

# 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 around 40-60 pixels 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 cloudy 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 probability 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 statistics are presented in following 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 August , 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	4253	4600	24378
Sounder Uncertain	762	858	12283
Sounder Cloudy	1588	1497	100320

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2496	7599	23136
Sounder Uncertain	365	1566	11972
Sounder Cloudy	862	3489	99054

### Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2015	7132	24084
Sounder Uncertain	270	1402	12231
Sounder Cloudy	598	3108	99699

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.83	3.06	16.19
Sounder Uncertain	0.51	0.57	8.16
Sounder Cloudy	1.05	0.99	66.64

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1.66	5.05	15.37
Sounder Uncertain	0.24	1.04	7.95
Sounder Cloudy	0.57	2.32	65.80

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1.34	4.74	16.00
Sounder Uncertain	0.18	0.93	8.12
Sounder Cloudy	0.40	2.06	66.23

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.87	0.94	0.03
Frequency Bias	5.03	2.00	0.75
Probability of Detection	0.64	0.12	0.73
False Alarm Rate	0.64	0.29	0.07

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.700
Kuiper Skill Score	0.365
Heidke Skill Score	0.170

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.92	0.89	0.04
Frequency Bias	8.93	1.10	0.77
Probability of Detection	0.67	0.12	0.74
False Alarm Rate	0.65	0.26	0.09

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.685
Kuiper Skill Score	0.301
Heidke Skill Score	0.159

**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.94	0.90	0.04
Frequency Bias	11.53	1.19	0.76
Probability of Detection	0.70	0.12	0.73
False Alarm Rate	0.66	0.26	0.08

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.685
Kuiper Skill Score	0.299
Heidke Skill Score	0.144

## INSAT-3D Sounder vs MODIS for August , 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	3173	4236	14754
Sounder Uncertain	574	710	6896
Sounder Cloudy	1538	1243	57021

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1929	6162	14072
Sounder Uncertain	279	1192	6709
Sounder Cloudy	845	3174	55783

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1541	5780	14842
Sounder Uncertain	204	1069	6907
Sounder Cloudy	586	2848	56368

**2. Confusion matrix of percentage number of collocations**

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3.52	4.70	16.37
Sounder Uncertain	0.64	0.79	7.65
Sounder Cloudy	1.71	1.38	63.25

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.14	6.84	15.61
Sounder Uncertain	0.31	1.32	7.44
Sounder Cloudy	0.94	3.52	61.88

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1.71	6.41	16.46
Sounder Uncertain	0.23	1.19	7.66
Sounder Cloudy	0.65	3.16	62.53

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.86	0.91	0.05
Frequency Bias	4.19	1.32	0.76
Probability of Detection	0.60	0.11	0.72
False Alarm Rate	0.65	0.26	0.10

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.676
Kuiper Skill Score	0.330
Heidke Skill Score	0.190

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.91	0.85	0.07
Frequency Bias	7.26	0.78	0.78
Probability of Detection	0.63	0.11	0.73
False Alarm Rate	0.65	0.22	0.13

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.653
Kuiper Skill Score	0.269
Heidke Skill Score	0.170

**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.93	0.87	0.06
Frequency Bias	9.51	0.84	0.77
Probability of Detection	0.66	0.11	0.72
False Alarm Rate	0.66	0.23	0.11

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.654
Kuiper Skill Score	0.267
Heidke Skill Score	0.155

## INSAT-3D Sounder vs MODIS for August , 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	1080	364	9624
Sounder Uncertain	188	148	5387
Sounder Cloudy	50	254	43299

#### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	567	1437	9064
Sounder Uncertain	86	374	5263
Sounder Cloudy	17	315	43271

#### Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	474	1352	9242
Sounder Uncertain	66	333	5324
Sounder Cloudy	12	260	43331

### 2. Confusion matrix of percentage number of collocations

#### Method1 :Taking Mode of MODIS Pixels



MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1.79	0.60	15.94
Sounder Uncertain	0.31	0.25	8.92
Sounder Cloudy	0.08	0.42	71.69

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.94	2.38	15.01
Sounder Uncertain	0.14	0.62	8.71
Sounder Cloudy	0.03	0.52	71.65

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.78	2.24	15.30
Sounder Uncertain	0.11	0.55	8.82
Sounder Cloudy	0.02	0.43	71.75

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.90	0.97	0.01
Frequency Bias	8.40	7.47	0.75
Probability of Detection	0.82	0.19	0.74
False Alarm Rate	0.63	0.35	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.737
Kuiper Skill Score	0.521
Heidke Skill Score	0.118

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	0.95	0.93	0.01
Frequency Bias	16.52	2.69	0.76
Probability of Detection	0.85	0.18	0.75
False Alarm Rate	0.65	0.33	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.732
Kuiper Skill Score	0.428
Heidke Skill Score	0.125

**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.96	0.94	0.01
Frequency Bias	20.05	2.94	0.75
Probability of Detection	0.86	0.17	0.75
False Alarm Rate	0.65	0.33	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.731
Kuiper Skill Score	0.426
Heidke Skill Score	0.112

## **INSAT-3D Sounder vs MODIS for August , 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
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Sounder Clear	1085	763	7696
Sounder Uncertain	164	140	4442
Sounder Cloudy	1378	1130	45042

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	482	2201	6861
Sounder Uncertain	56	403	4287
Sounder Cloudy	764	2920	43866

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	368	1939	7237
Sounder Uncertain	35	347	4364
Sounder Cloudy	522	2607	44421

**2. Confusion matrix of percentage number of collocations**

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1.75	1.23	12.45
Sounder Uncertain	0.27	0.23	7.18
Sounder Cloudy	2.23	1.83	72.84

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.78	3.56	11.09
Sounder Uncertain	0.09	0.65	6.93
Sounder Cloudy	1.24	4.72	70.93

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.60	3.14	11.70

Sounder Uncertain	0.06	0.56	7.06
Sounder Cloudy	0.84	4.22	71.83

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.89	0.97	0.05
Frequency Bias	3.63	2.33	0.83
Probability of Detection	0.41	0.07	0.79
False Alarm Rate	0.54	0.30	0.16

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.748
Kuiper Skill Score	0.198
Heidke Skill Score	0.100

#### Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.95	0.92	0.08
Frequency Bias	7.33	0.86	0.86
Probability of Detection	0.37	0.07	0.80
False Alarm Rate	0.53	0.25	0.22

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.724
Kuiper Skill Score	0.147
Heidke Skill Score	0.096

#### Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.96	0.93	0.07

Frequency Bias	10.32	0.97	0.85
Probability of Detection	0.40	0.07	0.79
False Alarm Rate	0.55	0.26	0.19

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.730
Kuiper Skill Score	0.144
Heidke Skill Score	0.084

## INSAT-3D Sounder vs MODIS for August , 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	1081	638	4611
Sounder Uncertain	159	117	2097
Sounder Cloudy	1378	1116	28159

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	480	2048	3802
Sounder Uncertain	53	369	1951
Sounder Cloudy	764	2902	26987

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	367	1816	4147

Sounder Uncertain	34	317	2022
Sounder Cloudy	522	2594	27537

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.75	1.62	11.72
Sounder Uncertain	0.40	0.30	5.33
Sounder Cloudy	3.50	2.84	71.55

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1.22	5.20	9.66
Sounder Uncertain	0.13	0.94	4.96
Sounder Cloudy	1.94	7.37	68.57

### Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.93	4.61	10.54
Sounder Uncertain	0.09	0.81	5.14
Sounder Cloudy	1.33	6.59	69.97

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.83	0.95	0.08
Frequency Bias	2.42	1.27	0.88
Probability of Detection	0.41	0.06	0.81
False Alarm Rate	0.52	0.23	0.25

Overall Skill Score

Skill Score	Value
Proportion Correct	0.746
Kuiper Skill Score	0.203
Heidke Skill Score	0.143

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.92	0.84	0.12
Frequency Bias	4.88	0.45	0.94
Probability of Detection	0.37	0.07	0.82
False Alarm Rate	0.51	0.17	0.32

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.707
Kuiper Skill Score	0.159
Heidke Skill Score	0.136

**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.94	0.87	0.10
Frequency Bias	6.86	0.50	0.91
Probability of Detection	0.40	0.07	0.82
False Alarm Rate	0.54	0.18	0.28

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.717
Kuiper Skill Score	0.155
Heidke Skill Score	0.121

# INSAT-3D Sounder vs MODIS for August , 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	4	125	3085
Sounder Uncertain	5	23	2345
Sounder Cloudy	0	14	16883

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2	153	3059
Sounder Uncertain	3	34	2336
Sounder Cloudy	0	18	16879

### Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1	123	3090
Sounder Uncertain	1	30	2342
Sounder Cloudy	0	13	16884

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.02	0.56	13.72
Sounder Uncertain	0.02	0.10	10.43
Sounder Cloudy	0.00	0.06	75.09

### Method2 :Taking Weighted Average of MODIS pixels



MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.01	0.68	13.61
Sounder Uncertain	0.01	0.15	10.39
Sounder Cloudy	0.00	0.08	75.07

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	0.55	13.74
Sounder Uncertain	0.00	0.13	10.42
Sounder Cloudy	0.00	0.06	75.09

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	0.99	0.00
Frequency Bias	357.11	14.65	0.76
Probability of Detection	0.44	0.14	0.76
False Alarm Rate	0.58	0.42	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.752
Kuiper Skill Score	0.363
Heidke Skill Score	0.022

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	0.99	0.00
Frequency Bias	642.80	11.58	0.76
Probability of Detection	0.40	0.17	0.76
False Alarm Rate	0.58	0.42	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.752
Kuiper Skill Score	0.369
Heidke Skill Score	0.027

**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	0.99	0.00
Frequency Bias	1607.00	14.30	0.76
Probability of Detection	0.50	0.18	0.76
False Alarm Rate	0.58	0.42	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.752
Kuiper Skill Score	0.379
Heidke Skill Score	0.022

## INSAT-3D Sounder vs MODIS for August , 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	2945	3645	16039
Sounder Uncertain	567	701	7491
Sounder Cloudy	91	312	51575

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1873	5035	15721
Sounder Uncertain	294	1107	7358
Sounder Cloudy	37	395	51546

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1540	4844	16245
Sounder Uncertain	224	1003	7532
Sounder Cloudy	26	339	51613

**2. Confusion matrix of percentage number of collocations**

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3.53	4.37	19.24
Sounder Uncertain	0.68	0.84	8.99
Sounder Cloudy	0.11	0.37	61.87

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.25	6.04	18.86
Sounder Uncertain	0.35	1.33	8.83
Sounder Cloudy	0.04	0.47	61.83

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1.85	5.81	19.49
Sounder Uncertain	0.27	1.20	9.03
Sounder Cloudy	0.03	0.41	61.91

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.87	0.92	0.01
Frequency Bias	6.28	1.88	0.69
Probability of Detection	0.82	0.15	0.69
False Alarm Rate	0.70	0.29	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.662
Kuiper Skill Score	0.453
Heidke Skill Score	0.197

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.92	0.87	0.01
Frequency Bias	10.27	1.34	0.70
Probability of Detection	0.85	0.17	0.69
False Alarm Rate	0.72	0.27	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.654
Kuiper Skill Score	0.420
Heidke Skill Score	0.189

**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.93	0.89	0.01
Frequency Bias	12.64	1.42	0.69
Probability of Detection	0.86	0.16	0.68
False Alarm Rate	0.72	0.27	0.01

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.650
Kuiper Skill Score	0.409
Heidke Skill Score	0.171

## INSAT-3D Sounder vs MODIS for August , 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	1869	3409	9690
Sounder Uncertain	384	577	4613
Sounder Cloudy	41	73	26289

#### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1308	3756	9904
Sounder Uncertain	211	769	4594
Sounder Cloudy	20	100	26283

#### Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1067	3618	10283
Sounder Uncertain	159	701	4714
Sounder Cloudy	14	93	26296

### 2. Confusion matrix of percentage number of collocations

#### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3.98	7.26	20.64
Sounder Uncertain	0.82	1.23	9.83
Sounder Cloudy	0.09	0.16	56.00

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.79	8.00	21.10
Sounder Uncertain	0.45	1.64	9.79
Sounder Cloudy	0.04	0.21	55.99

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.27	7.71	21.90
Sounder Uncertain	0.34	1.49	10.04
Sounder Cloudy	0.03	0.20	56.01

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.88	0.90	0.00
Frequency Bias	6.52	1.37	0.65
Probability of Detection	0.81	0.14	0.65
False Alarm Rate	0.72	0.27	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.612
Kuiper Skill Score	0.412
Heidke Skill Score	0.205

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	0.91	0.86	0.00
Frequency Bias	9.73	1.21	0.65
Probability of Detection	0.85	0.17	0.64
False Alarm Rate	0.74	0.26	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.604
Kuiper Skill Score	0.398
Heidke Skill Score	0.191

**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.93	0.87	0.00
Frequency Bias	12.07	1.26	0.64
Probability of Detection	0.86	0.16	0.64
False Alarm Rate	0.74	0.26	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.598
Kuiper Skill Score	0.385
Heidke Skill Score	0.172

## INSAT-3D Sounder vs MODIS for August , 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
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Sounder Clear	1076	236	6349
Sounder Uncertain	183	124	2878
Sounder Cloudy	50	239	25286

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	565	1279	5817
Sounder Uncertain	83	338	2764
Sounder Cloudy	17	295	25263

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	473	1226	5962
Sounder Uncertain	65	302	2818
Sounder Cloudy	12	246	25317

**2. Confusion matrix of percentage number of collocations**

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.95	0.65	17.43
Sounder Uncertain	0.50	0.34	7.90
Sounder Cloudy	0.14	0.66	69.43

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1.55	3.51	15.97
Sounder Uncertain	0.23	0.93	7.59
Sounder Cloudy	0.05	0.81	69.36

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1.30	3.37	16.37



Sounder Uncertain	0.18	0.83	7.74
Sounder Cloudy	0.03	0.68	69.51

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.86	0.96	0.01
Frequency Bias	5.85	5.32	0.74
Probability of Detection	0.82	0.21	0.73
False Alarm Rate	0.66	0.31	0.03

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.727
Kuiper Skill Score	0.526
Heidke Skill Score	0.162

#### Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.93	0.89	0.01
Frequency Bias	11.52	1.67	0.76
Probability of Detection	0.85	0.18	0.75
False Alarm Rate	0.69	0.28	0.03

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.718
Kuiper Skill Score	0.431
Heidke Skill Score	0.170

#### Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.94	0.91	0.01

Frequency Bias	13.93	1.80	0.75
Probability of Detection	0.86	0.17	0.74
False Alarm Rate	0.70	0.28	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.716
Kuiper Skill Score	0.426
Heidke Skill Score	0.154

## INSAT-3D Sounder vs MODIS for August , 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	35	36	115
Sounder Uncertain	6	2	54
Sounder Cloudy	11	7	454

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	21	64	101
Sounder Uncertain	2	7	53
Sounder Cloudy	7	13	452

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	17	62	107

Sounder Uncertain	1	8	53
Sounder Cloudy	6	12	454

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4.86	5.00	15.97
Sounder Uncertain	0.83	0.28	7.50
Sounder Cloudy	1.53	0.97	63.06

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.92	8.89	14.03
Sounder Uncertain	0.28	0.97	7.36
Sounder Cloudy	0.97	1.81	62.78

### Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.36	8.61	14.86
Sounder Uncertain	0.14	1.11	7.36
Sounder Cloudy	0.83	1.67	63.06

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.81	0.97	0.04
Frequency Bias	3.58	1.38	0.76
Probability of Detection	0.67	0.04	0.73
False Alarm Rate	0.66	0.26	0.08

Overall Skill Score

Skill Score	Value
Proportion Correct	0.682
Kuiper Skill Score	0.374
Heidke Skill Score	0.222

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.89	0.89	0.04
Frequency Bias	6.20	0.74	0.78
Probability of Detection	0.70	0.08	0.75
False Alarm Rate	0.69	0.23	0.08

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.667
Kuiper Skill Score	0.341
Heidke Skill Score	0.220

**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.91	0.87	0.04
Frequency Bias	7.75	0.76	0.77
Probability of Detection	0.71	0.10	0.74
False Alarm Rate	0.70	0.22	0.07

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.665
Kuiper Skill Score	0.339
Heidke Skill Score	0.208

# INSAT-3D Sounder vs MODIS for August , 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	35	36	84
Sounder Uncertain	6	2	21
Sounder Cloudy	11	6	276

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	21	64	70
Sounder Uncertain	2	7	20
Sounder Cloudy	7	12	274

### Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	17	62	76
Sounder Uncertain	1	8	20
Sounder Cloudy	6	12	275

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7.34	7.55	17.61
Sounder Uncertain	1.26	0.42	4.40
Sounder Cloudy	2.31	1.26	57.86

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4.40	13.42	14.68
Sounder Uncertain	0.42	1.47	4.19
Sounder Cloudy	1.47	2.52	57.44

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3.56	13.00	15.93
Sounder Uncertain	0.21	1.68	4.19
Sounder Cloudy	1.26	2.52	57.65

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.77	0.93	0.06
Frequency Bias	2.98	0.66	0.77
Probability of Detection	0.67	0.05	0.72
False Alarm Rate	0.73	0.16	0.10

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.656
Kuiper Skill Score	0.365
Heidke Skill Score	0.266

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.86	0.76	0.06
Frequency Bias	5.17	0.35	0.80
Probability of Detection	0.70	0.08	0.75
False Alarm Rate	0.77	0.13	0.11

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.633
Kuiper Skill Score	0.348
Heidke Skill Score	0.267

**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.89	0.72	0.06
Frequency Bias	6.46	0.35	0.79
Probability of Detection	0.71	0.10	0.74
False Alarm Rate	0.78	0.12	0.10

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.629
Kuiper Skill Score	0.343
Heidke Skill Score	0.251

## INSAT-3D Sounder vs MODIS for August , 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	0	31
Sounder Uncertain	0	0	33
Sounder Cloudy	0	1	178

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	0	31
Sounder Uncertain	0	0	33
Sounder Cloudy	0	1	178

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	0	31
Sounder Uncertain	0	0	33
Sounder Cloudy	0	0	179

**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	0.00	12.76
Sounder Uncertain	0.00	0.00	13.58
Sounder Cloudy	0.00	0.41	73.25

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	0.00	12.76
Sounder Uncertain	0.00	0.00	13.58
Sounder Cloudy	0.00	0.41	73.25

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	0.00	12.76
Sounder Uncertain	0.00	0.00	13.58
Sounder Cloudy	0.00	0.00	73.66

**3. Skill Scores**



**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	1.00	0.01
Frequency Bias	inf	33.00	0.74
Probability of Detection	nan	0.00	0.74
False Alarm Rate	0.48	0.51	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.733
Kuiper Skill Score	-0.200
Heidke Skill Score	-0.006

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	1.00	0.01
Frequency Bias	inf	33.00	0.74
Probability of Detection	nan	0.00	0.74
False Alarm Rate	0.48	0.51	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.733
Kuiper Skill Score	-0.200
Heidke Skill Score	-0.006

**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	1.00	0.00
Frequency Bias	inf	inf	0.74
Probability of Detection	nan	nan	0.74
False Alarm Rate	0.48	0.52	0.00

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.737
Kuiper Skill Score	nan
Heidke Skill Score	0.000

## INSAT-3D Sounder vs MODIS for August , 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	2	3	8
Sounder Uncertain	6	0	32
Sounder Cloudy	30	2	647

#### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	7	6
Sounder Uncertain	4	8	26
Sounder Cloudy	5	44	630

#### Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	5	8
Sounder Uncertain	1	10	27
Sounder Cloudy	3	40	636

### 2. Confusion matrix of percentage number of collocations

#### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.27	0.41	1.10
Sounder Uncertain	0.82	0.00	4.38
Sounder Cloudy	4.11	0.27	88.63

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	0.96	0.82
Sounder Uncertain	0.55	1.10	3.56
Sounder Cloudy	0.68	6.03	86.30

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	0.68	1.10
Sounder Uncertain	0.14	1.37	3.70
Sounder Cloudy	0.41	5.48	87.12

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.85	1.00	0.05
Frequency Bias	0.34	7.60	0.99
Probability of Detection	0.05	0.00	0.94
False Alarm Rate	0.14	0.47	0.40

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.889
Kuiper Skill Score	0.111
Heidke Skill Score	0.101

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	1.00	0.79	0.07
Frequency Bias	1.44	0.64	1.03
Probability of Detection	0.00	0.14	0.95
False Alarm Rate	0.14	0.33	0.53

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.874
Kuiper Skill Score	0.152
Heidke Skill Score	0.171

**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	0.74	0.06
Frequency Bias	3.25	0.69	1.01
Probability of Detection	0.00	0.18	0.95
False Alarm Rate	0.15	0.33	0.51

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.885
Kuiper Skill Score	0.174
Heidke Skill Score	0.184

## **INSAT-3D Sounder vs MODIS for August , 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
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Sounder Clear	2	0	2
Sounder Uncertain	6	0	30
Sounder Cloudy	30	2	620

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	2	2
Sounder Uncertain	4	8	24
Sounder Cloudy	5	44	603

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	2	2
Sounder Uncertain	1	10	25
Sounder Cloudy	3	40	609

**2. Confusion matrix of percentage number of collocations**

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.29	0.00	0.29
Sounder Uncertain	0.87	0.00	4.34
Sounder Cloudy	4.34	0.29	89.60

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	0.29	0.29
Sounder Uncertain	0.58	1.16	3.47
Sounder Cloudy	0.72	6.36	87.14

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	0.29	0.29

Sounder Uncertain	0.14	1.45	3.61
Sounder Cloudy	0.43	5.78	88.01

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.50	1.00	0.05
Frequency Bias	0.11	18.00	1.00
Probability of Detection	0.05	0.00	0.95
False Alarm Rate	0.03	0.51	0.46

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.899
Kuiper Skill Score	0.097
Heidke Skill Score	0.095

#### Method2 :Taking Weighted Average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	0.78	0.08
Frequency Bias	0.44	0.67	1.04
Probability of Detection	0.00	0.15	0.96
False Alarm Rate	0.05	0.35	0.60

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.883
Kuiper Skill Score	0.134
Heidke Skill Score	0.161

#### Method3: Taking Weighted Product average of MODIS pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	0.72	0.07

Frequency Bias	1.00	0.69	1.03
Probability of Detection	0.00	0.19	0.96
False Alarm Rate	0.05	0.36	0.59

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.895
Kuiper Skill Score	0.165
Heidke Skill Score	0.189

## INSAT-3D Sounder vs MODIS for August , 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	0	3	6
Sounder Uncertain	0	0	2
Sounder Cloudy	0	0	27

**Method2 :Taking Weighted Average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	5	4
Sounder Uncertain	0	0	2
Sounder Cloudy	0	0	27

**Method3: Taking Weighted Product average of MODIS pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	3	6

Sounder Uncertain	0	0	2
Sounder Cloudy	0	0	27

## 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	7.89	15.79
Sounder Uncertain	0.00	0.00	5.26
Sounder Cloudy	0.00	0.00	71.05

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	13.16	10.53
Sounder Uncertain	0.00	0.00	5.26
Sounder Cloudy	0.00	0.00	71.05

### Method3: Taking Weighted Product average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	7.89	15.79
Sounder Uncertain	0.00	0.00	5.26
Sounder Cloudy	0.00	0.00	71.05

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	1.00	0.00
Frequency Bias	inf	0.67	0.77
Probability of Detection	nan	0.00	0.77
False Alarm Rate	0.82	0.18	0.00

Overall Skill Score



Skill Score	Value
Proportion Correct	0.711
Kuiper Skill Score	0.357
Heidke Skill Score	0.152

**Method2 :Taking Weighted Average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	1.00	0.00
Frequency Bias	inf	0.40	0.82
Probability of Detection	nan	0.00	0.82
False Alarm Rate	0.82	0.18	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.711
Kuiper Skill Score	0.379
Heidke Skill Score	0.230

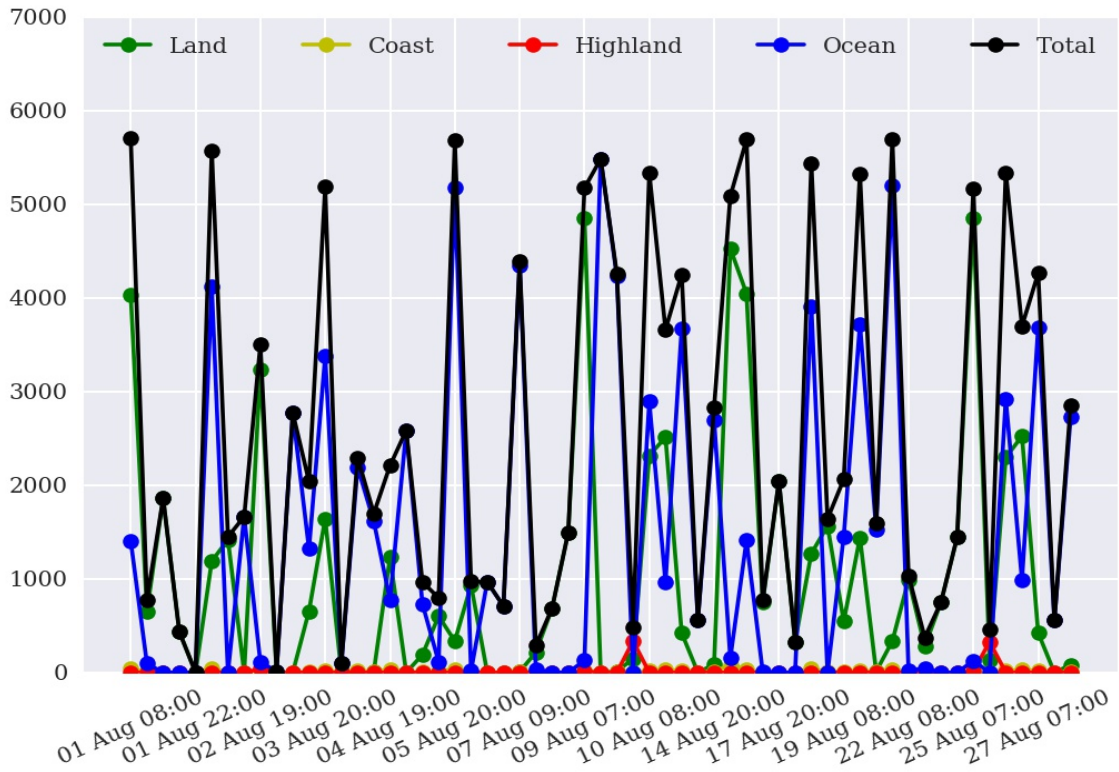
**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	1.00	1.00	0.00
Frequency Bias	inf	0.67	0.77
Probability of Detection	nan	0.00	0.77
False Alarm Rate	0.82	0.18	0.00

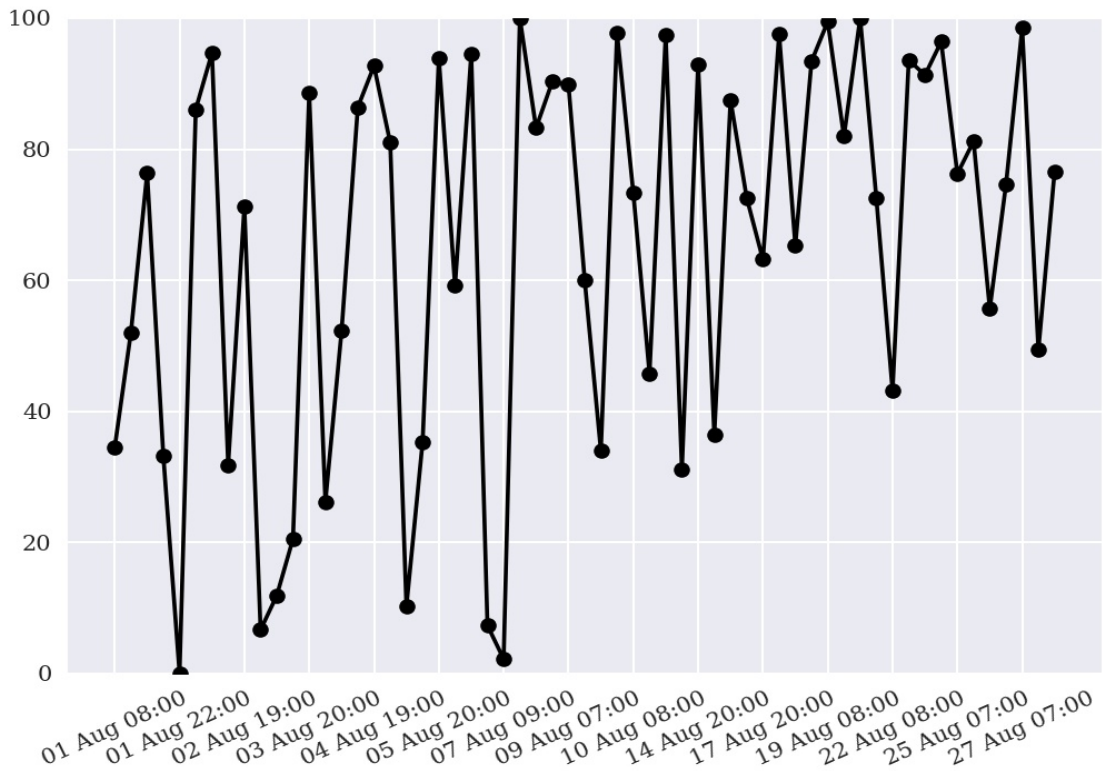
**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.711
Kuiper Skill Score	0.357
Heidke Skill Score	0.152

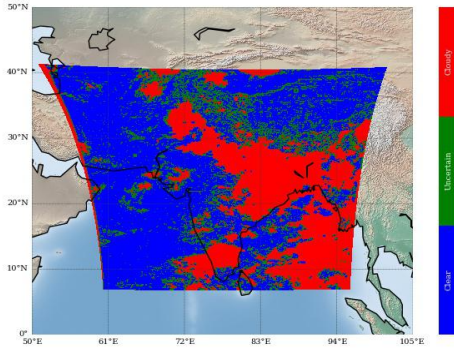
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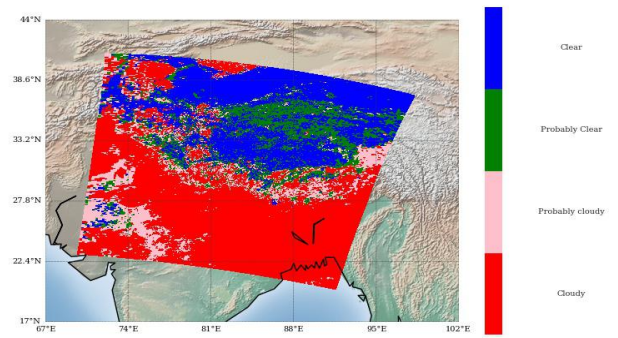
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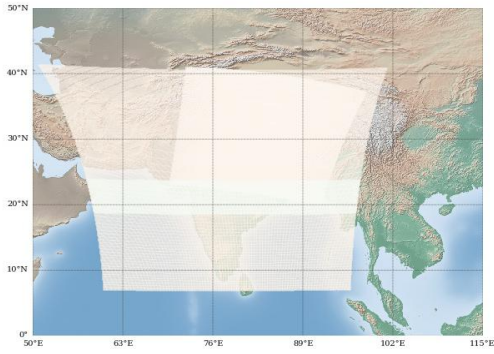
INSAT-3D Sounder Cloud Mask on 01 August, 2017 20:00 UTC



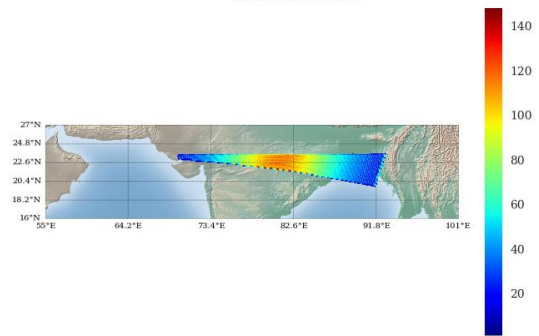
Modis Cloud Mask on 01 August, 2017 20:20 UTC



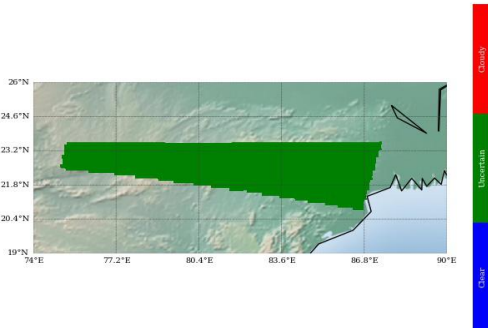
MODIS pass over INSAT-3D Sounder on 01 August, 2017 20:20 UTC



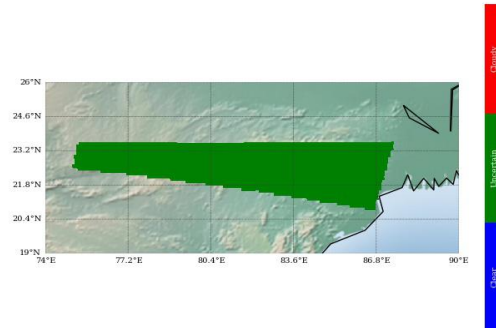
Number of Modis Pixels per Sounder Pixels on a spatially and Temporally Collocated Domain on 01 August, 2017 20:20 UTC



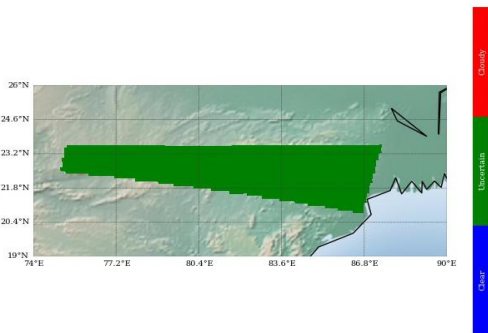
Modis Cloud Mask on Sounder Grid Method 1 : Mode of Modis pixels



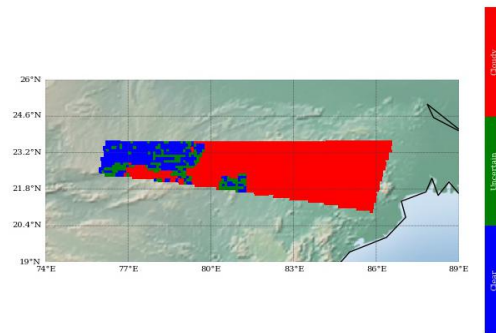
Modis Cloud Mask on Sounder Grid Method 2 : Weighted Average



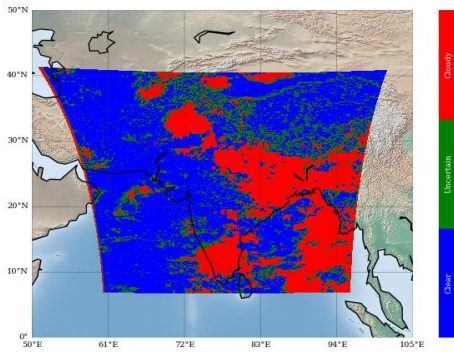
Modis Cloud Mask on Sounder Grid Method 3 : Weighted Product Average



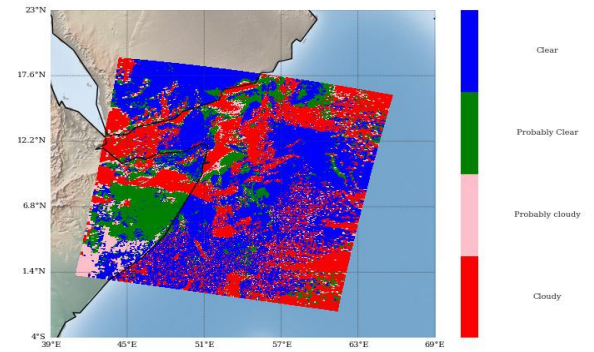
Sounder Cloud Flag on Collocated Area



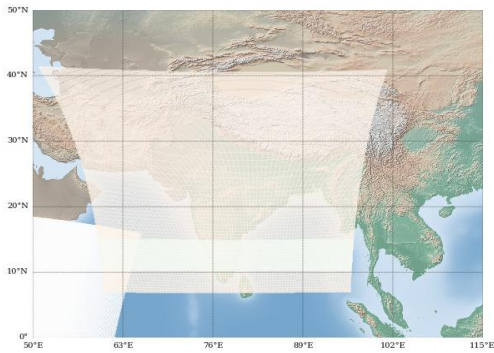
INSAT-3D Sounder Cloud Mask on 01 August, 2017 22:00 UTC



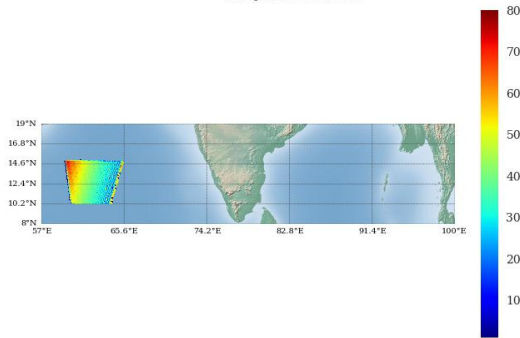
Modis Cloud Mask on 01 August, 2017 22:05 UTC



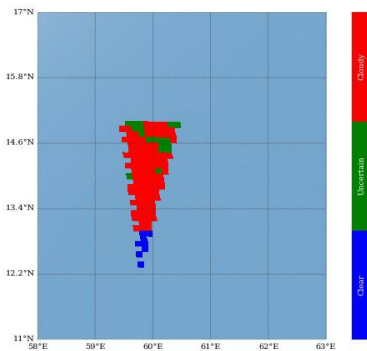
MODIS pass over INSAT-3D Sounder on 01 August, 2017 22:05 UTC



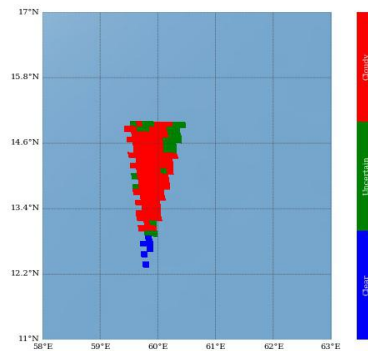
Number of Modis Pixels per Sounder Pixels on a spatially and Temporally Collocated Domain on 01 August, 2017 22:05 UTC



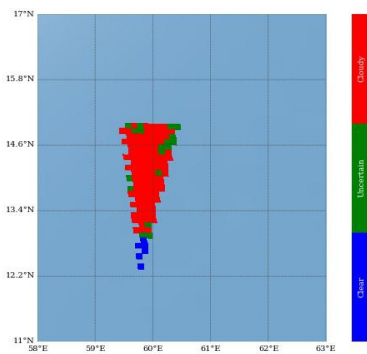
Modis Cloud Mask on Sounder Grid Method 1 : Mode of Modis pixels



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

