GCOS science conference, 2 Mar. 2016, Amsterdam

Status of Surface Radiation Budget Observation for Climate

Nozomu Ohkawara
Japan Meteorological Agency (JMA)

Contents

1. Background

Surface radiation budget is a fundamental component for monitoring climate change. ⇒ designated as one of the ECVs

Domain	GCOS Essential Climate Variables	
Atmospheric (over land, sea and ice)	Surface:	Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, **Surface radiation budget**.
	Upper-air:	Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance).
	Composition:	Carbon dioxide, Methane, and other long-lived greenhouse gases, Ozone and Aerosol, supported by their precursors.
Oceanic	Surface:	Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current, Ocean colour, Carbon dioxide partial pressure, Ocean acidity, Phytoplankton.
	Sub-surface:	Temperature, Salinity, Current, Nutrients, Carbon dioxide partial pressure, Ocean acidity, Oxygen, Tracers.
Terrestrial	River discharge, Water use, Groundwater, Lakes, Snow cover, Glaciers and ice caps, Ice sheets, Permafrost, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), Above-ground biomass, Soil carbon, Fire disturbance, Soil moisture.	

Observation network

- the national meteorological services all over the world
- the Baseline Surface Radiation Network (BSRN)

What is “BSRN”?

- A precise radiometric network initiated by WCRP/GEWEX to support climate research
- Provides validation materials for satellites radiometry and climate models
- Started in 1992 with 5 stations.
- Designated as a baseline network of surface radiation budget of GCOS in 2004.

Data archive center

- WMO World Radiation Data Center (St. Petersburg, Russia)
- World Radiation Monitoring Center (AWI in Germany)

2. Status of surface radiation budget observation reviewed in the GCOS status report

Action for National Met Services and others in IP-10

Action A13: Submit surface radiation data to WRDC and expand radiometer deployments

Action: Submit surface radiation data with quality indicators from national networks to the World Radiation Data Centre (WRDC), and expand deployment of net radiometers at WWW/GOS surface synoptic stations.

Who: National Meteorological Services and others, in collaboration with the WRDC.

Time-Frame: Ongoing.

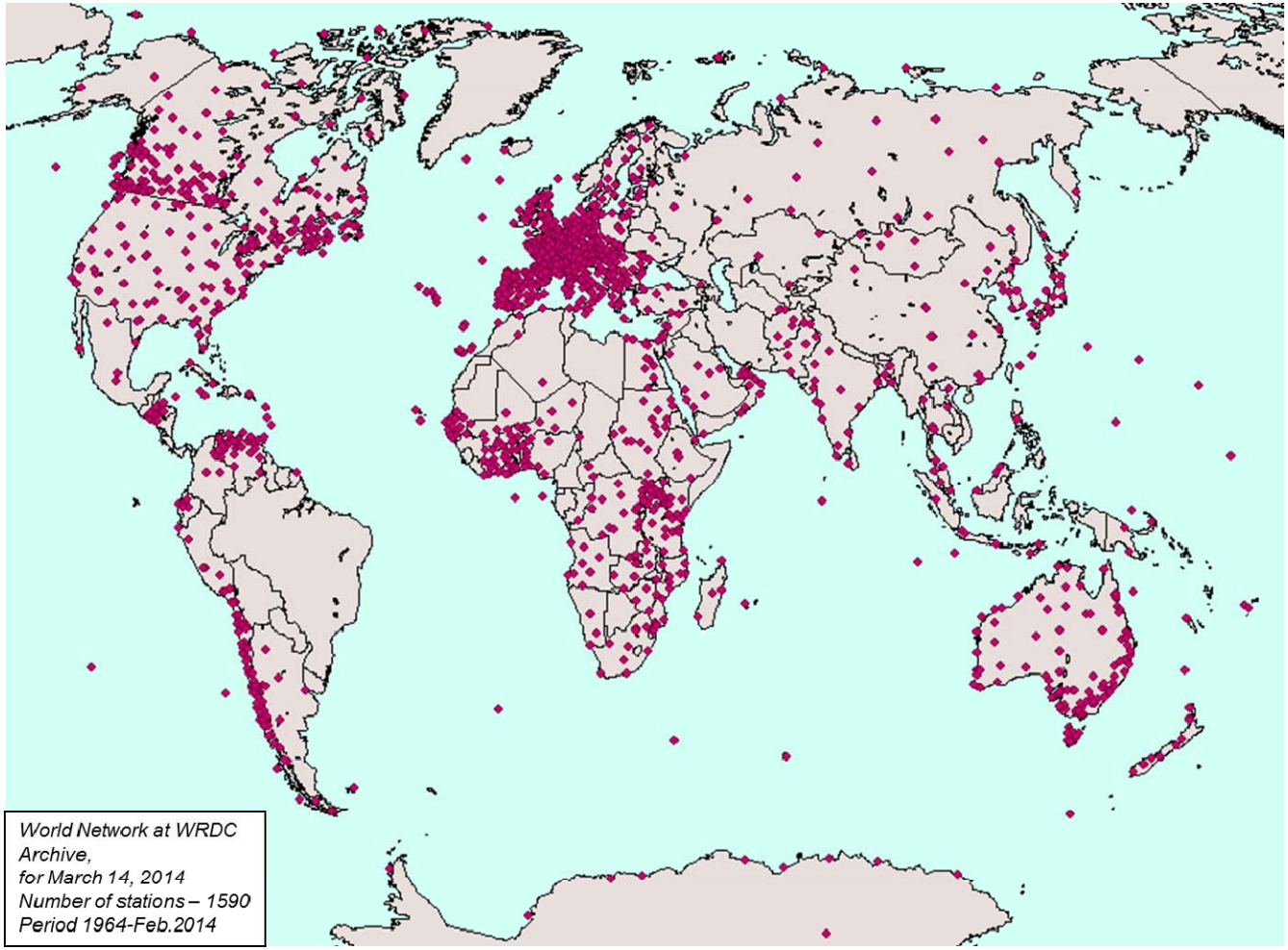
Performance Indicator: Data availability in WRDC.

Annual Cost Implications: 1-10M US$ (70% in non-Annex-I Parties).

Category D: Limited progress overall, though progress may be moderate or good on some part of the action.

Status of archived data at the WRDC in the period of IP-10 (2010-2015)

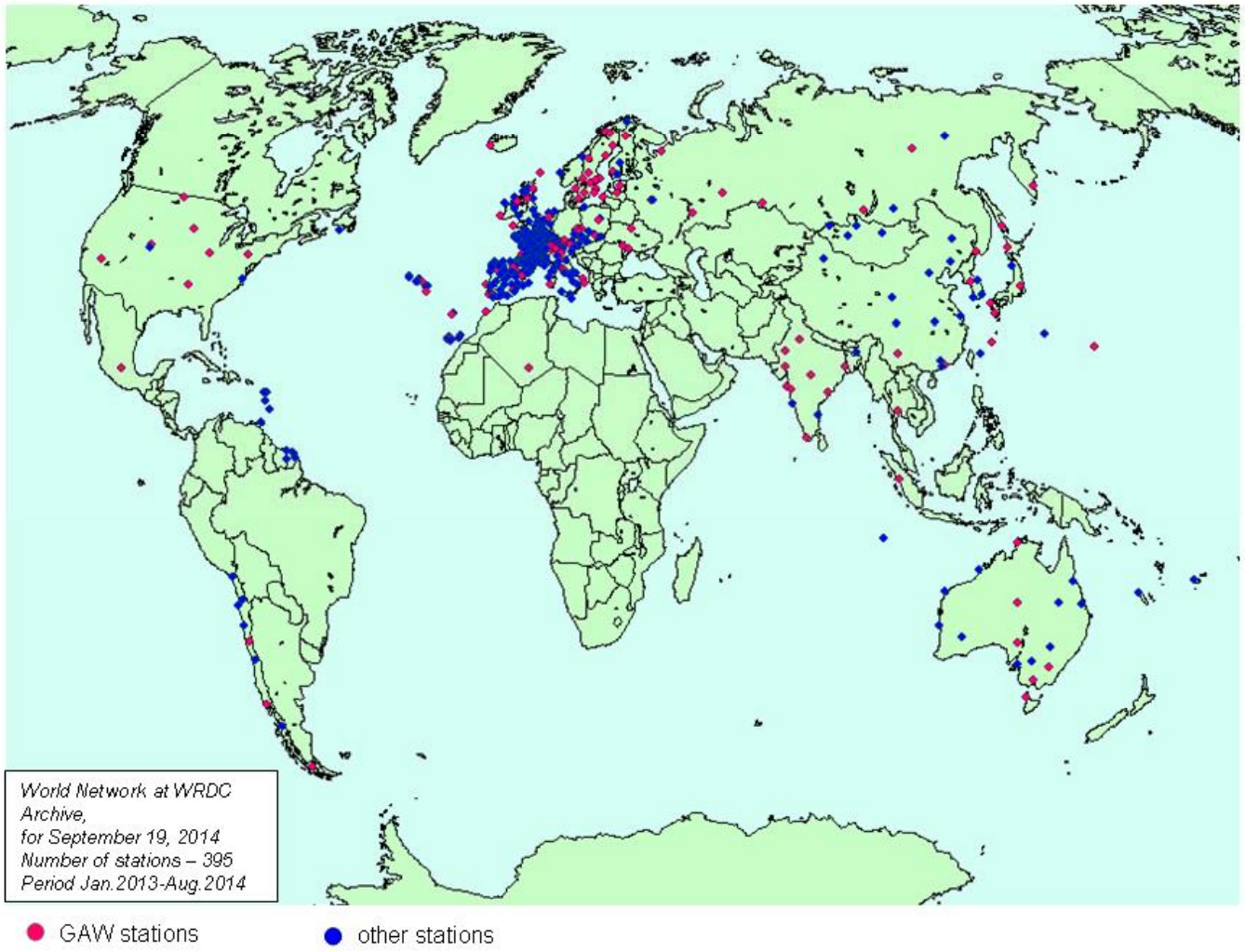
The total number of stations archived at the WRDC reaches 1590 since the start of archive in 1964.



The locations of stations reporting for the period from 1964 to February 2014 (as of 19September 2014)

Courtesy of WRDC

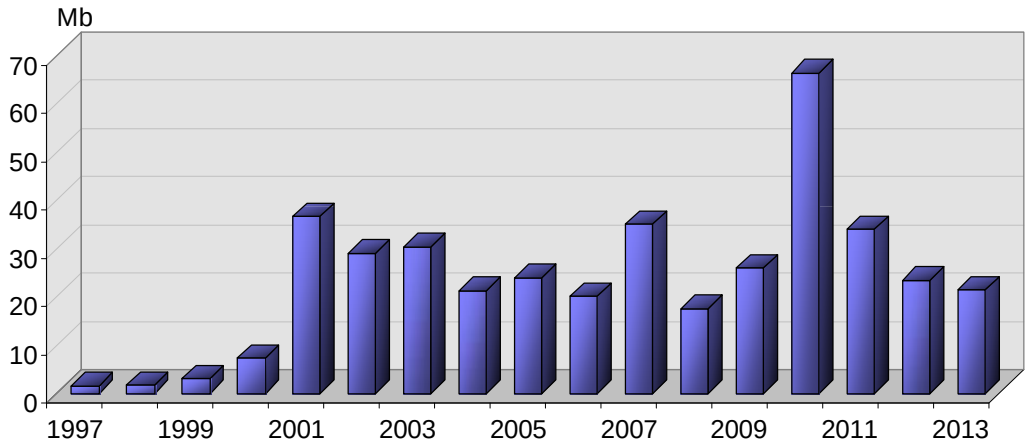
The count of 395 stations reporting to the WRDC is almost the same as before.



The locations of stations reporting for the period from January 2013 to August 2014 (as of 19September 2014)

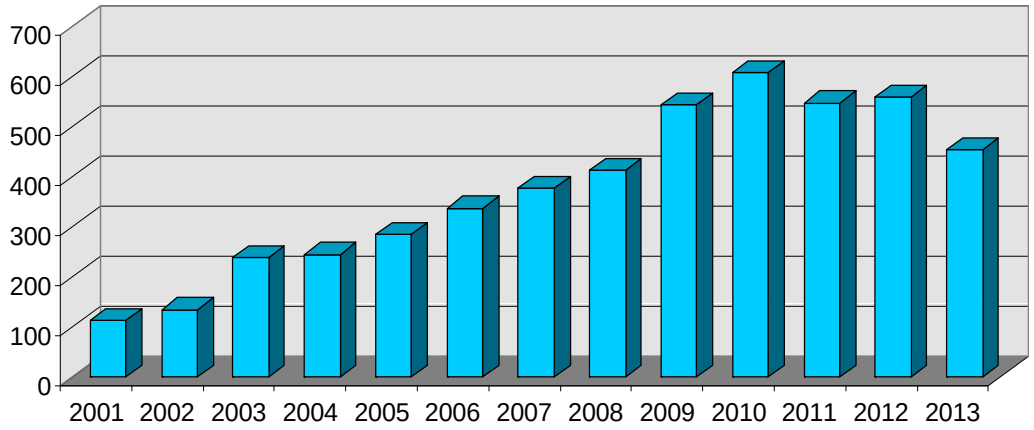
Courtesy of WRDC

The data have been steadily reported to the WRDC.



An amount of data received at the WRDC (ASCII codes) in Mb

Users have been constantly accessing the WRDC data .



WRDC Activity For March 14, 2014

The number of users of the WRDC Server

Courtesy of WRDC

Action for Parties operating BSRN stations in IP-10

Action A14: Ensure continued long-term operation of the BSRN and expand the network

Action: Ensure continued long-term operation of the BSRN and expand the network to obtain globally more representative coverage. Establish formal analysis infrastructure.

Who: Parties' national services and research programmes operating BSRN sites in cooperation with AOPC and the WCRP GEWEX Radiation Panel.

Time-Frame: Ongoing (network operation and extension); by 2012 (analysis infrastructure).

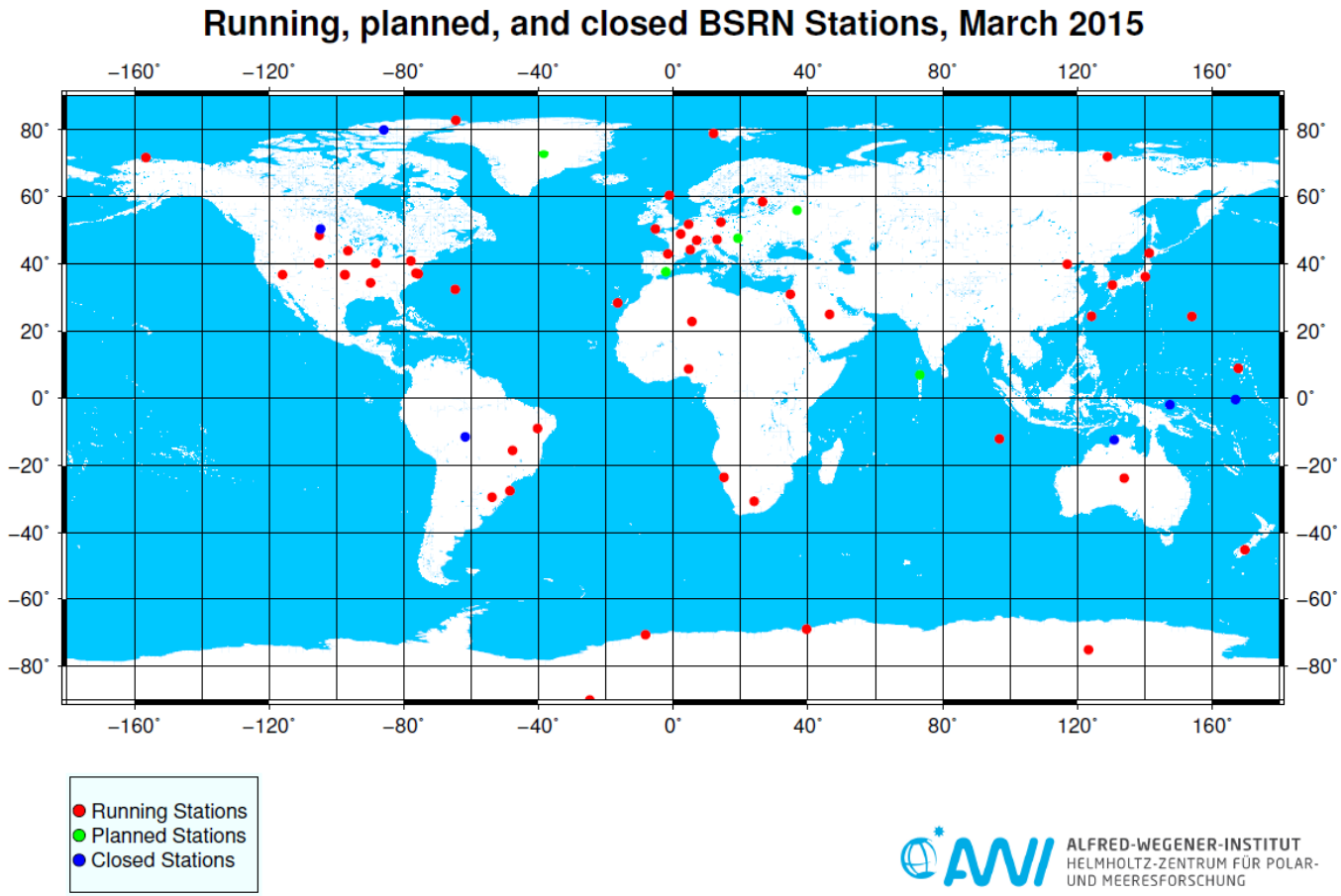
Performance Indicator: The number of BSRN stations regularly submitting data to International Data Centres; analysis infrastructure in place.

Annual Cost Implications: 1-10M US$ (20% in non-Annex-I Parties).

Category C: Moderate progress overall, though progress may be good on some part of the action.

Status of archived data at the WRMC in the period of IP-10 (2010-2015)

The total data amounts archived in the WRMC have been growing steadily although data scarce area remain, especially over oceans, eastern Africa and central Asia.



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

WRMC website operated by AWI (http://bsrn.awi.de/)

Data archive status (as of Sep 2015)

PANGAEA®
Data Publisher for Earth & Environmental Science

Not logged in (log in or sign up)

Baseline Surface Radiation Network

[BSRN homepage] - [Staff | Stations | Parameter | Methods] - [**LR0100** | LR0300 | LR0500 | LR1000 | LR1100 | LR1200 | LR1300 | LR3010 | LR3030 | LR3300 | All | latest datasets]

Click on a number shows a list of all datasets for selected year and station.

Station	Short name	Station scientist 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	2013	2014	2015	All
Alert	ALE	Christopher Cox (christopher.j.cox@noaa.gov)														5	12	12	12	12	12	12	12	12	2			X
Alice Springs	ASP	Bruce Forgan (B.Forgan@bom.gov.au)					12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	11	9		X
Barrow	BAR	David Longenecker (David.U.Longenecker@noaa.gov)		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	2						X
Bermuda	BER	David Longenecker (David.U.Longenecker@noaa.gov)		12	12	12	12	12	12	12	12	12	12	12	10	12	12	12	12	12	12	12	12	12	2			X
Billings	BIL	Charles Long (chuck.long@noaa.gov)			4	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	4				X
Bondville	BON	John Augustine (John.A.Augustine@noaa.gov)					12	12	12	12	12	12	12	12	12	12	12	12	12	12	6							X
Boulder, SURFRAD	BOS	John Augustine (John.A.Augustine@noaa.gov)					5	12	12	12	12	12	12	12	12	12	12	12	12	12	6							X
Boulder	BOU	David Longenecker (David.U.Longenecker@noaa.gov)		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	7	X
Brasilia	BRB	Enio Bueno Pereira (eniobp@cptec.inpe.br)																8	10	4	12	12	12	6	12	12	1	X
Cabauw	CAB	Wouter Knap (knap@knmi.nl)															11	12	12	12	12	12	12	12	12	12	8	X
Camborne	CAM	Jonathan Tamlyn (jonathan.tamlyn@metoffice.gov.uk)											12	12	12	12	12	12	12	1						12	7	X
Carpentras	CAR	Thierry Duprat (thierry.duprat@meteo.fr)						4	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	6	X
Chesapeake Light	CLH	Fred M. Denn (Frederick.M.Denn@nasa.gov)										8	12	11	12	12	12	12	12	12	12	12	12	12	12	12	8	X
Cener	CNR	Xabier Olano (xolano@cener.com)																			6	12	12	12	7	8	1	X
Cocos Island	COC	Bruce Forgan (B.Forgan@bom.gov.au)														3	10	8	12	12	12	12	12	9	4	12	3	X
De Aar	DAA	Lucky Ntsangwane (lucky.ntsangwane@weathersa.co.za)										7	6	12	11	12	1											X
Darwin	DAR	Charles Long (chuck.long@noaa.gov)												10	12	12	12	12	12	12	12	12	12	12	12	10	1	X
Desert Rock	DRA	John Augustine (John.A.Augustine@noaa.gov)								10	12	12	12	12	12	12	12	12	12	12	6							X
Concordia Station	DOM	Vito Vitale (v.vitale@isac.cnr.it)																12	12	12	12	2						X
Darwin Met Office	DWN	Bruce Forgan (B.Forgan@bom.gov.au)																		12	12	12	12	12	9	12	3	X
Eureka	EUR	Station closed end of 2011																	4	12	12	12	12					X
Southern Great Plains	E13	Charles Long (chuck.long@noaa.gov)				12	7	12	12	12	12	12	12	12	12	12	12	12	12	12	11	12	12	4				X
Florianopolis	FLO	Sergio Colle (colle@emc.ufsc.br)				6	12	12	10	12	12	9	12	12	12	12	12								4	12	6	X
Fort Peck	FPE	John Augustine (John.A.Augustine@noaa.gov)					12	12	12	12	12	12	12	12	12	12	12	12	12	12	6							X
Fukuoka	FUA	Masao Omori (irc-jma@met.kishou.go.jpp)																				9	12	12	12	12	6	X
Goodwin Creek	GCR	John Augustine (John.A.Augustine@noaa.gov)					12	12	12	12	12	12	12	12	12	12	12	12	12	12	6							X
Gobabeb	GOB	Roland Vogt (roland.vogt@unibas.ch)																						8	12	12	7	X
Neumayer Station	GVN	Gert König-Langlo (Gert.Koenig-Langlo@awi.de)	121	9	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	1	X
Ilorin	ILO	T O Aro		4	12	8	7	12	12	6	12	12	12	7	12	12	7											X
Ishigakijima	ISH	Masao Omori (irc-jma@met.kishou.go.jp)																				9	12	12	12	12	6	X
Izana	IZA	Emilio Cuevas-Agulló (ecuevasa@aemet.es)																			10	12	12	12	12	12	8	X
Kwajalein	KWA	David Longenecker (David.U.Longenecker@noaa.gov)		9	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12			X
Lauder	LAU	Bruce Forgan (B.Forgan@bom.gov.au)									5	12	12	12	12	12	12	12	12	12	11	12	12	12	12	9		X
Lerwick	LER	Jonathan Tamlyn (jonathan.tamlyn@metoffice.gov.uk)											12	12	12	12	11	11	12	5						12	6	X
Lindenberg	LIN	Klaus Behrens (Klaus.Behrens@dwd.de)				3	12	12	12	12	12	12	12	12	12	12	12	12	4									X
Langley Research Center	LRC	Fred M. Denn (Frederick.M.Denn@nasa.gov)																								1	8	X
Momote	MAN	Charles Long (chuck.long@noaa.gov)						3	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10			X
Minamitorishima	MNM	Masao Omori (irc-jma@met.kishou.go.jp)																				9	12	12	12	12	6	X
Nauru Island	NAU	Charles Long (chuck.long@noaa.gov)								2	12	12	12	12	12	12	12	12	12	12	12	12	12	12	9			X
Ny-Alesund	NYA	Marion Maturilli (Marion.Maturilli@awi.de)		5	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		X
Palaiseau	PAL	Martial Haeffelin (martial.haeffelin@lmd.polytechnique.fr)													7	12	12	12	12	12	12	12	12	12	12			X
Payerne	PAY	Laurent Vuilleumier (laurent.vuilleumier@meteoswiss.ch)		3	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	5					X
Rock Springs	PSU	John Augustine (John.A.Augustine@noaa.gov)								7	12	12	12	12	12	12	12	12	12	12	6							X
Petrolina	PTR	Enio Bueno Pereira (eniobp@cptec.inpe.br)																1	7	4	12	12	12	12	12	12	1	X
Regina	REG	Station closed end of 2011					12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12					X
Rolim de Moura	RLM	Enio Bueno Pereira (eniobp@cptec.inpe.br)																	2									X
Sapporo	SAP	Masao Omori (irc-jma@met.kishou.go.jp)																				9	12	12	12	12	6	X
Sede Boger	SBO	Nurit Agam (agam@bgu.ac.il)													12	12	12	12	12	12	12	12	12	9				X
São Martinho da Serra	SMS	Enio Bueno Pereira (eniobp@cptec.inpe.br)																9	12	7	12	12	12	12	12	12	1	X
Sonnblick	SON	Marc Olefs (marc.olefs@zamg.ac.at)																							12	12	5	X
Solar Village	SOV	Naif Al-Abbadi (nabbadi@kacst.edu.sa)								3	12	12	12	12														X
South Pole	SPO	Charles Long (chuck.long@noaa.gov)		12	12	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	7	X
Sioux Falls	SXF	John Augustine (John.A.Augustine@noaa.gov)													7	12	12	12	12	12	6							X
Syowa	SYO	Masato Fukuda (antarctic@met.kishou.go.jp)				12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	1		X
Tamanrasset	TAM	Mohamed Mimouni (m_mimouni_dz@yahoo.fr)										10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	6	X
Tateno	TAT	Osamu Ijima (ijima@met.kishou.go.jp)						11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	6	X
Tiksi	TIK	Vasilii Kustov (kustov@aari.ru)																				7	12	12	8			X
Toravere	TOR	Ain Kallis (kallis@aai.ee)									12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	8	X
Xianghe	XIA	Xiangao Xia (xxa@mail.iap.ac.cn)																12	12	12	12	12	8	6	9	12	5	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	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	2013	2014	2015	All

[BSRN homepage] - [Staff | Stations | Parameter | Methods] - [**LR0100** | LR0300 | LR0500 | LR1000 | LR1100 | LR1200 | LR1300 | LR3010 | LR3030 | LR3300 | All | latest datasets]

Click on a number shows a list of all datasets for selected year and station.

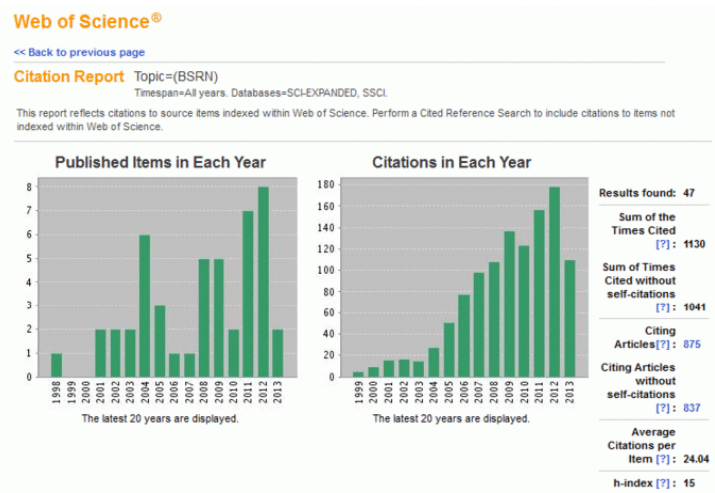
Download this table as plain text

Contact

Data archive status from WRMC website operated by AWI (http://bsrn.awi.de/)

About 8400 station-month (700 years) in the archive

60 stations providing data



Citation to "BSRN" in Web of Science

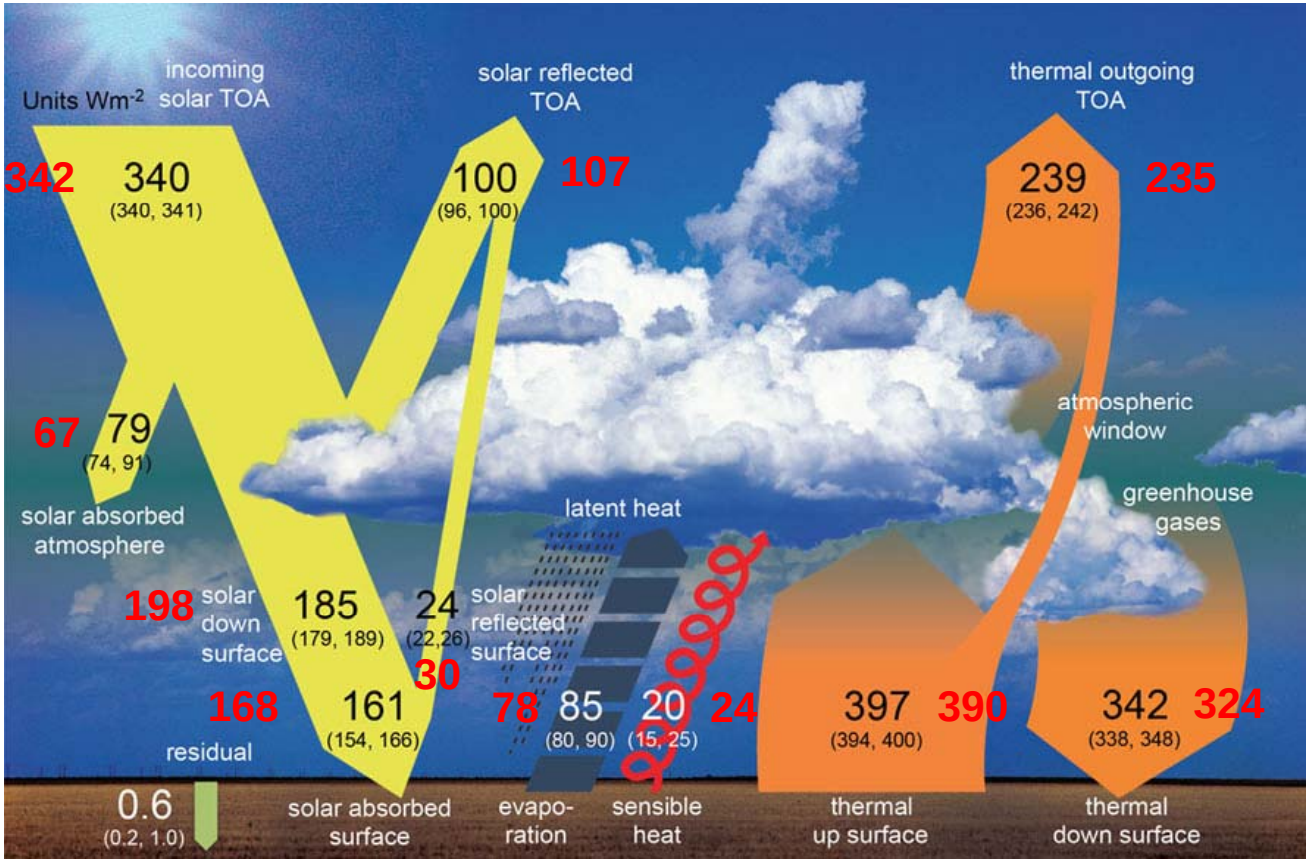
Citations to BSRN in Web of Science has been strongly increasing with time

3. Use of the data for climate research

Estimate and monitor of radiative energy balance

1） Global mean energy balance

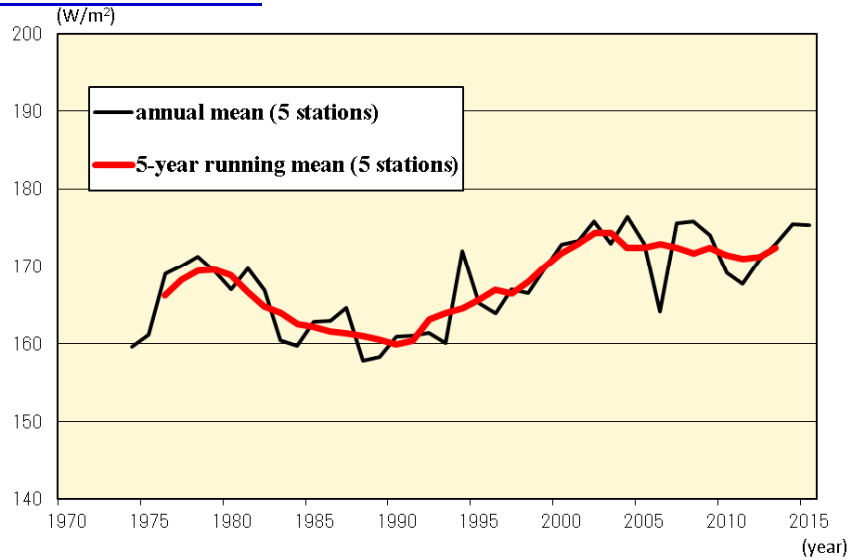
Update the value of each elements → IPCC AR5



Schematic diagram of the global mean energy balance of the Earth at the beginning of the 21st century.（Wild et al. 2012 / IPCC 2013）

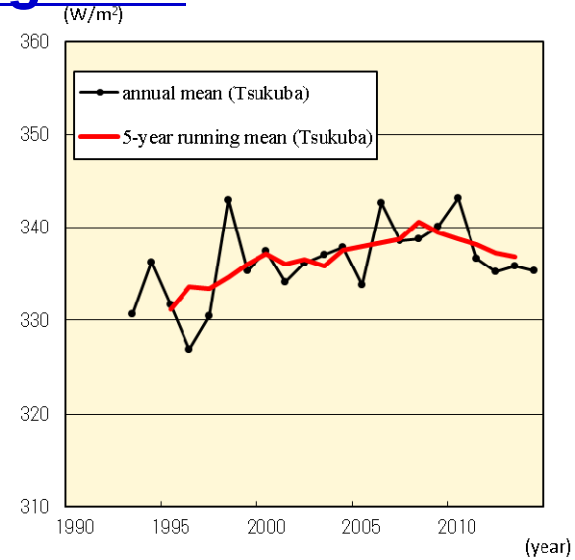
2) Long-term variation of surface radiation

Shortwave

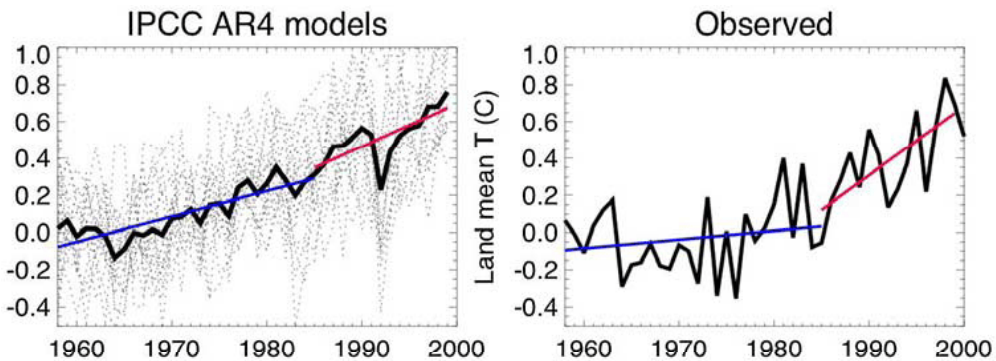


Long-term variations of global solar radiation (average of 5 Japanese BSRN stations)

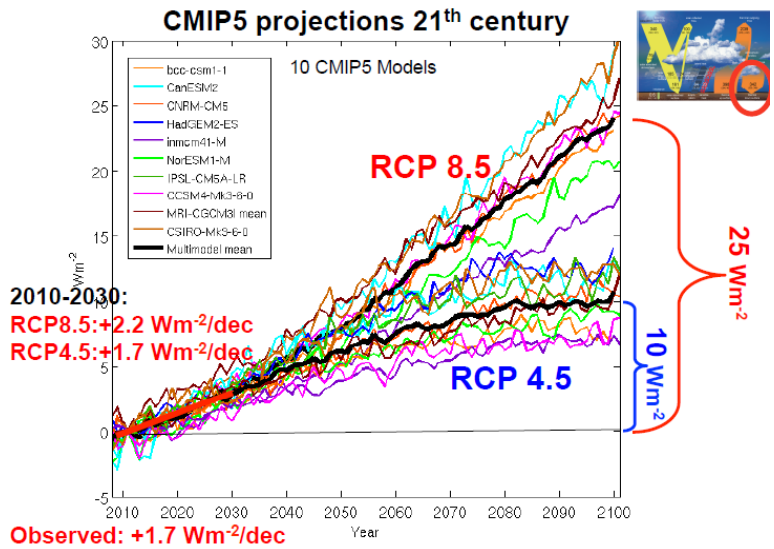
Longwave



Long-term variations of downward longwave radiation （BSRN Tateno station）



Deviation of surf. air temp. from 20th century average (Land) (Wild, 2009)

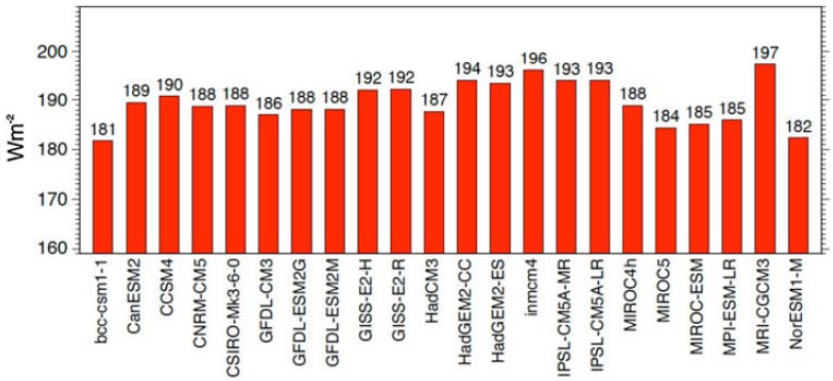


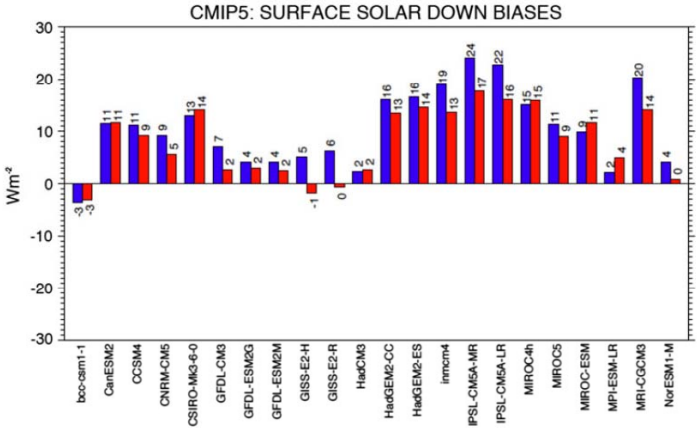
CMIP5 projections 21st century (Wild et al. 2014)

Validation of climate models

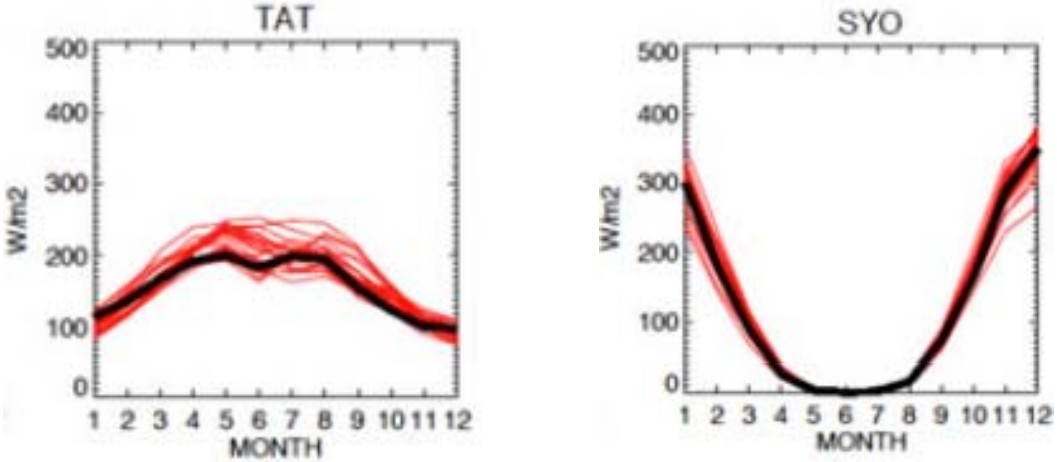
1) Downward Shortwave

Almost all climate models overestimate global solar radiation.





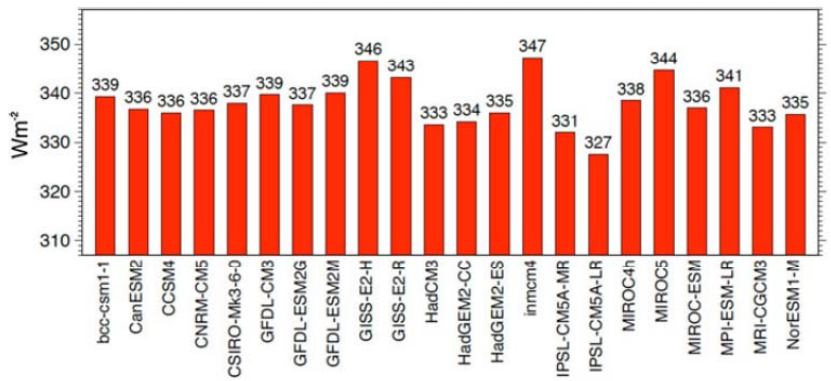
Climate model calculations (left) and comparisons between climate model calculations and observations（right）(Wild et al. 2013）

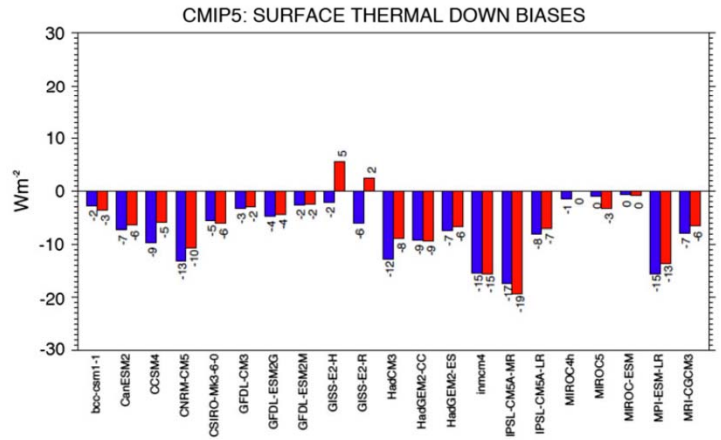


Mean annual cycle of observation and CMIP5 calculations at BSRN sites（Wild et al. 2013）

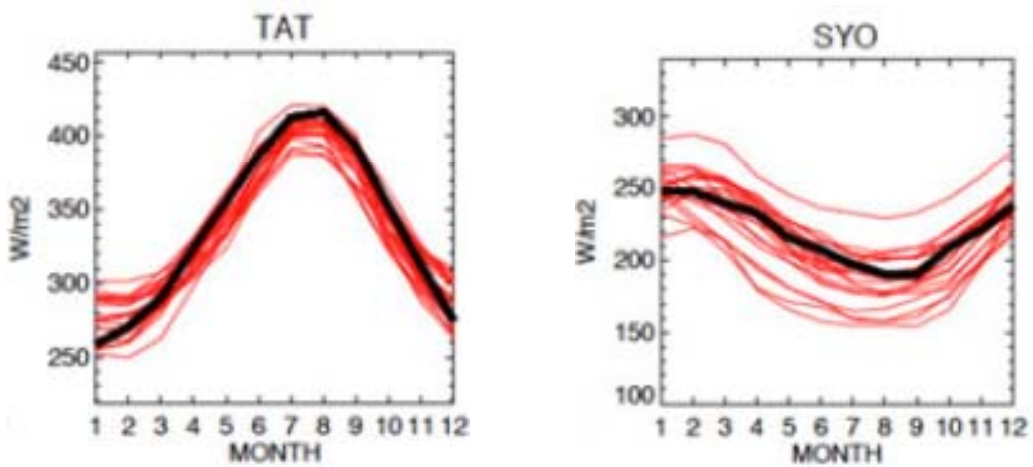
2) Downward Longwave

Almost all climate models underestimate downward longwave radiation.





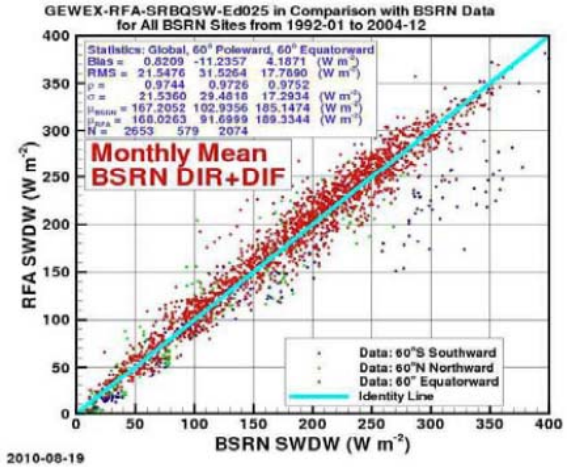
Climate model calculations (left) and comparisons between climate model calculations and observations（right）(Wild et al. 2013）

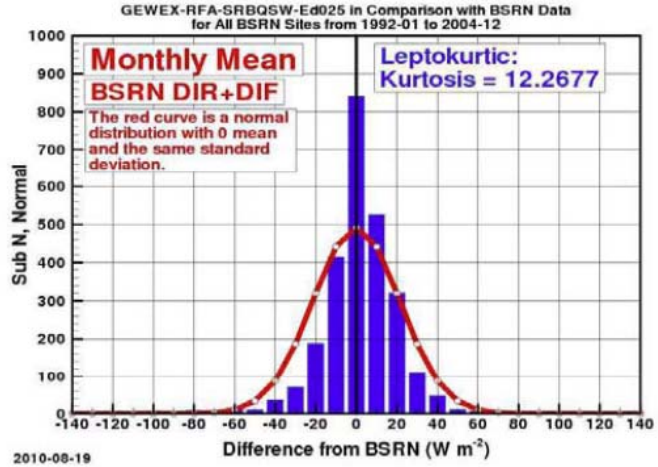


Mean annual cycle of observation and CMIP5 calculations at BSRN sites（Wild et al. 2013）

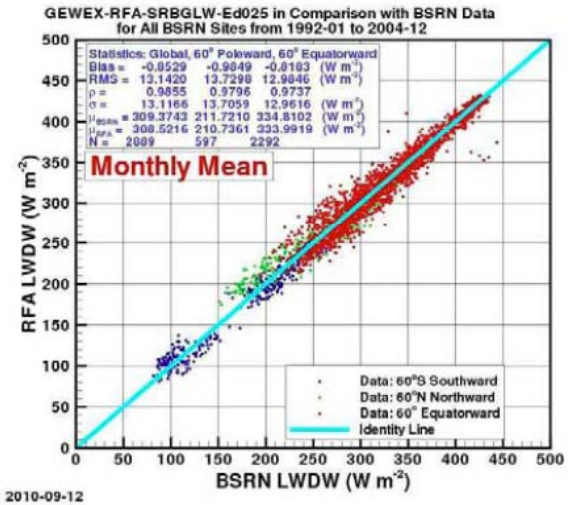
Validation of satellite SRB data sets

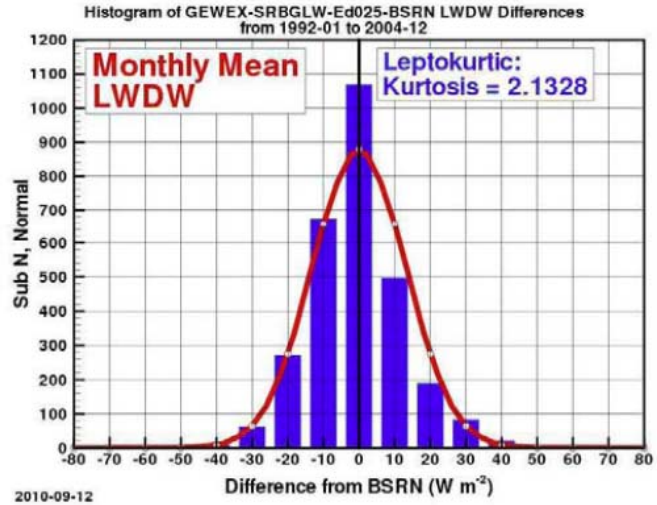
Shortwave





Longwave





Comparisons between satellite SRB data sets and BSRN data (GEWEX 2012)
Shortwave: GEWEX SRBQSW-Ed025, Longwave: GEWEX-SRBGLW

4. Summary

- Surface radiation budget is a fundamental component for monitoring climate change and designated as one of the ECVs in GCOS.
- The data are effectively used for climate research.
- Recent progress of surface radiation budget observation was reported in "Status of the Global Observing System for Climate" last year;
  - The total data amount archived at data centres has significantly increased.
  - Regular receipt of data has remained about the same as before.
  - Data scarce areas also remain in some regions.

We should make sustained effort to enhance surface radiation budget observation.

Thank you

for your attention!