Resume: Jim Lovell

Jim has a PhD in physics from the University of Tasmania and has worked primarily in the fields of radio astronomy and geodesy, with roles in research, operations and project management. He has extensive experience in managing large survey-oriented research programs from planning through to observations, data management, analysis and publication. Jim can provide assistance in developing techniques and strategies for efficient gathering of experimental data and software solutions for data organisation, management, analysis and visualisation.

Skills

Research:

My background is in experimental physics (space science) and operations of astronomical and geodetic facilities, working with large digital data sets and field instrumentation. I also have extensive experience in developing software to facilitate operations, manage, visualise and analyse data.

Communication:

I have presented my work to professional scientists, engineers, the general public and the media. I have extensive experience in the communication of technical requirements to contractors, equipment manufacturers, suppliers etc and in writing material for publication in journals, conference proceedings and client reports. I have provided hardware and software training and authored the associated documentation.

Computer Languages:

Strong in Python and Perl. Proficient in C, C++ and FORTRAN. Familiar with IDEs including PyCharm, Spyder and Atom.

Operating Systems:

I have used Unix-based systems for over 20 years and have extensive experience at the command-line and with shell scripting (sh, bash, csh, tcsh). I am familiar with command-line tools such as sed, awk, grep, etc and with the vi and emacs editors. I have also used virtual machines extensively, for example running a Ubuntu virtual machine under Mac OS to run geodetic scheduling software only supported for Linux.

Software:

Databases: Installed and used the sqlite, MSQL and MySQL relational database packages to construct databases to assist in the management of large surveys.
Version control: Working knowledge of the management and use of Git and have previously used RCS, CVS and SVN.
Publishing/office software: Well versed in LaTeX and Microsoft Office applications
Astronomical: Extensive experience with AIPS, Difmap and Miriad

Web:

Good experience in managing web pages using HTML, PHP and CSS and with packages such as Adobe Dreamweaver. I have installed and manage several wiki pages (using the dokuwiki package). Experience with Python frameworks such as Flask and Dash for web presentation of data.

Graphics, imaging:

Extensive experience with Adobe Photoshop and Lightroom packages and in landscape photography (jimlovellphoto.com).

Hardware:

Experience with Arduino microprocessors, Raspberry Pi computers and additional hardware for data collection and processing systems.

Astro-ecoacoustics:

I have recently been working on adapting radio astronomy interferometry techniques to passive acoustic wildlife monitoring. This has involved building microcontroller and Raspberry Pi- based audio data recorders and post-processing the data to obtain low noise spectrograms and signal direction measurements from cross-correlation analysis. More information is available at jimlovellphoto.com/astroecoacoustics.

Work Experience

October 2019 to present:

Next Generation Field System for Very Long Baseline Interferometry,
NASA Space Geodesy Project,
NVI Inc, NASA Goddard Spaceflight Center
Greenbelt MD, USA (currently a 12 month contract, 50% FTE).

I am currently working on a project to develop a radio telescope control system to be deployed across the NASA Space Geodesy Network. At the core of this is a task to replace the control software which has been in use for over 40 years but is poorly suited to modern hardware, multi-Gbps data sampling rates and real-time data transfer. This task has two main components:

1. To prepare a detailed requirements document for the new software. This involves extensive client consultation to identify capabilities that should be preserved and new ones that should be added.
2. As a trial of some possible new techniques for the control system, build and test code to automate operational procedures that are labour intensive and time consuming with the current system. This includes Python code to automate telescope start-up procedures, including the retrieval and processing of schedule files from remote servers, then starting them automatically. Observation logs and a time-series database (InfluxDB) are then monitored to report status information to users and to identify and act on any problems or errors as they occur. The software will automatically remedy any known problems or alert a person if a solution can not be found. An initial release of the schedule management component is on GitHub (https://github.com/jejl/fesh2).

October 2017 to present:

Operations support and data analysis,
Mount Pleasant Observatory,
University of Tasmania (casual, 20% FTE).

I recently completed work on an improved pointing model for the 26m diameter telescope and developed new (Python) code to streamline and automate the data collection and analysis process. I recently built environment monitoring and logging systems at the radio telescopes that use Raspberry Pi computers connected to sensors to log data to a SQL database and publish on a web server using the Flask and Dash frameworks in Python.

June 2018 to present:

Data wrangler for the [Where? Where? Wedgie!]() citizen science project (volunteer).

This is a citizen science project aimed at monitoring the population of the threatened Tasmanian wedge-tailed eagle. My tasks were to merge data submitted by the general public into a SQL database, carry out checks, detect anomalies, make corrections, provide reports to the participants and finally to produce a cleaned dataset ready for statistical analysis. I have also participated in a series of Expos to present the results of the first year of the project to the general public.

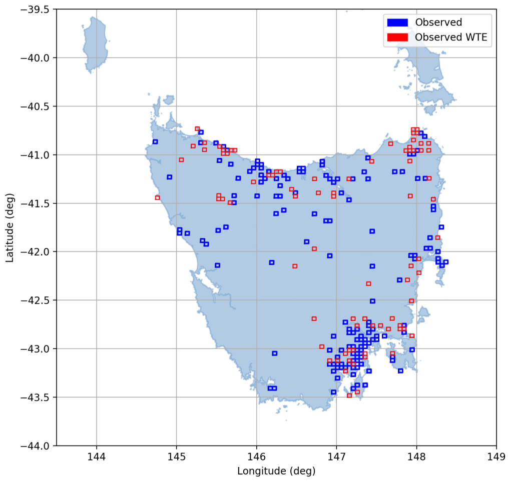

Figure 1: Visualisation of observations made for WWW. Red squares indicate wedge-tailed eagle sightings.

March 2007 to June 2017:

AuScope VLBI Project Manager/Scientist
University of Tasmania, Hobart

As part of NCRIS Capability 5.13: "Structure and Evolution of the Australian Continent", I was responsible for establishing and operating three 12m diameter radio telescopes in Australia (Tas, WA and NT). The coordinated telescope array was operated from the University of Tasmania campus in Sandy Bay. It is this array that ties Australian geodesy into the International Geospatial Reference Frame which is tied to the International Celestial Reference Frame.

November 2001 to March 2007:

Research Scientist: Tidbinbilla Support
CSIRO Australia Telescope National Facility, Canberra

Support of radioastronomy activities at Tidbinbilla including Very Long Baseline Interferometry (VLBI) and single-dish spectroscopy. I also conducted my own research in quasar intra-day variability, multi-wavelength observations of quasars with kpc-scale jets and gravitational lensing.

February 1999 to November 2001:

Postdoctoral Research Fellow: Tidbinbilla Support
CSIRO Australia Telescope National Facility, Canberra

Support of radioastronomy activities at Tidbinbilla.

February 1997 to February 1999:

Postdoctoral Research Fellow
Japan Society for the Promotion of Science, ISAS, Sagamihara, Japan

Research at ISAS involving the VLBI Space Observatory Program (VSOP) mission - the first dedicated Space VLBI mission. I contributed to data reduction and mission operations activities, as well as computer support for data reduction.

September to November 1996:

Research Associate,
University of Tasmania, Mt. Pleasant Observatory

I was involved in software development for the antenna control and data analysis system at the observatory.

February 1992 to January 1997

Doctoral Student ,
University of Tasmania, Hobart, Tasmania

I investigated extragalactic radio sources using the Australia Telescope Compact Array, VLBI and single dish radio observations. My PhD was conferred on December 18, 1997.

Education

PhD in Physics, 1997, University of Tasmania;
"Southern Radio Gravitational Lens Survey and Observations"

B.Sc. (Hons., First Class) in Physics, 1992,
University of Tasmania;

HSC, The Hobart College, Mt Nelson, Tasmania

Background and Career Highlights

For the 10 years following the completion of my PhD, I worked in the field of astrophysics as a professional astronomer first in Japan as a post-doctoral fellow at the Institute of Space and Astronautical Science on the VSOP (VLBI Space Observatory Programme) mission, then in Canberra conducting research in astronomy and supporting observations at NASA's Deep Space Station at Tidbinbilla for CSIRO's Australia Telescope National Facility (ATNF). During this time I gained work experience in writing observing proposals, conducting observations, reducing and analysing data and publishing the results. I developed a thorough grounding in the technique of Very Long Baseline Interferometry (VLBI) which is the basis for high angular resolution imaging as well as precise determination of positions on the Earth.

My position at ATNF was a 50% support, 50% research role. My support work involved conducting astronomical observations with the antennas at Tidbinbilla on behalf of astronomers around the world as part of the National Facility. My own research work involved the observation and study of quasars.

From 2007 until 2017 I was Project Manager of the AuScope VLBI project (Lovell et al. 2013) at the University of Tasmania. This involved the construction and operation of a $7 million array of three radio telescopes in Australia (Hobart (Tas), Katherine (NT) and Yarragadee (WA)) designed specifically for geodesy (Figure 1). The construction of the array was completed on time and on budget and commenced operations in 2010. I managed an annual operations budget of ~$900k.

Figure 2: The three 12-m diameter telescopes of the AuScope VLBI array. From left to right: Hobart, Katherine and Yarragadee.

Geodetic VLBI uses observations of quasars by global arrays of telescopes to establish a positional reference frame for our planet. Critically, VLBI is the only technique that can provide a length of day measurement, essential for the calibration of GPS, as well as a complete set of Earth Orientation Parameters which tie the terrestrial reference frame to the only inertial reference frame we have: the Celestial Reference Frame (CRF). The CRF is uniquely observable by VLBI. VLBI also provides a measurement of the scale of the terrestrial frame and an accurate and precise measurement is essential for studying our dynamic planet and the effects of climate change such as sea level rise. Geodetic VLBI is organised and coordinated globally through the International VLBI Service (IVS, ivscc.gsfc.nasa.gov) which is governed by a Directing Board. IVS is a Service of the International Association of Geodesy (IAG) and of the International Astronomical Union (IAU).

The AuScope array is a very important addition to the global array of geodetic telescopes coordinated by the IVS as it greatly improves the density of observatories in the Southern Hemisphere and therefore the quality of geodetic solutions globally. The operations funding I attracted for the array also allowed for many more observations per year (up to 208 days), improving the density of the geodetic time series, and allowing for astrometric observations of potential reference quasars for the latest realization of the International Celestial Reference Frame (ICRF). The lack of observations of potential reference sources in the south has long been a limiting factor in improving the precision of the entire ICRF and these observations were designed to address this (Figure 2).

Much of my research work has involved surveys of a large number of quasars, requiring automated processing software. I have developed software to allow for automatic imaging and analysis of interferometer data and for error analysis of models fitted to them. I have also written programs for use in the analysis of interferometer and single-dish quasar brightness monitoring and spectral-line data, including the fitting of analytical models to sampled data, and a variety of graphical display and data editing utilities. Within the AuScope project I have been responsible for software that provides real-time monitoring and diagnostic information on observations. I have also led a research project that aims to implement a strategy to optimize the observing efficiency of global VLBI telescope networks by allowing real-time adaptation to changing conditions and resources, a technique called Dynamic Observing.

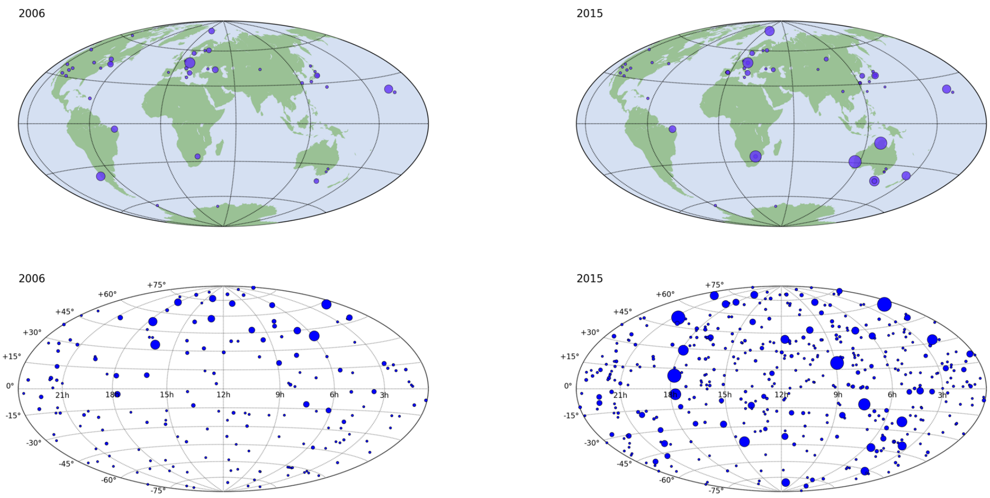

Figure 3: The impact of the AuScope VLBI array on global geodesy. The figures compare geodetic observations in 2006 (left, pre-AuScope) to 2015 (right, the AuScope era). The top figures show the distribution of VLBI observatories and symbol sizes are proportional to the number of days the telescopes were used. The bottom figures show the distribution of quasars on the sky (north at the top) with symbol sizes representing the number of times they were observed. This clearly illustrates the importance of the AuScope array in improving geographic coverage in the southern hemisphere and in improving the celestial reference frame.

My astronomical research activities have included surveys for and observations of gravitational lenses, a Space VLBI quasar survey, multi-wavelength observations of quasar jets, and observations of scintillating quasars. Highlights from these research programs include:

- The first large-scale survey for scintillating quasars, the Micro-Arcsecond Scintillation-Induced Variability (MASIV) survey, which I led, and which has now identified over 200 variable sources and found evidence for scattering in the inter-galactic medium (Lovell et al 2003, Lovell et al 2008). Scintillating quasars are extremely compact and therefore ideal sources for geodesy and astrometry (Ojha et al 2004, Schaap et al., 2013). A major focus of my research work at UTAS was in exploiting this research to improve the quality of the southern hemisphere reference frame.
- Measuring the brightness temperature distribution of a large sample of quasars with VSOP (Lovell et al 2004, Scott et al 2004, Horiuchi et al 2004, Dodson et al 2008). High brightness temperature quasars are dominated by compact nuclei, again making them ideal for geodesy and astrometry.

My contributions to the field of astrophysics over the past 13 years include:

- 2011 – 2013 : Member of CSIRO ATNF Time Assignment Committee
- 2003 – 2007: Appointed Scheduler for the CSIRO/ATNF Long Baseline Array and Secretary of ATNF Users' Committee
- 2002-2004: Invited to referee proposals for the USA's National Radio Astronomy Observatory's Very Large Array (VLA) and Very Long Baseline Array (VLBA) telescopes

While my background prior to 2007 was in astronomical VLBI, I have become an expert in geodetic techniques and more strongly involved in areas of research pertinent to geodesy, particularly those that have a connection to high resolution source structure and evolution.

My involvement, recognition and standing in the international geodetic and astrometric VLBI community is evidenced as follows:

- With my colleagues at UTAS, we have built a vibrant and expanding research group that bridges geodesy, astrometry and astrophysics, including four ARC Super Science Fellows.
- In 2013 I was elected by members of the IVS to the IVS Directing Board as Network Representative. The IVS DB determines the policies, priorities and standards for the network.
- I have been a member of the IVS VGOS Technical Committee (VTC) since 2014 and was appointed as Chair by the IVS Directing Board between October 2015 and June 2017. The VTC sets the strategies and directions for the next generation of geodetic VLBI infrastructure and operations.
- I was also a member of the IVS Observing Program Committee which sets the direction and priorities of global geodetic VLBI observing.
- In 2014 I was elected as the inaugural Chair of the Asia-Oceania VLBI Group for Geodesy and Astrometry (AOV), which is a group of scientists in the Asia-Oceania region supporting geodetic and astrometric VLBI and is a sub-group of the IVS. The aim of the AOV is to focus on VLBI applications in the region, form and strengthen links between the institutions, promote and represent VLBI within the broader scientific community. The initial activities of the AOV include the establishment of an observing program involving telescopes in Australia, New Zealand, China, Japan and Korea where participants are working together through the entire process from scheduling to observing, data reduction, analysis and publication.

<u>Funding to support research in geodetic VLBI.</u>

- The success of the AuScope program led to the acquisition of Federal funds for ongoing operations. I managed the only university-run VLBI array in the world and was central in the coordination (organising, scheduling and analysis) of 120 days of additional observations over two years with telescopes from AuScope, Warkworth (New Zealand) and Hartebeesthoek (South Africa).
- At UTAS I was successful in attracting $14,000 of internal funding to establish a software correlator at our Mount Pleasant Observatory and $70,000 from the Faculty of Science, Engineering and Technology to establish an astronomy Operations Room in the School of Maths & Physics.