

VIS - Global Practice (SciVis)

Geopotential height using transfer function

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1 Project context

The idea is to represent geopotential data from a concrete instant of time and draw it over the cartography to visualise the necessary property values by using OpenGL.

In order to perform this kind of visualisation with the provided geopotential data a technique is proposed : transfer function.

The transfer function can be understood as a function used to transform data into an expression based on color and opacity, usually represented as an RGBA value, where RGB are the usual color components of an image, and the final A represents the opacity commonly called ‘alpha’.

2 Input Data Set

First, a set of files with the cartography are provided (europe. folder) :

- euro_contour: list of points limiting the contour of Europe and closest zones
- euro_meridians: list of points defining the meridians over the previous zone
- euro_parallels: list of points defining the parallels in the same zone
- euro_points: list of point which complements the parallels in the same zone

Indeed, this files contains the points which define all the necessary elements. The first value from file is the number of points, N, followed by the N pairs of values corresponding to the coordinates (x,y) of each point.

Example :

```
4
0.01 0.09
0.05 0.07
0.08 0.04
0.12 0.01
```

Secondly, a set of data for the geopotential height for this zone in different time instants is provided (geopotential folder). The geopotential height is the way to measure the surface pressure. Quoting Wikipedia :

“Geopotential height is a vertical coordinate referenced to Earth’s mean sea level — an adjustment to geometric height (elevation above mean sea level) using the variation of gravity with latitude and elevation. Thus it can be considered a ”gravity-adjusted height”. One usually speaks of the geopotential height of a certain pressure level, which would correspond to the geopotential height necessary to reach the given pressure .”

For this data, another set of files is provided, using the pattern name geoXX.grd, where XX is the time instant. These files are in ASCII code and contains a header with the following structure:

```
DSAA 35 25 // number of columns and rows
0.00 26.20 // values for the geometric points values in the X axis
0.00 18.60 // values for points in the Y axis
272.06 325.15// range for the following property values
```

Finally, in the second part, each file has a list with the corresponding property values of the same time instant.

3 Run program

To run this program, simply go to 'code' directory, once there, execute the following commands:

1. Build the project: `gradle compileGroovy`
2. Run the project: `gradle run`

4 Legend information

In the lower-left part of the windows, we can find a small rectangle showing the plot legend, it shows the minimum and maximum geopotential height values, each of them above the corresponding color used to draw the transfer function.

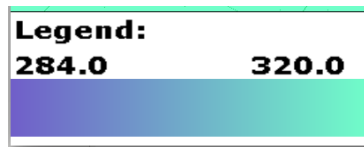


Figure 1: Legend view

Notice that this legend is dynamic, and change in real time according to other interactions from the user.

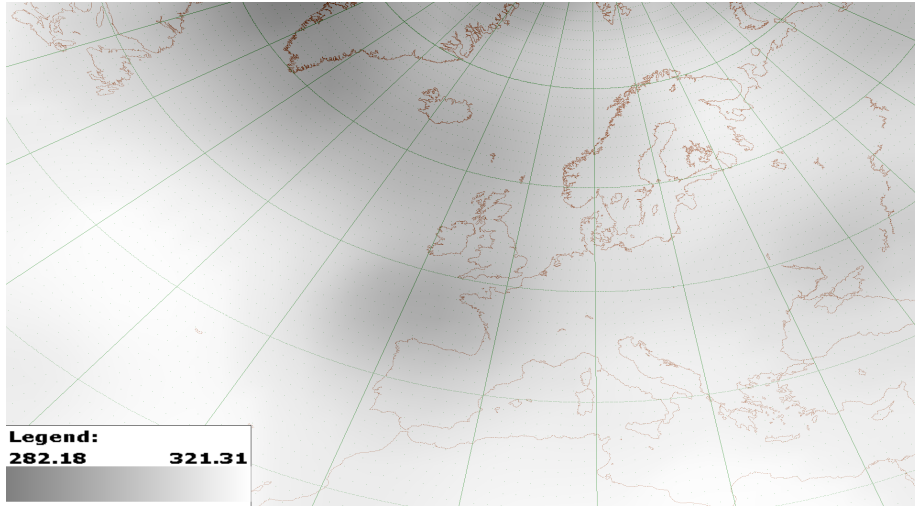


Figure 2: Original view

5 User interactions

The interaction with this software is quite easy, simply use one of the following keys:

- ‘a’: increase the time instant data set used to plot the transfer function.

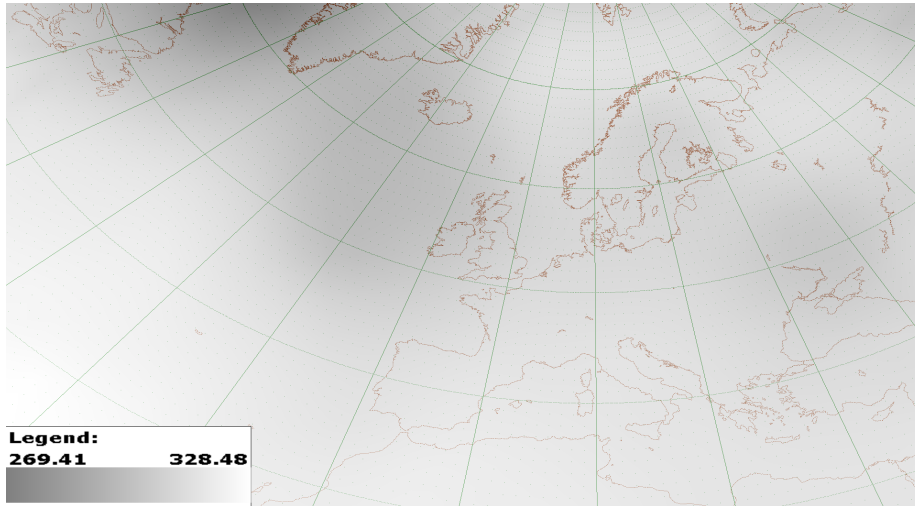


Figure 3: View after pressing ‘a’ key once

- ‘z’: decrease the time instant data set used to plot the transfer function.

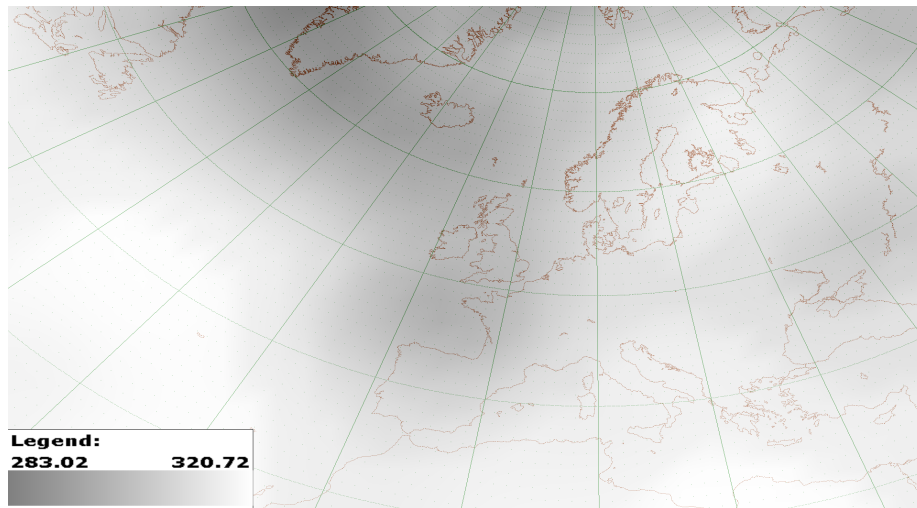


Figure 4: View after pressing 'z' key once

- 'q': decrease alpha value when plotting transfer function (after reaching 0, the alpha value is set to 1).

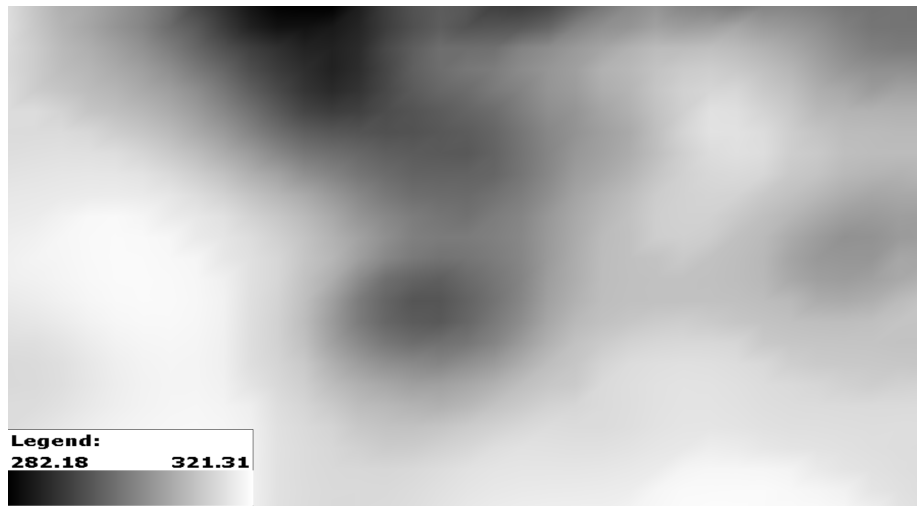


Figure 5: View after pressing 'q' key several times

- 'l': show or hide legend block.



Figure 6: View after pressing 'l' key once

- '1': increase minimum red value in RGB when plotting transfer function (after reaching maximum red value, the minimum is set to 0).

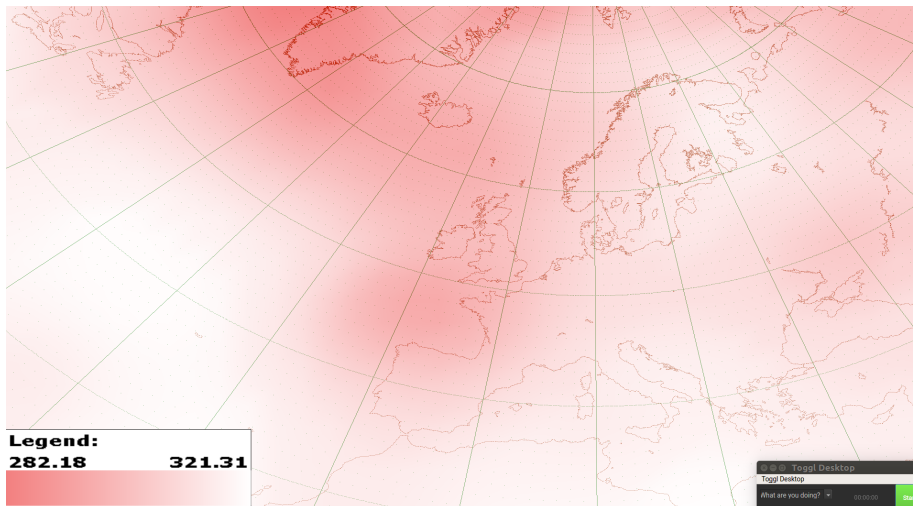


Figure 7: View after pressing '1' key several times

- '2': decrease maximum red value in RGB when plotting transfer function (after reaching minimum red value, the maximum is set to 255).

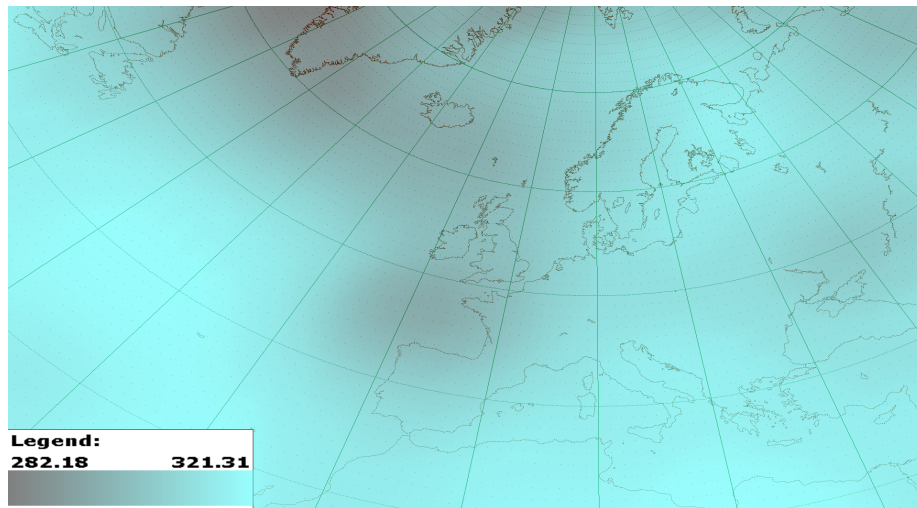


Figure 8: View after pressing '2' key several times

- '3': increase minimum blue value in RGB when plotting transfer function (after reaching maximum blue value, the minimum is set to 0).

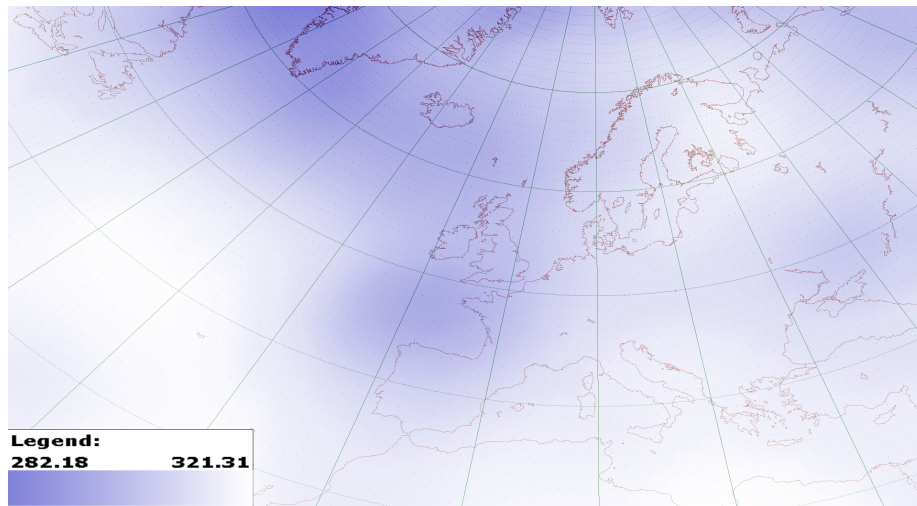


Figure 9: View after pressing '3' key several times

- '4': decrease maximum blue value in RGB when plotting transfer function (after reaching minimum blue value, the maximum is set to 255).

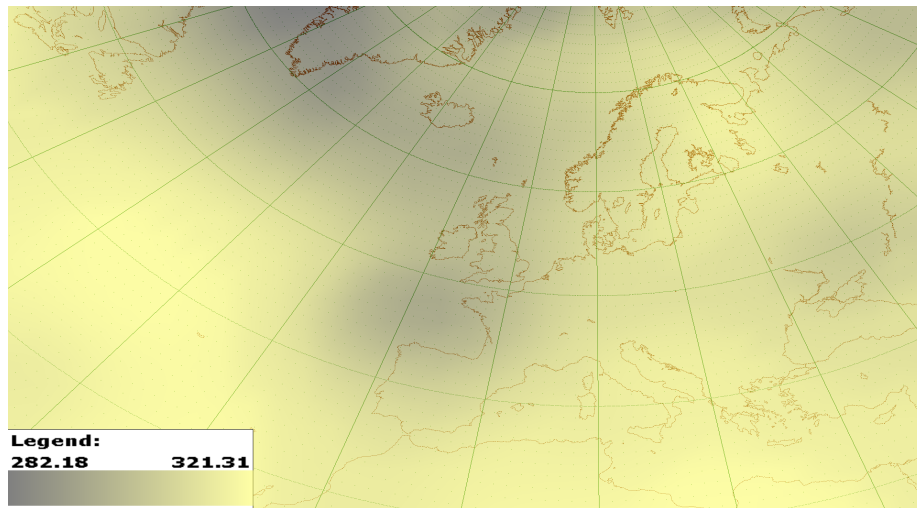


Figure 10: View after pressing '4' key several times

- '5': increase minimum green value in RGB when plotting transfer function (after reaching maximum green value, the minimum is set to 0).

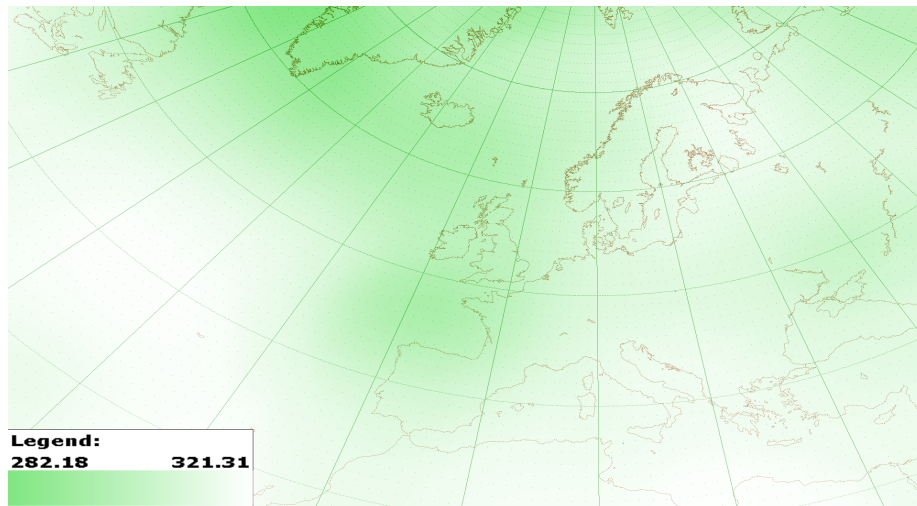


Figure 11: View after pressing '5' key several times

- '6': decrease maximum green value in RGB when plotting transfer function (after reaching minimum green value, the maximum is set to 255).

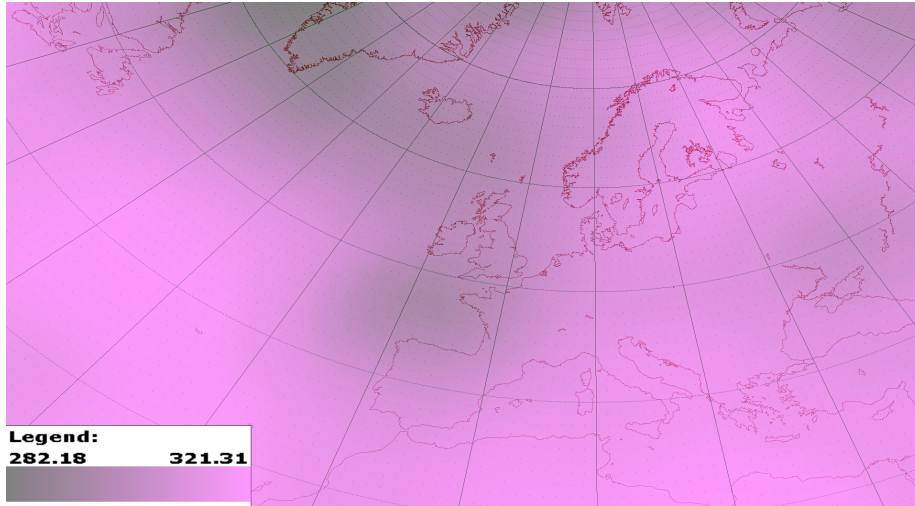


Figure 12: View after pressing ‘6’ key several times

- ‘r’: reset all values to initial state and plot first time instant from geopotential data set.

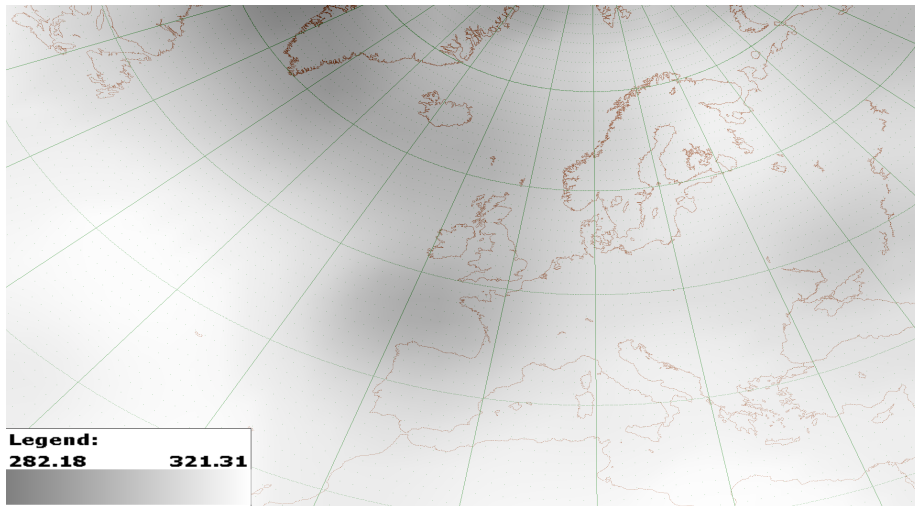


Figure 13: View after pressing ‘r’ key once

6 Other results

If we combine some of the interactions the results can be also interesting, give us some extra information or even just make the plots look nicer:

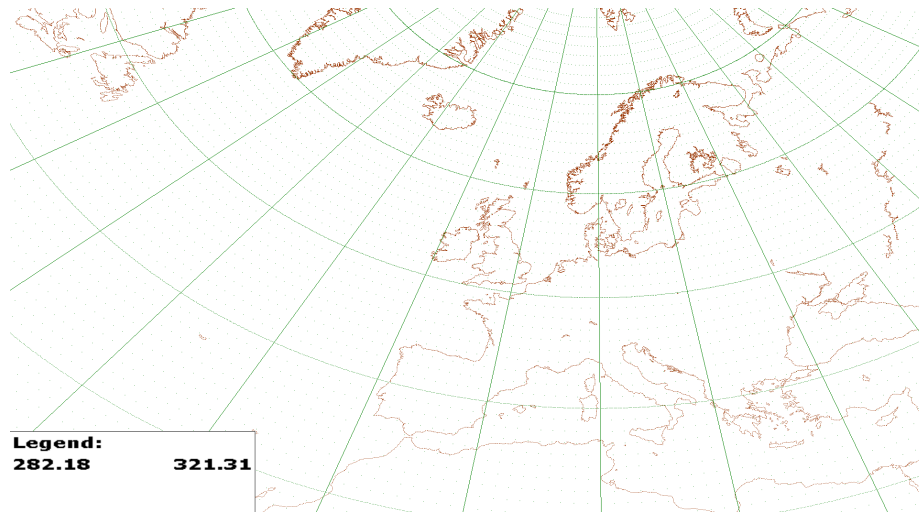


Figure 14: Hiding transfer function by decreasing alpha value

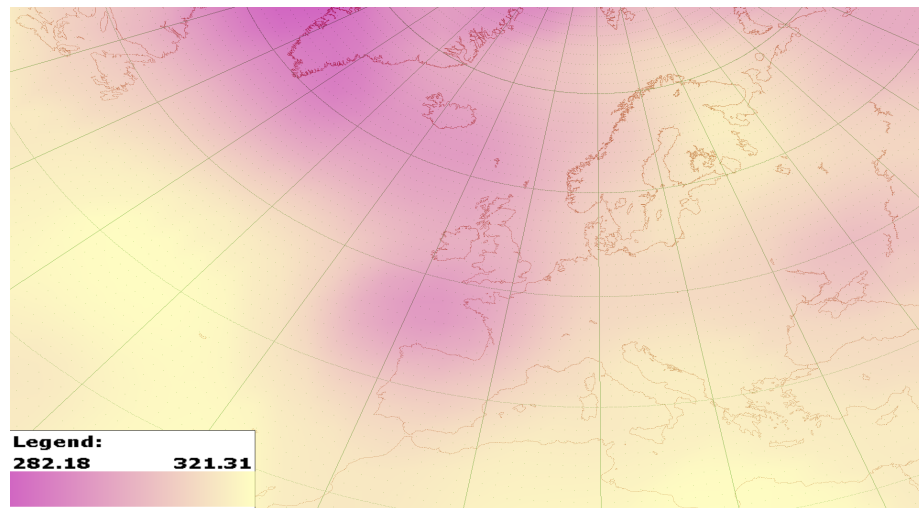


Figure 15: Mixing colors to highlight differences

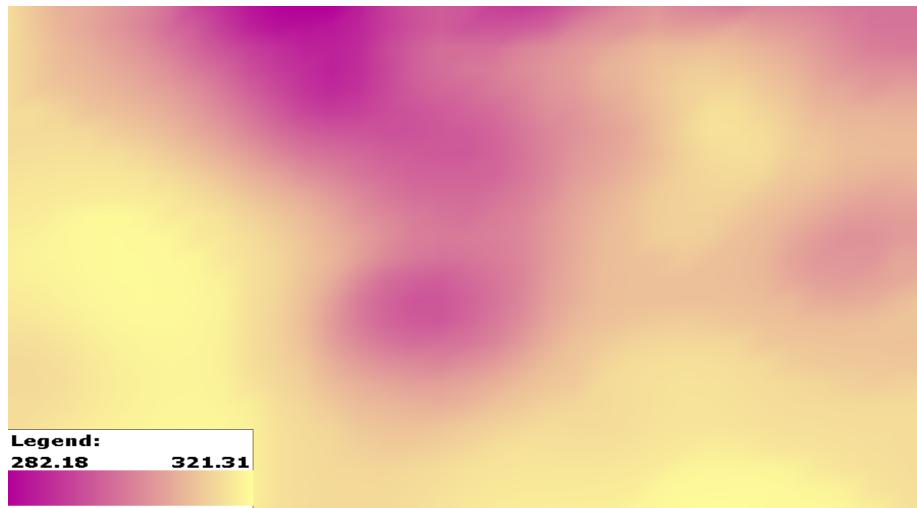


Figure 16: Showing only geopotential values by increasing alpha value

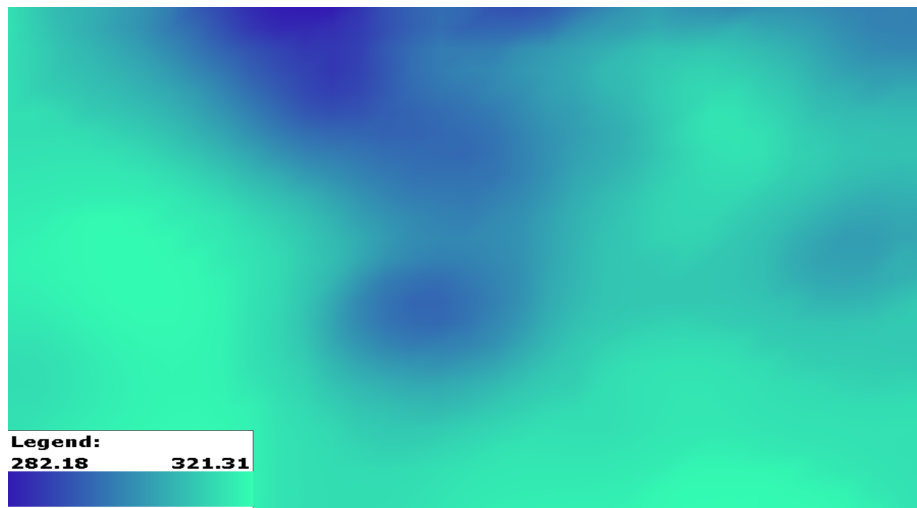


Figure 17: Changing color margins

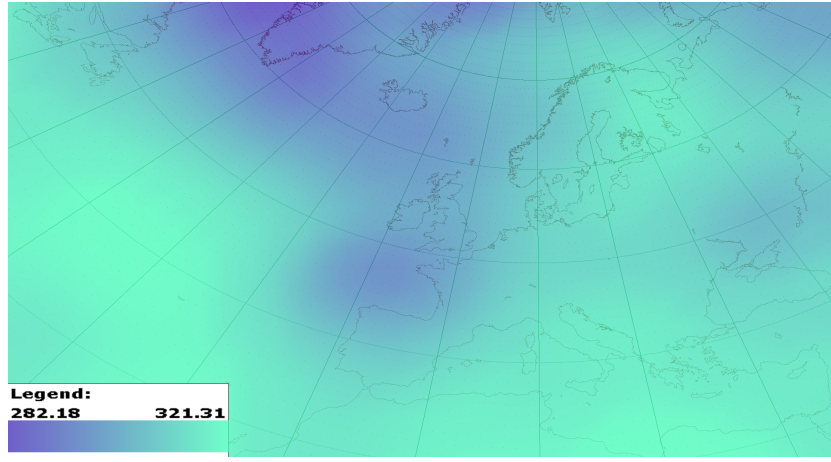


Figure 18: Showing only a faint image of the map, giving more importance to geopotential values

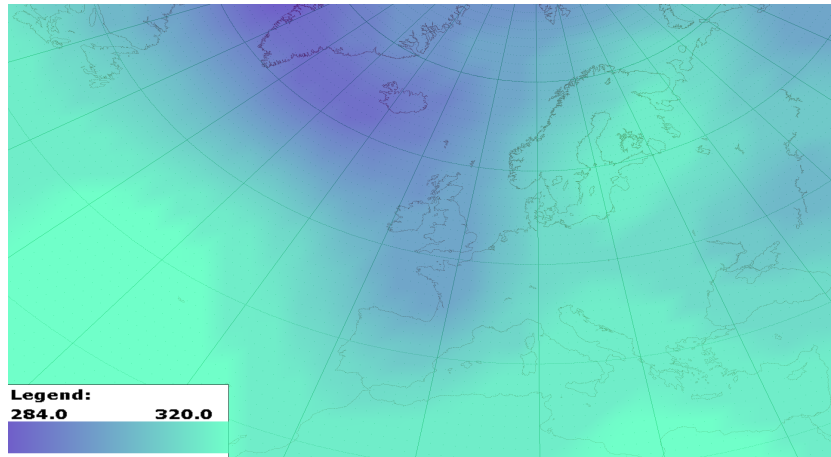


Figure 19: Trying with a different instant data set

7 Conclusion

After executing and interacting with the program is evident how useful the transfer function might be, specially when trying to show some data overlapping another one. In this case for instance, it would be completely useless showing the map or the geopotential values independently, hence, this kind of information is perfect to be plotted using the transfer function method.