

Assimilation of tropospheric-sensitive infrared radiances over land

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What we said in ITSC-20 ?

We didn't expect to get far by using the same methods over land as those used over sea

Summary

Applying a departure-based cloud detection over land introduces correlation between observation and background errors – these cannot be handled properly by any data assimilation scheme

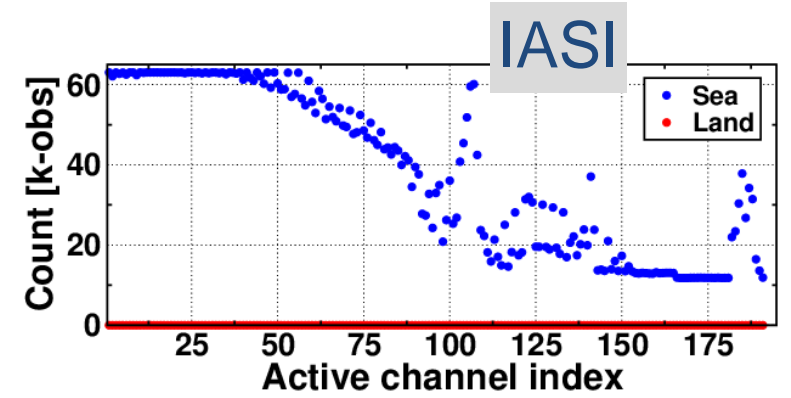
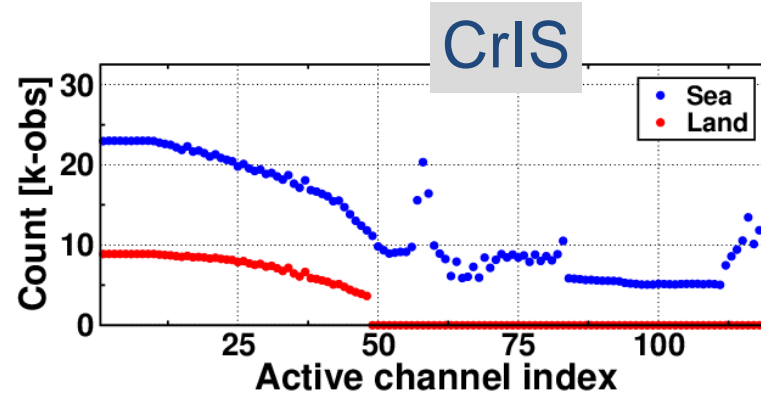
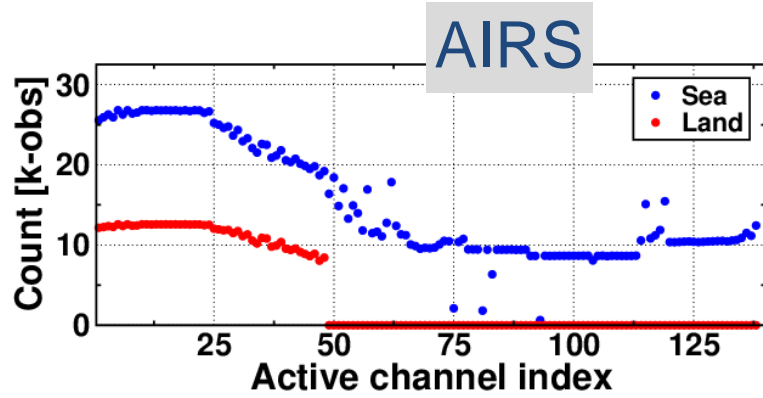
Recent and near-future developments to the cloud detection aim at reducing the dependency on background information

- Using collocated imager information
- Exploiting inter-channel differences in observed spectra

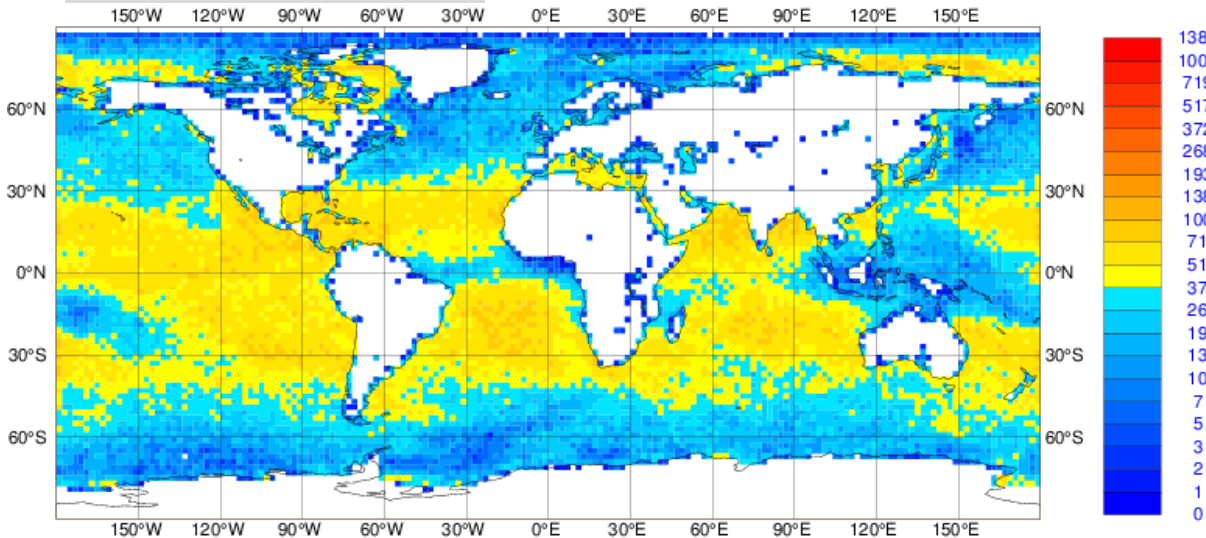
The future use of infrared radiances over land will rely on fundamentally different cloud detection and observation error covariance as compared with the use of radiances over sea



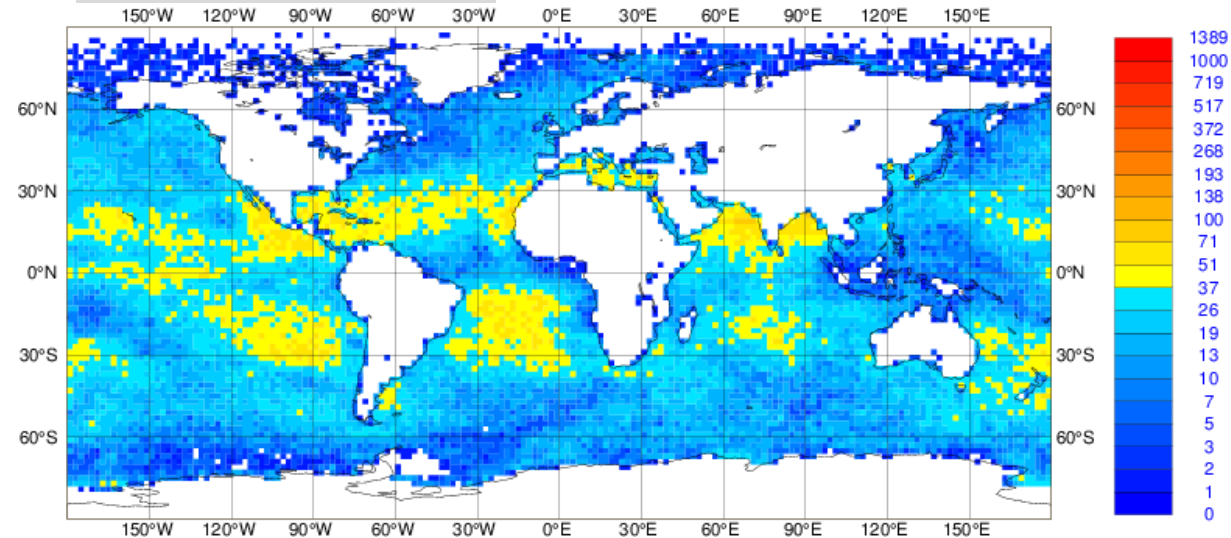
Current use of hyperspectral radiances (Cy43r3)



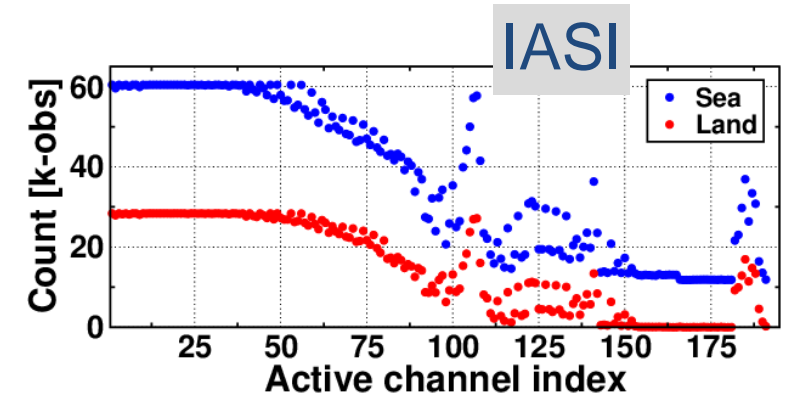
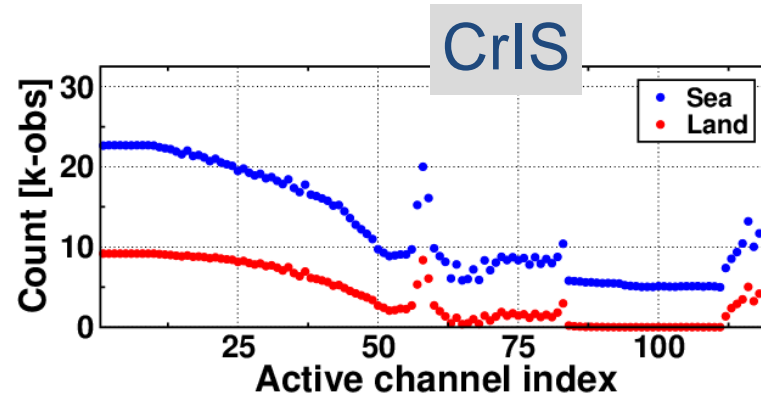
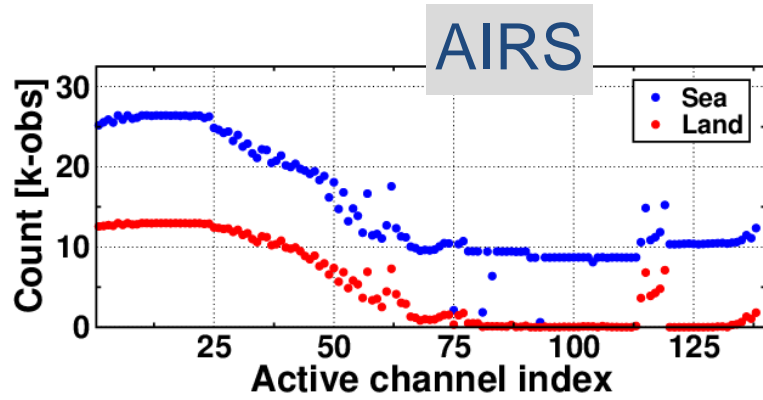
$\sim 716 \text{ cm}^{-1}$



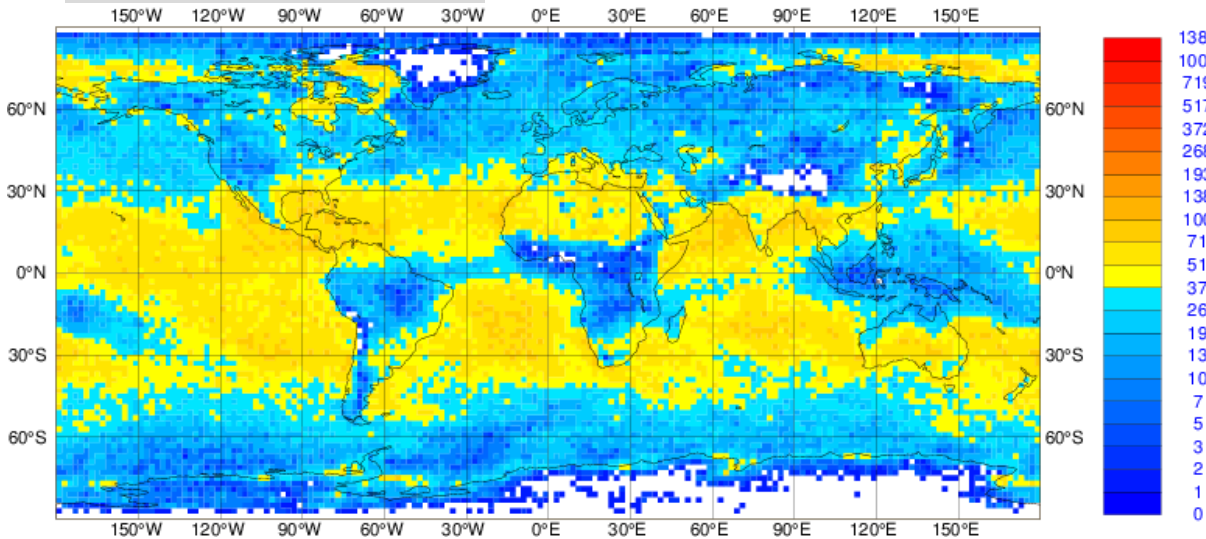
$\sim 775 \text{ cm}^{-1}$



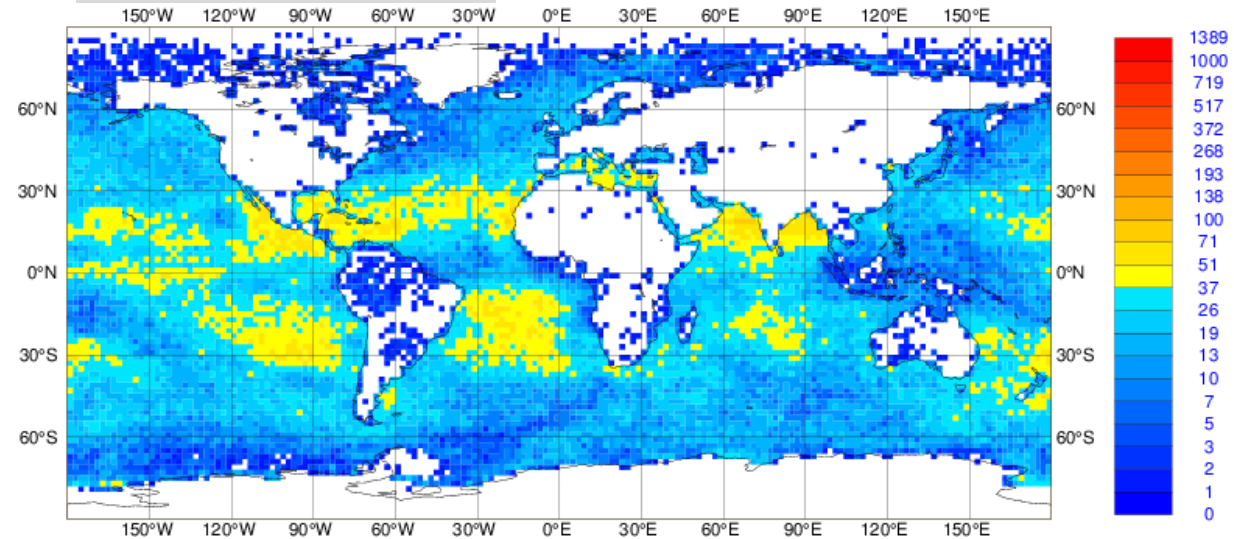
Near-future use of hyperspectral radiances (Cy45r1)



$\sim 716 \text{ cm}^{-1}$



$\sim 775 \text{ cm}^{-1}$



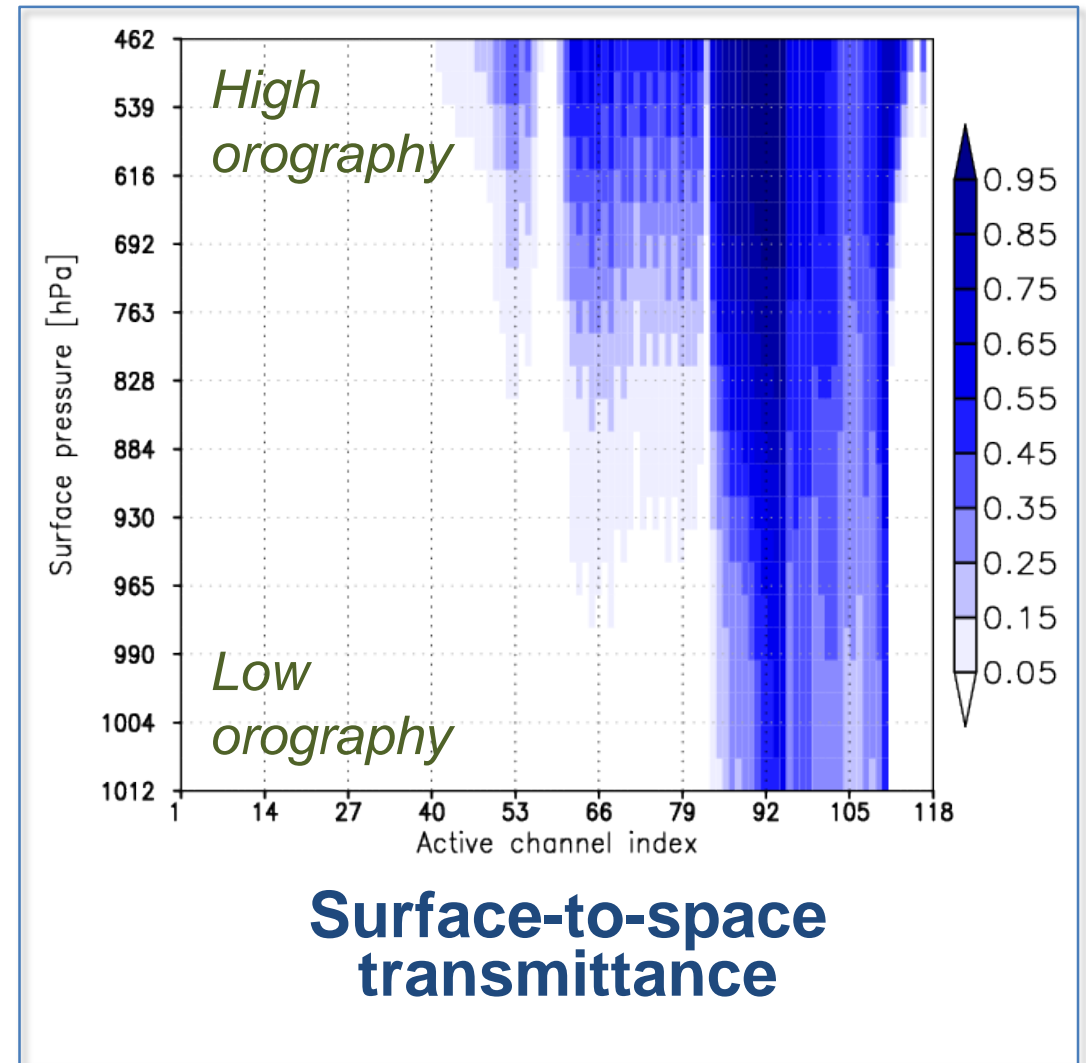
Land-sensitive channels are rejected on a case-by-case basis

In terms of the cloud detection, the transitioning from Cy43r3 to Cy45r1 changes nothing

→ Continued use of departure-based scheme also over land

Instead of rejecting / activating fixed channel subsets in a blacklist, exactly the same channels are set active over land as over sea

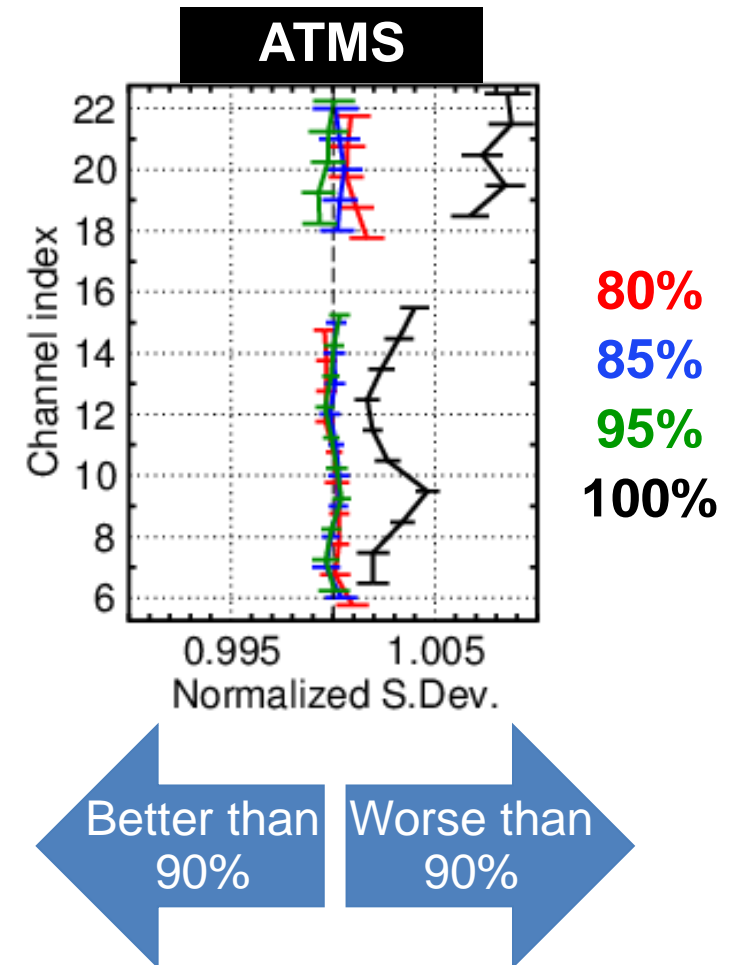
Surface-sensitive channels are identified and rejected on a case-by-case basis



How much is too much of land surface sensitivity ?

We set a threshold based on channel height assignments (CHA)

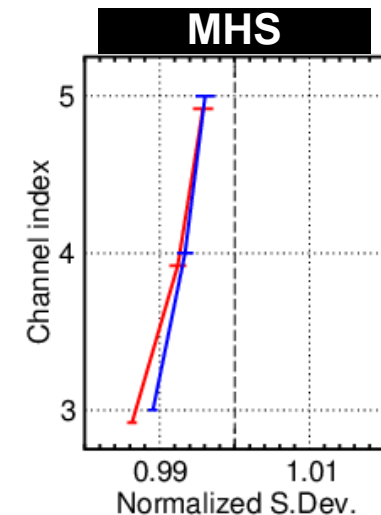
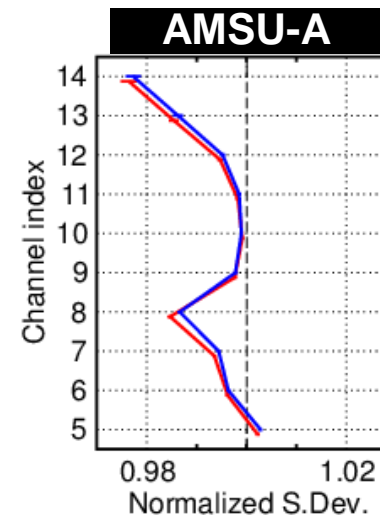
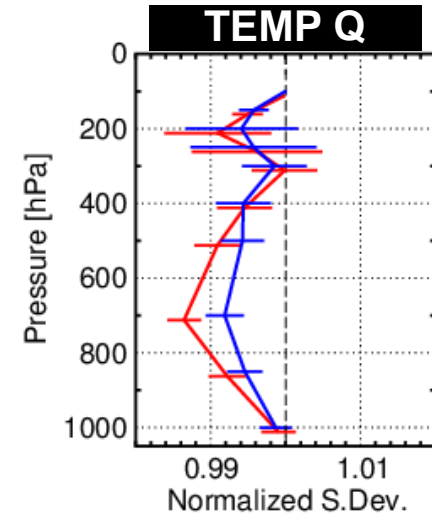
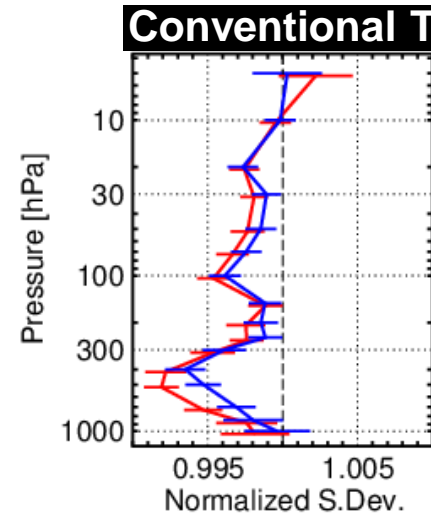
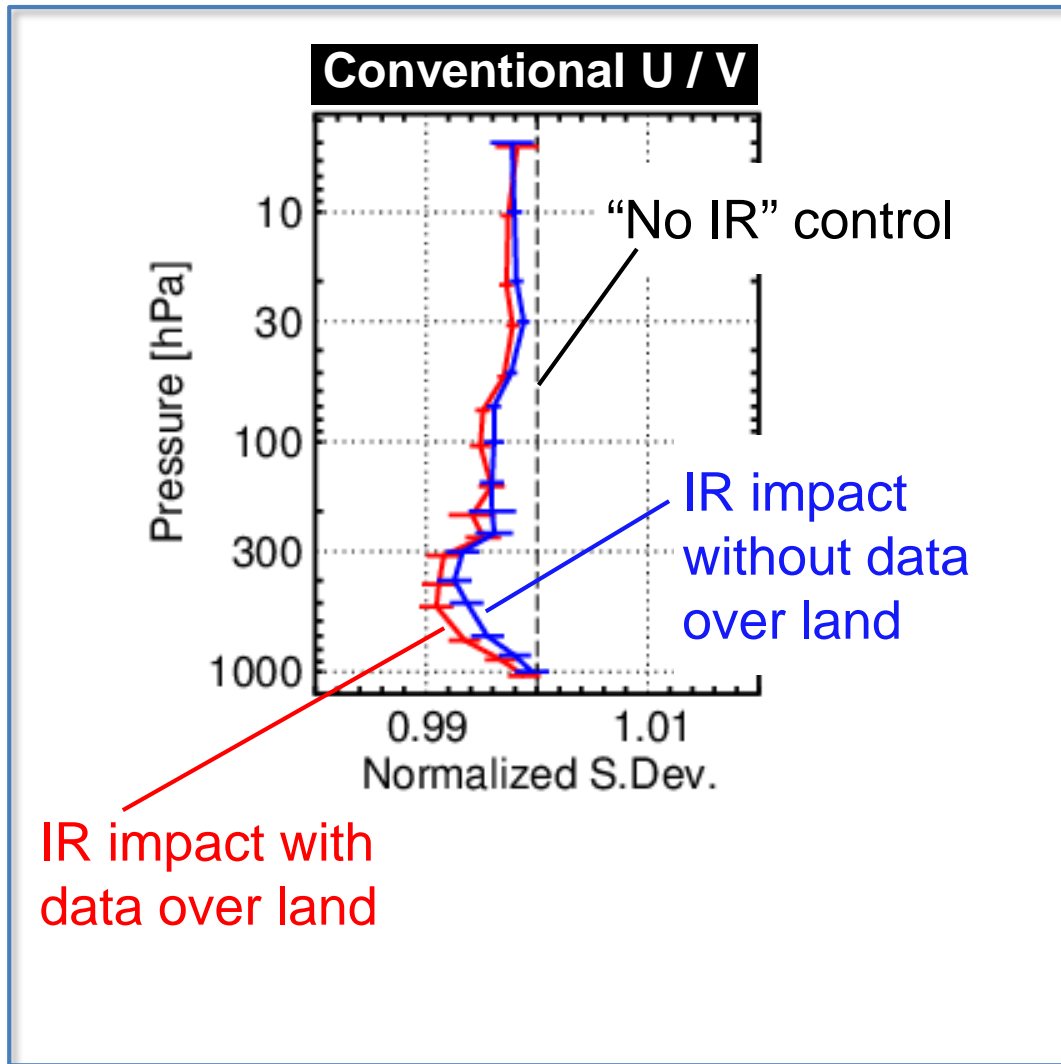
- A channel is considered surface-sensitive if its CHA exceeds 90% of the maximum CHA in the spectrum
- Independent background fit diagnostics indicate little sensitivity to threshold value in the range 80—95%



A global 3-month sample of observation minus background departure data

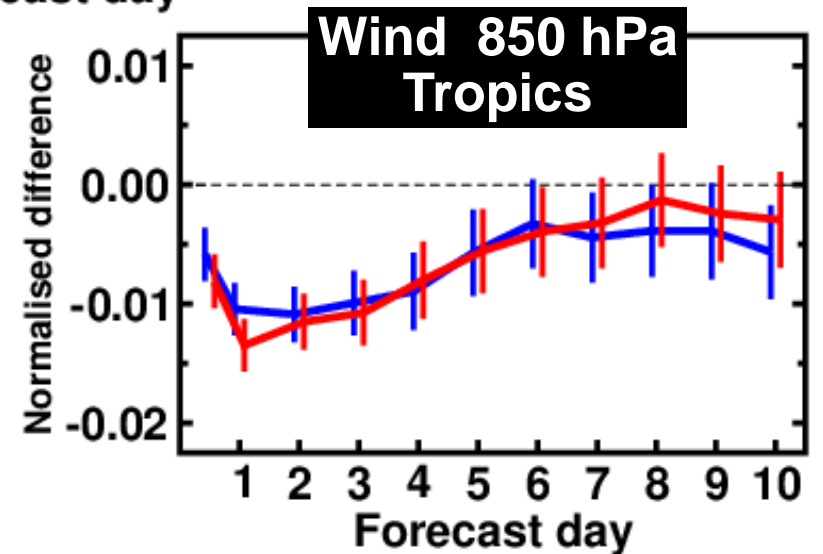
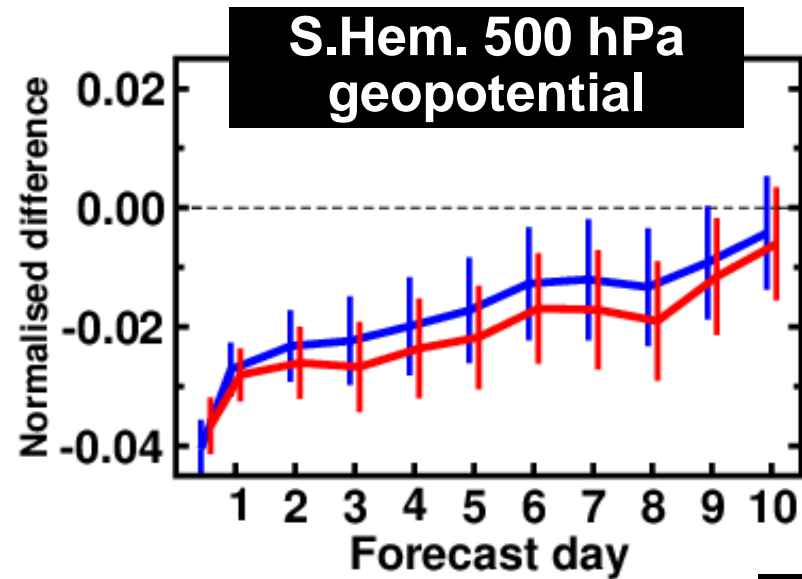
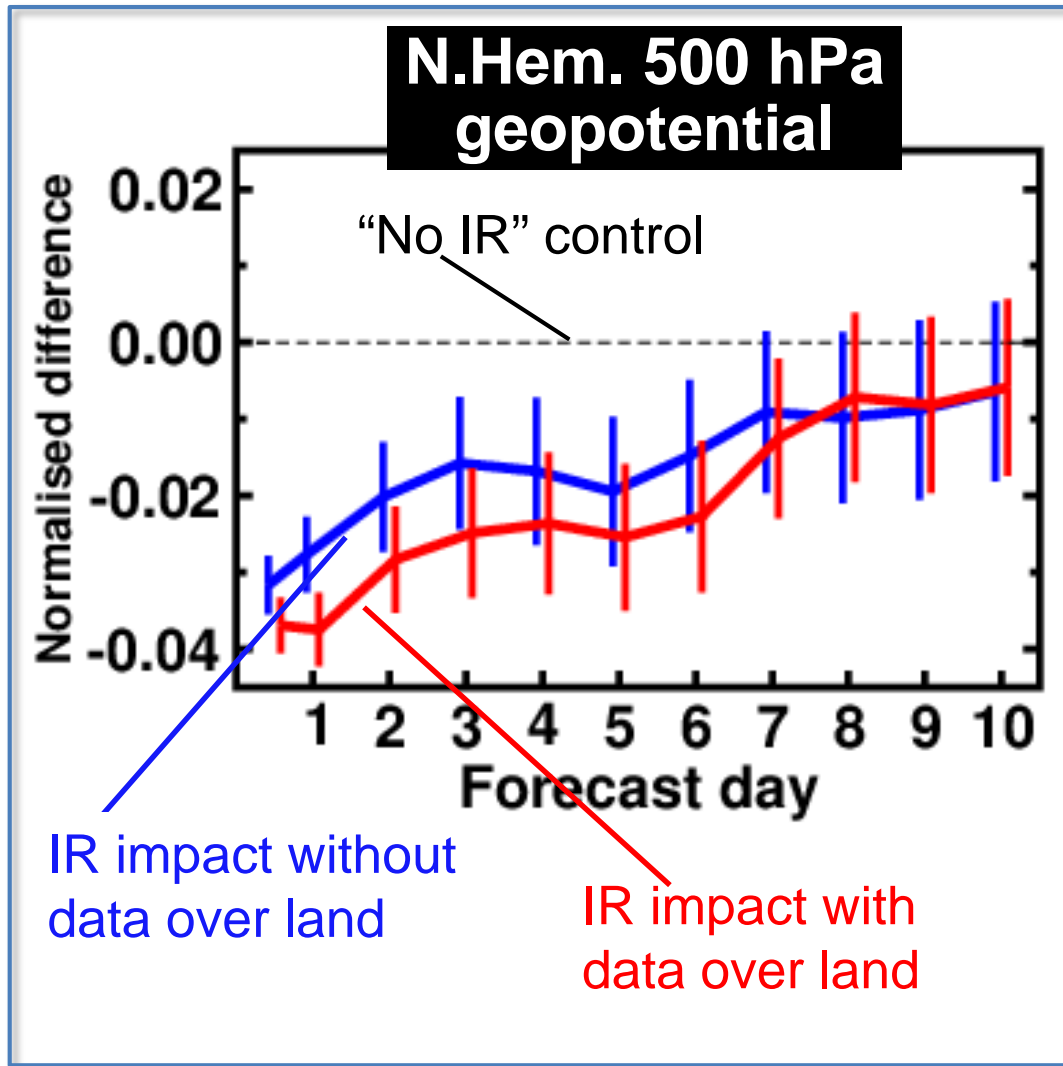
Short-range performance evaluation

Global 8-month observation minus background departure statistics

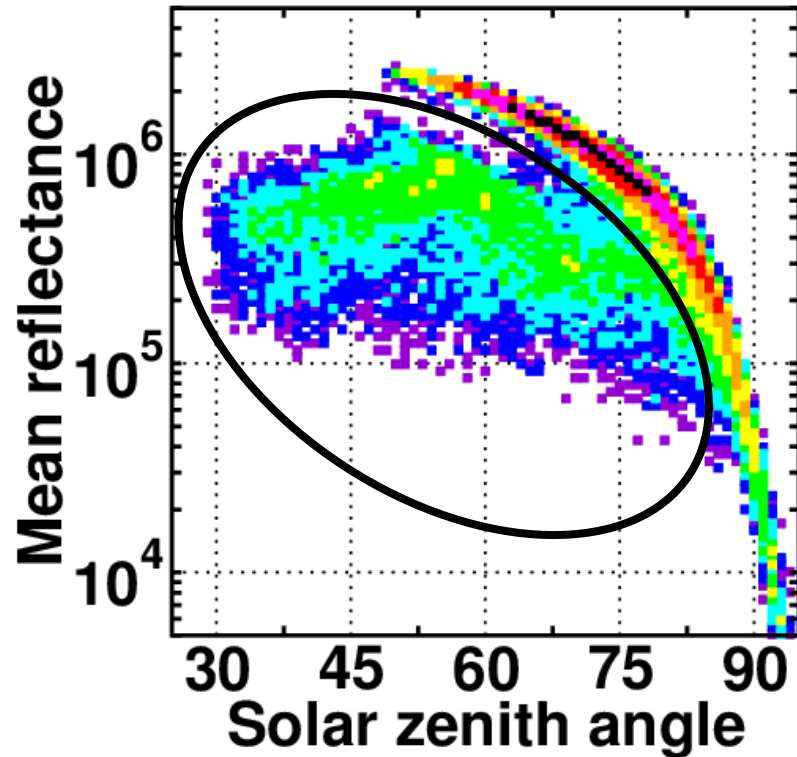


Medium-range performance evaluation

Global 8-month forecast RMSE as verified against own analysis



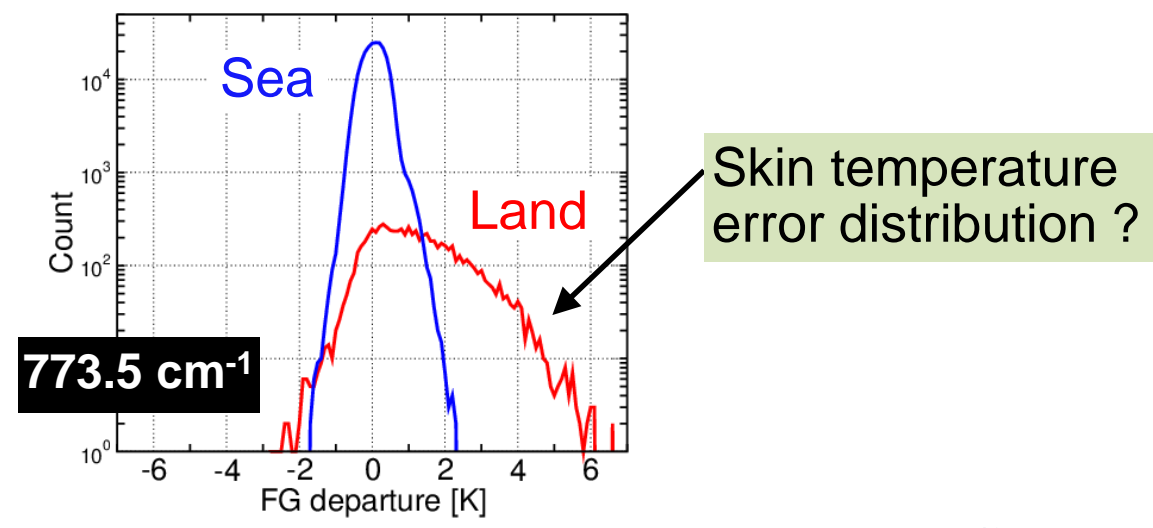
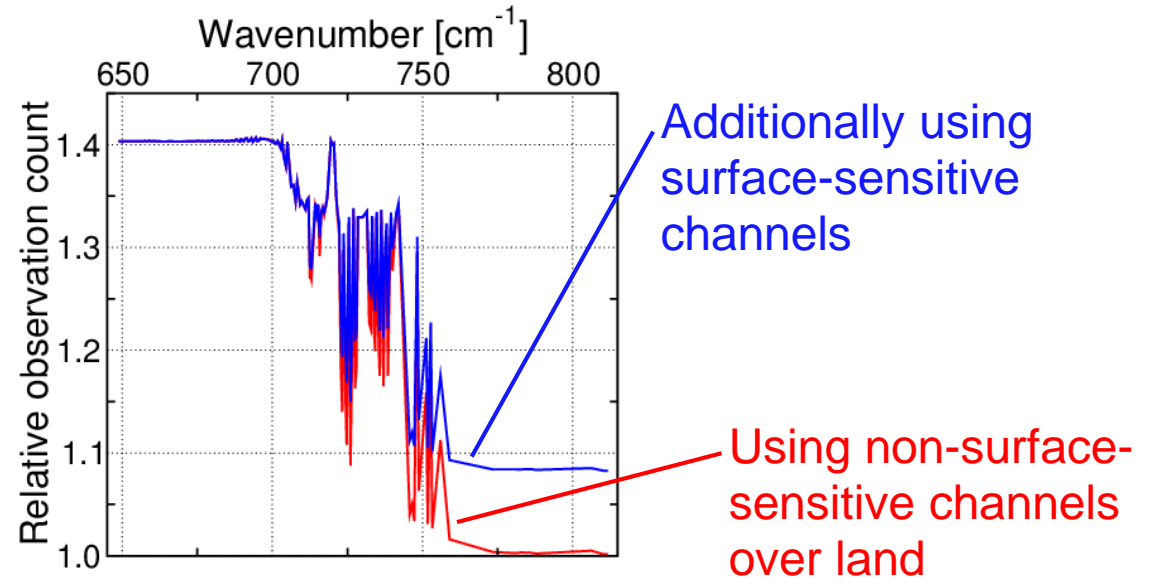
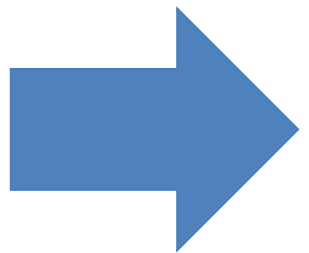
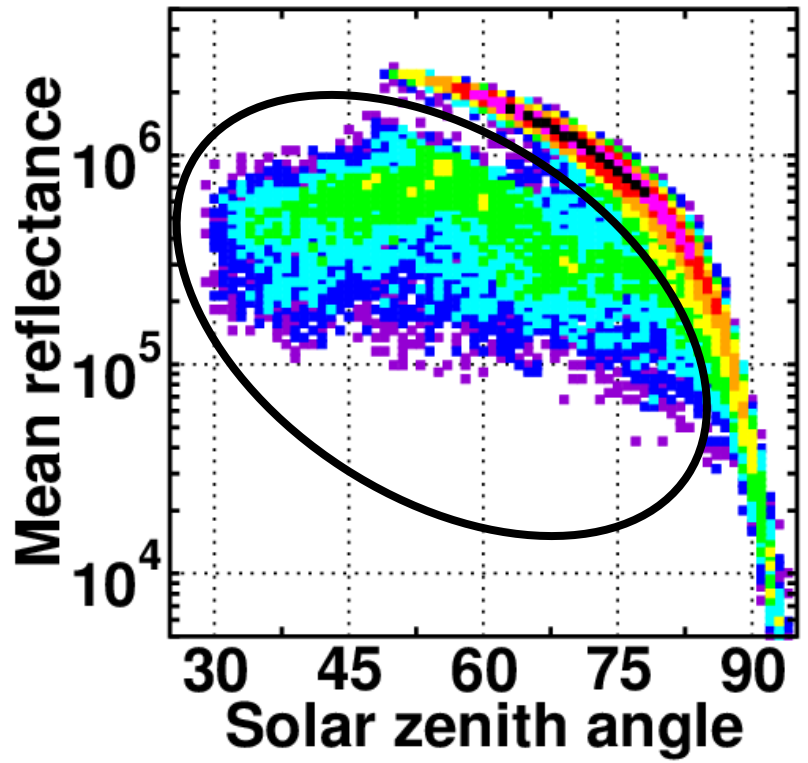
Towards using surface-sensitive channels over land ?



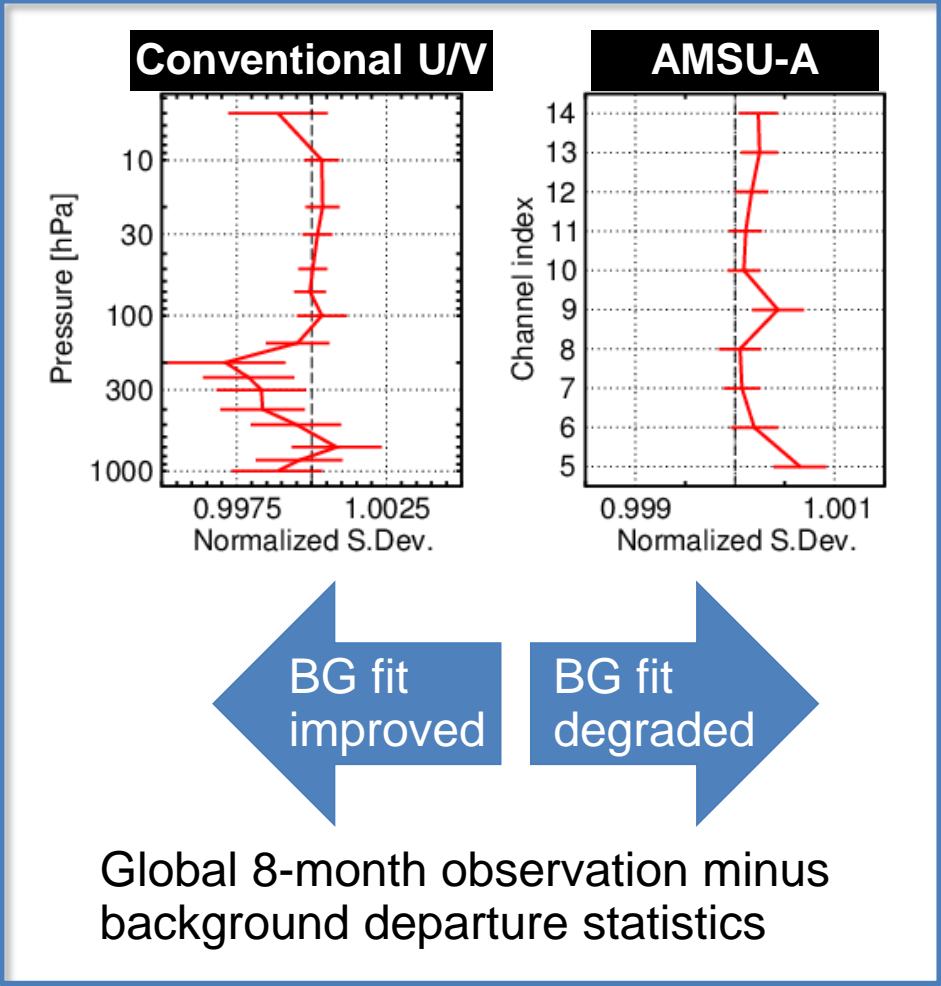
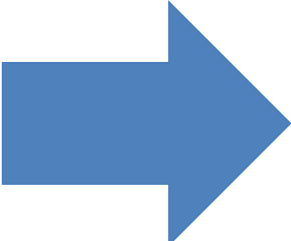
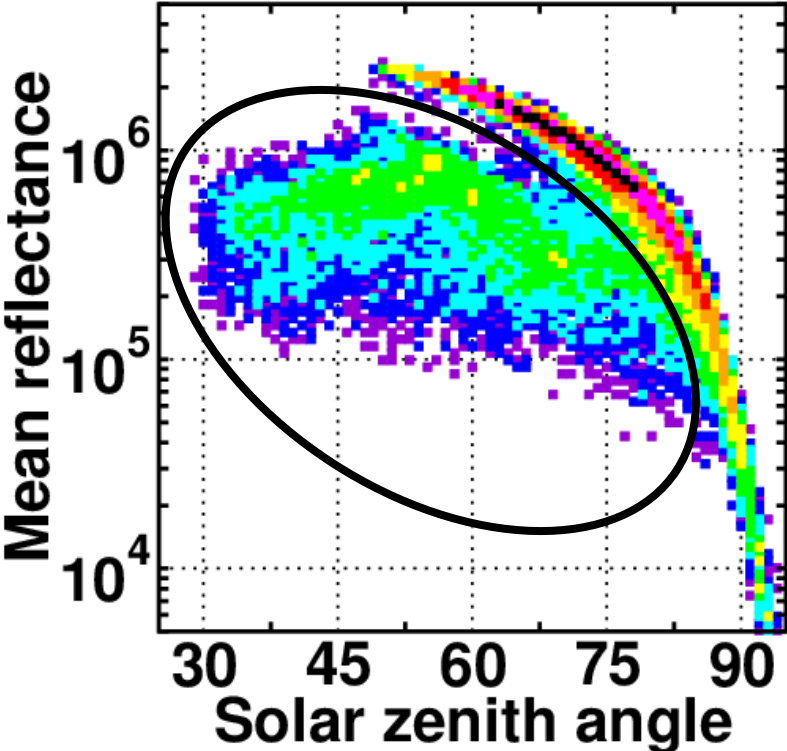
Try activating land-sensitive IASI channels in the day time when the following requirements are met:

- 1) All non-surface-sensitive channels are clear
- 2) Maximum inter-cluster BT difference in the $10.8 \mu\text{m}$ AVHRR channel is less than 1.0 K
- 3) Mean visible AVHRR channel reflectance falls below a solar-angle dependent threshold

~8% increase in global data count in the long-wave window



Impact of land-sensitive channels is still mixed at best



Conclusions

Situation-dependent identification of channels that are sensitive to surface emission

- Allows to use majority of IR channels in the same way over land as they are used over sea
- Results in a notable enhancement in IR radiance impact on NWP

Use of surface-sensitive channels over land remains a challenge

- Relying on both IR and visible channels of a collocated imager, the cloud detection is probably good enough
- It is necessary to improve the modelling of skin temperature and its error statistics