Agricultural Terrain Analysis Using IFSAR DEMs

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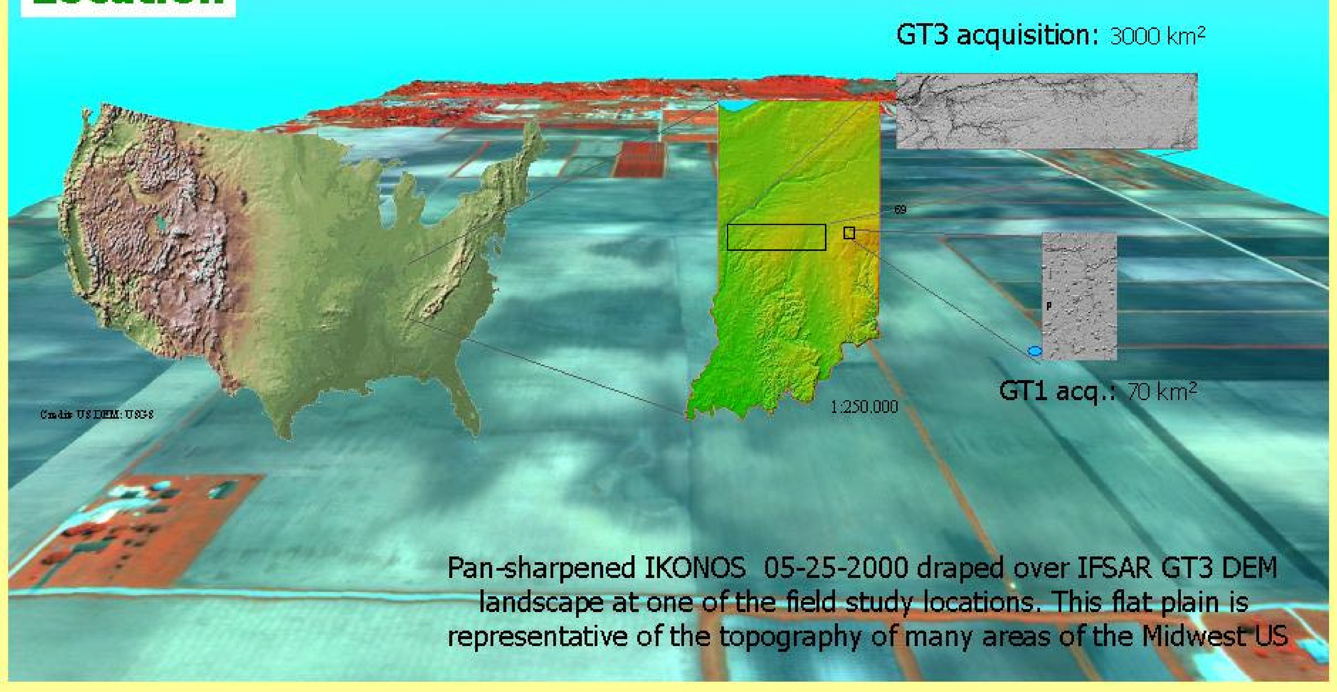
Introduction

Precision farming techniques require detailed information to build geospatial databases. Field level topographic data and the several derivatives obtained from it are important datasets to: support soil characterization and delineation, determine crop management zones, analyze yield variability, delineate areas sensitive to extreme weather conditions, and perform hydrologic modeling. Currently remote sensing is one of the converging technologies that can produce Digital Elevation Models (DEMs). This poster presents some of the results of an extensive evaluation focused on agricultural and hydrologic applications of DEMs obtained from airborne Interferometric Synthetic Aperture Radar (IFSAR) technology.

Location



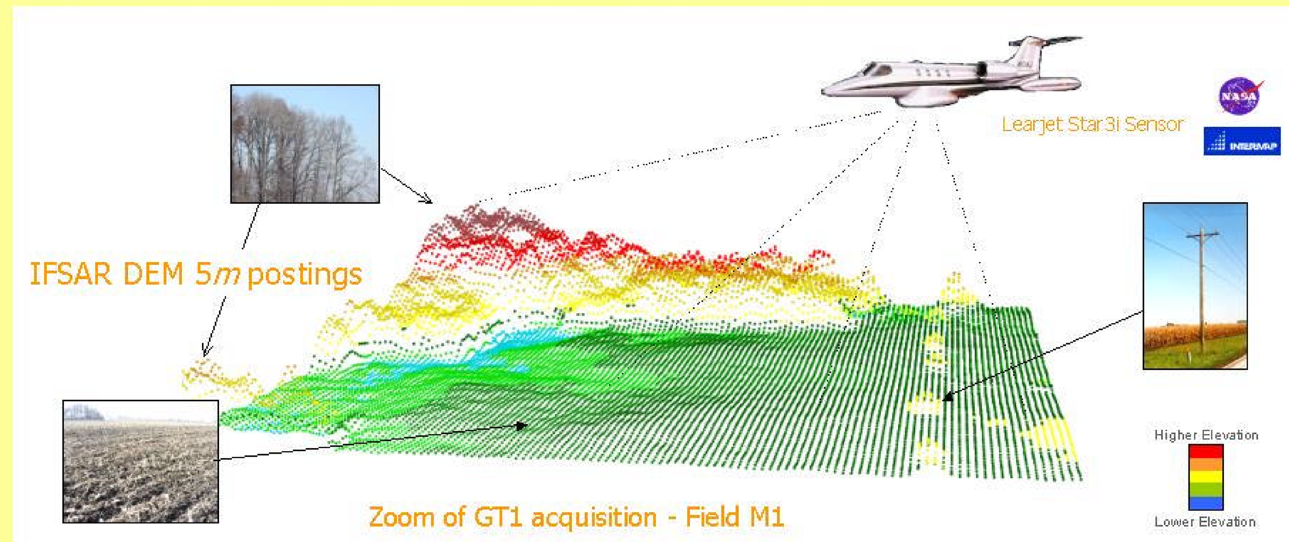
Pan-sharpened IKONOS 05-25-2000 draped over IFSAR GT3 DEM landscape at one of the field study locations. This flat plain is representative of the topography of many areas of the Midwest US

Objectives

- Generation of topographic attributes for terrain analysis of agricultural fields.
- Combination of image-based remote sensing with topographic attributes for soil characterization.

IFSAR DEM Data Collection

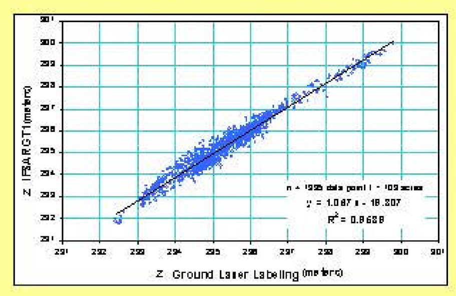
IFSAR GT1 and GT3 Digital Surface Model are continuous DEM postings, 5 and 10 meters grid cell size. According to NASA & Intermap, the specifications for the vertical accuracy is 1m or better for GT1 acquisition mode and 3 m or better for GT3.



Zoom of GT1 acquisition - Field M1

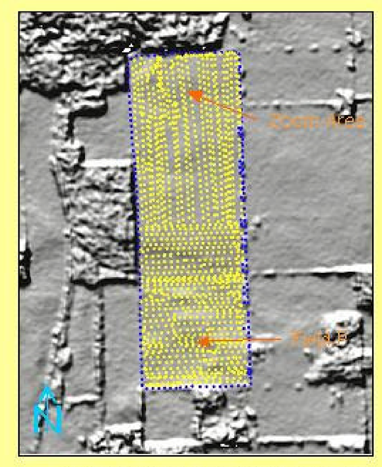
Accuracy Assessment

An independent study was performed to test the vertical accuracy of IFSAR GT1 at the field level. A dense ground laser leveling survey - DGPS with specifications for elevation accuracy of 15 cm (6 inches) was used as check points. The surface conditions were *bald earth - bare soil*. Field boundaries and end rows have been removed to avoid influence of man-made features (electric poles) and vegetation in the return signal.



Area: 48 hectares (109 acres)
n: 1335 data points
R^2 **:** 0.958
RMSE: 0.32 m
95 % CI: 0.62 m

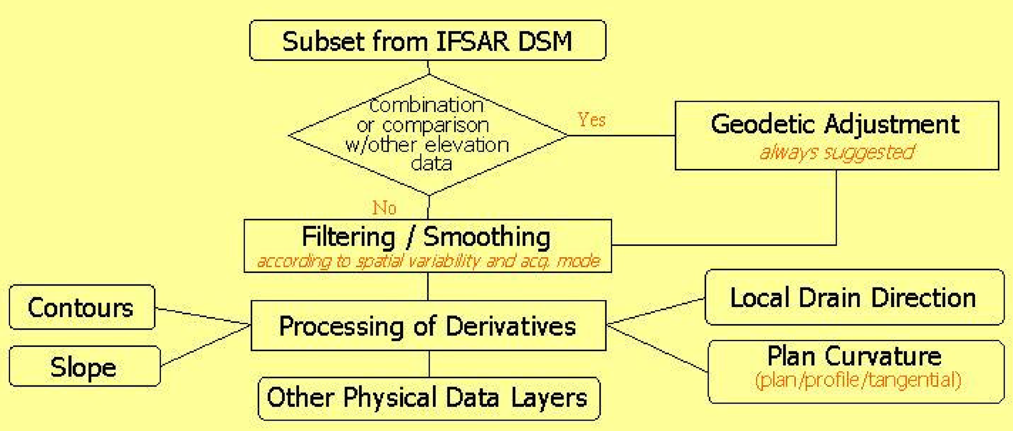
Shaded Relief GT1
Southern Fields Davis Farm
with laser data point overlay for accuracy assessment



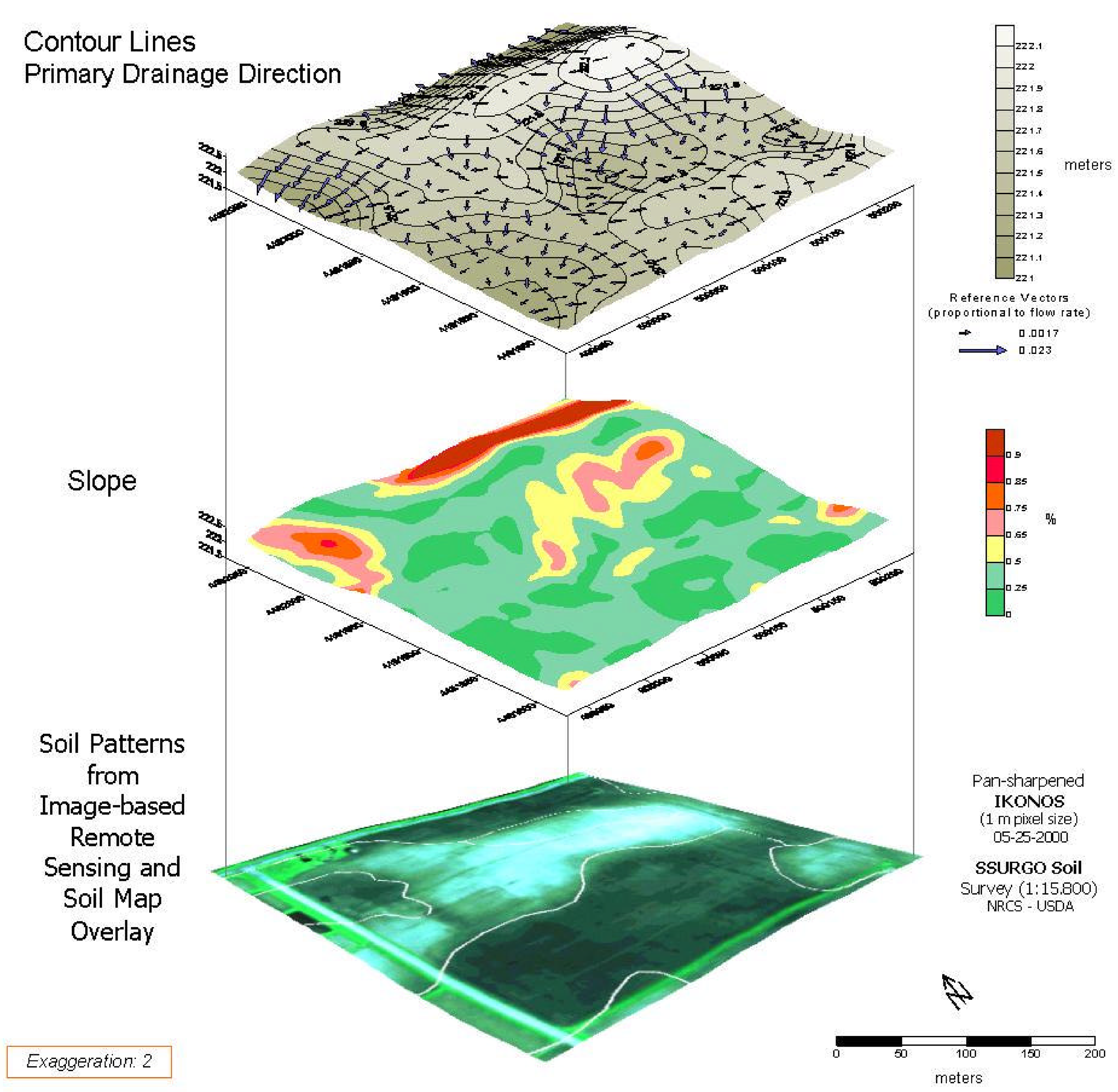
- 1335 data points included in analysis
- Field borders and end rows

Generation of Topographic Attributes

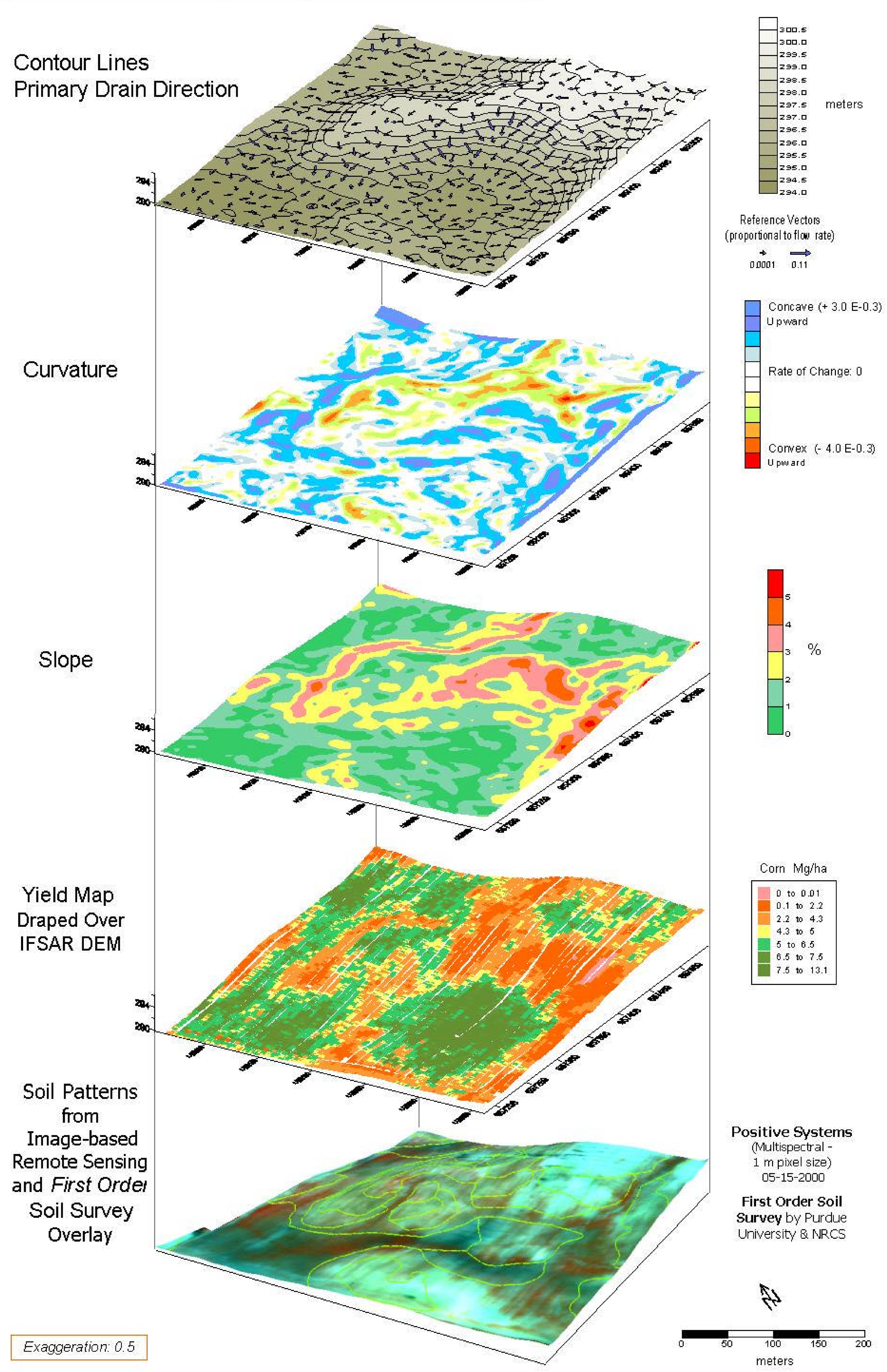
- Study locations for each DEM type at the Purdue University Agronomy Research Centers and LARS Verification and Validation Sites (V&V) for Agriculture
- Analysis approach flowchart (summary):



GT3 DEM
Field 69 Agronomy Research Center: 16 Ha (39 acres)
Extremely Flat Topography with less than 1 meter of relief



GT1 DEM
Field P Purdue Davis Farm: 13 Ha (32 acres)
Flat to Gently Sloping Topography



Highlights and Conclusions

- The overall technical merit of the IFSAR technology is the ability to produce consistent DEMs over broad agricultural areas.
- This research reveals the attractive possibility of using this data even in extremely flat, gently or undulating topography, to produce topographic derivatives for soil characterization and site specific applications.
- A unique geodetic baseline is necessary before comparison between different sources of *Z*. The accuracy of topographic derivatives depends on the terrain relief, on the algorithm used and on the acquisition mode as well.
- End rows and field boundaries can be removed to avoid outliers in terrain analysis.
- A suitable combination with optical remote sensing allows for quantitative terrain analysis, which is a gateway for a wide variety of precision farming applications.