Comparison of global cloud fraction S5P/TROPOMI measurements from November 2017 to December 2021 with Synoptic observations

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Data

Synoptic
- Cloud fraction (CF) (geometric) and cloud type daytime **observations** of around 150 land stations worldwide performed by **experienced meteorologists**.

S5P / TROPOMI
- Effective radiometric CF **measurements**.
- "Clouds-As-Layers" (CAL) model [clouds are treated as optically uniform layers of light-scattering particles (water droplets)].
- Optical Cloud Recognition Algorithm (OCRA) / Retrieval of Cloud Information using Neural Networks (ROCINN) algorithms.
- Level-2 processed in offline mode with UPAS Version-2.
- Qa_value ≥ 0.5, SZA < 80°, Snow/ice absent (flag).

Analysis

- Temporal difference between Synoptic observation and S5P.TROPOMI measurement ≤ 10 min.
- Spatial distance between S5P/TROPOMI pixel center and Synoptic land station ≤ 11 km.

Results

Analysis results between S5P/TROPOMI CF measurements and Synoptic CF observations — Nov. 2017-Dec. 2021, V2, OCRA/ROCINN CAL

	Mean of differences	SD	Number of collocations	% of total data	r	Slope	Intercept
In case of different Synoptic cloud types been observed in							
Northern Polar-Region							
total data	-7.7	21.7	3384	100	0.74	0.99	-6.9
clear sky	--	--	<30	--	--	--	--
a single h.l.	-7.4	26.1	418	12	0.67	0.86	0.2
multiple h.l.	-10.4	23.5	1803	53	0.69	1.01	-11.4
a single or multiple h.l.	-4.1	15.1	1140	34	0.32	0.86	8.9
Southern Polar-Region							
total data	-27.4	38.6	517	100	0.35	0.44	15.3
clear sky	--	--	<30	--	--	--	--
a single h.l.	-26.4	45.5	138	27	0.14	0.15	26.3
multiple h.l.	-30.5	36.9	290	56	0.36	0.52	7.1
a single or multiple h.l.	-21.5	27.2	86	17	0.16	0.59	18.1
Tropical Region							
total data	-15.9	26.0	852	100	0.63	1.04	-18.9
clear sky	--	--	<30	--	--	--	--
a single h.l.	-16.3	24.4	209	25	0.58	0.96	-13.8
multiple h.l.	-18.3	28.2	525	62	0.44	0.87	-9.1
a single or multiple h.l.	-4.8	12.3	118	14	0.10	0.17	77.1
Northern Temperate Region							
total data	-4.6	20.0	6029	100	0.82	0.93	-1.3
clear sky	6.6	9.5	668	11	--	--	--
a single h.l.	-4.4	18.7	1890	31	0.76	0.96	-2.8
multiple h.l.	-6.9	21.5	3414	57	0.76	1.08	-12.3
a single or multiple h.l.	-3.3	14.8	57	1	--	--	--
Southern Temperate Region							
total data	-17.7	24.5	9932	100	0.77	0.94	-14.0
clear sky	3.6	6.2	756	8	--	--	--
a single h.l.	-22.7	23.4	3661	37	0.66	0.79	-11.9
multiple h.l.	-19.3	26.0	4662	47	0.72	1.21	-34.9
a single or multiple h.l.	-6.3	16.3	853	9	-0.02	-0.08	101.9

* CF: cloud fraction; SD: standard deviation of mean of differences; h.l.: height level/s.

- **Correlation coefficient:**
  Ranges from **0.35** in the southern polar-region **to 0.82** in the northern temperate region.
- **Bias of CF differences:**
  Ranges from **-27%** (southern polar-region) **to -5%** (northern temperate region).

In low height-levels Stratus, Stratocumulus, Cumulus and Cumulonimbus clouds can be observed.
In middle height-levels Altocumulus, Altostratus and Nimbostratus clouds can be observed.
In high height-levels Cirrus, Cirrocumulus and Cirrostratus clouds can be observed.

Whether different types of clouds have been observed in a single- (either low, middle or high) or in multiple- height-level/s:
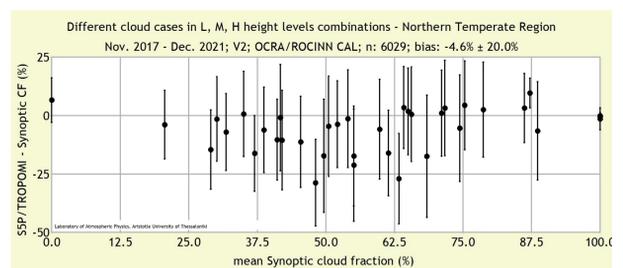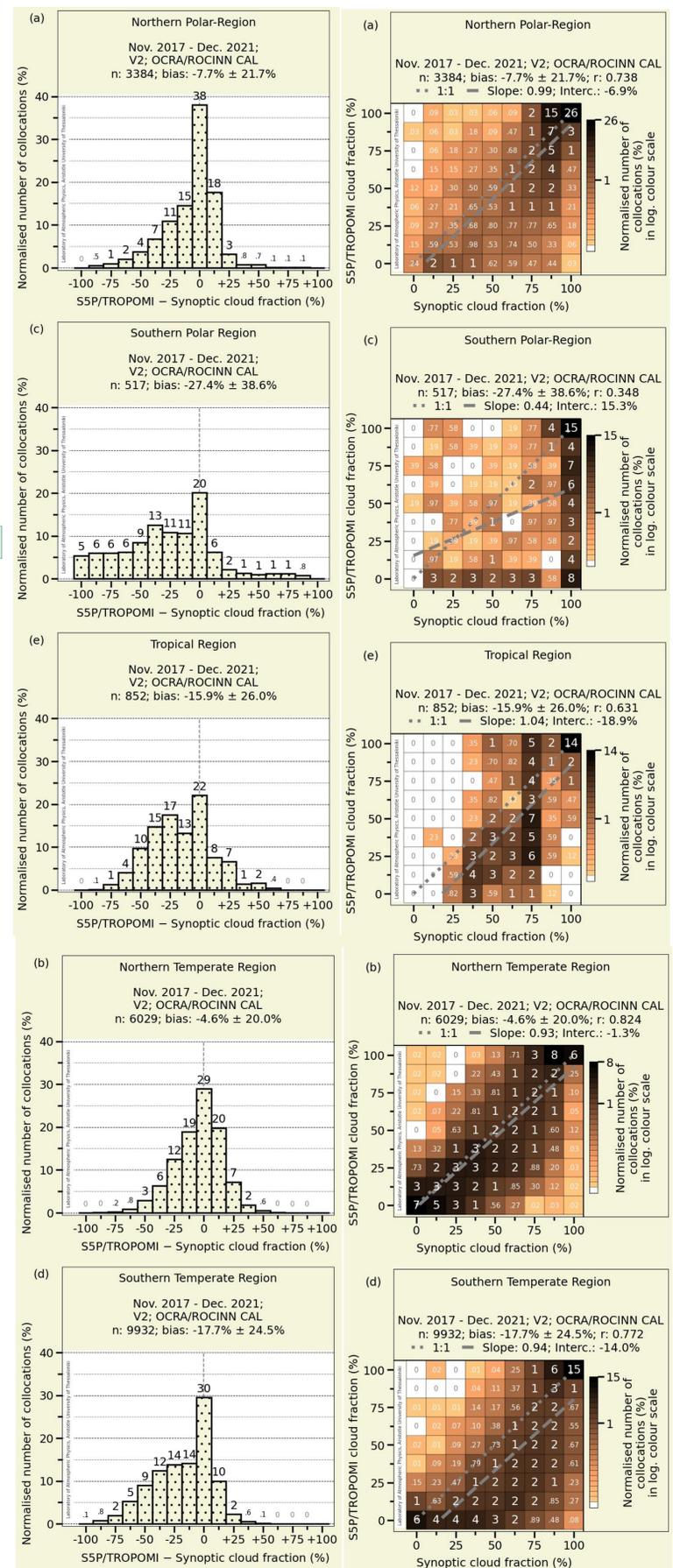
- Differences in the bias and correlation coefficients are found between these cases.
- **Best comparison results for a single-height-level case:**
  Stratus clouds (low height-level) (r = 0.84 and bias = -4% in the northern temperate region).
- **Best comparison results for a multiple-height-levels case:**
  Simultaneous presence of Stratocumulus (low height-level) **and Altocumulus** (middle height-level) **clouds** (r = 0.95 and bias = -11% in the tropical region).

Aknowledgements

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