Progress Report #1: How to calculate the "frost point" from the GLDAS-2 dataset

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1 Dataset description

The dataset we use is GLDAS_NOAH025_3H.2.0, it is 3-hourly on a 0.25 grid. Its temporal coverage is from January 1, 1948 to December 31, 2010.

To every data file, the data is for a certain time and date. For example, the file "GLDAS_NOAH025_3H.A20100101.0000.020.nc4", it contains the data for 0Z o'clock in Jan 1, 2010.

The data is formatted by NetCDF4. In one data file, there are 36 1440 by 600 matrixes (1440 lon x 600 lat for the 0.25° data), each matrix contains the data for one field. For example, the matrix labeled "Tair_f_inst" has the air temperature data on the ground. More detailed data description can be found in the README Document.

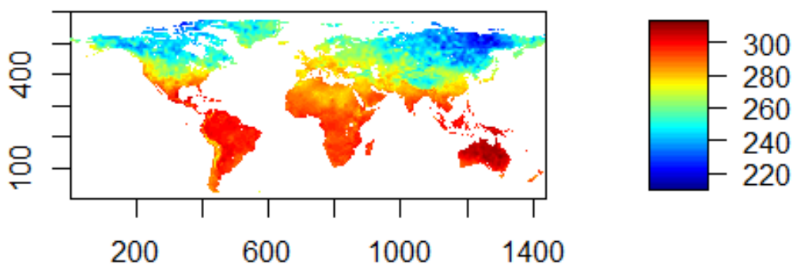
2 Data reading

By using the "ncdf4" package for R, reading the data is quite easy. For example:

R code for getting the Air Temperature (0Z o'clock in Jan 1, 2010)

```
install.packages("ncdf4") # install ncdf4 package
library(ncdf4) # load ncdf4 package
fname<-"GLDAS_NOAH025_3H.A20100101.0000.020.nc4"
f<-nc_open(fname) # open the data file
T<-ncvar_get(f,varid="Tair_f_inst") # get Temperature (in K)
```

And then to draw the matrix T:



Air Temperature (in K) at 0Z o'clock in Jan 1, 2010.

3 Frost point calculation

As we know that "the frost point is when the 'dew point' drops below freezing". Hence the work is to compute the dew point (Td) firstly, and then find the areas whose Td values are less than 0℃(the freezing point).

By referring to the CEOP Derived Parameter Equations, the dew point (Td) can be calculated from surface air pressure (p) and specific humidity (q), which are labeled "Psurf_f_inst" and "Qair_f_inst" in our dataset.

The formulas are:

$$e=(p*q)/(0.622+0.378*q)$$

$$Td = \log(e/6.112)*243.5/(17.67-\log(e/6.112))$$

p = surface pressure in mb

q = specific humidity in kg/kg

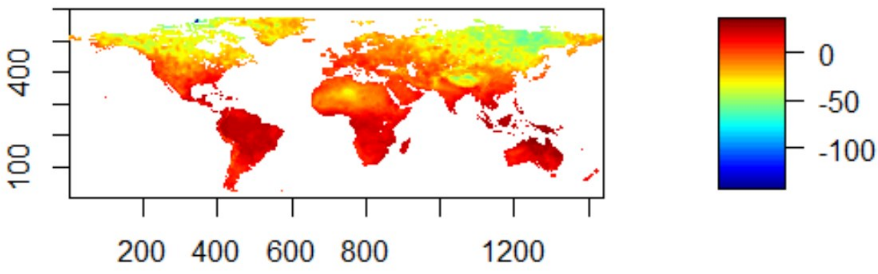
e = vapor pressure in mb

Td = dew point in deg-C

1 Pa = 0.01 mb; deg-C = K- 273.15

R code for computing Td:

```
# calculate dew point Td(in deg C)  by
# surface pressure p(in mb) and specific humidity q(in kg/kg)
dew_point<-function(p,q){
  e=(p*q)/(0.622+0.378*q)
  Td = log(e/6.112)*243.5/(17.67-log(e/6.112))
  return(Td)
}
# f is the opening file "GLDAS_NOAH025_3H.A20100101.0000.020.nc4"
q<-ncvar_get(f,varid="Qair_f_inst") # get Specific humidity (in kg/kg)
p<-ncvar_get(f,varid="Psurf_f_inst") # get surface air pressure (in Pa)
dew<-matrix(data=NA,nrow=1440,ncol=600) # new matrix of dew point
for (i in 1:1440){
  for (j in 1:600){
    a_p<-p[i,j]
    a_q<-q[i,j]
    if ((!is.na(a_p))&(!is.na(a_q))){ # both p and q are not NA
      dew[i,j]<-dew_point(a_p*0.01,a_q) # 1 Pa=0.01 mb
    }
  }
}
```

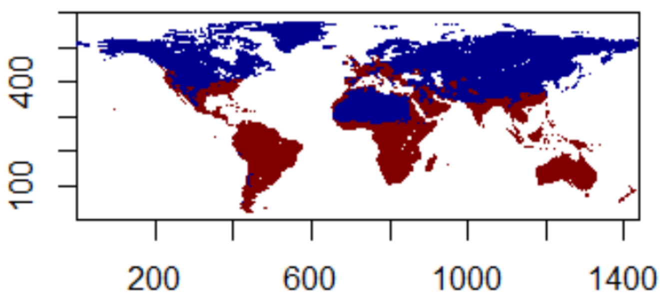


Dew point (in℃) at 0Z o'clock in Jan 1, 2010.

As shown in the figure above, in the dew point matrix, some values are less than 0℃. They are the frost points.

4 Discussion

In order to see the frost point areas more obviously, we can put the dew point values into two groups by comparing with the freezing point (0℃).



Frost point (Blue) at 0Z o'clock in Jan 1, 2010.

The northern hemisphere is winter in January, so most frost point areas are in this region.