Monitoring of Local Deformations in North Borneo

Mohamad Asrul Mustafar, Wim J.F. Simons,
Kamaludin Mohd Omar, Boudewijn A.C. Ambrosius

Profile

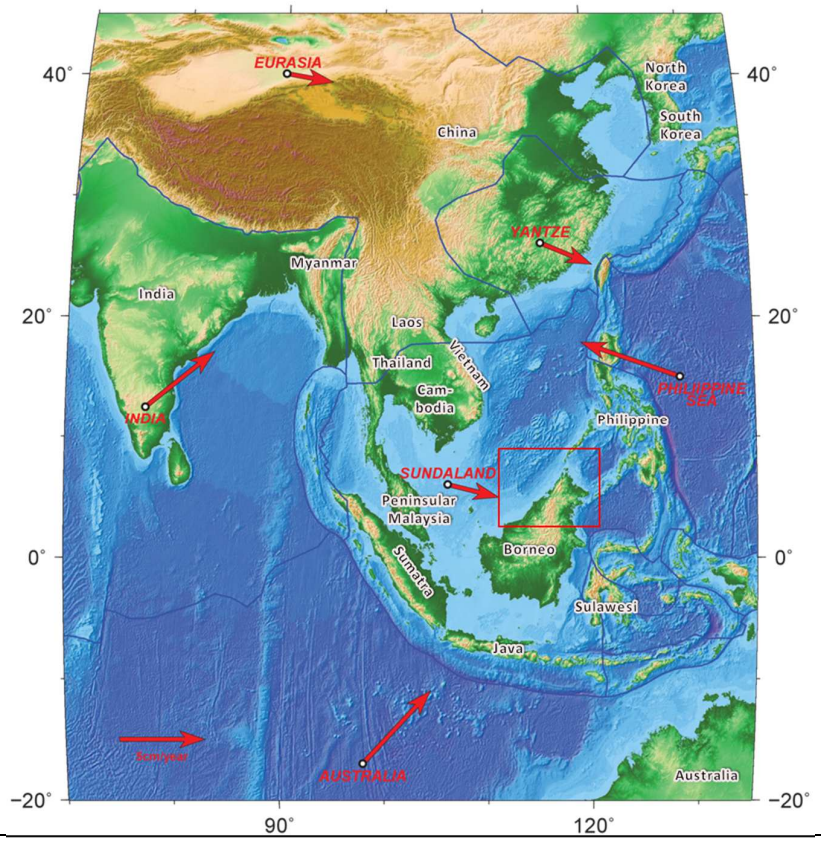
- Service – UiTM Perlis, Malaysia
- Study leave – TU Delft, Netherlands
- Study area - Impacts of crustal deformations in North Borneo

Outline

- Intoduction
- Seismotectonic of North Borneo
- Data & Processing
- North Borneo Motion
- Vertical Motion
- Conclusion

Introduction

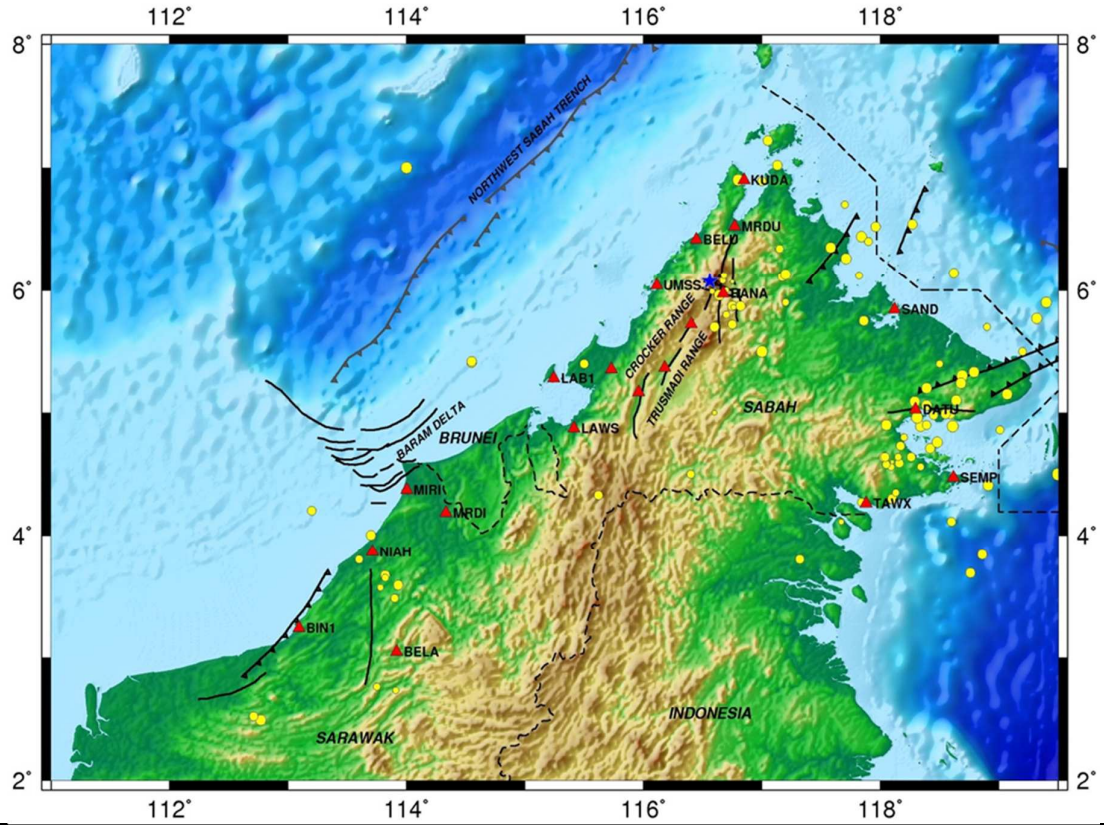
- North Borneo – part of Sundaland block
- Highest mountain on Sundaland – Mount Kinabalu (4095m, 8 million years old)
- North Borneo deforms differently
- NW Borneo – gravity gliding
- GNSS – tool for geodynamics studies
- Continuous GNSS station – understanding of active tectonics
- Main constraint – lack of data



South-East Asia plates & blocks boundary.
Red box is study area, North Borneo.

Seismotectonic of North Borneo

- SEA - complicated configuration of crustal plates
- NW Trench – subduction zone South China Sea & NW Borneo
- Baram Delta – active fold-and-thrust belt
- Major faults – Crocker range & Trusmadi range
- Earthquakes region
  - Ranau
  - Lahad Datu - Tawau
- Latest EQ - February 1st 2014, 4.6 Mw, Ranau



Data & Processing

- GNSS data (MyRTKnet) provided by Deparment Surveying & Mapping Malaysia (DSMM)
- Since 2007, DSMM added more stations – close to coastal area of North Borneo
- 20 stations
- 3-year span, Jan 2009 – Dec 2011
- Software, GIPSY-OASIS II 6.1.2
- PPP was applied

Data & Processing …

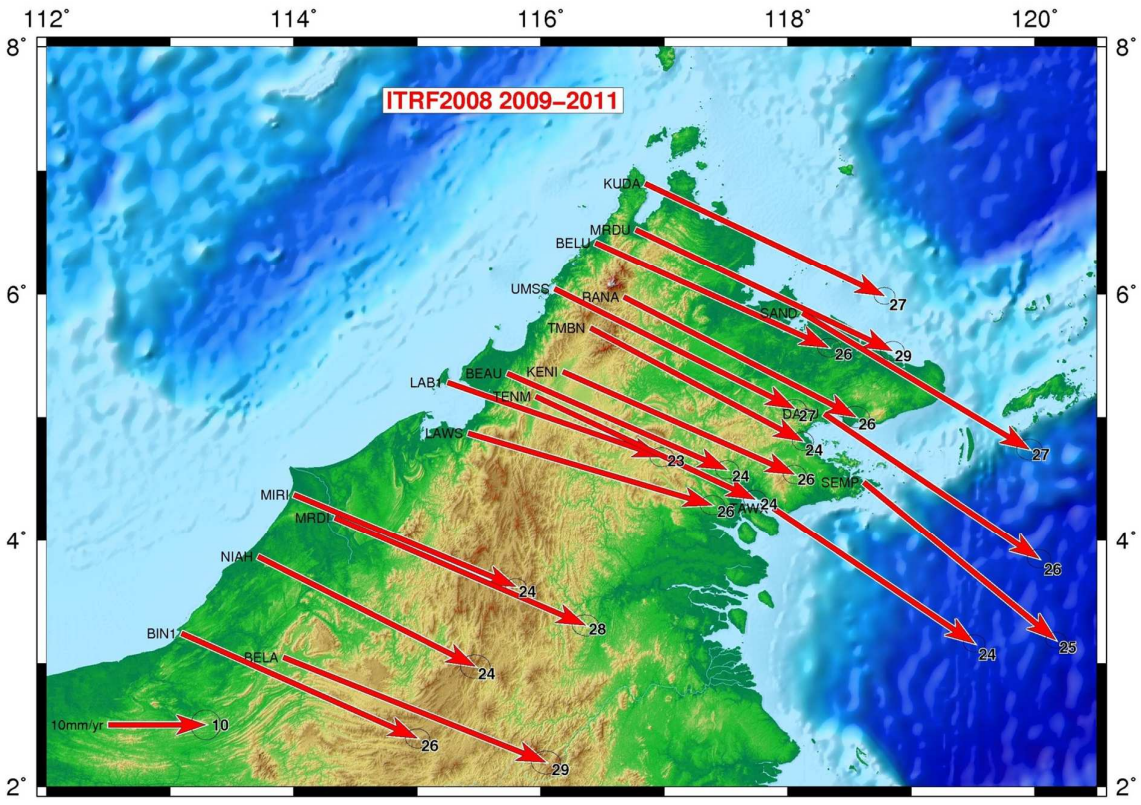
Parameter	Technique/model
Data interval	5 minutes
Cut-off angle	7 degrees
Differencing technique	Zero differences
Linear combination	Ionosphere free
Tropospheric mapping	VMF1
Ocean loading	FES2004
Ambiguity fixing	Ambizap3

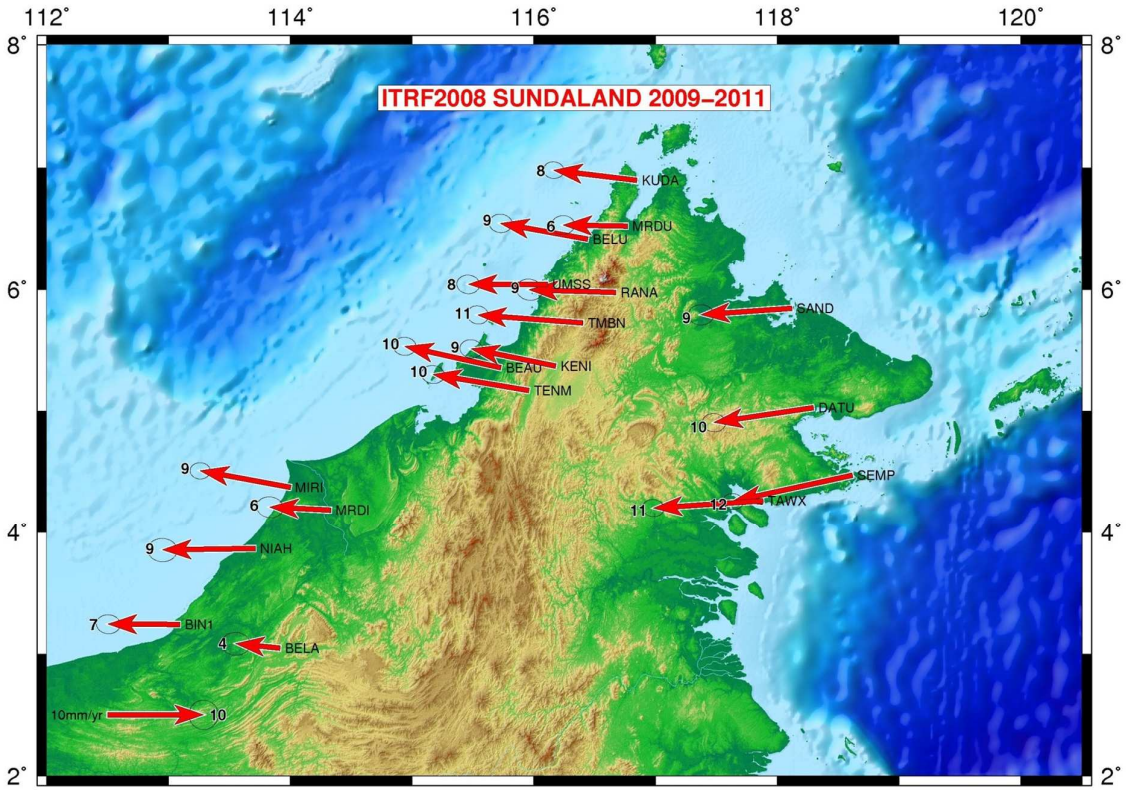
Data & Processing …

- Multi-day averaged:
  - Days : 7 day-average
  - Outlier detection : Median Absolute Deviation
  - Reference frame : ITRF2008
  - Mapping : x-file JPL package
  - Transformation : 7-parameter Helmert

North Borneo Motion

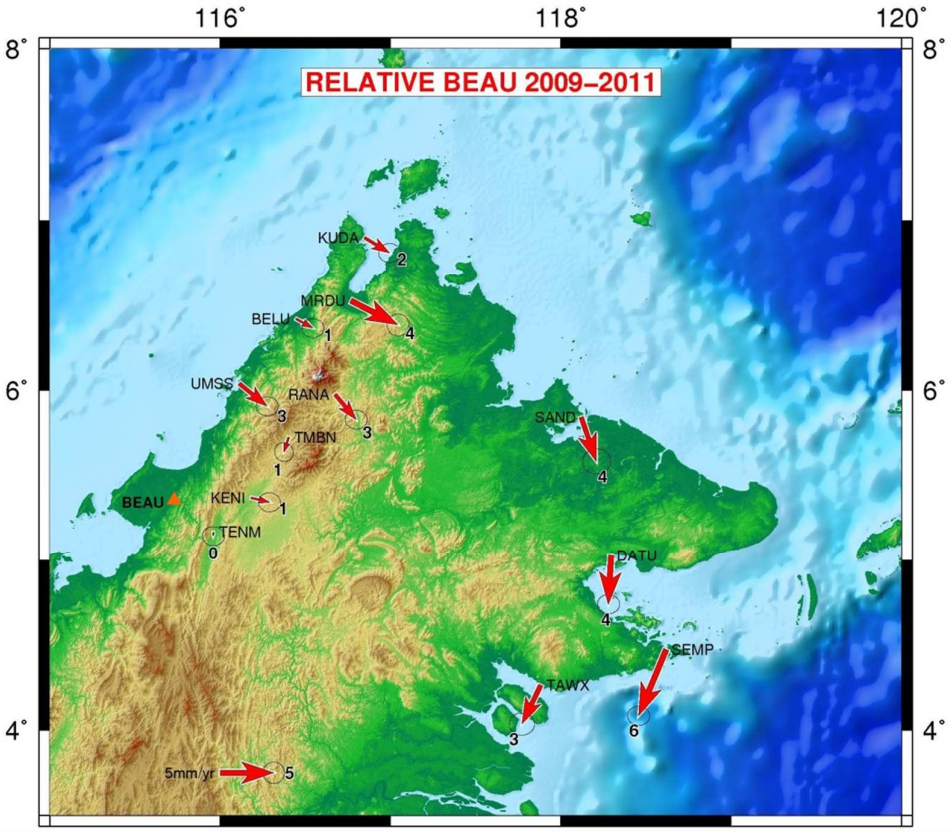
- Time series – linear regression
- Analyzing misfits – 3D fitting
- Iterative outlier detection step

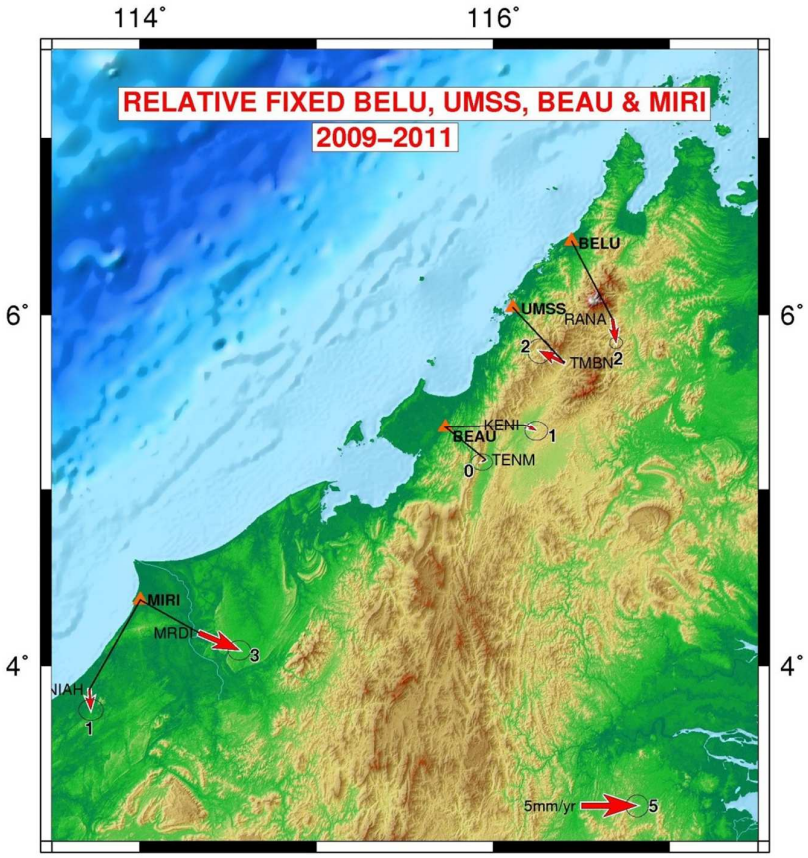




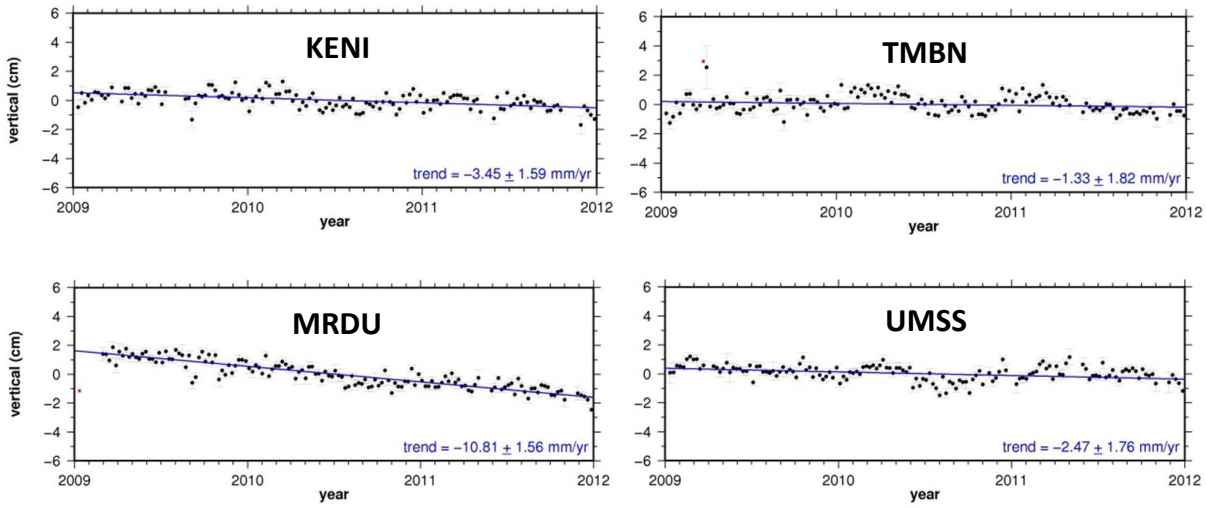
Baseline Analisis

- Reduce seasonal effects
- Mapping errors
- Better accuracy of local interaction
- Fixed a station

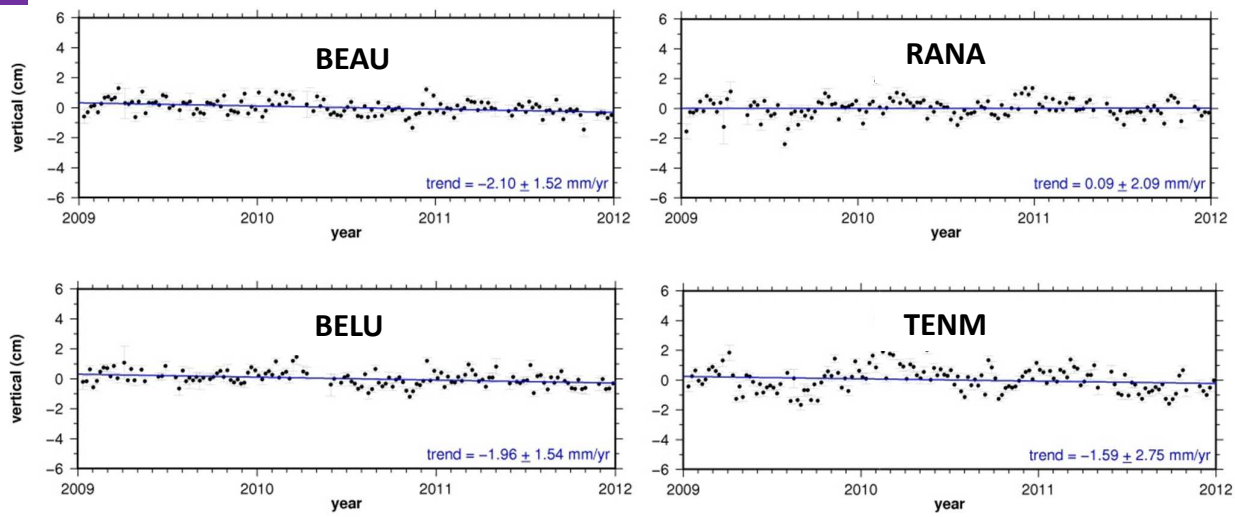

RELATIVE BEAU 2009–2011
116°
118°
120°
8°
6°
4°
KUDA
2
MRDU
4
BELU
1
UMSS
3
RANA
3
TMBN
1
SAND
4
BEAU
KENI
1
TENM
0
DATU
4
SEMP
6
TAWX
3
5mm/yr
5


RELATIVE FIXED BELU, UMSS, BEAU & MIRI
2009–2011
114°
116°
6°
4°
BELU
UMSS
RANA
2
TMBN
2
KENI
1
BEAU
0
TENM
MIRI
MRDI
3
1
5mm/yr
5

Vertical motion



Vertical motion



Conclusion

- Station MIRI & MRDI –extension rate 3mm/yr
- NW Borneo do not show significant extension/compression
- Results might be affected - local or individual motions
- Vertical motions – need longer time series
- Need additional info – geological setting North Borneo
- North Borneo as a block – identify possibility of new fault line

Acknowledgement

- DSMM – provided GNSS data
- Minerals and Geoscience Department – Seismotectonics Map 2009
- Malaysian Metrological Department – list of EQ
- Grant NWO Programme Space Research
- Scholarship – UITM & MOE