Proposed MODIS-Atmosphere Collection 006 Change Document

L2 Cloud Optical Properties Version 29 (4/21/2011)

Status Keyword List: [Not Started], [Investigating], [Coding], [Testing], [Dropped] or [Implemented]. Note: If no status keyword appears after an item, the status was not communicated to the author of this document.

Cloud (06_L2)

Cloud Optical Properties (06OD) (Updated 4/21/2011) Gala Wind, Steve Platnick

- Integrate low-cloud temperature retrievals into the MOD06OD algorithm to include non-unity emissivity (from optical thickness, effective radius retrieval). Iterative approach requiring independent 11 µm cloud-top properties code from R. Frey et al. (retrieval logic and 11 µm radiative transfer code). Primary method: in conjunction w/3.7 µm retrieval (but could be done with other r_e retrievals as well). Status. DONE

- Multilayer Flag. Update current MOD06OD multilayer flag to include other techniques and approaches (e.g., Pavolonis and Heidinger). Status. Coding: P&H integration completed. Initial Primary test (#2) completed. First iterative test (#2.1) completed; analysis ongoing.

- Separate 1.6 and 3.7 µm r_e retrievals

  - Retrieve and store 1.6 and 3.7 µm retrievals as absolute values instead of differences from 2.1 µm. Allows for successful retrievals in absence of successful 2.1 µm retrieval, and separate aggregations in Level-3. [Status: Done]
  - Add retrieval uncertainties to these separate size retrievals. [Status: Pending]

- Clear Sky Restoral algorithm

  - Retrieved CSR-flagged pixels but assign a unique QA that allows them to be optionally included in Level-3 aggregations. [Status: Done]
  - Add "color test" by adding 412 nm band. [Status: Incorporation of additional band in L1B read routines completed. CSR logic modification not started]
  - Use new information incoming from collection 6 cloud mask (250m band 1 and 2 mean and standard deviation from L1B) for potentially better retrieval QA and/or clear sky restoral results. [Status: Not Started]
  - CSR logic and QA assignment need to come last in the code structure. [Status: Done]
  - 250m cloud mask handling

    * [from STM notes] CSR. According to Gala Wind, the default for 250 m tests is to set all of the 250 m pixels to clear, and then change to cloud upon reading such as result from cloud mask. But the logic should be reversed, i.e., all 250 m pixels are set to cloudy and then changed to clear upon reading such a result from the cloud mask. Either approach is irrelevant unless there are missing 250 m L1B pixels. This is the likely reason why CSR was showing thick ice cloud striping due to the faulty QA in the Jan. 2007 L1B LUT delivery. The old/original LUT was then used to reprocess data so isn't a cause of immediate widespread concern but this is an error in the logic. [Status: Done]

- Cloud-Top Properties. Use new C6 UW-Madison 1-km cloud top properties product for cloud top pressure and temperature instead of 5-km version. [Status: Integration. Use of 1km data set completed; awaiting final C6 version from UW]

- Retrieval QA.

  - Link QA to pixel-level uncertainty estimates. Status. Not started.
  - Use new information incoming from collection 6 cloud mask (250m band 1 and 2 mean and standard deviation from L1B) for potentially better QA and/or clear sky restoral results. [Status. Not started]

- New Water and Ice Cloud Reflectance and Flux Reflectance/Transmittance Look-Up Tables (LUT).
  - Replace discrete ordinate/asymptotic theory combination with DISORT to simplify code logic structure. [Status: Done]
  - Determine needed LUT discretization and intervals (τ, r_e, μ, μ_0, $\Delta\phi$) to achieve linear interpolation error much less than other error sources. Status: completed; storing Fourier components for $\Delta\phi$ interpolation. Status: Done.
  - Integrate Cox-Munk BRDF for water surfaces (vs. Lambertian in C5) for improved thin cloud (e.g., cirrus) retrievals. Determine number of wind speeds need achieve linear interpolation error much less than other error sources. [Status: Done]
  - For ice clouds, include arrays of g and ϖ_0 so users can compare/scale the answers to their own radiative cloud models (i.e., scale τ from MOD06 retrievals to their user library of g's for non-absorbing bands, and g & ϖ_0 for absorbing bands; scale MOD06 r_e to their user library of r_e by scaling ϖ_0). Also, done for water clouds for completeness. [Status: Done]

- Retrieval Algorithm
  - Solution logic that will allow retrievals just slightly outside the library space to proceed. [Status: Not Started]
  - Retrieval processing direction now in along-track direction to minimize LUT interpolation (using 99 along-track pixel positions at a time). [Status: Done]

- Cloud Phase Algorithm

  - Retrievals will be done for both liquid and ice phases simultaneously and effective radii differences between 2.1 and 1.6 μm will be used as a replacement to existing SWIR reflectance tests (requires update of retrieval code logic). Retrievals for only one phase will be kept and phase QA assignments need to precede CSR in code logic structure. [Status: Coding. Dual phase logic completed; still investigating phase logic changes]
  - Phase of thin cirrus. Cloud mask correctly detects the clouds with IR window difference and 3.9-11 μm tests, but we are getting a liquid water phase while IR is undetermined. Clearly, if the mask can detect the cirrus then we ought to use those mask tests to help in the phase logic. [Status: Not Started]

- Ancillary

- Temporally and, where applicable, spatially interpolate GDAS fields to better capture diurnal heating rates and synoptic features that affect atmospheric and emission corrections. Will be using temporally and spatially interpolated surface temperature from UW-Madison's 1-km cloud top properties product in 3.7μm retrieval. Also read in the entire profile instead of roughly half of it, as done currently. [Status: science test completed, final requires UW-Madison official 1-km CT]
- Examine possibility/effects of using next day's NISE in order to better capture freshly fallen snow. Currently incorrect non-absorbing band is used in those situations and abnormal cloud optical thicknesses result. [Status: Dropped. Changing production rules to use later NISE didn't help.]

- Aqua VIS focal plane adjustment for band 1 and 2.
  - Pursue study of Terra deregistration sensitivity.
  - Jan '10: Became aware of Ralf Bennartz Aqua re-registration algorithm and test in the Wisconsin PEATE.

    Status: Terra deregistration test completed in MODAPS. Need to compare Bennartz results with Terra deregistration test, and determine significance of misregistration sensitivity. Ongoing investigation, but unlikely to pursue.

- Improve cirrus cloud retrievals of τ_c, r_e
  - Improve thin cirrus detection using a combination of IR and 1.38 μm bands
  - Perform additional retrieval of τ_c using IR and/or 1.38 μm bands as an augmentation of the current solar reflectance approach Pavolonis/Heidinger beta 1DVAR.

    [Status: Dropped. Investigation will continue via ROSES 2009 Aqua/Terra NRA proposals.]

- Partly cloudy pixels
  - Better use of 250 m cloud mask (at least over ocean) for QA of MOD06OD and CT retrievals.
  - Coakley-type spatial variance vs. temperature approach (Note: Rich Frey doesn't think the Coakley algorithm should be included in this list. However, he could see calculating a variance statistic of some kind using band 2 and including a flag in the L2 output that indicates a non-uniform scene. I think the cloud team should discuss this more before we commit to anything.)

    [Status: Dropped]

Other items from previous change document …

- Change the multilayer cloud code so that above-cloud precipitable water is interpolated instead of being estimated by the nearest table index. [Done. However the impact wasn't as significant as thought it would be]
- Examine correcting the 0.86 μm ozone in the multilayer cloud detection algorithm. [Dropped. The extinction cross-section is too small to bother]
- Use ecosystem-dependent vegetation and snow/ice thresholds in the multilayer cloud detection algorithm. [Dropped]
- Reduce the size of multilayer and cloud phase SDSs from 16 bit to 8 bit to save space. [Done]

- Examine the effect of interpolated (advected where needed) ancillary data on the retrievals. [Done]
- Document the meaning of the settings (0 to 4) in the CDL file spec and HDF file for the "Cloud_Phase_Optical_Properties" SDS. Add a new local attributed called "description". [Done]
- Change the SDS size for Cloud_Multi_Layer_Flag and Cloud_Phase_Optical_Properties from 16 bits to 8. This will save 5.5 Mb/granule uncompressed. [Done]
- Examine the possibility of augmenting the Surface Albedo dataset to include colored water albedo: sedimented / blooming / shallow. [Dropped]

Cloud Optical Properties (06OD) (Updated 1/16/2010) Steve Platnick, Michael King, Gala Wind

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  - Retrieval processing direction now in along-track direction to minimize LUT interpolation (using 99 along-track pixel positions at a time). [Status: Completed]
  - Set the value of 3.7 μm solar spectral irradiance according to the Terra and Aqua average in Platnick and Fontenla (1998), Table 2, i.e., 10.93 W/m^2-μm. [Status: Not yet implemented]

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  From Gala Wind: "Drop the item about GDAS advection. It turned out to be too much of an overkill and also created some computational 'waves' in the profile fields that I really didn't like. They (and we) are temporally interpolating profiles instead. Seems to work just fine."

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ppm per year using 367 for Jan 2000)