Australian Government
Department of Defence
Defence Science and
Technology Organisation

# Scheduling multi-spectral collection of the Australian landmass using a 6U cubesat constellation

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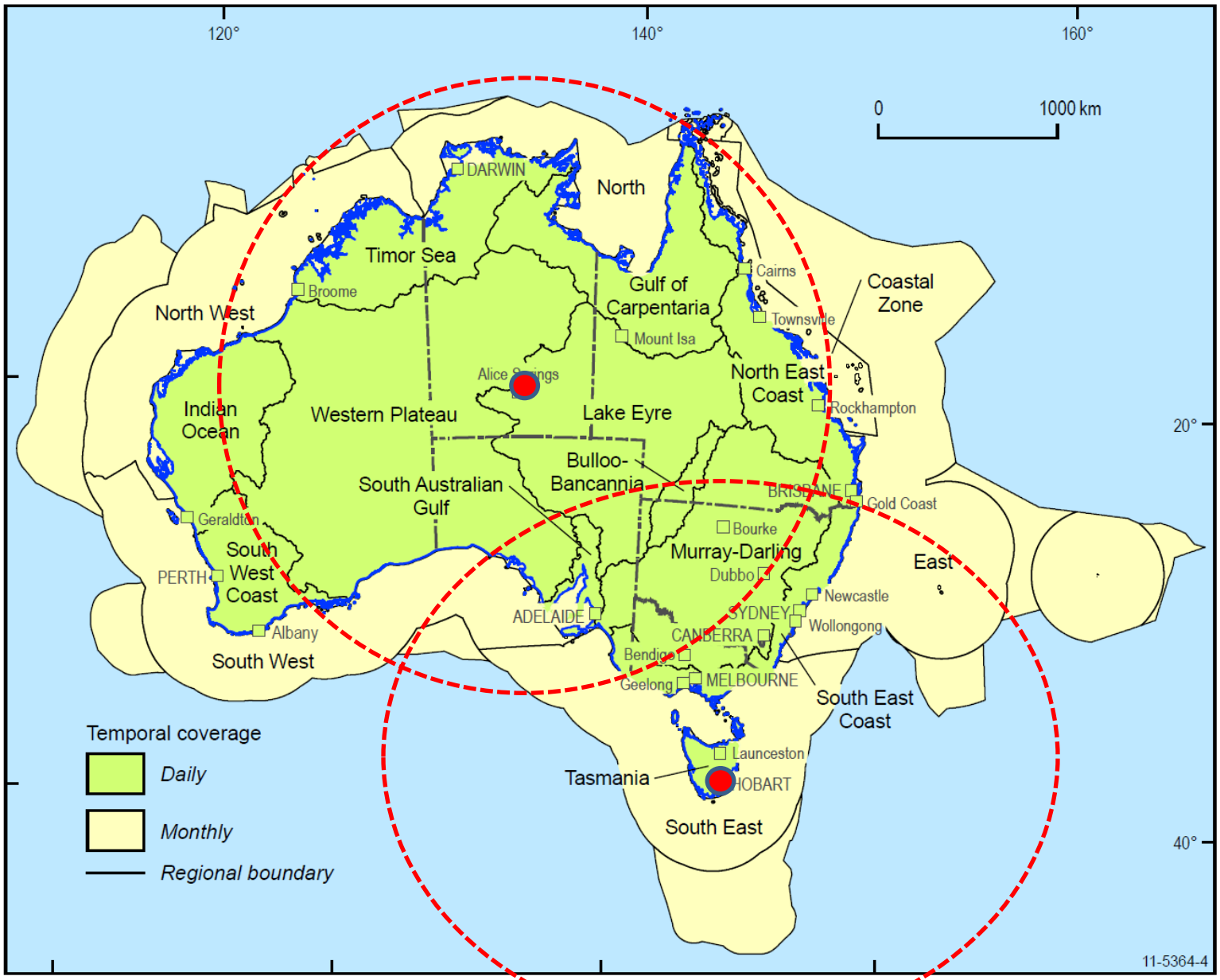
DSTO

# Outline

- Problem we are addressing
- Scheduling tool we are using
- Scope of our analysis
- Our modelling approach
  - 6U cubesat
  - Hypothetical constellations
- Scheduling results for a single day
  - Impact of constraints related to data storage & downlink
  - Impact of cloud
- Conclusions & further work

# The Problem



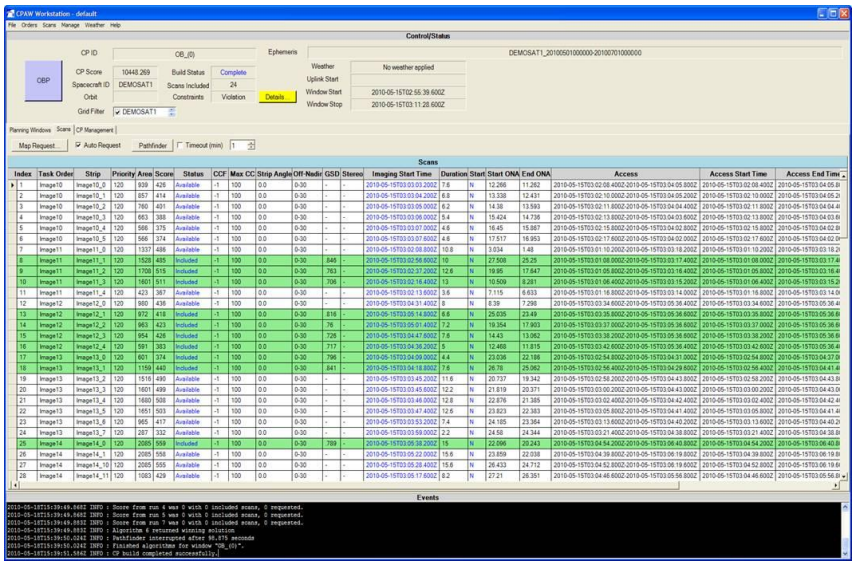

GA: Continuity of Earth Observation Data for Australia, Hudson 2011

# Collection Planning & Analysis Workstation (CPAW)

- Schedule collections by imaging satellites
- Electro-optic & Synthetic Aperture Radar
- Operationally proven heritage
- High fidelity spacecraft modelling
- Multiple advanced scheduling algorithms
- U.S. International Traffic in Arms Regulations

Includes constraints related to:

1. Solid state recorder capacity
2. Downlink
3. Battery
4. Cloud



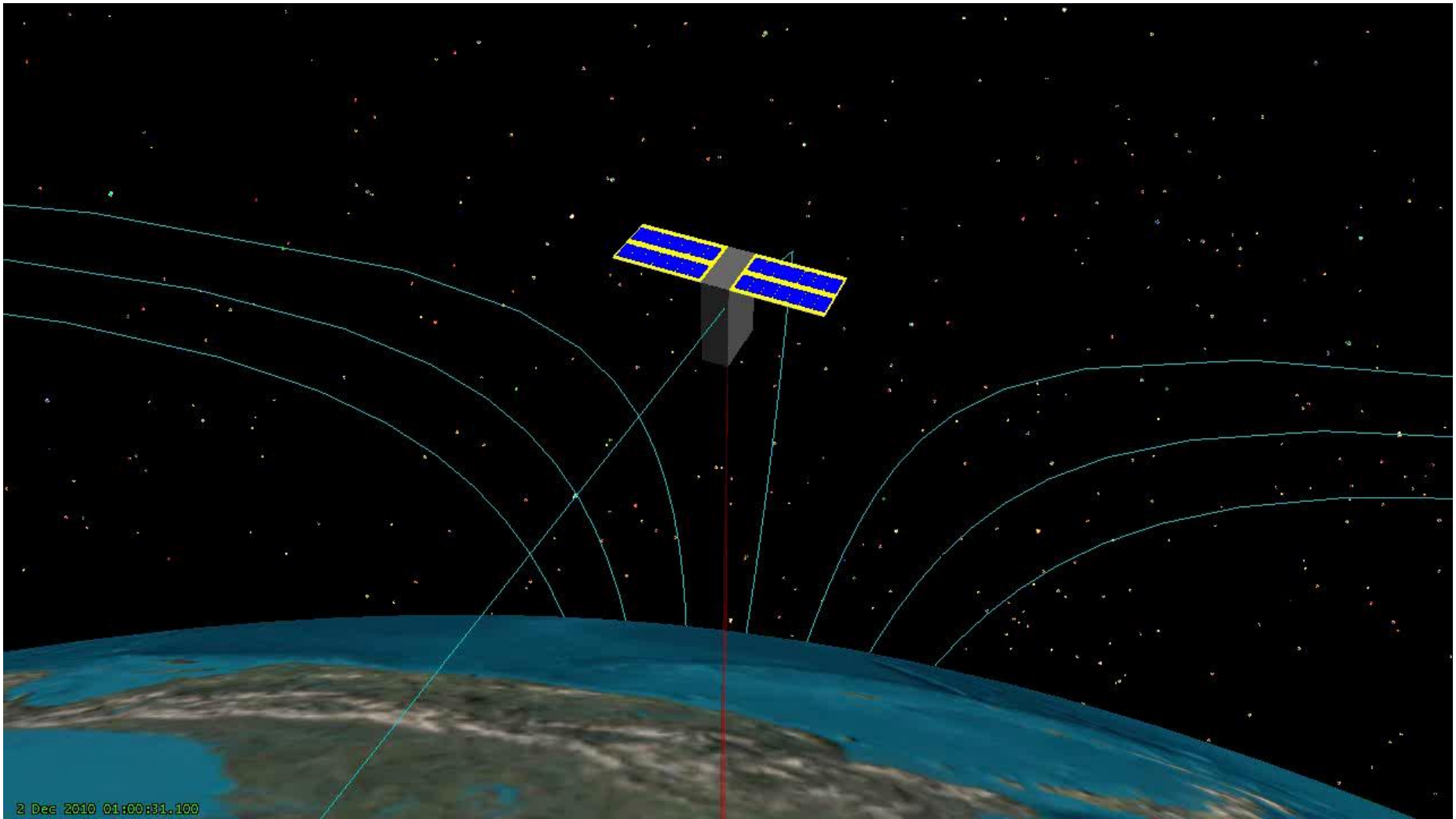
# Scope

- Not a comprehensive feasibility analysis of Tsitas & Kingston design
  - Alternative designs have been considered
- Only a subset of the key issues have been considered:
  - Mission planning
  - Orbit design
  - Ground station network
- Key issues not considered include:
  - Sensor design
  - Launch of cubesats
  - Station-keeping
  - Detailed cost estimates

UNCLASSIFIED

# 6U Cubesat

| Parameter | Cubesat 1 | Cubesat 2 |
|---|---|---|
| Ground Sample Distance | 23.5 m | 6.5 m |
| Swath width | 94 km | 26 km |
| Downlink rate | 5.4 Mbps | |
| Max power generation | 35 W (T-wing) | |

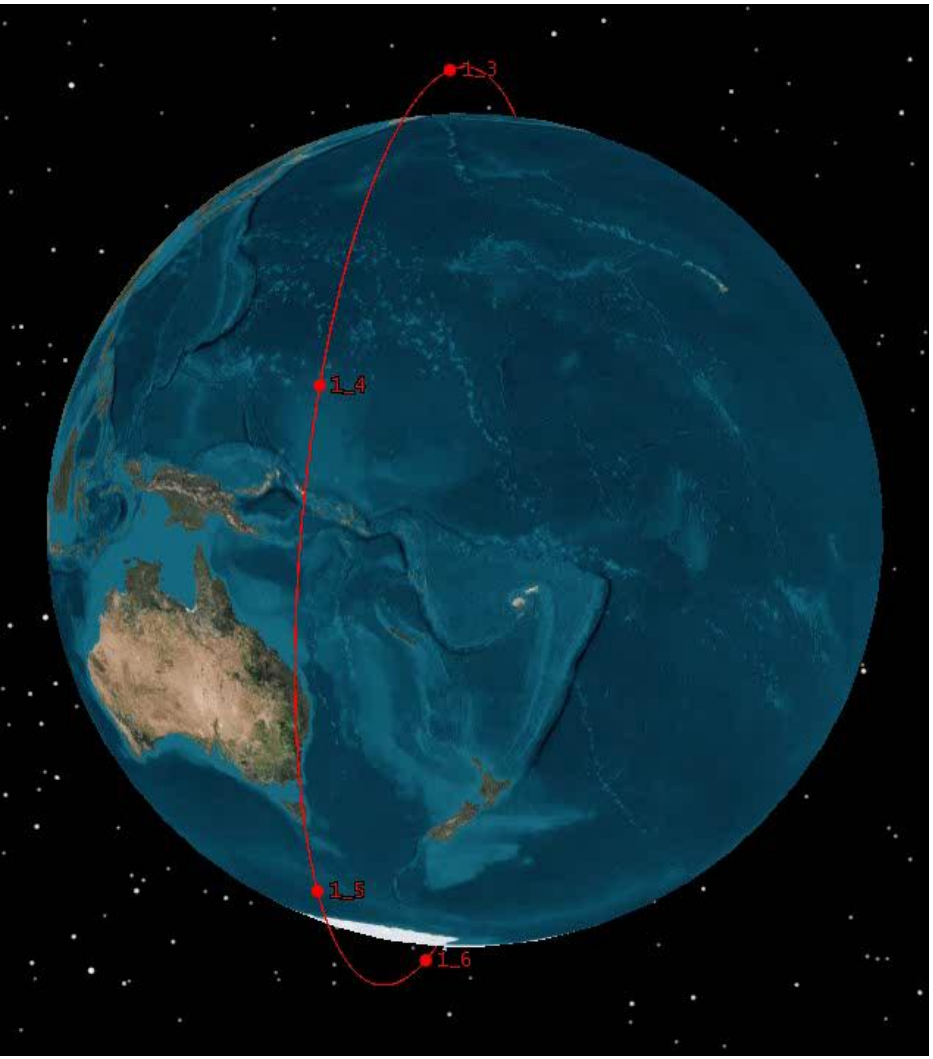


# Constellation Parameters

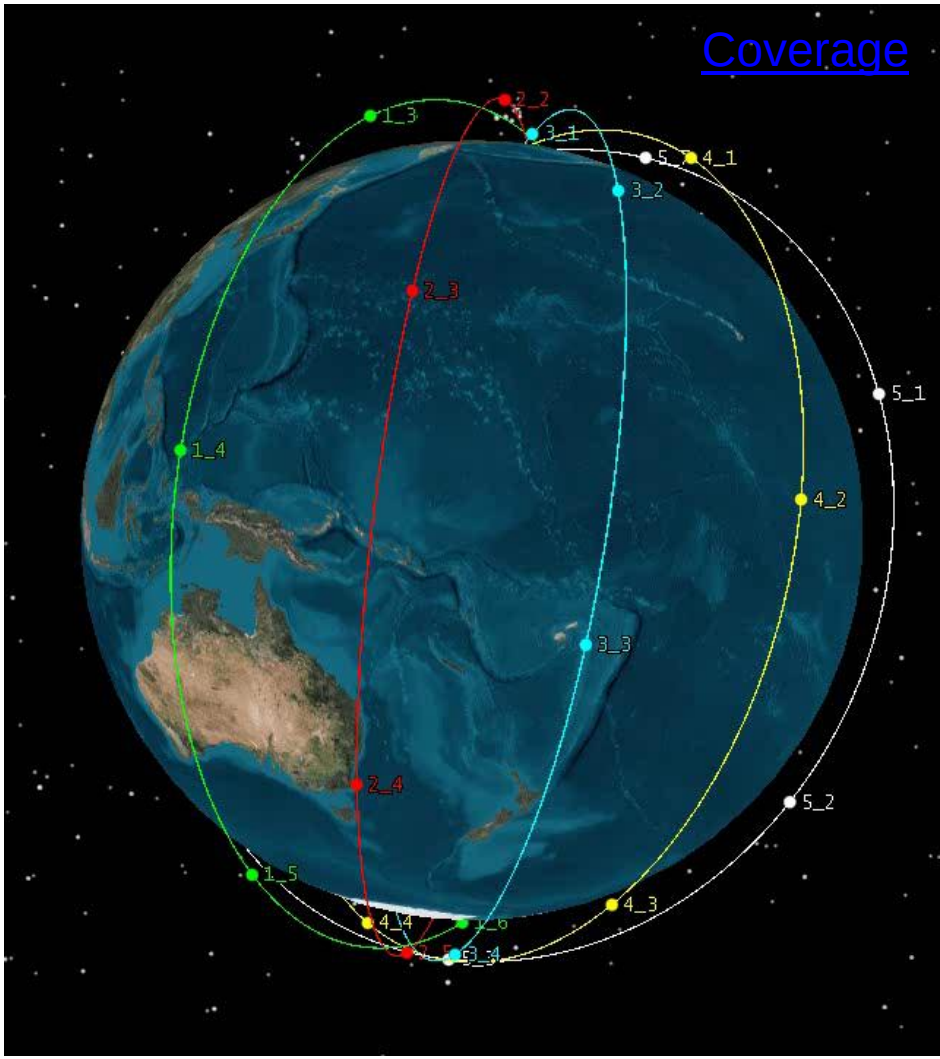
| Parameter | Medium Resolution Constellation | High Resolution Constellation |
|---|---|---|
| Satellites per orbit plane | 7 | 7 |
| Orbit planes | 1 | 5 |
| Local time of equatorial descending pass | 10:30 | 9:00, 10:30, 12:00 13:30, 15:00 |
| Ground Sample Distance | 23.5m | 6.5m |
| Cost (1 sat = US $1.3M) | US $9.1M | US $45M |
| Analogous system | ResourceSat-1 | RapidEye |

# Constellations

Medium Resolution




High Resolution



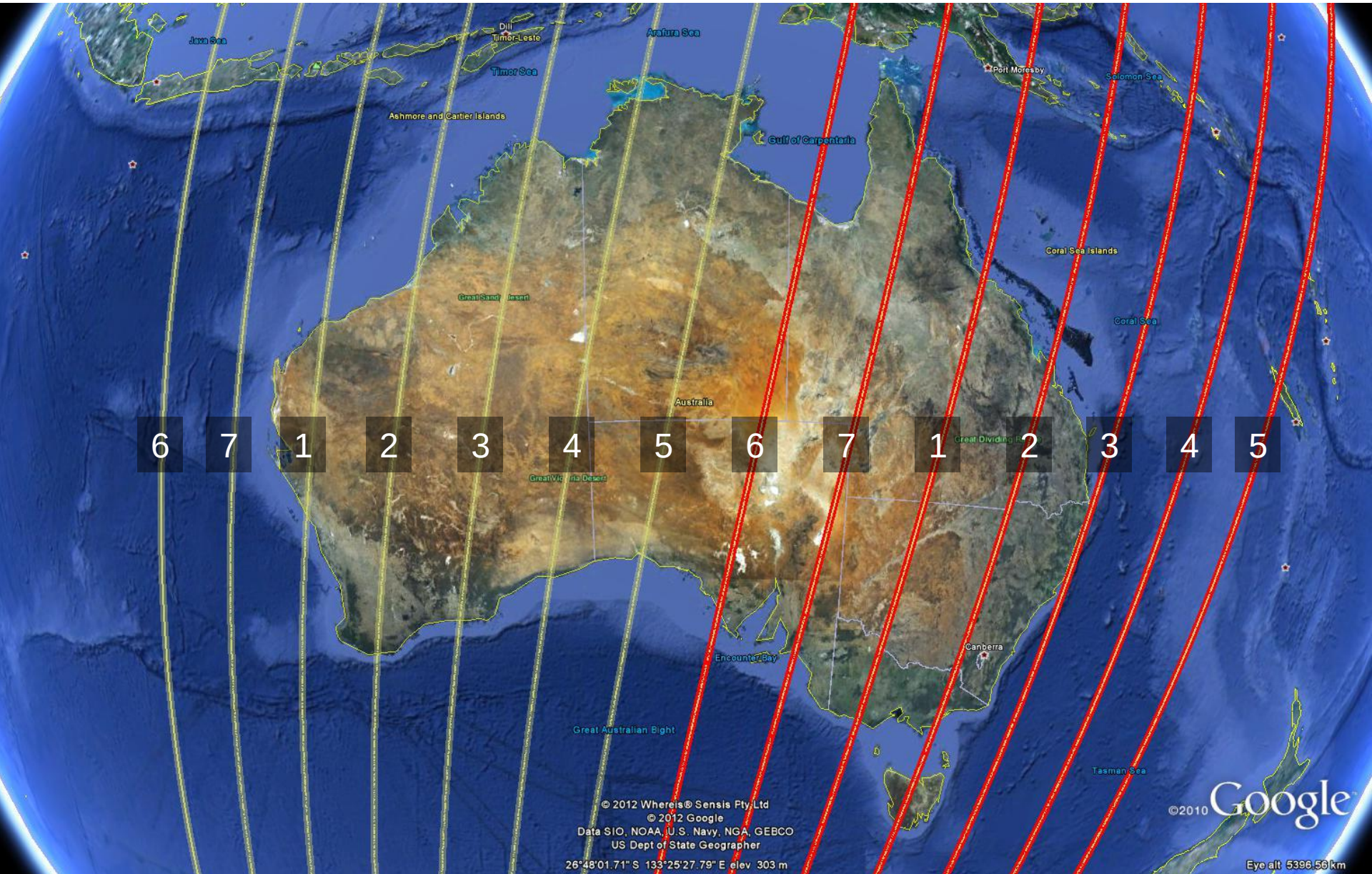
# Example Collection Plan

# Overview of results

- Aim is to image entire landmass of Australia daily
- Scheduling results are presented for a single day
- Analysis:
  - Impact of including constraints related to data storage & downlink
  - Impact of cloud
- Impact of power budget not yet considered

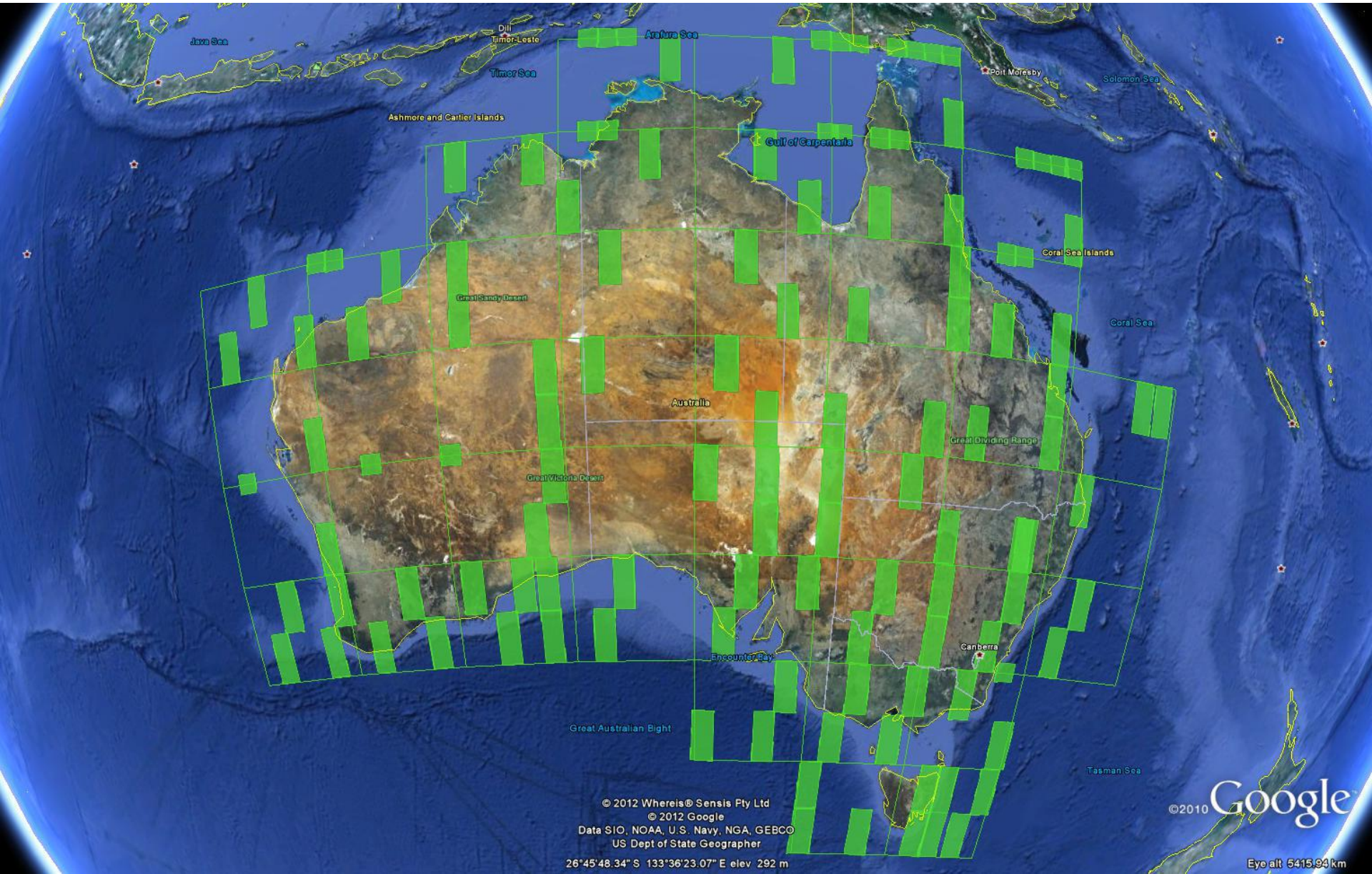
Area of Australia - 7,741,220 km²

# 1 Day - 7 satellites - 14 Passes
# Medium Resolution



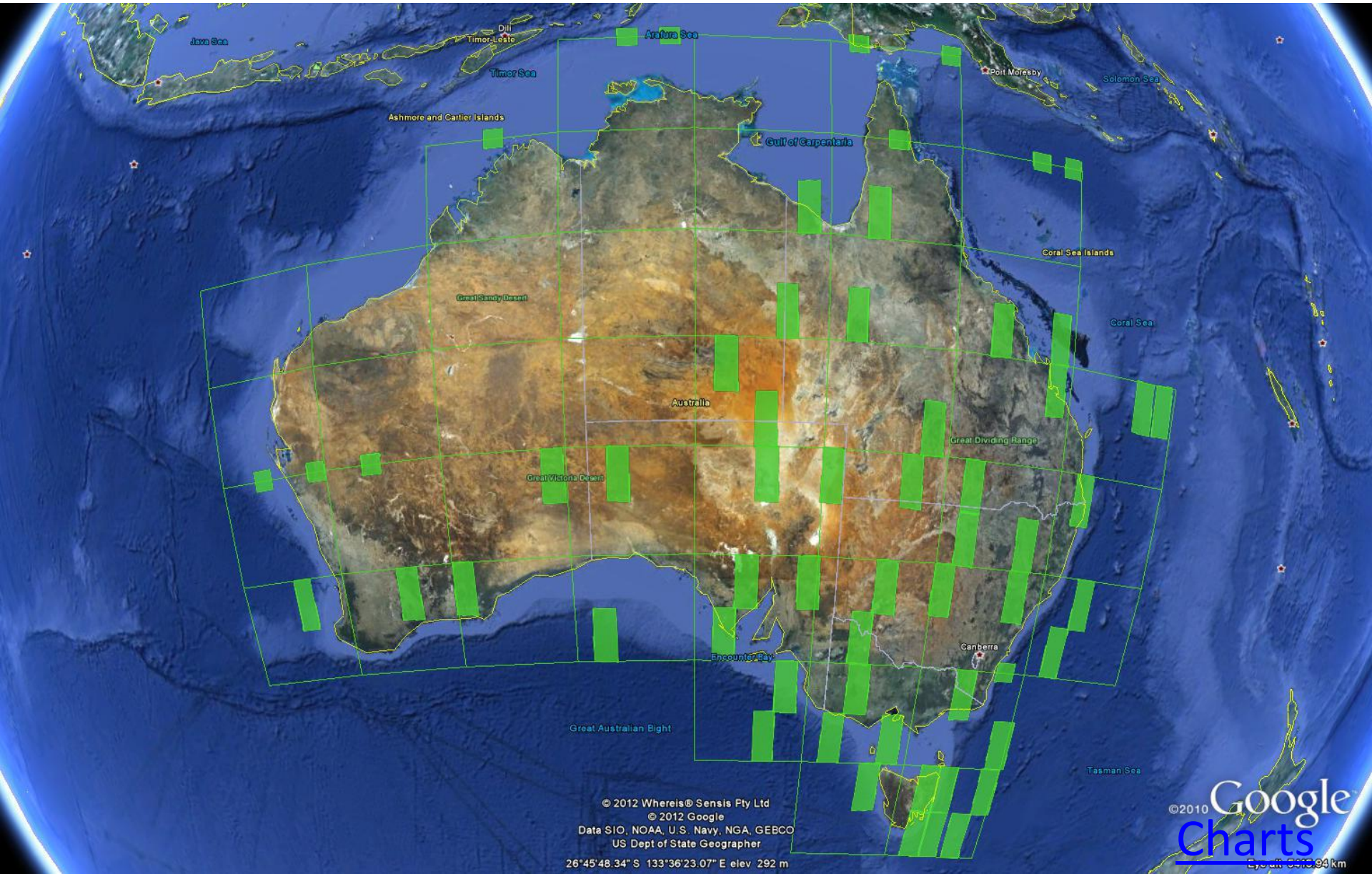
Area of Australia - 7,741,220 km²
Area Collected – 2,670,592 km²
**Percentage – 34%**

# 7 satellites, no data constraint
## Medium Resolution



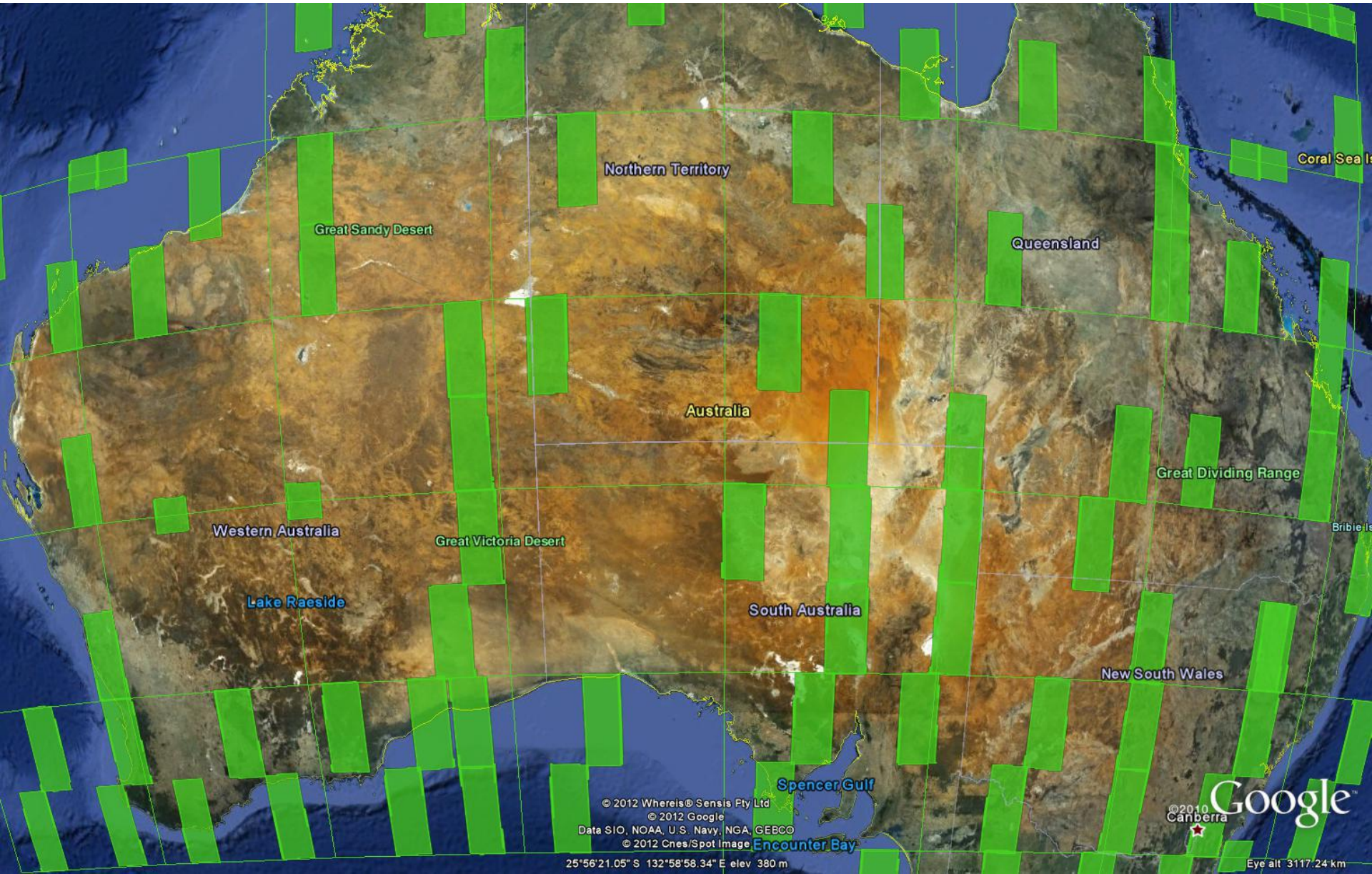
Area of Australia - 7,741,220 km²
Area Collected – 1,417,530 km²
**Percentage – 18%**

# 7 satellites, data constraint
# Medium Resolution



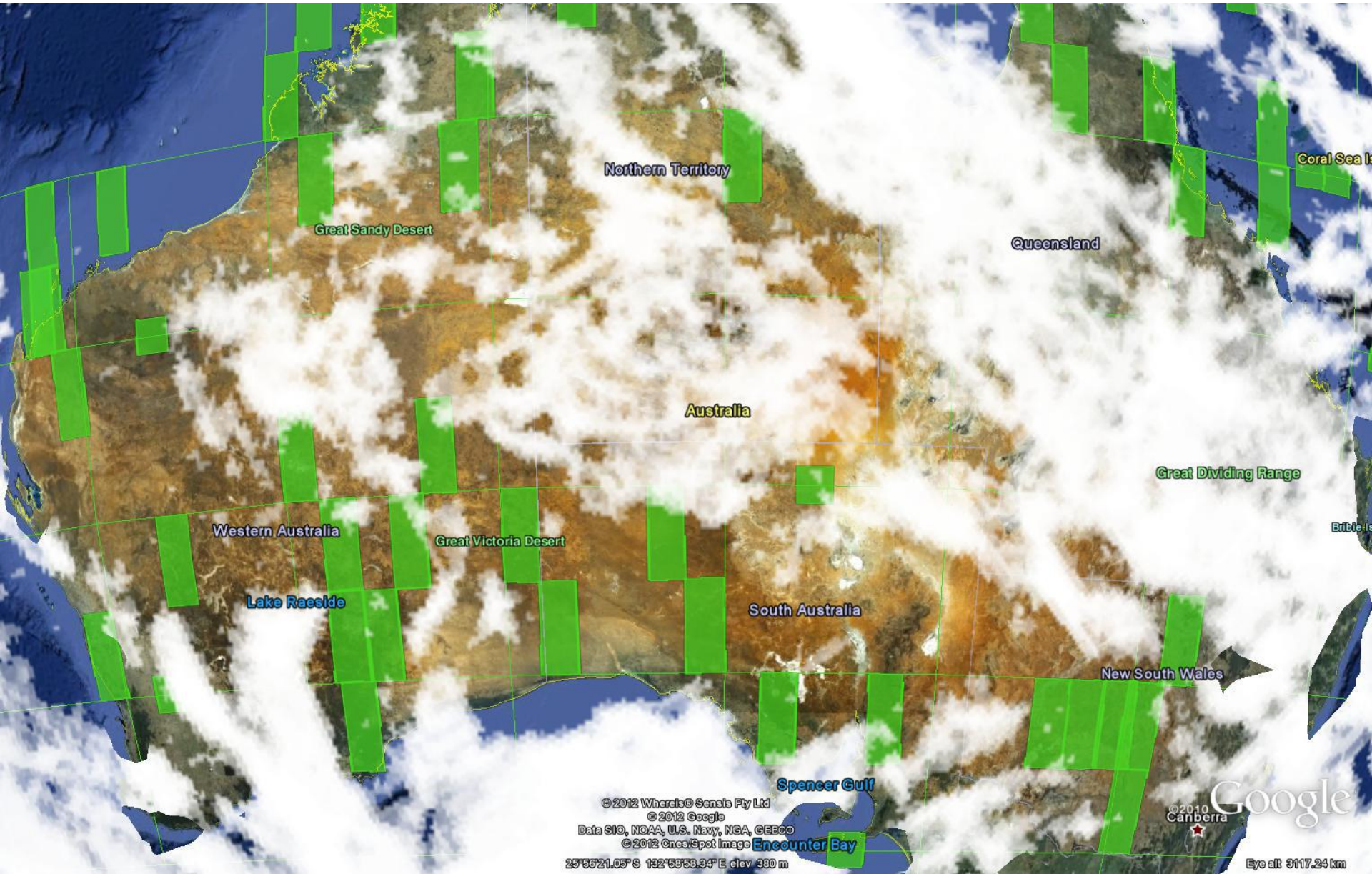
Area of Australia - 7,741,220 km²
Area Collected – 2,670,592 km²
**Percentage – 34%**

# 7 satellites, no data constraint
# Medium Resolution



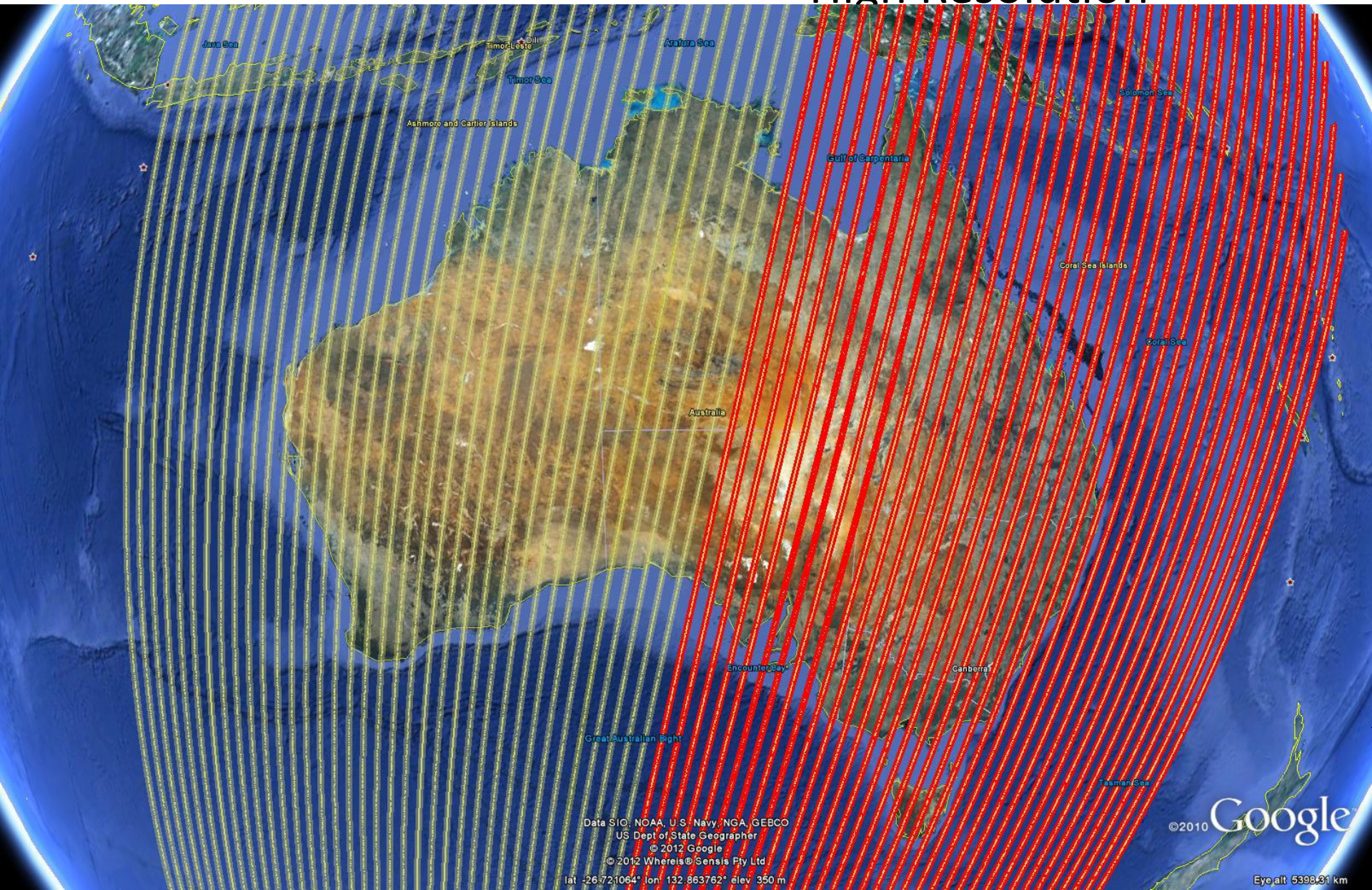
Area of Australia - 7,741,220 km²
Area Collected – 1,323,645 km²
**Percentage – 17%**

# 7 satellites, cloud constraint
# Medium Resolution



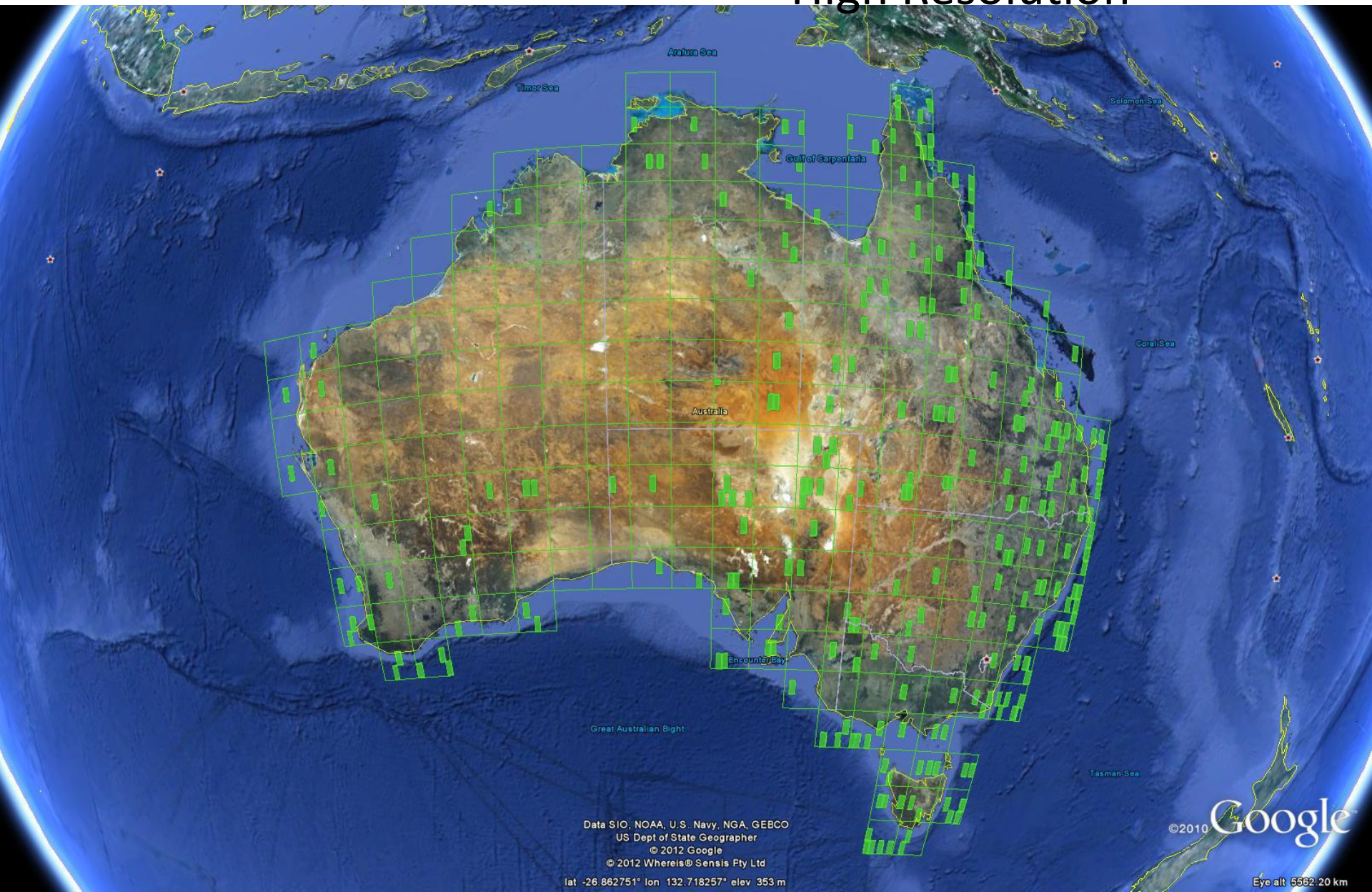
Area of Australia - 7,741,220 km²

# 1 Day - 35 satellites – 70 Passes High Resolution

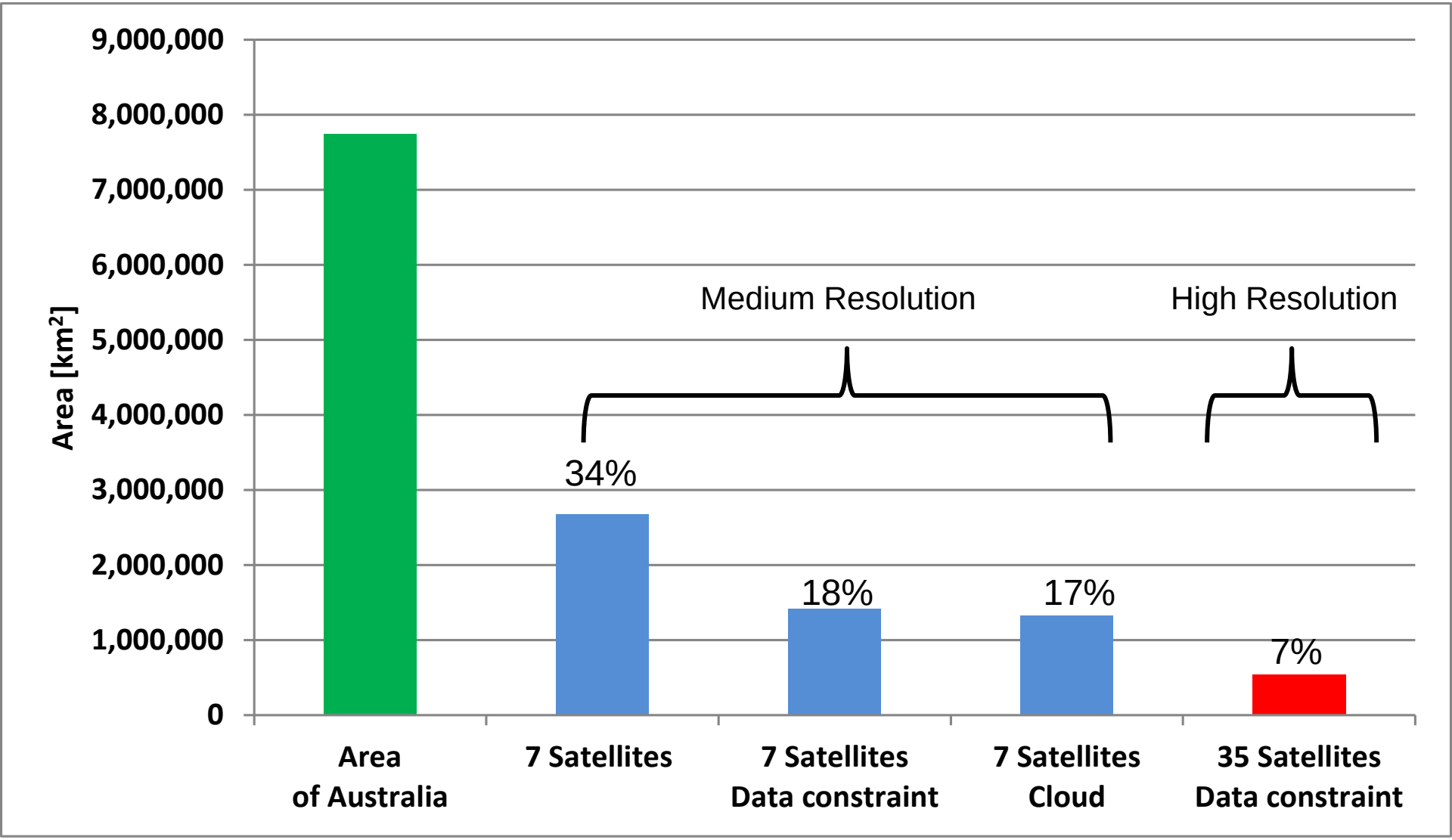


Area of Australia - 7,741,220 km²
Area Collected – 533,806 km²
**Percentage – 7%**

# 35 satellites, data constraint
# High Resolution



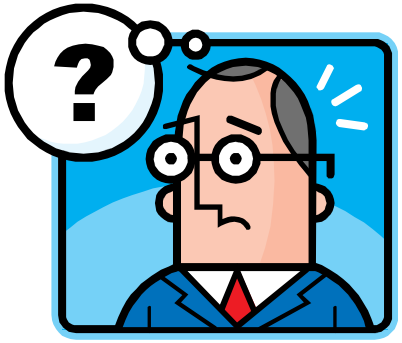
# Results Summary



# Conclusions & Further Work

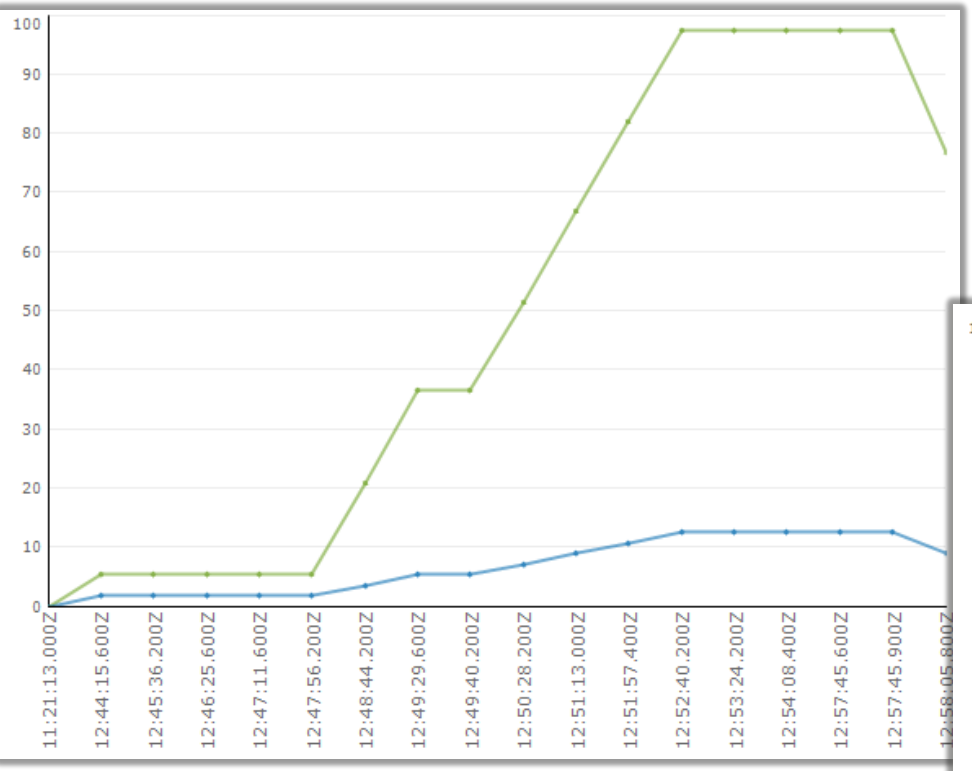
- CPAW is a valuable tool for assessing mission effectiveness
- Constraints associated with data flow are a bottleneck in the analysed 6U cubesat systems
- It is essential to include cloud forecasts in the assessment
- Future work includes:
  - Gain better understanding of constraints related to:
    - Power
    - Star tracker pointing
  - Explore alternative options for the ground station network

# Questions??

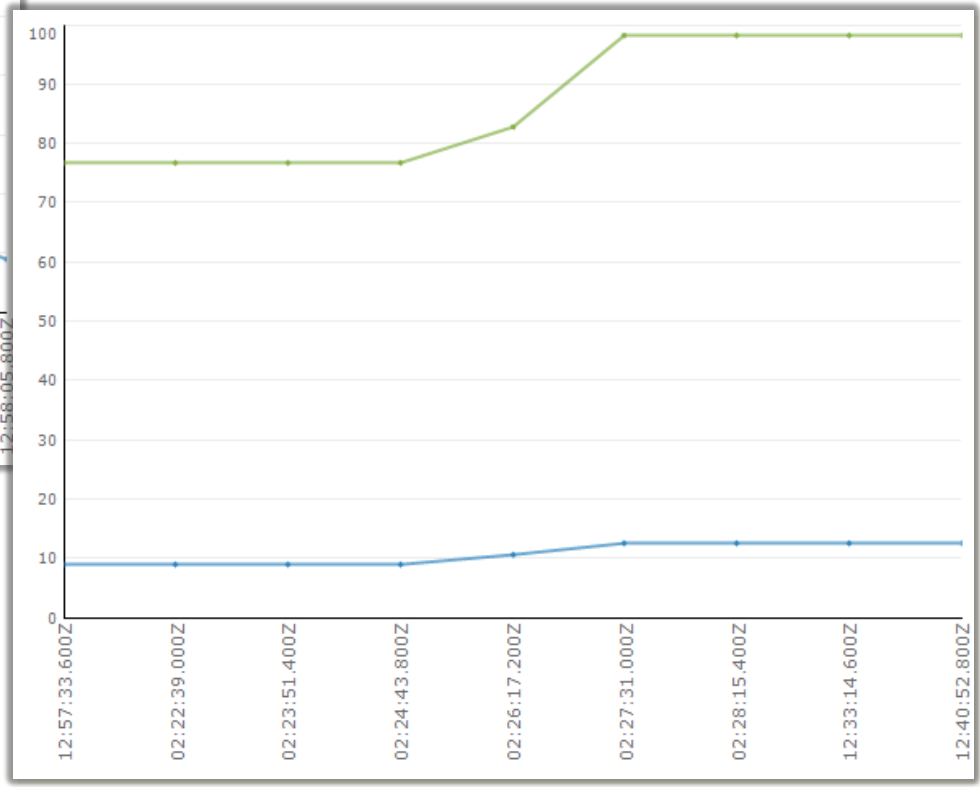


# SSR state

1st pass




2nd pass




Return

# Coverage by Constellations

Medium Resolution

High Resolution

Return