AUTOMATED BLENDING OF LANDSAT AND MODIS SURFACE REFLECTANCES AT GLOBAL SCALES

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1. INTRODUCTION

The 30 meter spatial resolution of Landsat sensors makes it one of the most suitable datasets for bridging the gap between local measurements and large-scale studies of biophysical processes, yet its usage is limited by the availability of cloud-free surface observations. Methods have been proposed to combine Landsat data with measurements from sensors of coarse spatial resolution but high temporal frequency to enhance their applications [1][2]. In particular, the spatial and temporal adaptive reflectance fusion model (STARFM) [1] utilizes associations between concurrent Landsat and MODIS observations, and temporal changes in MODIS observations to predict corresponding changes in Landsat data. However, because STARFM uses an unsupervised classification algorithm to cluster spectrally similar pixels in a Landsat scene, it is computationally time-consuming and thus not suitable for applications at continental and global scales.

As an on-going community project, we started to process a global Landsat dataset (the Global Land Survey 2005) to create a global LAI dataset that is compatible with MODIS. A key component of this project is to adjust the reflectance of GLS2005 data, which have different dates of acquisition (DOA), to approximately its peak-growing-season (PGS) level when vegetation reaches its maximum greenness. To do this, therefore, we developed an alternative approach to expedite the classification algorithm in STARFM and apply it to process the global data. The method and the preliminary results are briefly described below.

2. METHODS

Because Landsat shares the same polar orbit with MODIS (Terra) and has a narrow field of view of about 15^o, its observations are most comparable with the Nadir BRDF-Adjusted Reflectance (NBAR) product of MODIS [3]. Because the two sensors essentially look at the same scene, when aggregated to coarser resolutions, Landsat reflectance should match with NBAR data in theory. In practice, uncertainties may be introduced by different processing procedures, but they are expected to be in a systematic fashion and thus predictable. Therefore, corresponding temporal changes in Landsat reflectance and MODIS NBAR should also match each other at coarser resolutions. The task of spectral blending thus becomes finding finer spatial features for the largely matching coarser resolution windows. On the other hand, temporal changes in sub-grid features are most likely induced by seasonal development of different vegetation types, while such phenological changes are generally similar for vegetation of the same types. Therefore, instead of clustering the pixels solely by their spectral features, we can utilize existing information such as the MODIS Land Cover product [4]. Of course, we need to downscale the coarse MODIS Land Cover map to Landsat resolution. However, with the MODIS prior information and the DOA Landsat data, this can be achieved with relatively simple classifiers. In addition, the downscaled land cover map is reusable – it can be saved and refined separately by dedicated software packages if it is necessary.

With the above considerations, we setup our processing chain as follows:

1. Process a Landsat scene using LEDAPS for radiometric calibration and atmospheric corrections;
2. Composite MODIS NBAR (DOA) climatology and PGS NBAR by maximizing greenness for the same scene;
3. Downscale MODIS Land Cover map or acquire existing maps (e.g., NLCD dataset);
4. Applying STARFM with the revised algorithm to adjust DOA Landsat reflectance to its PGS level.

3. PRELIMINARY RESULTS AND DISCUSSIONS

As a test, we applied the above discussed method to process a scene (Row 34 Column 42 in WRS coordinates) over northern and central California. This scene was selected because it covers a wide range of land cover types including evergreen forests, shrubs, savannas, and cropland, which have distinct phenological characteristics. A part of the scene is shown in Figure 1. The data were acquired on July 28th, 2006, when most of the non-forests already turned yellow. Therefore, both Landsat and MODIS data show quite high reflectance in the red band (Figure 1, Left panels). These vegetation types usually reach their peak greenness in late March, when the absorption of in the red wavelength is highest. Such temporal changes in reflectance are well captured by the MODIS NBAR data, which however lack detailed spatial features (Figure 1, Top panels). On the other hand, these spatial features are depicted by the Landsat (DOA) data (Figure 1, Bottom-Left panel). Combining all the information together, we used the revised STARFM algorithm to predict the PGS Landsat reflectance (Figure 1, Bottom-Right panel). As shown, the estimated PGS data have similar reflectance level with the MODIS data while preserving most of the spatial features seen in the Landsat (DOA) data.

Several issues are also found in the test run. The current algorithm does not process missing values in the MODIS NBAR data, but simply fills them with the Landsat DOA. The inconsistency in the predicted data resulted from the missing values is visible in Figure 1. Also, because in most cases we don't have observed Landsat PGS data to

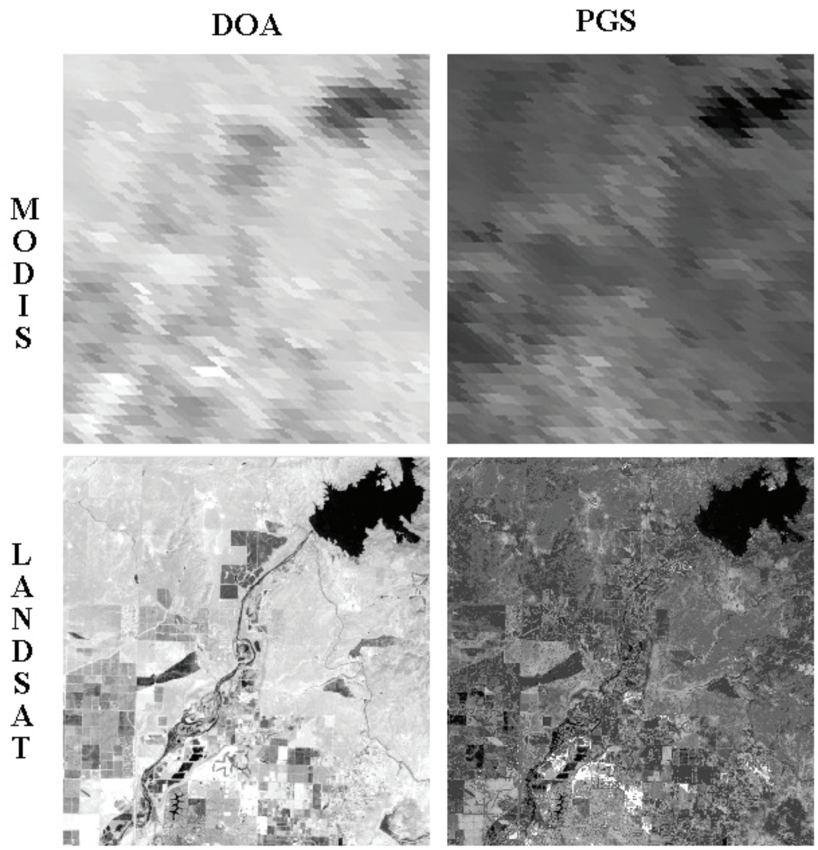

Figure 1. PGS Landsat reflectance of the red band predicted from MODIS NBAR data (Top panels) and DOA Landsat reflectance (Bottom/Left). The data are rescaled to exploit the full grey scale. The place shown in the map is close to Tracy, California.

compare with, a set of other diagnostics needs to be developed to check the performance of the algorithm, especially when it is applied to process global data.

4. CONCLUSION

In this study we propose a revised STARFM algorithm that automates the blending of Landsat and MODIS surface reflectance. This algorithm utilizes existing land cover information to expedite the clustering of Landsat pixels that have similar spectral characteristics, and thus makes STARFM more suitable for applications over continental or global scales. Preliminary tests indicate satisfactory performance of the algorithm; however, more systematic diagnostics need to be developed to evaluate its applications over large scales.

5. REFERENCES

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