

**Danish National Report  
IAG  
IUGG General Assembly 2007  
Perugia – Italy**

**by  
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Danish National Space Center  
Technical University of Denmark**

In the period 2003 – 2006 Danish geodesy has developed well at the University of Aalborg, University of Copenhagen and now very lately at the Technical University of Denmark. Due to new Danish research policies the sector specific geodesy groups at the Danish National Survey and Cadastre at January 1<sup>st</sup> 2005 merged with the Danish Space Research Institute and again at January 1<sup>st</sup> 2007 this new organization merged with relevant space and remote sensing groups at the Technical University of Denmark forming a new Danish National Space Center.

Danish GPS Center (DGC) in Aalborg in the period 2003-2006 participated in two COST actions:

On December 1-3, 2003 the last Management Committee meeting in COST action 716: "Exploitation of ground-based GPS for operational numerical weather prediction and climate applications" was held at the Royal Meteorological Institute, de Bilt, the Netherlands. The successful action finished by publishing a final report in 2005.

Another COST action 625 "3-D Monitoring of Active Tectonic Structures" arranged a working group meeting at Firenze December 12-13, 2003. The next working group meeting was at Granada May 12-16, 2004.

In December 2004 Department of Communication, Institute of Electronic Systems granted €10000 to a publication of selected papers by the Danish geodesist Torben Krarup. The book was published by Springer in June 2006. On October 13, 2006 the book was presented to the public during a workshop dedicated to Torben Krarup.

During September--October 2005 Kai Borre was lecturing at Department of Aeronautics and Astronautics, Stanford University. The topic was on software-defined GPS and Galileo receivers. The following autumn professor Per Enge visited DGC in the period from August to October 2006. Since then an agreement of cooperation between Aalborg and Stanford Universities on positioning, navigation, and time has been established.

In the period from August 2005 to January 2007 a project called "Navigation and Information Technology in Denmark" (NavIT.dk) was supported by "It-

Korridoren". The consortium comprised of Terma Space, Hardi-International, GateHouse, DGC, and Dansk Jordbrugsforskning, forskningscenter Bygholm. In the realm of NavIT.dk was given several advanced courses in April 4-7, 2006. Kostas Dragas and Vitalijus Linikas lectured on EGNOS; Günther Hein and Bernd Eissfeller lectured on GNSS Integrity.

In 2006 IfEN, GmbH in collaboration with DGC carried out for Galileo Joint Undertaking (call 2423) a project called "GSPF Reference Application Line" (GRAL). GSPF is an acronym for GNSS Simulation & Processing Framework.

On October 24, 2006 the textbook "A Software-Defined GPS and Galileo Receiver, A Single Frequency Approach" was published at Birkhäuser, Boston. The book was the Springer bestseller title in engineering during the month of November 2006.

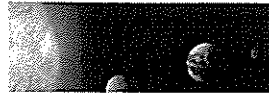
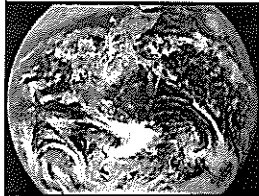
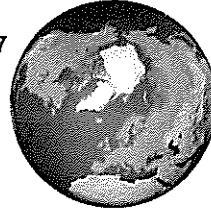
This publication and the writing of the Matlab code for the software-defined receiver has been the single, most outstanding activity at the DGC in the period 2003-2006.

The research and education activities at the University of Copenhagen have continued at high level with special focus at the missions COCE and CHAMP and in general gravity and potential field modeling. Further Carl Christian Tscherning has continued as Secretary General of IAG. As a special triumph for Danish geodesy and very much deserved Carl Christian Tscherning has been awarded the Levallois Medal, which he is going to receive at the IUGG General Assembly in Perugia.

The activities at the Danish National Space Center (DNSC) has in the period been very extensive and is best given in an overview as copies of slides below.

### New DNSC formed at January 1st 2007

- Part of Technical University of Denmark  
More focus on
- Earth observation – remote sensing
  - Advising



### Geodesy and infrastructure

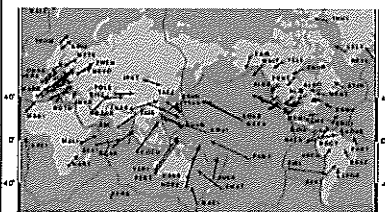
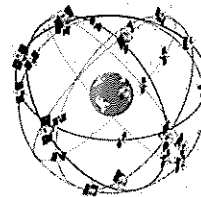
- DNSC research in geodesy
- Earth's shape and gravity
  - Reference systems for
    - Surveying and mapping
    - Navigation



Support infrastructure and public authorities:  
Kort & Matrikelstyrelsen  
Geodesy advising

### Surveying:

- DNSC research in GPS
- Surveying and navigation
  - Reference systems
  - Permanent GPS stations



Estimation of

- Geodynamics
- Continental drift

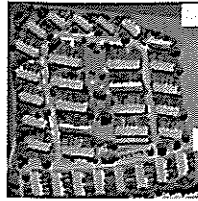
to ensure consistence between the GPS-system and the reference systems

Continental drift estimated by GPS

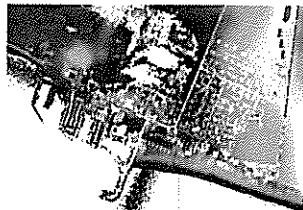
## Mapping:

DNSC research in use of satellite and aerial data

- Change detection
- Digital height models
- Urban mapping, coastal zone



Change detection by aerial photo



Laser scanner - DHM



DNSC develops aerial systems to

- Gravity surveying
- Laser scanning

## Earth observation and global change

DNSC research in global change and effects of climate changes:

- Sea level change
- Ice cap changes
- Sea ice cover in the Polar Sea



and participate in satellite missions through

- Pre studies and in situ data monitoring
- Calibration / validation
- Development of analysis methods



Actual satellite missions: Envisat, GRACE, GOCE, Icesat, Cryosat ...



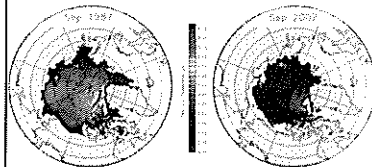
## Satellite based "products"



Global marine gravity

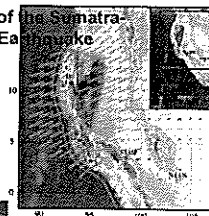


DHM of Greenland Ice cap



Polar Ice cover

GPS analysis of the Sumatra-Andaman Earthquake



## Global monitoring and security

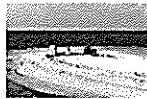
DNSC contributes to international programs on global monitoring and security:

- GEO System-of-systems – Global, inter-governmental coordination (GEO)
- GMES - Global Monitoring of Environment and Security (EU/ESA)
- FN / UNESCO – UNEP, JCOMM, G3OS
- ICSU/FAGS

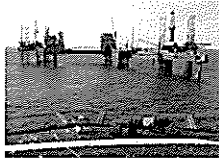


## Cooperation with private companies

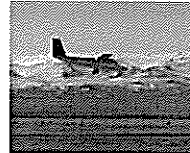
- Monitoring of oil rigs (nedsynkning)
- Sensor-development / navigation (Aerial System)
- Analysis of Earth observations data/images
- Knowledge transfer to Surveying Projects (Bridges)
- Gravity models (oil- and gas exploration)
- Tide models



Gravity surveying (Bahrain; COWI)

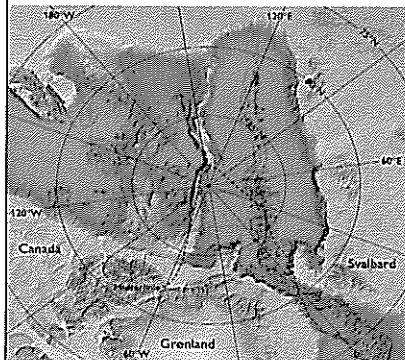


GPS monitoring of Oil rigs (Maersk)



Geoid models, Mongolia (NGA, MonMap, Atr Greenland)

## UNCLOS - UN Convention on the Law of the Sea



DNSC is a central partner in The Danish Continental Shelf Project