Towards Synergy of VLBI and GNSS Geodetic Techniques in Geologically Dynamic New Zealand

Institute for Radio Astronomy and Space Research
Auckland University of Technology

Sergei Gulyaev, Hiroshi Takiguchi,
Tim Natusch, Stuart Weston, Lewis Woodburn

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Introduction WARK12M

✧ Launch of New Zealand's
**first** & **only** research capable radio telescope
✧ 8 October, 2008

Antenna type	Dual-shaped Cassegrain
Manufacturer	Cobham/Patriot, USA
Main dish Diam.	**12.1 m**
Secondary refl. Diam.	1.8 m
Focal length	4.538 m
Surface accuracy	0.35 mm
Pointing accuracy	18"
Frequency range	1.4 - 43 GHz
Mount	alt-azimuth
Azimuth axis range	90˚ ± 270˚
Elevation axis range	6˚ to 88˚
Azimuth axis max speed	5˚/s
Elevation axis max speed	1˚/s
Main dish F/D ratio	0.375

✧ Institute for Radio Astronomy and Space Research, AUT
✧ 60 km north from Auckland

- ✧ valuable station of the southern hemisphere
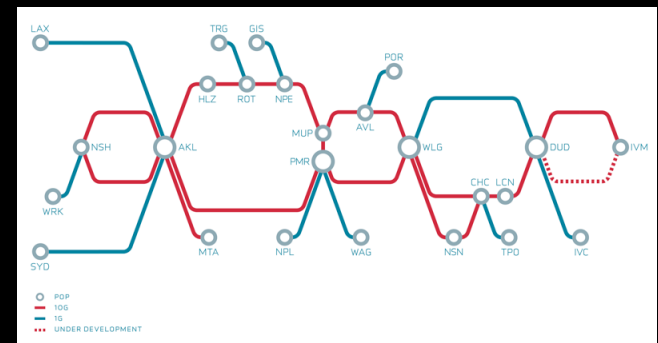
- ✧ DBBC, Mark5B+, Mark5C, Hydrogen Maser
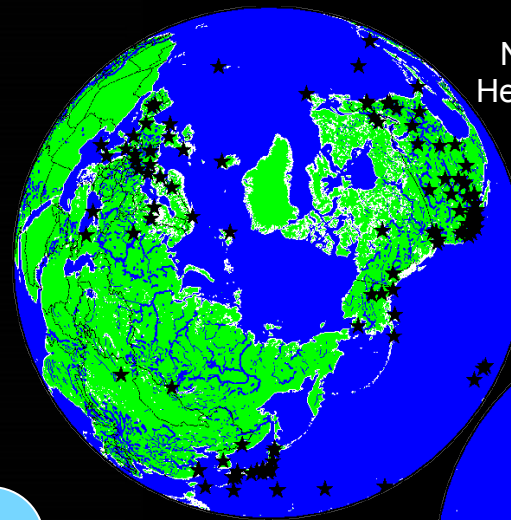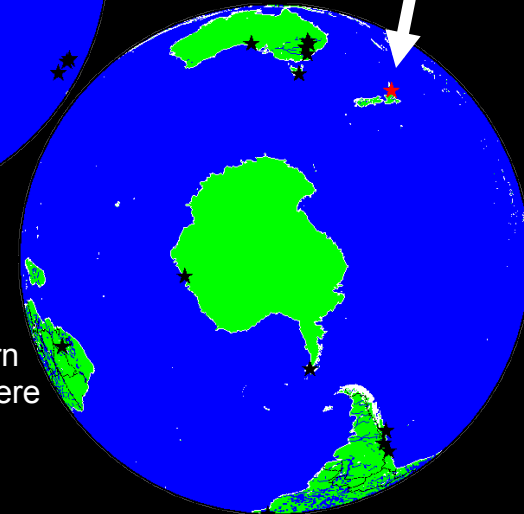
- ✧ Network: KAREN, Trans-Tasman, Southern Cross

connectivity
1Gbps

Introduction
Space Geodesy @NZ

✧ before launch of VLBI

   ✧ only GNSS

New Zealand Continuous GPS Recording Sites

★ VLBI

http://www.gns.cri.nz
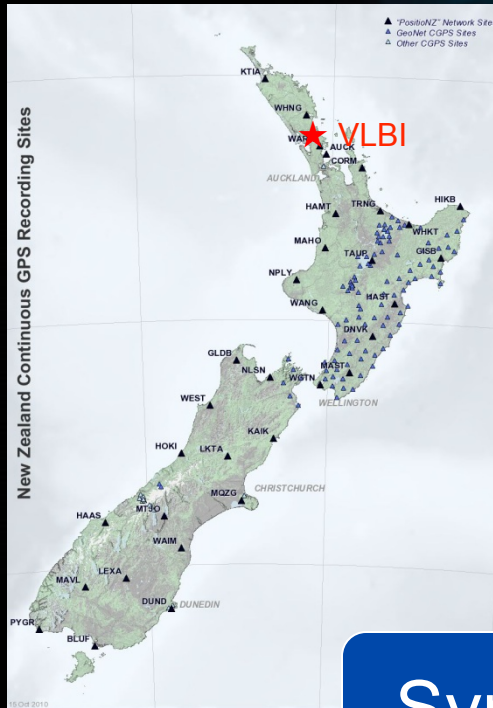
- **PositioNZ** by LINZ (Land Information New Zealand)
  - 31 (2:Chatham Islands, 3: Antarctica)
  - Geodetic system, NZGD2000, surveying, mapping

- **GeoNet** by Earthquake Commission & GNS Science
  - to monitor earthquakes, volcanic unrest, land deformation, geothermal activity and tsunami
  - seismometer, accelerometer, tide gauge, sea level pressure
  - GPS : active volcanic activity area, over 100

Synergy of VLBI and GNSS

Synergy of VLBI and GNSS

✧ Geodetic situation of New Zealand is similar to **Japan**
   ✧ locate the plate boundaries
      ✧ a lot of earthquakes
      ✧ active crustal deformation & volcanic activity
   ✧ GPS network
   ✧ Geodetic Datum
   ✧ VLBI

plate boundary & earthquake

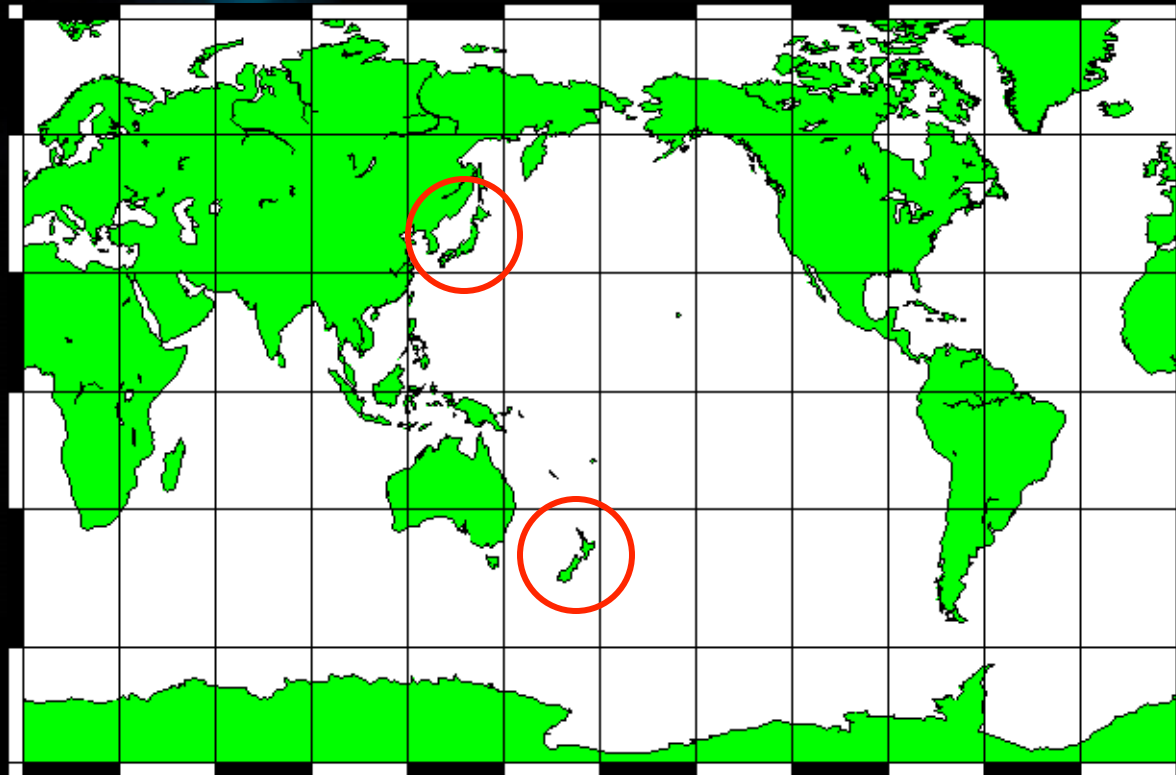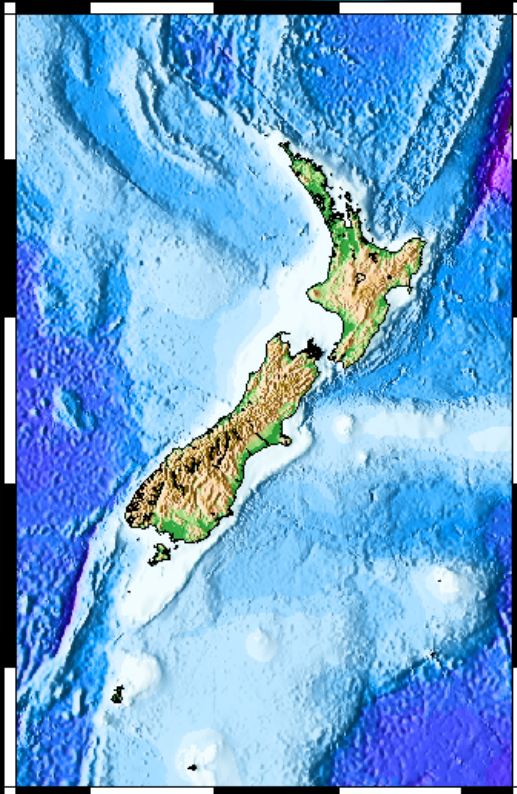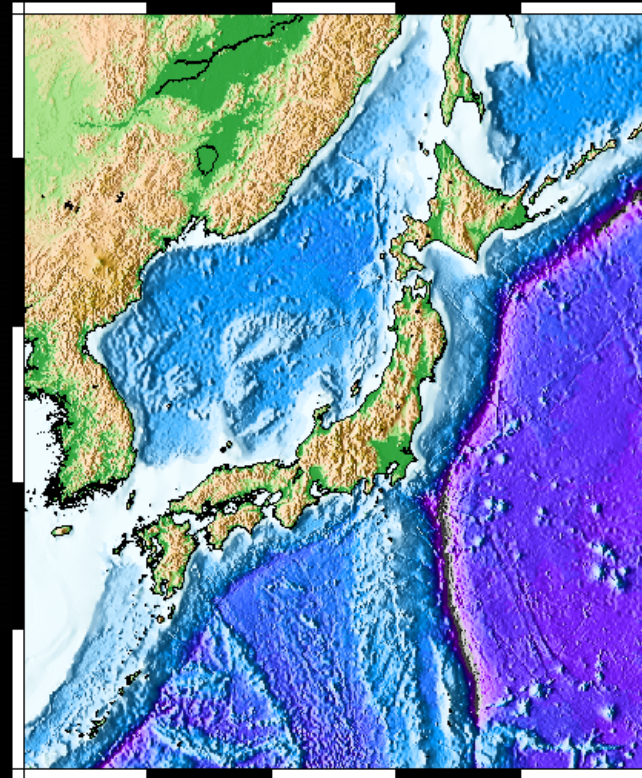✧ New Zealand   ✧ Japan

plate boundary & earthquake

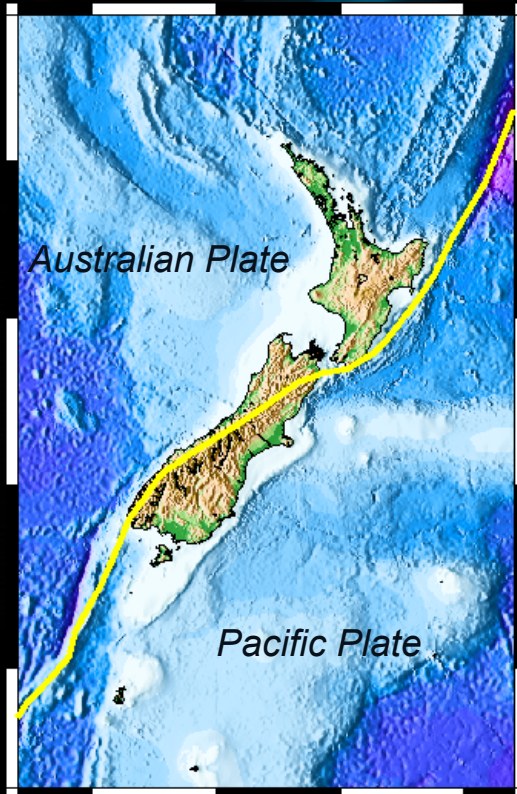✧ New Zealand

✧ Japan

268,680 km^2

377,914 km^2

plate boundary & earthquake

✧ New Zealand

✧ Japan

Australian Plate

Pacific Plate

Eurasian Plate

North American Plate

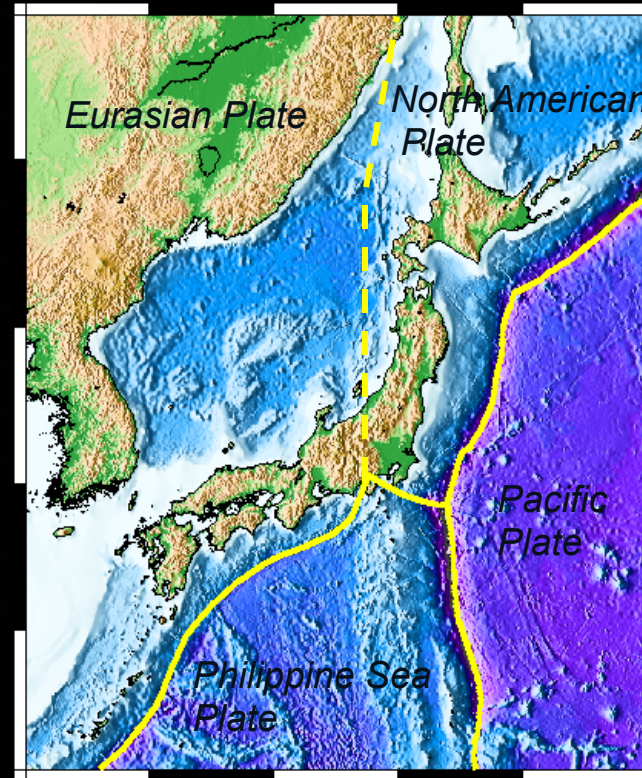Pacific Plate
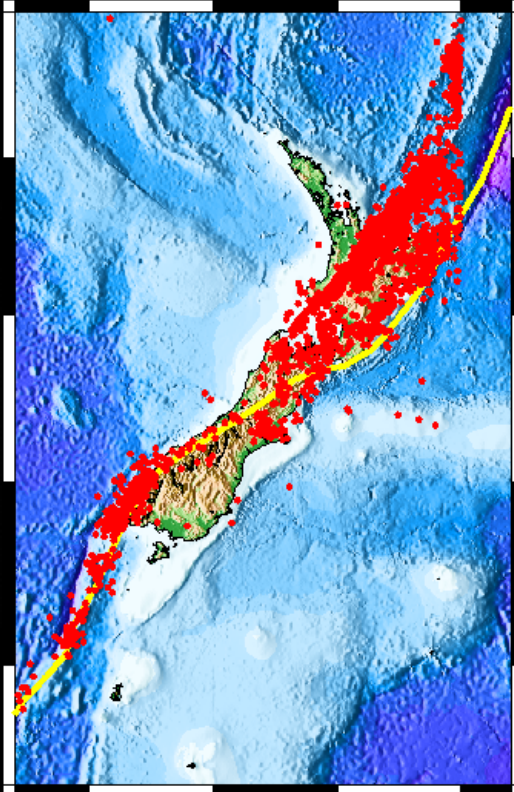
Philippine Sea Plate

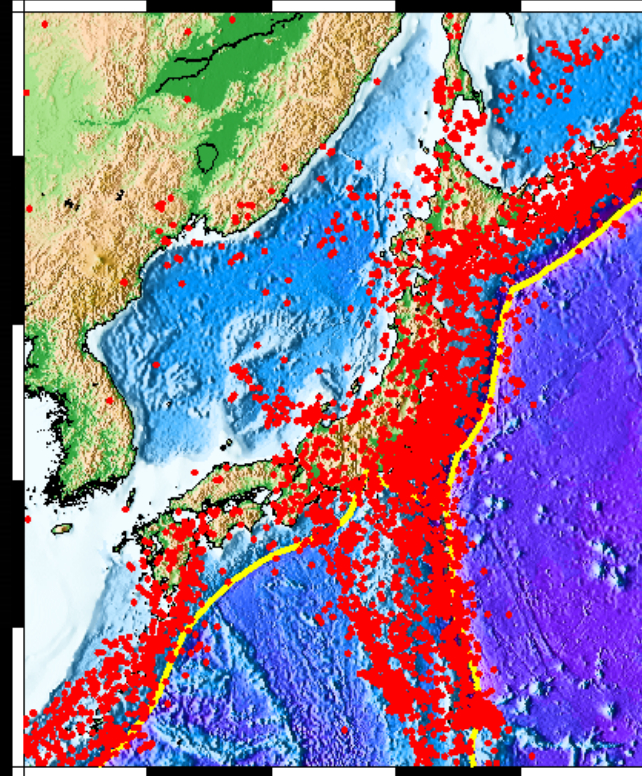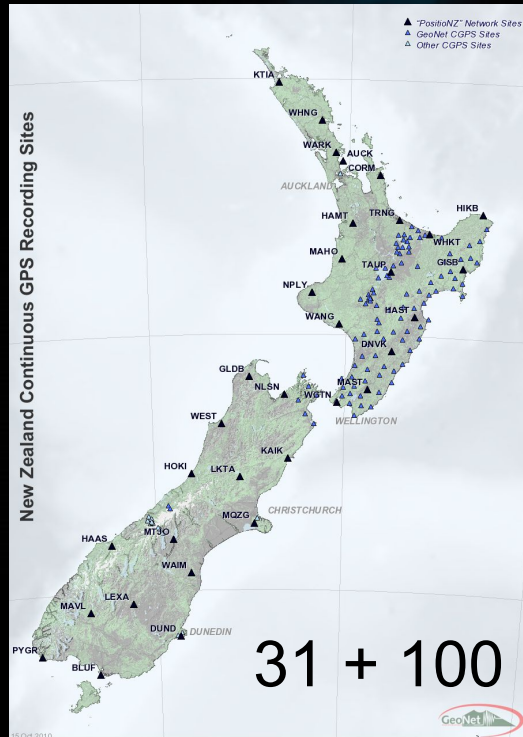AUT UNIVERSITY

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plate boundary & earthquake
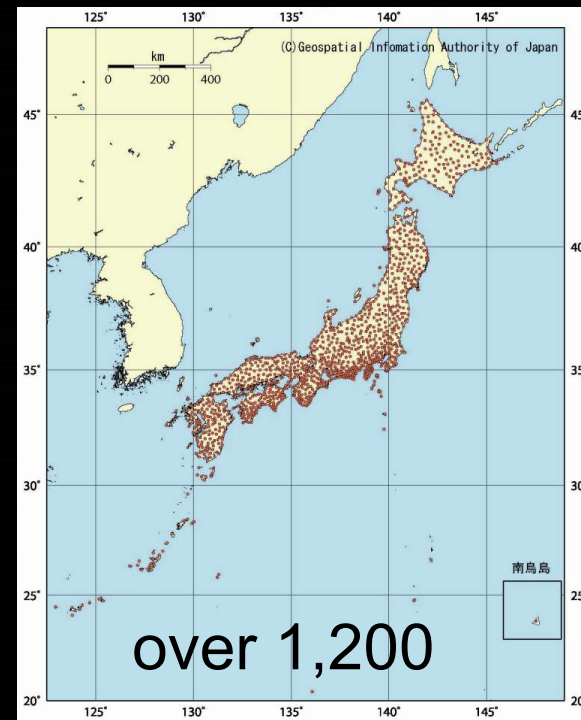
✧ New Zealand

✧ Japan

GPS network

✧ New Zealand
  ✧ PositioNZ, GeoNet

✧ Japan
  ✧ GEONET (GPS Earth Observation Network System)

31 + 100

http://www.gns.cri.nz

over 1,200

http://www.gsi.go.jp
Geospatial Information
Authority of Japan (GSI)

Geodetic Datum

✧ New Zealand
  ✧ NZGD2000 (1998)
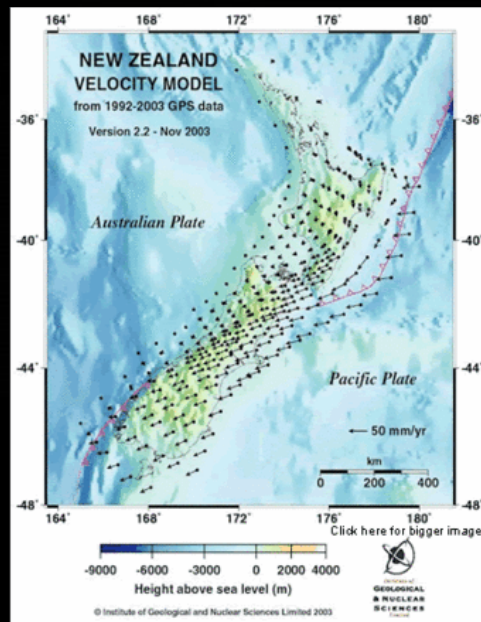   ✧ ITRF96, 2000.0
    ✧ Semi-dynamic system

GPS

http://www.linz.govt.nz

✧ Japan
  ✧ JGD2000 (2002)
    ✧ ITRF94, 1997.0
    ✧ Static system
      + Semi-dynamic correction
      (referred New Zealand)

VLBI + GPS

http://www.gsi.go.jp
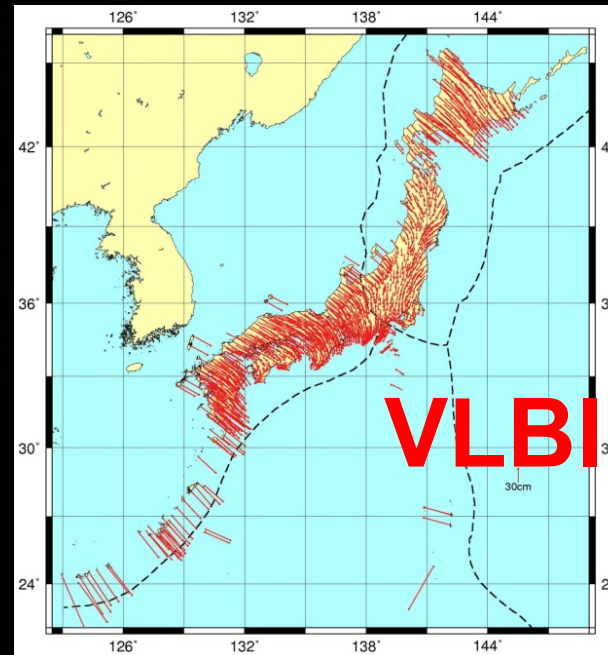
Synergy of VLBI and GNSS

✧ model of Japan

✧ Synergetic relationship between VLBI and GPS in Japan

International Contribution

Coordinates, EOP   *ITRF, EOP*

IVS → IERS → IGS

Obs, Corr   *ITRF*   *GPS Eph.*

New Zealand   VLBI ←→ GNSS

NZGD2000
Crustal Deformation, Sea Level Monitoring etc.

To validate GPS network's accuracy
Atmospheric & ionospheric information

Earth Science, Surveying & Mapping, GIS application

Leap sec

modified from *Tsuji et al. 2003*

First synergistic result

✧ Determination of VLBI reference point

✧ RTK GPS

✧ respect to PositioNZ: WARK


```
X = −5115324.5   +/− 0.1   m
Y =    477843.3   +/− 0.1   m
Z = −3767193.0   +/− 0.1   m
                      March 2010
```
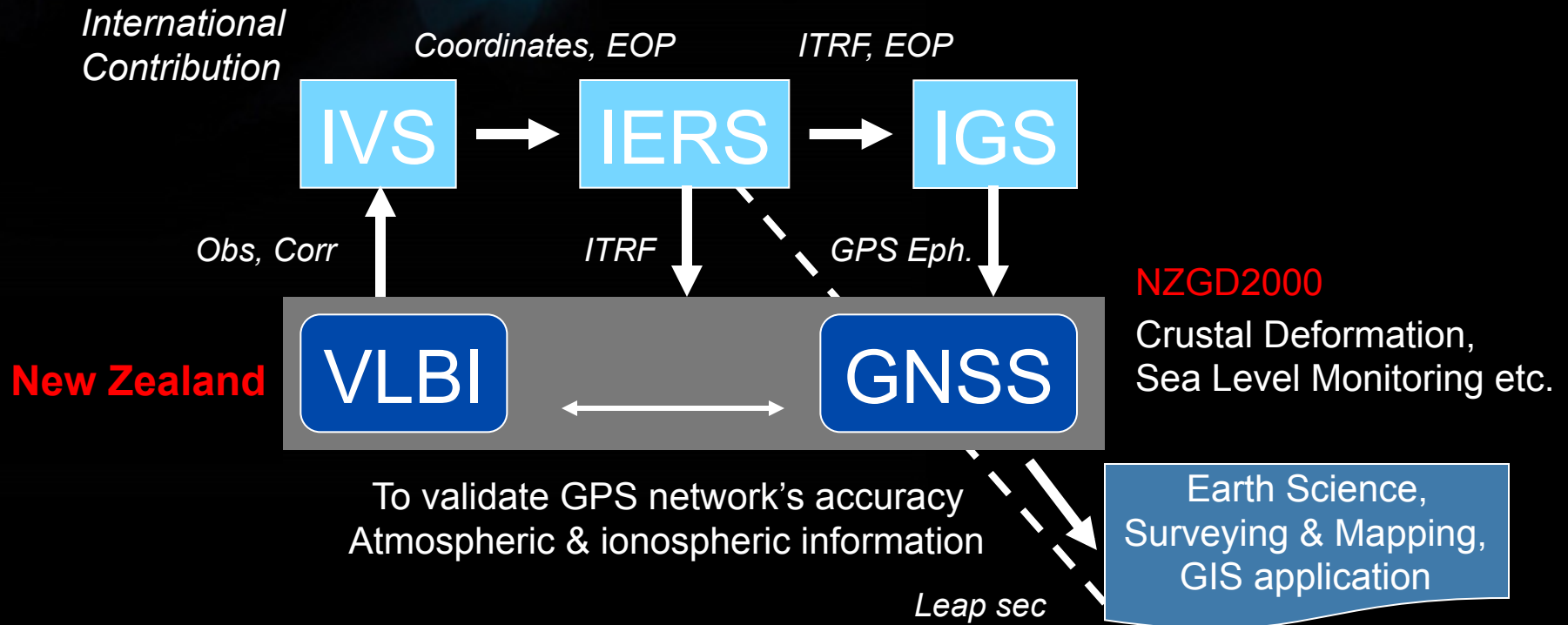
collaboration with
the New Zealand Crown Research Institute,
GNS Science and LINZ

The first IVS results

✧ IVS R1472 session
 S/X VLBI

- VLBI-GPS
  - less than 10cm
    @each component

```
X = -5115324.41 +/- 0.02 m
Y =    477843.31 +/- 0.02 m
Z = -3767192.93 +/- 0.06 m
                  February 2011
```

O. Titov

Projects in progress
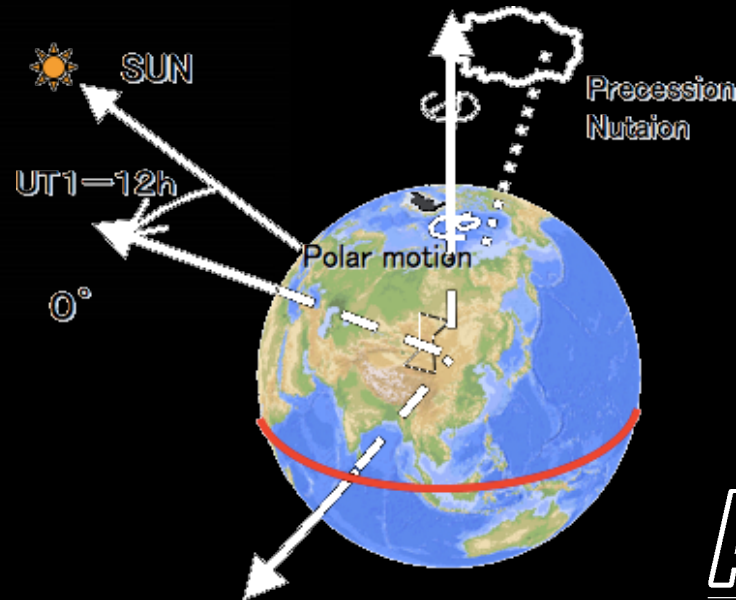
- ✧ IVS regular session

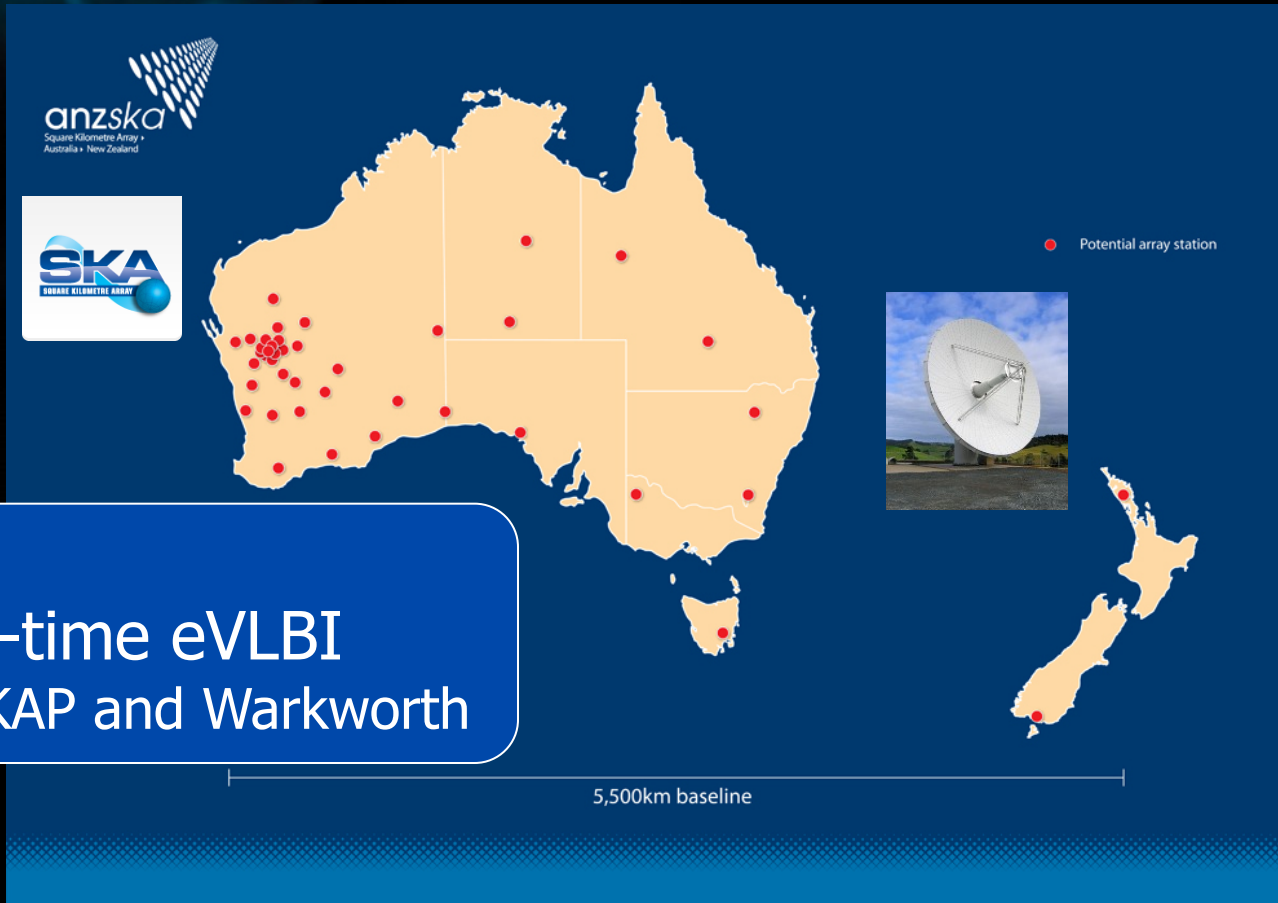- ✧ AuScope
- ✧ anz*ska*
  - ✧ joint project with Australia

- ✧ Ultra-rapid EOP measurement
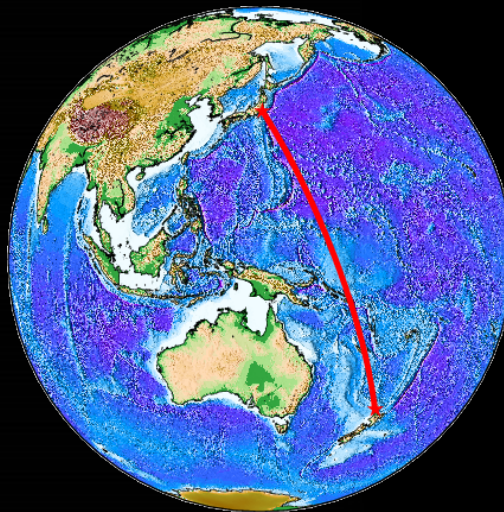 - ✧ cooperate with Japanese institute

anz*ska*

7 July, 2011
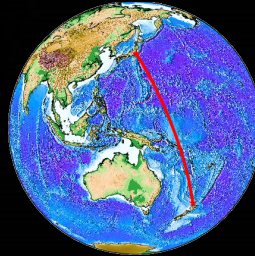the first real-time eVLBI involving ASKAP and Warkworth

Ultra-rapid EOP measurement

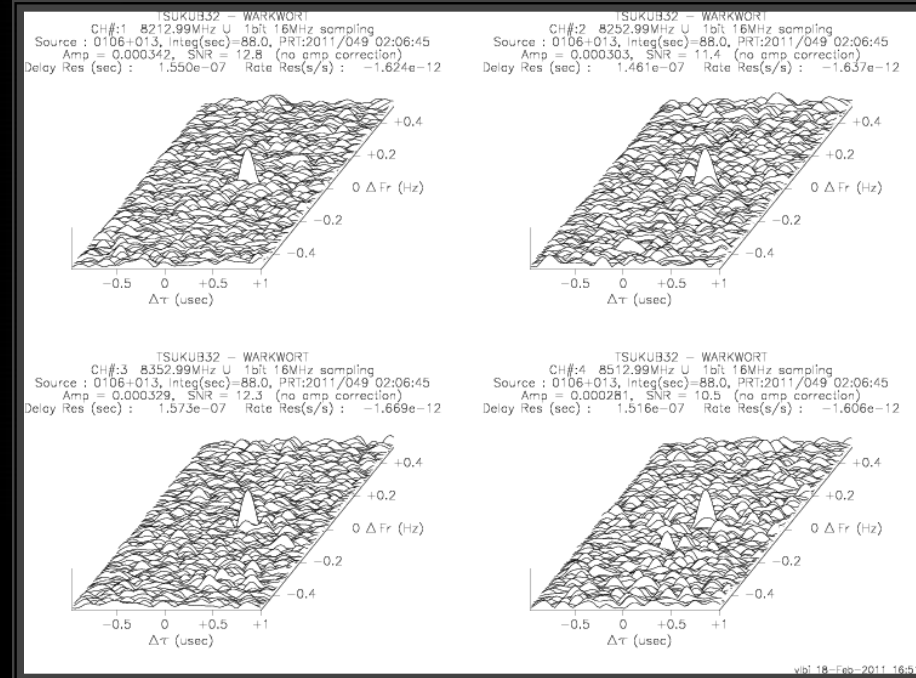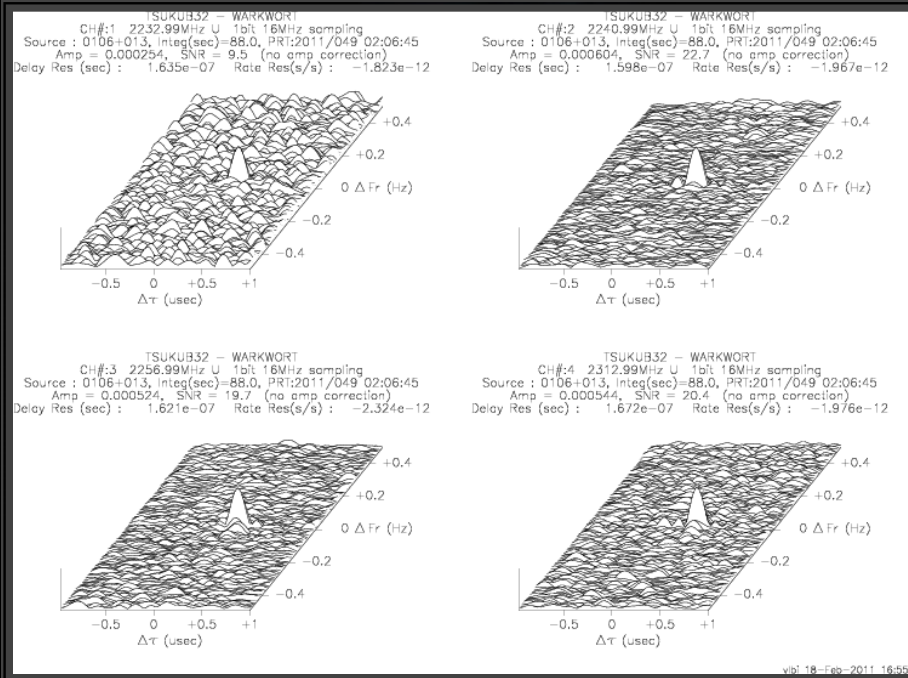we are coordinating the experiment together with GSI and NICT.

Warkworth 12m - Tsukuba 32m


S band

X band

Future Plans

✧ Develop new capabilities
   ✧ especially
      ✧ Ultra-rapid EOP Measurement
   ✧ IVS sessions
      ✧ cont11
         (campaign of two weeks continuous VLBI sessions)

✧ Periodical co-location observation
      ✧ GPS and other geodetic techniques

✧ Conversion of the 30m antenna

30m antenna

✧ November 2010
  Telecom NZ handed over 30m antenna to AUT

  ✧ It was manufactured in 1984 by NEC

  ✧ It located just 200m north of 12m radio telescope

  ✧ convert to radio telescope
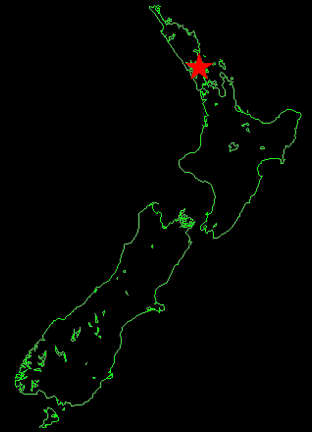
Thank you very much for your attention.