

Data inference in Geo-informatics

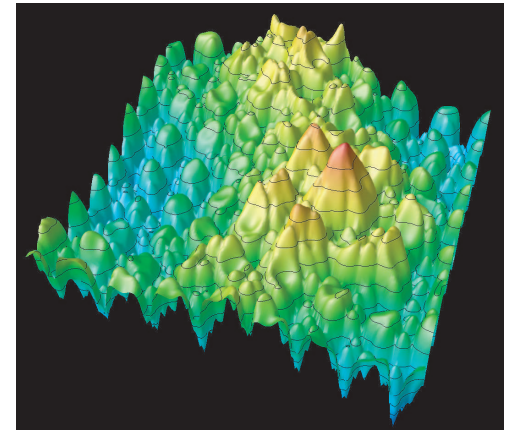
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Centre for Advanced Data Inference
Research School of Earth Sciences
Australian National University

Geoinformatics showcase, Univ. of Sydney 31st October 2005.



"To develop and use state-of-the-art computational methods for analyzing complex datasets and simulating Earth processes - combining forward and inverse modelling techniques"



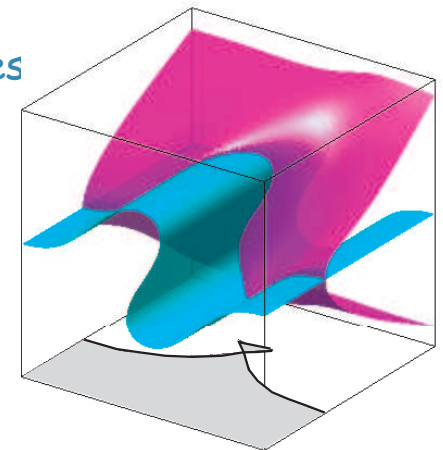
Inverse problems



A Research School of Earth Sciences (ANU) strategic initiative



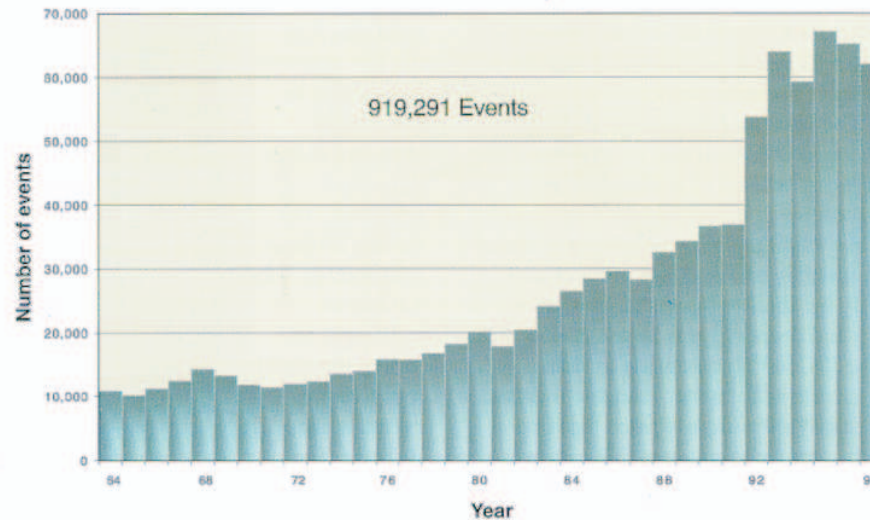
Terrawulf



Computational simulation

Data explosion

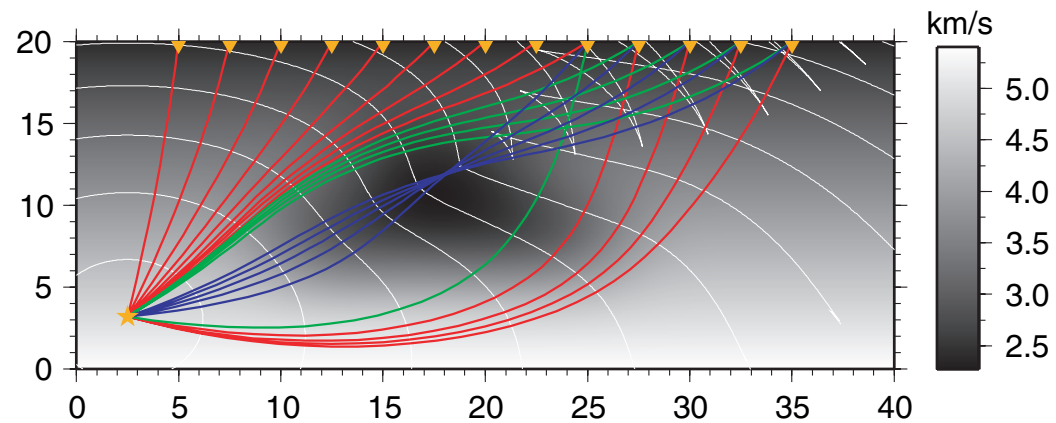
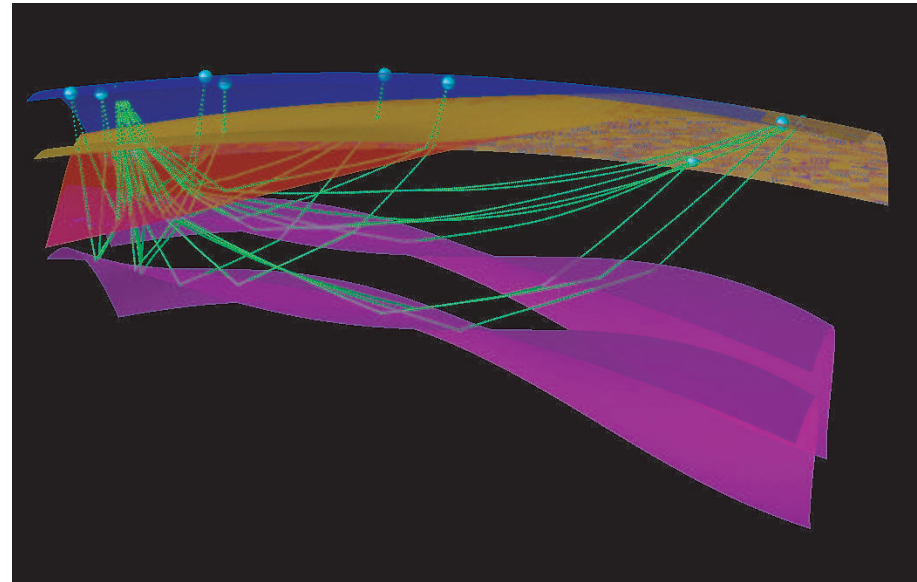
In most areas of the Earth Sciences there has been a rapid increase in the **quality** and **quantity** of data available.



Number of earthquakes recorded by the National Earthquake Information Center (1964-1997)

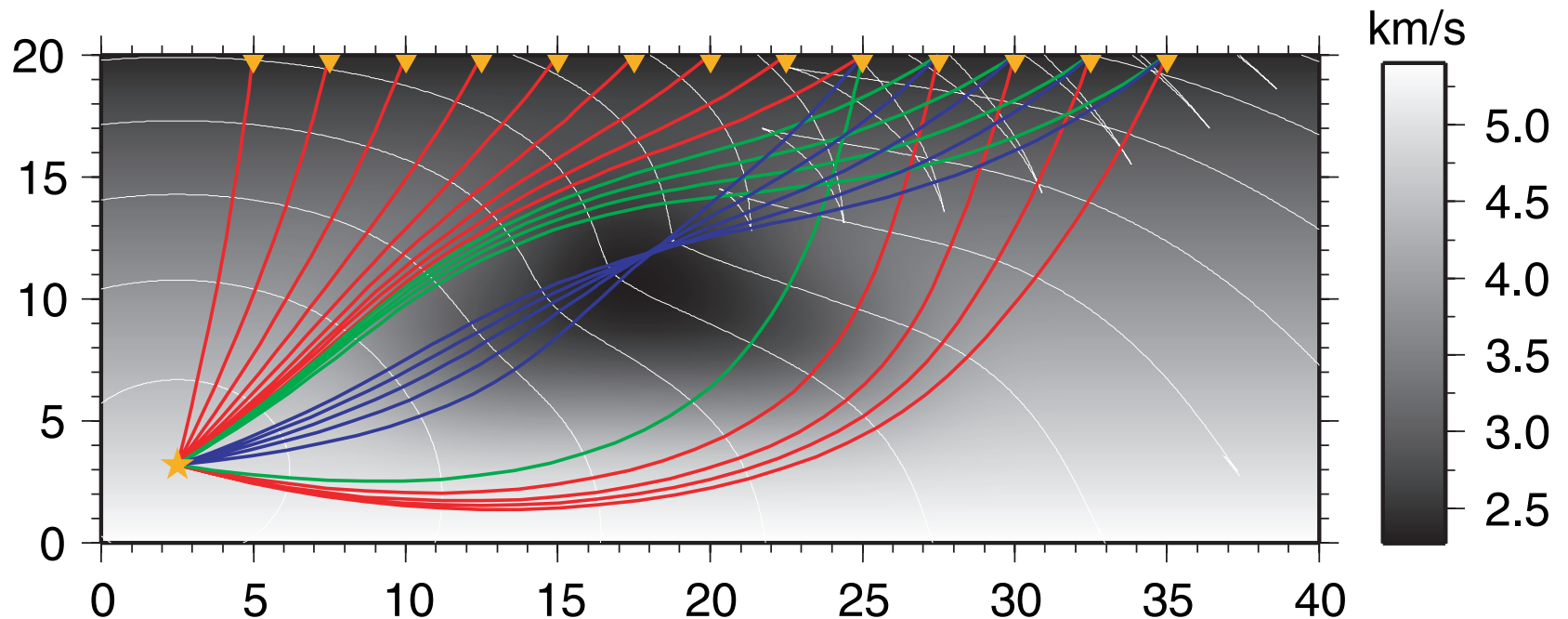
What new **challenges** does this present ?
What new **opportunities** does this present ?

New data = New challenges



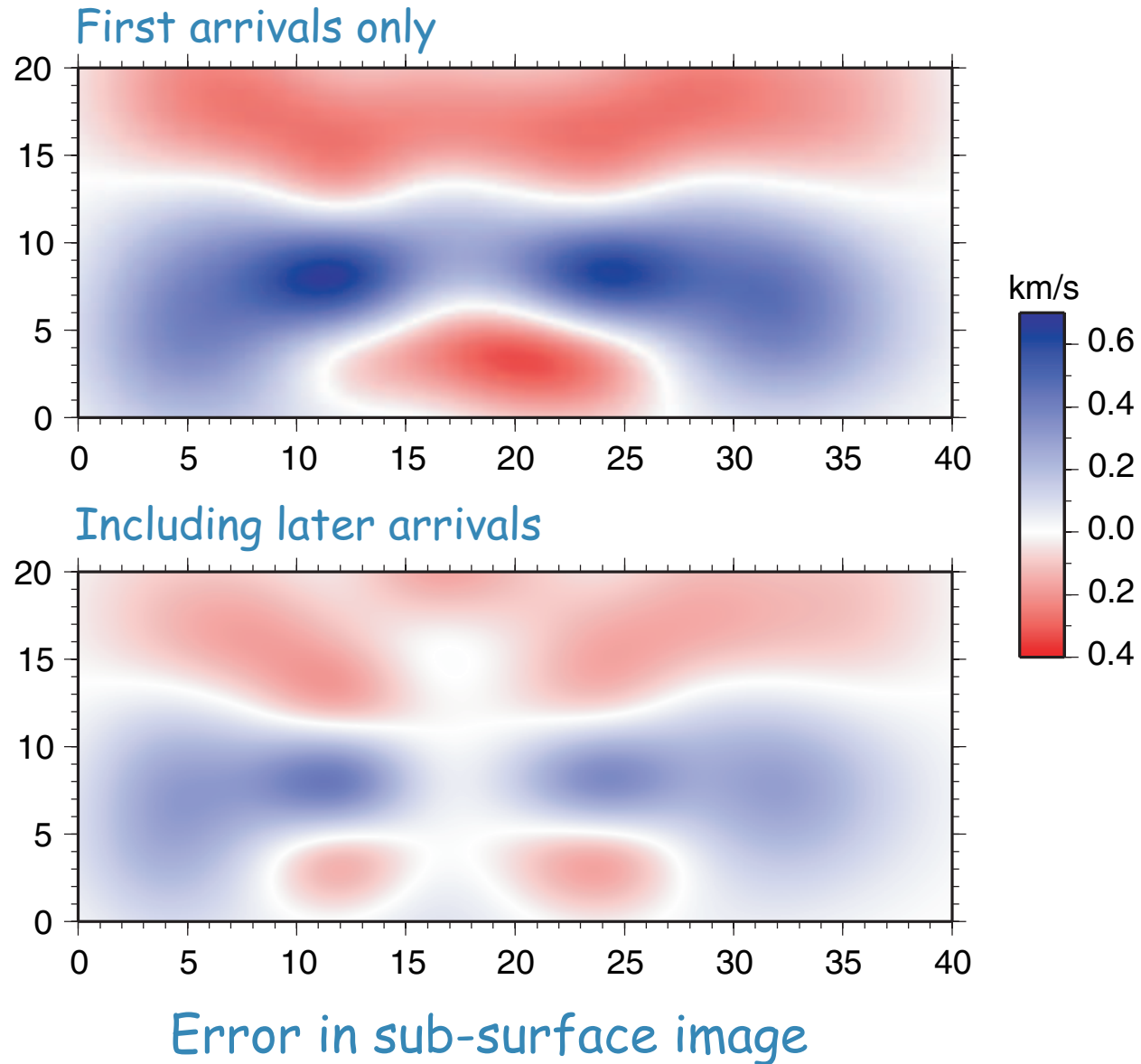
Latter arriving seismic phases can better constrain Earth structure

Tracking multiple seismic wavefronts



If we are to make use of **latter arriving** seismic phases then new ways to compute synthetic travel times are needed !

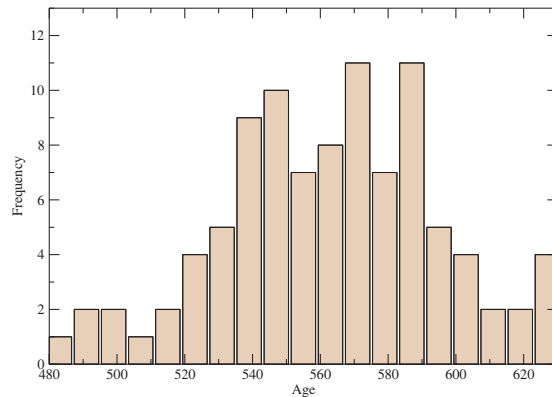
Improvements in sub-surface imaging



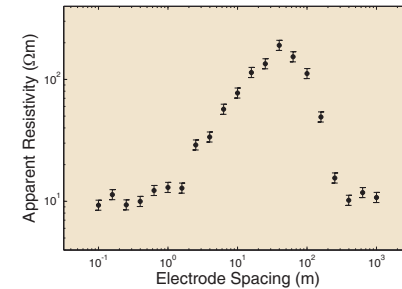
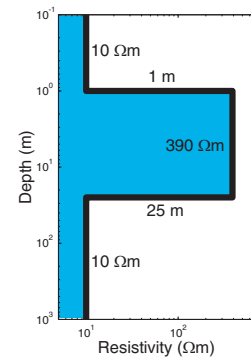
Some new directions

Trans-dimensional inverse problems

How many components ?

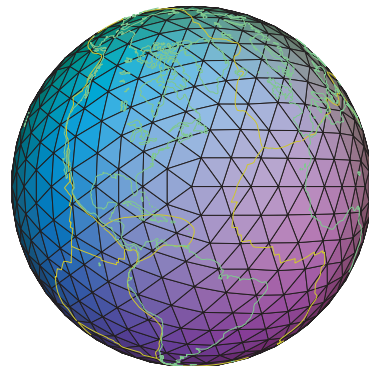


How many layers ?

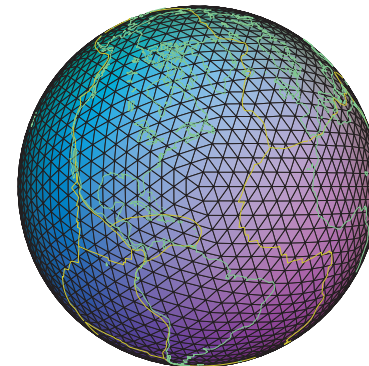


After Malinverno (2002)

When one of the things you don't know is the number of things you don't know.

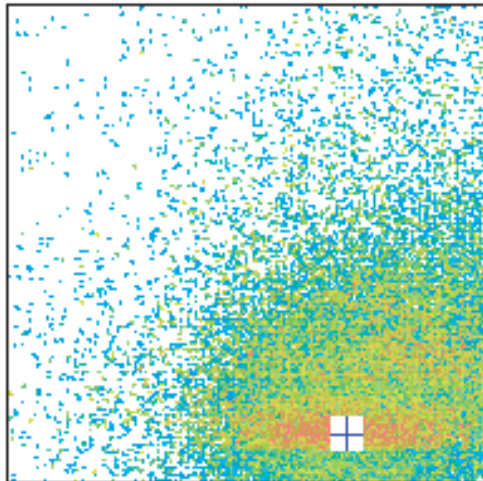


How many cells ?

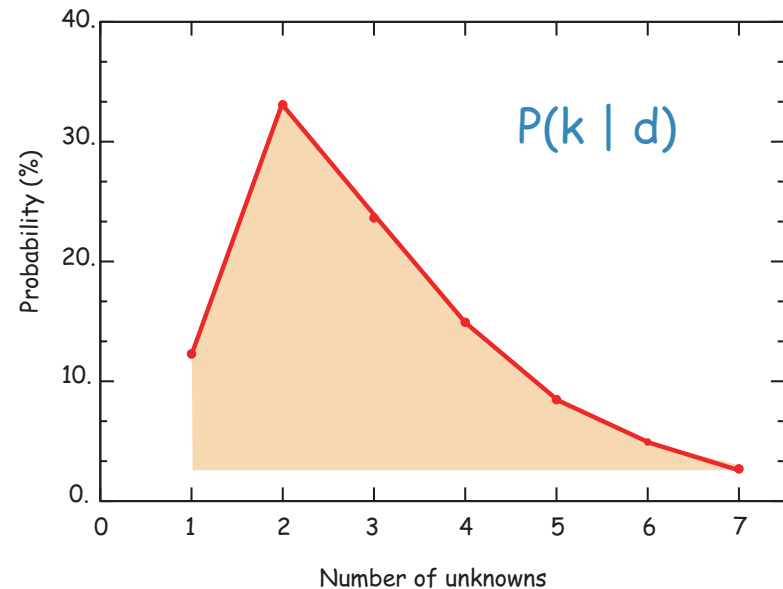


Bayesian sampling

Trans-dimensional Markov chain
Monte Carlo sampling



Probabilistic Constraints on
the number of unknowns



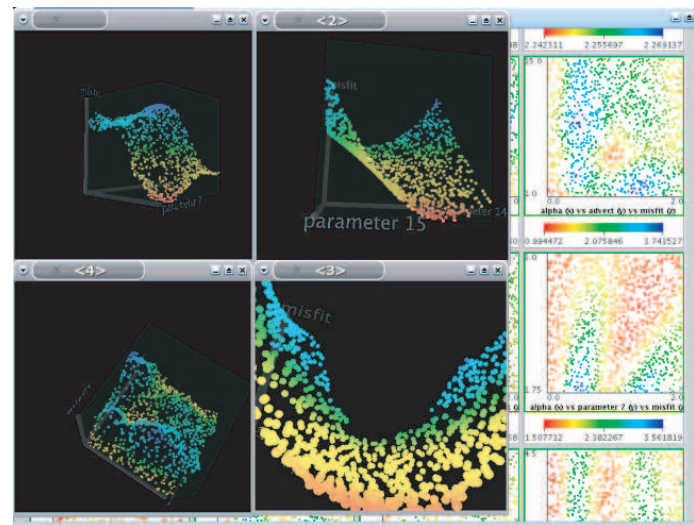
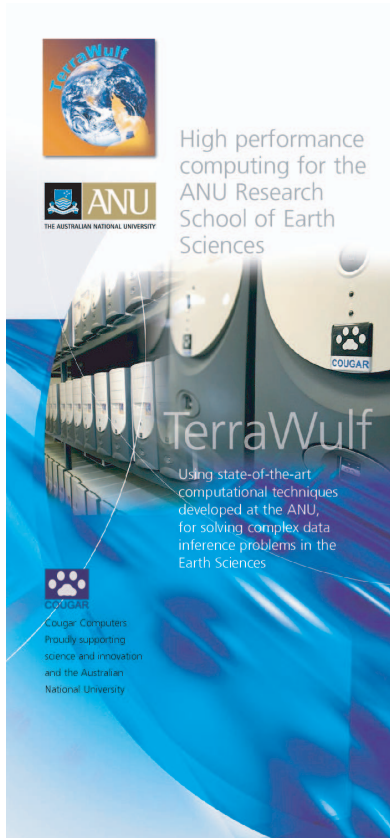
Breakthrough technique 'Reversible jump algorithm'
Green (1995, 2003) (virtually unknown in geosciences)

New methods are an active area of research

Curse of dimensionality -> Advanced computation needed

The future

Generalized tools for complex data inference



The CADI inversion toolkit

- Nonlinear inversion multiple algorithms
- Interactive visualization of sensitivity and trade-offs
- Menu driven interface
- Java based