# Assimilation and monitoring of SSMIS, AMSRE and TMI data at ECMWF

Niels Bormann, Graeme Kelly, Peter Bauer (ECMWF)
and Bill Bell (Met. Office)

ECMWF

# Outline

1. SSMIS (temperature-sounding channels)
2. SSMIS (SSMI-like channels), AMSR-E, TMI
3. Summary

# Outline

1. **SSMIS (temperature-sounding channels)**
2. SSMIS (SSMI-like channels), AMSR-E, TMI
3. Summary

# SSMIS: Problems for T sounding channels

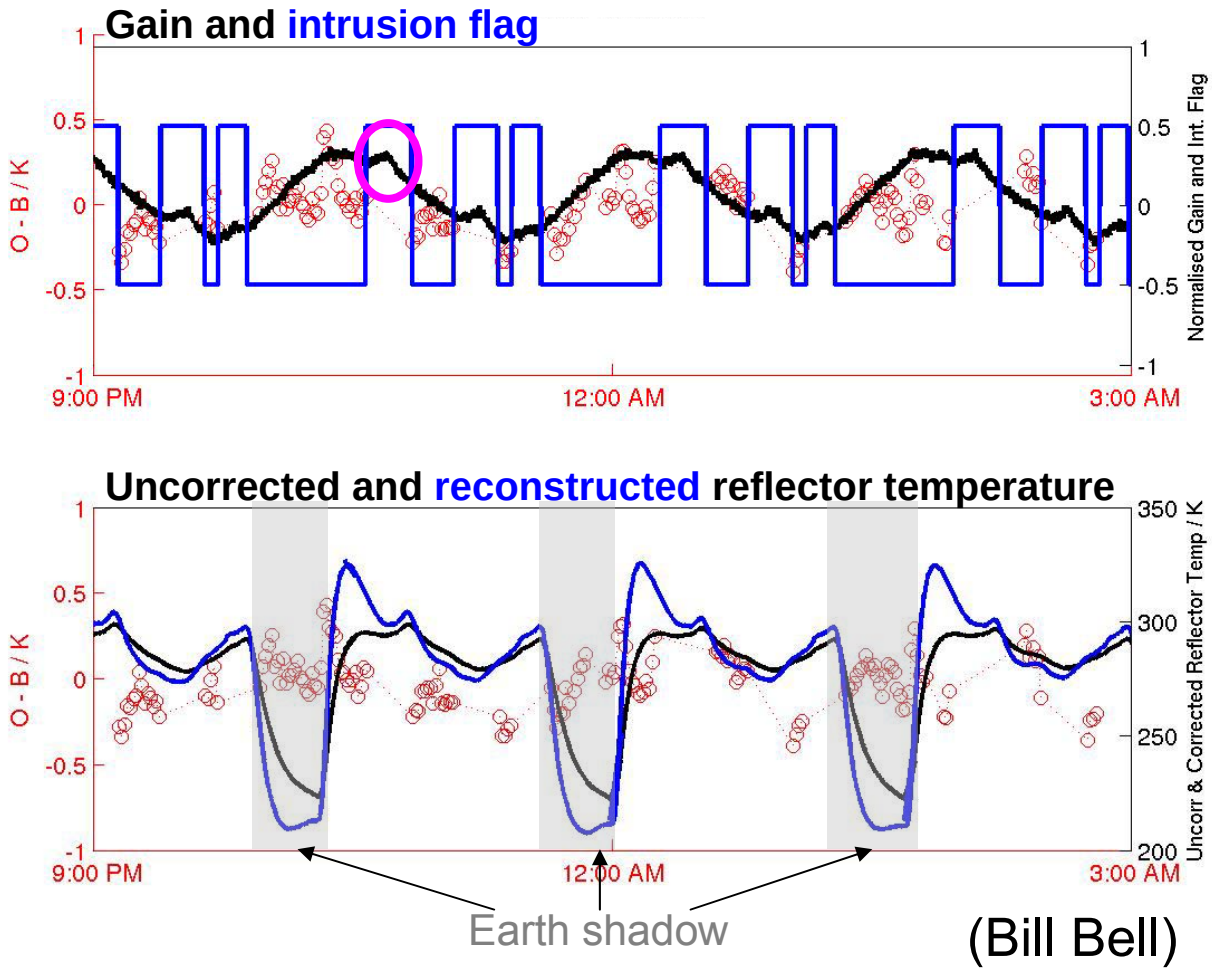
Main issues for temperature-sounding channels:

- Warm load solar intrusions (currently flagged, 30-40% of data)

- Reflector emission (correction applied)

These are dealt with in the SSMIS pre-processor (Met.Office, Bill Bell).

UK Met.Office Obs-FG (red)



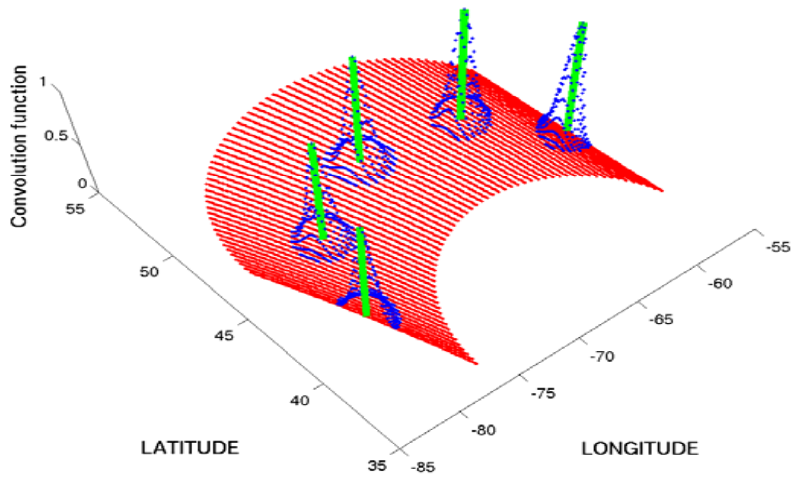

(Bill Bell)

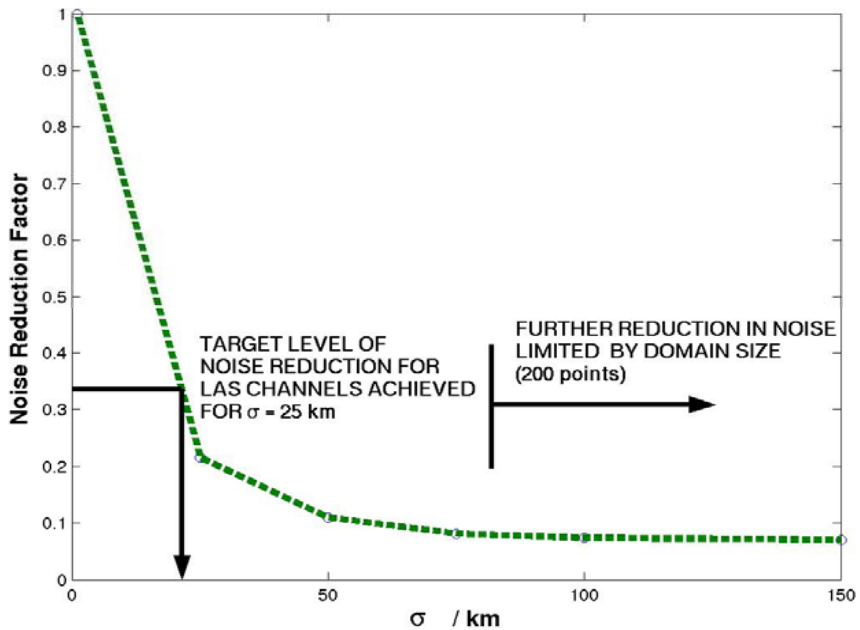
# SSMIS: Mapping performed by UKMO pre-processor

• Data is mapped & averaged to locations of lower atmospheric sounding channels.

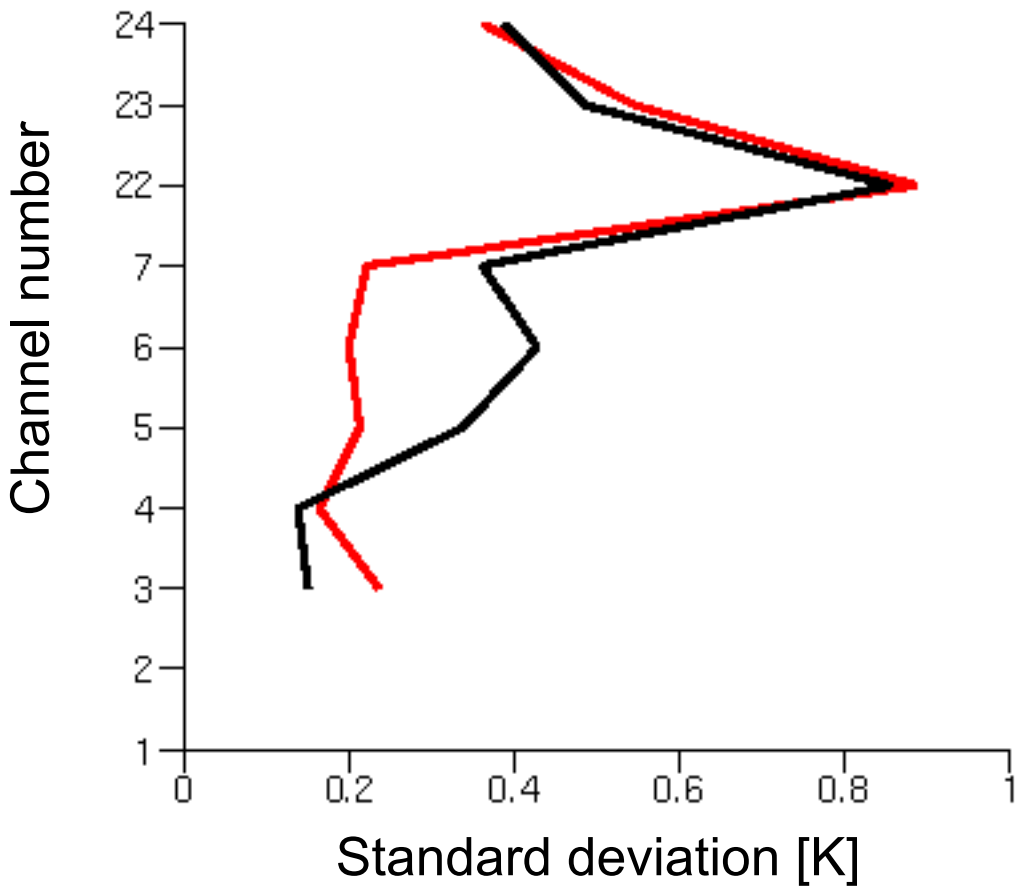
• This addresses:
  – Non-colocated FOVs
  – Along-track oversampling
  – Noise requirements:
    NEΔT for LAS channels is ~0.3K; require averaging to achieve $NE\Delta T_{eff}$ = 0.1K

• Pre-processor uses Gaussian averaging with σ = 50km (FWHM = 118km), $NE\Delta T_{eff}$ ~ 0.03K



# Monitoring of UKMO-mapped & averaged SSMIS data: FG departures vs AMSU-A



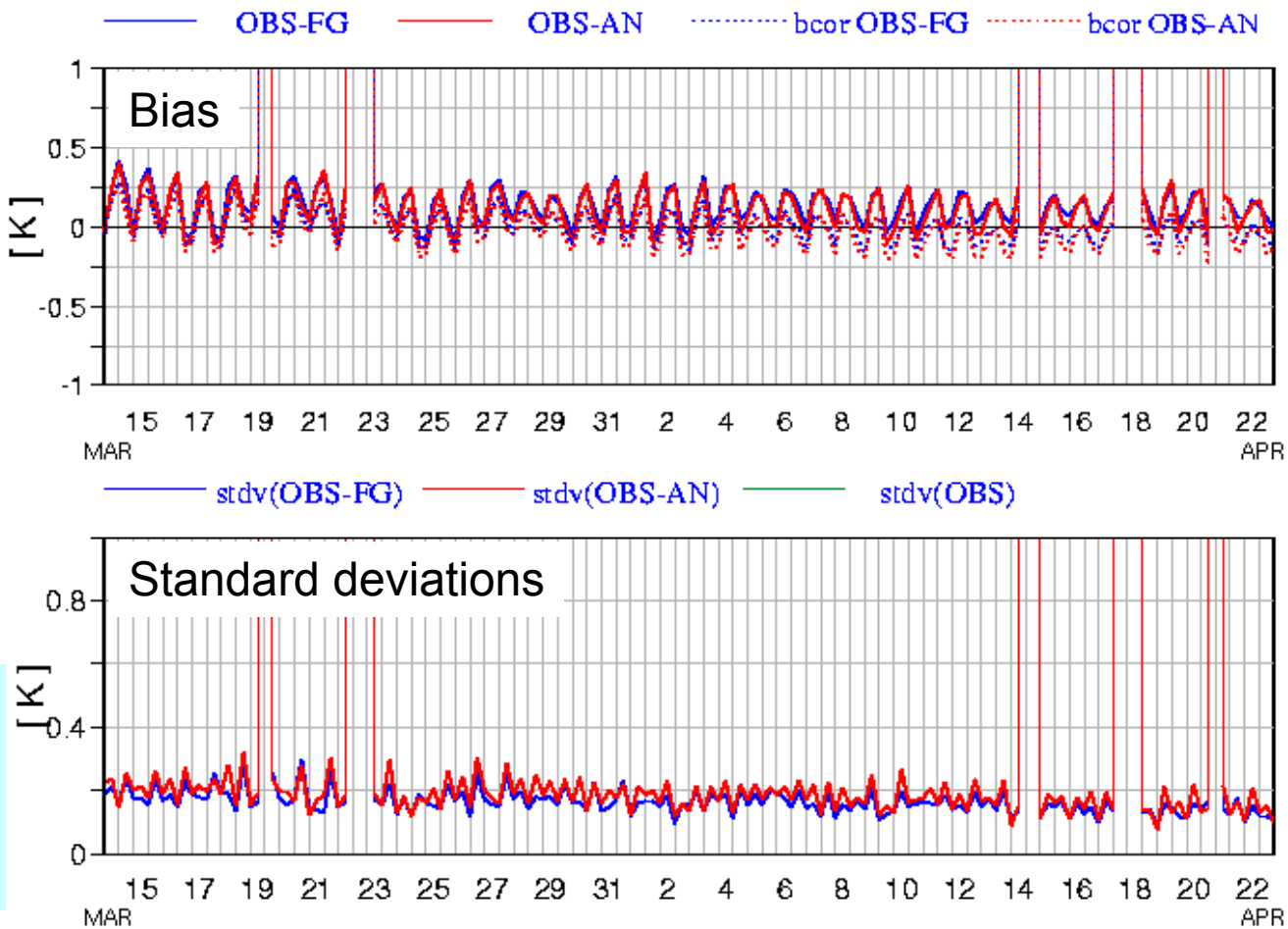

Southern Hemisphere
1-30 Sept 2006;
SSMIS passive,
others active

SSMIS obs-fg

AMSU-A obs-fg

# SSMIS monitoring of T-sounding channels: Timeseries of FG/AN departures

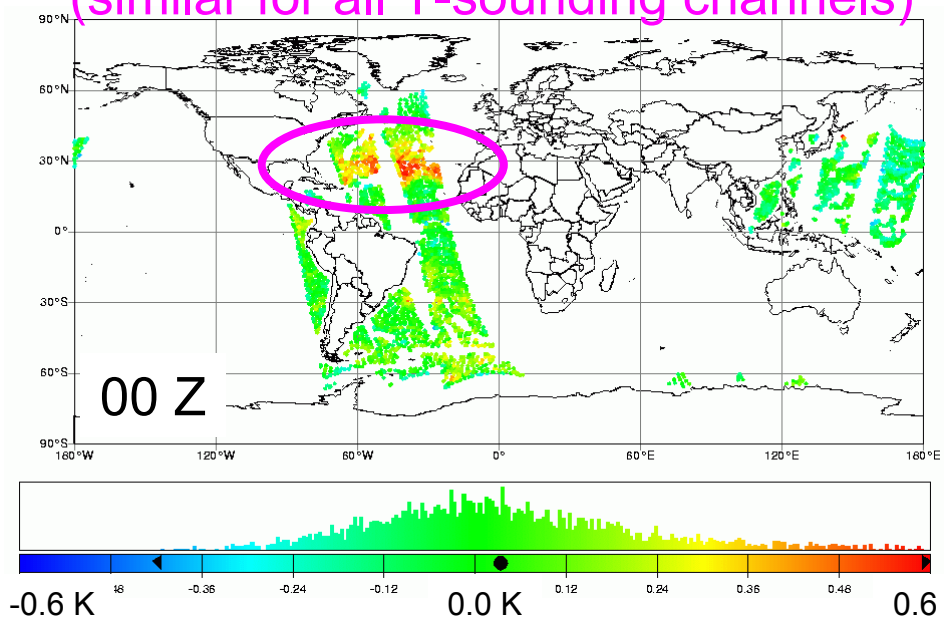
N.Mid.Lat (30-60N),
Channel 3
(~AMSU-A ch 5)

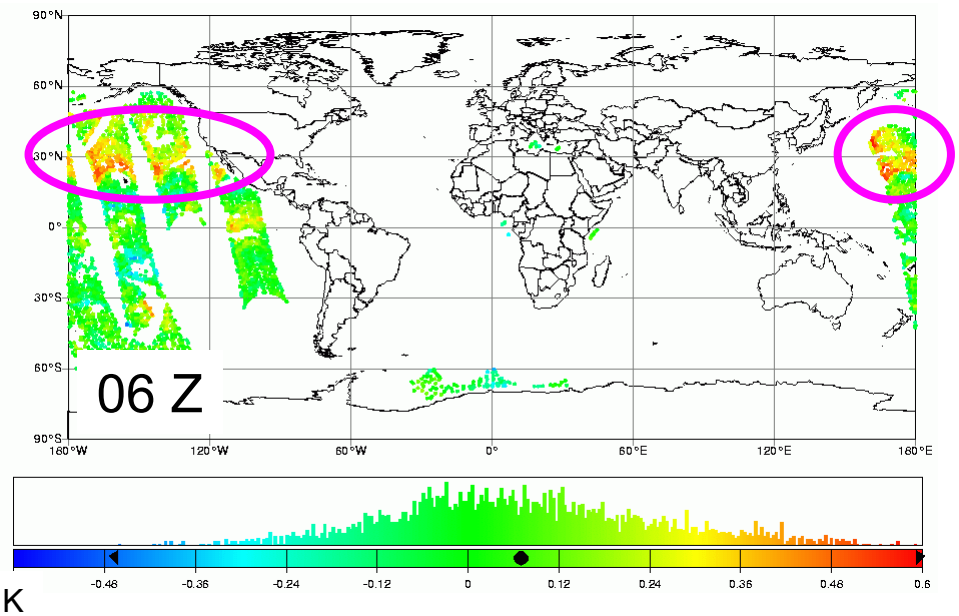


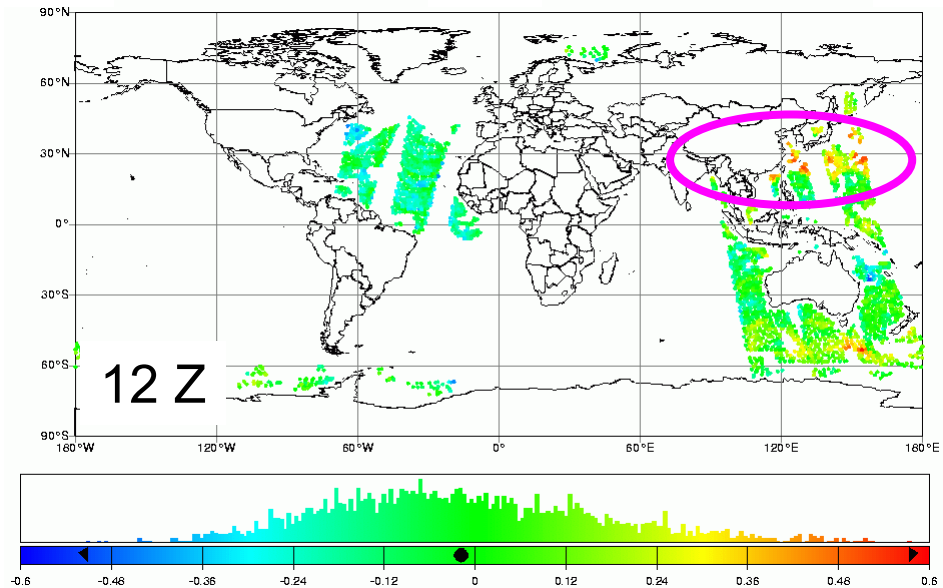

- Bias variations (almost) as large as standard deviations

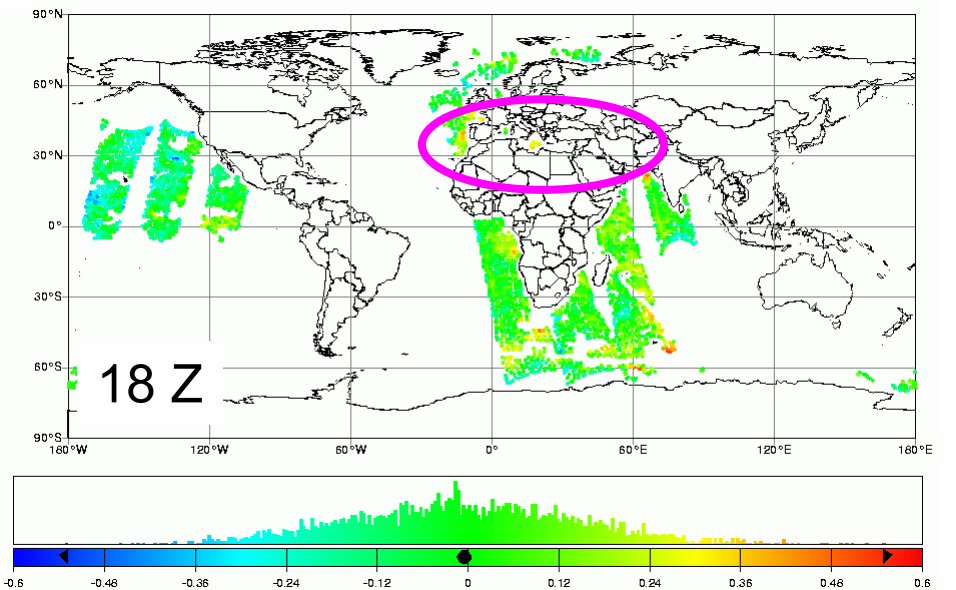
# SSMIS monitoring: FG departures for 3 April 2006, ch. 3

(similar for all T-sounding channels)

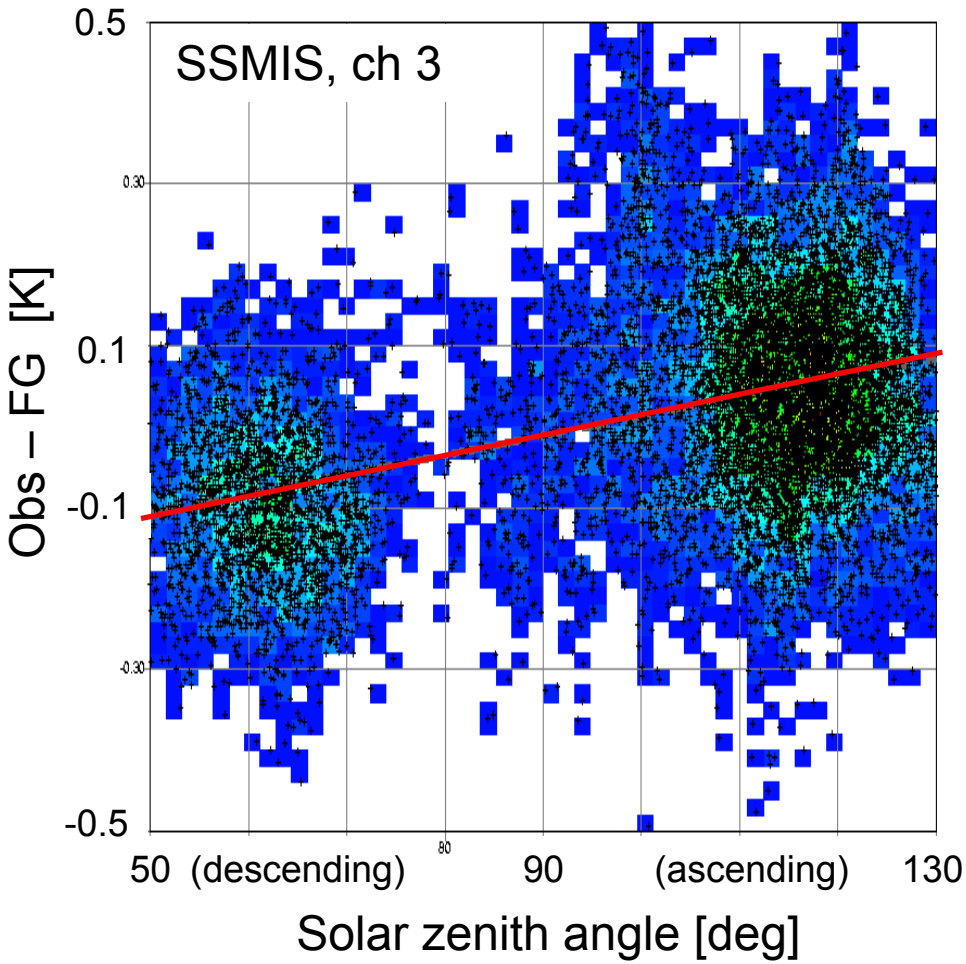


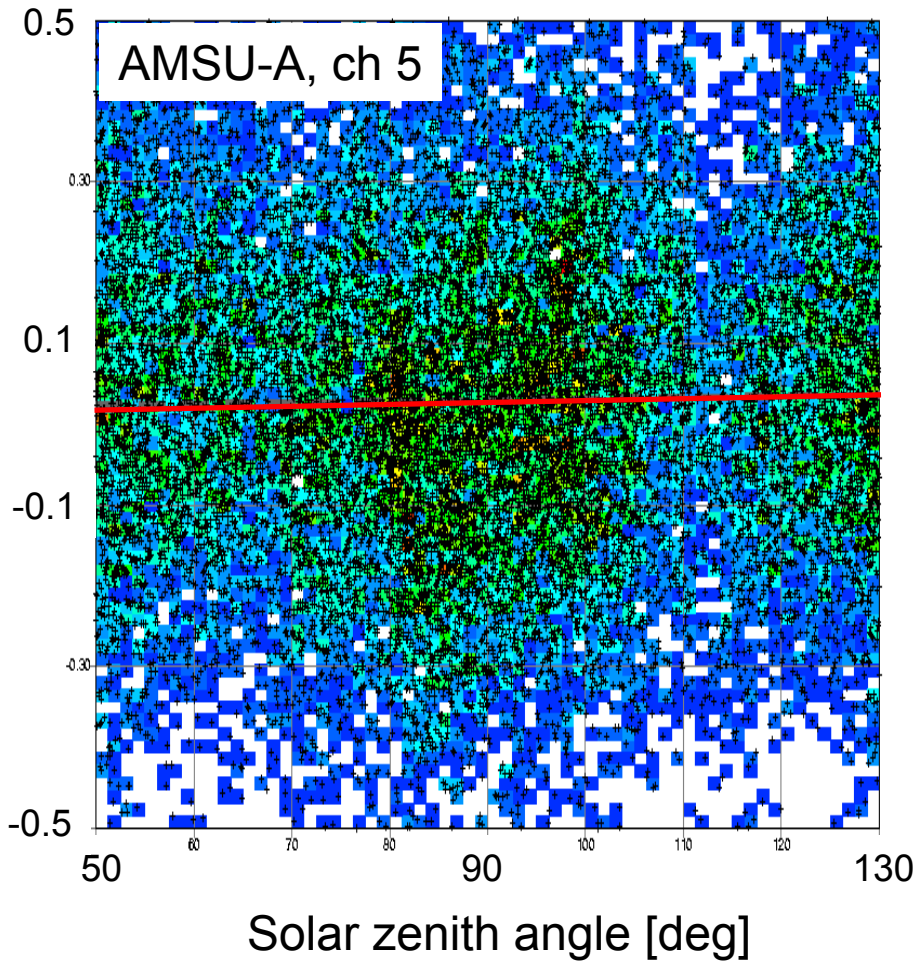



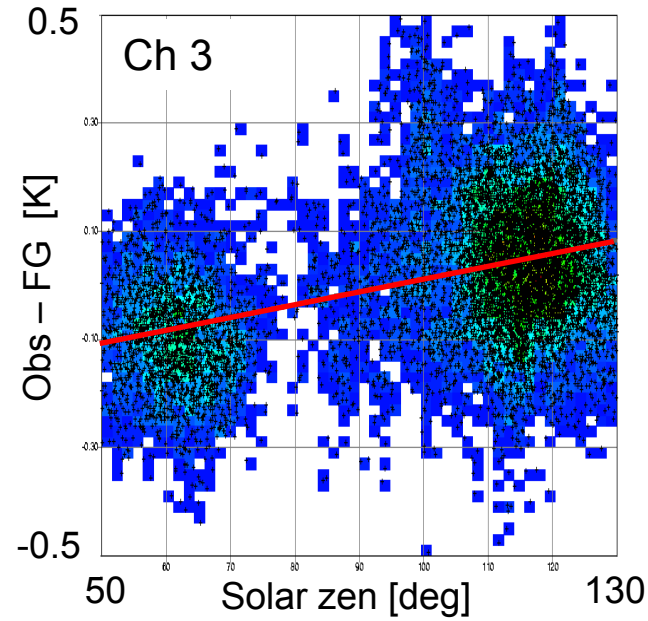



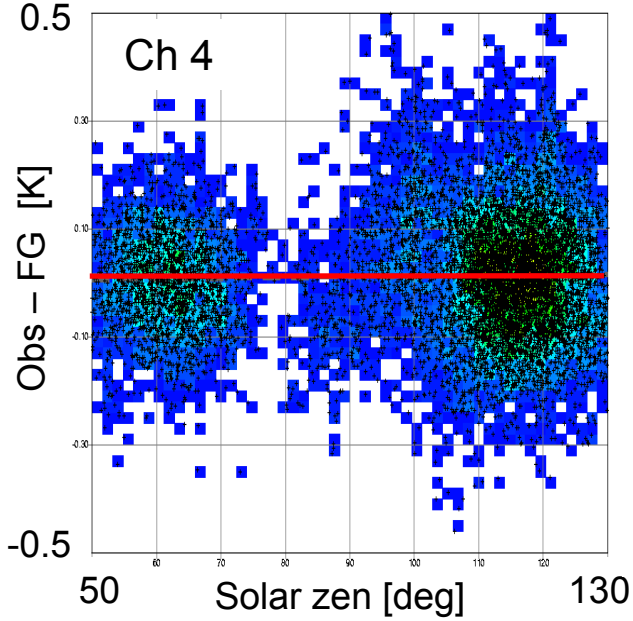
# SSMIS monitoring for T-sounding channels: FG departures vs solar zenith angle (3 April 2006)

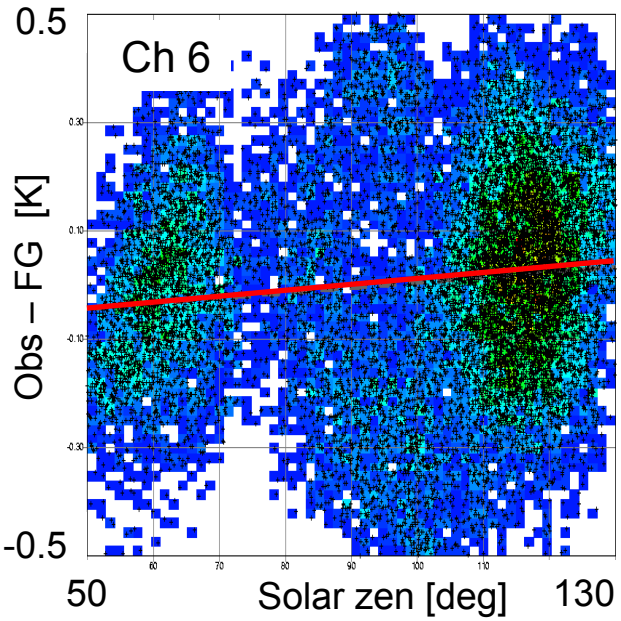


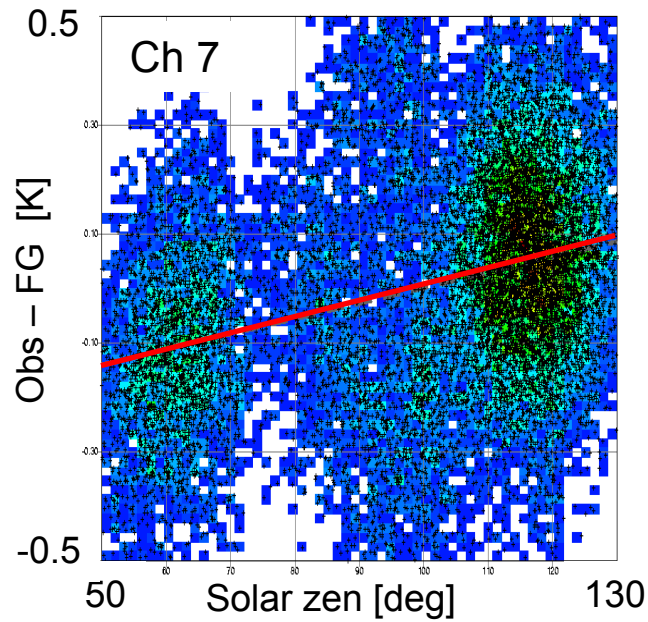



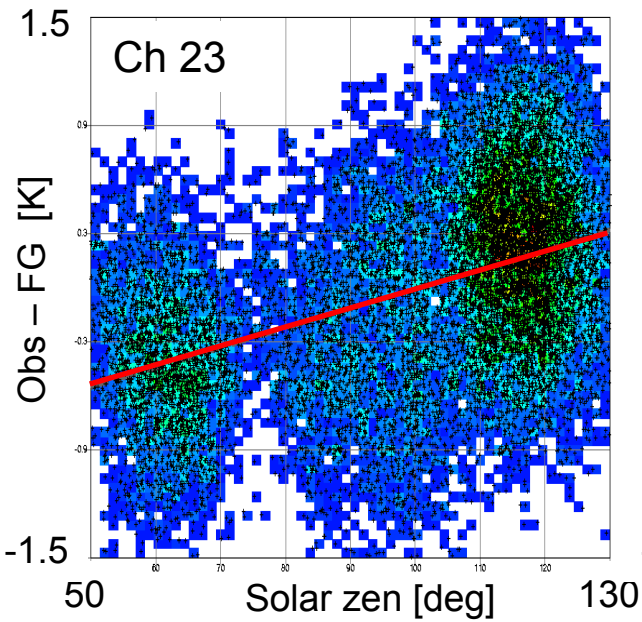
# FG departures vs solar zenith angle (3 April 2006)

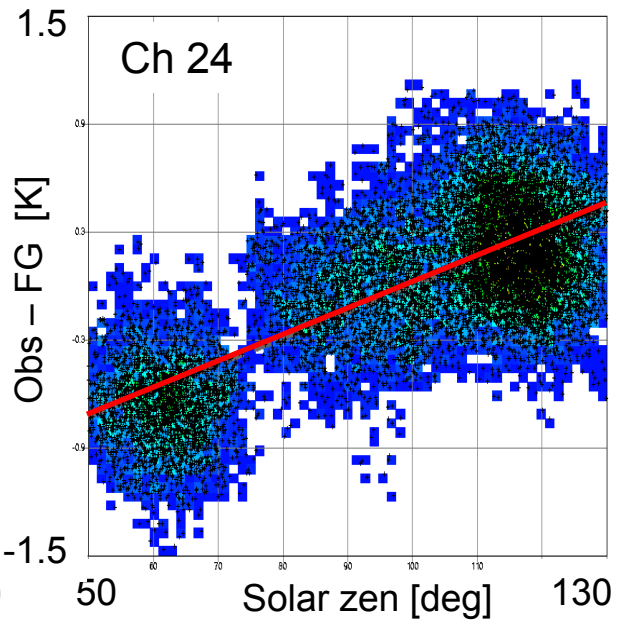


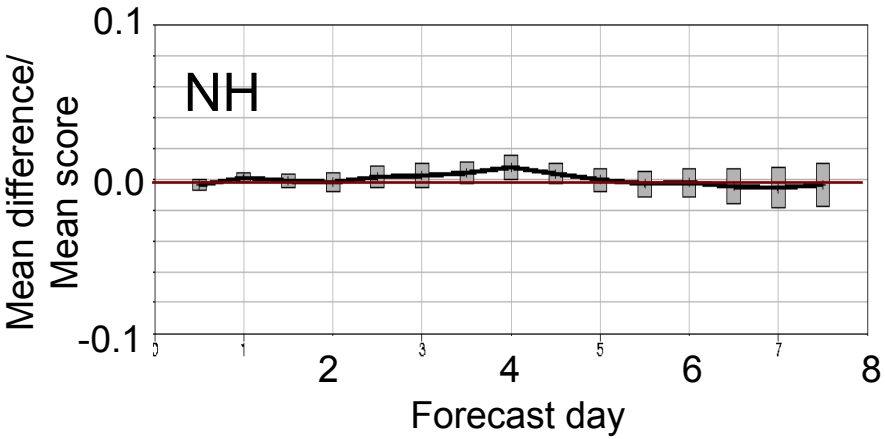



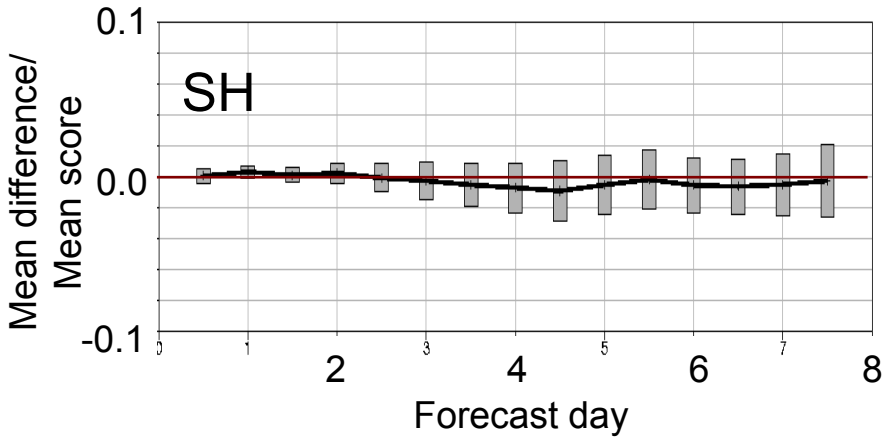



# Forecast impact of SSMIS T-sounding channels (I)
# Full system

- SSMIS used on top of operational observations.
- Channels 3-7, 23,24; 3 & 4 over sea only; set obs errors to larger than AMSU-A.
- 9 March – 30 April 2006 (53 days).
- T511 (~40km) model resolution, T159 (~125 km) analysis resolution, 91 levels.
- Overall no influence on fit to other observations.
- Neutral forecast impact.

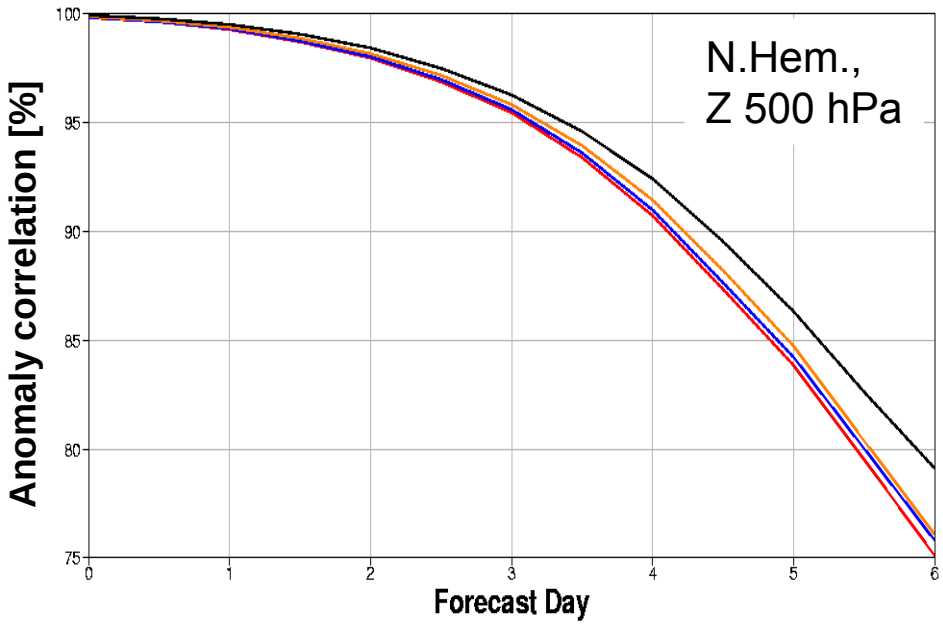
Difference in RMSE for Z 500 hPa, without – with SSMIS,
90 % confidence interval

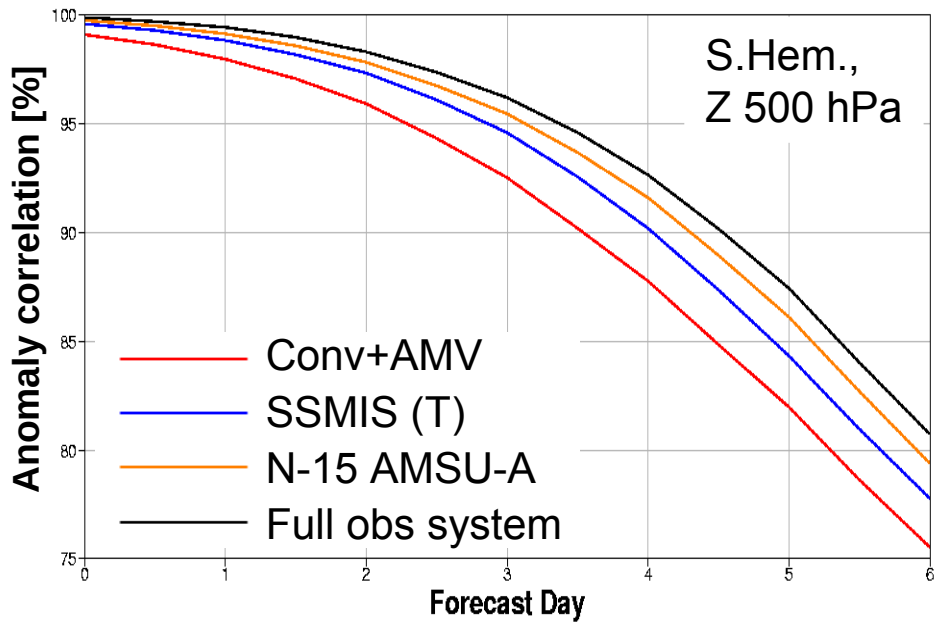


# Forecast impact of SSMIS T-sounding channels (II) “Baseline” system

- SSMIS added to conventional observations and AMVs only.
- Compared to adding NOAA-15 AMSU-A.
- 12 December 2005 – 11 January 2006 (31 days).
- T159 (~125 km) model and analysis resolution, 91 levels.

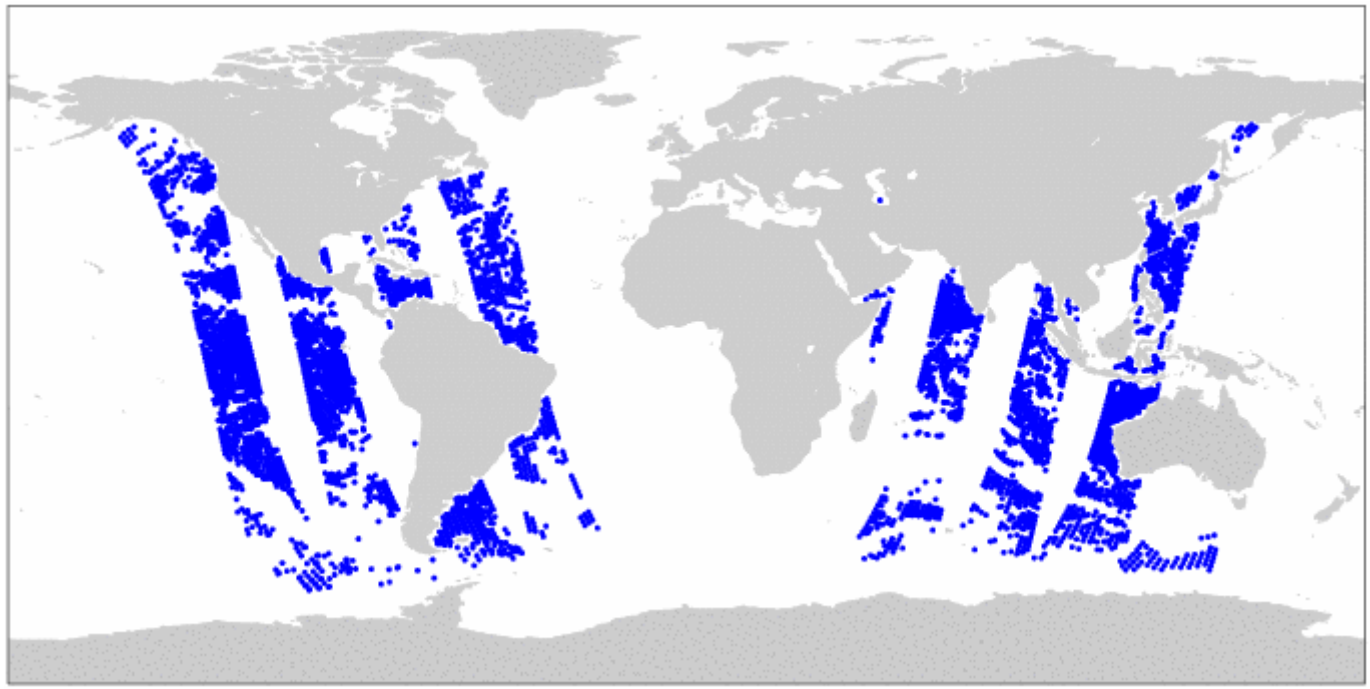


# Outline

1. SSMIS (temperature-sounding channels)
2. **SSMIS (SSMI-like channels), AMSR-E, TMI**
3. Summary

# Conically scanning microwave imagers (clear-sky)



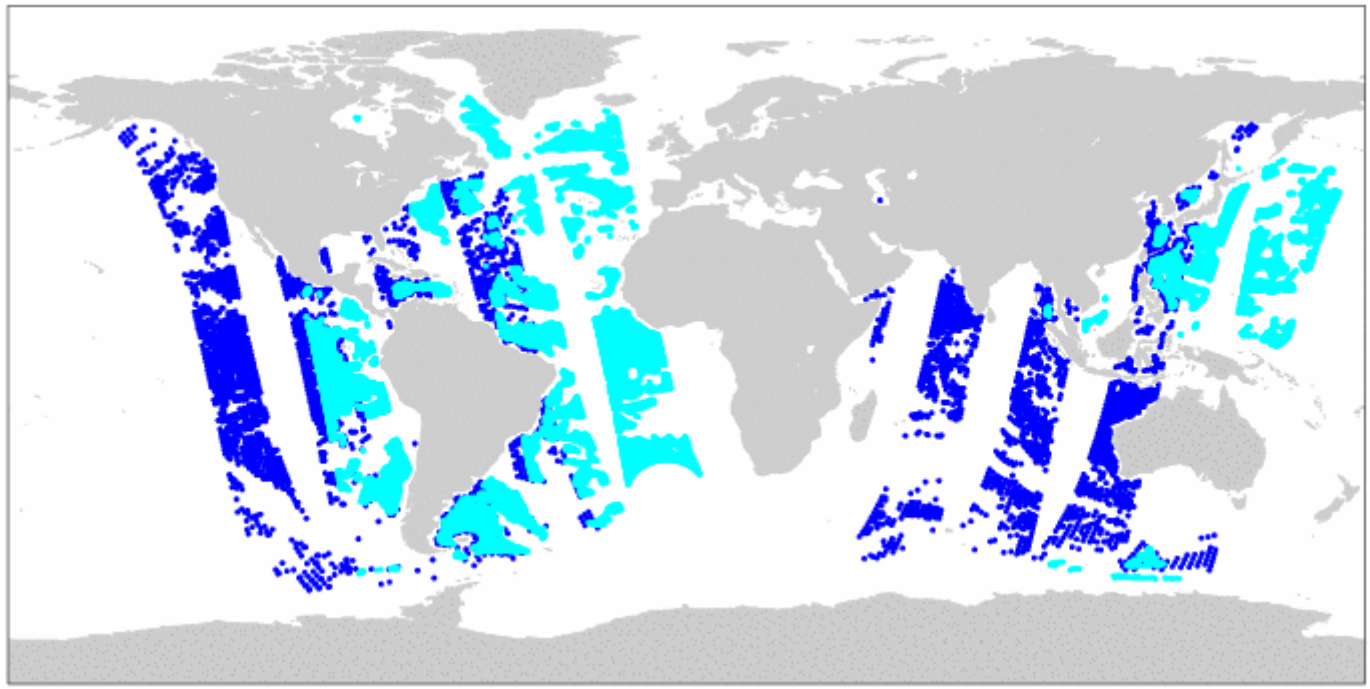
Coverage in 6-h period (DMSP-13&14)

Channel frequencies [GHz] and polarisations

| | | | | | | |
|---|---|---|---|---|---|---|
| SSMI | | | 19.35 V & H | 22.235 V | 37.0 V & H | 85.5 V & H |

SSMI currently used operationally

# Conically scanning microwave imagers (clear-sky)

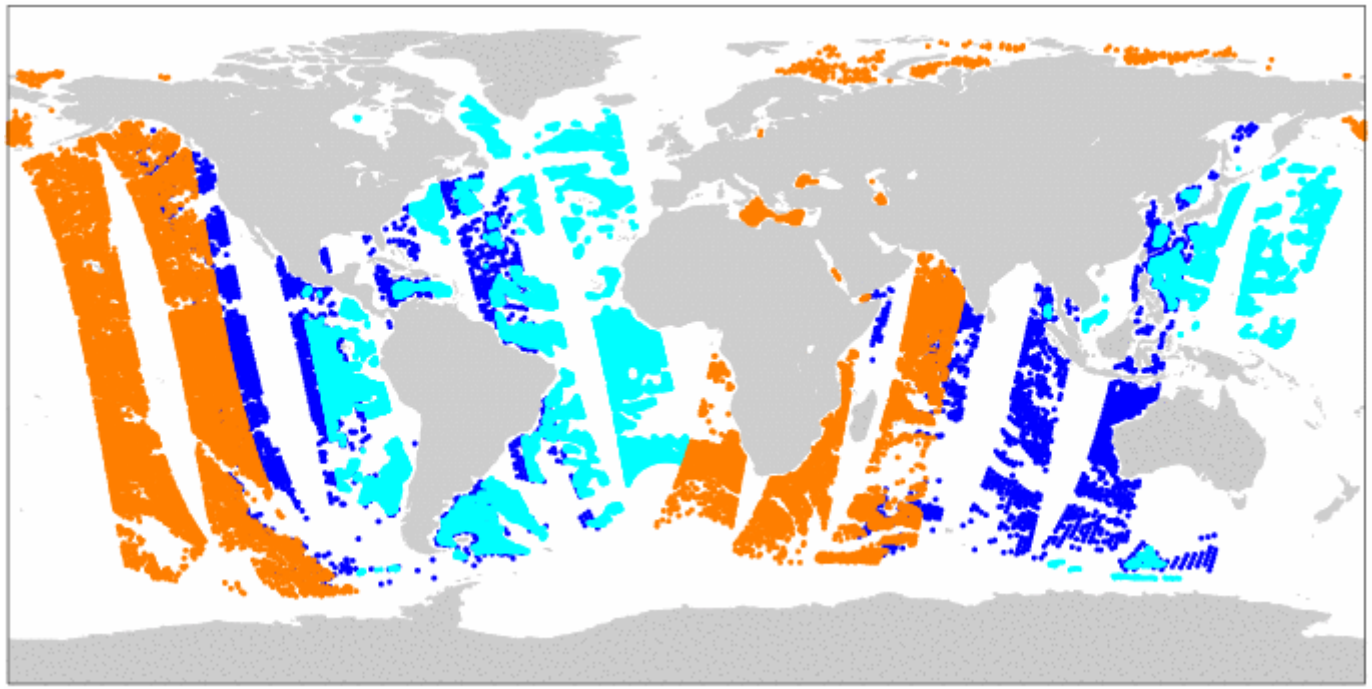


Coverage in 6-h period

Channel frequencies [GHz] and polarisations

| | | | | | | |
|---|---|---|---|---|---|---|
| SSMI | | | 19.35 V & H | 22.235 V | 37.0 V & H | 85.5 V & H |
| SSMIS | | | 19.35 V & H | 22.235 V | 37.0 V & H | 91.655 ± 0.9 V & H |

# Conically scanning microwave imagers (clear-sky)



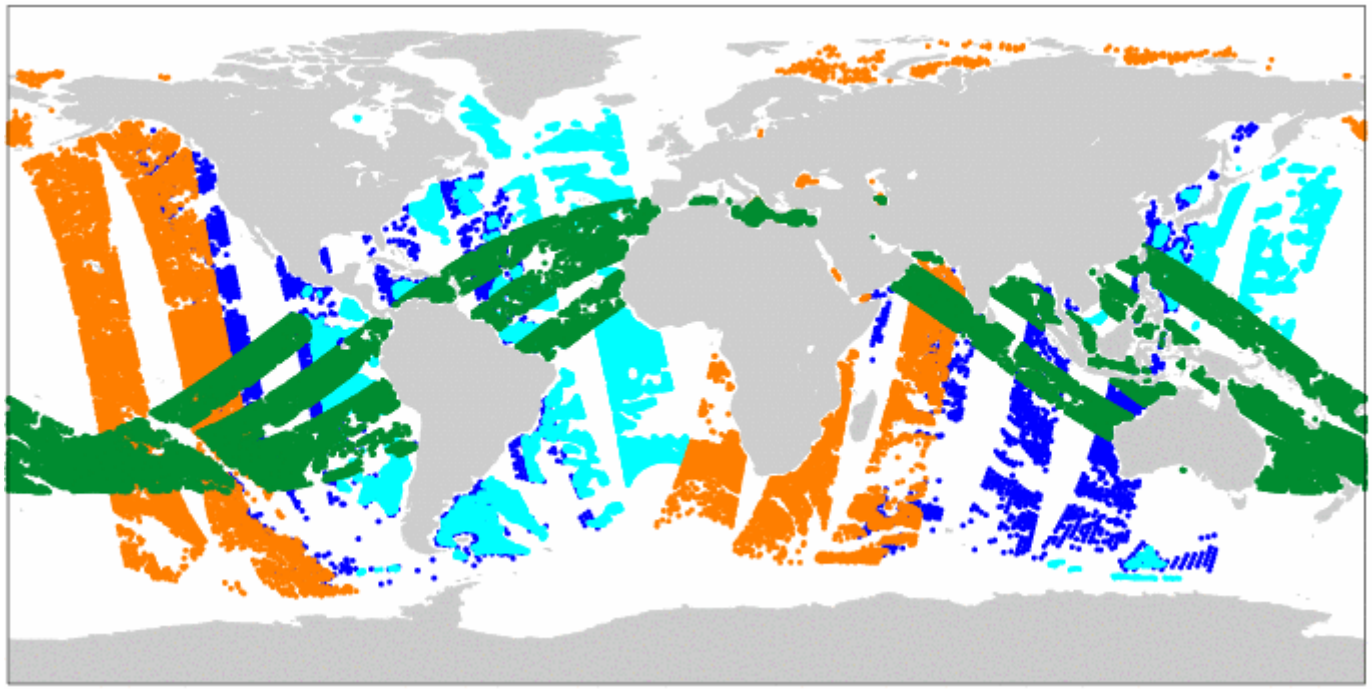
Coverage in 6-h period

Channel frequencies [GHz] and polarisations

| | | | | | | |
|---|---|---|---|---|---|---|
| SSMI | | | 19.35 V & H | 22.235 V | 37.0 V & H | 85.5 V & H |
| SSMIS | | | 19.35 V & H | 22.235 V | 37.0 V & H | 91.655 ± 0.9 V & H |
| AMSR-E | 6.925 V & H | 10.65 V & H | 18.7 V & H | 23.8 V & H | 36.5 V & H | (89.0 V & H) |

# Conically scanning microwave imagers (clear-sky)

Coverage in 6-h period

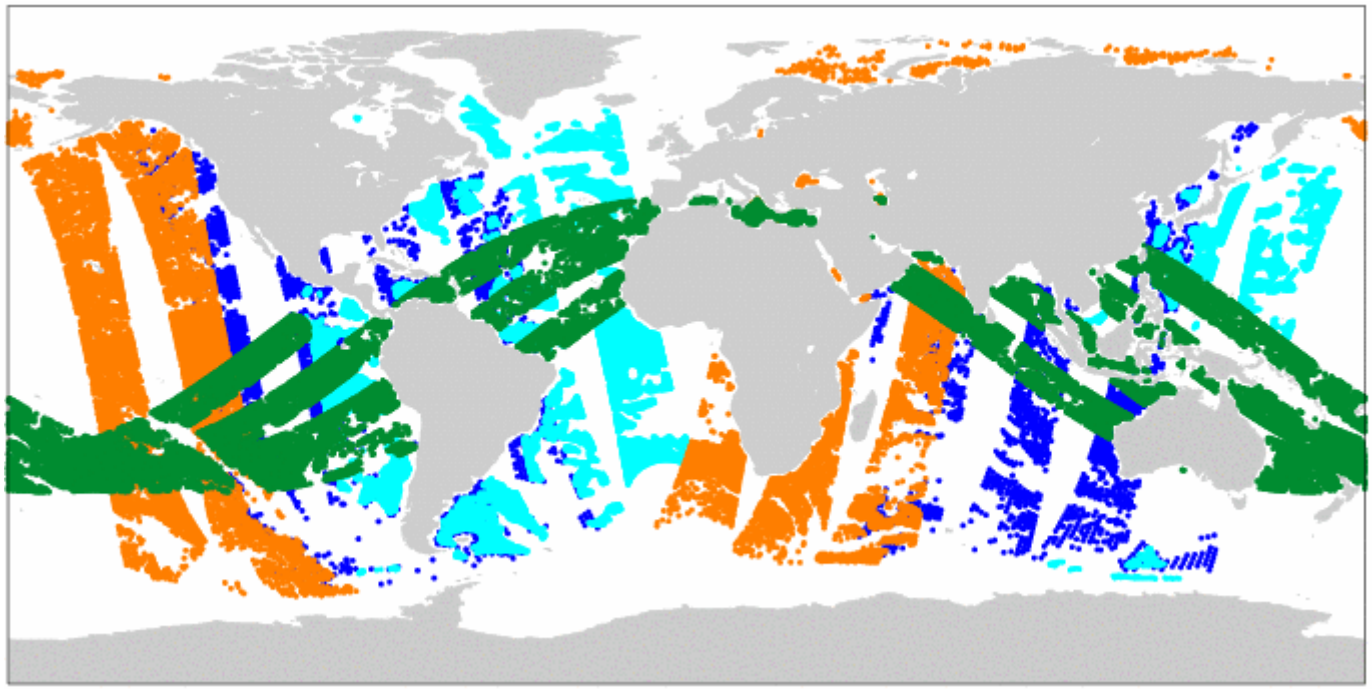


Channel frequencies [GHz] and polarisations

| | | | | | | |
|---|---|---|---|---|---|---|
| SSMI | | | 19.35 V & H | 22.235 V | 37.0 V & H | 85.5 V & H |
| SSMIS | | | 19.35 V & H | 22.235 V | 37.0 V & H | 91.655 ± 0.9 V & H |
| AMSR-E | 6.925 V & H | 10.65 V & H | 18.7 V & H | 23.8 V & H | 36.5 V & H | (89.0 V & H) |
| TMI | | 10.65 V & H | 19.35 V & H | 22.235 V | 37.0 V & H | 85.5 V & H |

# Conically scanning microwave imagers (clear-sky)

Coverage in 6-h period



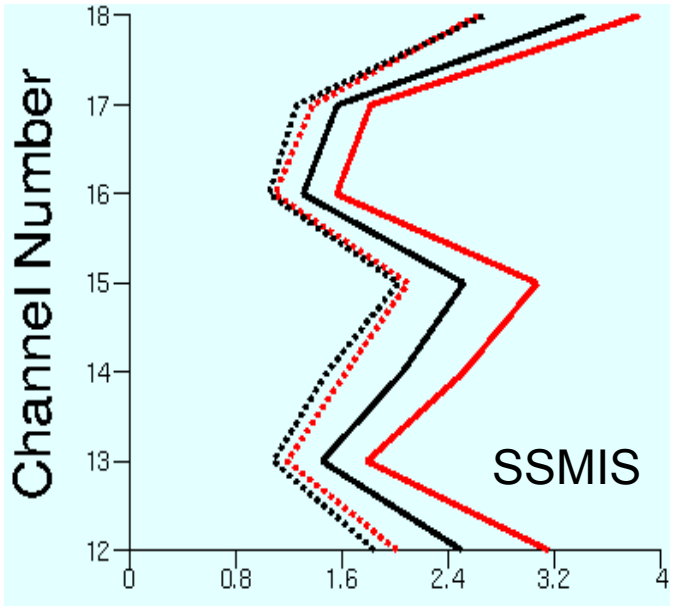
Channel frequencies [GHz] and polarisations

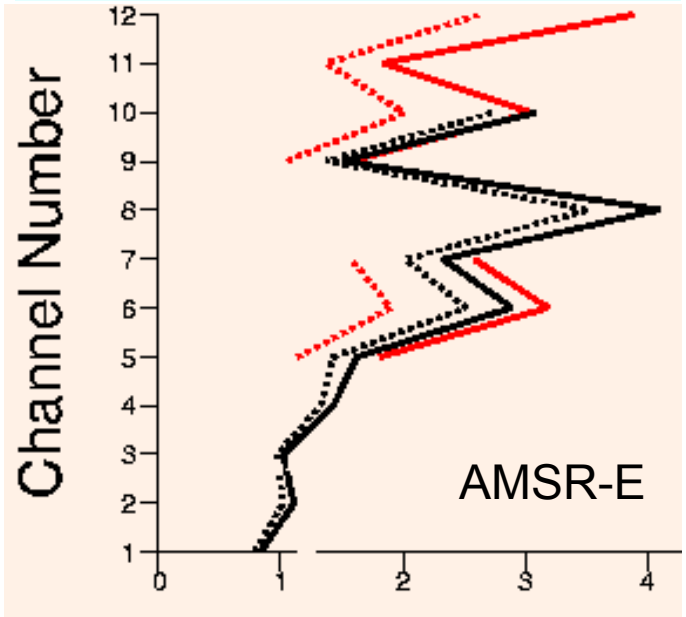
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SSMI | | | 19.35 V & H | 22.235 V | 37.0 V & H | 85.5 V & H | Ops |
| SSMIS | | | 19.35 V & H | 22.235 V | 37.0 V & H | 91.655 ± 0.9 V & H | |
| AMSR-E | 6.925 V & H | 10.65 V & H | 18.7 V & H | 23.8 V & H | 36.5 V & H | (89.0 V & H) | New |
| TMI | | 10.65 V & H | 19.35 V & H | 22.235 V | 37.0 V & H | 85.5 V & H | |

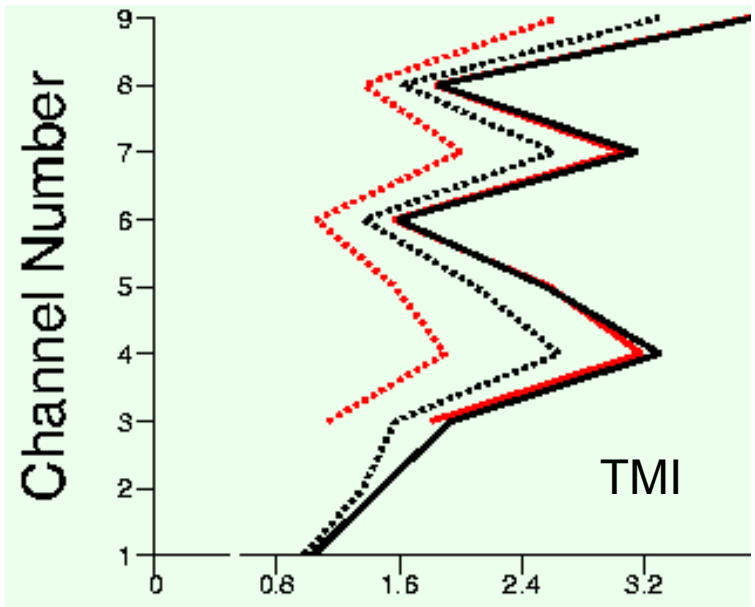
# Monitoring against First Guess

Standard deviations of FG departures [K] for **new MW imagers** (passive, screened) vs **SSMI** (used), Tropics

New MW imager vs FG
New MW imager vs AN
SSMI vs FG
SSMI vs AN



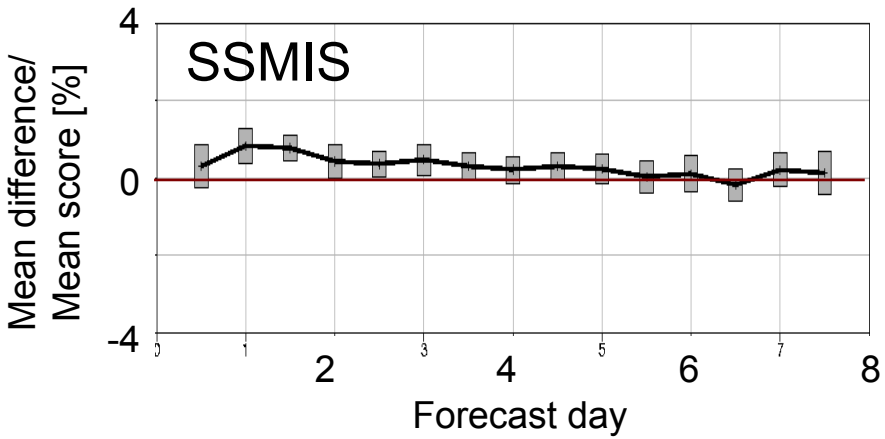



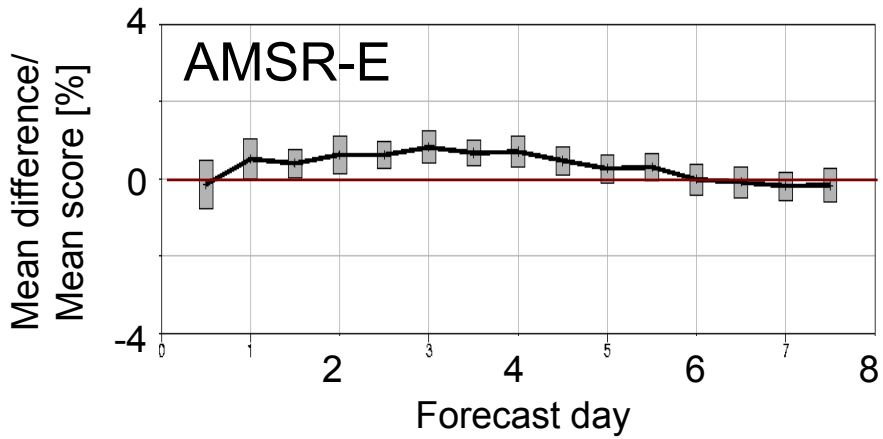



# Forecast impact of SSMIS & AMSR-E
# Full system

- SSMIS and AMSR-E assimilated on top of operational observations (2 separate experiments).
- SSMIS: channels 12-18;  AMSR-E: channels 5-10;  both clear-sky over sea only
- 9 March – 30 April 2006 (53 days).
- T511 (~40km) model resolution, T159 (~125 km) analysis resolution, 91 levels.

Difference in RMSE for RH 850 hPa, tropics, without – with,
90 % confidence interval

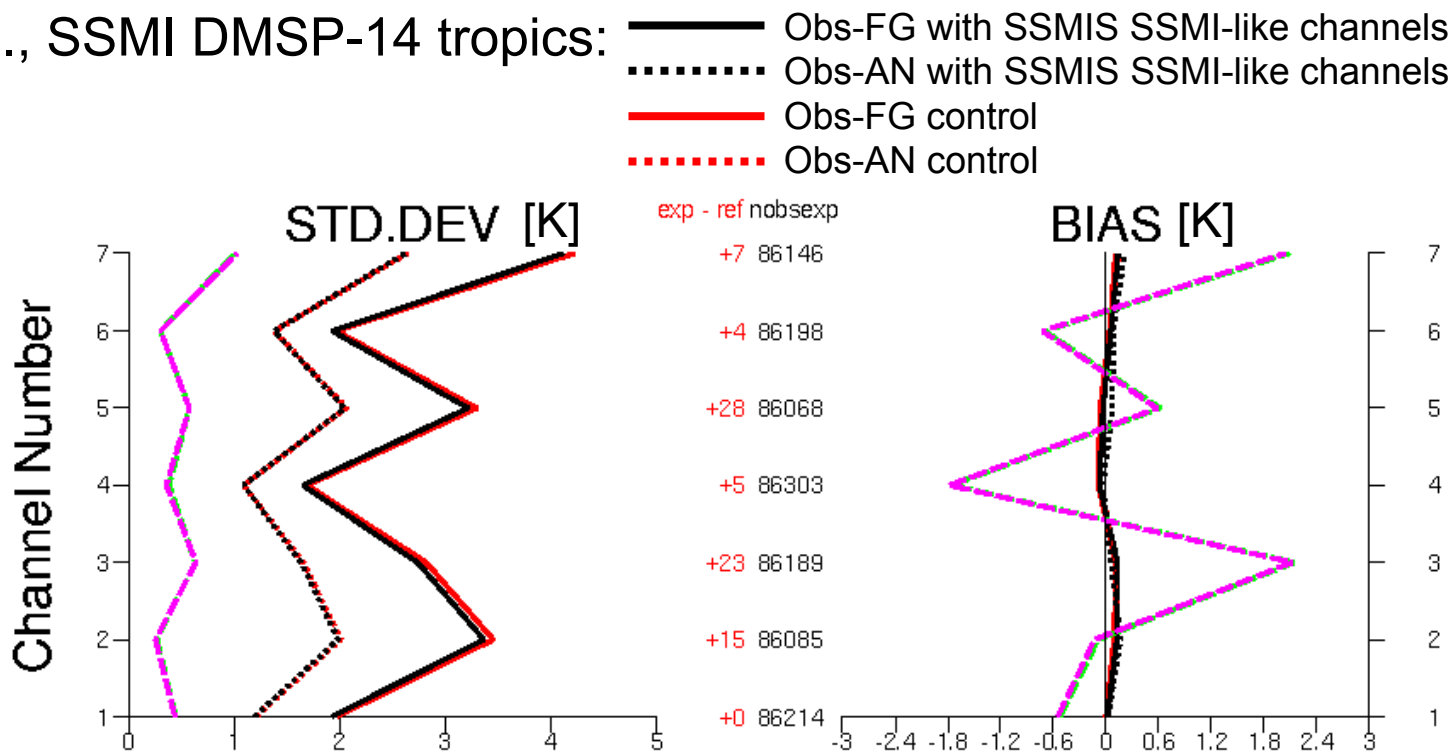


# Fit to other observations: SSMIS(SSMI) & AMSR-E

- Improved FG fit for other MW imagers for the Tropics.
- Little change in fit to other observations elsewhere.

E.g., SSMI DMSP-14 tropics:



# Summary

– **SSMIS T-sounding channels:**
  - Standard deviations of FG departures look reasonable in mapped & corrected data.
  - But significant bias anomalies remain:
    1. Over-correction of reflector temperature when the satellite reappears from the Earth's shadow.
    2. Day-night biases.

    » Improved flagging/better correction of anomalies desirable.
  - Neutral forecast impact when added to full system.
  - Adding SSMIS to baseline system (ie conventional obs + AMVs) gives ~2/3 of impact of NOAA-15 AMSU-A.

– **SSMIS SSMI-like channels, AMSR-E, TMI:**
  - Monitoring against FG shows similar statistics as SSMI (better for SSMIS, partly due to averaging)
  - Slight forecast improvement for lower tropospheric relative humidity in the tropics from assimilating SSMIS or AMSR-E.