Assessment of Sea Ice and Ice Sheet Elevation Change in Antarctic Region Using ICESAT

Remote Sensing Class Project

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2005, UTSA

SCOPE

1. **Why** is ice elevation change important?

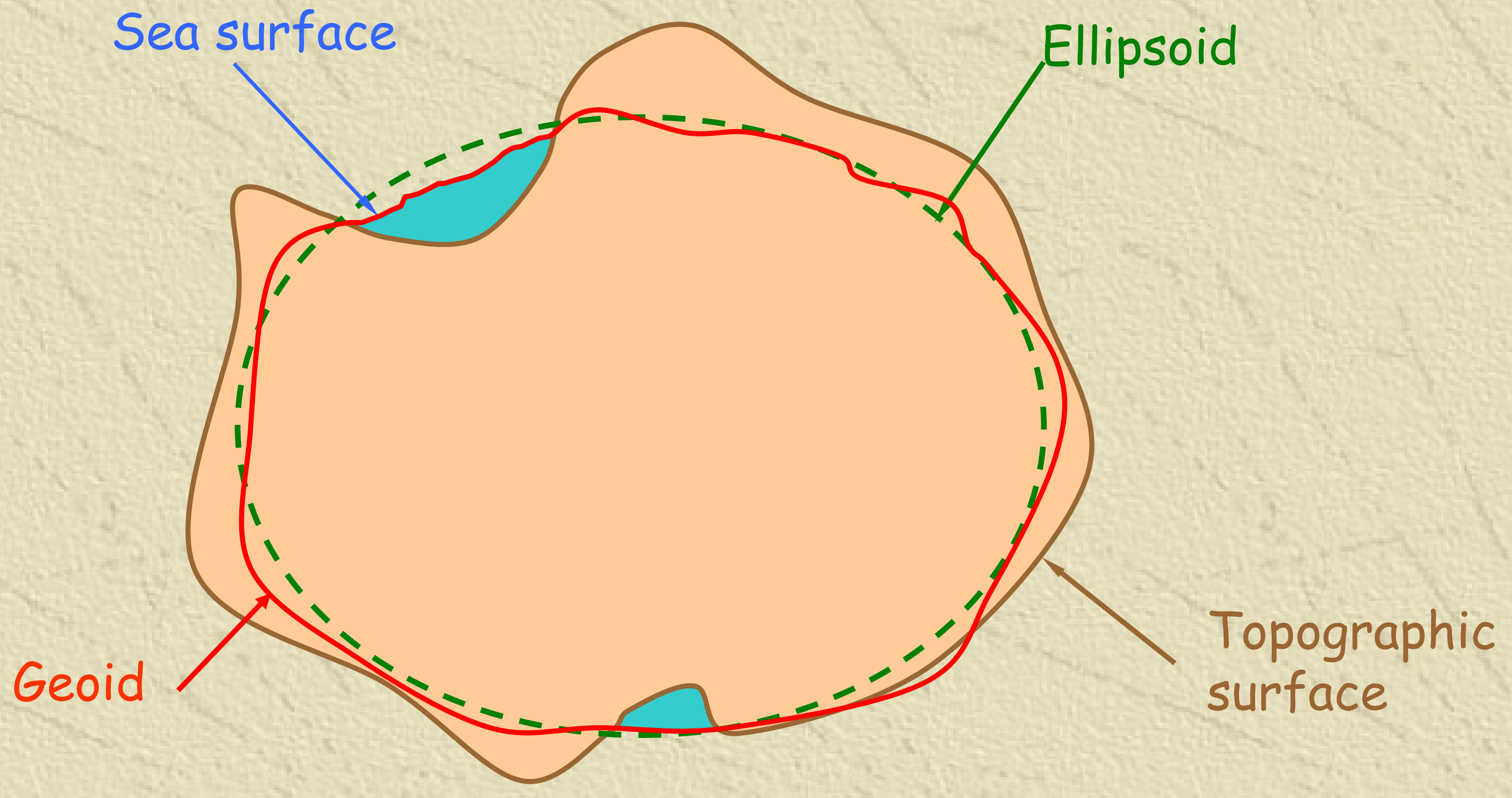
2. **Where** is the focus area?

3. **How** and What could we use to detect changes?

4. **Results** so far?

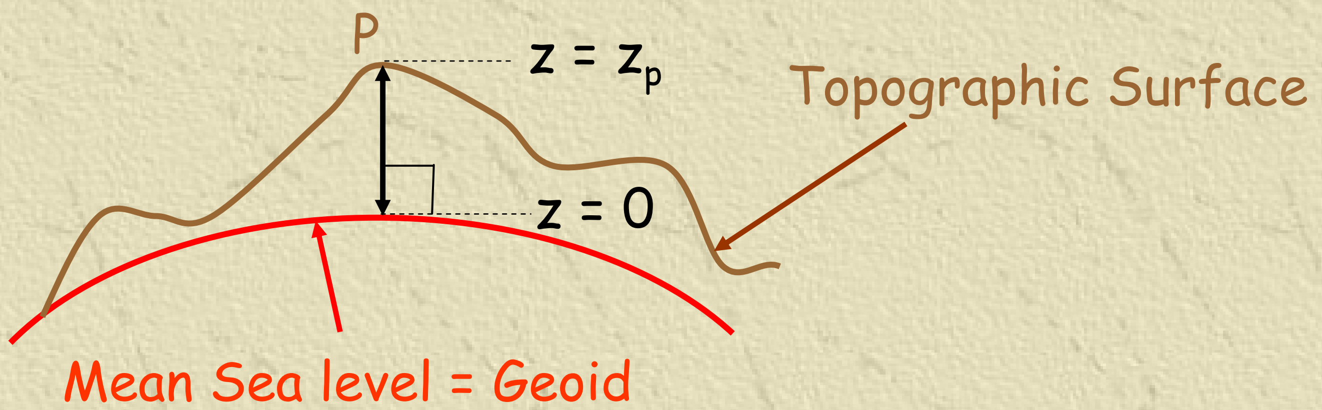
1.Why?

Earth Surfaces



Geoid is a surface of constant gravity.

Elevation

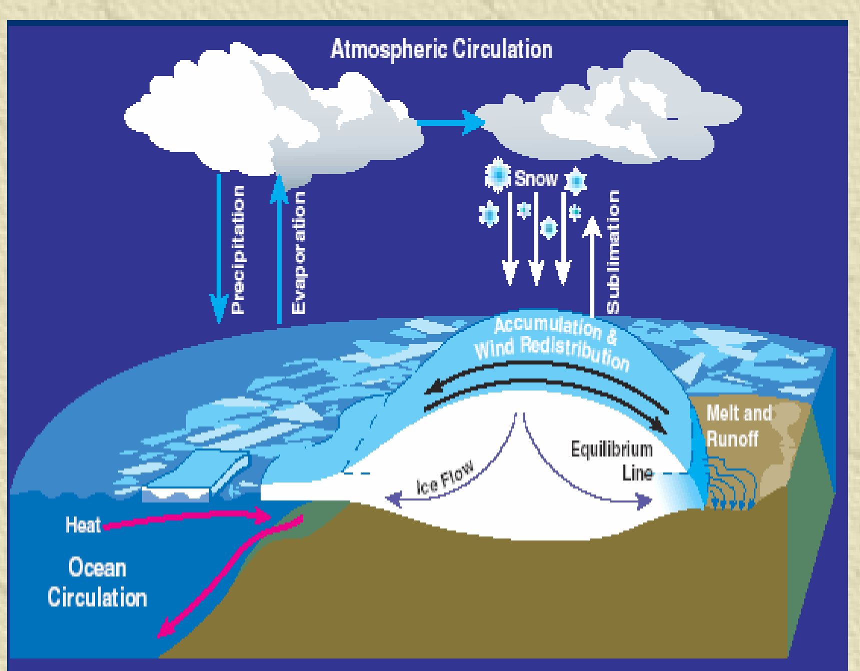


Elevation is measured from the Geoid

2.Where?

West & East Antarctic

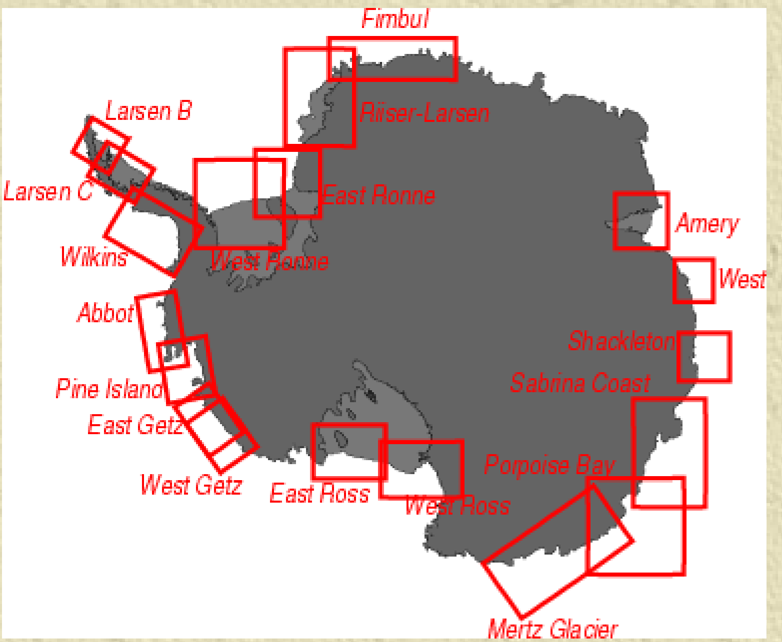
- Greenland: ~7 meters
- West Antarctica : ~5 meters
- East + West Antarctica: ~70 meters

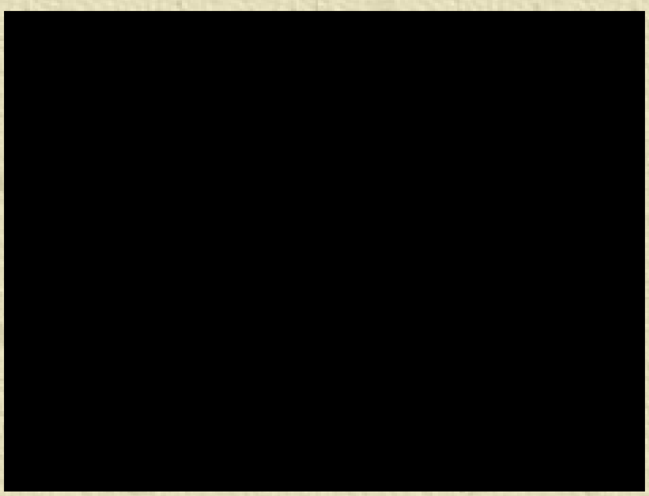


2.Where?

Ross Ice Shelf

The Ross Ice Shelf is larger than the state of Texas. Three years ago, the Ross Ice Shelf began shedding ice bergs.

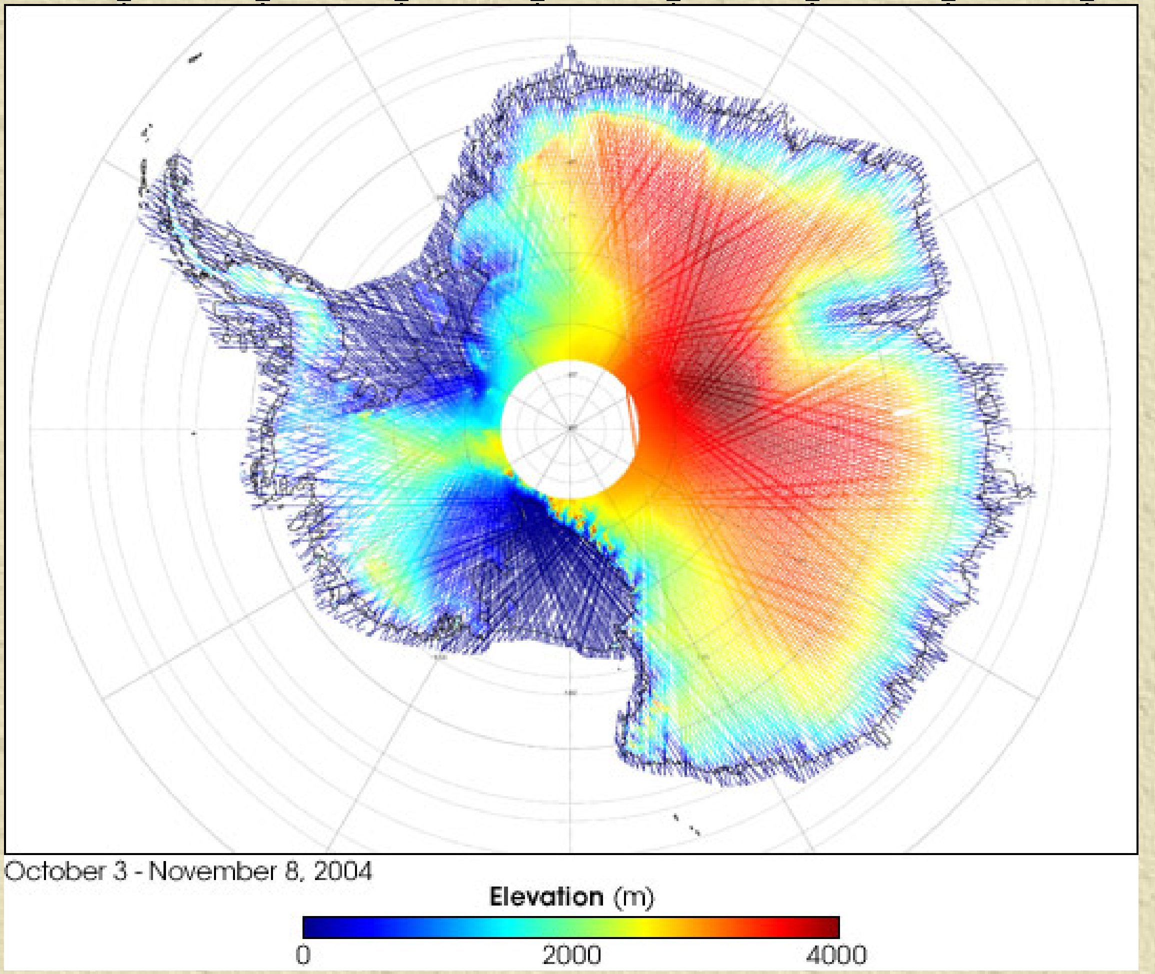




http://www.csr.utexas.edu/glas/pdf/fig1_antarc.pdf

2.Where?

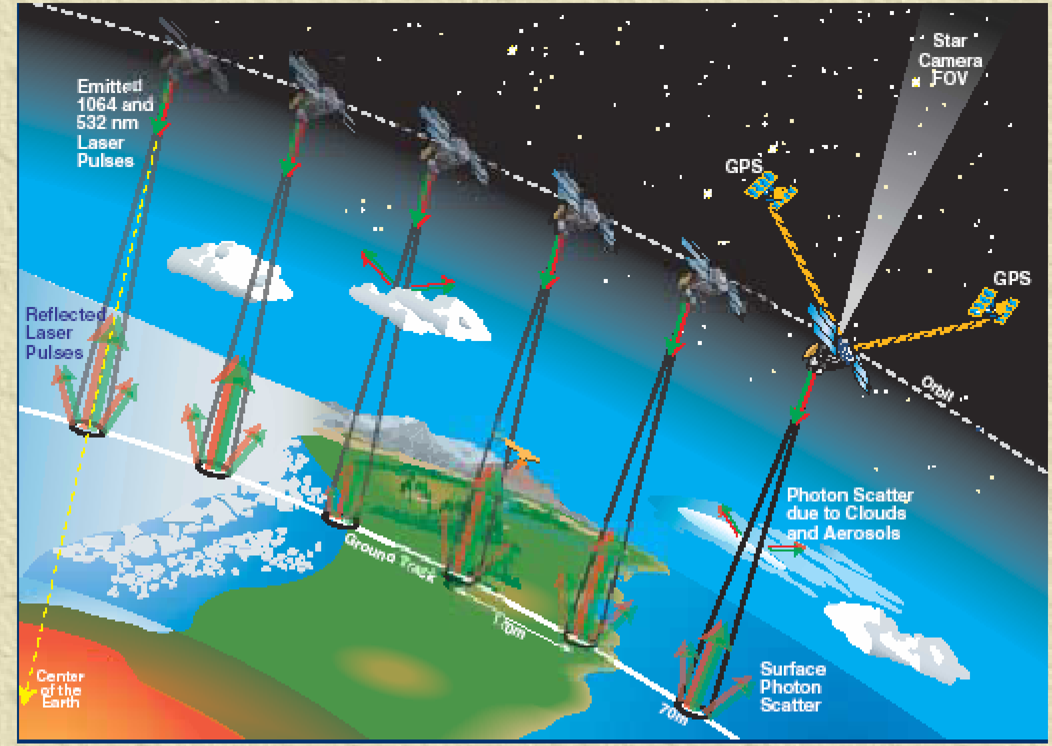
Ross Ice Shelf



Antarctica's Land and Ice Elevation

3. How?

ICESAT



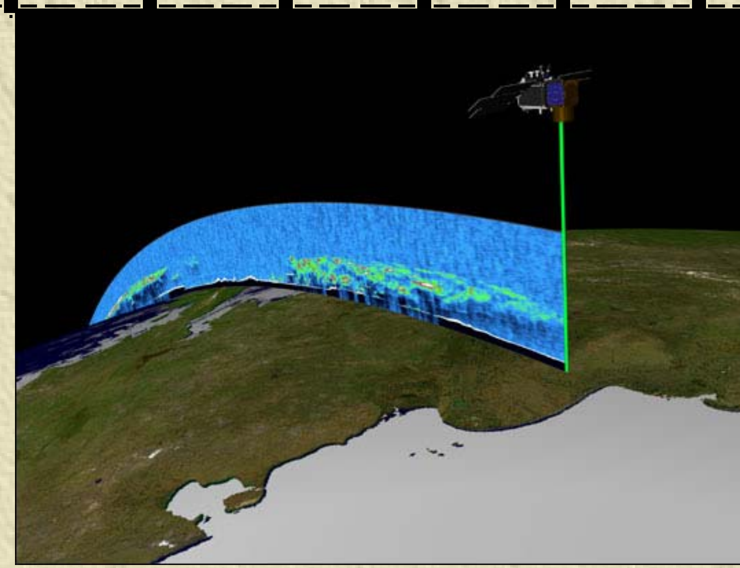
(GLAS) on ICESat is a "laser radar" that profiles the height distribution of clouds and aerosol particles in the atmosphere, along with the surface height.

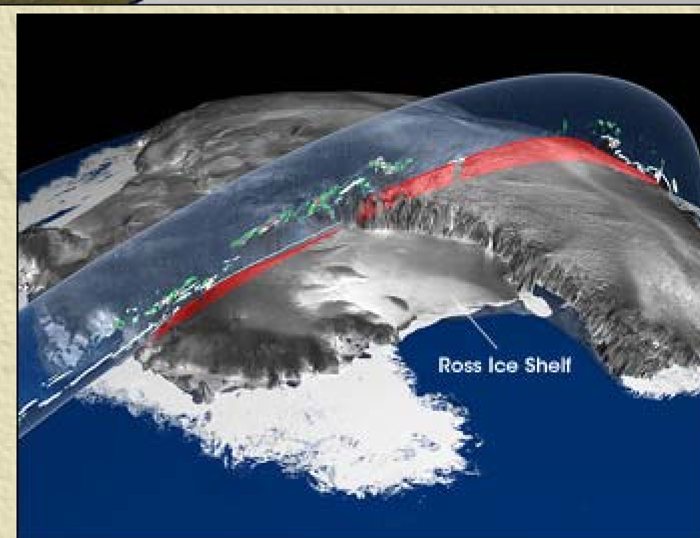
3. How?

ICESAT

ICESat captures Earth in Spectacular 3-D images

3-D Data from ICESat





The data are helping scientists understand how life on Earth is affected by changing climate.

ICESat Standard Data Products

- Seven Altimetry Products
  - GLA01, GLA05-06, GLA12-15
- Six Atmosphere Products
  - GLA02, GLA07-11
- Two Engineering Products
  - GLA03-04

3. How?

ICESat Standard Data Products

Short Name	Long Name	File size	Granules per day
GLA01	L1A Global Altimetry Data	9 MB	56
GLA02	L1A Global Atmosphere Data	671 MB	7
GLA03	L1A Global Engineering Data	19 MB	7
GLA04	L1A Global Laser Pointing Data	2 MB - 386 MB	7
GLA05	L1B Global Waveform-based Range Corrections Data	25 MB	56
GLA06	L1B Global Elevation Data	7 MB	56
GLA07	L1B Global Backscatter Data	827 MB	7
GLA08	L2 Global Planetary Boundary Layer and Elevated Aerosol Layer Heights	7 MB	1

3. How?

ICESat Standard Data Products

GLA09	L2 Global Cloud Heights for Multi-layer Clouds	82 MB	1
GLA10	L2 Global Aerosol Vertical Structure Data	289 MB	1
GLA11	L2 Global Thin Cloud/Aerosol Optical Depths Data	13 MB	1
GLA12	**L2 Global Antarctic and Greenland Ice Sheet Altimetry Data**	**104 MB**	**1**
GLA13	**L2 Global Sea Ice Altimetry Data**	**107 MB**	**1**
GLA14	L2 Global Land Surface Altimetry Data	209 MB	1
GLA15	L2 Global Ocean Altimetry Data	279 MB	1

3. How?

ICESAT

- Ordered Data (NSIDC – for Winter & Summer)
- Raw Data (binary) converted to txt. (IDL readers)
- Text document is subsetted by Labview
- GIS (ArcMap)

3. How?

Ground tracks to surface: GIS-Interpolation

- IDW: IDW assumes that the surface is being driven by local variation. IDW uses a simple algorithm based on distance.

- KRIGING: forms weights from surrounding measured values to predict values at unmeasured locations. Kriging methods depend on mathematical and statistical models. Kriging weights come from a semivariogram that was developed by viewing the spatial structure of the data.
  - Ordinary Kriging (unknown mean of elevation)
  - Simple Kriging (known mean of elevation)

Evaluations of different methods

- Mean prediction error should be near zero, the mean standardized error should be near zero
- The smaller the RMS (root-mean-square) prediction error, the better
- Uncertainty of prediction standard errors: average estimated standard error versus RMS prediction error.
  - equal, good
  - larger than RMS, overestimate
  - less than RMS, underestimate

  or RMS standardized error

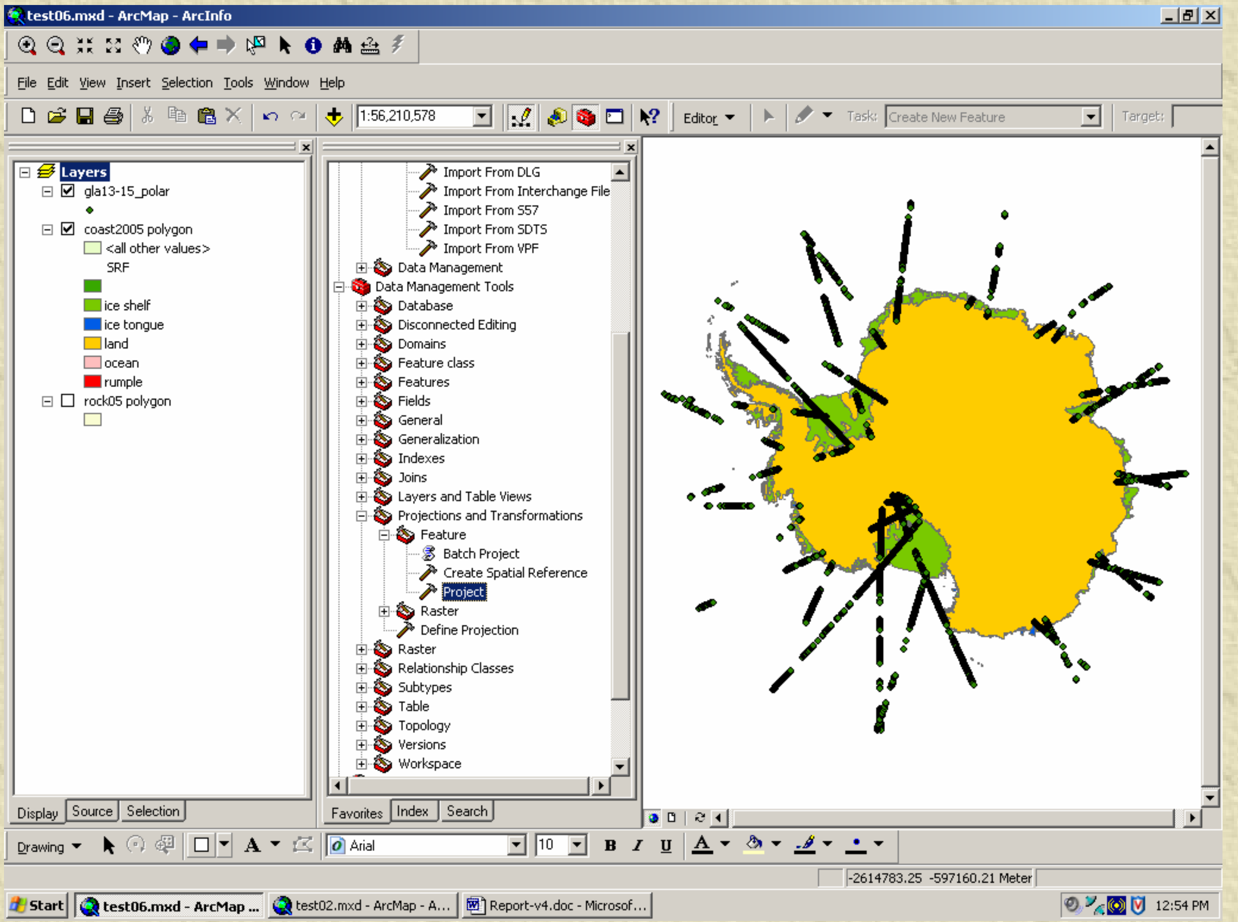
  - =1, good,
  - <1, overestimate
  - >1, underestimate

Calculation Of Mean for Study Area

- DEM download from NSIDC
- Get the average elevation of the study area (539 m)

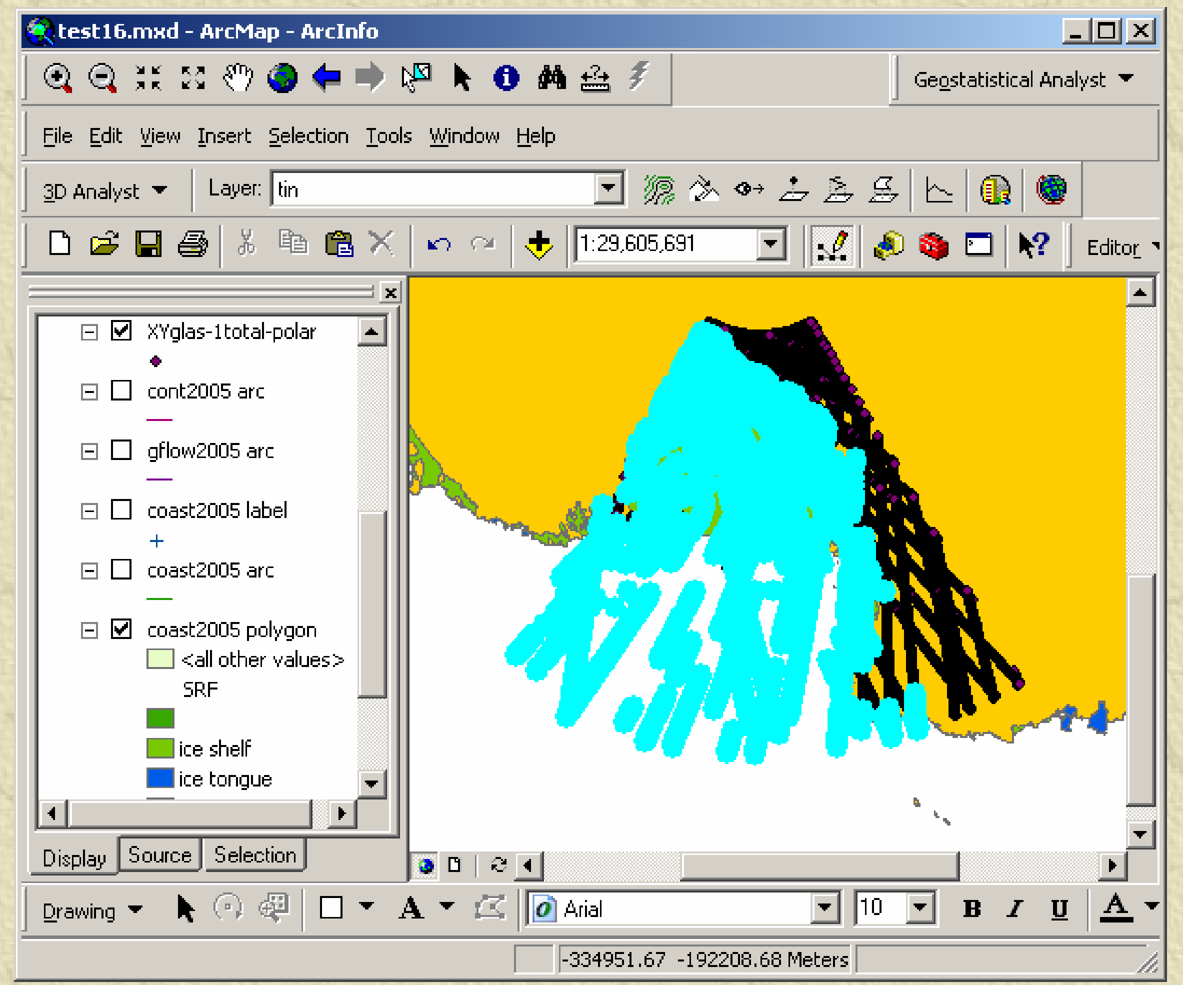
4. Results?

ICESat ground tracks in one day



4. Results?

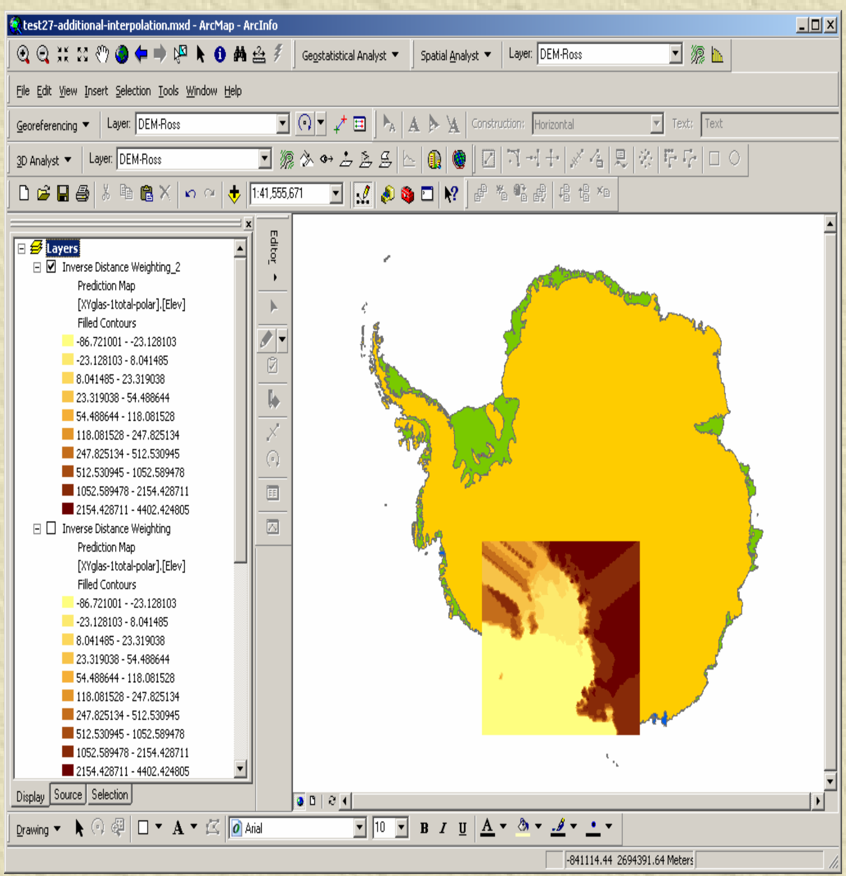
ICESat ground tracks in 9 days



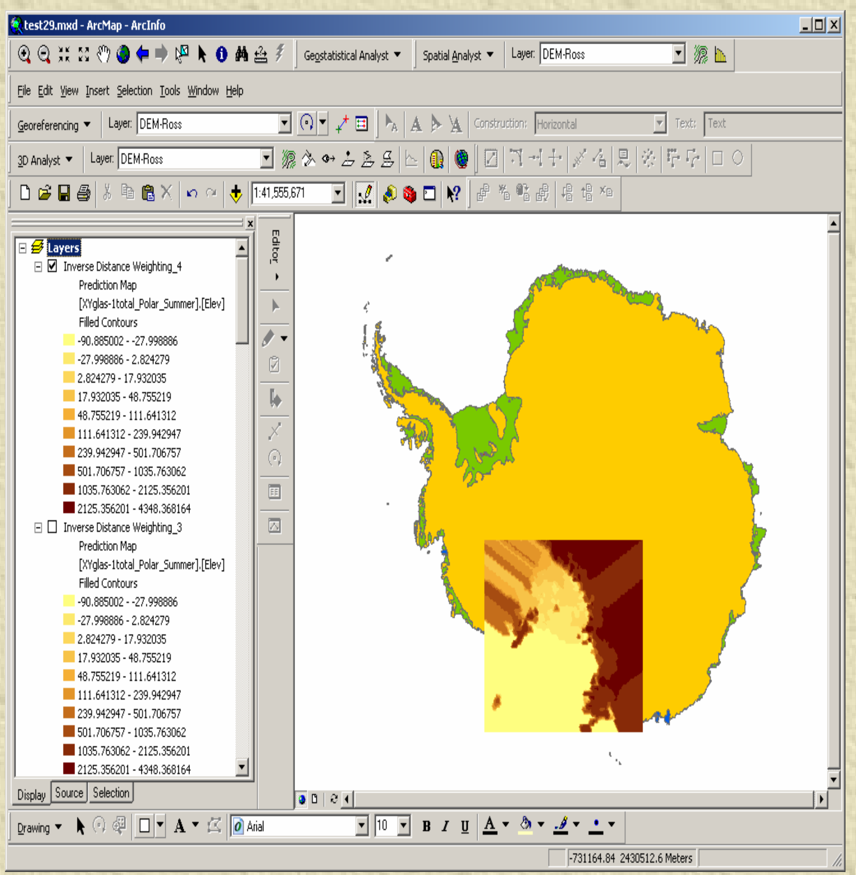
4. Results?

Surface of Interpolation

- IDW-Winter

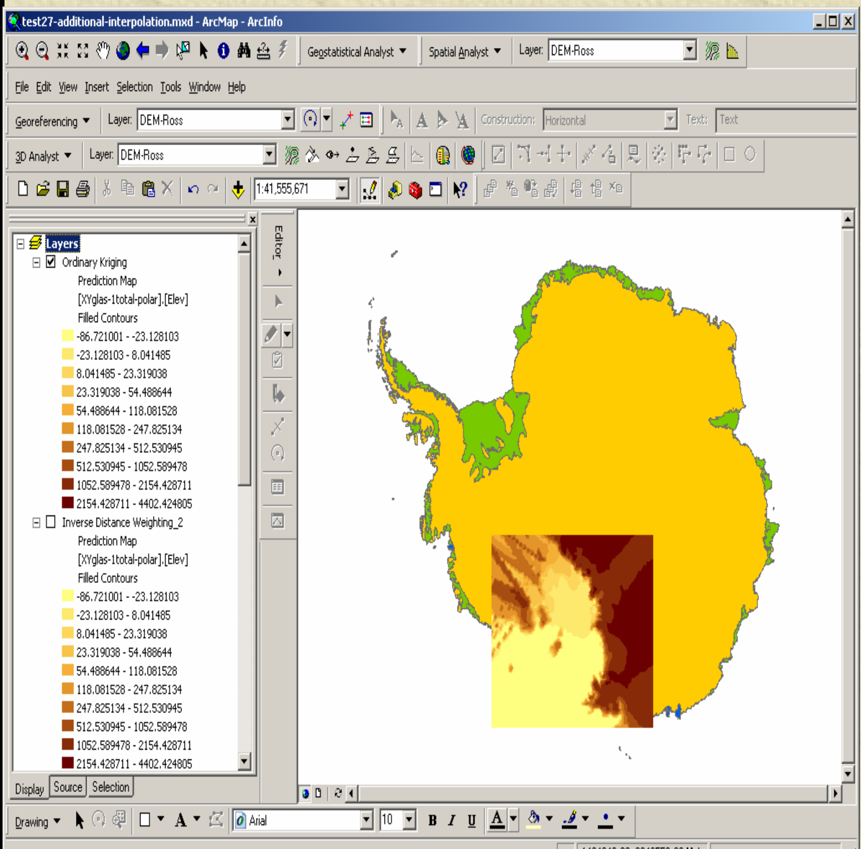


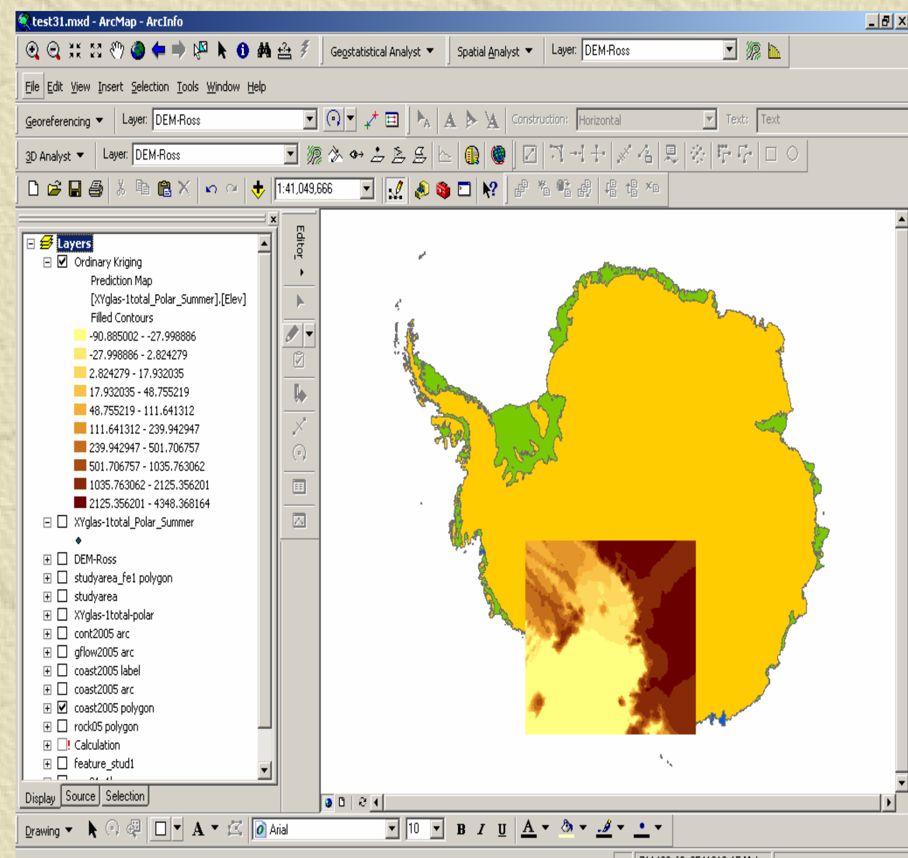
- IDW-Summer



GIS-Interpolation (4. What?)

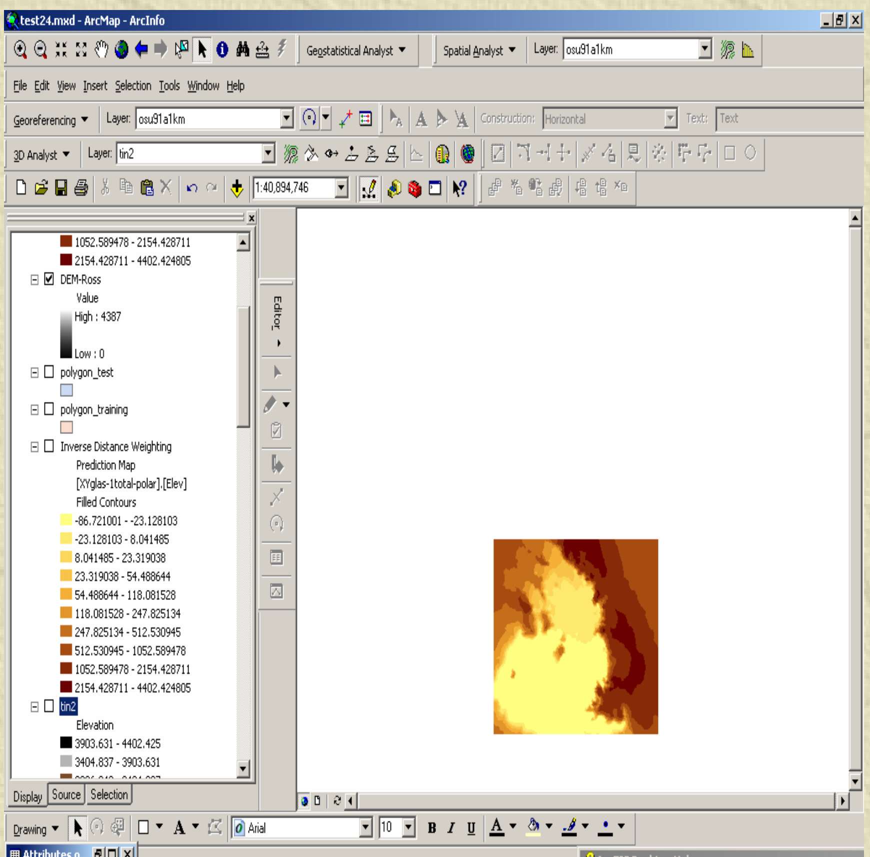
- Ordinary Kriging-Winter
- Ordinary Kriging-Summer



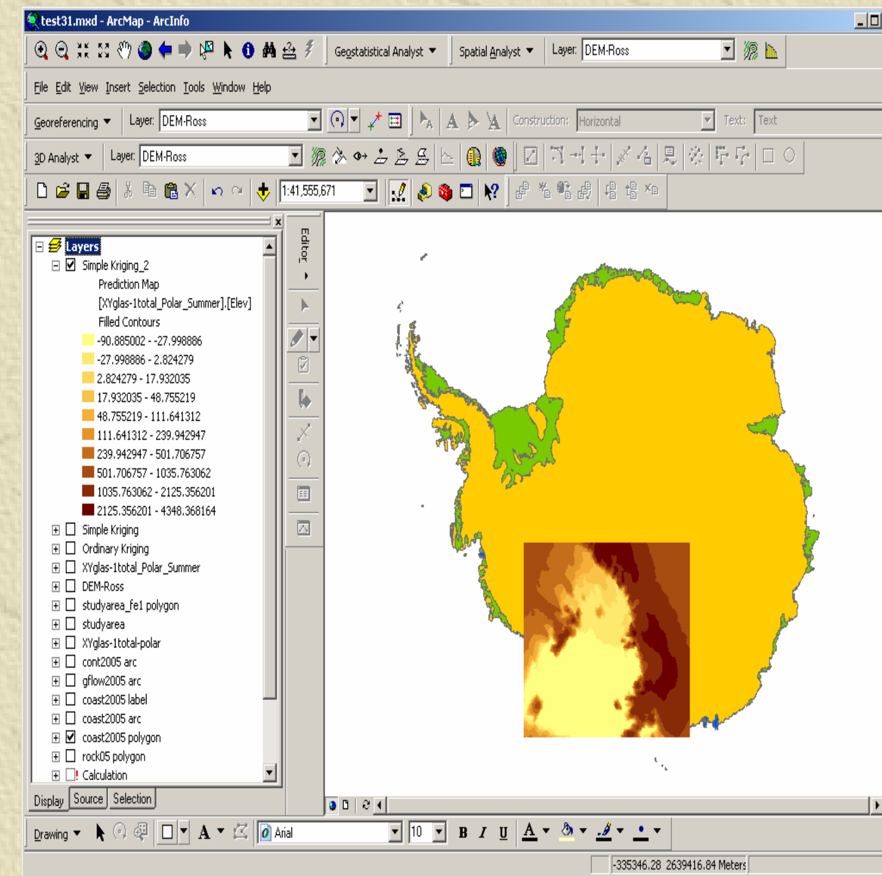


GIS-Interpolation (4. What?)

- Simple Kriging-Winter



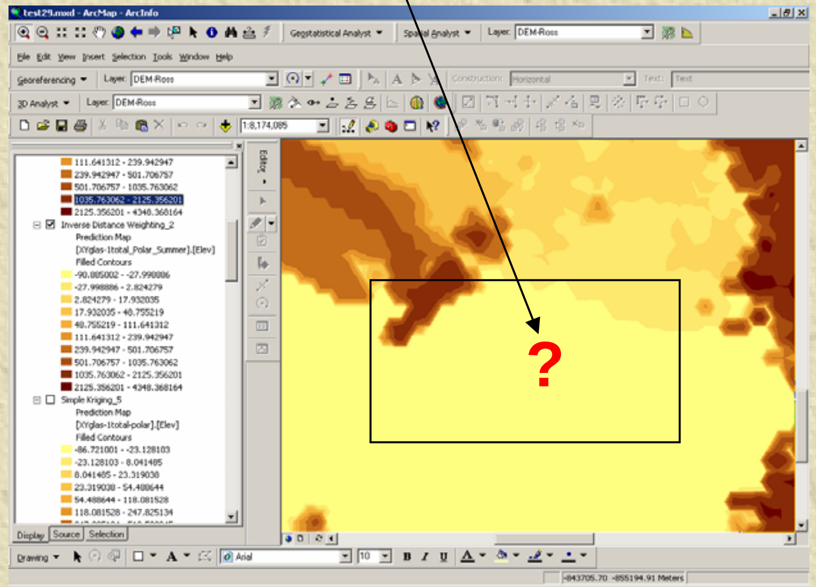
- Simple Kriging-Summer



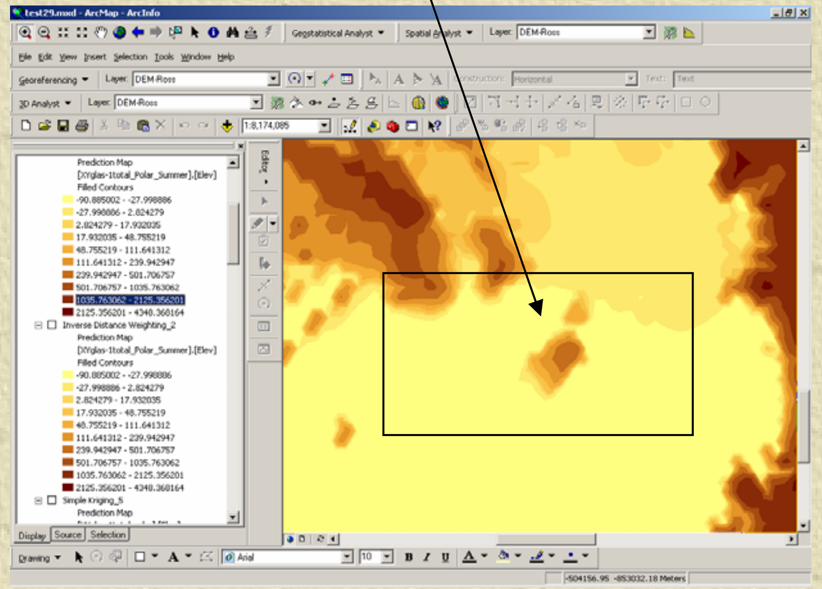
4. Results?

Winter iceberg was missed by the IDW method

IDW



Ordinary Kriging



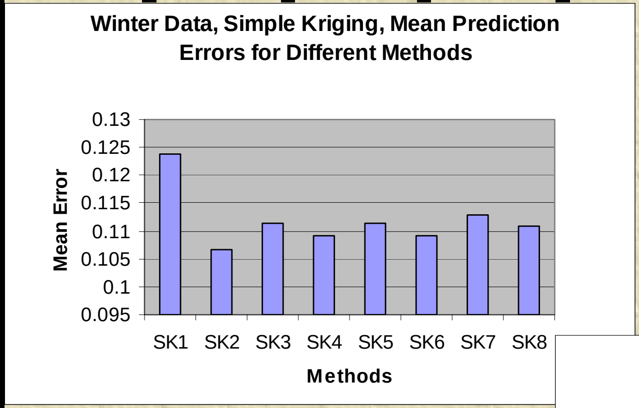
4. Results?

Parameters of Simple Kriging

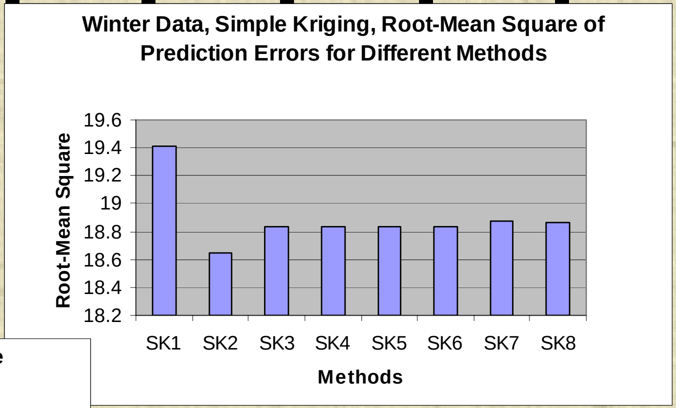
Simple Kriging (1)	1047.4/Neighboorhood	5	2	K1
Simple Kriging (2)	539/Neighboorhood	5	2	K2
Simple Kriging (3)	1047.4/Neighboorhood	10	2	K3
Simple Kriging (4)	539/Neighboorhood	10	2	K4
Simple Kriging (5)	1047.4/Neighboorhood	10	10	K5
Simple Kriging (6)	539/Neighboorhood	10	10	K6
Simple Kriging (7)	1047.4/Neighboorhood	15	10	K7
Simple Kriging (8)	539/Neighboorhood	15	10	K8

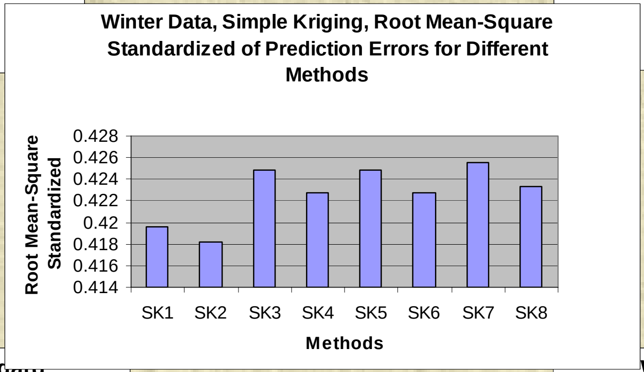
4. Results?

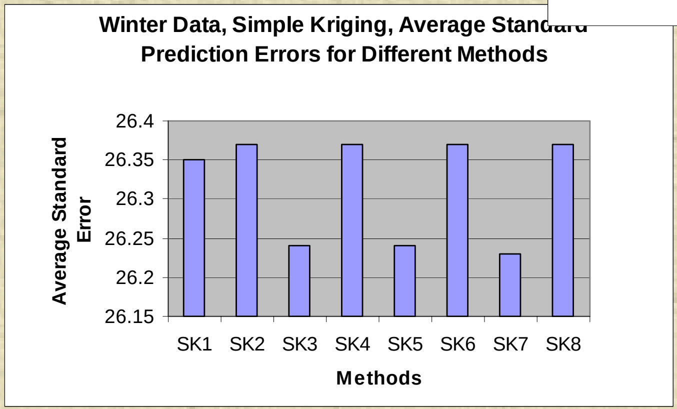
Simple Kriging Results

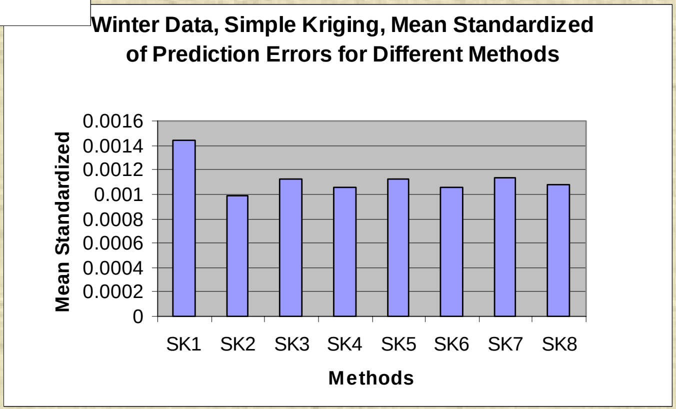


Excel-Winter





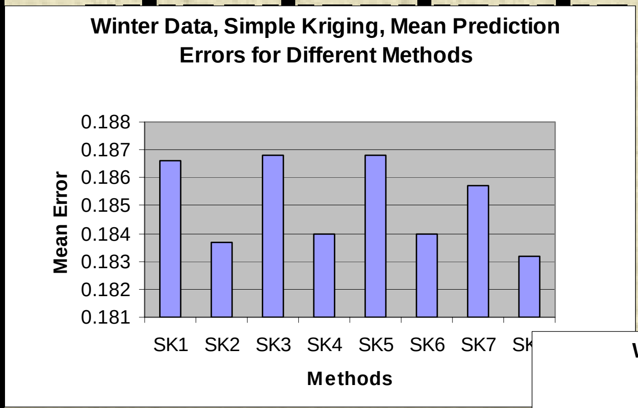


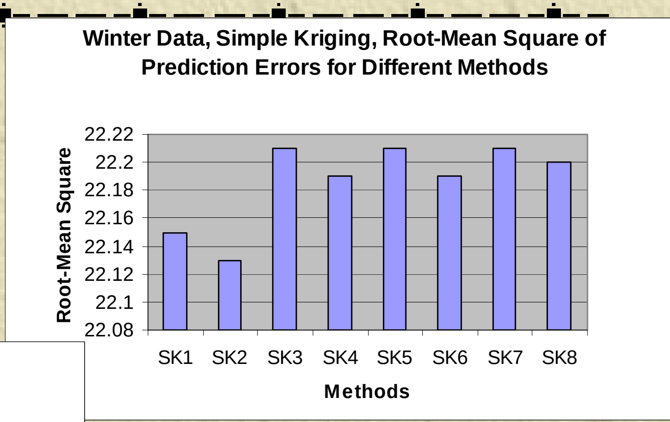


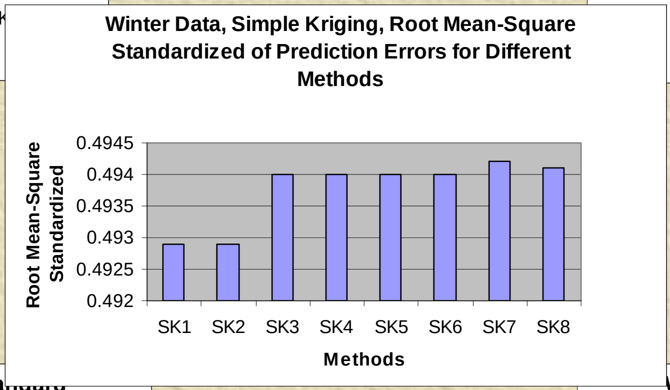
4. Results?

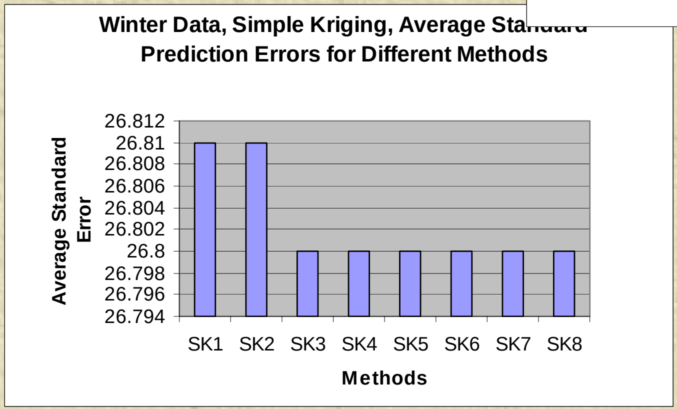
Simple Kriging Results

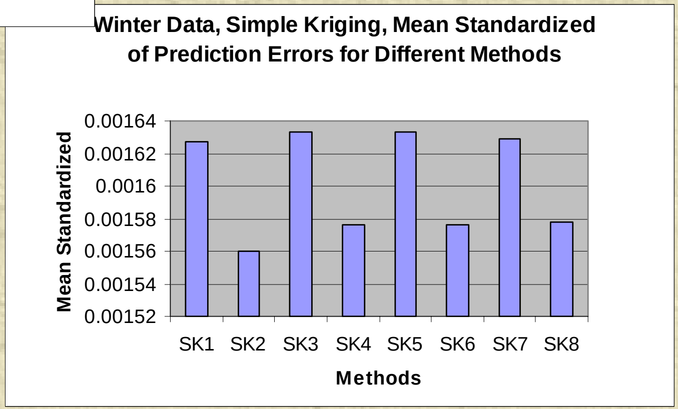
Excel-Summer







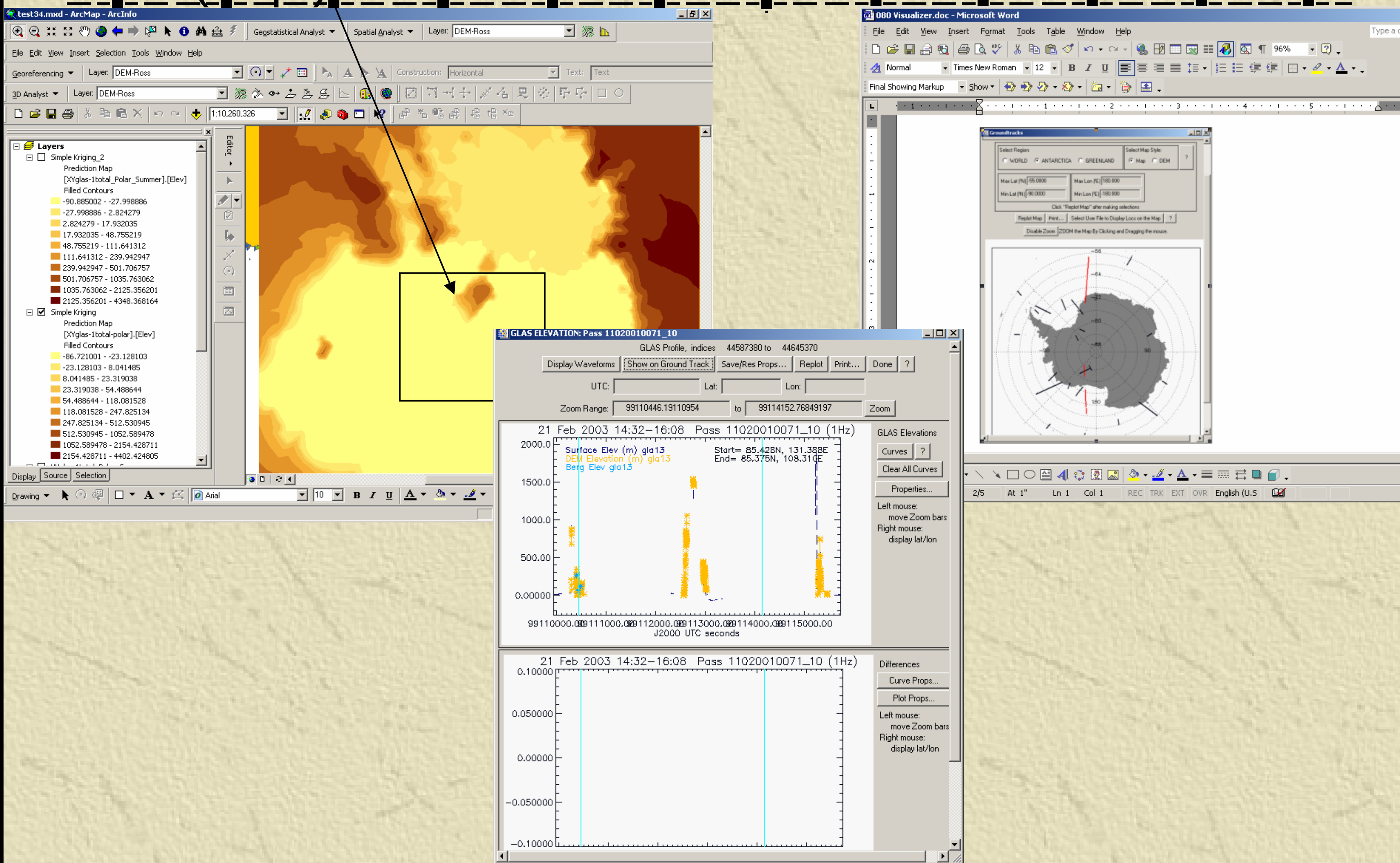




4. Results?

Comparison of Summer & Winter

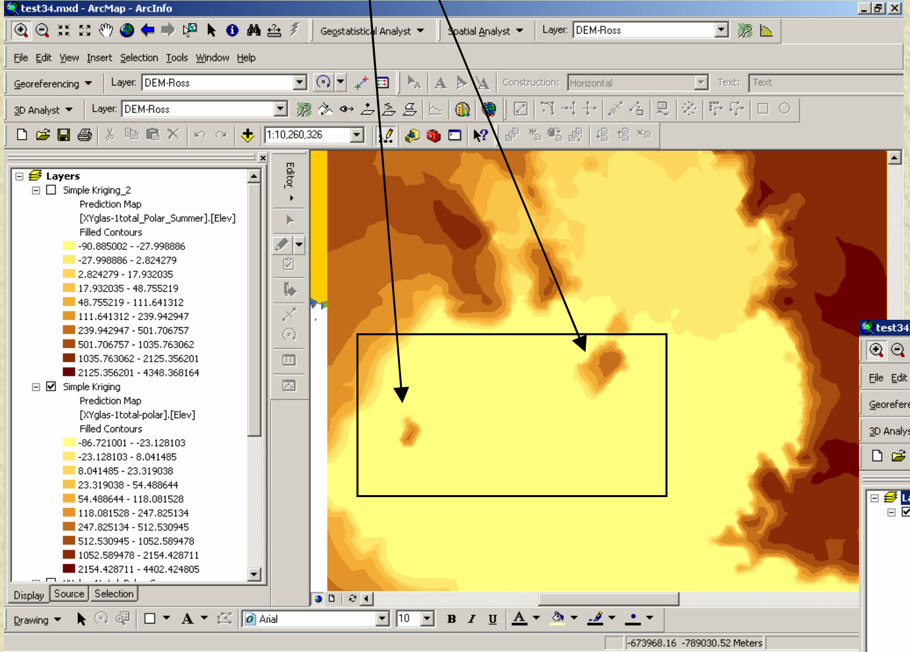
Winter (Sept) -2003



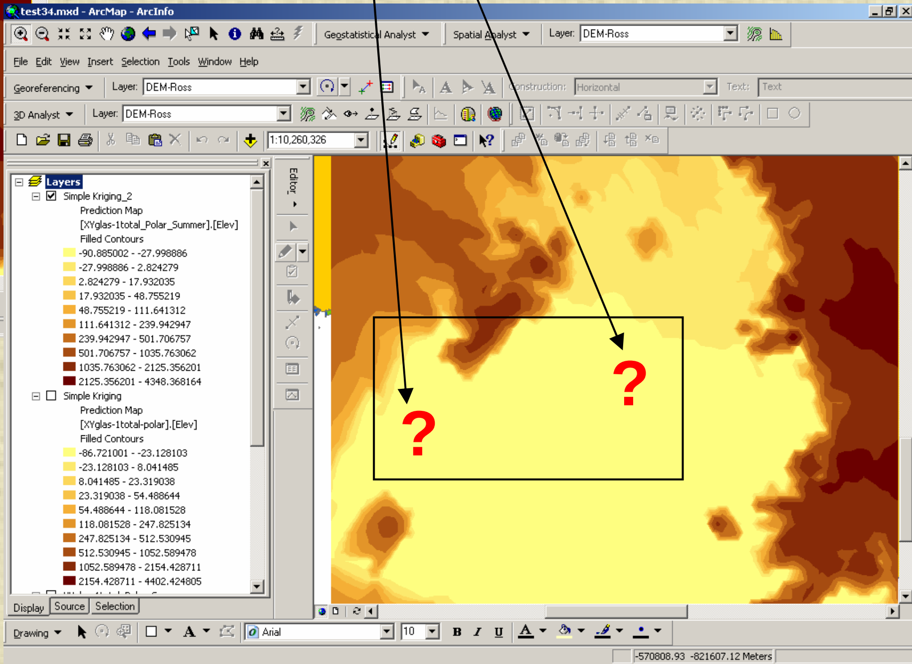
4. Results?

Comparison of Summer & Winter

Winter (Sept) -2003



Summer (Feb)-2003



Conclusion

- Simple Kriging produced better surface for this study.
- Sea ice cover minimum reduced about 6-7 meters during summer time
- Ice Land decreased minimum 20 meters during summer time

Future works

- Time Series
- Compare with MODIS,AMSR-E,ERS-1&2
- Crossover analysis; calculating the difference in elevation between an ascending and descending pass when it crosses over the same location but is separated temporally
- Validation with GPS data

Thank you…


The End