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Challenges to Strategic Innovation and Technology

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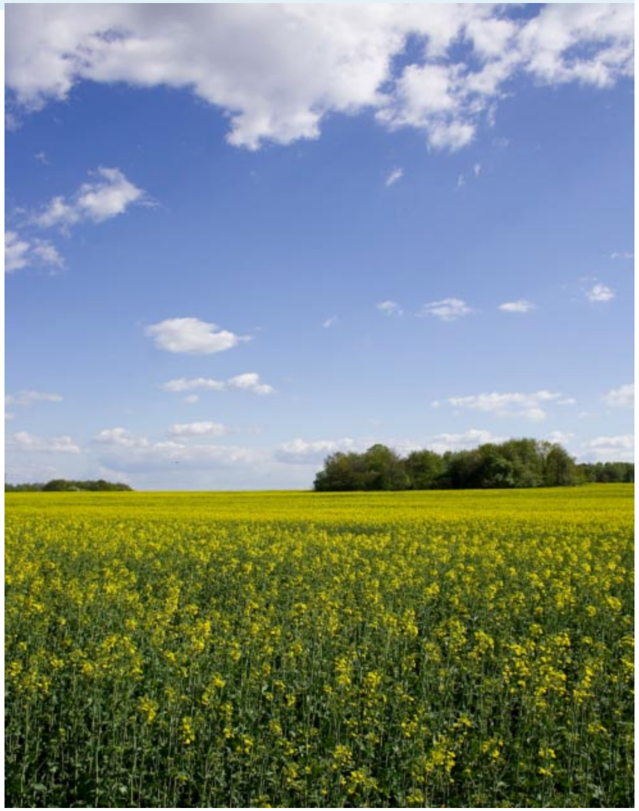

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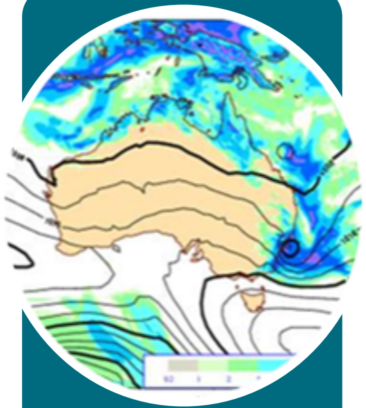
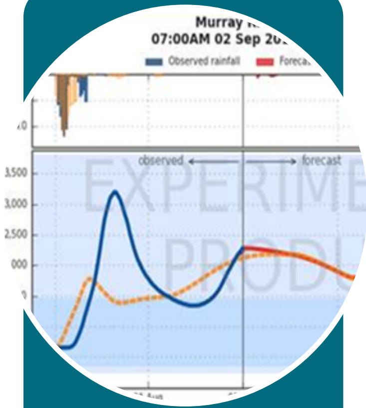
The Bureau's Strategic Mission

To provide Australians with environmental intelligence for safety, sustainability, security, well-being and prosperity





Observe

Analyse

Forecast

Inform

Warn

Information from environmental data and models to inform decisions

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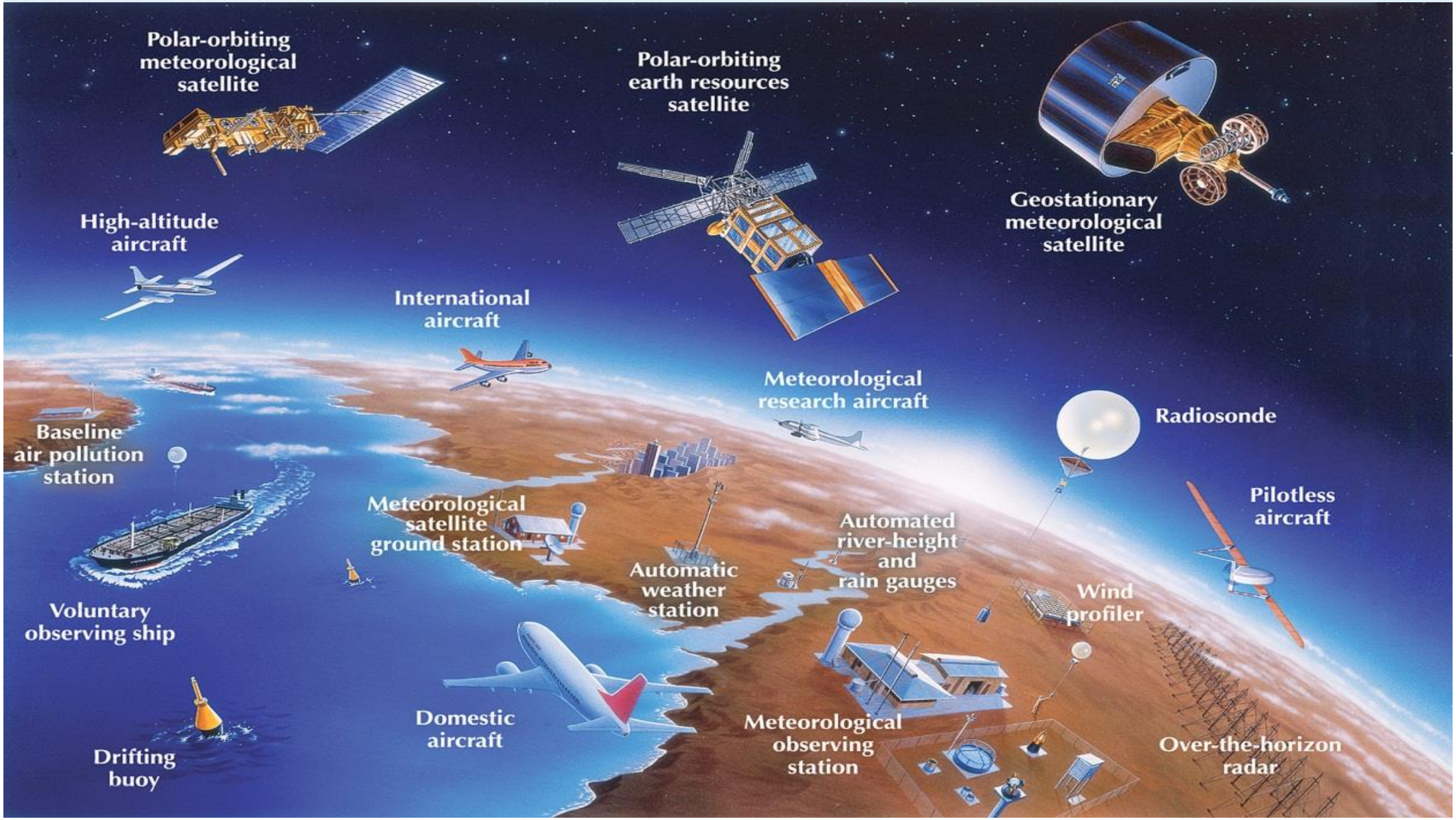
Daily Observations





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Daily Observations



- **~10 million atmosphere observations** suitable for ingest into our operational NWP systems are received each day.
  - These observations are reduced to around 600,000 before being input into the 4DVAR processes.
  - ACCESS-G observations received is shown.
  - ACCESS-G is run four times daily giving it access to a 24-hour window of observations.
- **~5.5 million ocean observations** suitable for ingest into our operational Ocean systems are received each day.
  - OceanMAPS observations received and accepted by a typical Ocean forecast run is shown.
- **~1 billion observations** in the next generation of satellites such as Himawari-8/9 from Japan
  - 10 minute observations
  - 16 channels in visible and IR wavelengths

APS1 ACCESS-Global	Received
ATOVS	700,000
AMV	600,000
AMDAR & AIREPS	200,000
ASCAT	200,000
AIRS	80,000
IASI	81,000
Surface	38,000
GPSRO	400

OceanMAPS Global	Received
Insitu (ARGO, Buoy,..)	30,000
Altimetry (Jason-2,..)	44,000
AVHRR (NAVO, …)	3,100,000
AMSR2	2,000,000
WindSat	320,000

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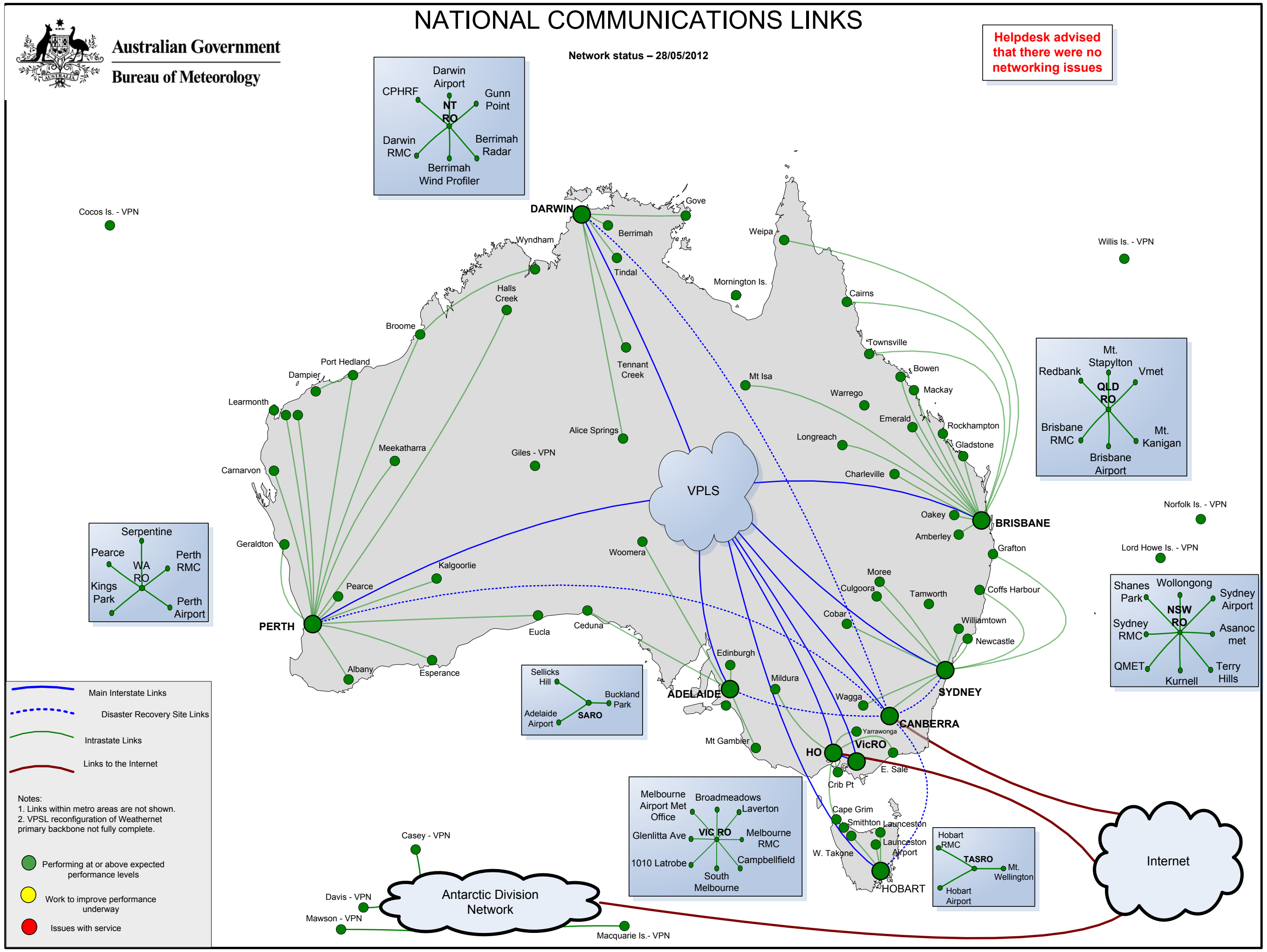
Daily Observations

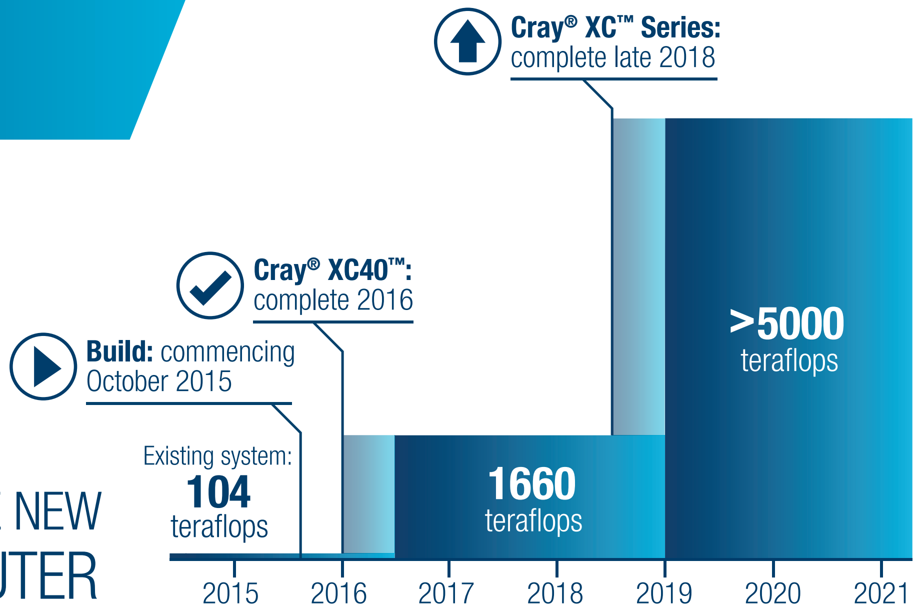


Australis HPC system

Supercomputer details

$59 MILLION (USD)
HAS BEEN ALLOCATED FOR THE PROJECT

CRAY Inc. WILL SUPPLY THE NEW SUPERCOMPUTER



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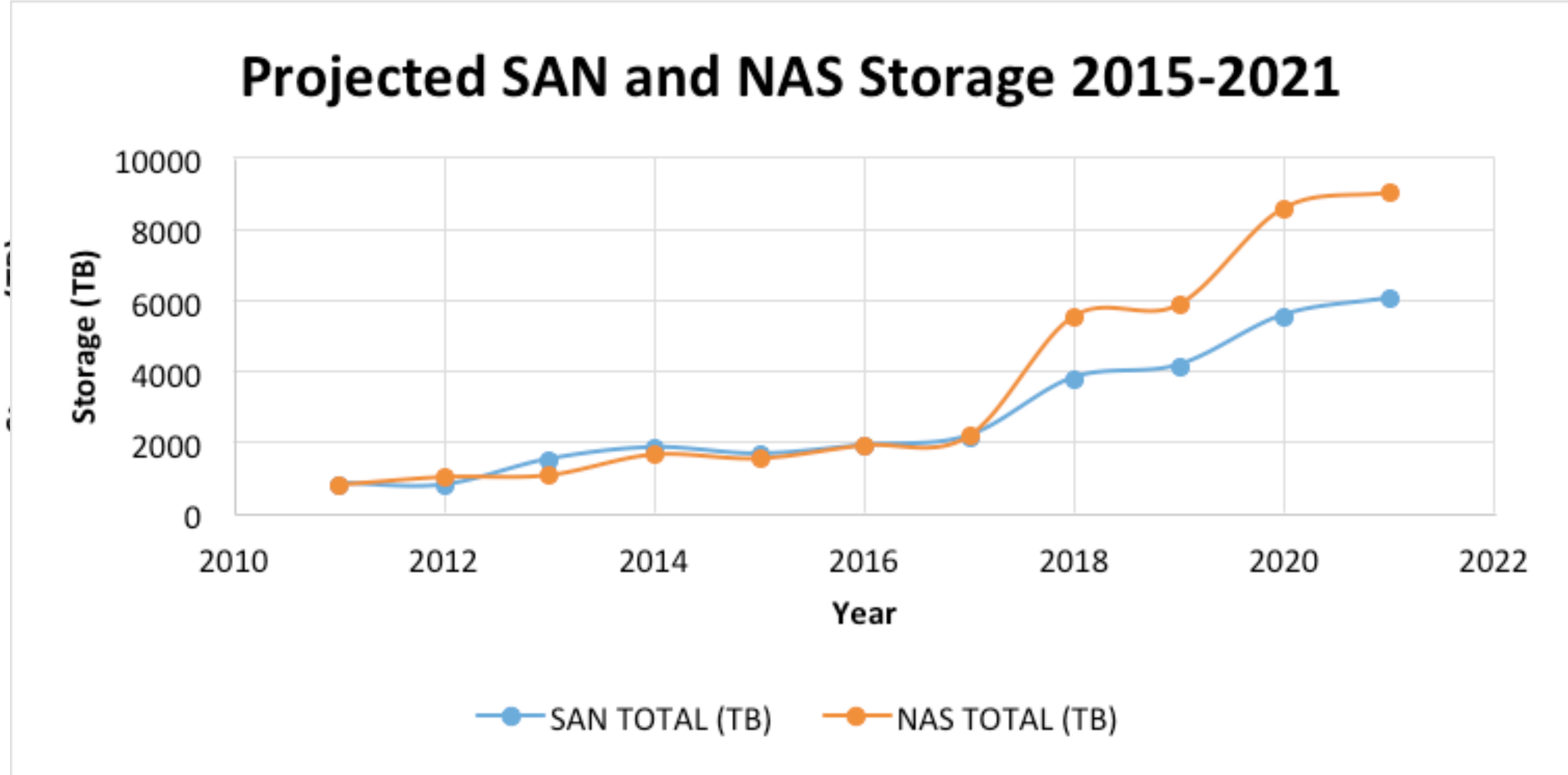
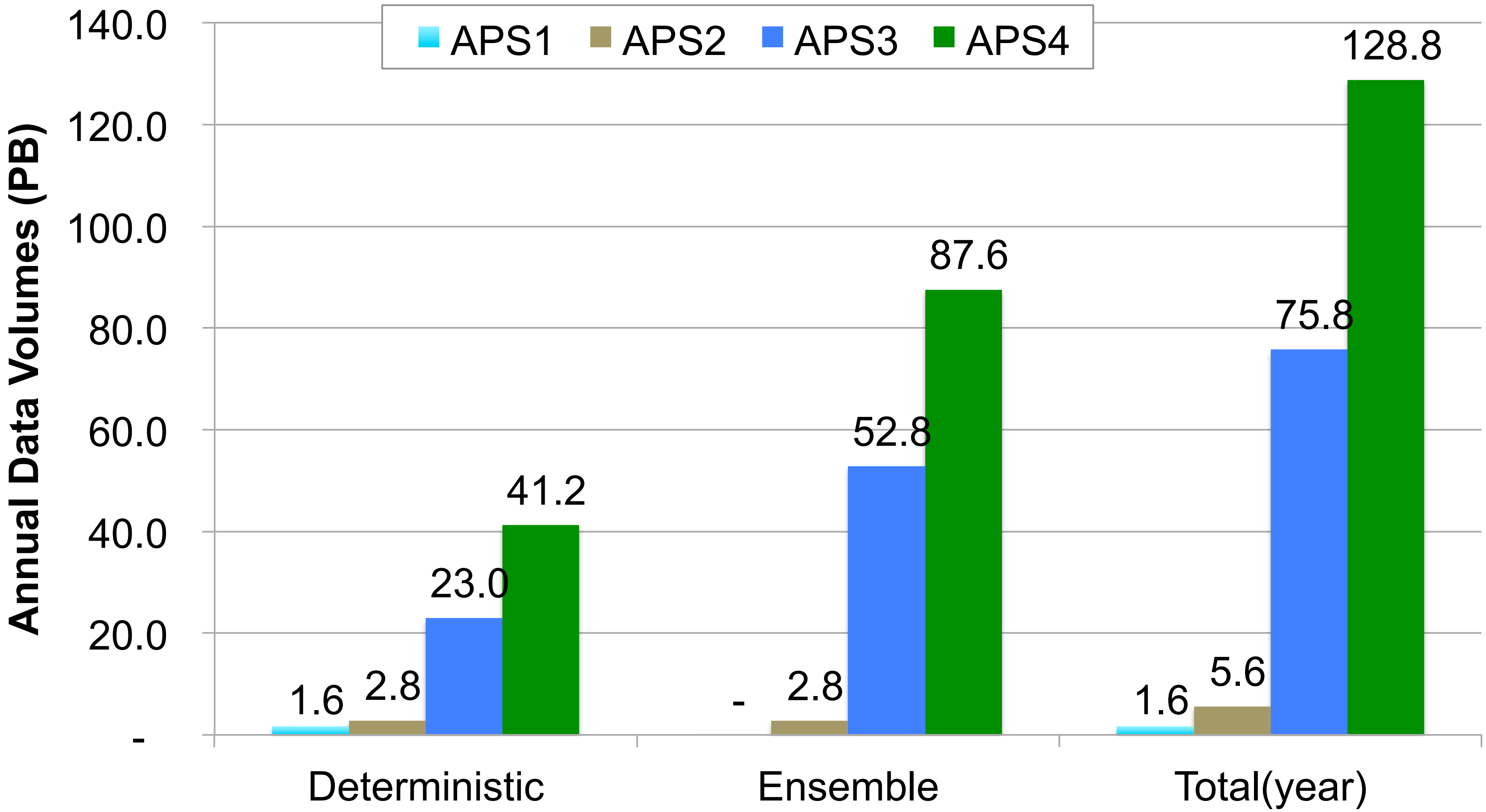
Data storage trends



NWP Model Data Production

Annual Data Volumes (PB)



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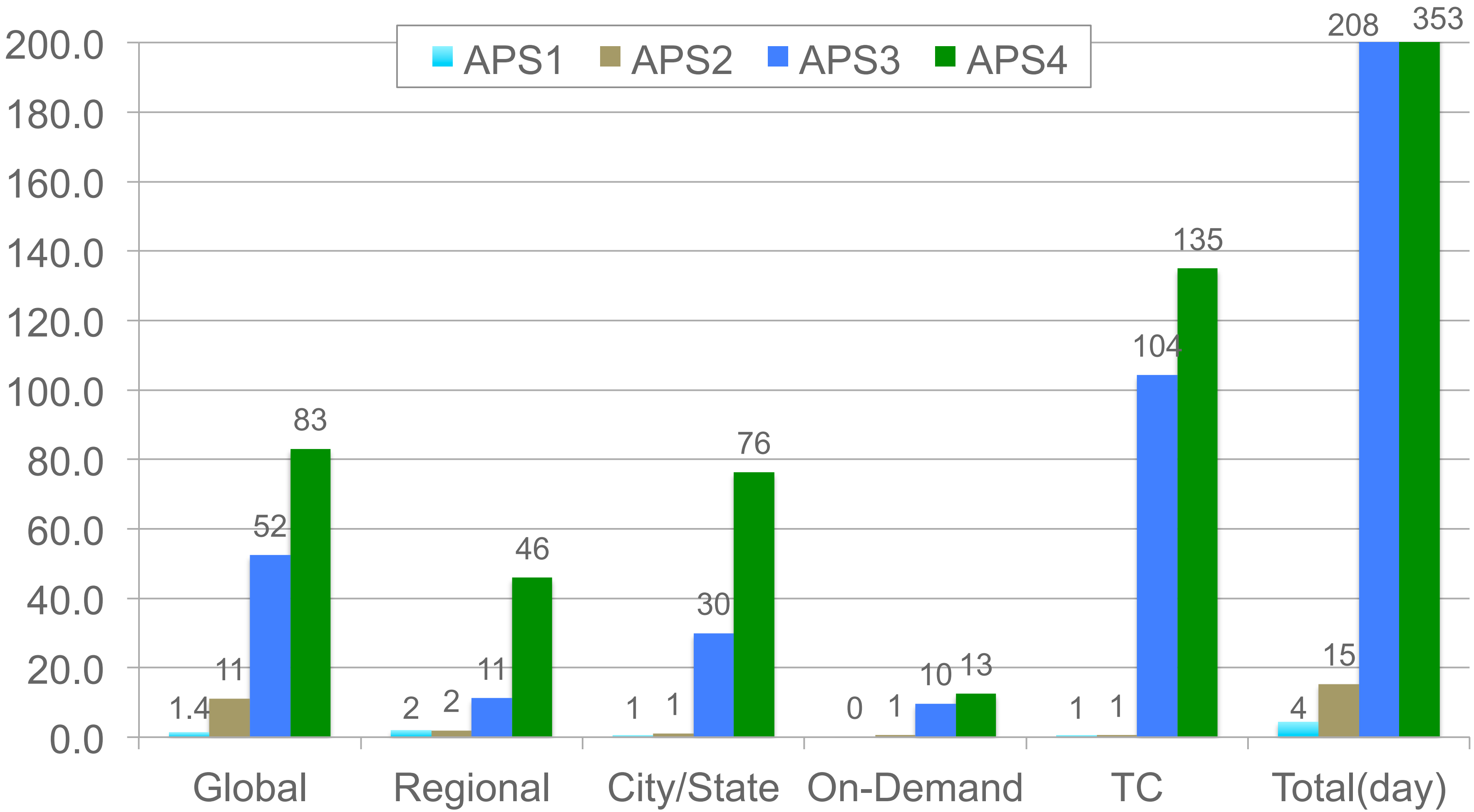
NWP Model Data Production

Deterministic & Ensemble (TB/day)



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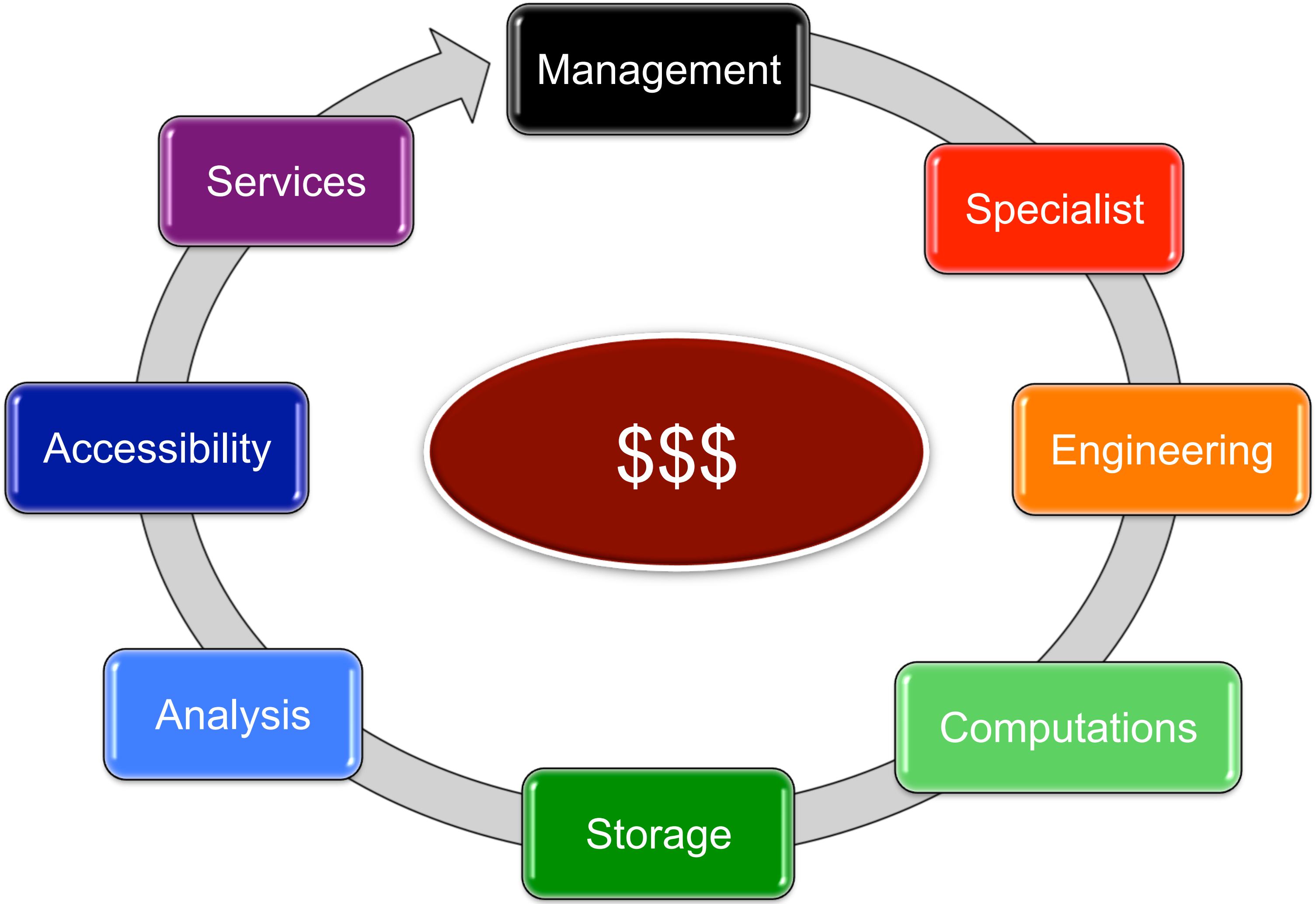
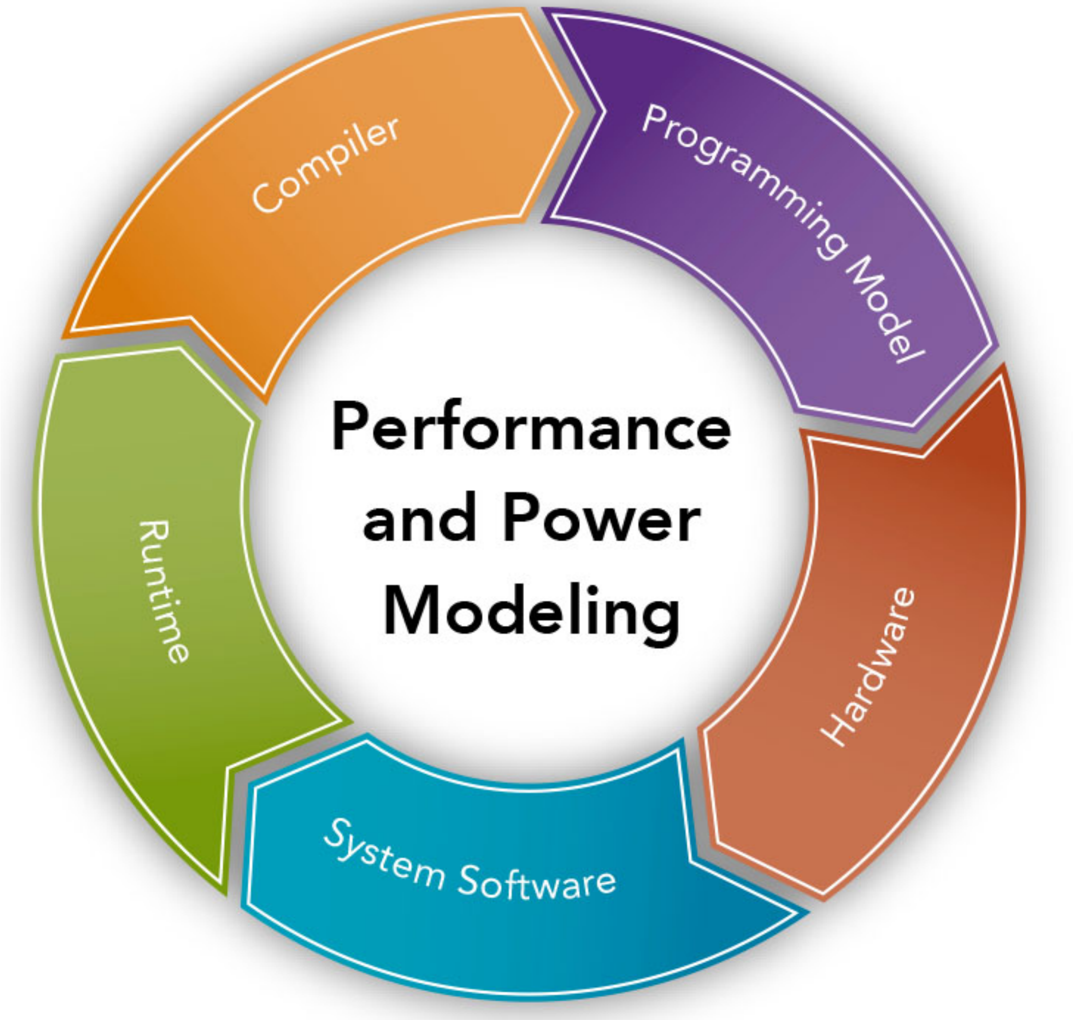
Generating data is not the issue; it's managing the constraints



Energy/Cost Equation



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Feature/Cost Equation



The ability to capture key processes and phenomena depends on how well the time and space scales of geophysical flows are represented and resolved, and it is substantially more compute and data intensive.

Feature	Capacity Change	Investment Costs
• Reducing the horizontal cell length (e.g. 25km to 12km)	Requires more capacity: 8-10 times more compute; 4 times more data storage.	Compute costs. *Compute doubles every 24 months
• Providing probability information (e.g. likelihood of an event) using ensembles	Requires more capacity: 4-5 times more compute 8-12 times more data storage.	Data Storage Costs (Disk and Tape) *Storage doubles every 24 months

Computation/Data Equation

- Nature of the weather and climate system makes it a grand challenge computing problem.
- We are at a critical juncture (grey zone): we want convection resolving weather prediction capabilities! …and ensembles & coupled models
- Computer clock/thread speeds are stalled: new processors and massive parallelism remain the future of supercomputing.
- Our current algorithms, parallelization strategies and architectures are inadequate for the task across processors, memory, networks, storage.
- We need software engineering and model acceleration improvements in all three areas if we are to meet the challenge.

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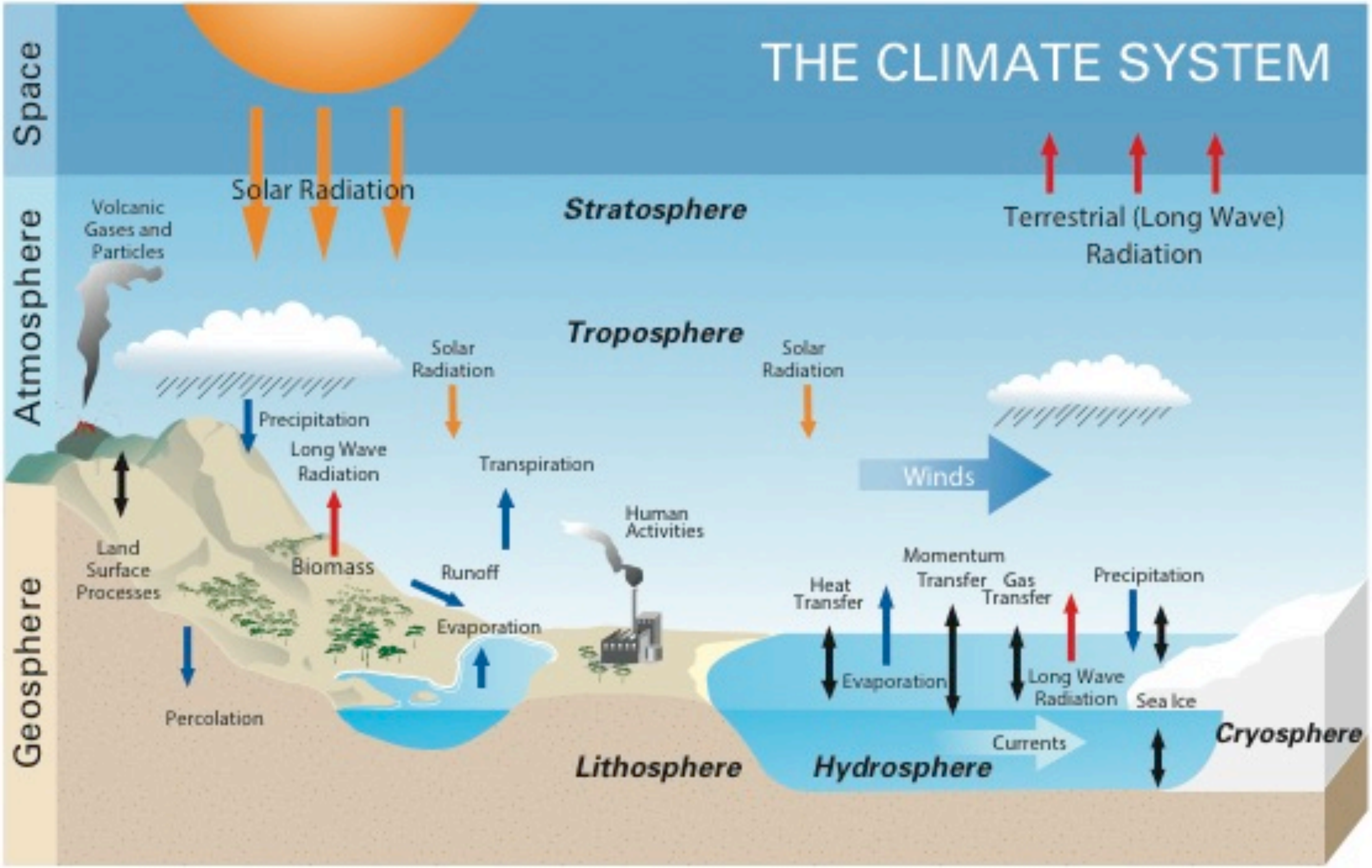
Critical Mission
Critical Infrastructure

- Why is solving these problems important?



Public Safety

Societal Wellbeing

National Security

Economic Prosperity

Environmental Sustainability

OUR USERS

Australian communities depend on the Bureau's essential forecast, warning and information services to protect lives and property, support national security and environmental sustainability, promote industry productivity and enhance societal well-being.

Many economically important, weather-sensitive industries rely on our services for their own effective operation. These include emergency services, defence, aviation, shipping, resources, agriculture and water.

We distribute environmental intelligence to all Australians—directly, through various channels such as briefings, our website, social media and mobile platforms—and also through the media and third-party service providers.

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Digital

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Challenges

Challenges	Developments
Petascale to Exascale	Large systems: robustness and resilience 24x7 Production (1-hour downtime per month)
Application Scalability	Large core count, single application runs (>10,000s)
Software Engineering	Hybrid Parallelism for large models Multi-threading for small applications Coupled model development
Scientific Integrity	Traceability and reproducibility Verification and case studies
Engineering Integrity	Unit Testing and Code Validation
Data Integrity	Data Management and File/Record Integrity
Data in the Large	Proximity (locality) and Accessibility
Data in the Small	Both in the chip and understanding users
Data Delivery	Compression, lazy consumption, throwaway

Solution

Q. If you had a petascale computer what would you do with it?

A. Use it as a prototype of an exascale computer.

Rich Loft, NCAR

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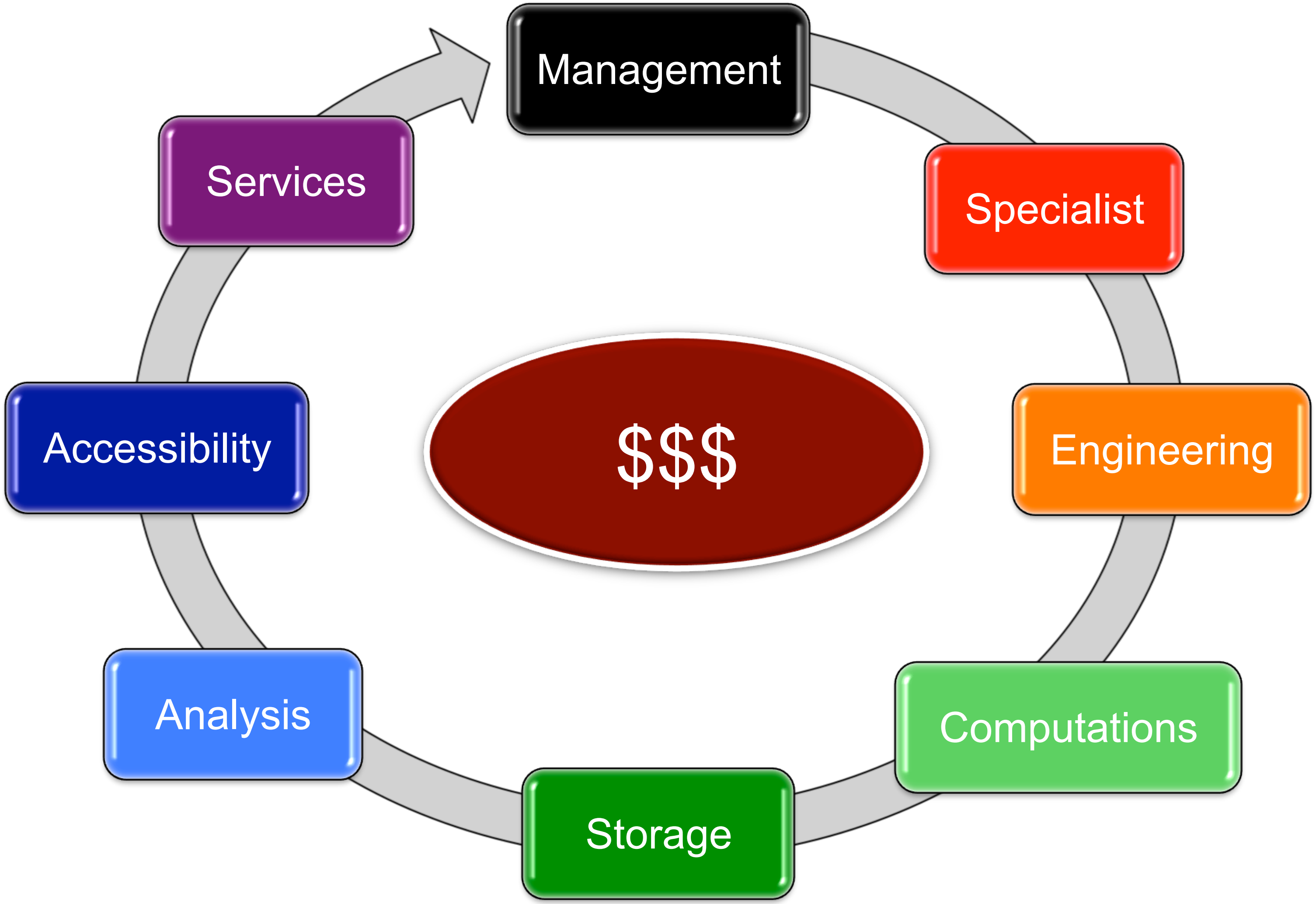

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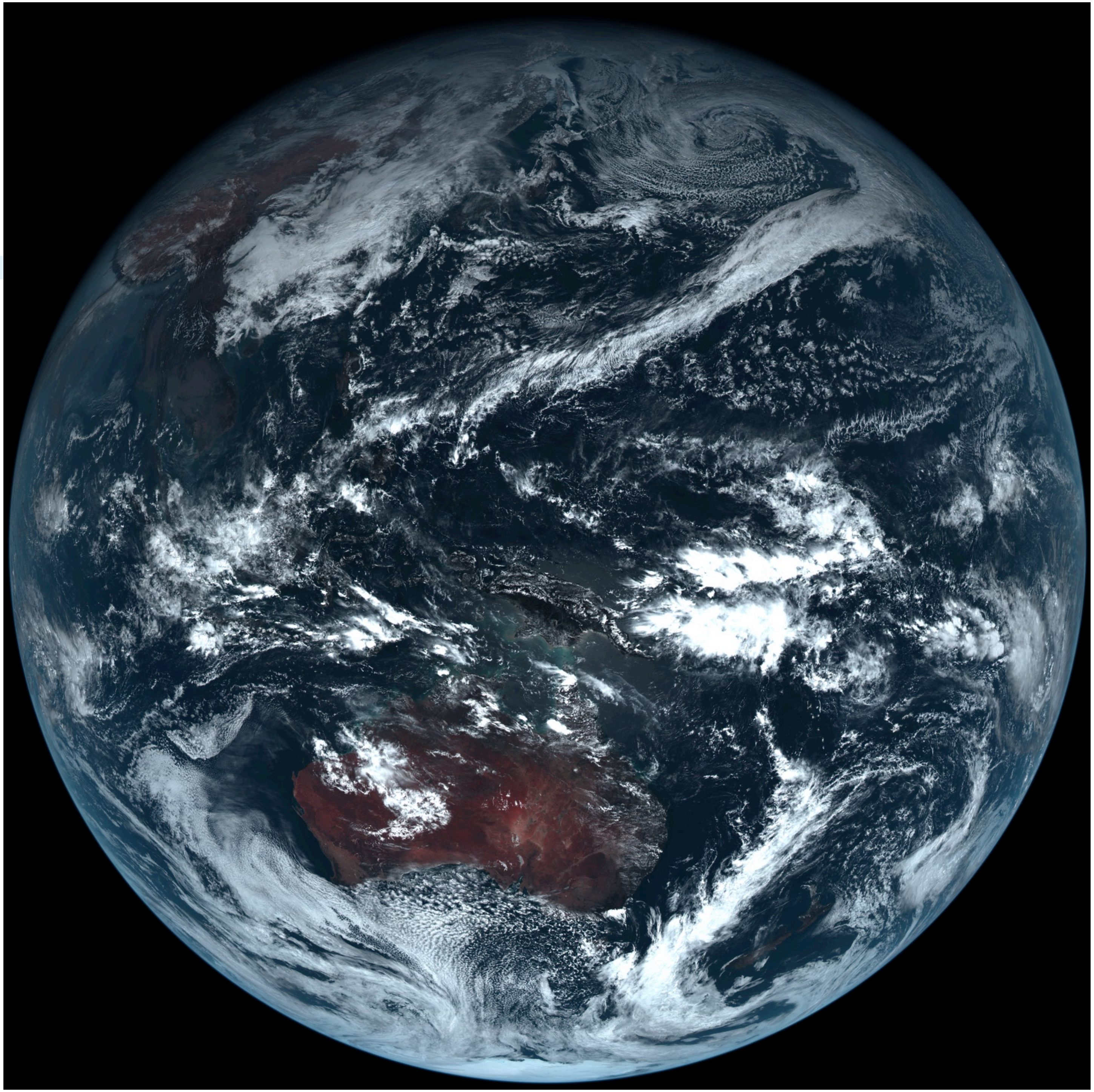
Thank you…



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