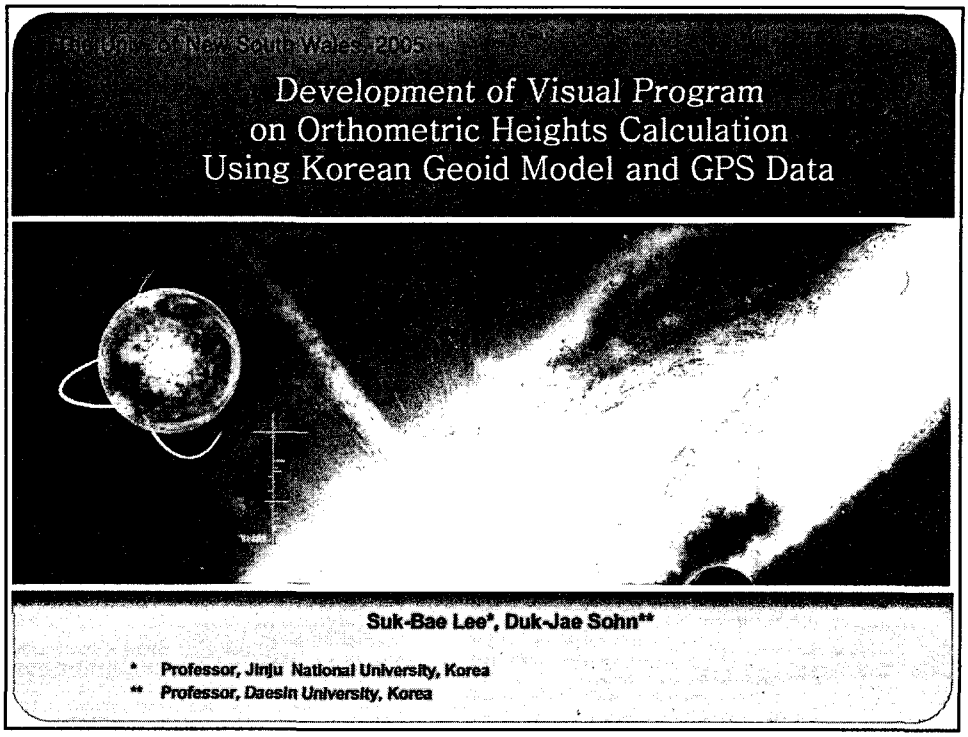
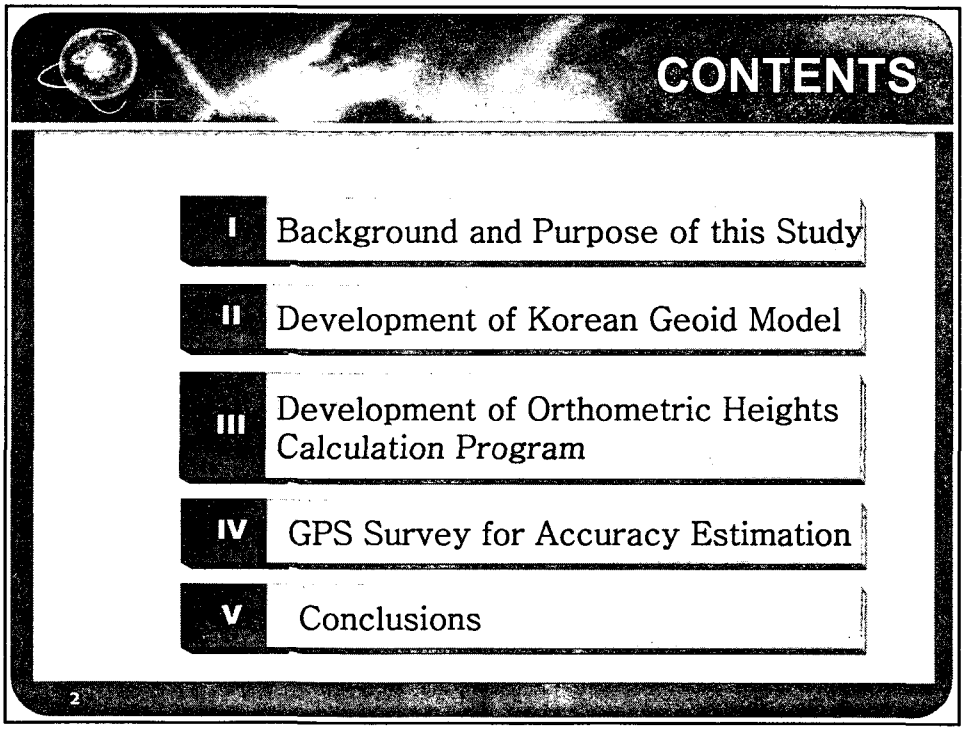

The Univ. of New South Wales 2005
Development of Visual Program
on Orthometric Heights Calculation
Using Korean Geoid Model and GPS Data
Suk-Bae Lee*, Duk-Jae Sohn**
* Professor, Jinju National University, Korea
** Professor, Daesin University, Korea

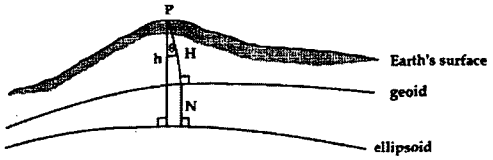

CONTENTS
I Background and Purpose of this Study
II Development of Korean Geoid Model
III Development of Orthometric Heights Calculation Program
IV GPS Survey for Accuracy Estimation
V Conclusions
2

## 1. Background and Purpose of this Paper

Increase of GPS application field → Application of GPS for leveling is possible.

Application of GPS for leveling is possible. → Construction of precise Korean geoid model

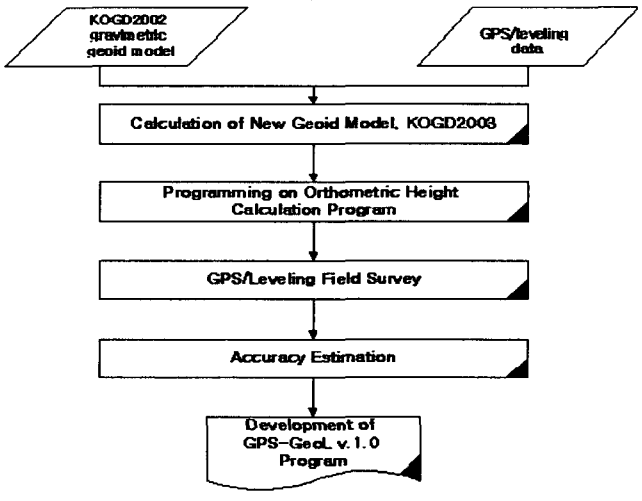
Construction of precise Korean geoid model → Development of Orthometric Heights Calculation Program




$$H = h - N$$

3

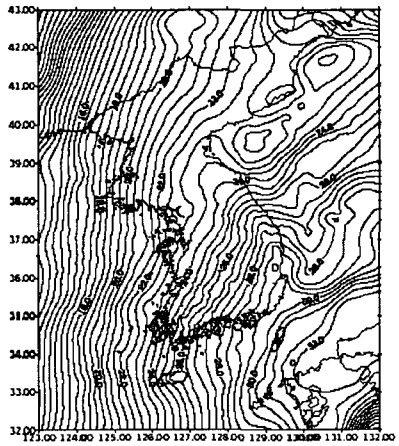
## 1. Background and Purpose of this Study




<Flow Chart of the research process>

4

## 2. Development of Korean Geoid Model

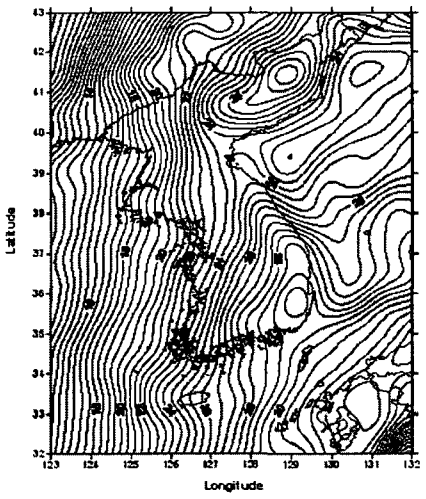


Countour Map of KOGD2002
geoidal heights referred to GRS80
(Countour interval = 0.5m)

-KOGD2002 was made and published by Lee(2002)
-Computation Area:
Latitude 32。N ~ 43。N,
Longitude 123。E ~ 132。E
-Numerical Computation :
Stokes' theory, FFT
2'X2'grid, 89,701 grid point
- Remove and Restore Technique
remove : $\Delta g_{res} = \Delta g_{FA} - \Delta g_{GM} - \Delta g_h$
restore: $N = N_{GM} + N_{\Delta gres} + N_h$
- Data used :
long-wavelength effect : EGM96
medium-wavelength effect :
14,608 gravity data
19,833 satellite altimetry data
short-wavelength effect :
Korean 2'X2'grid dem

5

## 2. Development of Korean Geoid Model




-But, the KOGD2002 have a certain limit of accuracy.

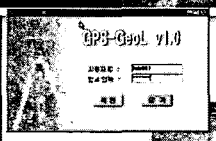
-So, to improve the accuracy of the geoid model, geometric geoid combined to KOGD2002.

-KOGD2002 + 59 GPS/leveling data
= KOGD2003

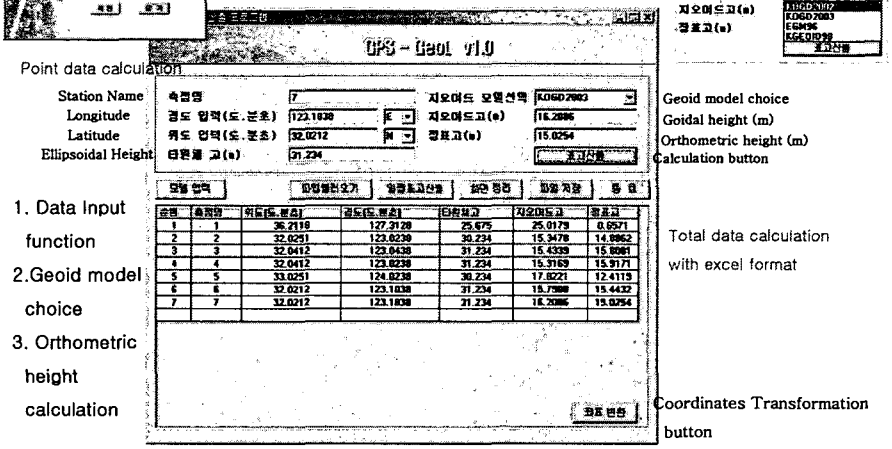
Countour Map of KOGD2003
geoidal heights referred to GRS80
(Countour interval = 0.5m)

6

# 3. Development of Orthometric Heights Calculation Program




<Orthometric height calculation Part>




1. Data Input function
2.Geoid model choice
3. Orthometric height calculation



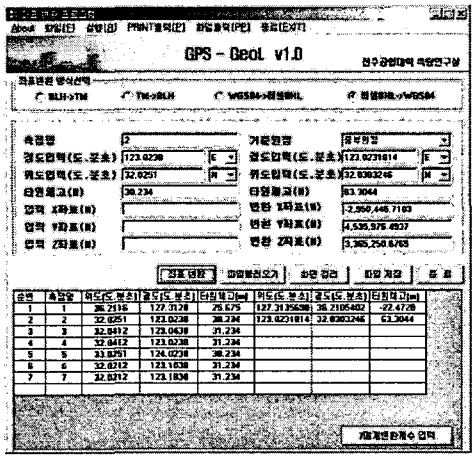
# Change of Korean geodetic reference syste

| Items | Before Change (local) (Until 2003) | After Change (geocentric) (Since 2003) |
|---|---|---|
| Geodetic frame | Tokyo Datum | ITRF 2000 |
| Reference ellipsoid | Bessel 1841 | GRS80 |
| Geodetic datum | Suwon geographical datum | Center of Earth Mass |
| Vertical datum | Korean mean sea level | Korean geoid (mean sea level) |
| Use | Surveying & cartography | In all national geographical information data |

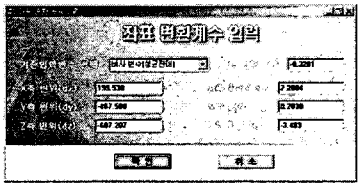
Prevent confusing, both coordinates system can use in period of 2003-2006

# 3. Development of Orthometric Heights Calculation Program

<Coordinates Transformation Part>




A main frame of GPS-GeoL v.1.0 about coordinates transformation

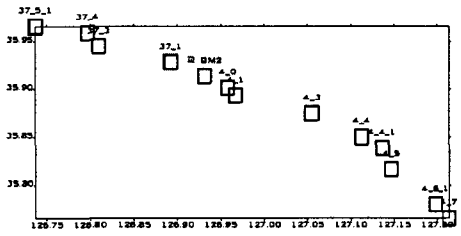


Input function of coordinates transformation parameter sets

Choice function of coordinates transformation parameter sets

9

# 4. GPS Survey for Accuracy Estimation



Map of GPS Survey area

For accuracy estimation, GPS survey was carried out at 13 vertical control points distributed in 53km Korean second leveling line, located in Kunsan and Jeonju city southwestern part of Korea.

| | |
|---|---|
| Number of survey point | 1 3 vertical control points and 2 horizontal control points |
| Receiver used | 2 Trimble 5700 and 4 Topcon Legacy |
| Observation period and time | Nov. 12 - Nov. 14, 2002<br>1 hour observation per session |
| Number of session | 4 |
| Data processing software | TGO(Trimble) and Pinnacle(Topcon) |

Data Processing : 'Regulations of 1st and 2nd order control points survey by GPS' of Korean NGII

10

# 4. GPS Survey for Accuracy Estimation

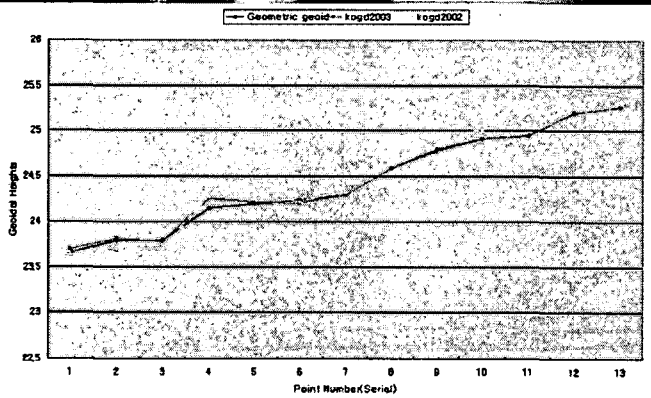
<Comparison of orthometric heights >

| NO. | BM NO | Longitude(°) | Latitude(°) | A | B | C | D | E |
|---|---|---|---|---|---|---|---|---|
| 1 | 37_5_1 | 126.736930E | 35.966176N | 28.883 | 23.6573 | 5.2603 | 5.2257 | 0.0346 |
| 2 | 37_4 | 126.796758E | 35.959321N | 33.690 | 23.7928 | 9.9196 | 9.8972 | 0.0224 |
| 3 | 37_3 | 126.809901E | 35.944910N | 32.610 | 23.7948 | 8.7977 | 8.8152 | -0.0175 |
| 4 | 37_1 | 126.892364E | 35.928256N | 29.402 | 24.1512 | 5.3572 | 5.2508 | 0.1064 |
| 5 | 四BM2 | 126.931213E | 35.913427N | 33.788 | 24.1927 | 9.6219 | 9.5953 | 0.0266 |
| 6 | 4_0 | 126.958376E | 35.901275N | 32.567 | 24.2303 | 8.3083 | 8.3367 | -0.0284 |
| 7 | 4_1 | 126.967062E | 35.893142N | 33.866 | 24.2952 | 9.5747 | 9.5708 | 0.0039 |
| 8 | 4_3 | 127.055345E | 35.874599N | 49.760 | 24.5883 | 25.1701 | 25.1717 | -0.0016 |
| 9 | 4_4 | 127.112949E | 35.850054N | 47.835 | 24.7959 | 23.0232 | 23.0391 | -0.0159 |
| 10 | 4_4_1 | 127.136536E | 35.838107N | 61.446 | 24.9129 | 36.5397 | 36.5331 | 0.0066 |
| 11 | 4_5 | 127.146569E | 35.815982N | 65.915 | 24.9592 | 40.9449 | 40.9558 | -0.0109 |
| 12 | 4_6_1 | 127.198336E | 35.779824N | 101.555 | 25.2061 | 76.3508 | 76.3489 | 0.0019 |
| 13 | 4_7 | 127.214016E | 35.765394N | 117.843 | 25.2712 | 92.5606 | 92.5718 | -0.0112 |

A : Ellipsoidal heights by GPS
B : Geoidal heights extracted from GPS-GeoL v1.0
C : Orthometric heights calculated in GPS-GeoL v1.0
D : Official coordinates of orthometric heights issued by NGII
E : Differences of C and D(C-D)

11

# 4. GPS Survey for Accuracy Estimation

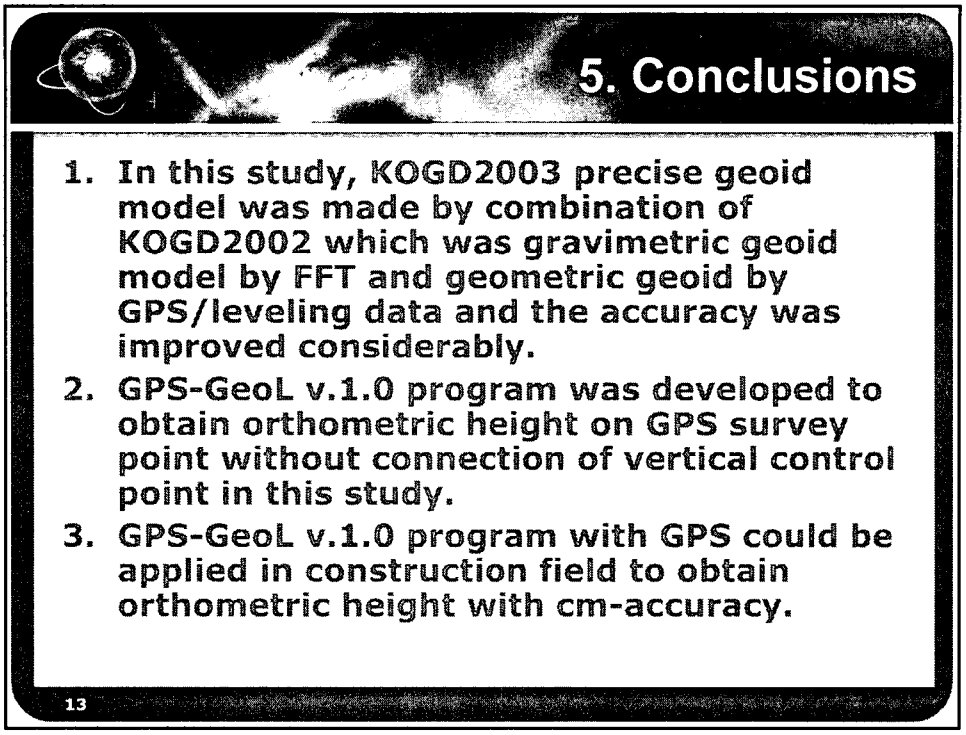



Comparison chart of geoidal heights of KOGD2002, KOGD2003 and GPS/leveling geoid

| Items | KOGD2002 | KOGD2003 |
|---|---|---|
| Minium value | -0.0871 m | -0.0284 m |
| Maximum value | 0.2296 m | 0.1064 m |
| Mean value | 0.0776 m | 0.0221 m |
| RMS | 0.0961 m | 0.0332 m |

Statistics of differences between KOGD2002, KOGD2003 and GPS/leveling geoid

12


5. Conclusions
1. In this study, KOGD2003 precise geoid model was made by combination of KOGD2002 which was gravimetric geoid model by FFT and geometric geoid by GPS/leveling data and the accuracy was improved considerably.
2. GPS-GeoL v.1.0 program was developed to obtain orthometric height on GPS survey point without connection of vertical control point in this study.
3. GPS-GeoL v.1.0 program with GPS could be applied in construction field to obtain orthometric height with cm-accuracy.
13