Comparison of cloud top heights derived from FY-2 satellites with heights derived from a ground-based cloud radar

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Introduction

Clouds are currently observed by both ground-based and satellite remote sensing techniques. Each technique has its own strengths and weaknesses depending on the observation method, instrument performance and the methods used for retrieval. We obtained CTT data from the FY-2 satellites and the cloud radar reflectivity data from June 2015 to May 2016. CTHs from the two datasets were retrieved and compared in order to evaluate the accuracy of CTH measurement of FY-2 satellites. The difference in CTHs was analyzed and the results is expected to be used as a reference for future research into synergistic cloud measurements.

Methods

- **Ground-based Cloud Radar**

Clutter Filtering → CTH Judgment → Quality Control

- **FY-2 Satellites**

CTT Retrival → CTH Searching using ATP → Quality Control

Space-time matching

Results

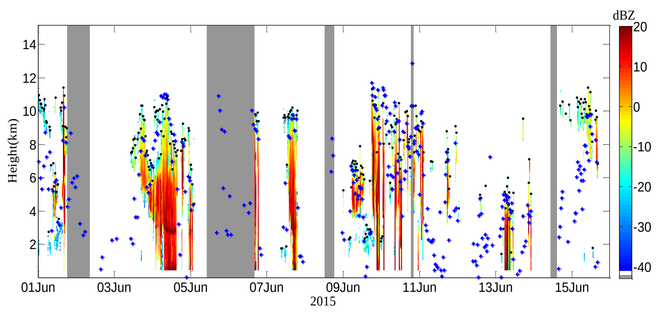
Cloud detection consistency

Period	Effective number	Consistent number	Both clouds	Both clear skies	Consistency rate (%)
Jun 2015	997	766	405	361	76.8
Jul 2015	825	581	196	385	70.4
Aug 2015	1227	939	369	570	76.5
Sep 2015	927	776	371	405	83.7
Oct 2015	1142	837	249	588	73.3
Nov 2015	1311	825	501	324	62.9
Dec 2015	514	448	76	372	87.2
Jan 2016	561	460	72	388	82.0
Feb 2016	633	542	107	435	85.6
Mar 2016	563	499	113	386	88.6
Apr 2016	635	559	182	377	88.0
May 2016	694	596	263	333	85.9
Total	10029	7828	2904	4924	78.1

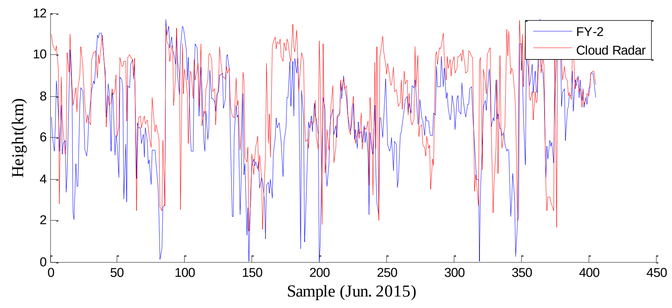
CTH averages and correlation

Period	FY-2 CTH (km)	Radar CTH (km)	Difference (RTH−CTH)	Correlation coefficient	Sample size
Jun 2015	6.99	7.93	0.94	0.49	405
Jul 2015	7.09	8.58	1.49	0.60	196
Aug 2015	5.88	8.18	2.30	0.53	369
Sep 2015	6.47	7.67	1.21	0.53	371
Oct 2015	5.79	8.16	2.37	0.51	249
Nov 2015	6.01	6.47	0.46	0.53	501
Dec 2015	5.11	6.28	1.17	0.45	76
Jan 2016	5.46	5.48	0.02	0.63	72
Feb 2016	5.68	6.76	1.08	0.59	107
Mar 2016	4.64	7.14	2.50	0.53	113
Apr 2016	6.37	8.56	2.18	0.46	182
May 2016	7.04	8.82	1.78	0.45	263
Total	6.04	7.50	1.46	0.52	2904

Cloud detection comparison

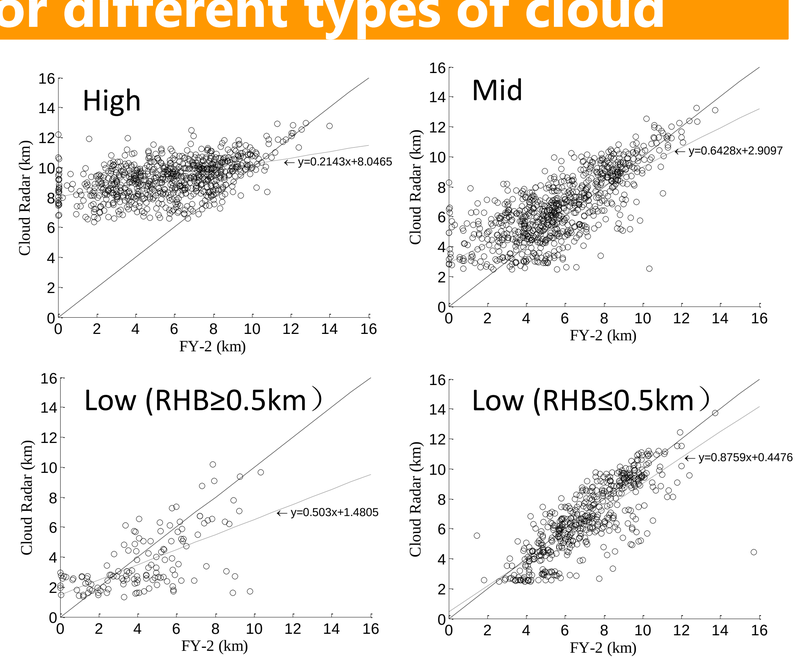


CTH comparison curves

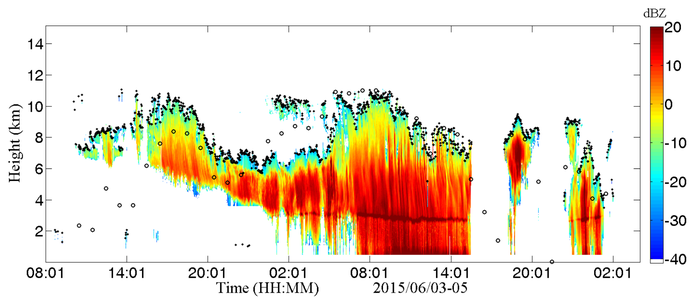


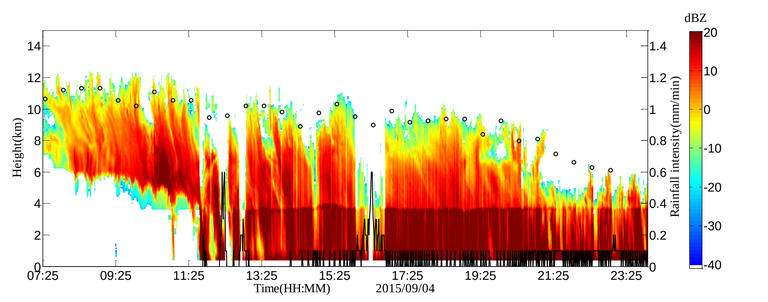
Contrast analysis of CTHs for different types of cloud

Cloud type (km)		No. of samples	Average difference (km)	Standard deviation (km)
High	RBH ≥ 6	741	3.56	2.39
Mid	2 ≤ RBH < 6	773	0.79	2.18
Low	0.5 ≤ RBH < 2	132	−0.67	1.98
	RBH < 0.5	481	−0.43	1.42



CTH comparison examples





Conclusions

- Methods to retrieve cloud top height from FY-2 satellites and a ground-based cloud radar were proposed.
- The cloud detection concordance rate between the two datasets was 78.1%, and the average difference was 1.46 km.
- The thicker clouds with a larger echo intensity and more continuous clouds gave a better consistency for the CTH.
- The satellite CTH can be used to compensate for attenuation errors in the cloud radar data.
- The consistencies of the time and space matching and the calibration of the two satellites are acceptable.
- The retrieved cloud top heights for high cirrus from FY-2 need to be improved.

Discussions

- Follow-up studies should further analyze the contribution of the spatiotemporal matching error to the difference in the height of the cloud top.
- The joint use of Lidar and Cloud radar can get more comprehensive cirrus information, and can better characterize the macro-physical properties of cirrus.
- The filtering method in this study needs to be further improved to better distinguish low-cloud from non-cloud echoes, and the satellite observation could be used as an effective validation for echo filtering.
- The radar reflectivity data could therefore be further applied to the calculation of the optical thickness of clouds to make the corresponding radiation correction to the CTH from satellite observations.