Estimating Uncertainties in MODIS Cloud Data Records
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Introduction

This project plans to implement a methodology to analyze the systematic errors and uncertainties in the MODIS cloud properties with the goal of deriving uncertainty estimates for the long-term MODIS cloud climatologies. The products of this error analysis will enable the proper use of MODIS cloud climatologies by climate modelers and climate researchers. While the MODIS cloud top and optical property algorithm developers have characterized the pixel-level performance of their algorithms using various empirical and/or analytic approaches, a full accounting of the uncertainties due to observation geometry, underlying surface type, and cloudiness characteristics remains.

Technical tasks

The technical task of incorporating data from several years of MOD06 granules necessitates culling the record to a manageable size without biasing the statistical calculations of uncertainty. For this purpose the "level2b" format was chosen. This data format consists of subsampled (not averaged) measurements mapped to an equal-angle global grid of pre-determined resolution; in this case 0.1° was chosen as the latitudinal and longitudinal resolution. Therefore, our first task was to generate code that read-in MYD02SSH and MYDATML2 granules for a full day, separating them into the ascending and descending satellite node, and then subsample the granular data to generate daily global files in the level2b format. Previous versions of similar code used nearest-neighbor or viewing angle criteria as a means of subsampling the data. The team discussed and decided that these approaches might bias the resulting level2b files, so the new version uses a random number generator to select the data point for each grid point. The level2b files are written out to netcdf format to facilitate access to the files. This task is complete and to date we have processed one year (2007) of AQUA data to this format. Figure 1 shows an example of one day's worth of cloud optical depth generated using this technique.

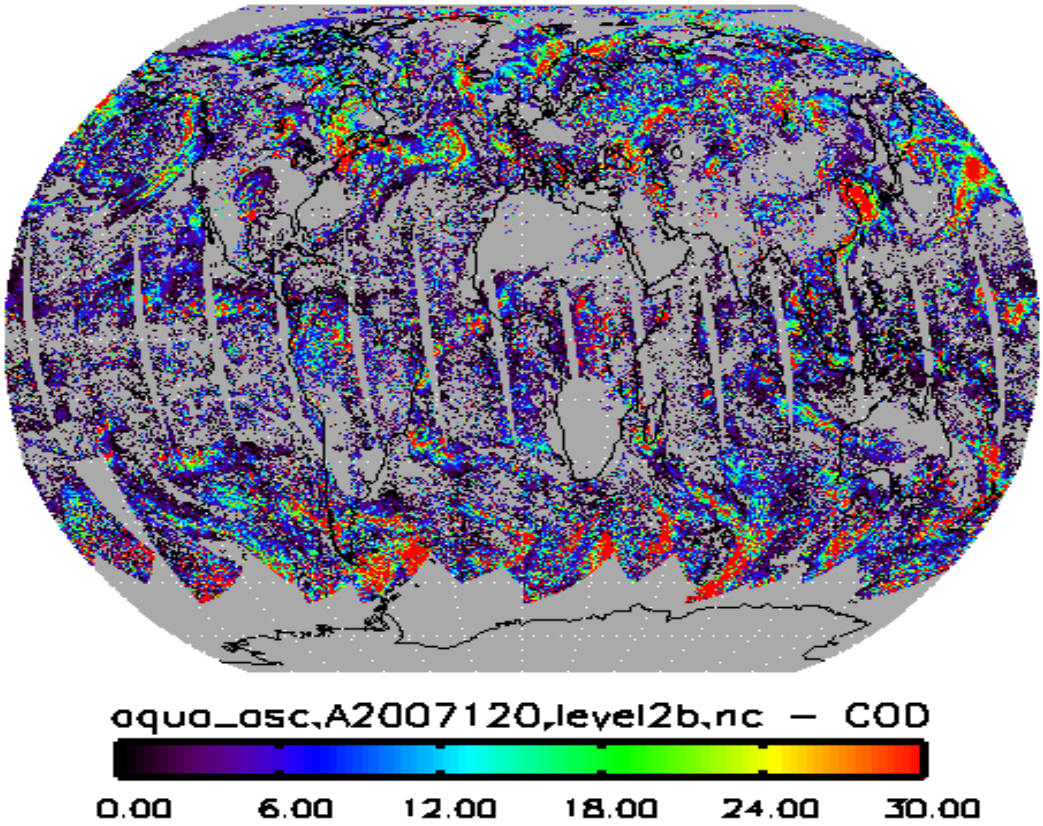

Figure 1 Level2b AQUA/MODIS Collection 5 data generated from MYD06ATML2 data on day 120 of year 2007. Data shown is for the ascending nodes.

The next task is to take these level2b files and create level3 monthly files. It was decided to initially focus on the optical properties of clouds and their angular dependence. As such cloud optical thickness, particle size, solar zenith angle, relative azimuth angle, and sensor viewing angle are the parameters currently written to the level2b files. Figure 2 shows an example of the distribution of the cloud optical depth (COD) with solar zenith angle for the data shown in Figure 1. The peak in the distribution occurs near the most common value of solar zenith angle at 13:30 local time on this day. This peak will change throughout the year and location. Solar zenith angle is one of the parameters used in the retrieval and errors in accounting for solar angle may significantly destroy the inferred seasonal cycle in the MODIS records. Our hope is to use these long-term data sets to separate the uncertainty for each of the driving parameters for the COD retrievals.

The level3 code reads in the level2b files, calculates the various angular dependences of cloud optical thickness and particle size, and averages over a spatial domain, currently 5°x5°. This is done for each month. The plan is to use an iterative method of setting angular thresholds to determine a distribution of cloud optical properties centered around near-nadir measurements, the assumption being that

near-nadir measurements are the closest representations of "truth". The standard deviation of the resulting distribution can then be considered an estimate of uncertainty. The aggregation of a single parameter, such as scattering angle, can be used to create and average for each 5°x5° box. A version of this code has been written, but is still being tested and has not been applied to significant amounts of the level2b data. It should also be noted that this code does not yet address the correlation among different parameters, such as solar zenith angle and scattering angle, which is an important component of calculating a single uncertainty estimate.

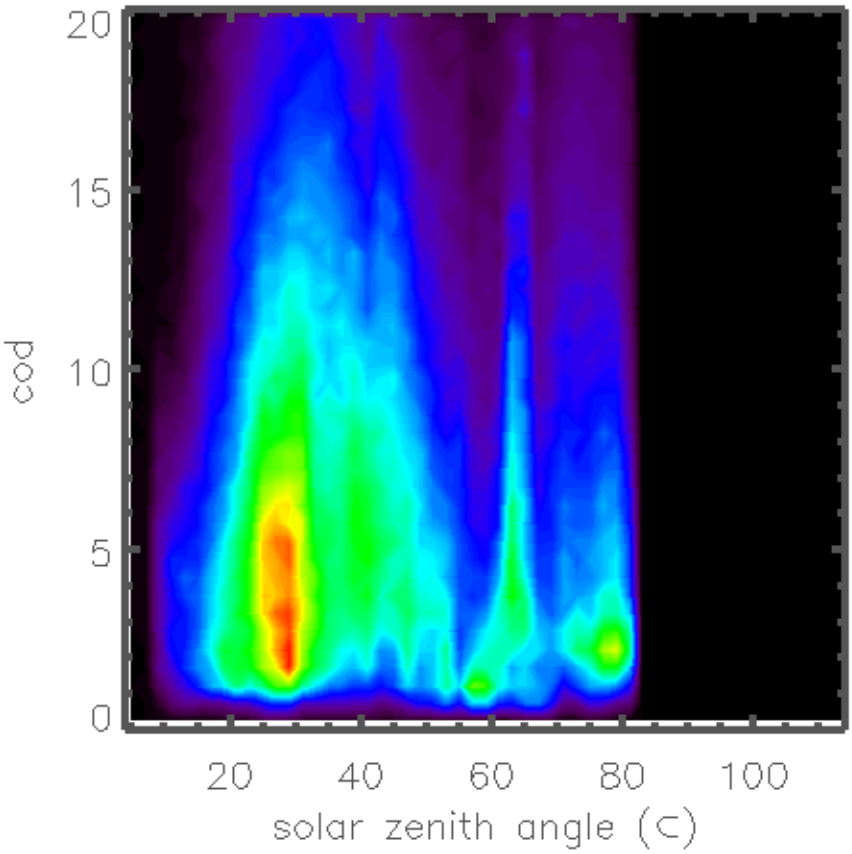

Figure 2 Distribution of cloud optical depth (COD) with solar zenith angle (degrees) in the level-2b data generated for day 120 of year 2007 for AQUA/MODIS Collection 5.

A task still in the beginning stages is comparing Collection 5 and Collection 6 cloud optical depth retrievals, in particular with regard to the clear sky restoral algorithm and those pixels for which retrievals are not performed. As stated above development on this has just begun and as yet we do not have a functional algorithm.

Milestones

The table below lists the specific two-year tasks and their status.

Dataset Preparation		
Collection of MODIS data for Terra and Aqua	Year 1 activity	Started
Composite of MODIS data for error parameters	Year 1&2	Started
Production of monthly uncertainty maps	Year 2	Pending
Production of long-term uncertainties	Year 2	Pending