



Australian Government

Bureau of Meteorology

Overview of the Use of Satellite Data in the Bureau of Meteorology

Dr Anthony Rea

Australian Bureau of Meteorology





Australian Government

Bureau of Meteorology

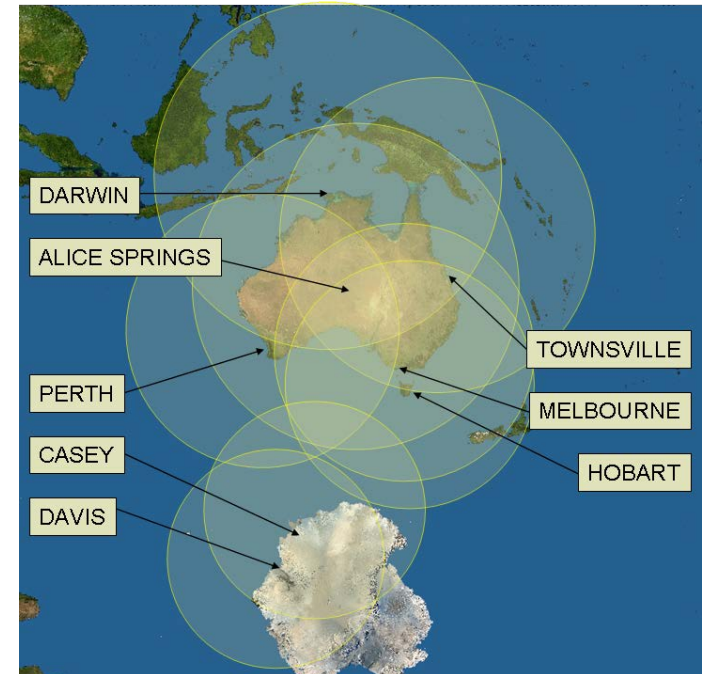
Outline

- Overview
- Himawari
- COSMIC-2
- eReefs
- Environmental applications
- Ground station consolidation
- Fengyun-4 Ranging support
- Use of satellites in ACCESS
- International activities



Australian Bureau of Meteorology

- The BoM provides Australians with environmental intelligence for safety, sustainability, well-being and prosperity
 - Monitor and report on current environmental conditions.
 - Analyse and explain trends in environmental data.
 - Provide forecasts, warnings and long-term outlooks on environmental phenomena that affect the safety, prosperity and resilience of Australians.
 - Foster greater public understanding and use of environmental intelligence.



Direct Reception Sites: Bureau, GA, AIMS and consortia (WASTAC, TERSS)
Davis is L-Band only



Australian Government

Bureau of Meteorology

Use of Satellite Data in the Bureau

Most of the applications in the Bureau focus on the atmosphere

Weather and Warnings

- Timeliness = key factor
- **Forecasters** mainly use VIS, IR, WV products for nowcasting
 - e.g. cloud images, volcanic ash products, fog detection

Numerical Prediction Models:

- **Temperature and humidity soundings**
 - key sources - microwave and IR polar orbiting satellite data
 - GPS is an emerging data source (Radio Occultation and ground-based water vapour)
- **Wind**
 - scatterometers
 - satellite derived Atmospheric Motion Vectors

Earth-related applications:

- **Sea Surface Temperature, NDVI, Grassland Curing, Solar Radiation**

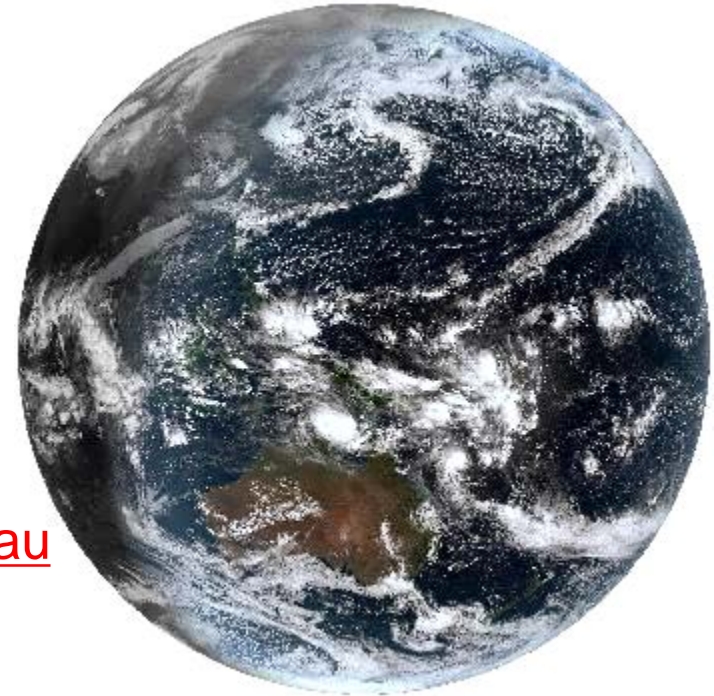


Australian Government

Bureau of Meteorology

Himawari-8 Transition Project

- Data Access
 - Direct data link to JMA MSC
 - HimawariCloud as backup
 - HimawariCast as secondary backup
- Visualisation
 - Delivered to forecaster workstations in GRIB2/netCDF
 - Public product: <http://satview.bom.gov.au>
- Processing
 - In-house developed based on standard GEOCAT suite





Australian Government
Bureau of Meteorology

Himawari-8 Quantitative Products

- NOAA NESDIS STAR and UW-CIMSS
 - Cloud properties (Pavolonis & Heidinger)
 - Cloud microphysical properties (Heidinger)
 - Fog & low cloud (Pavolonis & Calvert)
 - Volcanic ash retrievals (Pavolonis)
- Bureau
 - Atmospheric Motion Vectors (Le Marshall)
 - Sea Surface Temperature (Griffin)
- MINES ParisTech
 - Solar Radiation (Qu et. al., Gschwind, Grant)

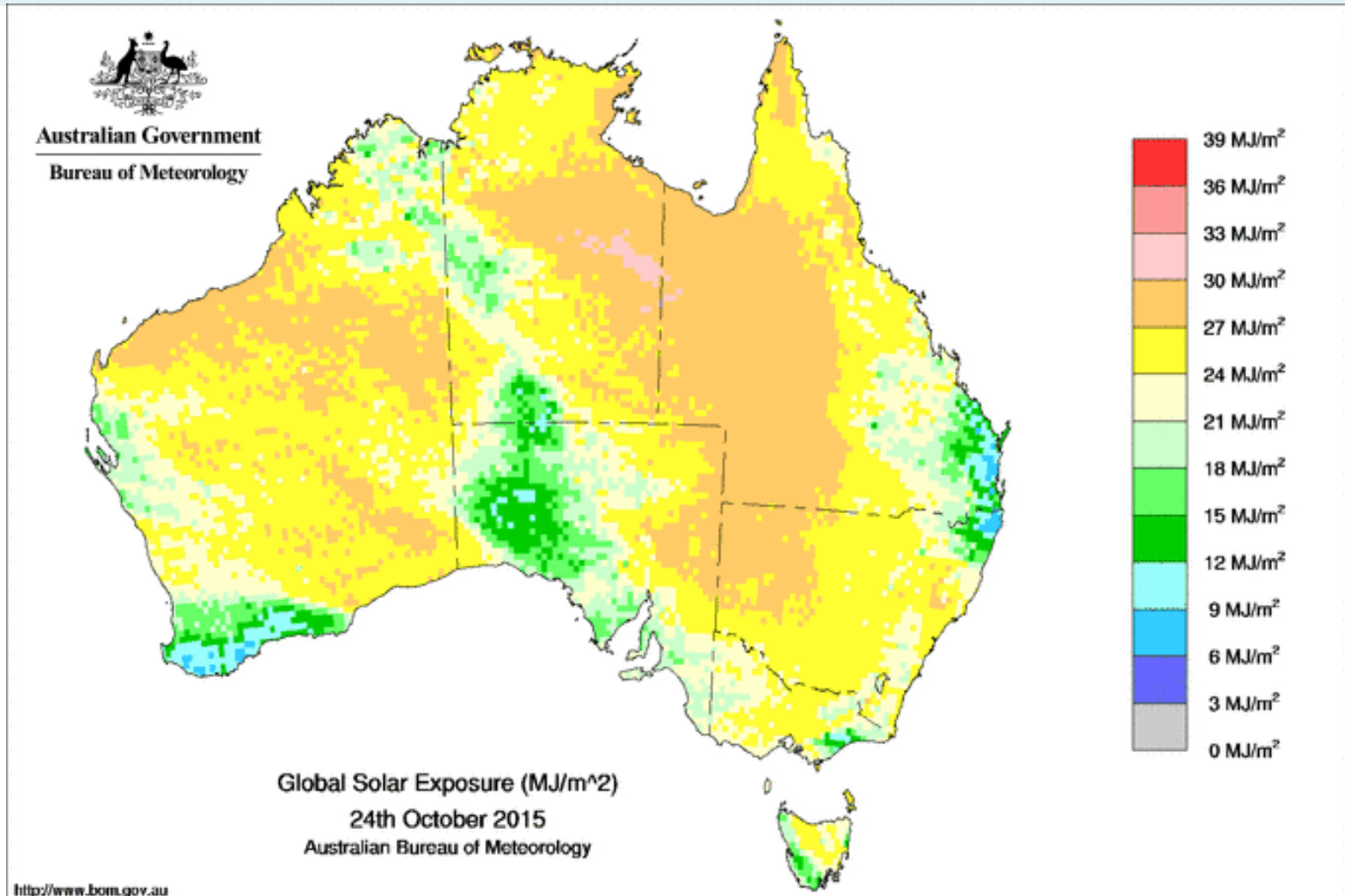




Australian Government
Bureau of Meteorology

Environmental Applications

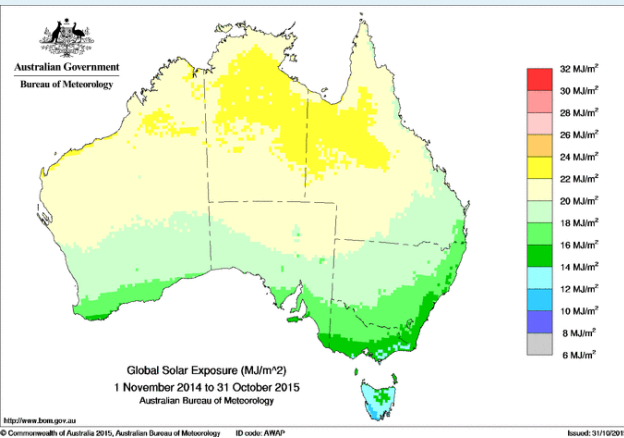
Solar Exposure



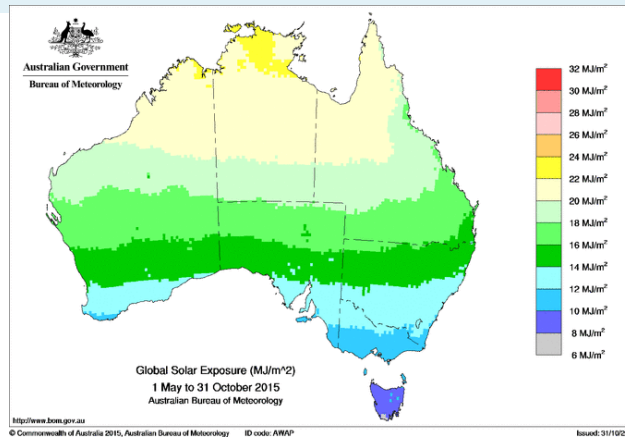


Australian Government
Bureau of Meteorology

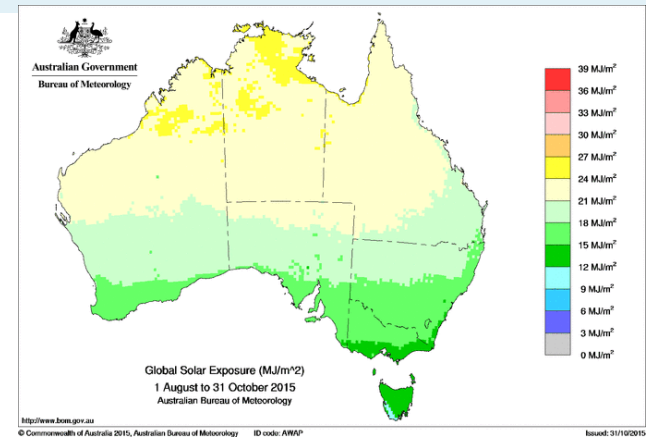
Environmental Applications Solar Exposure



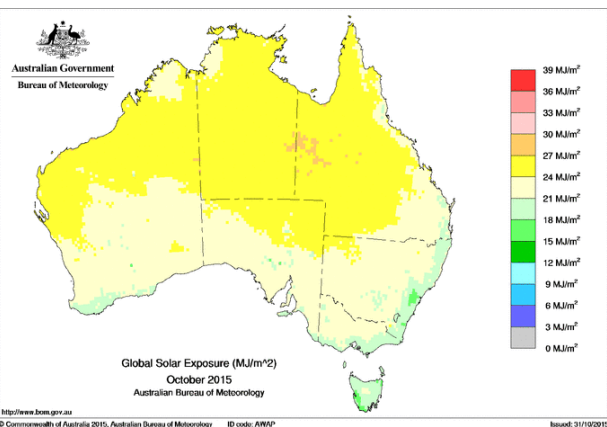
Yearly



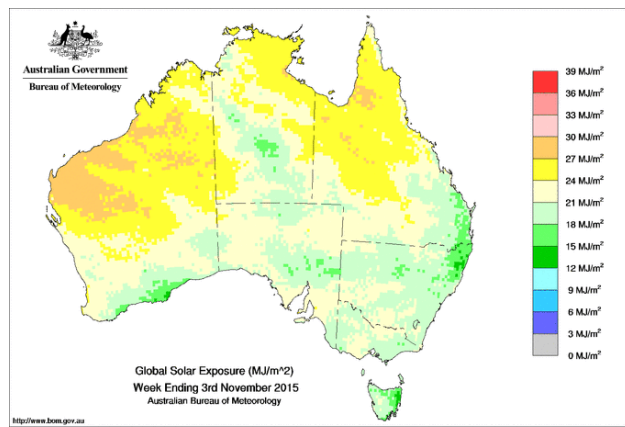
1/2 Yearly



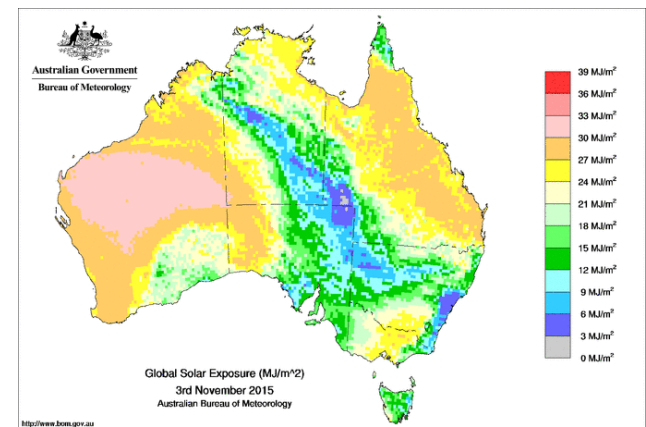
1/4 Yearly



Monthly



Weekly



Daily



Atmospheric Motion Vectors from Himawari-8

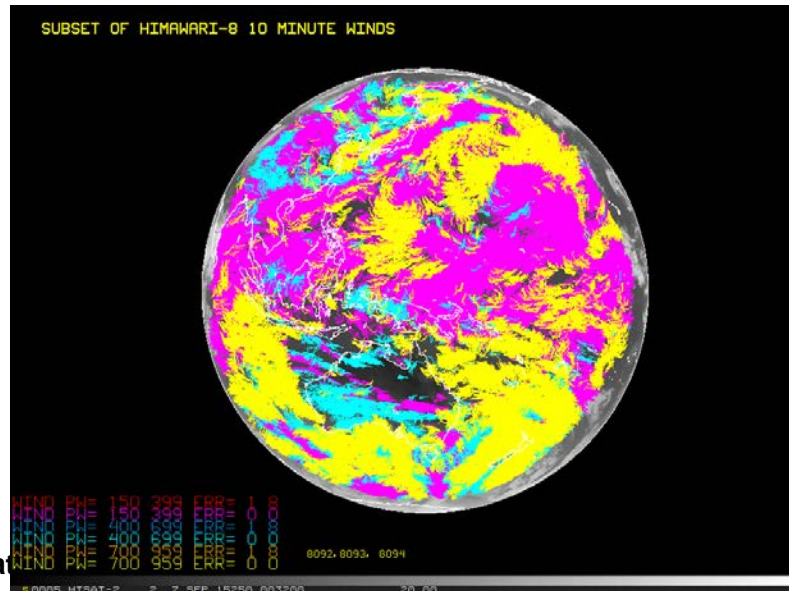
RT Wind Estimation and Error characterisation
Assimilation

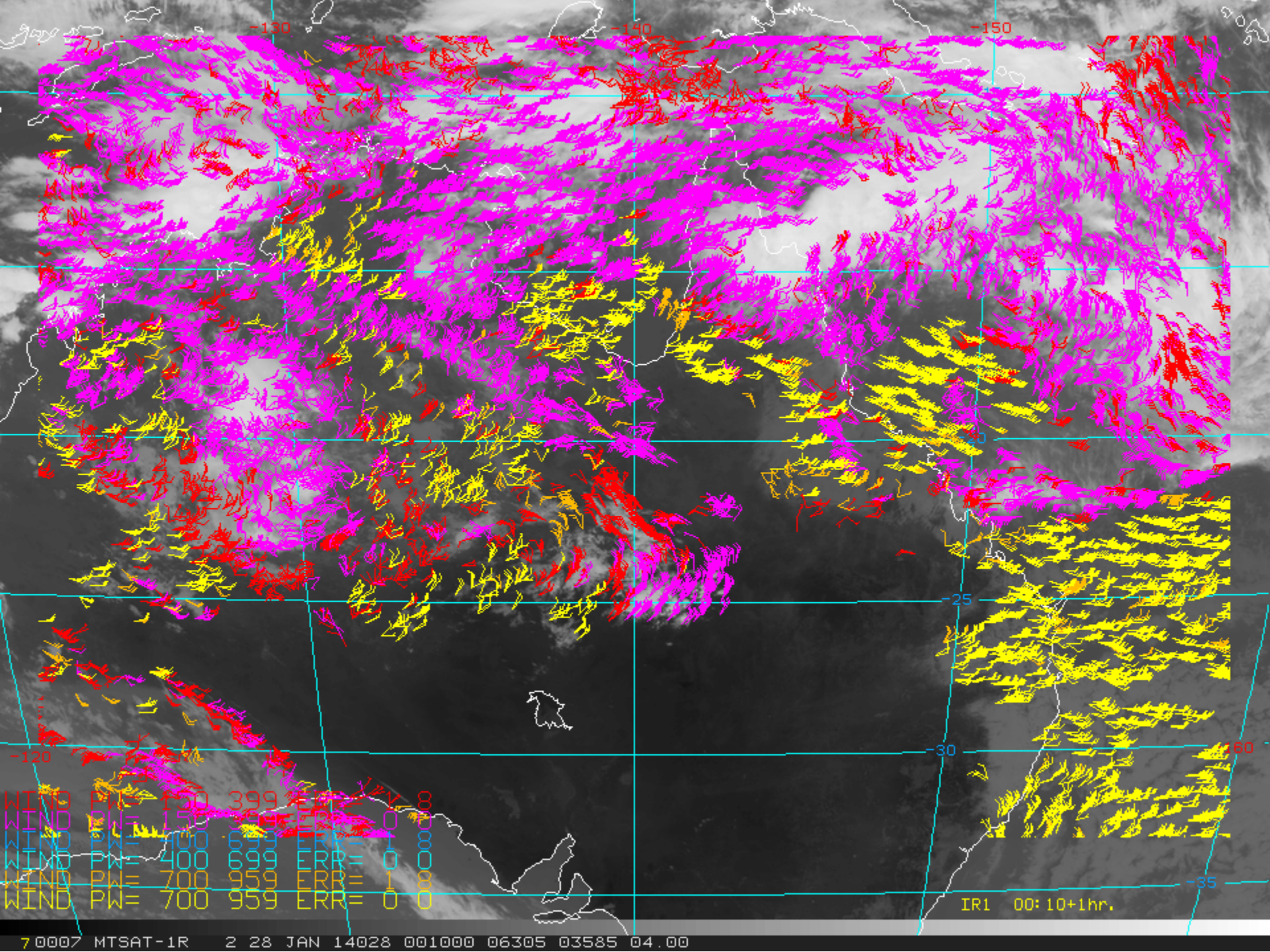
Geocat cloud characterization

AMV Generation code share with NOAA, JCSDA,
And U of Wisconsin

Table 1 Verification Table for Himawari-8 IR (channel 14) AMVs compared to radiosondes 18 August – 18 September 2015

AMV Type	Category	m/s	NOBS
Low Sep. <150km	MMVD	3.00	4911
	RMSVD	3.61	
	BIAS	0.71	
Low Sep. <50km	MMVD	2.36	473
	RMSVD	2.75	
	BIAS	0.29	
Middle Sep. <150km	MMVD	3.16	1202
	RMSVD	3.78	
	BIAS	-0.61	
High Sep. <150km	MMVD	4.11	15688
	RMSVD	4.88	
	BIAS	-0.64	





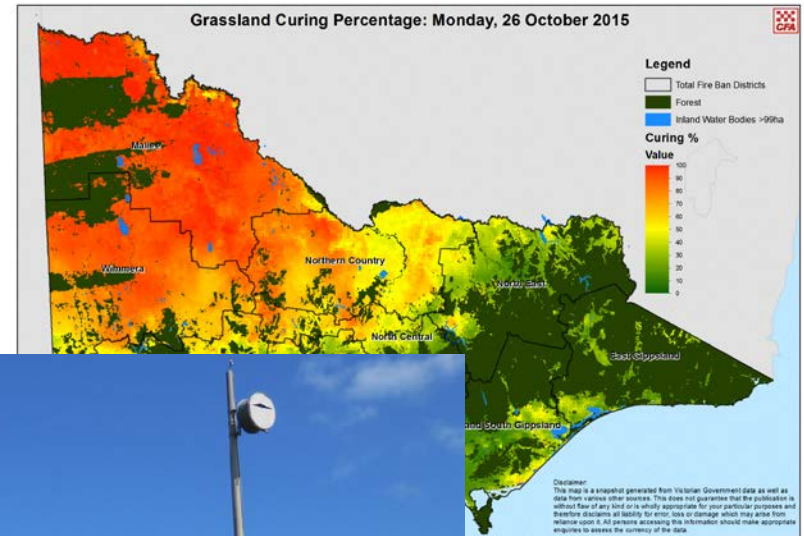
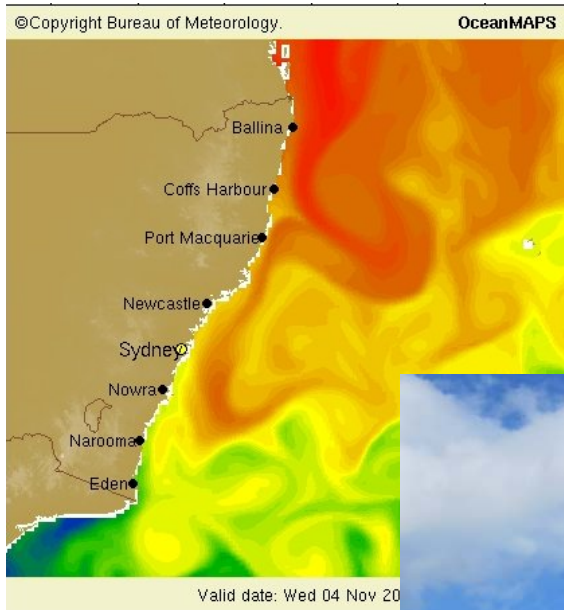
WIND	PW=	500	399	ERR=	0	0
WIND	PW=	1500	6999	ERR=	0	0
WIND	PW=	4000	6999	ERR=	0	0
WIND	PW=	7000	959	ERR=	1	0
WIND	PW=	7000	959	ERR=	0	0

IR1 00:10+1hr.



Australian Government
Bureau of Meteorology

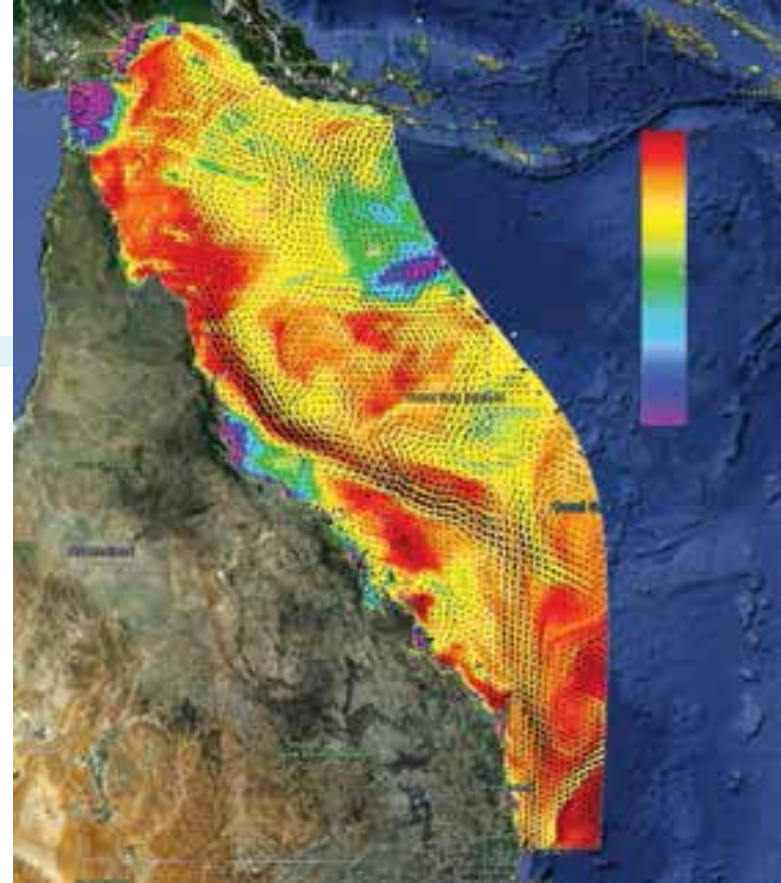
Direct Applications – Polar Orbiters





Australian Government
Bureau of Meteorology

eReefs



- Input into models comes from many sources including multispectral imagery ingested directly by the Bureau of Meteorology and associated organisations.
- MODIS and VIIRS for ocean colour
- Himawari-8 will add value to this project

Snapshot from the near real-time hydrodynamic model of the Great Barrier Reef showing sea-surface salinity and surface currents.
Image provided by CSIRO

eReefs is a collaboration between:

GREAT BARRIER REEF
foundation



Australian Government
Bureau of Meteorology



Supported by funding from:



CARING
FOR
OUR
COUNTRY



Queensland
Government

SCIENCE AND
INDUSTRY
ENDOWMENT
FUND



BHP Billiton Mitsubishi Alliance



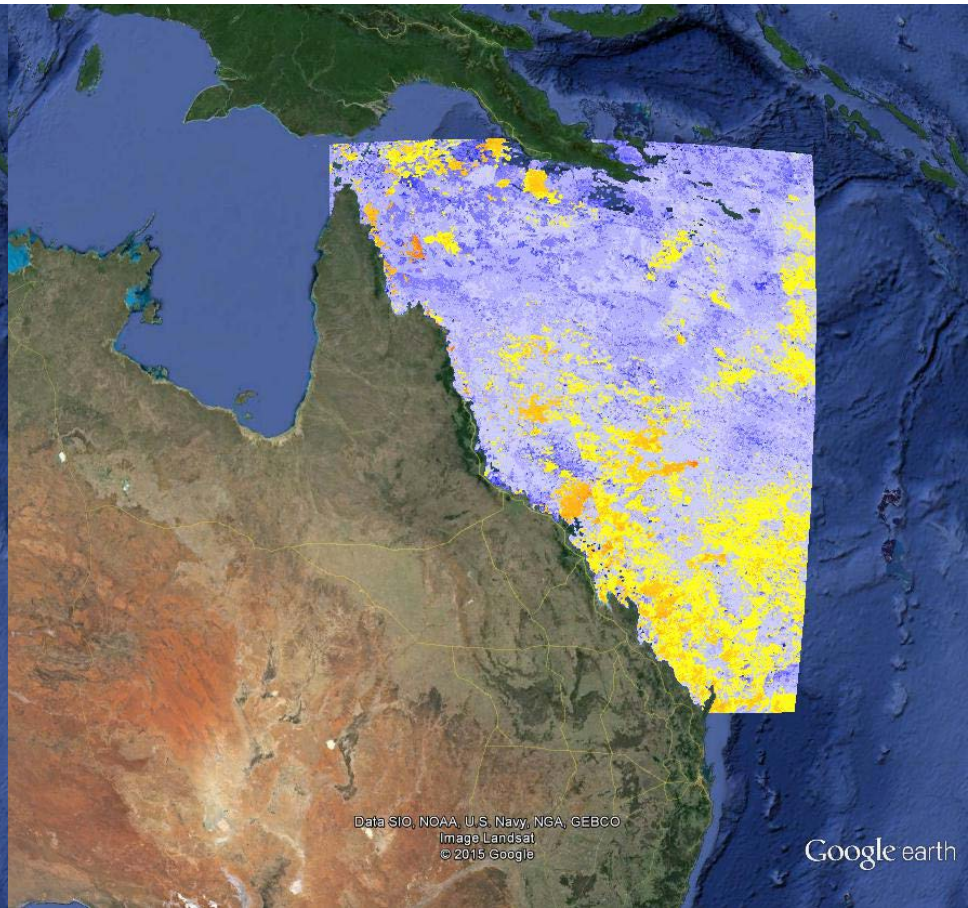
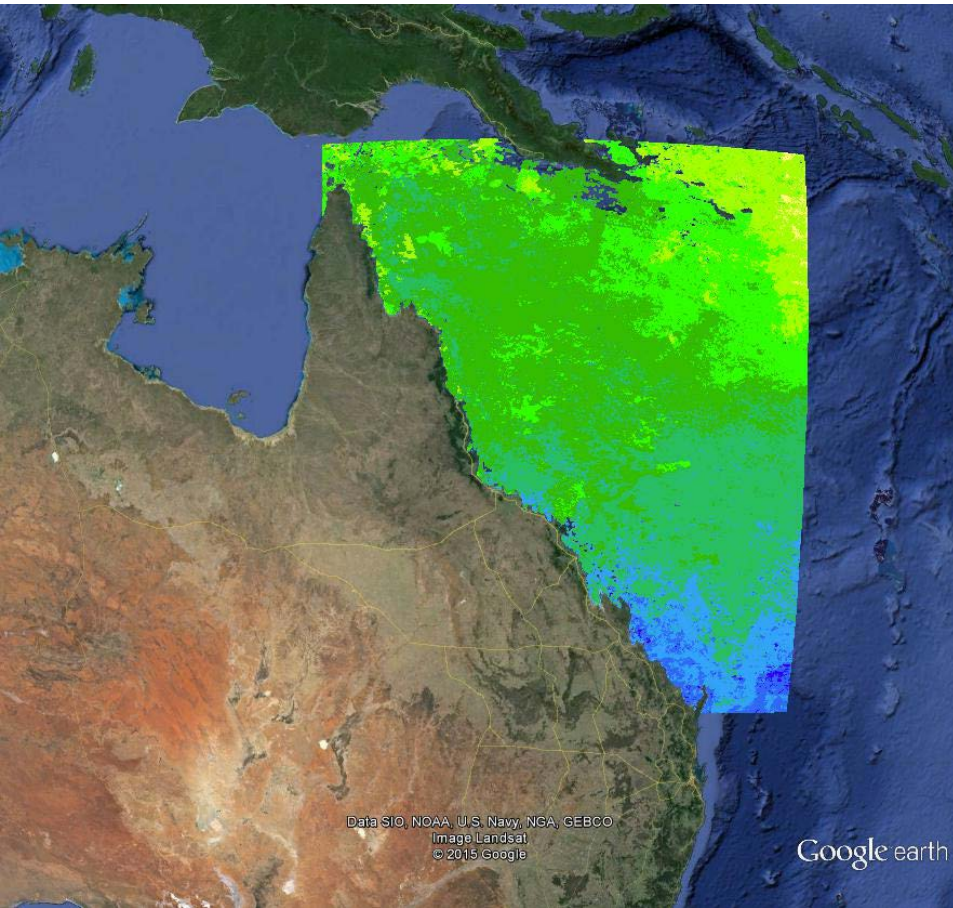
Australian Government

Bureau of Meteorology

ReefTemp

IMOS 14-day Mosaic: SST
25 October 2015 GBR Region

IMOS 14-day Mosaic: SST Anomaly
25 October 2015 GBR Region

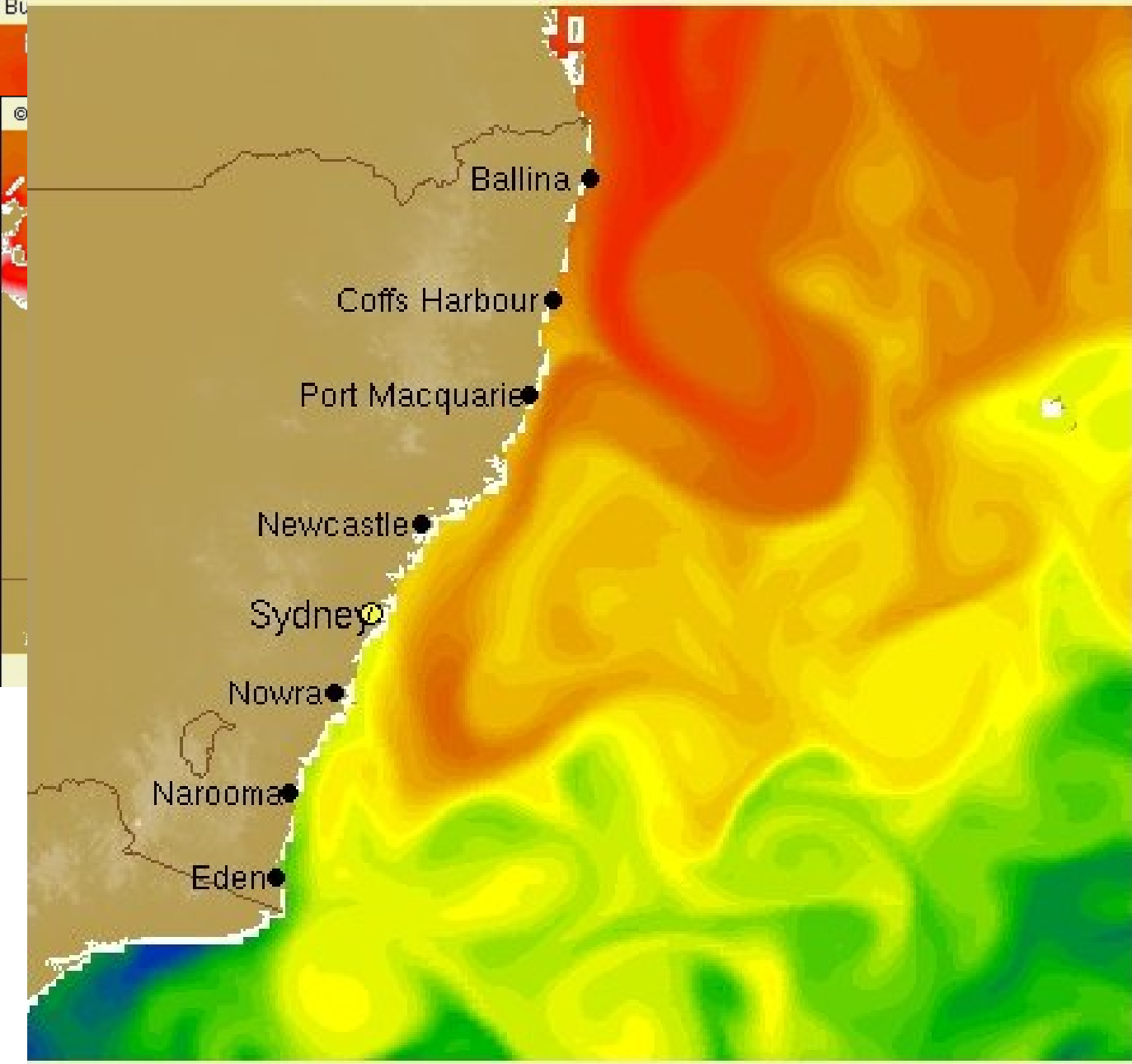




Environmental Applications Sea Surface Temperatures

The screenshot shows a web browser window displaying the Australian Bureau of Meteorology's 'Sea temperatures and Currents' page. The browser address bar shows the URL: <http://www.bom.gov.au/oceanography/forec>. The page features a navigation menu with links for 'HOME', 'ABOUT', 'MEDIA', and 'CONTACTS', along with a search bar. The main content area is titled 'Sea temperatures and Currents' and includes a sub-header 'Bureau Home > Marine & Ocean > Sea Temperature & Currents'. Below this, there are tabs for 'Forecast Regions', 'Forecast Loops', 'Site Help', 'Forecast Help', and 'System Information'. A text block explains that users should select an area on the map or use the table below, and that forecasts are subject to the Bureau's copyright and disclaimer. It also mentions that users can access forecast data sets by subscribing and becoming a registered user. A large map of Australia is displayed, showing various ocean forecast regions (MWA, SWA, SA, VIC/TAS, NSW, QLD, NT) and islands (Christmas Island, Cocos (Keeling) Islands, Norfolk Island, Lord Howe Island, Macquarie Island). A legend for 'Ocean Forecast Regions' indicates Tropics, Mid-Latitudes, and High-Latitudes. To the right of the map, there is a 'Sea Temperature Analysis' section with links to ocean temperature maps for the Sea Surface and Subsurface, covering daily, weekly, and monthly periods. At the bottom of the page, there is a table titled 'Tropics' with columns for 'Cocos (Keeling) Islands', 'Christmas Island', and 'North Western Australia', and rows for 'Northern Territory' and 'Queensland'.

aps



MAPS

Valid date: Wed 04 Nov 2015 Forecast hour: 000

dur: 000 2015



Australian Government
Bureau of Meteorology

Environmental Applications Grassland Curing

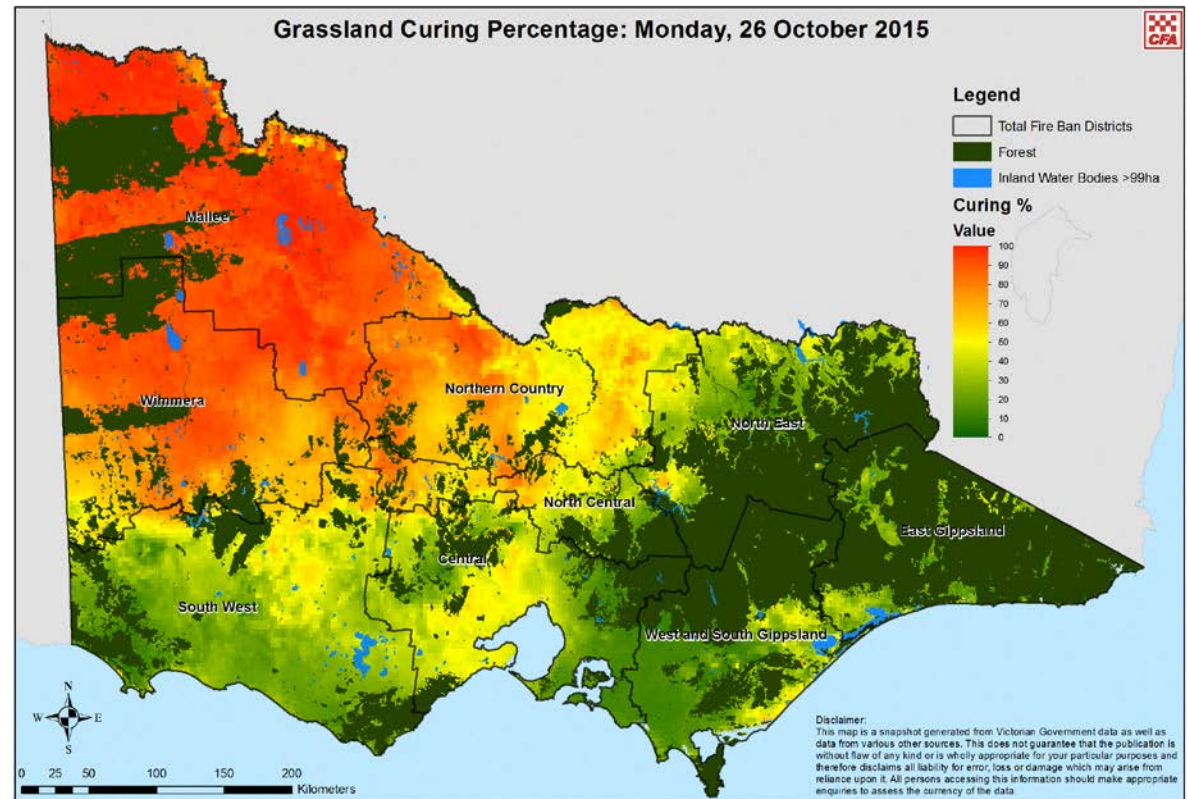
- Fire agencies require maps of grassland curing
- Field observations are sparse; new satellite products reveal fine detail



Fire Burning on bad day
with 20% curing



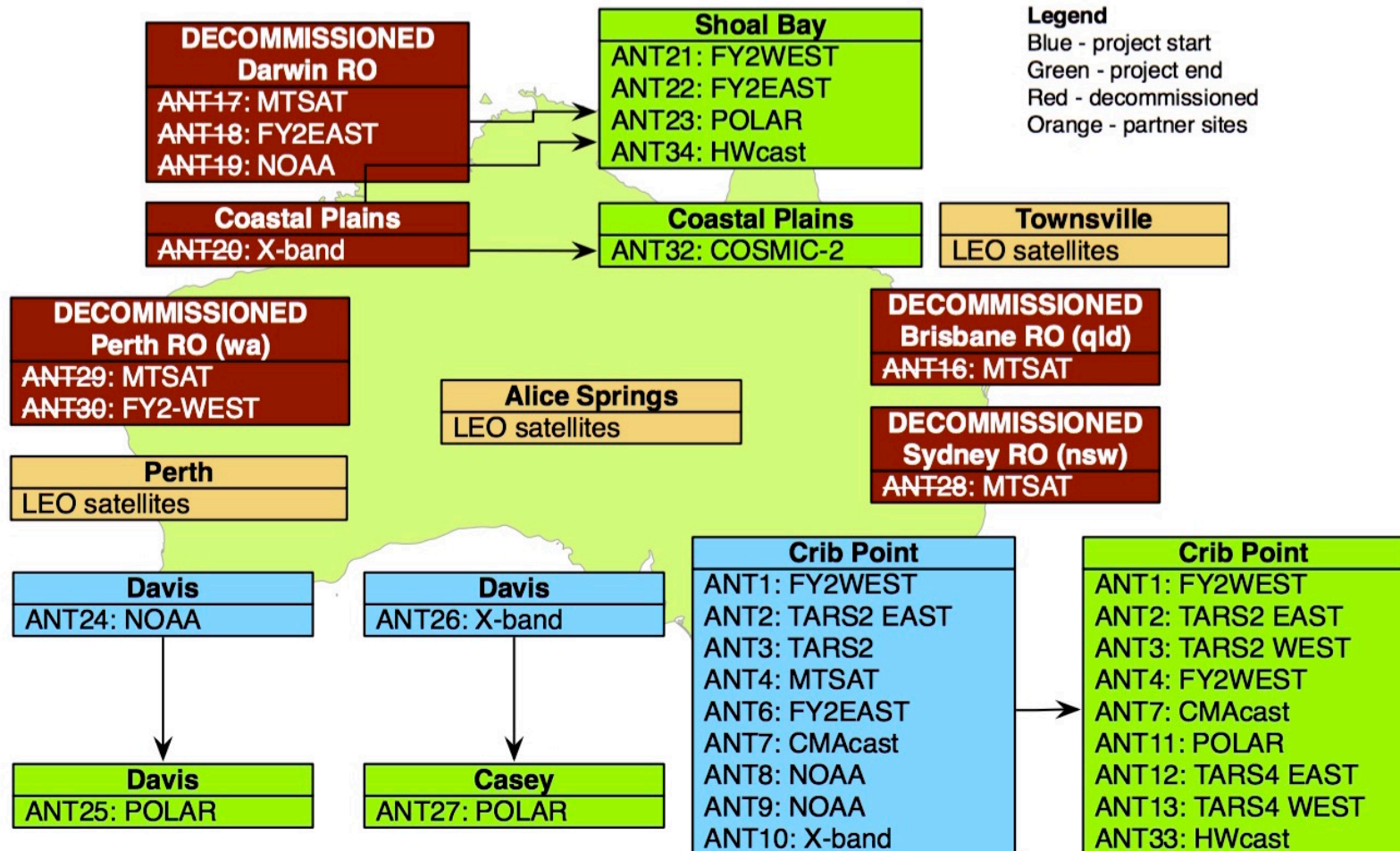
Fire Burning on bad day
with 100% curing





Ground station consolidation

Satellite Infrastructure Project





Australian Government

Bureau of Meteorology

Ground station consolidation

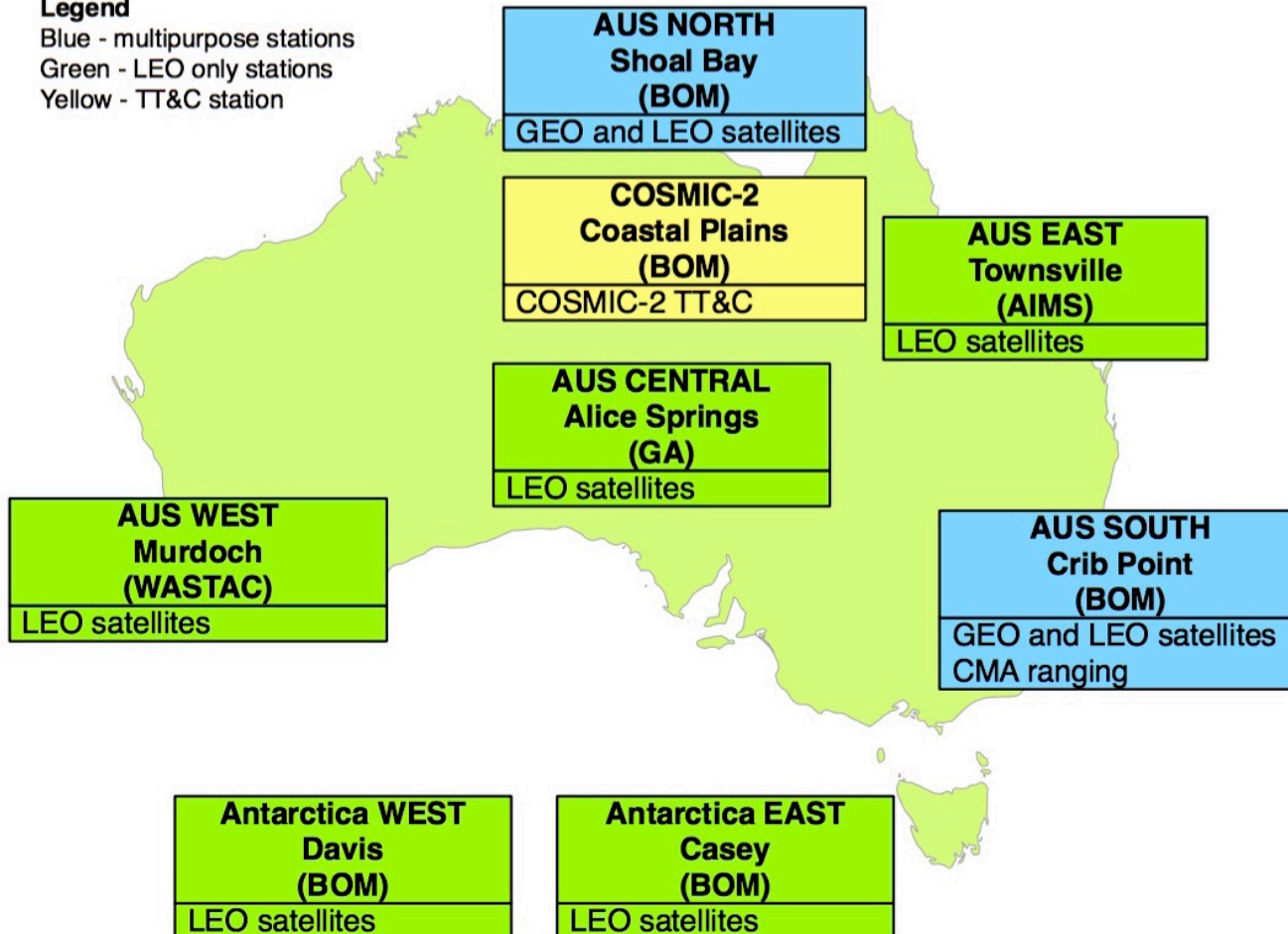
WoAG Satellite Earth Stations (Functional Overview)

Legend

Blue - multipurpose stations

Green - LEO only stations

Yellow - TT&C station





Australian Government

Bureau of Meteorology

COSMIC-2

- Bureau supporting COSMIC-2 mission by hosting a 3.7m Telemetry, Tracking and Command System tracking antenna in Darwin
- Darwin station supports mission control which adds capacity to both control COSMIC-2 satellites as well as downlink data
- Antenna was installed in October 2015 and the station is scheduled to be commissioned and fully operational by May 2016





Australian Government

Bureau of Meteorology

Fengyun-4 TARS (Satellite Ranging)

- Two 7.3m antennas to be hosted in Melbourne for the next generation of FY GEO satellites
- First antenna to be installed in 2016
- Crib Point originally built to host rangings for FY-2A in 1994 providing 20+ years of cooperation with CMA

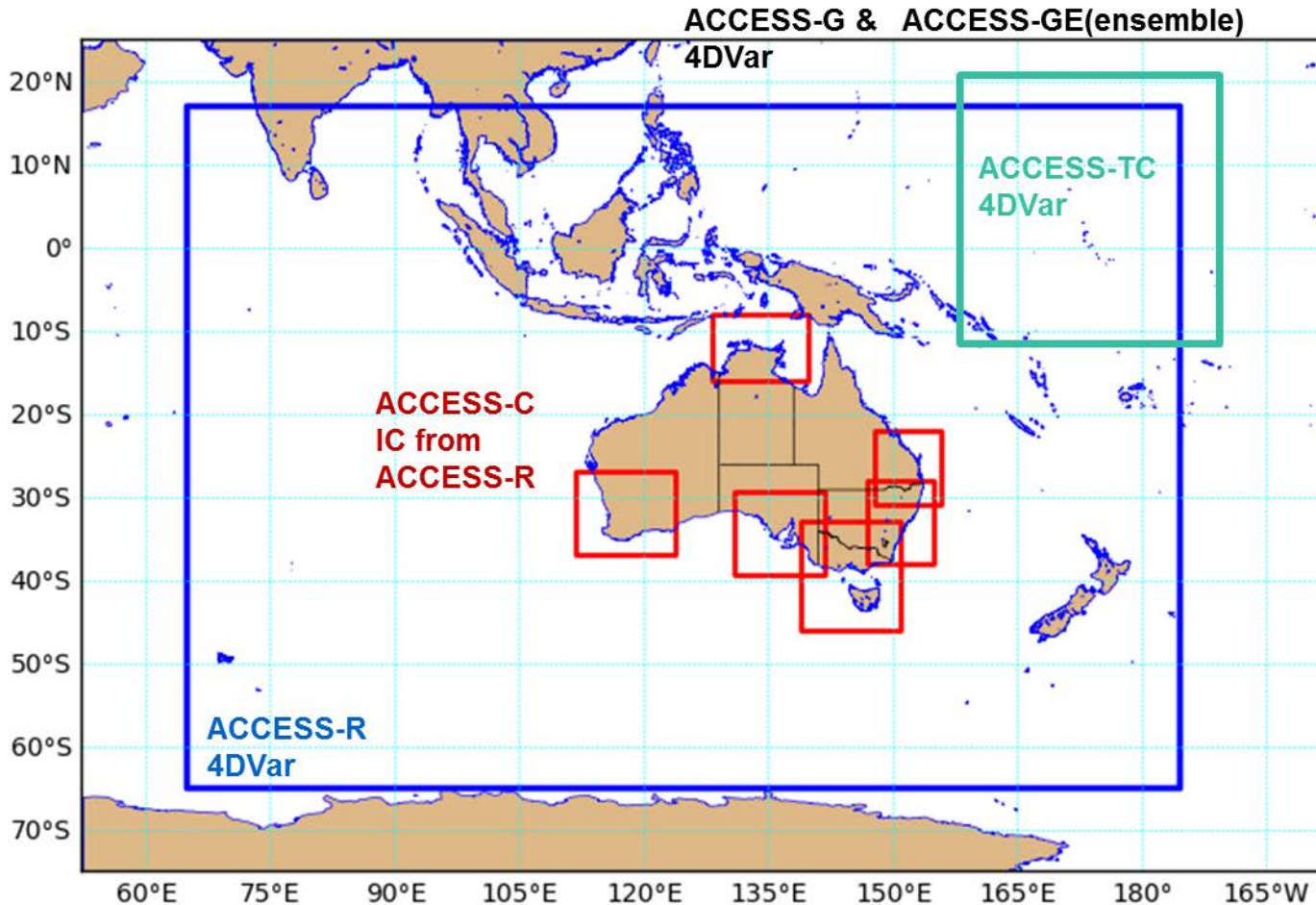




Australian Government

ACCESS: APS1 → APS2

ACCESS Domains



Grid size (km)

	APS1
G	40
R	12
TC	12
C	4

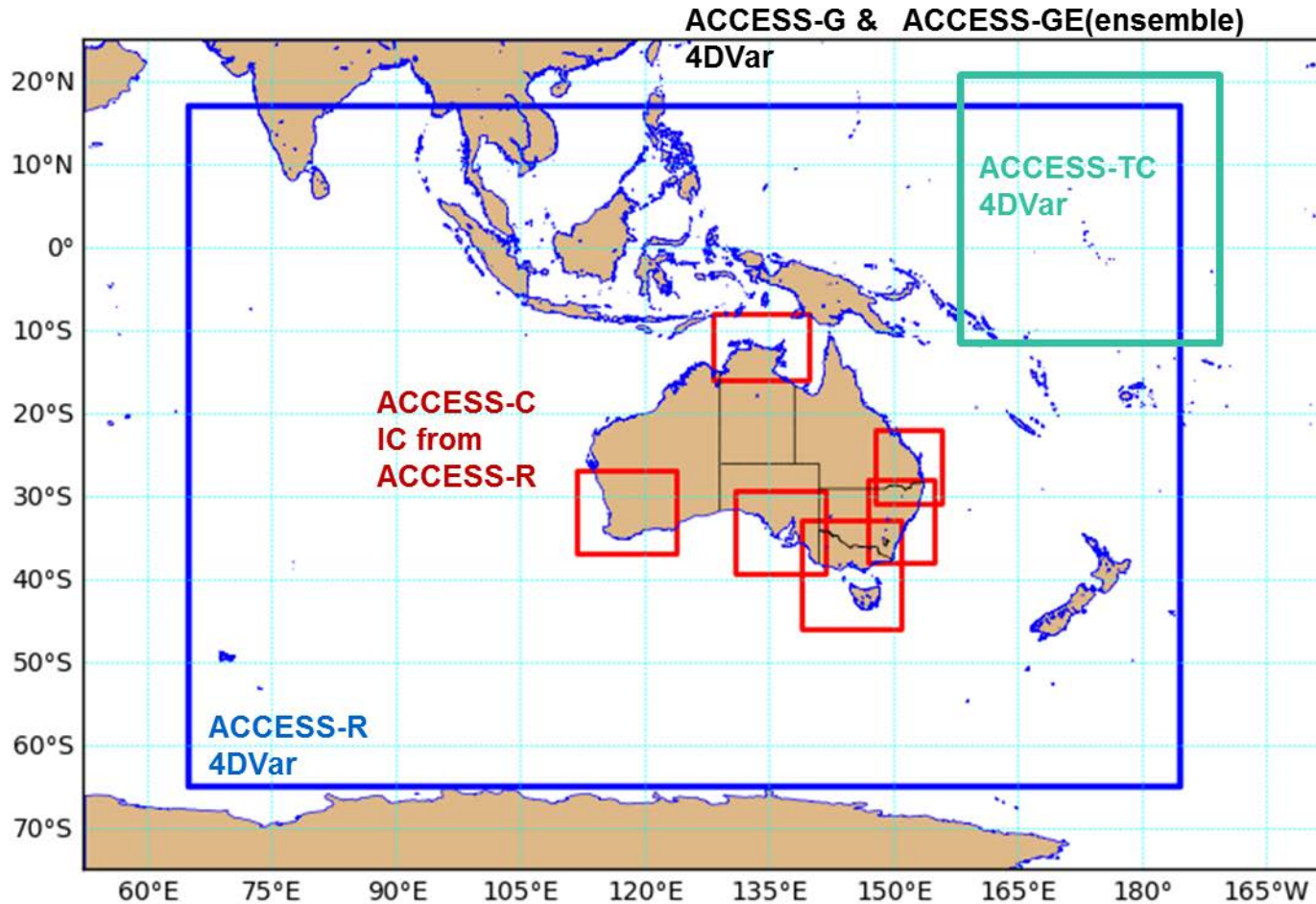
70 vertical levels



Australian Government

ACCESS: APS1 → APS2

ACCESS Domains



Grid size (km)

	APS1	APS2
G	40	25
R	12	12
TC	12	12
C	4	1.5

70 vertical levels



ACCESS: APS1 → APS2

APSI	Surface: synops, ships, buoys Sondes, wind profilers Aircraft: AIREPS, AMDARS	
	Satellite observations (I) <u>Wind</u> : Scatterometer surface winds (ASCAT), AMVs from GEOS & POES <u>GNSS-RO</u> : bending angle observations	
	Satellite observations (II): IR and MW radiances	
	Platform	Instrument
	NOAA-16 NOAA-17 NOAA-18 NOAA-19 MetOp-A EOS:Aqua	AMSU-A/B + HIRS AMSU-B + HIRS AMSU-A/B + HIRS AMSU-A/B + HIRS AMSU-A/B HIRS IASI (138 channels) AIRS (48 channels) (old instrument)



ACCESS: APS1 → APS2

APS2

Surface: synops, ships, buoys
Sondes, **extra** wind profilers
Aircraft: AIREPS, AMDARS

Satellite observations (I)

Wind: Scatterometer surface winds (ASCAT), AMVs from GEOS & POES
GNSS-RO: bending angle observations

Satellite observations (II): IR and MW radiances **reduced thinning**

Platform

NOAA-18
NOAA-19
MetOp-A

MetOp-B

EOS:Aqua
Suomi-NPP

MTSAT-2 (Himawari-8)

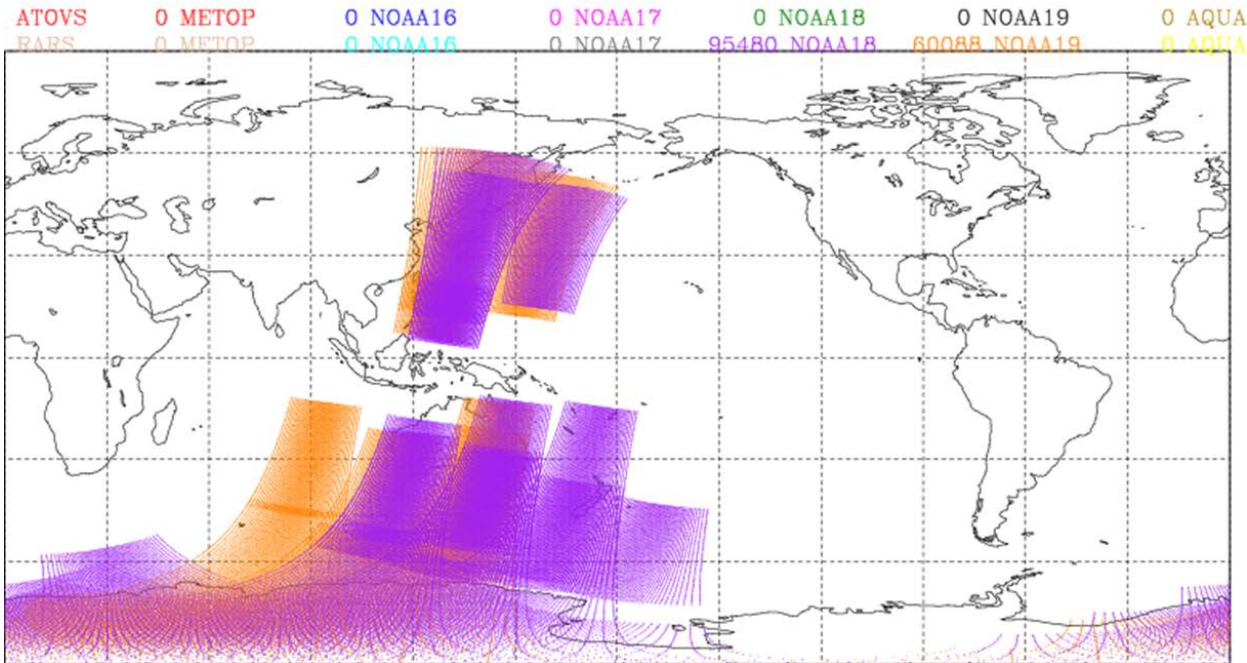
Instrument

AMSU-A/B
AMSU-A/B
AMSU-A/B + HIRS
IASI (138 channels)
AMSU-A/B + HIRS
IASI (138 channels)
AIRS (139 channels)
CrIS (134 channels)
ATMS
Clear Sky Radiances



Satellite observations: AP-RARS coverage

Australian BoM ACCESS-G Received observations coverage
ATOVS 20141002 1800 UTC
Total number of obs = 155568



Issue time 23UTC 02 Oct 2014

Asia Pacific Regional
ATOVS Re-transmission Service



- Lower-latency data extends coverage in short cut-off ACCESS-R cycles
- Adds robustness to ACCESS-G



Australian Government

Bureau of Meteorology

APS3+

- ACCESS-C 1.5 km domains will have their own assimilation cycles for the first time
- Key systems for significant weather forecasting
- Hourly Rapid Update Cycle (RUC)
- Crucial data:
 - High temporal resolution Himawari-8 AMVs
 - Himawari-8 Cloud Top Temperatures/Pressures
 - Himawari-8 Clear Sky Radiances
- **Local image processing and AMV generation will be essential to meet the low latency (~ 30 min max.) required by the RUC cycle**



Australian Government
Bureau of Meteorology

International Collaboration to Benefit the Region

- Australia collaborates internationally to enhance training and utilisation of satellite observations and to support exchange and access to satellite observations.
 - WMO Commission for Basic Systems (CBS) Inter-Program Expert Team on Satellite Utilisation and Products (IPET-SUP)
 - Regional ATOVS Retransmission Service (RARS)
 - RA-V Working Group on Infrastructure has formed a Task Team on Satellite User Requirements
 - TARS support for CMA satellites
 - Support for COSMIC-2



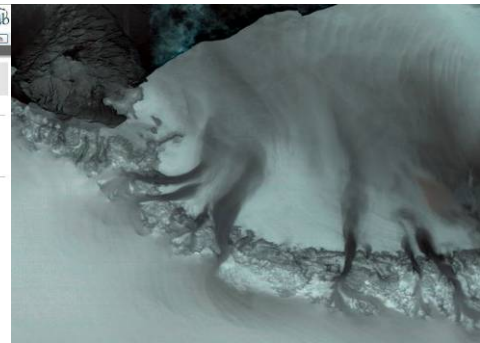
Australian Government
Bureau of Meteorology

International Collaboration to Benefit the Region

- VLab Australian Centre of Excellence
- JMA is our sponsoring satellite operator
- Development programs for regional participants
- Training event held in conjunction with 4th AOMSUC
- Regional Focus Group meetings occur on a monthly basis



www.virtuallab.bom.gov.au





Australian Government

Bureau of Meteorology

Summary

- The Bureau, and those who use our services, rely on satellite observations
 - Forecasting for weather and warnings, oceans, tropical cyclones and aviation
 - Numerical Weather Prediction and Ocean Prediction
 - Climate and environmental applications
- Australia is improving coordination to enable better national and regional collaboration
- We continue to work with our partners to maximise regional benefit from present and future satellite missions



Australian Government

Bureau of Meteorology

Thank you...

Dr Anthony Rea
Assistant Director Observing Strategy and Operations
Australian Bureau of Meteorology
a.rea@bom.gov.au