The Bracknell Chart Revisited

by Ernst Lobsiger

When I read the article in the GEO Newsletter No. 72 about overlaying a Bracknell chart on an UTM output of MeteorGIS as a retired teacher, I had to say: “Well, he has tried something new!”. But of course this was a mathematical “no go” and if you criticize something being wrong you have to show a correct and maybe better way to solve the problem. I admit that, to really understand what this is all about, you need to know a few things about shape files. The basic ESRI white paper is found here:

https://www.esri.com/content/dam/esrisites/sitecore-archive/Files/Pdfs/library/whitepapers/pdfs/shapefile.pdf

You should also have a basic understanding of map projections as we use PROJ under the hood:

Historic paper: https://pubs.usgs.gov/of/1990/of90-284/ofr90-284.pdf Todays link: https://proj.org/

But David Taylor has explained a couple of times that most Windows users are not interested in how things work, they just want “click and go”. As a physicist I always want to know how things work and as a retired teacher I still hope that a few of you at least try to understand some of the stuff above. But for the rest of this paper I just assume you can install QGIS and find the right buttons to press.

This is a formula on how to overlay the Bracknell MSLP Chart onto the UTM as well as the Mercator output of MeteorGIS. We use the power of QGIS. This free GIS is available for almost any language and OS. For this paper I used long term standalone release 3.16 64bit. It can be downloaded from:

https://www.qgis.org/en/site/forusers/download.html

We had to find out the hard way, that you *MUST* install with the MSI installer that has this note:

Note that the MSI installers are much bigger than the previous installers. This is because they include significant larger packages (e.g. PROJ 8). The main reason for the switch to MSI were the size limits previously used NSIS has, which was blocking updates of dependencies.

If you install with the *.exe installer you will get a previous GDAL package that cannot cope with the **crazy idea** of polygonizing a Bracknell.png chart. You will get errors and finally an incomplete result.

Very different from MeteorGIS there is an absolutely overwhelming QGIS documentation here:

https://docs.qgis.org/3.16/en/docs/user_manual/index.html

Unfortunately, the Bracknell chart is found in a couple of different versions, resolutions and image types on the Internet. Archived versions AFAIK only exist as low resolution types. For good results we must use the highest resolution analysis charts available. These are found as 6 hourly issues here:

https://www.weathercharts.net/ukmo_mslp_analysis/ppva_fullsize.gif

The latest chart is always published 30 minutes to 4 hours after 00:00, 06:00, 12:00 and 18:00 UTC. Because these charts are antialiased in different shades of gray and have a white frame they must be prepared in a special way to be optimum inputs for QGIS. ImageMagick (IM) is used to do this job. Different from a GEO-tif the resulting *.png image has no georeference at all. To be used in QGIS we need two additional helpers: We must use a so called world file *.pngw that tells QGIS how to find projection coordinates from the intrinsic (x,y) pixel coordinates of the prepared image. The intrinsic

coordinates are displayed when opening an image in Paint.exe. A world file can be opened in any editor and has just 6 numbers to describe an affine mapping. Then we must tell QGIS exactly what kind of projection was used to generate the Bracknell chart. Both points must be done only once.

I provide Windows CMD scripts that download with wget and prepare the Bracknell chart(s) with IM and I also provide the *.pngw that works with (and only with) the resulting 2148x1452 Bracknell.png. There are Bracknell "forecast" charts as well, but as we use the most accurate "analysis" charts, this implies that we will have to reprocess an occurred MeteorM2 pass with MeteorGIS in manual mode.

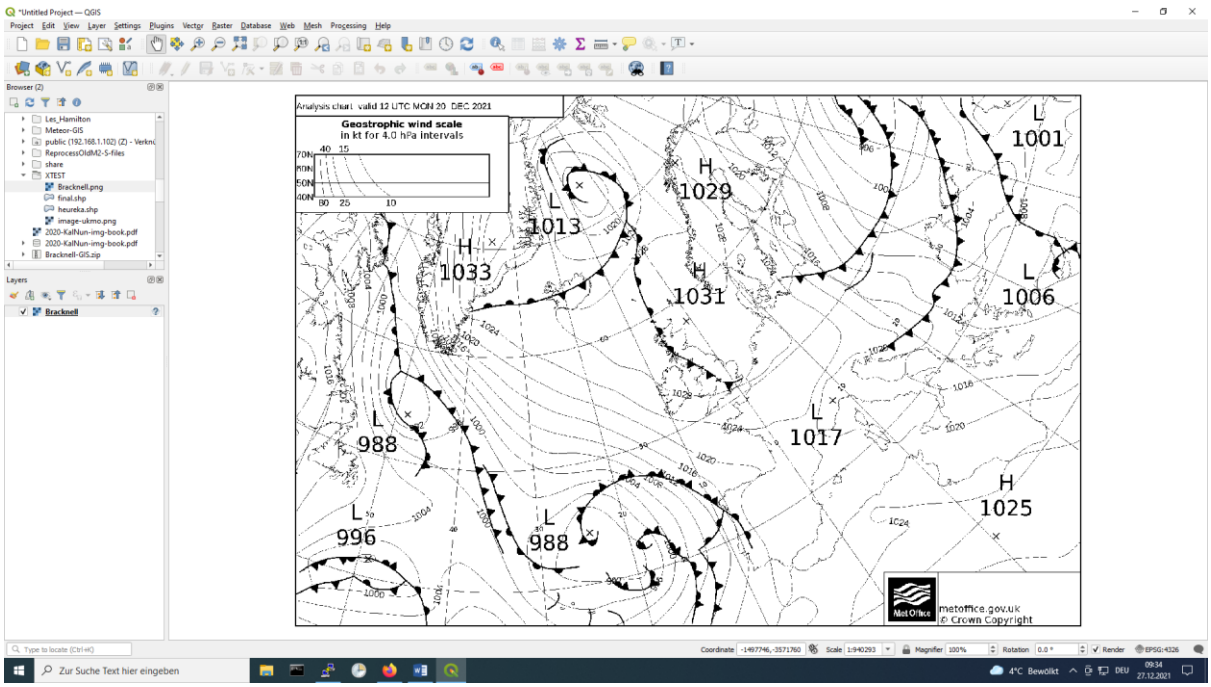
Once QGIS is installed, you have to define a user Coordinate Reference System (CRS) using the definition below. This WKT string has been copied from a GEO-tif output of PyTROLL/Satpy:

```
PROJCRS["Bracknell MSLP Chart",
    BASEGEOGCRS["unknown",
        DATUM["Unknown_based_on_WGS84_ellipsoid",
            ELLIPSOID["WGS 84",6378137,298.257223563,
                LENGTHUNIT["metre",1],
                ID["EPSG",7030]]],
        PRIMEM["Greenwich",0,
            ANGLEUNIT["degree",0.0174532925199433,
                ID["EPSG",9122]]]],
    CONVERSION["Polar Stereographic (variant A)",
        METHOD["Polar Stereographic (variant A)",
            ID["EPSG",9810]],
        PARAMETER["Latitude of natural origin",90,
            ANGLEUNIT["degree",0.0174532925199433],
            ID["EPSG",8801]],
        PARAMETER["Longitude of natural origin",-35,
            ANGLEUNIT["degree",0.0174532925199433],
            ID["EPSG",8802]],
        PARAMETER["Scale factor at natural origin",1,
            SCALEUNIT["unity",1],
            ID["EPSG",8805]],
        PARAMETER["False easting",0,
            LENGTHUNIT["metre",1],
            ID["EPSG",8806]],
        PARAMETER["False northing",0,
            LENGTHUNIT["metre",1],
            ID["EPSG",8807]]],
    CS[Cartesian,2],
        AXIS["(E)",south,
            MERIDIAN[90,
                ANGLEUNIT["degree",0.0174532925199433,
                    ID["EPSG",9122]]],
            ORDER[1],
            LENGTHUNIT["metre",1]],
        AXIS["(N)",south,
            MERIDIAN[180,
                ANGLEUNIT["degree",0.0174532925199433,
                    ID["EPSG",9122]]],
            ORDER[2],
            LENGTHUNIT["metre",1]]]
```

Open QGIS and under "Settings/Custom Projections..." press the plus sign, rename the "new CRS" to Bracknell. Then, using default format WKT, just copy and paste the above definition into the lower "Parameters" window. Then press "Validate". If the WKT is accepted valid you can save it with "OK".

If you now go to “Project/Properties/CRS” and enter Bracknell in the filter line you should find your “User Defined Coordinate System” Bracknell. If this is the case, we are ready to go. For this you must have your input Bracknell.png and the accompanying Bracknell.pngw side by side in some place.

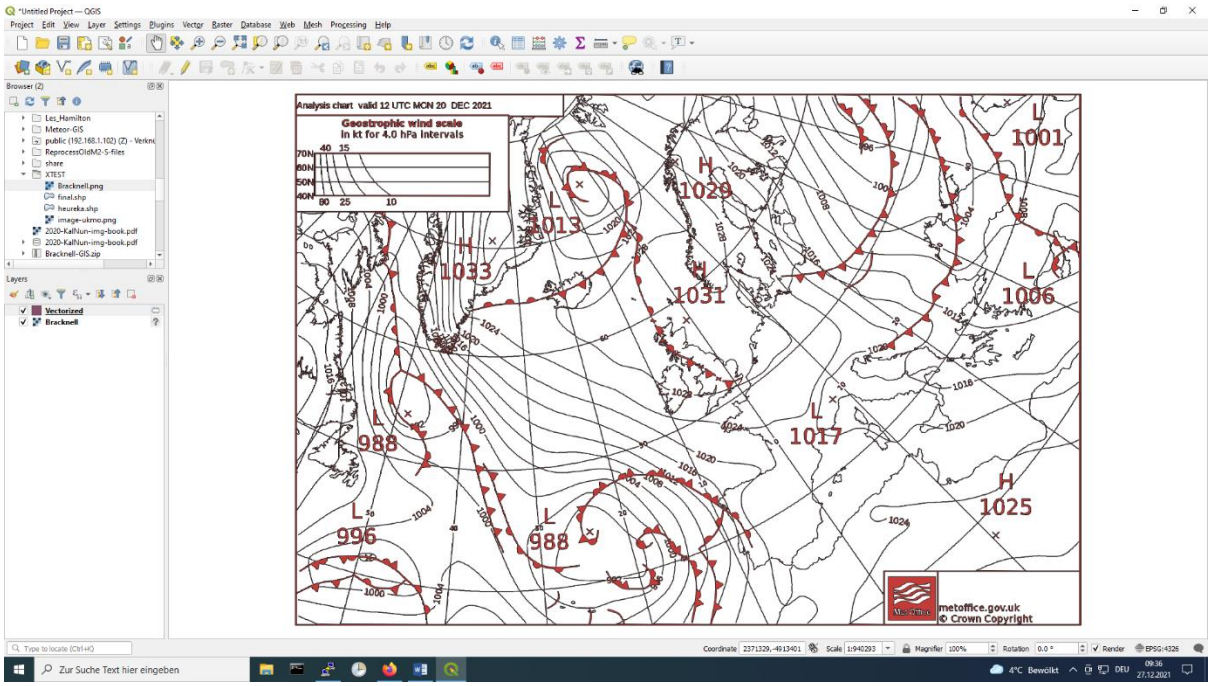
If the two important panels are not already there right click on the menu bar on top (right click = click on the menu bar pressing the right mouse key) and select “Browser (2) Panel” and “Layers Panel”. The main window should show a new empty project if not press the button top left. Now in the “Browser (2)” panel select (double click) your image Bracknell.png. You have a first layer called “Bracknell” that also shows up as an entry in the “Layers” panel. If you got lost somewhere in the main window zooming in and out press the “Zoom Full” button to get a home view of the layer.



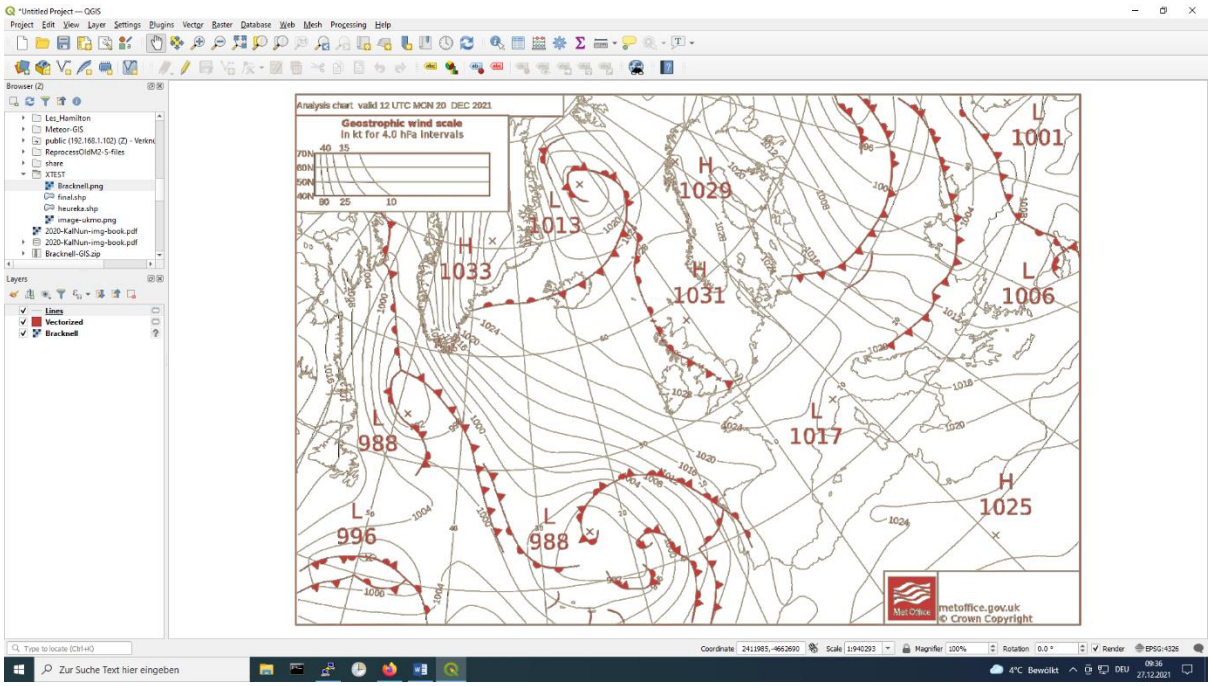
This is just an image but nevertheless you should already see projection coordinates at the bottom due to the magic of the world file *.pngw. We have a raster layer and we have to vectorize it first.

Press “Raster/Conversion/Polygonize (Raster to Vector)…” and using all defaults press “Run”. This will take a while until you get a new layer and can close the “Polygonize (Raster to Vector)” window.

*You may skip the following explanation if you are of the “click and go” type! What QGIS, calling an underlying GDAL script, actually does here is this: It follows every border black to white and digitizes this in a series of map coordinates. These (Mx,My) coordinates form the basis of shape file Multipart Polygons. Such a polygon, in its most basic form, is a closed non intersecting line called “ring”. This means the first and the last point are identical. A ring has an inside and outside. The ESRI definition is such that the outmost ring is oriented CW. So if you walk along the coordinates with increasing index the inner side of the (ESRI) polygon will be at your right. But as the name says a Multipart Polygon can have multiple parts. As a simple example think of the outlines of a donut. It has an outer ring and an inner ring. To comply with the ESRI shape file definition the inner ring must be oriented CCW. So again if you walk along the inner ring the inside of the polygon will be at your right. The next simple form will be the bold number **8**. If you polygonize that, it will have one outer ring and two inner rings. That’s why the numbers like **0** and **8** will look “outlined” in the final MeteorGIS overlay result. After this most astonishing GDAL digitizing step I found Bracknell polygons that had up to 490 parts (!).*

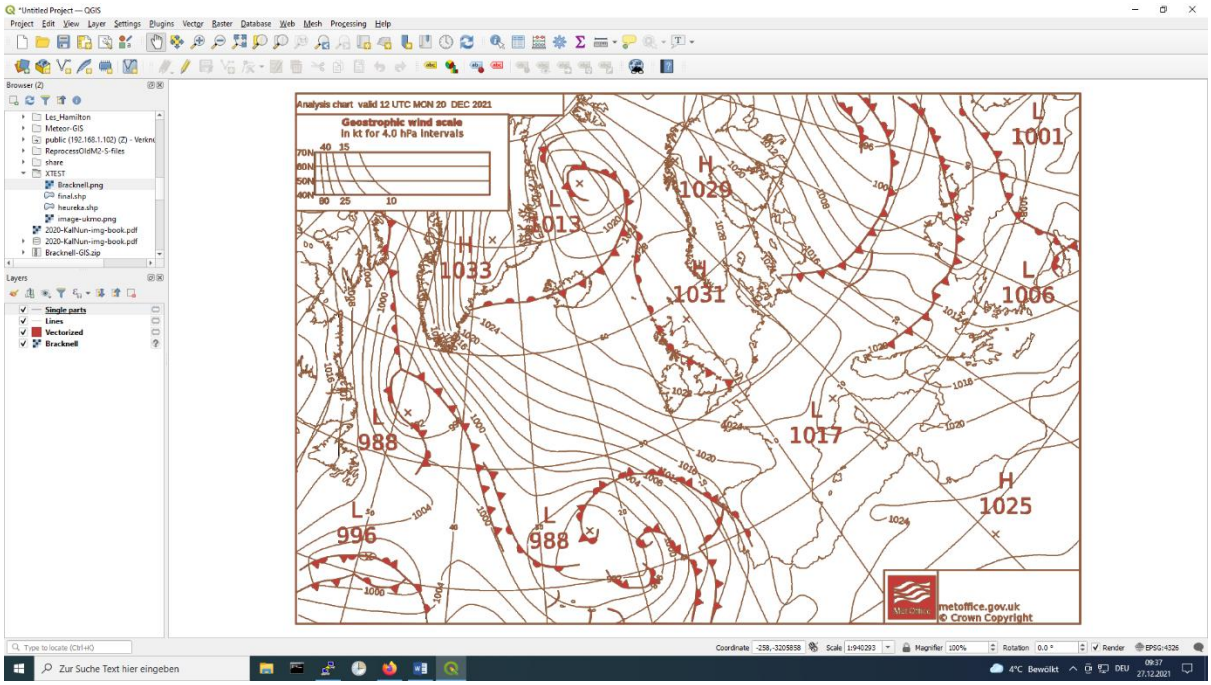


Now you have a “Vectorized” layer of Polygons. These are closed nonintersecting lines. Polygons have an in- and outside and can have multiple parts. A donut is a polygon. MeteorGIS does only understand Lines and Points. We have to convert the layer using “Vector/Geometry Tools/Polygons to Lines...”. This takes only a second and you have a new vector layer called “Lines” on top of all.

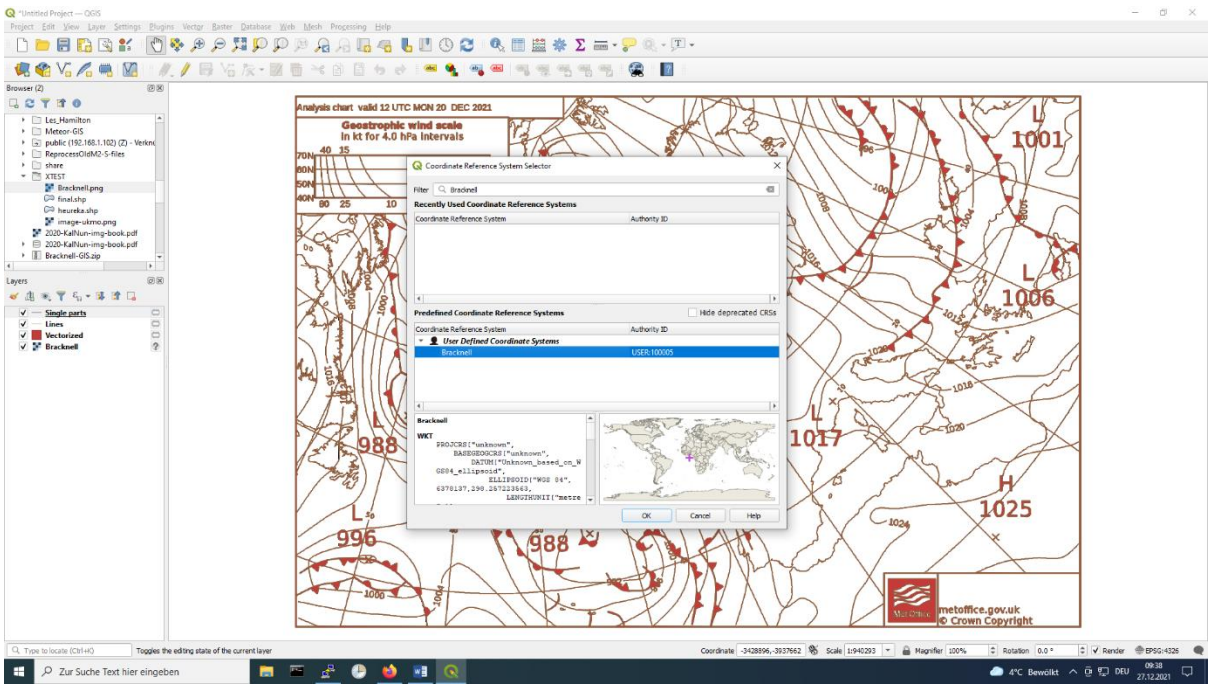


Unfortunately, this layer is still Multipart Lines while MeteorGIS only understands Singlepart Lines. It does scratch from one part to the next without lifting the pen! But this can be fixed quickly again.

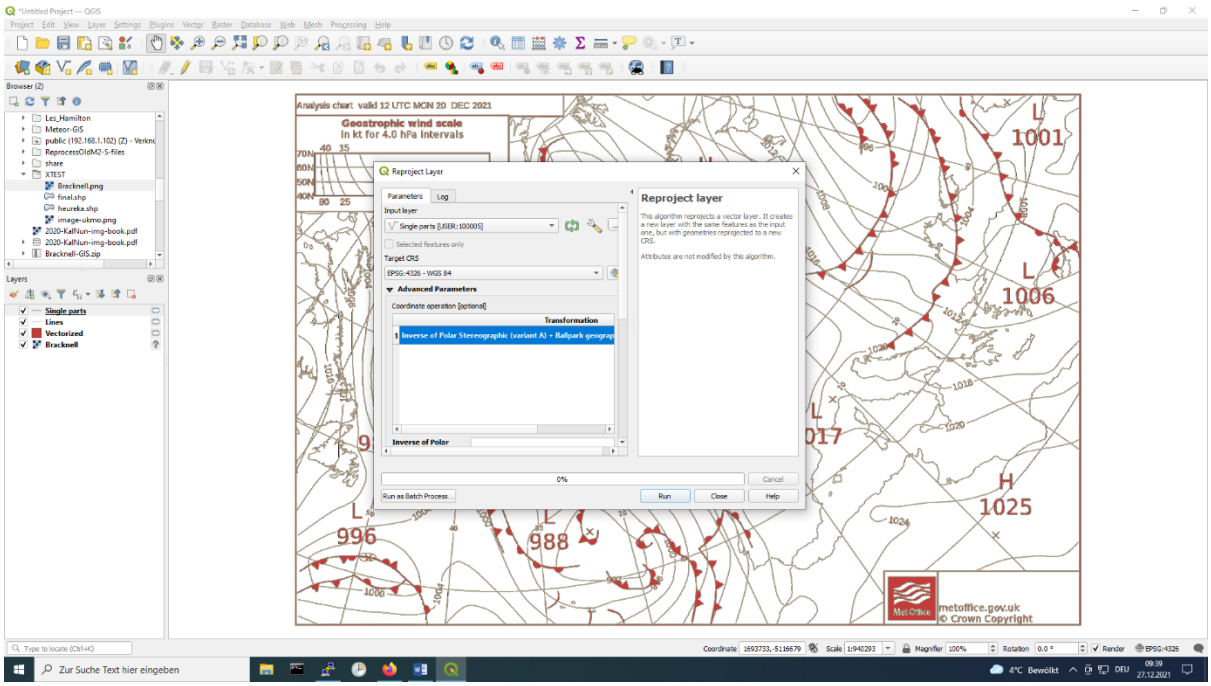
Press “Vector/Geometry Tools/Multipart to Singleparts…” and you get a new layer again. Now it’s about high time to tell QGIS how these coordinates you see at the bottom have to be interpreted. Only after having done this intermediate “properties” step it is possible to produce the final layer.



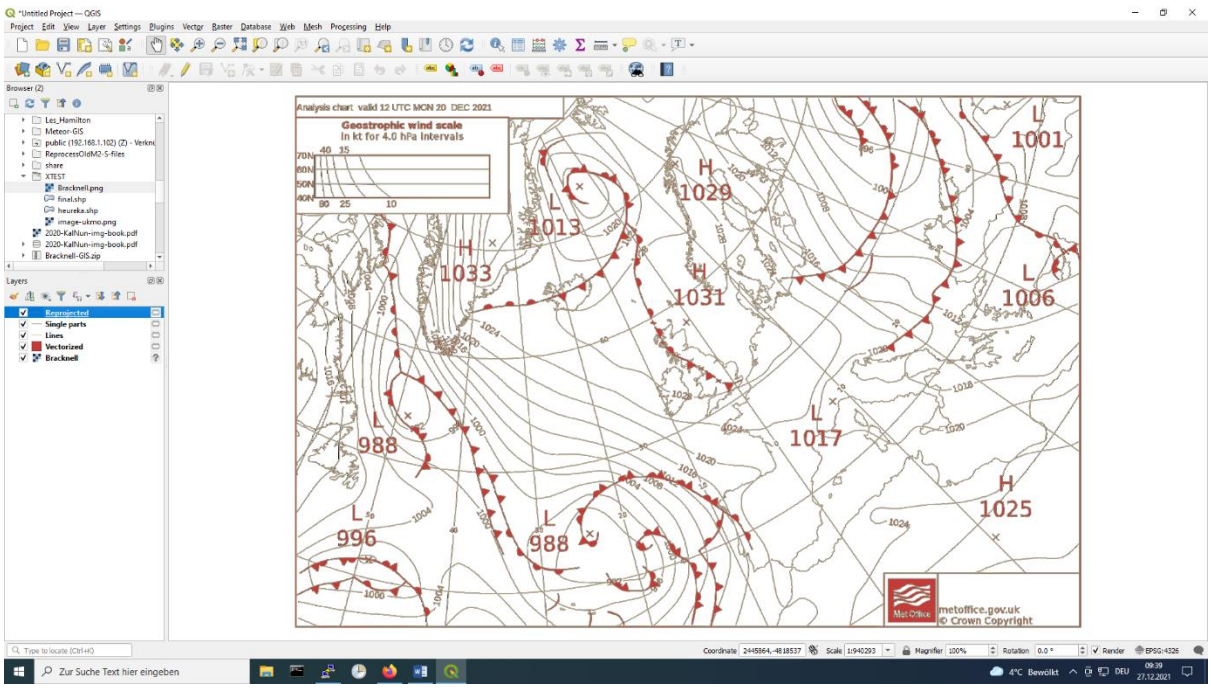
In the “Layers” panel right click the latest “Single parts” layer and select “Layer CRS/Set Layer CRS...”. This opens the “Coordinate Reference System Selector”. In the filter line you enter “Bracknell” and you are lead to your user defined “Bracknell” CRS. Highlight this CRS and select it pressing “OK”.



Now that QGIS knows what the UK MetOffice did to produce the Bracknell chart, we can easily reproject it to any useful other CRS. Press “Vector/Data Management Tools/Reproject Layer…”. We are now reprojecting our last “Single parts” layer as input to the target and default CRS “EPSG:4326 WGS84”, the Plate Carreé projection, which is just longitude +/- 180 and latitude +/- 90 in degrees.

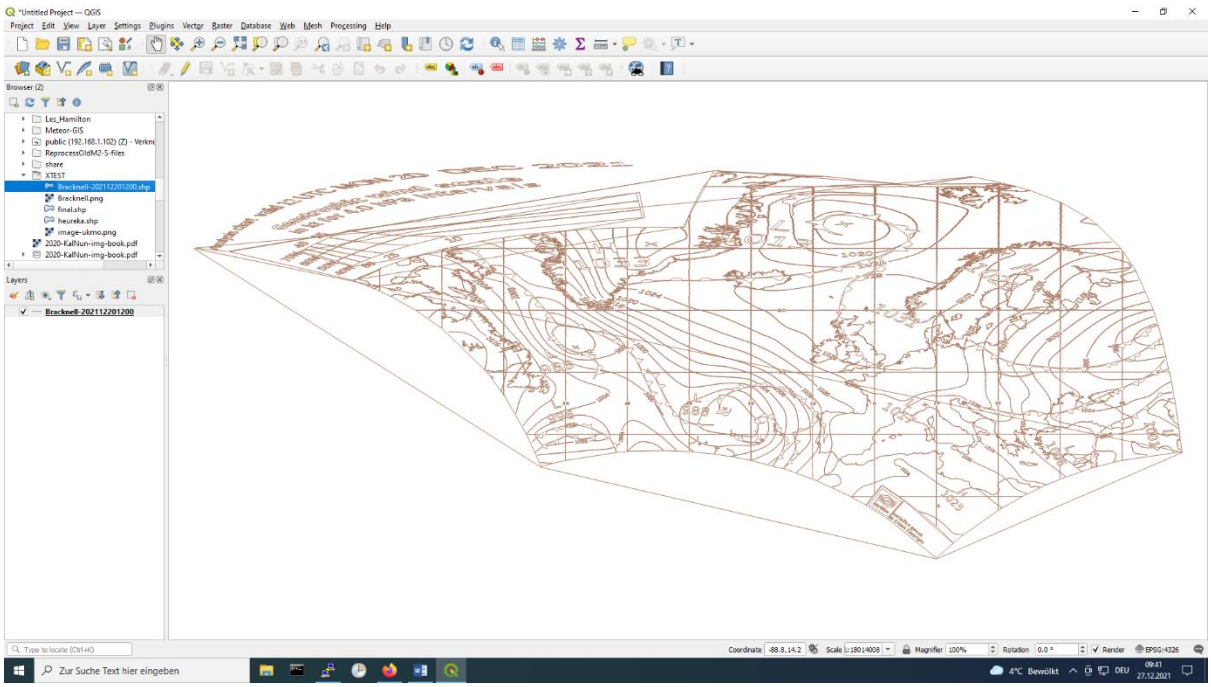


This is our final layer called “Reprojected” even if it still looks the same as all the other layers. As a matter of facts we just used the “Inverse Projection” of the UK MetOffice Polar Stereographic -35° meridian projection to go back to basic longitude and latitude where all projections normally start.



We are almost done: Press “Layer/Save As…” and you are able to save your final “Reprojected” vector layer as ESRI shape file with some useful naming wherever you want it in your file system. The first time you do that, you might have to choose format “ESRI Shapefile” with the bar on top. This actually produces 5 files *.shp, *.shx, *.dbf, *.prj and *.gcp. While QGIS will expect them all, MeteorGIS, for our purpose of a “digital” Bracknell chart overlay, will only use the first 3 of them.

You can now press the button top left to generate a new blank project. Do not save anything else. If you reload the shape file we just made, you should see something similar to the screenshot below:



You will note a weird line connecting 4 corners and you also see that the text top left fell out of its box. Don't worry, this is easily explained with the polygonizing and reprojecting steps. It will not influence the usefulness of this shape file to produce Bracknell overlays in MeteorGIS in any way.

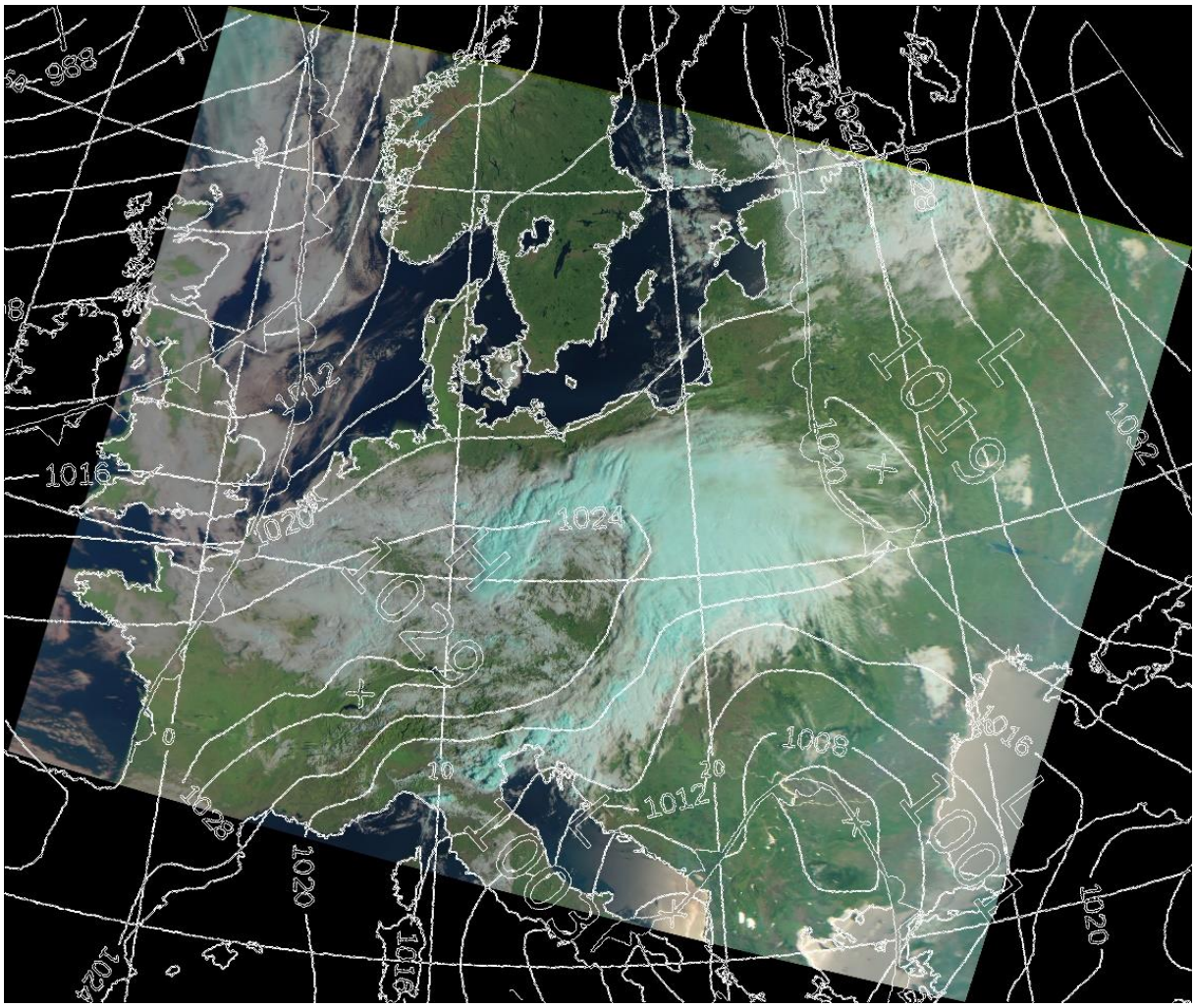
As a last step copy the *.shp, *.shx and *.dbf file into your MeteorGIS subdirectory and tell it in an appropriate *.ini to uses this shape file instead of coastlines. This is the right place as the Bracknell chart, besides the MSL pressure contours, already has the coast lines and the lon/lat graticules. As usual you can choose the line thickness and color (not colour!) of your overlay. And it works for both the (fake) UTM and (true) Mercator output of MeteorGIS. It's probably best to make a copy of your usually used *.ini file and name it overlays.ini. Then you must also have an overlays.bat containing:

```
MeteorGIS.exe /nolive /composeauto /sat:M2 /config:overlays.ini
```

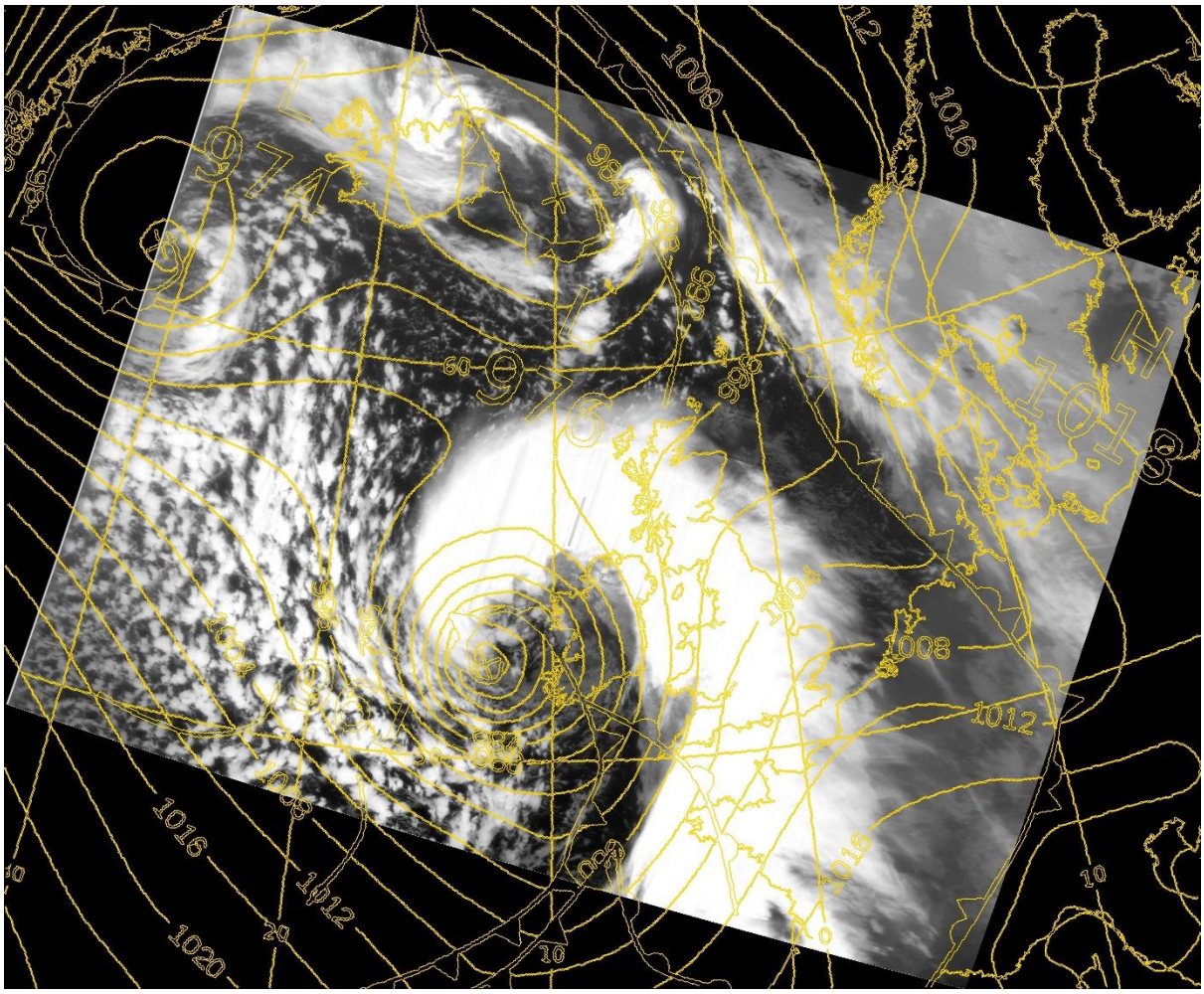
Your corresponding overlays.ini must contain the block below (just overlaying the Bracknell chart):

```
…
[Shapes]
shapesNumber=1
[Shape0]
filename=Bracknell.shp
color=FFFFFF
thickness=2
[Shape1]
…
```

But as a matter of fact you can experiment with different positions of the Bracknell overlay and different other layers added by MeteorGIS as well. You can even add Bracknell.shp as [Shape5].

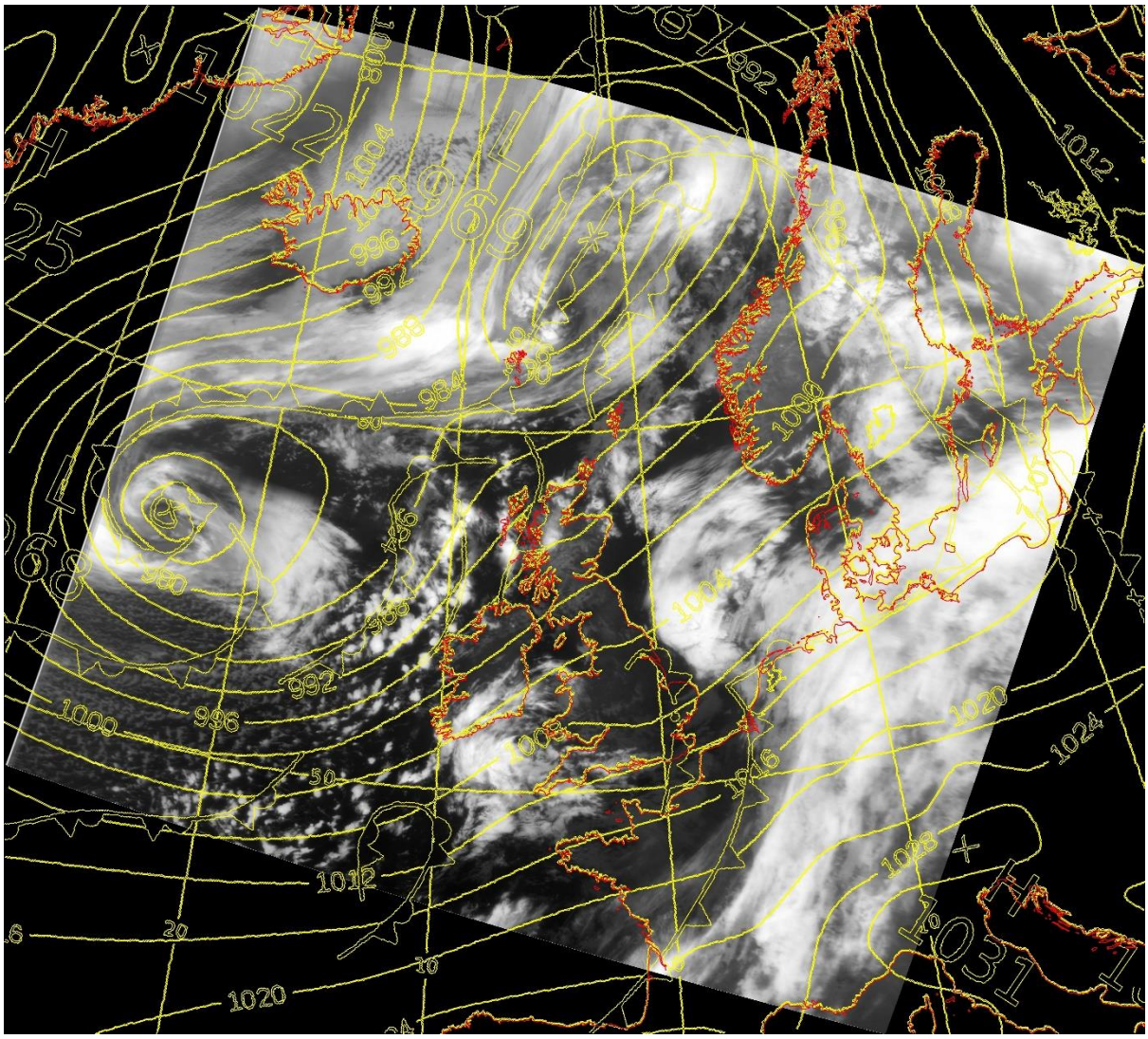


This was my first working overlay. S-File 2021-08-23-06-59 provided by Les Hamilton. Unfortunately, the overlay does not fit with the meteorological situation as I found no “full size” Bracknell chart of that date. Charts with lower resolution archived on the Internet don’t produce acceptable results.

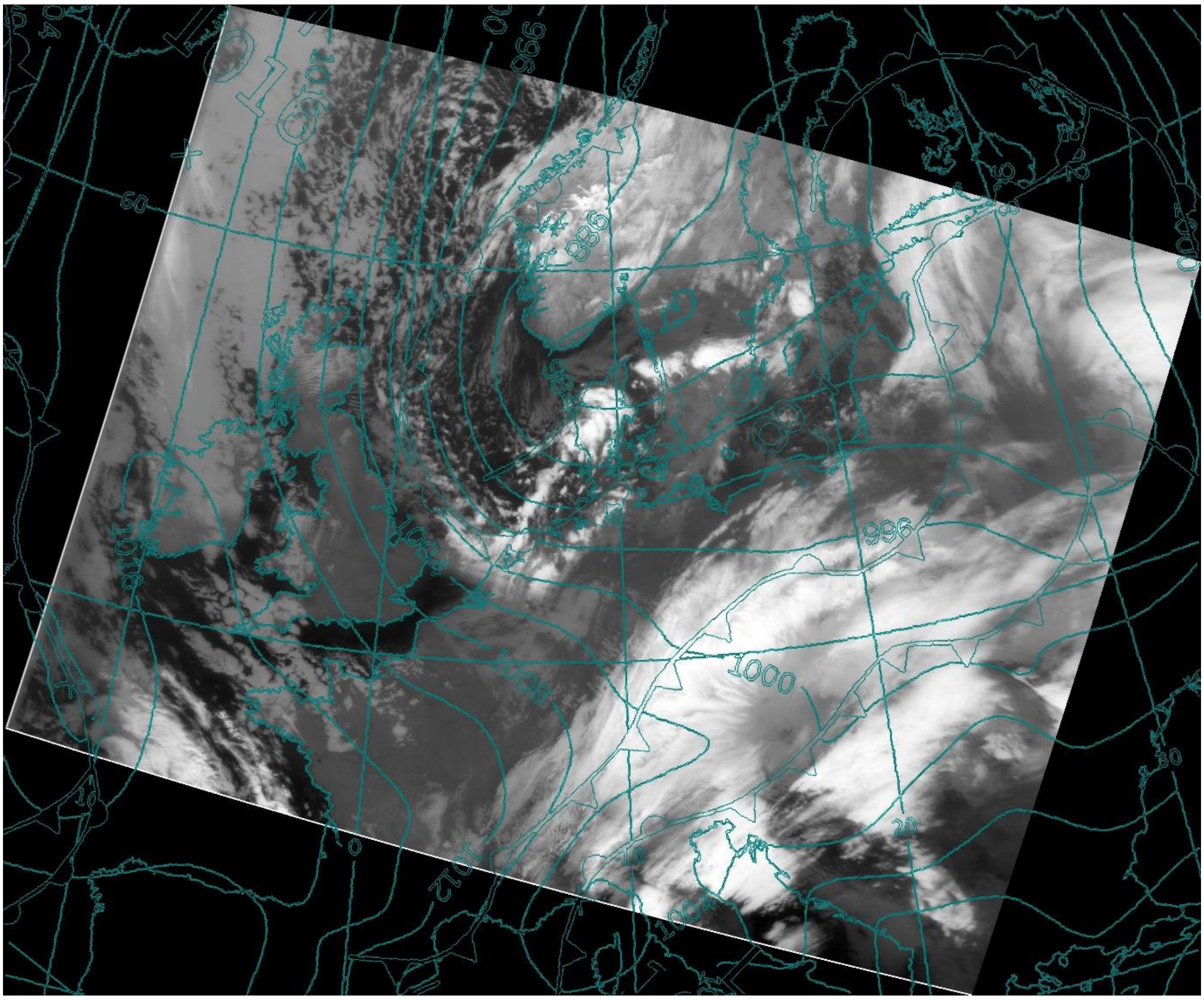


This is storm BARRA. S-File 2021-12-07-08-32 provided by Les Hamilton. Full size Bracknell overlay 202112070600 (that fits the meteorological situation as close as possible) from my own archive.

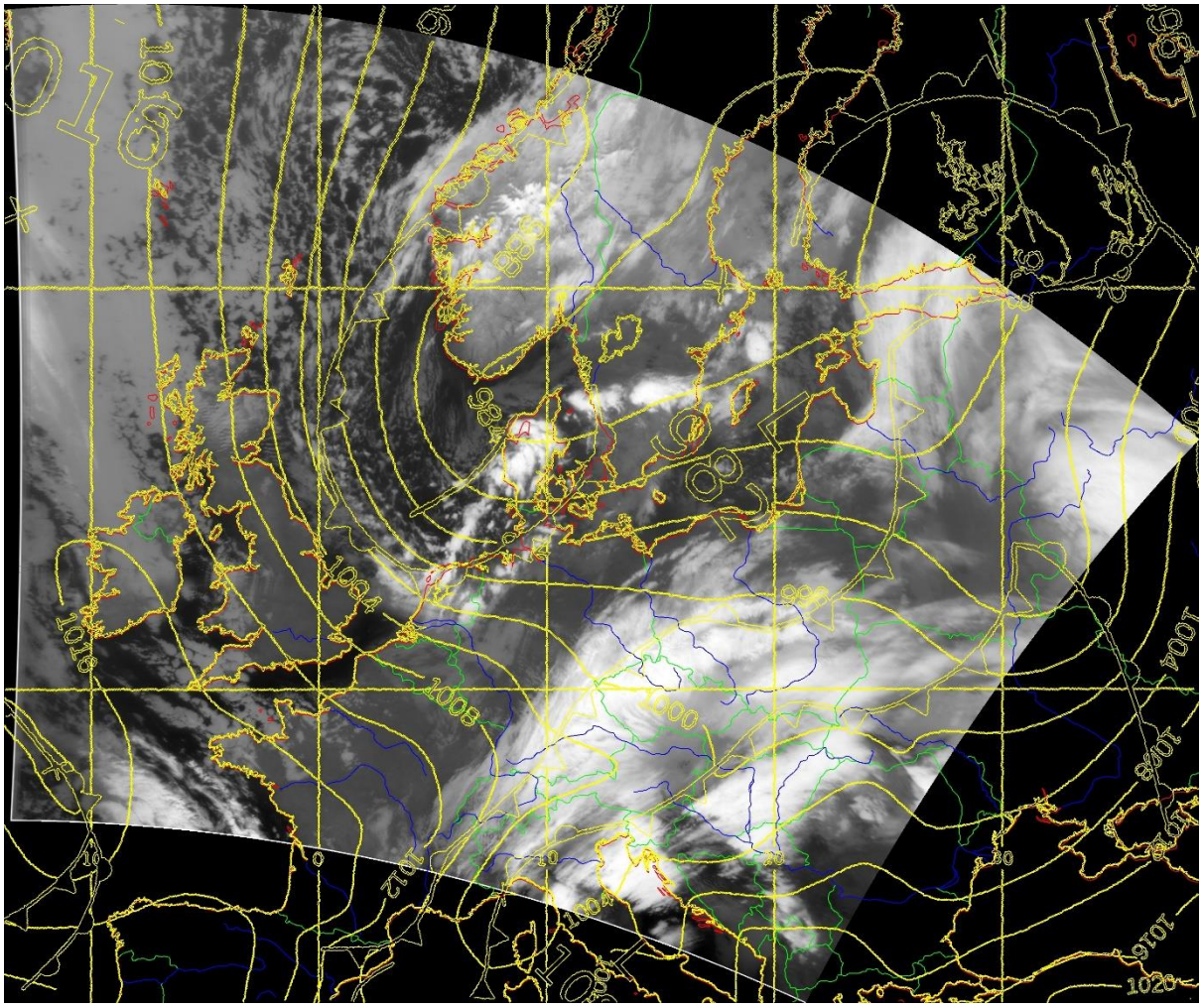
https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2021/2021_08_storm_barra.pdf



This image was produced by Les Hamilton with his S-File 2022-01-02-08-18 and a full size analysis Bracknell chart from 202201020600. Please note the excellent fit of the MeteorGIS produced coastlines in red with the yellow coloured Bracknell.shp overlay from Greenland down to Spain and Italy. The method of this paper equally works for the Mercator projection and even multipath images produced by MeteorGIS. As the Bracknell chart is issued 6 hourly, there might be a time difference of up to 3 hours between the time the chart is valid and the maximum elevation of a pass.



Here is another fine image received and processed by Les Hamilton with S-File 2022-01-05-07-19 and "full size" Bracknell chart overlay 202201050600. The UK is on a high pressure ridge with polar air streaming down after the pass of a cold front that is now over eastern France.



This is from the same S-File 2022-01-05-07-19 and Bracknell 202201050600 overlay as the image on the previous page. Les Hamilton kindly sent me all the files I needed to experiment with my offline install. I just wanted to add one Mercator projection with overlay and also use some of the shape files provided with the MeteorGIS package. My default.ini used four shape files in the order below:

[Shape0] filename=ne_50m_admin_0_boundary_lines_land.shp color=00FF00 thickness=2
[Shape1] filename=ne_50m_rivers_lake_centerlines.shp color=0000FF thickness=2
[Shape2] filename=ne_50m_coastline.shp color=FF0000 thickness=2
[Shape3] filename=Bracknell.shp color=FFFF00 thickness=2

I found out that the rivers file contained Multipart Line shapes that MeteorGIS cannot handle correctly. This was easy to fix using QGIS. So as a little by-product rivers and lakes now work.

Conclusions

It has been shown that MeteorGIS can be used to display a “digital” Bracknell chart as overlay with its “UTM” and Mercator projection. But sorry, MeteorGIS “UTM” is not real UTM as it should always show rectangular intersections of meridians and parallels. MeteorGIS Mercator on the other hand is real Mercator. MeteorGIS can handle shape files of type single points and single part lines. This is not much of the zoo of ESRI shape file types. It seems that MeteorGIS has never been really finished but rather abandoned. In the latest official version MeteorGIS_v2.24.zip I found a ne_50m_lakes.dbf and a ne_50m_rivers_lake_centerlines.dbf but no sign of the also needed *.shp and *.shx. In the offline MeteorGIS install I worked with I found all three shape files for ne_50m_rivers_lake_centerlines but none for ne_50m_lakes. So it’s clear that someone has changed things later to experiment with. As MeteorGIS does not understand Multipart Lines you have to make sure it’s “Singleparts”. This is one step in the preparation of the “digital” Bracknell chart and it equally works for rivers shape files. Just read the rivers.shp into an empty QGIS project. You will see a “Plate Carrée” projection. Then press “Vector/Geometry Tools/Multipart to Singleparts…” and save the resulting layer as rivers_MGIS.shp. I also found one and only one Multipart Line shape in ne_50m_coastline.shp. This will scratch all the way down from the Bering Street to the Caspian Sea. While users in western Europe probably never receive S-Files that show the Caspian Sea, Russian users will eventually have this coastline problem. It seems that all the “official” and “unofficially added” shape files have a common origin on this site:

http://www.naturalearthdata.com

Users that want to experiment with shape files should download the MeteorGIS_Configurator.exe v1.20 as this version has an extended shape tab that almost disappeared in the last version v1.21. The MeteorGIS_Configurator.exe V1.20 will not work with settings as I have used for my last image (it just crashed) but it has a couple of hints that can be used to read out special attributes in point and maybe even line shapes. One guy has done interesting stuff using these point shape features:

https://usradioguy.com/layering-geo-spatial-fire-data-into-satellite-imagery

So far we have not bothered about the attribute content found in *.dbf. This is easy to display with EXCEL and even easier in QGIS itself. But that’s something the reader must find out. Windows 10 is not the OS of my choice and I want to go back to GNU/Linux and prepare my EUMETCast receivers and PyTROLL/Satpy scripts for MTG-1 and the Metop Second Generation series coming rather soon.

Many thanks go to Les Hamilton for his support of the project providing data and being a pilot user.

Provided CMD scripts

There are two CMD scripts to download and prepare the “full size” Bracknell charts for our purpose. The resulting charts are PNG 2bit, 2148 x 1452, black and white, where white is made transparent. Without the transparency step all polygons in QGIS would get filled with some colour making this layer hard to interpret. A main problem is to give the resulting charts the right date and time in the file name, as this information is not easily available. My scripts assume that a chart issued between 12:01 and 17:59 UTC (last modification UTC file time) must be a chart valid 12:00 UTC. The problem gets even more complicated for the download of 4 previous charts, that are available on the Internet site used. In any case your PC must have a time setting of plain UTC, if not, the CMD scripts may fail.

Get-the-latest.cmd This script downloads and processes the latest available (analysis) Bracknell chart. Don’t use it earlier than 1 hour after the valid date and time indication top left on the chart. Ask between 13:50 and 17:50 to get a 12:00 UTC chart.

Get-the-last30h.cmd This script will download the latest plus up to 4 previous charts. Use this if you need a chart from yesterday that you forgot to download manually. This is as far as we can go back. I found no archive of “full size” charts on the net.

CHEAT SHEET

After you have installed QGIS, defined the special Bracknell CRS, panels ready, you always start here:

1) Make sure you have a **Bracknell.png** and corresponding **Bracknell.pngw** side by side
2) Load **Bracknell.png** from the **Browser(2)** panel (you get a first **Bracknell** raster layer)
3) Press “Raster/Conversion/Polygonize (Raster to Vector)…” (you get layer **Vectorized**)
4) Press “Vector/Geometry Tools/Polygons to Lines...” (you get - still multipart - layer **Lines**)
5) Press “Vector/Geometry Tools/Multipart to Singleparts…” (you get line layer **Single parts**)
6) In the **Layers** panel right click the latest **Single parts** layer and select “Layer CRS/Set Layer CRS...”. Type Bracknell into the filter line and assign this layer our user defined Bracknell CRS.
7) Press “Vector/Data Management Tools/Reproject Layer…”. We are now reprojecting our last **Single parts** layer as input to the target and QGIS default CRS **EPSG:4326 WGS84**, the “Plate Carreé” projection. This final layer called **Reprojected** still looks the same as all other layers.
8) Press “Layer/Save As…” and you are able to save your final **Reprojected** vector layer as **ESRI Shapefile** (with full path) and some useful naming wherever you want it in your file system.
9) As an **optional double check step** you can press the button **New Project** top left without saving anything. Then reload from the **Browser (2)** panel and check the shape file just saved.
10) Leave QGIS without saving anything and copy (if not already in place) the three shape files Bracknell.shp, Bracknell.shx and Bracknell.dbf to the place MeteorGIS will be told to use.

If you have clicked this procedure a couple of times, you will be able to do it in one single minute!

Belp, Oase 2022/01/10 Ernst Lobsiger