



*Supplement of*

## **Climatologically invariant scale invariance seen in distributions of cloud horizontal sizes**

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## **S1 Numerical values of plotted data**

Tables S1 through S11 list the numerical values plotted in the Figures in the main text as well as additional information about the data in each plot. Note that all values listed here have been rounded in accordance with their uncertainties and might therefore appear slightly different in plots.

Table S1: Numerical values plotted in Fig. 2. The mean for all datasets is  $\langle \alpha \rangle = 0.95 \pm 0.08$ .

Dataset	$\alpha$	$a_{\min}$ (km <sup>2</sup> )	$a_{\max}$ (km <sup>2</sup> )	Total Count in Histogram	Dates Examined
<b>MODIS 0.25km</b>	$0.90 \pm 0.02$	$\leq 3$	$\geq 2 \times 10^4$	$1 \times 10^5$ (96763)	01 January 2021 to 10 January 2021
<b>MODIS 1km</b>	$0.943 \pm 0.008$	$\leq 1 \times 10^1$	$\geq 3 \times 10^4$	$3 \times 10^8$ (298407040)	01 January 2012 to 01 January 2013
<b>VIIRS</b>	$0.98 \pm 0.01$	$\leq 1 \times 10^1$	$\geq 4 \times 10^4$	$6 \times 10^8$ (551060352)	01 January 2021 to 01 January 2022
<b>POLDER</b>	$0.90 \pm 0.02$	$\leq 8 \times 10^1$	$\geq 5 \times 10^3$	$3 \times 10^5$ (305733)	01 January 2012 to 01 January 2013
<b>MSG 42°</b>	$0.94 \pm 0.01$	$\leq 1 \times 10^2$	$\geq 3 \times 10^5$	$3 \times 10^6$ (3244516)	01 January 2021 to 01 January 2022
<b>MSG 0°</b>	$0.96 \pm 0.02$	$\leq 1 \times 10^2$	$\geq 2 \times 10^5$	$4 \times 10^6$ (3784562)	01 January 2021 to 01 January 2022
<b>Himawari 141°</b>	$0.99 \pm 0.02$	$\leq 4 \times 10^1$	$\geq 2 \times 10^5$	$8 \times 10^6$ (7564319)	01 January 2021 to 01 January 2022
<b>EPIC</b>	$0.91 \pm 0.02$	$\leq 9 \times 10^3$	$\geq 4 \times 10^5$	$6 \times 10^5$ (627068)	01 January 2017 to 01 January 2018
<b>GOES -137°</b>	$0.99 \pm 0.02$	$\leq 4 \times 10^1$	$\geq 4 \times 10^5$	$8 \times 10^6$ (8462897)	01 January 2021 to 01 January 2022
<b>GOES -75°</b>	$1.01 \pm 0.02$	$\leq 4 \times 10^1$	$\geq 3 \times 10^5$	$8 \times 10^6$ (8045113)	01 January 2021 to 01 January 2022

Table S2: Numerical values plotted in Fig. 3. The mean for all satellite datasets (excluding SAM) is  $\langle\beta\rangle = 1.26 \pm 0.06$ .

<b>Dataset</b>	$\beta$	$p_{\min}$ (km)	$p_{\max}$ (km)	Total Count in Histogram	Dates Examined
<b>MODIS 0.25km</b>	$1.22 \pm 0.02$	$\leq 3$	$\geq 3 \times 10^4$	$5 \times 10^5$ (524171)	01 January 2021 to 10 January 2021
<b>MODIS 1km</b>	$1.22 \pm 0.02$	$\leq 1 \times 10^1$	$\geq 1 \times 10^4$	$5 \times 10^8$ (517218432)	01 January 2012 to 01 January 2013
<b>VIIRS</b>	$1.26 \pm 0.03$	$\leq 1 \times 10^1$	$\geq 2 \times 10^4$	$1 \times 10^9$ (1173681920)	01 January 2021 to 01 January 2022
<b>POLDER</b>	$1.25 \pm 0.03$	$\leq 8 \times 10^1$	$\geq 8 \times 10^2$	$1 \times 10^5$ (134915)	01 January 2012 to 01 January 2013
<b>MSG 42°</b>	$1.25 \pm 0.01$	$\leq 3 \times 10^1$	$\geq 3 \times 10^4$	$6 \times 10^6$ (5775306)	01 January 2021 to 01 January 2022
<b>MSG 0°</b>	$1.27 \pm 0.01$	$\leq 3 \times 10^1$	$\geq 2 \times 10^4$	$6 \times 10^6$ (6466694)	01 January 2021 to 01 January 2022
<b>Himawari 141°</b>	$1.30 \pm 0.02$	$\leq 2 \times 10^1$	$\geq 5 \times 10^4$	$1 \times 10^7$ (9946716)	01 January 2021 to 01 January 2022
<b>GOES -137°</b>	$1.267 \pm 0.005$	$\leq 2 \times 10^1$	$\geq 5 \times 10^4$	$1 \times 10^7$ (11779489)	01 January 2021 to 01 January 2022
<b>GOES -75°</b>	$1.316 \pm 0.008$	$\leq 2 \times 10^1$	$\geq 3 \times 10^4$	$1 \times 10^7$ (12494704)	01 January 2021 to 01 January 2022
<b>EPIC</b>	$1.25 \pm 0.01$	$\leq 3 \times 10^2$	$\geq 1 \times 10^4$	$2 \times 10^6$ (1869522)	01 January 2017 to 01 January 2018
<b>SAM</b>	$0.98 \pm 0.03$	$\leq 1$	$\geq 1 \times 10^3$	$4 \times 10^6$ (4143644)	Timesteps: 0000021600 to 0000045000

Table S3: Numerical values for VIIRS plotted in Fig. 4 for the northern midlatitude region (30°N to 60°N).

Dataset	Month	$\beta$	Total Count in Histogram	Dates Examined (Start/End)
VIIRS	Jan	$1.28 \pm 0.03$	$1 \times 10^7$ (11832716)	01 January 2021 to 01 February 2021
VIIRS	Feb	$1.26 \pm 0.03$	$1 \times 10^7$ (11235651)	01 February 2021 to 01 March 2021
VIIRS	Mar	$1.28 \pm 0.03$	$1 \times 10^7$ (11913838)	01 March 2021 to 01 April 2021
VIIRS	Apr	$1.27 \pm 0.03$	$1 \times 10^7$ (11172378)	01 April 2021 to 01 May 2021
VIIRS	May	$1.27 \pm 0.02$	$1 \times 10^7$ (12420857)	01 May 2021 to 01 June 2021
VIIRS	Jun	$1.28 \pm 0.03$	$1 \times 10^7$ (13869403)	01 June 2021 to 01 July 2021
VIIRS	Jul	$1.28 \pm 0.02$	$2 \times 10^7$ (16819652)	01 July 2021 to 01 August 2021
VIIRS	Aug	$1.27 \pm 0.02$	$2 \times 10^7$ (15563438)	01 August 2021 to 01 September 2021
VIIRS	Sept	$1.26 \pm 0.02$	$2 \times 10^7$ (15274810)	01 September 2021 to 01 October 2021
VIIRS	Oct	$1.27 \pm 0.03$	$1 \times 10^7$ (14316861)	01 October 2021 to 01 November 2021
VIIRS	Nov	$1.29 \pm 0.03$	$1 \times 10^7$ (11612482)	01 November 2021 to 01 December 2021
VIIRS	Dec	$1.27 \pm 0.03$	$1 \times 10^7$ (12388309)	01 December 2021 to 01 January 2022

Table S4: Numerical values for VIIRS plotted in Fig. 4 for the southern midlatitude region (60°S to 30°S).

Dataset	Month	$\beta$	Total Count in Histogram	Dates Examined (Start/End)
VIIRS	Jan	$1.27 \pm 0.03$	$1 \times 10^7$ (12760062)	01 January 2021 to 01 February 2021
VIIRS	Feb	$1.28 \pm 0.02$	$1 \times 10^7$ (11883713)	01 February 2021 to 01 March 2021
VIIRS	Mar	$1.28 \pm 0.03$	$1 \times 10^7$ (12439279)	01 March 2021 to 01 April 2021
VIIRS	Apr	$1.28 \pm 0.03$	$1 \times 10^7$ (12010962)	01 April 2021 to 01 May 2021
VIIRS	May	$1.29 \pm 0.03$	$1 \times 10^7$ (12073330)	01 May 2021 to 01 June 2021
VIIRS	Jun	$1.31 \pm 0.02$	$1 \times 10^7$ (11264441)	01 June 2021 to 01 July 2021
VIIRS	Jul	$1.31 \pm 0.02$	$1 \times 10^7$ (11542211)	01 July 2021 to 01 August 2021
VIIRS	Aug	$1.29 \pm 0.03$	$1 \times 10^7$ (10933924)	01 August 2021 to 01 September 2021
VIIRS	Sept	$1.28 \pm 0.03$	$1 \times 10^7$ (10506677)	01 September 2021 to 01 October 2021
VIIRS	Oct	$1.27 \pm 0.03$	$1 \times 10^7$ (11049687)	01 October 2021 to 01 November 2021
VIIRS	Nov	$1.28 \pm 0.02$	$1 \times 10^7$ (10384776)	01 November 2021 to 01 December 2021
VIIRS	Dec	$1.27 \pm 0.03$	$1 \times 10^7$ (11532109)	01 December 2021 to 01 January 2022

Table S5: Numerical values for MODIS 1km plotted in Fig. 4 for the northern midlatitude region (30°N to 60°N).

Dataset	Month	$\beta$	Total Count in Histogram	Dates Examined (Start/End)
MODIS 1km	Jan	$1.22 \pm 0.03$	$8 \times 10^6$ (7735275)	01 January 2012 to 01 February 2012
MODIS 1km	Feb	$1.22 \pm 0.03$	$7 \times 10^6$ (6994921)	01 February 2012 to 01 March 2012
MODIS 1km	Mar	$1.21 \pm 0.03$	$8 \times 10^6$ (7816003)	01 March 2012 to 01 April 2012
MODIS 1km	Apr	$1.22 \pm 0.03$	$7 \times 10^6$ (7441439)	01 April 2012 to 01 May 2012
MODIS 1km	May	$1.21 \pm 0.03$	$8 \times 10^6$ (7993072)	01 May 2012 to 01 June 2012
MODIS 1km	Jun	$1.21 \pm 0.03$	$8 \times 10^6$ (8015104)	01 June 2012 to 01 July 2012
MODIS 1km	Jul	$1.22 \pm 0.03$	$9 \times 10^6$ (8890881)	01 July 2012 to 01 August 2012
MODIS 1km	Aug	$1.24 \pm 0.02$	$9 \times 10^6$ (9147759)	01 August 2012 to 01 September 2012
MODIS 1km	Sept	$1.24 \pm 0.03$	$9 \times 10^6$ (8680551)	01 September 2012 to 01 October 2012
MODIS 1km	Oct	$1.24 \pm 0.03$	$8 \times 10^6$ (8231236)	01 October 2012 to 01 November 2012
MODIS 1km	Nov	$1.24 \pm 0.03$	$7 \times 10^6$ (7390606)	01 November 2012 to 01 December 2012
MODIS 1km	Dec	$1.23 \pm 0.03$	$7 \times 10^6$ (7330371)	01 December 2012 to 01 January 2013

Table S6: Numerical values for MODIS 1km plotted in Fig. 4 for the southern midlatitude region (60°S to 30°S).

Dataset	Month	$\beta$	Total Count in Histogram	Dates Examined (Start/End)
MODIS 1km	Jan	$1.27 \pm 0.02$	$5 \times 10^6$ (4843321)	01 January 2012 to 01 February 2012
MODIS 1km	Feb	$1.27 \pm 0.02$	$5 \times 10^6$ (4782315)	01 February 2012 to 01 March 2012
MODIS 1km	Mar	$1.27 \pm 0.02$	$4 \times 10^6$ (4497355)	01 March 2012 to 01 April 2012
MODIS 1km	Apr	$1.28 \pm 0.02$	$4 \times 10^6$ (4174592)	01 April 2012 to 01 May 2012
MODIS 1km	May	$1.29 \pm 0.02$	$4 \times 10^6$ (4461957)	01 May 2012 to 01 June 2012
MODIS 1km	Jun	$1.32 \pm 0.02$	$4 \times 10^6$ (4331315)	01 June 2012 to 01 July 2012
MODIS 1km	Jul	$1.32 \pm 0.02$	$4 \times 10^6$ (4261934)	01 July 2012 to 01 August 2012
MODIS 1km	Aug	$1.28 \pm 0.02$	$4 \times 10^6$ (4339969)	01 August 2012 to 01 September 2012
MODIS 1km	Sept	$1.28 \pm 0.02$	$4 \times 10^6$ (3975094)	01 September 2012 to 01 October 2012
MODIS 1km	Oct	$1.27 \pm 0.02$	$4 \times 10^6$ (4143936)	01 October 2012 to 01 November 2012
MODIS 1km	Nov	$1.27 \pm 0.02$	$4 \times 10^6$ (4260828)	01 November 2012 to 01 December 2012
MODIS 1km	Dec	$1.26 \pm 0.02$	$5 \times 10^6$ (4592295)	01 December 2012 to 01 January 2013

Table S7: Numerical values plotted in Fig. 5. The mean value for land is  $\langle\beta\rangle = 1.25 \pm 0.05$ , and the mean value for ocean is  $\langle\beta\rangle = 1.28 \pm 0.04$ .

Dataset	Surface Type	$\beta$	Total Count in Histogram	Dates Examined
<b>GOES -137°</b>	Land	$1.24 \pm 0.02$	$1 \times 10^6$ (1026350)	01 January 2021 to 01 January 2022
<b>GOES -137°</b>	Ocean	$1.29 \pm 0.02$	$1 \times 10^7$ (10782705)	01 January 2021 to 01 January 2022
<b>GOES -75°</b>	Land	$1.267 \pm 0.009$	$5 \times 10^6$ (5111640)	01 January 2021 to 01 January 2022
<b>GOES -75°</b>	Ocean	$1.29 \pm 0.01$	$8 \times 10^6$ (7515289)	01 January 2021 to 01 January 2022
<b>MSG 42°</b>	Land	$1.22 \pm 0.02$	$3 \times 10^6$ (2585362)	01 January 2021 to 01 January 2022
<b>MSG 42°</b>	Ocean	$1.27 \pm 0.02$	$3 \times 10^6$ (3238042)	01 January 2021 to 01 January 2022
<b>MSG 0°</b>	Land	$1.25 \pm 0.02$	$3 \times 10^6$ (2723026)	01 January 2021 to 01 January 2022
<b>MSG 0°</b>	Ocean	$1.24 \pm 0.02$	$4 \times 10^6$ (3816643)	01 January 2021 to 01 January 2022
<b>VIIRS</b>	Land	$1.28 \pm 0.04$	$3 \times 10^8$ (271358784)	01 January 2021 to 01 January 2022
<b>VIIRS</b>	Ocean	$1.29 \pm 0.03$	$9 \times 10^8$ (907178752)	01 January 2021 to 01 January 2022
<b>MODIS 1km</b>	Land	$1.21 \pm 0.03$	$2 \times 10^8$ (196269600)	01 January 2012 to 01 January 2013
<b>MODIS 1km</b>	Ocean	$1.28 \pm 0.02$	$3 \times 10^8$ (327173184)	01 January 2012 to 01 January 2013

Table S8: Numerical values plotted in Fig. 6.

Dataset	Latitude Band	$\beta$	Total Count in Histogram	Dates Examined
<b>VIIRS</b>	30° N to 60° N	$1.28 \pm 0.03$	$2 \times 10^8$ (158417344)	01 January 2021 to 01 January 2022
<b>VIIRS</b>	30° S to 30° N	$1.28 \pm 0.02$	$7 \times 10^8$ (660934016)	01 January 2021 to 01 January 2022
<b>VIIRS</b>	60° S to 30° S	$1.28 \pm 0.03$	$1 \times 10^8$ (138382944)	01 January 2021 to 01 January 2022
<b>MODIS 1km</b>	30° N to 60° N	$1.22 \pm 0.03$	$1 \times 10^8$ (95675152)	01 January 2012 to 01 January 2013
<b>MODIS 1km</b>	30° S to 30° N	$1.25 \pm 0.02$	$2 \times 10^8$ (247458704)	01 January 2012 to 01 January 2013
<b>MODIS 1km</b>	60° S to 30° S	$1.28 \pm 0.02$	$5 \times 10^7$ (52665044)	01 January 2012 to 01 January 2013

Table S9: Numerical values plotted in Fig. 8 for MODIS 0.25km. Cloudy pixels were defined as having optical reflectance  $R$  larger than the threshold (Section ??).

Threshold	$\beta$	Cloud Fraction	Total Count in Histogram	Dates Examined
$R = 0.10$	$1.25 \pm 0.03$	0.533	$6 \times 10^5$ (584446)	01 January 2021 to 11 January 2021
$R = 0.20$	$1.19 \pm 0.02$	0.368	$5 \times 10^5$ (489397)	01 January 2021 to 11 January 2021
$R = 0.30$	$1.11 \pm 0.02$	0.235	$4 \times 10^5$ (381510)	01 January 2021 to 11 January 2021
$R = 0.50$	$1.23 \pm 0.05$	0.064	$2 \times 10^5$ (152857)	01 January 2021 to 11 January 2021
$R = 0.70$	$1.19 \pm 0.05$	0.011	$2 \times 10^4$ (22156)	01 January 2021 to 11 January 2021

Table S10: Numerical values plotted in Fig. 8 for SAM “compressed”. Cloudy pixels were defined as having vertically-summed optical depth  $\tau$  larger than the threshold.

Threshold	$\beta$	Cloud Fraction	Total Count in Histogram	Dates Examined
$\tau = 0.1$	$1.44 \pm 0.05$	0.814	$4 \times 10^4$ (43503)	Timesteps: 0000021600 to 0000045000
$\tau = 0.3$	$1.27 \pm 0.06$	0.589	$8 \times 10^4$ (80621)	Timesteps: 0000021600 to 0000045000
$\tau = 1$	$1.19 \pm 0.05$	0.350	$8 \times 10^4$ (79375)	Timesteps: 0000021600 to 0000045000
$\tau = 3$	$1.13 \pm 0.05$	0.245	$5 \times 10^4$ (50676)	Timesteps: 0000021600 to 0000045000
$\tau = 10$	$1.01 \pm 0.05$	0.164	$3 \times 10^4$ (28389)	Timesteps: 0000021600 to 0000045000
$\tau = 30$	$0.93 \pm 0.04$	0.101	$2 \times 10^4$ (16088)	Timesteps: 0000021600 to 0000045000
$\tau = 100$	$0.99 \pm 0.05$	0.042	$8 \times 10^3$ (8071)	Timesteps: 0000021600 to 0000045000
$\tau = 300$	$0.94 \pm 0.08$	0.011	$3 \times 10^3$ (2996)	Timesteps: 0000021600 to 0000045000

Table S11: Numerical values plotted in Fig. 8 for SAM “layers”. Cloudy pixels were defined as those where all non-precipitating cloud condensate  $q_n$ , normalized by the saturation mixing ratio  $q^*$ , was greater than a threshold.

Threshold	$\beta$	Cloud Fraction	Total Count in Histogram	Dates Examined
$q_n/q^* = 0.003$	$0.98 \pm 0.03$	0.151	$5 \times 10^6$ (4526027)	Timesteps: 0000021600 to 0000045000
$q_n/q^* = 0.01$	$0.98 \pm 0.03$	0.133	$4 \times 10^6$ (4143644)	Timesteps: 0000021600 to 0000045000
$q_n/q^* = 0.03$	$0.96 \pm 0.03$	0.092	$3 \times 10^6$ (3345006)	Timesteps: 0000021600 to 0000045000
$q_n/q^* = 0.1$	$0.97 \pm 0.03$	0.024	$1 \times 10^6$ (1365900)	Timesteps: 0000021600 to 0000045000



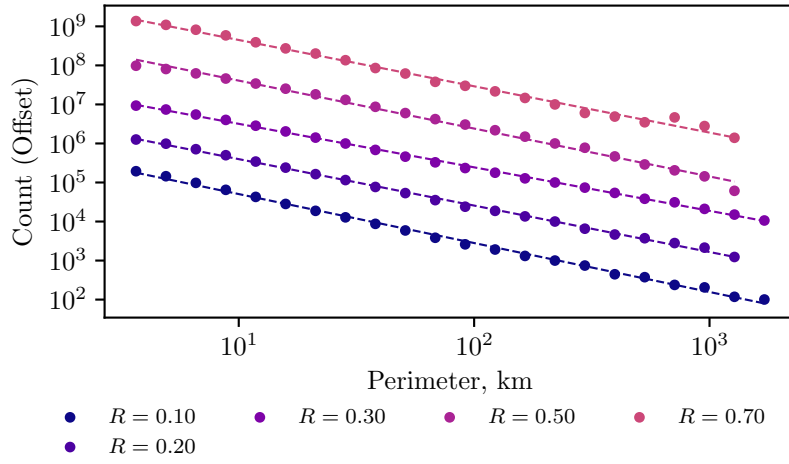


Figure S1: Cloud perimeter histograms from which values of  $\beta$  are calculated for MODIS 0.25km in Fig. 8. Values for  $\beta$  are calculated using a linear regression (dashed lines) as described in Sect. 4.3.

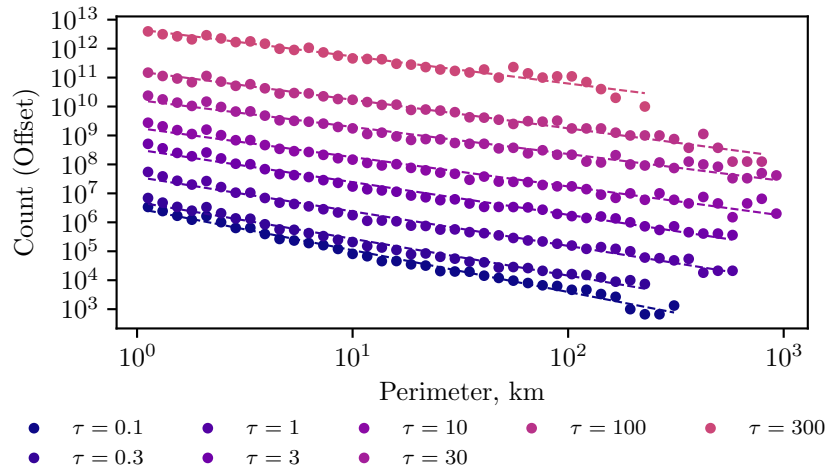


Figure S2: Cloud perimeter histograms from which values of  $\beta$  are calculated for SAM Compressed in Fig. 8. Values for  $\beta$  are calculated using a linear regression (dashed lines) as described in Sect. 4.3.

## S2 Histograms for Fig. 8

Figures S1, S2, and S3 display the cloud perimeter histograms from which values of  $\beta$  are calculated in Fig. 8 for the MODIS optical reflectance, SAM compressed, and SAM layers cases, respectively.

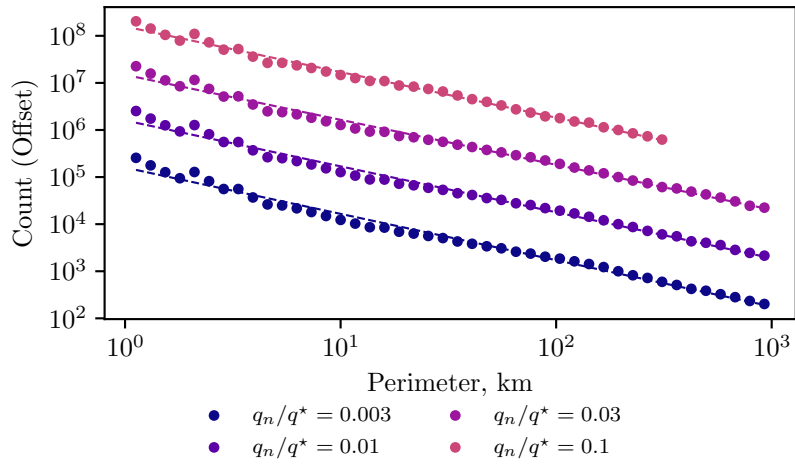


Figure S3: Cloud perimeter histograms from which values of  $\beta$  are calculated for SAM Layers in Fig. 8. Values for  $\beta$  are calculated using a linear regression (dashed lines) as described in Sect. 4.3.