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# Recent and future actions about Space Weather in Austria

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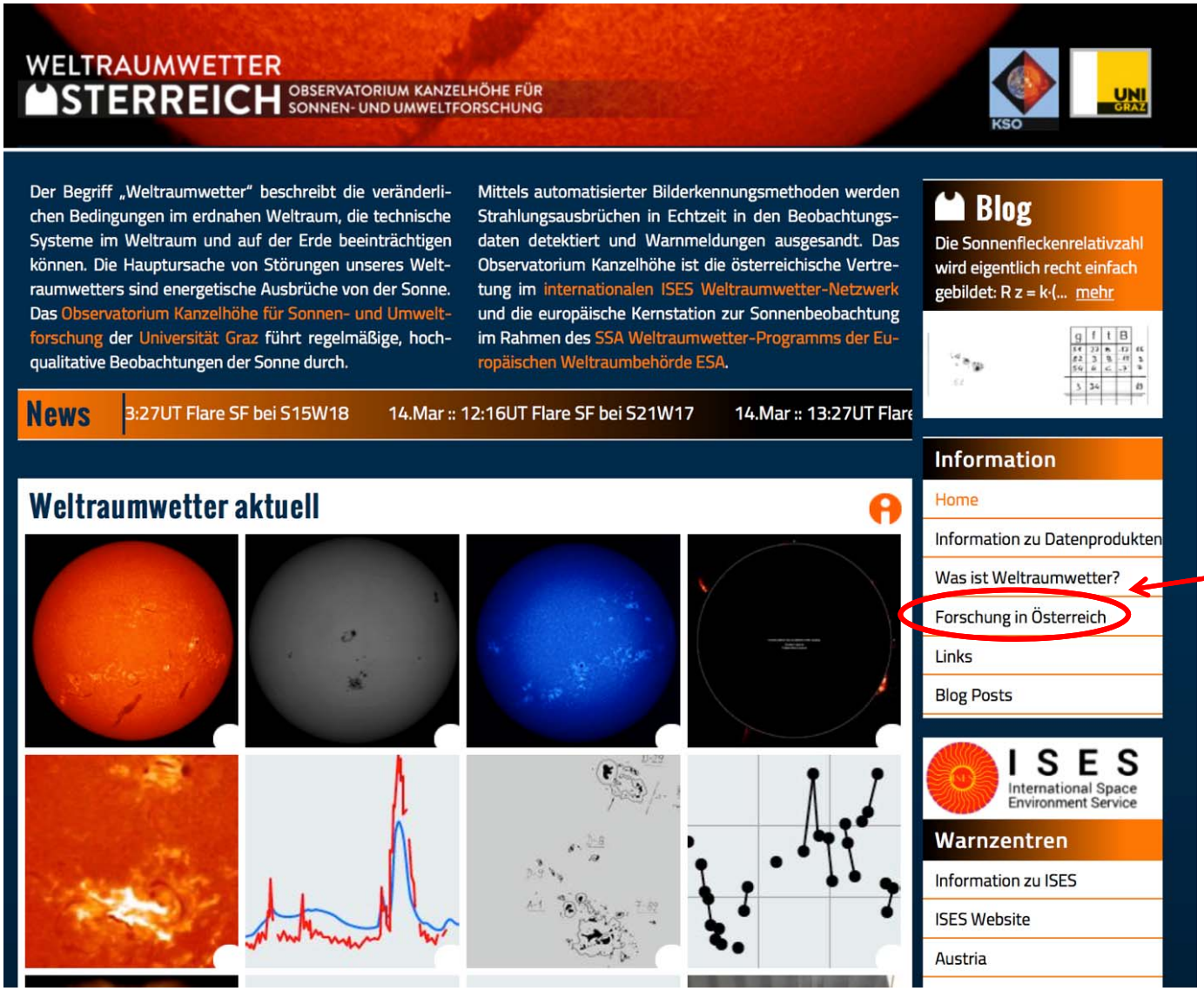
Institute of Physics, University of Graz, Austria

U.N. Space Weather Expert group Meeting and Workshop, Vienna, February 15 – 17, 2016

# Kanzelhöhe (UNI Graz) – ISES Network Regional Warning Center Austria




Space Weather Forecasts will become part of "daily life" (NASA/ESA).

**We aim towards better synergies and visibility of Space Weather within Austria.**

spaceweather.at / weltraumwetter.at

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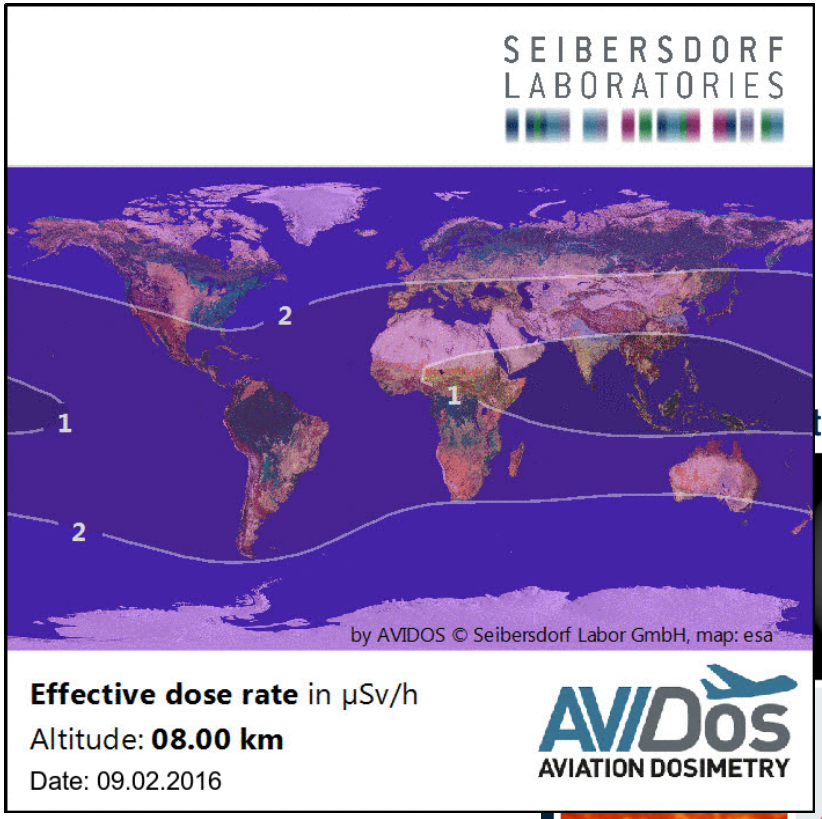
# Organization of the 1st Austrian Space Weather workshop 2015

Conrad Observatory (ZAMG) – Seibersdorf Laboratories – Space Research Institute Graz (IWF) – University of Graz

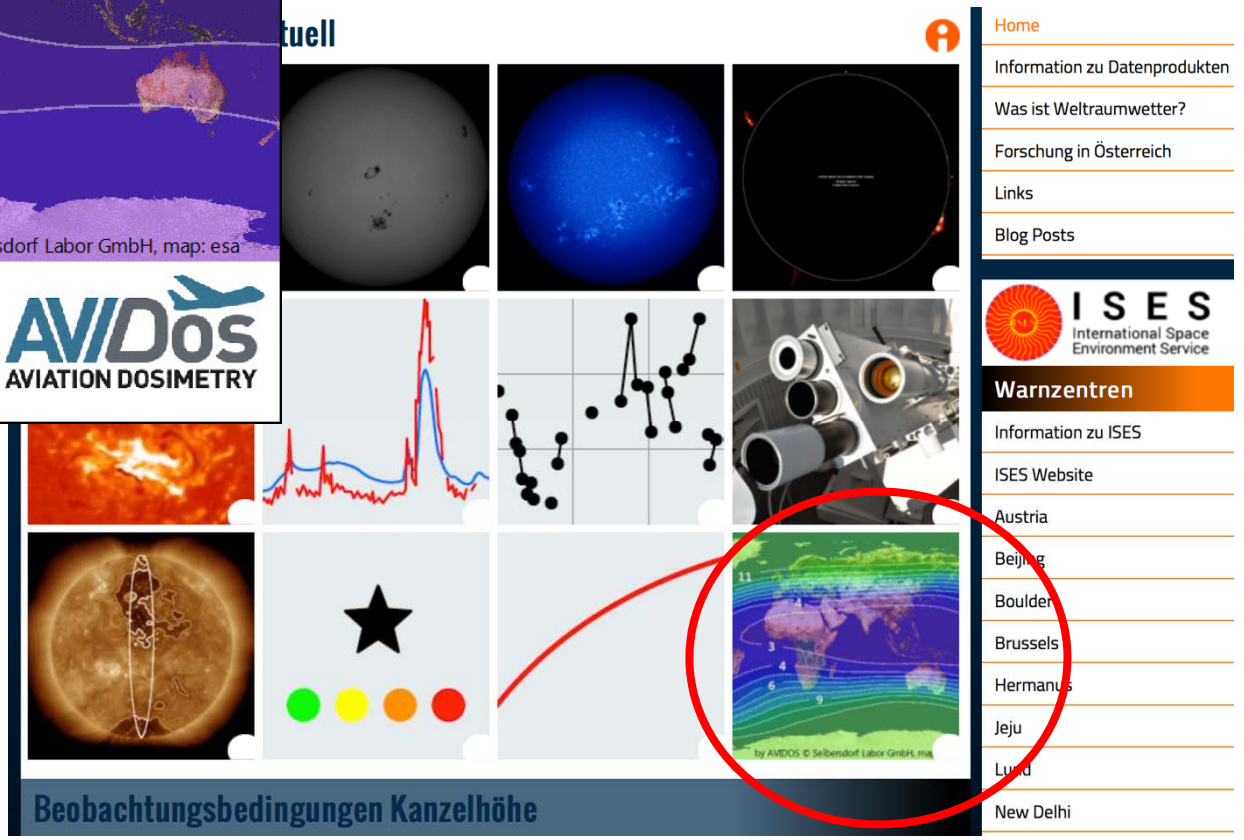

Special event: partial solar eclipse (March 20, 2015)

# „Fruits“ of the workshop...




AVIDOS: effective dose rates for aviation, implemented into spaceweather.at.

We clearly aim to continue the exchange of knowledge among Austrian SWE expert groups (next meeting hosted by Seibersdorf Laboratories).



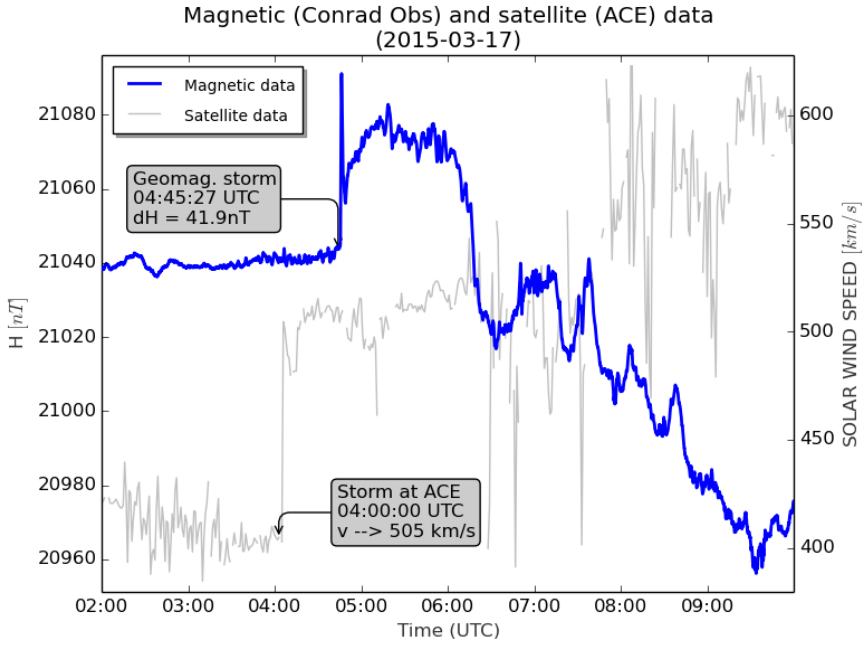
# Geomagnetically induced Currents in Austria

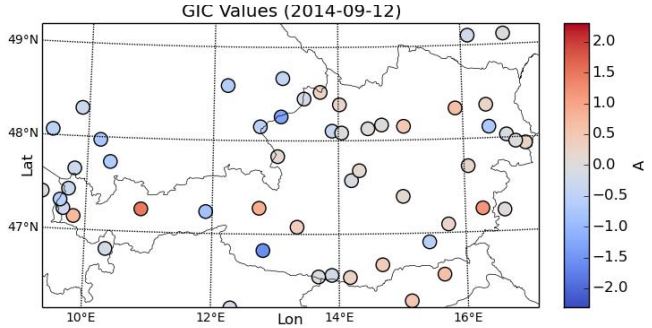
- The Conrad Observatory is (partly) a geomagnetic observatory

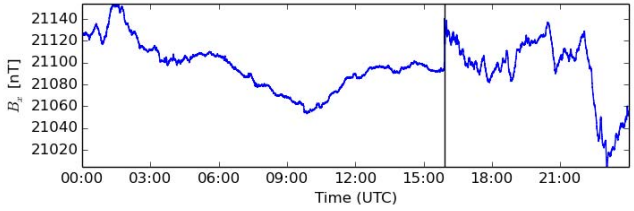
- "GEOMAGICA" is a **Conrad Observatorium** (ZAMG) project (financed by FFG-ASAP)

- 2015 plan: develop an **automated geomagnetic storm detection system** (upper figure)

- 2015-2017: development of a **model of GIC in the Austrian power grid** (lower figure)




ZAMG

# Further Information

- The storm detection system is based on a combination of solar wind and geomagnetic field data. In the case of a storm detection, warnings can be sent out via email or SMS

- To model GIC, one needs three parameters:
  - measurements of geomagnetic field variations
  - a model of the ground conductivity in Austria
  - a model of the Austrian power grid topology

- **Contact: Roman Leonhardt** and **Rachel Bailey**

Project partners: Austrian Power Grid, British Geological Survey, TU Graz, ...

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ÖAW IWF

# IWF/OEAW SPACE WEATHER RELEVANT ACTIVITIES

## Ongoing ILWS Mission Participation (Data Analysis & Hardware)

- Cluster, THEMIS, STEREO, MMS

## Participation in planning/hardware/preparation of SWE relevant future projects

- Solar Orbiter: Magnetometer, Radio and Plasma Waves
- Bepi Colombo PI/CoI: MGF on MMO, PICAM/MERMAG on MPO
- Service Oriented Spacecraft Magnetometer (SOSMAG) onboard GK-2A (Korean SC)
- Solar wind Magnetosphere Ionosphere Link Explore (SMILE): Soft-Xray Imager DPU
- Turbulence Heating ObserveR (THOR): Magnetometer, Sci Study Team

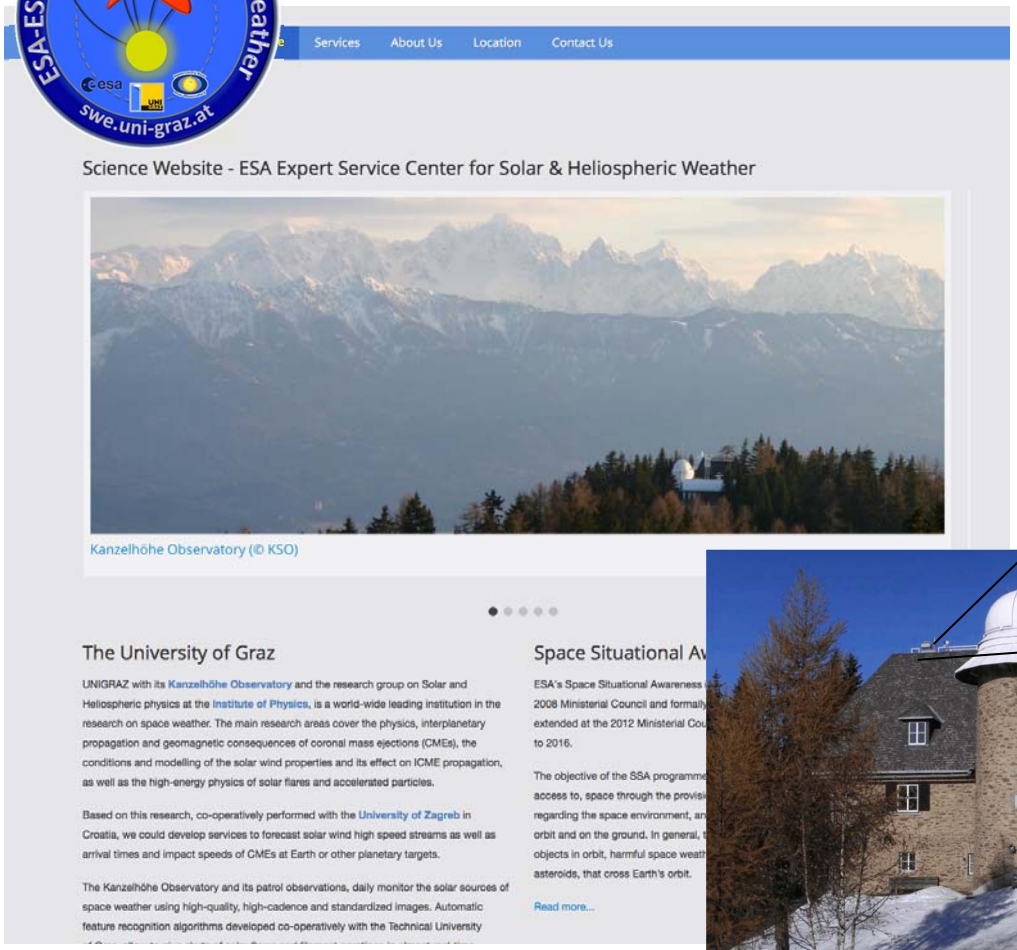
## Other SWE relevant studies

- Thermosphere-CME relation (Krauss et al., 2015 in collab. with UNI Graz)
- CME Propagation modeling
- Planetary space weather

***Contact: Rumi Nakamura***

# UNI Graz & Kanzelhöhe Observatory – ESA Expert Service Centers for Solar and Heliospheric Weather

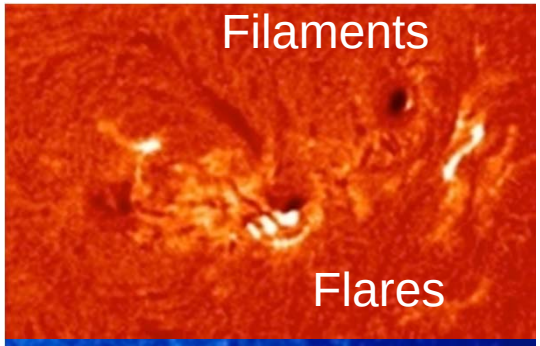
- Solar wind **high-speed-streams** forecast w/ 4 days lead time
- **CME propagation model** (DBM) using actual solar wind conditions (collaboration with Univ. Zagreb)
- Solar weather: H-alpha real-time **flare alerts** (filament eruptions)



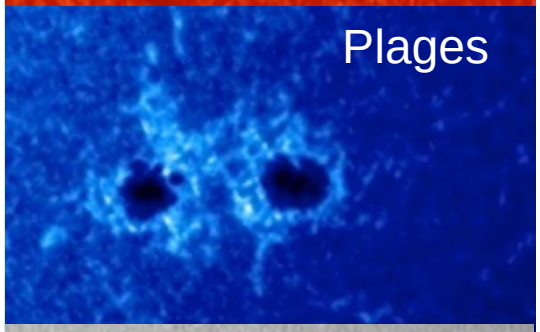

# Kanzelhöhe Obs. – data products

Full disk image data are available in near **real-time**.
Mean latency < 3 sec (see Pötzi et al., 2015).

Images of class 1 quality are immediately processed providing real-time flare and filament eruption alerts.




4 MegaPixel 12 bit
10 images / minute

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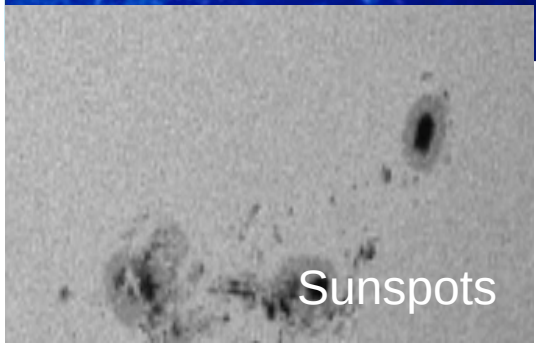
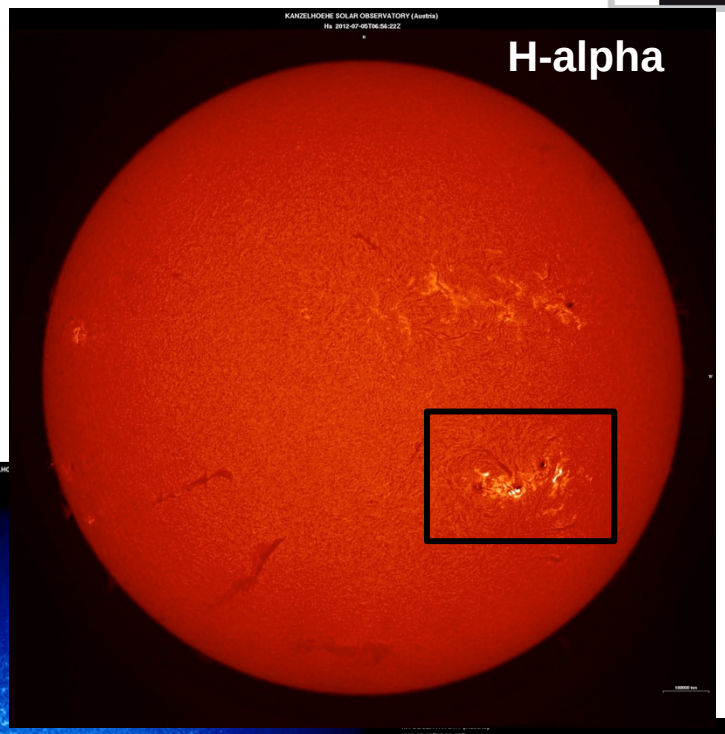
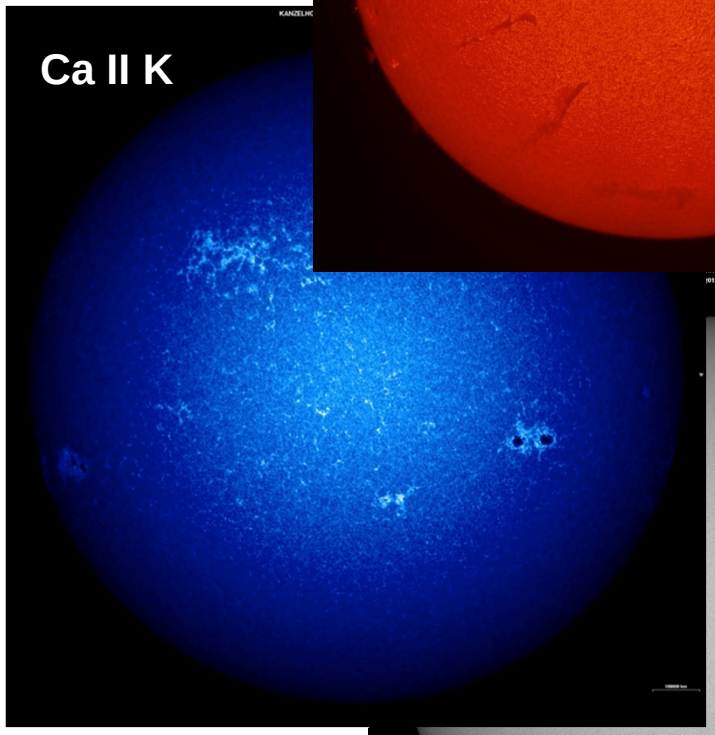
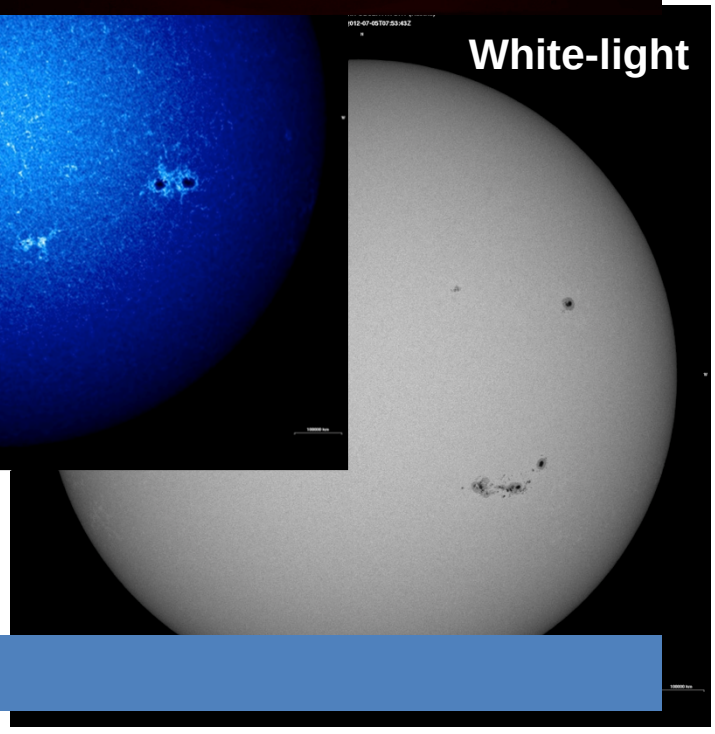



4 MegaPixel 10 bit
3 images / minute



# VarSITI: scientific program of SCOSTEP (2014-2018)

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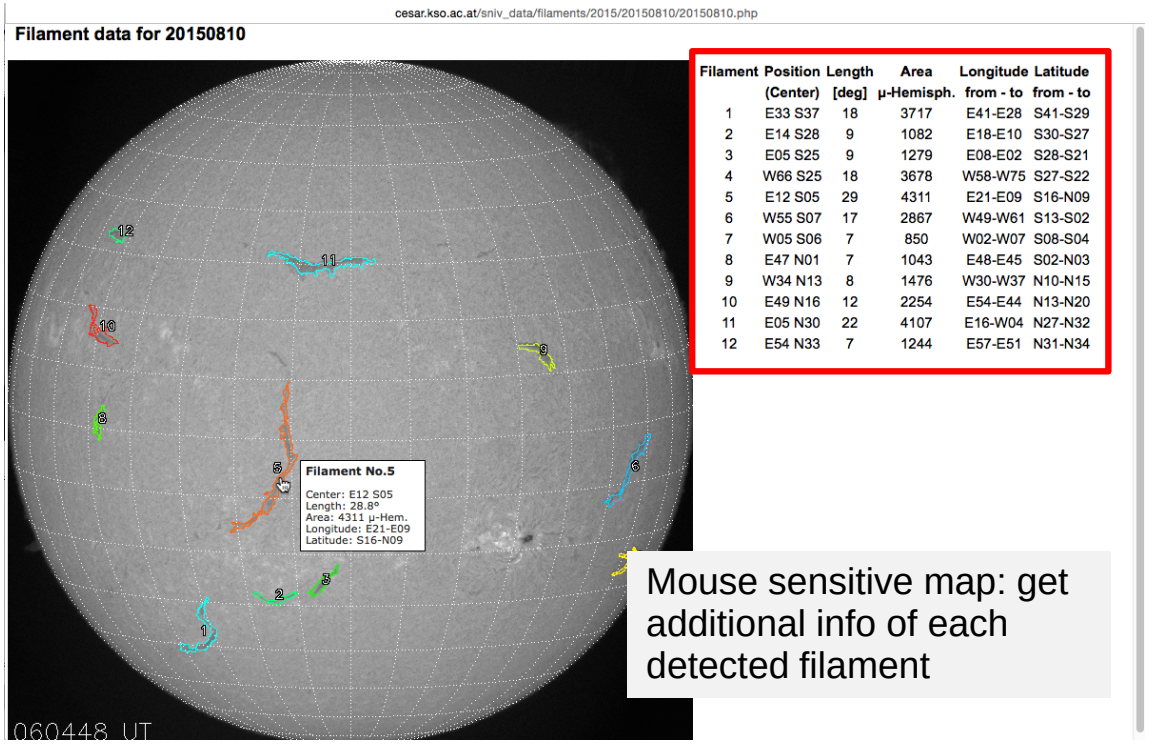
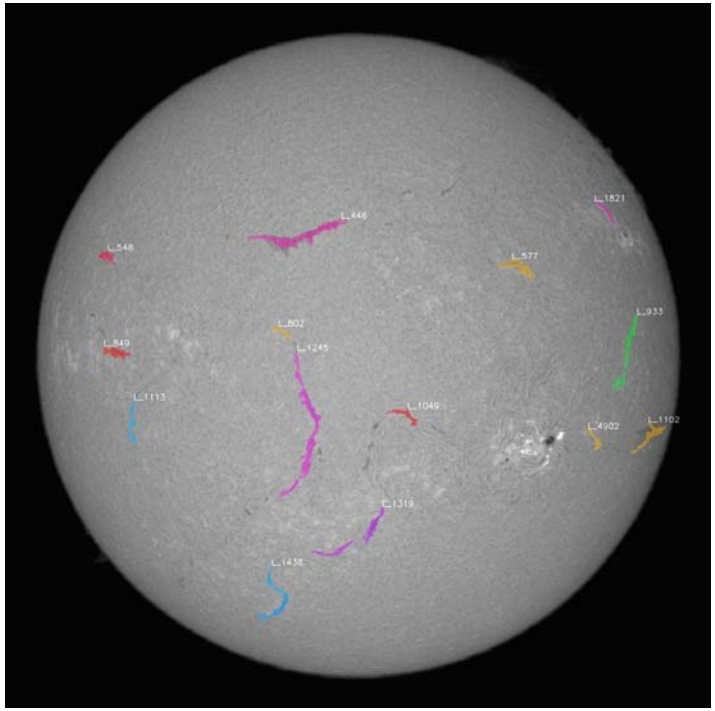
UNI Graz provides daily email service (ISEST/MiniMax24 campaign), giving forecasts of solar wind high speed streams and filament eruptions.

Automated filament detection at Kanzelhöhe (developed during ESA/SSA) is active since summer 2015.



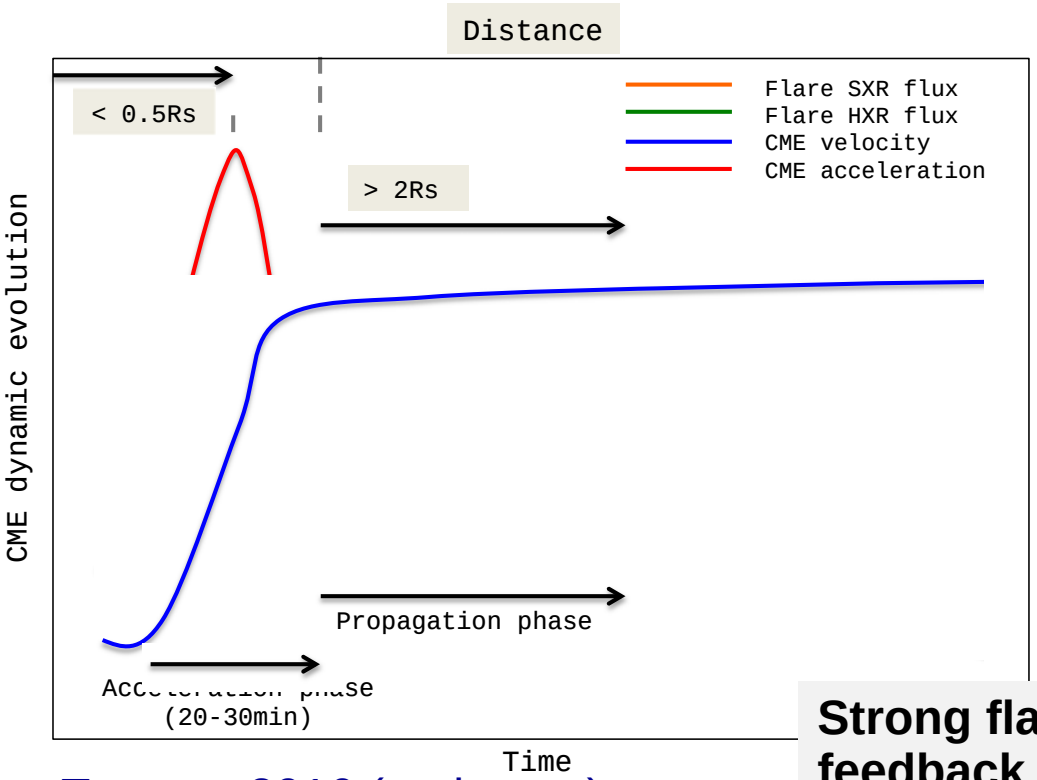

| Filament | Position (Center) | Length [deg] | Area µ-Hemisph. | Longitude from - to | Latitude from - to |
|---|---|---|---|---|---|
| 1 | E33 S37 | 18 | 3717 | E41-E28 | S41-S29 |
| 2 | E14 S28 | 9 | 1082 | E18-E10 | S30-S27 |
| 3 | E05 S25 | 9 | 1279 | E08-E02 | S28-S21 |
| 4 | W66 S25 | 18 | 3678 | W58-W75 | S27-S22 |
| 5 | E12 S05 | 29 | 4311 | E21-E09 | S16-N09 |
| 6 | W55 S07 | 17 | 2867 | W49-W61 | S13-S02 |
| 7 | W05 S06 | 7 | 850 | W02-W07 | S08-S04 |
| 8 | E47 N01 | 7 | 1043 | E48-E45 | S02-N03 |
| 9 | W34 N13 | 8 | 1476 | W30-W37 | N10-N15 |
| 10 | E49 N16 | 12 | 2254 | E54-E44 | N13-N20 |
| 11 | E05 N30 | 22 | 4107 | E16-W04 | N27-N32 |
| 12 | E54 N33 | 7 | 1244 | E57-E51 | N31-N34 |

Mouse sensitive map: get additional info of each detected filament



http://cesar.kso.ac.at/sniv/filaments.php

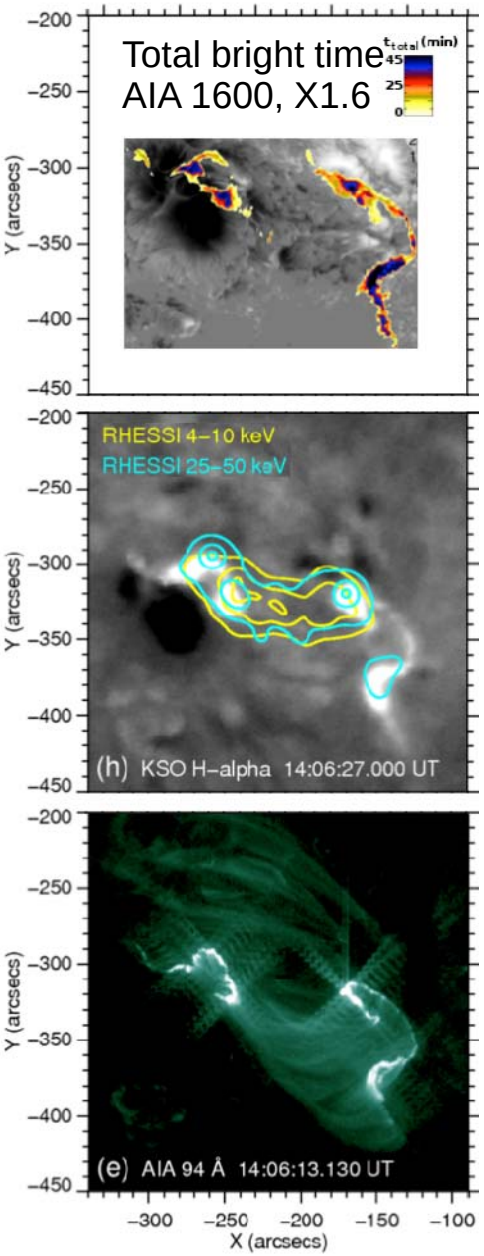
# SWE support: solar surface observations




Temmer 2016 (under rev)

**Strong flare-CME feedback relation**

Thalmann et al., 2015




Exceptions from the rule: confined events (e.g., Oct 2014) - strong overlying coronal magnetic fields (NLFF model) slowly decaying with height; flare: **no ribbon separation** (see Thalmann et al., 2015; Veronig and Polanec, 2015).

*Observations of flare ribbon dynamics and magnetic field models needed for more reliable SWE predictions.*

# SWE products „made in Austria“

- *Seibersdorf Laboratories*: AVIDOS – real-time aviation dose rates
- *Conrad Observatory*: GEOMAGICA – development of automated GIC warning system
- *Space Research Institute*: SWE satellite mission participation and research in planetary space weather as well as CME propagation
- *UNI Graz / Kanzelhöhe Observatory*:
  - Automatic near-real-time detection of flares and filaments (Pötzi et al., 2015; Veronig and Pötzi, 2016)
  - Automated forceasting of solar wind speed at distance of 1AU (Rotter et al., 2012, 2015; Reiss et al., 2016 (in prep))
  - In collaboration with University of Zagreb (Croatia), drag-based model (DBM) for forecasting arrival times of CMEs (latest version see: Žic, Vršnak, Temmer, 2015)
  - Research in preconditioning of IP space, CME propagation and relation to solar surface activities (flares, coronal waves, magnetic field models, ...)

ESA/SSA, VarSITI, ISES, ...