EO Education for Students and Teachers –

School Labs and Related Activities

Dieter Hausamann
German Aerospace Center (DLR)

23 April 2014

Contributions from …

- …ESA
  - Francesco Sarti
  - Nicolas Ackermann
  - Fulvio Marelli
  - …
- …DLR
  - Matthias Locherer
  - Martin Danner
  - Nicola Schneider
  - DLR_School_Lab Team
  - …
- …UK Space Agency/Space Academy
  - Anu Ojha
  - Hannah Garrett
  - …

Outline

- General Concept of STEM/EO School Labs
- DLR_School_Lab
- EO School Lab @ IGARSS-2012 & LPS-2013
- ESA-DLR School Lab Tutorial
- EO APP
- Conclusion & Future Outlook

EO School Lab - General Concept

	Institution	Recipient	Instructor	Process	Product
Education	**School**	**School Student**	**Teacher**	**Learning**	**Knowledge**

EO School Lab - General Concept

	Institution	Recipient	Instructor	Process	Product
Education	School	School Student	Teacher	Learning	Knowledge
Capacity Formation	School Lab	Sec. School Student TEACHER	University Student Scientist	Attraction Stimulation Motivation	Interest
Capacity Building	University Vocational Education	University Student Scientist Administrator	Expert	Training	Expertise & Application

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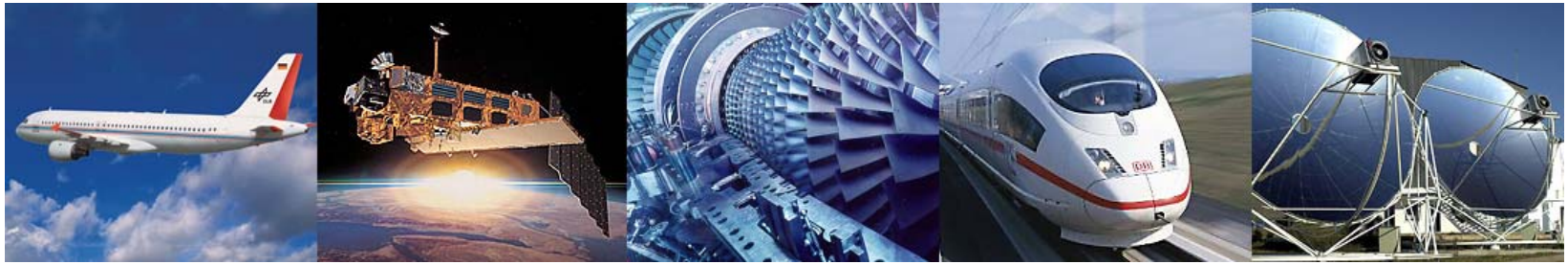
German Aerospace Center



- Research Institution
- Space Agency
- Project Management Agency

Locations and employees

7,700 employees across
32 institutes and facilities at
- 16 sites.

Offices in Brussels, Paris,
Tokyo and Washington.

1,700 employees in Oberpfaffenhofen

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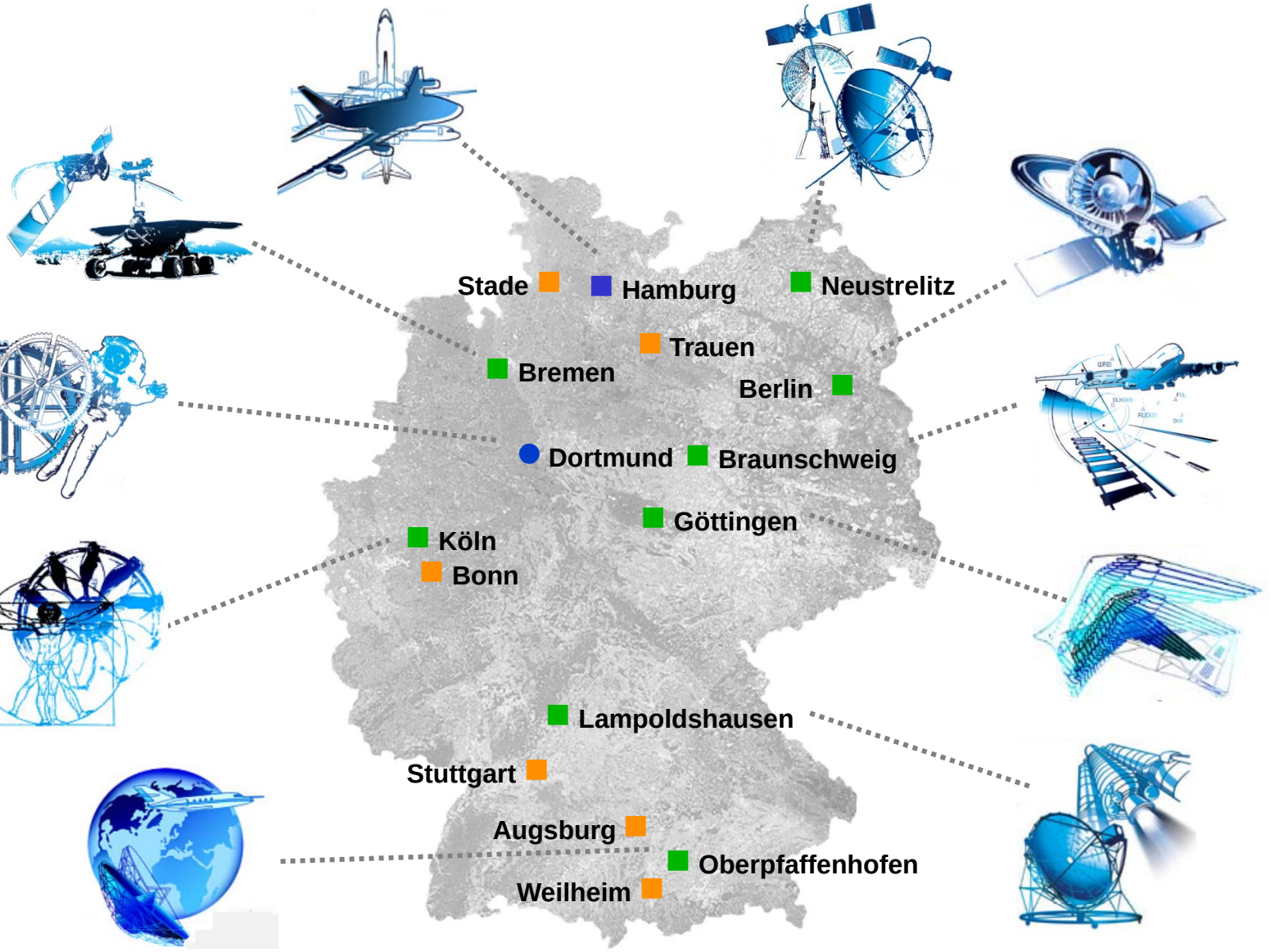
Promoting the Next-Generation Scientists

DLR_School_Labs



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DLR_School_Lab Oberpfaffenhofen - Characteristics

- Launch 2003
- Extracurricular Concept
- 13 Experiments Representing DLR‘s Aerospace Research
- Annual Budget 300,000 €
- Evaluated Concept (Pawek, 2009): Sustainable Increase in Stundents‘ Interest
- 22,000 School Students
    - o Age 15+/Secondary/High School/College Level
    - o >120 Classes per Year
    - o Max. Capacity 35 Students per Day, Group Size 4-8
- 2,000 Teachers
    - o Physics – Technics – Geography
    - o All Types of Schools
- Supervisors
    - o Scientists from the Respective DLR Institutes
    - o 15 University Students (MINT)
- Special Offers
    - o Talent Support (Research Projects for School Students)
    - o Education of Teachers of the Gifted
    - o International Projects

DLR Site Oberpfaffenhofen

Employees: Approx. 1,700
Size of site: 245 000 m²
Research institutes and facilities:

- Microwaves and Radar Institute
- Institute of Communication and Navigation
- Institute of Atmospheric Physics
- Remote Sensing Technology Institute
- Institute of Robotics and Mechatronics
- Institute of System Dynamics and Control
- German Remote Sensing Data Center
- Space Operations and Astronaut Training
- Galileo Control Center
- Flight Experiments

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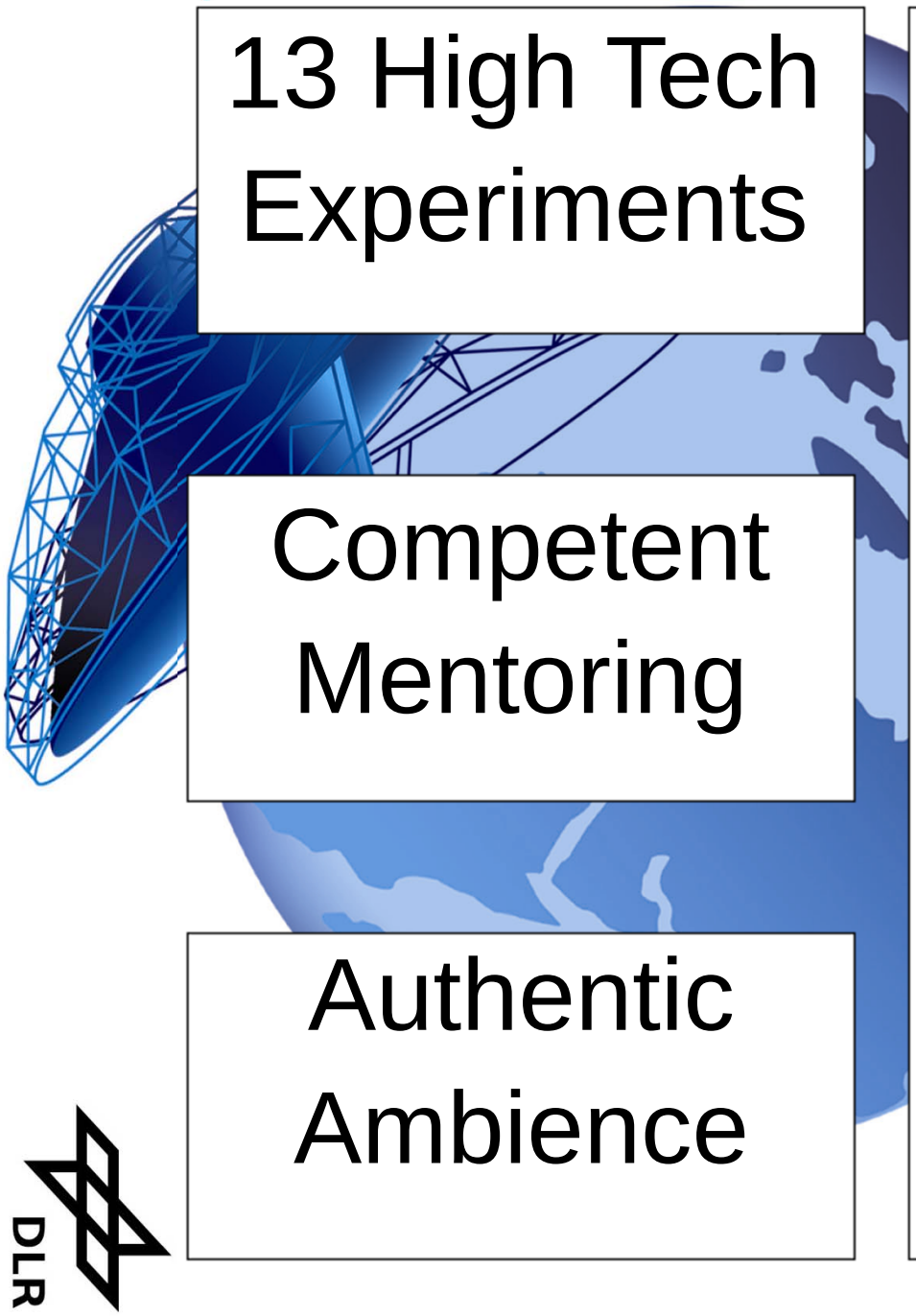
DLR_School_Lab

Oberpfaffenhofen



13 High Tech Experiments

Competent Mentoring

Authentic Ambience

DLR_School_Lab
Oberpfaffenhofen

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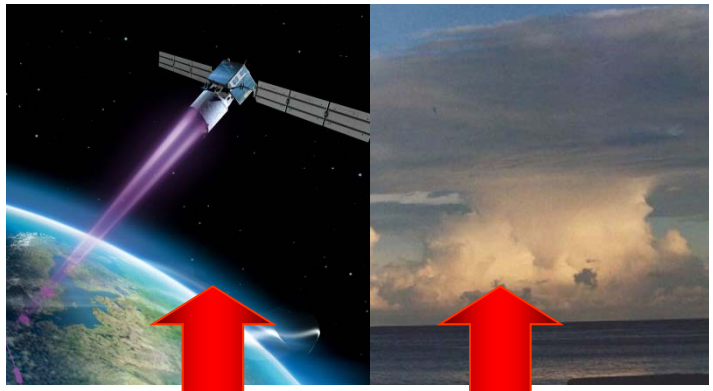
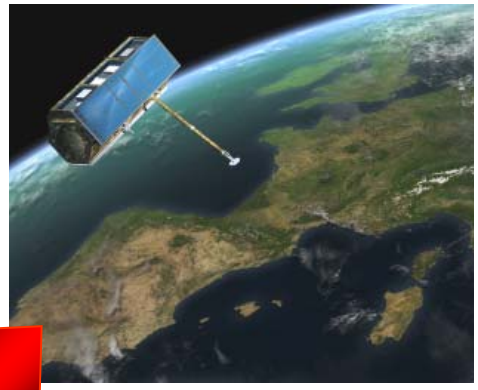
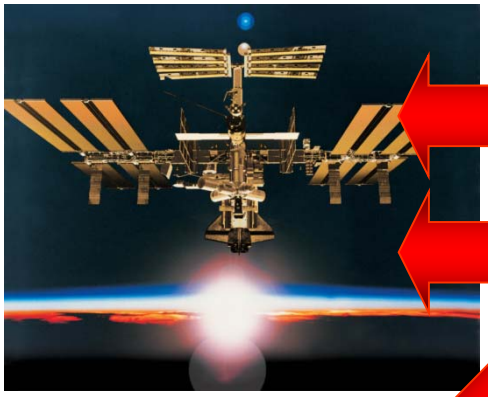
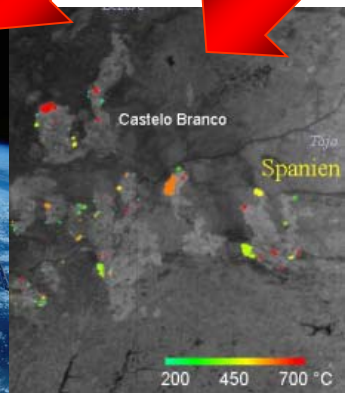


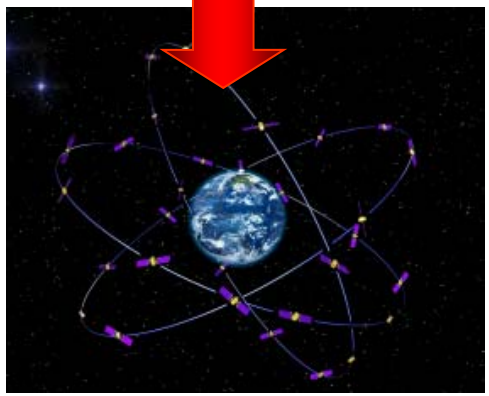


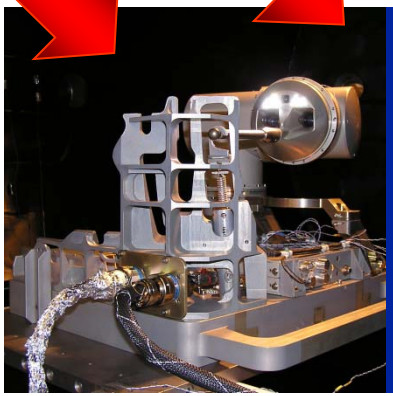
DLR_School_Lab

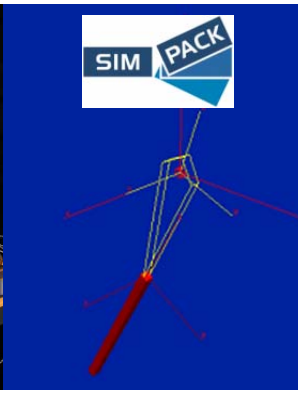
Oberpfaffenhofen











Experiments @ DLR_School_Lab Oberpfaffenhofen Represent the Research of All 10 DLR Institutes

Experiment	Institute
1. Infrared Technology	Remote Sensing Technology
2. Laser Technology	Physics of the Atmosphere
3. Radar Technology	Microwave and Radar Technology
4. Optical Remote Sensing	Remote Sensing Data Center
5. Weather and Climate	Physics of the Atmosphere
6. Satellite Data Analysis	Remote Sensing Data Center
7. Satellite Navigation	Communication and Navigation
8. Robotics	Robotics and Mechatronics
9. Virtual Mechanics	System Dynamics and Control
10. Flight Team Simulator	Flight Operations
11. Mobile Rocket Basis	Space Operations
12. ASUROnaut	Robotics and Mechatronics
13. Tunnel Boring Machine	Technical University Munich

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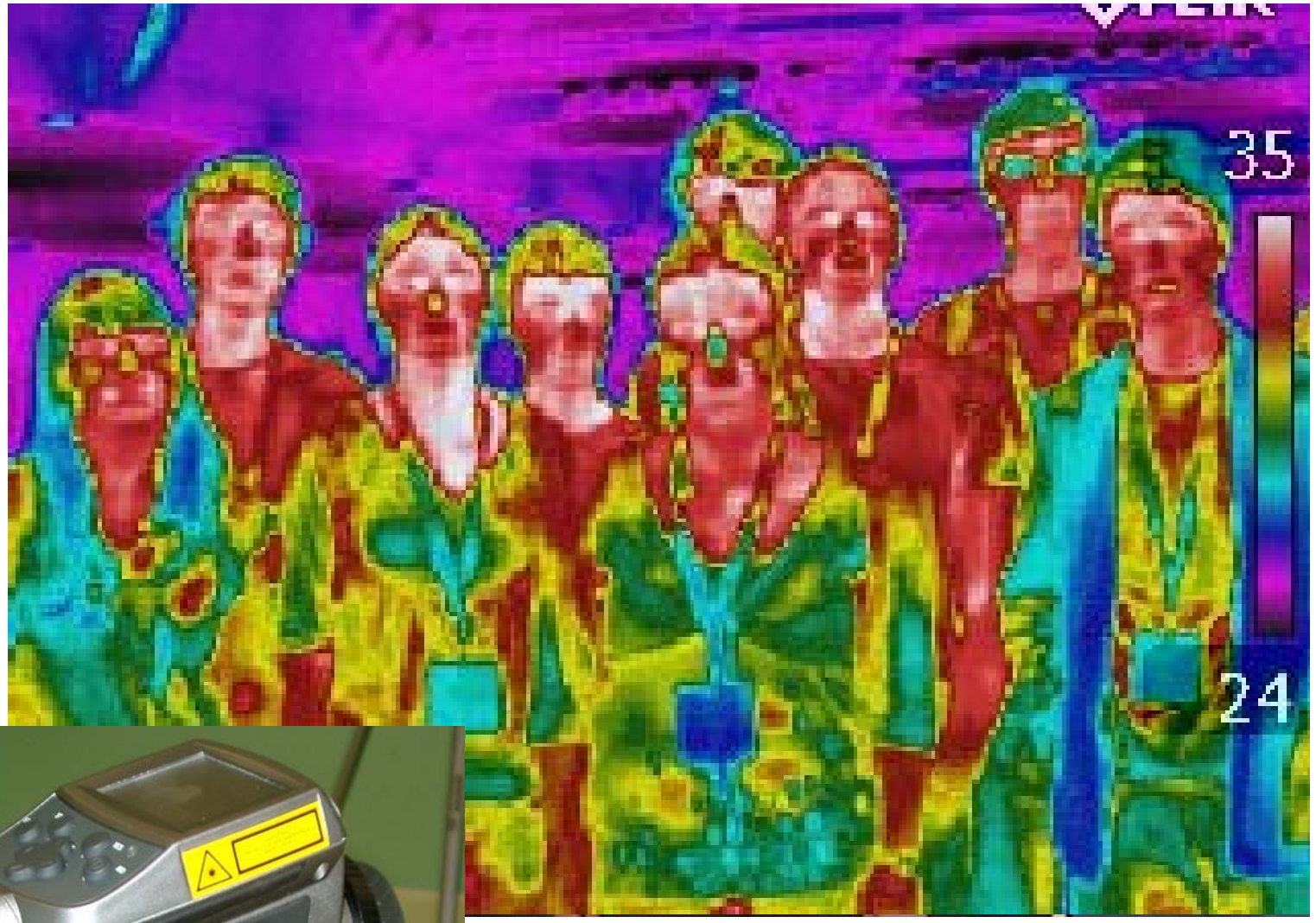


Infrared Technology


MODIS 26.08.07
Center for Satellite Based Crisis Information
– Emergency Mapping & Disaster Monitoring –
a service of DFD
DLR

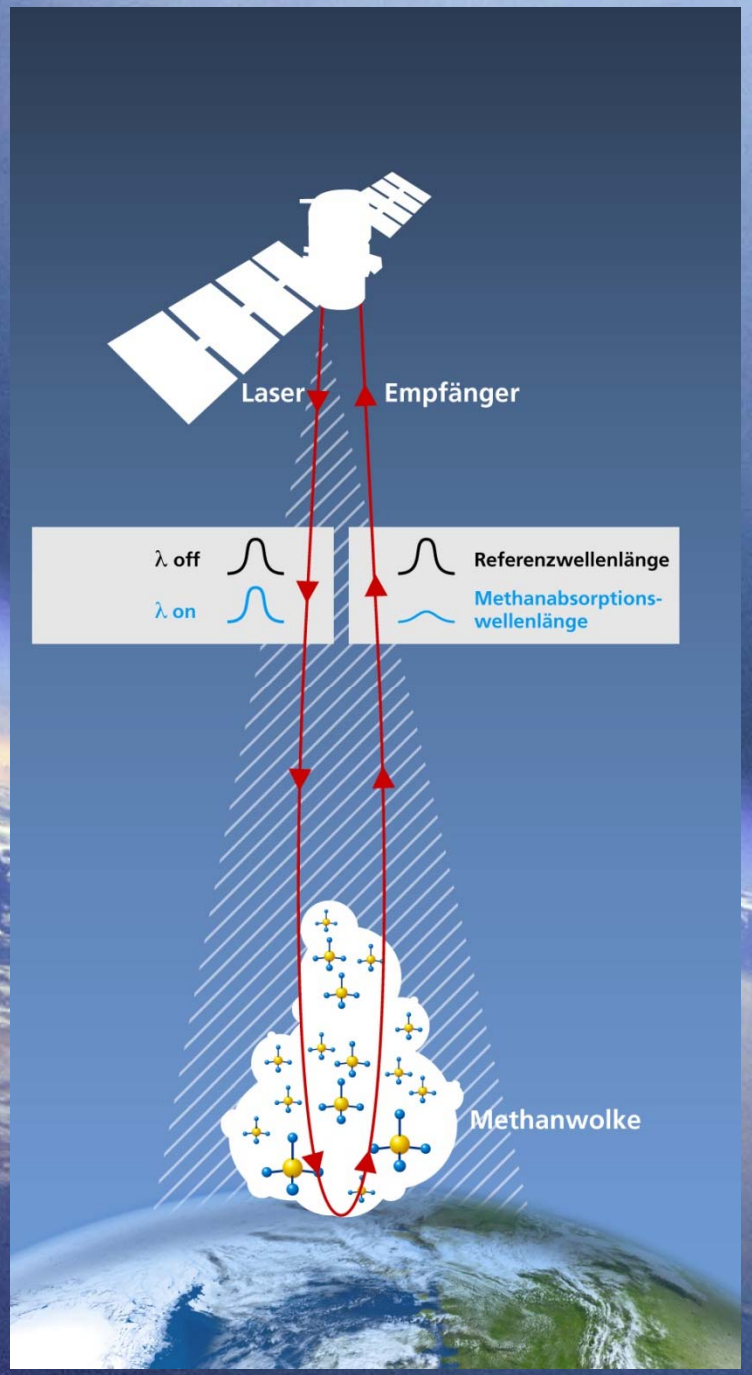

Laser Technology

Wake Vortex Studies

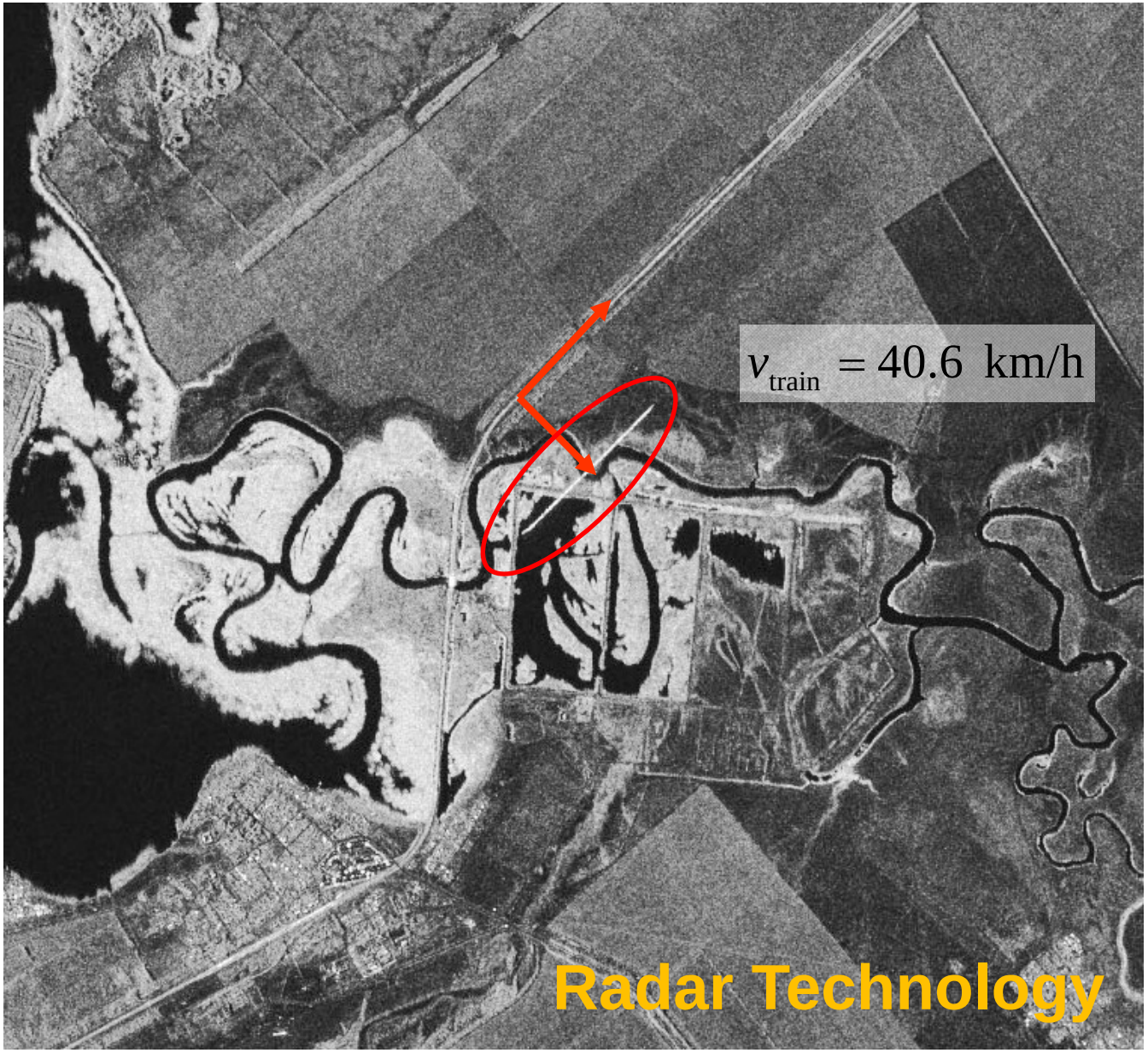
DLR

MERLIN

Methane Remote Sensing Lidar Mission




Radar Technology



„Train off Track“

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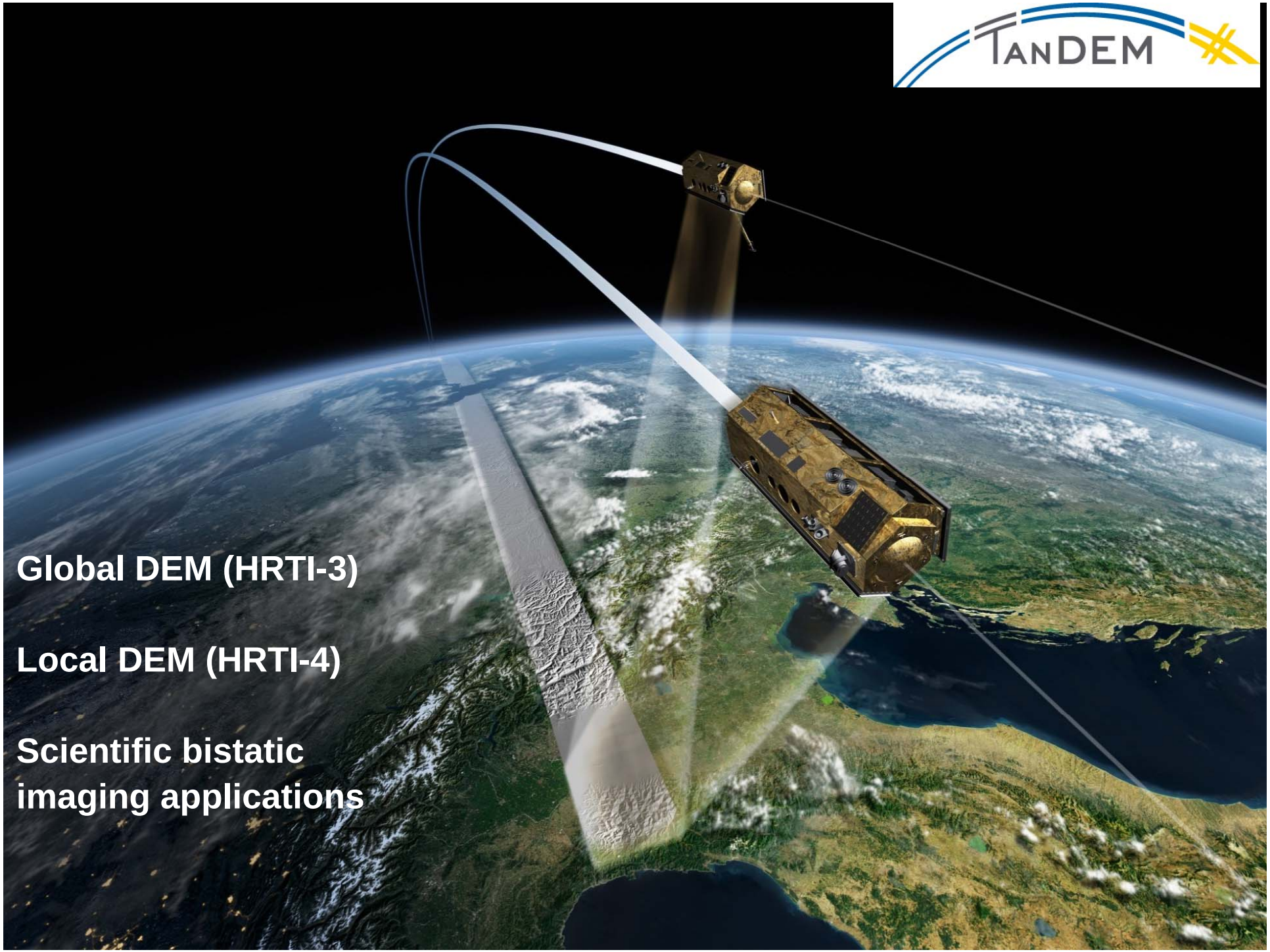
TanDEM
Global DEM (HRTI-3)
Local DEM (HRTI-4)
Scientific bistatic imaging applications

CW-ISAR: The New Imaging Radar Experiment

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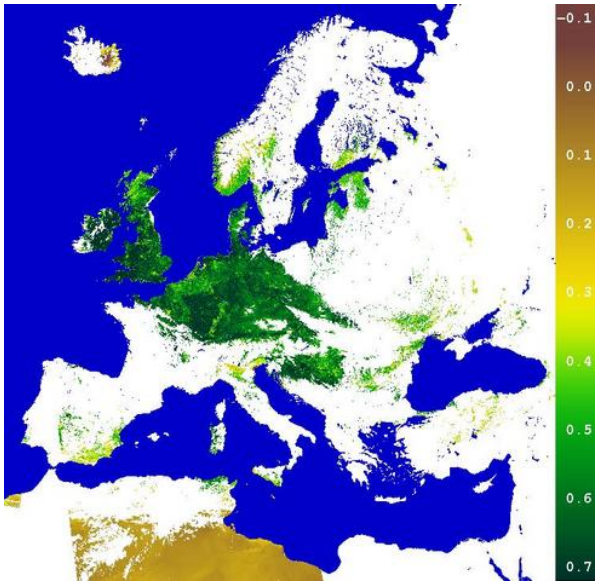
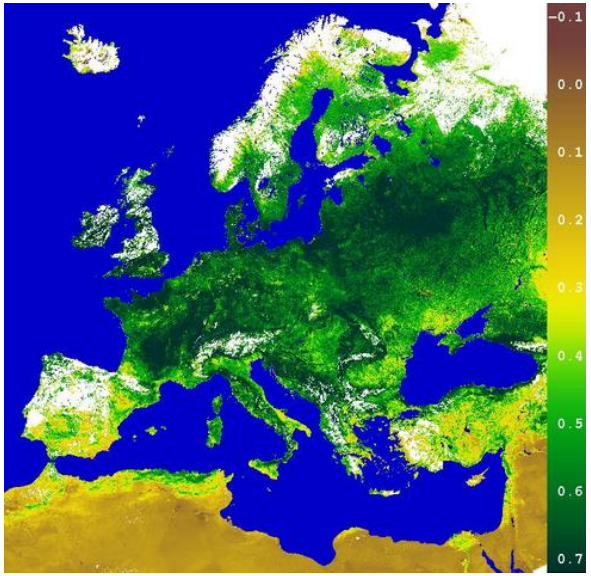
DLR_School_Lab
DLR_School_Lab
SLIK U2000
Optical Remote Sensing

NDVI



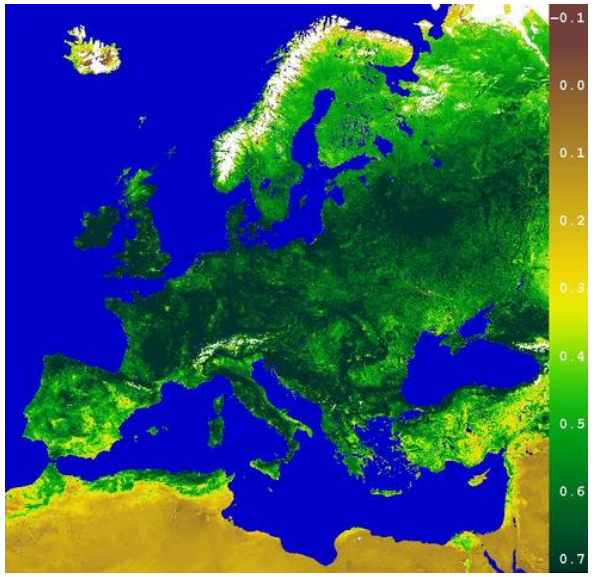
NDVI-Tageskomposite

Datum: 01.05.2007



NDVI-Wochenkomposite

Zeitraum: 21. – 27.05.2007

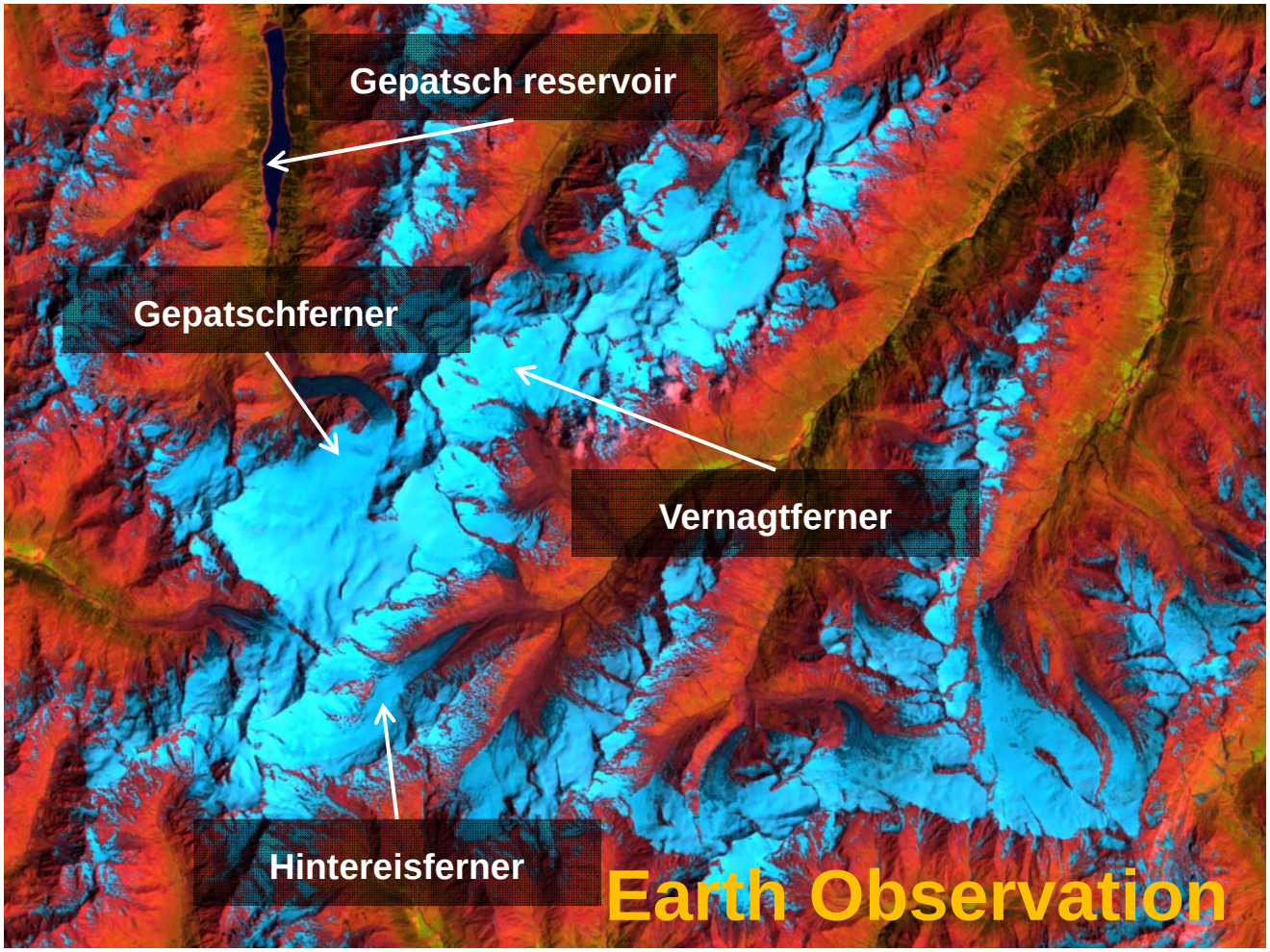


NDVI-Monatskomposite

Zeitraum: 1.– 31.05.2007

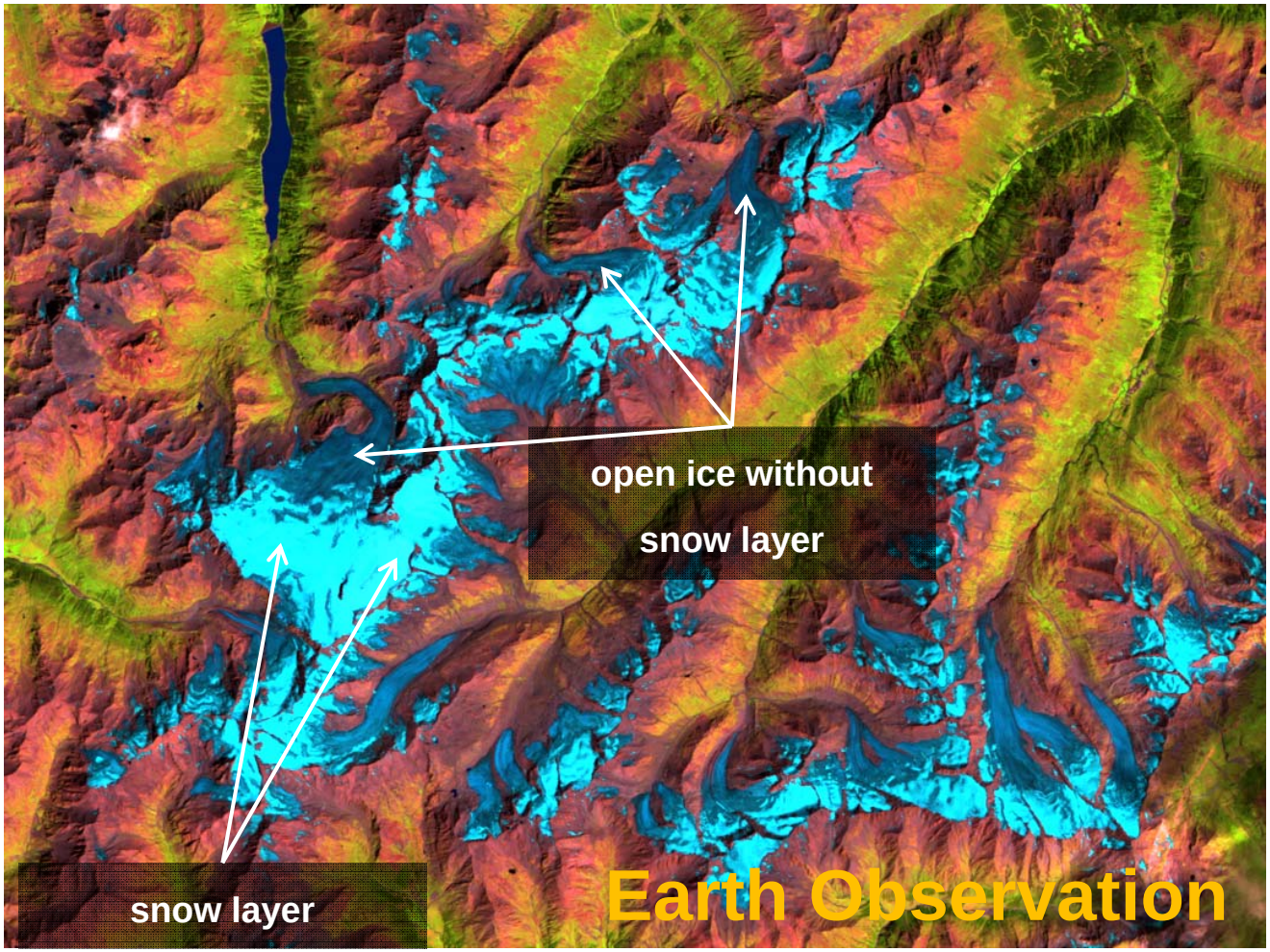

Weather & Climate

Ötztal Alps
September 1986



-Landsat TM, RGB 5/4/3

Ötztal Alps
September 2003



-Landsat TM, RGB 5/4/3

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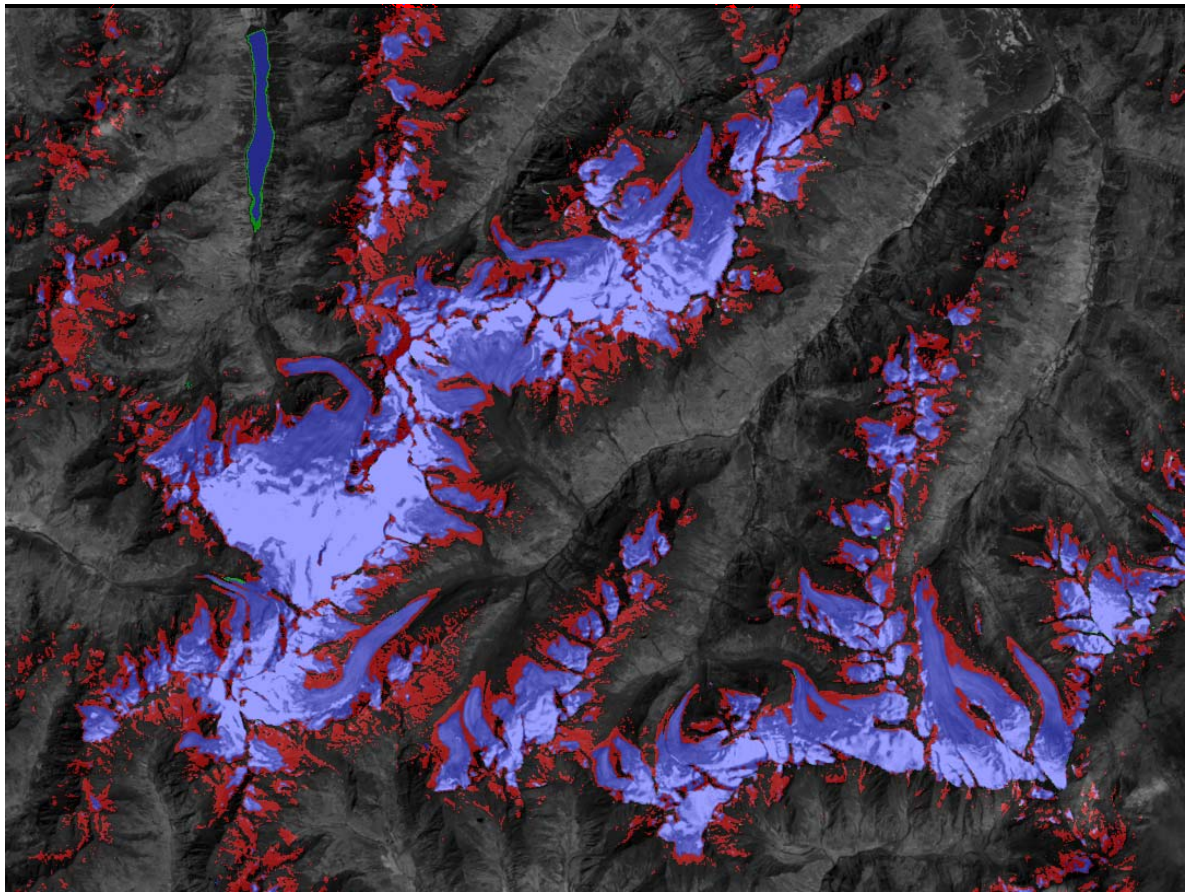
Change Detection
Combination – Transparent Overlay



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Zentrum für satellitengestützte Kriseninformation

ZKI

Center for Satellite Basec Crisis Information

Taifun, Philippines, November 2013

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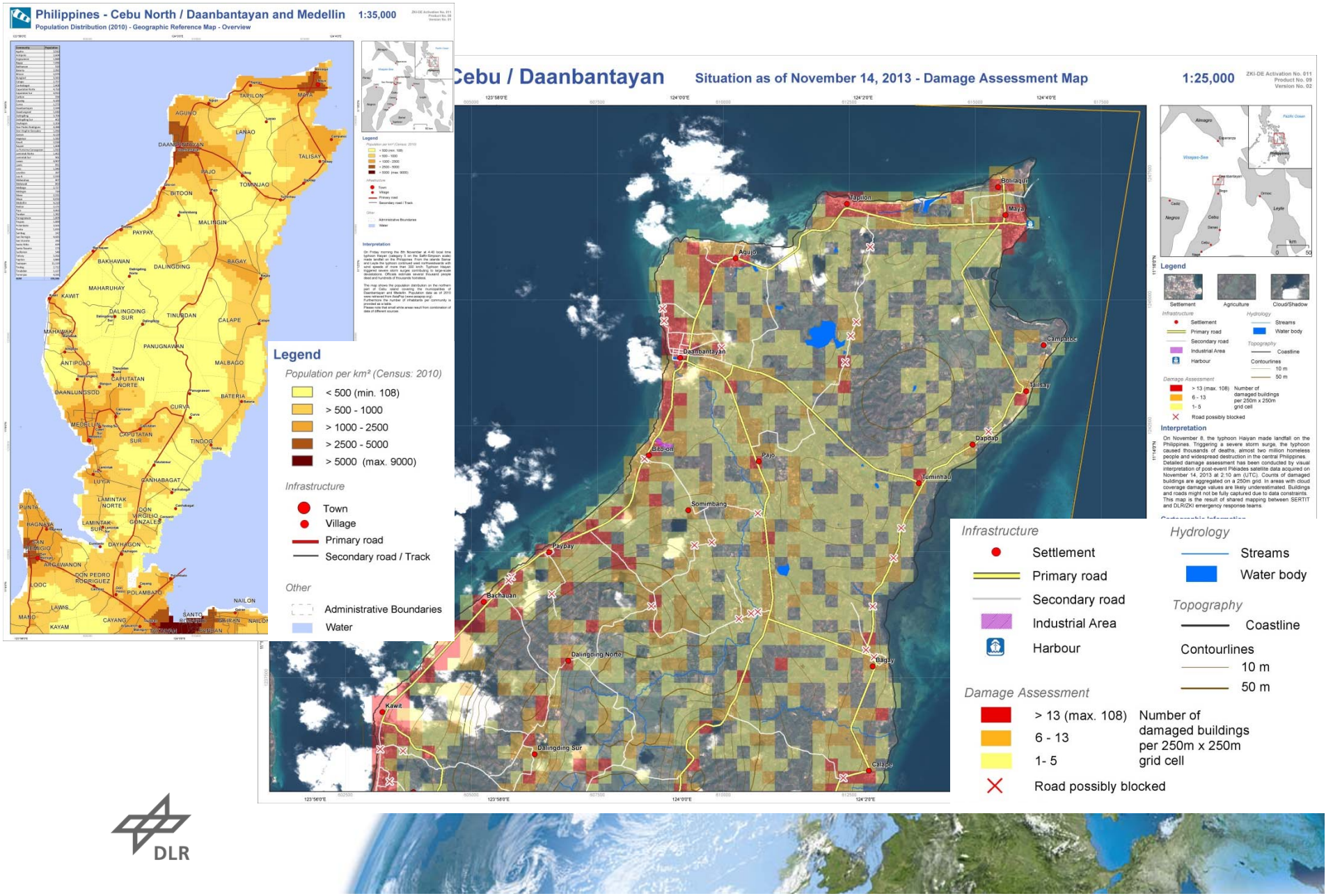
Taifun Philippinen, November 2013



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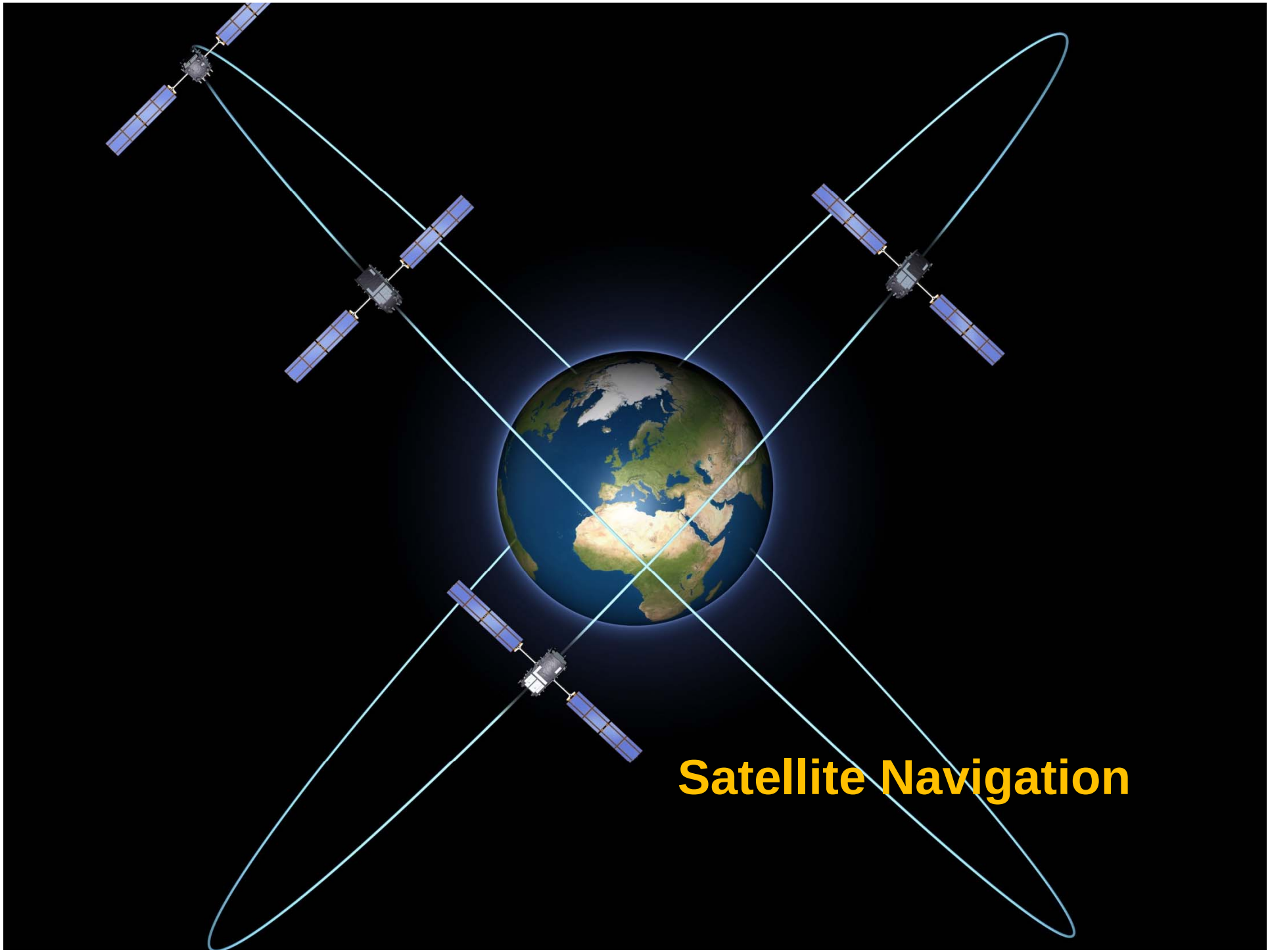
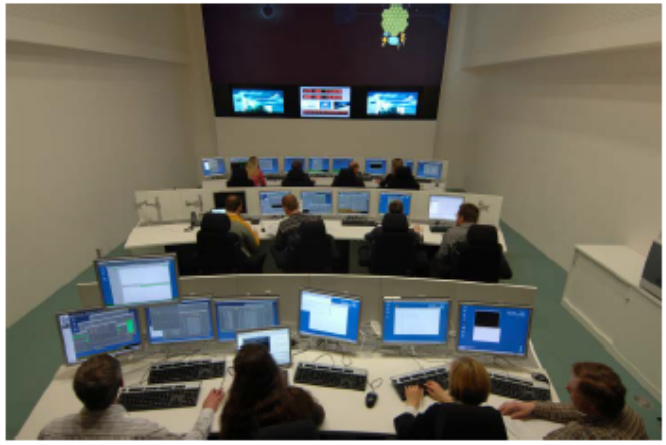

Satellite Navigation

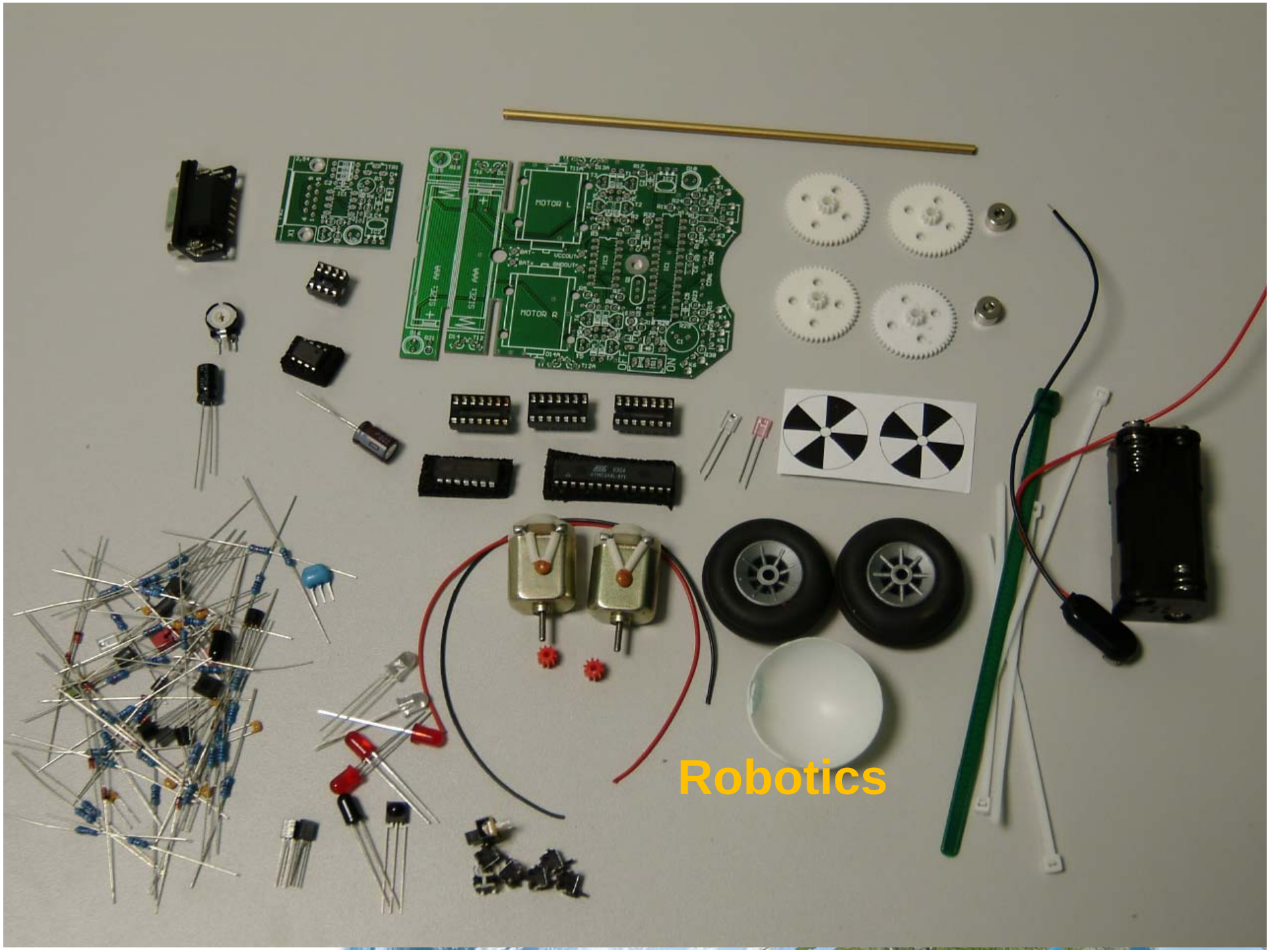
Galileo Control Center Oberpfaffenhofen



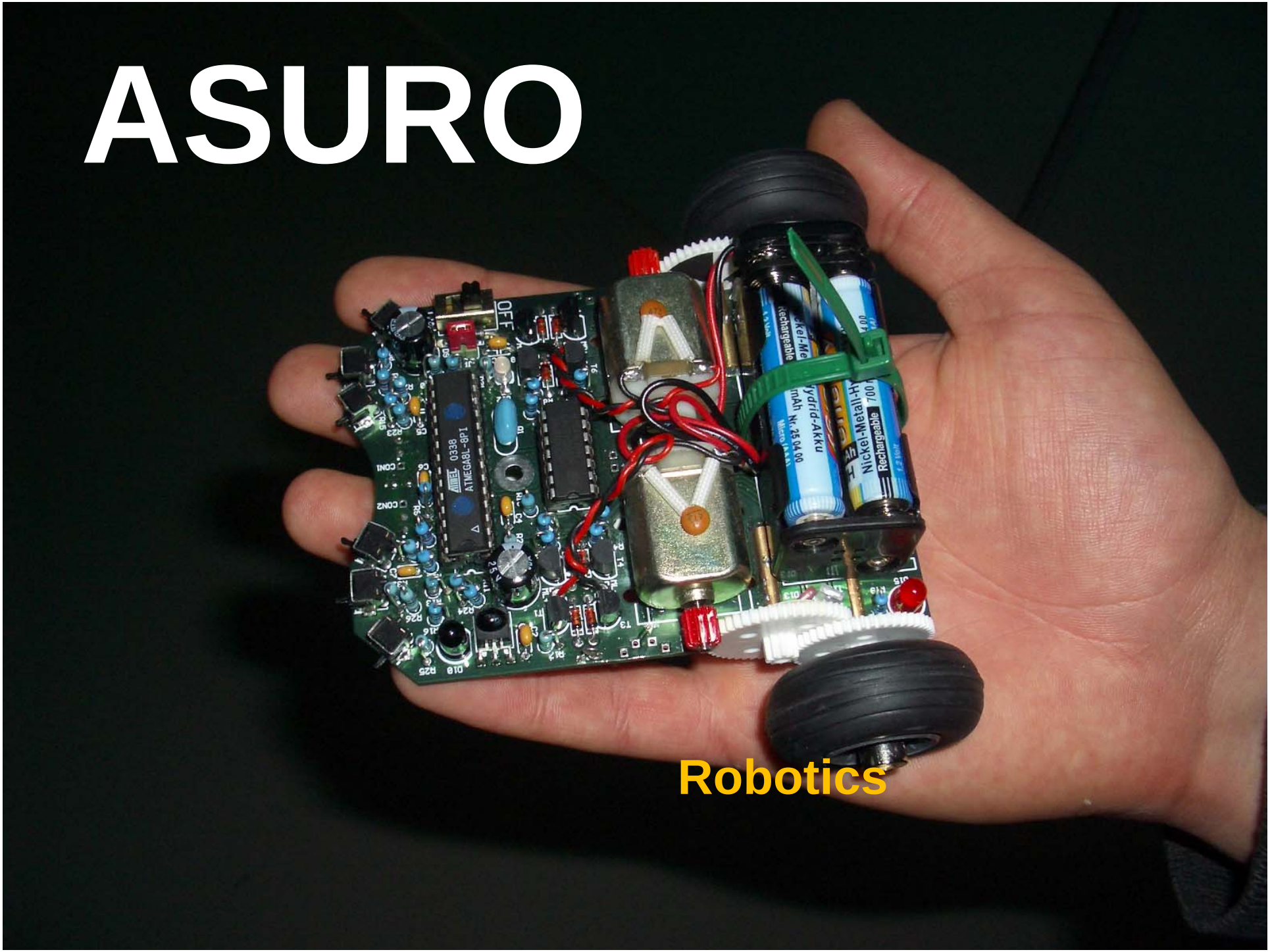
Special Ops Room 1

Special Ops Room 2

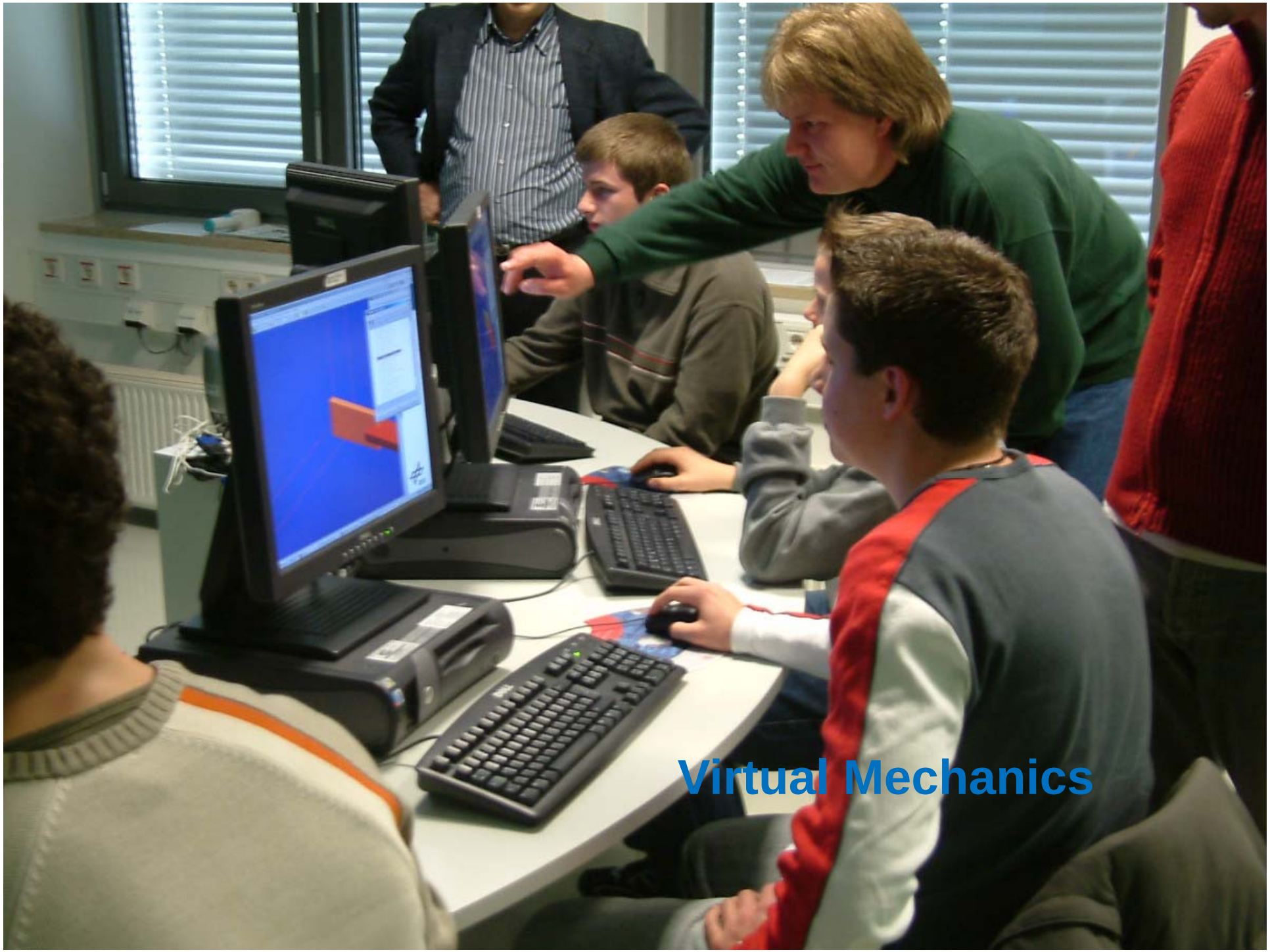
Main Control Room


MOTOR L
MOTOR R
Robotics

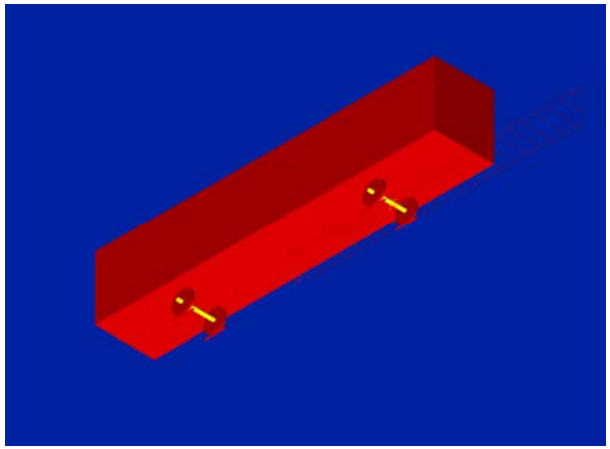
ASURO



Robotics

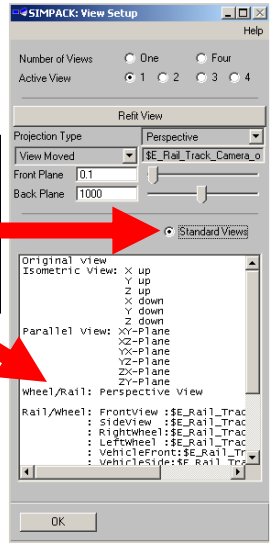

Virtual Mechanics

The virtual freight car



- Generate a new model: → **New**
- Enter name (no special characters like ä or ö!) → confirm with **<**RETURN>
- Edit model (*Model Setup*):
  - Change perspective: **View** → **View Setup**

View setup
- Click *Standard views* and choose *Wheel-Rail/ Perspective View*
- Close window with **OK**



- Change direction of gravitation: **Alt**+**G** or **Globals** → **Gravity**

Define G-Vector
- z : **9.81** [m/s²] (positive z-direction)
- Close window with **OK**

Project Next Generation Train

Ultra-High Speed Trains – up to 600 km/h

Quelle: Winter DLR-FK


Flight Team Simulator

HALO


Mobile Rocket Basis

Water Rocket Launch

DLR


SHEFEX II -
launched 22.6.12

Experimental Concept

…Representing the DLR-Institutes' Competence

➔ **Authenticity**

…Didactical Transfer

➔ **Inquiry-Based Science Education**


The Team
2013

Studying …

- Electrical Engineering
- Mechanical Engineering
- Physics
- Aerospace Engineering
- Mechatronics
- Informatics
- Geodesy
- Geosciences
- Meteorology

Finnish Students – December 6, 2013

09:15 – 10:00	Introduction	Dieter Hausamann
10:00 – 12:15	Experiment #1	
	➢ Laser Technology	Nicola Schneider
	➢ Moraba	Georg Landgraf
	➢ Virtual Mechanics	Ingo Kaiser
12:15 – 13:15	Lunch Break	
13:15 – 15:30	Experiment #2	
	➢ Robotics/Progr.	Chris Buschor
	➢ Moraba	Georg Landgraf
	➢ Virtual Mechanics	Ingo Kaiser
15:30 – 16:00	GSOC	Dieter Hausamann
16:00 – 16:30	Feedback	

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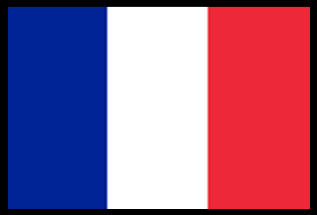
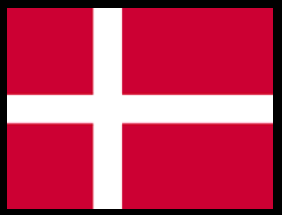
Foreign Student and Teacher Groups





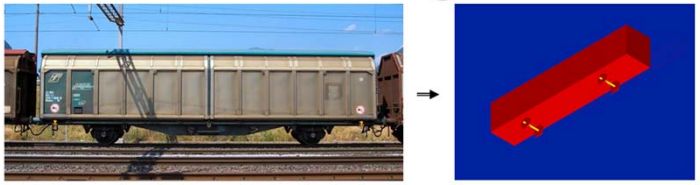






Internationalized Experiments

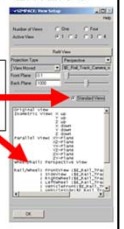
The virtual freight car



- Generate a new model: → New
- Enter a name for the model (no special characters like "é" or "ö") and confirm with <ENTER>!
- Edit model (*Model Setup*):
  - Change the perspective: View → View Setup

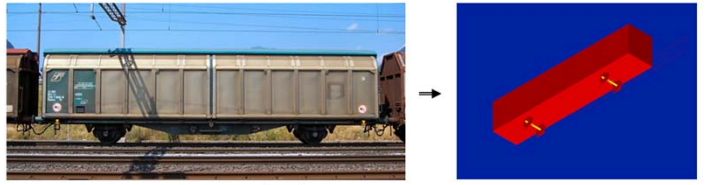
    View Setup
    - Click *Standard Views* and choose *Wheel/Rail: Perspective View*
    - Close window with OK
  - Change the direction of gravitation: **Alt-G** or Globals → Gravity

    Define G-Vector
    - *z* : **9.81** [m/s²] (***positive z-direction***)
    - Close window with OK



Il carro merci virtuale

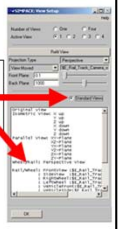
Traduzione: Ingo Kaiser, Fabrizio Re



- Generare un modello nuovo: → New
- Dare un nome al modello nuovo e confermare con **<RETURN>**
- Modificare il modello (*Model Setup*):
  - Cambiare la vista: View → View Setup

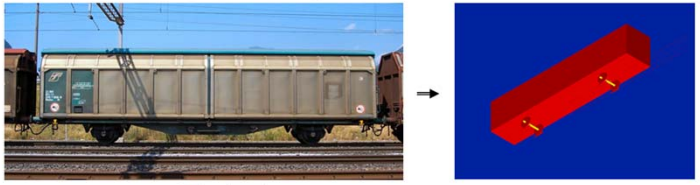
    View Setup
    - Cliccare su *Standard views* e scegliere *Wheel/Rail: Perspective View*
    - Chiudere la finestra con OK
  - Cambiare la direzione della gravitazione: **Alt-G** oppure Globals → Gravity

    Define G-Vector
    - *z* : **9.81** [m/s²] (***direzione positiva di z***)
    - Chiudere la finestra con OK



Wirtualny wagon towarowy

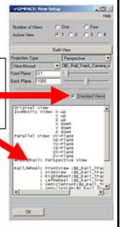
Tłumaczenie: Ingo Kaiser, Danuta Swist



- Wytworzyć nowy model: → New
- Wprowadzić nazwę (nie używać „ć", „ł" itd.) i potwierdzić klawiszem **<RETURN>**
- Zmienić ustawienia modelu (*Model Setup*):
  - Zmienić widok: View → View Setup

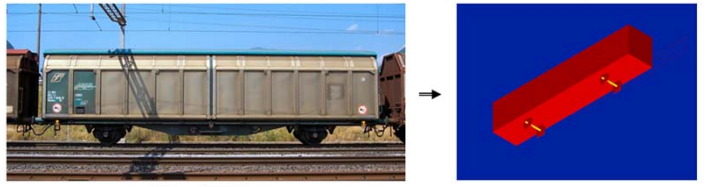
    View setup
    - Kliknąć *Standard views* i wybrać *Wheel-Rail/ Perspective View*
    - Zamknąć okno: OK
  - Zmienić kierunek grawitacji: **Alt-G** lub Globals → Gravity

    Define G-Vector
    - *z* : **9.81** [m/s²] (***pozytywny kierunek osi z***)
    - Zamknąć okno: OK



Den virtuella godsvagnen

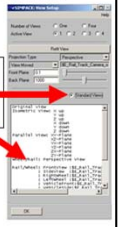
Översättning: Ingo Kaiser, Anneli Orvnäs, Stefan Hartweg



- Skapa en ny modell: → New
- Ge modellen ett namn (inget „å", „ä" eller „ö") och bekräfta med returtangenten **<RETURN>**
- Bearbeta modellen (*Model Setup*):
  - Ändra perspektivet: View → View Setup

    View setup
    - Klicka på *Standard views* och välj *Wheel-Rail/ Perspective View*
    - Stäng fönstret med OK
  - Ändra gravitationsriktningen: **Alt-G** eller Globals → Gravity

    Define G-Vector
    - *z* : **9.81** [m/s²] (***positiv z-riktning***)
    - Stäng fönstret med OK



http://www.dlr.de/schoollab/en

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Out of the Classroom - into the Lab!

The German Aerospace Center (DLR) is one of Europe's largest and most modern research institutions. Here is where the aircraft of the future are being developed and pilots trained, rocket engines tested and images of distant planets analyzed. In addition, over 6,500 DLR staff members are investigating next-generation high-speed trains, environmentally responsible methods of generating energy, and much more ...

At the DLR_School_Lab Oberpfaffenhofen, school students are introduced in a suitable manner to selected topics such as "robotics", "weather and climate", "infrared and radar measurement technology" and "rockets and satellites". They then conduct experiments on their own under the competent guidance of advanced natural science and engineering students who are supported by a team of staff scientists.

Touring Mars with the ASURO robot.

In the experiments we share our expertise and many technologies with the young researchers:

DLR_School_Lab Oberpfaffenhofen

at the Institute of Atmospheric Physics

Application form

to visit DLR_School_Lab

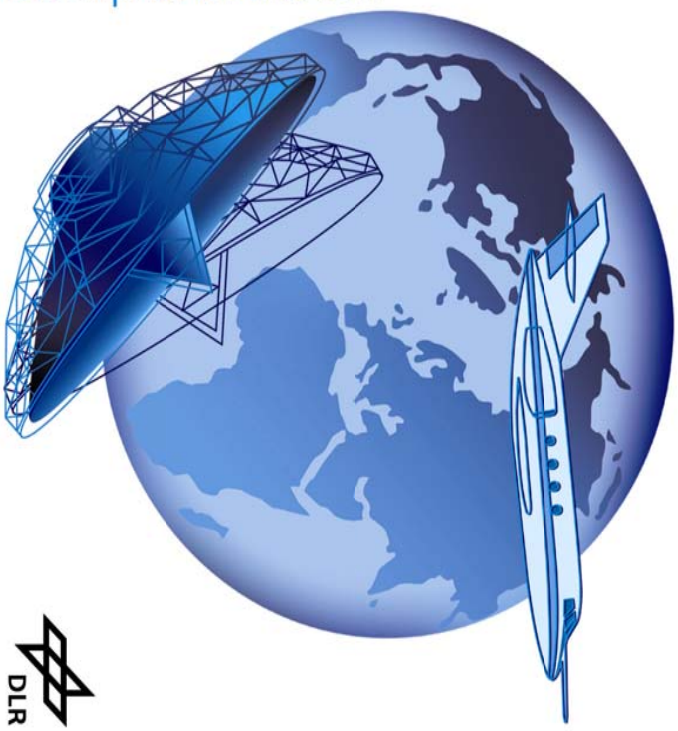
DLR_School_Lab Oberpfaffenhofen ...

... a panoramic view

[redacted]

DLR_School_Lab

Oberpfaffenhofen



DLR

esa

[redacted]

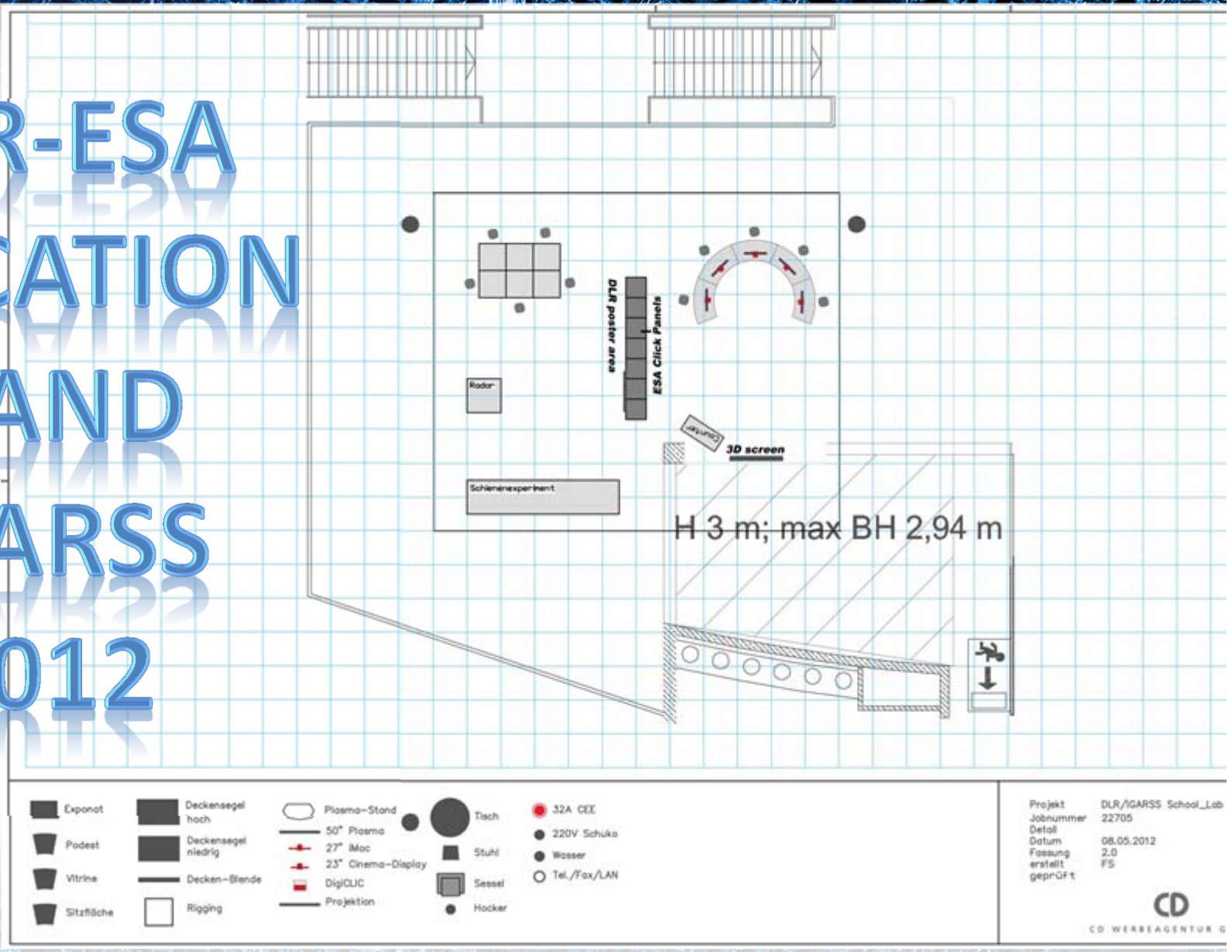
Joint DLR/ESA EO Education stand at IGARSS 2012 in Munich

Combined lab experiments, training sessions and 3D Demonstrations

Our Goals

- Attract (young) people to EO
  - Technology
  - Missions
  - Software
  - Data
  - Applications
- Create awareness for the usefulness of EO – especially in developing countries
- Demonstrate advantage of combined expertise

DLR-ESA EDUCATION STAND IGARSS 2012



2012 MUNICH IGARSS

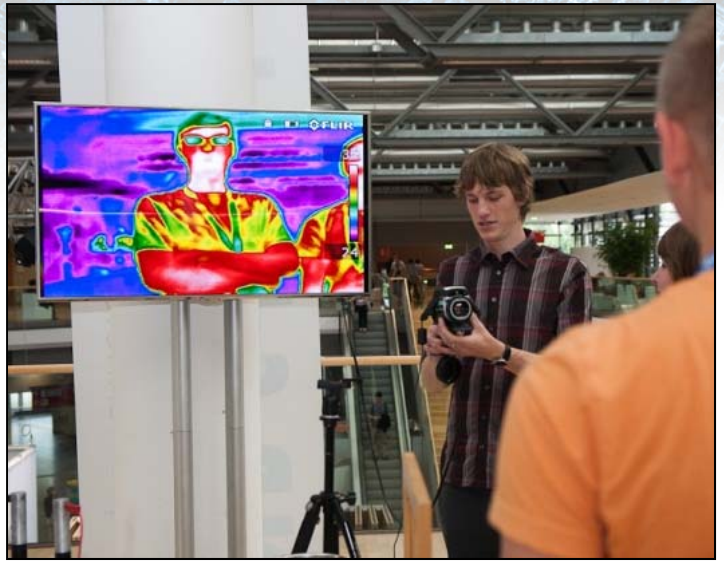
IEEE GRSS DLR esa

2012 MUNICH IGARSS

IEEE GRSS DLR esa

Radar experiment

Spectroscopy



Infrared techniques

The DLR School Lab experiments presented at IGARSS.

(More info at: http://www.dlr.de/schoollab/desktopdefault.aspx/tabid-1991)

The School Lab was combined with ESA lectures and computer practicals based on Eduspace *(http://www.esa.int/SPECIALS/Eduspace_EN/)* in a joint ESA/DLR EO Education stand for school visits

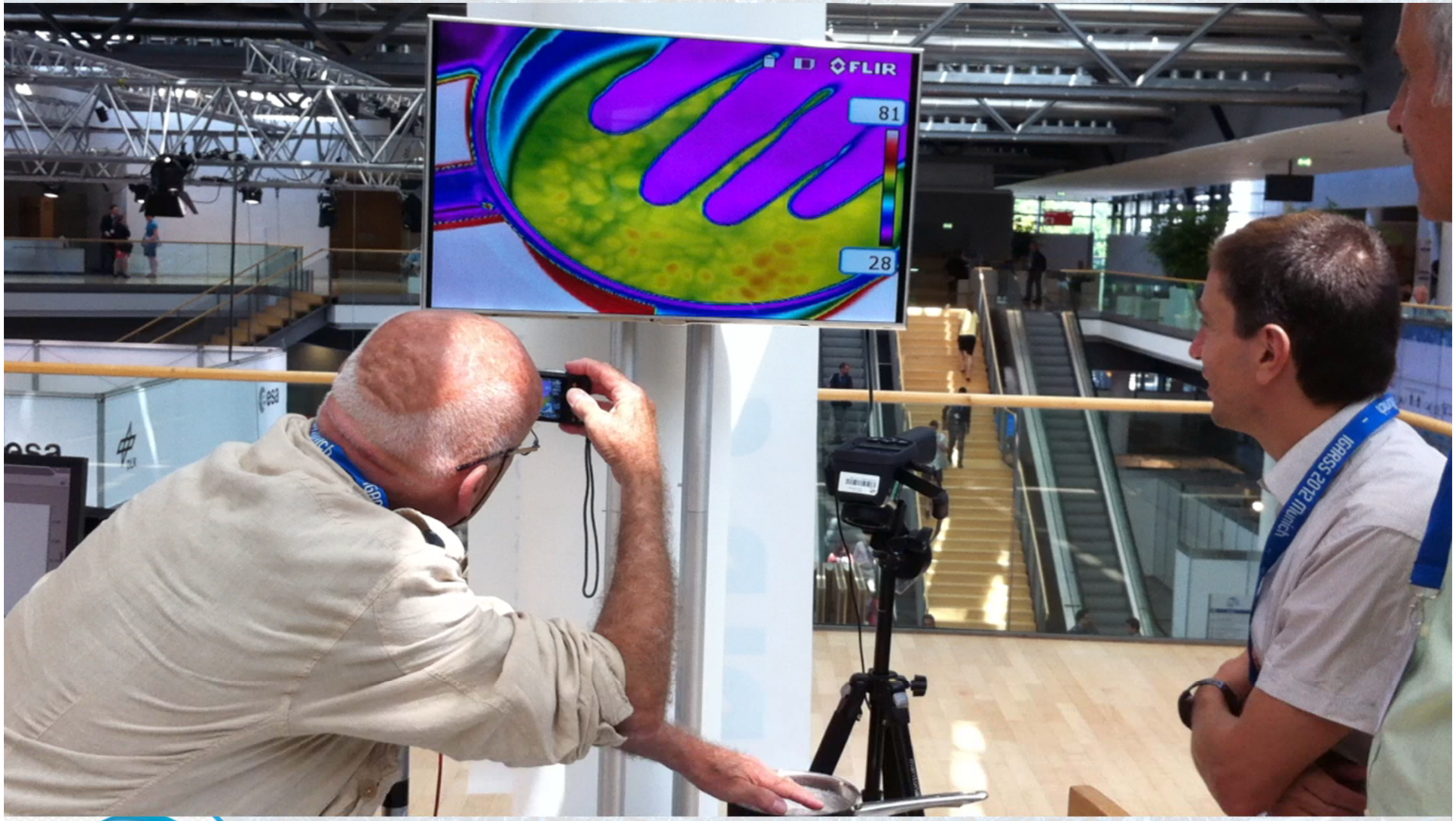
EO training sessions for high schools delivered by ESA.

(More info at: http://www.esa.int/SPECIALS/Eduspace_EN/)

esa education European Space Agency

2012 MUNICH IGARSS

IEEE GRSS DLR esa


FLIR
81
28

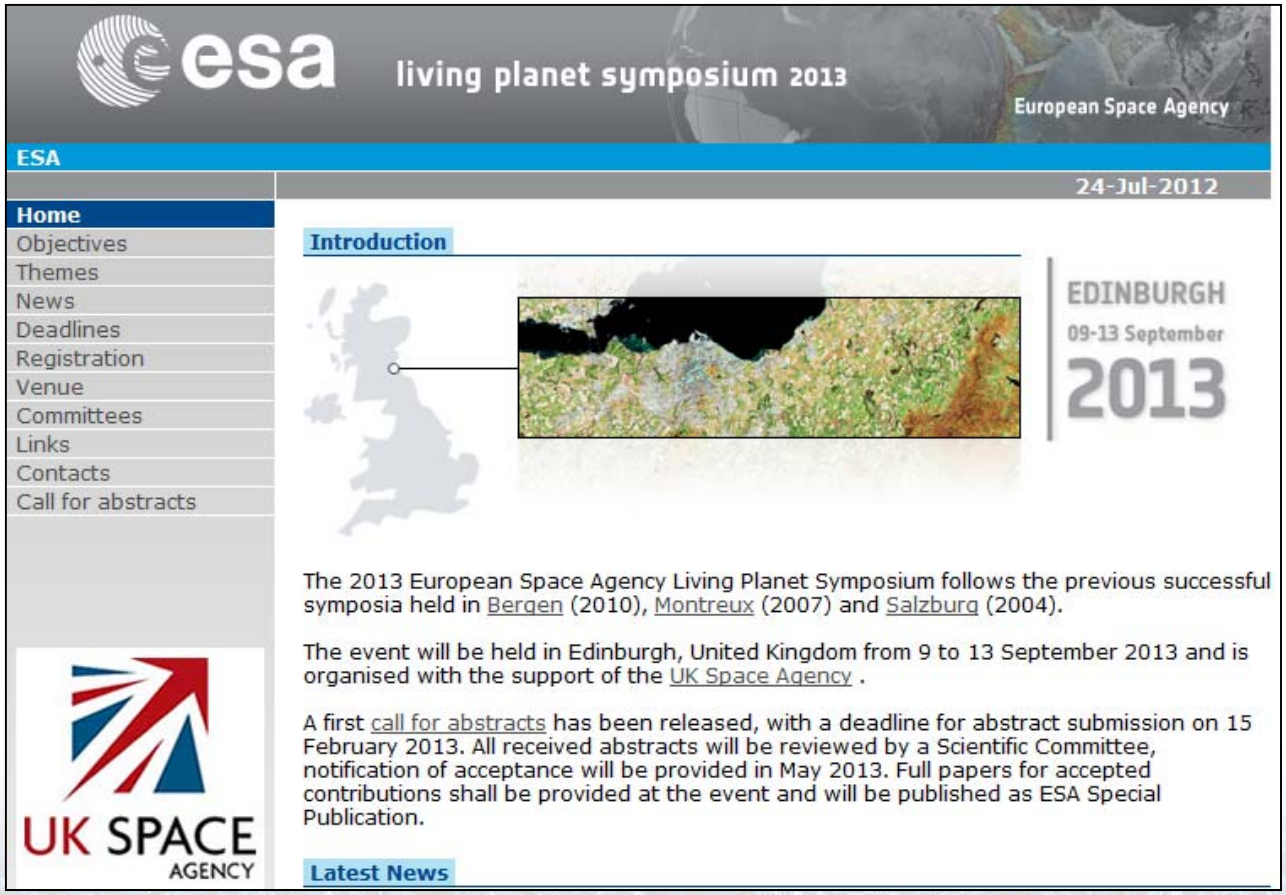
Our Vision

- Establish Practical EO Education and Training Centers in many places
- Special Focus: Developing Countries
  - Africa
  - Asia
- Use Existing Expertise of Space Agencies
  - DLR
  - ESA
  - UK Space
  - …

Next Step: Living Planet Symposium 2013

Edinburgh, United Kingdom, 09 - 13 September

→ a DLR/ESA/UK Space Agency EO education stand based on the IGARSS 2012 one



living planet symposium | EDINBURGH 09-13 September 2013

LPS School Lab

Edinburgh International Conference Centre
10 - 13 September 2013

Learn about the science and technology behind Earth Observation through half day sessions of lab experiments and demonstrations. Includes an exhibition tour at a major science conference.

Suitable for:

- Groups of ~15 students at S5 or S6 level*
- CPD sessions available for educators

* Includes content that complements the Biology, Chemistry Geography, Physics Highers and Advanced Highers and provides a clear example of interdisciplinary science

For FREE registration and information visit:
http://www.bis.gov.uk/ukspaceagency/news-and-events/2013/Jun/register-for-living-planet-symposium-school-lab

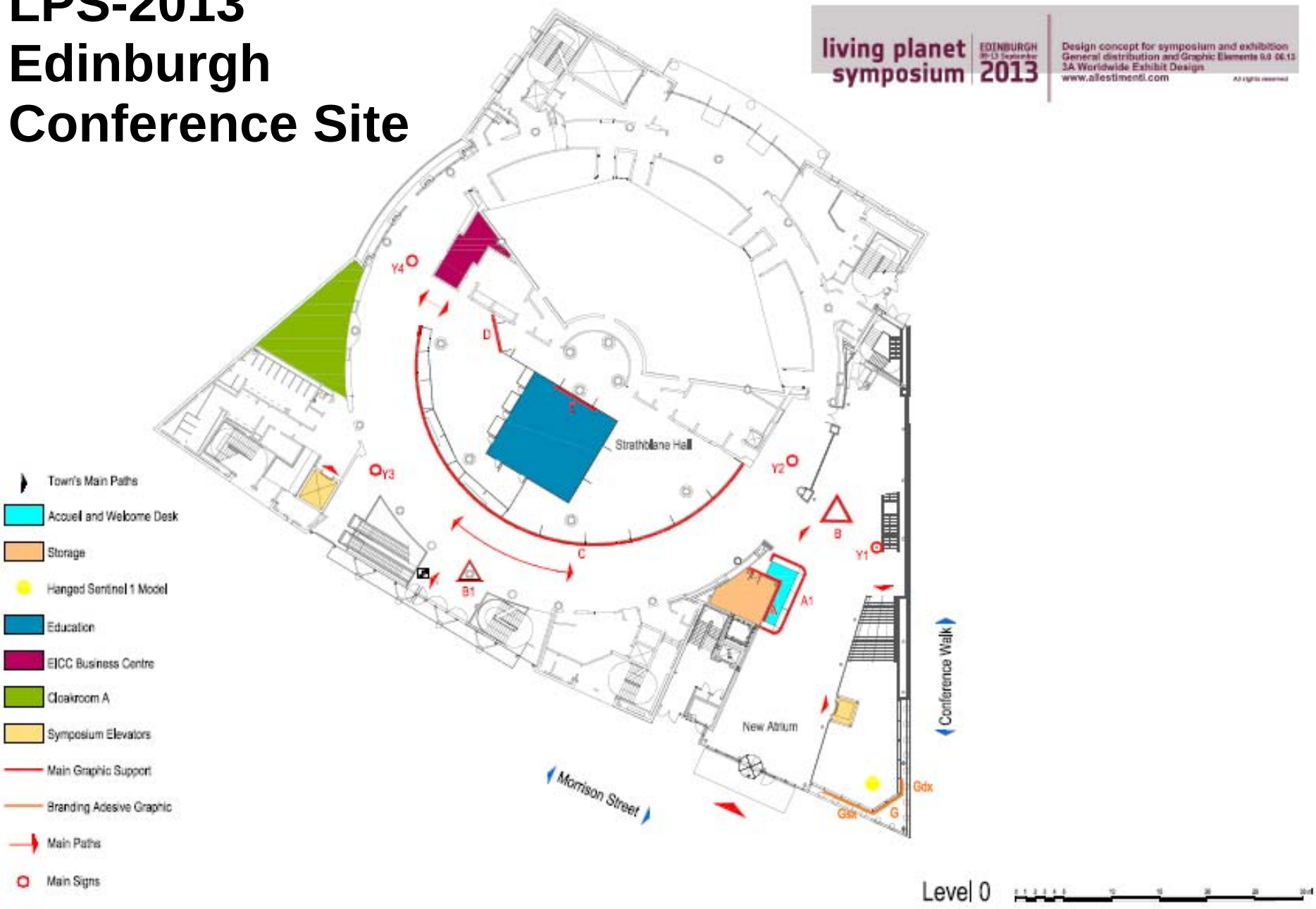
Image credit: ESA and DLR

DLR German Aerospace Center

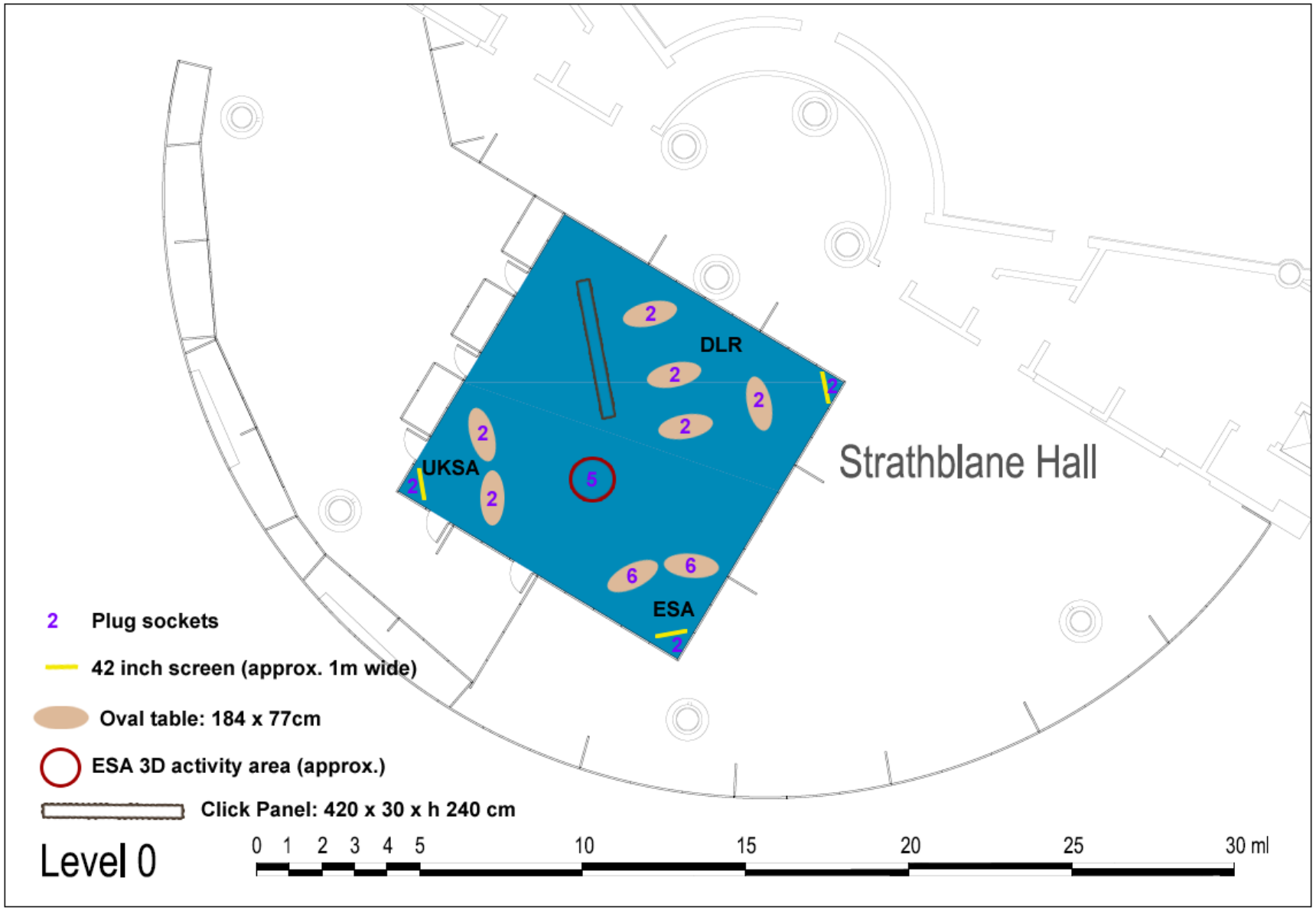
UK SPACE AGENCY

esa

LPS-2013
Edinburgh
Conference Site



LPS-2013 Edinburgh – School Lab Stand



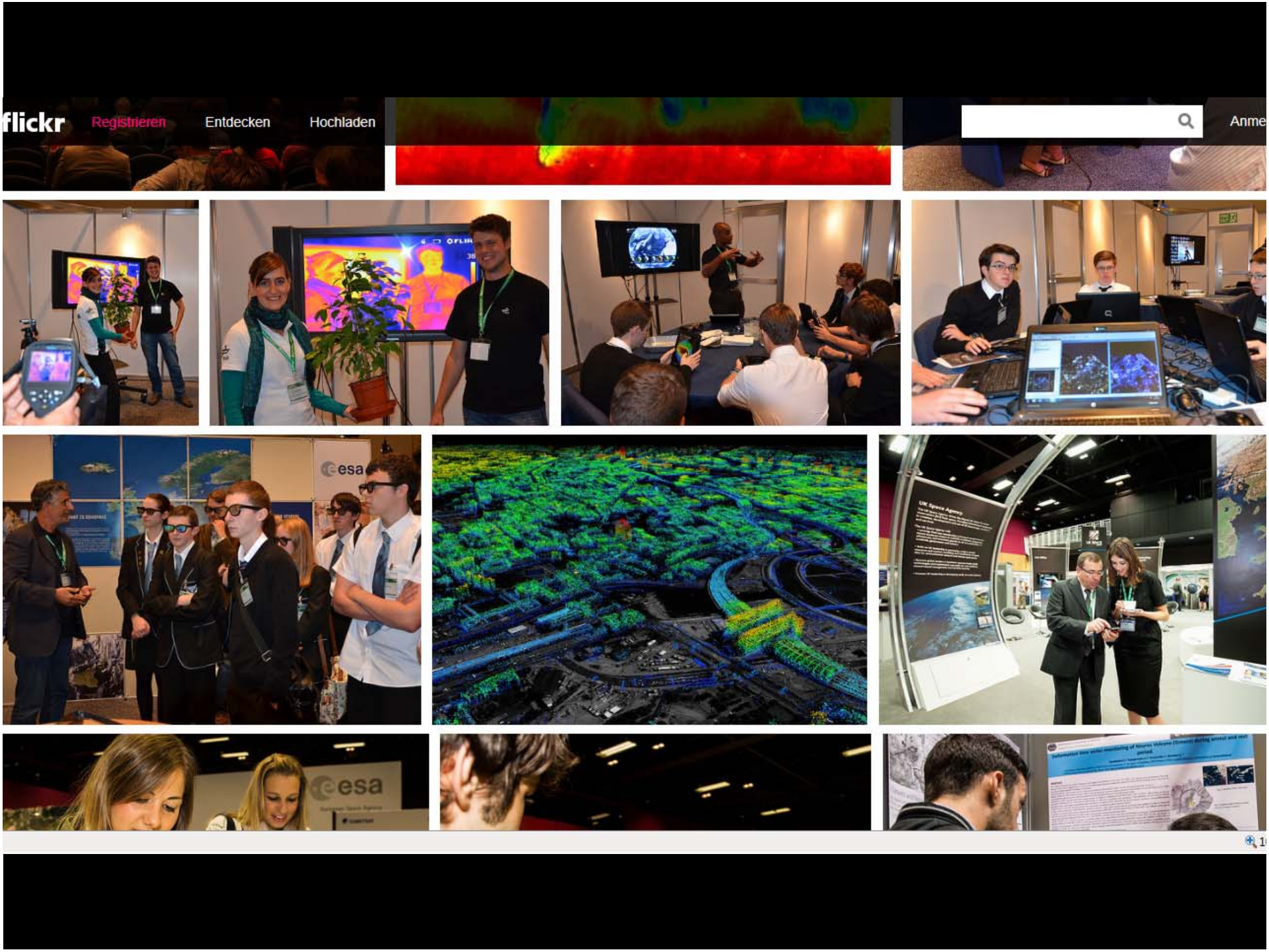
LPS School Lab Operation

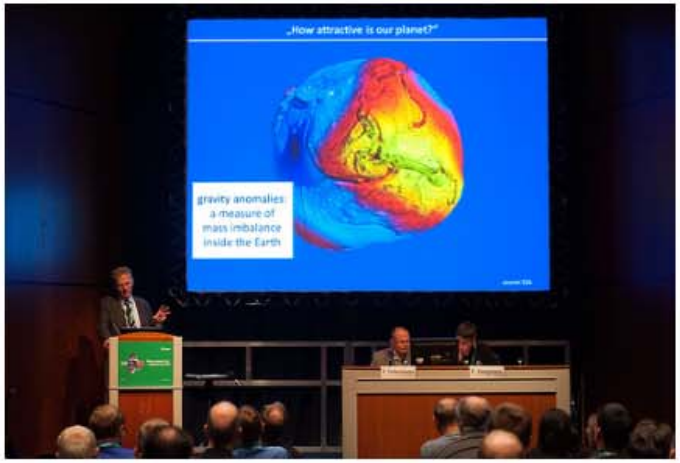
German Aerospace Center (DLR) UK SPACE AGENCY esa

School Lab Programme

Bookings for the School Lab status Sep 5, 2013:

Date and time of session	Type of session	School / individuals booked in
Monday 14:30	School	SCHOOL#1
Tuesday 9:00	School	SCHOOL#2
Tuesday 12:00	School	SCHOOL#3
Tuesday 14:30	Educator	Teachers & Symposium Participants
Wednesday 9:00	School	SCHOOL#4
Wednesday 12:00	School	SCHOOL#2
Wednesday 14:30	Educator	Teachers & Symposium Participants
Thursday 9:00	School	SCHOOL#5
Thursday 12:00	School	SCHOOL#2
Thursday 14:30	School	SCHOOL# 6


flickr
Registrieren
Entdecken
Hochladen
Anme
esa
esa



LPS-2013 School Lab:

Feedback of a teacher

German Aerospace Center (DLR)

UK SPACE AGENCY

LPS-2013 School Lab

Short Evaluation

Today's Date: 16. th October 2013

Date of Visit: 11 September 2013

Type of Educator: College for pre-schoolteachers

		++	+	o	-	--
	Total event	X				
	Presentation/Media/Material	X				
	Organisation	X				
	Usefulness for school or university	X				
	Content & competence	X				
Parts of event	UK Space Agency Living Planet	X				
	ESA Satellite Data	X				
	DLR Experiments	X				
	ESA 3D Demonstration	X				
	Guided tour of exhibition	X				

Comments: very interesting and motivating!
As a lecturer I got an insight of the subject of Earth observation
The material and didactical approach was very
stimulating and directly transformed into own involvement
into the activities.
My students loved it too and held a presentation about
their experience for their fellow students!

EO School Lab Tutorial by ESA and DLR

ESA:
Chris Stewart, Nicolas Ackermann, Francesco Sarti

DLR:
Matthias Locherer, Martin Danner, Dieter Hausamann

EO School Lab (Draft 1.0 18-04-2014)

1 INTRODUCTION

1.1 Background

During the IEEE Geoscience and Remote Sensing Symposium (IGARSS) 2012, in Munich, a School Laboratory (School Lab) was organised by DLR and ESA. The School Lab consisted of hands-on experiments demonstrating EO principles and techniques with the aid of instruments including a spectrometer, thermal camera and radar imager. The experiments were held during periodic group sessions to visiting school classes throughout the week long symposium in a dedicated open area. While they were mainly targeted to secondary school students and teachers, hundreds of interested conference participants from varying age groups and backgrounds were attracted, both during the group sessions and during the breaks.

Radar experiment Spectroscopy Infrared techniques

Figure 1: Illustration of School Labs.

Following the success of the IGARSS 2012 School Lab, the event was repeated at the ESA Living Planet Symposium in 2013 in Edinburgh. In addition to ESA and DLR, the UK Space Agency (UKSA) also contributed. Activities included thermal imaging of water bodies, spectroscopy of plants and other materials, computer practicals with EO data, and 3D demonstrations. From Edinburgh alone, around 200 high school students and teachers attended the School Lab, and as with IGARSS, many interested conference participants also attended.

1.2 Objectives

Having seen the impact and educational utility of the School Lab held during the various symposia, ESA and DLR decided to develop jointly a tutorial which describes the experiments that were developed. The ultimate goal of this tutorial is to provide teachers and students a description of EO

IGARSS 2012 Paper

PRACTICAL SCIENCE EDUCATION IN REMOTE SENSING AT THE DLR_SCHOOL_LAB OBERPFAFFENHOFEN

Locherer, M.[1,2], *Hausamann, D.*[2], *Schüttler, T.*[2,3]

1 Dept. of Geography, Ludwig-Maximilians University Munich, Luisenstr. 37, 80333 Munich;
2 DLR_School_Lab Oberpfaffenhofen, German Aerospace Center, Münchner Str. 20, 82234 Weßling;
3 Lecturer at the Kurt-Huber-Gymnasium (secondary school), Adalbert-Stifter-Platz 2 82166 Gräfelfing

Remote Sensing Experiments
Major Components

Experiment	Keywords	Instruments
Infrared Technology	thermometry, emissivity, black body, prism, BIRD, Herschel, Boltzmann	2 FLIR-Cameras, Pyrometer, special coated examination objects
Laser Technology	polarisation, emission, monochromatic light, quantum optics, signal transmission, LIDAR, HALO	Infrared Class IV Laser, Class II Laser for signal transmission, simulating 3D-Laserscanner
Radar Measuring Technology	microwaves, echo, Doppler effect, frequency, SAR, Tandem-X	Imaging Radar (SAR), One Dimensional Radar, Radar Speed Sensor
Optical Remote Sensing	sun spectrum, ozone, reflectance, hyperspectral RS, VNIR, NDVI	ASD-Spectroradiometer, Sun Photometer, Pyrometer
Earth Observation with Satellite Data	resolution, multispectral sensor, image processing, change detection, Landsat	LEOWorks image processing software, Landsat Data

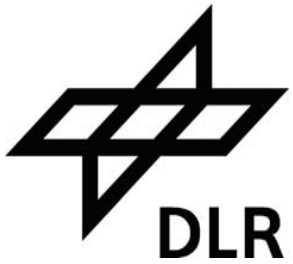
DLR

Observe Earth

Application for Smartphones & Tablets

Cooperation

- Synergy between Institutions
  - UK Space Agency (Anu Ojha)
  - ESA (Nicolas Ackermann, Fulvio Marelli, Francesco Sarti)
  - DLR School Lab (Matthias Locherer, Martin Danner, Dieter Hausamann)



Template: Living Earth

Observe Earth in a few words

- Objectives
  - Promote ESA EO data & missions
  - Educate
  - Stimulate interest in EO
- Tablets Earth Observation System
  - Visualisation
  - Analysis
  - Learning
  - Sharing
- ESA EO Products
  - Essential variables
  - Natural disasters
- Target audience
  - Students/teachers from secondary school
  - Passionate of new technologies (geeks)
  - Young scientists

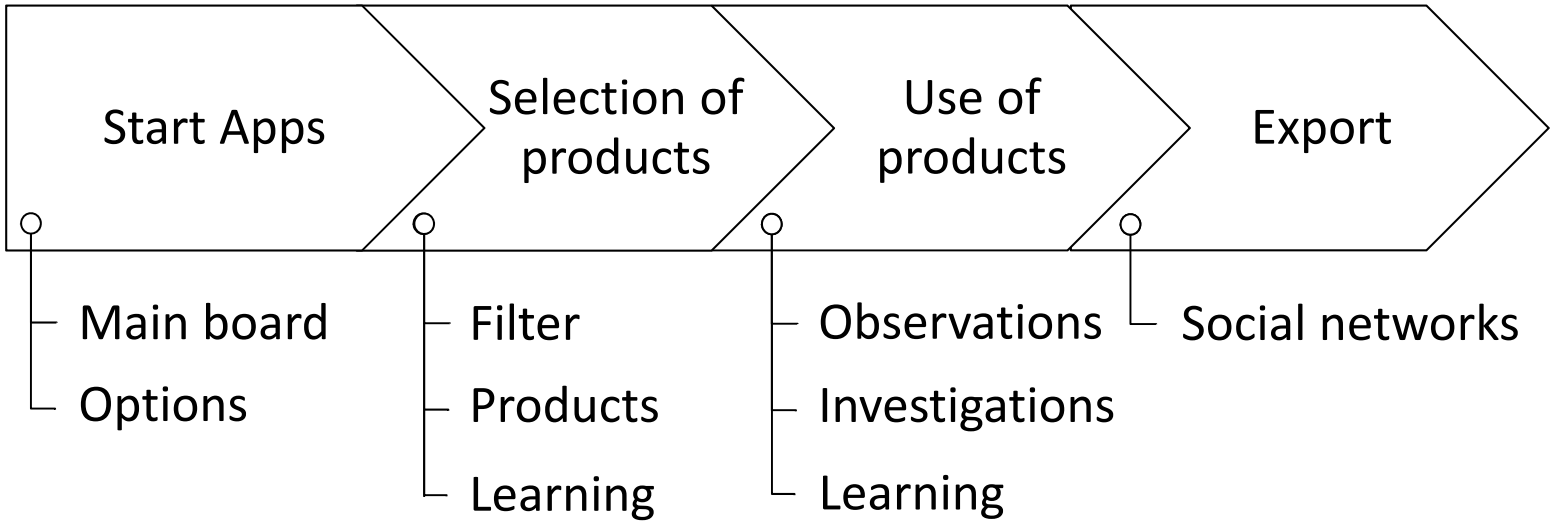
App products

- Disasters
  - Avalanche
  - Drought
  - Cyclone
  - Earth quake
  - El Nino
  - Flood
  - Forest fire
  - Hailstorm
  - Hurricane
  - Oil spill
  - Tsunami
  - Volcanic eruption
  - …
- Biophysical parameters
  - Air Temperature
  - Gravity Field
  - Carbon Dioxide
  - Wind
  - Ocean color
  - Forest biomass
  - Ice thickness
  - …
- Thematic maps
  - High Tension / Crisis Zones
  - Population Volume
  - Refugee Currents
  - Malaria extension
  - TV Ownership
  - Nuclear Desire
  - Fresh Water
  - Life Expectancy
  - …

Education component

- Video Tutorials
  - Explain how a function works
  - Explain how to analyse a certain phenomenon
- Case studies
  - Topic given by the medias
  - Do it yourself
- Theory animations
  - Overview board with links to the topic
  - Interactive animations story using the Earth model in background
  - The narration may stop so that the user can compare the projected data and given Models

Concept


Start Apps
Selection of products
Use of products
Export
Main board
Options
Filter
Products
Learning
Observations
Investigations
Learning
Social networks

Start Apps

- Main options
  - Display
  - Products
  - Satellites
  - Latest highlights
  - Learning
  - Print screen/Record

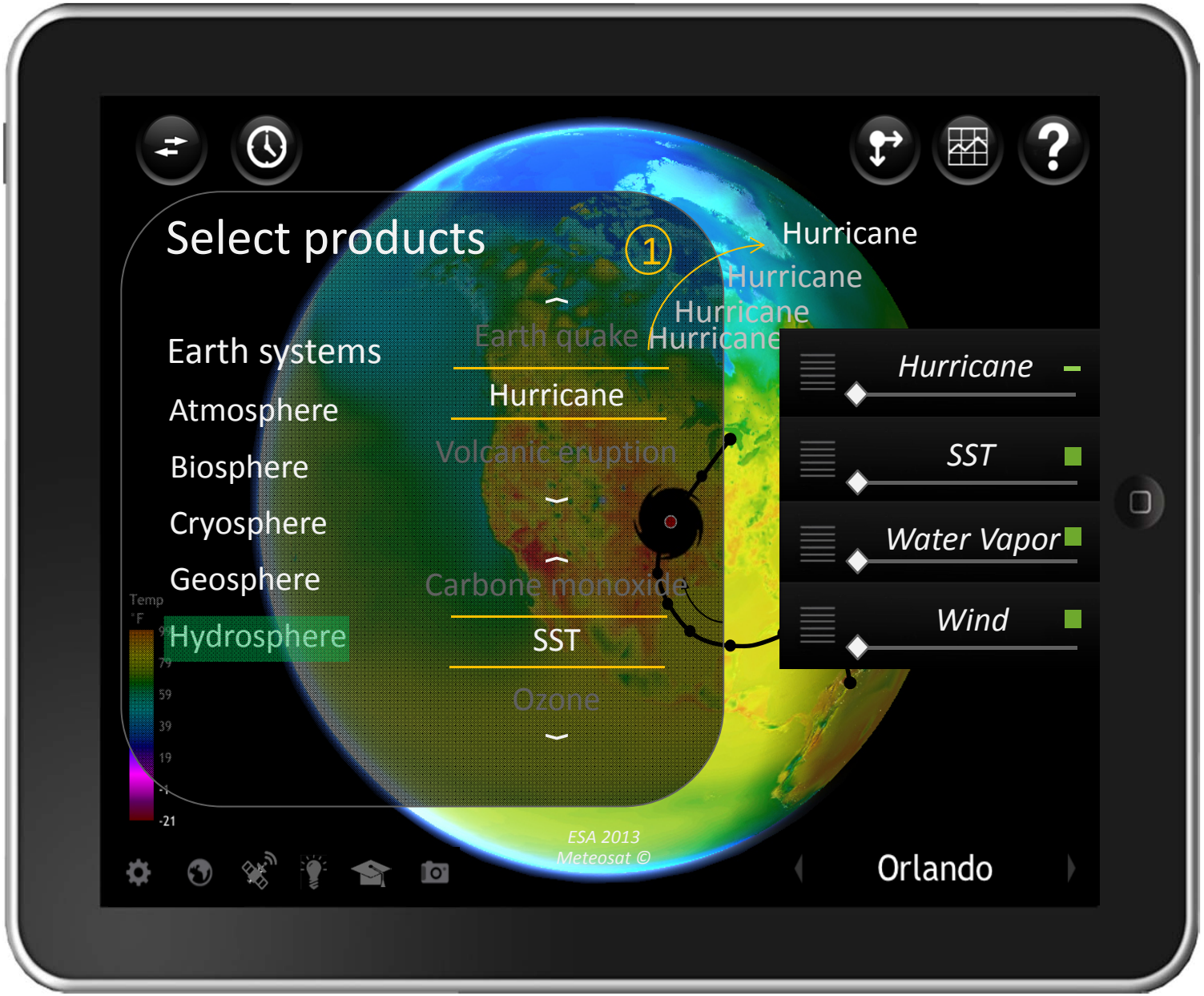
Selection of products

Select Products

Selection of products

① Select Biophysical parameter by hold and drag

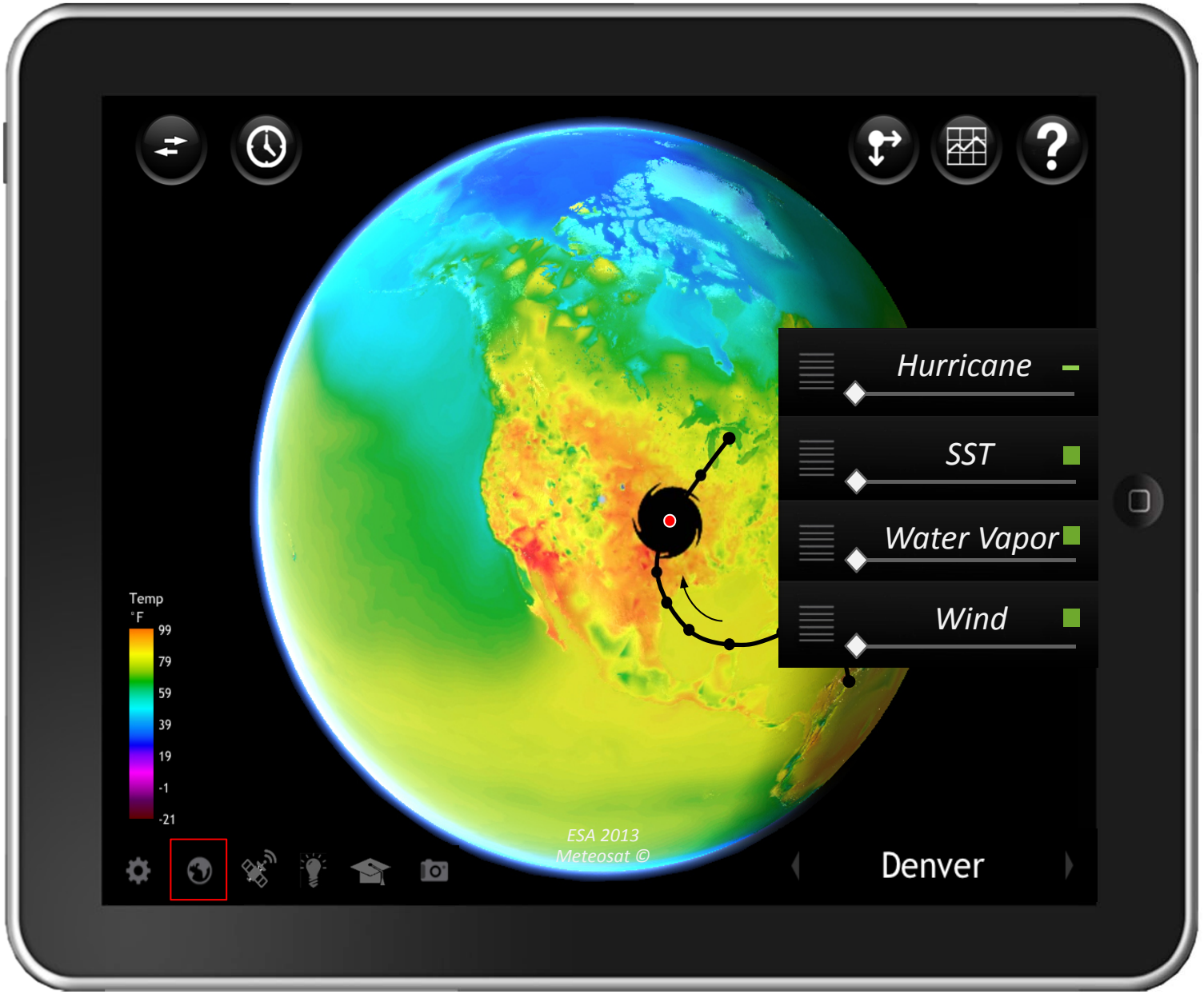
② Natural disaster product is stored as vector layer
+
Biophysical products related to the selected Natural disaster product are stored as raster layers



Selection of products

Press out the Product selection window to go out the window.

Return to the Product selection window using the «Products» symbol.



Selection of products

Select thematic products

Selection of products

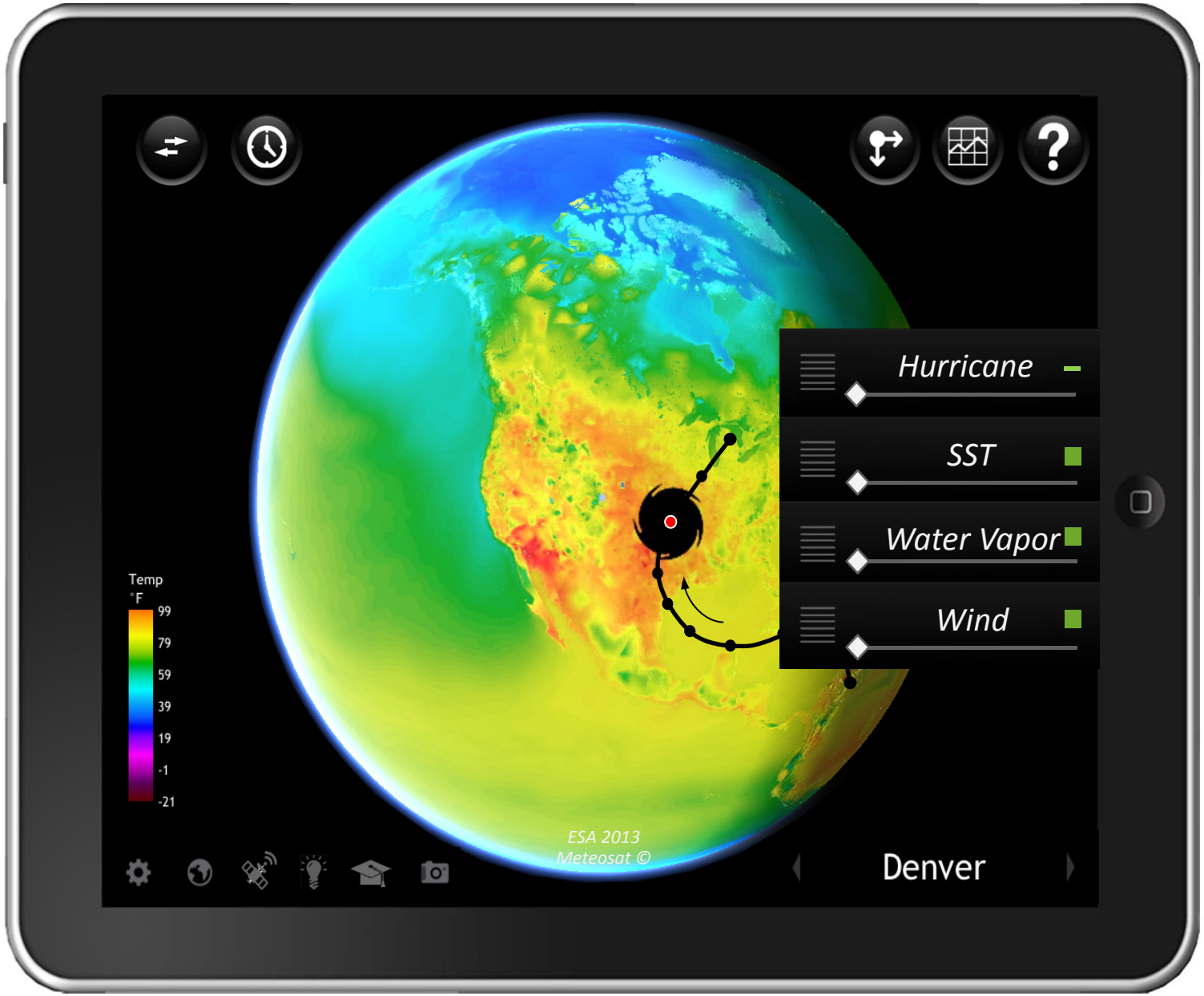
Select thematic products

Selection of products

Select thematic products

Selection of products

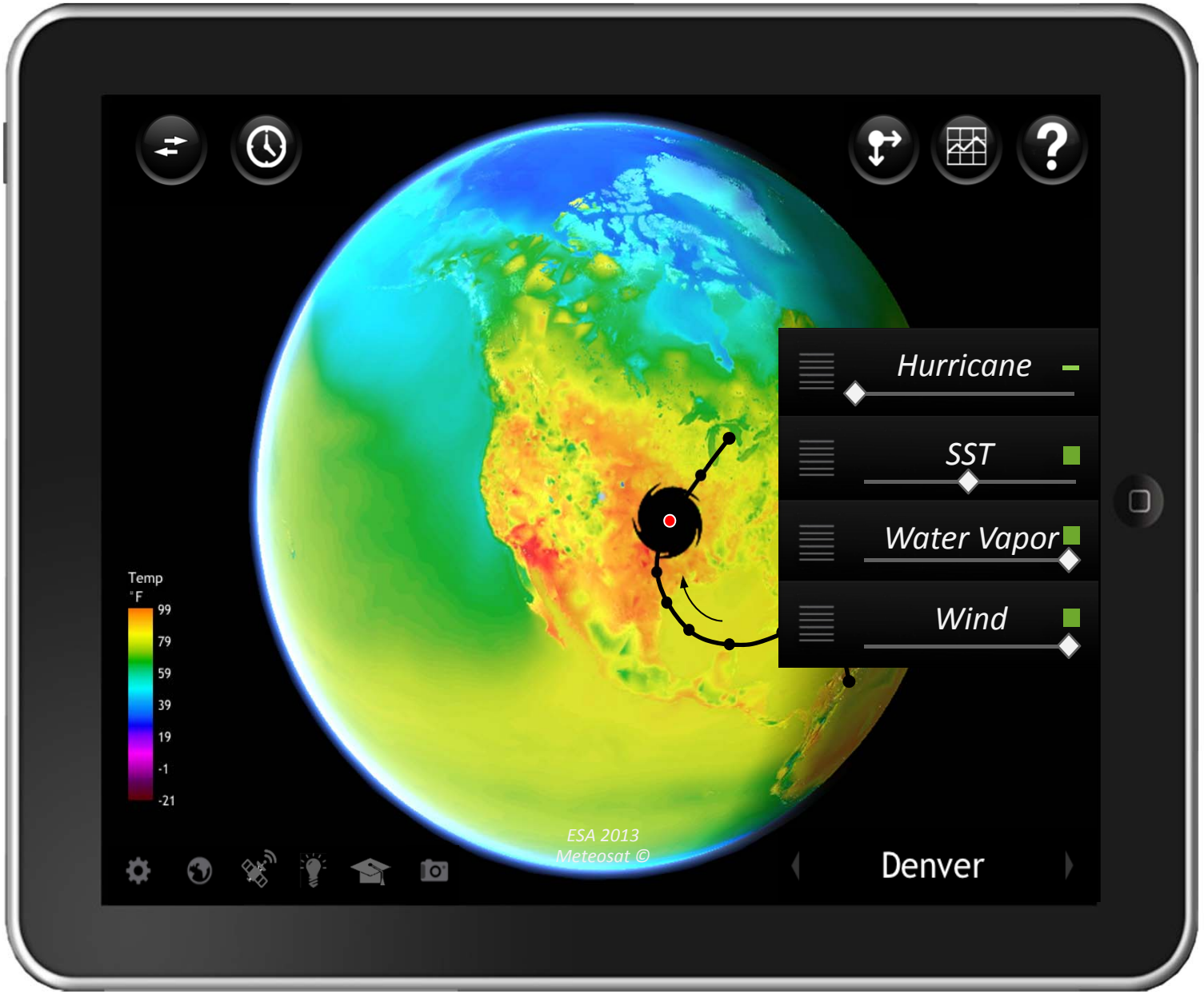
Layers of selected products



Use of products

Products Layers
Transparency

Hurricane 0%
SST 50%
Water Vapor 100%
Wind 100%



Use of products

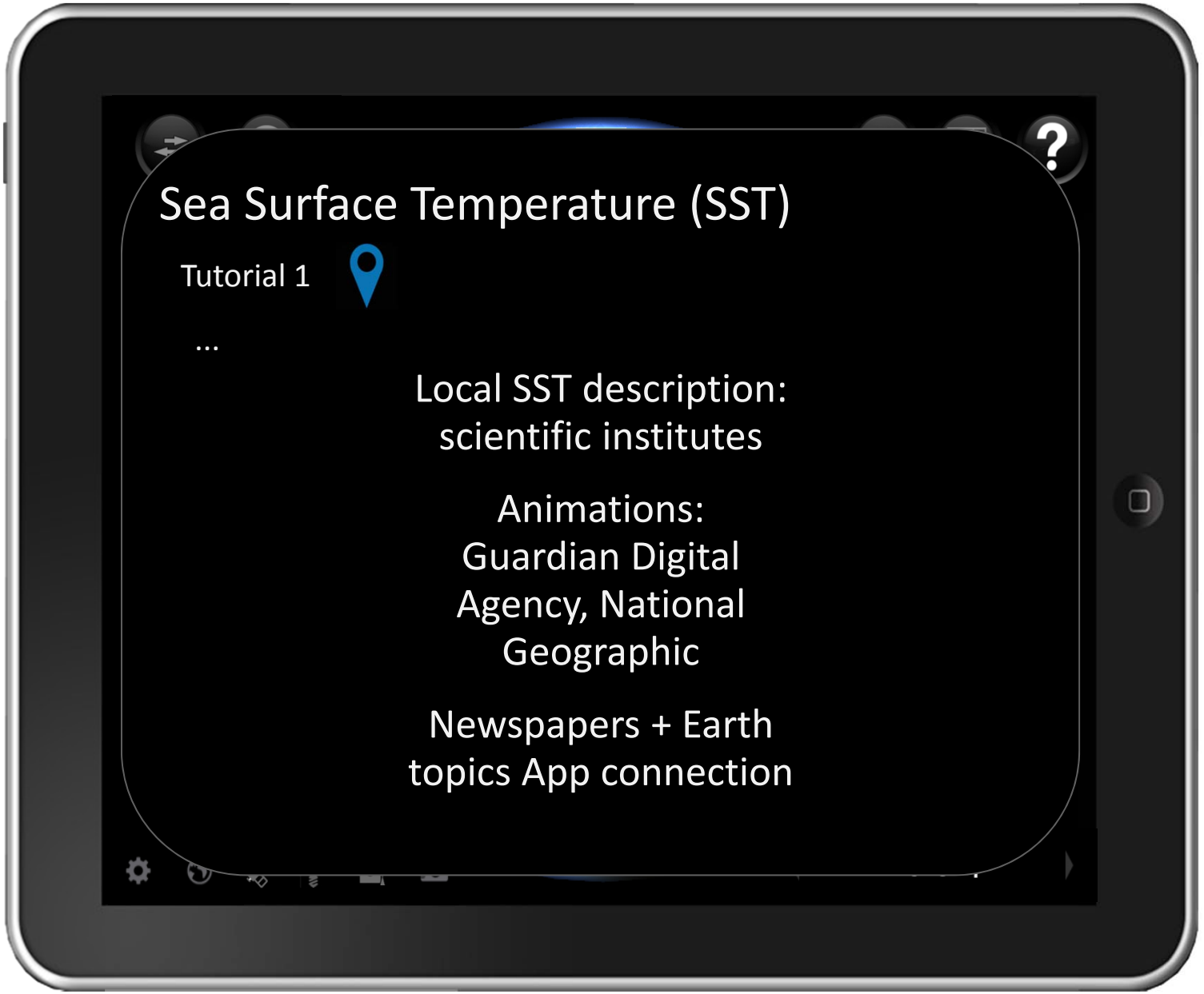
Products Layers
Transparency

Hurricane 0%
SST 100%
Water Vapor 100%
Wind 100%

Learning

Select Tutorial 1

Click on the marker to go to the location



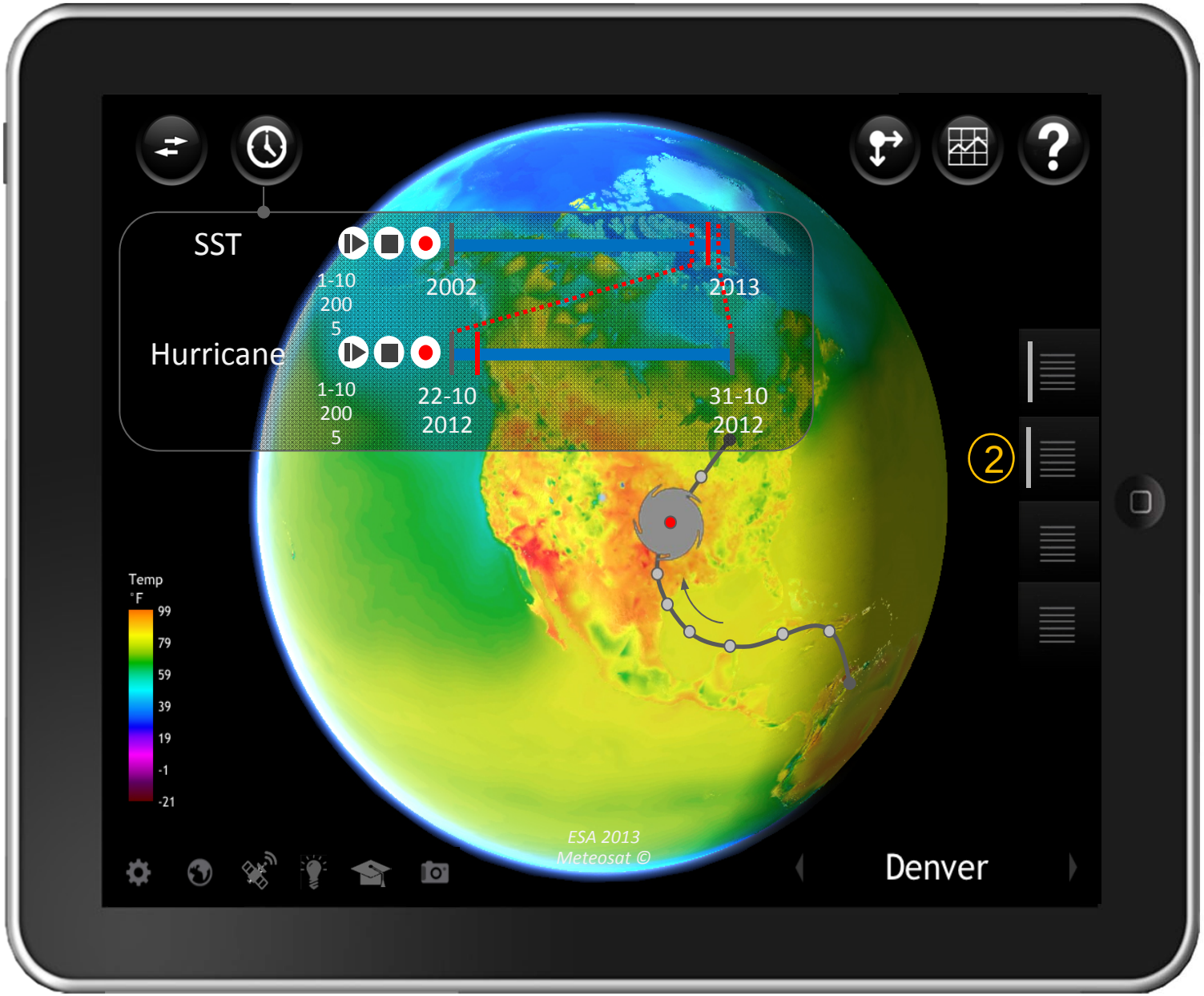
Use of products

Play/record different products together

②

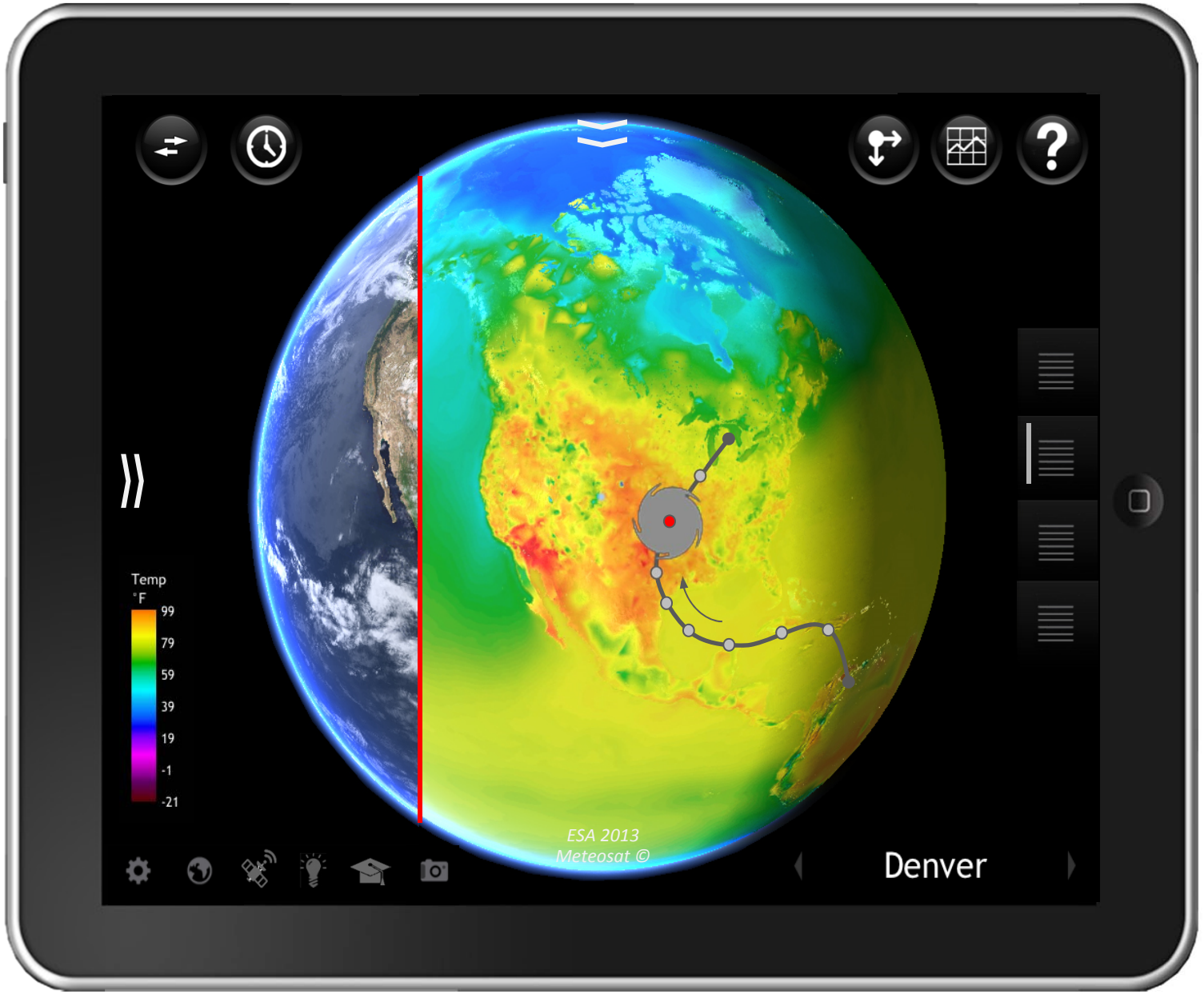
Press and hold a second layer to add it to the Timeline options

In this case, SST and Hurricane are played together



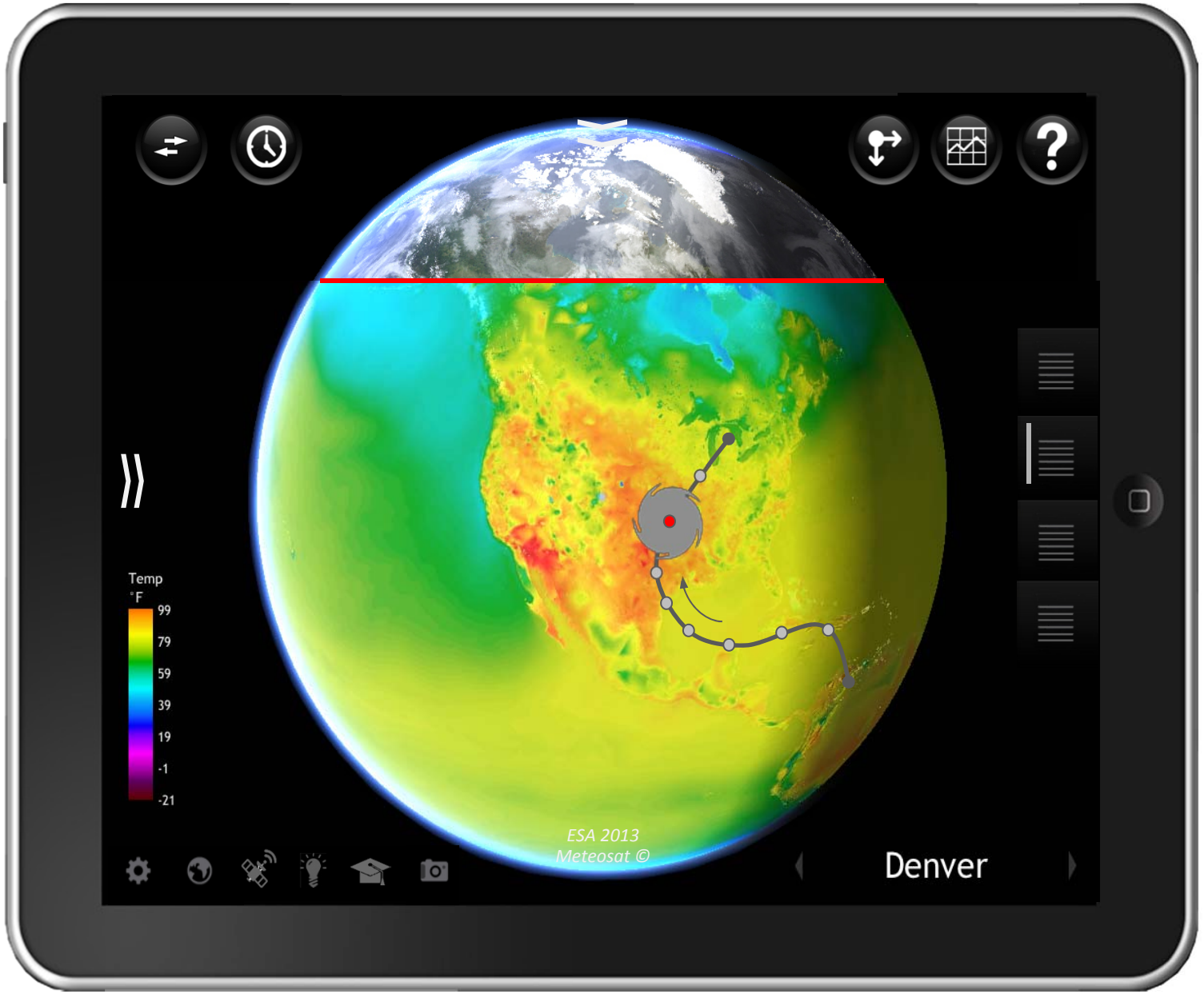
Use of products

Horizontal swipe



Use of products

Vertical swipe



Learning

Learning with
Video tutorials

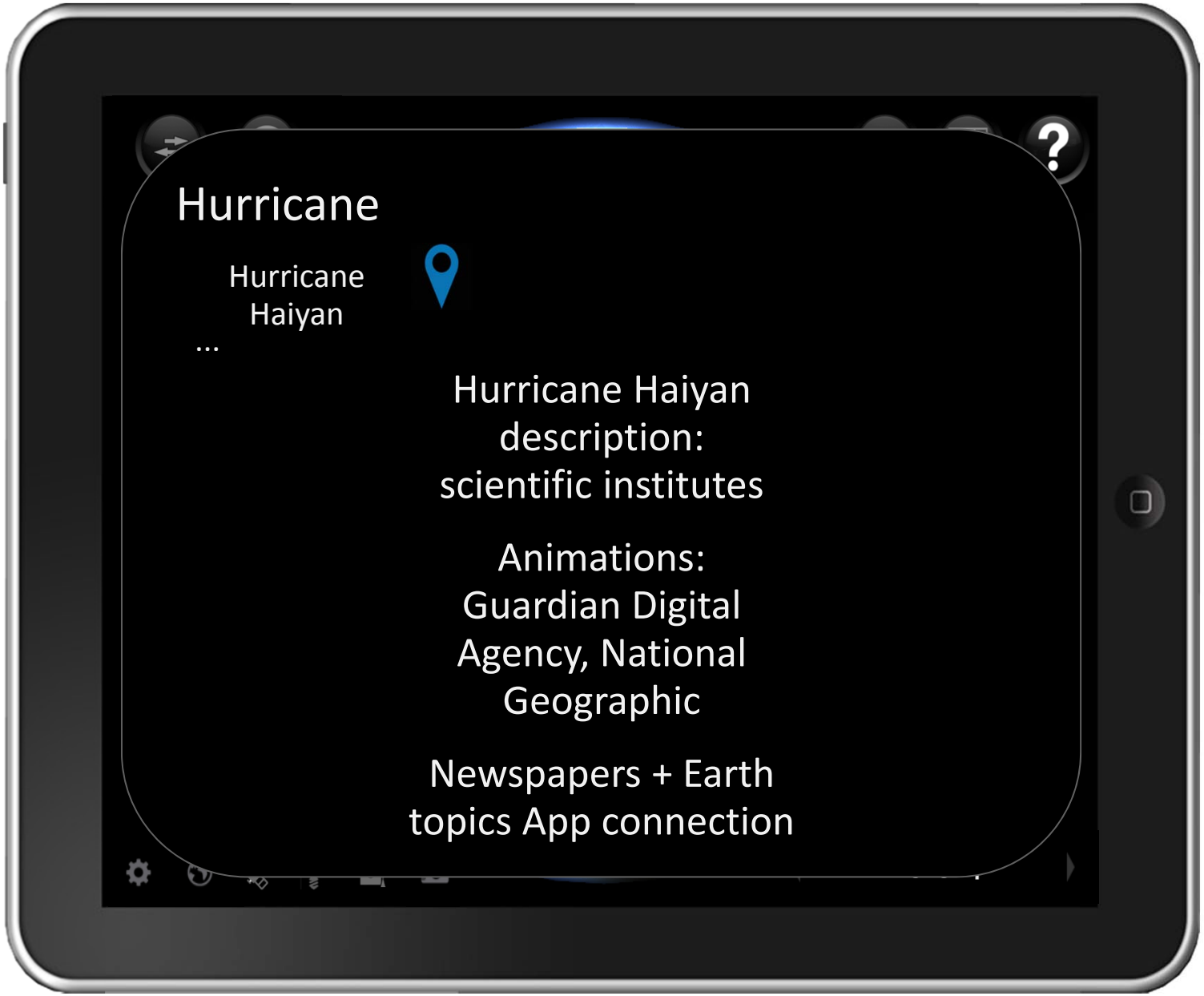
Learning

Learning with Theory

Learning

Select Huricane Haiyan

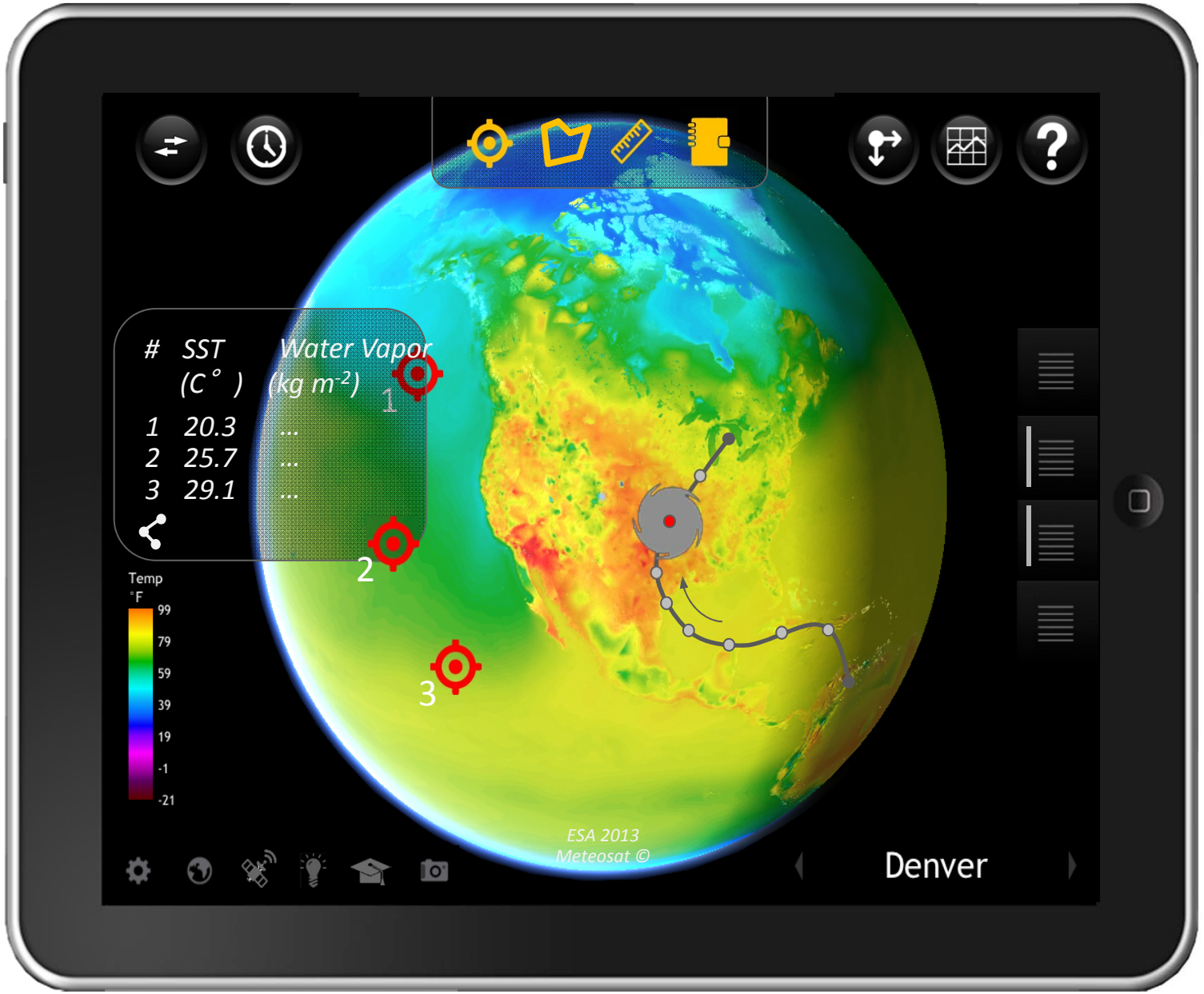
Click on the marker to go to the location



Use of products

Press and hold a second layer to add it to the Statistic options

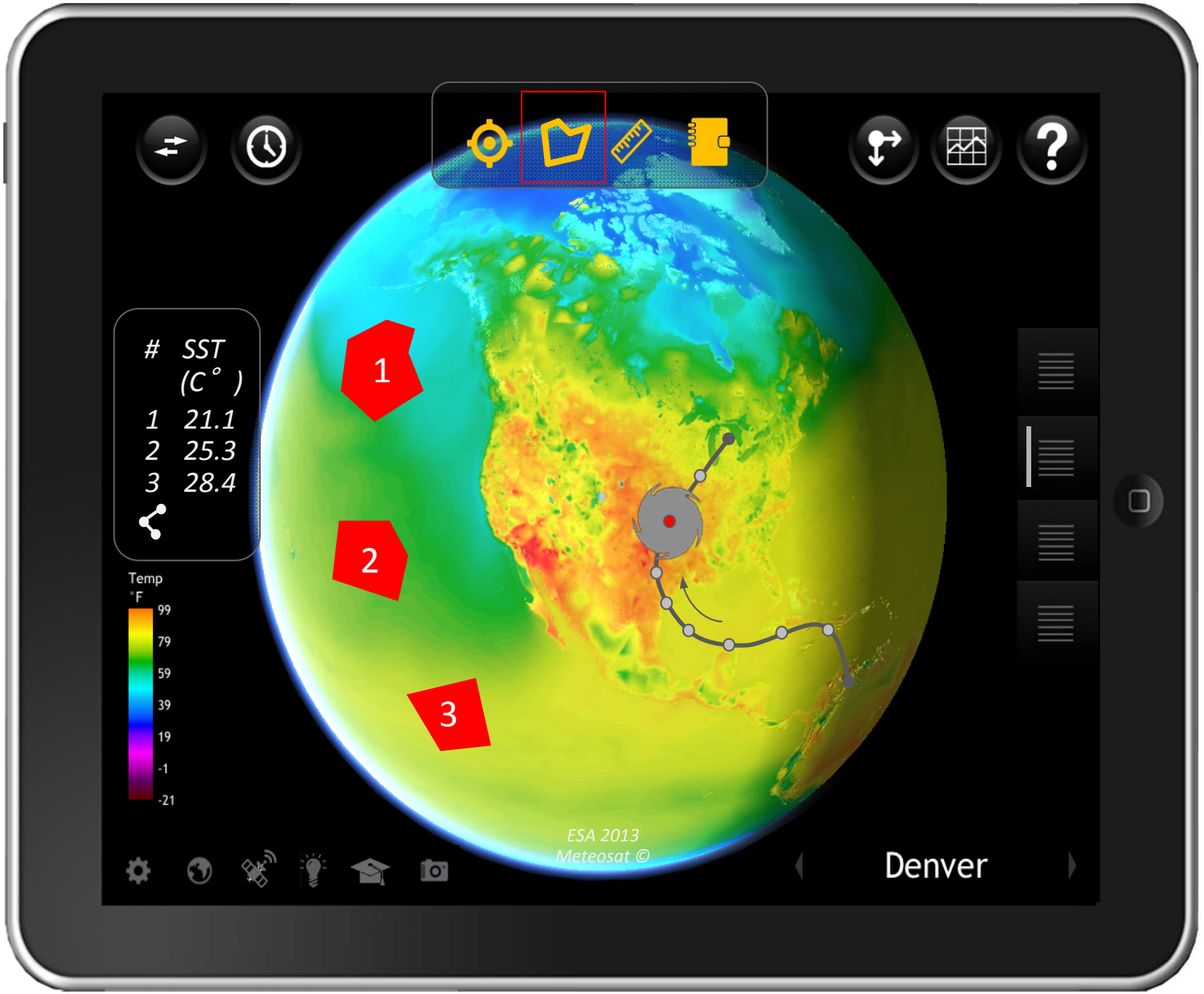
In this case, SST and Water Vapor are selected



Use of products

Select Regions of Interest (ROIs) to look at the corresponding averaged values

The «Sharing» symbol to exchange may also be used to export the values + other statistics (Standard Deviation, …) to Excel for further diagrams…



Functions - Further ideas

- Wallpaper function
- Tilt view
- Portrait/Landscape mode
- Active Earth rotation
- Night mode
- My home / Plan trip
    - Products (example European Environmental Agency (EEA))
    - Make your own forecast
- 3D mode to look with glasses

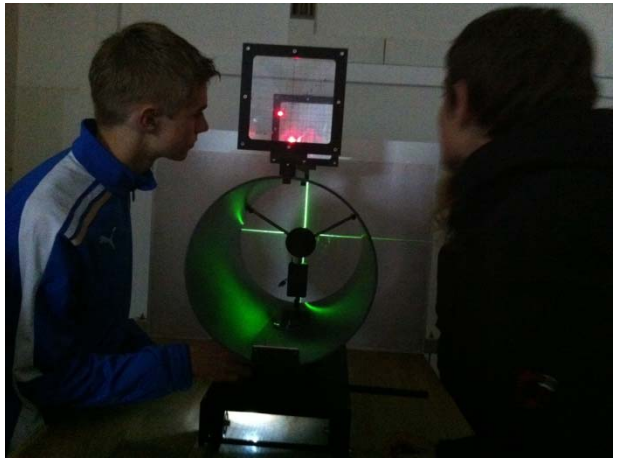
- … and many more …

Conclusion & Future Outlook

Capacity Formation in EO School Labs

- A new hands-on concept to attract secondary school students to STEM/EO
- Link between school education and Capacity Building:
  „A new column in the education system“ (M. Euler)
- Approved and evaluated @ research centers (e.g. DLR)
- Internationalization (invite other countries to visit)
- Joint show cases @ international conferences
- **Main goal: stimulate repetition by other agencies**
- Additional support by
  - exportable experiments
  - tutorials
  - mobile apps
  - conceptual papers
  - publications




Thank You for Your Attention!

DLR