Summary

The corner coordinates are erroneous in current projected 2-dimensional (a.k.a. Cartesian) radar products in ODIM_H5 generated by the Baltrad system and will be slightly adjusted in order to get a consistent way of calculating coordinates. Projected products are for example composite products, single site PPI and PCAPPI products.

The magnitude of this adjustment is somewhere between 30 and 70 meters depending on product and direction. The reason for this shift is that in earlier versions of the Baltrad component Rave the extent has been calculated somewhat different from when translating radar data into the Cartesian surface. However, to prepare for a move to PROJ >= 6 the way to translate lon/lat into surface coordinates and vice versa has been unified.

Due to some fundamental differences between PROJ.4 and PROJ >= 6, from now on referred to as PROJ 4 and PROJ 6, we will also have to change some projection definitions.

Introduction

According to the ODIM_H5 specification, see references below, the corner coordinates shall describe the outer boundaries of the area covered by the raster where the longitude and latitude coordinates are normalized to the WGS 84 ellipsoid and geodetic datum. For any projected product these coordinates are defined by the following eight attributes

```
/where/LL_lat, /where/LL_lon
/where/LR_lat, /where/LR_lon
/where/UL_lat, /where/UL_lon
/where/UR_lat, /where/UR_lon
```

These coordinates shall match the geometrical dimensions ("size") of the raster and the physical size ("scale") of each element in the raster. The ODIM_H5 attributes defining the geometrical properties are:

```
/where/xscale, /where/xsize
/where/yscale, /where/ysize
```

According to the ODIM_H5 specification, the cartesian product shall also contain a PROJ.4 projection definition in attribute:

```
/where/projdef
```

The changes

During the implementing of support for PROJ 6 it was noticed that there are a few behaviors that has changed between PROJ 4 and PROJ 6 that requires attention and will affect users of the Cartesian products.

Attribute /where/projdef

The first problem is that the order of arguments in projection definitions are handled differently.

In PROJ 4, the following projection definition:

```
+proj=stere +ellps=bessel +lat_0=90 +lon_0=14 +lat_ts=60 +datum=WGS84
```

will be handled like the definition

```
+proj=stere +ellps=bessel +lat_0=90 +lon_0=14 +lat_ts=60 +towgs84=0,0,0
```

In PROJ 6, the definition will instead be handled like:

```
+proj=stere +ellps=WGS84 +lat_0=90 +lon_0=14 +lat_ts=60 +towgs84=0,0,0
```

This means that PROJ will be using the Bessel ellipsoid in PROJ 4 and the WGS 84 ellipsoid in PROJ 6. To avoid this it is necessary to modify the projection definition to have a consistent parsing regardless of version of PROJ.

Corner coordinates and the product generation

Current calculations of the extent to and from longitude and latitude coordinates are using the set of functions pj_inv and pj_fwd, and for projecting the radar data to a Cartesian product the function pj_transform is used. These three functions produce consistent results in PROJ 4. But the corresponding functions in PROJ 6 produce inconsistent results for the longitude and latitude coordinates.

As a consequence of this, in some cases this has resulted in an navigation error of somewhere between 30 to 70 meters in the x and y directions in products that uses the polar stereograhic projection as defined above. When validating and comparing the product before and after the modification 2% of the pixels in the surrounding border had shifted slightly.

Modification / correction

To prepare for the future upgrade to PROJ 6 and to correct the navigation problem there are two different modifications that need to be implemented.

In a first step, corner coordinates for the Cartesian products will be slightly shifted in some cases. This means that the LL, UL, LR and UR coordinates might be changed, but the x and y sizes, and the x and y scales will remain the same. Test files and documentation covering the first step were made available 2022-02-23 meaning that the deployment of the corner coordinate change will take place 2022-05-23, the earliest.

In a second step, the most significant modification is that some of the projection definitions will be updated where the polar stereographic projection definition is used by a lot of products. This means that attribute /*where/*projdef will be changed in some cases.

As an example,

```
+proj=stere +ellps=bessel +lat_0=90 +lon_0=14 +lat_ts=60 +datum=WGS84
```

will be replaced with

`+proj=stere +ellps=bessel +lat_0=90 +lon_0=14 +lat_ts=60 +towgs84=0,0,0`

Important note: the change to the projection definition (bold text above) ,which is planned to be done sometime during 2022, more specifically it will be done after the deployment of step 1 which only impacts the corner coordinates.

The deployment of step 2 will take place after the mandatory 3 month test period starting from the date of release of documentation and test files covering this change.

The correction will affect users differently but as long as the attribute /*where/*projdef definition is read from the file and parsed as a PROJ string and the corner coordinates are read from the file the change will be handled automatically.

Developers that are using PROJ for transforming longitude and latitude coordinates into surface coordinates and vice versa should consider to use the function pj_transform/proj_trans with a source and destination projection instead of the classic pj_inv and pj_fwd to prepare for the change to PROJ >=6. If using a source and destination projection, the longitude and latitude projection should be:

```
+proj=longlat +ellps=WGS84 +datum=WGS84
```

References

Specification for ODIM H5 version 2.3:

http://eumetnet.eu/wp-content/uploads/2019/01/ODIM_H5_v23.pdf

Changing ellipsoid:

https://svn.osgeo.org/metacrs/proj/trunk/proj/html/faq.html#sphere_as_wgs84

PROJ backward incompatibilities:

https://proj.org/development/migration.html#backward-incompatibilities