

# 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 April , 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	45502	14104	11669
Sounder Uncertain	7604	2365	9736
Sounder Cloudy	17841	3222	22431

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	40635	20451	10189
Sounder Uncertain	5862	5082	8761
Sounder Cloudy	15184	7705	20605

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	36076	23906	11293
Sounder Uncertain	4822	5624	9259
Sounder Cloudy	12673	9586	21235

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	33.84	10.49	8.68
Sounder Uncertain	5.65	1.76	7.24
Sounder Cloudy	13.27	2.40	16.68

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	30.22	15.21	7.58
Sounder Uncertain	4.36	3.78	6.52
Sounder Cloudy	11.29	5.73	15.32

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	26.83	17.78	8.40
Sounder Uncertain	3.59	4.18	6.89
Sounder Cloudy	9.42	7.13	15.79

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.36	0.88	0.48
Frequency Bias	1.00	1.00	0.99
Probability of Detection	0.64	0.12	0.51
False Alarm Rate	0.40	0.27	0.33

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.523
Kuiper Skill Score	0.196
Heidke Skill Score	0.196

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.43	0.74	0.53
Frequency Bias	1.16	0.59	1.10
Probability of Detection	0.66	0.15	0.52
False Alarm Rate	0.45	0.21	0.34

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.493
Kuiper Skill Score	0.185
Heidke Skill Score	0.190

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.49	0.71	0.51
Frequency Bias	1.33	0.50	1.04
Probability of Detection	0.67	0.14	0.51
False Alarm Rate	0.49	0.20	0.31

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.468
Kuiper Skill Score	0.172
Heidke Skill Score	0.176

## INSAT-3D Sounder vs MODIS for April , 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	27347	11536	7117
Sounder Uncertain	5405	1729	6200
Sounder Cloudy	16146	2645	16908

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	25027	14408	6565
Sounder Uncertain	4191	3583	5560
Sounder Cloudy	13938	6432	15329

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	21724	16896	7380
Sounder Uncertain	3408	4023	5903
Sounder Cloudy	11614	8232	15853

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	28.78	12.14	7.49
Sounder Uncertain	5.69	1.82	6.52
Sounder Cloudy	16.99	2.78	17.79

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	26.34	15.16	6.91
Sounder Uncertain	4.41	3.77	5.85
Sounder Cloudy	14.67	6.77	16.13

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	22.86	17.78	7.77
Sounder Uncertain	3.59	4.23	6.21
Sounder Cloudy	12.22	8.66	16.68

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.41	0.87	0.53
Frequency Bias	0.94	0.84	1.18
Probability of Detection	0.56	0.11	0.56
False Alarm Rate	0.38	0.24	0.38

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.484
Kuiper Skill Score	0.152
Heidke Skill Score	0.151

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.46	0.73	0.57
Frequency Bias	1.07	0.55	1.30
Probability of Detection	0.58	0.15	0.56
False Alarm Rate	0.41	0.19	0.40

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.462
Kuiper Skill Score	0.152
Heidke Skill Score	0.154

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.53	0.70	0.56
Frequency Bias	1.25	0.46	1.23
Probability of Detection	0.59	0.14	0.54
False Alarm Rate	0.45	0.17	0.37

**Overall Skill Score**

Skill Score	Value
-------------	-------

Proportion Correct	0.438
Kuiper Skill Score	0.139
Heidke Skill Score	0.141

## INSAT-3D Sounder vs MODIS for April , 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	18155	2568	4552
Sounder Uncertain	2199	636	3536
Sounder Cloudy	1695	577	5523

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	15608	6043	3624
Sounder Uncertain	1671	1499	3201
Sounder Cloudy	1246	1273	5276

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	14352	7010	3913
Sounder Uncertain	1414	1601	3356
Sounder Cloudy	1059	1354	5382

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

#### Method1 :Taking Mode of MODIS Pixels



MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	46.03	6.51	11.54
Sounder Uncertain	5.58	1.61	8.97
Sounder Cloudy	4.30	1.46	14.00

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	39.57	15.32	9.19
Sounder Uncertain	4.24	3.80	8.12
Sounder Cloudy	3.16	3.23	13.38

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	36.39	17.77	9.92
Sounder Uncertain	3.59	4.06	8.51
Sounder Cloudy	2.69	3.43	13.65

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.28	0.90	0.29
Frequency Bias	1.15	1.69	0.57
Probability of Detection	0.82	0.17	0.41
False Alarm Rate	0.47	0.38	0.15

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.616
Kuiper Skill Score	0.312
Heidke Skill Score	0.313

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

Skill Score	Clear	Uncertain	Cloudy
-------------	-------	-----------	--------

False Alarm Ratio	0.38	0.76	0.32
Frequency Bias	1.36	0.72	0.64
Probability of Detection	0.84	0.17	0.44
False Alarm Rate	0.57	0.29	0.15

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.568
Kuiper Skill Score	0.267
Heidke Skill Score	0.282

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.43	0.75	0.31
Frequency Bias	1.50	0.64	0.62
Probability of Detection	0.85	0.16	0.43
False Alarm Rate	0.60	0.26	0.13

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.541
Kuiper Skill Score	0.251
Heidke Skill Score	0.262

## **INSAT-3D Sounder vs MODIS for April , 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
---------------	-------------	-----------------	--------------

Sounder Clear	29193	4597	3440
Sounder Uncertain	5455	957	3003
Sounder Cloudy	15645	2723	10121

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	27395	7380	2455
Sounder Uncertain	4375	2786	2254
Sounder Cloudy	13551	6303	8635

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	23934	10515	2781
Sounder Uncertain	3556	3378	2481
Sounder Cloudy	11281	8061	9147

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	38.85	6.12	4.58
Sounder Uncertain	7.26	1.27	4.00
Sounder Cloudy	20.82	3.62	13.47

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	36.46	9.82	3.27
Sounder Uncertain	5.82	3.71	3.00
Sounder Cloudy	18.04	8.39	11.49

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	31.86	13.99	3.70

Sounder Uncertain	4.73	4.50	3.30
Sounder Cloudy	15.01	10.73	12.17

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.22	0.90	0.64
Frequency Bias	0.74	1.14	1.72
Probability of Detection	0.58	0.12	0.61
False Alarm Rate	0.23	0.24	0.53

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.536
Kuiper Skill Score	0.218
Heidke Skill Score	0.187

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.26	0.70	0.70
Frequency Bias	0.82	0.57	2.13
Probability of Detection	0.60	0.17	0.65
False Alarm Rate	0.27	0.18	0.55

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.517
Kuiper Skill Score	0.221
Heidke Skill Score	0.203

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.36	0.64	0.68

Frequency Bias	0.96	0.43	1.98
Probability of Detection	0.62	0.15	0.63
False Alarm Rate	0.34	0.16	0.50

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.485
Kuiper Skill Score	0.197
Heidke Skill Score	0.189

## INSAT-3D Sounder vs MODIS for April , 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	21454	2680	1916
Sounder Uncertain	4416	578	1712
Sounder Cloudy	15224	2445	8830

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	20041	4723	1286
Sounder Uncertain	3488	2100	1118
Sounder Cloudy	13213	5898	7388

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	17295	7258	1497

Sounder Uncertain	2811	2628	1267
Sounder Cloudy	11013	7630	7856

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	36.21	4.52	3.23
Sounder Uncertain	7.45	0.98	2.89
Sounder Cloudy	25.69	4.13	14.90

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	33.82	7.97	2.17
Sounder Uncertain	5.89	3.54	1.89
Sounder Cloudy	22.30	9.95	12.47

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	29.19	12.25	2.53
Sounder Uncertain	4.74	4.44	2.14
Sounder Cloudy	18.59	12.88	13.26

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.18	0.91	0.67
Frequency Bias	0.63	1.18	2.13
Probability of Detection	0.52	0.10	0.71
False Alarm Rate	0.16	0.22	0.62

Overall Skill Score

Skill Score	Value
Proportion Correct	0.521
Kuiper Skill Score	0.238
Heidke Skill Score	0.188

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.23	0.69	0.72
Frequency Bias	0.71	0.53	2.71
Probability of Detection	0.55	0.17	0.75
False Alarm Rate	0.20	0.15	0.64

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.498
Kuiper Skill Score	0.235
Heidke Skill Score	0.203

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.34	0.61	0.70
Frequency Bias	0.84	0.38	2.50
Probability of Detection	0.56	0.15	0.74
False Alarm Rate	0.28	0.13	0.59

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.469
Kuiper Skill Score	0.206
Heidke Skill Score	0.190

# INSAT-3D Sounder vs MODIS for April , 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	7739	1917	1524
Sounder Uncertain	1039	379	1291
Sounder Cloudy	421	278	1291

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7354	2657	1169
Sounder Uncertain	887	686	1136
Sounder Cloudy	338	405	1247

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6639	3257	1284
Sounder Uncertain	745	750	1214
Sounder Cloudy	268	431	1291

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	48.74	12.07	9.60
Sounder Uncertain	6.54	2.39	8.13
Sounder Cloudy	2.65	1.75	8.13

### Method2 :Taking Weighted Average of MODIS pixels



MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	46.31	16.73	7.36
Sounder Uncertain	5.59	4.32	7.15
Sounder Cloudy	2.13	2.55	7.85

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	41.81	20.51	8.09
Sounder Uncertain	4.69	4.72	7.65
Sounder Cloudy	1.69	2.71	8.13

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.31	0.86	0.35
Frequency Bias	1.22	1.05	0.48
Probability of Detection	0.84	0.15	0.31
False Alarm Rate	0.53	0.36	0.11

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.593
Kuiper Skill Score	0.218
Heidke Skill Score	0.234

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.34	0.75	0.37
Frequency Bias	1.30	0.72	0.56
Probability of Detection	0.86	0.18	0.35
False Alarm Rate	0.58	0.31	0.11

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.585
Kuiper Skill Score	0.226
Heidke Skill Score	0.247

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.41	0.72	0.35
Frequency Bias	1.46	0.61	0.53
Probability of Detection	0.87	0.17	0.34
False Alarm Rate	0.63	0.27	0.10

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.547
Kuiper Skill Score	0.205
Heidke Skill Score	0.223

## INSAT-3D Sounder vs MODIS for April , 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	15118	8970	7498
Sounder Uncertain	1551	1290	6021
Sounder Cloudy	1303	398	9971

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	12262	12175	7149
Sounder Uncertain	1075	1873	5914
Sounder Cloudy	936	973	9763

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11301	12426	7859
Sounder Uncertain	933	1781	6148
Sounder Cloudy	812	1020	9840

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	29.01	17.21	14.39
Sounder Uncertain	2.98	2.48	11.55
Sounder Cloudy	2.50	0.76	19.13

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	23.53	23.36	13.72
Sounder Uncertain	2.06	3.59	11.35
Sounder Cloudy	1.80	1.87	18.73

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	21.68	23.84	15.08
Sounder Uncertain	1.79	3.42	11.80
Sounder Cloudy	1.56	1.96	18.88

**3. Skill Scores**

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.52	0.85	0.15
Frequency Bias	1.76	0.83	0.50
Probability of Detection	0.84	0.12	0.42
False Alarm Rate	0.64	0.29	0.07

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.506
Kuiper Skill Score	0.254
Heidke Skill Score	0.246

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.61	0.79	0.16
Frequency Bias	2.21	0.59	0.51
Probability of Detection	0.86	0.12	0.43
False Alarm Rate	0.68	0.25	0.07

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.459
Kuiper Skill Score	0.224
Heidke Skill Score	0.212

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.64	0.80	0.16
Frequency Bias	2.42	0.58	0.49
Probability of Detection	0.87	0.12	0.41
False Alarm Rate	0.69	0.24	0.06

**Overall Skill Score**

Skill Score	Value
-------------	-------

Proportion Correct	0.440
Kuiper Skill Score	0.212
Heidke Skill Score	0.195

## INSAT-3D Sounder vs MODIS for April , 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	4973	8401	4754
Sounder Uncertain	728	1080	4133
Sounder Cloudy	225	128	6054

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4196	9010	4922
Sounder Uncertain	508	1306	4127
Sounder Cloudy	173	213	6021

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3733	8920	5475
Sounder Uncertain	428	1210	4303
Sounder Cloudy	126	237	6044

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

#### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	16.32	27.57	15.60
Sounder Uncertain	2.39	3.54	13.56
Sounder Cloudy	0.74	0.42	19.86

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	13.77	29.56	16.15
Sounder Uncertain	1.67	4.29	13.54
Sounder Cloudy	0.57	0.70	19.76

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	12.25	29.27	17.96
Sounder Uncertain	1.40	3.97	14.12
Sounder Cloudy	0.41	0.78	19.83

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.73	0.82	0.06
Frequency Bias	3.06	0.62	0.43
Probability of Detection	0.84	0.11	0.41
False Alarm Rate	0.72	0.26	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.397
Kuiper Skill Score	0.188
Heidke Skill Score	0.163

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

Skill Score	Clear	Uncertain	Cloudy
-------------	-------	-----------	--------

False Alarm Ratio	0.77	0.78	0.06
Frequency Bias	3.72	0.56	0.43
Probability of Detection	0.86	0.12	0.40
False Alarm Rate	0.74	0.24	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.378
Kuiper Skill Score	0.183
Heidke Skill Score	0.152

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.79	0.80	0.06
Frequency Bias	4.23	0.57	0.40
Probability of Detection	0.87	0.12	0.38
False Alarm Rate	0.74	0.24	0.02

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.361
Kuiper Skill Score	0.170
Heidke Skill Score	0.137

## INSAT-3D Sounder vs MODIS for April , 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
---------------	-------------	-----------------	--------------

Sounder Clear	10145	569	2744
Sounder Uncertain	823	210	1888
Sounder Cloudy	1078	270	3917

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8066	3165	2227
Sounder Uncertain	567	567	1787
Sounder Cloudy	763	760	3742

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7568	3506	2384
Sounder Uncertain	505	571	1845
Sounder Cloudy	686	783	3796

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	46.87	2.63	12.68
Sounder Uncertain	3.80	0.97	8.72
Sounder Cloudy	4.98	1.25	18.10

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	37.27	14.62	10.29
Sounder Uncertain	2.62	2.62	8.26
Sounder Cloudy	3.53	3.51	17.29

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	34.97	16.20	11.01



Sounder Uncertain	2.33	2.64	8.52
Sounder Cloudy	3.17	3.62	17.54

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.25	0.93	0.26
Frequency Bias	1.12	2.78	0.62
Probability of Detection	0.84	0.20	0.46
False Alarm Rate	0.45	0.37	0.18

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.659
Kuiper Skill Score	0.396
Heidke Skill Score	0.382

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.40	0.81	0.29
Frequency Bias	1.43	0.65	0.68
Probability of Detection	0.86	0.13	0.48
False Alarm Rate	0.58	0.25	0.16

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.572
Kuiper Skill Score	0.292
Heidke Skill Score	0.304

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.44	0.80	0.28

Frequency Bias	1.54	0.60	0.66
Probability of Detection	0.86	0.12	0.47
False Alarm Rate	0.61	0.24	0.15

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.551
Kuiper Skill Score	0.277
Heidke Skill Score	0.286

## INSAT-3D Sounder vs MODIS for April , 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	183	92	74
Sounder Uncertain	51	18	47
Sounder Cloudy	120	14	134

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	157	136	56
Sounder Uncertain	47	23	46
Sounder Cloudy	104	38	126

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	141	141	67

Sounder Uncertain	36	33	47
Sounder Cloudy	90	48	130

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	24.97	12.55	10.10
Sounder Uncertain	6.96	2.46	6.41
Sounder Cloudy	16.37	1.91	18.28

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	21.42	18.55	7.64
Sounder Uncertain	6.41	3.14	6.28
Sounder Cloudy	14.19	5.18	17.19

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	19.24	19.24	9.14
Sounder Uncertain	4.91	4.50	6.41
Sounder Cloudy	12.28	6.55	17.74

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.48	0.84	0.50
Frequency Bias	0.99	0.94	1.05
Probability of Detection	0.52	0.15	0.53
False Alarm Rate	0.42	0.25	0.34

Overall Skill Score

Skill Score	Value
Proportion Correct	0.457
Kuiper Skill Score	0.118
Heidke Skill Score	0.119

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.55	0.80	0.53
Frequency Bias	1.13	0.59	1.18
Probability of Detection	0.51	0.12	0.55
False Alarm Rate	0.45	0.22	0.33

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.417
Kuiper Skill Score	0.093
Heidke Skill Score	0.095

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.60	0.72	0.51
Frequency Bias	1.31	0.52	1.10
Probability of Detection	0.53	0.15	0.53
False Alarm Rate	0.48	0.19	0.32

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.415
Kuiper Skill Score	0.108
Heidke Skill Score	0.109

# INSAT-3D Sounder vs MODIS for April , 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	174	83	65
Sounder Uncertain	43	13	42
Sounder Cloudy	104	12	95

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	150	124	48
Sounder Uncertain	40	17	41
Sounder Cloudy	94	28	89

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	135	130	57
Sounder Uncertain	34	23	41
Sounder Cloudy	83	36	92

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	27.58	13.15	10.30
Sounder Uncertain	6.81	2.06	6.66
Sounder Cloudy	16.48	1.90	15.06

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	23.77	19.65	7.61
Sounder Uncertain	6.34	2.69	6.50
Sounder Cloudy	14.90	4.44	14.10

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	21.39	20.60	9.03
Sounder Uncertain	5.39	3.65	6.50
Sounder Cloudy	13.15	5.71	14.58

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.46	0.87	0.55
Frequency Bias	1.00	0.91	1.04
Probability of Detection	0.54	0.12	0.47
False Alarm Rate	0.42	0.24	0.33

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.447
Kuiper Skill Score	0.088
Heidke Skill Score	0.088

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.53	0.83	0.58
Frequency Bias	1.13	0.58	1.19
Probability of Detection	0.53	0.10	0.50
False Alarm Rate	0.46	0.22	0.33

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.406
Kuiper Skill Score	0.062
Heidke Skill Score	0.063

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.58	0.77	0.56
Frequency Bias	1.28	0.52	1.11
Probability of Detection	0.54	0.12	0.48
False Alarm Rate	0.49	0.20	0.31

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.396
Kuiper Skill Score	0.068
Heidke Skill Score	0.070

## INSAT-3D Sounder vs MODIS for April , 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	9	9	9
Sounder Uncertain	8	5	5
Sounder Cloudy	16	2	39

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7	12	8
Sounder Uncertain	7	6	5
Sounder Cloudy	10	10	37

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6	11	10
Sounder Uncertain	2	10	6
Sounder Cloudy	7	12	38

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	8.82	8.82	8.82
Sounder Uncertain	7.84	4.90	4.90
Sounder Cloudy	15.69	1.96	38.24

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	6.86	11.76	7.84
Sounder Uncertain	6.86	5.88	4.90
Sounder Cloudy	9.80	9.80	36.27

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	5.88	10.78	9.80
Sounder Uncertain	1.96	9.80	5.88
Sounder Cloudy	6.86	11.76	37.25

**3. Skill Scores**



**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.67	0.72	0.32
Frequency Bias	0.82	1.12	1.08
Probability of Detection	0.27	0.31	0.74
False Alarm Rate	0.37	0.27	0.37

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.520
Kuiper Skill Score	0.193
Heidke Skill Score	0.194

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.74	0.67	0.35
Frequency Bias	1.12	0.64	1.14
Probability of Detection	0.29	0.21	0.74
False Alarm Rate	0.38	0.23	0.38

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.490
Kuiper Skill Score	0.168
Heidke Skill Score	0.172

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.78	0.44	0.33
Frequency Bias	1.80	0.55	1.06
Probability of Detection	0.40	0.30	0.70
False Alarm Rate	0.44	0.17	0.40

**Overall Skill Score**

Skill Score	Value
-------------	-------

Proportion Correct	0.529
Kuiper Skill Score	0.232
Heidke Skill Score	0.226

## INSAT-3D Sounder vs MODIS for April , 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	215	51	229
Sounder Uncertain	356	31	431
Sounder Cloudy	185	15	1485

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	137	182	176
Sounder Uncertain	222	256	340
Sounder Cloudy	98	186	1401

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	103	203	189
Sounder Uncertain	172	283	363
Sounder Cloudy	65	196	1424

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

#### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7.17	1.70	7.64
Sounder Uncertain	11.87	1.03	14.38
Sounder Cloudy	6.17	0.50	49.53

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	4.57	6.07	5.87
Sounder Uncertain	7.40	8.54	11.34
Sounder Cloudy	3.27	6.20	46.73

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	3.44	6.77	6.30
Sounder Uncertain	5.74	9.44	12.11
Sounder Cloudy	2.17	6.54	47.50

### 3. Skill Scores

**Method1 :Taking Mode of MODIS Pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.57	0.96	0.12
Frequency Bias	0.65	8.43	0.79
Probability of Detection	0.28	0.32	0.69
False Alarm Rate	0.22	0.62	0.16

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.577
Kuiper Skill Score	0.295
Heidke Skill Score	0.228

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

Skill Score	Clear	Uncertain	Cloudy
-------------	-------	-----------	--------

False Alarm Ratio	0.72	0.69	0.17
Frequency Bias	1.08	1.31	0.88
Probability of Detection	0.30	0.41	0.73
False Alarm Rate	0.30	0.47	0.24

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.598
Kuiper Skill Score	0.299
Heidke Skill Score	0.281

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.79	0.65	0.15
Frequency Bias	1.46	1.20	0.85
Probability of Detection	0.30	0.41	0.72
False Alarm Rate	0.33	0.45	0.22

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.604
Kuiper Skill Score	0.304
Heidke Skill Score	0.278

## **INSAT-3D Sounder vs MODIS for April , 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
---------------	-------------	-----------------	--------------

Sounder Clear	19	3	25
Sounder Uncertain	48	3	113
Sounder Cloudy	118	3	1404

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	12	18	17
Sounder Uncertain	24	42	98
Sounder Cloudy	54	131	1340

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	11	16	20
Sounder Uncertain	20	39	105
Sounder Cloudy	38	127	1360

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

**Method1 :Taking Mode of MODIS Pixels**

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	1.09	0.17	1.44
Sounder Uncertain	2.76	0.17	6.51
Sounder Cloudy	6.80	0.17	80.88

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.69	1.04	0.98
Sounder Uncertain	1.38	2.42	5.65
Sounder Cloudy	3.11	7.55	77.19

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	0.63	0.92	1.15

Sounder Uncertain	1.15	2.25	6.05
Sounder Cloudy	2.19	7.32	78.34

### 3. Skill Scores

#### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.60	0.98	0.08
Frequency Bias	0.25	18.22	0.99
Probability of Detection	0.10	0.33	0.91
False Alarm Rate	0.09	0.52	0.39

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.821
Kuiper Skill Score	0.189
Heidke Skill Score	0.175

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.74	0.74	0.12
Frequency Bias	0.52	0.86	1.05
Probability of Detection	0.13	0.22	0.92
False Alarm Rate	0.10	0.36	0.54

#### Overall Skill Score

Skill Score	Value
Proportion Correct	0.803
Kuiper Skill Score	0.194
Heidke Skill Score	0.218

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.77	0.76	0.11

Frequency Bias	0.68	0.90	1.03
Probability of Detection	0.16	0.21	0.92
False Alarm Rate	0.11	0.38	0.51

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.812
Kuiper Skill Score	0.195
Heidke Skill Score	0.210

## INSAT-3D Sounder vs MODIS for April , 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	196	48	204
Sounder Uncertain	308	28	318
Sounder Cloudy	67	12	81

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	125	164	159
Sounder Uncertain	198	214	242
Sounder Cloudy	44	55	61

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	92	187	169

Sounder Uncertain	152	244	258
Sounder Cloudy	27	69	64

## 2. Confusion matrix of percentage number of collocations

### Method1 :Taking Mode of MODIS Pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	15.53	3.80	16.16
Sounder Uncertain	24.41	2.22	25.20
Sounder Cloudy	5.31	0.95	6.42

### Method2 :Taking Weighted Average of MODIS pixels

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	9.90	13.00	12.60
Sounder Uncertain	15.69	16.96	19.18
Sounder Cloudy	3.49	4.36	4.83

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

MODIS/Sounder	MODIS Clear	MODIS Uncertain	MODIS Cloudy
Sounder Clear	7.29	14.82	13.39
Sounder Uncertain	12.04	19.33	20.44
Sounder Cloudy	2.14	5.47	5.07

## 3. Skill Scores

### Method1 :Taking Mode of MODIS Pixels

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.56	0.96	0.49
Frequency Bias	0.78	7.43	0.27
Probability of Detection	0.34	0.32	0.13
False Alarm Rate	0.26	0.65	0.08

Overall Skill Score



Skill Score	Value
Proportion Correct	0.242
Kuiper Skill Score	-0.028
Heidke Skill Score	-0.021

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

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.72	0.67	0.62
Frequency Bias	1.22	1.51	0.35
Probability of Detection	0.34	0.49	0.13
False Alarm Rate	0.37	0.51	0.11

**Overall Skill Score**

Skill Score	Value
Proportion Correct	0.317
Kuiper Skill Score	-0.016
Heidke Skill Score	-0.016

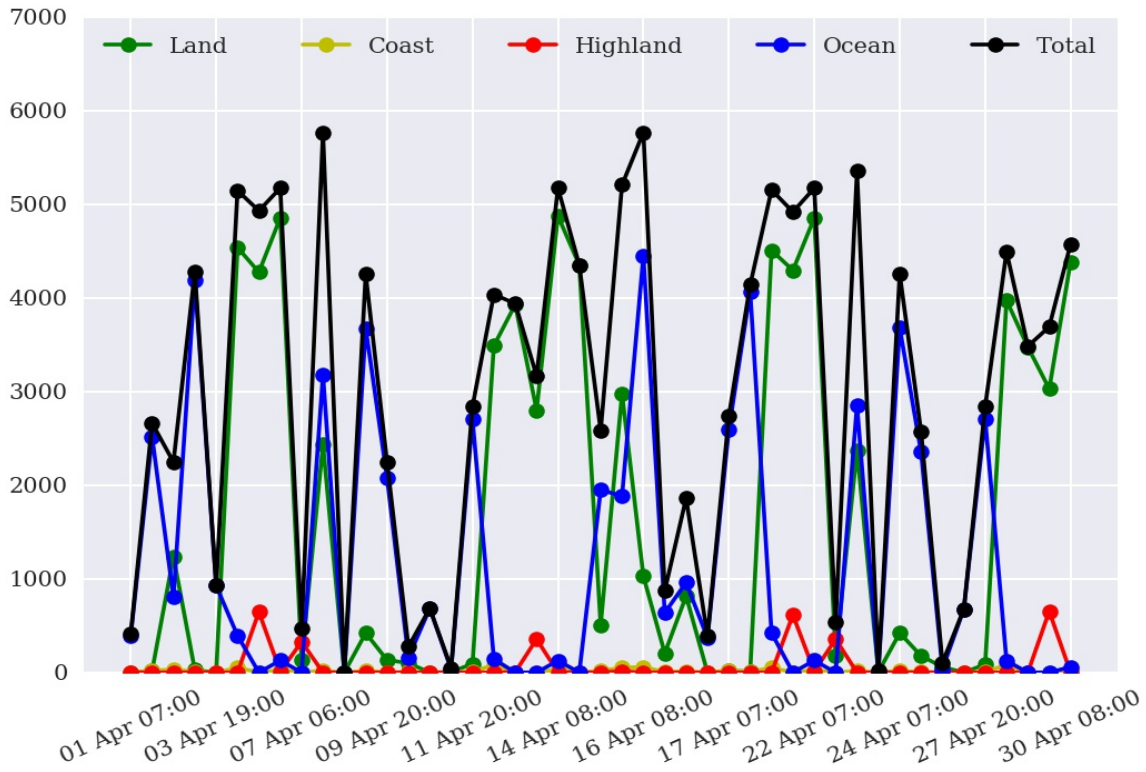
**Method3: Taking Weighted Product average of MODIS pixels**

Skill Score	Clear	Uncertain	Cloudy
False Alarm Ratio	0.79	0.63	0.60
Frequency Bias	1.65	1.31	0.33
Probability of Detection	0.34	0.49	0.13
False Alarm Rate	0.41	0.48	0.11

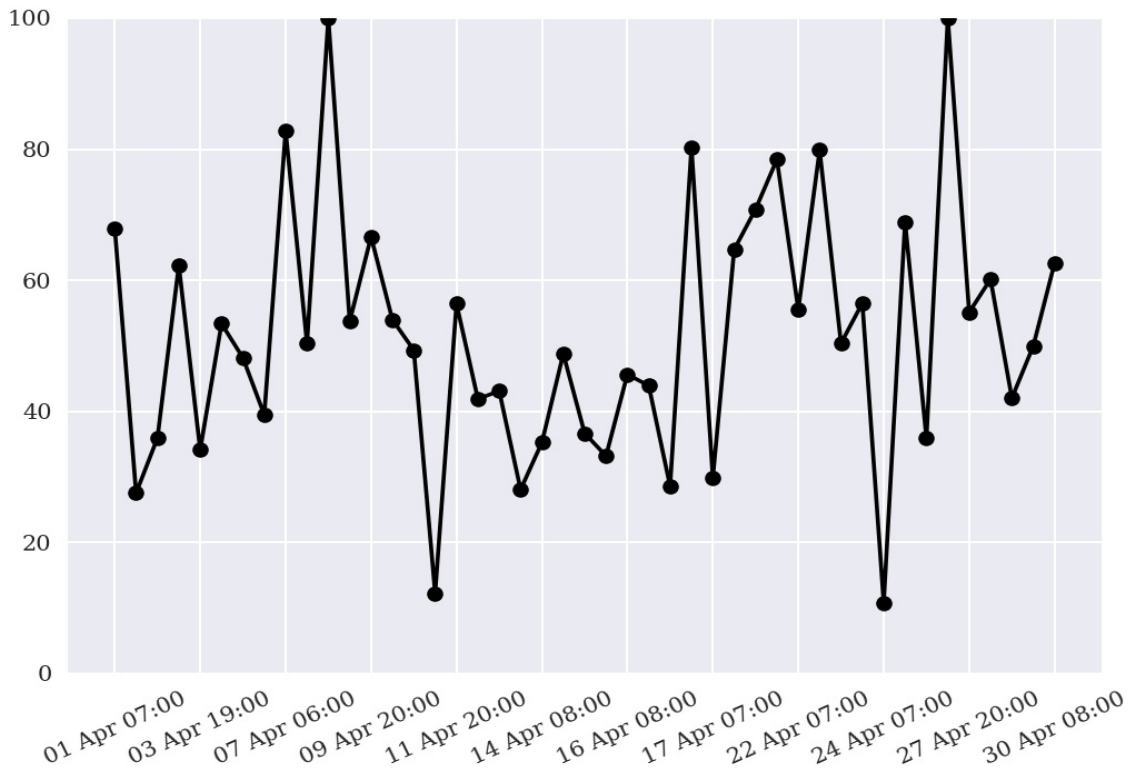
**Overall Skill Score**

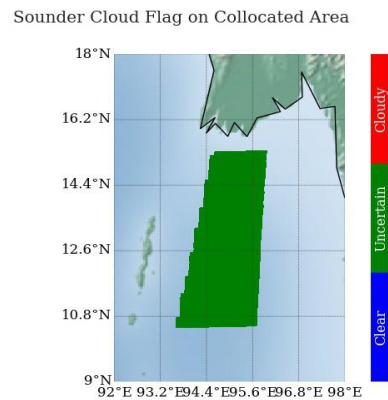
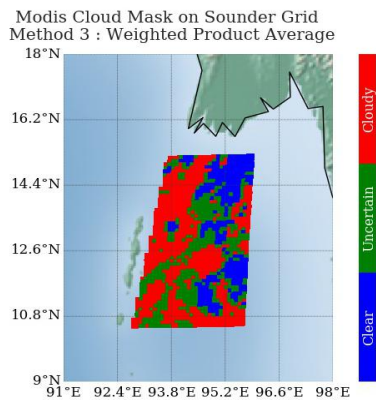
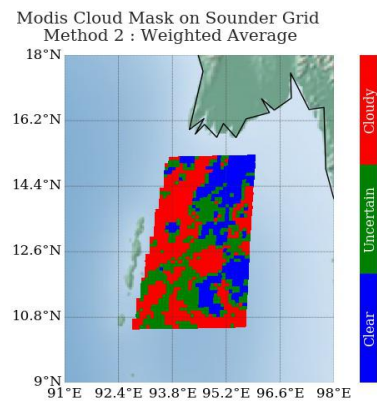
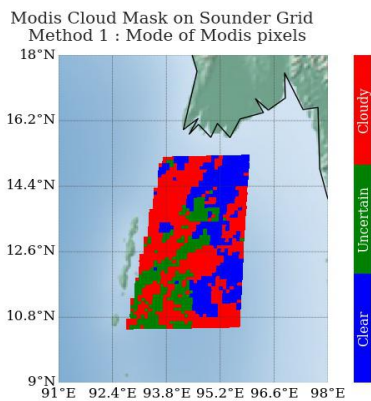
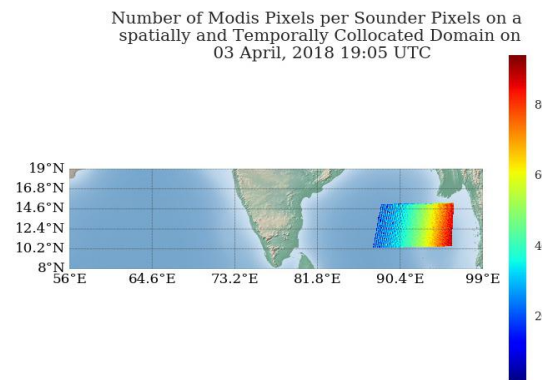
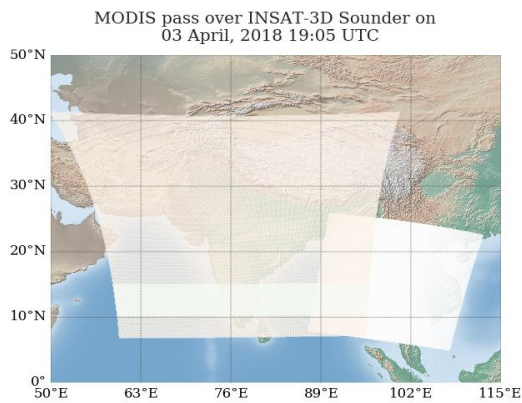
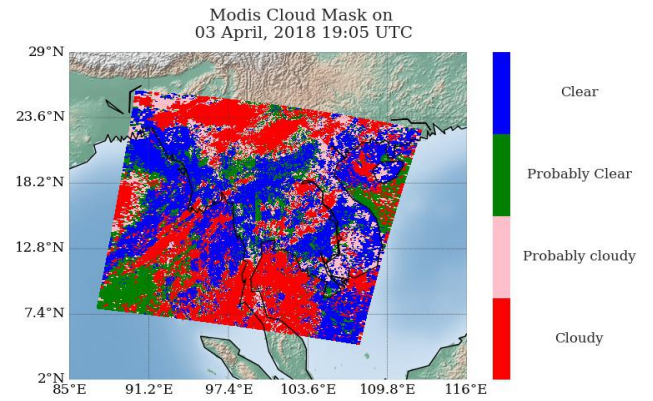
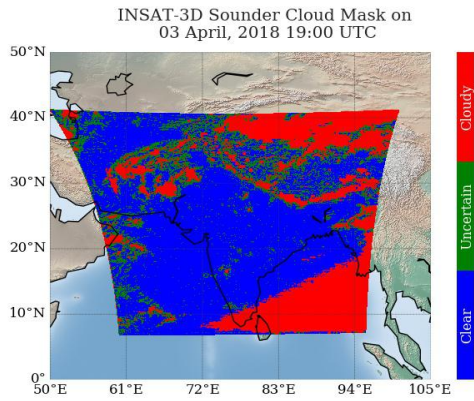
Skill Score	Value
Proportion Correct	0.317
Kuiper Skill Score	-0.022
Heidke Skill Score	-0.021

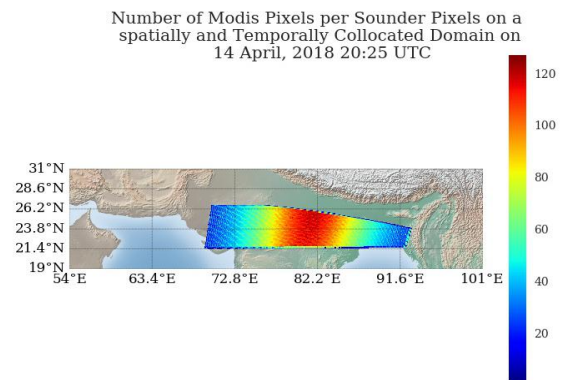
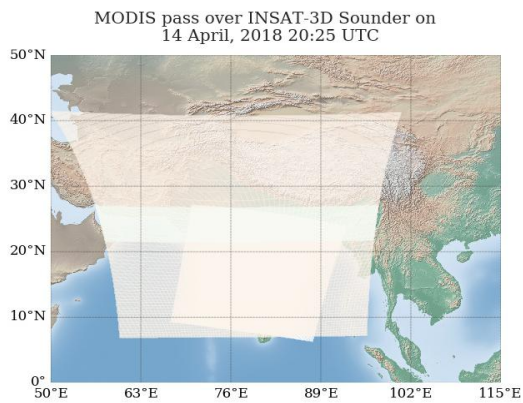
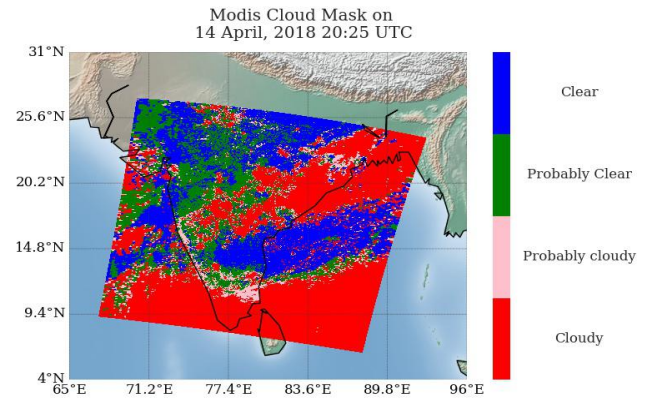
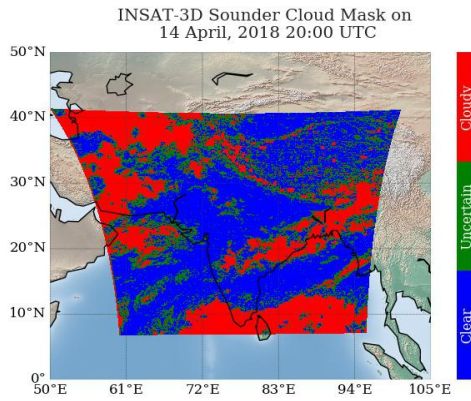
## Number of Collocations for Apr-2018



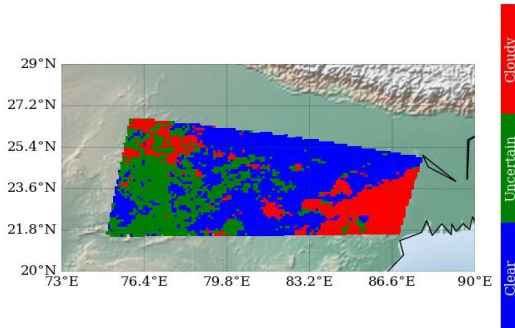
## Percentage Correct for Apr-2018



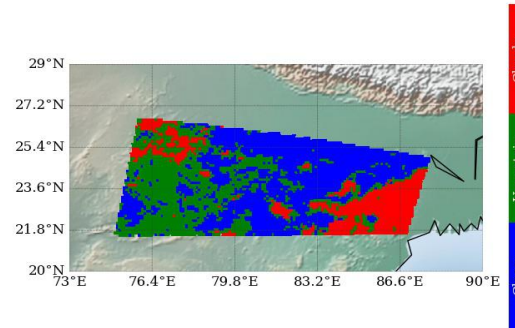




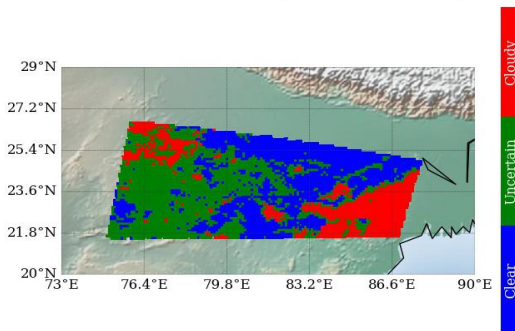
Modis Cloud Mask on Sounder Grid  
Method 1 : Mode of Modis pixels



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

