



Sixth Meeting of CNS/MET Sub-Group of APANPIRG

Bangkok, Thailand, 15 – 19 July 2002

**Agenda Item 12: Implementation of International Airway
Volcano Watch (IAVW)**

IMPROVING THE PERFORMANCE OF DARWIN VAAC

(Presented by Australia)

SUMMARY

This paper provides an overview of action taken by Australia to improve the operational performance of the Darwin VAAC and hence the IAVW.

1. Introduction

1.1 This paper (i) provides an overview of the status of research and development being undertaken in Australia, by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in conjunction with the Darwin VAAC, to improve satellite algorithms used for the identification of volcanic ash clouds and sulfur dioxide gas; (ii) action taken to establish a new position in the Darwin VAAC for a volcanic ash warning specialist; and (iii) work undertaken by the Bureau of Meteorology to develop an integrated volcanic ash advisory preparation system.

2. Development of a Robust Water Vapour Algorithm

2.1 Split-window infrared channels are used by Darwin VAAC to discriminate volcanic ash clouds from other meteorological clouds composed of water vapour, water droplets and ice particles. Current algorithms perform poorly in the presence of water vapour, and several problems have been identified in relation to volcanic eruptions in the tropics.

2.2 It is realised the presence of water vapour in the lower atmosphere is always going to interfere with the correct operation of the infrared temperature difference algorithm used by the Darwin VAAC to detect volcanic ash. However, the water vapour effect can be minimised using an independent estimate of the amount of water vapour in the lowest few kms of the atmosphere. Estimates of atmospheric water vapour from climatological data-bases, from weather analysis fields or from other satellite data can be used to overcome this problem.

2.3 An analysis of climatological water vapour fields in the tropics suggests that a good approximation of the water vapour effect can be achieved through a simple parametric algorithm that uses satellite infrared imagery. The temperature difference algorithm used by the Darwin VAAC is being modified to take into account the water vapour effect using satellite data only. This scene-based approach, relying only on the satellite image data, is simple and efficient to implement in an operational environment.

2.4 Initial tests of the new water vapour robust volcanic ash algorithm indicate that it has better sensitivity to low ash densities and thus improved discrimination of ash particles, particularly in the tropics.

3. **Sulfur Dioxide Identification**

3.1 Sulfur dioxide (SO₂) is a major constituent of erupted volcanic clouds. The gas quickly converts to sulfuric acid, which has a corrosive effect on aircraft frames, windows and internal surfaces. The sulfur dioxide gas itself is an indicator of a volcanic hazard, but is often transported in a different direction to volcanic ash because it is lighter. The separation of gas from ash is recognised as a frequent and important phenomenon, thus there is a requirement to identify both constituents.

3.2 The TIROS Operational Vertical Sounder (TOVS) is a package of instruments on board the NOAA polar orbiting satellites. The data are routinely received and processed by most national meteorological agencies. The Australian Bureau of Meteorology is a regular user of TOVS data for weather forecasting and other related services. The data are available for any given region on a twice daily basis from each of two operational satellites. Thus these data are of great use in tracking and monitoring volcanic clouds.

3.3 The TOVS package has many infrared channels that are used principally for deriving the vertical profiles of humidity and temperature in the atmosphere. One of the channels, intended for sounding lower troposphere humidity, covers a strong absorption feature of sulfur dioxide gas. Research studies using this channel, centred near 7.3 µm, have shown that it is very sensitive to the presence of SO₂ in the upper troposphere and lower stratosphere (i.e. above FL200).

3.4 A new algorithm is being developed and tested to exploit the 7.3 µm TOVS data. The algorithm is undergoing testing and should become a component of the Darwin VAAC's volcanic cloud detection system in the near future.

3.5 The new algorithm is also applicable to MODIS data, which has much better spatial resolution compared to TOVS.

4. **Volcanic Ash Warning Specialist**

4.1 To further improve the operational performance of the Darwin VAAC a new, volcanic ash warning specialist position has been created. The position which is at the senior meteorologist level (equivalent to the supervisor of a forecasting centre) and has the following duties:

- Provide a specialist focal point for the Darwin Volcanic Ash Advisory Centre (VAAC) for volcanic ash related issues.
- Establish and maintain effective communications links with the Philippine Institute of Volcanology and Seismology (PHIVOLCS); the Volcanological Survey of Indonesia (VSI) and the Rabaul Volcano Observatory (RVO) through regular liaison visits; telephone calls and other forms of contact. Maintain close liaison with airlines in the Asia Pacific Regions, other VAACs, IAVCEI, Geoscience Australia, AusAid, Department of Foreign Affairs and Trade (DFAT) and the CSIRO.
- Arrange for staff from PHIVOLCS, VSI and RVO to visit Australia for attachments and to participate in volcanic ash and related meetings. Assist the three volcanological agencies in the development of project plans to improve the monitoring of volcanic activity and communications.
- Ensure that staff in the Darwin VAAC are kept up to date with the latest techniques and procedures for the detection and prediction of movement of volcanic ash clouds.

- Undertake post eruption analyses/case studies with the aim of converting past experience into improved practices and procedures.
- Provide operational support during volcanic events.

5. **Advisory Preparation System**

5.1 The Bureau of Meteorology is close to completing the development of an integrated user interface designed to improve the volcanic ash advisory preparation process.

5.2 The interface displays a map of the Darwin VAAC area of responsibility together with all volcanoes listed in the Smithsonian volcano database. Users on selecting the volcano of interest are able to draw polygons that show the current and forecast location of volcanic ash clouds. The polygons can be manipulated as required. When the operator is satisfied with the graphical presentation, a text warning can be generated. This creates a text screen showing the Volcanic Ash Advisory with the most relevant fields already filled, including the coordinates for the observed and forecast ash cloud. Some fields, such as the eruption details, need to be completed manually by the operator. The final version of the Volcanic Ash Advisory (VAA) is sent directly from the text screen. A text message is generated and forwarded to the communications system for dissemination. At the same time, an html version of the text VAA is generated for uploading to the internet. The attached figures show the graphical user interface (Fig.1), the VAA text screen (Fig.2); and an example of the issued VAA (Fig.3). Work is now underway to improve operational reliability and usability of the system. The Bureau plans to provide the Darwin VAAC with the latest version of the system for operational trials by the end of August.

5.3 Future work will be directed to (i) the provision of a graphical output product; (ii) the ability to display satellite data on the graphical interface; and (iii) integration with the dispersion model.

6. **Action**

6.1 The meeting is invited to note the actions being undertaken by Australia to further improve the operational effectiveness of the Darwin VAAC and hence the IAVW; and

6.2 Encourage States that operate VAACs to undertake similar research in collaboration with Australia.

Figure 1. Volcanic Ash Warning Preparation System - User Interface

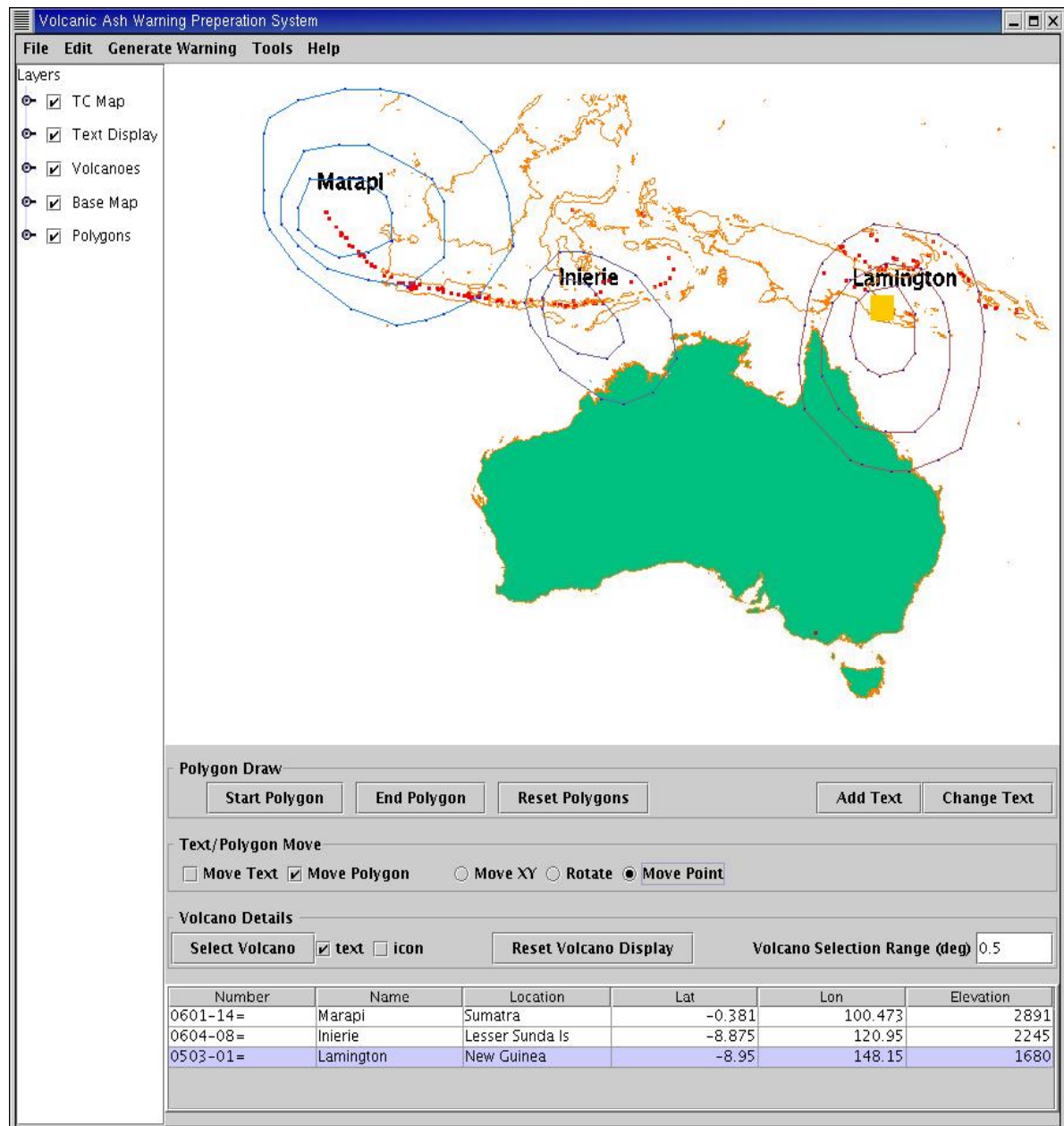


Figure 2. Text Warning Dialogue Display

Volcanic Ash Warning Preparation System

Text Warning Dialog

VOLCANIC ASH ADVISORY

ISSUED: 20020614/0125Z

VAAC: DARWIN

VOLCANO: Lamington 0503-01=

LOCATION: S0856 E14808

AREA: New Guinea

SUMMIT ELEVATION: 1680M = 5511FT

ADVISORY NUMBER: 1

INFORMATION SOURCE: Two aircraft reports at 0613/2200Z.

AVIATION COLOUR CODE: NIL

ERUPTION DETAILS: Pilot reported plume to FL300 at 0613/2200Z.

OBS ASH DATE/TIME: 0613/2200Z.

OBS ASH CLOUD: Description Area covered by cloud estimated tops between FL250 and FL300.

Lat-Lons

Speed Drifting south at 15 knots.

FCST ASH CLD + 6HR: FL250 and 300

FCST ASH CLD + 12HR: FL250 and 300

50730 E14700 - S0830 E14600 - S1130 E14530 - S1330 E14600 - S1430 E14700 - S1500 E14800 - S1430 E15000 - S1300 E15100 - S0930 E15100 - S0700 E14930

50630 E14530 - S0830 E14400 - S1130 E14300 - S1500 E14300 - S1800 E14430 - S1930 E14600 - S2000 E14830 - S2000 E15100 - S1800 E15300 - S1430 E15400 - S1100 E15400 - S0830 E15330 - S0530 E15130 - S0500 E14830

50300 E14500 - S0500 E14300 - S0730 E14200 - S1030 E14130 - S1400 E14100 - S1800 E14130 - S2230 E14530 - S2300 E14630 - S2330 E14900 - S2330 E15030 - S2230 E15300 - S2130 E15500 - S1600 E15630 - S1100 E15700 - S0730 E15630 - S0430 E15530

Lamington

Add Text Change Text

☒ Move One ☐ Move All

Selection Range (deg) 0.5

Lon	Elevation
100.473	2891
120.95	2245
148.15	1680

Figure 3. Volcanic Ash Advisory Message

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emacs@xodus.ho.bom.gov.au
Buffers Files Tools Edit Search Mule Help
VOLCANIC ASH ADVISORY
ISSUED: 20020614/0118Z
VAAC: DARWIN
VOLCANO: Lamington 0503-01=
LOCATION: S0856 E14808
AREA: New Guinea
SUMMIT ELEVATION: 1680M = 5511FT
ADVISORY NUMBER: 1
INFORMATION SOURCE: Two aircraft reports at 0613/2200Z.
AVIATION COLOUR CODE: NIL
ERUPTION DETAILS: Pilot reported plume to FL300 at 0613/2200Z.

OBS ASH DATE/TIME: 0613/2200Z.
OBS ASH CLOUD: Area covered by cloud estimated tops between FL250
and FL300.

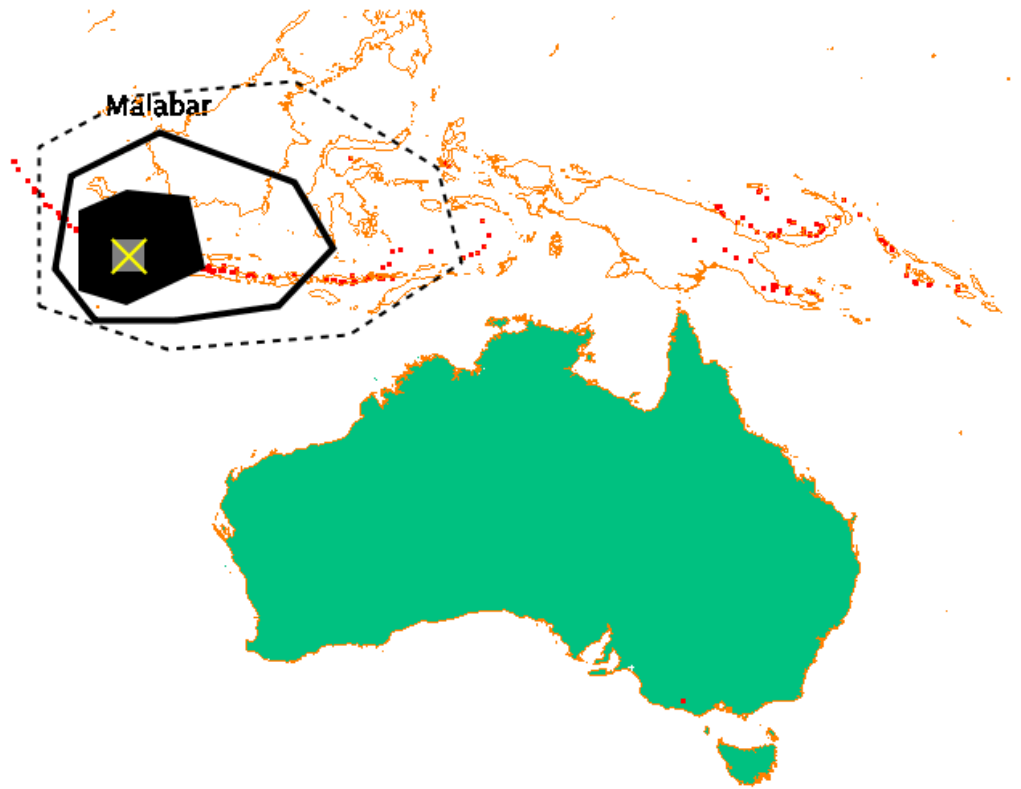
S0730 E14700 - S0830 E14600 - S1130 E14530 - S1330 E14600 - S1430 E14700 - S150\
0 E14800 - S1430 E15000 - S1300 E15100 - S0930 E15100 - S0700 E14930
Drifting south at 15 knots.
FCST ASH CLD + 6HR: 14/0516Z FL250 and 300
S0630 E14530 - S0830 E14400 - S1130 E14300 - S1500 E14300 - S1800 E14430 - S193\
0 E14600 - S2000 E14830 - S2000 E15100 - S1800 E15300 - S1430 E15400 - S1100 E1\
5400 - S0830 E15330 - S0530 E15130 - S0500 E14830
FCST ASH CLD + 12HR: 14/1116Z FL250 and 300
S0300 E14500 - S0500 E14300 - S0730 E14200 - S1030 E14130 - S1400 E14100 - S180\
0 E14130 - S2230 E14530 - S2300 E14630 - S2330 E14900 - S2330 E15030 - S2230 E1\
5300 - S2130 E15500 - S1600 E15630 - S1100 E15700 - S0730 E15630 - S0430 E15530\
- S0330 E15430 - S0230 E15300 - S0130 E14730
FCST ASH CLD + 18HR: dd/ttttZ height
ASH DISSIPATED/NO FCST
NEXT ADVISORY: No later than 14JUN2002/0600Z unless significant new informatio\
n is received.
REMARKS: Nil.
DARWIN VAAC.

--:-- DAR200206132334.txt (Text)--L1--All-----
For information about the GNU Project and its goals, type C-h C-p.

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Figure 4 – Volcanic Ash Advisory Number 1

Volcanic Ash Advisory Number 1



 Analysis Time	<u>Darwin VAAC</u>	
 +6HR FCST	Issued	20020705/0609Z
 +12HR FCST	Analysis Time	20020705/0607Z
 Volcano Position/s	Volcano/s	Malabar
	Number/s	0603-081
	Position/s	S0707 E10739