

# 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 December , 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	74431	10992	14292
Sounder Uncertain	10207	1383	9140
Sounder Cloudy	3431	359	22321

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	69814	18703	11198
Sounder Uncertain	8444	4674	7612
Sounder Cloudy	2614	1876	21621

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	64436	22827	12452
Sounder Uncertain	7562	4989	8179
Sounder Cloudy	2279	1939	21893

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	50.79	7.50	9.75
Sounder Uncertain	6.96	0.94	6.24
Sounder Cloudy	2.34	0.24	15.23

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	47.64	12.76	7.64
Sounder Uncertain	5.76	3.19	5.19
Sounder Cloudy	1.78	1.28	14.75

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	43.97	15.58	8.50
Sounder Uncertain	5.16	3.40	5.58
Sounder Cloudy	1.56	1.32	14.94

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.25	0.93	0.15
Frequency Bias	1.13	1.63	0.57
Probability of Detection	0.85	0.11	0.49
False Alarm Rate	0.52	0.40	0.08

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.670
Kuiper Skill Score	0.361
Heidke Skill Score	0.369

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.30	0.77	0.17
Frequency Bias	1.23	0.82	0.65
Probability of Detection	0.86	0.19	0.53
False Alarm Rate	0.59	0.32	0.09

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.656
Kuiper Skill Score	0.351
Heidke Skill Score	0.375

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.35	0.76	0.16
Frequency Bias	1.34	0.70	0.61
Probability of Detection	0.87	0.17	0.51
False Alarm Rate	0.64	0.28	0.08

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.623
Kuiper Skill Score	0.320
Heidke Skill Score	0.344

## INSAT-3D Sounder vs MODIS for December , 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	42235	7593	6056
Sounder Uncertain	6651	640	4235
Sounder Cloudy	1926	200	17427

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	39931	11211	4742
Sounder Uncertain	5442	2699	3385
Sounder Cloudy	1233	1423	16897

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	35902	14636	5346
Sounder Uncertain	4844	3018	3664
Sounder Cloudy	982	1469	17102

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	48.57	8.73	6.96
Sounder Uncertain	7.65	0.74	4.87
Sounder Cloudy	2.21	0.23	20.04

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	45.92	12.89	5.45
Sounder Uncertain	6.26	3.10	3.89
Sounder Cloudy	1.42	1.64	19.43

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	41.28	16.83	6.15
Sounder Uncertain	5.57	3.47	4.21
Sounder Cloudy	1.13	1.69	19.67

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.24	0.94	0.11
Frequency Bias	1.10	1.37	0.71
Probability of Detection	0.83	0.08	0.63
False Alarm Rate	0.51	0.41	0.08

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.693
Kuiper Skill Score	0.426
Heidke Skill Score	0.432

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.29	0.77	0.14
Frequency Bias	1.20	0.75	0.78
Probability of Detection	0.86	0.18	0.68
False Alarm Rate	0.58	0.32	0.10

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.685
Kuiper Skill Score	0.421
Heidke Skill Score	0.444

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.36	0.74	0.13
Frequency Bias	1.34	0.60	0.75
Probability of Detection	0.86	0.16	0.65
False Alarm Rate	0.65	0.27	0.08

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.644
Kuiper Skill Score	0.379
Heidke Skill Score	0.402

## INSAT-3D Sounder vs MODIS for December , 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	32196	3399	8236
Sounder Uncertain	3556	743	4905
Sounder Cloudy	1505	159	4894

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	29883	7492	6456
Sounder Uncertain	3002	1975	4227
Sounder Cloudy	1381	453	4724

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	28534	8191	7106
Sounder Uncertain	2718	1971	4515
Sounder Cloudy	1297	470	4791

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

#### Method1 :Taking Mode of MODIS Pixels



MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	54.03	5.70	13.82
Sounder Uncertain	5.97	1.25	8.23
Sounder Cloudy	2.53	0.27	8.21

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	50.15	12.57	10.83
Sounder Uncertain	5.04	3.31	7.09
Sounder Cloudy	2.32	0.76	7.93

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	47.88	13.74	11.92
Sounder Uncertain	4.56	3.31	7.58
Sounder Cloudy	2.18	0.79	8.04

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.27	0.92	0.25
Frequency Bias	1.18	2.14	0.36
Probability of Detection	0.86	0.17	0.27
False Alarm Rate	0.53	0.39	0.08

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.635
Kuiper Skill Score	0.255
Heidke Skill Score	0.263

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

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	0.32	0.79	0.28
Frequency Bias	1.28	0.93	0.43
Probability of Detection	0.87	0.20	0.31
False Alarm Rate	0.61	0.31	0.08

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.614
Kuiper Skill Score	0.238
Heidke Skill Score	0.262

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.35	0.79	0.27
Frequency Bias	1.35	0.87	0.40
Probability of Detection	0.88	0.19	0.29
False Alarm Rate	0.63	0.30	0.07

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.592
Kuiper Skill Score	0.223
Heidke Skill Score	0.246

## **INSAT-3D Sounder vs MODIS for December , 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	54421	5158	7721
Sounder Uncertain	4035	527	4719
Sounder Cloudy	795	56	11522

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	51658	9746	5896
Sounder Uncertain	3306	1892	4083
Sounder Cloudy	683	272	11418

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	47502	13308	6490
Sounder Uncertain	2911	2077	4293
Sounder Cloudy	638	272	11463

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	61.18	5.80	8.68
Sounder Uncertain	4.54	0.59	5.30
Sounder Cloudy	0.89	0.06	12.95

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	58.07	10.96	6.63
Sounder Uncertain	3.72	2.13	4.59
Sounder Cloudy	0.77	0.31	12.84

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	53.40	14.96	7.30

Sounder Uncertain	3.27	2.33	4.83
Sounder Cloudy	0.72	0.31	12.89

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.19	0.94	0.07
Frequency Bias	1.14	1.62	0.52
Probability of Detection	0.92	0.09	0.48
False Alarm Rate	0.57	0.39	0.04

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.747
Kuiper Skill Score	0.415
Heidke Skill Score	0.441

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.23	0.80	0.08
Frequency Bias	1.21	0.78	0.58
Probability of Detection	0.93	0.16	0.53
False Alarm Rate	0.65	0.31	0.04

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.730
Kuiper Skill Score	0.393
Heidke Skill Score	0.437

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.29	0.78	0.07

Frequency Bias	1.32	0.59	0.56
Probability of Detection	0.93	0.13	0.52
False Alarm Rate	0.71	0.26	0.03

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.686
Kuiper Skill Score	0.345
Heidke Skill Score	0.388

## INSAT-3D Sounder vs MODIS for December , 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	27526	4643	3348
Sounder Uncertain	2457	463	1898
Sounder Cloudy	208	50	8402

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	26195	6885	2437
Sounder Uncertain	2038	1220	1560
Sounder Cloudy	120	228	8312

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	22875	9805	2837

Sounder Uncertain	1743	1390	1685
Sounder Cloudy	98	210	8352

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	56.18	9.48	6.83
Sounder Uncertain	5.01	0.94	3.87
Sounder Cloudy	0.42	0.10	17.15

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	53.46	14.05	4.97
Sounder Uncertain	4.16	2.49	3.18
Sounder Cloudy	0.24	0.47	16.96

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	46.69	20.01	5.79
Sounder Uncertain	3.56	2.84	3.44
Sounder Cloudy	0.20	0.43	17.05

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.22	0.90	0.03
Frequency Bias	1.18	0.93	0.63
Probability of Detection	0.91	0.09	0.62
False Alarm Rate	0.63	0.35	0.02

Overall Skill Score

Skill Score	Value
Proportion Correct	0.743
Kuiper Skill Score	0.445
Heidke Skill Score	0.479

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.26	0.75	0.04
Frequency Bias	1.25	0.58	0.70
Probability of Detection	0.92	0.15	0.68
False Alarm Rate	0.70	0.27	0.03

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.729
Kuiper Skill Score	0.434
Heidke Skill Score	0.479

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.36	0.71	0.04
Frequency Bias	1.44	0.42	0.67
Probability of Detection	0.93	0.12	0.65
False Alarm Rate	0.77	0.21	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.666
Kuiper Skill Score	0.371
Heidke Skill Score	0.408

# INSAT-3D Sounder vs MODIS for December , 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	26895	515	4373
Sounder Uncertain	1578	64	2821
Sounder Cloudy	587	6	3120

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	25463	2861	3459
Sounder Uncertain	1268	672	2523
Sounder Cloudy	563	44	3106

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	24627	3503	3653
Sounder Uncertain	1168	687	2608
Sounder Cloudy	540	62	3111

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	67.31	1.29	10.94
Sounder Uncertain	3.95	0.16	7.06
Sounder Cloudy	1.47	0.02	7.81

### Method2 :Taking Weighted Average of MODIS pixels



MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	63.72	7.16	8.66
Sounder Uncertain	3.17	1.68	6.31
Sounder Cloudy	1.41	0.11	7.77

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	61.63	8.77	9.14
Sounder Uncertain	2.92	1.72	6.53
Sounder Cloudy	1.35	0.16	7.79

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.15	0.99	0.16
Frequency Bias	1.09	7.63	0.36
Probability of Detection	0.93	0.11	0.30
False Alarm Rate	0.49	0.45	0.06

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.753
Kuiper Skill Score	0.368
Heidke Skill Score	0.376

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.20	0.85	0.16
Frequency Bias	1.16	1.25	0.41
Probability of Detection	0.93	0.19	0.34
False Alarm Rate	0.59	0.35	0.06

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.732
Kuiper Skill Score	0.332
Heidke Skill Score	0.370

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.23	0.85	0.16
Frequency Bias	1.21	1.05	0.40
Probability of Detection	0.94	0.16	0.33
False Alarm Rate	0.62	0.33	0.05

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.711
Kuiper Skill Score	0.307
Heidke Skill Score	0.347

## INSAT-3D Sounder vs MODIS for December , 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	8849	4017	3767
Sounder Uncertain	308	111	1414
Sounder Cloudy	52	14	7525

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7804	5536	3293
Sounder Uncertain	193	320	1320
Sounder Cloudy	36	44	7511

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7277	5802	3554
Sounder Uncertain	163	309	1361
Sounder Cloudy	30	45	7516

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	33.96	15.42	14.46
Sounder Uncertain	1.18	0.43	5.43
Sounder Cloudy	0.20	0.05	28.88

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	29.95	21.25	12.64
Sounder Uncertain	0.74	1.23	5.07
Sounder Cloudy	0.14	0.17	28.83

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	27.93	22.27	13.64
Sounder Uncertain	0.63	1.19	5.22
Sounder Cloudy	0.12	0.17	28.84

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.47	0.94	0.01
Frequency Bias	1.81	0.44	0.60
Probability of Detection	0.96	0.03	0.59
False Alarm Rate	0.81	0.18	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.633
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	0.53	0.83	0.01
Frequency Bias	2.07	0.31	0.63
Probability of Detection	0.97	0.05	0.62
False Alarm Rate	0.85	0.15	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.600
Kuiper Skill Score	0.395
Heidke Skill Score	0.386

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.56	0.83	0.01
Frequency Bias	2.23	0.30	0.61
Probability of Detection	0.97	0.05	0.60
False Alarm Rate	0.85	0.14	0.01

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.580
Kuiper Skill Score	0.380
Heidke Skill Score	0.364

## INSAT-3D Sounder vs MODIS for December , 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	7460	2787	2290
Sounder Uncertain	221	56	918
Sounder Cloudy	22	1	6506

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6813	3687	2037
Sounder Uncertain	141	205	849
Sounder Cloudy	10	20	6499

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6400	3932	2205
Sounder Uncertain	122	205	868
Sounder Cloudy	9	19	6501

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

#### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	36.82	13.76	11.30
Sounder Uncertain	1.09	0.28	4.53
Sounder Cloudy	0.11	0.00	32.11

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	33.63	18.20	10.05
Sounder Uncertain	0.70	1.01	4.19
Sounder Cloudy	0.05	0.10	32.08

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	31.59	19.41	10.88
Sounder Uncertain	0.60	1.01	4.28
Sounder Cloudy	0.04	0.09	32.09

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.40	0.95	0.00
Frequency Bias	1.63	0.42	0.67
Probability of Detection	0.97	0.02	0.67
False Alarm Rate	0.81	0.18	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.692
Kuiper Skill Score	0.485
Heidke Skill Score	0.488

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

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	0.46	0.83	0.00
Frequency Bias	1.80	0.31	0.70
Probability of Detection	0.98	0.05	0.69
False Alarm Rate	0.85	0.15	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.667
Kuiper Skill Score	0.466
Heidke Skill Score	0.469

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.49	0.83	0.00
Frequency Bias	1.92	0.29	0.68
Probability of Detection	0.98	0.05	0.68
False Alarm Rate	0.86	0.14	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.647
Kuiper Skill Score	0.449
Heidke Skill Score	0.445

## INSAT-3D Sounder vs MODIS for December , 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	1389	1230	1477
Sounder Uncertain	87	55	496
Sounder Cloudy	30	13	1019

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	991	1849	1256
Sounder Uncertain	52	115	471
Sounder Cloudy	26	24	1012

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	877	1870	1349
Sounder Uncertain	41	104	493
Sounder Cloudy	21	26	1015

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	23.96	21.22	25.48
Sounder Uncertain	1.50	0.95	8.56
Sounder Cloudy	0.52	0.22	17.58

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	17.10	31.90	21.67
Sounder Uncertain	0.90	1.98	8.13
Sounder Cloudy	0.45	0.41	17.46

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	15.13	32.26	23.27



Sounder Uncertain	0.71	1.79	8.51
Sounder Cloudy	0.36	0.45	17.51

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.66	0.91	0.04
Frequency Bias	2.72	0.49	0.35
Probability of Detection	0.92	0.04	0.34
False Alarm Rate	0.81	0.17	0.01

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.425
Kuiper Skill Score	0.198
Heidke Skill Score	0.175

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.76	0.82	0.05
Frequency Bias	3.83	0.32	0.39
Probability of Detection	0.93	0.06	0.37
False Alarm Rate	0.84	0.14	0.01

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.365
Kuiper Skill Score	0.177
Heidke Skill Score	0.149

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.79	0.84	0.04

Frequency Bias	4.36	0.32	0.37
Probability of Detection	0.93	0.05	0.36
False Alarm Rate	0.85	0.14	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.344
Kuiper Skill Score	0.166
Heidke Skill Score	0.134

## INSAT-3D Sounder vs MODIS for December , 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	323	48	27
Sounder Uncertain	25	5	29
Sounder Cloudy	1	2	180

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	304	70	24
Sounder Uncertain	22	12	25
Sounder Cloudy	1	5	177

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	280	93	25

Sounder Uncertain	18	15	26
Sounder Cloudy	1	3	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	50.47	7.50	4.22
Sounder Uncertain	3.91	0.78	4.53
Sounder Cloudy	0.16	0.31	28.12

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	47.50	10.94	3.75
Sounder Uncertain	3.44	1.88	3.91
Sounder Cloudy	0.16	0.78	27.66

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	43.75	14.53	3.91
Sounder Uncertain	2.81	2.34	4.06
Sounder Cloudy	0.16	0.47	27.97

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.19	0.92	0.02
Frequency Bias	1.14	1.07	0.78
Probability of Detection	0.93	0.09	0.76
False Alarm Rate	0.57	0.41	0.02

Overall Skill Score

Skill Score	Value
Proportion Correct	0.794
Kuiper Skill Score	0.610
Heidke Skill Score	0.623

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.24	0.80	0.03
Frequency Bias	1.22	0.68	0.81
Probability of Detection	0.93	0.14	0.78
False Alarm Rate	0.64	0.32	0.04

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.770
Kuiper Skill Score	0.569
Heidke Skill Score	0.596

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.30	0.75	0.02
Frequency Bias	1.33	0.53	0.80
Probability of Detection	0.94	0.14	0.78
False Alarm Rate	0.71	0.27	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.741
Kuiper Skill Score	0.532
Heidke Skill Score	0.561

# INSAT-3D Sounder vs MODIS for December , 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	243	21	16
Sounder Uncertain	23	4	21
Sounder Cloudy	0	0	131

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	231	36	13
Sounder Uncertain	20	10	18
Sounder Cloudy	0	3	128

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	211	56	13
Sounder Uncertain	17	12	19
Sounder Cloudy	0	2	129

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	52.94	4.58	3.49
Sounder Uncertain	5.01	0.87	4.58
Sounder Cloudy	0.00	0.00	28.54

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	50.33	7.84	2.83
Sounder Uncertain	4.36	2.18	3.92
Sounder Cloudy	0.00	0.65	27.89

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	45.97	12.20	2.83
Sounder Uncertain	3.70	2.61	4.14
Sounder Cloudy	0.00	0.44	28.10

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.13	0.92	0.00
Frequency Bias	1.05	1.92	0.78
Probability of Detection	0.91	0.16	0.78
False Alarm Rate	0.46	0.54	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.824
Kuiper Skill Score	0.683
Heidke Skill Score	0.671

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.17	0.79	0.02
Frequency Bias	1.12	0.98	0.82
Probability of Detection	0.92	0.20	0.81
False Alarm Rate	0.54	0.42	0.03

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.804
Kuiper Skill Score	0.633
Heidke Skill Score	0.648

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.25	0.75	0.02
Frequency Bias	1.23	0.69	0.81
Probability of Detection	0.93	0.17	0.80
False Alarm Rate	0.64	0.34	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.767
Kuiper Skill Score	0.573
Heidke Skill Score	0.599

## INSAT-3D Sounder vs MODIS for December , 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	80	27	11
Sounder Uncertain	2	1	8
Sounder Cloudy	1	2	49

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	73	34	11
Sounder Uncertain	2	2	7
Sounder Cloudy	1	2	49

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	69	37	12
Sounder Uncertain	1	3	7
Sounder Cloudy	1	1	50

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	44.20	14.92	6.08
Sounder Uncertain	1.10	0.55	4.42
Sounder Cloudy	0.55	1.10	27.07

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	40.33	18.78	6.08
Sounder Uncertain	1.10	1.10	3.87
Sounder Cloudy	0.55	1.10	27.07

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	38.12	20.44	6.63
Sounder Uncertain	0.55	1.66	3.87
Sounder Cloudy	0.55	0.55	27.62

**3. Skill Scores**



**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.32	0.91	0.06
Frequency Bias	1.42	0.37	0.76
Probability of Detection	0.96	0.03	0.72
False Alarm Rate	0.75	0.20	0.06

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.718
Kuiper Skill Score	0.485
Heidke Skill Score	0.517

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.38	0.82	0.06
Frequency Bias	1.55	0.29	0.78
Probability of Detection	0.96	0.05	0.73
False Alarm Rate	0.79	0.16	0.05

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.685
Kuiper Skill Score	0.455
Heidke Skill Score	0.481

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.42	0.73	0.04
Frequency Bias	1.66	0.27	0.75
Probability of Detection	0.97	0.07	0.72
False Alarm Rate	0.83	0.14	0.03

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.674
Kuiper Skill Score	0.454
Heidke Skill Score	0.475

## INSAT-3D Sounder vs MODIS for December , 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	9295	1517	2525
Sounder Uncertain	5661	711	2808
Sounder Cloudy	2555	281	2220

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8621	2911	1805
Sounder Uncertain	4785	2353	2042
Sounder Cloudy	1875	1538	1643

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8077	3081	2179
Sounder Uncertain	4350	2487	2343
Sounder Cloudy	1594	1600	1862

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

#### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	33.71	5.50	9.16
Sounder Uncertain	20.53	2.58	10.18
Sounder Cloudy	9.27	1.02	8.05

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	31.27	10.56	6.55
Sounder Uncertain	17.35	8.53	7.41
Sounder Cloudy	6.80	5.58	5.96

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	29.29	11.17	7.90
Sounder Uncertain	15.78	9.02	8.50
Sounder Cloudy	5.78	5.80	6.75

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.30	0.92	0.56
Frequency Bias	0.76	3.66	0.67
Probability of Detection	0.53	0.28	0.29
False Alarm Rate	0.26	0.55	0.18

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.443
Kuiper Skill Score	0.108
Heidke Skill Score	0.091

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

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	0.35	0.74	0.68
Frequency Bias	0.87	1.35	0.92
Probability of Detection	0.56	0.35	0.30
False Alarm Rate	0.32	0.46	0.23

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.458
Kuiper Skill Score	0.120
Heidke Skill Score	0.116

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.39	0.73	0.63
Frequency Bias	0.95	1.28	0.79
Probability of Detection	0.58	0.35	0.29
False Alarm Rate	0.35	0.44	0.21

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.451
Kuiper Skill Score	0.122
Heidke Skill Score	0.121

## **INSAT-3D Sounder vs MODIS for December , 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	5901	48	297
Sounder Uncertain	3795	97	1293
Sounder Cloudy	1684	147	1773

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5672	381	193
Sounder Uncertain	3124	1187	874
Sounder Cloudy	1098	1161	1345

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5498	532	216
Sounder Uncertain	2861	1322	1002
Sounder Cloudy	872	1226	1506

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	39.25	0.32	1.98
Sounder Uncertain	25.24	0.65	8.60
Sounder Cloudy	11.20	0.98	11.79

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	37.73	2.53	1.28
Sounder Uncertain	20.78	7.89	5.81
Sounder Cloudy	7.30	7.72	8.95

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	36.57	3.54	1.44

Sounder Uncertain	19.03	8.79	6.66
Sounder Cloudy	5.80	8.15	10.02

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.06	0.98	0.51
Frequency Bias	0.55	17.76	1.07
Probability of Detection	0.52	0.33	0.53
False Alarm Rate	0.05	0.70	0.25

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.517
Kuiper Skill Score	0.377
Heidke Skill Score	0.227

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.09	0.77	0.63
Frequency Bias	0.63	1.90	1.49
Probability of Detection	0.57	0.43	0.56
False Alarm Rate	0.08	0.59	0.33

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.546
Kuiper Skill Score	0.337
Heidke Skill Score	0.274

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.12	0.75	0.58

Frequency Bias	0.68	1.68	1.32
Probability of Detection	0.60	0.43	0.55
False Alarm Rate	0.11	0.58	0.31

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.554
Kuiper Skill Score	0.337
Heidke Skill Score	0.293

## INSAT-3D Sounder vs MODIS for December , 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	3394	1469	2228
Sounder Uncertain	1866	614	1515
Sounder Cloudy	871	134	447

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2949	2530	1612
Sounder Uncertain	1661	1166	1168
Sounder Cloudy	777	377	298

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2579	2549	1963

Sounder Uncertain	1489	1165	1341
Sounder Cloudy	722	374	356

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	27.07	11.72	17.77
Sounder Uncertain	14.88	4.90	12.08
Sounder Cloudy	6.95	1.07	3.57

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	23.52	20.18	12.86
Sounder Uncertain	13.25	9.30	9.32
Sounder Cloudy	6.20	3.01	2.38

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	20.57	20.33	15.66
Sounder Uncertain	11.88	9.29	10.70
Sounder Cloudy	5.76	2.98	2.84

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.52	0.85	0.69
Frequency Bias	1.16	1.80	0.35
Probability of Detection	0.55	0.28	0.11
False Alarm Rate	0.46	0.42	0.12

Overall Skill Score



Skill Score	Value
Proportion Correct	0.355
Kuiper Skill Score	-0.026
Heidke Skill Score	-0.026

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.58	0.71	0.79
Frequency Bias	1.32	0.98	0.47
Probability of Detection	0.55	0.29	0.10
False Alarm Rate	0.51	0.35	0.14

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.352
Kuiper Skill Score	-0.035
Heidke Skill Score	-0.037

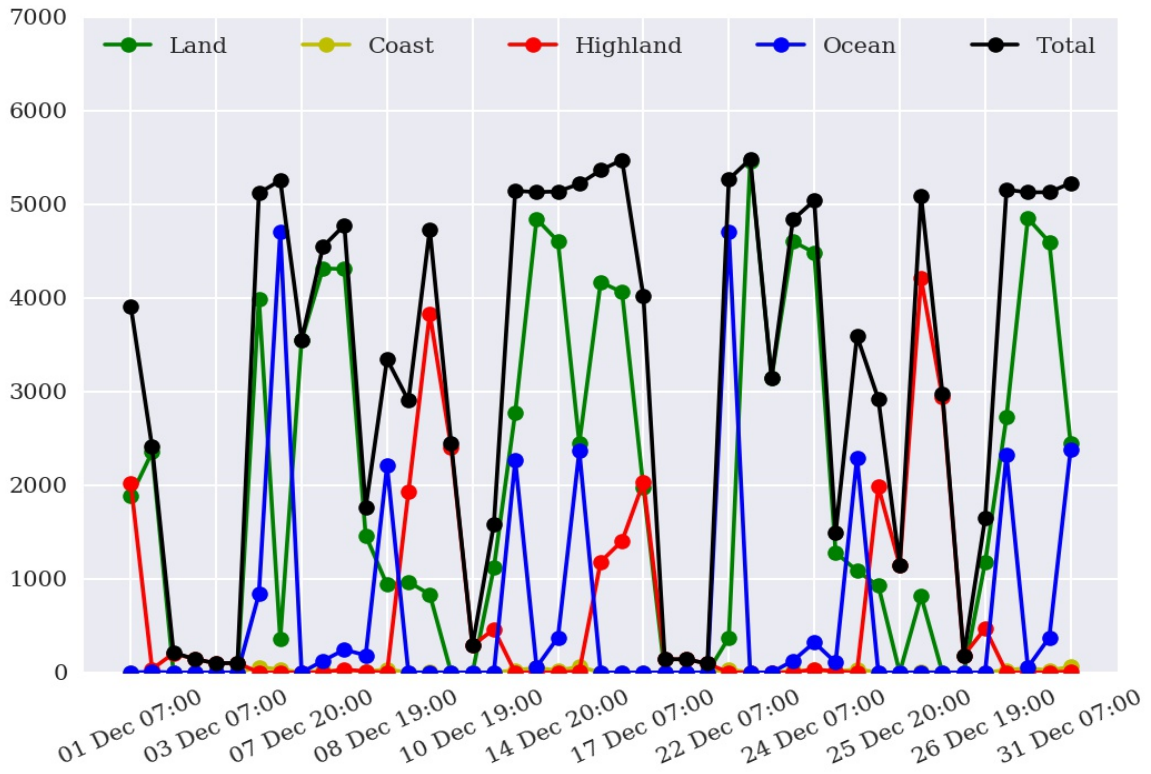
**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.64	0.71	0.75
Frequency Bias	1.48	0.98	0.40
Probability of Detection	0.54	0.28	0.10
False Alarm Rate	0.53	0.34	0.13

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.327
Kuiper Skill Score	-0.040
Heidke Skill Score	-0.041

## Number of Collocations for Dec-2017



## Percentage Correct for Dec-2017

