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Assessment of the NASA-USGS Global Land Survey (GLS) Datasets

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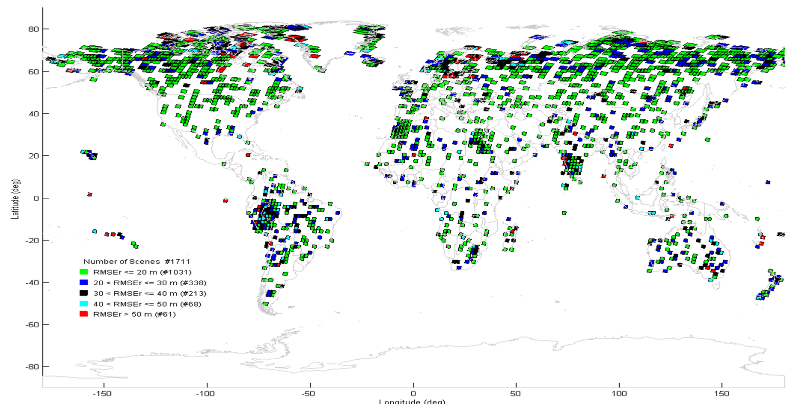
Introduction

Jointly produced by NASA and USGS, the Global Land Survey (GLS) datasets establish a solid baseline for monitoring land surface changes at medium spatial resolution by providing near complete global coverage of Landsat images for all land areas for epochs centered around 1975, 1990, 2000, 2005, and 2010. These datasets are available for free download through many web portals, including the USGS Earth Explorer (EE), USGS Global Visualization Viewer (GLOVIS), and the Global Land Cover Facility (GLCF). The GLS datasets are widely used in a broad range of land-cover and -change studies at local, regional, and global scales, including many funded by the Land Cover Land Use Change (LCLUC) and other NASA and USGS programs. In spite of the wide usage of these datasets, however, there is no documented assessment of their quality. This poster provides a comprehensive assessment of the quality characteristics of these data sets (except GLS 2010, which is still being generated), including their spatial coverage, temporal consistency, geodetic accuracy, image completeness, and cloud cover. Results from this study likely will benefit the users of the GLS datasets, and will provide valuable insights for future efforts to develop global datasets for land change monitoring.

Geodetic Accuracy Assessment

Geodetic accuracy of the GLS datasets was established in two steps:

- Used Landsat 7 systematic scenes during quiet gyro period (Mar 2005 – Mar 2007), which had accurate pointing knowledge, to evaluate the geolocation accuracy of the GLS 2000 dataset (Figure 1).
- Used image-to-image (I2I) assessment method to determine the coregistration accuracy of other GLS datasets with GLS 2000 as reference (Table 1, Figure 1).



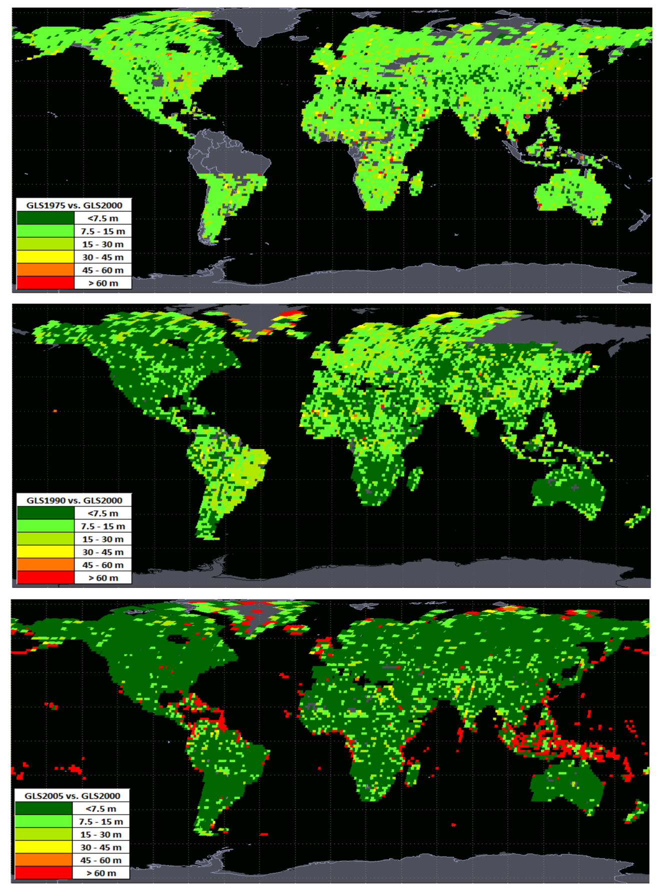


Figure 1. Root Mean Square Error (RMSE) of GLS 2000 inferred using L7 systematic scenes during quiet gyro period (left) and I2I registration accuracy of GLS 1975 (top right), 1990 (mid-right), and 2005 (lower right) as measured against GLS 2000.

Table 1. Summary of I2I corregistration accuracy of the GLS datasets measured using the GLS 2000 dataset as the reference.

Dataset	Total RMSE (Line)	Total RMSE (Sample)	Total RMSE
GLS 1975	18.2 m	16.95 m	24.88 m
GLS 1990	7.75 m	8.08 m	11.19 m
GLS 2005	4.69 m	5.09 m	5.89 m

Cloud Cover and Residual Gaps

- Cloud cover was calculated using an algorithm developed by Huang et al. (2011). It does not separate snow/ice from cloud (Clouds mapped over high latitude and high altitude regions are like snow/ice) and may overestimate cloud over desert area.
- About 75% of the GLS 2005 images are gap-filled Landsat 7 images. Many of them have residual gaps. Because the GLS images were produced using the cubic convolution resampling method that had a 4 x 4 kernel, up to two pixels from a residual gap pixel could be contaminated by the gap. Therefore, we expanded the residual gaps by 2 pixels in our calculation.

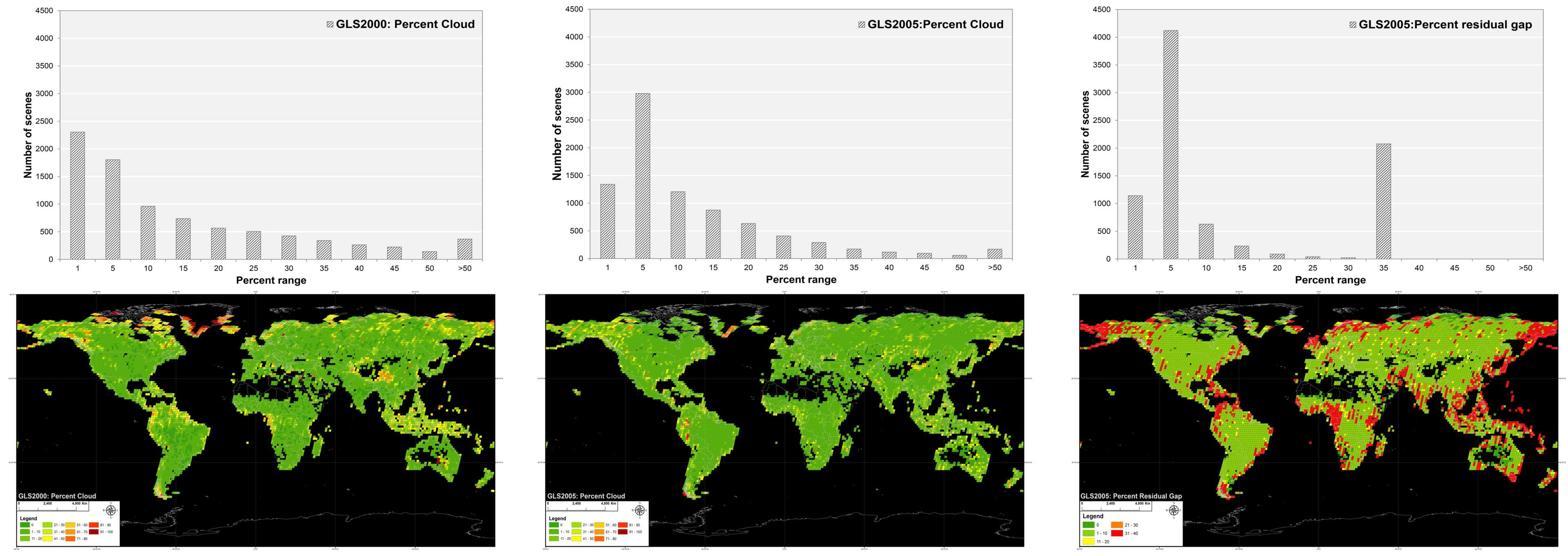


Figure 2. Frequency distribution and Global distribution of GLS percent cloud and residual gap.

Spatial Coverage and Temporal Distribution

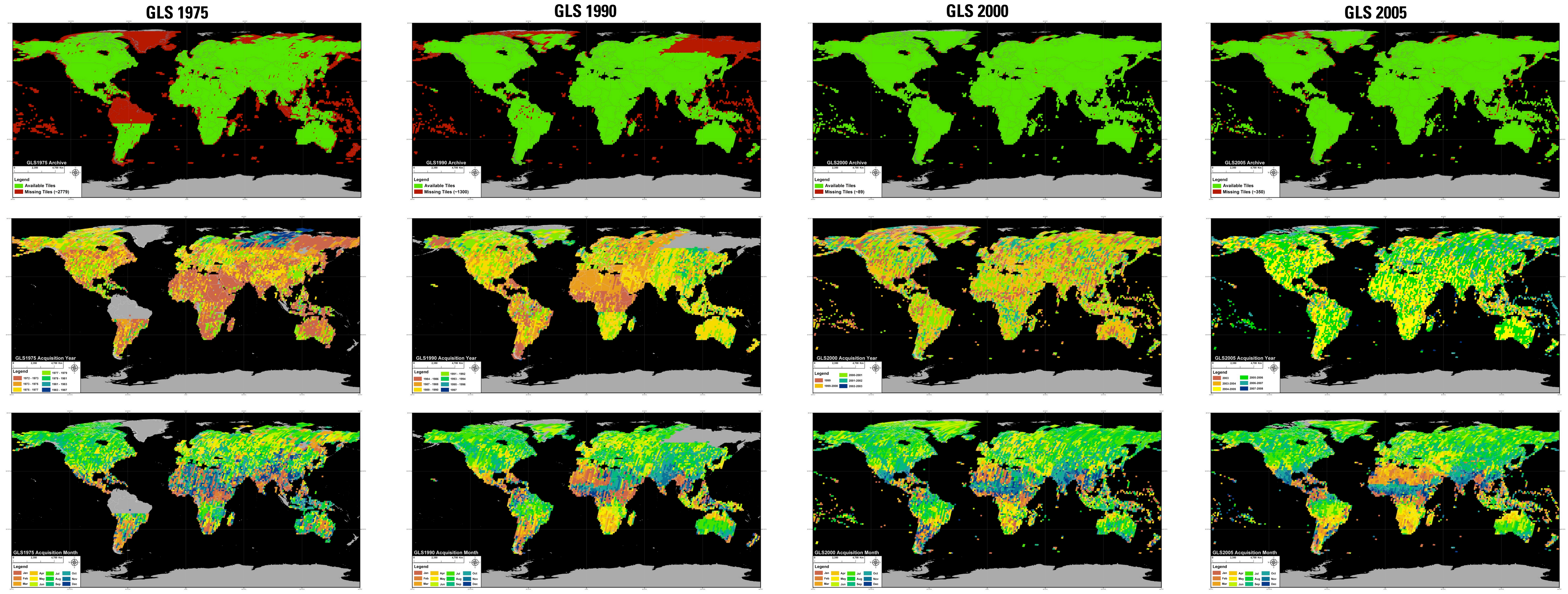


Figure 3. Spatial coverage (top), acquisition year distribution (middle), and distribution of acquisition month (bottom) of the GLS datasets.

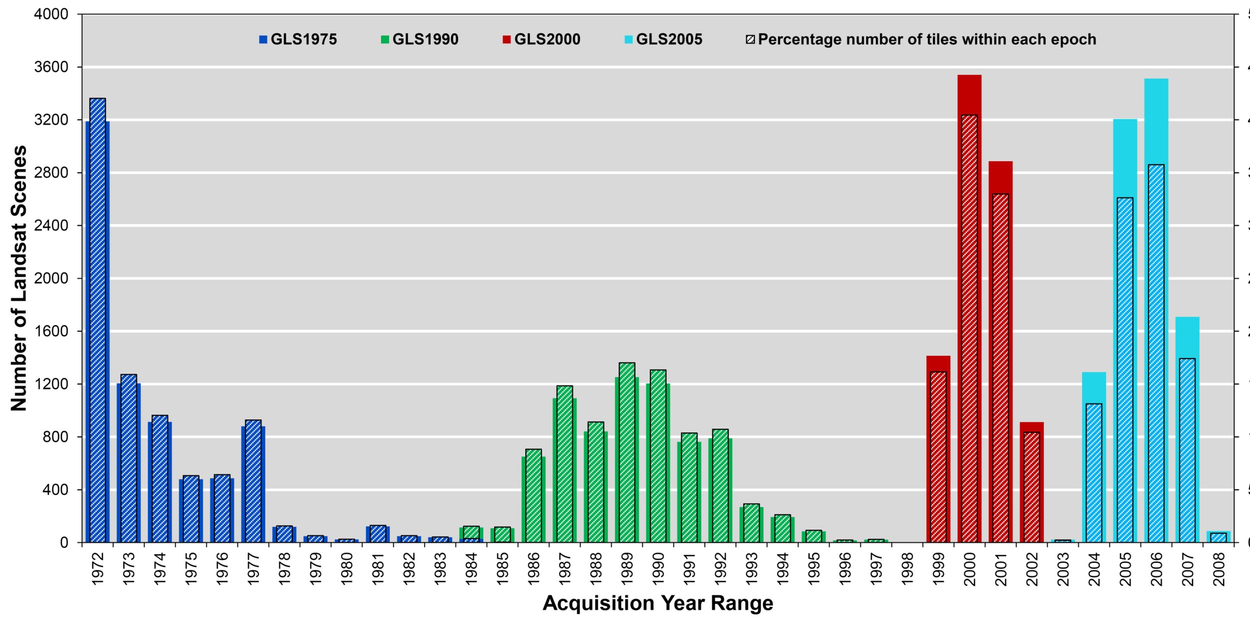


Figure 4. Acquisition year range of the GLS datasets.

Table 2. Percent land areas (%) not covered by GLS images.

Continent	GLS 1975	GLS 1990	GLS 2000	GLS 2005
	%Area	%Area	%Area	%Area
Africa	4.03	0.20	0.00	0.00
Asia	4.98	15.27	0.16	0.60
Australia	1.17	0.00	0.00	0.00
North America	11.06	4.82	0.61	1.82
Oceania	90.14	12.68	0.00	0.00
South America	57.24	3.48	0.00	0.07
Europe	2.88	0.66	0.66	0.72

Suitability for Land Cover Change Studies

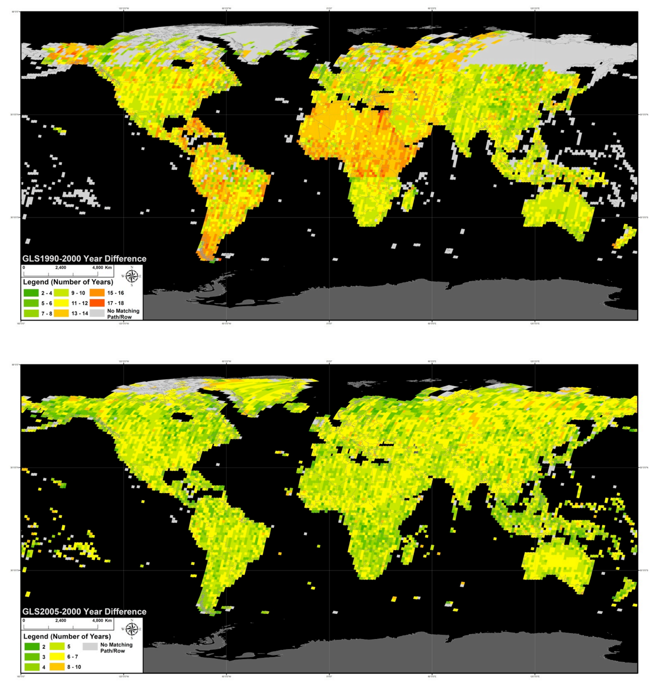


Figure 5. Acquisition year difference between GLS2000 and GLS1990 (top) and GLS2005 and GLS2000 (bottom).

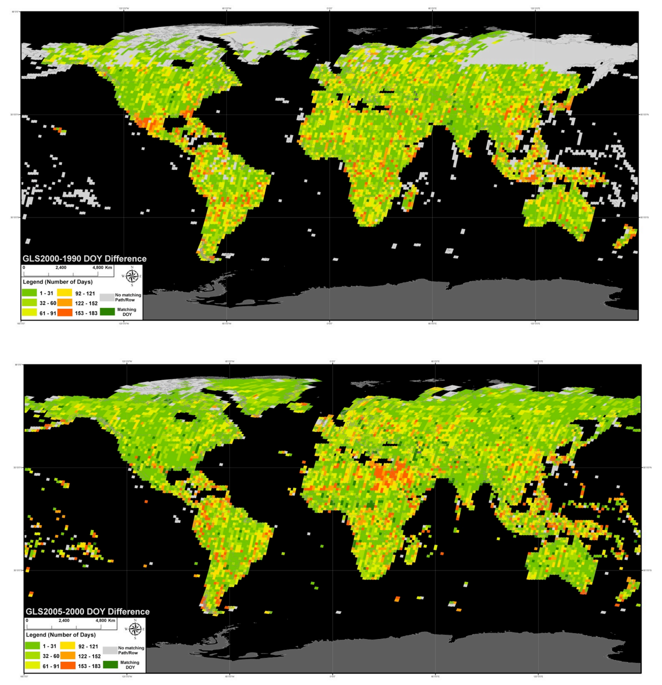


Figure 6. Day of year difference between GLS2000 and GLS1990 (top) and GLS2005 and GLS2000 (bottom).

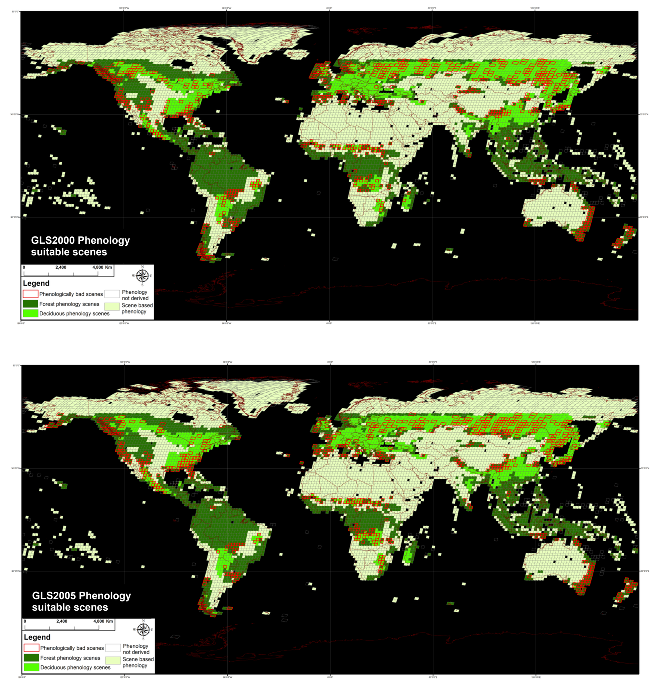


Figure 7. GLS 2000 (top) and 2005 (bottom) images that were acquired near or during the leaf-off season and may not suitable for forest change analysis.

- The year difference between paired GLS images varies across space (Figure 5). Such variations need to be normalized in calculating annual change rate;
- Many image pairs have day of year difference > 3 months (Figure 6), suggesting significant phenology difference in mid- to high-latitude areas that may result in spurious changes;
- About 20% of the GLS 2000 and 2005 images over forest regions were acquired near or during the leaf-off season and may not be suitable for forest change analysis. These images need to be replaced with leaf-on images in order to derive reliable forest change products.

Acknowledgement

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