EUV Irradiance Reconstruction in view of PROBA2

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Motivation for EUV reconstruction

- EUV spectral irradiance is important for various Space Weather phenomena
- Scattered SSI data are available
  - different temporal and spectral coverage
  - data gaps need to be filled through modeling
- Understand the mechanisms behind solar spectral irradiance variations in order to provide full temporal and spectral coverage

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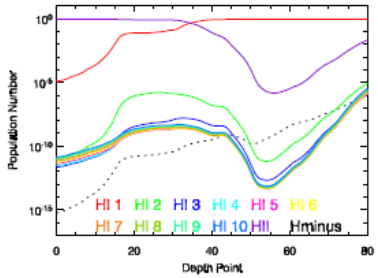
EUV reconstruction - Semi-empirical modeling

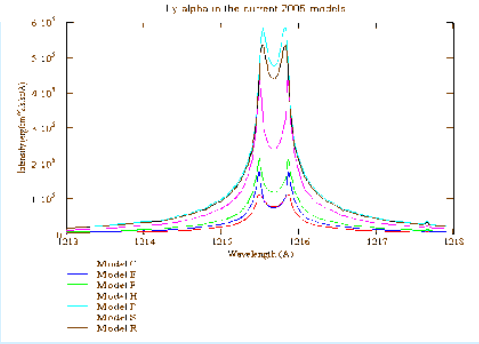


n_{level}, n_{el}, n_{ion}, …

(x,y,z,t)

Population numbers, Radiation field

Synthetic Spectrum

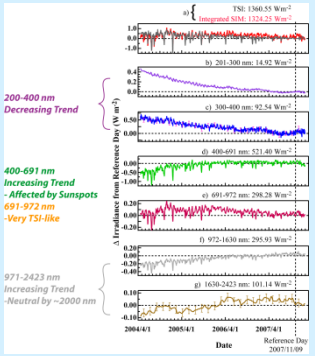


$I(\lambda,\mu,\varphi,t)$

Iterative process

Observed Spectrum

$I(\lambda,\mu,\varphi,t)$



Update of Physical Models T(z), ne(z), nh(z)

Atomic physics, collisional and radiative rates, abundances

El	A	W	ab_{cor}	ab_{coll}	ab_{rad}	$\frac{ab_{rad}}{ab_{cor}}$
H	1	1.008	0.911 E0	0.911 E0	0.911 E0	1.000
He	2	4.003	8.900 E-2	0.911 E-1	0.911 E-1	1.023
Li	3	6.941	1.318 E-11	3.552 E-12	1.022 E-11	0.775
Be	4	9.012	1.288 E-11	1.002 E-11	2.185 E-11	1.696
B	5	10.810	3.631 E-10	5.648 E-10	4.566 E-10	1.257
C	6	12.011	3.311 E-4	3.352 E-4	2.236 E-4	0.675
N	7	14.007	1.023 E-4	1.038 E-4	5.490 E-5	0.536
O	8	16.000	7.762 E-4	6.103 E-4	4.164 E-4	0.536
F	9	18.918	3.311 E-8	3.306 E-8	3.308 E-8	0.999
Ne	10	20.179	1.122 E-4	2.541 E-5	6.302 E-5	0.562
Na	11	22.990	1.950 E-6	1.567 E-6	1.347 E-6	0.691
Mg	12	24.305	3.467 E-5	3.125 E-5	3.086 E-5	0.890
Al	13	26.982	2.691 E-6	2.268 E-6	2.135 E-6	0.793
Si	14	28.086	3.236 E-5	3.198 E-5	2.948 E-5	0.911
P	15	30.974	2.570 E-7	2.432 E-7	2.087 E-7	0.812
S	16	32.060	1.479 E-5	1.467 E-5	6.302 E-6	0.426
Cl	17	35.453	2.884 E-7	4.026 E-7	2.880 E-7	0.999
Ar	18	39.948	3.311 E-6	4.026 E-6	1.379 E-6	0.416
K	19	39.098	1.513 E-7	1.011 E-7	1.095 E-7	0.724
Ca	20	40.080	2.089 E-6	1.931 E-6	1.860 E-6	0.890
Sc	21	44.956	1.148 E-9	1.057 E-9	1.022 E-9	0.890
Ti	22	47.900	8.912 E-8	4.955 E-8	7.236 E-8	0.812
V	23	50.941	9.120 E-9	1.139 E-8	9.110 E-9	0.999
Cr	24	51.996	4.266 E-7	4.518 E-7	3.976 E-7	0.932
Mn	25	54.938	2.239 E-7	1.430 E-7	2.236 E-7	0.999
Fe	26	55.847	4.266 E-5	2.268 E-5	2.567 E-5	0.602
Co	27	58.933	7.586 E-8	2.851 E-8	7.577 E-8	0.999
Ni	28	58.700	1.622 E-6	1.721 E-6	1.546 E-6	0.953
Cu	29	63.546	1.479 E-8	2.541 E-8	1.477 E-8	0.999
Zn	30	65.380	3.630 E-8	2.368 E-8	3.627 E-8	0.999

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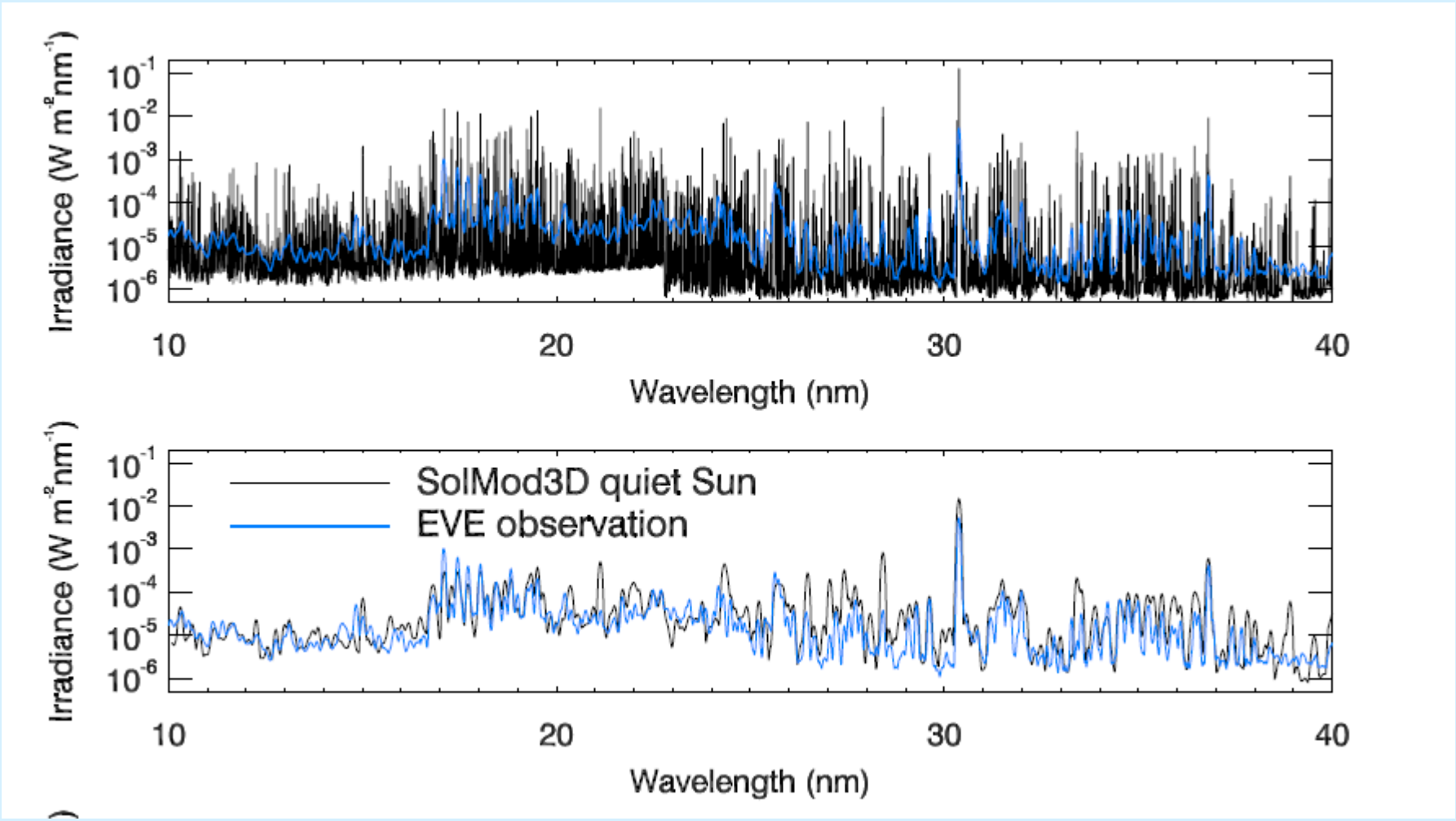
Comparison to SDO/EVE observations



Haberreiter, 2011, Solar Physics, 274, 473

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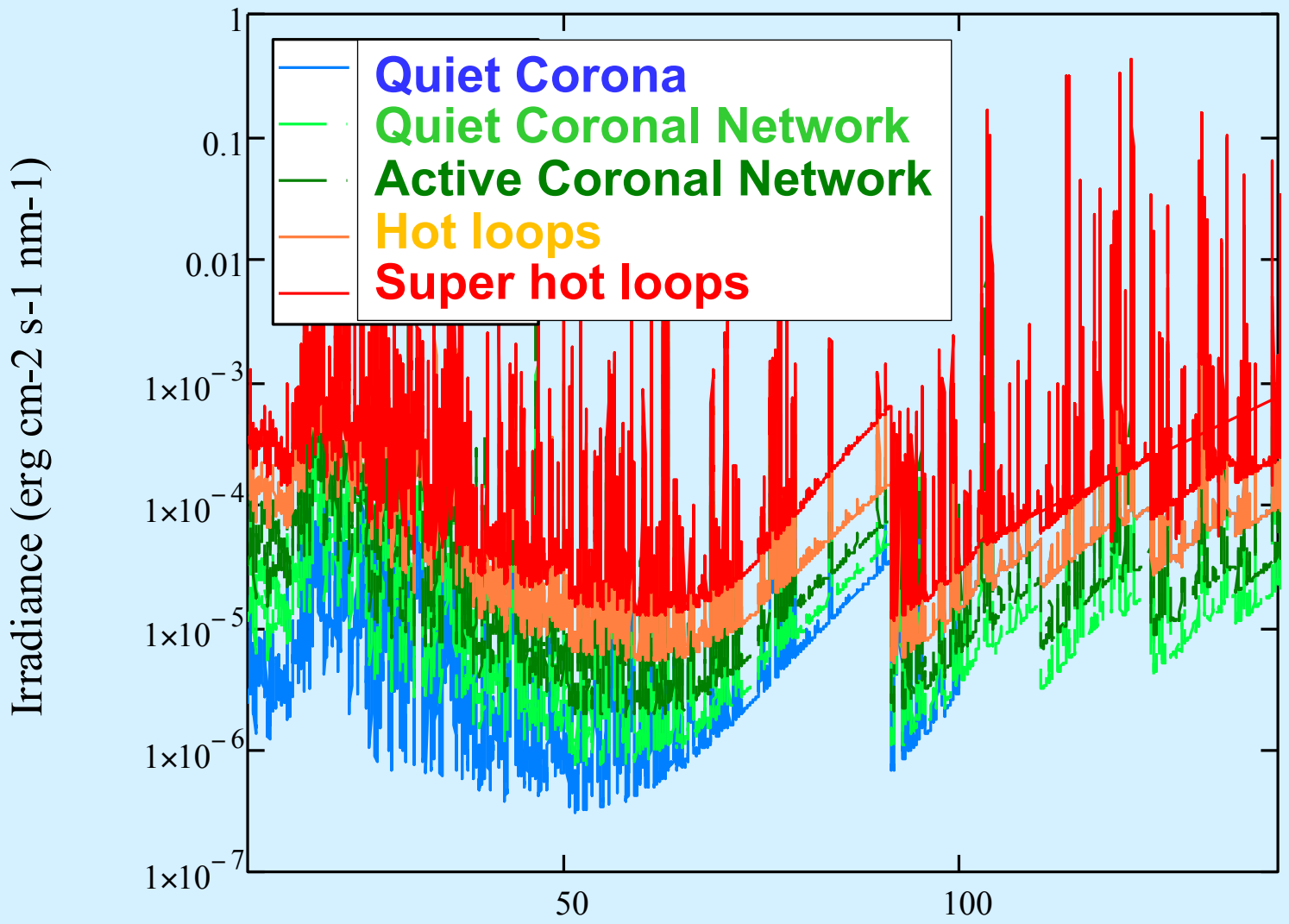
Synthetic EUV Spectra



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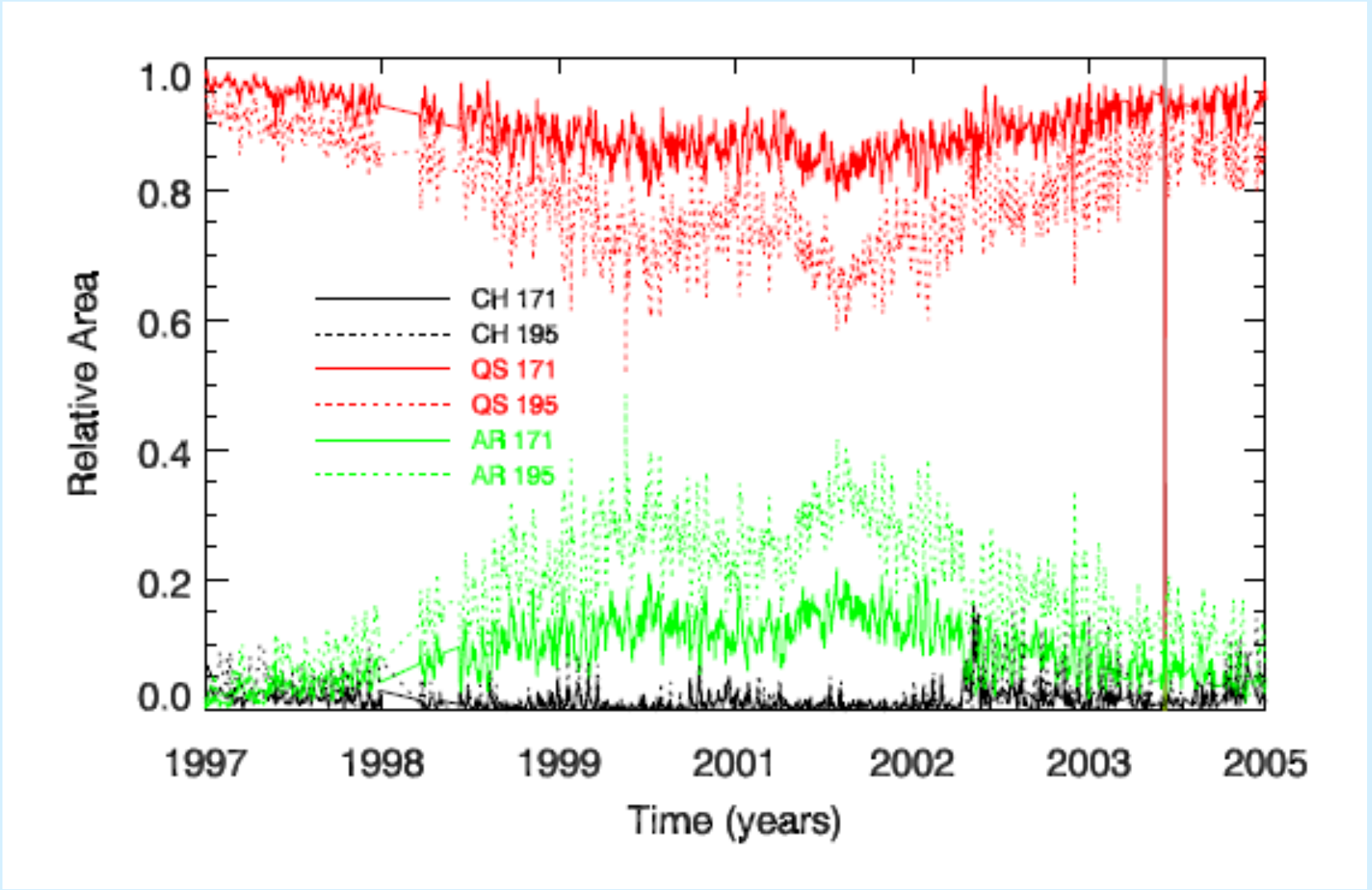
Scheme for Spectral Irradiance Reconstruction

1. Intensity spectra are calculated for different positions on the solar disk

2. Spectra are weighted based on the relative area coverage of different solar features for different posititions on the solar disk
   - Collaboration with ROB on image decomposition

3. Result: Spectral variability for various time-scales over a broad wavelength range

Area coverage over solar cycle 23



Barra et al., 2009, A&A

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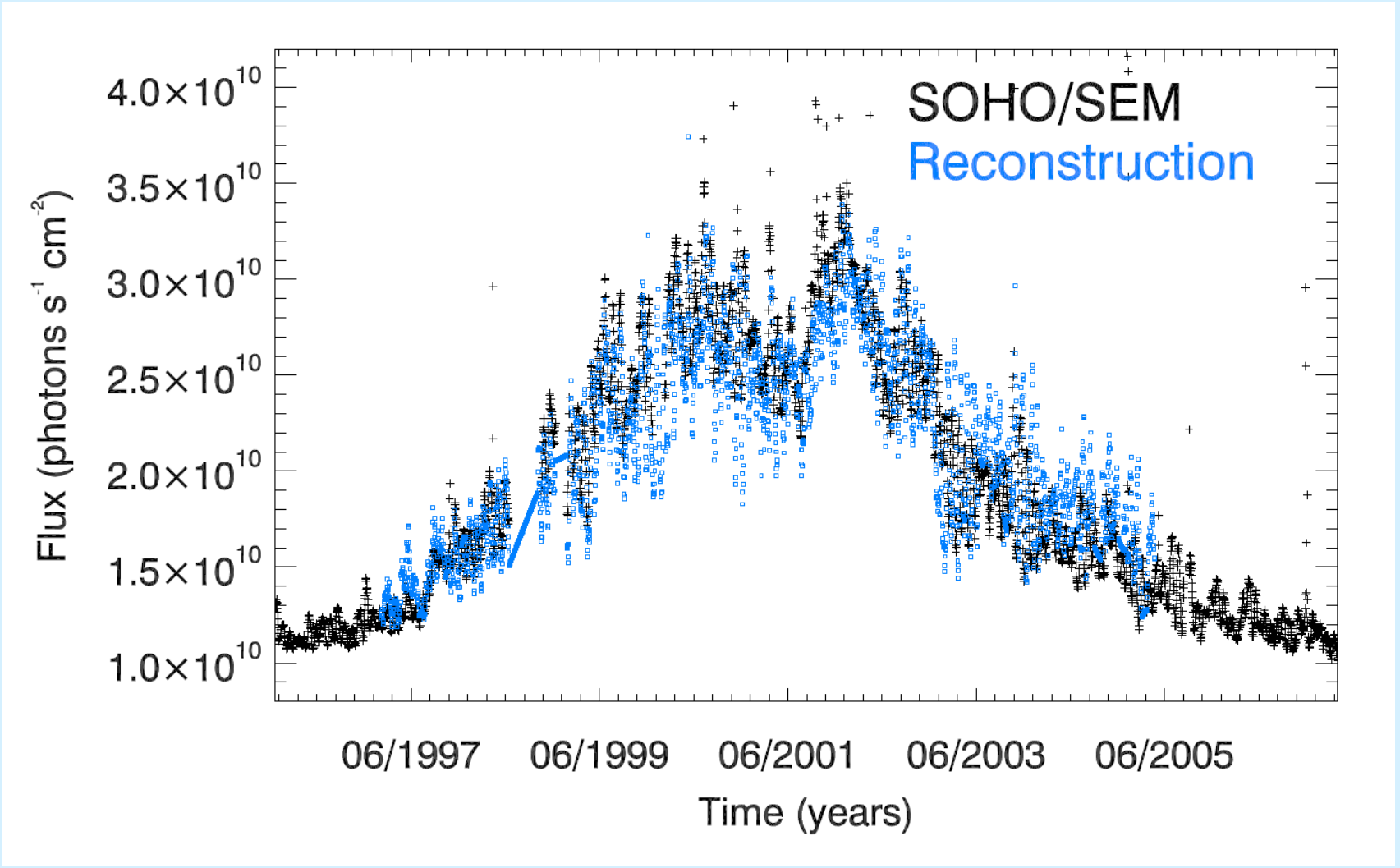
Reconstruction of the EUV for solar cycle 23



Haberreiter, 2012, IAU Symposium 286

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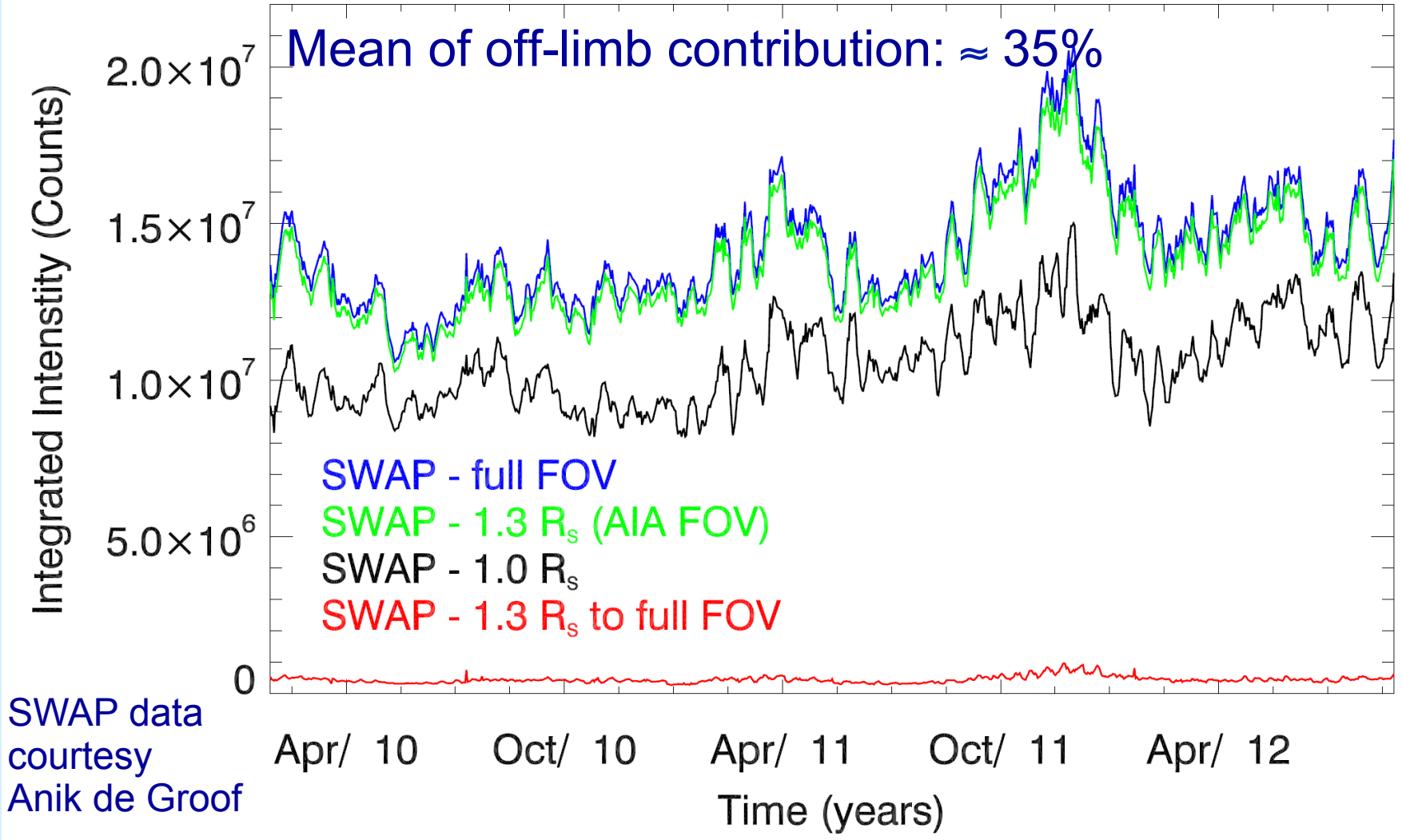
SWAP integrated intensities



SWAP data courtesy Anik de Groof

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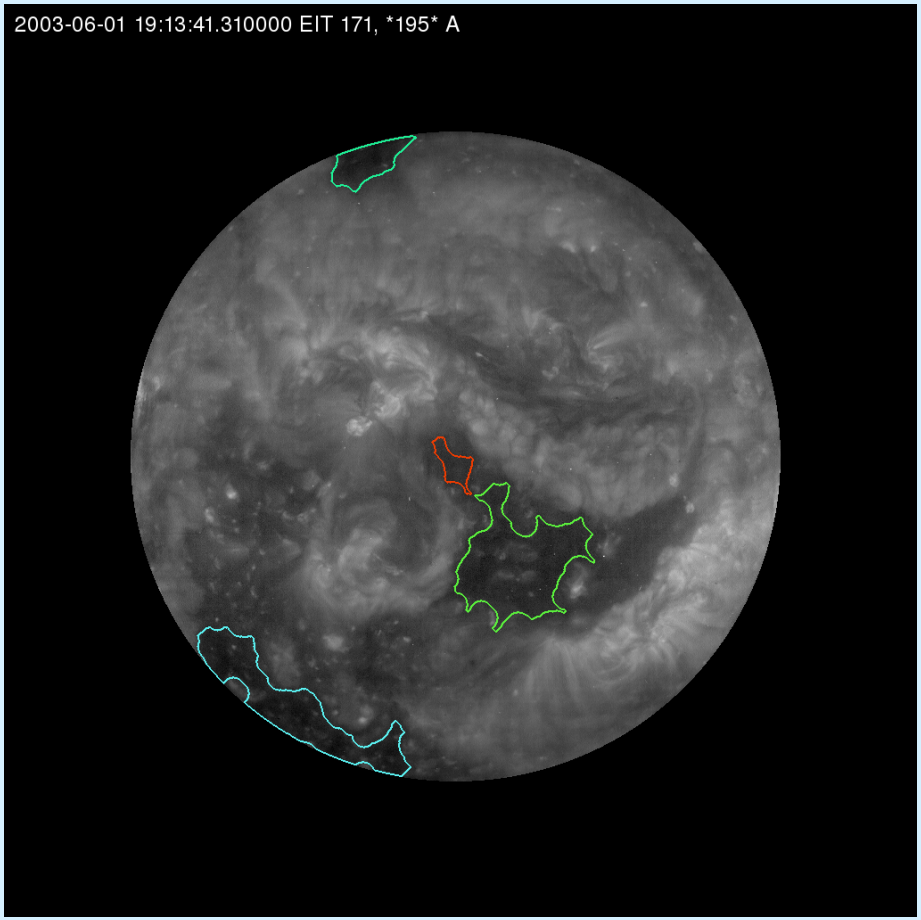
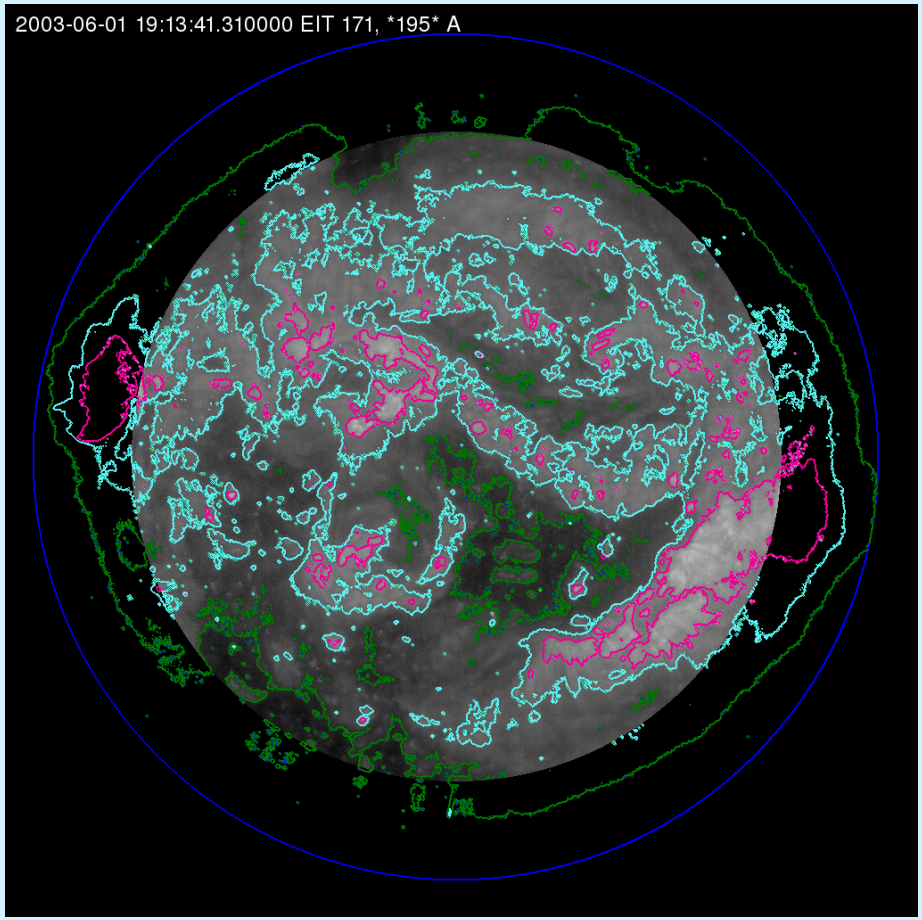
EIT Image Decomposition

June 1, 2003



Coronal Hole Mask



Active Region Mask

SPoCA Image Decomposition: Cis Verbeeck, ROB

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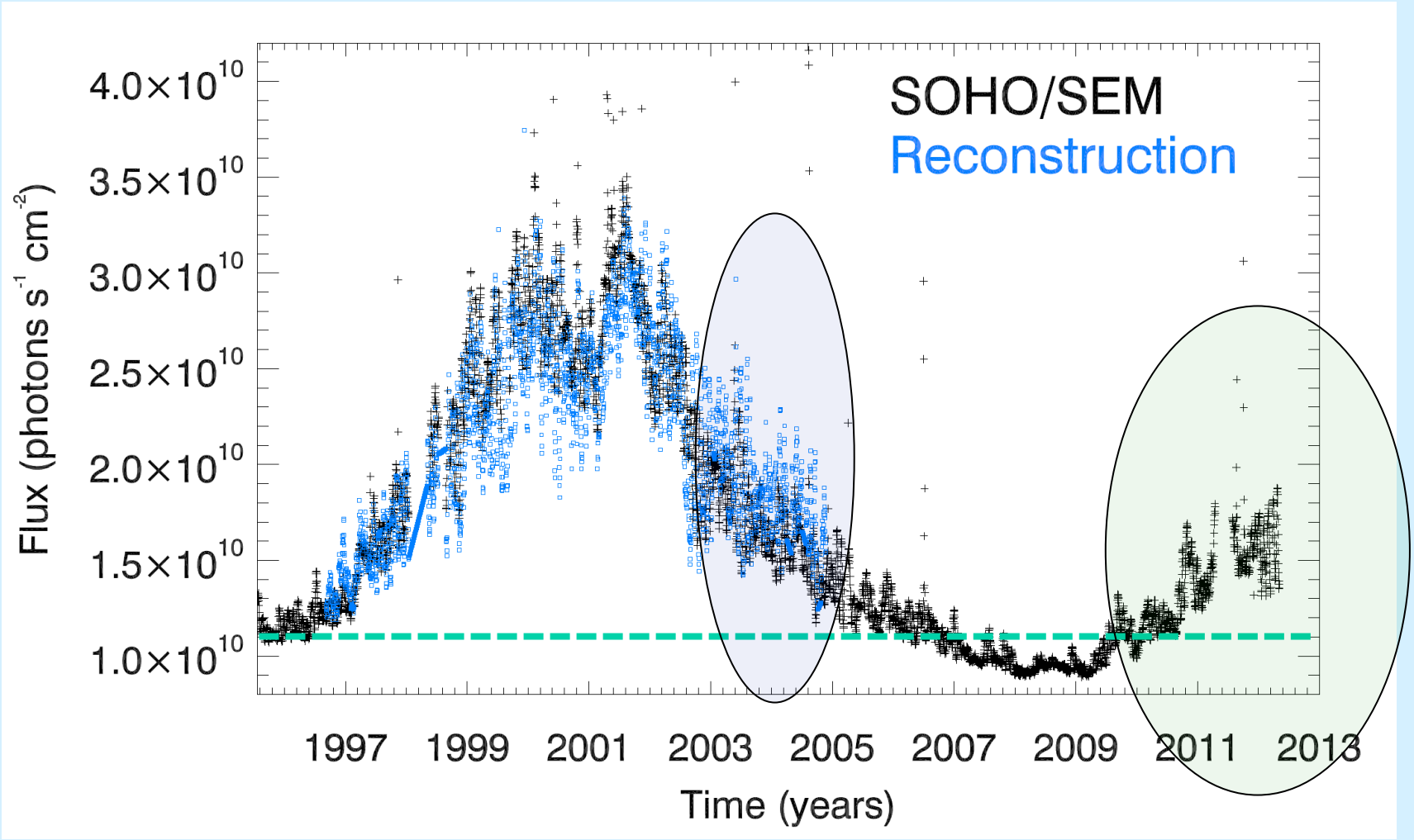
Reconstruction of the EUV for solar cycle 23



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Conclusion

- Understanding the physical mechanisms that drive solar spectral irradiance variations is important for Space Weather studies
- Successful reconstruction based on EIT image analysis
- Improvement of implementation of extended corona
- Extend the reconstruction to PROBA2 time series based on SWAP decomposition
- **More to come soon within the SOLID project**

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FP7 Space Project SOLID

- SOLID: **First European Comprehensive SOLar Irradiance Data exploitation**
- Coordinator PMOD/WRC (W. Schmutz, Project Manager: M. Haberreiter)
- Start: December 2012
- 10 Partners from 7 European Countries (CH, F, B, UK, I)
- Compilation and Analysis of the existing irradiance data from the XUV/ EUV, UV, visible to the IR along with solar irradiance modelling results

Poster 3A.1
Haberreiter et. al

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