Progress towards an assimilation strategy for AIRS at ECMWF

Tony McNally, N. Fourrié, M. Matricardi, JN. Thépaut*, P. Watts

Progress / plans

• End-to-end 3D/4D VAR technical / science testing of day-1 system using NESDIS and ECMWF AIRS radiance simulations

• RTTOV(6M) extended to AIRS and compared to NESDIS / UMBC AIRS RT

•Verify assimilation of NESDIS NRT selected channels in day-1 system (possible spectral EOF's later on)

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•Develop new radiance monitoring tools and bias correction strategy

•Monitoring system for CO2

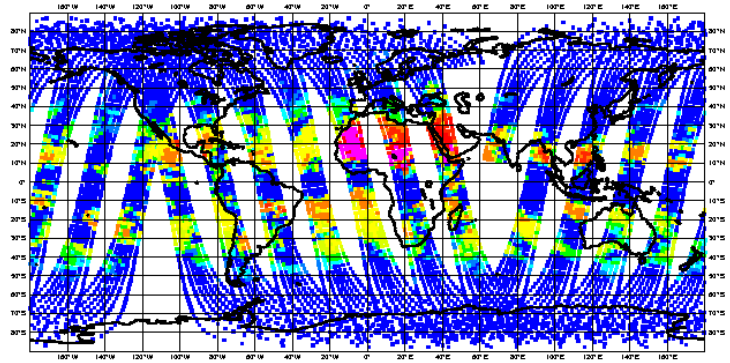
Simulated AIRS radiance data is very important

- The NESDIS NRT simulations in BUFR have allowed "end-to-end" technical testing of our monitoring and assimilation systems

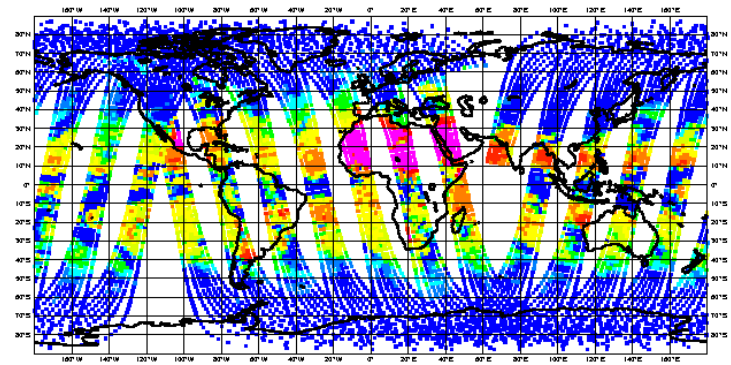
- This minimizes technical delays following launch (e.g. NOAA-16 implementation was tested pre-launch with simulated data and used operationally within 8 weeks!)

- ECMWF simulated AIRS radiances from "known" cloud conditions were used to train / verify our cloud detection algorithms

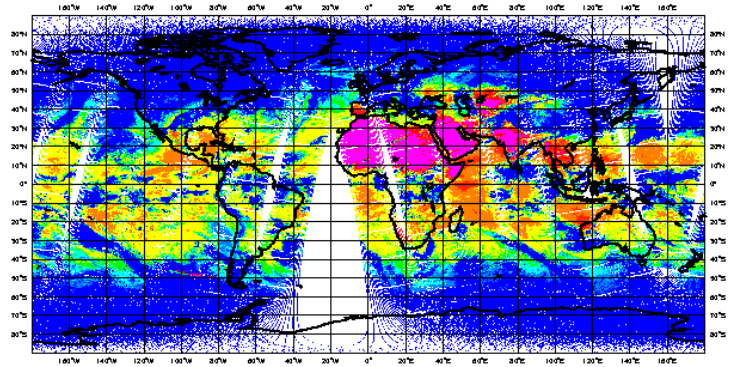
“Realism” of simulated cloudy AIRS radiances



NCEP
AIRS-760



ECMWF
AIRS-760



Observed
HIRS-8

- Realism of the implied cloud signal in the simulated radiances is important to ensure studies are not too optimistic or too pessimistic regarding the likely NWP impact of AIRS
- This realism will depend on the occurrence of cloud in the NWP model and the cloud radiative properties assumed in the RT calculations

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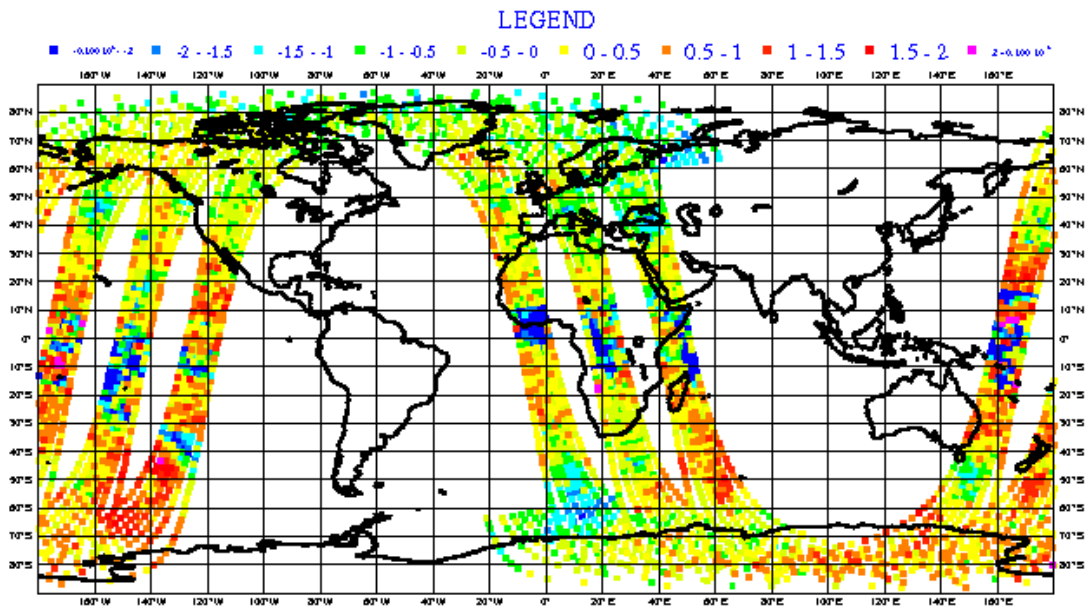
Radiative transfer model for AIRS

- RTTOV(6M) has been validated against LBL data
- Using NESDIS simulations RTTOV(6M) has implicitly been compared to the UMBC AIRS RT model.
- Dry temperature sounding channels generally display very good agreement. Yellow indicates better than 0.5 K
- See Matricardi+Chevallier talk

NESDIS-NRT minus EC-simulation in AIRS channel 139 (14.5 micron)



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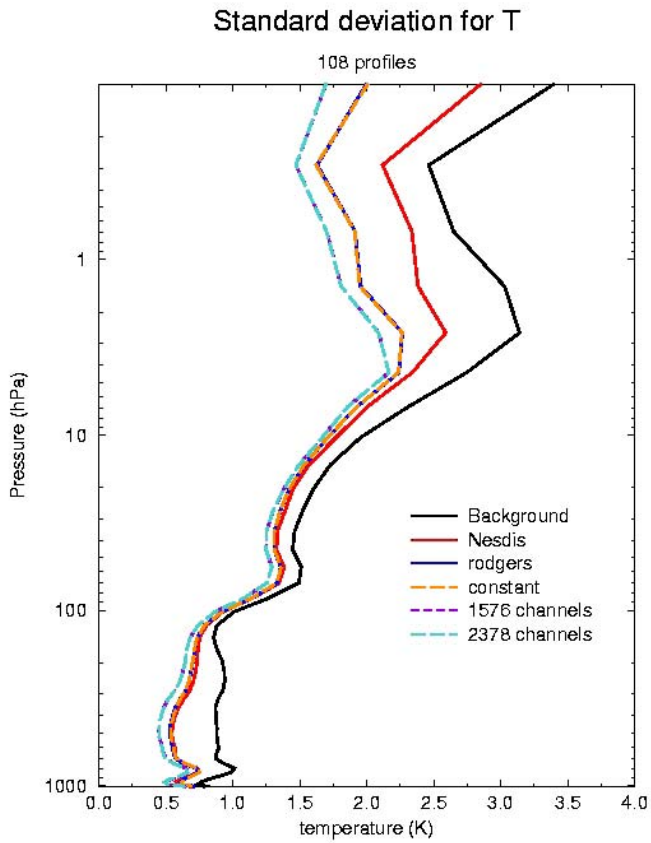
Channel selection and data compression for AIRS

•Spectral compression using e.g. truncated EOF's is not considered sufficiently accurate or robust for "Day-1 AIRS NWP assimilation"

•Thus a selected set of channels supplied in NRT by NOAA/NESDIS will be used at ECMWF

•Despite being independent of any given NWP system, the performance of these NESDIS selected channels is generally not too different to that of an optimized channel set (see Thépaut+Fourrié talk)



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New cloud detection algorithm for AIRS

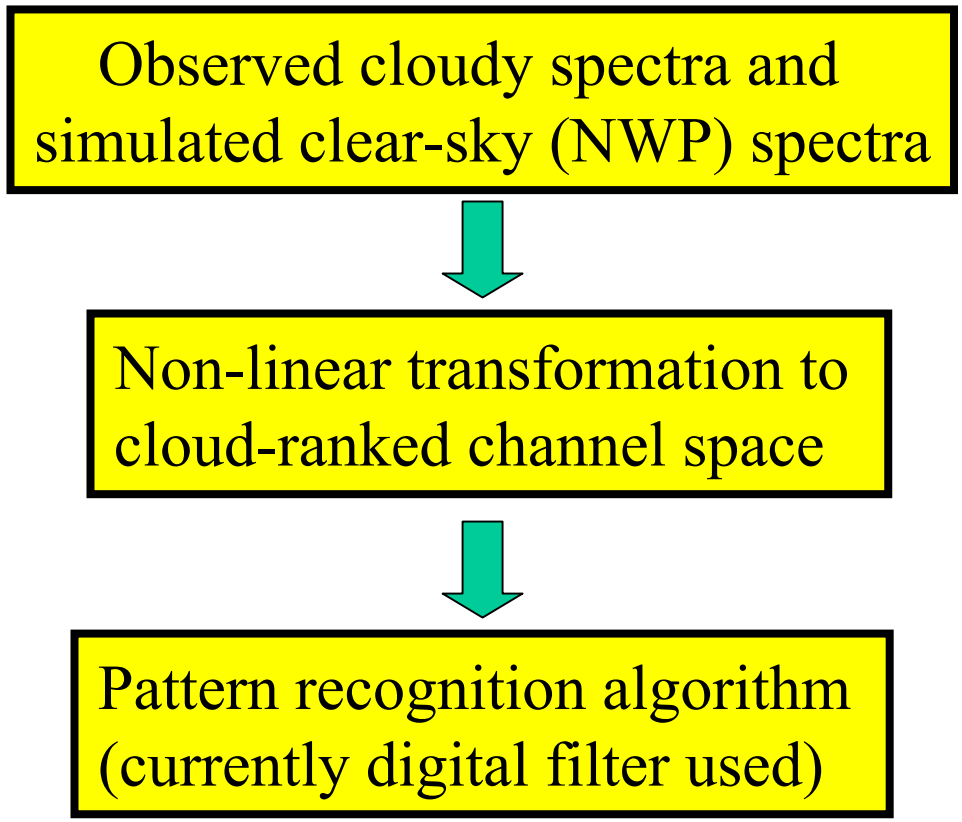
- Exploits NWP model accuracy (particularly in mid-upper trop constrained by AMSUA)

- Aims at dynamically finding clear channels rather than completely clear locations

- Validated with simulated cloudy AIRS radiances (real data will be used if AQUA slips)

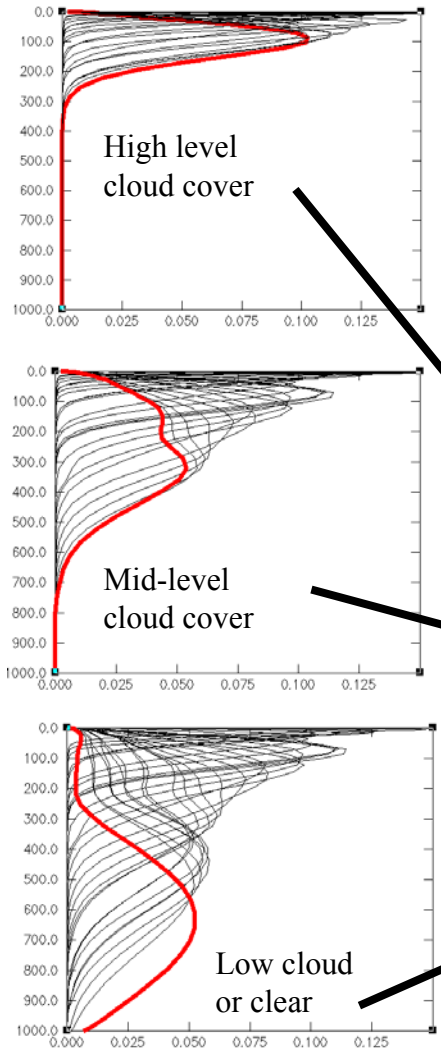
- Extendable to IASI

  (See McNally + Watts poster)

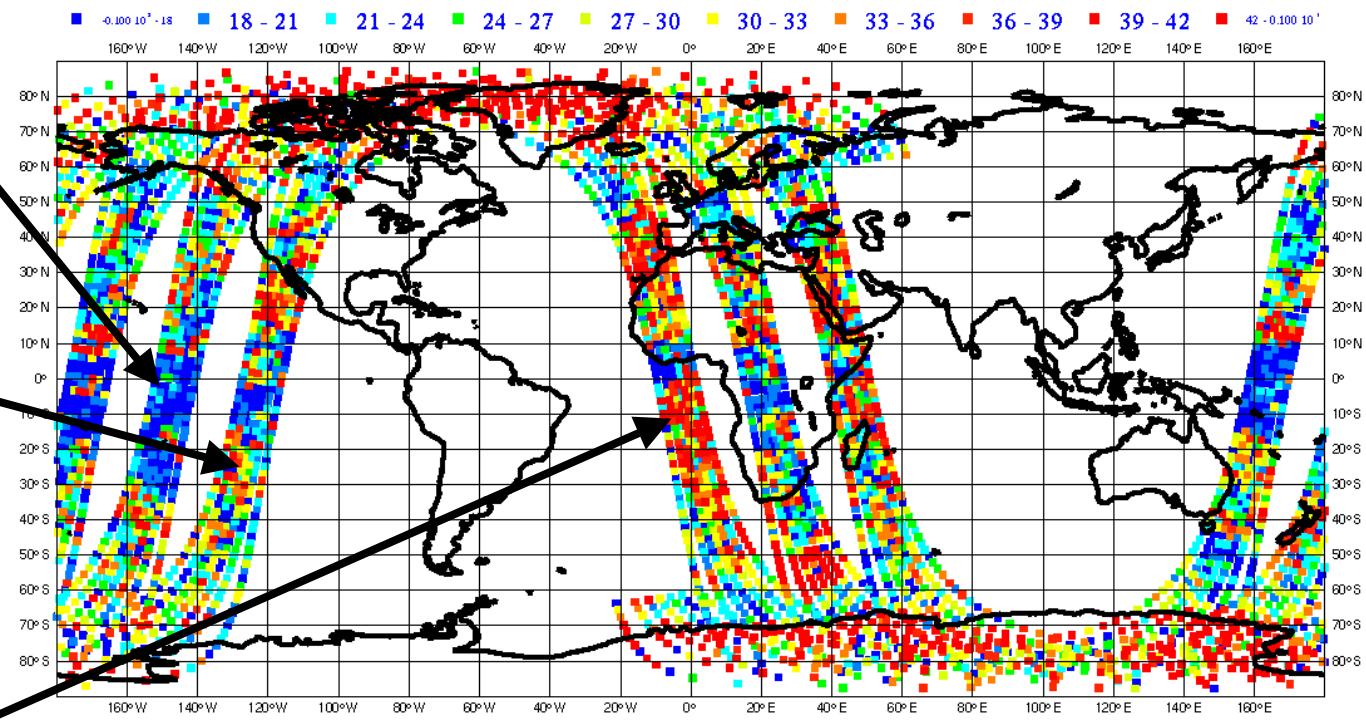


Cloud detection and channel use above clouds

Temperature
weighting functions



Index of lowest AIRS long-wave channel determined cloud-free
(clouds and AIRS radiances simulated from ECMWF model)



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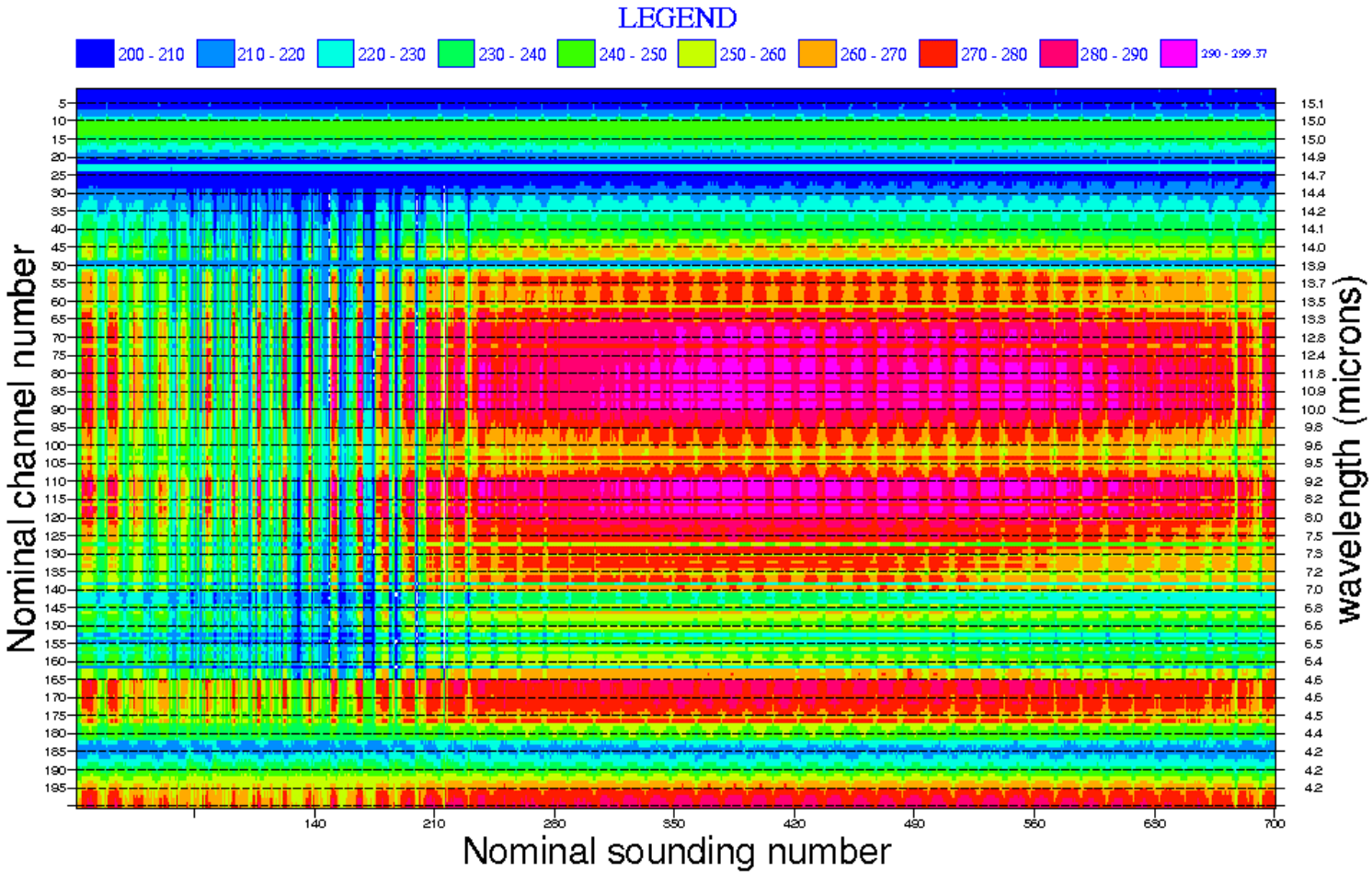
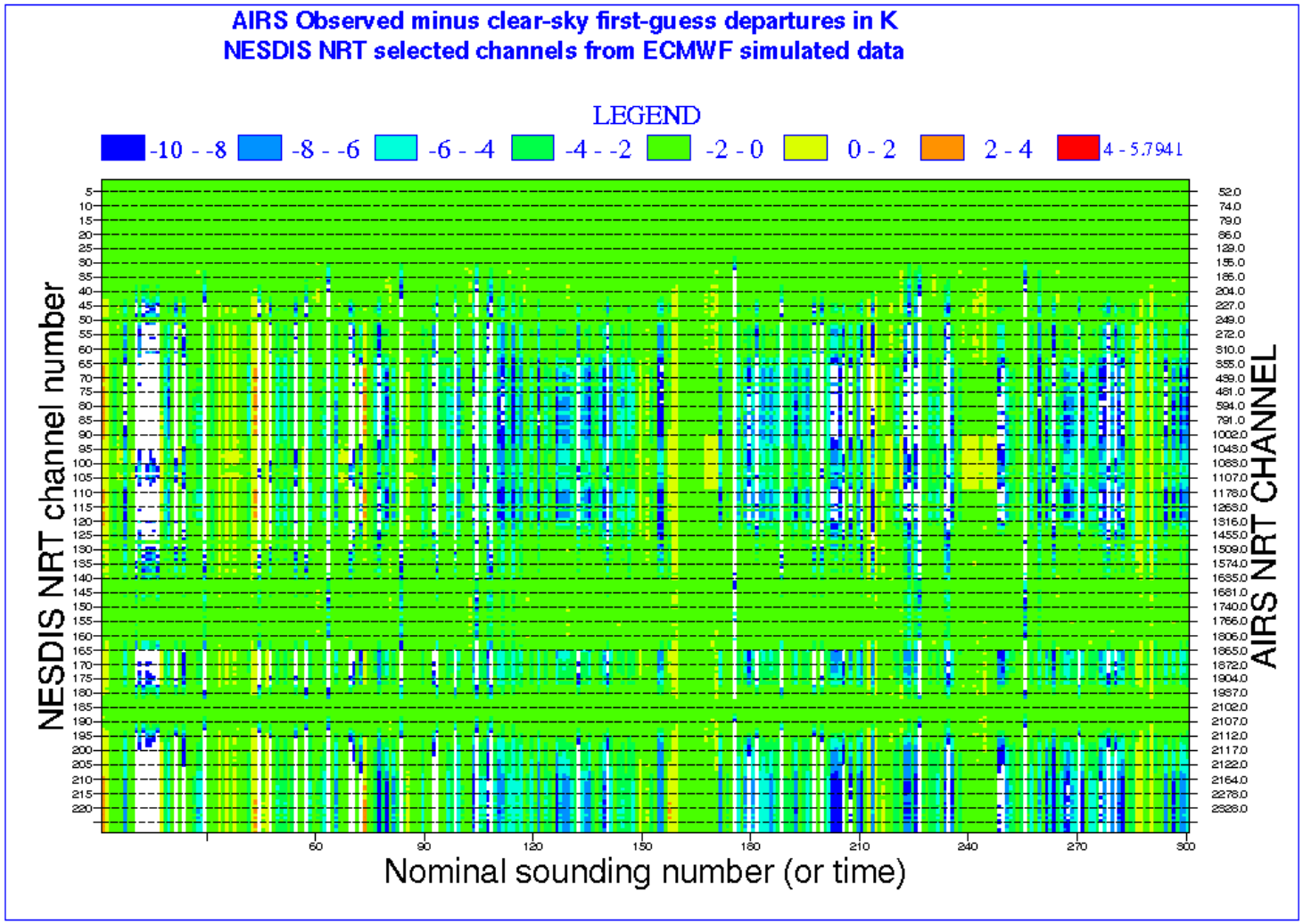
Quick-look monitoring of all AIRS channels (simulated Tb in clear and cloudy sky)



Monitoring of all AIRS channels (Observed minus simulated Tb in clear and cloudy sky)

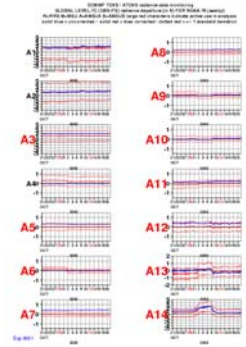


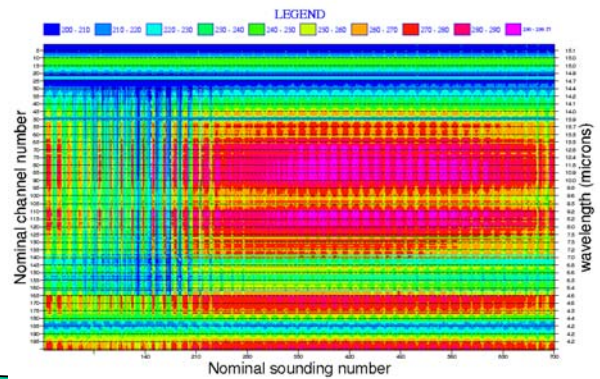
Monitoring and continuous feedback

SRF / calibration upgrades

NASA / AIRS SCIENCE TEAM

Validation at NWP centres





departure statistics (WWW)

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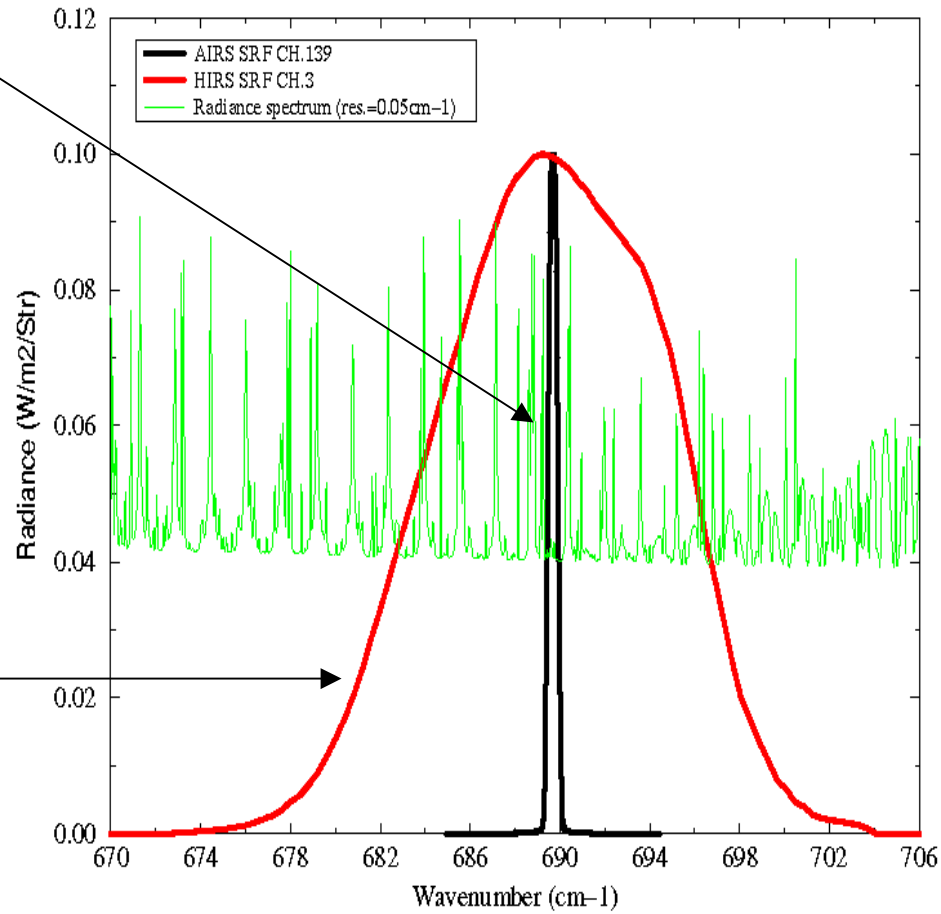
Why use AIRS to estimate CO_2?

•By sampling the IR spectrum at very high resolution (R=1200) we can measure radiation that is only dependent on temperature and the atmospheric CO_2 concentration (small groups of pure lines)

•If we have accurate temperature information (from the ECMWF analysis driven by AMSUA data) we can separate out the CO_2 signal.

•Instruments with coarse spectral resolution (e.g. HIRS) sample radiation that is a mixture of absorbing species (e.g. CO_2 / N_20 / O_3 and H_2O) and cannot resolve the CO_2



Key issues and limitations for CO_2

- We may have to average over long time periods (e.g. 1month) to reduce temperature uncertainty.

- Little or no near surface information on CO_2 (no contrast)

- We must employ transport models to link the upper level / total column measured to near surface sources /sinks of CO_2

- Robust cloud detection will be crucial

Hot news: RTTOV6(M) has been extended to handle variable CO2 (see Matricardi+Chevallier talk)