Proposed MODIS-Atmosphere Collection 006 Changes
Version 12 (01/14/09)

Source Key

Blue = from Bryan Baum's PPT at Atmosphere Breakout 5/16/08 (Input from multiple team members.)
Green = from Steve Platnick, Michael King, & Gala Wind (06OD Cloud Optical Properties)
Red = from Paul Hubanks (Level 3)
Violet = from Bo-Cai Gao (05_L2 Water Vapor and 06CD Cirrus Detection)
Orange = from Rich Frey (06CT Cloud Top Properties and 07_L2 Atm Profile)

Aerosol (04_L2) Lorraine Remer, Christina Hsu, Shana Mattoo, Rob Levy, Allen Chu

- Extend the Deep Blue aerosol retrieval through the entire Terra archive
- Create a "MODIS aerosol product" that combines the traditional and Deep Blue products
- Include POLDER nonsphericity information for a better MODIS aerosol retrieval for nonspherical aerosol
- Implement a better urban product
- Further considerations
  - Examine aerosols in the proximity of clouds
- Urge the Aerosol team to split the following three parameters into _47 and _66 versions in L2: Mean_Reflectance_Land_All, Path_Radiance_Land, Critical_Reflectance_Land. This is needed since the QA for the 47 version is different than the 66 version. This will allow a cleaner implementation of these parameters in L3, where the proper QA can be applied to each.
- There are two 04_L2 SDSs called "Cloud_Fraction_Ocean" and "Cloud_Fraction_Land", which have caused some confusion among users. It should be noted that these SDS's are not a cloud fraction but instead show the fraction of all the L2 pixels that do not make it into the aerosol retrieval. These pixels (scenes) where an aerosol retrieval cannot be performed include all clouds, lakes/rivers/oceans with sediments, swamps over land, snow and ice (both over land and ocean), bright surfaces, and ocean sun glint. A final decision on the SDS name is pending. Any potential change of these SDS names needs to be coordinated with L3 changes (to stay in sync).
- Urge the Deep Blue Aerosol development team to fix their L2 "Deep Blue Aerosol Type" flags … reverse smoke and sulfate flags (2=Sulfate, 3=Smoke) so they match the QA flags for the standard aerosol retrieval. (See QA Plan.)

Deep Blue Aerosol Type [6]	2	0	Mixed
Note: Flags 2 and 3 are reversed		1	Dust
from the Aerosol Type (over land		2	Smoke
only) above		3	Sulfate

Water Vapor (05_L2) Bo-Cai Gao

- Improve QA for the near-IR water vapor products, and thoroughly screen out pixels saturated over bright clouds.

Cloud (06_L2)

Cloud Optical Properties (06OD) Steve Platnick, Michael King, Gala Wind

- Integrate low cloud temperature retrievals into the MOD06OD algorithm to include non-unity emissivity (from optical thickness retrieval) (11/06)
- Update current MOD06OD multilayer flag to include other techniques and approaches (e.g., Pavolonis and Heidinger). (11/06)
- Improve cirrus cloud retrievals of τc, re
  - Improve thin cirrus detection using a combination of IR and 1.38 µm bands
  - Perform additional retrieval of τc using IR and/or 1.38 µm bands as an augmentation of the current solar reflectance approach Pavolonis/Heidinger beta 1DVAR. (05/08)
  - Phase of thin cirrus. Cloud mask correctly detects the clouds with IR window difference and 3.9-11 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. (04/07)
    * [removed 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.
- Modify table look-up libraries and solution algorithm
  - Add more small τc in libraries to reduce interpolation errors for thin clouds
  - Remove asymptotic algorithm for thick clouds, replacing it with more τc libraries; no impact on solutions but simplifying algorithm maintenance
  - Include ocean BRDF to accommodate, especially, thin cloud retrievals over ocean
- Partly cloudy pixels
  - Better use of 250 m cloud mask (at least over ocean) for QA of MOD06OD and CT retrievals (11/06)
  - 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.)
- Either provide scaled optical thickness in the data set AND/OR include a vector of ice cloud g and ssa in the data set, so: (1) users could scale optical thickness from our retrievals to their own library of g values in non-absorbing bands, and g & ssa for absorbing bands (e.g., a broadband code in a climate model). (2) users could scale our effective radius to their own library of re by scaling ssa. (03/08)
- Despite tradition, we don't believe that delta transmittance should be included in ice cloud radiative transfer calculations. For MODIS C5, eliminating delta transmittance reduces g for re>10 µm and reduces the slope of g vs. re. This mitigates some of the need for roughened particles. (05/08)
- Pursue Aqua cold focal plane adjustment in L1B production. Jack Xiong says Vermote has done something along these lines. (05/08)
- Change the multilayer cloud code so that above-cloud precipitable water is interpolated instead of being estimated by the nearest table index. (01/09)
- Examine correcting the 0.86 µm ozone in the multilayer cloud detection algorithm. (01/09)

- Use ecosystem-dependent vegetation and snow/ice thresholds in the multilayer cloud detection algorithm. (01/09)
- Reduce the size of multilayer and cloud phase SDSs from 16 bit to 8 bit to save space. (01/09)
- Store the 1.6 and 3.7 µm retrievals as actual values instead of differences from 2.1 µm. (01/09)
- Examine the effect of interpolated (advected where needed) ancillary data on the retrievals. (01/09)
- Examine the effect of 1km cloud top properties on cloud retrievals. (01/09)
- 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". (01/09)

Cloud Top Properties (06CT) Rich Frey, Kathy Strabela, Paul Menzel

- Check with Rich Frey if a new flag category should be added to the Cirrus Flag and High Cloud Flag. The category would be 3 = clear sky. Currently the category 0 = "missing" includes both missing satellite data and clear sky. This change would allow a true fraction to be implemented in L3. (01/09)
- Implement "top-down" method of final cloud top pressure choice for Aqua
- Avoid CO2 slicing solutions in water clouds and IRW solutions in ice or mixed phase clouds
- Output cloud (geopotential) heights along with cloud top pressures
- Run algorithm at 1 km resolution
- Include cloud overlap / phase at 1 km
- Include multiple cloud top pressure solution flag for window channel retrievals
- Investigate inversion detection for low level water cloud to be located below inversion
  - Survey globe to see frequency of occurrence of low level inversions in GDAS dataset used as ancillary information
    - ✓ Are these correctly found over ocean, land, and coastlines?
    - ✓ Are they found at the correct height, when present?

    This initial work has already been done. The use of GDAS to identify inversions is not perfect, but leads to much improvement in L2 output in marine stratus cloud regimes. I would simply include one bullet that states: GDAS temperature profile data will be used to identify regions where temperature inversions exist and an alternative IRW method will be implemented.

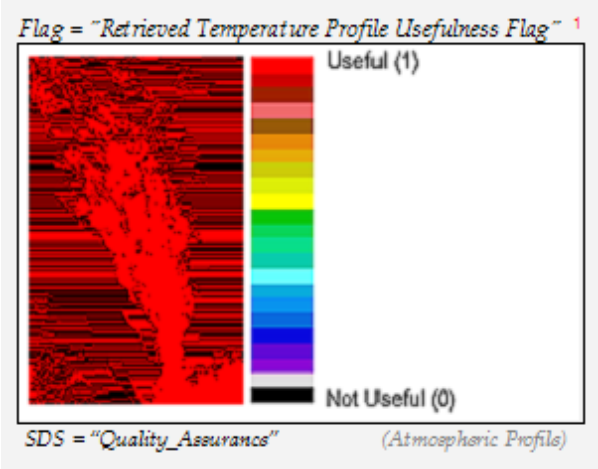
Cirrus Detection (06CD) Bo-Cai Gao

- Improve cirrus reflectance retrievals over dry high elevation areas, such Tibet Plateau, Andes Mountains, Antarctic and Greenland. The collection 05 cirrus reflectance products over these areas are slightly contaminated by surface reflection effects.

Atmospheric Profile (07_L2) Eva Borbas, Suzanne Seemann, Rich Frey

- Update surface emissivity data base to current version
- Investigate the dry bias in Aqua TPW and make adjustments to improve.

- Perform a more thorough evaluation of the ozone product through intercomparisons with TOMS and AIRS and make adjustments to algorithm
- Evaluate the current radiance bias adjustments in Aqua and Terra algorithms and make updates.
- Look into whether we can include all profiles at 101 levels in direct broadcast or at the DAAC, and an ozone profile instead of just TOZ.
- Assess the TPW Low and TPW High products and possibly change the levels of integration to make them more useful.
- Improve QA/QC flags and screening for bad input MOD02L1B data.
- Examine the MOD07 Level 3 products for consistency with other long term datasets (NVAP).
- Perform an experimental combined retrieval with AIRS, for at least a few cases.
- Making Aqua and Terra DAAC code uniform
- Have the Atmosphere Profile development team fix (remove the noise in fill regions) all 07_L2 Atmosphere Profile Usefulness and Confidence QA Flags. This problem might stem from the QA flags not being initialized as 0's; but this is unclear.



Cloud Mask (35_L2) Rich Frey, Steven Ackerman

- Implement angle-dependent 0.86 μm thresholds for day ocean
- Implement day/night, land/water dust detection algorithm
- Lower 1.38 μm thresholds to "thin cirrus" values, but keep thin cirrus flag for users (all scene types except snow/ice)
- Investigate cloud test using variability of 0.86 μm reluctances in a 3x3 region for day ocean
- Investigate angle and location-dependent 0.66 μm thresholds for day land
- Investigate cloud test using variability of 3.75 μm BTs for night ocean
- Investigate use of 7.2-11 μm BTDs in polar day scenes
- Use 11 μm BTs and surface data to help screen out false snow from both maps (night) and NDSI (day)
- Tune-ups:
  - 3.9-11 μm cloud test threshold/algorithm for night coastlines and shallow water (eliminate uncertain results as much as possible)
  - 3.9-11 μm cloud test thresholds for night land in moist environments (e.g., Amazon)
  - Adjust Antarctic night cloud test thresholds

Joint Atmosphere (ATML2) Paul Hubanks

- Check with all L2 development teams to ensure any changes to L2 HDF files (new parameters, new or changed QA, etc.) are accounted for in the Joint L2.

Level-3 Gridded Product (08_D3, 08_E3, 08_M3) Paul Hubanks

- Add joint histogram of cloud optical thickness and cloud top pressure for combined phase to more easily compare with ISCCP joint histogram
- Add smoke only, dust only, and sulfate only aggregations of Deep Blue aerosol. Aggregate aerosol single scattering albedo for dust from Deep Blue algorithm. Make sure to sync any L2 Deep Blue Aerosol Type flag change to L3.
- Modify Cloud Effective Radius (Re) liquid water cloud histograms and joint histograms to start at 4.0. In addition, use the newly defined Research L3 boundaries for Cloud Effective Radius (Re) joint histograms
  - New Bin Bounds for C006 = 4, 6, 8, 10, 12, 14, 16, 18, 20, 25, 30
  - Old Bin Bounds for C005 = 2, 4, 6, 8, 10, 12.5, 15, 17.5, 20, 25, 30
- Increase number of bins in the marginal histograms (especially for ice cloud effective radius). Check all the Research L3 histogram bin bounds against the Operational L3 (change the Operational L3 where appropriate). Increase # of bins and reduce histogram bin sizes for Re Ice esp in the 20 to 32 range but perhaps along entire range.
- Add Cloud Top Height parameter to L3. Add new marginal histograms for this SDS (develop a most useful definition of histogram bin boundaries). Q: Are new joint histograms based on this parameter envisioned?
- Modify L3 code to compute median. Add median statistics to some parameters of L3. (esp Cloud Optical Property parameters)
- Fix File Spec "long name" for Cloud Fraction Histogram Counts (delete at 10 intervals)
- Use uncertainty to develop new QA-weighted means of Cloud Optical Property parameters. (check with S.Platnick)
- Check with all L2 development teams to ensure any changes to L2 HDF files (new parameters, new or changed QA, etc.) are accounted for in the L3 (sync the L3 to L2)
- Investigate a clean up of the Mean_Reflectance_Land_All parameter (using QA for 47 and QA for 66)
- Investigate if the Standard Deviation of the Daily Means should be weighted in the multiday product (and if so, how should this be done and what does this mean). This statistic is currently weighted by D3 pixel counts, but I am unsure if this is actually correct. The statistic could be more intuitive if this was unweighted.
- Determine if the Aerosol group wants to add any of their new SDS's into L3.
- Add Cloud_Phase_Infrared_Cloud_Fraction_Liquid, Ice, Mixed, Undetermined and Combined. Previously only Histogram Counts were computed in L3.
- To allay user confusion, rename the L3 SDS "Aerosol_Cloud_Mask_Cloud_Fraction" SDS's. Some suggested names are "Fraction_Unsuitable_For_Aerosol_Retrieval" or "Aerosol_Retrieval_Mask". It should be noted that these SDS's are not a cloud fraction but instead show the fraction of all the pixels that do not make it into the retrieval. These pixels (scenes) where an aerosol retrieval cannot be performed include all clouds, lakes/rivers/oceans with sediments, swamps over land, snow and ice (both over land and ocean), bright surfaces, and ocean sun glint. A final decision on the SDS name is pending. The 04_L2 SDS, which is used to derive the L3 SDS,

is called “Cloud_Fraction_Ocean” and “Cloud_Fraction_Land”. SDS name changes need to be coordinated between L2 and L3.

- Revisit the Cloud_Fraction_Combined, _Liquid, _Ice, _Undetermined SDS names. Steve Platnick suggested adding the word Retrieval (Cloud_Retrieval_Fraction_Combined, _Liquid, _Ice, _Undetermined), since this SDS really shows the fraction of successful retrievals in each cloud phase category. An alternative could be to simply modify the “long_name” local attribute making this clearer.
- Check with Rich Frey if a new flag category should be added to the Cirrus Flag and High Cloud Flag. The category would be 3 = clear sky. This would allow a true fraction to be implemented in L3. This could be approximated with the current structure (format) by putting category (0) = missing in the denominator. It appears this category included both clear sky and missing satellite data. (01/09)