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), $\tau > 3$, and overcast (LCF ≥ 95%) grid cells over the marine stratocumulus region. The τ means and r_e means (in micron) are listed. The values in brackets are statistics without filtering for LCF ≥ 95% and $\tau > 3$, i.e., for the all-sky case.

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

Discussion: Frequency histograms of SEVIRI – MODIS LWP, τ, and r_e difference, as well as, the differences relative to MODIS LWP, τ, and r_e for the overcast condition aggregated during JAS 2011 and JAS 2012 are shown in Fig. S1. The histogram of SEVIRI – MODIS τ 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 τ relative to MODIS τ 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 τ appeared to be low by ~1 compared to MODIS τ.

SEVIRI r_e retrieved in the 1.6-μm channel was compared with MODIS r_e values retrieved in three water absorbing channels at 1.6-, 2.1-, and 3.7-μm. Compared to the 1.6-μm MODIS r_e, ~70 % of SEVIRI r_e have a mean difference of -1.5 μm. Compared to the 2.1- and 3.7-μm MODIS r_e, the difference histograms indicate larger

differences: ~55 % and ~50 % of SEVIRI r_e have a difference of -2.5 µm, respectively. Although SEVIRI r_e are biased low compared to all three MODIS r_e, the ~1 µm additional low bias relative to the 2.1- and 3.7-µm r_e likely indicates much smaller smoke-induced retrieval artifacts in these two channels. In general, the r_e 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 r_e 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, τ, and r_e differences, as well as the difference with respect to different MODIS channels for the 2-year aggregate are shown in Fig. S3 (all-sky case) and Fig. S4 (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 τ differences within 10 %, 20 %, and 30 % in the overcast case. Similarly, about 90 % of the observations show relative r_e differences within 30 % in the overcast case. Histograms of both τ and r_e differences reveal that the distribution is off centered. Histograms of τ 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 r_e 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.

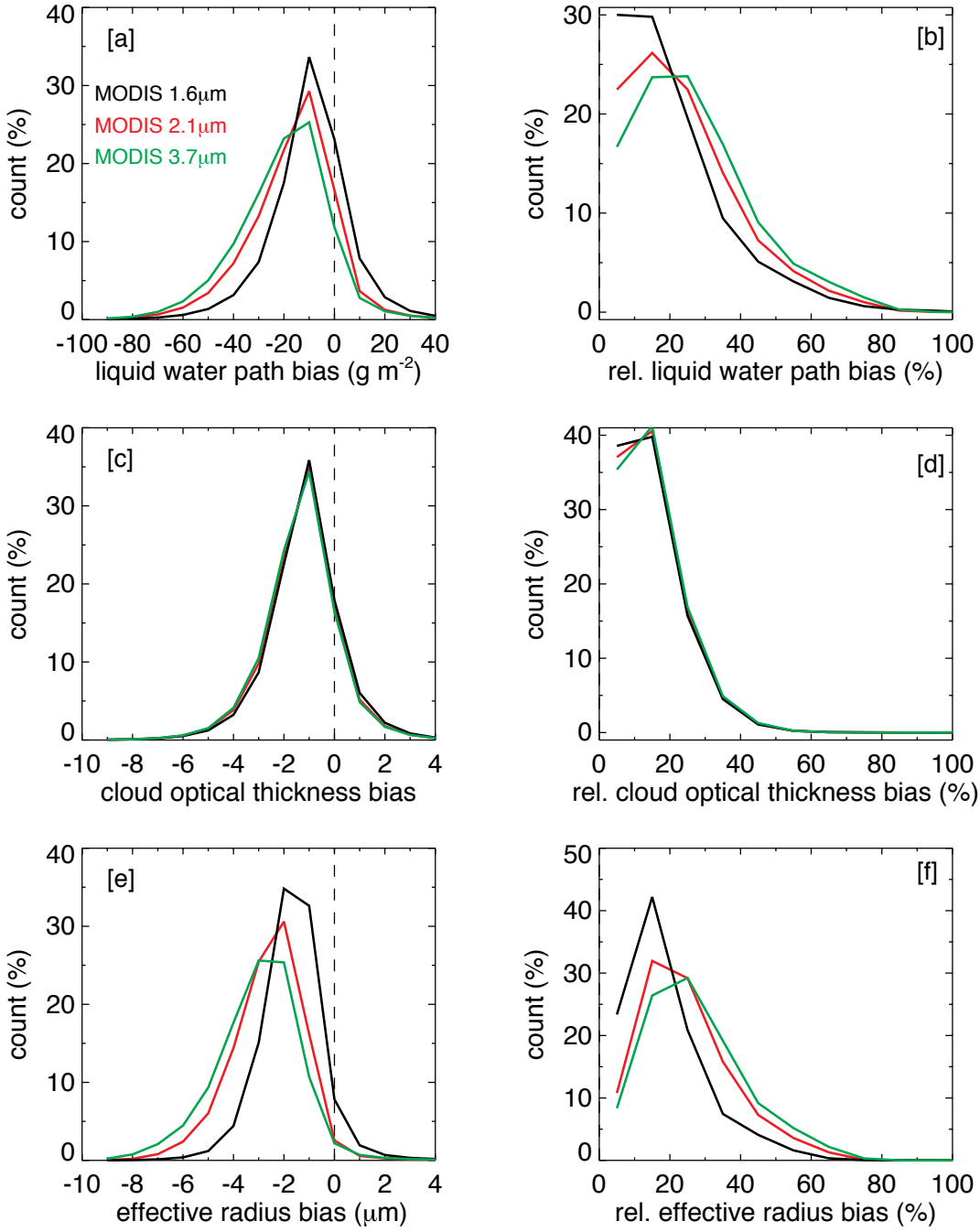

Figure S1. Histogram of SEVIRI – MODIS liquid water path differences (a), cloud optical thickness differences (c), and droplet effective radius differences (e), as well as, histogram of SEVIRI – MODIS LWP, τ, r_e differences relative to MODIS LWP (b), τ (d), and r_e (f) for JAS 2011 and JAS 2012 for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

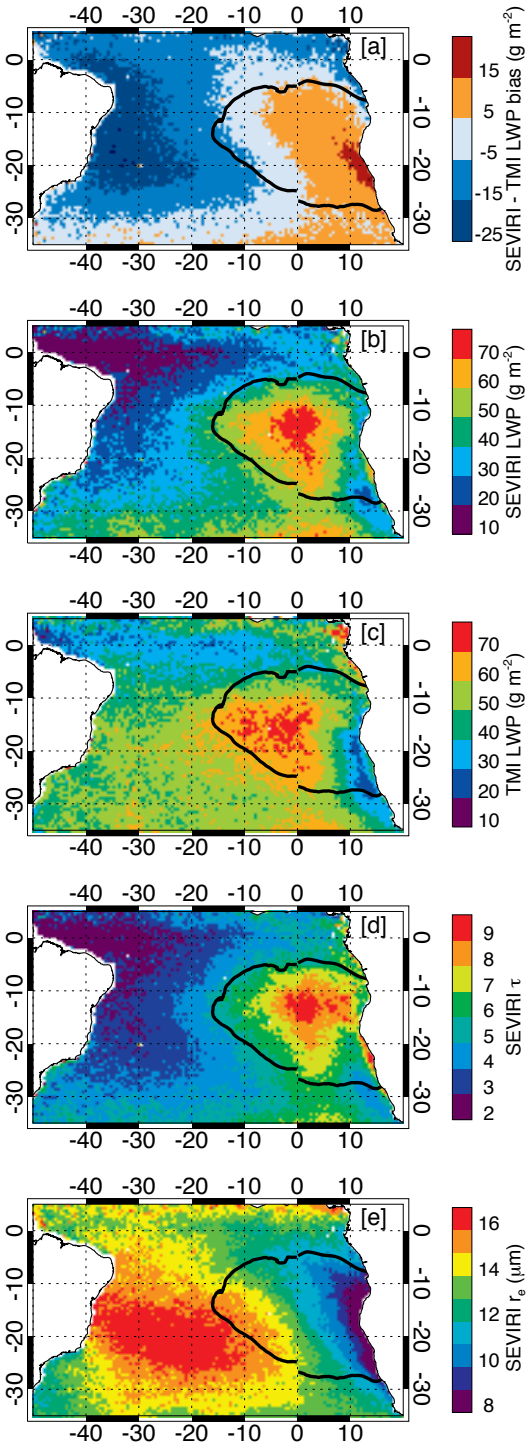

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Figure S2. Two-year mean map of (a) SEVIRI minus TMI LWP difference, (b) SEVIRI LWP, (c) TMI LWP, (d) SEVIRI τ, (e) SEVIRI 1.6-μm r_e, for the all-sky case. The solid black contour denotes the identified Sc region. Rain-, ice-, and aerosol-free conditions were applied.

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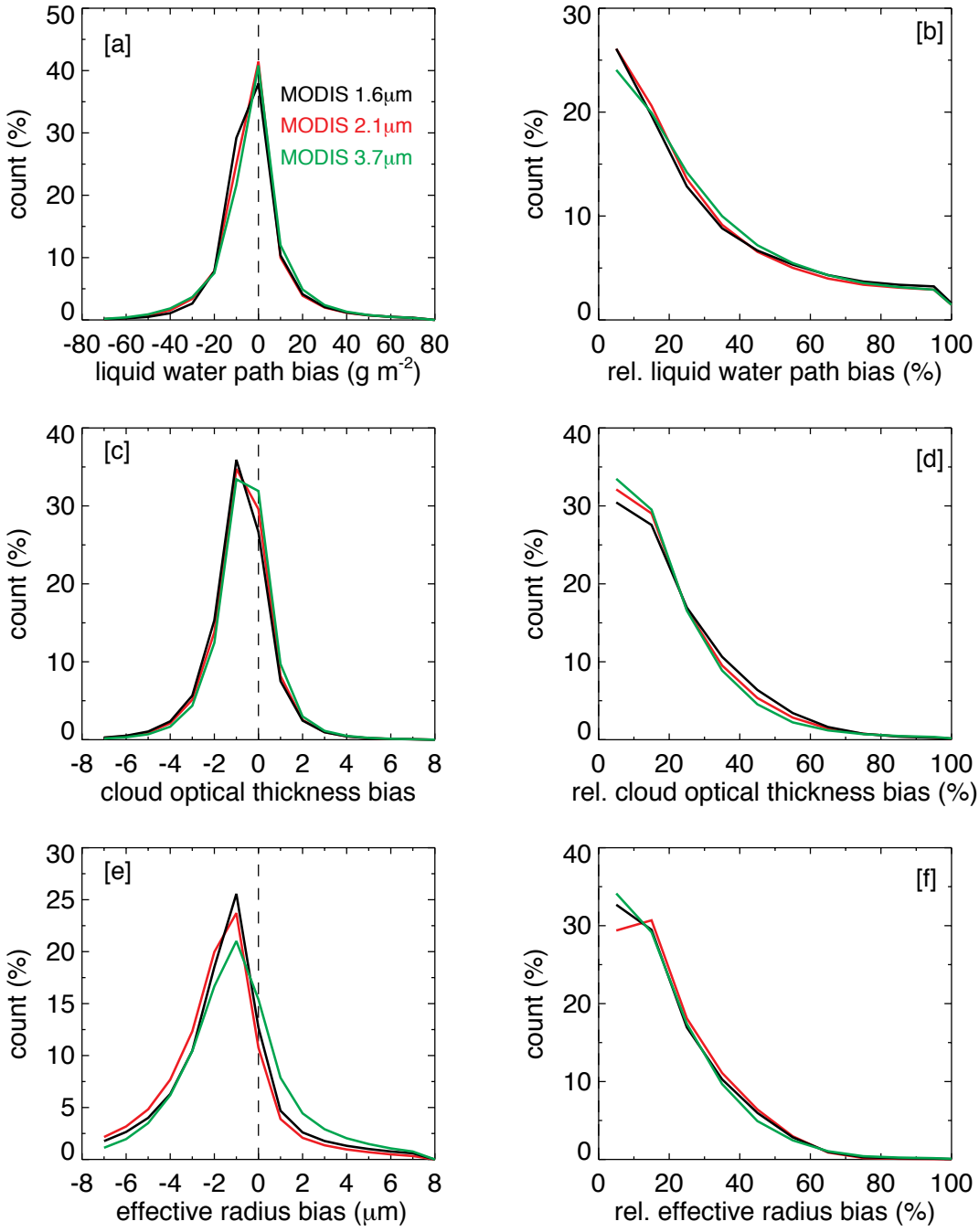

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Figure S3. Histogram of SEVIRI – MODIS liquid water path differences (a), cloud optical thickness differences (c), and droplet effective radius differences (e), as well as, histogram of SEVIRI – MODIS LWP, τ, r_e differences relative to MODIS LWP (b), τ (d), and r_e (f) for December 2010 to November 2012 for the all-sky case with rain- and ice-free conditions.

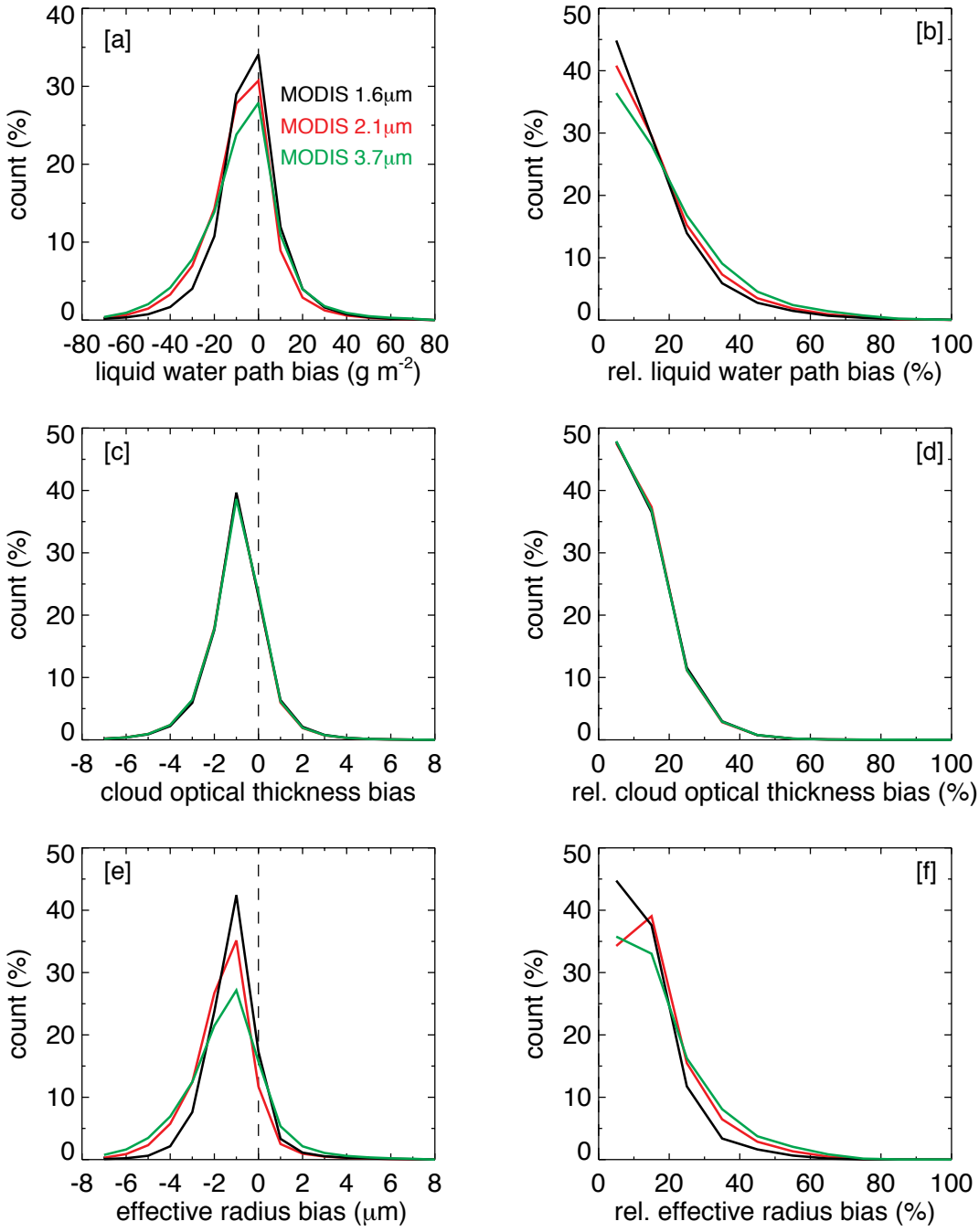

Figure S4. Histogram of SEVIRI – MODIS liquid water path differences (a), cloud optical thickness differences (c), and droplet effective radius differences (e), as well as, histogram of SEVIRI – MODIS LWP, τ, r_e differences relative to MODIS LWP (b), τ (d), and r_e (f) for December 2010 to November 2012 for the overcast case (LCF $\geq$ 95 % and $\tau > 3$) in rain- and ice-free conditions.

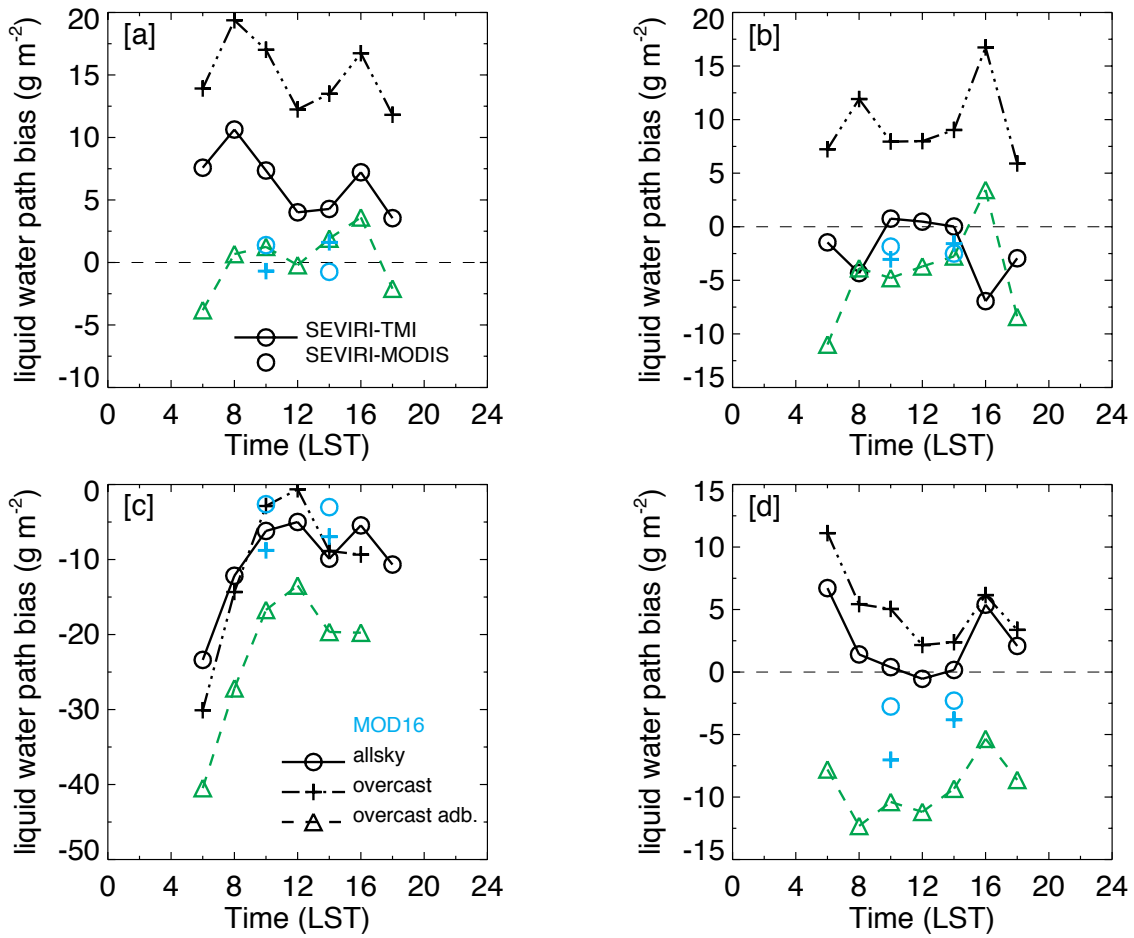

Figure S5. Seasonal mean diurnal cycle of SEVIRI LWP bias compared to TMI as well as Terra and Aqua MODIS, over the Sc region, both for all-sky and overcast-cases (LCF ≥ 95 % and τ > 3): (a) DJF, (b) MAM, (c) JJA, and (d) SON of the study period. Rain-, ice-, and smoke-free conditions were applied.

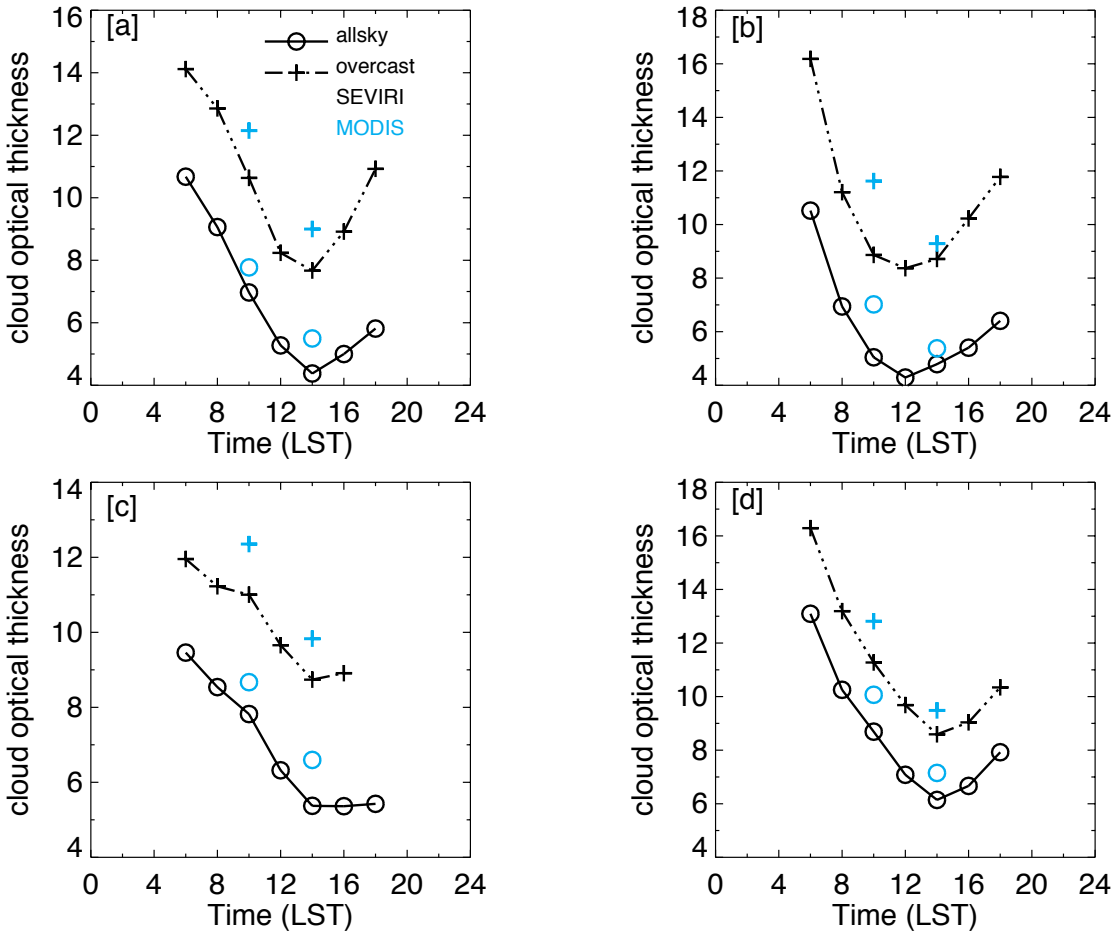

Figure S6. Seasonal mean diurnal cycle of SEVIRI and Terra and Aqua MODIS cloud optical thicknesses over the Sc region, both for all-sky and overcast-cases (LCF ≥ 95 % and $\tau > 3$): (a) DJF, (b) MAM, (c) JJA, and (d) SON of the study period.

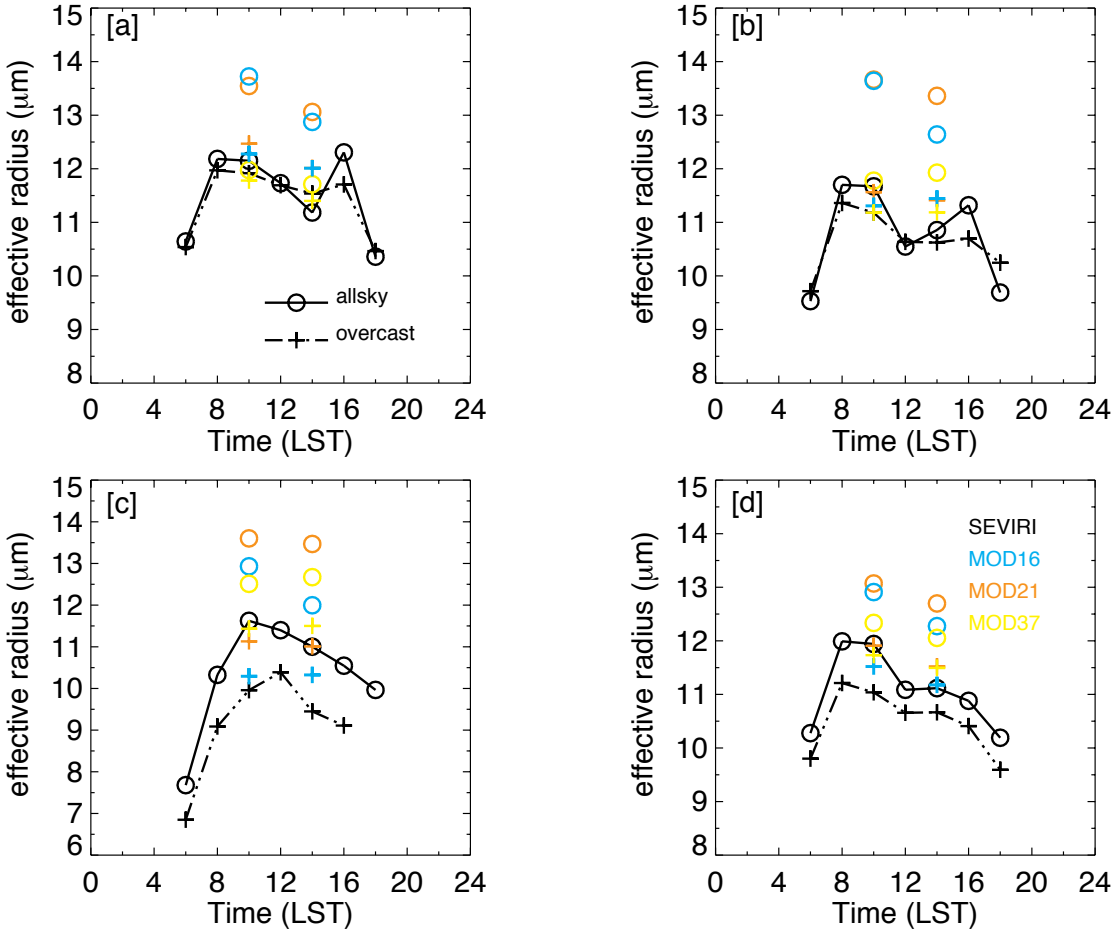

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Figure S7. Seasonal mean diurnal cycle of SEVIRI and Terra and Aqua MODIS cloud droplet effective radius over the Sc region, both for all-sky and overcast-cases (LCF ≥ 95 % and τ > 3): (a) DJF, (b) MAM, (c) JJA, and (d) SON of the study period.

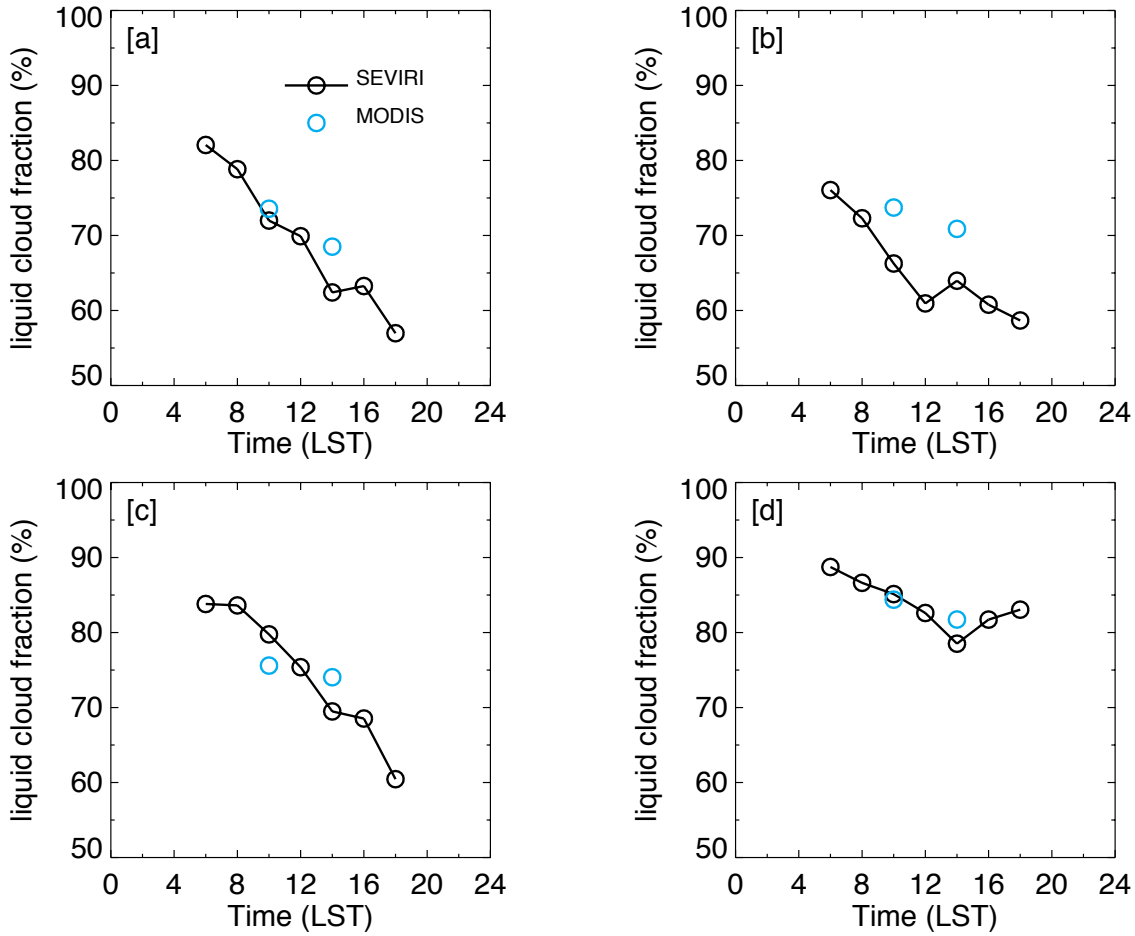

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Figure S8. Seasonal mean diurnal cycle of SEVIRI and Terra and Aqua MODIS liquid cloud fraction over the Sc region, for all-sky case: (a) DJF, (b) MAM, (c) JJA, and (d) SON of the study period.