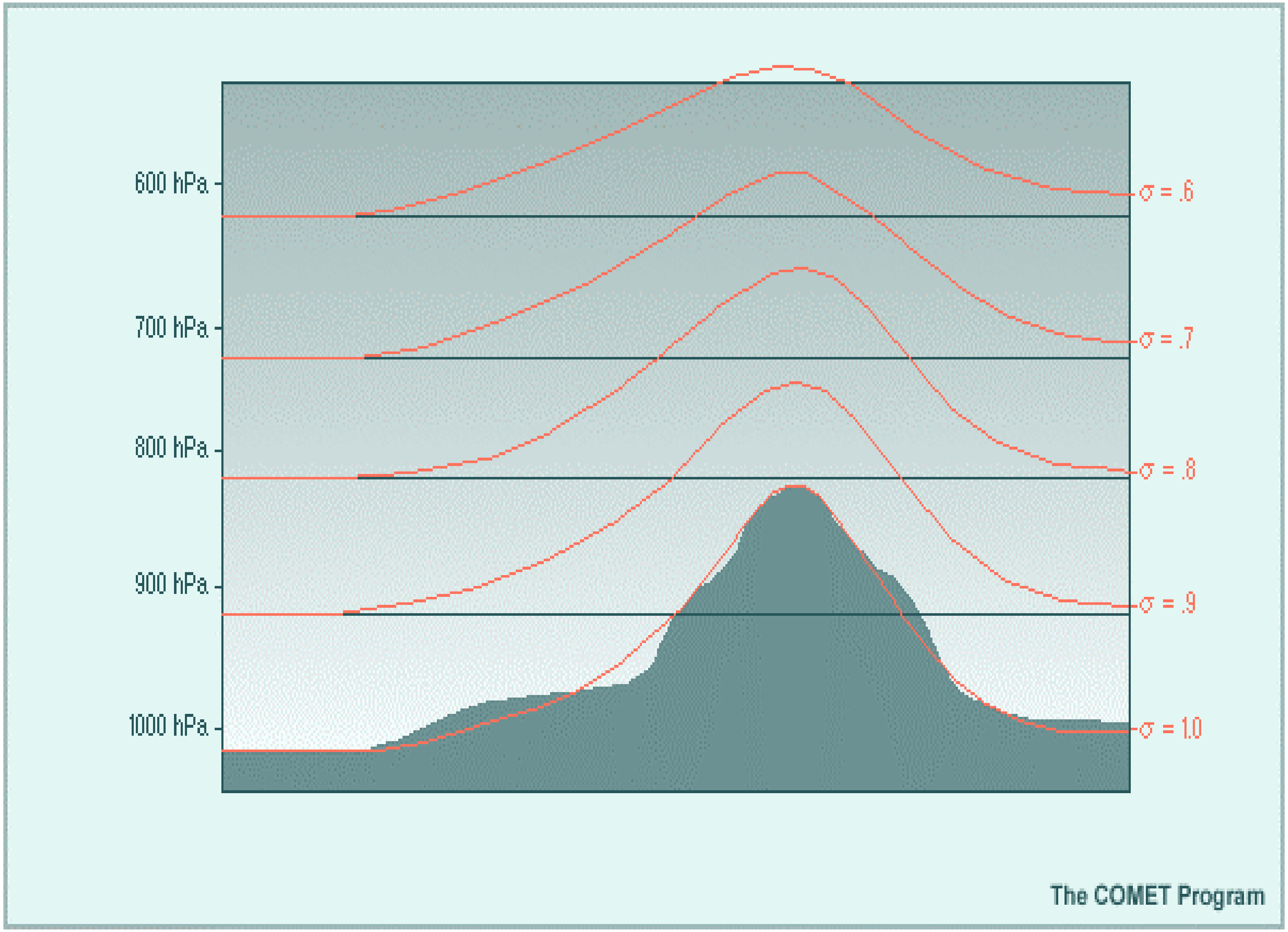
Use of forecasts: problem with forecast errors and cloud param.

- First guess by large scale fields from statistical Interpolation or ECMWF analysis

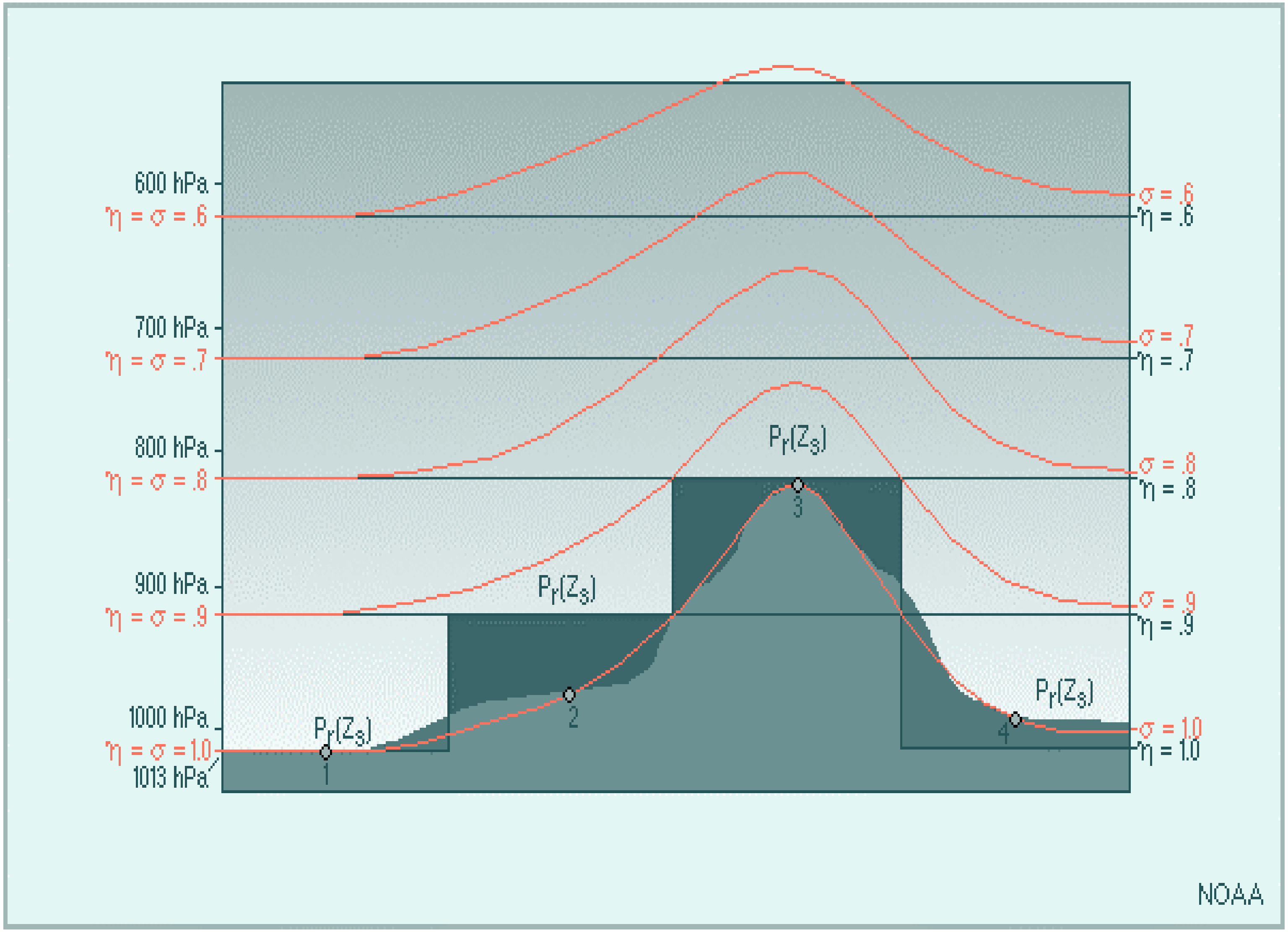
- Transformation to isentropic coordinates (inversions, local stability..)
- Correction by statist. Interpolation, ~ 25km² grid
- Correction by statist. Interpolation, ~ 2 or 4km² grid

- Transformation to eta or hybrid coordinates
- Adaptation to orography and landuse, ~ 1 to 4 km² grid


Isentropic Coordinate System
Pressure hPa
Theta Surfaces K
100
200
300
400
500
600
700
800
900
1000
410
380
360
350
342
335
330
325
320
316
312
Jet Level
308
304
Frontal Boundary
300
296
292
286
282
278
274
270
266
Surface Boundary Layer
NOAA/FSL



600 hPa
700 hPa
800 hPa
900 hPa
1000 hPa
σ = .6
σ = .7
σ = .8
σ = .9
σ = 1.0
The COMET Program



600 hPa
η = σ = .6
700 hPa
η = σ = .7
800 hPa
η = σ = .8
900 hPa
η = σ = .9
1000 hPa
η = σ = 1.0
1013 hPa
σ = .6
η = .6
σ = .7
η = .7
σ = .8
η = .8
σ = .9
η = .9
σ = 1.0
η = 1.0
Pr(Zs)
Pr(Zs)
Pr(Zs)
Pr(Zs)
1
2
3
4
NOAA

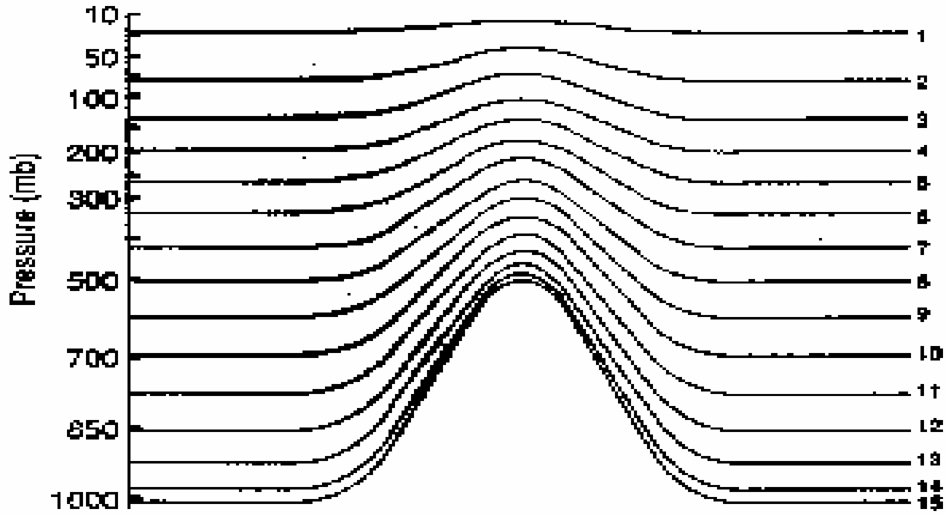
CTM Coordinates

Generalized horizontal coordinate systems, including latitude-longitude

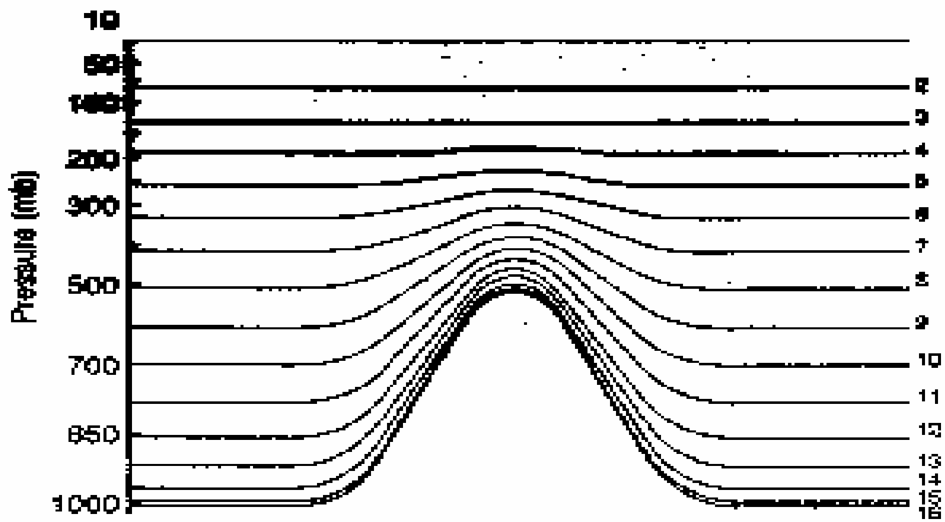
Multi layer system in terrain following coordinates,

fixed heights or

dynamically variing following the time depentent mixing height

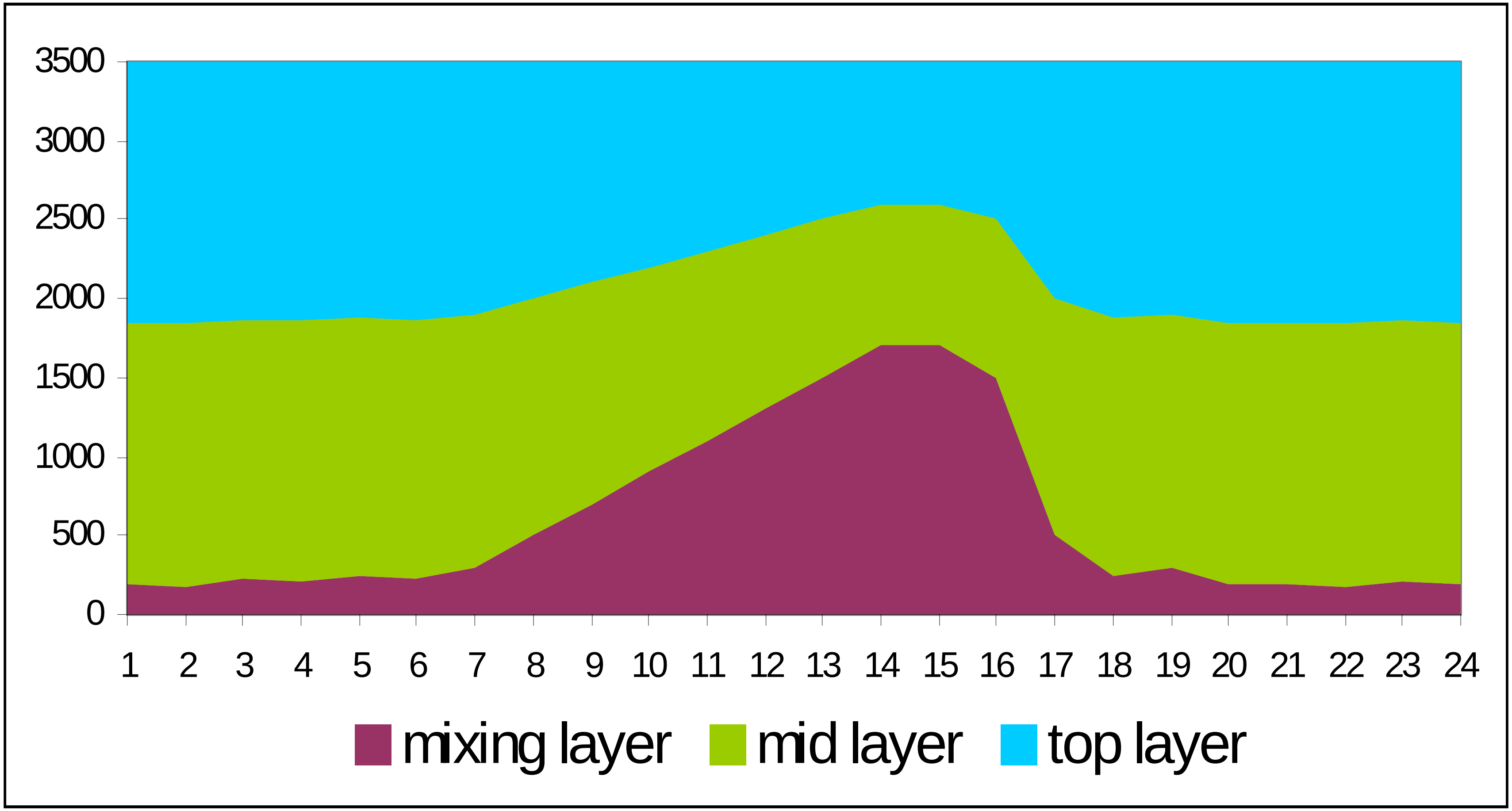


15 livelli in coordinate sigma



26 livelli incoordinate ibride

Vertical structure



Numerical Analysis

- Meteorological Parameter are analyzed in two steps
- 25km and 2km horizontal resolution
- Isentropic surfaces in the vertical,
- Boundary layer parameters are modeled
- Data from weather-services
- Additional wind data from monitoring net of envir. admin. of Berlin and Brandenburg
- Adjustment to topography (adjustment vertical velocity profiles, divergence minimization, blocking effects, sloping topography)

3-dimensional fields:
temperature, relative humidity, wind vector,
Montgomery potential, Exner function and local stability

2-dimensional fields:
Surface temperature, surface relative humidity, wind vector,
water temperature, surface pressure, pressure tendency,
cloud coverage, cloud type, cloud top and ceiling,
horizontal visibility,
temperature inversions (height and thickness)
precipitation 3 hourly or 1 hourly
snow cover

planetary boundary layer:
mixing height,
Monin Obukhov length,
ustar, turbulent temperatur scale, wstar
sensible heat flux, latent heat flux
Z0, albedo in dependence to landuse

Model Configuration

5 vertical layers:

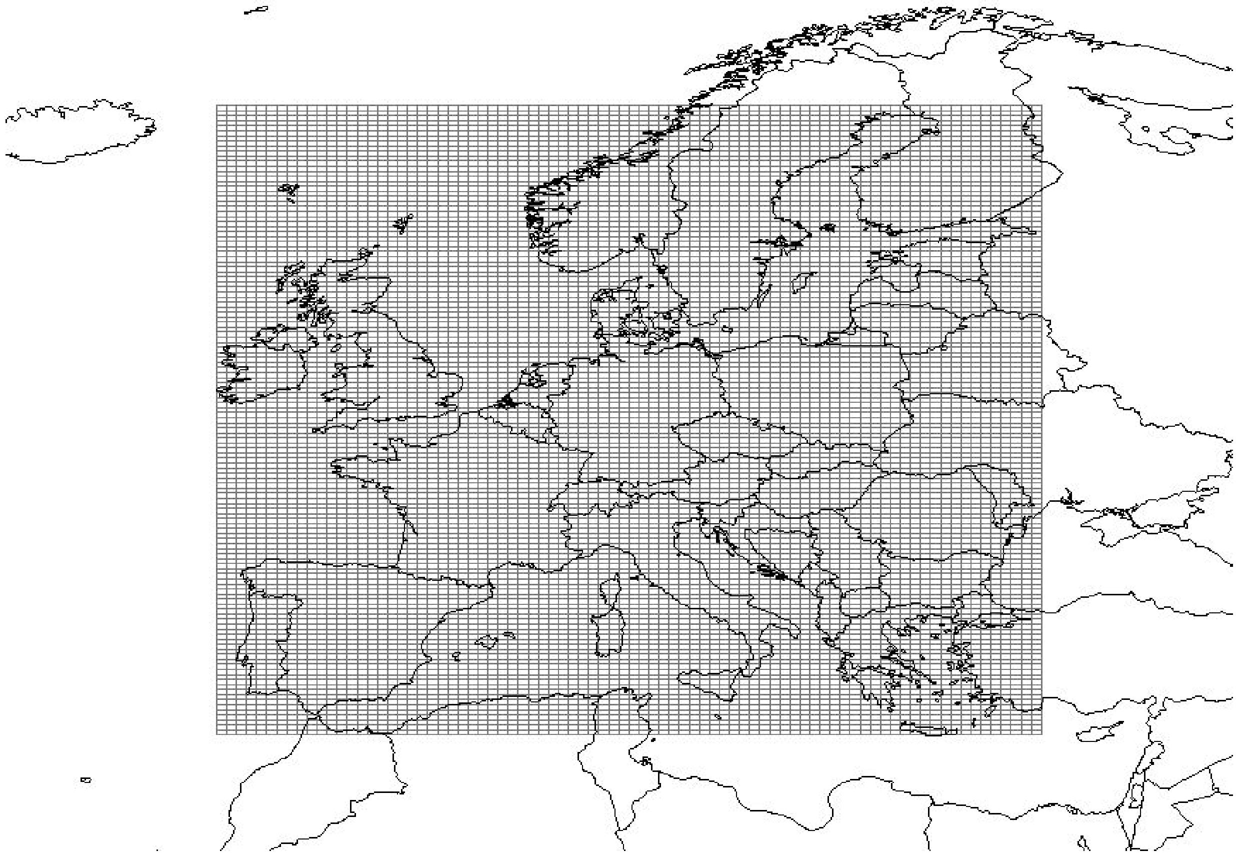
- a 20 m thick surface layer

- two equal-thickness layers below the mixing height

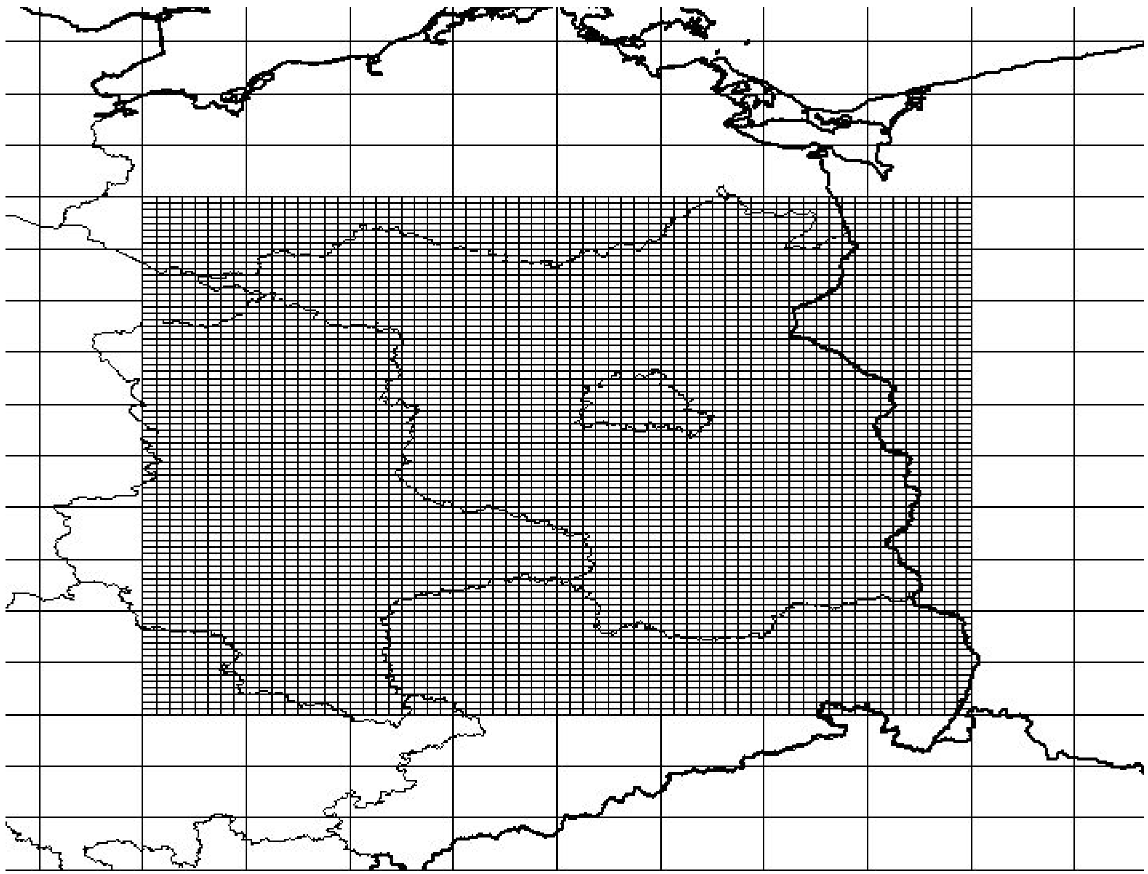
- 2 above the mixing height and extending to the domain top at 3000 m.

large scale model domain

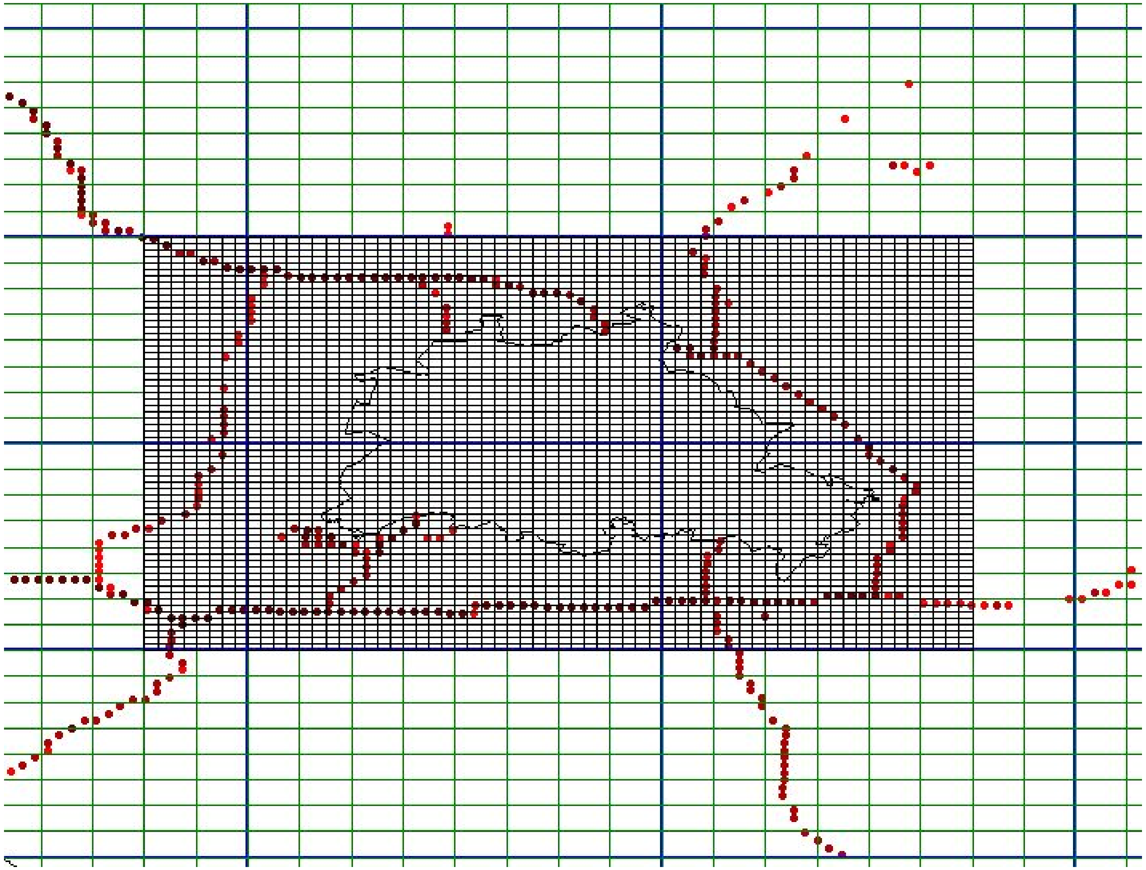
RESOLUTION: 0.25° LATIDUDE, 0.5° LONGITUDE
82 x 125 grid cells



urban/regional scale model domain Berlin-Brandenburg (Nest 1): 4x4 km^2



urban scale model domain Berlin-Brandenburg (Nest 2): 1x1 km^2



Street Canyon Model

1. Urban analysis parameters:

- Wind vector
- Local stability
- Cloud cover
- Stability classes (Klug – Manier)

2. Urban Model Miskam (Eulerian equations)

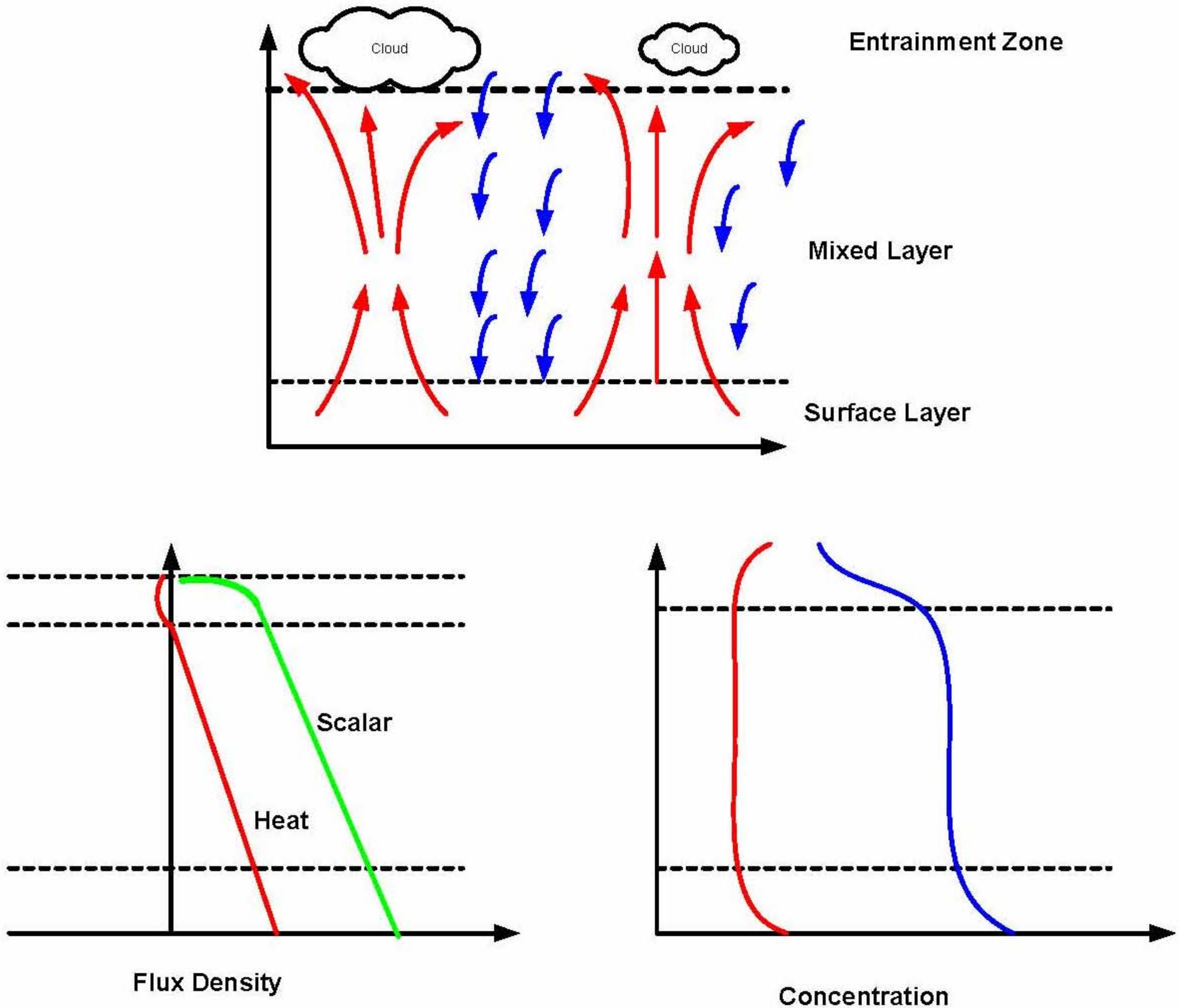


Figure 1 Conceptual view of the planetary boundary layer

- Several boundary layers are pertinent to the study of atmospheric turbulence. They are the planetary boundary layer, the surface boundary layer and the internal or constant flux layer.
- A nocturnal boundary layer exists at night with its own distinct properties, due to the stability of the surface layer. It is associated with decoupling between the surface and upper layer, there can be a jetting of winds aloft and turbulent transfer can be intermittent and associated with gravity waves.

- Friction velocity is a scaling velocity that is related to momentum transfer

$$u_* = \sqrt{\frac{\tau}{\rho}}$$

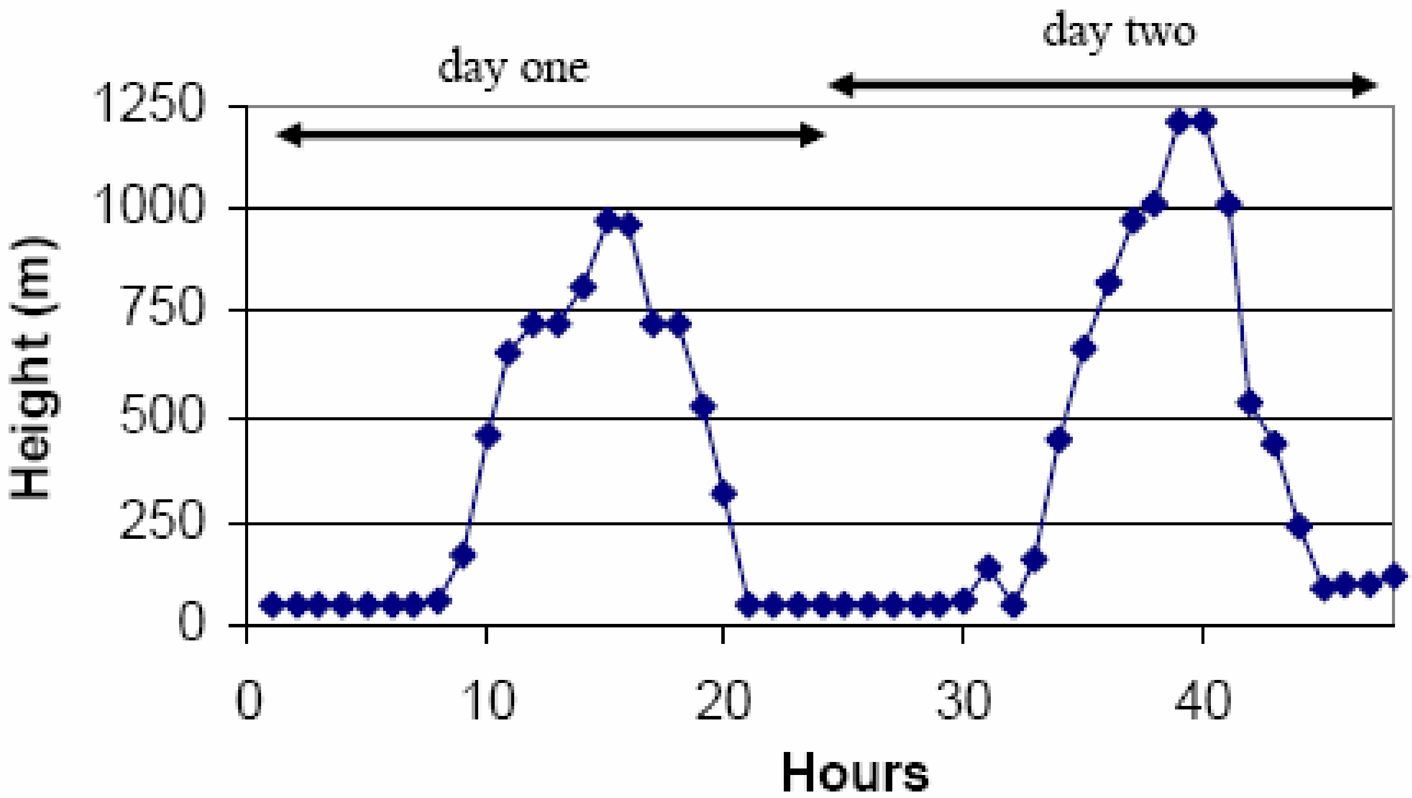
- The eddy exchange coefficient for momentum transfer can be estimated with measurements of wind profiles:

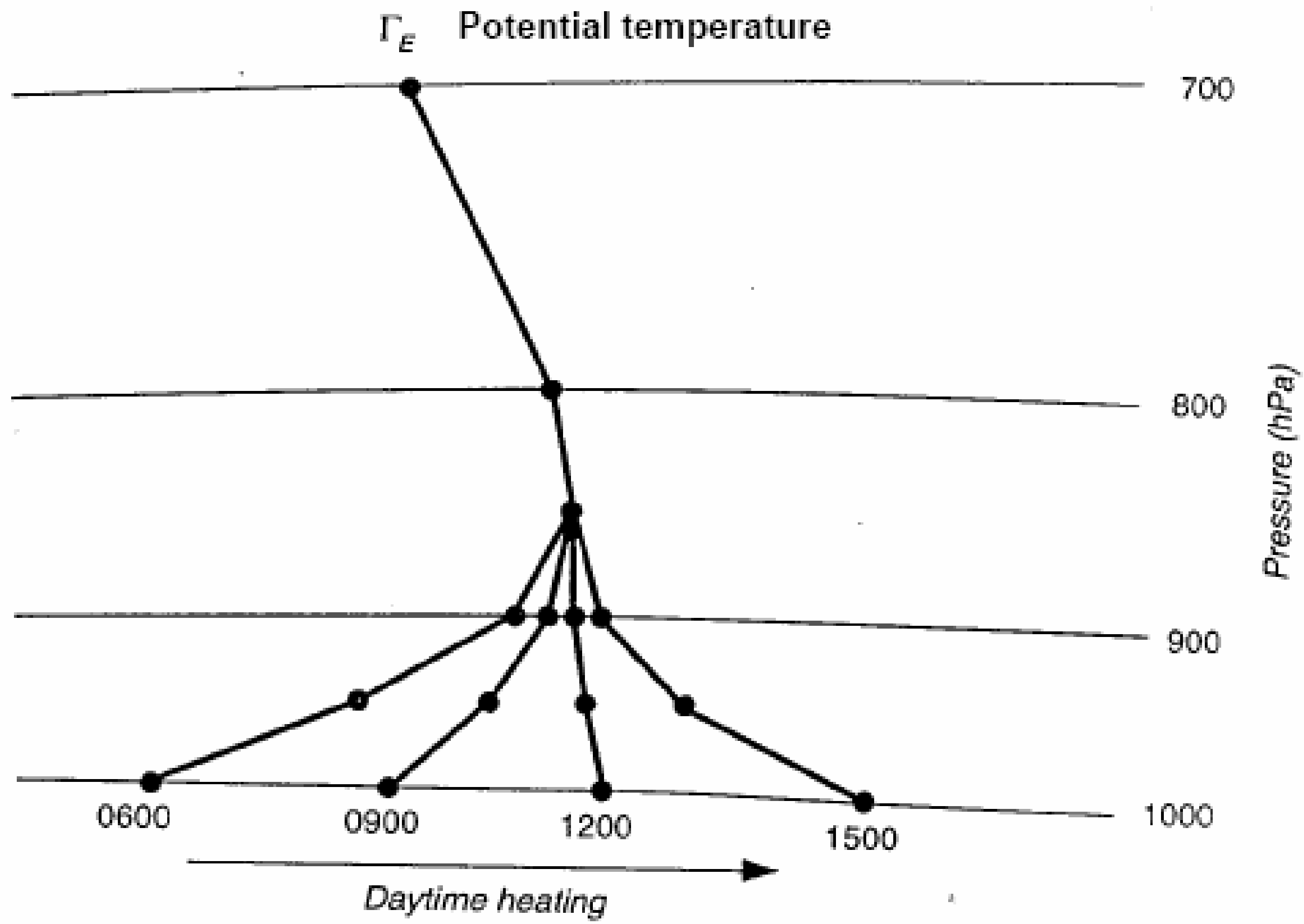
$$K_m = k^2 z^2 \frac{\partial u}{\partial z} = u_* k z \quad (\mathrm{m^2\ s^{-1}})$$

- Wind velocity profiles in the surface boundary layer is a logarithmic function of height. The slope of the log profile for wind velocity is a function of friction velocity and the zero intercept is a function of the roughness length (z_0); k is von Karman's constant (0.4):

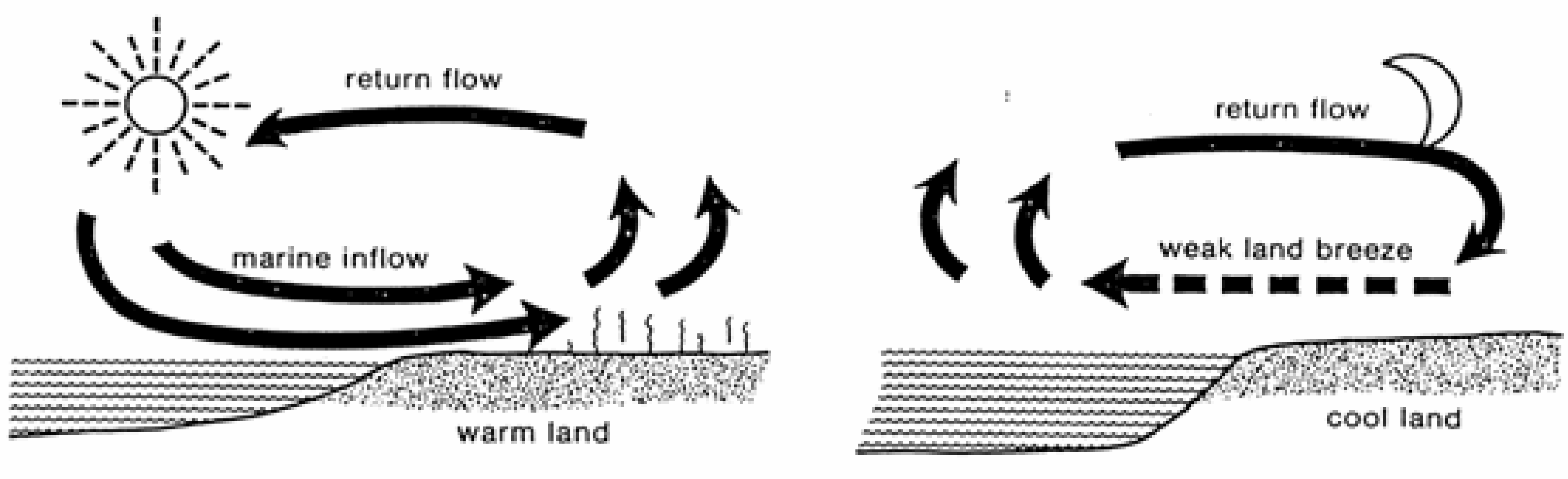
$$u(z) = \frac{u_*}{k} \ln(z / z_0)$$

- For a similar wind velocity at height z (u(z)), friction velocity increases with increasing surface roughness, eg z_0.

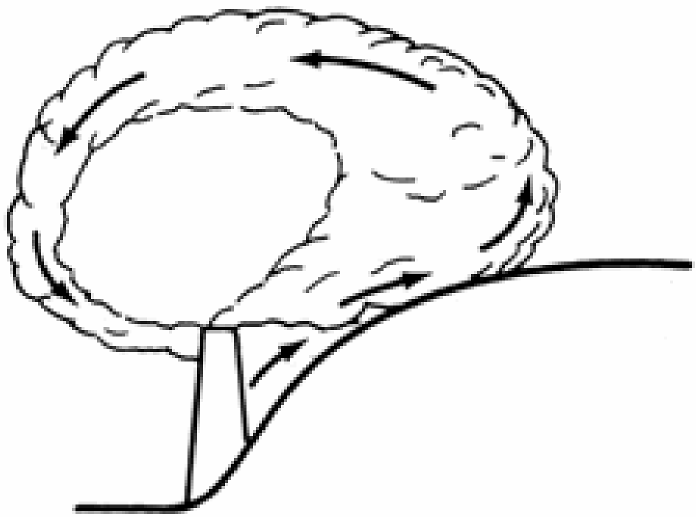

day one
day two
1250
1000
750
500
250
0
Height (m)
0
10
20
30
40
Hours



Γ_E Potential temperature
700
800
900
1000
Pressure (hPa)
0600
0900
1200
1500
Daytime heating



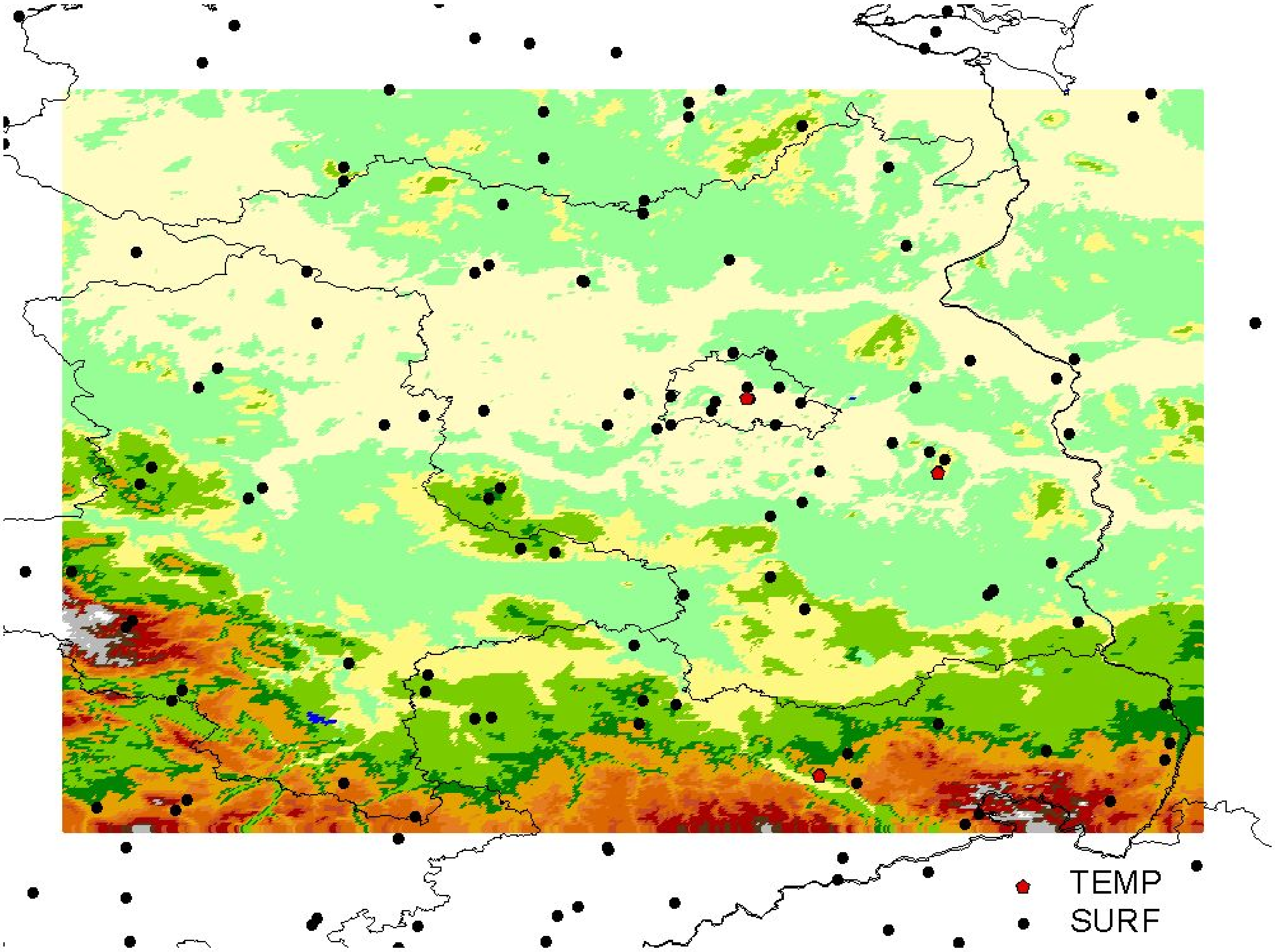
(a) Sea breeze (b) Land breeze



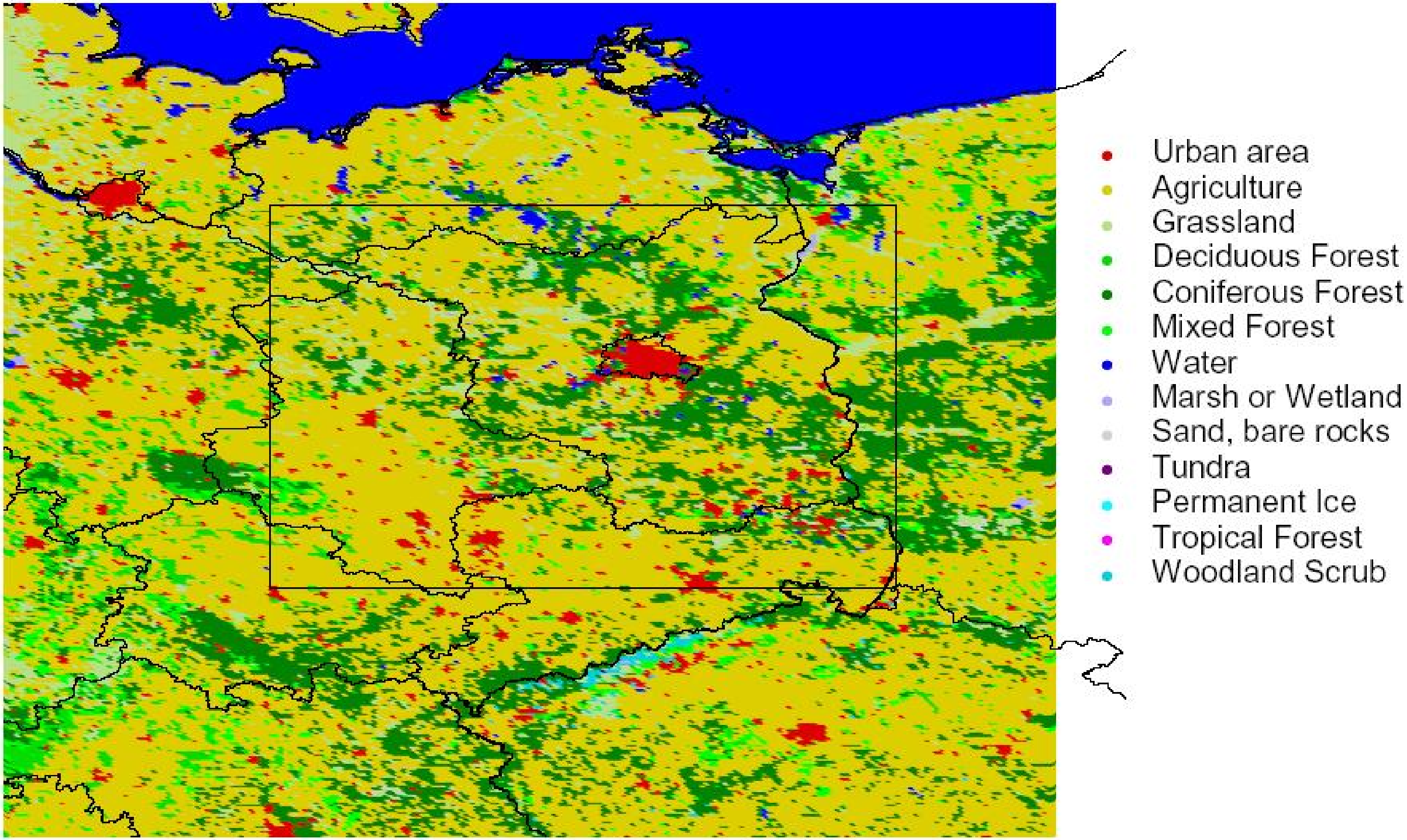
VALLEY BREEZE (daytime)

MOUNTAIN BREEZE (nighttime)

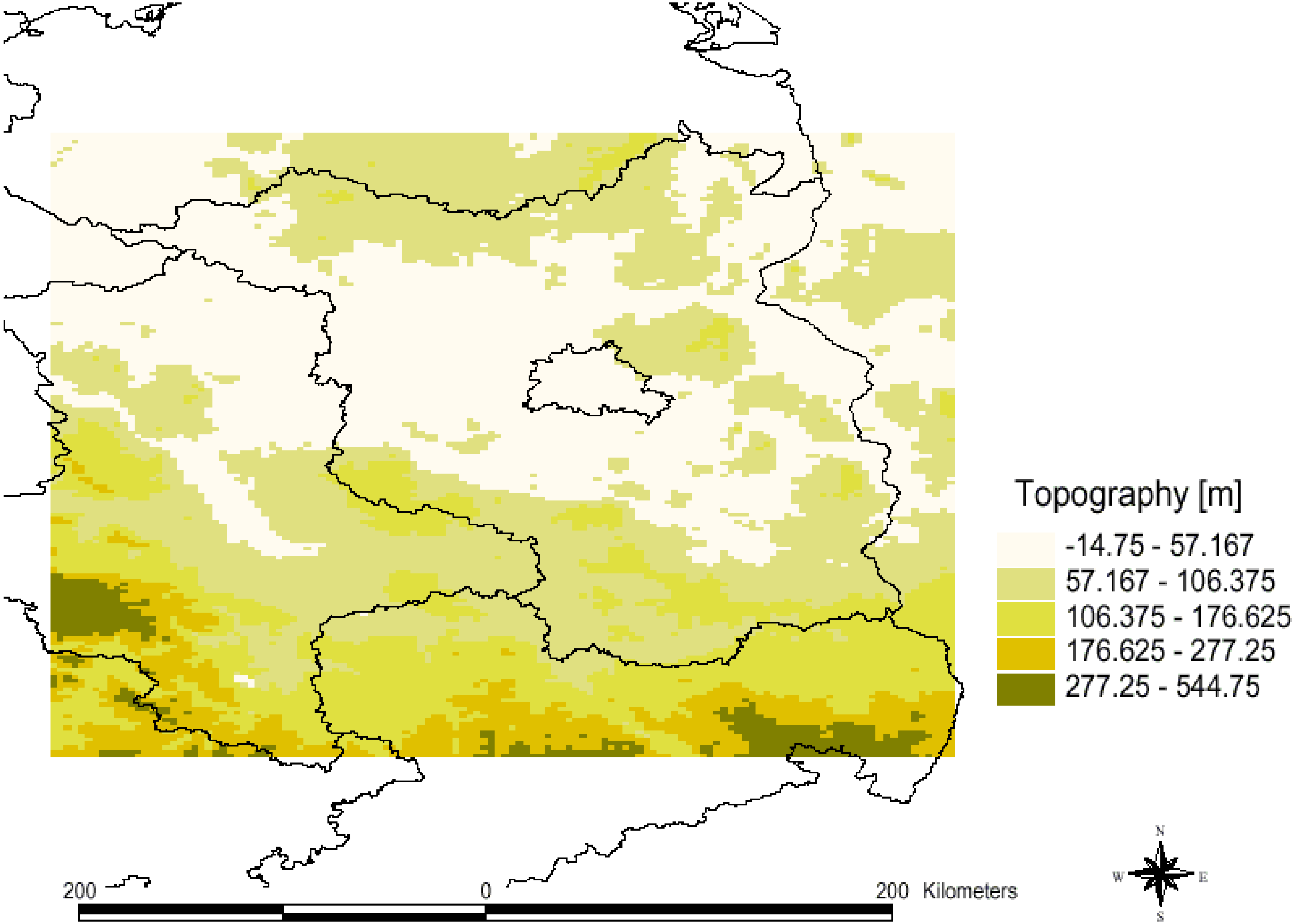
Urban/Regional Domain
topography and met. observations



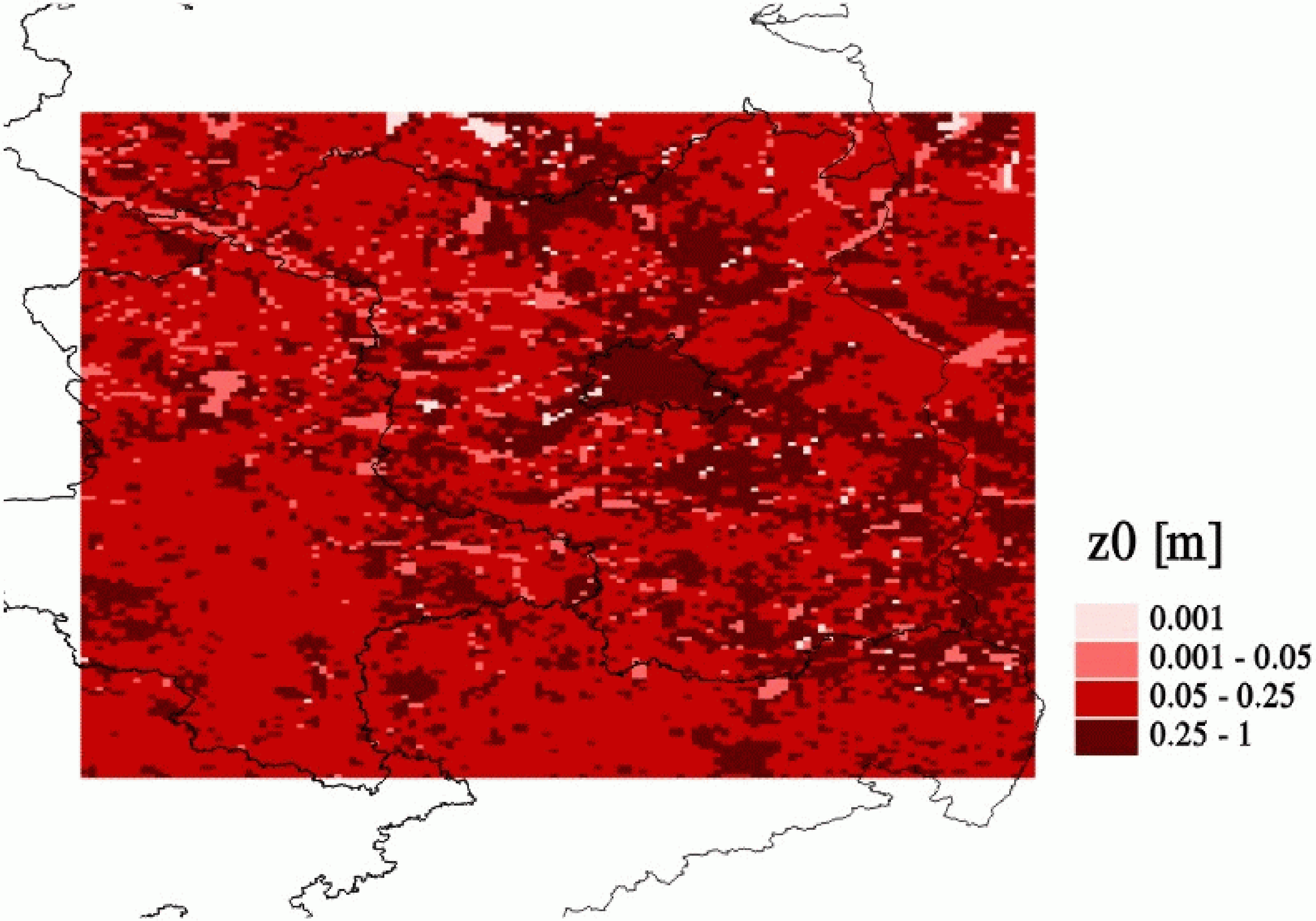
Landuse

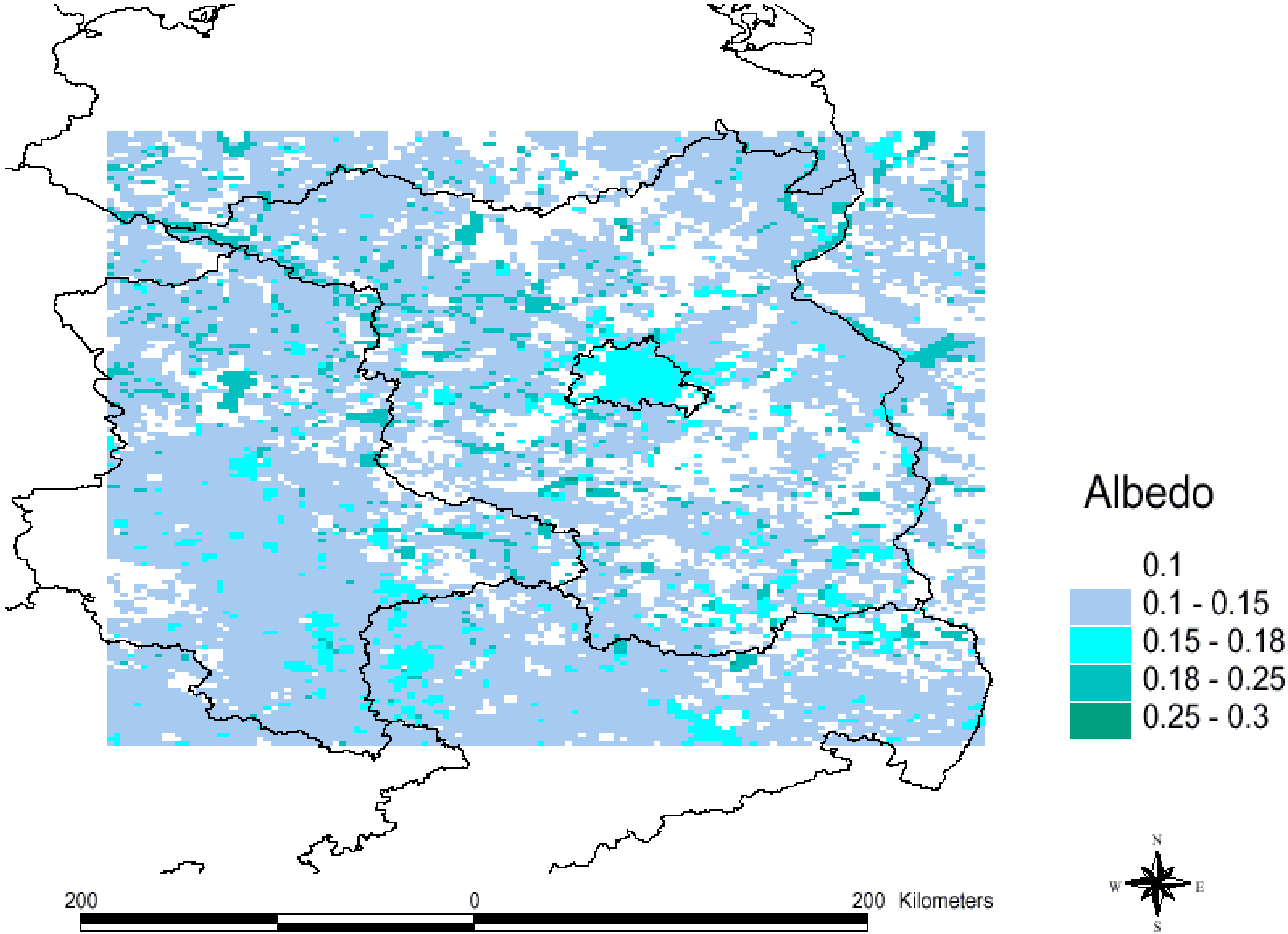


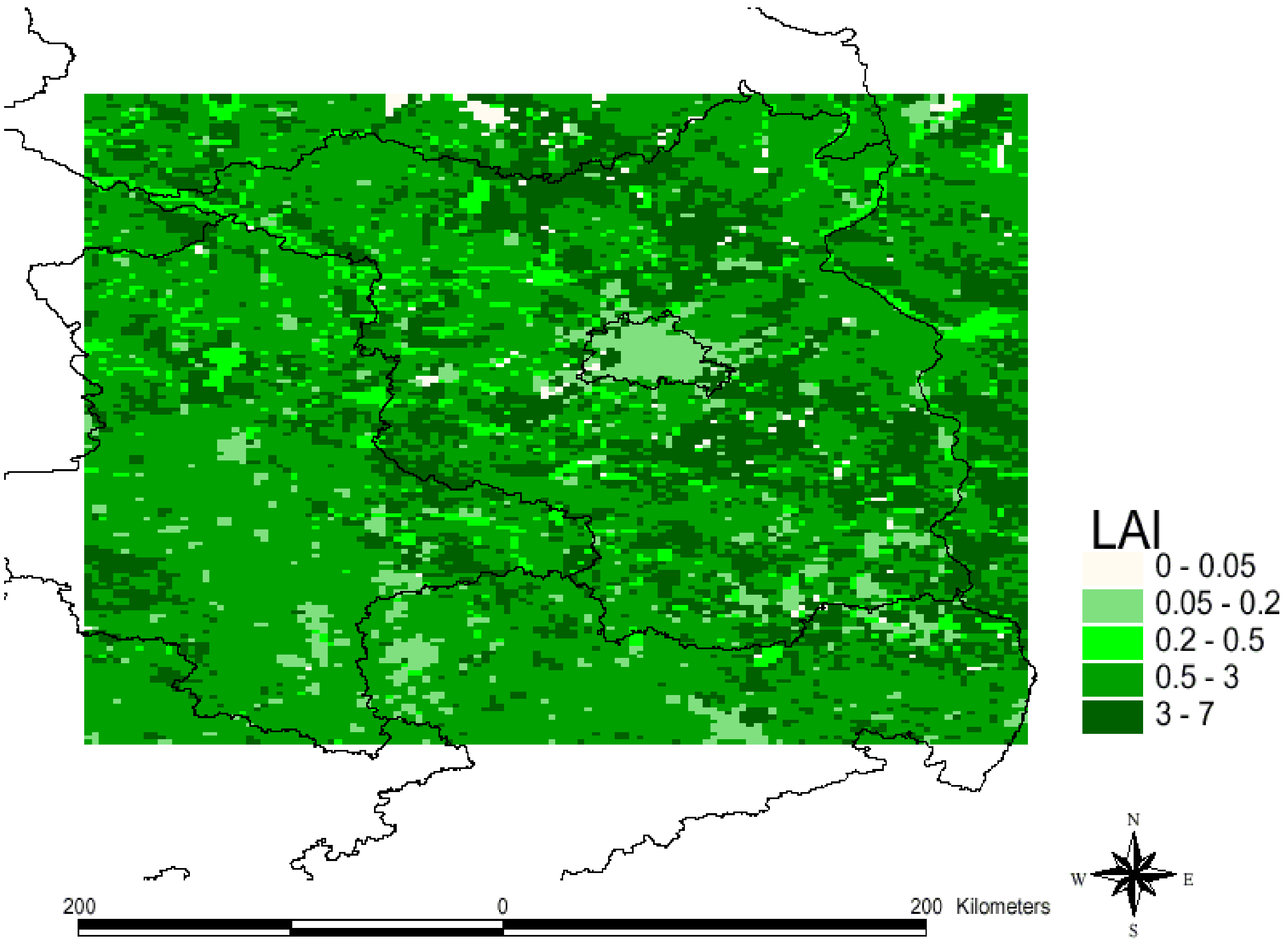
Urban area
Agriculture
Grassland
Deciduous Forest
Coniferous Forest
Mixed Forest
Water
Marsh or Wetland
Sand, bare rocks
Tundra
Permanent Ice
Tropical Forest
Woodland Scrub

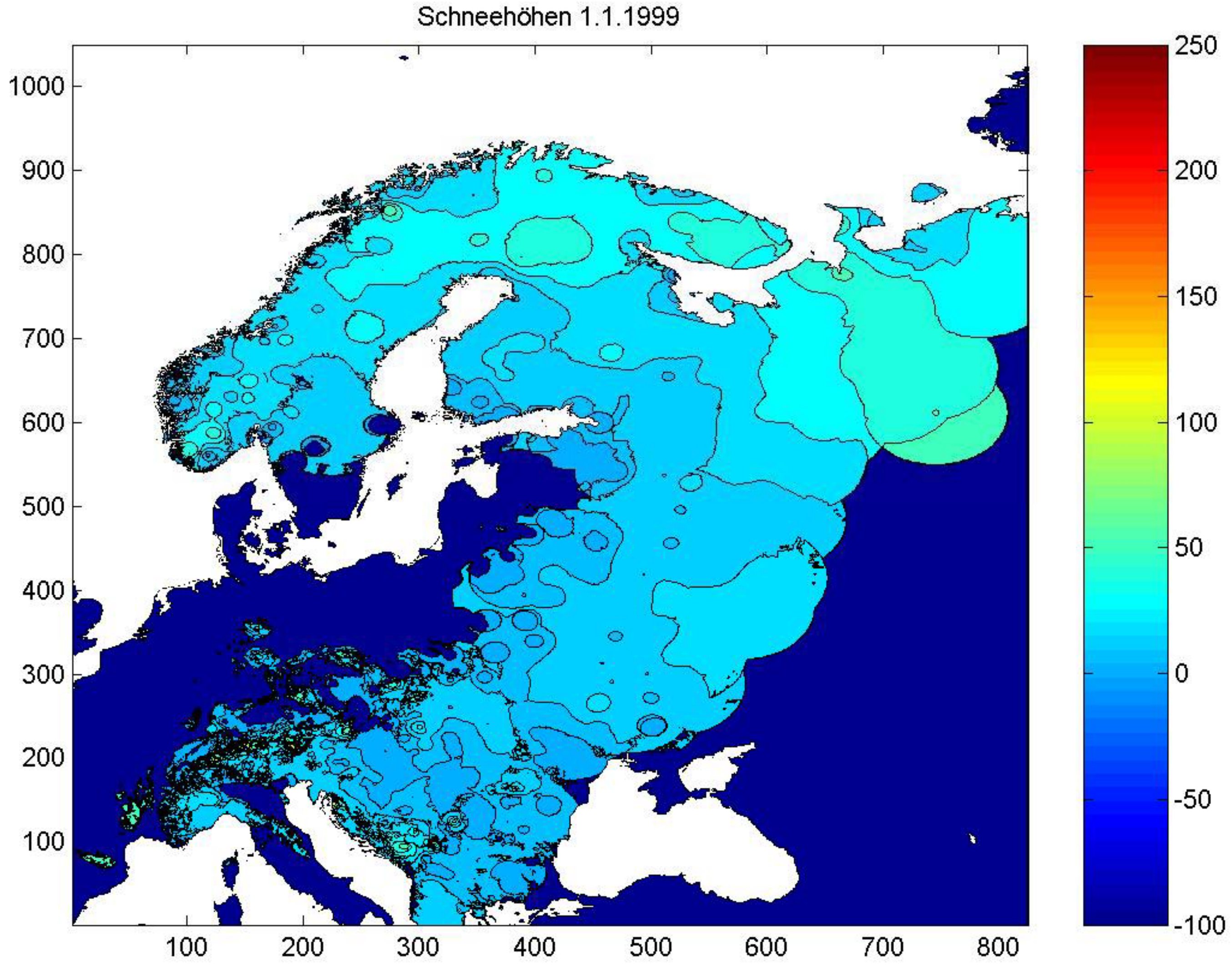


Topography [m]
-14.75 - 57.167
57.167 - 106.375
106.375 - 176.625
176.625 - 277.25
277.25 - 544.75
200
0
200 Kilometers
N
W
E
S


z0 [m]
0.001
0.001 - 0.05
0.05 - 0.25
0.25 - 1


Albedo
0.1
0.1 - 0.15
0.15 - 0.18
0.18 - 0.25
0.25 - 0.3
200
0
200 Kilometers
N
W
E
S


LAI
0 - 0.05
0.05 - 0.2
0.2 - 0.5
0.5 - 3
3 - 7
N
W
E
S
200
0
200 Kilometers


Schneehöhen 1.1.1999
1000
900
800
700
600
500
400
300
200
100
100
200
300
400
500
600
700
800
250
200
150
100
50
0
-50
-100