

# 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 September , 2018 (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	28709	15107	23096
Sounder Uncertain	4962	2395	16453
Sounder Cloudy	3999	1651	56904

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	23250	23432	20230
Sounder Uncertain	3264	5260	15286
Sounder Cloudy	2690	4363	55501

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	19914	24807	22191
Sounder Uncertain	2644	5260	15906
Sounder Cloudy	2015	4420	56119

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	18.73	9.86	15.07
Sounder Uncertain	3.24	1.56	10.73
Sounder Cloudy	2.61	1.08	37.13

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	15.17	15.29	13.20
Sounder Uncertain	2.13	3.43	9.97
Sounder Cloudy	1.76	2.85	36.21

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	12.99	16.18	14.48
Sounder Uncertain	1.72	3.43	10.38
Sounder Cloudy	1.31	2.88	36.61

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.57	0.90	0.09
Frequency Bias	1.78	1.24	0.65
Probability of Detection	0.76	0.13	0.59
False Alarm Rate	0.59	0.33	0.09

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.574
Kuiper Skill Score	0.361
Heidke Skill Score	0.309

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.65	0.78	0.11
Frequency Bias	2.29	0.72	0.69
Probability of Detection	0.80	0.16	0.61
False Alarm Rate	0.63	0.27	0.10

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.548
Kuiper Skill Score	0.335
Heidke Skill Score	0.295

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.70	0.78	0.10
Frequency Bias	2.72	0.69	0.66
Probability of Detection	0.81	0.15	0.60
False Alarm Rate	0.65	0.26	0.09

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.530
Kuiper Skill Score	0.320
Heidke Skill Score	0.271

## INSAT-3D Sounder vs MODIS for September , 2018 (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	22882	12254	16897
Sounder Uncertain	4053	1884	9817
Sounder Cloudy	3922	1617	41710

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	18176	19142	14715
Sounder Uncertain	2707	4033	9014
Sounder Cloudy	2646	4245	40358

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	15487	20258	16288
Sounder Uncertain	2192	4093	9469
Sounder Cloudy	1984	4304	40961

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	19.89	10.65	14.69
Sounder Uncertain	3.52	1.64	8.53
Sounder Cloudy	3.41	1.41	36.26

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	15.80	16.64	12.79
Sounder Uncertain	2.35	3.51	7.84
Sounder Cloudy	2.30	3.69	35.08

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	13.46	17.61	14.16
Sounder Uncertain	1.91	3.56	8.23
Sounder Cloudy	1.72	3.74	35.61

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.56	0.88	0.12
Frequency Bias	1.69	1.00	0.69
Probability of Detection	0.74	0.12	0.61
False Alarm Rate	0.60	0.29	0.11

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.578
Kuiper Skill Score	0.348
Heidke Skill Score	0.314

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.65	0.74	0.15
Frequency Bias	2.21	0.57	0.74
Probability of Detection	0.77	0.15	0.63
False Alarm Rate	0.65	0.22	0.13

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.544
Kuiper Skill Score	0.321
Heidke Skill Score	0.294

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.70	0.74	0.13
Frequency Bias	2.65	0.55	0.71
Probability of Detection	0.79	0.14	0.61
False Alarm Rate	0.67	0.21	0.12

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.526
Kuiper Skill Score	0.309
Heidke Skill Score	0.272

## INSAT-3D Sounder vs MODIS for September , 2018 (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	5827	2853	6199
Sounder Uncertain	909	511	6636
Sounder Cloudy	77	34	15194

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5074	4290	5515
Sounder Uncertain	557	1227	6272
Sounder Cloudy	44	118	15143

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4427	4549	5903
Sounder Uncertain	452	1167	6437
Sounder Cloudy	31	116	15158

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

#### Method1 :Taking Mode of MODIS Pixels



MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	15.24	7.46	16.21
Sounder Uncertain	2.38	1.34	17.35
Sounder Cloudy	0.20	0.09	39.73

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	13.27	11.22	14.42
Sounder Uncertain	1.46	3.21	16.40
Sounder Cloudy	0.12	0.31	39.60

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11.58	11.90	15.44
Sounder Uncertain	1.18	3.05	16.83
Sounder Cloudy	0.08	0.30	39.64

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.61	0.94	0.01
Frequency Bias	2.18	2.37	0.55
Probability of Detection	0.86	0.15	0.54
False Alarm Rate	0.54	0.45	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.563
Kuiper Skill Score	0.429
Heidke Skill Score	0.294

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

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	0.66	0.85	0.01
Frequency Bias	2.62	1.43	0.57
Probability of Detection	0.89	0.22	0.56
False Alarm Rate	0.58	0.41	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.561
Kuiper Skill Score	0.413
Heidke Skill Score	0.302

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.70	0.86	0.01
Frequency Bias	3.03	1.38	0.56
Probability of Detection	0.90	0.20	0.55
False Alarm Rate	0.60	0.39	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.543
Kuiper Skill Score	0.390
Heidke Skill Score	0.274

## INSAT-3D Sounder vs MODIS for September , 2018 (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	16960	4022	12839
Sounder Uncertain	3132	825	8254
Sounder Cloudy	3282	1351	33021

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	13538	10082	10201
Sounder Uncertain	2064	2756	7391
Sounder Cloudy	2291	3386	31977

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11454	11171	11196
Sounder Uncertain	1665	2807	7739
Sounder Cloudy	1715	3488	32451

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	20.27	4.81	15.34
Sounder Uncertain	3.74	0.99	9.86
Sounder Cloudy	3.92	1.61	39.46

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	16.18	12.05	12.19
Sounder Uncertain	2.47	3.29	8.83
Sounder Cloudy	2.74	4.05	38.21

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	13.69	13.35	13.38

Sounder Uncertain	1.99	3.35	9.25
Sounder Cloudy	2.05	4.17	38.78

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.50	0.93	0.12
Frequency Bias	1.45	1.97	0.70
Probability of Detection	0.73	0.13	0.61
False Alarm Rate	0.51	0.35	0.14

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.607
Kuiper Skill Score	0.386
Heidke Skill Score	0.329

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.60	0.77	0.15
Frequency Bias	1.89	0.75	0.76
Probability of Detection	0.76	0.17	0.65
False Alarm Rate	0.57	0.27	0.16

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.577
Kuiper Skill Score	0.346
Heidke Skill Score	0.316

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.66	0.77	0.14

Frequency Bias	2.28	0.70	0.73
Probability of Detection	0.77	0.16	0.63
False Alarm Rate	0.60	0.25	0.14

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.558
Kuiper Skill Score	0.328
Heidke Skill Score	0.289

## INSAT-3D Sounder vs MODIS for September , 2018 (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	14300	2049	9208
Sounder Uncertain	2799	454	4805
Sounder Cloudy	3271	1324	27173

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11056	7597	6904
Sounder Uncertain	1831	2154	4073
Sounder Cloudy	2282	3350	26136

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	9346	8552	7659

Sounder Uncertain	1484	2235	4339
Sounder Cloudy	1710	3455	26603

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	21.87	3.13	14.08
Sounder Uncertain	4.28	0.69	7.35
Sounder Cloudy	5.00	2.02	41.56

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	16.91	11.62	10.56
Sounder Uncertain	2.80	3.29	6.23
Sounder Cloudy	3.49	5.12	39.97

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	14.29	13.08	11.71
Sounder Uncertain	2.27	3.42	6.64
Sounder Cloudy	2.62	5.28	40.69

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.44	0.94	0.14
Frequency Bias	1.25	2.11	0.77
Probability of Detection	0.70	0.12	0.66
False Alarm Rate	0.48	0.32	0.20

Overall Skill Score

Skill Score	Value
Proportion Correct	0.641
Kuiper Skill Score	0.410
Heidke Skill Score	0.365

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.57	0.73	0.18
Frequency Bias	1.68	0.62	0.86
Probability of Detection	0.73	0.16	0.70
False Alarm Rate	0.56	0.23	0.22

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.602
Kuiper Skill Score	0.361
Heidke Skill Score	0.346

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.63	0.72	0.16
Frequency Bias	2.04	0.57	0.82
Probability of Detection	0.75	0.16	0.69
False Alarm Rate	0.60	0.21	0.19

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.584
Kuiper Skill Score	0.344
Heidke Skill Score	0.320

# INSAT-3D Sounder vs MODIS for September , 2018 (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	2660	1973	3631
Sounder Uncertain	333	371	3449
Sounder Cloudy	11	27	5848

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2482	2485	3297
Sounder Uncertain	233	602	3318
Sounder Cloudy	9	36	5841

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2108	2619	3537
Sounder Uncertain	181	572	3400
Sounder Cloudy	5	33	5848

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	14.53	10.78	19.84
Sounder Uncertain	1.82	2.03	18.84
Sounder Cloudy	0.06	0.15	31.95

### Method2 :Taking Weighted Average of MODIS pixels



MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	13.56	13.58	18.01
Sounder Uncertain	1.27	3.29	18.13
Sounder Cloudy	0.05	0.20	31.91

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11.52	14.31	19.32
Sounder Uncertain	0.99	3.13	18.58
Sounder Cloudy	0.03	0.18	31.95

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.68	0.91	0.01
Frequency Bias	2.75	1.75	0.46
Probability of Detection	0.89	0.16	0.45
False Alarm Rate	0.59	0.40	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.485
Kuiper Skill Score	0.338
Heidke Skill Score	0.231

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.70	0.86	0.01
Frequency Bias	3.03	1.33	0.47
Probability of Detection	0.91	0.19	0.47
False Alarm Rate	0.62	0.38	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.488
Kuiper Skill Score	0.335
Heidke Skill Score	0.241

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.74	0.86	0.01
Frequency Bias	3.60	1.29	0.46
Probability of Detection	0.92	0.18	0.46
False Alarm Rate	0.63	0.37	0.00

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.466
Kuiper Skill Score	0.311
Heidke Skill Score	0.213

## INSAT-3D Sounder vs MODIS for September , 2018 (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	10350	10558	9219
Sounder Uncertain	1202	1505	7317
Sounder Cloudy	221	236	20284

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8579	12396	9152
Sounder Uncertain	802	2053	7169
Sounder Cloudy	145	382	20214

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7492	12600	10035
Sounder Uncertain	670	1963	7391
Sounder Cloudy	119	352	20270

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	17.00	17.34	15.14
Sounder Uncertain	1.97	2.47	12.02
Sounder Cloudy	0.36	0.39	33.31

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	14.09	20.36	15.03
Sounder Uncertain	1.32	3.37	11.77
Sounder Cloudy	0.24	0.63	33.20

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	12.30	20.69	16.48
Sounder Uncertain	1.10	3.22	12.14
Sounder Cloudy	0.20	0.58	33.29

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.66	0.85	0.02
Frequency Bias	2.56	0.82	0.56
Probability of Detection	0.88	0.12	0.55
False Alarm Rate	0.69	0.30	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.528
Kuiper Skill Score	0.347
Heidke Skill Score	0.290

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.72	0.80	0.03
Frequency Bias	3.16	0.68	0.57
Probability of Detection	0.90	0.14	0.55
False Alarm Rate	0.72	0.27	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.507
Kuiper Skill Score	0.332
Heidke Skill Score	0.272

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.75	0.80	0.02
Frequency Bias	3.64	0.67	0.55
Probability of Detection	0.90	0.13	0.54
False Alarm Rate	0.73	0.26	0.02

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.488
Kuiper Skill Score	0.315
Heidke Skill Score	0.249

## INSAT-3D Sounder vs MODIS for September , 2018 (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	7349	9804	6832
Sounder Uncertain	663	1376	4286
Sounder Cloudy	160	230	11118

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6133	10772	7080
Sounder Uncertain	498	1471	4356
Sounder Cloudy	113	306	11089

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5287	10865	7833
Sounder Uncertain	413	1409	4503
Sounder Cloudy	96	274	11138

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

#### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	17.57	23.44	16.34
Sounder Uncertain	1.59	3.29	10.25
Sounder Cloudy	0.38	0.55	26.59

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	14.67	25.76	16.93
Sounder Uncertain	1.19	3.52	10.42
Sounder Cloudy	0.27	0.73	26.52

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	12.64	25.98	18.73
Sounder Uncertain	0.99	3.37	10.77
Sounder Cloudy	0.23	0.66	26.63

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.69	0.78	0.03
Frequency Bias	2.94	0.55	0.52
Probability of Detection	0.90	0.12	0.50
False Alarm Rate	0.76	0.23	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.475
Kuiper Skill Score	0.289
Heidke Skill Score	0.250

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

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	0.74	0.77	0.04
Frequency Bias	3.56	0.50	0.51
Probability of Detection	0.91	0.12	0.49
False Alarm Rate	0.77	0.21	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.447
Kuiper Skill Score	0.271
Heidke Skill Score	0.225

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.78	0.78	0.03
Frequency Bias	4.14	0.50	0.49
Probability of Detection	0.91	0.11	0.47
False Alarm Rate	0.78	0.20	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.426
Kuiper Skill Score	0.256
Heidke Skill Score	0.204

## INSAT-3D Sounder vs MODIS for September , 2018 (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	3001	754	2387
Sounder Uncertain	539	129	3031
Sounder Cloudy	61	6	9166

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2446	1624	2072
Sounder Uncertain	304	582	2813
Sounder Cloudy	32	76	9125

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2205	1735	2202
Sounder Uncertain	257	554	2888
Sounder Cloudy	23	78	9132

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	15.73	3.95	12.51
Sounder Uncertain	2.83	0.68	15.89
Sounder Cloudy	0.32	0.03	48.05

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	12.82	8.51	10.86
Sounder Uncertain	1.59	3.05	14.75
Sounder Cloudy	0.17	0.40	47.84

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11.56	9.10	11.54



Sounder Uncertain	1.35	2.90	15.14
Sounder Cloudy	0.12	0.41	47.88

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.51	0.97	0.01
Frequency Bias	1.71	4.16	0.63
Probability of Detection	0.83	0.15	0.63
False Alarm Rate	0.46	0.53	0.01

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.645
Kuiper Skill Score	0.542
Heidke Skill Score	0.366

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.60	0.84	0.01
Frequency Bias	2.21	1.62	0.66
Probability of Detection	0.88	0.26	0.65
False Alarm Rate	0.53	0.45	0.02

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.637
Kuiper Skill Score	0.498
Heidke Skill Score	0.368

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.64	0.85	0.01

Frequency Bias	2.47	1.56	0.65
Probability of Detection	0.89	0.23	0.64
False Alarm Rate	0.55	0.44	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.623
Kuiper Skill Score	0.477
Heidke Skill Score	0.343

## INSAT-3D Sounder vs MODIS for September , 2018 (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	259	98	176
Sounder Uncertain	37	9	93
Sounder Cloudy	27	14	278

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	202	173	158
Sounder Uncertain	27	23	89
Sounder Cloudy	17	39	263

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	173	193	167

Sounder Uncertain	25	24	90
Sounder Cloudy	8	44	267

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	26.14	9.89	17.76
Sounder Uncertain	3.73	0.91	9.38
Sounder Cloudy	2.72	1.41	28.05

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	20.38	17.46	15.94
Sounder Uncertain	2.72	2.32	8.98
Sounder Cloudy	1.72	3.94	26.54

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	17.46	19.48	16.85
Sounder Uncertain	2.52	2.42	9.08
Sounder Cloudy	0.81	4.44	26.94

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.51	0.94	0.13
Frequency Bias	1.65	1.15	0.58
Probability of Detection	0.80	0.07	0.51
False Alarm Rate	0.62	0.29	0.09

Overall Skill Score

Skill Score	Value
Proportion Correct	0.551
Kuiper Skill Score	0.315
Heidke Skill Score	0.287

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.62	0.83	0.18
Frequency Bias	2.17	0.59	0.63
Probability of Detection	0.82	0.10	0.52
False Alarm Rate	0.66	0.23	0.11

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.492
Kuiper Skill Score	0.259
Heidke Skill Score	0.240

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.68	0.83	0.16
Frequency Bias	2.59	0.53	0.61
Probability of Detection	0.84	0.09	0.51
False Alarm Rate	0.68	0.22	0.10

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.468
Kuiper Skill Score	0.246
Heidke Skill Score	0.219

# INSAT-3D Sounder vs MODIS for September , 2018 (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	227	82	137
Sounder Uncertain	32	8	74
Sounder Cloudy	26	14	249

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	176	143	127
Sounder Uncertain	26	16	72
Sounder Cloudy	16	37	236

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	152	161	133
Sounder Uncertain	24	18	72
Sounder Cloudy	7	42	240

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	26.74	9.66	16.14
Sounder Uncertain	3.77	0.94	8.72
Sounder Cloudy	3.06	1.65	29.33

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	20.73	16.84	14.96
Sounder Uncertain	3.06	1.88	8.48
Sounder Cloudy	1.88	4.36	27.80

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	17.90	18.96	15.67
Sounder Uncertain	2.83	2.12	8.48
Sounder Cloudy	0.82	4.95	28.27

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.49	0.93	0.14
Frequency Bias	1.56	1.10	0.63
Probability of Detection	0.80	0.08	0.54
False Alarm Rate	0.60	0.29	0.11

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.570
Kuiper Skill Score	0.333
Heidke Skill Score	0.310

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.61	0.86	0.18
Frequency Bias	2.05	0.58	0.66
Probability of Detection	0.81	0.08	0.54
False Alarm Rate	0.64	0.23	0.13

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.504
Kuiper Skill Score	0.265
Heidke Skill Score	0.248

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.66	0.84	0.17
Frequency Bias	2.44	0.52	0.65
Probability of Detection	0.83	0.08	0.54
False Alarm Rate	0.67	0.22	0.11

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.483
Kuiper Skill Score	0.256
Heidke Skill Score	0.232

## INSAT-3D Sounder vs MODIS for September , 2018 (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	32	16	39
Sounder Uncertain	5	1	19
Sounder Cloudy	1	0	29

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	26	30	31
Sounder Uncertain	1	7	17
Sounder Cloudy	1	2	27

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	21	32	34
Sounder Uncertain	1	6	18
Sounder Cloudy	1	2	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	22.54	11.27	27.46
Sounder Uncertain	3.52	0.70	13.38
Sounder Cloudy	0.70	0.00	20.42

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	18.31	21.13	21.83
Sounder Uncertain	0.70	4.93	11.97
Sounder Cloudy	0.70	1.41	19.01

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	14.79	22.54	23.94
Sounder Uncertain	0.70	4.23	12.68
Sounder Cloudy	0.70	1.41	19.01

**3. Skill Scores**



**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.63	0.96	0.03
Frequency Bias	2.29	1.47	0.34
Probability of Detection	0.84	0.06	0.33
False Alarm Rate	0.69	0.30	0.01

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.437
Kuiper Skill Score	0.227
Heidke Skill Score	0.178

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.70	0.72	0.10
Frequency Bias	3.11	0.64	0.40
Probability of Detection	0.93	0.18	0.36
False Alarm Rate	0.74	0.22	0.04

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.423
Kuiper Skill Score	0.234
Heidke Skill Score	0.197

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.76	0.76	0.10
Frequency Bias	3.78	0.62	0.38
Probability of Detection	0.91	0.15	0.34
False Alarm Rate	0.75	0.22	0.03

**Overall Skill Score**

Skill Score	Value
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Proportion Correct	0.380
Kuiper Skill Score	0.195
Heidke Skill Score	0.155

## INSAT-3D Sounder vs MODIS for September , 2018 (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	132	2	89
Sounder Uncertain	379	8	340
Sounder Cloudy	389	14	1696

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	80	81	62
Sounder Uncertain	213	292	222
Sounder Cloudy	202	402	1495

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	63	95	65
Sounder Uncertain	150	328	249
Sounder Cloudy	146	404	1549

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

#### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4.33	0.07	2.92
Sounder Uncertain	12.43	0.26	11.15
Sounder Cloudy	12.76	0.46	55.62

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.62	2.66	2.03
Sounder Uncertain	6.99	9.58	7.28
Sounder Cloudy	6.63	13.18	49.03

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.07	3.12	2.13
Sounder Uncertain	4.92	10.76	8.17
Sounder Cloudy	4.79	13.25	50.80

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.41	0.99	0.19
Frequency Bias	0.25	30.29	0.99
Probability of Detection	0.15	0.33	0.80
False Alarm Rate	0.08	0.59	0.33

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.602
Kuiper Skill Score	0.232
Heidke Skill Score	0.199

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

Skill Score	Clear	Uncertain	Cloudy
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False Alarm Ratio	0.64	0.60	0.29
Frequency Bias	0.45	0.94	1.18
Probability of Detection	0.16	0.38	0.84
False Alarm Rate	0.12	0.37	0.51

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.612
Kuiper Skill Score	0.243
Heidke Skill Score	0.263

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.72	0.55	0.26
Frequency Bias	0.62	0.88	1.13
Probability of Detection	0.18	0.40	0.83
False Alarm Rate	0.14	0.36	0.50

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.636
Kuiper Skill Score	0.264
Heidke Skill Score	0.281

## **INSAT-3D Sounder vs MODIS for September , 2018 (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	132	2	89
Sounder Uncertain	379	8	339
Sounder Cloudy	389	13	1688

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	80	81	62
Sounder Uncertain	213	292	221
Sounder Cloudy	202	401	1487

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	63	95	65
Sounder Uncertain	150	328	248
Sounder Cloudy	146	403	1541

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4.34	0.07	2.93
Sounder Uncertain	12.47	0.26	11.15
Sounder Cloudy	12.80	0.43	55.54

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.63	2.67	2.04
Sounder Uncertain	7.01	9.61	7.27
Sounder Cloudy	6.65	13.20	48.93

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	2.07	3.13	2.14

Sounder Uncertain	4.94	10.79	8.16
Sounder Cloudy	4.80	13.26	50.71

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.41	0.99	0.19
Frequency Bias	0.25	31.57	0.99
Probability of Detection	0.15	0.35	0.80
False Alarm Rate	0.08	0.59	0.33

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.602
Kuiper Skill Score	0.232
Heidke Skill Score	0.199

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.64	0.60	0.29
Frequency Bias	0.45	0.94	1.18
Probability of Detection	0.16	0.38	0.84
False Alarm Rate	0.12	0.37	0.51

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.612
Kuiper Skill Score	0.243
Heidke Skill Score	0.263

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.72	0.55	0.26

Frequency Bias	0.62	0.88	1.13
Probability of Detection	0.18	0.40	0.83
False Alarm Rate	0.14	0.36	0.50

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.636
Kuiper Skill Score	0.264
Heidke Skill Score	0.281

## INSAT-3D Sounder vs MODIS for September , 2018 (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	0	0
Sounder Uncertain	0	0	1
Sounder Cloudy	0	1	8

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	0	0
Sounder Uncertain	0	0	1
Sounder Cloudy	0	1	8

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0	0	0

Sounder Uncertain	0	0	1
Sounder Cloudy	0	1	8

## 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	0.00
Sounder Uncertain	0.00	0.00	10.00
Sounder Cloudy	0.00	10.00	80.00

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	0.00	0.00
Sounder Uncertain	0.00	0.00	10.00
Sounder Cloudy	0.00	10.00	80.00

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.00	0.00	0.00
Sounder Uncertain	0.00	0.00	10.00
Sounder Cloudy	0.00	10.00	80.00

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	nan	1.00	0.11
Frequency Bias	nan	1.00	1.00
Probability of Detection	nan	0.00	0.89
False Alarm Rate	0.00	0.50	0.50

Overall Skill Score



Skill Score	Value
Proportion Correct	0.800
Kuiper Skill Score	-0.111
Heidke Skill Score	-0.111

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	nan	1.00	0.11
Frequency Bias	nan	1.00	1.00
Probability of Detection	nan	0.00	0.89
False Alarm Rate	0.00	0.50	0.50

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.800
Kuiper Skill Score	-0.111
Heidke Skill Score	-0.111

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	nan	1.00	0.11
Frequency Bias	nan	1.00	1.00
Probability of Detection	nan	0.00	0.89
False Alarm Rate	0.00	0.50	0.50

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.800
Kuiper Skill Score	-0.111
Heidke Skill Score	-0.111