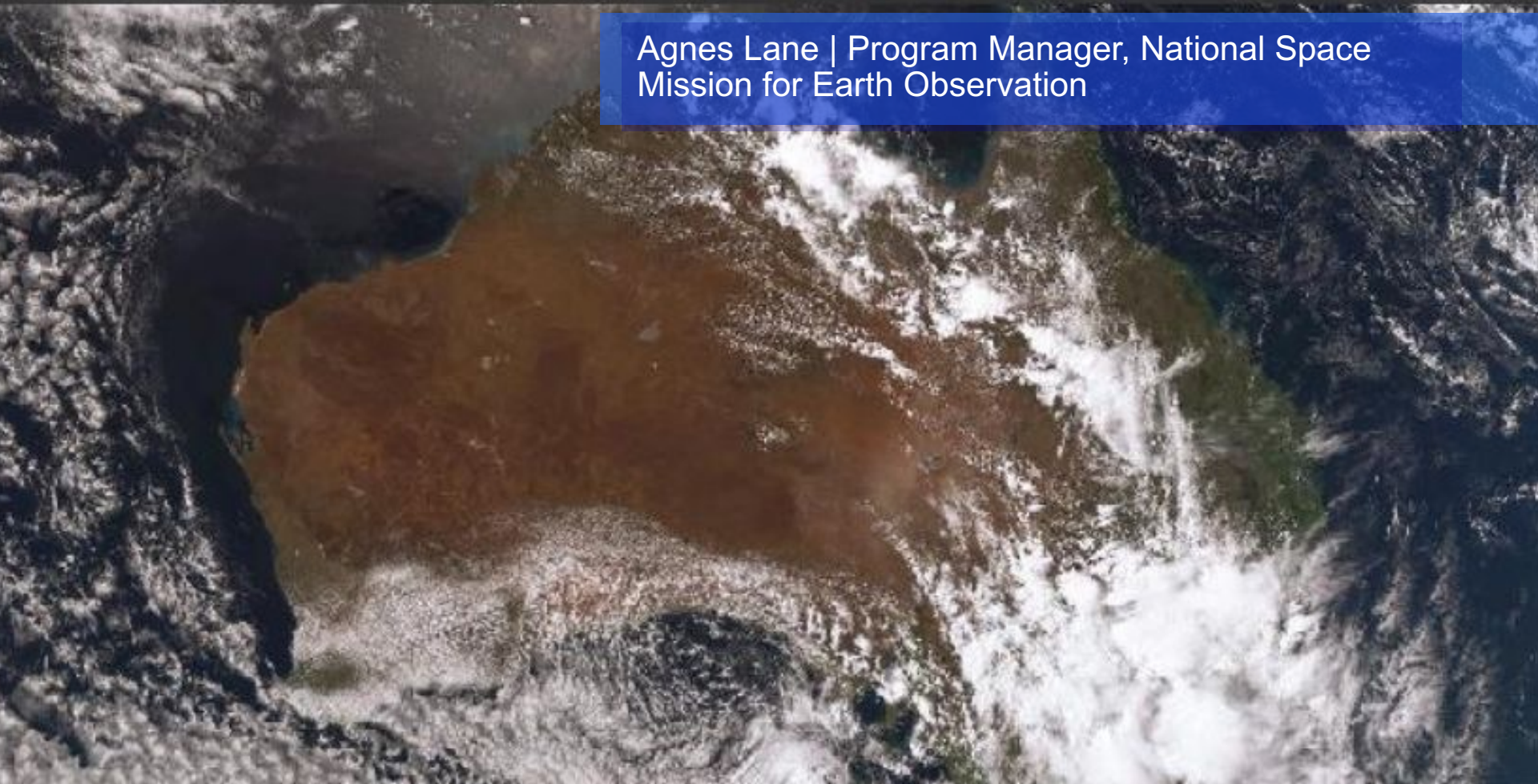




The Bureau
of Meteorology

Utilisation of satellite observations at the Bureau of Meteorology

Agnes Lane | Program Manager, National Space
Mission for Earth Observation



About the Bureau

The Bureau of Meteorology is Australia's national weather, climate, water and space weather agency.

We provide one of the most fundamental and widely used services of government.

We provide regular forecasts, warnings, monitoring and advice spanning the Australian region and Antarctic territory.

The screenshot displays the Bureau of Meteorology's website interface. At the top, there is a navigation bar with links for HOME, ABOUT, MEDIA, and CONTACTS, along with a search bar. Below this, the page title is "MetEye - your eye on the environment". A yellow warning banner is visible. The main content area shows the "Forecast for Canberra" for Tuesday, 22 September 2020. A table provides a 7-day forecast with icons for weather conditions, maximum and minimum temperatures, and chances of rain. A "Rainfall Forecasts" section on the left lists various forecast types like 3-hourly, Daily from tomorrow, and Wind Forecasts. A radar loop image titled "128 km Canberra (Captains Flat) Radar Loop" is shown, with a table of radar data including Loops, Single images, and Radar Site Information. The BOM logo and a call to action to download the official weather app are at the bottom.

	Tue, 22 Sep	Wed, 23 Sep	Thu, 24 Sep	Fri, 25 Sep	Sat, 26 Sep	Sun, 27 Sep	Mon, 28 Sep
Max (°C)	-	15	13	12	12	14	16
Min (°C)	-	5	4	2	1	-1	1
Chance of rain (%)	-	30	10	90	30	5	5
Rainfall range (mm)	-	0 to					

Loops	Single images	Radar Site Information
Radar	64 km	128 km
Rainfall	5 mm	1 hour



Why are satellite observations critical for the Bureau's weather services?

1. Satellite EO for **Numerical Weather Prediction (NWP)**
 - ✓ 95 % of observations assimilated by NWP are satellite observations
 - ✓ 36 million satellite observations assimilated per day
 - ✓ 70% of forecast accuracy attributed to satellite observations
2. Satellite EO for **Nowcasting and situational awareness**
 - ✓ Satellite images are also used directly by forecasters during bushfires, flood, severe thunderstorms, TC and volcanic ash), sea ice service, fog, etc

Australian BoM ACCESS-G Accepted observations coverage
ATMS
20181115 0000 UTC
Total number of obs = 16812

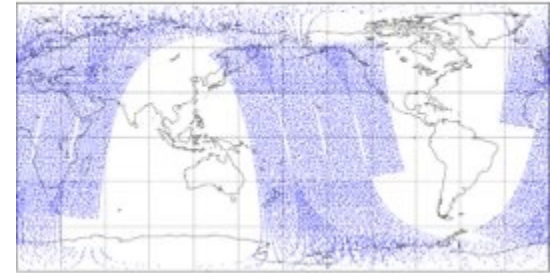
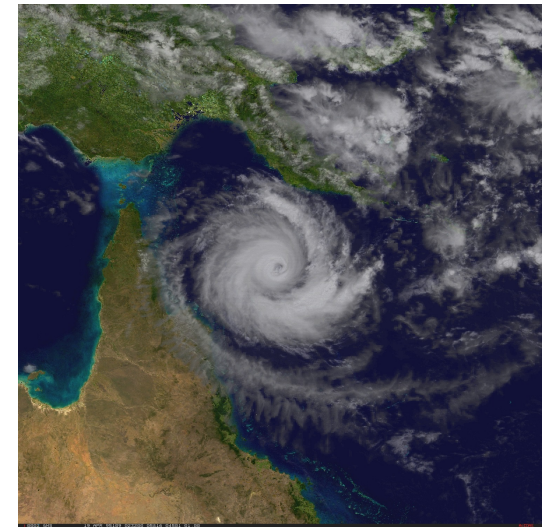
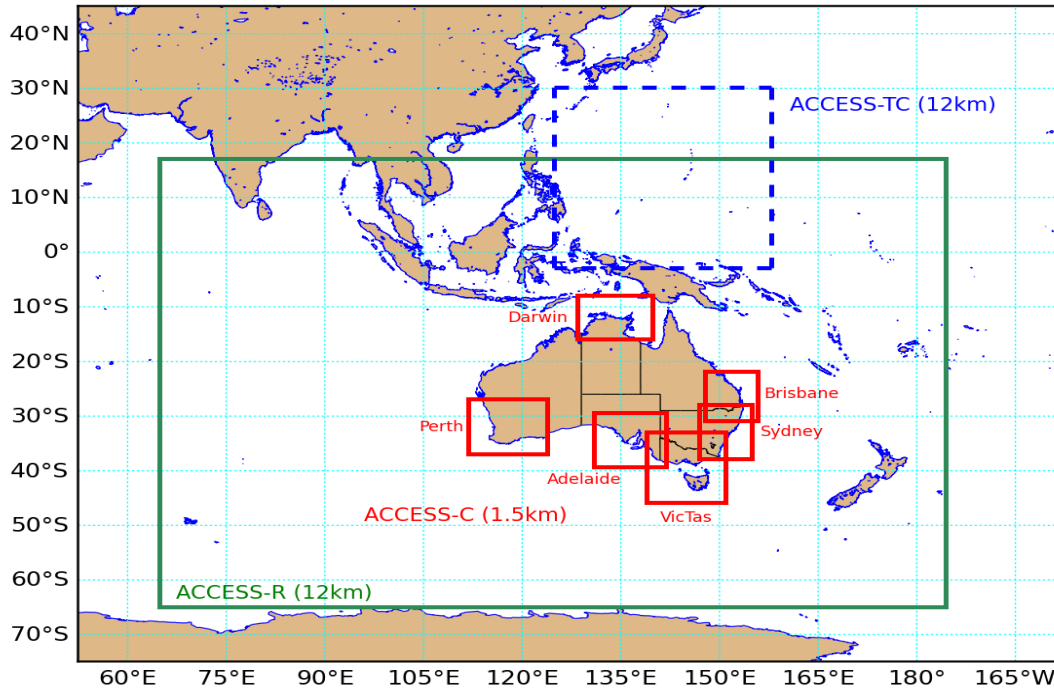


Figure 1: The ACCESS-G 15 Nov 2018



Global and regional atmosphere model: ACCESS

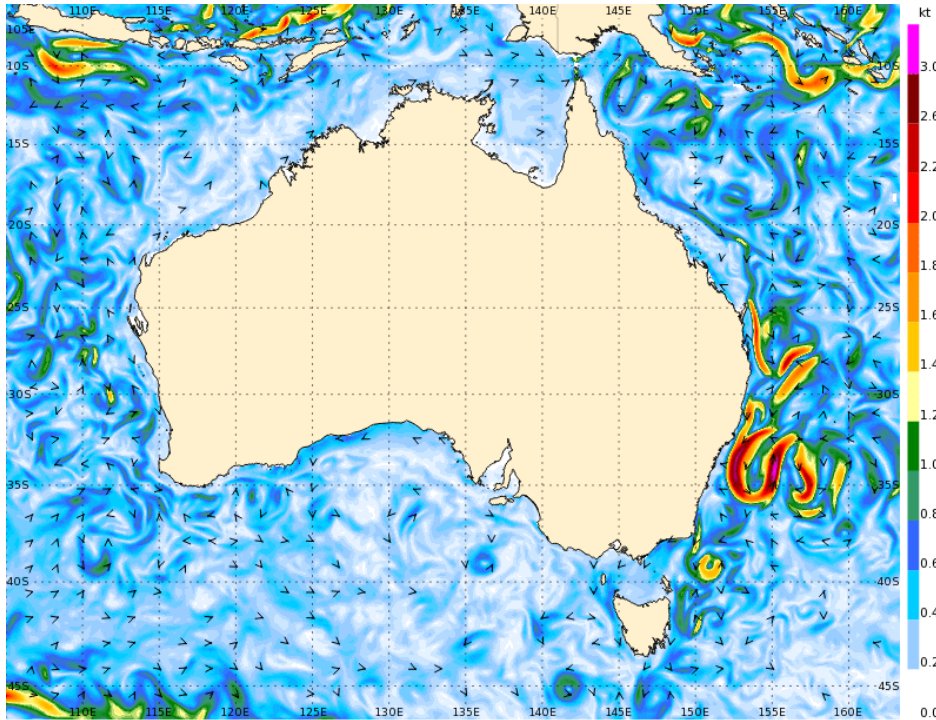


Model	Domain	Resolution
ACCESS-G	Global	0.17578125° longitude by 0.1171875° latitude (12km in the mid-latitudes, ~17km in tropics)
ACCESS-C3	City	0.0135° (1.5km)
ACCESS-TC	Relocatable	0.036° (4km)





Ocean Model: OceanMAPS



Surface Currents (knots): 24hr Average centred on **Tue 16 Feb 2021 00UTC**
 Model Base Time: Mon 15 Feb 2021 12UTC
 (c) Copyright Australian Bureau of Meteorology | OceanMAPS

The screenshot shows the 'Sea Temperatures and Currents' page on the Australian Bureau of Meteorology website. The page includes a map of Australia with various forecast regions highlighted, such as the Tropics, Mid-Latitude, and High-Latitude regions. Below the map, there are sections for 'Tropics', 'Mid-Latitude', and 'High-Latitude' with links to specific forecast areas. The page also features a 'WARNINGS' section and a footer with social media links and a 'National Weather Services' section.

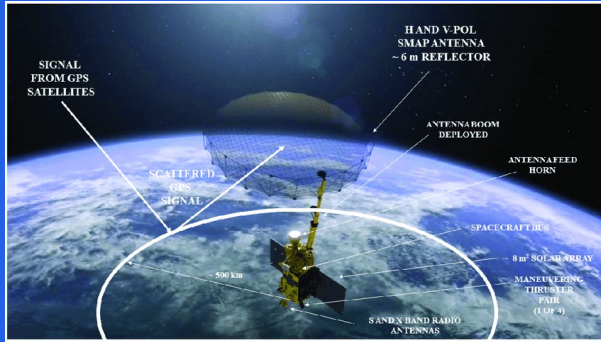
OceanMAPS forecasts are near-global (75 N to 75 S), eddy-resolving (0.1 degree grid spacing), and stretch out to 7 days.

Publicly available images of 24-hour averages for the Australian region are located on the external web.

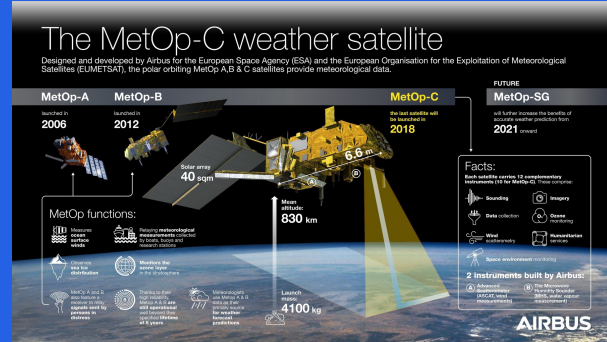
<http://www.bom.gov.au/oceanography/forecasts/index.shtml>



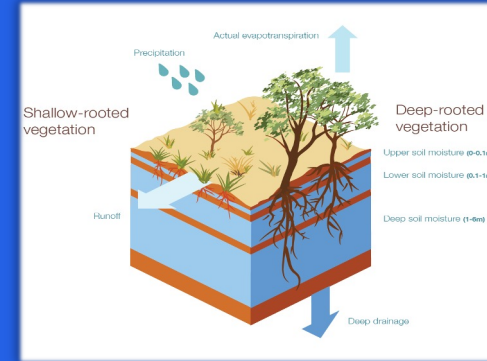
Hydrological model: AWRA-L



SMAP Enhanced L2
Radiometer Half-Orbit 9 km



ASCAT NRT 12.5 km
(Metop -B and -C)



AWRA-L upper
layer soil moisture

Australian Government Bureau of Meteorology Australian Water Outlook

Products FAQs About Community

Historical Forecast Projections Download

Time aggregation: Day Month Year

Day: 09 Month: Sep Year: 2021

Variable: Precipitation (selected), Root zone (selected)

Location: Finke River Selection: Point River region Values: Actual Relative

Root zone soil moisture 09/09/2021

Root zone soil moisture (percentile rank)

- Highest 1%
- Very Much Above Average
- Above Average
- Average
- Below Average
- Very Much Below Average
- Lowest 1%

100 km

Finke River Value: Missing

Upper layer Lower layer Deep layer

Satellite Data Assimilation: observations & requirements

ACCESS NWP

NOAA-15
NOAA-18
NOAA-19
DMSP F-17
Aqua
Coriolis
SUOMI-NPP
NOAA-20
METOP-B
METOP-C
GCOM-W1
Himawari-8
GNSS-ground
(various)

GOES-16
GOES-17
FY-3C
FY-3D
FY-3E
Meteosat-8
Meteosat-11
Sentinel-3A
Sentinel-3B
ScatSat-1
TerraSAR-X
Tandem-X
GRACE (2 sats)

Locally-received observations
from Metop-B/C, NOAA-18, -19,
-20, SNPP, Terra, Aqua

OceanMAPS

Sentinel-3A
Sentinel-3B
Jason-3
SARAL
Cryosat2
Satellite SSTs
Sentinel-6

Future:
SWOT (wide swath
altimetry)
SSMIS and AMSR-2 ice
concentration
SAR

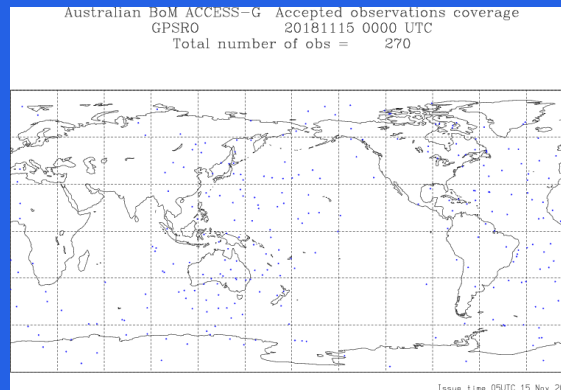
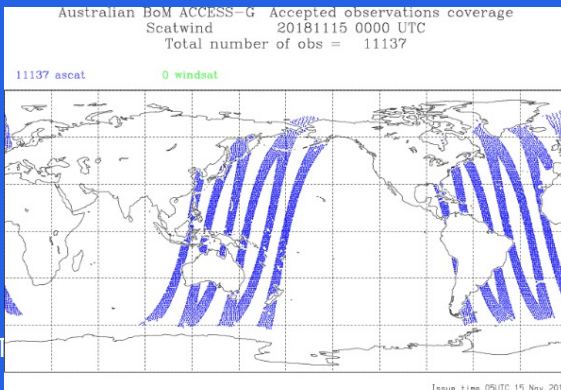
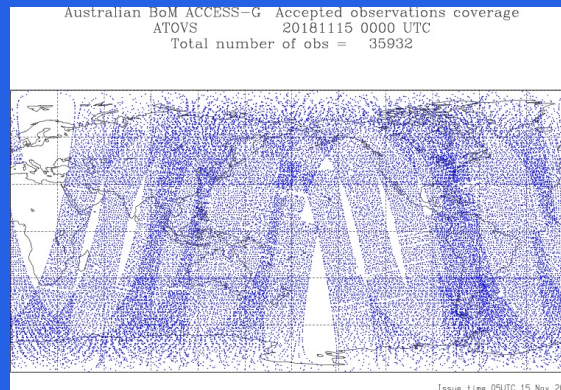
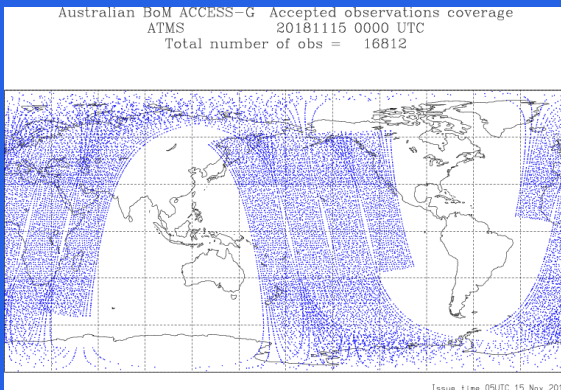
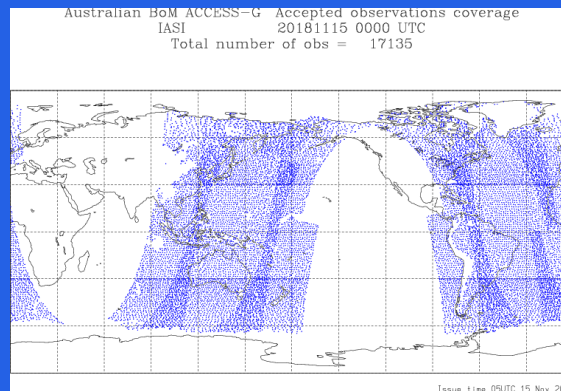
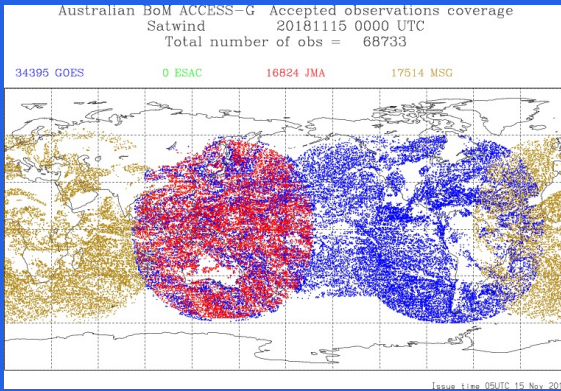
AWRA-L

SMAP
AMSR2

Requirements collected and coordinated by GODEX-NWP



Satellite instruments



Microwave sounder

IR sounder

VIS/IR imager

Scatterometer

Microwave imager

GPS RO

Altimeter

GNSS to ground

SAR

Precipitation Radar





The Bureau's ground station network

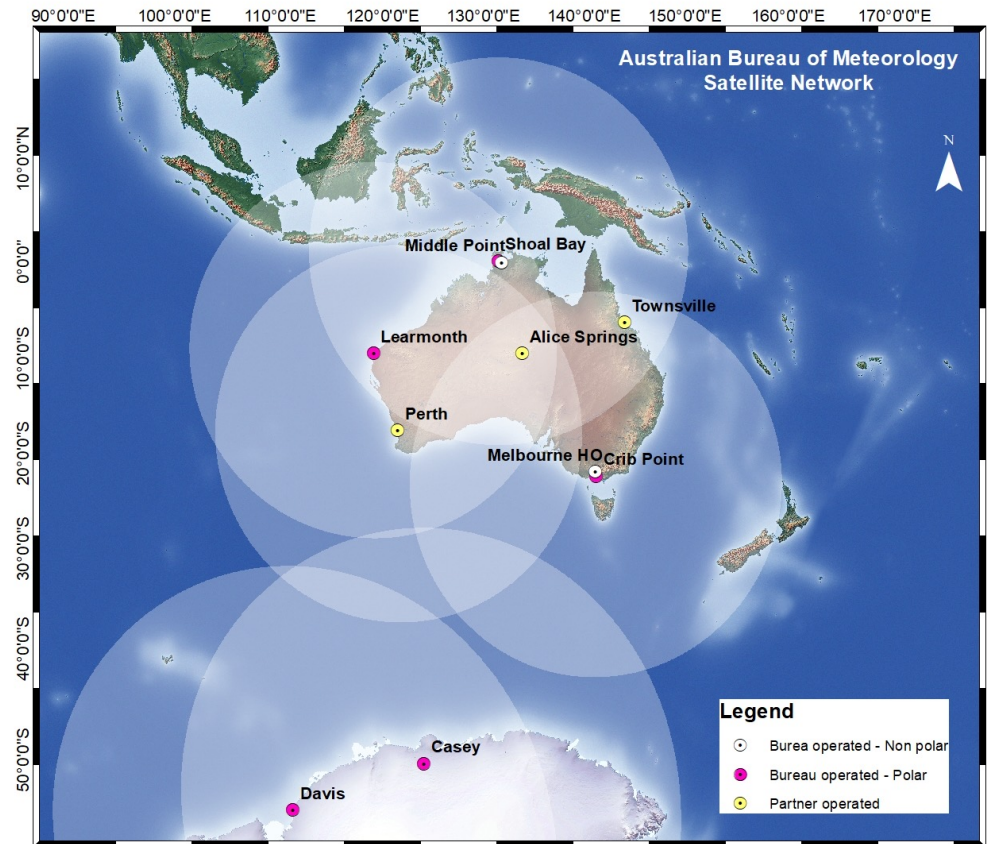
Ground network includes:

- 5 polar tracking ground stations (Crib Point, Learmonth, Shoal Bay, Casey, Davis)
- COSMIC-2 (Middle Point)
- FY-2 and TARS (Crib Point)

Upgrades completed to receive JPSS-2 at all sites

All sites will be upgraded to receive EPS-SG by end 2023.

The polar tracking ground stations are part of the Direct Broadcast Network (DB-Net), providing low latency data for NWP.



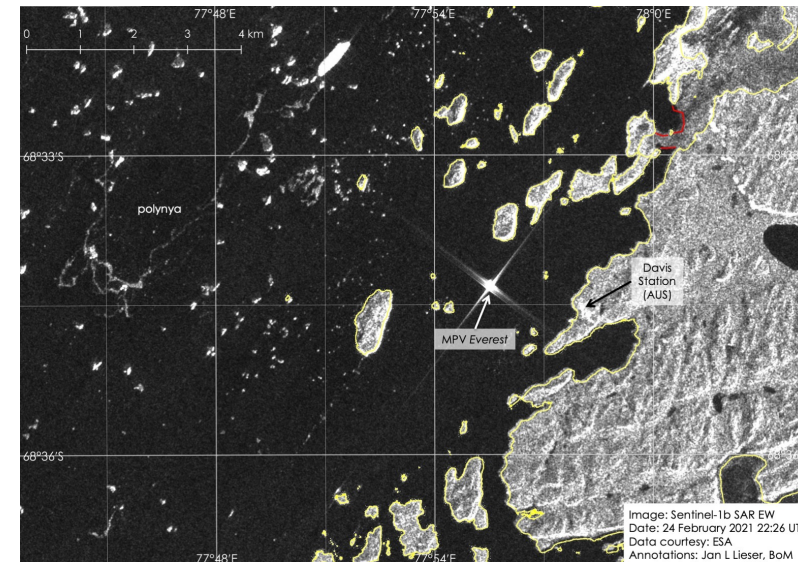
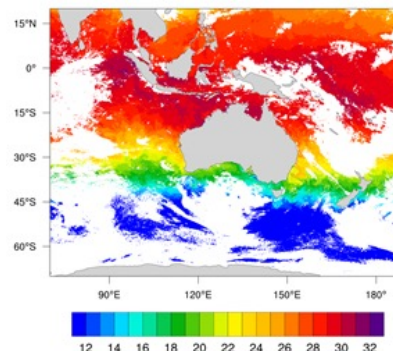
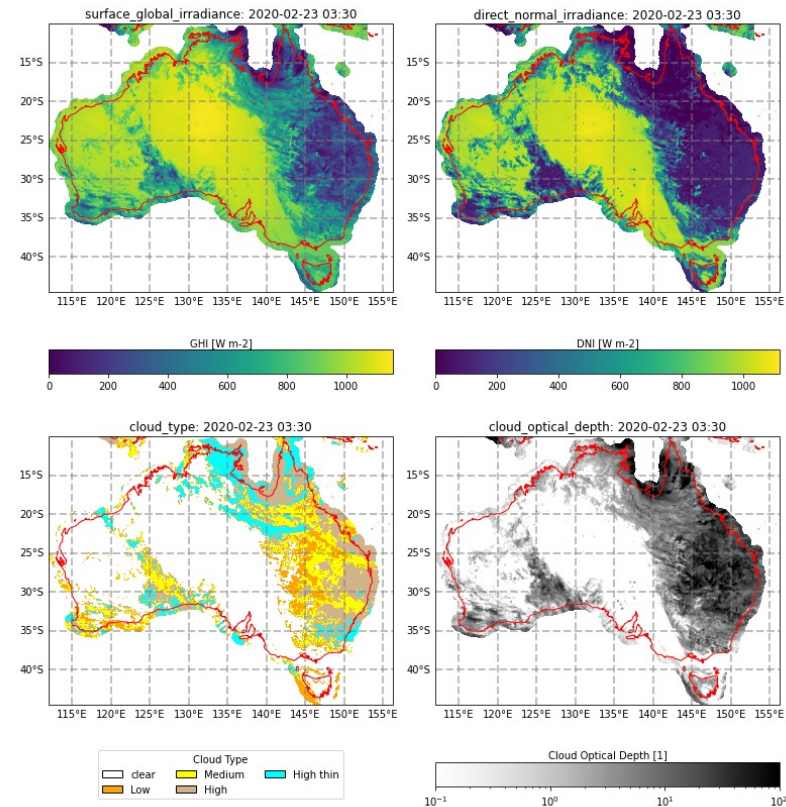


Satellite products

Products developed in the Bureau:

- Solar Irradiance
- SSTs
- Cloud properties and precipitation
- Volcanic Ash (RGBs and predictions)
- Fog and low stratus

Many others via internet, GTS etc.
from international partners



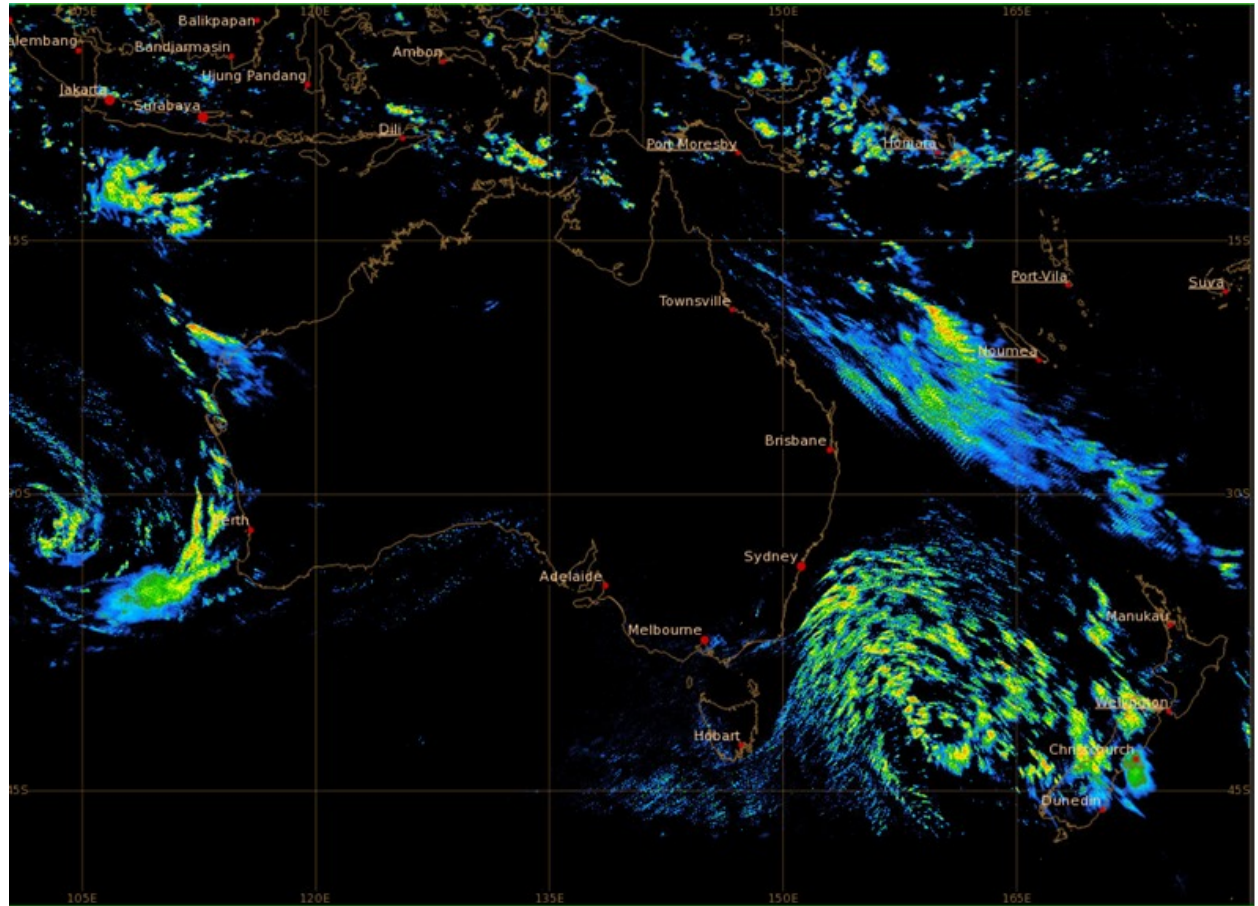


Nowcasting : new products

Satellite Precipitation

New product for forecasters using Himawari-8, lightning data, NWCSAF GEO, model output:

- 2km resolution
- Every 10 minutes
- Australian region and coastal zone
- Includes uncertainty
- Verification with rain gauges, GSMAP NOW, GPM/iMerg



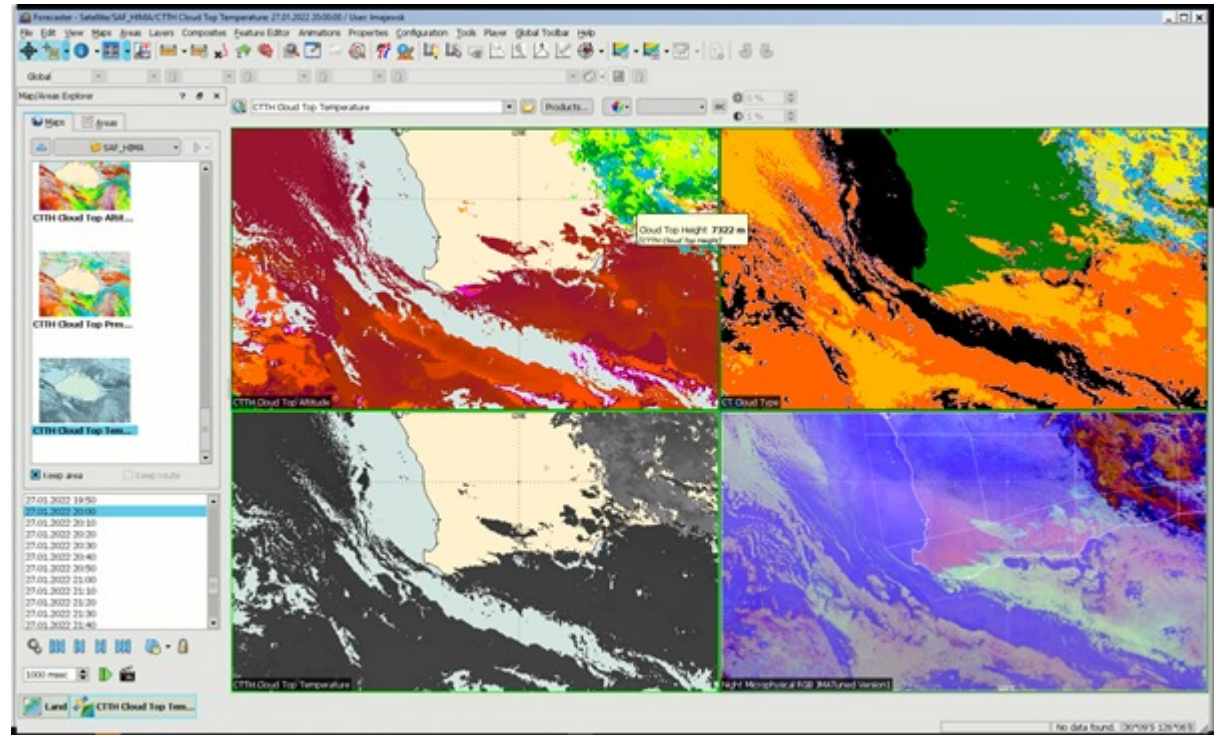


Nowcasting: new products

National Satellite-based Cloud Analysis

New product for forecasters using Himawari-8, model output, GAMSSA SSTs :

- 2km resolution
- Identifies cloud free areas, types of cloud, cloud top parameters, presence of snow or sea ice, dust clouds, volcanic plumes and smoke.





Nowcasting : future plans

National satellite-based storm cells detection

Will provide tracking and nowcasts of the location, direction and intensity of storms including thunderstorms across the entire country. Will rely on Himawari-8 and lightning data. For use by forecasters.

National storm blending

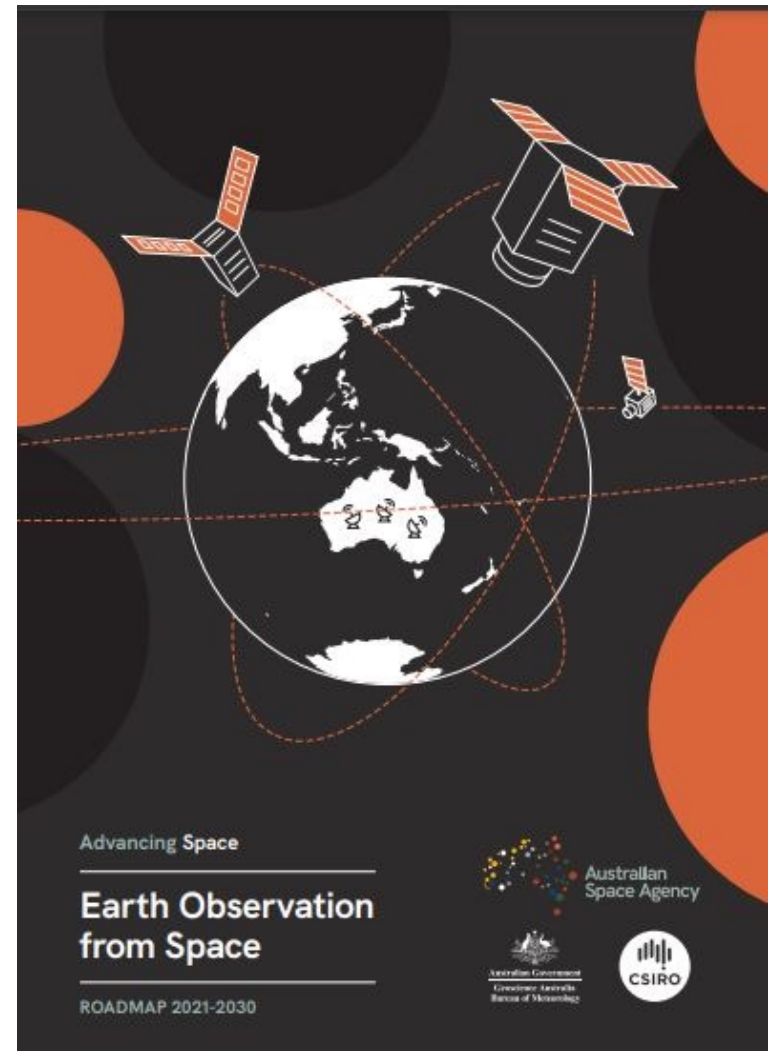
Will provide maps of storm cells severity from radar and satellite observations across Australia, in near real-time. For use by forecasters.

Vision for Australian Earth Observation satellites

The Australian Space Agency released the EO Roadmap in November 2021.

Builds on the Civil Space Strategy 2019-28 to: **significantly grow its market segment from around 10,000 jobs and a market size of \$3.9 billion to up to another 20,000 jobs and \$12 billion by 2030**

In the EO Roadmap, the Bureau articulates an ambition for an operational Meteorological satellite capability by the 2030s.





Planning for Australian meteorological satellites



To explore the feasibility of Australian meteorological satellites, the Bureau is working with UNSW Canberra Space on 3 Pre-Phase A studies:

- Microwave sounder
- Lightning sensor
- SAR

Reports will be publicly available in early 2023.

UNSW Canberra Space CDF workshop, October 2022



The Bureau
of Meteorology

Thank you

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