LARRY STOWE'S NOTES AND ACTIONS FROM GACP TUESDAY NIGHT MEETING AT AGU:

The special GACP meeting Tuesday night at AGU was attended by about 30 GACP scientists, to review the GISS comparison of clear-sky reflectances for July 1990 provided by GISS, NESDIS, and Oregon State University. No reflectances have yet been made available by the U. of Tokyo or the Naval Postgraduate School groups.

AVHRR CHANNEL 1 & 2 CLEAR-SKY OCEAN REFLECTANCE COMPARISONS:

Igor Geogdzhayev presented maps of monthly mean clear-sky reflectances for channels 1 and 2 of AVHRR for July 1990 and their temporal standard deviation over the 31 days of the month which are used by each group to estimate aerosol optical thickness and in some cases, a particle size parameter. Each group had used the NOAA/NESDIS recommended calibration from N. Rao's published degradation equations for July 15, 1990 and the AVHRR Pathfinder Atmosphere (PATMOS) 110 km equal area grid cell representation of the Earth's surface for mapping and display. He showed maps of differences between OSU VS GISS and NESDIS (PATMOS) VS GISS reflectances and standard deviations. The results between OSU and GISS were more similar than those between NESDIS and GISS. The figures showed NESDIS mean values to be much higher in the northern tropics and lower (much lower in channel 2) in the southern hemisphere and high northern hemisphere. The ensuing discussions revealed that Igor had used the monthly mean "Daytime clear albedo (darkest 30%) for aerosol retrieval" (also referred to as "aerosol burden albedo") parameters from the PATMOS-2 dataset. Larry Stowe realized that he had failed to make it clear in earlier instructions to GISS that the AOT values presented in PATMOS-2 are derived from PATMOS-1 daily grid cell mean values of the "cloud-free (pixel) albedo" parameter that are further screened to satisfy the following favorable aerosol retrieval geometrical and surface conditions within the grid cell before an AOT retrieval is computed: solar zenith angle <70; satellite zenith <60; relative azimuth > 90; and gamma angle (angle between viewing angle and specular ray from flat ocean) > 40; percent land = 0, and percent snow/ice = 0. Igor, having extracted the monthly mean "aerosol burden albedo" from PATMOS-2 was using radiances which had not been screened for any of the geometrical and surface conditions favorable to AOT retrieval. This then explained the high values in the northern tropics as being due to ocean specular reflection. The low values in the southern hemisphere result from the fact that pixels from the lowest (darkest) 30% of channel 2 cloud-free albedos in the grid cell are used to compute the mean "aerosol burden albedos" in channels 1,2 and 3. It was thus decided that no further quantitative comparisons should be done with the NESDIS PATMOS dataset until the above conditions used in PATMOS-2 for aerosol retrieval are replicated by GISS in the processing of PATMOS-1 daily data from which the monthly mean should be computed. It was further recommended that ratios relative to GISS as well as differences be used for the comparisons. It was also concluded that ratios relative to GISS of the different group's aerosol optical thickness values should be mapped, to illustrate the justification for doing the clear-sky reflectance comparisons.

It was also thought that maps of ratios relative to GISS of each group's fraction of clear pixels within a grid cell, as well as the number of clear days that were used in each group's monthly mean map, would be useful cloud mask evaluation parameters. It was also decided that GISS would add the following two conditions used in the NESDIS AOT pixel selection process into their pixel selection process to test if those could be the cause of their differences with the NESDIS clear-sky reflectances: 1) relative azimuth has to be greater than 90 degrees; and 2) ch3 albedo (computed by formulae published in CLAVR-1 paper, Stowe, et al, 1999 JTECH, 16, p. 677) has to be less than 3%.

It was further suggested by Jim Coakley that several orbits be selected for detailed examination of satellite images to aid in the determination of which cloud masking algorithm is working better (least cloud contamination). These orbits could be selected to cover areas exhibiting large differences between the various cloud screening algorithms from the above comparisons in July 1990, perhaps with Local Area Coverage (AVHRR 1 km pixel) data available, or from some other time period. Larry Stowe is of the opinion that the best algorithm would be the one yielding the lowest clear-sky reflectances in the southern hemisphere (known to be the cleanest of the two hemispheres) and exhibiting higher reflectances in regions known to be persistently affected by aerosols in the northern hemisphere. Michael Mishchenko suggested that the lowest reflectances may be biased low because some aerosol types are being excluded by the cloud mask (e.g., haze or aerosols near the edge of clouds).

Larry Stowe also commented on the value of consistency checks of each algorithm, where AOT statistics (max, min, mean, stnd. dev.) for a given time period and geographic location are plotted as functions of solar, satellite, scattering, and gamma angles, and cloud amount, if available. Ideally, the AOT mean values should not vary with any of these variables. However, the NESDIS operational single channel retrieval algorithm checks suggest that there may be some adverse effects of specular reflection from the ocean (it is not yet included in the NESDIS retrieval algorithm) since AOT values are progressively elevated as gamma angle decreases from about 55 degrees to 40 degrees. There also appears to be some variability with scattering angle, which is indicative of aerosol modeling errors in the phase function. Each group's AOT retrievals for some or all days of July 1990 should also be compared in this way, to see which cloud-screening (and specular screening) and AOT retrieval algorithms provide statistics closest to the ideal.

Larry Stowe further suggested that the final decision on the best cloud screening and retrieval algorithm may depend on the only truth we have in our work, and that is the sun-photometer observations of aerosol optical thickness. He showed an example of the kind of statistical regression validation the NESDIS group is doing with 1998 data from AVHRR and TRMM/VIRS AOT retrievals using the AERONET ocean sites as truth. Their analysis provides estimates of the satellite systematic and random errors relative to the sun-photometer. He suggested that if all groups were to first use the NESDIS provided cloud-free pixels with NESDIS calibration adjustments that are contained in their validation AVHRR VS AERONET match-up data base for 1998 and apply their own AOT retrieval algorithm, the resulting AOTs could be evaluated against the AERONET data (systematic and random errors). Secondly, if each group then applies their own cloud-screening algorithms for AVHRR pixels (still using NESDIS calibration adjustment) contained within the same space window used by NESDIS (100-200 km radius circle centered on each site, excluding area within 25 km of site) and then applies their AOT retrieval algorithms, these results could also be evaluated against the AERONET data. We could then objectively determine which of the various cloud screening algorithms and retrieval algorithms produces the smallest errors relative to AERONET, over all available AERONET regions, and would thus be deemed appropriate algorithms for the GACP aerosol climatology. There are six AERONET locations in 1998, covering the three major northern hemisphere ocean regions that have sufficient "level-2 (quality controlled and cloud screened) datasets from which valid statistical conclusions could be made. Michael Mishchenko commented that the sun-photometer data may also have problems with clouds, and we should be sure we understand the conditions which they deem necessary for an observation to be valid (level 2), just as we must do this for the satellite retrievals. He pointed out that comparisons of satellite retrievals and sun-photometer measurements do not always provide a reliable check of the satellite cloud screening algorithm and also suggested that we may have to revisit the issue of giving proper definitions of cloudy and clear-sky conditions. [Discussions after the meeting with Michael and Igor indicated that because they are using ISCCP processed data, they would not be able to apply the ISCCP cloud screening to the matchup database available from NESDIS for 1998, because it is too complex to make special runs just for a few locations and times in 1998, and routine production of ISCCP data for 1998 is not expected soon enough for this task. Larry Stowe suggested that we still might be able to infer the performance of the ISCCP based cloud screened AOT retrievals from their 1998 matchup database by the following process: 1) have GISS use NESDIS clear-sky grid cell reflectance (REF) statistics for July 1990 an apply the GISS AOT retrieval algorithm to it, which will yield daily values of AOT(GISS,REF[NESDIS]); 2) GISS would derive a functional relationship between AOT(GISS,REF[GISS]) and AOT(GISS, REF[NESDIS]) from this July 1990 dataset; they could use this functional relationship to scale AOT(GISS, REF[NESDIS]) derived from1998 MATCHUP dataset into AOT(GISS, REF[GISS]). This may give us a good estimate of whether the GISS or NESDIS cloud mask, when applied to the matchup data, yields AOTs which are in better agreement with the AERONET observations of 1998.

SUMMARY OF POSSIBLE ACTION ITEMS RESULTING FROM ABOVE NOTES:

- GISS will compute clear-sky reflectance from PATMOS-1 daily reflectances used in AOT retrievals as described in first paragraph above.
- Each group will provide grid cell maps of AOT, clear-sky reflectance, fraction of clear pixels, and clear days in the month to GISS so that they may prepare maps of ratios relative to GISS values, as described in first paragraph above.

- Select several orbits from regions exhibiting large differences in clear-sky reflectances and process them with each group's pixel level cloud screening algorithm and identify clear-sky pixels on satellite images (preferably LAC resolution imagery) as discussed in second paragraph above and provide these images to GISS..
- Each group performs algorithm consistency checks as described in third paragraph above and submits results to GISS.
- Each group performs statistical regression analyses using the NESDIS validation matchup database as described in forth paragraph above and submits results to GISS.

The above are recommended courses of action to resolve the issue of which calibration, cloud screening (specular screening) and aerosol retrieval algorithms are appropriate for use in generating the GACP aerosol climatology.