

GNSS-R Mission Planning Aboard the Research Aircraft HALO

Ralf Stosius¹, Georg Beyerle¹, Maximilian Semmling¹,
Markus Markgraf², Oliver Montenbruck², Rodrigo Rivas²,
Serni Ribó³, Antonio Rius³, Estel Cardellach³,
Lutz Eberlein⁴, Mirko Scheinert⁴,
Thomas Gerber¹, and Jens Wickert¹

¹Helmholtz-Centre Potsdam German Research Centre for Geosciences GFZ,
Telegrafenberg, 14473 Potsdam, Germany

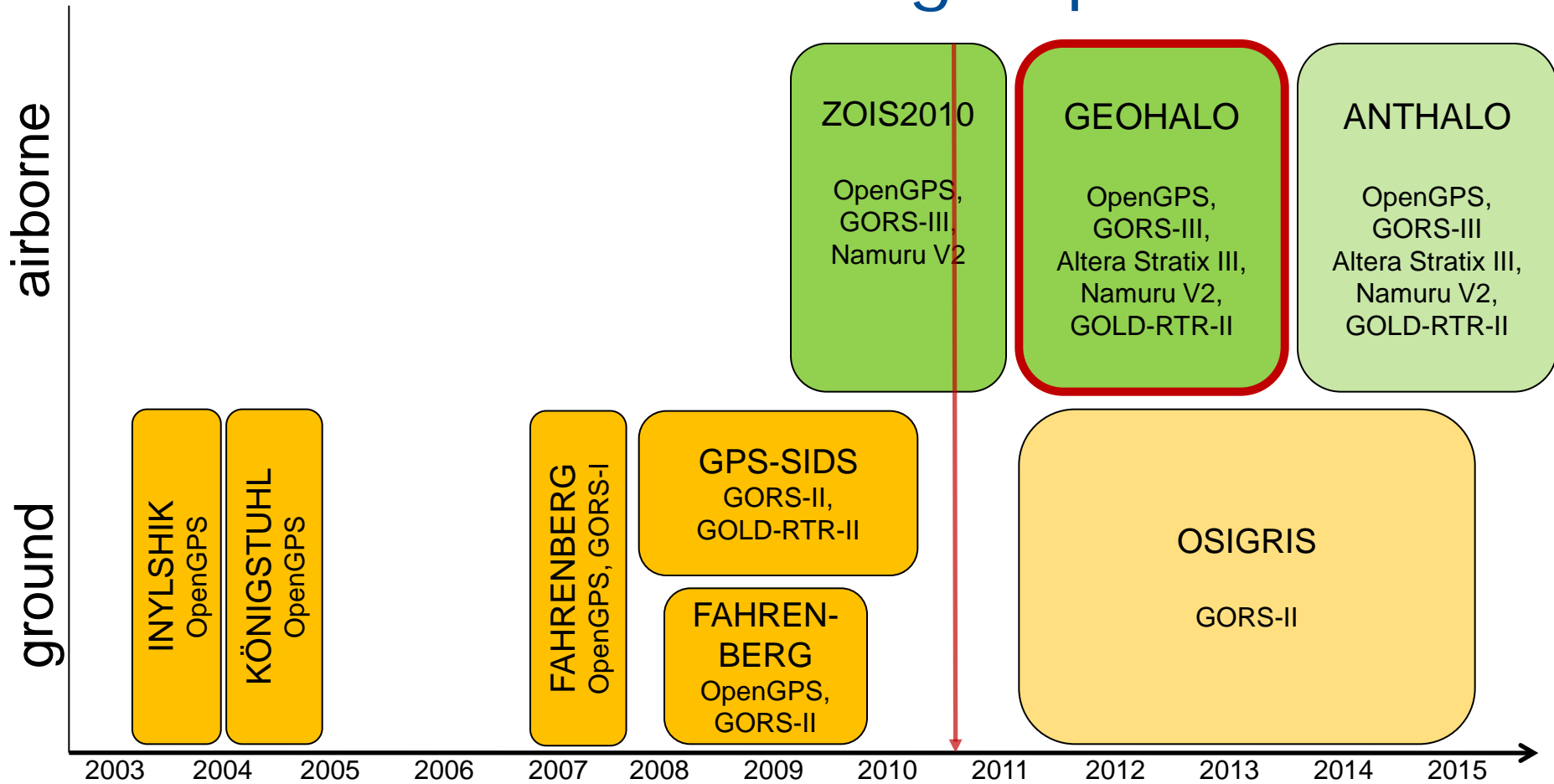
²Deutsches Zentrum für Luft- und Raumfahrt (DLR),
Oberpfaffenhofen, Germany

³Institut d'Estudis Espacials de Catalunya, (CSIC/IEEC)
Barcelona, Spain

⁴Technische Universität Dresden (TUD),
Dresden, Germany

rstosius@gfz-potsdam.de

GNSS-Remote Sensing Experiments



OpenGPS is an open source GNSS-R development by GFZ (G. Beyerle)

GORS (GNSS Occultation, Reflectometry and Scatterometry) receivers are based on modified JAVAD receivers used by GFZ

Altera Stratix III and Namuru V2 boards are contributed by DLR (O. Montenbruck)

GOLD-RTR-II are contributed by CSIC/IEEC (A. Rius)

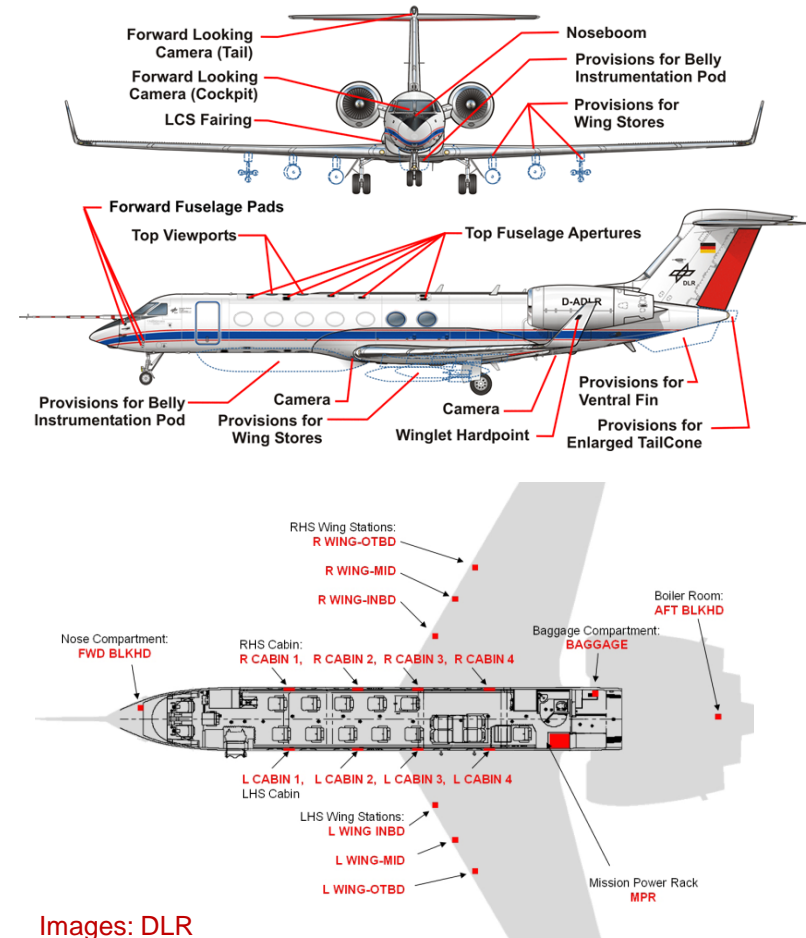
HALO research aircraft

- High Altitude and Long Range (HALO) research aircraft
 - 15 km max. height
 - 12,500 km range
 - 3 tons payload
 - 20-30 m² cabin-area
- Gulfstream G550 business jet
- Funded by the German Federal Ministry of Education and Research (BMBF) and the Max-Planck Gesellschaft (MPG)
- hosted by DLR Flight-Department, Oberpfaffenhofen, Germany



HALO interfaces

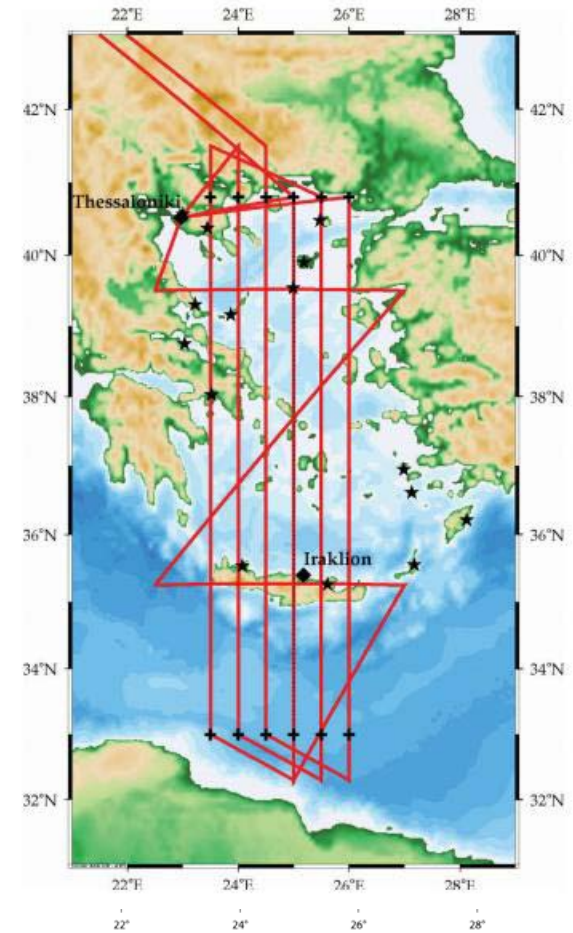
- Apertures, view ports, hardpoints, camera platforms at fuselage
- Belly pod, wing stores, nose boom
- Several 19" rack positions
- 28 V DC and 230 V AC power supply
- Ethernet data network
- In-flight AVIONIC data



Images: DLR

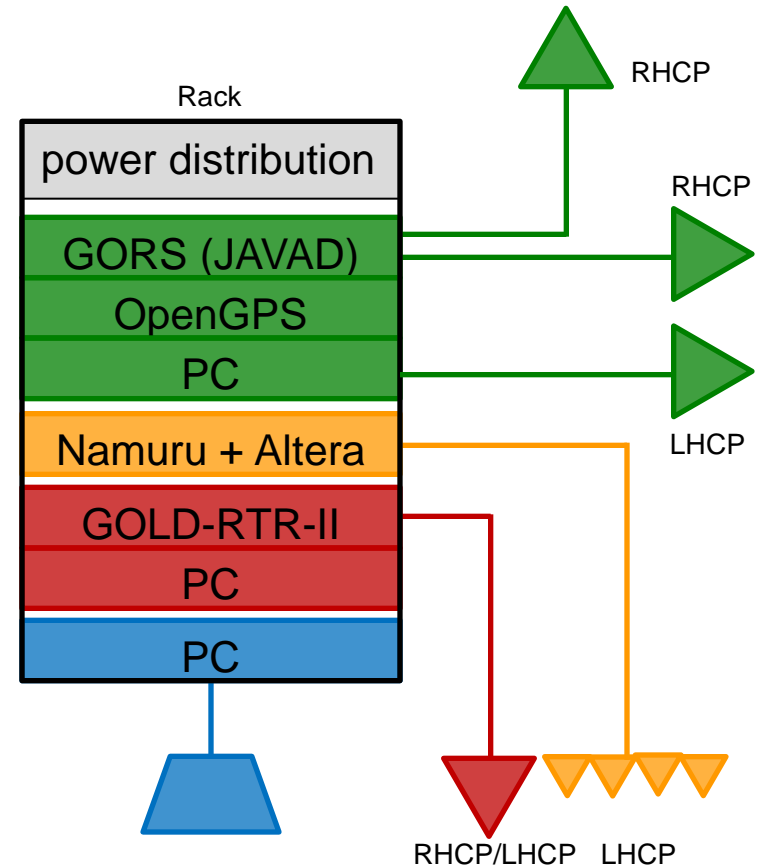
GEOHALO mission

- Geophysical Experiments in the Eastern Mediterranean (Aegan Sea)
- 3 days, 6 tracks at 2 and 15 km alt.
- Gravimetry (GFZ, BGR)
- Magnetometry (GFZ)
- GNSS-R (GFZ, DLR, IEEC)
- Laser altimetry (TUD)
- Ground GPS network (ETH)



GEOHALO-ROC

- GEOHALO - GNSS Reflectometry and Radio Occultation
- **GFZ**
Zenit and sidelooking antennas, OpenGPS and GORS receivers
- **DLR**
Nadir antenna array, receiver unit
- **CSIC/IEEC**
Nadir antenna, GOLD-RTR2
- **TUD**
Laser altimeter



GFZ Instrumentation

- Antennas

Zenith: RHCP (ANTCOM 3G1215A-XT-1)
mounted in top aperture



Sidelooking: RHCP (ANTCOM 3G1215A-XT-1) and
RHCP/LHCP (ANTCOM 3G1215RL-AA-XT-1)
mounted in
left window
viewport



GFZ Instrumentation

- Receiver unit

GORS-II receiver:

(zenith antenna signal)

GORS-III receiver:

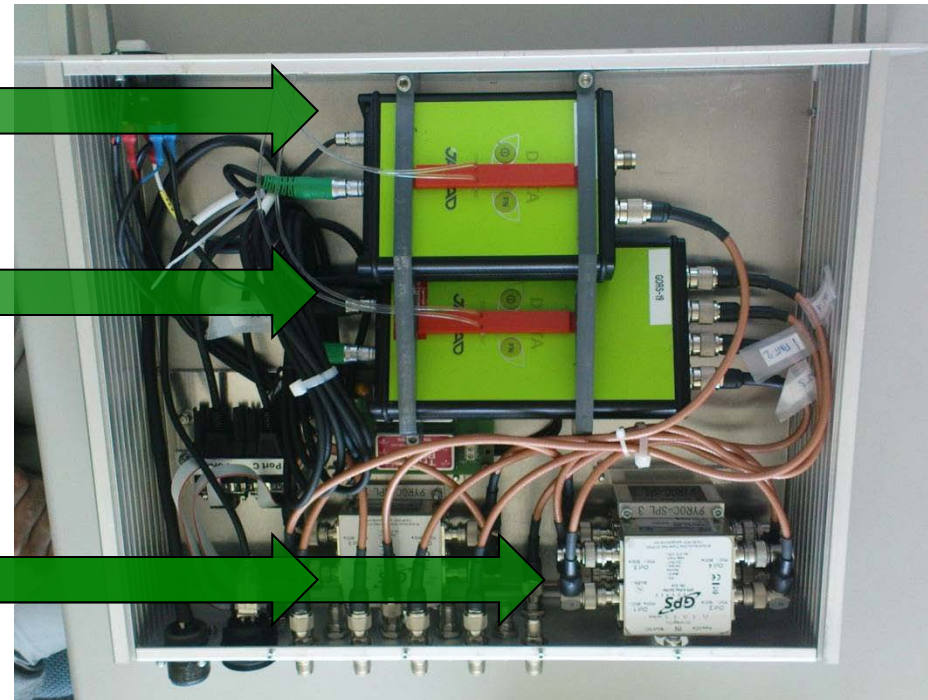
(zenith, RHCP and LHCP
horizontal and nadir signal)

4/1 Splitter:

(zenith and horizontal signals)

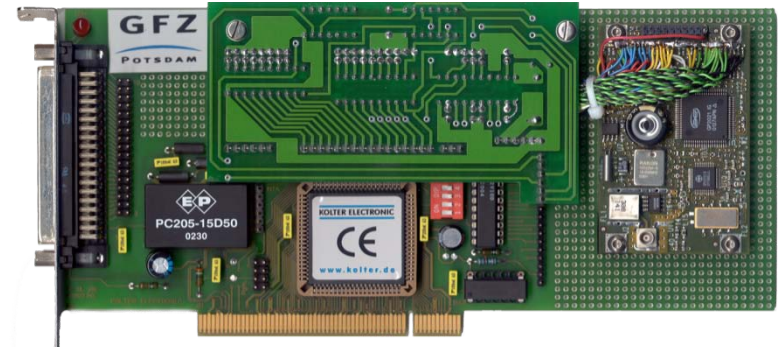
Power, data and antenna

connectors



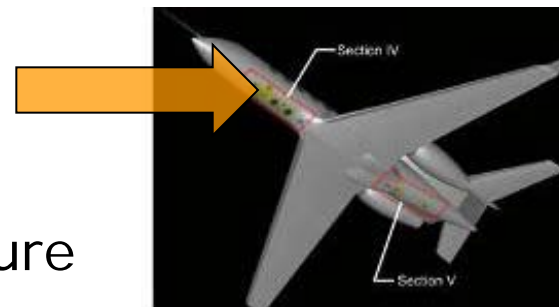
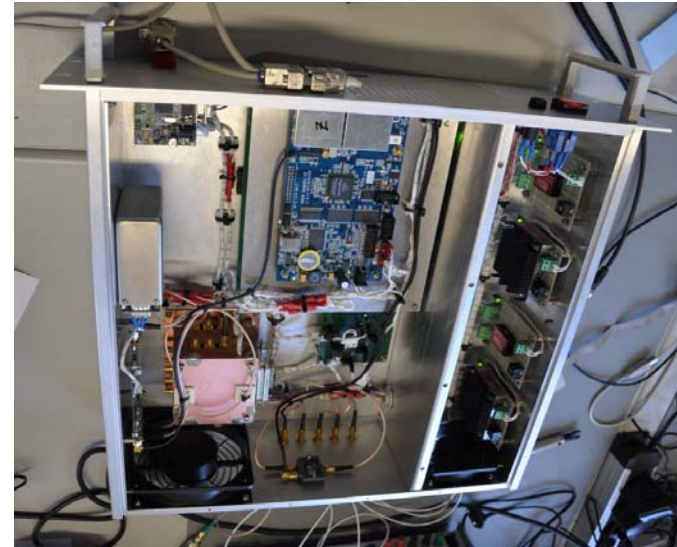
GFZ Instrumentation

- PC
GORS commanding
data storage on SSD
- OpenGPS
PC with GPS1001 receiver
ISA-board and GPS550
2 frontend extension
(GPS Creations)



DLR Instrumentation

- Receiver unit
 - Namuru V2 board
 - Altera Stratix III FPGA board
 - frontend boards
 - SD cards for data storage
 - rubidium clock
- Antenna array
 - 4 RHCP (ANTCOM) patch
 - antennas in bottom aperture



IEEC Instrumentation

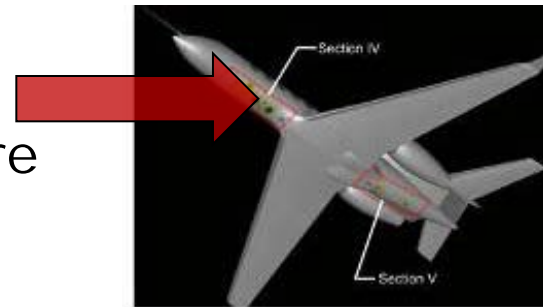
- GOLD-RTR-II
(developed by IEEC)



- PC
commanding and
data storage

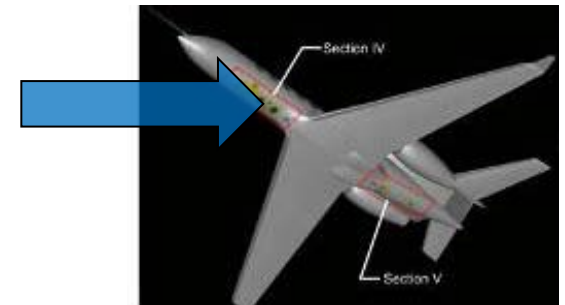
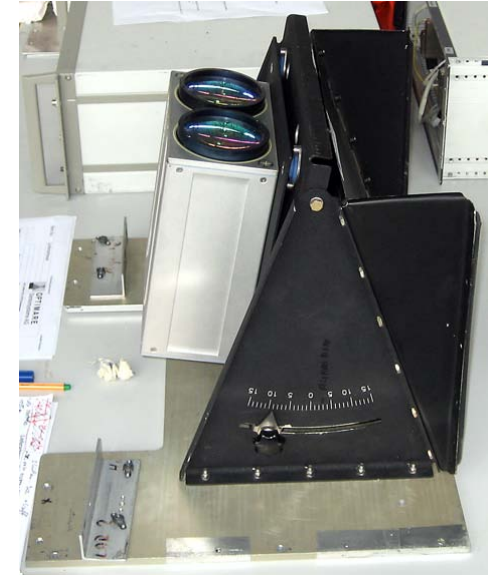


- Antenna
ANTCOM -42G1215RL-AA-XT-1
(RHCP/LCHP) in bottom aperture



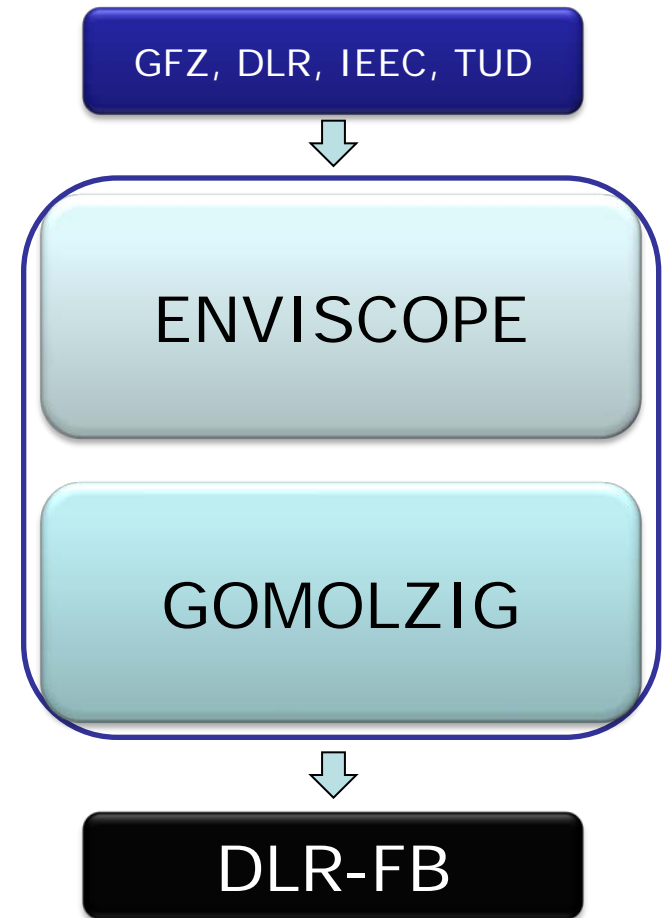
TUD Instrumentation

- Laser Altimeter
Riegl LD90-3800HiP altimeter
mounted behind downward view
port
- Rack unit
PC for data storage and Leica
GRX1200 GPS receiver connected
with HALO GPS antenna for
trajectory and timing



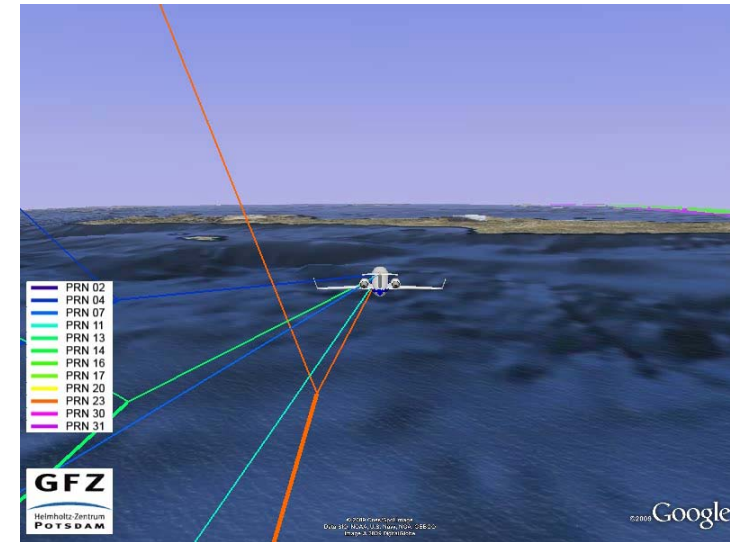
Certification Process

- Detailed experiment description
- Technical documentation
- Physical and electrical tests
- Certificate by LBA (German administration for air traffic)
- Mission certification by DLR
- Mission (2011/2012)



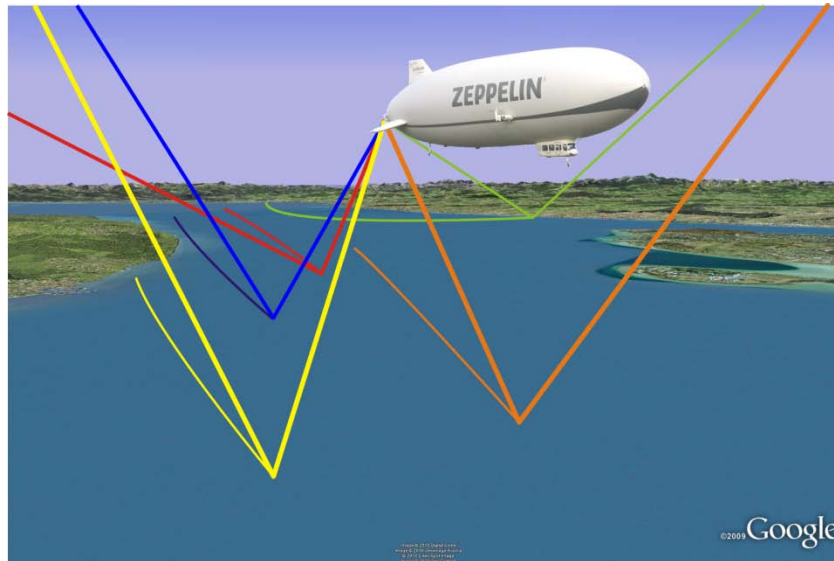
Scientific Observables

- Radio Occultation:
 - > atmospheric sounding / refractivity
(water vapour, temperature, ...)
- GNSS-Scatterometry:
 - > sea state (wind speed/direction)
- GNSS-Reflectometry (coherent and incoherent):
 - > sea surface height / altimetry
- Laser Altimetry:
 - > sea surface height (reference for GNSS-R altimetry)



ZOIS

(Zeppelin Occultation Interferometry Scatterometry)

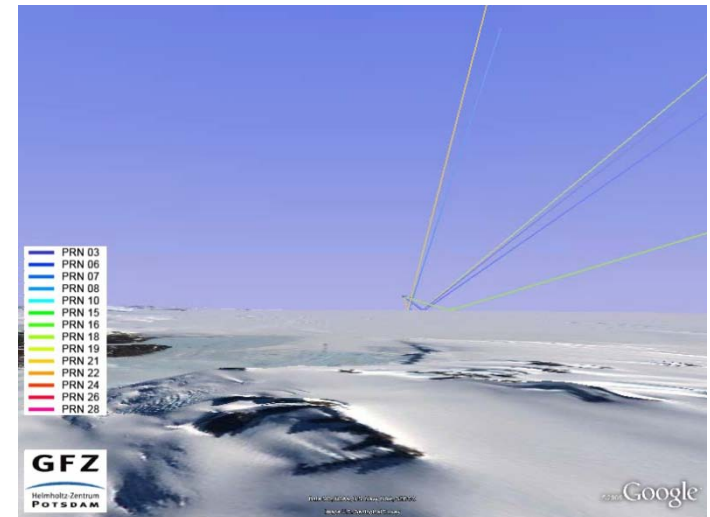


GNSS-R measurements by GFZ and DLR over Lake Constance on board of the Zeppelin NT in October 2010. Zenit and horizontal antennas at rear engine, nadir antenna array at cabin.

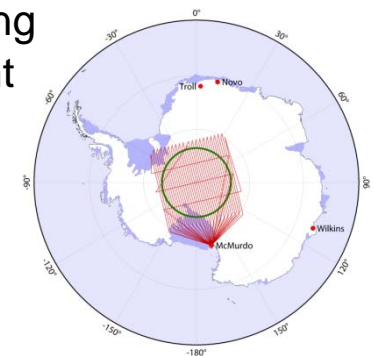


ANTHALO

- ANTHALO-PF:
Measurement of gravimetric and magnetometric potential fields
- ANTHALO-ROC:
GNSS reflectometry/scatterometry and atmospheric sounding
- ANTHALO-RES:
Radio echo sounding to measure ice sheet depth



Simulation of GNSS reflections reaching HALO during flight over central Antarctica



Thank you for your attention

