Precision Surveys at Australian Geodetic Observatories

Geoscience Earth Monitoring
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IERS Workshop on site co-location, Matera, Italy, Session 2 “Site Surveys”
Overview

• Geodetic Observatories
• Planning and Strategies
• Equipment and Equipment calibration
• Monumentation and local control networks
• Reference point on space geodesy instruments
• Preliminary computations
• Limitations and developments
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## Australian geodetic co-location

<table>
<thead>
<tr>
<th>Site</th>
<th>GPS</th>
<th>SLR</th>
<th>GLONASS</th>
<th>VLBI</th>
<th>DORIS</th>
<th>Absolute Gravity</th>
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</thead>
<tbody>
<tr>
<td>Mount Stromlo</td>
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<tr>
<td>Tidbinbilla</td>
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<tr>
<td>Hobart</td>
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<tr>
<td>Yarragadee</td>
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<td>Darwin</td>
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</tbody>
</table>

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Other geodetic co-location

- GPS and tide gauge
  - Australia
    - Hillarys, Bernie
  - Antarctica
    - Mawson, Casey, Davis
  - South Pacific
    - Samoa, Cook Islands, Fiji, Tuvalu, Tonga, Manus Island, PNG, Kiribati, Vanuatu, Marshall Islands, Nauru, Micronesia
    - Palau, Niue, Solomon Islands
South Pacific Sea Level Monitoring
GPS to Tide Gauge Benchmark Connection

• Multi-day GPS connection between ARGN site and TGBM
• Orthometric Levelling connection as well using Total Station Levelling (TSL)
• Connections typically completed biennially
Planning and Strategies

- Survey timing best when weather conditions are neutral ie. Optimum for survey observations
- Allow for several days down time on SLR or VLBI system
- Plan to avoid critical tracking campaigns
- Plan placement of marks on telescope to optimise design and computation approach (e.g. circle radii and arc length)
- Place instrument stand points so near orthogonal lines are observed into telescope
Yarragadee (SLR)
Mount Stromlo (SLR)
Mount Stromlo (SLR) - after fire
Mount Stromlo (SLR) - today

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Hobart (VLBI)

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Tidbinbilla (VLBI)
Equipment

Leica TCA2003

Specification

• Angular 1” H & V
• distance 1mm + 1ppm

Factory Calibration

• Angular 0.6” H & V
• distance 0.5mm + 0.4ppm
Equipment

- Leica Precision prisms with Tribrach and carriers (including plate bubble)

- Zenith Nadir Plummet for centring tripods where required
Equipment

- Fixed height prism pole (pogo) for Total Station Levelling (TSL)
- Invar Staff for instrument heighting
Equipment
Equipment
Equipment Calibration

• Total Station
  – Factory calibration initially (when purchased)
  – Annual comparison with standard baseline (linked to national standard)
  – Internal angular calibrations at time of survey
  – Comparison with GPS
  – Calibration of prism / reflectors over a known baseline length
Equipment Calibration

• Invar Staff
  – Factory calibration initially (when purchased)
  – Biennial calibration
Monumentation

- Survey network linking instrumentation should be an over determined braced quadrilateral.
- Ideally instrument standpoints are stable bedrock anchored pillars.
- Pillars should have reference marks to monitor local deformation.
- Survey marks should have an unambiguous reference point.
Yarragadee Control Network

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GPS/DORIS reference points

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Reference Points

$q(q_n, q_e, q_u)$

secondary (moving) axis

$p(p_n, p_e, p_u)$

primary (fixed) axis

$\tilde{p} - \tilde{q}$
IVP Determination

- Survey targets placed on the telescope and observed through a rotational series
- Arcs scribed by target are centered around the axis of rotation
Principal

Axis of rotation

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Limitations

• Measurement of instrument trunion axis height
• Transfer of ellipsoidal height (geoid model error)
• Impact of tape reflectors on distance and angular measurement
• Unknown effect of refraction on lines which have a temperature gradient
Instrument Heighting

\[ H = \frac{S_2 \cot Z_1 - S_1 \cot Z_2}{\cot Z_1 - \cot Z_2} - (H_1 - H_2) \]

Where:
- \( S_n \) are staff readings
- \( Z_n \) are zenith angles

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Developments

• Use of Total Station Levelling (TSL) to reduce refraction and staff calibration issues
• Motorization and Automatic Target Recognition (ATR) in Total Stations reducing observer errors
• Possible use of laser scanning or terrestrial photogrammetry to determine VLBI antenna deformation