

# Analysis Report of AOV Observation

Masafumi Ishigaki, Takahiro Wakasugi, Michiko Umei,  
Shinobu Kurihara, Haruka Ueshiba, Hiroshi Munekane

Geospatial Information Authority of Japan (GSI)

**What is AOV?**



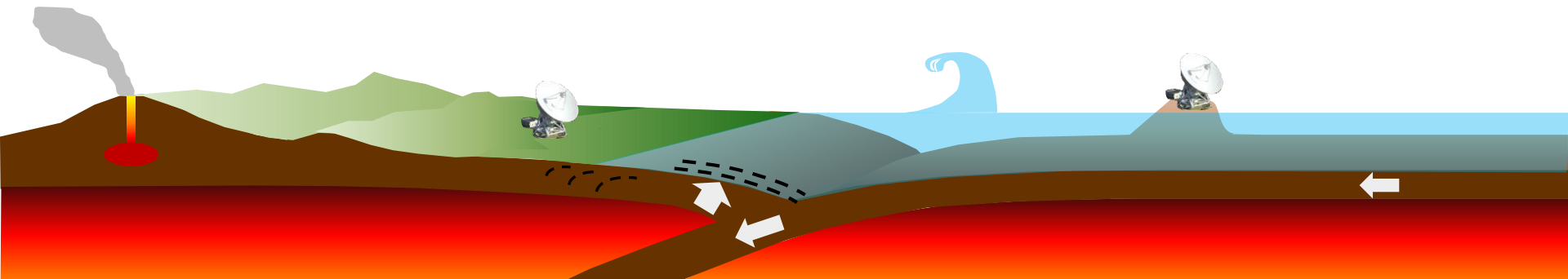
# What is AOV?

- **A**sia-**O**ceania **V**LBI Group for Geodesy and Astrometry
- Subgroup of IVS (International VLBI Service for Geodesy and Astrometry)
- Fostering regional collaboration in VLBI
- Consisting of 12 institutions in 5 countries
- Chair: Takahiro Wakasugi (GSI)
- Secretary: Lucia McCallum (UTAS)



# Motivation

- The Asia-Oceania region is highly dynamic in geophysics and climate (earthquakes, tsunamis, typhoons...)
- The AOV has an important role to play through measurement of plate motion and determination of the Geodetic Reference Frame for the region
- All process from scheduling, observation, correlation & analysis are operated by AOV members



# AOV seeks to...

1. Foster the use of VLBI in geodesy and astrometry from the Asia-Oceania region
2. Strengthen links between the different Asia-Oceania VLBI components from observations to data analysis
3. Promote and represent Asia-Oceania VLBI within the international communities
4. Provide and archive information and results of Asia-Oceania VLBI
5. Organize regular working meetings between members of the AOV
6. Support and promote education and training regarding VLBI in the region

# Brief History

Mar. 2013	Informal discussions with several researchers from East Asian countries during the 21st EVGA Meeting in Finland
Sep. 2013	Agreement on establishment of a regional VLBI community for Asia-Oceania at IAG Scientific Assembly in Potsdam Approval of the AOV establishment by the 30th IVS Directing Board meeting
Mar. 2014	AOV inaugural meeting at the IVS General Meeting in Shanghai
Sep. 2014	Terms of Reference established
Oct. 2014	Election of the Chair (1st)
Mar. 2015	Launch of VLBI sessions by AOV
Nov. 2015	1st AOV meeting in Hobart
Mar. 2017	Election of the Chair (2nd)
May. 2017	2nd AOV meeting in Kobe
Nov. 2018	3rd AOV meeting in Canberra



Discussion during the meeting in Finland

# Relation with Other Associations

**IAG** (International Association of Geodesy)

**IERS** (International Earth Rotation and Reference Systems Service)

**IAU** (International Astronomical Union)

**IVS** (International VLBI Service for Geodesy and Astrometry)

**EVGA** (European VLBI Group for Geodesy and Astrometry)

**AOV** (Asia-Oceania VLBI Group for Geodesy and Astrometry)

# Member of AOV

Country	AOV Member Organization
<b>New Zealand</b>	Auckland University of Technology
<b>Australia</b>	Commonwealth Scientific and Industrial Research Organisation
<b>Australia</b>	Geoscience Australia
<b>Japan</b>	Geospatial Information Authority of Japan (GSI)
<b>South Korea</b>	Korea Astronomy and Space Science Institute
<b>Japan</b>	National Astronomical Observatory of Japan
<b>South Korea</b>	National Geographic Information Institute (NGII)
<b>Japan</b>	National Institute of Information and Communications Technology (NICT)
<b>Japan</b>	National Institute of Polar Research
<b>China</b>	Shanghai Astronomical Observatory (SHAO)
<b>Australia</b>	University of Tasmania (UTAS)
<b>China</b>	Xinjiang Astronomical Observatory



# AOV Stations

16 telescopes now participate in the AOV sessions



# AOV Schedulers & Correlators

Schedulers and correlators are shared by AOV members



# 1st AOV Meeting

- **1st AOV Science and Technology Meeting was held** on November 19-20, 2015 in Hobart, Australia
- Sharing information from institutions and discussing future vision for AOV
- Determining the plan to held further AOV meetings every 1~1.5 year



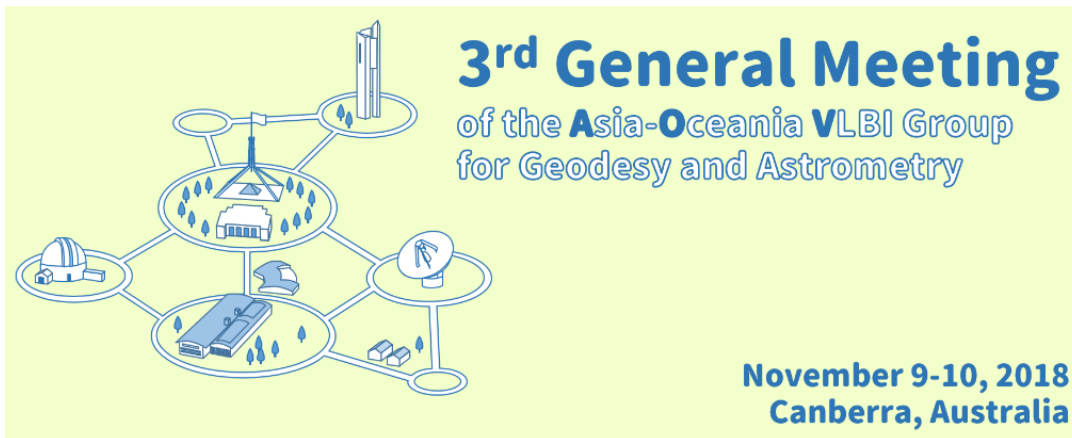
# 2nd AOV Meeting

- **Held in Kobe, Japan** on Jul. 31 – Aug. 1, 2017, as a side meeting of the IAG-IASPEI conference
- 19 members participated from JPN, AUS, CHN, and NZL
- Synergy of AOV and IVS was encouraged in a speech of IVS Chair (Axel Nothnagel)
- Increase of the number of sessions in 2018 was agreed (6 → 12 per year)



# 3rd AOV Meeting

- **Held in Canberra, Australia on Nov. 9 – 10, 2018**
- Conjunction with the International Workshop on Laser Ranging
- Director of ILRS (Michael Pearlman) and GGOS WG of Japan (Toshimichi Otsubo) were invited





# AOV Sessions

- VLBI sessions by AOV have started from March 2015
- 12 sessions are conducted in 2018

AOV sessions in 2018						
Session	Date	# of Stations	Sked	Corr	Rate	Purpose
AOV019	23-Jan	10	SHAO	SHAO	1 Gbps	Astro
AOV020	27-Feb	7	GSI	GSI	128 Mbps	Geodesy
AOV021	20-Mar	8	SHAO	SHAO	1 Gbps	Astro
AOV022	1-May	10	UTAS	SHAO	1 Gbps	R&D
AOV023	21-May	7	UTAS	GSI	1 Gbps	Geodesy
AOV024	19-Jun	7	GSI	GSI	128 Mbps	Geodesy
AOV025	24-Jul	8	SHAO	SHAO	1 Gbps	Astro
AOV026	7-Aug	9	UTAS	SHAO	1 Gbps	Geodesy
AOV027	18-Sep	6	SHAO	SHAO	1 Gbps	Astro
AOV028	16-Oct	8	GSI	GSI	1 Gbps	Geodesy
AOV029	22-Nov	10	SHAO	SHAO	1 Gbps	Astro
AOV030	11-Dec	7	UTAS	GSI	1 Gbps	Geodesy

# Analysis of AOV sessions



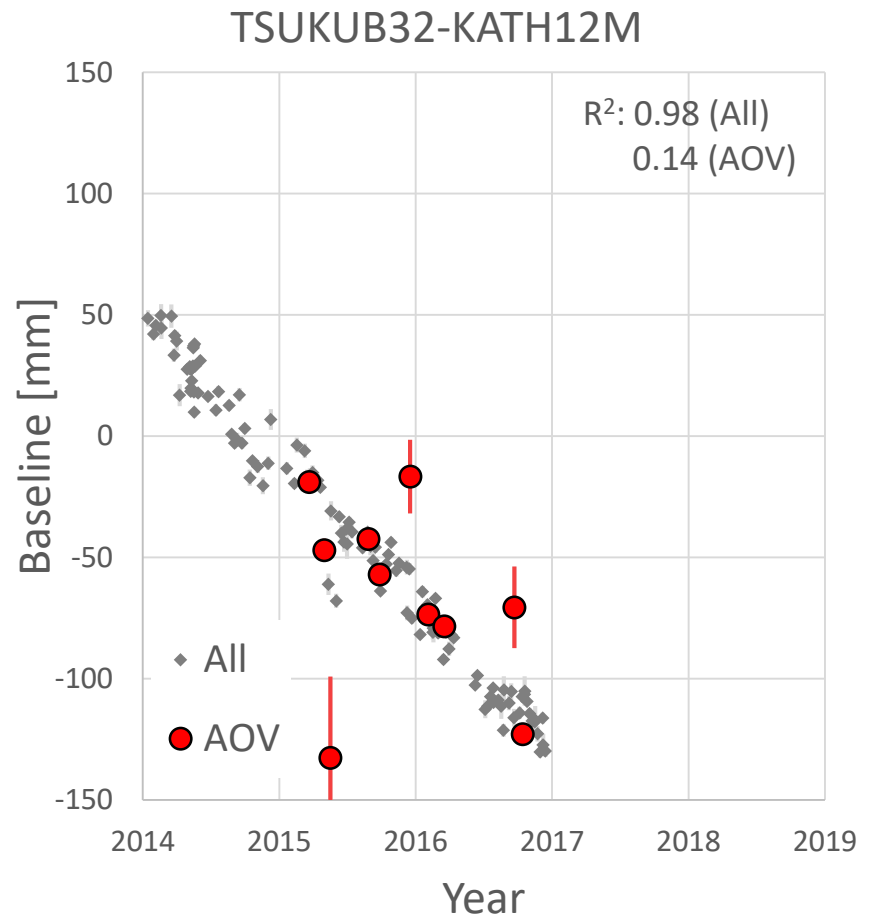
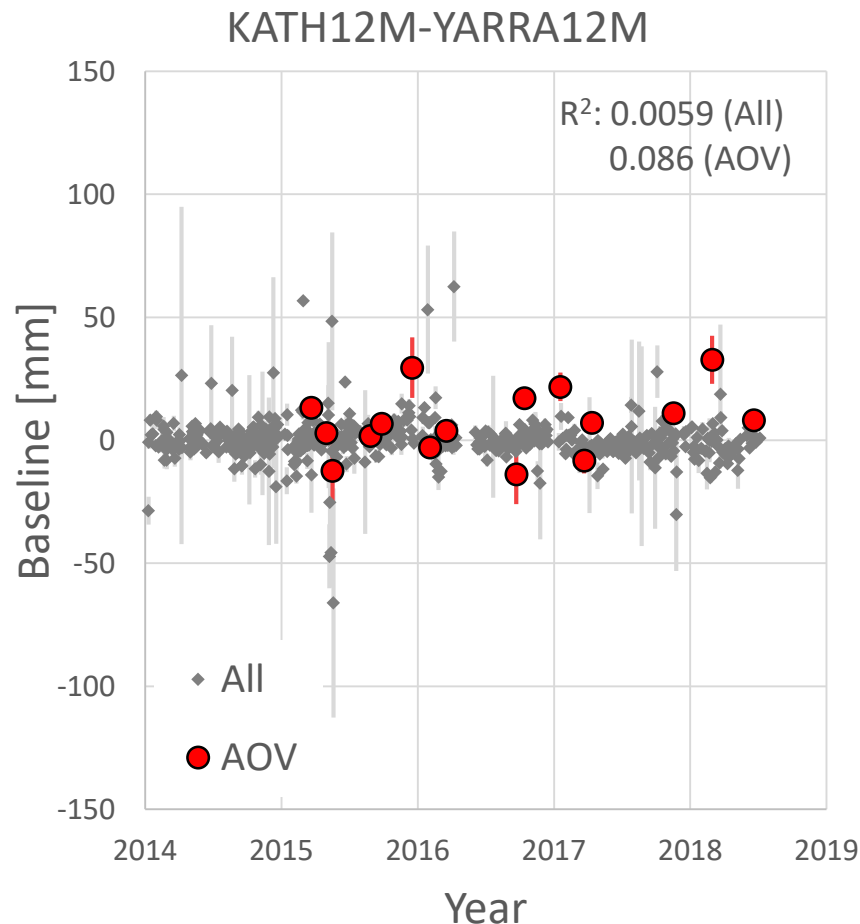
# Baselines & EOP

<b>Software</b>	Calc/Solve
<b>Period</b>	AOV: 2015-2018 (AOV001-024) Others: 1980-2018
<b># of sessions</b>	6493
<b>Estimated parameters</b>	Station position/velocity EOP Source position
<b>Apriori</b>	ITRF2014 USNO finals, IAU2006/2000 Precession/Nutation ICRF2



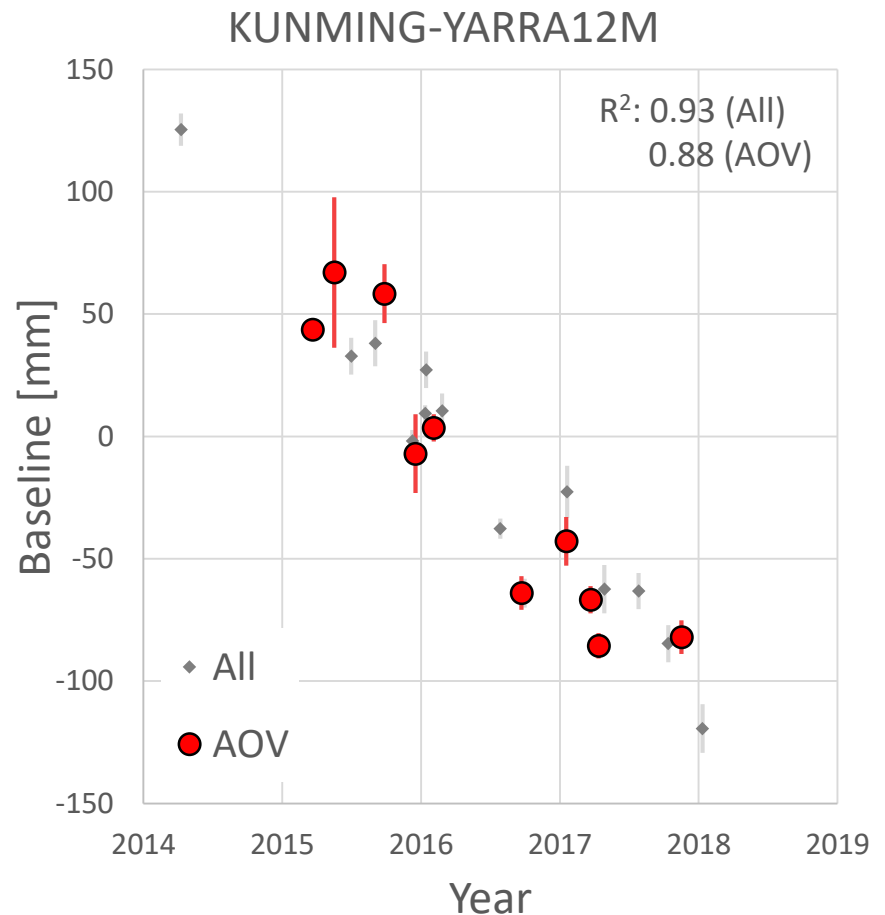
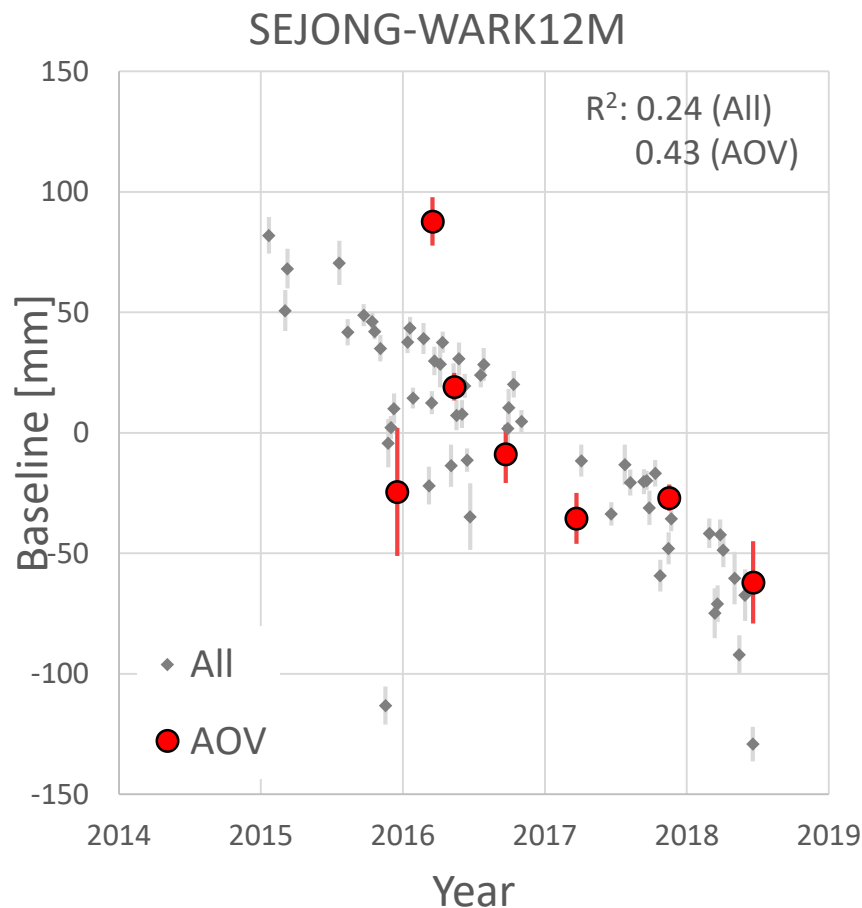
# Baselines

- The results of AOV are consistent with other sessions
- Errors are also comparable to others



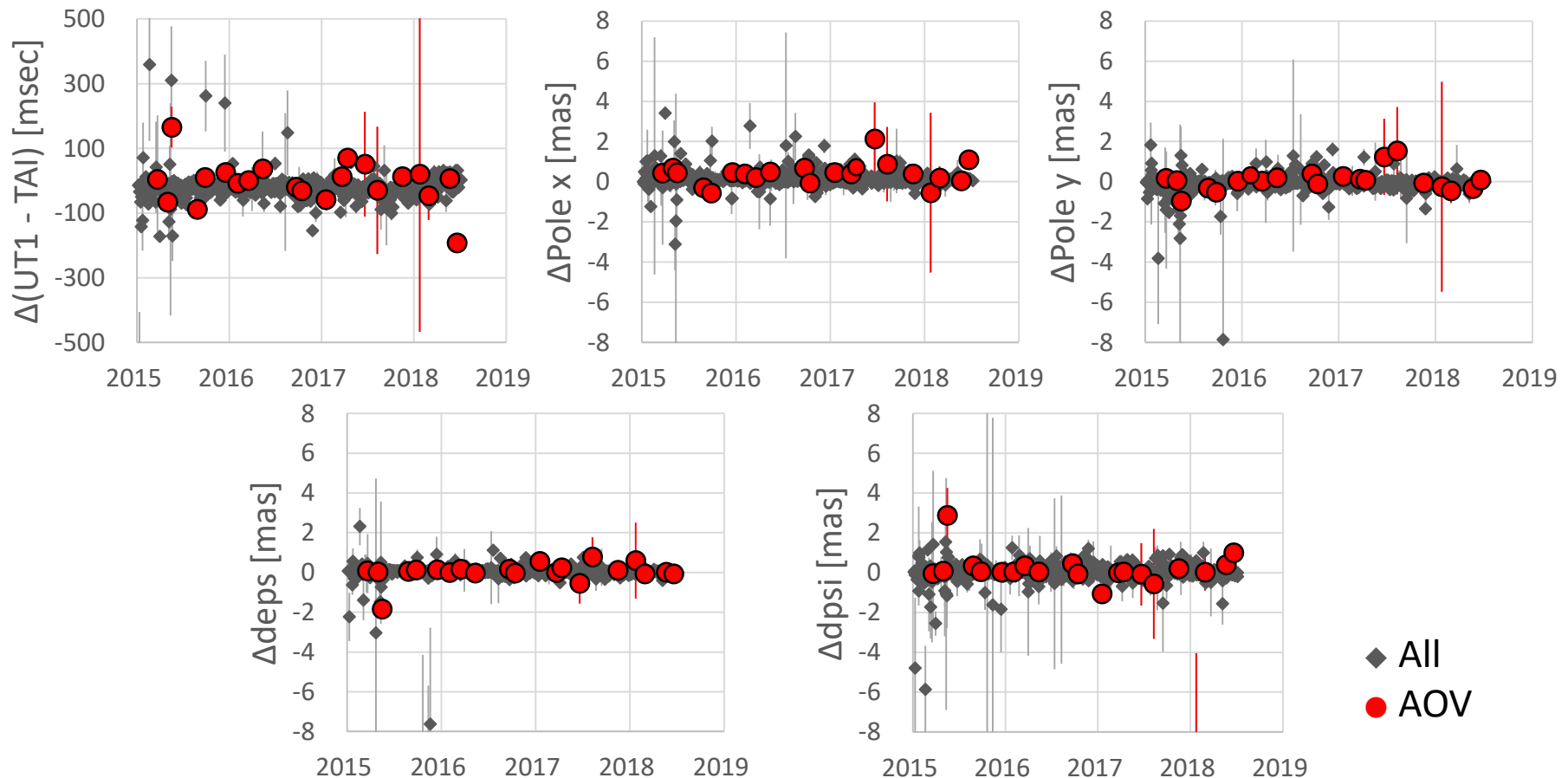
# Baselines

- The results of AOV are consistent with other sessions
- Errors are also comparable to others



# Earth Orientation Parameters (EOP)

- Estimate the residuals to IERS EOPC04.08 series
- Sensitivity is comparable to other sessions



# Station Positions

- Calculate the station positions from the data sets which:
  - a. includes **all** sessions from 2015
  - b. includes sessions from 2015 **except AOV**
- Number of sessions are
  - a. 657
  - b. 641
- Take difference between the position of a and b ( $dx, dy, dz$ ) and sigma of a and b ( $d\sigma_x, d\sigma_y, d\sigma_z$ )

# Station Positions

	dx (mm)	dσx (mm)	dy (mm)	dσy (mm)	dz (mm)	dσz (mm)	total session	AOV session (%)
ISHIOKA	-1.07	0.024	0.78	0.023	1.93	0.014	178	5.6
KASHIM34	-2.01	0.379	1.21	0.284	-1.39	0.212	46	13.0
VERAMZSW	-13.65	4.067	-4.41	3.943	4.50	4.289	24	25.0
SESHAN25	-1.04	0.021	1.74	0.061	0.61	0.025	81	8.6
SEJONG	2.06	0.012	-2.23	0.017	-1.72	0.010	158	5.7
URUMQI	-1.77	0.287	-3.90	0.672	0.91	0.951	28	32.1
HOBART12	-0.92	0.003	0.34	0.003	-1.63	0.006	281	3.2
KATH12M	0.14	0.002	-0.53	0.002	-0.37	0.002	458	3.1
YARRA12M	-0.14	0.002	-0.06	0.001	-0.43	0.003	479	3.1
WARK12M	-0.20	0.004	-0.13	0.002	-0.63	0.004	268	5.2
SYOWA	8.46	1.218	-9.42	0.547	-3.23	2.579	11	9.1

  
Improved by AOV sessions

# Summary

- AOV has been active since 2014 to foster collaboration of VLBI in Asia-Oceania region
- All sessions are scheduled, observed, correlated and analyzed by AOV members
- AOV meetings have been held three times so far
- We derive geodetic results of AOV sessions, which are comparable to other observations
- AOV sessions also focus on other purposes, such as astrometry and R&D

# Future Prospects



# VGOS (VLBI Global Observing System)

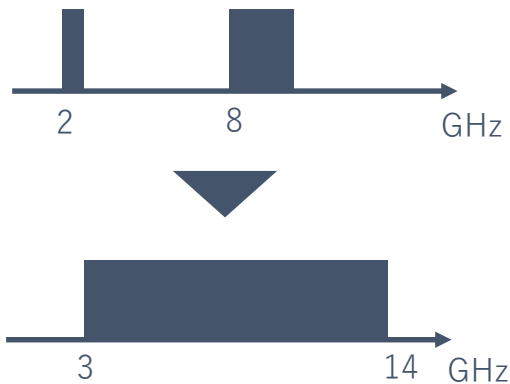
## Legacy system

Several-mm position accuracy  
observations for a few days per week  
Geodetic results in ~ 2 weeks

## VGOS

1-mm accuracy  
Continuous operations  
Initial results in < 24 hours

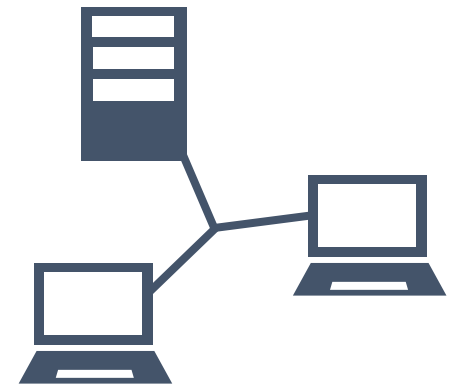
To achieve the goals...



Broadband



Fast Slewing Antenna



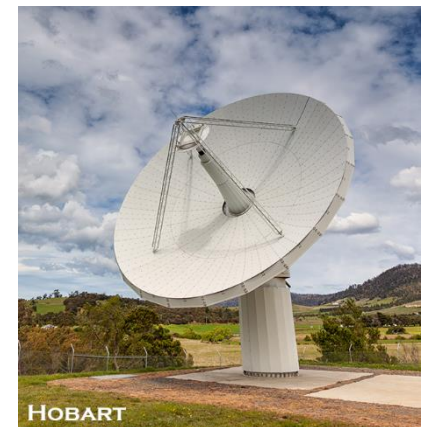
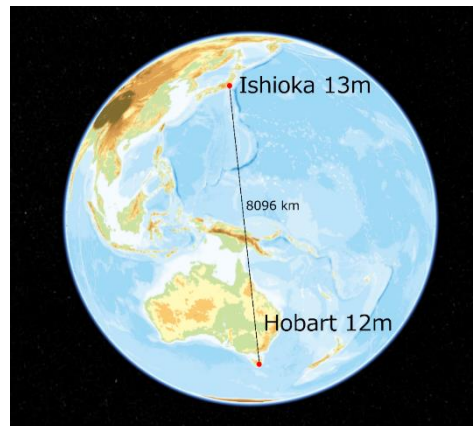
High Speed Network



# AOV Broadband experiment

- Ishioka and Hobart succeeded in broadband experiment in August to September 2018
- Performance test of VGOS stations before joining VGOS Test of IVS

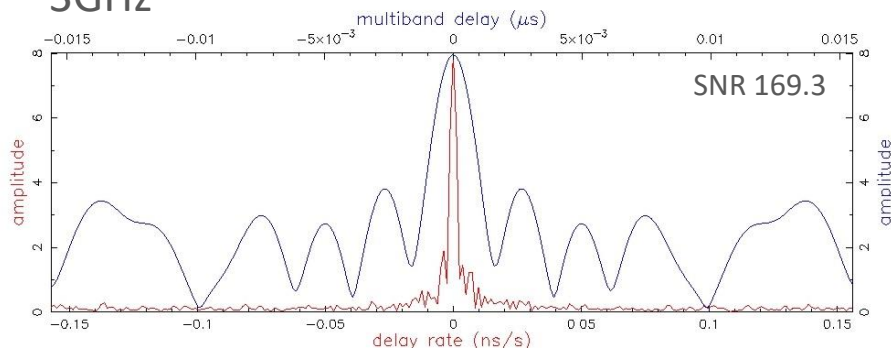
- ① 2018/8/8 UT4:30-5:00 (f18220)
- ② 2018/9/4 UT2:30-4:00 (f18247)
- ③ 2018/9/10 UT2:30-4:10 (f18253)



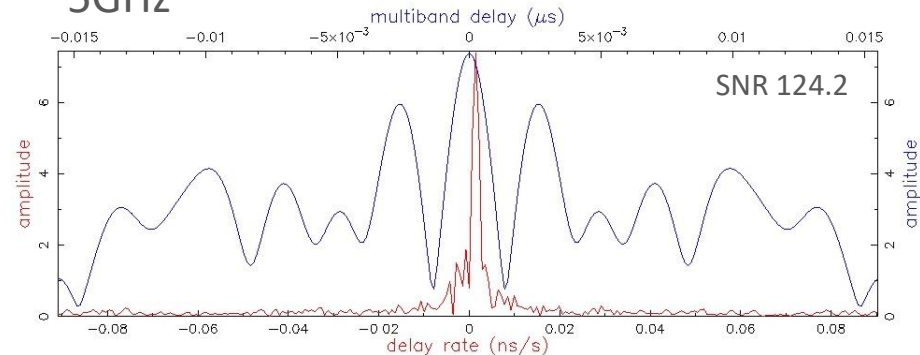
# AOV Broadband experiment

- The data were correlated in UTAS
- Detect fringes in each band

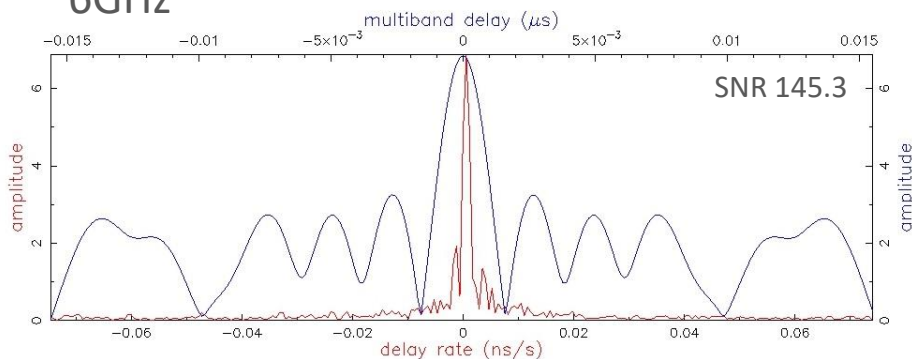
3GHz



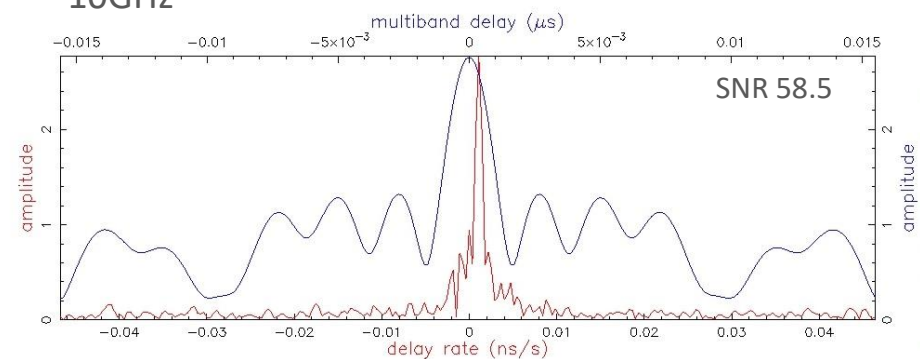
5GHz



6GHz



10GHz



# Future Prospects

- AOV will continue to carry out broadband experiment in addition to legacy AOV observation
- We welcome new stations to strengthen the network of AOV!