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Cloud Free Line of Sight Probabilities And Persistence Probabilities From Whole Sky Imager Data

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1. Introduction

Cloud Free Line of Sight (CFLOS) statistics can be important to a number of applications involving transmittance of light through the atmosphere. These applications might include missile defense (either airborne, ground based, or at sea), other laser applications such as laser communications, detection of visual and other targets through the atmosphere, modeling of cloud fields for scene simulators, and related applications. The Atmospheric Optics Group at Marine Physical Lab (MPL), Scripps Institution of Oceanography, University of California San Diego, has recently completed an initial study of CFLOS statistics, including Probability of CFLOS (PCFLOS), Probability of Cloudy Lines of Sight (PCLOS), and Persistence of CFLOS and CLOS.

These studies are based on ground-based data from the Day/Night Whole Sky Imager (D/N WSI)[1,2]. The WSI systems are automated digital imaging systems developed by the Atmospheric Optics Group. This recent study is based on a few months of data acquired every six minutes with a Day/Night WSI. The results are also supported by a more extensive analysis of Day WSI data taken in the 1980's[3,4,5] A D/N WSI database consisting of several years' data at each of several sites is available for further studies.

CFLOS is defined as the probability that a given line of sight is cloud free, at a given point in time. For this study, we extracted CFLOS statistics as a function of zenith angle and cloud fraction, and as a function of cloud type. Persistence is defined as the probability that a line of sight will remain clear throughout an interval T, given that the line of sight is cloud free at time T_0. In comparison, Recurrence is the probability that the line of sight will be clear again at time T. Persistence statistics were extracted as a function of zenith angle and of the cloud fraction at time T_0. Previous studies will be discussed in Section 2, and an overview of the WSI and its database will be discussed in Sections 3 and 4. The results of this study will be discussed in the later sections. Shields et al[6] provides an overview of these results not including the sorting as a function of cloud type as also been written by Shields et al[6]

2. Previous Studies

The most extensive previous set of CFLOS and Persistence data that we are aware of is the data published by Lund and Shanklin[7,8,9] The Lund data were acquired using a film camera, with infrared film and a fisheye lens, as well as a solar occultor to minimize stray light. Sample images are shown in Fig. 1. A template as shown in Fig. 2 was overlaid on each image, and a visual assessment of the presence of clouds in each circled point on the template was made and recorded.

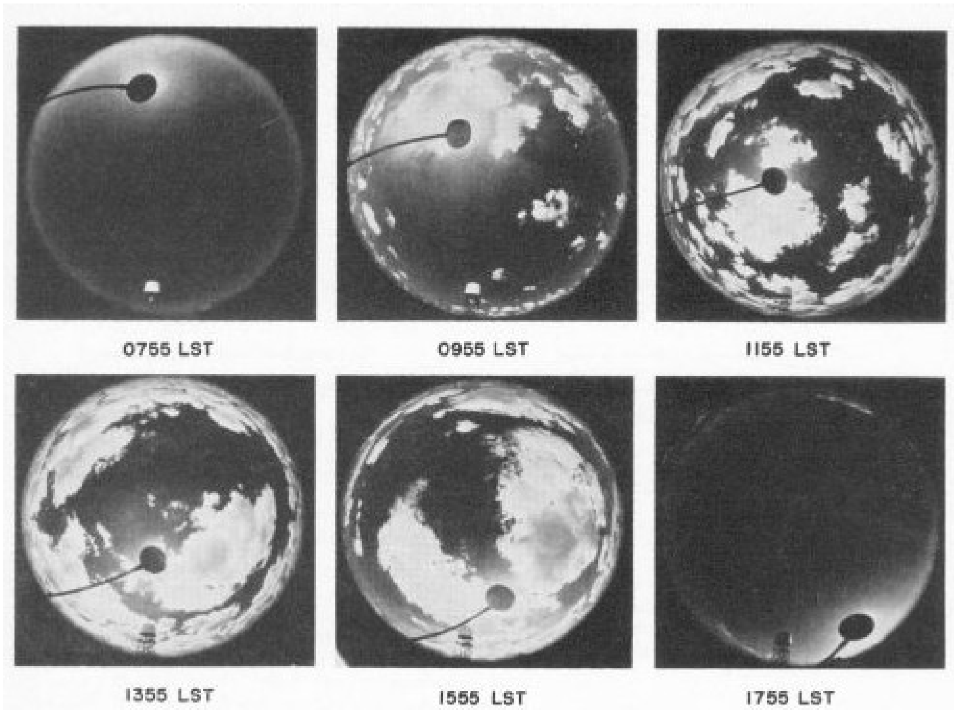

Fig. 1. Sample raw images from Lund data set

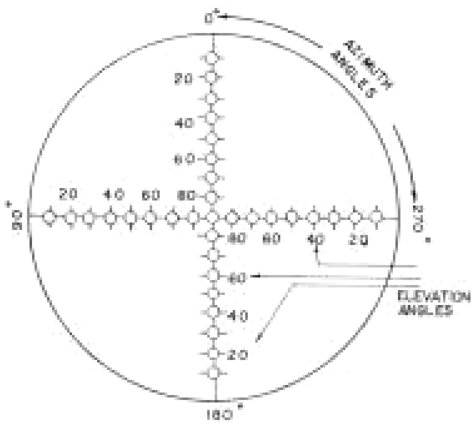

Fig. 2. Template used to visually process Lund images

For the initial Lund studies[7] hourly data taken in Columbia, Missouri for the summers of 1966 through 1969 were processed. Approximately 3300 images were processed and evaluated in each of 4 cardinal directions, to yield 13,000 observations of each zenith angle, or 110,000 observations total. The corresponding total cloud fraction was taken from the weather service ground-based records. The second Lund study[8] used data taken 3 times a day for a full three years. This data set included approximately 3100 images, and the results (for all cloud types combined) were nearly identical to the previous results. We have used these results in this paper.

The Lund data were identified using a human visual "image processor", which is normally a quite good cloud detector. However, human visual determination is not always consistent, and can be limited somewhat by the film characteristics. The Lund data has the disadvantage of limited data, representing only one site. The data also only go down to 80 degrees zenith angle. However, these data appear to have provided reasonable results for many years[10]. The Lund PCFLOS results for all cloud types are shown in Fig. 3.

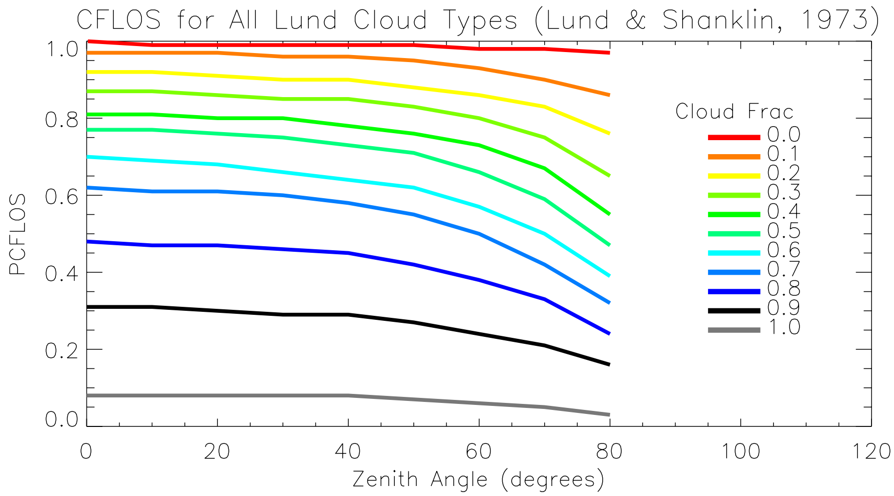

Fig. 3. Lund PCFLOS for all cloud types

As described in the Lund references, if PCFLOS as a function of cloud fraction and zenith angle is reasonably well known, then cloud fraction climatologies may be used to apply the results to multiple sites. In addition, if the data are sorted as a function of cloud type, then this information may be used to provide somewhat more accurate results. Although a thorough literature review is beyond the scope of this report, we would like to note that CFLOS modeling studies have been done, including modeling the results of Lund's study. Some current applications use the Lund data directly[10]. Examples of how to apply the data directly will be given in a later section.

3. Overview of WSI

The original concept for the Whole Sky Imagers at MPL evolved out of the group's Atmospheric Optics program, a measurement and modeling program using multiple sensors for monitoring sky radiance, atmospheric scattering coefficient profiles, and other parameters related to vision through the atmosphere (Johnson et al 1980). In particular, the first automated WSI was conceived as combining the features of the all-sky camera with the scanning radiometer systems that provided quantitative measurements of sky radiance distribution. Early systems were based on digital cameras (sometimes CCD, sometimes Charge Injection Device or CID systems), with fisheye lenses, optical filter changers, relay optics to provide the proper image size and location, equatorial sun occultors to provide shading for the lens, and early versions of personal computers for automated control[3,4,5]. Fig. 4 shows some of this evolution. The film-based all-sky camera in use in a 1963 deployment is shown in Fig. 4a, and the automated Day-only WSI developed in the mid-1980's based on CID technology is shown in Fig. 4b.

With the use of very low noise 16-bit CCD cameras and an occultor modified to handle both sun and moon, these systems were further developed into the Day/Night WSI shown in Fig. 4c[1,2]. Unlike the more common 24-bit color camera with 8-bit resolution in each color, this system has

16-bit (65,536 grey levels) in each spectral filter, as well as additional neutral density filters and exposure control for a useful dynamic range of over 10 logs or 10^{10}. As a result, the WSI data are fully onscale for 24/7, so that night sky between stars has an excellent signal to noise, yet bright clouds near the sun are also onscale. The system optics are fully shaded, providing outstanding data quality. Algorithm results can be extracted all the way down to the horizon, although for this study the results are reported to a 88° zenith angle. Although more advanced WSI systems and other related systems have been recently developed at MPL[11,12,13], this study is based on data acquired with the version of the D/N WSI shown in Fig. 4c. Some typical images from the Day/Night WSI are shown in Fig. 5.

(a) (b) (c)

Figure 4: Some of the WSI Systems developed at MPL: a) the All-Sky Camera used in 1963; b) the Day-only digital WSI developed and used in the 1980's; c) the Day/Night WSI used since the early 1990's and used to acquire the data for this study.

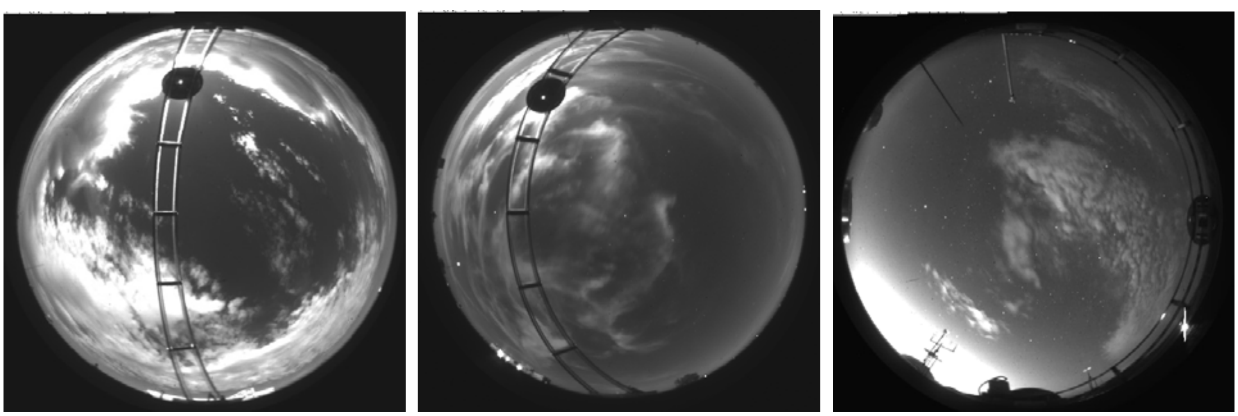

Figure 5: Sample imagery from the Day/Night WSI for sunlight, moonlight, and starlight conditions.

4. Data Base Used for the CFLOS Study

Data has been acquired at multiple sites over many years under the auspices of the Department of Energy's Atmospheric Radiation Measurements (ARM) program[14]. We chose to base this study on data acquired at the Southern Great Plains (SGP) site in 2002. Approximately three million image sets are currently available in data archive for the D/N WSI. However, at the present time, the versions of the cloud algorithms used to process much of this data are not as accurate as desired for this study. As a result, data were re-processed using the MPL cloud algorithm. This cloud algorithm is based on the red/blue algorithm developed by MPL in the '80's[15,16] and more recently upgraded and improved. The algorithm is currently under further development; for example red skies at dawn often cause the current version of the algorithm to misidentify the sky (work is in progress to alleviate this problem). Any algorithm results that were not reasonable were eliminated from the study.

Sample algorithm results are shown in Fig. 6. Figures 6a and 6c show raw red images. Figures 6b and 6d show the cloud algorithm result, where white indicates optically opaque cloud, light blue indicates optically thin cloud, and darker blue indicates clear sky. Figures 6a and 6b show a case with multiple cloud layers, and Figures 6c and 6d show a case dominated by cirrus, possibly resulting from airplane contrails. Fig. 6b shows the results of an initial run that shows the complete field of view. Most of the processing for this study used the occultor masking shown in Fig. 6d, and the horizon masking shown in Fig. 6b; some months used the horizon masking in 6d that masked out grasses that grew up into the field of view late in the summer.

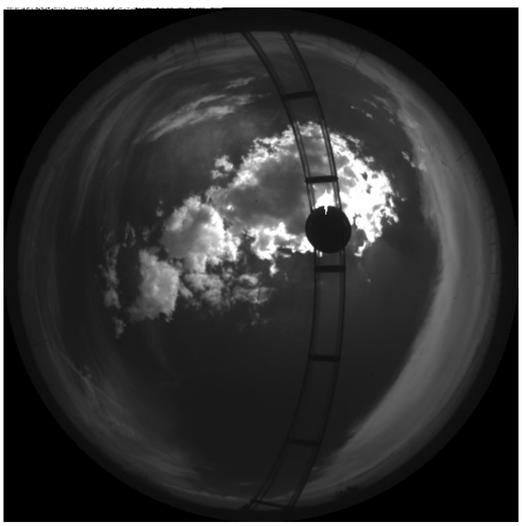

Fig. 6a. Raw red image, 12 Aug 02 1706z

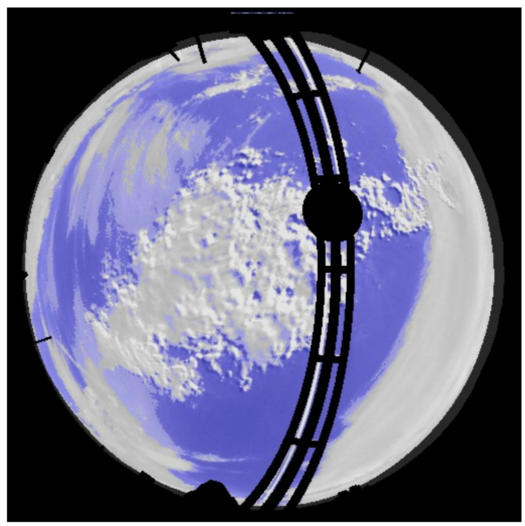

Fig 6b. Cloud decision image, 12 Aug 02 1706z

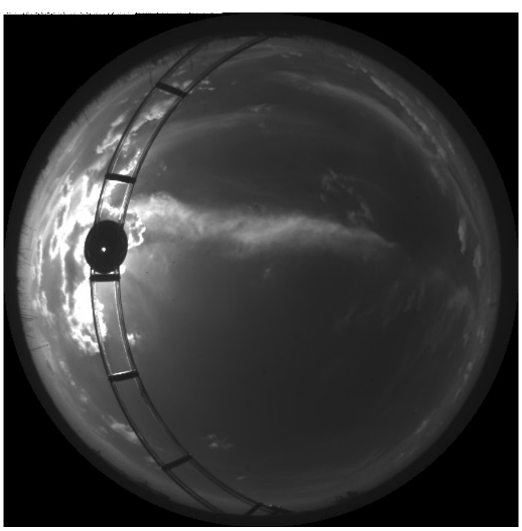

Fig. 6c. Raw red image, 16 Aug 02 2218z

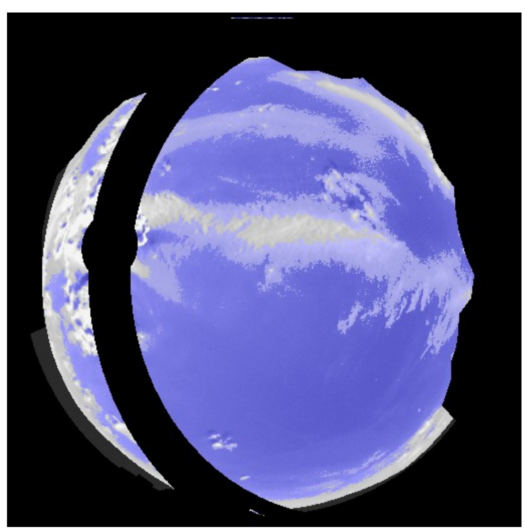

Fig 6d. Cloud decision image, 16 Aug 02 2218z

Figure 6. Sample Cloud Algorithm Results from this data set

The algorithm sorts thin cloud from opaque cloud based on its spectral signature; whiter cloud is identified as opaque. The opaque clouds have a fixed spectral signature that is independent of look angle or solar zenith angle. The thin clouds are those transparent clouds that are less white than the opaque clouds. Their spectral signature is dependent on both look angle and solar zenith angle. That is, because they are transparent, their optical signature is a perturbation with respect to the clear sky background signature. Cumulus clouds tend to be identified as opaque and cirrus as thin, however tenuous edges of low clouds may be identified as thin, and likewise the thickest parts of cirrus may be identified as opaque. We have presented plots both for opaque only, and for opaque and thin. The thin cloud algorithm tends to be less accurate than the opaque algorithm. However cirrus clouds can have significant impact on applications such as laser propagation, and the opaque plus thin plots will be most accurate for assessing these scenarios.

Initially, this study used 3 months of data from the SGP site: February, March, and August '02. February and March are the cloudiest months, and August is the least cloudy month, based on typical highest and lowest monthly means of total sky cover. In the second part of the study, in which data were sorted as a function of cloud type, we found that there was insufficient data for certain combinations of cloud type and cloud amount. As a result, we sorted the weather reports to select additional days with the desired conditions, and supplemented the study with WSI data from these additional days. A total of 7081 images were used.

The angular calibration is based on the night star field, and is generally accurate to approximately half a pixel or 1/6 degree. CFLOS is pulled for a 3 x 3 region surrounding a pixel. The pixel size is about 1/3 degree in zenith angle, or approximately 12 m for low clouds and 58 m for high clouds at the zenith. Near the horizon, the geometric calibration was verified to be accurate to within about a pixel by using the setting and rising sun positions.

5. Extraction of the CFLOS Data

The WSI data, once it had been processed to yield the cloud decision images, were then processed through programs designed to determine the CFLOS statistics. CFLOS determinations were extracted from the cloud decision images every 15 degrees in azimuth and 5 degrees in zenith angle up to 80 degrees, and every 1 degree from 81-90 degrees, as shown in Fig. 7.

Approximately 7081 images were processed. Data were extracted at 24 azimuth angles and 27 zenith angles, to yield 2,600,000 CFLOS data points. Data were then averaged azimuthally to yield 191,000 averaged results. Lund lists the number of data points extracted at each zenith angle (except 0). For this set, since there were 7081 images and 24 azimuthal points per zenith angle, there were 170,000 points at each zenith angle. These number of cases for each cloud fraction are given, with the corresponding WSI data points, in Table 1. (The number of data points is slightly less near the horizon, where the mask blocks some points.) The number of images and the total number of data points for each month are shown in Table 2.

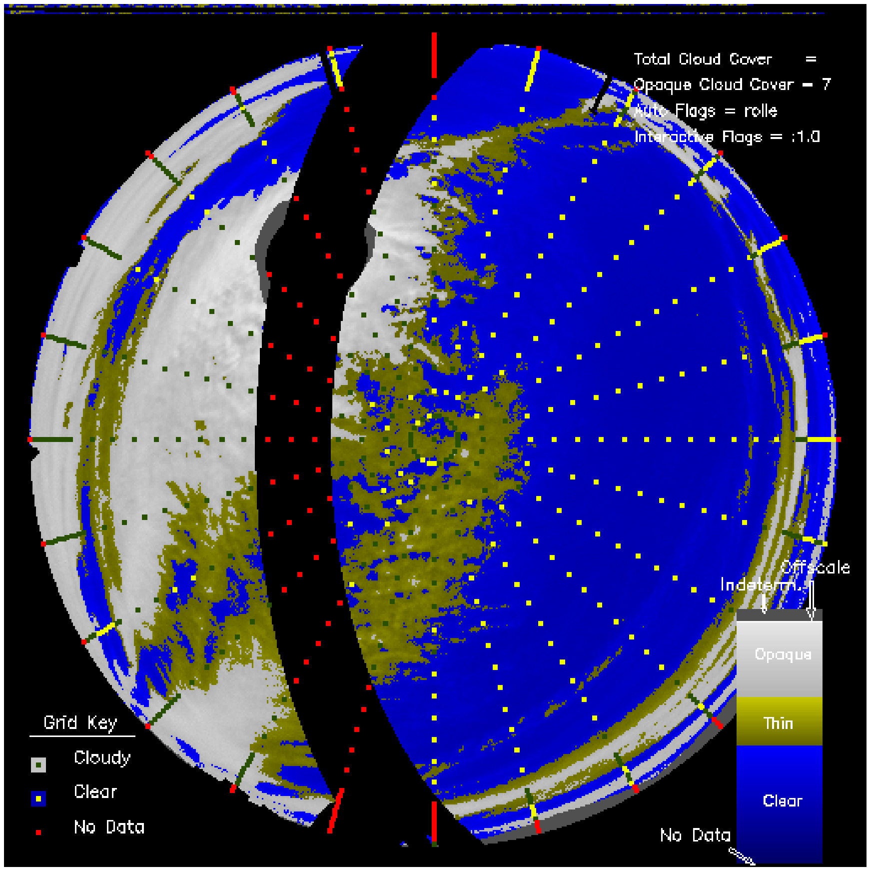

Figure 7. An illustration of the extracted CFLOS data points. In this illustration, thin cloud is colored dark yellow. Extracted data points are colored grey, white, and red, for cloud, clear, and no data respectively.

Table 1
Number of data points extracted at each zenith angle (except 0) as a function of cloud fraction

Cloud Fraction	WSI Study	Lund Study
0	31056	2276
.1	14688	568
.2	7728	576
.3	7248	800
.4	6624	450
.5	5784	356
.6	5808	548
.7	5832	544
.8	8376	664
.9	14976	788
1.0	61824	4760
Total	169944	12330

Table 2
Number of Images and Data Points used in WSI CFLOS Study

Month	Number of Images	Number of Data Points
February '02	726	470,000
March '02	2451	1,590,000
April '02	236	153,000
May '02	577	374,000
June '02	632	410,000
July '02	735	476,000
August '02	1477	957,000
September '02	191	124,000
October '02	56	36,300
Total	7081	4,590,000

The processed data set included more than double the number used by Lund. Because the CFLOS data were extracted at 24 azimuth angles, and the Lund date were extracted at 4 azimuth angles, the actual number of line of sight detections that contributed to each zenith angle determination were more than a factor of 10 (about 2 times 24/4) more than Lund had available.

The data were further sorted for this study as a function of cloud form, using the Lund cloud categories cirriform, middle, cumuliform, and stratiform. We have also referred to the last two categories as low-level convective, and low-level non-convective. The specific cloud types are shown in Table 3. Like Lund, we used the numbers 1 – 4 to designate these cloud forms, and 5 to designate mixed cloud scenes. We also used 0 to designate the total of all cloud forms, and 6 to designate cases where the observer reported no cloud. (In Table 3, the H, M, and L categories are used by the SGP personnel, and are defined in in-house documentation that can be made available on request.)

Coincident hourly visual weather observations reported by SGP staff were used to determine appropriate cloud types for each image used in the study, while cloud fractions were obtained using the WSI daytime cloud algorithm. Each WSI image was examined to determine the validity of the hourly weather observations and identify off-hour cloud types

The number of images, and the number of lines of sight for each zenith angle for WSI and Lund are shown in Tables 4 through 7. In spite of the relatively large number of line of sight observations associated with the WSI data, there are clearly certain categories of data that do not contain adequate observations for statistical significance. (These tables show the number of cases included in this study. However, many times this number of WSI cases are available in the WSI database but have not been processed to yield cloud algorithm images.)

Table 3. Correspondence Between SGP Cloud Types and Lund Cloud Types

Lund Cloud Type	SGP Cloud Type
1	Upper-level clouds: H1- H9 Cirrus, Cirrostratus, Cirrocumulus
2	Mid-level clouds: M1-M9 Altocumulus, Altocumulus castellanus, Altostratus
3	Low-level convective clouds: L1-L3, L7-L9 Cumulus, Cumulonimbus, Cumulonimbus mammatus, Fractocumulus
4	Low-level non-convective clouds: L4-L6 Stratus, Nimbostratus, Fractostratus, Stratocumulus
5	Two or more SGP cloud types corresponding with two or more Lund cloud types 1, 2, 3, and 4
6	No clouds

Table 4
Number of Images for each case (WSI)

Category	0	1	2	3	4	5
0	1294	305	182	117	0	25
.1	612	286	79	163	0	54
.2	322	98	62	131	0	31
.3	302	94	67	106	1	34
.4	276	62	48	116	3	47
.5	241	50	36	99	5	51
.6	242	72	38	70	4	58
.7	243	74	63	51	3	52
.8	349	122	90	55	9	73
.9	624	186	196	109	30	103
1.0	2576	291	727	578	666	314
Total	7081	1640	1588	1595	721	842

Table 5
Number of Lines of Sight for each zenith angle (except 0) (WSI)

Category	0	1	2	3	4	5
0	31056	7320	4368	2808	0	600
0.1	14688	6864	1896	3912	0	1296
0.2	7728	2352	1488	3144	0	744
0.3	7248	2256	1608	2544	24	816
0.4	6624	1488	1152	2784	72	1128
0.5	5784	1200	864	2376	120	1224
0.6	5808	1728	912	1680	96	1392
0.7	5832	1776	1512	1224	72	1248
0.8	8376	2928	2160	1320	216	1752
0.9	14976	4464	4704	2616	720	2472
1	61824	6984	17448	13872	15984	7536
Total	169944	39360	38112	38280	17304	20208

Table 6
Number of Images for each zenith angle (except 0) (Lund)

Category	0	1	2	3	4	5
0	569	38	18	51	12	7
.1	142	67	13	38	13	10
.2	144	51	9	42	7	34
.3	200	56	10	44	15	25
.4	112	24	5	36	10	37
.5	89	15	0	26	8	45
.6	137	35	3	39	16	43
.7	136	34	3	22	12	63
.8	166	38	8	10	15	95
.9	197	29	19	8	23	118
1.0	1190	99	84	13	543	426
Total	3082	486	172	329	674	903

Table 7
Number of Lines of Sight for each case (Lund)

Category	0	1	2	3	4	5
0	2276	152	72	204	48	28
.1	568	268	52	152	52	40
.2	576	204	36	168	28	136
.3	800	224	40	176	60	100
.4	450	96	20	144	40	148
.5	356	60	0	104	32	180
.6	548	140	12	156	64	172
.7	544	136	12	88	48	252
.8	664	152	32	40	60	380
.9	788	116	76	32	92	472
1.0	4760	396	336	52	2172	1704
Total	12330	1944	688	1316	2696	3612

6. CFLOS Results

6.1 All Cloud Forms

The CFLOS results for all cloud forms (eg type 0) are shown for opaque and thin clouds in Fig. 8, and for opaque only in Fig. 9. Tables of PCFLOS results are given in Appendix 1.

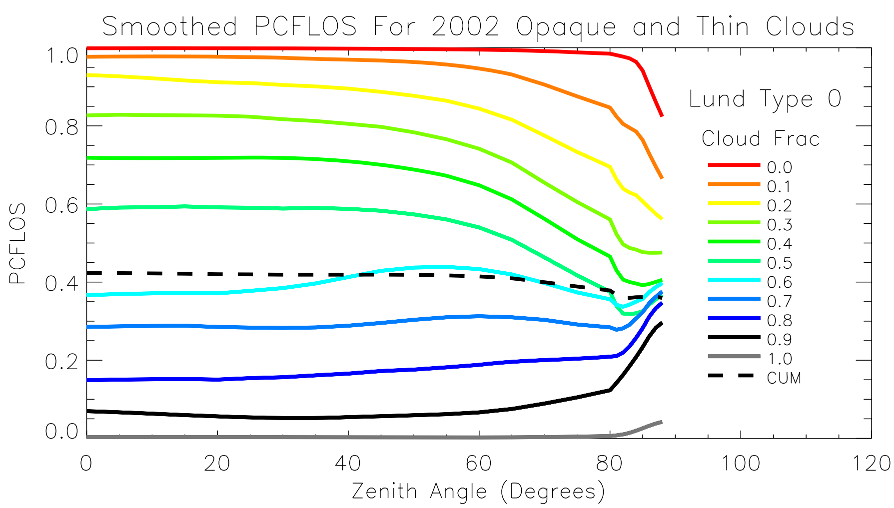

Figure 8. Probability of Cloud Free Line of Sight as a function of cloud fraction and zenith angle, including opaque and thin clouds

The combined results for the full data set are shown in Fig.8. In this figure, the PCFLOS results are shown as a function of zenith angle and cloud fraction. The zenith angle is 0 overhead, and 90 at the horizon. The cloud fraction is determined from the cloud decision images. Fig. 8 shows the results when both opaque and thin clouds are considered to block the line of sight. The cloud fraction 0.0 category includes 0 – 5% cloud fraction. Similarly, the 1.0 category includes 95 – 100%. The other categories .1, .2, etc include cloud fractions 5% to 15%, 15% to 25%, etc. These results have also been slightly smoothed using a boxcar average.

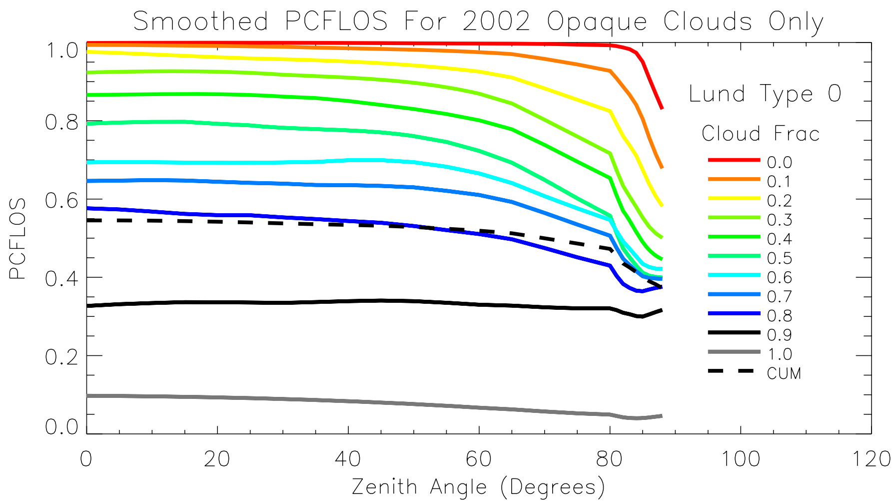

Figure 9. Probability of Cloud Free Line of Sight as a function of cloud fraction and zenith angle, including optically opaque clouds only

The cumulative curve shows approximately a 40 - 45% probability of CFLOS. This number is not very useful, because it will clearly depend on how often it is clear, overcast, etc, which can be highly site-dependent. Clearly there is a very strong dependence of CFLOS on the cloud fraction. By using the probability distribution for cloud fraction, and combining it with these statistics as a function of cloud fraction, the result should be much more applicable to varied sites. (This is the method suggested by Lund, and demonstrated in Section 7.)

For some applications, it may be that only opaque clouds need to be considered as blocking the line of sight. Fig. 9 shows a similar plot showing the PCFLOS for opaque clouds only. It is plotted as a function of TOTAL cloud fraction. As an example, note the curve for 0.9 cloud fraction. At the zenith, the probability of CFLOS is close to 0.1 if all clouds are considered, but goes up to about 0.3 if only opaque clouds are considered.

We have also computed the Probability of Cloudy Line of Sight statistics. PCLOS is the inverse of the Probability of Cloud-free Line of Sight statistics, as expected and defined by Equation 1.

$$\text{PCLOS}(\theta, \text{Cld Fraction}) = 1 - \text{PCFLOS}(\theta, \text{Cld Fraction}) \quad (1)$$

An example is shown in Figure 10.

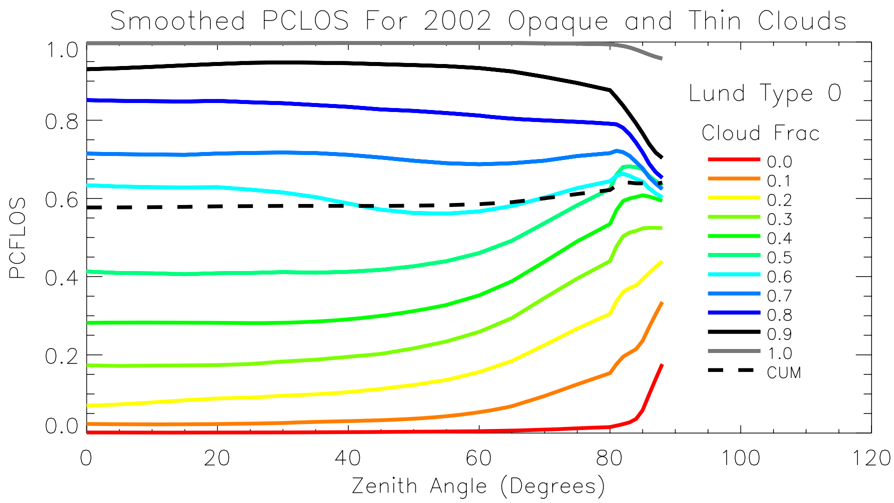

Figure 10. Probability of Cloudy Line of Sight as a function of cloud fraction and zenith angle, including opaque and thin clouds

6.2. Comparison with Lund Data

The data in Fig. 8 may be compared with the Lund data in Fig. 3. We first note that the Lund curves are generally significantly higher at the zenith. For example, when the cloud fraction is near 0.9 (black line), we would expect the PCFLOS to average near 0.1. The WSI data are near 0.1, however the Lund data are near 0.3. Similarly, when the cloud fraction is 0.6 (turquoise), the PCFLOS should be near 0.4, as it is in the WSI data, however in the Lund data it lies near 0.7. We believe this is due to an inconsistency between the observer values Lund used to provide cloud fraction, and the Lund CFLOS visually determined from the film. It is difficult to say whether the inconsistency in the Lund data is due to errors in the CFLOS (perhaps due to the film processing) or errors in the visually estimated cloud fractions. Because the WSI study uses the pixel-by-pixel determination of cloud presence to determine the cloud fraction from the imagery, it should be much more accurate.

However, we should note that when CFLOS statistics are used, it is important to be aware of whether the cloud fraction is determined from WSI or other ground-based sensors, from visual observers, or from satellite climatologies. That is, uncertainties in the cloud fraction statistics can affect the final conclusions. Further studies of WSI data taken at sites with trained observers should be considered to determine the WSI CFLOS statistics as a function of trained observer cloud fractions and satellite cloud fractions.

Another very interesting difference between the Lund data and the WSI data is the behavior near the horizon. The Lund data consistently decrease as the horizon is approached. Under broken cloud conditions, the WSI PCFLOS data actually increase as the horizon is approached, and under scattered cloud conditions, the WSI PCFLOS data decrease much faster than the Lund data. This appears more extreme partly because the WSI reported results extend to 2 degrees above the horizon, while the Lund results only extend to 10 degrees above the horizon. However, these trends in the WSI data begin about 30 degrees above the horizon

We believe this behavior is real and is a very significant finding. In the simple case of a broken cloud field of puffy clouds with uniform distribution, limited horizontal extent, and significant vertical structure, we would expect the line of sight to be blocked more often at the horizon and PCFLOS to decrease toward the horizon under broken cloud conditions data. However, in reviewing the images, we see far more clouds with more horizontal structure, or sheet-like behavior, than we do clouds with vertical structure and small horizontal size. The clouds with more horizontal structure are primarily cirrus or stratus-type cloud layers. In particular, if there is a single contiguous layer overhead, resulting in a greater than 50% cloud fraction, it may well be clear on the horizon. Or, if the cloud fraction is less than 50%, there may be a cloud layer on the horizon. Thus it seems reasonable that the increase in CFLOS at the horizon under broken cloud conditions may be associated with sheet-like clouds.

We carefully evaluated the results for cloud fractions in the .8 category for one month, to determine whether this horizon behavior might be due to a weakness in the algorithm, but we found that in every case the apparent hole at the horizon was real, and not an artifact of the algorithm. Although we cannot show a movie in this context, time-lapse series of the cloud motion at 6-min intervals gave us even more confidence in the algorithm results. Similarly, the clouds on the horizon under scattered cloud conditions do not appear to be caused by algorithm issues. Three typical examples are shown in Fig. 11.

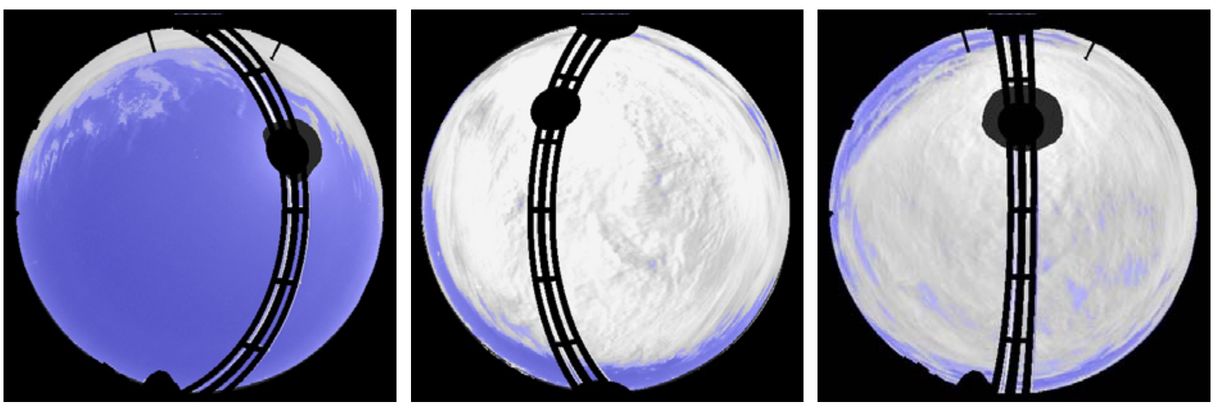

Fig. 11. Three samples of near-horizon algorithm behavior under scattered and broken conditions

For these reasons, we believe that the very different horizon behavior observed in the WSI data set is valid. There are many data years at other sites acquired with the D/N WSI, and as we improve the algorithm, we hope to further investigate this data in order to further evaluate this horizon behavior and the conditions under which it occurs.

6.3. Day WSI Data for Comparison

The Lund data were all taken at a single site, Columbia MO. The D/N WSI data used in this data study were also from one site, in Oklahoma. A large set of Day WSI data was acquired in the late 1980's (by MPL), at multiple sites, and is useful in evaluating whether this PCFLOS behavior as a function of zenith angle occurs at other sites. The set of processed Day WSI data is larger, however we don't have quite as much confidence in the results, as the data were acquired with a less accurate imaging system, and the algorithm was an earlier version. However, this data set has the advantage of multiple sites, as well as a large quantity of processed data. Over 95,000 image sets have been processed, and about 37 million data points were extracted for CFLOS studies.

The Day WSI data were taken at the following sites: White Sands C-Station, New Mexico (WSC), Kirtland Air Force Base at Albuquerque, New Mexico (KAA), Malmstrom Air Base at Great Falls Montana (MAG), Malabar Tracking Station near Cape Canaveral in Florida (BAR), and Columbia Missouri (COL), at the same site where the Lund data were acquired. The PCFLOS results for these stations are shown (in slightly different format) in Figures 12 through 21.

Note that ALL of the opaque and thin cloud plots (even number plots) show the same horizon characteristics as the D/N WSI data. The PCFLOS increases toward the horizon in broken cloud conditions, and decreases more swiftly than Lund data under scattered cloud conditions. Looking at the opaque only (odd number plots), most of the plots show the PCFLOS to be essentially level toward the horizon under broken cloud conditions. Only the Columbia and Malmstrom sites show significant decrease, and only for the opaque clouds. Thus the Day WSI support the belief that increases in PCFLOS toward the horizon are quite reasonable, particularly when both thin and opaque clouds are included in the analysis. The Columbia opaque data are consistent with the Lund data, showing a decrease in PCFLOS toward the horizon, but most other sites do not show this decrease under broken cloud conditions.

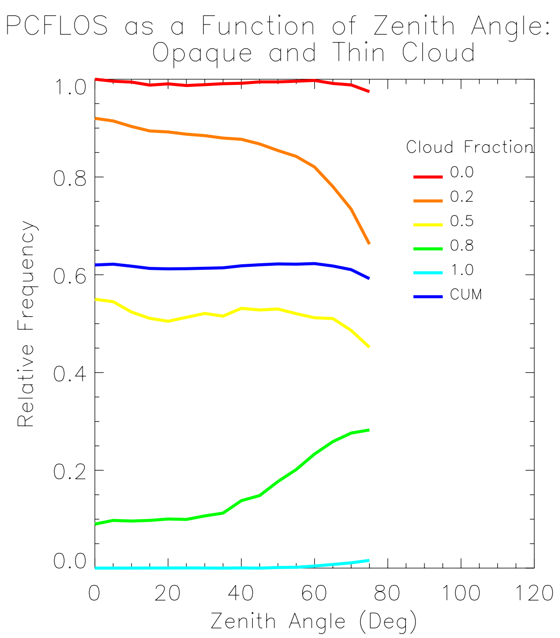

Fig. 12. Day WSI PCFLOS for Opq and Thin, White Sands (WSC)

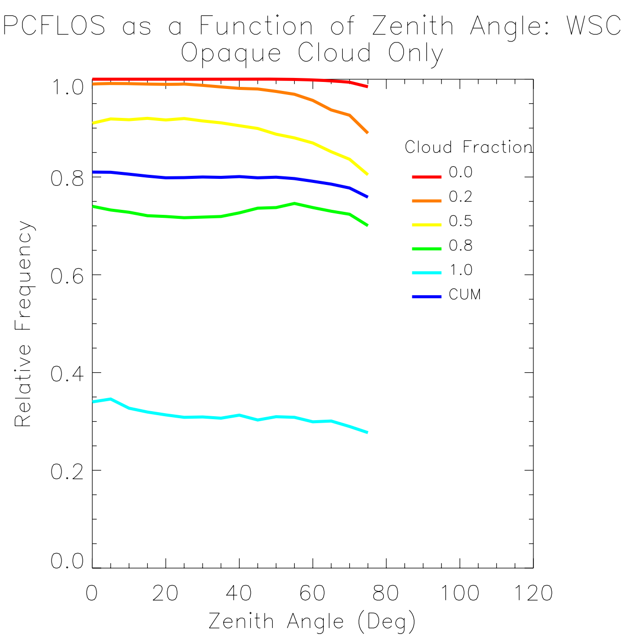

Fig. 13. Day WSI PCFLOS for Opq only, White Sands (WSC)

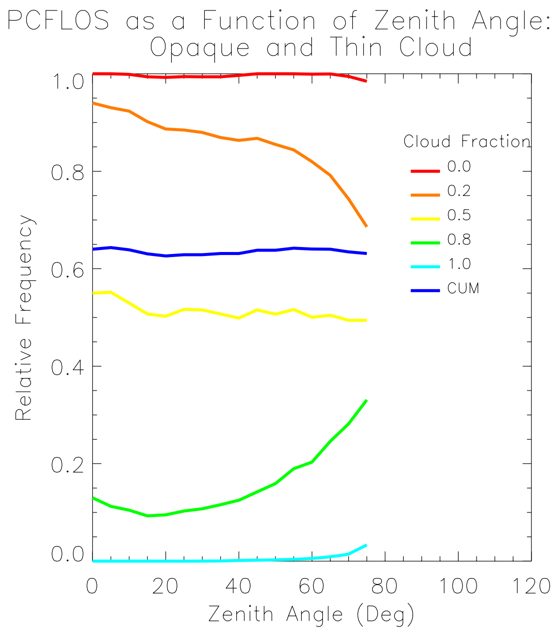

Fig. 14. Day WSI PCFLOS for Opq and Thin, Kirtland (KAA)

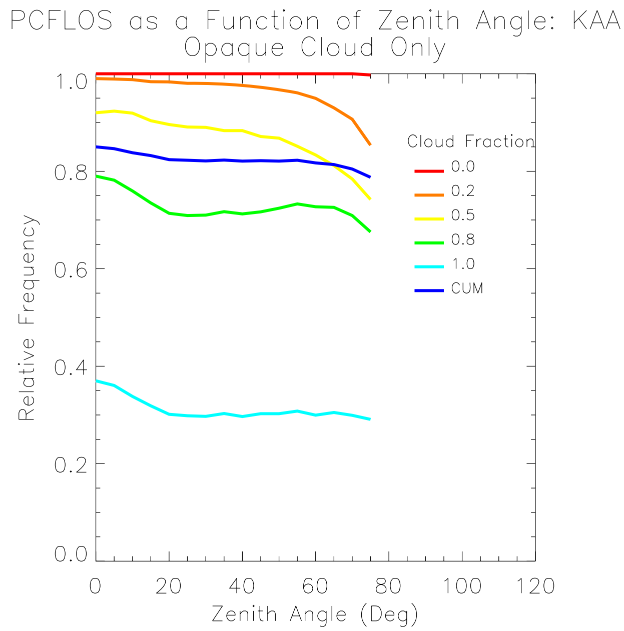

Fig. 15. Day WSI PCFLOS for Opq only, Kirtland (KAA)

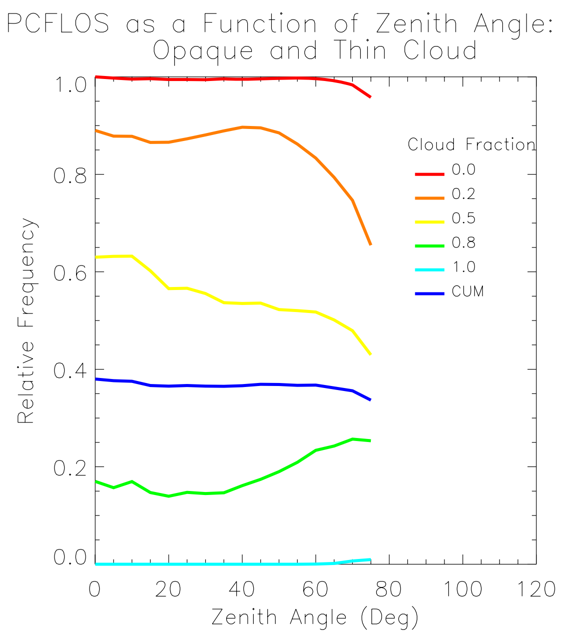

Fig. 16. Day WSI PCFLOS for Opq and Thin, Malmstrom (MAG)

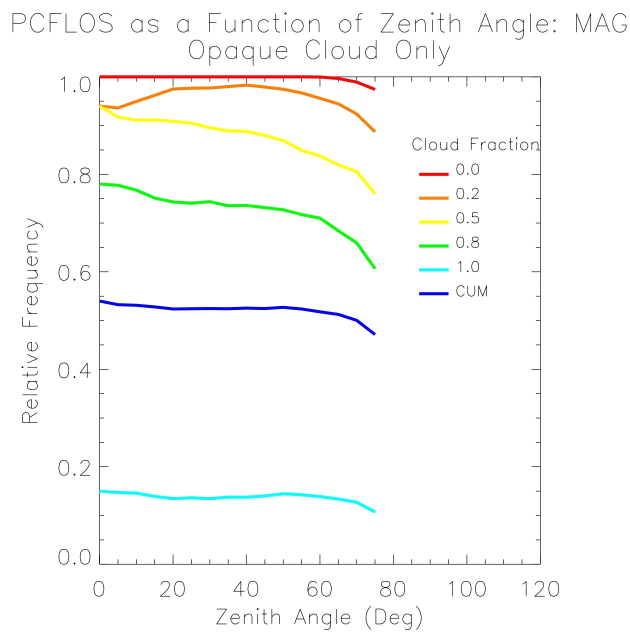

Fig. 17. Day WSI PCFLOS for Opq only, Malmstrom (MAG)

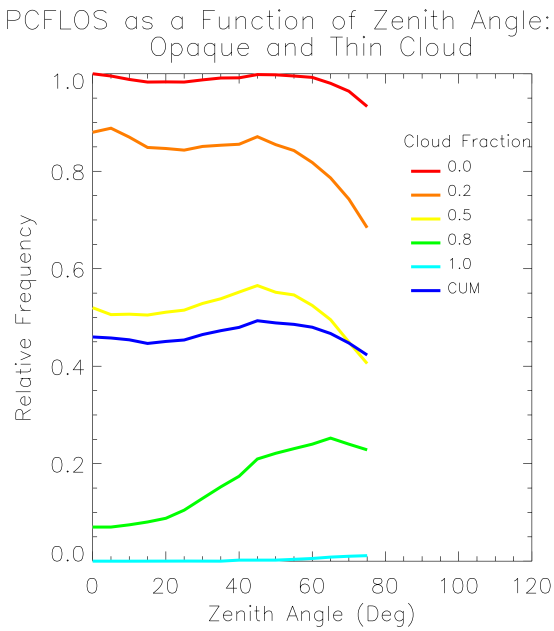

Fig. 18. Day WSI PCFLOS for Opq and Thin, Malabar (BAR)

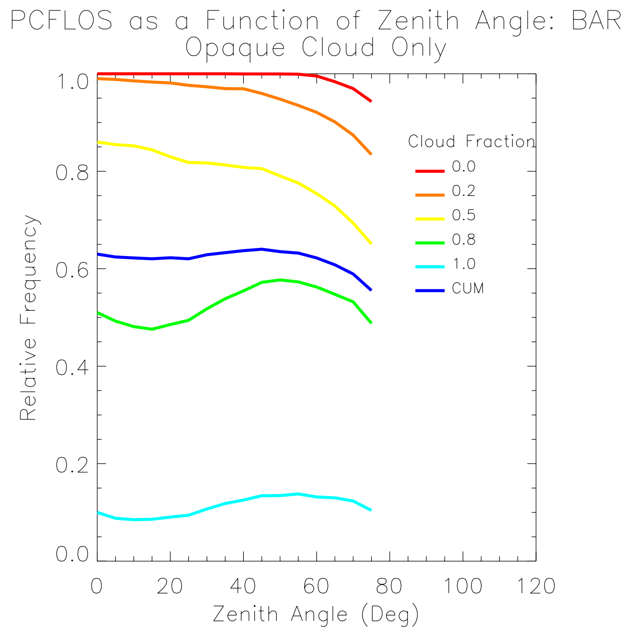

Fig. 19. Day WSI PCFLOS for Opq only, Malabar (BAR)

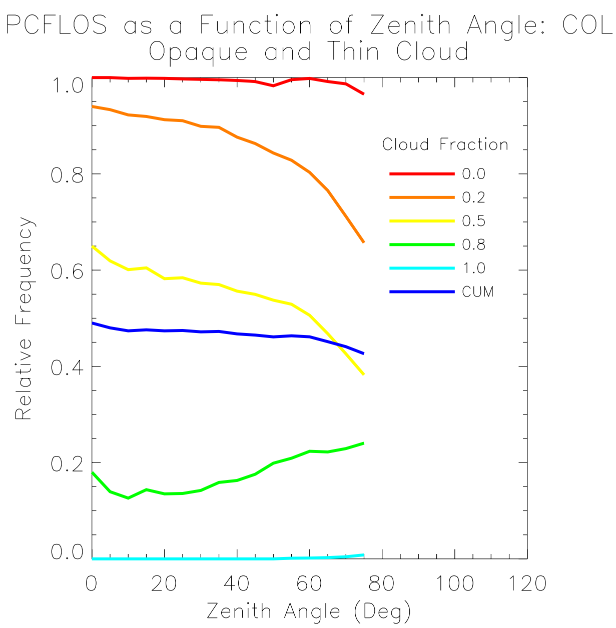

Fig. 20. Day WSI PCFLOS for Opq and Thin, Columbia (COL)

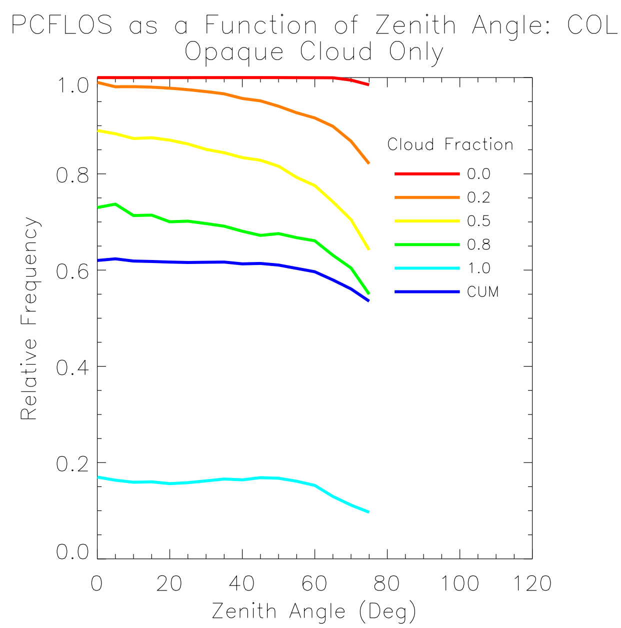

Fig. 21. Day WSI PCFLOS for Opq only, Columbia (COL)

6.4. Expected Maxima and Minima based on most and least cloudy months

As mentioned earlier, data were also sorted for the months of August 02, which was the least cloudy month based on monthly mean of total sky cover data, and the February/March 02 period, which was the most cloudy period. This data is useful because it provides some idea of how much variance can be expected. The results are shown in Figures 22 – 25. The color indicators are the same as in Fig. 8. Results are similar to those discussed above. The use of these plots will be discussed in Section 7.

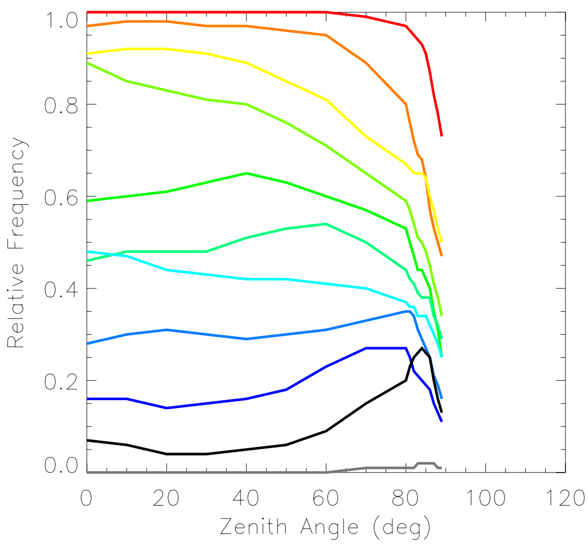

Fig. 22. PCFLOS for Aug 02, opaque and thin clouds

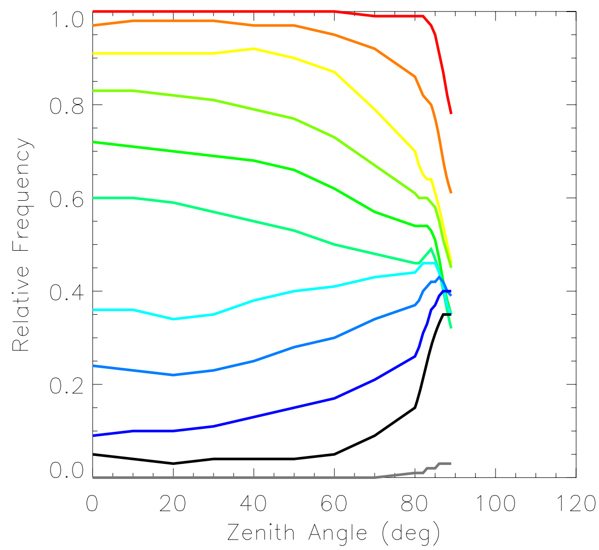

Fig. 23. PCFLOS for Feb/Mar 02, opaque and thin clouds

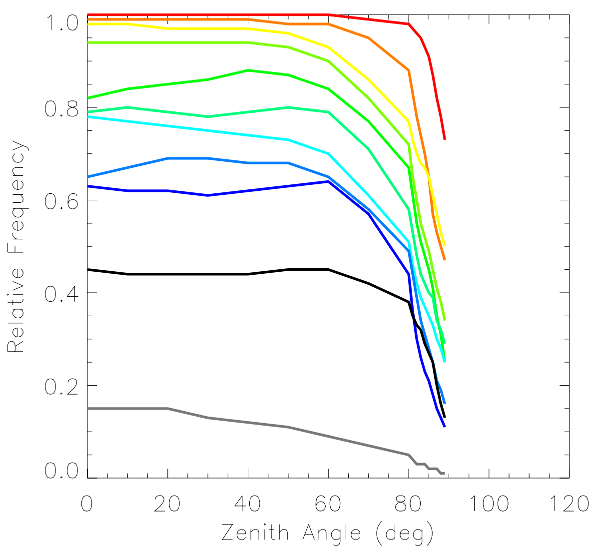

Fig. 24. PCFLOS for Aug 02, opaque clouds

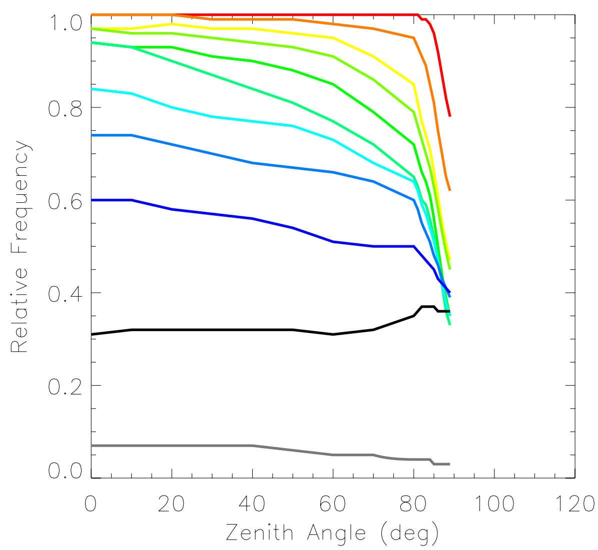

Fig. 25. PCFLOS for Feb/Mar 02, opaque clouds

6.5 Data sorted by Cloud Form

In order to provide more accurate predictions of CFLOS, Lund recommended further sorting the data as a function for cloud form. In this way, at sites where the statistical distribution of cloud form is available, these data can be used. Section 5 discusses the cloud types and the sorting. The results for opaque and thin clouds are given in Fig. 26 through 30.

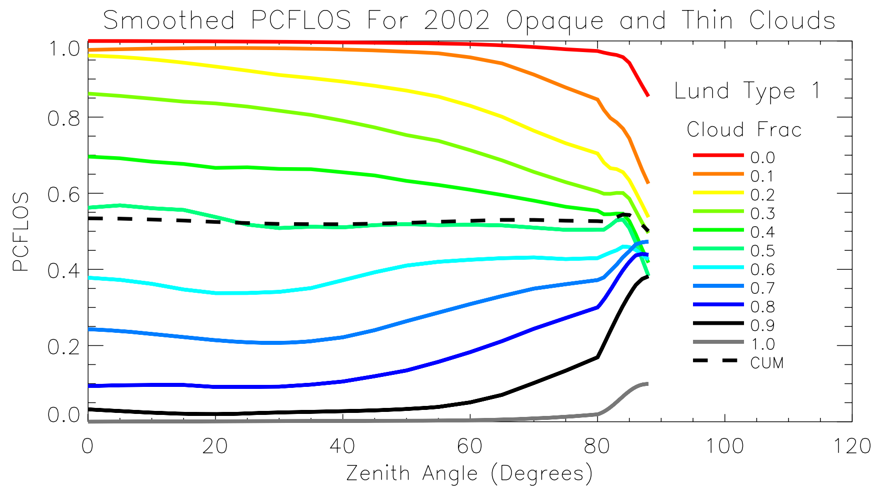

Fig. 26. CFLOS results for Type 1: Cirriform clouds or high clouds, including opaque and thin clouds

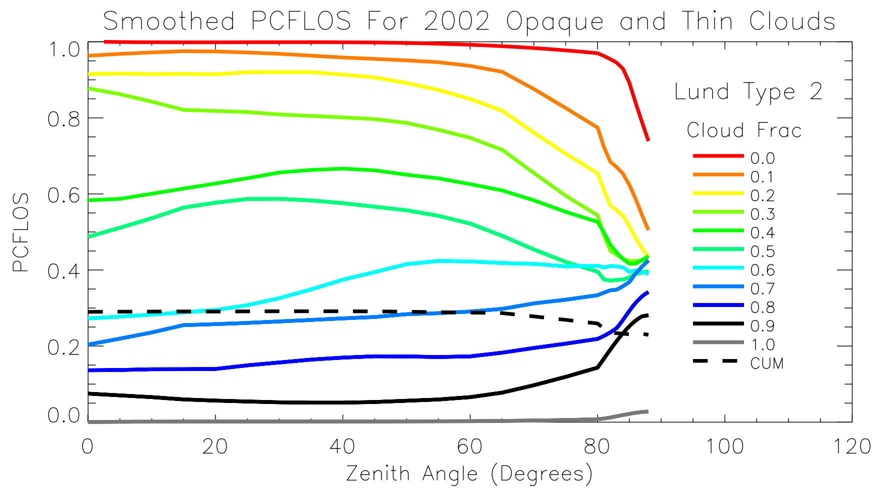

Fig. 27. CFLOS results for Type 2: Middle clouds, including opaque and thin clouds

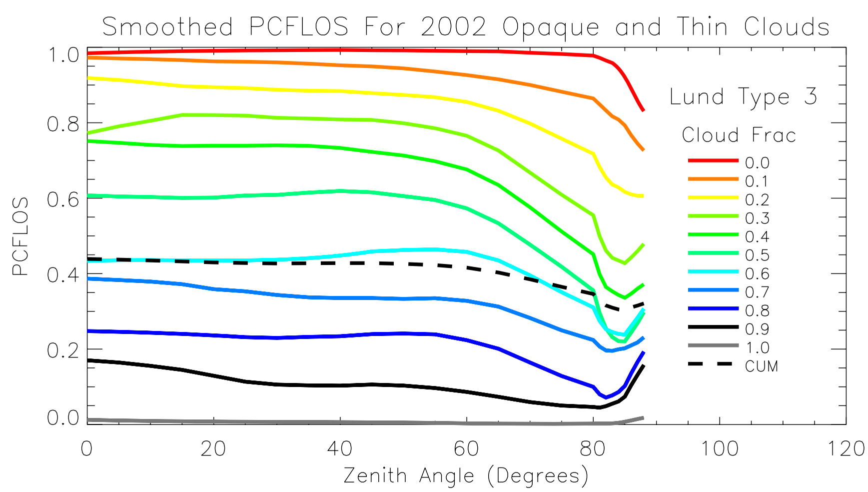

Fig. 28. CFLOS results for Type 3: Cumuliform clouds or low convective clouds, including opaque and thin clouds

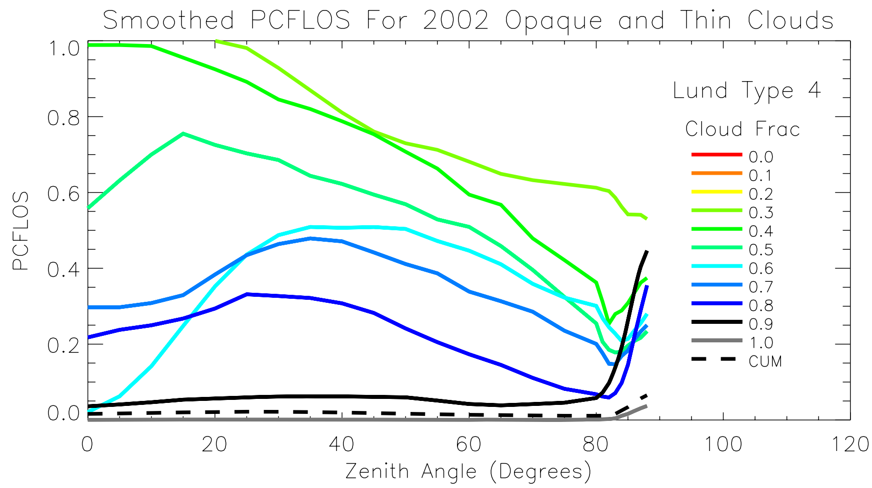

Fig. 29. CFLOS results for Type 4: Stratiform clouds or low non-convective clouds, including opaque and thin clouds

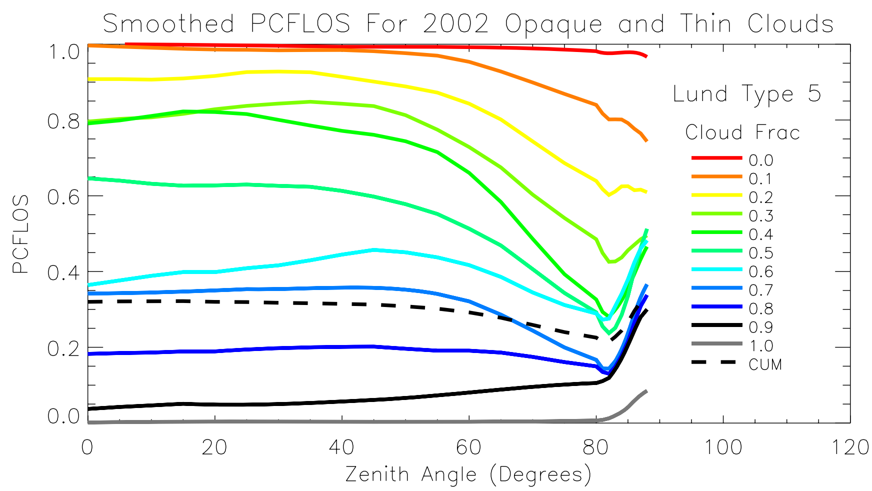

Fig. 30. CFLOS results for Type 5: Mixed cloud forms, including opaque and thin clouds

These data are less well behaved than the data shown in Fig. 8, because the data are sparse in some categories. This is particularly obvious in the Type 4 plot. Although we specifically processed additional data for this cloud case, most of it was overcast, and provided very little additional clear to scattered information. Since there were no results for 3 cloud categories for Type 4 we have replaced the rows for these three categories with the results for all cloud cases in Appendix 1.

It should also be noted that the horizon behavior that we believe is associated with sheet like clouds is much larger in the cirrus and stratus cases (Fig 26 and 29). It occurs much less with the mid level clouds (alto-cumulus) and low convective cumulus (Fig 27 and 28).

For some applications, it may be desired to use opaque clouds only. The opaque cloud results similar to Figs. 26 – 30 are shown in Figs. 31 – 35.

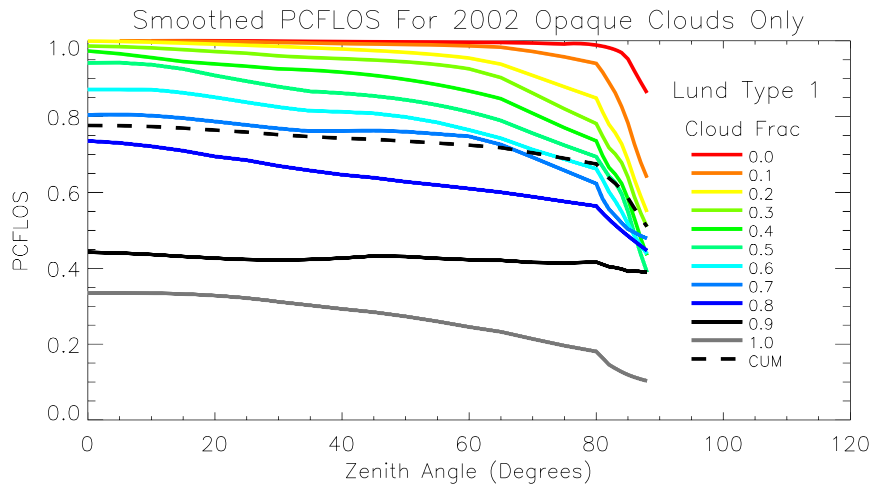

Fig. 31. CFLOS results for Type 1: Cirriform clouds or high clouds, only opaque clouds

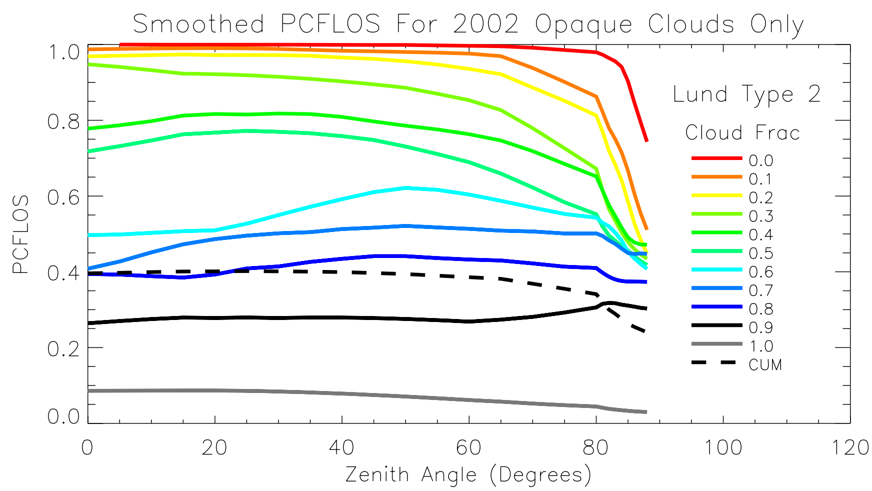

Fig. 32. CFLOS results for Type 2: Middle clouds, only opaque clouds

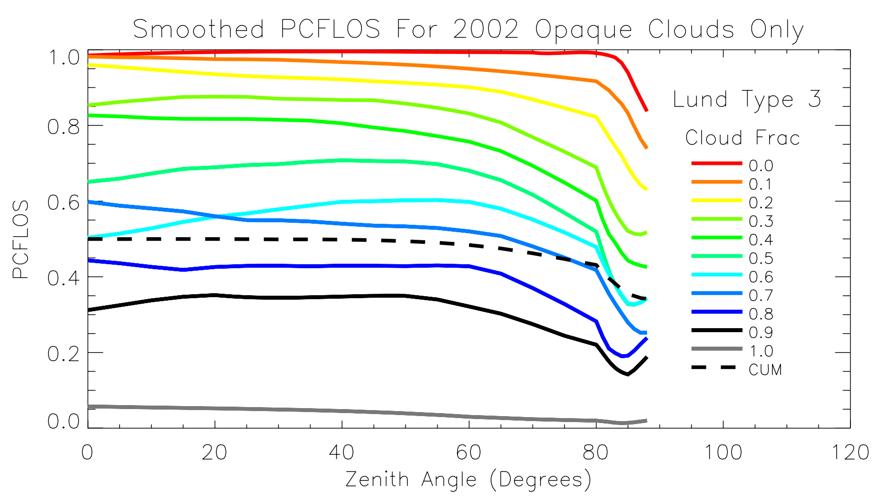

Fig. 33. CFLOS results for Type 3: Cumuliform clouds or low convective clouds, only opaque clouds

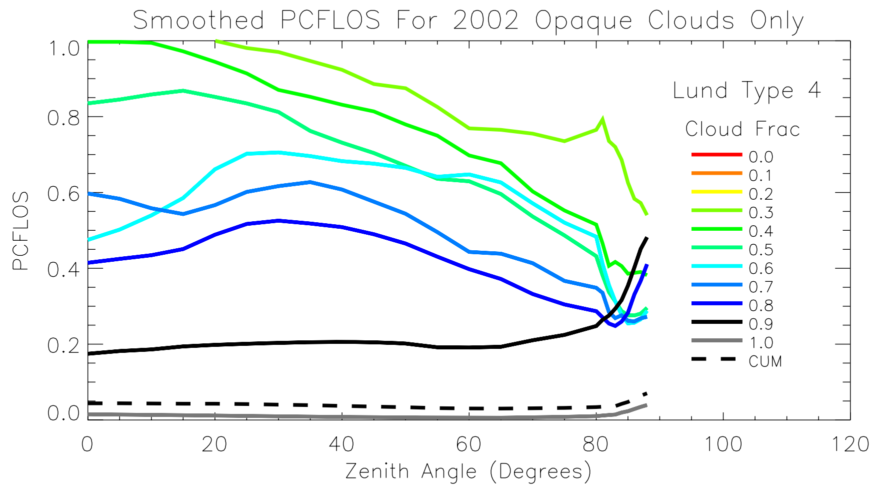

Fig. 34. CFLOS results for Type 4: Stratiform clouds or low non-convective clouds, only opaque clouds

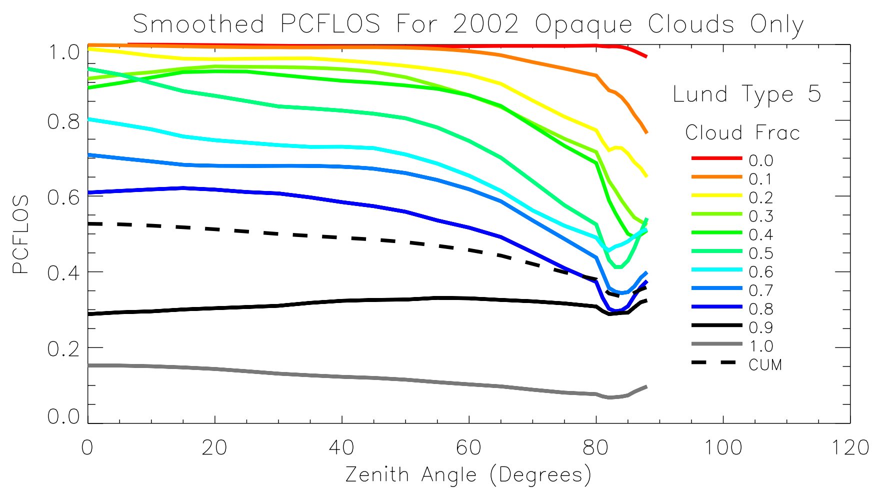

Fig. 35. CFLOS results for Type 5: Mixed cloud forms, only opaque clouds

Table 4 in Section 5 listed the number of cases for each plot. Based on this table, and the character of the plots in Figures 26 through 35, we believe that the results for cloud types 1, 2, and 3 are reasonably representative. These cloud types are 1: upper level cirriform; 2: mid-level such as altocumulus and altostratus; and 3: lower level convective clouds. Also, the results for cloud type 4, cloud fractions greater than or equal to .8, should be valid. These represent broken to overcast conditions for low-level non-convective clouds. We do not feel there are sufficient data in the data sample for the scattered to broken low-level non-convective clouds. Cloud category 5 had sufficient cases, but this category is not often very useful, in our opinion.

For comparison, Lund's results are shown in Figs. 36 – 40.

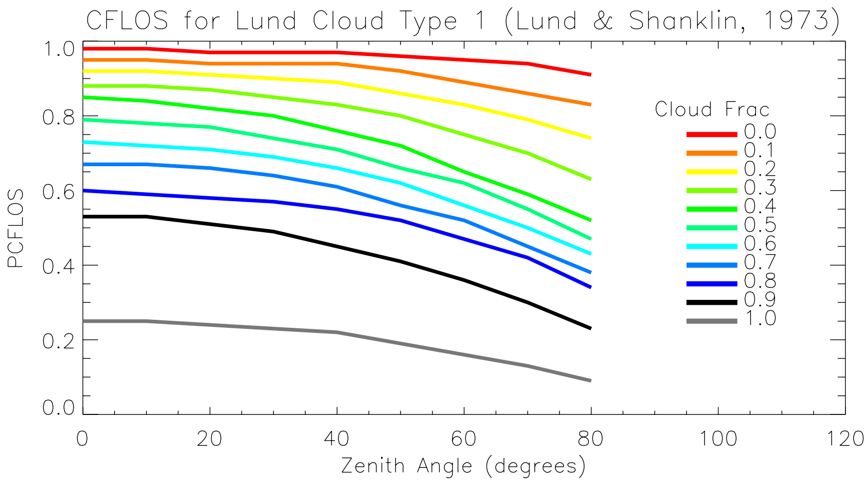

Fig. 36. CFLOS results for Type 1: Cirriform clouds or high clouds, Lund data

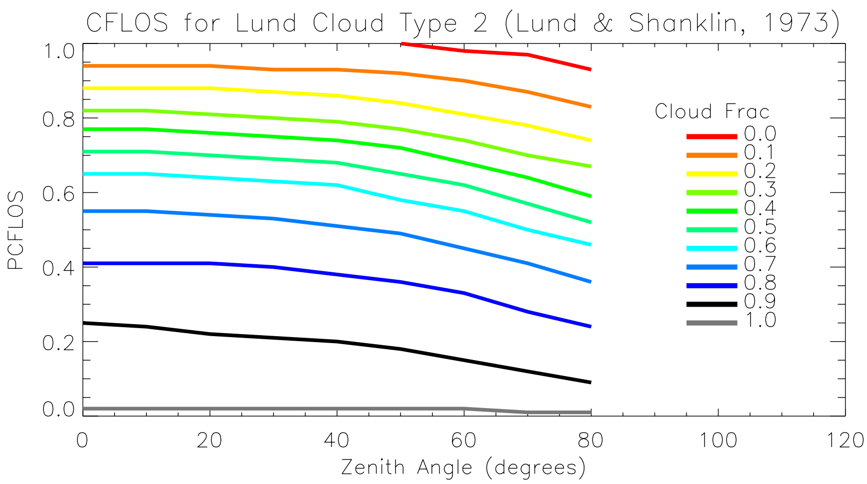

Fig. 37. CFLOS results for Type 2: Middle clouds, Lund data

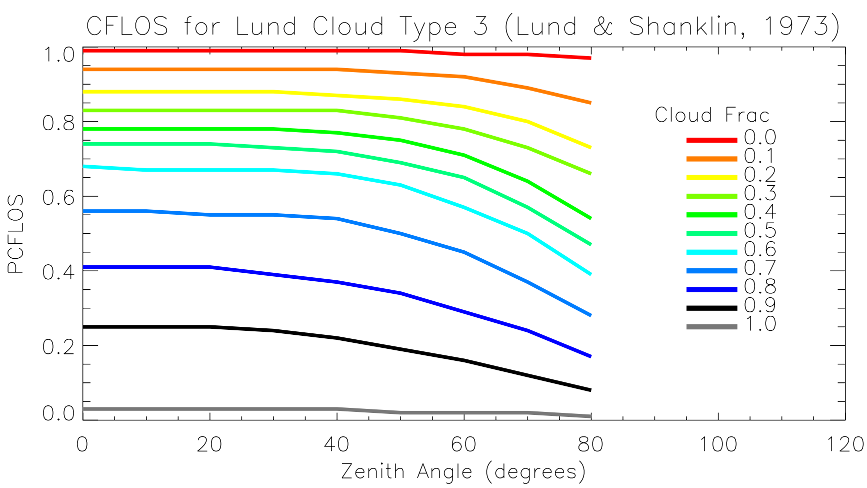

Fig. 38. CFLOS results for Type 3: Cumuliform clouds or low convective clouds, Lund data

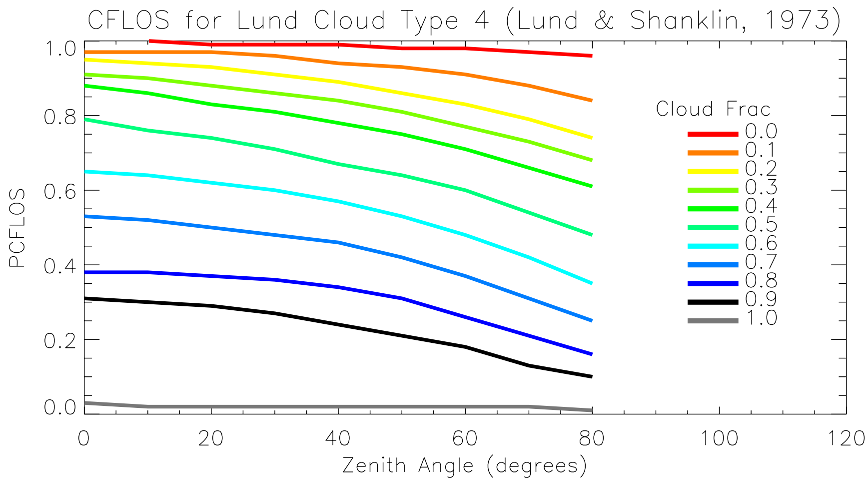

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Fig. 39 CFLOS results for Type 4: Stratiform clouds or low non-convective clouds, Lund data

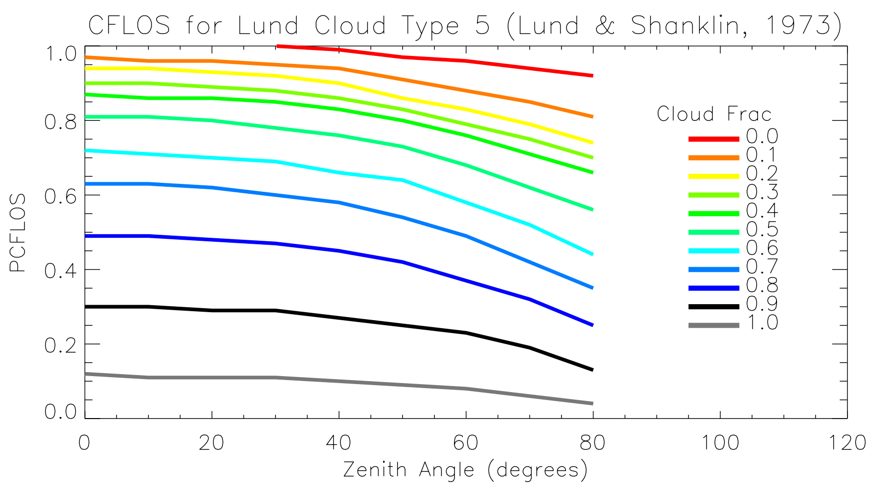

Fig. 40. CFLOS results for Type 5: Mixed cloud forms, Lund data

It should be noted that Lund's data have been smoothed much more than the WSI data. And, as discussed earlier, we believe the values are too high due to an inconsistency between the CFLOS and the cloud fractions, and we believe the results near the horizon are not representative of more typical cloud fields.

7. Application of the CFLOS Results

To determine PCFLOS for a random site in a random direction, we use Method A of Lund & Shanklin (1973). This method uses the matrix of PCFLOS values as a function of zenith angle and cloud fraction (**C** matrix), and a site-dependent vector of relative frequency of cloud fraction for a site (**K** vector), to obtain a PCFLOS vector as a function of zenith angle for the given site. The equation is given below.

$$_{\alpha}P_1^A = {}_{\alpha}C_s K_1 \qquad (2)$$

where ${}_{\alpha}\mathbf{P}_1{}^{A}$ is a column vector of α rows, one row for each angle considered; ${}_{\alpha}\mathbf{C}_s$ is a matrix of α rows and s columns each, one row for each zenith angle, one column for each sky cover category; and $\mathbf{K}_1$ corresponds with a column of s rows. For example, Table 8 provides a matrix of PCFLOS as a function of cloud fraction and elevation angle (**C** matrix). The **C** matrix for the full database is shown in Table 8. In Table 9, we have provided several examples of the $\mathbf{K}_1{}^{N}$ vector: Lund's example for all cloud forms for Columbia, MO; the statistics for Feb/Mar 02 and for Aug 02 at SGP; and the statistics based on clear, scattered, broken, and overcast for Baghdad from the ISMCS data base*. The results are shown for several zenith angles in Table 10.

Table 8
C Matrix consisting of PCFLOS Results, all cloud forms, opaque and thin clouds

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0.98	0.93	0.83	0.72	0.59	0.37	0.29	0.15	0.07	0.00
10	1.00	0.98	0.92	0.83	0.72	0.59	0.37	0.29	0.15	0.06	0.00
20	1.00	0.98	0.91	0.83	0.72	0.59	0.37	0.29	0.15	0.06	0.00
30	1.00	0.97	0.90	0.82	0.72	0.59	0.38	0.28	0.16	0.05	0.00
40	1.00	0.97	0.90	0.81	0.71	0.59	0.41	0.29	0.17	0.05	0.00
50	1.00	0.96	0.88	0.78	0.69	0.57	0.44	0.30	0.18	0.06	0.00
60	1.00	0.95	0.84	0.74	0.65	0.54	0.43	0.31	0.19	0.07	0.00
70	0.99	0.91	0.78	0.65	0.56	0.46	0.40	0.30	0.20	0.09	0.00
80	0.98	0.85	0.70	0.56	0.47	0.38	0.36	0.28	0.21	0.12	0.01
81	0.98	0.82	0.66	0.52	0.43	0.34	0.34	0.28	0.21	0.14	0.01
82	0.98	0.81	0.64	0.50	0.41	0.32	0.34	0.28	0.22	0.16	0.01
83	0.97	0.80	0.63	0.49	0.40	0.32	0.34	0.29	0.24	0.18	0.01
84	0.96	0.79	0.62	0.48	0.40	0.32	0.35	0.31	0.26	0.21	0.02
85	0.94	0.76	0.61	0.48	0.39	0.33	0.36	0.32	0.28	0.23	0.03
86	0.90	0.73	0.59	0.48	0.40	0.34	0.37	0.35	0.31	0.26	0.03
87	0.86	0.70	0.58	0.48	0.40	0.36	0.39	0.36	0.33	0.28	0.04
88	0.82	0.66	0.56	0.48	0.41	0.37	0.40	0.38	0.35	0.30	0.04

Table 9
K Matrix for Several Locations, consisting of probability of cloud fraction

Cloud Fraction	Lund Columbia Summer	WSI SGP Feb-Mar	WSI SGP Aug	ISMCS Baghdad Jan	ISMCS Baghdad Jun
0.0	.187	.196	.292	.298	.878
0.1	.047	.075	.094	.062	.022
0.2	.047	.033	.038	.062	.022
0.3	.049	.026	.041	.062	.022
0.4	.037	.017	.024	.062	.022
0.5	.031	.019	.023	.061	.013
0.6	.045	.022	.028	.060	.004
0.7	.045	.023	.032	.060	.004
0.8	.055	.043	.045	.060	.004
0.9	.065	.085	.074	.060	.004
1.0	.392	.462	.310	.134	.002

* The International Station Meteorological Climate Summary Ver 4.0 (ISMCS) provides this information for 2600 worldwide sites. The database may be obtained on CD-ROM from the National Climatic Data Center online store. The web address for the product is http://ols.nndc.noaa.gov/plolstore/plsql/olstore.prodspecific?prodnum=C00268-CDR-A0001

Table 10
Resulting PCFLOS for specific sites and zenith angles

Zenith Angle	Lund Columbia Summer	WSI SGP Feb-Mar	WSI SGP Aug	ISMCS Baghdad Jan	ISMCS Baghdad Jun
0	0.40	0.37	0.52	0.60	0.97
20	0.40	0.37	0.51	0.60	0.96
40	0.40	0.37	0.51	0.60	0.96
60	0.40	0.37	0.51	0.59	0.96
80	0.36	0.35	0.48	0.53	0.93
88	0.35	0.33	0.43	0.49	0.78

In Table 10, the CFLOS probabilities for the SGP site are higher for August than for Feb/Mar, as expected. The results for Baghdad are significantly higher, particularly for the June period. The column for Lund is lower than Lund reported; it uses the Lund K vector, but the WSI C matrix, which is more consistent than the Lund data, as noted earlier.

Lund provides a method (B Method) for estimating cloud free line of sight if the joint probability of cloud fraction and cloud amount is known. However, we have not seen this method used in the past. It requires as input a knowledge for a given site of the probability for each combination of cloud type and cloud fraction. We have not been able to locate this type of data, and to the best of our knowledge it is not normally available.

As a result, we recommend that several calculations be made, depending on the application, to provide an estimate of the range of results that might be expected. We have provided tabular results in Appendix 1 for all clouds, most and least cloudy months, and cloud types 1 – 4. If calculations are to be done for a given site where it is known that high clouds dominate but low convective clouds occur at times, calculations can be made for both of these cases. If there is no knowledge of the expected cloud type, calculations can be made for the maximum and minimum results, as well as all cloud types. Sample results are shown for Baghdad in January, in Table 11.

Table 11
Resulting PCFLOS for Baghdad January at specific zenith angles
Calculated for various cloud types

Zenith Angle	All cloud types	Cld Type 1	Cld Type 2	Cld Type 3	Max Cld	Min Cld
0	0.60	0.59	0.58	0.62	0.59	0.59
20	0.60	0.58	0.58	0.61	0.59	0.59
40	0.60	0.58	0.59	0.61	0.59	0.59
60	0.59	0.58	0.58	0.60	0.58	0.58
80	0.53	0.57	0.54	0.51	0.51	0.57
88	0.49	0.52	0.45	0.46	0.41	0.49

From Table 11, the most likely CFLOS probability for 60 degrees is 59%. If one knows that high clouds are predominant, then the 58% for Cloud Type 1 would be a better number to use. The expected range is 58 – 60%, based on the data we have processed to date. Near the horizon however, there is somewhat more variance as a function of cloud type. At 88 degrees, the most likely CFLOS probability is 49%, but the overall range is 41% to 52%.

8. Persistence Results

For many applications, it is important to know how long a CFLOS condition is apt to persist. By persistence, we mean that given that there is a CFLOS in a given direction at time 0, what is the probability that it will remain clear throughout the interval T. The D/N WSI data were taken at 6-minute intervals. Using the earlier Day WSI data, taken at 1-minute intervals, we did a study to determine how much error results if data are acquired only at 5-minute intervals and used to estimate persistence based on 1-minute intervals. The error was reasonably small. For example, for one hour, the persistence probability for the tested site was 0.74 based on 1-minute intervals, and 0.78 based on 5-minute intervals. Therefore we felt it reasonable to use this 6-minute data to evaluate persistence, although it should be recognized that the results may be a few percentage points high.

Persistence statistics were determined earlier for the Day WSI data taken in the 1980's. For this earlier study, we did not extract persistence as a function of zenith angle, but did extract persistence in a few directions, such as in the direction of Polaris. Sample results are shown in Table 12.

Table 12
Day WSI Persistence Results:
Time (Hr) required for yearly persistence probabilities
For Polaris to drop below 0.5 or 50%

Station	Cloud Free	Cloudy
Albuquerque, NM	4.1	1.1
White Sands, NM	5.1	0.7
Columbia, MO	3.1	2.6
Malmstrom AFB, MT	1.5	2.9
Malabar Tracking Station, FL	0.8	0.4

For the first two sites, which were desert sites, the cloud free persistence is several hours. This is due to the many days of nearly clear skies. The cloudy persistences for these sites are quite short. That is, if it is cloudy in a given line of sight at time T_0, this condition is apt to last for only about an hour. The Missouri and Montana sites had somewhat shorter cloud free persistences, and their cloudy persistences were somewhat longer than at the desert sites. At the Florida site, which was characterized by small fast-moving clouds, both cloudy-free and cloudy persistences were quite short.

Unlike PCFLOS, where the probability of cloudy line of sight is the inverse of the probability of cloud free line of sight, the persistence probabilities for cloudy line of sight is not related in such a simple manner to the cloud free persistence. For this reason, we will present both cloud free and cloudy persistence results here. Persistence results were computed for both the Feb/Mar 02 period and the Aug 02 period. The persistence data were not computed as a function of cloud type.

8.1 Cloud Free Persistence Results

Persistence results were determined for zenith angles at ten-degree intervals from 0 to 80 degrees, and 2-degree intervals from 80 to 88 degrees. An example of the raw results is shown in Figure 41. Tabular results are given in Appendix 2. We found that toward the longer intervals, the results are driven by a small number of cases, so we removed those times/angles with fewer than 100 cases. These results are shown in Figures 42 – 45. (The color scale is the same as for Figure 41.) Even using only points with more than 100 observations, however, the results at intervals of 4 hours or more are strongly driven by how many days happened to be clear or overcast all day. As a result, we do not feel that the results beyond 4 hours are necessarily representative of the general case, and they should be ignored.

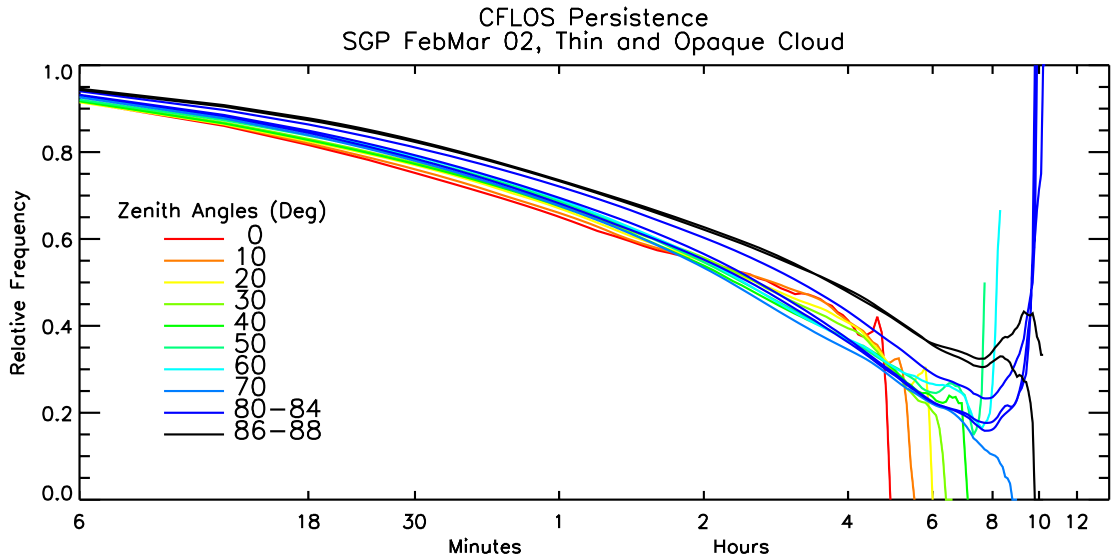

Fig. 41. Cloud-free Persistence results for Feb/Mar 02 Thin and Opaque Clouds, raw data including all cases; remaining figures only show points with more than 100 observations.

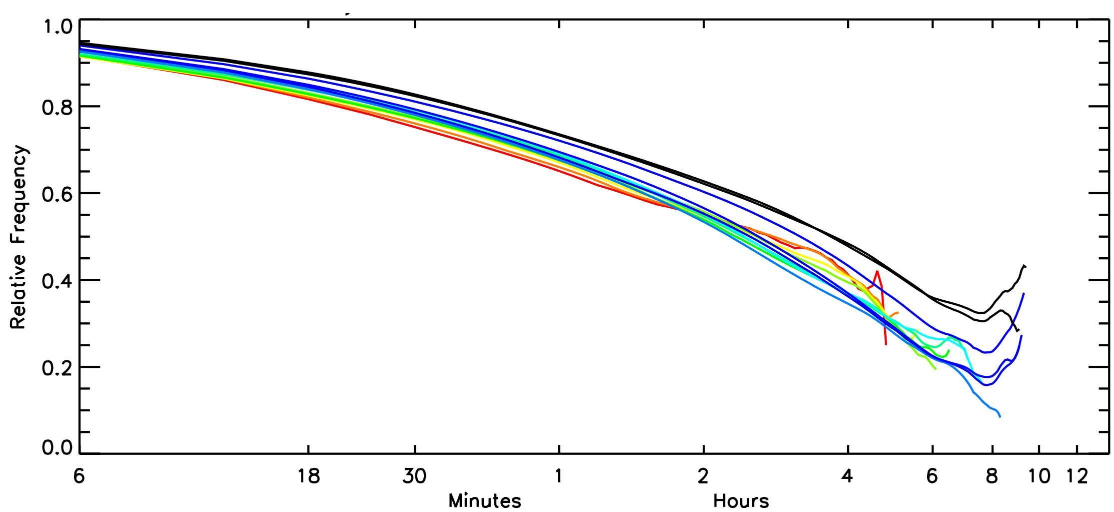

Fig. 42. Cloud-free Persistence results for Feb/Mar 02 Thin and Opaque Clouds

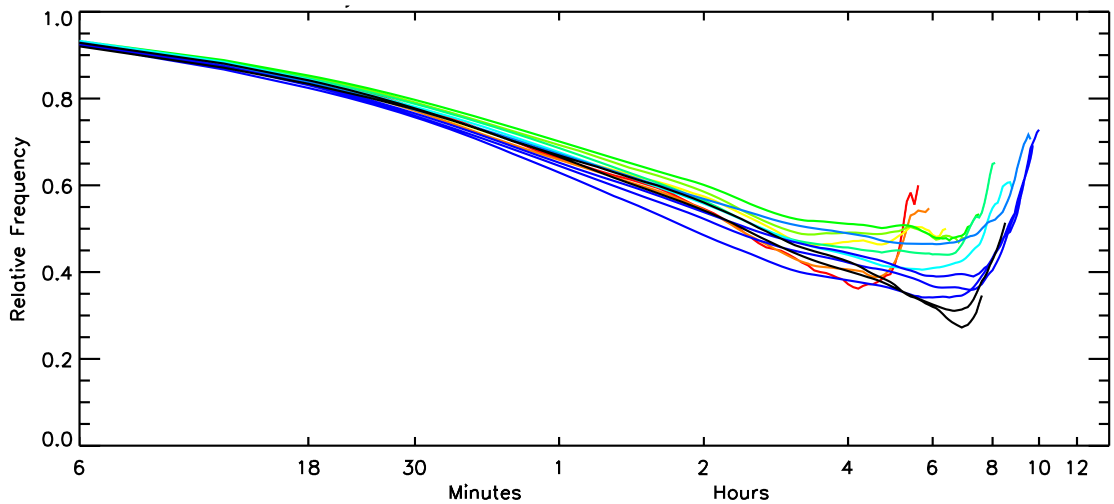

Fig. 43. Cloud-free Persistence results for Aug 02 Thin and Opaque Clouds

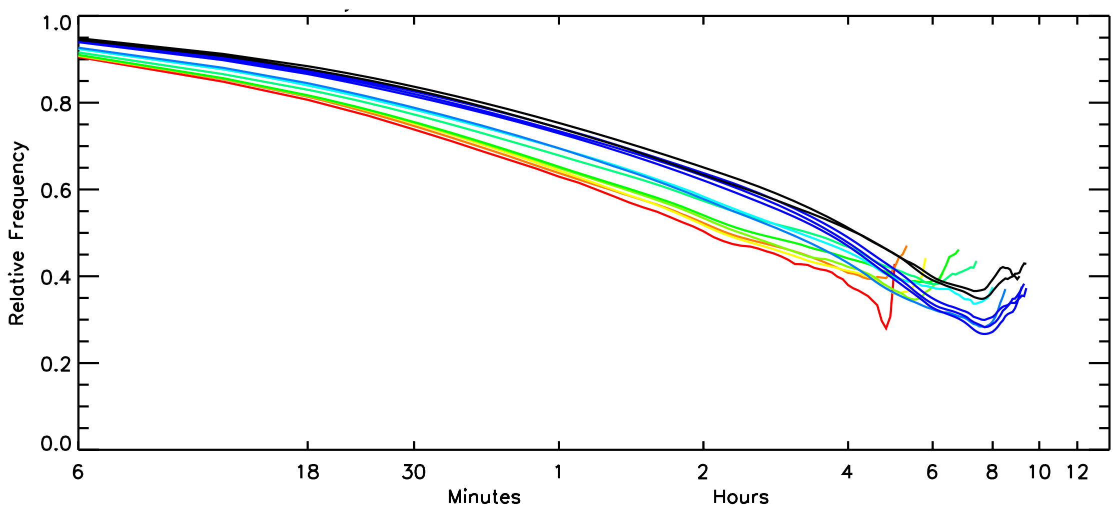

Fig. 44. Cloud-free Persistence results for Feb/Mar 02 Opaque Clouds

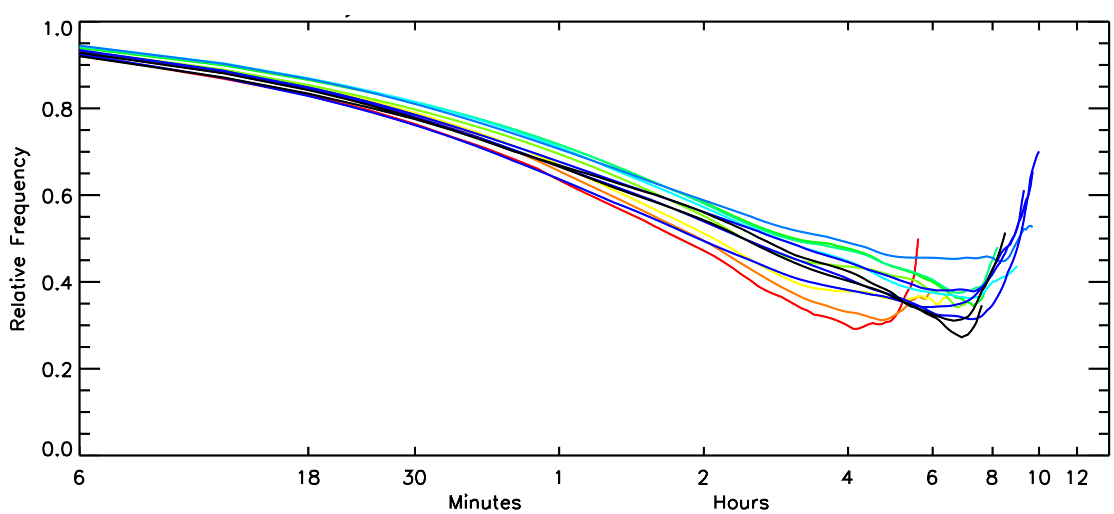

Fig. 45. Cloud-free Persistence results for Aug 02 Opaque Clouds

The statistics illustrated in Figures 42 – 45 indicate quite high persistence probabilities even for periods of an hour or more. As shown in Table 13, for periods of one hour, the persistence probability is consistently over 60%. Even for periods of 3 hours, persistence values are generally near 50%

Table 13
Sample Cloud Free Persistence Results
Probability of Persistence in %

Time (Hr)	Zenith Angle	Opaque and Thin		Opaque	
		Feb/Mar	Aug	Feb/Mar	Aug
1	0	63%	65%	62%	61%
	50	67%	67%	67%	70%
	80	67%	63%	72%	65%
	88	72%	65%	73%	65%
3	0	47%	43%	43%	35%
	50	43%	47%	51%	50%
	80	44%	45%	54%	45%
	88	54%	46%	56%	46%

However, this is not the complete story. It makes sense that the probabilities should depend strongly on the initial conditions. Figures 46 and 47 show the results for opaque and thin clouds, when further sorted as a function of cloud fraction at time T_0. These results show that when the sky is relatively clear, the persistence is quite long (red, orange curves). When the sky is cloudy, the persistence over most of the sky drops to periods of a few minutes (blue curves). However, if the sky is fairly cloudy, and the line of sight to the horizon is clear, then this condition is apt to persist for a longer period, due to the angular perspective (last plot, blue curves). We have reviewed several movies with these conditions, and believe these horizon results are valid. A good rule of thumb is that the persistences are high for the cumulative case (black line), high when the sky is mostly clear (red line), and high near the horizon (last plot).

Although tables of persistence as a function of angle and initial cloud cover are only given for four angles in Appendix 2, tables for all angles will be provided to the sponsor on CD.

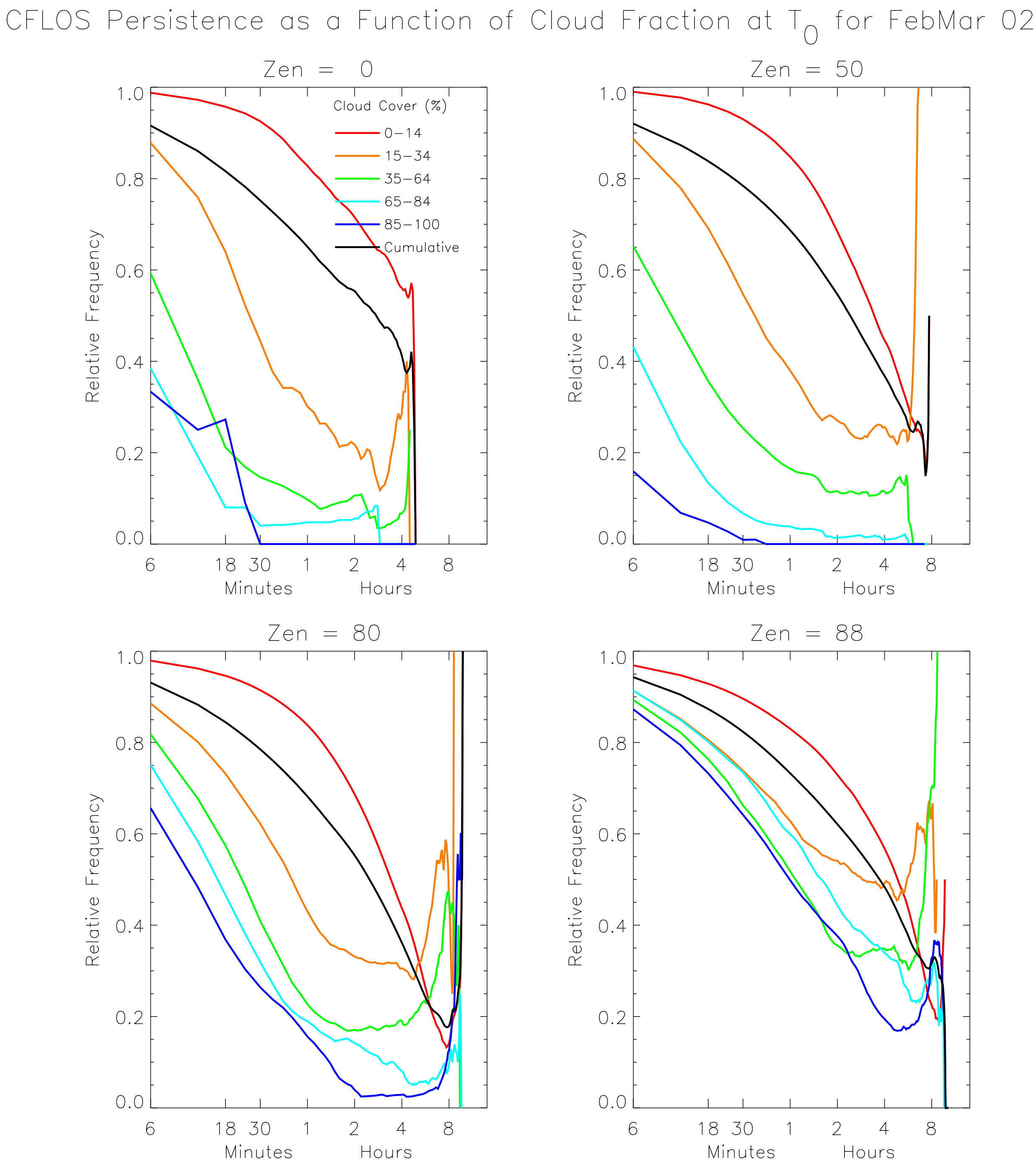

Fig. 46. Probability of CFLOS persistence as a function of initial sky condition. Feb-Mar, Thin-Opq, CFLOS

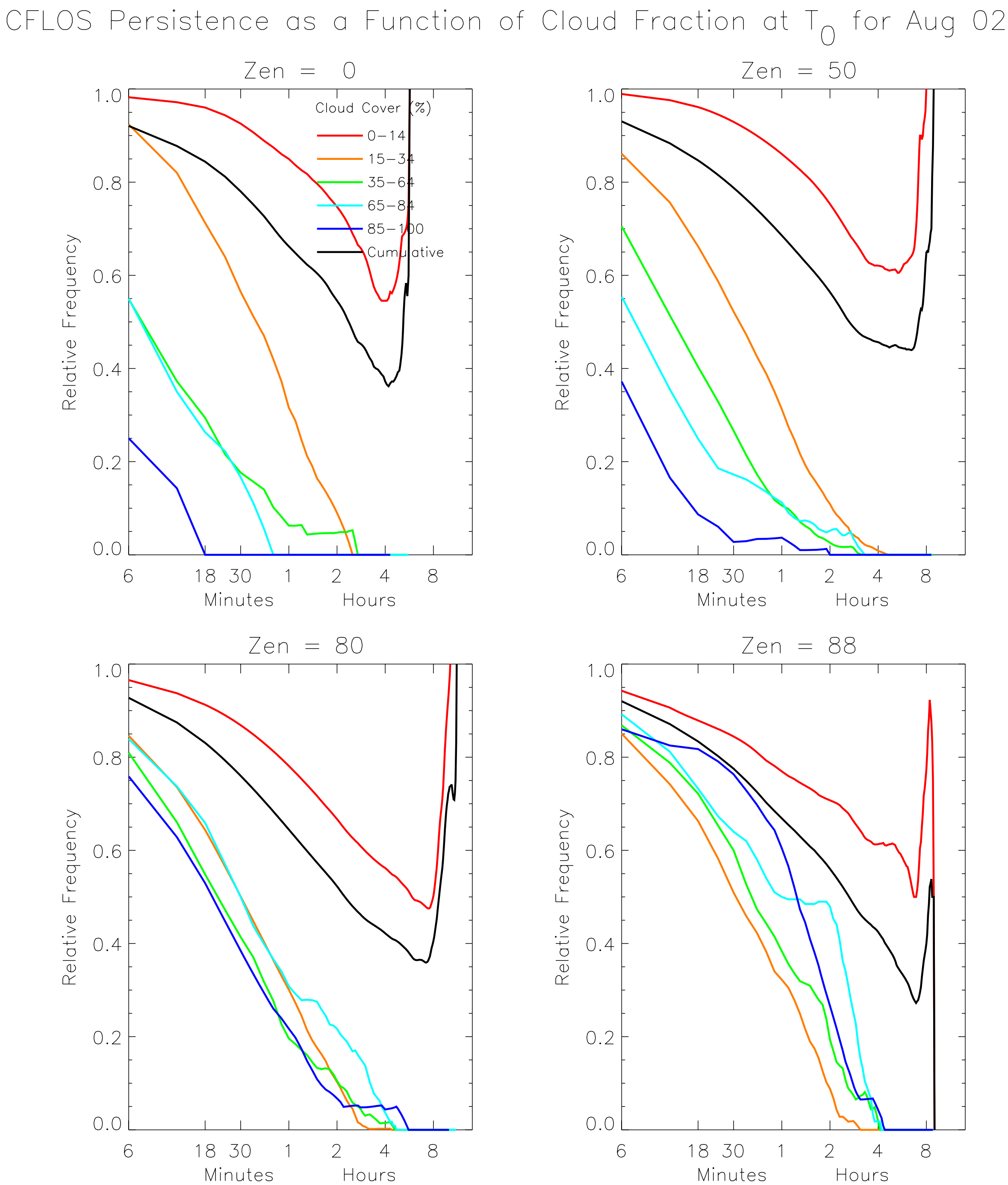

Fig. 47. Probability of CFLOS persistence as a function of initial sky condition. Aug, Thin-Opq, CFLOS

8.2 Cloudy Persistence Results

Results for cloudy line of sight persistence are somewhat similar to the results for cloud-free line of sight. The plots are shown in Figures 48 – 51, and the results are tabulated in Table 14.

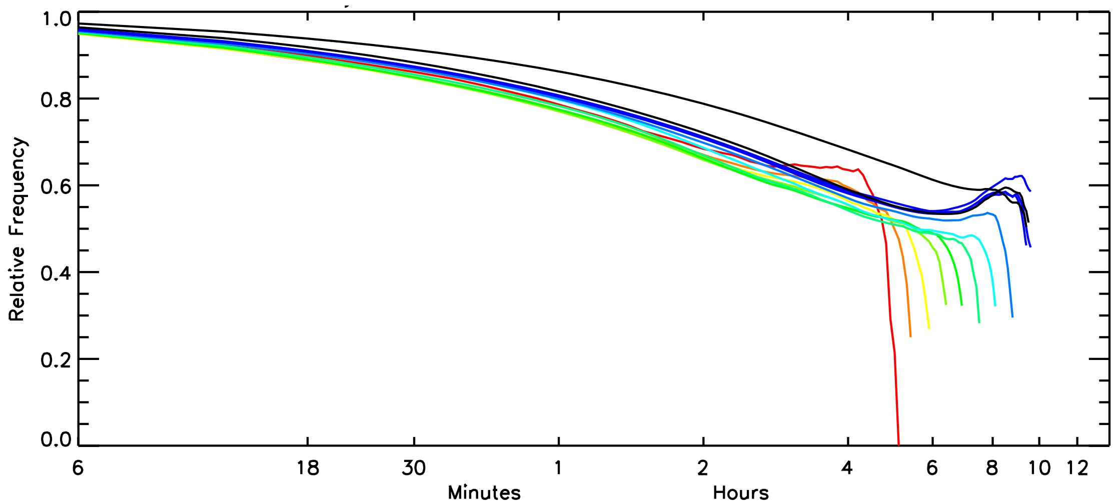

Fig. 48. Cloudy Persistence results for Feb/Mar 02 Thin and Opaque Clouds

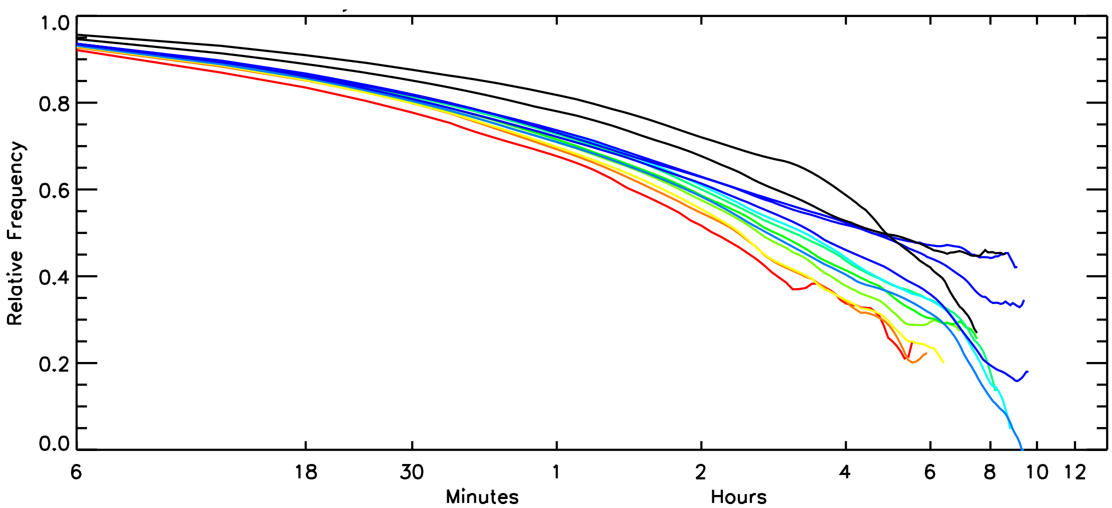

Fig. 49. Cloudy Persistence results for Aug 02 Thin and Opaque Clouds

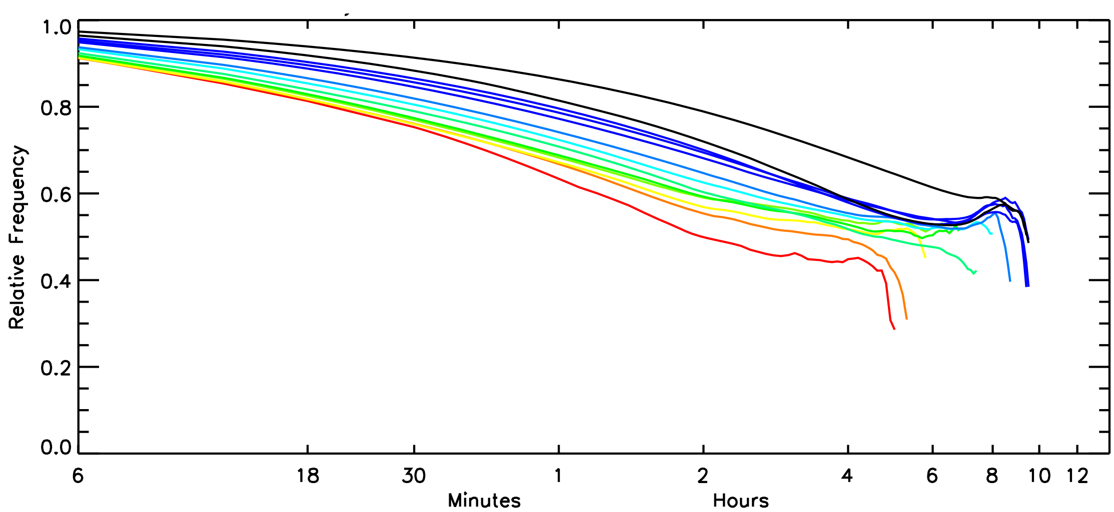

Fig. 50. Cloudy Persistence results for Feb/Mar 02 Opaque Clouds

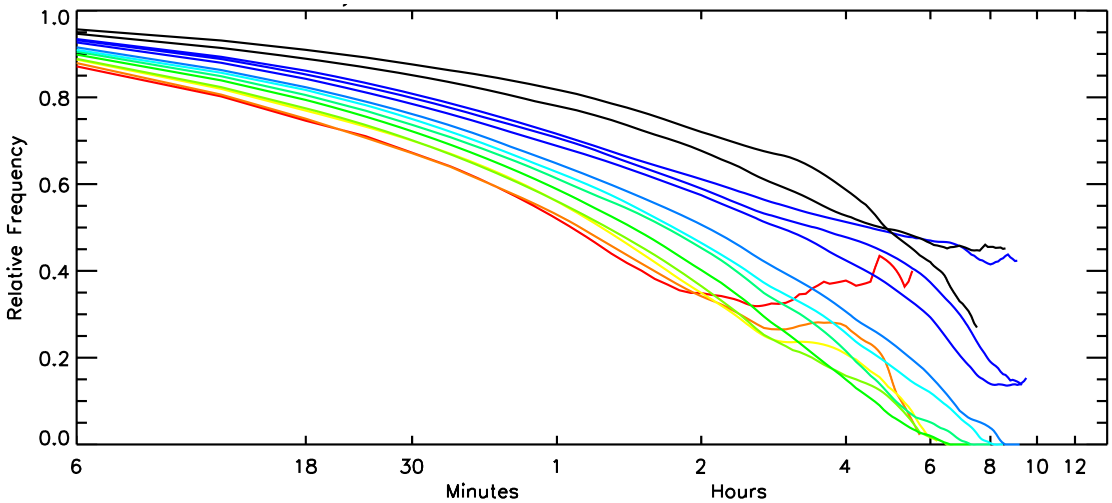

Fig. 51. Cloudy Persistence results for Aug 02 Opaque Clouds

Table 14
Sample Cloudy Persistence Results
Probability of Persistence in %

Time (Hr)	Zenith Angle	Opaque and Thin		Opaque	
		Feb/Mar	Aug	Feb/Mar	Aug
1	0	61%	77%	66%	61%
	50	70%	77%	71%	70%
	80	65%	79%	71%	76%
	88	65%	85%	81%	85%
3	0	35%	65%	37%	46%
	50	50%	59%	50%	55%
	80	45%	63%	53%	62%
	88	46%	72%	66%	73%

As with cloud-free persistence, the cloudy persistence depends strongly on the initial conditions. These results are shown in Figures 52 – 53. A good rule of thumb for cloudy line of sight is that the persistence probabilities are quite high for the cumulative case (black line), when the sky is mostly cloudy (blue line), and near the horizon (last plot). Again, we have evaluated several movies to verify that the results near the horizon are valid, and not strongly driven by algorithm artifacts. As with the cloud-free persistence results, we do not feel that the results beyond 3 to 4 hours are representative of the general case.

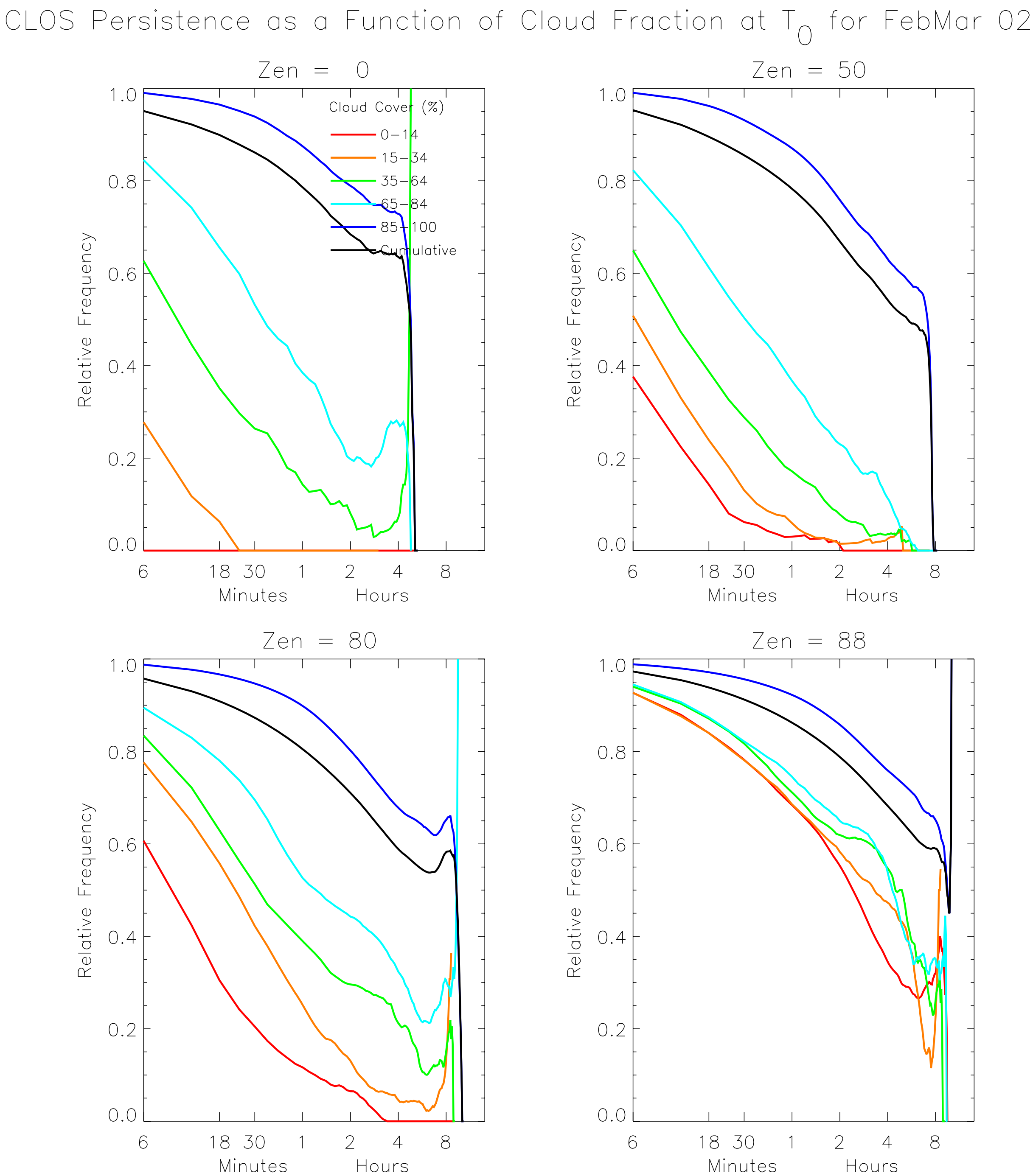

Fig. 52. Probability of CLOS persistence as a function of initial sky condition. Feb-Mar, Thin-Opq, CLOS

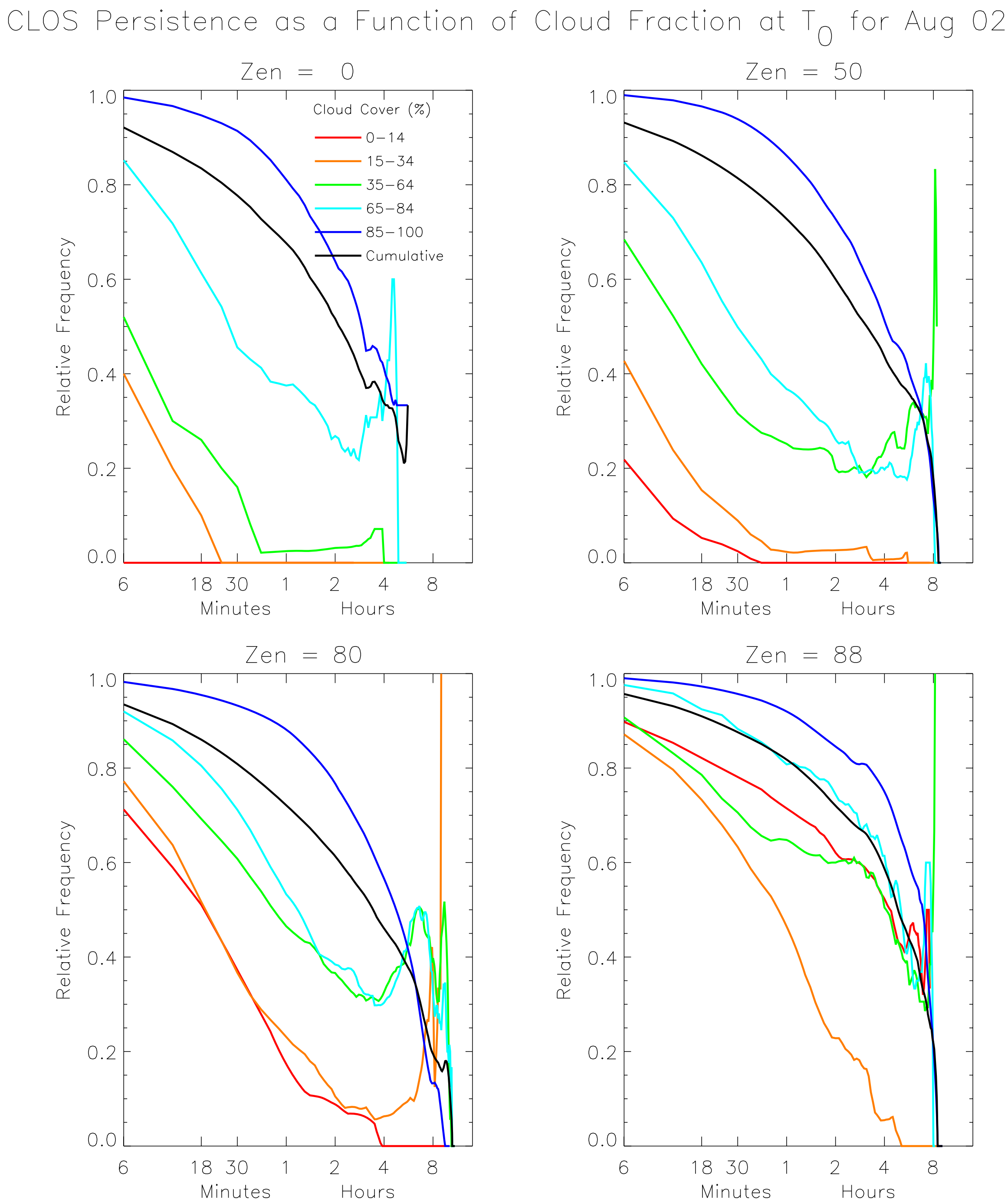

Fig. 53. Probability of CLOS persistence as a function of initial sky condition. Aug, Thin-Opq, CLOS

9. Application of the Persistence Results

We do not yet have a good feel for how representative these persistence results are for a general site. Clearly from Table 12, the cumulative persistence results (ie for all initial conditions) depend strongly on the character of the site. By sorting the data as a function of both zenith angle and initial cloud condition, the results are much more general than they would otherwise be. However, we recognize that the results for sites like Florida, with small low fast-moving clouds, might result in shorter persistence values than some other sites, even given the same initial conditions. At the present time, we believe these data are significantly better than other existing data we are aware of, however clearly it would be useful to further process data from other sites and months.

In order to apply these persistence results for a specific site, the tables of persistence results are given in Appendix 2. For situations where the distribution of cloud fraction at the site and/or the initial conditions are unknown, the cumulative results in Tables 1 through 8 may be used. If initial conditions are known, the remaining tables may be used. Similarly, Tables 1 through 8 may be used to determine most likely results, but the remaining tables may be used to determine a range of likely results.

As with the PCFLOS statistics, it should be more accurate to compute the persistence statistics using the tables that are a function of cloud fraction. These matrices are combined with tables of cloud fraction probability to yield probabilities of persistence. As an example, suppose we wish to know the probability that an existing clear path of sight will persist for one hour, and we consider that both opaque and thin clouds are important for the application. To compute the results for zenith angles of 50, 80, and 88, we use Tables 10 – 12 of Appendix 2 for the Feb-Mar Cirrus/Stratus case, and we use Tables 14 – 16 of Appendix 2 for the Aug Cirrus/Alto Cu case. In each table, we extract the row corresponding to a one-hour time delay, and multiply this by the cloud fraction vector.

As an example, we choose another location, and use the K vector for Wonsan, North Korea, extracted from Nahrstedt[10], shown in Table 15. PCFLOS results, calculated as described in Section 7, are shown in Table 16, and the persistence results are shown in Table 17. The Lund data are not exactly the same, and will be explained later.

Table 15
Sample Cloud Fraction Climatology, **K** vector for Wonsan, North Korea

Sky Cover	January	July
0.0	.60	.07
0.1	.00	.00
0.2	.00	.00
0.3	.10	.14
0.4	.00	.00
0.5	.00	.00
0.6	.00	.00
0.7	.00	.00
0.8	.10	.15
0.9	.00	.00
1.0	.21	.59

Table 16
PCFLOS Results using Opaque and Thin CFLOS Matrix Tables

	January N. Korea			July N. Korea		
Zenith Angle	Ci/St	Ci/ACu	Lund	Ci/St	Ci/ACu	Lund
50	.69	.69	.73	.20	.20	.29
80	.69	.67	.68	.20	.20	.21
88	.59	.52	-	.20	.13	-

Table 17
Persistence Probabilities of CFLOS for a One-Hour Time Delay
Given initial Cloud Free LOS

	January N. Korea			July N. Korea		
Zenith Angle	Ci/St	Ci/ACu	Lund	Ci/St	Ci/ACu	Lund
50	.54	.55	.72	.11	.13	.32
80	.58	.56	-	.22	.25	-
88	.71	.65	-	.51	.51	-

First, comparing Tables 16 and 17, we see that in January, a PCFLOS is reasonably likely, and reasonably likely to last for an hour. This is because January is dominated by clear skies. Near the horizon, a CFLOS is less likely to occur (last row Table 16), but if it occurs, it is more likely to last (last row Table 17). In July, which is more dominated by overcast, a CFLOS is less likely to occur, and less likely to last for an hour. However, near the horizon, if a CFLOS does occur under these conditions, it has a reasonable chance of lasting for an hour.

The Lund results shown in Table 17 differ somewhat from the WSI computation. Most importantly, the Lund data were not presented as a function of look angle. Also, the persistence values are for 55 minutes, rather than 1 hour. Finally, the Lund data were sorted into 11 cloud fraction categories, whereas the WSI data in Tables 9 – 24 were sorted into only 5 cloud fraction categories. Thus the WSI data for the first cloud category includes data from 0 to 15% cloud fraction, whereas the first Lund category presumably includes data from 0 to 5% cloud fraction. In a regime dominated by clear skies, this could make a significant difference in the result. We believe this is why the Lund result for January is somewhat higher than the WSI results, but matches reasonably for the more cloudy July period.

This also points out still another subtlety in this type of analysis. If the **K** vector is only available with four cloud fraction categories (clear, scattered, broken, overcast), as in Table 1, we believe the most accurate results would be obtained by similarly sorting the **C** matrix into the same four cloud categories. Where the standard 11 cloud categories (0, .1, …1.0) are available for the **K** vector, then the 11-category **C** matrix should provide most accurate results. We are not certain if this makes a significant difference, but if a larger study were conducted in the future it might make sense to provide both types of **C** matrices.

The persistence probabilities for CLOS may be computed in a similar manner to those shown above, but using the CLOS tables. As noted earlier, although PCLOS probabilities may be computed directly from PCFLOS probabilities, CLOS persistence probability values are not related in a simple way to CFLOS persistence probability.

10. Summary

The Day/Night Whole Sky Imager has been used to acquire many years of data at many sites. Data from several months have been processed to extract Cloud Free Line of Sight and Persistence statistics. The results show that the CFLOS probabilities are somewhat lower than shown in the Lund data set. They also show that PCFLOS rises toward the horizon in broken cloud conditions, and falls more sharply than predicted by Lund in scattered cloud conditions. Detailed analysis of the processed images reveals that this does not appear to be an artifact of the data processing, but can be expected for regions with frequent contiguous or sheet-like clouds. The persistence results show that persistence probabilities for PCFLOS are typically quite high, with about a 50% probability for periods of 3 hours. The persistence results also depend very strongly on initial conditions, i.e., the cloud fraction at the start of the interval. Persistence probabilities can be quite low when the cloud fraction is moderate to high. We feel these results are significantly more reliable than the Lund data, as they are based on a substantial data set of over 7000 images was used, and the cloud algorithm results were quite good all the way down to the horizon, although there are additional studies we would recommend. These data can also be used to provide a variety of mission-specific statistics. The WSI archive includes more than 3 million image sets taken at many sites over many years, and these data may be used for further evaluation of CFLOS and Persistence for a variety of applications.

11. Acknowledgements

We would like to express our appreciation to Jerry Bukley and the Boeing SVS in Albuquerque, New Mexico, for his support and encouragement in this CFLOS analysis. Thanks to Ann Slavin and the Air Force Starfire Optical Range for supporting the algorithm development, as well as an earlier CFLOS analysis that contributed to this effort. And finally, we appreciate DOE's Atmospheric Radiance Measurements program for supporting the fielding of the D/N WSI's used in this study, and for providing the data to us.

12. References

Published Documents

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In-house Technical Memos available to the sponsor on request

AV04-037t: "Oklahoma Cloud Climatology", J. E. Shields, 31 Aug 2004

AV04-038t: "Processing of SGP Feb 02 Data for Cloud Decision", J. E. Shields, 31 Aug 2004

AV04-039t: "Processing of SGP Mar 02 Data for Cloud Decision", J. E. Shields, 31 Aug 2004

AV04-041t: "Geometric Calibration Check for Boeing CFLOS Study", A. R. Burden, 8 Sep 2004

AV04-042t: "Documentation of Boeing PCFLOS Software Procedures", A. R. Burden, Sep 10 2004

AV04-047t: "Abnormal Red/blue ratios in Aug 02 SGP D/N WSI Data Set", J. E. Shields, 14 Oct 2004

AV04-049t: "Processing of SGP Aug 02 Data for Cloud Decision", J. E. Shields, 23 Oct 2004

AV04-050t: "Reprocessing of SGP Feb and Mar 02 Data for Cloud Decision", J. E. Shields, 3 Nov 2004

AV04-053t: "Documentation of Boeing Persistence Software Procedures", A. R. Burden, Dec 31 2004

AV05-001t mod: "Cloud Type Information at SGP Site for CFLOS Study", J. E. Shields, Jan 21 2005, rev 10 May 2005

AV05-005t: "Probability of Cloud Free Line of Sight Study Results", J. E. Shields, Feb 21 2005

AV05-006t: "Tabular Results for Probability of Cloud Free Line of Sight Study", J. E. Shields, Feb 21 2005

AV05-007t: "Persistence of CFLOS/CLOS For 2002 SGP Imagery", A. R. Burden, Feb 22 2005

AV05-008t: "Tabular Results for Persistence of Cloud Free Line of Sight Study", J. E. Shields, Feb 22 2005

AV05-009t: "PCFLOS Study Summary", ", J. E. Shields and A. R. Burden, Feb 23 2005

AV05-013t mod: "Assessment of Weather Observations for SGP Dataset used in Boeing CFLOS Study", A. R. Burden, Apr 06 2005, rev May 05 2005

AV05-014t: "Cloud Type Image Analysis for CFLOS Study", J. E. Shields, May 12 2005

AV05-017t: "PCFLOS as a Function of Cloud Type Using SGP Imagery", A. R. Burden, Jun 01 2005

AV05-018t: "Additional CFLOS Data from SGP", J. E. Shields, Jun 13, 2005

AV05-019t: "PCFLOS as a Function of Cloud Type Using SGP Imagery: Cumulative Case", A. R. Burden, Jun 15, 2005

Appendix 1: Tabular Results for PCFLOS C-matrix

1. PCFLOS for all cases, opaque and thin clouds

File CFLOS_Table_SGP_Lund0_ThinOpaq_All_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0.98	0.93	0.83	0.72	0.59	0.37	0.29	0.15	0.07	0.00
10	1.00	0.98	0.92	0.83	0.72	0.59	0.37	0.29	0.15	0.06	0.00
20	1.00	0.98	0.91	0.83	0.72	0.59	0.37	0.29	0.15	0.06	0.00
30	1.00	0.97	0.90	0.82	0.72	0.59	0.38	0.28	0.16	0.05	0.00
40	1.00	0.97	0.90	0.81	0.71	0.59	0.41	0.29	0.17	0.05	0.00
50	1.00	0.96	0.88	0.78	0.69	0.57	0.44	0.30	0.18	0.06	0.00
60	1.00	0.95	0.84	0.74	0.65	0.54	0.43	0.31	0.19	0.07	0.00
70	0.99	0.91	0.78	0.65	0.56	0.46	0.40	0.30	0.20	0.09	0.00
80	0.98	0.85	0.70	0.56	0.47	0.38	0.36	0.28	0.21	0.12	0.01
81	0.98	0.82	0.66	0.52	0.43	0.34	0.34	0.28	0.21	0.14	0.01
82	0.98	0.81	0.64	0.50	0.41	0.32	0.34	0.28	0.22	0.16	0.01
83	0.97	0.80	0.63	0.49	0.40	0.32	0.34	0.29	0.24	0.18	0.01
84	0.96	0.79	0.62	0.48	0.40	0.32	0.35	0.31	0.26	0.21	0.02
85	0.94	0.76	0.61	0.48	0.39	0.33	0.36	0.32	0.28	0.23	0.03
86	0.90	0.73	0.59	0.48	0.40	0.34	0.37	0.35	0.31	0.26	0.03
87	0.86	0.70	0.58	0.48	0.40	0.36	0.39	0.36	0.33	0.28	0.04
88	0.82	0.66	0.56	0.48	0.41	0.37	0.40	0.38	0.35	0.30	0.04

2. PCFLOS for all cases, opaque clouds only

File CFLOS_Table_SGP_Lund0_Opaq_All_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0.99	0.98	0.92	0.87	0.79	0.69	0.65	0.58	0.33	0.10
10	1.00	0.99	0.97	0.93	0.87	0.80	0.69	0.65	0.57	0.33	0.10
20	1.00	0.99	0.96	0.93	0.87	0.79	0.69	0.64	0.56	0.34	0.09
30	1.00	0.99	0.96	0.92	0.86	0.78	0.69	0.64	0.55	0.33	0.09
40	1.00	0.98	0.95	0.91	0.85	0.78	0.70	0.64	0.54	0.34	0.08
50	1.00	0.98	0.94	0.90	0.83	0.76	0.69	0.63	0.53	0.34	0.08
60	1.00	0.98	0.93	0.87	0.80	0.72	0.67	0.61	0.51	0.33	0.07
70	1.00	0.96	0.88	0.80	0.74	0.65	0.61	0.56	0.47	0.32	0.06

80	0.99	0.93	0.82	0.72	0.65	0.56	0.55	0.51	0.43	0.32	0.05
81	0.99	0.91	0.79	0.67	0.61	0.51	0.52	0.48	0.40	0.32	0.05
82	0.99	0.89	0.76	0.63	0.57	0.47	0.49	0.45	0.38	0.31	0.04
83	0.98	0.87	0.74	0.61	0.54	0.45	0.47	0.43	0.37	0.31	0.04
84	0.97	0.84	0.71	0.58	0.52	0.43	0.45	0.42	0.37	0.30	0.04
85	0.95	0.80	0.67	0.55	0.49	0.41	0.43	0.40	0.36	0.30	0.04
86	0.91	0.76	0.64	0.53	0.47	0.40	0.43	0.40	0.37	0.31	0.04
87	0.87	0.71	0.61	0.51	0.46	0.40	0.42	0.40	0.37	0.31	0.04
88	0.83	0.68	0.58	0.50	0.45	0.40	0.42	0.40	0.38	0.32	0.05

3. PCFLOS for all cases, opaque and thin clouds, from most cloudy month Feb/Mar
File CFLOS_Table_SGP_Lund0_ThinOpaq_FEbMar_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0.97	0.91	0.83	0.72	0.60	0.36	0.24	0.09	0.05	0.00
10	1.00	0.98	0.91	0.83	0.71	0.60	0.36	0.23	0.10	0.04	0.00
20	1.00	0.98	0.91	0.82	0.70	0.59	0.34	0.22	0.10	0.03	0.00
30	1.00	0.98	0.91	0.81	0.69	0.57	0.35	0.23	0.11	0.04	0.00
40	1.00	0.97	0.92	0.79	0.68	0.55	0.38	0.25	0.13	0.04	0.00
50	1.00	0.97	0.90	0.77	0.66	0.53	0.40	0.28	0.15	0.04	0.00
60	1.00	0.95	0.87	0.73	0.62	0.50	0.41	0.30	0.17	0.05	0.00
70	0.99	0.92	0.79	0.67	0.57	0.48	0.43	0.34	0.21	0.09	0.00
80	0.99	0.86	0.70	0.61	0.54	0.46	0.44	0.37	0.26	0.15	0.01
81	0.99	0.84	0.67	0.60	0.54	0.46	0.45	0.38	0.28	0.18	0.01
82	0.99	0.82	0.65	0.60	0.54	0.47	0.46	0.40	0.31	0.21	0.01
83	0.98	0.81	0.64	0.60	0.54	0.48	0.46	0.41	0.33	0.25	0.02
84	0.97	0.80	0.64	0.59	0.53	0.49	0.46	0.42	0.36	0.28	0.02
85	0.95	0.77	0.61	0.58	0.51	0.47	0.46	0.42	0.37	0.31	0.02
86	0.91	0.73	0.58	0.55	0.47	0.44	0.44	0.43	0.39	0.33	0.03
87	0.87	0.68	0.54	0.51	0.42	0.40	0.41	0.42	0.40	0.35	0.03
88	0.82	0.64	0.50	0.48	0.38	0.36	0.37	0.40	0.40	0.35	0.03
89	0.78	0.61	0.46	0.45	0.35	0.32	0.35	0.39	0.40	0.35	0.03

4. PCFLOS for all cases, opaque clouds only, from most cloudy month Feb/Mar
File CFLOS_Table_SGP_Lund0_Opaq_FebMar_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10

0	1.00	1.00	0.97	0.97	0.94	0.94	0.84	0.74	0.60	0.31	0.07
10	1.00	1.00	0.97	0.96	0.93	0.93	0.83	0.74	0.60	0.32	0.07
20	1.00	1.00	0.98	0.96	0.93	0.90	0.80	0.72	0.58	0.32	0.07
30	1.00	0.99	0.97	0.95	0.91	0.87	0.78	0.70	0.57	0.32	0.07
40	1.00	0.99	0.97	0.94	0.90	0.84	0.77	0.68	0.56	0.32	0.07
50	1.00	0.99	0.96	0.93	0.88	0.81	0.76	0.67	0.54	0.32	0.06
60	1.00	0.98	0.95	0.91	0.85	0.77	0.73	0.66	0.51	0.31	0.05
70	1.00	0.97	0.91	0.86	0.79	0.72	0.68	0.64	0.50	0.32	0.05
80	1.00	0.95	0.85	0.79	0.72	0.65	0.64	0.60	0.50	0.35	0.04
81	1.00	0.93	0.81	0.76	0.69	0.63	0.62	0.58	0.49	0.36	0.04
82	0.99	0.91	0.77	0.73	0.66	0.60	0.59	0.55	0.48	0.37	0.04
83	0.99	0.89	0.74	0.70	0.64	0.59	0.57	0.53	0.47	0.37	0.04
84	0.98	0.85	0.71	0.67	0.61	0.56	0.54	0.51	0.46	0.37	0.04
85	0.96	0.81	0.66	0.63	0.56	0.52	0.51	0.48	0.45	0.37	0.03
86	0.92	0.75	0.61	0.58	0.50	0.47	0.47	0.46	0.43	0.36	0.03
87	0.87	0.70	0.55	0.53	0.44	0.42	0.42	0.43	0.42	0.36	0.03
88	0.82	0.65	0.51	0.49	0.39	0.36	0.38	0.41	0.41	0.36	0.03
89	0.78	0.62	0.47	0.45	0.35	0.33	0.35	0.39	0.40	0.36	0.03

5. PCFLOS for all cases, opaque and thin clouds, from least cloudy month Aug

File CFLOS_Table_SGP_Lund0_ThinOpaq_Aug_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0.97	0.91	0.89	0.59	0.46	0.48	0.28	0.16	0.07	0.00
10	1.00	0.98	0.92	0.85	0.60	0.48	0.47	0.30	0.16	0.06	0.00
20	1.00	0.98	0.92	0.83	0.61	0.48	0.44	0.31	0.14	0.04	0.00
30	1.00	0.97	0.91	0.81	0.63	0.48	0.43	0.30	0.15	0.04	0.00
40	1.00	0.97	0.89	0.80	0.65	0.51	0.42	0.29	0.16	0.05	0.00
50	1.00	0.96	0.85	0.76	0.63	0.53	0.42	0.30	0.18	0.06	0.00
60	1.00	0.95	0.81	0.71	0.60	0.54	0.41	0.31	0.23	0.09	0.00
70	0.99	0.89	0.73	0.65	0.57	0.50	0.40	0.33	0.27	0.15	0.01
80	0.97	0.80	0.67	0.59	0.53	0.44	0.37	0.35	0.27	0.20	0.01
81	0.96	0.76	0.66	0.57	0.50	0.42	0.36	0.35	0.25	0.23	0.01
82	0.95	0.72	0.65	0.54	0.47	0.41	0.36	0.34	0.22	0.25	0.01
83	0.94	0.69	0.65	0.51	0.44	0.39	0.34	0.31	0.21	0.26	0.02
84	0.93	0.68	0.65	0.50	0.44	0.38	0.34	0.29	0.20	0.27	0.02
85	0.91	0.64	0.64	0.48	0.42	0.38	0.34	0.27	0.19	0.26	0.02
86	0.87	0.57	0.60	0.45	0.40	0.38	0.32	0.25	0.18	0.25	0.02
87	0.82	0.53	0.57	0.41	0.35	0.34	0.30	0.21	0.15	0.20	0.02

88	0.78	0.50	0.53	0.38	0.31	0.32	0.28	0.19	0.13	0.16	0.01
89	0.73	0.47	0.50	0.34	0.25	0.29	0.25	0.16	0.11	0.13	0.01

6. PCFLOS for all cases, opaque clouds only, from least cloudy month Aug
File CFLOS_Table_SGP_Lund0_Opaq_Aug_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0.99	0.98	0.94	0.82	0.79	0.78	0.65	0.63	0.45	0.15
10	1.00	0.99	0.98	0.94	0.84	0.80	0.77	0.67	0.62	0.44	0.15
20	1.00	0.99	0.97	0.94	0.85	0.79	0.76	0.69	0.62	0.44	0.15
30	1.00	0.99	0.97	0.94	0.86	0.78	0.75	0.69	0.61	0.44	0.13
40	1.00	0.99	0.97	0.94	0.88	0.79	0.74	0.68	0.62	0.44	0.12
50	1.00	0.98	0.96	0.93	0.87	0.80	0.73	0.68	0.63	0.45	0.11
60	1.00	0.98	0.93	0.90	0.84	0.79	0.70	0.65	0.64	0.45	0.09
70	0.99	0.95	0.86	0.82	0.77	0.71	0.61	0.58	0.57	0.42	0.07
80	0.98	0.88	0.77	0.72	0.67	0.58	0.51	0.49	0.44	0.38	0.05
81	0.97	0.83	0.73	0.65	0.61	0.53	0.46	0.44	0.36	0.35	0.04
82	0.96	0.78	0.70	0.60	0.55	0.48	0.42	0.39	0.30	0.33	0.03
83	0.95	0.74	0.68	0.55	0.51	0.44	0.39	0.34	0.26	0.32	0.03
84	0.93	0.70	0.67	0.52	0.48	0.42	0.37	0.31	0.23	0.29	0.03
85	0.91	0.65	0.65	0.49	0.45	0.40	0.35	0.28	0.21	0.27	0.02
86	0.87	0.57	0.61	0.45	0.41	0.39	0.33	0.25	0.18	0.25	0.02
87	0.82	0.53	0.57	0.41	0.35	0.34	0.30	0.21	0.15	0.20	0.02
88	0.78	0.50	0.53	0.38	0.31	0.32	0.28	0.19	0.13	0.16	0.01
89	0.73	0.47	0.50	0.34	0.25	0.29	0.25	0.16	0.11	0.13	0.01

7. PCFLOS for all cases, opaque and thin clouds, Type 1 upper level clouds
File CFLOS_Table_SGP_Lund1_ThinOpaq_All_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0.98	0.96	0.86	0.70	0.56	0.38	0.24	0.09	0.03	0.00
10	1.00	0.98	0.95	0.85	0.68	0.56	0.36	0.23	0.10	0.02	0.00
20	1.00	0.98	0.93	0.84	0.67	0.54	0.34	0.21	0.09	0.02	0.00
30	1.00	0.98	0.91	0.82	0.66	0.51	0.34	0.21	0.09	0.02	0.00
40	1.00	0.98	0.89	0.79	0.66	0.51	0.37	0.22	0.11	0.03	0.00
50	0.99	0.97	0.87	0.75	0.63	0.52	0.41	0.26	0.13	0.03	0.00
60	0.99	0.96	0.83	0.71	0.61	0.52	0.43	0.31	0.18	0.05	0.00

70	0.98	0.91	0.76	0.66	0.58	0.51	0.43	0.35	0.24	0.10	0.01
80	0.97	0.85	0.70	0.61	0.55	0.50	0.43	0.37	0.30	0.17	0.02
81	0.97	0.82	0.68	0.60	0.54	0.50	0.44	0.38	0.32	0.20	0.03
82	0.97	0.80	0.67	0.60	0.55	0.52	0.44	0.40	0.35	0.24	0.04
83	0.96	0.79	0.66	0.60	0.55	0.53	0.45	0.41	0.37	0.27	0.05
84	0.96	0.77	0.66	0.60	0.55	0.53	0.46	0.43	0.40	0.31	0.07
85	0.94	0.74	0.63	0.59	0.53	0.51	0.46	0.45	0.42	0.33	0.08
86	0.91	0.70	0.60	0.55	0.49	0.47	0.45	0.47	0.44	0.36	0.09
87	0.88	0.66	0.57	0.52	0.45	0.43	0.44	0.47	0.44	0.37	0.10
88	0.85	0.63	0.54	0.50	0.42	0.38	0.43	0.47	0.44	0.38	0.10

8. PCFLOS for all cases, opaque clouds only, Type 1 upper level clouds
File CFLOS_Table_SGP_Lund1_Opaq_All_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	1.00	1.00	1.00	0.99	0.97	0.94	0.87	0.80	0.74	0.44	0.33
10	1.00	1.00	1.00	0.98	0.96	0.94	0.87	0.80	0.72	0.44	0.33
20	1.00	1.00	0.99	0.97	0.94	0.91	0.85	0.79	0.69	0.43	0.33
30	1.00	1.00	0.99	0.96	0.93	0.88	0.83	0.77	0.67	0.42	0.31
40	1.00	0.99	0.98	0.95	0.92	0.86	0.81	0.76	0.65	0.43	0.29
50	1.00	0.99	0.97	0.94	0.90	0.84	0.80	0.76	0.63	0.43	0.27
60	1.00	0.99	0.95	0.93	0.87	0.81	0.76	0.75	0.61	0.42	0.25
70	0.99	0.97	0.91	0.86	0.81	0.76	0.71	0.69	0.59	0.42	0.21
80	0.99	0.94	0.85	0.78	0.74	0.69	0.66	0.62	0.56	0.42	0.18
81	0.99	0.92	0.81	0.75	0.70	0.67	0.63	0.58	0.55	0.41	0.16
82	0.98	0.89	0.78	0.72	0.67	0.64	0.60	0.56	0.53	0.40	0.15
83	0.98	0.86	0.76	0.70	0.65	0.63	0.58	0.54	0.51	0.40	0.14
84	0.97	0.83	0.73	0.68	0.62	0.60	0.55	0.52	0.50	0.40	0.13
85	0.95	0.78	0.69	0.64	0.58	0.55	0.52	0.50	0.49	0.39	0.12
86	0.92	0.73	0.64	0.59	0.53	0.49	0.49	0.49	0.47	0.39	0.11
87	0.89	0.68	0.59	0.55	0.48	0.44	0.46	0.49	0.46	0.39	0.11
88	0.86	0.64	0.55	0.51	0.43	0.39	0.44	0.48	0.45	0.39	0.10

9. PCFLOS for all cases, opaque and thin clouds, Type 2 mid level clouds
File CFLOS_Table_SGP_Lund2_ThinOpaq_All_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10

0	1.00	0.96	0.92	0.88	0.58	0.49	0.27	0.20	0.14	0.07	0.00
10	1.00	0.97	0.91	0.84	0.60	0.54	0.28	0.24	0.14	0.07	0.00
20	1.00	0.97	0.91	0.82	0.63	0.58	0.29	0.26	0.14	0.06	0.00
30	1.00	0.97	0.92	0.81	0.66	0.59	0.33	0.26	0.16	0.05	0.00
40	1.00	0.96	0.91	0.80	0.67	0.58	0.37	0.27	0.17	0.05	0.00
50	1.00	0.95	0.89	0.79	0.65	0.56	0.42	0.28	0.17	0.06	0.00
60	0.99	0.94	0.85	0.75	0.63	0.52	0.42	0.29	0.17	0.07	0.00
70	0.98	0.88	0.76	0.65	0.58	0.45	0.42	0.31	0.19	0.10	0.00
80	0.97	0.77	0.65	0.54	0.53	0.40	0.41	0.33	0.22	0.14	0.01
81	0.96	0.72	0.61	0.49	0.50	0.38	0.41	0.34	0.23	0.17	0.01
82	0.95	0.68	0.57	0.45	0.47	0.37	0.41	0.35	0.24	0.19	0.01
83	0.95	0.67	0.56	0.44	0.45	0.37	0.41	0.35	0.25	0.21	0.02
84	0.93	0.65	0.54	0.43	0.43	0.37	0.41	0.36	0.27	0.23	0.02
85	0.89	0.62	0.52	0.42	0.42	0.38	0.40	0.37	0.29	0.25	0.02
86	0.84	0.59	0.48	0.42	0.42	0.39	0.40	0.39	0.31	0.27	0.02
87	0.79	0.54	0.46	0.42	0.43	0.39	0.39	0.41	0.33	0.28	0.03
88	0.74	0.50	0.43	0.42	0.44	0.40	0.39	0.43	0.34	0.28	0.03

10. PCFLOS for all cases, opaque clouds only, Type 2 mid level clouds

File CFLOS_Table_SGP_Lund2_Opaq_All_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0.99	0.97	0.95	0.78	0.72	0.50	0.41	0.39	0.26	0.09
10	1.00	0.99	0.97	0.93	0.80	0.75	0.50	0.45	0.39	0.28	0.09
20	1.00	0.99	0.97	0.92	0.82	0.77	0.51	0.49	0.39	0.28	0.09
30	1.00	0.99	0.97	0.92	0.82	0.77	0.55	0.50	0.41	0.28	0.08
40	1.00	0.98	0.97	0.90	0.81	0.76	0.59	0.51	0.43	0.28	0.08
50	1.00	0.98	0.96	0.89	0.79	0.73	0.62	0.52	0.44	0.28	0.07
60	1.00	0.98	0.94	0.85	0.76	0.69	0.60	0.51	0.43	0.27	0.06
70	0.99	0.94	0.89	0.78	0.72	0.62	0.57	0.51	0.42	0.28	0.05
80	0.98	0.86	0.81	0.67	0.65	0.55	0.54	0.50	0.41	0.31	0.04
81	0.97	0.82	0.77	0.61	0.61	0.52	0.53	0.49	0.40	0.32	0.04
82	0.96	0.78	0.72	0.57	0.58	0.50	0.52	0.48	0.39	0.32	0.04
83	0.96	0.75	0.68	0.53	0.55	0.48	0.50	0.47	0.38	0.32	0.04
84	0.94	0.72	0.64	0.50	0.52	0.47	0.48	0.46	0.38	0.31	0.03
85	0.90	0.67	0.59	0.48	0.49	0.46	0.45	0.45	0.38	0.31	0.03
86	0.85	0.61	0.53	0.46	0.48	0.44	0.44	0.45	0.37	0.31	0.03
87	0.79	0.55	0.48	0.45	0.47	0.43	0.42	0.45	0.37	0.30	0.03
88	0.74	0.51	0.45	0.43	0.47	0.42	0.41	0.45	0.37	0.30	0.03

11. PCFLOS for all cases, opaque and thin clouds, Type 3 lower level convective clouds
File CFLOS_Table_SGP_Lund3_ThinOpaq_All_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	0.98	0.97	0.92	0.77	0.75	0.61	0.43	0.39	0.25	0.17	0.01
10	0.99	0.97	0.91	0.81	0.74	0.60	0.44	0.38	0.24	0.16	0.01
20	0.99	0.96	0.89	0.82	0.74	0.60	0.43	0.36	0.24	0.13	0.01
30	0.99	0.96	0.89	0.81	0.74	0.61	0.44	0.34	0.23	0.11	0.01
40	0.99	0.95	0.88	0.81	0.73	0.62	0.45	0.34	0.23	0.10	0.01
50	0.99	0.94	0.87	0.80	0.71	0.61	0.46	0.33	0.24	0.10	0.01
60	0.99	0.93	0.86	0.77	0.68	0.57	0.46	0.33	0.22	0.09	0.00
70	0.99	0.90	0.80	0.67	0.58	0.48	0.40	0.28	0.16	0.06	0.00
80	0.98	0.86	0.72	0.55	0.45	0.36	0.31	0.22	0.10	0.05	0.00
81	0.97	0.85	0.68	0.50	0.40	0.30	0.27	0.21	0.08	0.04	0.00
82	0.97	0.83	0.65	0.46	0.36	0.25	0.25	0.20	0.07	0.05	0.00
83	0.96	0.82	0.64	0.44	0.35	0.23	0.25	0.20	0.08	0.06	0.00
84	0.94	0.81	0.63	0.43	0.34	0.22	0.24	0.20	0.09	0.06	0.00
85	0.92	0.79	0.62	0.43	0.34	0.22	0.24	0.20	0.10	0.07	0.01
86	0.89	0.77	0.61	0.44	0.35	0.24	0.26	0.21	0.14	0.10	0.01
87	0.86	0.74	0.61	0.46	0.36	0.27	0.28	0.22	0.17	0.13	0.01
88	0.83	0.73	0.61	0.48	0.37	0.30	0.31	0.23	0.19	0.16	0.02

12. PCFLOS for all cases, opaque clouds only, Type 3 lower level convective clouds
File CFLOS_Table_SGP_Lund3_Opaq_All_Smooth.out

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	0.98	0.98	0.96	0.85	0.83	0.65	0.50	0.60	0.44	0.31	0.06
10	0.99	0.98	0.95	0.87	0.82	0.67	0.53	0.58	0.43	0.34	0.05
20	0.99	0.98	0.94	0.88	0.82	0.69	0.56	0.56	0.43	0.35	0.05
30	0.99	0.97	0.93	0.87	0.82	0.70	0.58	0.55	0.43	0.34	0.05
40	1.00	0.97	0.92	0.87	0.81	0.71	0.60	0.54	0.43	0.35	0.05
50	0.99	0.96	0.91	0.86	0.79	0.70	0.60	0.53	0.43	0.35	0.04
60	0.99	0.95	0.90	0.83	0.76	0.68	0.60	0.52	0.43	0.32	0.03
70	0.99	0.94	0.87	0.77	0.69	0.62	0.55	0.48	0.37	0.27	0.02
80	0.99	0.92	0.82	0.69	0.60	0.52	0.48	0.42	0.28	0.22	0.02
81	0.99	0.90	0.80	0.64	0.55	0.47	0.44	0.39	0.24	0.20	0.02

82	0.98	0.89	0.77	0.60	0.51	0.42	0.41	0.36	0.21	0.18	0.02
83	0.98	0.87	0.74	0.57	0.49	0.38	0.38	0.33	0.20	0.16	0.01
84	0.97	0.86	0.72	0.54	0.46	0.35	0.35	0.30	0.19	0.15	0.01
85	0.94	0.83	0.69	0.52	0.44	0.33	0.33	0.28	0.19	0.14	0.01
86	0.90	0.80	0.66	0.51	0.44	0.33	0.33	0.26	0.20	0.15	0.02
87	0.87	0.76	0.64	0.51	0.43	0.33	0.33	0.25	0.22	0.17	0.02
88	0.84	0.74	0.63	0.52	0.43	0.34	0.34	0.25	0.24	0.19	0.02

13. PCFLOS for all cases, opaque and thin clouds, Type 4 lower level non-convective clouds (limited reliability except for broken and overcast)

File CFLOS_Table_SGP_Lund4_ThinOpaq_All_Smooth_edit.out

There were no results for sky cover 0, 1, and 2; the file has been edited to use the valutes from Table 2 for these columns

	Sky Cover (tenths)										
Zen Ang (deg)	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0.98	0.93	1.00	0.99	0.56	0.02	0.30	0.22	0.04	0.00
10	1.00	0.98	0.92	1.00	0.99	0.70	0.14	0.31	0.25	0.05	0.00
20	1.00	0.98	0.91	1.00	0.93	0.73	0.35	0.38	0.29	0.06	0.00
30	1.00	0.97	0.90	0.93	0.85	0.69	0.49	0.46	0.33	0.06	0.00
40	1.00	0.97	0.90	0.81	0.79	0.62	0.51	0.47	0.31	0.06	0.00
50	1.00	0.96	0.88	0.73	0.71	0.57	0.50	0.41	0.24	0.06	0.00
60	1.00	0.95	0.84	0.68	0.59	0.51	0.45	0.34	0.17	0.04	0.00
70	0.99	0.91	0.78	0.63	0.48	0.40	0.36	0.29	0.11	0.04	0.00
80	0.98	0.85	0.70	0.61	0.36	0.25	0.30	0.20	0.07	0.06	0.00
81	0.98	0.82	0.66	0.61	0.31	0.21	0.27	0.18	0.06	0.07	0.00
82	0.98	0.81	0.64	0.60	0.25	0.18	0.24	0.15	0.06	0.10	0.00
83	0.97	0.80	0.63	0.59	0.28	0.18	0.23	0.15	0.07	0.14	0.00
84	0.96	0.79	0.62	0.56	0.29	0.18	0.21	0.17	0.10	0.19	0.01
85	0.94	0.76	0.61	0.54	0.31	0.20	0.21	0.18	0.15	0.26	0.02
86	0.90	0.73	0.59	0.54	0.34	0.21	0.24	0.21	0.22	0.34	0.02
87	0.86	0.70	0.58	0.54	0.36	0.22	0.26	0.23	0.29	0.40	0.03
88	0.82	0.66	0.56	0.53	0.37	0.23	0.28	0.25	0.35	0.45	0.04

14. PCFLOS for all cases, opaque clouds only, Type 4 lower level non-convective clouds (limited reliability except for broken and overcast)

File CFLOS_Table_SGP_Lund4_Opaq_All_Smooth_edit.out

There were no results for sky cover 0, 1, and 2; the file has been edited to use the valutes from Table 2 for these columns

Zen Ang (deg)	Sky Cover (tenths) 0	1	2	3	4	5	6	7	8	9	10
0	1.00	0.99	0.98	1.00	1.00	0.84	0.47	0.60	0.41	0.17	0.01
10	1.00	0.99	0.97	1.00	0.99	0.86	0.54	0.56	0.43	0.19	0.01
20	1.00	0.99	0.96	1.00	0.94	0.85	0.66	0.57	0.49	0.20	0.01
30	1.00	0.99	0.96	0.97	0.87	0.81	0.71	0.62	0.53	0.20	0.01
40	1.00	0.98	0.95	0.92	0.83	0.73	0.68	0.61	0.51	0.21	0.01
50	1.00	0.98	0.94	0.87	0.78	0.67	0.66	0.54	0.47	0.20	0.01
60	1.00	0.98	0.93	0.77	0.70	0.63	0.65	0.44	0.40	0.19	0.01
70	1.00	0.96	0.88	0.76	0.60	0.54	0.57	0.41	0.33	0.21	0.01
80	0.99	0.93	0.82	0.77	0.52	0.43	0.48	0.35	0.29	0.25	0.01
81	0.99	0.91	0.79	0.79	0.47	0.38	0.41	0.34	0.27	0.26	0.01
82	0.99	0.89	0.76	0.74	0.41	0.34	0.36	0.28	0.25	0.28	0.01
83	0.98	0.87	0.74	0.72	0.42	0.31	0.31	0.27	0.25	0.29	0.01
84	0.97	0.84	0.71	0.69	0.41	0.29	0.28	0.28	0.26	0.32	0.02
85	0.95	0.80	0.67	0.63	0.39	0.28	0.25	0.26	0.28	0.35	0.02
86	0.91	0.76	0.64	0.58	0.39	0.28	0.26	0.26	0.33	0.40	0.03
87	0.87	0.71	0.61	0.57	0.39	0.28	0.27	0.27	0.37	0.45	0.03
88	0.83	0.68	0.58	0.54	0.38	0.30	0.29	0.27	0.41	0.48	0.04

Appendix 2: Tabular Results for Persistence

Table 1. PCFLOS, Feb-Mar, Opaq and Thin.
File Persistence_Table_CFLOS_ThinOpq_FebMar.out dated 01/03/05

	Zenith Angle (deg)												
Time (hours)	0	10	20	30	40	50	60	70	80	82	84	86	88
0.1	0.92	0.92	0.91	0.92	0.92	0.92	0.93	0.93	0.93	0.93	0.94	0.95	0.94
0.3	0.78	0.79	0.80	0.80	0.80	0.81	0.82	0.81	0.81	0.82	0.84	0.85	0.85
0.5	0.73	0.74	0.75	0.75	0.75	0.76	0.77	0.76	0.76	0.77	0.79	0.81	0.80
1.0	0.63	0.64	0.65	0.66	0.66	0.67	0.67	0.66	0.67	0.68	0.71	0.72	0.72
2.0	0.54	0.54	0.54	0.55	0.53	0.54	0.54	0.52	0.54	0.55	0.59	0.62	0.61
3.0	0.47	0.48	0.46	0.45	0.43	0.43	0.43	0.41	0.44	0.45	0.51	0.54	0.54
4.0	0.40	0.40	0.40	0.39	0.36	0.36	0.36	0.34	0.35	0.36	0.42	0.47	0.48
5.0	NaN	0.33	0.29	0.28	0.29	0.30	0.30	0.27	0.28	0.28	0.35	0.41	0.41
6.0	NaN	NaN	NaN	0.19	0.23	0.25	0.26	0.22	0.22	0.22	0.28	0.36	0.35
7.0	NaN	NaN	NaN	NaN	NaN	0.22	0.22	0.16	0.20	0.19	0.26	0.33	0.32
8.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.10	0.18	0.17	0.24	0.35	0.32
9.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.25	0.25	0.34	0.41	0.29
10.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Table 2. PCFLOS, Aug, Opaq and Thin.
File Persistence_Table_CFLOS_ThinOpq_Aug.out dated 01/03/05

	Zenith Angle (deg)												
Time (hours)	0	10	20	30	40	50	60	70	80	82	84	86	88
0.1	0.92	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.92	0.93	0.92
0.3	0.81	0.81	0.81	0.82	0.82	0.82	0.81	0.80	0.79	0.80	0.79	0.81	0.80
0.5	0.75	0.74	0.75	0.77	0.77	0.76	0.76	0.75	0.73	0.74	0.73	0.75	0.75
1.0	0.65	0.64	0.66	0.68	0.69	0.67	0.66	0.66	0.63	0.64	0.61	0.65	0.65
2.0	0.54	0.53	0.57	0.58	0.59	0.55	0.55	0.56	0.51	0.53	0.48	0.53	0.55
3.0	0.43	0.43	0.47	0.49	0.52	0.47	0.47	0.51	0.45	0.47	0.40	0.44	0.46
4.0	0.37	0.41	0.47	0.49	0.51	0.45	0.44	0.49	0.42	0.44	0.38	0.40	0.42
5.0	0.45	0.44	0.48	0.49	0.51	0.45	0.41	0.47	0.40	0.41	0.36	0.36	0.36
6.0	NaN	NaN	0.48	0.47	0.48	0.44	0.41	0.46	0.37	0.39	0.34	0.32	0.32
7.0	NaN	NaN	NaN	NaN	0.50	0.49	0.44	0.48	0.36	0.39	0.35	0.32	0.28
8.0	NaN	NaN	NaN	NaN	NaN	0.65	0.56	0.52	0.42	0.44	0.44	0.44	NaN
9.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.66	0.56	0.58	0.56	NaN	NaN
10.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Table 3. PCFLOS, Feb-Mar, Opaq only.
File Persistence_Table_CFLOS_Opq_FebMar.out dated 01/03/05

Zenith Angle (deg)

Time (hours)	0	10	20	30	40	50	60	70	80	82	84	86	88
0.1	0.91	0.91	0.91	0.91	0.91	0.92	0.92	0.93	0.94	0.94	0.94	0.95	0.94
0.3	0.77	0.78	0.78	0.78	0.78	0.80	0.81	0.81	0.84	0.84	0.85	0.86	0.85
0.5	0.71	0.72	0.73	0.73	0.73	0.75	0.76	0.77	0.79	0.80	0.81	0.82	0.81
1.0	0.62	0.62	0.63	0.63	0.64	0.67	0.68	0.68	0.72	0.72	0.73	0.74	0.73
2.0	0.49	0.51	0.51	0.52	0.53	0.57	0.57	0.57	0.61	0.62	0.63	0.64	0.63
3.0	0.43	0.46	0.45	0.46	0.48	0.51	0.50	0.49	0.54	0.55	0.56	0.57	0.56
4.0	0.37	0.41	0.41	0.42	0.44	0.46	0.45	0.42	0.46	0.47	0.48	0.51	0.50
5.0	NaN	0.44	0.36	0.36	0.40	0.41	0.39	0.36	0.39	0.40	0.41	0.45	0.45
6.0	NaN	NaN	NaN	0.38	0.39	0.38	0.37	0.32	0.32	0.33	0.34	0.39	0.39
7.0	NaN	NaN	NaN	NaN	NaN	0.42	0.35	0.30	0.29	0.30	0.32	0.36	0.37
8.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.31	0.28	0.29	0.31	0.37	0.40
9.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.36	0.36	0.35	0.41	0.40
10.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Table 4. PCFLOS, Aug, Opaq only.
File Persistence_Table_CFLOS_Opq_Aug.out dated 01/03/05

	Zenith Angle (deg)												
Time (hours)	0	10	20	30	40	50	60	70	80	82	84	86	88
0.1	0.92	0.93	0.93	0.93	0.94	0.94	0.94	0.94	0.93	0.93	0.92	0.93	0.92
0.3	0.80	0.81	0.82	0.82	0.84	0.84	0.84	0.84	0.81	0.82	0.79	0.81	0.80
0.5	0.73	0.75	0.76	0.77	0.79	0.79	0.79	0.79	0.75	0.76	0.73	0.75	0.75
1.0	0.61	0.63	0.65	0.68	0.70	0.70	0.69	0.69	0.65	0.66	0.62	0.65	0.65
2.0	0.46	0.48	0.50	0.54	0.57	0.57	0.56	0.58	0.53	0.55	0.48	0.53	0.55
3.0	0.35	0.37	0.40	0.45	0.50	0.50	0.49	0.52	0.45	0.49	0.41	0.44	0.46
4.0	0.29	0.33	0.38	0.43	0.47	0.47	0.44	0.49	0.40	0.44	0.38	0.40	0.42
5.0	0.33	0.33	0.36	0.41	0.43	0.43	0.39	0.46	0.36	0.40	0.36	0.36	0.36
6.0	NaN	NaN	0.35	0.38	0.39	0.40	0.37	0.46	0.33	0.38	0.34	0.32	0.32
7.0	NaN	NaN	NaN	0.36	0.35	0.38	0.36	0.46	0.32	0.38	0.36	0.32	0.28
8.0	NaN	NaN	NaN	NaN	NaN	0.47	0.40	0.45	0.36	0.43	0.44	0.44	NaN
9.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.50	0.50	0.54	0.54	NaN	NaN
10.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Table 5. PCLOS, FebMar, Thin-Opaq.
File Persistence_Table_CLOS_ThinOpq_FebMar.out dated 01/03/05

	Zenith Angle (deg)												
Time (hours)	0	10	20	30	40	50	60	70	80	82	84	86	88
0.1	0.95	0.95	0.95	0.95	0.95	0.95	0.96	0.96	0.96	0.96	0.96	0.96	0.97
0.3	0.88	0.87	0.87	0.87	0.87	0.87	0.88	0.88	0.89	0.89	0.89	0.90	0.92
0.5	0.85	0.83	0.83	0.83	0.83	0.84	0.85	0.85	0.86	0.86	0.86	0.87	0.90
1.0	0.77	0.76	0.76	0.76	0.76	0.77	0.79	0.79	0.79	0.79	0.80	0.80	0.85
2.0	0.68	0.66	0.66	0.65	0.65	0.66	0.68	0.69	0.70	0.70	0.70	0.71	0.78
3.0	0.65	0.62	0.61	0.60	0.59	0.59	0.60	0.62	0.63	0.63	0.63	0.64	0.72

4.0	0.63	0.59	0.56	0.55	0.54	0.54	0.55	0.57	0.59	0.58	0.58	0.58	0.68
5.0	0.00	0.48	0.52	0.51	0.52	0.51	0.52	0.54	0.56	0.55	0.55	0.55	0.64
6.0	NaN	NaN	NaN	0.45	0.49	0.49	0.49	0.52	0.54	0.53	0.54	0.53	0.61
7.0	NaN	NaN	NaN	NaN	NaN	0.44	0.48	0.53	0.55	0.54	0.56	0.54	0.59
8.0	NaN	NaN	NaN	NaN	NaN	NaN	0.32	0.53	0.58	0.58	0.60	0.58	0.59
9.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.55	0.57	0.62	0.58	0.55
10.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Table 6. PCLOS, Aug, Thin-Opaq.
File Persistence_Table_CLOS_ThinOpq_Aug.out dated 01/03/05

	Zenith Angle (deg)												
Time (hours)	0	10	20	30	40	50	60	70	80	82	84	86	88
0.1	0.92	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.94	0.94	0.95	0.96
0.3	0.80	0.82	0.82	0.83	0.83	0.84	0.84	0.83	0.83	0.84	0.84	0.87	0.89
0.5	0.75	0.77	0.78	0.78	0.79	0.79	0.80	0.78	0.79	0.80	0.80	0.84	0.86
1.0	0.66	0.68	0.68	0.69	0.70	0.71	0.72	0.70	0.71	0.72	0.72	0.77	0.81
2.0	0.50	0.53	0.54	0.56	0.58	0.59	0.60	0.57	0.60	0.62	0.62	0.67	0.71
3.0	0.37	0.41	0.42	0.46	0.48	0.50	0.51	0.47	0.53	0.55	0.56	0.58	0.66
4.0	0.33	0.33	0.34	0.37	0.41	0.43	0.43	0.40	0.46	0.52	0.52	0.52	0.58
5.0	0.24	0.26	0.28	0.31	0.35	0.38	0.38	0.36	0.41	0.48	0.49	0.49	0.48
6.0	NaN	NaN	0.23	0.30	0.30	0.34	0.34	0.31	0.35	0.44	0.47	0.46	0.41
7.0	NaN	NaN	NaN	NaN	0.28	0.29	0.26	0.21	0.26	0.39	0.46	0.45	0.32
8.0	NaN	NaN	NaN	NaN	NaN	0.16	0.15	0.11	0.19	0.34	0.44	0.46	NaN
9.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.03	0.16	0.33	0.42	NaN	NaN
10.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Table 7. PCLOS, Feb-Mar, Opaq only
File Persistence_Table_CLOS_Opq_FebMar.out dated 01/03/05

	Zenith Angle (deg)												
Time (hours)	0	10	20	30	40	50	60	70	80	82	84	86	88
0.1	0.91	0.91	0.91	0.92	0.92	0.92	0.93	0.94	0.95	0.95	0.96	0.96	0.97
0.3	0.78	0.79	0.79	0.79	0.80	0.81	0.83	0.84	0.87	0.87	0.88	0.90	0.93
0.5	0.73	0.74	0.74	0.75	0.75	0.77	0.79	0.80	0.83	0.84	0.85	0.87	0.90
1.0	0.61	0.65	0.66	0.67	0.68	0.70	0.71	0.73	0.76	0.77	0.78	0.80	0.85
2.0	0.49	0.55	0.56	0.59	0.59	0.60	0.62	0.64	0.67	0.69	0.69	0.71	0.78
3.0	0.46	0.51	0.54	0.56	0.55	0.55	0.57	0.59	0.62	0.63	0.62	0.64	0.73
4.0	0.45	0.49	0.52	0.53	0.52	0.51	0.54	0.55	0.58	0.59	0.57	0.58	0.68
5.0	NaN	0.40	0.52	0.53	0.51	0.49	0.53	0.54	0.56	0.55	0.54	0.54	0.64
6.0	NaN	NaN	NaN	0.53	0.51	0.48	0.52	0.52	0.54	0.54	0.53	0.53	0.61
7.0	NaN	NaN	NaN	NaN	NaN	0.43	0.52	0.52	0.53	0.55	0.54	0.53	0.59
8.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.56	0.56	0.58	0.58	0.57	0.59
9.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.51	0.52	0.56	0.56	0.55
10.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Table 8. PCLOS, Aug, Opaq only
File Persistence_Table_CLOS_Opq_Aug.out dated 01/03/05

	Zenith Angle (deg)												
Time (hours)	0	10	20	30	40	50	60	70	80	82	84	86	88
0.1	0.87	0.88	0.89	0.89	0.90	0.91	0.91	0.92	0.93	0.93	0.93	0.95	0.96
0.3	0.71	0.71	0.73	0.74	0.76	0.77	0.78	0.79	0.81	0.82	0.83	0.87	0.89
0.5	0.64	0.64	0.67	0.67	0.69	0.71	0.72	0.74	0.76	0.78	0.79	0.84	0.86
1.0	0.49	0.51	0.53	0.54	0.57	0.59	0.61	0.63	0.67	0.69	0.70	0.77	0.81
2.0	0.34	0.33	0.33	0.35	0.39	0.44	0.45	0.49	0.56	0.58	0.60	0.67	0.71
3.0	0.33	0.27	0.24	0.22	0.25	0.31	0.34	0.39	0.49	0.51	0.54	0.58	0.66
4.0	0.37	0.26	0.20	0.15	0.14	0.20	0.25	0.30	0.42	0.47	0.51	0.52	0.58
5.0	0.40	0.12	0.12	0.09	0.06	0.10	0.17	0.23	0.36	0.43	0.48	0.49	0.48
6.0	NaN	NaN	0.01	0.01	0.02	0.05	0.11	0.15	0.28	0.37	0.47	0.46	0.41
7.0	NaN	NaN	NaN	NaN	0.00	0.01	0.05	0.07	0.19	0.28	0.45	0.45	0.32
8.0	NaN	NaN	NaN	NaN	NaN	NaN	0.00	0.03	0.14	0.19	0.42	0.46	NaN
9.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.00	0.14	0.14	0.42	NaN	NaN
10.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Table 9. PCFLOS as a function of initial cloud fraction, Feb-Mar, Thin-Opaq, Zenith 0
File PersistencebyCldCvr_Table_CFLOS_ThinOpq_FebMar_Zen0.out dated 01/03/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.99	0.88	0.59	0.38	0.33	0.92
0.3	0.94	0.52	0.17	0.08	0.09	0.78
0.5	0.91	0.38	0.14	0.04	0.00	0.73
1.0	0.81	0.29	0.09	0.05	0.00	0.63
2.0	0.71	0.21	0.11	0.06	0.00	0.54
3.0	0.63	0.13	0.04	0.00	0.00	0.47
4.0	0.56	0.33	0.07	0.00	0.00	0.40
5.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
6.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
7.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
8.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 10. PCFLOS as a function of initial cloud fraction, Feb-Mar, Thin-Opaq, Zenith 50
File PersistencebyCldCvr_Table_CFLOS_ThinOpq_FebMar_Zen50.out dated 01/03/05

Cloud Cover (%)

Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.99	0.89	0.65	0.43	0.16	0.92
0.3	0.95	0.61	0.29	0.09	0.03	0.81
0.5	0.91	0.50	0.23	0.05	0.01	0.76
1.0	0.83	0.36	0.16	0.03	0.00	0.67
2.0	0.67	0.27	0.11	0.01	0.00	0.54
3.0	0.54	0.23	0.11	0.02	0.00	0.43
4.0	0.44	0.25	0.11	0.01	0.00	0.36
5.0	0.35	0.24	0.14	0.02	0.00	0.30
6.0	0.27	0.39	0.00	0.00	0.00	0.25
7.0	0.22	1.00	0.00	0.00	0.00	0.22
8.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 11. PCFLOS as a function of initial cloud fraction, Feb-Mar, Thin-Opaq, Zenith 80
File PersistencebyCldCvr_Table_CFLOS_ThinOpq_FebMar_Zen80.out dated 01/03/05

			Cloud Cover (%)			
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.98	0.89	0.82	0.75	0.66	0.93
0.3	0.93	0.67	0.49	0.38	0.30	0.81
0.5	0.90	0.58	0.36	0.27	0.24	0.76
1.0	0.82	0.41	0.21	0.18	0.14	0.67
2.0	0.67	0.33	0.17	0.14	0.03	0.54
3.0	0.54	0.32	0.18	0.10	0.03	0.44
4.0	0.43	0.30	0.18	0.08	0.03	0.35
5.0	0.32	0.32	0.21	0.06	0.03	0.28
6.0	0.22	0.43	0.24	0.06	0.04	0.22
7.0	0.16	0.55	0.34	0.08	0.06	0.20
8.0	0.15	0.42	0.44	0.11	0.14	0.18
9.0	0.24	-NaN	0.33	0.10	0.56	0.25
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 12. PCFLOS as a function of initial cloud fraction, Feb-Mar, Thin-Opaq, Zenith 88
File PersistencebyCldCvr_Table_CFLOS_ThinOpq_FebMar_Zen88.out dated 01/03/05

			Cloud Cover (%)			
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.97	0.91	0.89	0.91	0.87	0.94
0.3	0.91	0.77	0.71	0.76	0.68	0.85

0.5	0.88	0.71	0.63	0.70	0.61	0.80
1.0	0.82	0.61	0.50	0.58	0.48	0.72
2.0	0.72	0.53	0.35	0.43	0.37	0.61
3.0	0.64	0.49	0.34	0.37	0.25	0.54
4.0	0.56	0.50	0.34	0.34	0.19	0.48
5.0	0.48	0.47	0.32	0.29	0.17	0.41
6.0	0.39	0.54	0.32	0.24	0.18	0.35
7.0	0.30	0.61	0.45	0.26	0.23	0.32
8.0	0.22	0.67	0.70	0.30	0.33	0.32
9.0	0.21	-NaN	1.00	0.21	0.33	0.29
10.0	-NaN	-NaN	-NaN	-NaN	0.00	0.00

Table 13. PCFLOS as a function of initial cloud fraction, Aug, Thin-Opaq, Zenith 0
File PersistencebyCldCvr_Table_CFLOS_ThinOpq_Aug_Zen0.out dated 01/03/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.98	0.92	0.55	0.55	0.25	0.92
0.3	0.94	0.64	0.22	0.22	0.00	0.81
0.5	0.91	0.51	0.16	0.11	0.00	0.75
1.0	0.84	0.29	0.06	0.00	0.00	0.65
2.0	0.74	0.07	0.05	0.00	0.00	0.54
3.0	0.63	0.00	0.00	0.00	0.00	0.43
4.0	0.55	0.00	0.00	0.00	0.00	0.37
5.0	0.68	0.00	0.00	0.00	-NaN	0.45
6.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
7.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
8.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 14. PCFLOS as a function of initial cloud fraction, Aug, Thin-Opaq, Zenith 50
File PersistencebyCldCvr_Table_CFLOS_ThinOpq_Aug_Zen50.out dated 01/03/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.99	0.86	0.71	0.55	0.37	0.93
0.3	0.95	0.59	0.33	0.19	0.06	0.82
0.5	0.91	0.47	0.21	0.16	0.03	0.76
1.0	0.85	0.28	0.10	0.09	0.03	0.67
2.0	0.74	0.10	0.02	0.05	0.00	0.55

3.0	0.65	0.03	0.00	0.01	0.00	0.47
4.0	0.62	0.01	0.00	0.00	0.00	0.45
5.0	0.61	0.00	0.00	0.00	0.00	0.45
6.0	0.63	0.00	0.00	0.00	0.00	0.44
7.0	0.80	0.00	0.00	0.00	0.00	0.49
8.0	1.00	0.00	0.00	0.00	0.00	0.65
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 15. PCFLOS as a function of initial cloud fraction, Aug, Thin-Opaq, Zenith 80
File PersistencebyCldCvr_Table_CFLOS_ThinOpq_Aug_Zen80.out dated 01/03/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.97	0.85	0.81	0.84	0.76	0.93
0.3	0.89	0.57	0.47	0.57	0.45	0.79
0.5	0.85	0.45	0.37	0.44	0.33	0.73
1.0	0.77	0.27	0.18	0.29	0.20	0.63
2.0	0.66	0.09	0.09	0.20	0.06	0.51
3.0	0.59	0.00	0.03	0.12	0.05	0.45
4.0	0.56	0.00	0.02	0.03	0.04	0.42
5.0	0.53	0.00	0.00	0.00	0.03	0.40
6.0	0.49	0.00	0.00	0.00	0.00	0.37
7.0	0.48	0.00	0.00	0.00	0.00	0.36
8.0	0.51	0.00	0.00	0.00	0.00	0.42
9.0	0.71	0.00	0.00	0.00	0.00	0.56
10.0	0.97	0.00	0.00	0.00	-NaN	0.74

Table 16. PCFLOS as a function of initial cloud fraction, Aug, Thin-Opaq, Zenith 88
File PersistencebyCldCvr_Table_CFLOS_ThinOpq_Aug_Zen88.out dated 01/03/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.94	0.85	0.87	0.89	0.86	0.92
0.3	0.86	0.58	0.65	0.67	0.79	0.80
0.5	0.83	0.46	0.53	0.62	0.73	0.75
1.0	0.76	0.31	0.36	0.49	0.57	0.65
2.0	0.70	0.07	0.17	0.45	0.24	0.55
3.0	0.64	0.00	0.07	0.15	0.07	0.46
4.0	0.61	0.00	0.00	0.02	0.03	0.42
5.0	0.61	0.00	0.00	0.00	0.00	0.36

6.0	0.56	0.00	0.00	0.00	0.00	0.32
7.0	0.53	0.00	0.00	0.00	0.00	0.28
8.0	0.81	0.00	-NaN	0.00	0.00	0.42
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 17. PCFLOS as a function of initial cloud fraction, Feb-Mar, Opaq only, Zenith 0
File PersistencebyCldCvr_Table_CFLOS_Opq_FebMar_Zen0.out dated 01/03/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.99	0.90	0.68	0.36	0.11	0.91
0.3	0.97	0.60	0.26	0.02	0.00	0.77
0.5	0.94	0.46	0.14	0.03	0.00	0.71
1.0	0.85	0.36	0.07	0.00	0.00	0.62
2.0	0.72	0.21	0.03	0.00	0.00	0.49
3.0	0.64	0.18	0.05	0.00	0.00	0.43
4.0	0.58	0.13	0.25	0.00	0.00	0.37
5.0	-NaN	0.00	1.00	-NaN	-NaN	0.67
6.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
7.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
8.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 18. PCFLOS as a function of initial cloud fraction, Feb-Mar, Opaq only, Zenith 50
File PersistencebyCldCvr_Table_CFLOS_Opq_FebMar_Zen50.out dated 01/03/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.99	0.90	0.72	0.49	0.26	0.92
0.3	0.96	0.65	0.32	0.21	0.04	0.80
0.5	0.94	0.55	0.21	0.13	0.01	0.75
1.0	0.89	0.40	0.10	0.05	0.00	0.67
2.0	0.79	0.27	0.05	0.03	0.00	0.57
3.0	0.71	0.27	0.05	0.01	0.00	0.51
4.0	0.64	0.27	0.07	0.02	0.00	0.46
5.0	0.59	0.26	0.05	0.04	0.00	0.41
6.0	0.59	0.23	0.12	0.03	0.00	0.38
7.0	0.67	0.24	0.49	0.00	0.00	0.42
8.0	-NaN	-NaN	1.00	-NaN	-NaN	1.00

9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 19. PCFLOS as a function of initial cloud fraction, Feb-Mar, Opaq only, Zenith 80
File PersistencebyCldCvr_Table_CFLOS_Opq_FebMar_Zen80.out dated 01/03/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.99	0.90	0.80	0.75	0.63	0.94
0.3	0.95	0.70	0.48	0.43	0.30	0.84
0.5	0.93	0.61	0.36	0.32	0.22	0.79
1.0	0.88	0.42	0.25	0.19	0.18	0.72
2.0	0.77	0.33	0.12	0.11	0.09	0.61
3.0	0.68	0.33	0.08	0.04	0.04	0.54
4.0	0.59	0.31	0.08	0.02	0.03	0.46
5.0	0.50	0.30	0.07	0.02	0.01	0.39
6.0	0.41	0.33	0.08	0.01	0.00	0.32
7.0	0.34	0.36	0.10	0.01	0.00	0.29
8.0	0.32	0.35	0.16	0.00	0.00	0.28
9.0	0.46	0.39	0.31	0.00	0.00	0.36
10.0	-NaN	-NaN	1.00	-NaN	-NaN	1.00

Table 20. PCFLOS as a function of initial cloud fraction, Feb-Mar, Opaq only, Zenith 88
File PersistencebyCldCvr_Table_CFLOS_Opq_FebMar_Zen88.out dated 01/03/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.97	0.91	0.89	0.91	0.79	0.94
0.3	0.90	0.75	0.72	0.73	0.58	0.85
0.5	0.87	0.68	0.65	0.67	0.52	0.81
1.0	0.81	0.55	0.52	0.53	0.44	0.73
2.0	0.71	0.43	0.38	0.41	0.36	0.63
3.0	0.64	0.44	0.33	0.31	0.24	0.56
4.0	0.57	0.47	0.31	0.18	0.17	0.50
5.0	0.50	0.46	0.28	0.13	0.04	0.45
6.0	0.45	0.45	0.25	0.14	0.00	0.39
7.0	0.38	0.50	0.32	0.04	0.00	0.37
8.0	0.37	0.57	0.44	0.00	0.00	0.40
9.0	0.53	0.39	0.54	-NaN	0.00	0.40
10.0	-NaN	-NaN	-NaN	-NaN	0.00	0.00

Table 21. PCFLOS as a function of initial cloud fraction, Aug, Opaq only, Zenith 0
File PersistencebyCldCvr_Table_CFLOS_Opq_Aug_Zen0.out dated 01/03/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.99	0.88	0.72	0.56	0.30	0.92
0.3	0.96	0.56	0.31	0.62	0.00	0.80
0.5	0.92	0.44	0.20	0.46	0.00	0.73
1.0	0.82	0.25	0.09	0.22	0.00	0.61
2.0	0.66	0.03	0.00	0.00	0.00	0.46
3.0	0.53	0.00	0.00	0.00	0.00	0.35
4.0	0.44	0.00	0.00	0.00	0.00	0.29
5.0	0.50	0.00	0.00	-NaN	-NaN	0.33
6.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
7.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
8.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 22. PCFLOS as a function of initial cloud fraction, Aug, Opaq only, Zenith 50
File PersistencebyCldCvr_Table_CFLOS_Opq_Aug_Zen50.out dated 01/03/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.99	0.90	0.80	0.65	0.25	0.94
0.3	0.95	0.70	0.47	0.31	0.05	0.84
0.5	0.93	0.61	0.34	0.29	0.04	0.79
1.0	0.86	0.43	0.20	0.17	0.05	0.70
2.0	0.75	0.16	0.11	0.10	0.04	0.57
3.0	0.65	0.07	0.03	0.06	0.03	0.50
4.0	0.60	0.06	0.04	0.02	0.00	0.47
5.0	0.57	0.03	0.01	0.00	0.00	0.43
6.0	0.56	0.00	0.00	0.00	0.00	0.40
7.0	0.62	0.00	0.00	0.00	-NaN	0.38
8.0	0.86	0.00	0.00	-NaN	-NaN	0.47
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 23. PCFLOS as a function of initial cloud fraction, Aug, Opaq only, Zenith 80
File PersistencebyCldCvr_Table_CFLOS_Opq_Aug_Zen80.out dated 01/03/05

			Cloud Cover (%)			
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.96	0.83	0.81	0.87	0.73	0.93
0.3	0.88	0.53	0.50	0.68	0.39	0.81
0.5	0.84	0.43	0.35	0.61	0.28	0.75
1.0	0.76	0.23	0.19	0.44	0.14	0.65
2.0	0.62	0.14	0.11	0.21	0.06	0.53
3.0	0.53	0.08	0.08	0.14	0.04	0.45
4.0	0.48	0.06	0.05	0.07	0.05	0.40
5.0	0.45	0.03	0.01	0.01	0.05	0.36
6.0	0.41	0.00	0.00	0.00	0.00	0.33
7.0	0.40	0.00	0.00	0.00	0.00	0.32
8.0	0.44	0.00	0.00	0.00	0.00	0.36
9.0	0.65	0.00	0.00	-NaN	-NaN	0.50
10.0	0.94	0.00	0.00	-NaN	-NaN	0.71

Table 24. PCFLOS as a function of initial cloud fraction, Aug, Opaq only, Zenith 88
File PersistencebyCldCvr_Table_CFLOS_Opq_Aug_Zen88.out dated 01/03/05

			Cloud Cover (%)			
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.93	0.83	0.91	0.94	0.72	0.92
0.3	0.82	0.64	0.77	0.81	0.51	0.80
0.5	0.78	0.53	0.71	0.75	0.31	0.75
1.0	0.69	0.40	0.60	0.54	0.19	0.65
2.0	0.61	0.18	0.39	0.36	0.07	0.55
3.0	0.55	0.05	0.10	0.13	0.07	0.46
4.0	0.52	0.00	0.01	0.03	0.07	0.42
5.0	0.50	0.00	0.00	0.00	0.00	0.36
6.0	0.47	0.00	0.00	0.00	0.00	0.32
7.0	0.43	0.00	0.00	0.00	0.00	0.28
8.0	0.70	0.00	0.00	-NaN	0.00	0.42
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 25. PCLOS as a function of initial cloud fraction, Feb-Mar, Thin-Opaq, Zenith 0
File PersistencebyCldCvr_Table_CLOS_ThinOpq_FebMar_Zen0.out dated 02/23/05

			Cloud Cover (%)			
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.00	0.28	0.63	0.84	0.99	0.95

0.3	0.00	0.00	0.30	0.60	0.95	0.88
0.5	0.00	0.00	0.25	0.49	0.93	0.85
1.0	0.00	0.00	0.13	0.37	0.86	0.77
2.0	0.00	0.00	0.07	0.19	0.78	0.68
3.0	0.00	-NaN	0.04	0.21	0.75	0.65
4.0	0.00	-NaN	0.08	0.27	0.73	0.63
5.0	-NaN	-NaN	-NaN	-NaN	0.00	0.00
6.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
7.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
8.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 26. PCLOS as a function of initial cloud fraction, Feb-Mar, Thin-Opaq, Zenith 50
File PersistencebyCldCvr_Table_CLOS_ThinOpq_FebMar_Zen50.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.38	0.51	0.65	0.82	0.99	0.95
0.3	0.08	0.18	0.33	0.55	0.95	0.87
0.5	0.06	0.10	0.26	0.47	0.92	0.84
1.0	0.03	0.05	0.16	0.35	0.86	0.77
2.0	0.00	0.01	0.07	0.23	0.75	0.66
3.0	0.00	0.02	0.03	0.17	0.68	0.59
4.0	0.00	0.03	0.04	0.11	0.63	0.54
5.0	0.00	0.00	0.02	0.04	0.59	0.51
6.0	0.00	0.00	0.00	0.00	0.57	0.49
7.0	0.00	-NaN	0.00	0.00	0.50	0.44
8.0	-NaN	-NaN	-NaN	-NaN	0.00	0.00
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 27. PCLOS as a function of initial cloud fraction, Feb-Mar, Thin-Opaq, Zenith 80
File PersistencebyCldCvr_Table_CLOS_ThinOpq_FebMar_Zen80.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.61	0.78	0.83	0.89	0.99	0.96
0.3	0.24	0.49	0.56	0.74	0.96	0.89
0.5	0.17	0.38	0.47	0.65	0.94	0.86
1.0	0.11	0.23	0.38	0.51	0.89	0.79

2.0	0.06	0.12	0.29	0.44	0.79	0.70
3.0	0.01	0.06	0.27	0.39	0.72	0.63
4.0	0.00	0.04	0.21	0.32	0.67	0.59
5.0	0.00	0.04	0.16	0.24	0.65	0.56
6.0	0.00	0.02	0.10	0.21	0.63	0.54
7.0	0.00	0.05	0.12	0.25	0.62	0.55
8.0	0.00	0.16	0.17	0.30	0.65	0.58
9.0	-NaN	-NaN	0.00	0.33	0.58	0.55
10.0	-NaN	-NaN	-NaN	-NaN	0.00	0.00

Table 28. PCLOS as a function of initial cloud fraction, Feb-Mar, Thin-Opaq, Zenith 88
File PersistencebyCldCvr_Table_CLOS_ThinOpq_FebMar_Zen88.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.93	0.93	0.94	0.94	0.99	0.97
0.3	0.81	0.81	0.84	0.85	0.96	0.92
0.5	0.76	0.76	0.79	0.80	0.95	0.90
1.0	0.67	0.67	0.70	0.73	0.92	0.85
2.0	0.54	0.57	0.62	0.64	0.85	0.78
3.0	0.42	0.52	0.60	0.61	0.80	0.72
4.0	0.34	0.47	0.54	0.52	0.76	0.68
5.0	0.29	0.42	0.47	0.40	0.73	0.64
6.0	0.27	0.29	0.35	0.35	0.70	0.61
7.0	0.30	0.15	0.29	0.32	0.67	0.59
8.0	0.33	0.27	0.28	0.34	0.65	0.59
9.0	0.31	-NaN	0.00	0.40	0.58	0.55
10.0	-NaN	-NaN	-NaN	-NaN	1.00	1.00

Table 29. PCLOS as a function of initial cloud fraction, Aug, Thin-Opaq, Zenith 0
File PersistencebyCldCvr_Table_CLOS_ThinOpq_Aug_Zen0.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.00	0.40	0.52	0.85	0.98	0.92
0.3	0.00	0.00	0.20	0.54	0.93	0.80
0.5	0.00	0.00	0.08	0.43	0.89	0.75
1.0	0.00	0.00	0.03	0.38	0.79	0.66
2.0	0.00	0.00	0.03	0.26	0.62	0.50
3.0	-NaN	0.00	0.05	0.31	0.45	0.37
4.0	-NaN	0.00	0.00	0.38	0.40	0.33

5.0	-NaN	-NaN	0.00	0.00	0.33	0.24
6.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
7.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
8.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 30. PCLOS as a function of initial cloud fraction, Aug, Thin-Opaq, Zenith 50
File PersistencebyCldCvr_Table_CLOS_ThinOpq_Aug_Zen50.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.22	0.43	0.68	0.85	0.99	0.93
0.3	0.04	0.12	0.36	0.55	0.95	0.84
0.5	0.01	0.06	0.29	0.46	0.92	0.79
1.0	0.00	0.02	0.24	0.36	0.85	0.71
2.0	0.00	0.03	0.19	0.25	0.72	0.59
3.0	0.00	0.03	0.18	0.19	0.61	0.50
4.0	0.00	0.01	0.25	0.20	0.50	0.43
5.0	0.00	0.01	0.24	0.18	0.45	0.38
6.0	0.00	0.00	0.34	0.27	0.37	0.34
7.0	0.00	0.00	0.31	0.39	0.28	0.29
8.0	-NaN	0.00	0.57	0.07	0.12	0.16
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 31. PCLOS as a function of initial cloud fraction, Aug, Thin-Opaq, Zenith 80
File PersistencebyCldCvr_Table_CLOS_ThinOpq_Aug_Zen80.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.71	0.77	0.86	0.92	0.98	0.93
0.3	0.43	0.43	0.65	0.76	0.94	0.83
0.5	0.32	0.32	0.57	0.67	0.92	0.79
1.0	0.15	0.22	0.45	0.52	0.87	0.71
2.0	0.08	0.10	0.36	0.38	0.75	0.60
3.0	0.06	0.08	0.31	0.32	0.65	0.53
4.0	0.00	0.06	0.33	0.31	0.56	0.46
5.0	0.00	0.08	0.38	0.38	0.47	0.41
6.0	0.00	0.10	0.48	0.48	0.36	0.35
7.0	0.00	0.22	0.46	0.49	0.21	0.26

8.0	0.00	0.22	0.39	0.30	0.13	0.19
9.0	0.00	-NaN	0.45	0.28	0.05	0.16
10.0	-NaN	-NaN	0.10	0.21	0.00	0.12

Table 32. PCLOS as a function of initial cloud fraction, Aug, Thin-Opaq, Zenith 88
File PersistencebyCldCvr_Table_CLOS_ThinOpq_Aug_Zen88.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.90	0.87	0.91	0.98	0.99	0.96
0.3	0.80	0.68	0.74	0.91	0.96	0.89
0.5	0.77	0.59	0.68	0.87	0.95	0.86
1.0	0.71	0.43	0.64	0.81	0.91	0.81
2.0	0.61	0.23	0.60	0.73	0.84	0.71
3.0	0.59	0.16	0.57	0.68	0.81	0.66
4.0	0.52	0.06	0.50	0.59	0.74	0.58
5.0	0.42	0.00	0.41	0.49	0.65	0.48
6.0	0.46	0.00	0.37	0.33	0.56	0.41
7.0	0.38	0.00	0.29	0.55	0.46	0.32
8.0	-NaN	0.00	0.67	0.00	0.18	0.21
9.0	-NaN	-NaN	-NaN	-NaN	0.00	0.00
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 33. PCLOS as a function of initial cloud fraction, Feb-Mar, Opaq only, Zenith 0
File PersistencebyCldCvr_Table_CLOS_Opq_FebMar_Zen0.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.00	0.15	0.52	0.78	0.98	0.91
0.3	0.00	0.00	0.16	0.44	0.90	0.78
0.5	0.00	0.00	0.16	0.33	0.86	0.73
1.0	0.00	0.00	0.07	0.19	0.75	0.61
2.0	0.00	0.00	0.07	0.02	0.61	0.49
3.0	-NaN	0.00	0.00	0.00	0.54	0.46
4.0	-NaN	0.00	0.00	0.00	0.54	0.45
5.0	-NaN	-NaN	-NaN	-NaN	0.00	0.00
6.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
7.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
8.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 34. PCLOS as a function of initial cloud fraction, Feb-Mar, Opaq only, Zenith 50
File PersistencebyCldCvr_Table_CLOS_Opq_FebMar_Zen50.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.51	0.57	0.66	0.80	0.99	0.92
0.3	0.19	0.31	0.33	0.46	0.93	0.81
0.5	0.13	0.27	0.26	0.37	0.89	0.77
1.0	0.05	0.19	0.15	0.27	0.82	0.70
2.0	0.00	0.07	0.07	0.13	0.71	0.60
3.0	0.00	0.01	0.03	0.11	0.64	0.55
4.0	0.00	0.00	0.03	0.11	0.59	0.51
5.0	0.00	0.00	0.01	0.04	0.57	0.49
6.0	0.00	0.00	0.00	0.00	0.55	0.48
7.0	-NaN	0.00	0.00	0.00	0.49	0.43
8.0	-NaN	-NaN	-NaN	-NaN	0.00	0.00
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 35. PCLOS as a function of initial cloud fraction, Feb-Mar, Opaq only, Zenith 80
File PersistencebyCldCvr_Table_CLOS_Opq_FebMar_Zen80.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.63	0.79	0.85	0.89	0.99	0.95
0.3	0.29	0.52	0.61	0.68	0.96	0.87
0.5	0.22	0.43	0.52	0.59	0.94	0.83
1.0	0.17	0.31	0.40	0.43	0.89	0.76
2.0	0.06	0.22	0.28	0.27	0.81	0.67
3.0	0.02	0.13	0.23	0.19	0.76	0.62
4.0	0.00	0.08	0.17	0.17	0.73	0.58
5.0	0.00	0.07	0.10	0.12	0.73	0.56
6.0	0.00	0.07	0.11	0.06	0.73	0.54
7.0	0.00	0.07	0.12	0.06	0.72	0.53
8.0	0.00	0.07	0.14	0.24	0.75	0.56
9.0	-NaN	0.00	0.21	0.17	0.73	0.51
10.0	-NaN	-NaN	-NaN	-NaN	0.00	0.00

Table 36. PCLOS as a function of initial cloud fraction, Feb-Mar, Opaq only, Zenith 88
File PersistencebyCldCvr_Table_CLOS_Opq_FebMar_Zen88.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.93	0.94	0.95	0.97	0.99	0.97
0.3	0.81	0.84	0.87	0.89	0.98	0.93
0.5	0.76	0.80	0.83	0.86	0.97	0.90
1.0	0.68	0.71	0.74	0.78	0.94	0.85
2.0	0.55	0.60	0.65	0.67	0.88	0.78
3.0	0.45	0.52	0.62	0.55	0.84	0.73
4.0	0.38	0.44	0.52	0.48	0.81	0.68
5.0	0.33	0.36	0.40	0.36	0.81	0.64
6.0	0.28	0.27	0.32	0.27	0.81	0.61
7.0	0.25	0.22	0.29	0.24	0.78	0.59
8.0	0.28	0.21	0.28	0.17	0.78	0.59
9.0	0.29	0.19	0.35	0.25	0.72	0.55
10.0	-NaN	-NaN	-NaN	-NaN	1.00	1.00

Table 37. PCLOS as a function of initial cloud fraction, Aug, Opaq only, Zenith 0
File PersistencebyCldCvr_Table_CLOS_Opq_Aug_Zen0.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.00	0.27	0.60	0.80	0.98	0.87
0.3	0.00	0.00	0.27	0.30	0.91	0.71
0.5	0.00	0.00	0.17	0.20	0.84	0.64
1.0	0.00	0.00	0.08	0.11	0.66	0.49
2.0	0.00	0.00	0.00	0.00	0.49	0.34
3.0	-NaN	0.00	0.00	0.00	0.45	0.33
4.0	-NaN	0.00	0.00	0.00	0.50	0.37
5.0	-NaN	0.00	0.00	-NaN	0.50	0.40
6.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
7.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
8.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 38. PCLOS as a function of initial cloud fraction, Aug, Opaq only, Zenith 50
File PersistencebyCldCvr_Table_CLOS_Opq_Aug_Zen50.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative

0.1	0.22	0.50	0.74	0.85	0.98	0.91
0.3	0.03	0.24	0.41	0.52	0.93	0.77
0.5	0.00	0.17	0.31	0.40	0.88	0.71
1.0	0.00	0.12	0.20	0.26	0.76	0.59
2.0	0.00	0.05	0.11	0.15	0.58	0.44
3.0	0.00	0.02	0.08	0.03	0.40	0.31
4.0	0.00	0.00	0.06	0.04	0.26	0.20
5.0	0.00	0.00	0.05	0.03	0.13	0.10
6.0	0.00	0.00	0.03	0.05	0.06	0.05
7.0	0.00	0.00	0.02	0.00	0.00	0.01
8.0	-NaN	0.00	0.00	0.00	0.00	0.00
9.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN

Table 39. PCLOS as a function of initial cloud fraction, Aug, Opaq only, Zenith 80
File PersistencebyCldCvr_Table_CLOS_Opq_Aug_Zen80.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.73	0.86	0.91	0.92	0.99	0.93
0.3	0.43	0.62	0.76	0.73	0.96	0.81
0.5	0.33	0.55	0.68	0.65	0.94	0.76
1.0	0.19	0.43	0.54	0.52	0.88	0.67
2.0	0.10	0.37	0.43	0.32	0.74	0.56
3.0	0.07	0.34	0.46	0.25	0.60	0.49
4.0	0.04	0.38	0.46	0.25	0.49	0.42
5.0	0.05	0.39	0.46	0.25	0.37	0.36
6.0	0.07	0.43	0.43	0.22	0.24	0.28
7.0	0.08	0.39	0.25	0.17	0.11	0.19
8.0	0.00	0.26	0.18	0.17	0.05	0.14
9.0	0.00	0.23	0.05	0.00	0.00	0.14
10.0	0.00	0.16	0.00	-NaN	-NaN	0.13

Table 40. PCLOS as a function of initial cloud fraction, Aug, Opaq only, Zenith 88
File PersistencebyCldCvr_Table_CLOS_Opq_Aug_Zen88.out dated 02/23/05

	Cloud Cover (%)					
Time (hours)	0-14	15-34	35-64	65-84	85-100	Cumulative
0.1	0.90	0.94	0.98	0.97	0.99	0.96
0.3	0.78	0.84	0.93	0.90	0.96	0.89
0.5	0.73	0.79	0.89	0.88	0.95	0.86

1.0	0.65	0.74	0.86	0.81	0.91	0.81
2.0	0.51	0.65	0.84	0.69	0.82	0.71
3.0	0.47	0.63	0.76	0.44	0.80	0.66
4.0	0.39	0.54	0.65	0.28	0.75	0.58
5.0	0.29	0.58	0.43	0.12	0.65	0.48
6.0	0.26	0.56	0.36	0.05	0.57	0.41
7.0	0.17	0.48	0.22	0.00	0.42	0.32
8.0	0.00	0.67	0.00	0.00	0.00	0.21
9.0	-NaN	-NaN	-NaN	-NaN	0.00	0.00
10.0	-NaN	-NaN	-NaN	-NaN	-NaN	-NaN