

MODIS Cloud Fraction Data to aid Landsat Global Coverage

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The problem at hand:

- Landsat-7 (L7) acquires limited number of scenes/day (about 1/3 of land day scene candidates are collected)
- Cloud-free scenes are most desirable
- Daily target scene selection process considers global cloud forecasts
- Goal - improve yield of cloud-free acquired scenes

Approach: Test various proposed enhancements to the existing L7 target acquisition planner - refine the cloud avoidance rules.

Methodology: Develop a long-term mission planning model that can run *hindcast* scenarios of the past several years. We will use this test-bed to assess the performance of each proposed rule change.

The Need: Populate the long-term planning model with empirical global cloud conditions over the past several years.

- We know the CF of acquired scenes (according to L7's ACCA algorithm).
- We don't know the CF of scenes not acquired
- **What we need:** "Cloud Truth" - or at least a close approximation

How MODIS helps:

- MODIS CF furnishes cloud assessment independent of L7's ACCA CF
- MODIS/Terra flies in formation with L7, following by half hour
- We extract MODIS CF data corresponding to L7 scenes (collected and uncollected) Fig. 1 shows samples.
- We build a MODIS CF climatology database matching these L7 scenes
- For collected scenes, we cross-calibrate MODIS CF against L7 ACCA. See Figs 2 and 3.

- We examine the characteristics of uncollected scenes by deriving equivalent ACCA scores using MODIS CF of those scenes. (Fig. 4, middle panel of Fig. 5).
- We evaluate the effectiveness of the cloud avoidance scheduling policy based on the frequency of clear opportunities lost (top and bottom panel of Fig. 5).
- We can conduct 'what-if' planning scenarios using a scheduling simulator that uses MODIS CF (scaled to ACCA CF, see bottom panel of Fig.3).

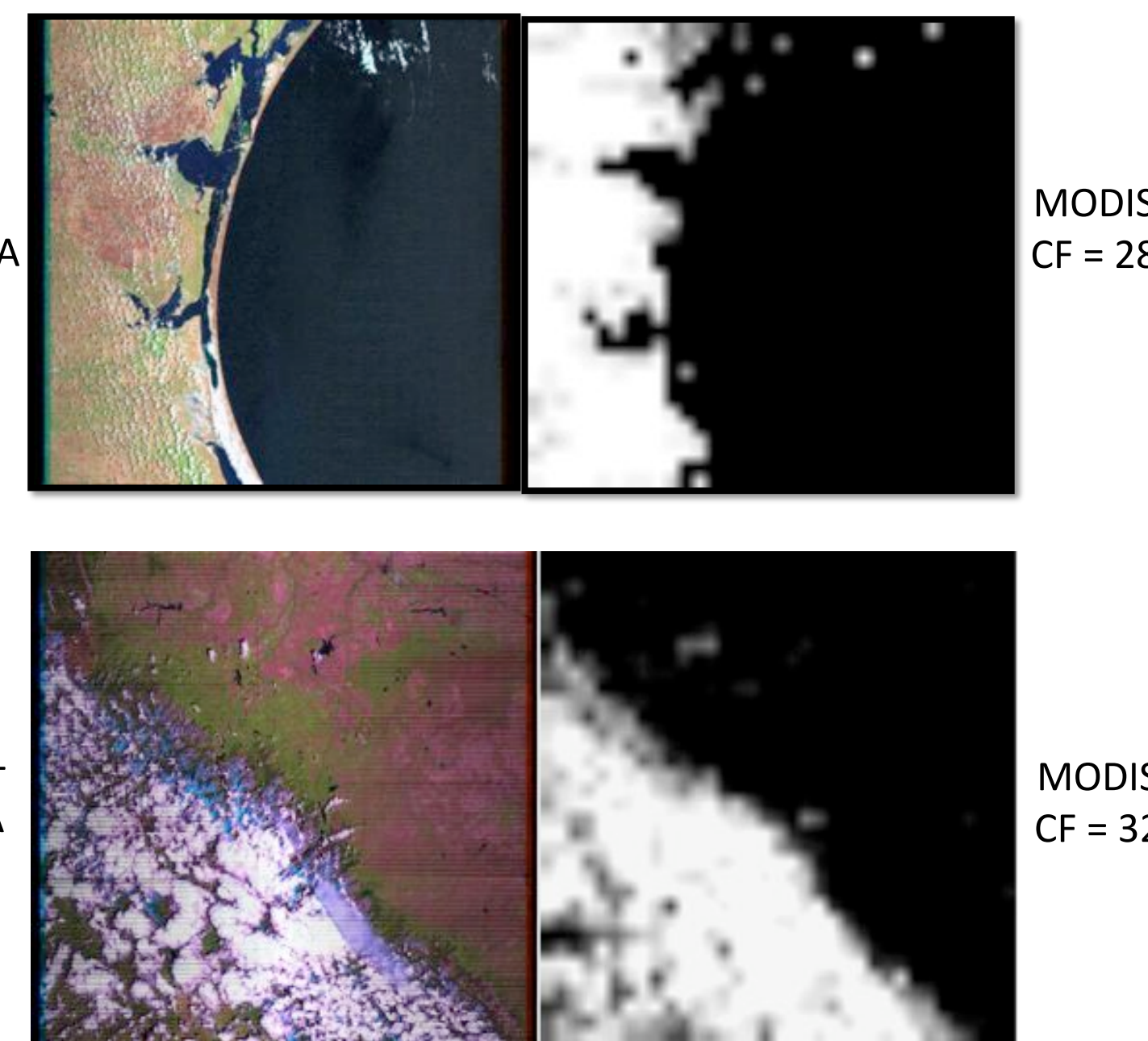


Figure 1. Samples of L7 scenes visualizing MODIS CF where (top) ACCA and MODIS CFs disagree, and where (bottom) they agree.

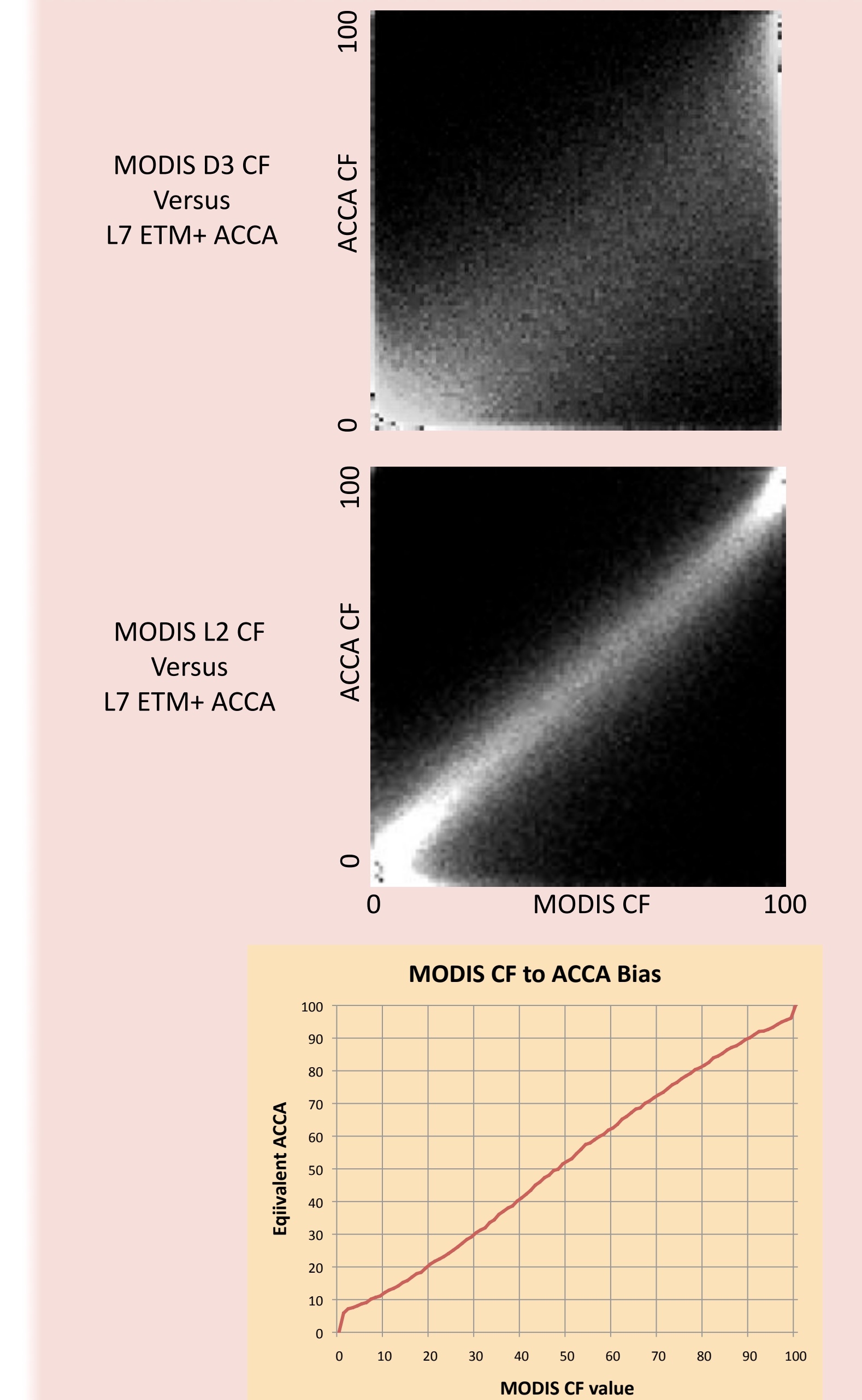


Figure 3. 2D histogram of ACCA vs. MODIS CF for all acquired L7 scenes 2005-2009. Top panel uses D3 CF and middle panel adjusted (CF=0 for $\tau < 2$ over ocean and CF=0 for CF<40 over land) MODATML2 CF. Bottom panel is average of middle panel. D3 CF is inappropriate for comparisons with ACCA CF, but MODATML2 CFs correlate well with ACCA CFs.

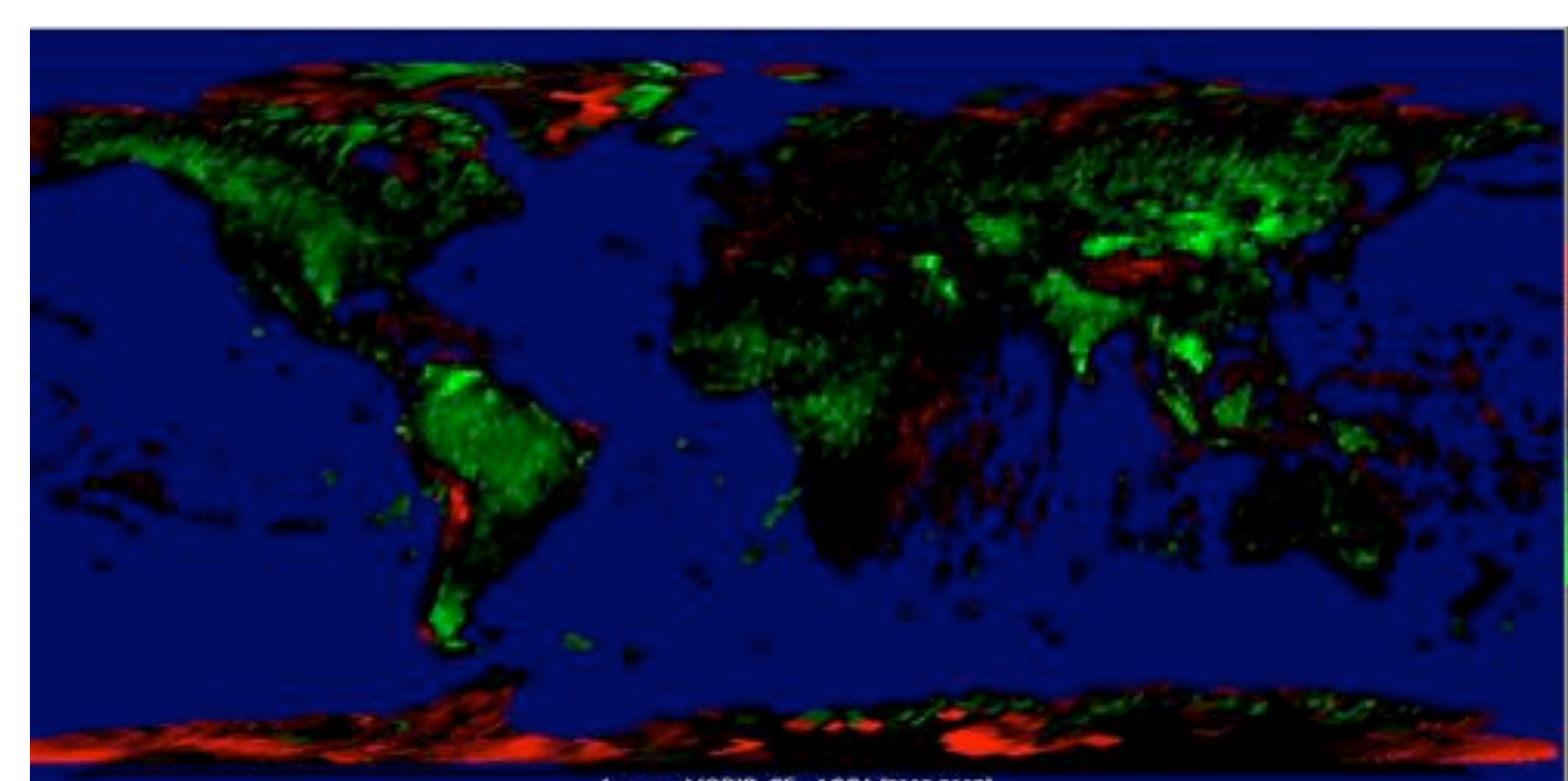


Figure 2. MODIS(L2)-ACCA CF for 2005-2009. MODIS tends to have higher CFs, with the exception of high latitudes, due to better thin high cloud detection capability and overestimates of CF for sparse cumulus cloud fields (as top example of Fig. 1).

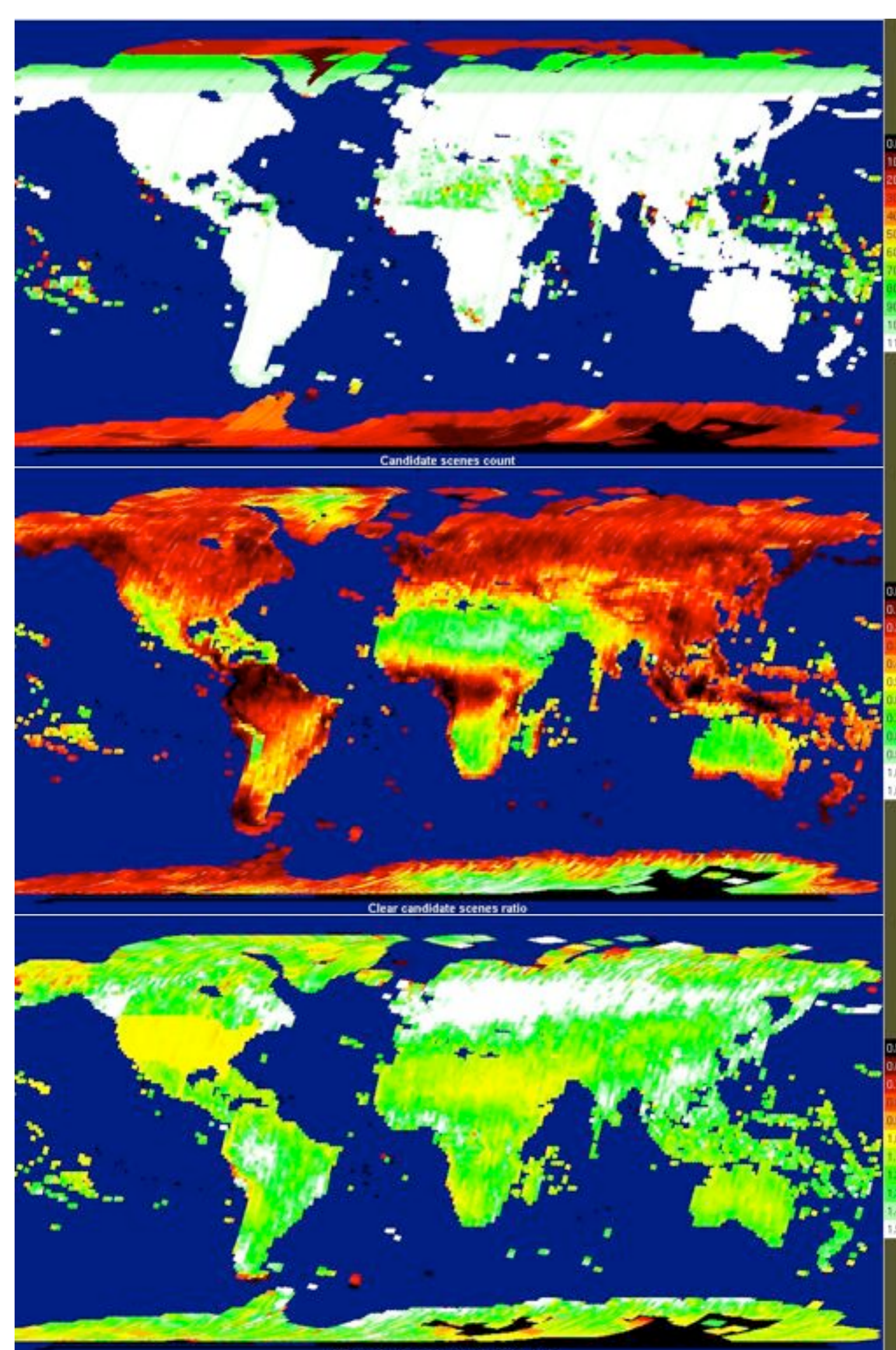


Figure 4. Number of L7 scenes considered for acquisition, i.e., "candidate" scenes (top); fraction of those scenes that are "cloud-free", defined as MODIS CF<10 (middle); ratio of clear-sky fraction of acquired L7 scenes to clear sky fraction of candidate scenes (bottom). Yellow is neutral indicating no advantage offered by the cloud avoidance algorithm. Note that over CONUS all candidate scenes are acquired.

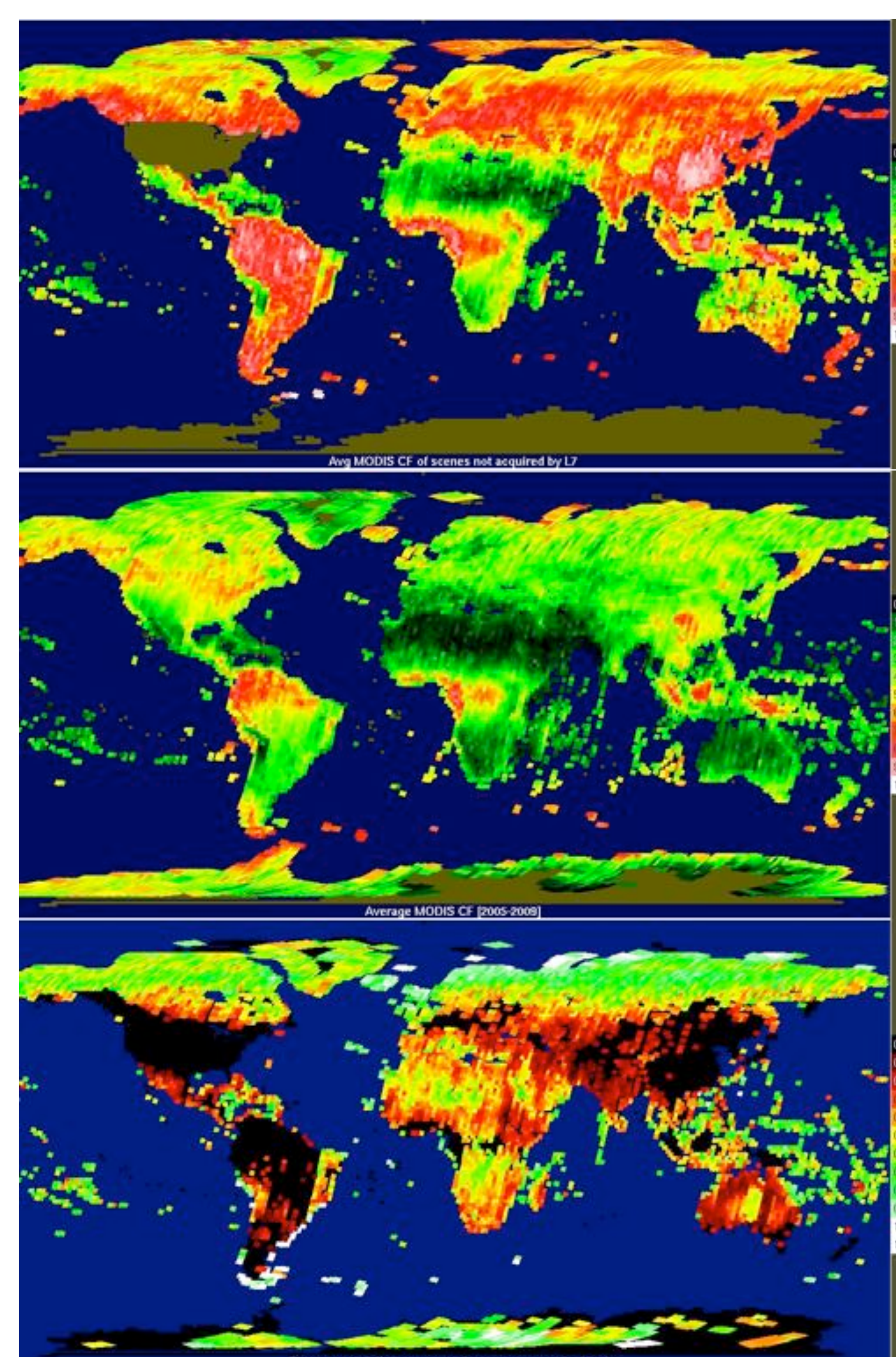


Figure 5. Cloud fraction (MODIS L2) of uncollected L7 scenes (top); cloud fraction of collected scenes (middle); fraction of uncollected scenes that were "cloud-free" according to MODIS (bottom). The bottom panel then shows "the pearls that fell on the floor".

L7-tailored CF climatology from MODIS:

L7's cloud avoidance strategy targets scenes with favorable predicted CF conditions. Favorability increases when predicted CF is better (less) than the monthly average climatology. NCEP GFS furnishes CF predictions. Climatology derives from the monthly-averaged 280 km ISCCP D2 dataset, which represents diurnally averaged conditions. L7 is weighing potential advantages of replacing ISCCP climatology with a data set derived from MODIS L2 CF, customized to the L7 overpass path and time of day (within half hour). Fig. 6 depicts an example.

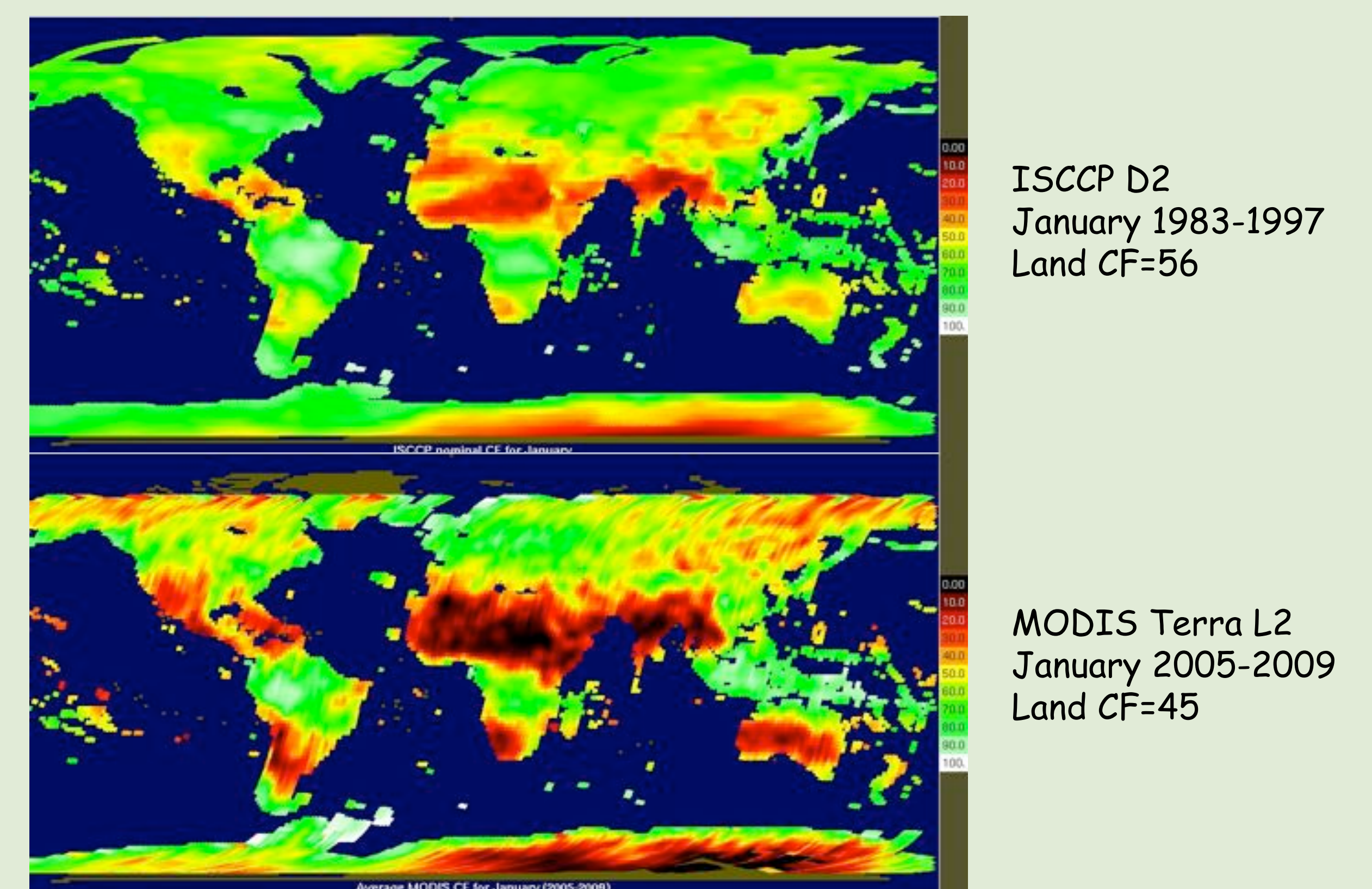


Figure 6. Land Cloud Fraction climatology from ISCCP D2 for January for the period 1983-1997 (top); MODIS January Land Cloud Fraction Climatology for the period 2005-2009 corresponding to 10:30 AM LST (bottom).