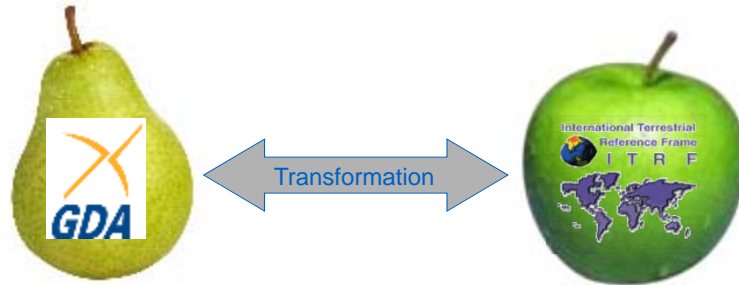


Coordinate transformations between GDA94 and the ITRF

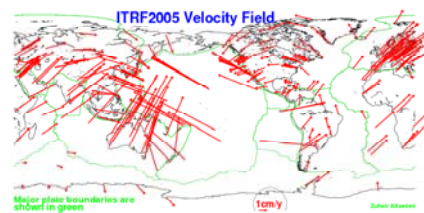


John Dawson – Geoscience Australia
Alex Woods – Office of Surveyor-General Victoria

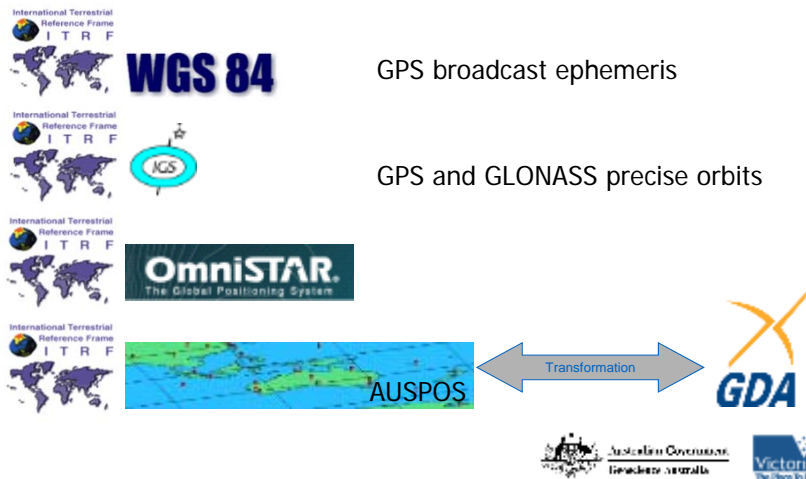


Diverging Reference Frames

- ITRF is a dynamic reference frame
- GDA94 is a static coordinate datum (ITRF1992 @ 1994.00)
- Two reference frames diverged due to:
 - Ongoing refinement of the ITRF
 - Tectonic motion of the Australian plate (~70mm / yr in NNE)
 - Crustal deformation
- Absolute difference is now approximately 1 m!
- Many Australian users work across the two reference frames



ITRF Standard



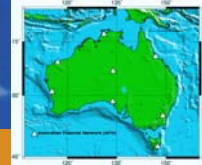
14 Parameter Transformation

- Standard seven parameter transformation model + first time derivatives (rates) for each parameter

$$\begin{pmatrix} X_{GDA94} \\ Y_{GDA94} \\ Z_{GDA94} \end{pmatrix} = \begin{pmatrix} t_x + \dot{t}_x(t - t_0) \\ t_y + \dot{t}_y(t - t_0) \\ t_z + \dot{t}_z(t - t_0) \end{pmatrix} + (1 + s_c + \dot{s}_c(t - t_0)) \begin{pmatrix} 1 & r_x + \dot{r}_x(t - t_0) & -r_y - \dot{r}_y(t - t_0) \\ -r_x - \dot{r}_x(t - t_0) & 1 & r_x + \dot{r}_x(t - t_0) \\ r_y + \dot{r}_y(t - t_0) & -r_x - \dot{r}_x(t - t_0) & 1 \end{pmatrix} \begin{pmatrix} X_{ITRF} \\ Y_{ITRF} \\ Z_{ITRF} \end{pmatrix}$$

- three translations, t_x, t_y, t_z (+ $\dot{t}_x, \dot{t}_y, \dot{t}_z$)
- three rotations, r_x, r_y, r_z (+ $\dot{r}_x, \dot{r}_y, \dot{r}_z$)
- one scale factor, s_c (+ \dot{s}_c)
- Transformation software available at:
<http://www.icsm.gov.au/icsm/gda/gdatm/index.html>

Input data and Derivation



- New transformation parameters (and associated uncertainty) between GDA94 and ITRF:
 - ITRF1996, ITRF1997, ITRF2000 ITRF2005 and ITRF2008 (when released)
- First available release for ITRF2005 and ITRF2008
- Input data:
- ITRF solutions obtained from the ITRF product centre of the IERS
 - station coordinates and velocities
 - corresponding full VCV matrix.
- GDA94 coordinate values obtained from the gazetted positions of the AFN
- GDA94 VCV matrix created with only block diagonal terms,
 - horizontal and vertical coordinate precision of 0.03 m and 0.05 m (at a 95% confidence level)
- CATREF software (Combination and Analysis of Terrestrial Reference Frames)



Parameters and Uncertainties (σ)

	tx, tx	ty, ty	tz, tz	sc, sc	rx, rx	ry, ry	rz, rz
From ITRF2005 to GDA94							
Para	-139.3	-15.7	98.0	5.79	1.039	4.214	3.504
±	134.2	79.6	104.0	11.66	1.713	4.247	4.121
Rates	0.6	-1.6	-0.6	0.09	1.454	1.172	1.221
±	1.0	0.7	1.2	0.07	0.030	0.035	0.026
From ITRF2000 to GDA94							
Para	-190.3	-20.9	137.7	7.36	1.807	5.931	4.799
±	137.0	80.4	109.5	11.71	1.922	4.396	4.149
Rates	7.6	-0.4	-5.1	0.06	1.325	0.962	1.039
±	5.2	2.4	6.5	0.22	0.166	0.212	0.099
From ITRF1997 to GDA94							
Para	-165.8	-14.5	142.3	6.61	1.947	5.227	3.889
±	138.6	81.3	112.8	11.71	2.058	4.485	4.165
Rates	-5.2	-2.0	4.9	-0.07	1.460	1.330	1.352
±	8.1	3.9	10.9	0.29	0.282	0.350	0.133
From ITRF1996 to GDA94							
Para	-121.0	-25.5	92.4	7.08	0.785	3.551	3.185
±	147.4	85.3	134.4	11.80	2.834	5.033	4.232
Rates	-11.7	-0.3	10.9	0.29	1.689	1.689	1.689
±	22.0	11.3	31.3	0.66	0.030	0.035	0.026

Parameters and Uncertainties (σ)

Translations – mm, mm/yr Scale – ppb, ppb/yr Rotations – mas, mas/yr $t_0 = 1994.00$

	tx, tx	ty, ty	tz, tz	sc, sc	rx, rx	ry, ry	rz, rz
E.g. From ITRF2005@1994 to GDA94							
Para	-139.3	-15.7	98.0	5.79	1.039	4.214	3.504
±	134.2	79.6	104.0	11.66	1.713	4.247	4.121
Rates	0.6	-1.6	-0.6	0.09	1.454	1.172	1.221
±	1.0	0.7	1.2	0.07	0.030	0.035	0.026

$$\begin{pmatrix} X_{GDA94} \\ Y_{GDA94} \\ Z_{GDA94} \end{pmatrix} = \begin{pmatrix} t_x + t_x(t-t_0) \\ t_y + t_y(t-t_0) \\ t_z + t_z(t-t_0) \end{pmatrix} + (1 + s_c + s_c(t-t_0)) \begin{pmatrix} 1 & r_x + r_x(t-t_0) & -r_y - r_y(t-t_0) \\ -r_y - r_y(t-t_0) & 1 & r_x + r_x(t-t_0) \\ r_x + r_x(t-t_0) & -r_x - r_x(t-t_0) & 1 \end{pmatrix} \begin{pmatrix} X_{ITRF} \\ Y_{ITRF} \\ Z_{ITRF} \end{pmatrix}$$

ITRF2005 RMS Error
~ 10 mm (horiz)
~ 25 mm (vert)



Summary

- Static GDA94 and the dynamic ITRF have diverged
- 14 parameter transformation between reference frames
- Official parameters to be released in a Journal of Applied Geodesy paper
- Parameters to be published on GA web site – www.ga.gov.au
- Thank you

