GACOS

System description

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Welcome to our Generic Atmospheric Correction Online Service for InSAR (GACOS).

GACOS utilises the Iterative Tropospheric Decomposition (ITD) model (Yu et al., 2017) to separate stratified and turbulent signals from tropospheric total delays, and generate high spatial resolution zenith total delay maps to be used for correcting InSAR measurements and other applications. GACOS has the following key features: (i) globally available; (ii) operational in a near real time mode; (iii) easy to implement; and (iv) users to be informed how the model performs and whether the correction is recommended.

Datasets used in GACOS include:

- High Resolution ECMWF weather model at 0.125-degree and 6-hour resolutions;
- GNSS derived tropospheric delay products from Neveda Geodetic Laboratory (soon to be released);
- SRTM DEM (90 m, S60-N60);
- ASTER GDEM (90 m, N60-N83, S60-S83);

GACOS tropospheric delay maps are given in a grid binary format (4-byte float little endian, name convention YYYYMMDD.ztd). A ReadMe (ftp://stella.ncl.ac.uk/pub/chen/ReadMe.pdf) file is provided to demonstrate how to use GACOS tropospheric correction maps. MATLAB codes are also available from (ftp://stella.ncl.ac.uk/pub/chen/GACOS_Ultility.zip) to help apply GACOS corrections and view the results instantly.

The website has restricted the submitted job to be maximum 5 by 5 degrees for up to 10 days. We will soon release an API which applied no restrictions but in a command based manner to be incorporated into any automatic processing chains.

Whenever using the GACOS products, please cite the following references:

- Yu, C., N. T. Penna, and Z. Li (2017), Generation of real-time mode high-resolution water vapor fields from GPS observations, Journal of Geophysical Research: Atmospheres, 122, 2008–2025. [link]
- Yu, C., Li, Z., & Penna, N. T. (2017). Interferometric synthetic aperture radar atmospheric correction using a GPS-based iterative tropospheric decomposition model. Remote Sensing of Environment, 204(2018), 109-121. [link]

How to use GACOS correction maps

Step 1. **Time Differencing**

GACOS produces a tropospheric delay map for each date you specify (saved in the same format as the interferograms, named as YYYYMMDD.ztd, **unit in meters**). For SInSAR atmospheric correction, you should make a difference between the delay maps of two dates. As a convention, please make sure you always use the delay map at the later date to minus that at an earlier date.

$$ZPDDM(date1, date2) = ZTD(date2) - ZTD(date1)$$

Note that when only two days are specified, GACOS will automatically generate the corresponding Zenith Path Delay Difference Map (ZPDDM).

Step 2. **Space Differencing (reference point)**

InSAR observations are not only differenced in time, but also in space, indicating that all the measured phase observations are relative to a reference point **A**.

- If you know where A is, subtract the delay value on A from ZPDDM:

$$SZPDDM(lat_i, lon_i) = ZPDDM(lat_i, lon_i) - ZPDDM(lat_A, lon_A)$$

- If you are not sure where A is, choose a relatively stable point **B**, then difference both the interferogram and the atmosphere delay maps against **B**:

$$Phase(lat_i, lon_i) = Phase(lat_i, lon_i) - Phase(lat_B, lon_B)$$

$$SZPDDM(lat_i, lon_i) = ZPDDM(lat_i, lon_i) - ZPDDM(lat_B, lon_B)$$

It is important that you use the same reference point for all your interferograms in a time series analysis.

Step 3. **Apply the correction**

Once differenced both in space and time, you can simply apply tropospheric correction to your geocoded interferograms by plus or minus the differenced atmosphere delays:

$$Corrected\_Phase(lat_i, lon_j) = Phase(lat_i, lon_i) \pm SZPDDM(lat_i, lon_i)$$

Depending on how you generate your interferograms, the sign for corrections are different. If you use a later date to minus an earlier one in the interferometric processing, you should use minus. (If not sure, just try both).

Step 4. **Linear detrending (Optional)**

After correction, there may still be residual atmosphere delays, orbital errors and etc. You may want to use a best-fit plane to remove the residual linear trends of your interferogram.

Appendix 1 Data storage format

Grid binary format is often used in image files e.g. interferograms, DEMs and the atmospheric delay maps generated by GACOS. Figure 1 gives a brief instruction of how the data is stored in this format. The whole area is divided into uniform grids with fixed xstep and ystep. To get the coordinate of point at (row, col), just use equation:

$$lat(row, col) = Yfirst + Ystep * row$$

$$lon(row, col) = Xfirst + Xstep * col$$

Please always be aware that the (Xfirst, Yfirst) point is located in the left-up corner (Northwest). If the data was saved as integer, the file size should be 2*WIDTH*FILE_LENGTH bytes, and 4*WIDTH*FILE_LENGTH bytes for float files. The text file (header file) followed by each binary file (usually named as *.rsc) gives the information needed to read the binary file. Please download the MATLAB codes and refer to the example for applying GACOS corrections on interferograms (ftp://stella.ncl.ac.uk/pub/chen/GACOS_Utility.zip).

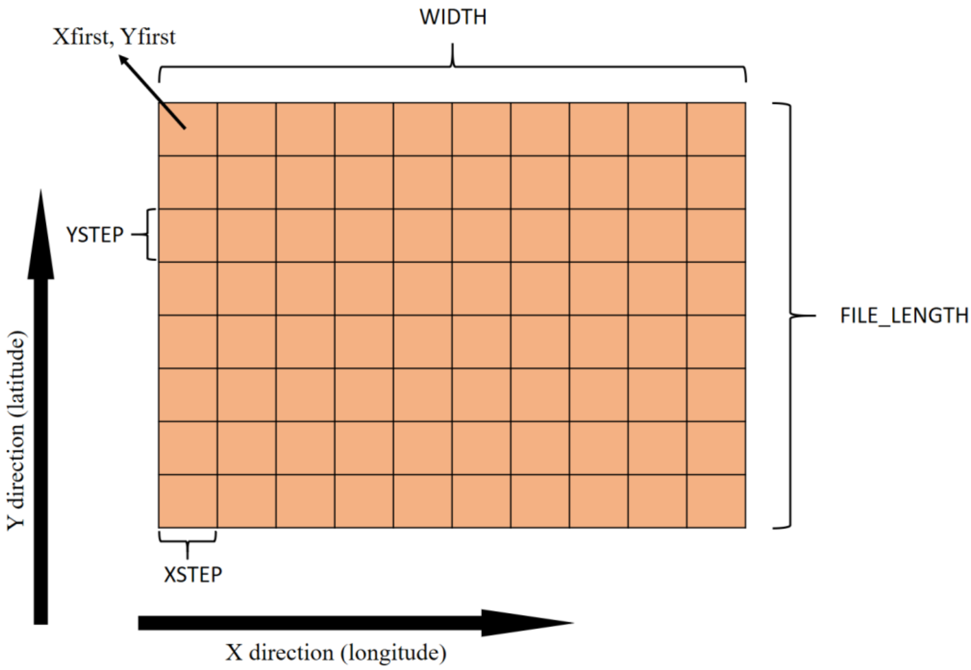

Figure 1 Binary grid data format