Report to the IRC on
Activities of the ASA (Atmospheric Spectroscopy Applications) Working Group

HITRAN database remains to be a backbone of the interpretation of spectral atmospheric retrievals and important input to the radiative transfer codes. In the last year substantial effort have been made to assess the quality and extent of spectroscopiv parameters in the HITRAN2016 edition (Gordon et al. 2017) in application to the current and upcoming remote sensing missions. These missions include TEMPO (Zoogman et al. 2017), GOSAT and GOSAT-2 (Kuze et al. 2009), OCO-2 and OCO-3 (Frankenberg et al. 2015), SCIAMACHY (Frankenberg et al. 2011), MERLIN (Ehret et al. 2017), CarbonSat (Buchwitz et al. 2013), TROPOMI (Butz et al. 2012), MethaneSAT (EDF 2018), MicroCarb (Pasternak et al. 2017) and many others. While major improvements were noticed with respect to the previous compilation HITRAN2012 (Rothman et al. 2013), remaining issues (especially when sub-percent accuracy is required) have been identified and are now addressed by the spectroscopic community. Some examples are given below:

1) The 1.27 micron band of oxygen is identified as an attractive alternative to the A-band as a benchmark for the satellite missions, because of its closer proximity to the target CO_2 and CH_4 bands, lesser saturation issues, etc. Previously this band was avoided because of the airglow issues, however we can now model the airglow efficiently (Sun et al. 2018). Nevertheless, there are remaining issues which include the need for advanced line shape parameters and better experimental intensities. New measurements and calculations are underway in laboratories worldwide.
2) In recent years it was concluded that the consistency between the HITRAN intensities of the microwave, 5 µm and 10 µm and UV bands of ozone is good. However, recent works have shown (Birk et al. 2019) that the MW band intensities are off by 3-4%, and entire ozone line list will need to be re-evaluated.
3) The quality of water vapour paraeters in the visible and UV remains to be an issue. Indeed, the experimental data are sparse and theoretical calculations are often unreliable because of the increased complexity. Nevertheless, recent advances in theoretical dipole moment calculations show promise that the situation will soon be improved (Conway et al. 2018). Calculation of the new line list is underway.
4) Methane spectroscopy remains to be a major challenge in the remote sensing, and new experimental studies are being incorporated to resolve remaining issues.

It is noted that although HITRAN now provides advanced line shape parameters for many bands the radiative transfer codes are not on par with that and some changes to the community codes are required. Naturally, forther population of these parameters in the database is also anticipated.

Taking advantage of the new structure and interface available at www.hitran.org (Hill et al. 2016) and the HITRAN Application Programming Interface (Kochanov et al. 2016) broadening of lines by water vapour has been introduced to the HITRAN database. This will allow more accurate modelling in the tropical regions, where water concentrations are high in the atmosphere.

Future:

The work on the HITRAN2020 edition of the database is well underway. It is expected to be publicly released in late 2020.

The next ASA/HITRAN meeting will be in Reims, France in August 2020.

Subsequent to that meeting the HITRAN Advisory Committee will be held. One of the goals of the meeting will be to discuss remaining deficiencies in the HITRAN database, and draw a roadmap for the future improvements that can aid terrestrial atmospheric remote sensing.

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Brief Report of the IRC Working Group BSRN - Baseline Surface Radiation Network

Amelie Driemel, Christian Lanconelli

- 2019-05-28 -

Current Status/Objectives/Activities

BSRN - a project of the Global Data and Analysis Panel (GDAP) from the Global Energy and Water Cycle Experiment (GEWEX) under the umbrella of the World Climate Research Programme (WCRP) - is aimed at detecting important changes in the Earth's radiation field at the Earth's surface. BSRN is designated as the global surface radiation network for the Global Climate Observing System (GCOS) and contributes to the Global Atmospheric Watch (GAW). Since 2008 the BSRN archive (World Radiation Monitoring Center, WRMC) is hosted by the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany (AWI). Since January 2017 Amelie Driemel is **WRMC Director**. In 2018 the BSRN Project Manager Charles N. Long retired. At the biannual BSRN Workshop in July 2018, Christian Lanconelli was proposed as the new **Project Manager** and officially appointed by WMO on October 2018**.**

At the moment (status May 2019) BSRN comprises 65 stations in contrasting climatic zones, covering a latitude range from 80°N to 90°S. Thirteen of those are unfortunately closed and will not submit more data. One new candidate station (Paramaribo) already submitted three months of data and will be added as an official station soon (after having submitted 6 full months of data). Seven more stations were accepted as candidate stations on the 2018 meeting and are expected to send data to the archive soon. More than **11 000 months of radiation data** are available either via PANGAEA or via the ftp server (https://dataportals.pangaea.de/bsrn/?q=LR0100 or http://bsrn.awi.de/data/data-retrieval-via-ftp/). To gain access to the data (login info) just contact Amelie Driemel.

The 15th BSRN Scientific Review and Workshop took place in July, 16-20, 2018 in Boulder. The details can be accessed here: https://bsrn.awi.de/meetings/2018/. A summary of the activities of the workshop was provided by Long (2018)**.** Among the several discussion occurred during the workshop, it may be significant to mention here the institution of a “Data Quality WG”. It already met once in 2019 and aims at improving the overall data quality of BSRN data. Furthermore, it was decided to update the BSRN Manual, and a specific committee was established to pursue the activities during the inter-workshop period. It is expected to draft the manual for the 2020 workshop. Other active working groups are: infrared measurements issues (Groebner), spectral measurements (Lantz), broadband (McComiskey) measurements, Uncertainties (Hyett), Cold Climate Issue (Cox) and Renewable Energies (Pereira).

The Project Manager reported on the status of the network to GEWEX GDAP meeting in November 2018 (Lisbon, https://www.gewexevents.org/events/2018-gdap-meeting/), and to the Atmospheric Observation Panel for Climate (AOPC) during the GCOS Joint Panel Meeting in March 2019 (Marrakech, https://gcos.wmo.int/en/gcos-joint-panels-meeting).

Research Results

A list of **publications related to BSRN** can be found at http://bsrn.awi.de/other/publications/. Within the Web of Science the topic "BSRN" is cited more than 2900 times (without self citations) within 123 articles (statistic from 2019-05-24, see Figure 1).

Schwarz (2018) applied the concepts of decorrelation lengths (δ), spatial sampling biases (β), and spatial sampling errors (ϵ) to three high-resolution gridded monthly mean SSR data sets (CLARA, SARAH-P, and SARAH-E) provided by the CM SAF (www.cmsaf.eu). While δ quantifies the area for which a point observation is representative, β and ϵ are uncertainty estimates with respect to the 1° reference grid (G). An average of the CLARA dataset against BSRN monthly averages for the stations between 50S and 55N, provided an average δ_G = 3.5° with only three sites with a δ_G <1° and 26 sites with a δ_G >3°. Average biases and errors was found to be β_G = 2.8 W/m^2, and ϵ_G = 8.7 W/m^2, respectively.

Other works relevant to solar forecast (Wang et al., 2019), product validation (Zhang et al., 2018; Garcia et al., 2018), climate trends (Nyeki et al., 2019) have been presented, confirming the solid support of BSRN dataset for scientific production relevant to climate monitoring (Wild et al., 2018) and the definition of standards observation procedures (Nyeki et al., 2017; Wang et al., 2019).

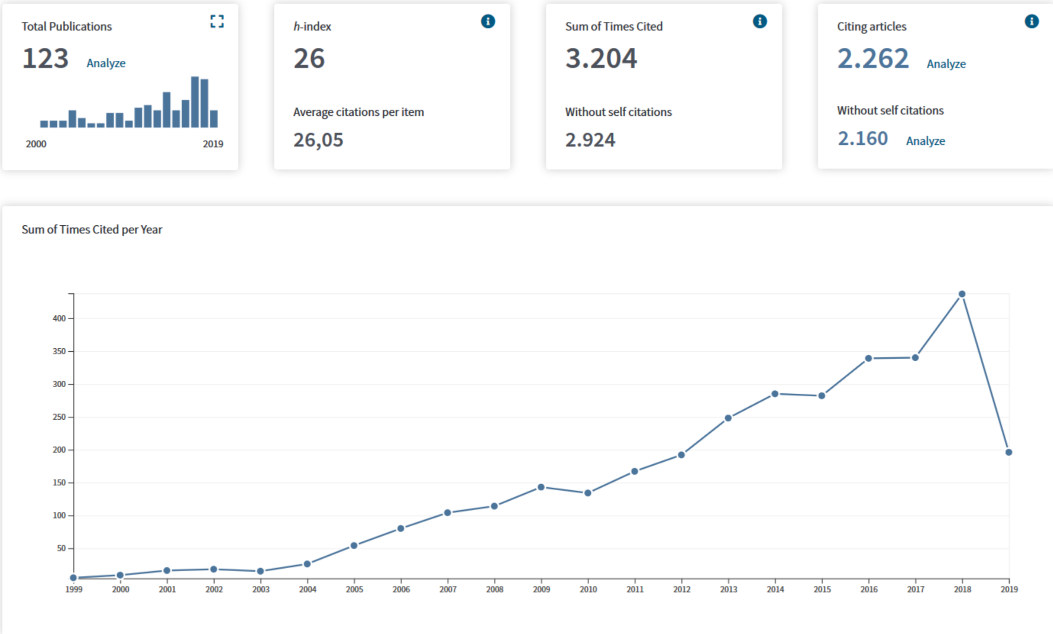

Figure 1 Web of Science Citation Report for the Topic "BSRN" (2019-05-24)

In August 2018 the data paper on BSRN was published in the journal Earth System Science Data, see https://doi.org/10.5194/essd-10-1491-2018. It has already been cited 12 times according to Google Scholar.

Plans

1. Manual review and collaboration with CIMO TT/ET (B. Forgan),
2. Cover the network knowledge gaps, harmonizing measurements, implement ground meteorological traceability (T, p, RH),
3. expand albedo measurements (tower/drones?, Zhang),
4. extending inter-network interactions (within GCOS, P. Lai GAW),
5. explore the space agencies interests to invest in area gap coverage (Africa/Pacific) for validation purposes (EU),

6. integrate the computation of average as a BSRN product made by professionals for users,
7. integrate the cloud screening/cloud effects,
8. integrate a quality control system following the outcomes of the DQWG,
9. Organize the 2020 Workshop (as rotating over continents it will be probably set in Europe),
10. Workshop with the ocean community (as an outcome of the GCOS JPM).

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I3RC Working Group Report

Alexander Marshak – NASA Goddard Space Flight Center

During the past year, we gave the code only to 4 people (3 from China, 1 from the US). This is down from 14 last year and 12 the year before. This number, however, does not include the direct downloads from GitHub for Alexandra Jones's expanded versions of the I3RC code, one of which includes thermal emission (this was released in 2017), and the other allows broadband calculations (this was released in 2018 and was not yet mentioned in my report last year).

Also, we released the I3RC online simulator (i3rcsimulator.umbc.edu) during this past year. Not counting ourselves and the people to whom we gave accounts only out of courtesy but are unlikely to become actual users (e.g., Stefani, Belay, or some others at UMBC who helped in the setup), we have 34 users: 16 from the US, 4 from Germany, 2 from each of China, India, Russia, and France, and 1 from each of Japan, Taiwan, Brazil, Israel, UK, Canada.

BRIEF REPORT ON ICLAS ACTIVITIES (2017-2019)

BACKGROUND:

The Society, called the International Coordination-group on Laser Atmospheric Studies (ICLAS), is a nonprofit, constituent Working Group of the International Radiation Commission (IRC).

ICLAS works to promote the study of the environment (atmosphere, hydrosphere and lithosphere) including meteorology, pollution, atmospheric physics and chemistry, solid earth, biology, and climate, as elements of Earth and planetary sciences.

ACTIVITIES:

I) CONFERENCES

One of the major activities of ICLAS is to organize the International Laser Radar Conferences (ILRCs). In the reporting period (2017-2019) two (2) ILRCs were organized and held, as follows: Bucharest, Romania (2017) and Hefei, China (2019).

Moreover, during these events, ICLAS awards the Inaba Prize and the Lifetime Achievement Awards. The Inaba Prize is awarded to the best oral paper first-authored and presented by an attendee below the age of 40. The prize carries a monetary award of $1.200, which is funded by ICLAS through an endowment by the Inaba family. ICLAS's highest honor is the Lifetime Achievement Award (LAA) which honors up to 2 members of the lidar community. Awardees can be selected for outstanding contributions in two areas: 1) for outstanding leadership and service to the international lidar community, supporting, promoting and advocating on behalf of lidar activities around the world; and, 2) for sustained outstanding and innovative scientific or technical achievements in the areas of lidar techniques, technologies, and observations.

- *Bucharest, Romania (2017)*

The 28th ILRC Conference was organized by Dr. Doina Nicolae and National Institute of Research and Development for Optoelectronics (Romania).

It was held on the campus of the "Politehnica" University of Bucharest from 25-30 June 2017 (http://ilrc28.inoe.ro). It had 353 participants form 31 countries (259 regular members and 94 students). There were 299 papers presented including 93 oral presentations and 206 posters. The program included the ILRC Summer School organized by Prof. Gary Gimmestad of Georgia Institute of Technology (USA) and offered on 25 June for over 160 students and young scientists, also held at the “Politehnica” University of Bucharest.

The conference provided a total of 62 students and scholars support to attend the ILRC and present their work.

Four awards were given for the: best oral presentation awarded to Jens Reinhard (Germany), best student oral awarded to Moritz Haarig (Germany), best poster was awarded to Volker Freudenhaaler (Germany) and best student poster was awarded to Tomoki Kubota (Japan). Finally, the Inaba Prize was awarded to Dr. Rodelize Mamouri (Cyprus), while LAA was presented to Dr. Upendra Signh (USA) and Dr. Mike Hardesty (USA).

- *Hefei, China (2019)*

The 29th ILRC Conference was organized by Prof. Dr. Dong Liu and the Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences (China).

It was held from 24-28 June 2019 (http://www.ilrc29.cn). It had 600 participants from 38countries (250 regular members and 350 students). There were 278 papers presented including 86 oral presentations and 192 posters. The program included the ILRC Summer School organized by Prof. Gary Gimmestad of Georgia Institute of Technology (USA) and was offered on 24 June for over 200 students and young scientists.

The conference provided a total of 70 students and scholars support to attend the ILRC and present their work.

Four awards were given for the: best oral presentation awarded to Xiaoxia Shang (Finland), best student oral awarded to Philipp Gash (Germany), best poster was awarded to Andreas Behrendt (Germany) and best student poster was awarded to Adrien Genoud (USA). Finally, the Inaba Prize was awarded to Dr. Alexandra Tsekeri (Greece), while LAA was presented to Dr. Ed Eloranta (USA) and Dr. Bob Menzies (USA).

II) ELECTIONS

Another major agenda item of the ICLAS Committee is to organize the elections for determining new Working Group Members.

2019

The five ICLAS members, whom term expired at the 29th ILR, June 2019, were: Dr. F. Gibert (France), Dr. E. Landulfo (Brazil, Dr. A. Makato (Japan), Dr. S. Bobrovnikov (Russia), Dr. K. Strawbridge (Canada).

These members will be replaced after elections during Autumn 2019.

On behalf of ICLAS

Prof. Alex Papayannis	Dr. Upendra Singh
(ICLAS President)	(Outgoing ICLAS President)

International Coordination-group for Laser Atmospheric Studies (ICLAS) Working Group Report for 2017-2019

Alex PAPAYANNIS, ICLAS P*resident*
National Technical University of Athens, Greece
Upendra N. SINGH, *Past ICLAS President*
NASA Langley Research Center, Hampton, VA, USA

- ICLAS: Promotes the development and application of laser sensing techniques and laser instrument architectures used to study the atmospheres of the Earth and other planets.
- ICLAS: Takes care of the promotion and organization of the International Laser Radar Conferences (ILRCs), gathering the laser remote sensing community and are convened every 2 years. The ILRCs are held under the auspices of the ICLAS.

ICLAS

ICLAS is composed of:

- The President, who is the WG Chairman
- The Working Group
- The Executive Committee

➢ The term of office of the President is 6 years
➢ The Working Group members shall have 6-year terms
➢ 13 members with 6-year terms
➢ Committee meets at the ILRC Conference site every 2 years
➢ Candidates are proposed and selected seeking to achieve a reasonable balance in their geographical and professional distribution
➢ Executive Committee (EC) members include, President, Past President, with 6-year term and Treasurer with no term limitation
➢ The Executive Committee in consultation with ICLAS members elects new members and selects the winners of different awards, including Inaba Prize, Lifetime Achievement Award and various oral and poster awards

ICLAS

Name	Country	Term
Landulfo, Eduardo	Brazil	2012-2019
Fix, Andreas	Germany	2015-2021
Tzeremes, Georgios	ESA	2017-2023
Donovan, Dave	The Netherlands	2017-2023
Gibert, Fabien	France	2012-2019
Bobrovnikov, Sergey	Russia	2012-2019
Abo, Makato	Japan	2012-2019
Balis, Dimitris	Greece	2015-2021
Moshari, Fred	U.S.A.	2017-2023
Strawbridge,Kevin	Canada	2012-2019
Chu, Xinzhao	U.S.A.	2015-2021
Ishii, Shoken	Japan	2017-2023
Liu, Dong	China	2017-2023

Report on the 28th International Laser Radar Conference (ILRC)

- 25-30 June 2017, Bucharest, Romania (http://ilrc28.inoe.ro)
- 353 attendees – 31 countries (259 regular members and 94 students)
- Conference co-chairs: Dr. D. Nicolae
- 299 submitted papers (93 oral and 206 posters), with the paper summaries (extended abstracts) published in a USB stick
- 12 oral sessions, plus 3 keynote presentations and 11 poster sessions
- Prior to its official start, on 25 June 2017, the 3rd free lidar course for beginners was organized onsite.
- In total 62 travel grants were provided to students to attend this ILRC.

Report on the 29th International Laser Radar Conference (ILRC)

- 24-28 June 2019, Hefei, China (http://www.ilrc29.cn)
- 522 registered attendees – 33 countries (388 regular members and 134 students)
- Conference co-chairs: Prof. Y. Wang and D. Liu, AIOFM, Anhui, China
- 278 submitted papers (86 oral and 192 posters), with the paper summaries (extended abstracts) published with DOI number
- 14 oral sessions, plus 17 keynote/invited presentations and 9 poster sessions
- On the previous day of the Conference 23 June 2019, the 4th free lidar course for beginners was organized onsite
- In total 70 travel grants were provided to students to attend this ILRC

Acknowledgements for Supporting Students, Junior and Senior Scientist's Travel to ILRC

- Chinese Academy of Sciences (CAS)
- Hefei Institutes of Physical Science, Chinese Academy of Sciences (CASHIPS)
- Hefei Bureau of Science and Technology
- Prof. Fred Moshary, CUNY, NASA funds
- ILRC Local Organizing Committee
  - Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences (AIOFM)
  - Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Scien ces (SIOM)
  - Xi'an University of Technology, China (XAUT)
  - Ocean University of China (OUC)
  - Wuhan University, China (WHU)
  - Lanzhou University, China (LZU)

IPRT - International working group on polarized radiative transfer

Claudia Emde and Bernhard Mayer

Meteorological Institute
Ludwig-Maximilians-University Munich
Germany

IRC business meeting, Montreal, 10 July 2019

International Working Group on Polarized Radiative Transfer

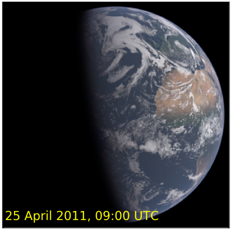
Aims of working group IPRT:

- bring the community together (workshops)
- **compare and improve models, 3D model intercomparison**
- **provide benchmark results**
- provide information about free codes
- develop new and faster, publically available codes
- provide input data (scattering matrices, BPDFs – bidirectional polarization distribution functions, ...)

Project website:
www.meteo.physik.uni-muenchen.de/~iprt

Polarized radiative transfer in fully spherical geometry

- Model intercomparison study in fully spherical geometry planned to be launched in September 2019
- Particularly challenging for vector radiative transfer models using explicit methods (e.g. discrete ordinate or doubling-and-adding)
- Investigate accuracy of approximations
- Important for satellite-based limb sounding observations
- So far no benchmark results exist!



Earth as seen by the moon, simulated with MYSTIC in fully 3D spherical geometry.

Model intercomparison for polarized radiative transfer in fully spherical geometry

- Observational setups
  - Ground-based sensor (Polarization in twilight)
  - Satellite-based sensor (Limb geometry)
- Atmospheric setups
  - Clear-sky
  - Aerosol
  - Thin 1D cirrus cloud
  - Finite 3D cumulus clouds
- Model setups
  - pseudo-spherical approximation
  - spherically symmetric atmosphere (refraction neglected)
  - spherically symmetric atmosphere (refraction enabled)
  - 3D spherical atmosphere
- Detailed defintion of test cases currently in preparation, will be provided on IPRT website in September
- Groups which can handle VRTE in spherical geometry will be invited to participate

Working Group-Ultraviolet Radiation

Co-chairs: Julian Gröbner and Ann Webb

Members: A. Bais, L. Egli, M. Blumthaler

The University of Manchester

Overview of Activities 2018/2019

- ECUVM –
  European Conference on Solar UV Monitoring, 12-14 September 2018, Vienna, AT.
- UNEP - United Nations Environment Programme :
  UNEP EEAP Quadrennial Report on "Environmental Effects of Ozone Depletion and Interactions with Climate Change - 2018" has several chapters on solar UV radiation and effects
  Work is also published in *Photochemistry and Photobiology*
- NOG –

  Nordic Ozone Group Meeting, 26-27 March, 2019, Chilton, UK

  Presentations on ozone, UV and UV effects. Summaries to be published in UV4plant Bulletin
- Biennial Brewer Intercomparison, June 2019, El Arenosillo, Spain, also attended by QASUME instrument (WMO UV World Calibration Standard)

Upcoming:

- ESP-IUPB International Photobiology Meeting, August 25-30, Barcelona, Spain

  Includes session on UV measurements, and several on UV effects

On–site at the campaign in El Arenosillo, June 2019

Some recent publications on UV radiation

- A. F. Bais, G. Bernhard, R. L. McKenzie, P. J. Aucamp, P. J. Young, M. Ilyas, P. Jöckel and M. Deushi. Ozone–climate interactions and effects on solar ultraviolet radiation. *Photochem. Photobiol. Sci*., 2019, **18**, 602
- Other publications in the same themed issue of *Photochemical and Photobiological Sciences*: Environmental effects of ozone depletion and its interaction with climate change: 2018 assessment.
- J. W. Krzyścin and P. S. Sobolewski, Trends in erythemal doses at the Polish Polar Station, Hornsund, Svalbard based on the homogenized measurements (1996–2016) and reconstructed data (1983–1995), *Atmos. Chem. Phys*., 2018, **18**,1-11
- Fountoulakis, Ilias, Christos S. Zerefos, Alkiviadis F. Bais, John Kapsomenakis, Maria Maria-Elissavet Koukouli, Nozomu Ohkawara, Vitali Fioletov, Hugo De Backer, Kaisa Lakkala, Tomi Karppinen, and Ann Webb. 25 years of spectral UV-B measurements over Canada, Europe and Japan: trends and effects from changes in ozone, aerosols, clouds and surface reflectivity. *Comptus Rendus Geoscience,* 2018*,* **350**, 393-402
- Seckmeyer Gunther, Christopher Mustert, Michael Schrempf, Richard L. McKenzie, J. Ben Liley, Michael Kotkamp, Alkiviadis F. Bais, Didier Gillotay, Harry Slaper, Anna-Maria Siani, Andrew R.D. Smedley, Ann Webb. Why is it so hard to gain enough Vitamin D by solar exposure in the European winter? *Meteorologische Zeitschrift* 2018. DOI 10.1127/metz/2018/085