Recent and future solar-terrestrial activities in Switzerland

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The solar-terrestrial community in Switzerland
The solar-terrestrial community in Switzerland

The Swiss solar-terrestrial community is small but very active. Switzerland becoming a member of SCOSTEP in 2015 was taken as opportunity to establish an actual Swiss solar-terrestrial community and represent it within CH and internationally.

Main institutes

Fachhochschule Nordwestschweiz (FHNW), Brugg/Windisch

Physikalisches-Meteorologisches Observatorium Davos / World Radiation Center (PMOD/WRC), Davos

Paul Scherrer Institute (PSI), Villigen

International Space Science Institute (ISSI), Bern

Istituto Ricerche Solari Locarno (IRSOL), Locarno

Öschger Center for Climate Research, Uni Bern, Bern
Activities

1 Fundamental research

Solar physics and solar activity

Effects of the Sun and solar activity on the atmosphere and climate

2 Instrument development

3 Solar monitoring

4 Computation, Big Data

5 Community building and support
1 Fundamental research

1.1 Solar flares as drivers of space weather

Solar Flares are the most powerful explosions in the solar system and one of the drivers of space weather.

X-ray observations provide information on:

- Energy release site
- Particle acceleration
- Response of the solar atmosphere to flare energy input (heating)

Krucker & Battaglia 2014
Magnetic fields

Underlying cause of solar activity
Can be measured near the solar surface directly through spectropolarimetry
Coronal magnetic field through (NLFF) extrapolations

Small scale heating events

X-ray observations with the NASA NuSTAR telescope reveal small-scale energy release events in the quiet Sun
→ A solution to the “coronal heating problem”?
1.2 Effects of solar activity on climate

The contribution of solar activity to early 20th century warming
Contribution (%) of different forcing agents to global and seasonal mean temperature trends for the period 1910–1940

The influence of potential solar activity decline on future climate and ozone layer
On the global scale a reduced solar forcing compensates for at most 15 % of the expected greenhouse warming at the end of the 21st and around 25 % at the end of the 22nd century.
2 Instrument development

Swiss involvement in 3 instruments of ESA’s Solar Orbiter Mission

- ESA M-Class Mission to study the link of the Sun and formation of the heliosphere
- 10 instruments: remote sensing and in-situ
- Launch date: **February 6 2020**
- Extra-ordinary orbit:
  - Out of ecliptic orbit
  - 0.3 AU
STIX (Spectrometer/Telescope for imaging X-rays)  
Swiss lead instrument (FHNW, S. Krucker)  
Imaging and spectroscopy of X-ray emission in solar flares

EUI (Extreme UV Imager)  
Belgium lead instrument  
High resolution ultraviolet images of the Sun

SPICE (Spectral Imaging of the Coronal Environment)  
ESA lead instrument  
Observations of spectral lines in the ultraviolet
Other instruments

**LYRA on board proba-2 (since 2009)**

Developed and built at PMOD/WRC  
Measures the solar EUV/UV radiation  
Onboard PROBA-2 Mission

**ZIMPOL**

High sensitivity imaging polarimeter  
Developed by IRSOL  
In use e.g. at the German  
GREGOR telescope on Teneriffe (since 2014)
Other instruments

Radiation Monitor for ESA Lagrange mission
LGR is ESA solar weather mission concept led by UCL (UK)
Currently in Phase B1
Radiation monitor in development at PSI for measuring charged particles, particle directionality, and particle spectra

SXI on SMILE
SMILE: joint mission between ESA and Chinese Academy of Sciences to measure the solar wind and its dynamic interaction with the magnetosphere.
FHNW leads thermal design of soft X-ray imager (SXI)

Timeline
PDR: June 2019
CDR: Oct 2020
Delivery: Jan 2020
Launch: Nov 2023
3 Solar Monitoring

Monitoring TSI (total solar irradiance) \( p_{mod\ wrc} \)

CLARA on NORSAT-1
Monitoring of total solar irradiance
Instrument is placed NORSAT-1

\[ Y = \frac{X}{1 + X} \]

Claus Fröhlich

e-CALLISTO Network \( n\ w \)
Solar Radio Burst Observation
Education and Training
Radio Monitoring
Initiative of C. Monstein, former ETHZ. Data center at FHNW.
4 Computation & Big Data

- Identification of MgII line spectra during solar flares using **machine learning** (Panos et al. 2018)

- **FLARECAST** (EU Horizon 2020 project until 2017)
  Automated solar flare forecasting
  Greek lead, FHNW contribution

- Magneto-hydrodynamic **numerical simulations** of the near surface layers of the solar atmosphere for direct comparison with real observations

- Past- and future climate modelling (PMOD/WRC, Uni Bern)
5 Community building and support

ISSI Bern supports international science teams, workshops, and organisations.

**Upcoming**: FORUM “Next scientific Solar-Terrestrial Program (SCOSTEP)”, Feb 25 – 27, 2019

The Swiss National SCOSTEP committee, part of the Swiss Academy of Sciences consists of members from all participating institutes and represents the community.

**Upcoming**: 3rd Swiss SCOSTEP workshop, Mar 6 – 7, 2019, PMOD/WRC, Davos
Summary

• Switzerland has a long history of solar-terrestrial science

• Activities include: fundamental research, instrument development, solar monitoring, and community building

• The community makes significant contributions to major international missions such as Solar Orbiter

Conference picture,
2nd Swiss SCOSTEP workshop
October 2017, Locarno