Options for Modernising the Geocentric Datum of Australia

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Outline

• Drivers for datum modernisation
• Tools and technical progress
• The Plan for datum modernisation
• The finer detail:
  – Technical options still to be decided
Drivers for Datum modernisation (1)...

*current datum is not good enough*

Drivers for Datum modernisation (2)...

*deformation demands datum maintenance*
Drivers for Datum modernisation (3)
demand for high quality spatial data is insatiable

Real-time precise positioning has becomes easy(er)
... the datum must respond to changes in technology

The Aim

Geocentric Datum of Australia 1994
‘GDA94’
ITRF92(1994.0)

Australian Terrestrial Reference Frame
‘ATRF’
ITRF2013(current)
Dynamic!
**APREF (Asia-Pacific Reference Frame)**

**Regional Densification of ITRF**
(as well as a real-time positioning infrastructure)

A combination of National & State & Territory & Private CORS networks


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**National GNSS Archive**

6hr+ GNSS observations at key stations

- Pigeon House
- Narrawa
- Kosciuszko
- Stromlo

>800 stn
- <2013
- 2013/2014
Jurisdictional (State and Territory) Adjustment

Total:
>100,000 station
>500,000 measurements

New Software and Hardware

**DynaNet**
‘Phased Adjustment’
• No limit on stations
• No limit on measurements
• Rigorous Adjustment
→ Coordinates + Uncertainty

**eGeodesy**
• XML based on GML
• Transfer of data and results

**National Computing Infrastructure (NCI)**
400,000 stations
+ 2,500,000 measurements
25 hours to adjust
The Plan for a Modernised Australian Datum

Australian Terrestrial Reference Frame (ATRF)
- Fully rigorous single adjustment
- 3D
- Coordinates AND Uncertainties
- Seam-less across Australia
- All stations
- All measurements ("to the street corner")
- Immediately include new measurements
- Therefore, responsive to new technologies

The Finer Details: Options to Consider

1. Adopt a modern, homogenous, national adjustment
2. Update from ITRF92 to latest ITRF
3. Choice of Static / Semi-Dynamic / Dynamic Datum
4. Choice of Reference Epoch (Past, Present, or Future)
5. Choice of Deformation Model
6. Frequency of National Adjustment
1) Modern, simultaneous, national adjustment

2) Update from ITRF92 to latest ITRF

ITRF92 to ITRF2013
4 cm horizontal change
9 cm vertical change
ITRF is now stable at cm-level
3) Static vs. Semi-Dynamic vs. Dynamic

Time

Position

Reference Epoch
e.g. ‘1994.0’

The ideal world!

Reality… Complex deformation

Simple

Semi-dynamic [NZGD2000]

Semi-dynamic [ETRF89]

Static Datum [GDA94]
4) Choice of Reference Epoch

- ~70 mm/yr
- ~1.3 m since 1994.0

1994.0 ?
2015.0 ?
2020.0 ?

5) Deformation Modelling

Simple: Tectonic Plate motion
  • Horizontal only

Complex: Grids/patches, variable-resolution
  • Horizontal and Vertical
  • Velocities
  • Displacements (Jumps)
  • Uncertainties

Requires TIME metadata
6) Frequency of national adjustment

<table>
<thead>
<tr>
<th>Time</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defined</td>
<td>GDA94</td>
<td>ATRF</td>
<td></td>
</tr>
</tbody>
</table>

Interim ‘GDA2020’
Semi-dynamic
Epoch: 2020.0
+ Deformation

Dynamic
Epoch: Current
+ Deformation

Re-adjust Annually

Re-adjust Daily?
Weekly?
As required?

Options for Modernised Datum

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<thead>
<tr>
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<tbody>
<tr>
<td>Do nothing: retain static GDA94</td>
<td>New national adjustment + deformation model</td>
<td>New national adjustment + deformation model + New ITRF</td>
<td>New national adjustment + deformation model + New ITRF + new modern ref. epoch</td>
<td>New national adjustment + deformation model + New ITRF + new future ref. epoch</td>
<td>New national adjustment + deformation model + New ITRF + dynamic datum current epoch</td>
<td>Multiple datums</td>
<td></td>
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</table>
### Options for Modernised Datum

<table>
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<tr>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
</tr>
<tr>
<td>Alignment with existing 1994.0 epoch</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
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28/05/15
## Options for Modernised Datum

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<tr>
<th>Option</th>
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<th>Alignment with existing 1994.0 epoch</th>
<th>New data acquired in WGS84 / ITRF are compatible without further data manipulation</th>
<th>Data manipulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do nothing: retain static GDA94</td>
<td>×</td>
<td>✓</td>
<td>×</td>
<td>✓ + 1.5m offset</td>
</tr>
<tr>
<td>2</td>
<td>New national adjustment + deformation model + New ITRF + New modern ref. epoch</td>
<td>✓</td>
<td>✓</td>
<td>×</td>
<td>✓ + 1.5m offset</td>
</tr>
<tr>
<td>3</td>
<td>New national adjustment + deformation model + New ITRF + New modern ref. epoch</td>
<td>✓</td>
<td>✓</td>
<td>×</td>
<td>✓ + 1.5m offset</td>
</tr>
<tr>
<td>4</td>
<td>New national adjustment + deformation model + New ITRF + New modern ref. epoch</td>
<td>✓</td>
<td>✓</td>
<td>×</td>
<td>✓ + 1.5m offset</td>
</tr>
<tr>
<td>5</td>
<td>New national adjustment + deformation model + New ITRF + New future ref. epoch</td>
<td>✓</td>
<td>✓</td>
<td>×</td>
<td>✓ + 1.5m offset</td>
</tr>
<tr>
<td>6</td>
<td>New national adjustment + deformation model + New ITRF + New future ref. epoch</td>
<td>✓</td>
<td>✓</td>
<td>×</td>
<td>✓ + 1.5m offset</td>
</tr>
<tr>
<td>7</td>
<td>New ITRF(2015) DYNAMIC</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
<td>✓ + 1.5m offset</td>
</tr>
<tr>
<td>8</td>
<td>New ITRF(2020) DYNAMIC</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
<td>✓ + 1.5m offset</td>
</tr>
<tr>
<td>9</td>
<td>New ITRF(2020) DYNAMIC</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
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### Notes:
- Distortions in GDA94 corrected
- Alignment with existing 1994.0 epoch
- New data acquired in WGS84 / ITRF are compatible without further data manipulation
- Data manipulation: ✓ indicates no bias; × indicates bias
- Bias at metre-level & 9 cm ITRF(2013) vertical bias
- Bias currently greater than metre-level
- Bias increases (~7mm/a from 2015)
- Bias increases (~7mm/a from 2020)
- Bias increases (~1.8m offset from 2020)
- Bias increases (~1.5m offset from 2020)
- Bias increases (~1.5m offset from 2020)
- No bias for new data
- Multiple datums

### Additional Information:
- Option 6: Dynamic
- Option 7: Semi-dynamic at epoch 1994.0
- Option 8: Semi-dynamic at epoch 2020.0
- Option 9: Semi-dynamic at epoch 2020.0
- Option 10: Semi-dynamic at epoch 2020.0

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## Options for Modernised Datum

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### Notes:
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## Additional Information:
- Option 6: Dynamic
- Option 7: Semi-dynamic at epoch 1994.0
- Option 8: Semi-dynamic at epoch 2020.0
- Option 9: Semi-dynamic at epoch 2020.0
- Option 10: Semi-dynamic at epoch 2020.0

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## Conclusion:

The table above outlines various options for modernising a datum, each with its own set of advantages and implications.的选择应基于特定项目的需求和目标。考虑数据的准确性和兼容性，以及对现有数据处理的必要性。
Options for Modernised Datum

<table>
<thead>
<tr>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
<th>Option 4</th>
<th>Option 5</th>
<th>Option 6</th>
<th>Option 7</th>
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**Description**
- Do nothing: retain static GDA94
- New national adjustment + deformation model
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- New national adjustment + deformation model
- New national adjustment + deformation model

**Distortions in GDA94 corrected**
- Option 1: ✓
- Option 2: ✓
- Option 3: ✓
- Option 4: ✓
- Option 5: ✓
- Option 6: ✓
- Option 7: ✓

**Alignment with existing 1994.0 epoch**
- ✓
- ✓
- ✓
- ✓
- ✓
- ✓
- ✓

**New data are compatible without deformation model**
- ✓
- ✓
- ✓
- ✓
- ✓
- ✓
- ✓

**(Plate motion)**
- ✓
- ✓
- ✓
- ✓
- ✓
- ✓
- ✓

**(Plate Rotation)**
- ✓
- ✓
- ✓
- ✓
- ✓
- ✓
- ✓

**Datum accuracy with deformation model**
- cm-level sub cm-level mm-level to cm-level mm-level mm-level mm-level mm-level

Conclusions

- Development of ATRF is currently under-way:
  - National, homogenous, simultaneous adjustment
  - Research into accurate deformation modelling
- Best outcome:
  - Dynamic datum to cater for highest-accuracy users
  - Semi-dynamic datum to cater for other users
- Risks / Cautions:
  - Software tools need to be developed to cater for deformation
  - Data from different epochs needs to be carefully combined
  - Metadata management needs to improve!