

The Use of Level-1d ATOVS Radiances in GASP

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Overview

- Brief description of 1DVAR in GenSI
- Use of Radiances in operational GASP
- New T239L60 GASP model
- New AAPP radiances from Met Office
- AAPP radiances in L60 assimilation
- Experimental results
- Future Work

1DVAR Retrieval System

- Based on ECMWF (Eyre et. al. 1993) system
- Direct computation of background and retrieval error for each retrieval to implement variance and increment scaling.
- Retrieval mapped onto 15 thick layers
- Information content of radiances determines weight of layer increments in GenSI analysis
- Harris and Kelly (2001) radiance bias correction

Assimilation of Retrievals

$$x_{b,r}^{thick} = P(x_{b,r})$$

$$\mathbf{R}^{thick} = \mathbf{P}(x_r)^T \mathbf{R} \mathbf{P}(x_r)$$

$$\Lambda_i^{th,rh} = \frac{\sigma_{Ri}^{2\ th, rh}}{\sigma_{Bi}^{2\ th, rh} - \sigma_{Ri}^{2\ th, rh}}$$

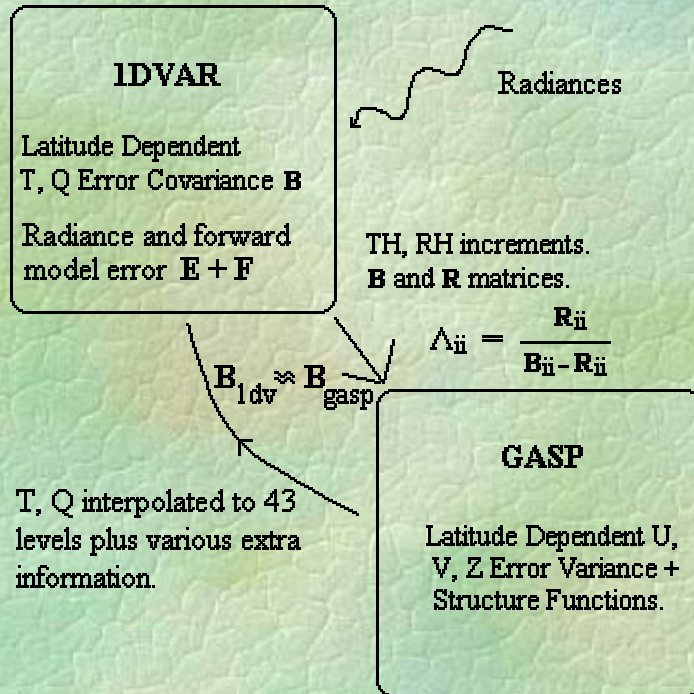
$$\mathbf{B}^{thick} = \mathbf{P}(x_r)^T \mathbf{B} \mathbf{P}(x_r)$$

$$\Delta th'_i = (1 + \Lambda_i^{th}) \Delta th_i$$

$$\Delta rh'_i = (1 + \Lambda_i^{rh}) \Delta rh_i$$

$$\sigma_{Ri}^{2\ th, rh} = \Lambda_i^{th, rh} \sigma_{Bi}^{2\ th, rh} = (1 + \Lambda_i^{th, rh}) \sigma_{Ri}^{2\ th, rh}$$

1DVAR/GASP



■ 1DVAR

- Background errors in temperature and mixing ratio.
- Uncorrected radiances as input.
- Background temperature and mixing ratio profile as input.
- Background and retrieval in thickness and mean layer relative humidity as output.
- Background and retrieval errors in thickness and precipitable water as output.

■ GASP

- Background errors in wind and geopotential height.
- 1DVAR precipitable water errors converted to relative humidity.
- Scaling factors computed as a function of 1DVAR background and retrieval errors.
- GASP background error scaled to give pseudo-observation error.
- Scaled increments of thickness and relative humidity, plus pseudo-observation error passed to analysis.

Operational GASP

- T239L29 model top at 10 hPa
- NESDIS Level 2 ATOVS 120km product 1DVAR retrievals below 100 hPa
- NESDIS retrievals above 100 hPa
- Radiative transfer (RTTOV-7) uses NESDIS retrievals from 10 hPa to 0.1 hPa
- NOAA-15 and 16 only, no AMSU-B

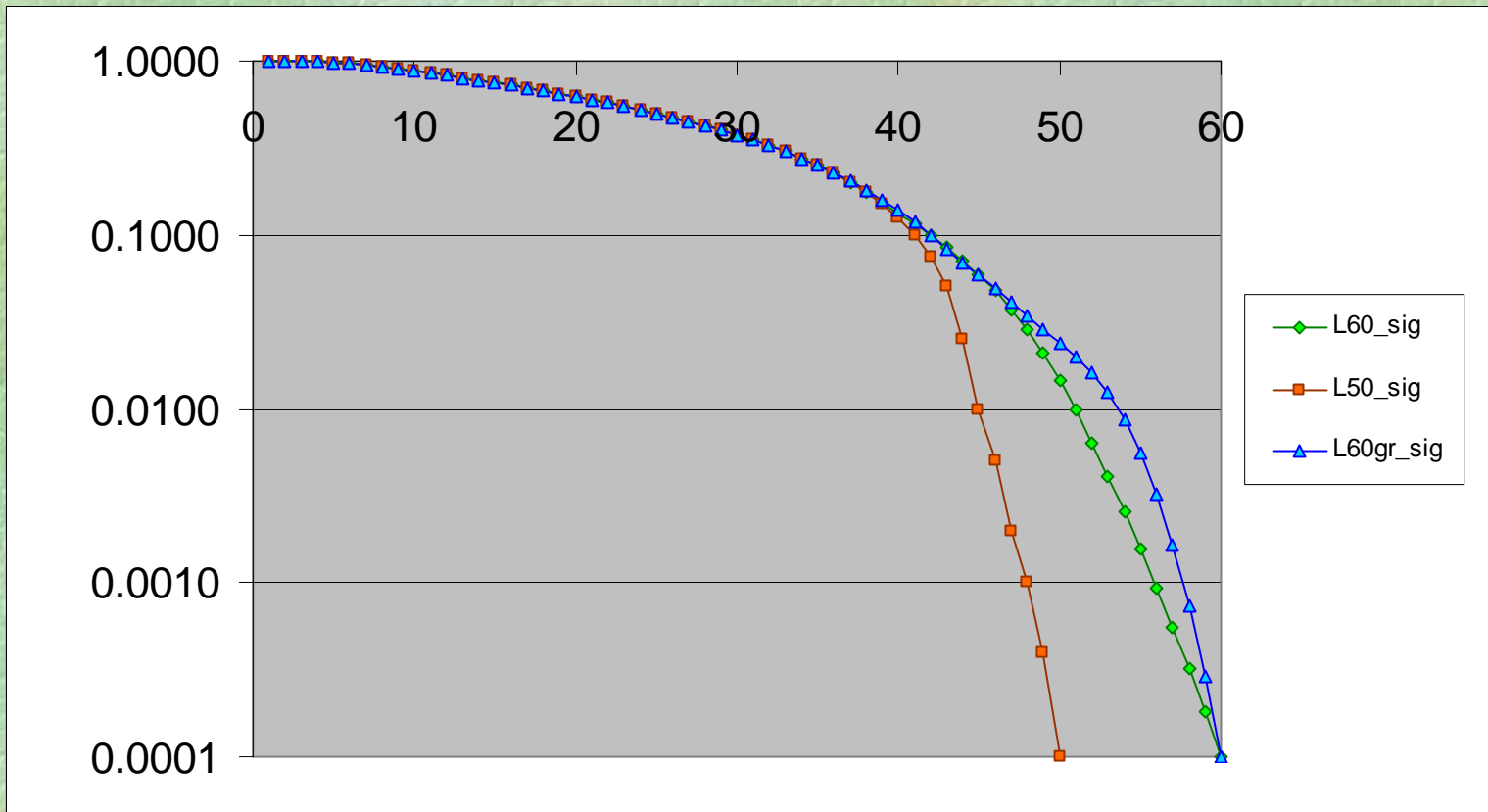
Old 50 Level GASP Model

- Only 5 sigma levels above 10hPa
- Many levels in boundary layer
- Required high Raleigh friction over 4 levels
- Promising results but bad biases especially over Northern Hemisphere

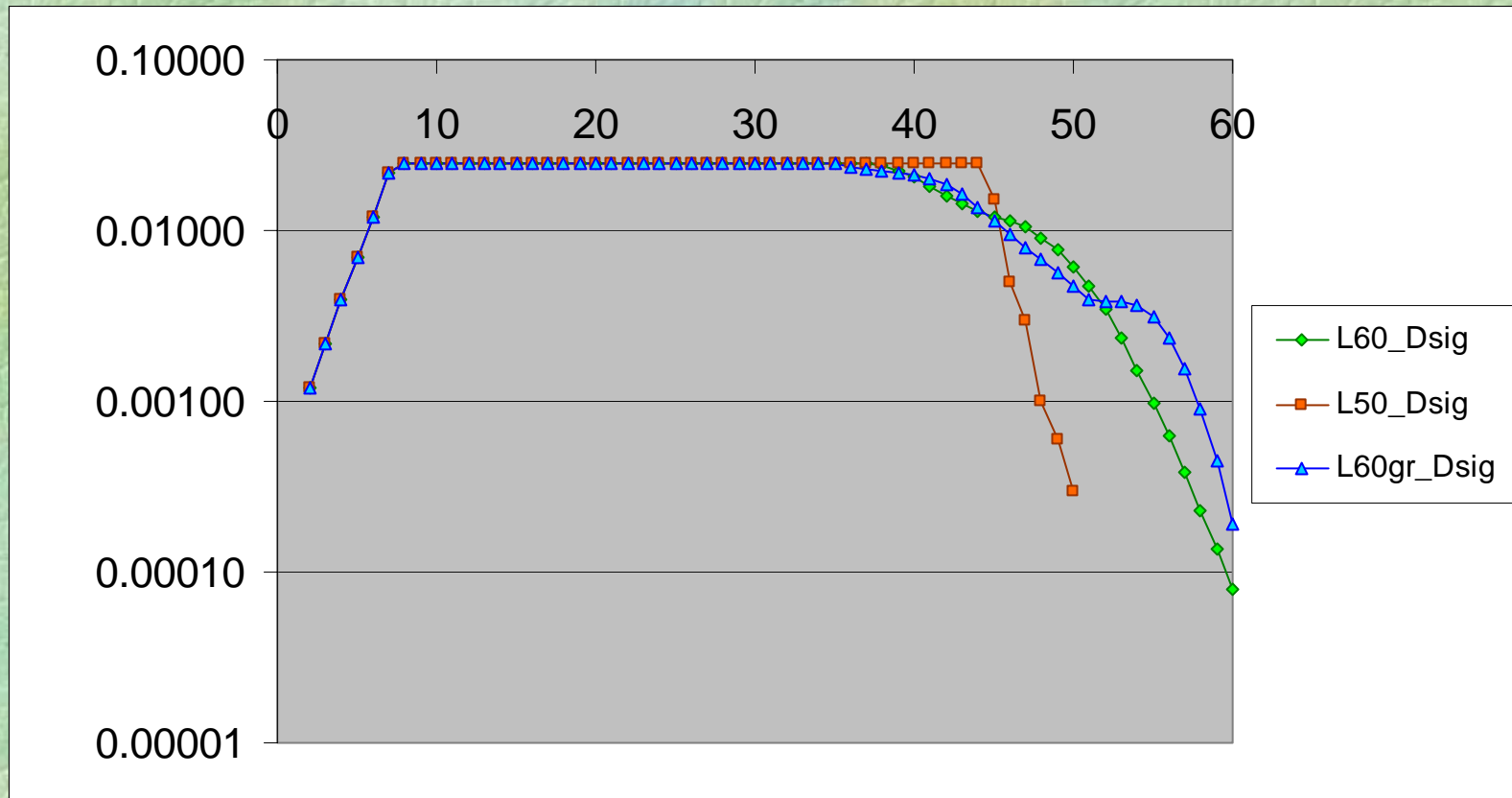
New 60 Level Model

- 10 levels above 10 hPa
- Care taken with level spacing (G.Roff)
- Excel spreadsheet to view and modify level spacing
- Smoothing by hand in sigma and $\ln(\text{sigma})$
- Some modification to GASP code (M. Naughton)
- Raleigh friction only applied in top 2 levels
- Biases greatly reduced

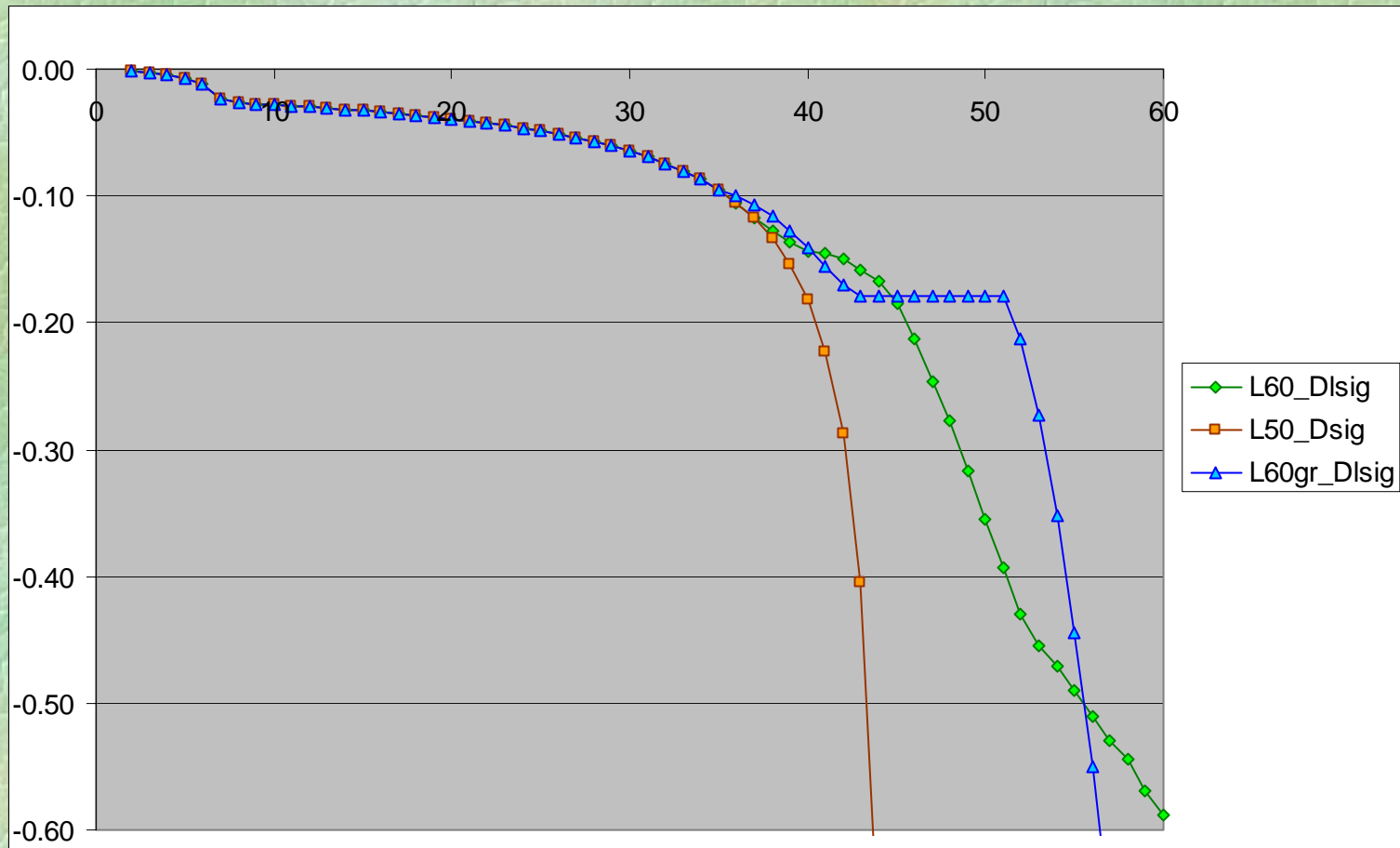
Sigma Levels



Delta-Sigma



Delta ln(sigma)

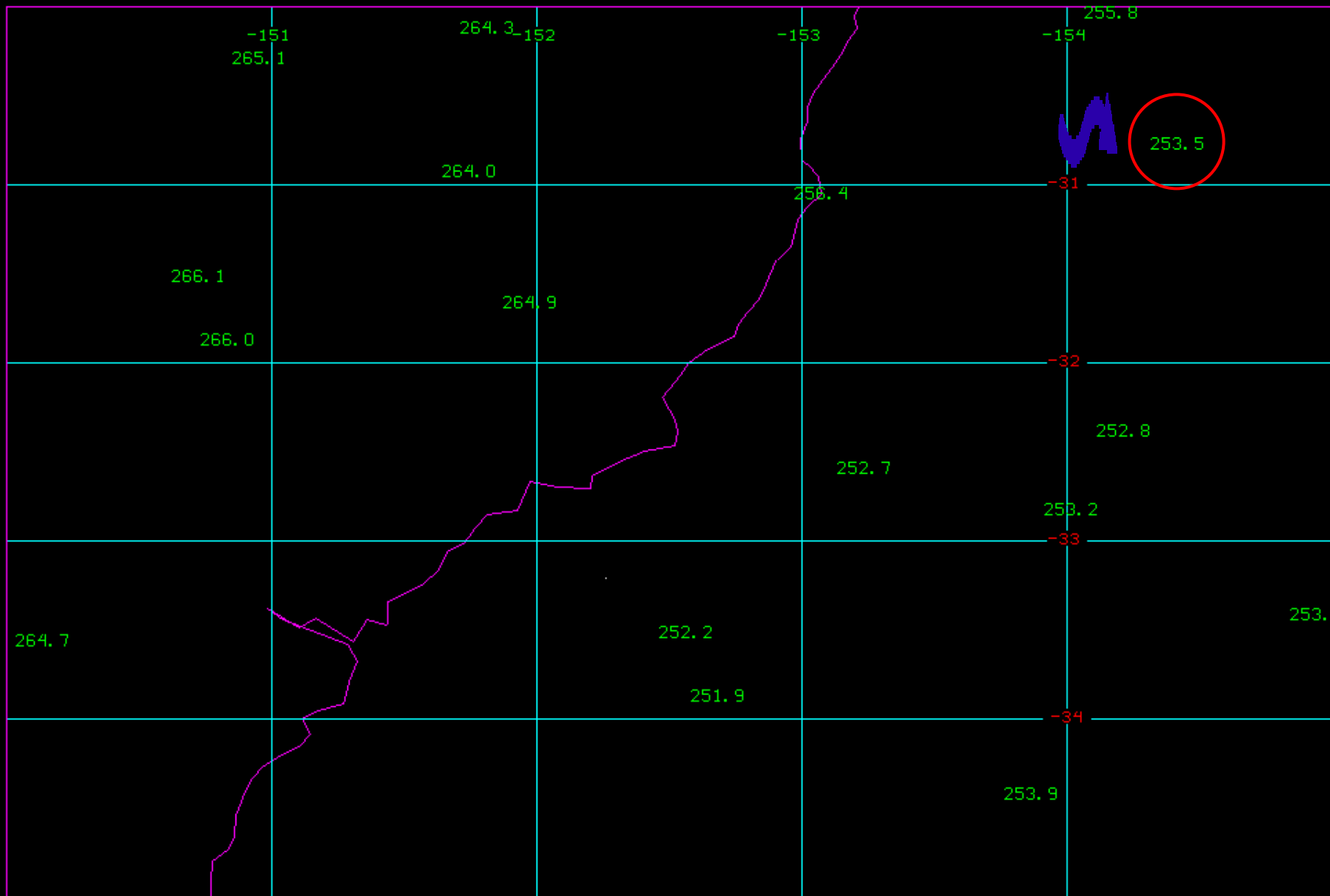


AAPP Radiances from Met Office

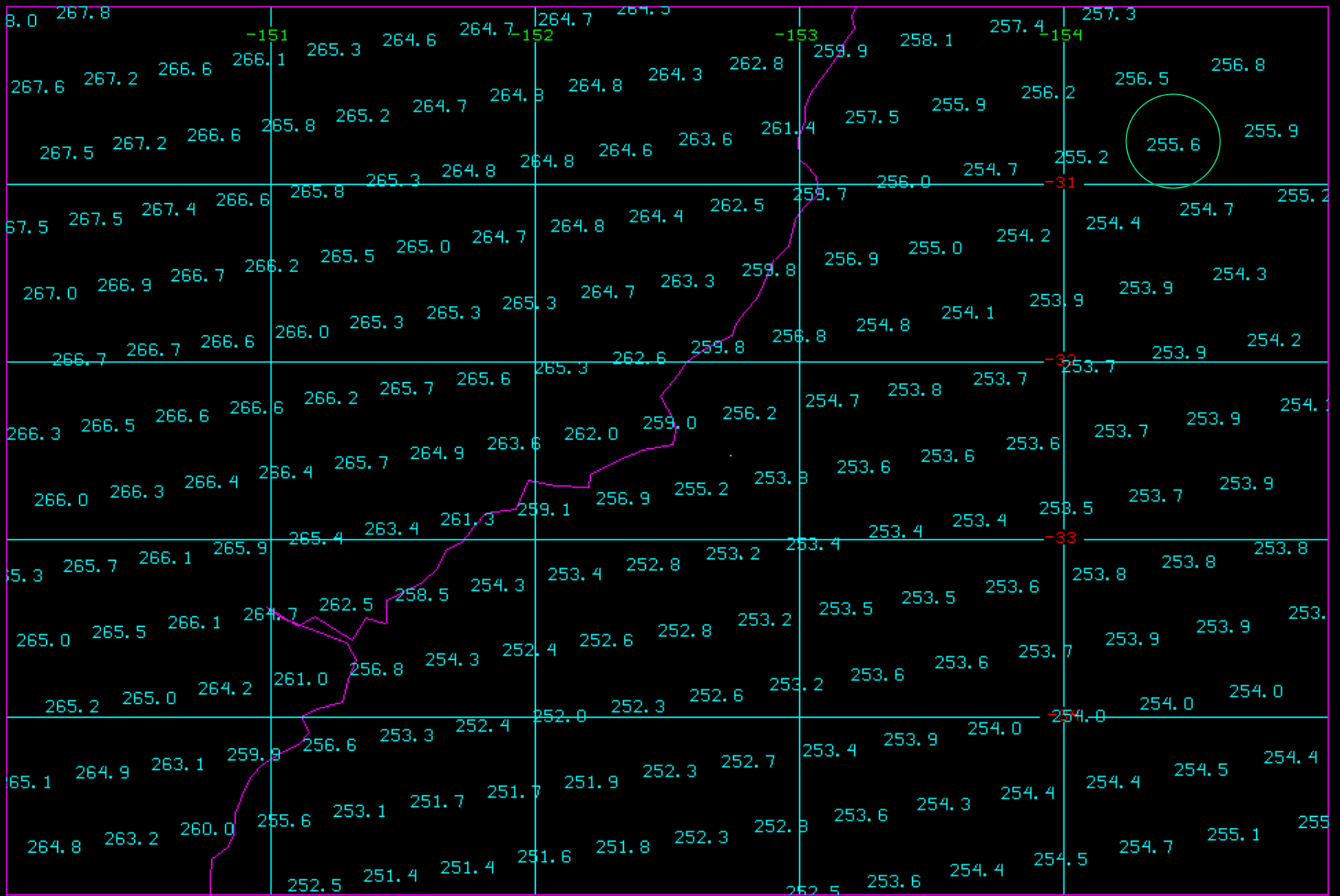
- Level-1d radiances from NOAA-15, 16, 17
- AMSU-B radiances
- AQUA AMSU-A available
- No retrieval
- Different microwave remapping than NESDIS
- HIRS footprint 30km resolution
- No cloud detection performed

NESDIS vs AAPP Radiances

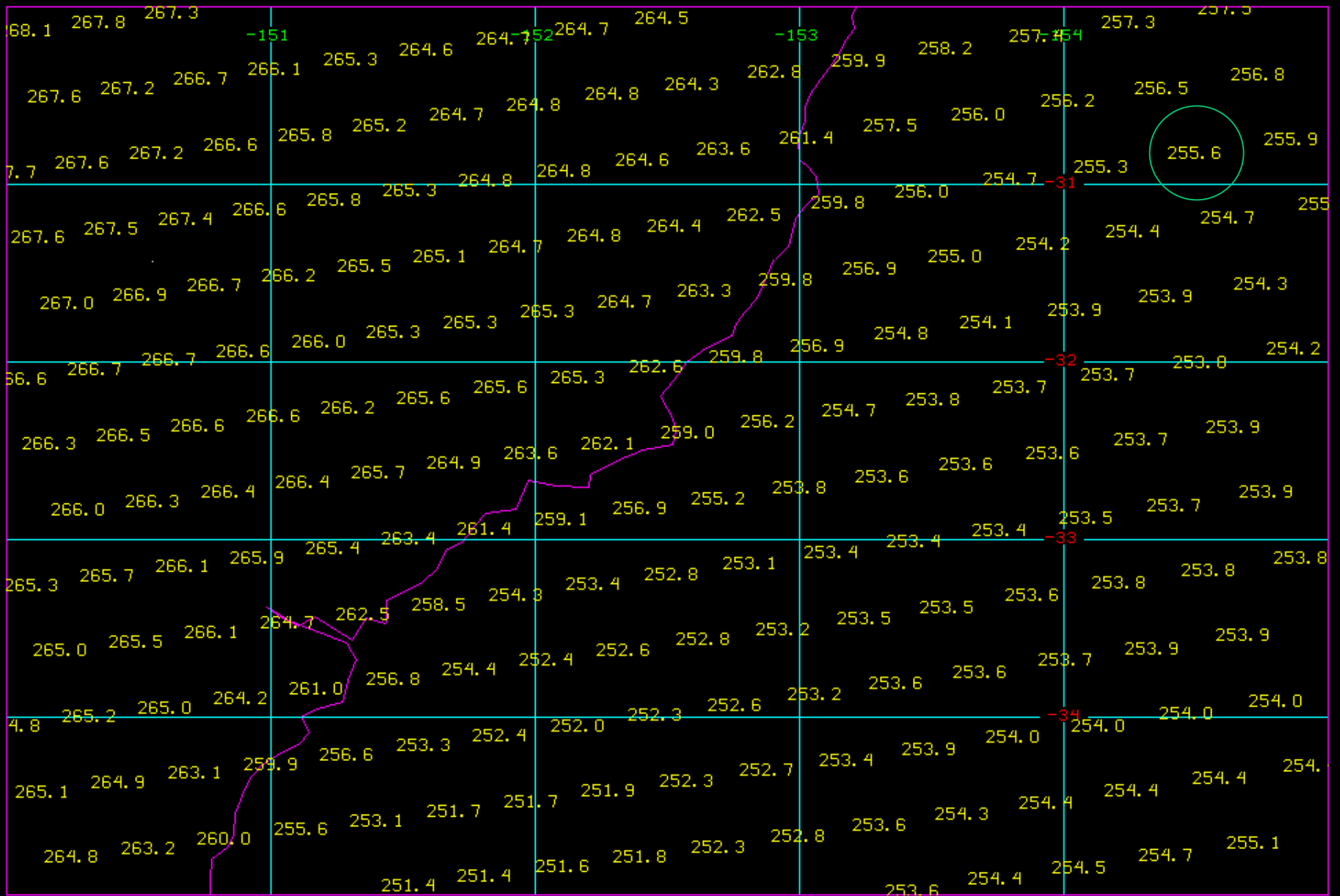
- AAPP radiances from Met Office consistent with locally received ATOVS data
- Coincident HIRS radiances the same
- AMSU-A radiances very different
- RTTOV FASTEM-1 microwave emissivity gives much smaller scan biases for AAPP radiances



MO04(DEG) SRT=207 NHR=4 NMIN=31.46



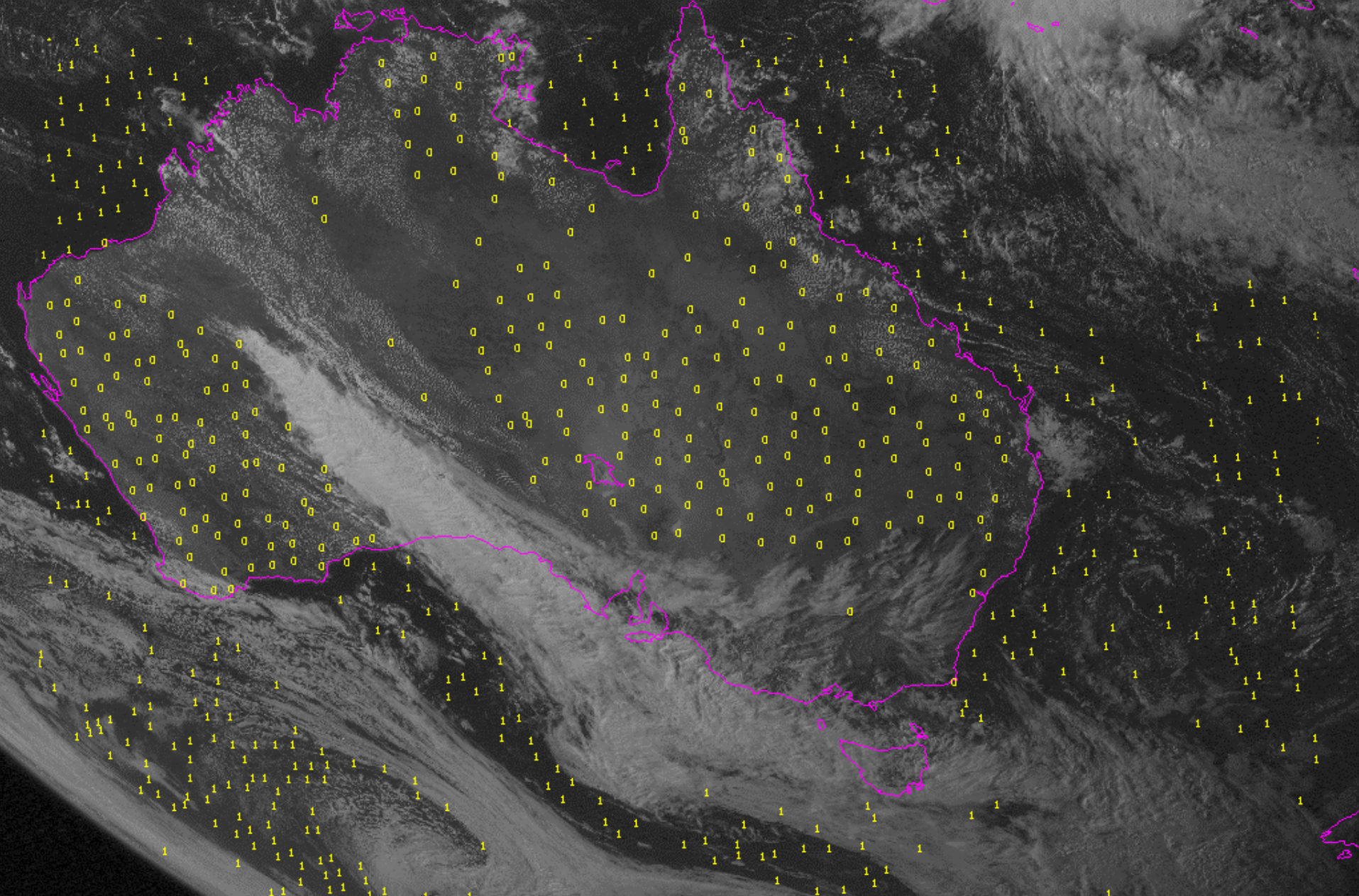
MD04(DEG) SAT=207 NHR=4 NMIN=31 46



MD04 (DEG) SAT=207 NHR=4 NMIN=31 46

Use of AAPP Radiances in 1dvar

- Level-1d use –2K check on HIRS Ch-8 radiance departure
- ECMWF/Grody AMSU-A tests for surface type and precipitation
- AMSU-B –6K check on Ch B-2



FLS SAT=207 RET=160

Experimental Results

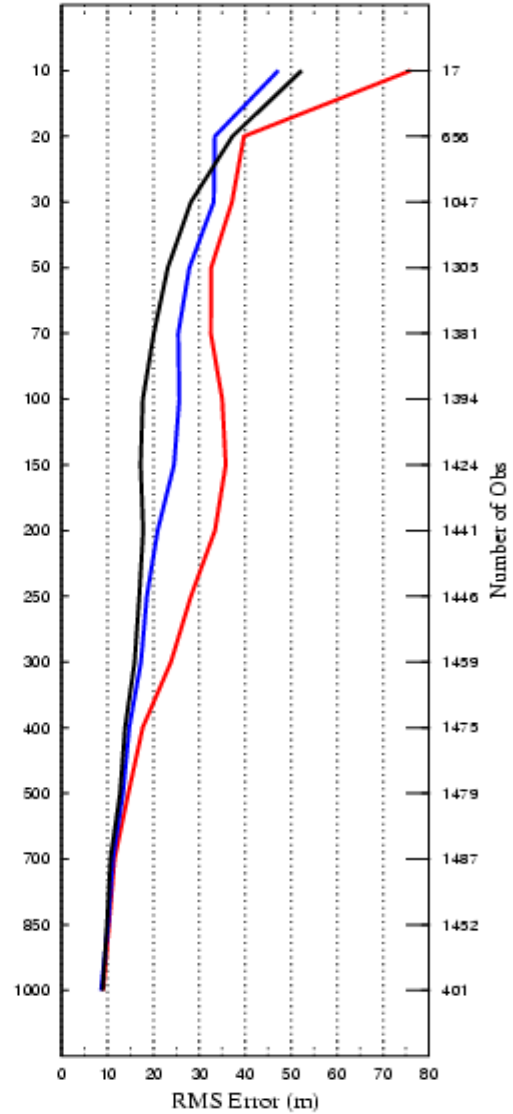
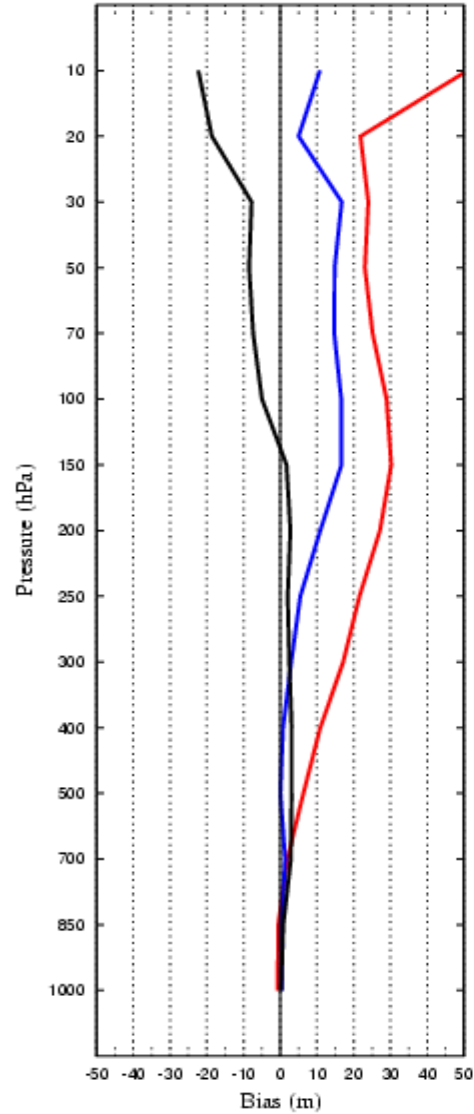
- GASP vs L60_nes vs L60_1d
- Observation fitting statistics 6h first guess
- Cold bias from NESDIS radiances
- Removed using AAPP radiances
- RMS error much smaller
- Forecast verification using 60 levels

Sonde Geopotential Height

- GASP (GESF)
- L60_nes (GESF)
- L60_1d (GESF)

S ANNULUS 60S to 20S

20040922/0Z to 20041006/12Z

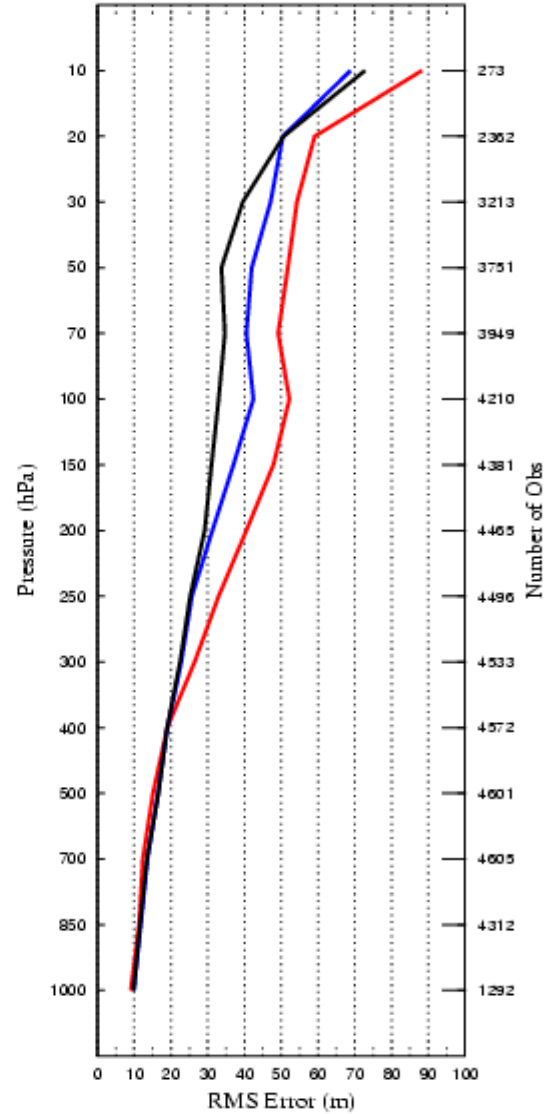
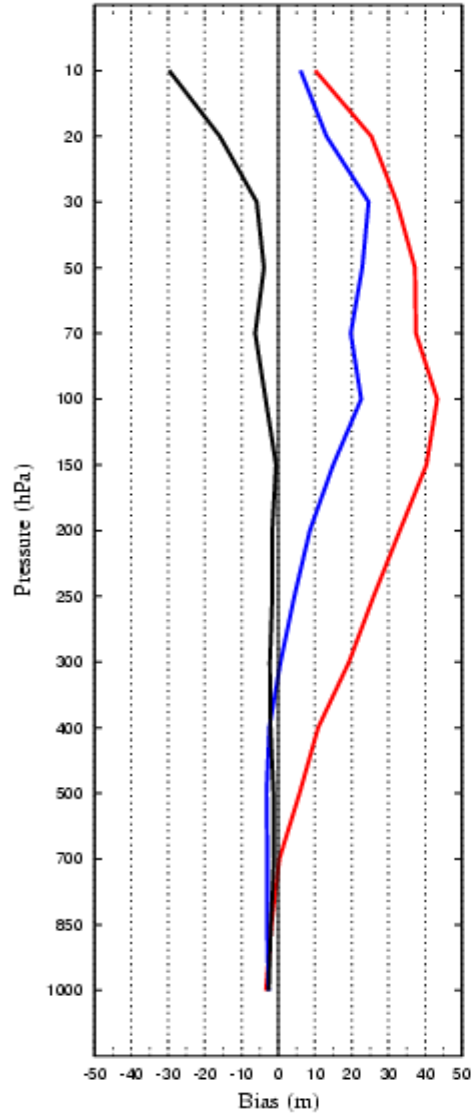


- GASP (GESF)
- L60_mes (GESF)
- L60_1d (GESF)

Sonde Geopotential Height

TROPICS 30S to 30N

20040922/0Z to 20041006/12Z

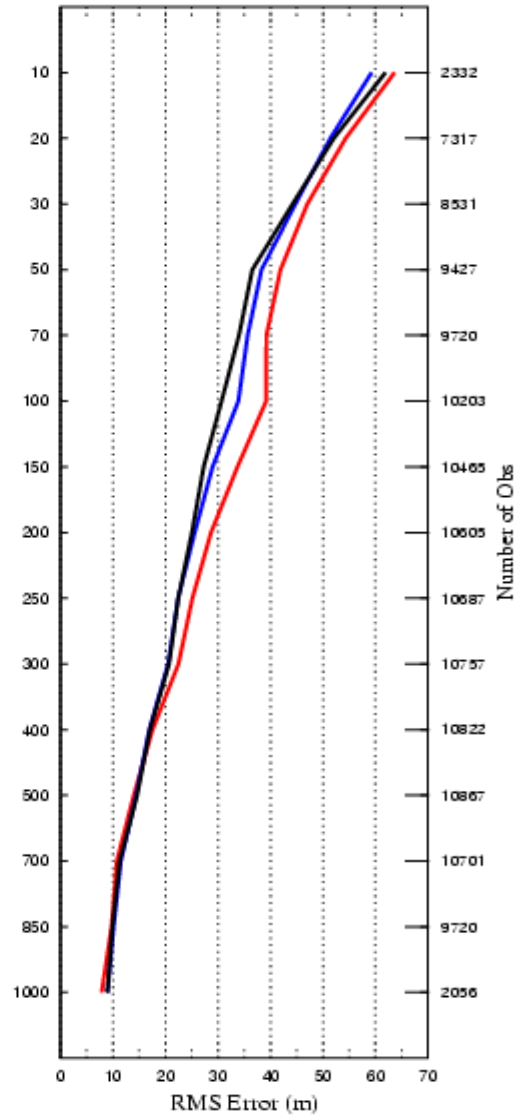
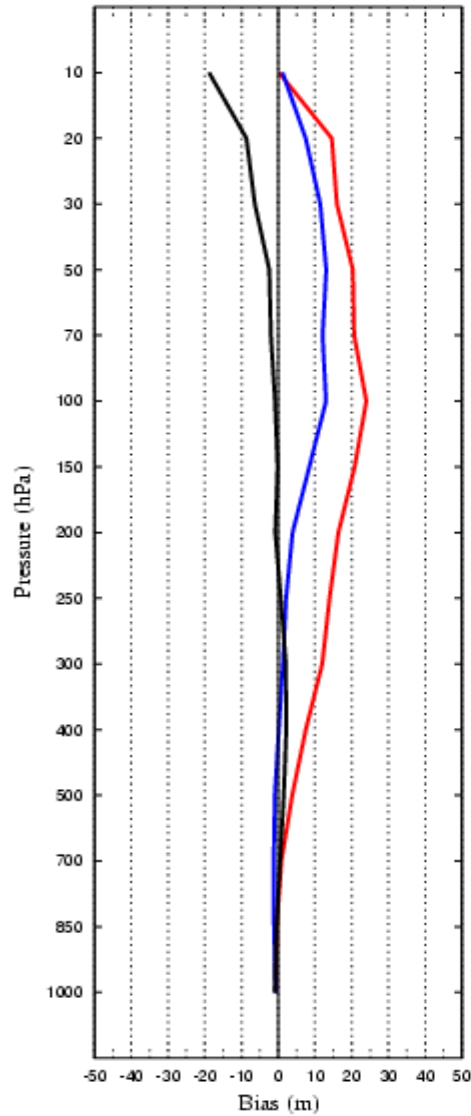


- GASP (GESF)
- L60_mes (GESF)
- L60_1d (GESF)

Sonde Geopotential Height

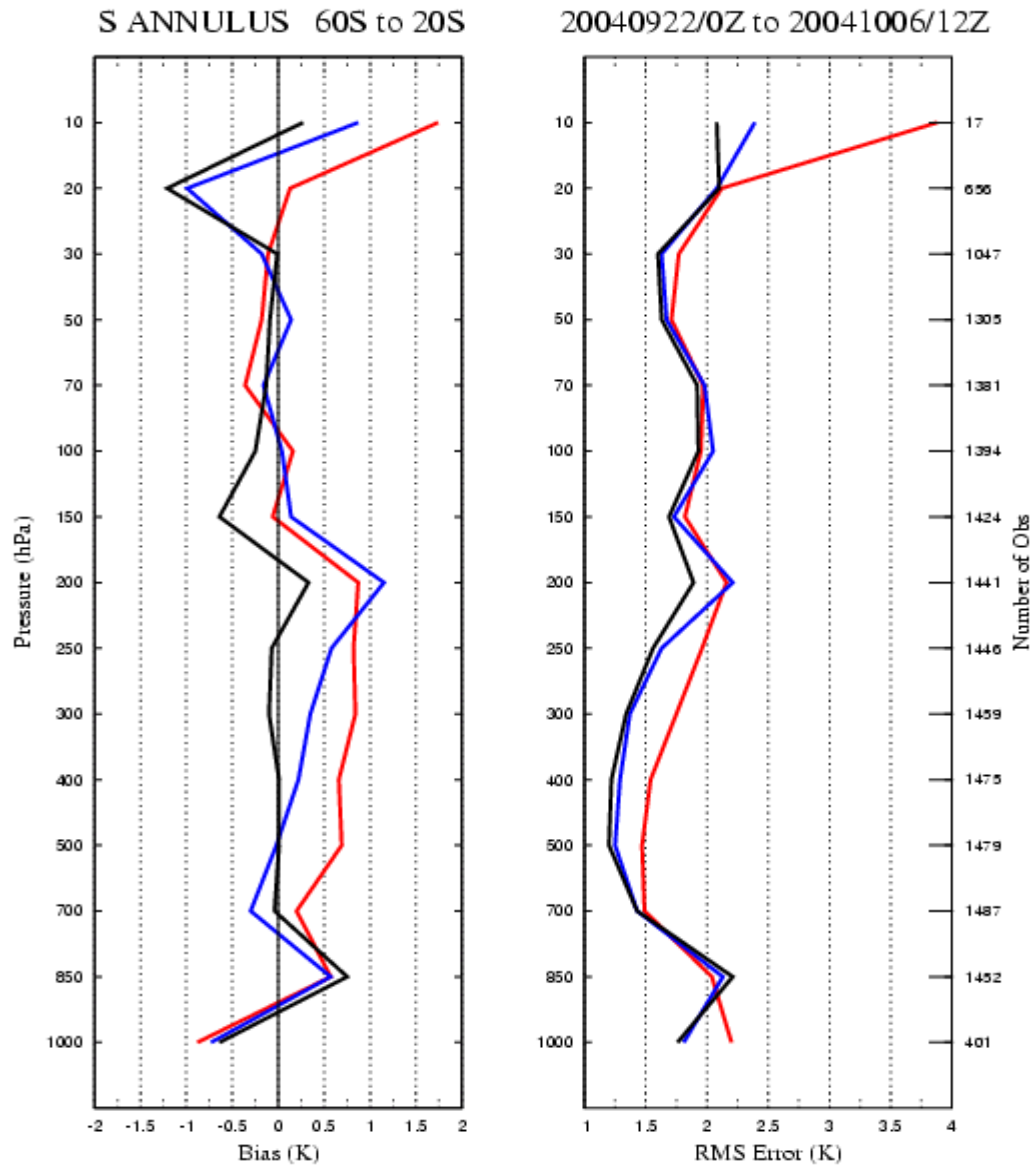
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20040922/0Z to 20041006/12Z



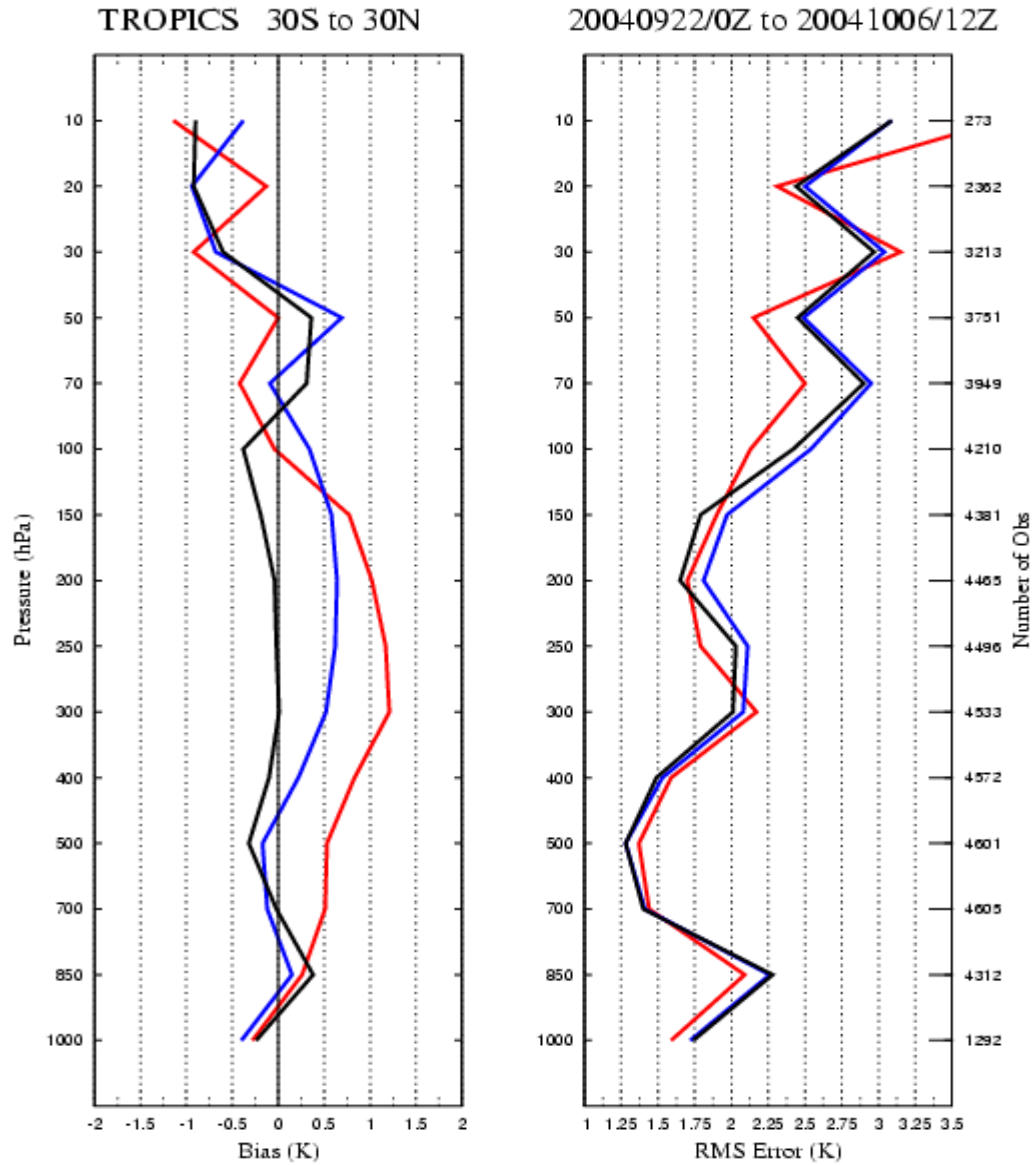
- GASP (GESF)
- L60_mes (GESF)
- L60_1d (GESF)

Sonde Temperature



- GASP (GESF)
- L60_mes (GESF)
- L60_1d (GESF)

Sonde Temperature

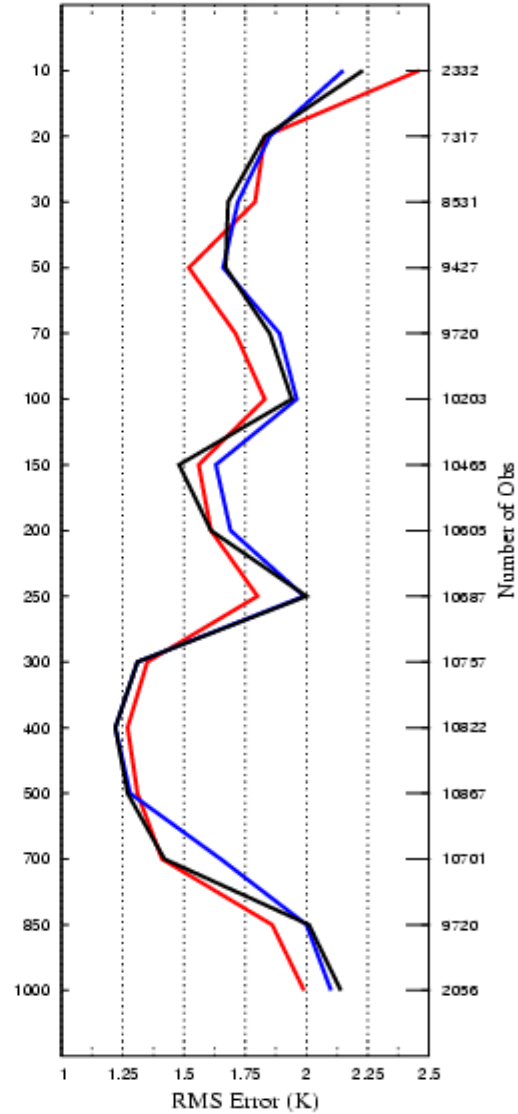
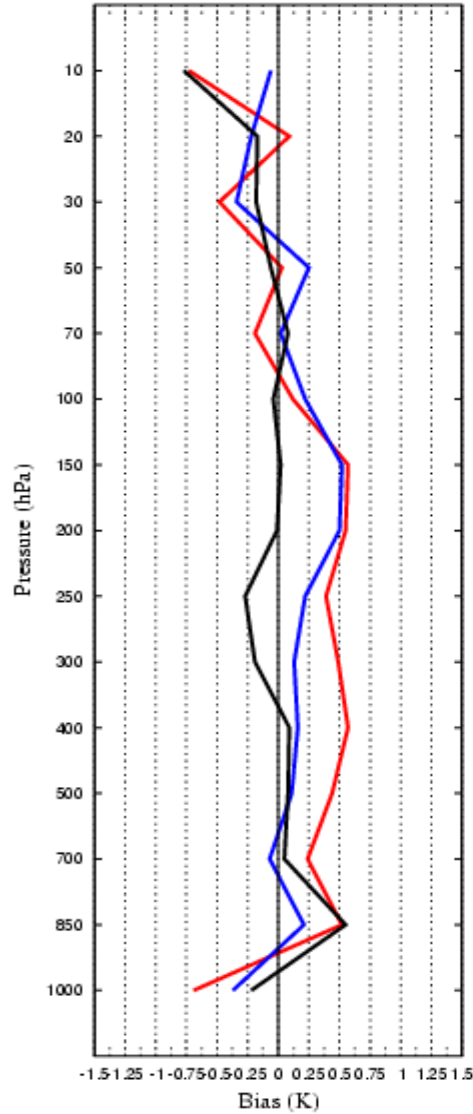


- GASP (GESF)
- L60_mes (GESF)
- L60_1d (GESF)

Sonde Temperature

N ANNULUS 20N to 60N

20040922/0Z to 20041006/12Z

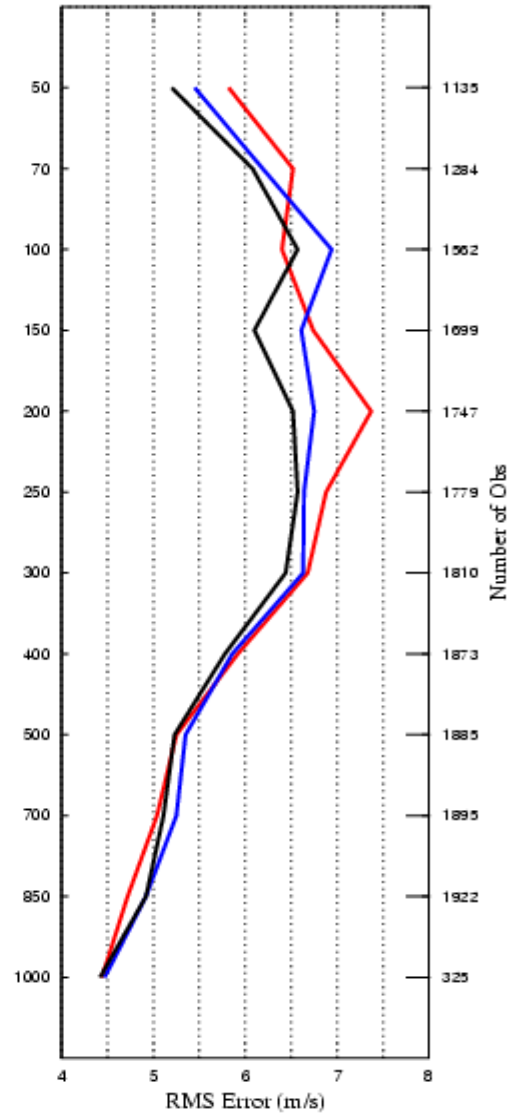
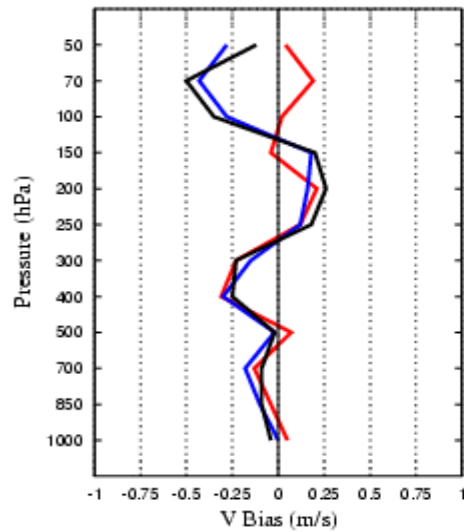
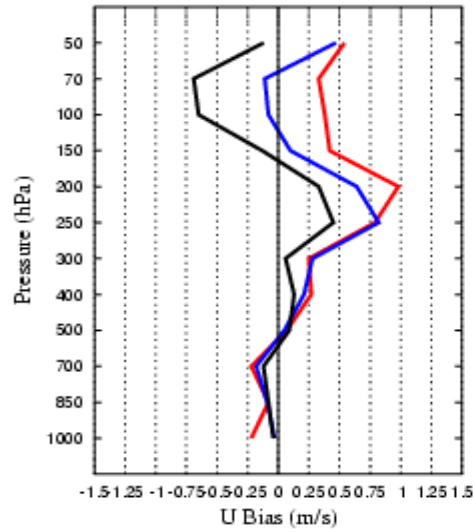


- GASP (GESF)
- L60_mes (GESF)
- L60_1d (GESF)

RAWIN

S ANNULUS 60S to 20S

20040922/0Z to 20041006/12Z

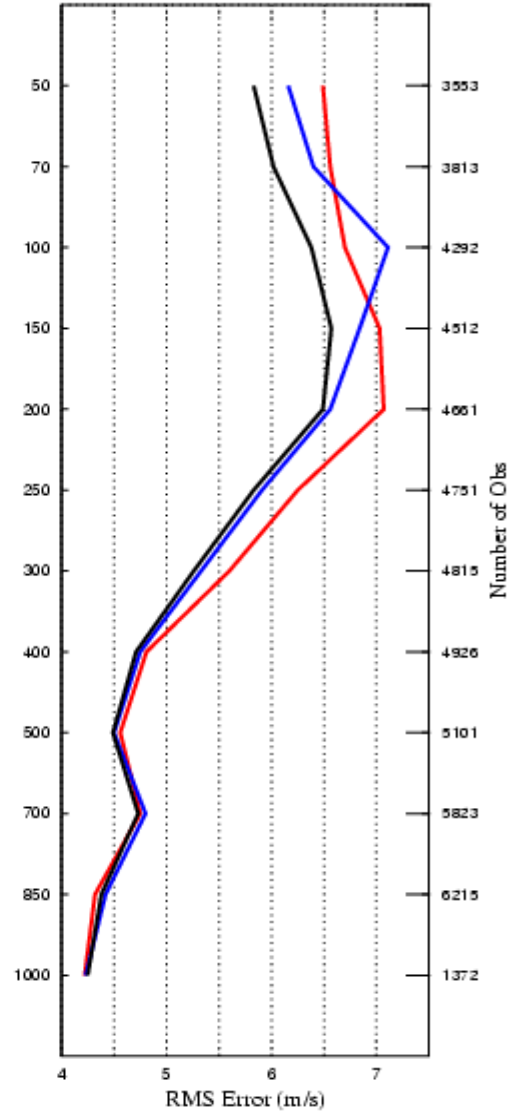
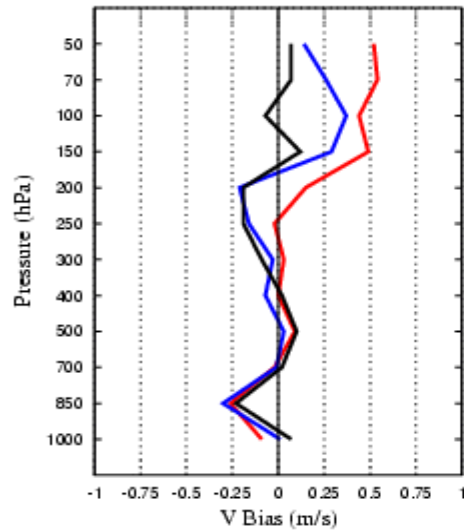
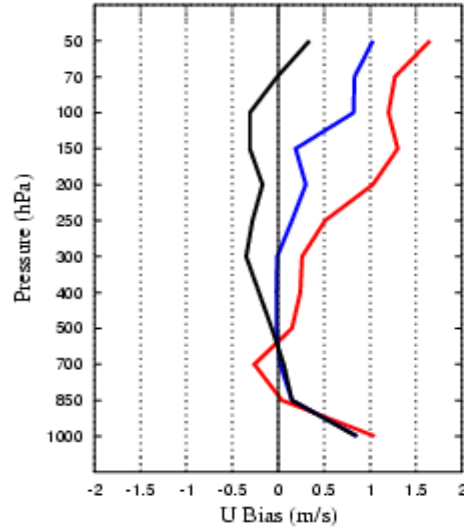


- GASP (GESF)
- L60_mes (GESF)
- L60_1d (GESF)

RAWIN

TROPICS 30S to 30N

20040922/0Z to 20041006/12Z

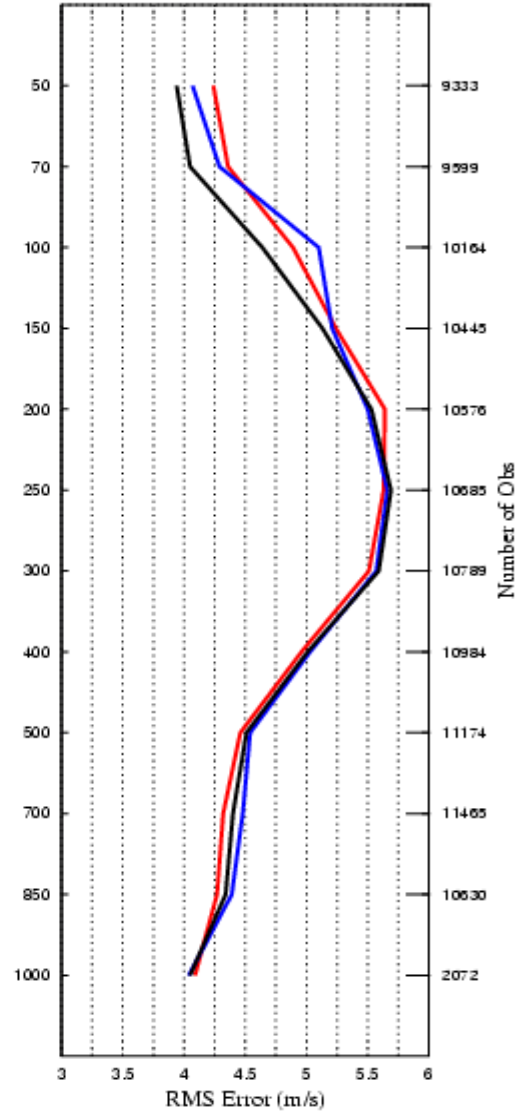
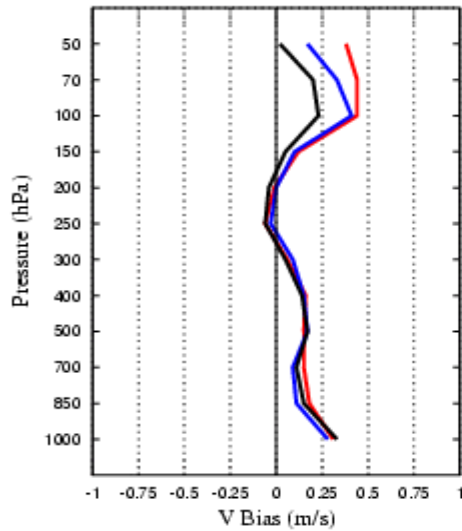
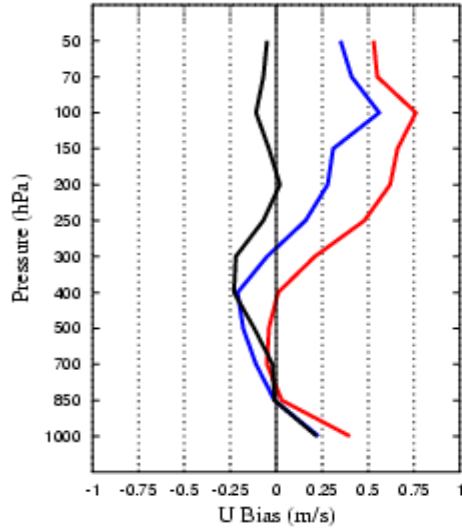


- GASP (GESF)
- L60_mes (GESF)
- L60_1d (GESF)

RAWIN

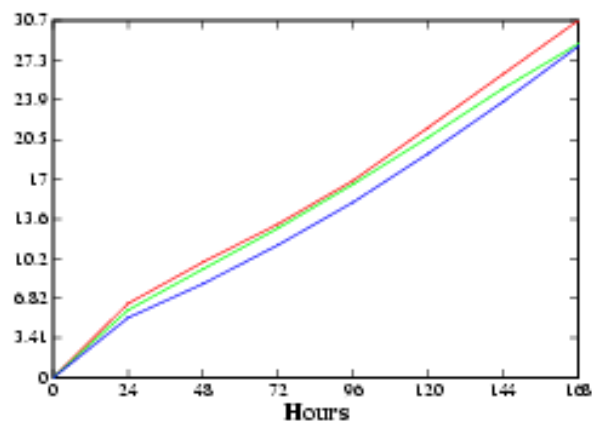
N ANNULUS 20N to 60N

20040922/0Z to 20041006/12Z

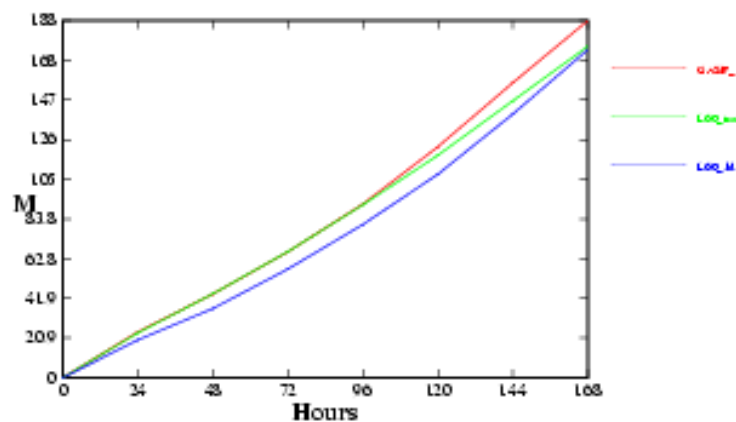


Thu Apr 14 13:39:08 2005

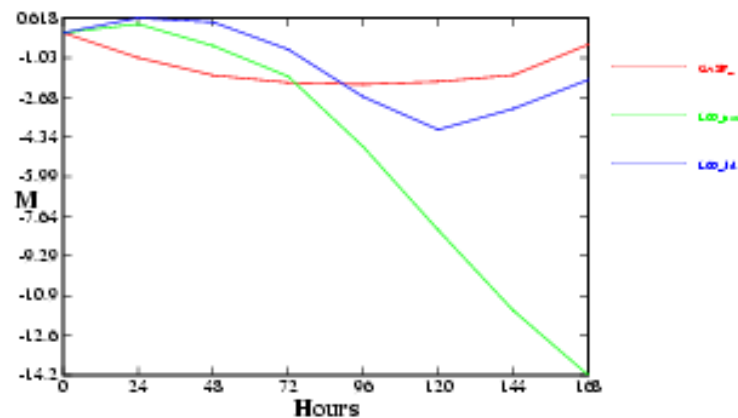
SKILL-SCORE



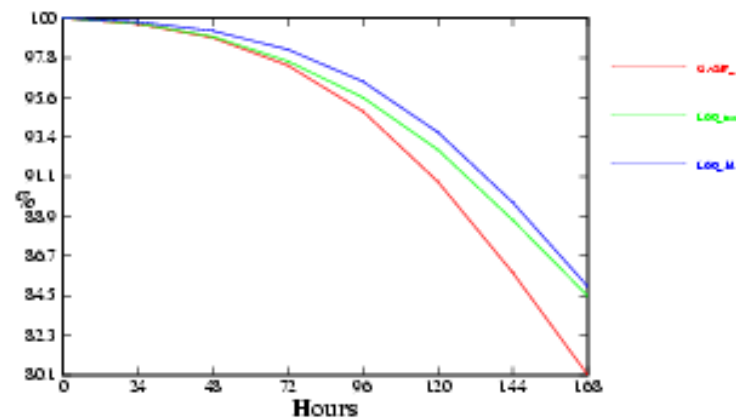
RMS_ERRORS



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AN-CORRELATION



GASP_/L60_ne/L60_Id

Field: 50.00 HGHTBM

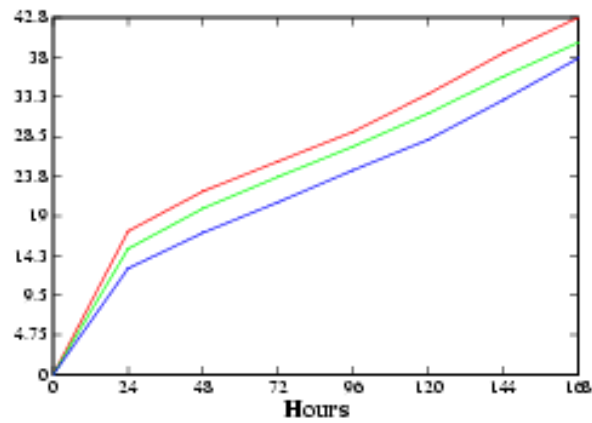
Region: south pole (90S - 55S 0E - 360E)

AVERAGE (59 CASE(S), 0 EXCLUSION(S))

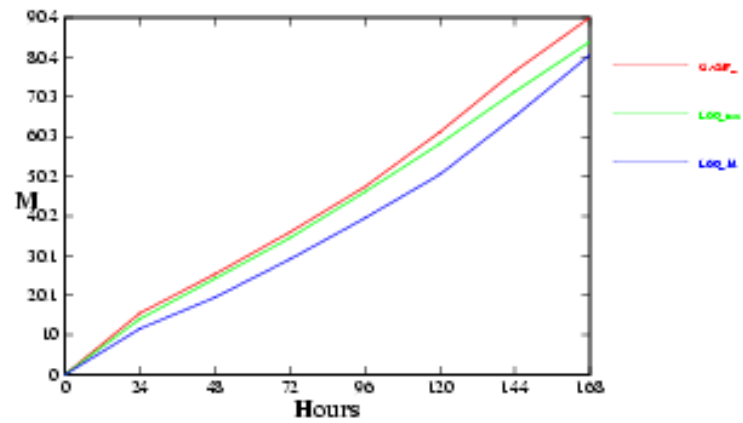
Base Dates: 20040925-00Z to 20041122-12Z

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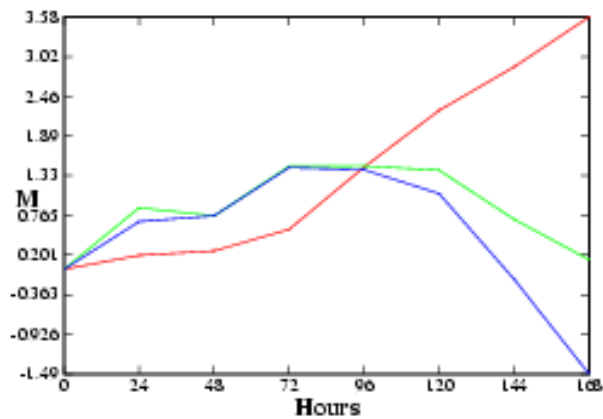
SKILL-SCORE



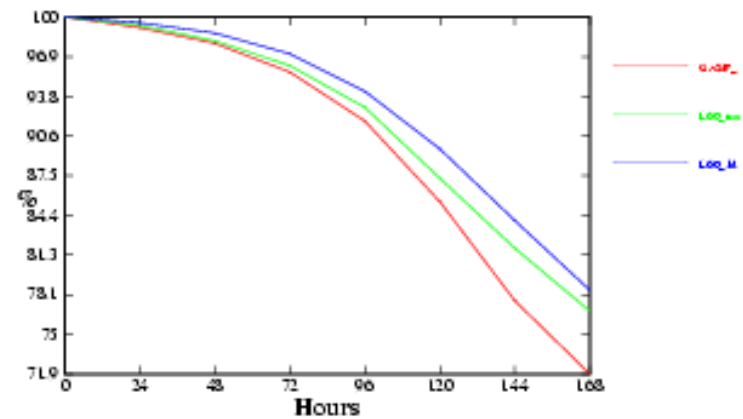
RMS_ERRORS



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AN-CORRELATION



GASP_/L60_nes/L60_Id

Field: 50.00 HGHTBM

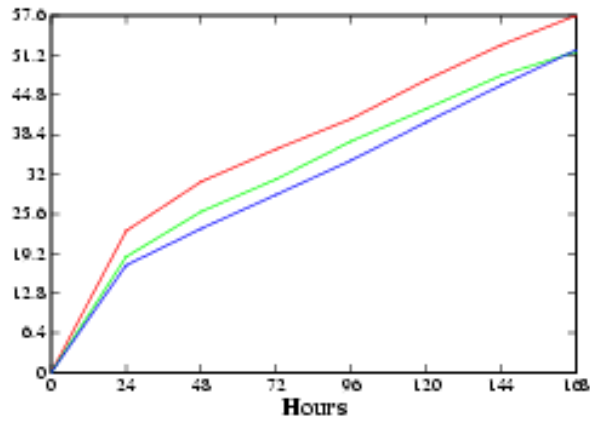
Region: s. hem. annulus (60S - 20S 0E - 360E)

AVERAGE (59 CASE(S), 0 EXCLUSION(S))

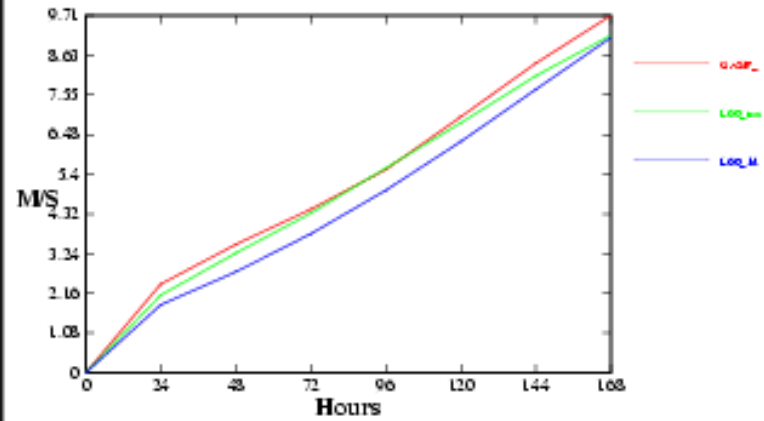
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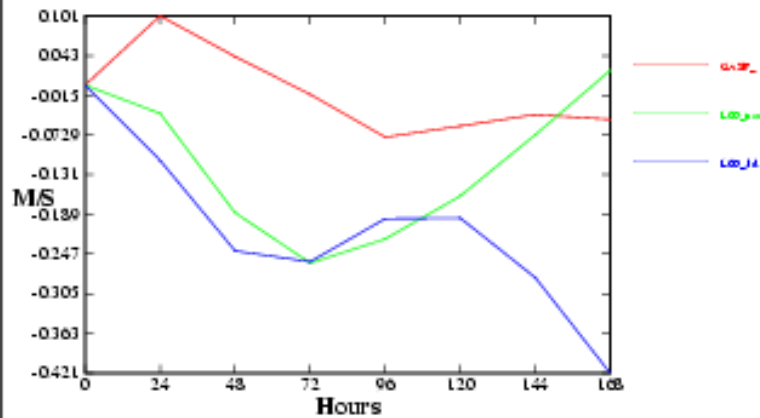
SKILL-SCORE



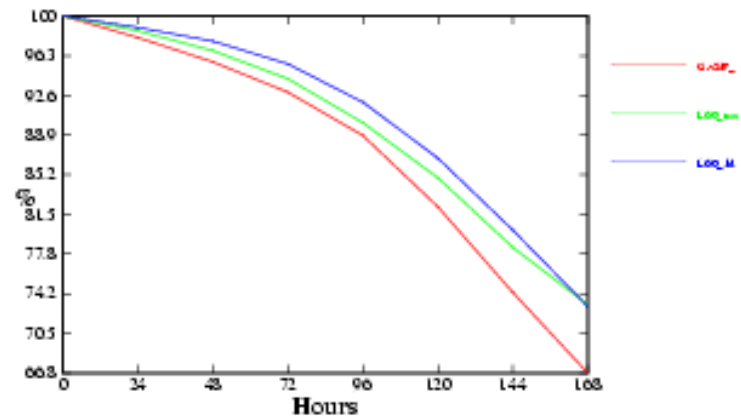
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AN-CORRELATION



GASP_/L60_nes/L60_Id

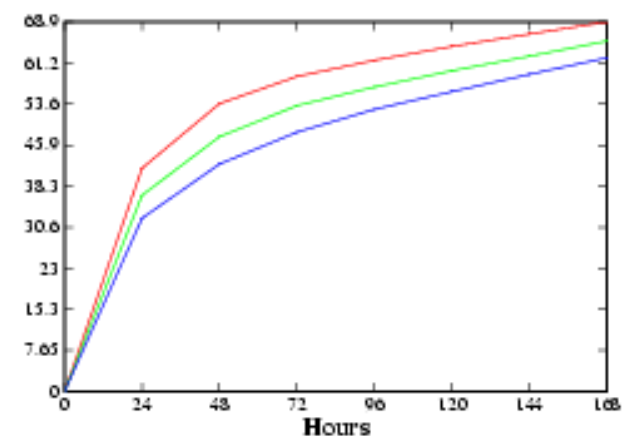
Field: 50.00 U

Region: south pole (90S - 55S 0E - 360E)

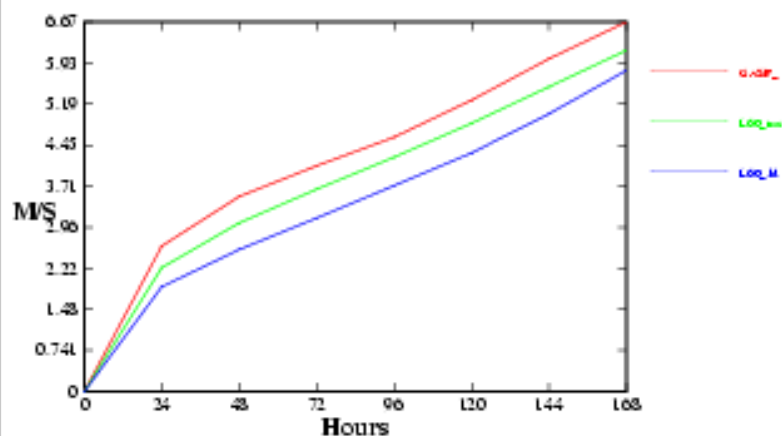
AVERAGE (59 CASE(S), 0 EXCLUSION(S))

Base Dates: 20040925-00Z to 20041122-12Z

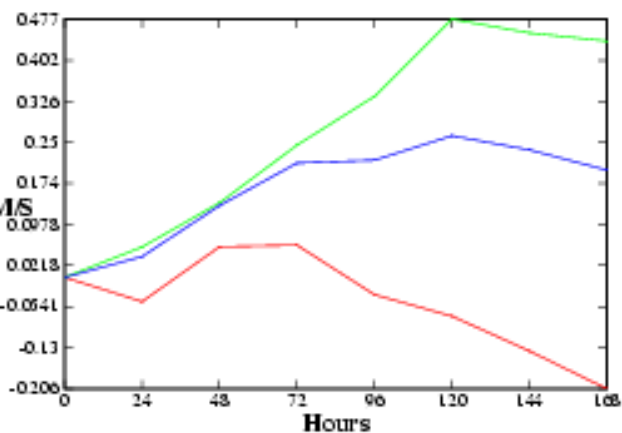
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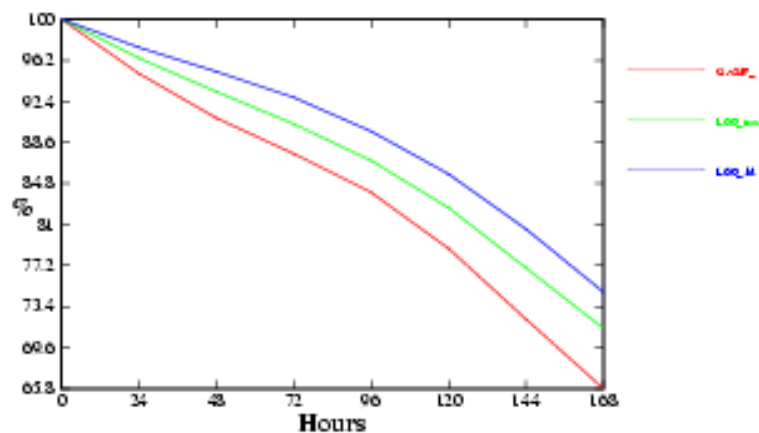
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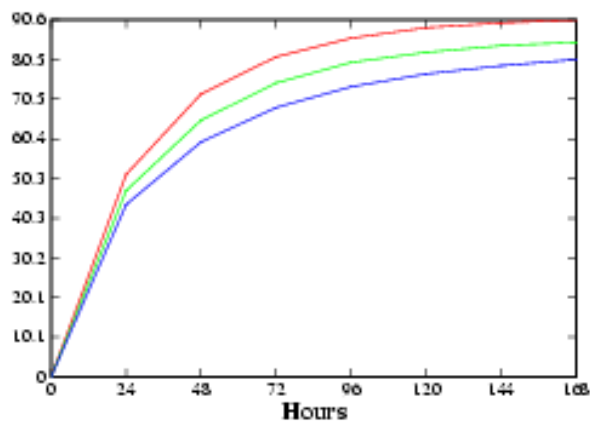


GASP_/L60_nes/L60_Id

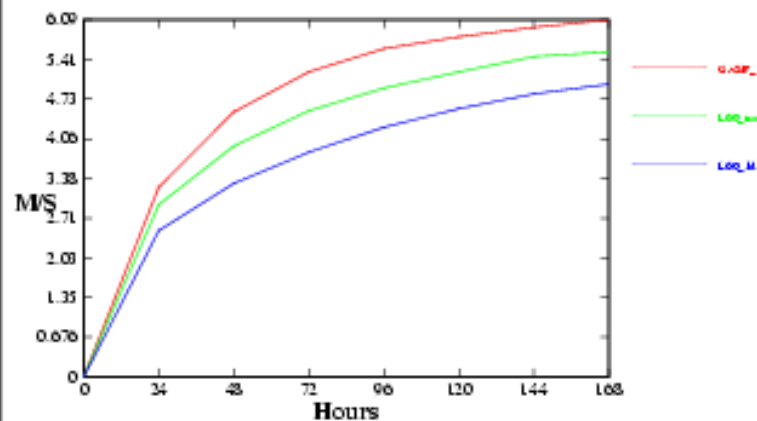
Field: 50.00 U
 Region: s. hem. annulus (60S - 20S 0E - 360E)
 AVERAGE (59 CASE(S), 0 EXCLUSION(S))
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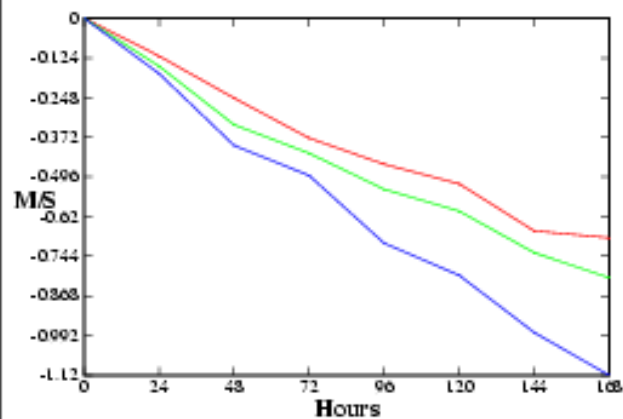
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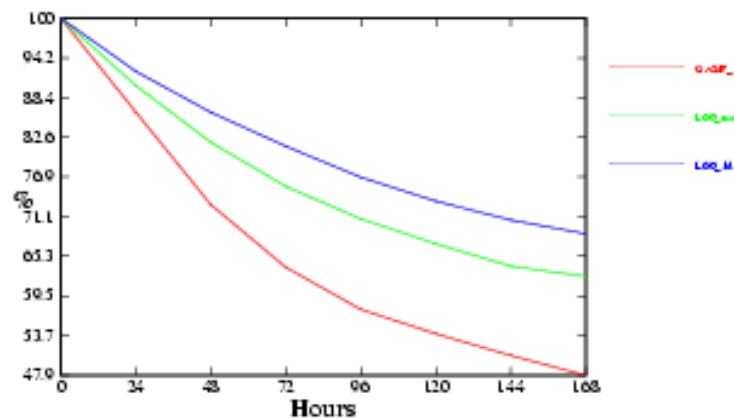
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GASP/L60_nes/L60_1d

Field: 50.00 U

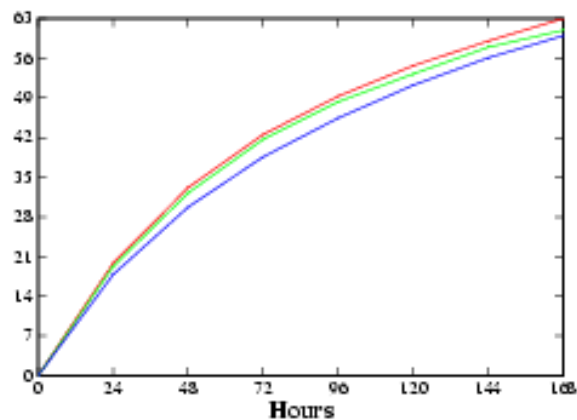
Region: tropics (20S - 20N 0E - 360E)

AVERAGE (59 CASE(S), 0 EXCLUSION(S))

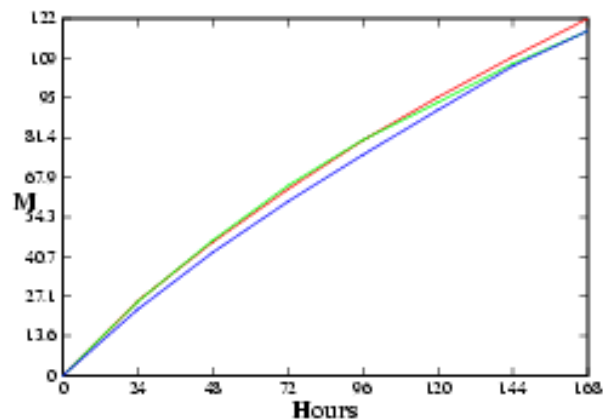
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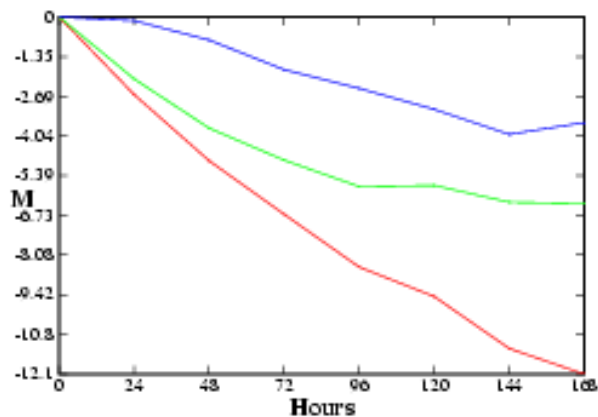
SKILL-SCORE



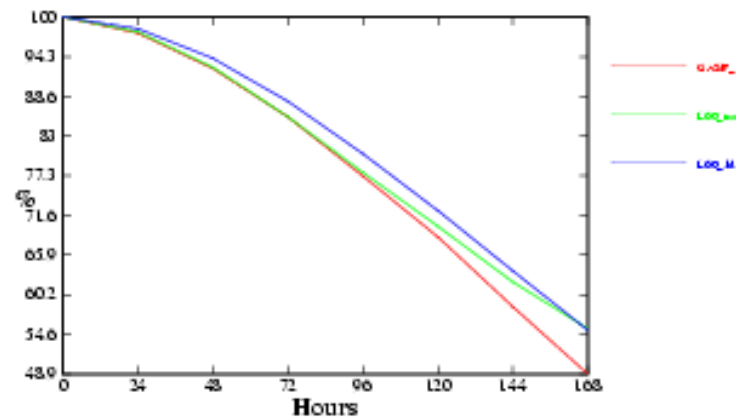
RMS_ERRORS



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GASP/L60_ne/L60_Id

Field: 500.00 HGHTBM

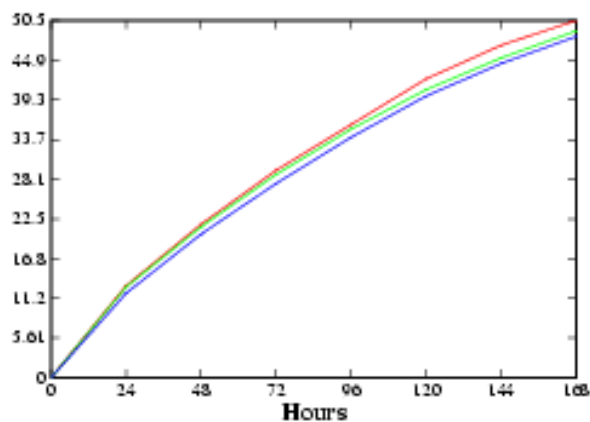
Region: south pole (90S - 55S 0E - 360E)

AVERAGE (59 CASE(S), 0 EXCLUSION(S))

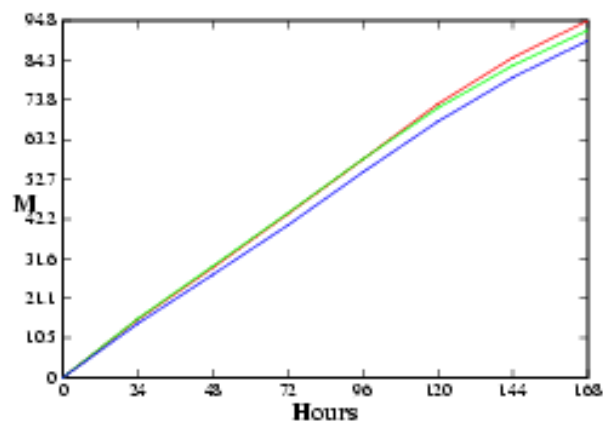
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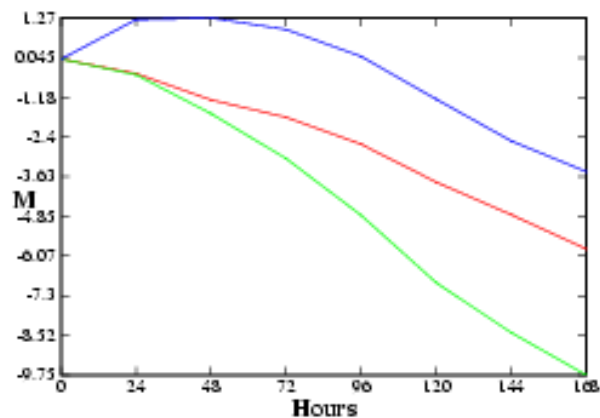
SKILL-SCORE



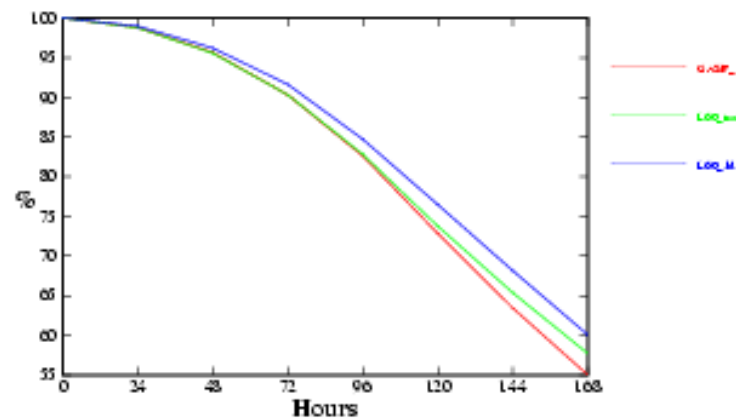
RMS_ERRORS



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AN-CORRELATION



GASP_/L60_nes/L60_Id

Field: 500.00 HGHTBM

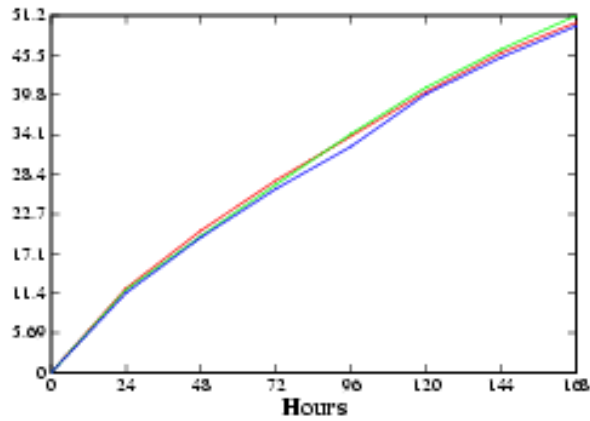
Region: s. hem. annulus (60S - 20S 0E - 360E)

AVERAGE (59 CASE(S), 0 EXCLUSION(S))

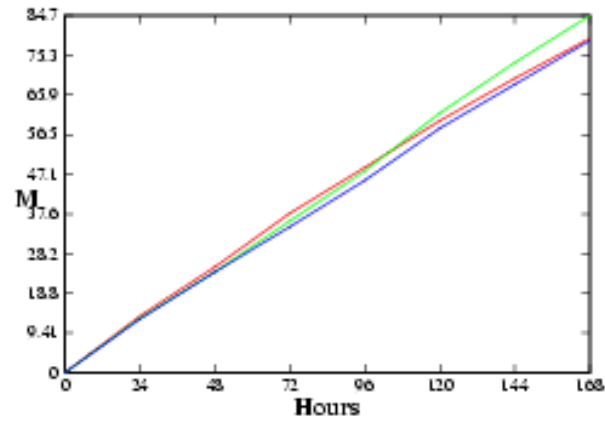
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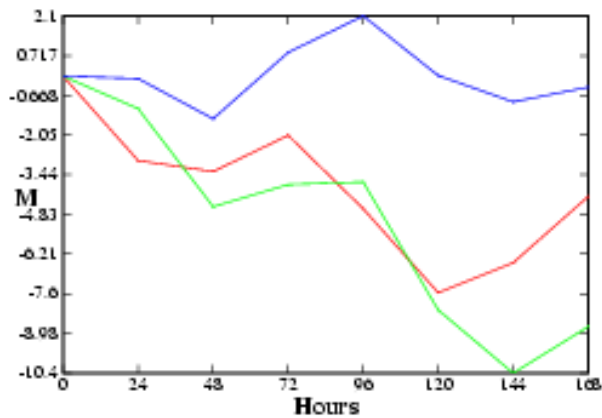
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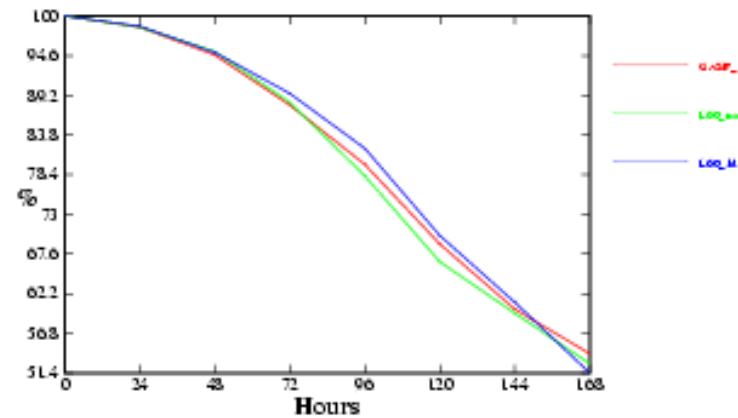
RMS_ERRORS



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AN-CORRELATION



GASP_/L60_nes/L60_Id

Field: 500.00 HGHTBM

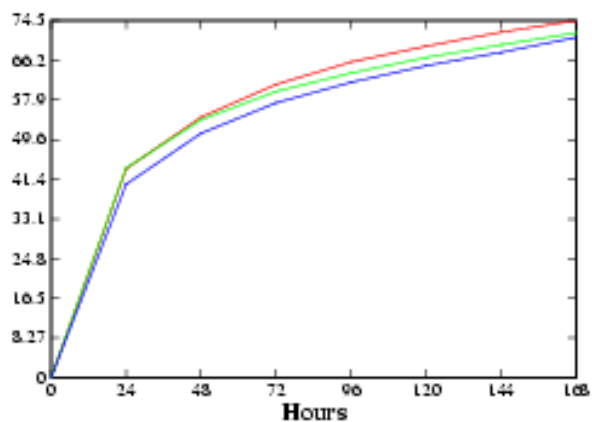
Region: australia (irregular grid)

AVERAGE (59 CASE(S), 0 EXCLUSION(S))

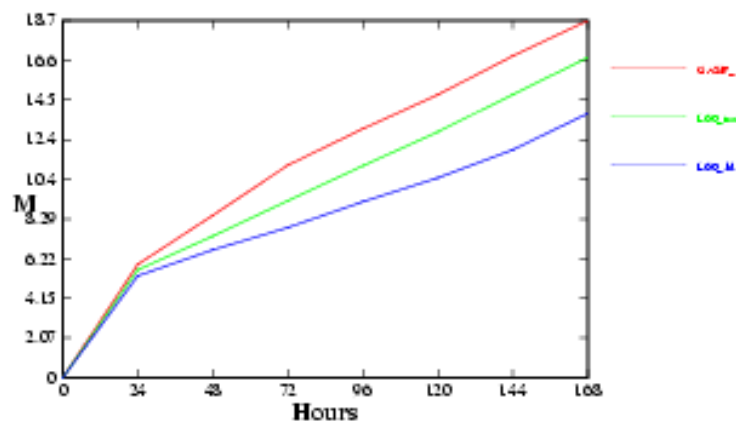
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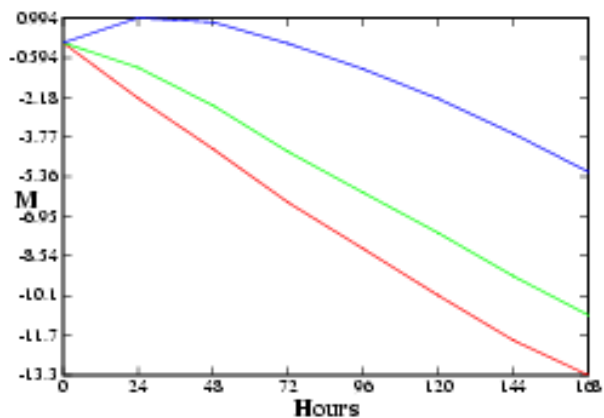
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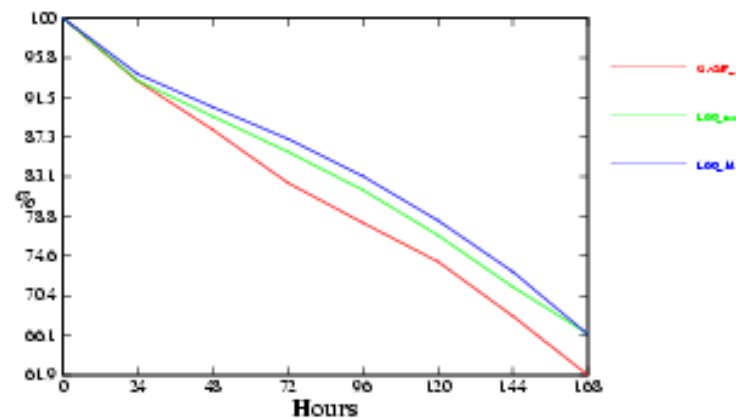
RMS_ERRORS



BIAS



AN-CORRELATION



GASP/L60_n/L60_M

Field: 500.00 HGHTBM

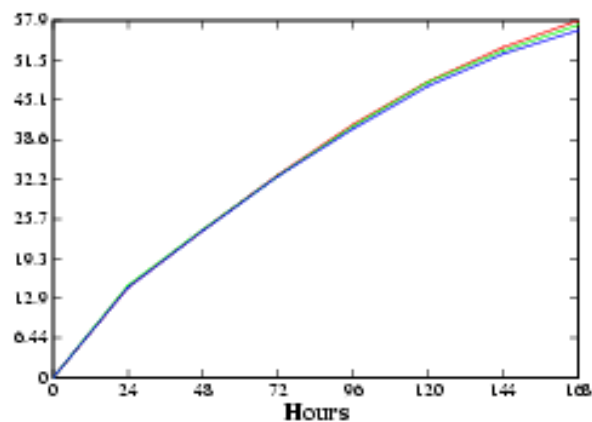
Region: tropics (20S - 20N 0E - 360E)

AVERAGE (59 CASE(S), 0 EXCLUSION(S))

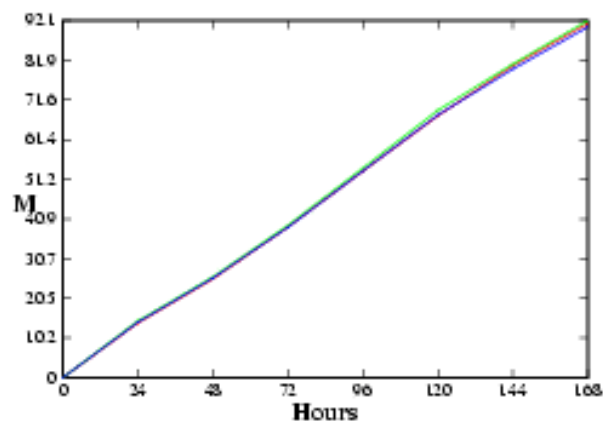
Base Dates: 20040925-00Z to 20041122-12Z

Thu Apr 14 13:38:27 2005

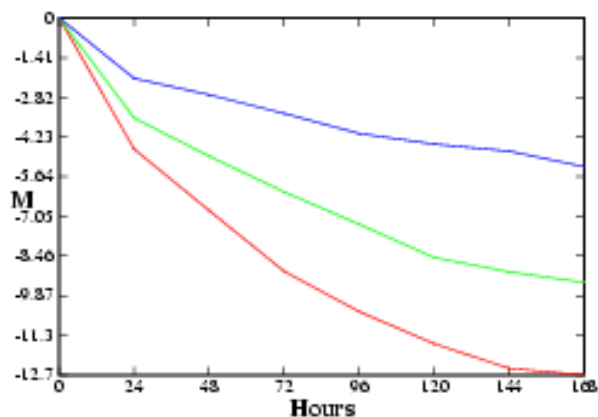
SKILL-SCORE



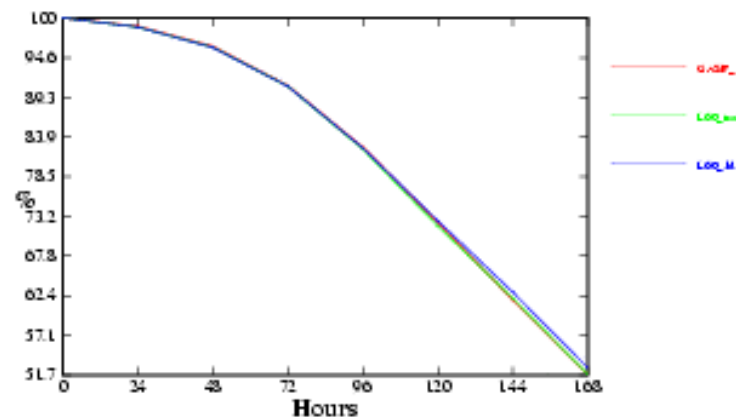
RMS_ERRORS



BIAS



AN-CORRELATION



GASP/L60_ne/L60_Id

Field: 500.00 HGHTBM

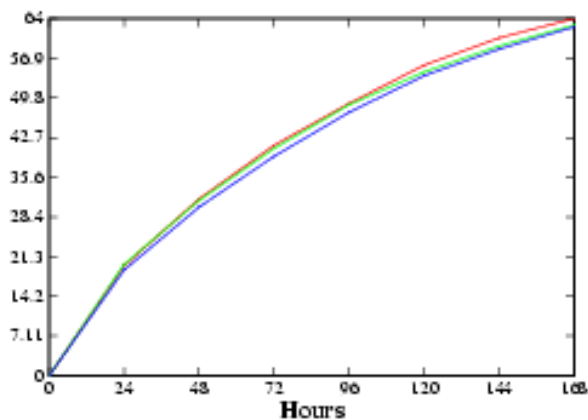
Region: n. hem. annulus (20N - 60N 0E - 360E)

AVERAGE (59 CASE(S), 0 EXCLUSION(S))

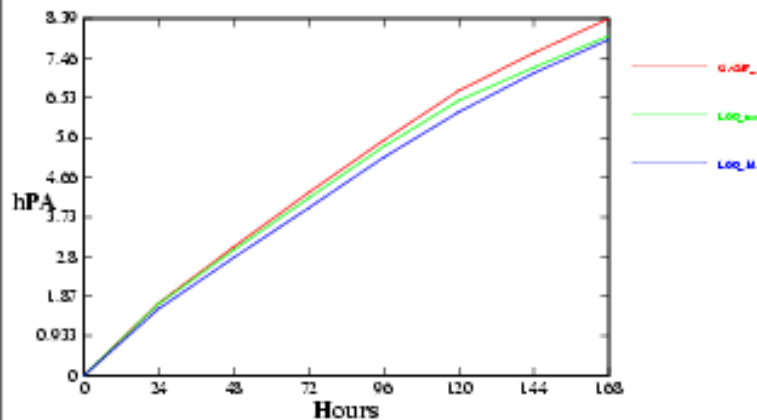
Base Dates: 20040925-00Z to 20041122-12Z

Thu Apr 14 13:37:58 2005

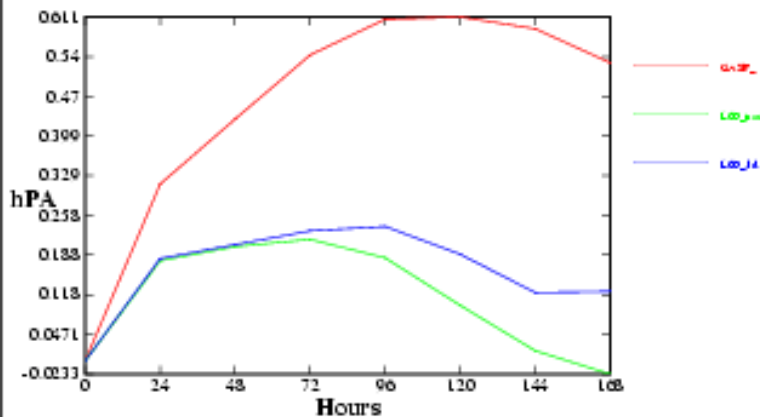
SKILL_SCORE



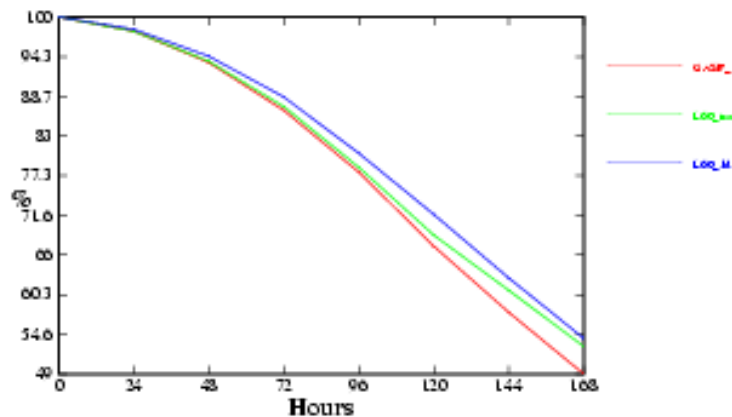
RMS_ERRORS



BIAS



AN-CORRELATION



GASP/L60_ne/L60_Id

Field: 0.00 MSLP

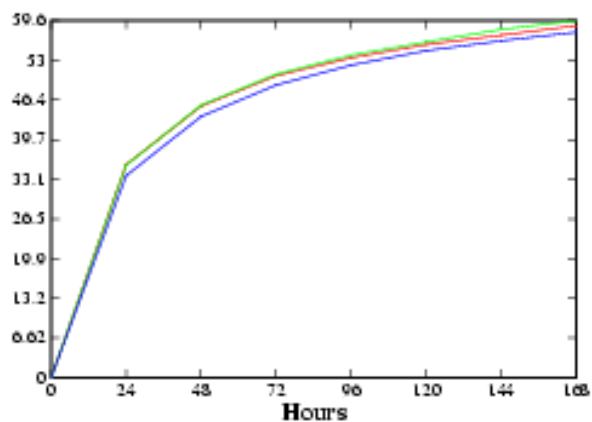
Region: s. hem. annulus (60S - 20S 0E - 360E)

AVERAGE (59 CASE(S), 0 EXCLUSION(S))

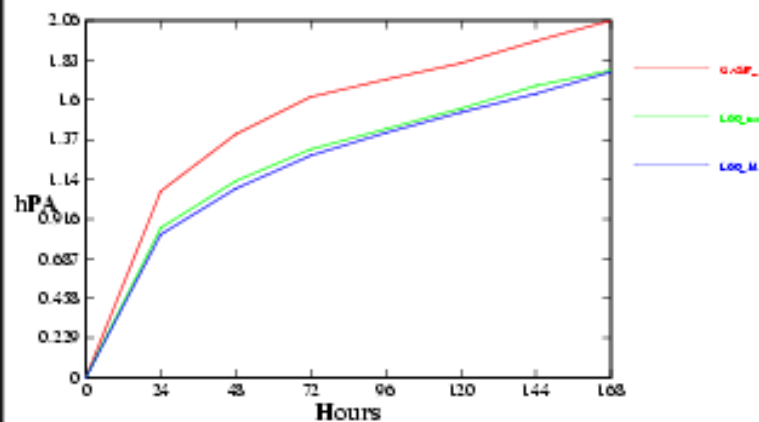
Base Dates: 20040925-00Z to 20041122-12Z

Thu Apr 14 13:38:03 2005

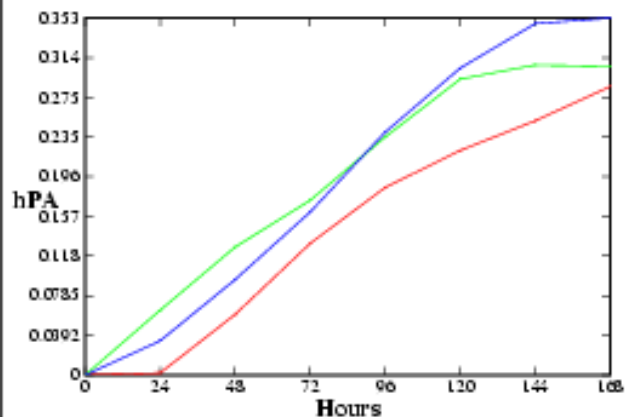
SKILL_SCORE



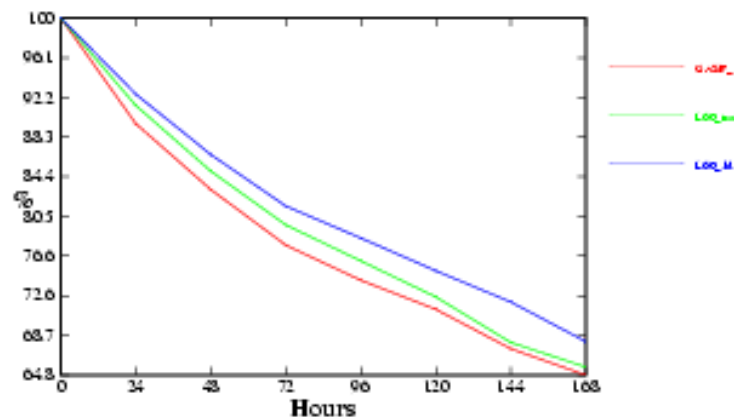
RMS_ERRORS



BIAS



AN-CORRELATION



GASP/L60_ne/L60_Id

Field: 0.00 MSLP

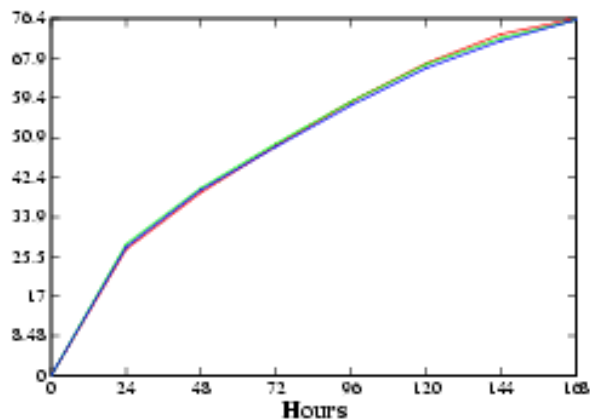
Region: tropics (20S - 20N 0E - 360E)

AVERAGE (59 CASE(S), 0 EXCLUSION(S))

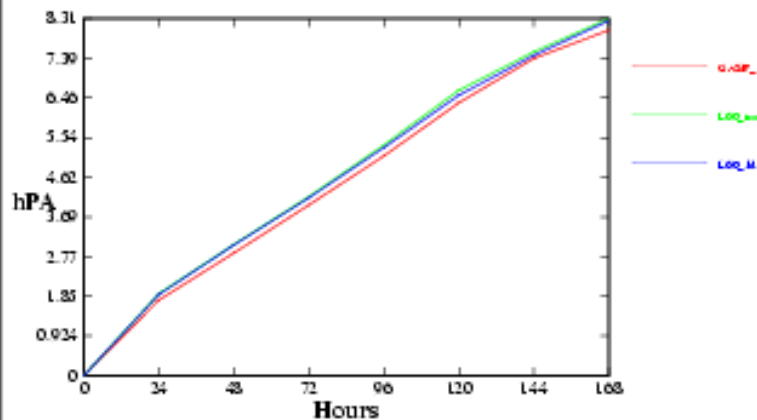
Base Dates: 20040925-00Z to 20041122-12Z

Thu Apr 14 13:38:00 2005

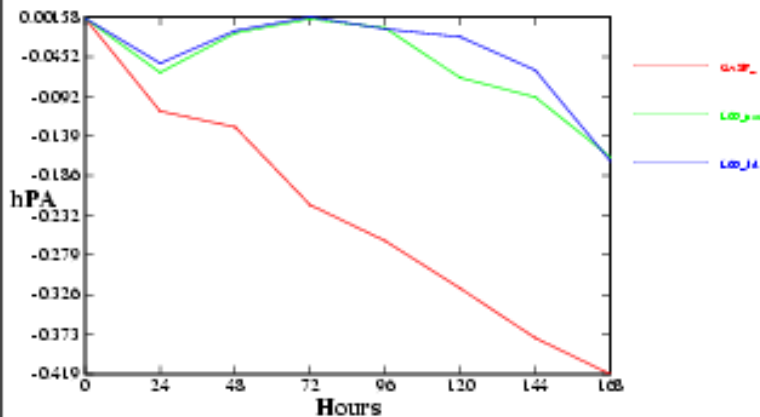
SKILL-SCORE



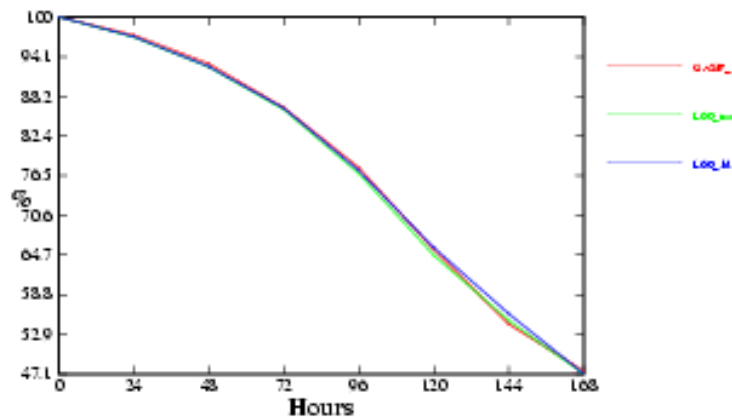
RMS_ERRORS



BIAS



AN-CORRELATION



GASP/L60_ne/L60_Id

Field: 0.00 MSLP

Region: n. hem. annulus (20N - 60N 0E - 360E)

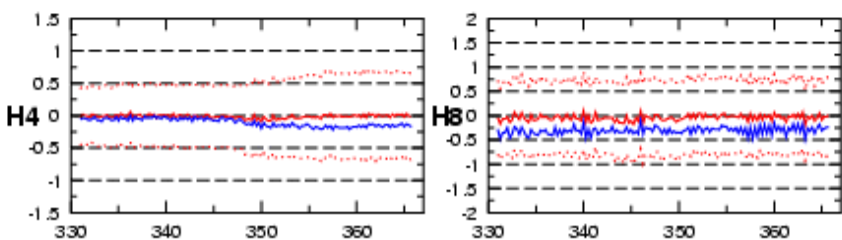
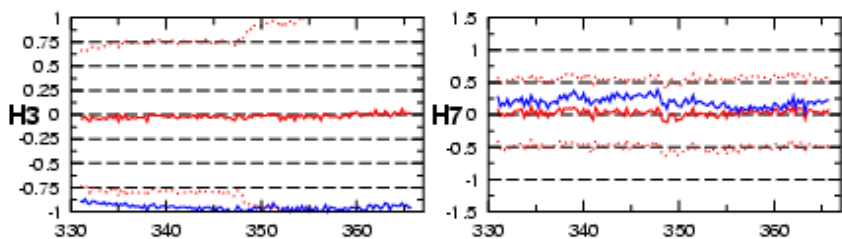
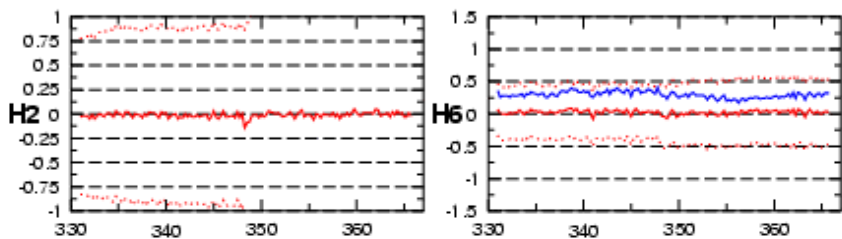
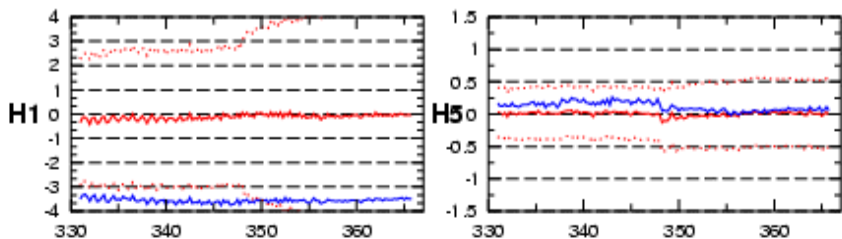
AVERAGE (59 CASE(S), 0 EXCLUSION(S))

Base Dates: 20040925-00Z to 20041122-12Z

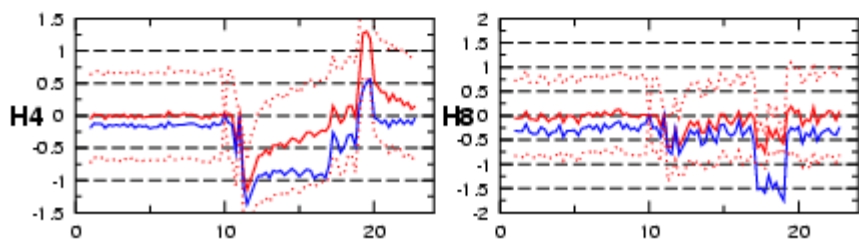
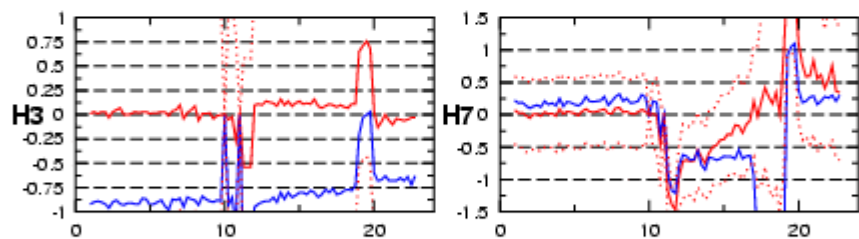
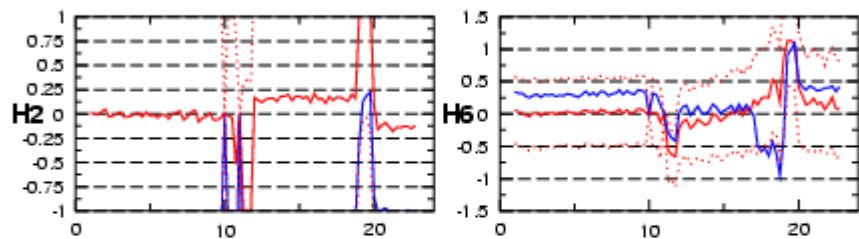
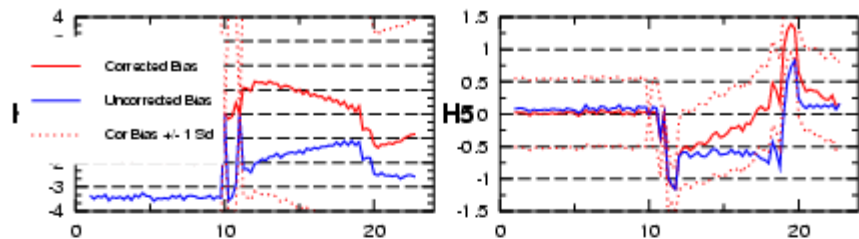
Addition of NOAA-17 HIRS

- Some improvement
- NOAA-16 HIRS malfunction mid Dec 04
- Drop-out around Jan 10 2005
- NOAA-17 makes up for missing HIRS information - especially water vapour

NOAA 16 BIAS GLOBAL L60_d17 12 :

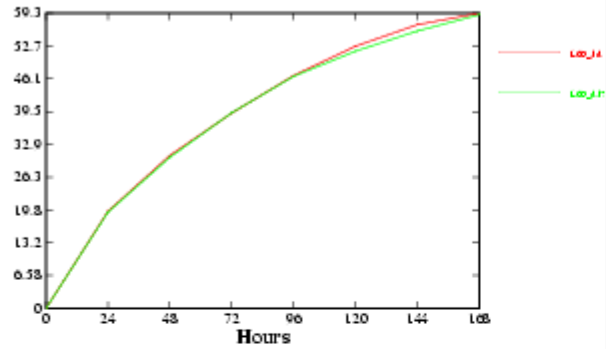


NOAA 16 BIAS GLOBAL L60_d17 01 2005

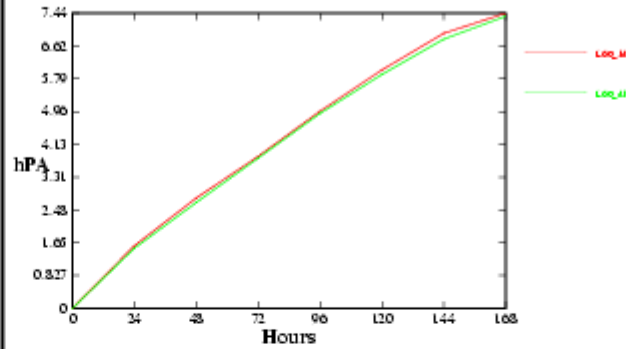


Fri Apr 15 15:03:51 2005

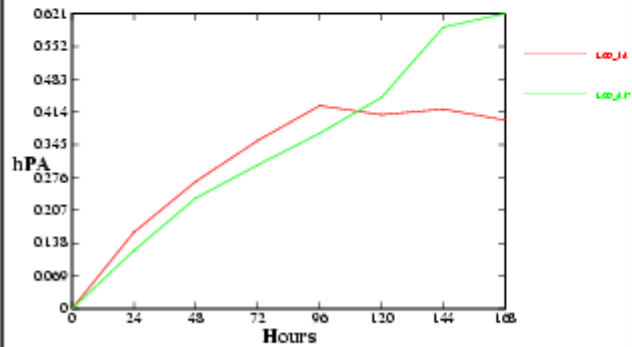
SKILL SCORE



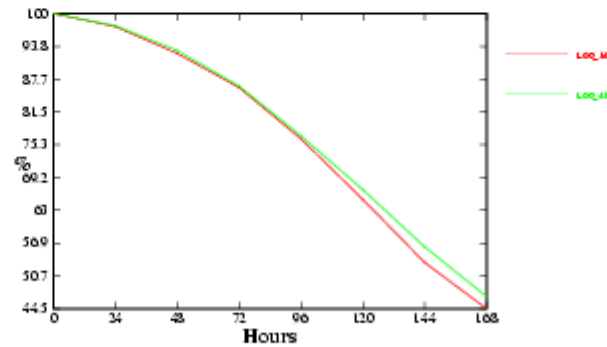
RMS_ERRORS



BIAS



AN-CORRELATION



L60_d17/L60_d17

Field: 0.00 MSLP

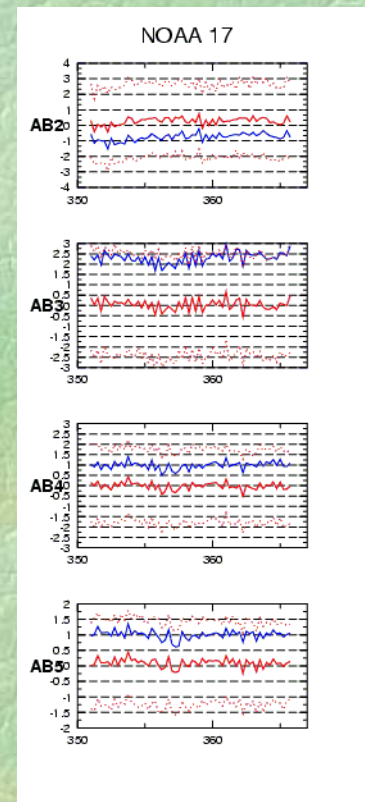
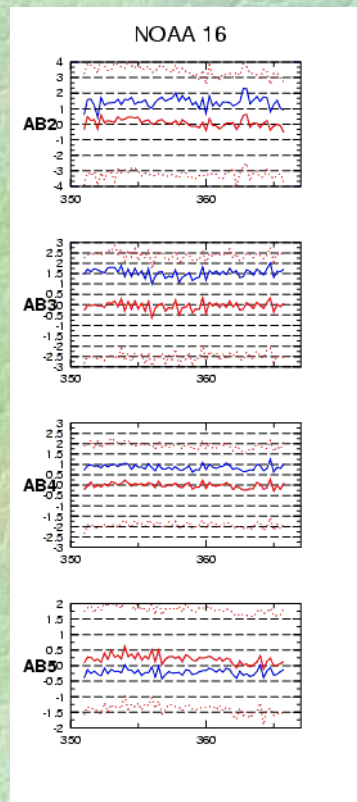
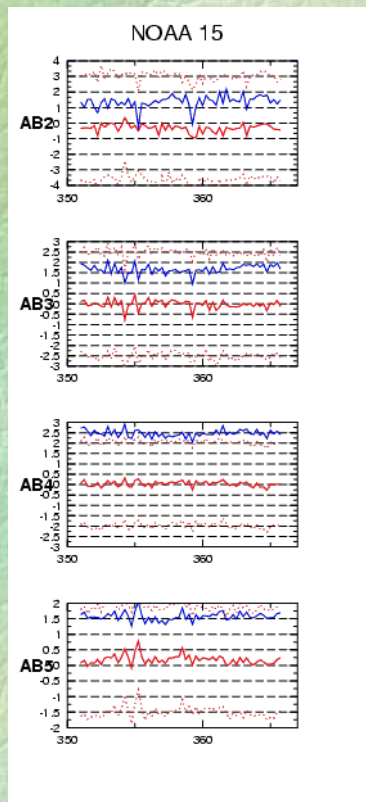
Region: s. hem. annulus (60S - 20S 0E - 360E)

AVERAGE (19 CASE(S), 0 EXCLUSION(S))

Base Dates: 20050101-00Z to 20050119-12Z

Current Work

- Monitoring AMSU-B from NOAA-15,16 and 17



Current Work

- Initial tests using AMSU-B show change in tropical moisture but little impact
- Added AMSU-A from AQUA with little impact
- Possibly due to limitation of 1DVAR system

Future Work

- Increase use of retrievals over land and ice
- Move to direct use of radiances in GenSI/3DVAR (with Peter Steinle)
- Other systems (SSMIS, AIRS, IASI...)