Indira Rani
Indirarani.s@gov.in

An overview of the Satellite Sounding Radiance Assimilation in the Indian regional Reanalysis IMDAA*

S. Indira Rani, John P. George, Richard Renshaw
NCMRWF, Met Office (UK)

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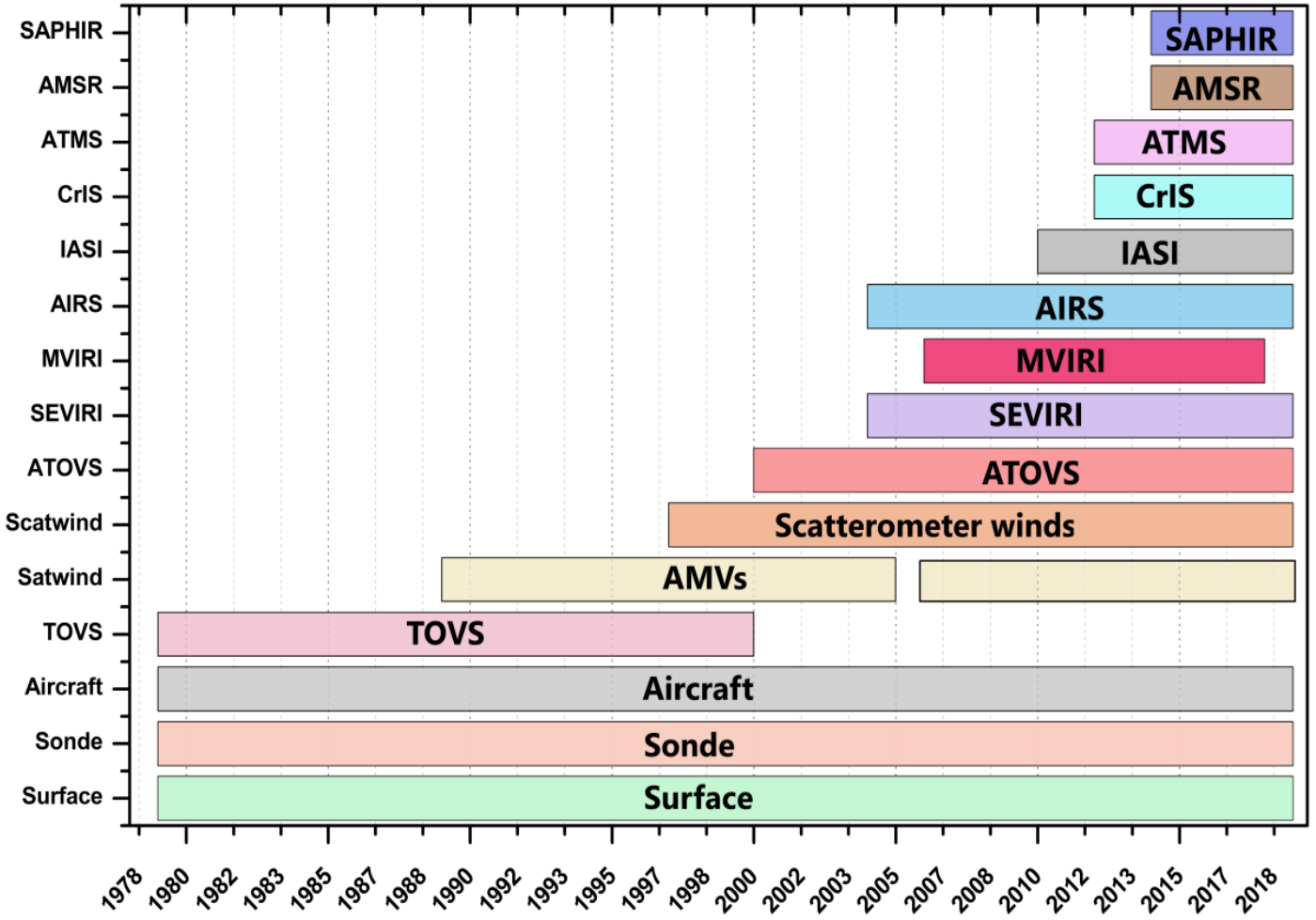
Introduction

- **Indian Monsoon Data Assimilation and Analysis (IMDAA) is the**
  - **current high-resolution (~12 km),**
  - **long-term (1979 -2018, extending to 2020),**
  - **satellite-era regional reanalysis**

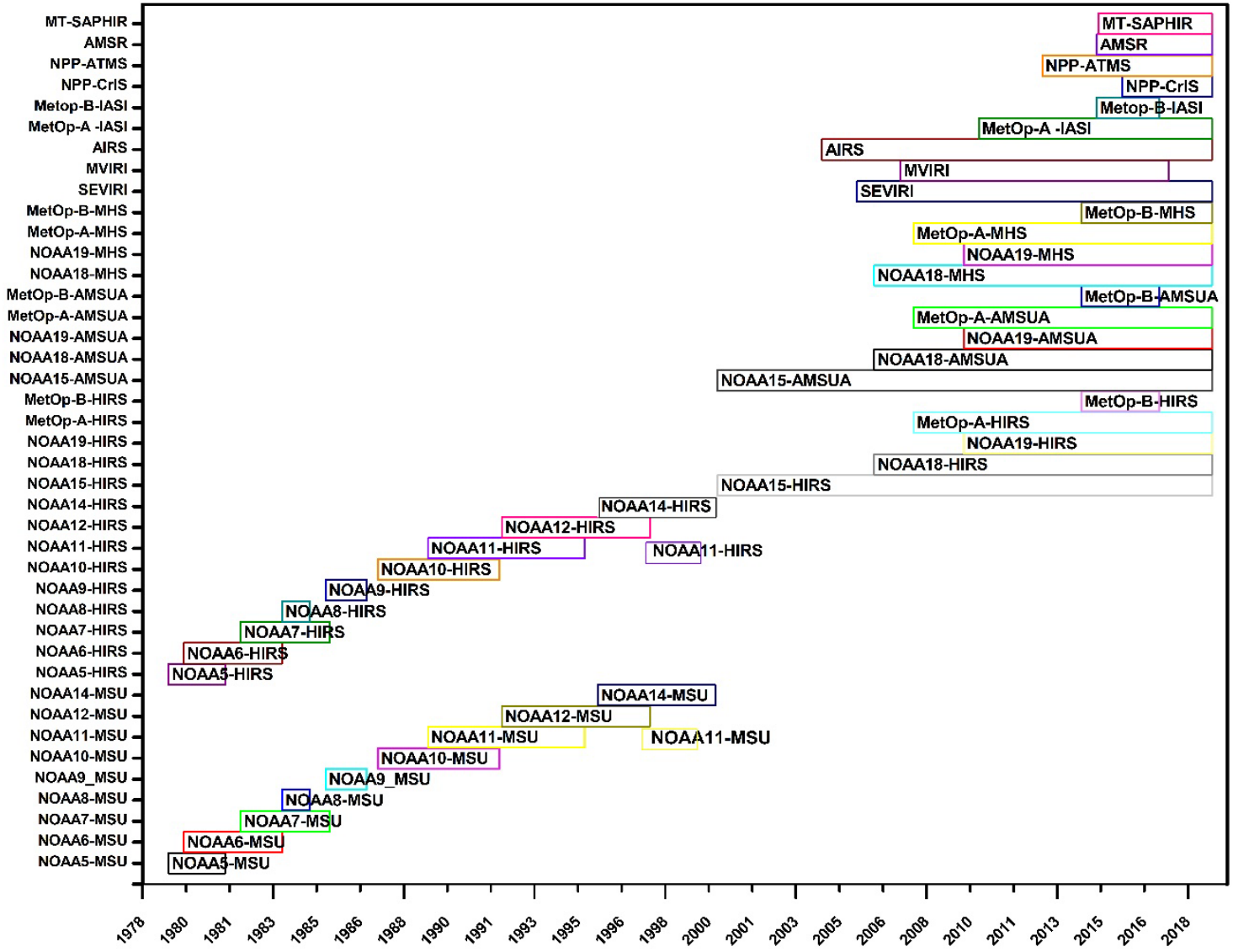
over India and the surrounding oceanic region where the world's most extensive annual monsoon occurs.

- **Radiances from various infrared (multispectral and hyperspectral) and microwave sounders were assimilated in the IMDAA system after proper quality control and bias correction.**

Timeline of various observations assimilated in the IMDAA reanalysis



Timeline of satellite radiances assimilated in the IMDAA reanalysis



QC procedures to the satellite radiances in the IMDAA

(i) initial QC: rejects observations with missing values, flagged as bad by the data producer, duplicates, outside the normal physical range, inconsistent in terms of location/track, too large departures from the hydrostatic equilibrium;

(ii) blacklist QC: rejects cloud contaminated and surface affected radiances, unusable channels, data when instruments have known problems;

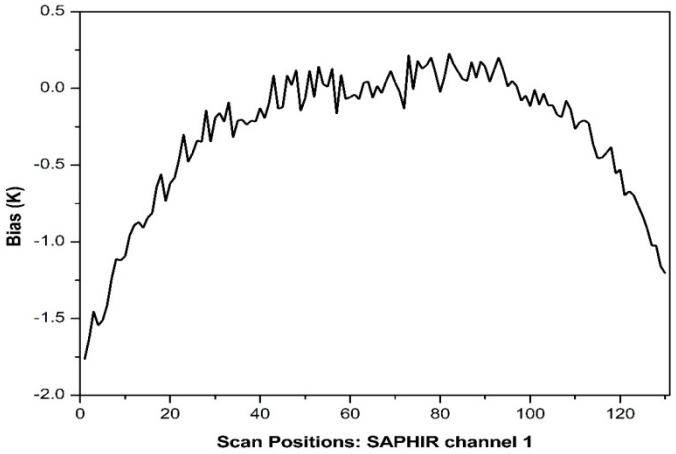
(iii) background QC: rejects radiances with large background departures, does thin to eliminate the observation cross-correlation errors

(iv) VarBC: rejects observations those are too far from analysis after successive minimization.

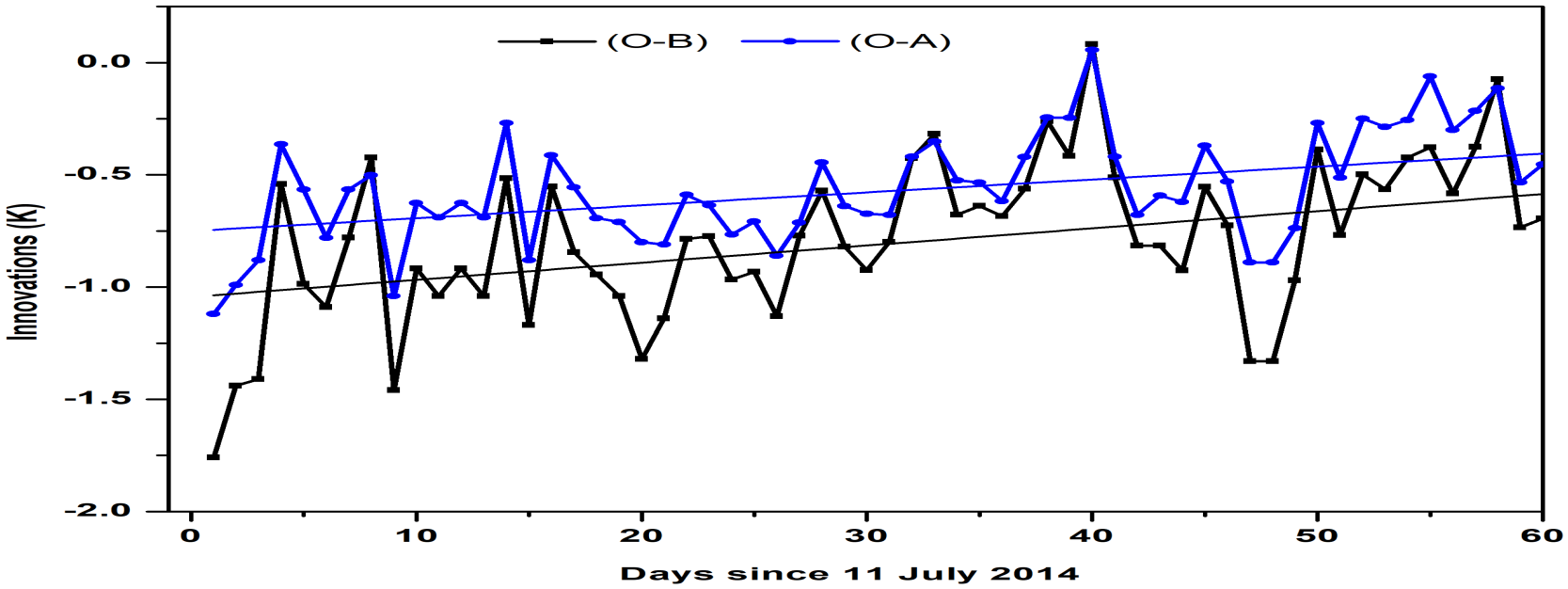
Variational Bias Correction (VarBC) in IMDAA

- Biases in the satellite radiances vary with time, geography, air mass, scan position of satellite instrument, and satellite position in its orbit
- VarBC keeps track of the bias predictors for radiances from all available satellite instruments.
- The VarBC scheme in IMDAA used the same method implemented in the UM system (Cameron and Bell, 2018) and closely follows the incremental formulation based on Auligne et al. (2007).
- The predictors used are 850 to 300 hPa thickness, 200 to 50 hPa thickness, and total column water vapor.
- The blacklisting information is similar to that used in ECMWF reanalyses (Dee et al., 2011).
- Compared to the global assimilation system, the IMDAA reanalysis system has taken more time to stabilize.

Megha-Tropique SAPHIR: Channel 1

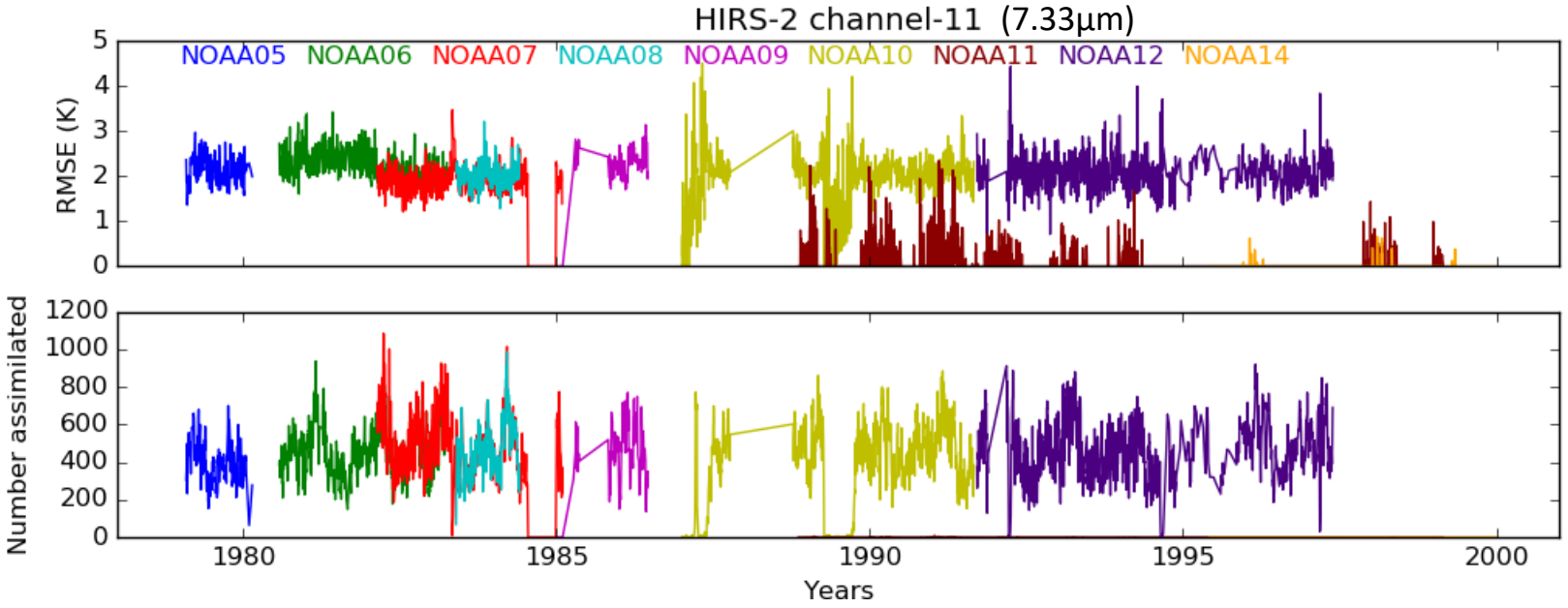


Introduced MT-SAPHIR microwave radiances in the IMDAA system since 11 July 2014



Use of TOVS in IMDAA

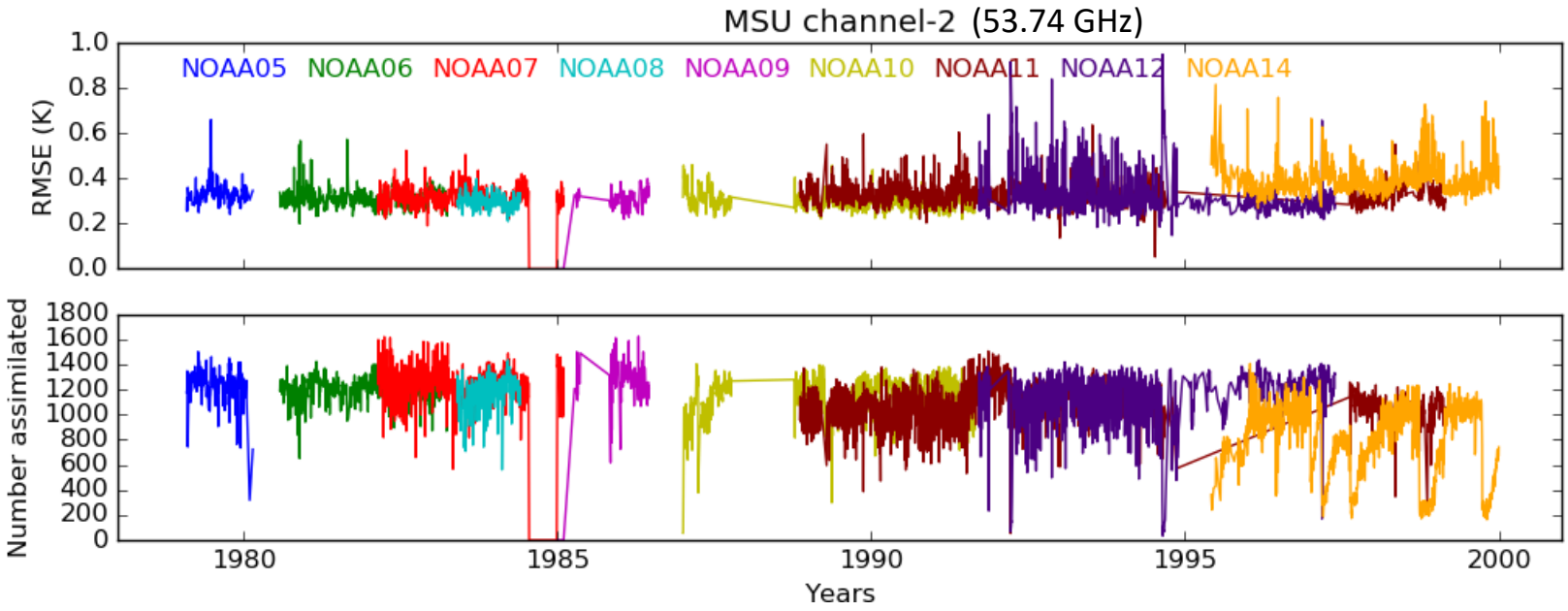
1978 -2000



R matrix value of HIRS-2 channel 11 = 3K

RMSE: Generally between 2 and 3 K, but > 1 for NOAA11 and 14

Use of TOVS in IMDAA 1978 -2000

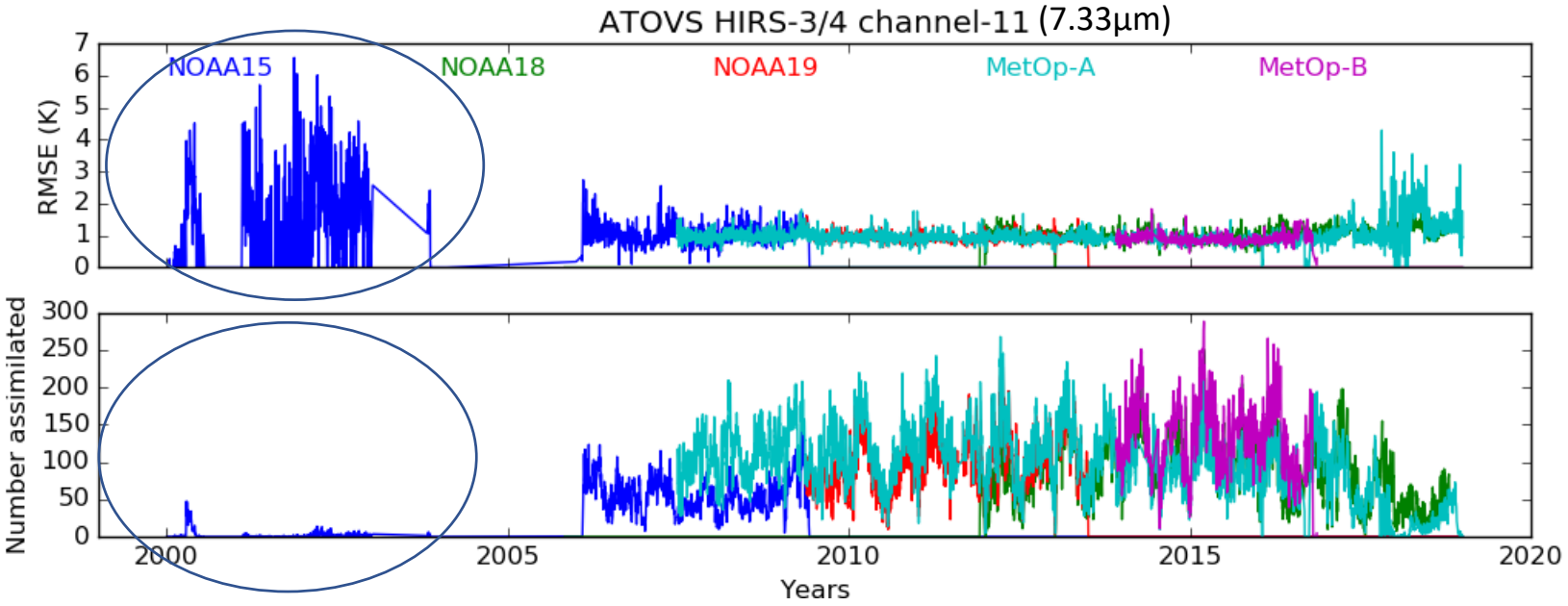


R matrix value of MSU channel 2 = 0.2 K

RMSE: > 0.6 K

Use of ATOVS in IMDAA

2000 -2018

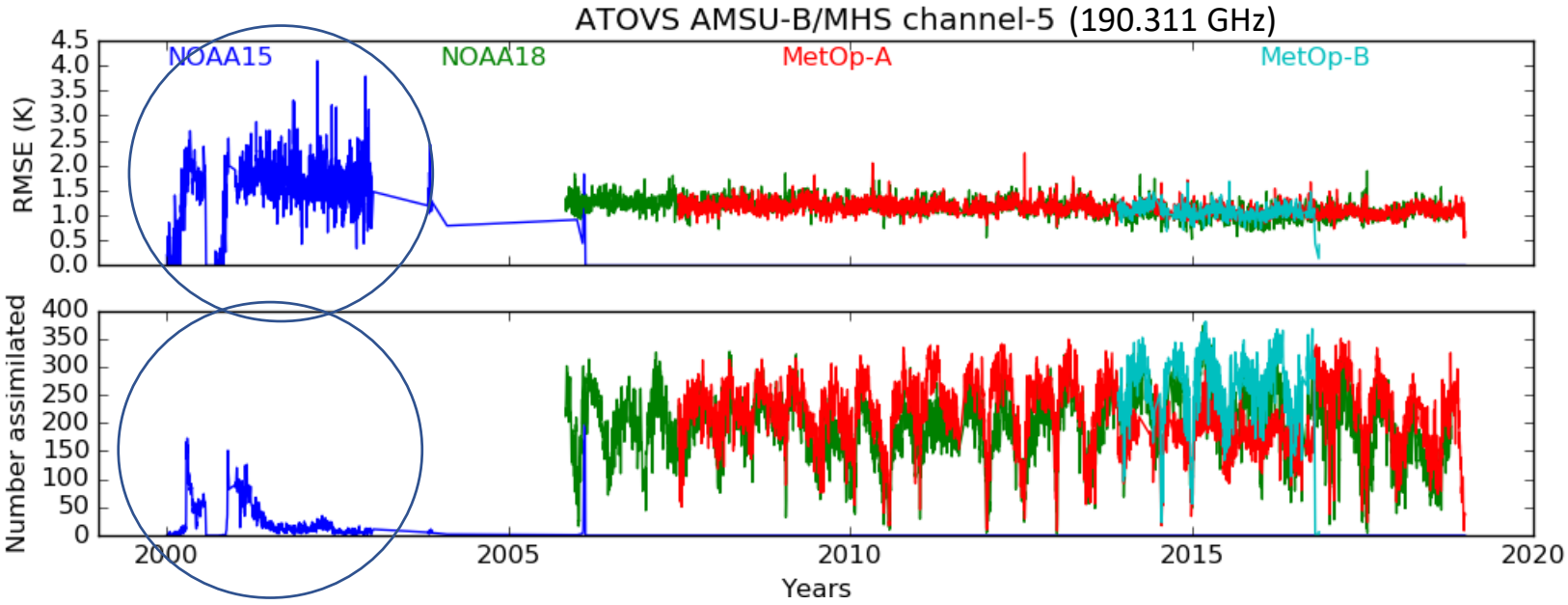


R matrix value of HIRS-3/4 channel 11 = 5K

RMSE: between 1 and 2 K, but high RMSE in NOAA15 from 2000 to 2005

Use of ATOVS in IMDAA

2000 -2018



R matrix value of AMSU-B/MHS channel-5 = 4K

RMSE: between 1 and 2 K

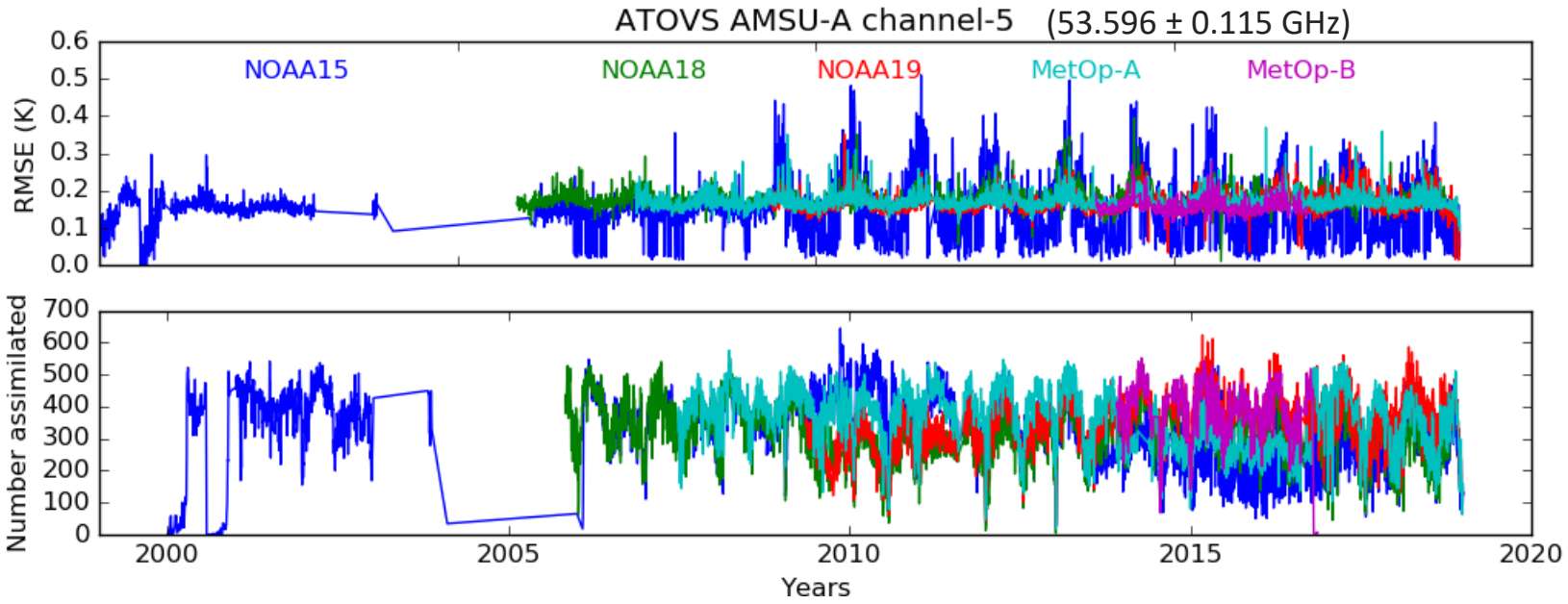
The RMSE in the 183 GHz channels are:

1- 2 K for 183.31 ± 1.0

2 -3 K for 183.31 ± 3.0

Use of ATOVS in IMDAA

2000 -2018



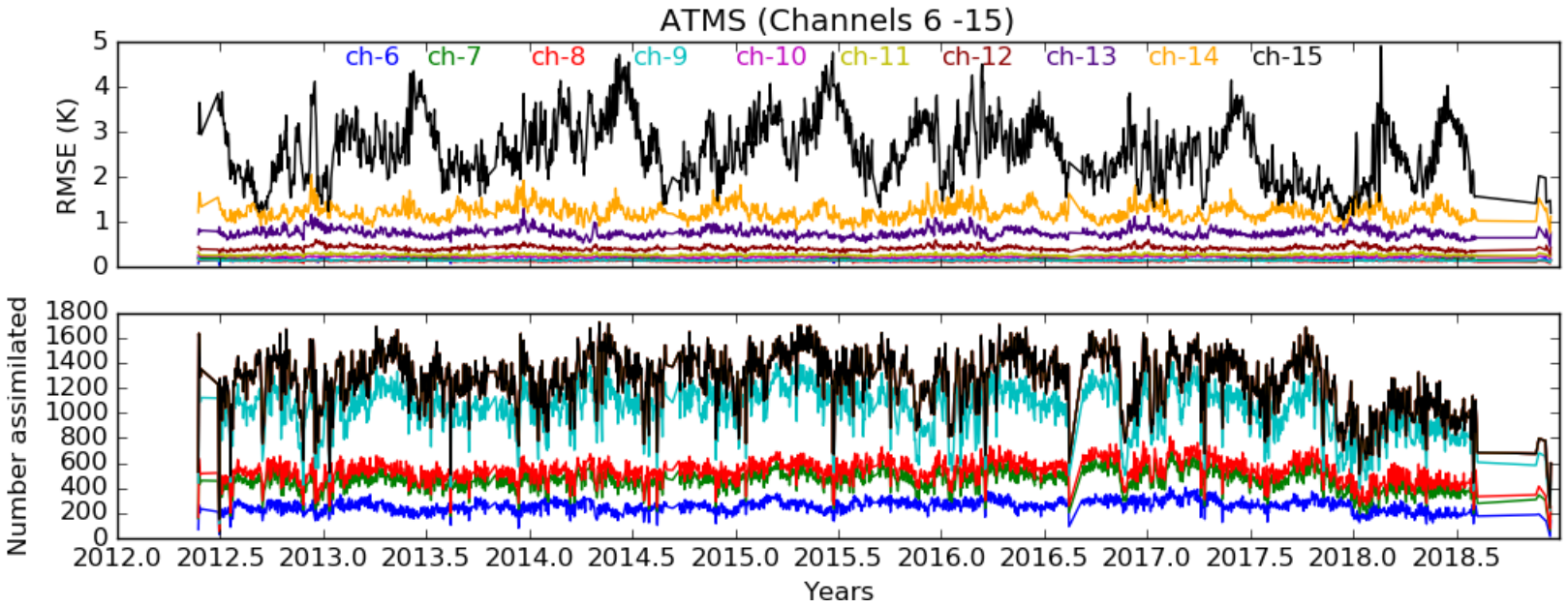
R matrix value of AMSU-A channel-5 = 0.25 K

RMSE: between 0.2 and 0.3 K, highly varying for NOAA15

1- 2 K RMSE in channels 12, 13, and 15

Use of ATMS in IMDAA

2012 -2018

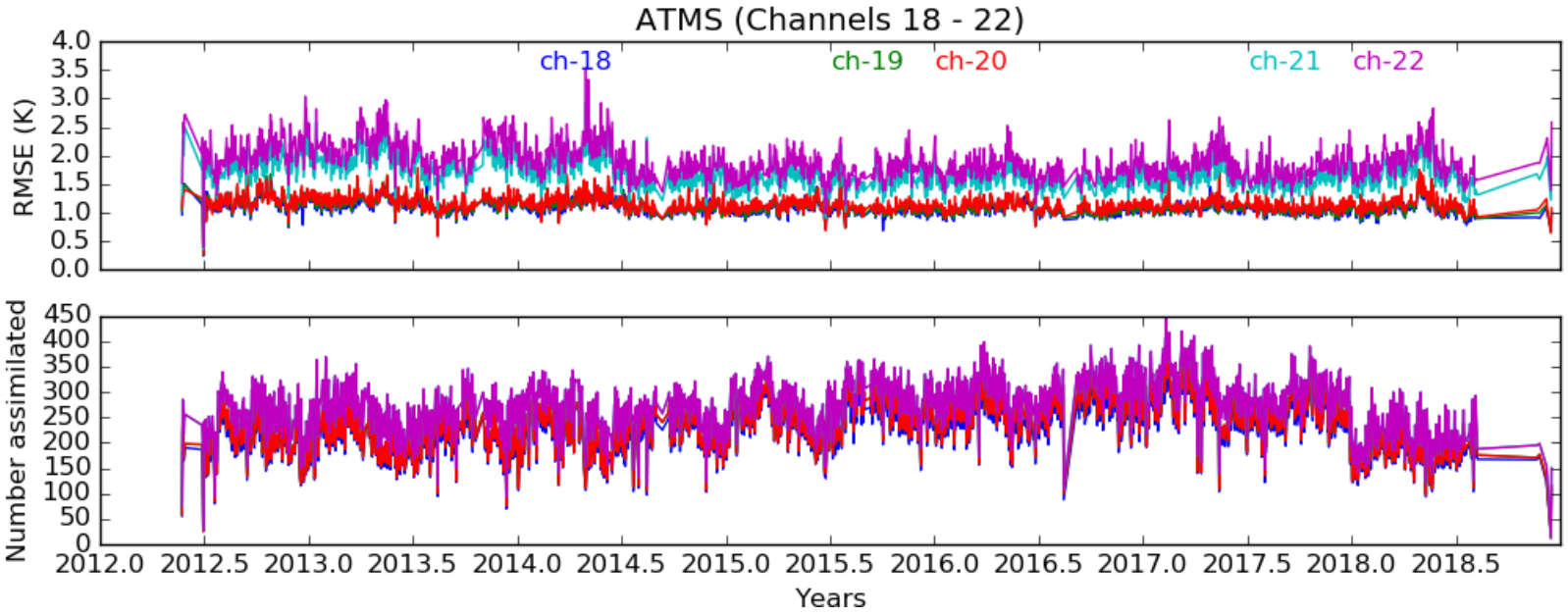


R Value : 0.35 K (Ch-6, 7,8, 9,10)

0.9818 (ch-11) 0.9 (ch-12) 1.1 (ch-13) 0.8875 (ch-14) 1.2821 (ch-15)

Use of ATMS in IMDAA

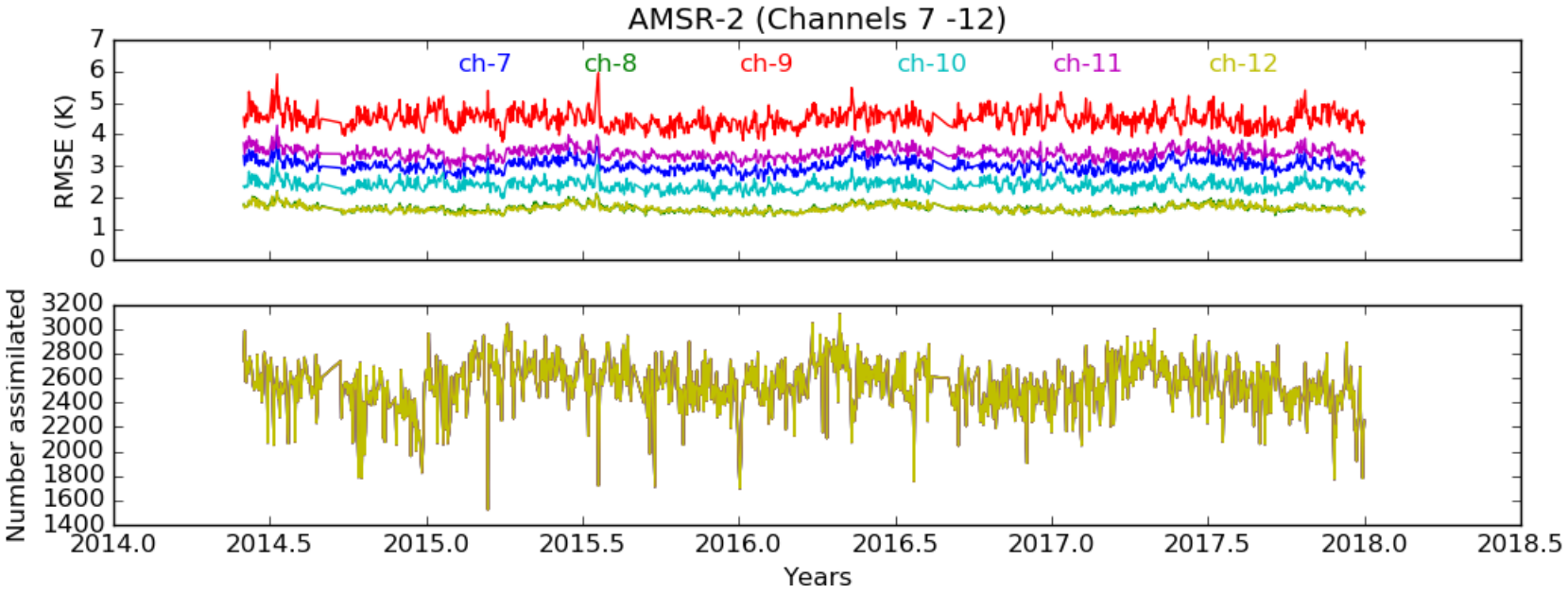
2012 -2018



R Value : 4 K (ch-18, 19, 20, 21), 4.5 K (ch-22)

Use of AMSR-2 in IMDAA

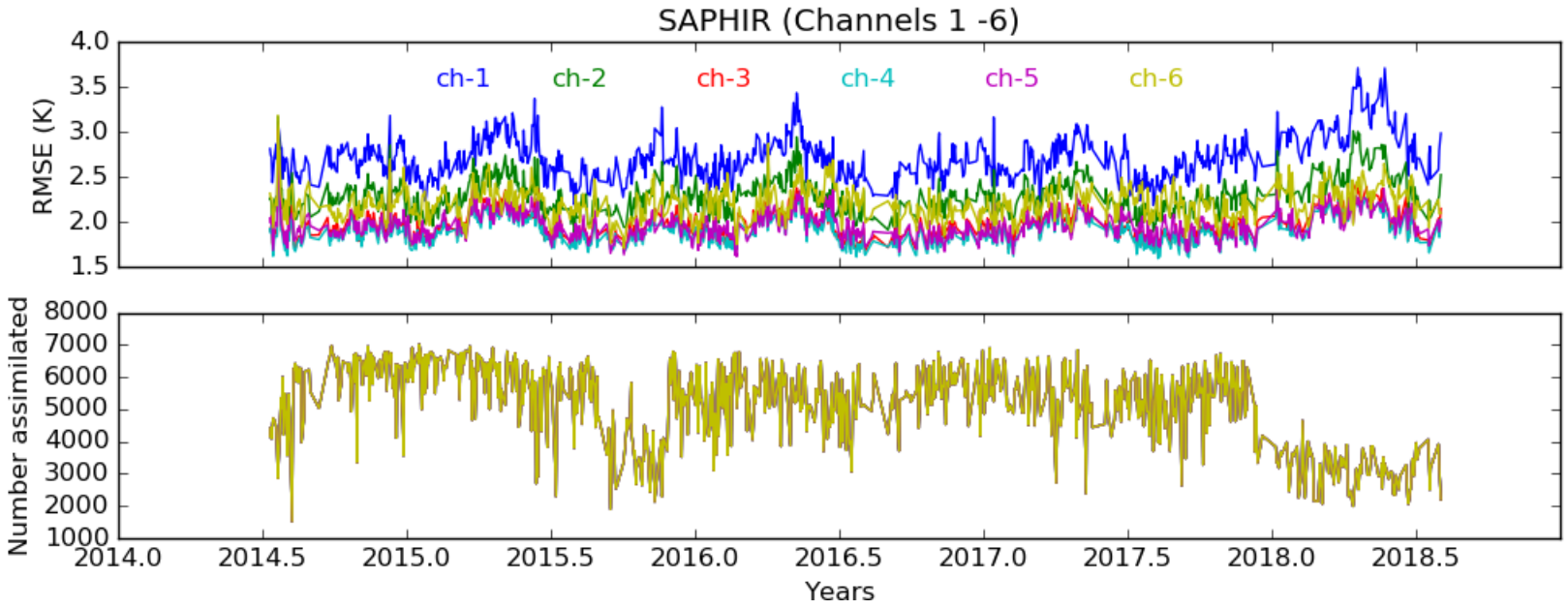
2014 -2018



R Value : 9.6 K (ch-7), 5.6 (ch-8), 14.4 (ch-9), 7.6 (ch-10), 12 (ch-11), 5.6 (ch-12)

Use of SAPHIR in IMDAA

2014 -2018

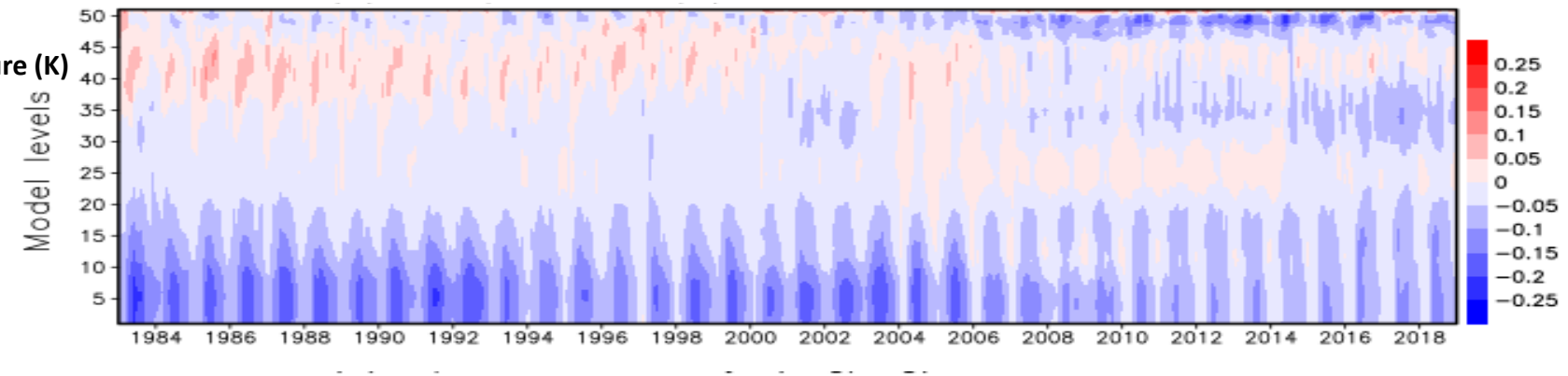


R Value :

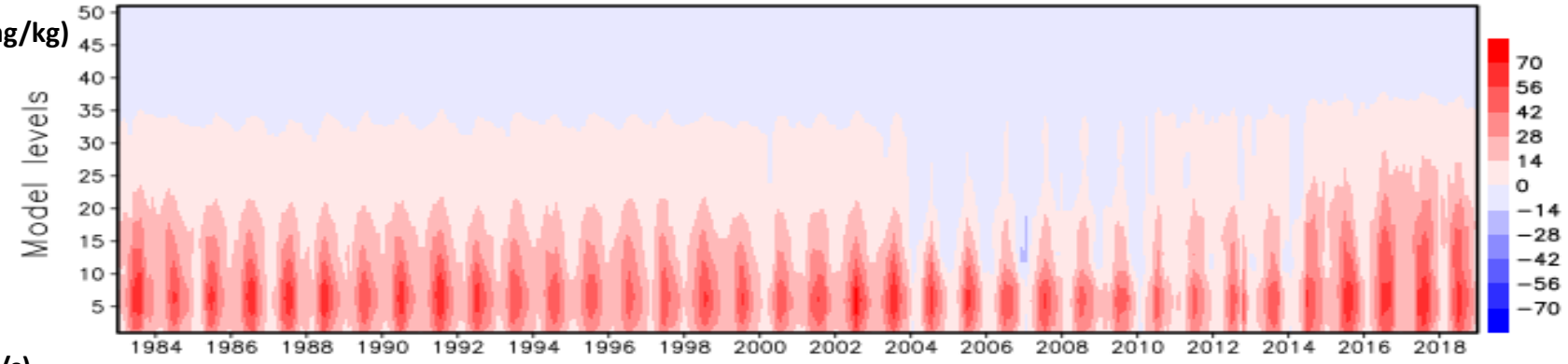
4.1505 (ch-1) 3.4232 (ch-2) 3.1358 (ch-3) 3.1687 (ch-4) 3.5809 (ch-5) 4.3853 (ch-6

Analysis increments

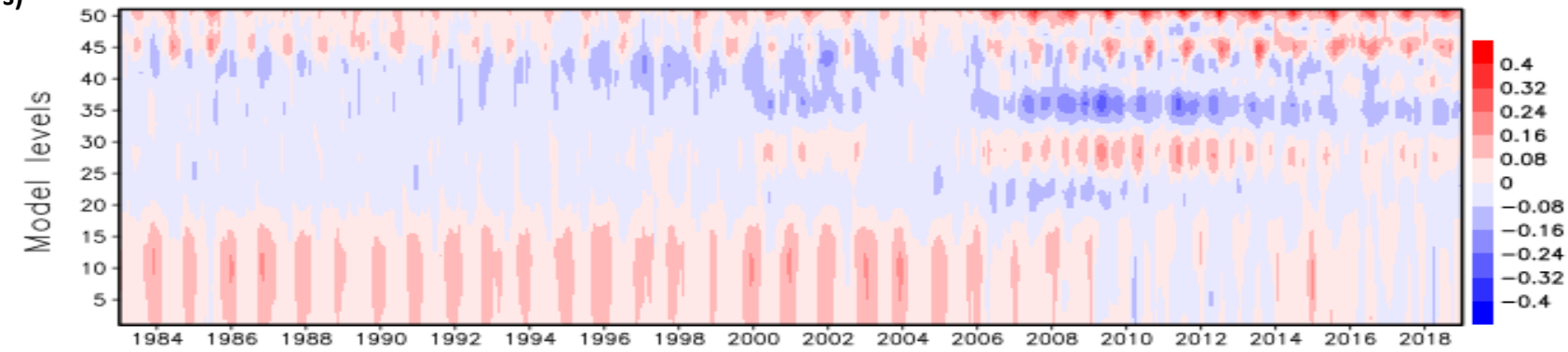
Temperature (K)



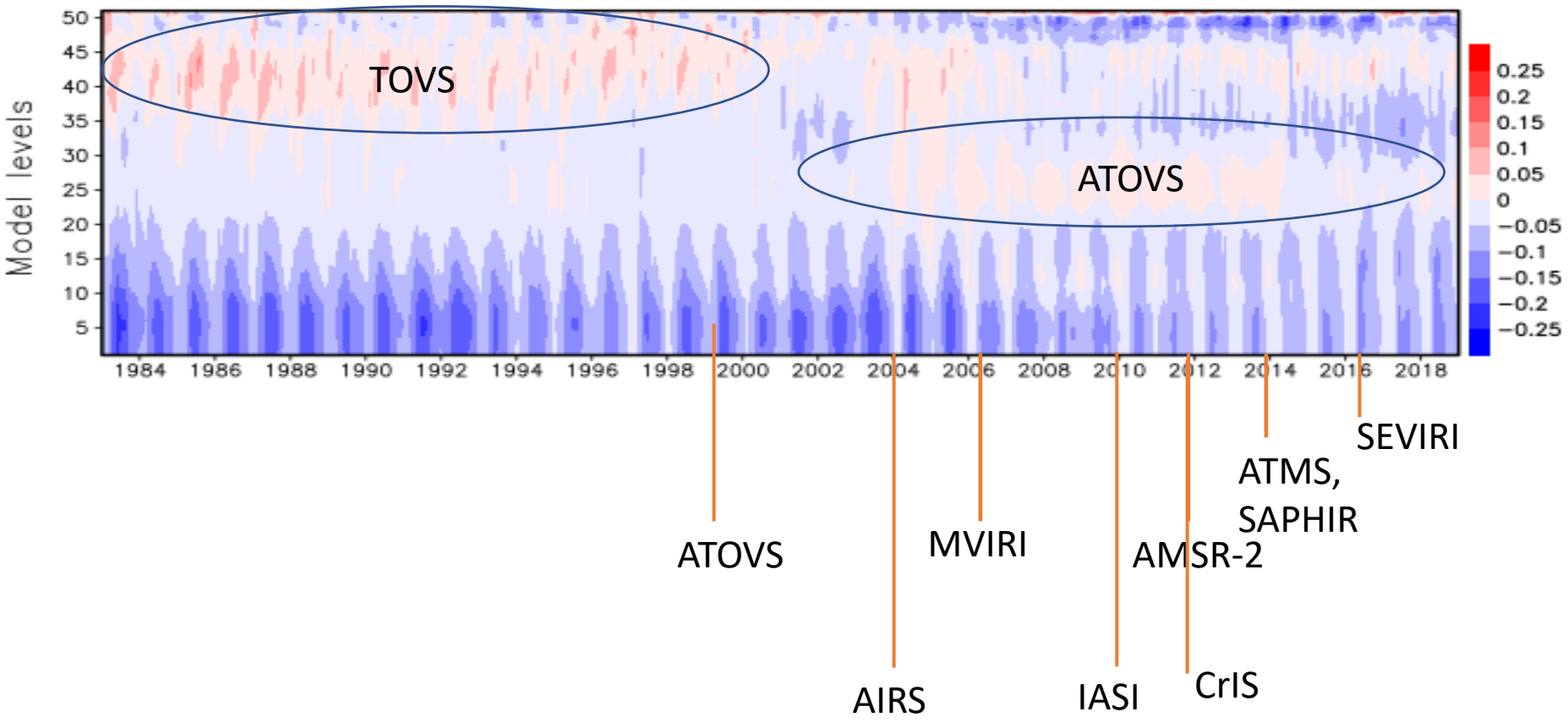
Sp.hum (mg/kg)



u wind (m/s)



Analysis increment in Temperature: Response to the radiance assimilated



Conclusions

- **IMDAA is the first high resolution satellite era retrospective analysis over the Indian monsoon region**

- **Satellite radiances from almost 25 instruments, onboard more than 40 different satellites, have been assimilated after initial, background, and redundancy quality controls.**

- **Response to the radiance data assimilated is clearly visible in the analysis increments**

- **IMDAA high resolution regional reanalysis data is available at https://rds.ncmrwf.gov.in/datasets**

- **Details of IMDAA reanalysis and a comparison with ERA5 is available in https://doi.org/10.1175/JCLI-D-20-0412.1**

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Thank you