Results from the Regional AUSTRAL VLBI Sessions for Southern Hemisphere Reference Frames

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The world's busiest antennas

From contributing to ~40-50 IVS sessions in 2012, over 70-80 in 2013, the AuScope VLBI antennas (Hb, Ke, Yg) are each scheduled for ~170 sessions in 2014. Besides supporting almost every IVS-R1/R4 session, the AUSTRAL observing program has been increased tremendously (Fig. 1). This includes continuous AUST campaigns over 15 days in 2013 and 2014, as well as 48h weekend sessions additional to the traditional AUSTRAL experiments.

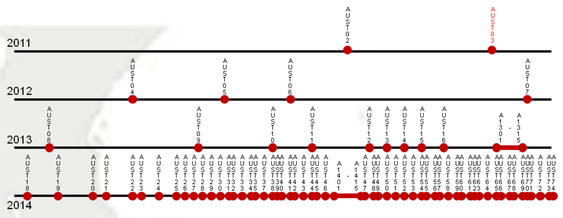

Figure 1: Calendar of the AUSTRAL sessions.

Introduction

Since 2011, more than 40 dedicated AUSTRAL VLBI sessions have been observed. Besides the three Australian AuScope antennas also the 15m dish in Hartebeesthoek (South Africa) and the 12m antenna in Warkworth (New Zealand) contribute.
We give an overview of the AUSTRAL observing program, summarise the results so far, and present our future plans.

Performance

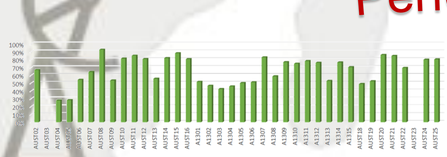

Figure 2: Percentage of successful observations in the analysed AUSTRALs.

Short-notice station fall-outs, wind stows, or other technical problems affect the overall performance of an experiment.
For the AUSTRALs, the percentage of successful observations is about 80% (Fig. 2).

In a small network, problems at one antenna can have a significant effect on the whole session performance (Fig. 3).

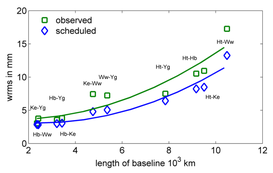

Figure 3: Simulated baseline length wrms for the AUST13 campaign. We distinguish between the originally scheduled and the actually observed observing plan.

Pre-VGOS scheduling

As a prototype for the VGOS system[1], the AUSTRAL antennas are small but fast antennas. The reduced sensitivity is compensated by an increased recording rate of 1 Gbps. In Figure 4 we show simulated baseline length wrms using various schedules, antenna capabilities, and measurement noise. We find that the 1Gps recording let us expect much better results than the traditional 256 Mbps. The positive effect of a system upgrade to broadband receivers is also clearly visible.
The scheduling is done at Vienna University of Technology using the VieVS software. Steady improvements led to a top of 30 scans per hour per station from AUST30 onwards (Fig 5). With the current analysis up to AUST25, we expect even better results soon.

[1]VLBI2010 Global Observing System

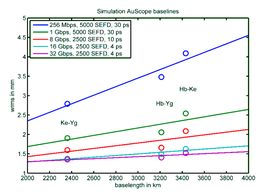

Figure 4: Simulated wrms in baseline lengths for schedules using different receiver and recording capabilities.

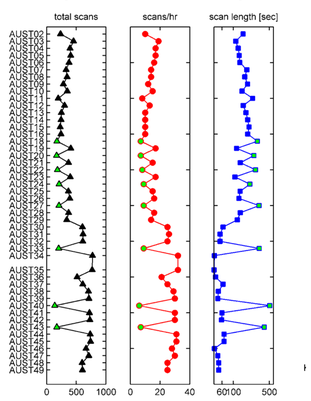

Figure 5: Average number of scans per station, scans/hour, and scan length in the AUSTRAL sessions. Astro-experiments are marked green.

Results

- **35 AUSTRALs analysed** *up to AUST25, incl. AUSTCont13*
- **R1/R4 from 2011/1-2014/6** *standard weekly IVS experiments*
- **Cont14** *incl. all AUSTRAL antennas*

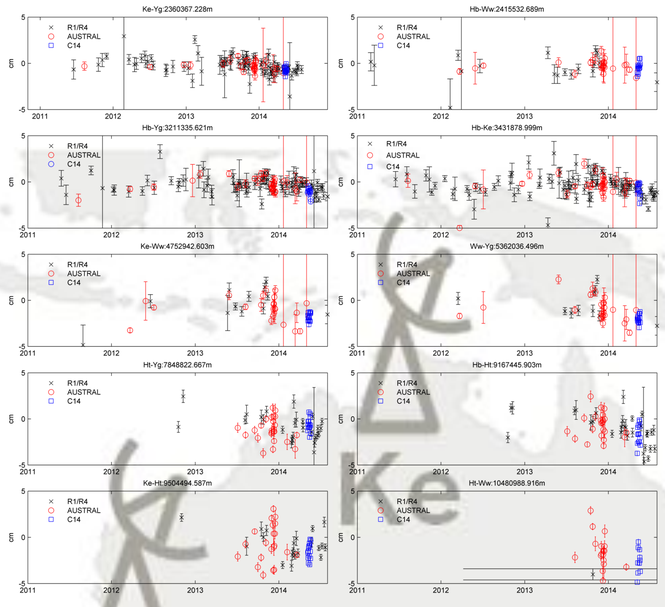

Figure 6: Time series of AUSTRAL baseline lengths.

- *Baselines are in accordance with IVS results (Fig. 6).*
- *Improved repeatabilities for AUSTRALs vs. IVS rapids (Tab. 1).*
- *Dense time series reveal unknown systematics (e.g. Hb-Ke).*

Table 1: Baseline length repeatabilities (wrms) as determined in the AUSTRALs, R1/R4 sessions, and Cont14.

baseline	AUSTRALS	R1/R4	Cont14
Hb-Ho	-	9.5 mm	1.7 mm
Ke-Yg	5.4 mm	7.5 mm	3.3 mm
Hb-Ww	5.6 mm	11.0 mm	5.1 mm
Hb-Yg	6.4 mm	7.7 mm	4.3 mm
Hb-Ke	8.6 mm	10.1 mm	6.4 mm
Ke-Ww	9.8 mm	13.4 mm	3.6 mm
Ww-Yg	11.0 mm	14.3 mm	4.5 mm
Ht-Yg	11.2 mm	11.5 mm	6.6 mm
Hb-Ht	13.3 mm	16.6 mm	8.0 mm
Ht-Ke	18.0 mm	14.2 mm	8.0 mm
Ht-Ww	17.9 mm	-	14.6 mm

EOP

The quality of determined Earth orientation parameters with the AUSTRALs is about 50% worse for polar motion and about 80% worse for dUT1 compared to IVS R1/R4 sessions. A clear difference is also visible in the formal uncertainties (Tab. 2).

Table 2: Difference (wrms) between the determined EOPs and the IERS 08 C04 series. The values and their formal uncertainites were determined in a global solution.

	xp	yp	dUT1	dX	dY
AUSTRAL	476 μas	491 μas	42 μs	426 μas	536 μas
	917 μas	795 μas	51 μs	630 μas	679 μas
R1/R4	321 μas	339 μas	23 μs	290 μas	308 μas
	330 μas	326 μas	8 μs	314 μas	316 μas

CRF

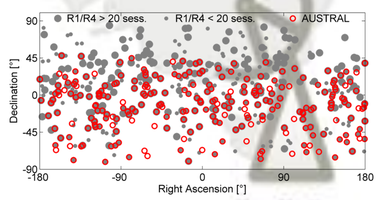

Figure 7: Observed radio sources in the analysed AUSTRAL and R1/R4 sessions.

The AUSTRALs heavily increase the number of observations to southern sources (Fig. 7).
Special astrometry sessions are performed once per month. The goal is astrometry of radio sources with limited number of S/X observations and flux appropriate for observing with 12m radio telescopes.

Summary

The AUSTRAL observing program greatly improves the number of observations of both, southern baselines and southern radio sources.

Geodetic results in terms of baseline lengths are consistent with (and slightly better than) standard IVS products. For the determination of EOPs, the AUSTRALs are less suitable.

Improved scheduling and continuation of the frequent observing are expected to yield further improved results.

Outlook

- **Many more sessions to analyse and observe in 2014/15**
  AUST-74 until the end of 2014, AUST-CONT14, two AUST continuous campaigns in early 2015.
- **Hobart goes VGOS**
  Hb will be upgraded with a broadband feed & 16 Gbps sampler/recording system in mid 2015.
- **Dynamic observing**
  Ongoing developments for improved operations with real time correlation & quality control.
- **Sibling Telescopes**
  Twin-Experiments with the legacy-VGOS antenna pairs in Hobart and Hartebeesthoek (Fig. 8).
- **Source structure studies**
  Continuation of source structure studies with broadband/phase delay observations.

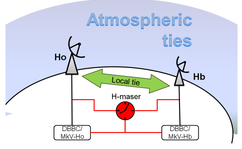

Figure 8: Observations with sibling telescopes: improved analysis through atmospheric ties and common clock parameters.

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