GNSS Education at the University of Melbourne

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Outline of Presentation

- Introduction
- What we teach
- How we teach
- When we are not teaching…
- Questions

Danger! Danger!

- This is not a normal presentation
- You will be asked to ACTIVELY participate!
- It’s an important part of how we teach

Instructional Objectives

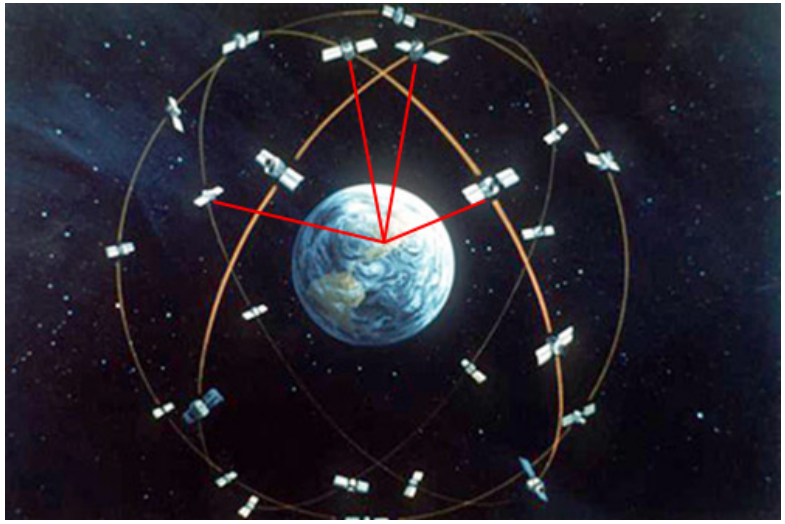
- By the end of this presentation you will be able to:

- Describe the GNSS course at Melbourne University

- List the advantages of Active Learning

- Explain how GNSS signals work using a drinking straw

What we teach



GNSS Education

- GNSS is an important part of a larger Geomatics degree
- Subjects with GNSS include

- Mapping Environments

- First look at GNSS
- Segments (Space, Control, User)
- Applications

- Satellite Positioning and Geodesy (SPAG)

- Theory of satellite positioning

- Reference frames, datums, projections
- Orbits, signals, errors, observation equations
- Processing strategies (SPP, DD, NRTK)
- GNSS heighting (geoid modelling)

Course Structure

Background (Chapters 1-2)

•Geodesy, Coordinates, Systems, Geodetic Datums

The Global Positioning System (Chapters 3-8)

•Chapter 3 – System Structure

-Space, Control and User segments

•Chapter 4 – Code based positioning

- Absolute and relative positioning

•Chapter 5 – GPS error sources

- Satellite, receiver and transmission errors

•Chapter 6 – GPS orbit description

- Keplerian orbits, broadcast ephemeris (currently not taught)

•Chapter 7 – Carrier phase positioning

- Carrier phase observable, measurement differencing

•Chapter 8 – Practical issues in GPS surveying

- Ambiguity resolution, cycle slips, data processing options

Heights from GPS (Chapter 9)

•Geoid Modelling

The Future of Satellite Positioning (Chapter 10)

•GNSS developments

Activity 1 - Reinforcement

- It's your turn…
- Look at our course structure again…
- Write down (or type in your laptop)

- 1 similarity with a course you attended/taught
- 1 difference with a course you have attended/taught

SPAG – Practical Learning

- Single Point Position Computation
  - Theoretical knowledge
    - Orbits (precise ephemerides)
    - GNSS observation types
    - SPP observation equation

$$p_r^s(t) = \rho_r^s(t, t - \tau_r^s) + c[dt_r(t) - dt^s(t - \tau_r^s)] + e_r^s$$

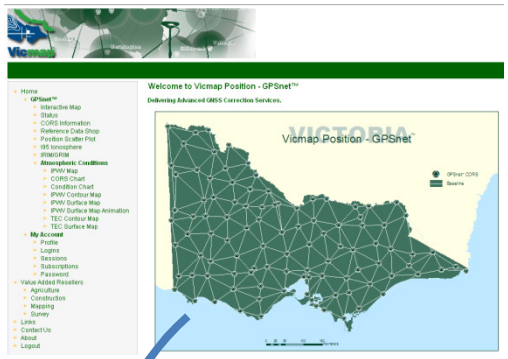
    - Least squares estimation

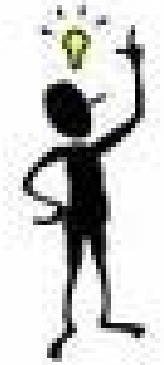
$$\hat{x} = (A^T V_m^{-1} A)^{-1} A^T V_m^{-1} y$$

    - Reference frames and rotation matrices

$$\begin{bmatrix} \delta e \\ \delta n \\ \delta h \end{bmatrix} = \begin{bmatrix} -\sin\lambda & \cos\lambda & 0 \\ -\sin\phi\cos\lambda & -\sin\phi\sin\lambda & \cos\phi \\ \cos\phi\cos\lambda & \cos\phi\sin\lambda & \sin\phi \end{bmatrix} \begin{bmatrix} \delta x \\ \delta y \\ \delta z \end{bmatrix}$$

SPP – Position Computation Process





Ah, But I know why!

(C

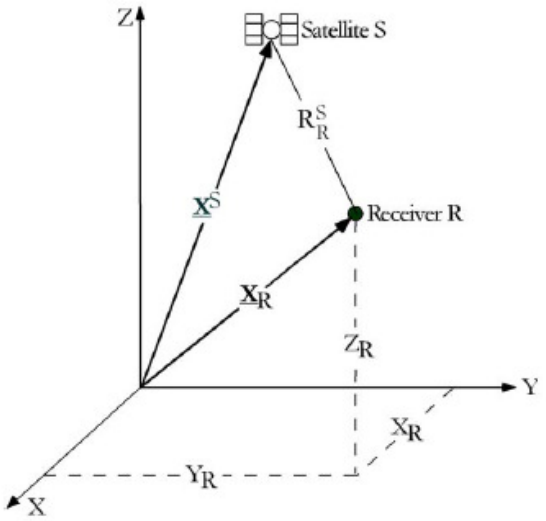
$$\rho = |\mathbf{X}^S - \mathbf{X}_R| - cdT + cdt$$

50-100m

XYZ

My answer is different?!?

mpute Single
oint Position



(Satellite XYZ)

SPAG – Practical Learning

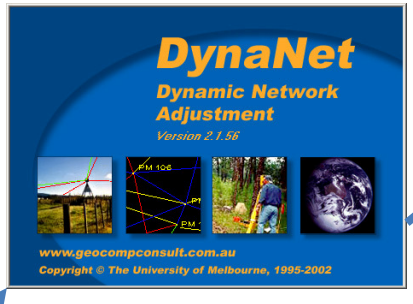
- GNSS Control Network
  - Observe, reduce and adjust a control network
  - Theoretical knowledge
    - GNSS carrier phase positioning

$$\phi_r^s = \rho_r^s + c(dt_r - dt^s) - dI_r^s + dT_r^s + \lambda N_r^s + dM_r^s + \varepsilon_r^s$$

    - GNSS carrier phase processing
    - Network adjustment
    - Network testing

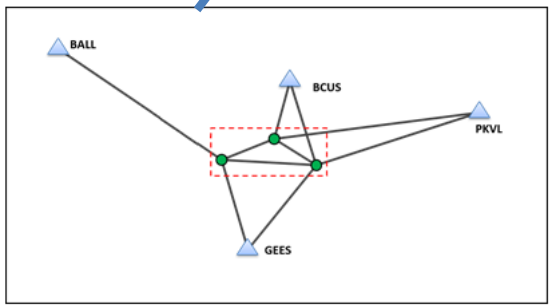
GNSS Control Network

Student Data



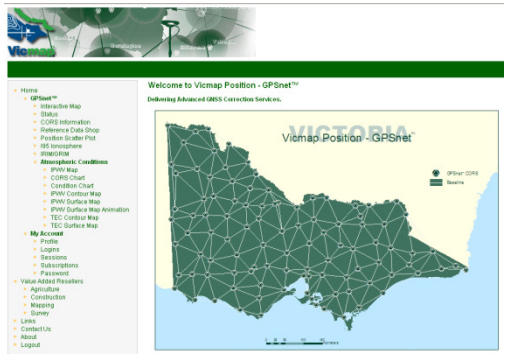
Network Adjustment and Testing

XYZ

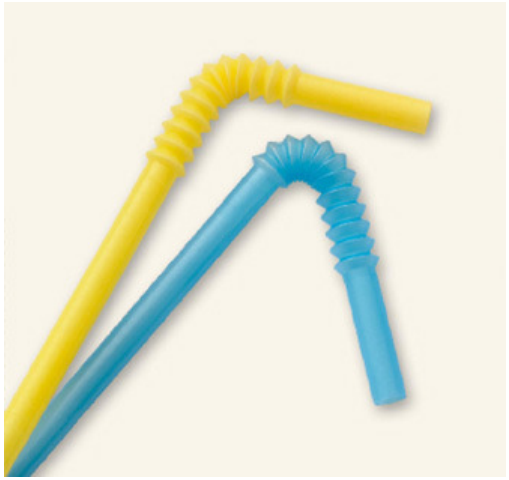


Process Baselines

CORS Data (RINEX)



How we teach



Approach to Teaching

- Organised

- Majority of course material available immediately
- Clearly defined course structure (you've seen it)

- Open and Accountable

- Instructional Objectives

- Clear and measurable objectives for students
- Our expectations of the students

- Marking Guides

- Remove subjectivity in assessment (for us and students)
- Set out our expectations for students

Example Marking Guide

451-337 - Assignment 3	Mark out of	Mark given
Set-up of problem		
Observation equations	1	
Linearisation	4	
Variance matrix	2	
Least squares algorithm	1	
Solution		
Receiver coordinates	10	
Receiver clock offset	2	
Calculated PDOP and GDOP	4	
Coordinate comparison	2	
Discussion of solution	6	
Discussion of PDOP and GDOP values	2	
Satellite locations		
Azimuth of each satellite	3	
Zenith angle of each satellite	3	
Skyplot	3	
Discussion	2	
Quality of report	5	

Approach to Teaching

- Active Learning

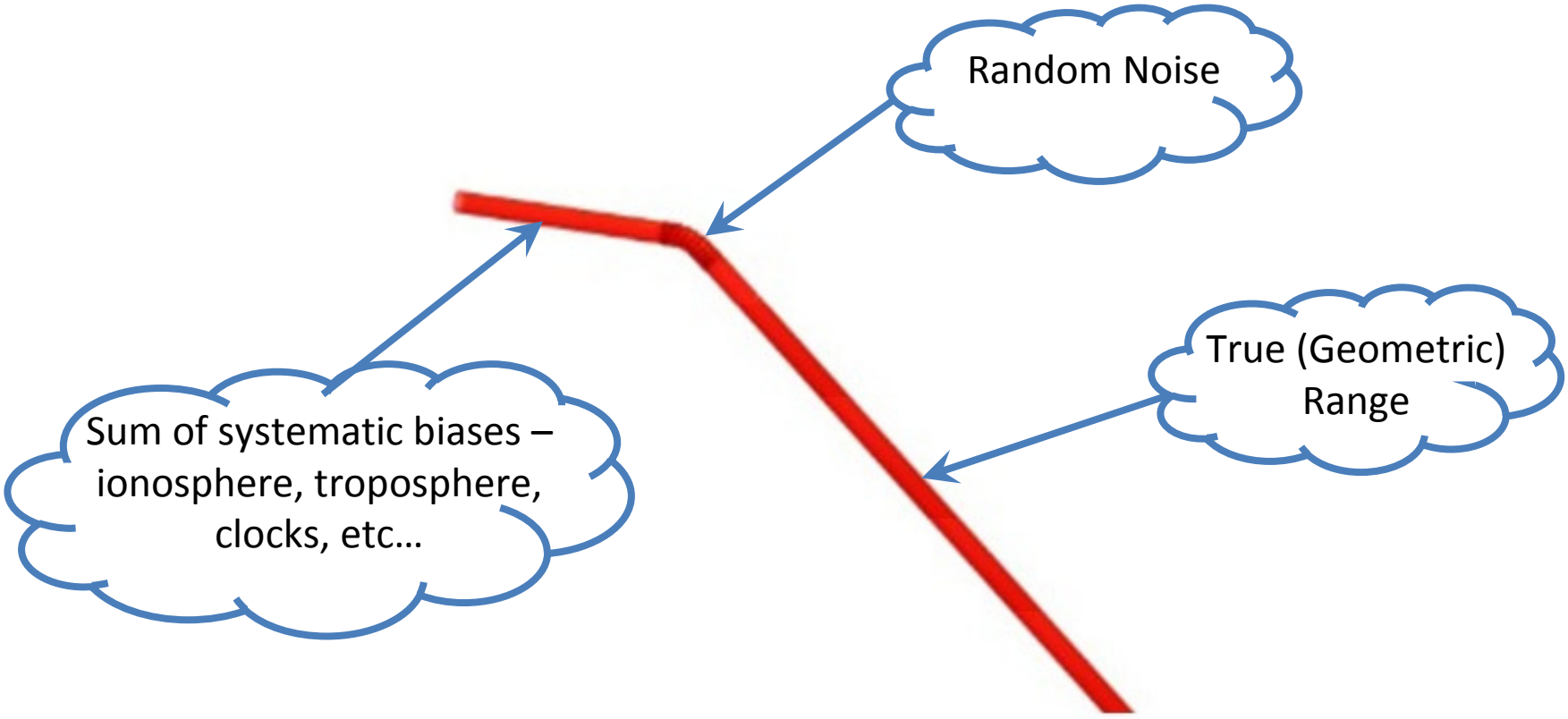
- Small exercises or activities undertaken in a lesson
- Group (2-3 people) or individual based
- Why?
- Involves students in their learning
- Helps to reinforce presented material
- Breaks up the lesson, energizes class

- At varied times (5-20 minute intervals)

- Varied length (1-5 minutes)

Activity 2 – Drinking Straws are Cool!

- Activity – explain how GNSS signal works using a straw

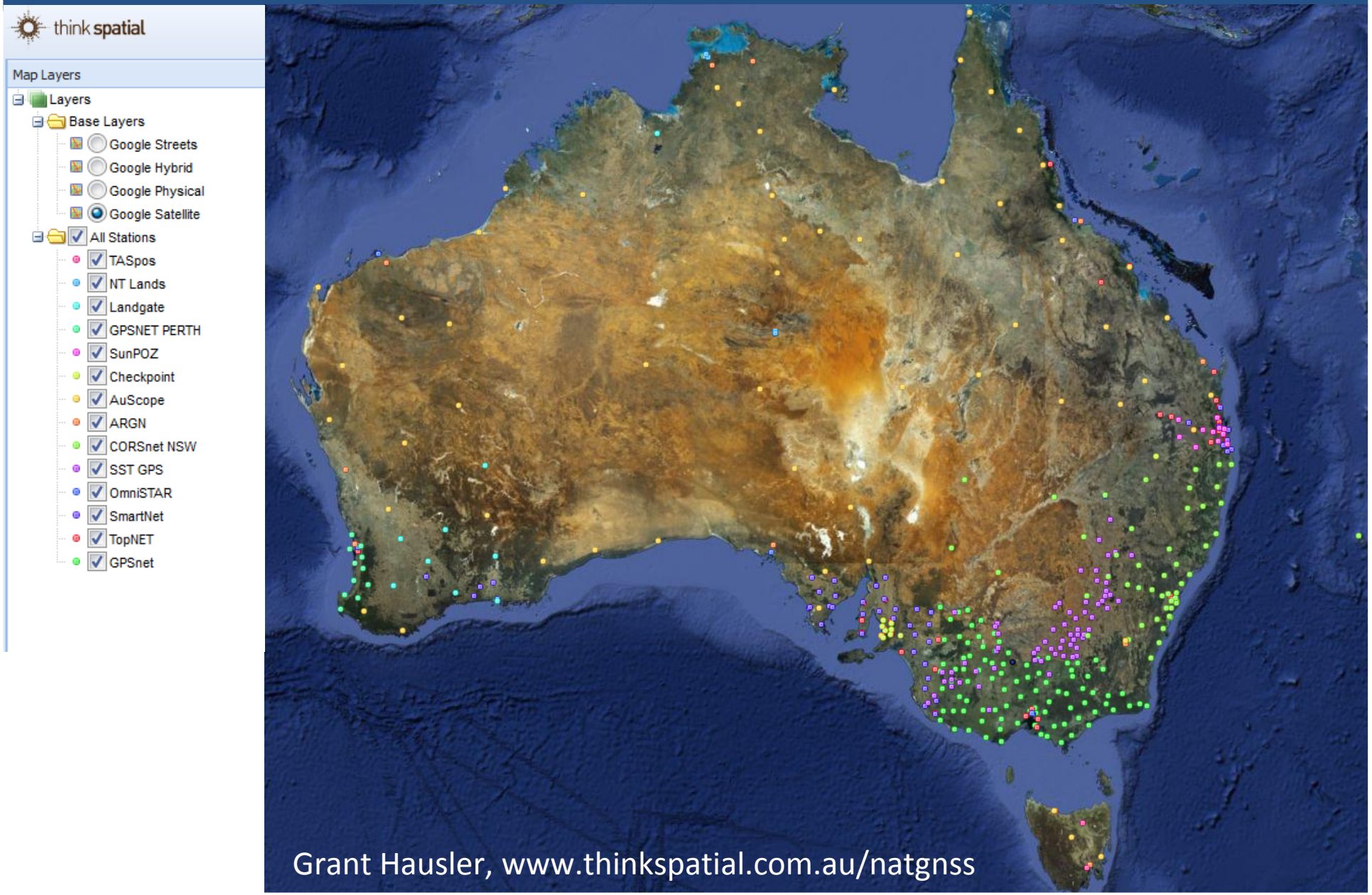


When we are not teaching

Research

- Melbourne University and CRC-SI
- Quality Control for CORS Networks and Mobile Users
  - Real Time Quality Control (RTQC) Software
  - NRTK Evaluation
- Stochastic Modelling
- GNSS Heighting

Research


think spatial
Map Layers
Layers
Base Layers
Google Streets
Google Hybrid
Google Physical
Google Satellite
All Stations
TASpos
NT Lands
Landgate
GPSNET PERTH
SunPOZ
Checkpoint
AuScope
ARGN
CORSnet NSW
SST GPS
OmniSTAR
SmartNet
TopNET
GPSnet
Grant Hausler, www.thinkspatial.com.au/natgnss

ThinkSpatial

- Spatial Information Professionals
  - GNSS Surveying
    - CORS & Survey Networks, Heighting, Engineering
  - Intelligent Mapping
    - Mobile (iOS, Android) & Web
  - Education & Training
    - GNSS, Networks, & Spatial Mathematics
    - 2 – 12 week courses tailored to student needs

Questions

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