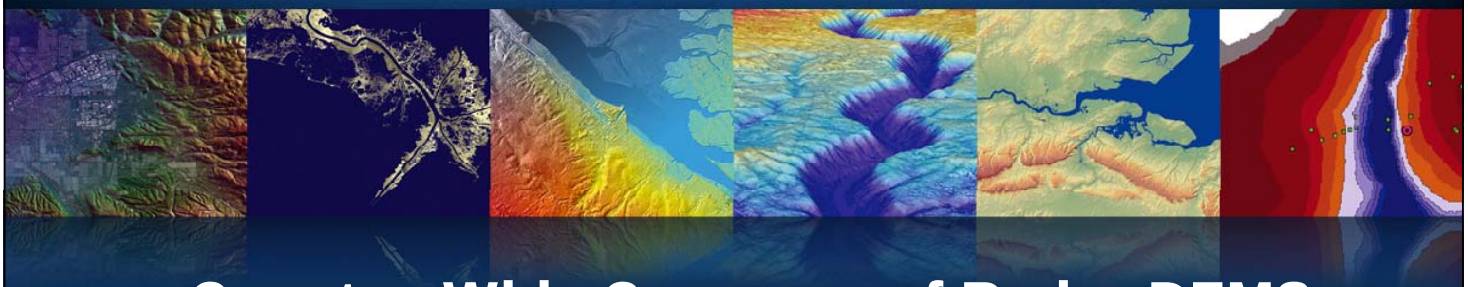

Country-Wide Coverage of Radar DEMS: The Intermap Approach

Photogrammetric Week 2009, Stuttgart

Bryan Mercer, Intermap Technologies

www.intermap.com

Contents

- **Introduction**
- **DEMs from Radar**
  - Airborne InSAR
  - The Data Products
- **NEXTMap**
  - Status
- **How it has been accomplished**
- **Validation**
- **Some applications and derived products**

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Intermap: Geospatial Data and Solutions Provider

- Founded in 1996
  - Formerly Intera Technologies
  - 2D and 3D airborne radar since 1975
- Public Company
- Over 800 employees involved with radar or its applications
- Major Offices in Calgary, Denver, Ottawa, Munich, Prague, and Jakarta

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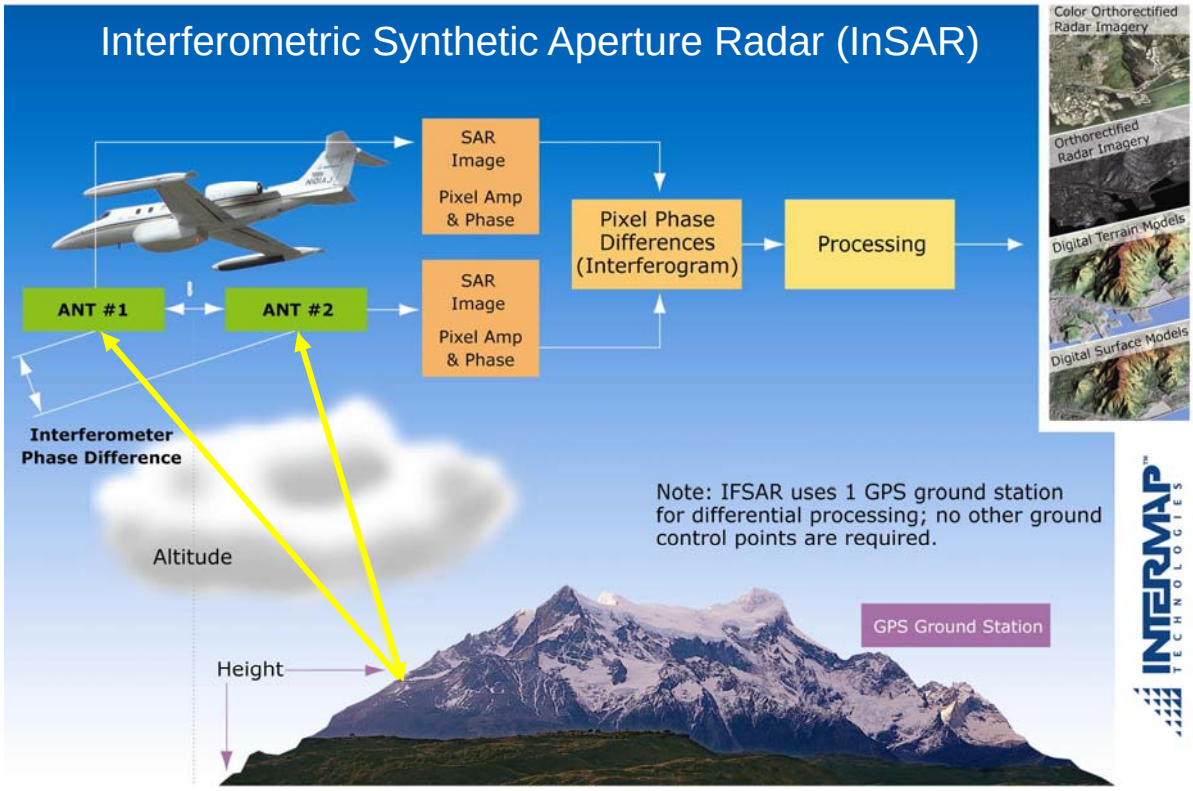
DEMs and ORIs from InSAR: Conceptual



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InSAR ORI

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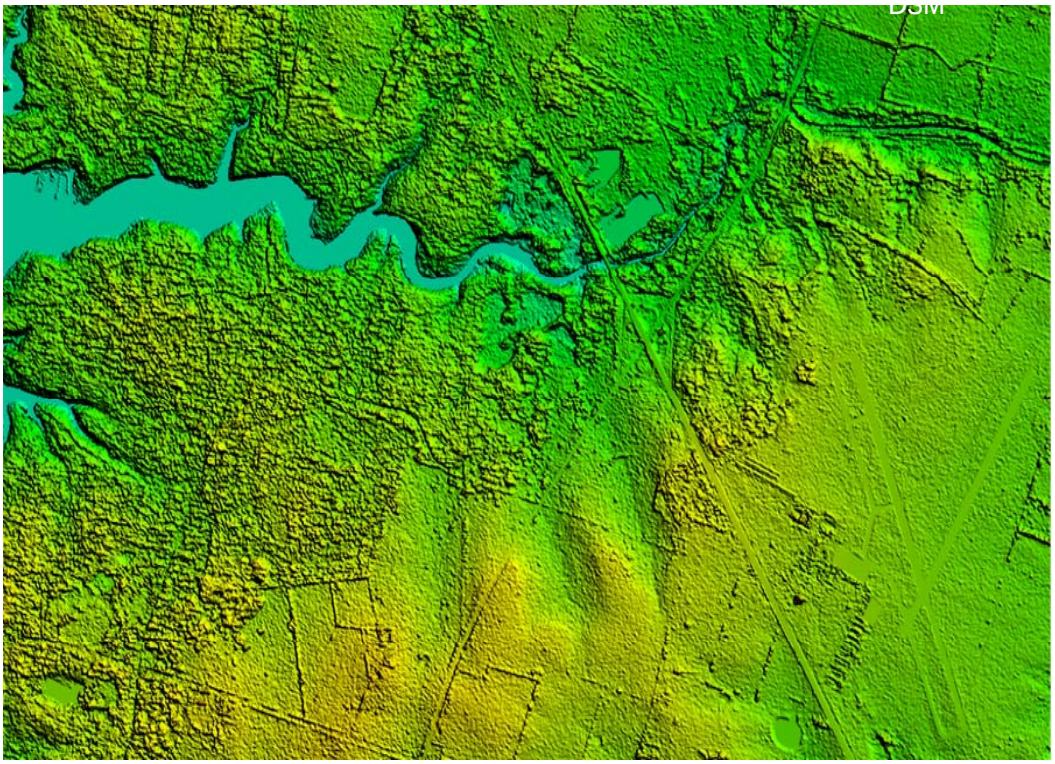
InSAR DSM



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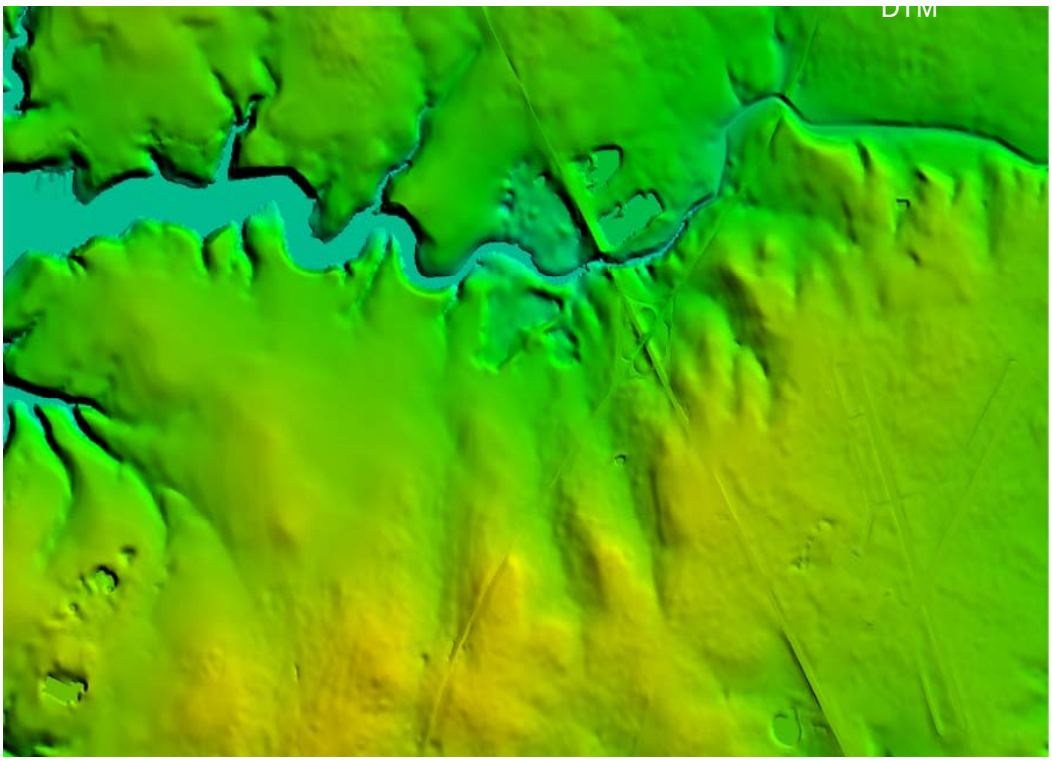
InSAR DTM (derived from DSM)



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InSAR Product Types and Specifications

	DSM (m)		DTM (m)		ORI (m)	
	RMSE	Spacing	RMSE	Spacing	RMSE	Pixel
Type I+	0.5	5	0.7	5	<2	0.625
Type I	0.5	5	0.7	5	2	1.25
Type II	1	5	1	5	2	1.25
Type III	3	5	-	-	-	1.25

Notes:

- **NEXTMap Europe is Type II**
  - **except for Ireland (Type I+) and SE England (Type I)**

- **Vertical accuracy specifications apply only to bare, unobstructed terrain with slopes <10°**

- **ORI:**
  - **RMSE refers to horizontal (circular) error**
  - **Pixel refers to pixel spacing which is close to the resolution**

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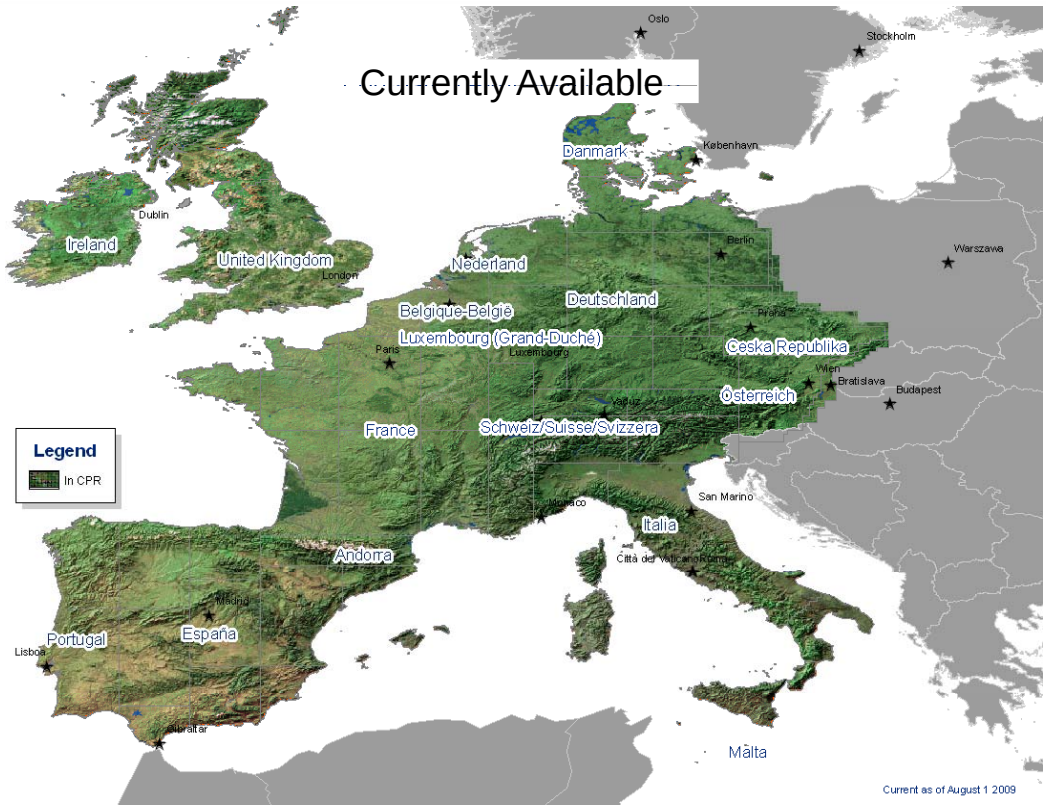
Intermap's Business Model Includes NEXTMap and Custom Programs

- NEXTMap Concept
  - create a homogeneous, large area 3D database
  - national, trans-national, and continental scales
  - internally funded
  - license the data to many users – scalable shared cost
  - much cheaper ($/km²) than lidar but less detailed
    - complimentary
  - much more detailed than SRTM but more costly

Intermap's Business Model Includes NEXTMap and Custom Programs

- NEXTMap Europe
  - 2.2 M kmsq of Western Europe including 15 countries
    - Single, homogeneous data base, Type II products
    - Completed early 2009
    - Available in Intermap's 'Terrain On Demand' data base
- NEXTMap USA
  - 8.1 M kmsq of lower 48 plus Hawaii, Type II products
    - Acquisition completed early 2009
    - 60% currently available in Terrain On Demand data base
    - Completion in early 2010
- Custom Programs and Other NEXTMap programs
  - Types I, II and III Products
  - SE Asia, Australia and other parts of the world

NEXTMap Europe Coverage



The fifteen countries currently in the NEXTMap Europe data-set include:

Austria,
Belgium,
Czech Republic,
Denmark,
France,
Germany,
Ireland,
Italy,
Luxembourg,
Malta,
Netherlands,
Portugal,
Spain,
Switzerland,
United Kingdom.

bmercer@intermap.com

NEXTMap Europe DSM (>80 billion elevation samples)

The fifteen countries currently in the NEXTMap Europe data-set include:

Austria,
Belgium,
Czech Republic,
Denmark,
France,
Germany,
Ireland,
Italy,
Luxembourg,
Malta,
Netherlands,
Portugal,
Spain,
Switzerland,
United Kingdom.

bmercer@intermap.com

Data Acquisition Complete

- 8 million km^2
- 57% complete & in the library
- Complete and commercially available early 2010

bmercer@intermap.com

How is this accomplished?

Planning and Acquisition

↓

Navigation and Interferometric Processing

↓

Editing and Final Production

↓

Independent V&V → iStore

bmercer@intermap.com

Acquisition: Four Platforms Provided Capacity and Redundancy

Intermap Platforms:

1. STAR-3 (upgraded in 2002)
2. STAR-4 (developed in 2004)
3. STAR-5 (added in 2006)
4. STAR-6 (added in 2007)

Characteristics (LearJet Platforms):

- Altitude 9 - 10 km
- Swath 8.5 – 10.5 km
- Speed 700 km/hr

Combined acquisition capacity has grown from 300,000 km²/yr to 5,000,000 km²/yr

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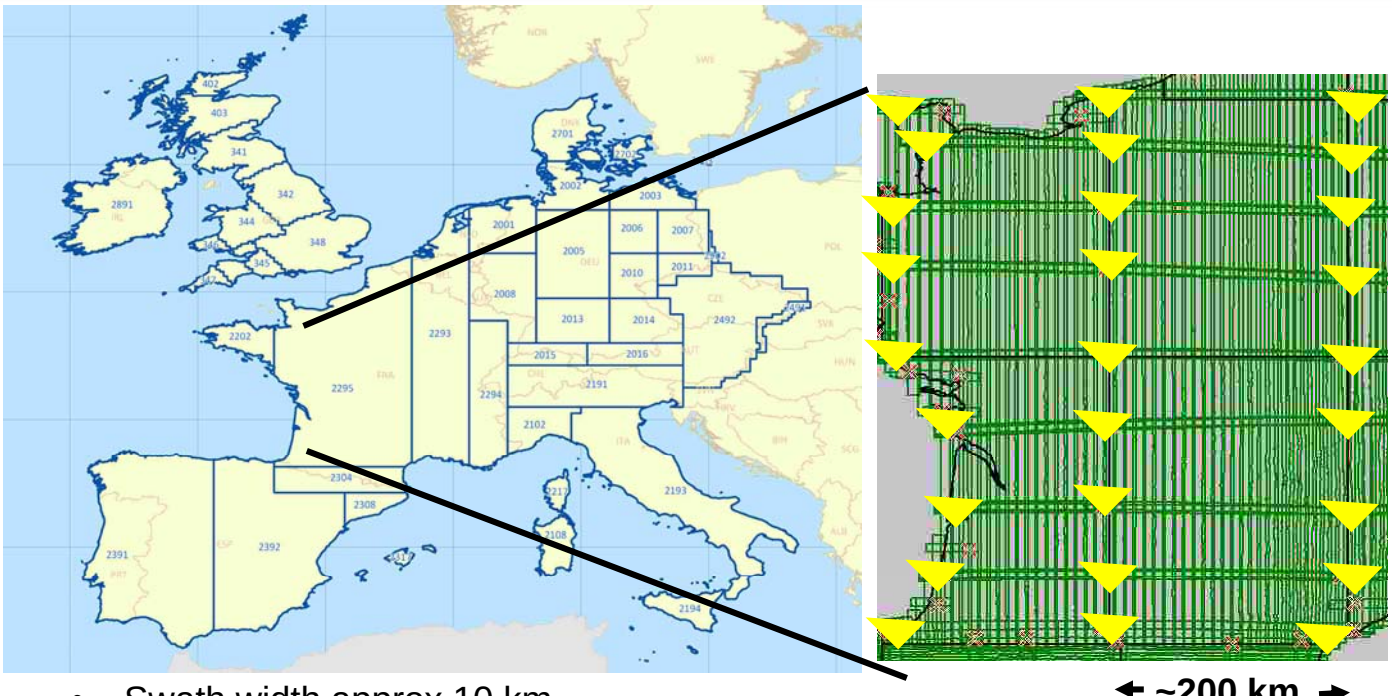
Planning and Acquisition: Block Structure, Tie Lines and Reflectors



- Swath width approx 10 km,
- Sidelap varies depending on terrain
- Vertical lines are the primary data
- Horizontal lines are tie lines
- Yellow triangles are GPS surveyed ‘corner reflectors’

bmercer@intermap.com

Navigation and Interferometric Processing

- Navigation Solution (from Kalman Filtered GPS/INU)
- Interferometric Processing
  - Motion compensation
  - SAR processing
  - Interferometric processing
  - Block adjustment (tie lines, absolute reflector coordinates)
  - Geocoding, mosaicking, tiling >> ORI, DSM (unedited)
    - Ready to go to editing
- Automated
- Scalable (can keep up with acquisition)
- Current capacity 5 million kmsq/year

bmercer@intermap.com

Editing and Production

- Stereo viewing environment
  - Editing tools (internally developed)
- DSM feature editing
  - Hydrology: Lakes, rivers, ocean
  - Transportation Features: Highways, Railways, Airports, Docks
  - Radar Anomalies
- DTM Editing
  - First stage automated
    - Removes buildings, power poles, clusters of trees
  - Streams
  - Supported by Ancillary data, particularly in difficult areas
- Output format

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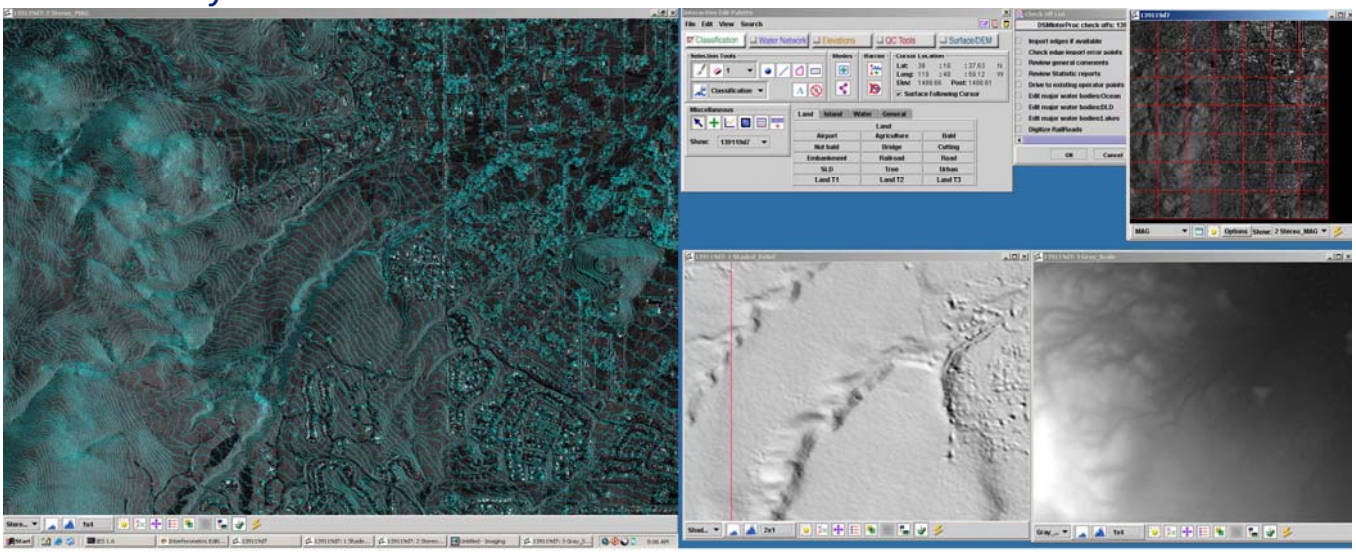
DSM and DTM Editing

- Proprietary Interferometric Editing System (IES) software used to edit DEM data.
  - Takes place in a 3D environment.
  - Semi-automated for consistency.
  - Work off a well defined set of editing rules.
- Currently 150 workstations



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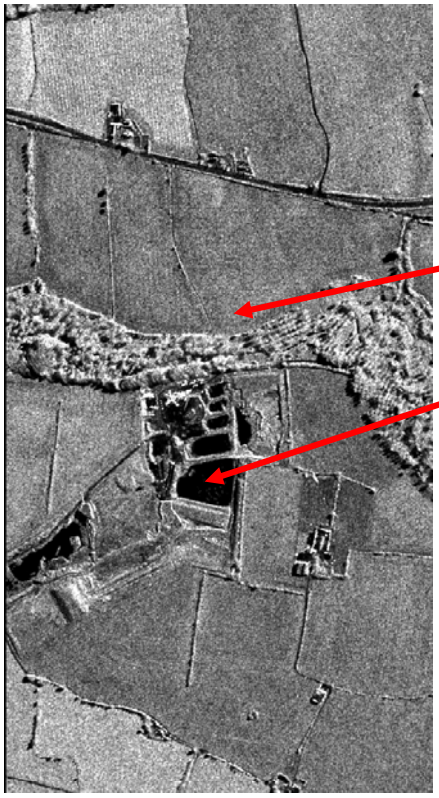
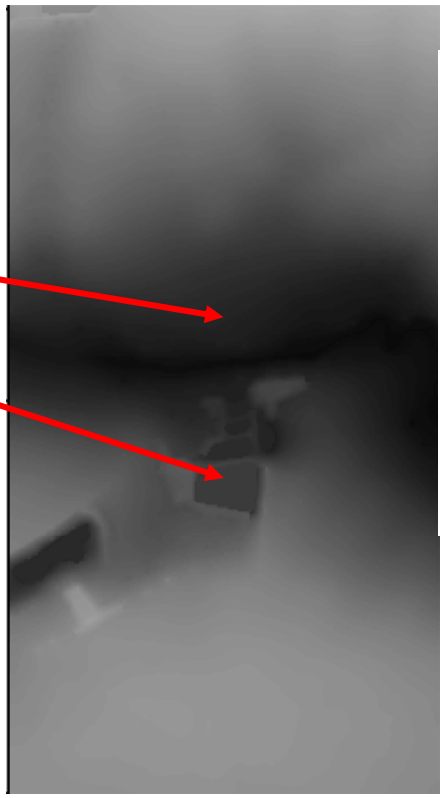
For example editing water bodies



- ORI and DTM
- river valley and trees
- water bodies are edited to a constant elevation



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Independent Verification & Validation

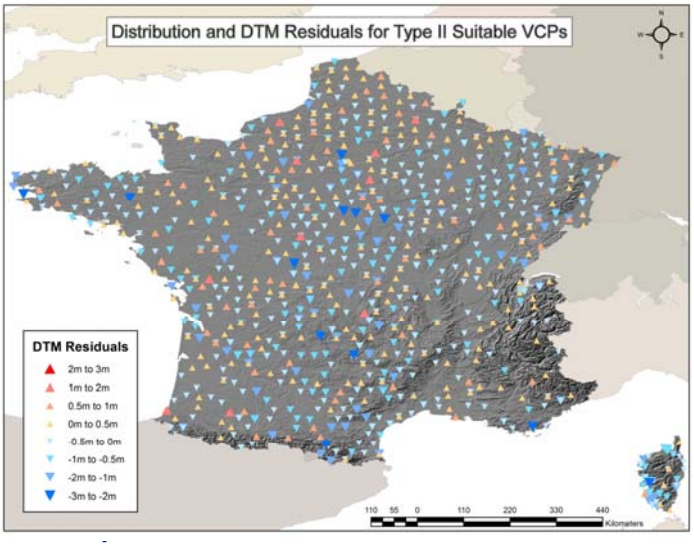
- Utilize 3rd party data for validation
  - Typically survey markers from government agencies
- Re-process control survey data
- Examination of final products versus stated specifications

- Release to iStore

bmercer@intermap.com

Country-based Validation Statistics

- 'Validation Check Points' (VCPs) f
  reference
- All survey reports checked for sui
  - Where possible, also checked on
  - Excluded from validation process
- Reports created for each country
  - First 5 NEXTMap Europe country
    - mean spacing of VCPs ~5 km
  - Similar results for USA state repc
- Results well within Type II spec (



Difference Statistics (meters)	Belgium		France		Germany		Italy		Spain	
	DSM	DTM	DSM	DTM	DSM	DTM	DSM	DTM	DSM	DTM
Mean	0.23	0.12	0.01	-0.22	0.01	-0.16	-0.11	-0.38	0.22	-0.27
Standard Dev'n	0.57	0.58	0.53	0.59	0.68	0.68	0.60	0.78	0.67	0.73
RMSE	0.61	0.58	0.53	0.63	0.68	0.69	0.61	0.87	0.70	0.78
95 Percentile	1.18	1.10	1.06	1.33	1.42	1.47	1.13	1.85	1.38	1.59
No. Check Pts.	53	53	987	987	690	690	703	703	2619	2619

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Applications and Products: Examples in Bold to Follow

- **Mapping Services:**
  - **Image Orthorectification and Merging with Optical**
  - Base Mapping
  - Topographic Mapping
  - Geological Mapping
  - Vegetation Mapping
  - Urban Mapping
  - Land Cover Classification
- **Products:**
  - Contour Maps
  - **3D Roads for Automotive**
  - **3D Visualization**
  - **Off-road Recreational (PND, iPhone)**
  - Hybrid Hill Shader

- **Flight Simulation**
- Automotive Safety, Energy Savings, Mapping Convenience
- Infrastructure Design
- Environmental Planning
- Engineering Planning
- Telecommunications
- Land Slip Risk Assessment
- Biomass Study
- **Flood Risk Analysis**
- Hydrology
- Seismic Hazards
- Situational Awareness
- Change Detection

bmercer@intermap.com

Orthorectification of Optical Images

- NEXTMap ORI as source of GCPs (and CPs)
  - 1.25 m (or 0.625 m) pixel (GSD)
  - Fundamental accuracy limited by DSM accuracy
  - Large numbers available - robust
- NEXTMap DSM
- Applicable to
  - high or med resolution satellite images
  - air photo
- Demonstrated in 2001 with early Ikonos and subsequently with Quickbird and air photo
  - Following summer/winter Ikonos scenes totally different geometries

bmercer@intermap.com

Winter Ikonos Scenes (orthorectified using 'old' STAR-3 data)

Derived RPCs from ORI/Ikonos match. Approx 2 m RMSE (abs)

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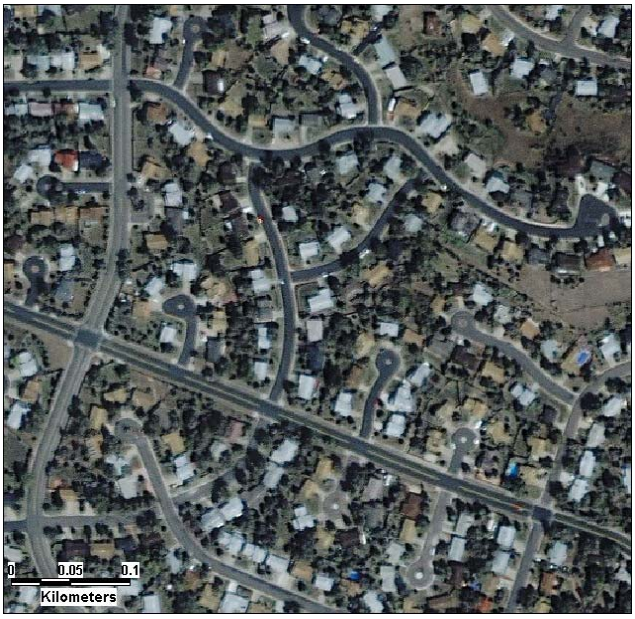
Summer Ikonos Scenes (orthorectified using 'old' STAR-3 data)



Derived RPCs from ORI/Ikonos match. Approx 2 m RMSE (abs)

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Visualization (various examples and applications)

- 2001 Ikonos scene – orthorectified (as shown previously) and draped over STAR-3i DSM in Denver, USA area
- Presented at PhotoWeek 2001

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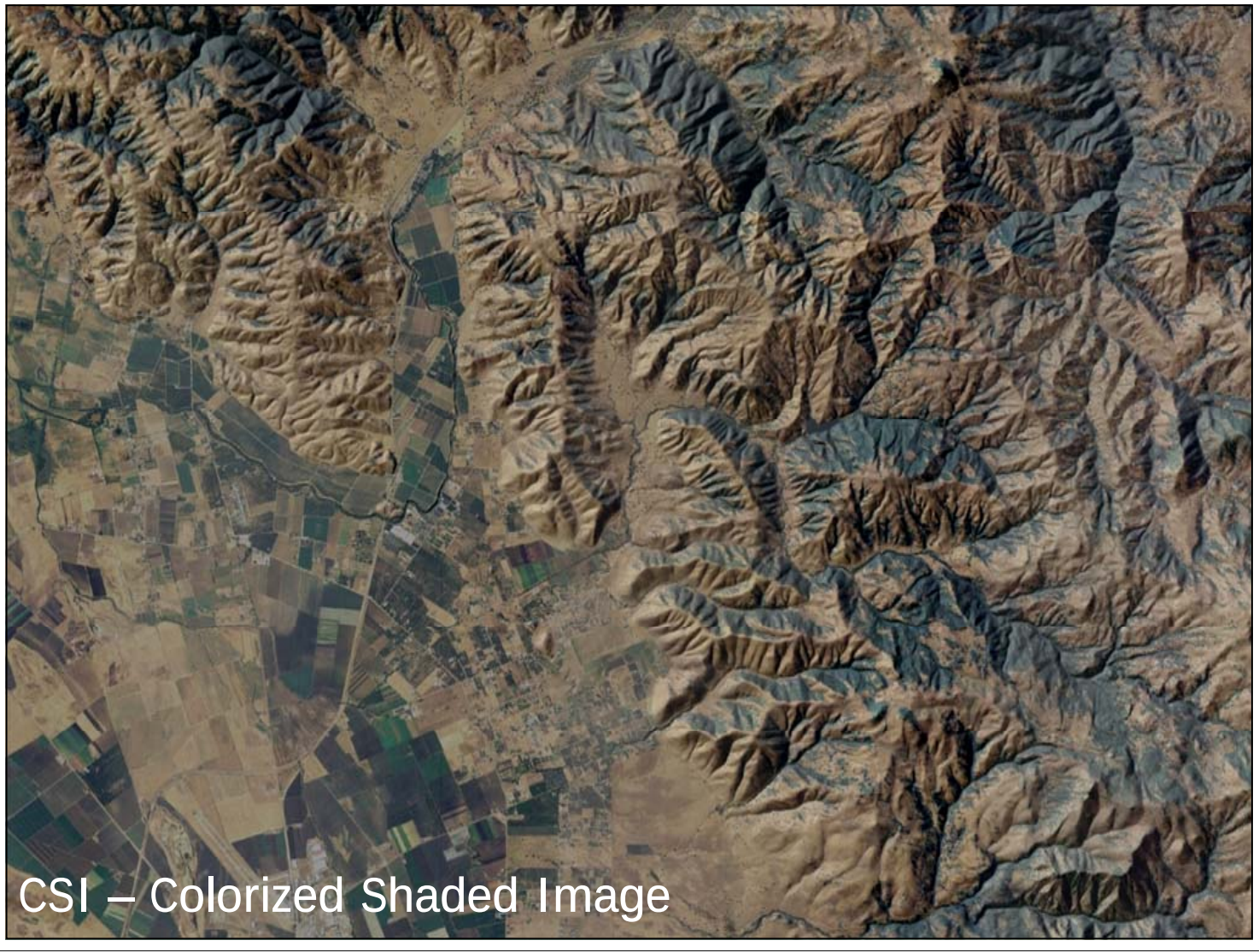

Microsoft Flight Simulator: NEXTMap® *ProMesh*™ and FS Dreamscapes

Moving Map Displays

From This

To THIS!

Consumer Markets & Devices

3 Market Segments

Dedicated GPS

Off-road & Recreation Markets

Personal Navigation Device (PND)

Add 3D Terrain Views & Elevation Shaded Image layers

iPhone / SmartPhone

Launch additional platforms

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AccuTerra Developed for GPS Devices

AccuTerra elevation imagery provides updated, accurate, visually appealing outdoor recreation maps for dedicated GPS devices, PNDs, and iPhone/SmartPhones.

2008: 3 OEM Agreements Signed

Magellan
Triton 2000 with 3D terrain modeling

Bushnell®
Onix™ 400

Lowrance®
Endura™ Sierra, Safari & Out&Back

2009: 2 More OEM Agreements

GOVE mapping ahead

pronounced TECHNOLOGIES

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Introducing AccuTerra for the iPhone

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Apple Design Award

Winner
iPhone OS 3.0 Beta App
AccuTerra v1.0.0 Beta,
Intermap Technologies
www.mobile.accuterra.com

"Best iPhone 3.0 Beta App"

- AccuTerra recognized by Apple for:
  - ✓ Design innovation
  - ✓ Superior quality
  - ✓ High standards of user interaction
  - ✓ Functionality offers added value to consumers

Apple Design Awards 2009

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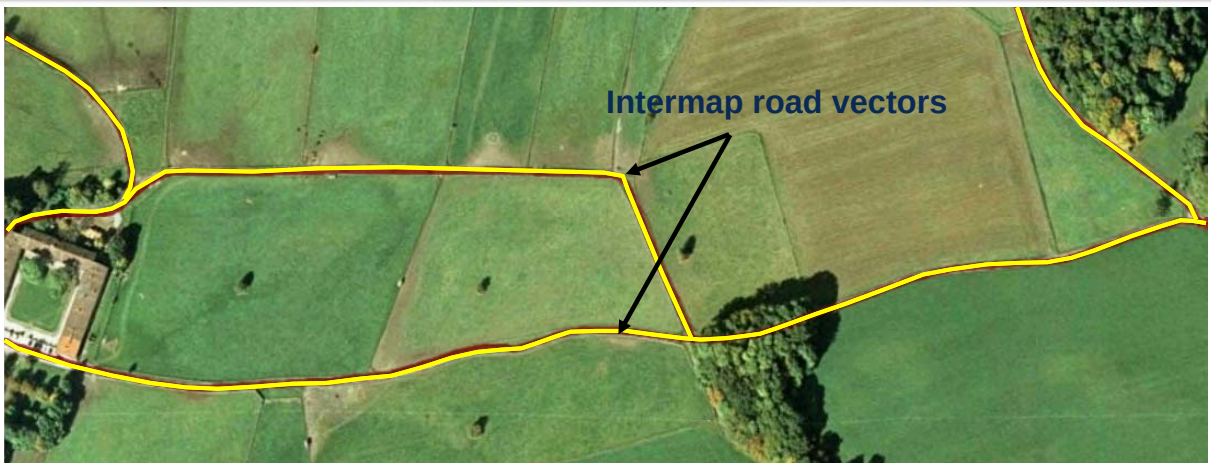
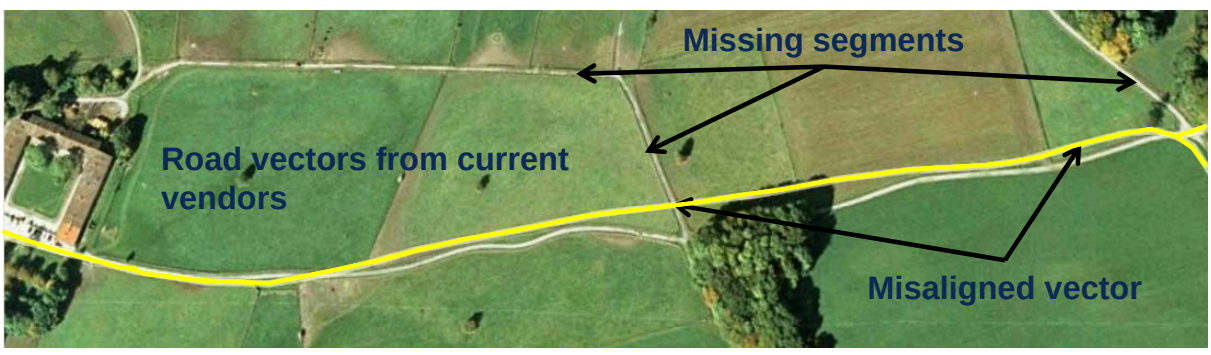
2D Roads – NEXTMap vs. Available 2D Data





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2D/3D Road Vectors for ADAS and Fuel Efficiency

- Scalable high volume collection of 3D road vectors

- Requirements:
  - CORE Products
    - DSM/DTM
    - CORI
  - 3D Work Station
  - Road Vector Collection Software

- Outputs:
  - 2D Road Vectors
  - 3D Road Vectors
  - 3D Drapes

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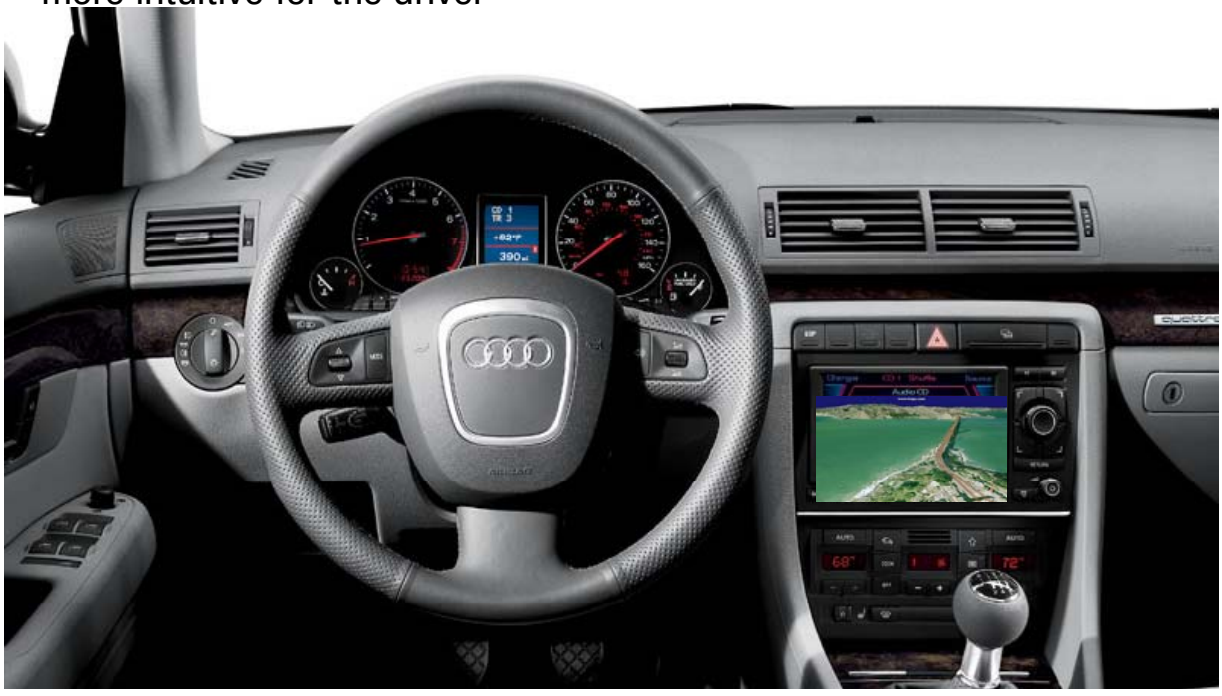
Terrain View In-dash Navigation Systems

- Elevation data coupled with color image improves the display and makes it more intuitive for the driver



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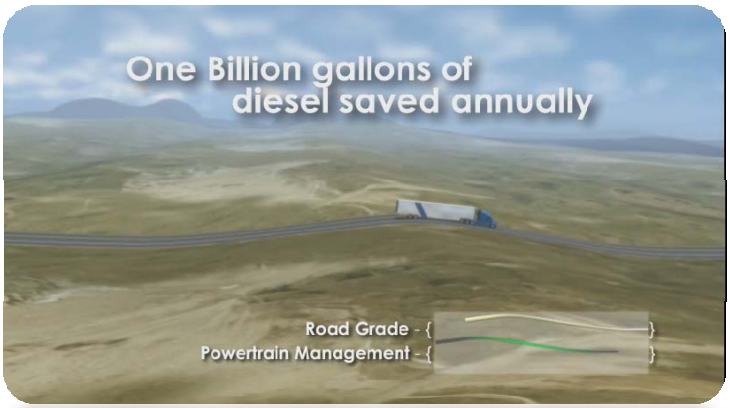
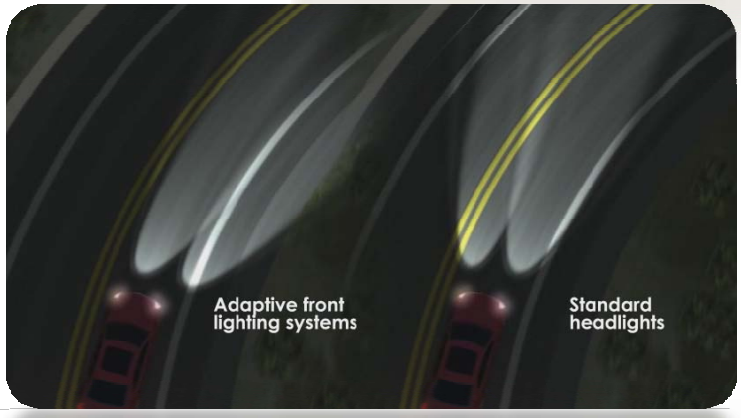
Automotive ADAS: Early Target Applications





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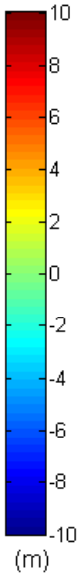
Colorized Elev. Error (3DR): Airphoto and ORI



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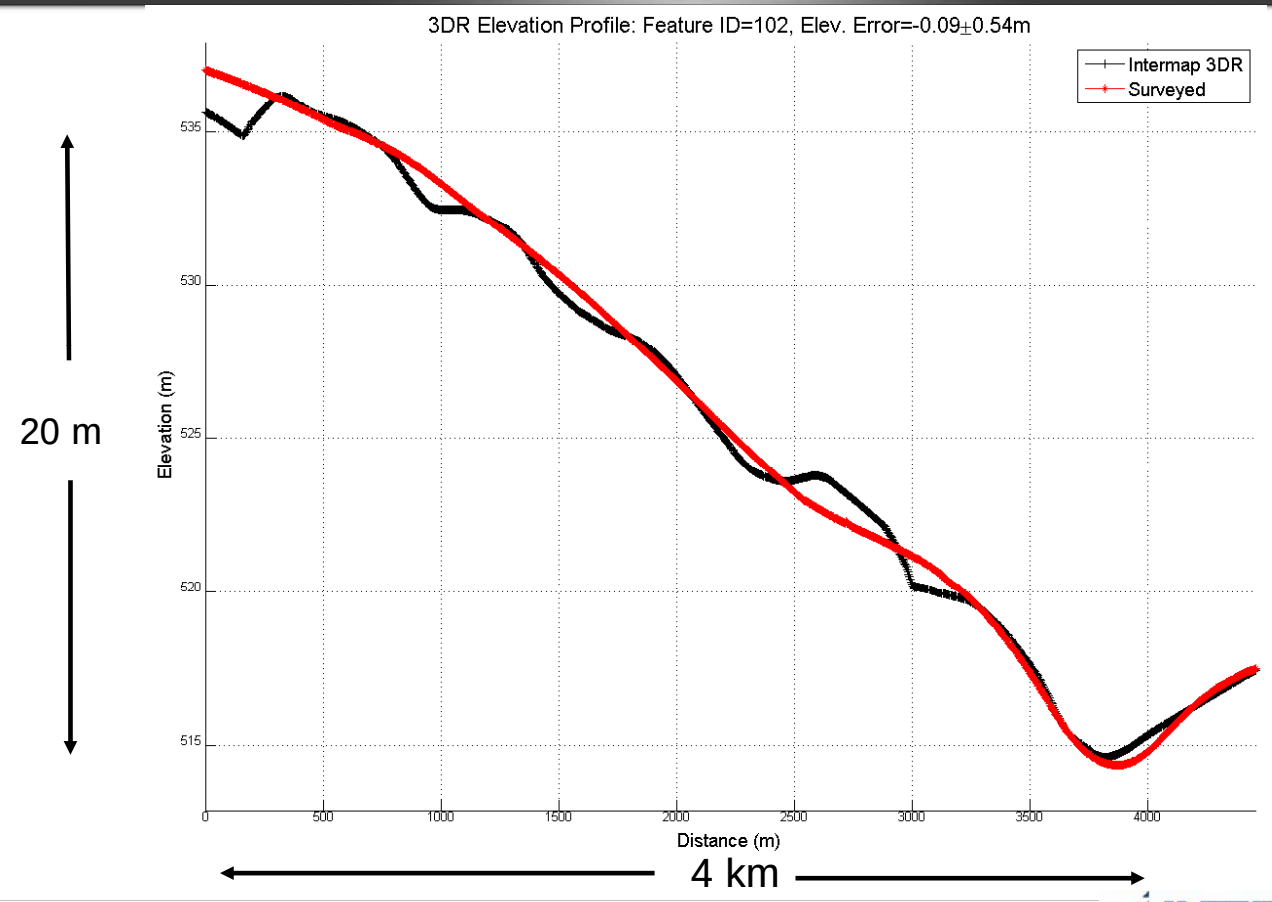
Elevation Profile



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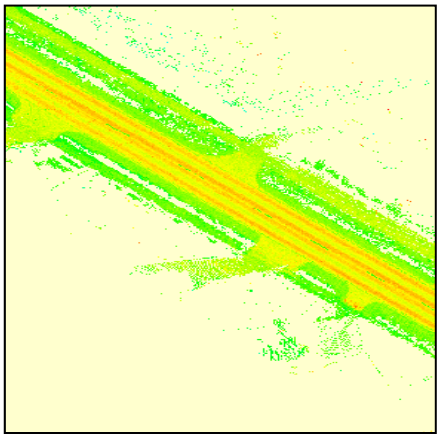
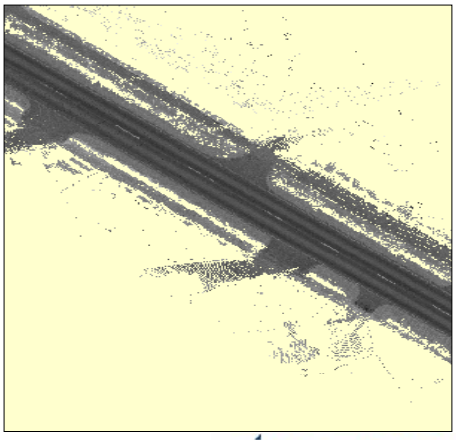
Validation of Road Centerline Data

- How to validate x, y, z of road centerlines?
- Special-purpose mobile lidar scanner for road centerline capture
- Recent build, calibration and test system, now operational
- Test accuracies at 3 cm level

Elevations



Intensities



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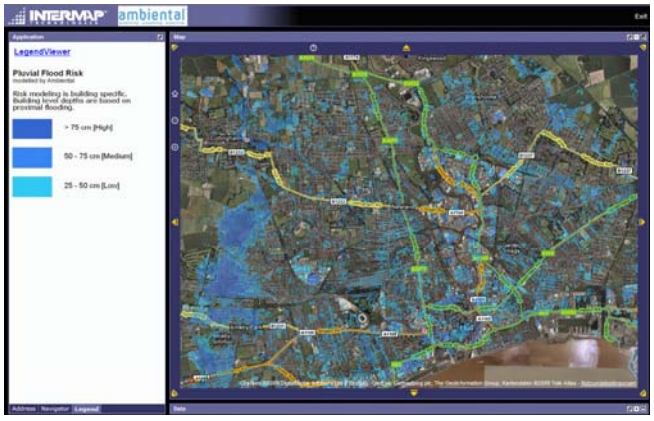
Example: Pluvial Flood Module UK

- Pluvial Flood Modules available for different applications:
  - Insurance Underwriting
  - Accumulation Control



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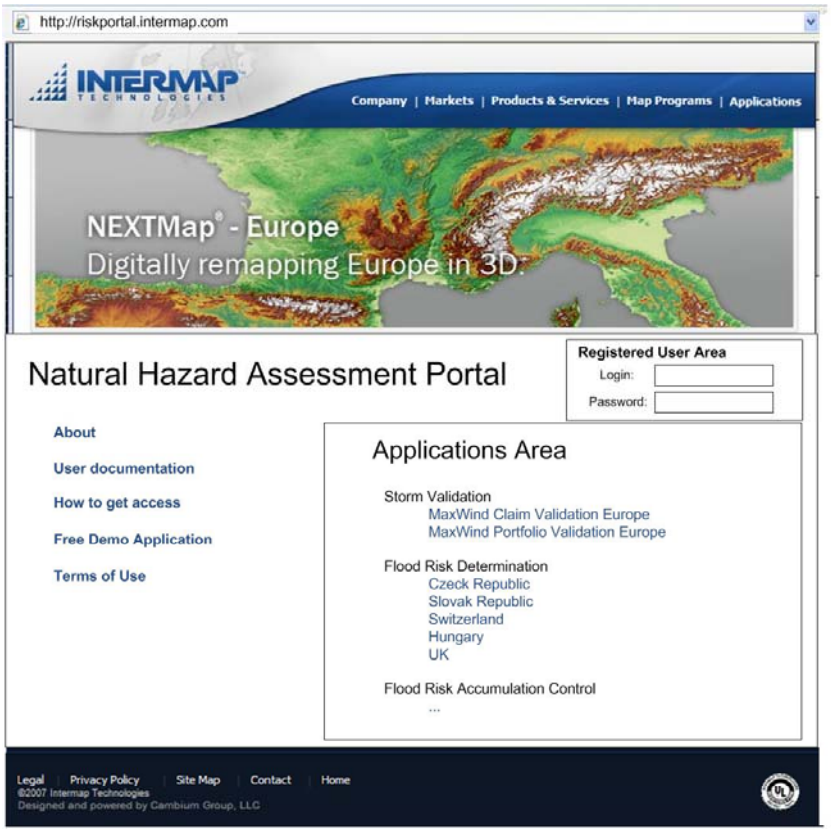
Central access – Risk Portal

- All products accessed from a central web page
- Online Registration and Account Generation
- Payment Module
- Product Documentations
- Free Demos



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Central access – Risk Portal

Risk Portal

UK Pluvial

Wind Monitoring EU

Switzerland

CZ River + pluvial

CZ River + pluvial

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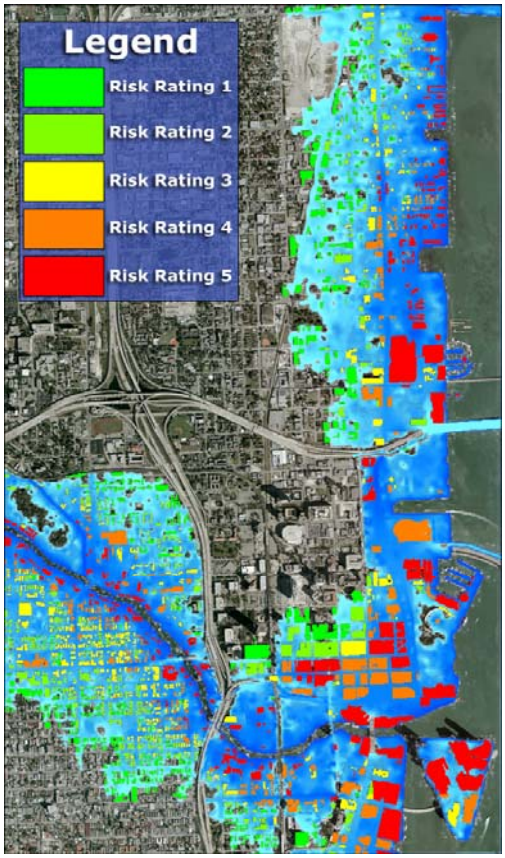
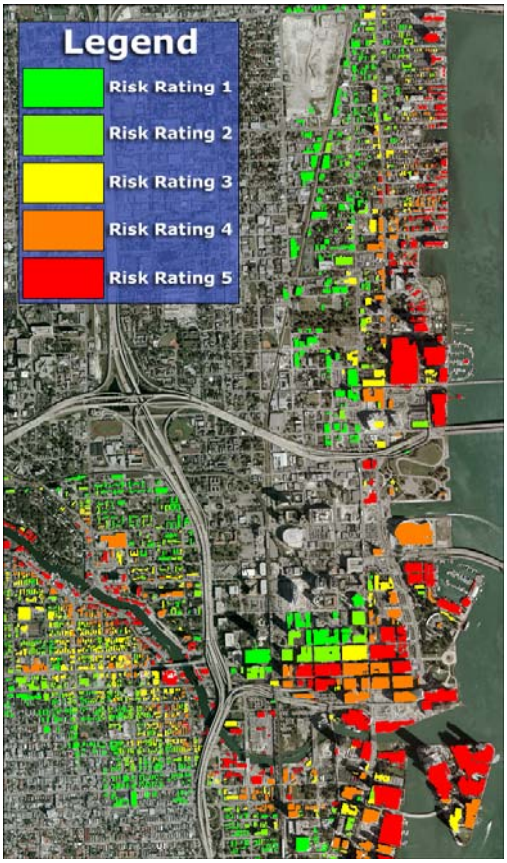
Flood Risk Assessment Product
Miami Beach: Category 5 Hurricane Storm Surge Model





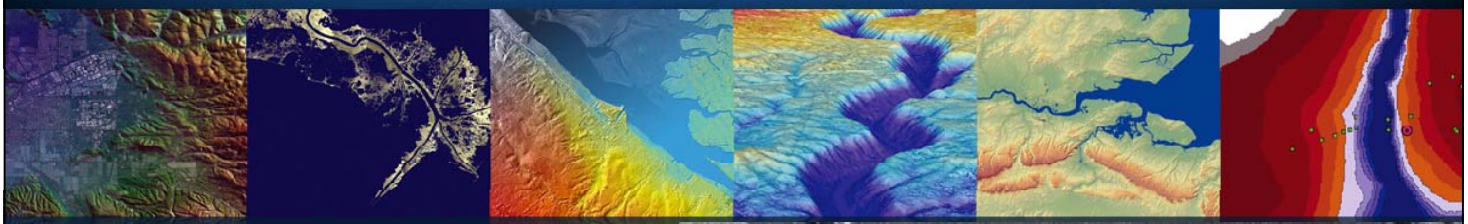
bmercer@intermap.com

Summary

- We have provided an update regarding NEXTMap: the creation of trans-national, regional and continental scale 3D data-bases using airborne InSAR
  - NEXTMap Europe is now available for 15 + countries covering 2.2 million kmsq of western Europe through 'Terrain-on-Demand'
  - NEXTMap USA will be completed in early 2010
- The vertical accuracy of DSM and DTM has been tested against several thousand independent check points distributed across each of the countries with RMSE values well under the 1.0 m Type II specification.
- A number of applications related to emerging markets were demonstrated (many were not)

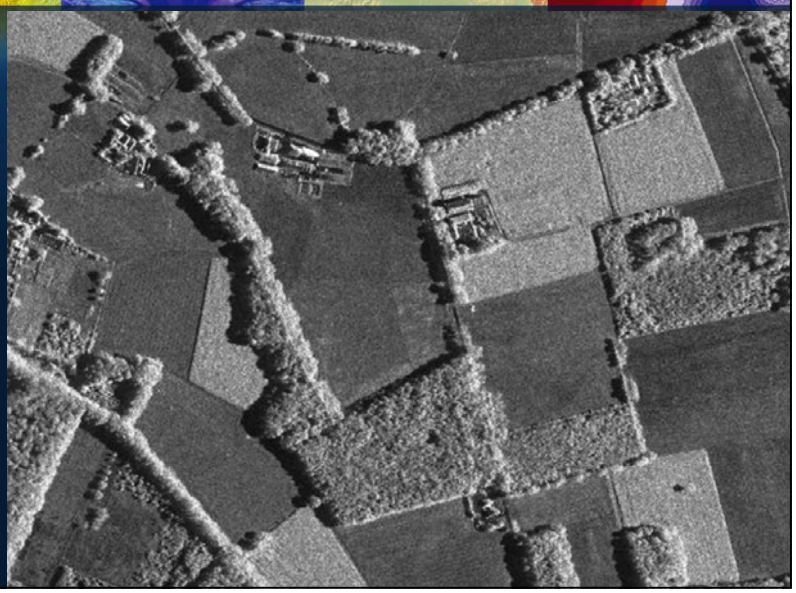
bmercer@intermap.com

INTERMAP™ TECHNOLOGIES



Thank you!

bmercer@intermap.com



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