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

\[ x_{b,r}^{thick} = P(x_{b,r}) \]

\[ \Lambda_i^{th,rh} = \frac{\sigma_{R_i}^2}{\sigma_{B_i}^2 - \sigma_{R_i}^2} \]

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

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

\[ \sigma_{R_i}^{2,th,rh} = \Lambda_i^{th,rh} \sigma_{B_i}^{2,th,rh} = (1 + \Lambda_i^{th,rh}) \sigma_{R_i}^{2,th,rh} \]

\[ R^{thick} = P(x_r)^T R P(x_r) \]

\[ B^{thick} = P(x_r)^T B P(x_r) \]
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(sigma)
- Some modification to GASP code (M. Naughton)
- Raleigh friction only applied in top 2 levels
- Biases greatly reduced
Sigma Levels

![Graph showing sigma levels with data points for L60_sig, L50_sig, and L60gr_sig.](image)
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
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
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

S Annulus 60S to 20S

2004-09-22 0Z to 2004-10-06 12Z

Bias (m) vs Pressure (hPa)

RMS Error (m) vs Number of Obs
Sonde Geopotential Height

N ANNULUS  20N to 60N

20040922/0Z to 20041006/12Z
RAWIN

TROPICS 30S to 30N

20040922/0Z to 20041006/12Z

Pressure (hPa)

U Bias (m/s)

V Bias (m/s)

RMS Error (m/s)

GASP (GESF)

U0 Nes (GESF)

U0 Id (GESF)
GASP /L60_nes/L60_1d
Field: 50.00 HIGHTBM
Region: s. hem. annulus (60S - 20S 0E - 360E)
AVERAGE (50 CASE(S), 0 EXCLUSION(S))
Base Dates: 20040925-00Z to 20041122-12Z
GASP/L60_nes/L60_1d
Field: 50.00 U
Region: s. hem. annulus (60S - 20S 0E - 360E)
AVERAGE (59 CASE(S), 0 EXCLUSION(S))
Base Dates: 20040925-00Z to 20041122-12Z
GASP/L60_nes/L60_1d
Field: 50.00 U
Region: tropics (20S - 20N 0E - 360E)
AVERAGE (59 CASE(S), 0 EXCLUSION(S))
Base Dates: 20040925-00Z to 20041122-12Z
GASP/L60_0es/L60_1d
Field: 500.00 HGTBM
Region: south pole (90S - 55S 0E - 360E)
AVERAGE (50 CASE(S), 0 EXCLUSION(S))
Base Dates: 20040925-00Z to 20041122-12Z
**GASP /L60_nes/L60_1d**

Field: 500.00 HGHTEM
Region: s. hem. annulus (60S - 20S 0E - 360E)
AVERAGE (50 CASES, 0 EXCLUSION)
Base Dates: 20040925-00Z to 20041122-12Z
**GASP /L60_0nes/L60_1d**
Field: 500.00 HGTBM
Region: australia (Irregular grid)
AVERAGE (50 CASE(S), 0 EXCLUSION(S))
Base Dates: 20040925-00Z to 20041122-12Z
GASP/L60_nes/L60_Ld
Field: 500.00 HGTBM
Region: tropics (20S - 20N, 0E - 360E)
AVERAGE (50 CASES), 0 EXCLUSION(S))
Base Dates: 20040925-00Z to 20041122-12Z
GASP /L60_nes/L60_Id
Field: 500.00 HGTBM
Region: n. hem. arnulus (20N - 60N 0E - 360E)
AVERAGE (50 CASE(S), 0 EXCLUSION(S))
Base Dates: 20040925-00Z to 20041122-12Z
GASP/L60_nes/L60_1d
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
GASP/L60_nes/L60_Id
Field: 0.00 MSLP
Region: tropics (20S - 20N, 0E - 360E)
AVERAGE (50 CASE(S), 0 EXCLUSION(S))
Base Dates: 20040925-00Z to 20041122-12Z
**GASP /L60_nes/L60_Id**

Field: 0.00 MSLP
Region: n. hem. arctics (20N - 60N 0E - 360E)
AVERAGE (50 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
**L60_1d/L60_d17**
Field: 0.00 MSLP
Region: s. hem. annulus (60S - 20S 0E - 360E)
AVERAGE (19 CASES), 0 EXCLUSIONS
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…)