Project Proposal

Management:

Project title:	AuScope Atmosphere
Lead organisations:	CSIRO (Oceans & Atmosphere) and The University of Melbourne
Leaders:	[redacted]
Collaborators:	[redacted]

Project summary:

AuScope Atmosphere will be a national monitoring capability for atmospheric composition across the Australian region, spanning the continent and the Southern Ocean to Antarctica. The main focus will be on greenhouse gases, aerosols and reactive gases and key atmospheric chemical and isotopic tracers. Central measurement and calibration laboratories will provide the capabilities required for field monitoring at key locations and platforms, from the Northern Territory Baseline Air Pollution Station at Gunn Point, to stations in the Australian Antarctic Territory, complementing the Cape Grim Baseline Air Pollution Station (operated by BoM), and the atmospheric observations onboard ships including the Research Vessel *Investigator* (operated by CSIRO as the Marine National Facility). AuScope Atmosphere would enhance the Total Carbon Column Observing Network (TCCON), the Network for Detection of Atmospheric Composition Change (NDACC) and the AeroSpan Network to validate satellite measurements of atmospheric composition and aerosol optical properties in the Australian region. New field sites in under-sampled regions would provide data for the greatest improvement in determining emissions. Monitoring would also be established at basin and city scales to better understand the changes in atmospheric composition in regions of intense emissions (particularly from energy) that are likely to be target areas for mitigation.
AuScope Atmosphere would be Australia's first integrated national capability for atmospheric composition monitoring and would bring together the world leading capabilities in agencies across the country. It would provide researchers and policymakers with the necessary Earth System information to act on one of the most pressing issues of our time- the management of atmospheric constituents that influence climate change.

National challenge or science question:

The gaseous and particulate composition of the atmosphere determines our climate, UV radiation exposure and air quality. Management of the emissions that affect the levels of greenhouse gases, ozone depleting gases, and other active constituents is one of the most important yet demanding national and global challenges. Australia is exposed to the risks of these atmospheric changes through their impacts on the environment and because the mitigation of their emissions will lead to local and global readjustments in sectors such as energy and agriculture. A comprehensive observational capability is required to understand the causes of the emissions, to track the efficacy of mitigation measures, and to avoid unwanted consequences of action.

The atmosphere is the main interconnector between the emission sources, such as earth resources, industry and agriculture, and where they are removed, mainly by chemical reactions in the atmosphere or uptake by the ocean and land surfaces. The atmosphere is therefore a crucial sphere of the geosciences and monitoring its chemical changes provides the basis to track emissions and to determine their fate and their impacts.

AuScope Atmosphere would build and operate the infrastructure to significantly improve the spatiotemporal density of these observations in the Australian region needed to quantify regional and global emissions. The observations would be further used to drive and verify Earth Systems models, such as Australia's ACCESS, that simulate the coupled geosphere's future responses to emissions. This would provide the crucial predictive capability to help guide decisions on future sustainability.

AuScope Atmosphere would support atmospheric observations that are directly relevant to the National Research Priorities (notably environmental change, health and energy), the decadal plan for Australian Geoscience 2018–27 (Australia's energy future, the whole earth system including the atmosphere, climate change research, and the Anthropocene), and seven of the seventeen UN Sustainable Development Goals.

Project rationale:

At a time when the world is moving to implement the changes required under the Paris Climate Agreement, the Montreal Protocol, and more broadly trying to make progress towards the UN's Sustainability Development Goals, it is vital that Australia invest in the infrastructure to monitor changes in atmospheric composition in our region.

AuScope Atmosphere will be a nationally integrated capability to monitor the atmospheric constituents that drive regional and global climate- greenhouse gases, their tracers such as isotopes, aerosols and reactive gases such as ozone. It would help to complete the NCRIS support of Earth System infrastructure, currently the solid earth geosciences (AuScope), the terrestrial ecosystem (TERN) and the oceans (IMOS). Atmospheric composition changes are caused largely by interactions with the environments observed by existing NCRIS infrastructure (the land surface, the lithosphere including resource industries, and oceans). Monitoring the atmosphere enables an independent, measurement based approach to detecting and quantifying the emissions from these domains.

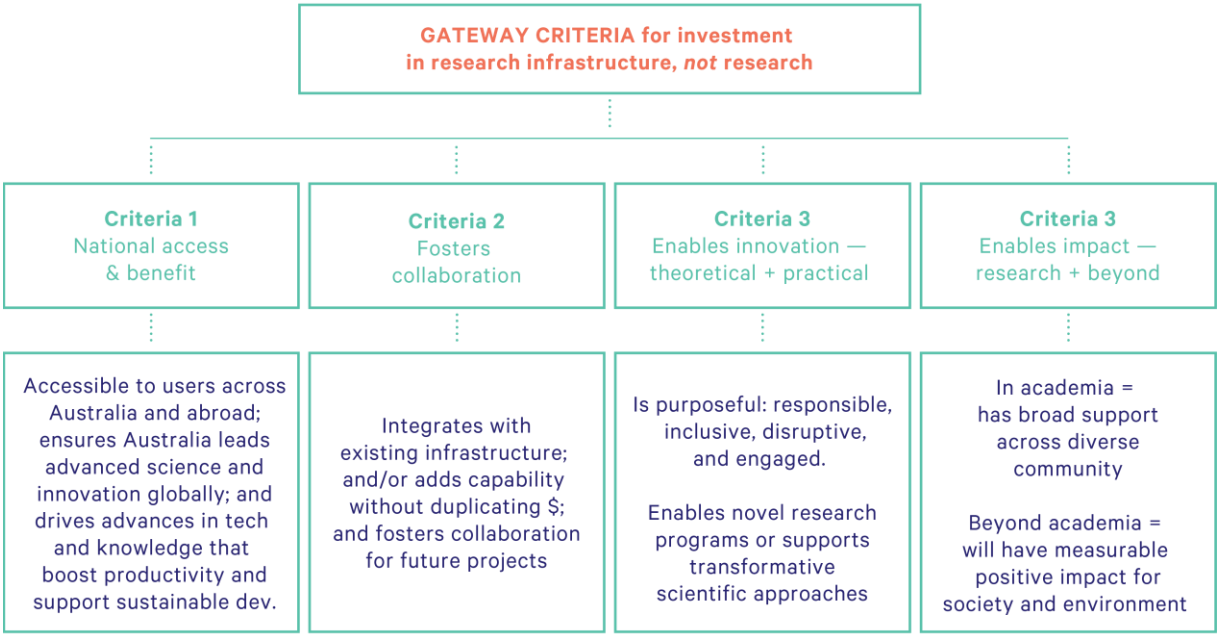
Human-induced atmospheric change is also one of the largest drivers of recent changes in marine and terrestrial systems. AuScope Atmosphere therefore integrates closely with the Downward Looking Telescope theme of the broader AuScope field group (see field group Rationale document).

The region that Australia has an obligation to monitor is vast, and no single organisation has the capability or capacity to build and maintain an atmospheric observation network capable of delivering the measurement types, density and quality required to address the science challenges mentioned above. AuScope Atmosphere would integrate the existing observational activities in Australia, build on existing monitoring expertise, expand the geographical coverage and enhance the breadth of measurements currently undertaken by the monitoring networks. Because source emissions are inferred from the small differences in gas and isotopic concentrations over time and between locations, a critical aspect of atmospheric monitoring is the need for highly precise and intercomparable (calibrated) measurements across networks. This proposal would unify the lead organisations' efforts in atmospheric composition observations in this country, allowing quantitative linking of their measurements for an enhanced and more effective national network.

AuScope Atmosphere addresses the following Gateway Criteria:

Criterion 1- End-users (researchers, natural resource managers, policy makers, Australian and international) will have ease of access to internationally consistent, well documented, high quality atmospheric composition data sets for a wide range of uses such as assessing the effectiveness of mitigation, the sustainability of development (especially in the resources sector), and to inform and validate earth system models.
Criterion 2- AuScope Atmosphere represents an opportunity to leverage the considerable historical investment in the existing components of atmospheric observational infrastructure by many organisations, i.e. CSIRO, BoM, AAD, ANSTO, and the Universities of Wollongong and Melbourne. By uniting these disparate efforts through AuScope, we would realise greater opportunities for co-locating equipment, avoid unnecessary duplication, benefit from large efficiency gains, and safeguard key infrastructure from shifting priorities at individual institutional levels. The collaborative environment across universities and national research programs will be an excellent training ground for the next generation of atmospheric scientists and will help attract research funding from the ARC and other research bodies.
Criterion 3- Innovative and transformative research programs will use AuScope Atmosphere data as a foundation for developments of methodologies, such as quantification of emissions using "top down" atmospheric techniques, or of new measurement technologies. Cross-discipline approaches are likely to result, for example, exploring the connections between signals in atmospheric constituents and processes occurring at the earth's surface.
Criterion 4- The research enabled by AuScope Atmosphere is likely to be undertaken at pure and strategic levels in universities and research institutions, with impacts across many of the sciences of the Earth System. It would also be applied to earth resource, agricultural and environmental management by industry bodies and government.

Note: the rationale for AuScope Atmosphere as a project across the 3 project groups (field, laboratory and digital infrastructure) can be found in a separate document Atmospheric_Rationale.doc on the Google Docs site.



Project Aims:

To build a nationally integrated observational network of the composition of the atmosphere covering a broad spatial scale across the Australian region (tropics to pole, continent and ocean, including Australia's Antarctic Territory). The concentrations of greenhouse gases, ozone-depleting gases, reactive gases and aerosols will be continuously measured in key locations, supported by central laboratories that provide analytical, calibration and technical development capabilities and data management. These data are fundamental to quantifying the emissions and sinks of the main atmospheric constituents that drive climate change and environmental health.

What does success look like?
For the first time, Australia will have a national observational capability for atmospheric composition. This capability will provide comprehensive data (compound type, location, precision and calibration to international standards) for Australian and international research to quantify:

- The changes in the background state of the atmosphere
- The regional influences of cities, basins and oceans
- The impacts of existing and emerging energy systems
- Atmospheric feedbacks of natural systems under climate change

- The response to and effectiveness (including unanticipated consequences) of efforts to mitigate emissions, including the verification of meeting international protocols, using atmospheric measurement techniques
- The future state of the atmosphere by improving predictions of earth system models, such as the Australian Community Climate and Earth System Simulator (ACCESS)

Project Milestones:

GASLAB analytical and calibration facility (CSIRO, BoM, AAD).
- flask sampling and analysis network for baseline air and regional emissions; years 1-5
- provide the Australian atmospheric monitoring community and stations with calibration gases linked to international scales; years 1-5.
- upgrade with new GCs, isotope ratio mass spectrometer (IRMS) for CO2 and CH4 stable isotopes, including a technical operating role; 3 years.
- new monitoring site locations identified by network design modelling; 1 year.
- 2 monitoring stations prepared for energy/urban campaign studies; 2 years.

Monitoring stations at Gunn Point (tropical) and Casey (polar/Southern Ocean), complementing the Cape Grim (Tasmania) premier site (CSIRO, ANSTO, Universities of Wollongong and Melbourne, BoM, AAD);
- support for operations: years 1-5.
- upgrades, including Radon 222 tracer measurements to identify atmospheric source and sink areas: years 1-3

AIRBOX mobile monitoring facility (AIRBOX consortium- Universities of Wollongong, Melbourne, Tasmania, Macquarie, CSIRO, ANSTO, QUT, BoM, AAD) operations; years 1-5.
- Operational support for maintenance and deployment of facility
- Calibration of instruments against world standards.

TCCON/NDACC ground based and column measurements and satellite ground truthing for Australian region satellite greenhouse gas retrievals, and other trace gases related to stratospheric ozone and tropospheric gases emitted from biomass burning.
- Support of monitoring at existing Wollongong and Darwin stations; years 1-5
- Spectrometers for regional and local column GHG emission studies; years 3-5
- New TCCON/NDACC station (Central Australia); establish in 3 years.

AeroSpan aerosol network- provides measurements for aerosol climate forcing and enables satellite retrievals.
- Upgrades during year 1 and 2;
- Operational support thereafter.

Data QC'd and calibrated to international standards (e.g. WMO Global Atmosphere Watch- WMO GAW). Made available through annual data releases to national and international databases:

- CSIRO station data; submissions to WMO-GAW, State of the Environment, State of the Climate; years 1-5
- TCCON/NDACC: NDACC data is archived 1 year after measuremen to the publically available Aura Validation Data Center (AVDC), the Envisat Validation Data Center (EVDC) and the NDACC Data Handling Facility (DHF), using the Generic Earth Observation Metdata Standard (GEOMS). TCCON data is hosted by the Carbon Dioxide Information Analysis Center (CDIAC).
- AIRBOX: Data analysis and establishing submission regime to international (NDACC, GAW) networks for terrestrial field based campaigns (years 1-5). Instrument deployment for international calibration and validation of permanent network sites instrumental traceability (years 1 and 3 and 5).
- Aerospan: submitted to NASA's Aerosol Robotic NETwork (AERONET) databasehttps://aeronet.gsfc.nasa.gov/

Resources:

Please imagine up to three scenarios where this project might be funded fully (Tier 1), adequately (Tier 2), and at minimum (Tier 3) over a five-year period. Please details costings for initial capital, and yearly operations and maintenance.

Also, would you imagine that this project could be co-founded and sustained financially together with other interested collaborators than AuScope? If so, which orgs/companies/agencies?

-Yes, labour will be co-invested by up to 50:50, depending on organisation (CSIRO, Uni Wollongong, Uni Melbourne, ANSTO).
-In kind support of operations (e.g. ship platforms, Antarctic station access, existing ground stations) is likely across all infrastructure

TIER 1 FUNDING SCENARIO ($1000's)

$ TYPE	Year 1	Year 2	Year 3	Year 4	Year 5
Capital	2545	1745	2455	755	755
Operations: incl labour (co-invested)	1380	1380	1610	1610	1610
Maintenance	386	386	436	436	436

- How many new FTEs will be funded by the project? Total for each year: 8.5, 9.5, 8, 9, 9. Co-investment by partner organisations brings a further ~6 FTE each year.
- If the project goes beyond 5 years, what will the yearly operational costs be? Expect $1610 K per annum ongoing

TIER 2 FUNDING SCENARIO ($1000's)

$ TYPE	Year 1	Year 2	Year 3	Year 4	Year 5
Capital	1645	555	2025	240	240
Operations: incl labour (co-invested)	1080	1080	1080	1200	1200
Maintenance	281	281	281	281	281

- How many new FTEs will be funded by the project? Total for each year: 6,6,6,7,7. Co-investment by partner organisations brings a further ~4 FTE each year.
- If the project goes beyond 5 years, what will the yearly operational costs be? Expect $1200 K per annum ongoing

TIER 3 FUNDING SCENARIO ($1000's)

$ TYPE	Year 1	Year 2	Year 3	Year 4	Year 5
Capital	1465	405	1740	240	240
Operations: incl labour (co-invested)	645	645	620	620	620
Maintenance	206	206	206	206	206

- How many new FTEs will be funded by the project? Total for each year: 3.5, 3.5, 3.5, 3.5, 3.5. Co-investment by partner organisations brings a further ~2.5 FTE each year.
- If the project goes beyond 5 years, what will the yearly operational costs be? Expect $620 K per annum ongoing

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Any further details:

AuScope Atmosphere spans across the original AuScope project groupings of field, laboratory and digital. It therefore has its own Rationale document and integrates closely with the field group Rationale document.