

# Reference Frames in Practice Manual

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## Background

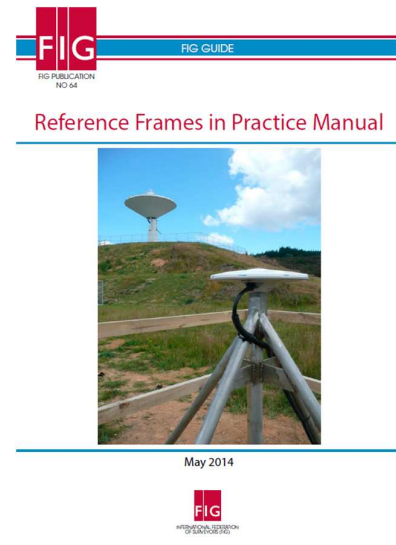
### Seminars on Reference Frames in Practice

- 2012 FIG working week Rome [20],
- 2013 SE Asian Survey Congress Manila [40],
- 2013 FIG/UN-GGIM-AP Pacific Smalls Developing States Symposium Fiji [20].
- Manual addresses technical issues surrounding reference frames
- Provides a brief introduction to the use of Reference Frames in Practice.
- This presentation gives an overview of the Manual

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Surveyors Congress, Kuala  
Lumpur, Malaysia, 16 – 21 June



## 1. Introduction

Graeme Blick, Land Information New Zealand, New Zealand  
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- Addresses technical issues surrounding reference frames
- It is arranged as a series of short fact sheets
- Provide a brief introduction to the use of Reference Frames in Practice.
- It is intended for surveyors.
- It contains a number of technical terms and lists references where additional information may be found.



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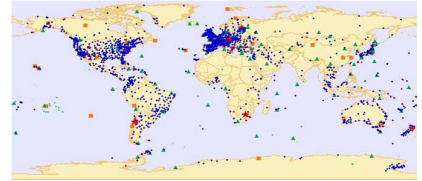


## 2. Geodesy and Global Reference Frames

Chris Rizos, University of New South Wales, Australia

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- This section gives an overview of the science of geodesy and use of global reference frames.
  - Surveyors increasingly use satellite positioning systems that provide position in terms of global reference frames.
  - Important for surveyors to understand these reference frames and how they relate to local reference frames.



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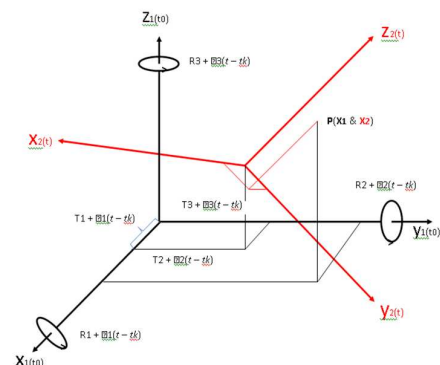


## 3. Global Terrestrial Reference Systems and Frames

Neil D. Weston and Tomás Soler, National Geodetic Survey, NOAA, USA

[neil.d.weston@noaa.gov](mailto:neil.d.weston@noaa.gov)

- This section provides knowledge of global terrestrial reference systems and frames and transformations between them.
  - It is often necessary to transform between different global reference frames.



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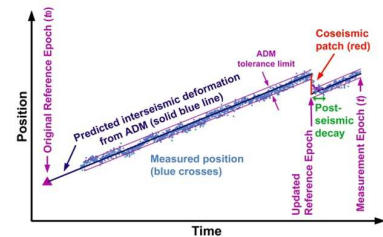


# 4. Regional and National Reference Frames

Richard Stanaway, Australia

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- This section provides information for the surveyor on the different types of reference frames and datums and how crustal deformation can be accommodated in them.
  - Surveyors often make measurements in terms of regional or national reference frames.
  - We need to be concerned with accommodating the effects of crustal deformation in our datums.



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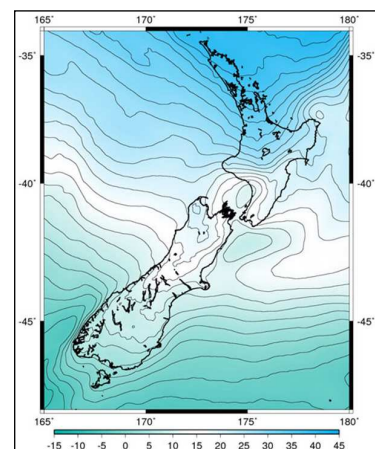


# 5. Height Systems

Daniel R. Roman, National Geodetic Survey, NOAA, USA

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- This section describes the various height systems and how heights can be transformed between these systems.
  - Traditionally the surveyor is interested in determining heights in terms of sea level.
  - Satellite positioning systems determine heights relative to the ellipsoid



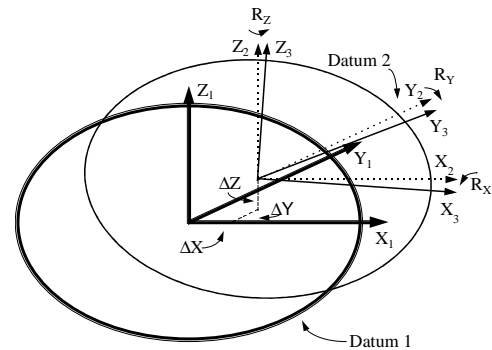
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# 6. Transforming Between Datums

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- This section provides information on the commonly used transformation methods and some of the more specific cases
  - The surveyor is often required to transform data between different datums.



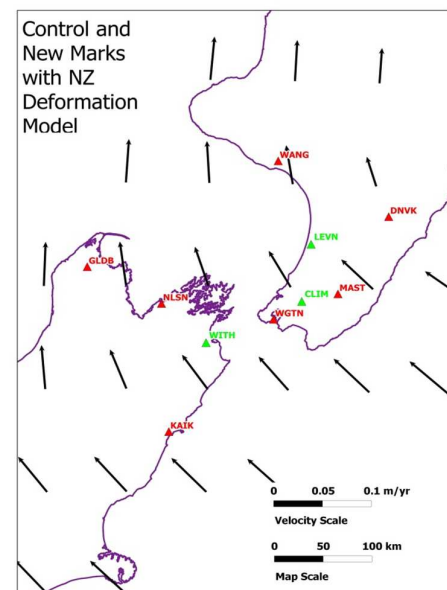
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# 7. Transforming Between Datums in Non-static Reference Frames

Nic Donnelly, Land Information New Zealand  
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- This section details the specific case for transforming between these non static reference frames.
  - Surveyors are increasingly working in non-static reference frames, reference frames that account for the effects of crustal movements.



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## 8. Reference Frame Parameter Estimation and Testing via the technique of Least Squares

Roger Fraser, Geodetic Survey, Victoria, Australia

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- This section focuses on the propagation of an international or regional reference frame onto national or local stations.
  - When making a set of measurements the surveyor will often be required to test the accuracy of those measurements and identify any outliers or errors.
  - This is most commonly carried out using the method of Least Squares.

$$\hat{\mathbf{x}} = (\mathbf{A}^T \mathbf{V}_m^{-1} \mathbf{A})^{-1} \mathbf{A}^T \mathbf{V}_m^{-1} \mathbf{m}$$
$$\mathbf{V}_{\hat{\mathbf{x}}} = (\mathbf{A}^T \mathbf{V}_m^{-1} \mathbf{A})^{-1}$$



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## 9. Testing Measurements and Least Squares Parameter Estimates

Roger Fraser, Geodetic Survey, Victoria, Australia

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- The section on Reference Frame Parameter Estimation and Testing via the technique of Least Squares gave a general overview of the topic.
- This section briefly reviews some basic concepts and techniques for the testing of geodetic measurements and least squares parameter estimates, and for estimating network reliability.

$$\tau = \frac{\sigma_m}{\sigma_v} = \frac{\sigma_m}{\sqrt{\sigma_m^2 - \sigma_a^2}}$$



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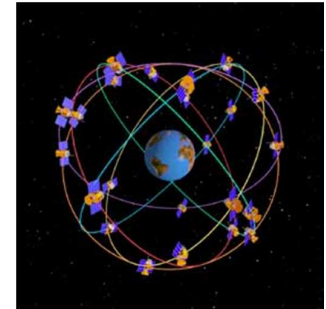


# 10. Global Navigation Satellite Systems

Chris Rizos, University of New South Wales, Australia

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- This section provides an overview of the various systems available and methods of making measurements.
  - Increasingly surveyors are using satellite based positioning systems to make their survey measurements.
  - A number of systems are now fully or partially operational and several regional augmentation systems are being developed.



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# 11. GNSS CORS Networks and Linking to ITRF

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Mikael Lilje, Geodesy Department Lantmäteriet Sweden,

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- This section details how to link information from a CORS to global reference frames.
  - More and more countries are building networks of CORS.
  - These provide services to the surveyor that can increase the efficiency
  - Real time positions may be generated in terms of local or global reference frames if required.



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# 12. The International GNSS Service (IGS)

Nic Donnelly, Land Information New Zealand, New Zealand  
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- This section details the structure of the IGS and services provided by them.
  - Many of the commercially available GNSS software packages have options which enable the surveyor to download and utilize the IGS data and products in their processing.
  - This enables the generation of precise coordinates aligned to the latest version of ITRF



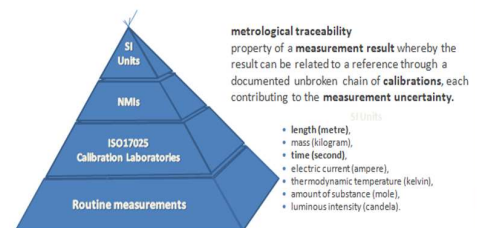
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# 13. Standards and Traceability of Terrestrial Reference Frames

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- Surveyors as professionals must fulfill certain legal, regulatory and/or accuracy requirements for their clients.
- Using internationally recognized standards such as the ISO series and ensuring traceability in measurement are two internationally and widely accepted ways of doing this.



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**FIG** Working  
Week

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