A neural network based algorithm for the retrieval of TPW from AMSU measurements

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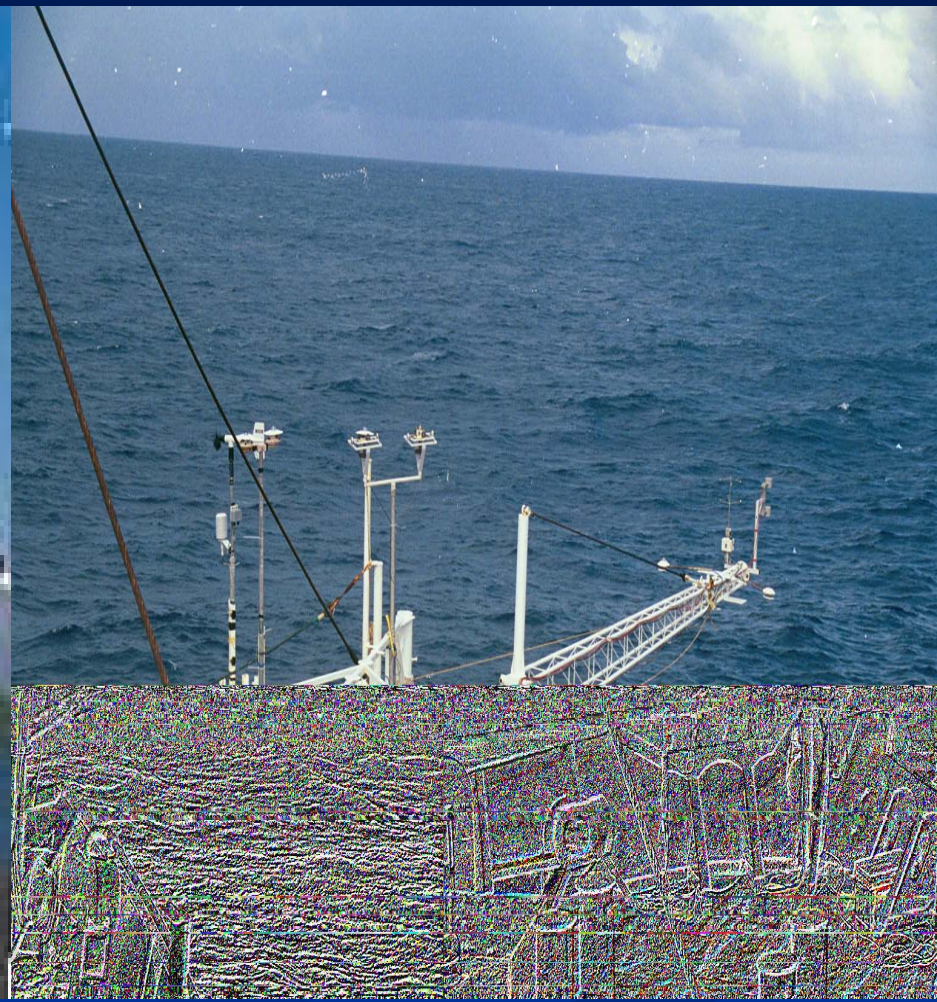
Radiosonde observations

The radiosonde observations were taken using the Vaisala RS80 radiosonde instrument.

The pressure sensor is a capacitive aneroid with a measuring range from 1060 to 3 hPa and with a resolution of 0.5hPa.

The temperature sensor is a capacitive bead with a measuring range from +60°C to -90°C and with a resolution of 0.2°C.

The humidity sensor is a thin film capacitor with a measuring range from 0 to 100% RH and with a resolution of 3%.



Specifications of the Meteorological Sensors used with AWS on board ORV Sagar Kanya during BOBMEX .

Sensor	Specifications	
Wind speed	Range	0-60 m/s
	Gust survival	100 m/sec.
	Threshold sensitivity	1.0m/sec.
	Pitch	30 cm air passage per revolution
	Distance constant	2.7meter for 63% recovery
	Output frequency	3 cycles/rotation, 0.098m/s per Hz
	Sensor type	propeller from RM YOUNG USA
	Model No.	05103
Wind direction	Range	360° mechanical, 355° electrical (5° open)
	Delay distance	1.3m for 50% recovery
	Damping ratio	0.25
	Type	Precession conductive plastic Potentiometer from RM YOUNG, USA

Air temperature	Range	0-45°C
	Accuracy	± 0.15°C
	Type	Thermistor, YSI 44202, USA
Barometric pressure	Range	800-1060 mbar
	Resolution	0.1 mbar
	Accuracy	± 0.5 mbar
	Sampling rate	10 Hz
	Output	RS232, TTL serial, parallel
	Power	8-16 volt dc, 6ma (oper),10μA(stdby)
	Type	Intellisensor AIR DB from A.I.R. USA
Humidity	Range	0 - 100 %RH
	Accuracy	3%
	Power	4.5 - 24 v, 10mA
	Type	Capacitive polymer, from Rotronic USA
Solar radiation	Sensitivity	80 μA/1000 mW/cm^2
	Linearity	1%
	Range	0 - 200 mW/cm^2
	Accuracy	5%
	Type	Silicon photodiode, LI-200 SA From Lycor Inc. USA

BOBMEX 1999(July)

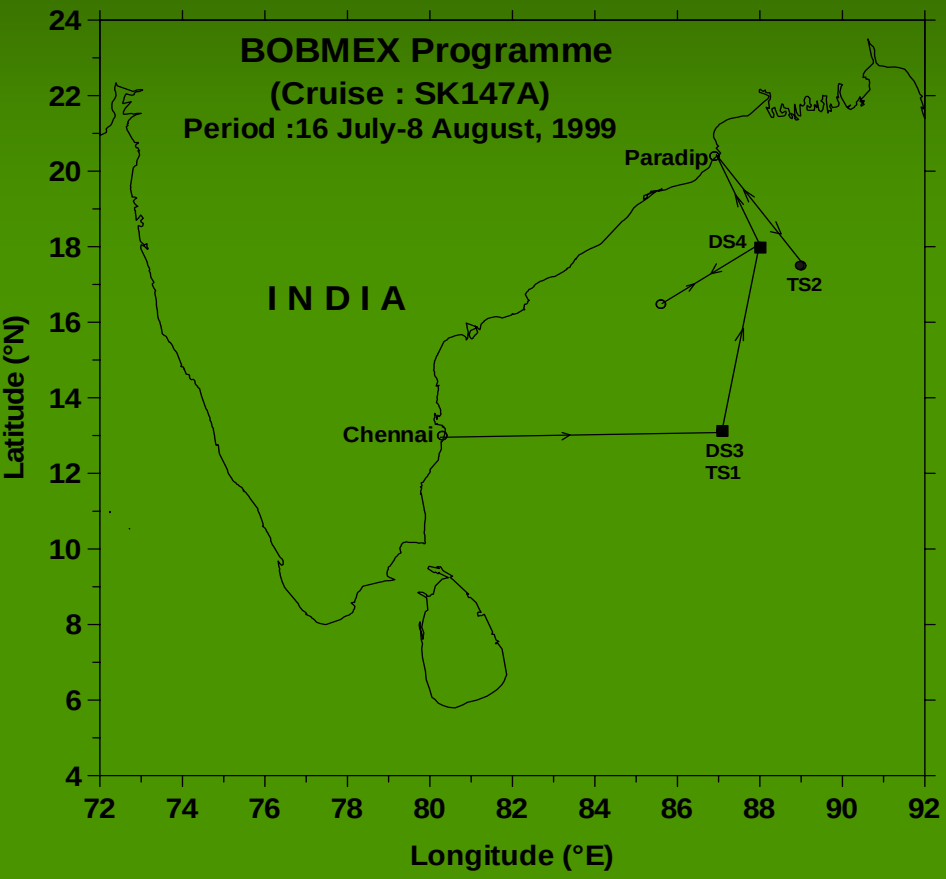


Fig. 1 : ORV Sagar Kanya cruise (SK147A) track.

BOBMEX 1999(August)

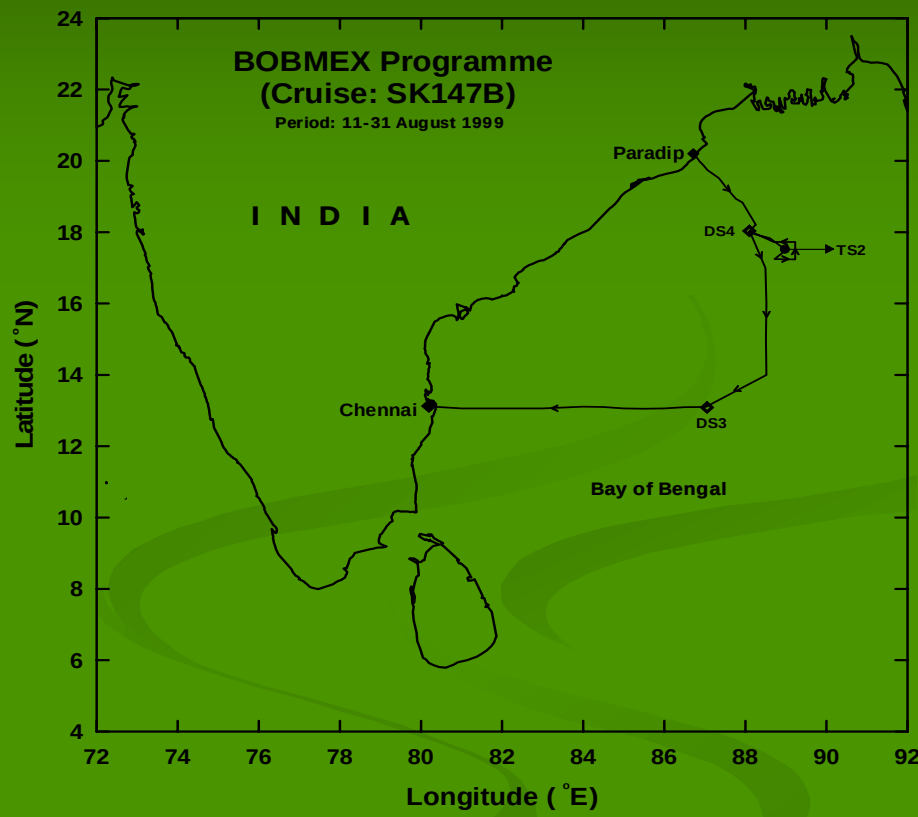
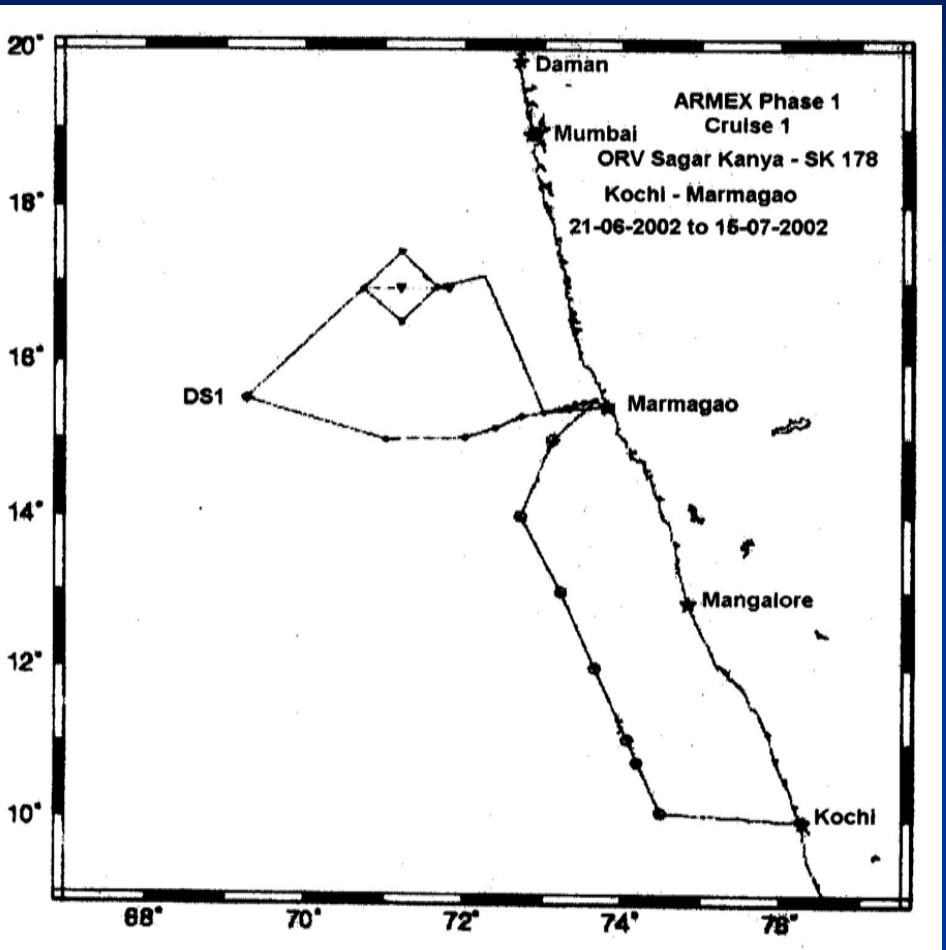
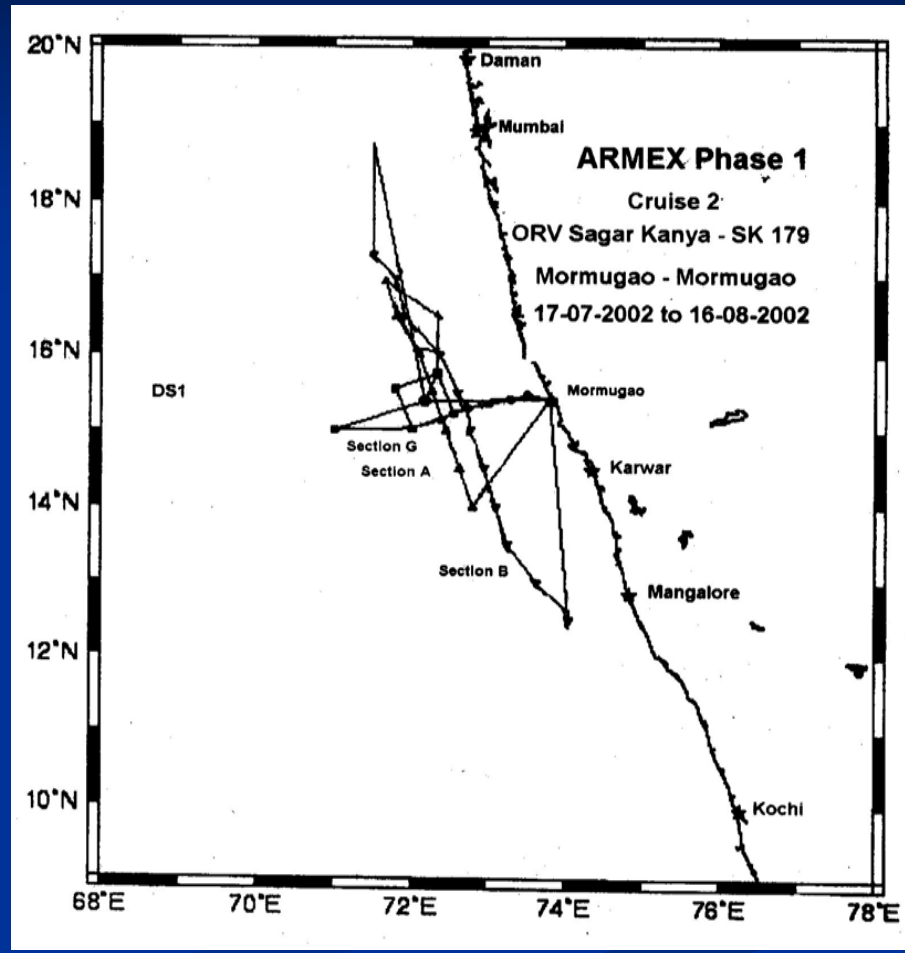


Fig. 2 ORV Sagar Kanya cruise (SK147B)Track

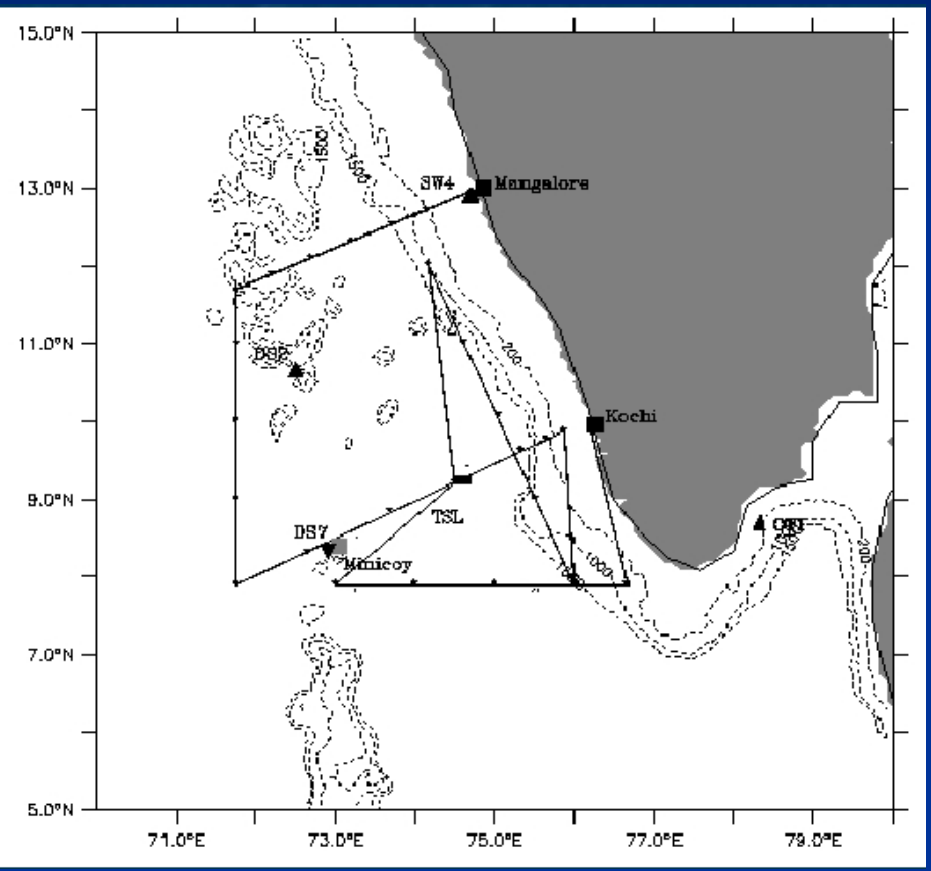
ARMEX 2002(June-July)



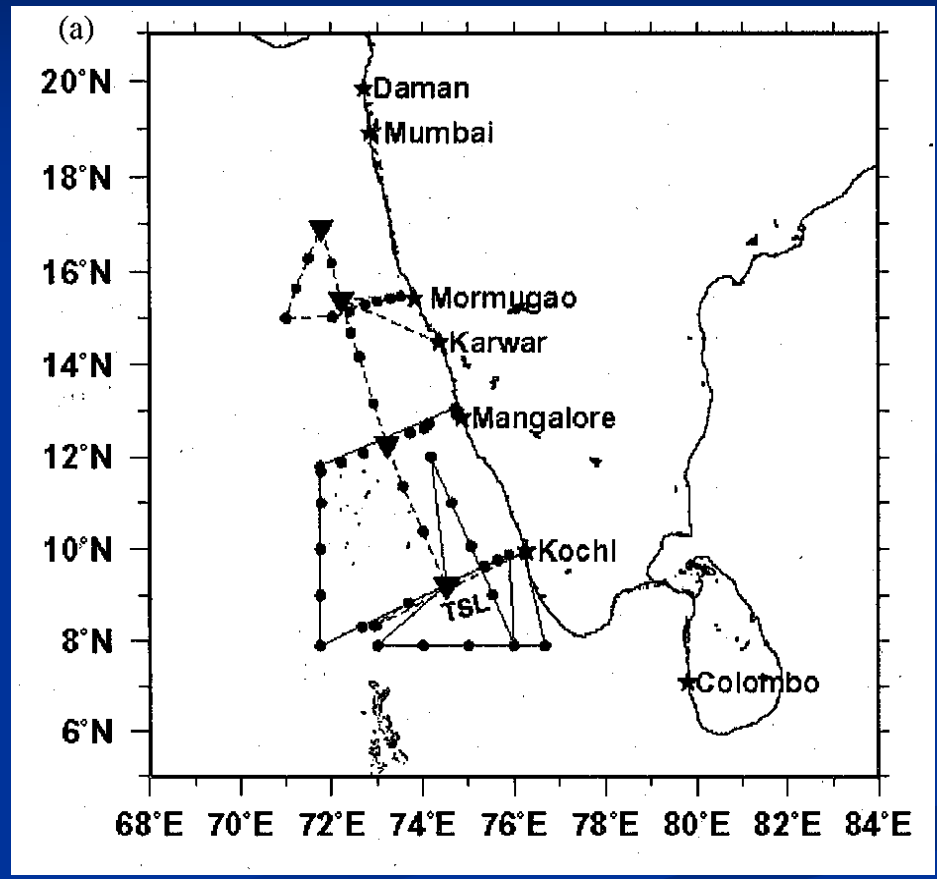
ARMEX 2002(July-August)

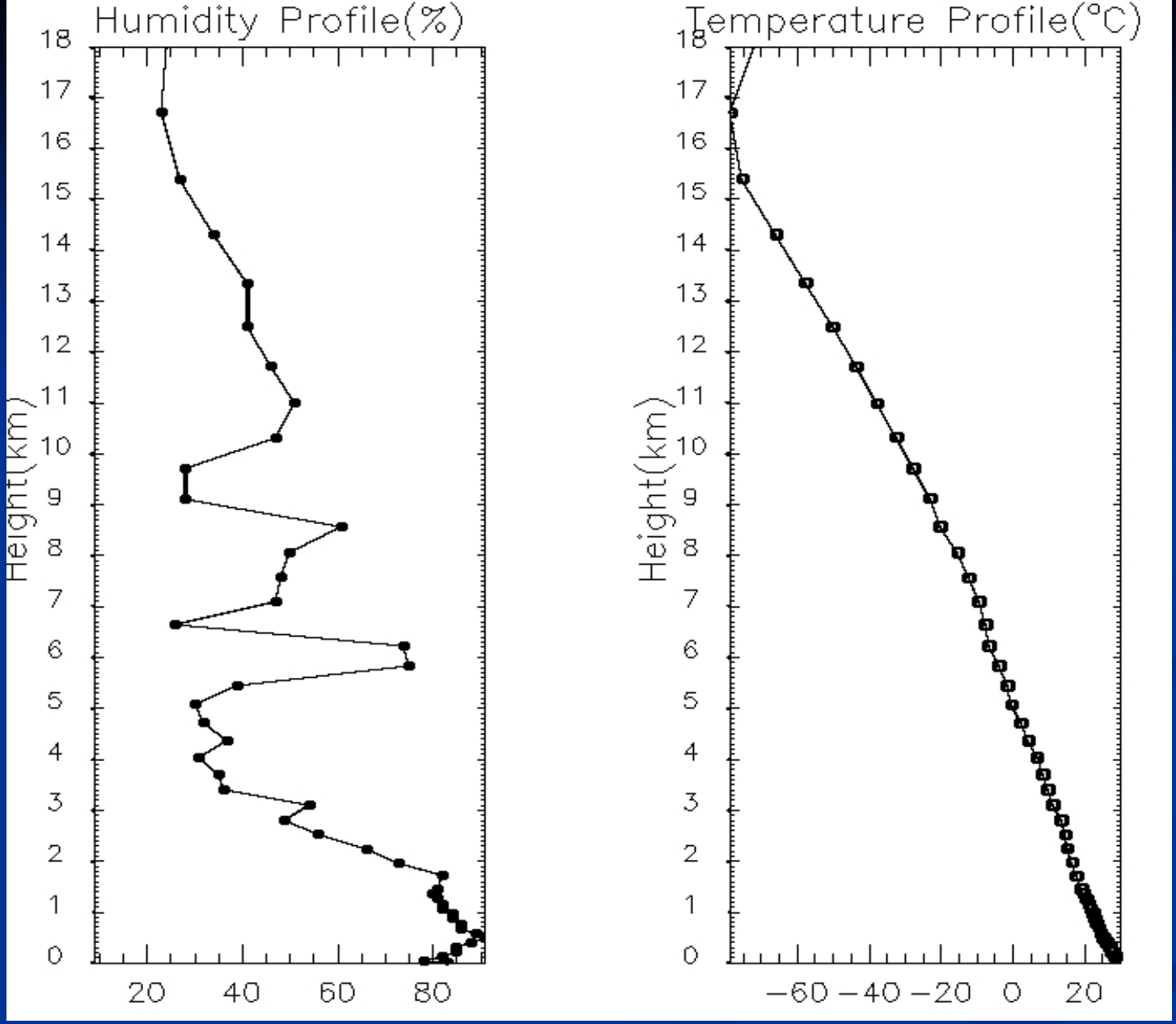


ARMEX 2003(March-April)



ARMEX 2003(May-June)





2003 – 06 – 18 05:28 UTC 15.39 N , 72.17 E

Total Precipitable Water

The TPW is computed from radiosonde profiles using the hypsometric equation (Alishouse et al., 1990a).

Out of all the radiosonde profiles only those profiles were selected which exceeded the 300-hPa levels.

To assure good quality of data, a quality control filter was applied to remove the radiosonde profiles with less than four levels of good observations for pressure greater than 300 hPa or with bad observations at the lowest level.

NOAA-16 AMSU MEASUREMENTS

The AMSU was designed primarily to improve the accuracy of temperature soundings beyond that of the four channels MSU.

AMSU-A also has window channels at 31.4 and 89 GHz to monitor surface features and precipitation and a 23.8 GHz channel for obtaining the total precipitable water over oceans (Grody et al. 2001).

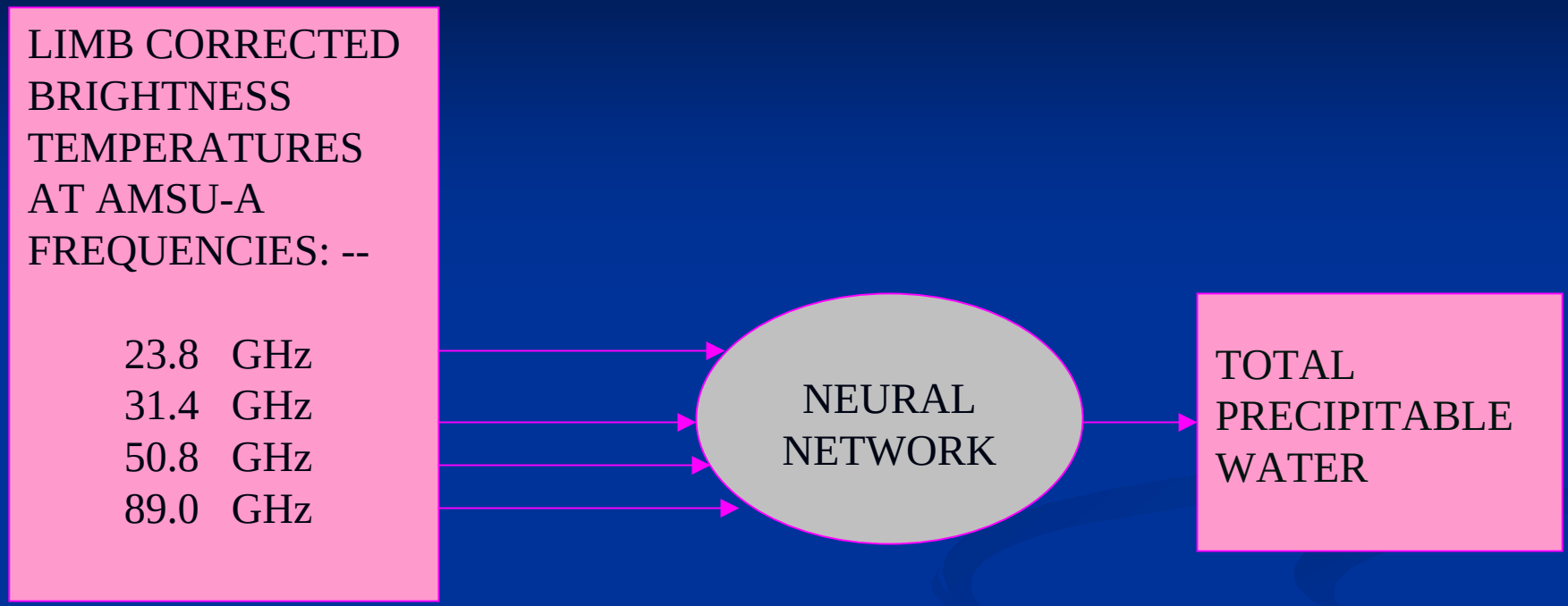
The four brightness temperatures at 23.8, 31.4, 50.3 and 89 GHz are considered for the input to the Neural Network.

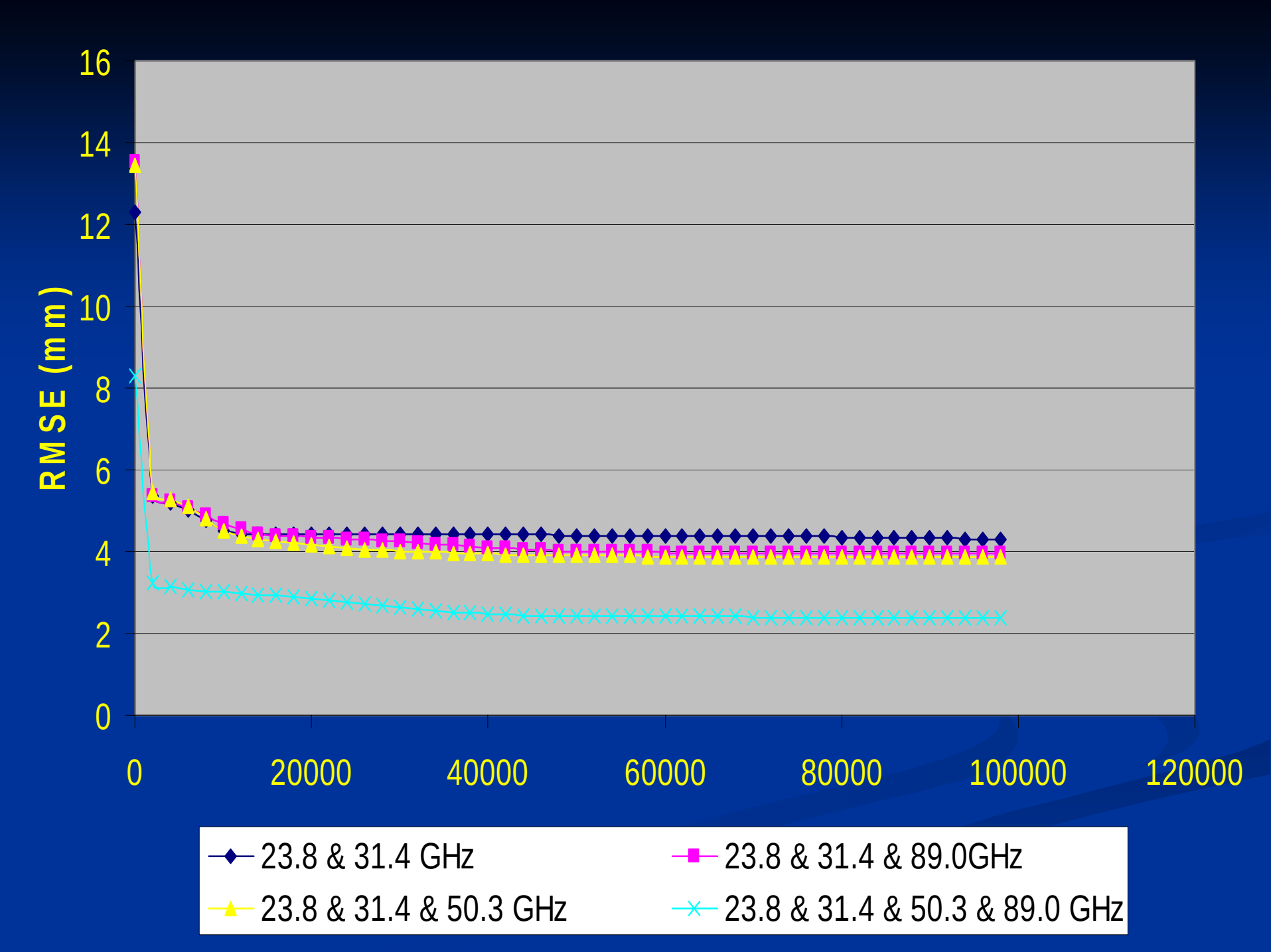
These four brightness temperatures are adjusted for limb correction (Goldberg et al. 2000) before using as input to the neural network algorithm.

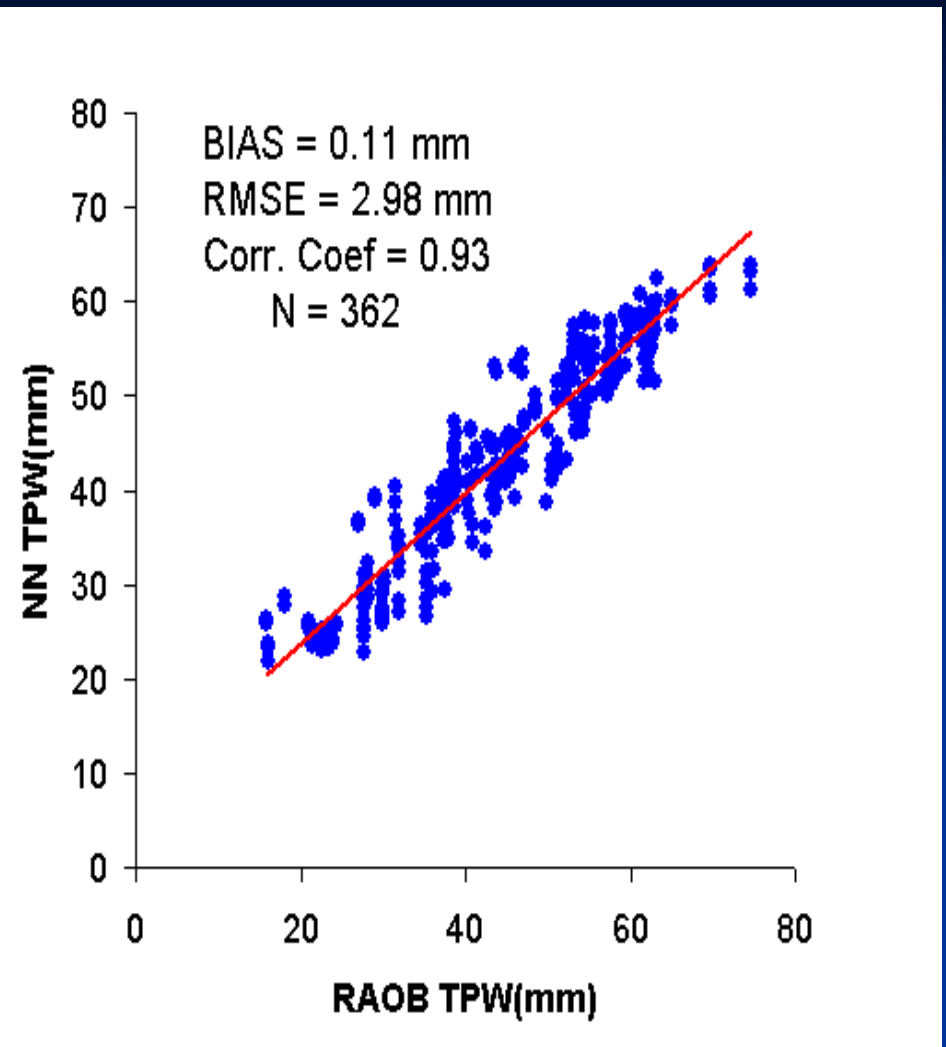
Why limb adjust?

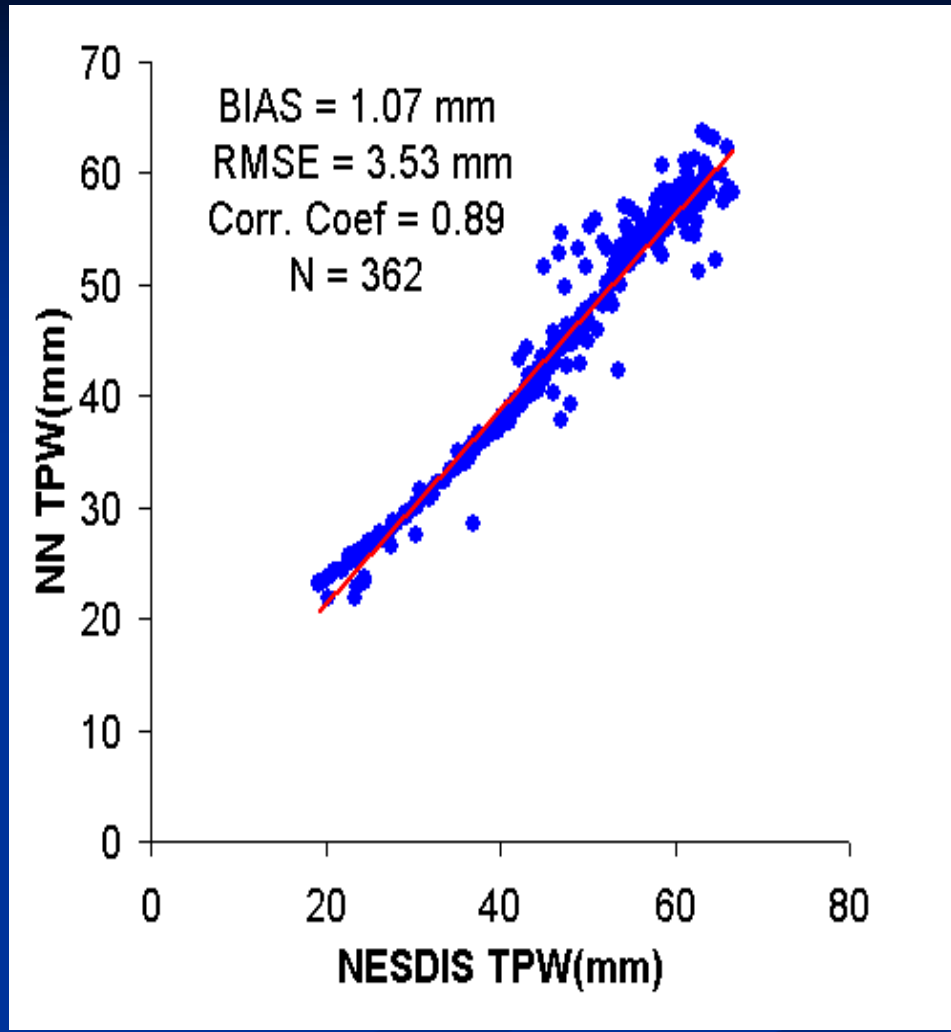
- Retrievals based on collocated observations of satellite data and raobs are simplified if brightness temperatures are normalized to fixed angle.
- Physical retrieval algorithms are simplified if you do not need to have bias corrections as a function of fov.
- Information content (vertical resolution of retrieval) is constant as a function of fov.
- The limb adjustment of AMSU-A is extremely accurate. Goldberg

Mitchell D. Goldberg, Davis S. Crosby and Lihang Zhou, 2000: The Limb adjustment of AMSU-A Observations: Methodology and Validation, Journal of Applied Meteorology,Vol-40,70-85pp.


LIMB CORRECTED BRIGHTNESS TEMPERATURES AT AMSU-A FREQUENCIES: --
23.8 GHz
31.4 GHz
50.8 GHz
89.0 GHz
NEURAL NETWORK
TOTAL PRECIPITABLE WATER

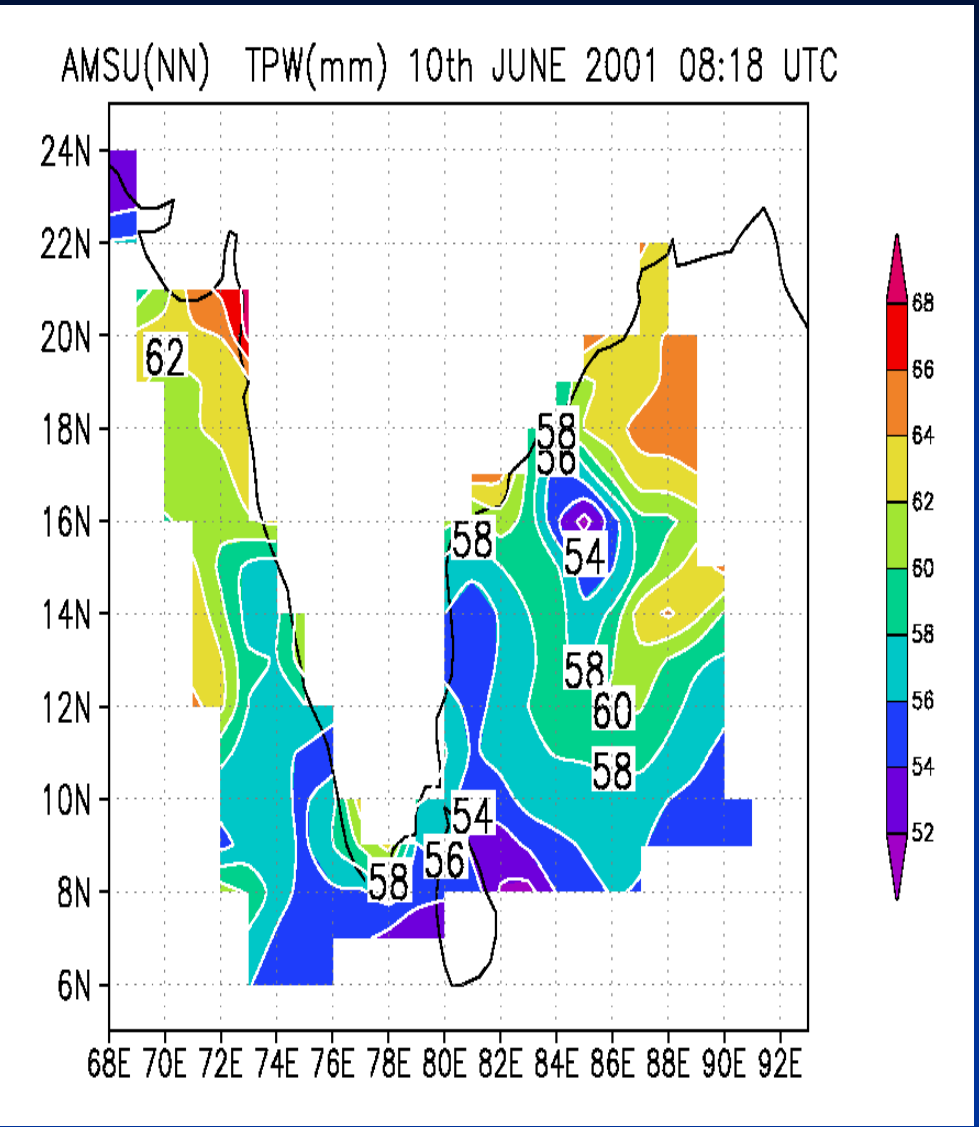

RMSE (mm)
16
14
12
10
8
6
4
2
0
0
20000
40000
60000
80000
100000
120000
23.8 & 31.4 GHz
23.8 & 31.4 & 89.0GHz
23.8 & 31.4 & 50.3 GHz
23.8 & 31.4 & 50.3 & 89.0 GHz

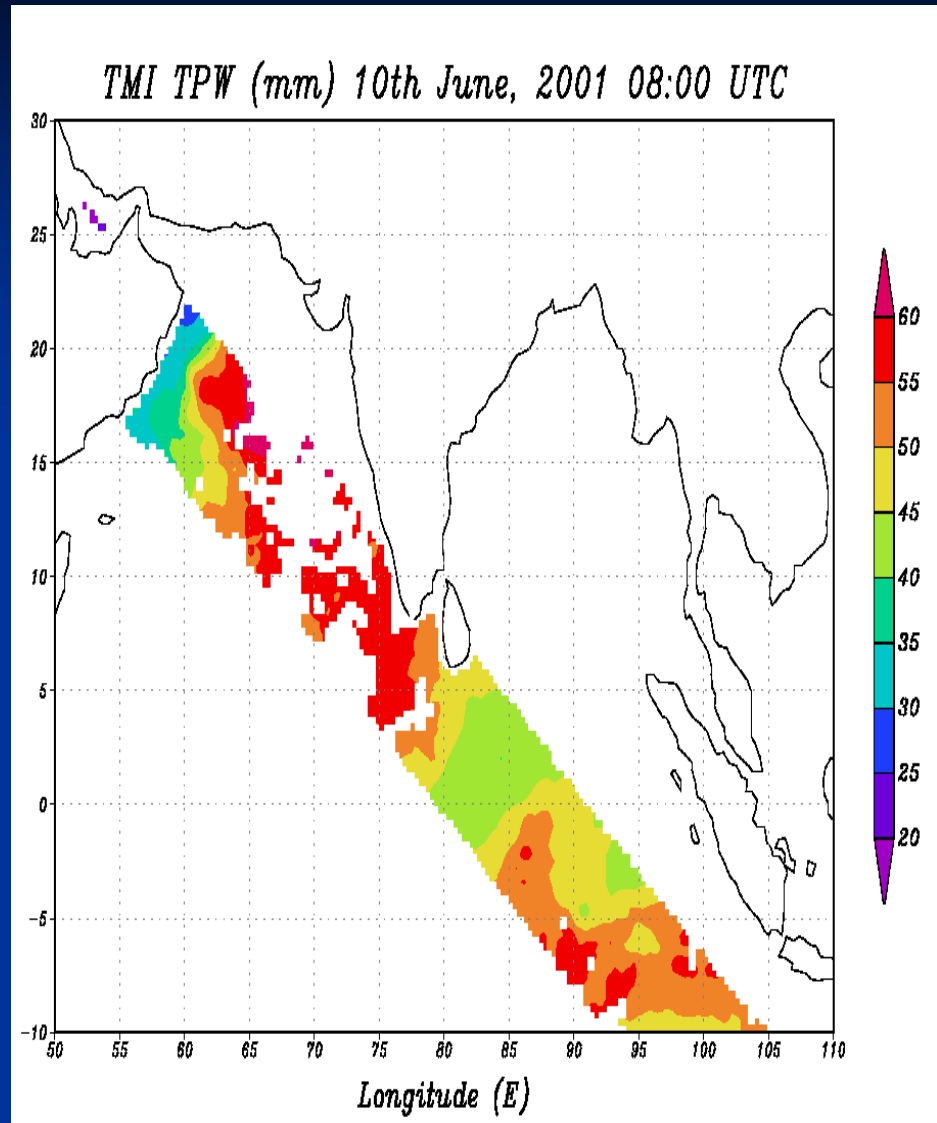

BIAS = 0.11 mm
RMSE = 2.98 mm
Corr. Coef = 0.93
N = 362
NN TPW(mm)
RAOB TPW(mm)
0
10
20
30
40
50
60
70
80
0
20
40
60
80

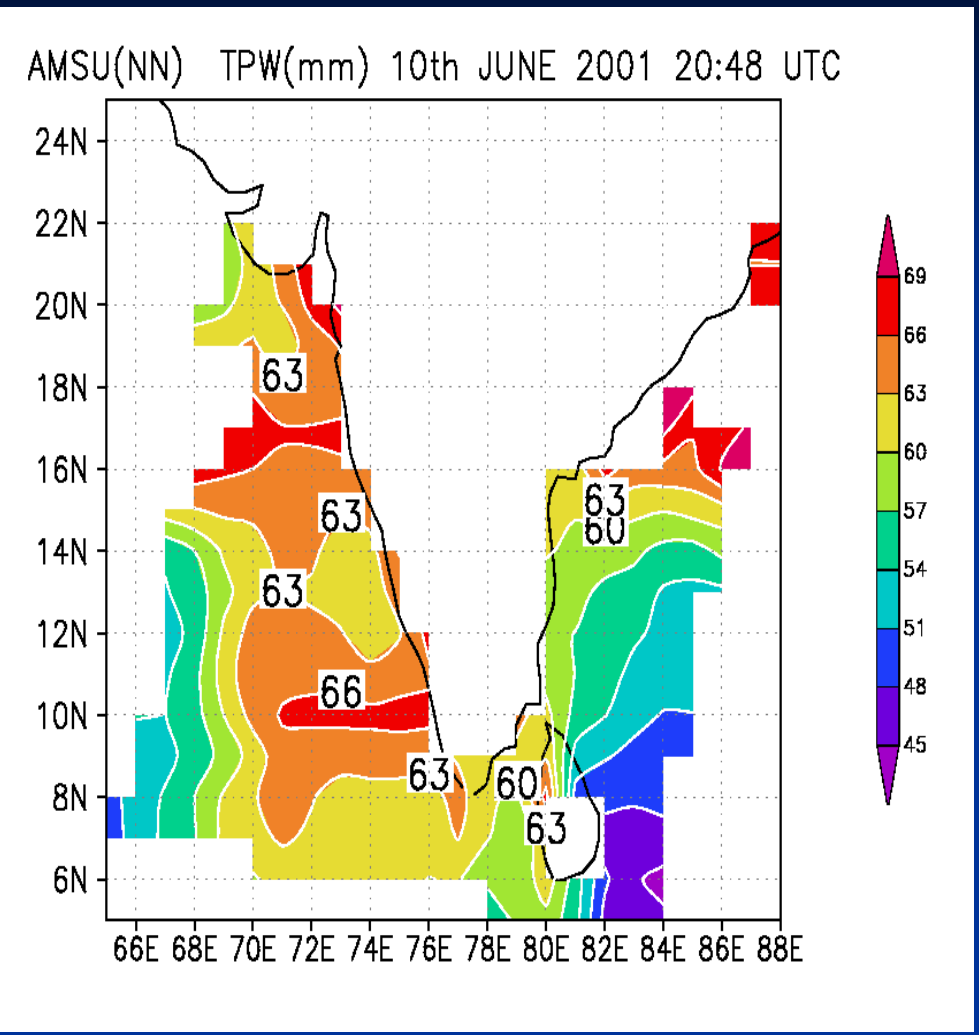

BIAS = 1.07 mm
RMSE = 3.53 mm
Corr. Coef = 0.89
N = 362
NN TPW(mm)
NESDIS TPW(mm)
0
10
20
30
40
50
60
70
0
20
40
60
80

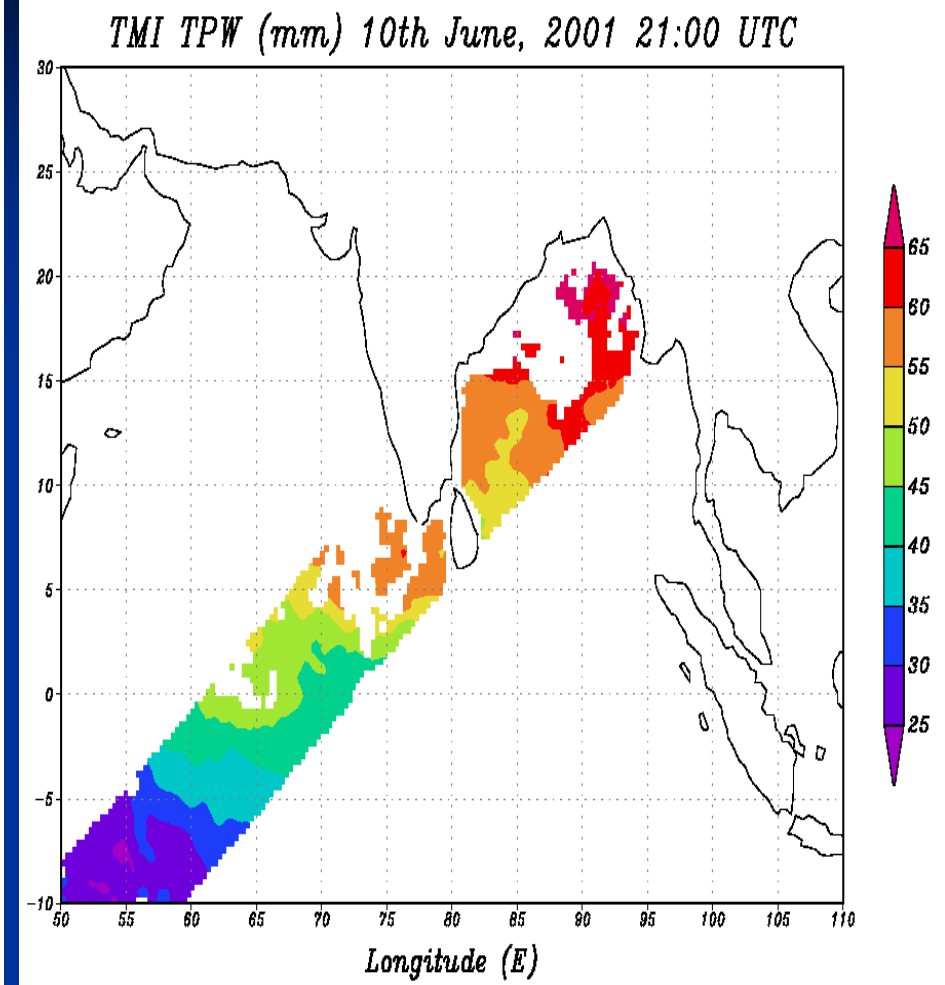
Case Study

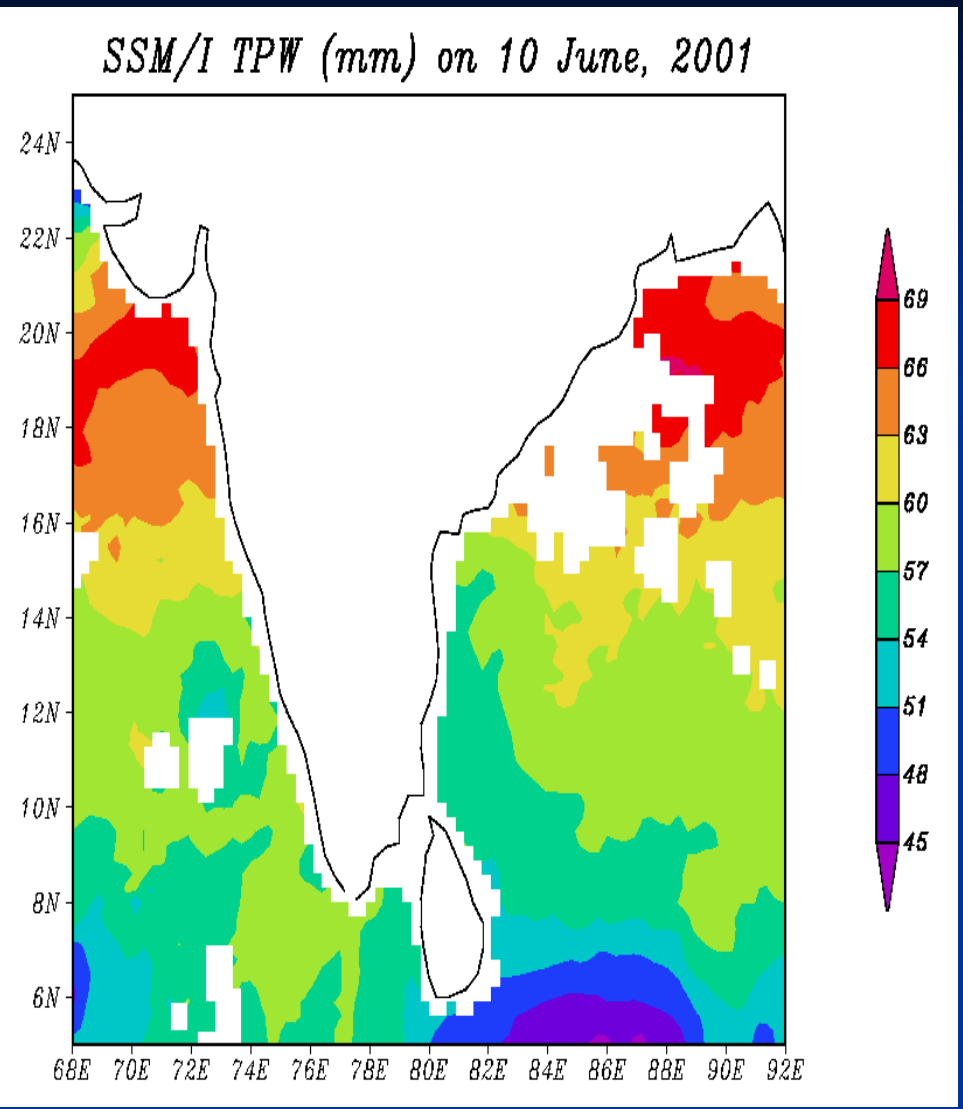
Application of Total Precipitable Water for predicting heavy rainfall along the west coast of India.

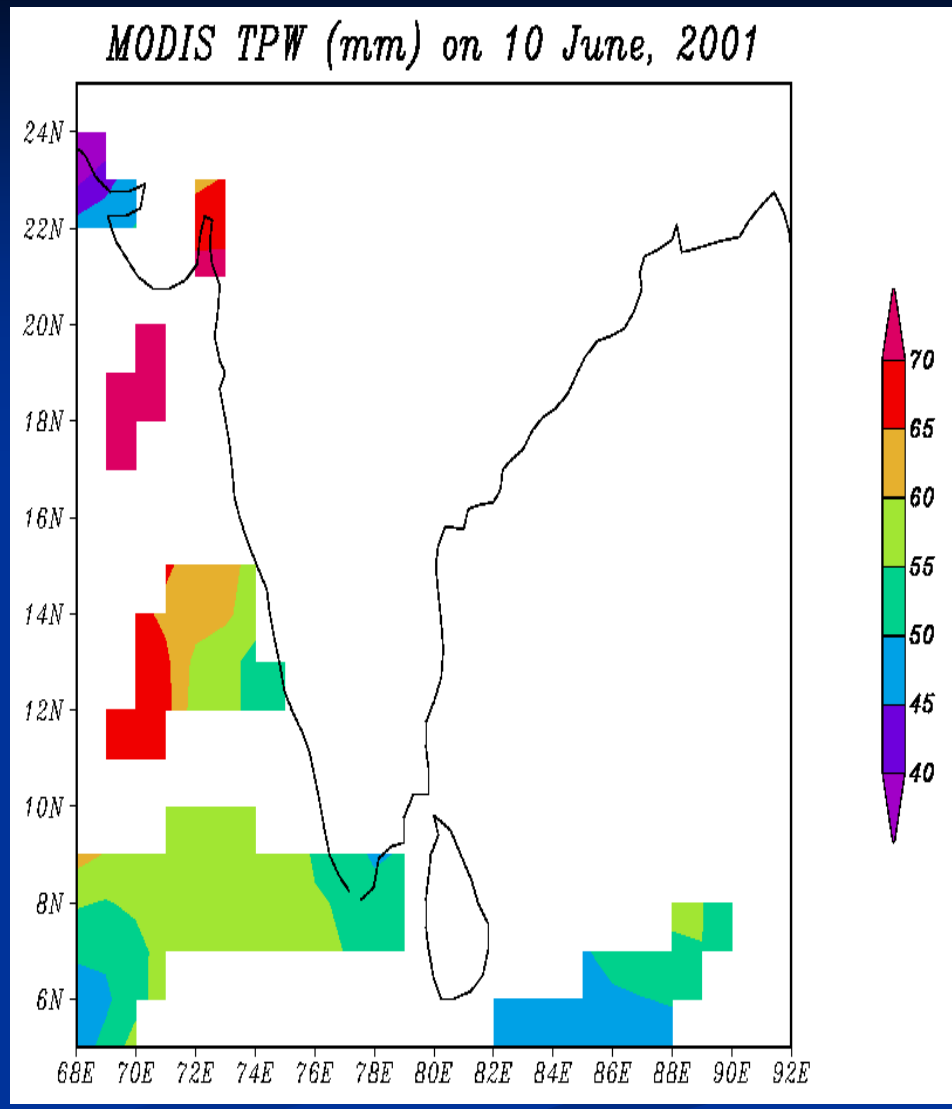

AMSU(NN) TPW(mm) 10th JUNE 2001 08:18 UTC
24N
22N
20N
18N
16N
14N
12N
10N
8N
6N
68E 70E 72E 74E 76E 78E 80E 82E 84E 86E 88E 90E 92E
62
58
58
54
58
60
58
54
56
58
68
66
64
62
60
58
56
54
52

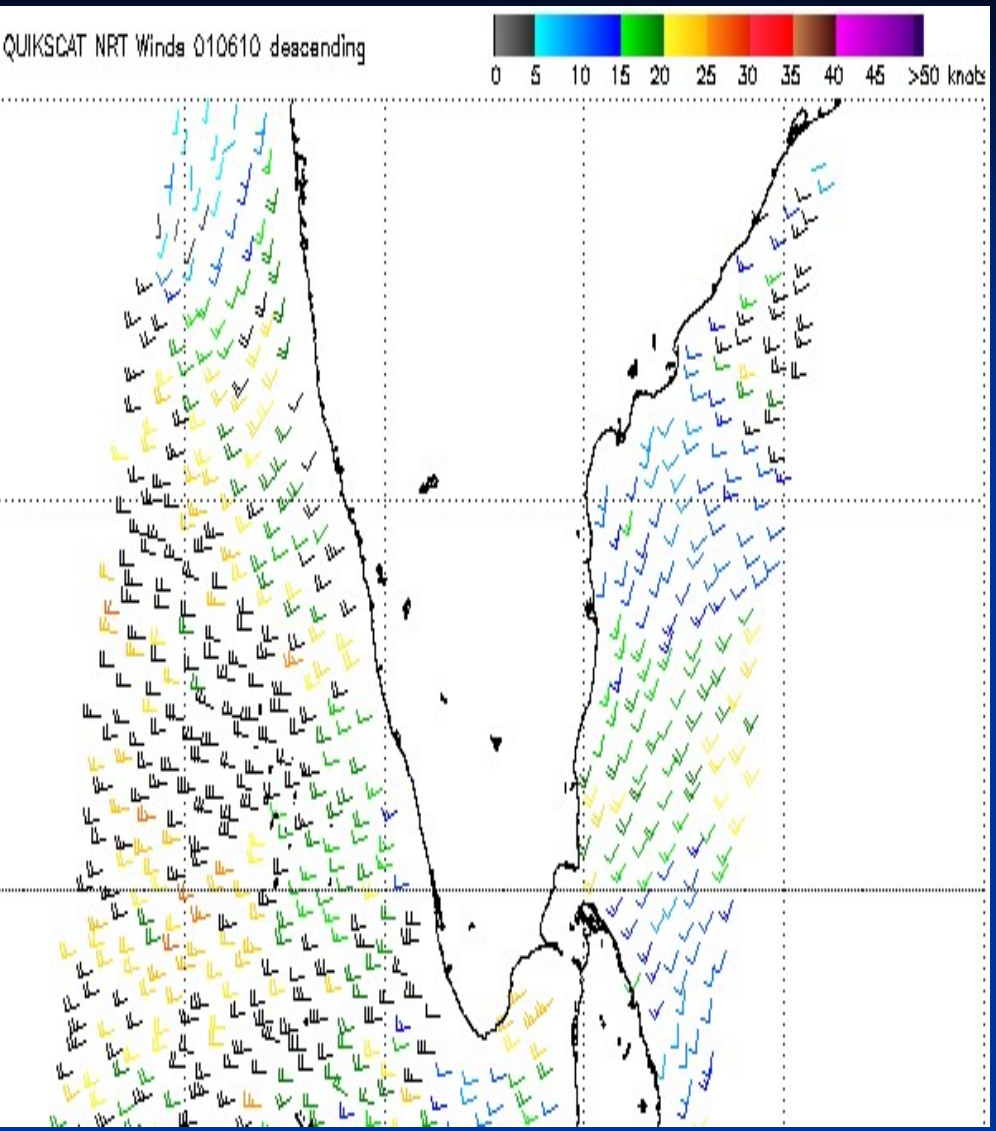

TMI TPW (mm) 10th June, 2001 08:00 UTC
30
25
20
15
10
5
0
-5
-10
50 55 60 65 70 75 80 85 90 95 100 105 110
Longitude (E)
60
55
50
45
40
35
30
25
20

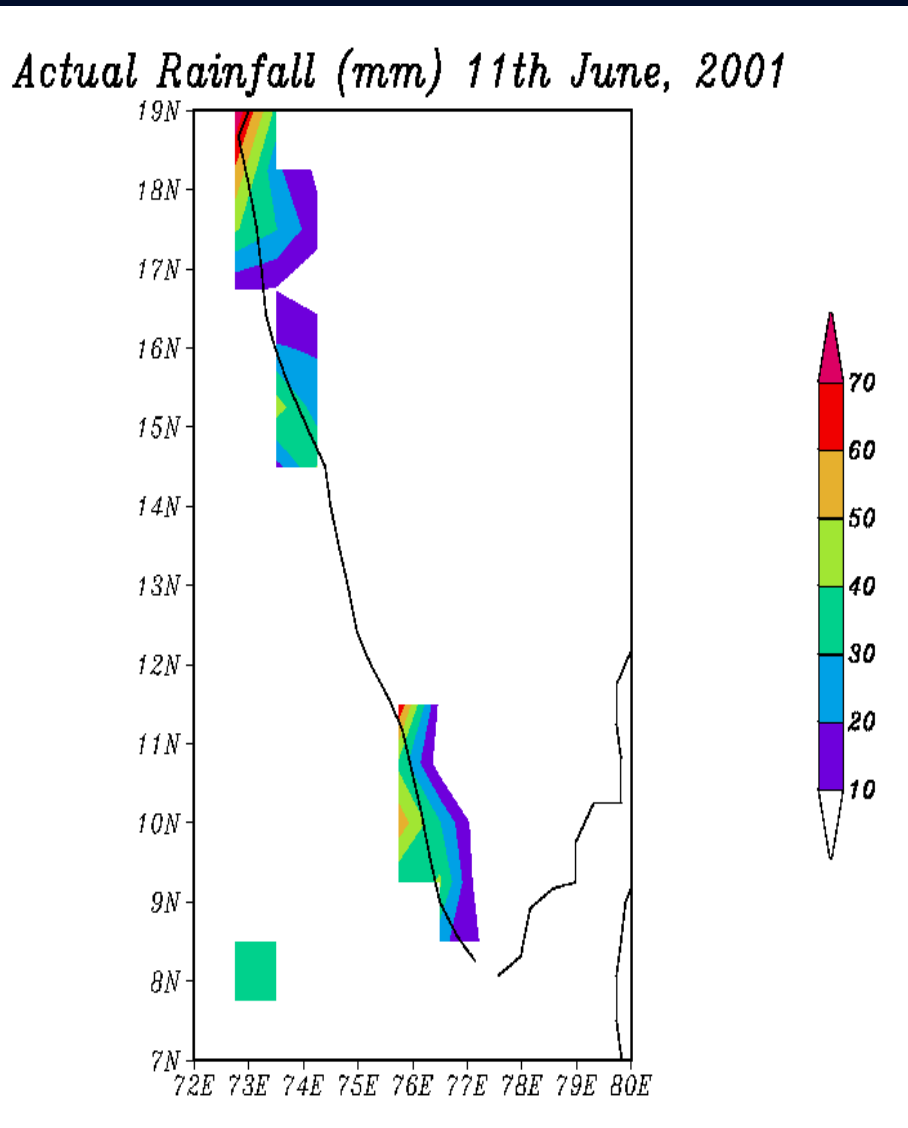

AMSU(NN) TPW(mm) 10th JUNE 2001 20:48 UTC
24N
22N
20N
18N
16N
14N
12N
10N
8N
6N
66E 68E 70E 72E 74E 76E 78E 80E 82E 84E 86E 88E
63
63
63
66
63
63
60
60
63
69
66
63
60
57
54
51
48
45


TMI TPW (mm) 10th June, 2001 21:00 UTC
30
25
20
15
10
5
0
-5
-10
50 55 60 65 70 75 80 85 90 95 100 105 110
Longitude (E)
65
60
55
50
45
40
35
30
25


SSM/I TPW (mm) on 10 June, 2001
24N
22N
20N
18N
16N
14N
12N
10N
8N
6N
68E 70E 72E 74E 76E 78E 80E 82E 84E 86E 88E 90E 92E
69
66
63
60
57
54
51
48
45


MODIS TPW (mm) on 10 June, 2001
24N
22N
20N
18N
16N
14N
12N
10N
8N
6N
68E 70E 72E 74E 76E 78E 80E 82E 84E 86E 88E 90E 92E
70
65
60
55
50
45
40


QUIKSCAT NRT Winds 010610 descending
0 5 10 15 20 25 30 35 40 45 >50 knots


Actual Rainfall (mm) 11th June, 2001
19N
18N
17N
16N
15N
14N
13N
12N
11N
10N
9N
8N
7N
72E 73E 74E 75E 76E 77E 78E 79E 80E
70
60
50
40
30
20
10

Conclusions

- TPW retrieved from AMSU data over Indian Oceanic region is comparable with that of other Instruments.
- The major advantage of locally retrieved TPW from AMSU measurements is that it is available in real time compared to the TPW from other sources to be used operationally by the field forecaster and numerical weather prediction centers.
- TPW along with Sea Surface Winds could be used to forecast heavy rainfall events at least 24 hours in advance.

Acknowledgements

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International TOVS Study Conference, 14th, ITSC-14, Beijing, China, 25-31 May 2005. Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2005.