NOAA's Contributions to and Utilization of GPM-era Data/Products – Contributions to the MW-RE Precipitation over Land Algorithm

Ralph Ferraro[1] and Nai-Yu Wang[2]

[1]NOAA/NESDIS/STAR – College Park, MD (Ralph.R.Ferraro@noaa.gov), [2]University of Maryland, ESSIC/Cooperative Institute for Climate and Satellites (CICS-MD)

1. Introduction

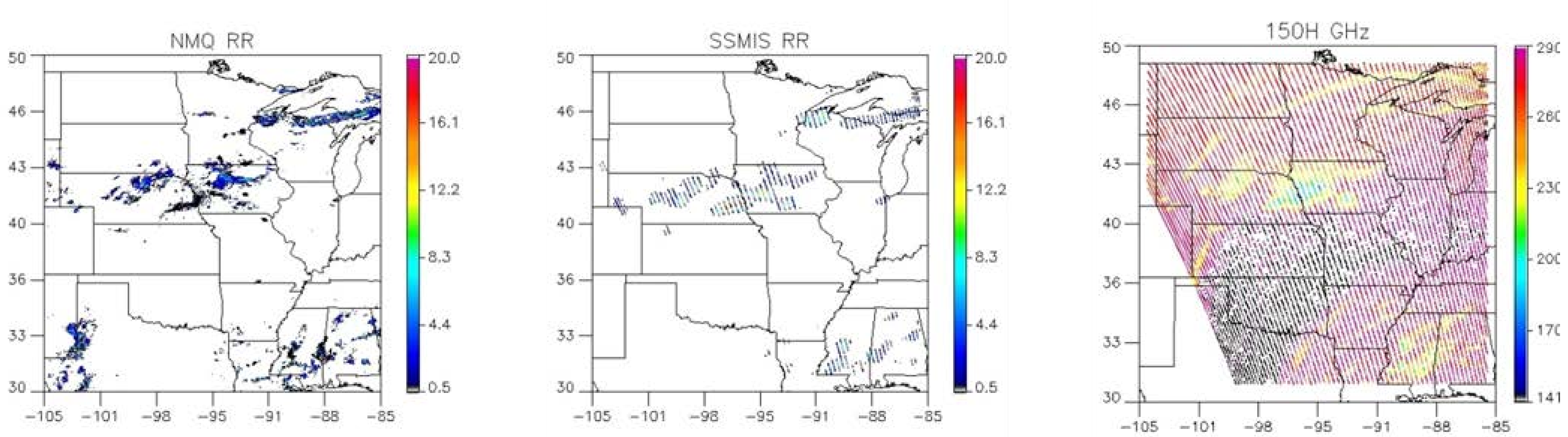
Our project continues to support the ongoing efforts of GPROF2014. Recent focus has been in the development of databases for use within GPROF2014. In addition, preliminary work has started to investigate the sensitivity of various parameters from MW-sounder sensors /high frequency measurements to determine the added information content and to optimize the databases.

2. GPROF2014 Database Generation Over Land

Our specific contribution to the MW-RE Algorithm Team was to construct a database of colocated SSMIS TB and NOAA NMQ radar derived reflectivities and rain rates. The overland database task can be thought of a two-step process : (1) attaching NMQ 0.01 deg resolution (~1km) rain-rates to SSMIS 37 GHz footprint (~27 km X 45 km) (2) matching observation SSMIS/NMQ with model simulations from GSFC MMF/CRM to get complete vertical hydrometeor profiles in order to translate to all constellation radiometers.

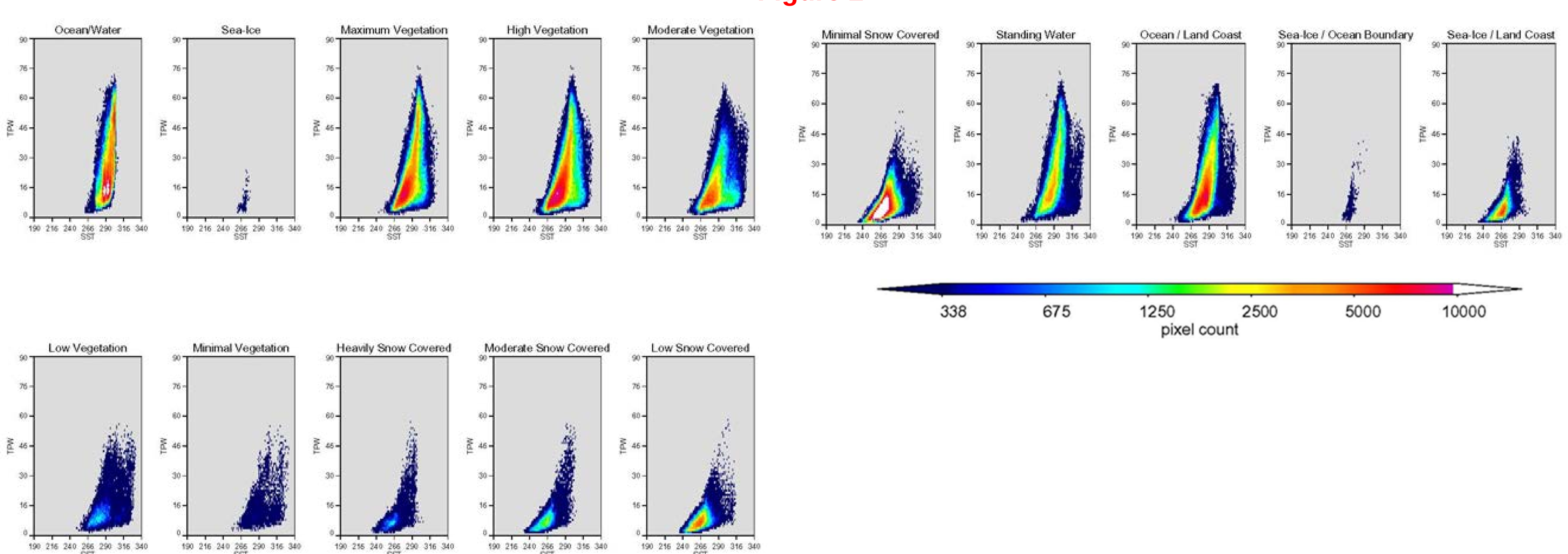
For the 1st step of attaching surface rain-rates to satellite radiometer observations, a year of SSMIS orbit TBs and NMQ rain-rates data from December 2009 to November 2010 were processed. The 1-km NMQ rain-rates are convolved to the SSMIS 37 GHz 27km by 45 km footprint based on a two-dimension Gaussian antenna beam pattern $g = \exp[-\left(\left(\frac{X}{FWHMX}\right)^2 + \left(\frac{Y}{FWHMY}\right)^2\right) \times 4 \times \ln 2]$ where FWHMX and FWHMY are the full width at half maximum at along track and cross track directions, respectively. **Figure 1** shows an example of such an convolution from 1km resolution NMQ surface rain-rates **(left)** to the 37 GHz footprint size of 27 km by 45 km **(middle)**, based on 833 km SSMIS F17 spacecraft altitude and half power beam widths. The satellite footprint averaging retains the main precipitation features from the finer resolution surface radar rain measurements, but the footprint averaging also smears out the small-scale high surface rain-rates detected by the surface radars. **Figure 1 (right)** shows the high frequency 150 GHz measurements from the same SSMIS overpass, which captures the finer details of the precipitating clouds from small ice particle scattering, relative to the 37 GHz.

Figure 1



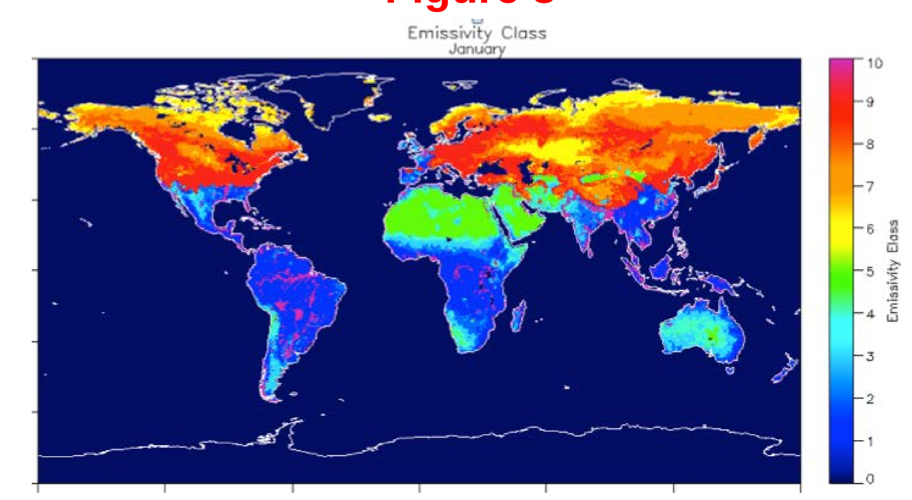
For the 2nd step of matching, the SSMIS observed TBs to the CRM simulated TBs. For SSMIS/NMQ matches with the MMF profiles, we would compute a "distance" between the SSMIS pixel and the MMF simulation which weights the differences between the Ts, TPW and emissivity class window. **Figure 2** (courtesy of D. Randel/CSU) shows the distribution of the final MMF-SSMIS matched database in each of the surface emissivity class, plotted as a function of surface temperature Ts and total water vapor TPW.

Figure 2



3. How best to optimize databases from MW Sounders/High Frequency Measurements?

Figure 3



Our NOAA team has vast experience with passive MW sounders such as AMSU and MHS. Such instruments will be key members of the GPM constellation; this includes the NPP-Suomi and JPSS ATMS sensor (i.e., AMSU follow on).

It is our intent to explore the information content of the sounders in order to optimize the database construction. For example, the current paradigm being used by the MW-RE team is to build the databases in emissivity, Ts and TPW space for 11 primary surface classes identified by F. Aires with SSM/I **(Figure 3)**; similar work was done by G. Petty with TMI. **Is this the best and most optimal approach for the MW sounders, which include frequencies in the 183 GHz water vapor band?** Here, we present some initial concepts and very preliminary results to outline our approach in solving this problem.

Different times of the years were explored; we took data from all surface vegetation classes from the IGBP, then stratified the data by AMSU-A and MHS, and ran PC Analysis on the data. Results from a day in January are shown in **Figures 4 & 5**. **Some initial findings include:**

- **PCA#1** – Very similar features between AMSU-A, MHS; reflects surface features. Also, general agreement with Aires 11 SSM/I PCA classes, with 4-5 classes of vegetation and 3-4 snow type classes.
- **PCA#2** – Features again similar; appears to reflect scattering signatures due to snow and precipitation. Both AMSU-A and MHS show "cold" and "warm" values associated with precipitation. Note that MHS explained variance is significantly higher than AMSU-A.
- **PCA#3** – Seeing more subtle features within snow cover (esp. in AMSU-A) and precipitation types (MHS) – deep convection? Again, MHS explained variance greater.
- **PCA#4** – Becomes more difficult to interpret, but there are clear differences between the two in some regions.

From this initial analysis, its difficult to determine what the added information content is from the MHS channels. Thus, our next steps will be:

- Analyze much more data for AMSU, MHS, SSMIS and ATMS and dig into the details! This will include use of precipitation free and precipitation data (Figure 2).
- Normalize by Ts (this does make a difference – not shown)
- Introduce ancillary data like Ts, TPW, etc. What information do they add?

MetOp-A Data from 31 January 2008

AMSU-A (23, 31, 50, 89 GHz) | **MHS (89, 157, 183±1, 183±3)**

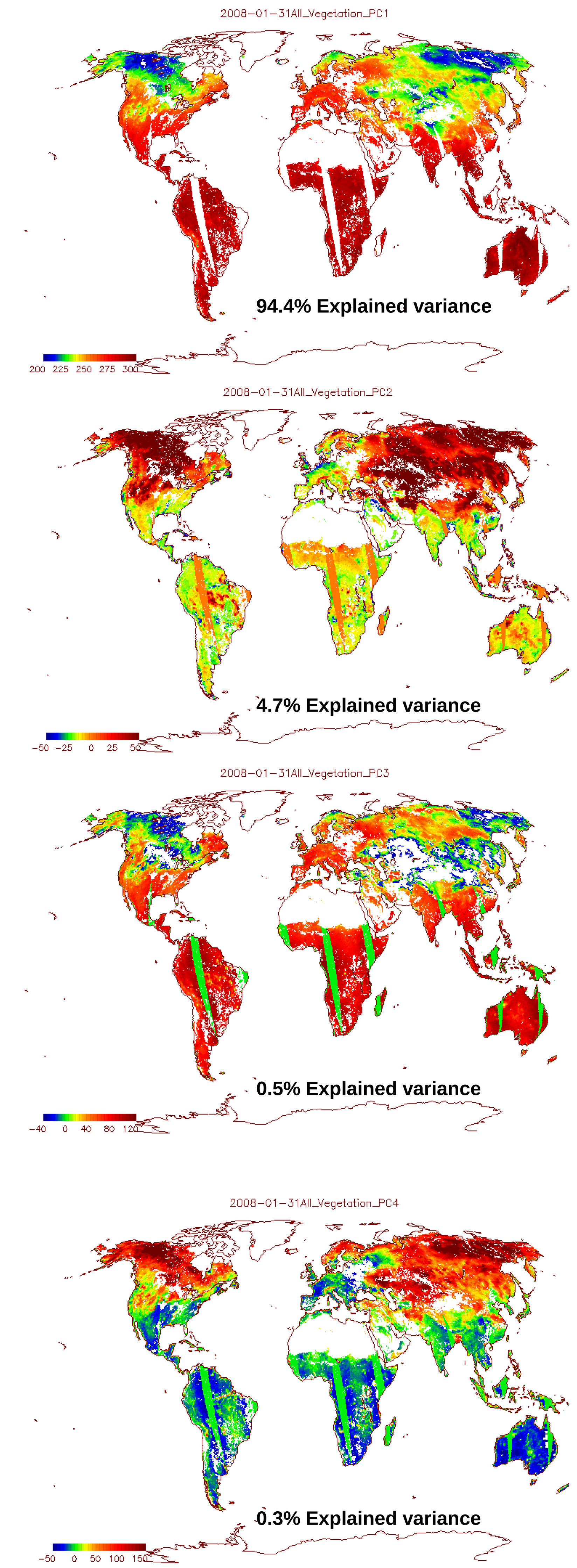


Figure 4

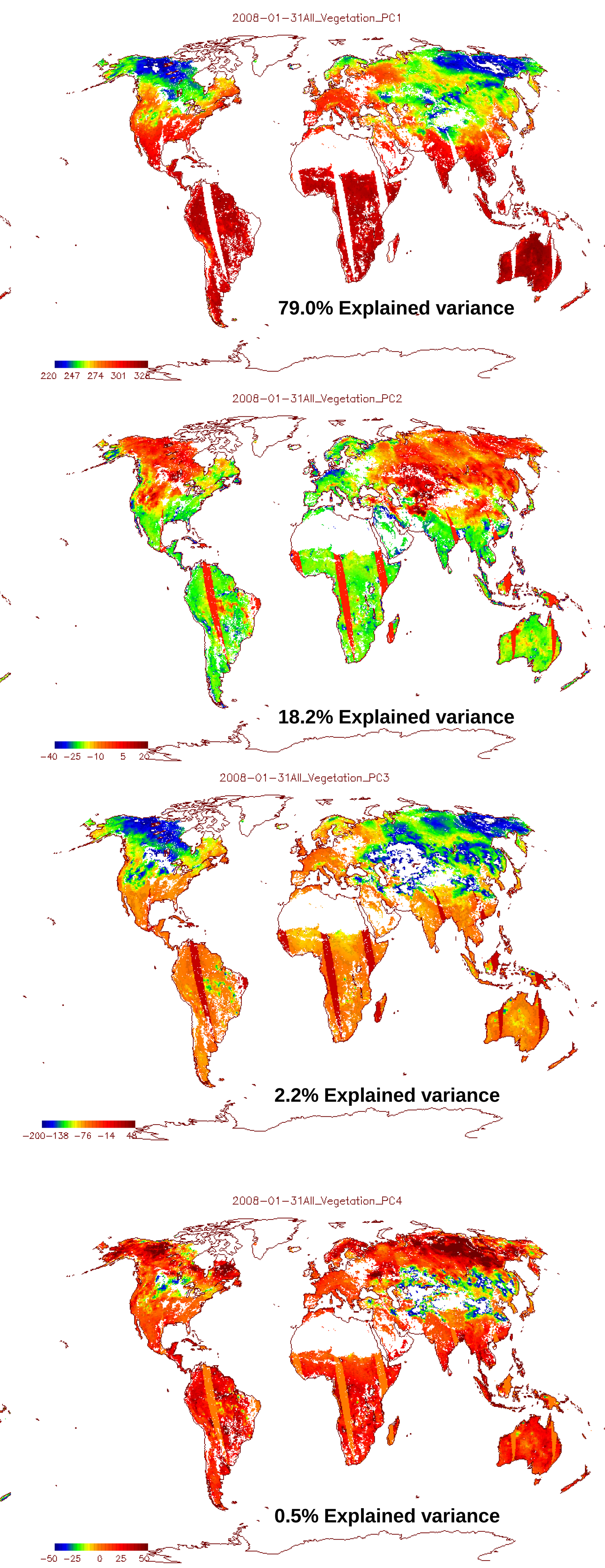


Figure 5