

# 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 October , 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	46293	13733	14171
Sounder Uncertain	9351	3263	10572
Sounder Cloudy	4361	1150	28194

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	42991	19713	11493
Sounder Uncertain	7601	6503	9082
Sounder Cloudy	3130	3613	26962

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	37973	23245	12979
Sounder Uncertain	6452	6956	9778
Sounder Cloudy	2467	3856	27382

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	35.31	10.48	10.81
Sounder Uncertain	7.13	2.49	8.06
Sounder Cloudy	3.33	0.88	21.51

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	32.80	15.04	8.77
Sounder Uncertain	5.80	4.96	6.93
Sounder Cloudy	2.39	2.76	20.57

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	28.97	17.73	9.90
Sounder Uncertain	4.92	5.31	7.46
Sounder Cloudy	1.88	2.94	20.89

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.38	0.86	0.16
Frequency Bias	1.24	1.28	0.64
Probability of Detection	0.77	0.18	0.53
False Alarm Rate	0.52	0.37	0.10

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.593
Kuiper Skill Score	0.338
Heidke Skill Score	0.336

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.42	0.72	0.20
Frequency Bias	1.38	0.78	0.71
Probability of Detection	0.80	0.22	0.57
False Alarm Rate	0.57	0.31	0.12

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.583
Kuiper Skill Score	0.336
Heidke Skill Score	0.343

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.49	0.70	0.19
Frequency Bias	1.58	0.68	0.67
Probability of Detection	0.81	0.20	0.55
False Alarm Rate	0.62	0.28	0.11

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.552
Kuiper Skill Score	0.311
Heidke Skill Score	0.314

## INSAT-3D Sounder vs MODIS for October , 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	32847	7657	6805
Sounder Uncertain	7141	1053	4802
Sounder Cloudy	4097	970	24342

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	30509	11388	5412
Sounder Uncertain	5902	3067	4027
Sounder Cloudy	2972	3236	23201

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	27141	14055	6113
Sounder Uncertain	5249	3449	4298
Sounder Cloudy	2355	3475	23579

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	36.61	8.53	7.59
Sounder Uncertain	7.96	1.17	5.35
Sounder Cloudy	4.57	1.08	27.13

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	34.01	12.69	6.03
Sounder Uncertain	6.58	3.42	4.49
Sounder Cloudy	3.31	3.61	25.86

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	30.25	15.67	6.81
Sounder Uncertain	5.85	3.84	4.79
Sounder Cloudy	2.63	3.87	26.28

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.31	0.92	0.17
Frequency Bias	1.07	1.34	0.82
Probability of Detection	0.75	0.11	0.68
False Alarm Rate	0.46	0.38	0.16

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.649
Kuiper Skill Score	0.415
Heidke Skill Score	0.409

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.36	0.76	0.21
Frequency Bias	1.20	0.73	0.90
Probability of Detection	0.77	0.17	0.71
False Alarm Rate	0.51	0.30	0.19

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.633
Kuiper Skill Score	0.399
Heidke Skill Score	0.408

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.43	0.73	0.20
Frequency Bias	1.36	0.62	0.87
Probability of Detection	0.78	0.16	0.69
False Alarm Rate	0.57	0.27	0.16

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.604
Kuiper Skill Score	0.371
Heidke Skill Score	0.379

## INSAT-3D Sounder vs MODIS for October , 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	13446	6076	7366
Sounder Uncertain	2210	2210	5770
Sounder Cloudy	264	180	3852

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	12482	8325	6081
Sounder Uncertain	1699	3436	5055
Sounder Cloudy	158	377	3761

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	10832	9190	6866
Sounder Uncertain	1203	3507	5480
Sounder Cloudy	112	381	3803

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

#### Method1 :Taking Mode of MODIS Pixels



MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	32.50	14.69	17.80
Sounder Uncertain	5.34	5.34	13.95
Sounder Cloudy	0.64	0.44	9.31

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	30.17	20.12	14.70
Sounder Uncertain	4.11	8.30	12.22
Sounder Cloudy	0.38	0.91	9.09

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	26.18	22.21	16.59
Sounder Uncertain	2.91	8.48	13.25
Sounder Cloudy	0.27	0.92	9.19

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.50	0.78	0.10
Frequency Bias	1.69	1.20	0.25
Probability of Detection	0.84	0.26	0.23
False Alarm Rate	0.61	0.36	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.472
Kuiper Skill Score	0.200
Heidke Skill Score	0.195

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

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	0.54	0.66	0.12
Frequency Bias	1.88	0.84	0.29
Probability of Detection	0.87	0.28	0.25
False Alarm Rate	0.66	0.31	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.476
Kuiper Skill Score	0.212
Heidke Skill Score	0.212

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.60	0.66	0.11
Frequency Bias	2.21	0.78	0.27
Probability of Detection	0.89	0.27	0.24
False Alarm Rate	0.69	0.29	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.438
Kuiper Skill Score	0.195
Heidke Skill Score	0.187

## **INSAT-3D Sounder vs MODIS for October , 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	31594	8384	9896
Sounder Uncertain	2823	1081	6357
Sounder Cloudy	2268	840	18342

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	29594	12093	8187
Sounder Uncertain	2220	2202	5839
Sounder Cloudy	1717	1966	17767

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	25905	14934	9035
Sounder Uncertain	1831	2328	6102
Sounder Cloudy	1324	2129	17997

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	38.73	10.28	12.13
Sounder Uncertain	3.46	1.32	7.79
Sounder Cloudy	2.78	1.03	22.48

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	36.27	14.82	10.03
Sounder Uncertain	2.72	2.70	7.16
Sounder Cloudy	2.10	2.41	21.78

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	31.75	18.30	11.07

Sounder Uncertain	2.24	2.85	7.48
Sounder Cloudy	1.62	2.61	22.06

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.37	0.89	0.14
Frequency Bias	1.36	1.00	0.62
Probability of Detection	0.86	0.10	0.53
False Alarm Rate	0.60	0.30	0.10

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.625
Kuiper Skill Score	0.371
Heidke Skill Score	0.373

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.41	0.79	0.17
Frequency Bias	1.49	0.63	0.67
Probability of Detection	0.88	0.14	0.56
False Alarm Rate	0.63	0.25	0.12

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.608
Kuiper Skill Score	0.358
Heidke Skill Score	0.368

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.48	0.77	0.16

Frequency Bias	1.72	0.53	0.65
Probability of Detection	0.89	0.12	0.54
False Alarm Rate	0.68	0.22	0.10

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.567
Kuiper Skill Score	0.326
Heidke Skill Score	0.329

## INSAT-3D Sounder vs MODIS for October , 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	21569	6094	4908
Sounder Uncertain	2273	679	2269
Sounder Cloudy	2255	819	14738

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	19964	8818	3789
Sounder Uncertain	1791	1484	1946
Sounder Cloudy	1710	1934	14168

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	17099	11142	4330

Sounder Uncertain	1485	1652	2084
Sounder Cloudy	1318	2103	14391

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	38.79	10.96	8.83
Sounder Uncertain	4.09	1.22	4.08
Sounder Cloudy	4.06	1.47	26.51

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	35.90	15.86	6.81
Sounder Uncertain	3.22	2.67	3.50
Sounder Cloudy	3.08	3.48	25.48

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	30.75	20.04	7.79
Sounder Uncertain	2.67	2.97	3.75
Sounder Cloudy	2.37	3.78	25.88

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.34	0.87	0.17
Frequency Bias	1.25	0.69	0.81
Probability of Detection	0.83	0.09	0.67
False Alarm Rate	0.59	0.24	0.17

Overall Skill Score

Skill Score	Value
Proportion Correct	0.665
Kuiper Skill Score	0.415
Heidke Skill Score	0.429

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.39	0.72	0.20
Frequency Bias	1.39	0.43	0.89
Probability of Detection	0.85	0.12	0.71
False Alarm Rate	0.63	0.19	0.18

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.641
Kuiper Skill Score	0.400
Heidke Skill Score	0.418

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.48	0.68	0.19
Frequency Bias	1.64	0.35	0.86
Probability of Detection	0.86	0.11	0.69
False Alarm Rate	0.69	0.16	0.15

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.596
Kuiper Skill Score	0.366
Heidke Skill Score	0.374

# INSAT-3D Sounder vs MODIS for October , 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	10025	2290	4988
Sounder Uncertain	550	402	4088
Sounder Cloudy	13	21	3604

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	9630	3275	4398
Sounder Uncertain	429	718	3893
Sounder Cloudy	7	32	3599

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8806	3792	4705
Sounder Uncertain	346	676	4018
Sounder Cloudy	6	26	3606

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	38.59	8.81	19.20
Sounder Uncertain	2.12	1.55	15.73
Sounder Cloudy	0.05	0.08	13.87

### Method2 :Taking Weighted Average of MODIS pixels



MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	37.07	12.61	16.93
Sounder Uncertain	1.65	2.76	14.98
Sounder Cloudy	0.03	0.12	13.85

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	33.89	14.60	18.11
Sounder Uncertain	1.33	2.60	15.47
Sounder Cloudy	0.02	0.10	13.88

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.42	0.92	0.01
Frequency Bias	1.63	1.86	0.29
Probability of Detection	0.95	0.15	0.28
False Alarm Rate	0.61	0.39	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.540
Kuiper Skill Score	0.308
Heidke Skill Score	0.281

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.44	0.86	0.01
Frequency Bias	1.72	1.25	0.31
Probability of Detection	0.96	0.18	0.30
False Alarm Rate	0.64	0.36	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.537
Kuiper Skill Score	0.300
Heidke Skill Score	0.285

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.49	0.87	0.01
Frequency Bias	1.89	1.12	0.30
Probability of Detection	0.96	0.15	0.29
False Alarm Rate	0.66	0.34	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.504
Kuiper Skill Score	0.272
Heidke Skill Score	0.254

## INSAT-3D Sounder vs MODIS for October , 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	6067	1614	1761
Sounder Uncertain	334	346	1506
Sounder Cloudy	50	93	5426

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5669	2139	1634
Sounder Uncertain	262	442	1482
Sounder Cloudy	34	104	5431

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5398	2253	1791
Sounder Uncertain	238	402	1546
Sounder Cloudy	29	94	5446

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	35.28	9.39	10.24
Sounder Uncertain	1.94	2.01	8.76
Sounder Cloudy	0.29	0.54	31.55

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	32.97	12.44	9.50
Sounder Uncertain	1.52	2.57	8.62
Sounder Cloudy	0.20	0.60	31.58

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	31.39	13.10	10.41
Sounder Uncertain	1.38	2.34	8.99
Sounder Cloudy	0.17	0.55	31.67

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.36	0.84	0.03
Frequency Bias	1.46	1.06	0.64
Probability of Detection	0.94	0.17	0.62
False Alarm Rate	0.63	0.34	0.03

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.688
Kuiper Skill Score	0.515
Heidke Skill Score	0.494

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.40	0.80	0.02
Frequency Bias	1.58	0.81	0.65
Probability of Detection	0.95	0.16	0.64
False Alarm Rate	0.67	0.31	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.671
Kuiper Skill Score	0.493
Heidke Skill Score	0.477

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.43	0.82	0.02
Frequency Bias	1.67	0.80	0.63
Probability of Detection	0.95	0.15	0.62
False Alarm Rate	0.68	0.30	0.02

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.654
Kuiper Skill Score	0.475
Heidke Skill Score	0.454

## INSAT-3D Sounder vs MODIS for October , 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	5956	1472	1411
Sounder Uncertain	319	316	1328
Sounder Cloudy	50	93	5407

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5614	1912	1313
Sounder Uncertain	257	395	1311
Sounder Cloudy	34	104	5412

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5360	2047	1432
Sounder Uncertain	235	364	1364
Sounder Cloudy	29	94	5427

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

#### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	36.42	9.00	8.63
Sounder Uncertain	1.95	1.93	8.12
Sounder Cloudy	0.31	0.57	33.07

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	34.33	11.69	8.03
Sounder Uncertain	1.57	2.42	8.02
Sounder Cloudy	0.21	0.64	33.10

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	32.78	12.52	8.76
Sounder Uncertain	1.44	2.23	8.34
Sounder Cloudy	0.18	0.57	33.19

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.33	0.84	0.03
Frequency Bias	1.40	1.04	0.68
Probability of Detection	0.94	0.17	0.66
False Alarm Rate	0.62	0.35	0.03

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.714
Kuiper Skill Score	0.547
Heidke Skill Score	0.530

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

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	0.36	0.80	0.02
Frequency Bias	1.50	0.81	0.69
Probability of Detection	0.95	0.16	0.67
False Alarm Rate	0.65	0.32	0.03

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.698
Kuiper Skill Score	0.526
Heidke Skill Score	0.514

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.39	0.81	0.02
Frequency Bias	1.57	0.78	0.67
Probability of Detection	0.95	0.15	0.66
False Alarm Rate	0.67	0.31	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.682
Kuiper Skill Score	0.507
Heidke Skill Score	0.491

## INSAT-3D Sounder vs MODIS for October , 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	111	142	350
Sounder Uncertain	15	30	178
Sounder Cloudy	0	0	19

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	55	227	321
Sounder Uncertain	5	47	171
Sounder Cloudy	0	0	19

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	38	206	359
Sounder Uncertain	3	38	182
Sounder Cloudy	0	0	19

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	13.14	16.80	41.42
Sounder Uncertain	1.78	3.55	21.07
Sounder Cloudy	0.00	0.00	2.25

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6.51	26.86	37.99
Sounder Uncertain	0.59	5.56	20.24
Sounder Cloudy	0.00	0.00	2.25

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4.50	24.38	42.49



Sounder Uncertain	0.36	4.50	21.54
Sounder Cloudy	0.00	0.00	2.25

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.82	0.87	0.00
Frequency Bias	4.79	1.30	0.03
Probability of Detection	0.88	0.17	0.03
False Alarm Rate	0.72	0.28	0.00

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.189
Kuiper Skill Score	0.028
Heidke Skill Score	0.018

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.91	0.79	0.00
Frequency Bias	10.05	0.81	0.04
Probability of Detection	0.92	0.17	0.04
False Alarm Rate	0.76	0.24	0.00

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.143
Kuiper Skill Score	-0.013
Heidke Skill Score	-0.008

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.94	0.83	0.00

Frequency Bias	14.71	0.91	0.03
Probability of Detection	0.93	0.16	0.03
False Alarm Rate	0.75	0.25	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.112
Kuiper Skill Score	-0.028
Heidke Skill Score	-0.015

## INSAT-3D Sounder vs MODIS for October , 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	204	22	60
Sounder Uncertain	25	4	38
Sounder Cloudy	24	1	126

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	182	54	50
Sounder Uncertain	21	12	34
Sounder Cloudy	24	8	119

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	169	65	52

Sounder Uncertain	20	11	36
Sounder Cloudy	19	11	121

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	40.48	4.37	11.90
Sounder Uncertain	4.96	0.79	7.54
Sounder Cloudy	4.76	0.20	25.00

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	36.11	10.71	9.92
Sounder Uncertain	4.17	2.38	6.75
Sounder Cloudy	4.76	1.59	23.61

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	33.53	12.90	10.32
Sounder Uncertain	3.97	2.18	7.14
Sounder Cloudy	3.77	2.18	24.01

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.29	0.94	0.17
Frequency Bias	1.13	2.48	0.67
Probability of Detection	0.81	0.15	0.56
False Alarm Rate	0.48	0.37	0.15

Overall Skill Score

Skill Score	Value
Proportion Correct	0.663
Kuiper Skill Score	0.434
Heidke Skill Score	0.413

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.36	0.82	0.21
Frequency Bias	1.26	0.91	0.74
Probability of Detection	0.80	0.16	0.59
False Alarm Rate	0.54	0.29	0.17

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.621
Kuiper Skill Score	0.367
Heidke Skill Score	0.373

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.41	0.84	0.20
Frequency Bias	1.38	0.77	0.72
Probability of Detection	0.81	0.13	0.58
False Alarm Rate	0.58	0.28	0.15

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.597
Kuiper Skill Score	0.344
Heidke Skill Score	0.349

# INSAT-3D Sounder vs MODIS for October , 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	192	17	25
Sounder Uncertain	21	2	28
Sounder Cloudy	24	1	124

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	171	45	18
Sounder Uncertain	17	9	25
Sounder Cloudy	24	8	117

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	158	56	20
Sounder Uncertain	16	8	27
Sounder Cloudy	19	11	119

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	44.24	3.92	5.76
Sounder Uncertain	4.84	0.46	6.45
Sounder Cloudy	5.53	0.23	28.57

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	39.40	10.37	4.15
Sounder Uncertain	3.92	2.07	5.76
Sounder Cloudy	5.53	1.84	26.96

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	36.41	12.90	4.61
Sounder Uncertain	3.69	1.84	6.22
Sounder Cloudy	4.38	2.53	27.42

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.18	0.96	0.17
Frequency Bias	0.99	2.55	0.84
Probability of Detection	0.81	0.10	0.70
False Alarm Rate	0.36	0.42	0.22

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.733
Kuiper Skill Score	0.549
Heidke Skill Score	0.523

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.27	0.82	0.21
Frequency Bias	1.10	0.82	0.93
Probability of Detection	0.81	0.15	0.73
False Alarm Rate	0.46	0.31	0.23

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.684
Kuiper Skill Score	0.459
Heidke Skill Score	0.468

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.32	0.84	0.20
Frequency Bias	1.21	0.68	0.90
Probability of Detection	0.82	0.11	0.72
False Alarm Rate	0.51	0.29	0.20

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.657
Kuiper Skill Score	0.424
Heidke Skill Score	0.436

## INSAT-3D Sounder vs MODIS for October , 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	12	5	35
Sounder Uncertain	4	2	10
Sounder Cloudy	0	0	2

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11	9	32
Sounder Uncertain	4	3	9
Sounder Cloudy	0	0	2

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11	9	32
Sounder Uncertain	4	3	9
Sounder Cloudy	0	0	2

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	17.14	7.14	50.00
Sounder Uncertain	5.71	2.86	14.29
Sounder Cloudy	0.00	0.00	2.86

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	15.71	12.86	45.71
Sounder Uncertain	5.71	4.29	12.86
Sounder Cloudy	0.00	0.00	2.86

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	15.71	12.86	45.71
Sounder Uncertain	5.71	4.29	12.86
Sounder Cloudy	0.00	0.00	2.86

**3. Skill Scores**



**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.77	0.88	0.00
Frequency Bias	3.25	2.29	0.04
Probability of Detection	0.75	0.29	0.04
False Alarm Rate	0.74	0.26	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.229
Kuiper Skill Score	0.034
Heidke Skill Score	0.021

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.79	0.81	0.00
Frequency Bias	3.47	1.33	0.05
Probability of Detection	0.73	0.25	0.05
False Alarm Rate	0.76	0.24	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.229
Kuiper Skill Score	0.023
Heidke Skill Score	0.016

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.79	0.81	0.00
Frequency Bias	3.47	1.33	0.05
Probability of Detection	0.73	0.25	0.05
False Alarm Rate	0.76	0.24	0.00

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.229
Kuiper Skill Score	0.023
Heidke Skill Score	0.016

## INSAT-3D Sounder vs MODIS for October , 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	7426	3584	2149
Sounder Uncertain	6014	1786	2489
Sounder Cloudy	1931	200	3590

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6650	5135	1374
Sounder Uncertain	4960	3762	1567
Sounder Cloudy	1280	1478	2963

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5686	5644	1829
Sounder Uncertain	4235	4129	1925
Sounder Cloudy	1035	1556	3130

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

#### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	25.46	12.29	7.37
Sounder Uncertain	20.62	6.12	8.53
Sounder Cloudy	6.62	0.69	12.31

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	22.80	17.60	4.71
Sounder Uncertain	17.00	12.90	5.37
Sounder Cloudy	4.39	5.07	10.16

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	19.49	19.35	6.27
Sounder Uncertain	14.52	14.16	6.60
Sounder Cloudy	3.55	5.33	10.73

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.44	0.83	0.37
Frequency Bias	0.86	1.85	0.70
Probability of Detection	0.48	0.32	0.44
False Alarm Rate	0.35	0.52	0.13

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.439
Kuiper Skill Score	0.129
Heidke Skill Score	0.123

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

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	0.49	0.63	0.48
Frequency Bias	1.02	0.99	0.97
Probability of Detection	0.52	0.36	0.50
False Alarm Rate	0.41	0.41	0.17

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.459
Kuiper Skill Score	0.148
Heidke Skill Score	0.148

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.57	0.60	0.45
Frequency Bias	1.20	0.91	0.83
Probability of Detection	0.52	0.36	0.45
False Alarm Rate	0.46	0.38	0.16

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.444
Kuiper Skill Score	0.140
Heidke Skill Score	0.141

## **INSAT-3D Sounder vs MODIS for October , 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	4201	20	355
Sounder Uncertain	4382	41	1082
Sounder Cloudy	1682	43	3365

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3922	436	218
Sounder Uncertain	3705	1137	663
Sounder Cloudy	1130	1136	2824

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3758	569	249
Sounder Uncertain	3390	1378	737
Sounder Cloudy	930	1204	2956

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	27.69	0.13	2.34
Sounder Uncertain	28.88	0.27	7.13
Sounder Cloudy	11.09	0.28	22.18

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	25.85	2.87	1.44
Sounder Uncertain	24.42	7.49	4.37
Sounder Cloudy	7.45	7.49	18.61

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	24.77	3.75	1.64

Sounder Uncertain	22.35	9.08	4.86
Sounder Cloudy	6.13	7.94	19.48

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.08	0.99	0.34
Frequency Bias	0.45	52.93	1.06
Probability of Detection	0.41	0.39	0.70
False Alarm Rate	0.05	0.72	0.23

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.501
Kuiper Skill Score	0.427
Heidke Skill Score	0.275

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.14	0.79	0.45
Frequency Bias	0.52	2.03	1.37
Probability of Detection	0.45	0.42	0.76
False Alarm Rate	0.09	0.60	0.31

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.520
Kuiper Skill Score	0.346
Heidke Skill Score	0.293

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.18	0.75	0.42

Frequency Bias	0.57	1.75	1.29
Probability of Detection	0.47	0.44	0.75
False Alarm Rate	0.12	0.58	0.30

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.533
Kuiper Skill Score	0.347
Heidke Skill Score	0.311

## INSAT-3D Sounder vs MODIS for October , 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	3225	3564	1794
Sounder Uncertain	1632	1745	1407
Sounder Cloudy	249	157	225

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2728	4699	1156
Sounder Uncertain	1255	2625	904
Sounder Cloudy	150	342	139

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1928	5075	1580

Sounder Uncertain	845	2751	1188
Sounder Cloudy	105	352	174

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	23.04	25.46	12.82
Sounder Uncertain	11.66	12.47	10.05
Sounder Cloudy	1.78	1.12	1.61

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	19.49	33.57	8.26
Sounder Uncertain	8.97	18.75	6.46
Sounder Cloudy	1.07	2.44	0.99

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	13.77	36.26	11.29
Sounder Uncertain	6.04	19.65	8.49
Sounder Cloudy	0.75	2.51	1.24

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.62	0.64	0.64
Frequency Bias	1.68	0.88	0.18
Probability of Detection	0.63	0.32	0.07
False Alarm Rate	0.61	0.35	0.05

Overall Skill Score



Skill Score	Value
Proportion Correct	0.371
Kuiper Skill Score	0.005
Heidke Skill Score	0.005

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.68	0.45	0.78
Frequency Bias	2.08	0.62	0.29
Probability of Detection	0.66	0.34	0.06
False Alarm Rate	0.69	0.25	0.06

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.392
Kuiper Skill Score	0.029
Heidke Skill Score	0.027

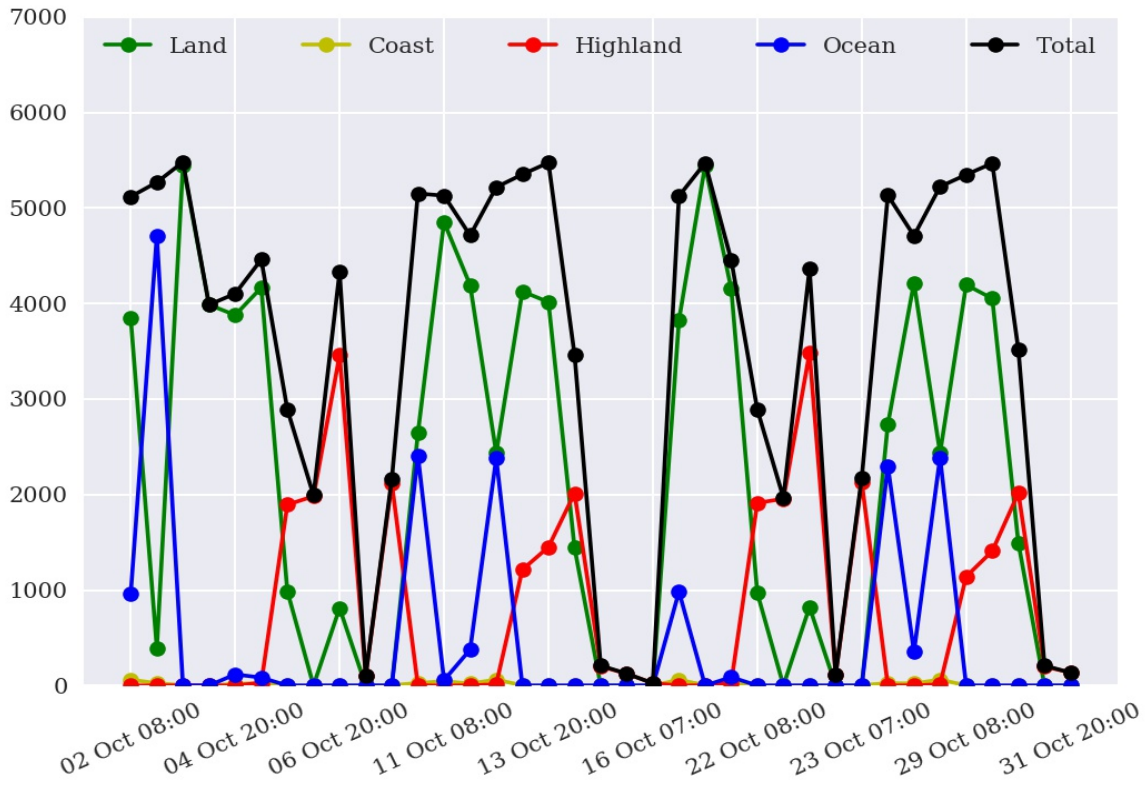
**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.78	0.42	0.72
Frequency Bias	2.98	0.58	0.21
Probability of Detection	0.67	0.34	0.06
False Alarm Rate	0.73	0.22	0.05

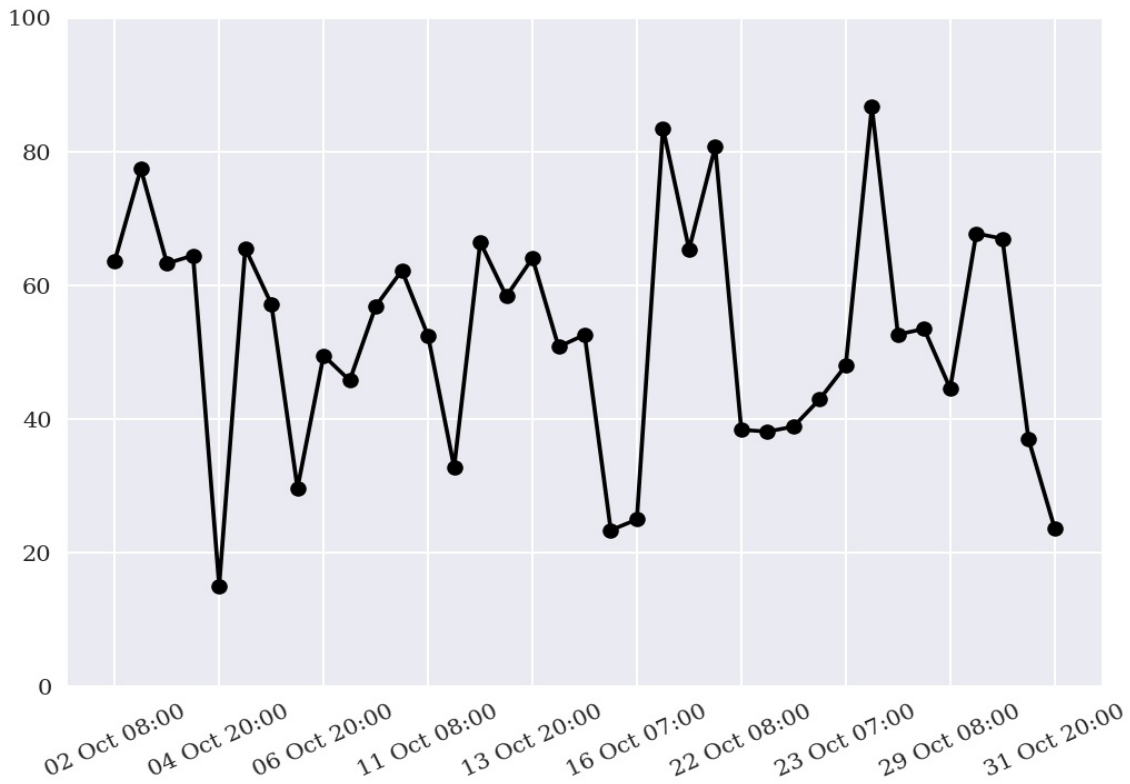
**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.347
Kuiper Skill Score	0.020
Heidke Skill Score	0.017

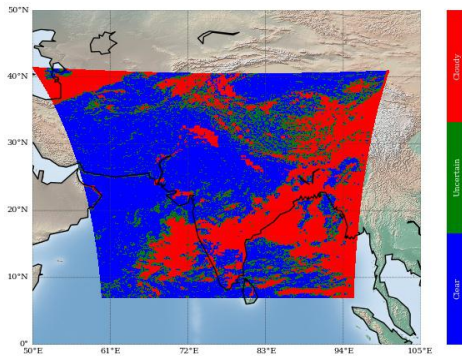
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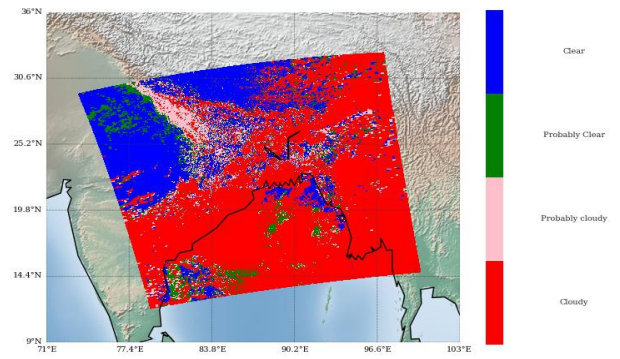
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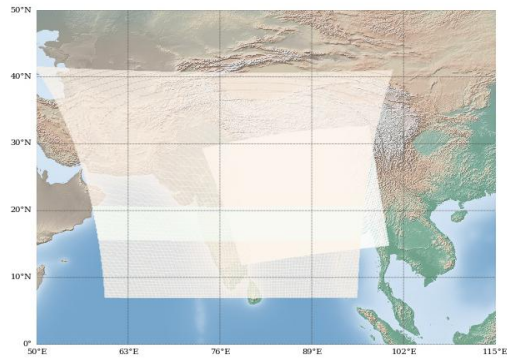
INSAT-3D Sounder Cloud Mask on  
03 October, 2017 07:00 UTC



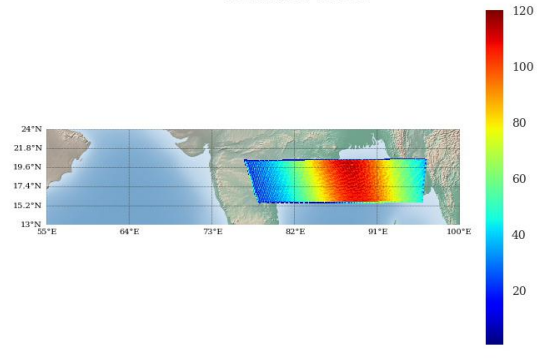
Modis Cloud Mask on  
03 October, 2017 07:30 UTC



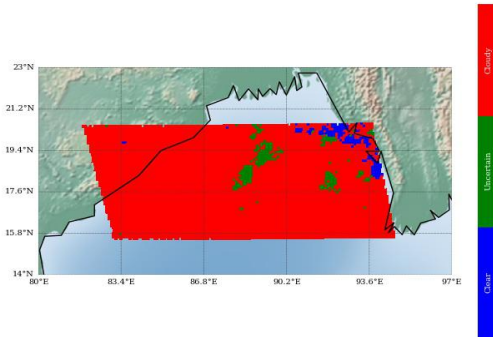
MODIS pass over INSAT-3D Sounder on  
03 October, 2017 07:30 UTC



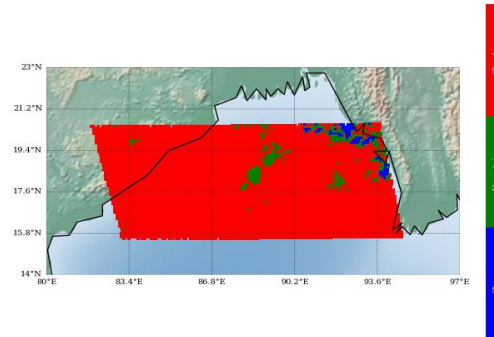
Number of Modis Pixels per Sounder Pixels on a  
spatially and Temporally Collocated Domain on  
03 October, 2017 07:30 UTC



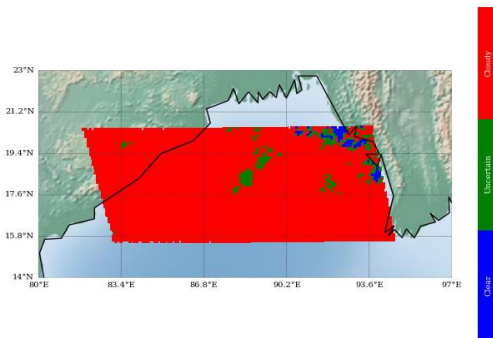
Modis Cloud Mask on Sounder Grid  
Method 1 : Mode of Modis pixels



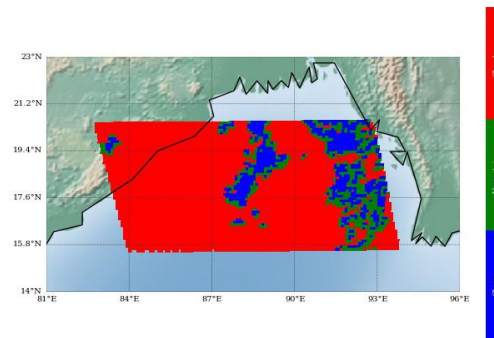
Modis Cloud Mask on Sounder Grid  
Method 2 : Weighted Average



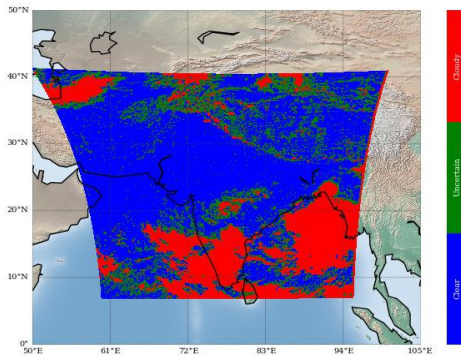
Modis Cloud Mask on Sounder Grid  
Method 3 : Weighted Product Average



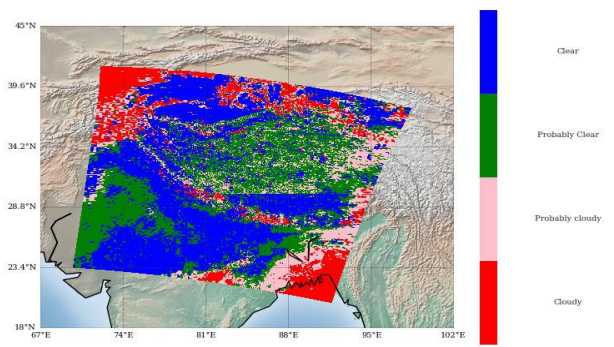
Sounder Cloud Flag on Collocated Area



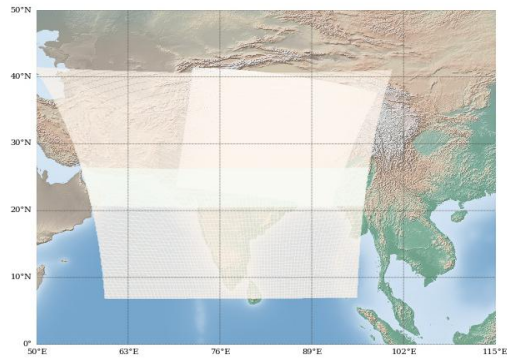
INSAT-3D Sounder Cloud Mask on  
04 October, 2017 20:00 UTC



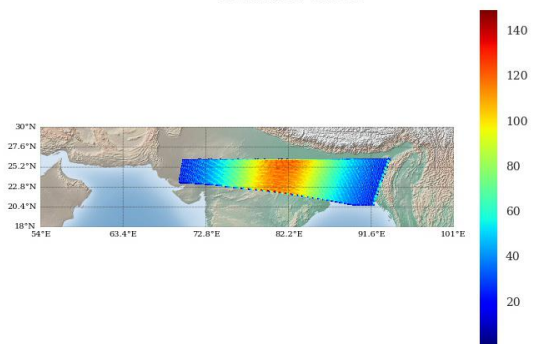
Modis Cloud Mask on  
04 October, 2017 20:20 UTC



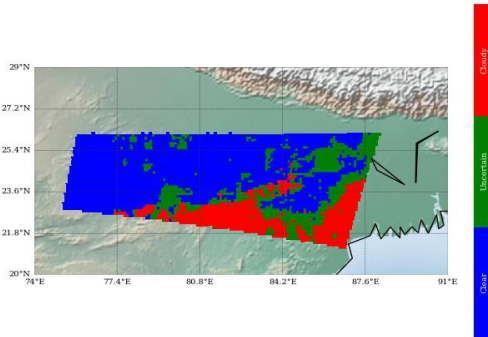
MODIS pass over INSAT-3D Sounder on  
04 October, 2017 20:20 UTC



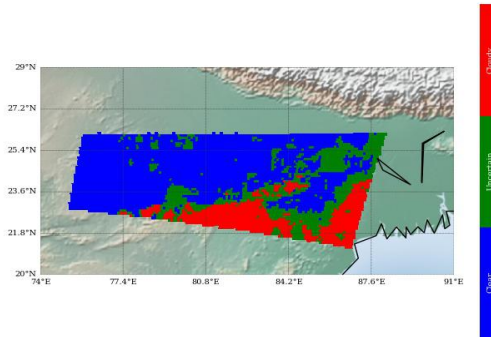
Number of Modis Pixels per Sounder Pixels on a  
spatially and Temporally Collocated Domain on  
04 October, 2017 20:20 UTC



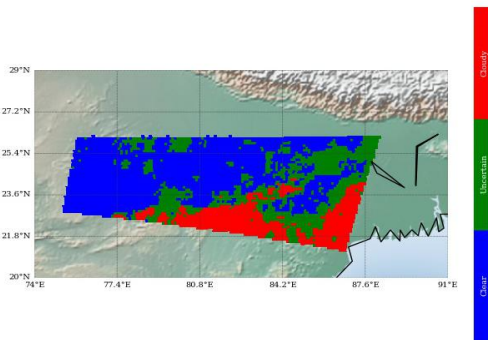
Modis Cloud Mask on Sounder Grid  
Method 1 : Mode of Modis pixels



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

