Cell size influence on DEM volume calculation

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What?

- Use high-resolution LiDAR data to see how the calculated volume changes as resolution decreases.

Why?

- Sedimentary Geology
- Numerical simulation of coastal systems
  - Volume is an important factor in simulations
  - Is SRTM good for this?

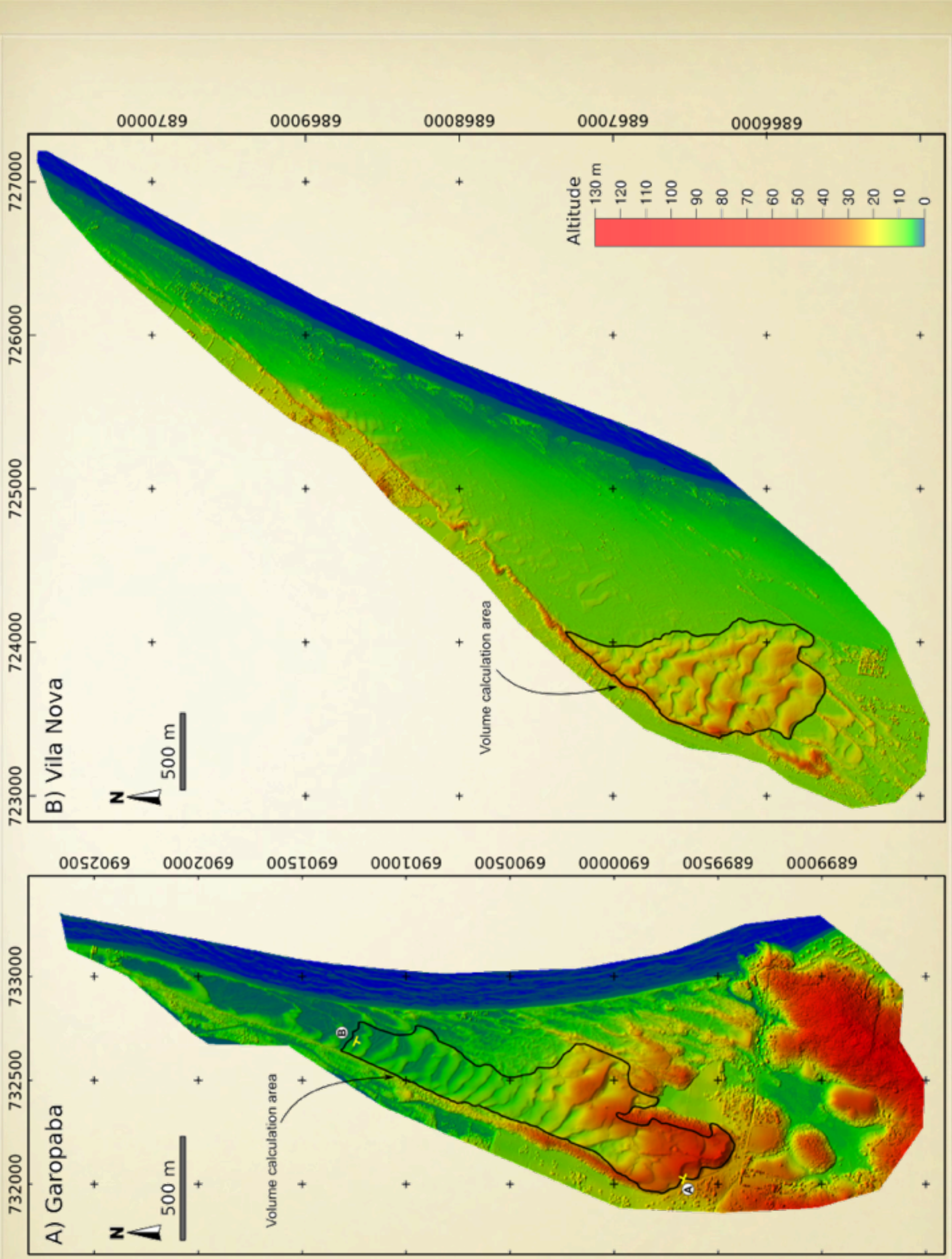
Where?

- Brazil (south)
- Garopaba and Imbituba, two small cities south of Florianópolis
    - Garopaba dune field
    - Vila Nova dune field

Brazil
Florianópolis
Santa
Catarina
Island
Enseada
do Brito
Guarda
do Embaú
Garopaba
Imbituba
Itapirubá
0
10
20 km

LiDAR survey

- Geoid Laser Mapping Co.
- Optech ALTM 3100
- About one point per 0.5m
- Altitude of 1200 m (4000 ft).
- Vertical accuracy of 0.15m
- Processed with libLAS and GRASS


A) Garopaba
B) Vila Nova
N
500 m
Volume calculation area
Altitude
130 m
120
110
100
90
80
70
60
50
40
30
20
10
0
732000
732500
733000
724000
725000
726000
727000
689000
689500
690000
690500
691000
691500
692000
692500
686000
686700
686800
686900
687000
723000
A
B

Volume calculation

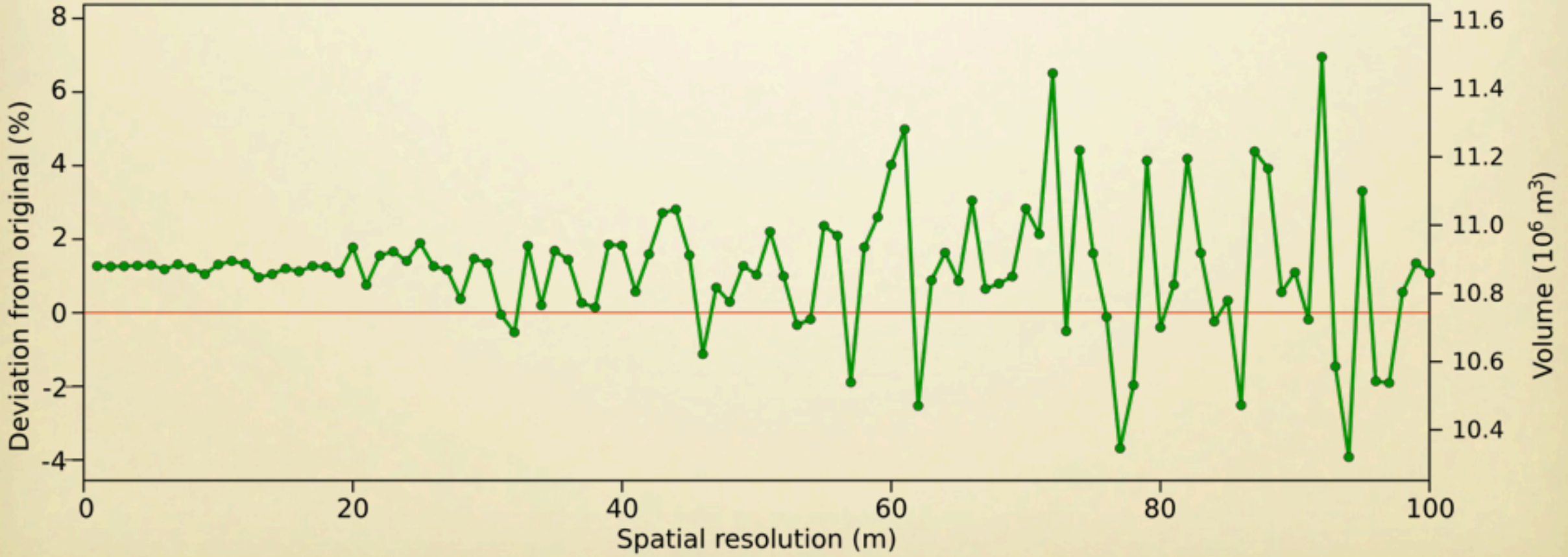
- Voxel-based (GRASS)
- Sea level (0m) as reference

Volume calculation

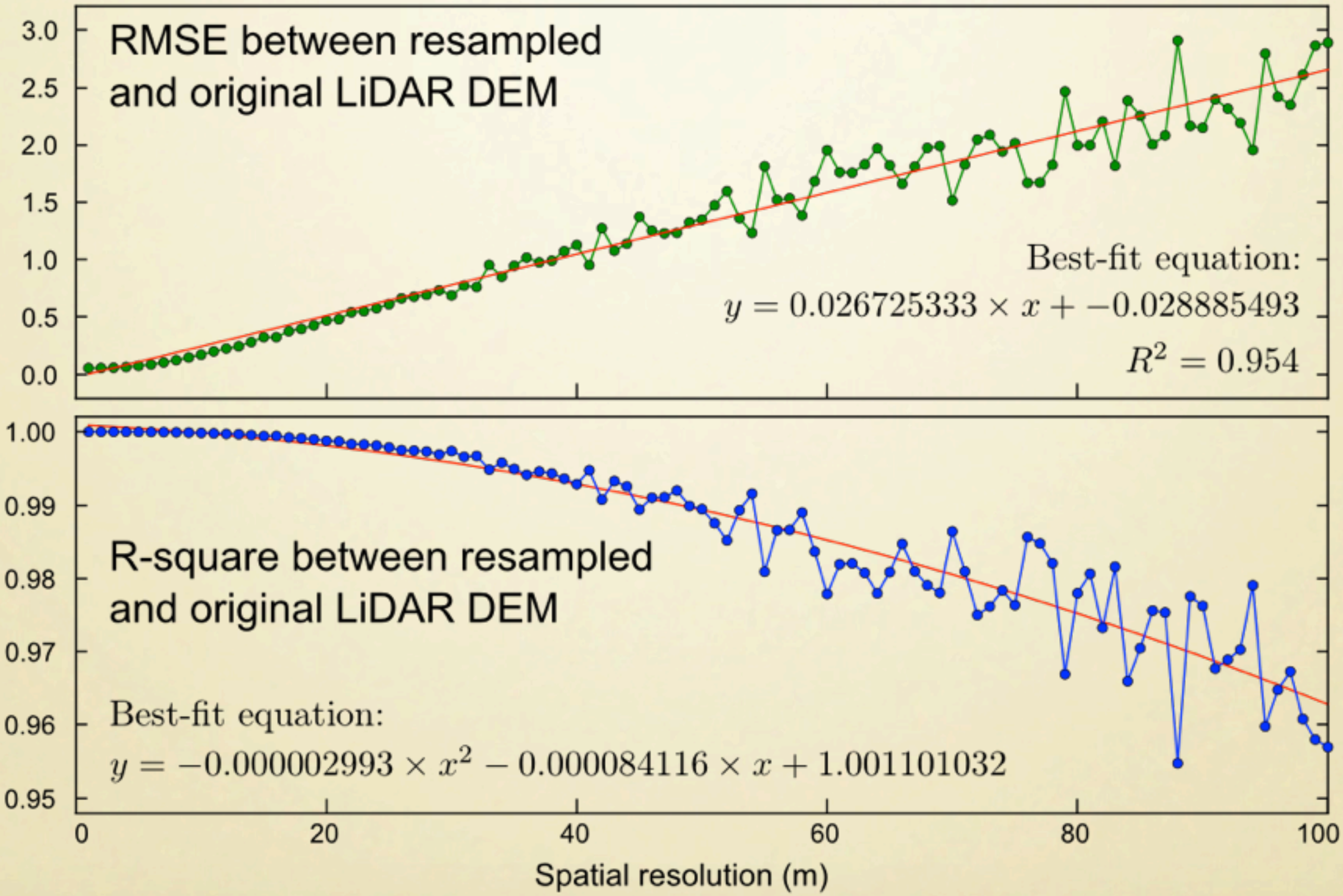
- ‘True’ volume
  - 0.5m resolution (horizontal and vertical)
- Resampled volume
  - 1m vertical resolution
  - 1-100m horizontal resolution
  - Elevation taken as the mean value of resampled cell

Deviation from 'true'

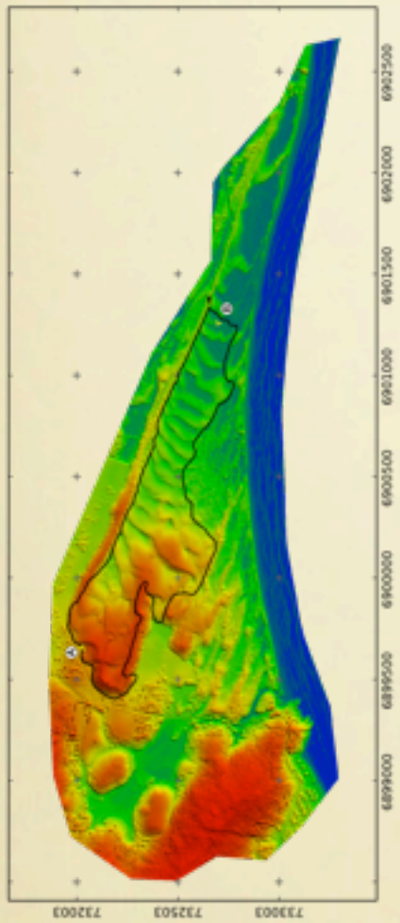
$$\text{Deviation} = \left(\frac{\text{Resampled volume - LiDAR volume}}{\text{LiDAR volume}} \right) \times 100$$

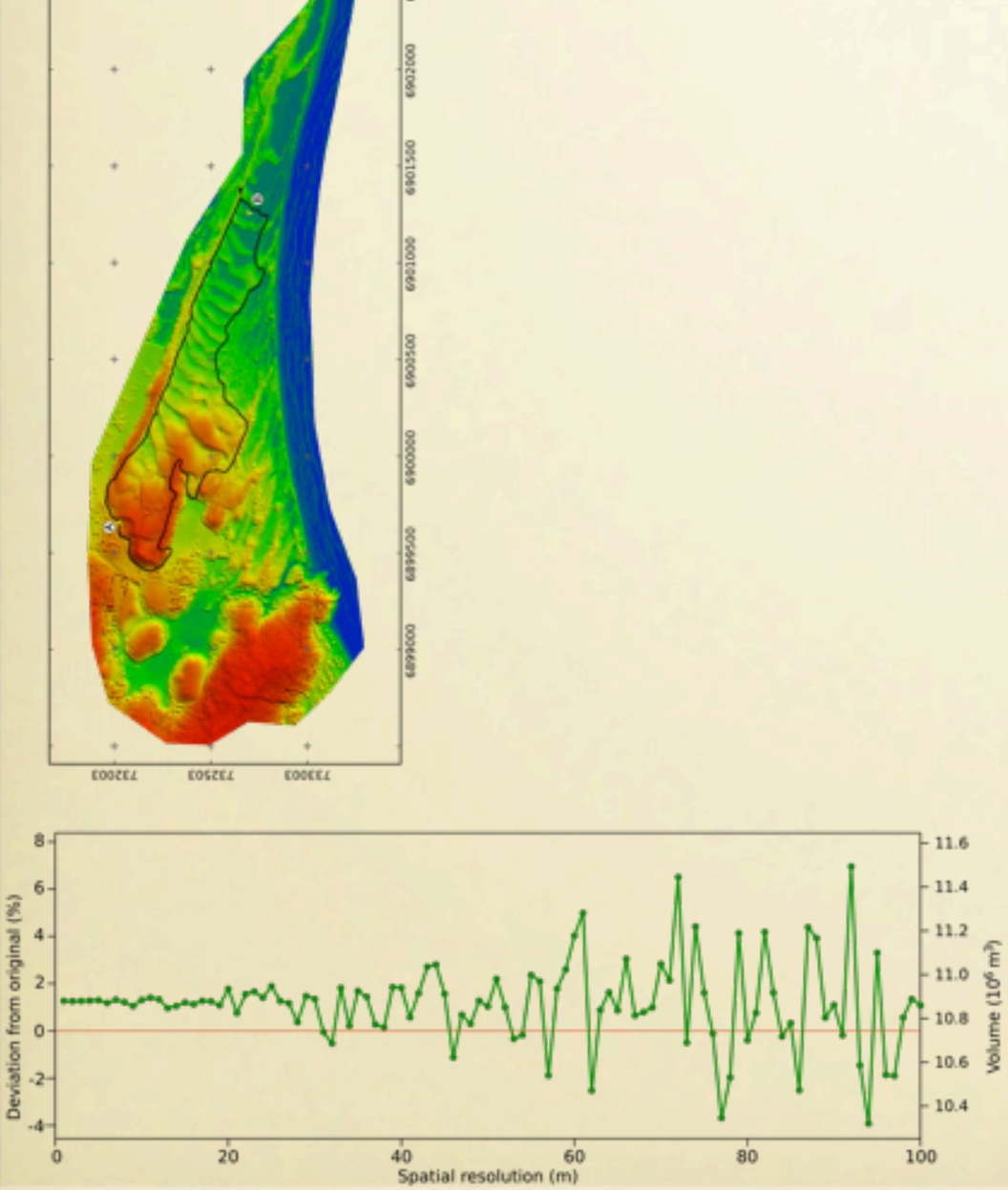


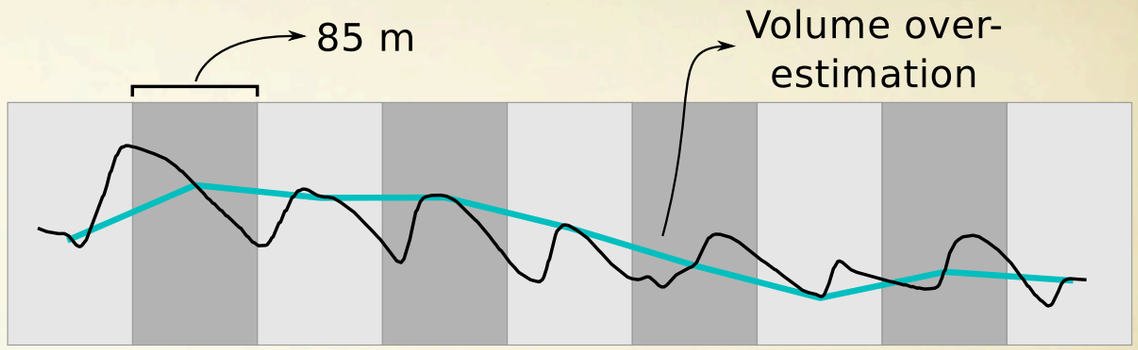
RMSE

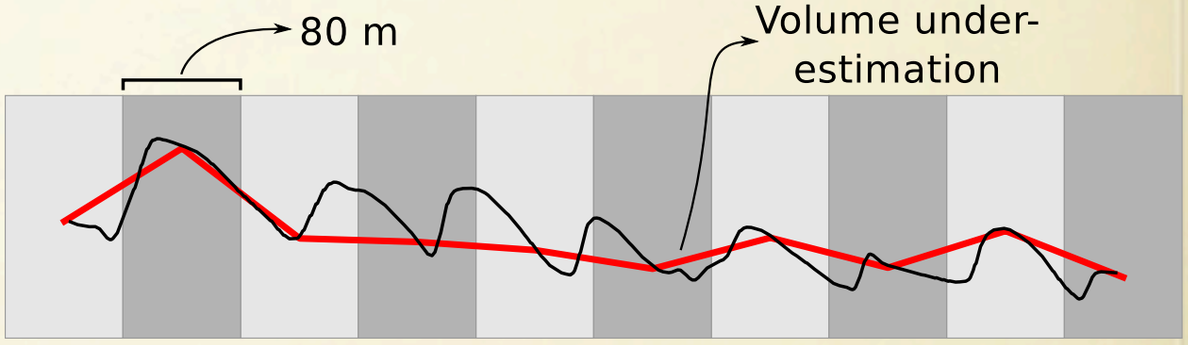

RMSE between resampled
and original LiDAR DEM
Best-fit equation:
$y = 0.026725333 \times x + -0.028885493$
$R^2 = 0.954$
3.0
2.5
2.0
1.5
1.0
0.5
0.0
R-square between resampled
and original LiDAR DEM
Best-fit equation:
$y = -0.000002993 \times x^2 - 0.000084116 \times x + 1.001101032$
1.00
0.99
0.98
0.97
0.96
0.95
0
20
40
60
80
100
Spatial resolution (m)

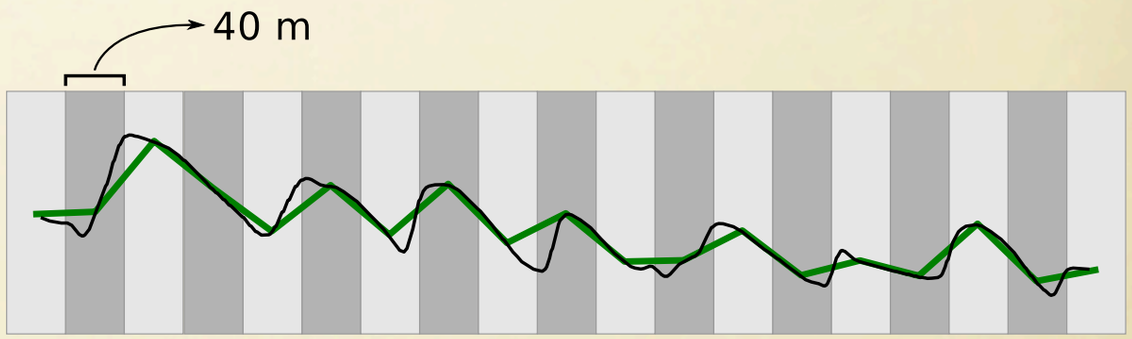
Volume Variations

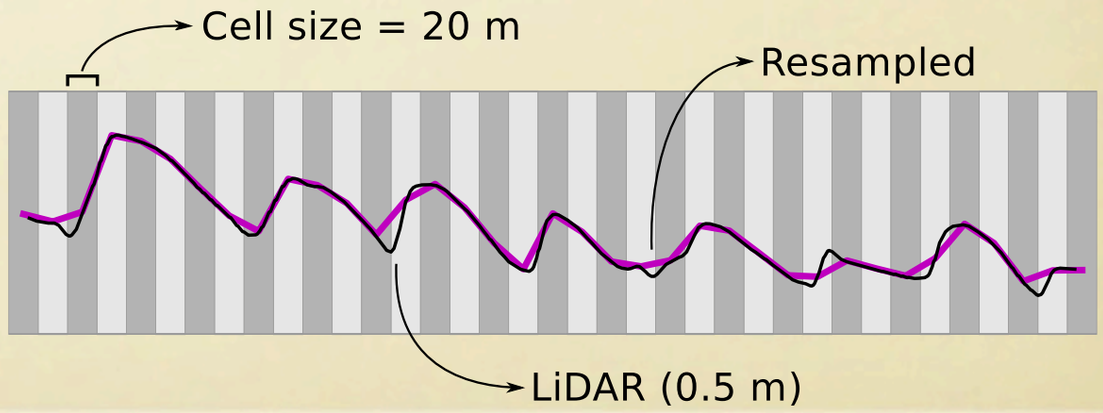






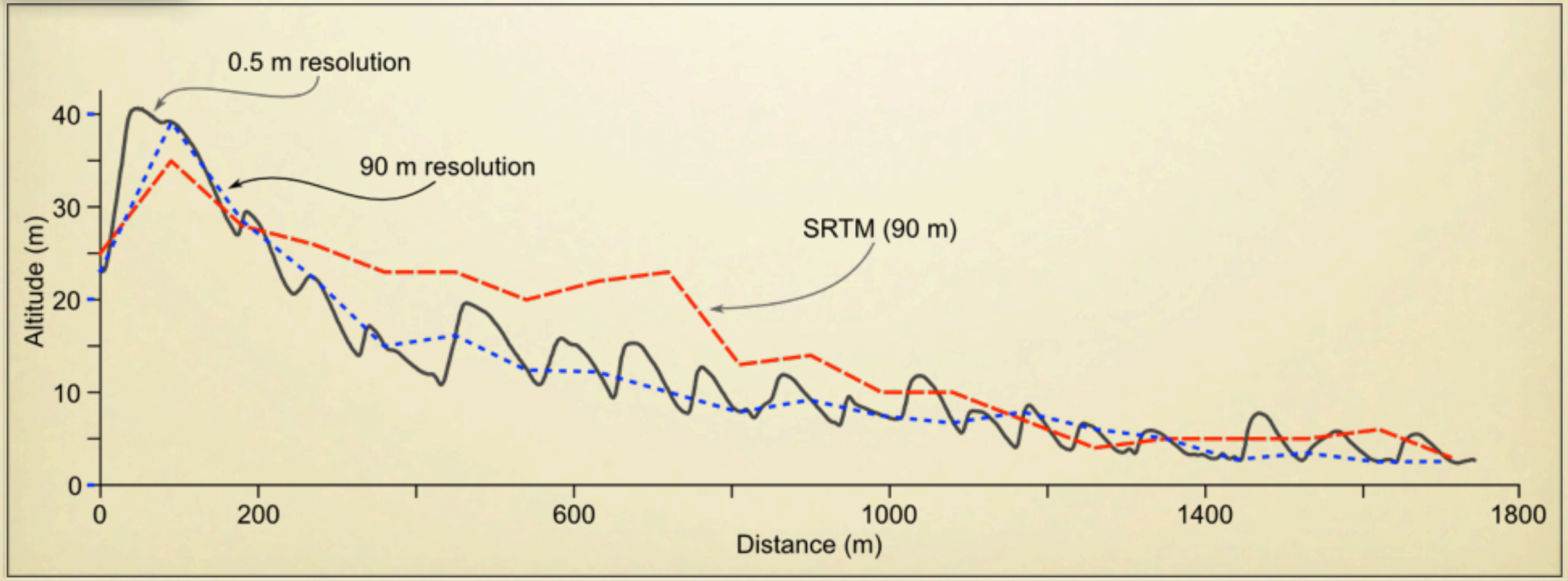






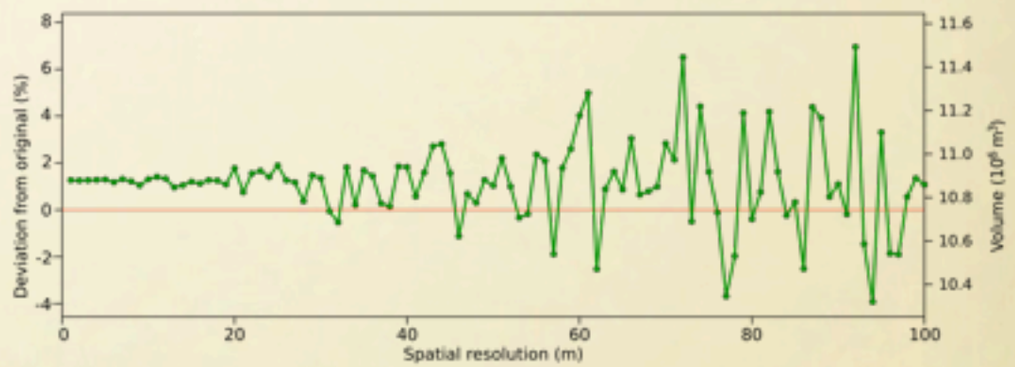
SRTM

Data	Dune field volume (m^3)	
	Garopaba	Vila Nova
LiDAR (0.5m)	10 605 783	16 045 793
SRTM (90 m)	10 076 400	17 236 800
Difference	-6.213 %	7.422 %



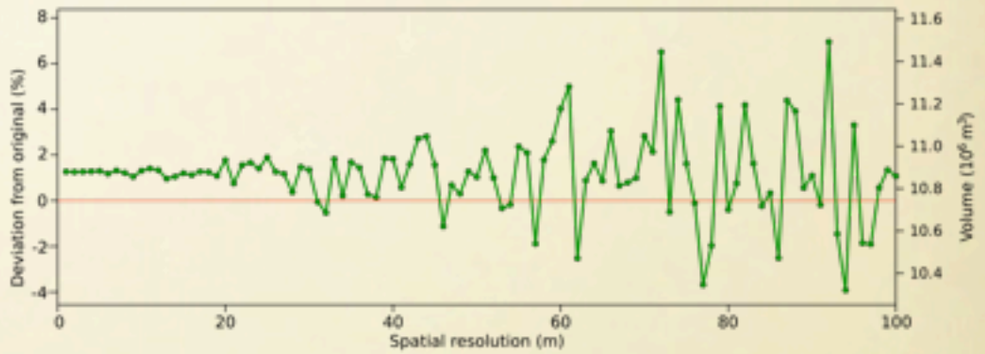
Conclusions (1)

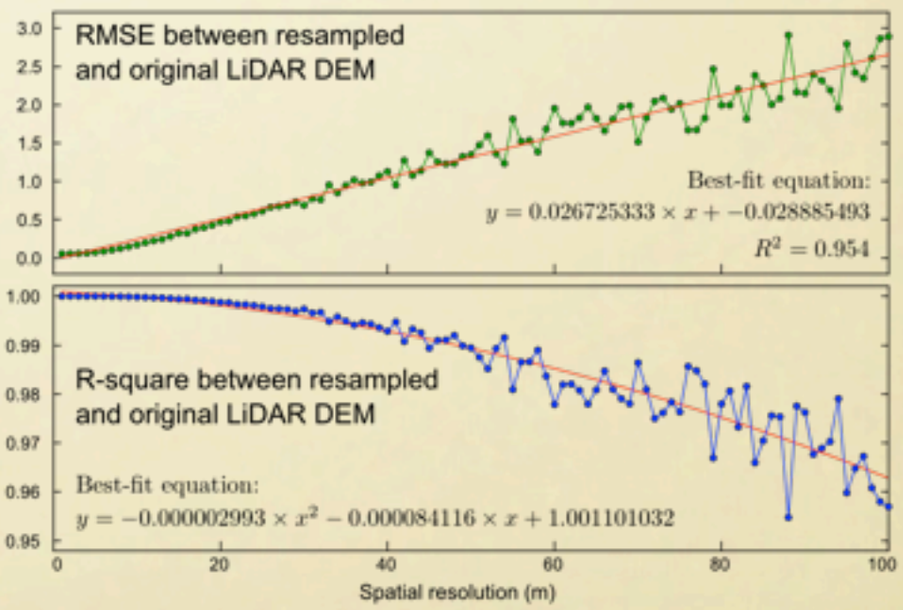
- Fluctuation of volume values about the reference
  - random factor between
    - cell size
    - landform size
    - position of cell about landform



Conclusions (2)

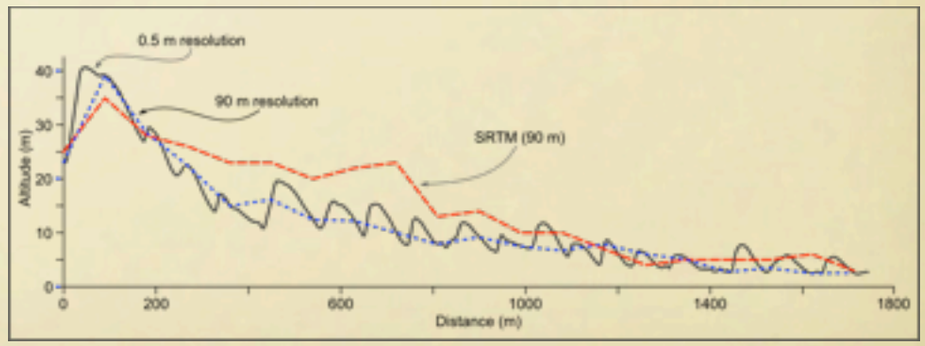
- Optimal cell size?
  - 20m
    - increase in deviation + fluctuation
  - 30m
    - accuracy drops more rapidly





Conclusions (3)

- Deviation of SRTM from LiDAR
  - smaller than +/- 10%
    - expected to decrease as area of field increases
- We consider SRTM to be a viable source of volume data for numeric simulations of dune field (and coastal systems) evolution



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Thanks!