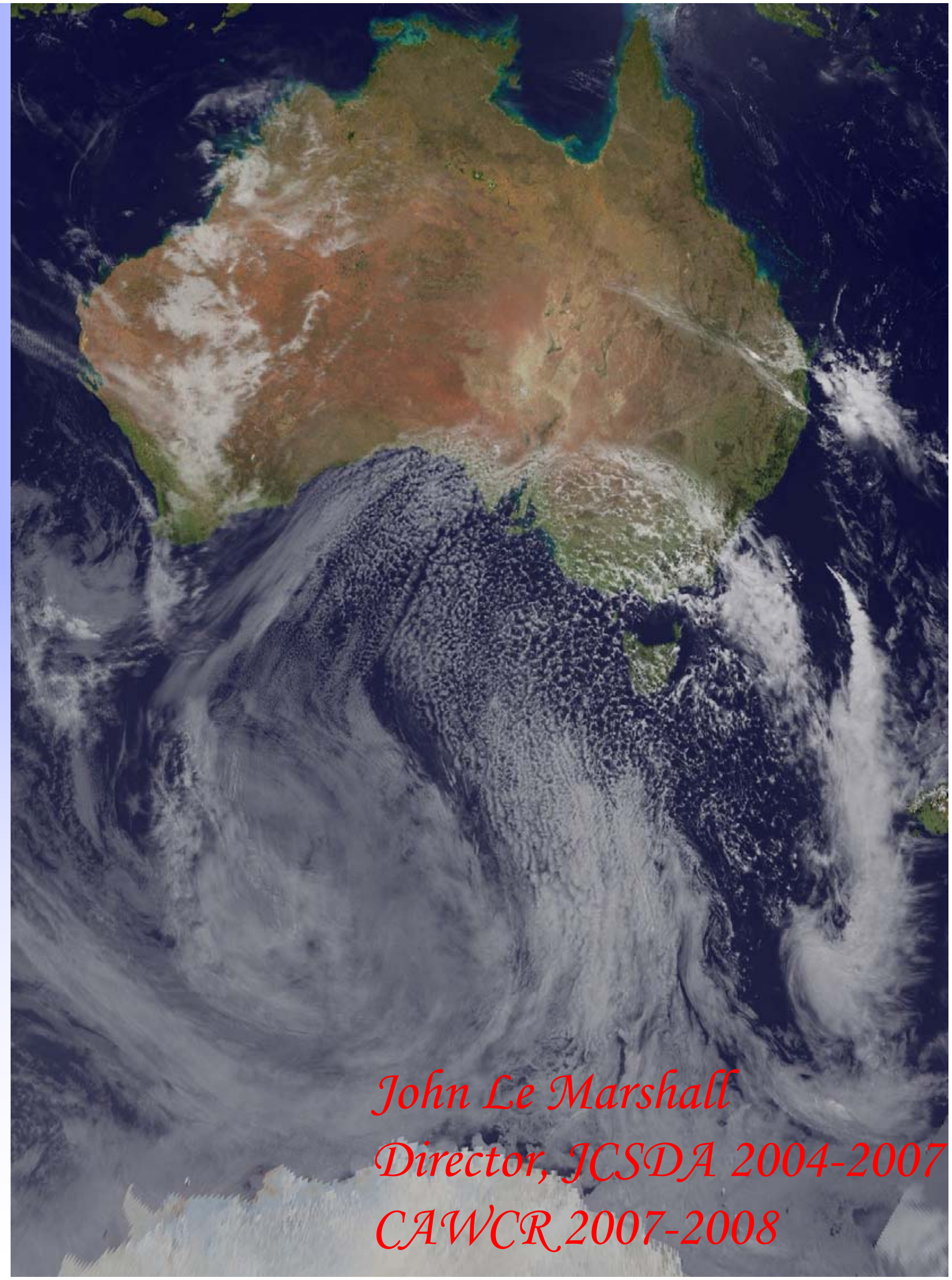
# The Contribution of Locally Generated MTSat-1R Atmospheric Motion Vectors to Operational Meteorology in the Australian Region

Australian Government
Bureau of Meteorology



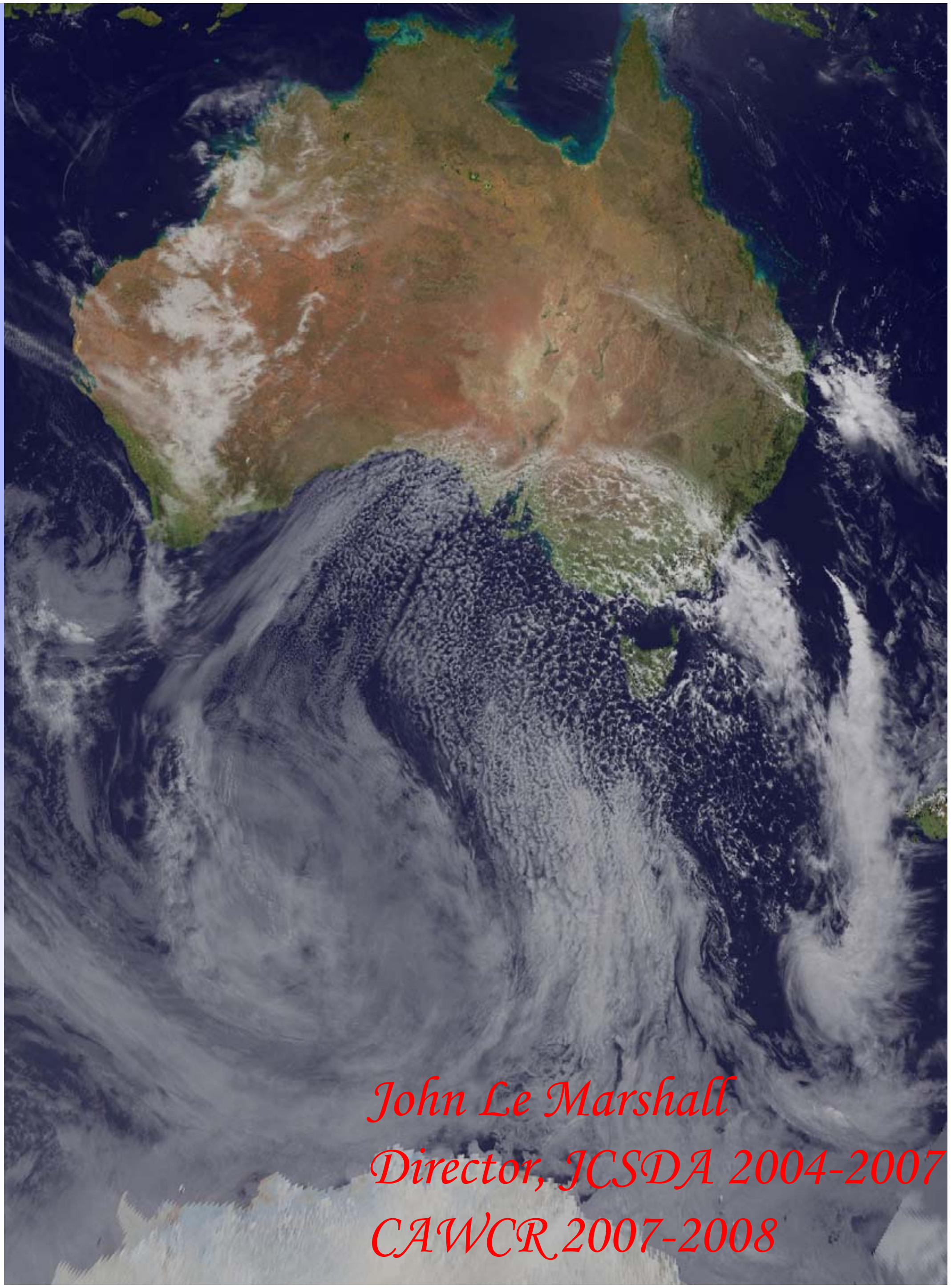
*John Le Marshall*
*Director, JCSDA 2004-2007*
*CAWCR 2007-2008*

Australian Government
Bureau of Meteorology

**J. Le Marshall, R. Seecamp, M. Dunn, C. Velden , S. Wanzong, J. Jung, K. Puri, R. Bowen, A. Rea, Y. Xiao, P. Steinle, H. Sims and T. Le**
***CAWCR, Bureau of Meteorology, Australia***

***Physics Dept., Latrobe University, Australia***

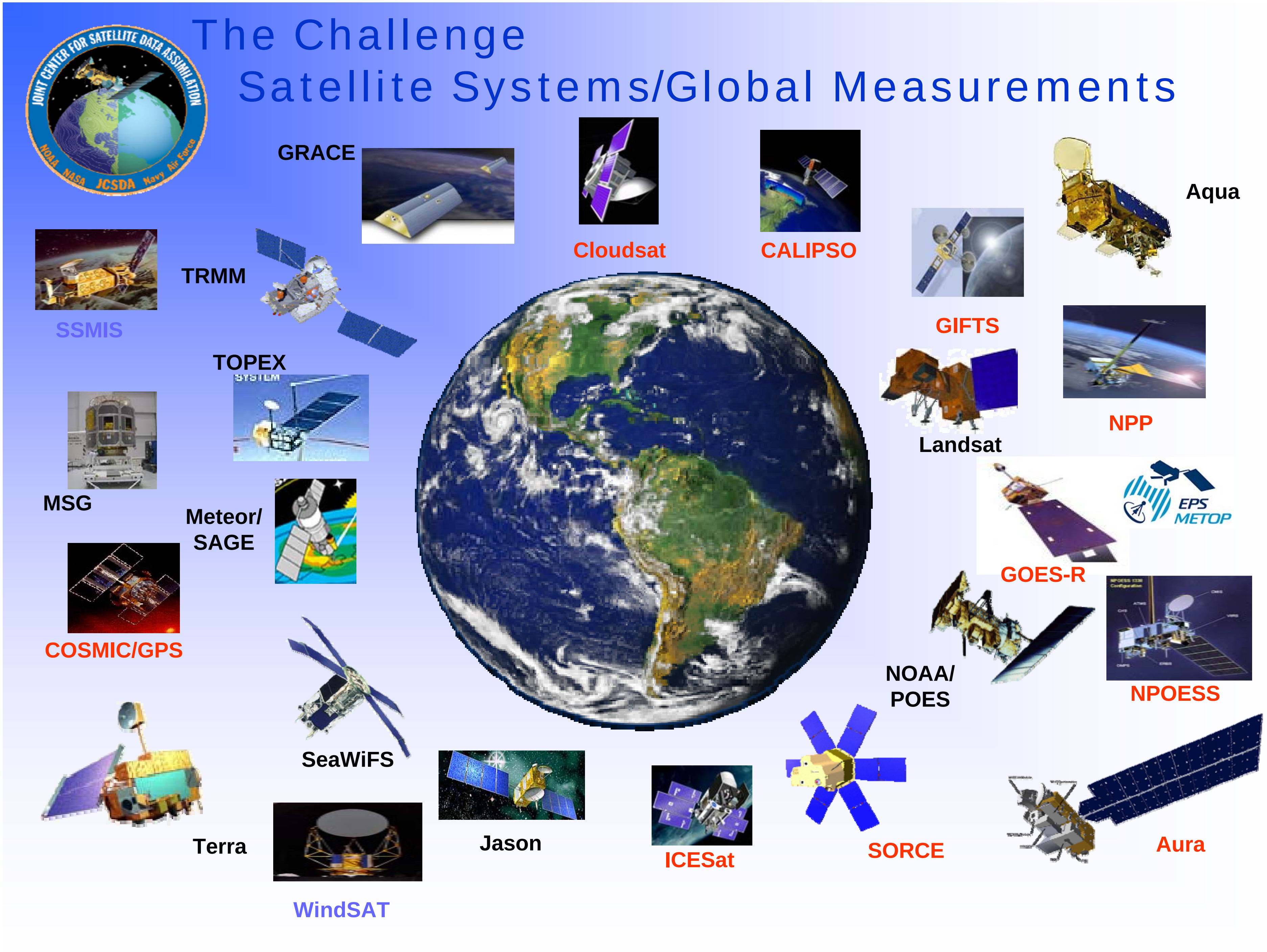
***CIMSS, University of Wisconsin, Madison, Wisconsin***



*John Le Marshall*
*Director, JCSDA 2004-2007*
*CAWCR 2007-2008*

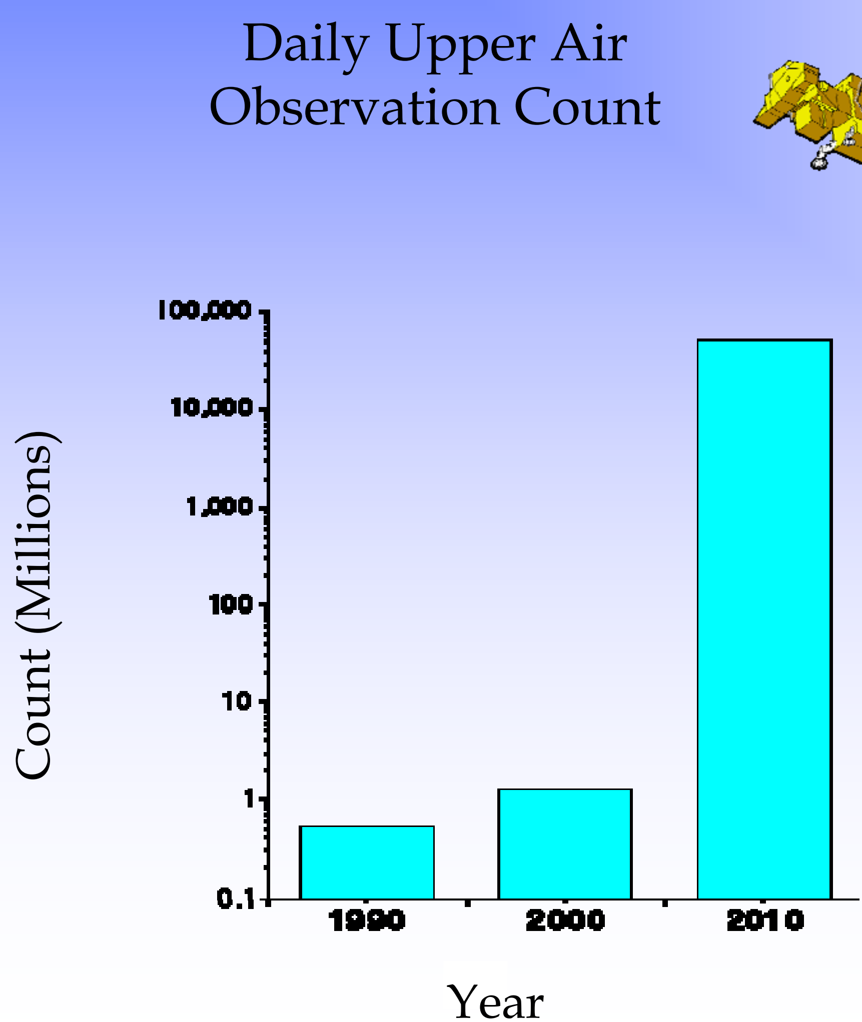
# Overview

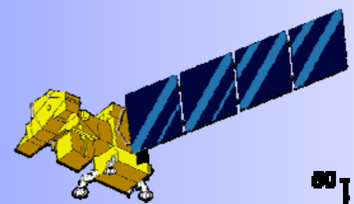
- The Challenge
- CAWCR
- The Satellite Program
- Recent Data Impact Studies
- MTSaT-1R Data Impact/error Characterization Studies
- Plans/Future Prospects
- Summary

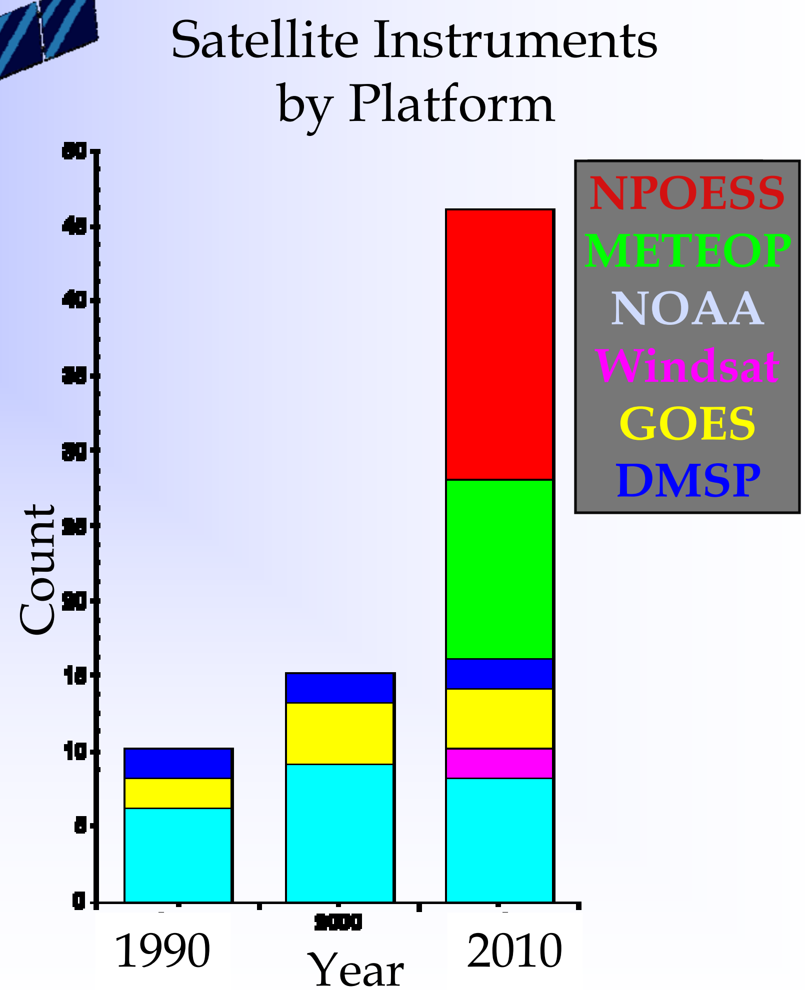


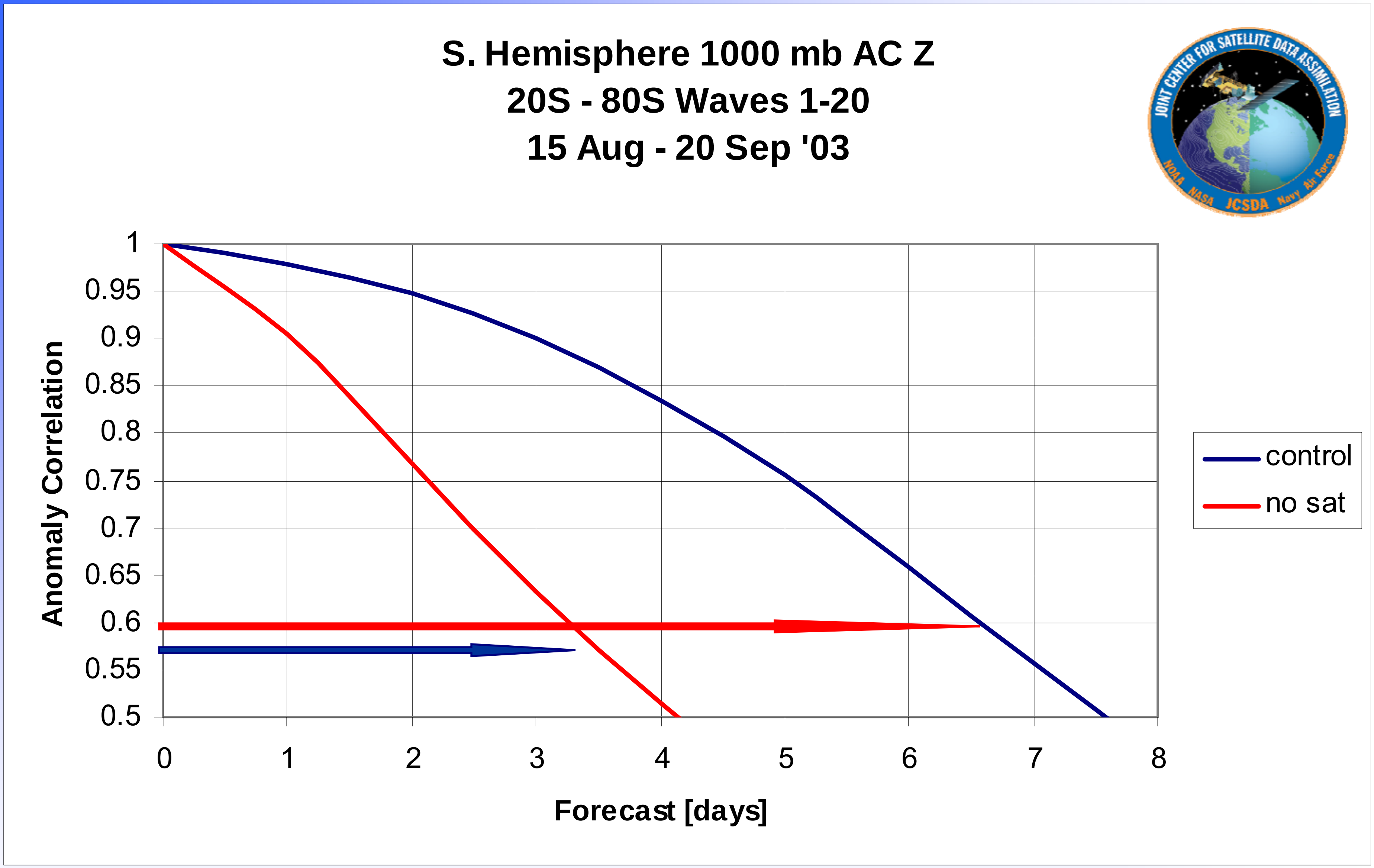
JOINT CENTER FOR SATELLITE DATA ASSIMILATION
NOAA NASA JCSDA Navy Air Force
The Challenge
Satellite Systems/Global Measurements
GRACE
Cloudsat
CALIPSO
Aqua
SSMIS
TRMM
GIFTS
TOPEX
NPP
Landsat
MSG
Meteor/
SAGE
EPS
METOP
GOES-R
COSMIC/GPS
NOAA/
POES
NPOESS
SeaWiFS
Terra
Jason
ICESat
SORCE
Aura
WindSAT

# 5-Order Magnitude Increase in Satellite Data Over 10 Years








**Anomaly correlation for days 0 to 7 for 500 hPa geopotential height in the zonal band 20°-80° for January/February. The red arrow indicate use of satellite data in the forecast model has doubled the length of a useful forecast.**

Australian Government
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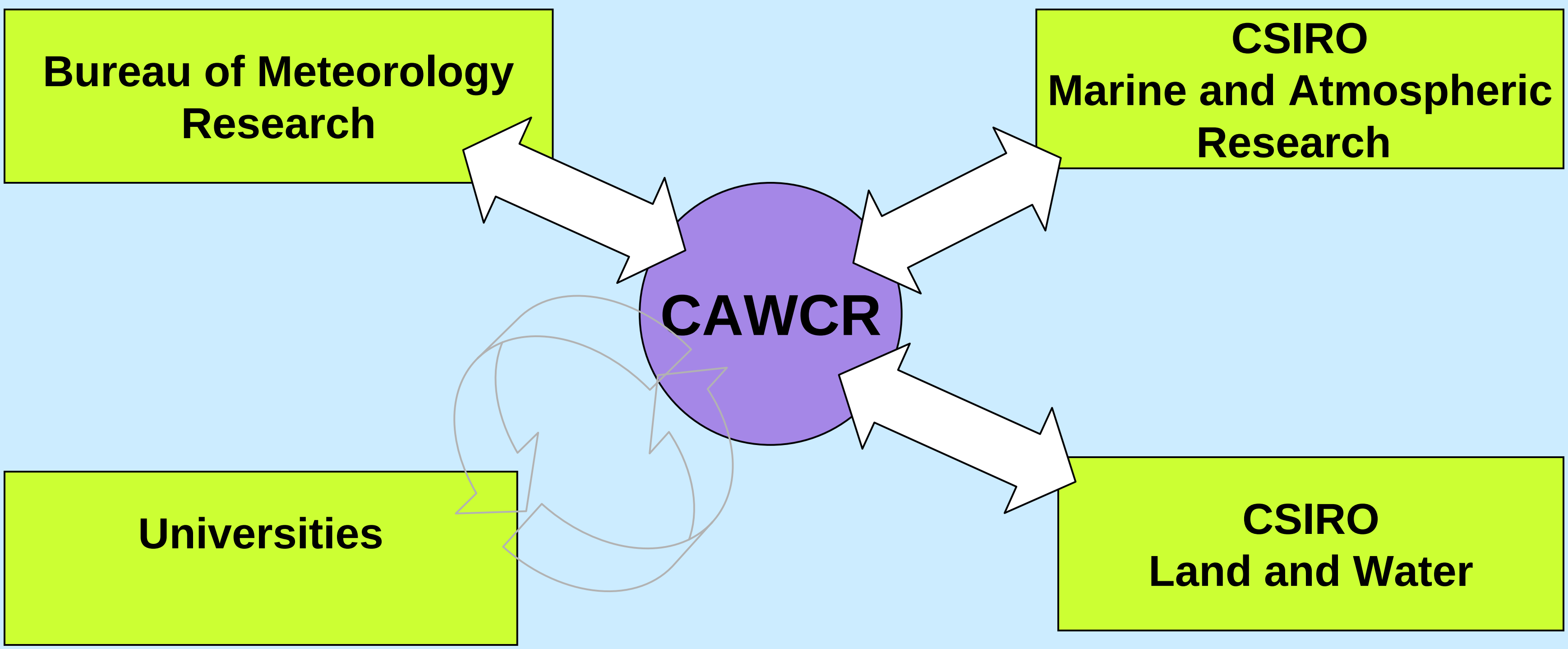
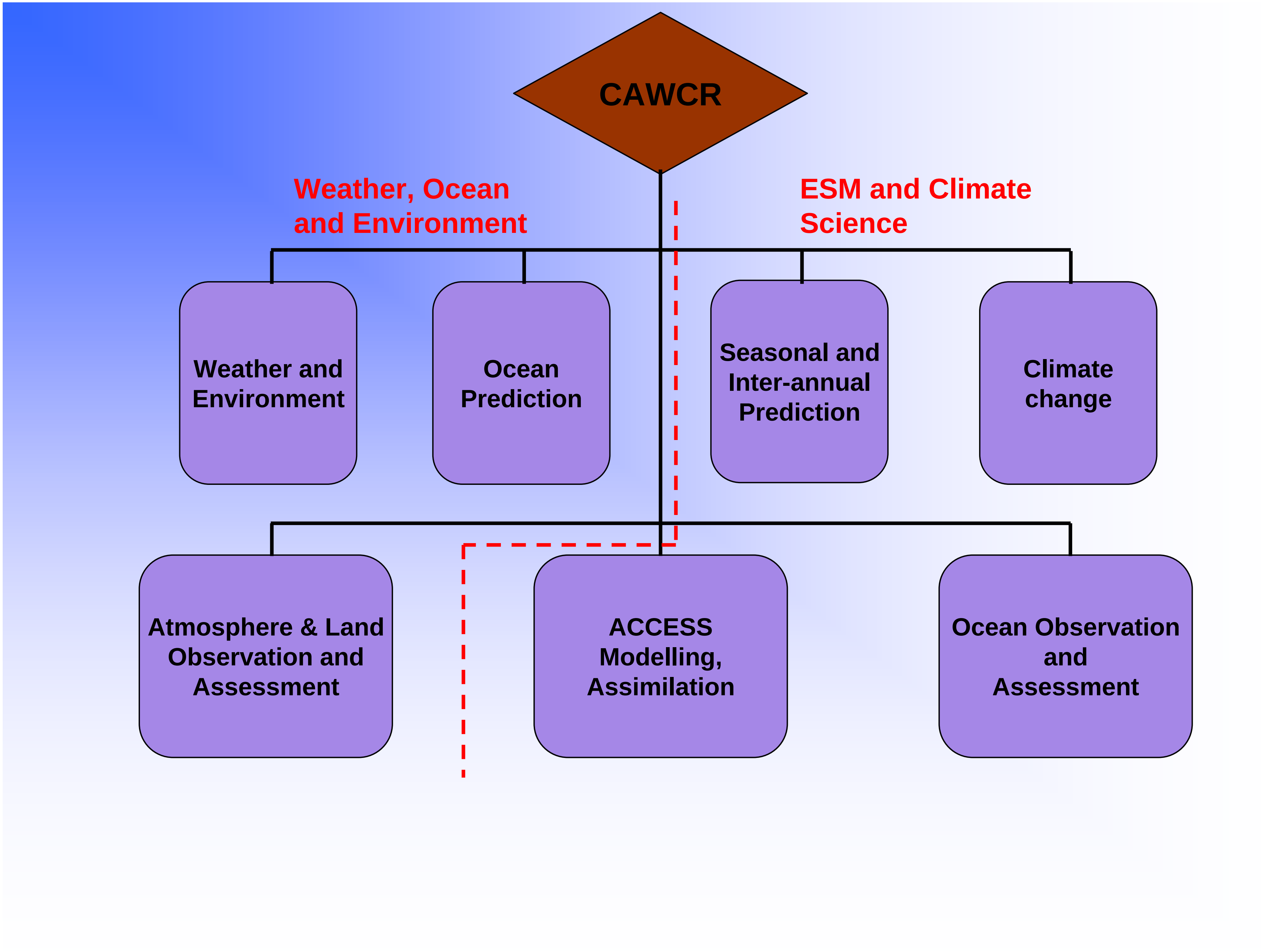
CSIRO

# CAWCR

# The Centre for Australian Weather and Climate Research

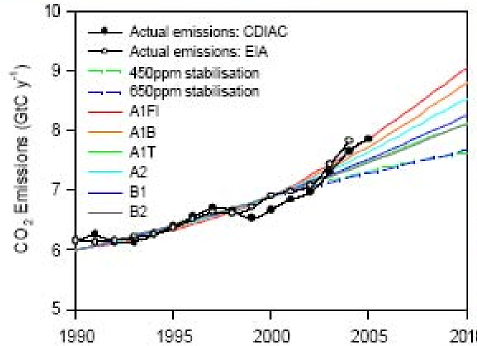
# CAWCR Partners



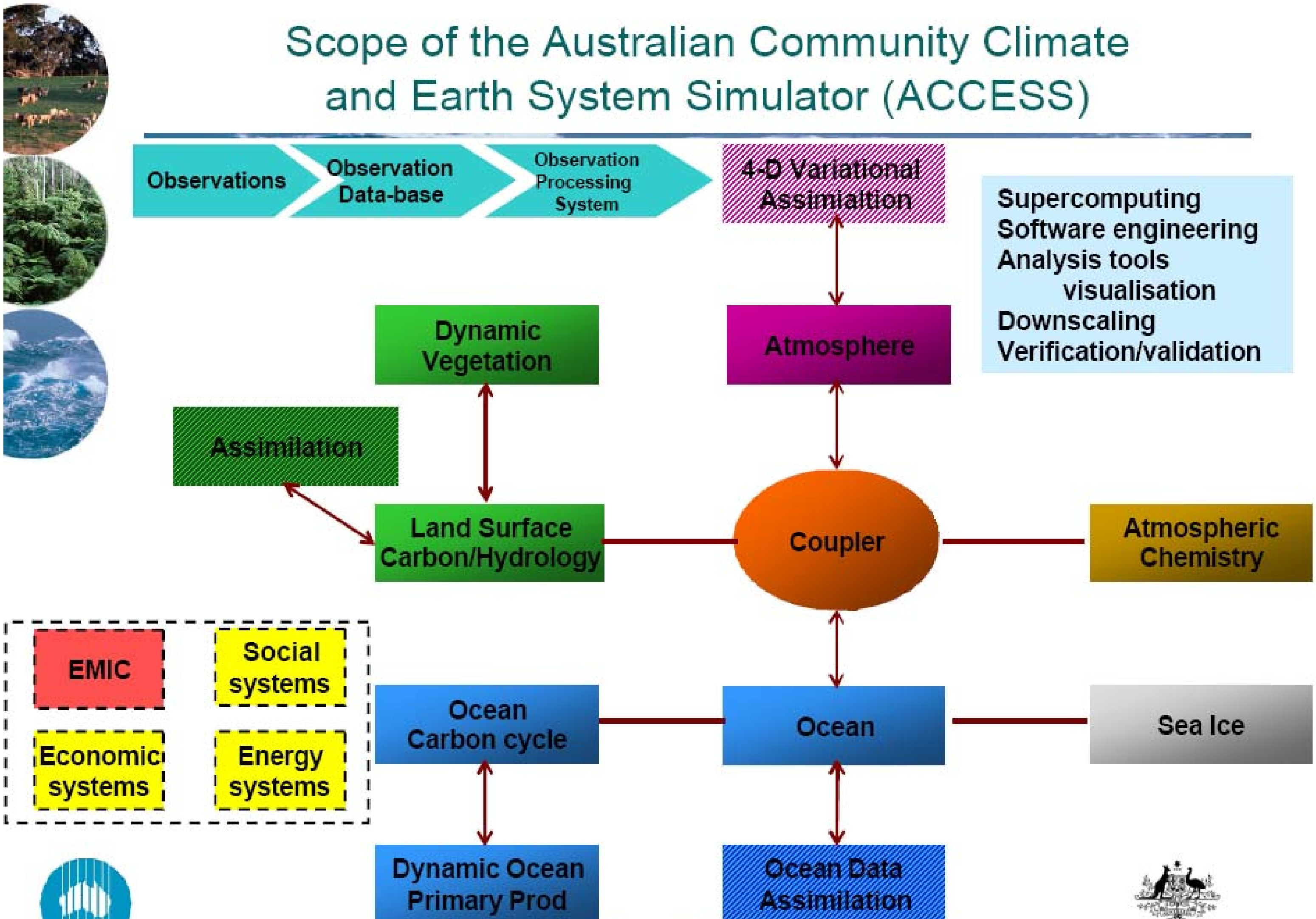

CAWCR
Weather, Ocean and Environment
ESM and Climate Science
Weather and Environment
Ocean Prediction
Seasonal and Inter-annual Prediction
Climate change
Atmosphere & Land Observation and Assessment
ACCESS Modelling, Assimilation
Ocean Observation and Assessment

# Atmosphere-Land Observation & Assessment

- Atmospheric composition
  - gases
  - aerosol
- Cloud, radiation and precipitation processes
- Biogeochemical cycles (carbon & water)
- Micrometeorology
- Observing system technologies
- Remote sensing and data assimilation



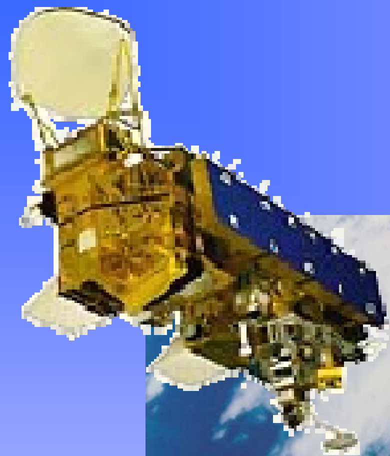

# Scope of the Australian Community Climate and Earth System Simulator (ACCESS)




CSIRO

Centre for Australian Weather and Climate Research: a partnership between CSIRO and the Bureau of Meteorology

Australian Government
Bureau of Meteorology



# SOME RECENT ADVANCES / DATA IMPACT

# *OBSERVING SYSTEM EXPERIMENTS*

**OBSERVING SYSTEM EXPERIMENTS**
**WITH**
**SATELLITE AND CONVENTIONAL**
**DATA**

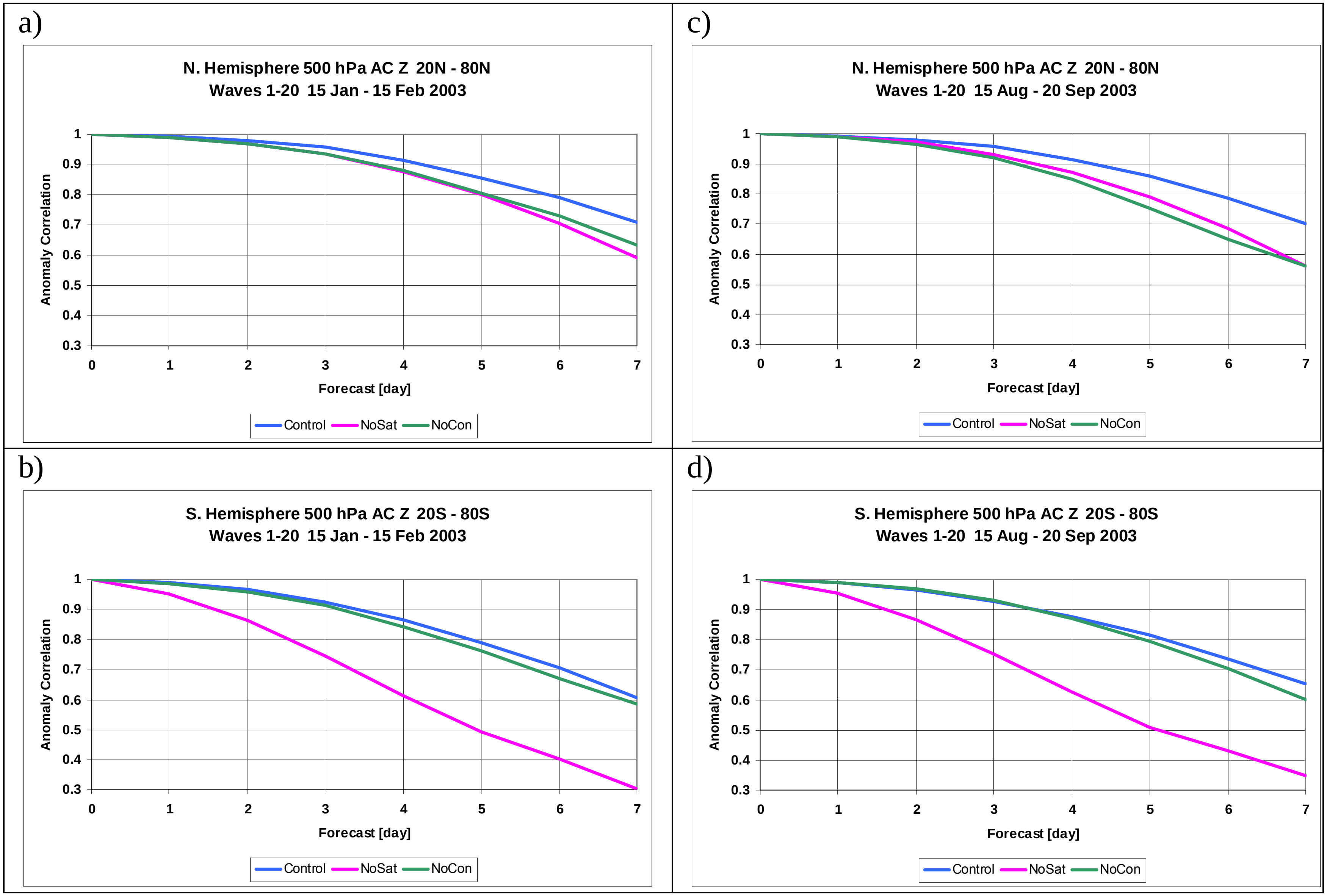



Fig. 6. Anomaly correlation for days 0 to 7 for 500 hPa geopotential height in the zonal band 20°-80° for each Hemisphere and season. The control simulation is shown in blue, while the NoSat and NoCon denial experiments are shown in magenta and green, respectively.

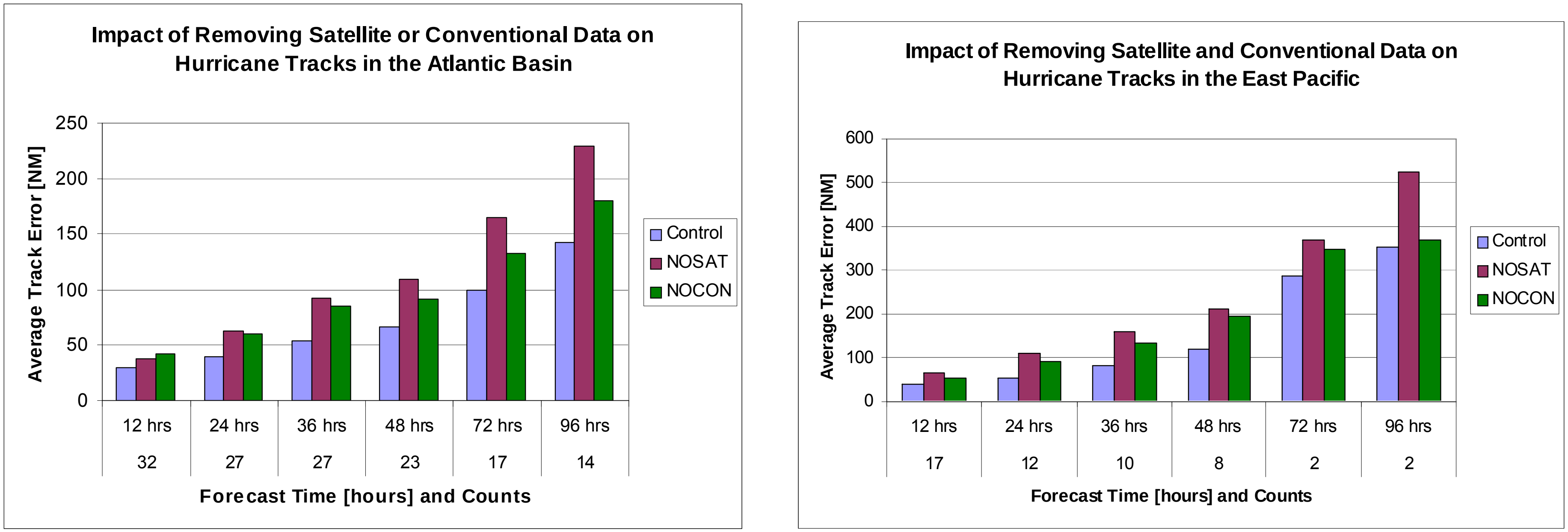



Fig. 7 The impact of removing satellite and in-situ data on hurricane track forecasts in the GFS during the period 15 August to 20 September 2003. Panels (a and b) show the average track error (NM) out to 96 hours for the control experiment and the NoSat and NoCon denials for the Atlantic and Pacific Basins, respectively.

# *OBSERVING SYSTEM EXPERIMENTS*

**OBSERVING SYSTEM EXPERIMENT**
**WITH**
**FOUR SATELLITE DATA TYPES AND**
**RAWINSONDE DATA**

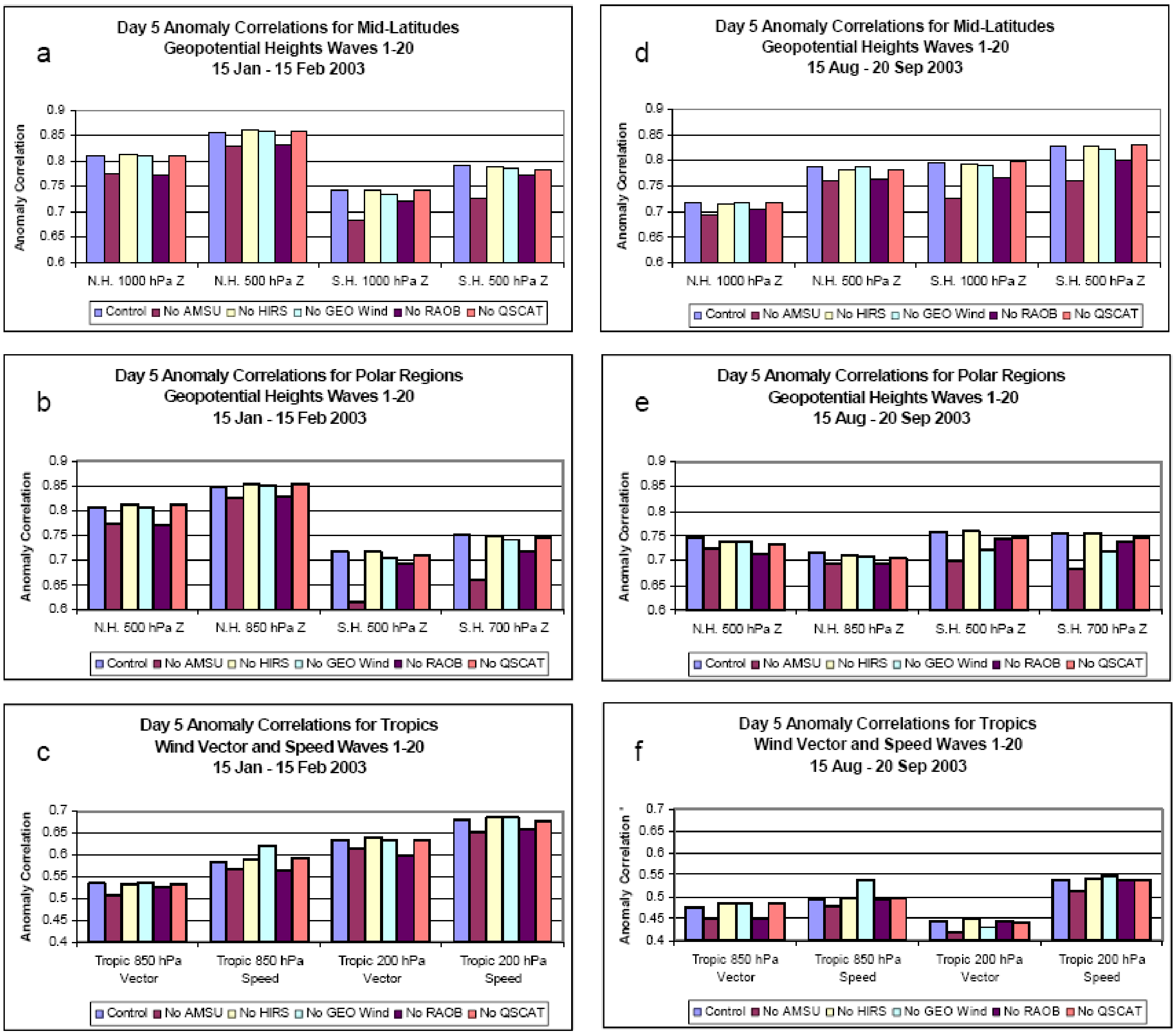



**Fig. 8 The day 5 anomaly correlations for waves 1-20 for the (a and d) mid-latitudes, (b and e) polar regions and (c and f) tropics. Experiments shown for each term include, from left to right, the control simulation and denials of AMSU, HIRS, GEO winds, Rawinsondes and QuikSCAT. The 15 January to 15 February 2003 results are shown in the left column and the 15 August to 20 September results are shown in the right column. Note the different vertical scale in (c and f).**

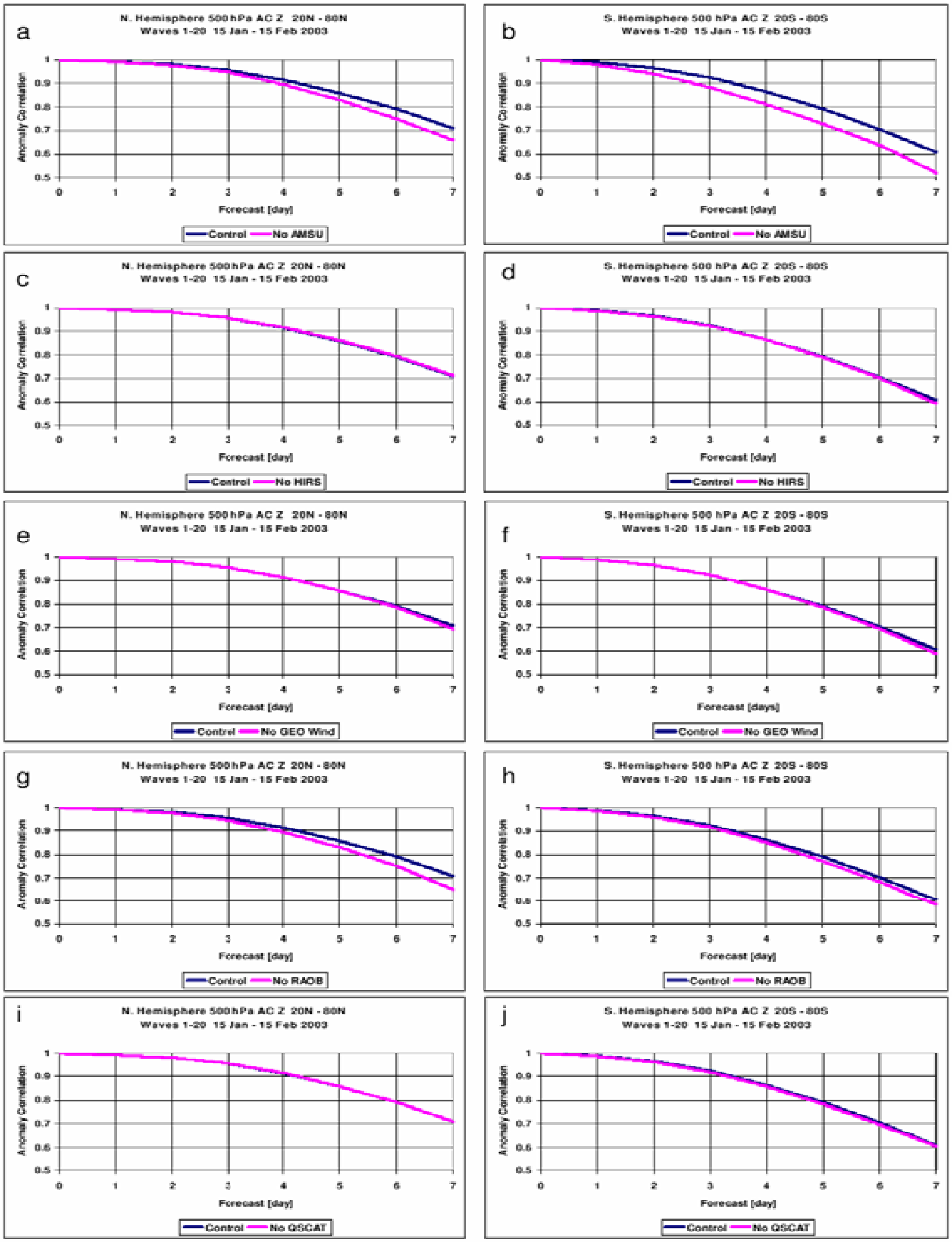



**Fig. 9. The 15 January to 15 February 2003 day 0-7 500 hPa geopotential height die-off curves for the control and five denial experiments. The Northern Hemisphere results are shown in the left panels and the Southern Hemisphere results are shown in the right panels.**

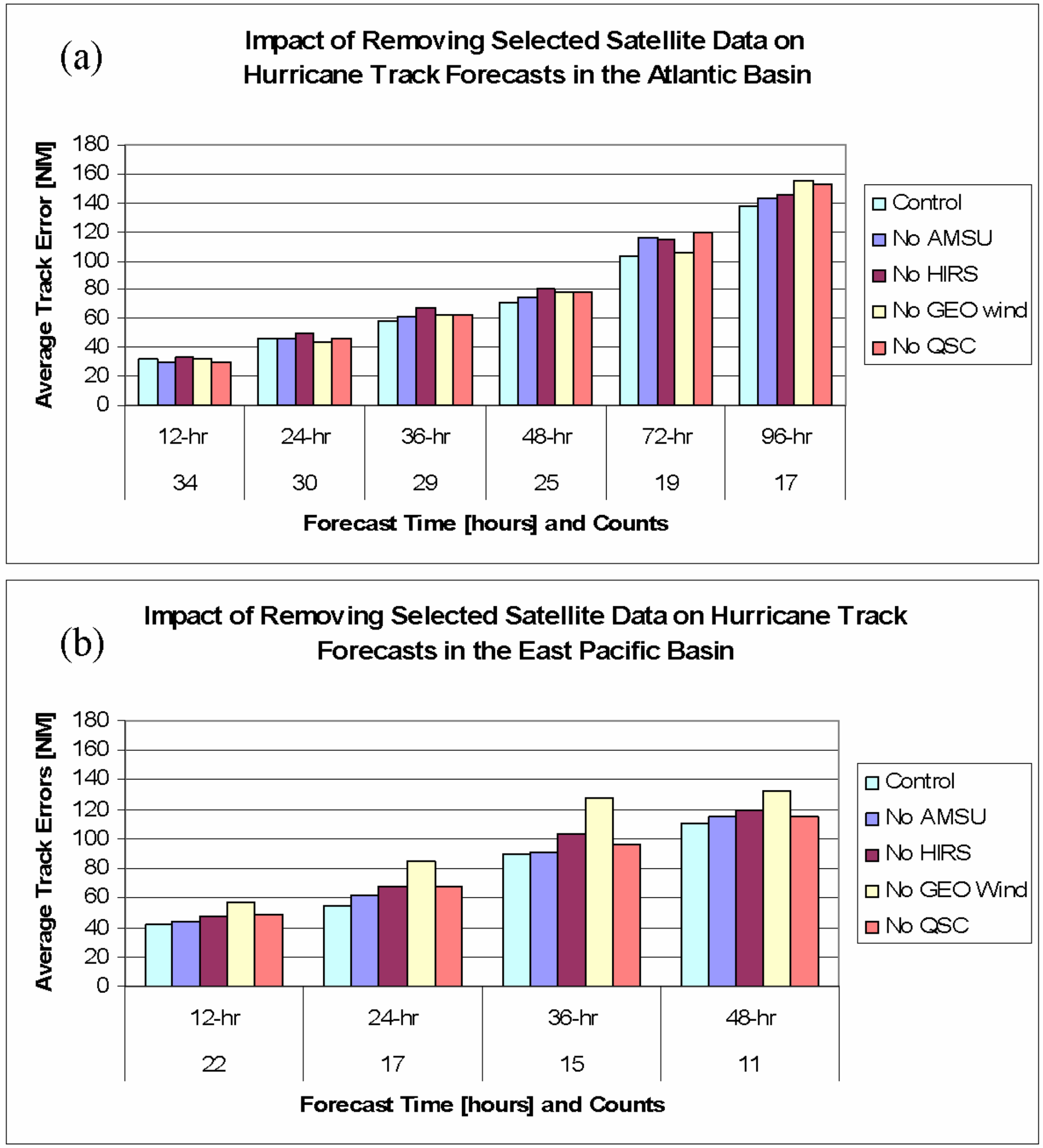



**Fig. 10. Average track error (NM) by forecast hour for the control simulation and experiments where AMSU, HIRS, GEO winds and QuikSCAT were denied. The Atlantic Basin results are shown in (a), and the Eastern Pacific Basin results are shown in (b). A small sample size in the number of hurricanes precludes presenting the 96 hour results in the Eastern Pacific Ocean.**

# *MODIS Wind Assimilation into the NCEP Global Forecast System*

# *Global Forecast System Background*

- Operational SSI (3DVAR) version used
- Operational GFS T254L64 with reductions in resolution at 84 (T170L42) and 180 (T126L28) hours. 2.5hr cut off

# *The Trial*

- Winds assimilated only in second last analysis (later "final" analysis) to simulate realistic data availability.

## *Table 1: Satellite data used operationally within the GMAO/NCEP Global Forecast System*

| | |
|---|---|
| HIRS sounder radiances | TRMM precipitation rates |
| AMSU-A sounder radiances | ERS-2 ocean surface wind vectors |
| AMSU-B sounder radiances | Quikscat ocean surface wind vectors |
| GOES sounder radiances | AVHRR SST |
| GOES 9,10,12, Meteosat atmospheric motion vectors | AVHRR vegetation fraction |
| GOES precipitation rate | AVHRR surface type |
| SSM/I ocean surface wind speeds | Multi-satellite snow cover |
| SSM/I precipitation rates | Multi-satellite sea ice |
| | SBUV/2 ozone profile and total ozone |

**Table 1: Comparison of radiosonde wind estimates with Terra and Aqua based MODIS AMVs, colocated within 150km over high latitudes for the period 5 May 2005 to 10 January 2006 inclusive, where the AMV QI $\geq$ 0.85. [IR = 11µm based winds, WV = 6.7 µm based winds and MMVD = mean magnitude of vector difference ($ms^{-1}$)].**

| Type | | AQUA IR | AQUA WV | TERRA IR | TERRA WV |
|---|---|---|---|---|---|
| Low 999-700hPa | No. of Obs. | 142 | N/A | 80 | N/A |
| | MMVD ($ms^{-1}$) | 3.92 | N/A | 3.58 | N/A |
| | RMS Vec. Diff. ($ms^{-1}$) | 4.57 | N/A | 4.02 | N/A |
| | Speed Bias ($ms^{-1}$) | -0.30 | N/A | -0.03 | N/A |
| Middle 699-400HPa | No. of Obs. | 342 | 558 | 287 | 485 |
| | MMVD ($ms^{-1}$) | 4.38 | 4.34 | 4.20 | 4.30 |
| | RMS Vec. Diff. ($ms^{-1}$) | 4.93 | 4.90 | 4.79 | 4.85 |
| | Speed Bias ($ms^{-1}$) | -1.01 | -0.72 | -0.35 | -0.24 |
| High 399-150hPa | No. of Obs. | 106 | 358 | 76 | 345 |
| | MMVD ($ms^{-1}$) | 4.71 | 4.96 | 4.81 | 4.28 |
| | RMS Vec. Diff. ($ms^{-1}$) | 5.22 | 5.55 | 5.26 | 4.83 |
| | Speed Bias ($ms^{-1}$) | -0.80 | -0.65 | -0.50 | -0.34 |

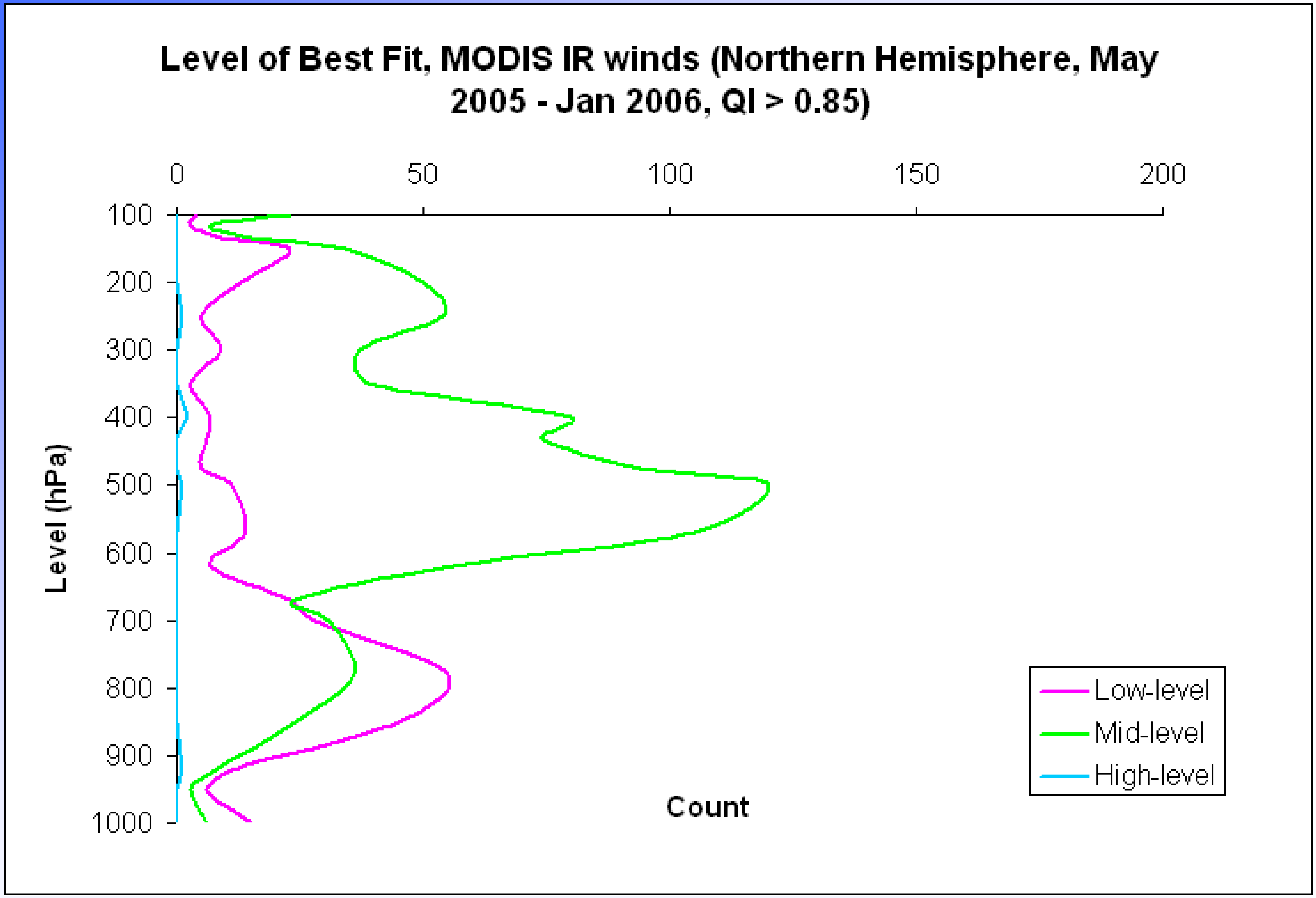



**Fig 1 (a) Distribution of levels of best fit compared to a collocated radiosonde profile for AMVs with pressure altitudes in the ranges 500 ± 50 hPa (Mid-level), 300 ± 50 hPa (High level) and , 850 ± 50 hPa (Low level). In all cases, the AMV QI is in the range 0.85 to 1.0.**

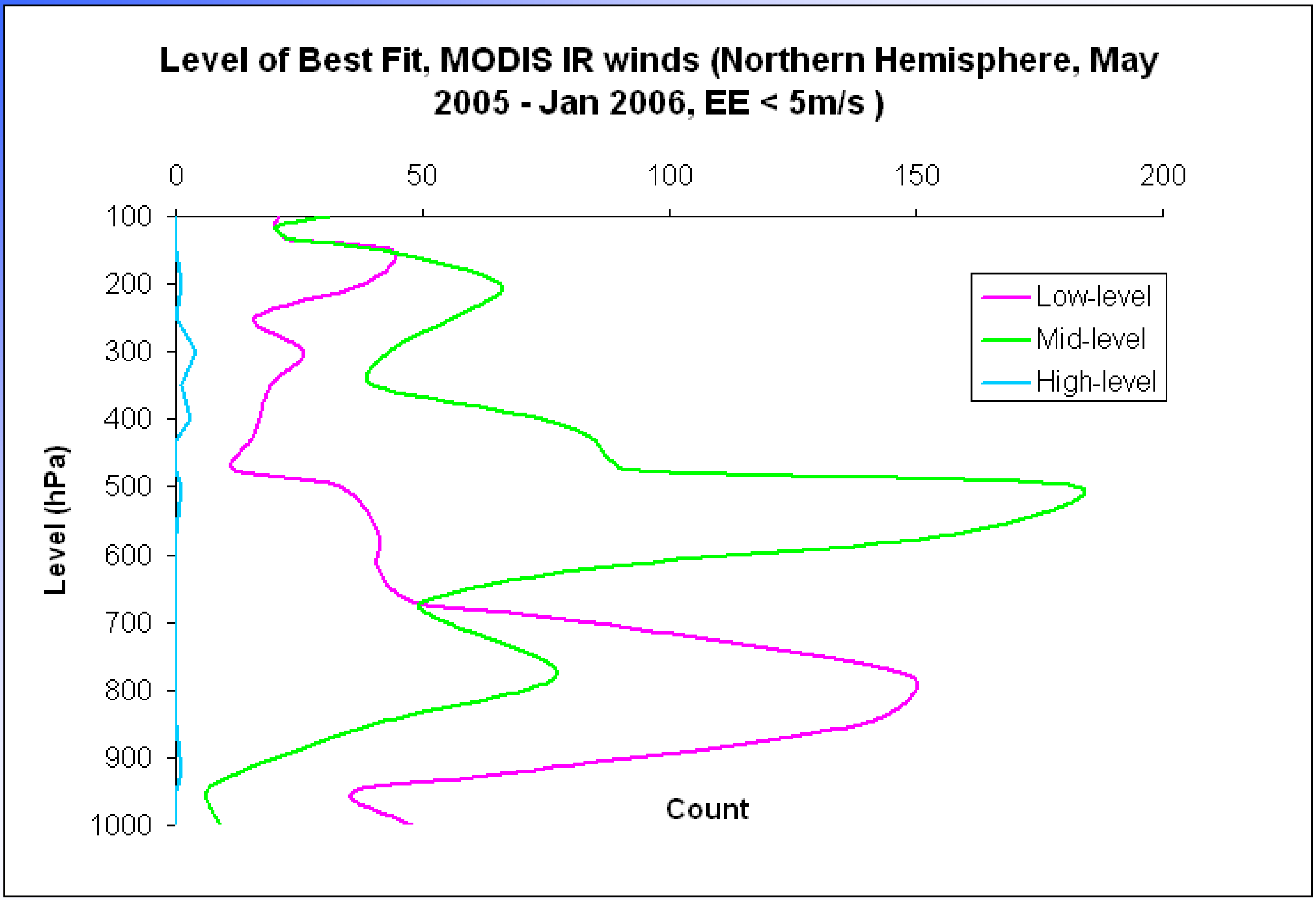



**Fig 1 (b) Distribution of levels of best fit compared to a collocated radiosonde profile for AMVs with pressure altitudes in the ranges 500 ± 50 hPa (mid-level), 300 ± 50 hPa (high level) and , 850 ± 50 hPa (low level). In all cases, the AMV EE is less than 5 m/s.**

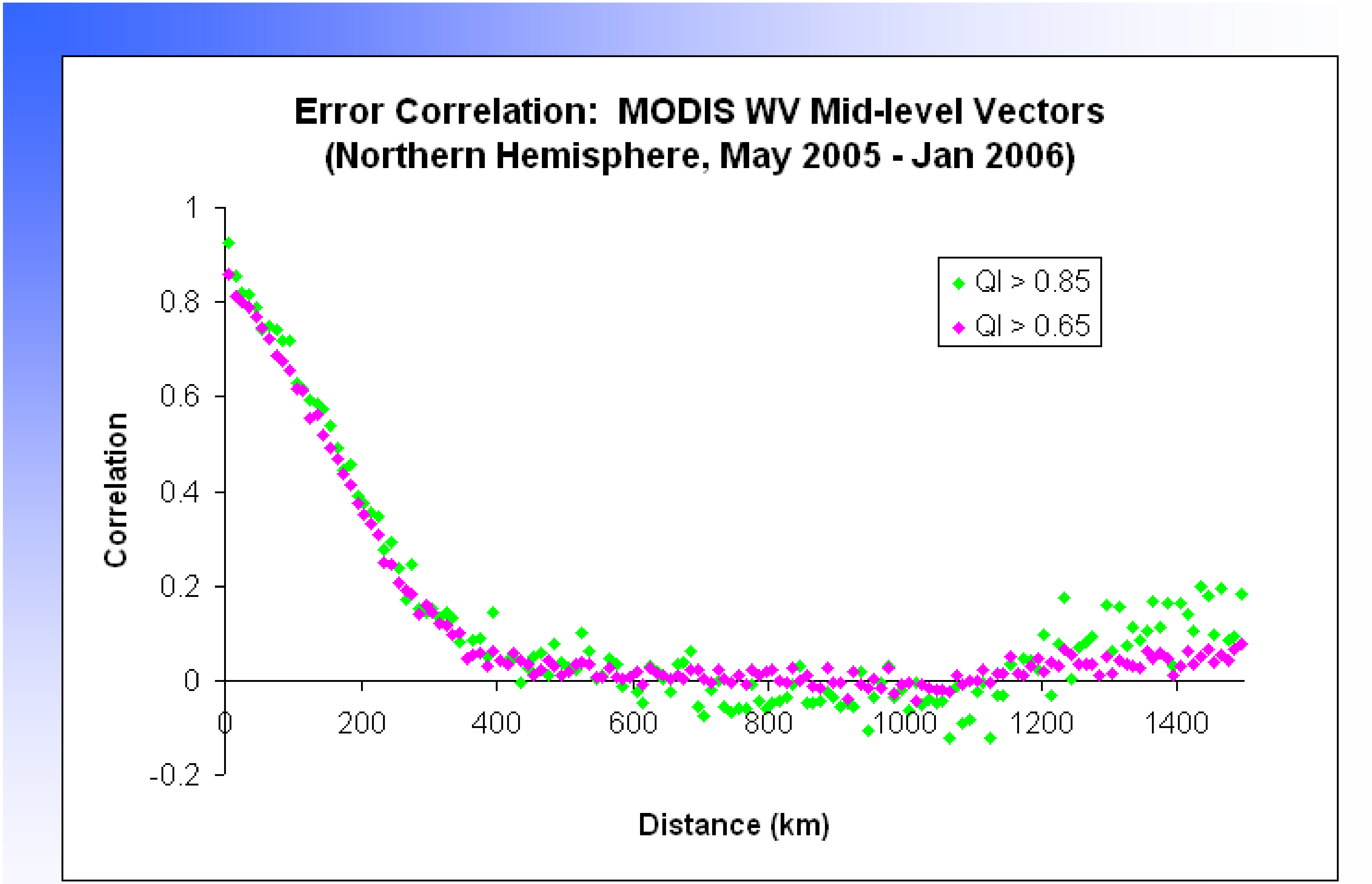



**Fig. 2 (a) Error Correlation versus distance (using 10 km bins), determined by comparison with radiosonde winds, for MODIS WV Mid-level Vectors (Northern Hemisphere, May 2005 – Jan 2006)**

**Table 2 (a) Parameters of the SOAR function (Equation 1) which best model the measured error correlations for the MODIS AMV types listed in the left column of the table. (QI = 0.65 to 1)**

| Type | $R_{00}$ | $R_0$ | L (km) | Corr. Err. ($ms^{-1}$) | RMSD ($ms^{-1}$) |
|---|---|---|---|---|---|
| Low IR | -0.029 | 0.68 | 128.9 | 3.01 | 4.51 |
| Mid IR | -0.010 | 0.82 | 113.1 | 4.16 | 5.07 |
| High IR | 0.029 | 0.78 | 117.7 | 4.28 | 5.49 |
| Mid WV | 0.010 | 0.85 | 95.3 | 4.29 | 5.05 |
| High WV | -0.051 | 0.91 | 107.6 | 4.83 | 5.31 |

**Table 2 (b) Parameter of the SOAR function (Equation 1) which best model the measured error correlations for the MODIS AMV types listed in the left column of the table. $R_{00}$ is assumed to be 0. (QI = 0.65 to 1)**

| Type | $R_{00}$ | $R_0$ | L (km) | Corr. Err. ($ms^{-1}$) | RMSD ($ms^{-1}$) |
|---|---|---|---|---|---|
| Low IR | 0 | 0.77 | 123.6 | 3.47 | 4.51 |
| Mid IR | 0 | 0.84 | 120.3 | 4.26 | 5.07 |
| High IR | 0 | 0.83 | 98.6 | 4.56 | 5.49 |
| Mid WV | 0 | 0.89 | 100.4 | 4.49 | 5.05 |
| High WV | 0 | 0.95 | 100.8 | 5.04 | 5.31 |

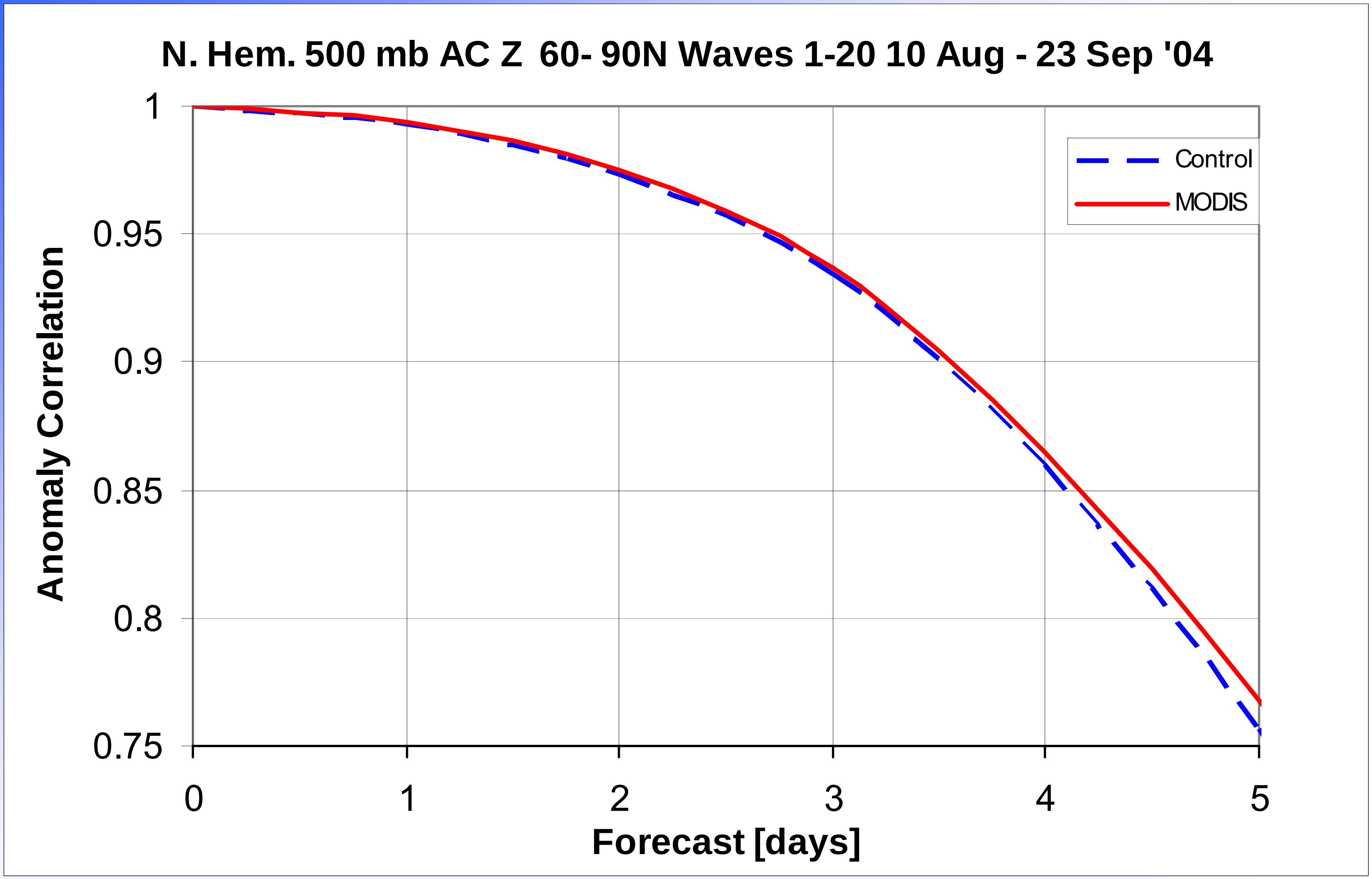



**Fig. 3. The 500 hPa geopotential height Anomaly Correlation for the Northern Hemisphere polar Region (60° N – 90° N), for the GFS control and the GFS control including MODIS AMVs, for the period 10 August to 23 September 2004.**

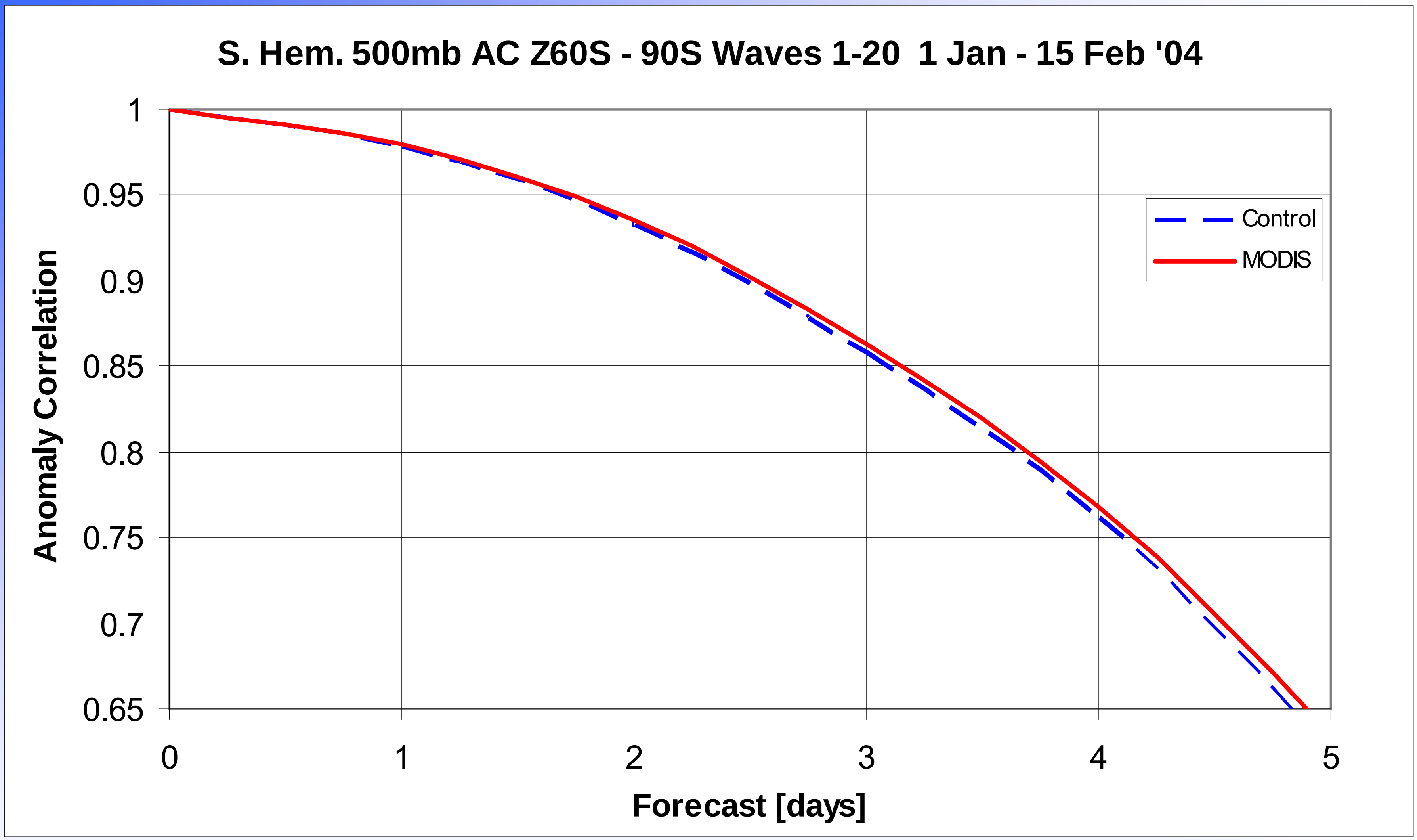



**Fig. 5. The 500hPa geopotential height anomaly correlation for the Southern Hemisphere polar region (60° S – 90° S), for the GFS control and the GFS control including MODIS AMVs, for the period 1 January to 15 February 2004.**

# 2004 ATLANTIC BASIN

# AVERAGE HURRICANE TRACK ERRORS (NM)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 13.2 | 43.6 | 66.5 | 94.9 | 102.8 | 157.1 | 227.9 | 301.1 | Cntrl |
| 11.4 | 34.8 | 60.4 | 82.6 | 89.0 | 135.3 | 183.0 | 252.0 | Cntrl + MODIS |
| 74 | 68 | 64 | 61 | 52 | 46 | 39 | 34 | Cases (#) |
| 00-h | 12-h | 24-h | 36-h | 48-h | 72-h | 96-h | 120-h | Time |

Results compiled by Qing Fu Liu.

# *The Contribution of Locally Generated MTSat-1R Atmospheric Motion Vectors to Operational Meteorology in the Australian Region*

# *MTSaT-1R IR1 AMVs*

Uses 3 images separated by 15 min. or 60 min.

Uses $H_20$ intercept method for upper level AMVs (Schmetz et al., 1993) or Window Method.

Uses cloud base assignment for lower level AMVs (Le Marshall et al. 1997) or Window Method

Q.C. via EE, QI, ERR, RFF etc.

No autoedit

**Table 1. Real time schedule for MTSat-1R Atmospheric Motion Vectors at the Bureau of Meteorology. Sub-satellite image resolution, frequency and time of wind extraction and separations of the image triplets used for wind generation ($\Delta$T) are indicated.**

| Wind Type | Resolution | Frequency-Times (UTC) | Image Separation |
|---|---|---|---|
| Real Time IR | 4 km | 6-hourly – 00, 06, 12, 18 | 15 minutes |
| Real Time IR (hourly) | 4 km | Hourly – 00, 01, 02, 03, 04, 05, . . . , 23 | 1 hour |

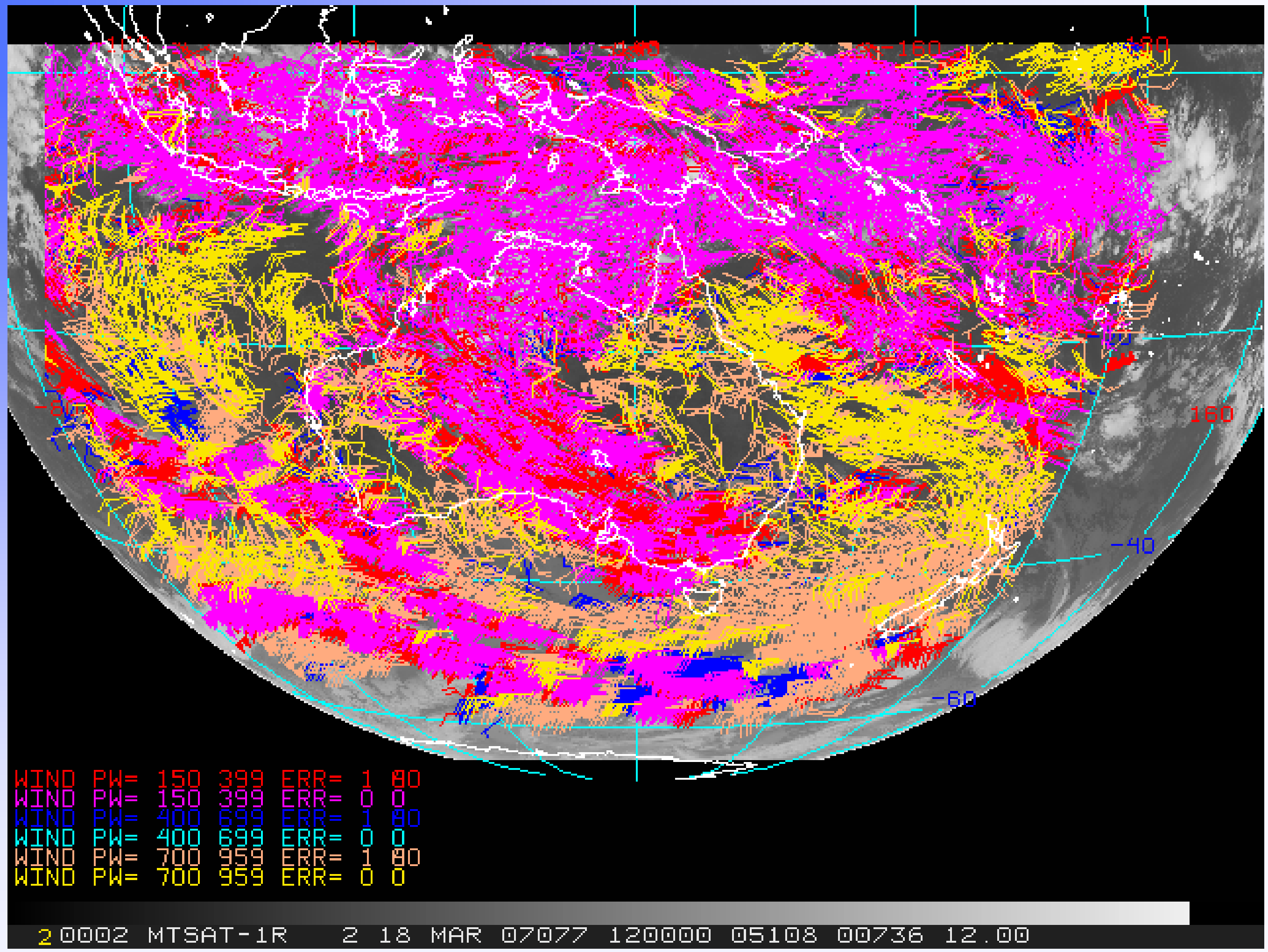



**Fig. 1 (a) MTSat-1R AMVs generated around 12 UTC on 18 March 2007. Magenta denotes upper level tropospheric vectors, yellow, lower level tropospheric vectors**

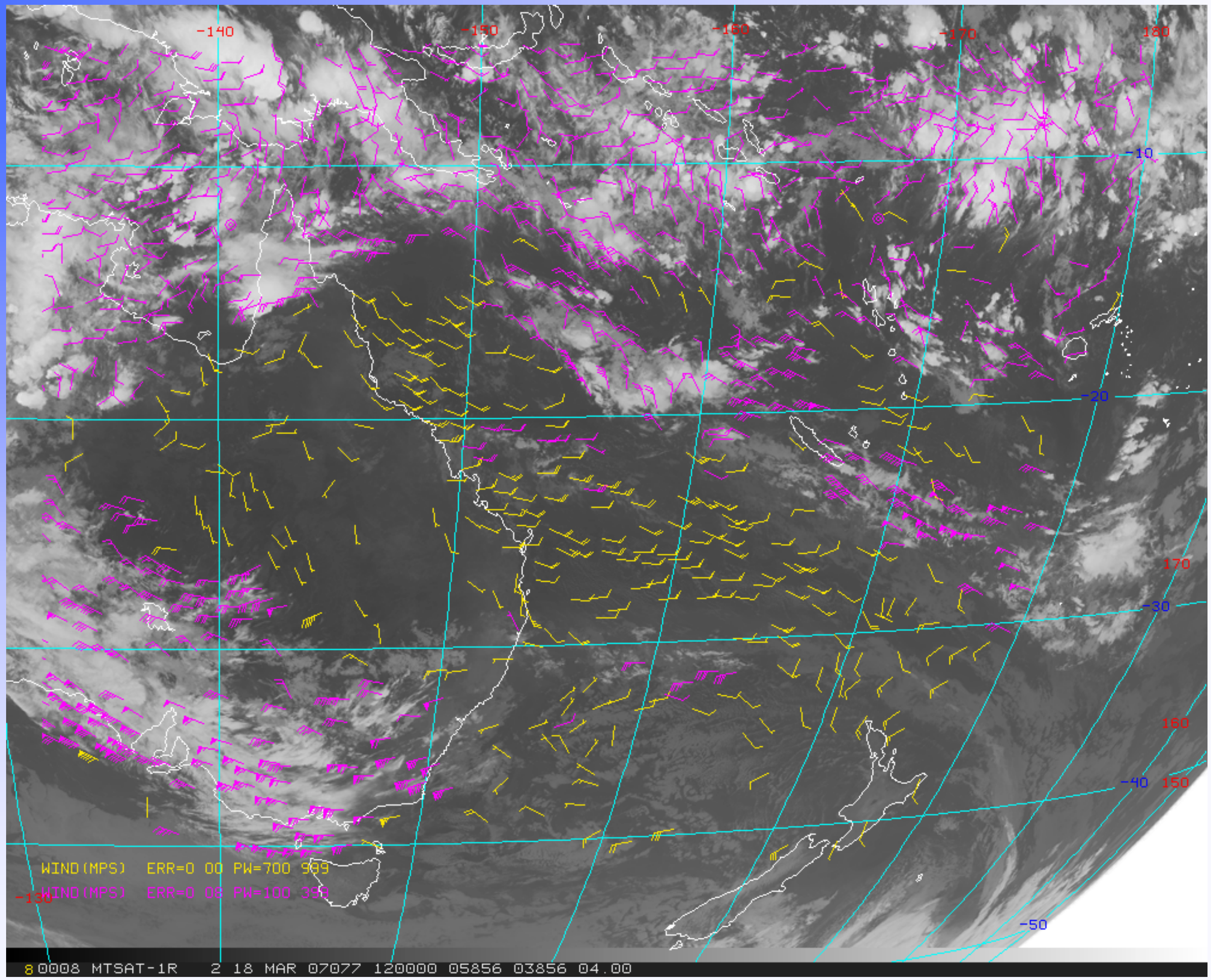
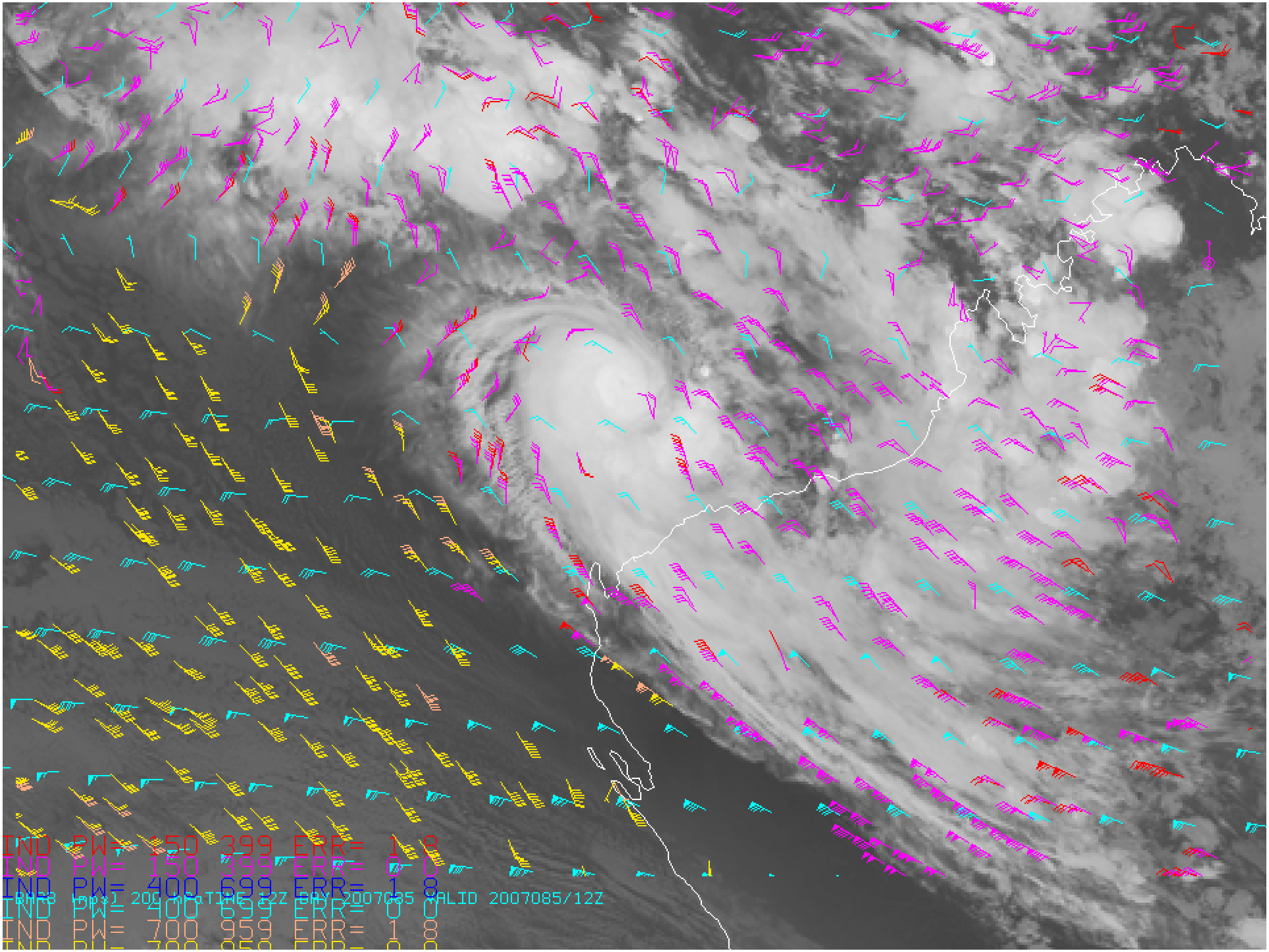
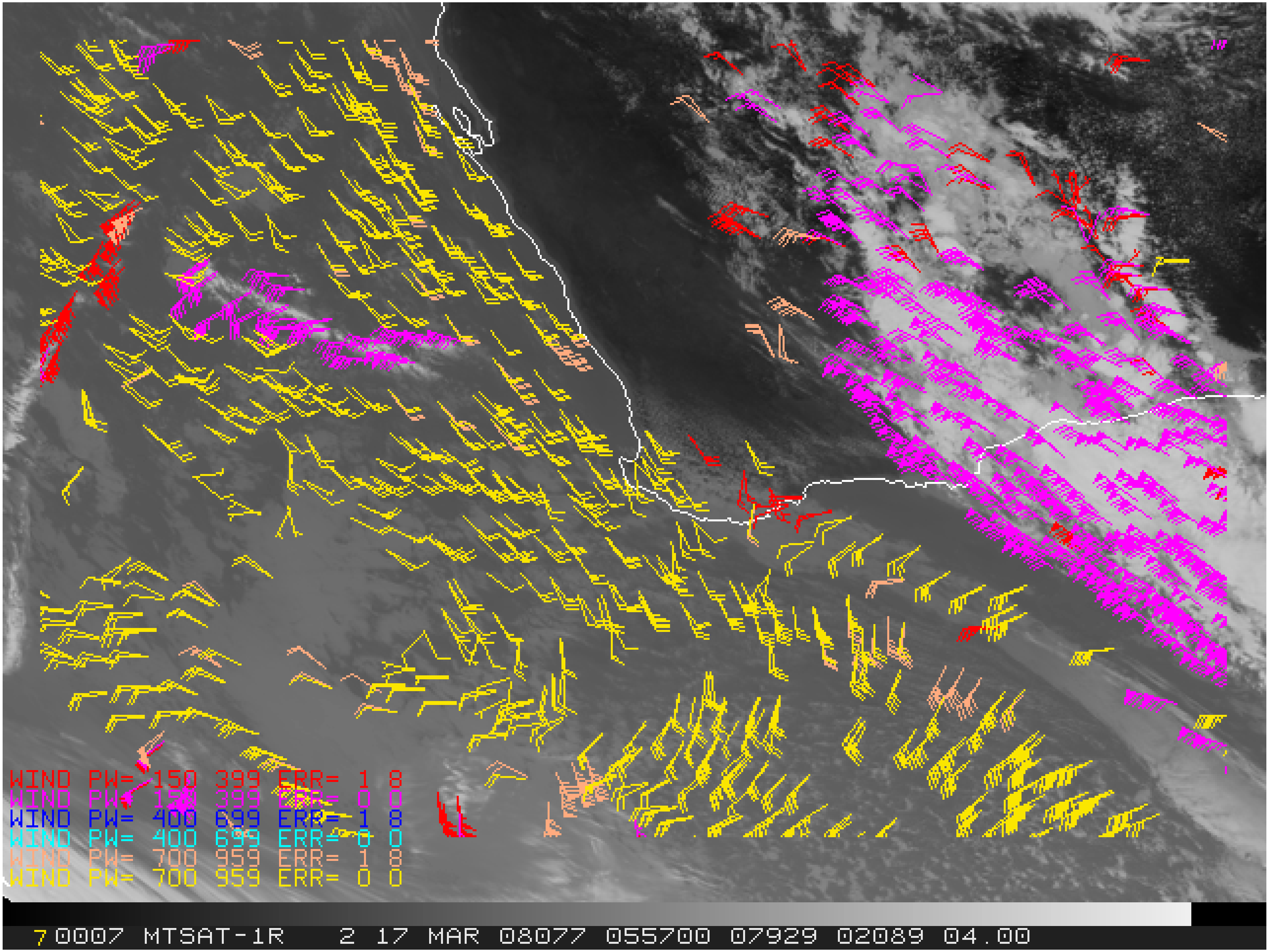
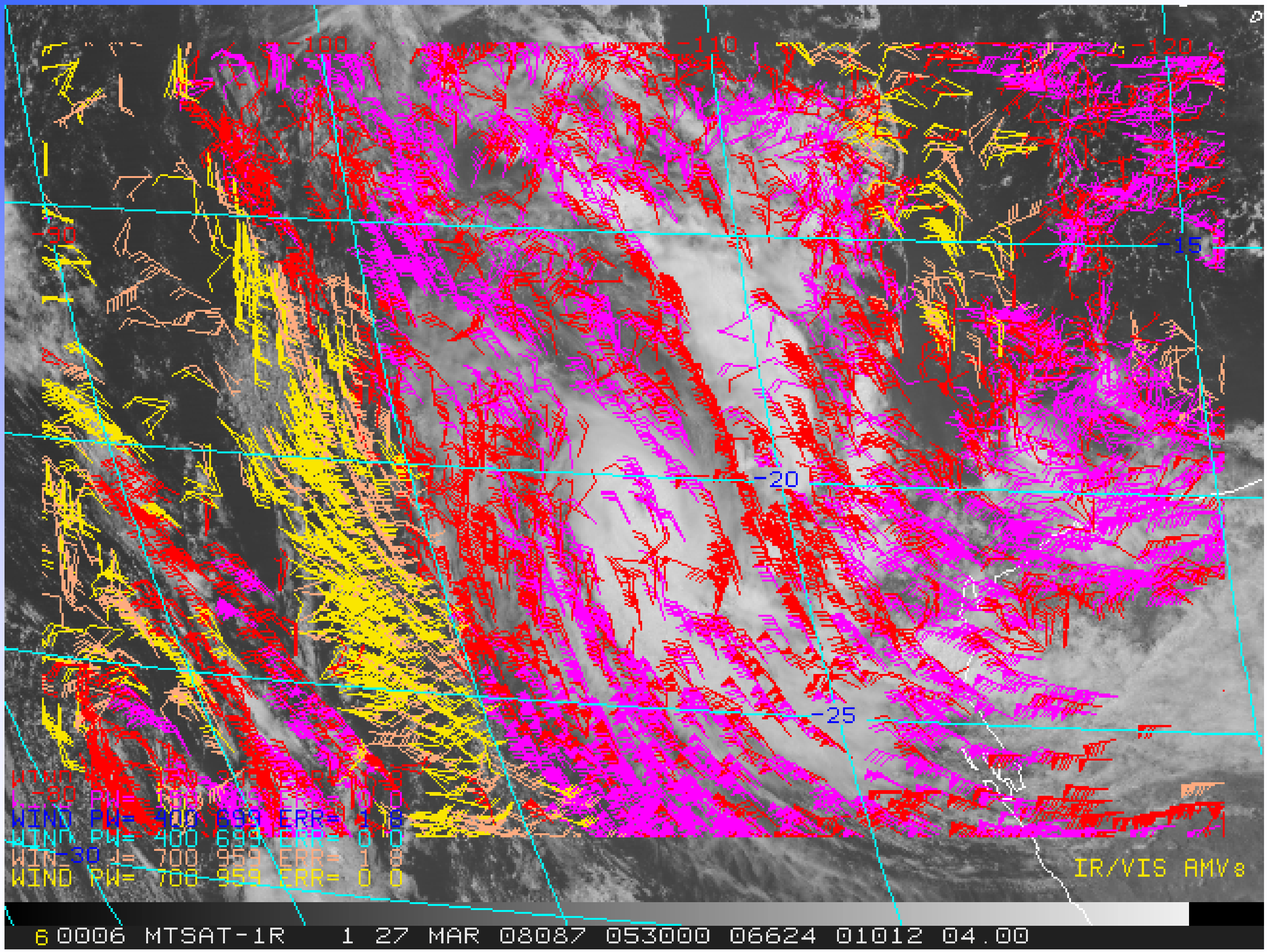



**Fig. 1 (b) A selection of MTSat-1R AMVs generated around 12 UTC on 18 March 2007. Magenta denotes upper level tropospheric vectors (above 500 hPa), yellow, lower level tropospheric vectors (below 500 hPa)**


IND PW= 150 399 ERR= 1 8
IND PW= 150 399 ERR= 0 0
IND PW= 400 699 ERR= 1 8
IND PW= 400 699 ERR= 0 0
IND PW= 700 959 ERR= 1 8
VALID 2007085/12Z


WIND PW= 150 399 ERR= 1 8
WIND PW= 150 399 ERR= 0 0
WIND PW= 400 699 ERR= 1 8
WIND PW= 400 699 ERR= 0 0
WIND PW= 700 959 ERR= 1 8
WIND PW= 700 959 ERR= 0 0
7 0007 MTSAT-1R 2 17 MAR 08077 055700 07929 02089 04.00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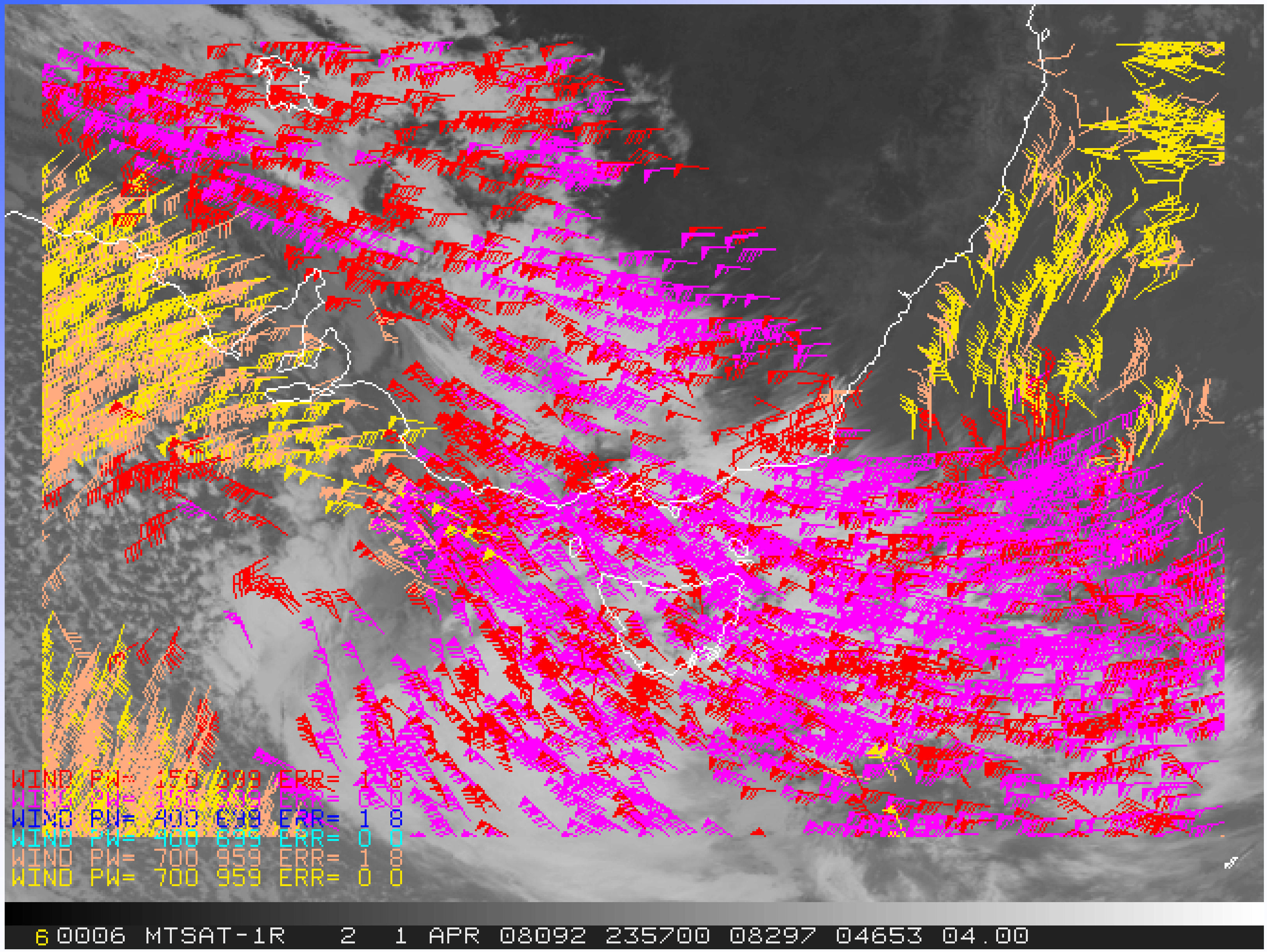
-110
-120
-15
-20
-25
IR/VIS AMVs
6 0006 MTSAT-1R 1 27 MAR 08087 053000 06624 01012 04.00



WIND PW= 150 399 ERR= 1 8
WIND PW= 150 399 ERR= 0 0
WIND PW= 400 699 ERR= 1 8
WIND PW= 400 699 ERR= 0 0
WIND PW= 700 959 ERR= 1 8
WIND PW= 700 959 ERR= 0 0
6 0006 MTSAT-1R 2 1 APR 08092 235700 08297 04653 04.00

*ERROR CHARACTERIZATION OF ATMOSPHERIC MOTION VECTORS*

# QUALITY CONTROL

# QUALITY CONTROL

- Several components to quality control process

**ERR:** Wind data accepted and errors assigned, in conjunction with several rejection criteria, including :

* Correlation between images
* U acceleration
* V acceleration
* U component deviation from guess
* V component deviation from guess
* ………..

**QI**

**EXPECTED ERROR**

# **Quality Control**

## **(ERR)**

Considers

- Correlation between images
- U acceleration
- V acceleration
- U deviation from first guess
- V deviation from first guess
- ………

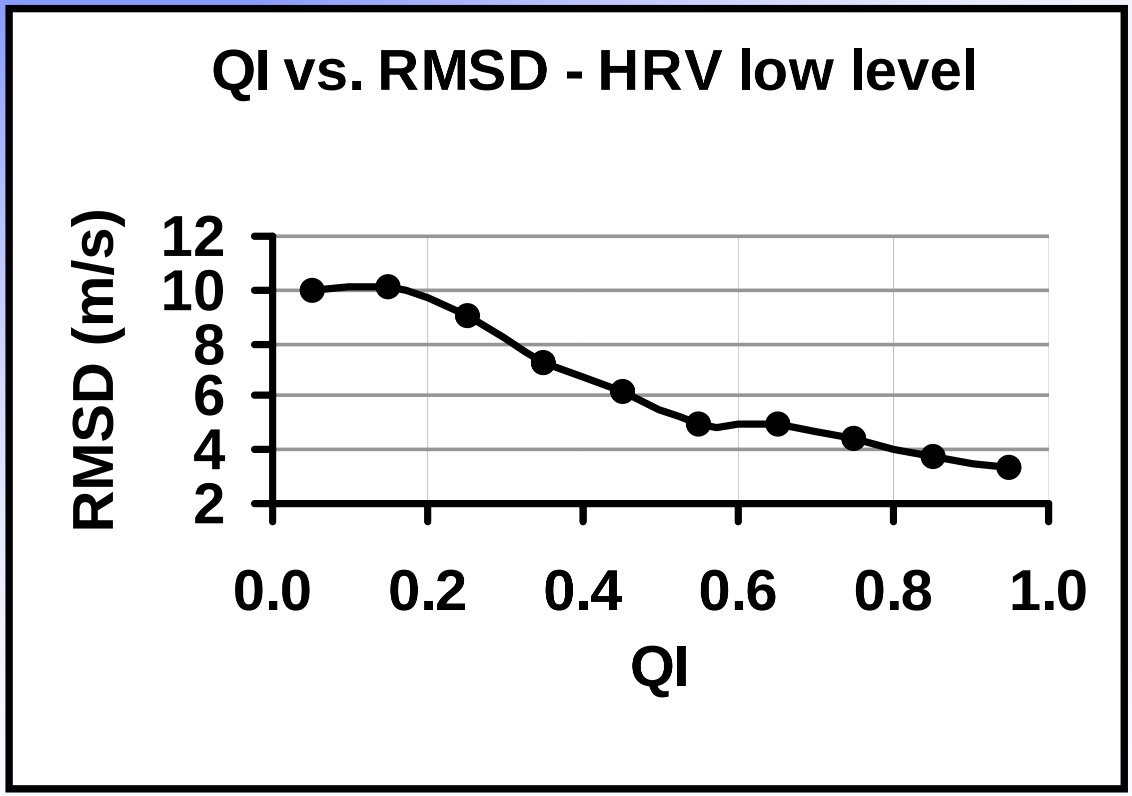
## Quality Indicator (QI)

Considers

- Direction consistency (pair)
- Speed consistency (pair)
- Vector consistency (pair)
- Spatial Consistency
- Forecast Consistency

$$QI = \sum w_i . QV_i / \sum w_i$$

**Fig.3. Quality Indicator (QI) versus root mean square difference (RMSD) with radiosondes within 150 km for low level high-resolution visible image based AMVs for 28 April, 2000 to 29 April 2001.**



## EE - provides RMS Error (RMS)

In current ops. currently estimated from:
the five QI components, wind speed vertical wind shear, temperature shear, pressure level which are used as predictands for root mean square error

Other statistical and physical calculation methods have been tested

# EE ( RMS Error (RMS))

Is inserted into current NESDIS BUFR (in test mode) using

$$QualityFlag\left(EE\right) = \left(100 - 10.0 * EE\right)$$

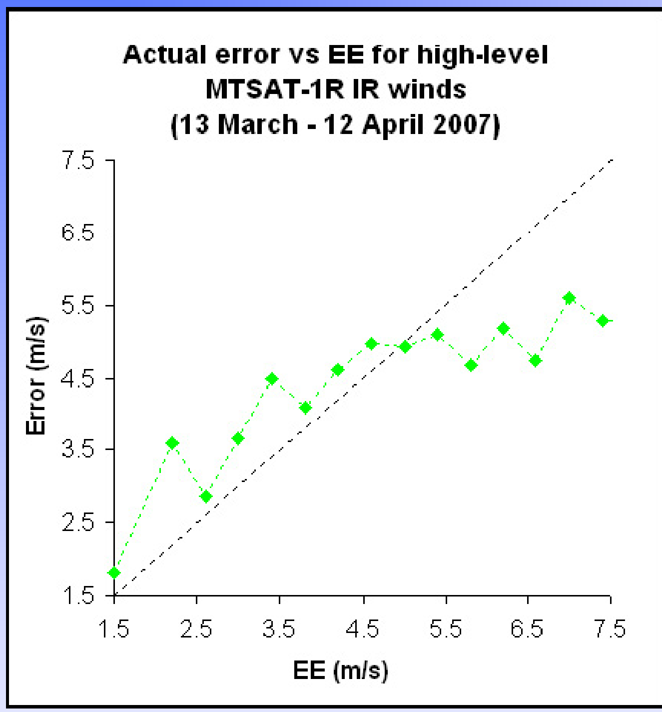



Fig. 2 (a) Measured error (m/s) versus EE for high-level MTSAT-1R IR winds (13 March - 12 April 2007

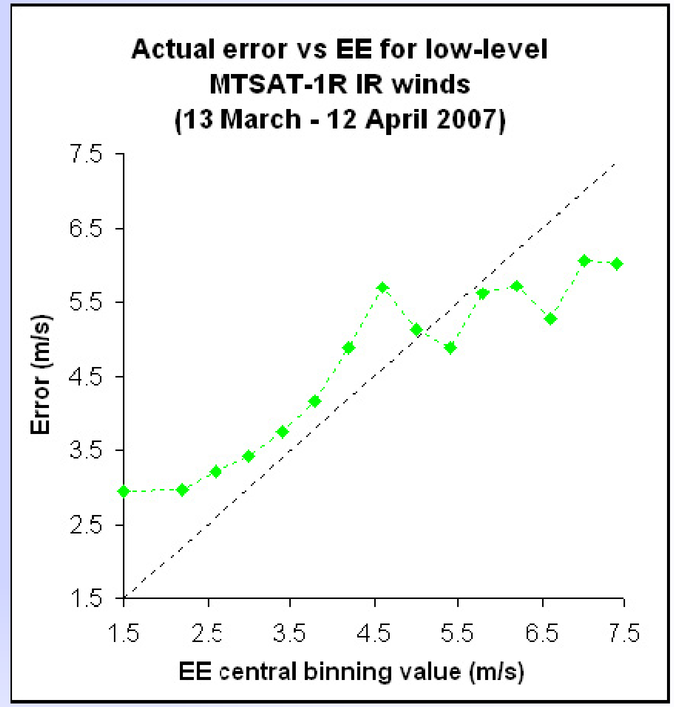



Fig. 2 (b) Measured error (m/s) versus EE for low-level MTSAT-1R IR winds (13 March - 12 April 2007)

## Table 2. Mean Magnitude of Vector Difference (MMVD) between MTSat-1R AMVs, forecast model first guess and radiosonde winds within 150 km for March 2007

| Level | No. of Obs | First Guess MMVD ($ms^{-1}$) | AMV MMVD ($ms^{-1}$) |
|---|---|---|---|
| Low<br>950 – 700 hPa | 192 | 2.67 | 2.92 |
| Middle<br>699 – 400 hPa | 88 | 3.79 | 3.75 |
| High<br>399 – 150 hPa | 706 | 4.13 | 4.08 |

Table 5.2: AMV numbers and comparative errors in predicted error when selecting upper level WV AMVs (November 2002) using EE and QI. Vector samples here are chosen with average MMVD equal to 5 and 6 $ms^{-1}$ respectively. (From Le Marshall et al. (2004a))

| | EE | QI | EE | QI |
|---|---|---|---|---|
| **Threshold** | EE < 5.2 | QI>.98 | EE<8.5 | QI>.89 |
| **No. of matches** | 3156 | 514 | 7265 | 2863 |
| **Av. MMVD** | 5.00 | 5.00 | 6.0 | 6.0 |
| **Av. error in predicted error** | 3.17 | 5.24 | 3.25 | 4.31 |

# *Correlated Error*

## Correlated error

The correlated error has been analysed for the Bureau produced MTSat-1R winds. The methodology was similar to that followed previously (Le Marshall et al., 2004). The correlated error and its spatial variation (length scale) were determined using the Second Order Auto Regressive (SOAR) function :

$$R(r) = R_{00} + R_0(1 + r/L)\exp(-r/L) \qquad (2)$$

Where **R(r)** is the error correlation, $\mathbf{R_0}$ and $\mathbf{R_{00}}$ are the fitting parameters (greater than 0), L is the length scale and r is the separation of the correlates. The difference between AMV and radiosonde winds (error) has been separated into correlated and non-correlated parts. A typical variation of error correlation with distance for MTSat-1R IR1 AMVs is seen in Figure 3, while the parameters of the SOAR function which best fits the observations are contained in Table 3.

## Fig. 3 Error correlation versus distance (100 km bins) for low-level MTSat-1R AMVs with EE < 6 and 8 m/s (March – July 2007)

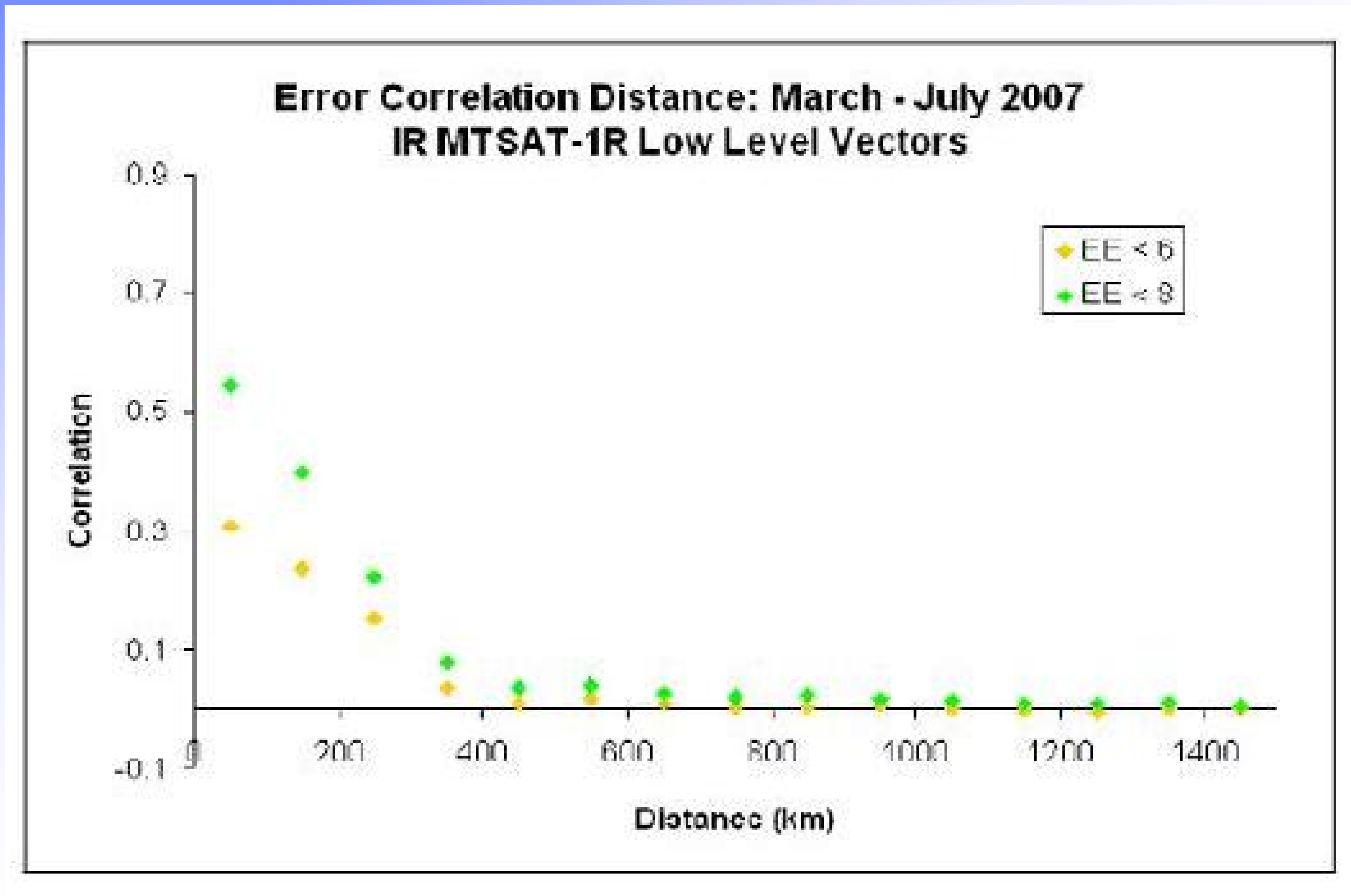


**Table 3. Parameters of the SOAR function (Equation 2) which best model the measured error correlations for the MTSat-1R AMVs listed in the left column of the table. (February – April, 2007)**

| **MTSat-1R IR1 AMVS** | **$R_{00}$** | | **$R_0$** | | **L (km)** | |
|---|---|---|---|---|---|---|
| | Low | High | Low | High | Low | High |
| **EE < 6** | 0.006 | 0.370 | 0.460 | 0.460 | 86.000 | 99.900 |
| **EE < 8** | 0.066 | 0.052 | 0.640 | 0.440 | 122.700 | 110.900 |

# *MTSaT-1R DIRECT READOUT AMV GENERATION AND RT ASSIMILATION*

MTSaT-1R at 140°E 0°S from 2005

Ch2 (IR1) AMVs generated in RT

RT trial 30 May - 15 June 2007 – 30 cases
Trial used then operational RT LAPS 375 51 levels

RT trial 1 Sept. - 8 Aug. 2007 – 72 cases
Trial used now operational RT LAPS 375 61 levels

Local AMVs subsequently accepted for operational use.

# *RT MTSaT–1R  IR1 AMVs*

Used 3 images separated by 15 min. or 60 min.

Used $H_20$ intercept method for upper level AMVs (Ch3/4) (Schmetz et al., 1993) or Window Method.

Used cloud base assignment for lower level AMVs (Ch4)  (Le Marshall et al. 1997) or Window Method.

Q.C. via EE, QI, ERR, RFF etc.

No autoedit

# *OPERATIONAL TRIAL*

30 May – 15 June 2008

Used

* Real Time Local Satellite Winds

~ 2 sets of IR1 quarter hourly motion vectors every six hours.

* Operational Regional Forecast Model (L51)and Data Base ( Inc JMA AMVs)

* Operational Regional Verification Grid

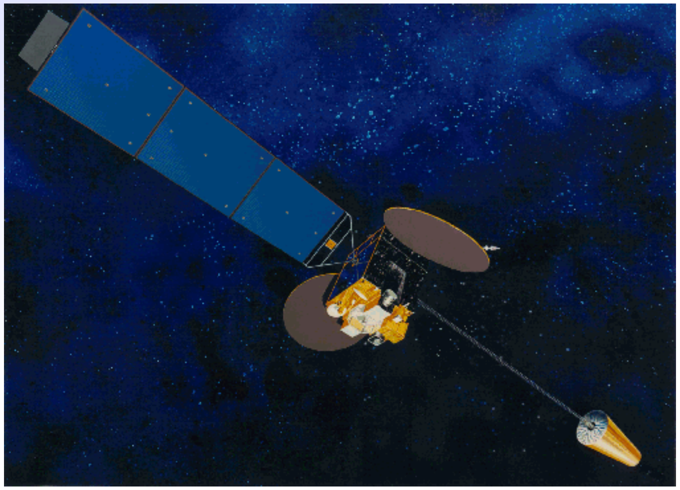


**Table 4. Mean Magnitude of Vector Difference (MMVD) and Root Mean Square Difference (RMSD) between MTSat-1R AMVs, forecast model first guess winds and radiosonde winds for the period 30 May to 15 June 2007**

| Level | Data Source | Bias ($ms^{-1}$) | No. of Obs | MMVD ($ms^{-1}$) | RMSVD ($ms^{-1}$) |
|---|---|---|---|---|---|
| **High** – up to 150 km separation between radiosondes and AMVs | **AMVs** | -0.55 | 1386 | 3.90 | 4.47 |
| | **First Guess** | 1.3776 | 1386 | 4.42 | 5.09 |
| **Low -** up to 150 km separation between radiosondes and AMVs | **AMVs** | -0.76 | 540 | 3.18 | 3.72 |
| | **First Guess** | -0.70 | 540 | 2.72 | 3.12 |
| **Low** – up to 30 km separation between radiosondes and AMVs | **AMVs** | -0.44 | 18 | 2.45 | 3.08 |
| | **First Guess** | -0.20 | 18 | 2.67 | 3.07 |

Accepted/Rejected Observations for LAPS model based on Wind Spd/Dir
WMC/RTH Melbourne
Date: 20071216 at cycle 3 analysis 00Z (extracted at 00:49 UTC)

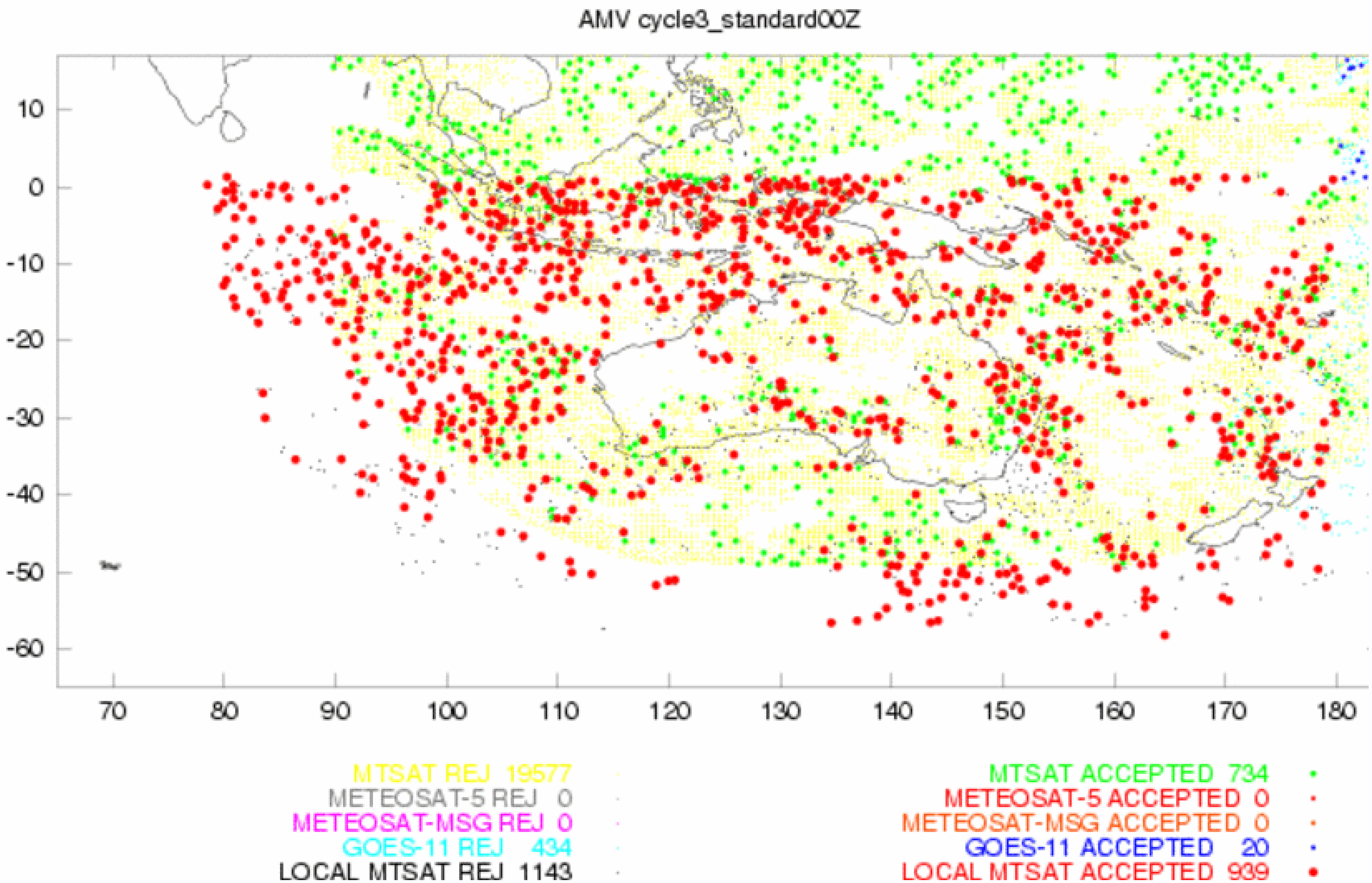


**Table 5 (a) 24 hr forecast verification S1 Skill Scores for the May 2007 operational regional forecast system (L51 LAPS) and L51 LAPS with IR, 6-hourly image based AMVs for 30 May to 15 June 2007 (34 cases)**

| LEVEL | (LAPS) S1 | (LAPS + MTSAT-1R AMVS) S1 |
|---|---|---|
| MSLP | 19.00 | 18.81 |
| 1000 hPa | 21.35 | 20.80 |
| 900 hPa | 22.42 | 22.08 |
| 850 hPa | 22.81 | 22.76 |
| 500 hPa | 15.96 | 15.91 |
| 300 hPa | 13.65 | 13.65 |
| 250 hPa | 12.62 | 12.58 |

# *OPERATIONAL TRIAL*

1 September – 8 October 2008

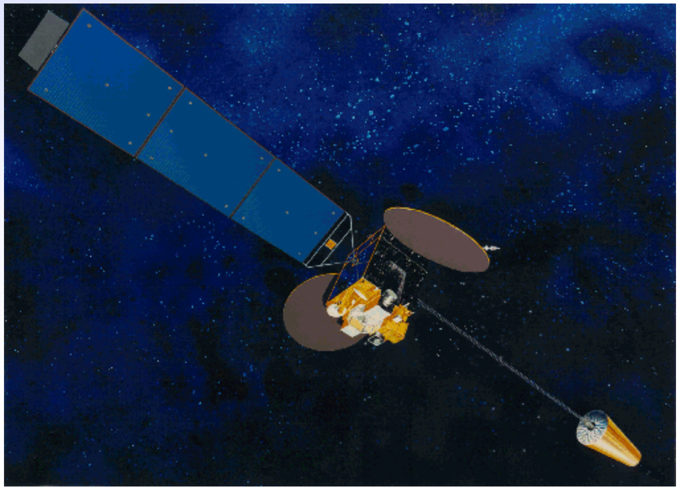
Used

* Real Time Local Satellite Winds

~ 2 sets of IR1 quarter hourly motion vectors every six hours.

* Operational Regional Forecast Model (L61)and Data Base ( Inc JMA AMVs)

* Operational Regional Verification Grid



## Table 5 (b) 24 hr forecast verification S1 Skill Scores for the next operational regional forecast system (L61 LAPS) and L61 LAPS with IR, 6-hourly image based AMVs for 1 September to 8 October 2007 (72 cases)

| LEVEL | (LAPS) S1 | (LAPS + MTSAT-1R AMVS) S1 |
|---|---|---|
| MSLP | 20.24 | 19.15 |
| 1000 hPa | 20.06 | 19.13 |
| 900 hPa | 18.65 | 17.75 |
| 850 hPa | 17.41 | 16.69 |
| 500 hPa | 12.41 | 11.73 |
| 300 hPa | 10.49 | 9.76 |
| 250 hPa | 12.41 | 11.90 |

| Table 5 (a) 24 hr forecast verification S1 Skill Scores for the May 2007 operational regional forecast system (L51 LAPS) and L51 LAPS with IR, 6-hourly image based AMVs for 30 May to 15 June 2007 (34 cases) | | | Table 5 (b) 24 hr forecast verification S1 Skill Scores for the next operational regional forecast system (L61 LAPS) and L61 LAPS with IR, 6-hourly image based AMVs for 1 September to 8 October 2007 (72 cases) | | |
|---|---|---|---|---|---|
| **LEVEL** | **(LAPS) S1** | **(LAPS + MTSAT-1R AMVS) S1** | **LEVEL** | **(LAPS) S1** | **(LAPS + MTSAT-1R AMVS) S1** |
| **MSLP** | 19.00 | 18.81 | **MSLP** | 20.24 | 19.15 |
| **1000 hPa** | 21.35 | 20.80 | **1000 hPa** | 20.06 | 19.13 |
| **900 hPa** | 22.42 | 22.08 | **900 hPa** | 18.65 | 17.75 |
| **850 hPa** | 22.81 | 22.76 | **850 hPa** | 17.41 | 16.69 |
| **500 hPa** | 15.96 | 15.91 | **500 hPa** | 12.41 | 11.73 |
| **300 hPa** | 13.65 | 13.65 | **300 hPa** | 10.49 | 9.76 |
| **250 hPa** | 12.62 | 12.58 | **250 hPa** | 12.41 | 11.90 |

# *The Transition from MTSaT–1R HIRID Format to HRIT Format*

02:30 UTC 12 March 2008

| HRIT IR1 AMV/RAOB Comparison: 24 January – 20 February, 2008 v1 15min. | | | | | | |
|---|---|---|---|---|---|---|
| **Wind Level** | **LOW** ERR=0,EE<3.5 | | | | **High** ERR=0,QI=.6-1. | |
| **Wind Type** | **AMV** | | **Background** | | **AMV** | **Background** |
| **RAOB/AMV Sep** | **75** | **150** | **75** | **150** | **150** | **150** |
| **No of Vectors** | **53** | **264** | **53** | **264** | **2953** | **2953** |
| **Bias m/s** | **0.27** | **0.3** | **-0.26** | **-.28** | **-0.05** | **-0.92** |
| **MMVD** | **2.40** | **2.83** | **2.56** | **2.73** | **4.04** | **4.17** |
| **RMS VD m/s** | **2.72** | **3.24** | **2.76** | **3.08** | **4.59** | **4.81** |

| HRIT IR1 AMV/RAOB Comparison: 24 January – 20 February, 2008 v2 15min. | | | | | | |
|---|---|---|---|---|---|---|
| **Wind Level** | **LOW** ERR=0,EE<3.5 | | | | **High** ERR=0,QI=.6-1. | |
| **Wind Type** | **AMV** | | **Background** | | **AMV** | **Background** |
| **RAOB/AMV Sep** | **75** | **150** | **75** | **150** | **150** | **150** |
| **No of Vectors** | **53** | **264** | **53** | **264** | **3254** | **3254** |
| **BIAS m/s** | **-0.08** | **-0.21** | **-0.26** | **-0.28** | **0.80** | **-1.07** |
| **MMVD m/s** | **2.22** | **2.71** | **2.56** | **2.73** | **3.82** | **4.28** |
| **RMS VD m/s** | **2.53** | **3.12** | **2.76** | **3.08** | **4.41** | **4.92** |

# HRIT AMVs – Pre-implementation Operational Test

**Operational TLAPS S1 Scores versus Operational TLAPS plus HRIT IR1 Atmospheric Motion Vectors (AMVs)-Feb 21 –March-10 (17 Cases)**

| | Ops. | Ops. + HRIT |
|---|---|---|
| **MSLP** | 24.76 | 24.29 |
| **1000 hPa** | 24.47 | 24.17 |
| **850hPa** | 23.88 | 23.47 |
| **500 hPa** | 18.23 | 17.88 |
| **300 hPa** | 16.88 | 16.70 |
| **250 hPa** | 15.76 | 15.52 |

# The Future

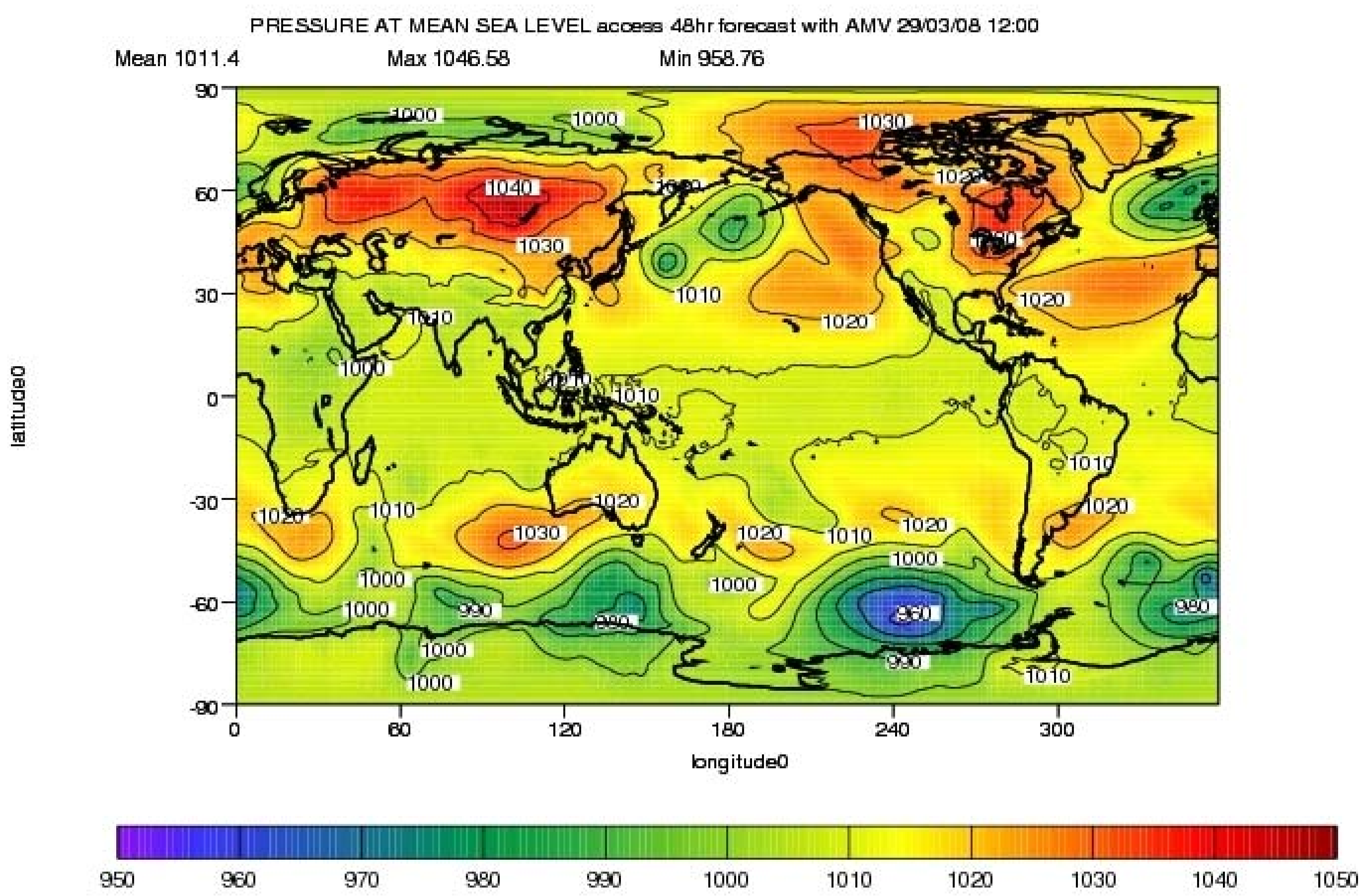
- ACCESS – UKUM
- Global and Regional Impact Studies
- Use of Continuous Data- Hourly AMVs in 4D-VAR

  eg.TC Nicholas Western Australian region February 2008

# The Future

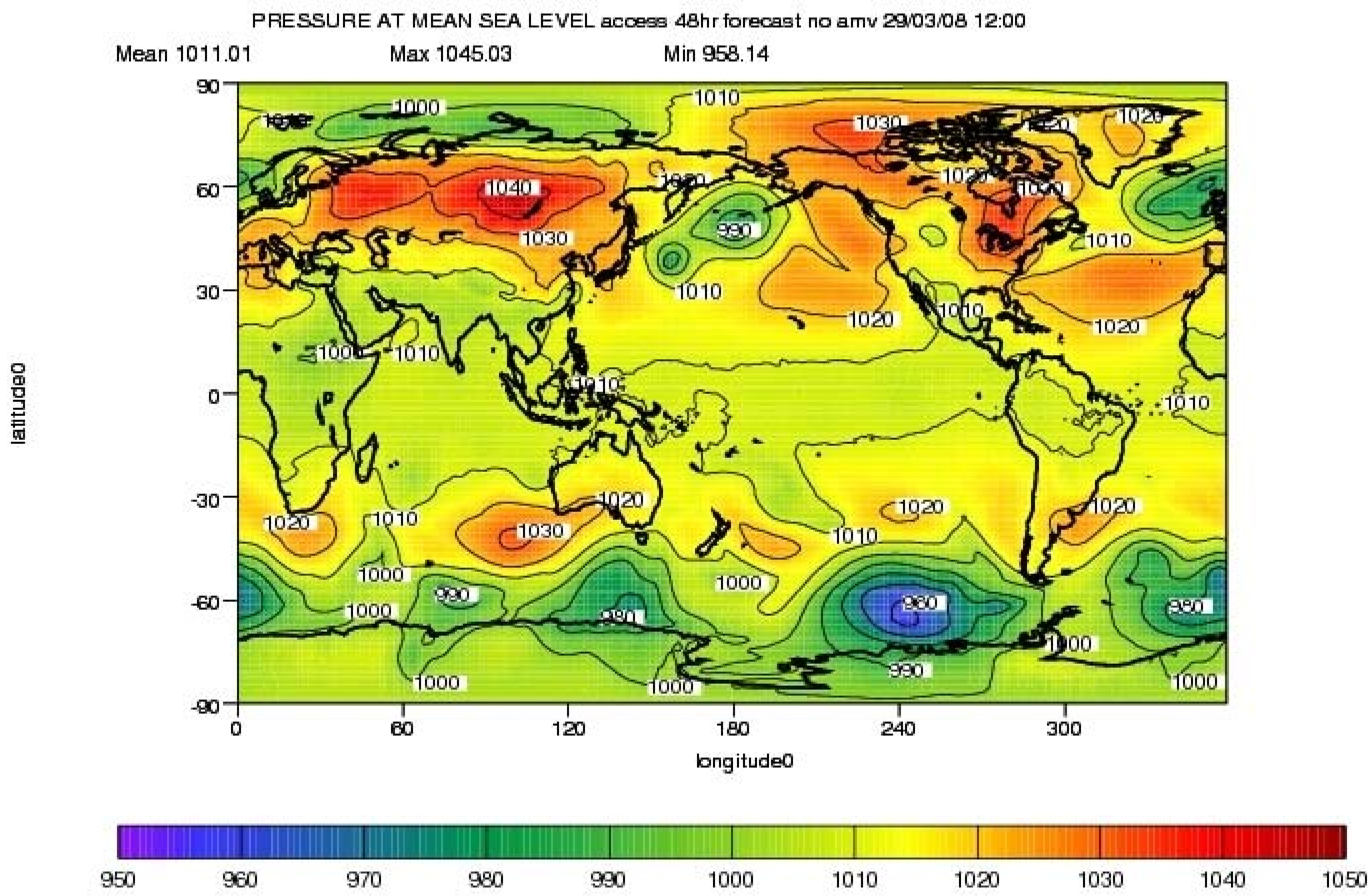
- ACCESS – UKUM
- Global and Regional Impact Studies

# The Future



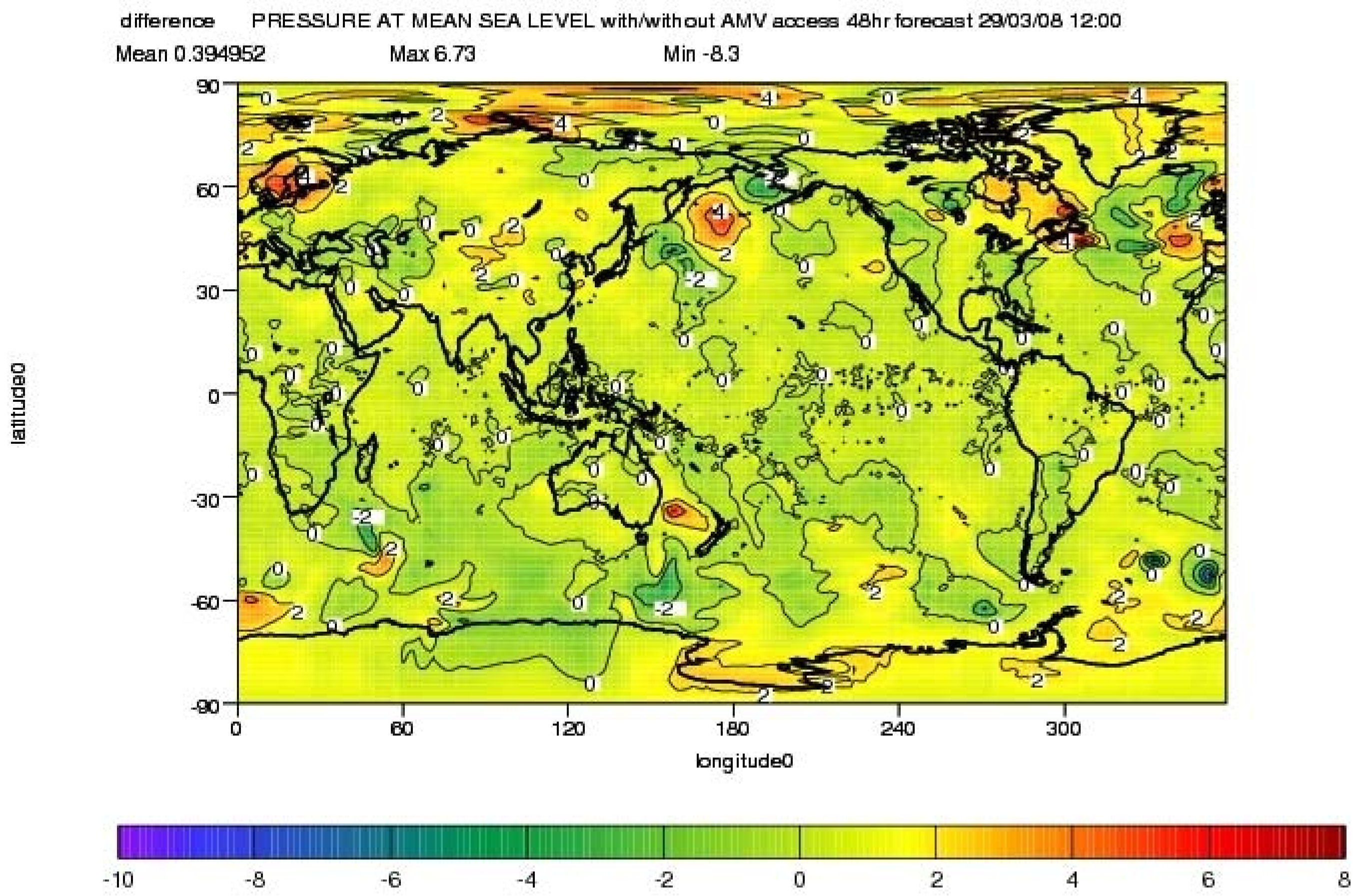
PRESSURE AT MEAN SEA LEVEL access 48hr forecast with AMV 29/03/08 12:00
Mean 1011.4
Max 1046.58
Min 958.76
latitude0
longitude0
90
60
30
0
-30
-60
-90
0
60
120
180
240
300
950
960
970
980
990
1000
1010
1020
1030
1040
1050

# The Future



PRESSURE AT MEAN SEA LEVEL access 48hr forecast no amv 29/03/08 12:00
Mean 1011.01
Max 1045.03
Min 958.14
latitude0
longitude0

# The Future

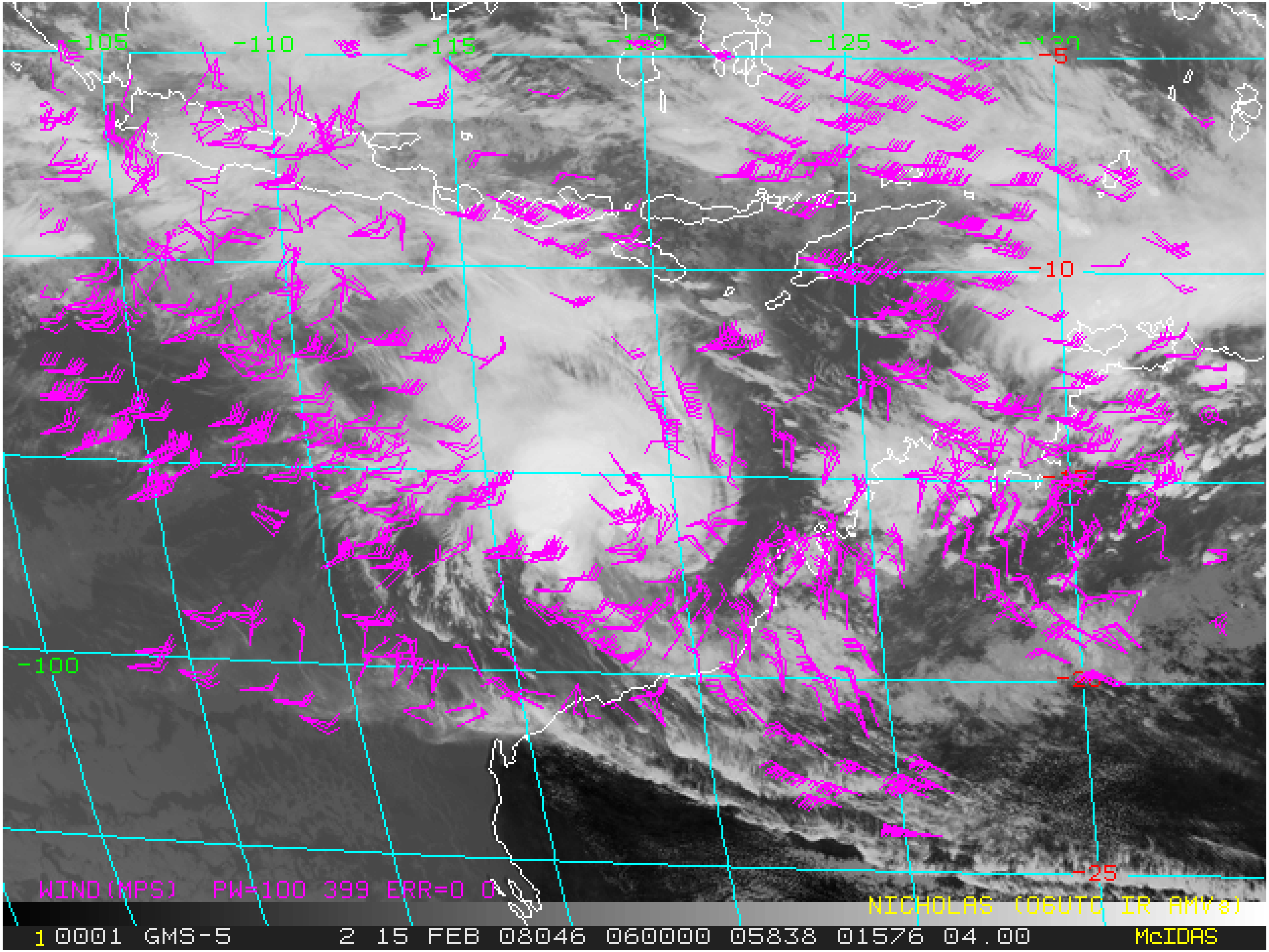

difference PRESSURE AT MEAN SEA LEVEL with/without AMV access 48hr forecast 29/03/08 12:00
Mean 0.394952
Max 6.73
Min -8.3
latitude0
longitude0
90
60
30
0
-30
-60
-90
0
60
120
180
240
300
-10
-8
-6
-4
-2
0
2
4
6
8

# The Future

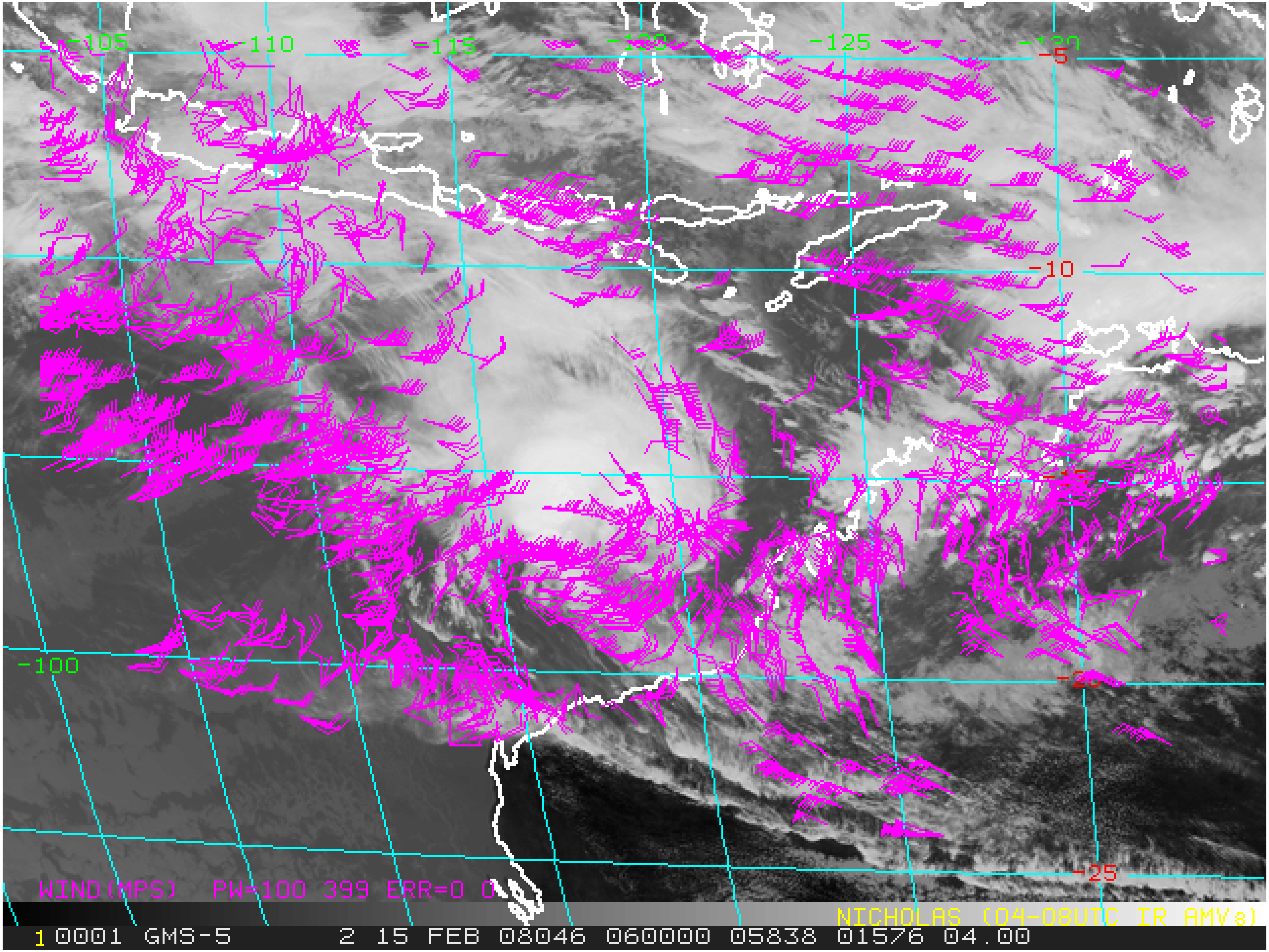
- ACCESS – UKUM

- Use of Continuous Data- Hourly AMVs in 4D-VAR (Regional 37.5km )

  eg.TC Nicholas Western Australian region February 2008



-105
-110
-115
-120
-125
-130
-5
-10
-15
-20
-25
-100
WIND(MPS) PW=100 399 ERR=0 0
NICHOLAS (06UTC IR AMV's)
1 0001 GMS-5 2 15 FEB 08046 060000 05838 01576 04.00 McIDAS


-105
-110
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-120
-125
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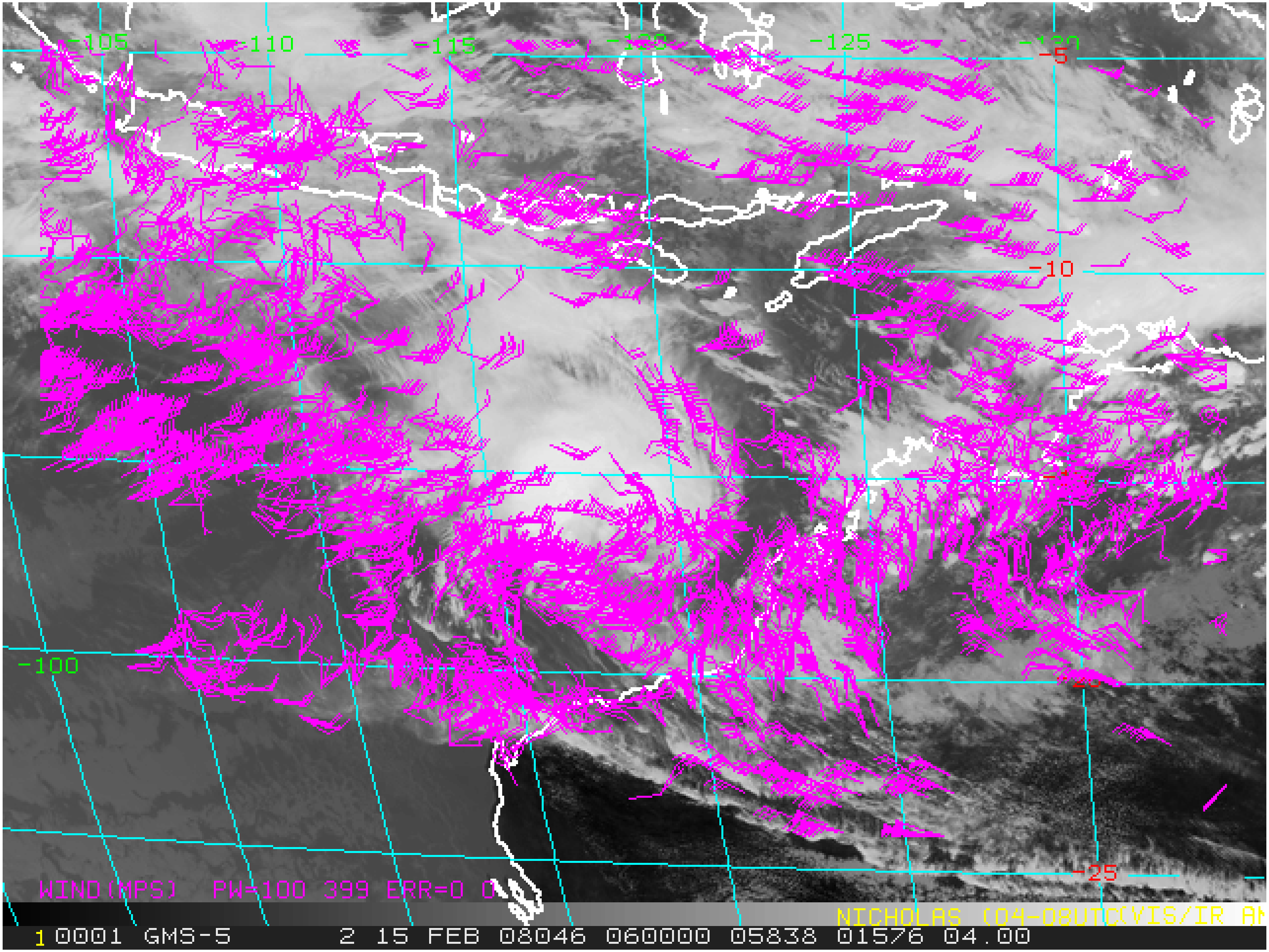
-20
-25
-100
WIND(MPS) PW=100 399 ERR=0 0
NICHOLAS (04-08UTC IR AMVs)
1 0001 GMS-5 2 15 FEB 08046 060000 05838 01576 04.00



-105
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-125
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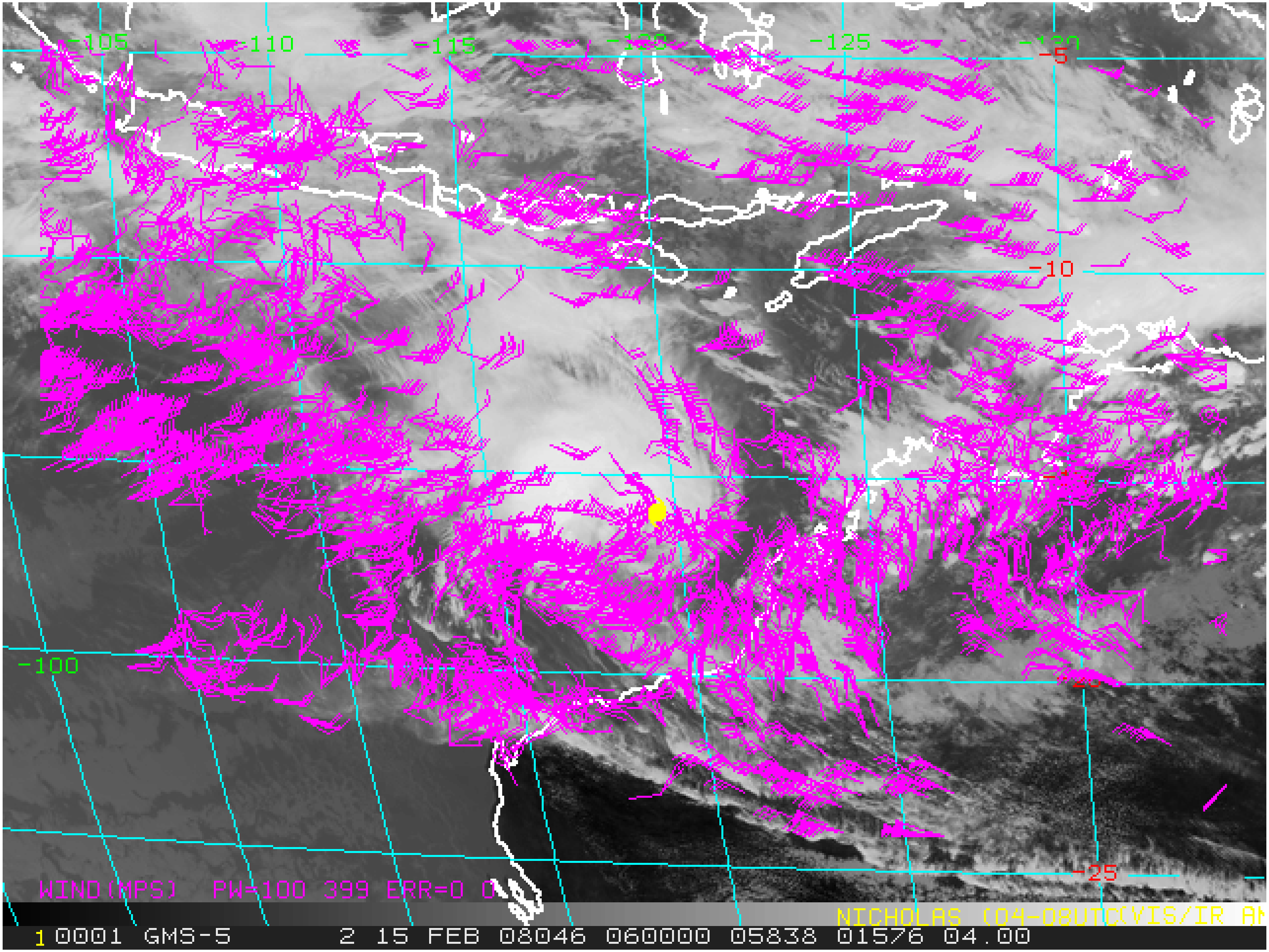
-5
-10
-20
-25
-100
WIND(MPS) PW=100 399 ERR=0 0
NICHOLAS (04-08UTC(VIS/IR AN
1 0001 GMS-5 2 15 FEB 08046 060000 05838 01576 04.00


-105
-110
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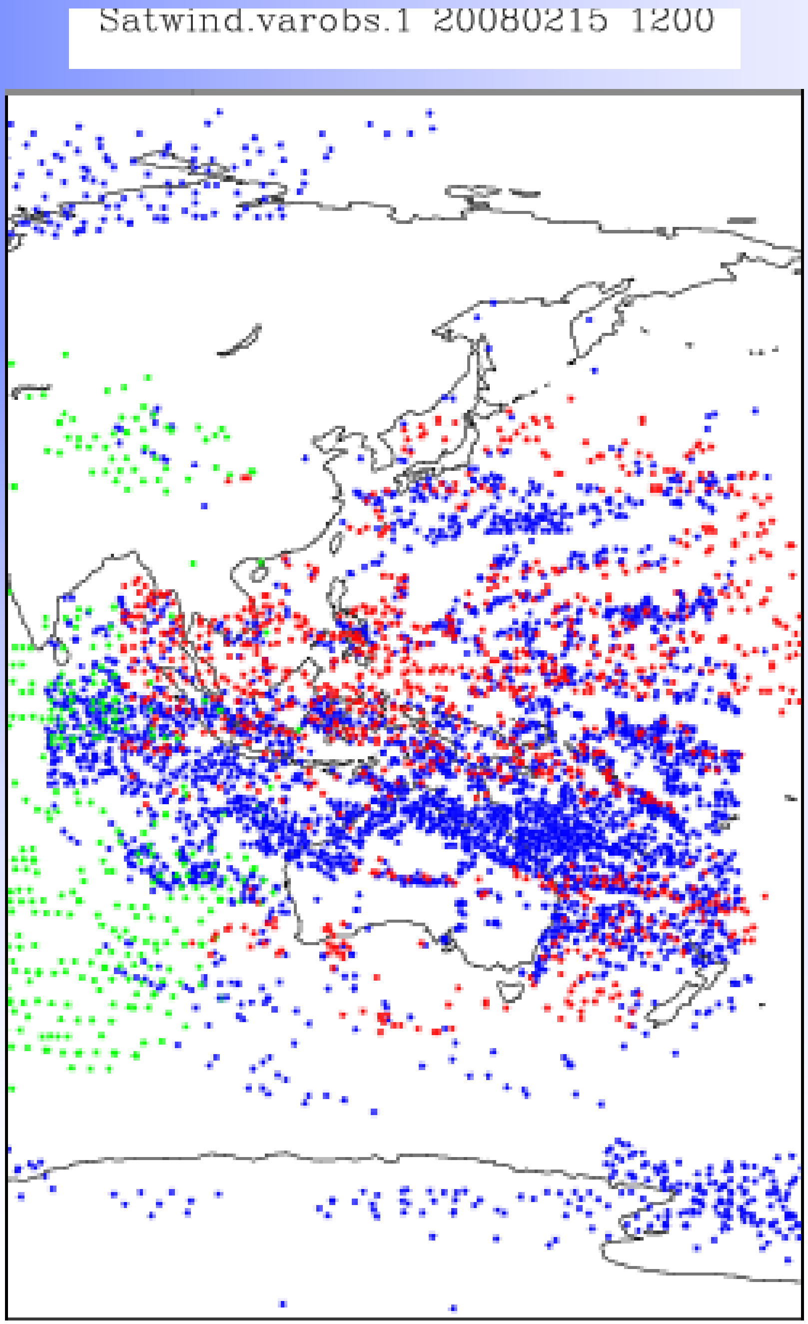
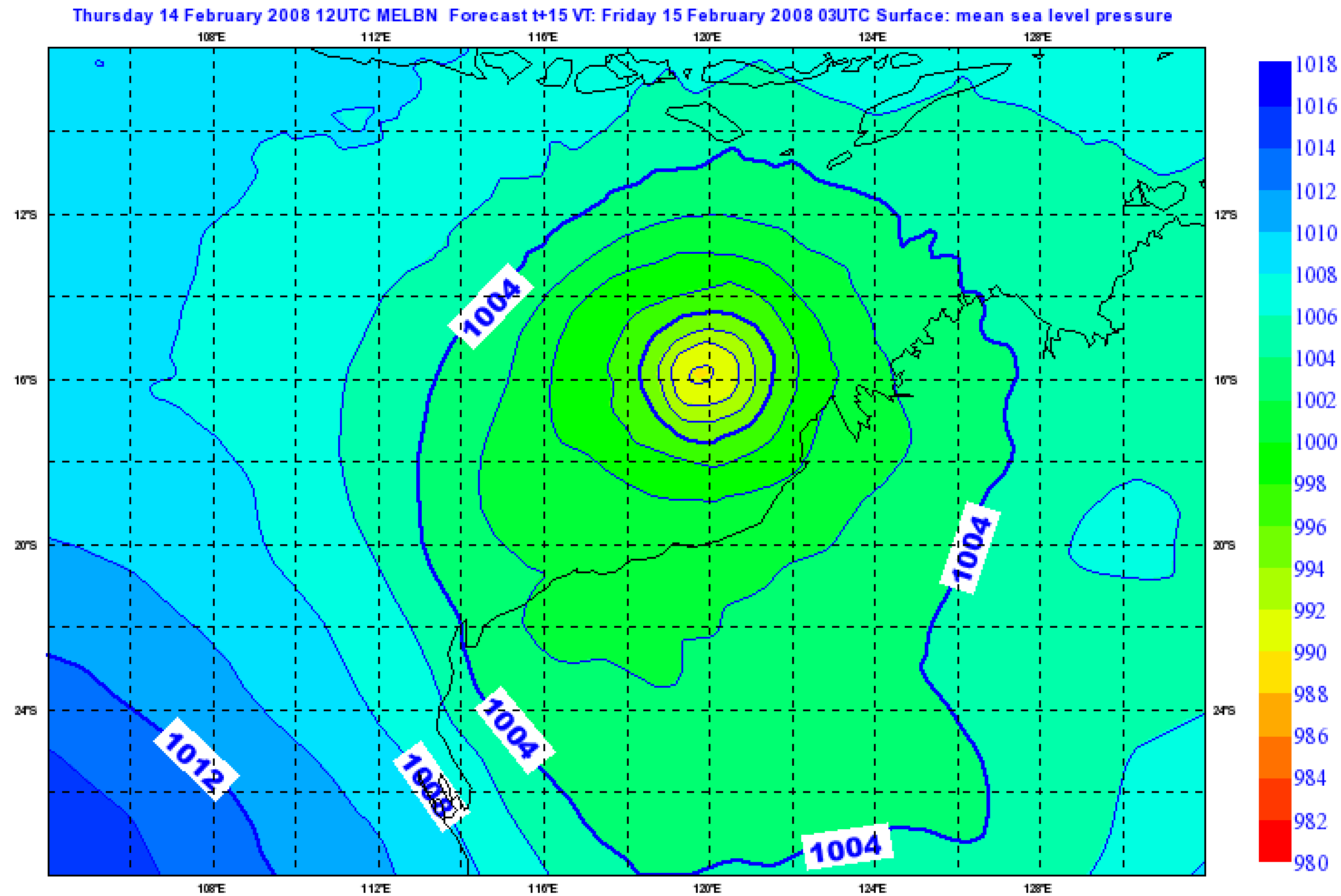
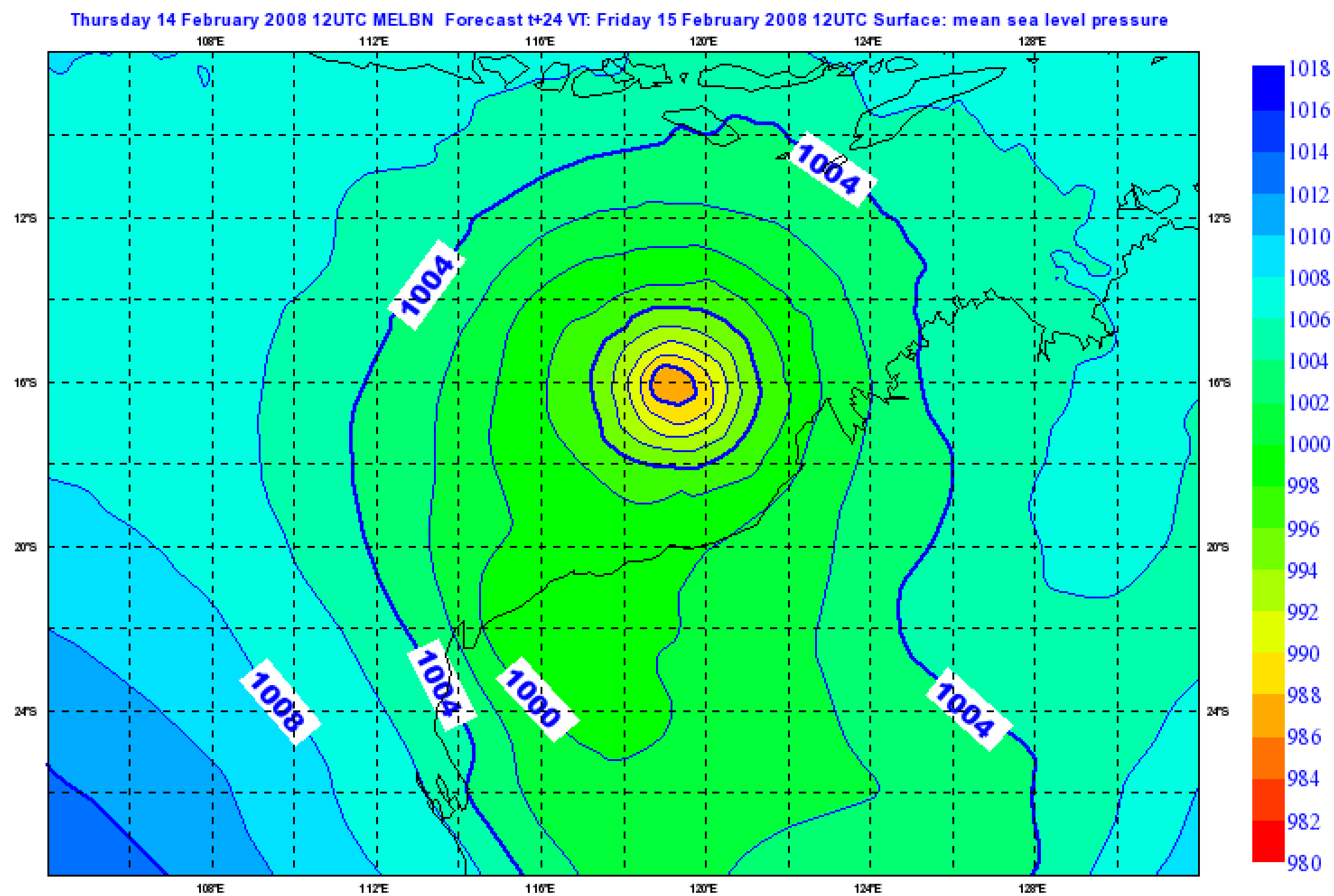
-120
-125
-130
-5
-10
-25
-100
WIND(MPS) PW=100 399 ERR=0 0
NICHOLAS (04-08UTC(VIS/IR AN
1 0001 GMS-5 2 15 FEB 08046 060000 05838 01576 04.00

Local MTSat-1R
JMA
ESAC




Thursday 14 February 2008 12UTC MELBN Forecast t+15 VT: Friday 15 February 2008 03UTC Surface: mean sea level pressure
108°E
112°E
116°E
120°E
124°E
128°E
12°S
16°S
20°S
24°S
1004
1004
1004
1004
1008
1012
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
998
996
994
992
990
988
986
984
982
980


Thursday 14 February 2008 12UTC MELBN Forecast t+24 VT: Friday 15 February 2008 12UTC Surface: mean sea level pressure
108°E
112°E
116°E
120°E
124°E
128°E
12°S
16°S
20°S
24°S
1004
1004
1004
1004
1008
1000
1018
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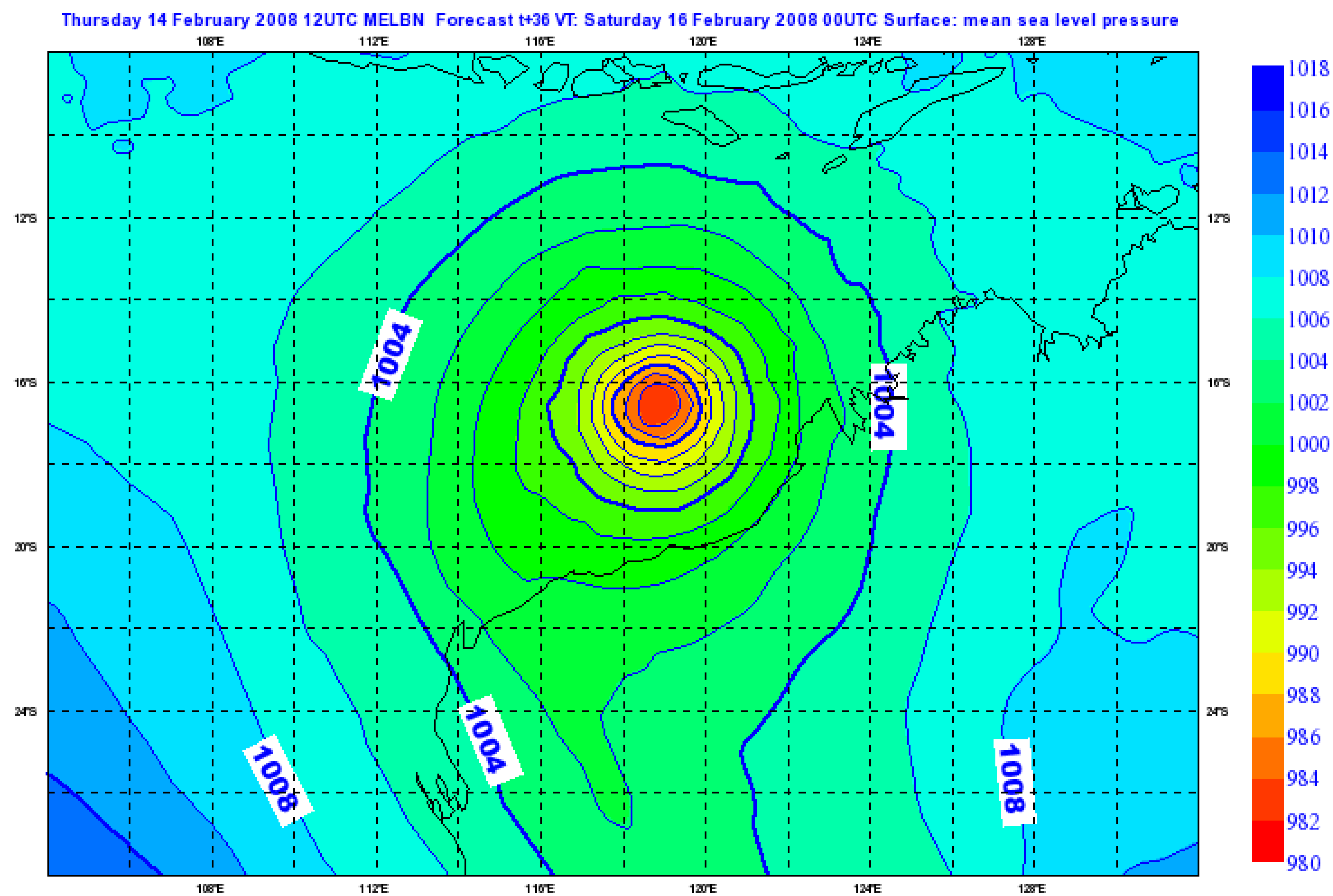
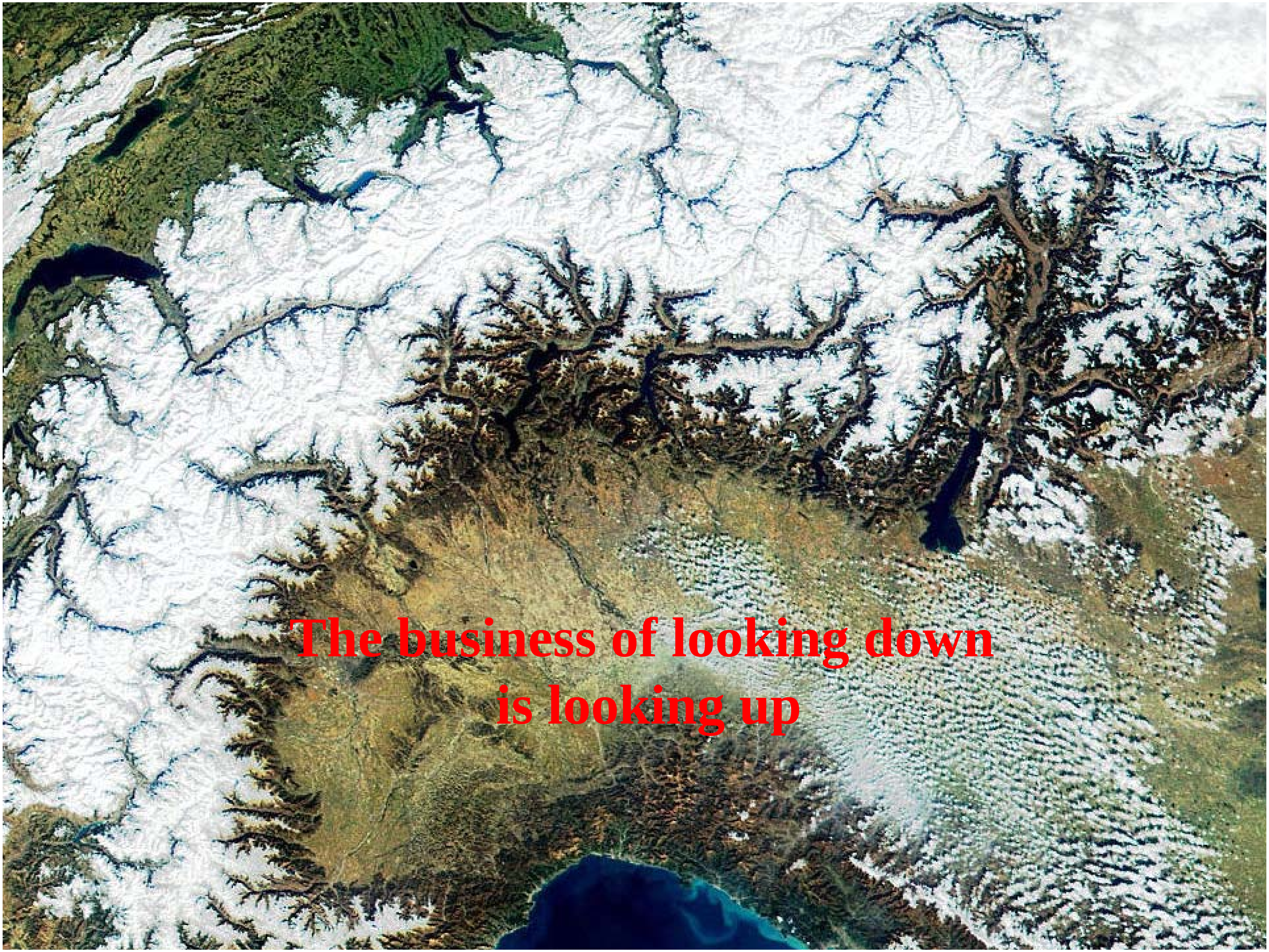
986
984
982
980


Thursday 14 February 2008 12UTC MELBN Forecast t+36 VT: Saturday 16 February 2008 00UTC Surface: mean sea level pressure
108°E
112°E
116°E
120°E
124°E
128°E
12°S
16°S
20°S
24°S
1004
1004
1004
1008
1008
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
998
996
994
992
990
988
986
984
982
980

# The Future

- Cloud Height Assignment and Verification – LBF, A-Train
- AMV Error Characterization
- Model Clouds
- Continuous data/4D-VAR
- Moisture tracking / 4D-VAR
- ………..



The business of looking down
is looking up

# Discussion and Conclusions

- Both the geo-stationery and polar orbiting satellite-based AMVs have been shown to make a significant contribution globally to operational analysis and forecasting.
- MODIS AMVs have been shown to make a positive contribution in polar, mid-latitude and tropical regions.
- MTSaT-1R AMVs have been generated at the Australian BoM and have been shown to provide significant benefits in the Australian region.
- The successful application of MTSaT-1R AMVs has been facilitated by the careful use of quality-control parameters such as the EE, ERR and QI.
- Assimilatiom studies with UKUM based ACCESS model underway and showing promising results.

Australian Government

Bureau of Meteorology

CSIRO

JOINT CENTER FOR SATELLITE DATA ASSIMILATION

NOAA NASA JCSDA Navy Air Force