# Leveraging GeoTIFF compatibility for visualizing a new EASE-Grid 2.0 global satellite passive microwave climate record

M. J. Brodzik[1] (brodzik@nsidc.org), A. Paget[2], D. G. Long[3], M. A. Hardman[1], T. M. Haran[1]
[1]National Snow & Ice Data Center/CIRES, University of Colorado at Boulder
[2]University of Connecticut   [3]Microwave Earth Remote Sensing Laboratory, BYU

Problem

In recent years, the GeoTIFF metadata standard (Ritter and Ruth, 2000) has emerged as a popular format for embedding georeferencing information into image files. However, none of the various historical Level 3 gridded passive microwave data products (e.g. Armstrong *et al.*, 1994; Maslanik and Stroeve, 2004) could be formatted as GeoTIFFs without reprojection, because the cartographic projection ellipsoids did not match the WGS84 reference datum used for the source data geolocation. Our project is funded to produce a completely reprocessed Calibrated Passive Microwave Daily EASE-Grid 2.0 Brightness Temperature (CETB) Earth Science Data Record (ESDR). One of our goals is to produce the data in a format that can leverage the power of the GeoTIFF standard so that popular software packages like GDAL, ENVI or ESRI ArcMap can easily import, understand, and analyze the geolocation metadata.
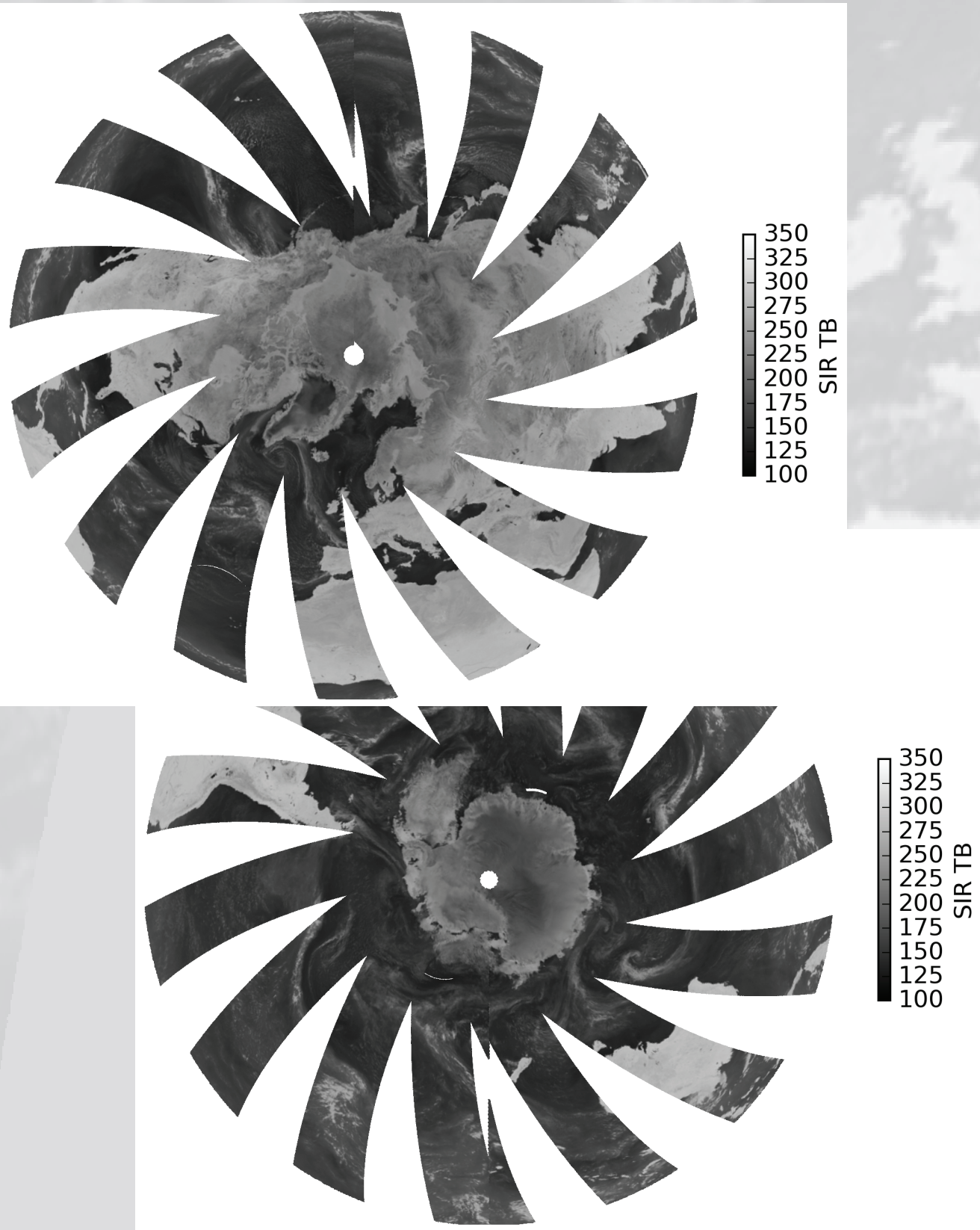
Sample gridded CETB SSM/I 37 GHz horizontally-polarized brightness temperatures, evening overpasses, Jan. 5, 2003, in Northern and Southern EASE-Grid 2.0 azimuthal projections (data also produced in cylindrical projection, not shown).

Our Solution

We have adopted a twofold approach for our gridded data products:

   1) Update the EASE-Grid projection definition from the original, spherical projection ellipsoid to the WGS84 projection ellipsoid.

   2) Format our data files using NetCDF-CF conventions and include metadata that allows GDAL utilities to correctly extract any image variable as a GeoTIFF (Haran *et al.*, 2015). In the following example, gdalinfo correctly understands the PROJCS metadata:

```
$ gdalinfo NETCDF:"cetb_file.nc":TB_num_samples
Driver: netCDF/Network Common Data Format
Files: EASE2_N25km.F13_SSMI.2003001.85H.E.GRD.CSU.v0.1.nc
Size is 720, 720
Coordinate System is:
PROJCS["LAEA (WGS84) ",
    GEOGCS["WGS 84",
        DATUM["WGS_1984",
            SPHEROID["WGS 84",6378137,298.257223563,
                AUTHORITY["EPSG","7030"]],
            TOWGS84[0,0,0,0,0,0,0],
            AUTHORITY["EPSG","6326"]],...
```

Also, gdal_translate can be used to produce a GeoTIFF of this layer, with one command:

```
$ gdal_translate -of GTiff -b 1 \
NETCDF:"cetb_file.nc":TB_num_samples TB_num_samps.tif
Input file size is 720, 720
0...10...20...30...40...50...60...70...80...90...100 - done.
```
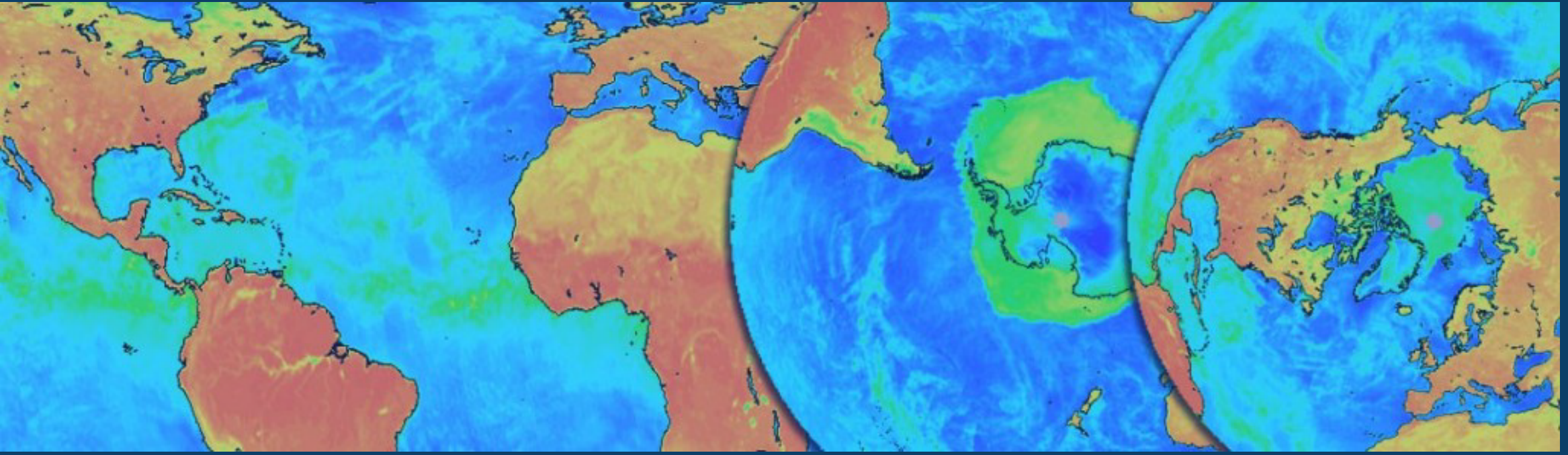
The GeoTIFF from this gdal_translate command can be read and correctly reprojected in ArcMap, ENVI and other GDAL utilities.
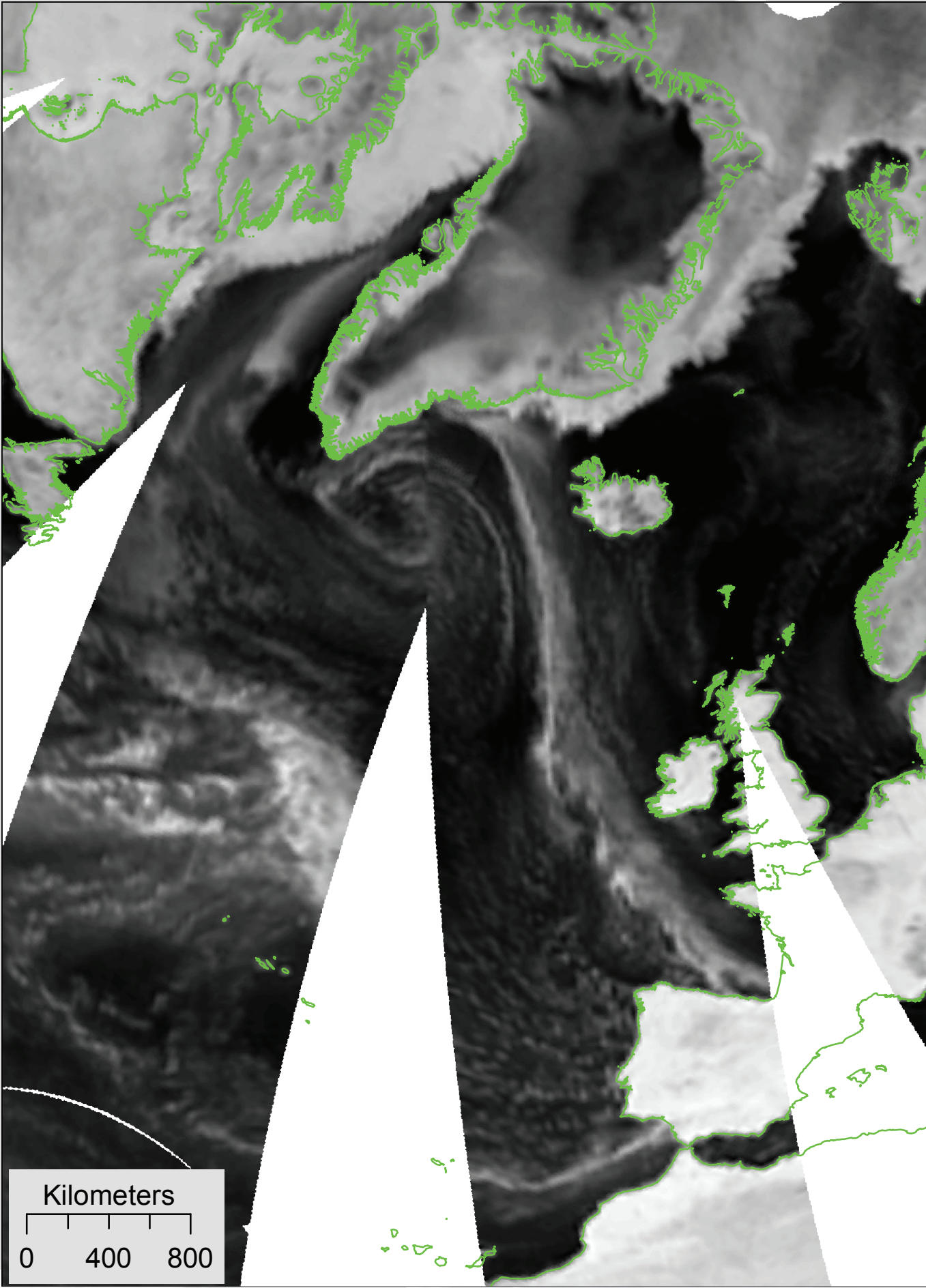
CETB 3.125 km brightness temperature GeoTIFF (same data as above), zoomed to North Atlantic, easily overlaid in ArcMap with coastlines (Wessel and Smith, 2015) with no special steps required.

Implementation Details

Task	Benefit	Status
Define and publish new EASE-Grid 2.0 projections with WGS84 datum and projection ellipsoid	Provide peer-reviewed, published reference with projection details	Complete (Brodzik *et al.* 2012; 2014)
Submit EASE-Grid 2.0 definitions to the EPSG Geodetic Parameter Registry (*www.epsg-registry.org*)	Geospatial Data Abstraction Library (GDAL/OGR, *www.gdal.org*) and other software packages use EPSG codes directly in commands: "EPSG:6931" instead of the cumbersome, error-prone proj4 string "+proj=laea +lat_0=90 +lon_0=0 +x_0=0 +y_0=0 +ellps=WGS84 +datum=WGS84 +units=m"	Complete (Three new projection definitions, EASE2_N (EPSG:6931), EASE2_S (EPSG:6932), EASE2_M (EPSG:6933) defined in EPSG v8.6, released Nov 2014; first included with GDAL 2.0.2, released Jan 2016)
Identify applicable metadata standards from NetCDF-CF, ESIP and ESDSWG Data Interoperability Working Group	Well-defined metadata for dimension variables and coordinate reference system are directly usable by GDAL tools	Complete (Brodzik and Long, 2016)
Test using gdalinfo and gdal_translate to produce GeoTIFFs	Independently-developed, open source tools can understand geolocation information to produce data layers as GeoTIFFs *without reprojection*	Complete (Bug report, *https://trac.osgeo.org/gdal/ticket/6337*, submitted to osgeo, Jan 2016: unsigned 2-byte int variables resulted in seg faults; problem fixed in GDAL 1.11 and 2.0 trunks)
Import and reproject resulting GeoTIFFs in ArcMap and/or ENVI	Independently-developed, widely-used tools can import GeoTIFF geolocation; GeoTIFF form of data can be easily overlaid and combined with complementary information (e.g. coastlines or in situ data)	Complete (after resolution of gdal ticket #6337; also see *http://nsidc.org/data/ease/versions.html* for ongoing status of software compatibility with EASE-Grid 2.0 projections)

Our users benefit from these data design choices, which significantly reduce the steps and technical knowledge required to correctly import, analyze and reproject our geolocated gridded data.

Further Work

We are distributing a prototype version of the CETB data for evaluation by our volunteer Early Adopter community. We expect the work described here that leverages the GeoTIFF standard to elicit favorable feedback from our user community. If you are interested in being an Early Adopter, please contact us (*brodzik@nsidc.org*). For more information on our project, see *http://nsidc.org/pmesdr*.
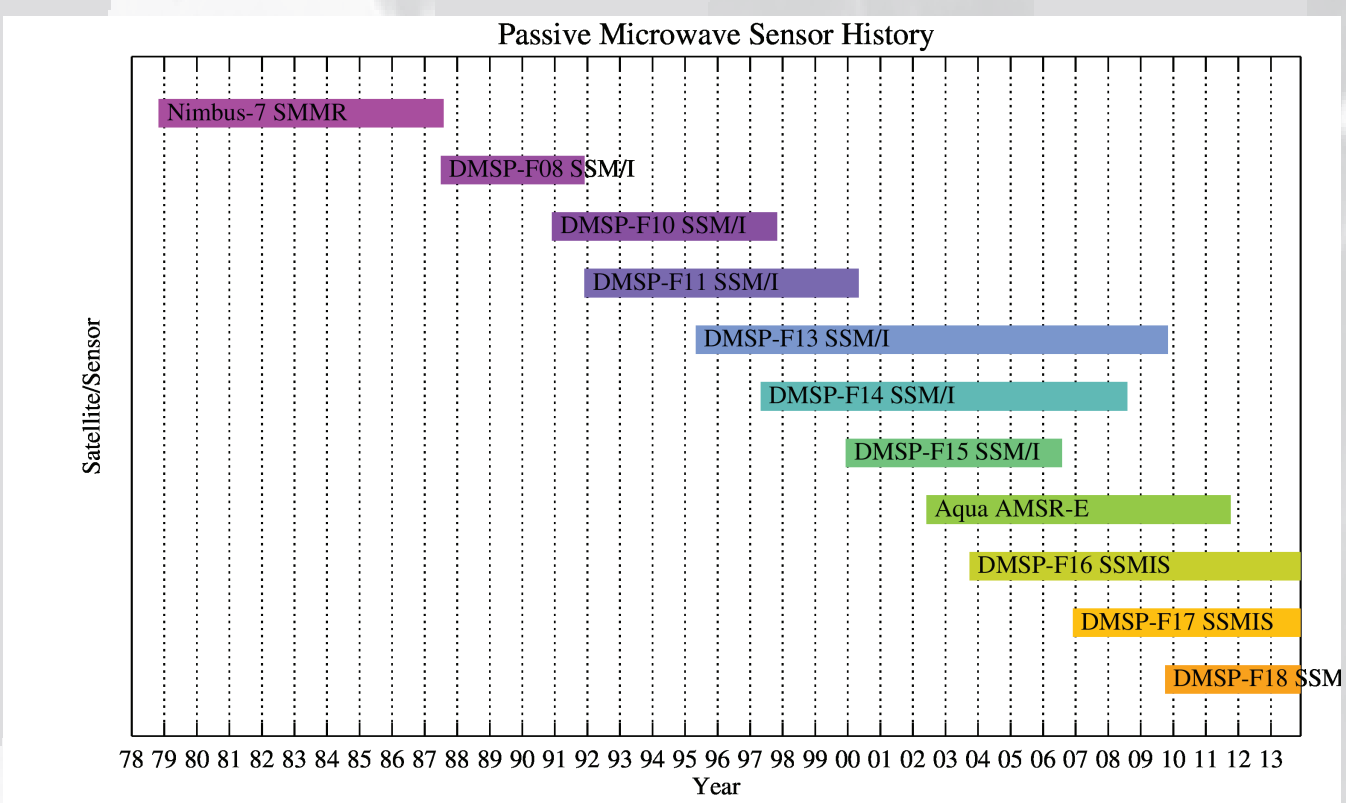
Timeline of CETB product sensors: SMMR, AMSR-E, SSM/I and SSMIS (dates are approximate); DMSP-F19 launched 3 Apr 2014 and F20 is not yet launched.

References

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