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EX-3

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In this project, the atmospheric profiles of two geographically distinct regions are examined and analyzed:

- Abu Dhabi in the Middle East
- One of the observation stations in Africa

These data include vertical atmospheric information such as temperature (TEMP), pressure (PRES), height (HGHT), and wind speed (SKNT) and i.e measured by weather balloons.

To begin the analysis, the respective text files for each region Abu-Dhabi.txt for the Middle East and africa.txt for the African station were imported into the programming environment using Python and the Pandas library. Subsequently, necessary preprocessing steps were applied, such as converting wind speed from knots to meters per second, in order to make the data suitable for analysis and comparison.

```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
#----------------------------------
src1 = 'D:\\education\\BTU\\microclimate\\ex3\\Abu-Dhabi.txt'

da = pd.read_csv(src1,
                 header=[0,1],
                 skipfooter=4,
                 delim_whitespace=True,
                 na_values=-999.00)

src2= 'D:\\education\\BTU\\microclimate\\ex3\\africa.txt'
db = pd.read_csv(src2,
                 header=[0,1],
                 skipfooter=4,
                 delim_whitespace=True,
                 na_values=-999.00)
#----------------------------------
da.columns
```

Selection of Lower Layers

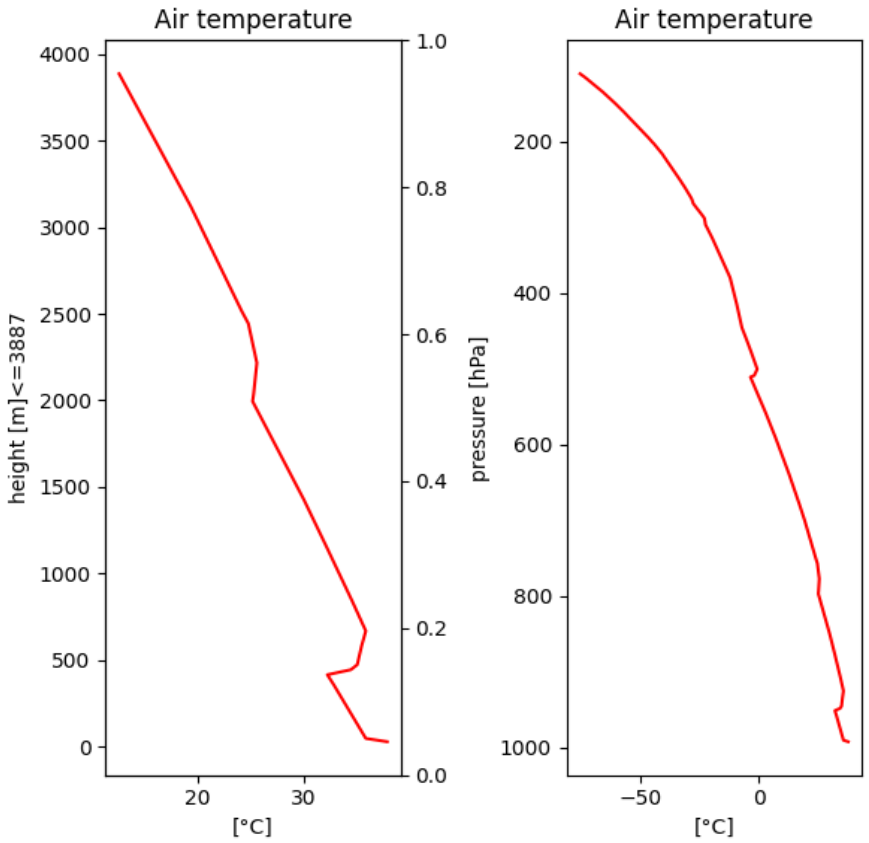
Based on the temperature profile, a significant change in the lapse rate is observed around 3887 meters. Below this height, the temperature decreases more gradually, indicating the lower atmospheric layers. Therefore, data below 3887 m was selected as a subset for further analysis.

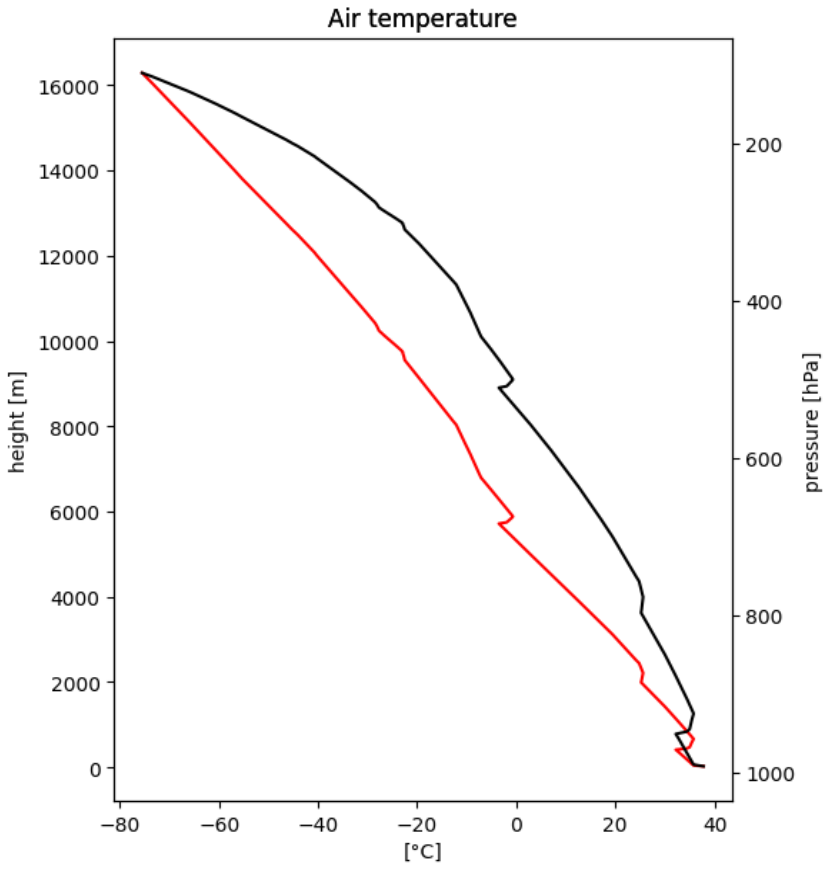
```python
da['SKNT', 'knot']= da['SKNT', 'knot']*0.514444 # convert to m/s
db['SKNT', 'knot']= db['SKNT', 'knot']*0.514444 # convert to m/s
lower_layers = da[da[('HGHT', 'm')] <= 3887]
fig, (tmp1,tmp2) = plt.subplots(1,2,figsize=(6,6))
tmp11=tmp1.twinx()
tmp1.plot(lower_layers[('TEMP','C')],lower_layers[('HGHT','m')],'r',label='Temp, lower  layers')
tmp1.set_ylabel('height [m]<=3887')
tmp1.set_xlabel('[°C]')
tmp1.set_title('Air temperature')

tmp2.plot(da[('TEMP','C')],da[('PRES','hPa')],'r',label='Temp')
tmp2.invert_yaxis()
tmp2.set_ylabel('pressure [hPa]')
tmp2.set_xlabel('[°C]')
tmp2.set_title('Air temperature')
fig.tight_layout()
plt.show()
```

Temperature Profile Visualization

The first plot shows the temperature profile only for the lower layers, i.e., up to an altitude of 3887 meters, based on the previously defined threshold.

The second plot combines both the temperature vs. height and temperature vs. pressure profiles in a single diagram using two y-axes. This allows for a more comprehensive view of the atmospheric structure. Temperature vs. height is shown in red, Temperature vs. pressure is shown in black.


Air temperature
height [m]<=3887
[°C]
Air temperature
pressure [hPa]
[°C]

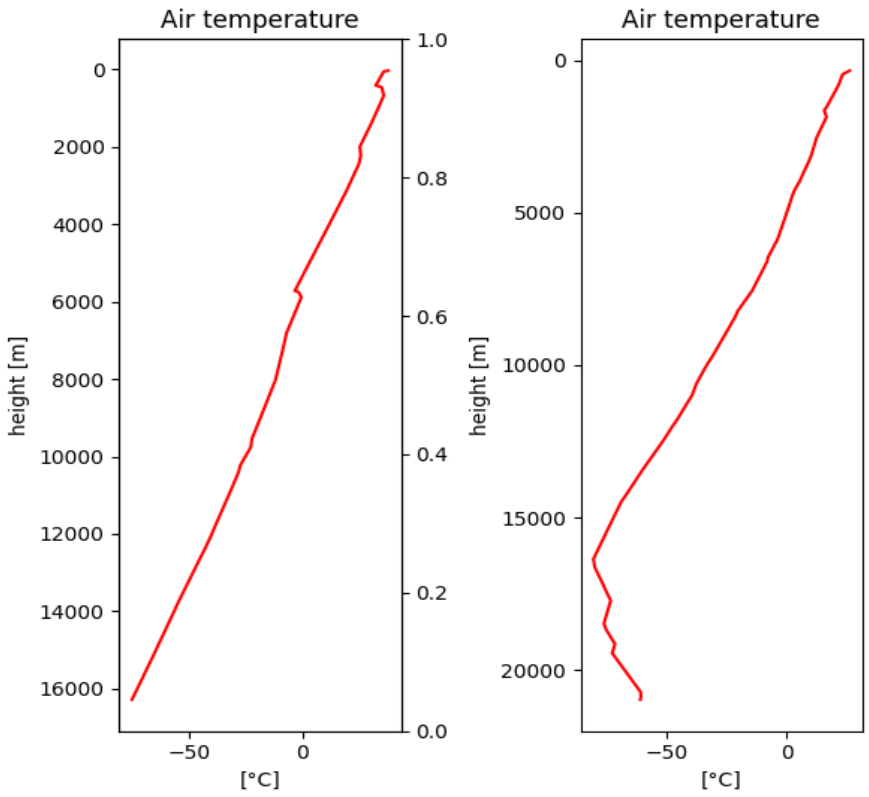

Air temperature
height [m]
pressure [hPa]
[°C]

Identification of Inversion and PBLH

Yes, an inversion can be identified in the temperature profile. Between approximately 443 meters and 667 meters, the temperature increases with height, which is a clear indication of a temperature inversion.

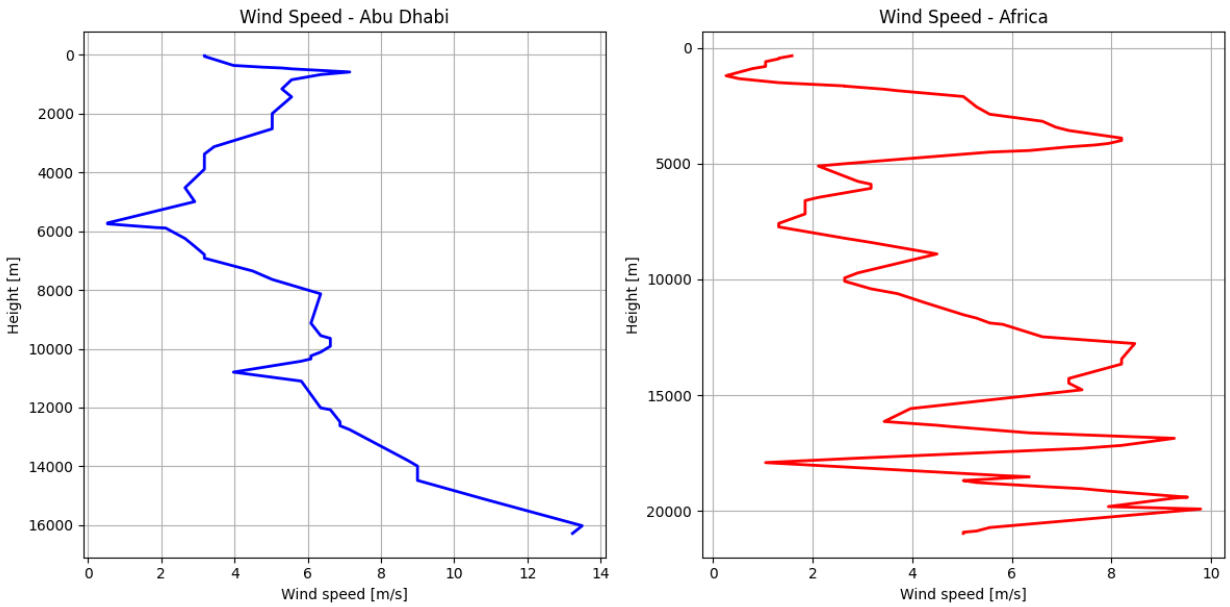
This inversion layer marks the Planetary Boundary Layer Height (PBLH) at that time step. A comparison between the two-time steps shows that the PBLH is varying, as the height and strength of the inversion differ, indicating changes in atmospheric stability conditions over time.

This project visualizes and compares the vertical temperature profiles from two datasets (Abu Dhabi and Africa).



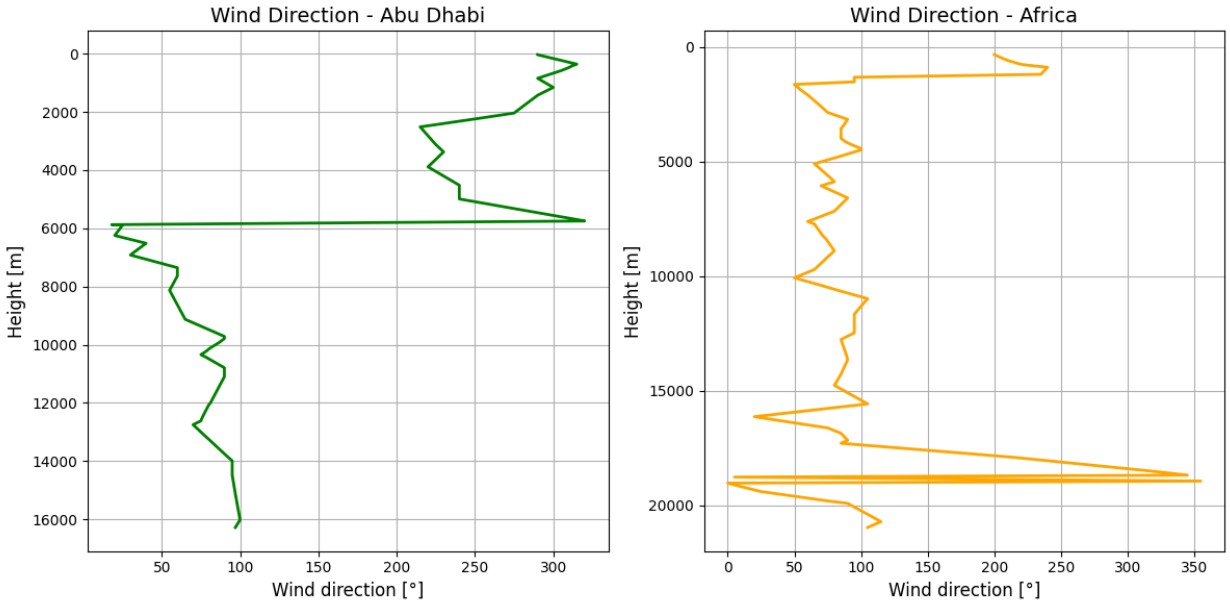
Wind Speed Visualization

The wind speed profiles for Abu Dhabi and Africa were plotted separately to observe how wind speed changes with height in each region.



Wind Direction Visualization

Wind direction profiles for Abu Dhabi and Africa were plotted separately to analyze how wind direction changes with altitude.



Air Temperature Profiles

The temperature profiles for both Abu Dhabi and Africa show a typical atmospheric pattern: temperature decreases with altitude in the troposphere. Around 12–16 kilometers above the surface, this trend slows down or even reverses, which indicates the start of the stratosphere. During the daytime, surface temperatures are warmer due to solar heating, which is clearly visible in the lower parts of the profiles. At night, surface temperatures drop, resulting in steeper lapse rates near the ground. In some cases, inversion layers where temperature increases with height are observed, suggesting atmospheric stability or descending air masses.

Wind Speed Profiles

Wind speed in Abu Dhabi increases steadily with height, reaching up to 13–14 m/s in the upper layers. In contrast, Africa's wind profile is more irregular, with fluctuating wind speeds and signs of vertical wind shear. These patterns may be influenced by the time of day, as the diurnal cycle can affect wind development, especially in the lower atmosphere. In both locations, wind speed becomes more consistent and stronger at higher altitudes, likely reflecting the presence of jet streams or reduced surface friction.

Wind Direction Profiles

Wind direction (DRCT) varies significantly with height in both datasets. Abu Dhabi shows sharp changes in wind direction around 6000 meters, suggesting vertical wind shear or different air masses. Africa’s wind direction profile is more gradual, maintaining relative consistency up to about 12,000 meters before shifting. These patterns help identify atmospheric layers and possible weather phenomena.

Summary of Regional Atmospheric Profiles

Both Abu Dhabi and Africa exhibit typical vertical profiles of temperature, wind speed, and direction, but with regional differences. Abu Dhabi shows smoother wind speed increase and more abrupt directional shifts, while Africa’s profiles indicate more variable wind speeds with smoother directional changes. Moisture and stability parameters further highlight differences in atmospheric conditions between the two regions.