Assimilation of Level-1D ATOVS Radiances in the Australian Region LAPS System

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Bureau of Meteorology Research Centre

Bureau of Meteorology, Melbourne, Australia

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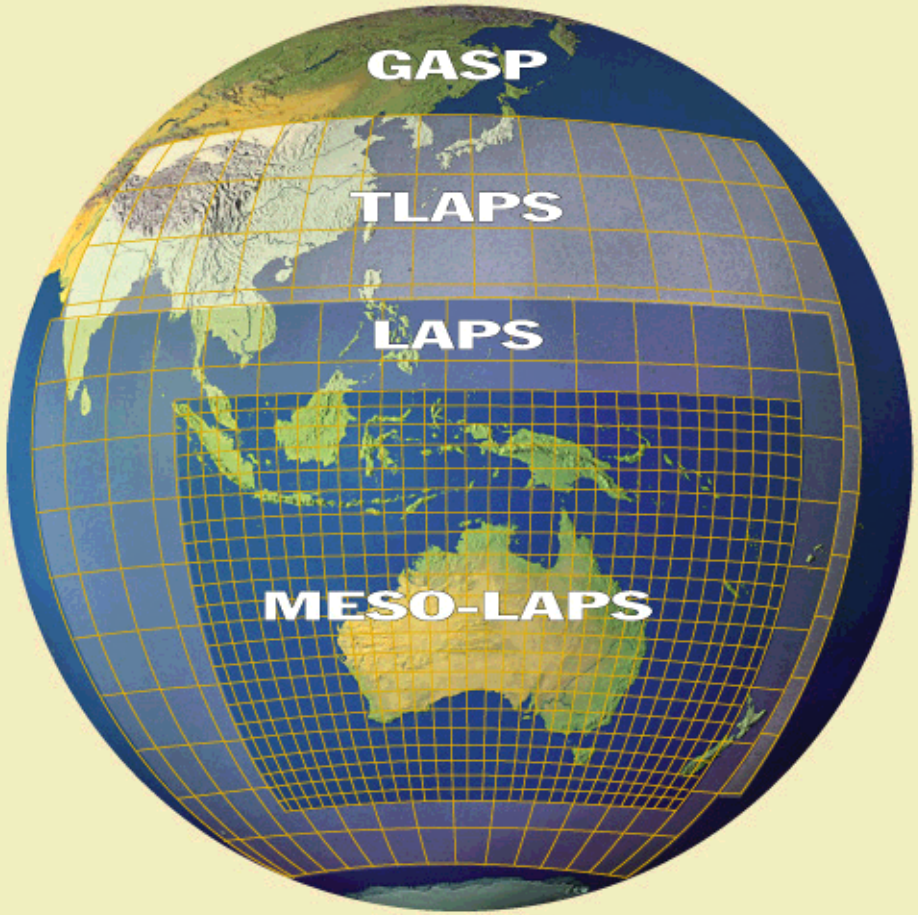
The Domains of the Operational Suite of

Numerical Weather Analysis and Prediction Systems



GASP

Global Analysis and Prediction System

- T_L239 (smallest half wavelength resolved : 83 km)
- 29 levels
- Prediction to 8 days

LAPS

Limited Area Prediction System
Australian Region

- 0.375° horizontal grid spacing
- 29 levels
- Prediction to 72 hours

TLAPS

Tropical Limited Area Prediction System

- 0.375° horizontal grid spacing
- 29 levels
- Special features for tropical analysis
- Prediction to 48 hours

MESO-LAPS

Smaller scale versions of LAPS

- 0.05°–0.125° horizontal grid spacing
- 29 levels
- Prediction to 36 hours

- Special version for tropical cyclone prediction

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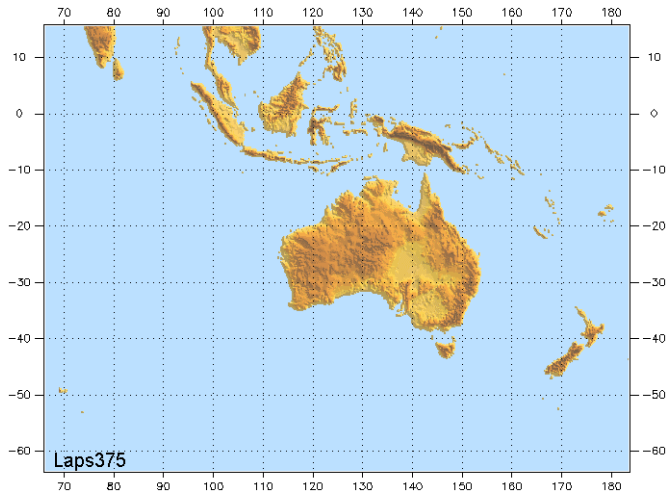
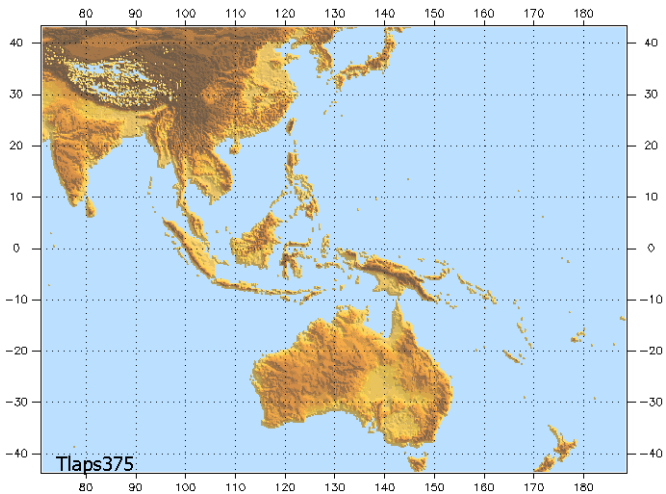
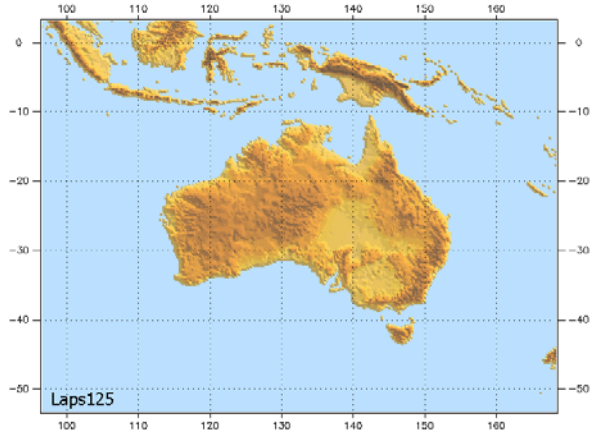
LAPS 0.375º grid

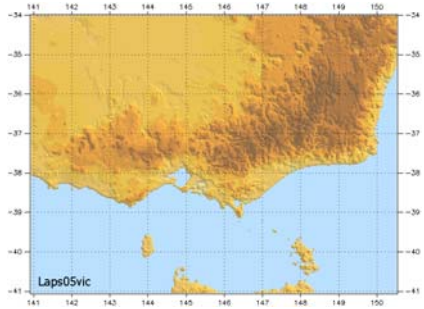


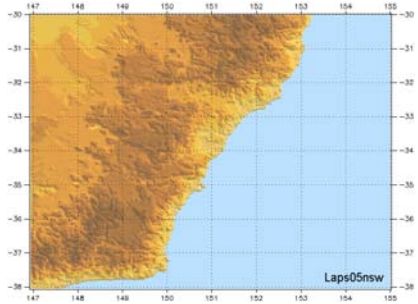
TXLAPS 0.375º grid



MESOLAPS 0.125º grid







CITY-CENTRED DOMAINS 0.05º grids

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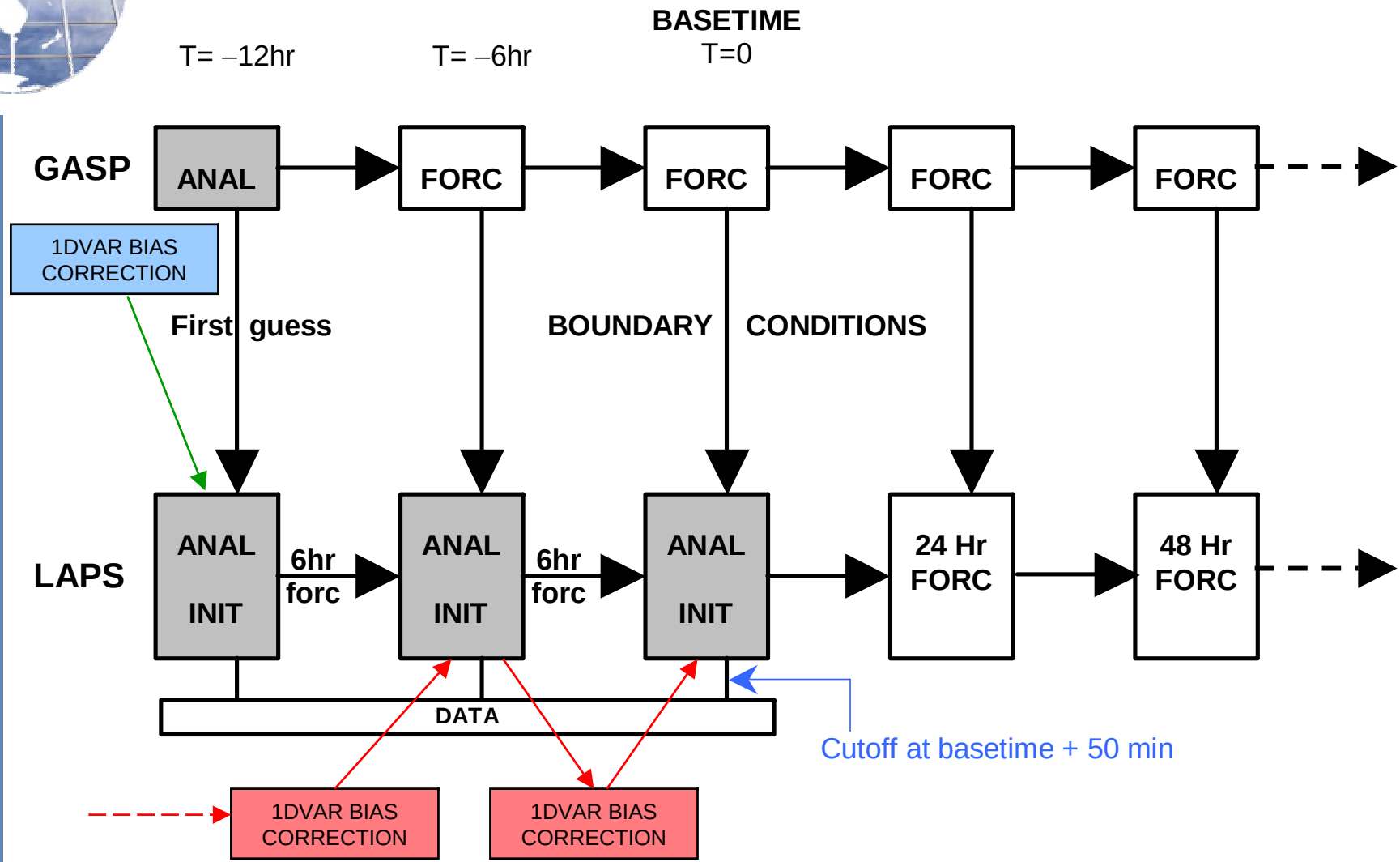
LAPS Configuration

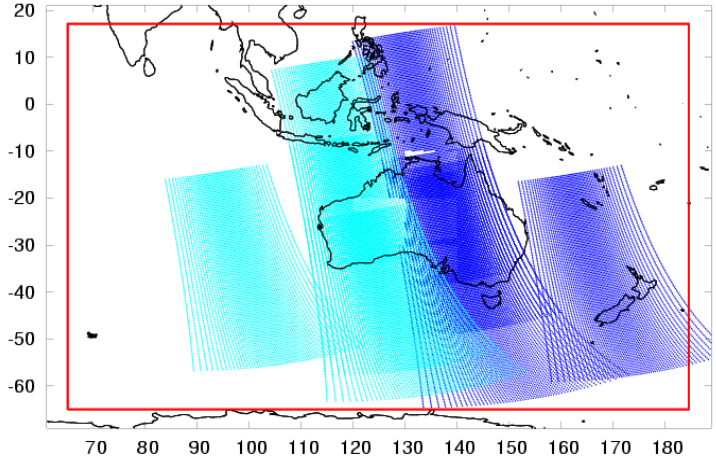
- Hydrostatic
- Miller-Pearce explicit time-stepping scheme
- Third order upwinding advection scheme
- ECMWF land surface and vertical diffusion scheme
- Radiation: Fels-Schwartzkopf (SW) Lacis-Hansen (LW)

  ==> Sun-Edwards-Slingo
- Convection: Tiedtke's, early ECMWF mass flux scheme with MC trigger and closure. ==> CAPE closure
- Large Scale Rain : Bulk Explicit Microphysics


BASETIME
T=0
T= –12hr
T= –6hr
GASP
ANAL
FORC
FORC
FORC
FORC
1DVAR BIAS CORRECTION
First guess
BOUNDARY CONDITIONS
LAPS
ANAL INIT
6hr forc
ANAL INIT
6hr forc
ANAL INIT
24 Hr FORC
48 Hr FORC
DATA
Cutoff at basetime + 50 min
1DVAR BIAS CORRECTION
1DVAR BIAS CORRECTION

20050115-12Z

LOCAL 1D



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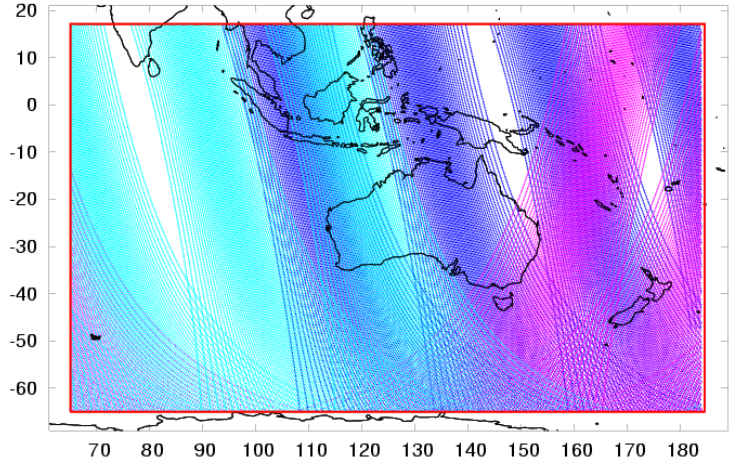
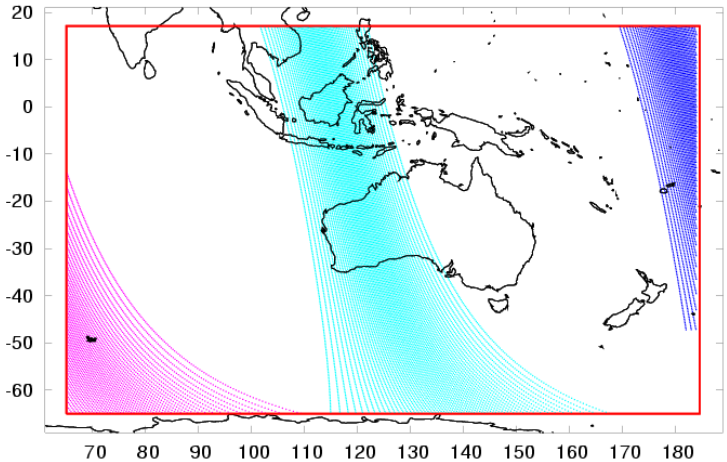
tovs_NOAA-16 flag 2 [0]
tovs_NOAA-15 flag 2 [25639]

GLOBAL 1D



tovs_NOAA-17 flag 2 [40145]
tovs_NOAA-16 flag 2 [21167]
tovs_NOAA-15 flag 2 [34782]

Simulated Early Cut Off 1D



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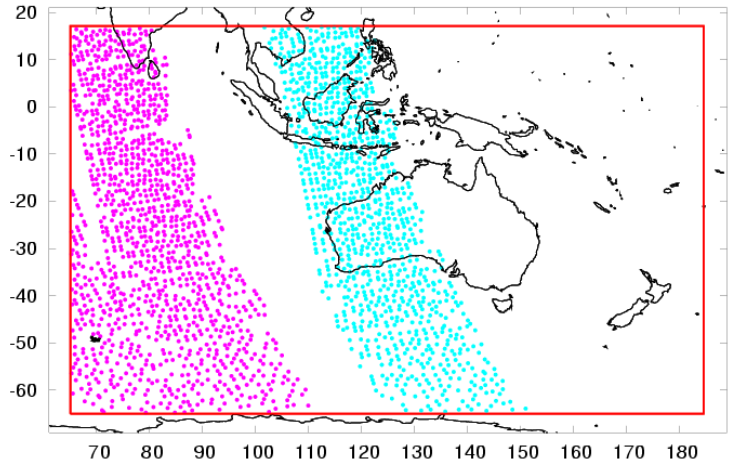
Operational NESDIS



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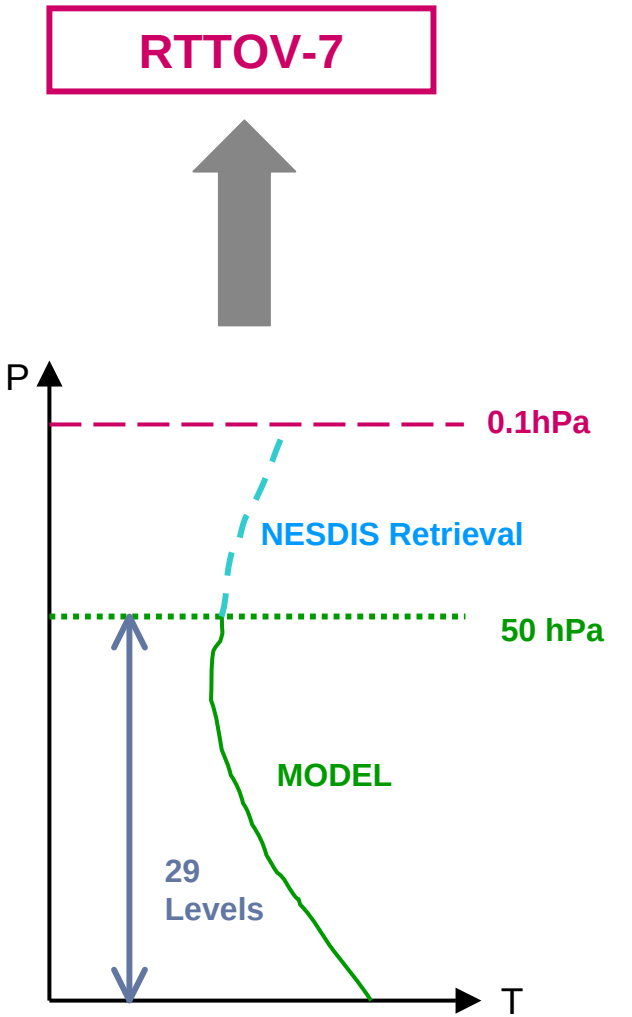

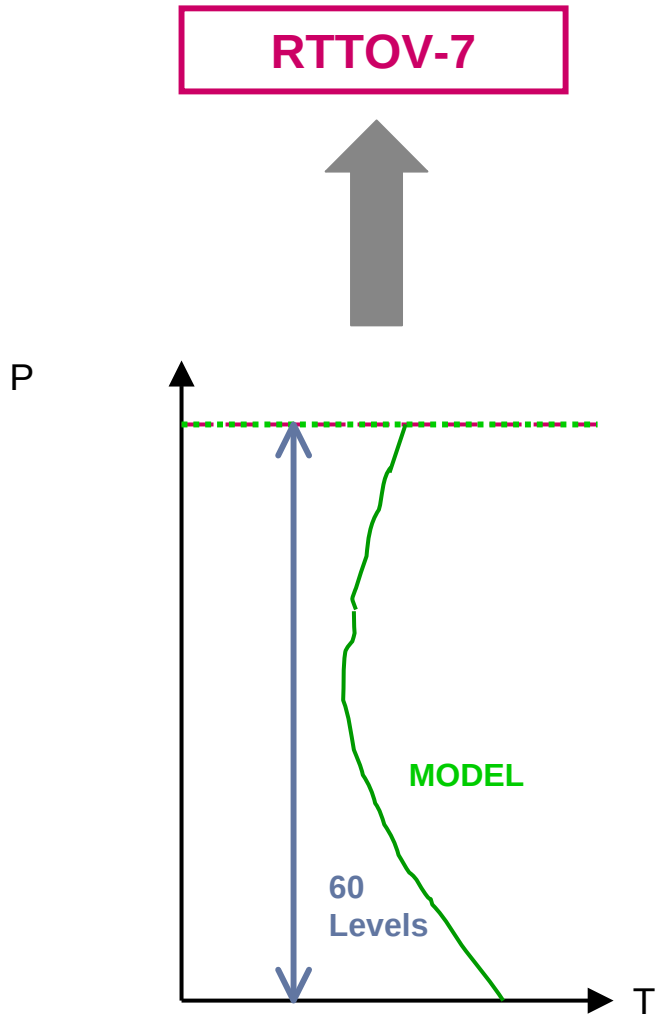

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1DVAR in the Bureau of Meteorology

$$\min J = (x - x_b)^T \mathbf{B}^{-1}(x - x_b) + (y_0 + y(x))^T [\mathbf{E} + \mathbf{F}]^{-1}(y_0 - y(x))$$

x_b : background field

y_0 : observed radiances

x : control vector

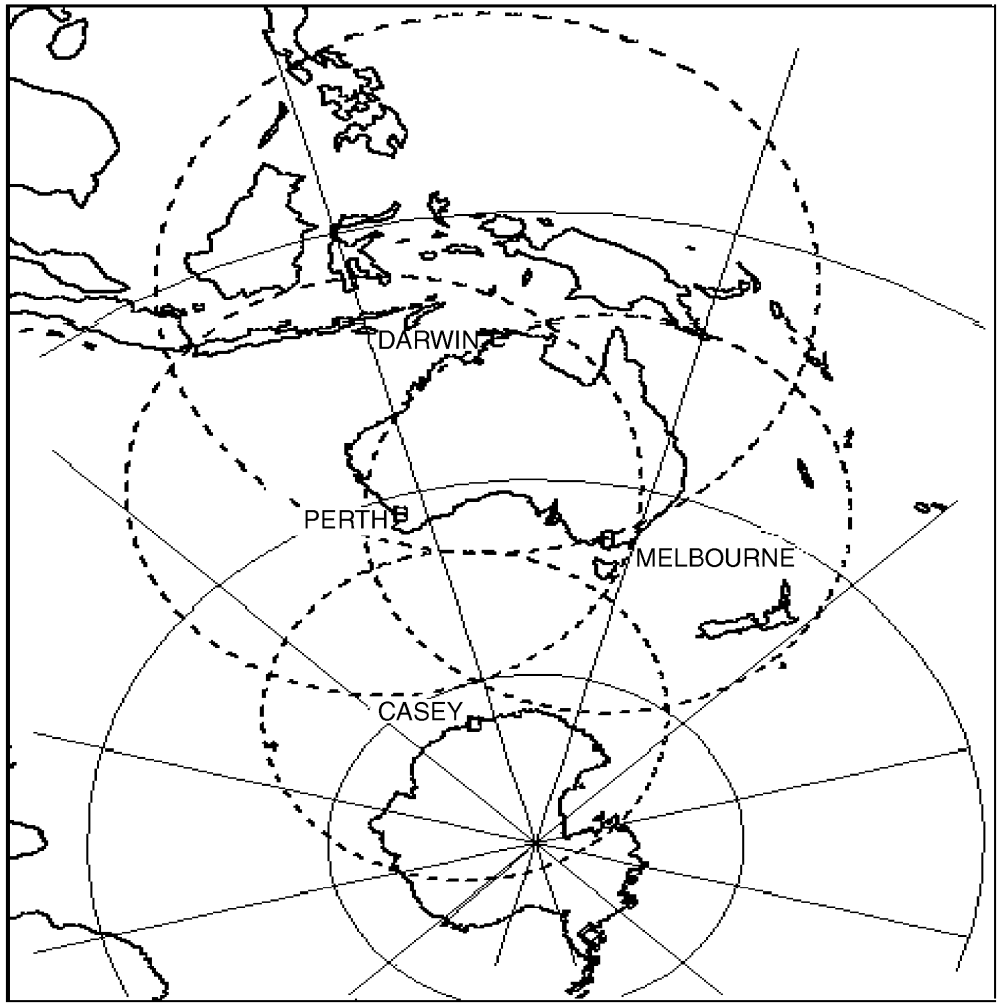
$\mathbf{B}$: background error covariance matrix

$\mathbf{E} + \mathbf{F}$: Observation and Forward model error covariance

$y(x)$: Forward operator

- Purser type dynamic error scaling
- Air mass dependent radiance bias predictors & bias monitoring
- Latitudinally varying scan correction
- Implemented operationally in GASP July 2000, LAPS Sept 2002

Local HRPT reception



ATOVS handling

Local reception

BoM Space Based Observations Section

HRPT → AAPP → 1D → BUFR ENCODING

Met Office
1D BUFR radiances

FTP

NESDIS
1D radiances + retrievals

GTS

MARS

REAL TIME DB

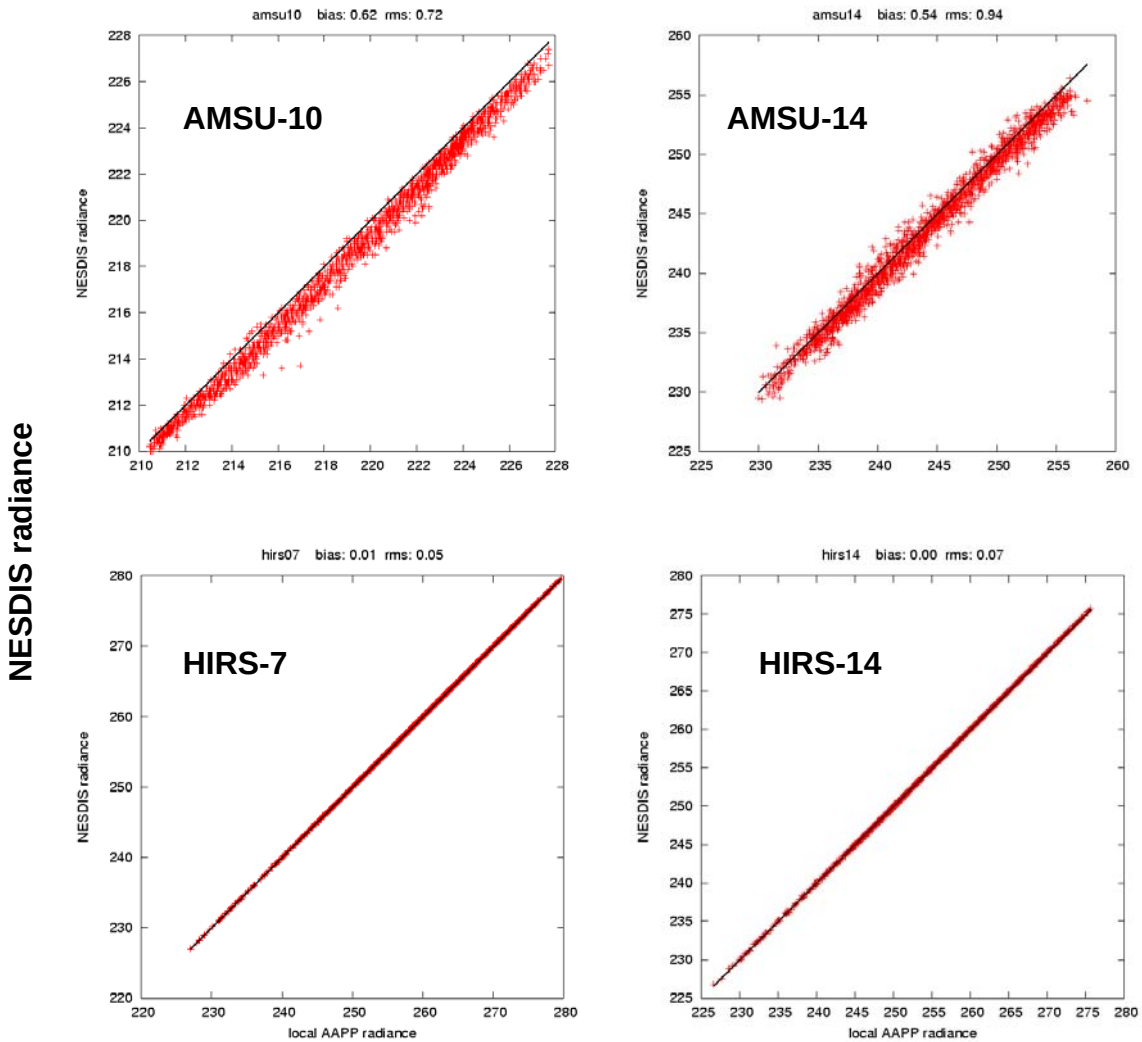
OBS DATA

AMV SONDE AIREP
SYNOP METAR SHIP
BUOY SCAT GPS
GMSQ

1DVAR

GenSI
ANALYSIS

Comparison of locally received and processed (AAPP) NOAA-17
1D radiances with corresponding NESDIS values



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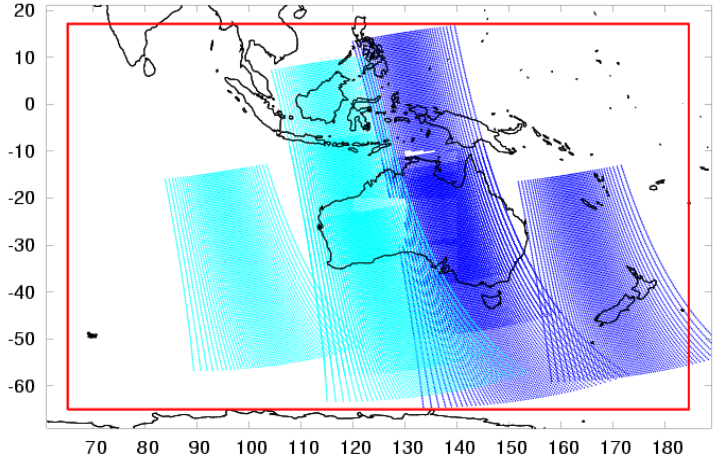
LAPS 60-level Trials

1. All Met Office 1D radiance data available to final (base date-time) analysis
2. Restricted set of Met Office 1D radiances available to final analysis – simulates impact of early cut-off
3. NESDIS radiances (as used by operational LAPS system) used for all analyses
4. Locally received and processed 1D radiances used in final analysis

- All experiments nested in same GASP L60 trial
- All other data types as per operational model

20050115-12Z

LOCAL 1D



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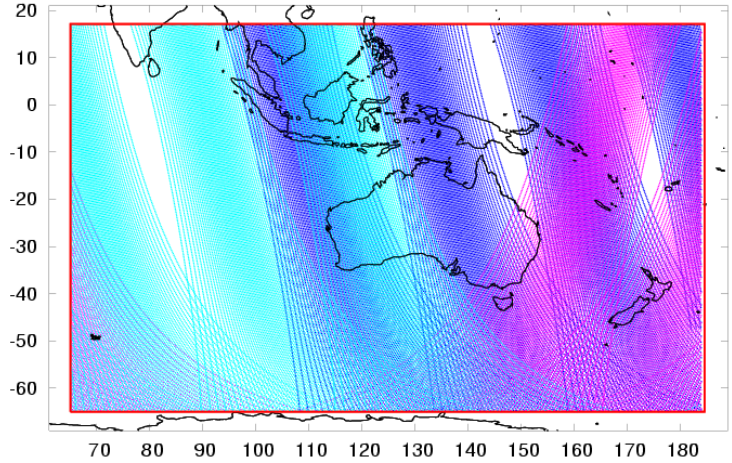

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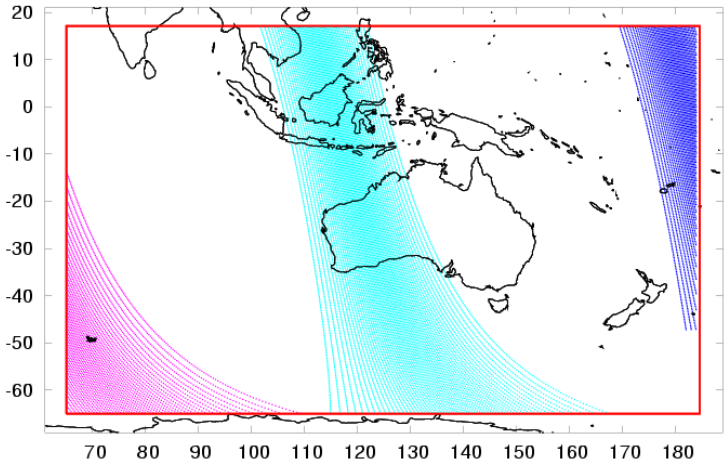

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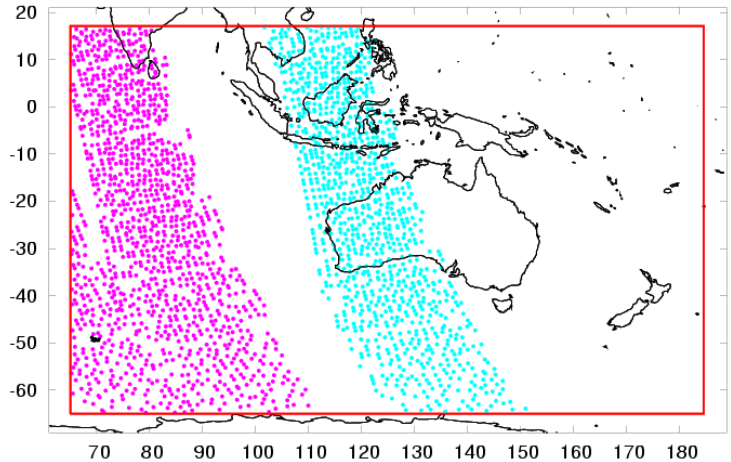

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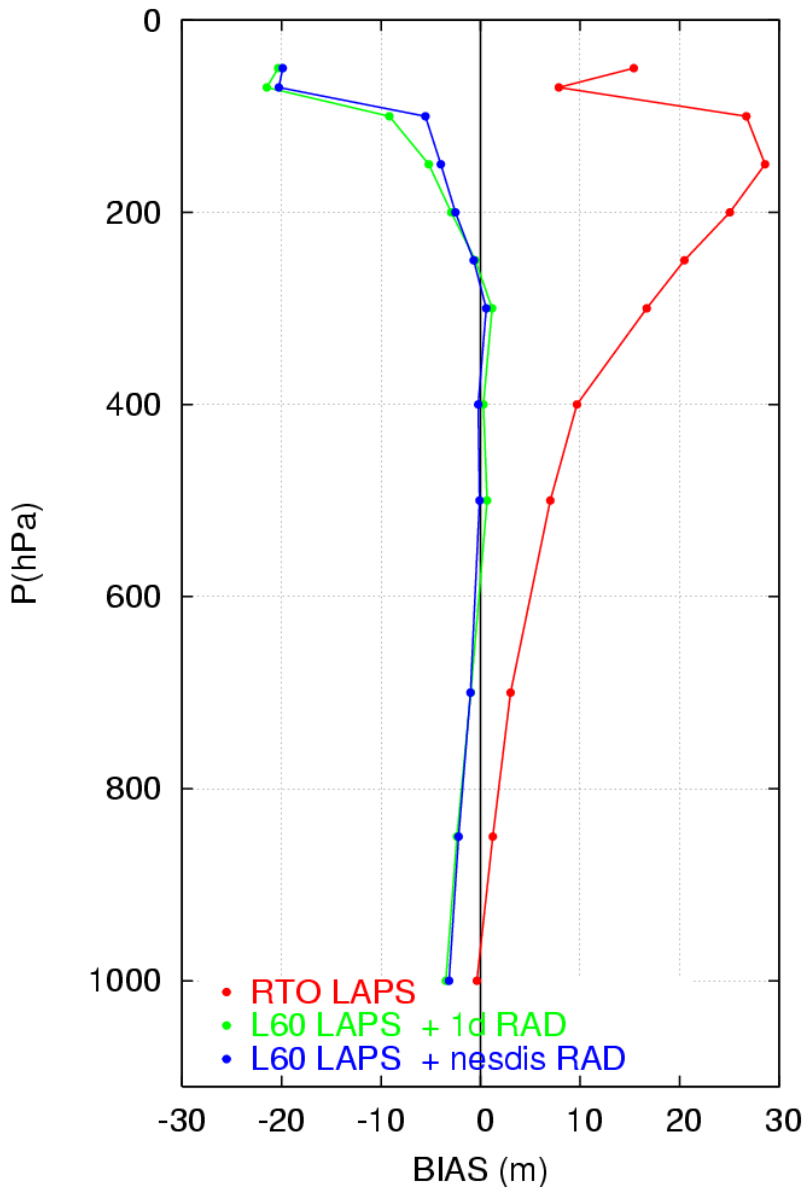
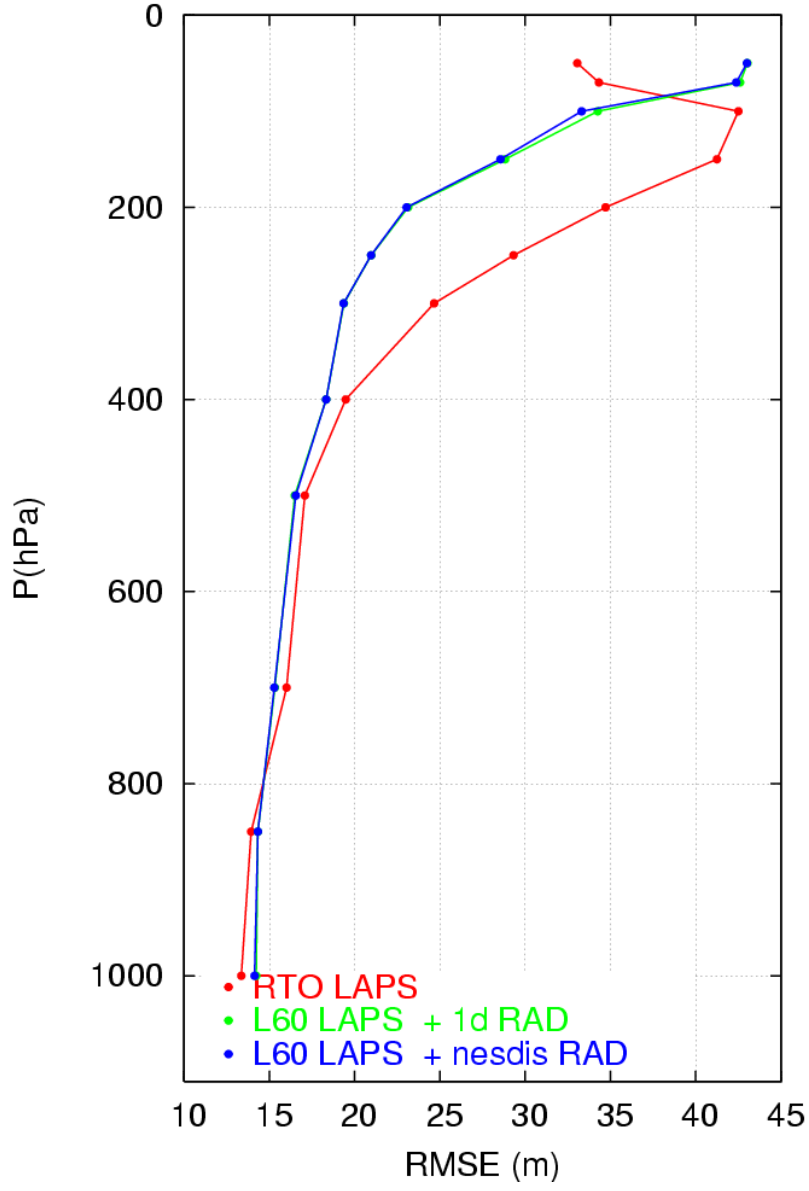
OBS FITTING STATISTICS: FG AGAINST SONDE Z





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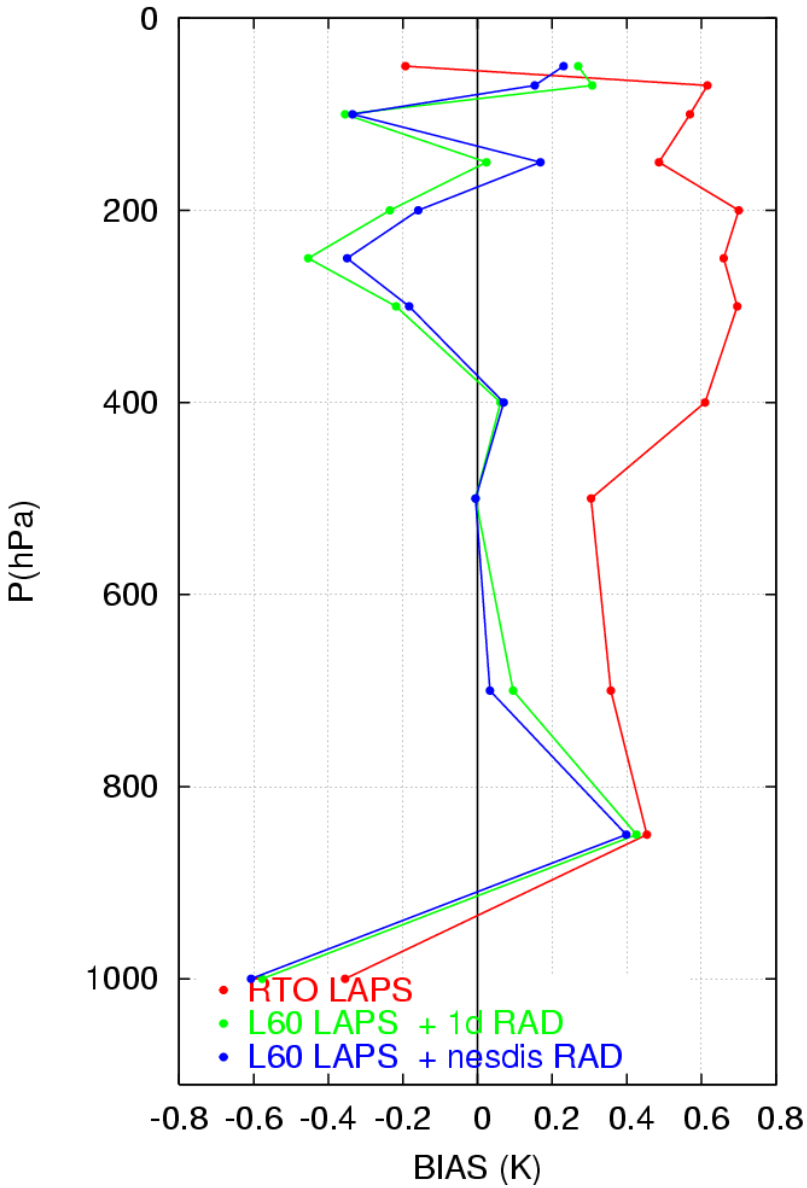

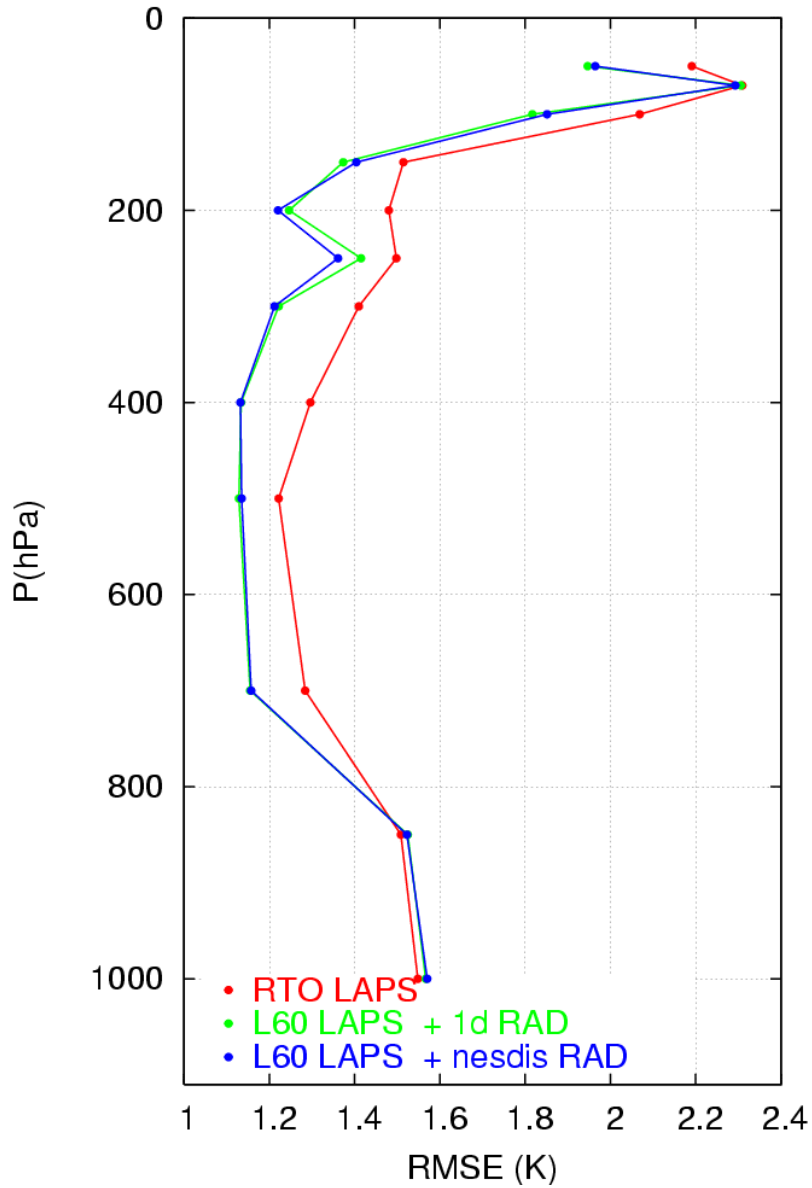

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FORECAST SKILL - MSLP

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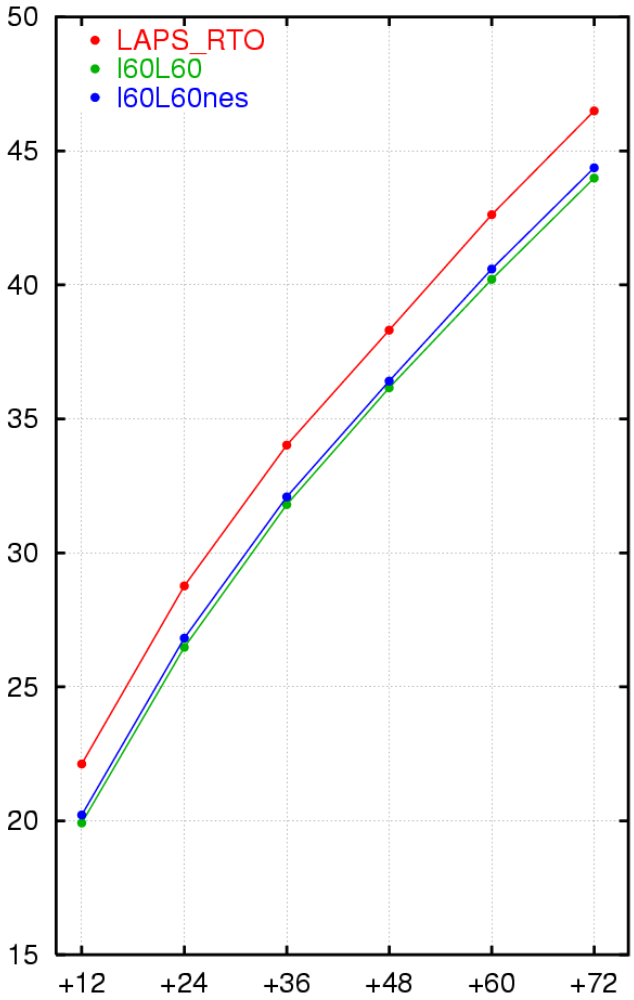

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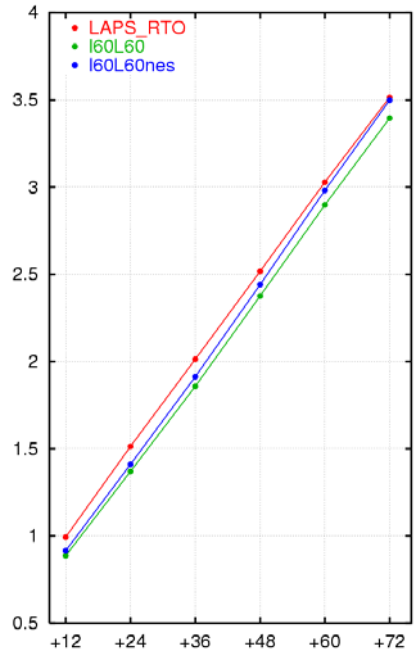

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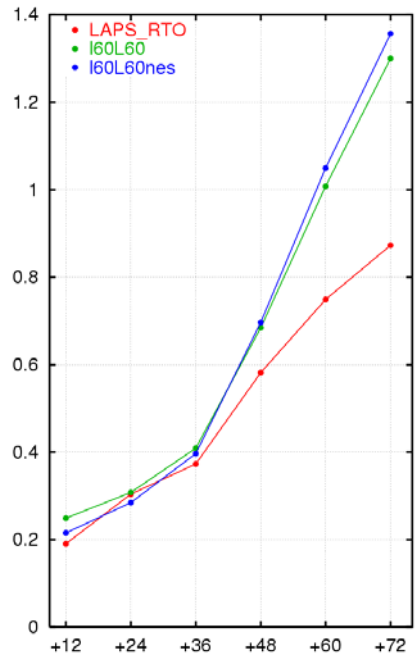

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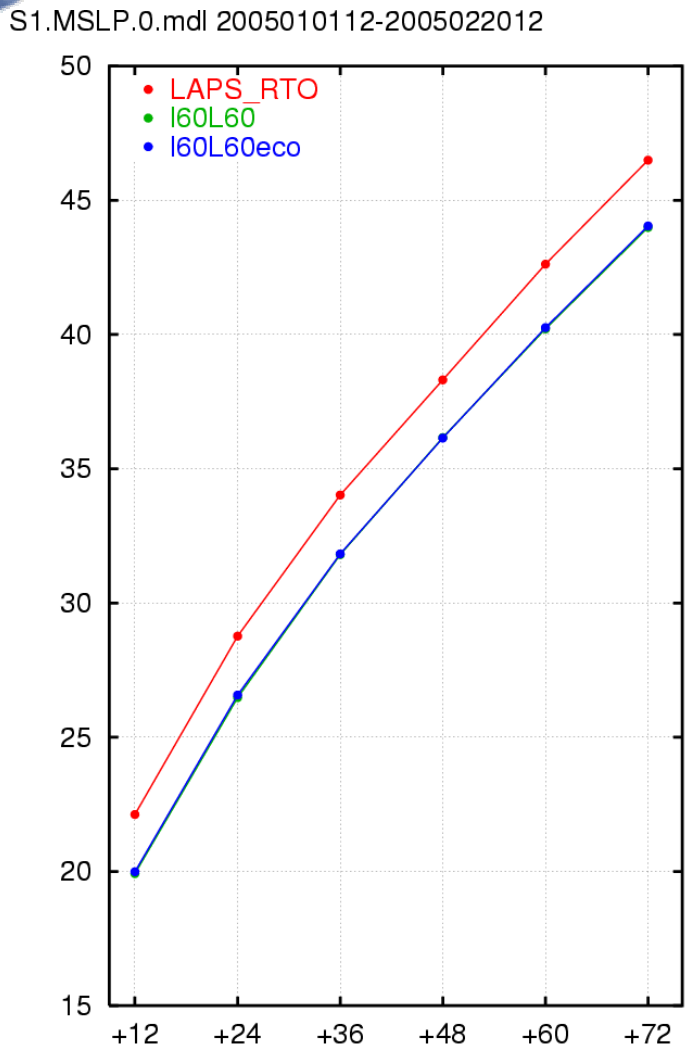

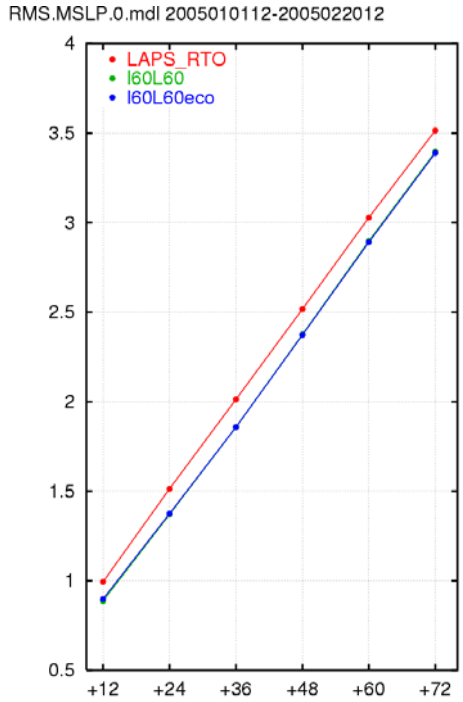

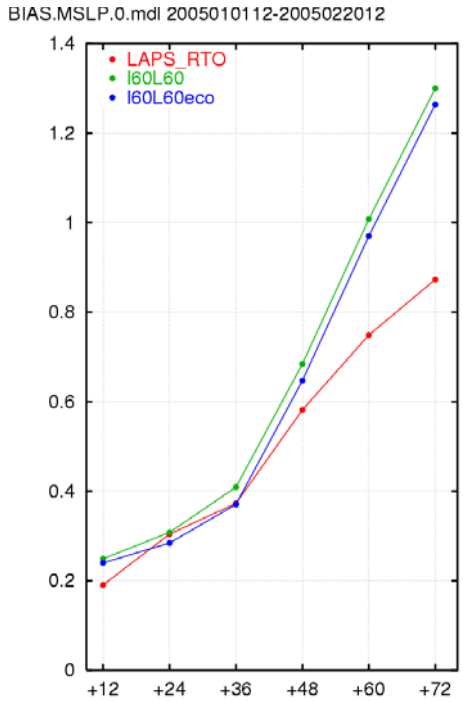

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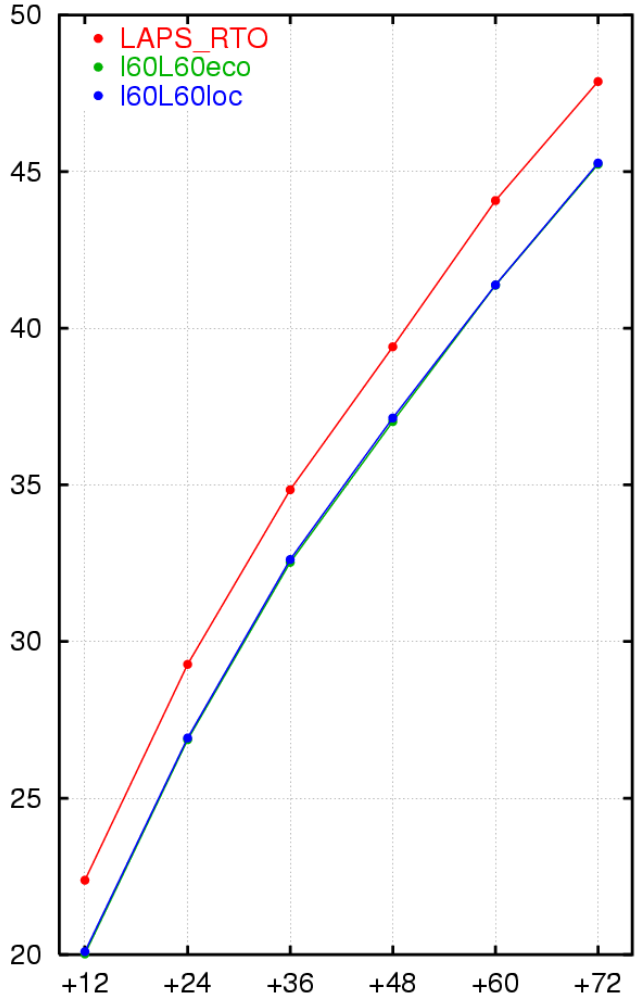

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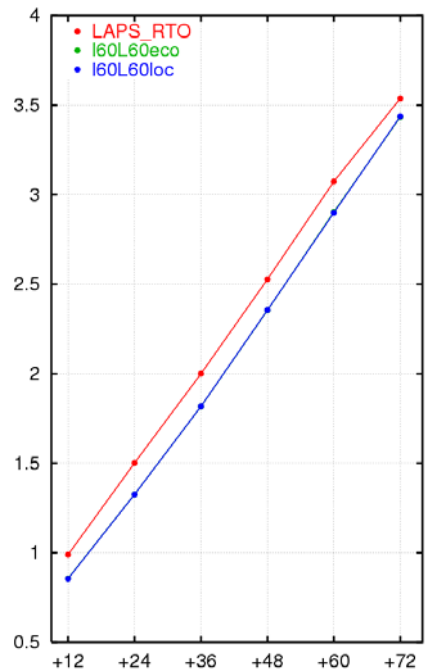

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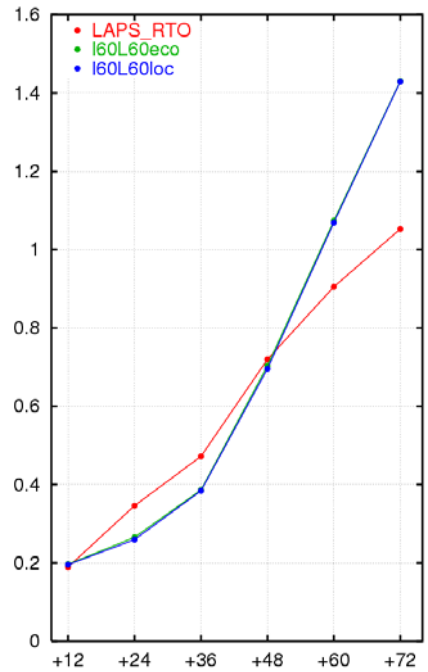
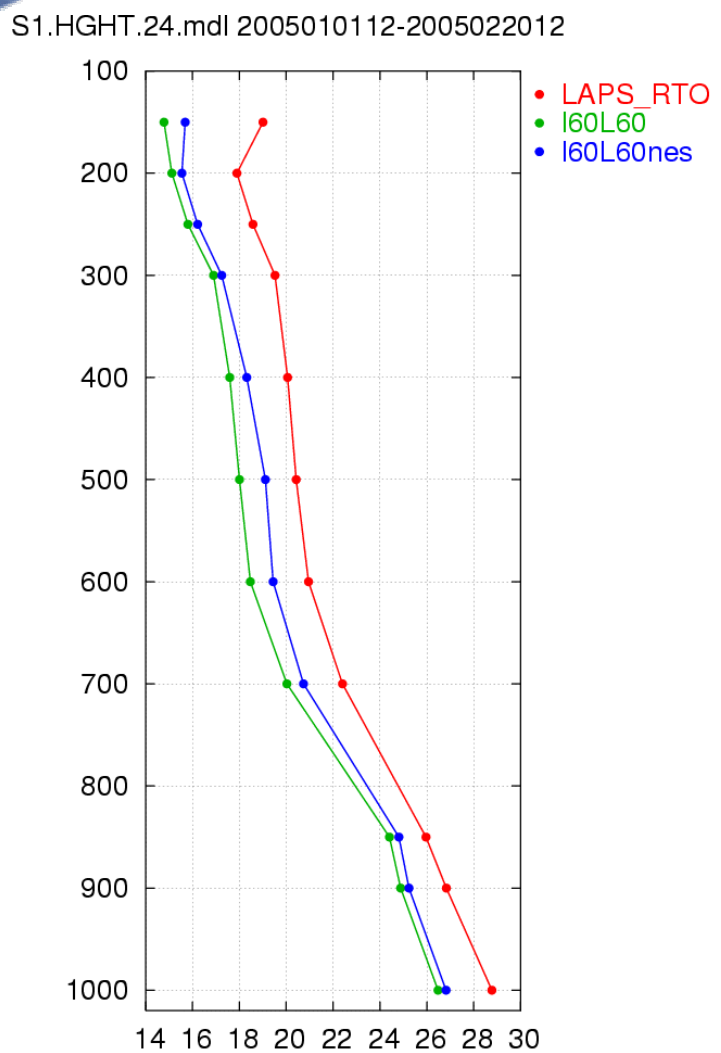
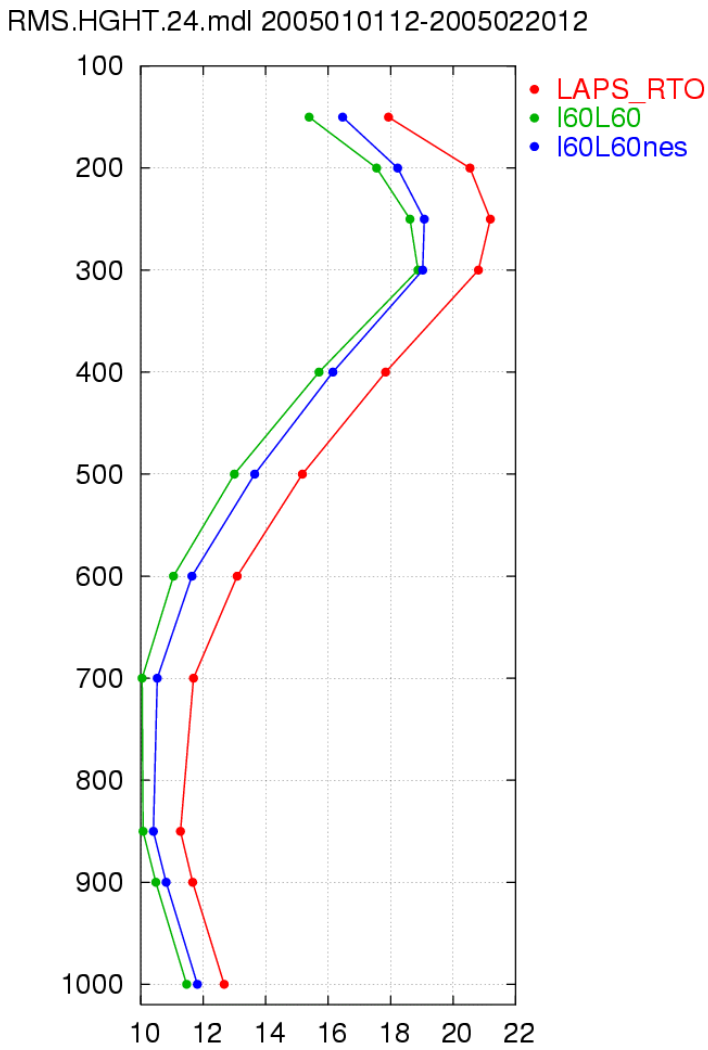


FORECAST SKILL - Z





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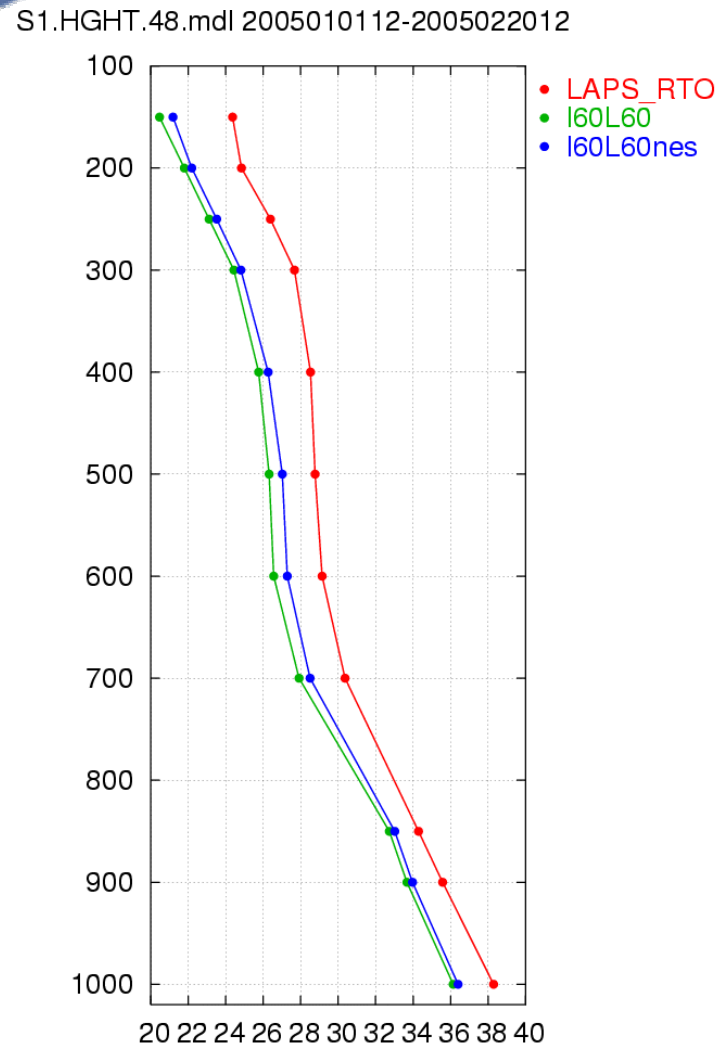

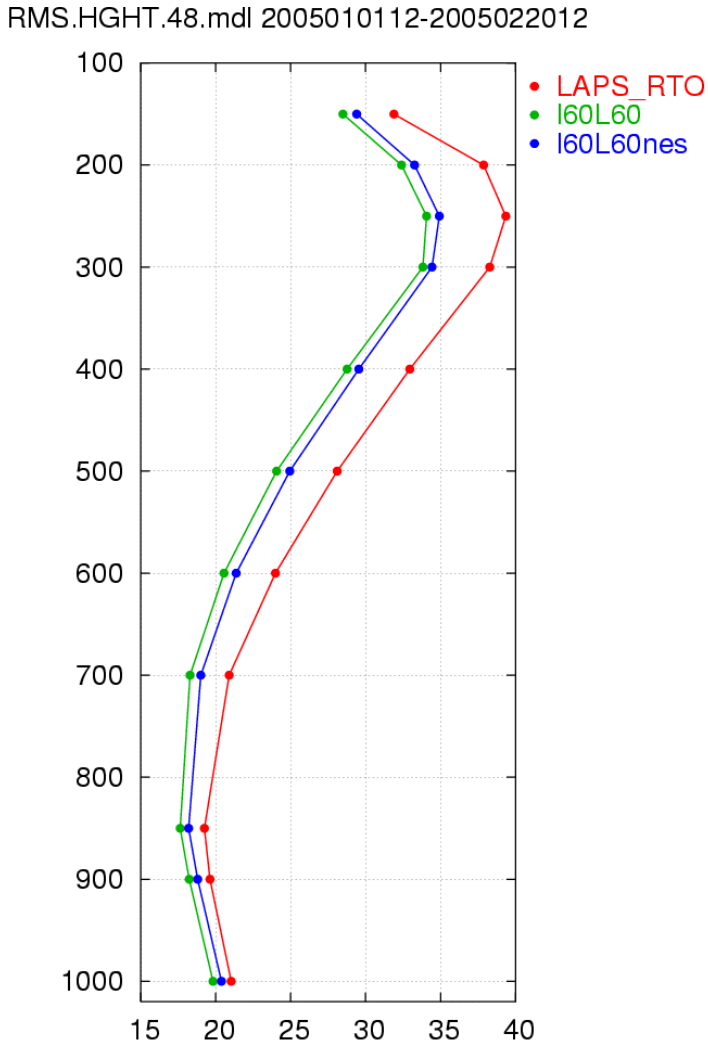

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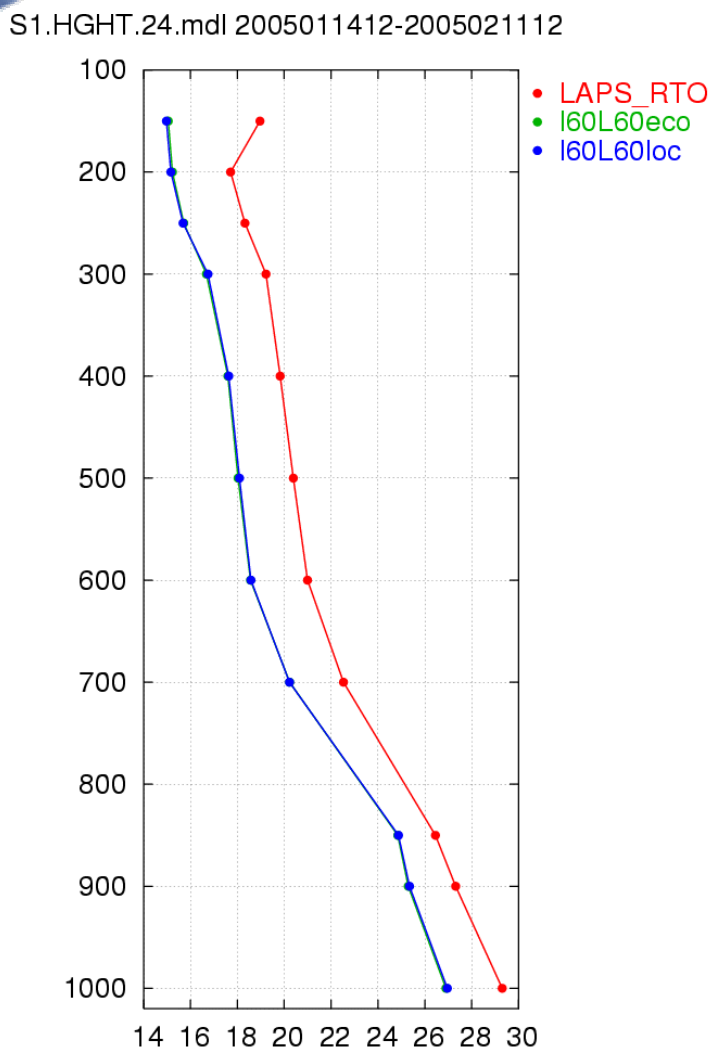

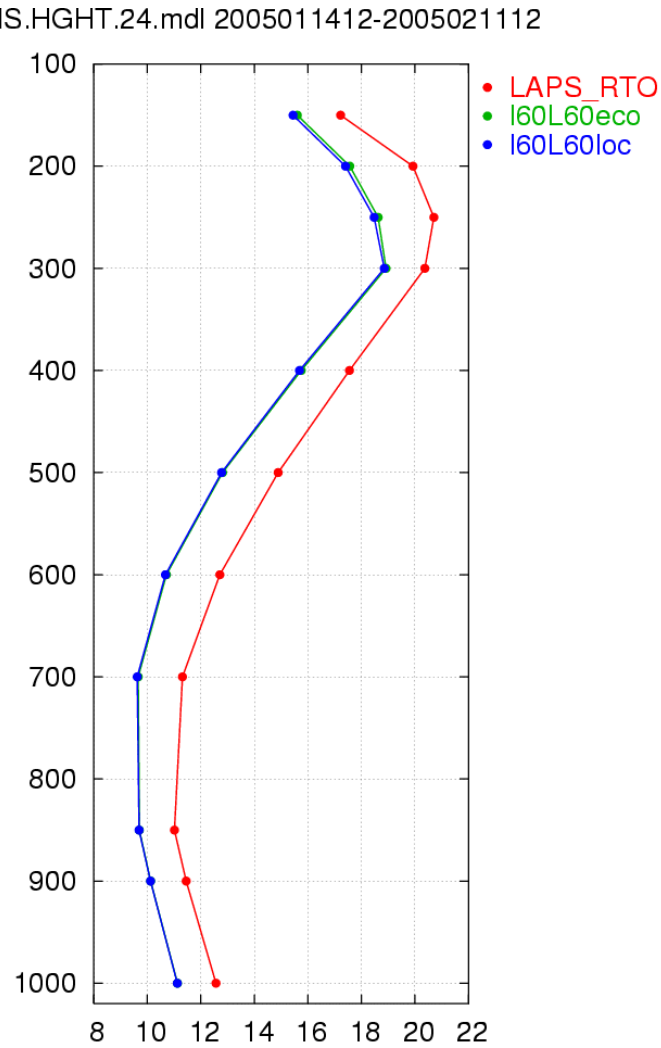

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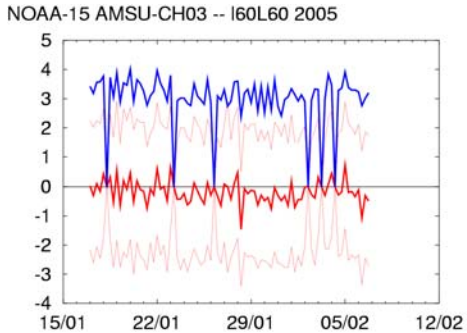
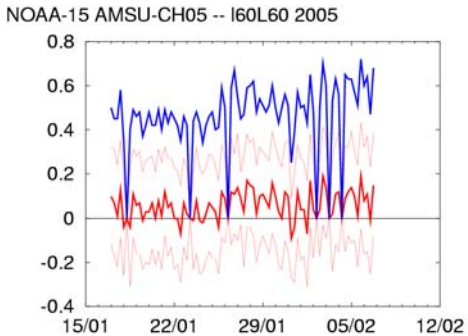
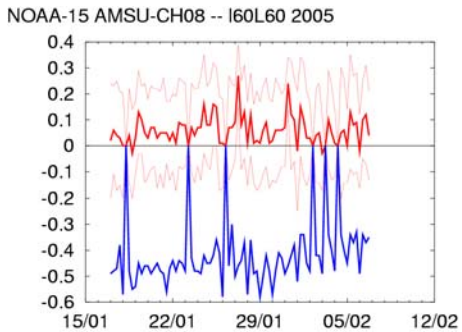
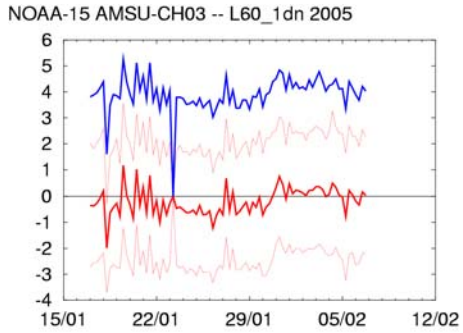
LAPS

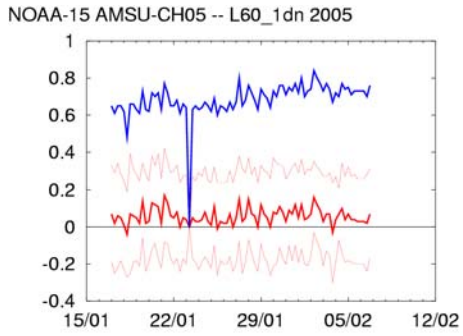


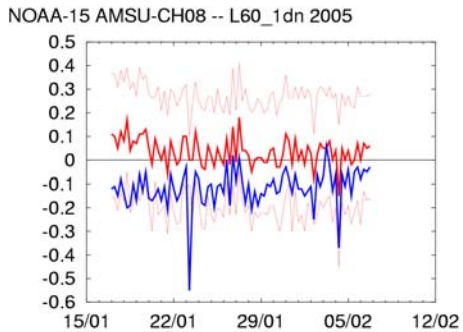




GASP



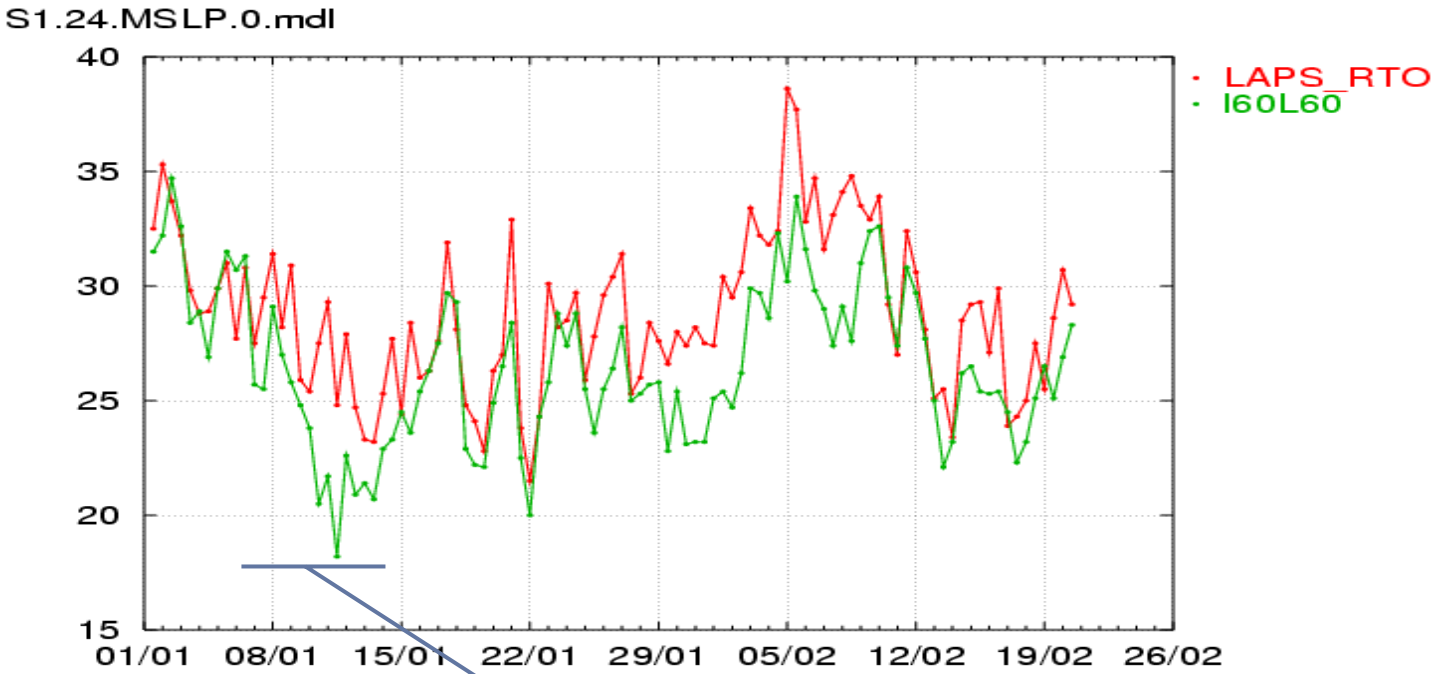




Radiance

Bias

Monitoring



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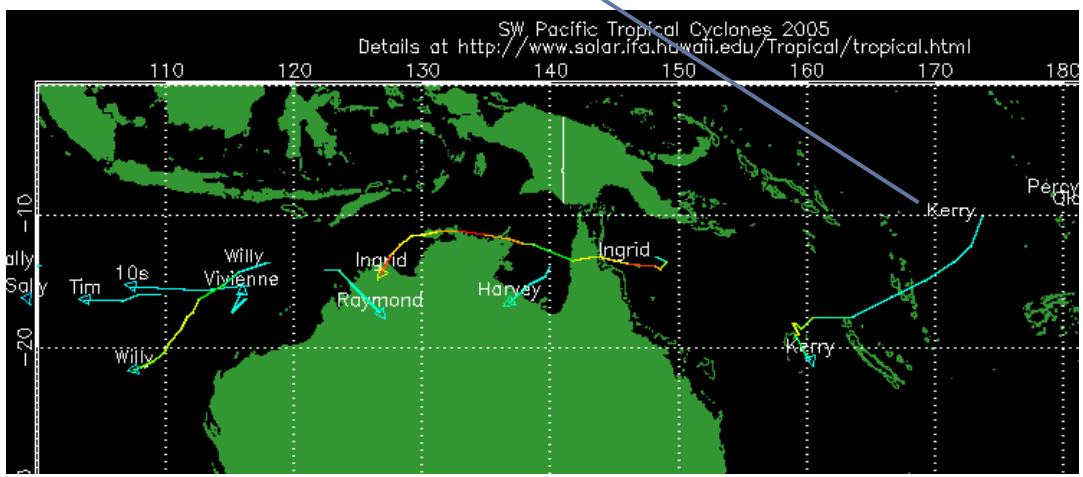

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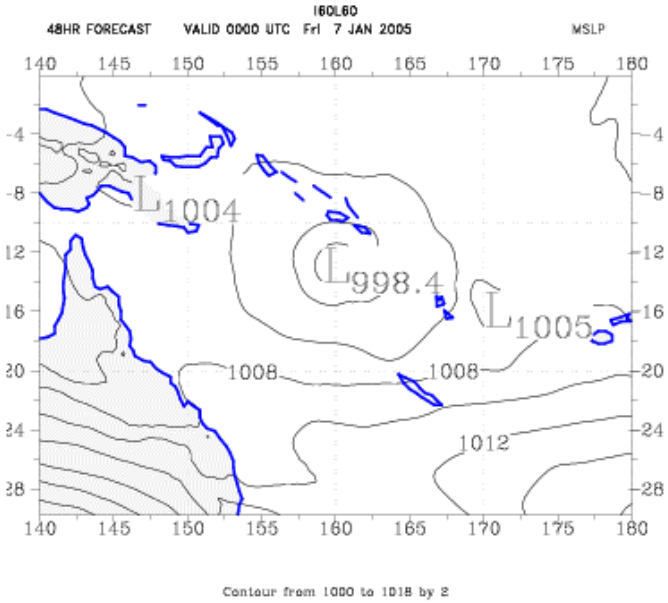

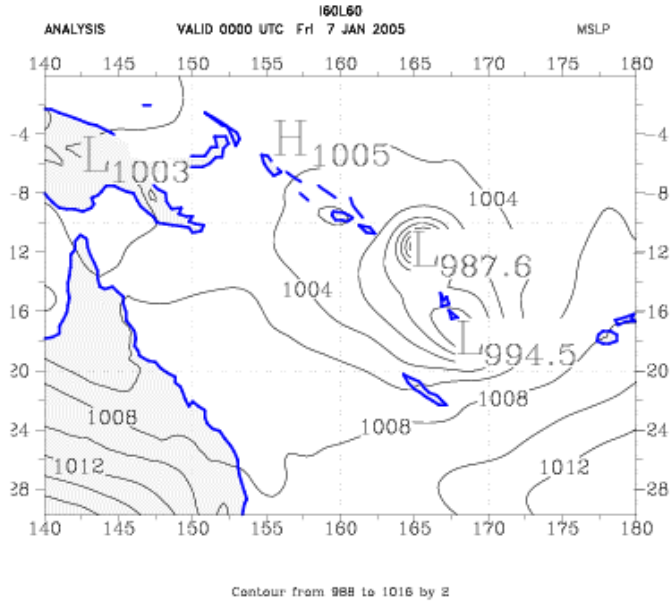

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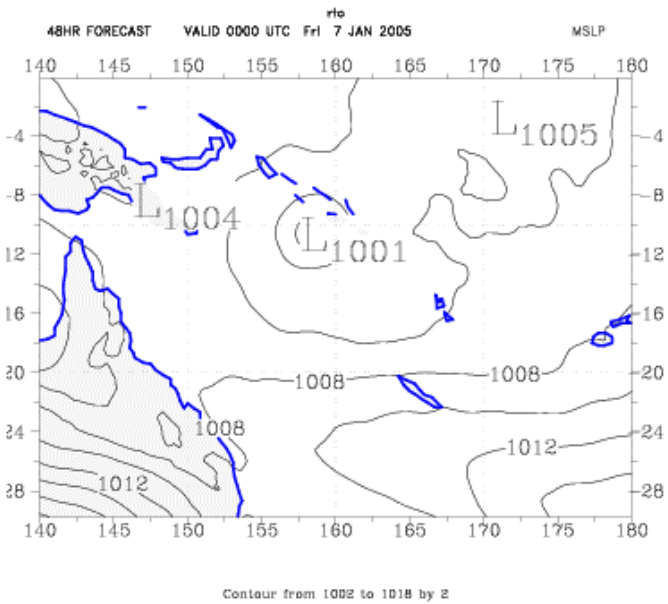

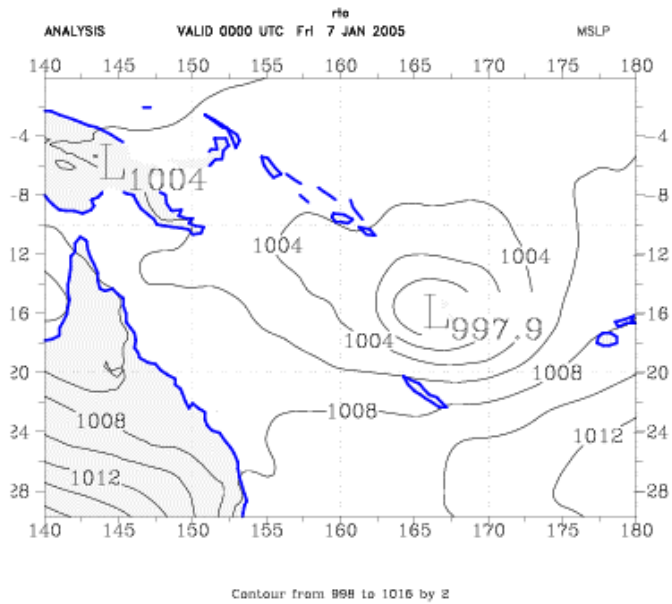

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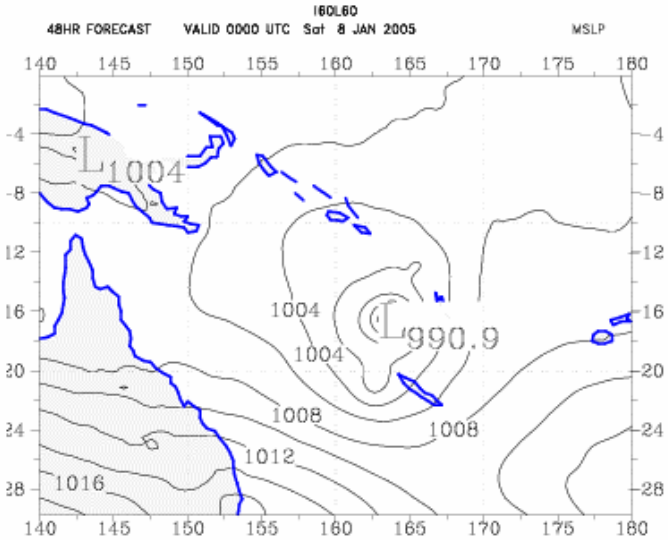

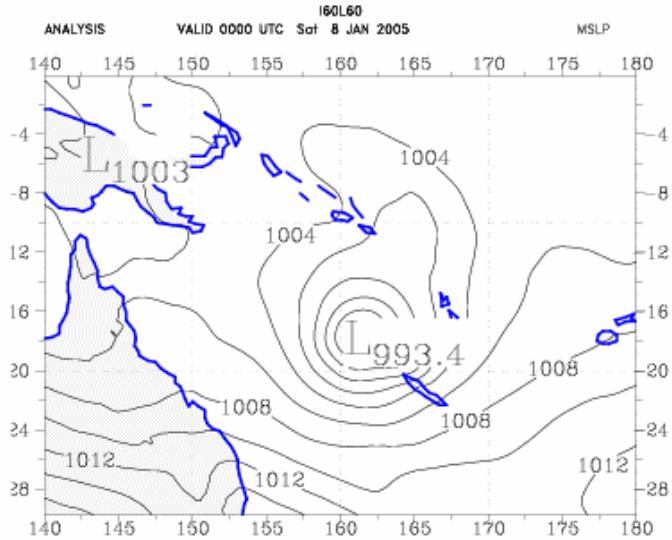

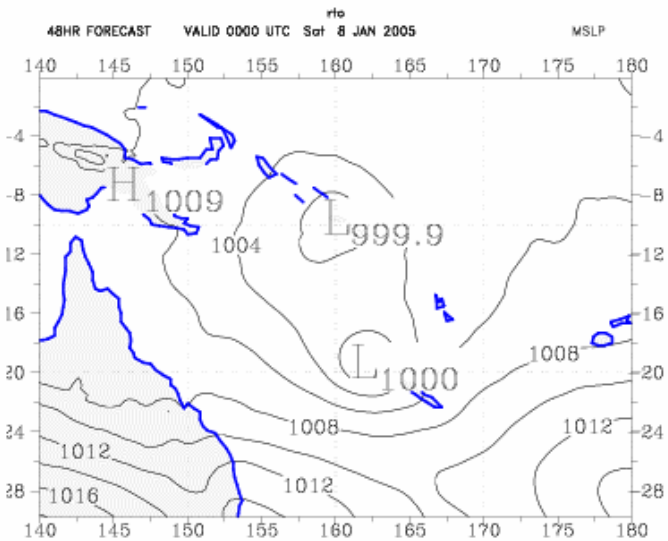

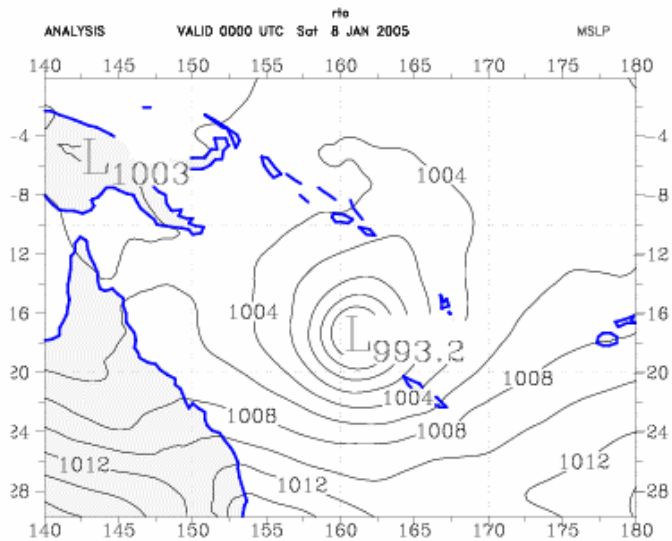

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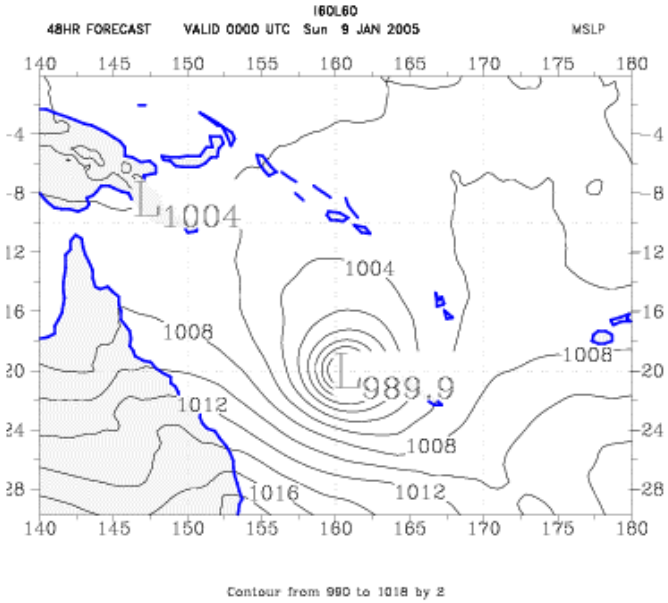

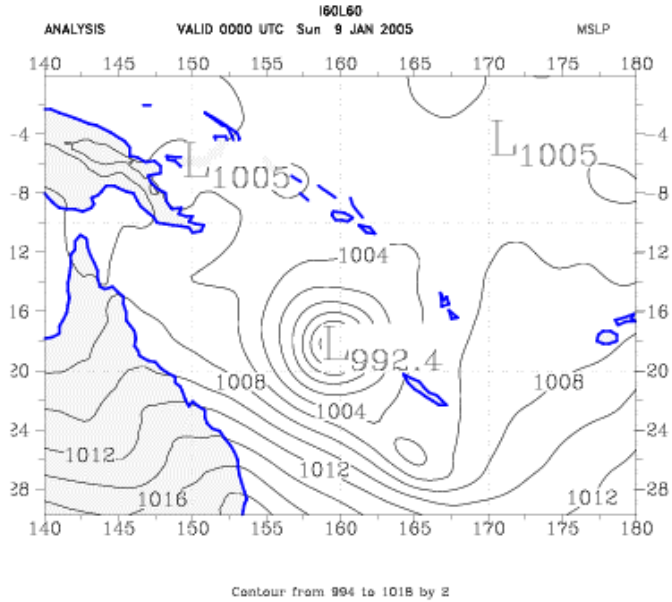

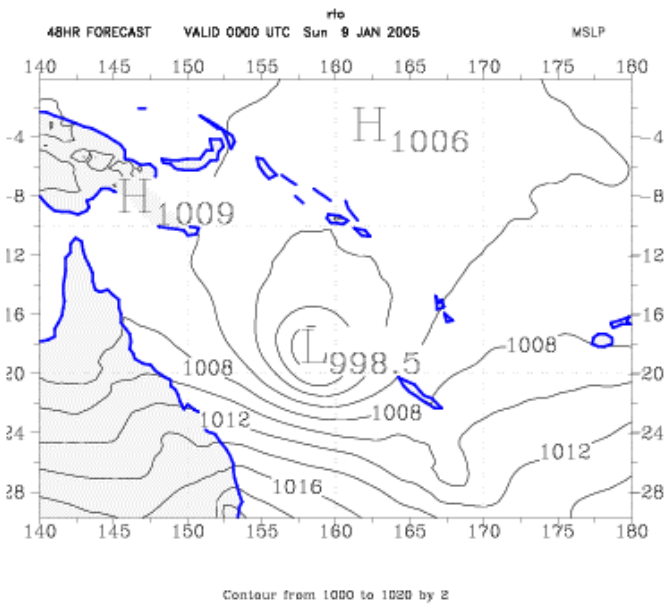

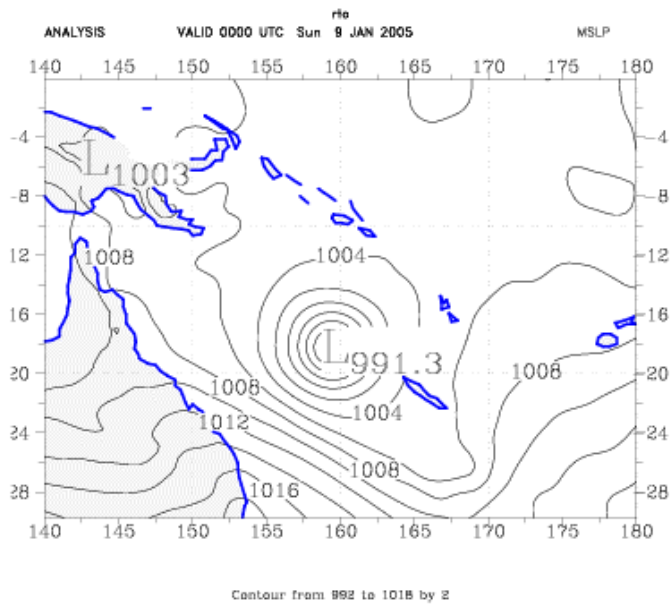

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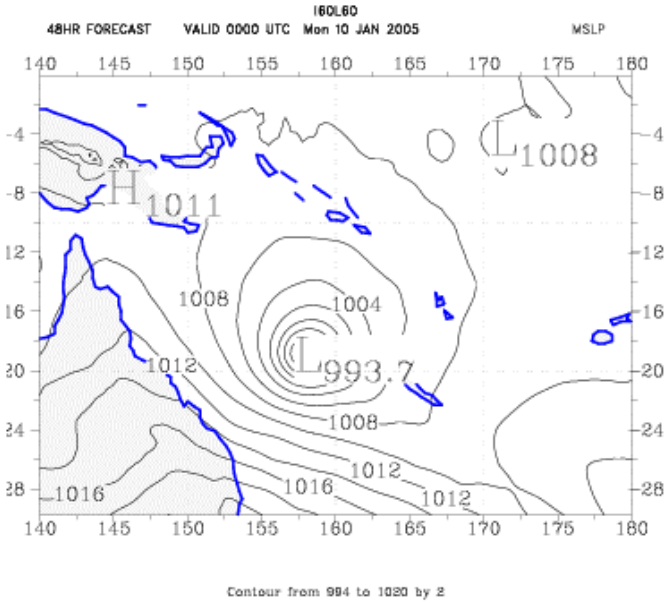

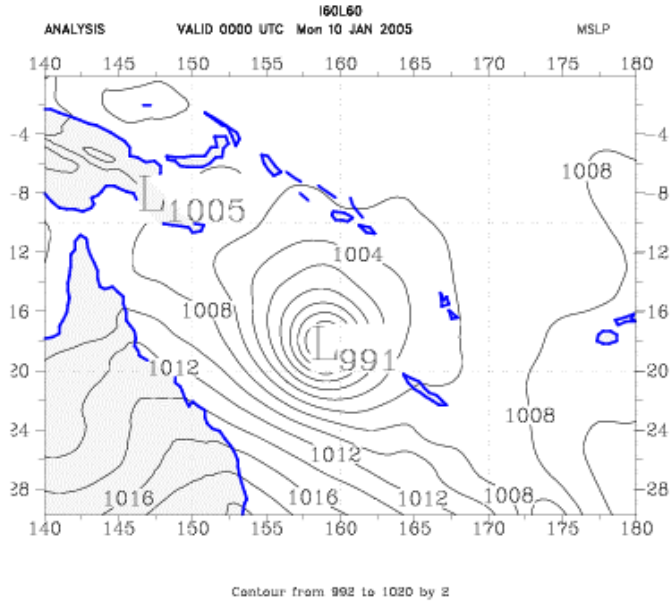

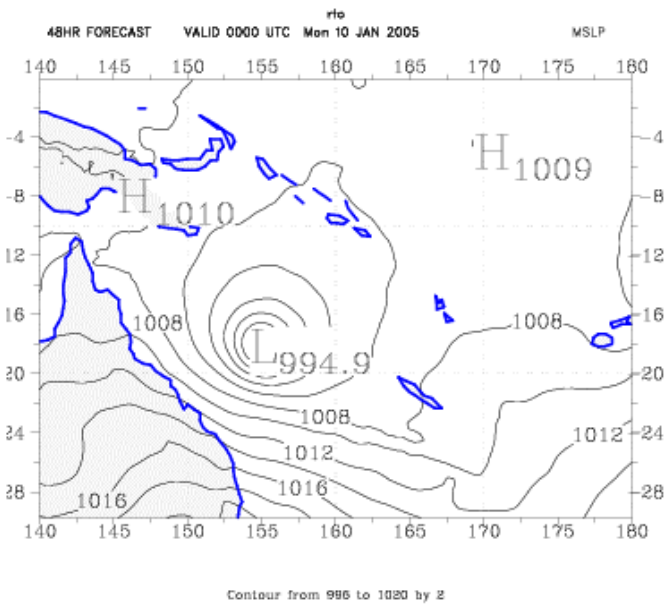

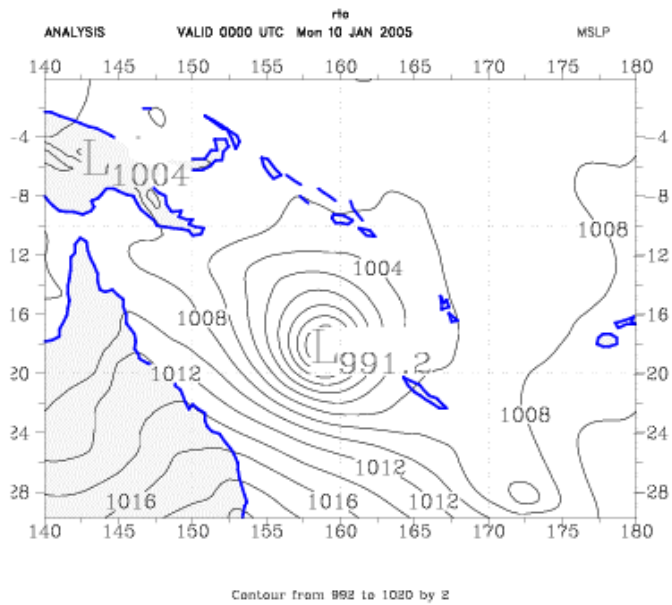

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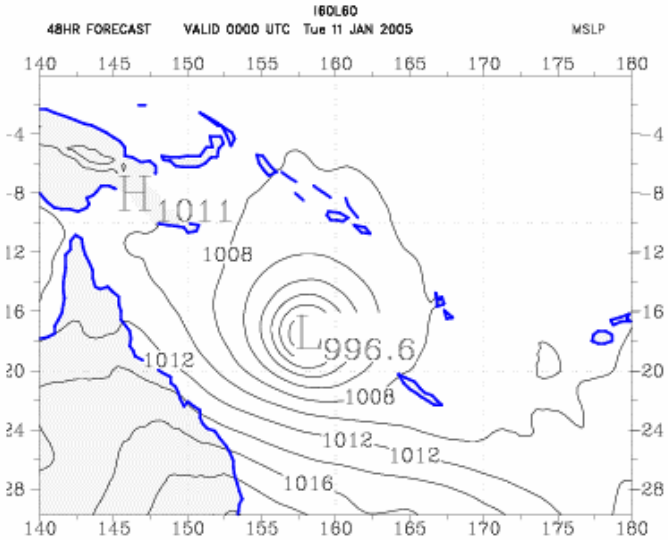

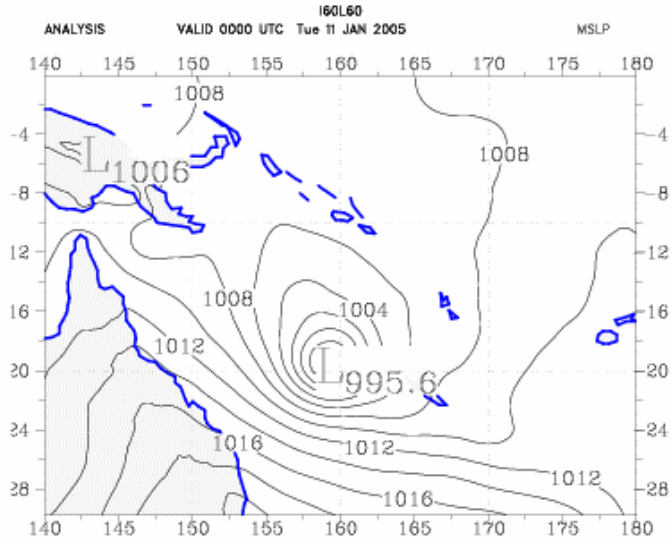

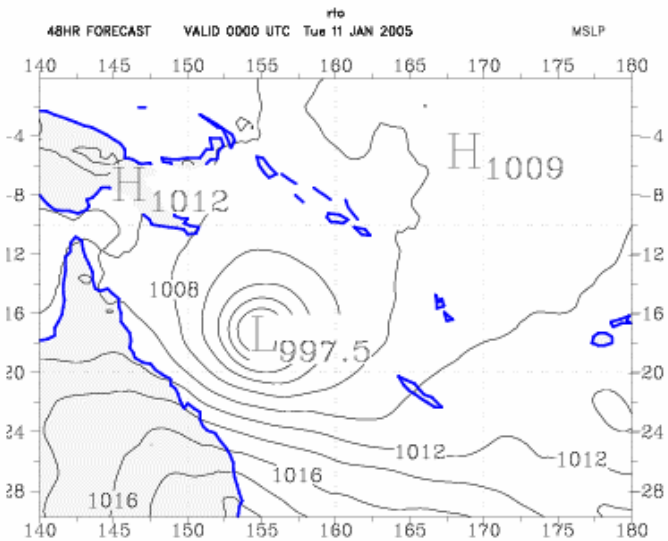

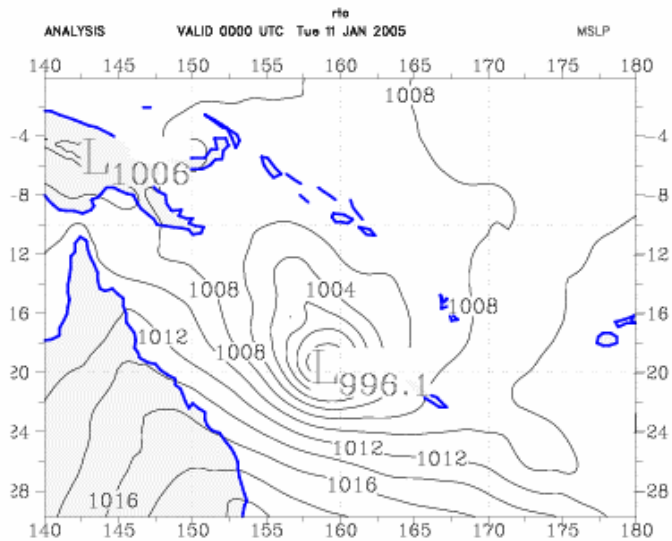

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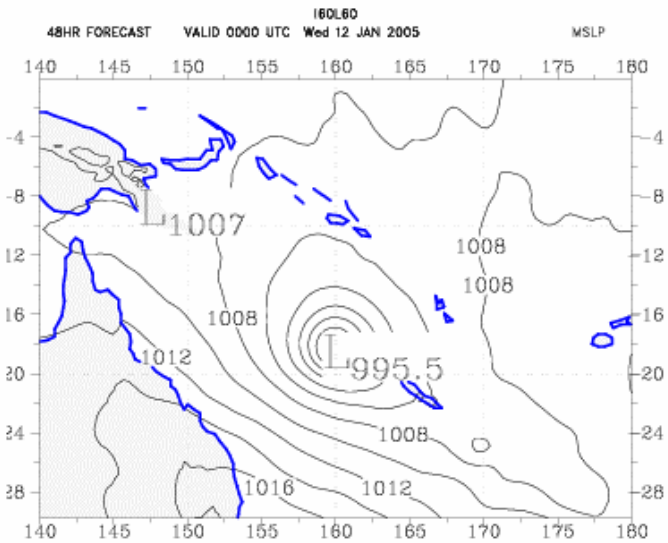

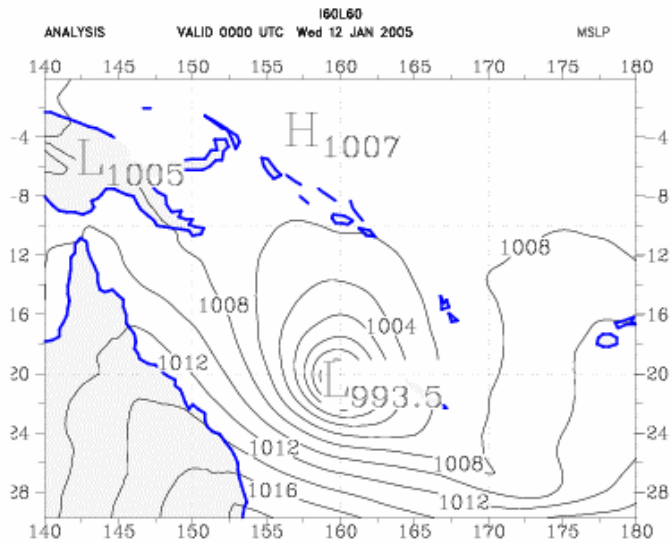

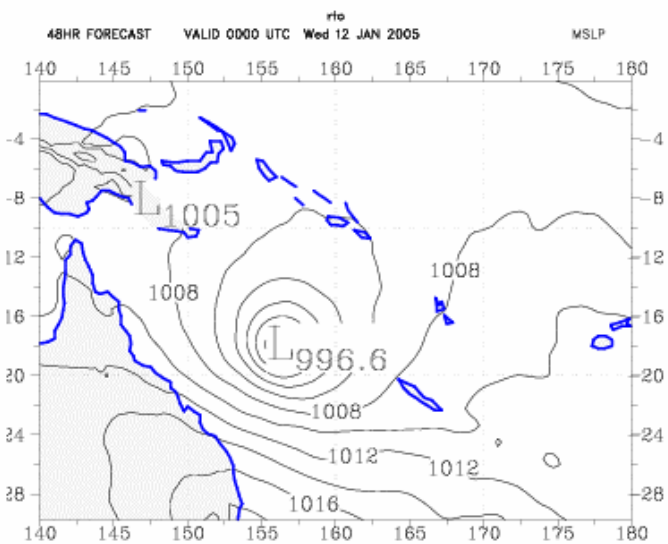

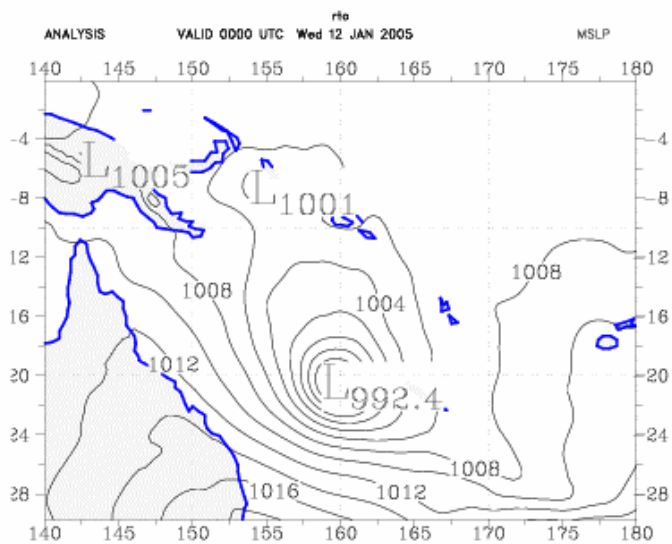

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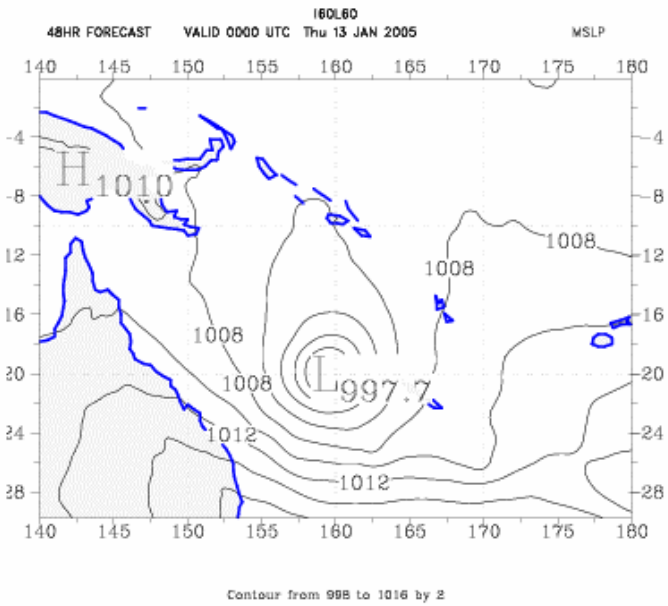

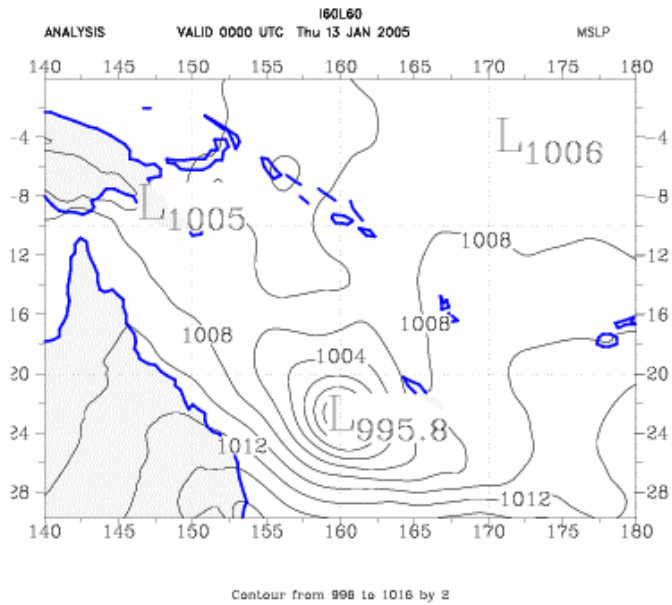

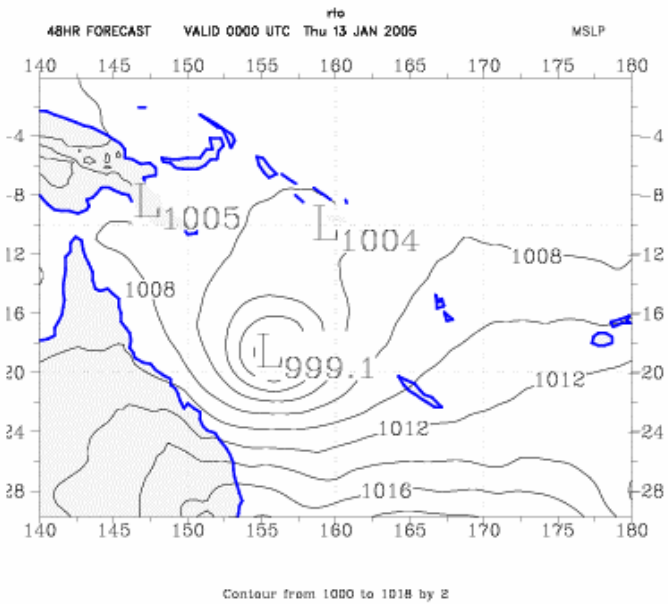

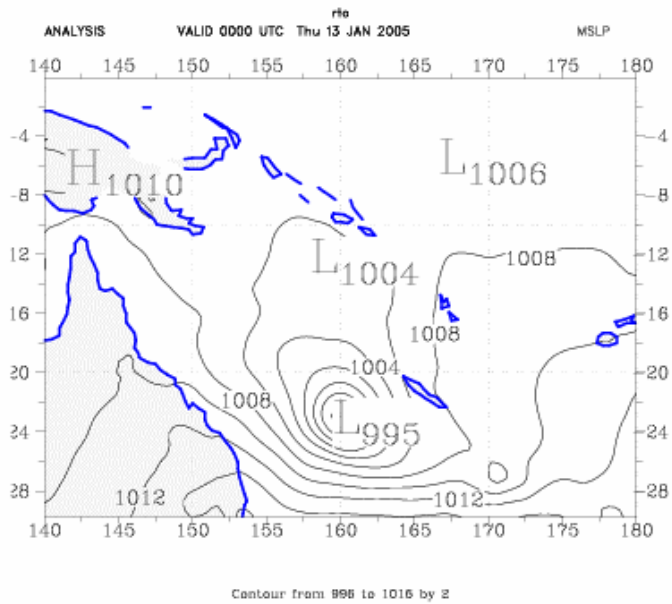

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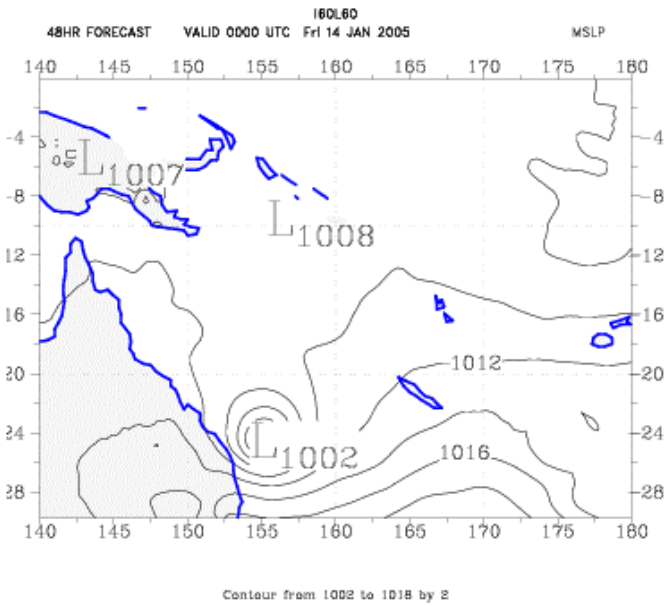

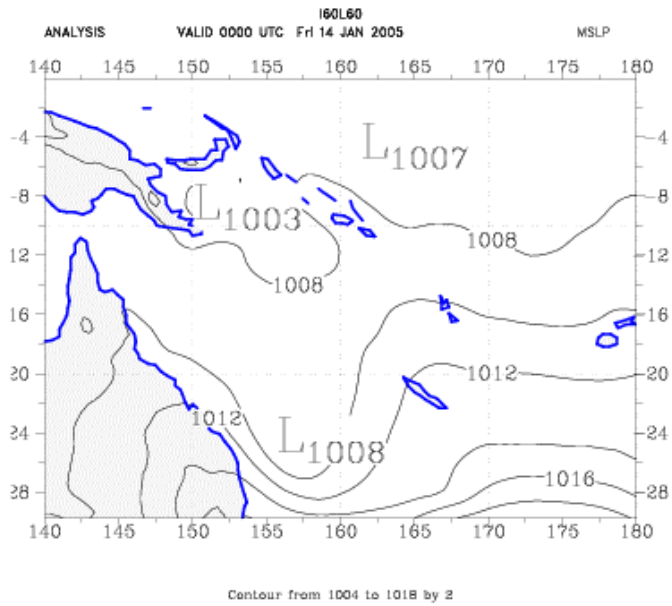

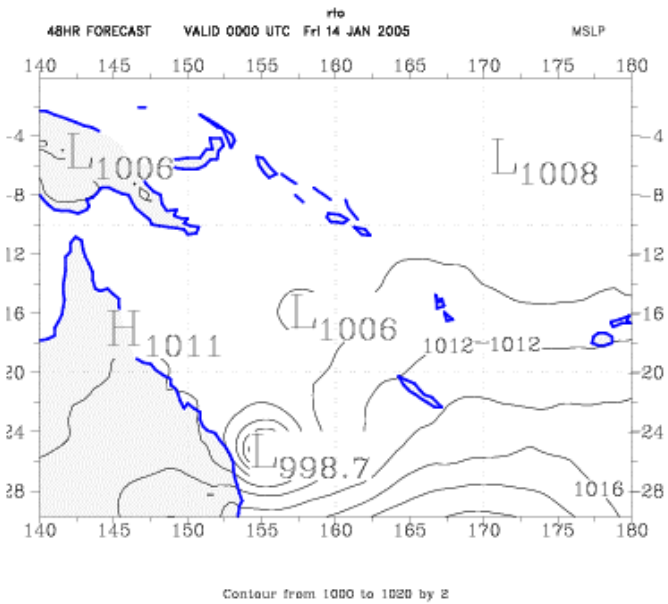

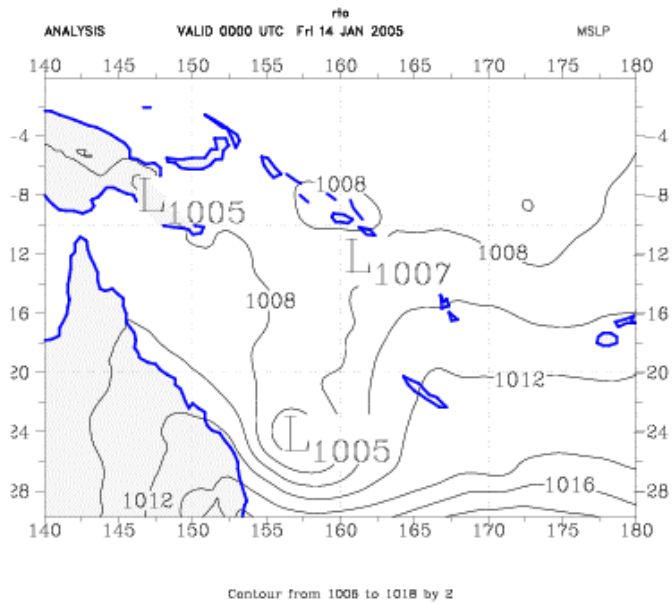

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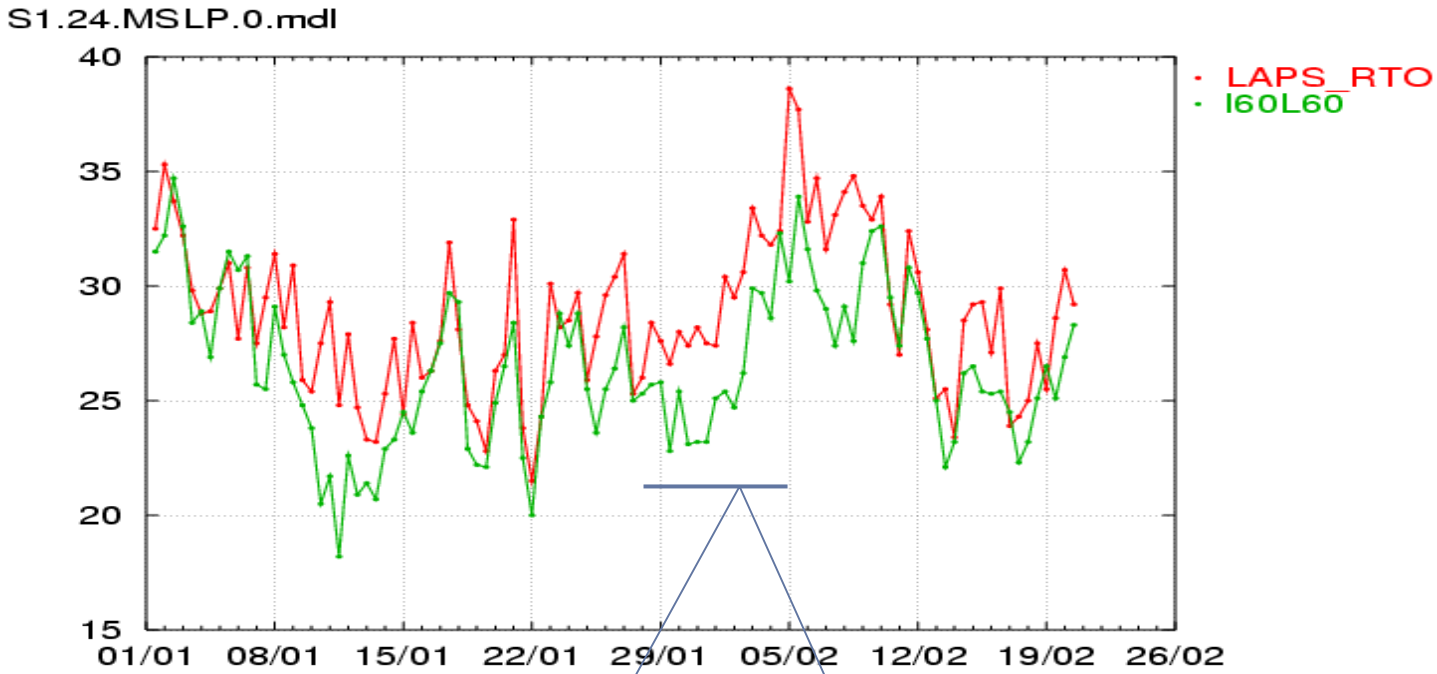

Melbourne floods Feb 3rd 2005

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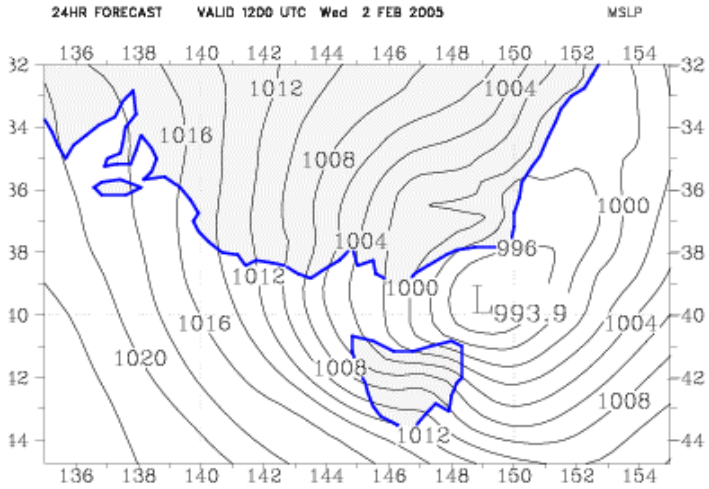

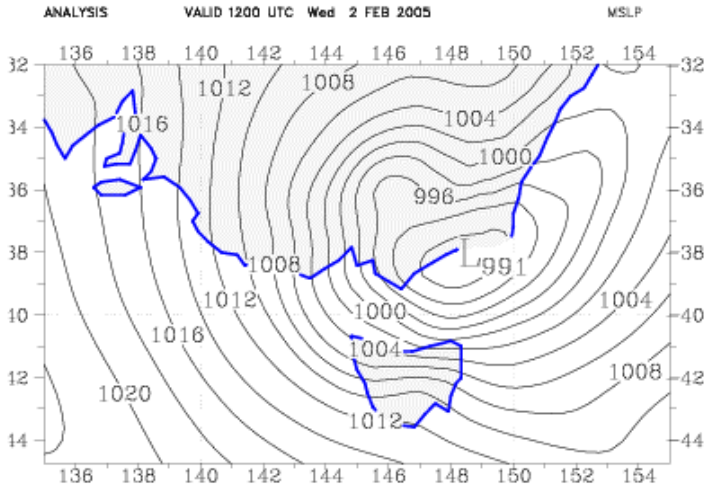

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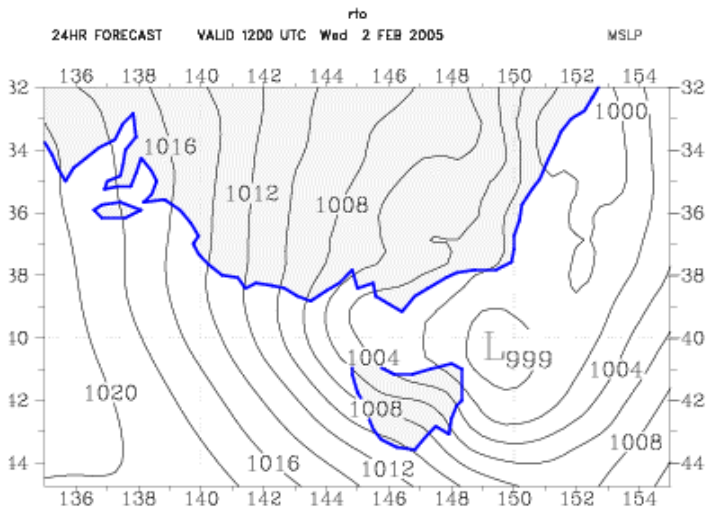

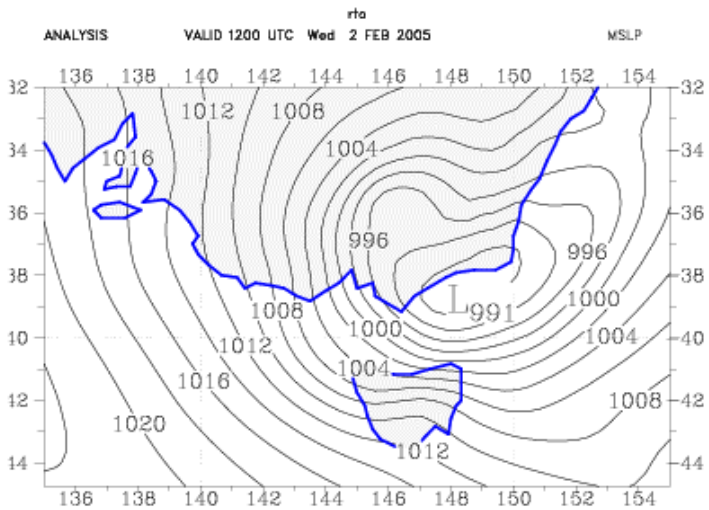

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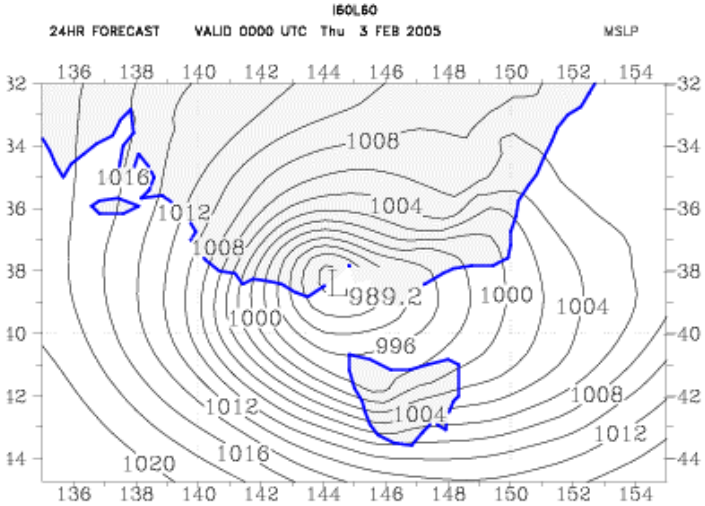
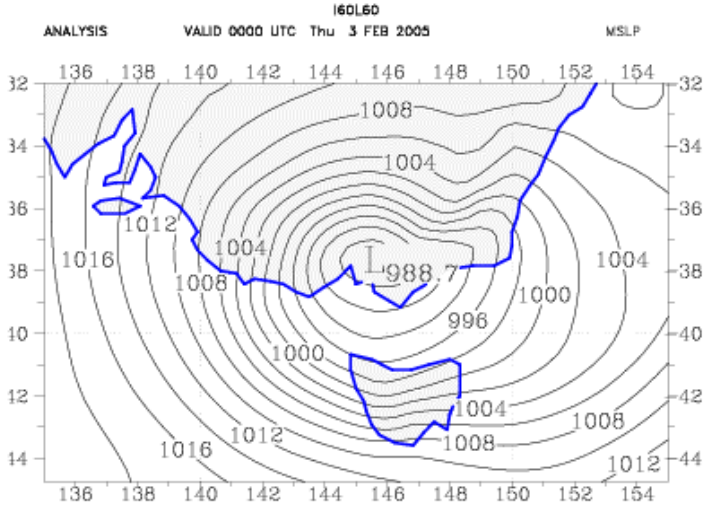


Contour from 990 to 1020 by 2



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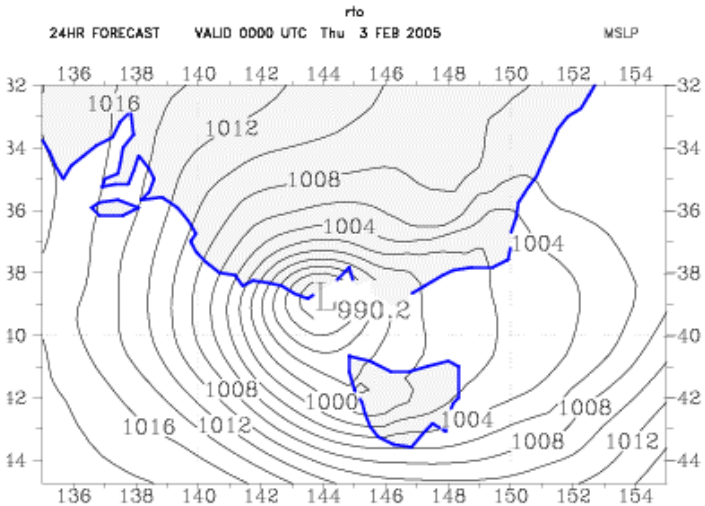

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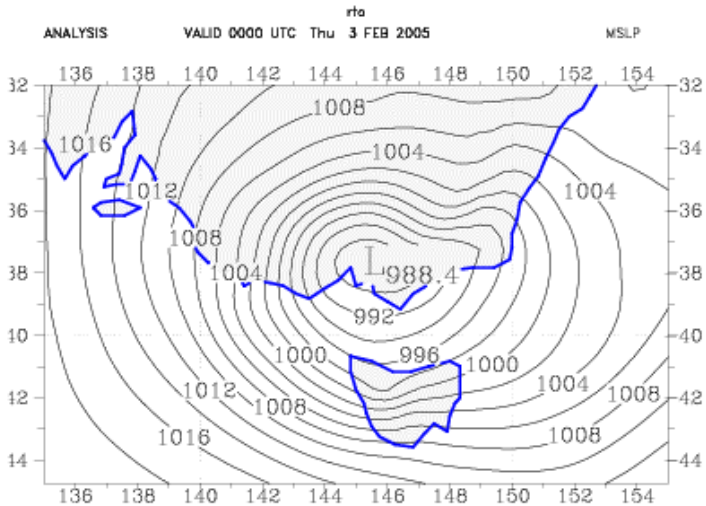

Contour from 990 to 1018 by 2

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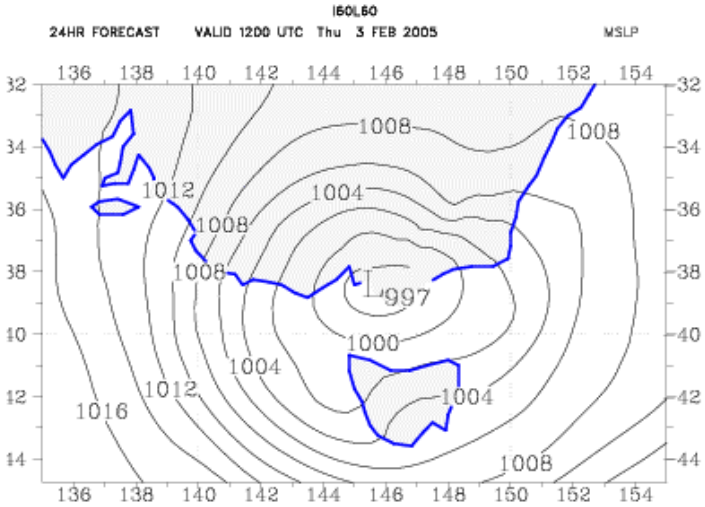

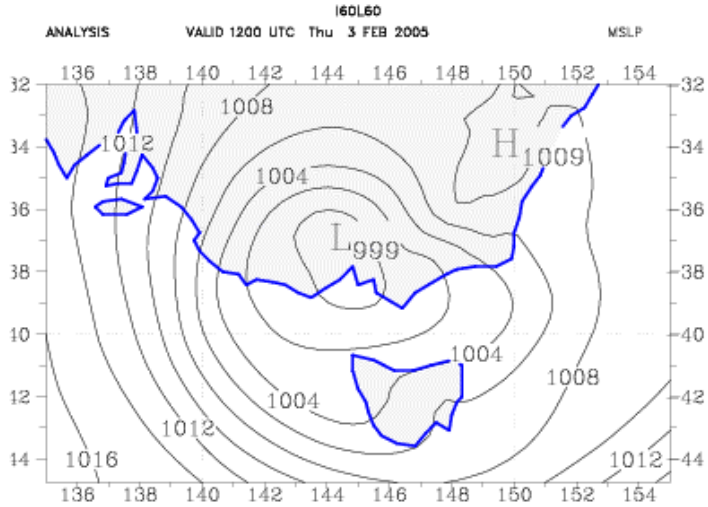

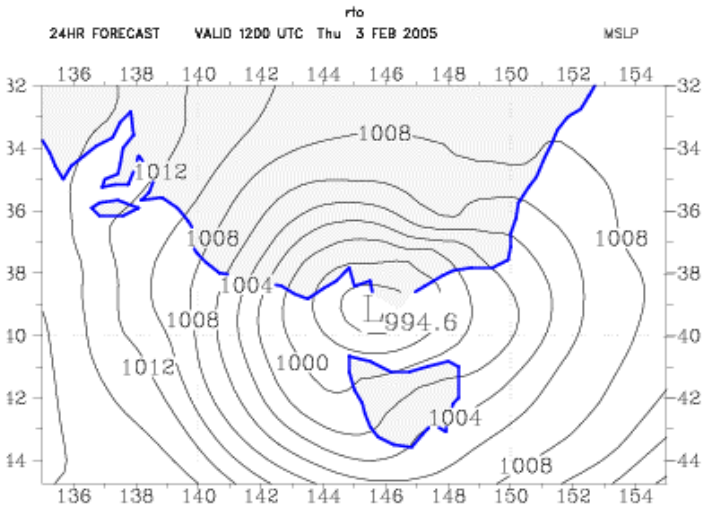

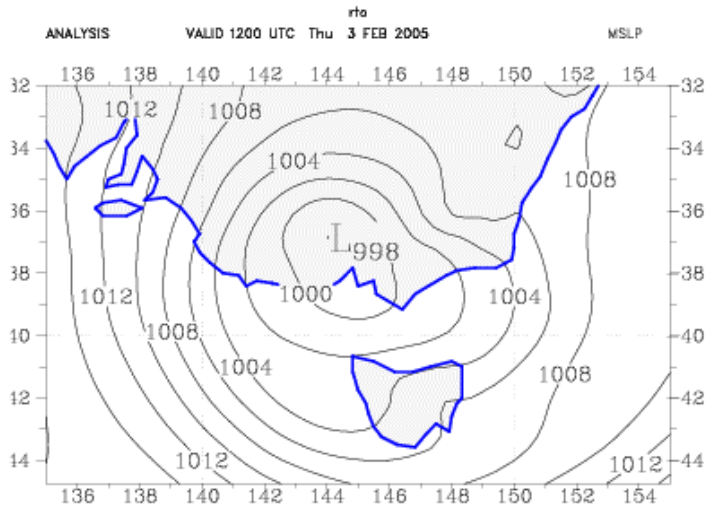

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Conclusions

- Significant improvement in forecast quality from transition to 60 vertical levels in LAPS
- Additional improvement from use of AAPP derived 1D radiances
- Early cut-off may be a less significant issue for final (base date-time) analysis
- Successful assimilation of locally received and processed radiances

Further work

- AMSU-B
- Rainfall forecast verification
- Aqua
- GenSI/3D-VAR
- Mesoscale (10 km) assimilation
  - more frequent (3 hourly) insertions
  - earlier data extraction cut-offs
  $\Rightarrow$ local radiances essential

International TOVS Study Conference, 14th, ITSC-14, Beijing, China, 25-31 May 2005.
Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center,
Cooperative Institute for Meteorological Satellite Studies, 2005.