Current Activities and Plans of the AOV - Asia-Oceania VLBI Group

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Abstract Founded in 2014, the Asia-Oceania VLBI group for Geodesy and Astrometry (AOV) has been active in fostering collaboration and pushing progress in our region. Since 2015, 18 AOV sessions have been scheduled, observed, correlated, and analyzed by AOV member institutions. Furthermore, 12 sessions follow in 2018. Two AOV meetings have been held in the region, and we have also undergone a successful re-election of the AOV representatives, the Chair and Secretary positions, in 2017. In this contribution we report on the recent activities within the AOV, current topics, and plans for the future. An overview of the AOV sessions is given, including a summary of the aims and results. A proof for the success of the AOV initiative is a number of small collaborations in correlation and VGOS testing. Details on these projects are provided. Overall, the aim of this contribution is to inform the IVS community about our activities and invite interested colleagues to join the AOV in individual projects, observations, and meetings.

Keywords Asia-Oceania VLBI group, AOV sessions

1 Introduction

Founded in 2014, the Asia-Oceania VLBI group for Geodesy and Astrometry (AOV) has been active in fostering collaboration and pushing progress in our region. The motivation for running dedicated AOV sessions is to maintain the knowledge of scheduling and correlation amongst the member groups. Finally, the similar time zones and reduced spatial distances may help to allow more frequent meetings and visits amongst collaborators, also enabling more students with limited travel budgets to experience international liaisons, which we consider the backbone of global VLBI. That said, we also invite interested stations and people outside the AOV region to join the AOV sessions and activities.

Fig. 1 AOV station network.

2 AOV Sessions

The first AOV session took place in 2015, as part of the IVS observing program. The primary motivation for the AOV sessions is to keep and extend the skill set within the institutes of the AOV. This includes the capability of generating new observing modes and frequencies that are compatible for all participating stations and frequency ranges, on the one hand, and making optimal use of modern hardware on the other. The

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scheduling of these sessions is split between three institutes (GSI, SHAO, and UTAS), and the correlation amongst two (GSI and SHAO).

Initially at a cadence of six sessions per year in 2015, 2016, and 2017, in 2018 the number was increased to one session per month. As visible in Figure 2, a high of 13 participating telescopes was reached in AOV010. Subject to compatibility of all stations, new AOV modes were developed with most AOV sessions now being observed at a 1 Gbps mode, with 512 MHz channels at two bit sampling.

While conducting the experiments alone is one of our aims, the sessions do follow specific targets. In principle one can distinguish between geodetic, astrometric and research and development (R&D) sessions. Suggestions for the latter are welcome at any time.

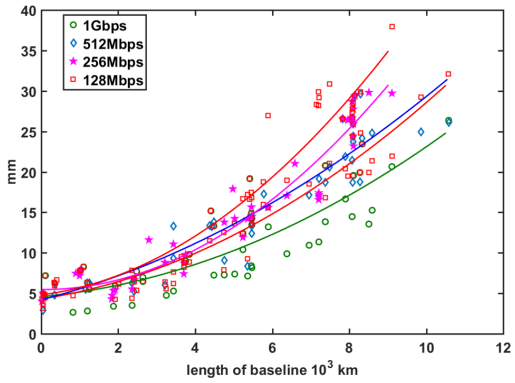

Fig. 3 Simulated baseline length repeatabilities for AOV schedules. Different colors and symbols represent different observing modes used in the sessions. The solid lines are fitted second-order polynomials. Despite variations in the station network that may affect this simulated comparison, we expect improved results using the 1 Gbps mode (shown with green circles).

2.1 Results

- **Geodesy**
  The geodetic sessions are scheduled with the aim of achieving a high number of observations, but also accounting for the large variety of telescopes in the network. While the Antarctic station Syowa or the more astrometrically used telescopes of the VERA network have restrictions in available bandwidth or recording, pairing up small and fast (e.g. AuScope, Ishioka) telescopes with large and sensitive but rather slow ones (e.g. Hobart26, Urumqi, Tianma65) is not a trivial task. A few hardware upgrades and the development of new observing modes now allow us to run most geodetic experiments at a 1 Gbps mode using two bit sampling of 512 MHz wide bands.
  While real-time EOP extraction was used in a few AOV experiments in 2015, deriving those parameters from a regional network is challenging. Geodetically more useful results are baseline lengths and station coordinates. In Figure 3 we show simulated baseline length repeatabilities for AOV schedules with different recording rates. Despite variations in the station network, we expect improved results using the 1 Gbps mode.
- **Astrometry**
  Multiple AOV sessions had an astrometric focus. There are several telescopes with high sensitivity in the region, which regularly could be arranged to join the AOV sessions. Most prominently, these are the Tianma65 or the Parkes telescopes, allowing for special aims of the AOV sessions.
  Emphasis has been put on the ecliptic plane (for deep space navigation) and middle southern sources which are invisible to the VLBA. An overview of the target sources is shown in Figure 4.

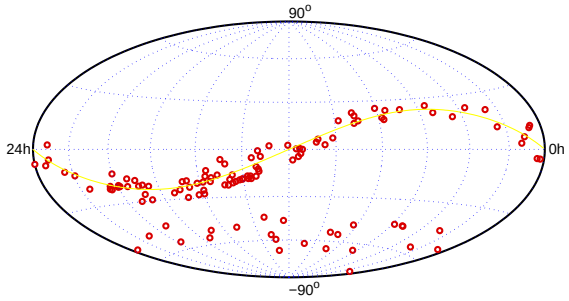

Fig. 4 Astrometric target sources of the AOV sessions. Efforts are focussed on an ecliptic plane survey as well as middle southern sources that are invisible to the VLBA.

- **R&D**
  AOV operations are notable for their responsivity. Multiple sessions were organized flexibly, on short notice via informal e-mail exchange. This allows reacting on short notice to the availability of heavily booked telescopes or tailoring sched-

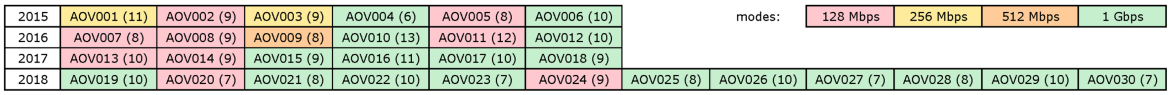

Fig. 2 AOV sessions (and number of stations), color-coded with the observing mode (128 Mbps: AOV002, 005, 007, 008, 011, 013, 014, 020, and 024; 256 Mbps: AOV001 and 003; 512 Mbps: AOV009, and 1 Gbps: AOV004, 006, 010, 012, 015 through 019, 021 through 023, and 025 through 030).

ules to special constellations or observing targets. For example, in AOV022 the three Russian stations Badary, Svetloe, and Zelenchukskaya joined in observations aimed at testing relativity.
Informal communication also enabled AOV network stations to join observations of the Chang'E-3 lander, additional stations to join the Australian AUA sessions, e.g. AUA020 [1], or the Chinese geodetic sessions.

2.2 APSG Sessions

The primary purpose of the APSG sessions is to monitor the relative motions of the plates in the Asia-Pacific region. After some discussion about ceasing these sessions within the IVS, the APSG sessions' scheduling and correlation is now handled by SHAO, under their commitment to the AOV region from 2015 onwards.

3 AOV Meetings and Governance

Regular meetings, an elected structure, and good communication are considered to be essential for the success of the AOV. All relevant information is distributed via dedicated e-mail lists and published at our website: `www.auscope.phys.utas.edu.au/aov`. A few highlights of the previous years are:

- **1st AOV Science and Technology Meeting, November 19-20, 2015, Hobart, Australia**
  An inaugural meeting with about 20 participants and 15 talks. A meeting within the region quickly revealed its benefits, with engaged discussions and keen plans for future collaboration. A key outcome of this meeting was the plan of further AOV meetings at a 1.5 year cadence, preferably hosted by member institutions in alternating hemispheres. The program, copies of the talks, and the meeting minutes are available on the AOV website (see above).
- **March 2017: new Chair and Secretary elected**
  Following the retirements from VLBI by both the AOV chair (Jim Lovell) and the Secretary (Ryoji Kawabata) in early 2017, new elections were held. Takahiro Wakasugi from GSI Japan was elected for the new chair, and he appointed Lucia McCallum from the University of Tasmania for the role of Secretary.
- **2nd General Meeting of the AOV, July 31 to August 1, 2017, Kobe, Japan**
  The second AOV meeting was held as a side meeting of the 2017 IAG-IASPEI conference in Kobe, Japan. While participation of the southern hemisphere was a bit lower this time, a group of around 15 contributed to a successful meeting (see group picture in Figure 5). Noteworthy results are the decision to double the number of AOV sessions per year from six to 12, or the agreement for some common VGOS projects (see below). Furthermore, the meeting program was enhanced with a keynote speech by the IVS chair, Axel Nothnagel, about synergy aspects of the AOV and IVS, as well as an invited talk by John Dawson from Geoscience Australia, on collaboration with the UN-GGIM-AP WG1. It was also a pleasure to welcome both masters and PhD students at this meeting. For details on the program, the talks and meeting minutes the interested reader once more is referred to our website.
- **AOV Retreat, March 6-8, 2018, Hobart, Australia: Chair and Secretary**
  In March 2018, the Chair visited his Secretary in Hobart. During this two-day retreat, some of the agenda items were details of the 3rd AOV meeting (see below), the status of the ongoing AOV operations, representation at the upcoming IVS GM in

Fig. 5 Participants of the second AOV meeting, held in Kobe, Japan.

Svalbard, as well as future VGOS activities within the AOV.

- **3rd Meeting of the AOV, November 9-10, 2018, Canberra, Australia**
  The next AOV meeting will be held in Canberra, hosted by Geoscience Australia and coinciding with the ILRS Workshop. Registration was opened, and the meeting Web site went online in August. Following the tradition of the previous meeting, one day will be dedicated to discussions within the VLBI experts, while the second day will consist of reports, scientific talks, and invited presentations, also with the intention of attracting a wider audience from different fields and techniques.

4 VGOS and the AOV

The AOV is working together on VGOS observations. The testing so far has contributed to the quality checking of VGOS equipment and the accumulation of operational knowledge. In particular we tested modes and compatibility between the DBBC-3 (in Hobart) and the Japanese GALA-V system (at Ishioka and Kashima). Correlation was performed at NICT and in Hobart, investigating group delays obtained with zoom-bands and FOURFIT and those from the Japanese full-bandwidth processing. This has prompted active development of the DBBC in Hobart, testing multiple frequency bands and polarization combinations using the DBBC's OCT-mode.

With the now established procedures for scheduling and data transfers, further tests are planned within the next months. Focus will be given to polarization combinations and source structure studies, as well as further development on correlation and post-correlation procedures (at SHAO).

References

1. O. Titov, A. Girdiuk, S.B. Lambert, J. Lovell, J. McCallum, S. Shabala, L. McCallum, D. Mayer, M. Schartner, A. deWitt, F. Shu, A. Melnikov, D. Ivanov, A. Mikhailov, S. Yi, B. Soja, B. Xia, and T. Jiang, "Testing general relativity with geodetic VLBI - What a single, specially designed experiment can teach us", Astronomy and Astrophysics, man. no. 33459, doi:10.1051/0004-6361/201833459, 2018.