2014 IRC Working Group Reports

1. Baseline Surface Radiation Network (BSRN)

   Gert König-Langlo, Rapporteur; Joe Michalsky, Chair.

2. Clouds and Radiation (CR)

   Stefan Kinne, Rapporteur

3. Global Energy Balance (GEB)

   Martin Wild and Norman Loeb, Co-chairs.

4. International TOVS Working Group (ITWG)

   Mitch Goldberg & Niels Bormann, Co-Chairs.

5. GEWEX Data and Assessments Panel (GDAP)

   Christian Kummerow, Chair, GDAP

2014 IRC Working Group Reports

6. Solar UltraViolet Radiation (UV)

   Co-Chairs: Julian Gröbner and Mario Blumthaler

7. Continuous Intercomparision of Radiation Codes (CIRC)

   Lazaros Oreopoulos & Eli Mlawer, Co-Chairs.

8. Three-Dimensional Radiative Transfer (3DRT)

   Alexander Marshak & Jean-Luc Widlowski, Co-Chairs.

9. International Polarized Radiative Transfer (IPRT)

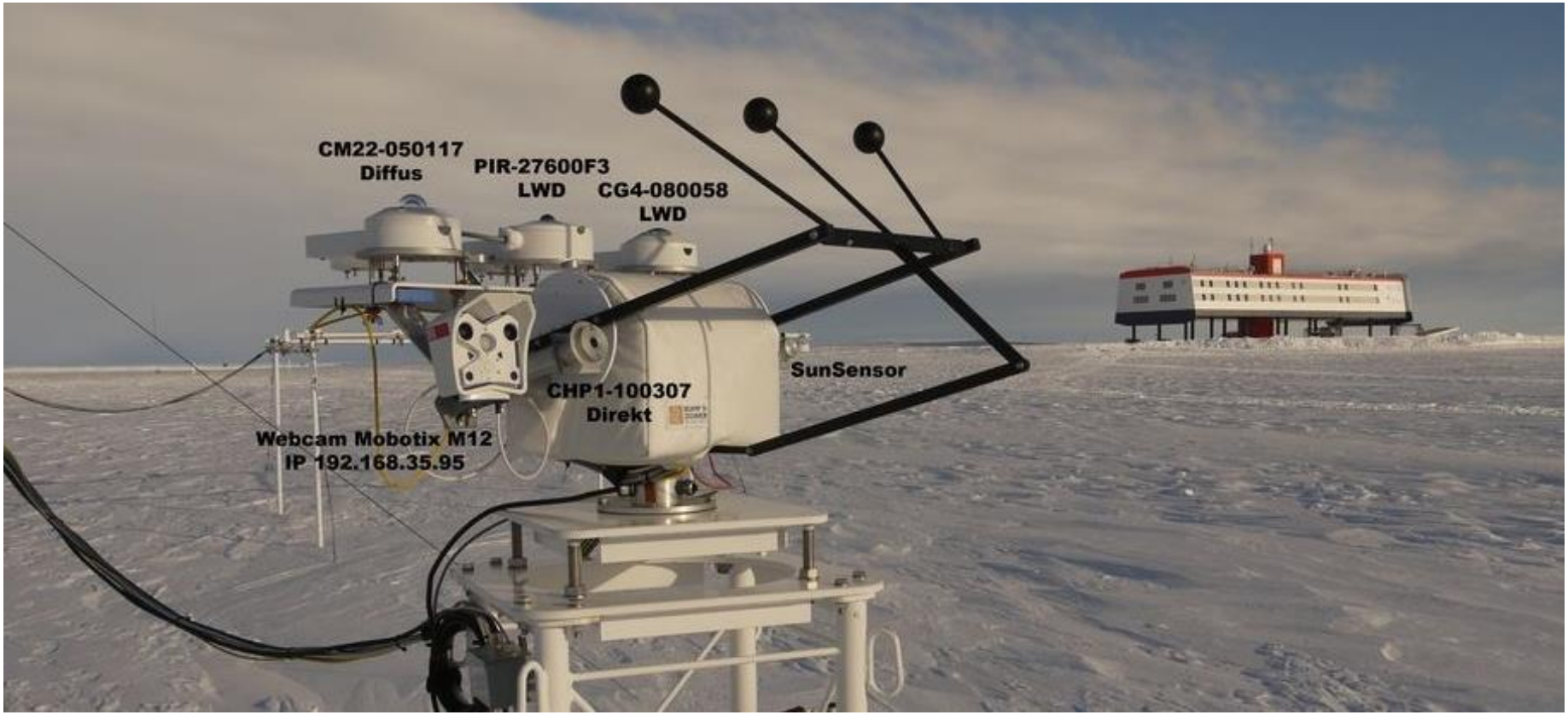
   Bernhard Mayer & Claudia Emde, Co-Chairs.

1. Baseline Surface Radiation Network (BSRN)

Gert König-Langlo, Rapporteur

Joe Michalsky, chair

Report of the Working Group
BSRN – Baseline Surface Radiation Network



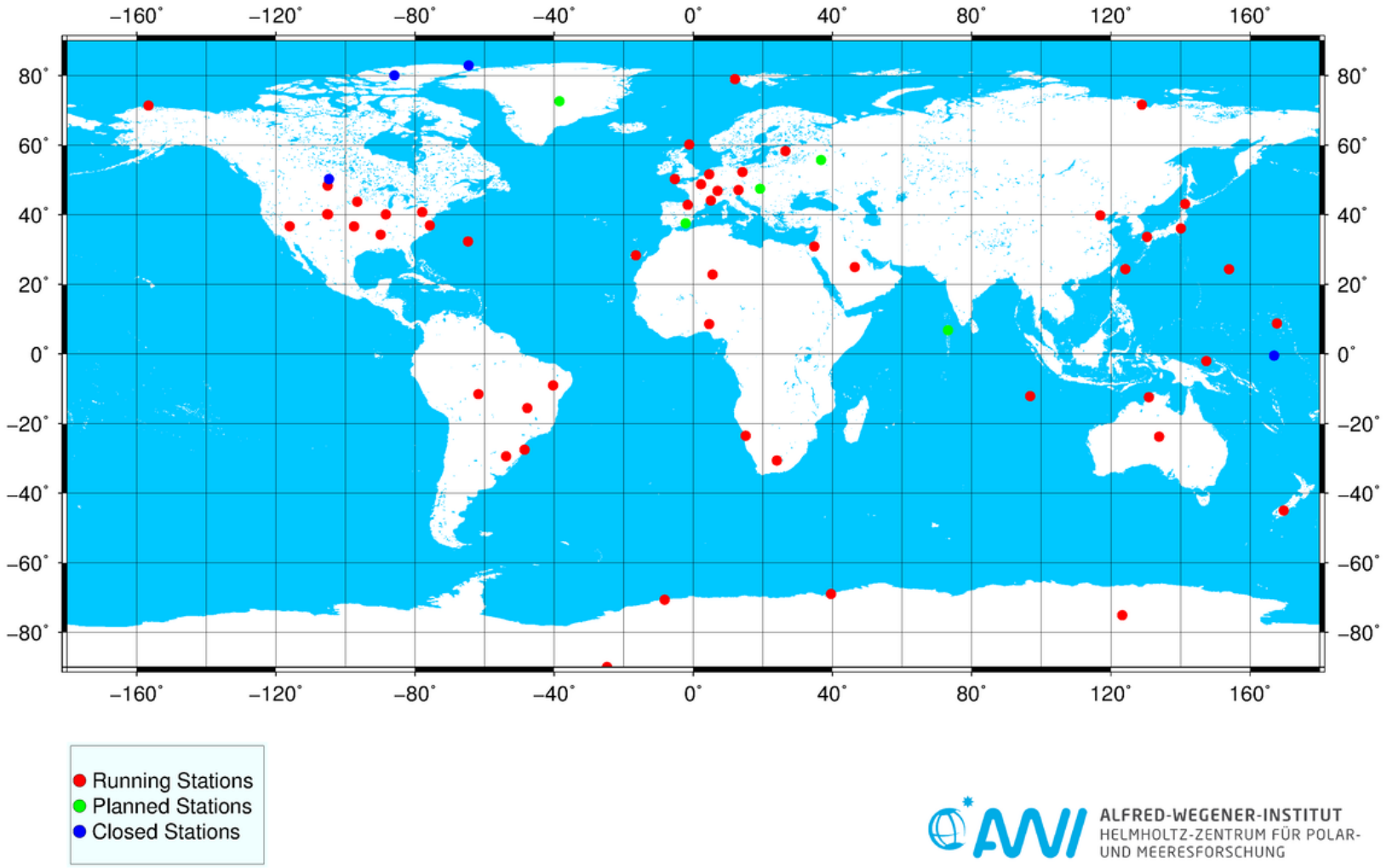
Gert König-Langlo 2014

WRMC-BSRN

World Radiation Monitoring Center- Baseline Surface Radiation Network

hosted by AWI

Running, planned, and closed BSRN Stations , April 2014



ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

BSRN-Station Changes

Closed

1. Alert, Canada, Lincoln Sea: 2011-12-31
2. Eureka, Canada, Ellesmere Island: 2011-12-31
3. Regina, Canada, Saskatchewan: 2011-12-31
4. Nauru Island, Nauru (USA): 2013-09-30

Opened

1. Gobabeb, Namib Desert, Namibia (Swiss) : 2012-05-15
2. Sonnblick, Austria: 2013-01-01

Interest to join BSRN:

Peru (Huancayo), Spain (North Spain Plateau),Oman (Southern Arabian Peninsula), Australia (Newcastle), Taiwan, Barbados

WRMC-BSRN
World Radiation Monitoring Center- Baseline Surface Radiation Network

hosted by AWI

Present State of the WRMC: 7728 station-months available

Station	Short name	Station manager currently in charge	pre BSRN	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	All
Alert	ALE	David Halliwell (David.Halliwell@ec.gc.ca)																							X
Alice Springs	ASP	Bruce Forgan (B.Forgan@bom.gov.au)					12	12	12	12	12	12	11	12	12	12	12	12							X
Barrow	BAR	Ellsworth Dutton (Ellsworth.G.Dutton@noaa.gov)		12	12	12	12	12	12	12	12	12	12	12	12	12									X
Bermuda	BER	Ellsworth Dutton (Ellsworth.G.Dutton@noaa.gov)		12	12	12	12	12	12	12	12	12	12	12	10										X
Billings	BIL	Charles Long (chuck.long@pnl.gov)			4	12	12	12	12	12	12	12	11									7	12	4	X
Bondville	BON	John Augustine (John.A.Augustine@noaa.gov)					12	12	12	12	12	12									6				X
Boulder, SURFRAD	BOS	John Augustine (John.A.Augustine@noaa.gov)					5	12	12	12									12	12	6				X
Boulder	BOU	Ellsworth Dutton (Ellsworth.G.Dutton@noaa.gov)		12	12	12	12	12									12	12	12	12	12	2			X
Brasilia	BRB	Enio Bueno Pereira (eniobp@cptec.inpe.br)																8	10	4	9	12	12	5	X
Cabauw	CAB	Wouter Knap (knap@knmi.nl)															11	12	12	12	12	12	12	4	X
Camborne	CAM	Patrick Fishwick (patrick.fishwick@metoffice.com)											12	12	12	12	12	12	6						X
Carpentras	CAR	Jean-Philippe Morel (jean-philippe.morel@meteo.fr)									12	12	12	12	12	12	12	12	12	12	12	12	12	5	X
Chesapeake Light	CLH	Fred M. Denn (Frederick.M.Denn@nasa.gov)										8	12	11	12	12	12	12	12	12	12	12	12	6	X
Serra																									
Solar Village	SOV	Naif Al-Abbadi								3	12	12	12	12											X
South Pole	SPO	Ellsw		12	12	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	2			X
Syowa	SYO	go.jp)				12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11		X
Sioux Falls		stine@noaa.gov)													7	12	12	12	12	12	6				X
Tamanra		_mimouni_dz@yahoo.fr)										10	12	12	12	12	12	12	12	12	12	12	12	4	X
Tateno		a (ijima@met.kishou.go.jp)						11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4	X
Tiksi		asilii Kustov (kustov@aari.ru)																				7	9		X
Toravere		Ain Kallis (kallis@aai.ee)									12	12	12	12	12	12	12	12	12	12	12	12	12	5	X
Xianghe	XIA	Xiangao Xia (xiangaoxia2000@yahoo.com)															12	12	12	8					X
Historical station	Eismitte		1																						X
	All			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			pre BSRN	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	All

~ 644 years of radiation measurements

Usage Statistics for ftp.bsrn.awi.de

Summary by Month

Month	Daily Avg				Monthly Totals							
	Hits	Files	Pages	Visits	Sites	kB F	kB In	kB Out	Visits	Pages	Files	Hits
May 2014	343	343	0	0	41	10784078	0	0	15	17	10635	10640
Apr 2014	437	437	0	0	50	12838171	0	0	9	10	13124	13125
Mar 2014	991	989	0	0	40	30791914	0	0	11	11	29693	29734
Feb 2014	576	574	0	0	48	16370478	0	0	10	11	14938	14994
Jan 2014	388	388	0	0	43	11881624	0	0	5	6	11662	11663
Dec 2013	178	178	0	0	34	4735140	0	0	5	6	5363	5368
Nov 2013	364	364	0	0	33	10315195	0	0	4	4	10569	10579
Oct 2013	468	468	0	0	42	34042435	0	0	12	12	14514	14518
Sep 2013	770	770	0	0	39	25860257	0	0	5	8	22332	22336
Aug 2013	223	222	0	0	38	17636359	0	0	4	4	6683	6690
Jul 2013	256	256	0	0	33	26379139	0	0	9	9	7943	7952
Jun 2013	898	897	0	0	49	36760087	0	0	17	25	26937	26951
Totals						**238394877**	**0**	**0**	**106**	**123**	**174393**	**174550**

Citation Report: WEB OF SCIENCE

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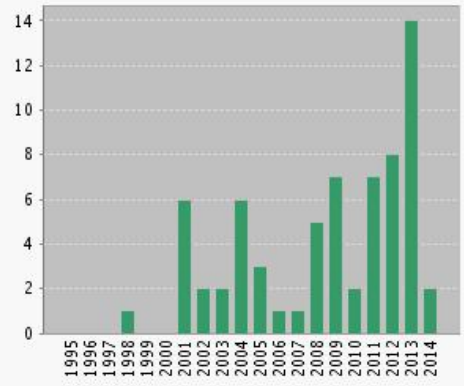
Citation Report: 68

(from Web of Science Core Collection)

You searched for: TOPIC: (BSRN) ...More

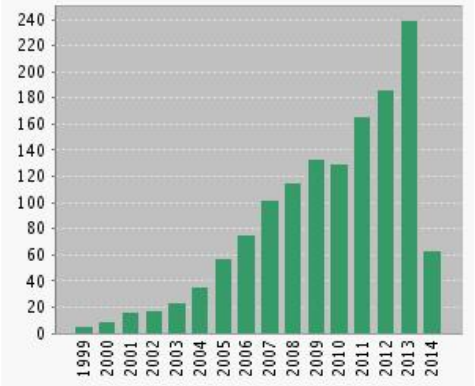
This report reflects citations to source items indexed within Web of Science Core Collection. Perform a Cited Reference Search to include citations to items not indexed within Web of Science Core Collection.

Published Items in Each Year



The latest 20 years are displayed.
View a graph with all years.

Citations in Each Year



The latest 20 years are displayed.

Results found:	68
Sum of the Times Cited [?] :	1374
Sum of Times Cited without self-citations [?] :	1274
Citing Articles [?] :	1070
Citing Articles without self-citations [?] :	1023
Average Citations per Item [?] :	20.21
h-index [?] :	16

Quality control:

AIM:
BSRN/WRMC consists only of a small number of selected research stations which provides surface radiation fluxes of the **best possible quality** currently available.

Responsibility:
The BSRN station scientist (not the WRMC!!!) is responsible for the data quality of their station(s).

Help from the WRMC:
- Providing tools to station scientists to detect errors prior to data submission
- Handling errors detected from BSRN customers
- Doing incoming checks (since beginning of 2012)
- Refuse/delay to import data containing obvious errors
- Corresponding with station scientists about violated quality limits
- Providing tools to BSRN customers to perform quality control

Quality control visualized for any station:

Averages

International Polar Year

Quality code

Physical possible limits

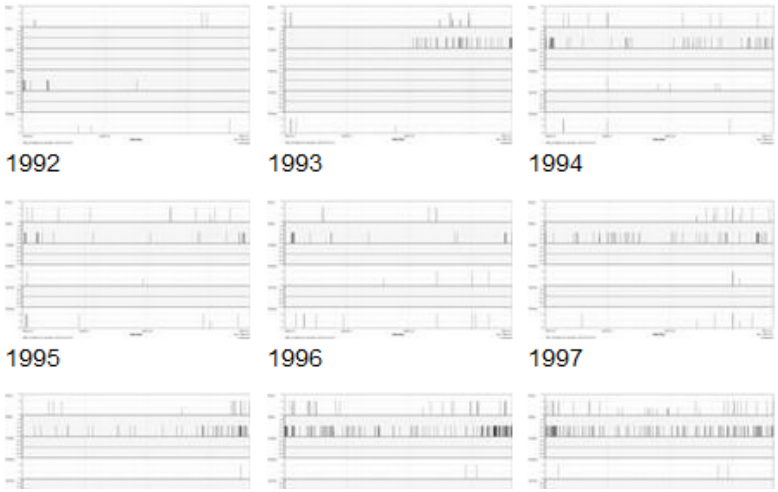
Alert
Alice Springs
Bermuda
Billings
Bondville
Boulder
Boulder Surfrad
Surfrad versus Boulder
Brazilia
Cabauw
Camborne
Carpentras
Chesapeake Light

Home › Products › Quality code › Physical possible limits › Neumayer Station

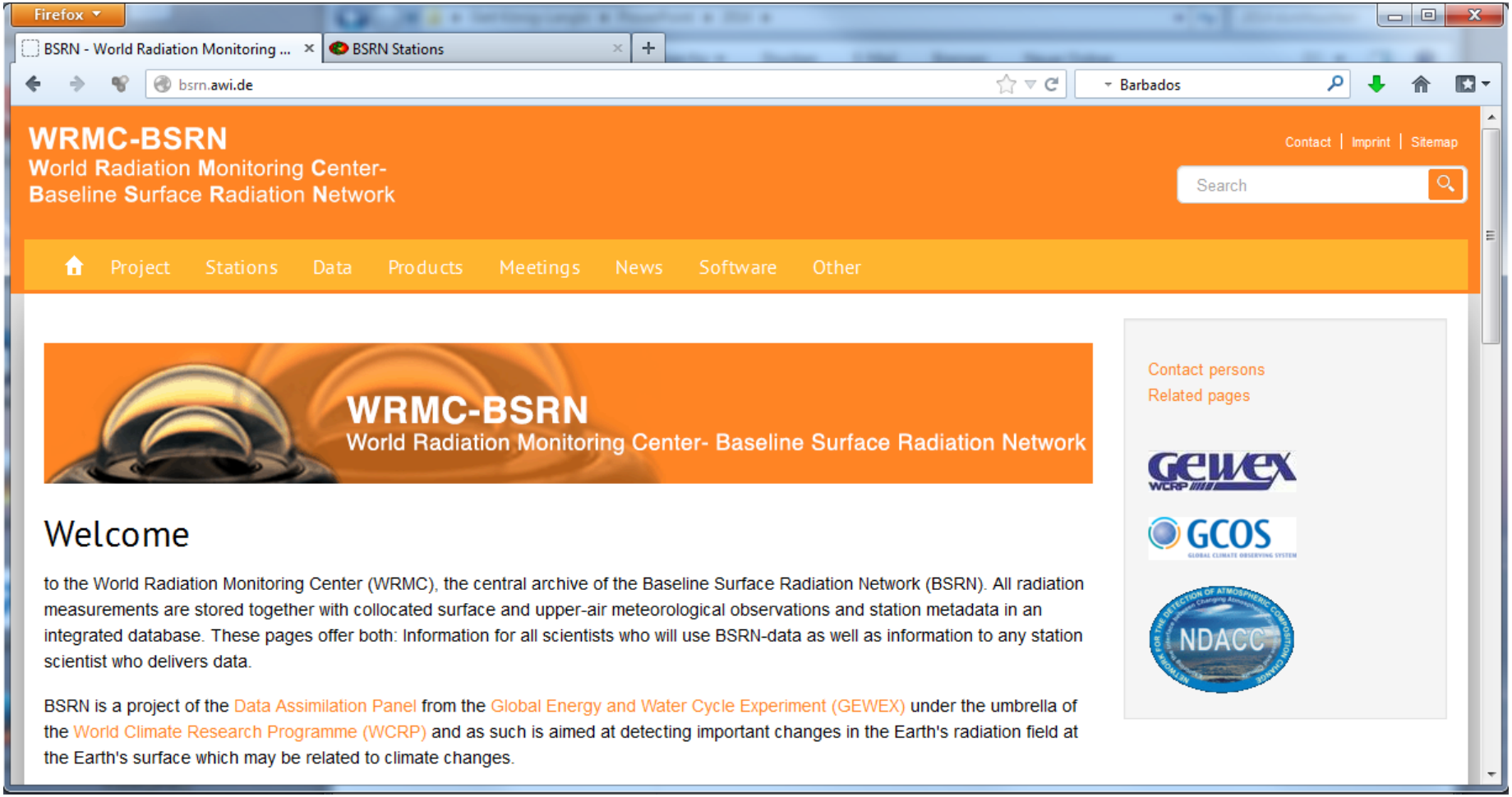
Contact persons
Related pages

Neumayer Station

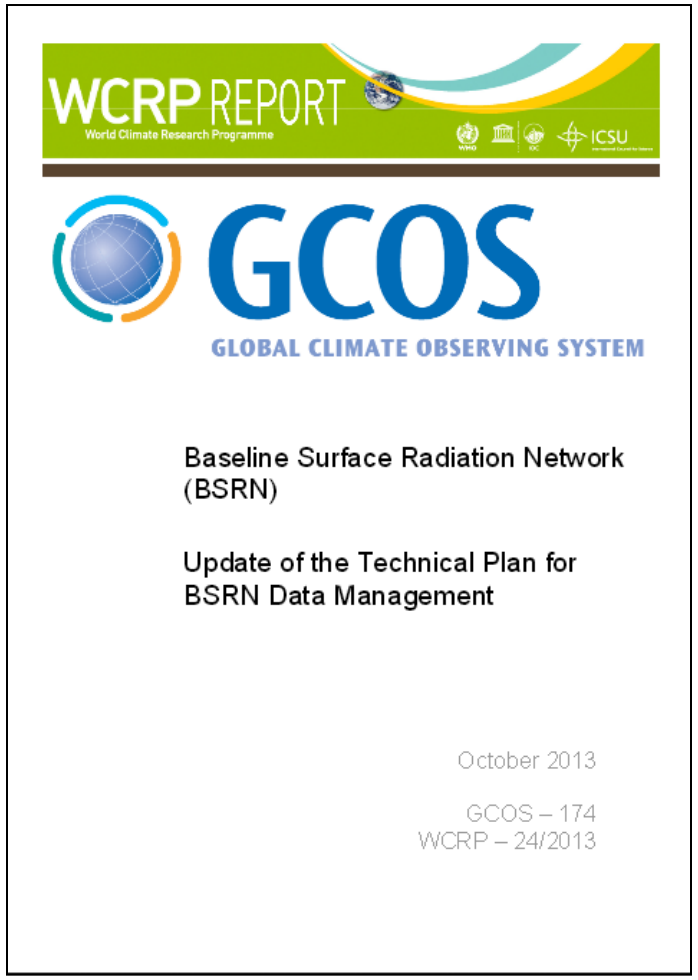
Direct radiation measurement instrumentation changed 2010-04 from Eppeley, NIP to Kipp & Zonen. Less night-time zeros are visible in quality codes.



Relaunch of bsrn.awi.de: 2014-05-05



Update of the Technical Plan for BSRN Data Management 2013-10



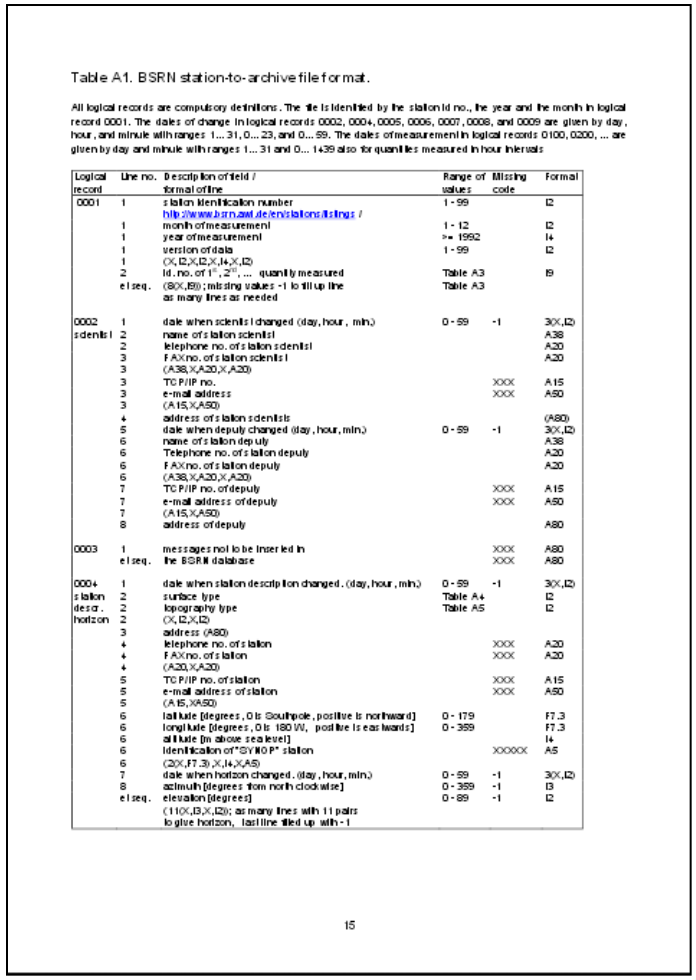


Table A1. BSRN station-to-archive file format.

All logical records are compulsory definitions. The file is identified by the station Id no., the year and the month in logical record 0001. The dates of change in logical records 0002, 0004, 0005, 0006, 0007, 0008, and 0009 are given by day, hour, and minute with ranges 1 ... 31, 0 ... 23, and 0 ... 59. The dates of measurement in logical records 0100, 0200, ... are given by day and minute with ranges 1 ... 31 and 0 ... 1439 also for quantities measured in hour intervals

Logical record	Line no.	Description of field / format of line	Range of values	Missing code	Format
0001	1	station identification number http://www.bsrn.awi.de/en/stations/listings/	1 - 99		I2
	1	month of measurement	1 - 12		I2
	1	year of measurement	>= 1992		I4
	1	version of data	1 - 99		I2
	1	(X,I2,X,I2,X,I4,X,I2)			
	2	Id. no. of 1st, 2nd, ... quantity measured	Table A3		I9
	el seq.	(80X,I8); missing values -1 to fill up line as many lines as needed	Table A3		
0002	1	date when scientist changed (day, hour, min.)	0 - 59	-1	3(X,I2)
scientist	2	name of station scientist			A38
	2	telephone no. of station scientist			A20
	3	FAXno. of station scientist			A20
	3	(A38,X,A20,X,A20)			
	3	TCP/IP no.		XXX	A15
	3	e-mail address		XXX	A50
	3	(A15,X,A50)			
	4	address of station scientists			(A80)
	5	date when deputy changed (day, hour, min.)	0 - 59	-1	3(X,I2)
	6	name of station deputy			A38
	6	Telephone no. of station deputy			A20
	6	FAXno. of station deputy			A20
	6	(A38,X,A20,X,A20)			
	7	TCP/IP no. of deputy		XXX	A15
	7	e-mail address of deputy		XXX	A50
	7	(A15,X,A50)			
	8	address of deputy			A80
0003	1	messages not to be inserted in		XXX	A80
	el seq.	the BSRN database		XXX	A80
0004	1	date when station description changed. (day, hour, min.)	0 - 59	-1	3(X,I2)
station	2	surface type	Table A4		I2
descr.	2	topography type	Table A5		I2
horizon	2	(X,I2,X,I2)			
	3	address (A80)			
	4	telephone no. of station		XXX	A20
	4	FAXno. of station		XXX	A20
	4	(A20,X,A20)			
	5	TCP/IP no. of station		XXX	A15
	5	e-mail address of station		XXX	A50
	5	(A15,XA50)			
	6	latitude [degrees, 0 is Southpole, positive is northward]	0 - 179		F7.3
	6	longitude [degrees, 0 is 180 W, positive is eastwards]	0 - 359		F7.3
	6	altitude [in above sea level]			I4
	6	identification of "SYNOP" station		XXXXX	A5
	6	(2(X,F7.3),X,I4,X,A5)			
	7	date when horizon changed. (day, hour, min.)	0 - 59	-1	3(X,I2)
	8	azimuth [degrees from north clockwise]	0 - 359	-1	I3
	el seq.	elevation [degrees]	0 - 89	-1	I2
		(11(X,I3,X,I2)); as many lines with 11 pairs to glue horizon, last line filled up with -1			

15

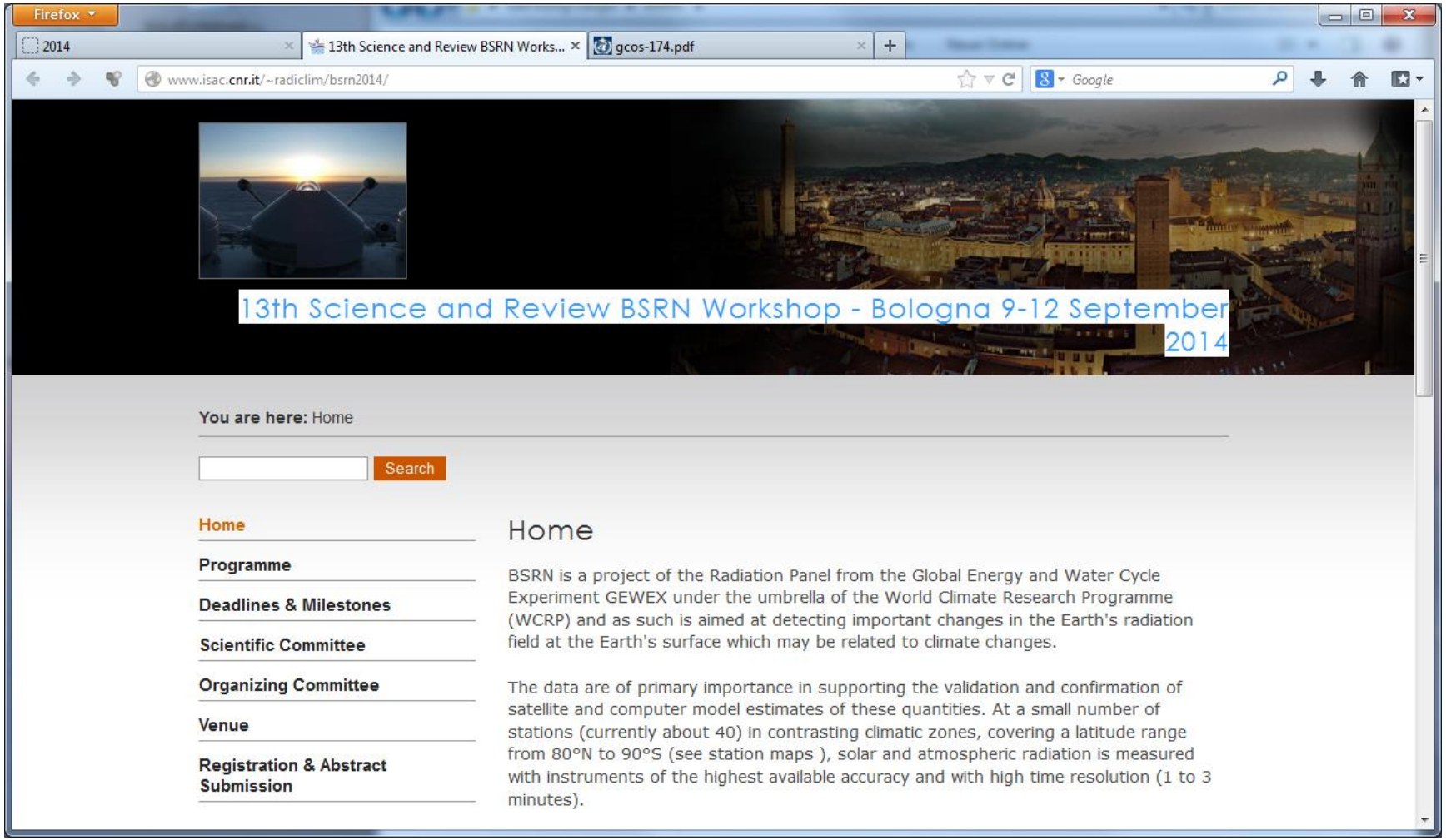
Gert König-Langlo 2014

WRMC-BSRN

World Radiation Monitoring Center- Baseline Surface Radiation Network

hosted by AWI

13th Science and Review BSRN Workshop - Bologna 9-12 September 2014



2. Clouds and Radiation (CR)

Stefan Kinne, Rapporteur

clouds and radiation

Stefan Kinne , Ehrhard Raschke and Bjorn Stevens

MPI-Meteorology

outline

- clouds in many regions are poorly represented in global (and climate) modeling
  - different TOA net-flux patterns compared to observations indicate a main problem with lower latitude and low altitude cloud-systems

  Why? sub-scales are inadequate represented (also involving convection and precipitation)

- a new WCRP effort has been established to make progress focusing on 4 major questions

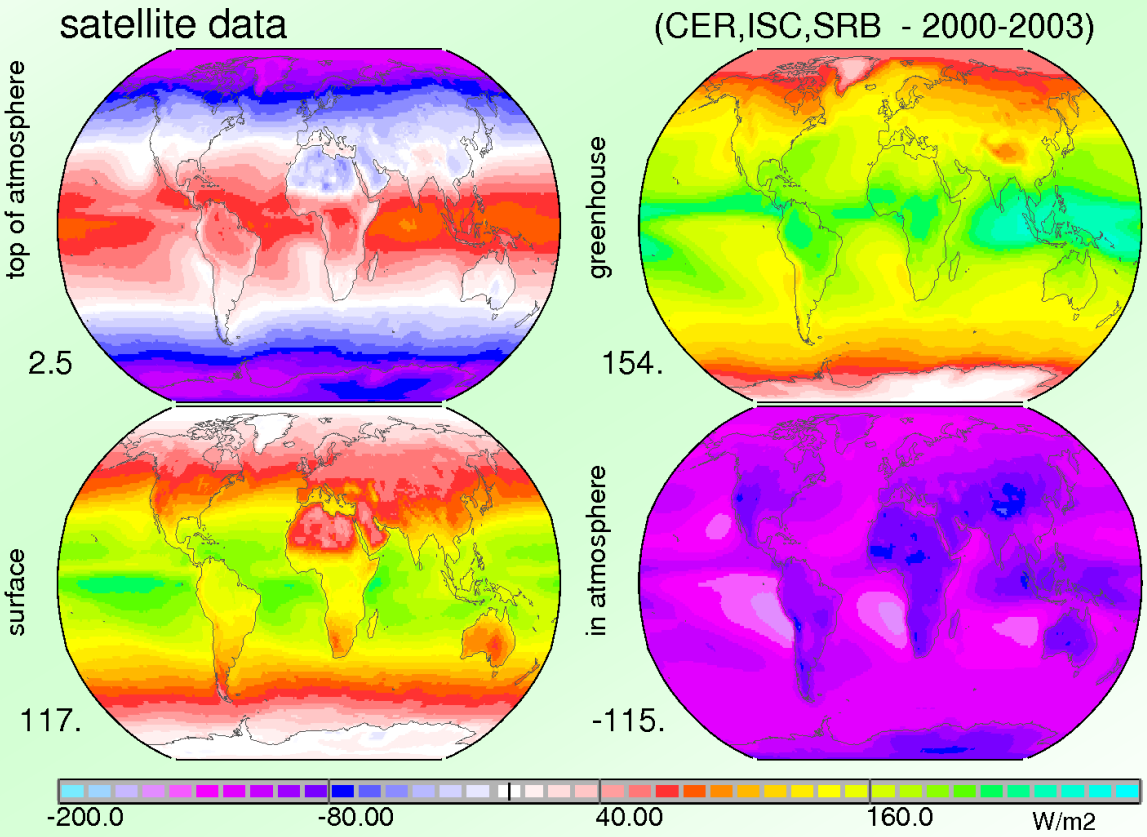
  effort is lead by S.Bony B.Stevens and C.Jakob

satellite ‘based’ annual flux maps

- satellite representation by averaging
  - CERES, ISCCP and SRB (4 years: 2000-2003)

at TOA
basically balanced

at surface
to be mainly balanced by sensible and latent heat



green-house effect

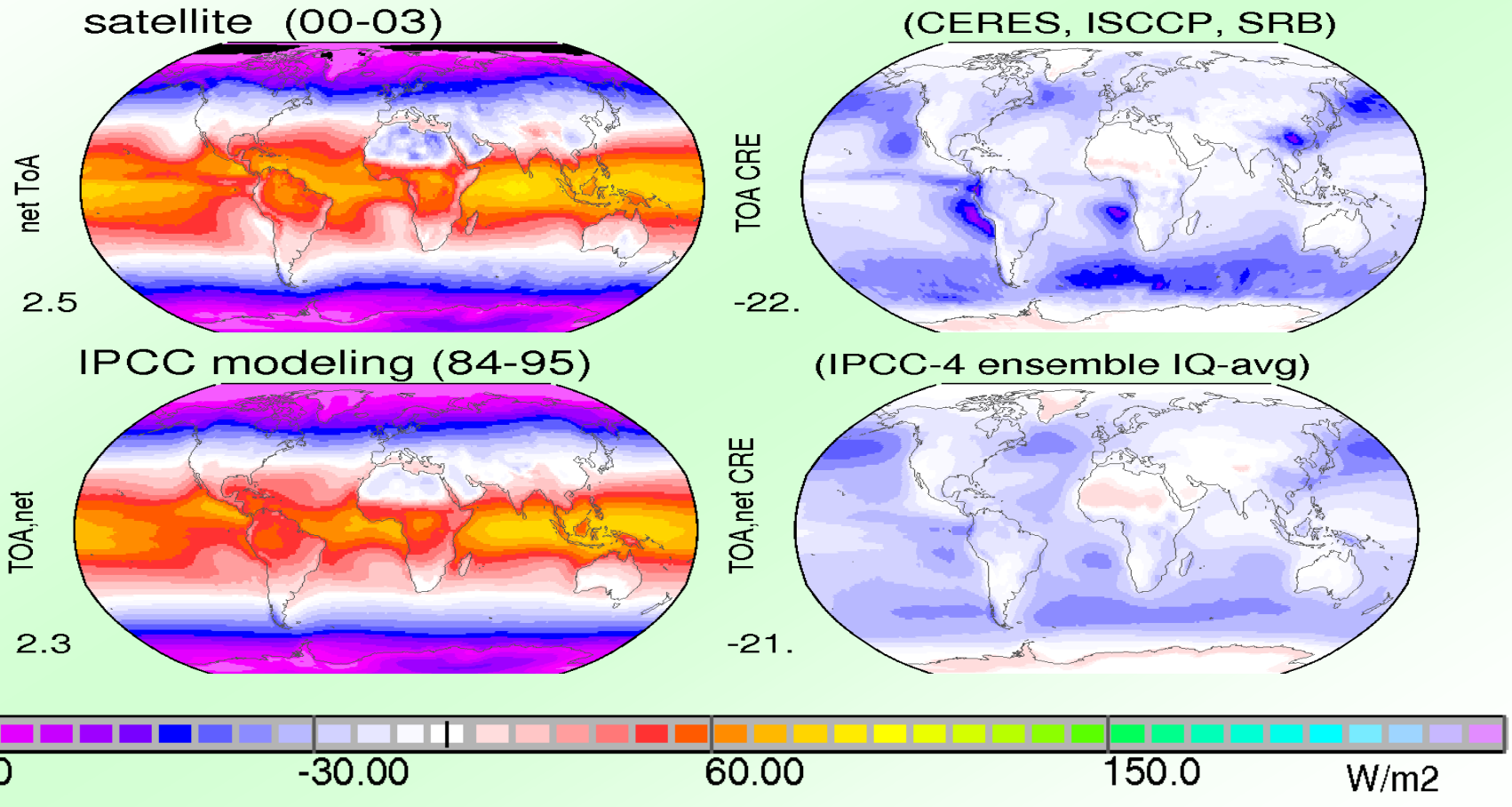
in atmos
‘cooling’

(IR cooling is iarger than solar heating)

TOA satellite vs modeling

net-flux **total (all-sky)**

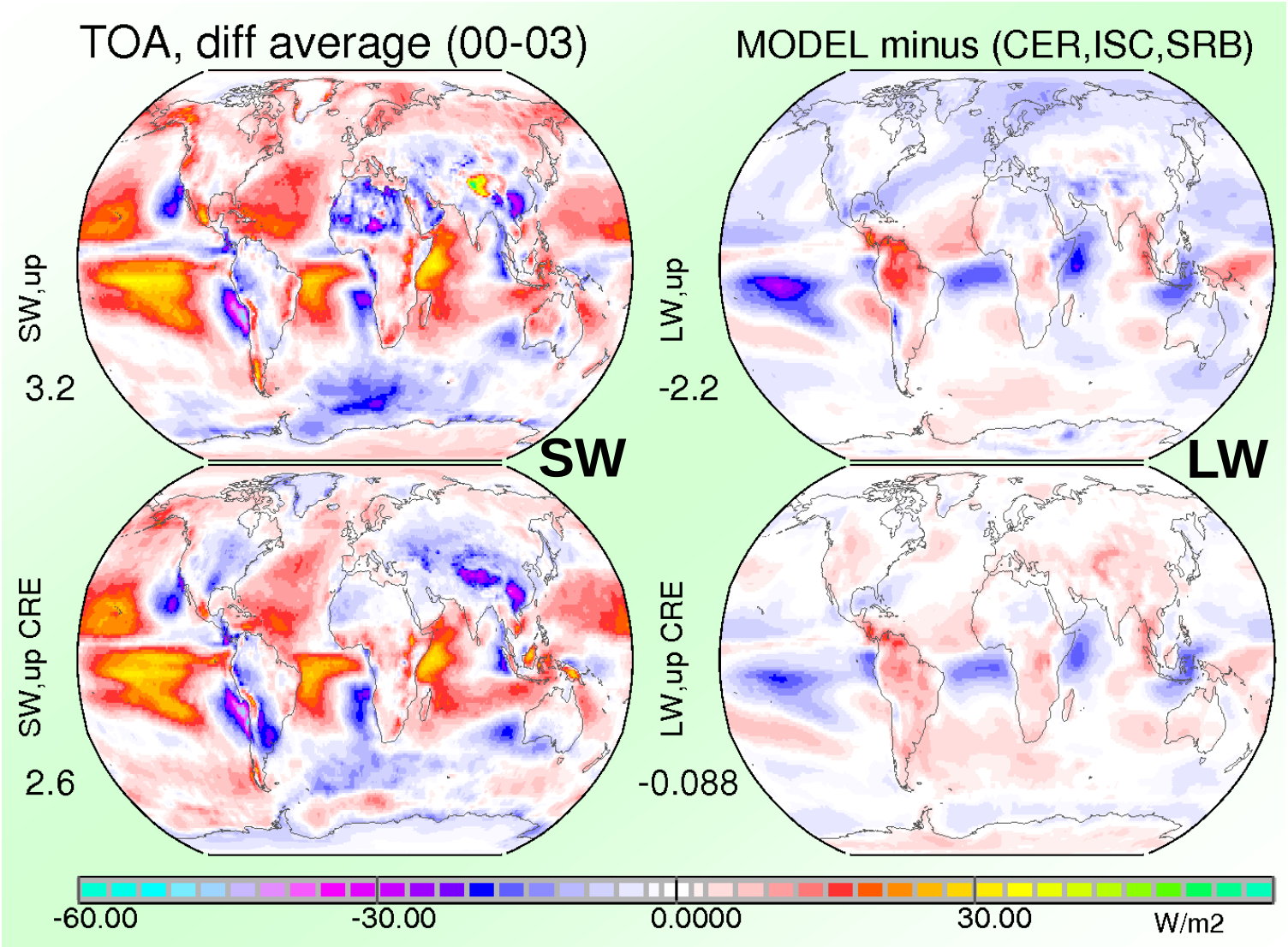
net-flux **cloud impact**



diff: model *minus* satellite - TOA flux

TOA
all-sky
difference

TOA
cloud
impact
differences

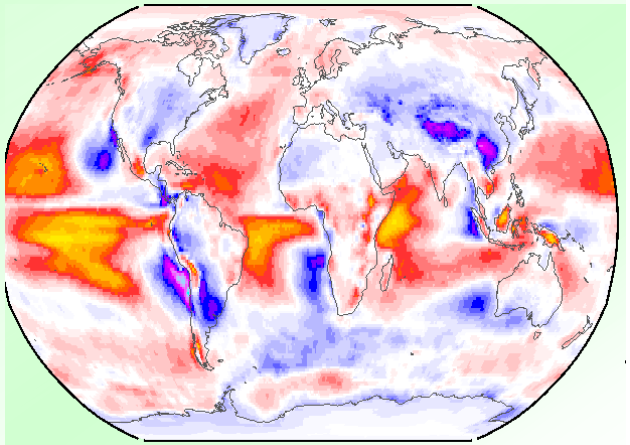


take home messages

- most regional TOA net-flux difference (between model and satellite data) is caused by the mis-representation of clouds in modeling

- major model deficiencies are in regions of low altitude clouds at lower latitudes

  - cloud impacts of strato-cumulus are underestimated
  - cloud impacts of trade-wind cumuli are overestimated



better clouds in models, how ?

– use advances in numerical modeling
  - simulations at finer resolutions (even globally)

– use advances in observations …
  - active remote sensing from ground and space

focus on just **four (4) questions:**

- How will storm tracks change in the future?
- What controls the position of tropical rain belt?
- Is convective aggregation important to climate?
- How does convection impact cloud feedbacks?

future storm track

- **storm tracks**
  - **organize precip and clouds in extra-tropics**
  - **key for weather related climate** (e.g. last winter)
  - **appear sensitive to external forcings** (GHG, O3)

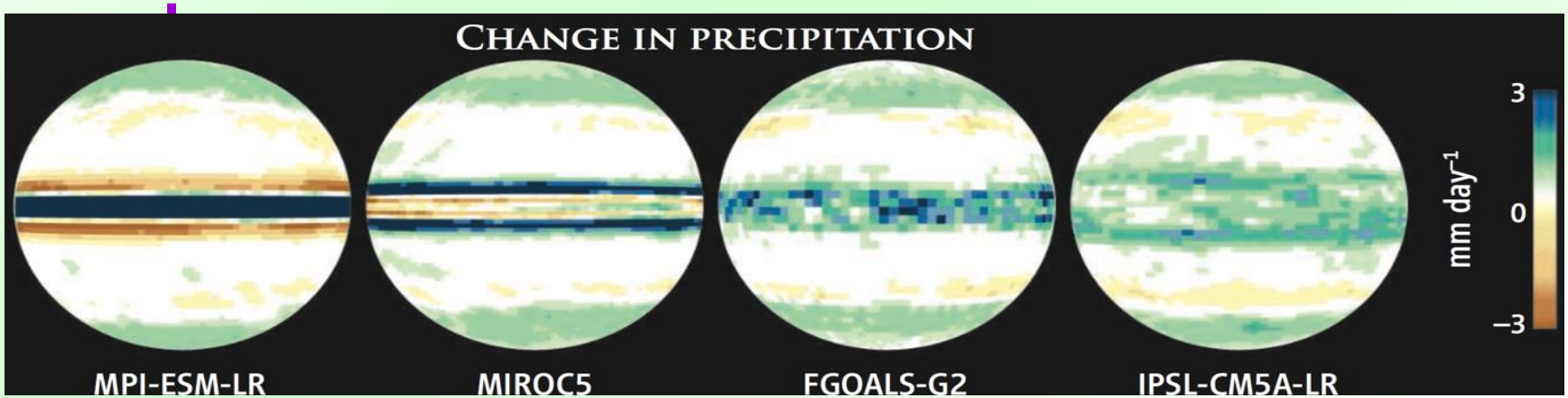
– **can high resolution (ca 100m) NWP inform?**

– **can paleo-records provide insights ?**

- ***how will the storm tracks change as the troposphere becomes warmer and wetter, as the stratosphere becomes cooler, and as the cryosphere shrinks ?***

trop. rain belt location

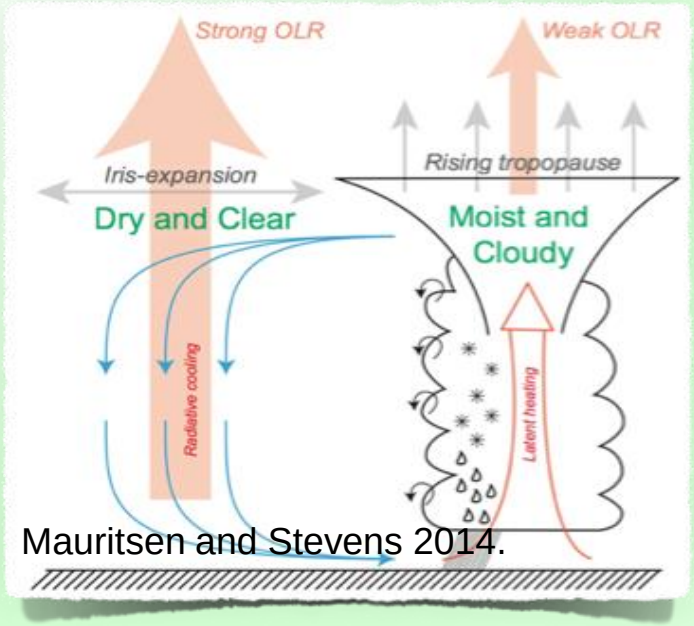
- **tropical rain belts**
  - **organize tropical circulation, evaporation patterns and patterns of clouds (& radiation)**
  - **their changes impact through teleconnections**
  - **– can paleo-records provide insights ?**
  - **– understand coupling of clouds and radiation**



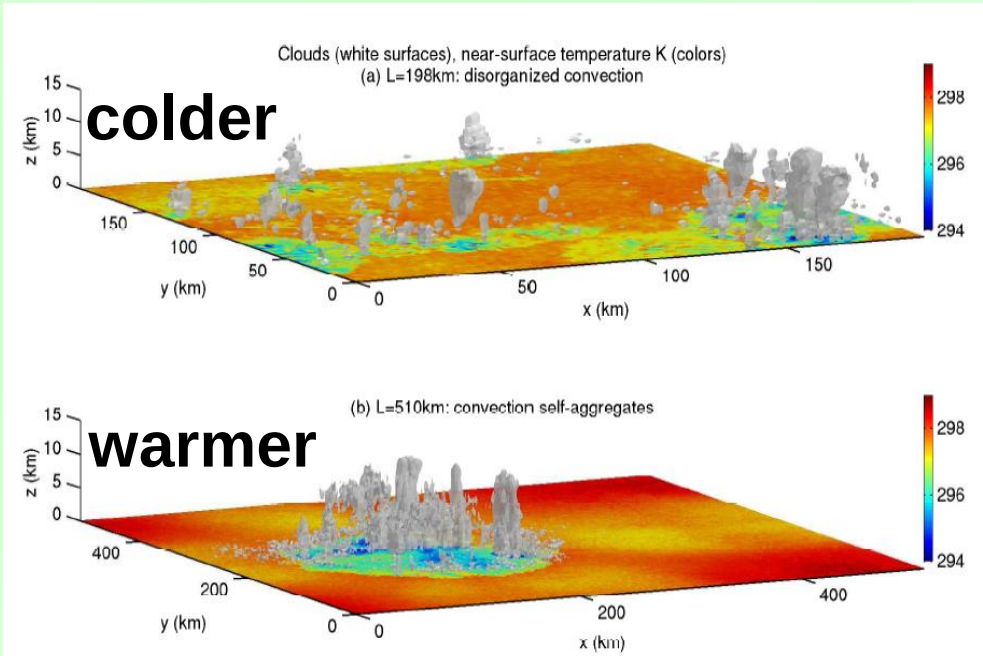
predicting precipitation change in a warmer climate has different (opposite) rain-belt responses in (Aqua-Planet) **climate model** [Bony and Stevens 2012]

convection aggreg → climate ?

- **convective aggregation**
  - **theory suggest an increase with temperature**
  - **– is there observational evidence?**



Mauritsen and Stevens 2014.



Images courtesy of Caroline Muller (LadHyX), see also *Wing & Emanuel, JAMES,* 2014
Khairoutdinov & Emanuel, *AMS,* 2010 also Held et al. 1993, Muller and Held 2012

convection → cloud feedback?

- **cloud feedback mechanisms**
  - **usually related to changes in large scale dyna.**
  - **the low-cloud feedback diversity is mainly responsible for inter-model climate sensitivity**
  - **climate sensitivity seems related to the strength of lower tropospheric mixing (CMIP5)**

– **apply high res modeling**

– **employ new observational capabilities**

clouds over the tropical Atlantic [Stevens]

final thoughts

- **a focus on few questions accelerates progress**
  - **by spurring model development**
  - **by pursueing new observations**
  - **by stimulating new analyses**
  - **by exploiting paleo-records**
  - **via new collaborations on common goals**

by Bjorn Stevens

- **and we need a better representation of clouds and cloud-systems in global modeling to have more confidence in future climate predictions**

3. Global Energy Balance (GEB)

Martin Wild, Co-chair

Norman Loeb, Co-chair

Global Energy Balance (GEB)

1. Current Activities

- 5th IPCC assessment section on “changes in radiation budget” (assesses the recent advances in research on the Earth’s radiation budget, including the temporal and spatial variations of its components) was put together by the working group Global Energy Balance (GEB) co-chairs Martin Wild (LA) and Norman Loeb (CA). The global mean energy balance as depicted in the related section of the 5th IPCC assessment report is reproduced in Figure 1 below.
- WG-GEB Co-Chairs Norman Loeb and Martin Wild are also involved in the CLIVAR Research focus “Consistency between planetary heat balance and ocean heat storage”. A related informal meeting took place during the GEWEX conference on the Global Water and Energy Cycle in Den Haag in July 2014. Both Co-Chairs are also part of the ISSI (International space Science Institute) initiative "Consistency of Integrated Observing Systems Monitoring the Energy Flows in the Earth System", with meetings in Bern, Switzerland.

Global Energy Balance (GEB)

1. Current Activities (*cont.*)

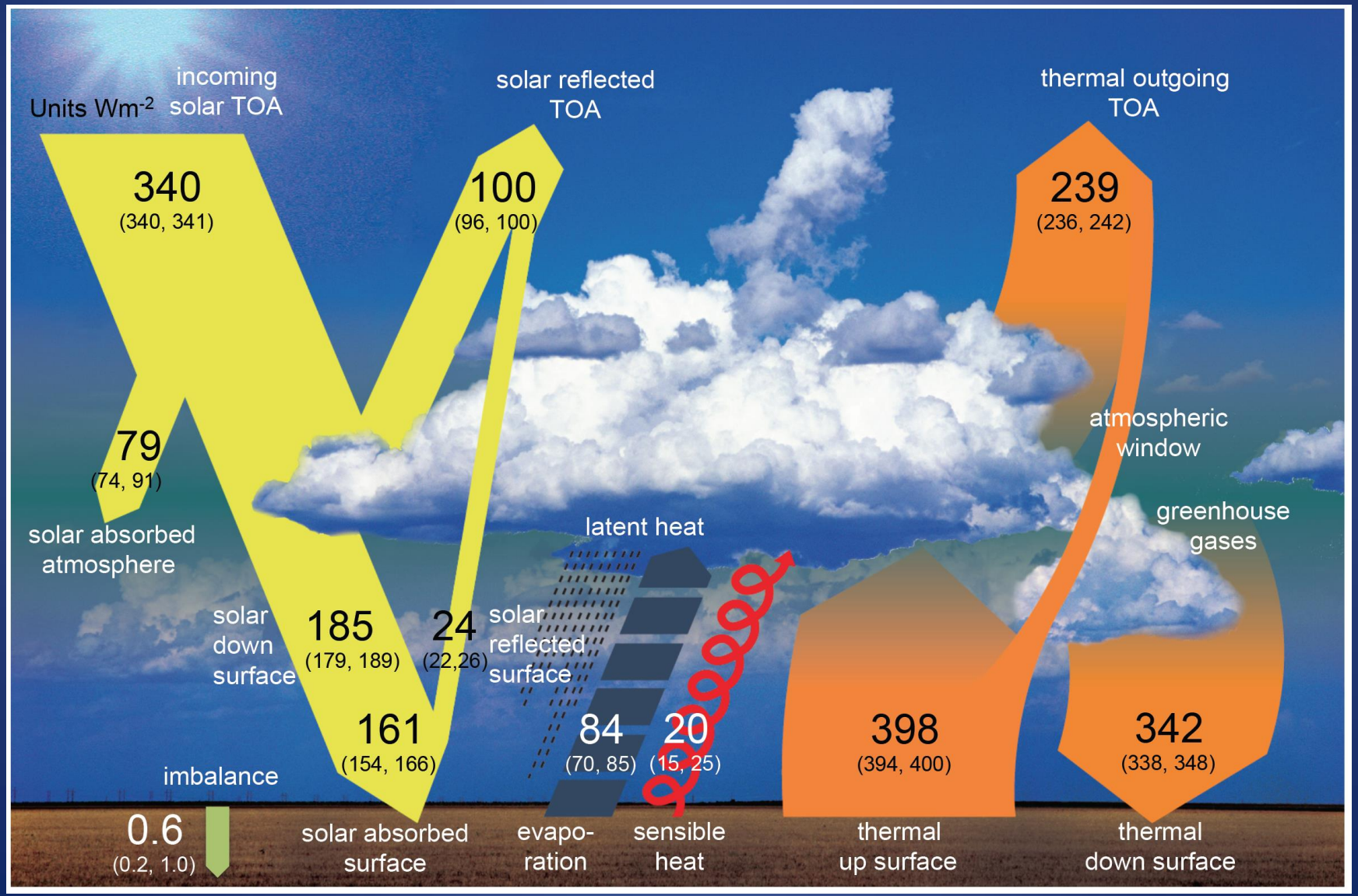
- In April 2014, at the European Geophysical Union (EGU) General Assembly WG-GEB Co-Chair Martin Wild organized once more the related session “Earth radiation budget, radiative forcing and climate change”. The session was very successful, with almost 50 contributions, and invited talks by former IRC president Dr. Bob Cahalan (NASA Goddard) as well as Dr. Y. Ming (GFDL Princeton). This session is also planned for the coming EGU in spring 2015.
- A new session related to this working group has been successfully proposed for the upcoming AGU fall meeting in San Francisco in December 2014: “Improved Understanding of the Surface Energy Balance and the spatio-temporal Variation of its Components”, with co-chair Martin Wild amongst the organizers.
- Further, following an IRC call, WG-GEB Co-Chair Martin Wild submitted a proposal for a related session (“radiation in the climate system”) for the IUGG 2015 in Prague, with support from Co-Chair Norman Loeb and IRC member Graeme Stephens.
- The above activities should ensure the availability of appropriate platforms to discuss the various aspects of the global energy balance at the major upcoming international conferences.

Global Energy Balance (GEB)

1. Current Activities (*cont.*)

- At ETH Zurich, the project "Towards an improved understanding of the Global Energy Balance: absorption of solar radiation" funded by the Swiss National Science Foundation has entered its 3rd year. The project aims at reducing the uncertainties in the absorption of solar radiation within the climate system, through the use of the information contained in worldwide surface radiation measurements in combination with satellite products.
  - Processing all BSRN station data to determine clear sky solar radiative fluxes at the BSRN sites,
  - Constructing monthly clear sky estimates at the BSRN sites
  - Estimating trends in surface solar radiation under cloud-free conditions solar absorption in the cloud-free atmospheric column above the sites.
- Further related work in progress at ETH Zurich is focusing on modelling the spatio-temporal variations of the Global Energy Balance using a state of the art climate model with interactive treatment of aerosol and cloud microphysics (ECHAM-HAM). A paper focusing on the radiation budget over China in these simulations is in preparation (Folini et al.), as well as a paper on the simulated radiative effects of aerosol plumes over the oceans (Dallafior et al.).

Figure 1: Best estimates of the global mean energy balance components together with their uncertainty ranges, representing present day climate. Surface estimates based on the analyses presented in this study. TOA estimates from Loeb et al. (2009). Units Wm-2 (from IPCC AR5, based on Wild et al. 2013a, with slight modifications as documented in Wild et al. 2013b).



Global Energy Balance (GEB)

2. Selected Research Results

- In a paper recently published in J. Climate, WG-GEB Co-Chair Norman Loeb used satellite and reanalysis data to determine interannual variations in atmospheric diabatic heating and circulation within the ascending and descending branches of the Hadley circulation (HC) during the past 12 yr. The column-integrated divergence of dry static energy (DSE) and kinetic energy is inferred from satellite-based observations of atmospheric radiation, precipitation latent heating, and reanalysis-based surface sensible heat flux for monthly positions of the HC branches, determined from a mass weighted zonal mean meridional streamfunction analysis. Mean surface radiative fluxes inferred from satellite and surface measurements are consistent to 1W m(-2) (<1%) over land and 4W m(-2) (2%) over ocean. In the ascending branch, where precipitation latent heating dominates over radiative cooling, discrepancies in latent heating among different precipitation datasets reach 22W m(-2) (17%), compared to 3-6 W m(-2) in the descending branches. Whereas direct calculations of DSE divergence from two reanalyses show opposite trends, the implied DSE divergence from the satellite observations of atmospheric diabatic heating exhibits no trend in all three HC branches and is strongly correlated (reaching 0.90) with midtropospheric vertical velocity. The implied DSE divergence from satellite observations thus provides a useful independent measure of HC circulation strength variability. (Loeb et al. 2014).

Global Energy Balance (GEB)

2. Selected Research Results (*cont*.)

- WG Co-Chair Martin Wild together with other WG members made an analyis to separate the global energy budget as shown in Figure 1 further into its land and ocean mean components (Fig. 2 and Fig. 3). A comprehensive set of radiation observations was combined with 43 state-of-the-art climate models from CMIP5 to infer best estimates for downward solar and thermal radiation averaged over land and ocean surfaces. Over land, where most direct observations are available to constrain the surface fluxes, 185 and 305 Wm-2 for solar and thermal downward radiation, respectively, were obtained (Fig. 2). Over oceans, with weaker observational constraints, corresponding estimates are around 185 and 356 Wm-2 (Fig. 3). These estimates closely agree, mostly within 3 Wm-2, with the respective quantities independently determined from recent state-of the-art reanalyses and satellite-derived products. This remarkable consistency enhances confidence in the determined flux magnitudes, which have traditionally introduced large discrepancies in the energy budget estimates and often hampered an accurate representation of surface climates in models. Considering additionally surface albedo and emission, an absorbed solar and net thermal radiation of 137 and -67 Wm-2 over land, and of 170 and -53 Wm-2 over oceans, respectively (Figs. 2, 3) was inferred. The surface net radiation is thus estimated at 70 Wm-2 over land and 117 Wm-2 over oceans, which may impose additional constraints on the respective sensible and latent heat fluxes. Combining these surface budget estimates with satellite-determined TOA budgets (CERES-EBAF) results in an atmospheric solar absorption of 76 and 82 Wm-2 over land and oceans, respectively (Figs. 2, 3) (Wild et al. submitted).

Figure 2: land mean energy budget inferred from surface and TOA observations. From Wild et al. (submitted)

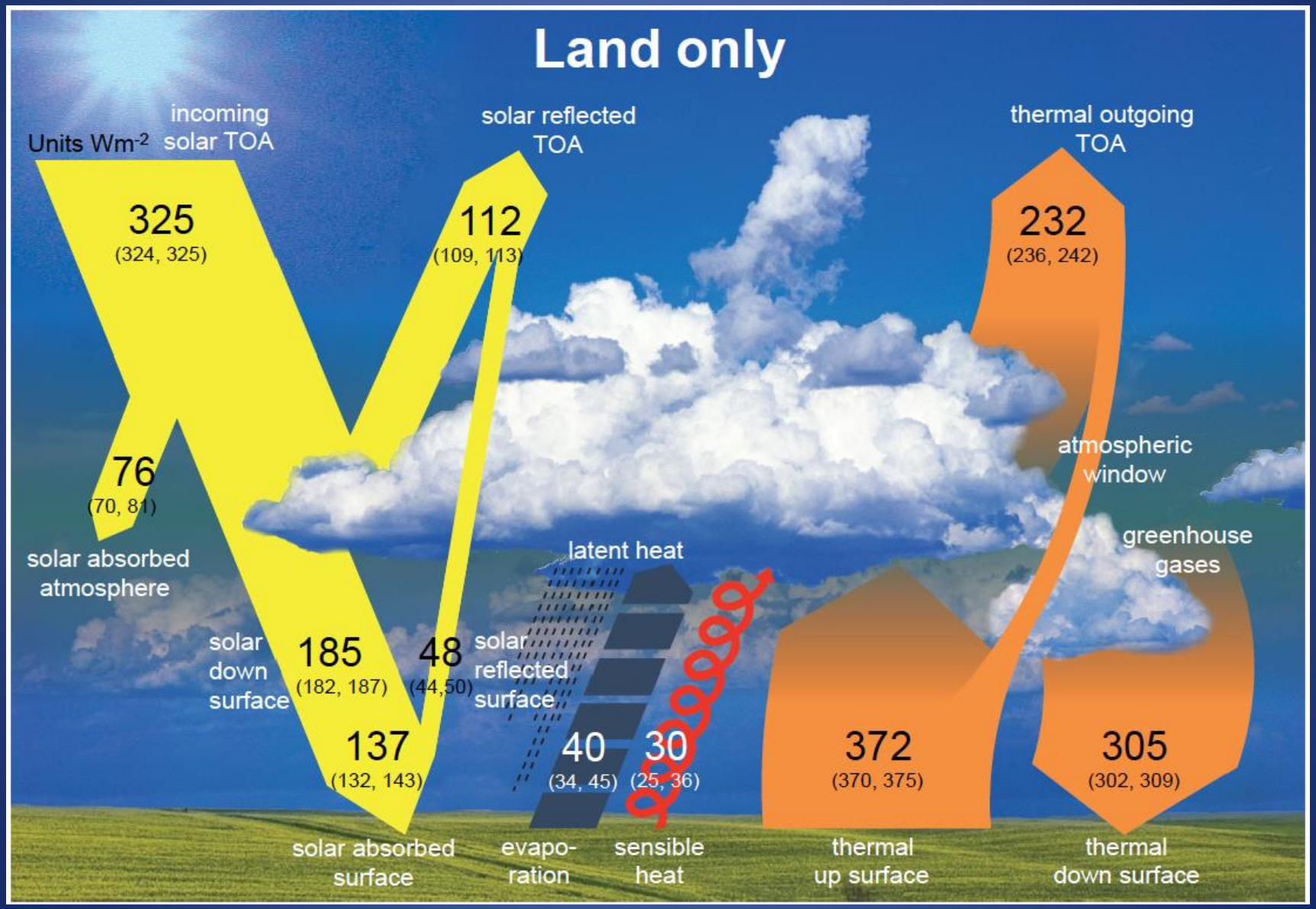
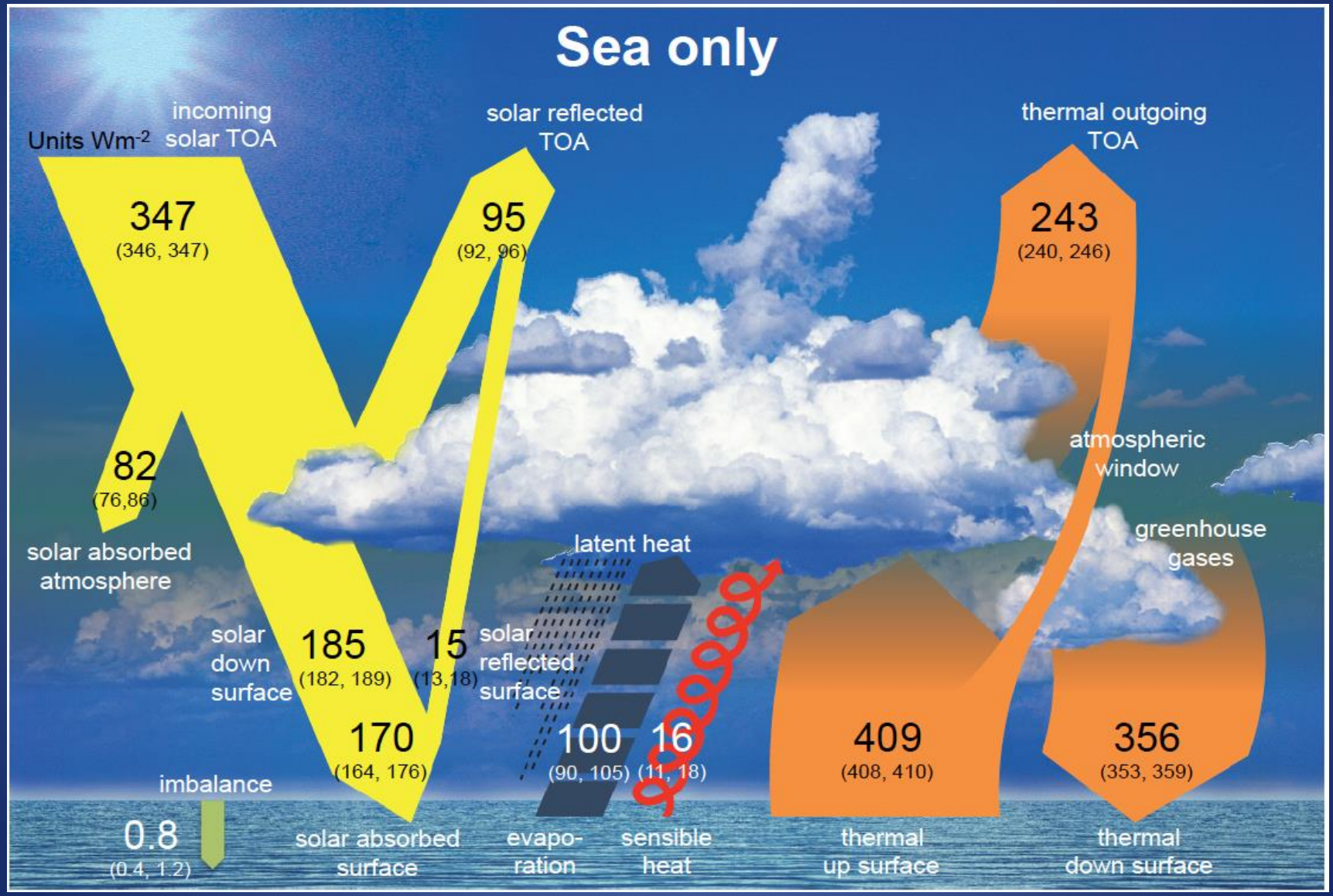


Figure 3: sea mean energy budget inferred from surface and TOA observations. From Wild et al. (submitted)



Global Energy Balance (GEB)

2. Selected Research Results (*cont*.)

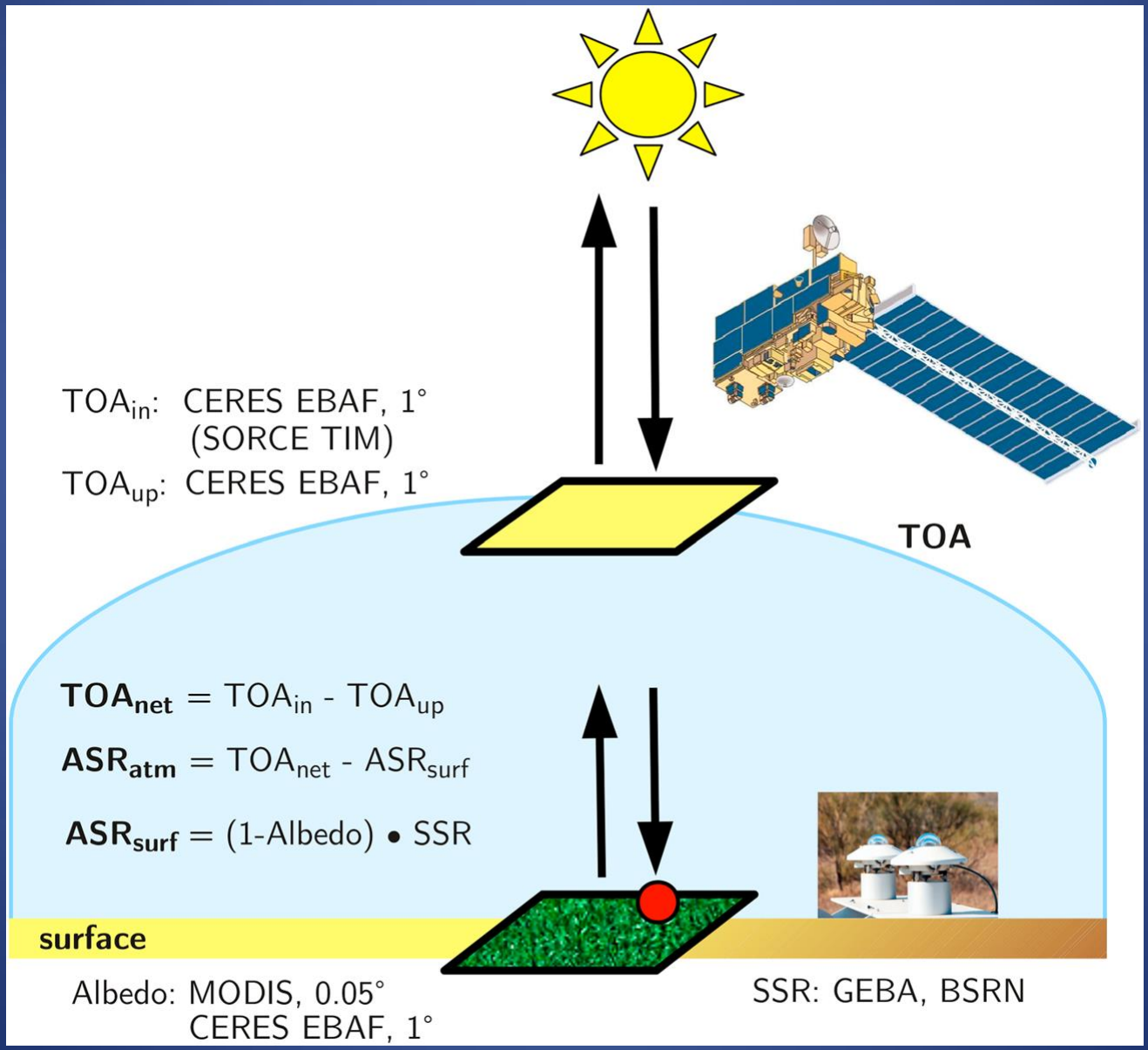
- WG Co-Chair Norman Loeb was involved in a study currently submitted to GRL (Allan et al. 2014) aiming at reconstructing the changes in the global net radiative imbalance over the period 1985-2012. Combining satellite data, atmospheric reanalyses and climate model simulations, the variability in the net downward radiative flux imbalance at the top of Earth's atmosphere (N) has been reconstructed and linked to recent climate change. Over the 1985-1999 period mean N (0.34±0.67 Wm−2) is lower than for the 2000-2012 period (0.62±0.43 Wm−2, uncertainties at 90% confidence level) despite the slower rate of surface temperature rise since 2000. While the precise magnitude of N remains uncertain, the reconstruction captures interannual variability which is dominated by the eruption of Mt. Pinatubo in 1991 and the El Nino Southern Oscillation.

Global Energy Balance (GEB)

2. Selected Research Results (*cont*.)

- Within the project “Towards an improved understanding of the Global Energy Balance: absorption of solar radiation” the worldwide surface radiation measurements of the Global Energy Balance Archive (GEBA) and Baseline Surface Radiation Network (BSRN) are combined with collocated satellite-inferred surface albedo and top-of-atmosphere (TOA) radiation data (MODIS, CERES) (Figure 4). Applying this methodology, Hakuba et al. (2014a) computed best estimates of absorbed solar radiation at the surface and within the atmosphere representative for Europe during 2000–2010, in a paper recently published in JGR. Best estimates of Europe land annual mean surface and atmospheric absorption of 117.3 ± 6 W m−2 (41.6 ± 2% of top-of-atmosphere incident irradiance) and 65.0 ±3Wm−2 (23.0 ± 1%) were found. The fractional atmospheric absorption of 23% represents a robust estimate largely unaffected by variations in latitude and season, thus, making it a potentially useful quantity for first-order validation of regional climate models.

Figure 4: Combination of satellite-derived data sets of top-of-atmosphere solar fluxes and surface albedo (area averages) with ground-based observations (point measurements) of surface solar radiation. The data sets used together with their spatial resolution are indicated as well (From Hakuba et al. 2014a)



Global Energy Balance (GEB)

3. Recommendations

a) Recommendations with respect to the TOA radiation budget components:

- The international community should urge government agencies responsible for building the next generation of Earth Radiation Budget instruments to include onboard calibration equipment that can detect and correct for on-orbit contamination of optics. Lessons learned from over a decade of in-flight experience (e.g., with CERES FM1-FM4 and the SORCE TIM, Kopp et al. 2005) clearly provide evidence that on-orbit contamination of optics does occur and must be detected and corrected for in order to ensure a robust climate record of the TOA radiation budget.
- The international community should urge government agencies responsible for building the next generation of Earth Radiation Budget instruments to provide sufficient time for ground calibration activities. Ground calibration is the last major test performed prior to shipment, when there are typically no financial or schedule reserves left. Shortening the length of the ground calibration period due to cost/schedule constraints adds uncertainty to the absolute calibration of the instrument.
- The international community should urge government agencies responsible for building the next generation of Earth Radiation Budget instruments to periodically re-verify the traceability of calibration targets on the ground.

Global Energy Balance (GEB)

3. a) Recommendations with respect to the TOA radiation budget components (*cont*.):

- The international community should urge government agencies responsible for building the next generation of Earth Radiation Budget instruments to establish collaborations with other international agencies specializing in calibration standards (e.g., NIST, NRL).
- The international community should provide guidance on the creation of Earth Radiation Budget climate data records. There is a naive notion in the community that complex climate data records involving a significant level of fusion of multiple data sources at climate accuracy can be transitioned from research to operations. The decades of expertise used to validate, understand, quality control, and continuously fix problems with instrument or ancillary input data sets cannot be bought or transplanted as a set of documents and software. Earth Radiation Budget Climate Data Records capable of accurately characterizing climate at decadal time-scales are inherently more research data products than they are operational data products. Assuming otherwise will likely lead to inferior data products characterized by artifacts that go unnoticed and unresolved in an operational processing environment. While an operational approach works fine for processing weather data, far more rigor and quality assurance is necessary for climate data products, where reprocessing is an integral part of the effort.

Global Energy Balance (GEB)

3. Recommendations (*cont.*)

b) Recommendations with respect to the surface/atmospheric radiation budget components:

- Letters of support from the International Radiation Commission to some of the National agencies funding BSRN stations may help to raise the recognition of the importance of these anchor sites for global energy budget studies.
- A continued and expanded operation and maintenance of a well calibrated network of long term surface radiation stations is required to provide direct observations and anchor sites for satellite-derived products and climate model validation, as well as for the detection of important changes in the radiation fields either not detectable by satellites or anticipated by models. The basic measurements include the four primary components (up and down, longwave and shortwave irradiance) with high temporal resolution (minute values) and known accuracy (BSRN accuracy standards).
- These high accuracy observation sites should be expanded to under-represented regions of the globe (such as many low latitude areas) and particularly oceans where alternate or modified observational strategies might be necessary. The use of newly available shortwave radiometers (SPN-1) that are well suited for use in remote deployments such as on buoys and ships, is recommended. These new radiometers comply with low-power systems measuring both diffuse and direct fluxes, which allows for proper correction of tilt from horizontal (Long et. al, 2010).

Global Energy Balance (GEB)

3. b) Recommendations with respect to the surface/atmospheric radiation budget components (*cont.*):

- Anchor sites should also include direct and/or diffuse shortwave measurements in addition to total incoming shortwave (SW) along with standard surface meteorological measurements. These measurements are useful for the diagnosis of cloud effects on the radiation budget (Zhang et al. 2010), for the evaluation of satellite-derived products and climate models, and for climate impact research (for example biosphere growth and terrestrial carbon uptake, Mercado et al. 2009).
- To improve surface albedo estimates over various surface types and for the assessment of satellite derived albedo products, high accuracy spectral and broadband measurements from towers are desirable at the anchor sites (Roman et al. 2009).
- Atmospheric spectral optical depths should be observed to infer atmospheric column abundance of aerosol, ozone, water vapor and other constituents.
- The spatial representativeness of surface anchor sites needs to be thoroughly assessed (Dutton et al. 2006, Roman et al. 2009). Some of these issues are addressed in Hakuba et al. (2013, 2014b). The possible “urbanization” effect (impact of local air pollution) in surface solar radiation trends needs quantification.
- Clear sky flux products derived from direct observations should be provided for the validation of corresponding fluxes in the models and satellite derived estimates.
- To achieve progress in the accuracy of satellite-derived surface radiation fields, improved and consistent satellite estimates of vertical distributions of cloud and aerosol radiative properties (size, single scattering albedo, asymmetry parameter) and of water vapor are required

Global Energy Balance (GEB)

4. Selected References

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4. International TOVS Working Group (ITWG)

Niels Bormann, Co-Chair
Mitch Goldberg, Co-Chair

International TOVS Working Group activities for MW and IR sounding

Niels Bormann, Mitch Goldberg

ITSC-19

- **Hosted by KMA on Jeju Island, South Korea**
  - 26 March – 1 April 2014
  - Local hosts: Dr Dohyeong Kim, Prof BJ Sohn
  - 196 participants (new record!)
  - Very strong contributions from Asia
  - 60 oral, 140 poster presentations

- **Topics Covered:**
  - Current, new and future observing systems
  - Reports from space agencies and NWP Centres
  - Data assimilation applications
  - Climate applications
  - Processing software systems
  - Advanced sounder science
  - Radiative transfer models
  - Cloud and precipitation applications
  - Retrieval Science
  - Atmospheric chemistry and composition

INTERNATIONAL ATOVS WORKING GROUP

Working Groups

Six Working Groups

- Radiative Transfer and Surface Property Modelling
- Climate
- Data Assimilation and NWP
- Advanced Sounders
- International Issues and Future Systems
- Products and Software

Technical Sub-Groups

- RTTOV
- CRTM
- RARS and direct broadcast packages
- (Remote Sensing and Modelling of Surface Properties)

INTERNATIONAL ATOVS WORKING GROUP

ITSC-19: Key Recommendations relevant to IRC

To IRC, CGMS and satellite agencies: Support for line-by-line (LBL) reference model development is of paramount importance and should be continued to ensure that users (in both operational and non-operational institutions) have access to the latest updates in LBL forward modelling.

To IRC, CGMS and satellite agencies: encourage validation and intercomparison of LBL models/spectroscopy to assess the impact of spectroscopic uncertainties and the differences between line-by-line and fast radiative transfer models.

To satellite agencies: instrument characteristics should be provided as early as possible (even approximate versions) to allow preparations for radiative transfer modelling and other evaluations. This includes in particular spectral response functions. Ultimately, detailed digitised channel system responses should be made available to allow the best-possible radiative transfer calculations.

INTERNATIONAL ATOVS WORKING GROUP

ITSC-19: Key Recommendations relevant to IRC

To IRC, CGMS and satellite agencies: conduct studies to trade off benefits of spectral, radiometric, and spatial resolutions of infra-red sounders considering the noise floor due to atmospheric noise and current uncertainties in spectroscopy, to enable improved spatial resolution and increased number of field of views for the next generation hyperspectral infra-red sounders.

To satellite agencies: noting that absolute calibration with on-orbit SI traceability is critical for significantly reducing uncertainties in monitoring climate trends, ITWG recommends to pursue the realization of absolute calibration missions (such as CLARREO), including considering flight opportunities on the International Space Station.

To CGMS and satellite agencies: conduct intercomparison studies between level 2 retrievals from hyperspectral instruments, recognising that there are now several software packages available that utilize IASI/CrIS/AIRS data for the generation of level 2 products.

INTERNATIONAL ATOVS WORKING GROUP

ITSC-20

28 October – 3 November 2015,
Grand Geneva Resort and Spa
Lake Geneva, Wisconsin, USA

Local Hosts: Space Science and Engineering Center

INTERNATIONAL ATOVS WORKING GROUP

Summary

- **International TOVS Working Group**
  - Expert group on infrared and microwave sounding applications
  - Provide biennial assessments of the state of the soundings
  - See: http://cimss.ssec.wisc.edu/itwg/index.html

- **Presentations and posters from most recent meeting ITSC-19 on Jeju Island 26 March – 1 April 2014:**
  - http://cimss.ssec.wisc.edu/itwg/itsc/itsc19/program/index.html

- **Next meeting: ITSC-20 at Lake Geneva, Wisconsin:**
  - 28 October – 3 November 2015

INTERNATIONAL ATOVS WORKING GROUP

5. GEWEX Data and Assessments Panel (GDAP)

Christian Kummerow, Chair

GEWEX Data and Assessments Panel (GDAP)

1. Panel activities

- Activities of the GDAP can be divided simply into Data Products, Product Assessments, and Radiative Transfer Code Assessments.
- The individual products for Clouds (ISCCP), Aerosols (GACP, MAC), Radiation (SRB), Turbulent Fluxes (SeaFlux and LandFlux), as well as Precipitation (GPCP) continue with reasonable support from agencies except for GACP which is currently unfunded. The Max Planck Institute für Meteorologie has begun producing an Aerosol Climatology that is being adopted by GDAP instead.
- Each of the GEWEX reference products is currently preparing for a reprocessing cycle that will result in common space and time grids as well as ancillary data and assumptions. These will be merged into a single product called the GEWEX Integrated Water and Energy Product.

GEWEX Data and Assessments Panel (GDAP)

1. Panel activities (*cont.*)

- The Integrated GEWEX product is designed to ensure that geophysical signals and their covariances are tied to the data and products themselves rather than inconsistencies in their assumptions.
- Reviewing the readiness of GEWEX reference products for this reprocessing with common assumptions and setting realistic goals for product deliveries was the primary objective of the GDAP team meeting held in Rio De Janeiro, Brazil, on 3-5 September, 2013.
- The panel has encountered significant issues, of the scientific rather than programmatic nature, as it has forged ahead to create this product. Details are found in the Rio de Janeiro meeting minutes. The first year of the integrated product is now scheduled for delivery by June 30, 2014.

GEWEX Data and Assessments Panel (GDAP)

1. Panel activities (*cont.*)

- The panel has now finished the Precipitation, Clouds and Radiation products which have been published in their entirety in BAMS; the Radiative Flux Assessment is still in the review process.
- GDAP is actively involved in the Aerosol assessment and Water Vapor Assessment which just held its most recent meeting in Fort Collins, CO in late September,2013.
- LandFlux and SeaFlux have combined initial assessments with product recommendations ; they are recommending the GEWEX standard product rather than assessing an existing one.
- GDAP has begun to expand to encompass the terrestrial water budget – including soil moisture, storage, and runoff. The panel plans to slowly add these parameters in order to further constrain the Water and Energy budgets on a scale that is relevant for climate processes.

GEWEX Data and Assessments Panel (GDAP)

2. New projects and activities being planned, including timeline

- GDAP is exploring the expansion of GEWEX standard products to include terrestrial water budget terms. It has begun the process by inviting Wouter Dorigo (Soil Moisture) and Felix Landerer (GRACE Observations of water storage) to join the team to advise on best ways to incorporate potential data sets. Formal decisions will be made in the following two years based upon the feasibility of creating standard products that would be recognized by the community.
- There was discussion at the meeting in Rio de Janeiro, held jointly with GHP, to join efforts of the two panels to tackle orographic precipitation as well as high altitude (snow) precipitation. GDAP is currently awaiting input from GHP about candidate regions. GDAP is still evaluating the feasibility of formalizing the Satellite Simulator Assessment. Decisions should be made at the next GDAP meeting in the summer of 2014.

GEWEX Data and Assessments Panel (GDAP)

3. Science Highlights

- All GEWEX reference products agreed to deliver the first year of the Integrated Product parameters by March 2014 for a June 2014 release of the Integrated Product. This includes uncertainties.
- The discrepancy in Water and Energy budgets seen in observations continues with radiative flux and the precipitation communities finding additional data to support their values. This implies significantly more precipitation globally (15-20%).
- Water budget closure studies over five Tropical Pacific basins suggests that precipitation, evaporation and water vapor divergence from Reanalyses close the budgets but that the Models have higher evaporation because of a dry bias in the near surface layers. The observations also show a significant trend of P-E drifting away from the water vapor divergence over the last decade in the West Pacific that is not seen in any of the other basins, suggesting that changes in geophsyisical parameters are the likely cause.

GEWEX Data and Assessments Panel (GDAP)

4. Science Issues

- The Panel views in situ reference measurements of radiation (BSRN), precipitation (GPCC), water vapor (through well calibrated radiosondes) and latent heat flux from ships and towers around the world as an important reference for Climate Data Records.
- The SSG and WCRP might consider a concerted effort to foster small but highly characterized networks (similar to BSRN) that can be used to assess satellite stability over very long periods. The maintenance of these activities is central to satellite derived products and GDAP cannot emphasize their importance enough.

GEWEX Data and Assessments Panel (GDAP)

5. Planned Workshops & Meetings

Support for 1-2 people may be needed for each meeting except BSRN meeting that requires support for travel from developing countries.

- Summer 2014. BSRN Semi-annual meeting. Location TBD (Beijing; Bologna; St. Petersburg or Princeton).
- 13-18 July 2014. GEWEX Data and Assessments Panel meeting, The Hague, NL
- 06-10 October, 2014. GEWEX Water Vapor Assessment meeting. Berlin, Germany
- Fall 2014. Precipitation Assessment meeting. Location likely in US.

GEWEX Data and Assessments Panel (GDAP)

6. List of members and their term dates:

** Indicates new member*

- Christian Kummerow 2008 – present
- Joerg Schulz 2010 – present
- Wouter Dorigo* 2013 – Present
- Carlos Jimenez 2010 – present
- Felix Landerer* 2013 – present

6. Solar UltraViolet Radiation (UV)

Julian Gröbner, Co-Chairs:

Mario Blumthaler, Co-Chairs:

Solar UltraViolet Radiation (UV)

I. Current Status

- The EMRP project ENV03 Traceability for surface spectral solar UV radiation finished on 31 July 2014. The UV community was involved in this activity through Researcher Excellence Grant schemes and collaborations with the project, allowing European researchers to participate and contribute to the project.
- The most important activities since the last IRC business meeting were the organization of the open UV workshop on 15-16 July 2014 and the UV intercomparison from 7 to 16 July 2014 at PMOD/WRC.

Solar UltraViolet Radiation (UV)

II. Main Results

- The dissemination of the project results through the inter-comparison and workshops were very appreciated by the UV community.
- More than 20 spectroradiometers participated at the intercomparison, most of them being array spectroradiometers measuring global solar UV irradiance.
- The necessity of a thorough characterization of array spectroradiometers has been recognized by the UV community through the dissemination activities of the EMRP project.
- Novel measurement techniques have been initiated such as hyperspectral imaging for retrieving full sky radiances in the solar UV.

Solar UltraViolet Radiation (UV)

III. Recommendations.

- None

IV. Future activities

- The follow-up project EMRP ENV09 ATMOZ, with the goal of improving the traceability of surface total column ozone measurements by characterizing existing instruments (Brewer & Dobson), was accepted and will begin on 1 October 2014 for a duration of three years. Measurements of direct solar UV irradiance and sky radiance with array spectroradiometers characterized with the techniques developed in the previous EMRP ENV03 project will be used for that purpose.

V. Future conference activities

- It is planned to organize a dedicated session on solar UV radiation at the next IRS 2016, following the large recognition of the one of IRS 2012.

7. Continuous Intercomparision of Radiation Codes (CIRC)

Lazaros Oreopoulos, Co-Chair

Eli Mlawer, Co-chair

The Continual Intercomparison of Radiation Codes (CIRC)

Status report to IRC, July 2014

Lazaros Oreopoulos[1] and Eli Mlawer[2]

[1]NASA-GSFC, Greenbelt, MD, USA (Chair)

[2]AER, Lexington, MA, USA (co-Chair)

What CIRC is about

- RT model intercomparison to serve as the standard for documenting the performance of RT codes used in GCMs
- Working group within IRC and GEWEX's GASS (ex-GCSS)
- Goal is to have RT codes of GCMs (incl. IPCC) report performance against CIRC
- Website: http://circ.gsfc.nasa.gov
- Two papers, BAMS 2010 and JGR 2012.

How CIRC differs from previous intercomparisons:

- *Observation-tested* (LW) LBL calculations are used as radiative benchmarks
- Benchmark results are publicly available
- Observationally-based input (chiefly from an ARM product named BBHRP)
- Intended to have flexible structure and be continual (i.e. updated periodically)

CIRC status report – activities since DACA-13 Davos BM

- CIRC remains unfunded
- CIRC section for upcoming ARM monograph (in chapter "Radiative Transfer Improvements in GCMs") is currently under review
- In the spirit of "Continual" we are updating the LBL reference calculations of CIRC Phase I using latest spectroscopy and other updates
- CIRC cases were used as baseline for 4xCO2 forcing reference calculations and evaluation of various RT codes as part of pilot study for future RFMIP (lead – Robert Pincus; see next slide) intercomparison within CMIP6
- First results of above study were presented by Pincus et al. at 14th AMS Radiation Conference in Boston early July 2014 and at the GEWEX meeting in Hague mid-July 2014
- Future plans
  - Ice cloud flux intercomparison for CIRC Phase II: Preliminary work underway by Mlawer and Ping Yang to create synthetic ice cloud cases using the latter's vast library of observed ice particle distributions and calculated single-scattering properties, matched with appropriate atmospheric profiles used in RRTM development. Some of these could serve as future CIRC cases, supplemented with observed ARM cases.
  - Support RFMIP (see next slide)

RFMIP and CIRC

- GASS endorses using observed (CIRC, Oreopoulos) and synthetic (RFMIP, Pincus) profiles to evaluate radiation codes: two approaches, one goal
- We are currently discussing the role observation-driven CIRC can play in support of the planned RFMIP (anticipated CMIP6 connection)
- Potential RFMIP components (subject to change, some DOE funding):
  - Greenhouse gas forcing (Pincus/Mlawer)
  - Aerosol instantaneous radiative forcing in CMIP6 GCMs (Collins/Ramaswamy)
  - Effective vs. instantaneous radiative forcing (Forster)
  - Diversity in forcing and response from non-greenhouse gas forcing (Stevens)
- RFMIP workshop in Hamburg, early September
- Mlawer/AER, Oreopoulos, CIRC involved mostly with first component
- IRC should consider endorsing RFMIP once settled

8. Three-Dimensional Radiative Transfer (3DRT)

Alexander Marshak, Co-Chair

Jean-Luc Widlowski, Co-Chair

Three-Dimensional Radiative Transfer (3DRT)

Status Report for Summer 2013 – Summer 2014

I3RC status: http://i3rc.gsfc.nasa.gov/

(I3RC is an ongoing project initiated in the late 1990s)

Objectives

- Comparing methods available for 3D atmospheric RT calculations
- Providing benchmark results for testing 3D RT codes
- Publishing an open source toolkit (community 3D MC code)
- Providing resources related to I3RC and 3D RT (codes, models, workshops, publications)

Three-Dimensional Radiative Transfer (3DRT)

Activities

- Due to security upgrades the I3RC site was down for a good part of the year; no visits occurred during this time. Now it's back except for the online 3D calculator. 13 people have downloaded the file containing all the source code of the I3RC Monte Carlo code (http://code.google.com/p/i3rc-monte-carlo-model/downloads/list). They are from Belarus, China, Germany, Israel, South Africa, Spain, Taiwan, and US. Other statistics was unavailable at the time of the report.
- A polarized version of the Spherical Harmonic Discrete Ordinate Method (SHDOM) for Atmospheric Radiative Transfer (Frank Evans, University of Colorado) has been released (http://nit.colorado.edu/%7Eevans/shdom.html). Now SHDOM can perform polarized radiative transfer for randomly oriented particles. The code can also make visualization output images using multiple processors with MPI.

Three-Dimensional Radiative Transfer (3DRT)

Activities (continued)

- A 3D radiative transfer session at the 14th AMS Conference on Atmospheric Radiation has been organized (chaired by Larry Di Girolamo, University of Illinois).
- The polarized Monte Carlo 3D Radiative Transfer model I3RC-POL (https://www.ideals.illinois.edu/bitstream/handle/2142/49638/Allison_Houghton.pdf) has been developed (Allison Houghton and Larry Di Girolamo, University of Illinois). The model hasn't been yet incorporated into the I3RC community code.

Three-Dimensional Radiative Transfer (3DRT)

What's now available:

- Online 3D calculator
- A new image archive about 3D radiative processes
- Consensus results of I3RC intercomparison for model verification
- Publicly available codes on 3D radiative transfer
- Expanded publication list on website: over 400 publications in the I3RC publication database

Plans

- Creating an educational web pages on 3D RT.
- Adding Rayleigh scattering and aerosols to the I3RC community code;
- Adding polarization to the I3RC community code.

9. International Polarized Radiative Transfer (IPRT)

Claudia Emde and Bernhard Mayer, Co-chairs

International Polarized Radiative Transfer (IPRT)

1. Polarized Radiative Transfer Model Intercomparison

- The major activity started this year is the IPRT model intercomparison. So far eight model developers from USA, France, Russia, Japan and Germany participate in this project.
- The following comprehensive set of test cases has been carefully been defined by C. Emde in collaboration with F. Evans:
  - Phase A: Relatively simple cases for a single plane-parallel layer
    - Pure Rayleigh scattering
    - Rayleigh scattering layer above a Lambertian surface.
    - Test case for a layer with small spherical aerosol particles corresponding to a typical water soluble aerosol.
    - Layer with aspherical aerosol particles with size parameter and refractive index typical for mineral dust.
    - Water cloud droplets with an effective radius of 10 μm.
    - Rayleigh scattering layer over an ocean surface.

International Polarized Radiative Transfer (IPRT)

1. Polarized radiative transfer model intercomparison (*cont*.)

- The following comprehensive set of test cases has been carefully been defined by C. Emde in collaboration with F. Evans:
  - Phase B: In the second phase we combine the parts of phase A to a more realistic atmosphere with 30 layers.
    - The radiation field is calculated for the standard atmosphere at the top, at the bottom and at 1 km altitude. This test checks whether the coupling of the layers is correctly implemented.
    - The same as the previous case but with absorption. Absorption decreases the intensity of the radiation but does not change the polarization state.
    - Test case including a realistic aerosol profile.
    - The final test case is for a standard atmosphere including a cloud layer above an ocean surface.

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1. Polarized radiative transfer model intercomparison (*cont*.)

- The goals of phases A and B are to identify possible model errors, to find common definitions of coordinate systems (this is particularly important for polarization because the sign of the Stokes components depend on the choice of the coordinate system), and to test the level of agreement of completely different approaches to solve the vector radiative transfer equation for cases of different complexity. Last but not least we will to provide benchmark results for other model developers.
- The definition of all test cases is available at the IPRT web-site: http://www.meteo. physik.uni muenchen.de/~iprt/doku.php?id=intercomparisons: intercomparisons.
- Deadline to submit results is the 31 October 2014. After publication of the results we will move to the phase C including fully spherical and three-dimensional atmospheres.

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2. Benchmark results

- TIPRT web-page now includes a comprehensive list of references of already published benchmark results.
- There are also several benchmark results for aerosol scattering (e.g. Wauben and Hovenier (1992); de Haan et al. (1987) and so far only one including aerosol and cloud scattering (Kokhanovsky et al. ,2010).
- Most of the benchmark results are for one or two layers only and the phase matrices are with one exception for small particles.
- The available benchmark results are good for testing but they do not include a completely realistic atmospheric setup.
- To our knowledge there are no benchmarks available for polarized surface reflection, for spherical atmospheres, and for 3D atmospheres including clouds and aerosols.
- We hope that IPRT will be able to fill this gap.

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3. Single scattering data and bulk optical properties

- New single scattering data of ice crystals including full phase matrices have been made available by Yang et al. (2013). These were used by Baum et al. (2014) to generate bulk optical properties, which may be used as input for radiative transfer calculations. All data is freely available.

4. Workshops

- A graduate workshop on polarization took place on 11/12 February 2014 in Leipzig. The scientific program included lectures on polarization measurements as well as on polarized radiative transfer. The workshop has been organized by A. Macke, a member of the IPRT working group.

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