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Intercomparison of Sentinel-5P TROPOMI cloud products for tropospheric trace gas retrievals

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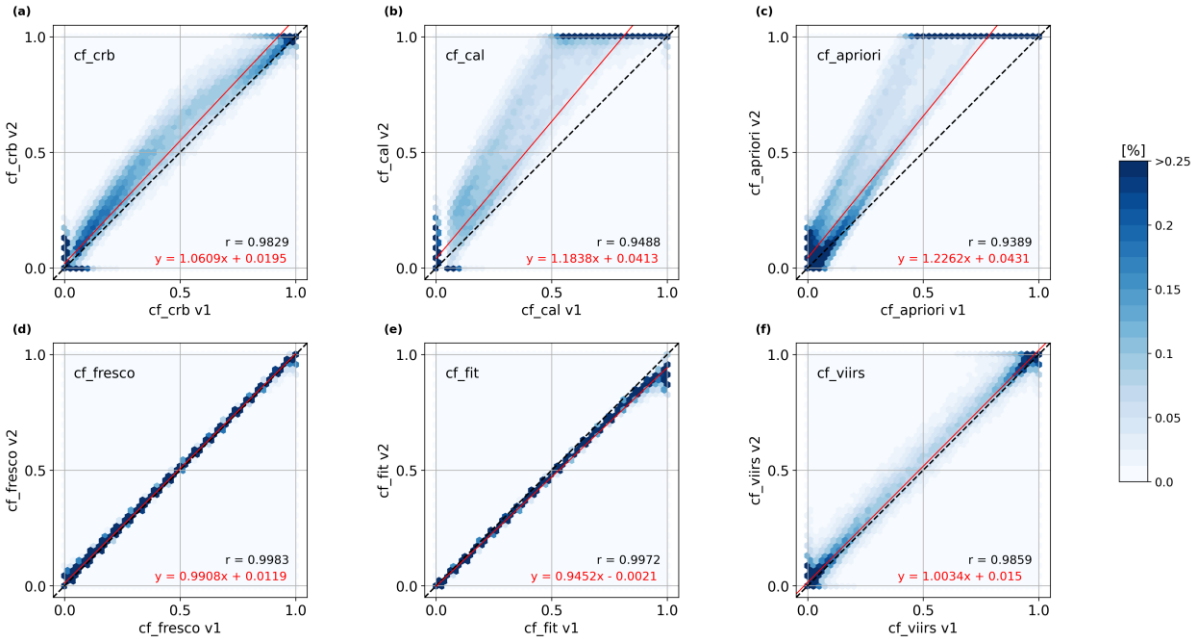


Figure S1: Density histograms between the version 1 and version 2 cloud fractions from (a) ROCINN CRB, (b) ROCINN CAL, (c) OCRA a priori, (d) FRESCO, (e) the NO_2 fitting window, and (f) VIIRS for Europe and the summer day (30 June 2018).

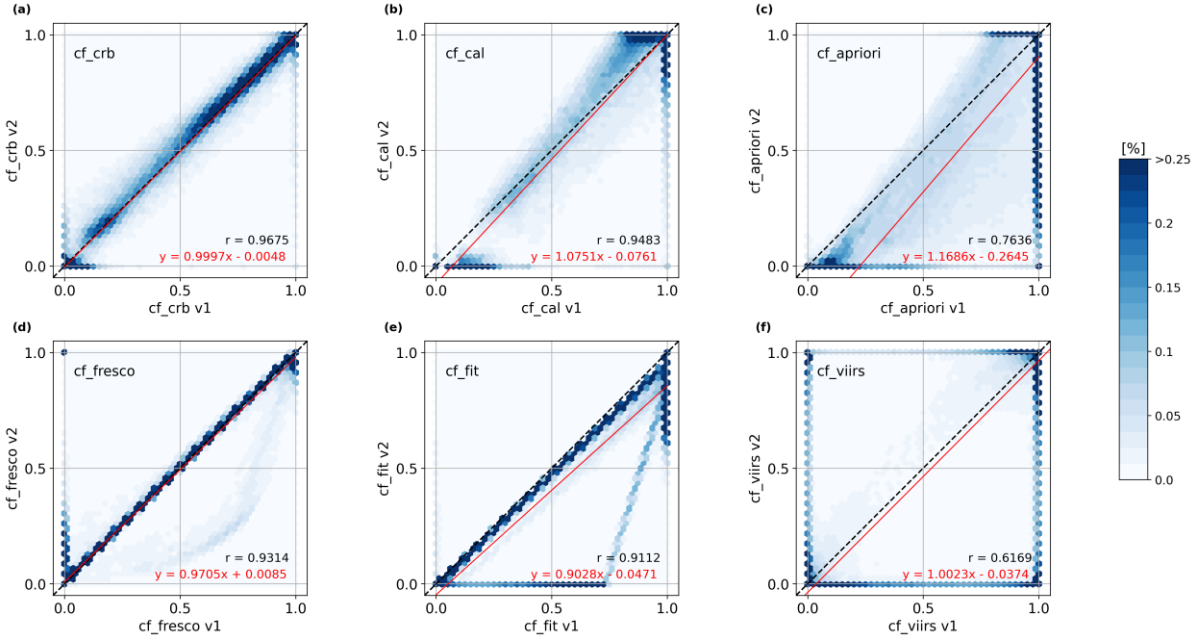
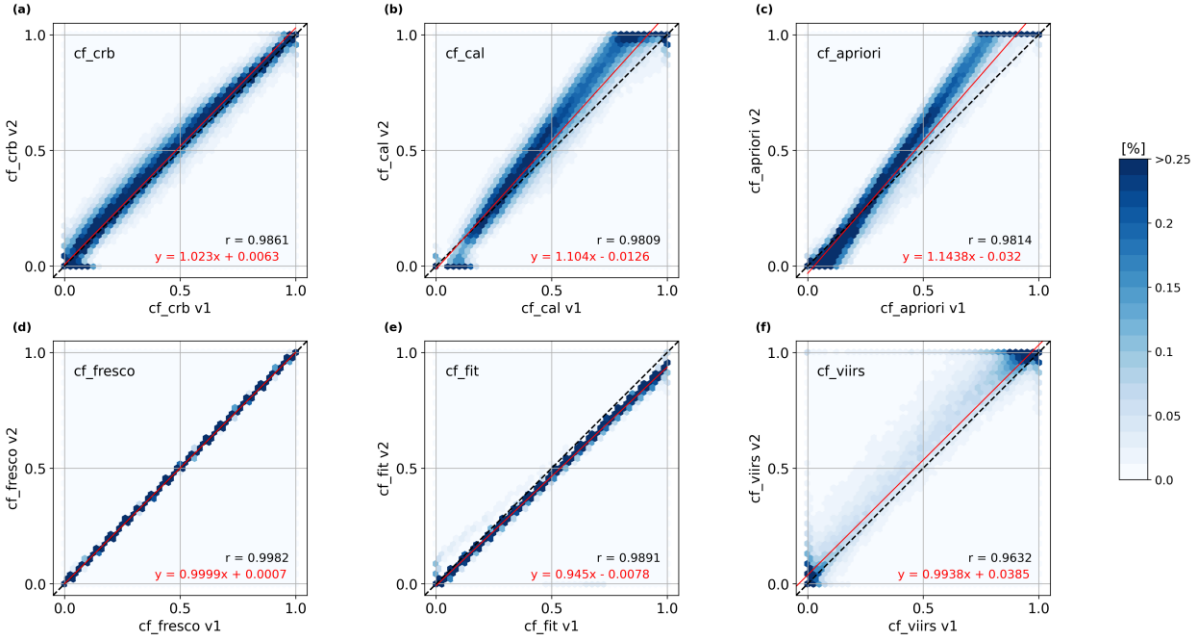


Figure S2: As Figure S1 but for the winter day (5 January 2019).



35 **Figure S3: As Figure S1 but for the autumn day (20 September 2019).**

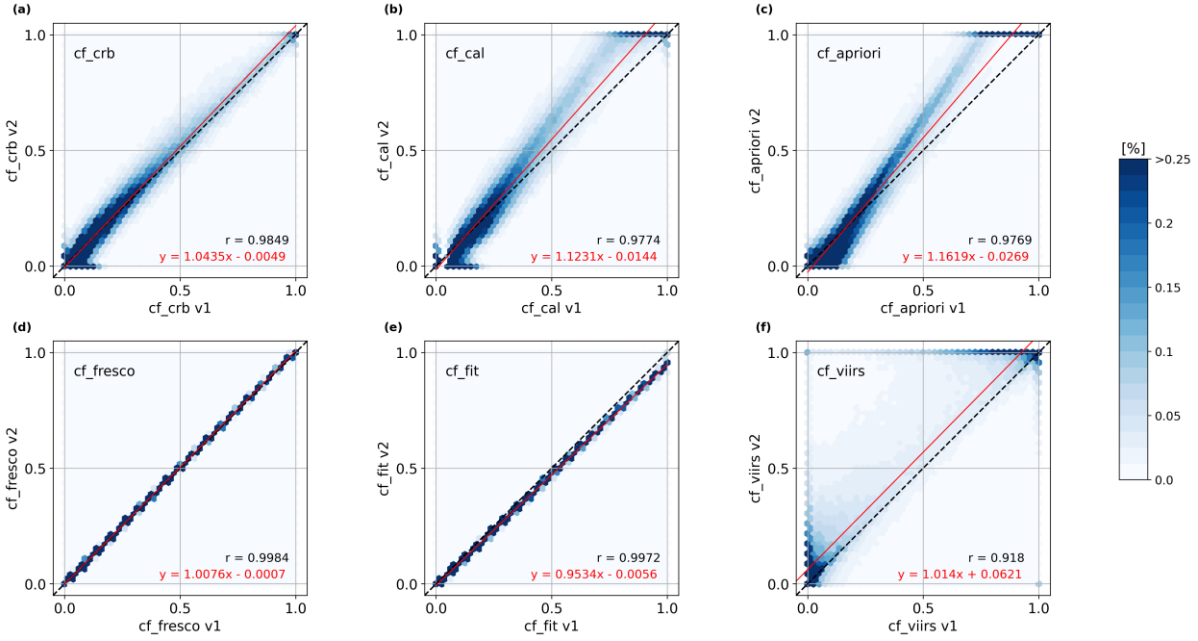


Figure S4: Density histograms between the version 1 and version 2 cloud fractions from (a) ROCINN CRB, (b) ROCINN CAL, (c) OCRA a priori, (d) FRESCO, (e) the NO_2 fitting window, and (f) VIIRS for Africa and the spring day (4 April 2019).

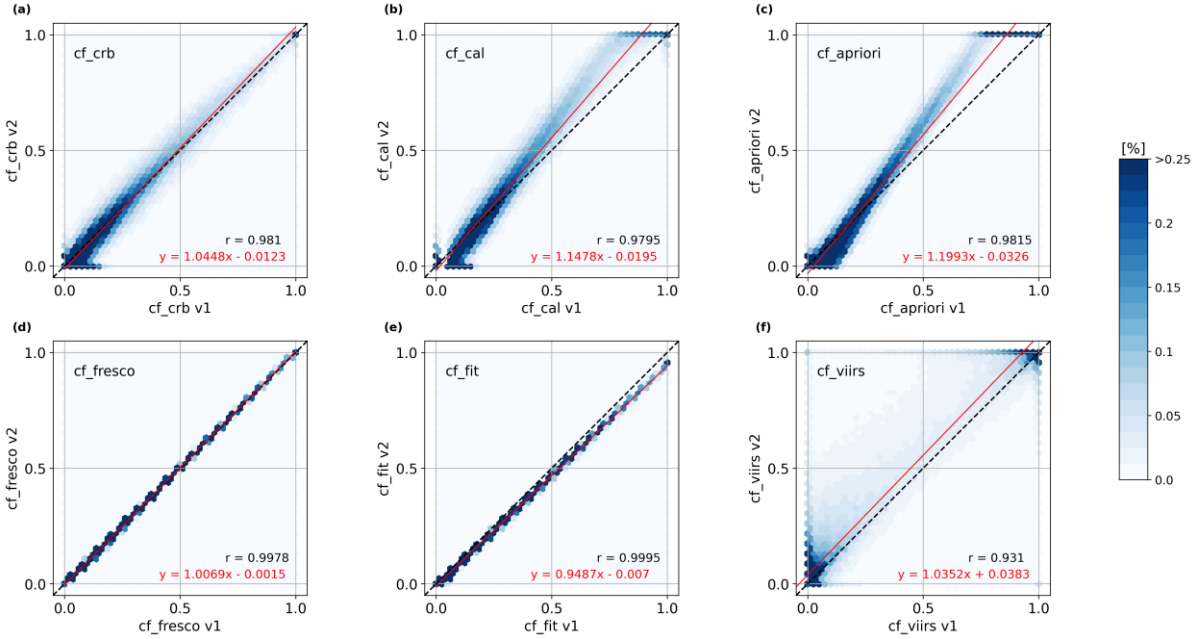


Figure S5: As Figure S4 but for the autumn day (20 September 2019).

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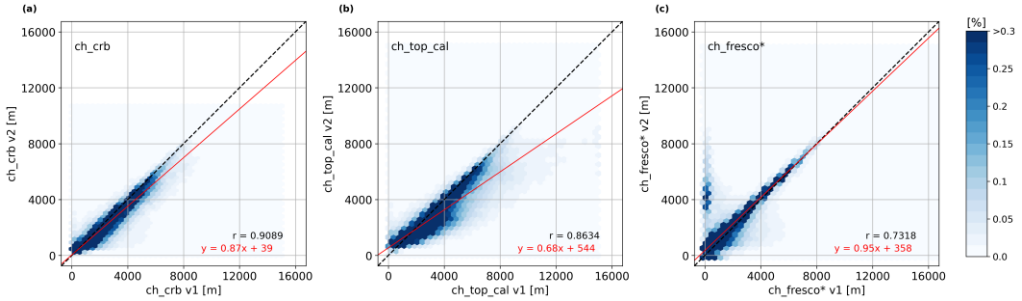

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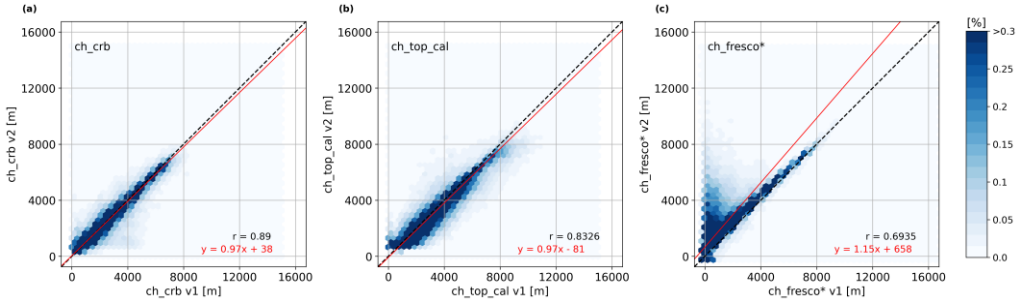


Figure S7: As Figure S6 but for the winter day (5 January 2019).

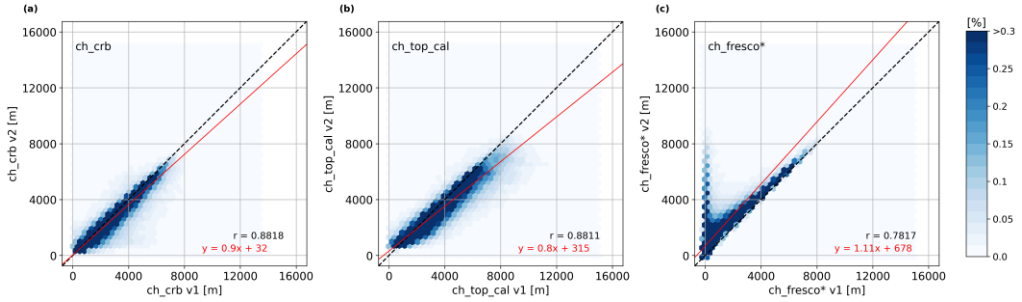
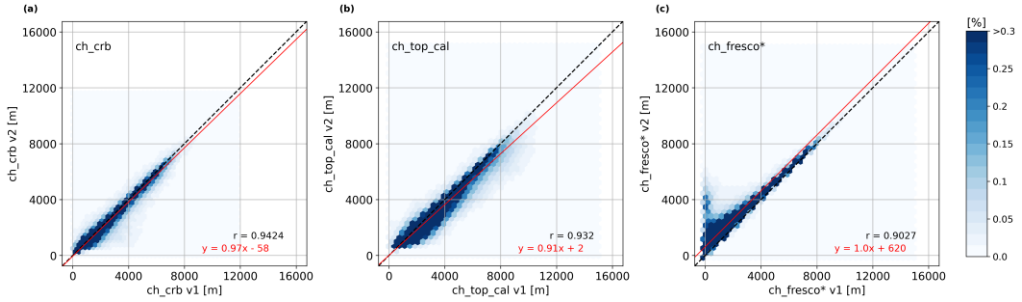


Figure S8: As Figure S6 but for the spring day (4 April 2019).



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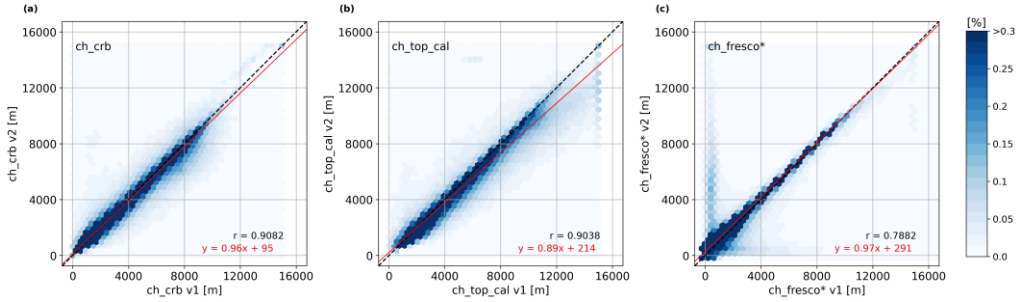

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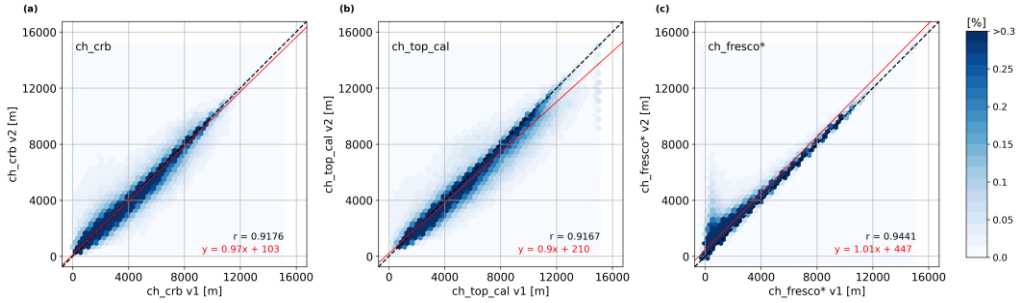

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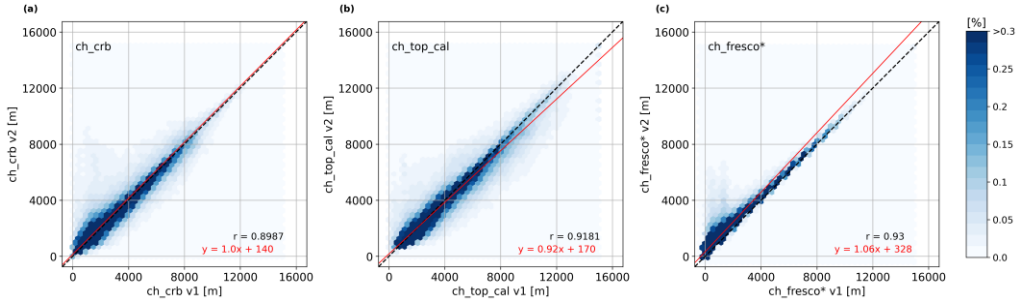

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S2 Additional plots of the intercomparison between the version 2 cloud products

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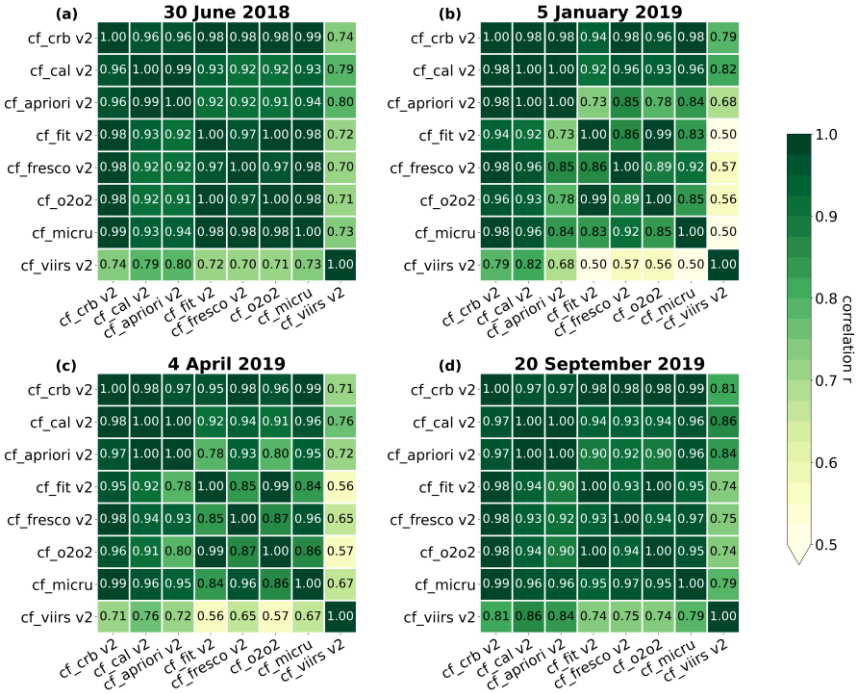

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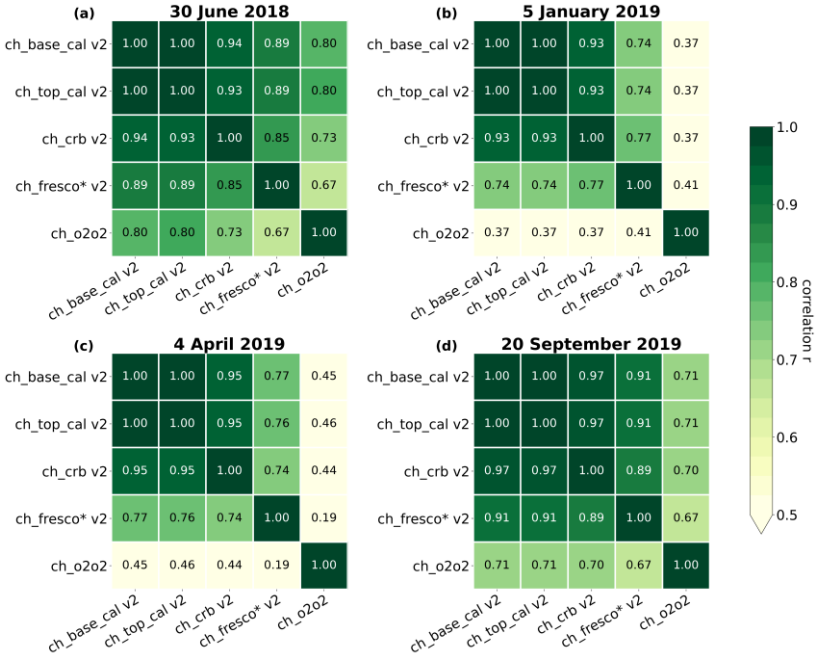

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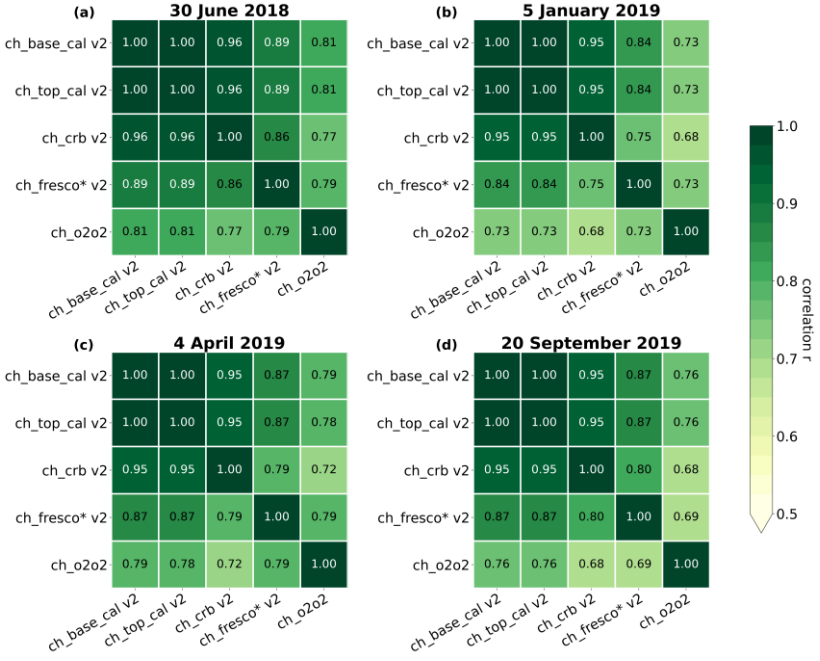

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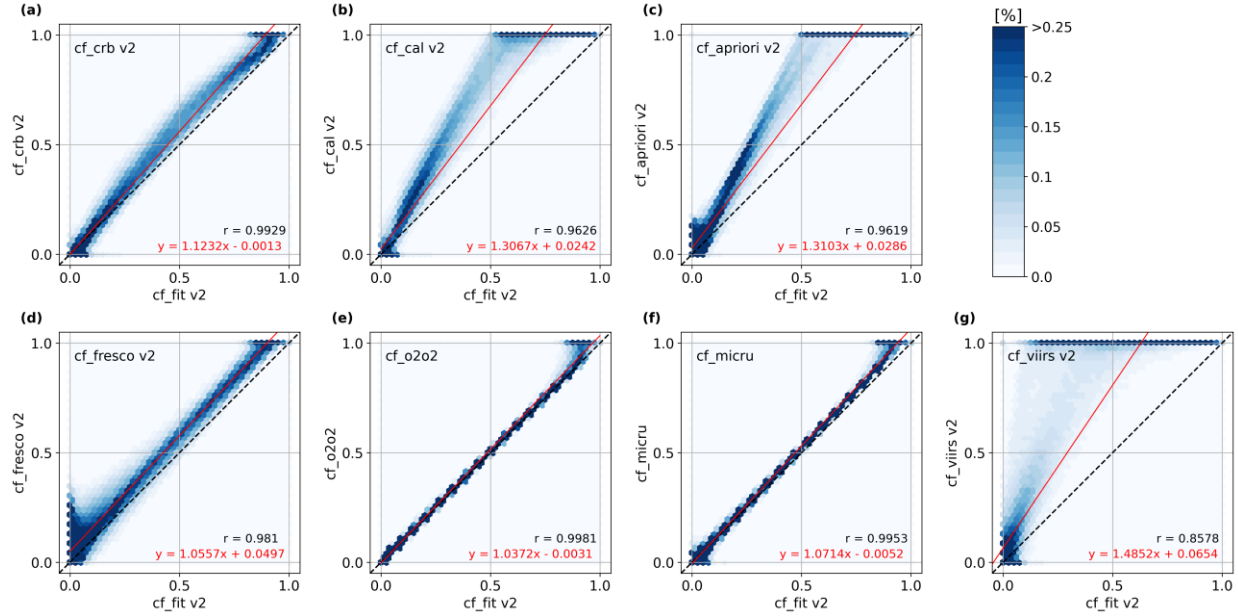

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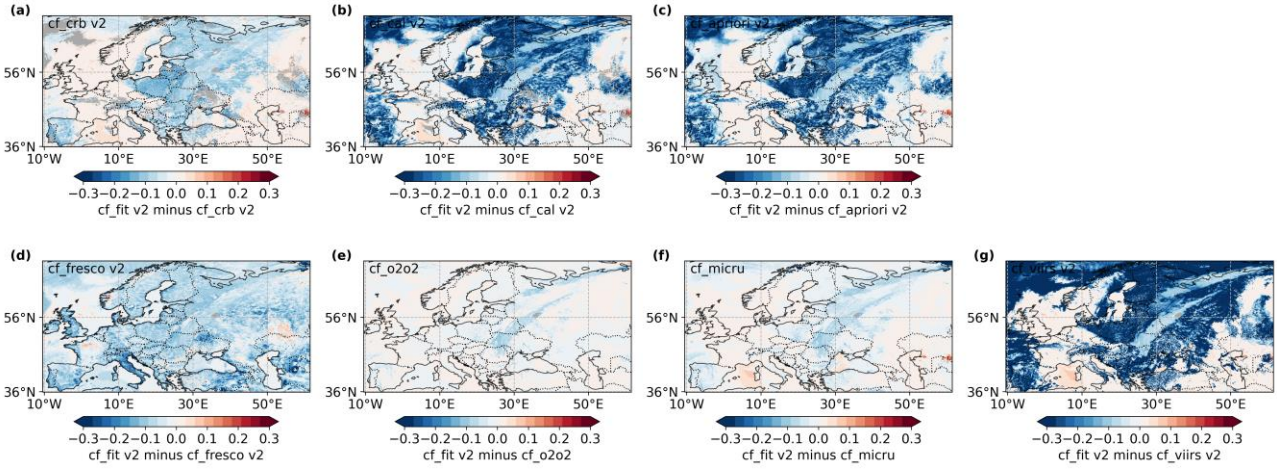

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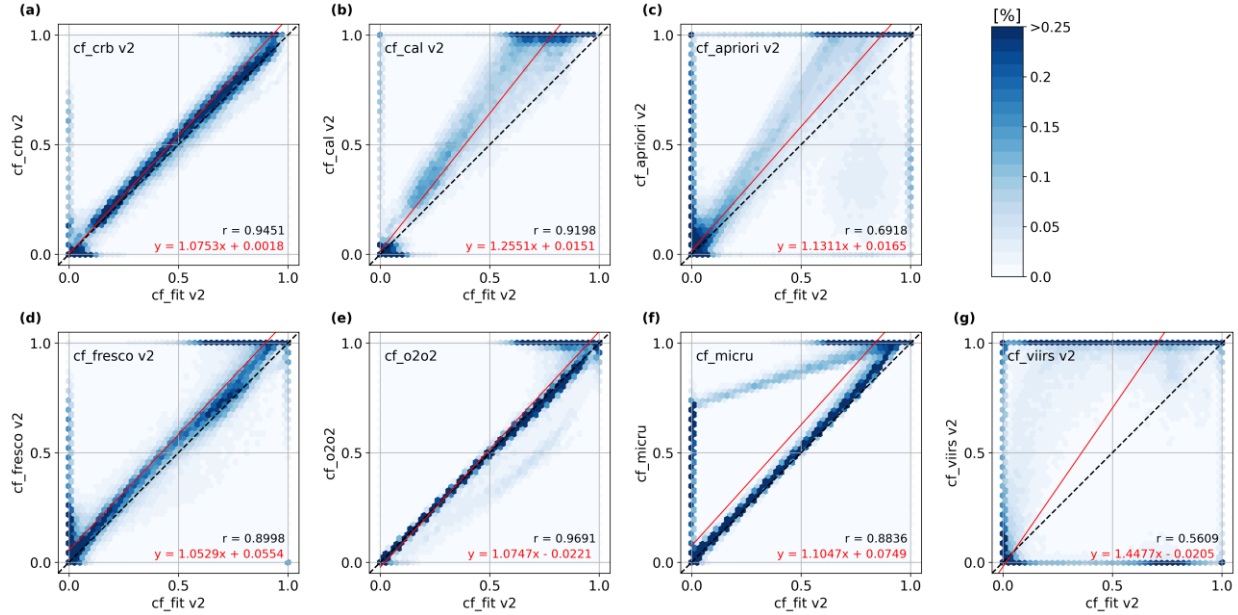

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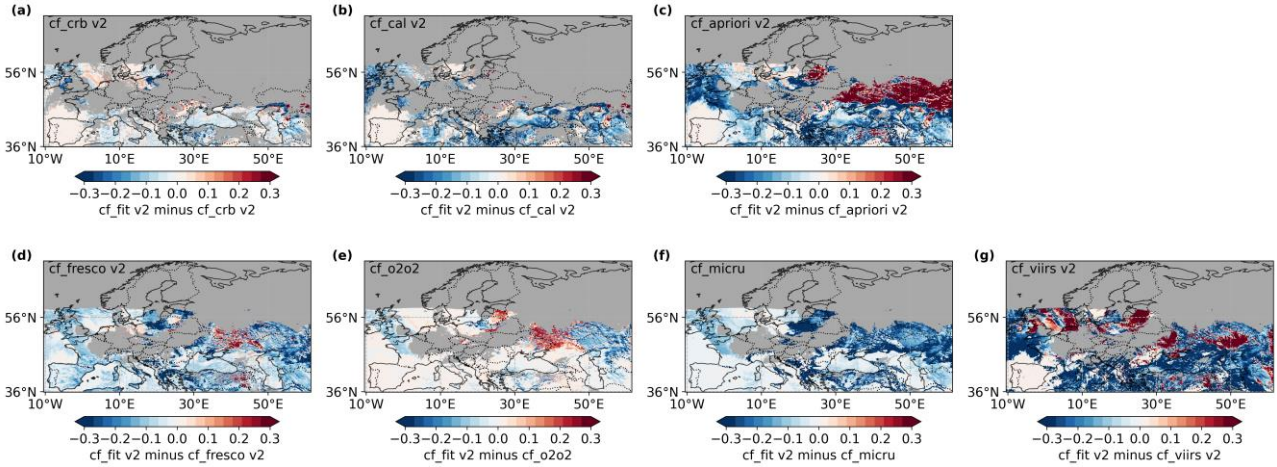


Figure S19: As Figure S17 but for the winter day (5 January 2019).

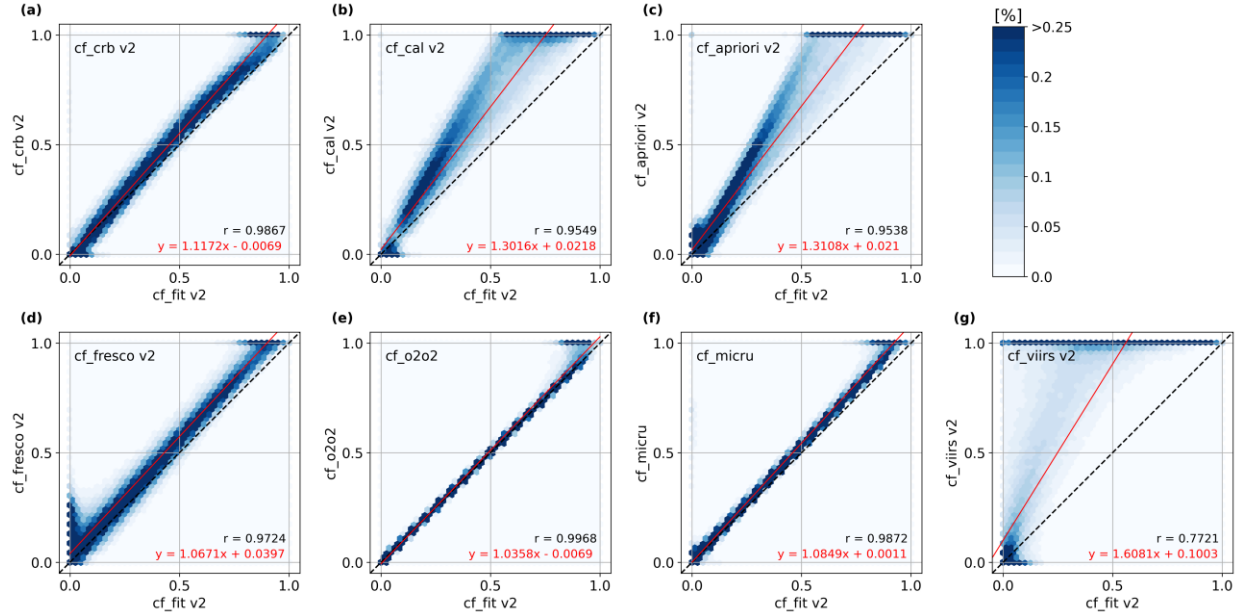


Figure S20: As Figure S16 but for the autumn day (20 September 2019).

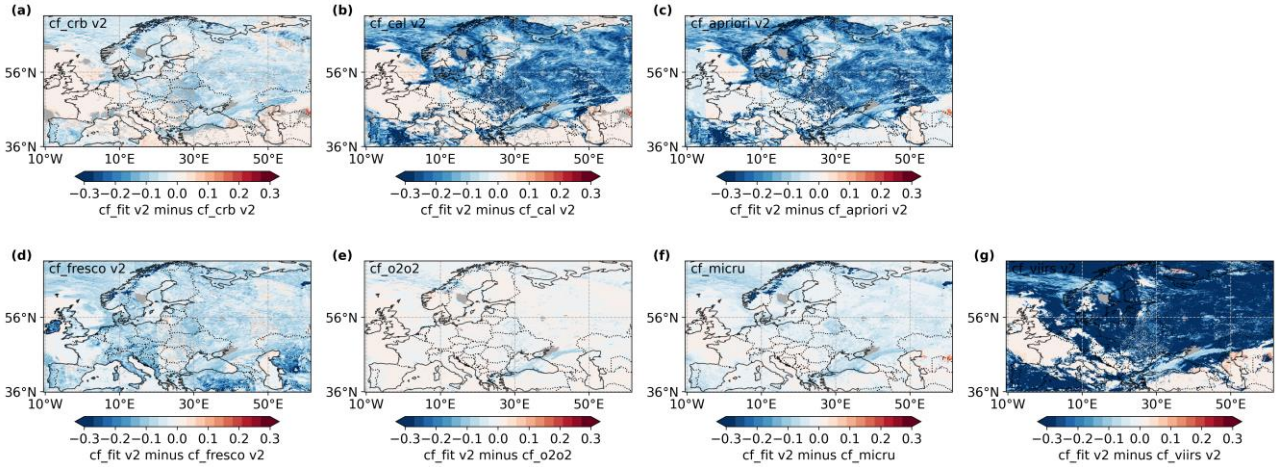
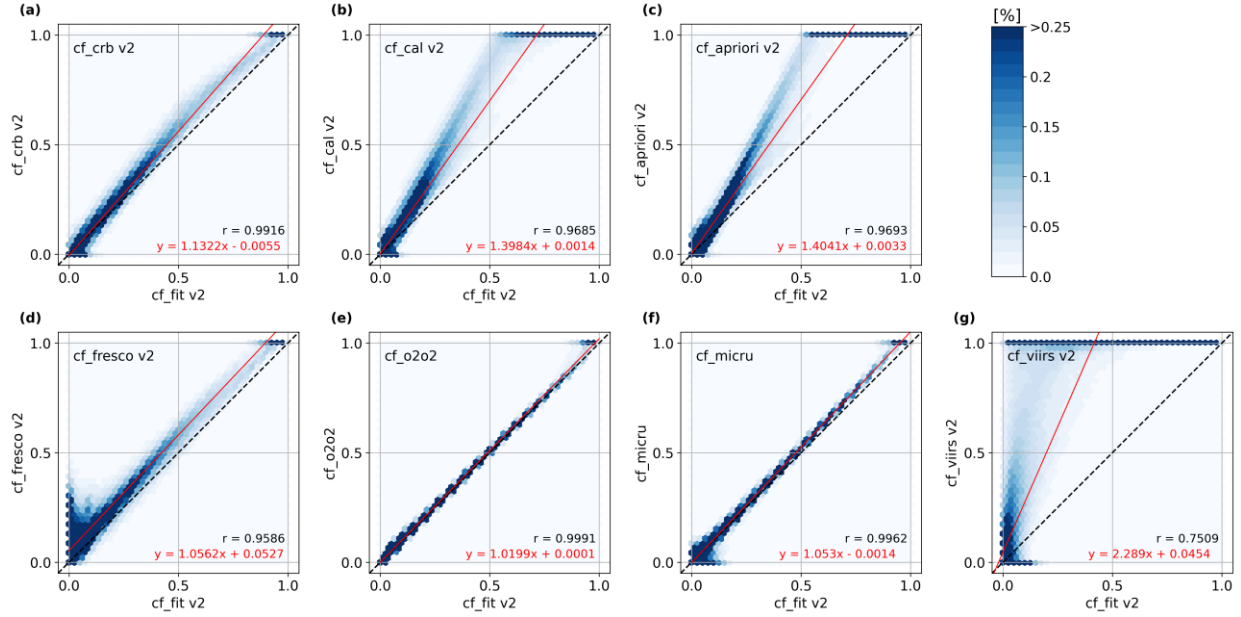


Figure S21: As Figure S17 but for the autumn day (20 September 2019).



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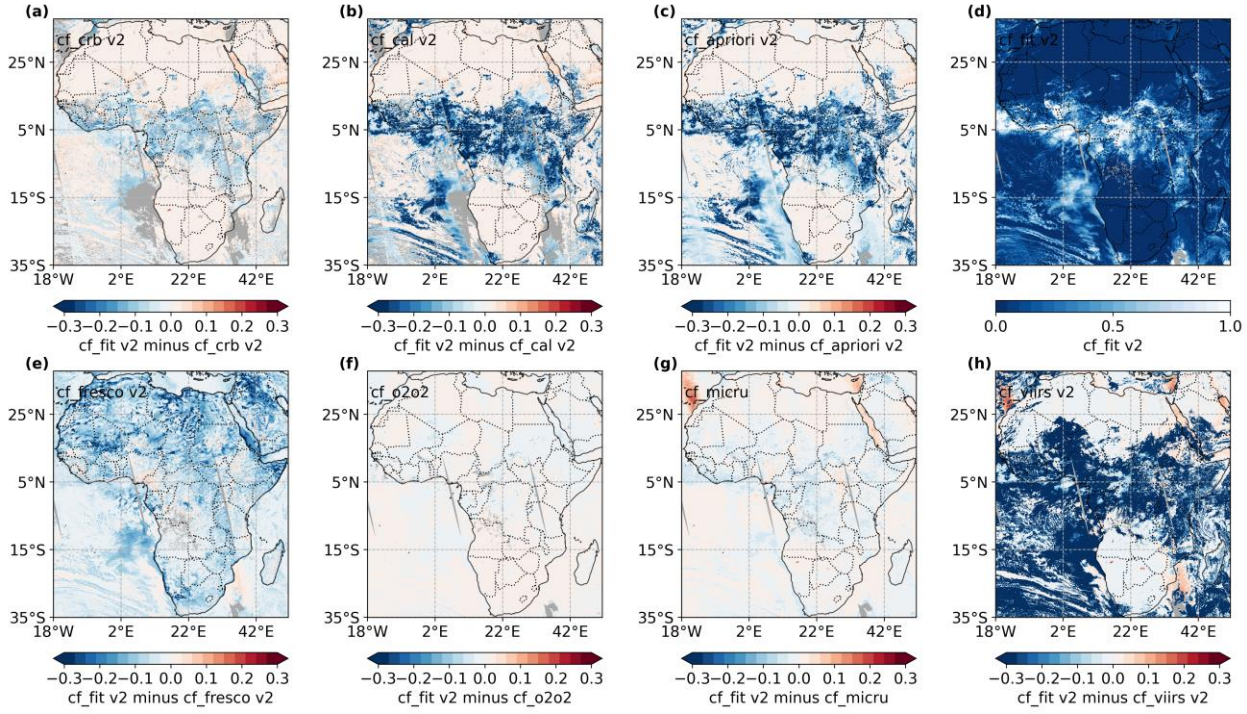

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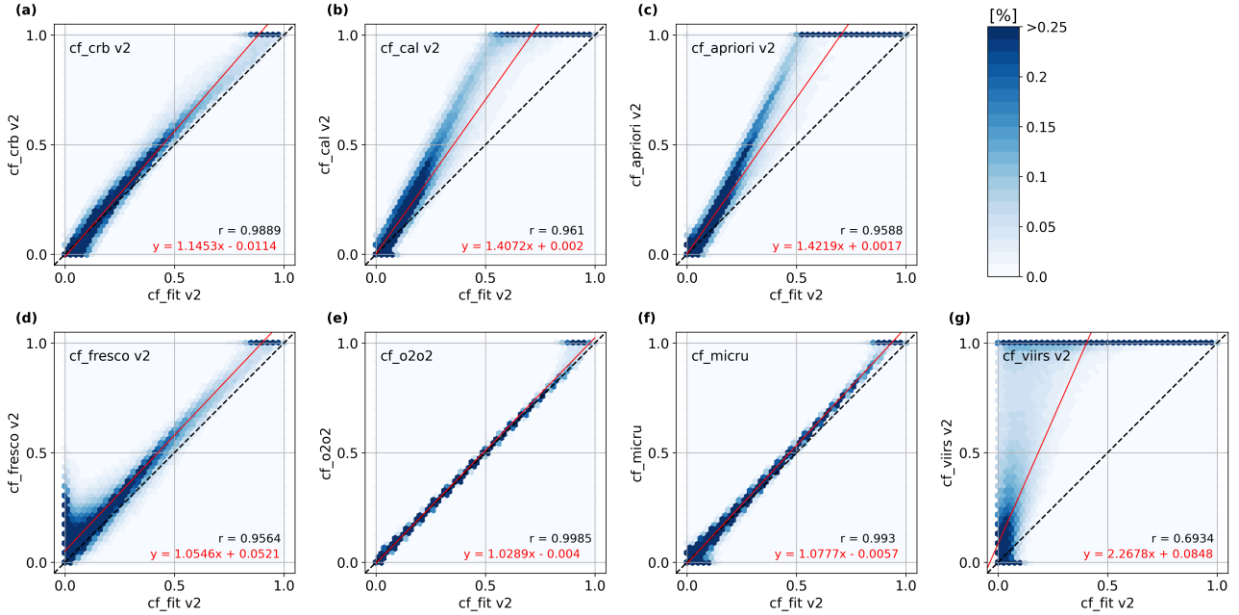


100 **Figure S24: As Figure S22 but for the spring day (4 April 2019).**

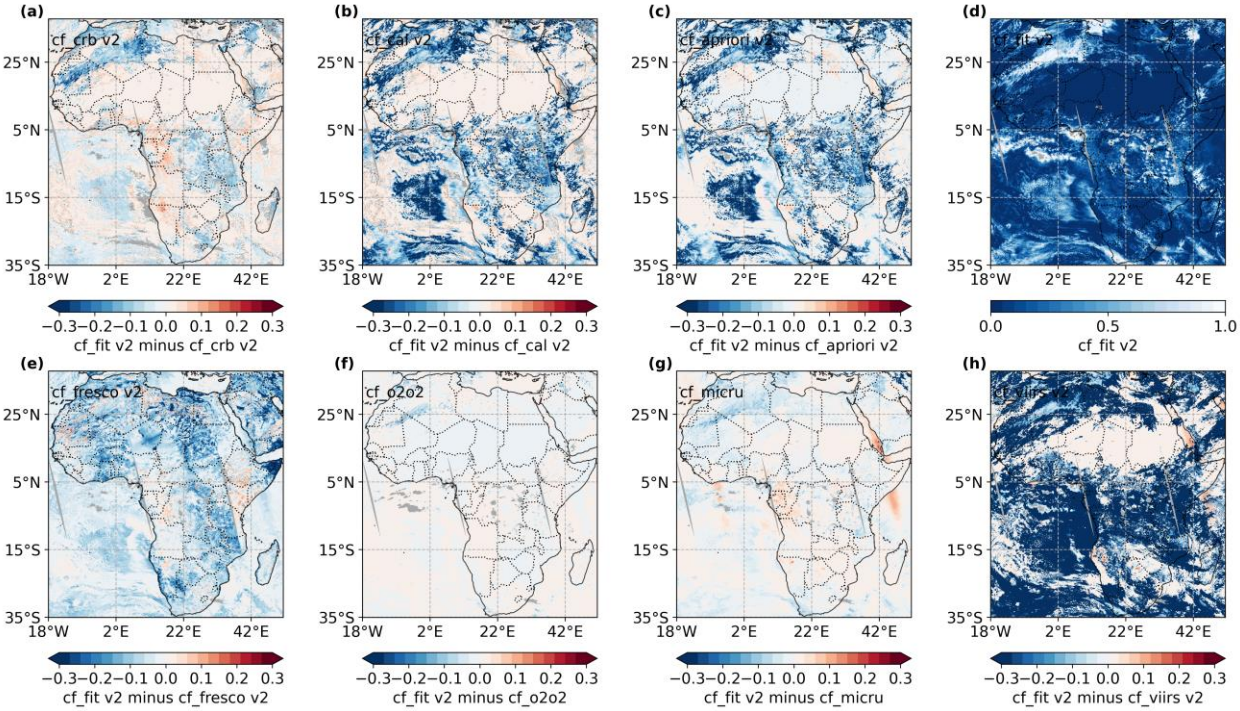
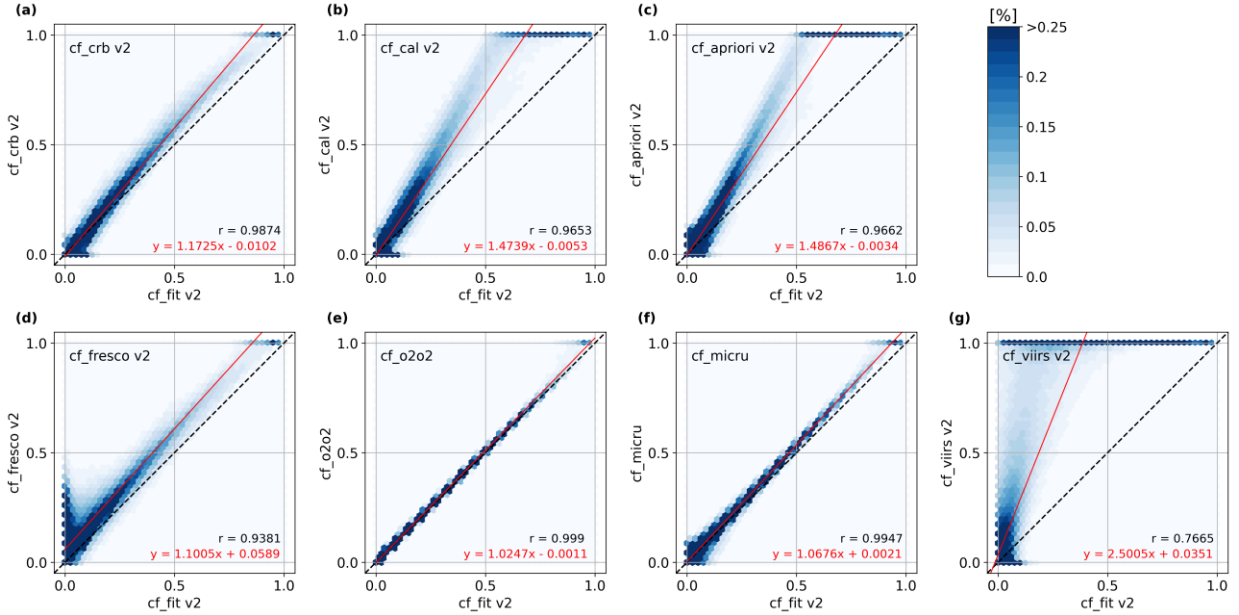


Figure S25: As Figure S23 but for the spring day (4 April 2019).



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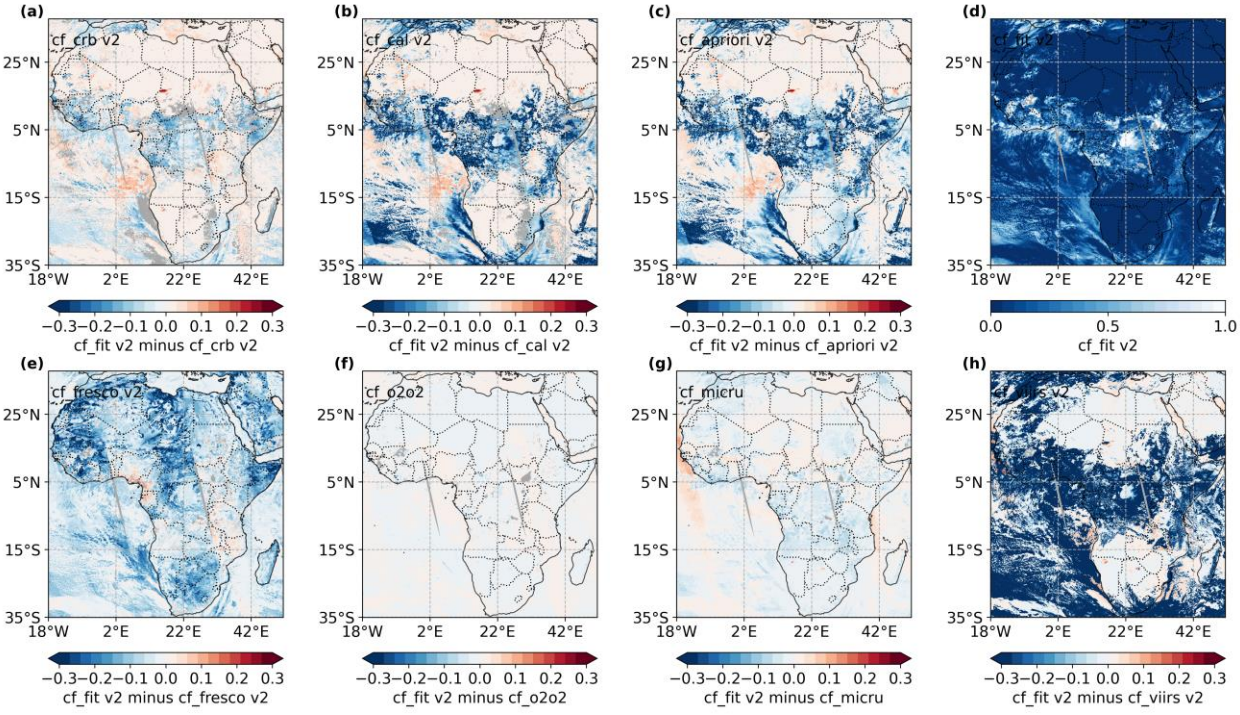

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S2.4 Density histograms and difference maps between the version 2 cloud heights for China

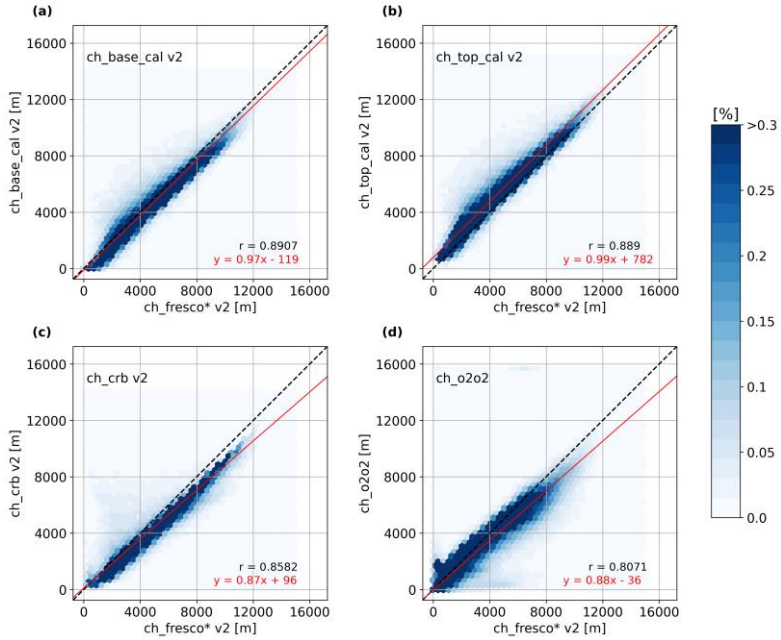
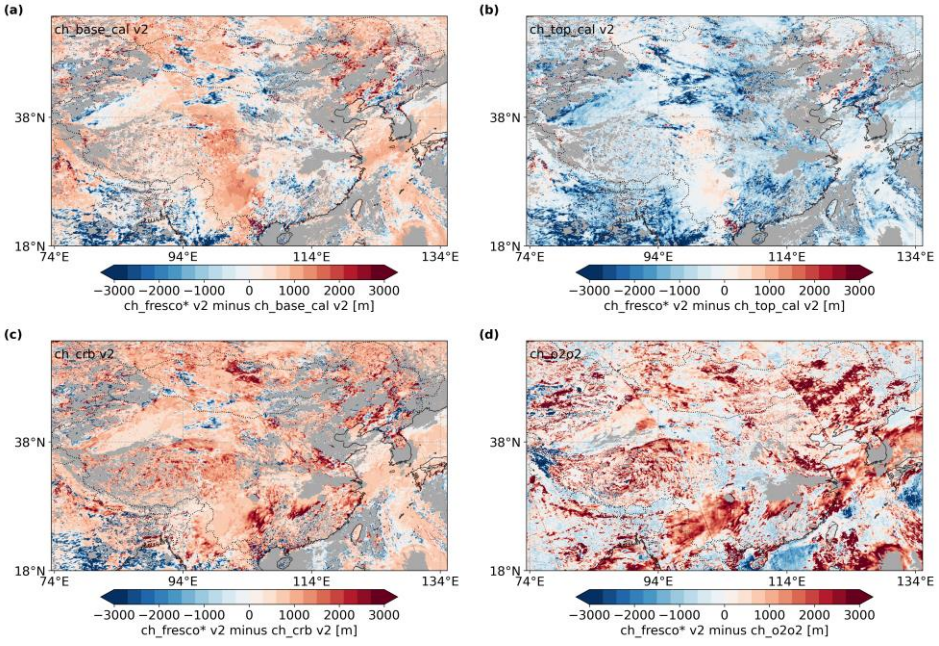


Figure S28: Density histograms between the version 2 (a) ROCINN CAL CBH, (b) ROCINN CAL CTH, (c) ROCINN CRB CH, and (d) O2-O2 CH and the FRESCO CH from the TROPOMI NO_2 product (ch_fresco*) for China and the summer day (30 June 2018).



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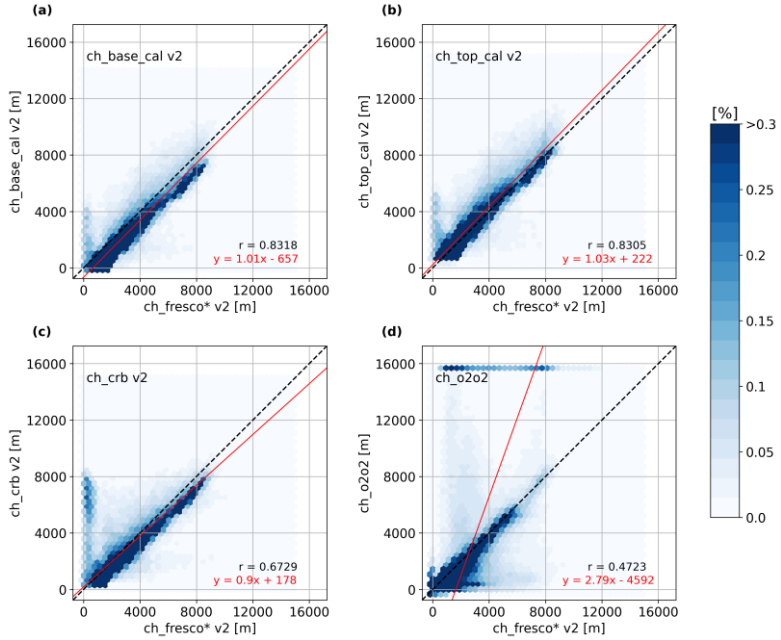
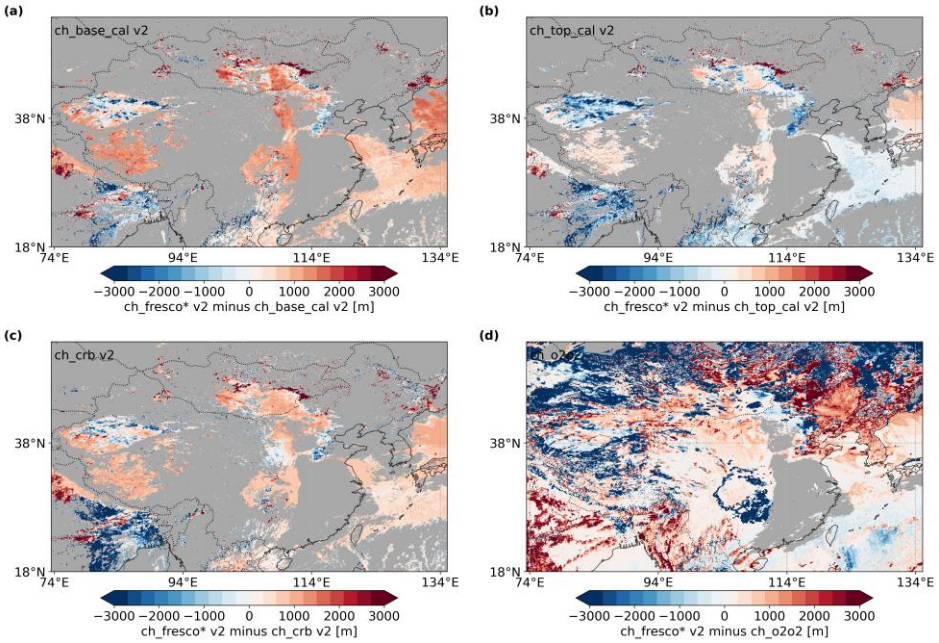


115 **Figure S30: As Figure S28 but for the winter day (5 January 2019).**



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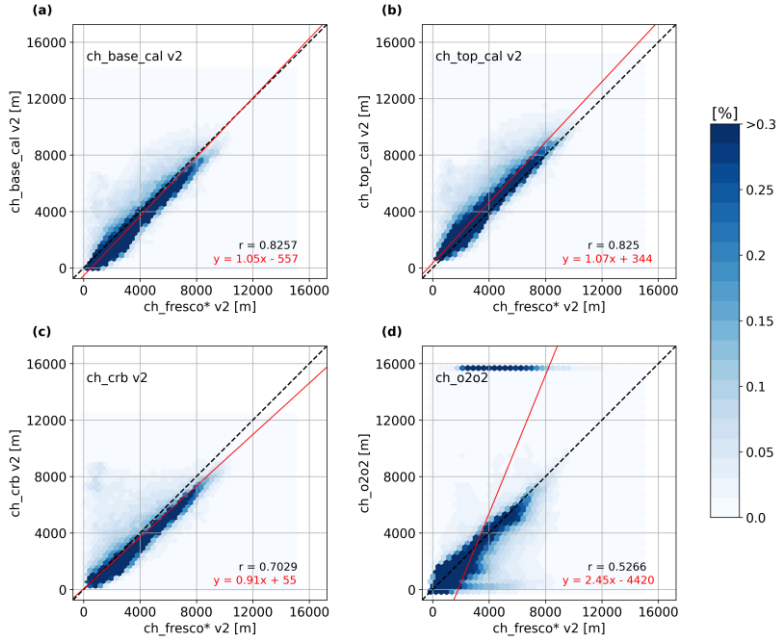

Figure S32: As Figure S28 but for the spring day (4 April 2019).

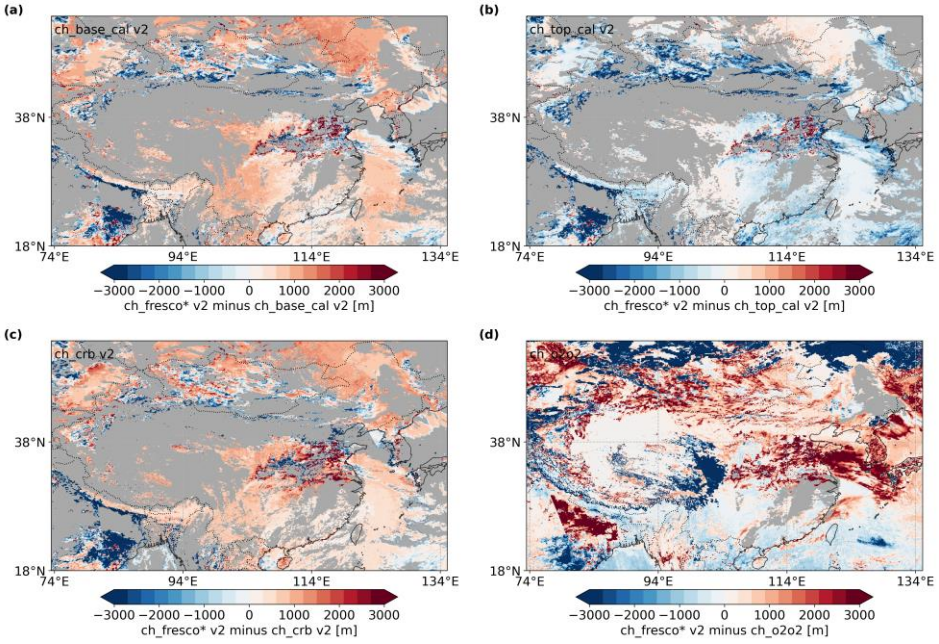

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Figure S33: As Figure S29 but for the spring day (4 April 2019).

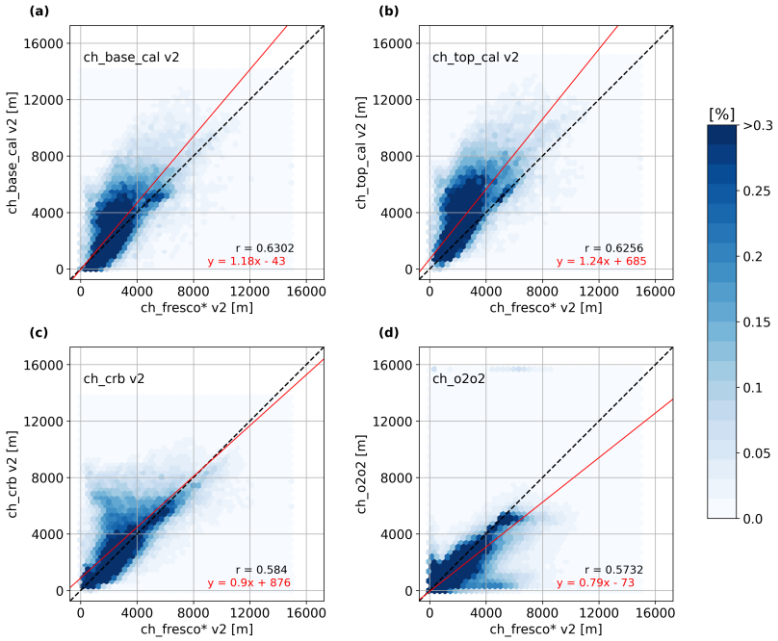

Figure S34: Density histograms between the version 2 (a) ROCINN CAL CBH, (b) ROCINN CAL CTH, (c) ROCINN CRB CH, and (d) O2-O2 CH and the FRESCO CH from the TROPOMI NO_2 product (ch_fresco*) for China and the summer day (30 June 2018) with a cloud fraction threshold of 0.2 (only CH for scenes with cloud fractions ≤ 0.2).

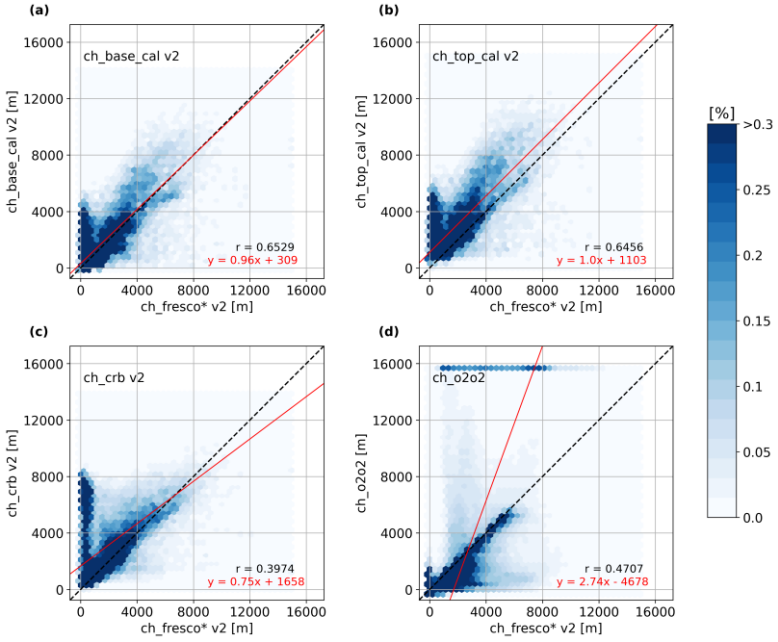

Figure S35: As Figure S34 but for the winter day (5 January 2019).

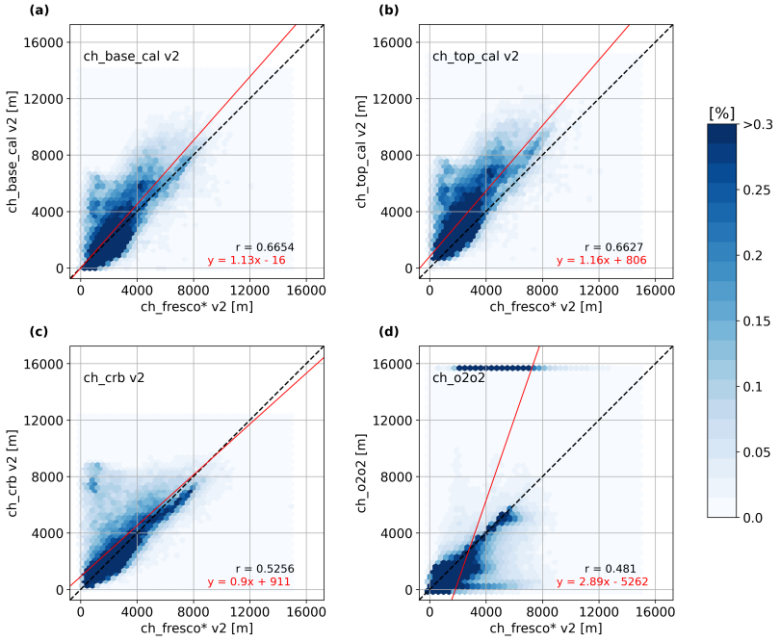

Figure S36: As Figure S34 but for the spring day (4 April 2019).

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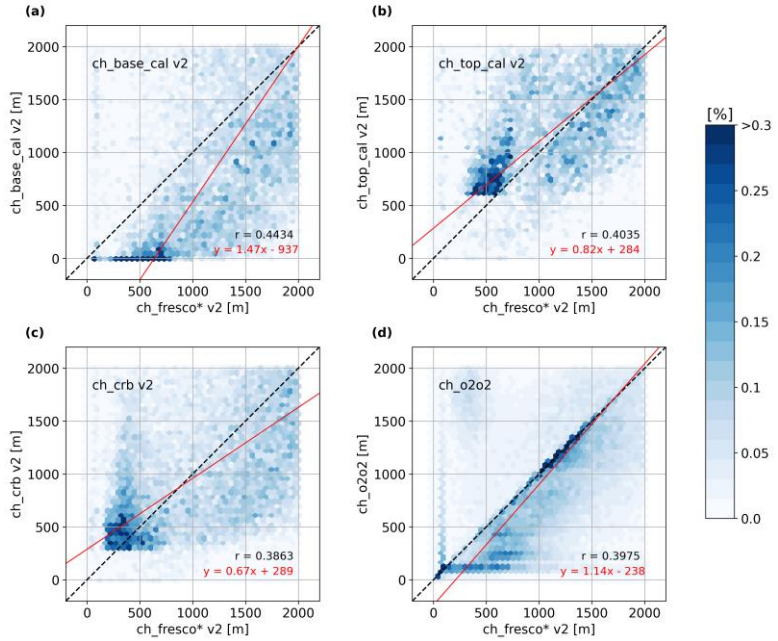

Figure S37: Density histograms between the version 2 (a) ROCINN CAL CBH, (b) ROCINN CAL CTH, (c) ROCINN CRB CH, and (d) O2-O2 CH and the FRESCO CH from the TROPOMI NO_2 product (ch_fresco*) for China and the summer day (30 June 2018) with a cloud fraction threshold of 0.2 for cloud heights lower than or equal to 2 km (only CH ≤ 2 km for scenes with cloud
135 **fractions ≤ 0.2).**

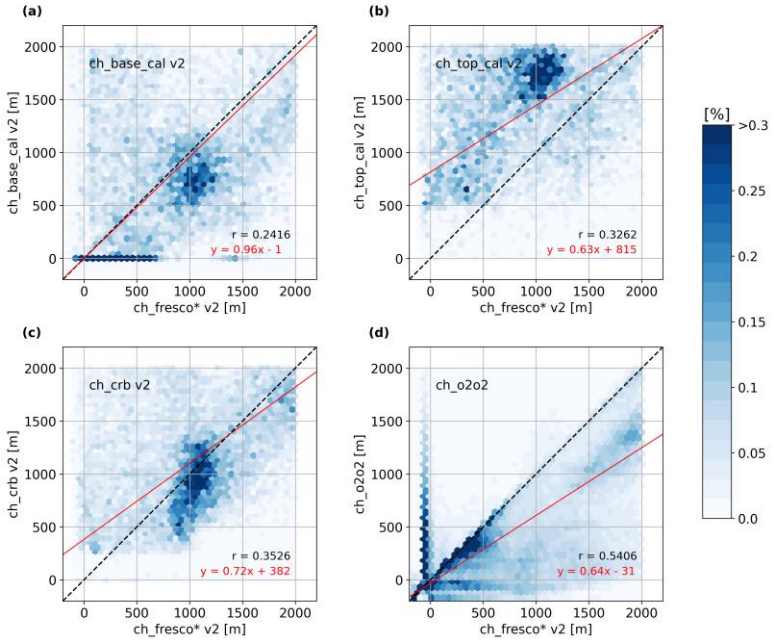

Figure S38: As Figure S37 but for the winter day (5 January 2019).

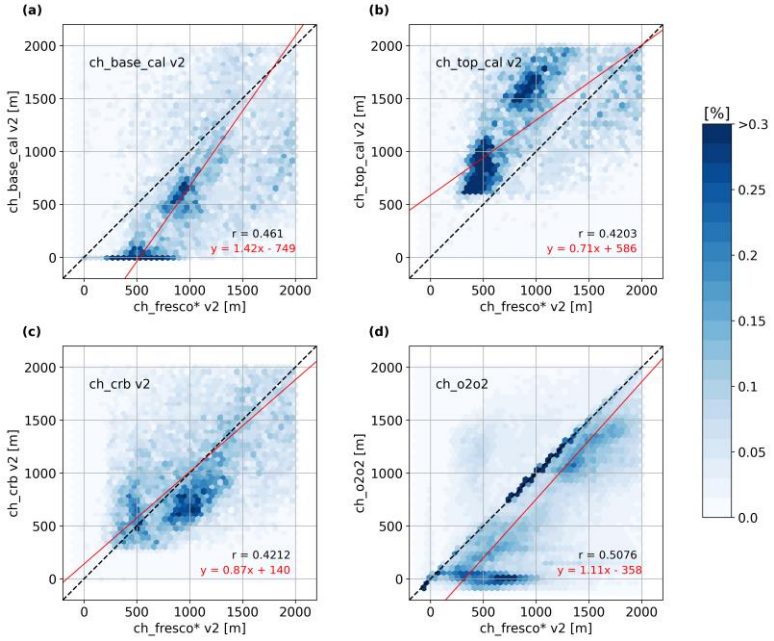

Figure S39: As Figure S37 but for the spring day (4 April 2019).

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S3: Across-track dependency plots of the version 2 cloud fractions and cloud heights for Europe, Africa, and China

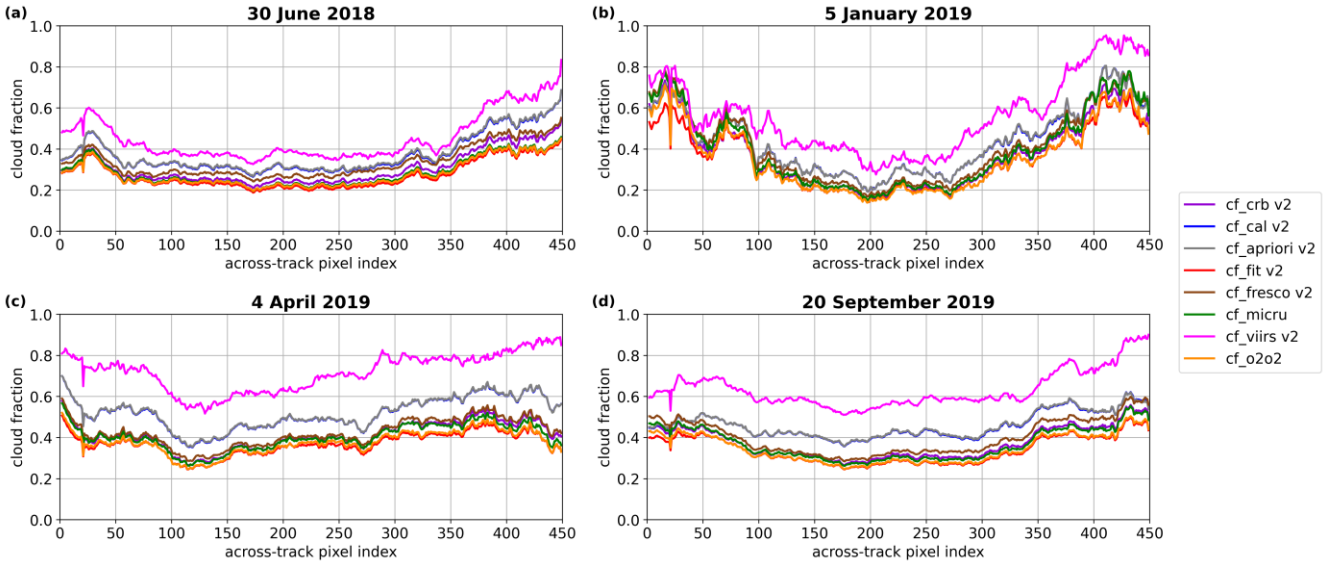


Figure S40: Mean values of version 2 cloud fractions, as a function of the across-track index, from ROCINN CRB, ROCINN CAL, OCRA a priori, the NO_2 fitting window (cf_fit), FRESCO, MICRU, VIIRS, and O2-O2 for Europe and (a) the summer day, (b) the winter day, (c) the spring day, and (d) the autumn day with quality, snow, and ice flagging and only including pixels that have valid values for all products.

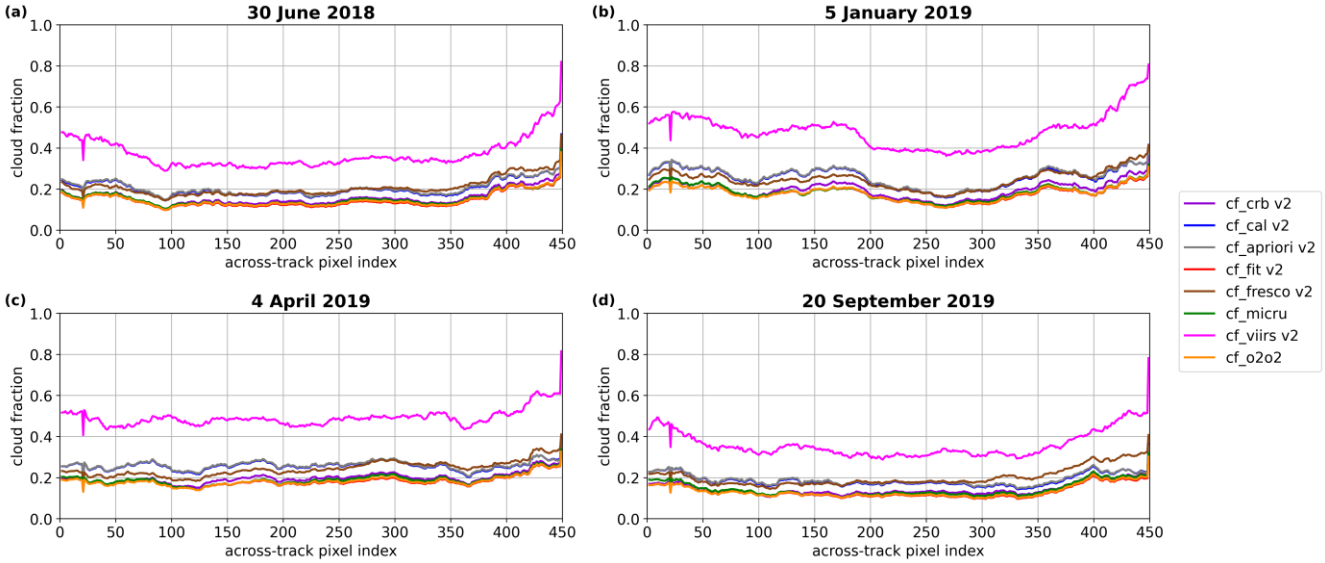


Figure S41: As Figure S40 but for Africa.

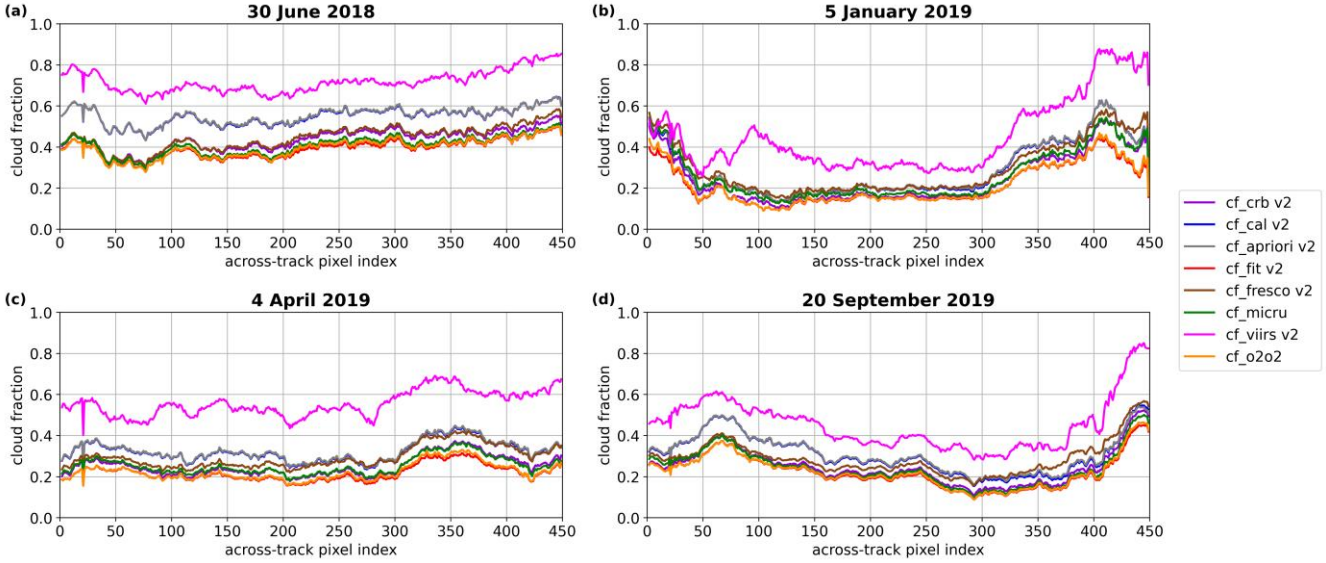


Figure S42: As Figure S40 but for China.

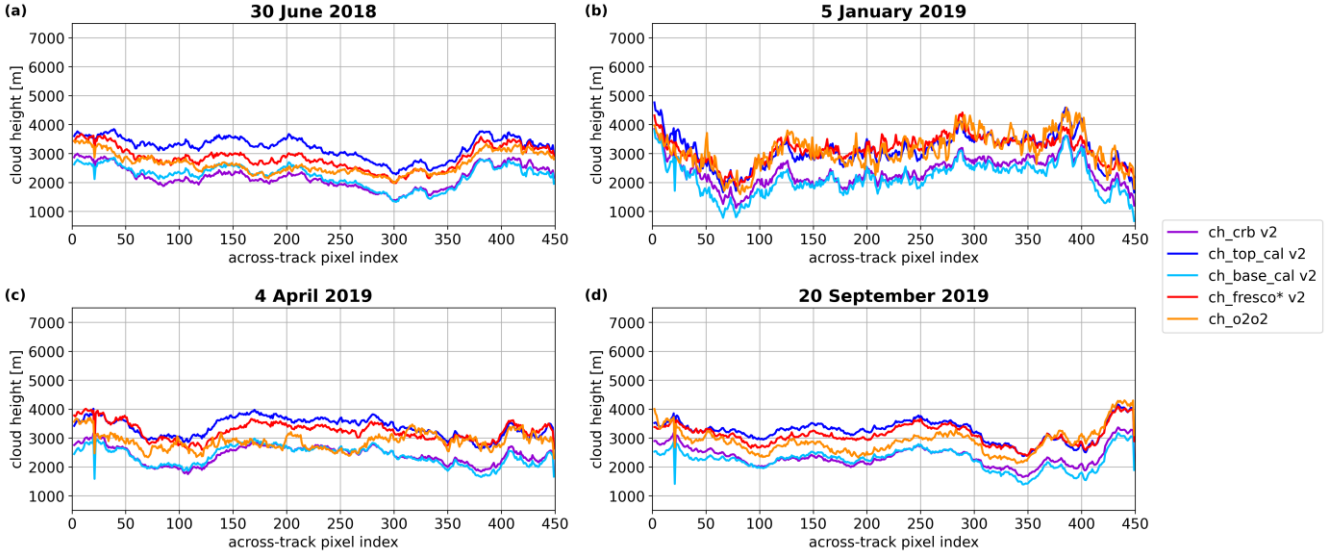


Figure S43: Mean values of version 2 cloud heights, as a function of the across-track index, from ROCINN CRB, ROCINN CAL top and base, FRESCO from the TROPOMI NO_2 product (ch_fresco*), and O2-O2 for Europe and (a) the summer day, (b) the winter day, (c) the spring day, and (d) the autumn day with quality, snow, and ice flagging and only including pixels that have valid values for all products.

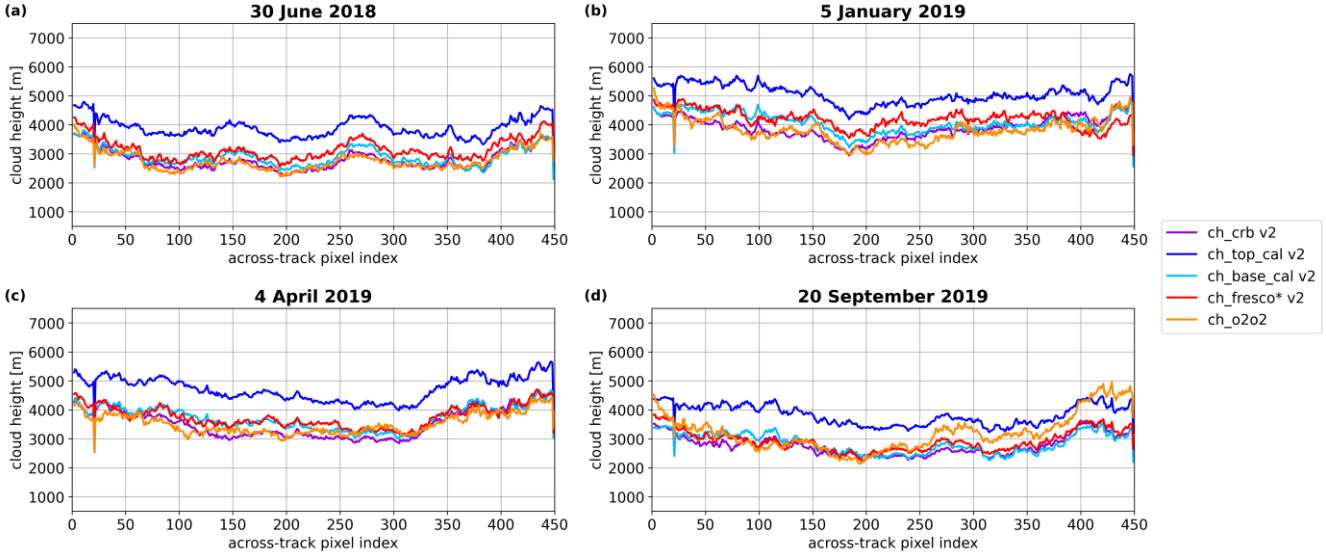


Figure S44: As Figure S43 but for Africa.

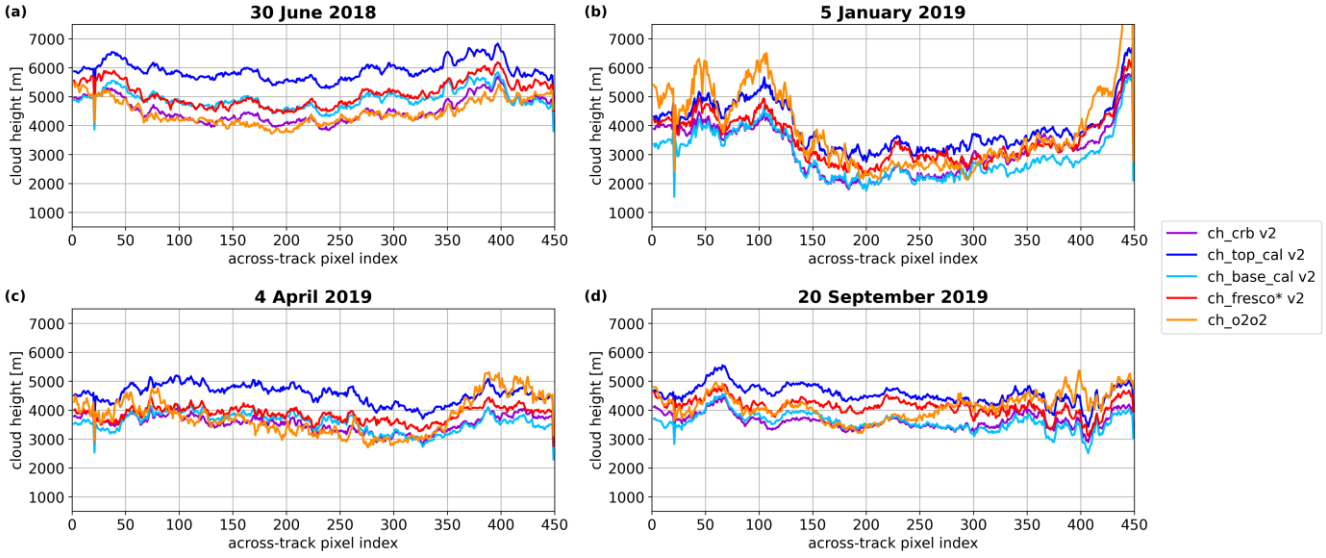


Figure S45: As Figure S43 but for China.

S4 Additional plots of the intercomparison between the version 1 cloud products

S4.1 Tabular intercomparison of the correlations between the version 1 cloud fractions for Europe, Africa, and China

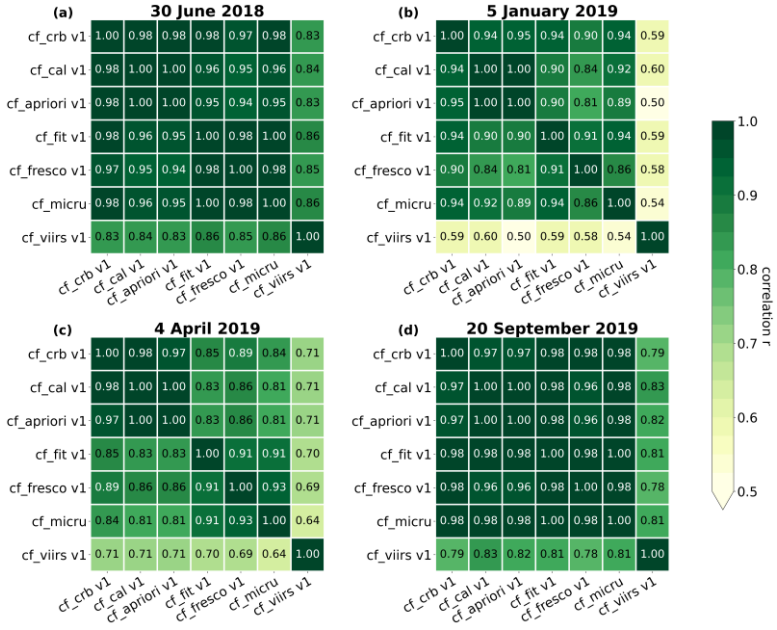


Figure S46: Tabular intercomparison of the correlations between the version 1 cloud fractions from ROCINN CRB, ROCINN CAL, OCRA a priori, the NO_2 fitting window (cf_fit), FRESCO, MICRU, and VIIRS for Europe and (a) the summer day, (b) the winter day, (c) the spring day, and (d) the autumn day.

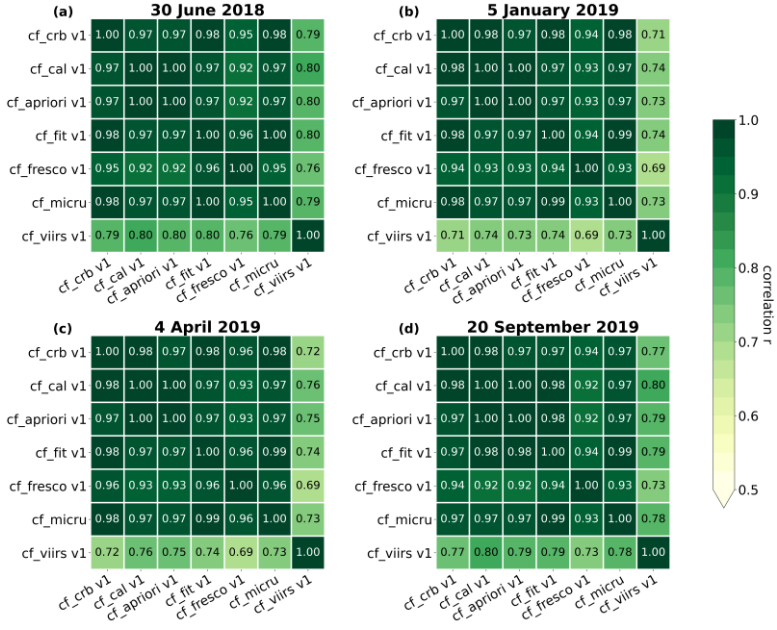
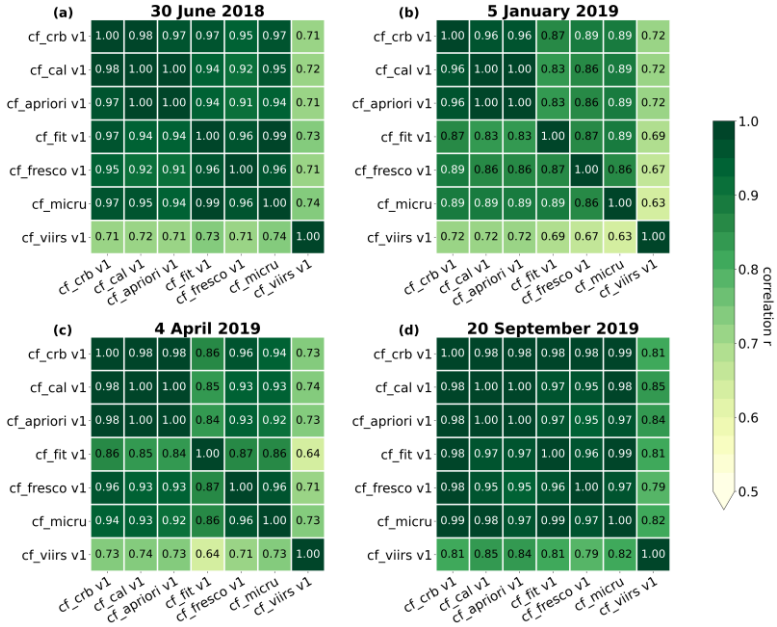


Figure S47: As Figure S46 but for Africa.



170 **Figure S48: As Figure S46 but for China.**

S4.2 Tabular intercomparison of the correlations between the version 1 cloud heights for Europe, Africa, and China

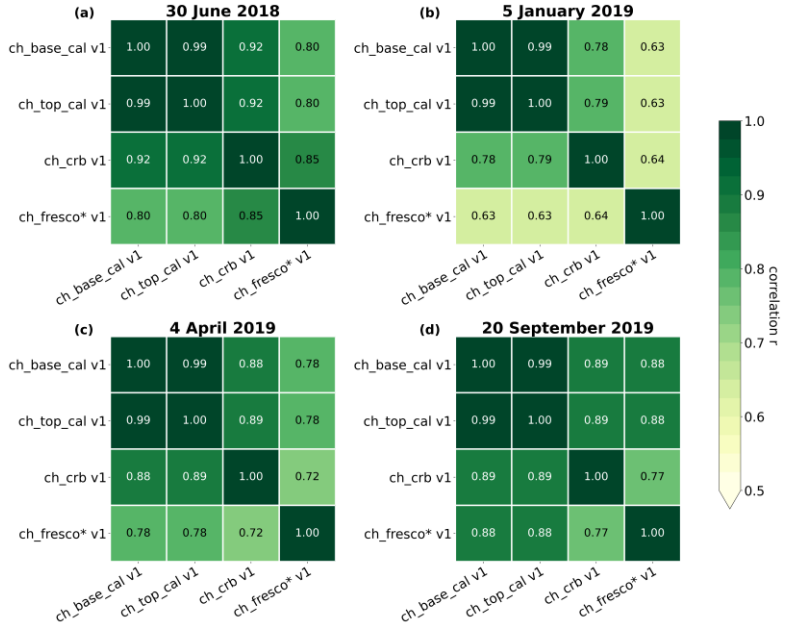


Figure S49: Tabular intercomparison of the correlations between the version 1 cloud heights from ROCINN CAL base and top, ROCINN CRB, and FRESCO from the TROPOMI NO_2 product (ch_fresco*) for Europe and (a) the summer day, (b) the winter day, (c) the spring day, and (d) the autumn day.

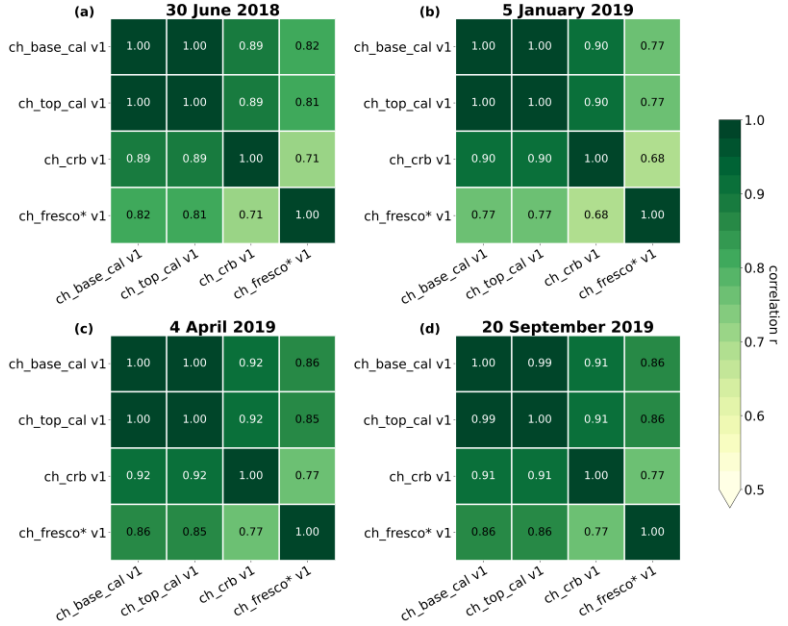


Figure S50: As Figure S49 but for Africa.

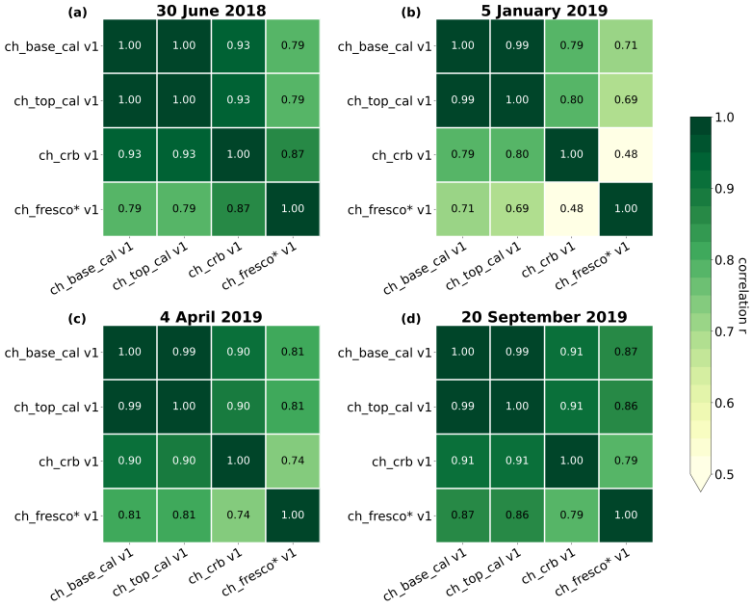


Figure S51: As Figure S49 but for China.

S4.3 Across-track dependency plots of the version 1 cloud fractions and cloud heights for the globe, Europe, Africa, and China

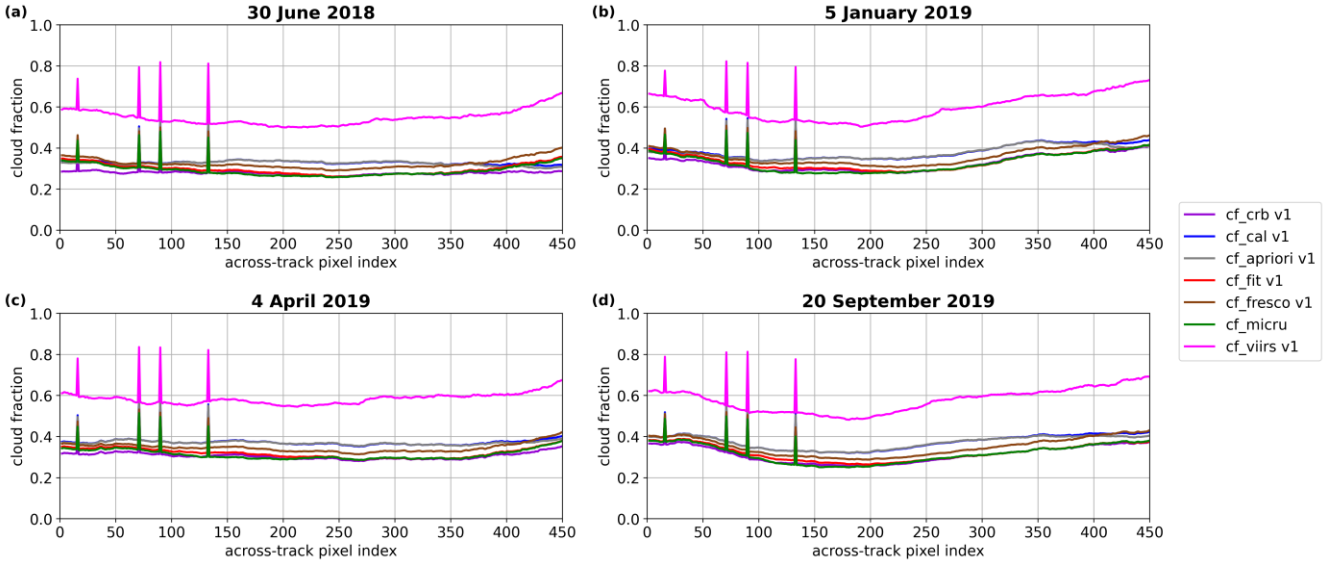


Figure S52: Mean values of version 1 cloud fractions, as a function of the across-track index, from ROCINN CRB, ROCINN CAL, OCRA a priori, the NO_2 fitting window (cf_fit), FRESCO, MICRU, and VIIRS for the globe and (a) the summer day, (b) the winter day, (c) the spring day, and (d) the autumn day with quality, snow, and ice flagging and only including pixels that have valid values for all products.

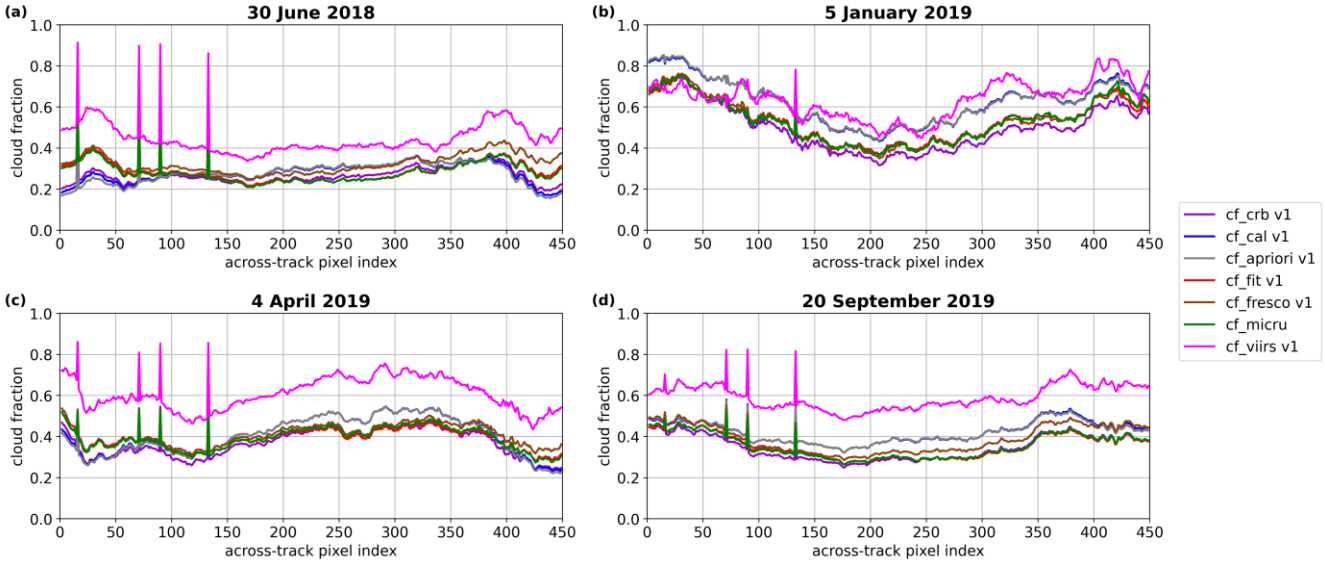


Figure S53: As Figure S52 but for Europe.

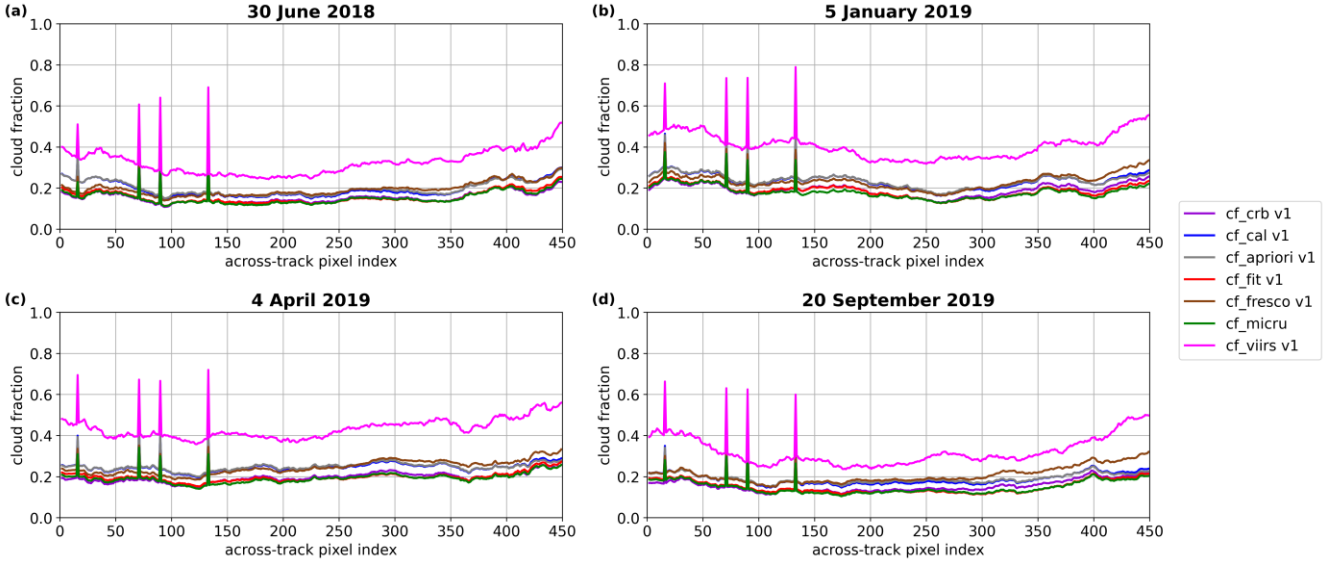


Figure S54: As Figure S52 but for Africa.

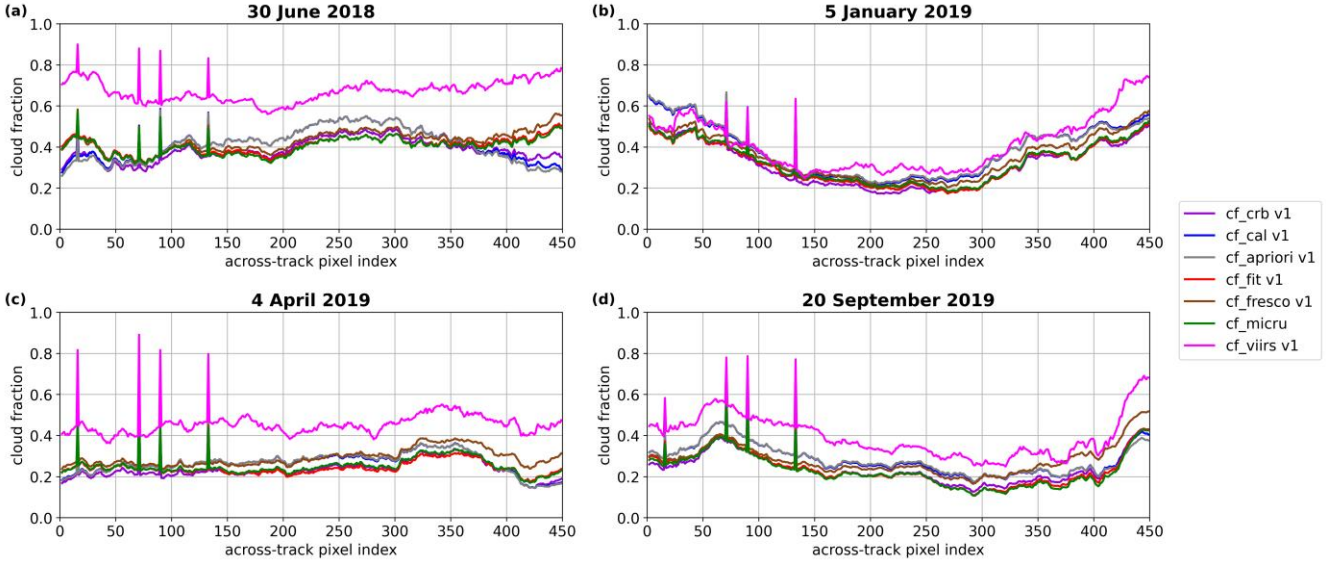


Figure S55: As Figure S52 but for China.

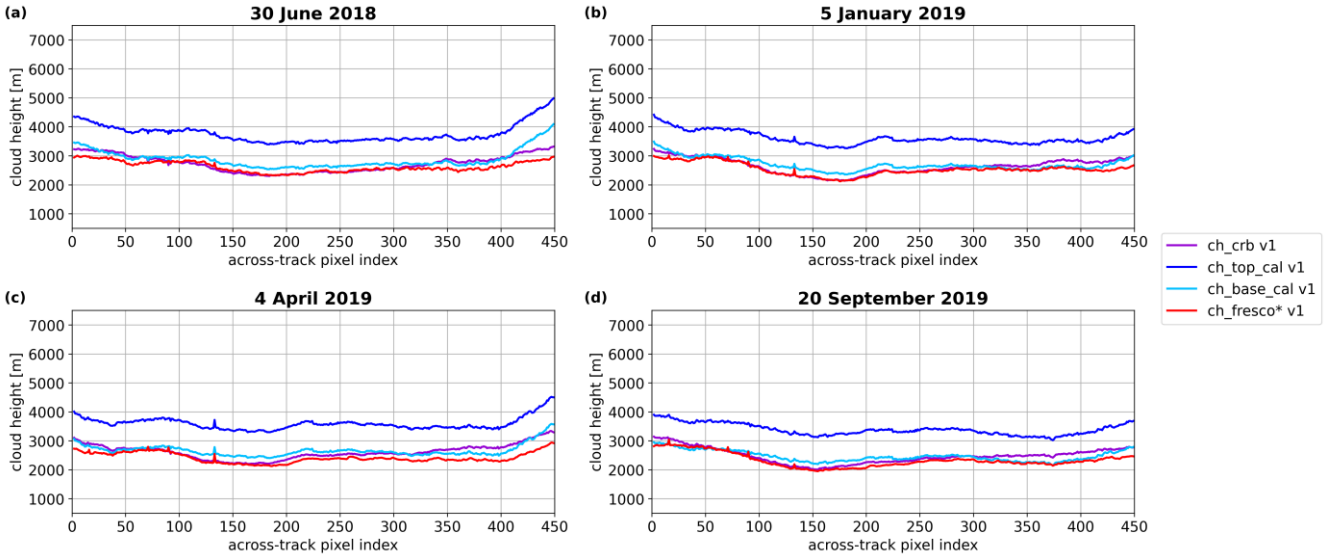


Figure S56: Mean values of version 1 cloud heights, as a function of the across-track index, from ROCINN CRB, ROCINN CAL top and base, and FRESCO from the TROPOMI NO_2 product (ch_fresco*) for the globe and (a) the summer day, (b) the winter day, (c) the spring day, and (d) the autumn day with quality, snow, and ice flagging and only including pixels that have valid values for all products.

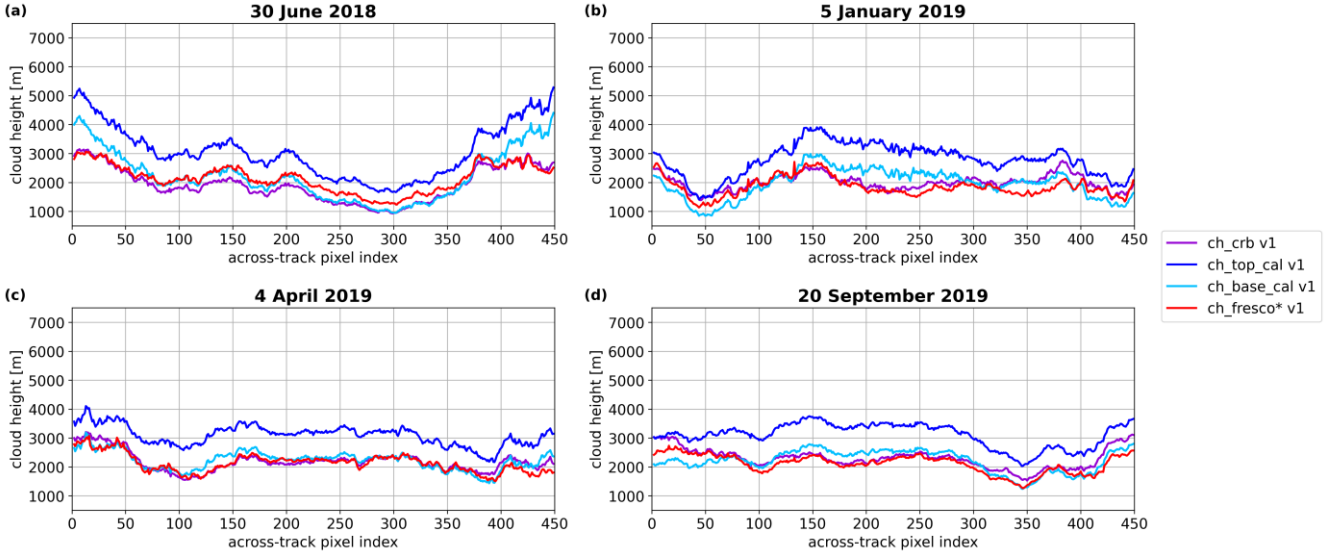


Figure S57: As Figure S56 but for Europe.

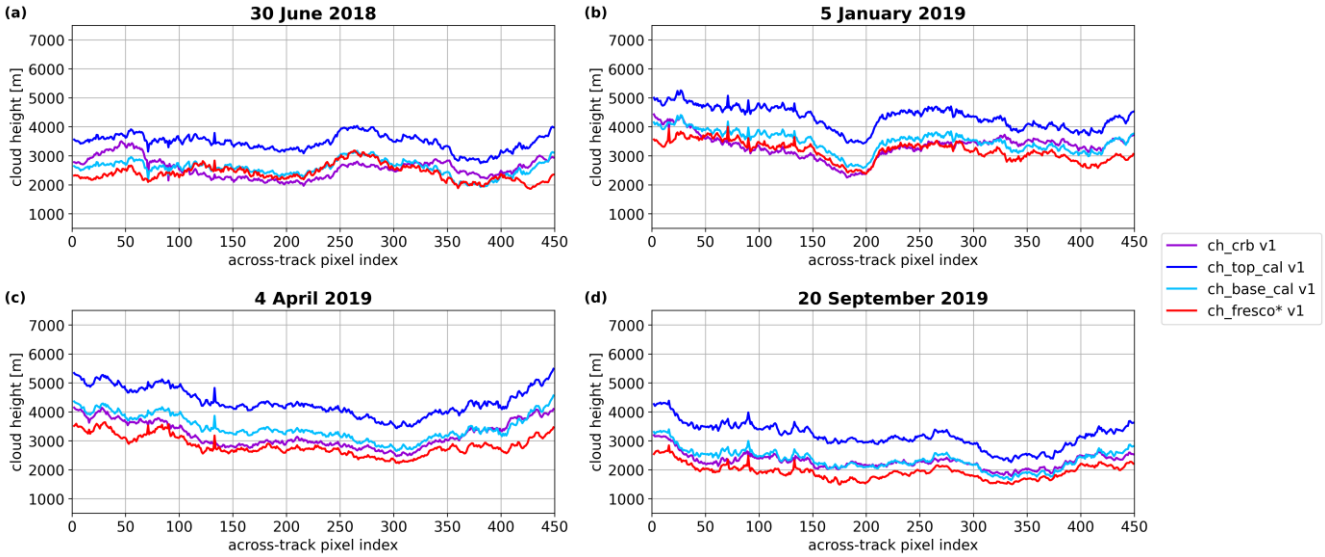


Figure S58: As Figure S56 but for Africa.

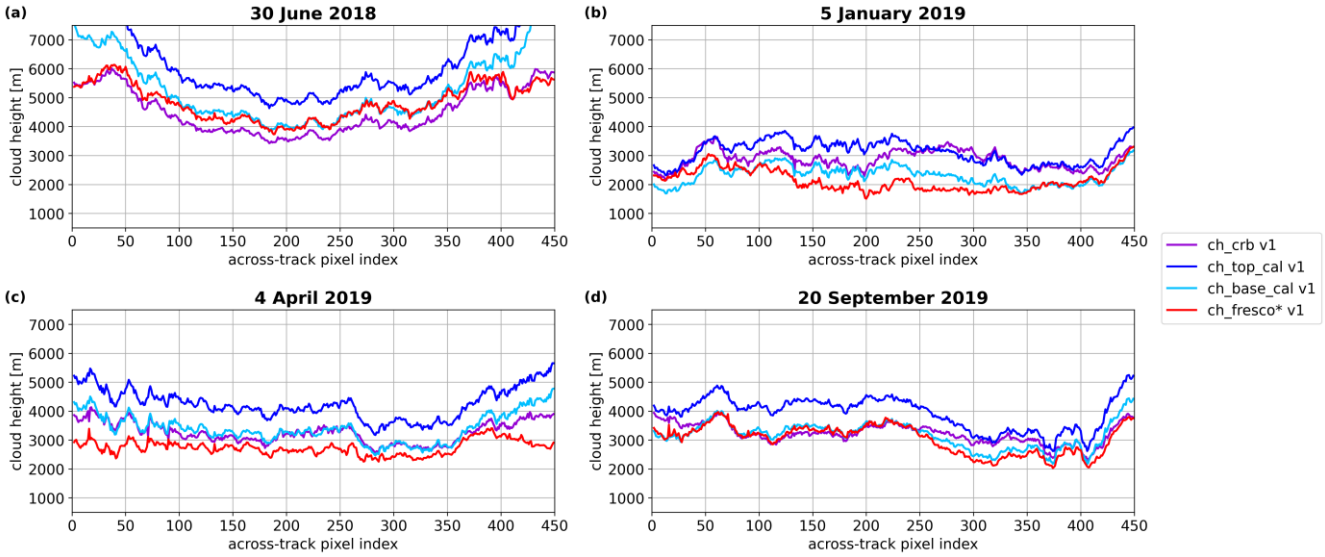


Figure S59: As Figure S56 but for China.