Space Weather and Society: CITEUC's contributions

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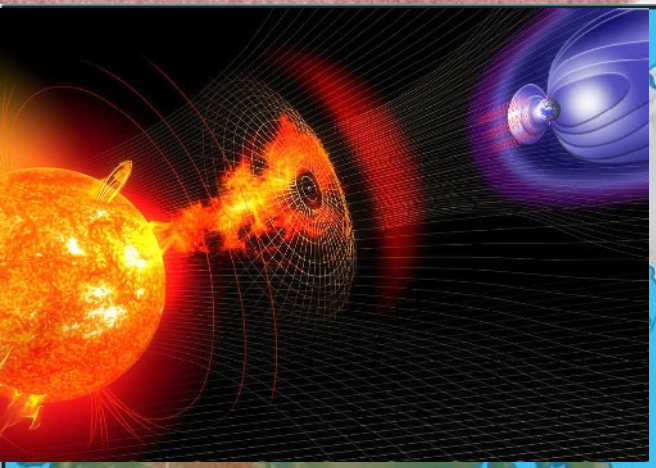
Space Weather: societal impact

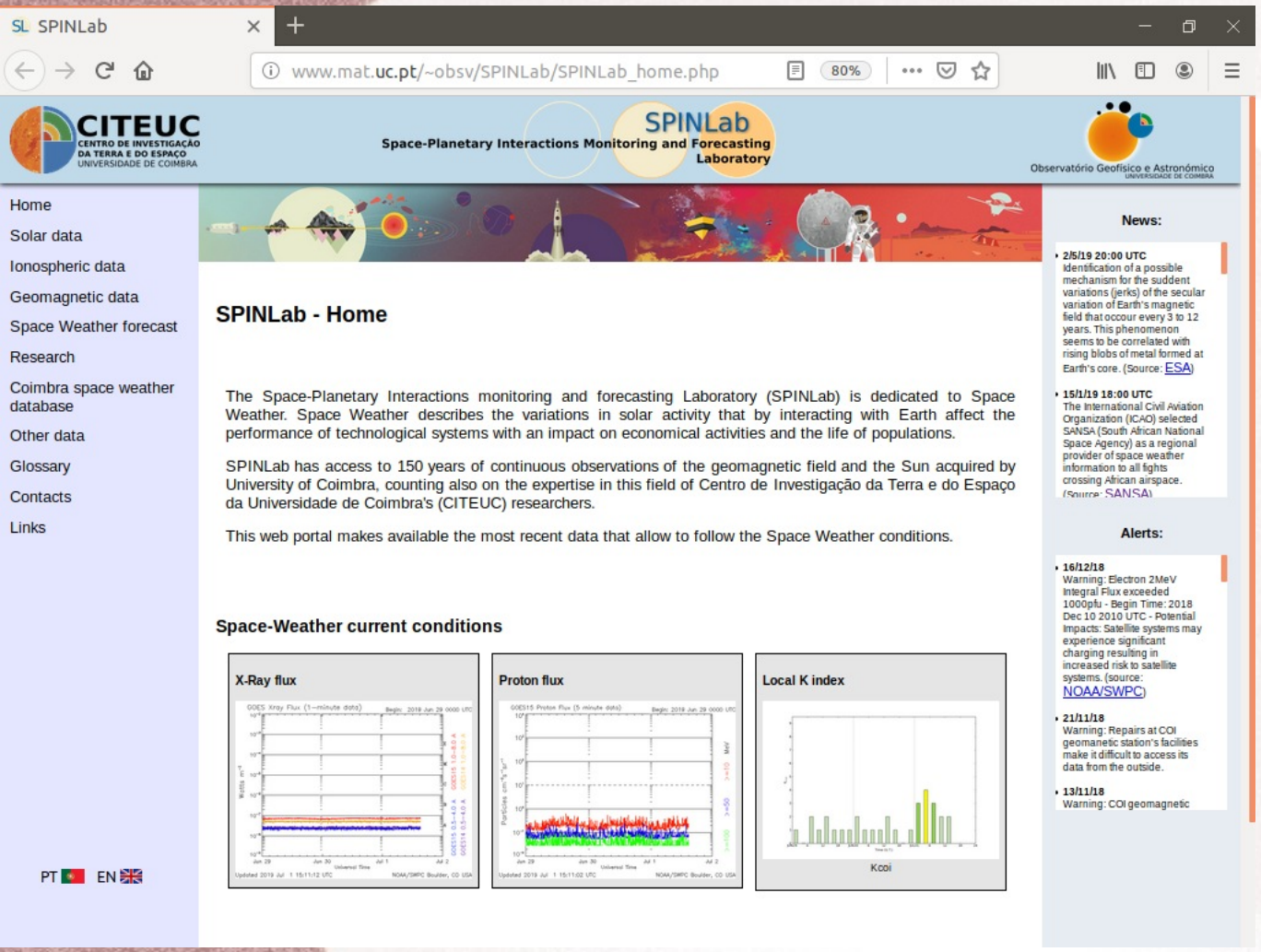


What about Portugal/Coimbra?

SPINLab

- OGAUC's produces solar and geomagnetic observations relevant for the study of S.W.
- CITEUC's know-how in wide array of fields:
  Astrophysics, Geophysics, Remote sensing, Geology, Physics. Mathmatics, etc.
- Decided to create a laboratory for the monitorization and mitigation of SW effects: Space-Planetary Interactions Monitoring and Forecasting Laborator
  Pi: T. Barata & J. Fernandes
- Service to be used as a support to human activities
- Feb. 2018 - web portal for the monitorisation of SW events:
  http://mat.uc.pt/~obsv/SPINLab/SPINLab_home.php

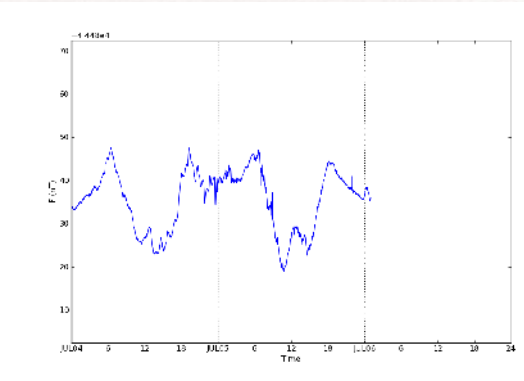
SPINLab portal



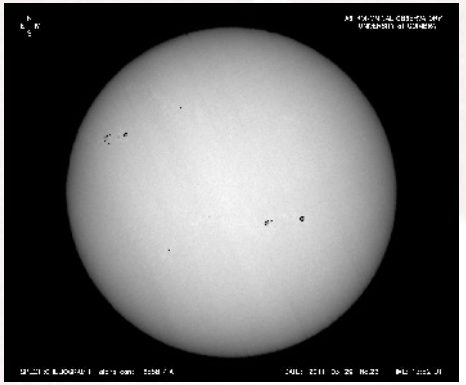
- OGAUC's solar & geomagnetic obs.
- CITEUC & UNINOVA's processed data
- Relevant data from other sources: NOAA, NASA, DLR, SILSO, WDC-Kyoto, GFZ-Potsdam, etc.
- NOAO/SWPC's forecast

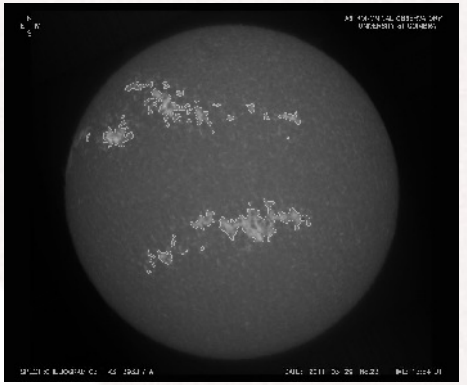
SPINLab portal

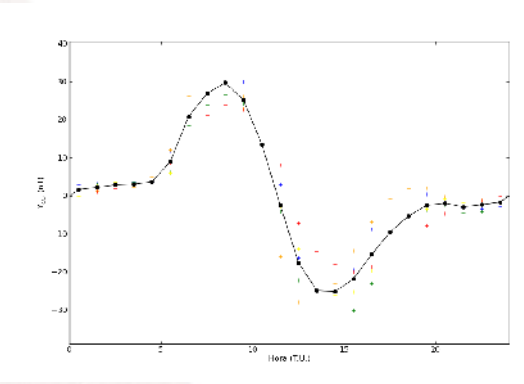
- OGAUC



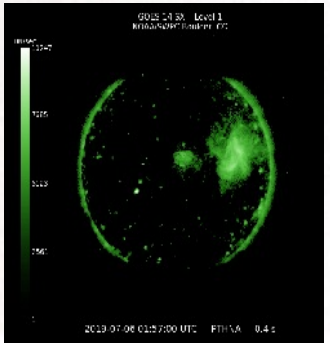
- CITEUC

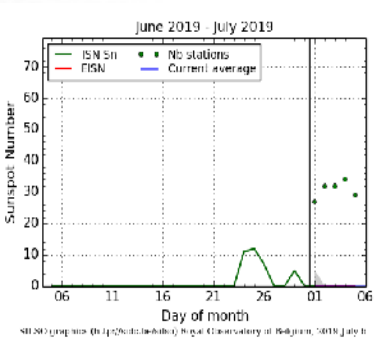


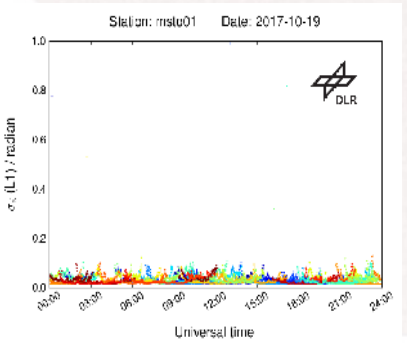


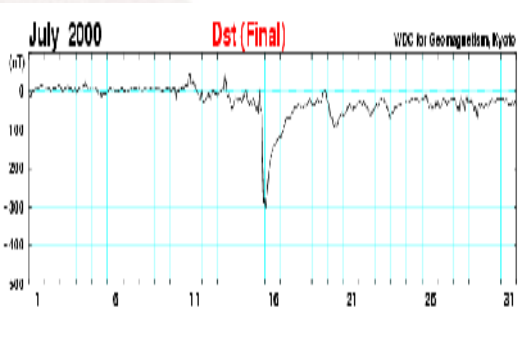


- Other









SPINLab portal

CITEUC CENTRO DE INVESTIGAÇÃO DA TERRA E DO ESPAÇO UNIVERSIDADE DE COIMBRA

SPINLab Space-Planetary Interactions Monitoring and Forecasting Laboratory

Observatório Geofísico e Astronómico UNIVERSIDADE DE COIMBRA

- Home
- Solar data
- Ionospheric data
- Geomagnetic data
- Space Weather forecast
- Research
- Coimbra space weather database
- Other data
- Glossary
- Contacts
- Links

PT EN

Light pollution

Zenithal night sky brightness is one of the most used measurements of the level of light pollution on a given place. Using the standard measurement of magnitude per squared arcsecond (mag/arcsec^2 or mpsas), higher values represent darker skies. Far from light pollution sources, it is possible to reach above 22 mpsas on clear moonless nights, during astronomical night (Sun 18° below the horizon). That is the case of a pristine sky, nowadays rare. By contrast, the values of measurements over a light polluted city centre under the same astronomical conditions may not exceed 18 or 19 mpsas.

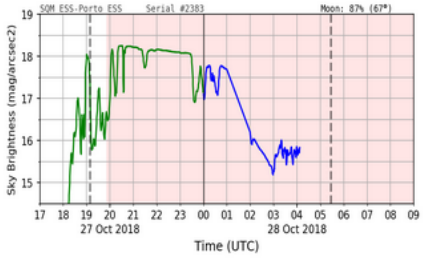
The measurements of the night sky brightness are dependent of the presence of clouds. Every estimate of the light pollution on a given place has to attend to this factor. The presence of clouds can be inferred from the graphs. On a strongly light polluted site, artificial light is reflected off the clouds increasing the total night sky brightness, when values as low as 14 or 13 mpsas could be reached. On a dark sky site, the opposite happens: clouds block the tenuous light from the stars, the natural skyglow and the Milky Way. In those circumstances, values could reach 23 mpsas.

Our measurements are taken every night using dedicated photometers, Unihedron Dark Sky Meters (one SQM-LU model, mounted at the Astronomical Observatory of Coimbra, and one SQM-LR model, installed at Escola Superior de Saúde do Politécnico do Porto). The SQM mounted at Escola Superior de Saúde do Politécnico do Porto courtesy of Salvador Barà – Facultade de Física da Universidade de Santiago de Compostela, Galicia. Open access data. Please credit as: "Data from Raul C. Lima (CITEUC & ESS- PPorto), available from the Space Weather service SPINLab (Space-Planetary Interactions Monitoring and Forecasting Laboratory)."

The plots are produced using the free software PySQM. PySQM is a multi-platform, open-source software designed to read and plot data from Unihedron SQM-LE and SQM-LU photometers, giving as output files complying with the International Dark Sky Association (IDA) NSBM Community Standards for Reporting Skyglow Observations (http://www.darksky.org/night-sky-conservation/248). PySQM is distributed under GNU GPL, either version 3 of the License, or (at your option) any later version. See the file LICENSE.txt for details. This software has been developed by Mireia Nievas (UCM) with the invaluable help of: Jaime Zamorano (UCM), Laura Barbas (OAN) & Pablo de Vicente (OAN).

Coordinates of the SQM at ESS-PPorto: Porto, 41.17734693977744N, - 8.606102155804138, alt. 109 m

Sky brightness



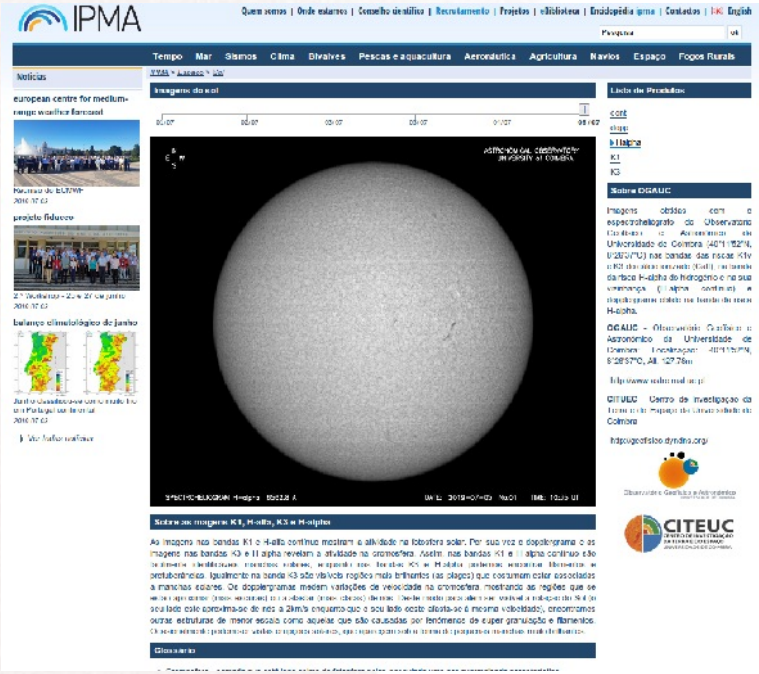
FCT Fundação para a Ciência e a Tecnologia MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

COMPETE 2020 PORTUGAL 2020 UNIÃO EUROPEIA Fundo Europeu de Desenvolvimento Regional

- Other observ.:
  light pollution
  COI seismic data
- CITEUC's S.W. publications & communications
- S.W. Glossary
- Links

S.W. beyond SPINLab

- UC's data shared with IPMA



- Outreach & Education

ISWI's goals include outreach & education
Pt coordinator: T. Barata (mtbarata@gmail.com)

Outreach activities incl. school/public visits, participation in events (e.g. Ciência Viva no Verão)

PhD & MSc thesis: Y. Castillho, J Domingos, S. Carvalho, A. Vasconcelos, S. Gomes, C. Francisco

What else?

Solar Risk Service - PTTI

- Portuguese Technology Transfer Initiative

esa IPN FCT Fundação para a Ciência e a Tecnologia

- Identification of best business opportunities in oil, gas & aviation

PRESENT TECHNOLOGIES CITEUC bluecower DCventures

EUC's coord. T. Barata

Air navigation

- ILS landing procedures are being replaced by GNSS procedures
- These are subject to S.W. events and jamming
- No European company currently addressing this issue

SWAIR – ESA Small ARTES

- 2015
- Viability study
- Identification of stakeholders
- CITEUC's coord. T. Barata

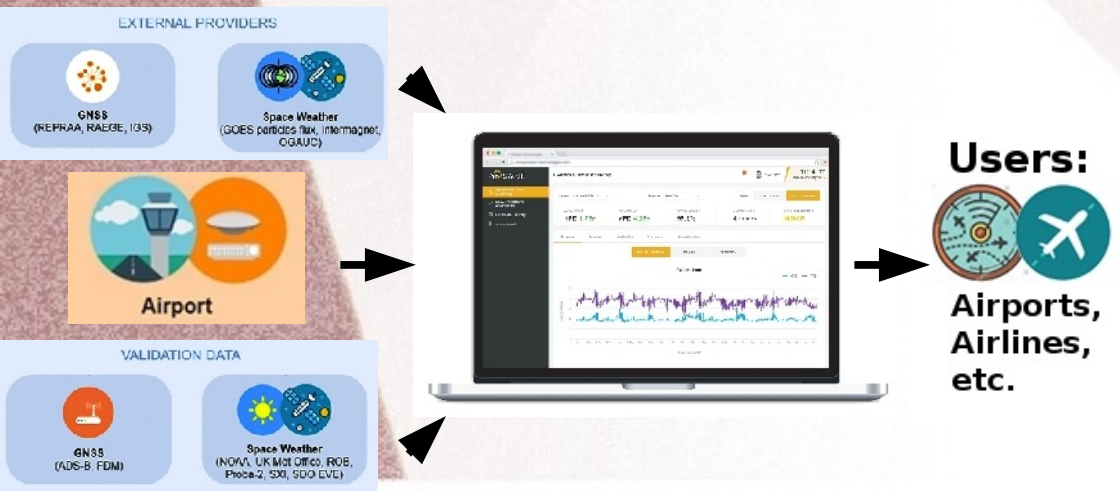
PRESENT TECHNOLOGIES bluecover CITEUC

SWAIR – ARTES 20 Demonstrator

- 2017
- 600 k€
- UC's contribution:
  - UC's solar and geomagnetic data
  - CITEUC's know-how incl. S.W., data processing & analysis
- CITEUC's coord.: T. Barata

Other collaborators:

SWAIR – ARTES 20 Demonstrator

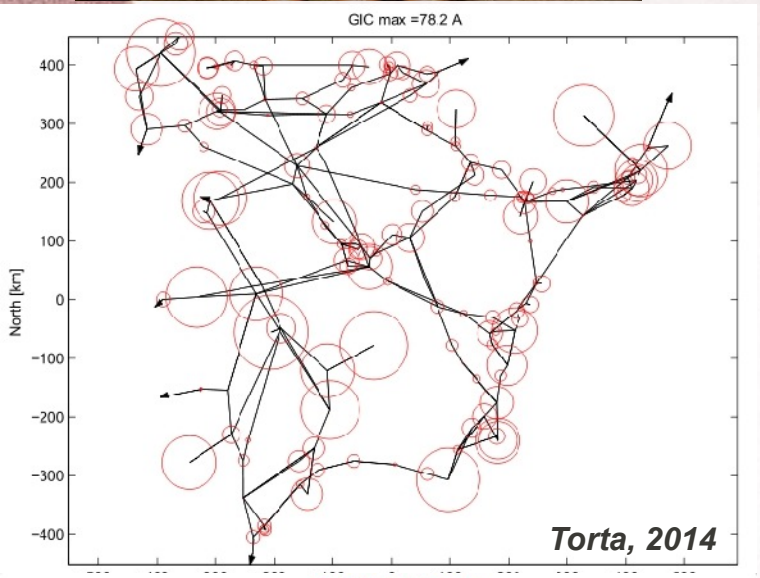


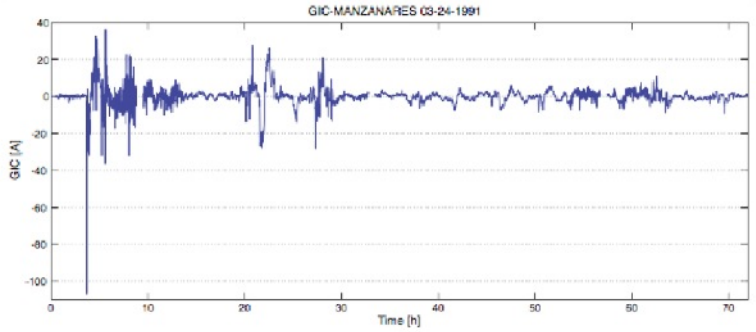
- **Milestones:**
  - **Baseline Design (actors & requirements)**
  - **System Architecture and prototyping**

https://swair.ptech.io/

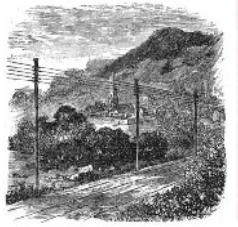
That's not all!

Geomagnetic Induced Currents





- Geomanetic storms can induce currents in high voltage power grid (GICs), that enter through the grounding points → power transf.
- Despite being associated with high latitudes, intermediate latitude coutries are conducting their own GIC studies
- What about Portugal?
  (GIC accouts in telegraph lines)



FCT's 2017 call:

MAG-GIC - Geomagnetically induced currents in Portugal mainland (PTDC/CTA-GEO/31744/2017)

~240k€

PI: M.A. Pais (CITEUC)

Partnership: CITEUC CENTRO DE INVESTIGAÇÃO DA TERRA E DO ESPAÇO UNIVERSIDADE DE COIMBRA; INSTITUTO DOM LUIZ

- **Project to assess the risk of GICs on the national high voltage power network**
- **Identification of magnetospheric currents causing GICs at intermediate latitudes**
- **Magnetotelluric survey of Portugal**
- **Transfer of COI magnetic station**

MAG-GIC partners/tasks:

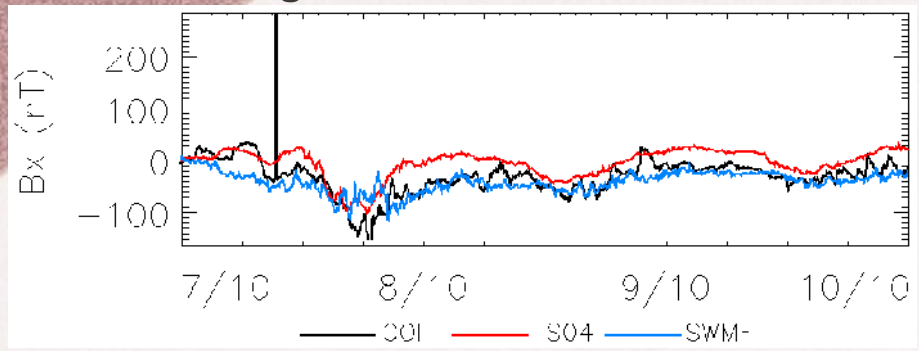
- **Relocation of the COI magnetic station (P. Ribeiro, CITEUC)**
- **Analysis of GIC inducing sources (A. Morozova, CITEUC)**
- **Crustal conductivity models (F. Santos, IDL)**
- **GIC simulations in the power grid (F. Pinheiro, CITEUC)**
- **Identification of magnetospheric GIC sources (M.A. Pais)**
- **Extra: detector for GIC measurements (J. Cardoso, UC)**

Other participants: J. Fernandes (CITEUC), M. Miranda (IDL/IPMA), J. Ribeiro

Collaborators/consultants: J. Cruz (IPMA), M. Mandea (IAGA), M. Torta,

Computing MAG-GICs

Geomagnetic storm data



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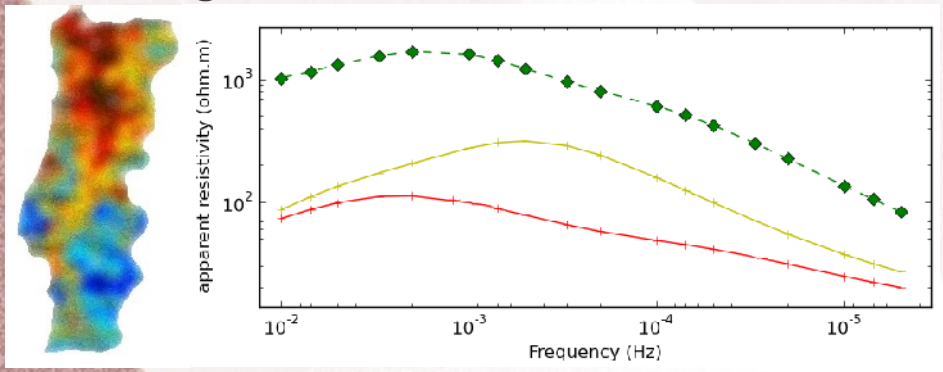
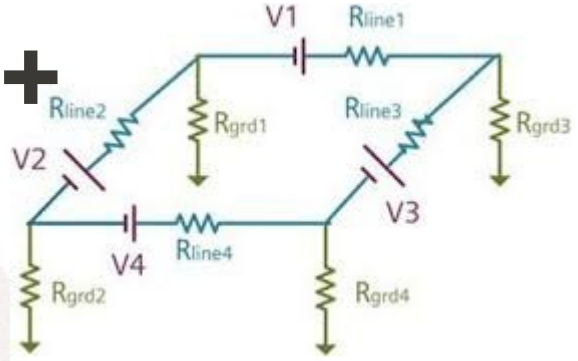
Magnetotelluric model

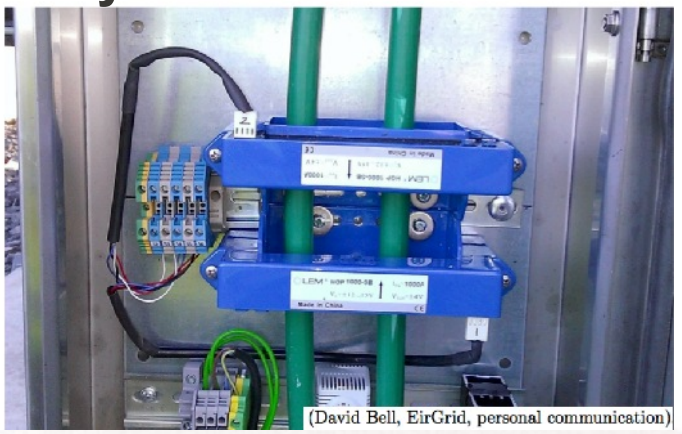


$$\begin{bmatrix} E_x & E_y \end{bmatrix} = \frac{1}{\mu_0} \begin{bmatrix} Z_{xx} & Z_{xy} \\ Z_{yx} & Z_{yy} \end{bmatrix} \begin{bmatrix} B_x & B_y \end{bmatrix}$$

+



Reality check...


(David Bell, EirGrid, personal communication)

Bonus: scientific outputs

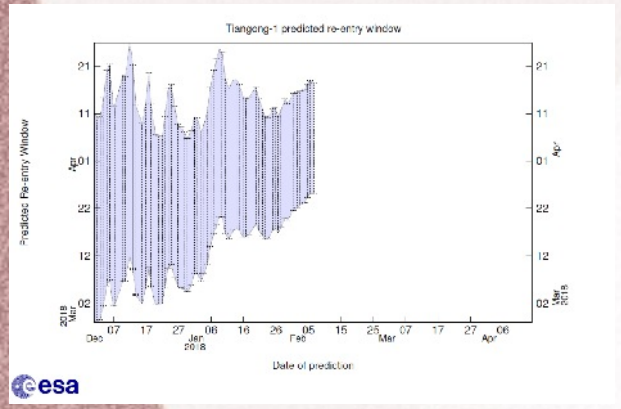
@ EGU General Assembly 2019:

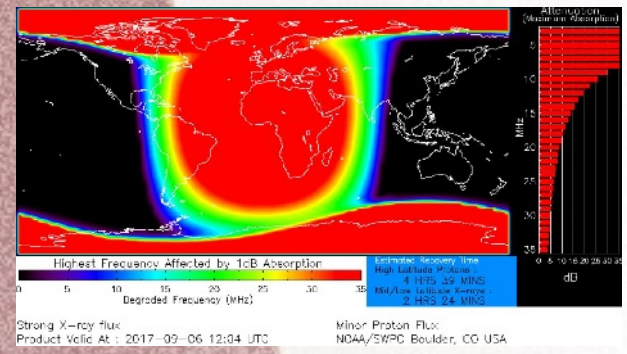
- Ionosphere vertical TEC calculated from GNSS receiver data in Lisbon: comparison with observations, T. Barlyaeva, T. Barata, A. Morozova (SWAIR)
- Scaning the crust with magnetospheric currents; F. Pinheiro, F. Santos, M. Pais, A. Morozova, P. Ribeiro, Y. Castillo, C. Francisco, J. Fernandes, M. Miranda (MAG-GIC)

in the near future:

- **MAGIBER** (Sep. 2019): Observatórios e Estações magnéticas em Portugal: entre a tradição e a modernidade; P. Ribeiro, J. Cruz., F. Pinheiro, M. Pais, M. Cruz
- **ESWW** (Nov. 2019): Geomagnetic induced currents in south-western Iberia. F. Pinheiro, J. Ribeiro, F. Santos, M. Pais, A. Morozova, P. Ribeiro, Y. Castillo, C. Francisco, J. Fernandes

Future





- **Furter developments of SPINLab: tools, calibrated data, applications...**
- **Several sectors remain unexplored → New partnerships to develop...**
- **CITEUC has the skills and willpower to tackle these challenges**

"His move testifies of a broader scientific view and of a flexible approach to problem solving"
FCT evaluation panel

Conclusions

- SW can have inpact in Portuguese human activities
  → threat & opportunity
- Portuguese fundamental space science institutions can generate knowledge with societal applications
- CITEUC is a good example of that: SWAIR (global nav.) & MAG-GIC (power transmission)
- Applied science projects can still be used to achieve fundamental science results
  just be creative!...

Thank you!!!

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