An Information Based Radiance Data Selection Scheme for Efficient Use of a Multi-Satellite Constellation

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Overview

- The radiance information problem
- Why thin satellite data ?
- Characteristics of satellites in current use
- The atmospheric and surface categorization
- Information based selection
- Further Refinements

The Observed Radiance

- In NWP, the satellite is always right ! (unbiased)
  (assume systematic errors are known)

- We compute $\delta y_i = y_{o,i} - y_i(\underline{x})$
- The forward model must predict the observed radiance as accurately and unbiased as possible

- Observation Space Error Covariance

  $$[\ \mathbf{H^T B H} + \mathbf{F} + \mathbf{O}\ ]$$

- **O** contains the information in $y_{o,i}$
  (in practice **F** + **O**)

Why thin satellite data ?

- “Everyone does it”
- Blacklist – instrument unusable
- Reject – practically unusable (system dep)
- Horizontally correlated (retrievals and remapped radiances)
- NWP length scales or orography
- Unknown correlated error due to **F**
- Thinned in space and time (4DVAR)

AAPP Radiances from the Met Office

- Level-1D ATOVS – HIRS/AMSU-A/B
- HIRS footprint 30km resolution

	HIRS	AMSU-A	AMSU-B
NOAA-15	✗	✓	✗
NOAA-16	✗	✓	✓
NOAA-17	✓	✗	✓
NOAA-18	✗	✓	✓
AQUA	✗	✓	✗
MetOP	✓	✓	✓

L60 GASP

- T239L60 model top at 0.1 hPa
- AAPP derived ATOVS radiances
- 1DVAR retrievals up to 0.4 hPa
- Thinned to 250km prior to 1DVAR
- RTTOV profiles from background 6hr guess
- NOAA-15, 16, 17, 18, AQUA and MetOp

Information Based Thinning Scheme

- Thinning done prior to 1DVAR
- Only one call to forward model (RTTOV-7)
- Around ~760,000 radiance profiles per 6h
- About 4 x 175,000 level-1D ATOVS
  [NOAA-15](NOAA-16, 17, 18)[MetOp]
- About 60,000 level-1C AQUA/AMSU-A
- 30% gain in total run-time with no loss of forecast skill

Atmosphere and Surface Categories

Surface

- Model – Sea (SST), Sea-Ice, Land Mask
- Grody AMSU-A Ch 1, 2, 3, 15 (if avail)
  - Sea (S), Sea-Ice (I), Land (L)

Atmosphere

- Use (o – b) > –2K check on HIRS Ch-8 (C)
- AMSU-A – liquid water path < 0.3 and
  AMSU-B Ch 2 | o – b | < 5K (P)
- Else high LWP and ice (No AMSU-B) (Cl)

Ranking by Information Content

- Eliminate unusable combinations
- If HIRS available and clear (C) always choose before AMSU only
- If no HIRS or IR-cloudy, choose AMSU-A and B if possible (P)
- Else only AMSU-A and no Ch-4,5 if highly contaminated

Information Ranking

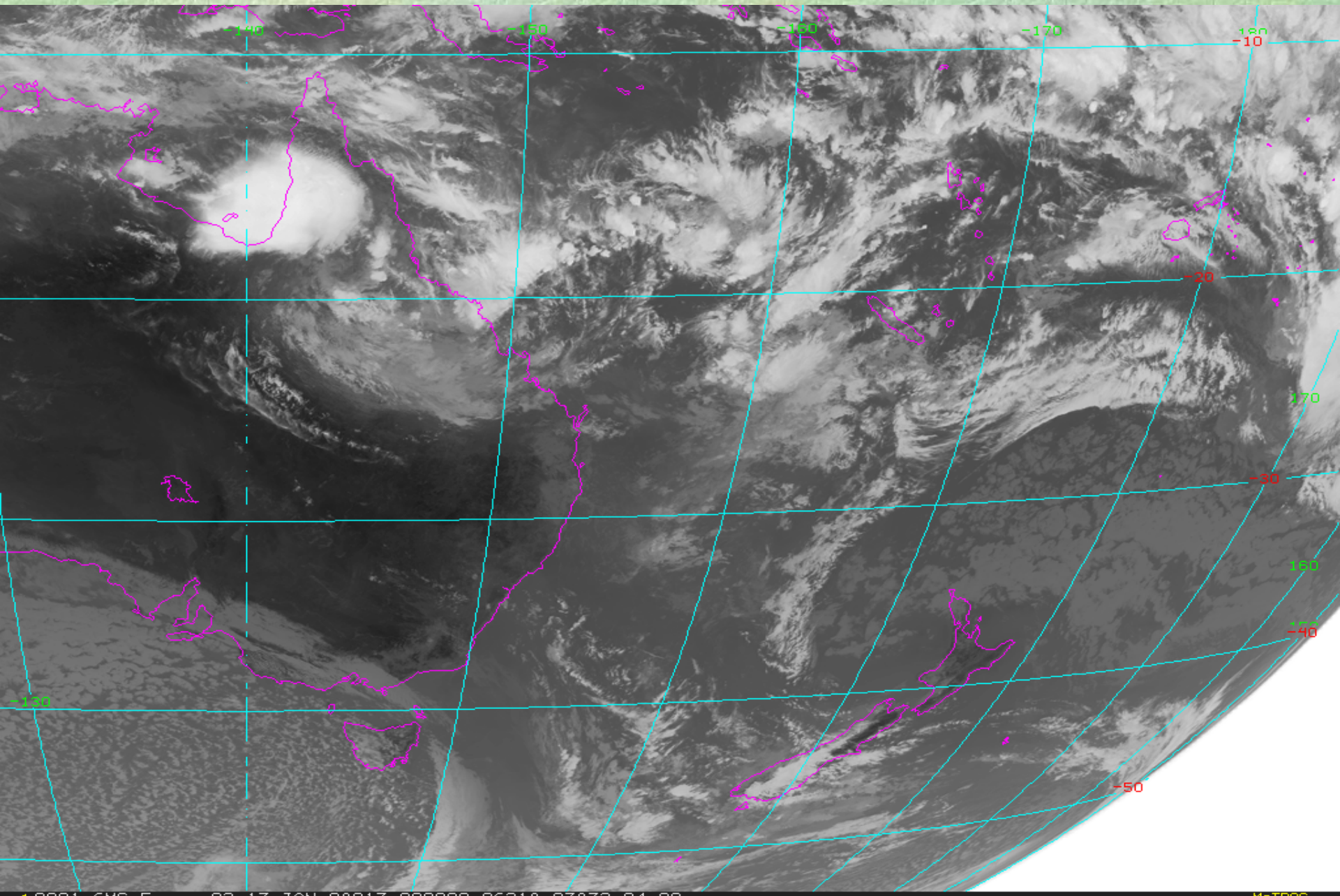
Satellite x [Weather(C,P,Cl) , Surface(S,I,L)]

	CS	PS	ClS	CI	PI	ClI	CL	PL	ClL
NOAA-15	X	X	10	X	X	20	X	X	29
NOAA-16	X	5	9	X	15	19	X	24	28
NOAA-17	2	X	X	12	X	X	X	X	X
NOAA-18	X	4	8	X	14	18	X	23	27
AQUA	X	X	6	X	X	16	X	X	26
MetOp	1	3	7	11	13	17	21	22	25

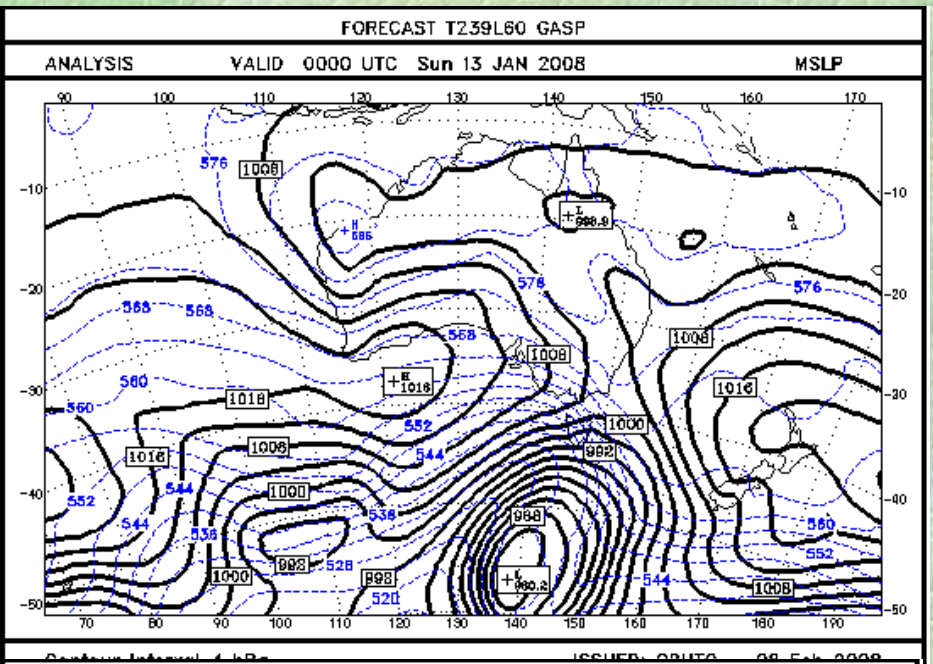
Effect of Inclusion of MetOp In GASP

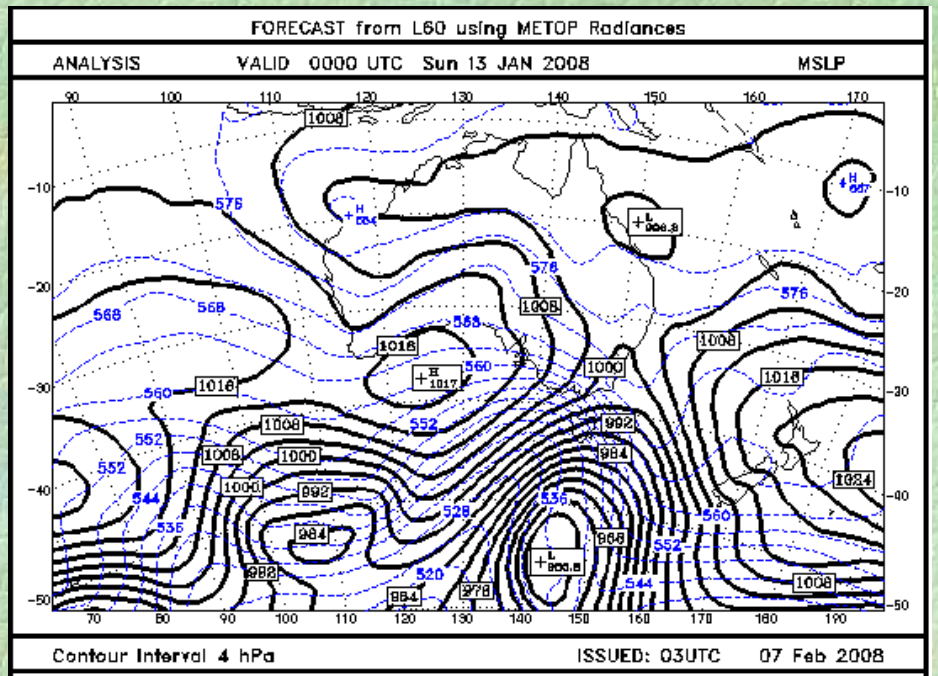
- Global Analysis at 00Z on 13 January 2008
- Operational GASP – NOAA-16, 17,18 and AQUA/AMSU-A
- Test Suite GASP – addition of MetOp
- Marked difference in 5 day (120hr) forecast over Tasman Sea and New Caledonia

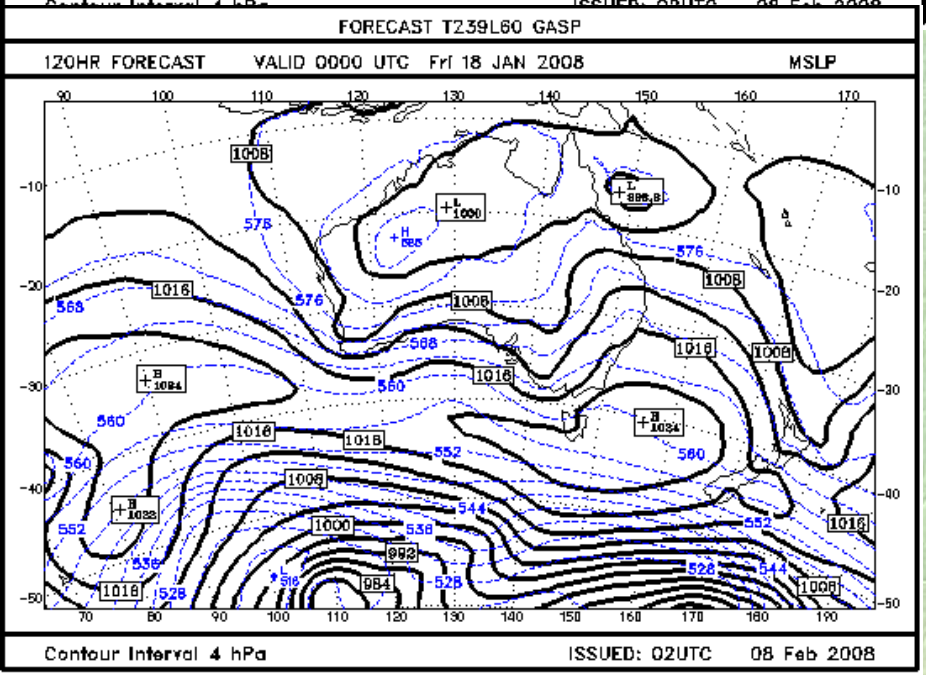
IR GMS Image at 00Z, 13 Jan 08

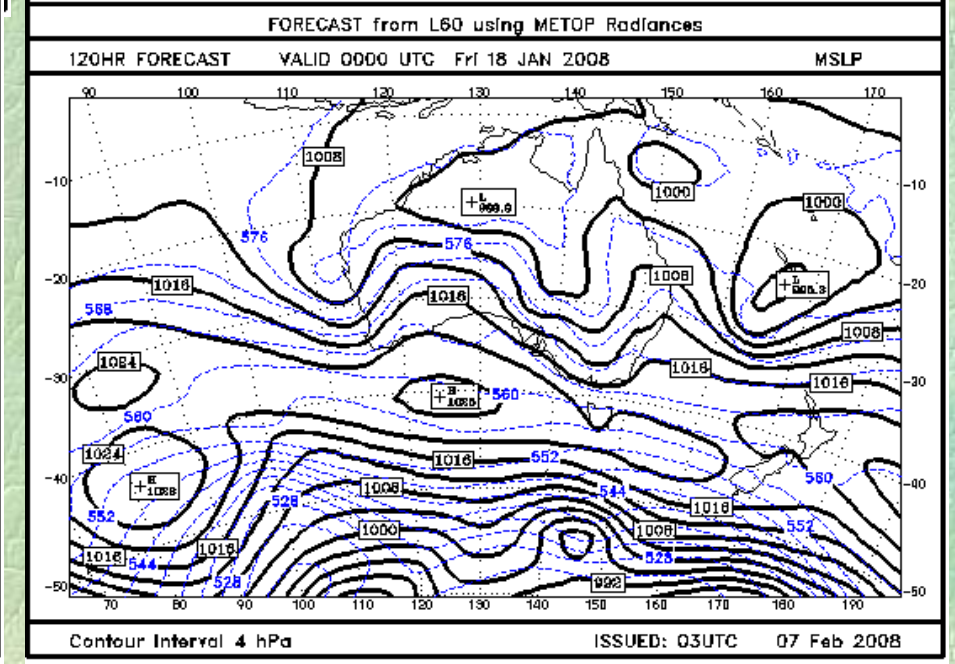


Analyses and Forecasts 00Z on 18 Jan 2008.

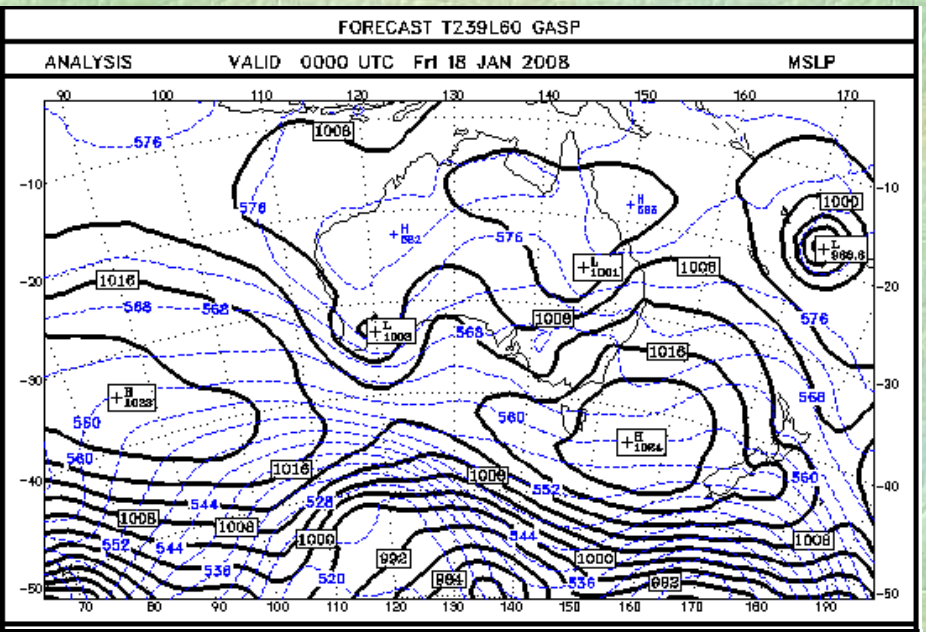


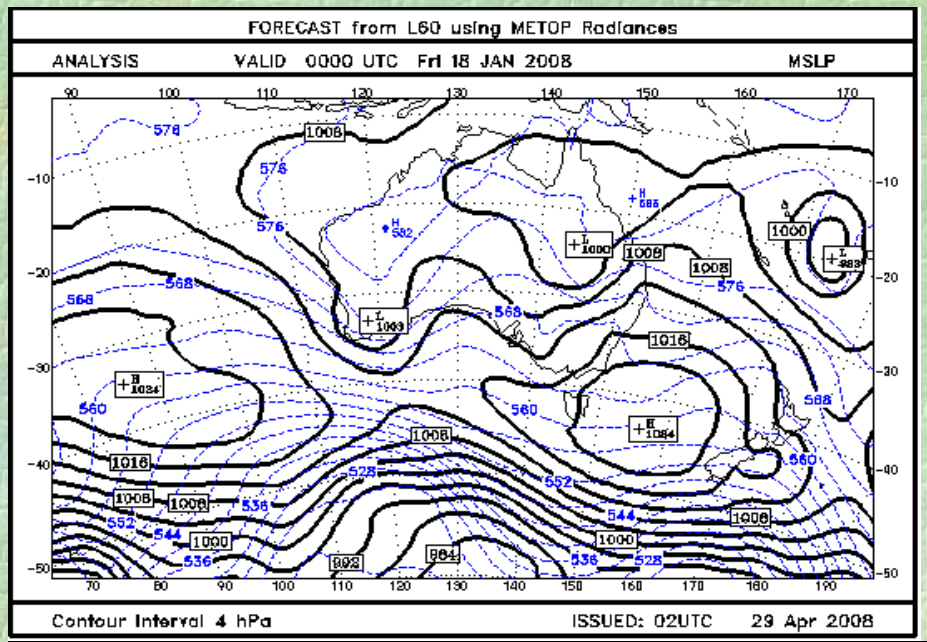


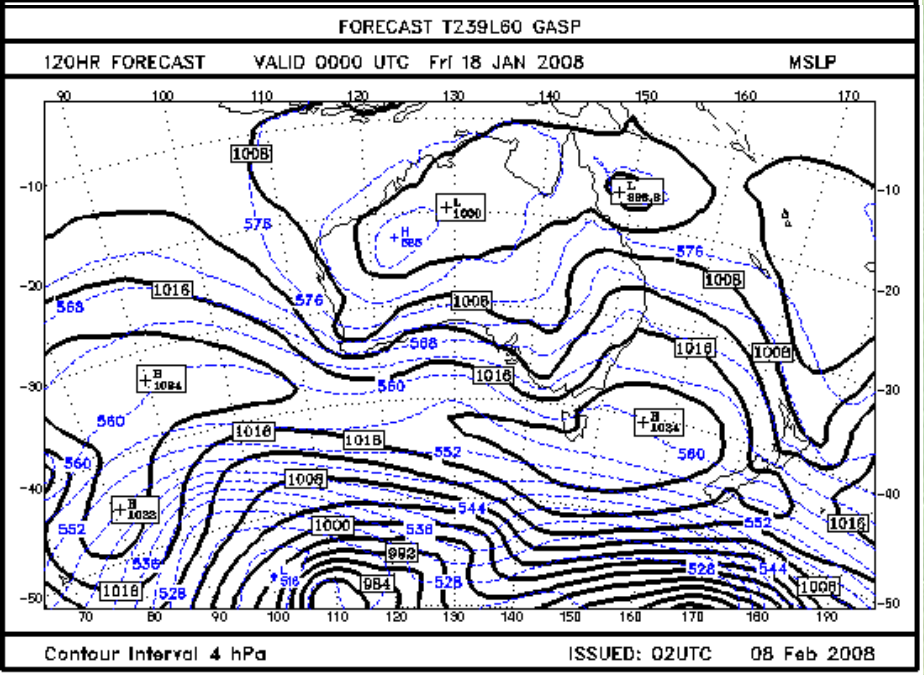


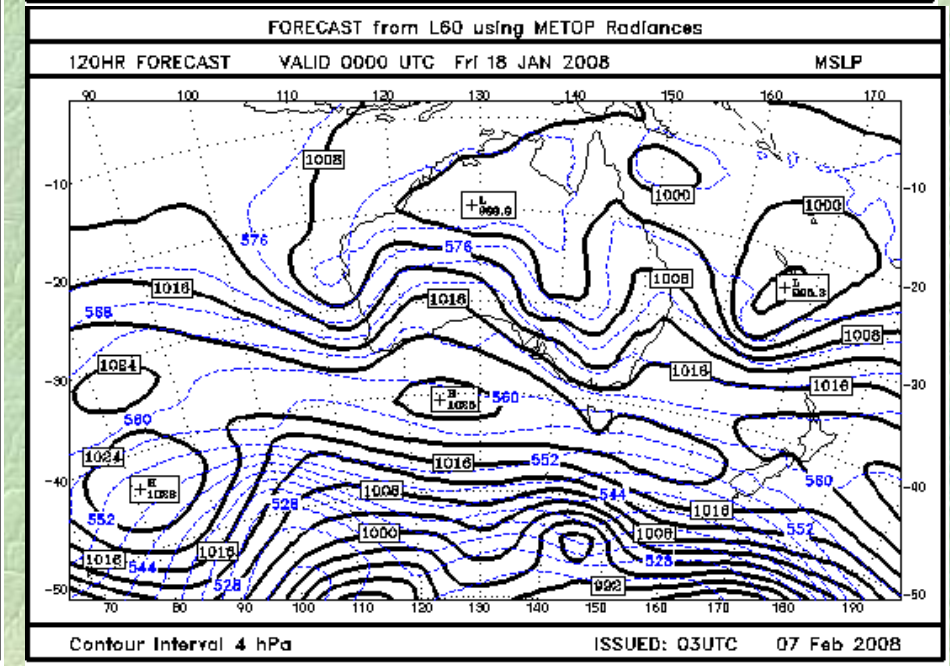


18 Jan 2008 – 00Z

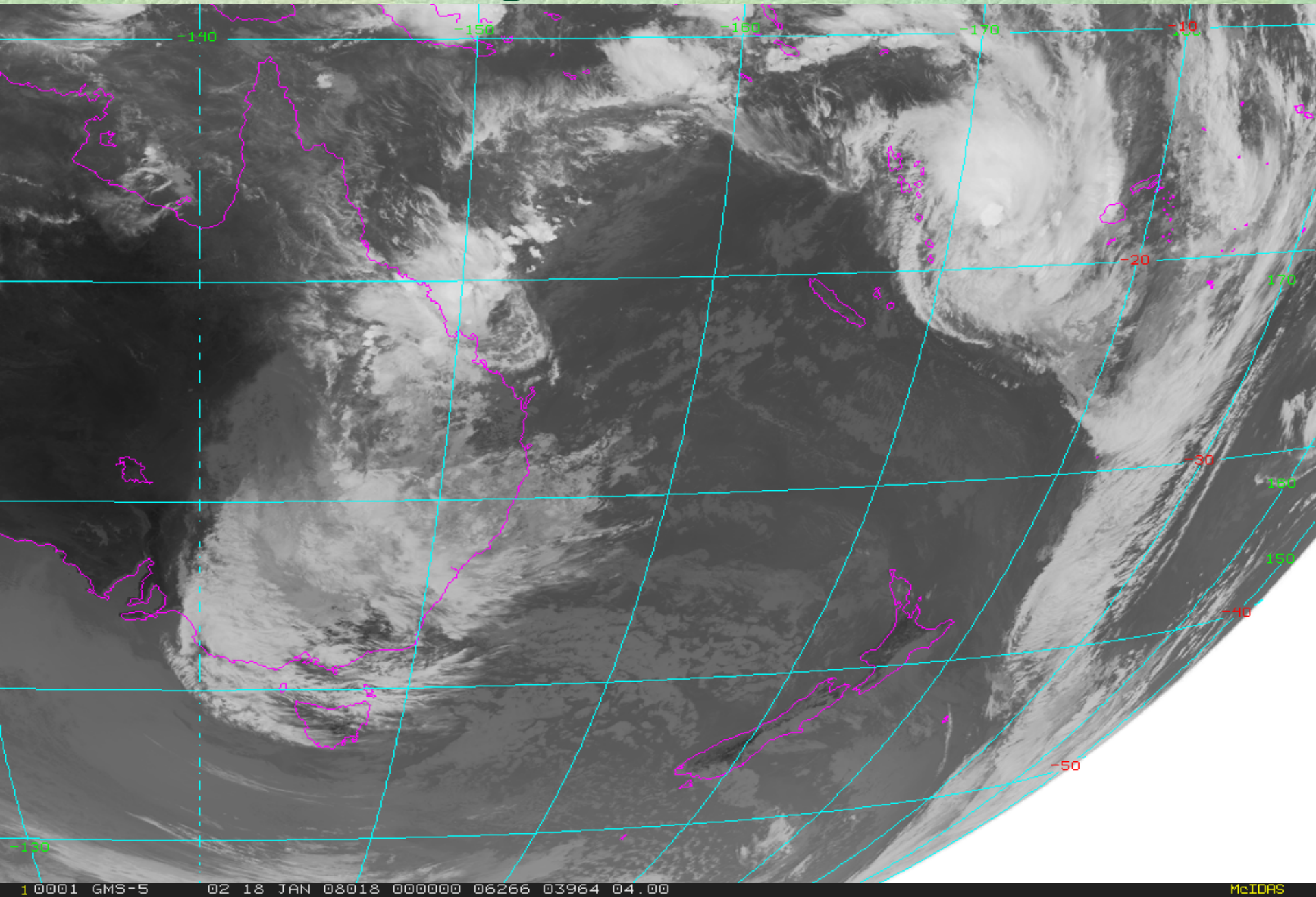








IR GMS Image at 00Z, 18 Jan 08



Further Refinements

- Relaxation of spatial thinning if sufficiently separated in time (4DVAR)
- Remove unnecessary coupling of different sensors by remapping – decouple IR from MW, perhaps remap AMSU-A to AMSU-B/MHS
- Online information content sorting (PC's)
- Assimilate PC's for hyperspectral sounders
- Better forward models and very careful rexamination of bias correction (**F**)

Conclusion

- Its all about information, information, information!!!!