SOLID - First European Comprehensive SOLar Irradiance Data Exploitation

Margit Haberreiter

SORCE Meeting, Jan 28-31, 2014  Margit Haberreiter
Thanks to the SOLID Team

Kick-off Meeting at PMOD/WRC
February 12-14, 2013

Annual Meeting in Orleans, France

http://projects.pmodwrc.ch/solid/

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SOLID Motivation I – Overlapping data and models do not agree

Ermolli et al., 2013, ACP
SOLID Motivation II –
Scattered SSI Data

Courtesy, T. Dudok de Wit
SOLID Aim – Homogeneous Data Set

Towards the end of SOLID -> gaps should be filled!

Courtesy, T. Dudok de Wit
SOLID in a nutshell

- **SOLID**: First European Comprehensive SOLar Irradiance Data exploitation
- **Goal**: provide a consistent SSI time series from the EUV to IR with error bars
- **Approach**: use all existing SSI and proxy data complemented with models to fill temporal and spectral gaps
- **Coordinator**: PMOD/WRC (W. Schmutz, Projekt Manager M. Haberreiter)
- **Partners**: 9 institutes from 7 Countries (CH, FR, BE, UK, DE, EL, IT)
  + 1 US collaborator (LASP)
- **Start**: December 2012; **Duration**: 3 years
# Codes/Short names of European Countries

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http://publications.europa.eu/code/pdf/370000en.htm#pays
SOLID – How do we address the problem

SOLID

ESA Observations (SOHO, ENVISAT, PROBA2, PICARD) + NASA missions and ground-based observations

WP2: Irradiance data exploitation

WP3: Solar Image Analysis

WP4: SSI Modeling based on observed proxies

WP5: SSI Modeling based on modelled proxies

WP6: Interaction with user communities

WP8: Dissemination

Scientific community workshops

WP7 Scientific and Technical Management

WP1 Management

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Interaction with user communities

WP2
SSI and TSI
EUV/UV spectra

WP3
WP4
WP5
proxies
data

WP6
Interaction with communities

WP8
Dissemination

atmospheric research
end-users
photobiology
modeling groups
space weather
ionosphere thermosphere

pmod wrc
SOLID Webpage

http://projects.pmodwrc.ch/solid/

- Database
- Wiki
- Deliverables

Get involved or email to margit.haberreiter@pmodwrc.ch
SOLID – What exactly we do

• Use existing
  – irradiance and proxy data
  – models for irradiance reconstruction

  – “Stitch it all together”

  – i.e. find an objective method to obtain the most correct SSI time series
SOLID – SSI Data Assessment

Solar irradiance at 180nm

Talks by Matthieu Kretzschmar and Micha Schöll

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SOLID – Modelling to fill the gaps

• Empirical modelling
  – Principal Component Analysis, Single Value Decomposition, MOCASSIM, MGNM

• Semi-Empirical Modelling
  – Combine synthetic spectra based on solar image analysis
  – SATIRE, COCOSIS, SOLMOD, OAR
Image Segmentation within SOLID

SOHO/EIT solar images were taken on 29/10/2003 (a) EIT 171 at 15:23UT (b) EIT 195 at 22:12UT (c) EIT 284 at 15:29UT (d) EIT 304 at 15:42UT.

SOHO/MDI solar images were taken on 29/10/2003 (a) MDI Continuum at 22:24UT and (b) MDI Magnetogram at 22:27UT.
Image Segmentation within SOLID

PROBA2/SWAP

Rome / PSPT
Reconstruction of EUV variations

\[ S(\lambda, t) = \frac{1}{N(t)} \frac{\pi R^2}{D^2} \sum_{i,j} N_j(r_i, t) \cdot I_j(r_i, \lambda) \]

\( i \): index concentric rings \( r_i \) \\
\( j \): index class (feature)

\( I_j(r_i, \lambda) \): Intensity for each feature and position on the solar disk
Solar Modeling (SOLMOD) code

- **Multi level atoms**
  - 373 ions, from H to Ni with ioncharge 25
  - ~14’000+ atomic levels
  - ~170’000+ spectral lines
  - Statistical equation is solved to get the level populations

- **Chromosphere and transition region**
  - Fontenla et al., 2009 atmosphere structures -> to be updated
  - for ioncharge ≤ 2:
    - full NLTE (Fontenla et al., 2009)

- **Corona**
  - Coronal structures (Haberreiter, 2011, 2012)
  - ioncharge >2
  - optically thin, i.e. collisions and spontaneous emission (updated to latest Chianti v7.1.9)
  - Line of sight integration accounts for opacity
  - **Spherical symmetry**
Irradiance Reconstruction – Synthetic EUV Spectra

- Quiet Corona (QS1)
- Quiet Coronal Network (QS2)
- Active Coronal Network (AR1)
- Hot loops (AR2)
- Super hot loops (AR3)

Wavelength (nm)

Irradiance (erg cm^{-2} s^{-1} nm^{-1})

- Quiet Corona (QS1)
- Quiet Coronal Network (QS2)
- Active Coronal Network (AR1)
- Hot loops (AR2)
- Super hot loops (AR3)
SOLMOD spectrum compared with EVE spectrum

Haberreiter, 2011, Solar Physics
SOLMOD Contrast at EIT passbands

Contrast of SOLMOD spectra for the EIT 171 and 195 passbands
EIT Image segmentation with SPOCA tool

Courtesy Veronique Delouille, Benjamin Mampeay, ROB, BE
Area coverage of EIT features

Haberreiter et al., 2014, SWSC, under review
SOLMOD Reconstruction versus SOHO/SEM observation

Haberreiter et al., 2014, SWSC, under review
SOLMOD Reconstruction versus SOHO/SEM

Missing some variability

AR2 and AR3 are represented by the brightest model (AR3)

Reasons: Background radiation from chromosphere and transition region needs to be added
SOLID – Assessing Atomic Data
Additional atomic data: N I, C I, S I

Top: SOHO/SUMER QS spectrum
Bottom: CHIANTI spectrum

Green: CHIANTI 7
Black: CHIANTI 8 including C I and S I, and the changes in N I

Courtesy Giulio Del Zanna
MDI Segmentation with the ASAP tool

Segmentation Map for Jan 7, 2003 MDI
umbra (red), penumbra (cyan)
faculae (yellow) active network (blue)

SWSC, under review
SOLID – Webpage and Database

http://projects.pmodwrc.ch/solid-visualization/makeover/
ST1.4 Solar irradiance variability: Measurements, Models, Proxies, and Causes.

Convener: Matthieu Kretzschmar
Co-Conveners: Margit Haberreiter, Marty Snow
Invited Speakers: Maria Dasi Espuig, Gerard Thuillier, Kok Leng Yeo

CL5.12: Solar Influence on the Middle Atmosphere and Dynamical Coupling to the Troposphere and the Ocean

Convener: Katja Matthes
Co-Convener: Margit Haberreiter (TOSCA and SOLID session)
Invited Speakers: Matthieu Kretzschmar, Nick Dunstone, Daniel Mitchell
Upcoming Newsletter

ANNUAL NEWSLETTER | Issue 1

first european comprehensive solar irradiance data exploitation

Newsletter #1

Greetings from SOLID

http://projects.pmodwrc.ch/solid/

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Questions
Advisory Panel

Katja Matthes
GEOMAR/Helmholtz-Zentrum für Ozeanforschung, Kiel, Germany

Farzad Kamalabadi:
University of Illinois, USA

Matt de Land:
Science Systems and Applications, USA
WP7: Upcoming SOLID Events

- **Error Analysis Workshop**
  - held at Imperial College London
  - March/April 2014

- **2\textsuperscript{nd} SOLID Annual Assembly**
  - planned for Oct/Nov 2014

- **TOSCA/SOLID School**
  - in collaboration with TOSCA (COST ES1005)
  - Exact date TBD
# SOLID - Consortium

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<td>IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE</td>
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<td>ISTITUTO NAZIONALE DI ASTROFISICA</td>
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<td>THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE</td>
<td>UCAM</td>
<td>United Kingdom</td>
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<tr>
<td>10</td>
<td>ARISTOTELIO PANEPISTIMIO THESSALONIKIS</td>
<td>AUTH</td>
<td>Greece</td>
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Irradiance Reconstruction back to 1874

SoHO/MDI magnetogram (left) and simulated magnetogram (right) and for July, 24 2004.
Courtesy Maria Dasi
In collaboration with N. Krivova, S. Solanki, and Y. Unruh
Irradiance Reconstruction back to 1874 with SATIRE using Simulated Magnetograms

TSI PMOD composite
Reconstruction WP5
Krivova et al. (2010)