Space Weather

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24.11.2010

Wetterbericht & Vorhersagen

Schweiz - Europa

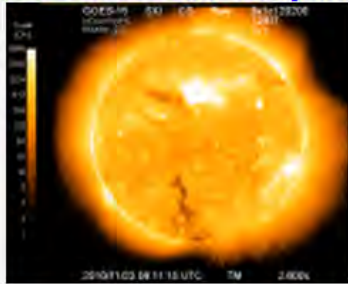
http://www.meteoschweiz.admin.ch/
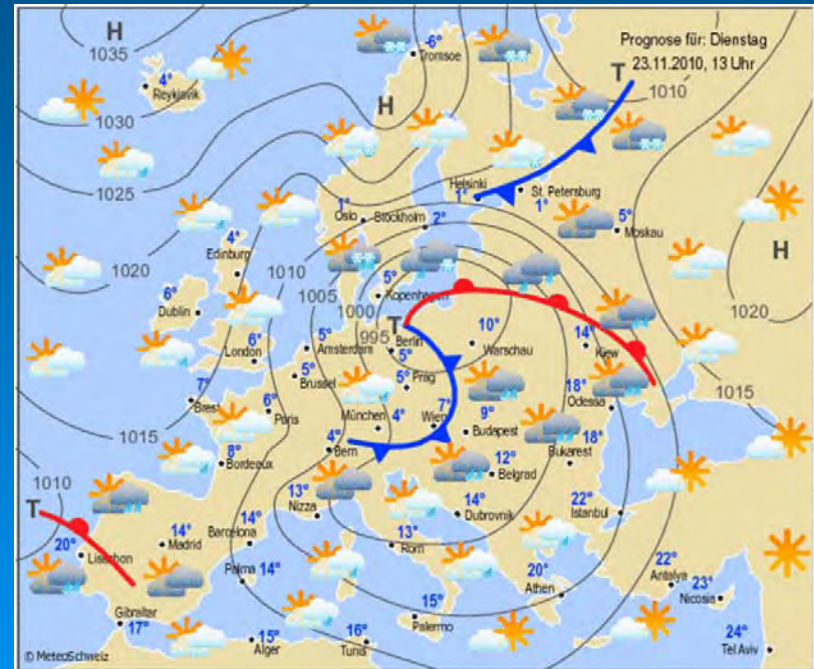
Von Mittwoch bis Samstag oft stark bewölkt und zeitweise Schneeschauer, vor allem am Donnerstag. Dazwischen auch Aufhellungen, besonders am Mittwoch sowie am Freitag und Samstag. Temperatur von 4 Grad allmählich gegen 0 Grad sinkend.

Wetterbericht & Vorhersagen

Weltraum

**Latest GOES Solar X-ray Image**

Alerts / Bulletins
Latest Alert: Nov 20 1150 UTC CONTI
Electron 2MeV Integral Flux exceeded
Last Advisory Bulletin: None in last 7 d
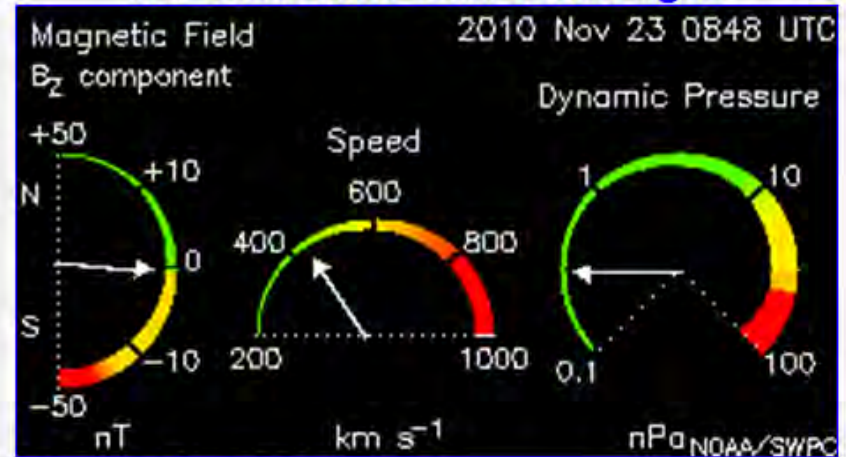
http://www.swpc.noaa.gov/SWN/

http://www.nict.go.jp/

Space Weather Forecast
This page announces the latest information on Space Weather such as solar flares, magnetic storms and aurora activity, etc.

Solar Activity: Quiet
Ionosphere: Quiet
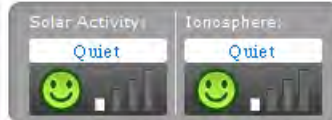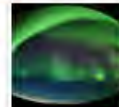
ACE Real-Time Solar Wind Pages
Magnetic Field B_z component — 2010 Nov 23 0848 UTC
Speed
Dynamic Pressure
erage over last 15 minutes
10 frames/sec
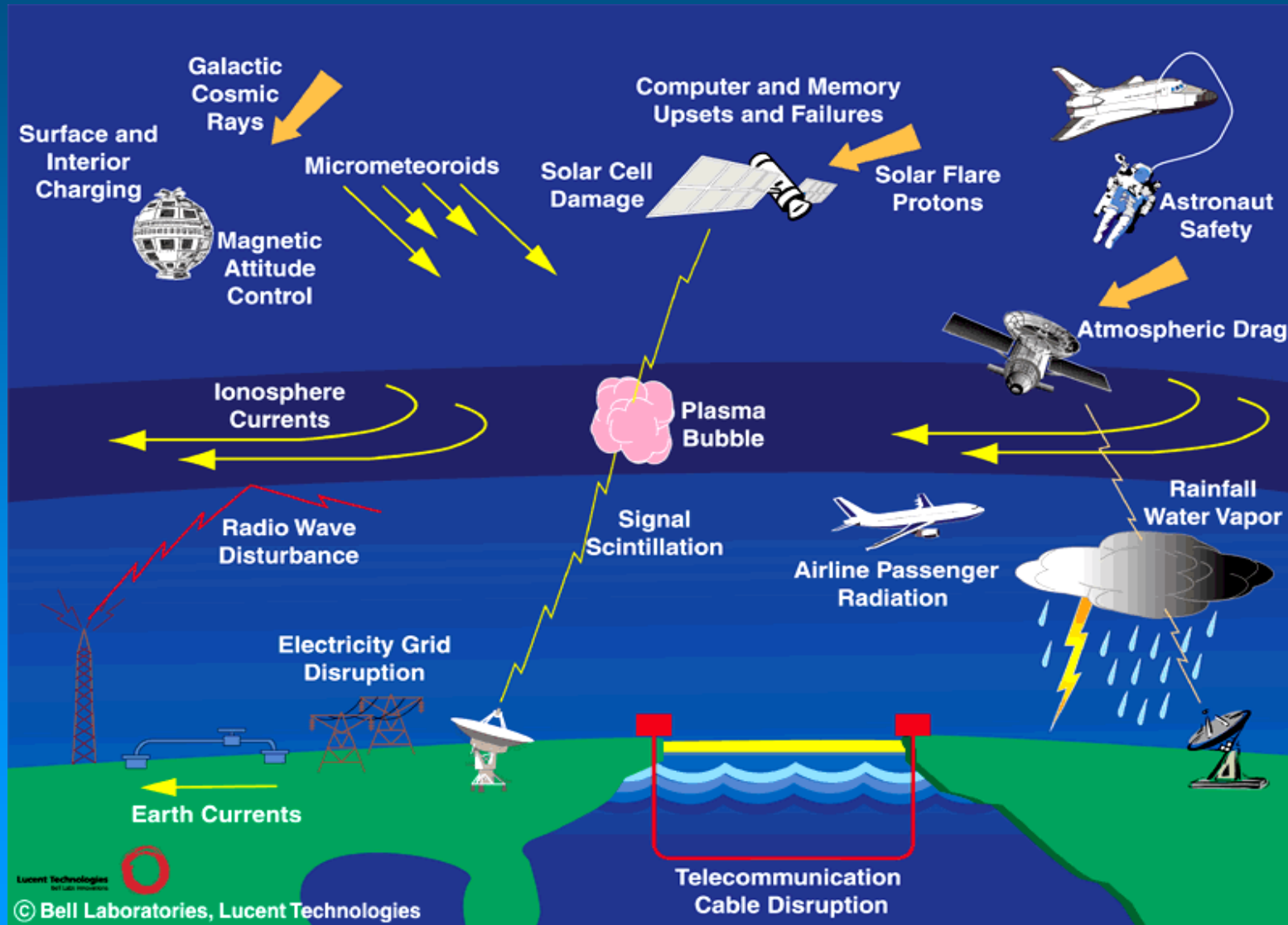NOAA/SWPC

24-hour Forecast:
Solar Activity: Solar activity is expected to be very low for the next three days (23-25 November).
Geophysical Activity: The geomagnetic field is expected to be mostly quiet for the next three days (23-25 November).
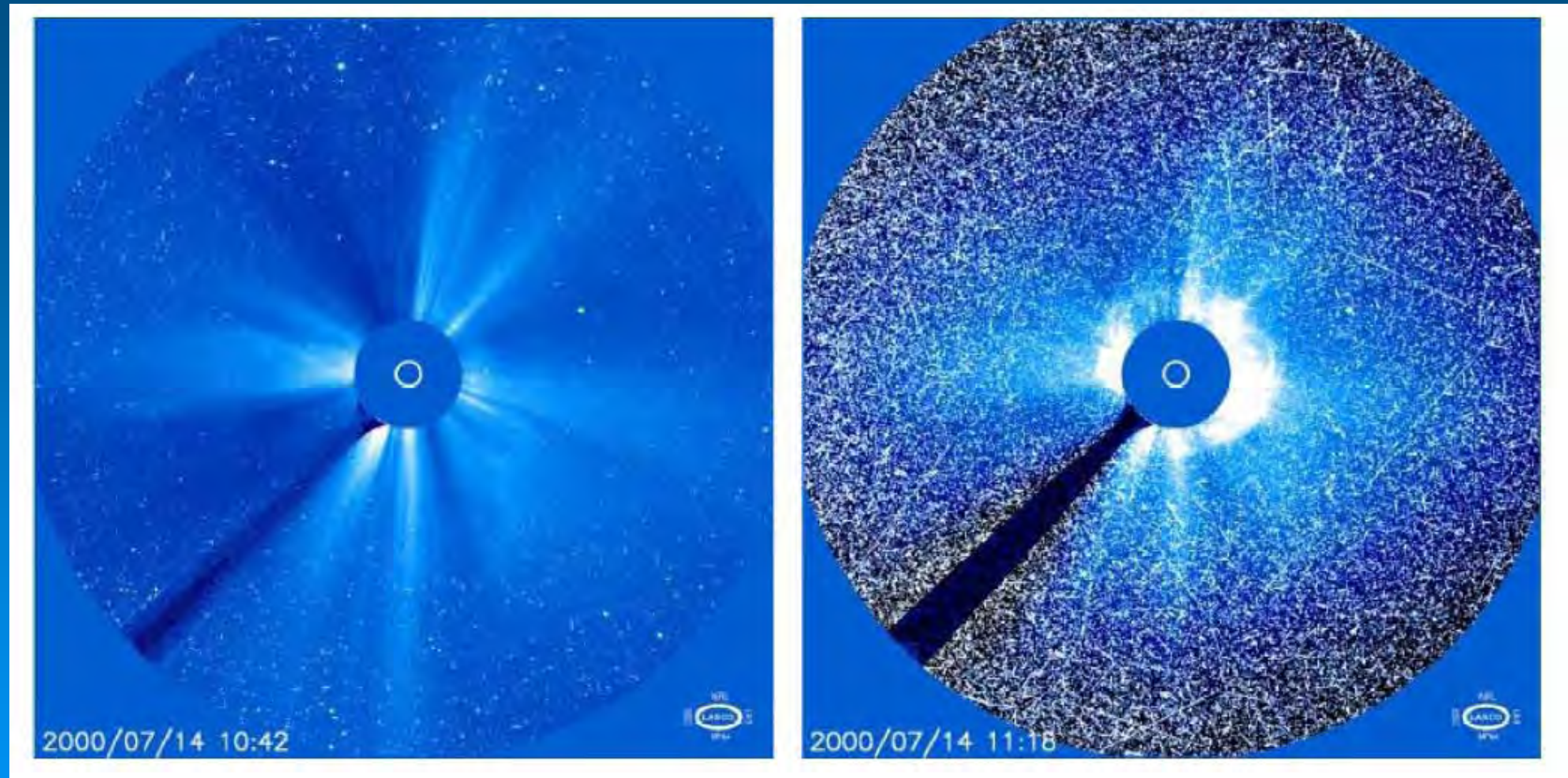
Nordlichter - Aurorae

Effekte auf technische Systeme

Galactic Cosmic Rays

Surface and Interior Charging

Magnetic Attitude Control

Micrometeoroids

Computer and Memory Upsets and Failures

Solar Cell Damage

Solar Flare Protons

Astronaut Safety

Atmospheric Drag

Ionosphere Currents

Plasma Bubble

Rainfall Water Vapor

Radio Wave Disturbance

Signal Scintillation

Airline Passenger Radiation

Electricity Grid Disruption

Earth Currents

Telecommunication Cable Disruption

Lucent Technologies

© Bell Laboratories, Lucent Technologies

Effekte: Satellitenelektronik

2000/07/14 10:42

2000/07/14 11:18

Bilder des LASCO Coronographs auf SOHO während des „Bastille-Ereignisses" 2000

Brekke et al., 2004

Effekte: Sonnenkollektoren
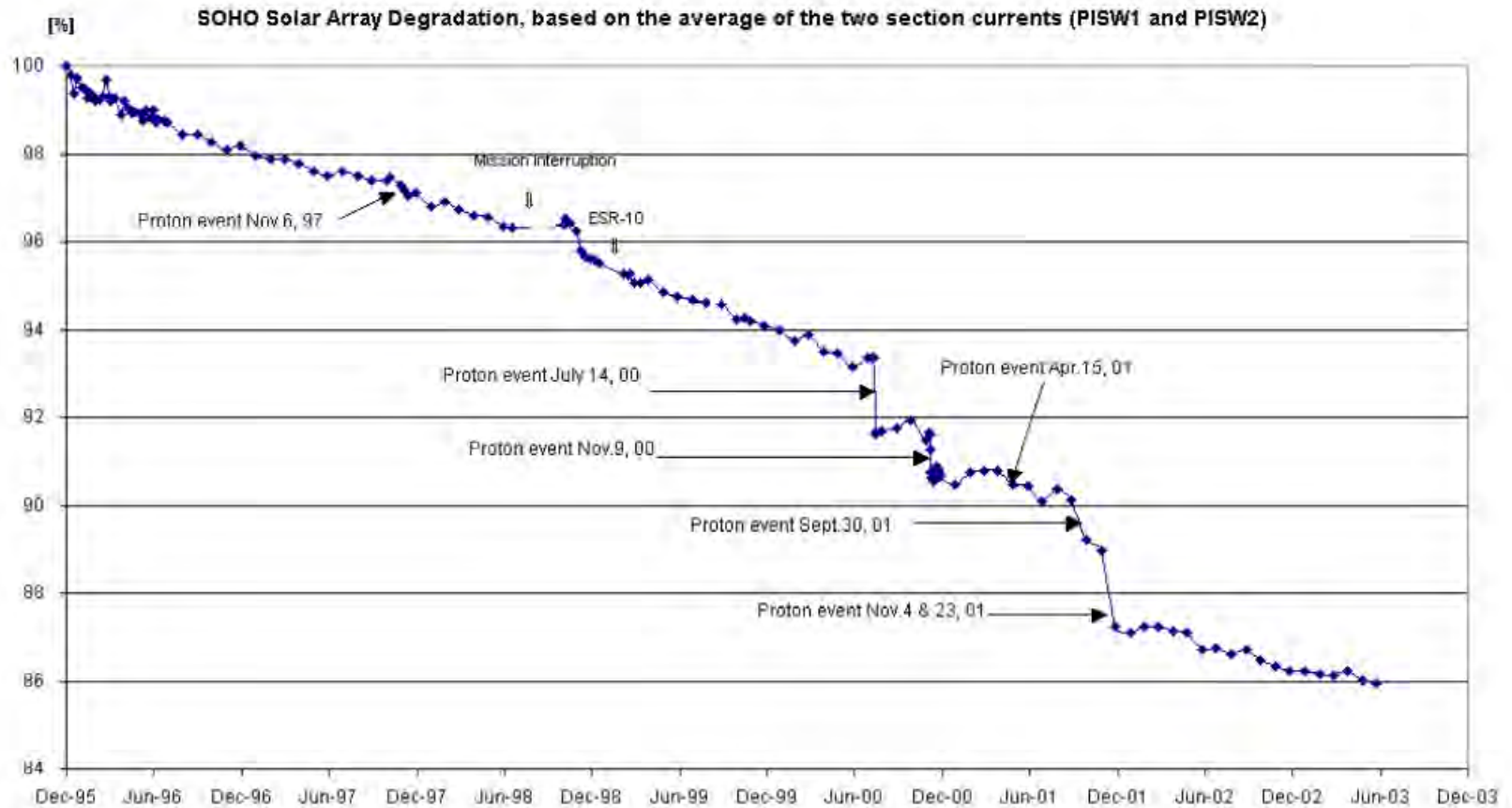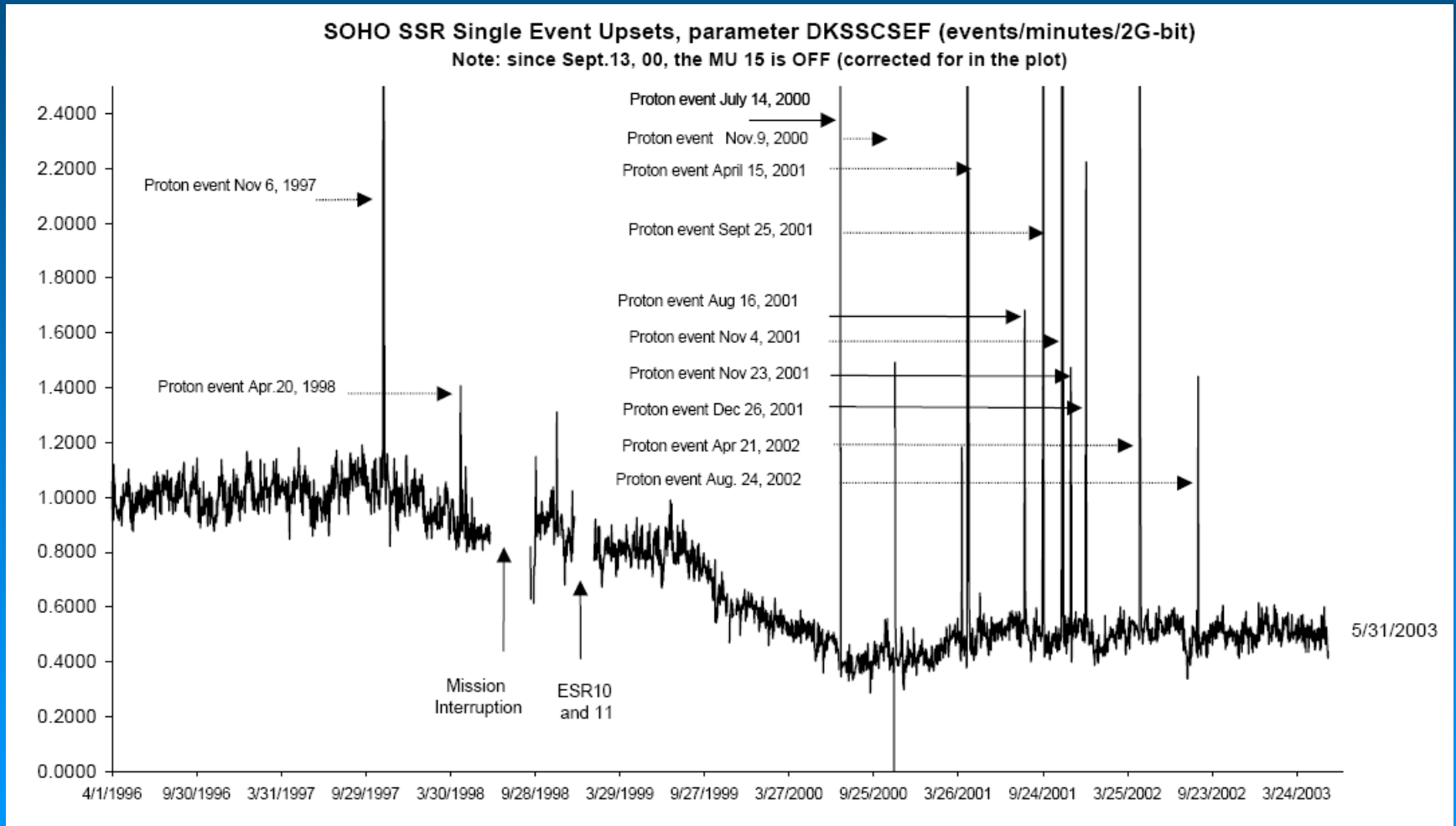

Figure 3. SOHO solar array degradation since the launch in 1995. The drop in sensitivity due to individual proton events is evident.

Brekke et al., 2004

Effekte: Bordcomputer

Brekke et al., 2004

Effekte: Verlust von Satelliten

Was ist also Space Weather?

„The conditions on the sun and in the solar wind, magnetosphere, ionosphere, and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and endanger human life or health."

US National Space Weather Programme

„Space weather is the physical and phenomenological state of natural space environments. The associated discipline aims, through observation, monitoring, analysis and modelling, at understanding and predicting the state of the sun, the interplanetary and planetary environments, and the solar and nonsolar driven perturbations that affect them; and also at forecasting and nowcasting the possible impacts on biological and technological systems."

COST Action 724

Die Ursache(n)
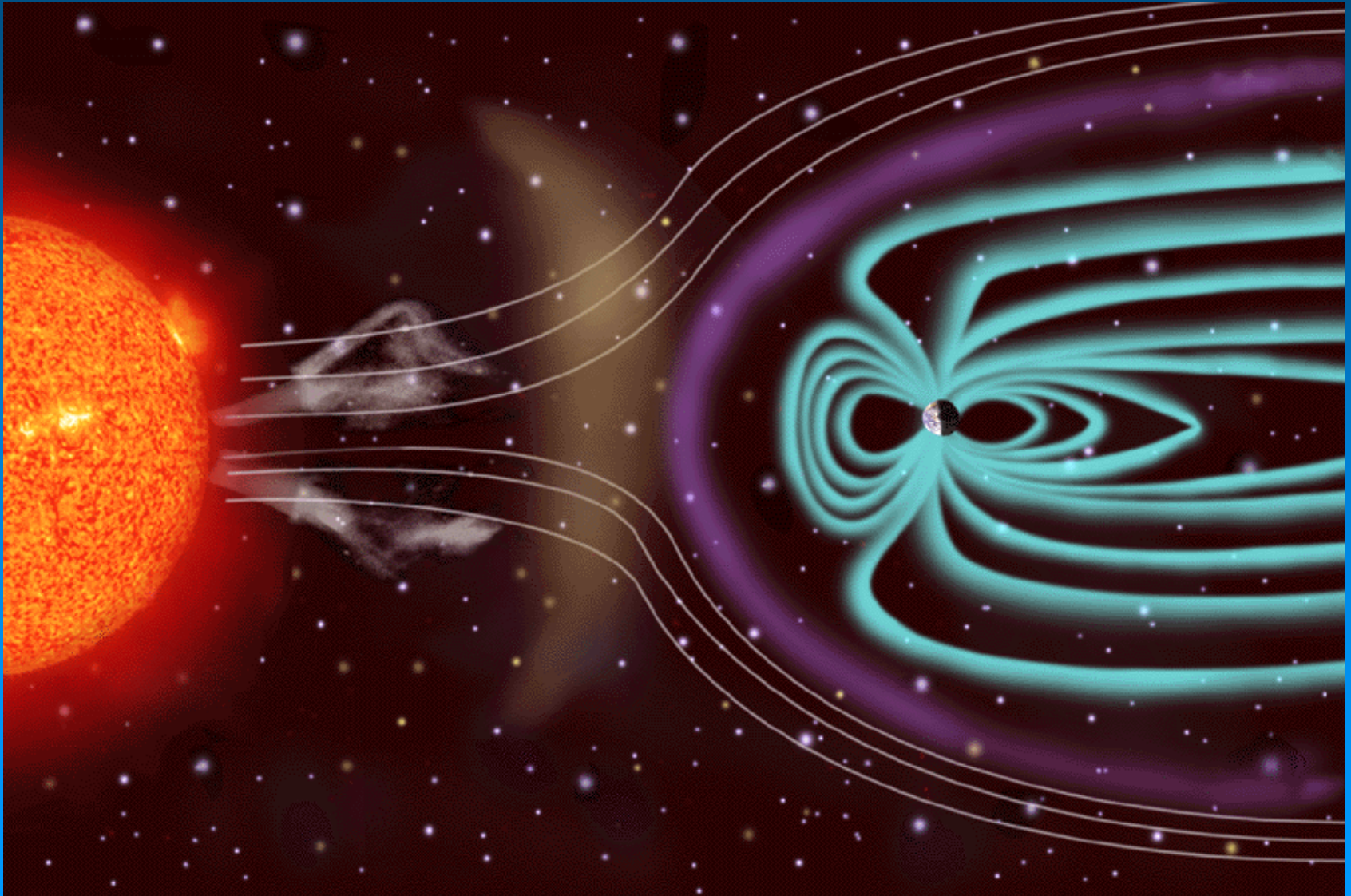
Die Ursache: Sonnenaktivität

http://sohowww.nascom.nasa.gov/gallery/Movies/10th/   (Spectacular.mpg)

Solar-Terrestrische Kopplung

http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=44721
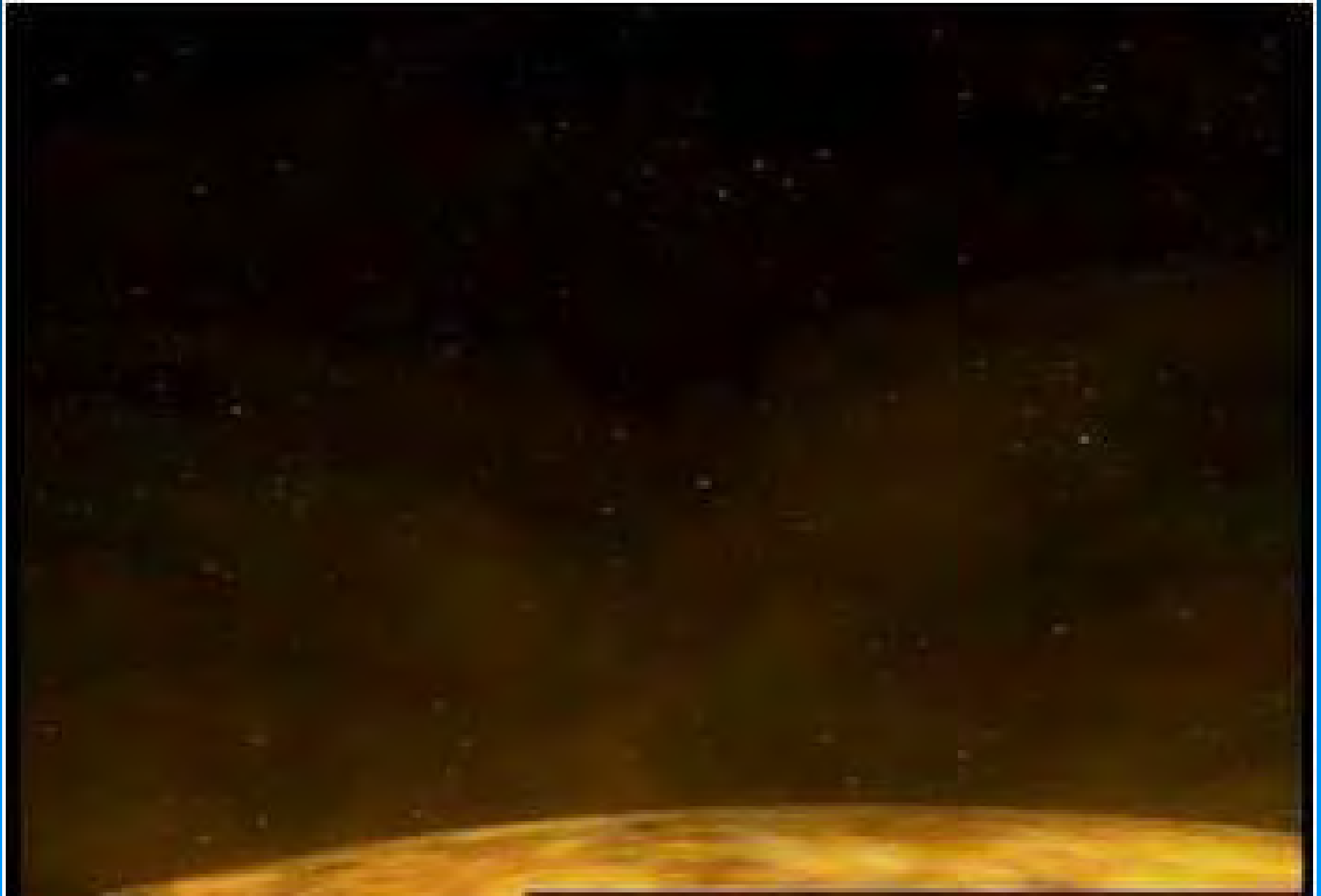
Solar-Terrestrische Kopplung
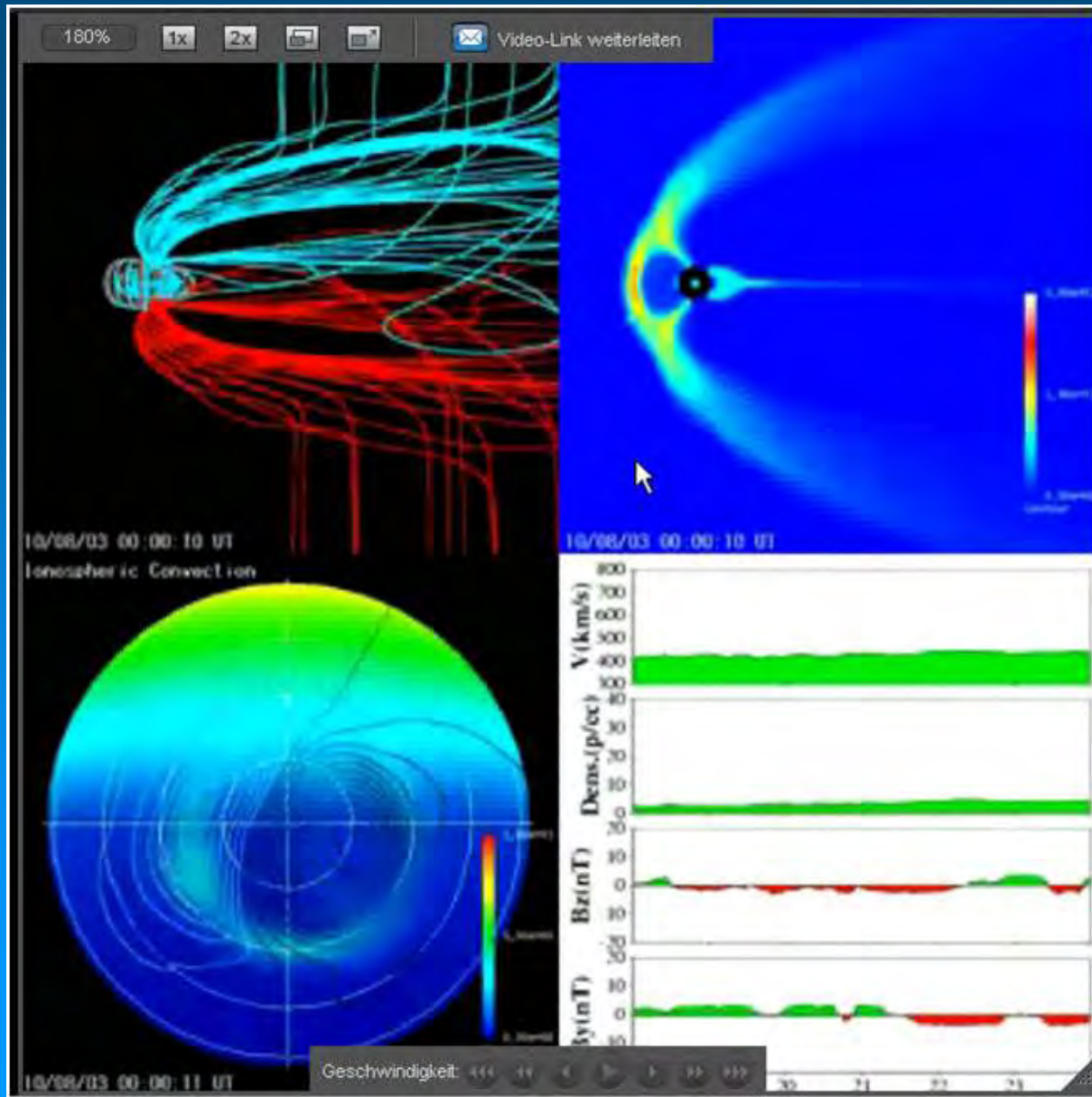
Solare Flares
Eigenschaften: Fluss/Zeit-Profile
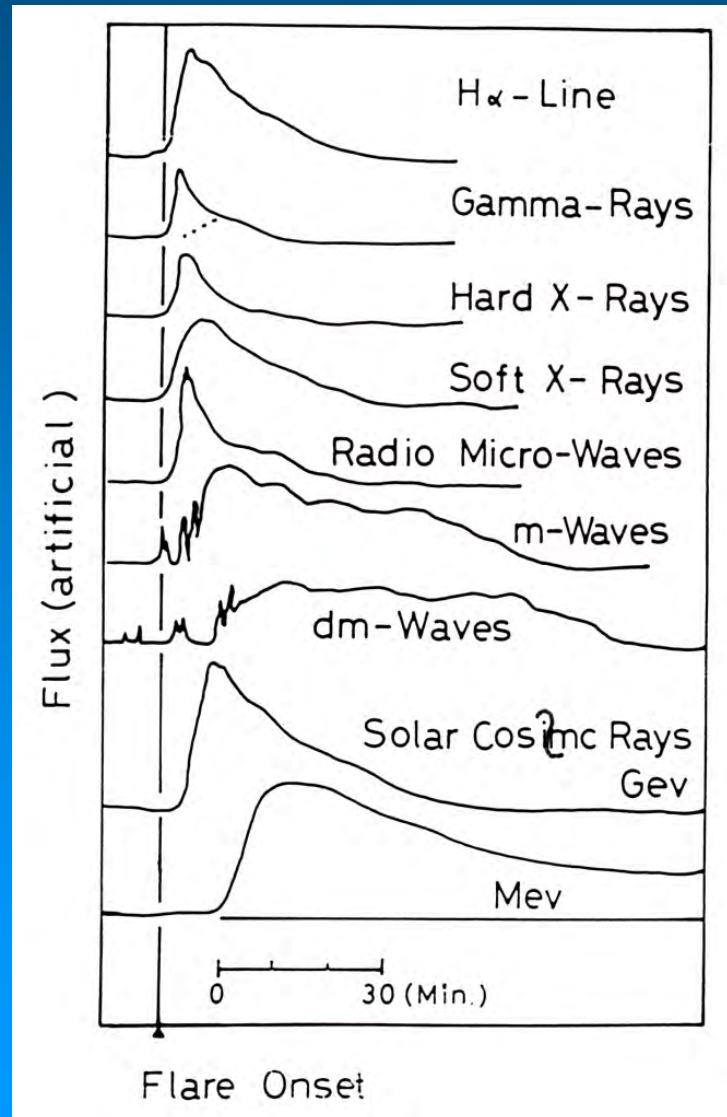
Sakurai, 1989

Solare Flares
Eigenschaften: Häufigkeit – Sonnenzyklus
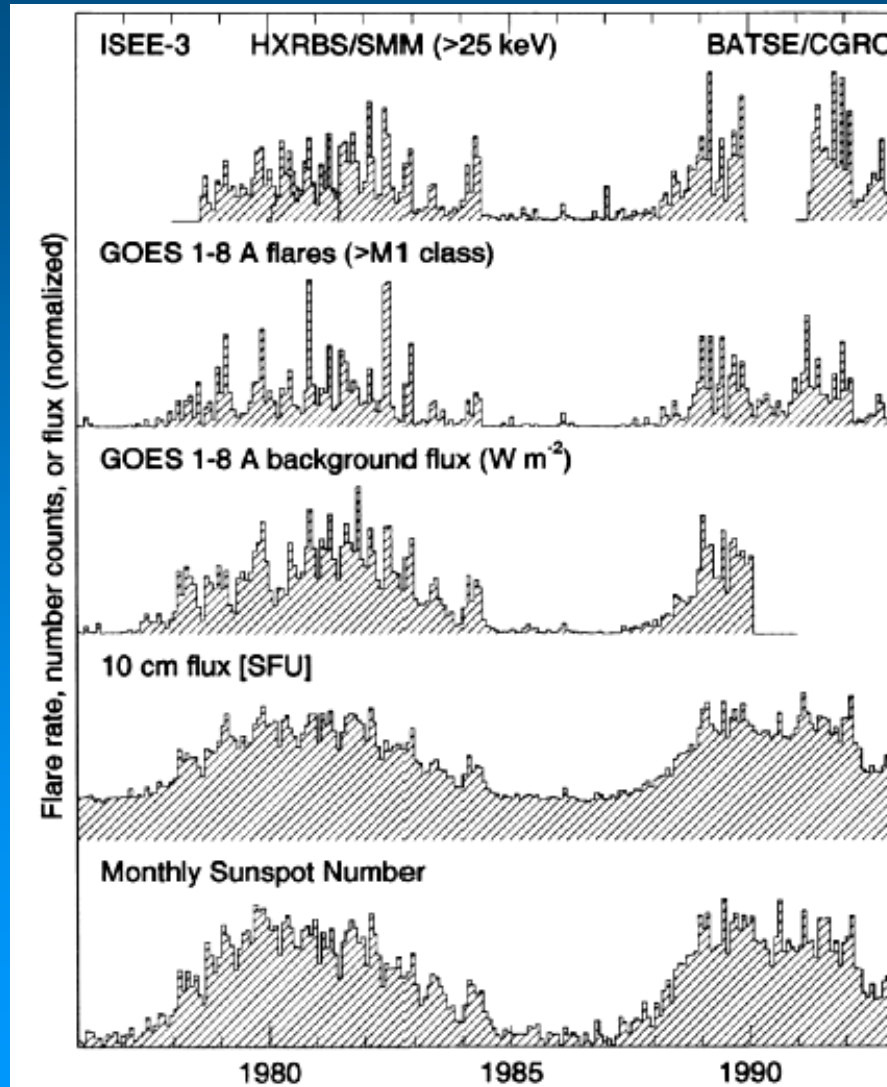
from Aschwanden, 1994

Sonnenfleckenaktivität

1991-2001

Smoothed Sunspot Number
Monthly Averages

Cycle 19   Cycle 20   Cycle 21   Cycle 22   Cycle 23

McMurdo, Antarctica, Neutron Monitor
Bartol Research Institute, University of Delaware
27-day Averages - data through April 2007

RP, May 2007
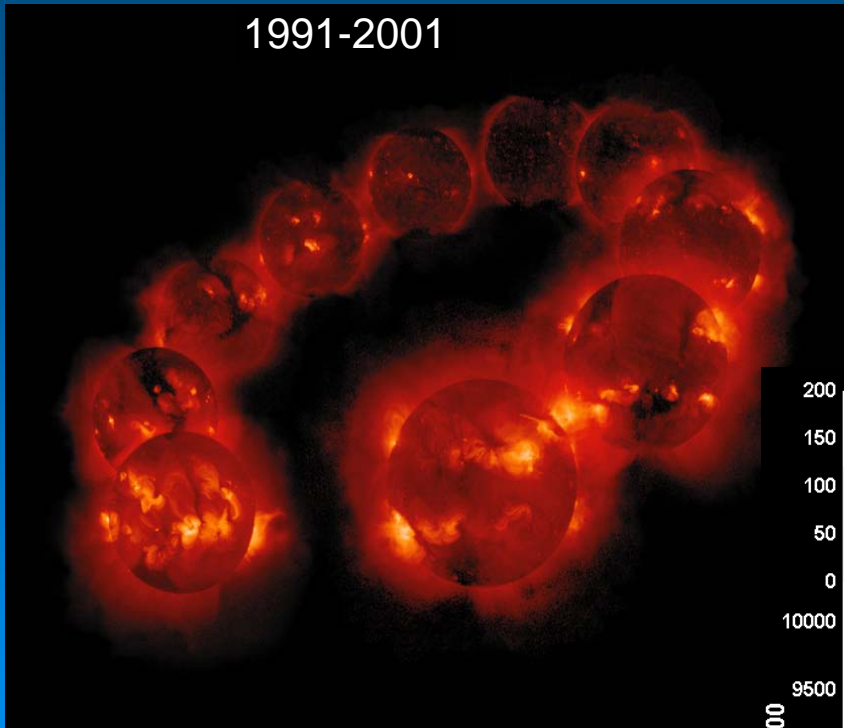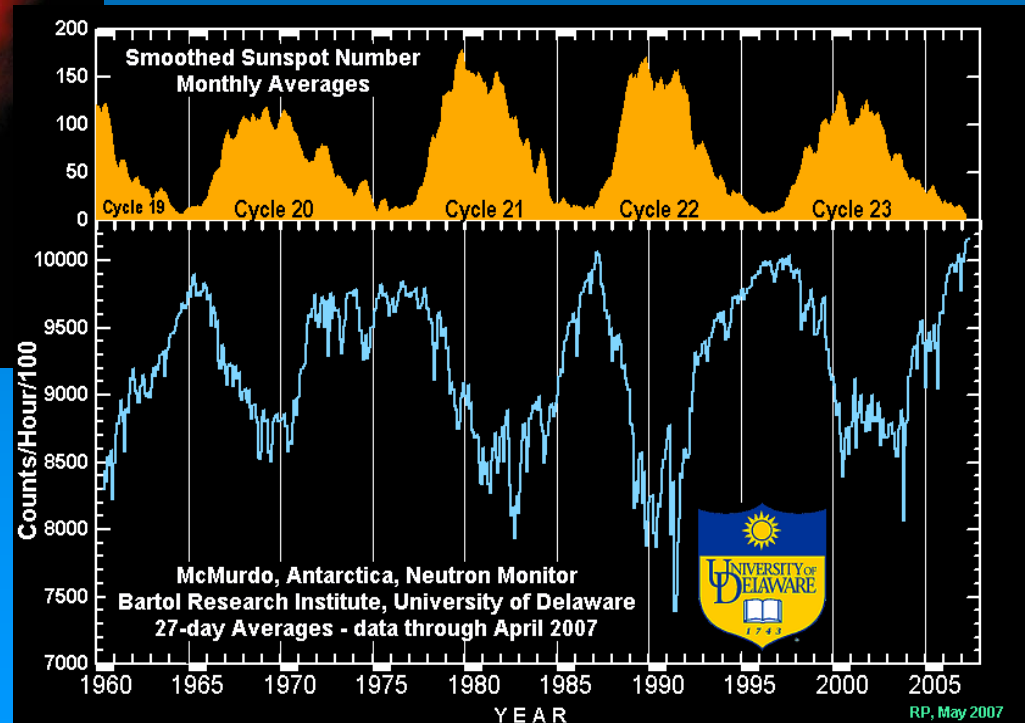
Detailliertes Beispiel 1:

Stahlenbelastung in Flugzeugen

Siehe auch: *http://kspc22.unibe.ch/*

Beitrag der Kosmischen Strahlung zur Strahlendosis
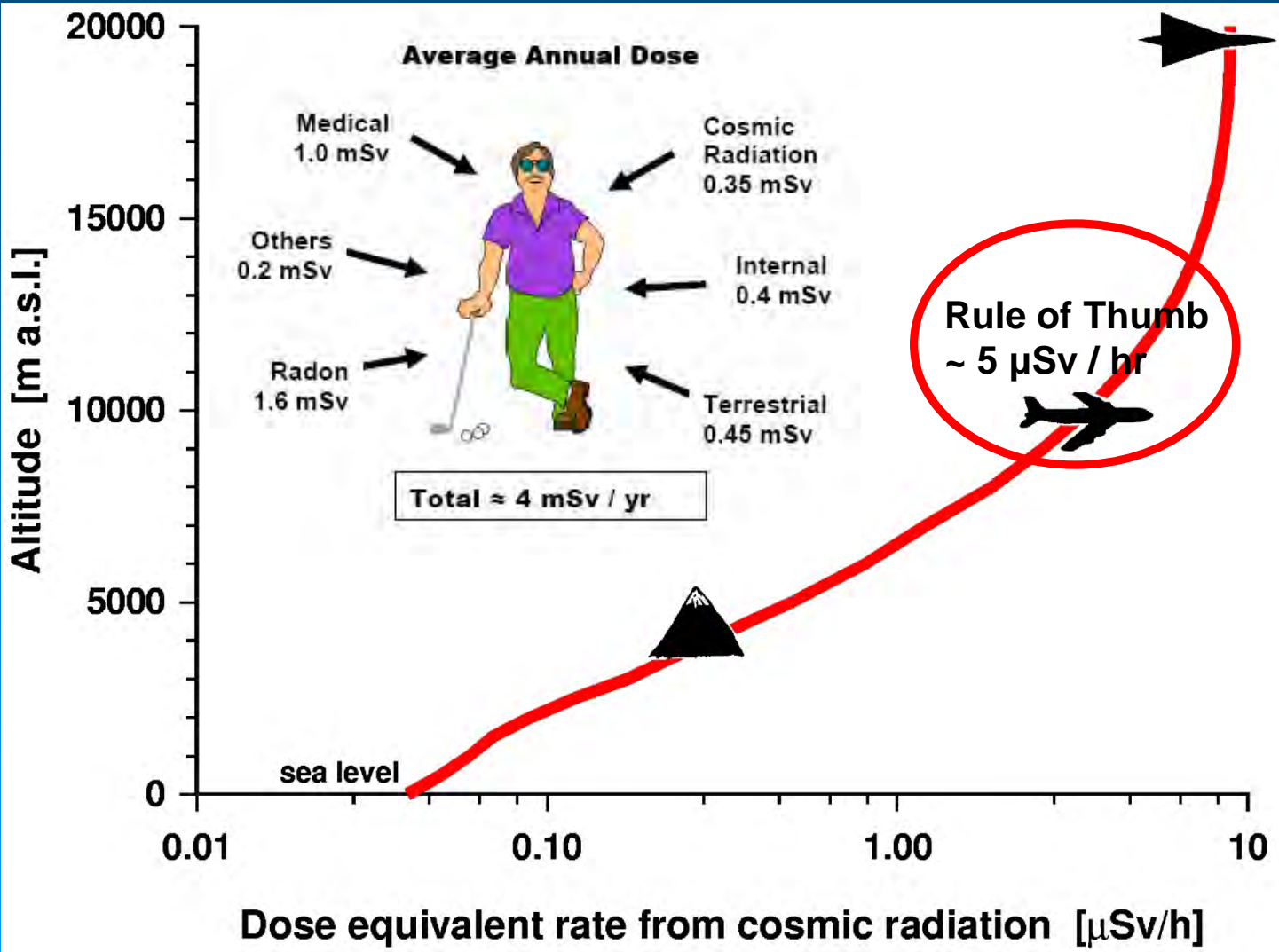
Strahlenbelastung in Flugzeugen
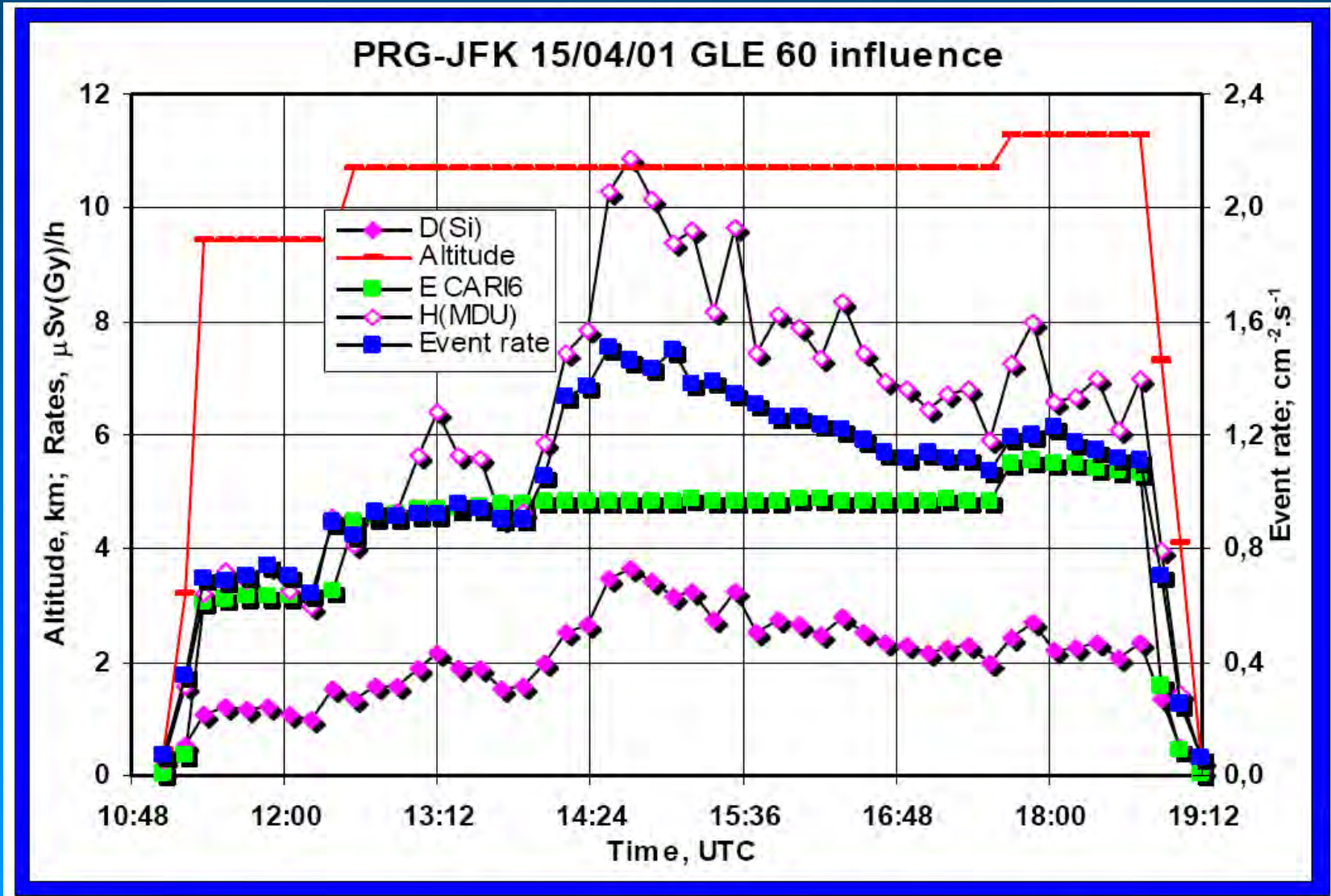
LIULIN measurements of GLE 60 during PRG-JFK flight

Beck et al., 2006

Das Solar Particle Event vom 13. Dezember 2006
Strahlenbelastung in Flugzeughöhe

Flückiger et al., ICRC 2007 Workshop

Das Solar Particle Event vom 13. Dezember 2006 Strahlenbelastung in Flugzeughöhe

Flückiger et al., ICRC 2007 Workshop
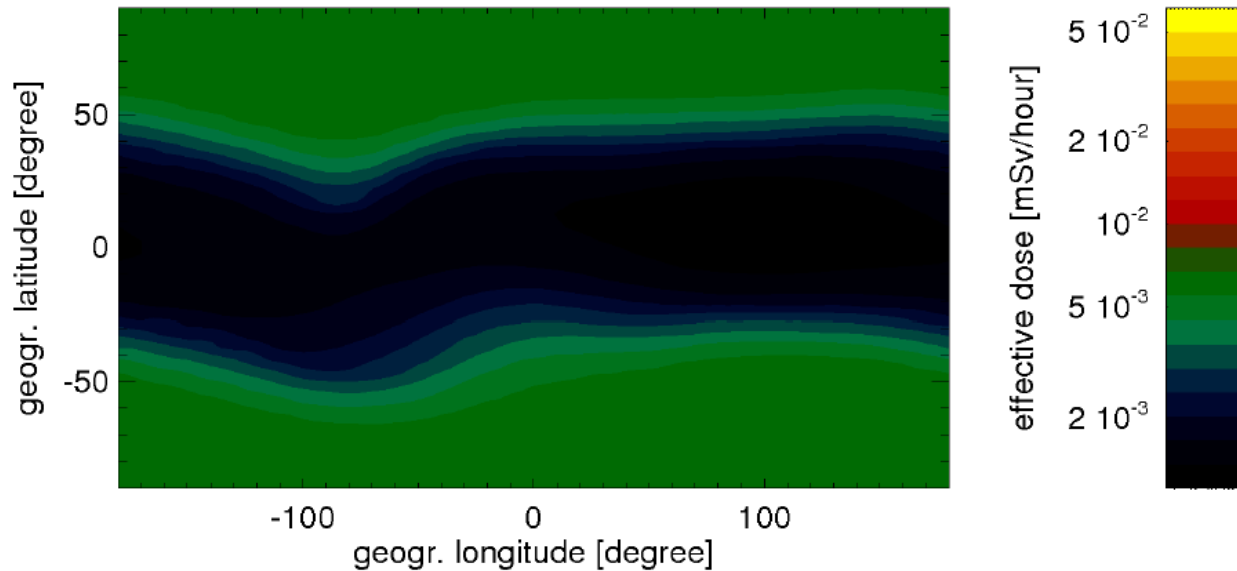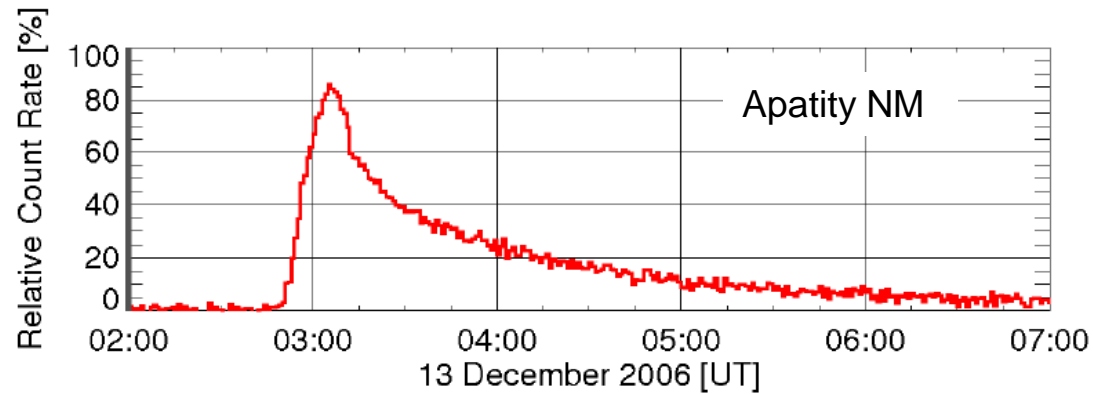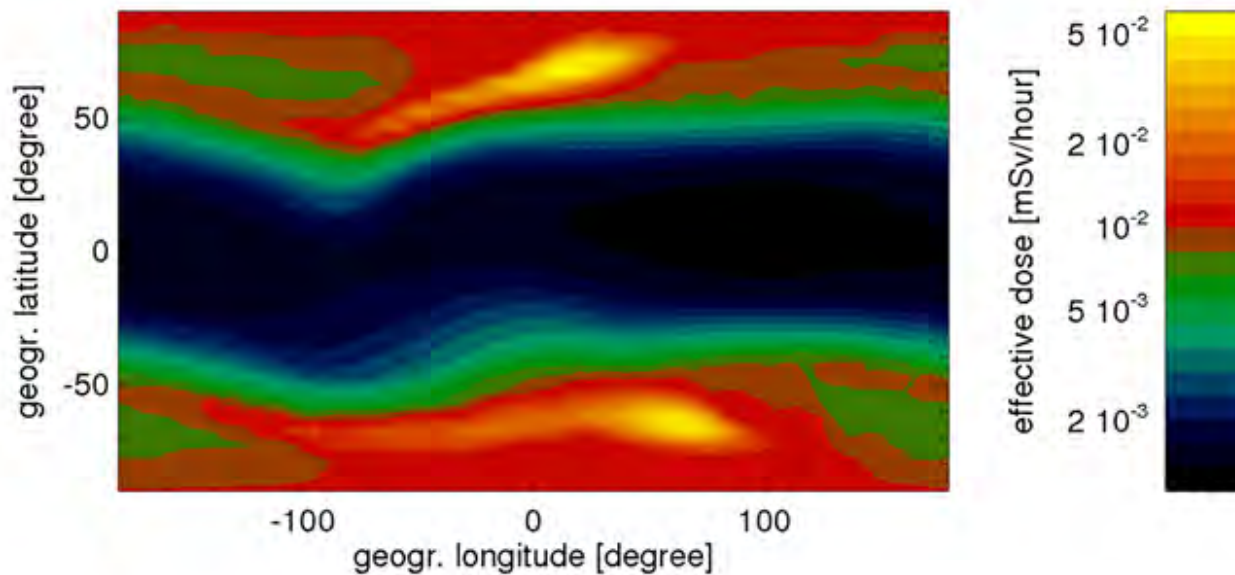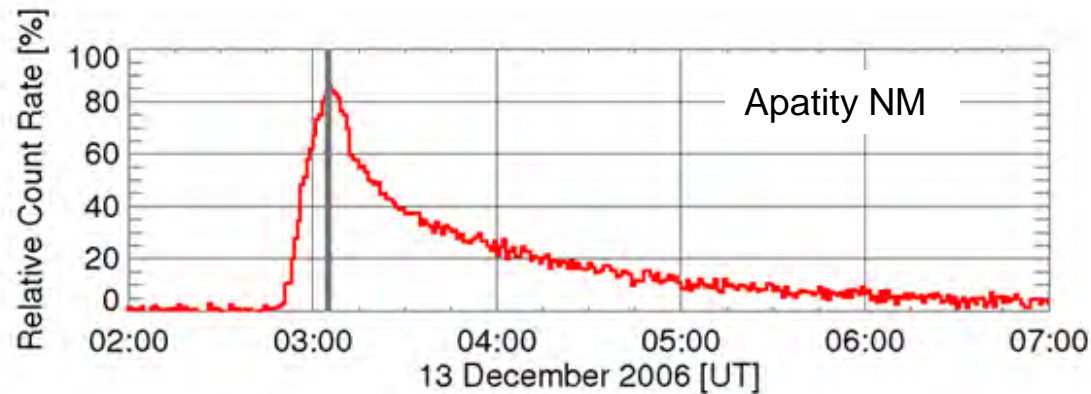
Detailliertes Beispiel 2:

Ionisation in der Atmosphäre
Ionosphärische Effekte
Radiokommunikation
Satellitennavigation

Ionen-Produktion in der Erdatmosphäre

Electromagnetic Radiation
UV & X-ray

GCR

Magnetospheric Particles

SCR

Geomagnetic Storms

Radioactive Constituents

Lightning
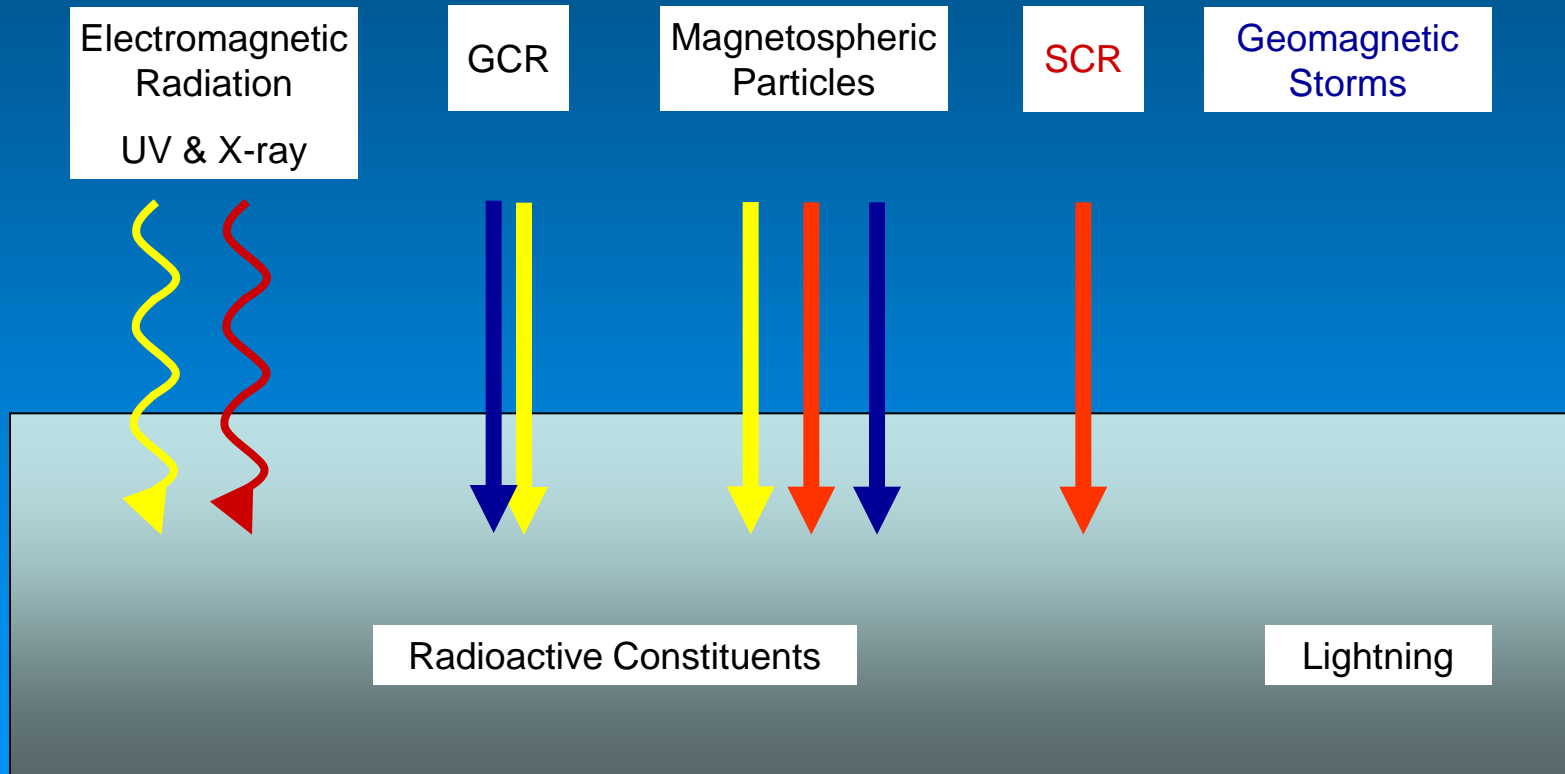
Oberhalb ca 50 km: UV/Röntgen-Strahlung

~3 to 35 km: Kosmische Strahlung

Ionisation durch GCR
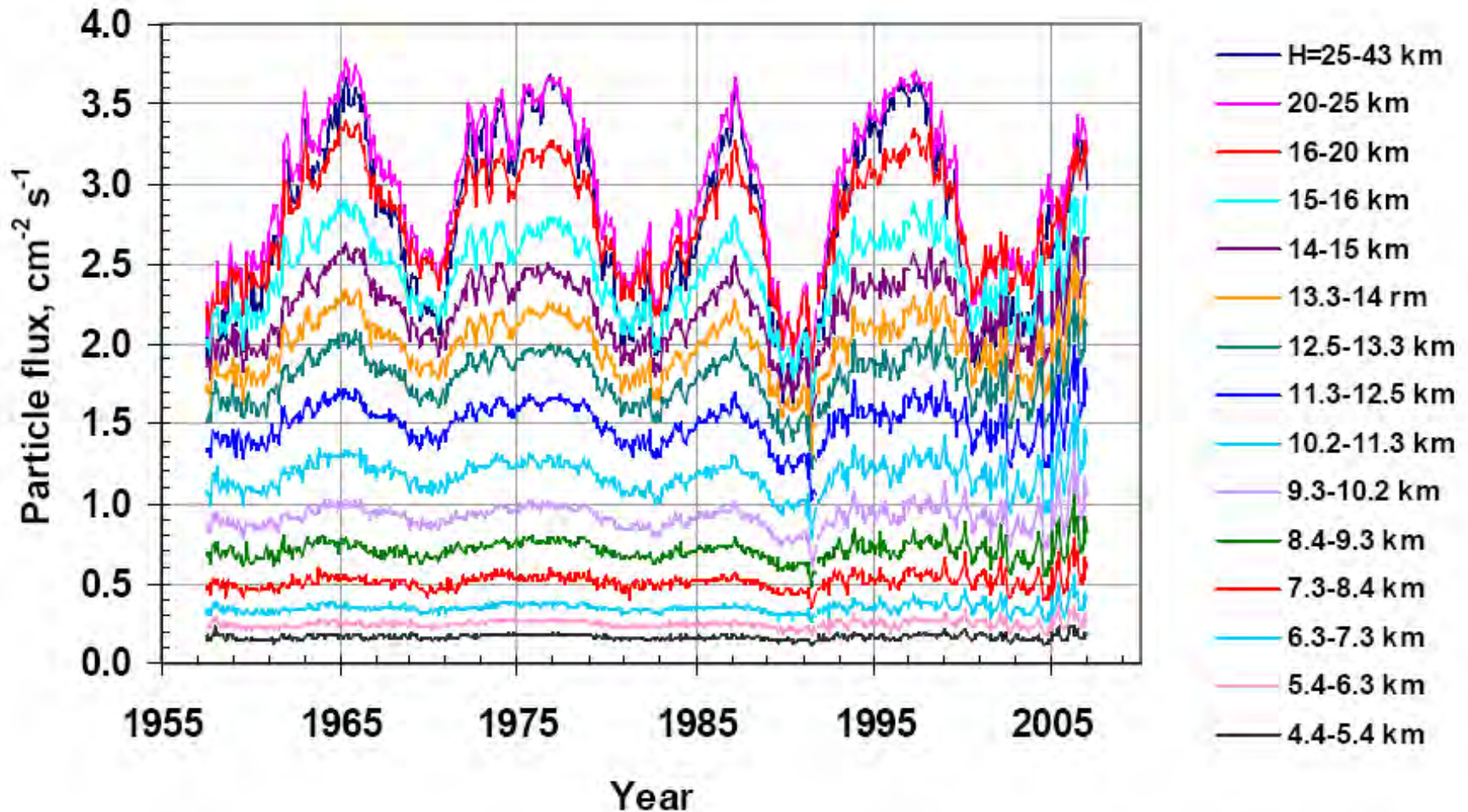
Monthly averaged fluxes of ionizing particles in the atmosphere over Murmansk region as measured by an omnidirectional Geiger counter

Bazilevskaya et al., 2007&2008

Ionisation durch GCR & SCR

Bern Model: *http://cosray.unibe.ch/~laurent/planetocosmics*

Desorgher et al., AOGS 2004
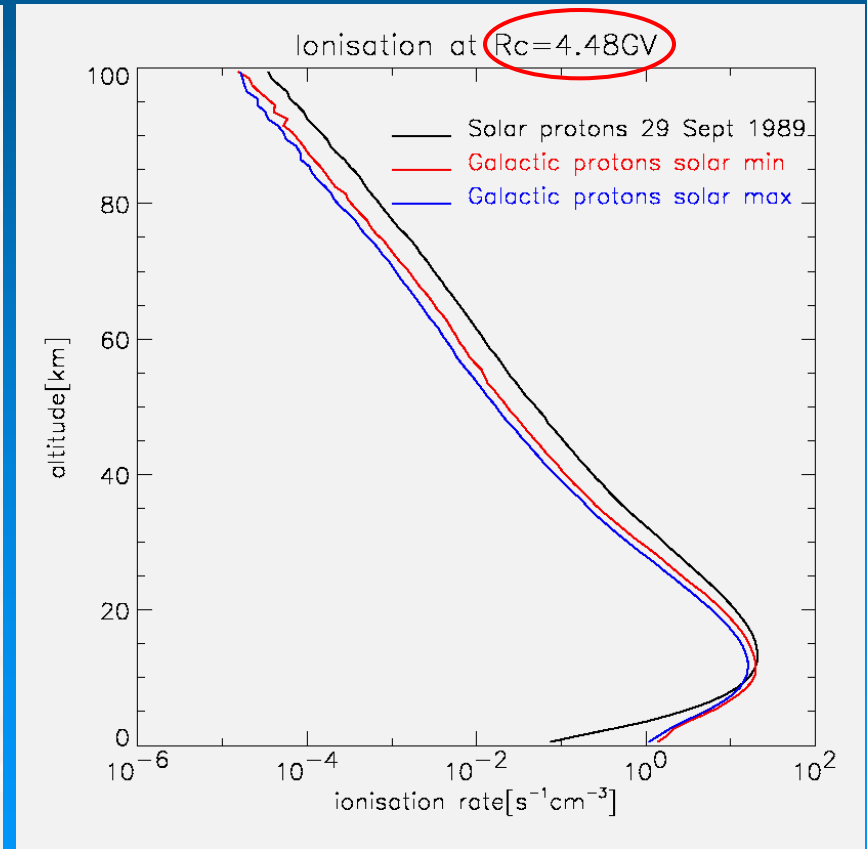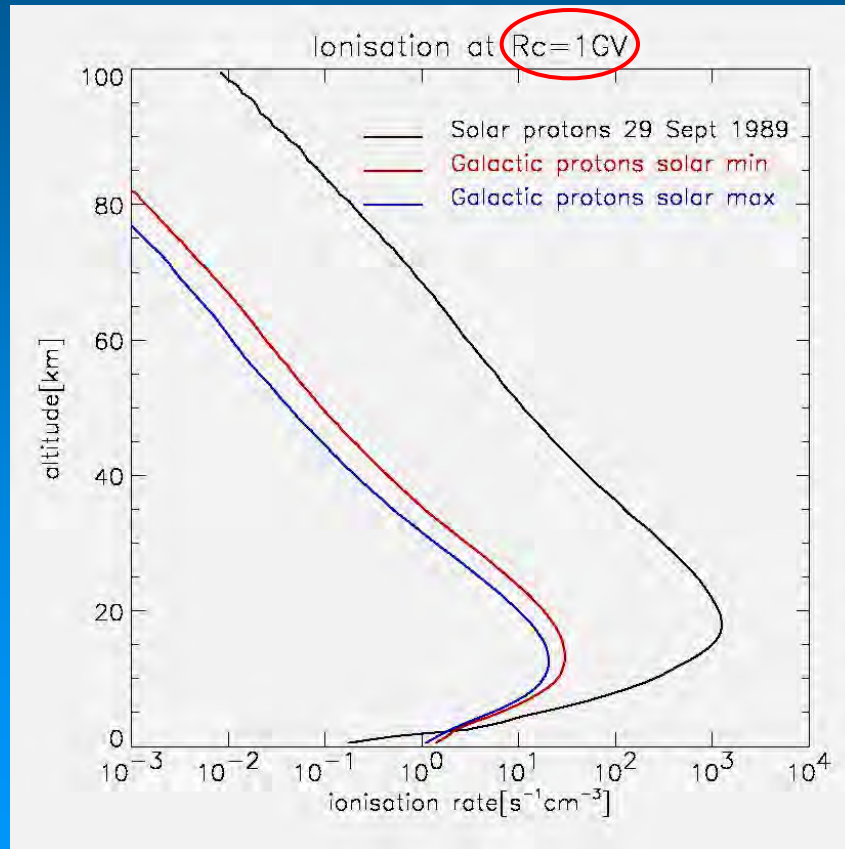
Ionospheric Effects on Radio Applications
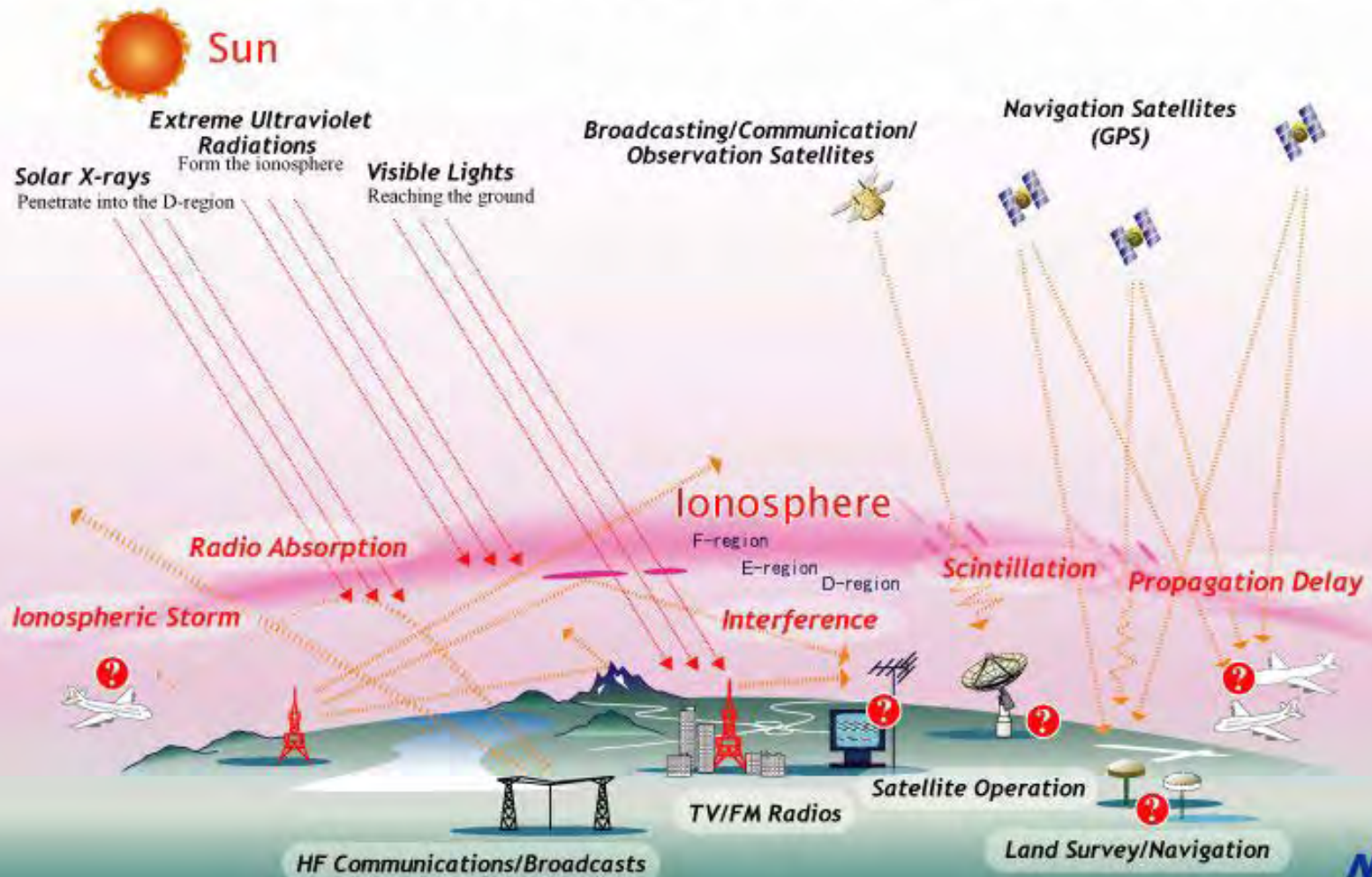
Space Weather Effekte auf Satellitenkommunikation

ORBIT Variation
due to drag (especially on LEO sats)

RADIATION
•Spacecraft electronics (especially on HEO sats)

Mobile links
f < 3 GHz

IONOSPHERE
•Scintillations
•Faraday rotation

Fixed links
f > 4 GHz

no effect

B. Arbesser-Rastburg; Alpbach 2002 Summer School
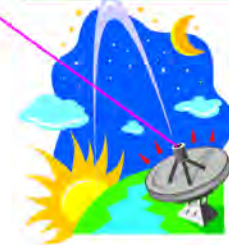
Space Weather Effekte auf Satellitennavigation
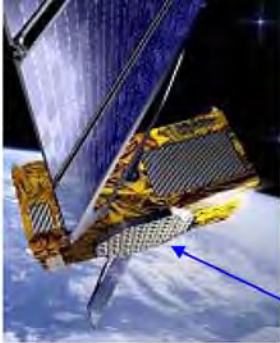
RADIATION
- Spacecraft electronics
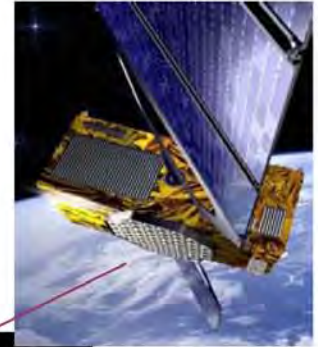
IONOSPHERE
- **TEC variations** affect position for single frequency receivers (UERE budget)
- **TEC gradients and irregularities** can affect the integrity

IONOSPHERE
- **Scintillations** affect continuity/availability

Transionospheric Radio Wave Propagation

Electron density n_e & Total Electron Content (TEC)
are closely related to the solar irradiance

$$TEC_V = \int n_e(h)\ dh$$

Height / km

Ionosphere

LoS

Night

ρ

Day

s

$f_1 > f_2$

f_2

f_1

Refraction

Ray path

Electron density n_e

Solar Flux

**TEC
50°N, 15°E**
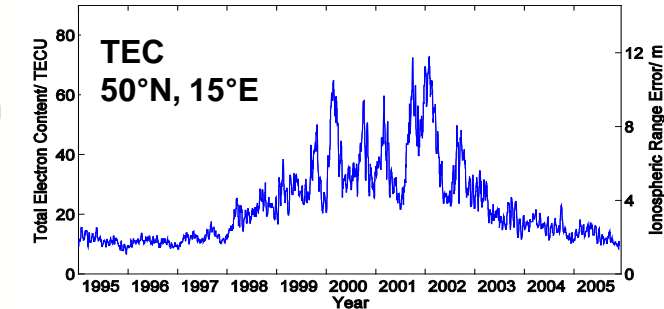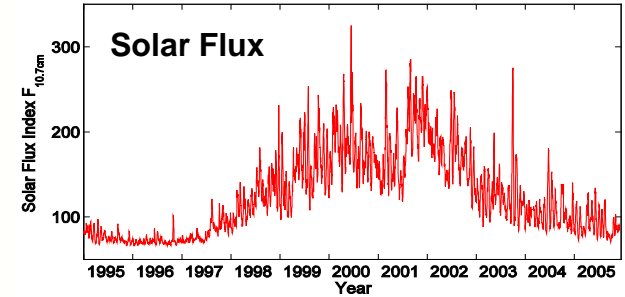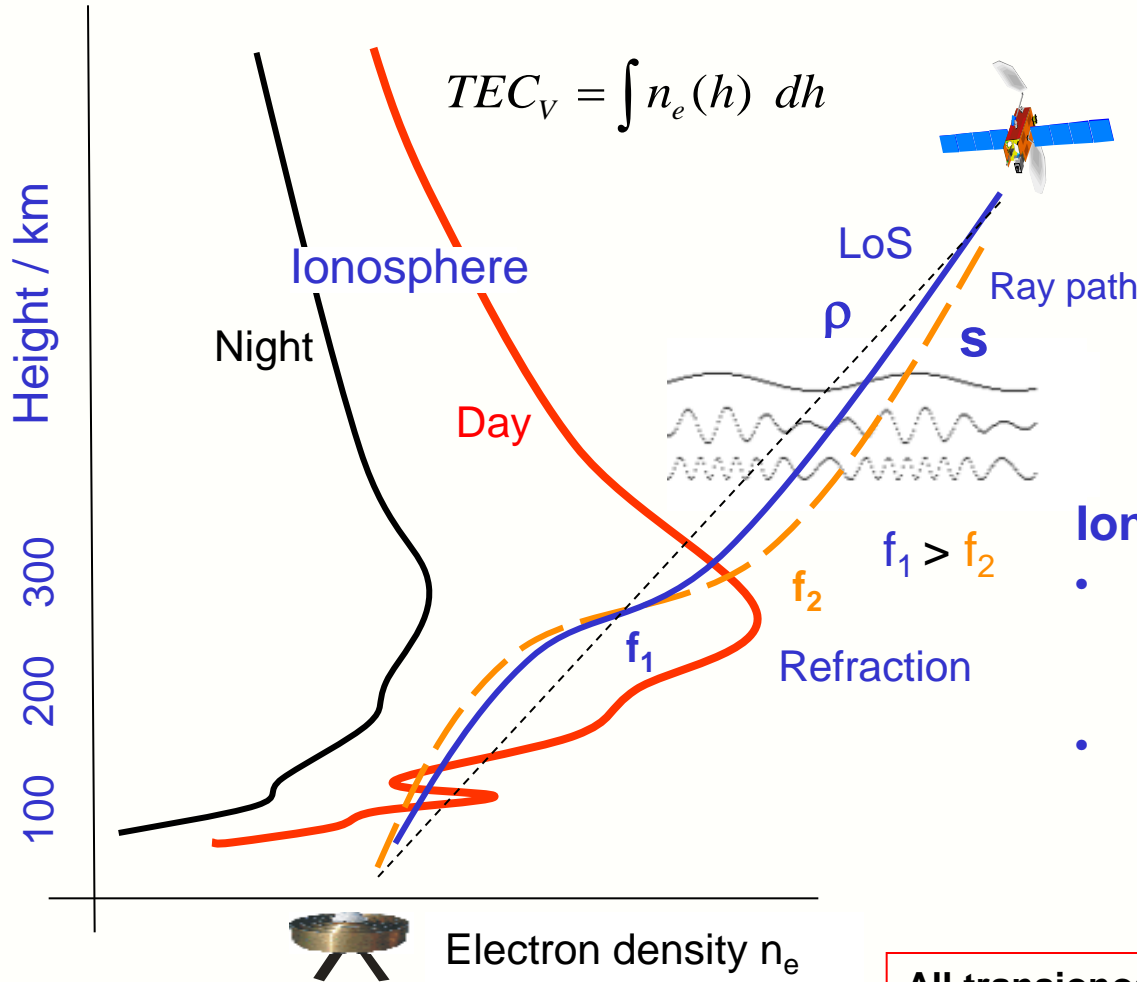
Ionosphere causes

- **Regular effects**

  - signal delay, range errors
    - rotation of polarisation plane

- **Irregular effects**

  - Radio scintillations,
  - Defocussing of radar images
  - Hazardous misleading information

All transionospheric radio systems operating at frequencies < 10 GHz are **affected**

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in der Helmholtz-Gemeinschaft

Space Weather Effekte
auf Kurzwellenkommunikation
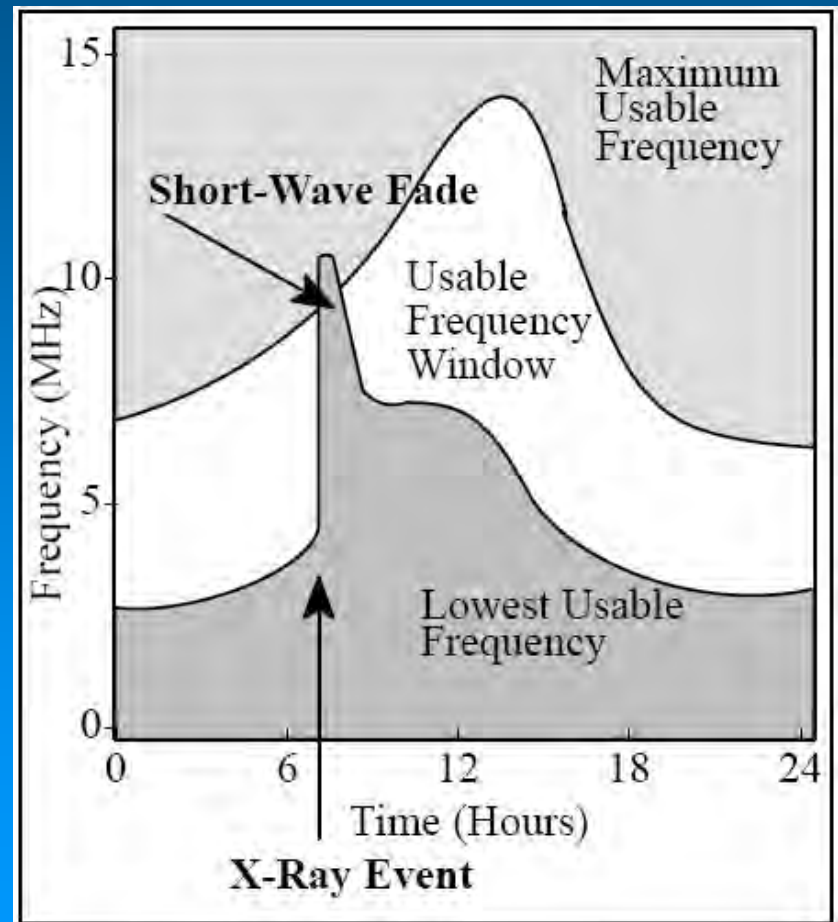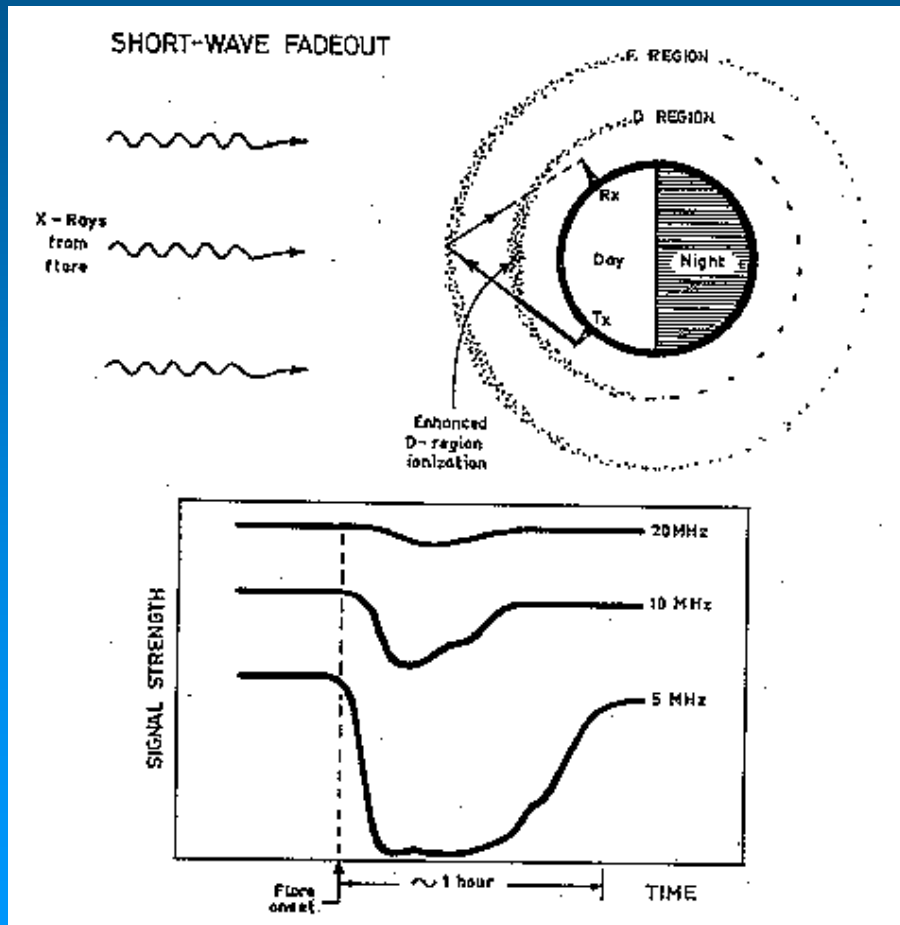
Space Weather Aktivitäten

Forschung / Austausch

„Weltraumwetter-Dienste"

z.T kommerziell

- Nowcasting / Alerts!

- Forecasting

- Post Event Analysis

Benutzer / Kunden

Konfektionierte Lösungen

z.B. Radiokommunikation:

http://hfradio.org/swp_proplab/

Space Weather Aktivitäten
Forschung / Austausch

- **Messungen**

- **Entwicklung von Modellen**

- **International koordinierte Forschungs-projekte**

- **Expertengruppen (ESA SWWT, EURADOS)**

- **Konferenzen / Workshops
  z.B. regelmässige
  „Space Weather Weeks"
  in USA und Europa**

Space Weather Services
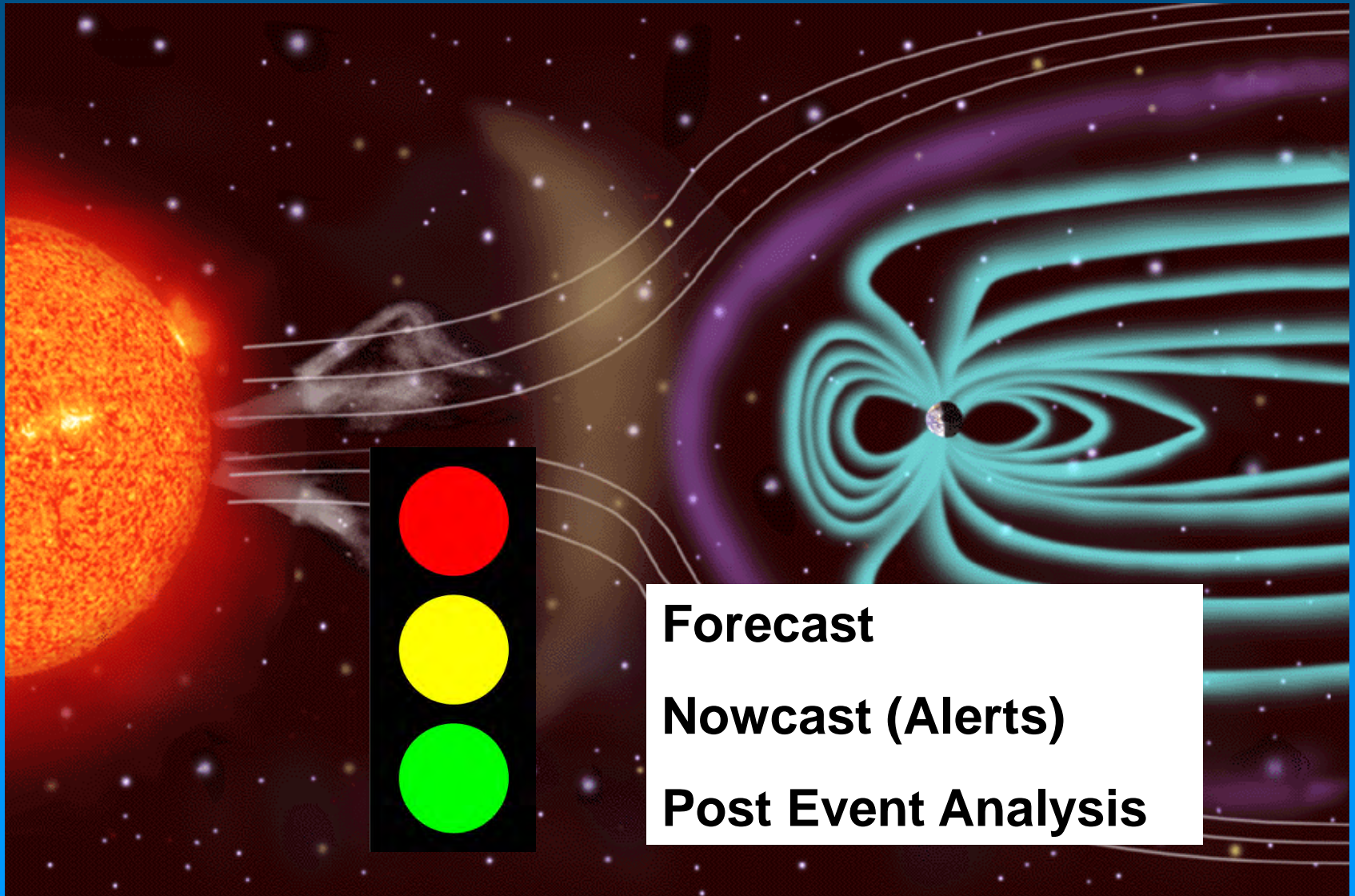
Forecast

Nowcast (Alerts)

Post Event Analysis

Space Weather Aktivitäten
Weltraumwetter-Dienste

z.B.

- **ESA European Space Weather Web Server**
  http://www.esa-spaceweather.net/

- **Japan NICT Space Weather Information Center**
  http://swc.nict.go.jp/contents/index_e.php

- **Australian IPS Radio and Space Services**
  http://www.ips.gov.au/

- **NOAA / NWS Space Weather Prediction Center**
  http://www.swpc.noaa.gov/

- **Space Weather Center**
  http://www.spaceweathercenter.org/stormalert/04/04.html

- **China Solar Activity Prediction Center, NAOC**
  http://rwcc.bao.ac.cn:8001/English/Rwcc_En.asp

- **……**

Space Weather Aktivitäten
Weltraumwetter-Dienste (Fortsetzung)

- **TESIS, Russland**
  http://www.tesis.lebedev.ru/en/

- **Aktuelle Sonnendaten (von NOAA)**
  http://www.n3kl.org/sun/noaa.html

- *http://www.spaceweather.com/*

- **Space Weather Resources**
  http://space.rice.edu/ISTP/

- **……**

- **Beispiele privater Initiativen**

  http://www.solarcycle24.com/

  http://dx.qsl.net/propagation/

  http://prop.hfradio.org/
  http://www.astrowetter.com/events/polarlichter/polarlichtwetter.php

- **Beispiel eines kommerziellen Anbieters:**

  http://www.spacew.com/swim/

- **……**
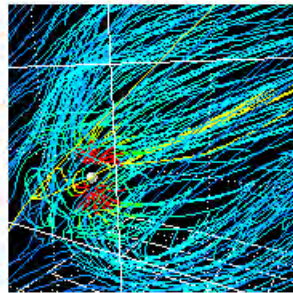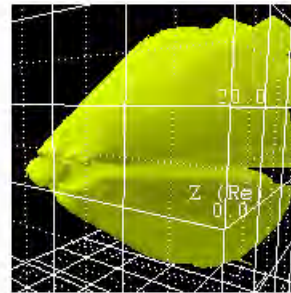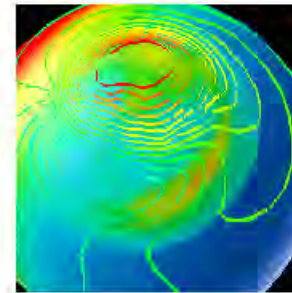
Space Weather Aktivitäten
Weltraumwetter-Dienste

Space Weather Aktivitäten

Weltraumwetter-Dienste / Alerts

CME Nowcast-Prediction [95 customers]

PLAIN PRESTO CULGOORA 03/0131UT NOV 2003

SOLAR RADIO EVENT 1: DRIFTING: 200 - 30 MHZ
START TIME: 0124 UT
END TIME: 0129 UT
SPECTRAL TYPE: TYPE II BURST
IMPORTANCE: STRONG

FUNDAMENTAL AND HARMONIC VISIBLE

ESTIMATED SHOCK SPEED 699 KM/S

FLARE OBSERVED IN REGION 10488

SHORTWAVE FADEOUT OBSERVED

Space Weather Aktivitäten
Weltraumwetter-Dienste / Detailiertes Beispiel

Space weather Application Center Ionosphere (SWACI)

http://swaciweb.dlr.de

⇁ The **Space Weather Application Center - Ionosphere** (SWACI) is a joint project of the Institute of Communications and Navigation and the German Remote Data Center of DLR.

⇁ The project is essentially supported by the German State Government of Mecklenburg-Vorpommern, will be finished in March 2011.

⇁ SWACI data base is mostly related to ground and space based GNSS measurements.

⇁ Data in particular suited to characterize ionospheric conditions along transionospheric radio links.

⇁ SWACI information shall support operators and users of transionospheric radio systems in communication, navigation and remote sensing.

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Folie 2

Ionosonde Juliusruh

http://www.iap-kborn.de/Ionogramm.262.0.html

http://swaciweb.dlr.de

TEC Europe

TEC World

Siehe auch: *http://www2.nict.go.jp/y/y223/simulation/ion/index.html*
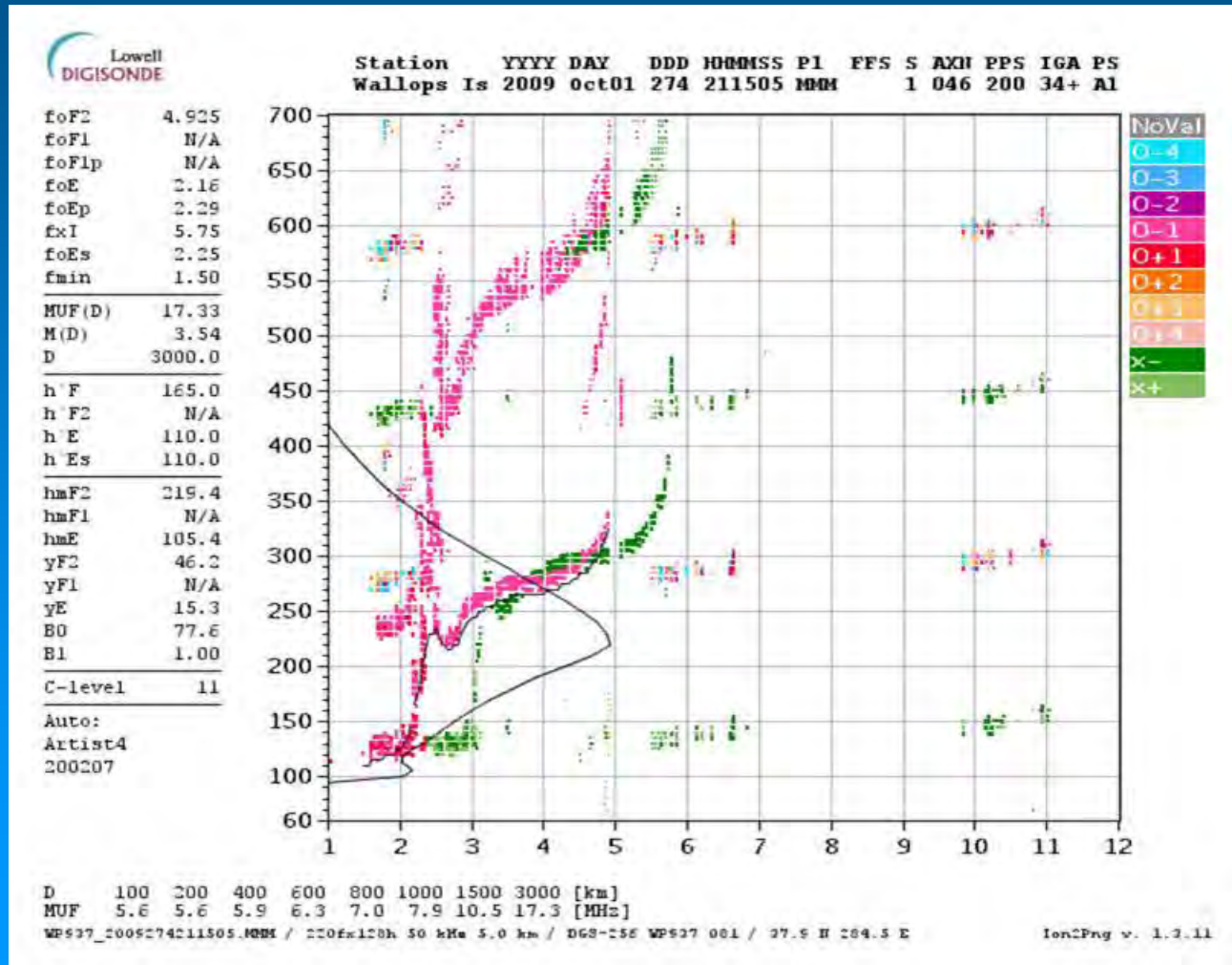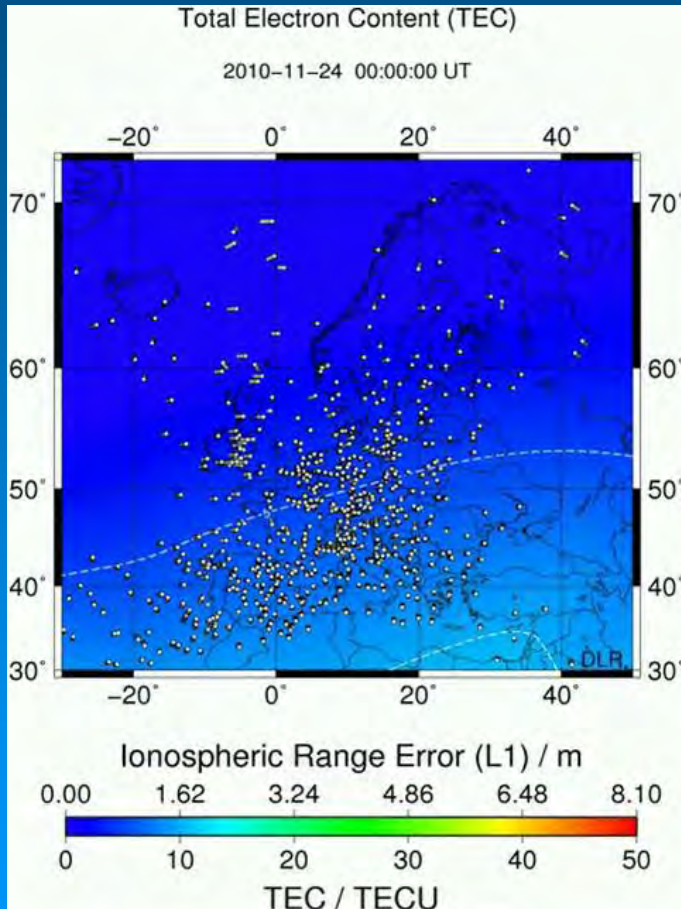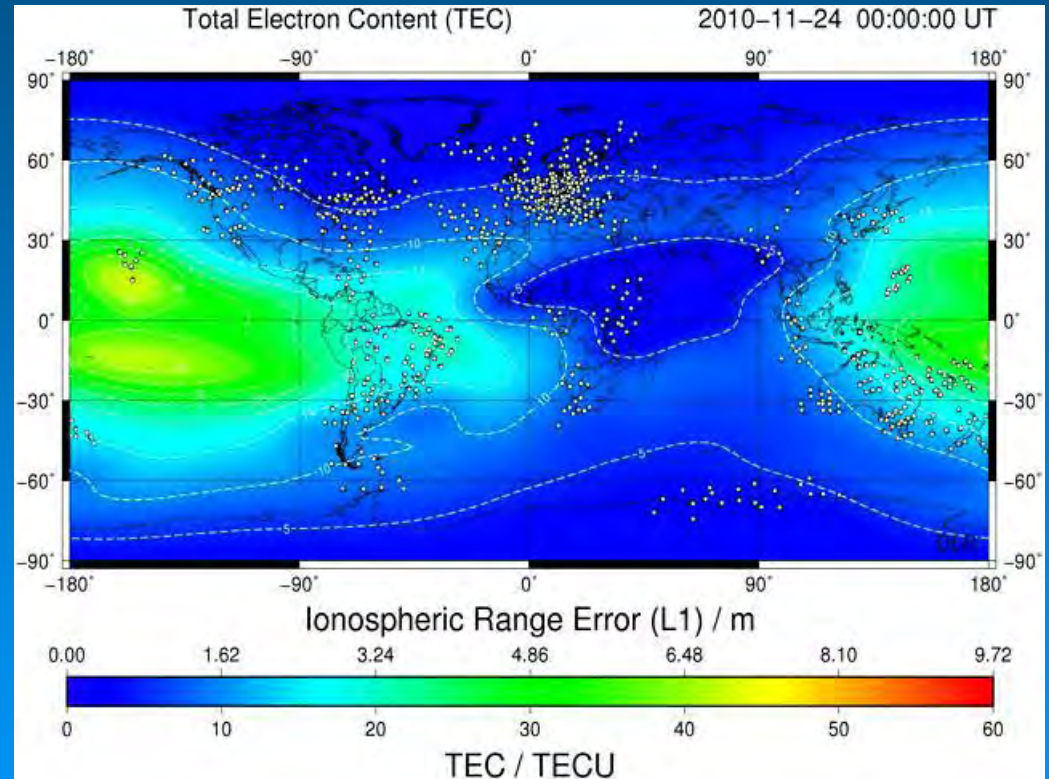
Radio-Propagation
http://hfradio.org/swp_proplab

Weltraumwetter
und
Funkamateure

Beispiel: Projekt SIMONE

Sun & Ionosphere MOnitoring NEtwork

Sun & Ionosphere MOnitoring NEtwork

N. Jakowski

on behalf of the SIMONE team

German Aerospace Center

Institute of Communications and Navigation,

Neustrelitz, Germany

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in der Helmholtz-Gemeinschaft

Solar & Ionosphere - MOnitoring NEtwork

Historical Background

➤ The national project SIMONE was initiated in the framework of the United Nation's world-wide International Heliophysical Year (IHY) campaign in collaboration with the Solar Physics Group at the University of Stanford, USA (Dr. Deborah Scherrer) , USA

➤ Establishment of the project 'Sun & Ionosphere MOnitoring NEtwork' in April 2007 including schools in Northern Germany by V. Bothmer (University of Göttingen) and N. Jakowski (German Aerospace Center)

➤ VLF receivers from the University of Stanford, sponsored by Astrium GmbH Friedrichshafen, were provided to schools to measure the signal strength of VLF signals at 24kHz from the US transmitter Cutler (Maine/USA).

Solar flare

Ionosphere

24 kHz

NAA Cutler ← ca. 6000 km → Schools in Germany

Receiver

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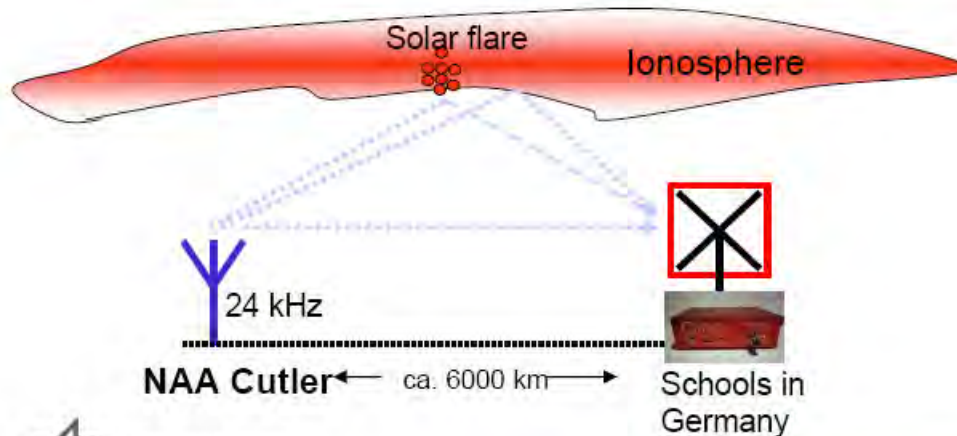
Solar & Ionosphere - MOnitoring NEtwork

➤ A number of Sudden Ionospheric Disturbances (SIDs) due to solar flares have been detected.

➤ After the Kick-off meeting in April 2007 at DLR Neustrelitz, several progress meetings were held. Here the participants learnt about the solar and ionospheric fundamentals of their measurements.

   With great enthusiasm they discussed their own observation results.

DLR Neustrelitz
25 September 2008
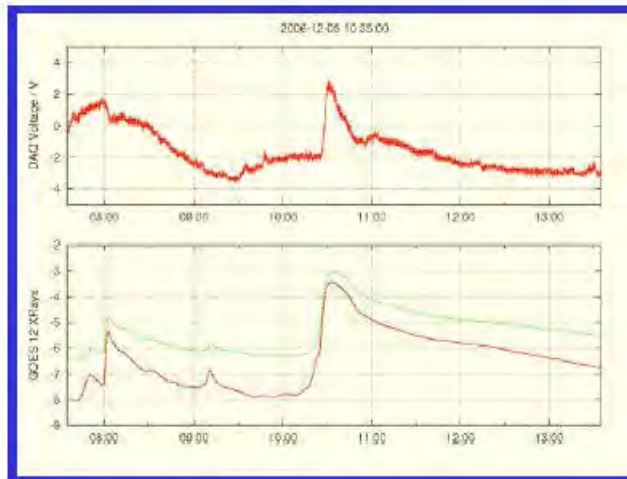
Strong correlation between GOES and SID monitor records

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Sun & Ionosphere MONitoring Network -SIMONE

Antenna

EMAG Bergen

Perfect measurements made by the EMAG school

Signal strength
1 June 2007

Solar
flare

SR

SS

EMAG Bergen

DLR Neustrelitz

Time / hrs
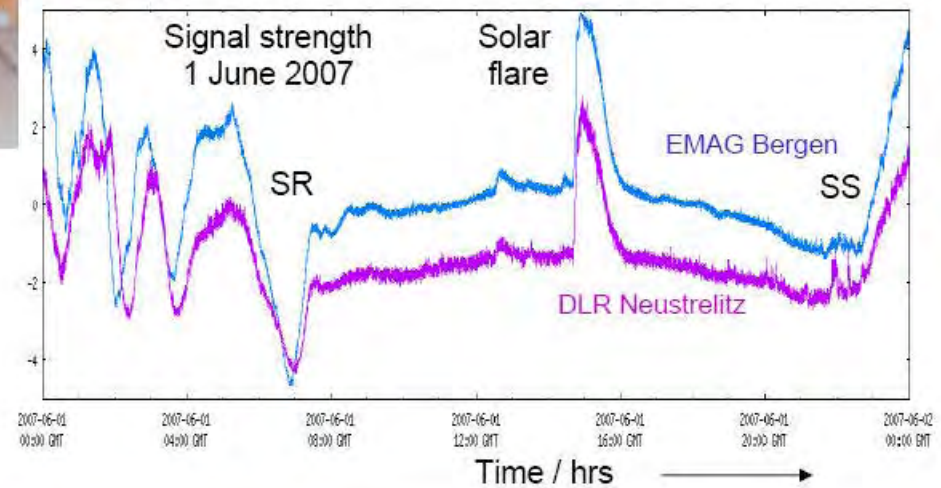
Solar & Ionospheric - MOnitoring NEtwork

➤ To be well prepared for the upcoming solar cycle, DLR started the development of a simple construction set for a single frequency VLF receiver (24 kHz). The receiver has successfully been tested recently.

➤ Supported by the ***DLR school_lab*** and the **SWACI project** a limited number of SIMONE construction sets were distributed to various schools, among them a school in Finland.

Candidate for a logo

Receiving antenna
built by students

Receiver/server construction set
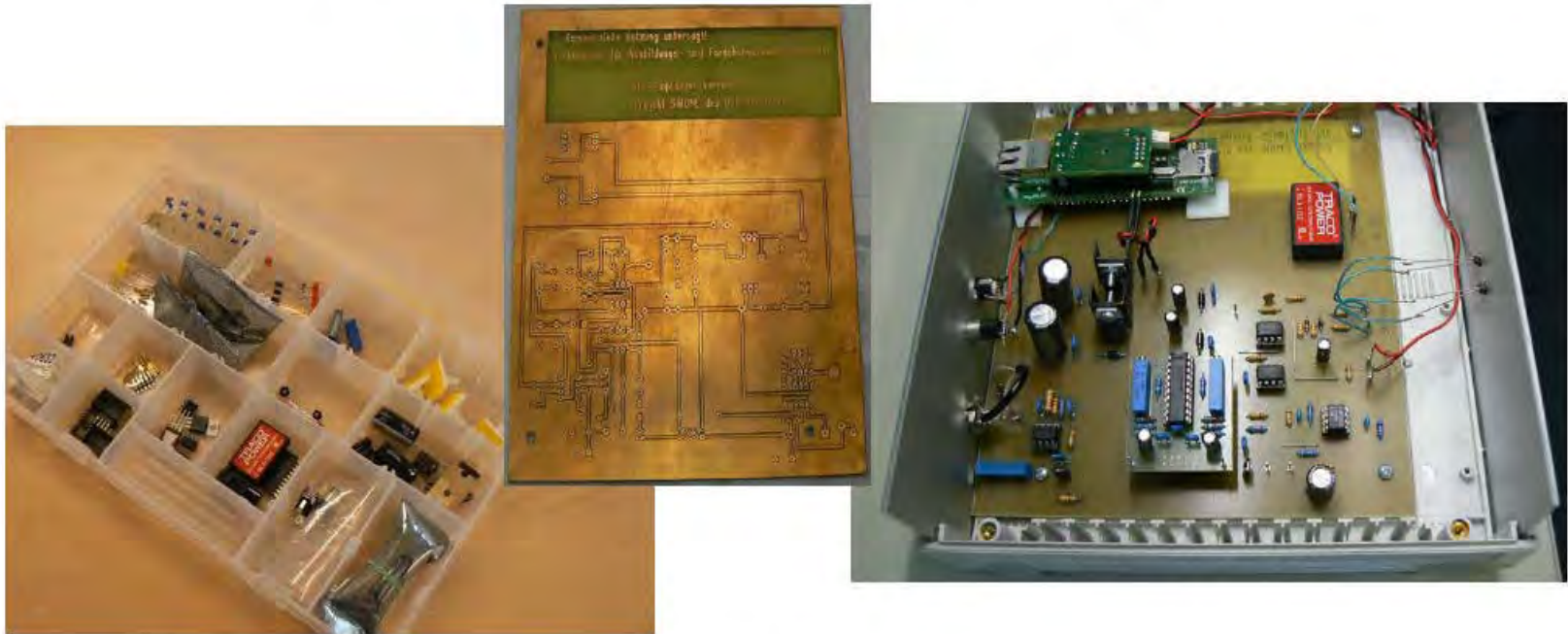
- Limited number of construction elements
- Construction can be managed by children following a construction guide
- Costs about 200 €

The Equipment

➤ Antenna and receiver/server box prepared by student work in the DLR School_Lab Neustrelitz

➤ The equipment doesn't need a PC for collecting the data, there will be real-time connection to SWACI system or internal storage of data

Functionality of the SID Monitor

Pre-Amp — All frequencies

Coax

24.0KHz Filter — Band-pass, Only 24.0KHz (Amplitude Modulation)

Signal Strength — DC voltage Level

10 bit, Analog to Digital Conversion

DATAQ — Computer — Sample every 5 Seconds

RS-232
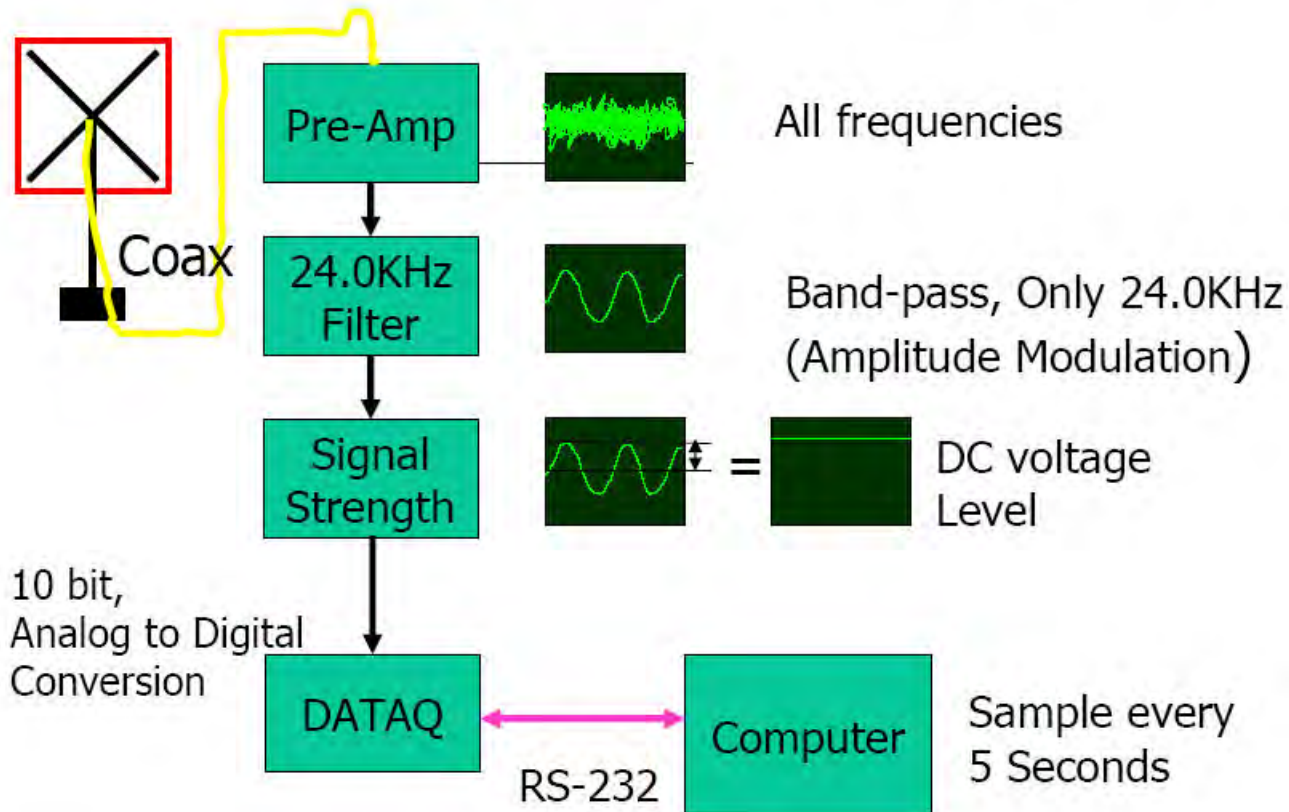
Solar & Ionospheric - MOnitoring NEtwork

➤ It is expected that the testing phase is finished end of January 2011. After reconfiguration according to suggestions, the Web platform will be open for all interested students participating in SIMONE hopefully in March 2011.

➤ In case of broad interest, SIMONE has the potential to become a European activity and even become an ISWI activity.

contact: Dr. Norbert Jakowski
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**Deutsches Zentrum
DLR für Luft- und Raumfahrt** e.V.
in der Helmholtz-Gemeinschaft

Sonnenzyklus
Rückblick und Prognose

http://sohowww.nascom.nasa.gov/gallery/Movies/10th/
(SOHO_EIT_sm.mpg)

Cycle 24 Smoothed Sunspot Numbers: Observed and Predicted
PRELIMINARY Based on December 2008 Smoothed Data

Mean of Cycles 8-23
Cycle 23
Observed Cycle 24
Predicted Cycle
Mean Rise 3.9 Years
Mean Fall 7.0 Years

Solar Geophysical Data   http://sgd.ngdc.noaa.gov/sgd/jsp/solarindex.jsp
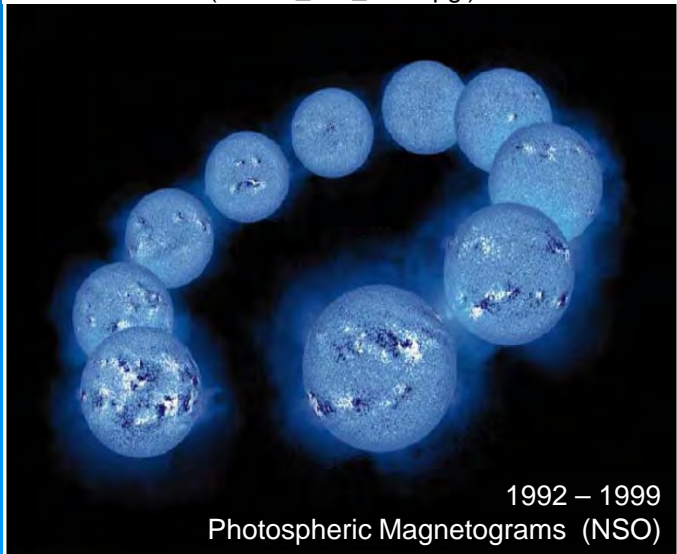
1992 – 1999
Photospheric Magnetograms (NSO)

Solar Irradiance (W/m^2)

Irradiance (daily/annual)
Sunspot Observations
Solar Flare Index
10.7 Radio Flux

http://science.nasa.gov/heliophysics/focus-areas/space-environment/

http://en.wikipedia.org/wiki/File:Solar-cycle-data.png
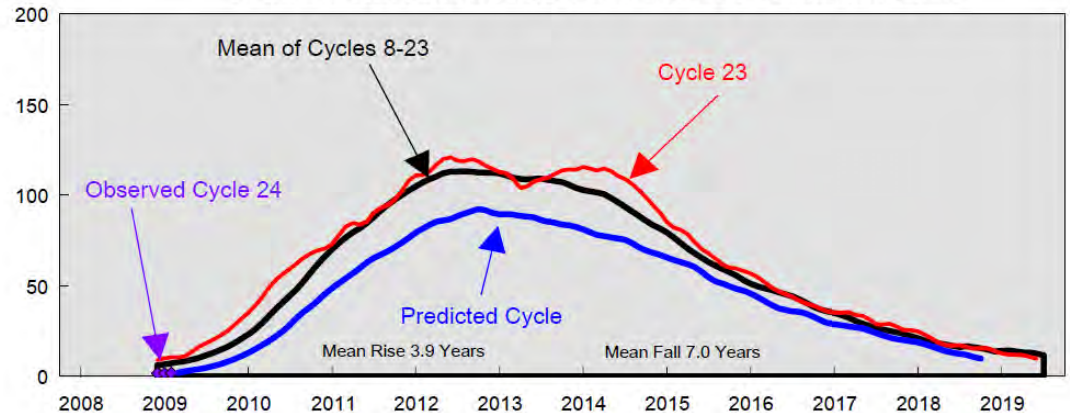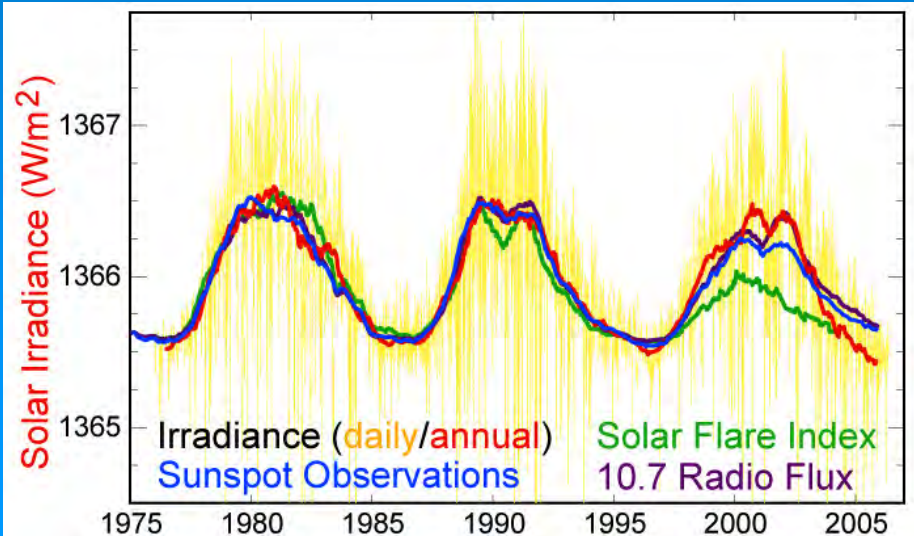
Sonnenzyklus
Rückblick und Prognose

Wie speziell ist dieses Sonnenminimum?

M. Temmer: Statistical properties of flares/sunspots over the solar cycle
SOHO 23, Northeast Harbor, Maine, 21 – 25 September 2009

Sonnenzyklus
Rückblick und Prognose

400 Jahre Sonnenflecken-Beobachtung

Maunder-minimum · Dalton-minimum · Modernes Maximum · Anzahl Sonnenflecken
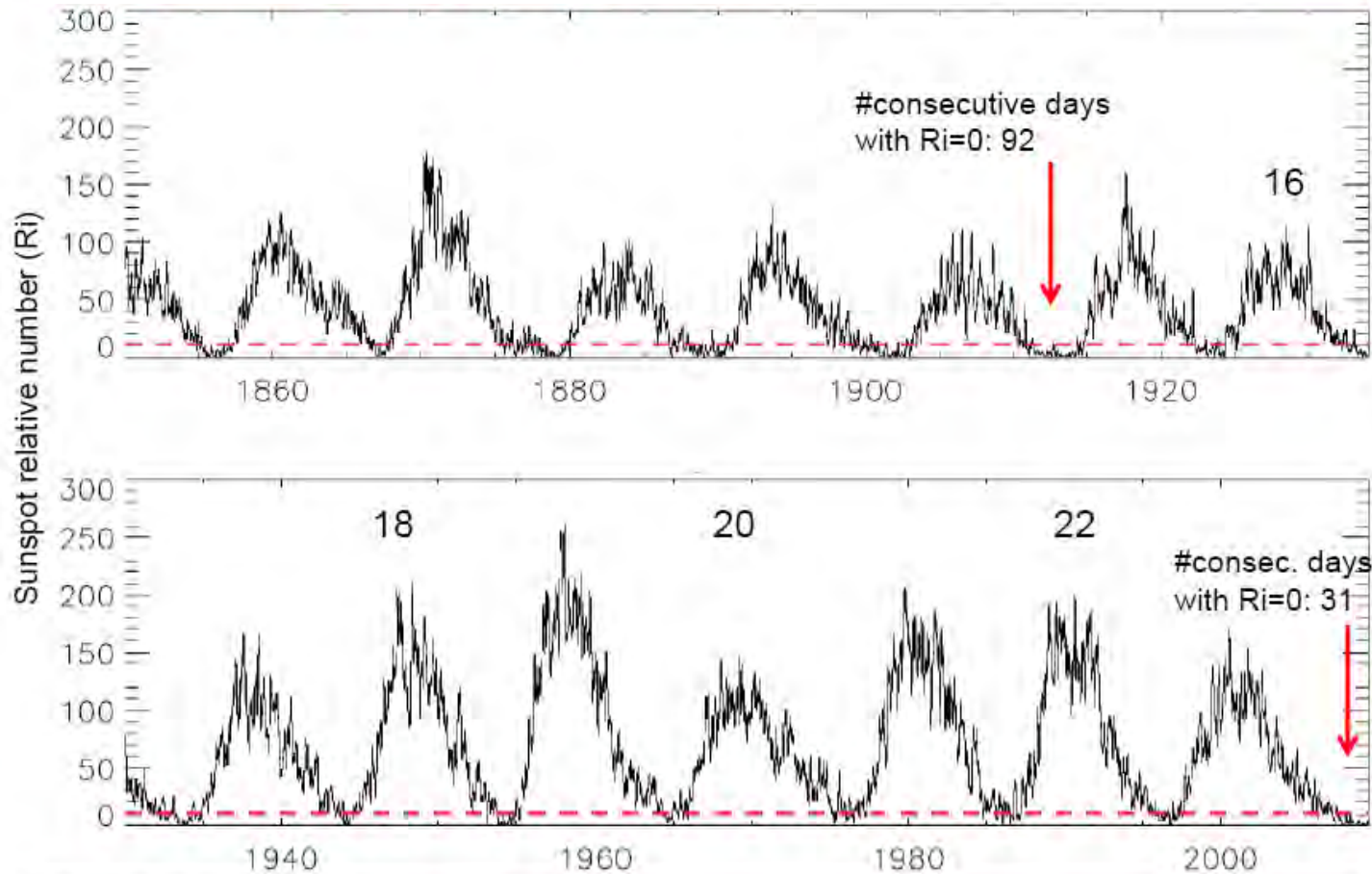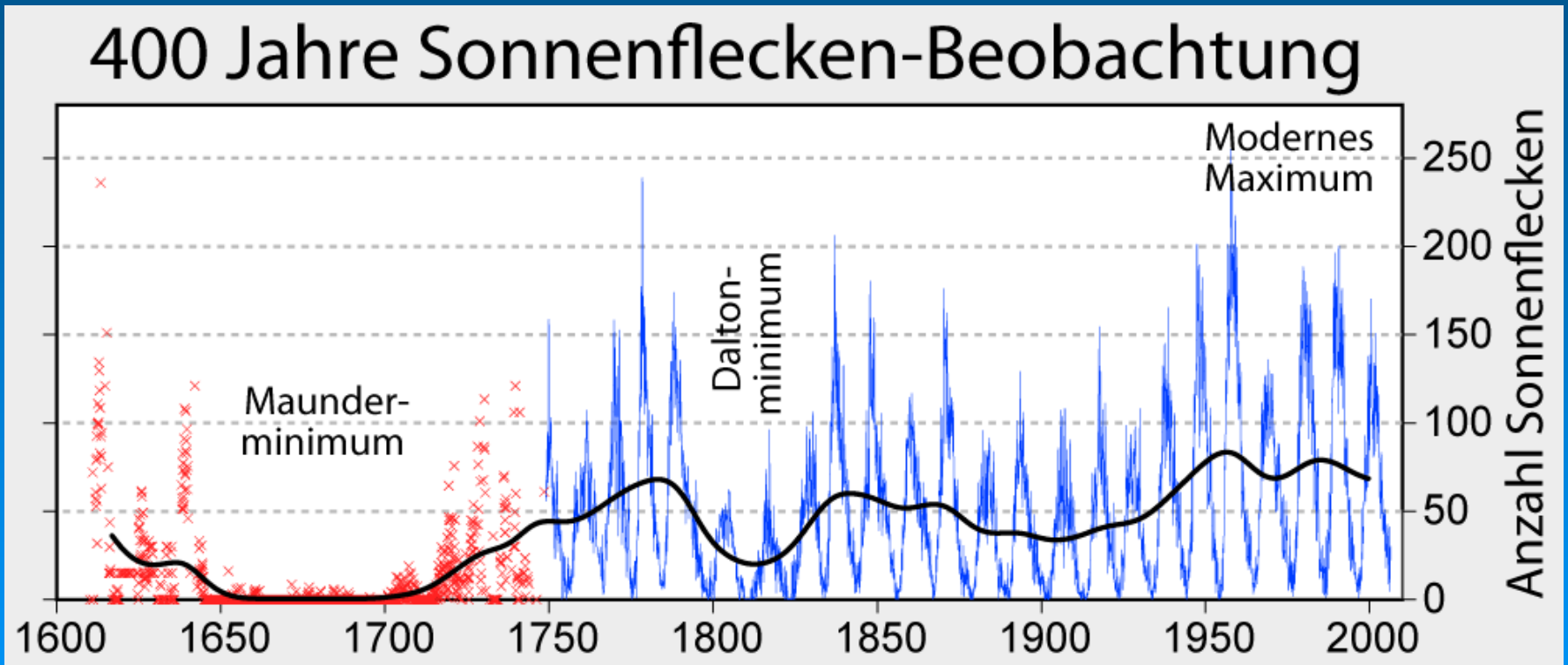
Sonnenzyklus
Rückblick und Prognose

Sonnenzyklus
Rückblick und Prognose

Zusammenfassung & Ausblick

- **Weltraumwetter betrifft uns alle**

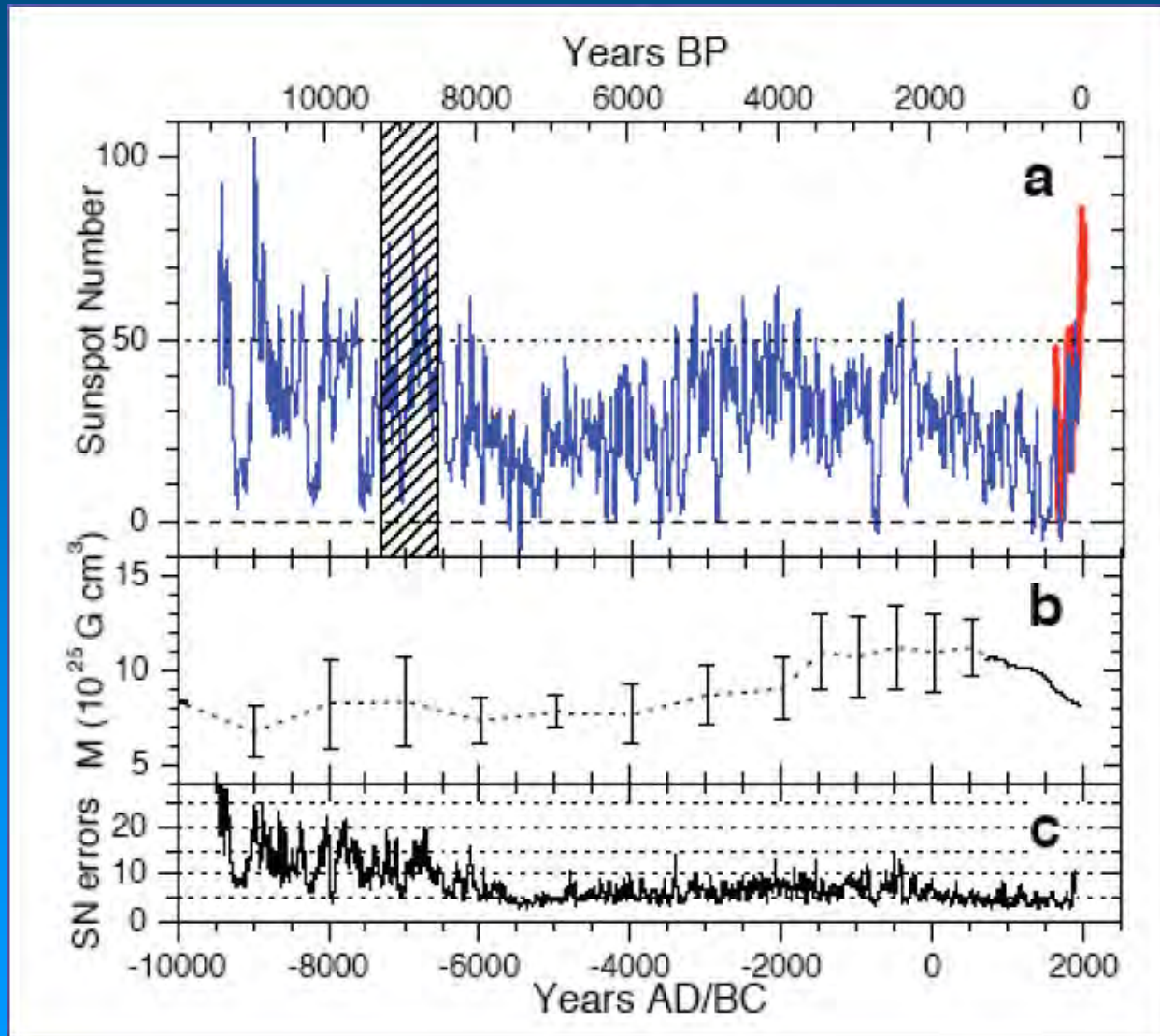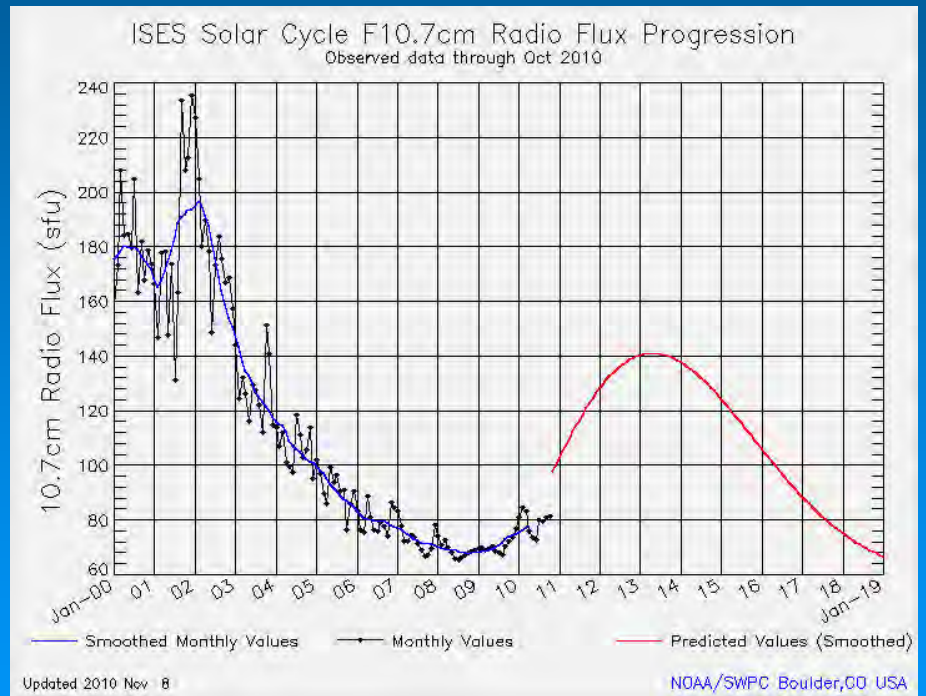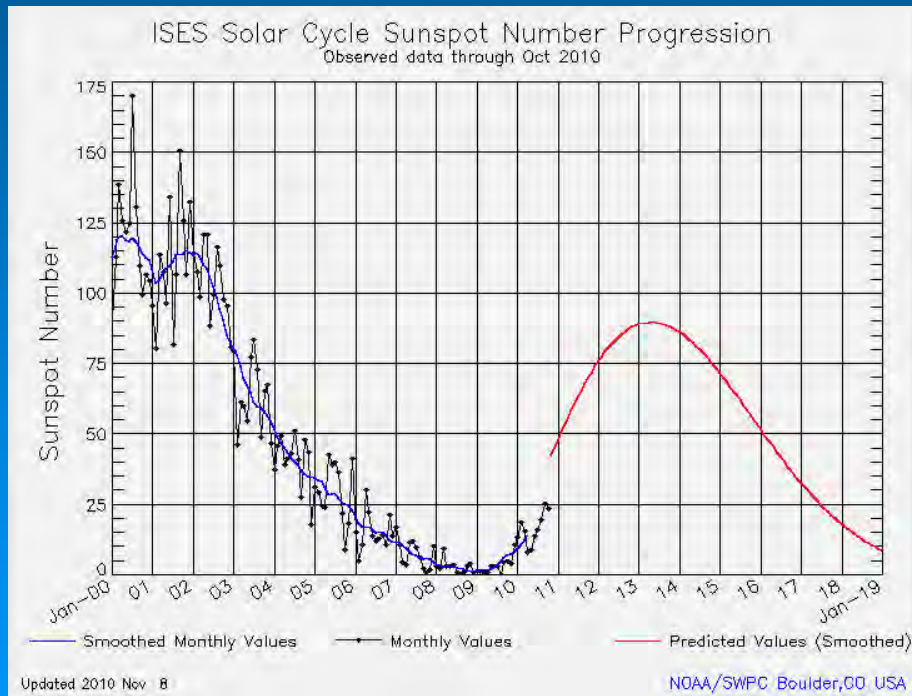- **Bedeutender Fortschritt in der Entwicklung von Modellen**

- **Weltraumwetter-Dienste in Echzeit**

- **Starke Kommerzialisierung**

- **Prognosen aber z.T. immer noch sehr unsicher**

extrem spannend!

Zusätzliche Information & Literatur I

z.B.

- **Space Weather: Gefahren aus dem Weltraum?
  SwissRe 2000
  pdf abrufbar auf** *http://www.swissre.com/publications/*

- **Weltraumwetter**
  http://www.utd.hs-rm.de/flare/Flare/Weltraumwetter/Weltraumwetter.htm
  http://www.esa.int/esaCP/ESAFM97708D_Germany_0.html

- **Ionosphäre**
  http://de.wikipedia.org/wiki/Ionosph%C3%A4re

- **HF Propagation Tutorial**
  http://www.astrosurf.com/luxorion/qsl-hf-tutorial-nm7m.htm

Zusätzliche Information & Literatur II

- *Space Weather*, **Paul Song, Howard J. Singer, and George L. Siscoe, Editors, Geophysical Monograph 125, American Geophysical Union, Washington, DC, 2001; ISBN 0-87590-984-1; ISSN 0065-8448**

- *Space Storms and Space Weather Hazards*, **Ioannis A. Daglis, Editor, NATO Science Series, II Mathematics, Physics and Chemistry, Vol. 38, Kluwer 2001; ISBN 1-4020-0031-6**

- *Effects of Space Weather on Technology Infrastructure*, **Ioannis A. Daglis, Editor, NATO Science Series, II Mathematics, Physics and Chemistry, Vol. 176, Kluwer 2004; ISBN 1-4020-2747-8**

- *Developing the scientific basis for monitoring, modelling and predicting Space Weather*, **J. Lilensten, A. Belehaki, M. Messerotti, R. Vainio, J. Watermann, and St. Poedts, Editors, Scientific Final Report, COST Action 724, COST Office, Brussels, 2008; ISBN 978-92-898-0044-0 (*http://bookshop.europa.eu*)**