

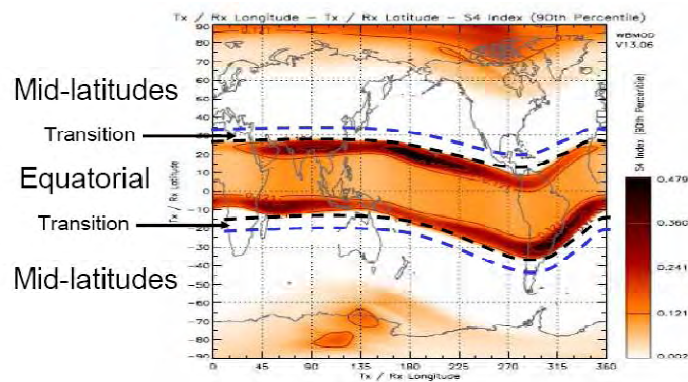
Activities for Ionospheric study for Ground Based Augmentation Systems (GBAS) in Singapore

Gao Shu, 6 May 2011

CAAS
Civil Aviation Authority of Singapore

Ionospheric effects

- Ionospheric effects are greatest at equatorial regions
- Ionospheric storm, expected to occur in 2013, causes a greater delay to the signals



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Outline

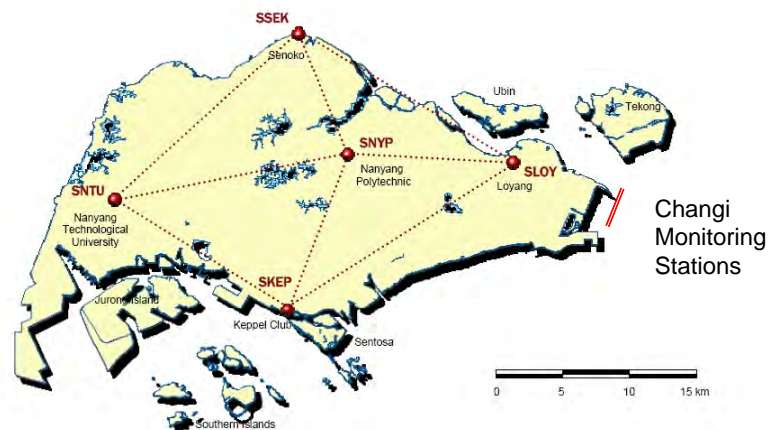
- Collaboration with Singapore Land Authority (SLA)
- Ionosphere monitoring stations to study Ionospheric impact at Changi Airport
- Future Plan

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SiReNT DGPS Network

SiReNT stands for Singapore Satellite Positioning Reference Network



Courtesy to
Singapore Land Authority (SLA)

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SiReNT RINEX format

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SKEP217A.080
OBSERVATION DATA G (GPS) RINEX VERSION / TYPE
GPSTime 2.50 2620 RINEX Merge 04-Aug-08 10:44:26 PGM / RUN BY / DATE
SKEP SKEP MARKER NAME
SIRent SINGAPORE LAND AUTHORITY MARKER NUMBER
4610206114 TRIMBLE NETRS Nav 1.15 OBSERVER / AGENCY
0 REC # / TYPE / VERS
4736A38170 TRM29659.00 RCV CLOCK OFFS APPL
-1521817.0581 6192367.3125 140106.7296 ANT # / TYPE
0.0000 0.0000 0.0000 APPROX POSITION XYZ
1 1 0 ANTENNA: DELTA H/E/N
9 C1 P2 C2 L1 L2 S1 S2 D1 D2# / TYPES OF OBSERV
15.000 INTERVAL
2008 8 4 0 0 0.0000000 GPS TIME OF FIRST OBS
***** COMMENT
Singapore Satellite Positioning Reference Network (SiReNT) COMMENT
***** COMMENT
The APPROX POSITION XYZ coordinates are NOT APPROXIMATE COMMENT
APPROX POSITION XYZ replaced by precise WGS84 VALUE COMMENT
END OF HEADER
08 8 4 0 0 0.0000000 0 11G09G22G14G05G12G18G31G24G21G30G29
22464487.531 22464484.711 -9758506.58406 -7611059.50307
47.000 34.000 -2479.663 -2479.663
24023365.539 24023359.066 2106.172 -5618531.88406 -3975464.64906
43.000 27.000 1641.173
23243521.117 23243517.266 -594.734 -10334445.37106 -8051792.33206
44.000 29.000 -463.429
22255392.008 22255388.195 -14858081.38107 -11576070.03607
50.000 39.000 726.047 565.751
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47.000 44.000 -33.703 -26.262
22423034.883 22423029.406 -12554254.60507 -9791387.91007
48.000 35.000 1819.656 1417.914
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43.000 43.000 3159.031 2461.583
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50.000 42.000 -2375.953 -1851.392
19853665.461 19853660.000 -28417873.41207 -22142923.43908
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44.000 42.000 -1614.938 -1258.393

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Why set up the monitoring stations at Changi?

- Effects of ionosphere on GBAS in Equatorial region and during ionospheric storm not known
- Data on max ionospheric delay useful for safe GBAS implementation at Changi

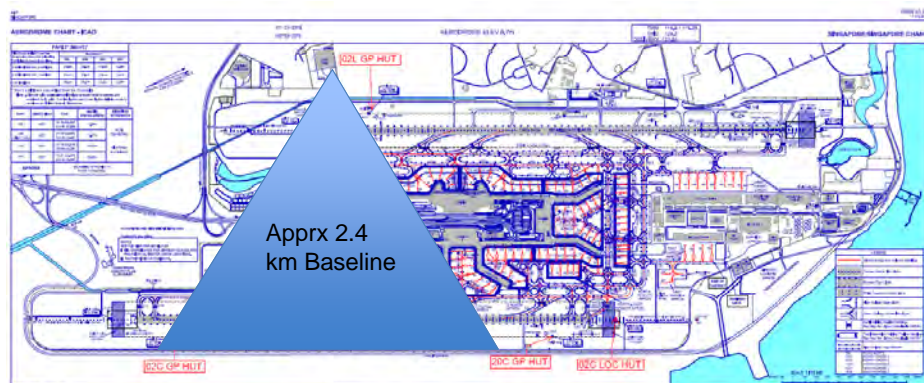
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Project Scope

- Collect data to understand the impact of the ionosphere
- Contribute to the international understanding of the ionosphere anomaly characteristics
- Set-up of 4 GPS monitoring stations at Singapore Changi Airport
- May approach local Univ to assist in the data mining, processing & visualization

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Location of the monitoring stations



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Tentative Project Timeline

S/N	Milestone	Estimated Completion
1	Prepare for data gathering project	Jan 2011
2	Set-up of the GPS receivers at Changi Airport	Jul 2011
3	First research report on data collected (Collation of 1 st six months' data and report of project set-up)	Jan 2012
4	Second research report on the analysis of the data (Based on 18 months of data collected)	Jun 2013
5	Final research report (Based on data collected during solar storm, due to occur between 2013 and 2014)	Oct 2014

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Future Plan

- GBAS (i.e. GLS) is one of our long term goals in the PBN roadmap (2016 and beyond)
- Overall plan for GBAS implementation and ILS replacement
 - Targetted GBAS implementation in 2016
 - Changi ILS replacement in phases before GBAS implementation

Implementation Considerations

- GBAS siting study need to be completed for inclusion in Changi Airport Masterplan
- Research Project on Ionospheric study and data sharing activities from 2011 to 2014

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Thank you

