Presented at the FIG Working Week 2016,
May 2-6, 2016 in Christchurch, New Zealand

FIG Working Week 2016

CHRISTCHURCH, NEW ZEALAND 2–6 MAY 2016

Recovery

from disaster

Organised by FIG NZIS

Platinum Partners Trimble esri

Diamond Partner Land Information New Zealand *Toitū te whenua*

Performance of Ionospheric Error Mitigation Techniques for Single-Frequency GNSS Positioning in the South East Asian Region

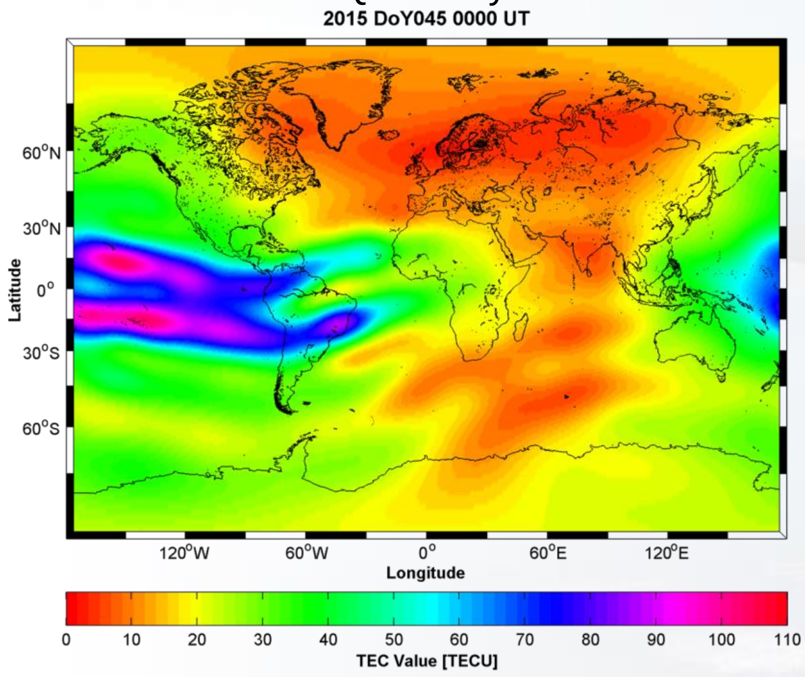
Shien Kwun LEONG
Regional Technical Support Engineer

Contents

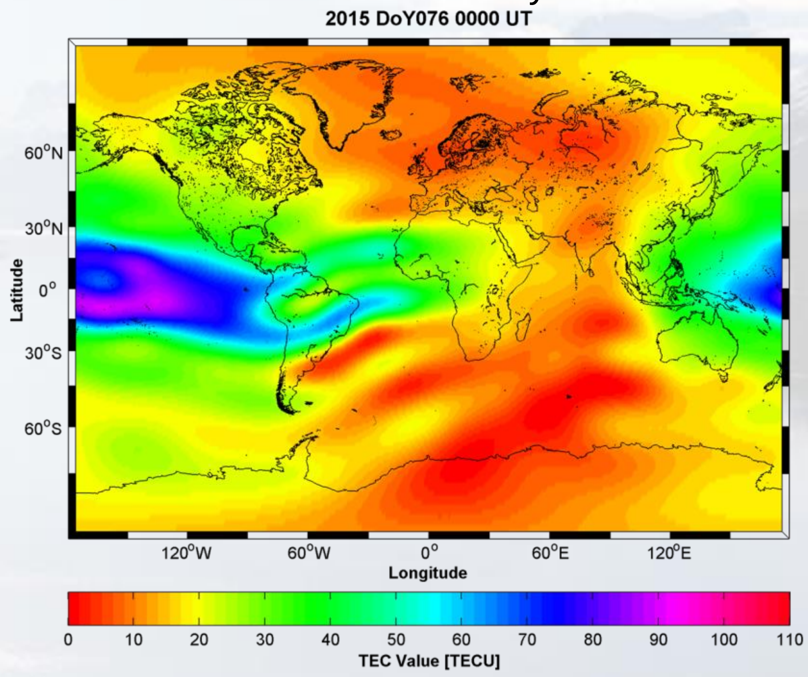
Motivation

- Center for Orbit Determination in Europe (CODE) Global Ionosphere Maps (GIM)

Quiet Day



Disturbed Day



Motivation

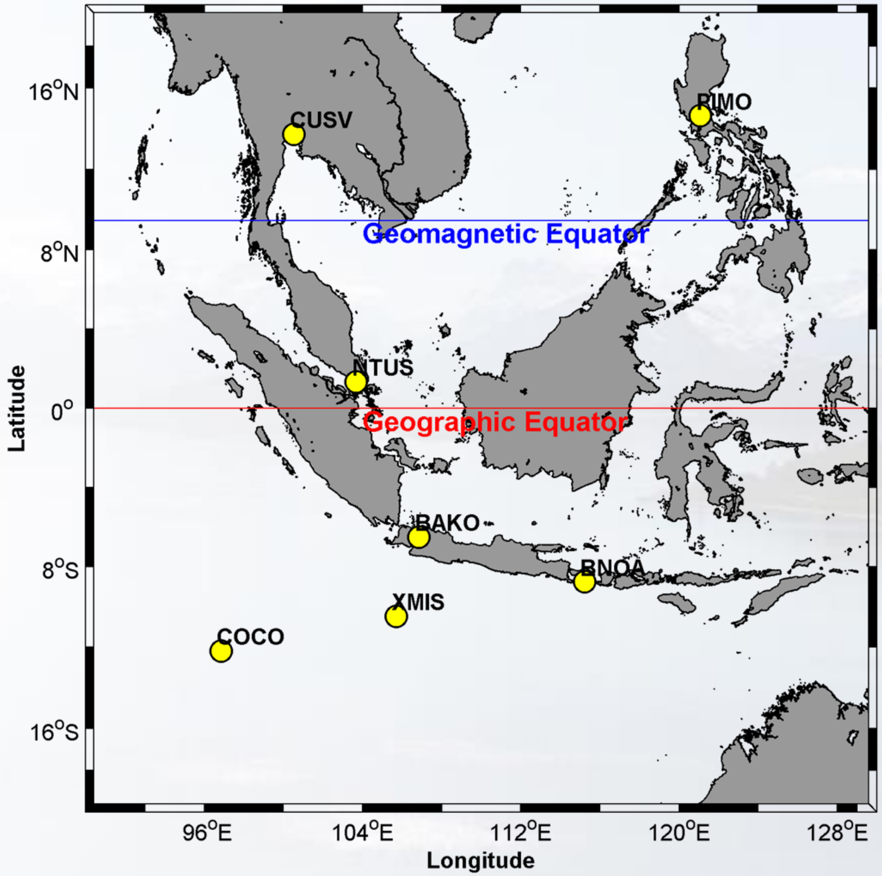
- Typical mitigation approach for GNSS positioning
  - Dual-frequency: Form ionosphere-free linear combination
  - Single-frequency:
    - Klobuchar model
    - International Reference Ionosphere (IRI)
    - NeQuick
    - Global Ionosphere Maps (GIM)

Motivation

- Under **different solar activity**, **baseline lengths** & **ionosphere models** …
  - What would be the achievable accuracy for **Single-Frequency Point Positioning (SFPP)** and **Single-Frequency Differential Positioning (SFDP)** in **South East Asia (SEA)**?
  - Which **ionosphere model** is suitable for SEA region?

Test 1: Single-Frequency GNSS Point Positioning

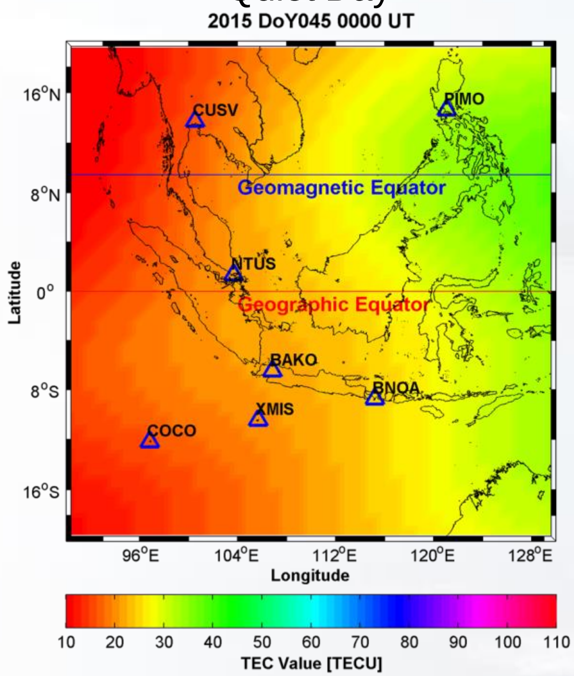
- Area of study



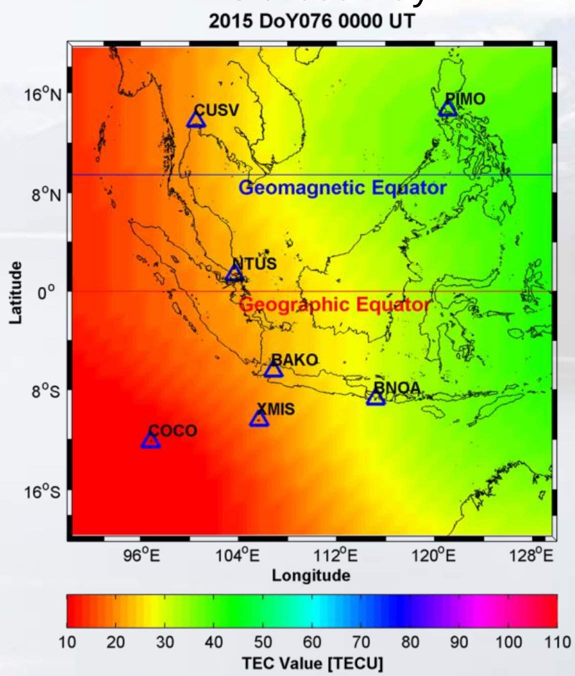
Test 1: Single-Frequency GNSS Point Positioning

- Center for Orbit Determination in Europe (CODE) Global Ionosphere Maps (GIM)

Quiet Day



Disturbed Day



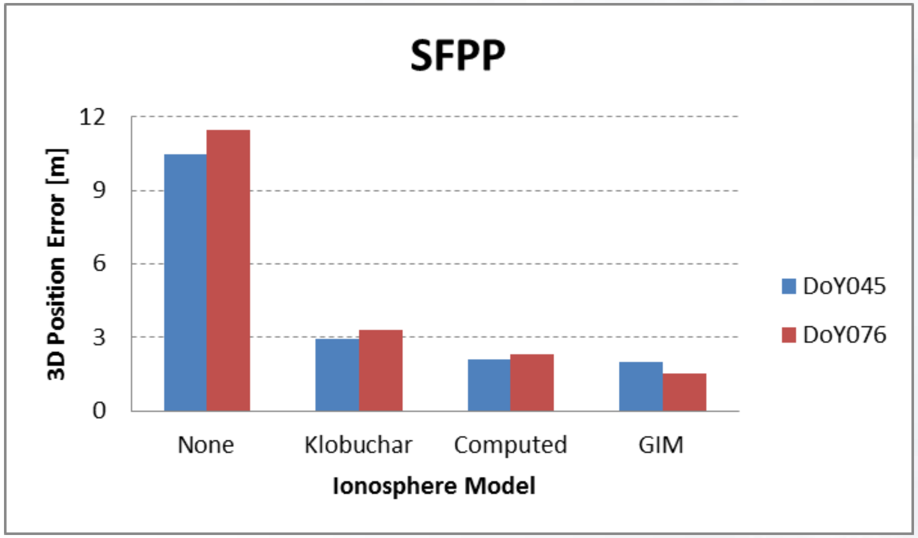
Test 1: Single-Frequency GNSS Point Positioning

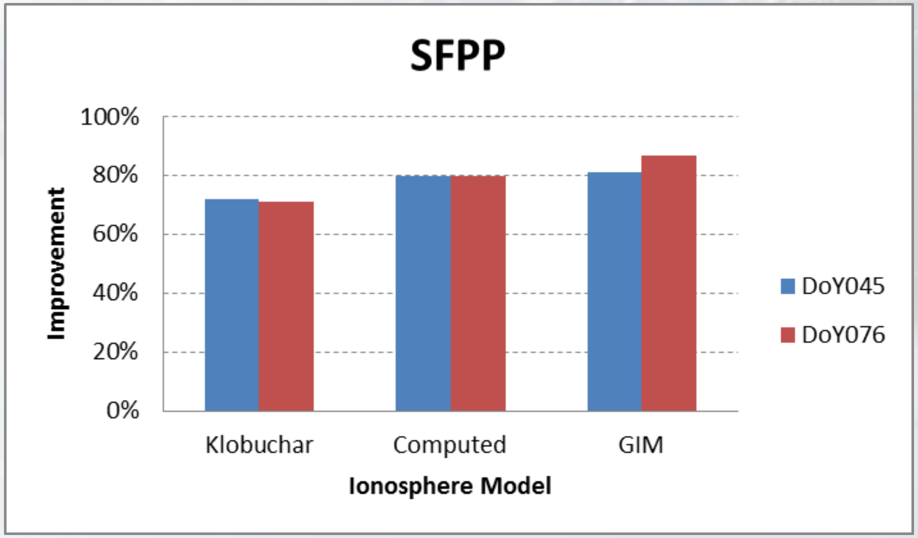
- Processing parameters and strategy

Processing Parameters	Processing Strategy
Software	Leica Geo Office 8.4
Positioning mode	Static Point Positioning
Satellite system	GPS+GLONASS
Frequency	L1 only
Observables	Smoothed code
Elevation cut-off angle	10°
Sampling rate	30 seconds
Satellite ephemeris	IGS precise final orbit (SP3)
Troposphere correction	Hopfield model
Ionosphere correction	Broadcast Klobuchar model
	Computed model (Single-layer model)
	CODE Global Ionosphere Maps (GIM)

Test 1: Single-Frequency GNSS Point Positioning

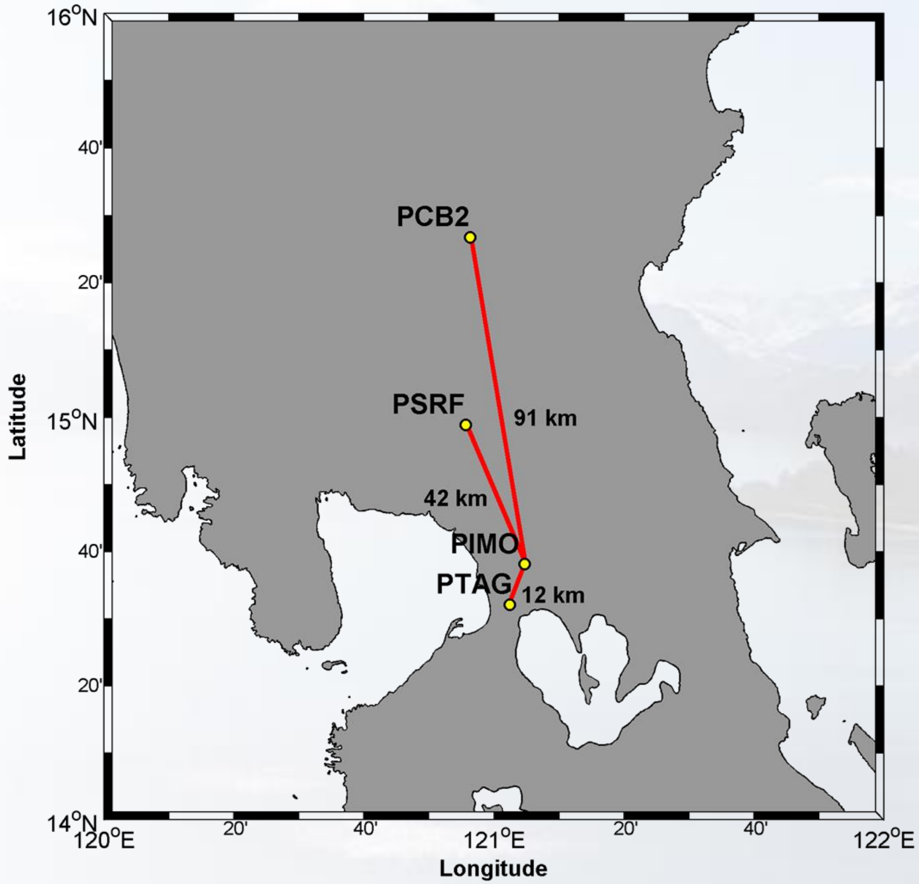
- CODE GIM
  - Average 3D position error < 2 m
  - > 80% improvement





Test 2: Single-Frequency GNSS Differential Positioning

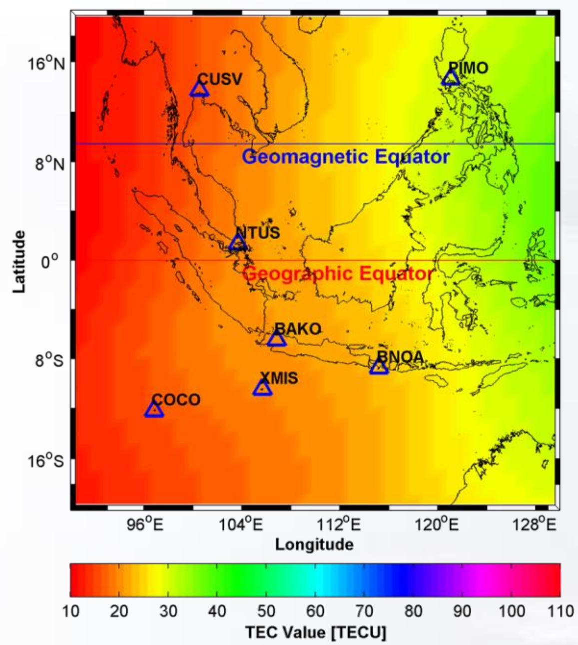
- Area of study
  - PageNET



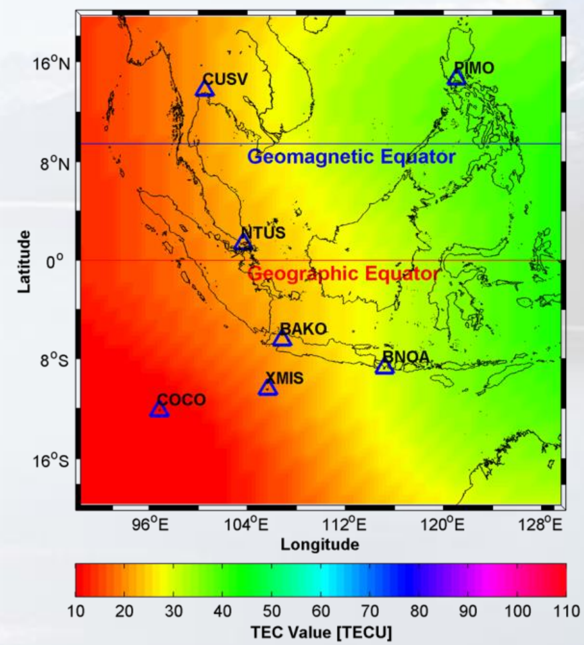
Test 2: Single-Frequency GNSS Differential Positioning

- Center for Orbit Determination in Europe (CODE) Global Ionosphere Maps (GIM)

Quiet Day
2015 DoY056 0000 UT



Disturbed Day
2015 DoY076 0000 UT



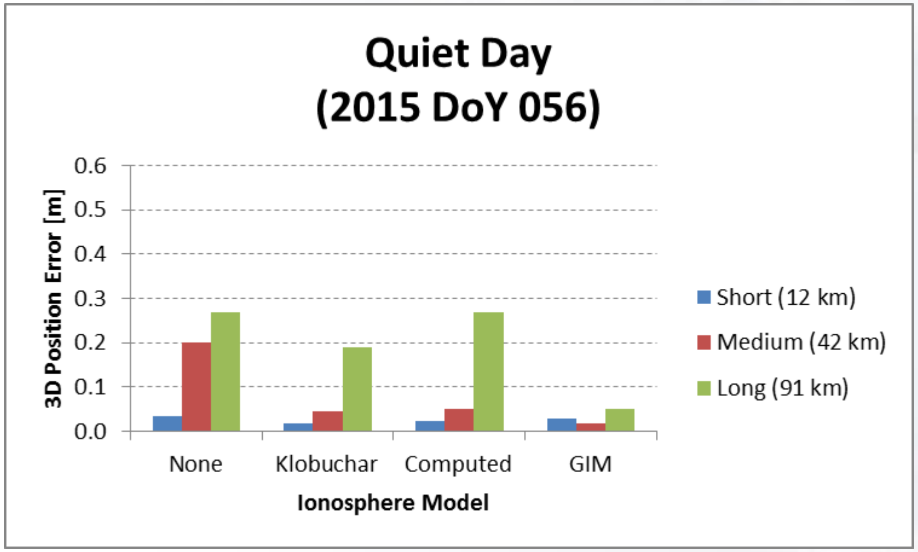
Test 2: Single-Frequency GNSS Differential Positioning

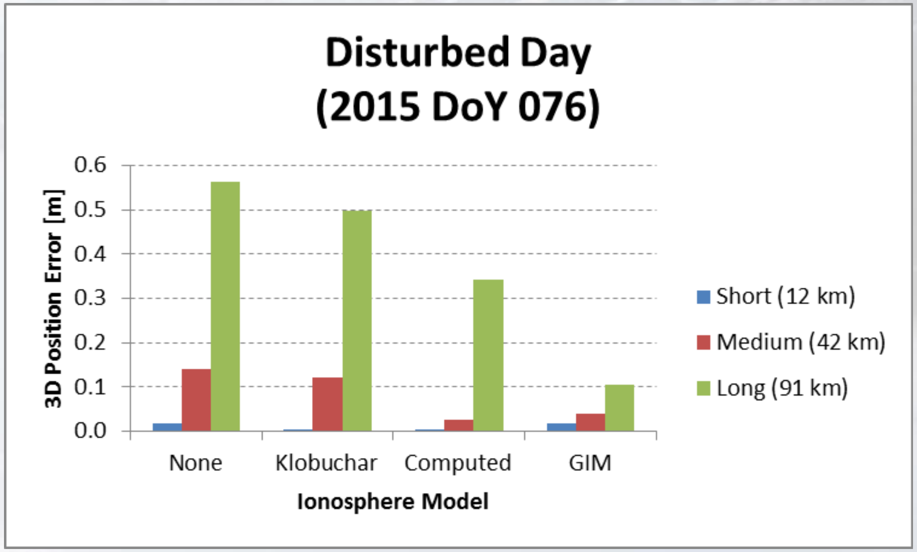
- Processing parameters and strategy

Processing Parameters	Processing Strategy
Software	Leica Geo Office 8.4
Positioning mode	Static Differential Positioning
Satellite system	GPS+GLONASS
Frequency	L1 only
Observables	Carrier phase
Elevation cut-off angle	10°
Sampling rate	30 seconds
Satellite ephemeris	IGS precise final orbit (SP3)
Troposphere correction	Hopfield model
Ionosphere correction	Broadcast Klobuchar model
	Computed model (Single-layer model)
	CODE Global Ionosphere Maps (GIM)

Test 2a: Single-Frequency GNSS Differential Positioning

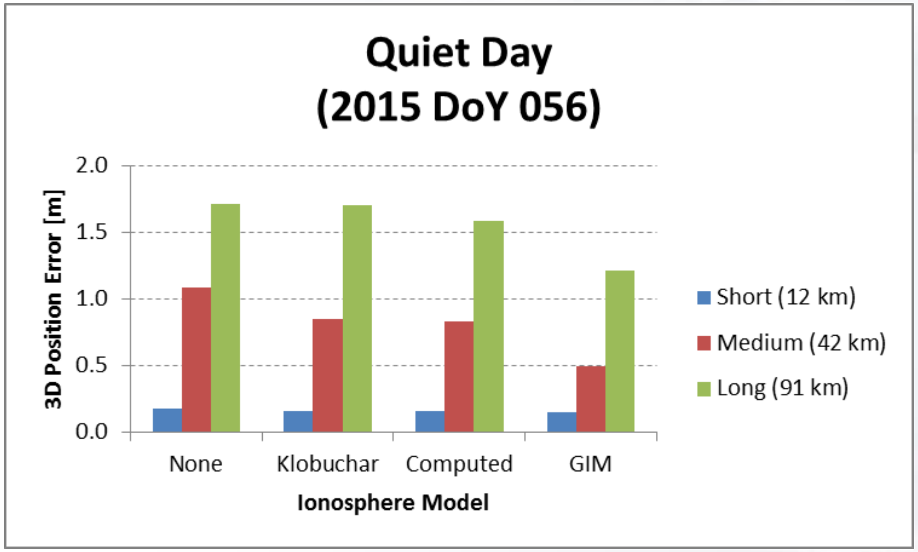
- Number of epoch: 2880 s
- SFDP with CODE GIM: 2 cm accuracy in medium baseline
- CODE GIM is effective for medium and long baselines

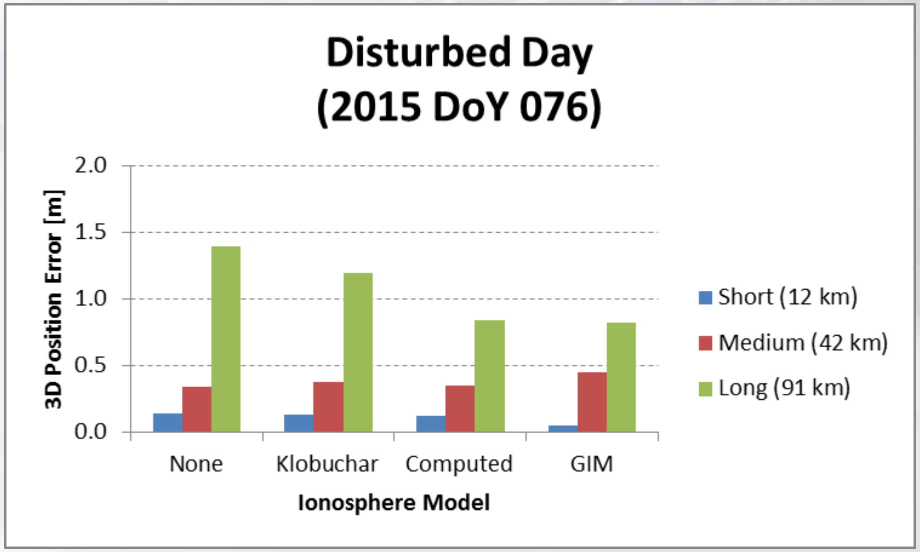




Test 2b: Single-Frequency GNSS Differential Positioning

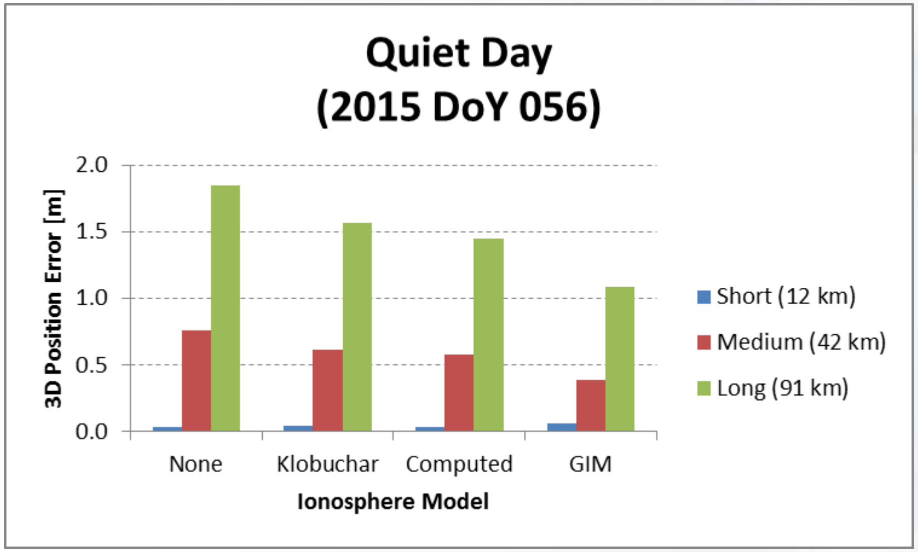
- Number of epoch: 120 s
- Insignificant difference in ionosphere model performance for short baseline

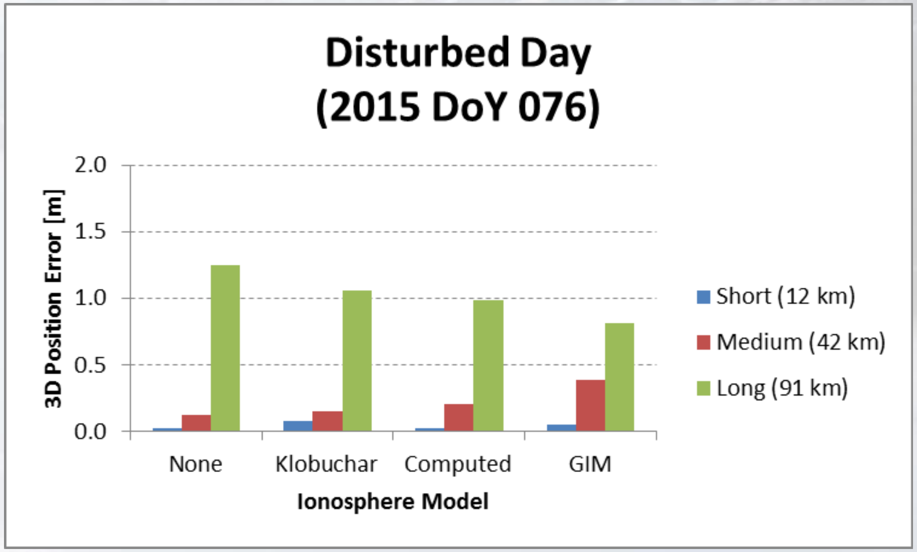




Test 2c: Single-Frequency GNSS Differential Positioning

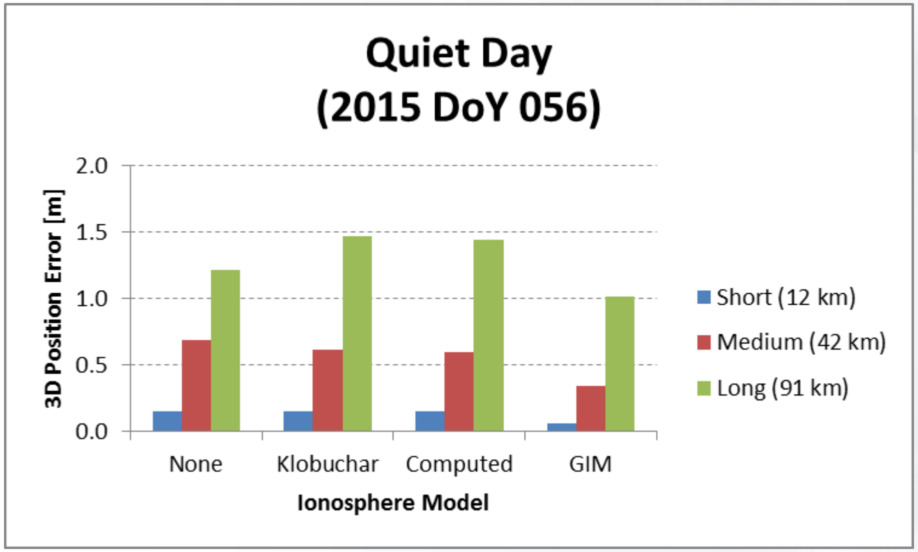
- Number of epoch: 240 s
- As expected, more data improves positioning results

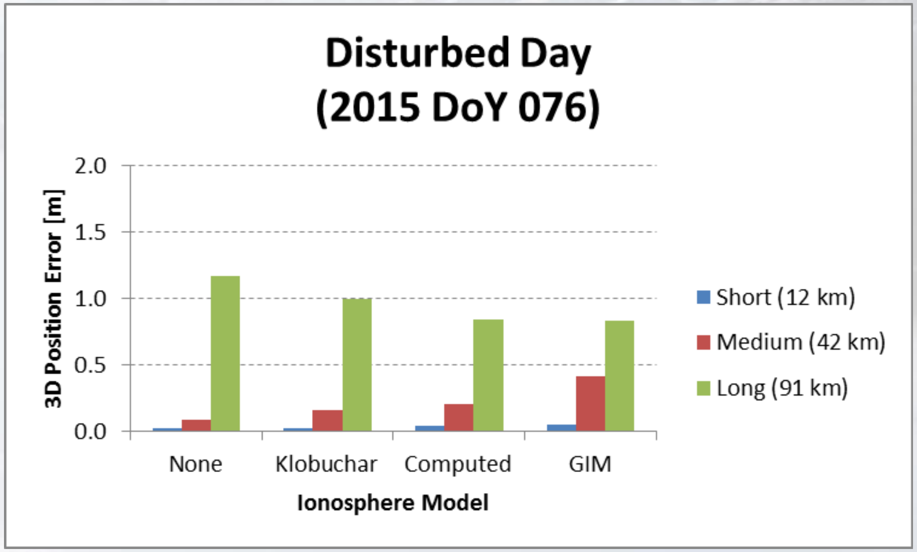




Test 2d: Single-Frequency GNSS Differential Positioning

- Number of epoch: 360 s
- For CODE GIM, increasing the amount of data does not significantly improve the positioning results





Concluding Remark

- CODE GIM improves SFPP by 80%
- Achievable 3D accuracy of SFDP: **2 cm** for medium baseline (42 km)
- In most cases, CODE GIM (global model) performs better than Computed model (local model) especially for long baseline, regardless of amount of data
- CODE GIM is effective for medium and long baselines

Acknowledgement

- IGS (International GNSS Service) data and products
- Center for Orbit Determination in Europe (CODE) products
- Dr. Peter N. Tiangco from National Mapping and Resource Information Authority (NAMRIA), Philippines for contribution of PageNET data