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CRF Network Simulations for the South

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Abstract

In order to monitor and improve the CRF in both the Southern Hemisphere and along the ecliptic, we perform various simulations using station networks based mostly on the Australian AuScope network, New Zealand's Warkworth antenna, and several Chinese antennas. The effect of other stations such as HartRAO and Kokee Park to enhance the East-West baseline coverage is also considered. It is anticipated that the simulation results will help IVS to decide on the composition of the CRF sessions of the IVS to be run from 2011 onward.

1. Introduction

A deficit of observations of radio sources in the Southern Hemisphere makes development of a program dedicated to exploiting the new Australian and New Zealand radio telescopes a priority. These fast slewing antennas bring the benefit of quickly producing a large number of observations, but due to their small size (12 meters), the number of available sources is limited. We considered different network configurations consisting either of these new antennas alone or these antennas complemented by existing larger diameter antennas. We show that these networks can process a sufficient number of radio sources with a flux density of 1 Jy or more to meet desired astrometric goals. Special attention was devoted to the Australian–Chinese network.

Table 1. Network configurations used in the simulations.

Number	**Network**
1 ≡ core	Hobart12, Katherine, Yarragadee, Warkworth
2	core + Parkes + Seshan25
3	core + Urumqi + Seshan25
4	core + Hartrao
5	core + Hartrao + Kokee
6	core + Fortaleza + Kokee
7	core + Fortaleza + Kokee + Hartrao
8	core + Fortaleza+ Kokee + Hartrao + Seshan25 + Urumqi
9	core + Seshan25 + Urumqi + Kunming
10	core + Parkes + Kokee + Hartrao + Seshan25 + Urumqi + Kunming

2. Solution Statistics

We used two source selection scenarios. For the first scenario, the SKED program was used to select objects from a list of 120 strong radio sources (flux density ≥ 1 Jy in S/X-bands), almost all of them located in the Southern Hemisphere. For the second scenario, 159 radio sources around the ecliptic zone were added to the list of 120 sources. Figures 1–3 show the number of sources, scans, and group delays scheduled in the ten networks using both source selection scenarios. Due to different network configurations SKED selected different numbers of sources for the simulated 24-hour sessions. For a regional network, comprised of the 12-meter Australian and New Zealand facilities only, the number of sources is 20, whereas for the largest network (No. 10) the number of sources is about 180 (Figure 1). The number of scans varies from 100 to 500 (Figure 2), and the number of group delays varies from 350 to 1000–1500 (Figure 3).

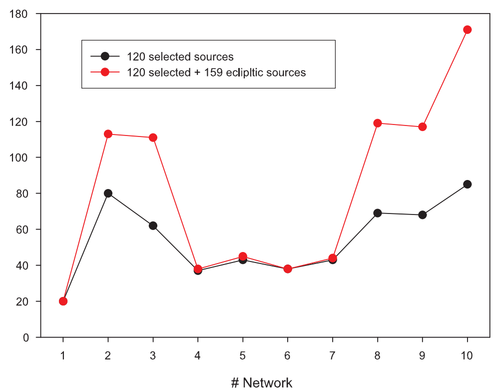

Figure 1. Number of sources scheduled for the two source selection scenarios.

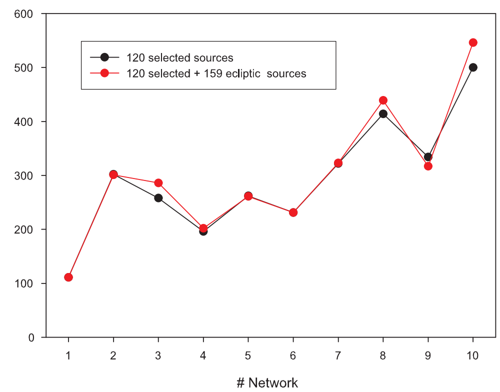

Figure 2. Number of scans scheduled for the two source selection scenarios.

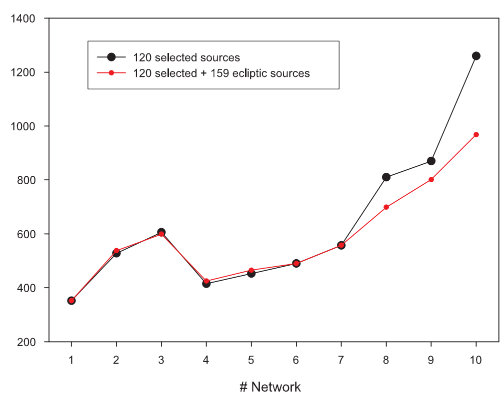

Figure 3. Number of group delays scheduled for the two source selection scenarios.

These statistics show that even the small regional network of four 12-meter antennas produces a sufficient number of observations to fulfill the astrometric goals. The addition of HartRAO, Fortaleza, and Kokee (networks 4, 5, and 6) does not change these numbers dramatically. The addition of the Chinese stations Seshan25, Urumqi, and Kunming in different combinations (networks 2, 3, 8, and 9) looks more promising. Our results show that the final network (No. 10) with ten antennas is the best option; however, this network is unlikely to be realized on a regular basis.

Simulations for a third scenario using the list of the 295 ICRF2 defining radio sources [1] have also been examined. These sources are more evenly distributed across the sky, so the number of scheduled sources varies from 84 to 200 for the different network configurations.

3. Positional Accuracy

The core network of four 12-meter dishes produces a reasonable accuracy for the 20 selected radio sources. Figure 4a shows that for this schedule the formal standard deviations lie within a range of 1–5 mas. The results for the second scenario (including ecliptic sources) are similar (Figure 4b).

The standard deviations of individual radio sources in the ICRF2 scenario lie within a range of 5–200 mas. Many more sources were scheduled (89) with many observed only one or two times, which results in large formal errors. In Figure 4c we plotted only the 19 sources observed at least 5 times. Alternatively, scheduling 14 ICRF2 defining sources astrometrically yielded formal errors of 2–5 mas.

Simulations for network No. 10 for all three cases are more similar. For the full group of 120 Southern Hemisphere sources the standard deviations are within the range of 1–3 mas, with some values up to 10 mas (Figure 4d). The other two scenarios provide more radio sources to be scheduled; consequently, more formal errors exceed 3 mas (Figures 4e and 4f). Nonetheless, the number of sources with standard deviations within a range of 1–3 mas is still adequate for accurate astrometry.

4. Conclusions

We can use the AuScope/New Zealand network of four VLBI sites for a program of astrometry of strong radio sources in the Southern Hemisphere. In conjunction with the facilities from the wider Asia-Pacific region, the network could be used to densify the reference radio sources along the ecliptic zone. Further improvement of the technical specifications of the 12-meter antennas, such as the reduction of SEFD values, will make the observational astrometric programs significantly more flexible.

5. Acknowledgments

This paper has been published with permission of the Chief Executive Officer of Geoscience Australia.

References

[1] Fey, A., D. Gordon, and C. Jacobs (eds.), The second realization of the International Celestial Reference Frame by Very Long Baseline Interferometry, IERS Technical Notes 35, 2009.

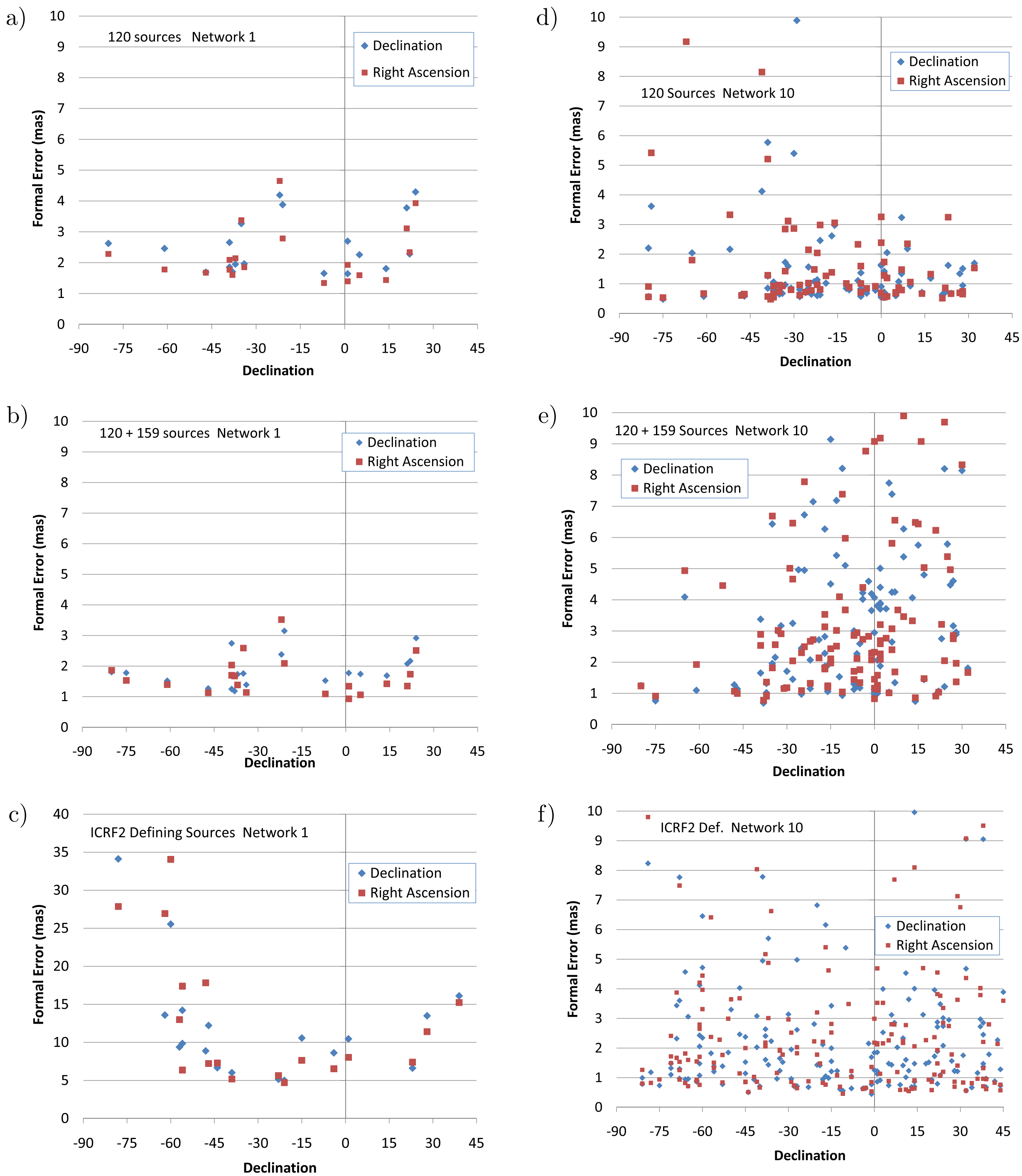

Figure 4. (left) Formal errors obtained in the simulations with the core network (network No. 1) for the source lists of a) 120 sources, b) 120 + 159 sources, and c) the ICRF2 defining sources. (right) Formal errors obtained in the simulations with the network No. 10 for the source lists of d) 120 sources, e) 120 + 159 sources, and f) the ICRF2 defining sources.