GCOS Reference Upper-Air Network: Operating Strategies for Synergy with the Baseline Surface Radiation Network (BSRN)

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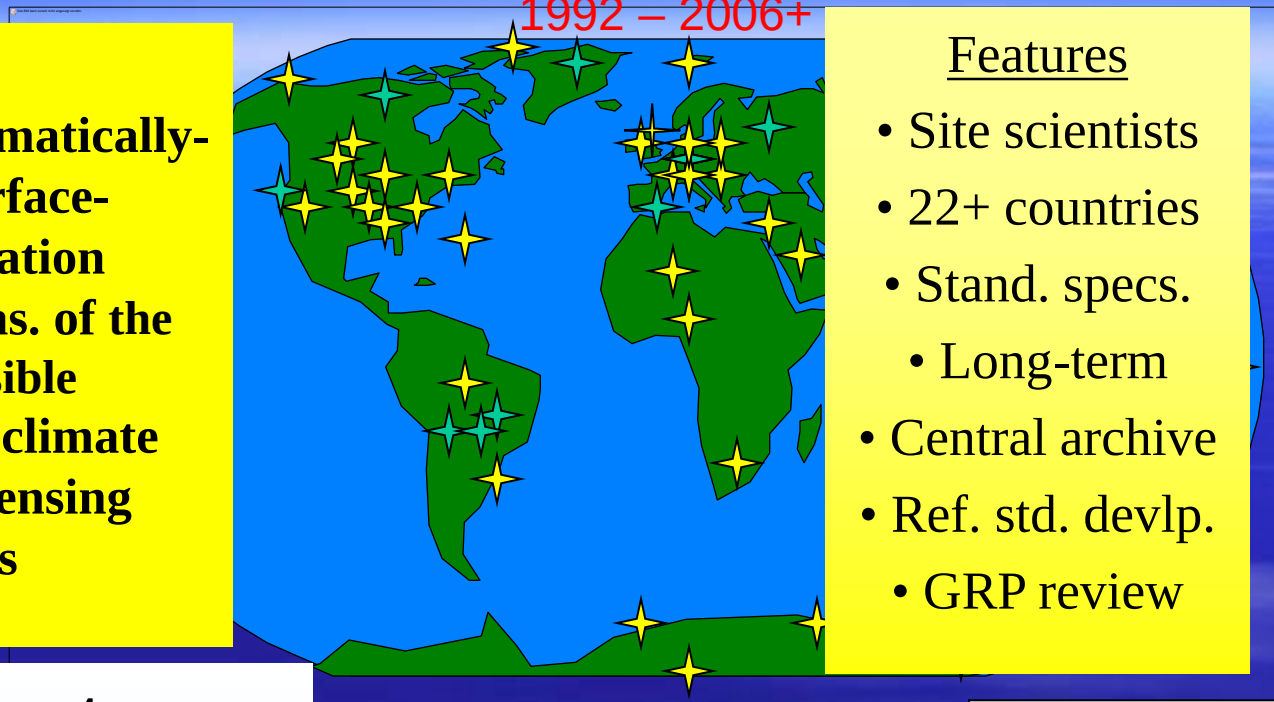
GCOS Ref U/A W/S
Seattle, Wash
22-24 May 2006

Baseline Surface Radiation Network

1992 – 2006+

Goal:

Acquire climatically-diverse, surface-based, radiation budget meas. of the highest possible quality for climate & remote sensing applications



Features

- Site scientists
- 22+ countries
- Stand. specs.
- Long-term
- Central archive
- Ref. std. devlp.
- GRP review

IOC

WMO

Measurements

- Direct & diffuse solar*
- Downward infrared *
- Upwelling irrad.
- PAR & UV
- Aerosol optical depth
- Surface meteorology*
- Upper air met.
- Sky imagery, cloud height

* all sites

Archiving Provisional

Regions

Oceanic Tropics Desert
Polar Coastal Rain forest
Agricultural Prairie

Data Applications

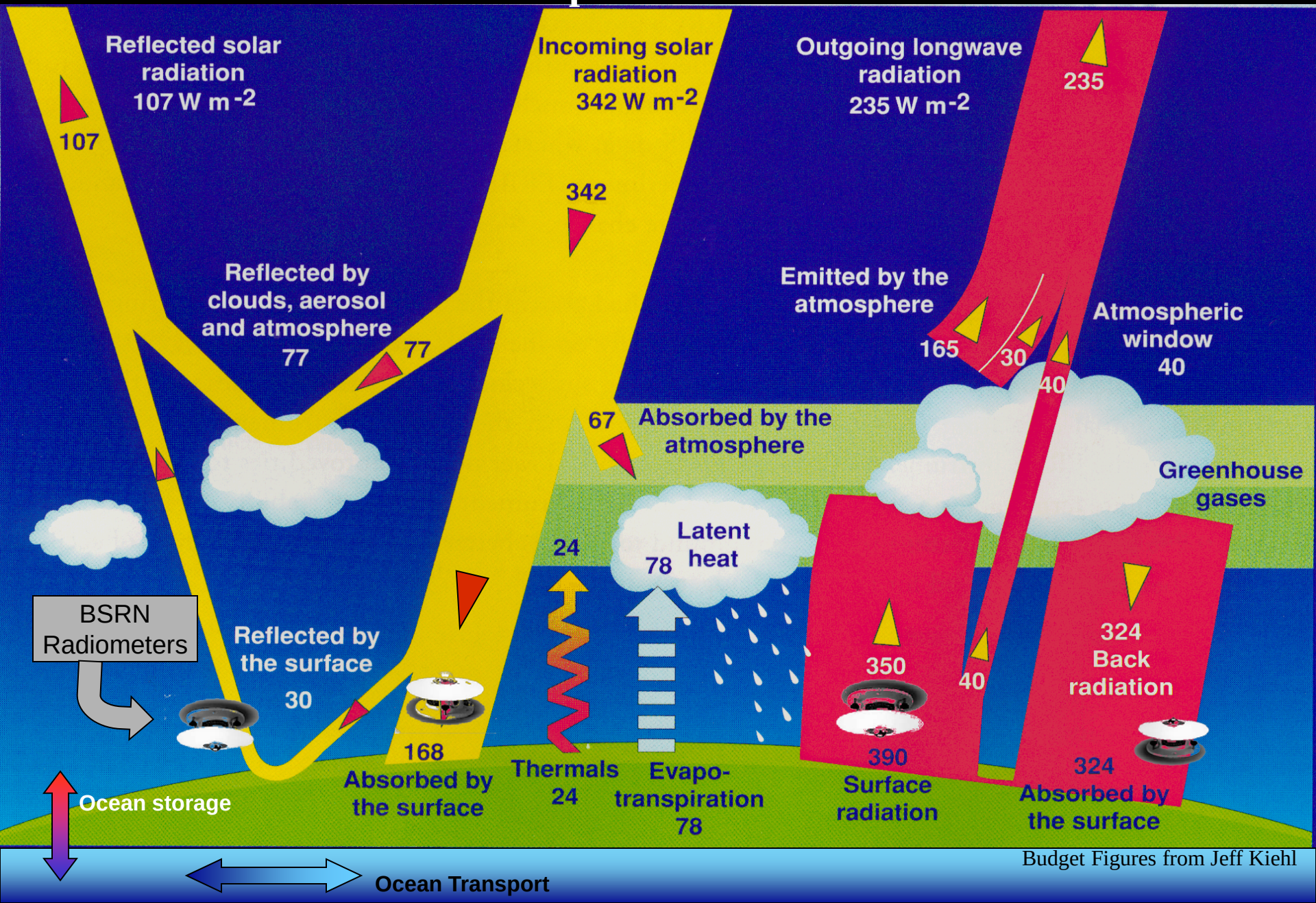
- GCM comparisons
- Satellite prod. validation
- Regional climatologies
- Radiation budget apps.
- Radiation model testing

Many national and international projects

E.G. Dutton, 14APR06

Earth's Energy Budget and BSRN Measurement of Atmospheric Radiation

Values are long-term global mean



Budget Figures from Jeff Kiehl

Variable	Net Radiation	Incoming Shortwave Radiation	Outgoing Shortwave Radiation
Priority (1-4)	1	2	2
Measurement Range	0-1500 W/m2 -300 to 1500	0-2000 W/m2[1]	0-1365 W/m2
Vertical Range	Surface	Surface	Surface
Precision	5 W/m2[1]	3 W/m2[2]	2 W/m2[1]
Accuracy	5 W/m2[1]	5 W/m2[2]	3%[1]
Long-Term Stability	0.1 W/m2	0.1 W/m2	0.1 W/m2
Comments	[1]Accuracy and precision units from BSRN.	[1]Incorporates cloud reflection effects. [2]Accuracy and precision units from BSRN.	[1]Accuracy and precision units from BSRN.

From 1st GCOS U/A W/S report
Requirements for Ref. network

BSRN deliverables

Variable	Incoming Longwave Radiation	Outgoing Longwave Radiation
Priority (1-4)	2	2
Measurement Range	0-900 W/m2 50 -700	0-900 W/m2 50 - 900
Vertical Range	Surface	Surface
Vertical Resolution	N/A	N/A
Precision	1 W/m2[1]	1 W/m2[1]
Accuracy	3 W/m2[1]	3 W/m2[1]
Long-Term Stability	0.1 W/m2	0.1 W/m2
Comments	[1]Accuracy and precision units from BSRN.	[1]Accuracy and precision units from BSRN.

Variable	Aerosol Optical Depth
Priority (1-4)	2
Measurement Range	0.005 - 5
Vertical Range	Total column
Vertical Resolution	N/A
Precision	0.005
Accuracy	0.005
Long-Term Stability	0.005
Comments	Spectral measurements

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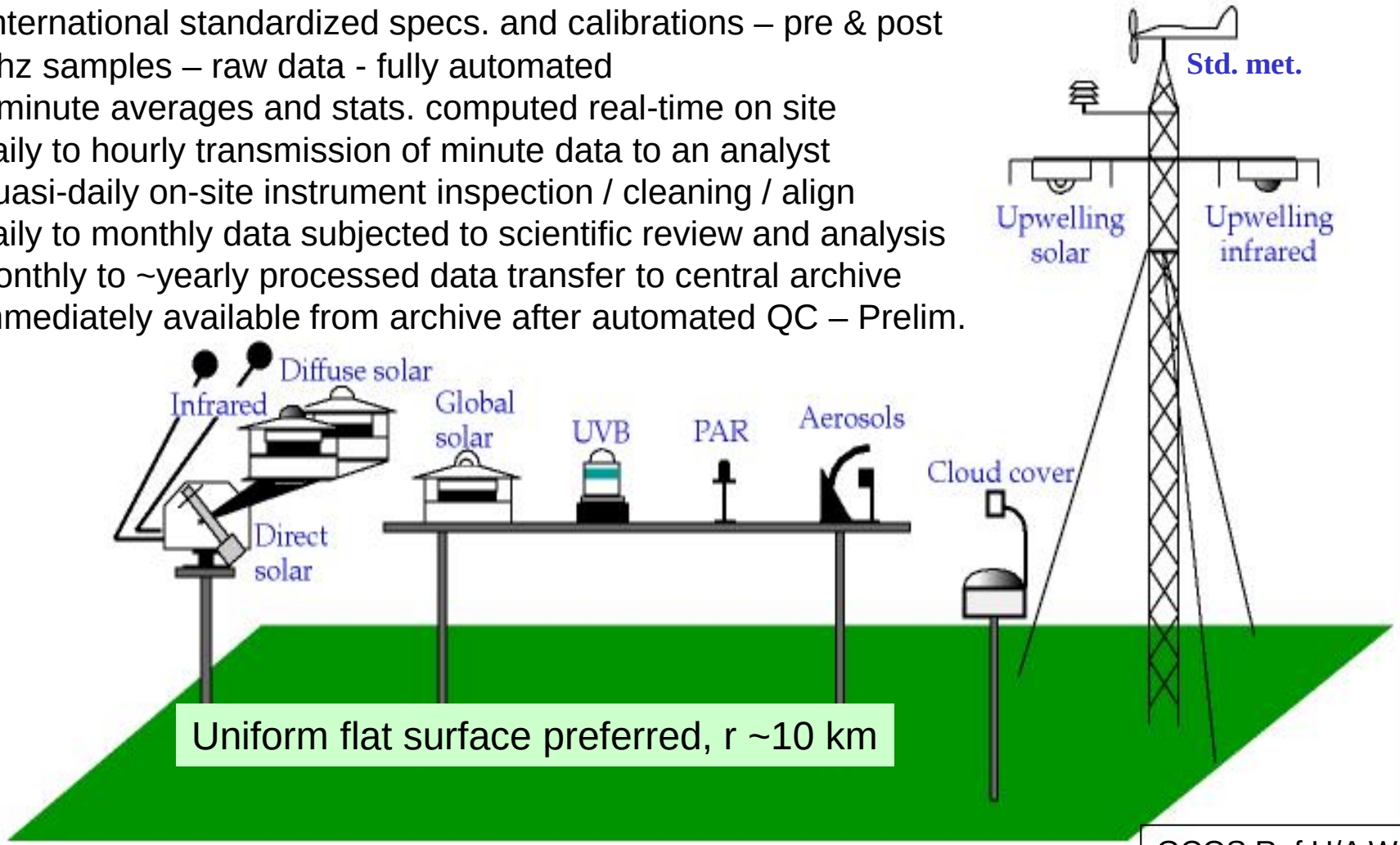
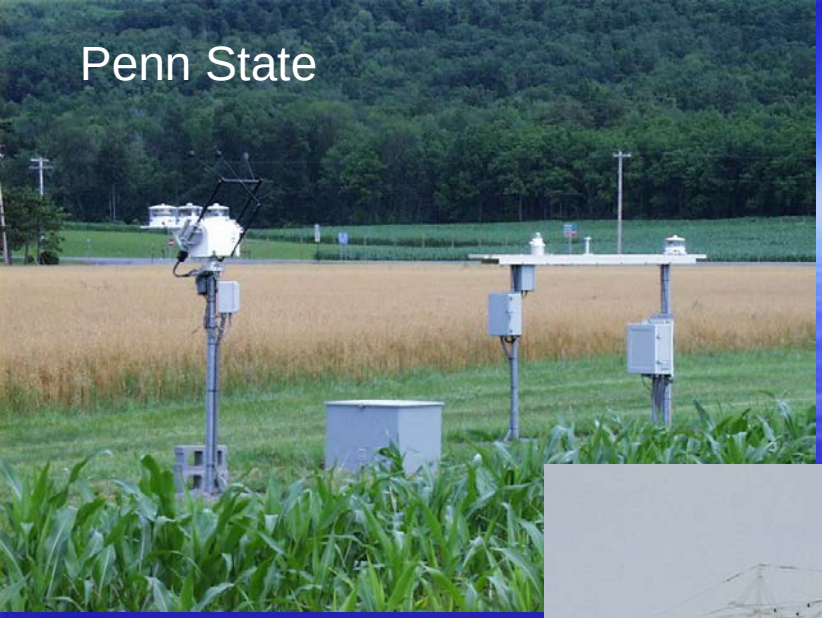
Generic BSRN Station
Instruments, Variables and Nominal Mode of Ops

- International standardized specs. and calibrations – pre & post
- 1-hz samples – raw data - fully automated
- 1-minute averages and stats. computed real-time on site
- Daily to hourly transmission of minute data to an analyst
- Quasi-daily on-site instrument inspection / cleaning / align
- Daily to monthly data subjected to scientific review and analysis
- Monthly to ~yearly processed data transfer to central archive
- Immediately available from archive after automated QC – Prelim.



Compliments of John Augustine, NOAA

Penn State



Marshal Is

Alert, Canada

Desert Rock, NEV

Ft Peck MT.

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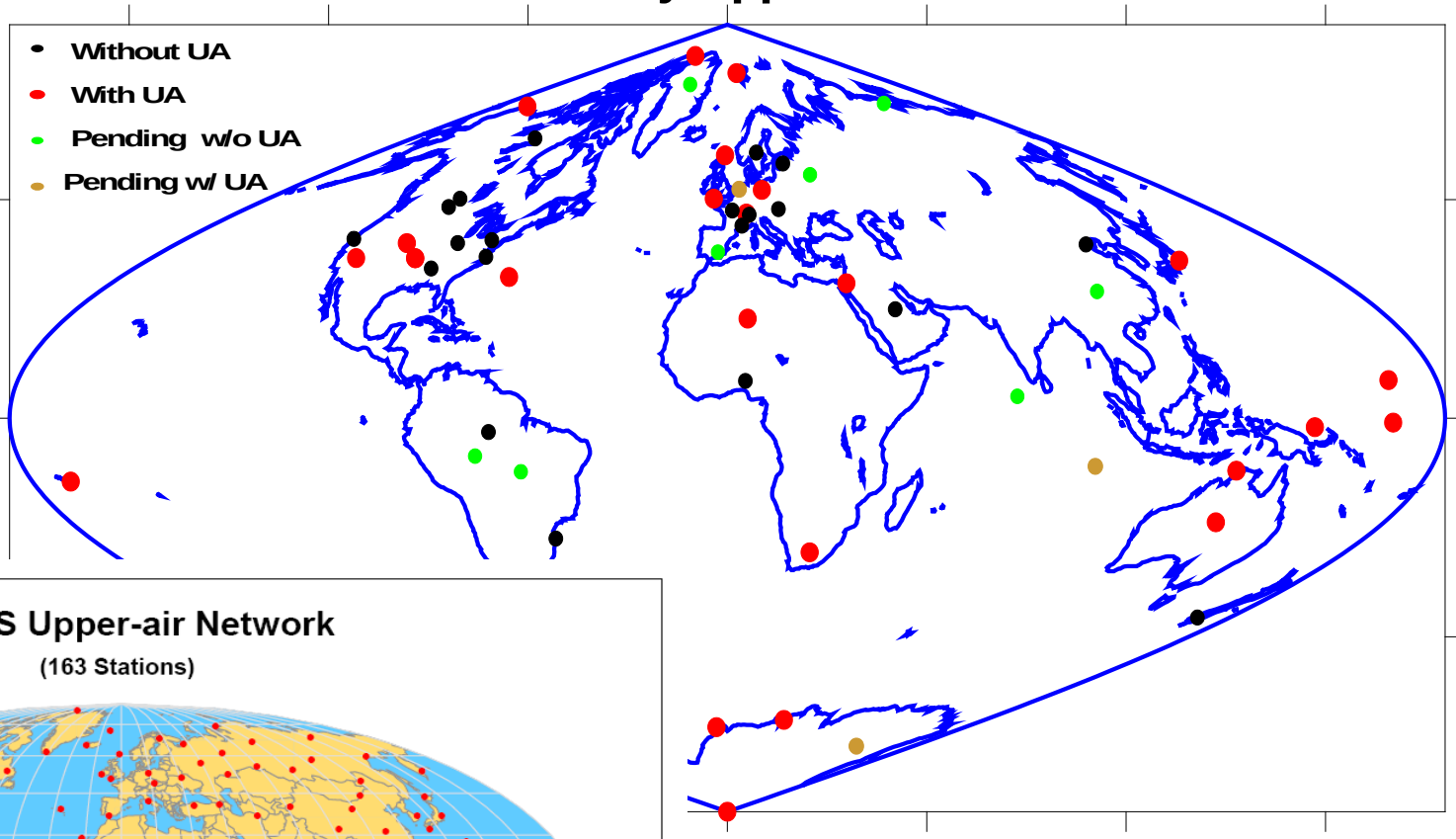
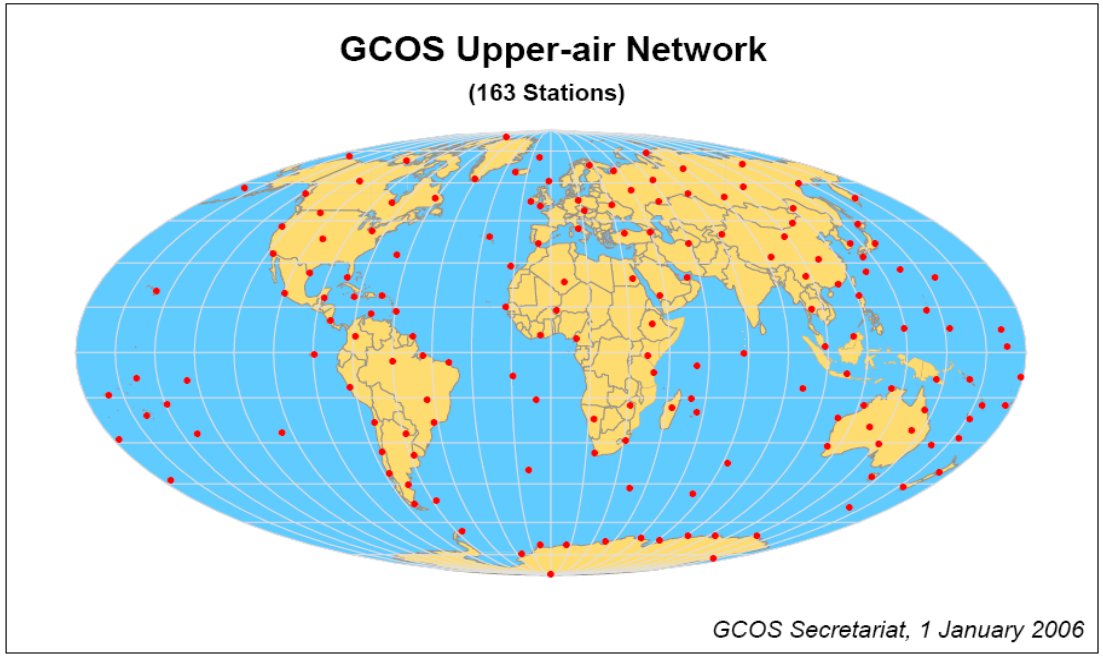
International Baseline Surface Radiation Network (BSRN) with and without nearby Upper Air launch sites





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Existing Collocated GUAN & BSRN Sites

- Tamanrasset, Algeria
- Tateno, Japan
- Bermuda
- Barrow, Alaska
- Darwin, Aus.
- Cocos Is, Aus.*
- American Samoa
- Lindenberg, Germany
- Lerwick, UK
- Camborne , UK
- von Neumayer, Antarc. (Germany)
- Syowa, Antarc. (Japan)
- Amundsen-Scott, Antarc. (US)

* Candidate BSRN site

Existing Collocated Non-GUAN-U/A & BSRN Sites

- Kwajalein, M.I.
- Dome C, Antarc.*
- Desert Rock, Nev
- Ny Ålesund, Spitsberg
- Sede Boqer, Israel
- De Aar, S. Africa
- Alice Springs, Aus.
- Denver, Colo.
- American Samoa*
- Nauru (ARM)
- Manus (ARM)
- SGP (ARM)

Strategic Considerations for Synergetic Operations – BSRN and RefUAN

- Both BSRN and Ref U/A Network are GCOS networks
- Both are intended to be climatological samples rather than spatially unbiased or complete
- Some BSRN applications need high quality UA data
- GCOS Ref. Net. requirements for BSRN-type data
- Combined operations at remote field sites can be more efficient and economical
- However, there are some differences in siting & operating requirements between the two projects
- Siting and local resources (scientific & logistic) drive BSRN site selection
- Ideal BSRN sites are rare
- There are existing collocated GUAN and BSRN sites.

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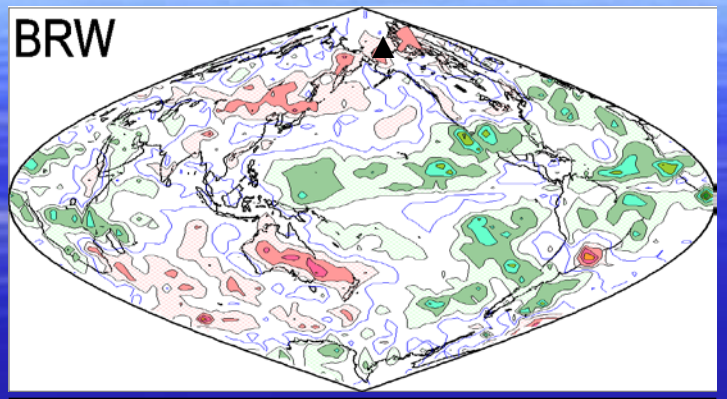
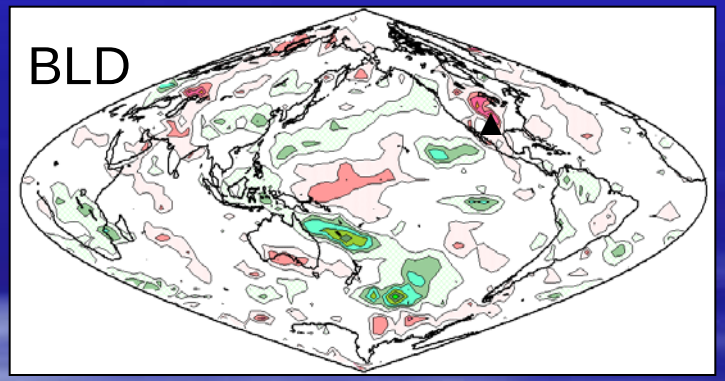
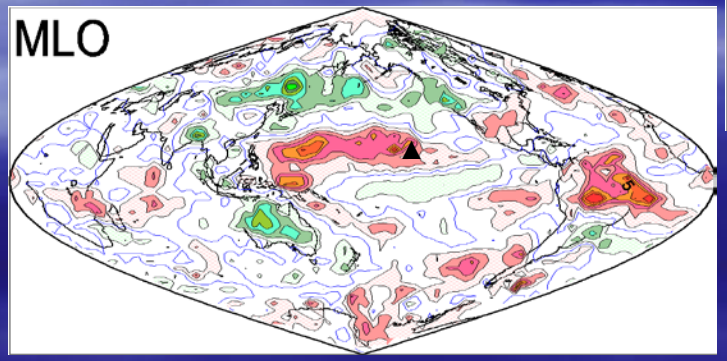
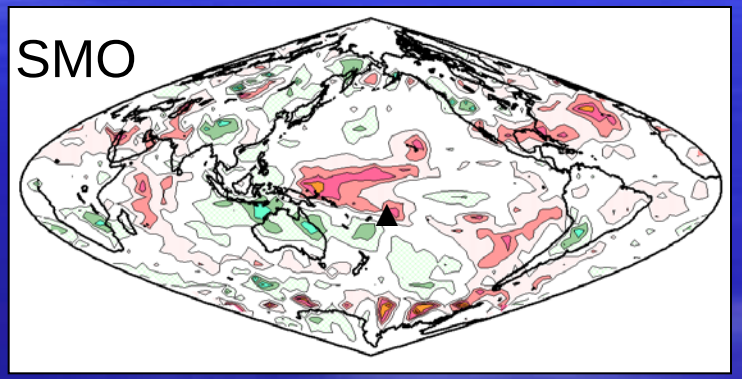
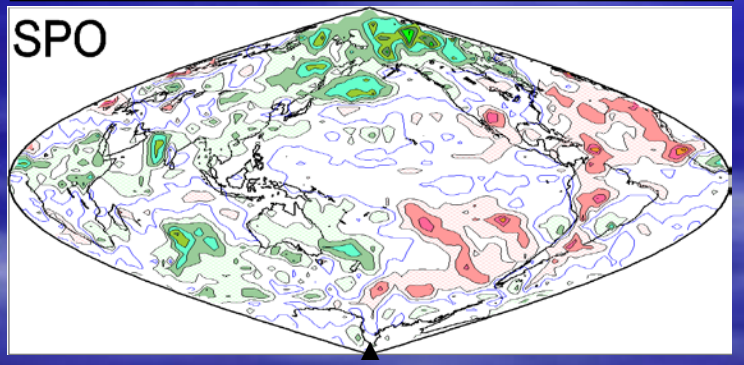
NOAA station data x-correlated with ISCCP-FD
annual averages, total surface solar 1984 - 2000

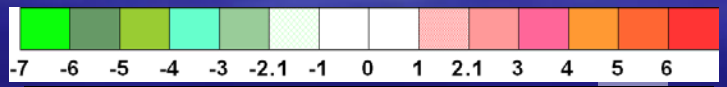






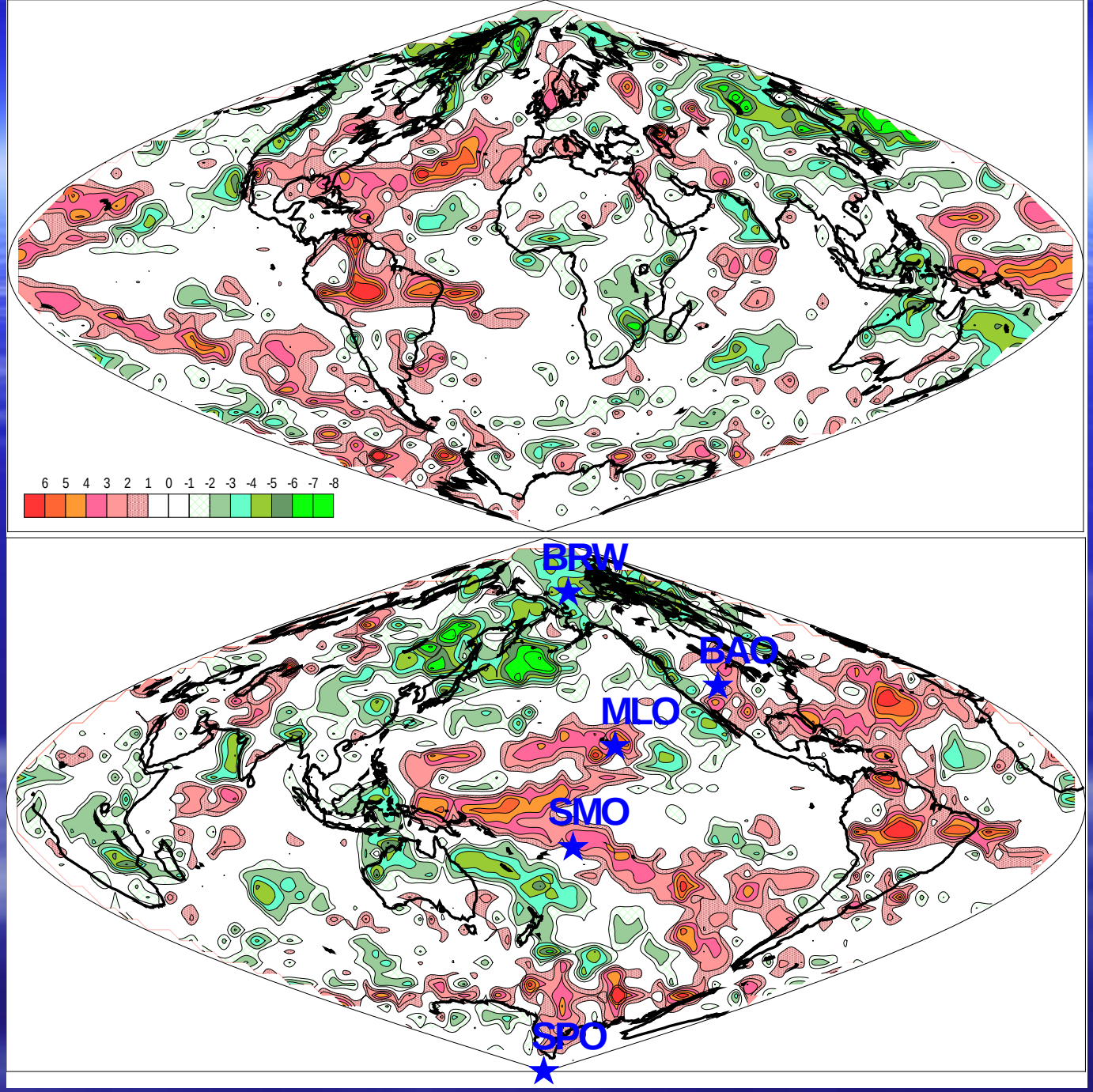






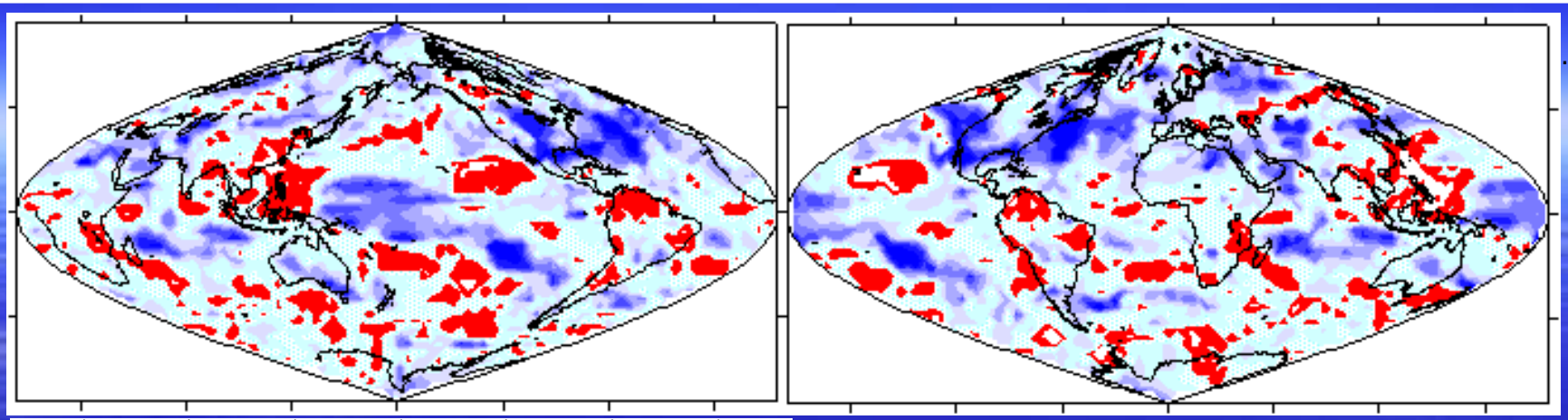
Units are X-Corr. Coef. / S. E.

E. Dutton et al., JGR 2006



E. Dutton et al., JGR 2006

Spatial representativeness of current 35 BSRN stations using 17yr ISCCP proxy



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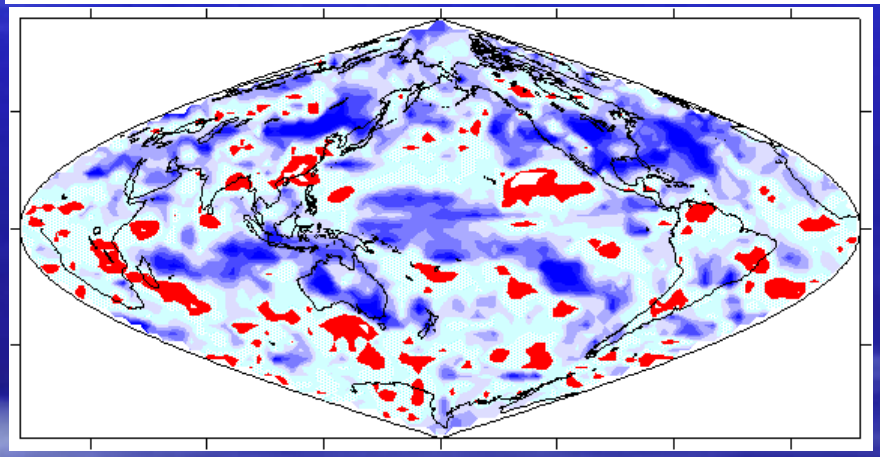
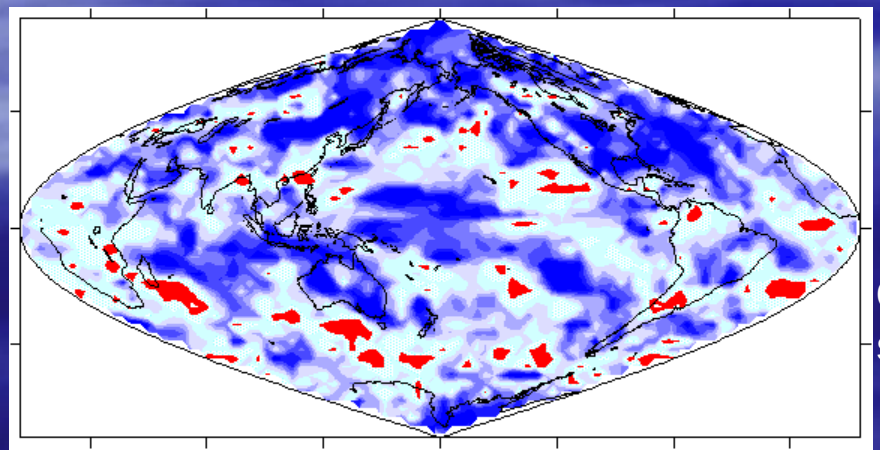


No. of sites represented at each grid point

11 10 9 8 7 6 5 4 3 2 1 0

Using annual averages and xcor > 0.4 & xcor/se > 2.1

Current + 8 pending stations



Current + 8 pending, + 11 candidate stations

Relationship Between Surface Radiation and Atmospheric Profile Variables

$$IR\ radiation = f\,(T(z),\ q(z),\ O_3,\ lw(z),\ p(z),\ CO_{2,\ldots})$$

$$Solar\ radiation = f\,(pw,\ lw(z),\ p_s,\ \tau_a(\lambda, z), T(z),\ p(z),\ldots)$$

where: IR and $Solar$ are both measured and modeled

$f(\,)$ is a model

$T, q, p, pw, O3, CO2, lw, \tau, \ldots$ are from vertical profiles

Types of radiative transfer models and examples:

Line-by-line (LBLRTM with HiTran…)

Narrow-band (Modtran…)

Wide-band (Fu-Liou…)

GCM parameterizations (Lacis and Hansen, RRTM…)

Broadband parametric (Bird, and many others)

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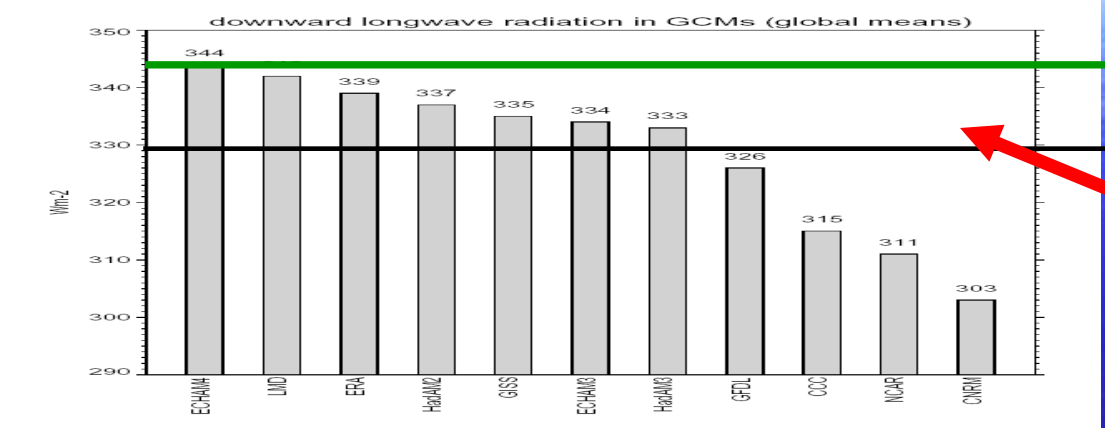
Over Last 6 Years, Climate Models Approach BSRN Downwelling IR Results

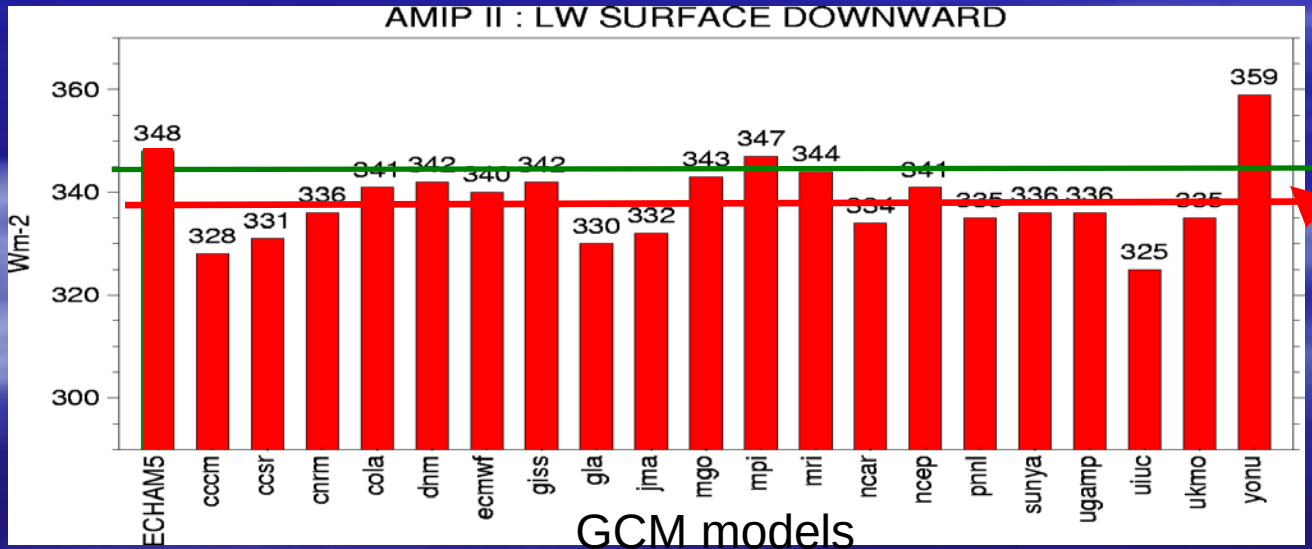


BSRN (344 W m^{-2})

Model Avg. (329)

Circa 1999

GCM models (global means)



BSRN (344)

Model Avg. (337)

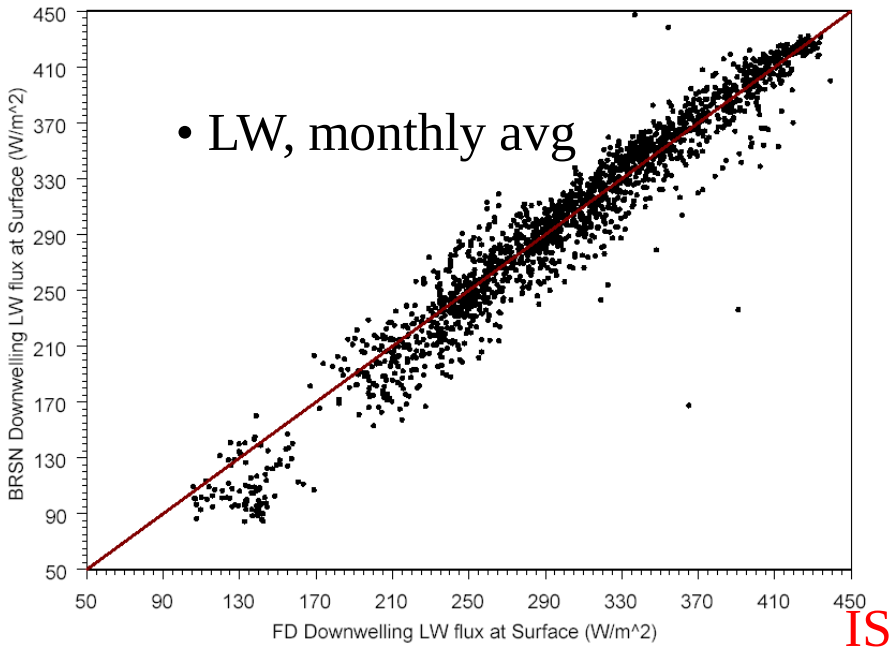
Circa 2005

GCM models
(global means)

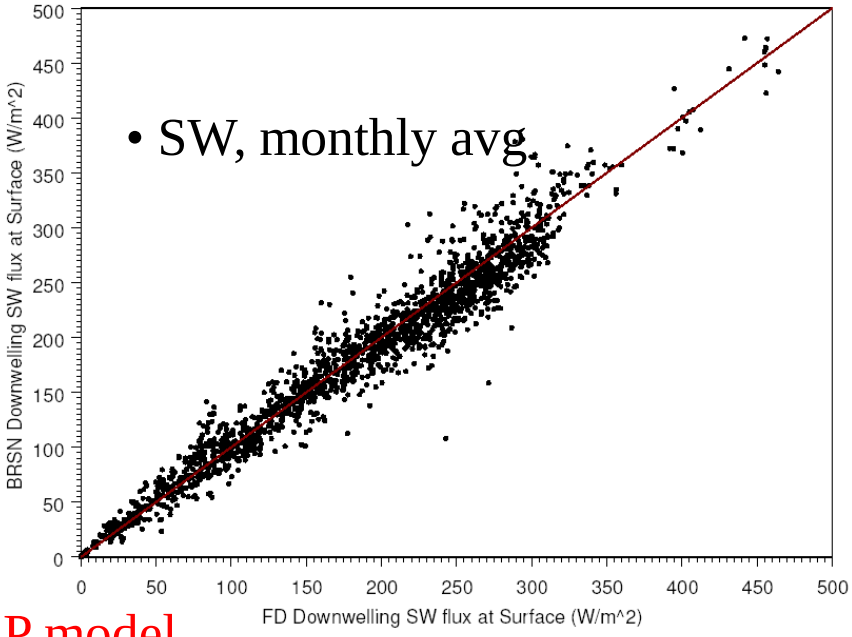
M. Wild 2001& 2005

BSRN Comparison to a New Satellite Product

Y. Zhang, W. B. Rossow, A. A. Lacis, V. Oinas, M M. Mishchenko, accepted JGR, 2004



BSRN



ISCCP model

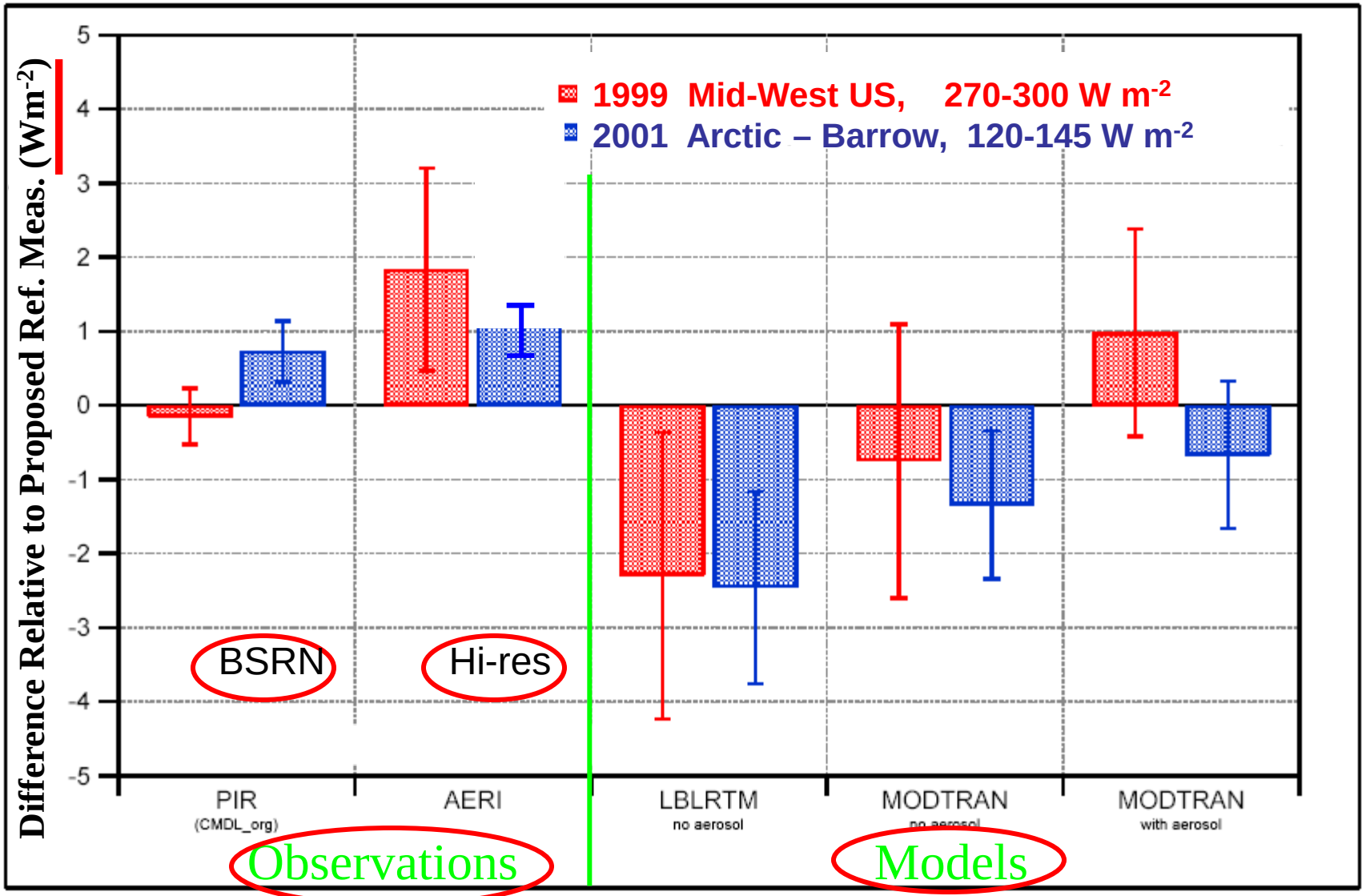
7a. Surface downwelling SW and LW fluxes for **all** ISCCP-FD and BSRN data.

Quantity	FD	BRSN	mean difference	Stdv	corr coefficient	Slope	intercept	Norm dev	sample #
$S\downarrow_s$	168.20	166.19	2.017	18.491	0.9825	0.96	3.90	13.07	1970
$L\downarrow_s$	302.23	300.01	2.219	19.042	0.9706	1.05	-17.40	12.89	1831

BSRN stations are a part of every ARM field facility. Those facilities have provided valuable demonstrations of what can be accomplished with the coexistence of high-quality UA profile data and BSRN-type surface data.

IR Radiometer Comparison to Models using UA obs

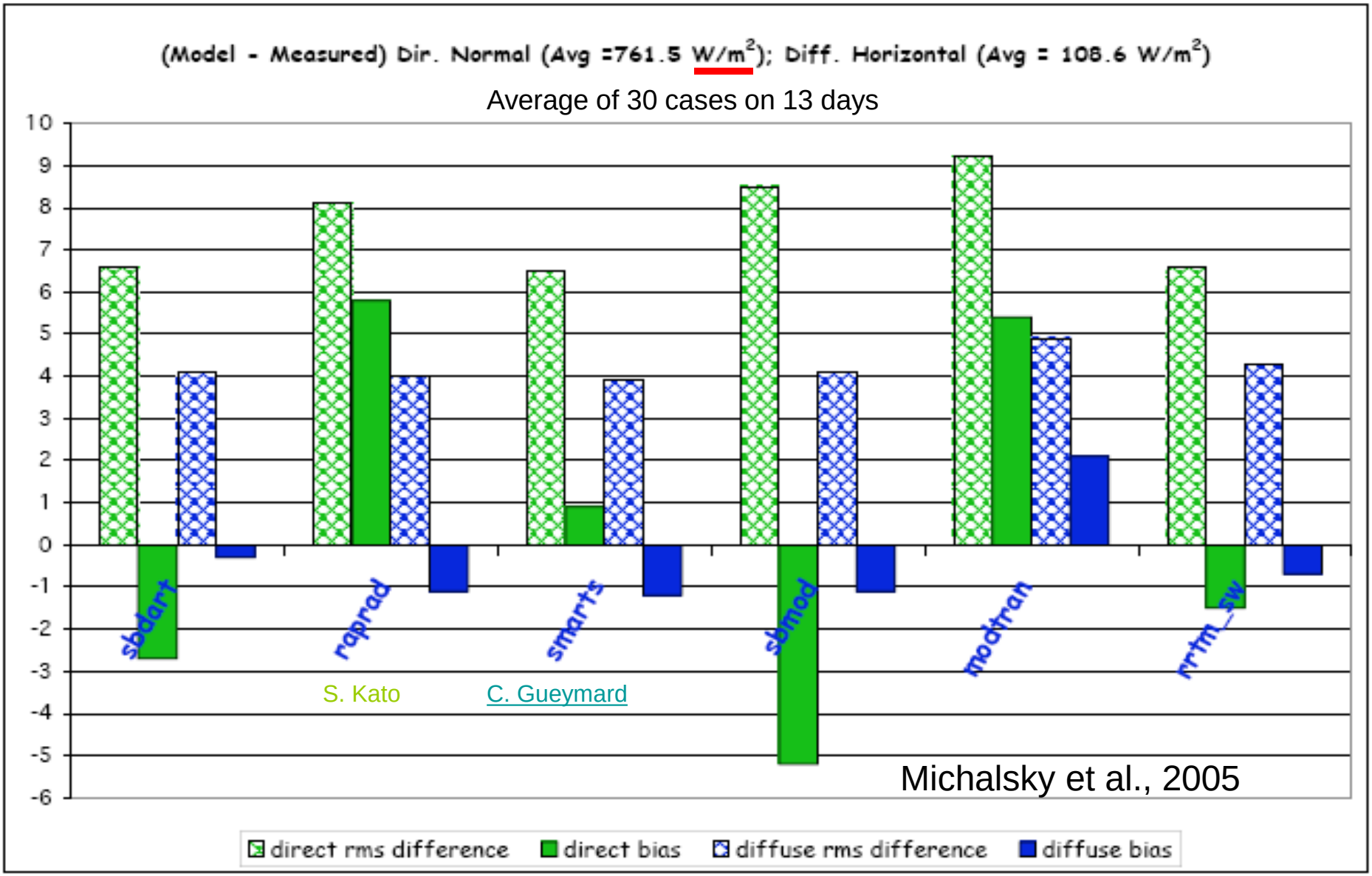
Total downwelling infrared irradiance – "Greenhouse" radiation



BSRN-ARM/NOAA

Philipona et al., 2001/Marty et al., 2003

Clear-sky surface radiative closure, diffuse and direct



Summary & Conclusions

- BSRN is providing cutting-edge high-quality surface irradiance observations to the atmospheric community and can contribute to a GCOS Reference Network
- There is an obvious scientific & operational synergy between BSRN and RefUAN
- Internationally there are currently 13 collocated BSRN – GUAN sites and 12 more BSRN sites with UA obs. Siting requirements would preclude some GUAN sites from being BSRN sites, although adequate proximity might be possible for RefUAN – more study needed.
- BSRN sites require more scientific oversight as compared to GUAN and probably RefUAN, although necessary on-site technical expertise would be similar

The End