ISSI Call for Proposals 2016 for International Teams
in Space and Earth Sciences

Towards a unified solar forcing input to climate studies

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Summary

Almost four decades of space-based solar irradiance monitoring have enriched us with a great amount of data from numerous experiments at different wavelengths. The utility of the available total and spectral irradiance records for atmospheric and climate research is, however, limited by their inhomogeneous and incomplete wavelength and temporal coverage and often by limited instrument stability. Currently only irradiance models can fill these gaps and furnish us with records that are more homogeneous and complete in wavelength coverage than the observations. Two kinds of models, proxy and semi-empirical, have been developed. Their products differ from each other in ways that are critical for modelling climate change. There is thus a strong need to understand the causes of differences between model outputs and to identify ways of overcoming model shortcomings. The proposed ISSI team includes experts representing both kinds of models.

The quality and reliability of the output of irradiance models is of crucial importance for the broad Earth- and solar-research communities, as can be judged from the various national and international projects addressing related issues. Thus the EU FP7 SOLID, NASA SIST, ISSI SHAPE, ISSI “An Assessment of the Accuracies and Uncertainties in the Total Solar Irradiance Climate Data Record,” and SNSF SILA projects evaluated the quality of different measured total and spectral irradiance data sets and made efforts to cross-calibrate some of the records. The German ROMIC/MUSIC project has taken steps towards significantly more physically consistent models. Related topics are also addressed by the ongoing ISSI team "Towards New Models of Solar Spectral Irradiance based on 3D MHD Simulations" (ID335). The progress in these individual areas provide a solid foundation for tackling the most pertinent issue - the lack of a sufficiently long, homogeneous and reliable solar irradiance record as required by global circulation and climate models.

The main goal of the proposed multi-disciplinary ISSI team, which includes experts in solar irradiance instrumentation, observations, data analysis and modelling, as well as atmospheric and climate scientists, is to fill this gap and reach a consensus on a single and homogeneous modelled irradiance record to recommend to the climate community. This effort will also include realistic estimates of the remaining uncertainties. The proposed ISSI team will play a central role in forming such a consensus, which will be summarized in a review article and later presented to and discussed within the wider community in a separate and larger meeting (to be organized outside ISSI).

Research domains

- Space Science (Solar-Terrestrial Sciences)
- Earth Sciences using space data

Rationale

Regular measurements of solar irradiance from space have been ongoing since 1978 and have revealed how changeable solar radiative output is (e.g., DeLand & Cebula 2008, Kopp 2014, and references therein). Both the total amount of solar radiative energy reaching Earth's atmosphere and its spectral distribution, termed total (TSI) and spectral (SSI) solar irradiance, respectively, fluctuate on all observed time scales. The variability in TSI and SSI is the prime external driver of changes in Earth's atmosphere and climate.

The body of TSI and SSI records from various monitoring missions forms the basis for our understanding of the spectral and temporal patterns of the variability. We know that solar total and UV irradiance vary in phase with the overall solar activity, and the relative variability in the UV is several orders of magnitude stronger than in the visible and IR wavelength ranges. However, due to the overall decrease of the relative variability with wavelength its long-term measurement above about 300 nm at the needed solar-cycle stability levels is challenging. At these wavelengths and timescales, the exact amplitude of the variation and even its phase in the visible remain disputed (Ermolli et al. 2013, Yeo et al. 2014a). The utility of the available TSI and SSI records for atmospheric and climate research is also limited by their inhomogeneous and incomplete wavelength and temporal coverage together with the relatively short period of time they cover. The main reasons for this are the limited lifetimes and aging of individual space-borne instruments as well as a strong dependence of on-orbit instrument degradation with wavelength.

Currently only irradiance models can fill these gaps, extend the available records, and furnish us with records that are more homogeneous and complete in wavelength coverage than the observations. Two kinds of models, proxy and semi-empirical, have been developed (Morrill et al. 2014, Yeo et al. 2014b, Coddington et al. 2015, see Ermolli et al. 2013 for further details and references). The basis for both approaches is the same – both relate solar variability to the evolution of the solar surface magnetic field. This field emerges at the solar surface in the form of bright (faculae, plage, network) and dark (sunspots) structures. The evolution and passage of these features across the visible solar disc with solar rotation cause brightening and darkening of the Sun on timescales of days. The modulation of their emergence rate with overall solar magnetic activity leads to changes on time scales of years and longer.

Despite the same fundamental assumption and reliance on the same or similar observational input data, the products of the models differ from each other in ways that are critical for modeling climate variability and change (Haigh et al. 2010, Ball et al. 2014, 2016). There is thus a strong need to understand the causes of differences between model outputs and to identify ways of overcoming model shortcomings. The latter involve uncertainties in model inputs including irradiance measurements and solar activity proxies (such as the Mg II index or photometric sunspot index), unaccounted noise in magnetograms, shortcomings of model assumptions and construction techniques, or neglected non-LTE effects in radiative transfer computations.

Various national and international projects have recently addressed related issues. Thus the EU FP7 SOLID, NASA SIST, ISSI SHAPE, ISSI TSI, and SNSF SILA/SIMA projects evaluated the quality of different measured irradiance data sets and made efforts to cross-calibrate some of the records. This knowledge helps indicate model outcome reliance on input observations. The German ROMIC/MUSIC project has taken steps towards significantly more physically consistent irradiance models. Related topics are also addressed by the ongoing ISSI team "Towards New Models of Solar Spectral Irradiance based on 3D MHD Simulations" (ID335). This completely new kind of model, which does not rely on the irradiance observations in their derivation, will allow a critical independent test of the existing models and their assumptions. The progress in all these individual

areas thus sets the scene for tackling the most pertinent issue - the lack of a sufficiently long, homogeneous and reliable solar irradiance record as required by global circulation and climate models. This shortcoming was clearly revealed by the recent effort to provide a solar forcing recommendation for the Coupled Model Intercomparison Project Phase 6 (CMIP6; Matthes et al., in prep.).

Goals

The main goals of the proposed multi-disciplinary ISSI team, which includes experts in solar irradiance observations, data analysis and modelling, and atmospheric and climate scientists, are:

- to fill this gap and reach a consensus on a single and homogeneous modelled irradiance record to recommend to the climate modelling community, and
- to provide realistic estimates of the remaining uncertainties.

The proposed ISSI team will play a central role in forming such a consensus, which will be summarized in a review article and later propounded to and discussed within the wider community in a separate and larger meeting to be organized outside ISSI.

Schedule

We propose to have two ISSI meetings. During the first meeting to be held by fall 2016, we will:

- Review the available irradiance measurements, their temporal and spectral coverage, updates and uncertainties (stated vs. real);
- Review the most recent versions of the models, discuss the differences and their potential sources, and suggest possible tests to be carried out after the meeting;
- Identify strengths and limitations of individual modelling approaches and prospects for possible improvements;
- Review the status of various alternative related projects (mentioned under Rationale) as well as the progress of the IAU Working Group “Solar irradiance” chaired by our proposed ISSI-team members G. Kopp and A. Shapiro;
- Identify the needs of the climate modelling community: spectral coverage and resolution, cadence on various time scales, critical issues, priorities, requirements on accuracy on different timescales;
- Discuss the format, focus and proposal preparation for a follow-up broader meeting. Options to be considered are: (i) a Focus Meeting during the IAU General Assembly in Vienna (2018), with support from the IAU Commission E1 “Solar Radiation and Structure” and IAU Working Group “Solar Irradiance”, (ii) a Workshop at the Lorentz Center in Leiden, the Netherlands, or (iii) an ISSI Workshop.

The period between the two meetings will be used for the actual tests, model improvements and comparisons, construction of the final data set, preparation of a draft of the review paper, writing and submitting a proposal for the workshop.

The second meeting should take place roughly one year after the first and will:

- report on the progress on the issues identified during the first meeting or during post-meeting discussion;
- present, discuss and finalise the final data set (TSI and SSI) to be recommended and its uncertainties;
- discuss and finalise the draft of the review paper;

- discuss the organization of the final broad-community meeting, where the outcome of this project including the recommendations on use of the irradiance data in climate models should be presented to the extended scientific research community.

Expected Output

- A review article co-authored by the team members presenting the state-of-the-art in our understanding of solar total and spectral irradiance variability on timescales of days to decades. This will cover solar irradiance measurements, complete with their most recent updates and improvements, and state-of-the-art models, all including estimates of the respective uncertainties and limitations. A recommendation of a data set for practical applications will be made.
- A record of solar total and spectral irradiance for climate applications.
- A proposal for a larger meeting (e.g., a Focus Meeting during the next IAU General Assembly in 2018 or a Lorentz workshop), where the output of this dialogue will be presented to and discussed among the wider community, including potential users of the data set.

Added value, facilities and financial support requested from ISSI

Reaching a consensus on the credibility and limitations of various available observational data sets and models is only possible through a dialogue between various parties involved. This project is very cross-disciplinary and requires involvement of representatives of different scientific communities, including specialists in space-based solar irradiance measurements, data analysis, solar physicists with a background in solar irradiance modelling, solar magnetism and radiative transfer, as well as terrestrial climate and atmospheric scientists. Our proposed team includes experts representing these communities, while the stimulating and efficient format of ISSI meetings provides an excellent opportunity for such a dialogue. The standard technical facilities offered by ISSI fully satisfy our requirements.

To reach the goals of this proposal, two meetings, each four days long, are requested. We ask for the standard ISSI support (living expenses while residing in Bern) for 10 core members. Four external, self-supported experts have agreed to contribute to the discussion, either through attending the meetings at their own costs or by joining via video conferencing. Two young scientists will be identified and invited once the proposal is accepted.

References

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K.L. Yeo, N.A. Krivova, S.K. Solanki, K.H. Glassmeier (2014b). Astron. Astrophys. 570, A85.

Proposed team members

Name	Institution	Area of expertise
Natalie Krivova	MPI for Solar System Research, Göttingen, Germany	Irradiance modeling; SATIRE irradiance model (semi-empirical)
Kok Leng Yeo		SATIRE (semi-empirical) and EMPIRE (proxy) irradiance models; irradiance modelling from 3D model atmospheres
Odele Coddington	LASP Univ. of Colorado, Boulder, USA	NRLSSI irradiance model (proxy)
Greg Kopp		TSI measurements, instrumentation
Marty Snow		UV SSI measurements, Mg II index
Eugene Rozanov	IAC ETH Zurich, Switzerland	climate and atmospheric research
William Ball	PMOD WRC, Davos, Switzerland	solar forcing in atmospheric simulations, irradiance data analysis
Matthew DeLand	NASA Goddard Space Flight Center & Sci. Systems and Applications, Inc., Maryland, USA	SSI measurements, stratospheric ozone
Matthieu Kretzschmar	Univ. of Orleans & CNRS, France	SOLID team, data analysis, space weather
Jeff Morrill	Naval Research Laboratory, USA	SSI measurement, instrumentation, SUSIM-based proxy model

External (self-supported) experts (all confirmed)

Name	Institution	Area of expertise
Katja Matthes	GEOMAR Helmholtz Centre for Ocean Research Kiel & Christian-Albrechts-Universität zu Kiel, Germany	stratosphere-troposphere-ocean coupling, natural climate variability, solar forcing in climate models, WCRP/SPARC-SOLARIS/HEPPA representative
Yvonne Unruh	Imperial College, London, UK	solar model atmospheres (1D and 3D) and spectra, radiative transfer
Sami K. Solanki	MPS, Göttingen, Germany	mechanisms of irradiance variations, solar magnetism
Alexander Shapiro		PMOD/COSI irradiance model (semi-empirical), non-LTE radiative transfer, brightness variations of sun-like stars

ADDRESSES OF THE PROPOSED TEAM MEMBERS

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SCIENTIFIC DEGREES

2012	Ph.D., Astrophysics, Imperial College London, UK
2008	MSci., University of Durham, UK

RESEARCH INTERESTS Solar irradiance, solar influence on Earth's climate and ozone, stratospheric chemistry and dynamics

PUBLICATIONS 10 refereed publications

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- Member of EGU (ID 294932) since 2014.
- Reviewer for international science journals.
- Member of ISSI Workgroup "An Assessment of the Accuracies and Uncertainties in the Total Solar Irradiance Climate Data Record", 2012-present.
- Member of SOLCLI (Solar Variability and Climate), NERC Consortium Project, 2008-2011.
- Co-founder "ClimateSnack" science communication project.

SELECTED RELEVANT PUBLICATIONS

1. **Ball, W.T.**, J. D. Haigh, E. V. Rozanov, A. Kuchar, T. Sukhodolov, F. Tummon, A. V. Shapiro and W. Schmutz (2016). High solar cycle spectral variations inconsistent with stratospheric ozone observations, Nature Geoscience, doi:10.1038/ngeo2640.
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2009 Ph.D., Atmospheric and Oceanic Sciences, CU Boulder, CO, USA
2002 B.A., Physics, CU Boulder, CO, USA

RESEARCH INTERESTS solar irradiance, Earth shortwave hyperspectral radiation, Earth remote sensing, solar influence on Earth's climate

PUBLICATIONS 12 refereed publications, 3 non-peer reviewed technical documents, 2 published data sets

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- NASA Total and Spectral Solar Irradiance (TSIS) Science Team Co-Investigator.
- NASA Solar Irradiance Science Team (SIST).
- NOAA Solar Irradiance Climate Data Record (CDR) Co-Principal Investigator.
- NASA Pre-Aerosol, Clouds, and ocean Ecosystem (PACE) Science Team.
- Reviewer for international science journals.
- 5-time mentor for the Solar and Space Physics Research Experience for Undergraduates (REU) program
- Member of American Geophysical Union, American Meteorological Society, and American Physical Society

SELECTED RELEVANT PUBLICATIONS

1. **Coddington, O**., J. Lean, P. Pilewskie, M. Snow, and D. Lindholm (2015), A solar irradiance climate data record, Bull. Amer. Meteor. Soc., doi:10.1175/BAMS-D-14-00265.1, *in press*.
2. **Coddington, O**., J. Lean, D. Lindholm, P. Pilewskie, M. Snow, and NOAA CDR Program (2015), NOAA Climate Data Record (CDR) of Solar Spectral Irradiance (SSI), Version 2. NOAA National Centers for Environmental Information, doi:10.7289/V51J97P6.
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7. **Coddington, O**., P. Pilewskie, and T. Vukicevic (2012), The Shannon information content of hyperspectral shortwave cloud albedo measurements: Quantification and practical applications, J. Geophys. Res., 117, D04205, doi:10.1029/2011JD16771.

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SCIENTIFIC DEGREES

1995 M.S., Meteorology, Univ. of Maryland
1985 M.A., Physics, Johns Hopkins Univ.

RESEARCH INTERESTS solar irradiance, polar mesospheric clouds, stratospheric ozone

PUBLICATIONS 61 refereed publications (20 as lead author)
221 presentations (86 as lead author)

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- Robert H. Goddard award for Science, NASA GSFC, 2016
- Team Leader, NASA Solar Irradiance Science Team, 2015-2018
- Member of Advisory Committee for European SOLID project, 2012-2015
- Member of CAWSES program, 2004-2007
- Member of ISCS program, 1998-2002
- Member of SOLERS22 program, 1993-1997

SELECTED RELEVANT PUBLICATIONS

1. **M. T. DeLand**, G. E. Thomas (2015), Updated PMC trends derived from SBUV data, J. Geophys. Res. Atmos., 120, doi:10.1002/2014JD022253
2. **M. DeLand** (2014), Use of solar reference spectra for satellite instruments, GSICS Quarterly, 8(2), 6-8, doi:10.7289/V5N29TWP
3. S. V. Marchenko, **M. T. DeLand** (2014), Solar spectral irradiance changes during Cycle 24, Astrophys. J., 789:117, doi:10.1088/0004-637X/789/2/117
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5. J. L. Lean, **M. T. DeLand** (2012), How does the Sun's spectrum vary?, J. Climate, 25, 2555-2560, doi:10.1075/JCLI-D-11-00571.1
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12. **M. T. DeLand**, R. P. Cebula (1993), The composite Mg II solar activity index for solar cycles 21 and 22, J. Geophys. Res., 98, 12,809-12,823

Greg Kopp

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SCIENTIFIC DEGREES

1990 Ph.D., Physics, Stanford Univ., Stanford, CA USA
1985 B.S., Physics, Caltech, Pasadena, CA USA

RESEARCH INTERESTS solar irradiance, solar influence on Earth's climate, solar variability, Earth energy balance, radiometry, spacecraft instrumentation

PUBLICATIONS 36 1st-author publications, 51 co-authored publications & proceedings, 180 conference presentations

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- Glory/TIM Principal Investigator and Science Team lead
- SORCE Co-Investigator and TIM Instrument Scientist
- TSIS/TIM Instrument Scientist
- TCTE Instrument Scientist
- TSI Radiometer Facility Principal Investigator
- Solar Irradiance Science Team (SIST) TSI Composite Principal Investigator
- ISSI team Principal Investigator for international assessment of TSI record
- CAESR (Carbon Absolute Electrical Substitution Radiometers) ACT Principal Investigator
- HySICS (HyperSpectral Imager for Climate Science) IIP Principal Investigator
- Hyperspectral Imager IIP Principal Investigator
- PROBA3/DARA Science Team member
- NORSAT 1/CLARA Co-Investigator
- PICARD Guest Investigator
- CLARREO Decadal Survey mission Science Definition Team Co-I

SELECTED RELEVANT PUBLICATIONS

1. **Kopp, G.,** "Earth's Incoming Energy: The Total Solar Irradiance," *Comprehensive Remote Sensing*, **5**, Chapter 1, 2016, in review.
2. **Kopp, G**., "Solar Variability Magnitudes and Timescales," *Journal of Space Weather and Space Climate*, 2016, in review.
3. **Kopp**, G., Krivova, N., Lean, J., and Wu, C.J., "The Impact of the Revised Sunspot Record on Solar Irradiance Reconstructions," *Solar Physics*, 2016, doi:10.1007/s11207-016-0853-x.
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5. Schmutz, W., Fehlmann, A., Finsterle, W., **Kopp, G.,** and Thuillier, G., "Total Solar Irradiance Measurements with PREMOS/PICARD," *AIP Conf. Proc*. 1531, 624-627, 2013.
6. **Kopp, G.,** Fehlmann, A., Finsterle, W., Harber, D., Heuerman, K., and Willson, R., "Total Solar Irradiance Data Record Accuracy and Consistency Improvements," *Metrologia*, 49, 2012, S29-S33, doi:10.1088/0026-1394/49/2/S29.
7. **Kopp, G**. and Lean, J.L., "A New, Lower Value of Total Solar Irradiance: Evidence and Climate Significance," *Geophys. Res. Letters* Frontier article, Vol. 38, L01706, doi:10.1029/2010GL045777, 2011.

Matthieu Kretzschmar

CURRENT POSITION Assistant Professor
LPC2E, CNRS & University of Orléans

SCIENTIFIC DEGREES
2002 Ph.D., Astrophysics and Astronomy, Grenoble Univ., France

RESEARCH INTERESTS solar irradiance, variability of the Sun and Sun-like stars, Solar flares, space weather

PUBLICATIONS 39 refereed publications in international journals of rank A

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- Co-Investigator on PROBA3/DARA (ESA, 2018) and SOLAR ORBITER/RPW (ESA, 2018)
- Associated scientist on PROBA2/LYRA
- Member of IAU Commission E1 “Solar radiation and structure” and Working group “Solar irradiance”
- Guest Editor for J. of Space Weather and Space Climate (JSWSC)
- Member of SOCs of international scientific meetings and sessions
- Participated in various national and international Sun-climate consortia and projects (e.g., ATMOP, SOLID, SHAPE, SOTERIA, CNES/PICARD/PREMOS)
- Reviewer for international journals and funding agencies.

SELECTED RELEVANT PUBLICATIONS

1. **M. Kretzschmar**, On the variation of the scaling exponent of the flare fluence with temperature, Solar Physics, 290(12), pp 3593-3609, 2015
2. M. Schöll, T. Dudok de Wit, **M. Kretzschmar**, and M. Haberreiter, Making of a solar spectral irradiance dataset I: observations, uncertainties, and methods, Journal of Space Weather and Space Climate, J. Space Weather Space Clim., 6, A14 (2016).
3. G. Cessateur, W. Schmutz, C. Wehrli, J. Grobner, M. Haberreiter, **M. Kretzschmar**, M. Schöll, A. Shapiro, G. Thuillier, W. Finsterle, N. Fox, J.-F. Hochedez, S. Koller, M. Meftah, P. Meindl, S. Nyeki, D. Pfiffner, H. Roth, M. Rouze, M. Spescha, R. Tagirov, L. Werner, J.-U. Wyss, The PREMOS radiometer aboard PICARD: In-flight performance and data release, A&A, in press, DOI : 10.1051/0004-6361/201527577 (2016)
4. **M. Kretzschmar**, I.E. Dammasch, M. Dominique, J. Zender, G. Cessateur, and E. D’Huys, Extreme Ultraviolet Solar Irradiance during the rising phase of solar cycle 24 observed by PROBA2/LYRA, J. Space Weather Space Clim., 2, A14, 2012b
5. **M. Kretzschmar**, T. Dudok de Wit, W. Schmudtz, S. Mekaoui, J.F. Hochedez, S. Dewitte, The effect of flares on the Total Solar Irradiance, Nature Physics, 6 , 690–692, 2010
6. **M. Kretzschmar**, J. Lilensten, J. Aboudarham, Retrieving the Whole Solar EUV Flux from 6 Irradiance Line Measurements, Advances in Space Research, 37(2) :341-346, 2006.

Natalie Krivova

CURRENT POSITION Leader of Minerva Research Group "Solar Variability & Climate"
Max-Planck-Institut für Sonnensystemforschung, Germany

SCIENTIFIC DEGREES

1998 Ph.D., Astrophysics and Radioastronomy, St. Petersburg Univ.
1992 M.Sc., Astronomy and Mathematics, St. Petersburg Univ.

RESEARCH INTERESTS solar irradiance, variability of the Sun and Sun-like stars, solar influence on Earth's climate

PUBLICATIONS 64 refereed publications (excluding reviews), 20 reviews, 17 proceedings and other non-refereed publications

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- President of IAU Commission E1 "Solar radiation and structure"
- Steering Committee Member of IAU Division E "Sun and Heliosphere"
- Member of IAU Working group "Solar irradiance"
- Organising Committee Member of IAU Commission 12 (2013-2015)
- Editor for J. of Space Weather and Space Climate (JSWSC)
- Guest Editor-in-Chief of JSWSC Topical Issue "Brightness Variations of the Sun and Sun-like Stars and Resulting Influences on their Environments"
- Guest editor of JSWSC Topical Issue "Solar variability, solar forcing, and coupling mechanisms in the terrestrial atmosphere"
- Expert reviewer for IPCC 5th Assessment Report Climate Change 2013, for international sci. foundations; reviewer for international sci. journals
- Chair (2) and member (4) of SOC of international scientific meetings and sessions
- Participated in various national and international Sun-climate consortia and projects (e.g., PMIP, ROMIC, NERC-SOLCLI, SPARC-SOLARIS, HEPPA-SOLARIS, COST ES TOSCA, CAWSES-I,II, MILLENNIUM)

SELECTED RELEVANT PUBLICATIONS

1. K.L. Yeo, W.T. Ball, **N.A. Krivova**, S.K. Solanki, Y.C. Unruh, J. Morrill (2015). UV solar irradiance in observations and the NRLSSI and SATIRE-S models. JGR 120, 5055-6070
2. K.L. Yeo, **N.A. Krivova**, S.K. Solanki, K.H. Glassmeier (2014). Reconstruction of total and spectral solar irradiance from 1974 to 2013 based on KPVT, SoHO/MDI, and SDO/HMI observations. Astron. Astrophys. 570, A85
3. W.T. Ball, **N.A. Krivova**, Y.C. Unruh, J.D. Haigh, S.K. Solanki (2014). A New SATIRE-S Spectral Solar Irradiance Reconstruction for Solar Cycles 21–23 and Its Implications for Stratospheric Ozone. J. Atmos. Sci. 71, 4086-4101
4. **N.A. Krivova**, L.E.A. Vieira and S.K. Solanki (2010). Reconstruction of solar spectral irradiance since the Maunder minimum. J. Geophys. Res. 115, A12112
5. **N.A. Krivova**, L. Balmaceda and S.K. Solanki (2007). Reconstruction of solar total irradiance since 1700 from the surface magnetic flux. Astron. Astrophys. 467, 335-346
6. **N.A. Krivova**, S.K. Solanki, M. Fligge and Y.C. Unruh (2003). Reconstruction of solar irradiance variations in cycle 23: Is solar surface magnetism the cause? Astron. Astrophys. 399, L1-L4

Katja Matthes

CURRENT POSITION Full Professor for Atmospheric Physics at the GEOMAR Helmholtz Center for Ocean Research Kiel and Christian-Albrechts-Universität zu Kiel, Germany

SCIENTIFIC DEGREES

2003 Ph.D., Meteorology, Freie Universität Berlin
2000 Diploma in Meteorology, Freie Universität Berlin

RESEARCH INTERESTS modeling solar influence on climate, stratosphere-troposphere-ocean coupling, natural climate variability

PUBLICATIONS 52 refereed publications and multiple contributions to international reports (WMO ozone assessment, SPARC CCMVal report)
7 non-refereed publications

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- Coordination of the SPARC solar influence study group (SOLARIS-HEPPA) for the World Climate Research Programme – Stratospheric Processes and their Role in Climate (WCRP-SPARC) http://solarisheppa.geomar.de
- Co-Chair of WG II-D "External Forcing of the Middle Atmosphere" of IAGA
- Member of the International Committee on the Middle Atmosphere (ICMA)
- Vice-chair of the EU-COST Action ES-1005 "Towards a more complete assessment of the impact of solar variability on the Earth's climate (TOSCA)" (2011-2015)
- Scientific Advisory Board of the Karlsruhe Institute of Technology (KIT)
- PI of the ROMIC-SOLIC Project (Quantification of uncertainties of solar-induced climate variability)
- Participated in various national and international Sun-climate consortia and projects (e.g., ROMIC, SPARC-SOLARIS, EU COST Network TOSCA, CAWSES-I,II, ROSMIC)

SELECTED RELEVANT PUBLICATIONS

1. Thiéblemont, R., **K. Matthes**, N. Omrani, K. Kodera, and F. Hansen (2015), Solar forcing synchronizes decadal North Atlantic climate variability, Nat. Comm., doi: 10.1038/ncomms9268.
2. Mitchell, D., S. Misios, L.J. Gray, K. Tourpali, **K. Matthes**, L. Hood, H. Schmidt, G. Chiodo, R. Thiéblemont, E. Rozanov, D. Shindell, A. Krivolutsky (2015), Solar Signals in CMIP-5 Simulations: The Stratospheric Pathway, Q. J. Roy. Met. Soc, doi:10.1002/qj.2530.
3. Ermolli, **K. Matthes**, T. Dudok de Wit, et al., 2013: Recent variability of the solar spectral irradiance and its impact on climate modelling, Atmospheric Chemistry and Physics, 13, 3945- 3977, DOI 10.5194/acp-13-3945-2013.
4. **Matthes, K.**, K. Kodera, et al., 2013: The Importance of Time-Varying Forcing for QBO Modulation of the Atmospheric 11-Year Solar Cycle Signal, J. Geophys. Res.,118, doi:10.1029/2012JD017764.
5. **Matthes, K.**, 2011: Solar Cycle and Climate Predictions, Nature Geoscience, doi: doi:10.1038/ngeo1298.
6. Meehl, G.A., J.M. Arblaster, **K. Matthes**, F. Sassi, and H. van Loon, 2009: Amplifying the Pacific Climate System Response to a Small 11-Year Solar Cycle Forcing, Science, 325, 1114, DOI:10.1126/science.1172872.

Jeff S.Morrill

CURRENT POSITION 2014 – Present Program Scientist, on Detail at NASA HQ

EXPERIENCE

1991-2014	Research Physicist, Naval Research Laboratory (NRL)
1991-2014	Physical Scientist, Government Contractor at NRL

SCIENTIFIC DEGREES

1999	Ph.D., Physical Chemistry, University of Maryland
1986	M.S., Physical Chemistry, University of Maryland
1979	B.S., Chemistry, University of Maryland

AWARDS, HONORS, AND PROFESSIONAL SOCIETIES

1994 - 1996	Edison Memorial Graduate Training Fellowship
1996	NRL Alan Berman Research Publication Award
1988 - present	American Geophysical Union
1997 - present	American Astronomical Society

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

Dr. Morrill is a Research Physicist in the Solar Physics Branch, Space Science Division NRL.

Career activities include:

- developed a solar UV spectral irradiance model and analyzed of solar UV spectra
- (SORCE, HRTS, SUSIM, SKYLAB),
- analyzed and calibrated SECCHI/STEREO and SMEI observations,
- determined and implement flight calibration of the LASCO coronagraphs.
- examined the electron energetics and time dependent emissions in red sprites
- analyzed ultra-violet emission from the thermosphere measured from space
- conducted research involving the kinetic and spectroscopic properties of molecular nitrogen emission in the laboratory and terrestrial atmosphere.
- instrument scientist on the MAHRSI (Middle Atmosphere High Resolution Spectrograph Investigation) spectrograph & RAIDS (Remote Atmospheric and Ionospheric Detection System) instrument suite.

SELECTED JOURNAL PUBLICATIONS

1. **Morrill, J. S**. , L. Floyd, D. McMullin, Comparison of Solar UV Spectral Irradiance from SUSIM and SORCE, Under review, Sol. Phys., 2012.
2. **Morrill, J. S.,** L. Floyd, R. Ulrich, S. Weaver, and D. McMullin, Estimating the Mg II Index from 1961 Through 1981 Using Ca II K Images from the Mt. Wilson Obs., Sol. Phys., 270, 109-124, 2011, DOI 10.1007/s11207-011-924-7.
3. **Morrill, J. S**. , L. Floyd, D. McMullin, The Solar UV Spectrum Estimated Using the Mg II Index and Ca II K Disk Activity, Sol. Phys., 269, 253-267, 2011, DOI 10.1007/s11207-011-7.
4. **Morrill, J. S.,** L. Floyd, D. McMullin, M. Snow, and R. Viereck, Comparing Estimates of the Mg II Index at Solar Minimum from 1961 Through 1981 with the Observed Mg II Index from 1978 to Present, SOHO 23 Proceedings, ASP Conf. Ser., 428, 315-320, 2010.
5. **Morrill, J. S**., and C.M. Korendyke, High Resolution Center-to-Limb Variation of the Quiet Solar SpectrumNearMg II, ApJ, 687, 646, 2008

Eugene Rozanov

CURRENT POSITION Senior Scientist, IAC ETHZ and PMOD/WRC, Davos, Switzerland

SCIENTIFIC DEGREES

1986 Ph.D., Physics and Mathematics, MGO, St. Petersburg, Russia
1979 M.Sc., Atmospheric Sciences, St. Petersburg Univ.

RESEARCH INTERESTS solar influence on Earth's climate and ozone layer, solar irradiance, energetic particles

PUBLICATIONS 170 refereed publications

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- Member of EGU (ID 25723) since 2001.
- Member of Swiss National SCOSTEP committee since 2015.
- Member of WG1 of SCOSTEP VarSITI ROSMIC project since 2015.
- National representative to the European COST action ES1005 TOSCA ("Towards a more complete assessment of the impact of solar variability on the Earth's climate") and co-leader of its WG1.
- Guest managing editor of JASTP Special Issue "Solar wind and climate".
- Associated Editor, Frontiers in Earth Science, Atmospheric Science.
- Expert reviewer for IPCC 4th Assessment Report Climate Change 2007.
- Lead author of WMO 2010 Assessments on Ozone depletion (Chapter 3).
- Co-author of SPARC CCMVAI-2 report (Chapter 3).
- Contributor to WMO Assessments on Ozone depletion and IPCC special report on the aviation effects on ozone and climate.
- Reviewer for international sci. foundations and international sci. journals.

SELECTED RELEVANT PUBLICATIONS

1. Ball, W., J. D. Haigh, **E. V. Rozanov**, A. Kuchar, T. Sukhodolov, F. Tummon, A. V. Shapiro and W. Schmutz (2016). High solar cycle spectral variations inconsistent with stratospheric ozone observations, Nature Geoscience, doi:10.1038/ngeo2640, 2016.
2. **Rozanov, E.,** K. Tourpali, H. Schmidt, and B. Funke (2016). Long-term variations of solar activity and their impacts: From the Maunder Minimum to the 21st century, SPARC newsletter, N^{o}46, 15-20, 2016.
3. Sukhodolov, T, **E. Rozanov**, A. I. Shapiro, J. Anet, C. Cagnazzo, T. Peter, and W. Schmutz, Evaluation of the ECHAM family radiation codes performance in the representation of the solar signal, Geosci. Model Dev., 7, 2859–2866, doi:10.5194/gmd-7-2859-2014, 2014.
4. Anet, J., **E.Rozanov**, S.Muthers, T.Peter, S.Bronnimann, F.Arfeuille, J.Beer, A. I. Shapiro, C. Raible, F.Steinhilber, and W.Schmutz, Impact of a potential 21st century "grand solar minimum" on surface temperatures and stratospheric ozone, Geophys. Res. Lett., *40*, 4420–4425, doi:10.1002/grl.50806, 2013.
5. Egorova, T., **E. Rozanov**, E. Manzini, M. Haberreiter, W. Schmutz, V. Zubov, and T. Peter, Chemical and dynamical response to the 11-year variability of the solar irradiance simulated with a chemistry-climate model, Geophys. Res. Lett., 31, L06119, doi:10.1029/2003GL019294, 2004.
6. **Rozanov, E.V.**, M. E. Schlesinger , T. A. Egorova, B. Li, N. Andronova, and V.A. Zubov, Atmospheric Response to the Observed Increase of Solar UV Radiation from Solar Minimum to Solar Maximum Simulated by the UIUC Climate-Chemistry Model, J. Geoph. Res., 109, D01110, doi:10.1029/2003JD003796, 2004.

Alexander Shapiro

CURRENT POSITION Marie-Curie Fellow
Max-Planck-Institut für Sonnensystemforschung, Germany

SCIENTIFIC DEGREES

2009 Doctorate (PhD) in Physics, ETH Zürich, Switzerland
2004 M.Sc., Astronomy and Mathematics, St. Petersburg Univ., Russia

RESEARCH INTERESTS variability of the Sun and Sun-like stars, modeling of the solar and stellar spectra, radiative transfer

PUBLICATIONS 35 refereed publications,
8 proceedings and other non-refereed publications

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- Head of the ESA "SOLAR" Topical Team
- Co-chair of IAU Working group "Solar irradiance"
- Guest editor of J. of Space Weather and Space Climate (JSWSC) Topical Issue "Brightness Variations of the Sun and Sun-like Stars and Resulting Influences on their Environments"
- Guest editor of JSWSC Topical Issue "Solar variability, solar forcing, and coupling mechanisms in the terrestrial atmosphere"
- Editor of the Proceedings of the IAU XXIX General Assembly, Astronomy in Focus Vol. 1
- Reviewer for international scientific journals (Astronomy and Astrophysics, The Astrophysical Journal, The Astrophysical Journal Letters, Solar Physics, Journal of Geophysical Research, Geophysical Research Letters, Journal of Atmospheric and Solar-Terrestrial Physics, New Astronomy)
- Chair (1) and member (4) of SOC of international scientific meetings and sessions
- Leader of a Work Package at COST action ES1005 TOSCA ("Towards a more complete assessment of the impact of solar variability on the Earth's climate")

SELECTED RELEVANT PUBLICATIONS

1. **A.I. Shapiro,** S.K. Solanki, N.A. Krivova, K.L. Yeo, W.K. Schmutz (2016). Are solar brightenss variations faculae- or spot-dominated? Astron. Astrophys., in press
2. **A.I. Shapiro,** S.K. Solanki, N.A. Krivova, R.V. Tagirov, W.K. Schmutz (2015). The role of the Fraunhofer lines in solar brightness variability. Astron. Astrophys. 581, 116
3. **A.I. Shapiro,** S.K. Solanki, N.A. Krivova, W.K. Schmutz, W.T. Ball, R. Knaack, E. Rozanov, Y.C. Unruh (2014). The variability of Sun-like stars: reproducing observed photometric trends. Astron. Astrophys. 569, A38
4. A.V. Shapiro, E. Rozanov, A.I. **Shapiro**, S. Wang, T. Egorova, W.K. Schmutz, Th. Peter (2012). Signature of the 27-day solar rotation cycle in mesospheric OH and H2O observed by the Aura Microwave Limb Sounder. Atmospheric Chemistry and Physics, 12, 7, 3181
5. **A.I. Shapiro**, W.K. Schmutz, E. Rozanov, M. Schoell, M. Haberreiter, A.V. Shapiro, S. Nyeki (2011). A new approach to the long-term reconstruction of the solar irradiance leads to large historical solar forcing. Astron. Astrophys 529A, 67S
6. **A.I. Shapiro**, W.K. Schmutz, M. Schoell, M. Haberreiter, E. Rozanov (2010). NLTE solar irradiance modelling with the COSI code. Astron. Astrophys 517A, 48S

Martin Snow

CURRENT POSITION Research Scientist III, University of Colorado
Laboratory for Atmospheric and Space Physics

SCIENTIFIC DEGREES

1995 Ph.D., Astrophysics, University of Colorado
1986 B.A., Physics and Mathematics, Kalamazoo College

RESEARCH INTERESTS ultraviolet solar irradiance variability, measurement of solar spectral irradiance, the heliosphere, solar irradiance proxies

PUBLICATIONS 25 refereed publications

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- Instrument scientist, SOLar-Stellar Irradiance Comparison Experiment (SOLSTICE)
- Instrument scientist, GOES-R EXIS, Mg II index channel
- Co-PI, Research Experience for Undergraduates site, Solar and Space Physics
- Co-I, Solar Radiation and Climate Experiment (SORCE)
- Team Leader, ISSI Team: Solar Heliospheric lyman Alpha Profile Effects (SHAPE)
- Team Member, ISSI Team: FONDUE (E. Quemerais, lead)

SELECTED RELEVANT PUBLICATIONS

1. K. Suess, **M. Snow**, R. Viereck, and J. Machol (2016). Solar spectral proxy irradiance from GOES (SSPRING): a model for solar euv irradiance. SWSC, 6, A10.
2. T. Woods, **M. Snow**, J. Harder, G. Chapman, A. Cookson (2015). A different view of solar spectral irradiance variations: modeling total energy over six-month intervals. Solar Phys. 290, 2649.
3. **M. Snow**, M. Weber, J. Machol, R. Viereck, E. Richard (2014). Comparison of magnesium II core-to-wing ratio observations during solar minimum 23/24. SWSC, 4, A04.
4. J. Fontenla, E. Landi, **M. Snow**, T. Woods (2014). Far- and extreme-uv solar spectral irradiance and radiance from simplified atmospheric physical models. Solar Phys. 289, 515.
5. O. R. White, G. Kopp, **M. Snow**, K. Tapping (2011). The solar cycle 23-24 minimum. A benchmark in solar variability and effects in the heliosphere. Solar Phys. 274, 159.
6. **M. Snow**, W. McClintock, T. Woods (2010). Solar spectral irradiance variability in the ultraviolet from SORCE and UARS SOLSTICE. Adv. Space Res. 528, 68.

Sami K. Solanki

CURRENT POSITION Director and Head of the department Sun and Heliosphere
Max-Planck-Institut für Sonnensystemforschung, Germany

SCIENTIFIC DEGREES

1982	Diploma (Masters Degree) in Physics, ETH Zurich, Switzerland
1987	Doctorate in Natural Sciences, ETH Zurich, Switzerland
1992	Habilitation in Astronomy, ETH Zurich, Switzerland

RESEARCH INTERESTS Solar and stellar physics, in particular solar magnetism and its effects, with particular emphasis on Sun-climate relations

PUBLICATIONS 410 refereed publications (excluding reviews), 75 reviews, 250 proceedings and other non-refereed publications

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- Advanced Grantee of the European Research Council
- Founder and Editor-in-Chief of the refereed review journal “Living Reviews in Solar Physics” (impact factor of 17.6)
- Editorial board member of the international refereed journal “Solar Physics”
- Chairman of the Space Research Programme Committee of the DLR
- Member of the Programme Commission for Space Activities of the DLR
- Permanent representative of the President of the MPG in the Senate of DLR
- Member of the Space Science Advisory Committee of ESA
- National Representative of SCOSTEP (Scientific Committee for Solar Terrestrial Physics)
- PI of SO/PHI on board Solar Orbiter (ESA/NASA) & of SUNRISE project of (DLR/NASA)
- Co-I of VIRGO on SOHO, & of EUI, SPICE and METIS on Solar Orbiter
- Member of the governing board of the European Union’s project to advance solar observing infrastructure and facilities, SolarNet
- Member of the Scientific Advisory Committee of the Instituto de Astrofísica de Canarias (IAC)

SELECTED PUBLICATIONS

1. **Solanki, S. K.**, Usoskin, I.G., Kromer, B., Schüssler, M., Beer, J., Unusual Activity of the Sun During Recent Decades Compared to the Previous 11,000 Years, *Nature* 431, 1084 (2004).
2. **Solanki S.K.**, Barthol P., Danilovic S., et al., Sunrise: Instrument, Mission, Data and First Results. *Astrophys. J. Lett.* 723, L127 (2010).
3. Vieira L.E.A., **Solanki S.K.**, Krivova N.A., Usoskin I.: Evolution of the Solar Irradiance During the Holocene. *Astron. Astrophys.* 531, A6, 20 (2011).
4. **Solanki S.K**., Unruh Y.C.: Solar Irradiance Variability. Astron. Nachr. 334, 145 (2013).
5. **Solanki S.K**., Krivova N.A., Haigh J.D.: Solar Irradiance Variability and Climate. Ann. Rev. Astron. Astrophys. 51, 311 (2013).
6. Buehler, D., Lagg, A., **Solanki, S.K**., van Noort, M.: Properties of Solar Plage from a Spatially coupled Inversion of Hinode SP Data. Astron. Astrophys. 576, A27, (2015).

Yvonne C Unruh

CURRENT POSITION Reader in Astrophysics
Blackett Laboratory, Imperial College London, UK

SCIENTIFIC DEGREES

1994 D.Phil. in Astrophysics, University of Sussex
1991 M.Sc. in Physics, University of Sussex

RESEARCH INTERESTS solar and stellar variability, stellar surface imaging

PUBLICATIONS 72 refereed publications, 21 proceedings and other non-refereed publications

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- Member of Astronomy Advisory Panel (STFC)
- Guest Editor of the JSWSC Topical Issue on “Brightness Variations of the Sun and Sun-like Stars and Resulting Influences on their Environments”
- Grant reviews for NSF, STFC (UK), Swiss and Danish Research Councils
- Regular reviewer for A&A, MNRAS and Solar Physics
- Past member and UK chair for AAT TAC

SELECTED RELEVANT PUBLICATIONS

1. K.L. Yeo, W.T. Ball, N.A. Krivova, S.K. Solanki, **Y.C. Unruh**, J. Morrill (2015). UV solar irradiance in observations and the NRLSSI and SATIRE-S models. JGR 120, 5055-6070
2. R.D. Haywood and 14 coauthors, including **Y.C. Unruh** (2014). Planets and stellar activity: hide and seek in the CoRoT-7 system. Mon. Not. Royal Astr. Soc. 443, 2517
3. W.T. Ball, N.A. Krivova, **Y.C. Unruh,** J.D. Haigh, S.K. Solanki (2014). A New SATIRE-S Spectral Solar Irradiance Reconstruction for Solar Cycles 21–23 and Its Implications for Stratospheric Ozone. J. Atmos. Sci. 71, 4086-4101
4. W.T. Ball, **Y.C. Unruh**, N.A. Krivova, S.K. Solanki, T. Wenzler, D.J. Mortlock, A.H. Jaffe (2012). Reconstruction of total solar irradiance 1974-2009. Astron. Astrophys. 541, A27
5. W.T. Ball, **Y.C. Unruh**, N.A. Krivova, S.K. Solanki, J.W. Harder (2011). Solar irradiance variability: a six-year comparison between SORCE observations and the SATIRE model. Astron. Astrophys. 530, A71
6. **Y.C. Unruh**, N.A. Krivova, S.K. Solanki, J.W. Harder, G. Kopp (2008). Spectral irradiance variations: comparisons between observations and the SATIRE model on solar rotation time scales. Astron. Astrophys. 586, 311
7. S.K. Solanki, **Y.C. Unruh** (2004). Spot sizes on Sun-like stars. Mon. Not. Royal Astr. Soc. 348, 307
8. N.A. Krivova, S.K. Solanki, M. Fligge and **Y.C. Unruh** (2003). Reconstruction of solar irradiance variations in cycle 23: Is solar surface magnetism the cause? Astron. Astrophys. 399, L1-L4
9. **Y.C. Unruh**, S.K. Solanki, M Fligge (1999). The spectral dependence of facular contrast and solar irradiance variations. Astron. Astrophys. 345, 635

Kok Leng Yeo

CURRENT POSITION Postdoctorate
Max-Planck-Institut für Sonnensystemforschung, Germany

SCIENTIFIC DEGREES

2014 Dr. Rer. Nat., Technische Universität Braunschweig
2004 MSci, Physics, Imperial College London

RESEARCH INTERESTS solar irradiance, solar activity, solar magnetism

PUBLICATIONS 6 refereed publications (excluding reviews), 2 reviews

SELECTED SCIENTIFIC AND OTHER RELATED ACTIVITIES

- Referee for international scientific journals (e.g., AJ, J. Space Weather Space Clim.).
- Participated in various national and international Sun-climate consortia and projects (e.g., ROMIC, HEPPA-SOLARIS, SOLID).

SELECTED RELEVANT PUBLICATIONS

1. A.I. Shapiro, S.K. Solanki, N.A. Krivova, **K.L. Yeo**, W.K. Schmutz. Are solar brightness variations faculae- or spot-dominated? Astro. Astrophys. (accepted)
2. **K.L. Yeo**, A.I. Shapiro, N.A. Krivova, S.K. Solanki. Modelling solar and stellar brightness variabilities. ASP Conf. Ser. (accepted)
3. **K.L. Yeo**, W.T. Ball, N.A. Krivova, S.K. Solanki, Y.C. Unruh, J. Morrill (2015). UV solar irradiance in observations and the NRLSSI and SATIRE-S models. JGR 120, 5055-6070
4. **K.L. Yeo**, N.A. Krivova, S.K. Solanki (2014). Solar cycle variation in solar irradiance. Space Sci. Rev. 186(1), 137-167
5. G. Thuillier, G. Schmidtke, C. Erhardt, B. Nikutowski, A. I. Shapiro, C. Bolduc, J. Lean, N.A. Krivova, P. Charbonneau, G. Cessateur, M. Haberreiter, S. Melo, V. Delouille, B. Mampaey, **K.L. Yeo**, W. Schmutz (2014). Solar spectral irradiance variability in November/December 2012: Comparison of observations by instruments on the International Space Station and models. Sol. Phys. 289, 4433-4452.
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