INSAT-3D Sounder Cloud Mask Validation Report

Validation Criteria :

1. Spatial Collocation : 10km (nominal resolution of INSAT-3D Sounder)

2. Temporal Collocation : 5 minutes

INSAT-3D sounder operational cloud mask product is available at 10km resolution at nadir. MODIS cloud mask product is available at 1 km resolution at nadir. Hence there will be approximately 100 pixels of Modis inside one Sounder Pixels provided both are looking at nadir. In general, there is arround 40-60 pixles of MODIS per sounder pixel.

Furthermore operational MODIS cloud mask has 4 flags : Confident clear, probably clear, probably cloudy and cloudy, while operational sounder cloud mask has only 3 flags : Clear, Cloudy and Uncertain. For validation we follow these steps :

1. Spatial and Temporal Collocation

2. Resampling of MODIS cloud Mask on sounder observation area

3. Conversion of 4 cloud flags of MODIS into 3 cloud flags of sounder

The following methodology is adopted for conversion of MODIS cloud flag to sounder cloud flag

(i) A probability value is assigned to each of the modis cloud flag. Here we have assigned the values of 0.125,0.25,0.5,1 for confident clear, probably clear, probably clouly and cloudy respectively.

(ii) For each collocated sounder pixel , a single probability value for MODIS is obtained using the following 3 methods of averaging :

a) Taking mode of modis pixel probability value

b) Taking weighted average of probability values

c) Taking weighted products of the odds and subtracting the final results from 1

(iii)Based on probabilty value (p) obtained from above mentioned methods, the cloud mask flag for modis is decided for each method as follows :

$p < 0.35$: Cloudy

$p = 0.35$-0.75 : Uncertain

$p > 0.75$: Clear

Based on this flag , confusion matrix and skill scores were computed for each of the 3 methods.

The validation satatistics are presented in follwing order :

1. All Surface

2. Land

3. Ocean

4. Coast

5. Highland (surface height > 2000 m)

For each of the 5 surface types , results are further categorised according to time of the day

1. All times
2. Daytime (0-12 UTC i.e. 05:30-17:30 IST)
3. Nighttime (12-24 UTC i.e. 17:30-05:30 IST)

For each of these cases following statistics are shown :

1. 3X3 Confusion matrices for clear, cloudy and uncertain conditions
2. Following skill scores based on confusion matrices :-

i). False Alarm Ratio (FAR)

ii). Frequency Bias (FB)

iii). Probability of Detection (POD)

iv). False Alarm Rate (F)

v). Proportion Correct (PCr)

vi). Kuiper Skill Score (KSS)

vii). Heidke Skill Score (HSS)

Following plots are also shown :

1. Time series of Total number of collocations obtained for each of the 5 categories
2. Time series of percentage correct pixels (100 * PCr)
3. Sample spatial plot of operational cloud products and collocations on Land and Ocean

INSAT-3D Sounder vs MODIS for September , 2017 (All times (day and night)) on all surface types

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	14797	7716	17867
Sounder Uncertain	3645	1395	13337
Sounder Cloudy	4829	915	71079

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11449	13565	15366
Sounder Uncertain	2451	3536	12390
Sounder Cloudy	3126	4649	69048

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	9356	14233	16791
Sounder Uncertain	1948	3564	12865
Sounder Cloudy	2548	4408	69867

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	10.91	5.69	13.18
Sounder Uncertain	2.69	1.03	9.84
Sounder Cloudy	3.56	0.67	52.43

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8.44	10.01	11.33
Sounder Uncertain	1.81	2.61	9.14
Sounder Cloudy	2.31	3.43	50.93

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6.90	10.50	12.38
Sounder Uncertain	1.44	2.63	9.49
Sounder Cloudy	1.88	3.25	51.53

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.63	0.92	0.07
Frequency Bias	1.74	1.83	0.75
Probability of Detection	0.64	0.14	0.69
False Alarm Rate	0.53	0.35	0.12

Overall Skill Score

Skill Score	Value
Proportion Correct	0.644
Kuiper Skill Score	0.392
Heidke Skill Score	0.303

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.72	0.81	0.10
Frequency Bias	2.37	0.84	0.79
Probability of Detection	0.67	0.16	0.71
False Alarm Rate	0.56	0.29	0.15

Overall Skill Score

Skill Score	Value
Proportion Correct	0.620
Kuiper Skill Score	0.348
Heidke Skill Score	0.291

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.77	0.81	0.09
Frequency Bias	2.92	0.83	0.77
Probability of Detection	0.68	0.16	0.70
False Alarm Rate	0.59	0.28	0.13

Overall Skill Score

Skill Score	Value
Proportion Correct	0.611
Kuiper Skill Score	0.335
Heidke Skill Score	0.267

INSAT-3D Sounder vs MODIS for September , 2017 (Day) on all surface types

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	9665	5324	11678
Sounder Uncertain	2654	589	7333
Sounder Cloudy	4717	786	52801

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7011	9950	9706
Sounder Uncertain	1701	2269	6606
Sounder Cloudy	3064	4413	50827

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5550	10305	10812
Sounder Uncertain	1360	2283	6933
Sounder Cloudy	2493	4201	51610

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	10.12	5.57	12.22
Sounder Uncertain	2.78	0.62	7.67
Sounder Cloudy	4.94	0.82	55.26

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7.34	10.41	10.16
Sounder Uncertain	1.78	2.37	6.91
Sounder Cloudy	3.21	4.62	53.20

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5.81	10.79	11.32
Sounder Uncertain	1.42	2.39	7.26
Sounder Cloudy	2.61	4.40	54.02

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.64	0.94	0.09
Frequency Bias	1.57	1.58	0.81
Probability of Detection	0.57	0.09	0.74
False Alarm Rate	0.52	0.31	0.17

Overall Skill Score

Skill Score	Value
Proportion Correct	0.660
Kuiper Skill Score	0.361
Heidke Skill Score	0.297

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.74	0.79	0.13
Frequency Bias	2.26	0.64	0.87
Probability of Detection	0.60	0.14	0.76
False Alarm Rate	0.55	0.23	0.21

Overall Skill Score

Skill Score	Value
Proportion Correct	0.629
Kuiper Skill Score	0.318
Heidke Skill Score	0.283

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.79	0.78	0.11
Frequency Bias	2.84	0.63	0.84
Probability of Detection	0.59	0.14	0.74
False Alarm Rate	0.58	0.23	0.19

Overall Skill Score

Skill Score	Value

Proportion Correct	0.622
Kuiper Skill Score	0.306
Heidke Skill Score	0.259

INSAT-3D Sounder vs MODIS for September , 2017 (Night) on all surface types

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5132	2392	6189
Sounder Uncertain	991	806	6004
Sounder Cloudy	112	129	18278

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4438	3615	5660
Sounder Uncertain	750	1267	5784
Sounder Cloudy	62	236	18221

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3806	3928	5979
Sounder Uncertain	588	1281	5932
Sounder Cloudy	55	207	18257

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	12.82	5.98	15.46
Sounder Uncertain	2.48	2.01	15.00
Sounder Cloudy	0.28	0.32	45.66

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11.09	9.03	14.14
Sounder Uncertain	1.87	3.16	14.45
Sounder Cloudy	0.15	0.59	45.51

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	9.51	9.81	14.94
Sounder Uncertain	1.47	3.20	14.82
Sounder Cloudy	0.14	0.52	45.60

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.63	0.90	0.01
Frequency Bias	2.20	2.34	0.61
Probability of Detection	0.82	0.24	0.60
False Alarm Rate	0.54	0.44	0.02

Overall Skill Score

Skill Score	Value
Proportion Correct	0.605
Kuiper Skill Score	0.470
Heidke Skill Score	0.317

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy

False Alarm Ratio	0.68	0.84	0.02
Frequency Bias	2.61	1.52	0.62
Probability of Detection	0.85	0.25	0.61
False Alarm Rate	0.58	0.41	0.02

Overall Skill Score

Skill Score	Value
Proportion Correct	0.598
Kuiper Skill Score	0.443
Heidke Skill Score	0.315

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.72	0.84	0.01
Frequency Bias	3.08	1.44	0.61
Probability of Detection	0.86	0.24	0.61
False Alarm Rate	0.59	0.39	0.02

Overall Skill Score

Skill Score	Value
Proportion Correct	0.583
Kuiper Skill Score	0.424
Heidke Skill Score	0.290

INSAT-3D Sounder vs MODIS for September , 2017 (All times (day and night)) on Land

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy

Sounder Clear	8710	3117	10897
Sounder Uncertain	1290	773	7595
Sounder Cloudy	3499	640	38700

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6550	7558	8616
Sounder Uncertain	783	1845	7030
Sounder Cloudy	2372	3186	37281

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5151	8014	9559
Sounder Uncertain	578	1732	7348
Sounder Cloudy	1958	2994	37887

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11.58	4.14	14.49
Sounder Uncertain	1.71	1.03	10.10
Sounder Cloudy	4.65	0.85	51.45

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8.71	10.05	11.45
Sounder Uncertain	1.04	2.45	9.35
Sounder Cloudy	3.15	4.24	49.56

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6.85	10.65	12.71

Sounder Uncertain	0.77	2.30	9.77
Sounder Cloudy	2.60	3.98	50.37

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.62	0.92	0.10
Frequency Bias	1.68	2.13	0.75
Probability of Detection	0.65	0.17	0.68
False Alarm Rate	0.52	0.33	0.15

Overall Skill Score

Skill Score	Value
Proportion Correct	0.641
Kuiper Skill Score	0.377
Heidke Skill Score	0.288

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.71	0.81	0.13
Frequency Bias	2.34	0.77	0.81
Probability of Detection	0.67	0.15	0.70
False Alarm Rate	0.55	0.26	0.19

Overall Skill Score

Skill Score	Value
Proportion Correct	0.607
Kuiper Skill Score	0.317
Heidke Skill Score	0.271

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.77	0.82	0.12

Frequency Bias	2.96	0.76	0.78
Probability of Detection	0.67	0.14	0.69
False Alarm Rate	0.58	0.26	0.16

Overall Skill Score

Skill Score	Value
Proportion Correct	0.595
Kuiper Skill Score	0.297
Heidke Skill Score	0.240

INSAT-3D Sounder vs MODIS for September , 2017 (Day) on Land

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7061	1600	7088
Sounder Uncertain	905	202	3114
Sounder Cloudy	3483	548	29926

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5003	5741	5005
Sounder Uncertain	476	1094	2651
Sounder Cloudy	2362	3083	28512

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3894	6091	5764

Sounder Uncertain	348	1009	2864
Sounder Cloudy	1949	2908	29100

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	13.09	2.97	13.14
Sounder Uncertain	1.68	0.37	5.77
Sounder Cloudy	6.46	1.02	55.49

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	9.28	10.65	9.28
Sounder Uncertain	0.88	2.03	4.92
Sounder Cloudy	4.38	5.72	52.87

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7.22	11.29	10.69
Sounder Uncertain	0.65	1.87	5.31
Sounder Cloudy	3.61	5.39	53.96

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.55	0.95	0.12
Frequency Bias	1.38	1.80	0.85
Probability of Detection	0.62	0.09	0.75
False Alarm Rate	0.52	0.24	0.24

Overall Skill Score

Skill Score	Value
Proportion Correct	0.690
Kuiper Skill Score	0.390
Heidke Skill Score	0.334

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.68	0.74	0.16
Frequency Bias	2.01	0.43	0.94
Probability of Detection	0.64	0.11	0.79
False Alarm Rate	0.56	0.16	0.28

Overall Skill Score

Skill Score	Value
Proportion Correct	0.642
Kuiper Skill Score	0.328
Heidke Skill Score	0.312

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.75	0.76	0.14
Frequency Bias	2.54	0.42	0.90
Probability of Detection	0.63	0.10	0.77
False Alarm Rate	0.60	0.16	0.24

Overall Skill Score

Skill Score	Value
Proportion Correct	0.631
Kuiper Skill Score	0.307
Heidke Skill Score	0.278

INSAT-3D Sounder vs MODIS for September , 2017 (Night) on Land

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1649	1517	3809
Sounder Uncertain	385	571	4481
Sounder Cloudy	16	92	8774

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1547	1817	3611
Sounder Uncertain	307	751	4379
Sounder Cloudy	10	103	8769

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1257	1923	3795
Sounder Uncertain	230	723	4484
Sounder Cloudy	9	86	8787

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7.74	7.12	17.89
Sounder Uncertain	1.81	2.68	21.04
Sounder Cloudy	0.08	0.43	41.20

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7.26	8.53	16.96
Sounder Uncertain	1.44	3.53	20.56
Sounder Cloudy	0.05	0.48	41.18

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5.90	9.03	17.82
Sounder Uncertain	1.08	3.40	21.06
Sounder Cloudy	0.04	0.40	41.27

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.76	0.89	0.01
Frequency Bias	3.40	2.49	0.52
Probability of Detection	0.80	0.26	0.51
False Alarm Rate	0.52	0.47	0.01

Overall Skill Score

Skill Score	Value
Proportion Correct	0.516
Kuiper Skill Score	0.368
Heidke Skill Score	0.205

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.78	0.86	0.01
Frequency Bias	3.74	2.04	0.53
Probability of Detection	0.83	0.28	0.52
False Alarm Rate	0.53	0.46	0.01

Overall Skill Score

Skill Score	Value
Proportion Correct	0.520
Kuiper Skill Score	0.366
Heidke Skill Score	0.214

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.82	0.87	0.01
Frequency Bias	4.66	1.99	0.52
Probability of Detection	0.84	0.26	0.51
False Alarm Rate	0.54	0.45	0.01

Overall Skill Score

Skill Score	Value
Proportion Correct	0.506
Kuiper Skill Score	0.344
Heidke Skill Score	0.189

INSAT-3D Sounder vs MODIS for September , 2017 (All times (day and night)) on Ocean

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4552	4093	5843
Sounder Uncertain	579	410	4523
Sounder Cloudy	245	158	26729

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3698	4977	5813
Sounder Uncertain	407	642	4463
Sounder Cloudy	146	343	26643

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3287	4991	6210
Sounder Uncertain	355	615	4542
Sounder Cloudy	125	314	26693

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	9.66	8.68	12.40
Sounder Uncertain	1.23	0.87	9.60
Sounder Cloudy	0.52	0.34	56.71

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7.85	10.56	12.33
Sounder Uncertain	0.86	1.36	9.47
Sounder Cloudy	0.31	0.73	56.53

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6.97	10.59	13.18
Sounder Uncertain	0.75	1.30	9.64
Sounder Cloudy	0.27	0.67	56.63

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.69	0.93	0.01
Frequency Bias	2.69	1.18	0.73
Probability of Detection	0.85	0.09	0.72
False Alarm Rate	0.64	0.33	0.03

Overall Skill Score

Skill Score	Value
Proportion Correct	0.672
Kuiper Skill Score	0.483
Heidke Skill Score	0.345

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.74	0.88	0.02
Frequency Bias	3.41	0.92	0.73
Probability of Detection	0.87	0.11	0.72
False Alarm Rate	0.67	0.30	0.03

Overall Skill Score

Skill Score	Value
Proportion Correct	0.657
Kuiper Skill Score	0.452
Heidke Skill Score	0.324

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.77	0.89	0.02
Frequency Bias	3.85	0.93	0.72
Probability of Detection	0.87	0.10	0.71
False Alarm Rate	0.68	0.30	0.03

Overall Skill Score

Skill Score	Value

Proportion Correct	0.649
Kuiper Skill Score	0.440
Heidke Skill Score	0.303

INSAT-3D Sounder vs MODIS for September , 2017 (Day) on Ocean

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1454	3597	3913
Sounder Uncertain	154	344	3325
Sounder Cloudy	158	134	17652

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1152	3647	4165
Sounder Uncertain	107	374	3342
Sounder Cloudy	95	250	17599

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	956	3543	4465
Sounder Uncertain	84	340	3399
Sounder Cloudy	79	226	17639

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4.73	11.70	12.73
Sounder Uncertain	0.50	1.12	10.82
Sounder Cloudy	0.51	0.44	57.44

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3.75	11.87	13.55
Sounder Uncertain	0.35	1.22	10.88
Sounder Cloudy	0.31	0.81	57.27

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3.11	11.53	14.53
Sounder Uncertain	0.27	1.11	11.06
Sounder Cloudy	0.26	0.74	57.40

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.84	0.91	0.02
Frequency Bias	5.08	0.94	0.72
Probability of Detection	0.82	0.08	0.71
False Alarm Rate	0.67	0.31	0.03

Overall Skill Score

Skill Score	Value
Proportion Correct	0.633
Kuiper Skill Score	0.392
Heidke Skill Score	0.257

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy

False Alarm Ratio	0.87	0.90	0.02
Frequency Bias	6.62	0.90	0.71
Probability of Detection	0.85	0.09	0.70
False Alarm Rate	0.67	0.30	0.03

Overall Skill Score

Skill Score	Value
Proportion Correct	0.622
Kuiper Skill Score	0.370
Heidke Skill Score	0.234

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.89	0.91	0.02
Frequency Bias	8.01	0.93	0.70
Probability of Detection	0.85	0.08	0.69
False Alarm Rate	0.68	0.30	0.03

Overall Skill Score

Skill Score	Value
Proportion Correct	0.616
Kuiper Skill Score	0.357
Heidke Skill Score	0.214

INSAT-3D Sounder vs MODIS for September , 2017 (Night) on Ocean

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy

Sounder Clear	3098	496	1930
Sounder Uncertain	425	66	1198
Sounder Cloudy	87	24	9077

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2546	1330	1648
Sounder Uncertain	300	268	1121
Sounder Cloudy	51	93	9044

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2331	1448	1745
Sounder Uncertain	271	275	1143
Sounder Cloudy	46	88	9054

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	18.89	3.02	11.77
Sounder Uncertain	2.59	0.40	7.30
Sounder Cloudy	0.53	0.15	55.34

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	15.52	8.11	10.05
Sounder Uncertain	1.83	1.63	6.83
Sounder Cloudy	0.31	0.57	55.14

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	14.21	8.83	10.64

Sounder Uncertain	1.65	1.68	6.97
Sounder Cloudy	0.28	0.54	55.20

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.44	0.96	0.01
Frequency Bias	1.53	2.88	0.75
Probability of Detection	0.86	0.11	0.74
False Alarm Rate	0.58	0.39	0.03

Overall Skill Score

Skill Score	Value
Proportion Correct	0.746
Kuiper Skill Score	0.635
Heidke Skill Score	0.498

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.54	0.84	0.02
Frequency Bias	1.91	1.00	0.78
Probability of Detection	0.88	0.16	0.77
False Alarm Rate	0.66	0.31	0.03

Overall Skill Score

Skill Score	Value
Proportion Correct	0.723
Kuiper Skill Score	0.568
Heidke Skill Score	0.474

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.58	0.84	0.01

Frequency Bias	2.09	0.93	0.77
Probability of Detection	0.88	0.15	0.76
False Alarm Rate	0.67	0.30	0.03

Overall Skill Score

Skill Score	Value
Proportion Correct	0.711
Kuiper Skill Score	0.550
Heidke Skill Score	0.451

INSAT-3D Sounder vs MODIS for September , 2017 (All times (day and night)) on Coast

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	67	29	130
Sounder Uncertain	8	10	90
Sounder Cloudy	16	25	382

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	50	54	122
Sounder Uncertain	7	13	88
Sounder Cloudy	12	31	380

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	37	64	125

Sounder Uncertain	7	13	88
Sounder Cloudy	7	28	388

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8.85	3.83	17.17
Sounder Uncertain	1.06	1.32	11.89
Sounder Cloudy	2.11	3.30	50.46

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6.61	7.13	16.12
Sounder Uncertain	0.92	1.72	11.62
Sounder Cloudy	1.59	4.10	50.20

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4.89	8.45	16.51
Sounder Uncertain	0.92	1.72	11.62
Sounder Cloudy	0.92	3.70	51.25

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.70	0.91	0.10
Frequency Bias	2.48	1.69	0.70
Probability of Detection	0.74	0.16	0.63
False Alarm Rate	0.53	0.33	0.14

Overall Skill Score

Skill Score	Value
Proportion Correct	0.606
Kuiper Skill Score	0.330
Heidke Skill Score	0.225

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.78	0.88	0.10
Frequency Bias	3.28	1.10	0.72
Probability of Detection	0.72	0.13	0.64
False Alarm Rate	0.56	0.30	0.14

Overall Skill Score

Skill Score	Value
Proportion Correct	0.585
Kuiper Skill Score	0.283
Heidke Skill Score	0.200

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.84	0.88	0.08
Frequency Bias	4.43	1.03	0.70
Probability of Detection	0.73	0.12	0.65
False Alarm Rate	0.59	0.30	0.11

Overall Skill Score

Skill Score	Value
Proportion Correct	0.579
Kuiper Skill Score	0.275
Heidke Skill Score	0.184

INSAT-3D Sounder vs MODIS for September , 2017 (Day) on Coast

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	67	21	91
Sounder Uncertain	8	5	62
Sounder Cloudy	16	25	324

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	50	44	85
Sounder Uncertain	7	8	60
Sounder Cloudy	12	31	322

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	37	56	86
Sounder Uncertain	7	8	60
Sounder Cloudy	7	28	330

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	10.82	3.39	14.70
Sounder Uncertain	1.29	0.81	10.02
Sounder Cloudy	2.58	4.04	52.34

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8.08	7.11	13.73
Sounder Uncertain	1.13	1.29	9.69
Sounder Cloudy	1.94	5.01	52.02

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5.98	9.05	13.89
Sounder Uncertain	1.13	1.29	9.69
Sounder Cloudy	1.13	4.52	53.31

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.63	0.93	0.11
Frequency Bias	1.97	1.47	0.77
Probability of Detection	0.74	0.10	0.68
False Alarm Rate	0.50	0.31	0.18

Overall Skill Score

Skill Score	Value
Proportion Correct	0.640
Kuiper Skill Score	0.352
Heidke Skill Score	0.269

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.72	0.89	0.12
Frequency Bias	2.59	0.90	0.78
Probability of Detection	0.72	0.10	0.69
False Alarm Rate	0.54	0.28	0.18

Overall Skill Score

Skill Score	Value
Proportion Correct	0.614
Kuiper Skill Score	0.301
Heidke Skill Score	0.238

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.79	0.89	0.10
Frequency Bias	3.51	0.82	0.77
Probability of Detection	0.73	0.09	0.69
False Alarm Rate	0.58	0.27	0.14

Overall Skill Score

Skill Score	Value
Proportion Correct	0.606
Kuiper Skill Score	0.291
Heidke Skill Score	0.219

INSAT-3D Sounder vs MODIS for September , 2017 (Night) on Coast

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	8	39
Sounder Uncertain	0	5	28
Sounder Cloudy	0	0	58

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	10	37
Sounder Uncertain	0	5	28
Sounder Cloudy	0	0	58

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	8	39
Sounder Uncertain	0	5	28
Sounder Cloudy	0	0	58

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	5.80	28.26
Sounder Uncertain	0.00	3.62	20.29
Sounder Cloudy	0.00	0.00	42.03

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	7.25	26.81
Sounder Uncertain	0.00	3.62	20.29
Sounder Cloudy	0.00	0.00	42.03

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	5.80	28.26
Sounder Uncertain	0.00	3.62	20.29
Sounder Cloudy	0.00	0.00	42.03

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	0.85	0.00
Frequency Bias	inf	2.54	0.46
Probability of Detection	nan	0.38	0.46
False Alarm Rate	0.63	0.37	0.00

Overall Skill Score

Skill Score	Value
Proportion Correct	0.457
Kuiper Skill Score	0.312
Heidke Skill Score	0.089

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	0.85	0.00
Frequency Bias	inf	2.20	0.47
Probability of Detection	nan	0.33	0.47
False Alarm Rate	0.63	0.37	0.00

Overall Skill Score

Skill Score	Value
Proportion Correct	0.457
Kuiper Skill Score	0.289
Heidke Skill Score	0.093

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	0.85	0.00
Frequency Bias	inf	2.54	0.46
Probability of Detection	nan	0.38	0.46
False Alarm Rate	0.63	0.37	0.00

Overall Skill Score

Skill Score	Value

Proportion Correct	0.457
Kuiper Skill Score	0.312
Heidke Skill Score	0.089

INSAT-3D Sounder vs MODIS for September , 2017 (All times (day and night)) on Highland (>2000 m)

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1171	310	436
Sounder Uncertain	1725	173	818
Sounder Cloudy	1026	45	3189

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	943	681	293
Sounder Uncertain	1224	975	517
Sounder Cloudy	573	967	2720

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	732	845	340
Sounder Uncertain	982	1156	578
Sounder Cloudy	438	979	2843

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	13.17	3.49	4.90
Sounder Uncertain	19.40	1.95	9.20
Sounder Cloudy	11.54	0.51	35.86

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	10.60	7.66	3.29
Sounder Uncertain	13.76	10.96	5.81
Sounder Cloudy	6.44	10.87	30.59

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8.23	9.50	3.82
Sounder Uncertain	11.04	13.00	6.50
Sounder Cloudy	4.93	11.01	31.97

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.39	0.94	0.25
Frequency Bias	0.49	5.14	0.96
Probability of Detection	0.30	0.33	0.72
False Alarm Rate	0.17	0.58	0.25

Overall Skill Score

Skill Score	Value
Proportion Correct	0.510
Kuiper Skill Score	0.285
Heidke Skill Score	0.243

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy

False Alarm Ratio	0.51	0.64	0.36
Frequency Bias	0.70	1.04	1.21
Probability of Detection	0.34	0.37	0.77
False Alarm Rate	0.23	0.41	0.36

Overall Skill Score

Skill Score	Value
Proportion Correct	0.522
Kuiper Skill Score	0.265
Heidke Skill Score	0.268

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.62	0.57	0.33
Frequency Bias	0.89	0.91	1.13
Probability of Detection	0.34	0.39	0.76
False Alarm Rate	0.28	0.37	0.34

Overall Skill Score

Skill Score	Value
Proportion Correct	0.532
Kuiper Skill Score	0.269
Heidke Skill Score	0.272

INSAT-3D Sounder vs MODIS for September , 2017 (Day) on Highland (>2000 m)

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy

Sounder Clear	791	8	271
Sounder Uncertain	1546	21	639
Sounder Cloudy	1017	34	3103

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	601	305	164
Sounder Uncertain	1082	748	376
Sounder Cloudy	572	930	2652

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	516	364	190
Sounder Uncertain	895	888	423
Sounder Cloudy	438	948	2768

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	10.65	0.11	3.65
Sounder Uncertain	20.81	0.28	8.60
Sounder Cloudy	13.69	0.46	41.76

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8.09	4.10	2.21
Sounder Uncertain	14.56	10.07	5.06
Sounder Cloudy	7.70	12.52	35.69

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6.94	4.90	2.56

Sounder Uncertain	12.05	11.95	5.69
Sounder Cloudy	5.90	12.76	37.25

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.26	0.99	0.25
Frequency Bias	0.32	35.02	1.04
Probability of Detection	0.24	0.33	0.77
False Alarm Rate	0.08	0.62	0.30

Overall Skill Score

Skill Score	Value
Proportion Correct	0.527
Kuiper Skill Score	0.312
Heidke Skill Score	0.250

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.44	0.66	0.36
Frequency Bias	0.47	1.11	1.30
Probability of Detection	0.27	0.38	0.83
False Alarm Rate	0.14	0.43	0.44

Overall Skill Score

Skill Score	Value
Proportion Correct	0.538
Kuiper Skill Score	0.269
Heidke Skill Score	0.275

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.52	0.60	0.33

Frequency Bias	0.58	1.00	1.23
Probability of Detection	0.28	0.40	0.82
False Alarm Rate	0.17	0.40	0.43

Overall Skill Score

Skill Score	Value
Proportion Correct	0.562
Kuiper Skill Score	0.285
Heidke Skill Score	0.295

INSAT-3D Sounder vs MODIS for September , 2017 (Night) on Highland (>2000 m)

1. Confusion matrix of Total number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	380	302	165
Sounder Uncertain	179	152	179
Sounder Cloudy	9	11	86

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	342	376	129
Sounder Uncertain	142	227	141
Sounder Cloudy	1	37	68

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	216	481	150

Sounder Uncertain	87	268	155
Sounder Cloudy	0	31	75

2. Confusion matrix of percentage number of collocations

Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	25.97	20.64	11.28
Sounder Uncertain	12.24	10.39	12.24
Sounder Cloudy	0.62	0.75	5.88

Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	23.38	25.70	8.82
Sounder Uncertain	9.71	15.52	9.64
Sounder Cloudy	0.07	2.53	4.65

Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	14.76	32.88	10.25
Sounder Uncertain	5.95	18.32	10.59
Sounder Cloudy	0.00	2.12	5.13

3. Skill Scores

Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.55	0.70	0.19
Frequency Bias	1.49	1.10	0.25
Probability of Detection	0.67	0.33	0.20
False Alarm Rate	0.55	0.42	0.02

Overall Skill Score

Skill Score	Value
Proportion Correct	0.422
Kuiper Skill Score	0.099
Heidke Skill Score	0.102

Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.60	0.55	0.36
Frequency Bias	1.75	0.80	0.31
Probability of Detection	0.71	0.35	0.20
False Alarm Rate	0.61	0.34	0.05

Overall Skill Score

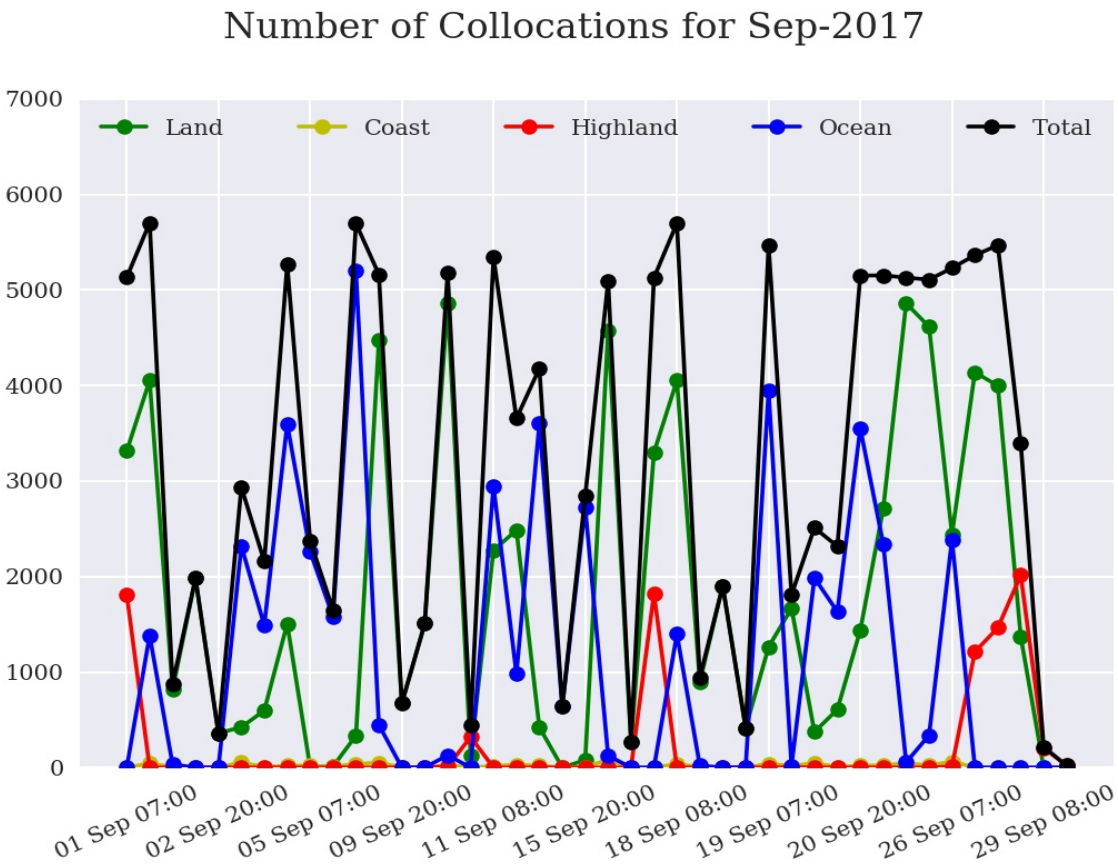
Skill Score	Value
Proportion Correct	0.435
Kuiper Skill Score	0.115
Heidke Skill Score	0.116

Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.74	0.47	0.29
Frequency Bias	2.80	0.65	0.28
Probability of Detection	0.71	0.34	0.20
False Alarm Rate	0.70	0.27	0.03

Overall Skill Score

Skill Score	Value
Proportion Correct	0.382
Kuiper Skill Score	0.095
Heidke Skill Score	0.085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Coast
Highland
Ocean
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1000
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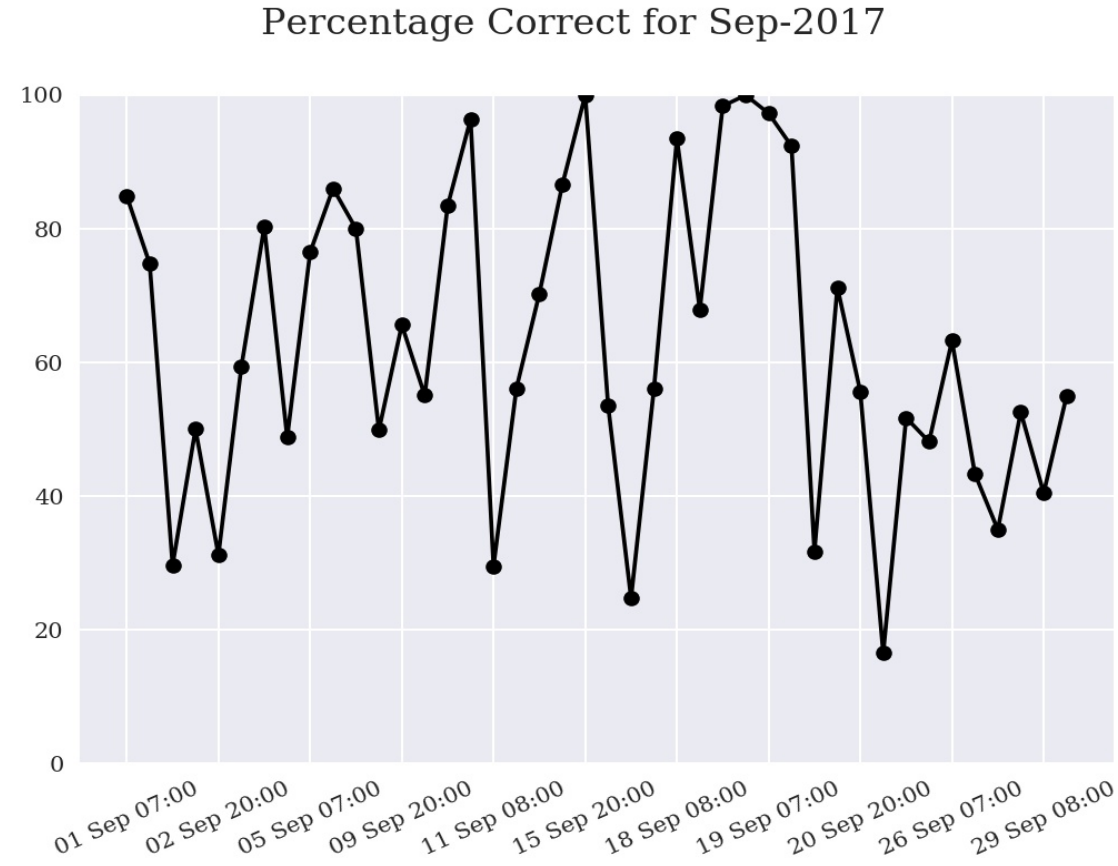
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80
60
40
20
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02 Sep 20:00
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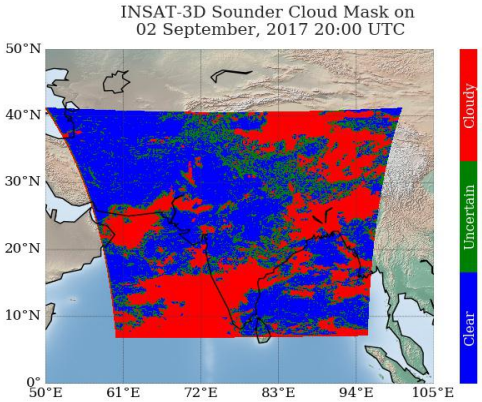
INSAT-3D Sounder Cloud Mask on
02 September, 2017 20:00 UTC
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40°N
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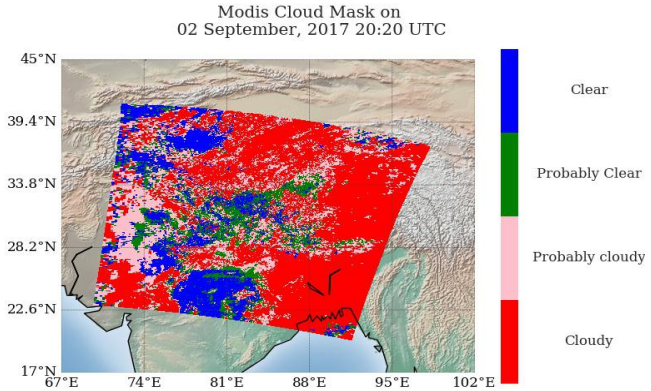
83°E
94°E
105°E
Cloudy
Uncertain
Clear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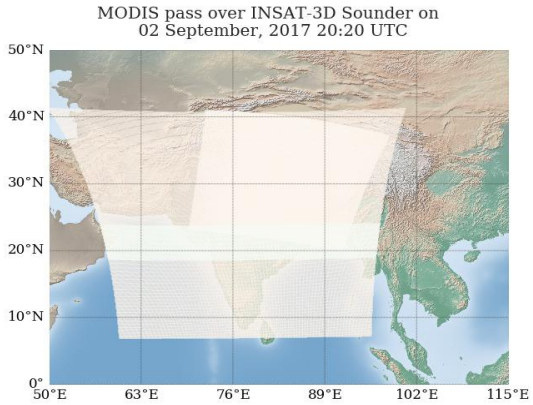
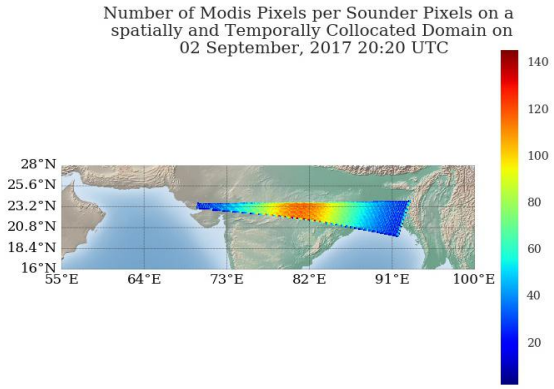
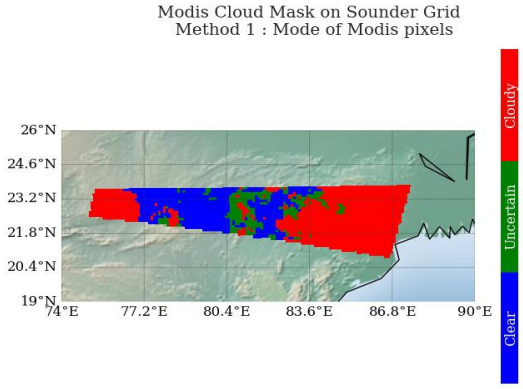
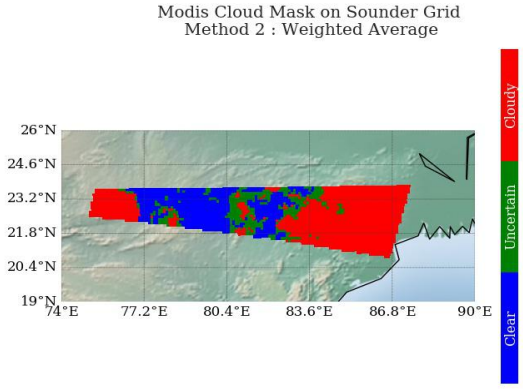
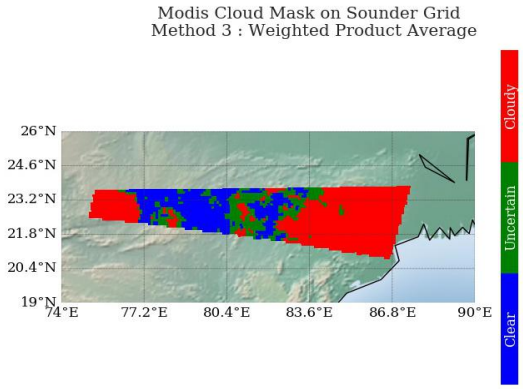
81°E
88°E
95°E
102°E
Clear
Probably Clear
Probably cloudy
Cloudy

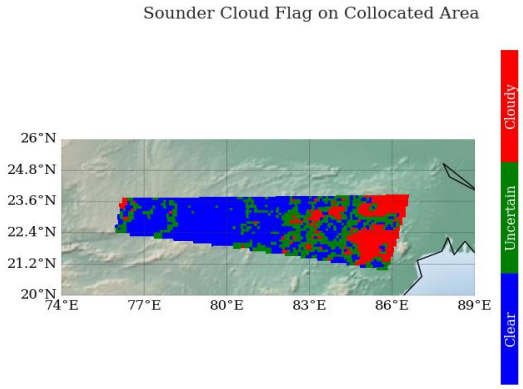

MODIS pass over INSAT-3D Sounder on
02 September, 2017 20:20 UTC
50°N
40°N
30°N
20°N
10°N
0°
50°E
63°E
76°E
89°E
102°E
115°E


Number of Modis Pixels per Sounder Pixels on a
spatially and Temporally Collocated Domain on
02 September, 2017 20:20 UTC
28°N
25.6°N
23.2°N
20.8°N
18.4°N
16°N
55°E
64°E
73°E
82°E
91°E
100°E
140
120
100
80
60
40
20

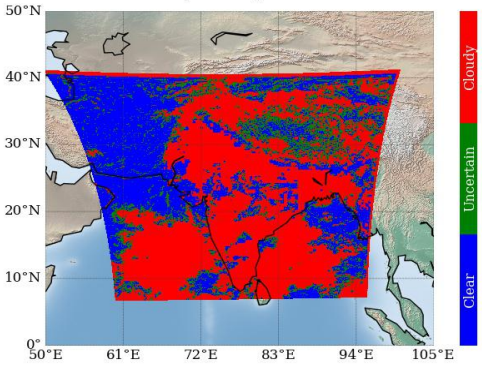

Modis Cloud Mask on Sounder Grid
Method 1 : Mode of Modis pixels
26°N
24.6°N
23.2°N
21.8°N
20.4°N
19°N
74°E
77.2°E
80.4°E
83.6°E
86.8°E
90°E
Cloudy
Uncertain
Clear


Modis Cloud Mask on Sounder Grid
Method 2 : Weighted Average
26°N
24.6°N
23.2°N
21.8°N
20.4°N
19°N
74°E
77.2°E
80.4°E
83.6°E
86.8°E
90°E
Cloudy
Uncertain
Clear

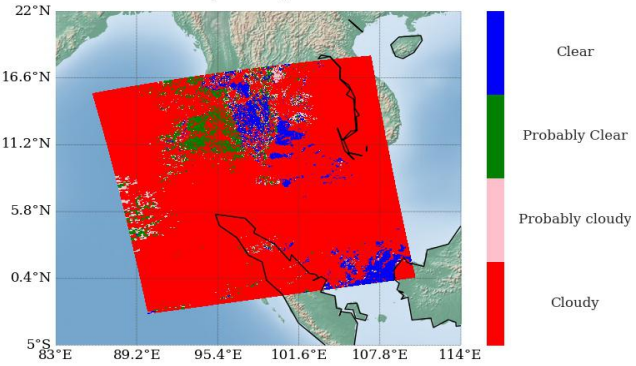

Modis Cloud Mask on Sounder Grid
Method 3 : Weighted Product Average
26°N
24.6°N
23.2°N
21.8°N
20.4°N
19°N
74°E
77.2°E
80.4°E
83.6°E
86.8°E
90°E
Cloudy
Uncertain
Clear


Sounder Cloud Flag on Collocated Area
26°N
24.8°N
23.6°N
22.4°N
21.2°N
20°N
74°E
77°E
80°E
83°E
86°E
89°E
Cloudy
Uncertain
Clear

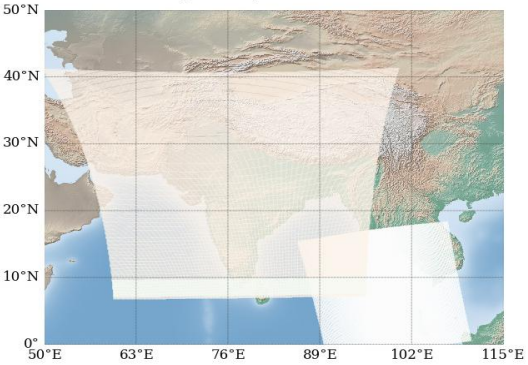
INSAT-3D Sounder Cloud Mask on
14 September, 2017 07:00 UTC



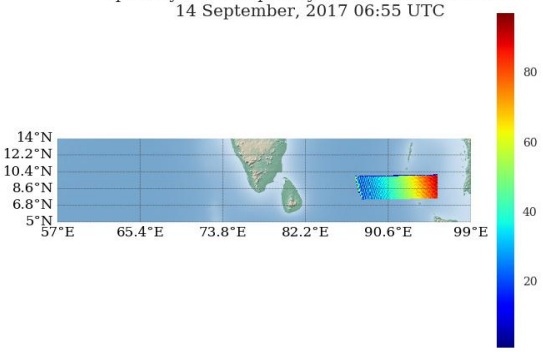
Modis Cloud Mask on
14 September, 2017 06:55 UTC



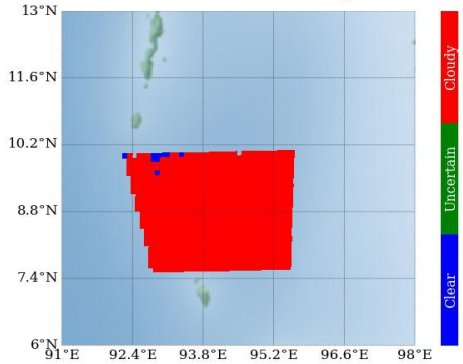
MODIS pass over INSAT-3D Sounder on
14 September, 2017 06:55 UTC



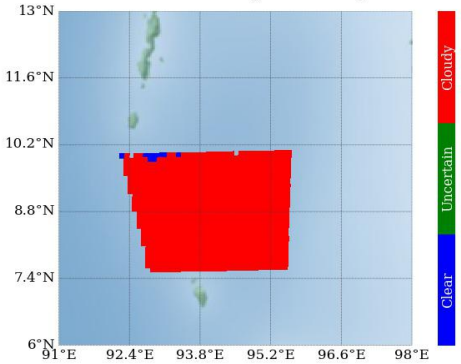
Number of Modis Pixels per Sounder Pixels on a
spatially and Temporally Collocated Domain on
14 September, 2017 06:55 UTC



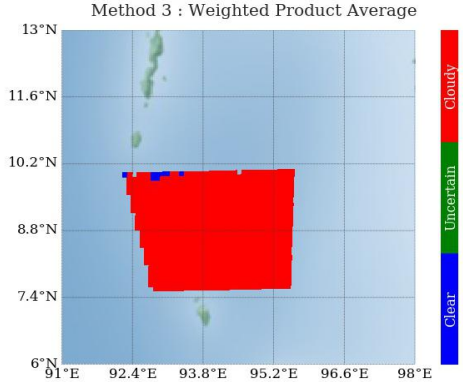
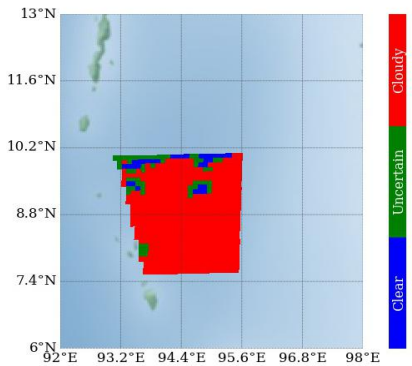
Modis Cloud Mask on Sounder Grid
Method 1 : Mode of Modis pixels



Modis Cloud Mask on Sounder Grid
Method 2 : Weighted Average



Modis Cloud Mask on Sounder Grid
Method 3 : Weighted Product Average



Sounder Cloud Flag on Collocated Area