Supplemental Materials

Table S1. Two-year mean and seasonal statistics of collocated SEVIRI and MODIS retrievals in rain-free, ice-free, smoke-free (AI<0.1), COT > 3, and overcast (LCF ≥95%) grid cells over the marine stratocumulus region. COT means and CER means (in micron) are listed. The values in brackets are statistics without filtering for LCF≥ 95% and COT >3, i.e., for the all-sky case.

	JJA	SON	DJF	MAM	Two-year
Stratocumulus (SEVIRI vs. MODIS)					
SEVIRI COT	10.2 (5.9)	10.3 (7.1)	9.9 (5.2)	9.9 (4.8)	10.2 (6.0)
MODIS 1.6 COT	11.3 (7.3)	11.3 (8.3)	10.8 (6.3)	10.8 (5.9)	11.1 (7.2)
MODIS 2.1 COT	11.4 (7.2)	11.3 (8.2)	10.8 (6.2)	10.8 (5.8)	11.2 (7.1)
MODIS 3.7 COT	11.4 (7.0)	11.3 (8.1)	10.7 (6.1)	10.8 (5.6)	11.2 (6.9)
SEVIRI CER	8.8 (10.2)	10.2 (11.1)	11.6 (11.4)	10.5 (10.7)	10.1 (10.9)
MODIS 1.6 CER	10.3 (12.6)	11.5 (12.9)	12.2 (13.4)	11.4 (13.2)	11.3 (13.0)
MODIS 2.1 CER	11.1 (13.8)	11.9 (13.3)	12.3 (13.4)	11.6 (13.6)	11.7 (13.5)
MODIS 3.7 CER	11.5 (12.6)	11.7 (12.5)	11.6 (11.9)	11.2 (11.8)	11.6 (12.2)
Correl. COT 1.6	0.96 (0.93)	0.97 (0.96)	0.96 (0.95)	0.96 (0.94)	0.96 (0.95)
Correl. COT 2.1	0.96 (0.94)	0.97 (0.96)	0.96 (0.95)	0.97 (0.95)	0.96 (0.95)
Correl. COT 3.7	0.96 (0.96)	0.97 (0.97)	0.96 (0.95)	0.97 (0.96)	0.96 (0.96)
Correl. CER 1.6	0.93 (0.73)	0.90 (0.76)	0.92 (0.60)	0.92 (0.62)	0.92 (0.70)
Correl. CER 2.1	0.90 (0.77)	0.87 (0.79)	0.91 (0.62)	0.92 (0.67)	0.89 (0.72)
Correl. CER 3.7	0.86 (0.81)	0.78 (0.76)	0.87 (0.64)	0.87 (0.74)	0.80 (0.74)

Discussion. Frequency histograms of SEVIRI – MODIS LWP, COT, and CER difference, as well as, the differences relative to MODIS LWP, COT, and CER for the overcast condition aggregated during JAS 2011 and JAS 2012 are shown in Fig. S1. The histogram of SEVIRI – MODIS COT differences revealed that the peak of the distribution is off zero with ~35 % of the data falling into the -1 bin. Only ~17 % of data showed mean zero difference, while ~23 % of data showed a difference of -2. The SEVIRI COT relative to MODIS COT was within 10 % for 36 % of the data, within 20 % for 80 % of the data, and within 30 % for 95 % of the retrievals. Overall, SEVIRI COT appeared to be low by ~1 compared to MODIS COT.

SEVIRI CER retrieved in the 1.6-µm channel was compared with MODIS CERs retrieved in three water absorbing channels at 1.6-, 2.1-, and 3.7-µm. Compared to the 1.6-µm MODIS CERs, ~70 % of SEVIRI CERs have a mean difference of -1.5 µm. Compared to the 2.1- and 3.7-µm MODIS CERs, the difference histograms indicate larger differences: ~55 % and ~50 % of SEVIRI CERs have a difference of -2.5 µm, respectively. Although SEVIRI CERs are biased low compared to all three MODIS CERs, the ~1 µm additional low bias relative to the 2.1- and 3.7-µm CERs likely indicates much smaller smoke-induced retrieval artifacts in these two channels. In general, the CER retrievals from SEVIRI tend to be lower than corresponding retrievals from the three MODIS channels, with SEVIRI having about 1.5 µm to 2.5 µm lower CER values.

The SEVIRI minus MODIS LWP distributions peak at about -10 g m^{-2} irrespective of the MODIS channel used for the retrieval. The differences between MODIS 1.6-µm and SEVIRI retrievals are within 10 % for about 30 % of SEVIRI pixels, within 20 % for about 60 % of the SEVIRI pixels, and within 30 % for about 80 % of the SEVIRI pixels. However, differences between SEVIRI and MODIS 2.1-µm and 3.7-µm channel retrievals are larger, with relative differences being smaller than 10 % for about 22 % of the SEVIRI pixels against MODIS 2.1-µm and for about 16 % of the SEVIRI pixels against MODIS 3.7-µm values.

The frequency histograms of SEVIRI – MODIS LWP, COT, and CER differences, as well as the difference with respect to different MODIS channels are shown in Fig. S4 (all-sky case) and Fig. S6 (overcast case). The peak of the LWP absolute/relative difference distribution is centred on zero, although the distribution is negatively skewed. Interestingly, in the all-sky case ~40 % of the data have shown negligible difference (zero LWP bias bin), whereas, only about 30 % of the data have shown a negligible difference in the overcast case. About 20–30 % of the data have fallen into the LWP difference bin of -10 g m^{-2} in either cases. In the overcast case, ~40 % of the data have shown a relative LWP difference < 10 % and ~90 % of the data have shown a relative LWP difference < 30 %; however, for the all-sky case, only about 25 % and 60 % of the data have shown relative LWP differences < 10 % and < 30 %. Respectively, about 48 %, 84 %, 95 % of the observations show relative COT differences within 10 %, 20 %, and 30 % in the overcast case. Similarly, about 90 % of the observations show relative CER differences within 30 % in the overcast case. Histograms of both COT and CER differences reveal that the distribution is off centered. Histograms of COT differences reveal a narrow distribution which peaks at -1 especially in the overcast case; however in the all-sky case a broader peak is noticed between -1 and 0. Histograms of CER differences reveal wider distributions (especially when compared against the 2.1- and 3.7-µm channels), which peak at -1 µm in the overcast case; however, in the all-sky case a broader peak is noticed between -2 µm and -1 µm.

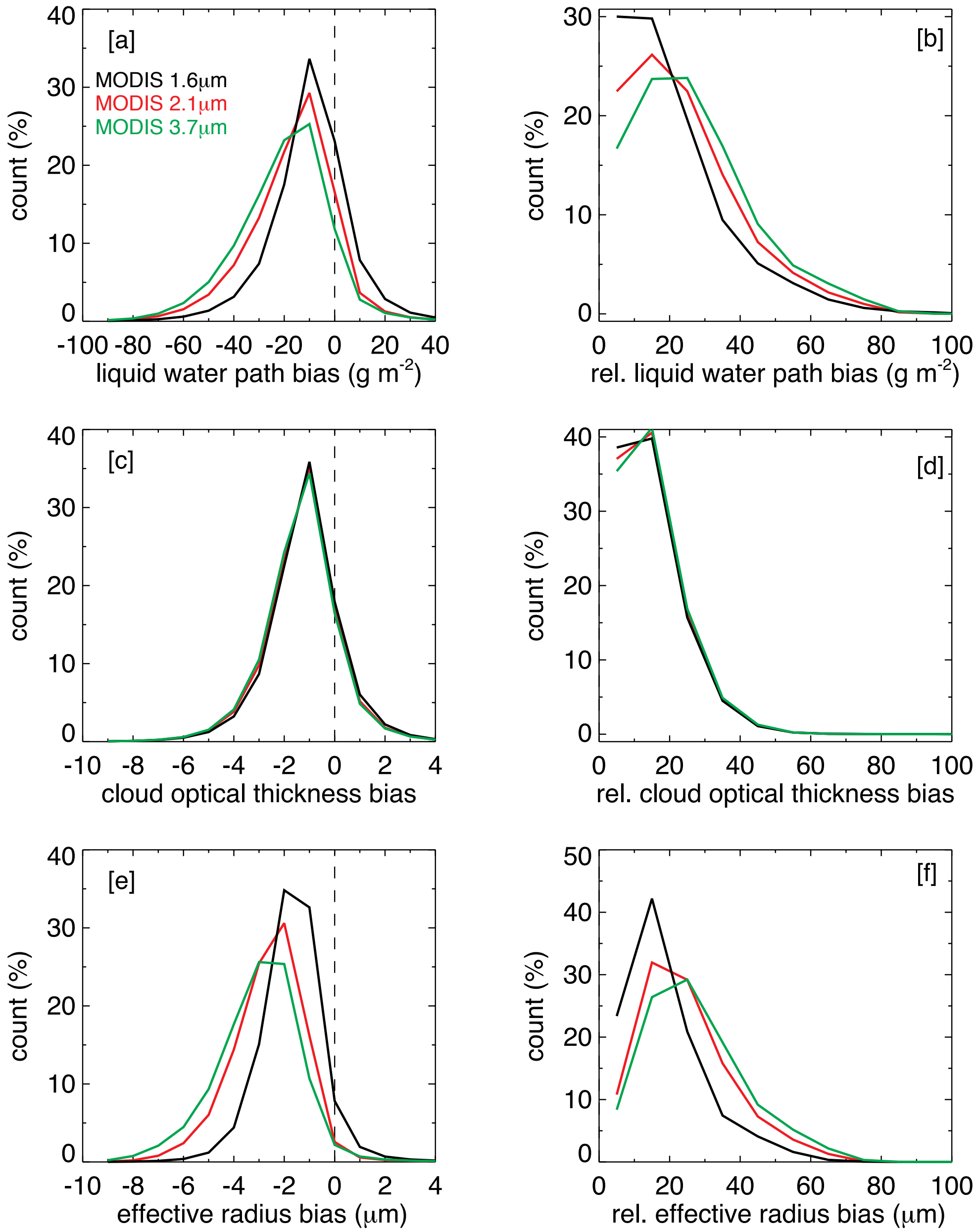

Figure S1. Histogram of SEVIRI – MODIS liquid water path differences (a), cloud optical thickness differences (c), and droplet effective radius differences (e), as well as, histogram of SEVIRI – MODIS LWP, COT, CER differences relative to MODIS LWP (b), COT (d), and CER (f) for JAS 2011 and JAS 2012 for overcast (LCF ≥ 95% and COT > 3) rain- and ice-free conditions.

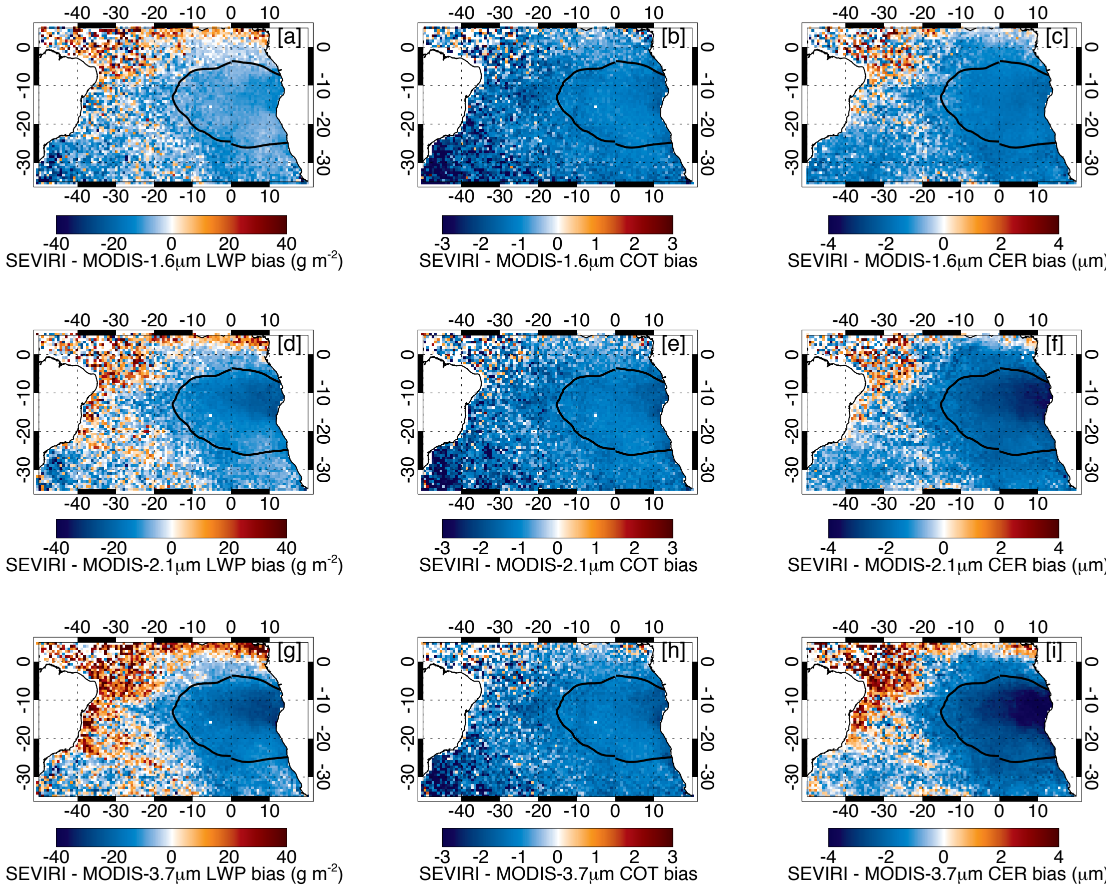

Figure S2. Spatial distribution of SEVIRI liquid water path biases (a, d, g), cloud optical thickness biases (b, e, h), and droplet effective radius biases (c, f, i), compared to MODIS 1.6-, 2.1-, and 3.7-μm channel retrievals, respectively, averaged for JAS 2011 and JAS 2012 for overcast (LCF ≥ 95% and COT > 3) rain- and ice-free conditions.

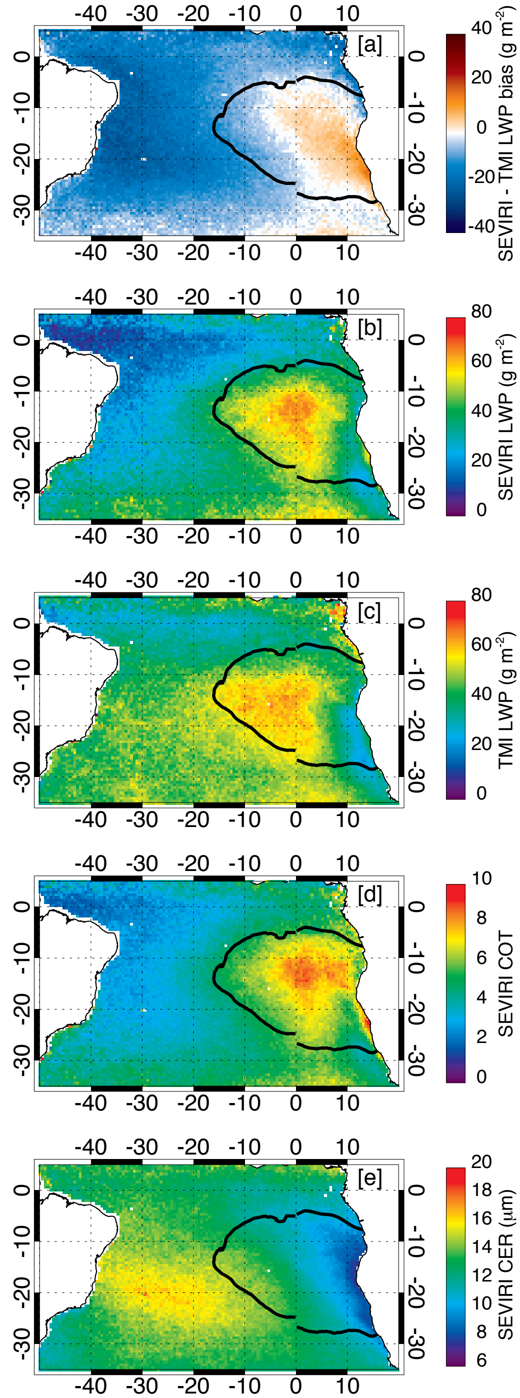

Figure S3. Two-year mean map of (a) SEVIRI minus TMI LWP difference, (b) SEVIRI LWP, (c) TMI LWP, (d) SEVIRI COT, (e) SEVIRI 1.6-μm CER, for the all-sky case. The solid black contour denotes the identified Sc region. Rain-, ice-, and aerosol-free conditions were applied.

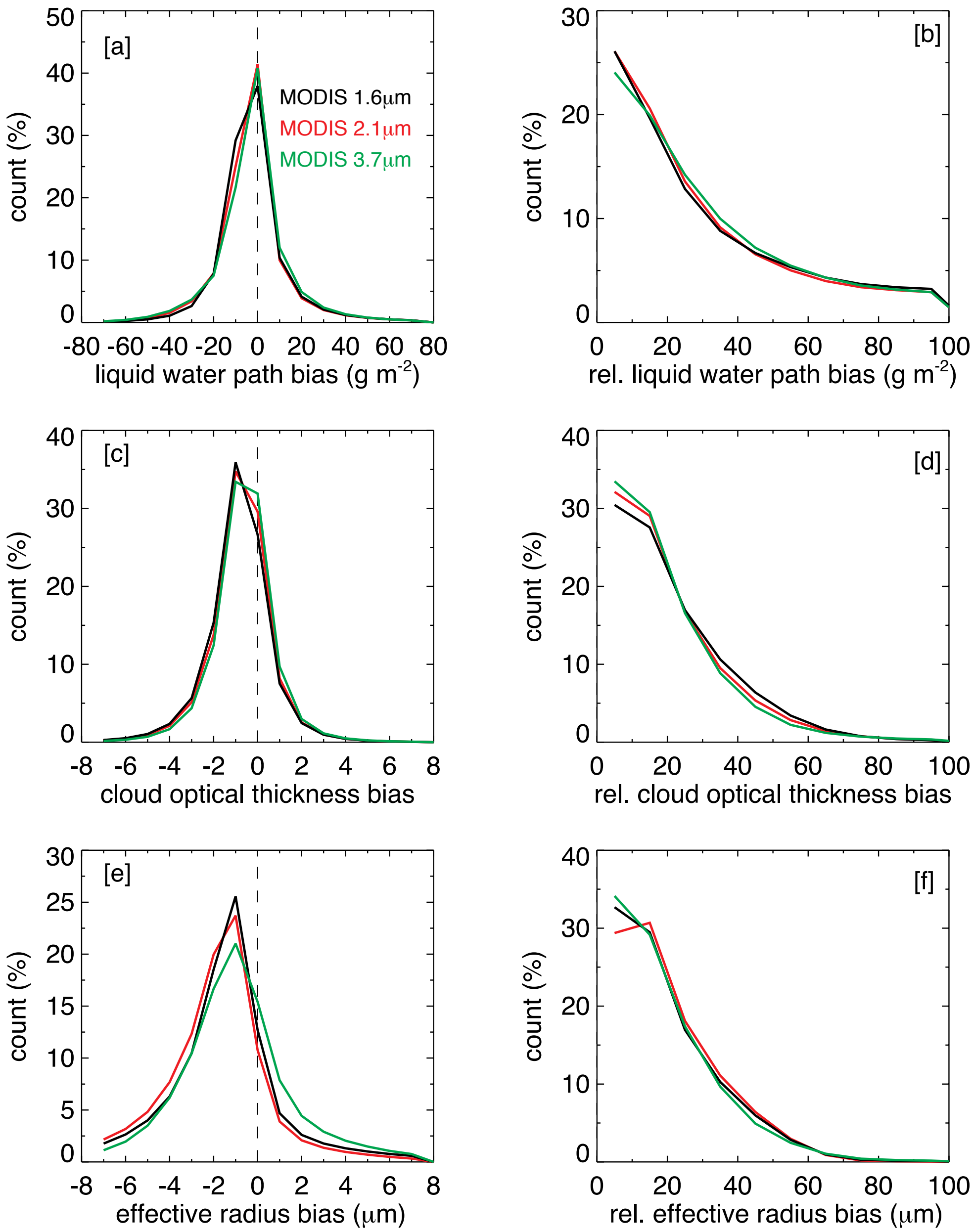

Figure S4. Histogram of SEVIRI – MODIS liquid water path differences (a), cloud optical thickness differences (c), and droplet effective radius differences (e), as well as, histogram of SEVIRI – MODIS LWP, COT, CER differences relative to MODIS LWP (b), COT (d), and CER (f) for December 2010 to November 2012 for the all-sky case with rain- and ice-free conditions.

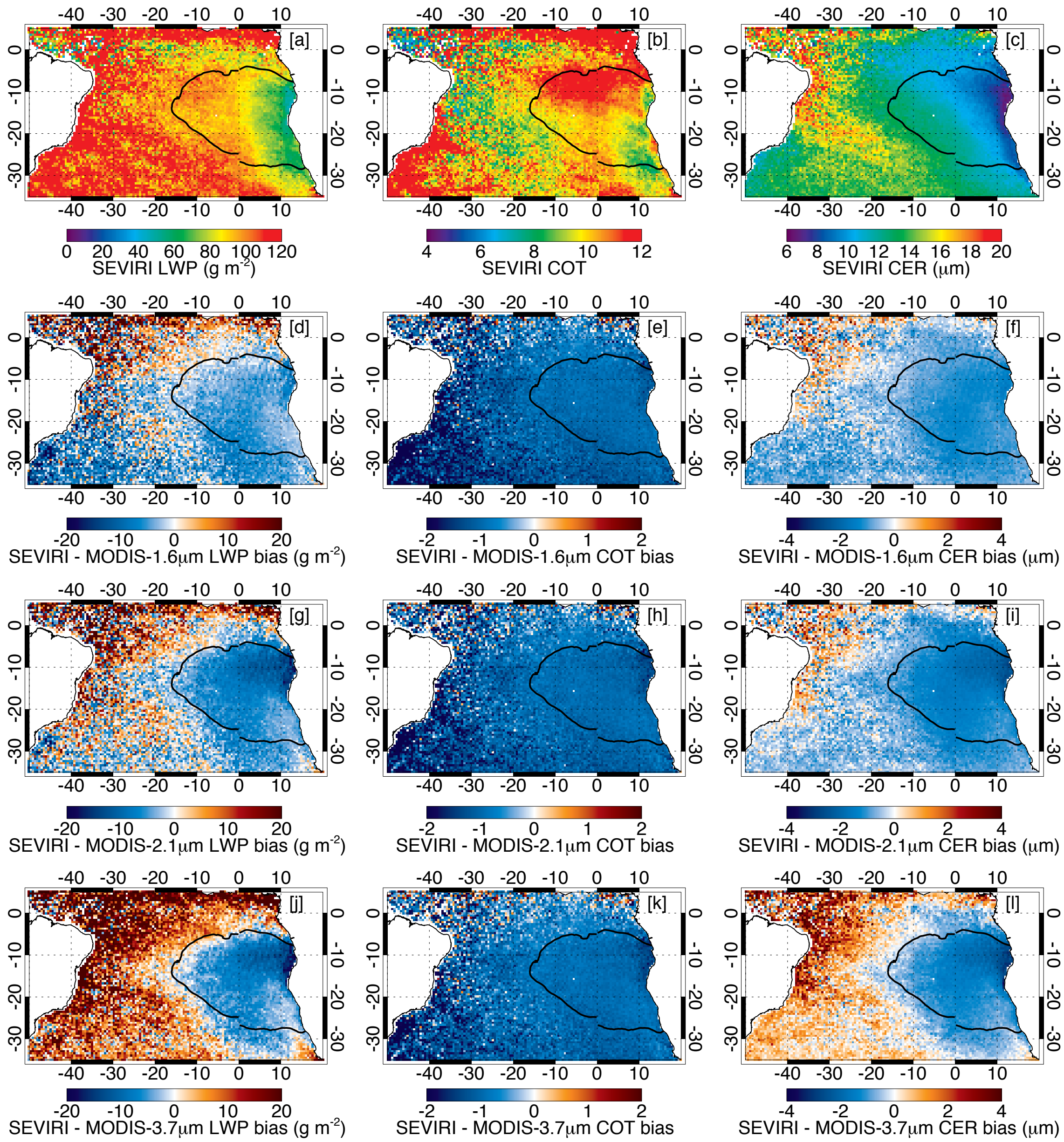

Figure S5. Two-year mean map of (a) SEVIRI LWP, (b) SEVIRI COT, (c) SEVIRI CER, (d, g, j) SEVIRI minus MODIS liquid water path biases, (e, h, k) SEVIRI minus MODIS cloud optical thickness biases, (f, i, l) SEVIRI minus MODIS droplet effective radius biases for the overcast case (LCF ≥ 95% and COT > 3) in ice- and smoke-free conditions.

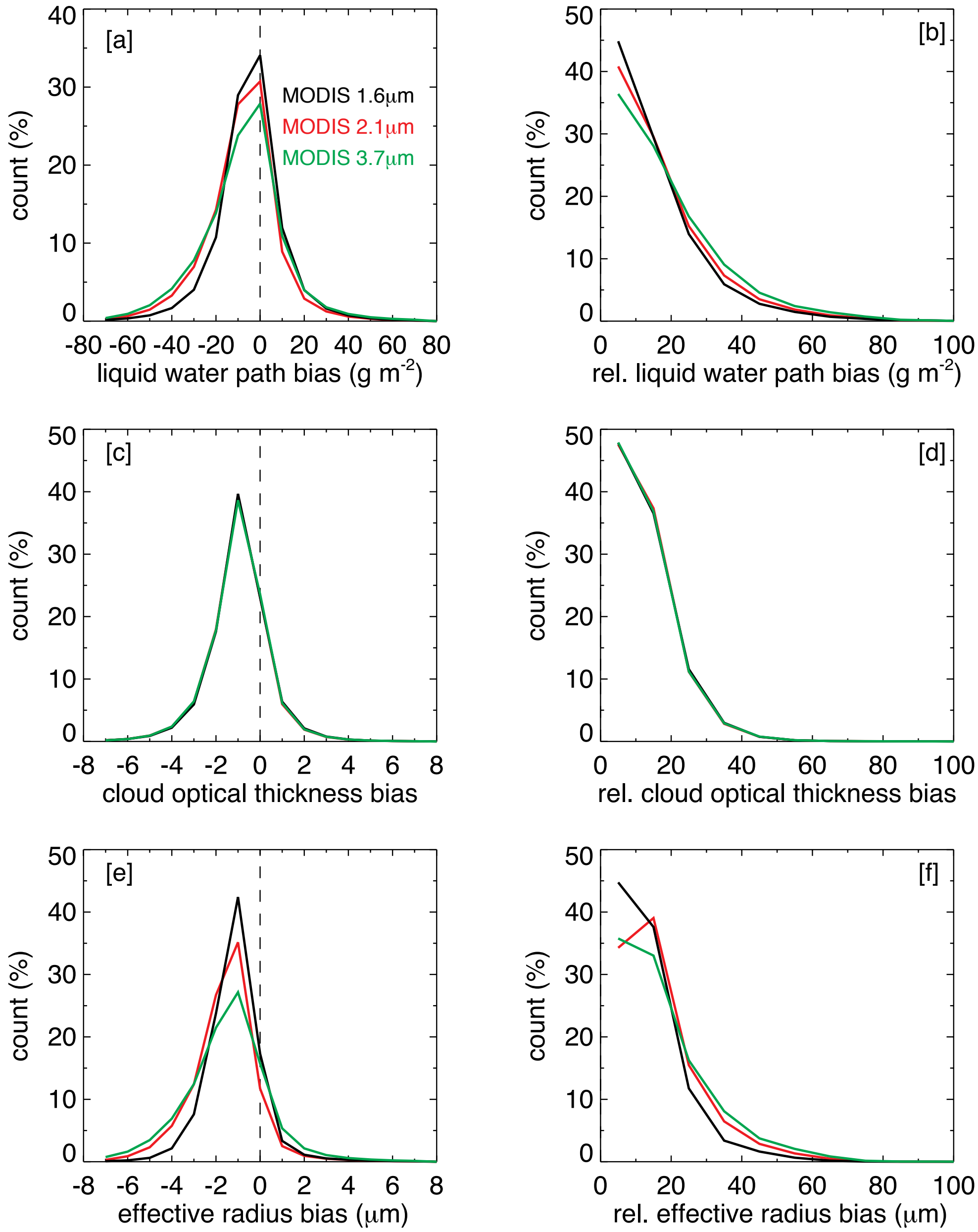

Figure S6. Histogram of SEVIRI – MODIS liquid water path differences (a), cloud optical thickness differences (c), and droplet effective radius differences (e), as well as, histogram of SEVIRI – MODIS LWP, COT, CER differences relative to MODIS LWP (b), COT (d), and CER (f) for December 2010 to November 2012 for the overcast case (LCF ≥ 95% and COT > 3) in rain- and ice-free conditions.

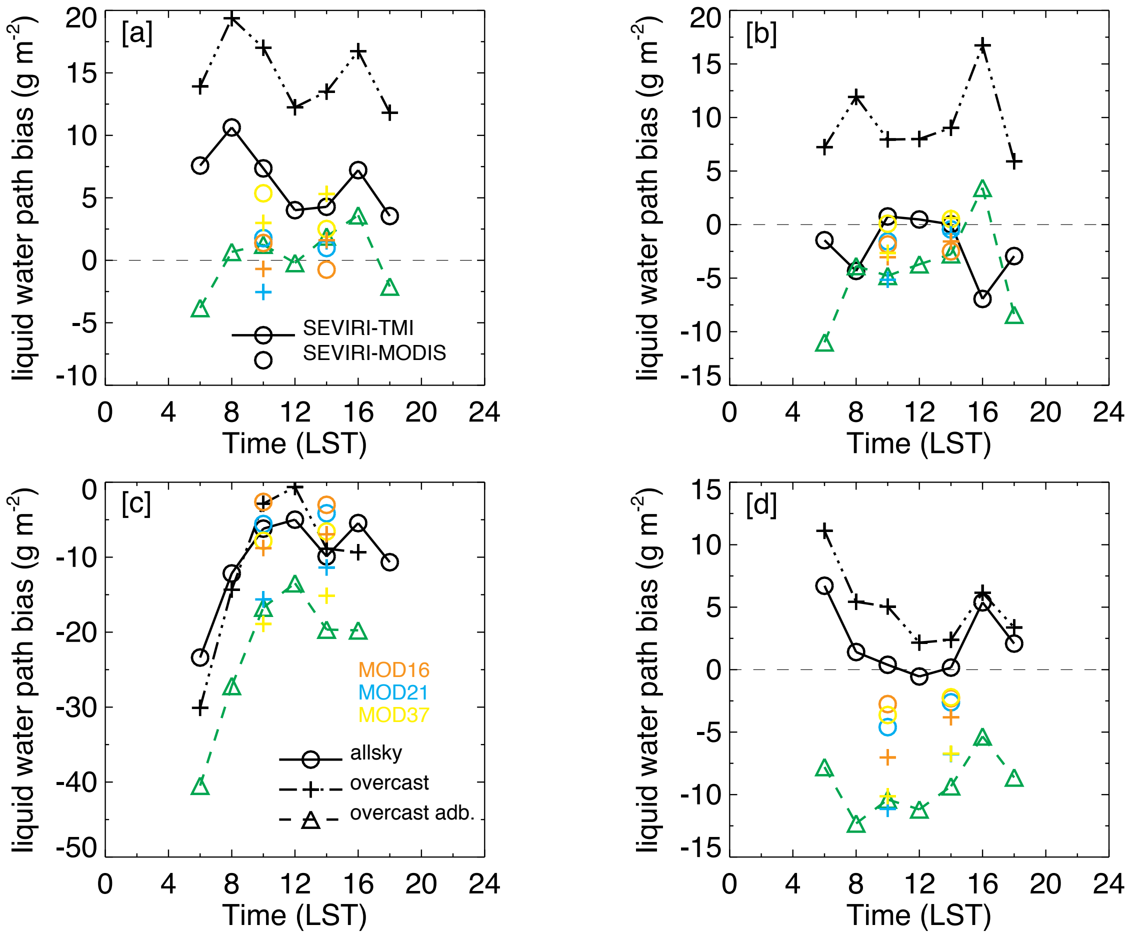

Figure S7. Seasonal mean diurnal cycle of SEVIRI LWP bias compared to TMI as well as Terra and Aqua MODIS, over the Sc region, both for all-sky and overcast-cases (LCF ≥ 95% and COT > 3): (a) DJF, (b) MAM, (c) JJA, and (d) SON of the study period. Rain-, ice-, and smoke-free conditions were applied.

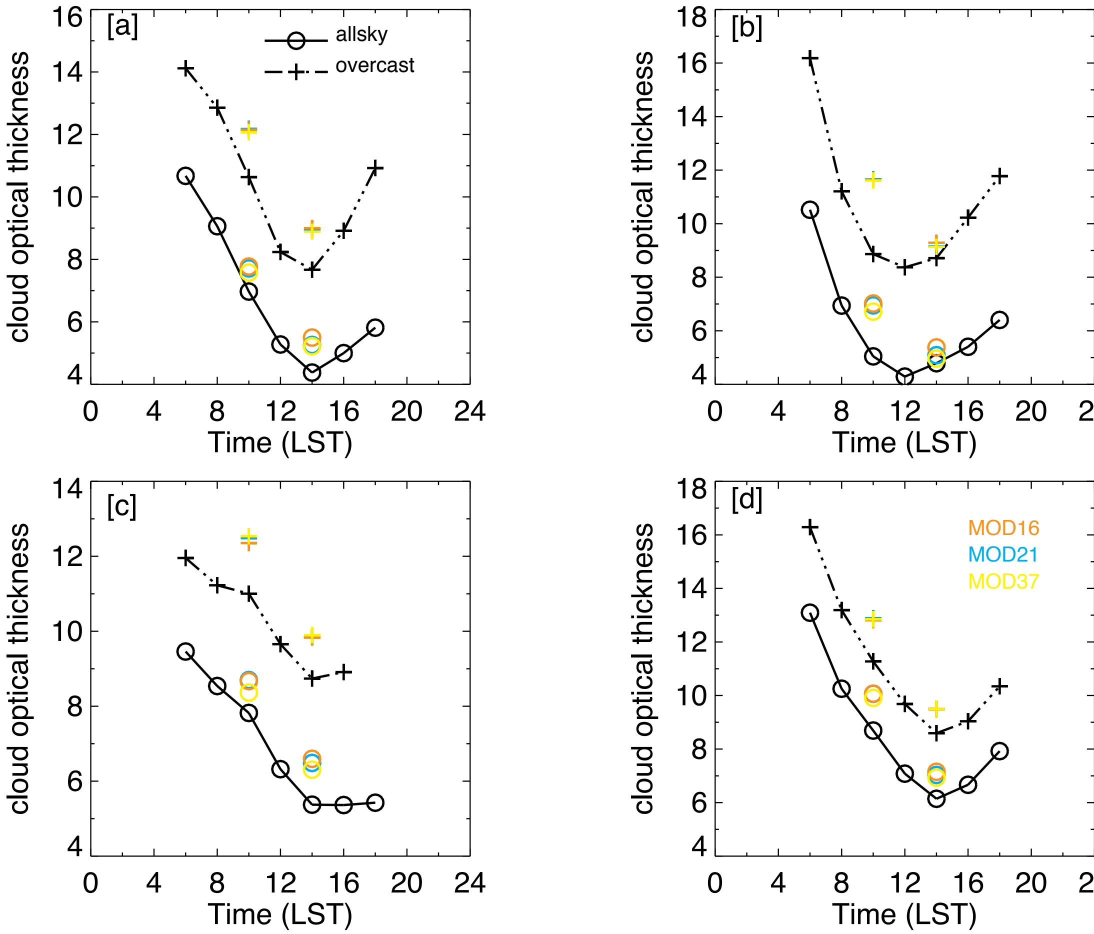

Figure S8. Seasonal mean diurnal cycle of SEVIRI and Terra and Aqua MODIS cloud optical thicknesses over the Sc region, both for all-sky and overcast-cases (LCF ≥ 95% and COT > 3): (a) DJF, (b) MAM, (c) JJA, and (d) SON of the study period.

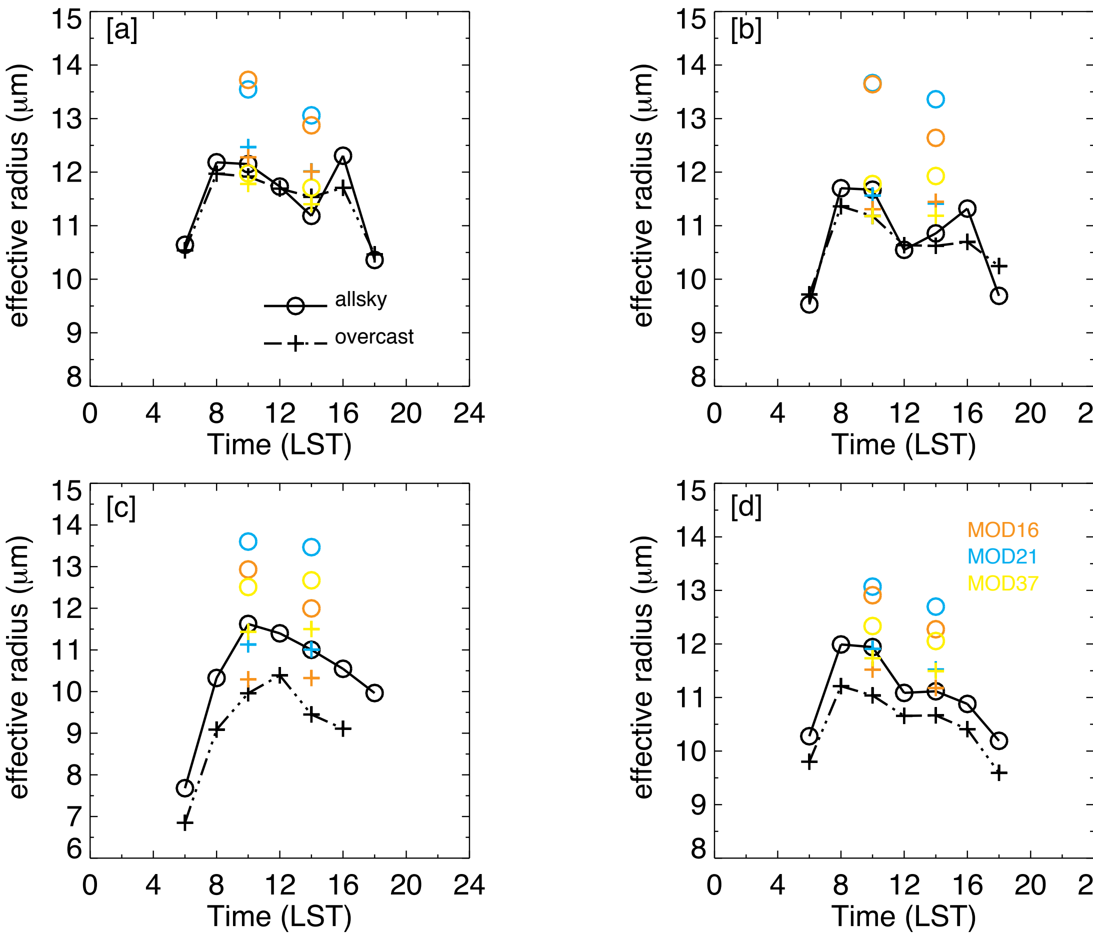

Figure S9. Seasonal mean diurnal cycle of SEVIRI and Terra and Aqua MODIS cloud droplet effective radius over the Sc region, both for all-sky and overcast-cases (LCF ≥ 95% and COT > 3): (a) DJF, (b) MAM, (c) JJA, and (d) SON of the study period.