SOLID - First European Comprehensive **SOL**ar **I**rradiance **D**ata Exploitation

Margit Haberreiter

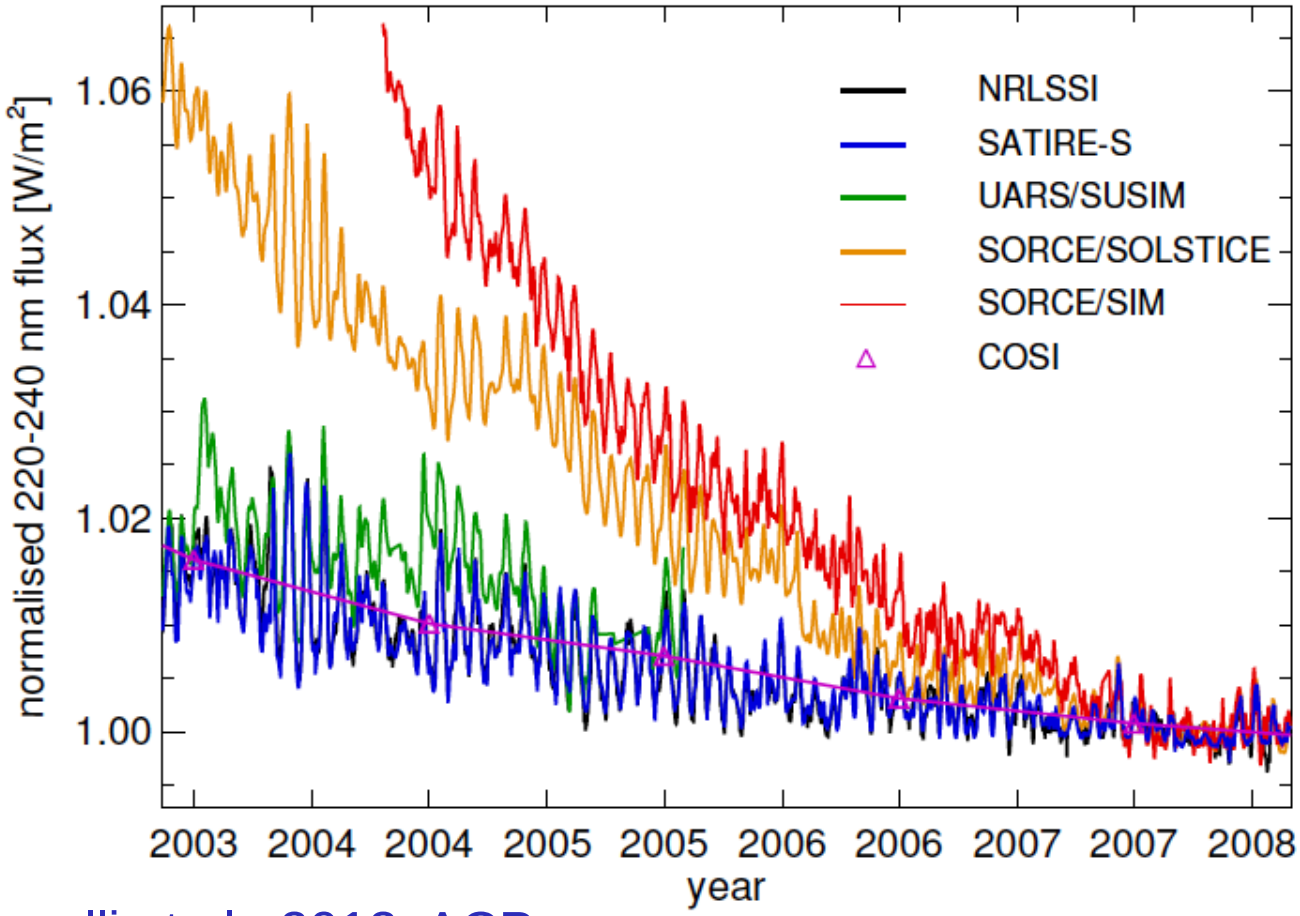
Thanks to the SOLID Team

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

Annual Meeting in Orleans, France

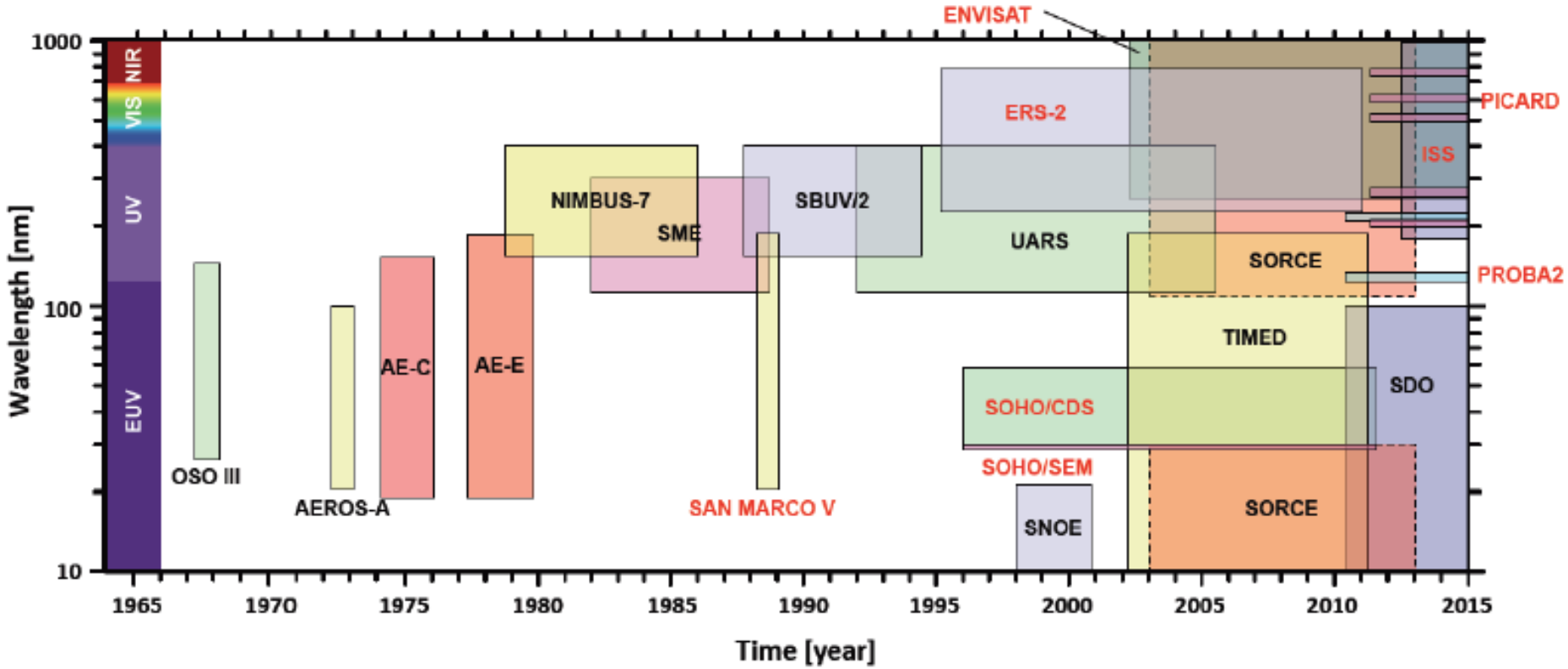
http://projects.pmodwrc.ch/solid/

SOLID Motivation I – Overlapping data and models do not agree



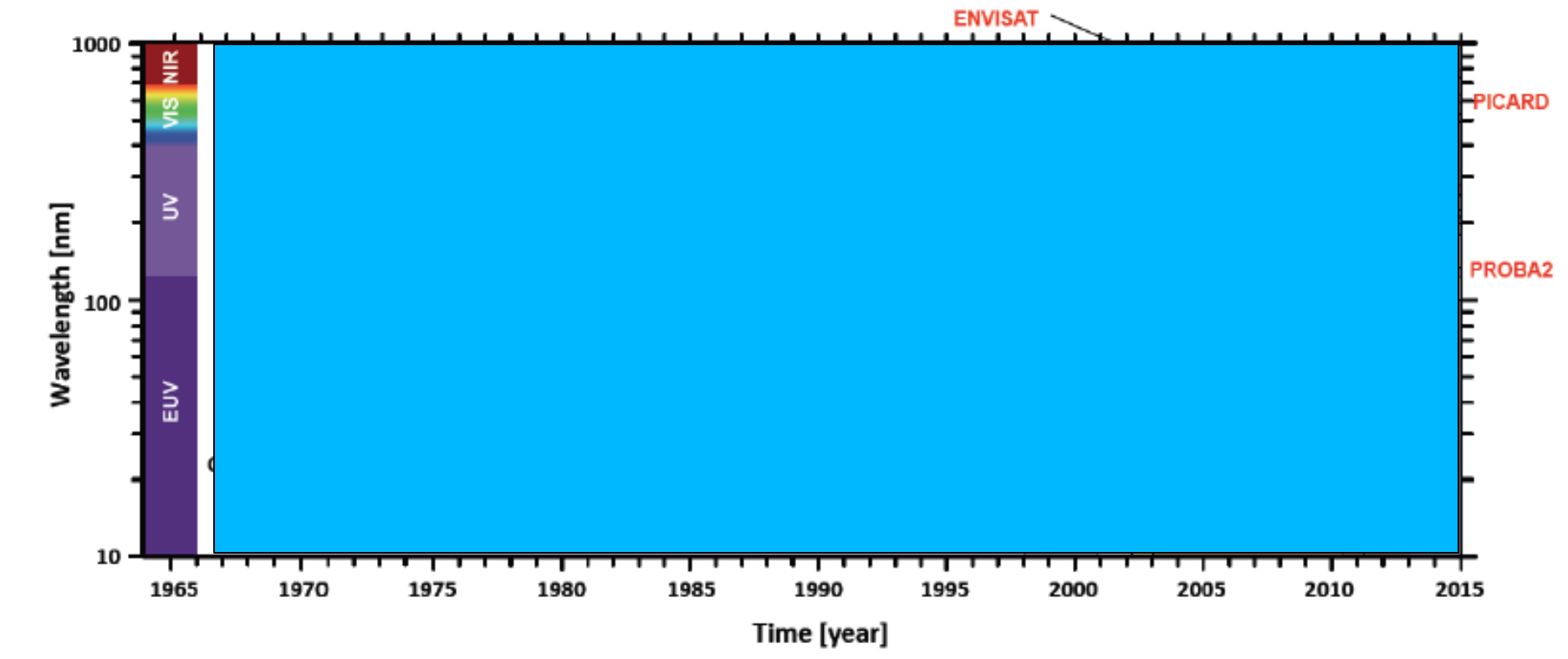
Ermolli et al., 2013, ACP

SOLID Motivation II – Scattered SSI Data



Courtesy, T. Dudok de Wit

SOLID Aim – Homogeneous Data Set



Courtesy, T. Dudok de Wit
Towards the end of SOLID -> gaps should be filled!

SOLID in a nutshell

- **SOLID**: First European Comprehensive **SOL**ar **I**rradiance **D**ata 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)

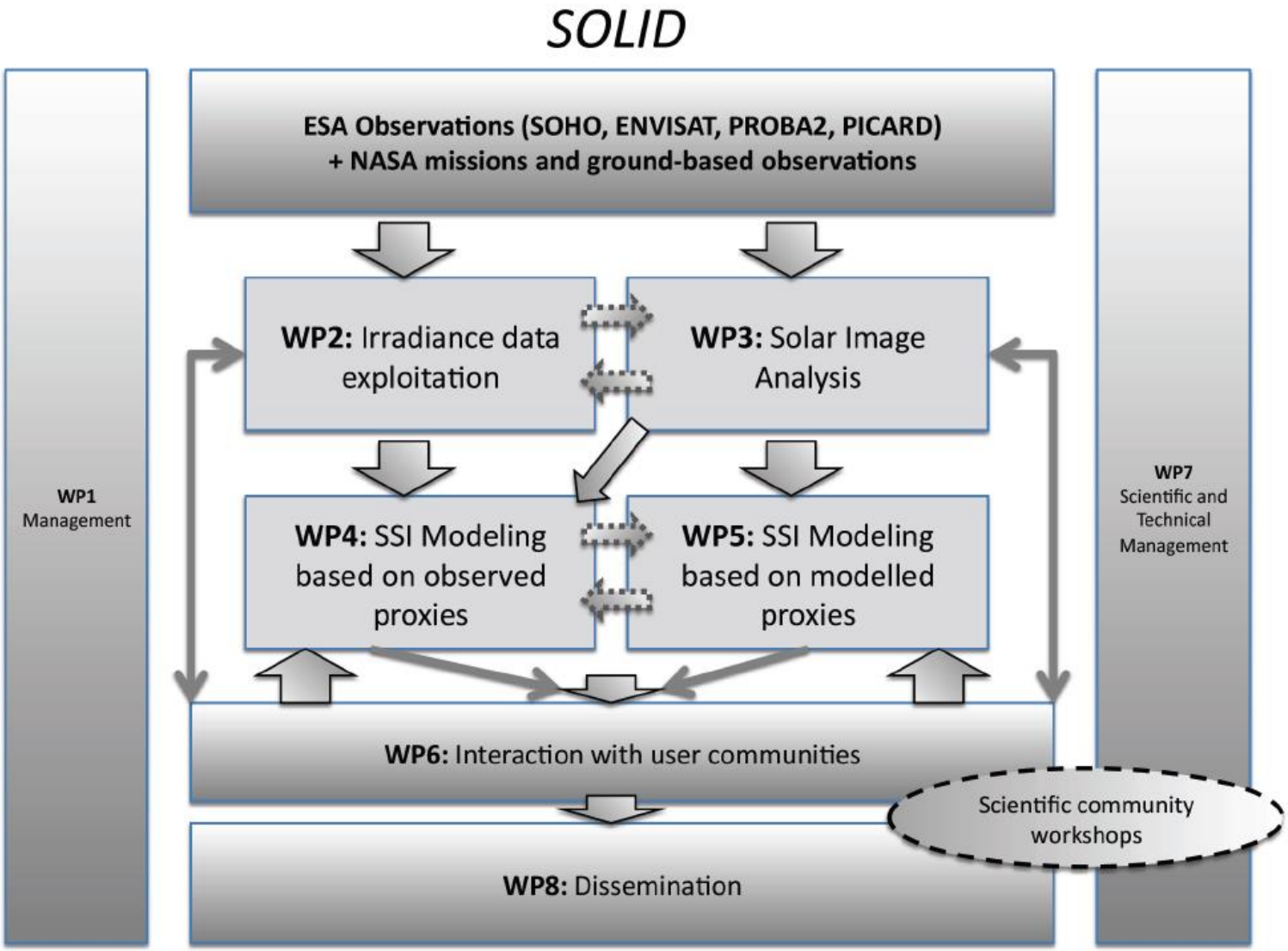
  + 1 US collaborator (LASP)
- **Start:** December 2012**; Duration**: 3 years

Codes/Short names of European Countries

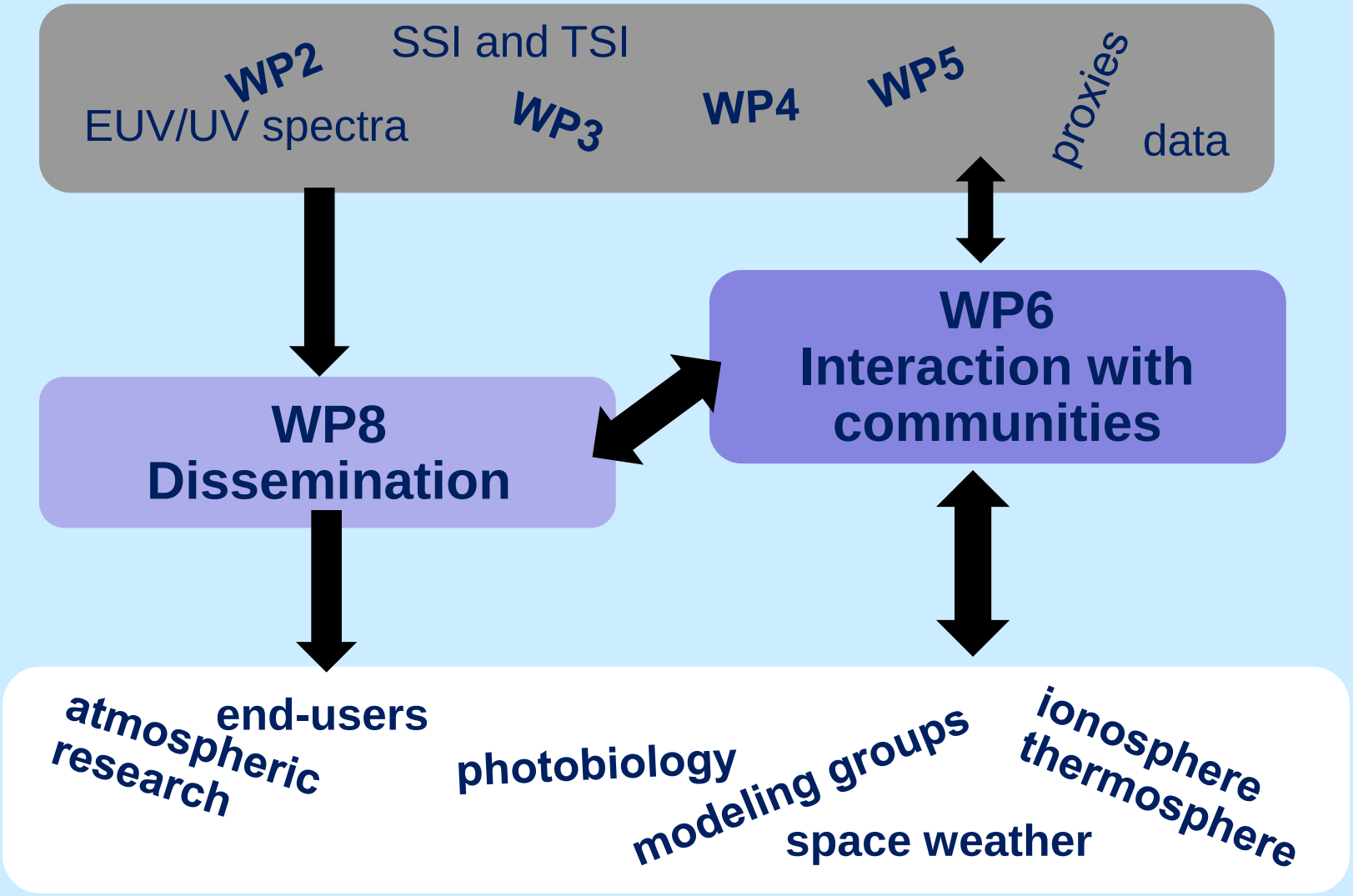
Short name (source language)	Short name (English)	Official name	Code (1)
Belgique/België	Belgium	Kingdom of Belgium	BE
България (*)	Bulgaria	Republic of Bulgaria	BG
Česká republika	Czech Republic	Czech Republic	CZ
Danmark	Denmark	Kingdom of Denmark	DK
Deutschland	Germany	Federal Republic of Germany	DE
Eesti	Estonia	Republic of Estonia	EE
Éire/Ireland	Ireland	Ireland	IE
Ελλάδα (*)	Greece	Hellenic Republic	EL
España	Spain	Kingdom of Spain	ES
France	France	French Republic	FR
Hrvatska	Croatia	Republic of Croatia	HR
Italia	Italy	Italian Republic	IT
Κύπρος (*)	Cyprus	Republic of Cyprus	CY
Latvija	Latvia	Republic of Latvia	LV
Lietuva	Lithuania	Republic of Lithuania	LT
Luxembourg	Luxembourg	Grand Duchy of Luxembourg	LU

http://publications.europa.eu/code/pdf/370000en.htm#pays

SOLID – How do we address the problem



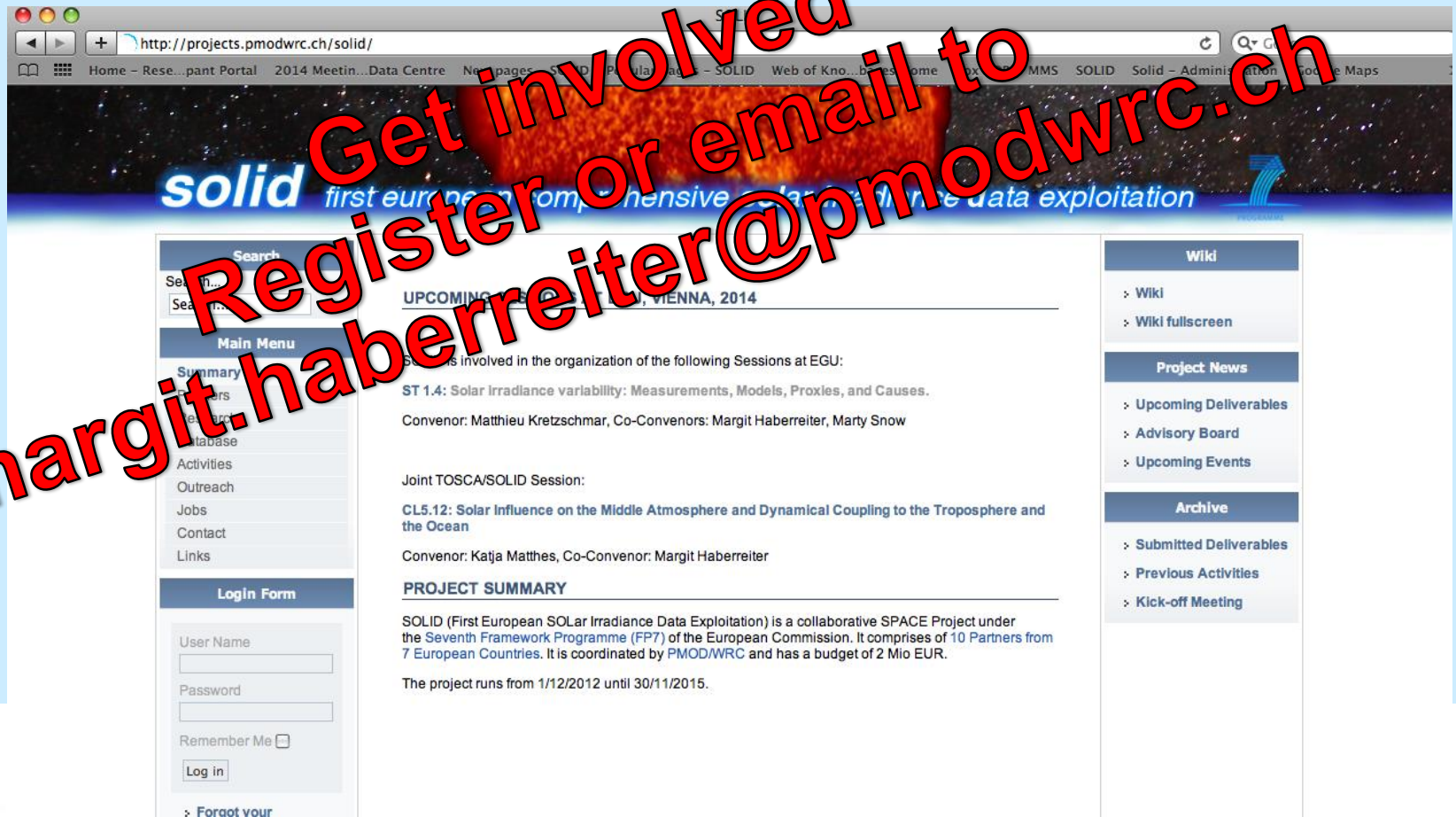
Interaction with user communities



SOLID Webpage

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

- Database
- Wiki
- Deliverables

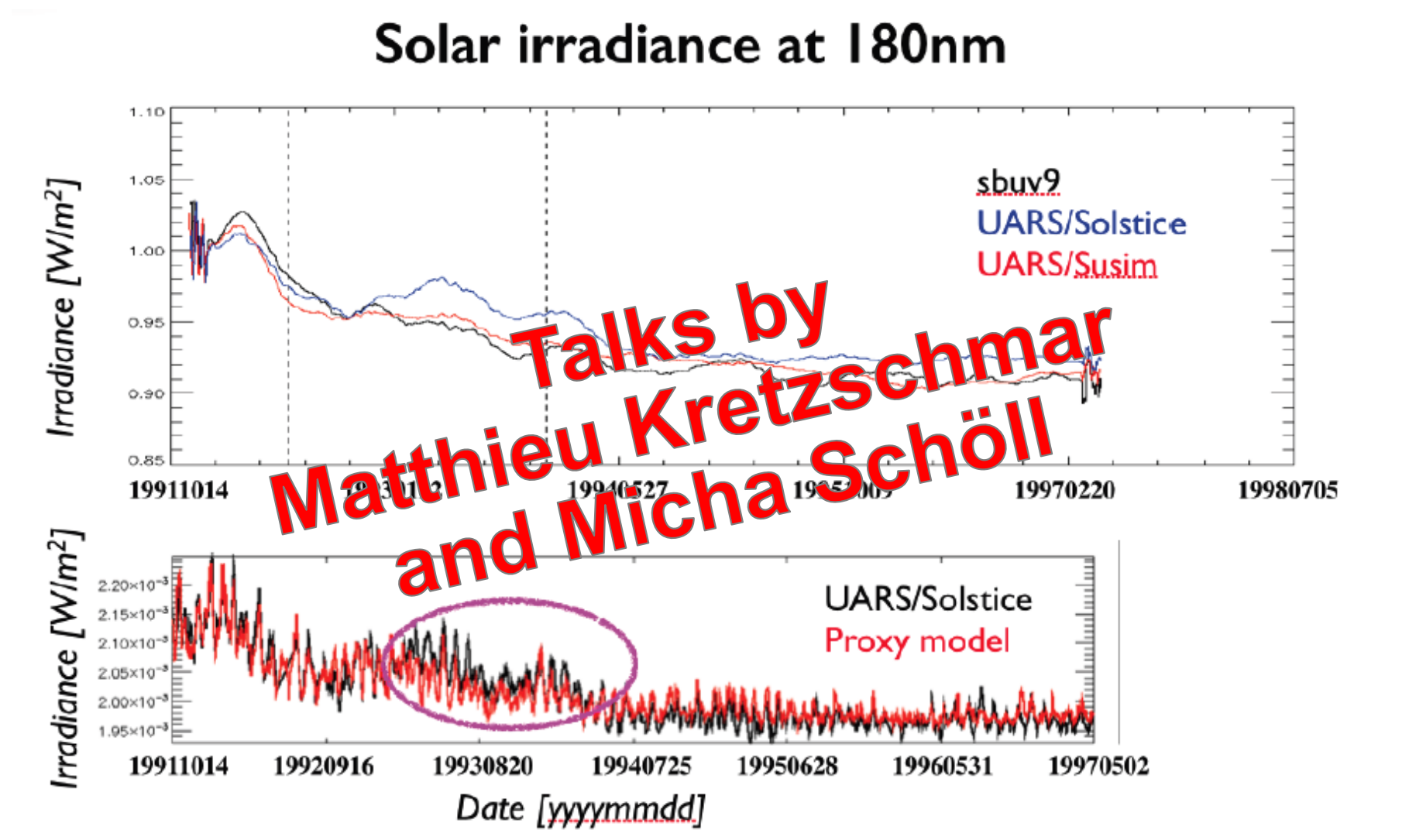


Get involved
Register or email to
margit.haberreiter@pmodwrc.ch

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

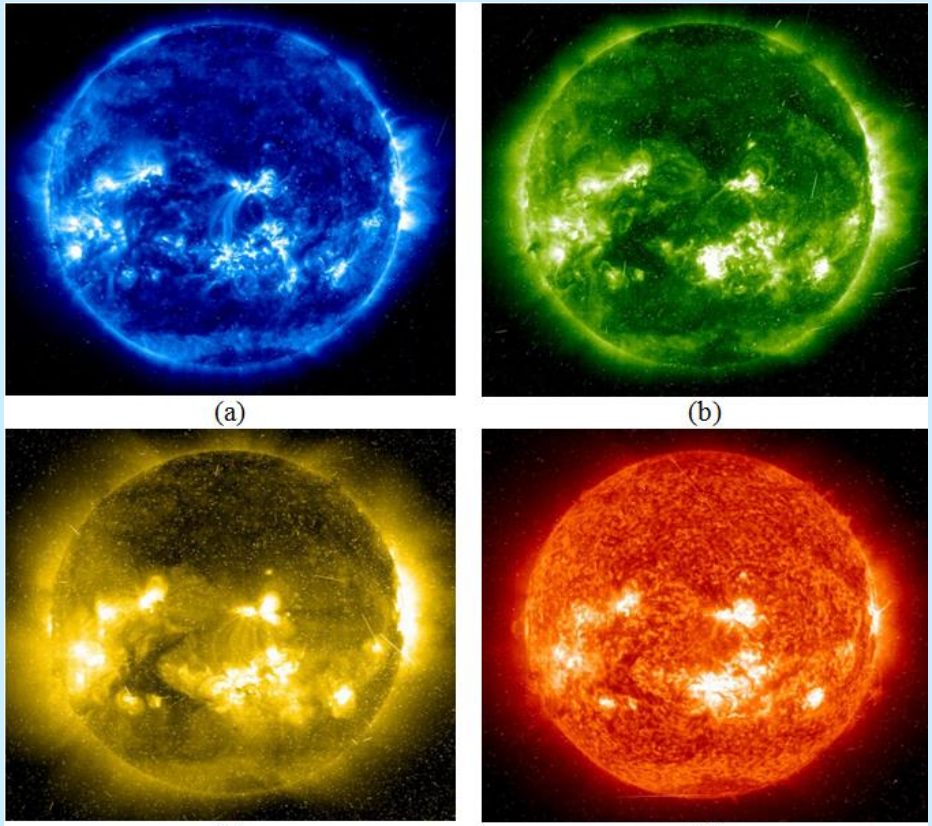


Talks by Matthieu Kretzschmar and Micha Schöll

SOLID – Modelling to fill the gaps

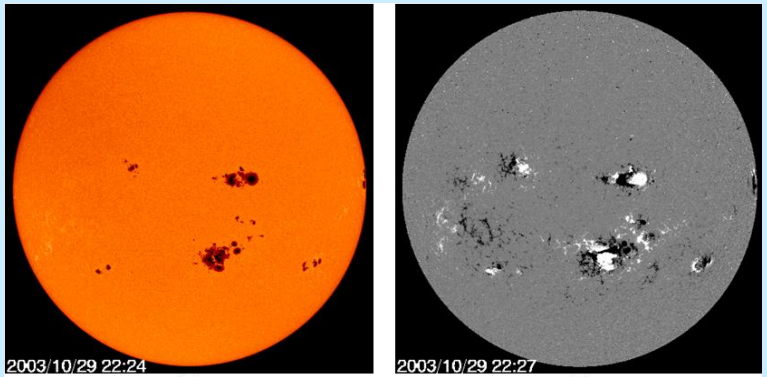
- **Empirical modelling**
  - Principal Component Analysis, Single Value Decomposition, MOCASSIM, MGNM
- **Semi-Empirical Modelling**
  - Combine synthetic spectra based on solar image analysis
  - SATIRE, COCOSIS, SOLMOD, OAR

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/EIT

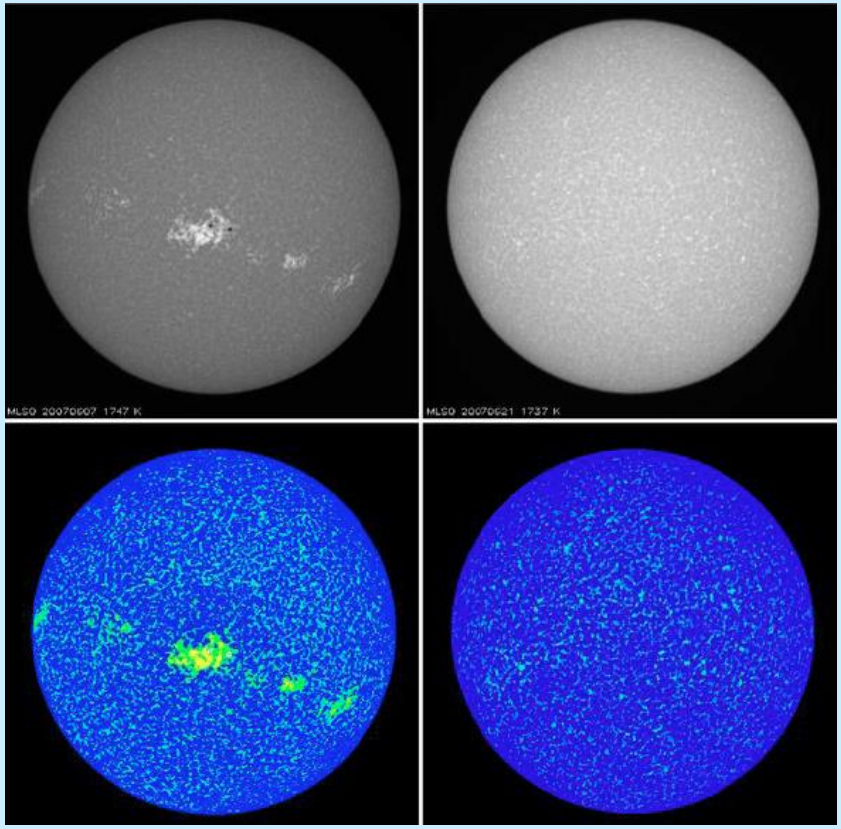


SOHO/MDI solar images were taken on 29/10/2003 (a) MDI Continuum at 22:24UT and (b) MDI Magnetogram at 22:27UT.

SOHO/MDI

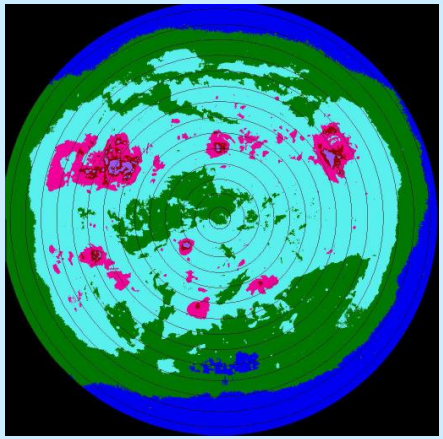
Image Segmentation within SOLID

PROBA2/SWAP



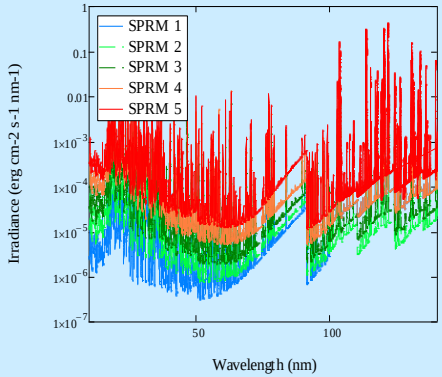
Rome / PSPT

Reconstruction of EUV variations



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

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

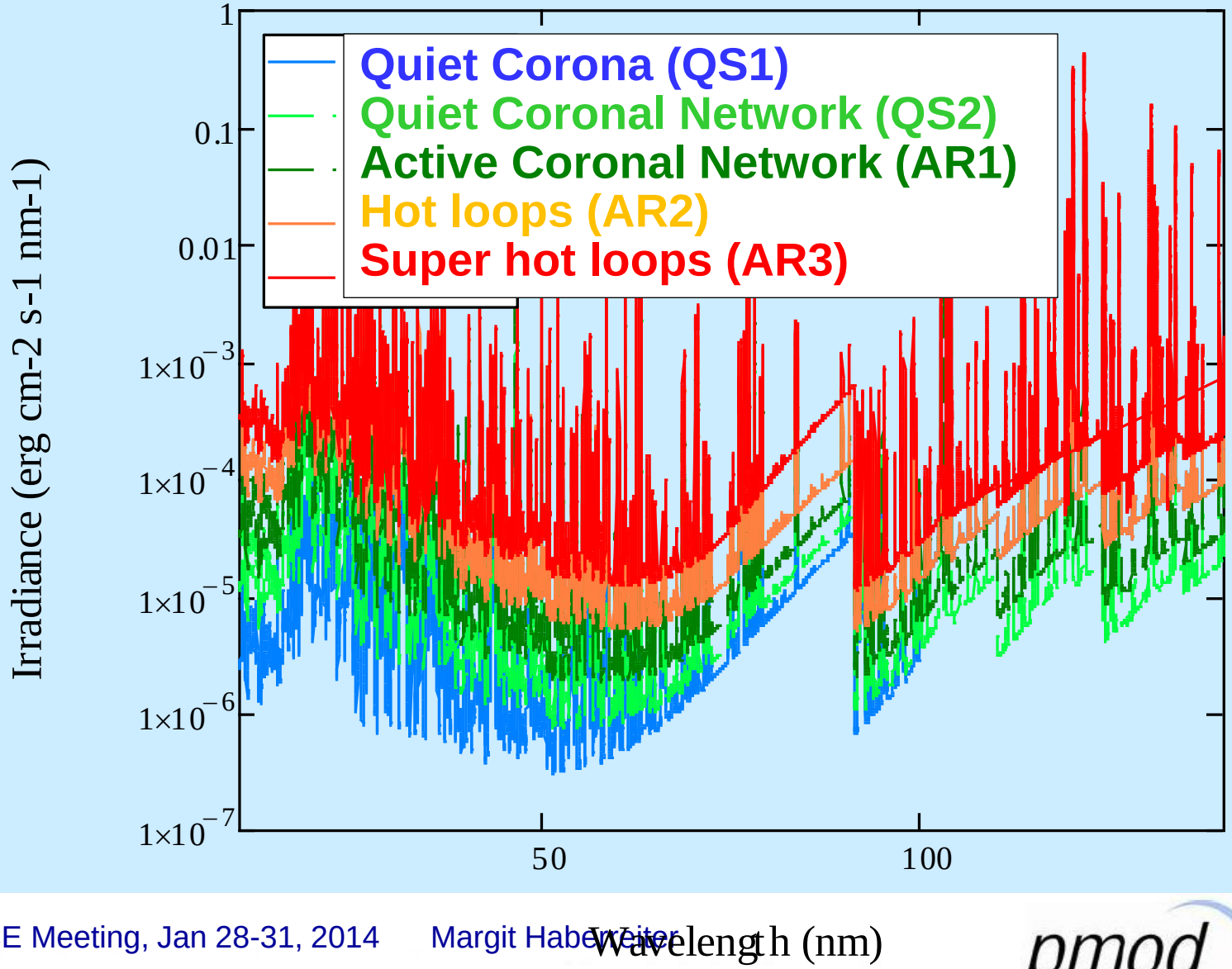


$I_j(r_i,\lambda)$: Intensity for each feature and position on the solar disk

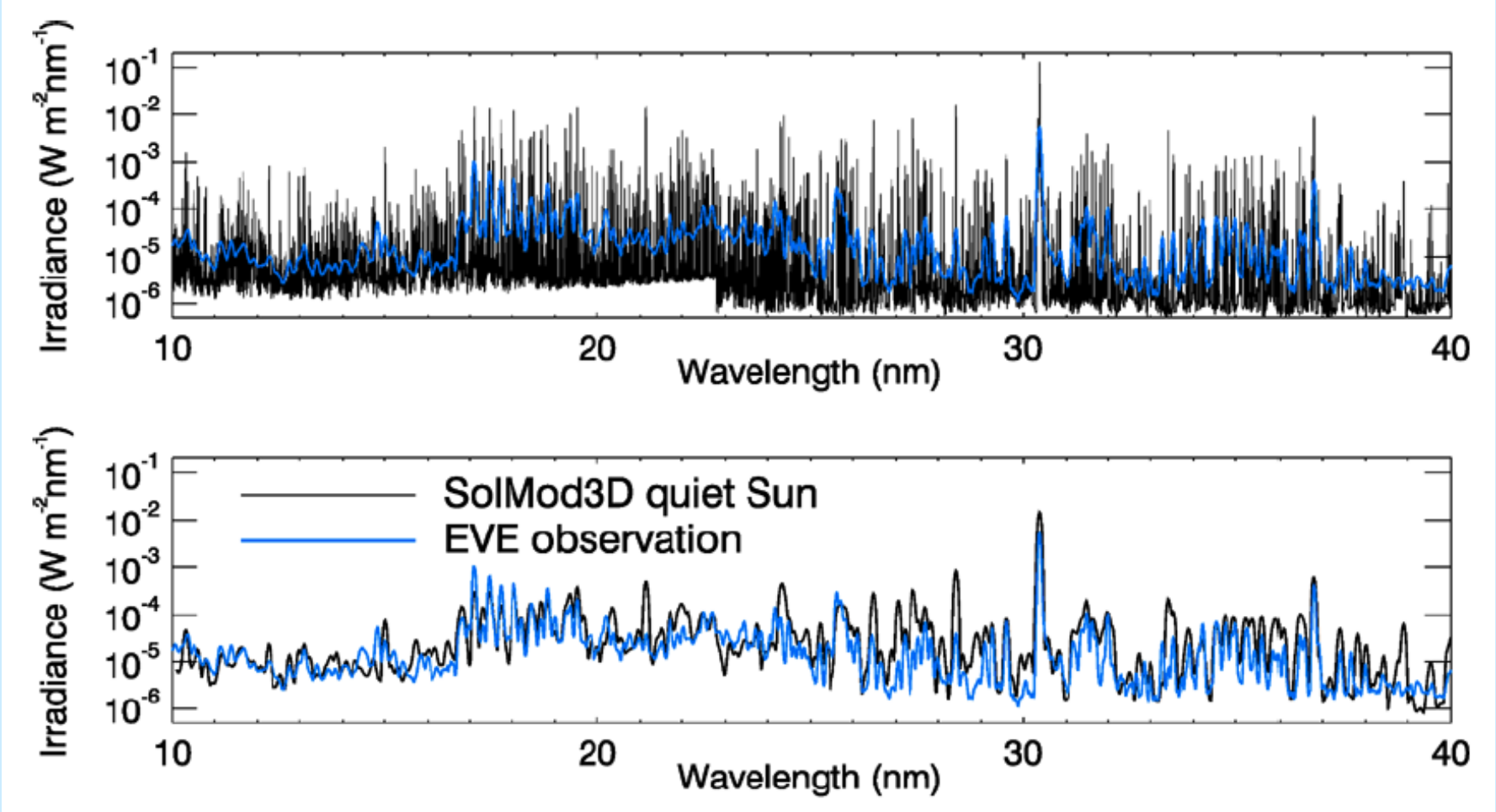
Solar Modeling (SOLMOD) code

- **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 $\leq$ 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

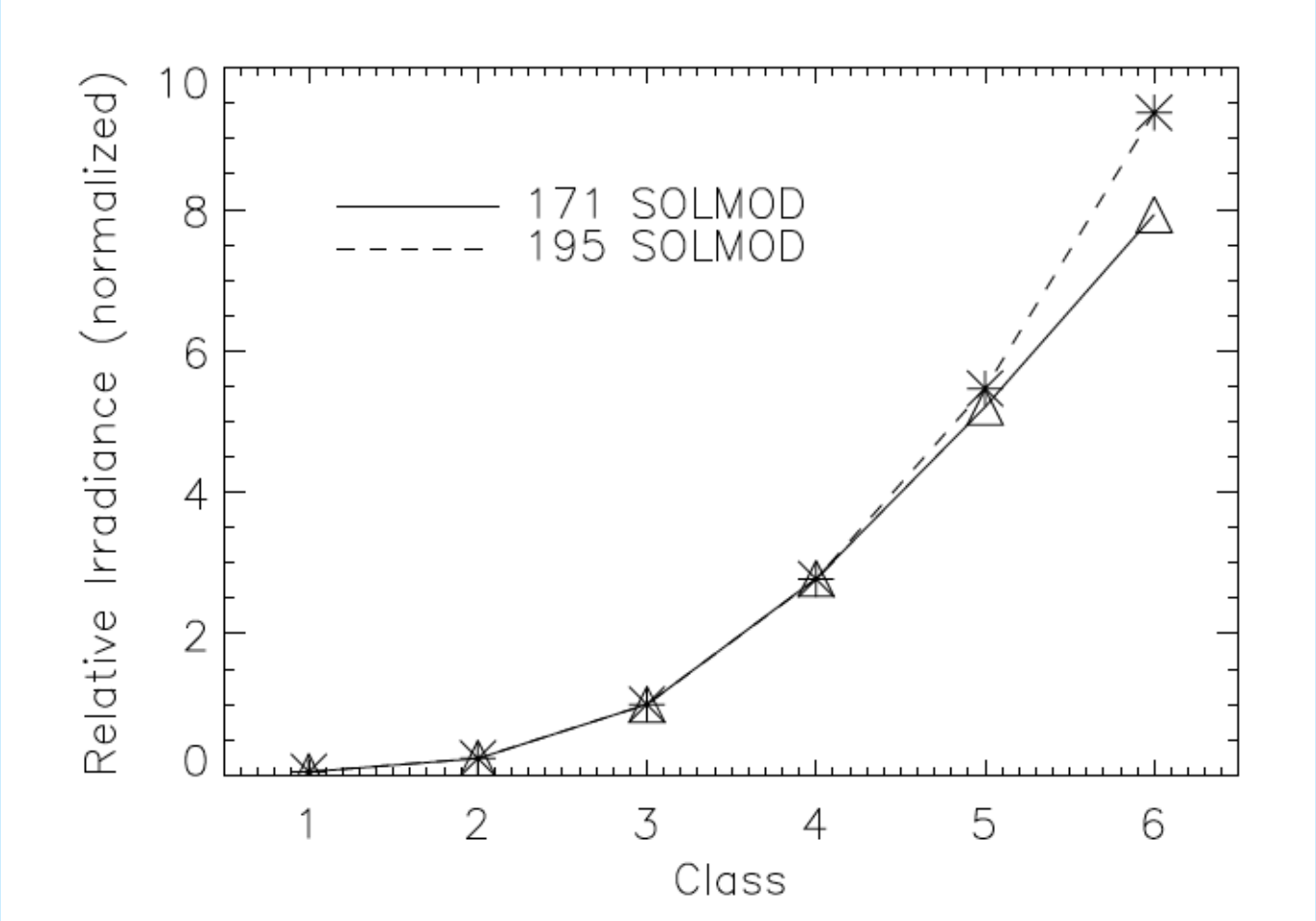


SOLMOD spectrum compared with EVE spectrum



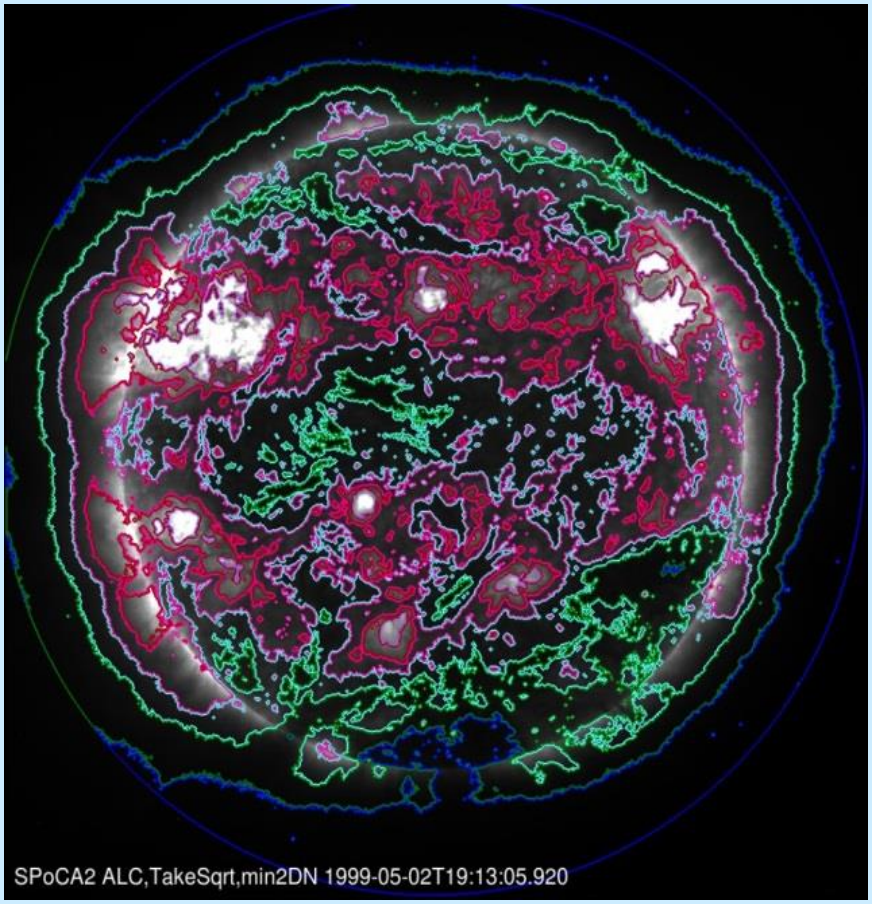
Haberreiter, 2011, Solar Physics

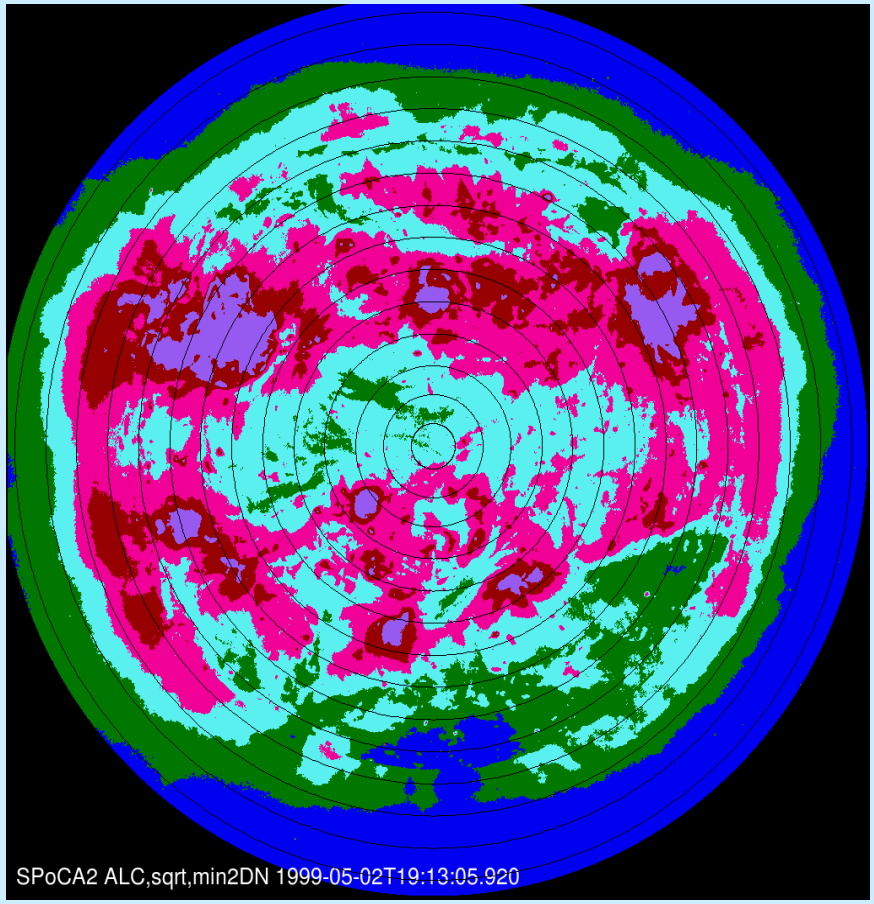
SOLMOD Contrast at EIT passbands



Contrast of SOLMOD spectra for the EIT 171 and 195 passbands

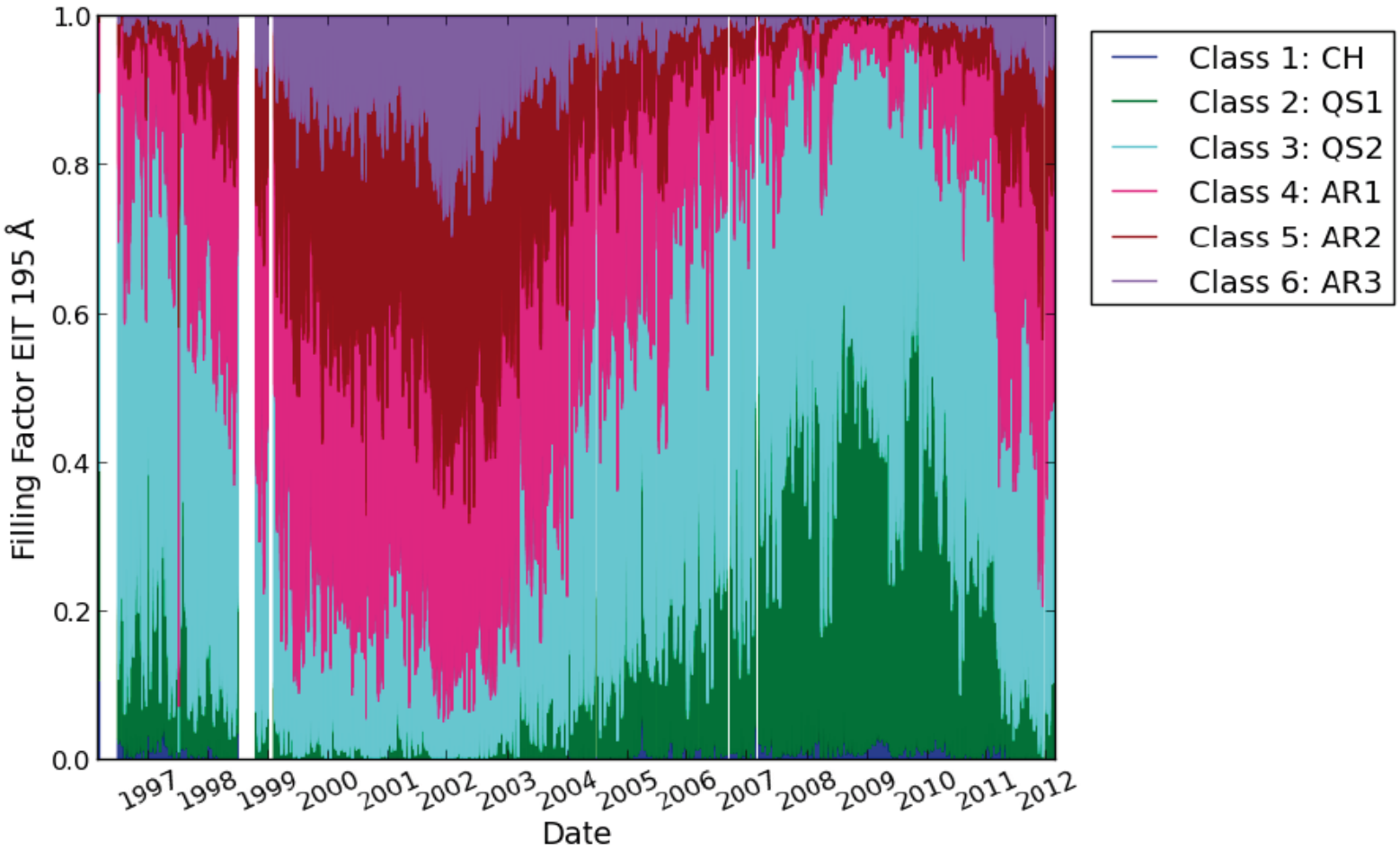
EIT Image segmentation with SPOCA tool





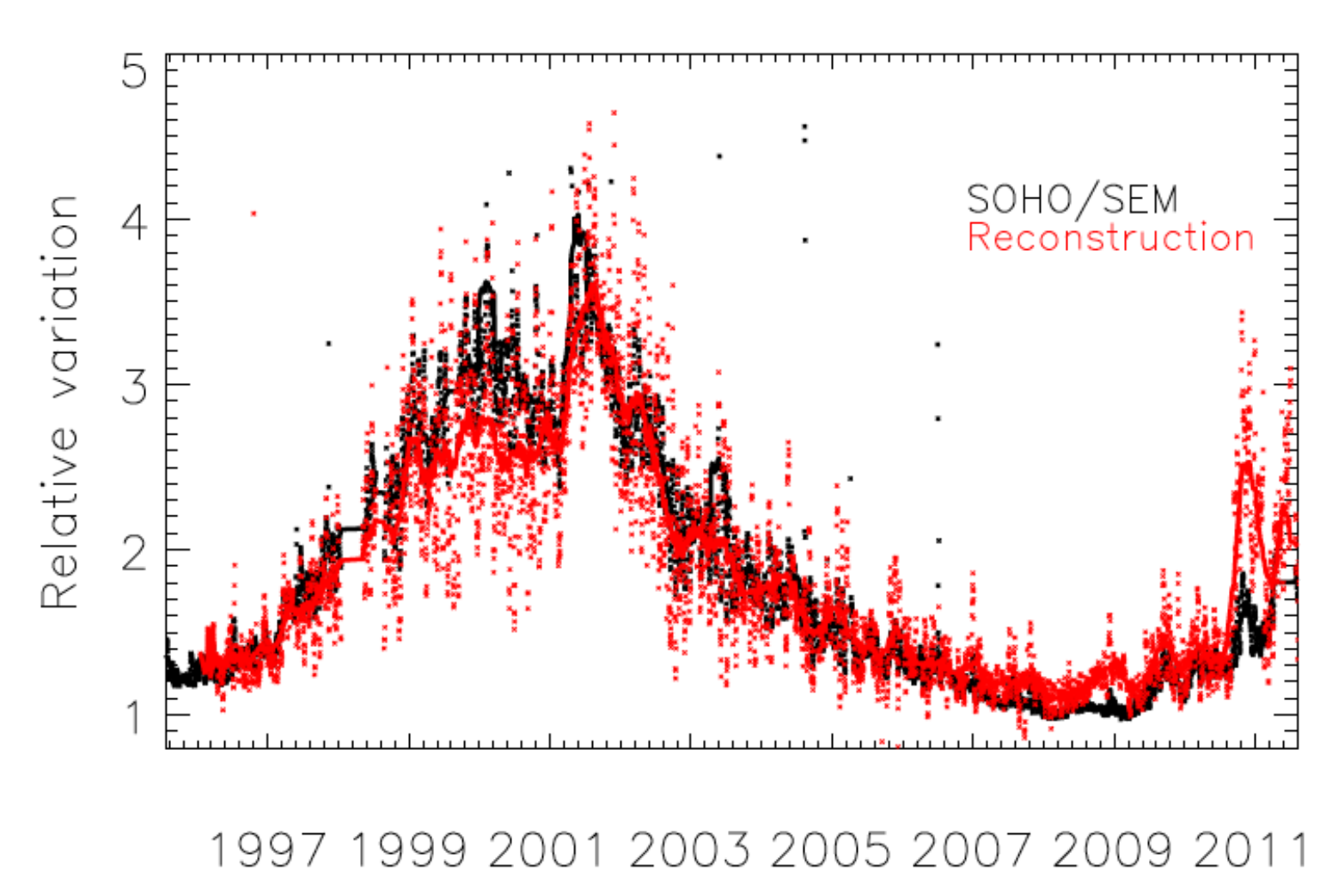
Courtesy Veronique Delouille, Benjamin Mampeay, ROB, BE

Area coverage of EIT features



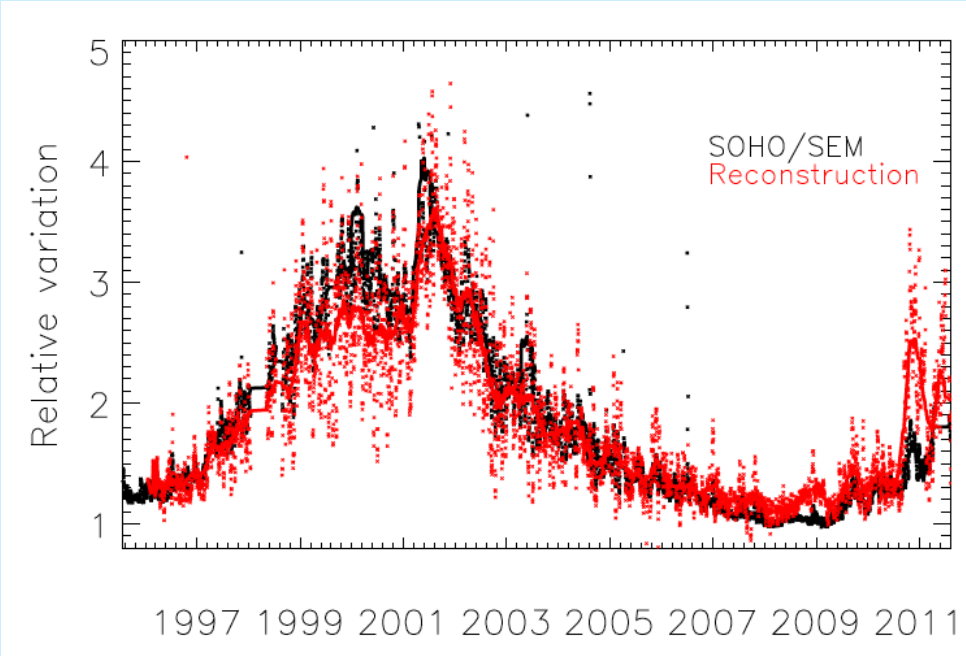
Haberreiter et al., 2014, SWSC, under review

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

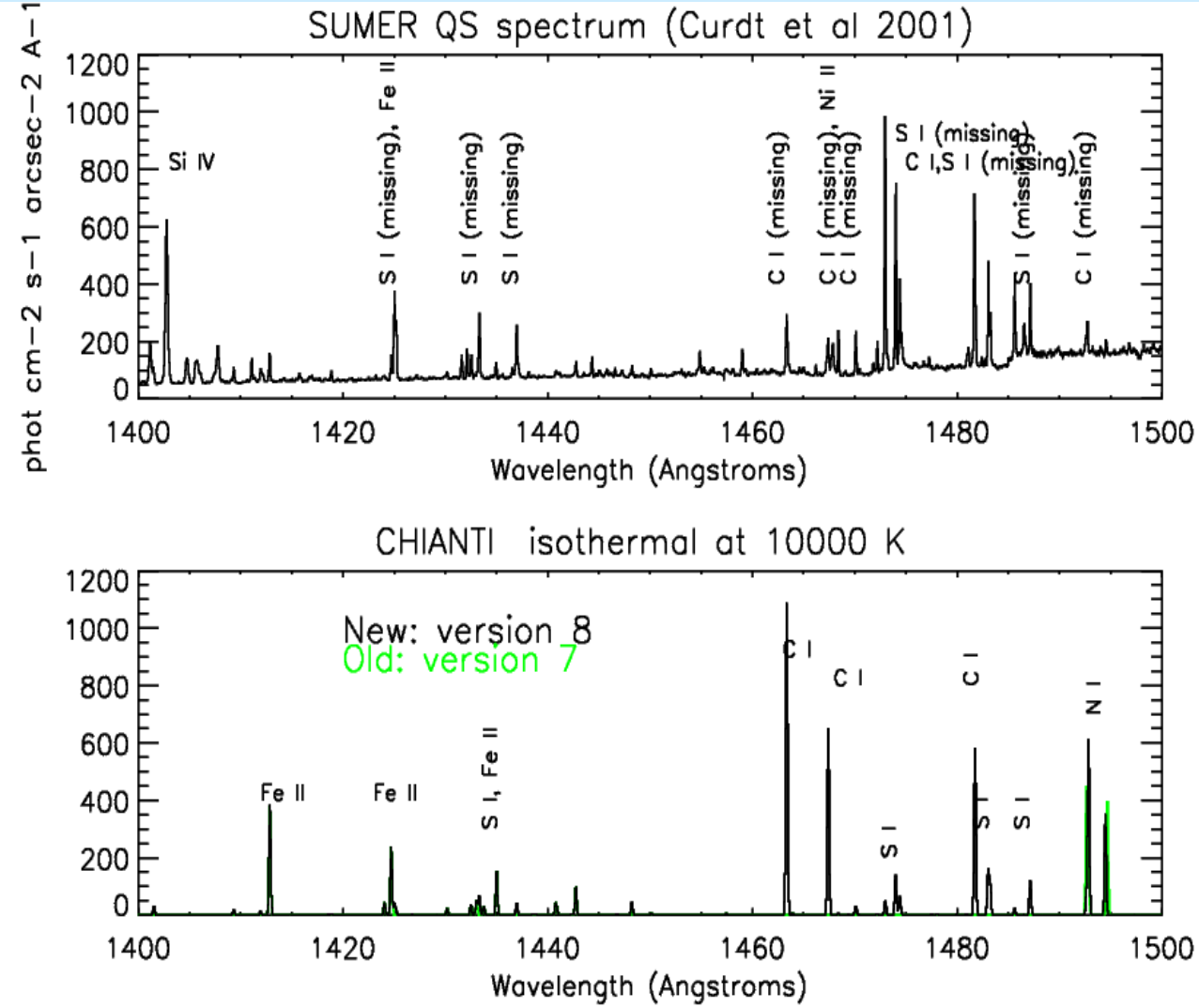
SOLID – Assessing Atomic Data
Additional atomic data: N I, C I, S I

Top: SOHO/SUMER QS spectrum

Bottom: CHIANTI spectrum

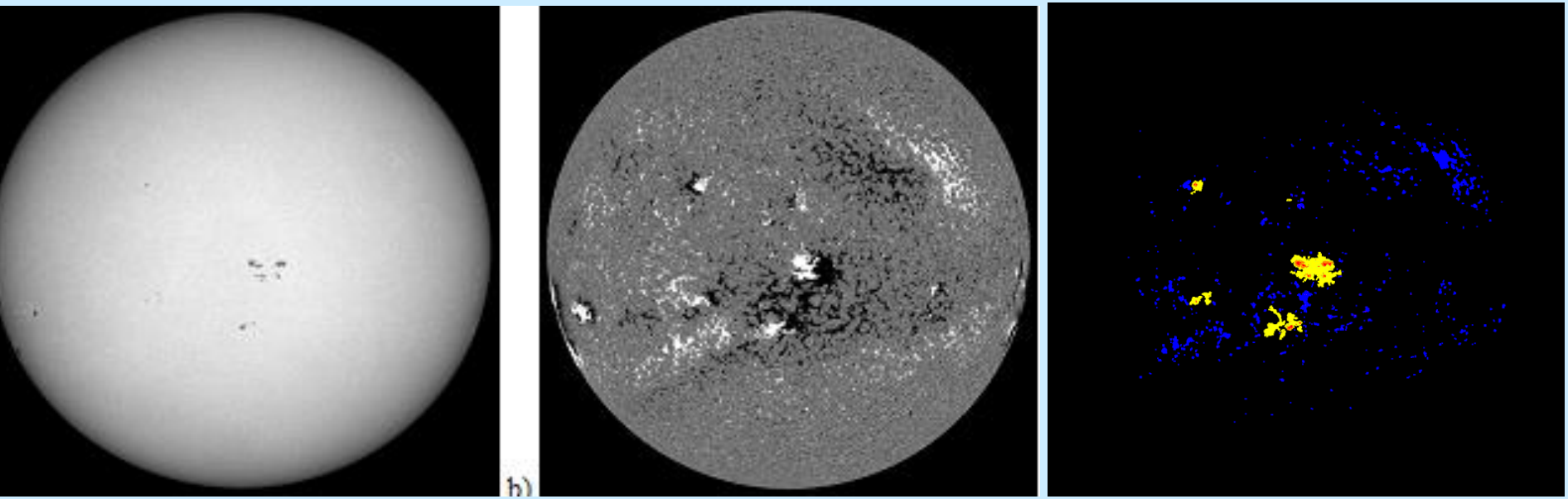
Green: CHIANTI 7

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

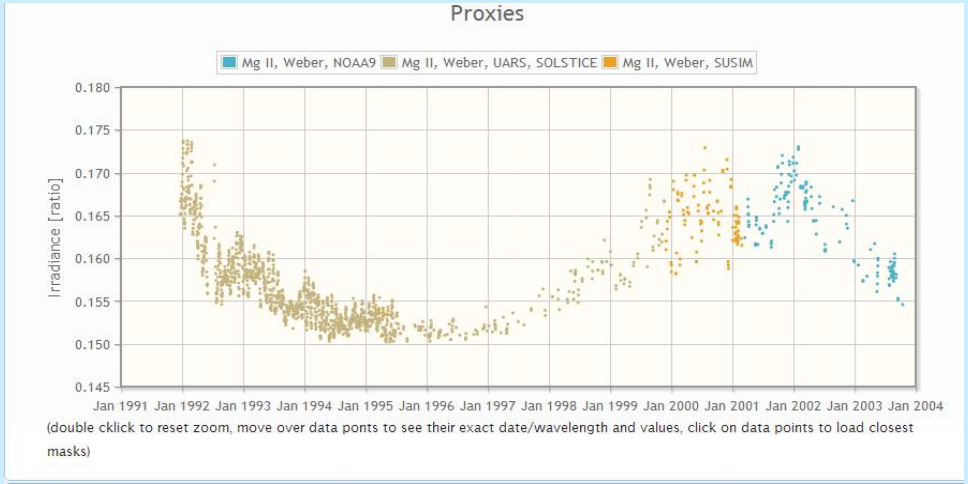


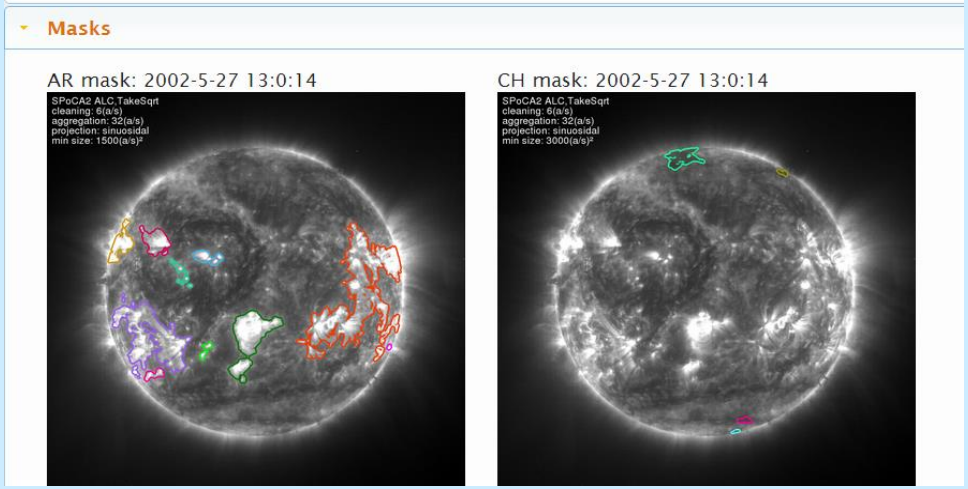
Qawahij, R., Ipson, S., Nibouche, O., and Haberreiter, M. (2014) SWSC, under review

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

SOLID – Webpage and Database

http://projects.pmodwrc.ch/solid-visualization/makeover/





EGU 2014, Vienna, Austria

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

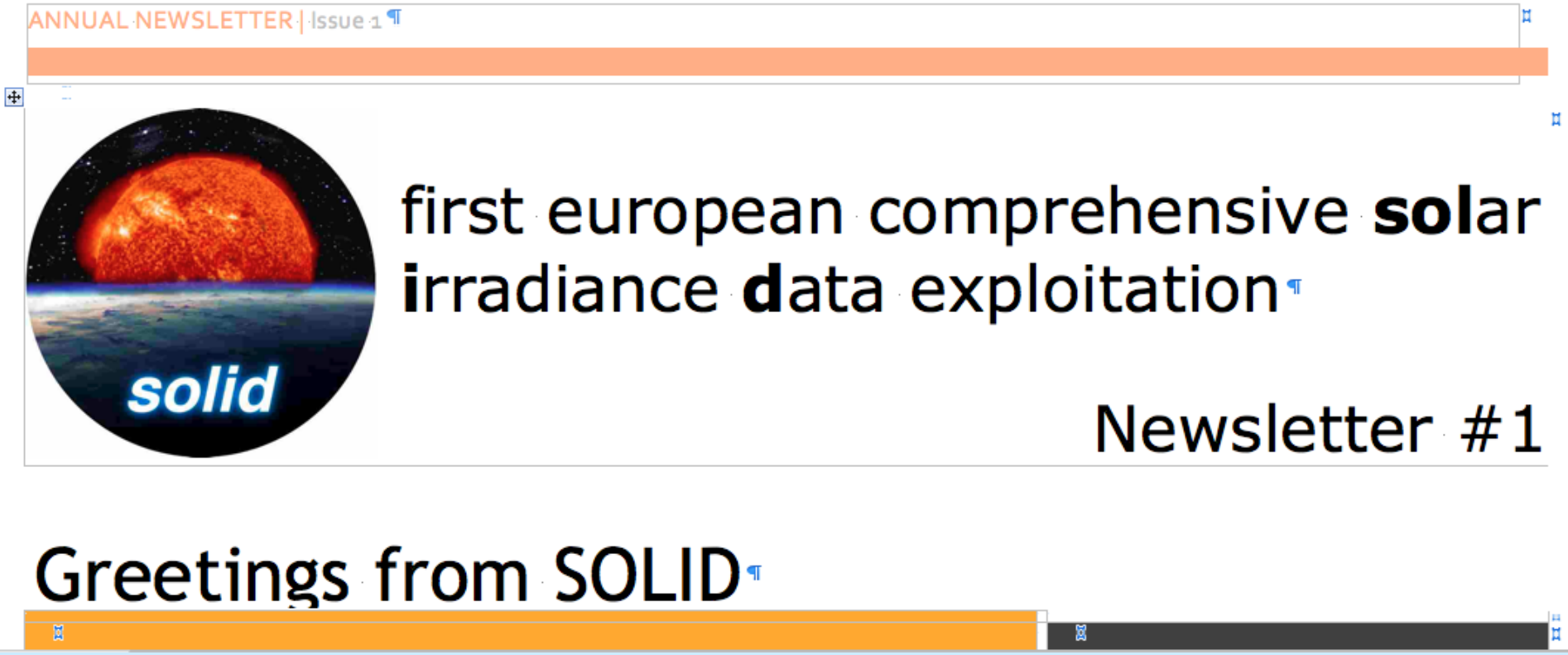
CL5.12: Solar Influence on the Middle Atmosphere and Dynamical Coupling to the Troposphere and the Ocean

Convener: Katja Matthes

Co-Convener: Margit Haberreiter (TOSCA and SOLID session)

Invited Speakers: Matthieu Kretzschmar, Nick Dunstone, Daniel Mitchell

Upcoming Newsletter



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

Questions

Advisory Panel

Katja Matthes

GEOMAR/Helmholtz-Zentrum für Ozeanforschung, Kiel, Germany

Farzad Kamalabadi:

University of Ilinois, USA

Matt de Land:

Science Systems and Applications, USA

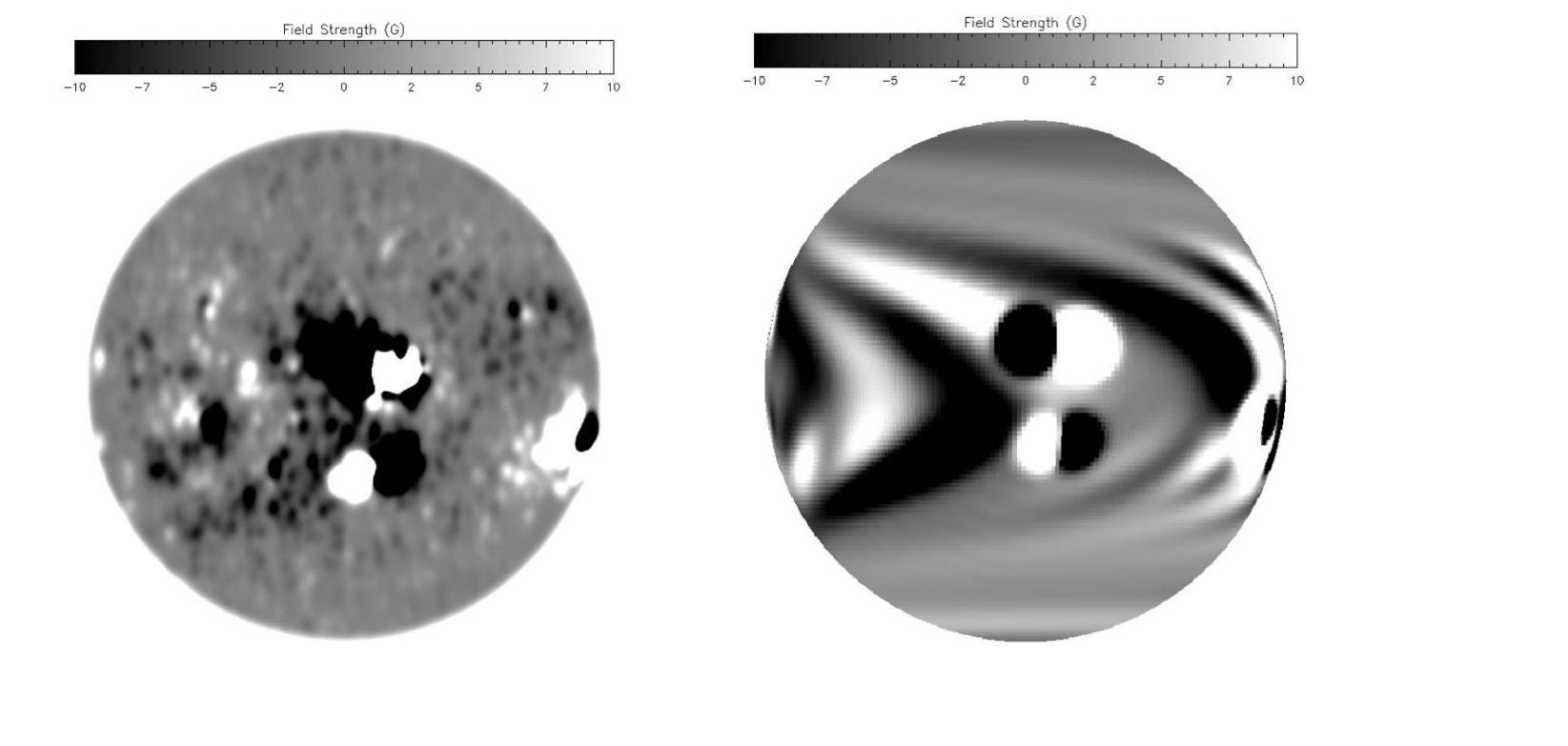
WP7: Upcoming SOLID Events

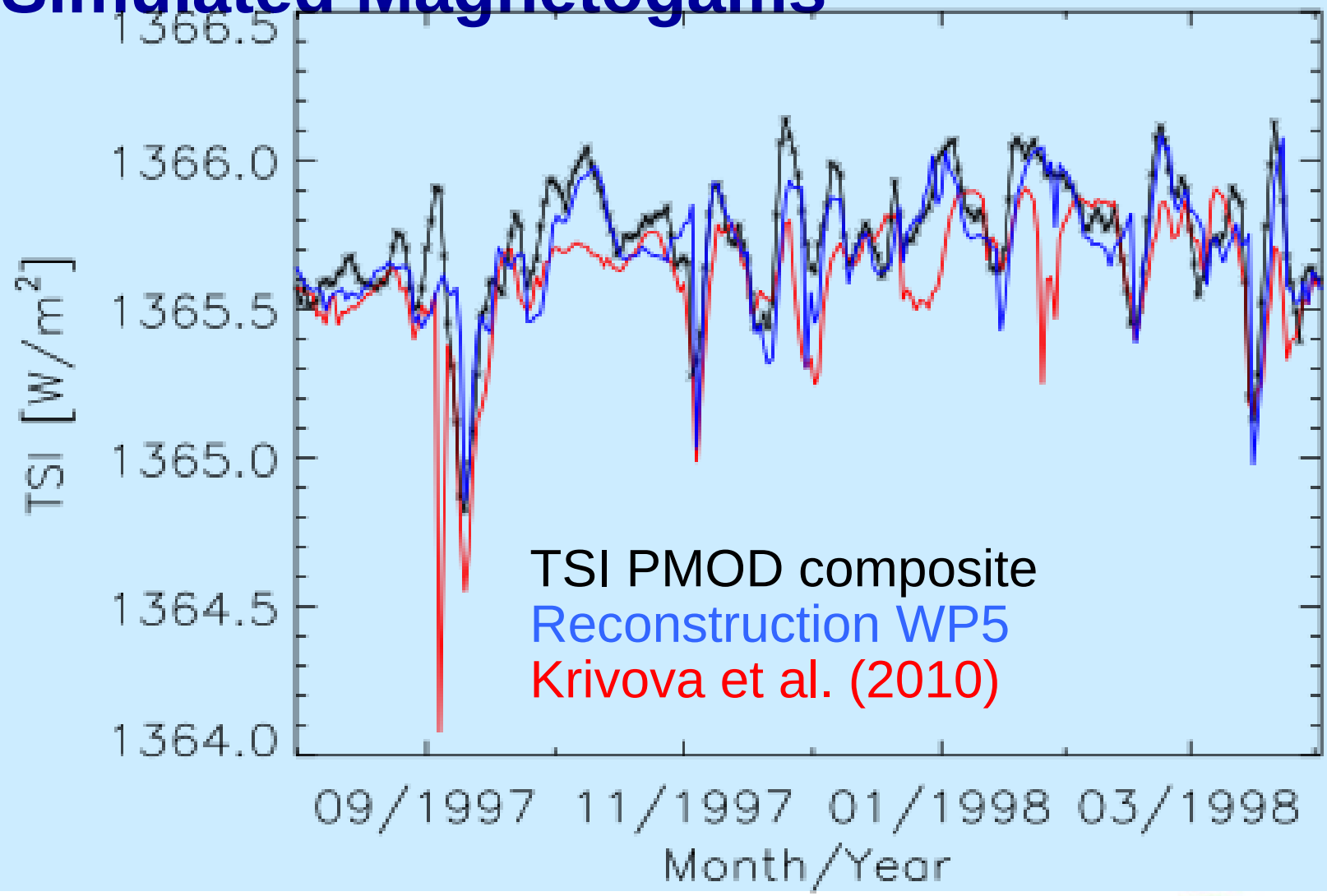
- **Error Analysis Workshop**
  - held at Imperial College London
  - March/April 2014
- **2nd SOLID Annual Assembly**
  - planned for Oct/Nov 2014
- **TOSCA/SOLID School**
  - in collaboration with TOSCA (COST ES1005)
  - Exact date TBD

SOLID - Consortium

No	Name	Short name	Country
1	SCHWEIZERISCHES FORSCHUNGSINSTITUT FUER HOCHGEBIRGSKLIMA UND MEDIZIN IN DAVOS	PMOD-WRC	Switzerland
2	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	CNRS	France
3	KONINKLIJKE STERRENWACHT VAN BELGIE	ROB	Belgium
4	UNIVERSITY OF BRADFORD	UNIBRAD	United Kingdom
5	UNIVERSITAET BREMEN	UBre	Germany
6	IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	Imperial	United Kingdom
7	MAX PLANCK GESELLSCHAFT ZUR FOERDERUNG DER WISSENSCHAFTEN E.V.	MPG	Germany
8	ISTITUTO NAZIONALE DI ASTROFISICA	INAF	Italy
9	THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE	UCAM	United Kingdom
10	ARISTOTELIO PANEPISTIMIO THESSALONIKIS	AUTH	Greece

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 Magnetogams