Optimisation of Oxygen sounding channel frequencies and polarisations

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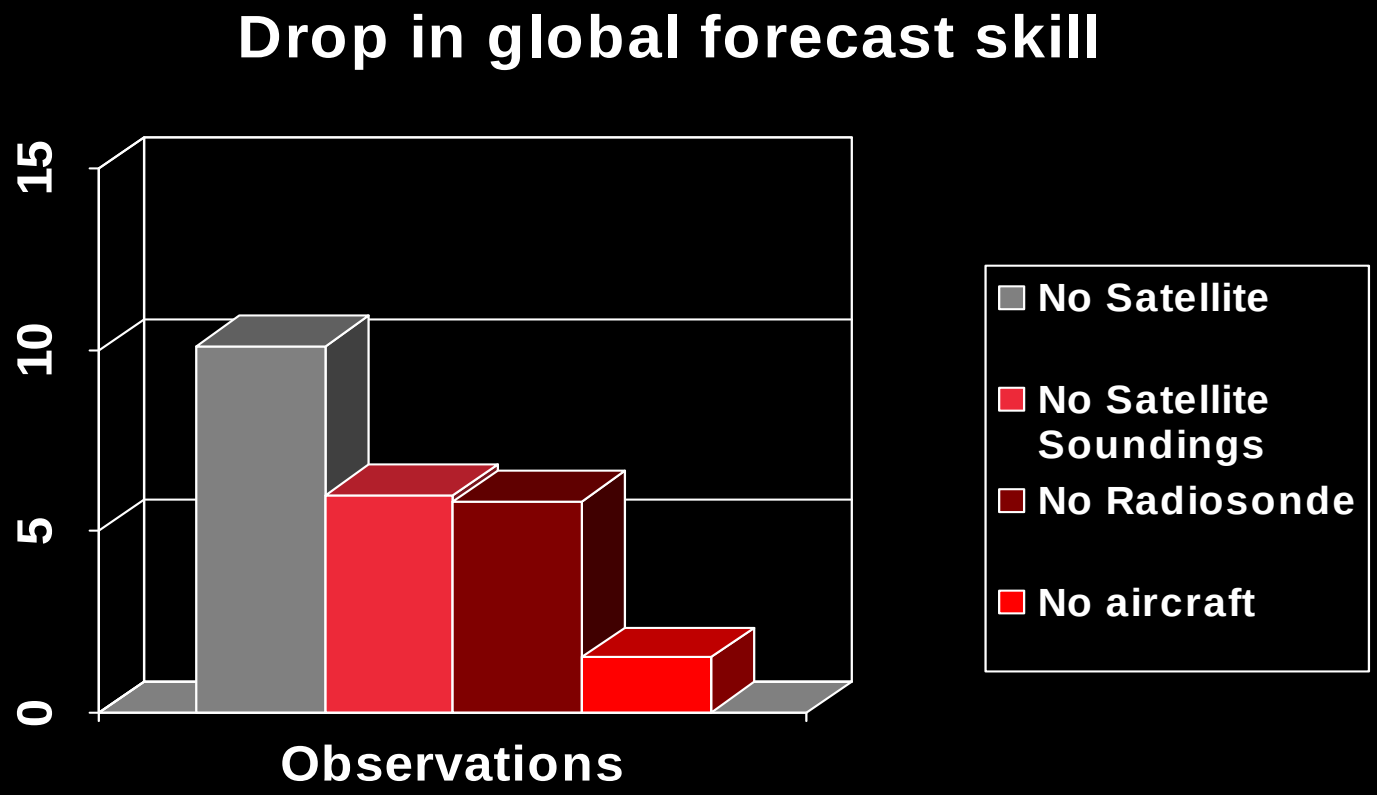
Motivation

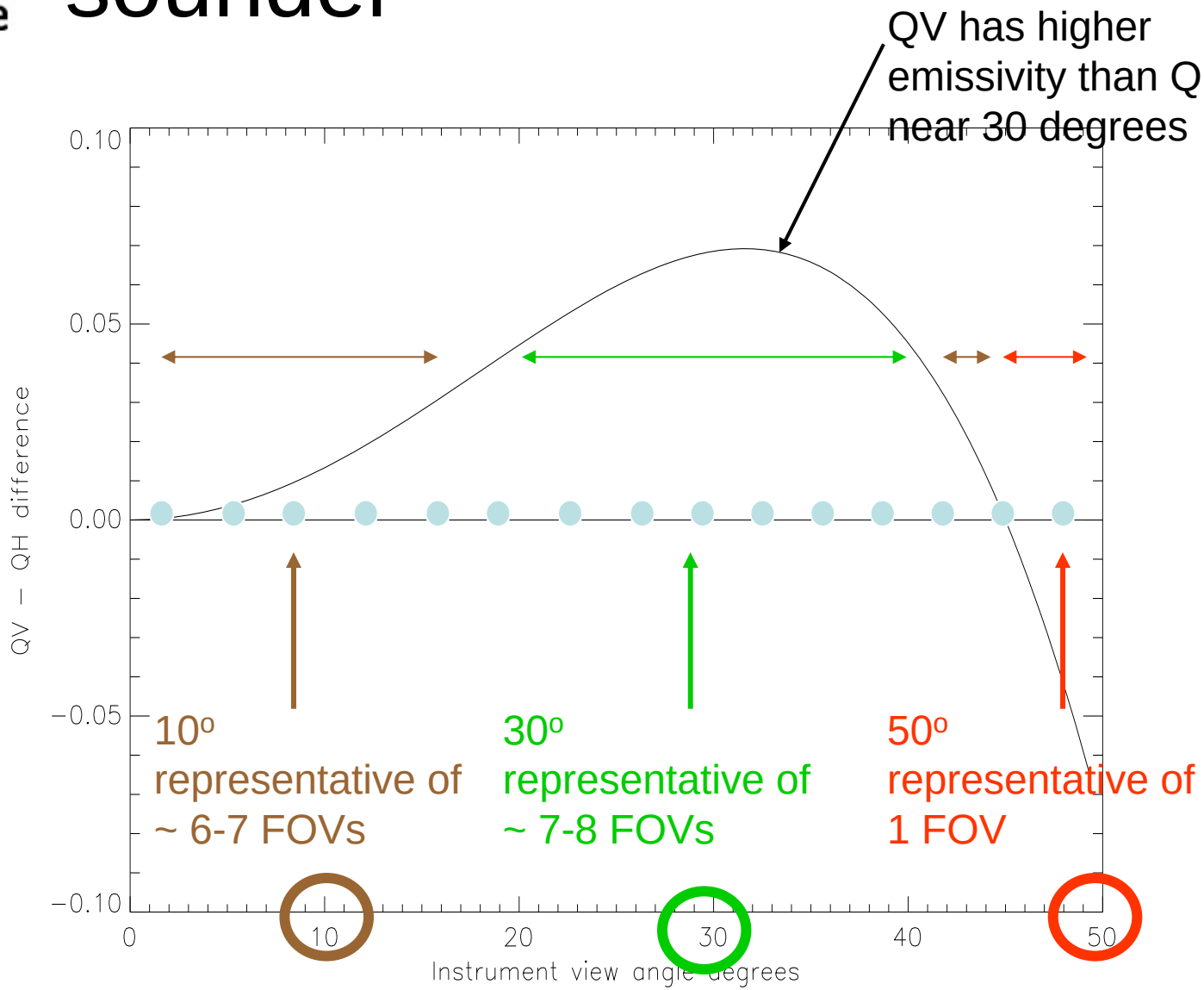


- Advanced Microwave sounding Unit (AMSU) made rapid advances in forecast accuracies over the last ten years.
- However, its design including channel bandwidth and polarisations originate from early 70s, and have not been revisited since (except for Lipton, 2003).

Polarisation

Spectrum Usage

Polarisation for a cross track sounder



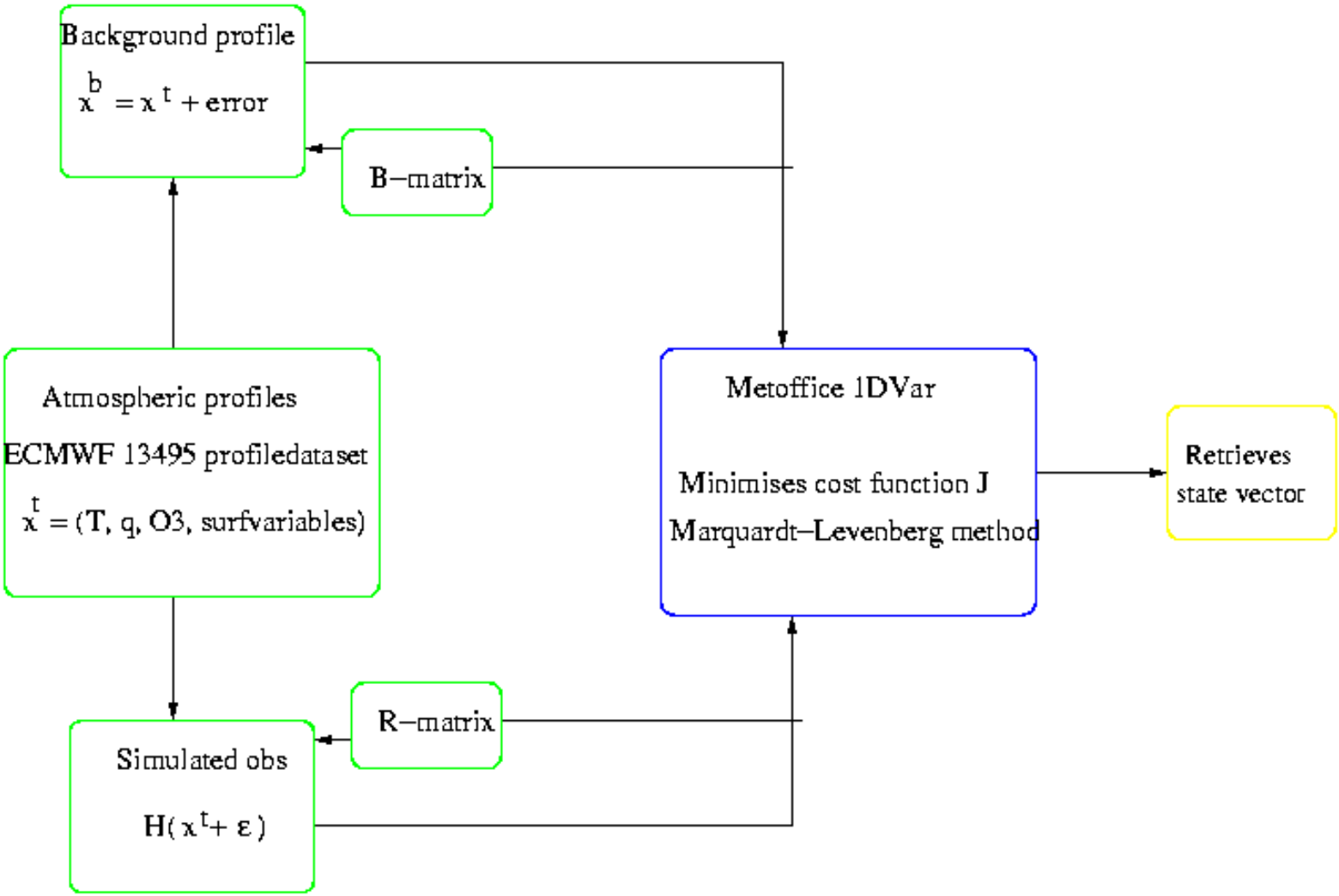
Questions

Advanced Microwave sounding Unit (AMSU)

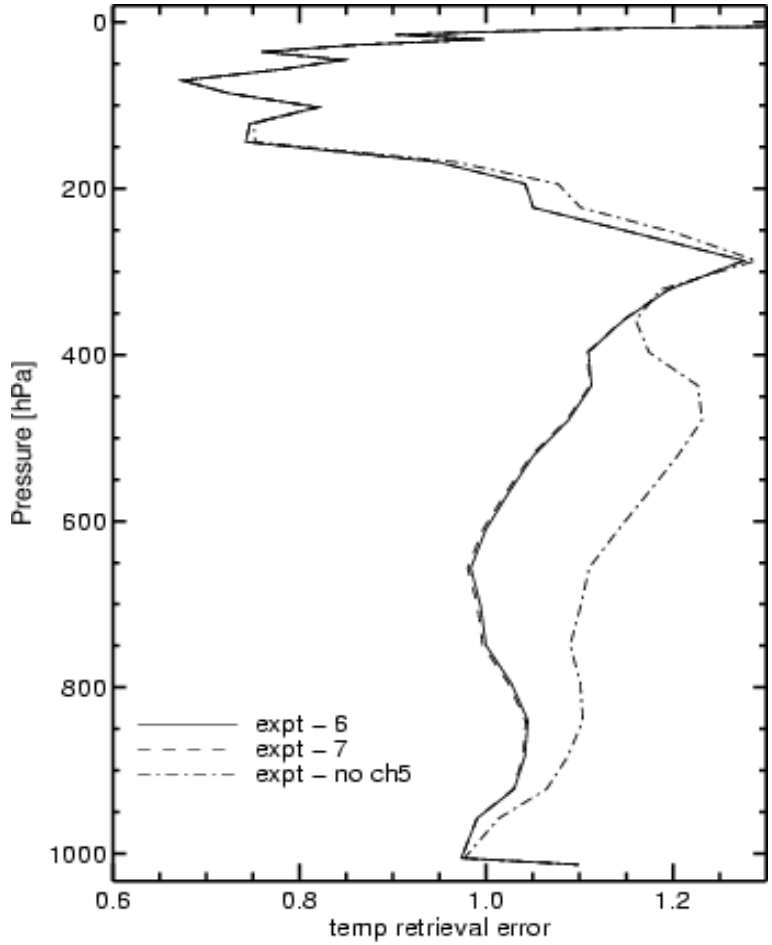
QV	QH
1-4, 7, 15-20	5, 6, 8-14

- $e_h < e_v$, errors in modelling e_v lower than errors in e_h
- Does polarisation matter for any MHS or AMSU-A channels?
- Does switching the polarisation between QV and QH matter for adjacent channels?
- Can current AMSU-A polarisation choices be significantly improved upon?

Simulation Set up



Impact of polarisation reversal for channel 5

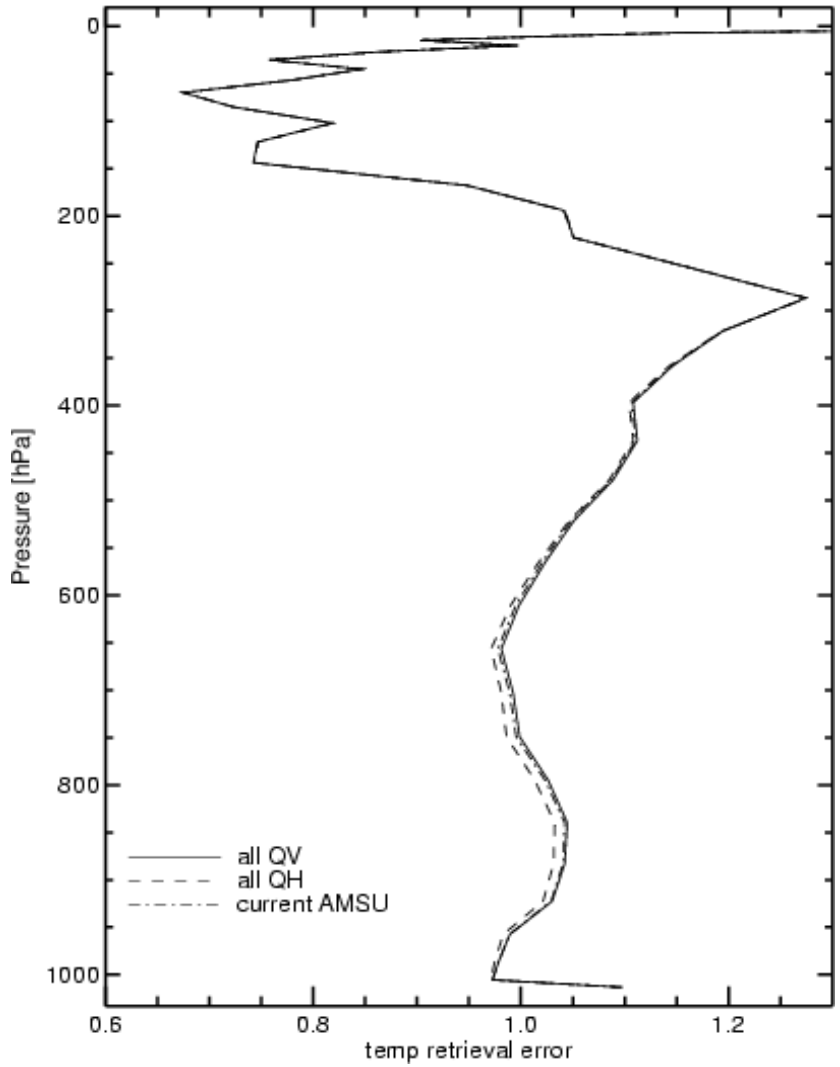


- Very small differences when polarisations are switched.

	QV	QH
expt 6	1-5,15-20	6-14
expt 7	1-4,15-20	5-14

- Not significant when compared to the impact of the channels.

Current AMSU



AMSU: 1-4, 7, 15-20 – QV

5,6, 8-14 – QH

- AMSU performance is sub-optimal
- But performs more close to the worst case.

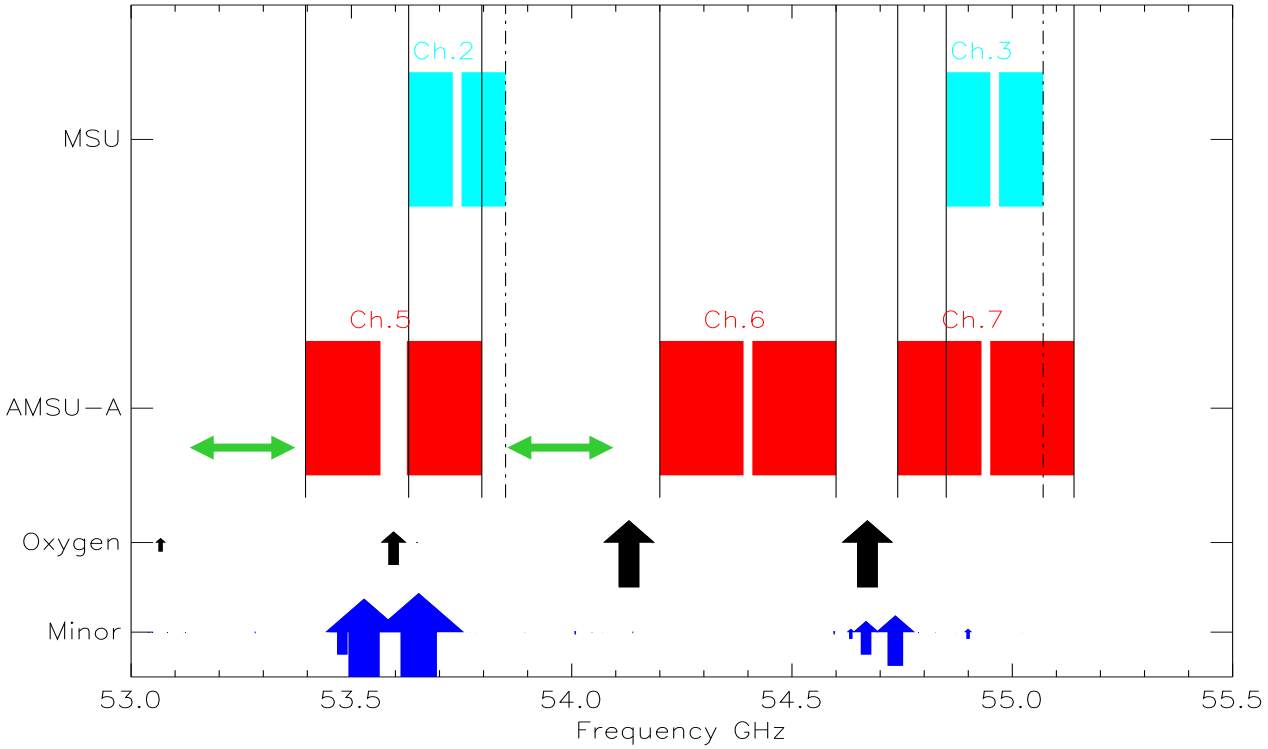
Met Office

Polarisation

Spectrum Usage

Comparison MSU and AMSU

- AMSU channels are in red, MSU in blue. Some of the MSU channel was “lost in the AMSU design, some useful looking spectrum (green arrows) has never been measured. Why? Oxygen and minor gas lines indicated by black and dark blue arrows.

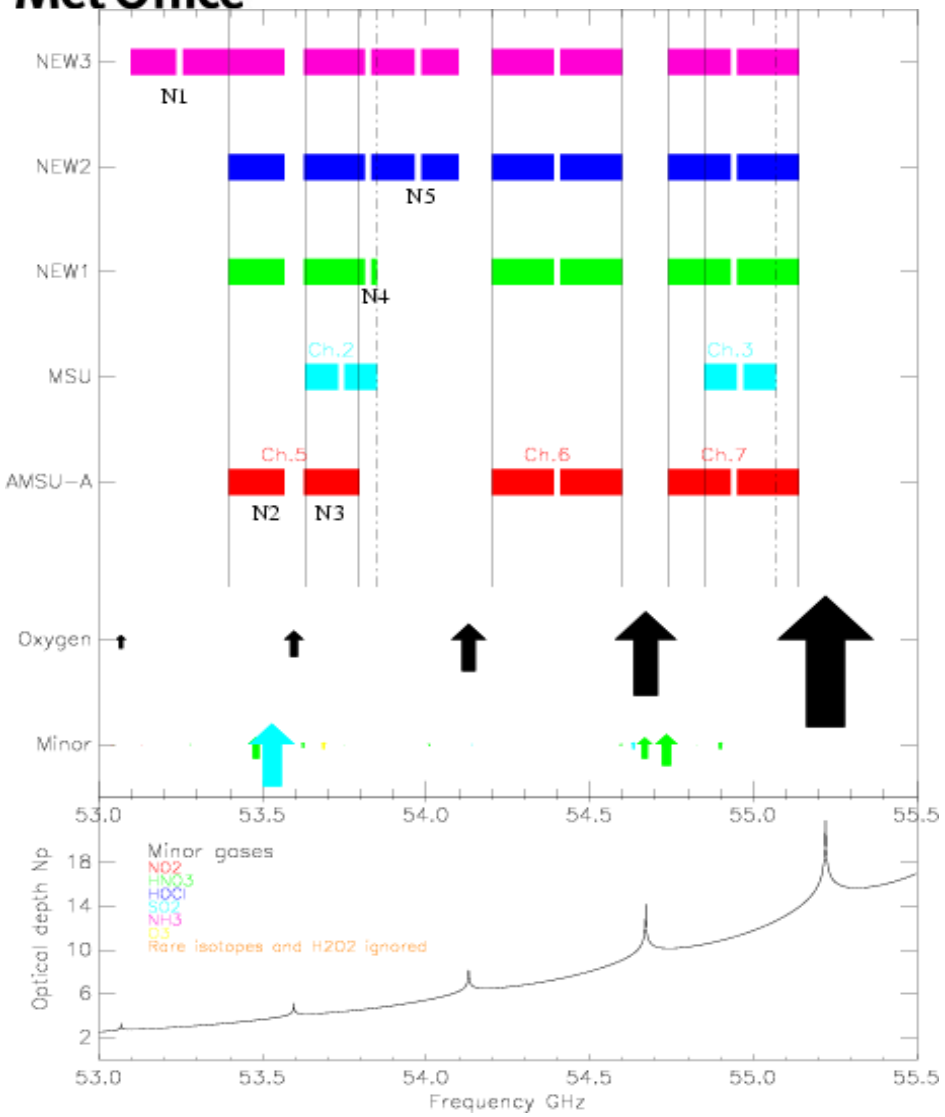


Climate Requirements

- Don’t change anything!
- Overlap with AMSU.
- Legacy channels, ideally ability to reproduce AMSU (and MSU) either by channels or well understood high spectral resolution sampling.
- Similar view geometry.
- Similar diurnal sampling.
- Absolute, traceable calibration!

- Quote: If these elements are in place then modifications will not degrade the climate data record.

Proposed channels



- Adding the missing MSU part of the spectrum

  N4 → 53.796 - 53.85 GHz

- Between AMSU 5 and 6

  N5 → 53.850 - 53.965 GHz

  53.985 - 54.100 GHz

- Between AMSU 4 and 5

  N1 → 53.097 - 53.236 GHz

  53.256 - 53.396 GHz

Setup

Observations simulated using RTTOV8.7 for AMSU,MSU,NEW1, NEW2 and NEW3

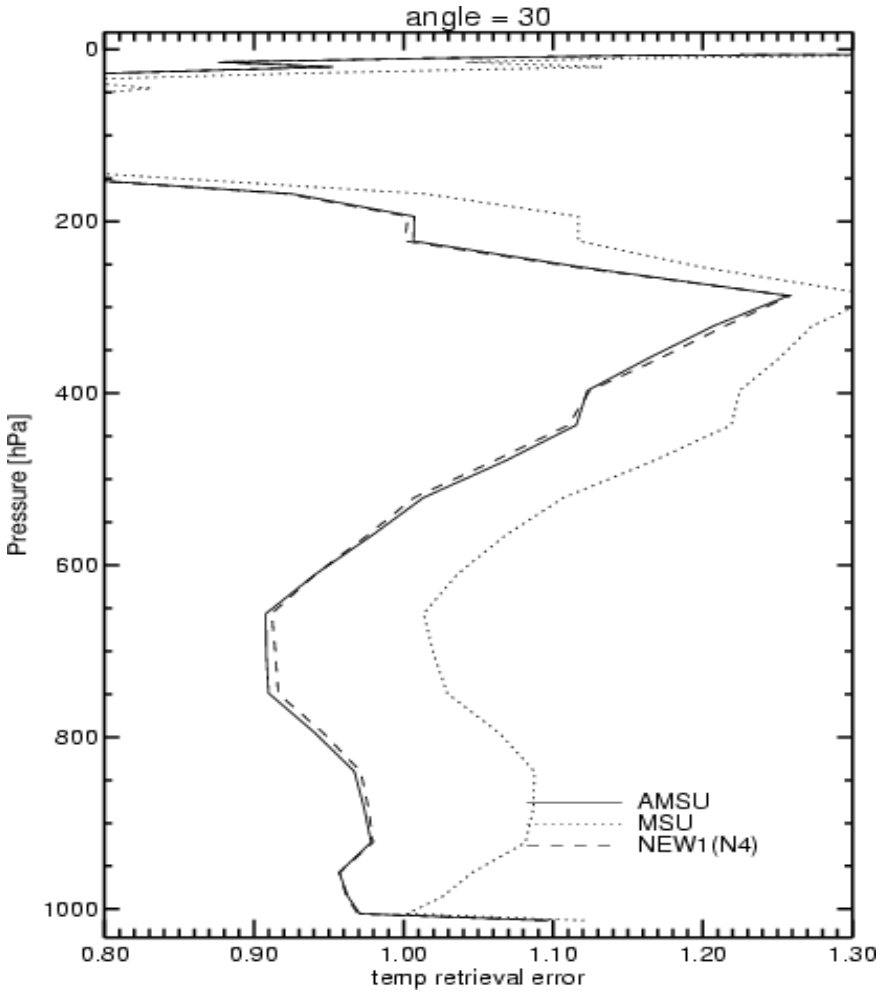
NEW1 ⟶ AMSU + N4

NEW2 ⟶ AMSU + N4 + N5

NEW3 ⟶ AMSU + N4 + N5 + N1

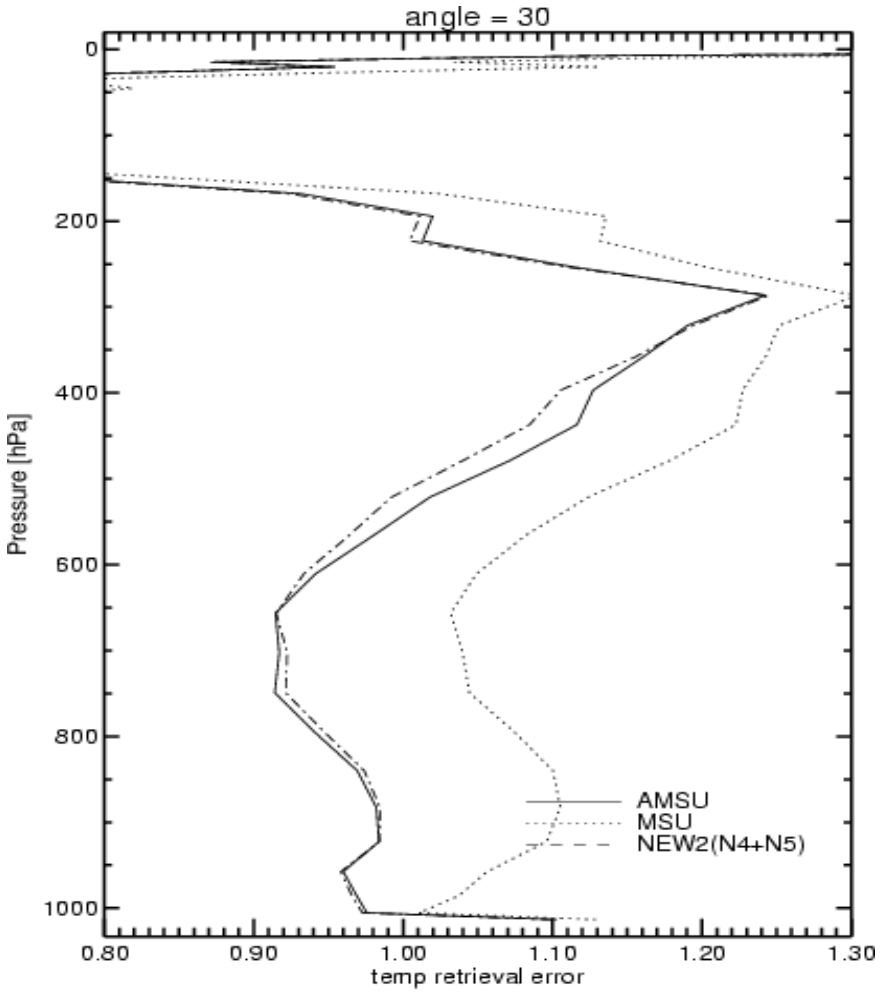
- All channels in QH polarisation
- Viewing angles – 10^0, 30^0 and 50^0
- Background generated as in Polarisation part
- Retrieval performance compared using 1DVar

AMSU Vs MSU Vs NEW1



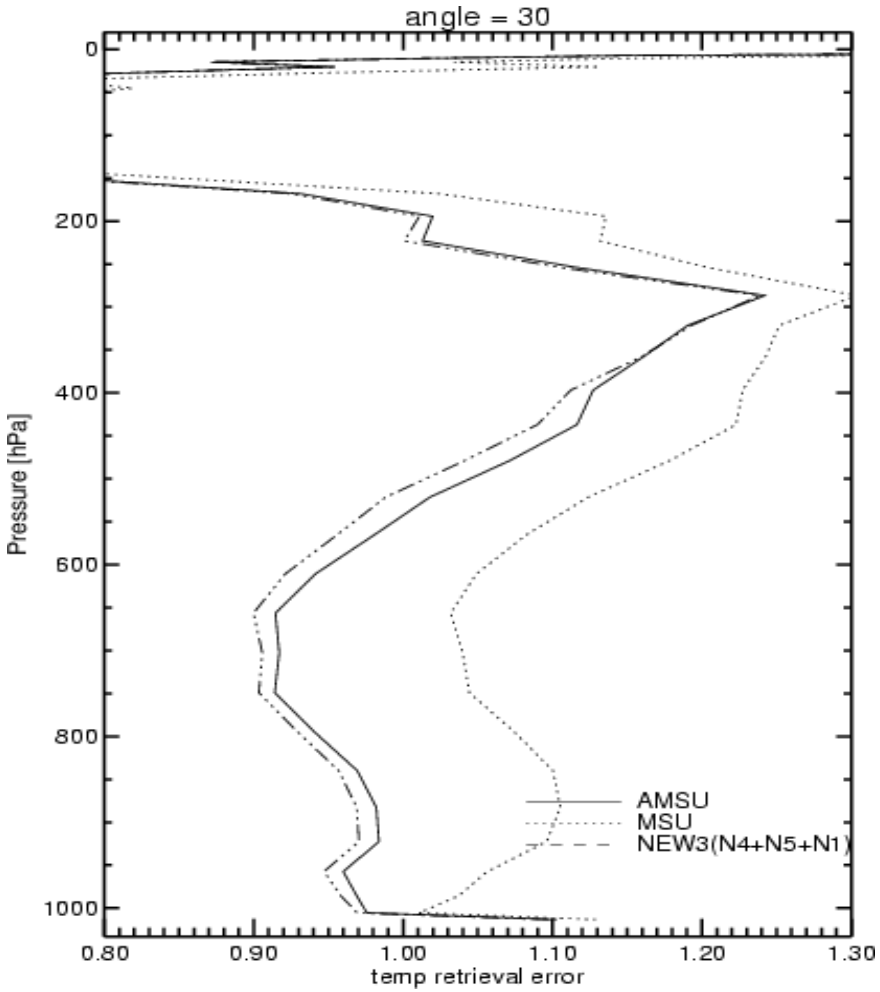
- Adding N4 has no significant impact

AMSU Vs MSU Vs NEW2



- Positive impact from adding N5

AMSU Vs MSU Vs NEW3



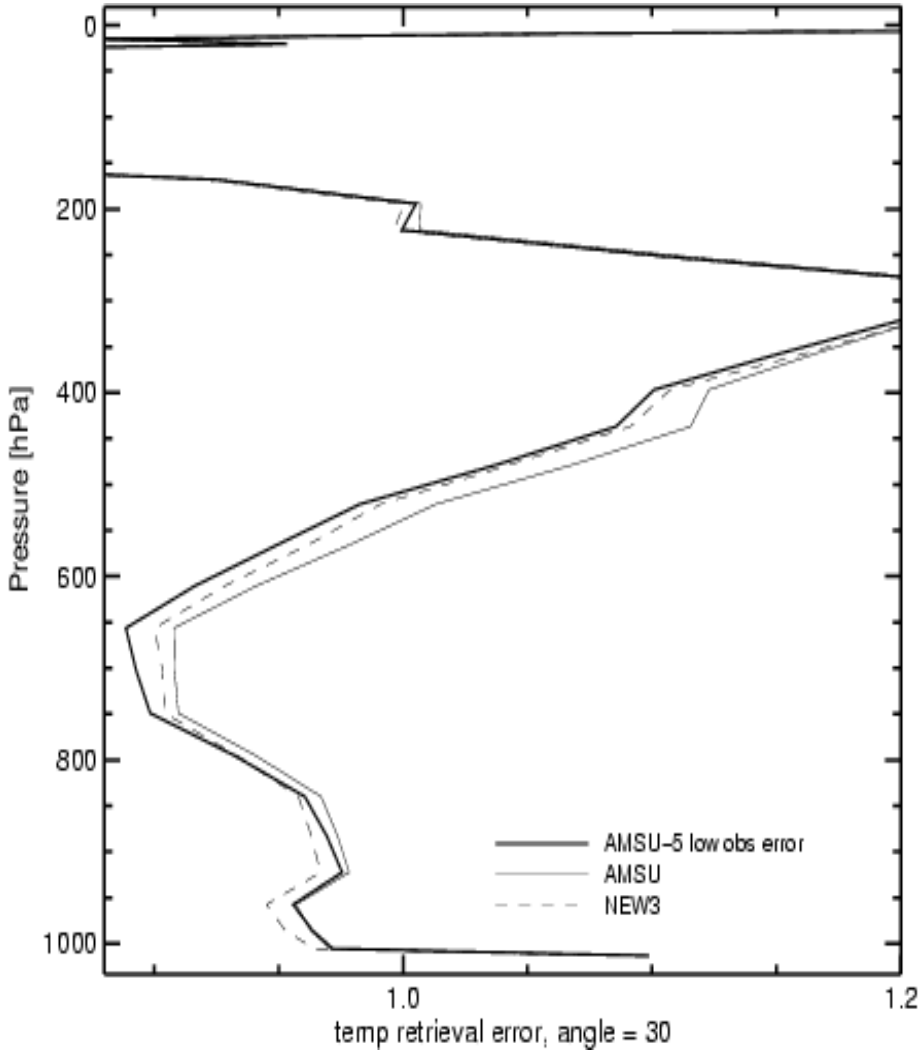
- Significant positive impact when N1 is included right from surface up to about 400 hPa

Performance of NEW3

- Does NEW3 perform better because of increased vertical structure information or increased bandwidth or both?

- AMSU channel 5 noise was reduced assuming total bandwidth as NEW3

Performance of NEW3



- From 800-500 hPa, AMSU with low Ch.5 noise performed better than NEW3
- Close to surface, NEW3 performs much better than AMSU

Conclusions

Conclusion: polarisation

- Current tradition of QV for window channels and QH for sounding gives good result but not as good as QH for all channels.

- None of the impacts detected are sufficient to make a strong case to change AMSU polarisation.

- Caveat 1: this study took no account of more difficult surfaces than ocean:

- Caveat 2: No account was taken of the impact of polarisation choice in the window channels on cloud screening.

Conclusions: Spectrum Usage

- No trace gas or radio frequency constraints on using undersampled spectrum between 53 and 55 GHz (except “use it or lose it”).
- “Lost” MSU band makes little difference (too little bandwidth).
- Extra channels as specified in “New3” give significant impact though ~30% of impact of AMSU channel 5
- As channels are proposed for addition to an AMSU baseline climate data record is not degraded.

Thank you!