

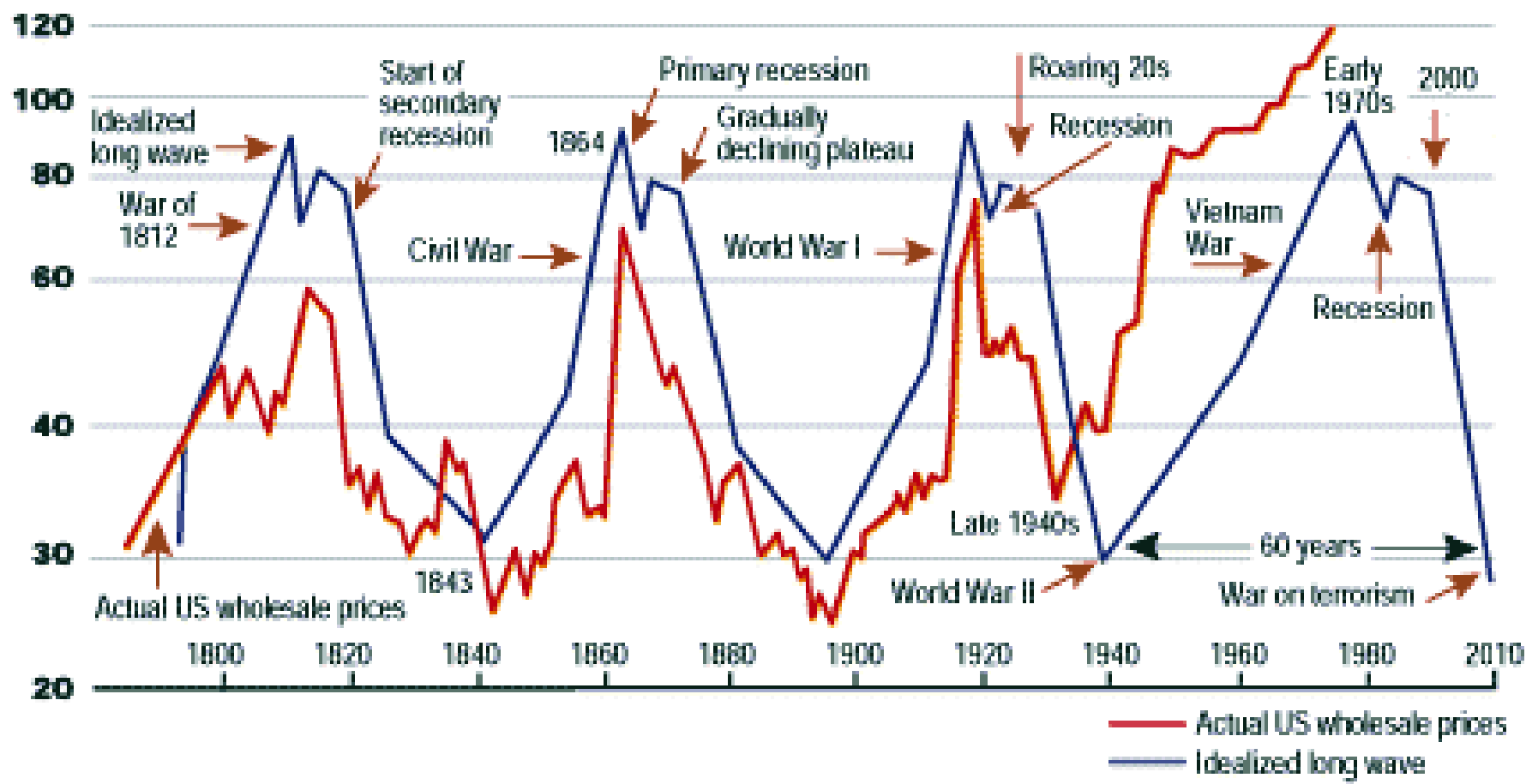
New Developments in Geoinformation Technology and their Impacts on Photogrammetry and Remote Sensing

**FIG & SSGA Workshop
Ulan Baatar, Mongolia, Sept 4 - 8, 2011**

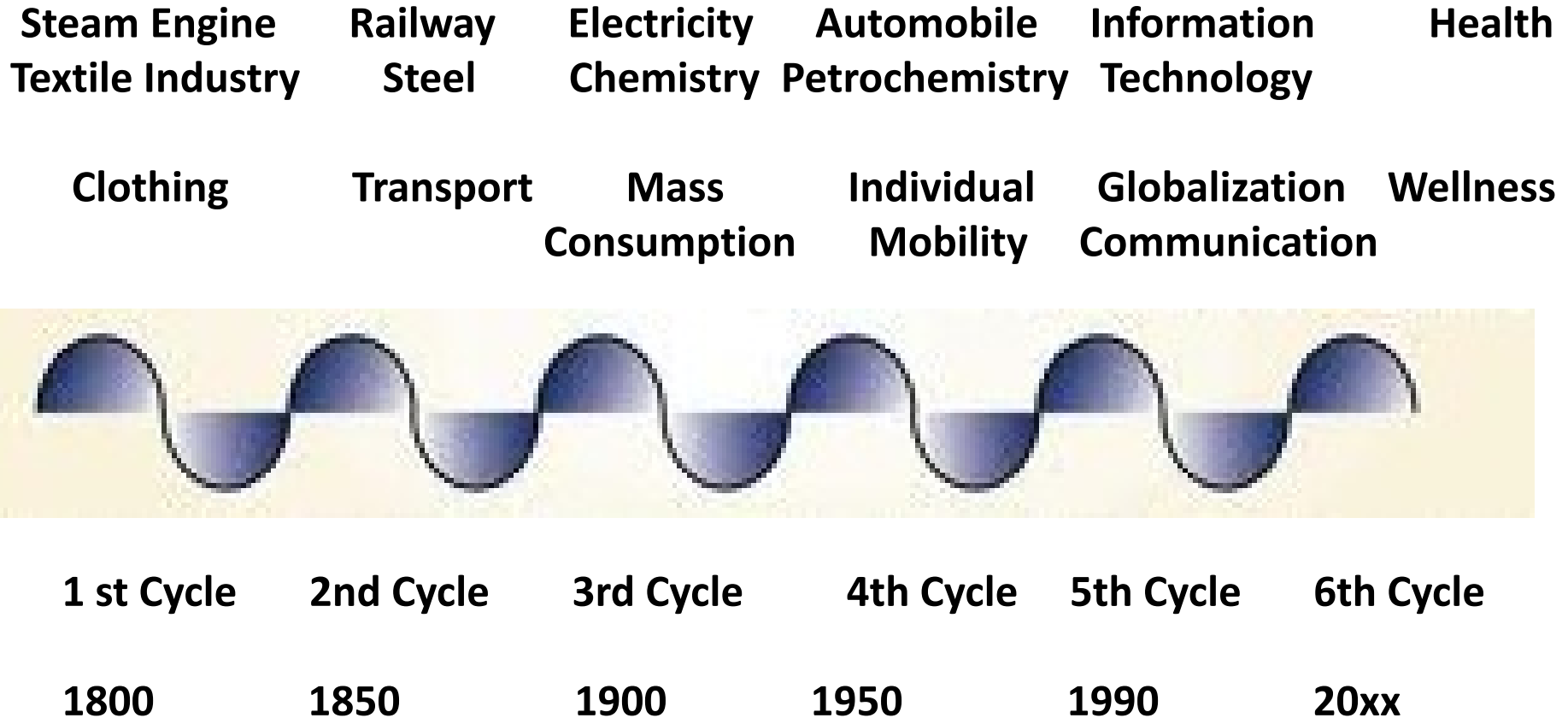
Presentation by

**Gottfried Konecny
Emeritus Prof. Leibniz University Hannover**

The Kondratieff Wave



The Kondratjev Cycles



100 year Anniversary of ISPRS in Vienna 2010

Election of Honorary Fellows of the Society:

**Li Deren, China; Costas Armanakis, Canada; Ivan Antipov, Russian Federation;
George Zarzicky, Canada; Stan Morain, USA**

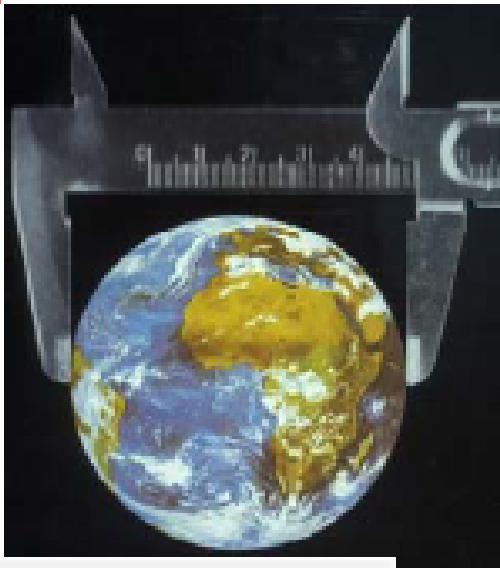


**New Technology made it possible,
that tasks, which were not affordable before,
are available now,
they can be used for partial automation:**

1. Satellite Positioning to cm accuracy (GNSS-GPS)
2. Imaging by digital aerial photography (ortho mapping)
3. Satellite Imagery covering the Globe (Google Earth)
4. Laser Scanning
5. Computer Technology Advances (Moore's Law)
6. Database Technology (Object Relational Data Bases)
7. Web Applications (Geoportals, Crowd Sourcing)
8. Mobile Technology Applications (Smart Phones)

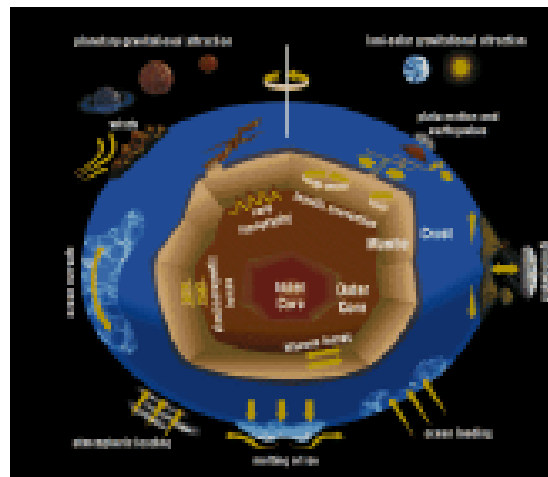
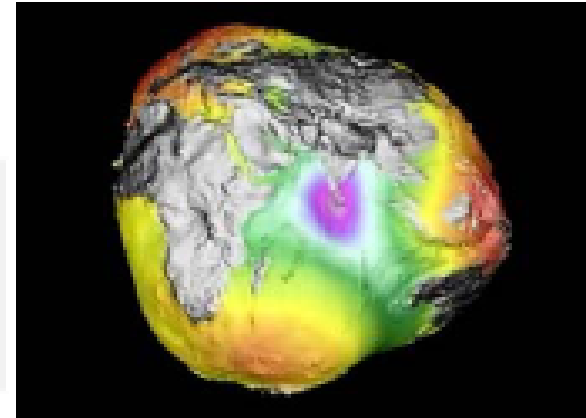
1. Satellite Positioning GNSS-GPS

1.1 The objective of geodesy



Geometrical figure of the Earth:
precise coordinates

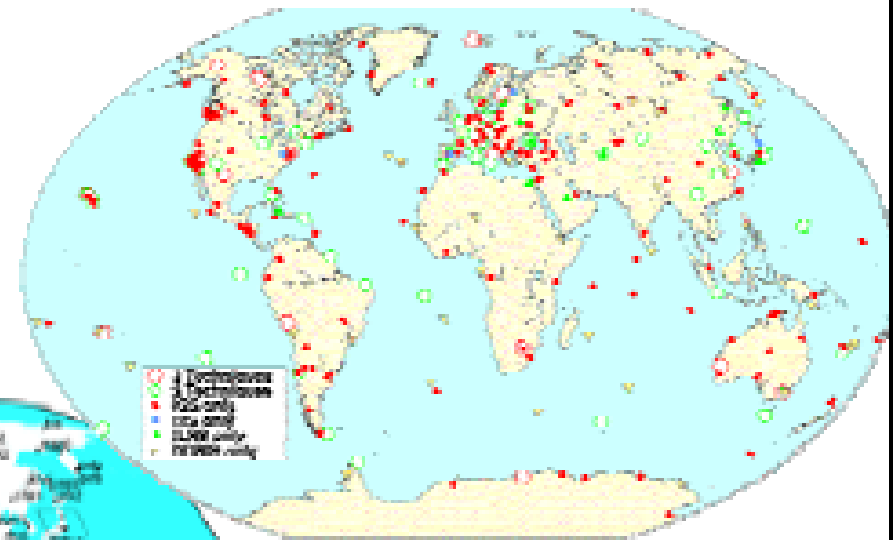
Physical figure of the Earth:
gravity field,
geoid



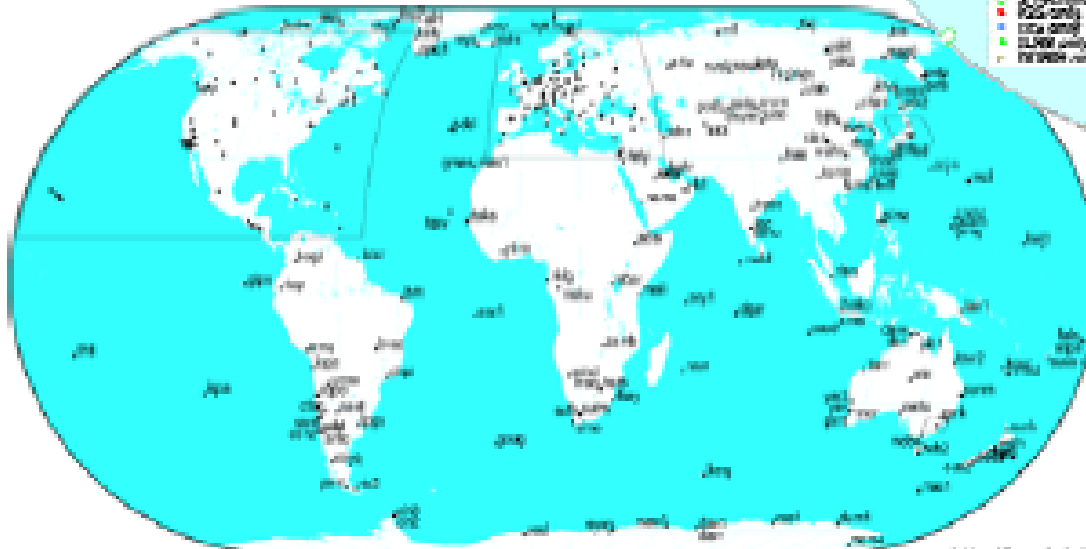
Variations thereof:
dynamic Earth,
Earth rotation,
crustal motion

1.2 Scientific and technical questions solved with GPS

- 1.) Determination of a high-precision, three-dimensional terrestrial reference frame
 - International Terrestrial Reference Frame (ITRF)
 - International GNSS Service (IGS)



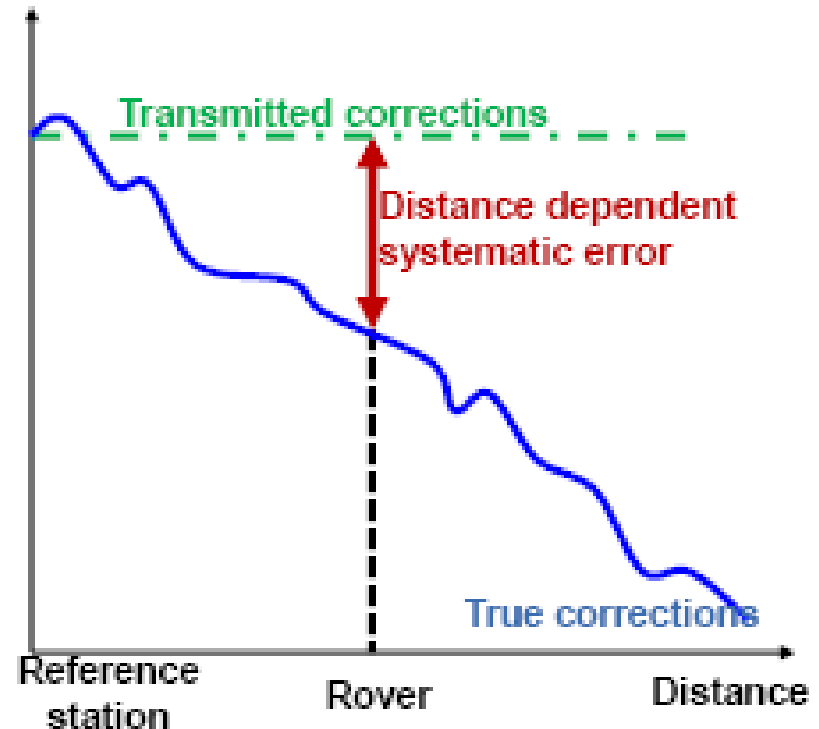
© <http://ifrf.ensg.ign.fr>



© http://igsb.jpl.nasa.gov/images/maps/all_world.png

6.2.4 Realizations

- Idea:
 - Interpolation of distance dependent systematic errors
- Realizations
 - Least-squares collocation
 - Interpolation polynomial
 - Interpolation functions
 - correction surface
 - State space representation of the errors in a network
- Representation
 - Virtual reference station
 - Area correction parameters



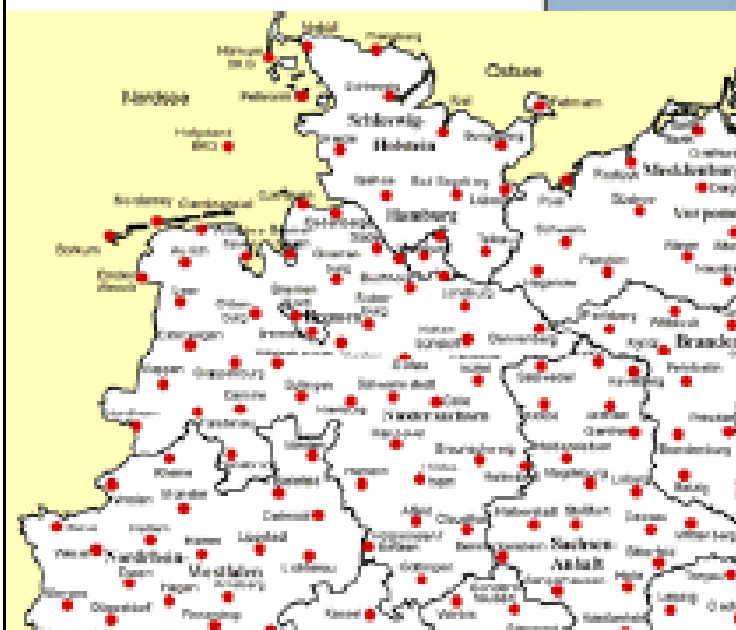
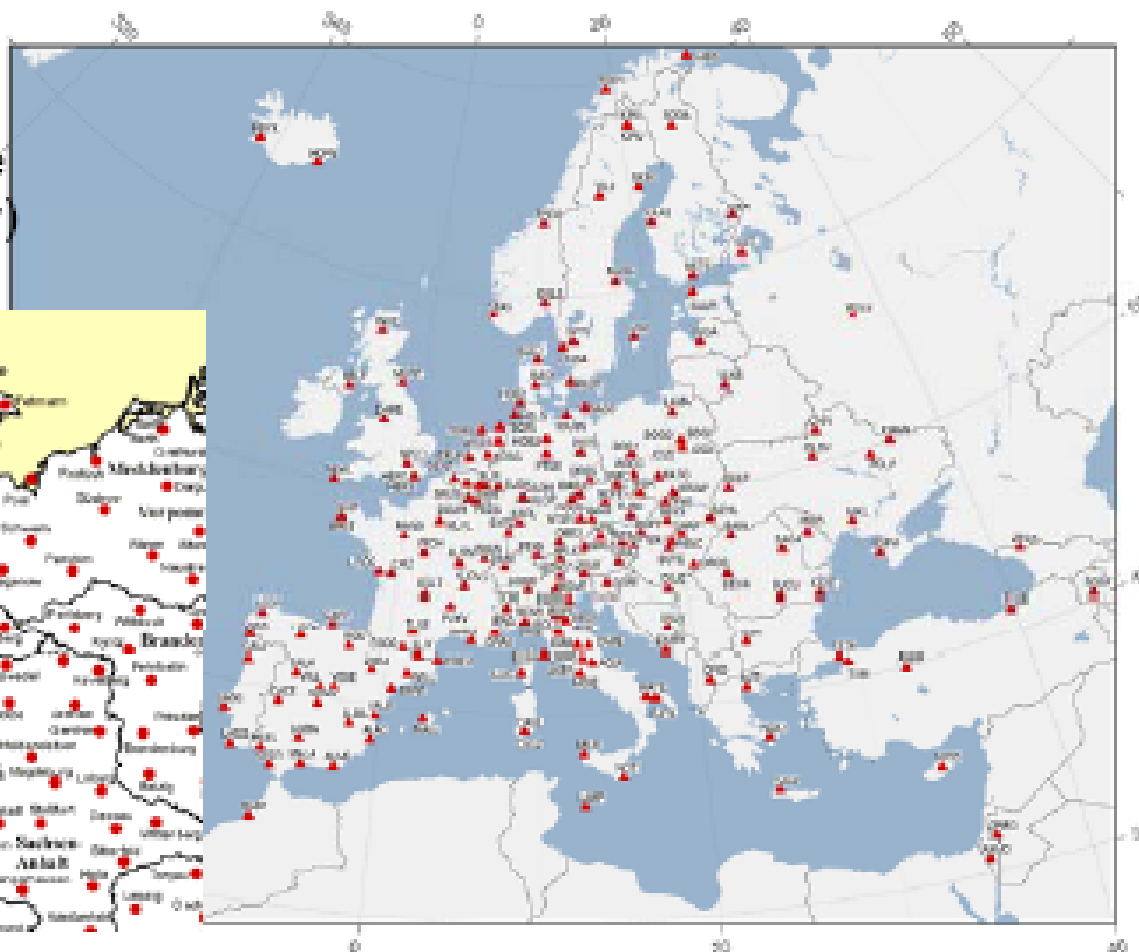
1.2 Scientific and technical questions solved with GPS

- EUREF

c <http://www.epncb.oma.be/>

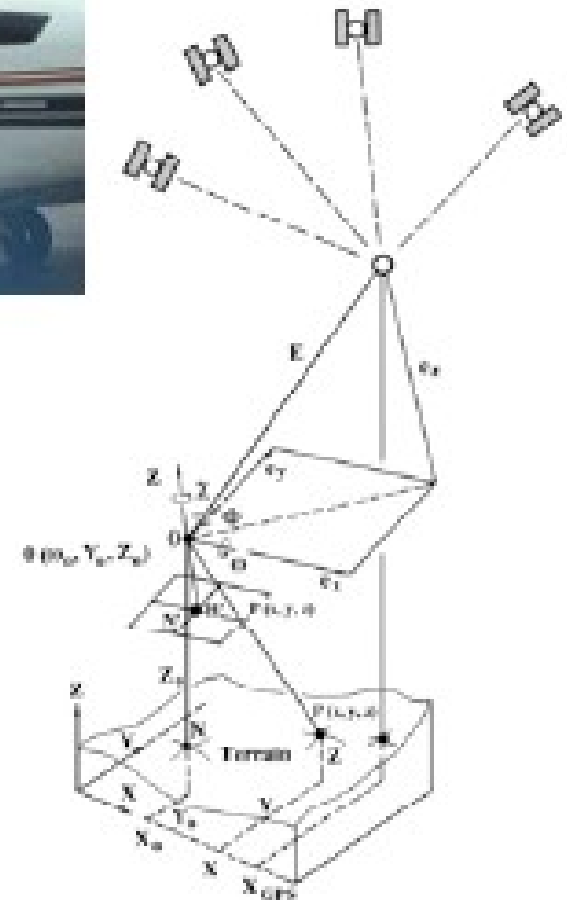
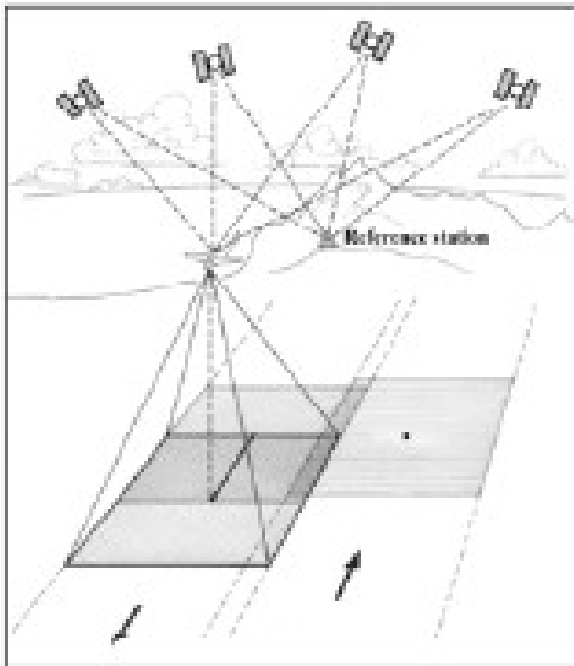
- SAPOS (satellite positioning service of the state survey)

EUREF Permanent Tracking Network



c www.sapos.de

1.5 GPS supported photogrammetry



Result:

- 1. Augmented Accuracy Systems such as EGNOS, WAAS, NTRIP and Omnistar permit static geolocation anywhere on the globe with +/- 50cm accuracy with inexpensive code receivers**
- 2. Phase receivers operating in RTK mode at a range of 10km or in CORS networks with station up to 50km range permit +/- 1cm accuracy**
- 3. Mobile applications with RTK or CORS reference permit +/- 1 dm accuracy**

2. Digital Aerial Photography

1. Digital Aerial Cameras

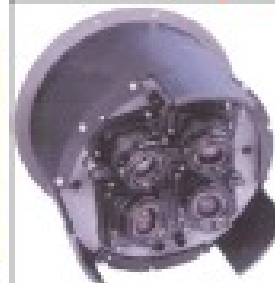
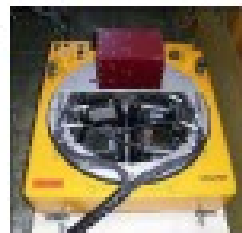


In most countries aerial film cameras not more accepted – Kodak and Agfa stopped production of aerial film

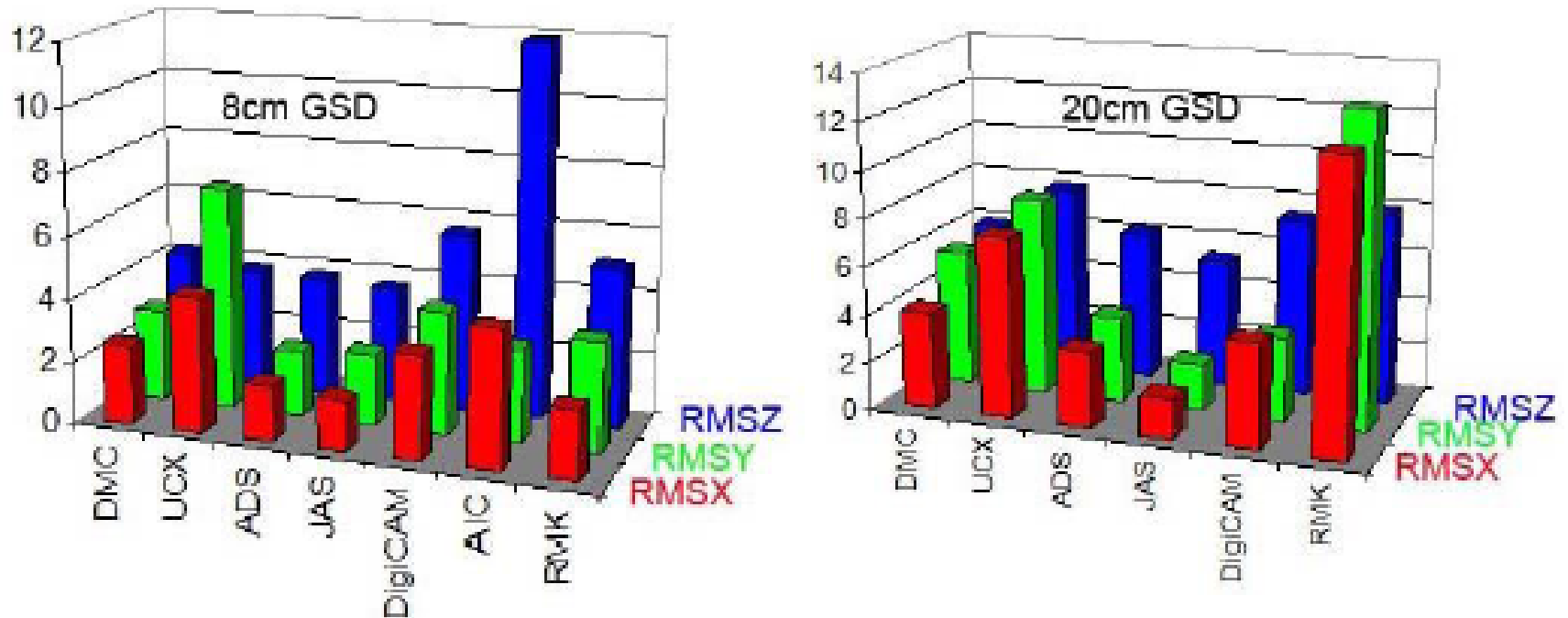
Aerial frame cameras (CCD-array) and **CCD-line-scan cameras**

Aerial frame cameras: **large format** (DMC, UltraCam), **mid format** cameras – several (only cameras with stable body respected, fix-focus – not cameras as Canon EOS)

also **combinations of mid format cameras** (2 up to 5 cameras), for UAVs **tiny cameras** in use



Geometric performance



Results of camera test by German Society of Photogrammetry, RS and Geoinf.
Bundle block adjustments: root mean square errors at independent check points

3. High Resolution Satellites

2. Optical space imagery for mapping purposes

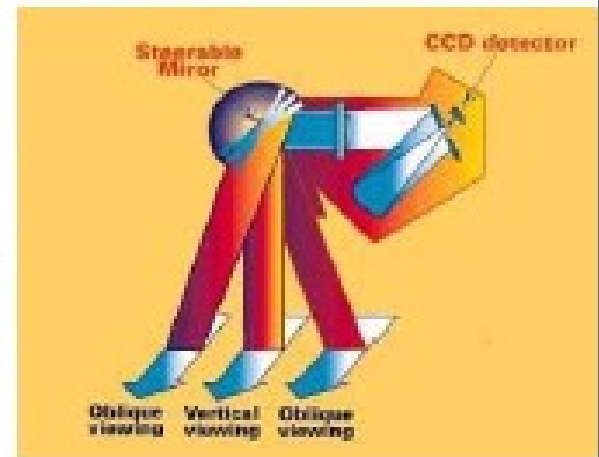
Limited to civilian available systems and systems usable for mapping (~<6.5m GSD)



GeoEye-1



Cartosat-2

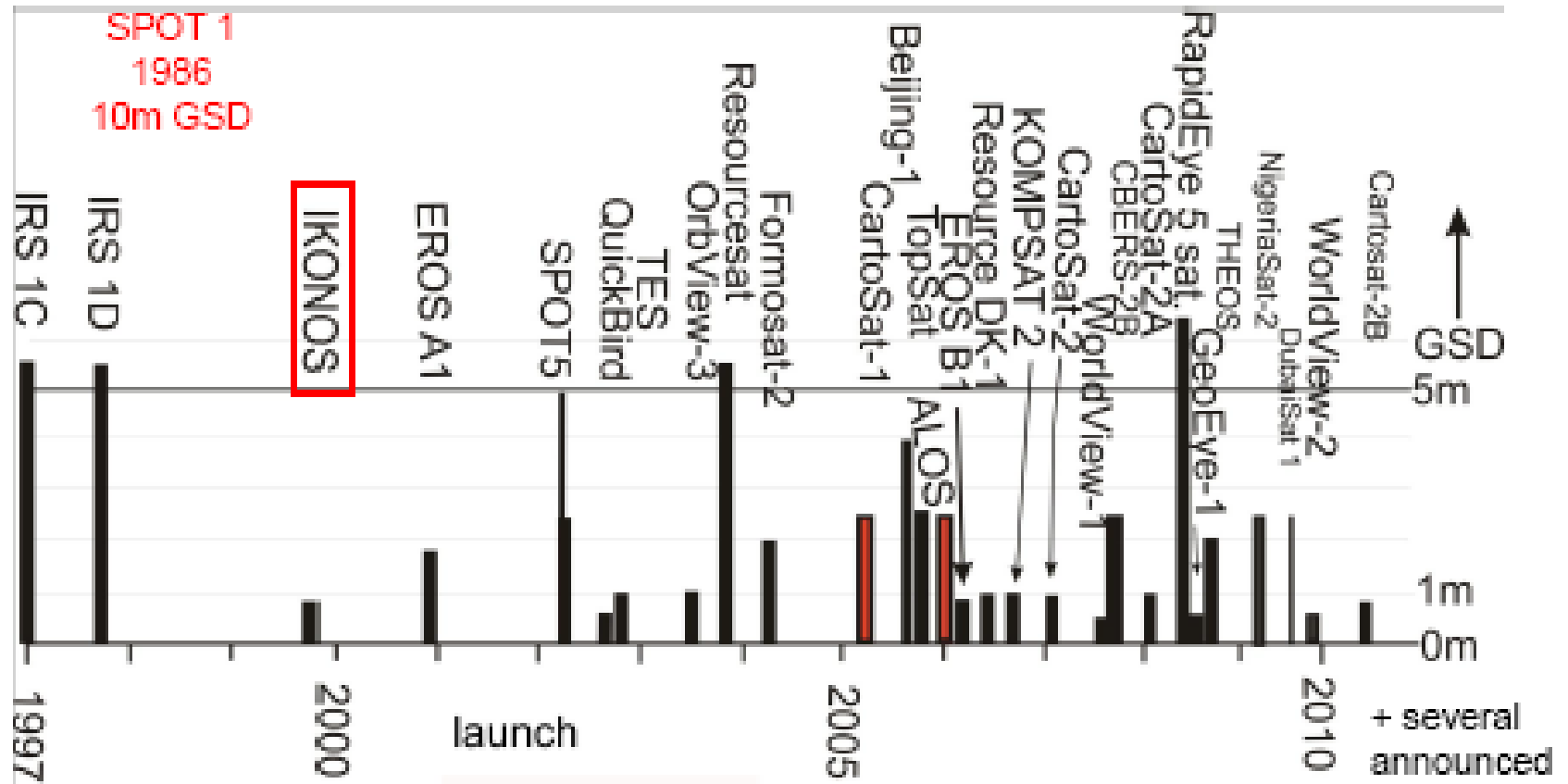


SPOT

Old systems: different view direction to side by rotating mirror or slowly rotating satellite – big satellite with cameras

New systems: one large camera, fast rotating satellite (big optical system with components around)

High and very high resolution optical satellites



SPOT 1 (1986) start of mapping from space

IKONOS (1999) competition with aerial images

ESRI Viewer for Change Detection of Landsat Images

1975

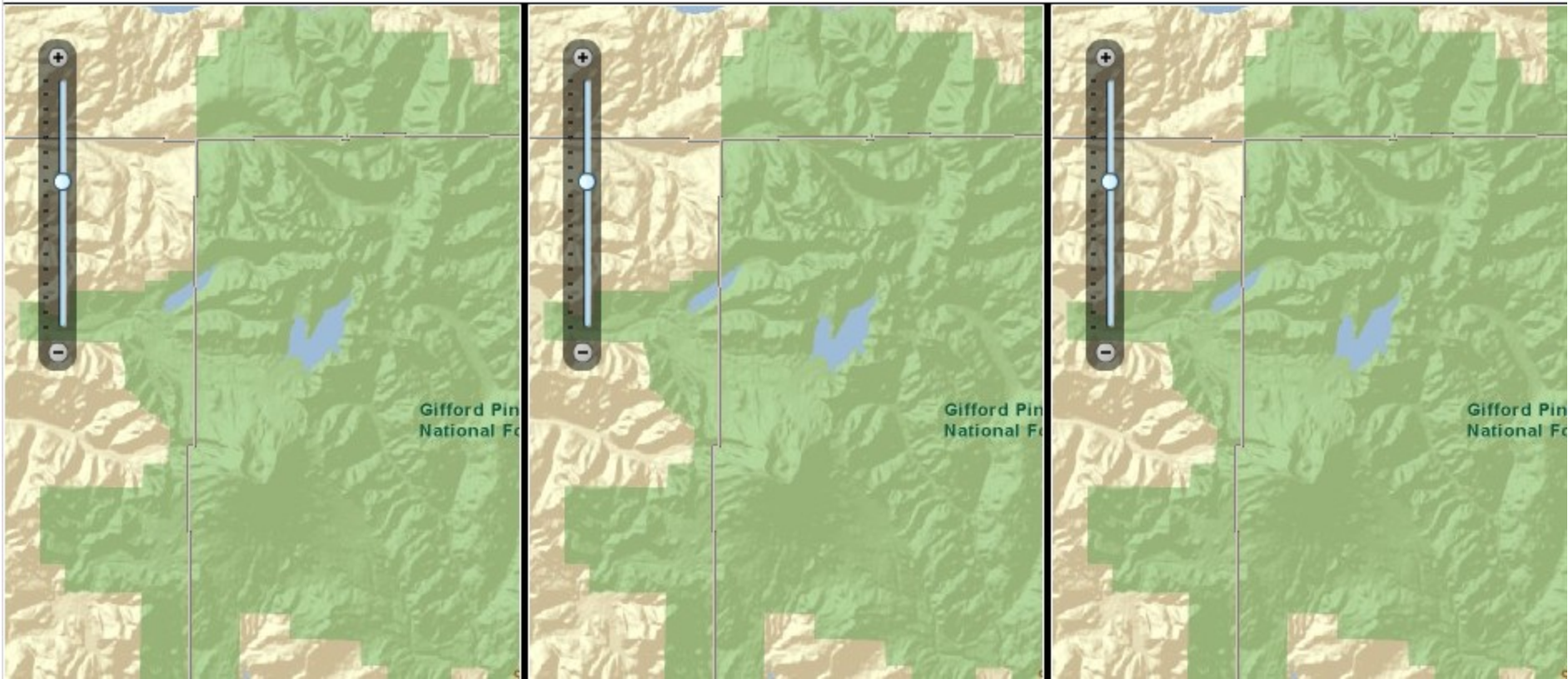
Full Screen 

2000

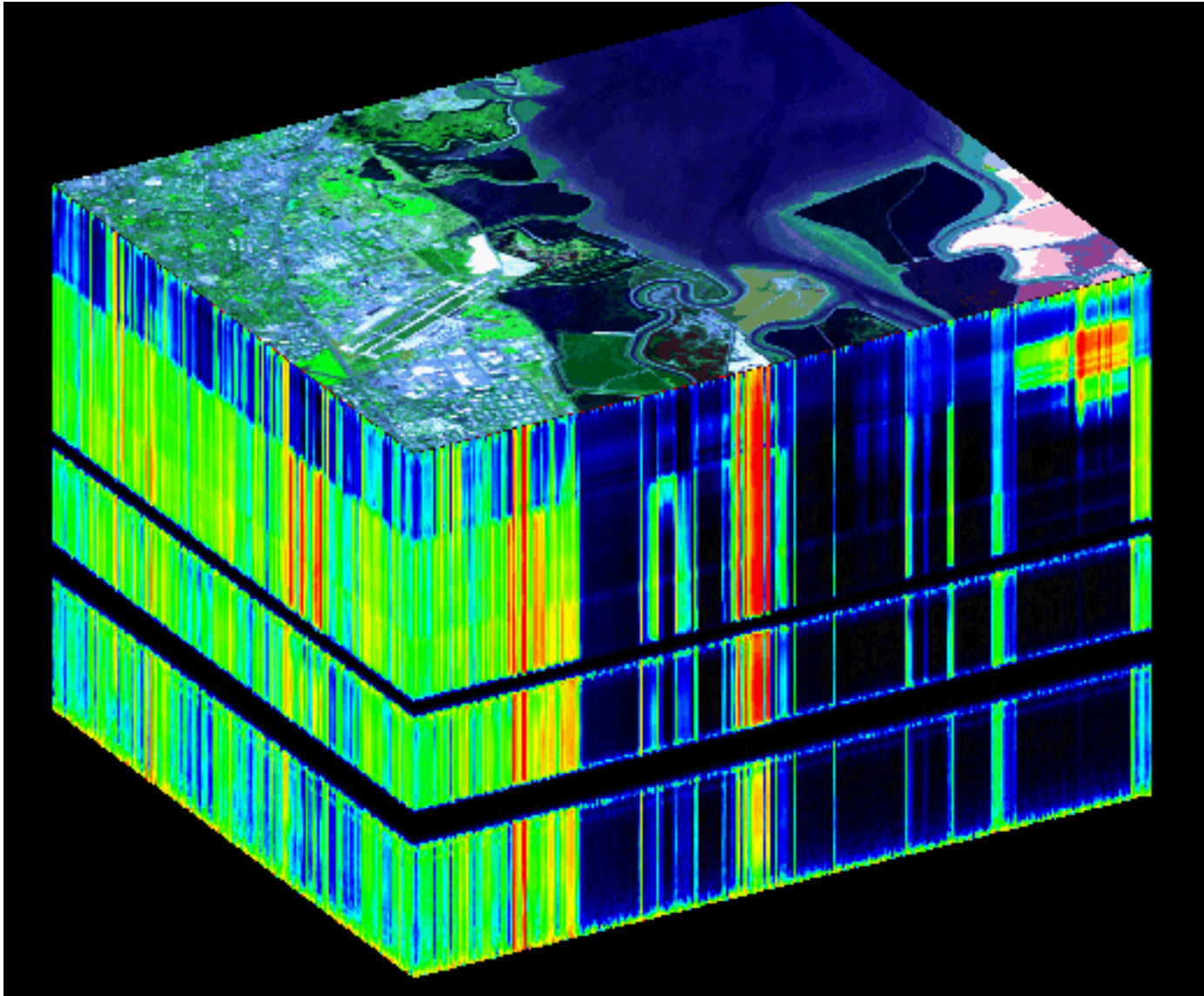
Full Screen 

NDVI Change 1975 - 2000

Full Screen 

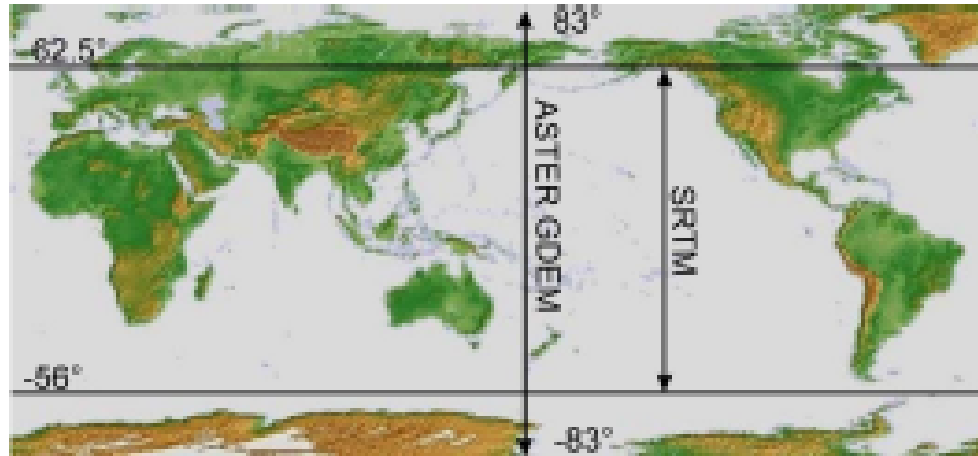


Hyperspectral Cube (AVIRIS Data)



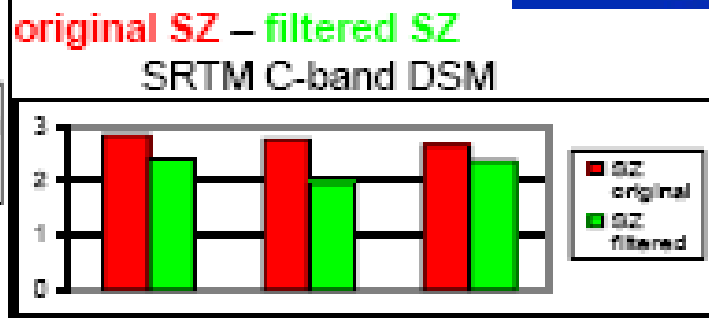
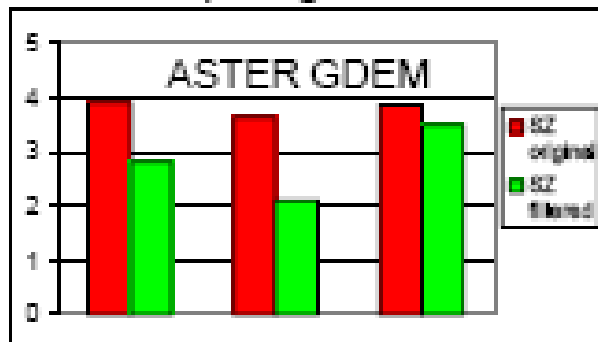
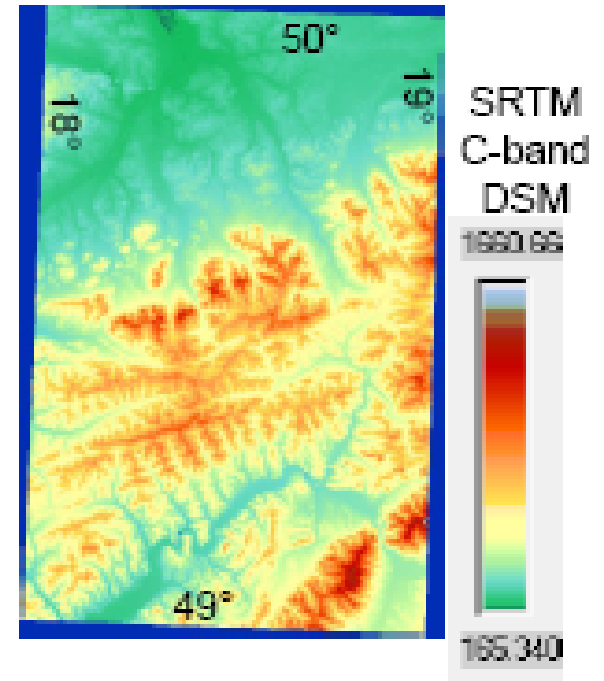
Competition between Optical and Radar Systems

Nearly world-wide height models: ASTER GDEM – SRTM C-band DSM



SRTM C-band DSM (Radar), 3 arcsec spacing ~90m

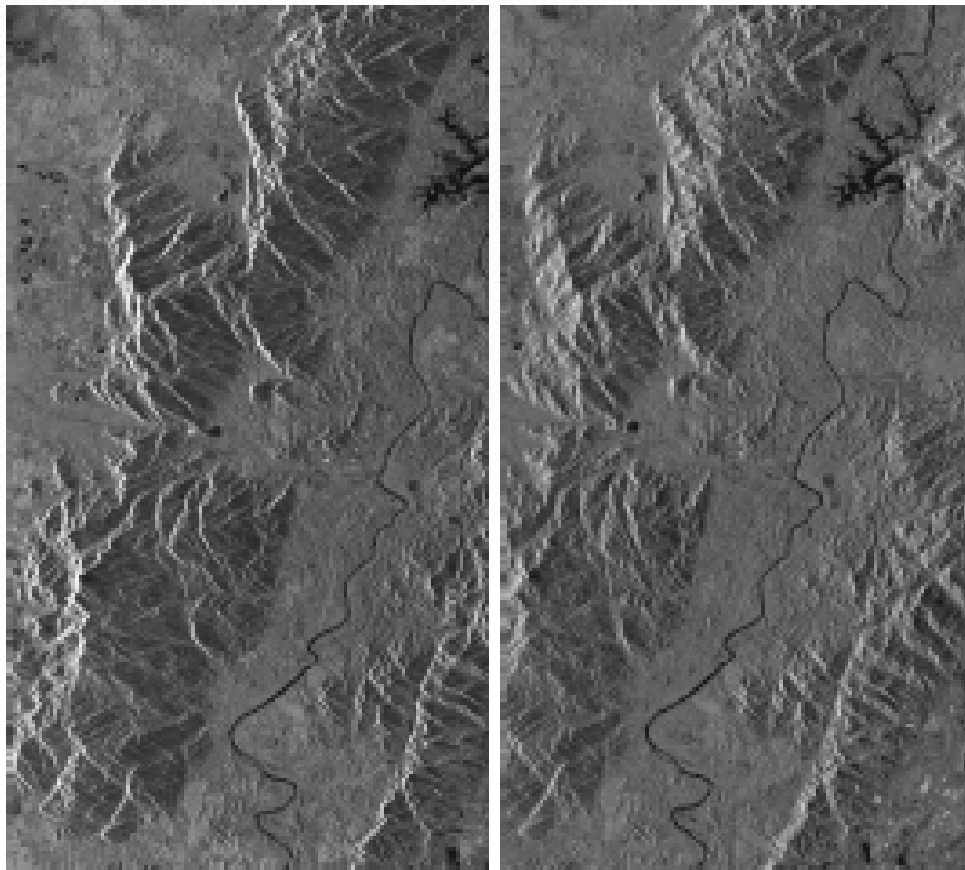
ASTER GDEM DSM based on ASTER images, 1 arcsec spacing ~ 30m



Test area Atlantic County
flat, partially forest with bushes and low trees

Experiment

TerraSAR-X stereo pair



Sep. 13, 2009

Incidence angle: 21.4°

Sep. 18, 2009

Incidence angle: 42.7°



LEIBNIZ UNIVERSITÄT BREMEN

LIOS

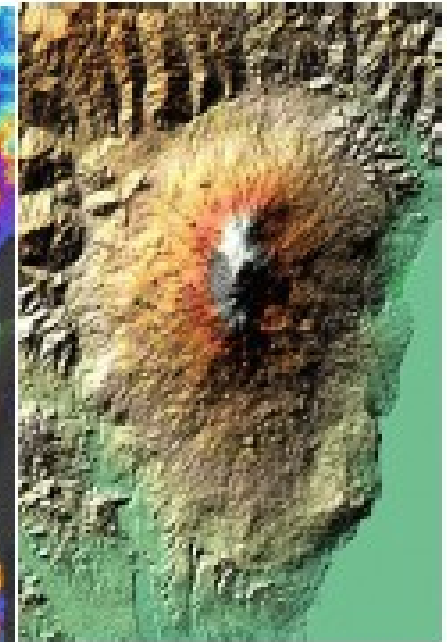
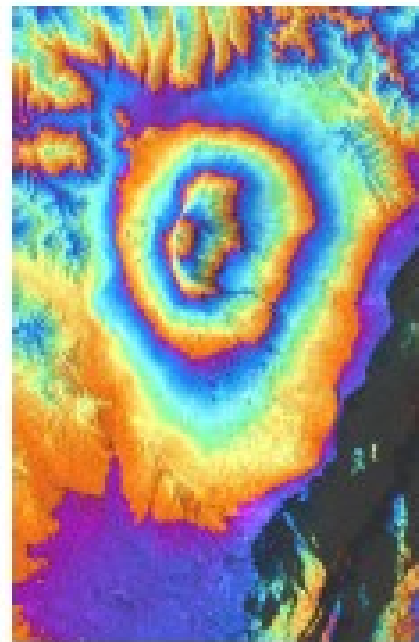
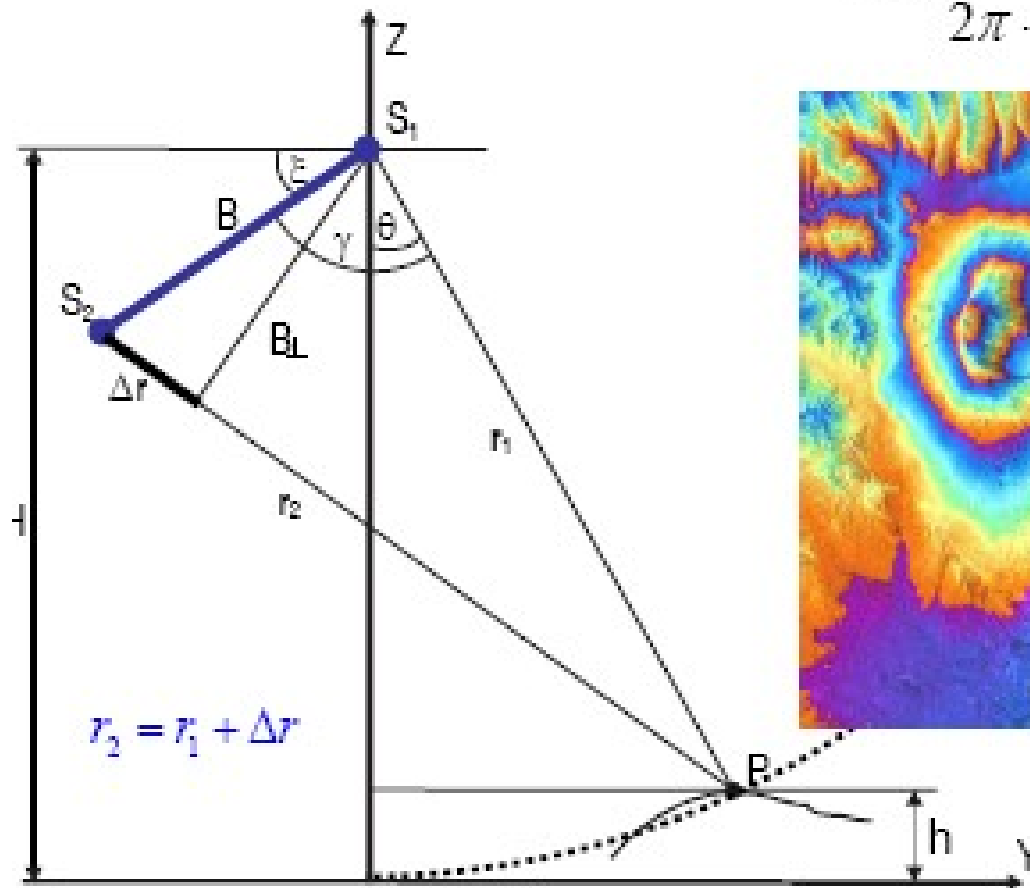
SAR Stereo:

- similar to Photogrammetry
- uses image amplitude
→ matching
- more robust against temporal decorrelation than InSAR
- requires sufficient basis (different θ)

Digital Elevation Models (DEM) from InSAR

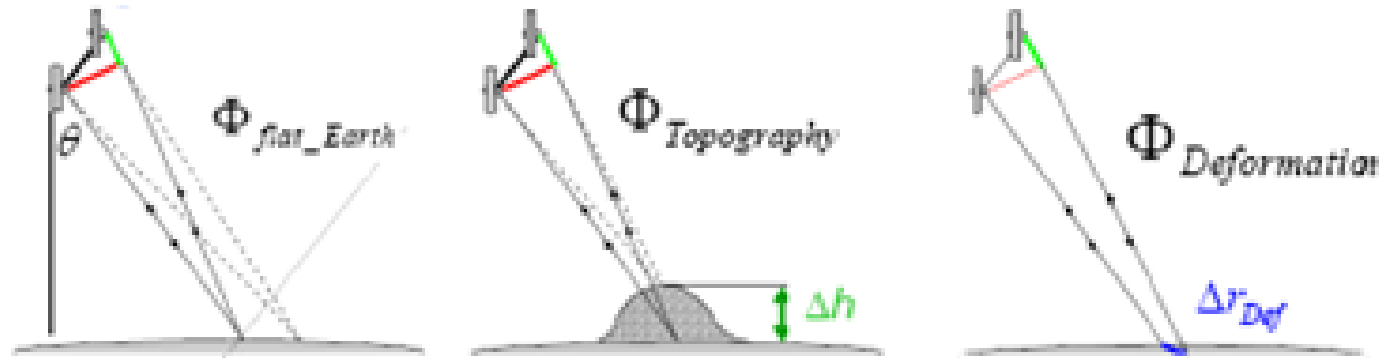
- Standard InSAR

$$h \approx \frac{\lambda}{2\pi \cdot p} \cdot \frac{r_1 \cdot \sin(\theta_0)}{B \cdot \cos(\theta_0 - \xi)} \cdot \Delta\varphi$$



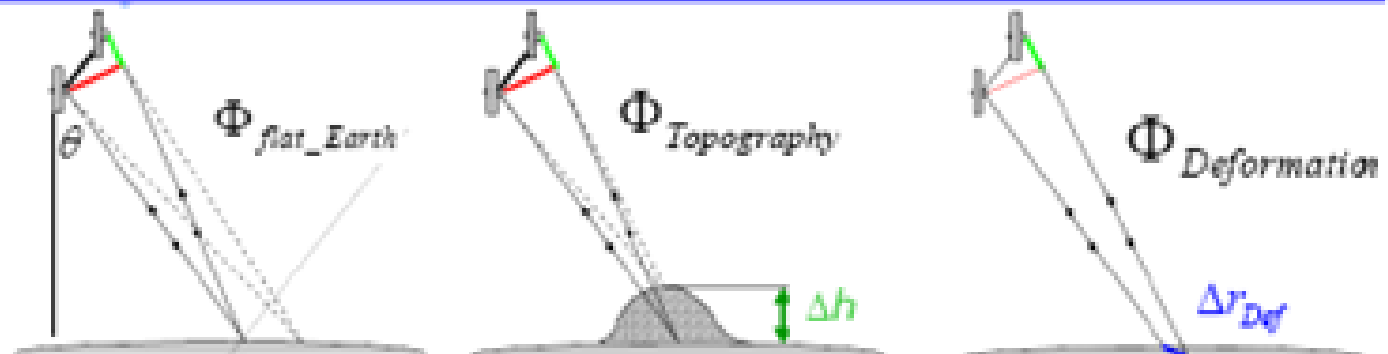
ERS-1/2, ©ESA

Surface motion: Interferometry



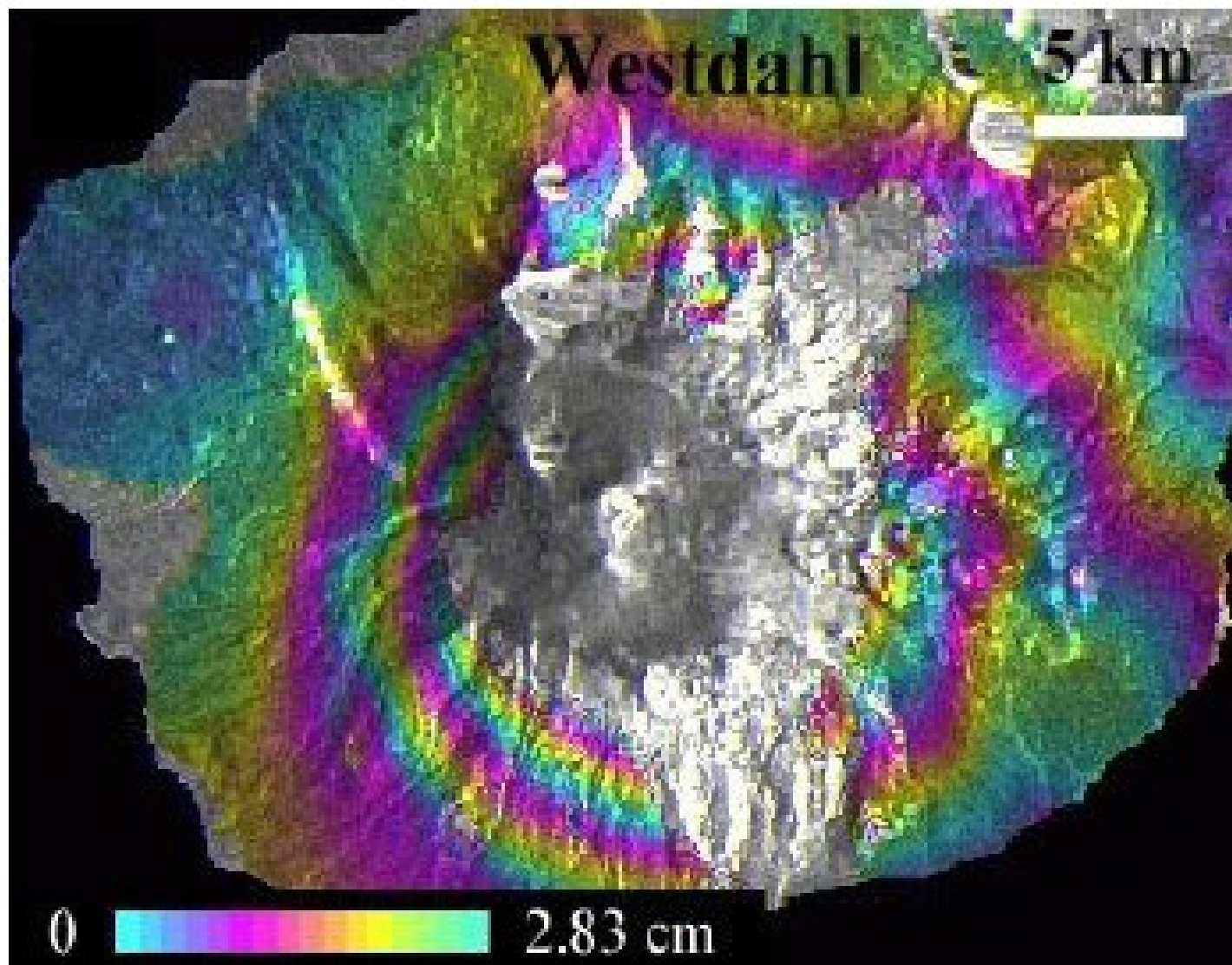
$$\Phi = W \left\{ \Phi_{flat_Earth} + \Phi_{Topography} + \Phi_{Deformation} + \Phi_{Error} \right\}$$

Surface motion: Differential Interferometry



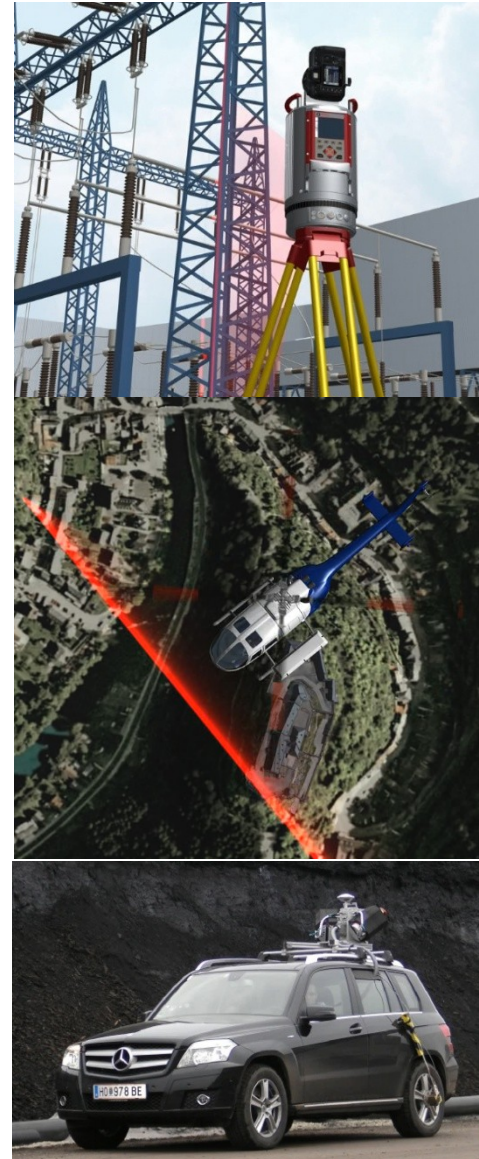
$$\Phi = W \left\{ \cancel{\Phi_{flat_Earth}} + \cancel{\Phi_{Topography}} + \Phi_{Deformation} + \Phi_{Error} \right\}$$

Motion of Vulcano



4. Laser Scanning

- TLS Terrestrial Laser Scanning
- ALS Airborne Laser Scanning
- MLS Mobile Laser Scanning



TLS Terrestrial Laser Scanning

Scanner and Camera



Properties of 3D Laserscanners

Model	RIEGL LMS VZ400
Distance	up to 500 m for Laser Class I
Scan range horizontal	total 100° (+60° / -40°)
Scan range vertical	max. 360°
Distance accuracy	± 5 mm
Data rate	125 000 points/sec.
Measurement	Interference

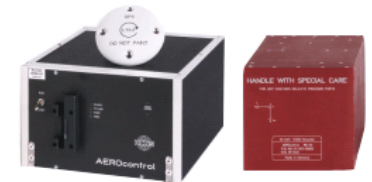
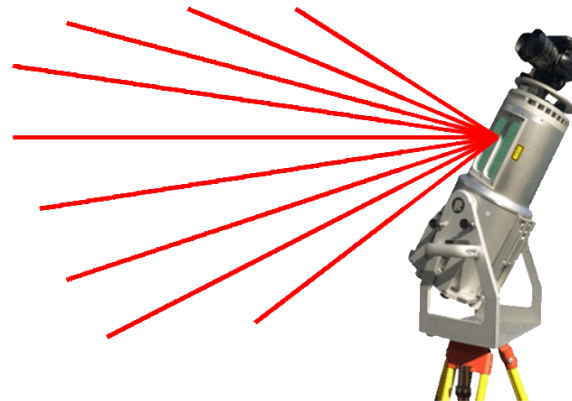
ALS Airborne Laser Scanning

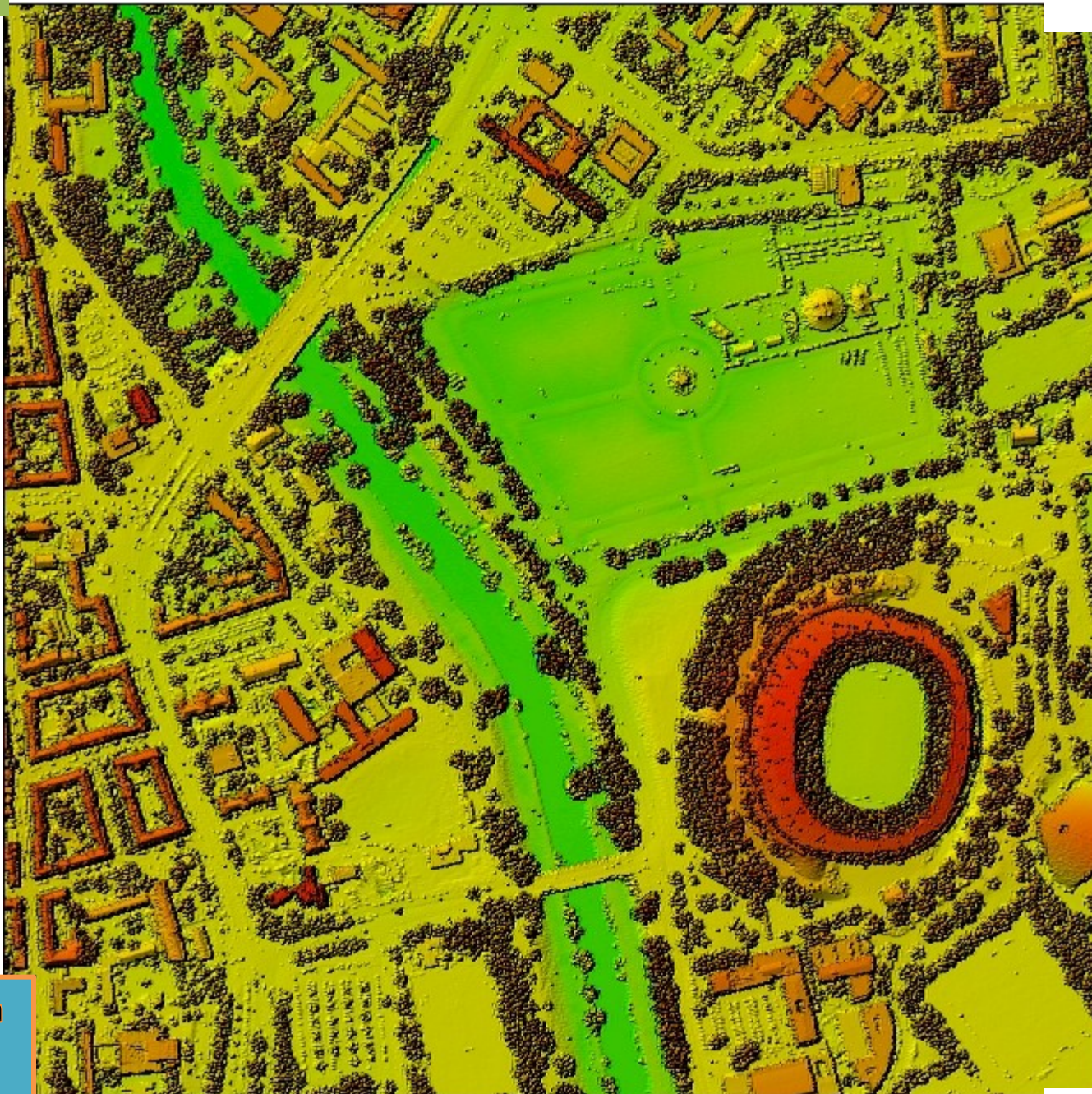


Aero-Complex-M Universal Data Collection System

with

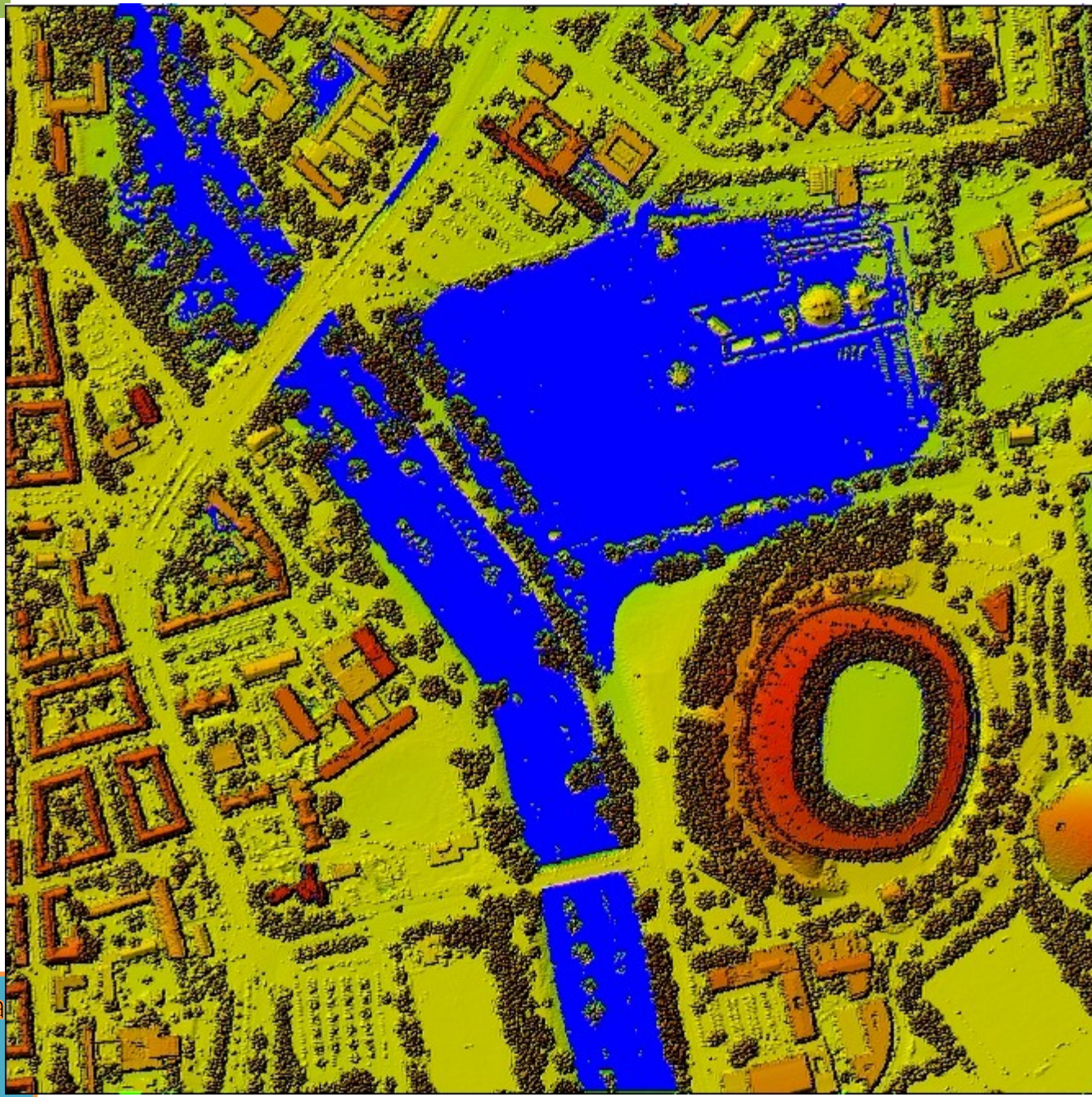
- Airborne Laser Scanning
- Infrared Thermography
- Terrestrisches Laser Scanning
 - Digital RGB Images
 - Imaging Spectrometer





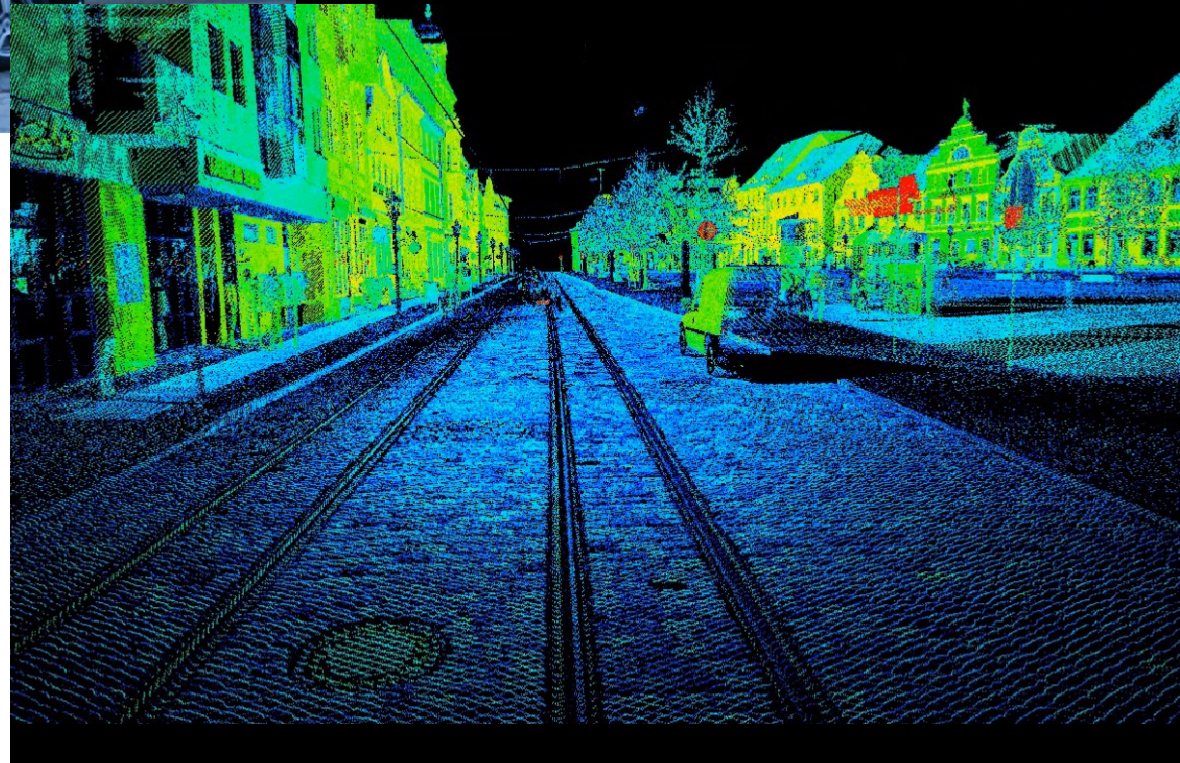
AWD – Arena

90 m



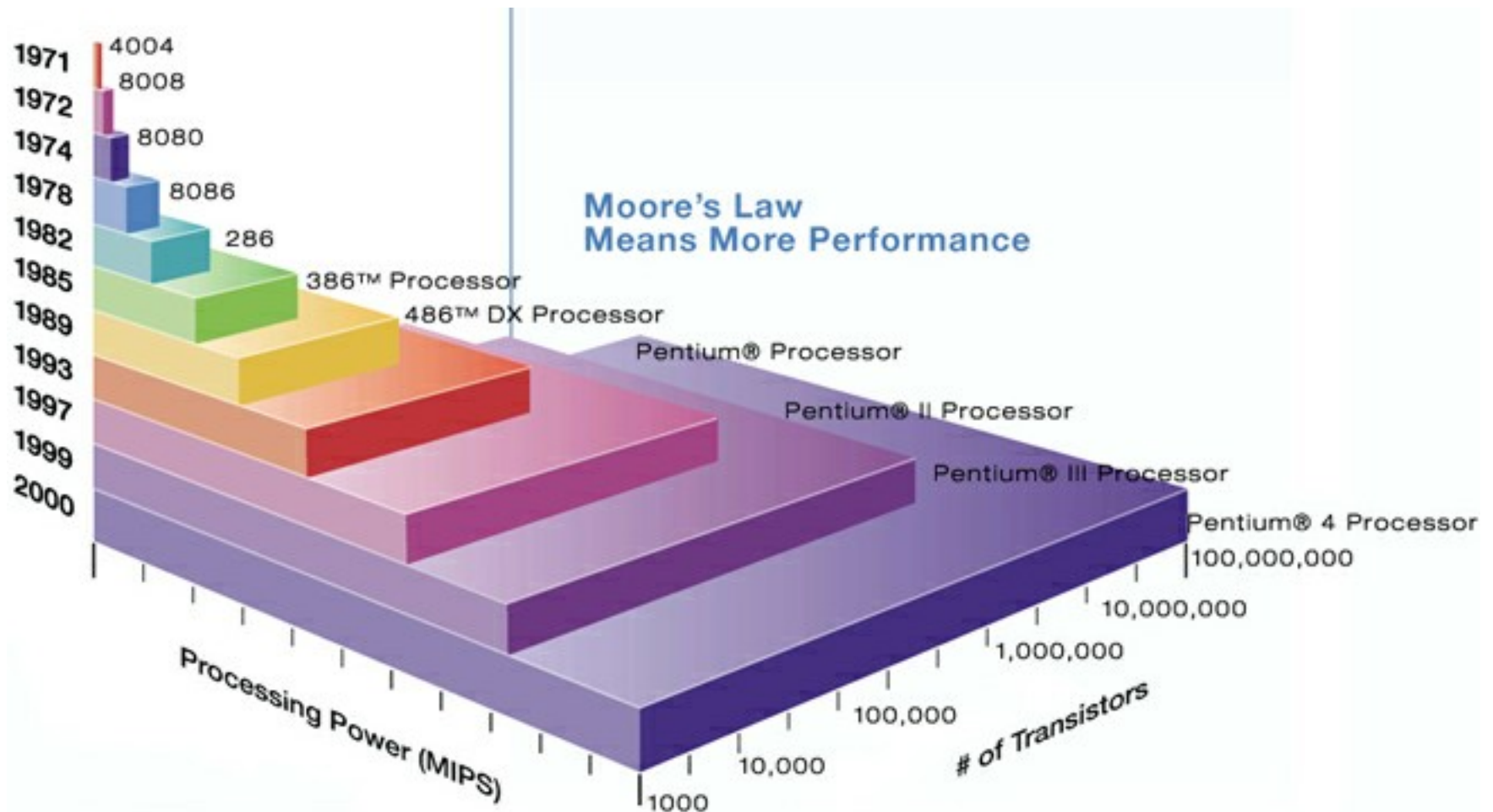
AWD – Arena
94 m

MLS - Mobile Laser Scanning



Stadt Cottbus

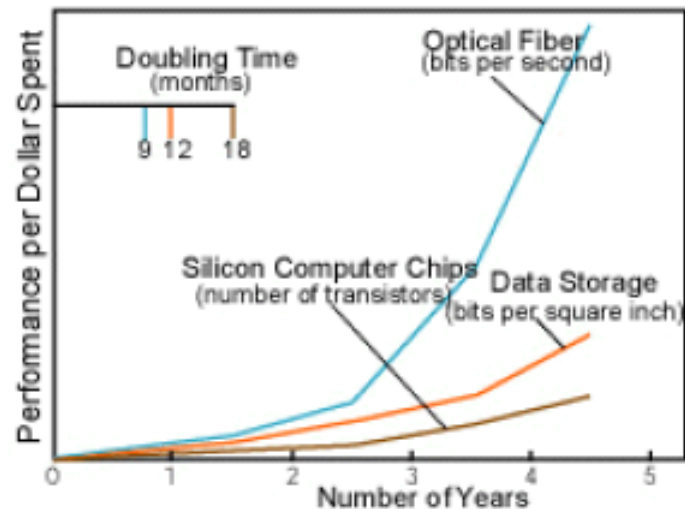
5. Exponential Growth of Computer Technology



Exponential Growth in Network Performance

Network exponentials

- Network vs. computer performance
 - computer speed doubles every 18 months
 - network speed doubles every 9 months
 - difference: order of magnitude per 5 years
- 1986 to 2000
 - computers: x 500
 - networks: x 340,000;
factor 1000
- 2001 to 2010
 - computers: x 60
 - networks: x 4000;
factor: 100



Moore's Law vs. storage improvements vs. optical improvements. Graph from **Scientific American** (2001) by Cleo Vilett, source Vined Khoslan, Kleiner, Caufield and Perkins

6. GIS and Database Technology

an example: ArcGIS

Software components in ArcGIS (1)

Introduction

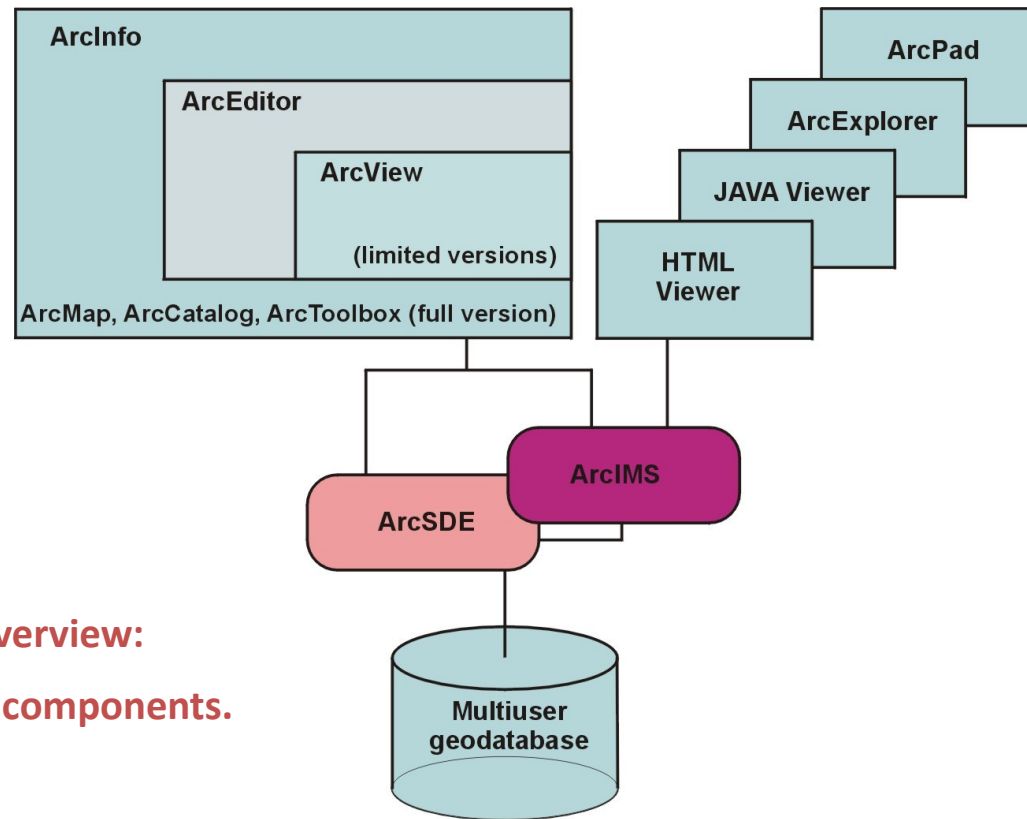
Objectives

Materials & Methods

Results

Conclusions / Outlook

Overview:
ArcGIS components.



Test Plots - Level 1 Map

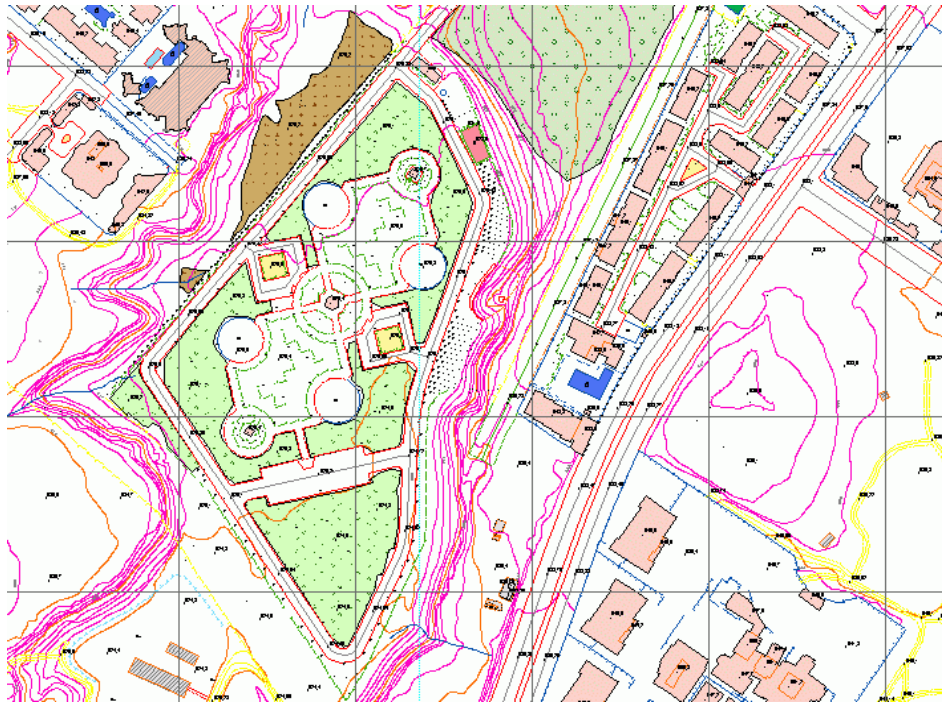
Introduction

Objectives

Materials &
Methods

Results

Conclusions /
Outlook



Result of import into
ArcGIS/ArcInfo and
automated polygon closure
& attribute allocation.

Test Plots - Level 2 Map

Introduction

Objectives

Materials &
Methods

Results

Conclusions /
Outlook



Result of import into
ArcGIS/ArcInfo and
manual polygon closure &
attribute allocation.

Image or Raster Data and the Geodatabase (3)

Introduction

1. Storage of raster data in database tables

Objectives

Materials & Methods

Results

Conclusions / Outlook

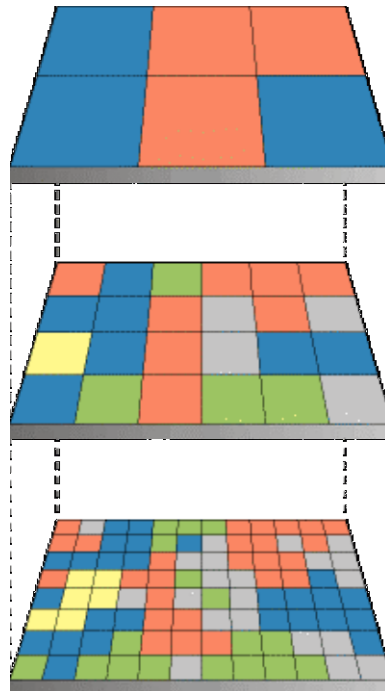


Image pyramid.

The geographical extent remains identical in every pyramid layer.

Test Plots - Level 2 Map

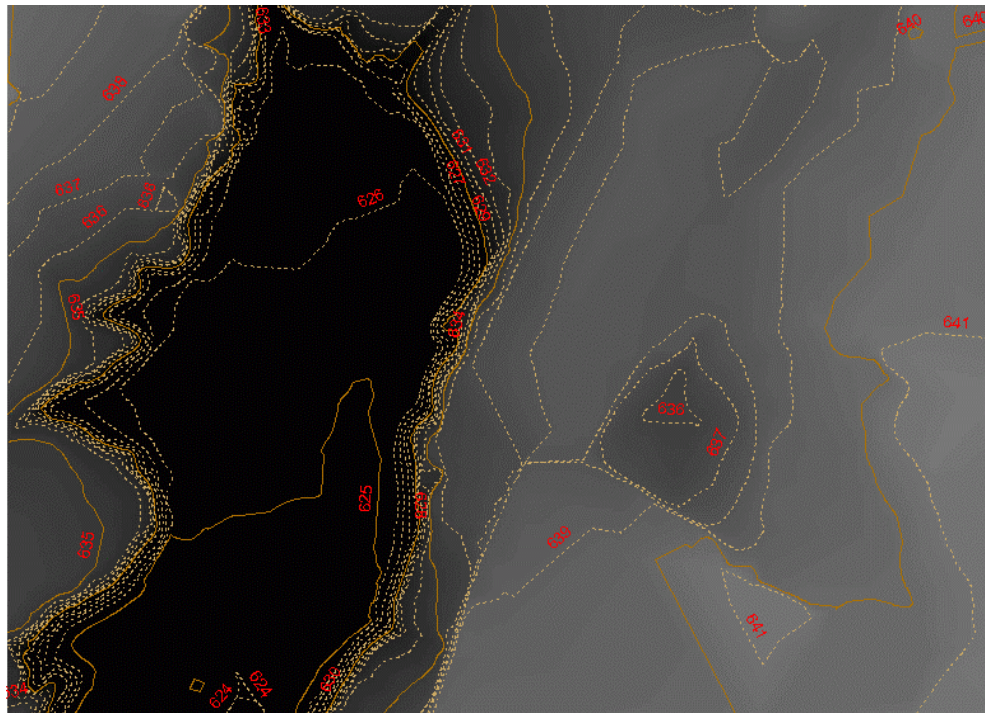
Introduction

Objectives

Materials &
Methods

Results

Conclusions /
Outlook



DEM from elevation
information with
automatically generated
contours.

Software components in ArcGIS (11)

Introduction

Components of **ArcGIS** desktop software (6):

Extensions (additional components):

Objectives

- **ArcGIS Spatial Analyst** for processing and modelling surface information in grids

Materials & Methods

- **ArcGIS 3D Analyst** for processing surface information in TINs
- **ArcGIS Geostatistical Analyst**

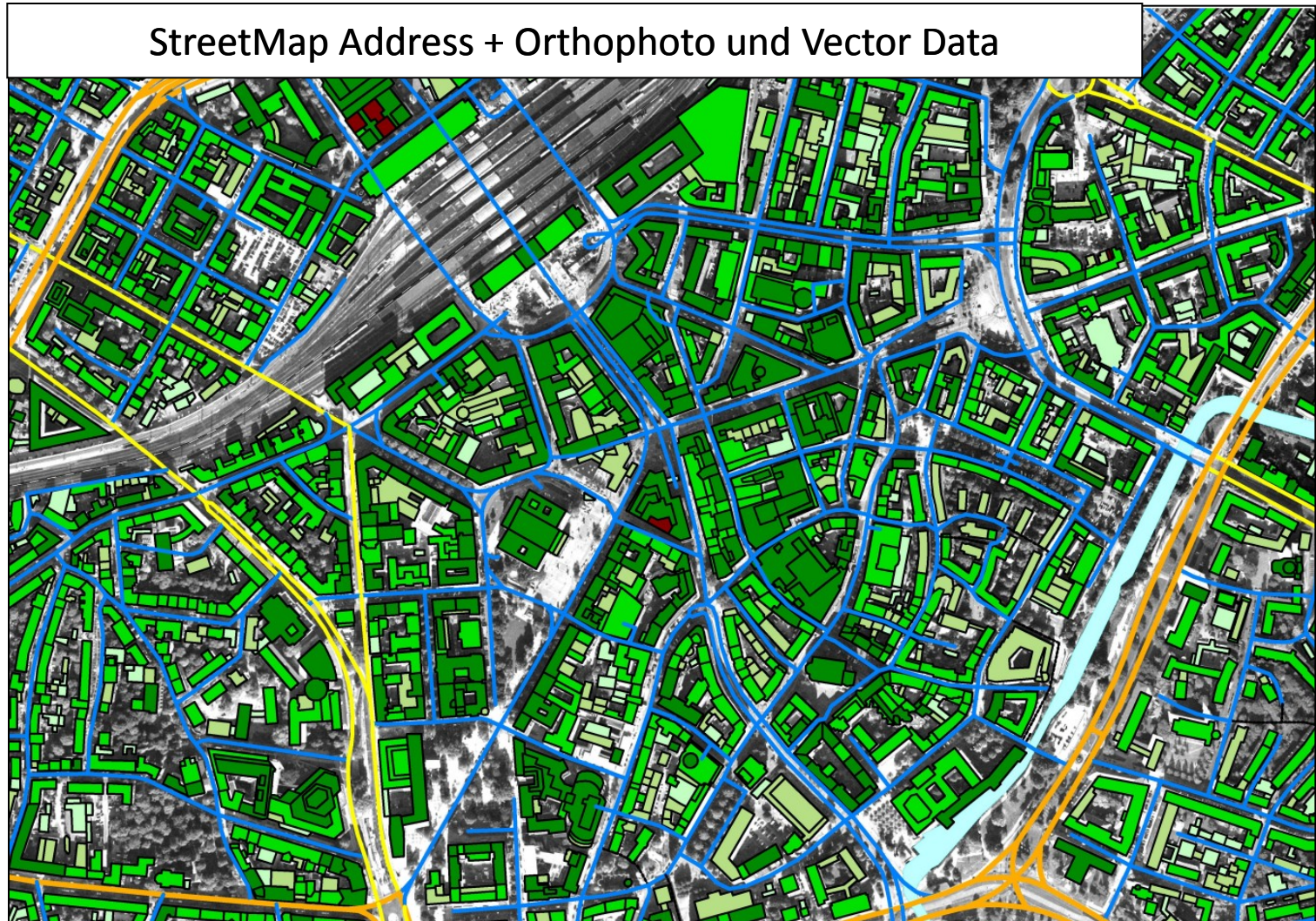
Results

- **ArcGIS Survey Analyst**

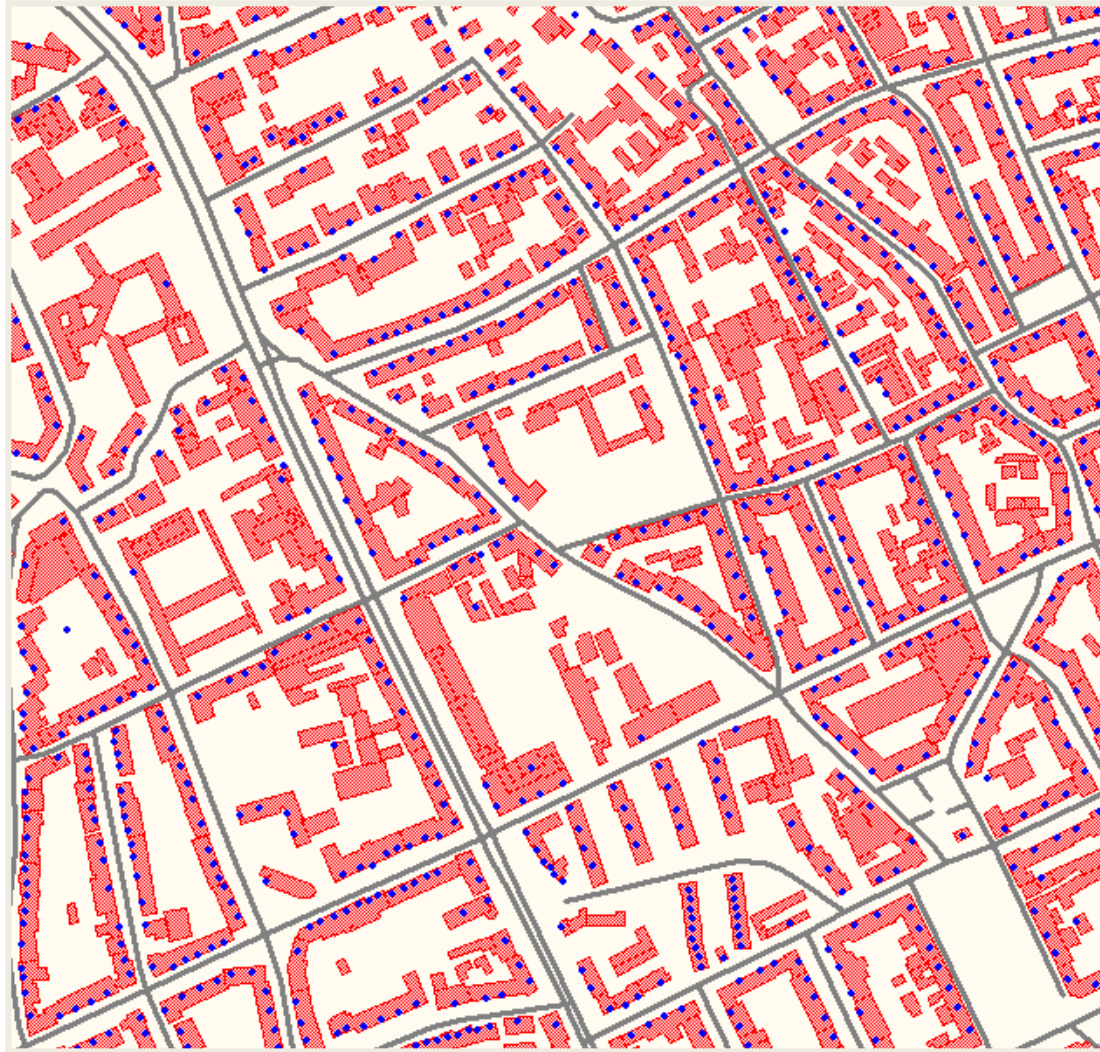
Conclusions / Outlook

- **ArcPress** for printing
- etc.

City models: Vector data



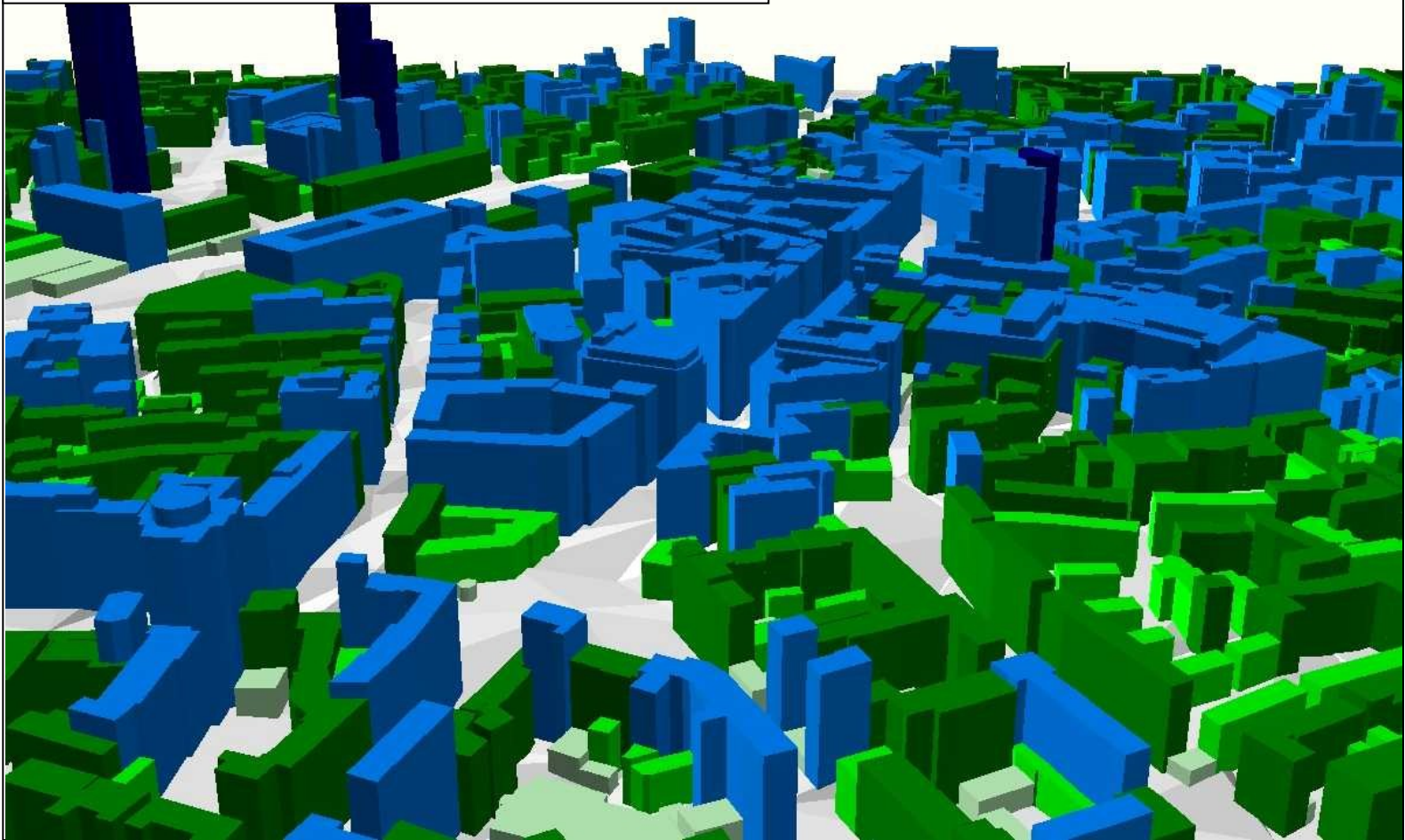
City models: Address information



- Point: address information
- Polygon of the building
- Road network

City models: Vector data

Building model: 3D presentation



City models: Orthophoto

Orthophoto Final - colour



ArcGIS Online



Maps and Apps for Everyone

Easy online discovery, access,
visualization, and dissemination of
geospatial information.

VIEW NOW 



Featured Maps



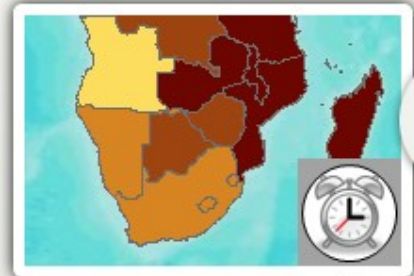
**Dutch Topographic
Basemap**



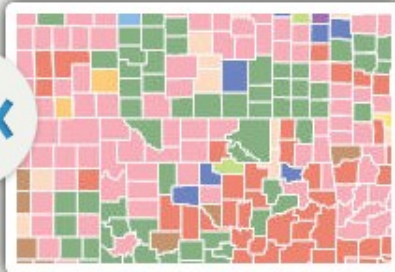
USA Federal Lands



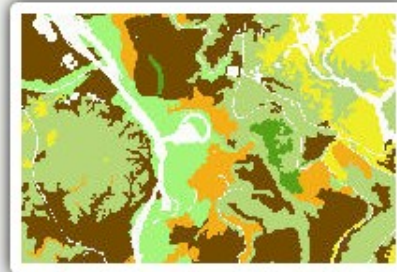
Ocean Basemap



**World Bank Pump Price,
Diesel and Gasoline**



**USA Tapestry
Segmentation**



USA Soil Survey



Canada Basemap



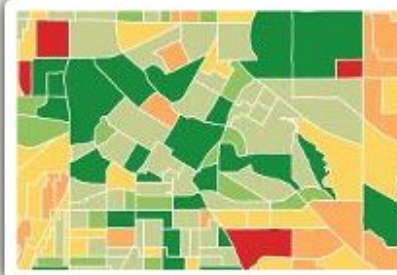
Hong Kong Street Map



**Landsat Time Enabled
Imagery**



Spain



**USA Population Change
2000-2010**



Portugal Imagery

7. Web Portal, Web Services, Data Management

Components	Element	Environment	Functions
Web-Portal	Web Site, Web Control	.NET	Search, Map Viewer, Publish, Administrate Query, Gazetteer, Mapping, Edit, Geo-coding
Web-services	Geographical Web-services	XML, SOAP, WSDL, WMS, WFS	Query, Map render/features, Transaction, Geocode
Data Management	DBMS	Oracle	Raster, vector, Tabular

Data to be distributed through the Portal



Ministry of Municipal and Rural Affairs Deputy Ministry for Land and Surveying

- Total Mapping Area approximately 2,000,000 Km².
- Number of Municipalities to cover around 300.
- Number of Parcels to upload 4,000,000 approx.

- Data volume is up to 80 Terra bytes.
- Around 7 Giga bytes are being added daily.
- Standards Followed: ISO, FIG, OGC, SDI, CaGIS, ISPRS, URISA .

Specifications, Standards and Project Data

- Surveying, Mapping and GIS Specifications
- Standards and Manuals
- Project Planning Data and Related Documents

Formats kmz, gpx, shp, dgn, dwg, dxf, xls, xls, mxd

Aerial Photography

Scale	Km ²	Photos
1:5,000	40,000	
1:10,000	8,000	
1:15,000	320,000	

Formats raw, tif, geotiff, xml, dxf, img

Orthophoto Maps

Scale	Km ²	Maps
1:5,000	40,000	
1:10,000	8,000	
1:15,000	320,000	

Formats geotiff

Topographic Mapping

Scale	Km ²	Maps
1:500	160	710
1:1,000	20,000	80,000
1:2,500	20,761	7,507
1:5,000	1,000	110
1:10,000	141,273	5,017
1:15,000	195,405	1,510
1:20,000	34,185	72
1:30,000	80,000	90

Formats shp, dgn, dwg, dxf, geotiff

References Intergraph, Inpho, Bentley

300 Layers and Features with municipal distributions: 1000 Layers

Other DMLS Products

Geodetic Network	Thematic maps	3D-City Model
Aerial Triangulation	Geodatabase	Anaglyph Stereo Images
Contact Prints	Land registration & geocoding	Relief maps
Photo Indexes	Cadastral maps & database	Topographic atlases
DEM/DTM/DSM	Panoramic Terrestrial maps	Metadata
Orthorectified Satellite maps	Flathrough	

Software

Intergraph, Inpho, Match-AT Survey, Bing, BECOM Appolo, ER Mapper Imagery, ECOM, ESRI ImageServer, ArcSDE, ArcGIS, Ultrimap/AT, UltraCAD, UltraOffice, GeoFlow, 3D Analyst, TrackIt, Bentley, Oracle

Hardware

Stereo Imager/tilers, GIS systems, Pallas Systems, Plotter, Printers, Color Box, Solid systems, Total Stations, GPS, Nexcel 300P, Appleton PDD, AT 10-800, Aerial Film Scanners

Geodetic description information:

SECOND ORDER REFERENCE STATION OF NAJRAF AREA

Station ID:	5010	Marka/Monument Type:	Concrete with 4 inch plastic pipe and paint 84		
-------------	------	----------------------	--	--	--

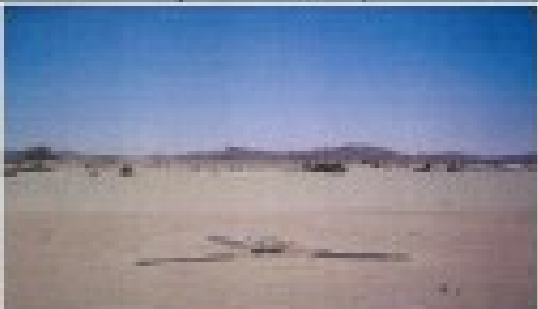
Description of Location:
For that point you have to go on the road south of Yadermah.
After 2 km you turn left and go 2 km on the road.
Turn to the right and go 1.5 km inside the area.

Station Coordinates (WGS 84)

Latitude	Longitude	Ellip. Height	X	Y	Z
10°59'01.7500''	44°14'35.6000''	1 187.209	4 090 620.862	4 202 112.060	2 041 077.644

UTM Co-ordinates (WGS 84, Zone 38)

Easting	Northing	Ellipsoidal Height	Orthometric Height
38 819 759.616	2 046 418.804	1 187.209	1121.066



GMN: Search by Region, Muhafza, GMN Number



8. Smart Phones

Apple



I Pod



I Pad



I Phone



I Phone G3



Blackberry



Samsung Omni

Smartphone

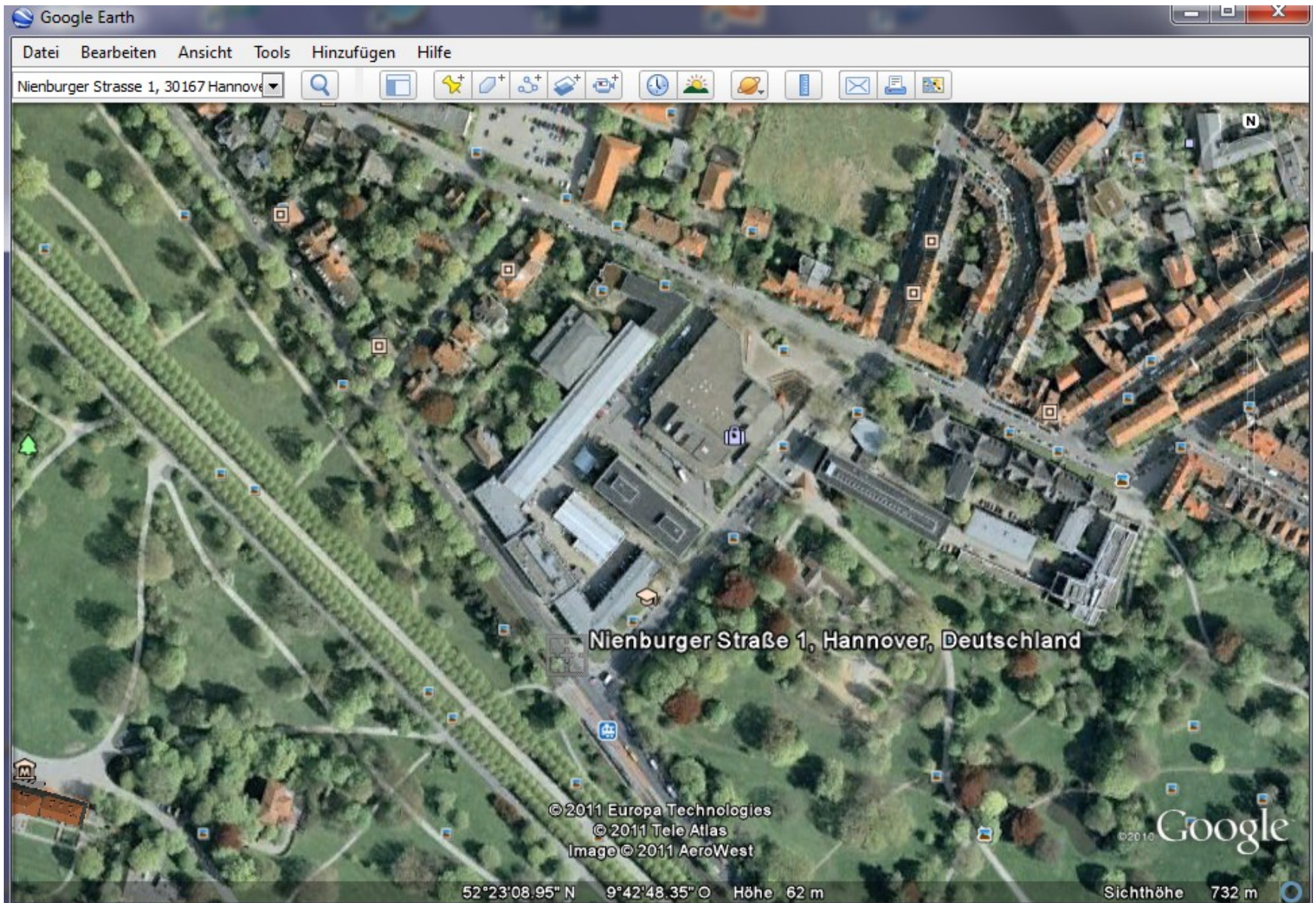


Ein Samsung I8910HD (Symbian S60)

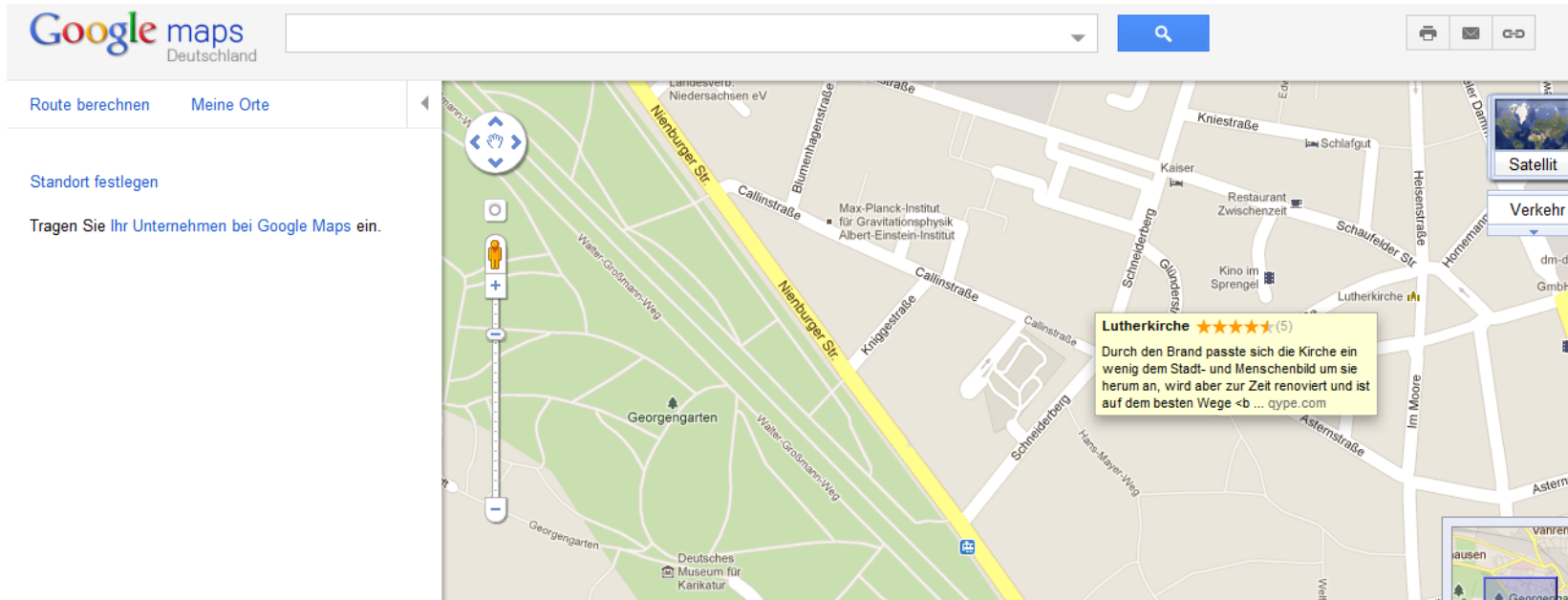
**Versatility
lies in the
downloadable
„Apps“
making the
Smartphone**

**a Navigation Device
(Google Maps, Navtech, Tom Tom)
an Internet Browser
a phone
a data base**

Google Earth Images



Google Maps and Address Search




Google Street View

Google maps Deutschland 52.385842,9.711052

Route berechnen Meine Orte



Nienburger Straße 1
30167 Hannover



Routenplaner In der Nähe suchen Mehr ▾

Erkunden Sie dieses Gebiet »

Fotos



© 2011 Google Ein Problem melden

Google Maps Navigation

The screenshot displays the Google Maps navigation interface. At the top, the search bar contains "Ernst-August-Platz 1, Hannover". The left sidebar shows the route calculation options, including a car icon and a pedestrian icon. The starting point (A) is "Nienburger Straße 1, Hannover" and the destination (B) is "Ernst-August-Platz 1, 30159 Hannover". A blue route is highlighted on the map, starting from Nienburger Straße and ending at Ernst-August-Platz 1. The map shows a detailed view of the city of Hannover, including streets like Nienburger Str., Bremer Damm, and Ernst-August-Platz. The interface includes a search bar, a map view selector (Karte, Verkehr), and a scale bar at the bottom left.

Google maps Deutschland

Ernst-August-Platz 1, Hannover

Route berechnen Meine Orte

Nienburger Straße 1, Hannover

Ernst-August-Platz 1, 30159 Hannover

Ziel hinzufügen - Optionen anzeigen

ROUTE BERECHNEN

Vorgeschlagene Routen

Nienburger Str.	2,5 km, 6 Minuten
Nienburger Str., L190 und Hamburger Allee	3,3 km, 7 Minuten

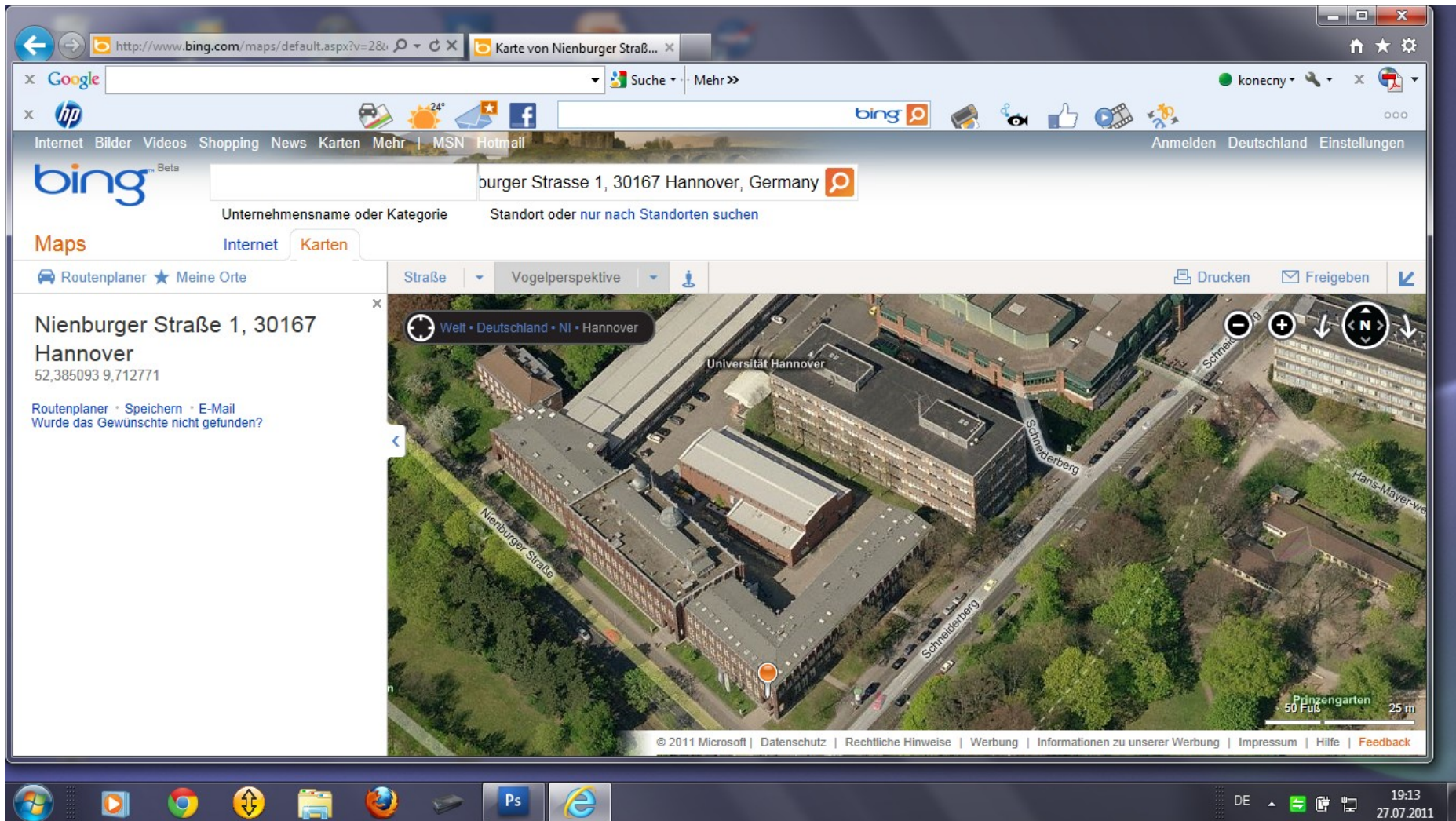
Route nach Ernst-August-Platz 1, 30159 Hannover

Nienburger Straße 1
30167 Hannover

- Von Nienburger Str. nach Südosten Richtung Schneiderberg starten
- Rechts abbiegen auf Schloßwender Str./L190

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Bing Maps 3D View



- 1. GIS has integrated aerial and satellite images**
- 2. It is able to display available and augmented maps**
- 3. It can incorporate address searches with street views**
- 4. It has become a navigation device**
- 5. It can incorporate 3D views (3D city models)**

What are then the problems our disciplines are facing?

The problems are sociological in nature:

1. do we have political support?
2. do the laws sufficiently protect our professional interests?
3. what is the esteem scientists and engineers have in society?

If we are not sufficiently heard, what are the alternatives for us?

1. to get engaged in social, economic, political and ultimately ethical issues
2. who can give us guidance in our approach to solve problems in integrating photogrammetry and remote sensing into a greater context?