UPDATE FROM OZ

by

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Presentation Overview

• The Task
• The System
• The Procedures
• The Base Products
• The “Other” Products
• The Hyperspectral Potential
• The Multi-mission Platform
Most Likely Area of Operations

Goulburn Operations Base
HAZARD NOTE

ISSUE 010  SEPTEMBER 2015
TOPICS IN THIS EDITION | FIRE WEATHER | FUEL MANAGEMENT

SOUTHERN AUSTRALIA SEASONAL BUSHFIRE OUTLOOK 2015-16

Bushfire Potential 2015-16
- Above Normal
- Normal

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The Platform: Firescan 222

Cessna 441 Conquest
- Turboprop
- Ceiling: 35 kft AMSL
- Cruise Speed: 285 kts
- Operational Endurance: 4 hours with reserves

Destinations
- Qld border: 90 mins
- Victorian border: 35 mins
- Blue Mountains: 20 mins
- Narabri: 60 mins
The Sensor Suite in Firescan 222

EO Sensors & Products

Core Sensor

HyMap
Hyperspectral + Thermal

Products for Firefighting
- Contour
- TIR
- Night
- Fire Temp / Intensity

Products for Post Fire
- Burn Severity
- Burnt Area
- Flood Mapping
- Oil Spills, Toxic Algal Blooms
- Environmental
- Vegetation Mapping
- Water Quality

Ancillary Sensors

Digital Cameras
Orthos of Fire Events
Damage Assessment

Forward Looking Thermal & Vis Cameras
Aircrew Situational Awareness

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Spatial and Spectral Characteristics of Hyperspectral Sensor

### Spatial Configuration
- **IFOV**: 2.5 mr
- **FOV**: 61 degrees (850 pixels)
- **Swath**: 2.3 km at 5m IFOV
  - 4.6 km at 10m IFOV

### Spectral Configuration

<table>
<thead>
<tr>
<th>Module</th>
<th>Spectral range</th>
<th>Bandwidth across module</th>
<th>Average spectral sampling interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIS</td>
<td>0.45 – 0.89 um</td>
<td>15 – 16 nm</td>
<td>15 nm</td>
</tr>
<tr>
<td>NIR</td>
<td>0.89 – 1.35 um</td>
<td>15 – 16 nm</td>
<td>15 nm</td>
</tr>
<tr>
<td>SWIR1</td>
<td>1.40 – 1.80 um</td>
<td>15 – 16 nm</td>
<td>13 nm</td>
</tr>
<tr>
<td>SWIR2</td>
<td>1.95 – 2.48 um</td>
<td>18 – 20 nm</td>
<td>17 nm</td>
</tr>
<tr>
<td>TIR (1)</td>
<td>3-12 um</td>
<td>Effectively 5 um</td>
<td>NA</td>
</tr>
<tr>
<td>TIR (2)</td>
<td>8-12 um</td>
<td>Effectively 4 um</td>
<td>NA</td>
</tr>
</tbody>
</table>

**HyMap spectral bands on green vegetation reflectance and arrows indicated bands used in standard image products**

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Airborne Work Flow

Work flow to be completed with minimum aircrew “interactive decision making.

One pilot & one sensor operator....they are busy multitasking.

Reduce opportunity for errors

Minimise time to transmit images to NSW RFS HQ.

Some deployments from ops base can last > 6 hours (same crew)

Last thing we want is
Tasking Email

Hello CORPORATE AIR / HYVISTA and Duty-Officer Aviation (NSW RFS).

Note: please repeat # 3. Round Waterhole at aprox. 21:00 hrs over fire ground

Please find attached the following email coordinates for incidents to be flown. In brief the incidents that MUST be collected during this mission are highlighted below.

1. Greens Rd, Warrimoo - Blue Mountains
   Lat: -33° 42.60'
   Long: 150° 34.95'

2. Cooraldooral Trl Fire - Nymboida NP - Glen Innes Severn Shire
   Lat: -29° 36.87'
   Long: 152° 17.94'

3. Round Waterhole - Guyra
   Lat: -30° 07.89'
   Long: 152° 10.96'
Flight Planning & Management : FireAviatrix

Waypoints (flight plan centres):
1. Greens Rd, Warmoo - Blue Mountains  -33.7100° 150.5625°
2. Cooralcooral Trf Fire - Nymboida NP - Glen Innes Severn Shire  -29.614° 152.1877°
3. Round Waterhole - Guyra  -30.1315° 152.1827°

Additional Flight Instructions:
A. Linescans to be flown over ALL priority listed areas AS SOON AS WEATHER
B. Preference is to obtain any linescan within the next best window of opportunity.

Thank you.
Flight Planning & Management: FireAviatrix
Flight Planning & Management: FireAviatrix

- Track: 294°  Speed: 225 kts
- AMSL: 5896ft  AGL: 3954ft
- Bearing to FP: 281°
- Dist to FP: 20km  10.6nm
- Time to FP: 2.3 minutes
Flight Planning & Management: FireAviatrix

HyVista

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Operations Monitoring: HyperTRAX

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Automated Image Product Generation: FireScanGeo

![FireScanGeo Interface](image-url)
Automated Image Product Generation: IMGviewer
## Standard Automated Products

<table>
<thead>
<tr>
<th>Image Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC (fire colour)</td>
<td>Active fire fronts and hot spots shown in red/yellow and background terrain in green. Burned areas show dark brown.  A day time product</td>
</tr>
<tr>
<td>FF (fire front) red on black</td>
<td>Enhanced to just show most active fire areas without any terrain in image. Used as a basis to also create active fire contours. Day or night product</td>
</tr>
<tr>
<td>TIR (thermal infrared)</td>
<td>TIR. Used either TIR band to show fire. Can also show terrain information. Day or night product.</td>
</tr>
<tr>
<td>NIGHT</td>
<td>Combination of the TIR bands and a SWIR band to generate an image where fire grades from red to orange as intensity increases and shows terrain (as green)</td>
</tr>
<tr>
<td>Contour</td>
<td>Creates a vector product which is a shape file that outlines the most active fire regions.</td>
</tr>
</tbody>
</table>

The left panel shows a true colour band combination and the centre panel shows a FC image product. The panel on the right shows a FF image product (red on black).
Products for Tactical Fire Fighting: Standard Products

Examples of fire front mapping products

Imagery is processed in near real time (including geo-referencing) and transmitted by satellite link to incident command centers within minutes of acquisition.

Color composite image showing terrain, active fire fronts and burned areas.

Infrared image that isolates active fire fronts and highlights hotspots and small fires generated by airborne ash ahead of main fire.

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Airborne Imagery on the NSW RFS Common Operating Picture (COP)
Vector Products: Burning Areas
Vector Products : Burning Areas

A product for measurement of fire front speed (?)
Other Products: Fire Intensity

Example from Sampson Flat Fire, South Australia, 3rd January 2015

The right side image is a screen grab (ENVI) of a true colour representation from HyMap bands in the VIS module. Images derived from the LWIR and MWIR thermal bands on the following page are of this area.
Other Products: Fire Intensity
Hyperspectral remote sensing adds information at all stages of wildfires

**Pre-fire**

- Vegetation species and fire fuel mapping
- Biomass
- Fuel condition (e.g. moisture)
- Risk assessment
- Monitoring effectiveness of prescribed burns

**During fire**

- Fire front and spot fire mapping
- Fire intensity and temperature
- Smoke hazard assessment
- Fuel condition and moisture in adjacent areas
Hyperspectral remote sensing adds information at all stages of wildfires

Post-fire

- Burnt area and burn severity mapping
- Ash distribution
- Soil condition
- Remaining ground cover
- Hazard assessment (erosion, water pollution)

Long Term Monitoring

- Multi-temporal measurements
- Soil erosion
- Effects on ecosystem and bio-diversity
- Invasive weeds
The red curve in the above figure shows the radiance recorded by NASA’s AVIRIS hyperspectral sensor in the NIR-SWIR2 region while flying over a wildfire in southern California. The signal in the SWIR2 region (1900—2500 nm) is saturated by the black body radiation of the fire. However, in the NIR and SWIR1 region (800—1800 nm) the signal does not saturate. Since the sensor is radiometrically calibrated, one can fit a blackbody curve (shown in green) to the radiance data and thus estimate the fire temperature.

The HyMap sensors operated by HyVista Corp have equivalent capabilities to the NASA AVIRIS sensor and the following pages show examples of smoke penetration and fire intensity mapping using a HyMap.

Temperatures 800 – 1450K
Figure above shows results of a computer model of “at sensor” photon flux. The lack curve is the flux from a sunlit target of 50% albedo with a solar zenith angle of 30 degrees. The blue curve represents the earth surface at 300 K and the red curve for 800K.
Hyperspectral Applications : Fire Temperature ??

Sample DN spectra from Yarrabin Fire (Jan 2013)

Operational Limitations:
• Sensor Saturation
• Radiance contributions from sunlit ground and clouds
• At higher temperatures, need to rely on shorter wavelength (NIR) but they have less smoke penetration
Hyperspectral Applications: Fire Temperature

Hyperspectral View of Wildfire
Bear Creek, Idaho

True Colour Image

SWIR Image
(2228 nm, 1260 nm, 1650 nm)

Fire Intensity Index
Hyperspectral Applications : Creating Shape Files of Burned Area

A large fire in a national park in Central-North NSW (2013) generated a pyro-cumulus nimbus cloud which poses some threat to aerial mapping missions.

The image to the right is a mosaic of several HyMap image strips and the large burnt area is readily identifiable (red-brown) and active fire fronts can be seen on the NW and SW edges of the area.
Hyperspectral Applications: Burn Severity Mapping

Sydney Christmas 2001 Fires---area of interest near Warragamba Dam

SPOT Imagery 1 Nov 2001, 7 Jan 2002 // HyMap Acquisition 7 March 2002

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Hyperspectral Applications: Burn Severity Mapping

Analysis by Sydney Catchment Authority using pre & post SPOT imagery

Fire Severity Classification

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HyVista Corporation
Spectrally-driven Classification of HyMap Imagery

Grouping of spectrally identified materials generates a fire severity map

The above is equivalent to the BAER maps used in the US

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Burn Severity Mapping: Hyperspectral Classification of Surface Materials

Kinglake, Victoria

A: true colour
B: LANDSAT 741 equivalent
C: Spectrally classified surface materials

No ground truth !!! Under total cloud cover !!!
Multi-Mission Platform

With the sensor suite on board, a multi-mission platform is available

One flight: multiple targets & multiple products

Outside of wild fire applications, the sensor suite is suitable for

• High resolution ortho-photography
• Oil and chemical spills
• Mine site contamination
• Floods
• General environmental applications
• SAR

March 2012: Floods near Griffith, NSW: HyMap Image as LANDSAT 7-4-1 colour

Hyperspectral classification can easily discriminate between standing water and moist soil
Digital Cameras for Synoptic View

Samples of Imagery from on-board 40MP Digital Camera
Digital Camera Products for Immediate Post-fire Damage Assessment

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10 cm pixel
Thank you for your attention

The voyage of discovery is not in seeking new landscapes but in having new eyes.~ Marcel Proust (1871-1922)
Hopefully all fire aerialist efforts will help us see less of this