**The Observer**

(Software for meteorological observations)

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**Abstract**

*The observer is a soft ware that is created to generate Qfe, Qfe in inches, QNH, QNE, Relative humidity, dew point temperature and confirms quantities that are entered; from the observed Wet bulb, dry bulb temperature and surface air pressure using primarily the Hypsometric equation. This eradicates the use of meteorological tables and the dew point calculator, a practice that is still widely used in developing countries. This product put the personal computer as a front line instrument of observation thereby; significantly reducing the standard time of observation, adds quality and uniformity to data by relegating human error only to parallax when reading the barometer and the two thermometers. Not withstanding, “Observer” also may serve in data comparison and calibration for modern electronic devices that may be expensive and subject to environmental error. In this presentation human errors are exposed by the soft ware when data from randomly picked observation stations in Zambia is compared to those generated by the soft ware and the most meticulous meteorological observers.*

 **Aim:**

The aim of this work was to find a tool that would input the list number of parameter and give out a much larger out put of the required meteorological data. The tool had to be modern and easy to use. This led to the creation of “observer” the soft ware… Like all other soft ware it is loaded on a Personal computer this makes the tool modern and easy to use.

**Background and calculations:**

A list of meteorological quantities was studied with the aim of finding which combination would yield the largest number of meteorological parameters. Atmospheric pressure, dry bulb temperature and Wet bulb temperature were chosen. From these, pressure, atmospheric temperature and moisture would be realized. The realization that, pressure, atmospheric temperature and moisture were the parameters that the legendary meteorologist Vaisala required for upper air observations (radiosonde) concluded the search.

Wallace and Hobbs highly commended Väisälä. Of him they wrote; ‘Vilho Väisälä (1899-1969) Finnish meteorologist developed a number of meteorological instruments, including a version of a radiosonde in which readings of temperature, pressure, and moisture are telemetered in terms of radio frequencies. The modern counterpart of this instrument (manufactured by Väisälä Oy Ltd) recently won recognition as one of Finniland’s most successful exports.’

Väisälä was no doubt a meteorologist with a highly enhanced level of Serendipity. His epic innovation as stated by Wallace and Hobbs was the radiosonde. The radiosondes observed parameters of temperature, pressure and moisture maybe the paramount parameters of the atmosphere at any level.

When temperature pressure and moisture are analyzed at the surface also, countless other meteorological parameters can be realized. These include the dew point, Relative Humidity, Station pressure, and mean sea level pressure the geopotential meter of a station cloud height etc.

To avoid the intricate calculations which generate meteorological parameters, Meteorologists from the antiquity developed meteorological tables, charts and calculators. These included the QNH tables, Humidity charts, cloud height chats, dew point calculators to mention a few. These methods of observation were aimed at improve data quality and uniformity.

In this work we focused on surface pressure (Qfe) mean sea level pressure (QNH) Dew point temperature and relative humidity.

Chelius and Frentz in their book, *A basic Meteorology exercise manual* state that, ‘Perhaps the most widely used measure of atmospheric moisture is the dew point’. They define dew point as; the temperature expressed in degrees centigrade or Fahrenheit at which the moisture in the atmosphere will condense when cooled at constant pressure. They added that Relative Humidity is the most common measure of atmospheric moisture used by the general public.

 Wallace and Hobbs define Relative humidity (**RH**) as the ratio expressed as a percentage of the actual mixing ratio ***w***to the saturation mixing ratio ***ws***, with respect to water at the same temperature.

RH= 100

At a less technical verbatim, wouldn’t we say that, relative humidity is the ratio of the amount of water vapor present in the atmosphere to the maximum amount of water vapor possible in the same atmosphere at the prevailing temperature and pressure expressed as a percentage?

Temperature in this work would be defined as the temperature of the dry bulb thermometer in the Stevenson’s screen at the time of observation. Wet bulb temperature is also that which is obtained from the screen. While station pressure is the pressure at the station

The station pressure and the station’s mean sea level pressure in milli bars of mercury are given the standard meteorological acronym of **Qfe** and **QNH** respectively. While the station’s mean sea level pressure in inches is the **QNE.**

To find pressure at the mean sea level, **QNH,** the Hypsometric equation

In a dry atmosphere where temperature is constant is used making pressure at sea level the subject.

In this equation, is the thickness of the layer between the station and the mean sea level, is the gas constant for dry air, in the global averaged acceleration due to gravity at the Earths surface. is the virtual temperature, and P is atmospheric pressure, and and are pressures at mean sea level and the station in question. (Wallace and Hobbs)

**Method:**

The named parameters of QNH, QNE, Dew point, Relative Humidity are calculated using FORTRAN programming for selected climatological stations in Zambia (fig 1). The program gives prompts for the input of the stations WMO number, values of surface pressure (Qfe), the stations dry bulb temperature and wet bulb temperature. The program gives an output of a verification of the input data, The QHN, QNE, Qfe in inches, Relative Humidity, Dew point temperature etc.



**Figure 1Station on observer Soft Ware Network**

**Results:**

Results from randomly selected days and stations are shown in the graphs below where results from the program as suffixed SW for soft ware and results computed or read from the conventional meteorological tables are entered as the parameter in question. Results for Ndola were as follows

Figure 2

The QHN calculation for the same observations where as follows

Figure 3

The dew point is shown below

Figure 4

Ndola’s results show that the soft ware would give values of Relative humidity (RH) lower than those that meteorological observer had when RH was low over Ndola as shown in figure 2. At the same station, the soft ware gives slightly lower values of QNH (fig 3) while dew point temperatures (fig 4) do not exhibit a specific trend of correlation. The last five dew point observations however merge with those of the software as was the case between the 19th and the 25th observations.

Mansa data results were as the follows

Figure 5

Figure 6

Figure 7

Mansa Relative humidity (fig 5) seems well correlated with a slight divergence when Relative humidity values drops. The QNH (fig 6) fitting for the station is well correlated but this time, the soft ware seems to give values that are slightly higher than those that are given by the observer. Again the Dew point results (fig 7) show some divergence when relative Humidity is high and a convergence when relative humidity is low. The last six dew point observations show a high level of correlation with the observed data.

Livingstone data gave the following the results

Figure 8

Figure 9

Figure 10

Livingstone’s Relative Humidity (fig 8) shows a high level of convergence as Humidity increases. However the soft ware’s results are lower than those that are observed. The QNH (fig 9) seems well correlated. The amplitude may not be as visible as is the case in the other QNH graphs due to the differences in the scales of the graphs. However, there is a difference of about 100 milli bars exhibited. This is an example of a station where further investigations would be curried out. Livingstone’s Dew point (fig 10) correlation differences were as depicted by other stations. Here, a definite correlation appearing during the last six observations.

These kinds of results were exhibited by many other stations and each station seemed to give its own correlation trend.

**Discussion:**

It is clear to see that the soft ware’s out puts of QHN and Relative Humidity correlates well with the data from the meteorological observers. Dew point calculations seem to be the most elusive as there seems to be no specific correlation between the values of the observers and those obtained from the soft ware. A direct correlation of Dew point values implies that the observer was meticulous in his or her calculations. Such a situation shows that the soft ware would provide uniformity for the observation of Dew point.

Current meteorological data does not necessarily come from standard meteorological thermometers and barometers. They come from both standard and electronic instruments. Electronic instrument observations are an advancement but with the advancement recurrent problems are introduced.

At times electronic devices can exhibit errors. The seriousness of this matter is depicted in some recent (2-3rd March 2010) data from Lusaka International Airport for example, where the digital instruments Vaisala PA12 is giving seriously erroneous data as depicted in figure 11. However, some observers continue using the device.

 Figure 11

 This graph (Fig 11) depicts that the three parameters of Dry bulb temperature, Wet bulb temperature and the Dew point gave the same value for the first 13 and the last seven observations. These data implies that relative humidity was 100% for all the mentioned observations. It is impossible to sustain such high Relative Humidity values for such along time in the latitudes of Zambia (8-18Degrees South). During the times these observations were taken, there was no significant weather phenomena that would warrant the observations. This is certainly an error on the part of the instrument giving the data.

The questions are, when did the device go a wary and where else are such errors occurring? If the soft ware in question were introduced, it would without a doubt curb such errors. Lusaka case, the correct data is forever lost at best. At worst lives could be lost if the pressure sensor from the same device gives up. As this station is one of the main landing pads for air crafts in the country of Zambia.

 It is known that when Väisälä introduced the prototype of such of instruments, the radiosonde, radiosondes were well packaged providing a high level of protection to the sensors. Whenever any radiosonde was taken out of its package, it was used immediately and only once per radiosonde ascent. Meaning that the time period for the use of the device was carefully and clearly defined. Software calculations would be preferred in this case.

**Conclusion:**

**I**n his paper on Forecasting problems: the meteorological factors, Daniel L. Smith says,’ weather forecasting has benefited from diminishing costs of computers through the provisions of microcomputers to the field officers for a variety of purposes. Systems are being used operationally for data acquisition (saving time and forecasters effort and making additional observations quickly available) for message composition and dissemination, and for data analysis’

We wish that this could be said about meteorology in Africa. This work however is a quest towards data uniformity and data quality and fulfilling the quoted Daniel L. Smith’s vision. When this soft ware is used, errors are relegated to parallax when observing the thermometers and Barometers. And at times, errors that could have existed at the station for a long time are exposed.

These long term errors explain the gap between the Soft ware’s and the observed data curves that have the same trend. The solution is the re-calibration of the instruments or the application of the correlation coefficient to the Soft ware, whichever could be considered right b the standard of the instrument.

When we use electronic devices, we have to define time period or life span for remote sensors to avoid cases like the one at Lusaka International Airport. While this is being done, this soft ware could provide an alternative and standardize data at the station.

The Paradigm has shifted; the observers that are being employed now are familiar with computers. They would rather use computed data than data from tables and slide rules. This work puts the computer as a front line instrument for observation and embraces the paradigm shift.

Finally, this soft ware could be used in time-spaced data comparison a factor that is helpful in monitoring climate change and many other atmospheric phenomena that require accurate data.

**Recommendations:**

I recommend that the Observer be extended to all the meteorological stations that are on the world weather watch program in Zambia and beyond. In Zambia, this could be done by providing training for all meteorological personnel in the nine provinces at provincial level and providing computers to every station that would be on the net work.

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