

Assimilation TOVS/VTPR/SSMI Radiances and use of Australian surface PAOBs

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ECMWF Workshop on Re-analysis 5 to 9 November 2001

Use of satellite radiance in ERA 40

PAOBs (bogus observations (BOM) from cloud imagery)

VTPR (8 channel IR sounder 1972-1979)

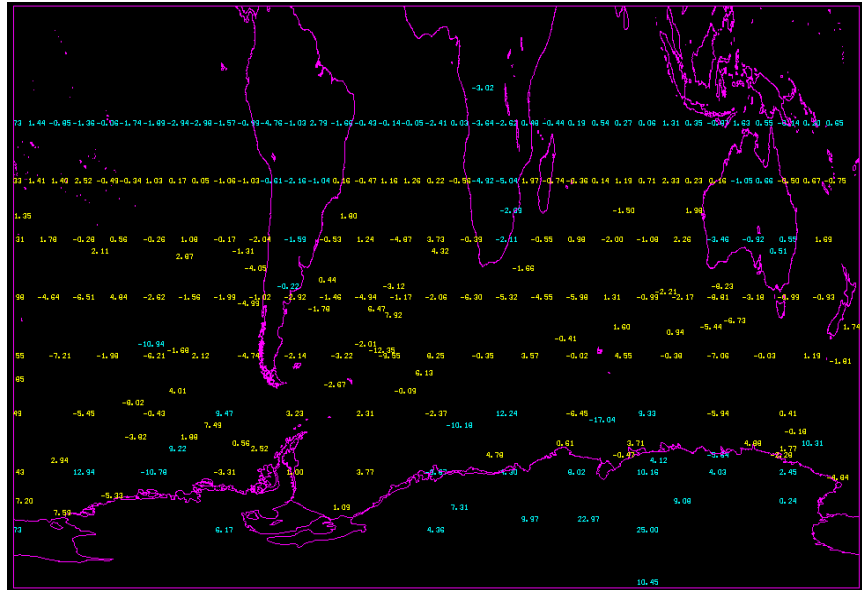
TOVS (3 sounder instruments 1978-2001)
HIRS 20 channel IR sounder
MSU 4 channel MW sounder
SSU 3 channel IR sounder

SSMI (7 channel MW imager 1987-2001)

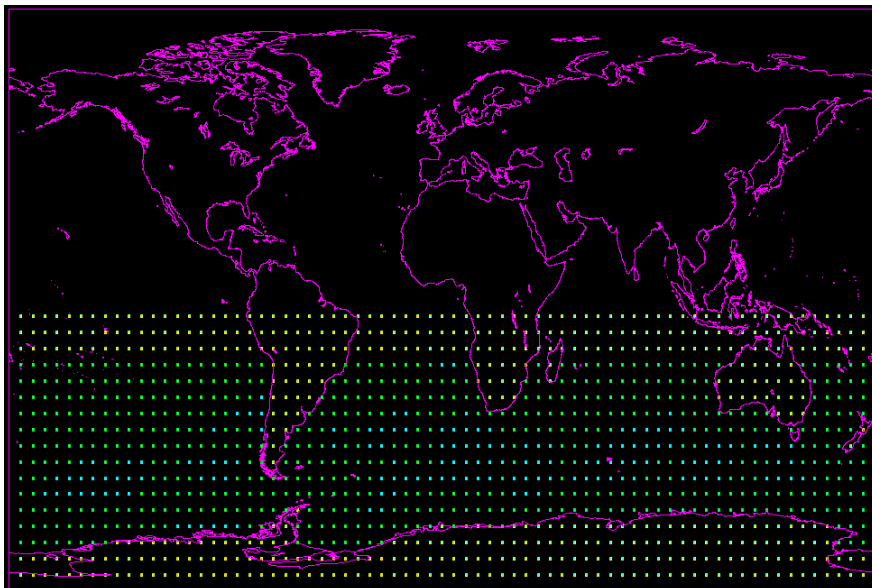
ATOVS (3 sounder instruments 1997-2001)
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AMSUA 20 channel MW sounder
AMSUB 5 channel MW sounder



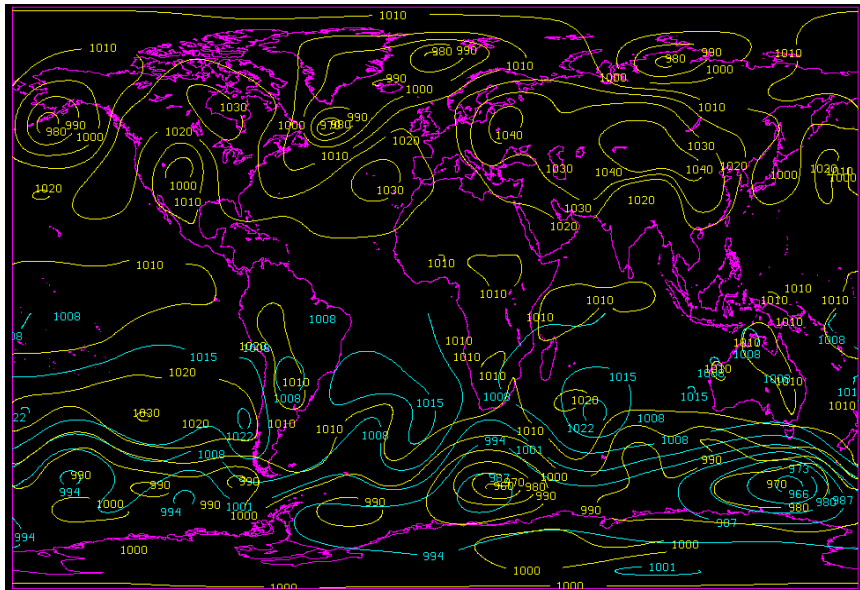
PAOBs generated from BOM for 00z 2/2/1993 (yellow used)



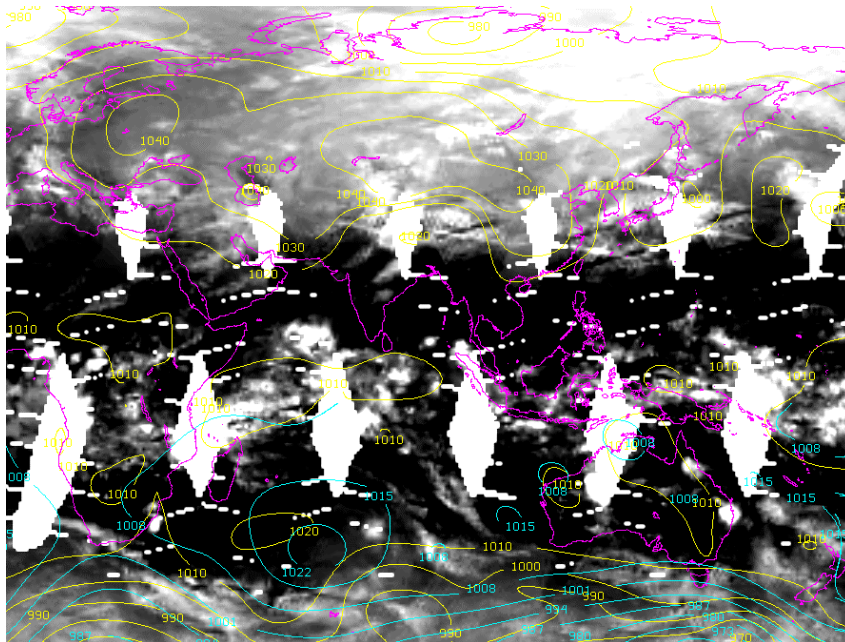
PAOBs generated from BOM for 00z 28/12/1972 (green used, yellow blacklisted, and blue rejected)



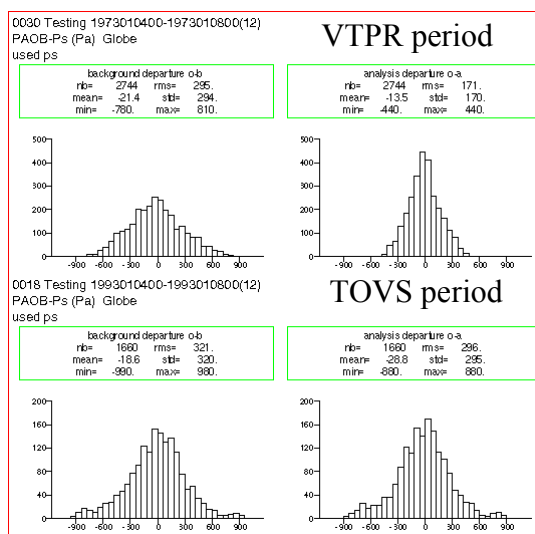
ERA 40 MSL analysis (yellow) & BOM operational 00z 28/12/1972



ERA 40 MSL analysis (yellow) & BOM (cyan) 00z 28/12/1972



Departure statistics. for used PAOBs



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Major issues with the use of radiances.

Accuracy of data assimilation including surface temperature.

Accuracy of radiosondes and radiosonde biases.

Accuracy of forward radiative model.

Instrument biases and stability.

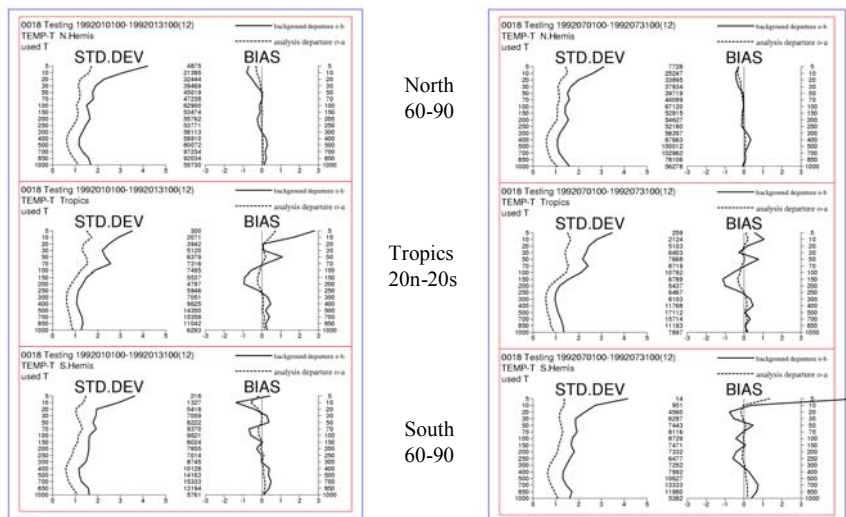
Cloud and rain contamination.

Stratospheric calibration.

Assimilation statistics for radiosondes

Jan 1992

July 1992



Bias and Scan Correction (TOVS & VTPR)

In ERA 15 NESDIS cloud cleared and nadir corrected radiances were used. The scan correction and biases were calculated monthly using model first guess profiles near radiosondes.

Scan corrections were just a global offset and applied first then a bias correction using MSU Channels 2, 3 and 4 as predictors.

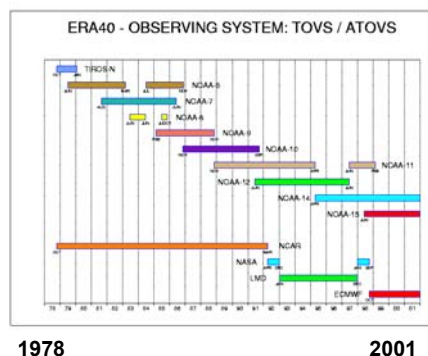
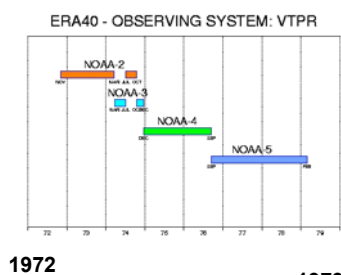
In ERA 40 raw radiances are used. The scan correction and biases are calculated on an initial monthly sample near radiosondes and are updated if there are instrumental problems.

Scan corrections are a function of latitude and applied first then the bias correction using 4 model predictors.

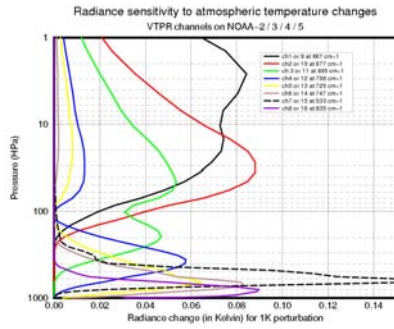
The predictors are:

- Model First Guess Thickness Z(1000-300)hPa,
- Model First Guess Thickness Z(200-50)hPa,
- Model First Guess Surface Skin Temperature,
- Model First Guess Total Column Water Vapour.

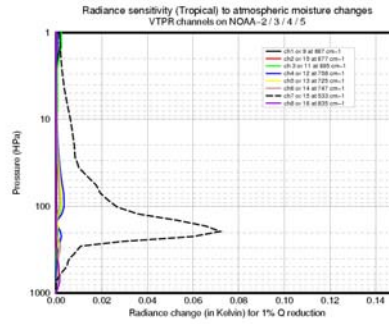
Radiances used from 15 NOAA satellites 41 sensors



VTPR Radiance Sensitivity



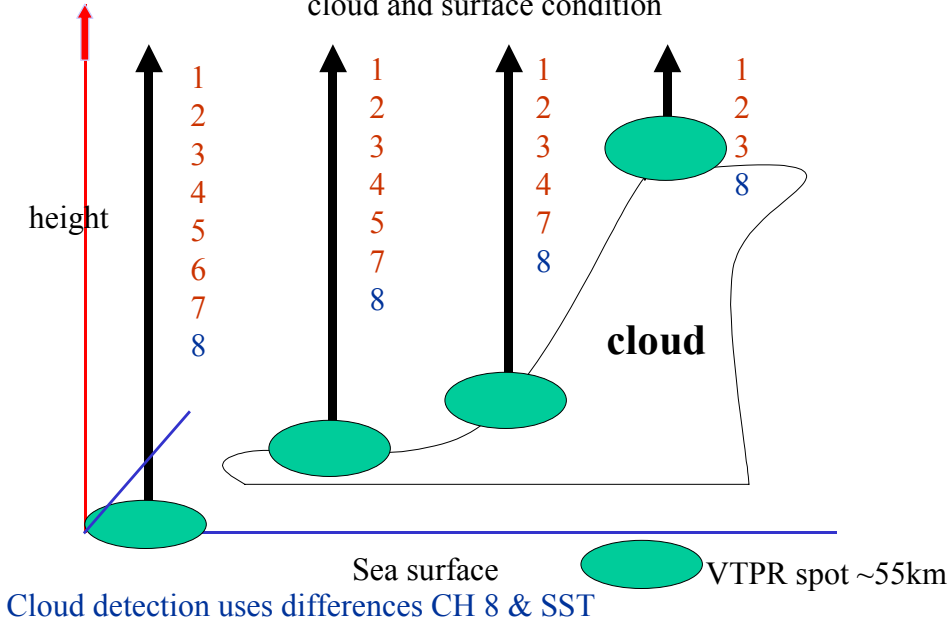
temperature



humidity



Schematic diagram of VTPR channels used for differing cloud and surface condition



VTPR data usage for two Tropospheric channels plotted on imagery from CH 8: magenta CH 6, yellow addition CH 5

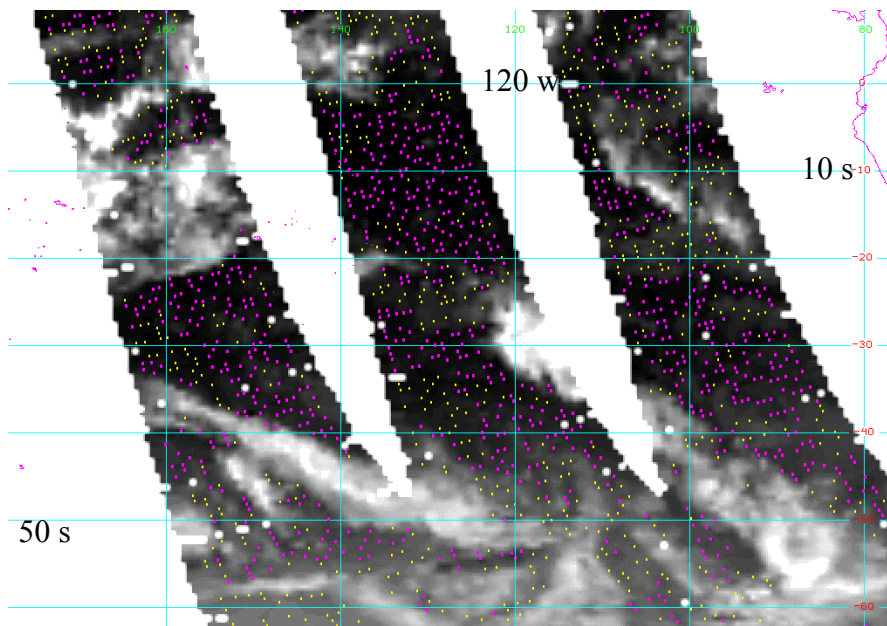
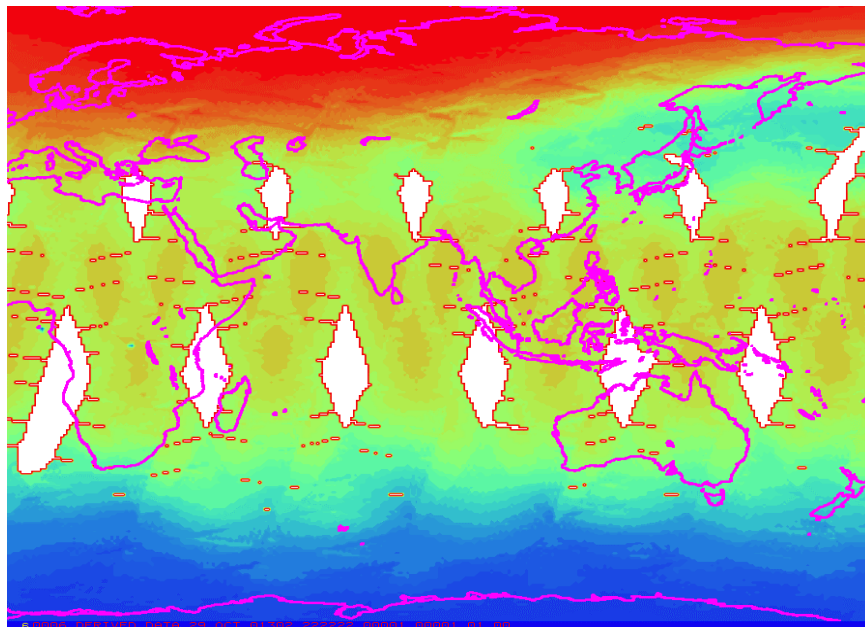
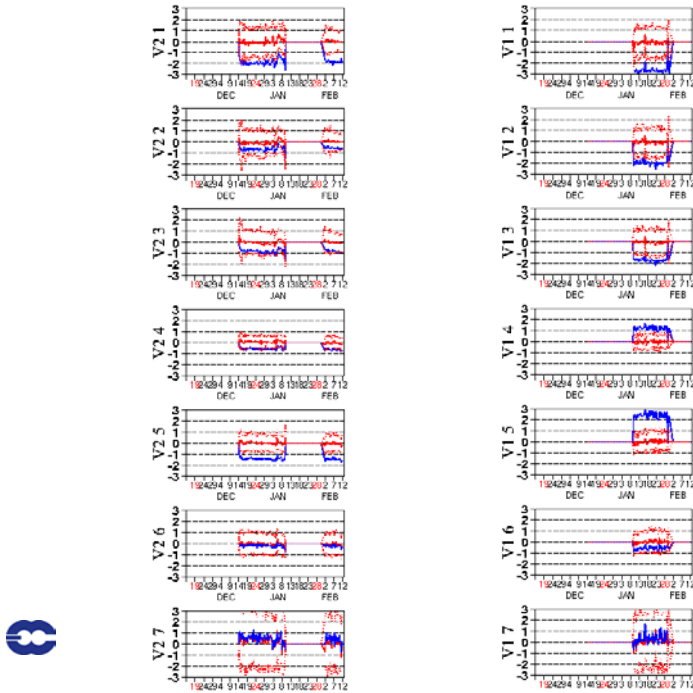
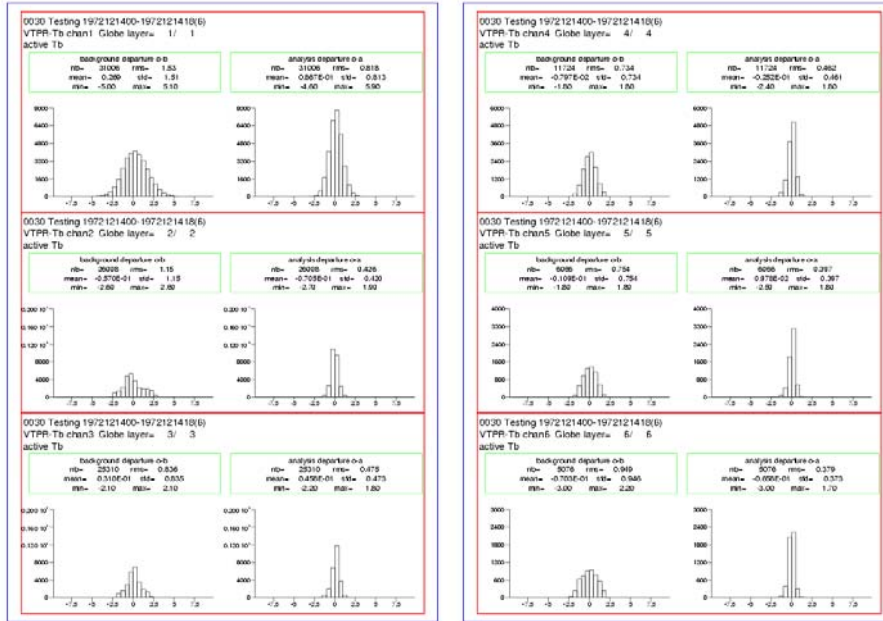


Image created from VTPR CH 2 for all orbits on 28/12/1972



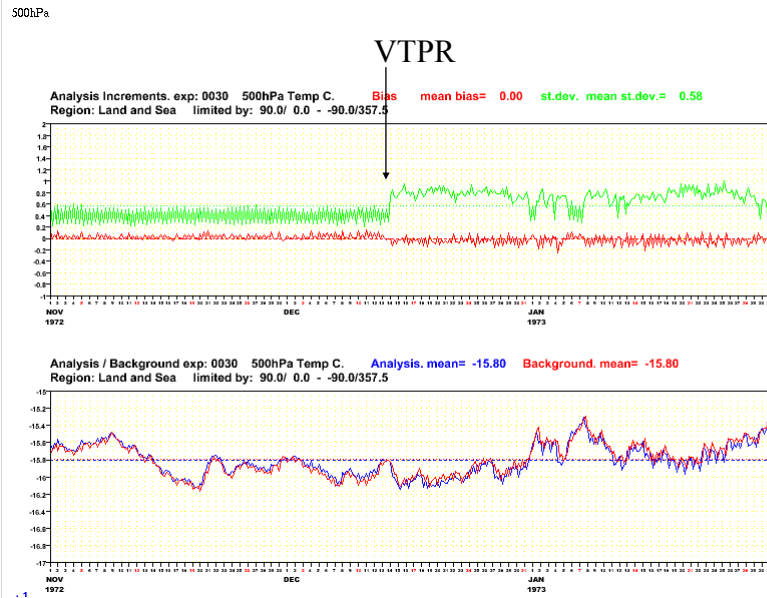
Departure statistics for VTPR channels 1 to 6



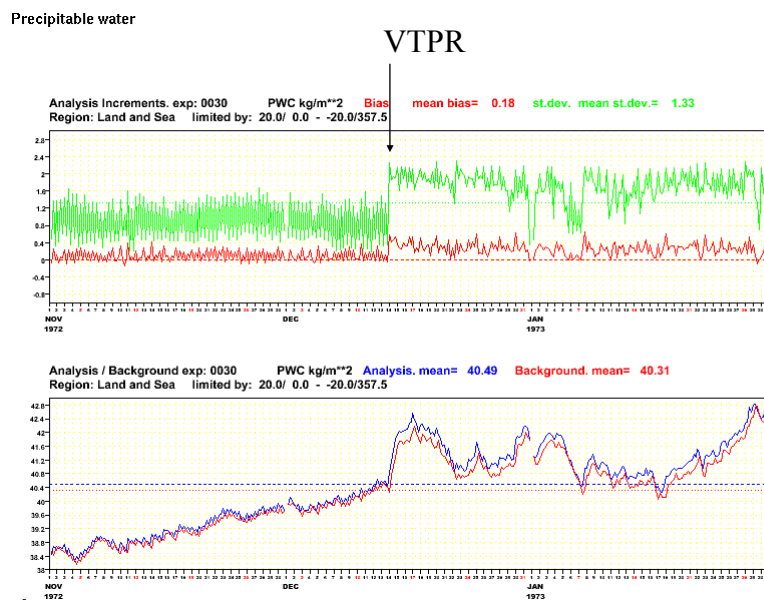
VTPR time series monitoring 1972/73



Analysis Increments at the start of VTPR radiance assimilation



Analysis Increments at the start of VTPR radiance assimilation



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VTPR (8 channel IR sounder 1972-1979)

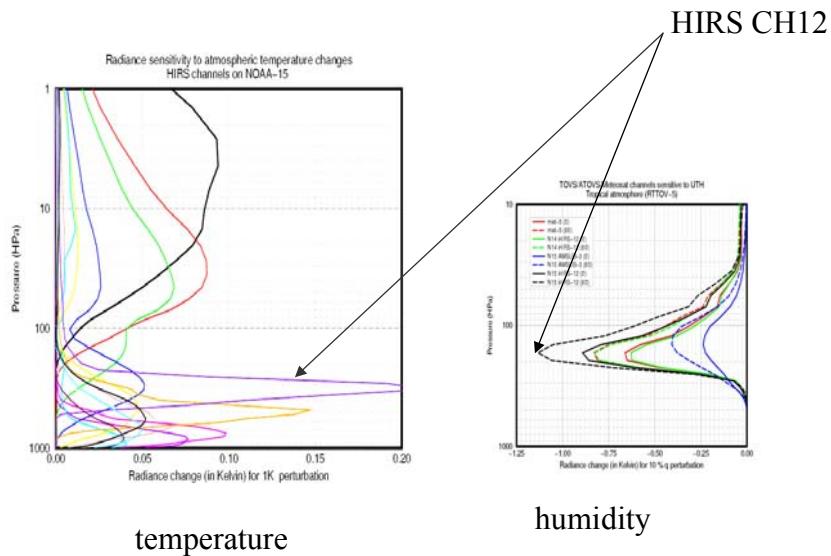
TOVS (3 sounder instruments 1978-2001)
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 MSU 4 channel MW sounder
 SSU 3 channel IR sounder

SSMI (7 channel MW imager 1987-2001)

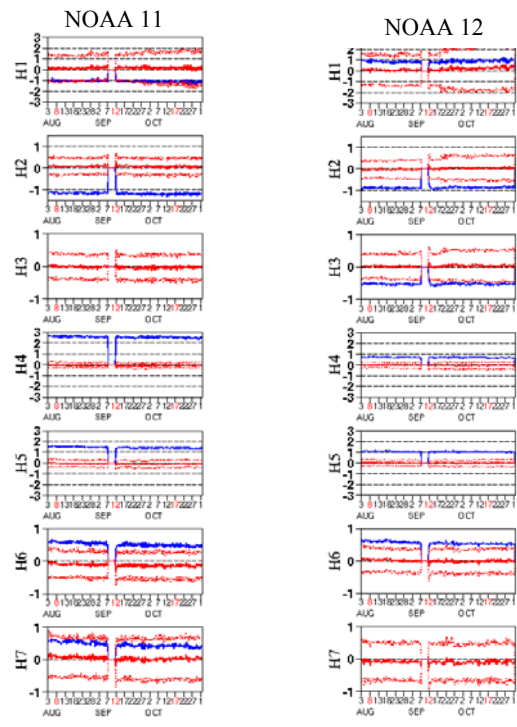
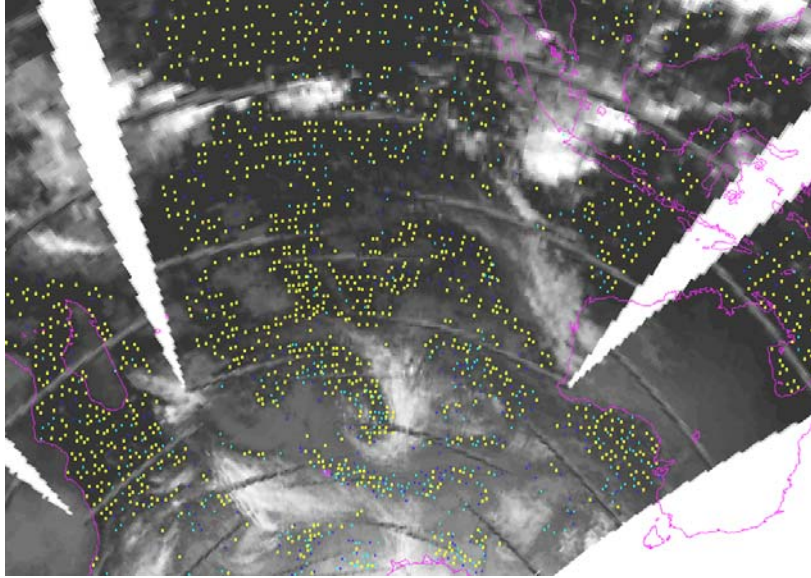
ATOVS (3 sounder instruments 1997-2001)
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 AMSUB 5 channel MW sounder



HIRS Radiance Sensitivity



HIRS data usage for three channels plotted on imagery from CH 8: yellow CH 7, cyan addition CH 6 & blue addition CH 5.

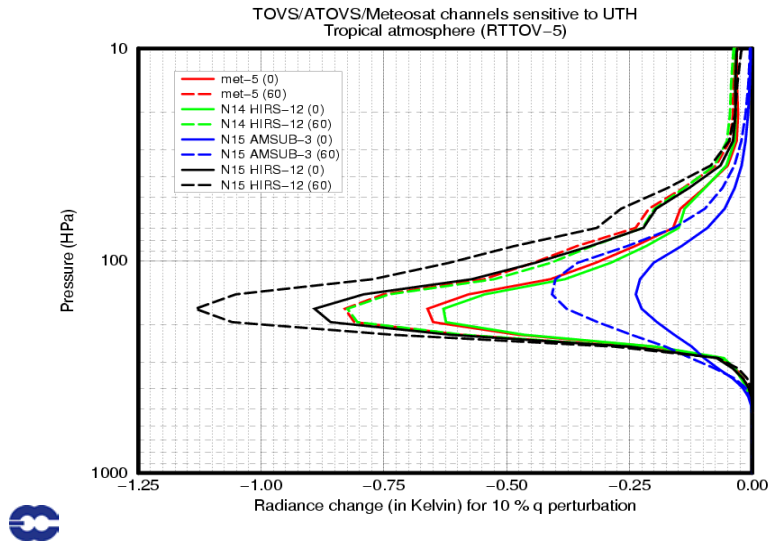


HIRS time series monitoring 1993

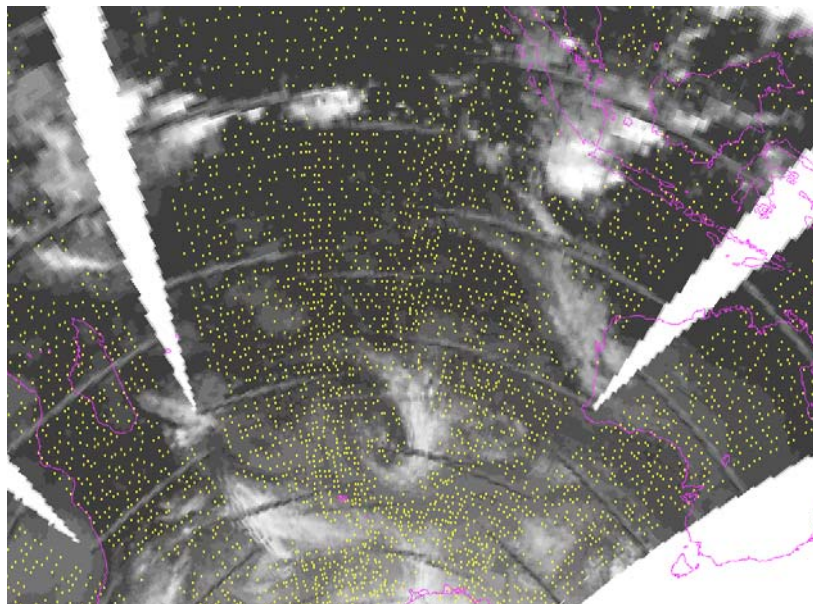
note: the data dropout on 7sept to 12sept

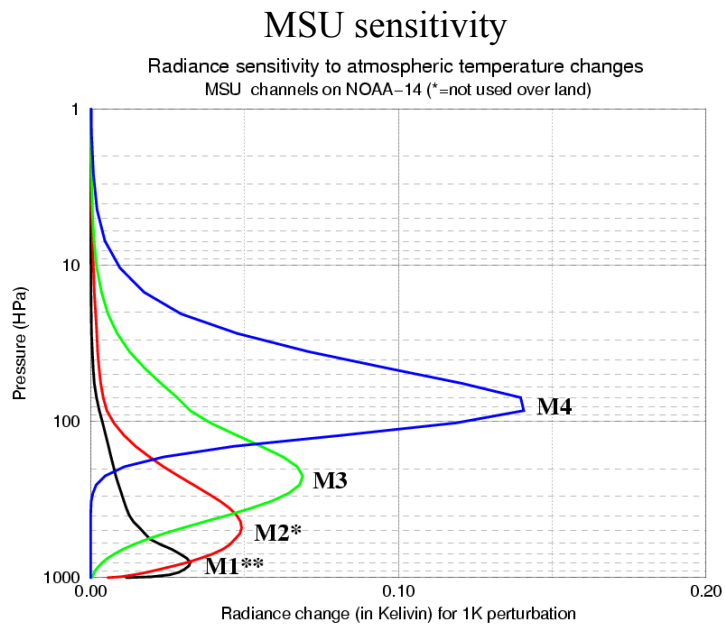


Sensitive to water vapour

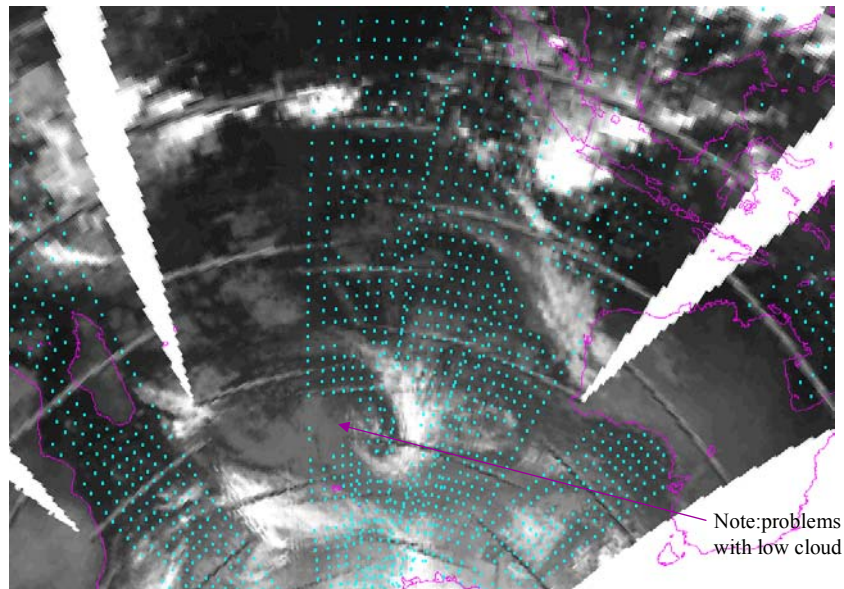


HIRS CH 12 data usage plotted on imagery from CH 8.

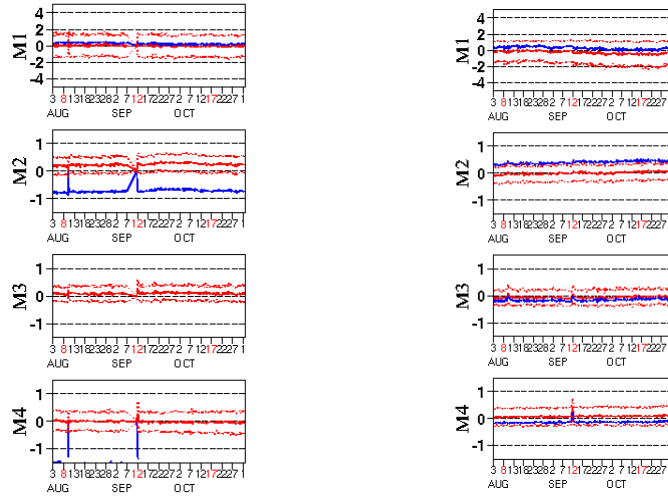




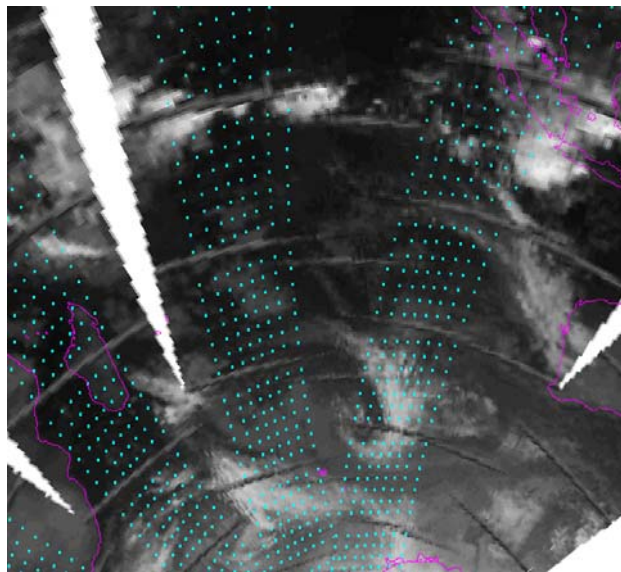
MSU CH 2 data usage plotted on imagery from HIRS CH 8



MSU time series monitoring 1993
NOAA 11 **NOAA 12**



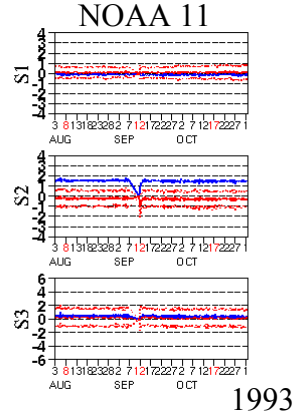
SSU CH 3 data usage plotted on imagery from HIRS CH 8



SSU time series monitoring 1993

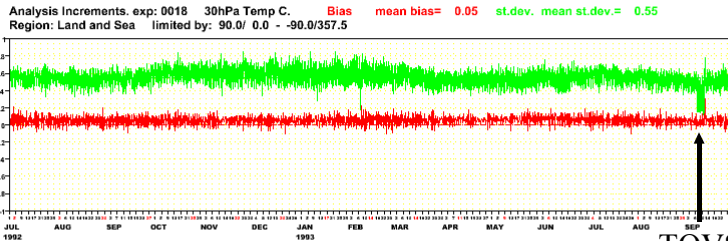
SSU bias correction

Scan correction is similar to HIRS but only channel 1 has the air-mass correction. Channels 2 and 3 have fixed biases with reference to AMSU A (see later).

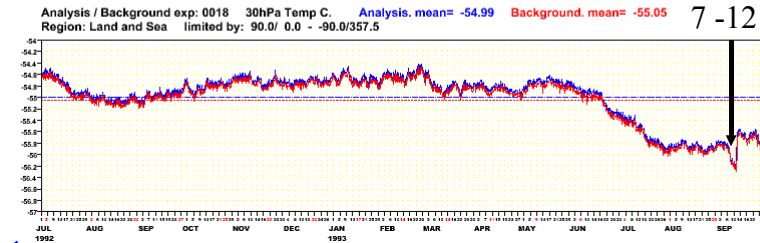


30 hPa Temp. Analysis Increments

30hPa

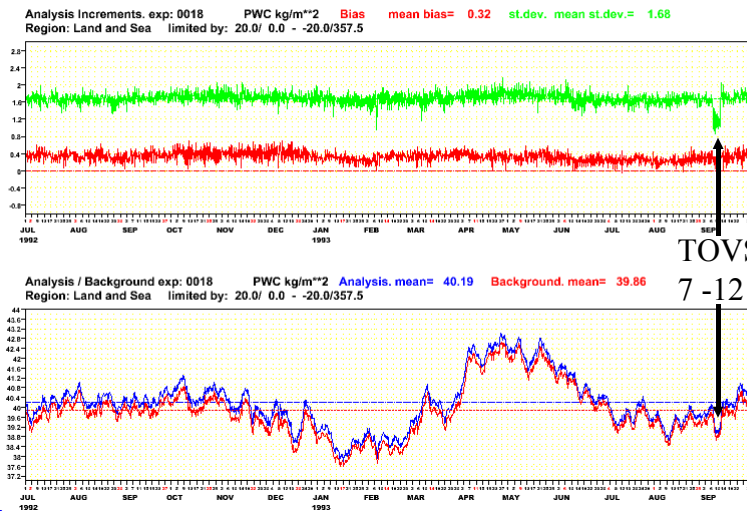


TOVS missing
7 -12 Sept.



Precipitable water Analysis Increments

Precipitable water



TOVS missing
7-12 Sept.

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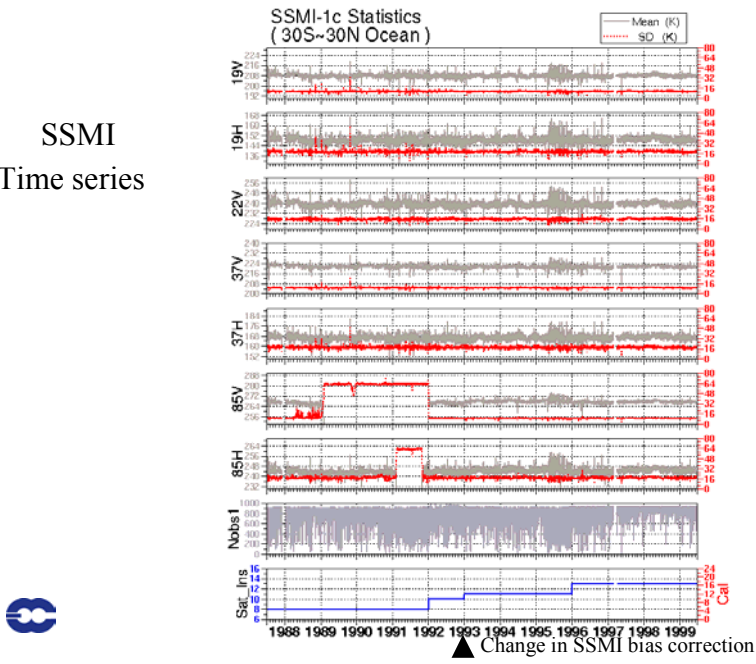
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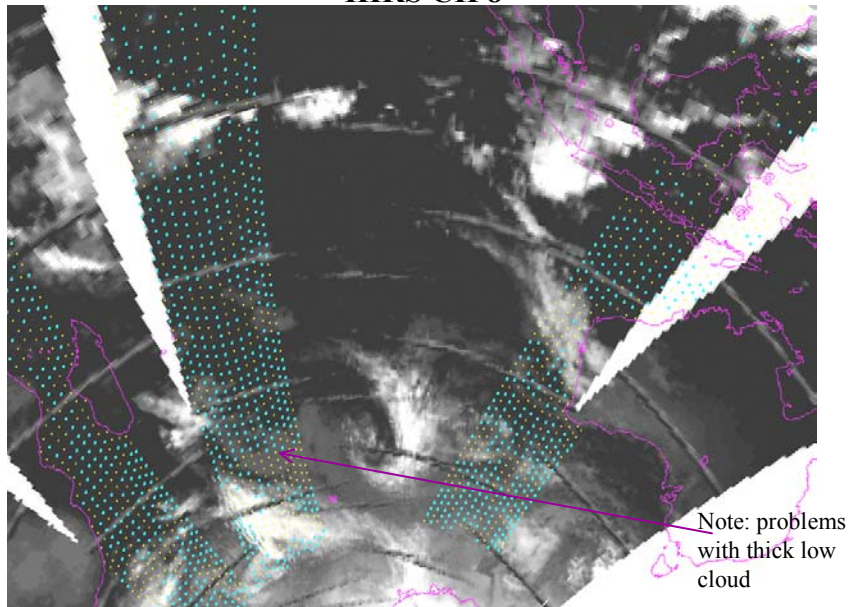
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SSMI
Time series



SSMI PWC 1D-VAR usage plotted on imagery from
HIRS CH 8



SSMI PWC points in yellow fail cloud liquid check

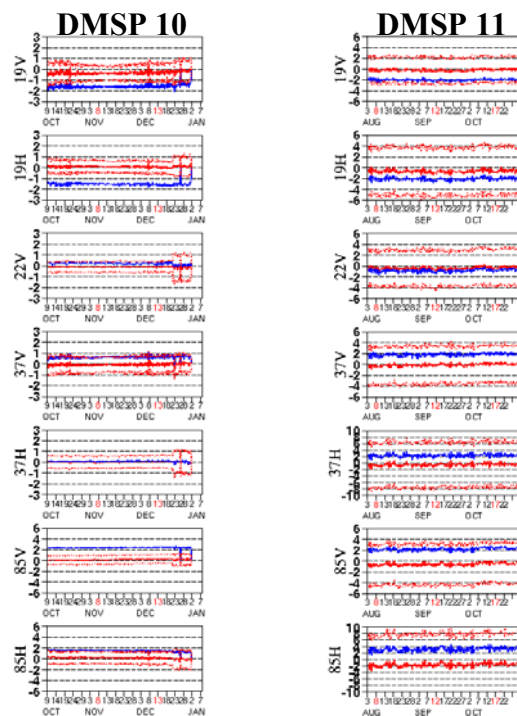
Bias and Scan Correction (SSMI)

The scan correction and biases are calculated on an initial monthly sample near radiosondes and are updated if there are instrumental problems.

Scan corrections are a function of SSMI spot position and applied first then the bias correction using 4 model predictors.

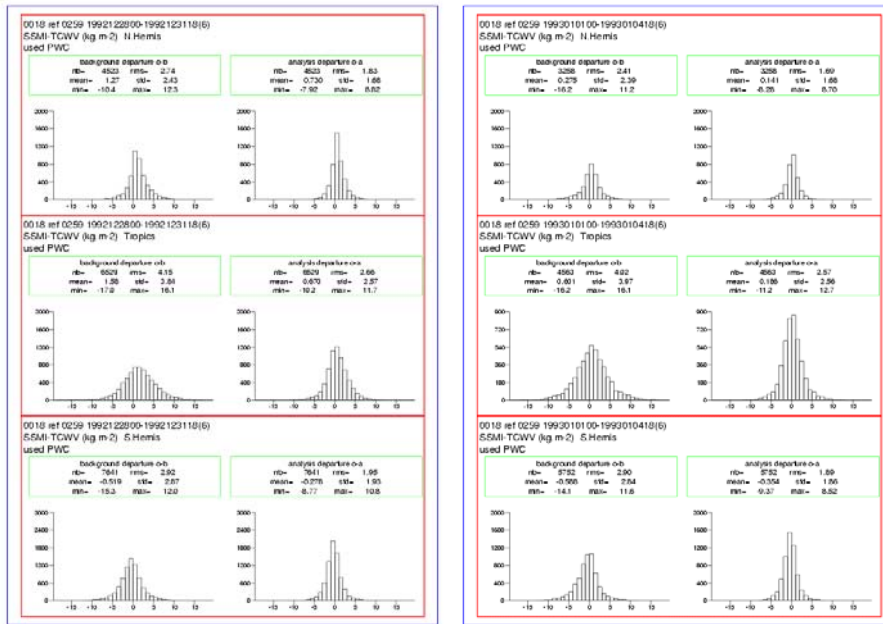
The predictors are:

- Model First Guess Mean Sea Level pressure,
- Model First Guess 10 m wind speed,
- Model First Guess Surface Skin Temperature,
- Model First Guess Total Column Water Vapour.



SSMI time series monitoring 1992/3

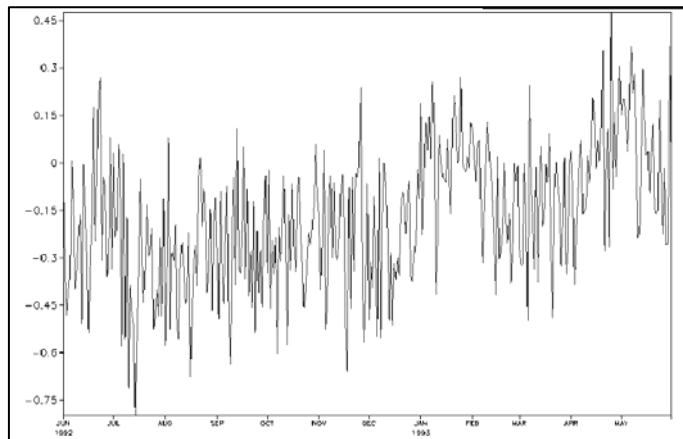
Departure statistics for SSMI PWC



Rain rate difference in ERA 40 forecasts

rain at 36 hrs - rain at 12 hrs

Rain rate mm/day



June 1992

Jan 1993

SSMI bias changed



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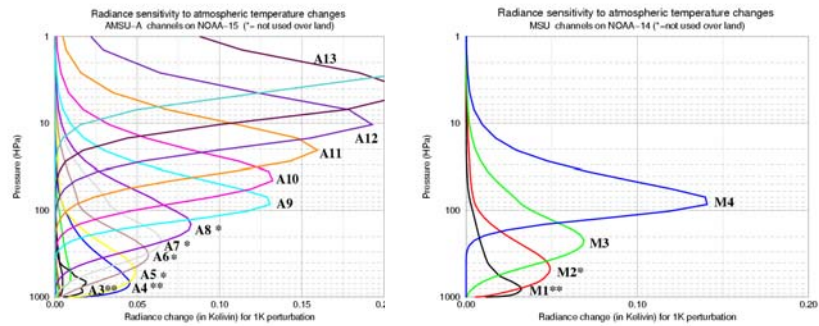
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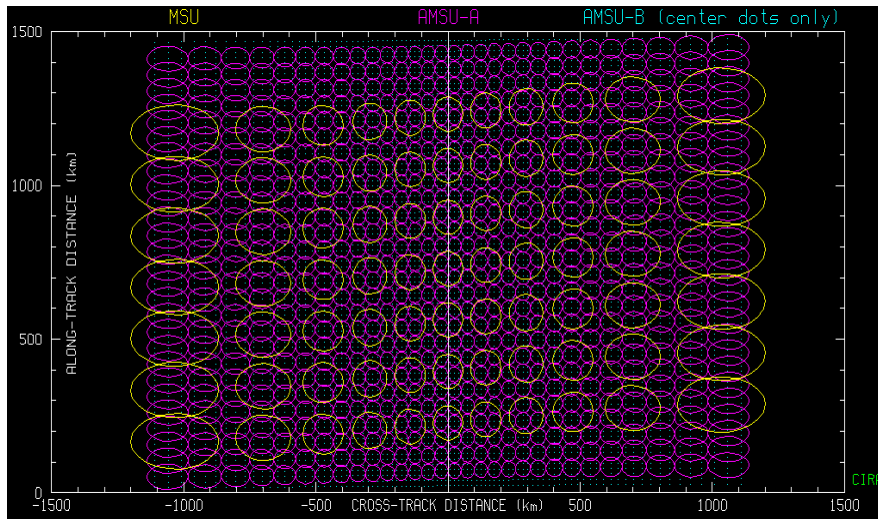
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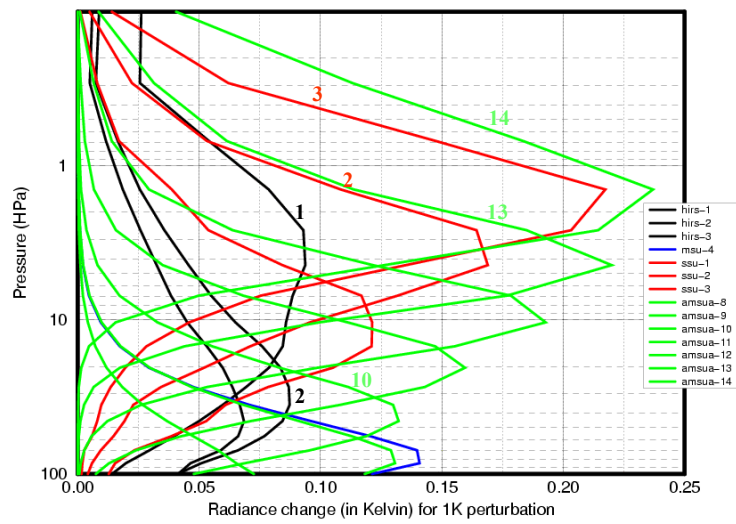
Radiance Sensitivity



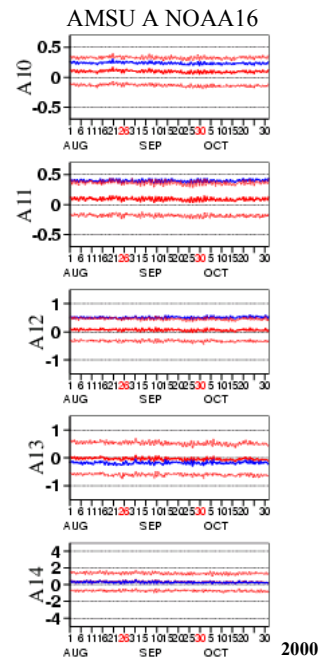
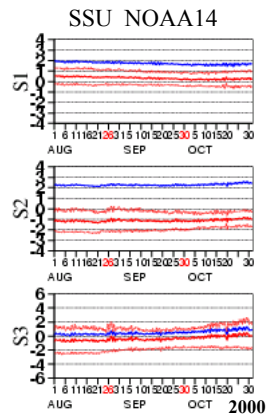
Comparison of MSU , AMSU-A & AMSU-B spots



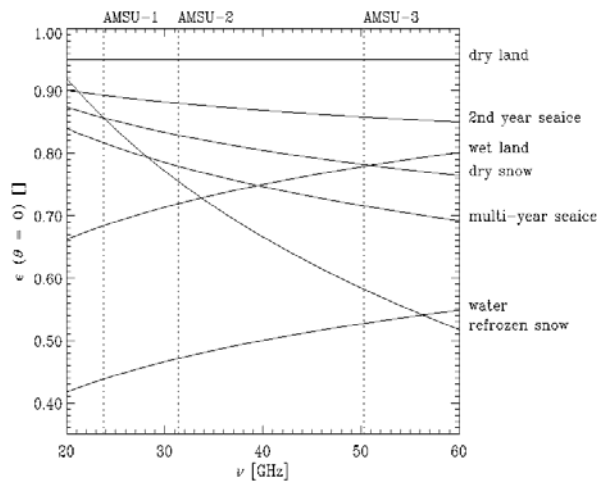
Radiance sensitivity TOVS / ATOVS CHANNELS SENSITIVE TO STRATOSPHERIC TEMPERATURE (RTTOV-5)



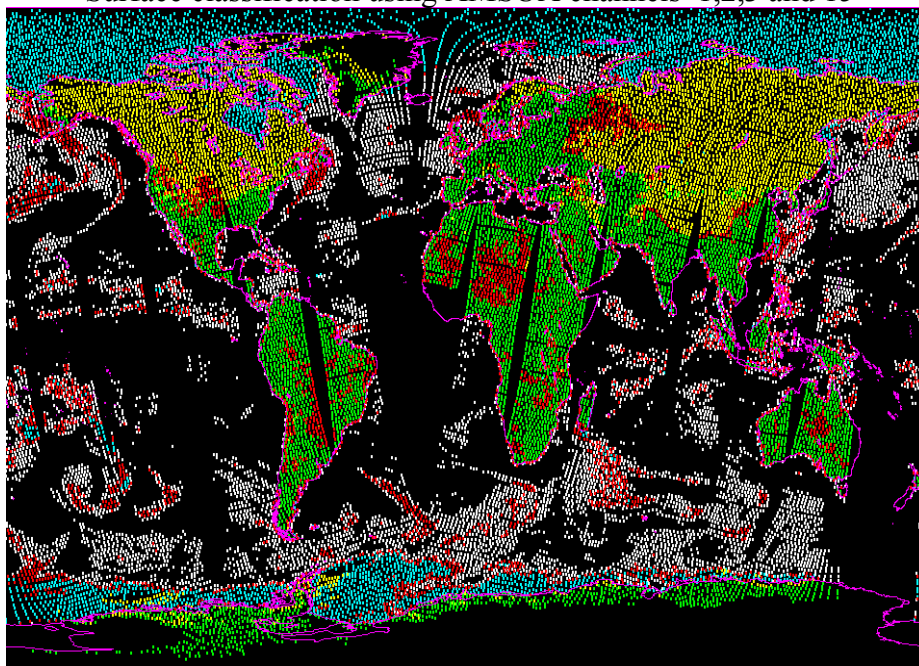
**Comparison of SSU
and AMSU A with current
ECMWF operational model**



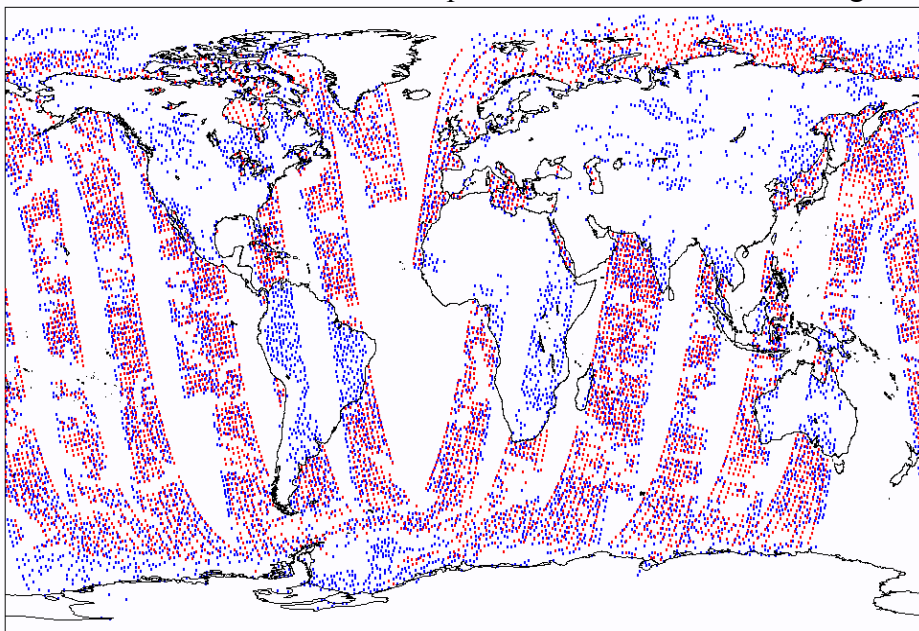
Surface emissivity for various surface types



Surface classification using AMSUA channels 1,2,3 and 15



AMSUA channel 5 active data red previous blue additional coverage

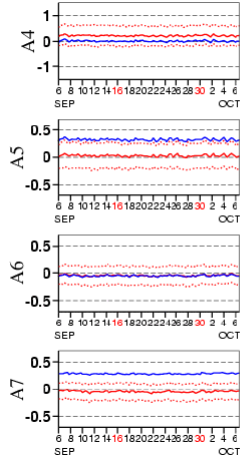


Operational monitoring

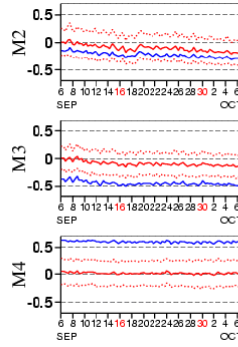
6/9/2001-6/10/2001

spacecraft manoeuvre

causing instrument heating



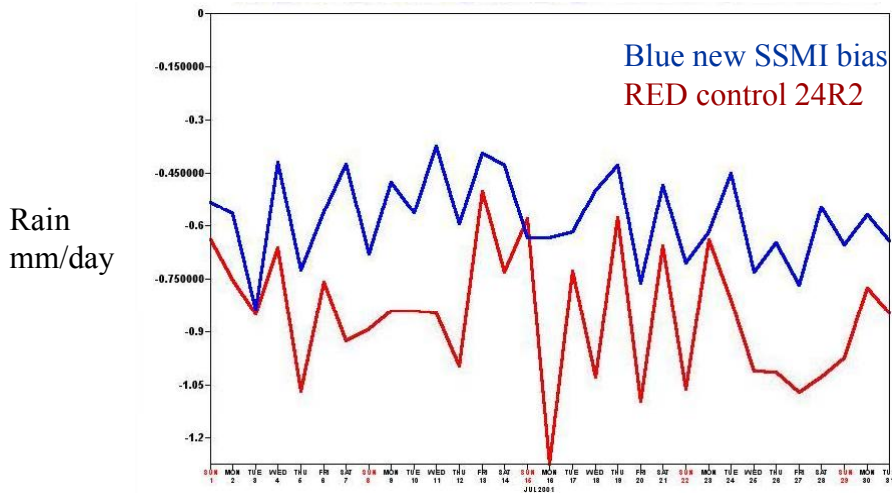
AMSU A NOAA 16



MSU NOAA 14

New SSMI bias correction

36-24hr precip. minus 12-0hr precip.



Rain in Tropics 20 ° N to 20 ° S

Conclusions

PAOBs are needed prior to the TOVS period in the Southern Hemisphere.

This is the first time that raw radiances have been used in a re-analysis with many satellite instruments.

The new bias predictors have removed the need for monthly updating of coefficients. However the tuning is based on the quality of the radiosondes used in the assimilation.

Instrument behaviour is still a problem. There are short periods where some instruments are unable to be used. Often when the instrument had recovered it requires new bias correction coefficients.

If there is only one satellite in the assimilation and a problem occurs with a satellite instrument. It may not be detected easily.

ERA 40 should provide information to calibrate the radiance measurements from the instruments used. Hence future reanalysis will be easier. However some further effort will be required.