Investigation of Forest Height Retrieval Using SRTM-DEM and ASTER-GDEM

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Problem

Forest canopy height is essential information for many forest management activities and is also a critical parameter in models of ecosystem processes and in better quantifying the terrestrial carbon cycle [1, 2]. Several categories of methods are available to measure canopy height from remote sensing technology, one of which is the Polarimetric interferometric SAR (PolInSAR). It uses polarimetric separation of scattering phase derived from interferometry to estimate canopy height [3-6]. A limitation of PollnSAR is that it requires a sufficient scattering phase center separation at each pixel to be able to derive accurate forest canopy height estimates[2]. Besides，PolInSAR data source is limited. It is not feasible to do forest height mapping in large areas. Another kind of method uses the wavelength-dependent penetration depth into the canopy. Neeff et al. took the difference between interferometric surface models derived from X-band and P-band as interferometric height. They found that interferometric height was related to a subset of the forest trees that changes according to the forest successional stages[7]. Balzter et al. [2] presented a method for canopy height mapping using dual-wavelength SAR interferometry (InSAR) at X- and L-band. Although the dual frequency method showed good potentials for forest height estimation, the difference of penetration depth was affected by the forest structure. For example, Hagberg et al. [8] found that the penetration depth at C band decreased from dense forest to less dense forest. To minimize the influence of forest structure, Kenyi et al.[9] used the USGS National Elevation Data (NED) DTM as ground elevation and tried to derived forest height from the difference between SRTM 30m grid DEM and NED-DTM. In fact it is difficult to get the elevation of ground surface in forested areas. On contrary, the elevation of canopy surface is relatively easy to attain by Stereo mapping. The ASTER Global Digital Elevation Model (ASTER-GDEM) at a spacing of 1 arcsecond which was produced mainly from ASTER stereo data has been released by Japanese Ministry of Economy, Trade and industry (METI) and NASA. The SRTM-DEM at a spacing of 3 arcsecond between the latitudes of 60^{o} north and 56^{o} south [9] has been released by Jet Propulsion Laboratory (JPL). SRTM DEM data was derived from C band InSAR which have penetrations in forested areas. The combination of SRTM DEM and ASTER DEM has potential to map forest height in large areas. The feasibility of forest height mapping using SRTM DEM and ASTER DEM is investigated in this paper.

Methodology

Figure 1 shows the methodology of this study. Because the field survey of forest parameters is time consuming and a hard work, it is very difficult to survey the forest parameters within all the GLAS footprints in research areas. Instead some typical GLAS footprints are selected and the forest parameters within these footprints are measured. Then the forest heights of remained GLAS footprints are derived by GLAS data. In order to get the elevation difference between ASTER-DEM and SRTM-DEM, ASTER-DEM are firstly resampled into the same resolution with SRTM-DEM, ie. 3 arc-second, then ASTER-DEM was registered to SRTM-DEM by tie points selected from their aspect maps. As mentioned above, the penetration depth of C band SAR data can be affected by forest structures. The classification map is necessary in the investigation of relationship between ASTER-SRTM elevation difference and forest height.

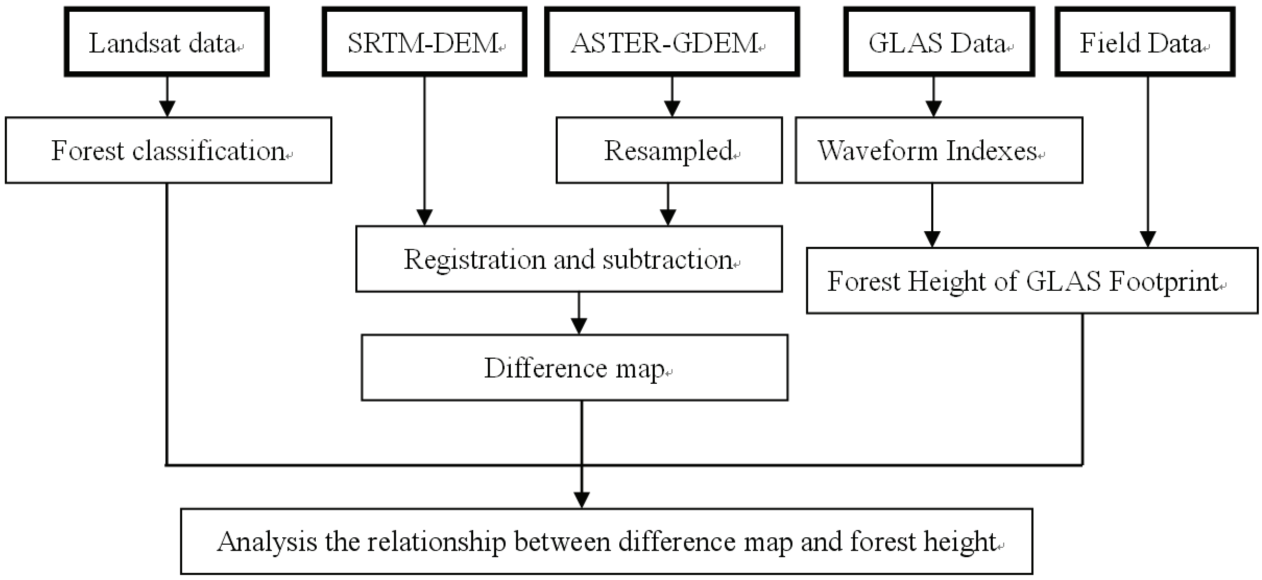

Figure 1. The workflow of this study

Preliminary Results

Figure 2 is the true color landsat image of the research area. Figure 3 is the elevation difference map between ASTER-GDEM and SRTM-DEM. The red symbols on figure 3 are footprints of GLAS data. The area covered by yellow square is Changbai Mountain National Nature Reserve. From these two figures we can see that the difference between ASTER-GDEM and SRTM DEM showed good relationships with forest heights in relatively flat areas while the correlation is weak in mountainous areas, such as on the right and upper part of research areas. The relationships will be further investigated in detail and the results will be presented in the paper.

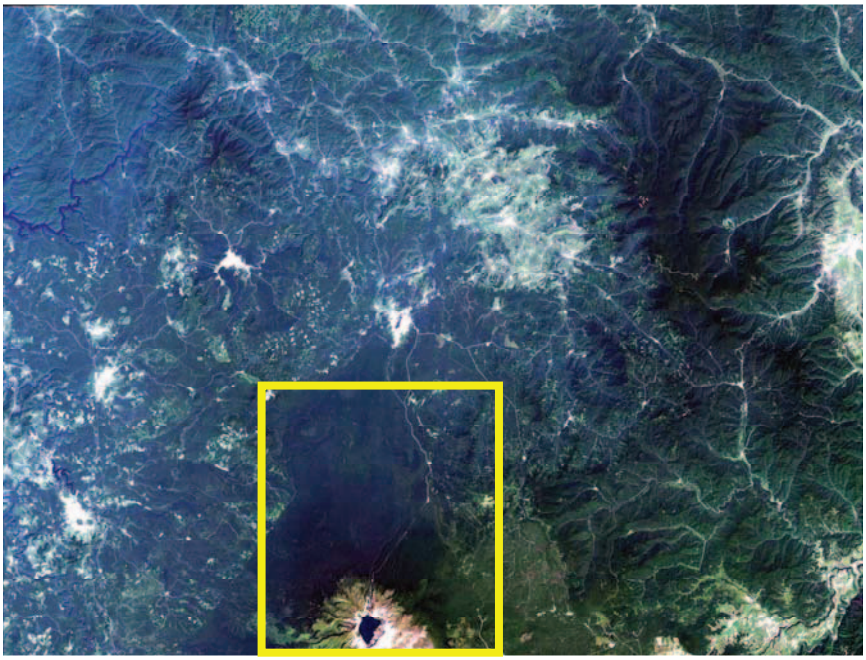

Figure 2. The true color landsat image of research area.

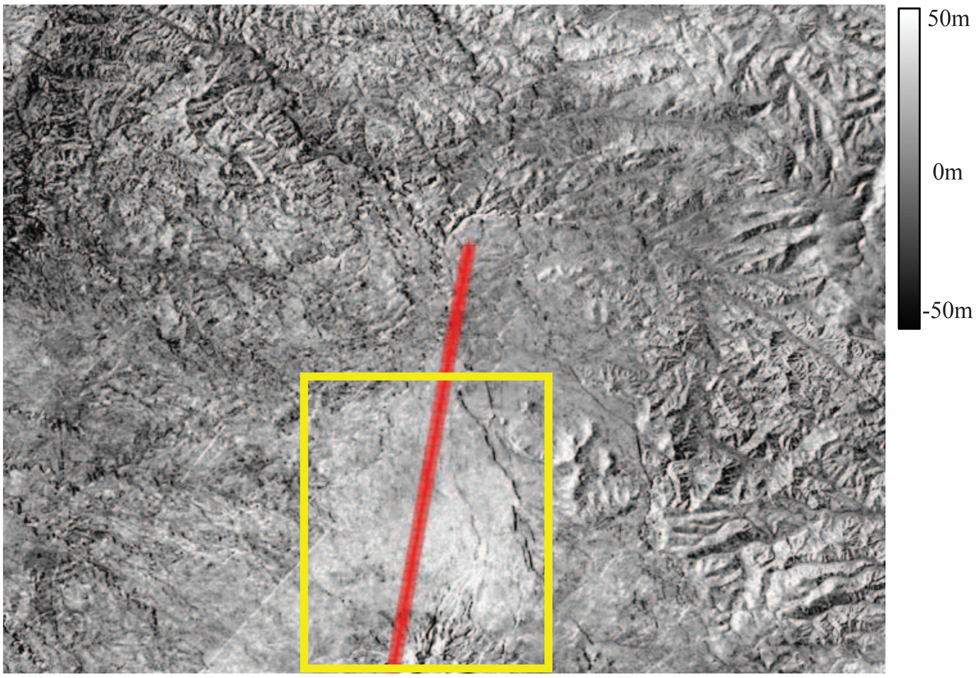

Figure 3. The map of ASTER_GDEM-SRTM_DEM. The red symbols are footprints of GLAS data.

Reference

1. Sexton, J.O., et al., *A comparison of lidar, radar, and field measurements of canopy height in pine and hardwood forests of southeastern North America.* Forest Ecology and Management, 2009. **257**(3): p. 1136-1147.
2. Balzter, H., C.S. Rowland, and P. Saich, *Forest canopy height and carbon estimation at Monks Wood National Nature Reserve, UK, using dual-wavelength SAR interferometry.* Remote Sensing of Environment, 2007. **108**(3): p. 224-239.
3. Cloude, S.R. and K.P. Papathanassiou, *Polarimetric SAR interferometry.* IEEE Transactions on Geoscience and Remote Sensing, 1998. **36**(5): p. 1551-1565.
4. Cloude, S.R. and K.P. Papathanassiou. *Three-stage inversion process for polarimetric SAR interferometry.*

2003.

5. Papathanassiou, K.P. and S.R. Cloude, *Single-baseline polarimetric SAR interferometry.* IEEE Transactions on Geoscience and Remote Sensing, 2001. **39**(11): p. 2352-2363.
6. Yamada, H., et al., *Polarimetric SAR interferometry for forest analysis based on the ESPRIT algorithm.* IEICE Transactions on Electronics, 2001. **E84-C**(12): p. 1917-1924.
7. Neeff, T., et al., *Tropical forest measurement by interferometric height modeling and P-band radar backscatter.* Forest Science, 2005. **51**(6): p. 585-594.
8. Hagberg, J.O., L.M.H. Ulander, and J. Askne, *Repeat-pass SAR interferometry over forested terrain.* IEEE Transactions on Geoscience and Remote Sensing, 1995. **33**(2): p. 331-340.
9. Kenyi, L.W., et al., *Comparative analysis of SRTM-NED vegetation canopy height to LIDAR-derived vegetation canopy metrics.* International Journal of Remote Sensing, 2009. **30**(11): p. 2797-2811.