Assimilation of Lower Tropospheric Sounding Channels over Land at Met Office

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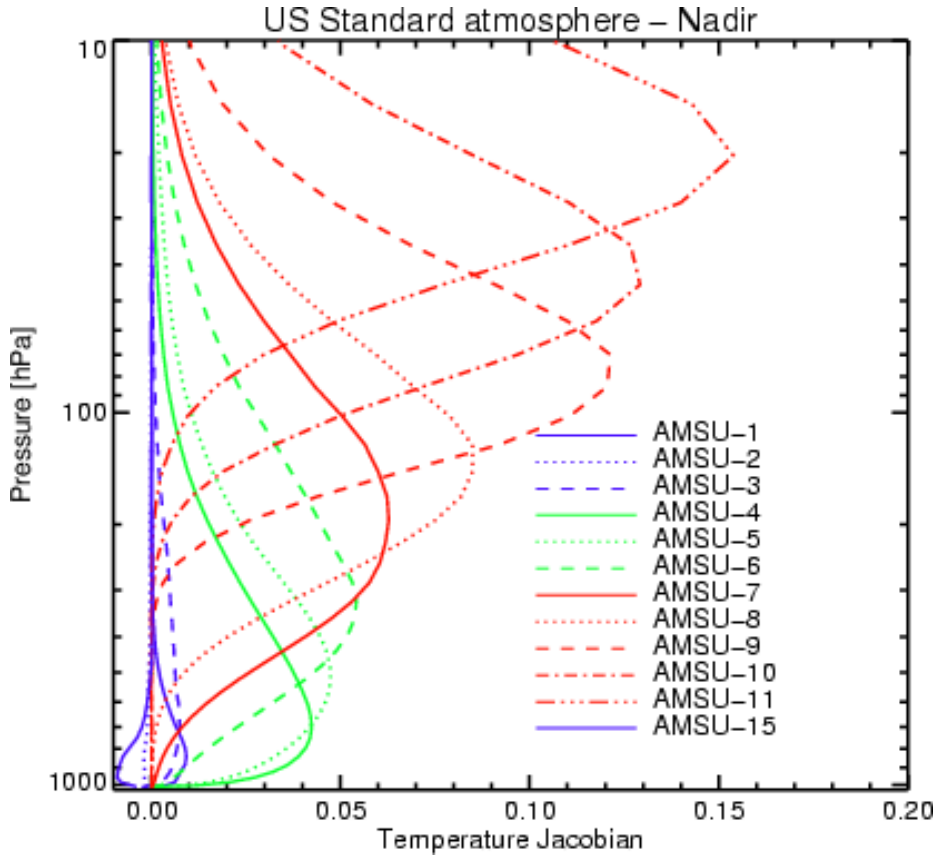
at Surface Properties Meeting, Toulouse

Contents

This presentation covers the following:

- Description of AMSU channels and their use over land and ice surfaces.
- Reminder: Impact of errors in Tskin and emissivity for sounding channels.
- Met Office cloud screening and emissivity and skin temperature analysis system (1D-var).
- Results in 1D-var and 4D-var.
- Summary and Future work.

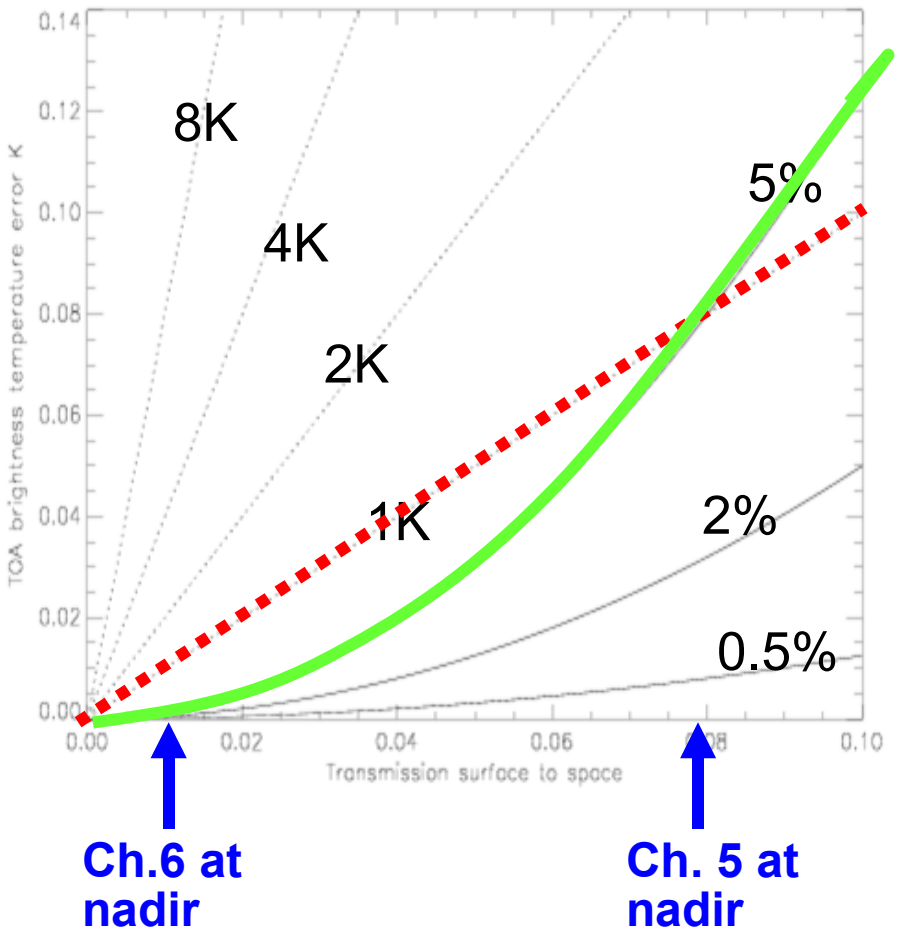
Advanced Microwave Sounding Unit (AMSU): Temperature Jacobians



- Channels 1-3,15→ Surface information.
- Channels7-14 → Sounding information, not sensitive to the surface.
- Channels 4-6 → Sounding information, sensitive to the surface.
  - Difficult to use
  - Errors in analysis system (e.g. inaccurate error covariances) tend to have a larger impact….

At the Met Office channels 4 and 5 are not used over land or sea ice but channel 6 is used but we have no proof that it is useful.

Emissivity and Tskin error

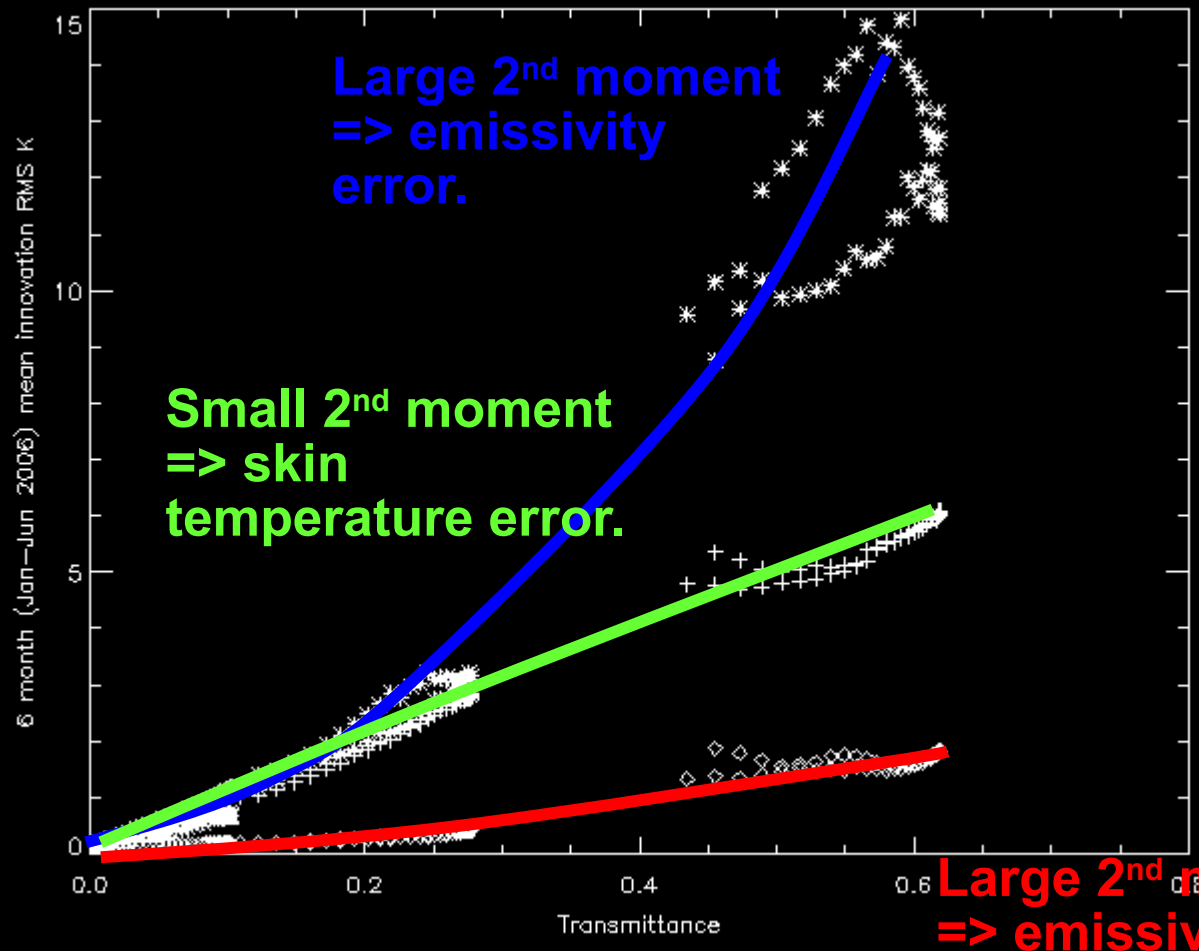


For a specular non-black surface….

- Channel 5: an emissivity error of 5% and a skin temperature error of 1 K have similar impact at nadir.
- Channel 6: an emissivity error of 5% has a much smaller impact than a skin temperature error of 1 K.
- "Window" channels can only analyse Tskin, and screen for clouds effectively, if we have other prior information about the surface e.g. the emissivity.

(Results from S.English, TGRS, 2008)

Impact of emissivity and skin temperature error

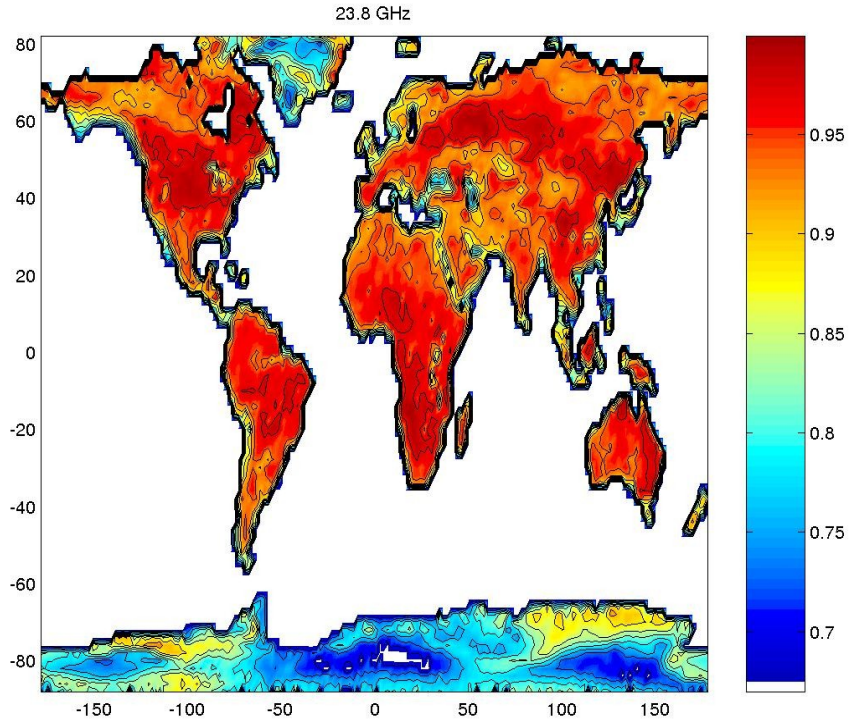


Sea ice

Land

Ocean

Emissivity Atlas from Karbou

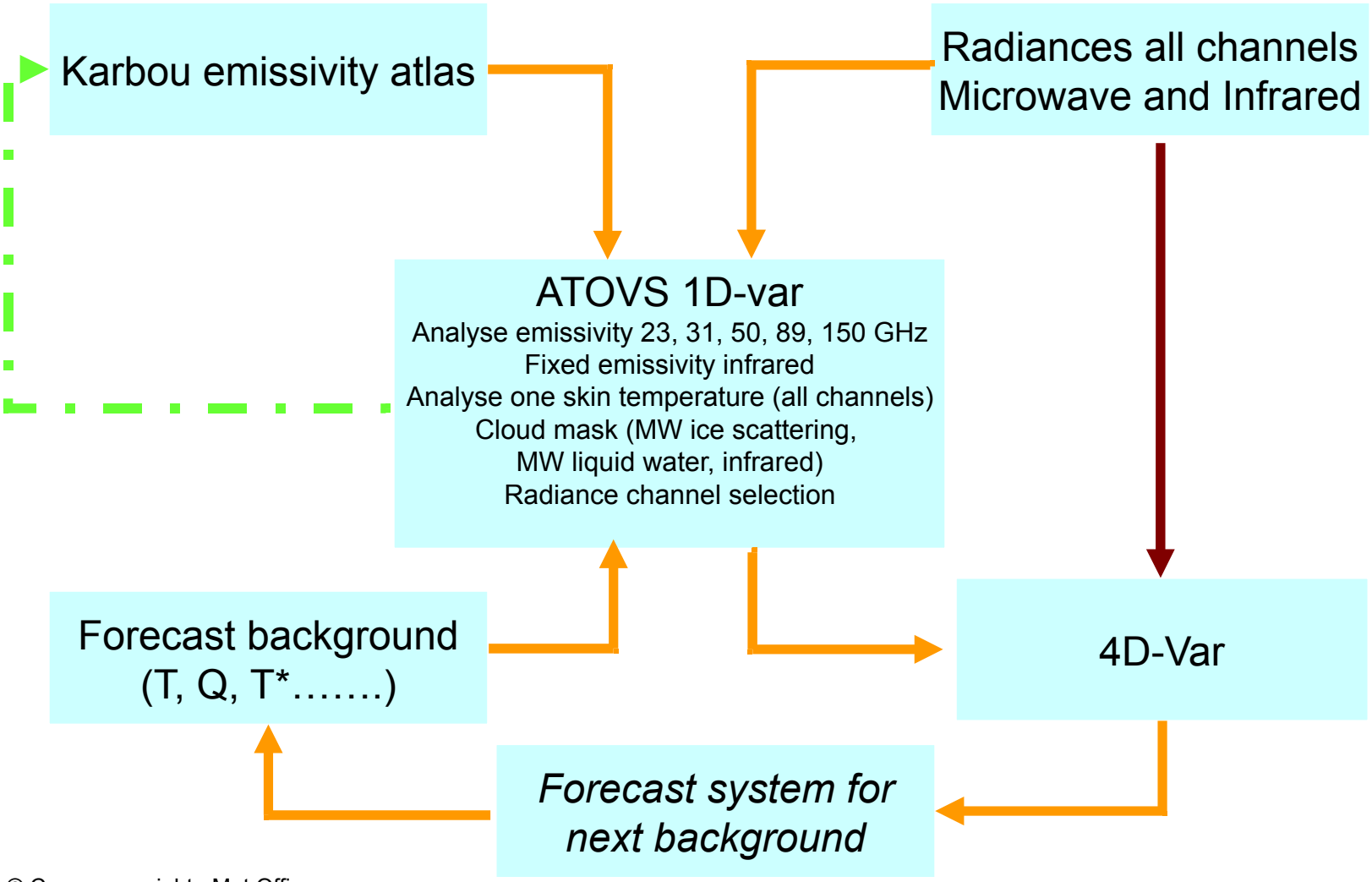


- Global monthly mean emissivities over land at 23.8, 31.4, 50, 89 and 150 GHz
- Emissivity values are interpolated to observation locations and are used as background.
- 1D-var analyses Tskin and emissivity.
- Emissivity error covariance matrix is assumed to take same form as full field covariance.

Atlas generated by F. Karbou

(Karbou et.al, QJRMS, 2006)

Surface analysis

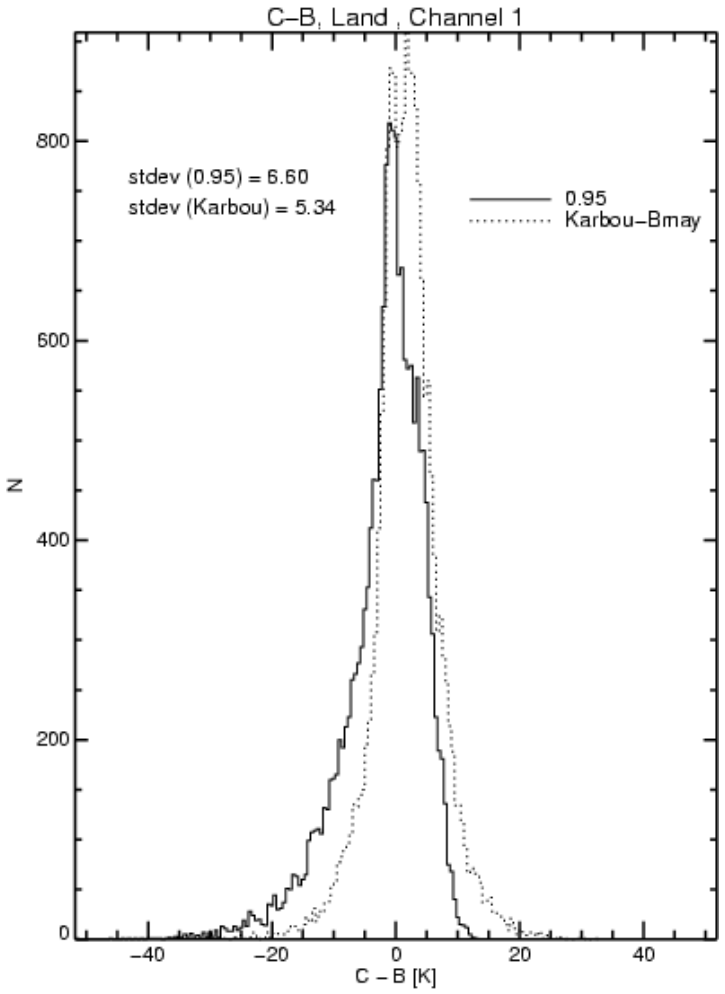


Fit to background in 1D-var and 4D-var

Experiment Description

- Operations: Use only AMSU-A channels 6-14. Emissivity = 0.95. Skin temperature used is from NWP background (plus HIRS if available).
- Control : As operations but used all AMSU-A channels thus allowing accurate skin temperature analysis if emissivity and cloud screening is good.
- Experiment: as control, but the emissivity is from the atlas of Fatima Karbou.
- 1D-var is run and fit of data to background and retrieval in 1D-var is examined and fit of data to background for data selected for use in 4D-var is also studied.

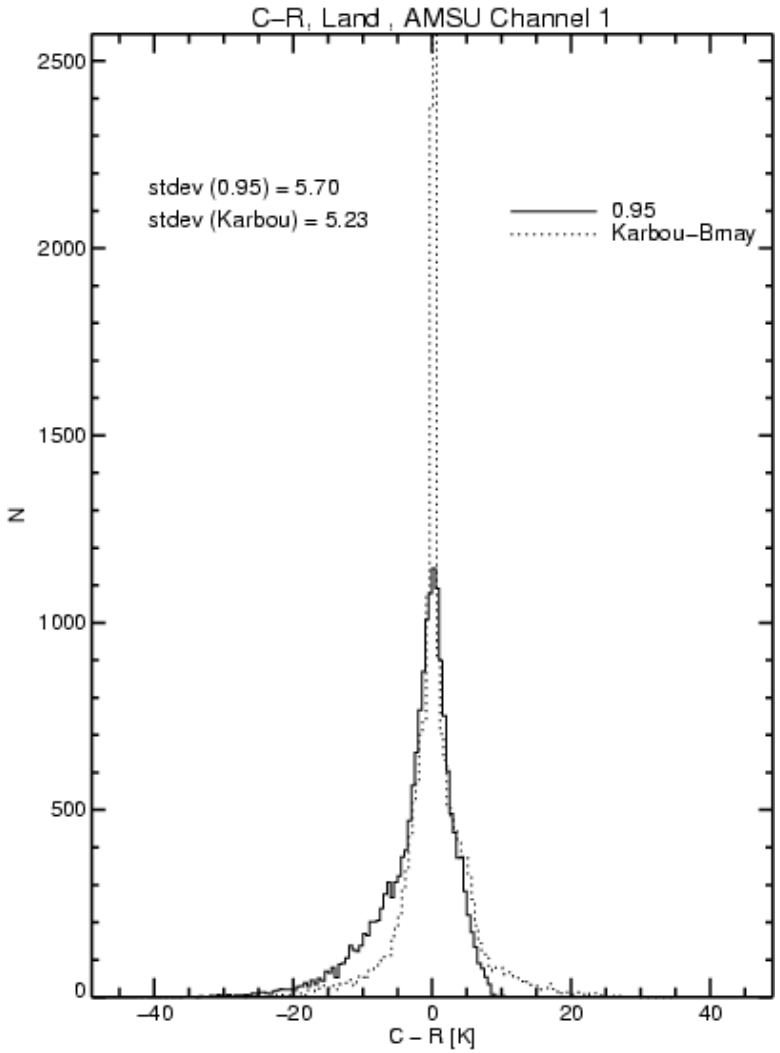
Observed – Background BTs



Channel 1 (window channel)

- More observations were accepted over land when the atlas is used
  - Total accepted obs (0.95) = 119817
  - Total accepted obs (atlas) = 129331
- The distribution is more Gaussian and the standard deviations are lower when the atlas is used.
- This is a useful verification that the atlas is providing new information!

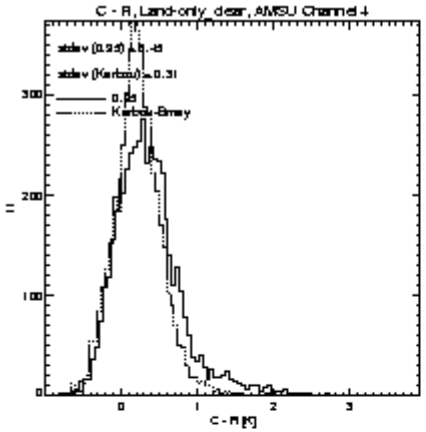
Observed – Retrieved BTs

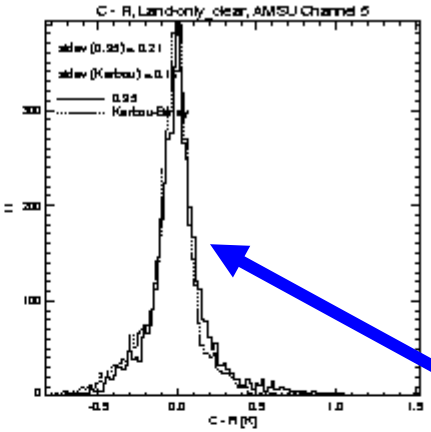


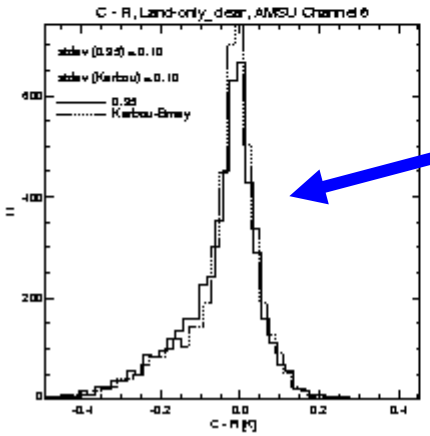
Channel 1 (window channel)

- Emissivities and Tskin are analysed and a good fit is achieved but there are outliers so the overall standard deviation is similar.
- So some cases simply can't fit the observations – indication that assumptions are wrong in modelling e.g. specular reflection or errors in cloud screening?
- But for most data 1D-var can fit the observations very well.

Observed – Retrieved BTs





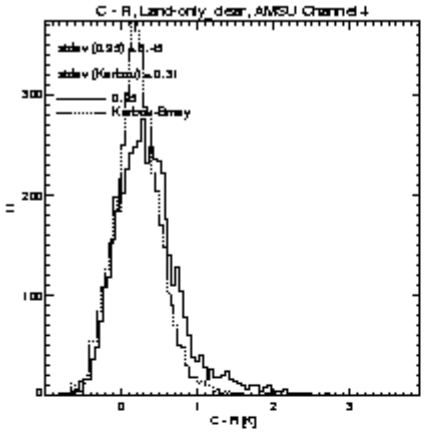


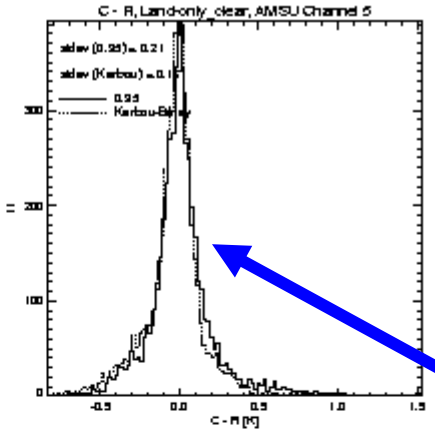
With a 2K error assigned to skin temperature in 1D-var we get no improvement in fit to AMSU channels 5 and 6. i.e. 1D-var fits the window channels only by modifying emissivity.

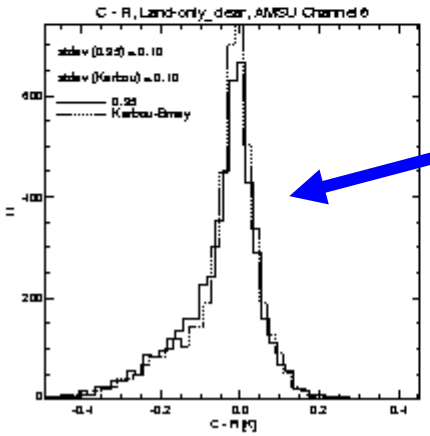
However with a 5K error assigned there is a notable improvement. So 1D-var is analysing a more accurate Tskin!

As with the window channels outliers remain which the analysis system can not fit.

Observed – Retrieved BTs







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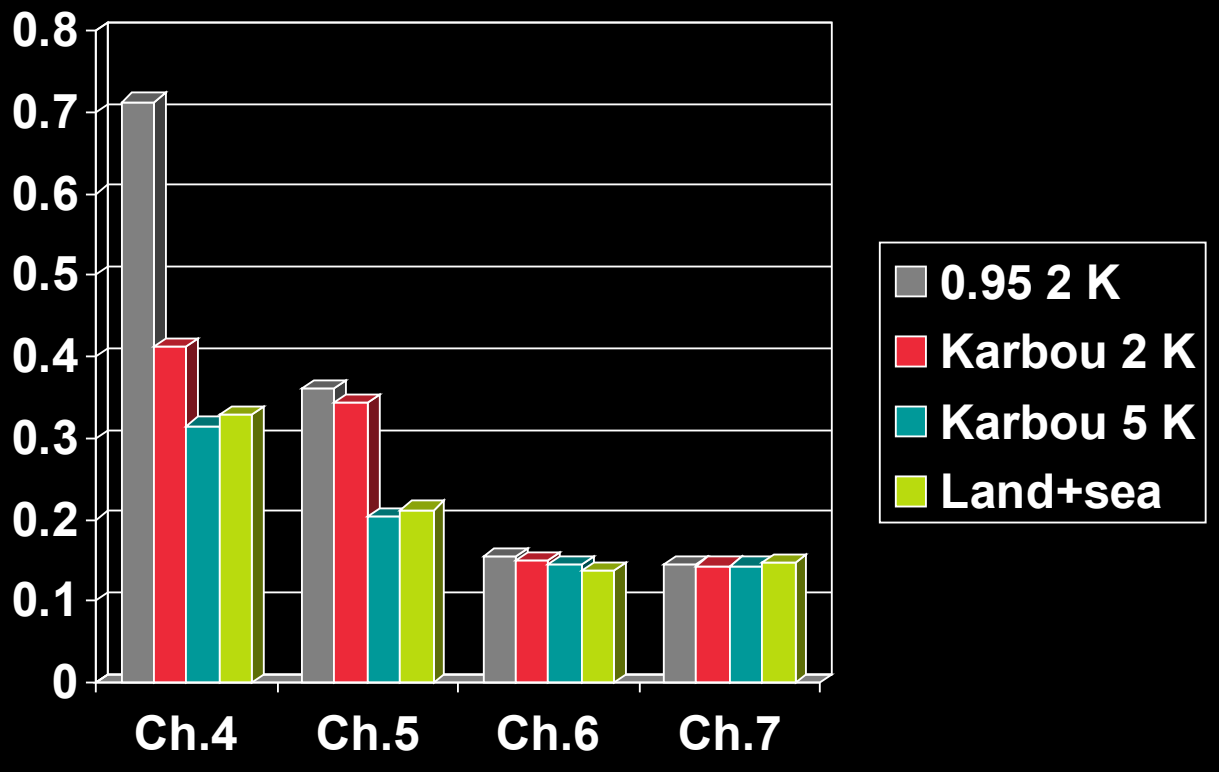
Comparison of fit over land in 4D-var using 0.95 and Karbou

However after re-running the skin temperature background error in 1D-var and improving the cloud screening the fit in 4D-var is dramatically improved!

Similar fit over land and sea!

Full forecast impact trials to follow soon!

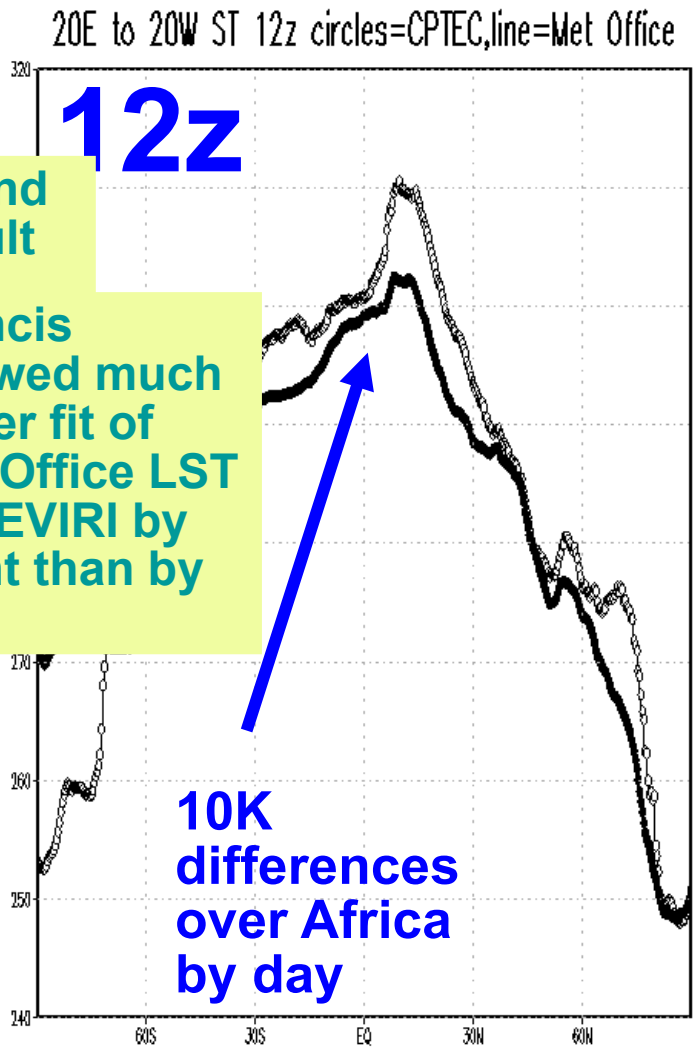


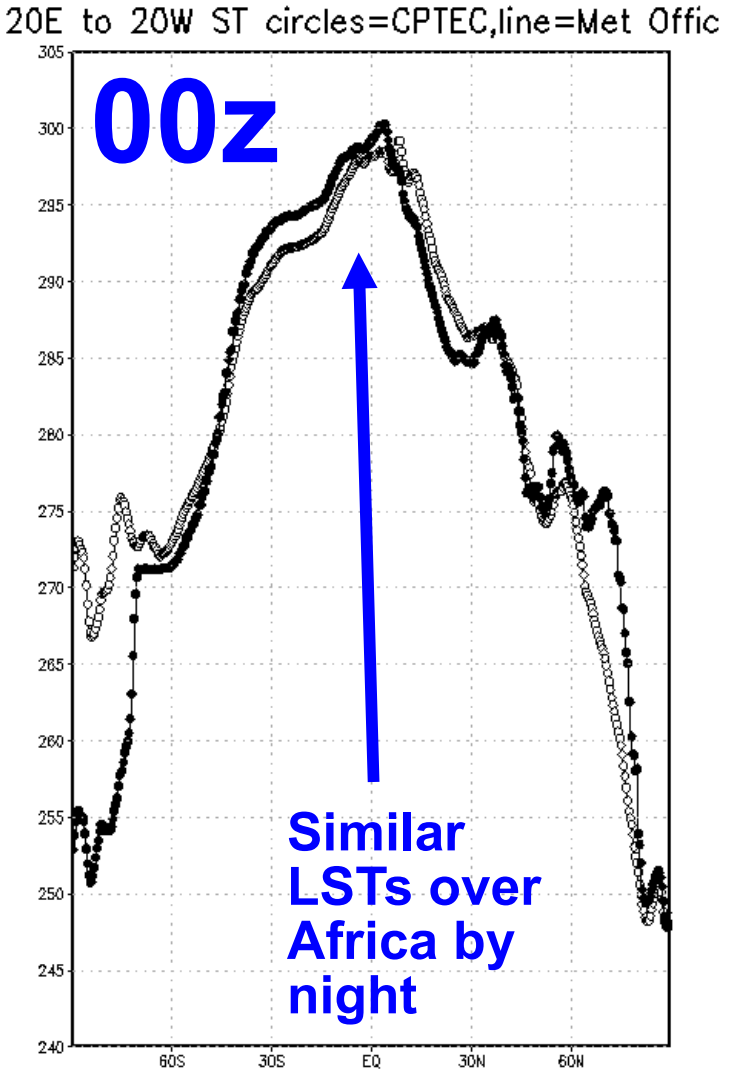
Ch.5 – 50% land obs used in 4D-var: similar to sea points.

Summary

- The assimilation of sounding channel radiances is very sensitive to the accuracy of the skin temperature estimate and the specification of skin temperature errors in 1D-var.
- NWP model skin temperature estimates have at least 2-5 K errors – this is not good enough and we need to analyse with the observations – needs very accurate knowledge of emissivity.
- Evidence we can analyse skin temperature well enough over land combined with good cloud screening to gain similar quality to data over the ocean.
- Could also apply some more screening – e.g. day:night to take account of diurnal variation of background skin temperature error.

Land Surface Temperature comparison: 20E to 20W

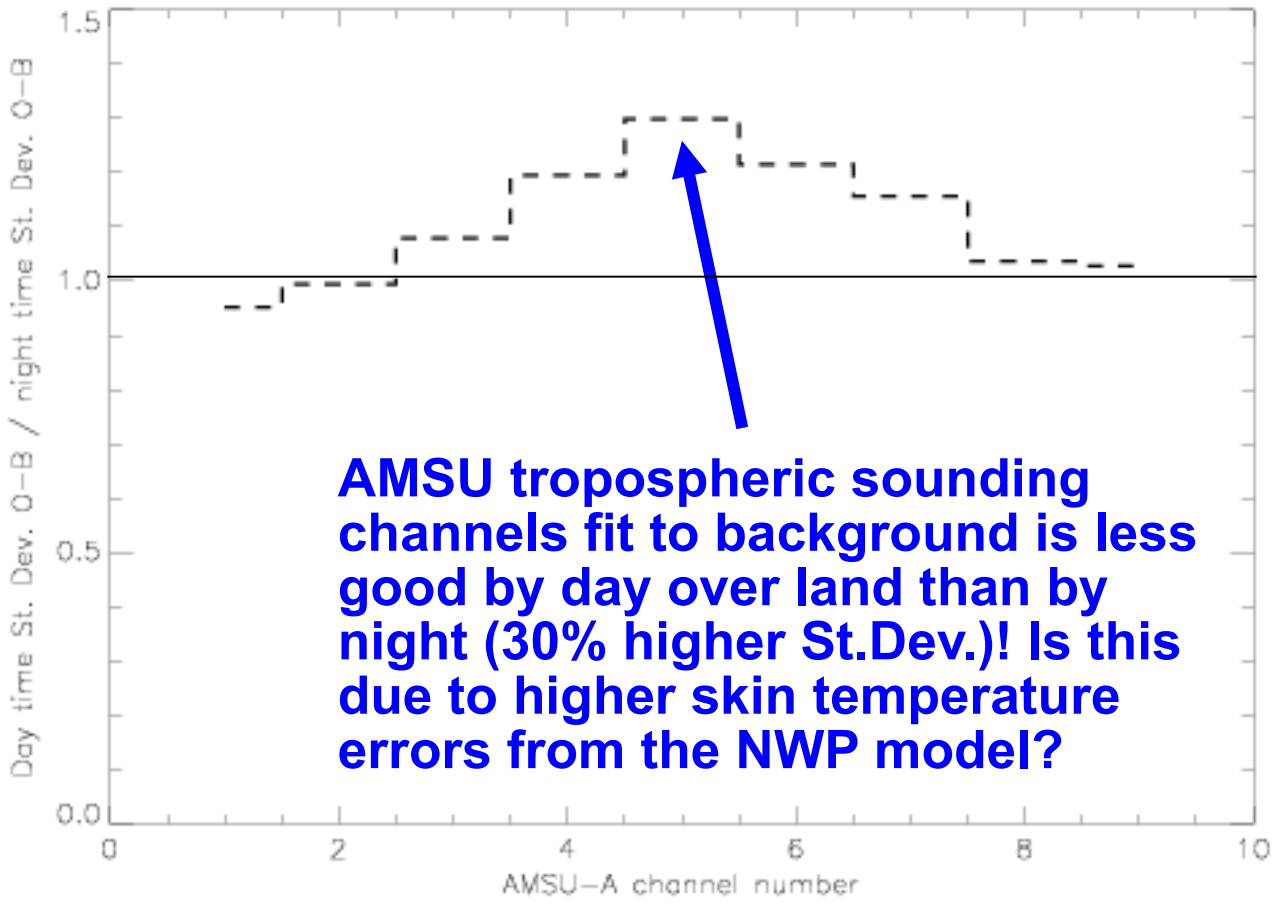




Ruston found similar result between ECMW Office NRL.

Francis showed much better fit of Met Office LST to SEVIRI by night than by day.

Day night O-B St.Dev. ratio



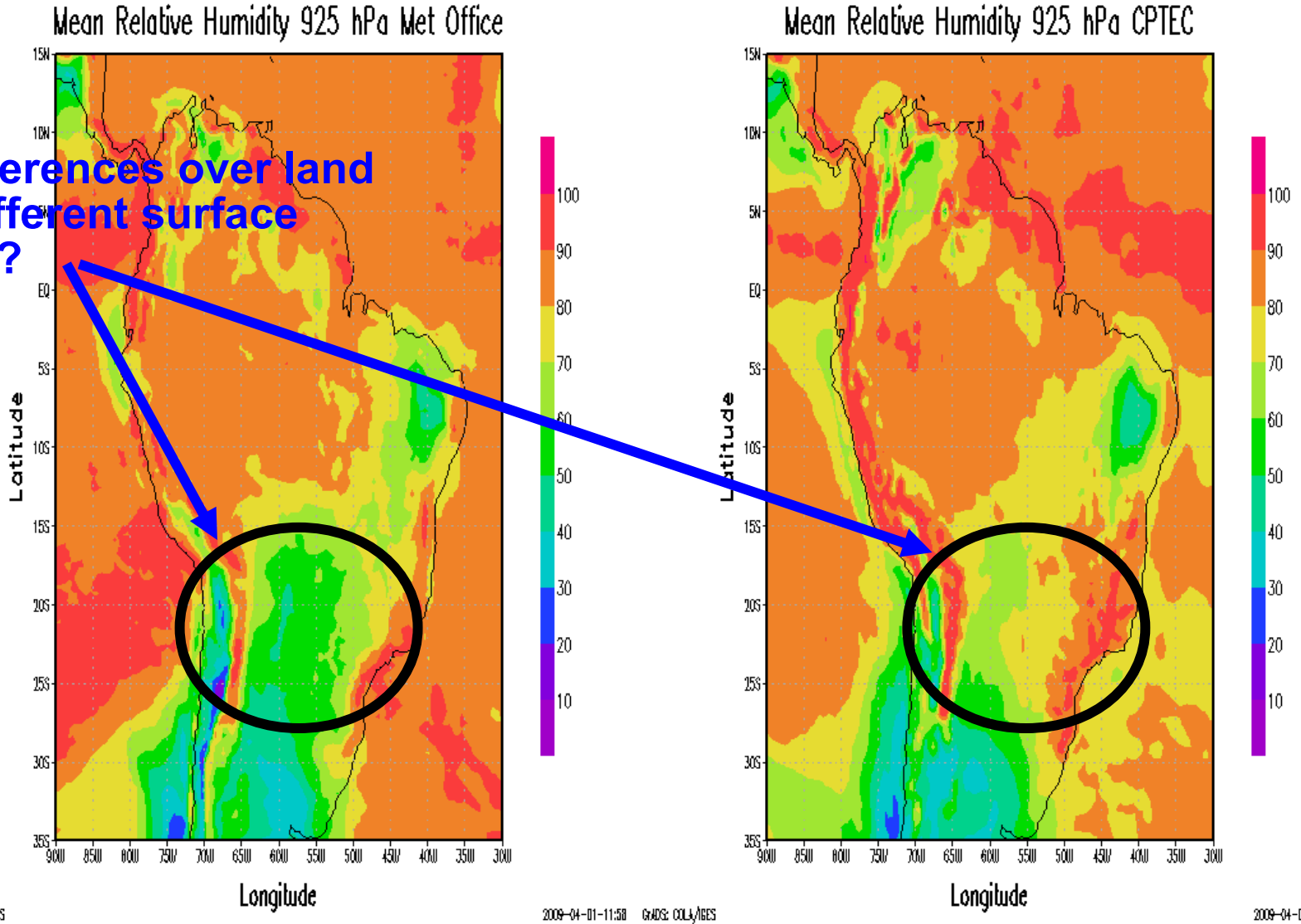
AMSU tropospheric sounding channels fit to background is less good by day over land than by night (30% higher St.Dev.)! Is this due to higher skin temperature errors from the NWP model?

Future work

- Results are now encouraging and merit longer forecast impact trials.
- Use of moisture channels should also be investigated noting encouraging results elsewhere (which I expect to be reported by others at this meeting!). See plot…
- Large intra-model differences for LST - why?
  - Land surface exchange models or
  - Atmospheric fluxes?
  - Is LST a “dustbin variable” to make the flux correct?

Humidity differences: compare CPTEC and Met Office global models

Huge differences over land due to different surface schemes?



Met Office

Thank You!

Questions?