



Royal Netherlands  
Meteorological Institute  
*Ministry of Infrastructure  
and Water Management*

## **Retrieval of Ocean Surface Wind Speed for Future Passive Microwave Imager: MWI**

Sisma Samuel, Anton Verhoef, Ad Stoffelen



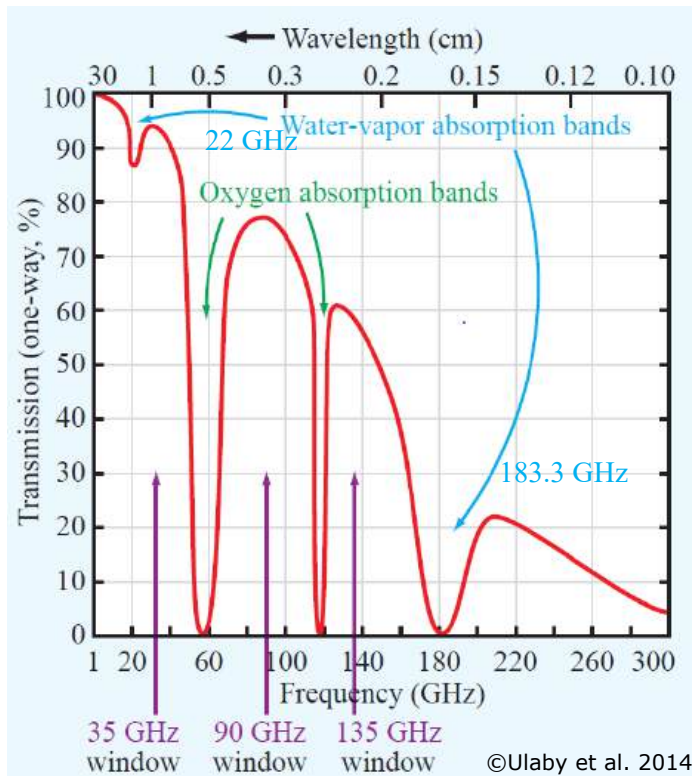
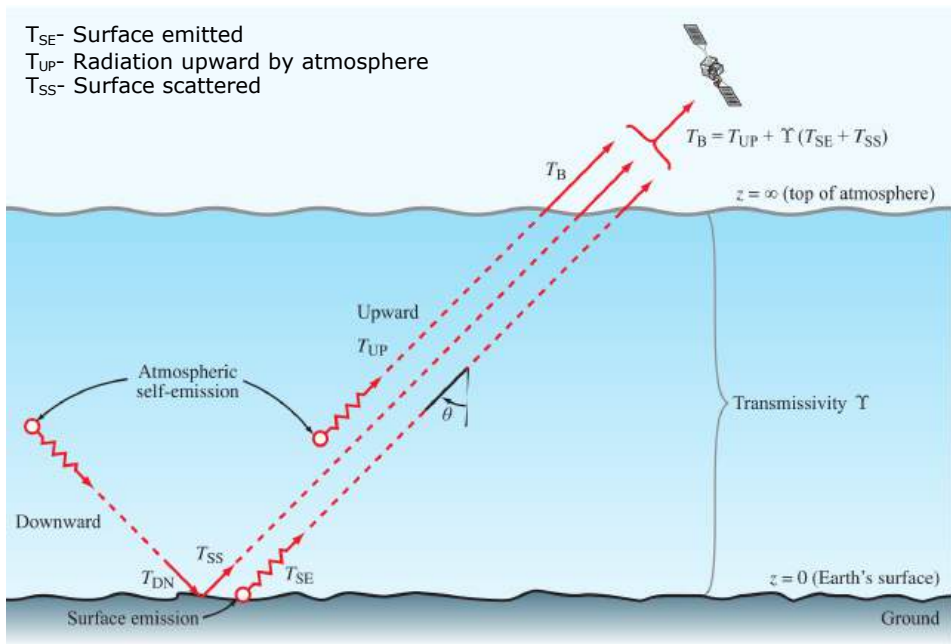
# Outline

- > Passive Microwave Remote Sensing: Introduction
- > Microwave Imager onboard Metop-SG
- > 1D-Var Retrieval of wind speed
- > Comparison of
  - Simulated vs Observed Brightness Temperature
  - Retrieved Wind speed vs model wind speed



# Passive Microwave Remote Sensing: Introduction

- Observes the thermal emissions- **Brightness temperature**

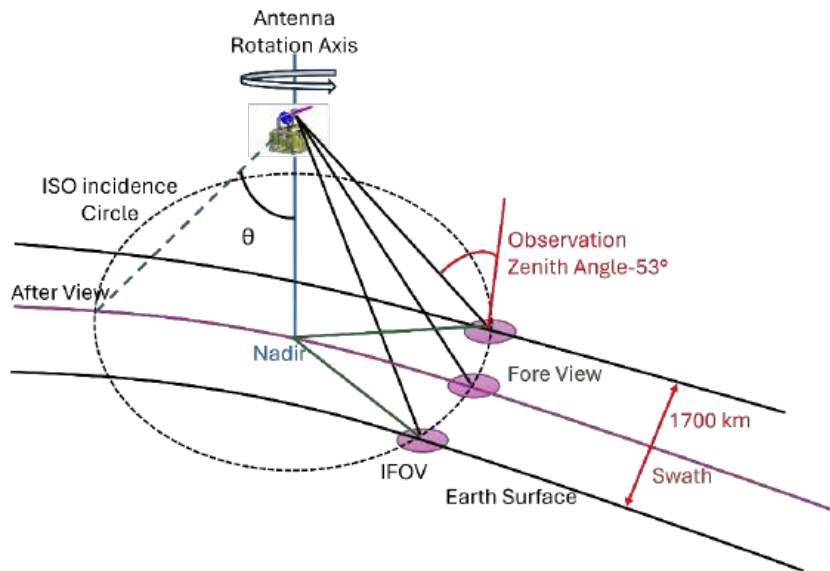


The longer wavelength of microwaves enables it to penetrate through clouds, haze, and dust



# Microwave Imager

- Microwave Imager (MWI) is a conically scanning Radiometer onboard Metop-SG
- 18 frequencies, 26 channels
- Constant Zenith Angle  $\sim 53^\circ$
- Swath 1700 km, 40 scans/min = 10 km/scan

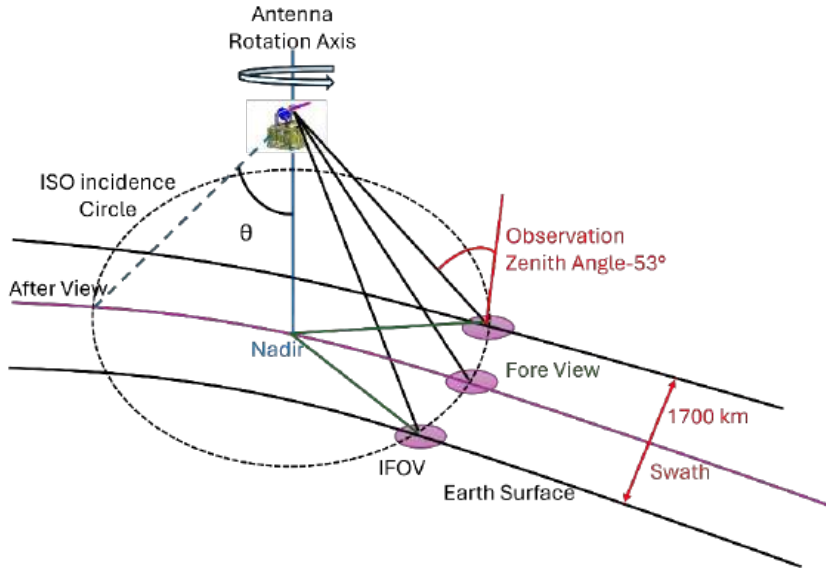


| No | Central frequency (GHz) | Bandwidth h (MHz) | Polarisations | IFOV  |
|----|-------------------------|-------------------|---------------|-------|
| 1  | 18.7                    | 200               | V, H          | 50 km |
| 2  | 23.8                    | 400               | V, H          | 50 km |
| 3  | 31.4                    | 200               | V, H          | 30 km |
| 4  | 50.3                    | 180               | V, H          | 30 km |
| 5  | 52.8                    | 400               | V, H          | 30 km |
| 6  | 53.24                   | 400               | V, H          | 30 km |
| 7  | 53.75                   | 400               | V, H          | 30 km |
| 8  | 89.0                    | 400               | V, H          | 10 km |
| 9  | 118.7503±3.2            | 1000              | V             | 10 km |
| 10 | 118.7503±2.1            | 800               | V             | 10 km |
| 11 | 118.7503±1.4            | 800               | V             | 10 km |
| 12 | 118.7503±1.2            | 800               | V             | 10 km |
| 13 | 165.5±0.725             | 2700              | V             | 10 km |
| 14 | 183.31±7.0              | 4000              | V             | 10 km |
| 15 | 183.31±6.1              | 3000              | V             | 10 km |
| 16 | 183.31±4.9              | 3000              | V             | 10 km |
| 17 | 183.31±3.4              | 3000              | V             | 10 km |
| 18 | 183.31±2.0              | 3000              | V             | 10 km |



# Microwave Imager

- Microwave Imager (MWI) is a conically scanning Radiometer onboard Metop-SG
- 18 frequencies, 26 channels
- Constant Zenith Angle  $\sim 53^\circ$
- Swath 1700 km, 40 scans/min = 10 km/scan

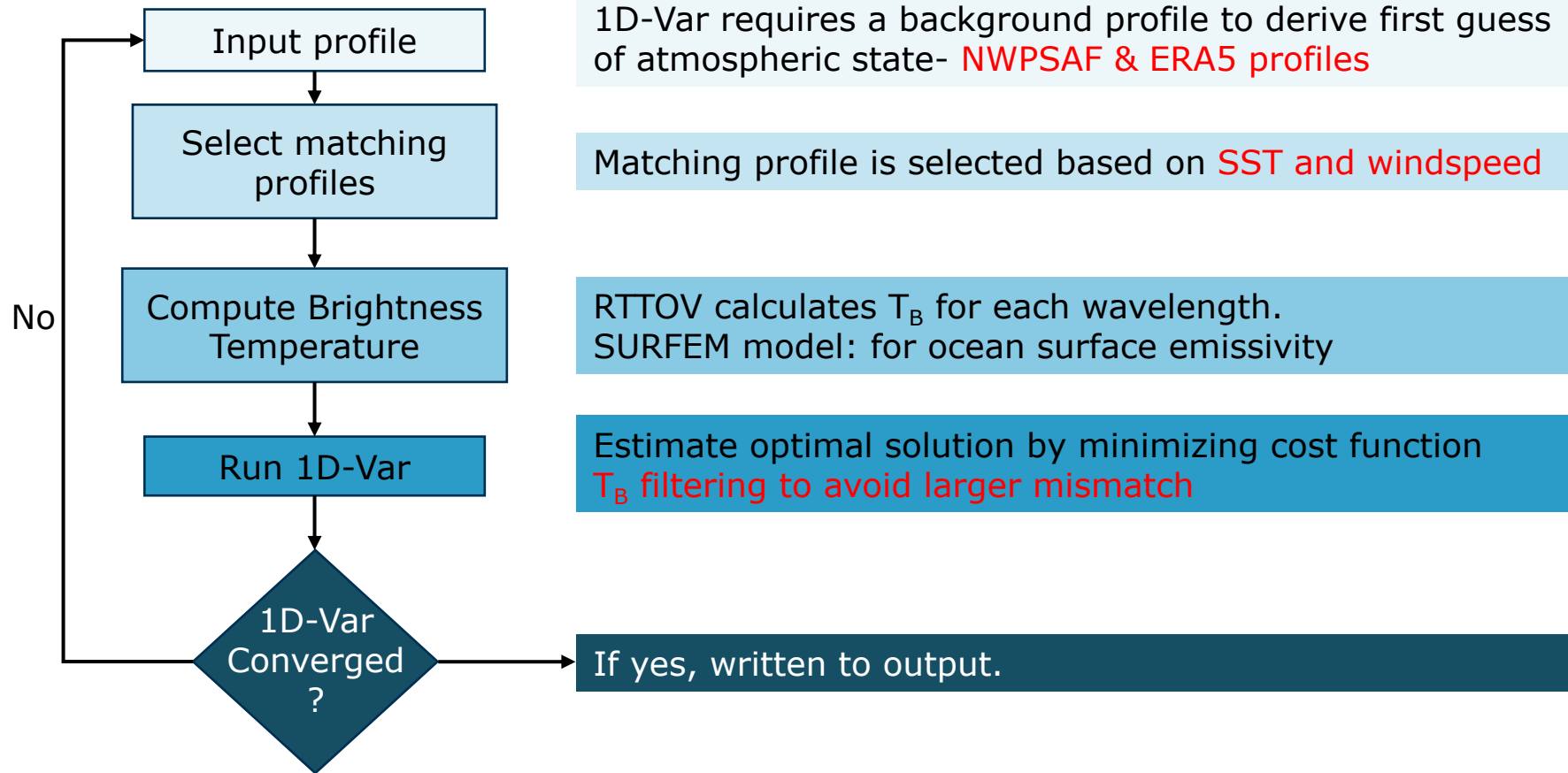


| Channel No | Central frequency (GHz) | Bandwidth (MHz) | Polarisation | IFOV |
|------------|-------------------------|-----------------|--------------|------|
| 12         | 19.35                   | 355             | H            | 25   |
| 13         | 19.35                   | 365             | V            | 25   |
| 14         | 22.235                  | 407             | V            | 25   |
| 15         | 37                      | 1615            | H            | 25   |
| 16         | 37                      | 1545            | V            | 25   |

Currently we make use of Special Sensor Microwave Imager/Sounder (SSMIS) for wind retrieval

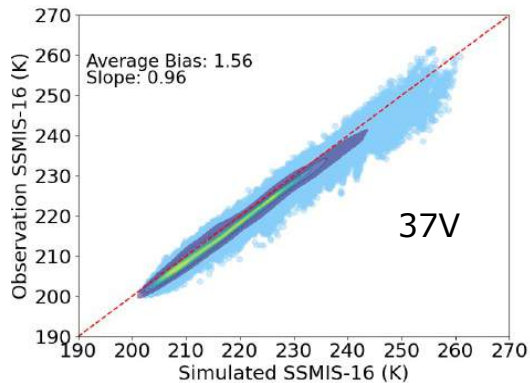
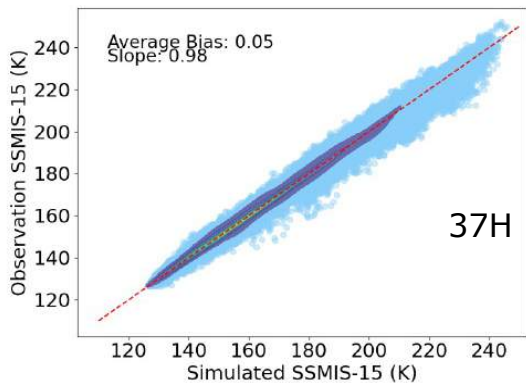
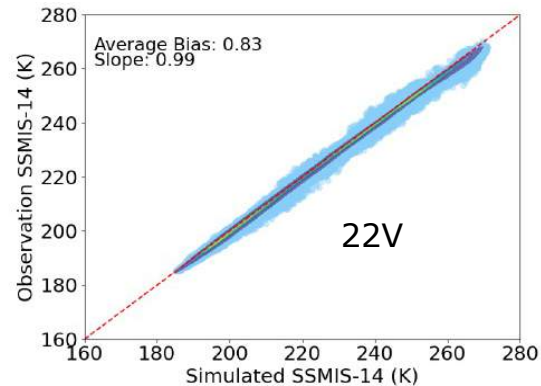
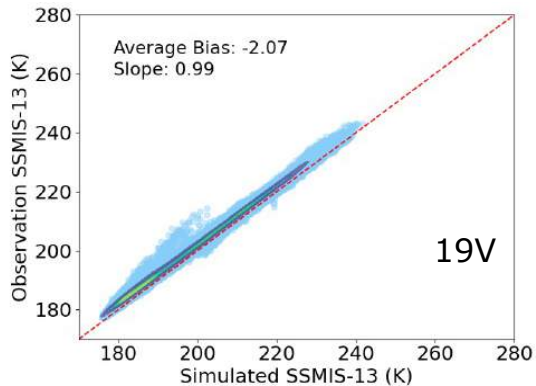
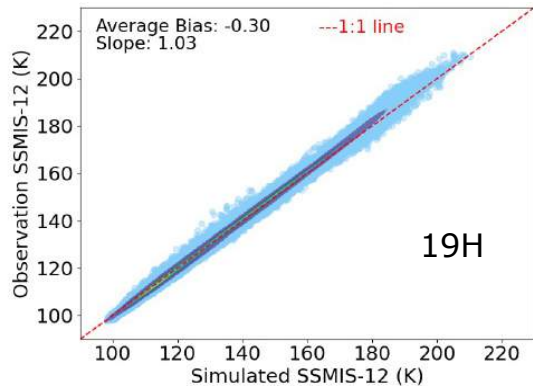


# 1D-Var Retrieval of wind speed





# Simulated vs Observed Brightness Temperature-All sky Condition

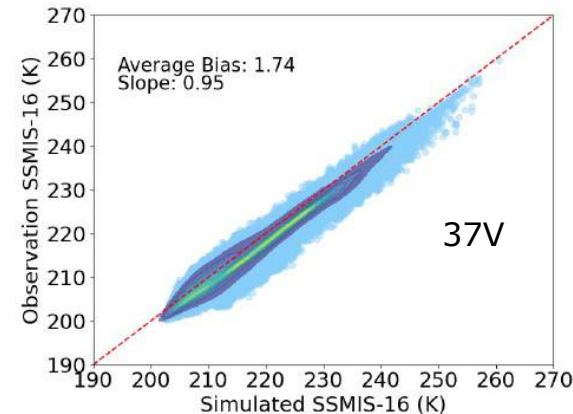
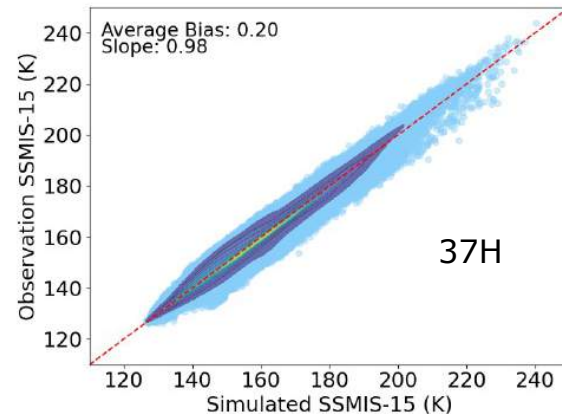
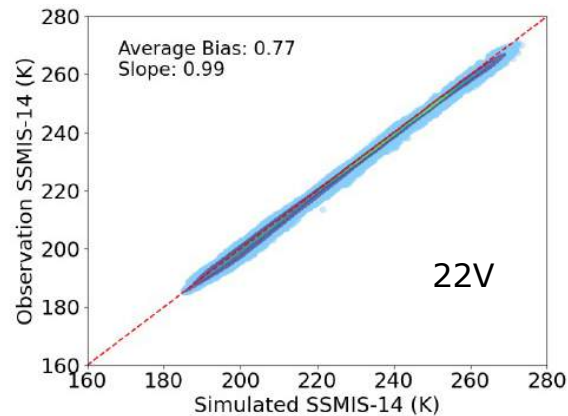
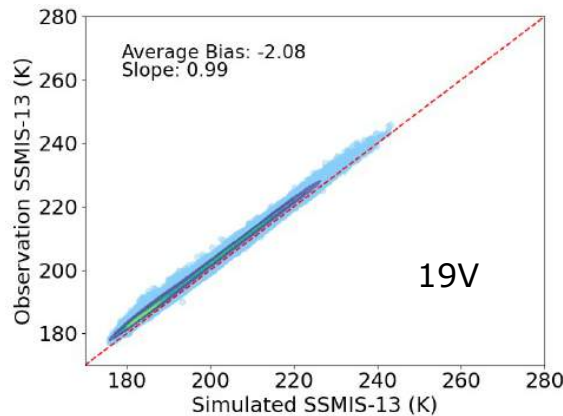
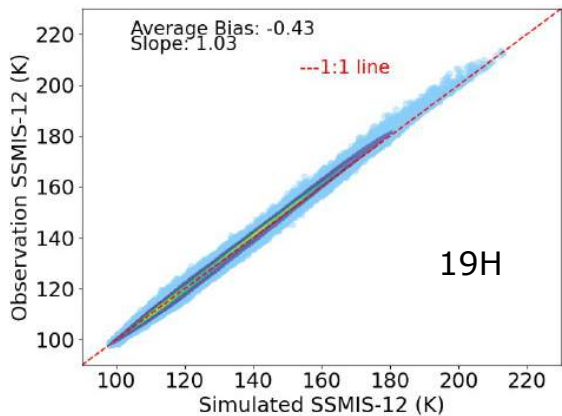


RTTOV calculates the  $T_B$  for each channel based on the background atmospheric profiles

NWPSAF Profile



# Simulated vs Observed Brightness Temperature-All sky Condition



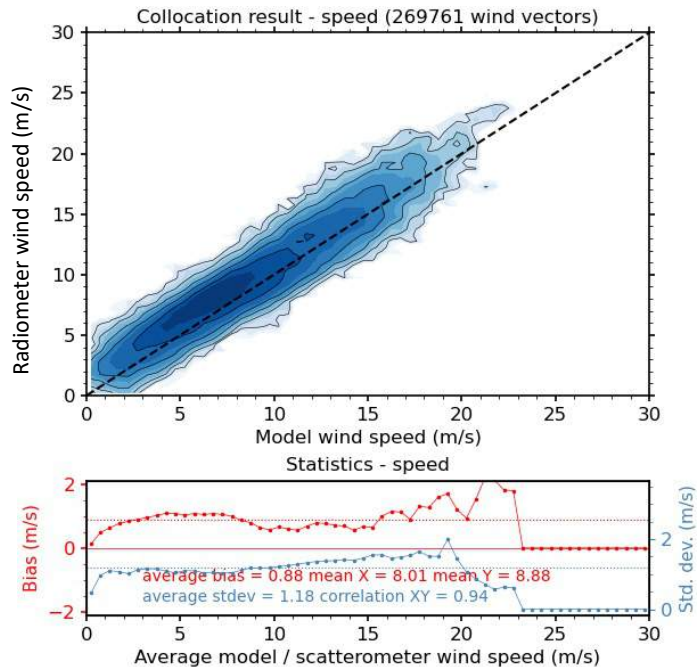
RTTOV calculates the  $T_B$  for each channel based on the background atmospheric profiles

ERA5 Profile

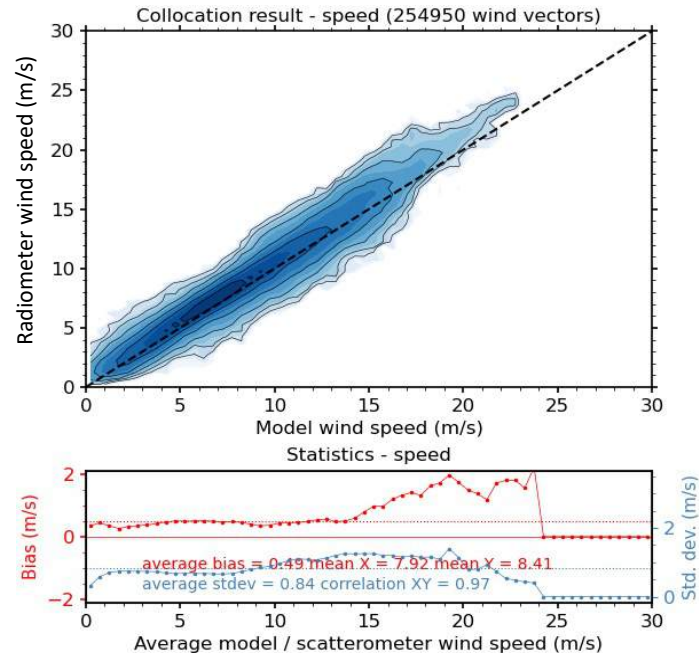


# Comparison of retrieved Wind speed to model windspeed

## NWPSAF Profile



## ERA5 Profile

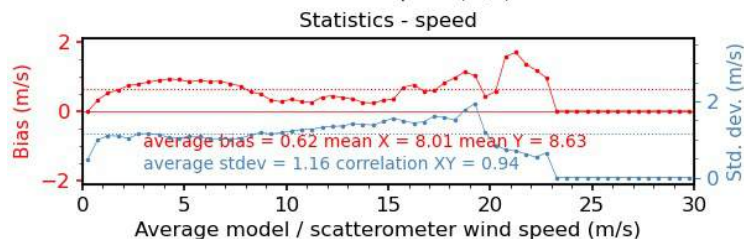
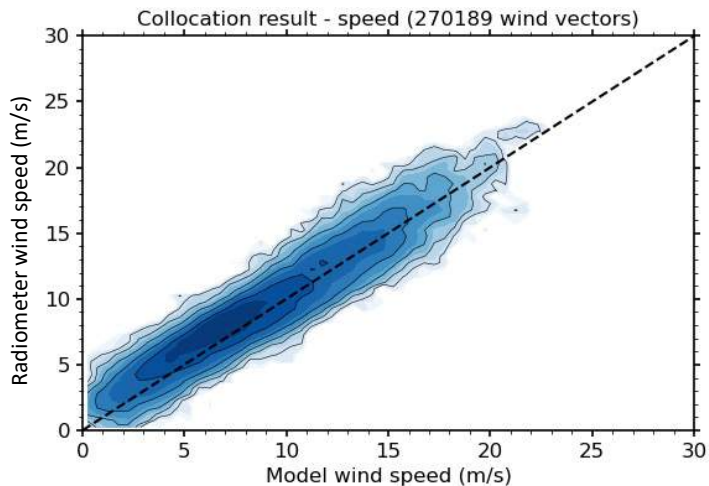


Wind speed was estimated by minimizing the cost function

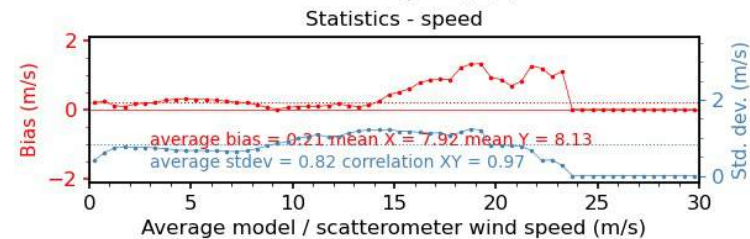
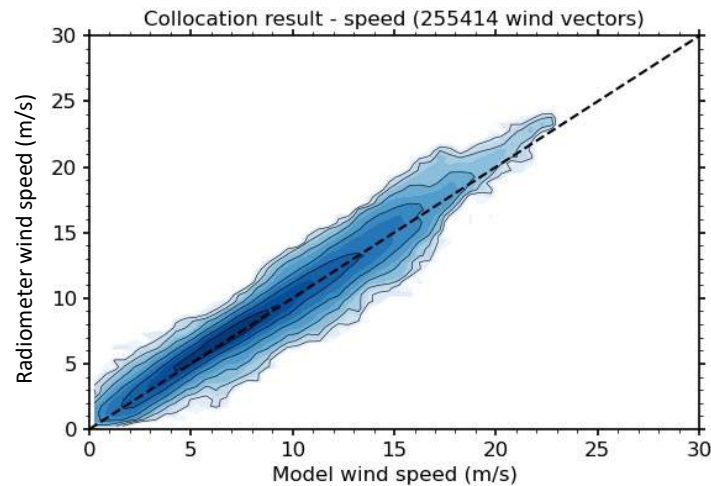


# Comparison of retrieved Wind speed: After Bias correction

## NWPSAF Profile



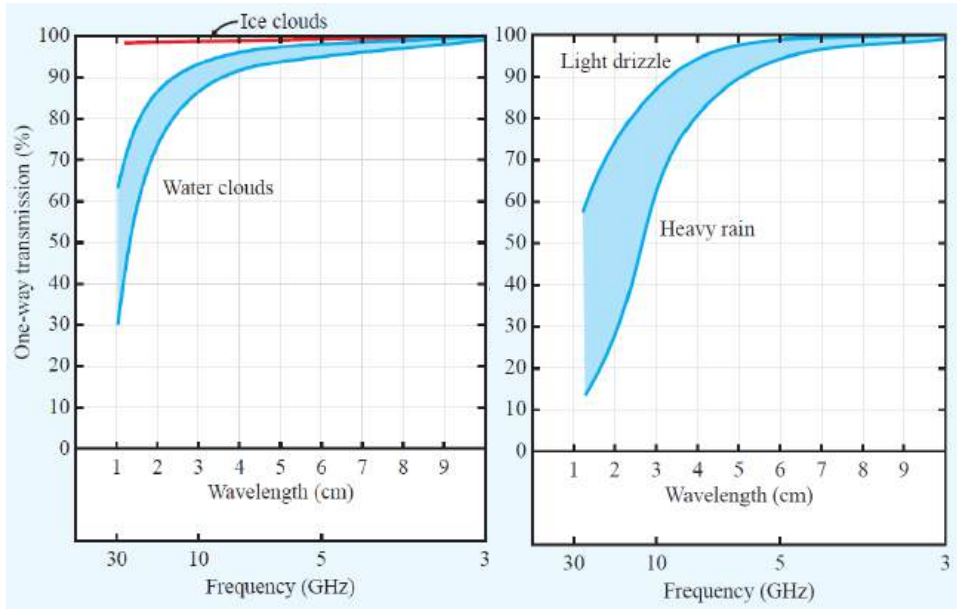
## ERA5 Profile



Average bias and Std Dev reduces after bias correction



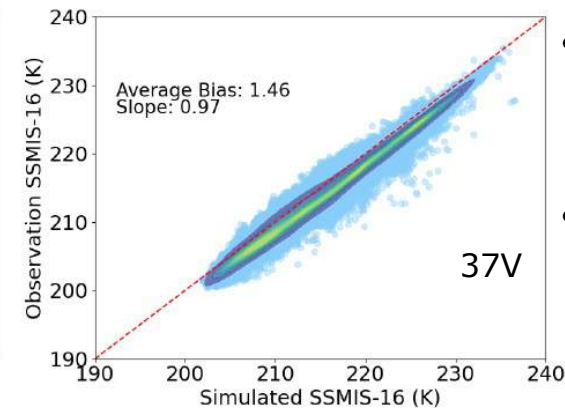
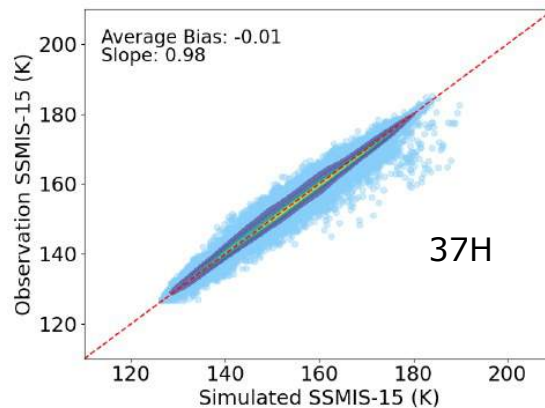
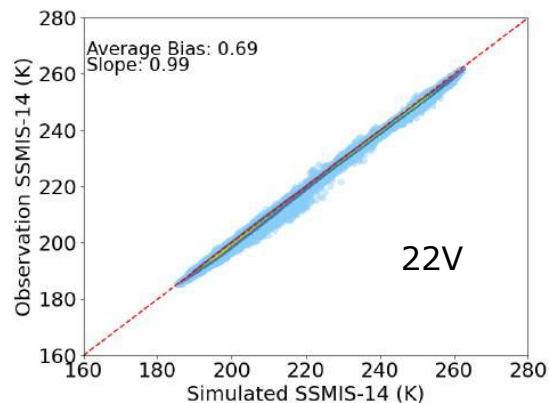
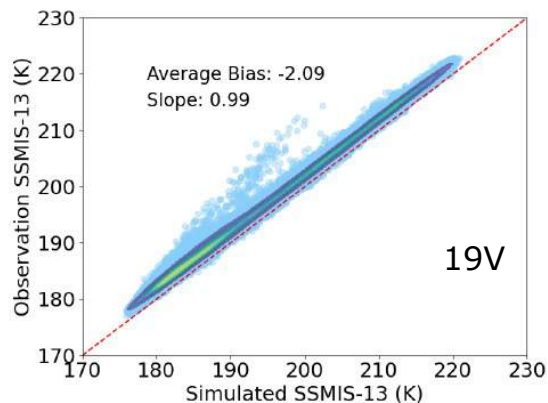
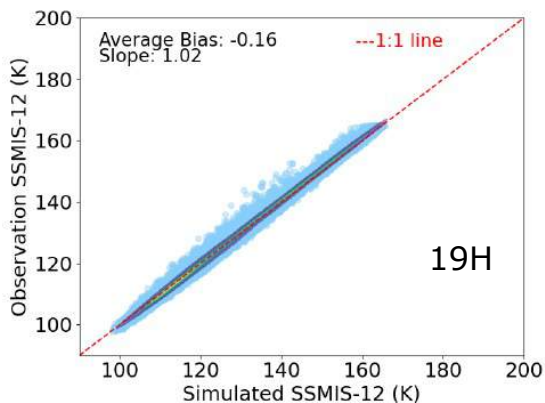
# Attenuation effect of rain



Rain Flag:  
 $T_B(37V) - T_B(37H) < 50K$   
 $T_B(19H) > 165K$



# Simulated vs Observed Brightness Temperature: Rain Flag

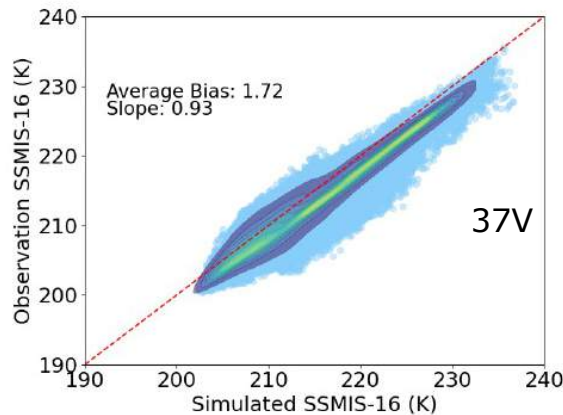
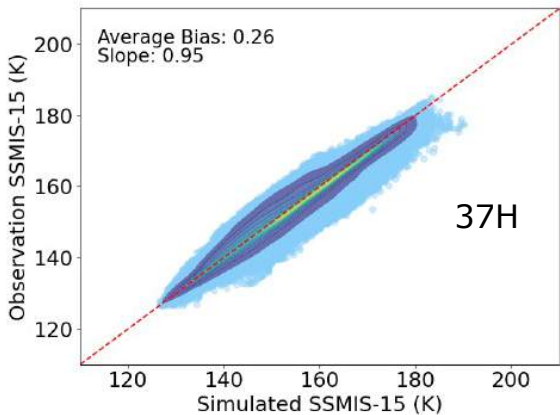
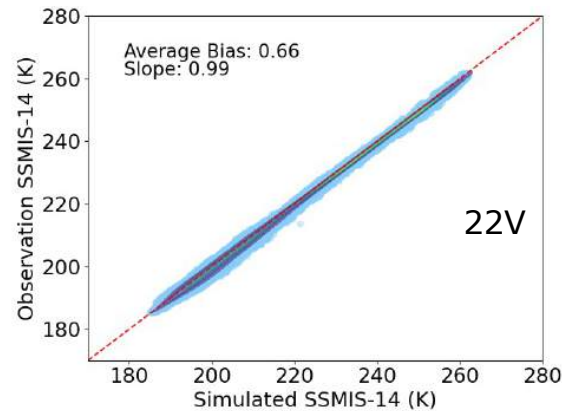
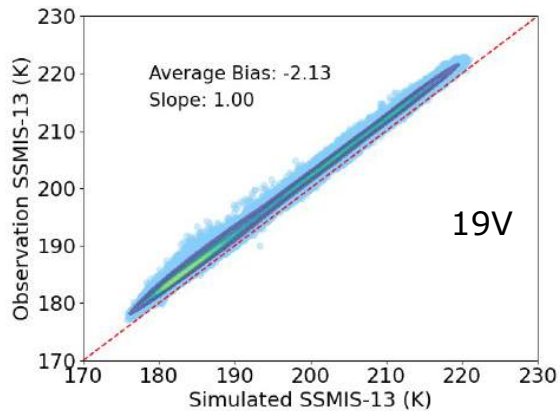
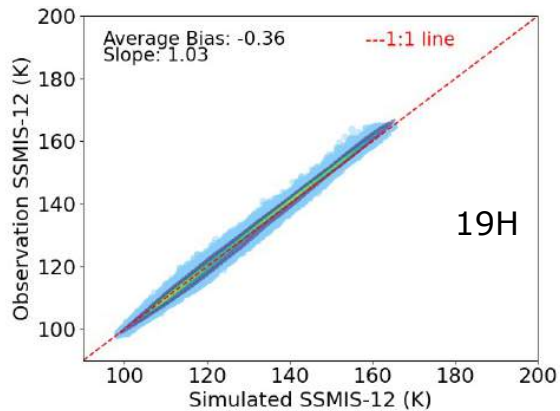


- RTTOV calculates the  $T_B$  for each channel based on the background atmospheric profiles.
- ~18% of points are removed after applying rain flag

NWPSAF Profile



# Simulated vs Observed Brightness Temperature: Rain Flag



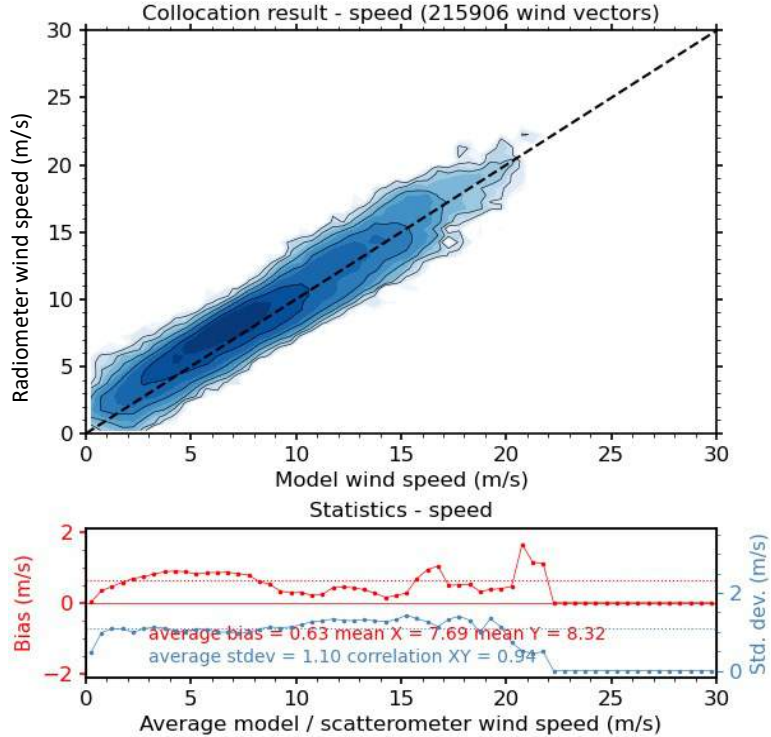
- RTTOV calculates the  $T_B$  for each channel based on the background atmospheric profiles.
- ~20% of points are removed after applying rain flag

ERA5 Profile

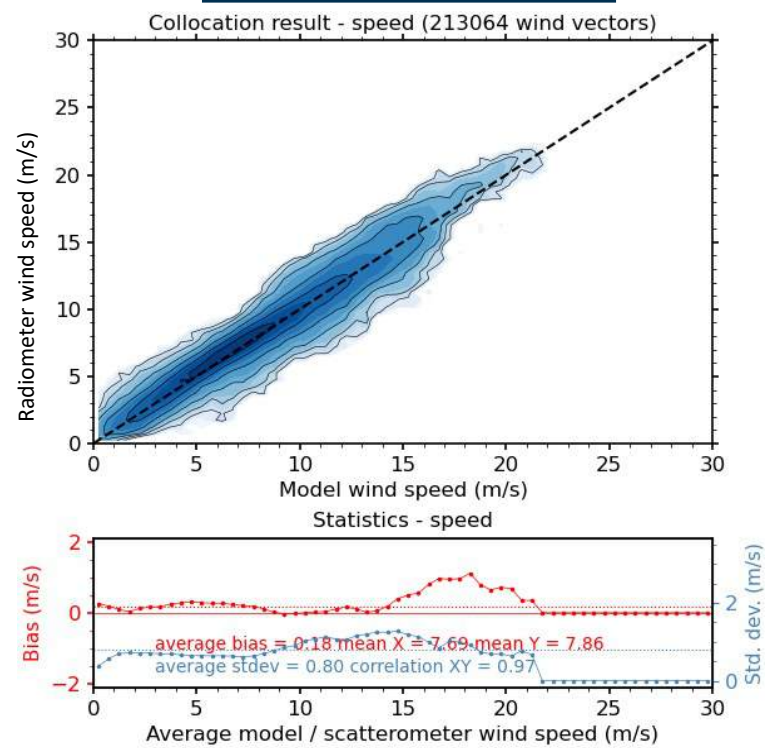


# Comparison of retrieved Wind speed: After bias correction

## NWPSAF Profile



## ERA5 Profile



Average bias and Std Dev reduces after bias correction for rain flag cases



# Conclusion

- Currently, we make use of the SSMIS onboard DMSP to prepare for future MWI retrievals.
- The NWP SAF 1-Dimensional Variational Technique and Radiative transfer model (RTTOV) is used for the retrieval of near surface wind speed.

|        | All-sky condition      |             |                       |             | Rain Flag             |             |
|--------|------------------------|-------------|-----------------------|-------------|-----------------------|-------------|
|        | Before Bias Correction |             | After Bias Correction |             | After Bias Correction |             |
|        | Bias                   | Std Dev     | Bias                  | Std Dev     | Bias                  | Std Dev     |
| ERA5   | <b>0.49</b>            | 0.84        | <b>0.21</b>           | 0.82        | <b>0.18</b>           | 0.80        |
| NWPSAF | <b>0.88</b>            | <b>1.18</b> | <b>0.62</b>           | <b>1.16</b> | <b>0.63</b>           | <b>1.10</b> |

Thank you