# The World Infrared Standard Group (WISG) of longwave radiometers: How can/should updated calibrations be transferred to BSRN records?

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# World Infra-Red Standard Group (WISG)

- **PMOD/WRC pyrgeo calibrations based on WISG**

  Eppley PIR — 31463 (>2001), 31464 (>09.2003)

  K&Z CG4 — FT004(>09.2003), 010535 (>09.2003)

- **WISG calibration based on …**

  PIR 31463, CG4 FT004 calibs based on IPASRC-I, -II (1999, 2001)

  Agreement of pyrgeos, ASR, AERI, RTMs was ±2 $W.m^{-2}$.

- **WISG**

  Internal stability ±1 $W.m^{-2}$ since Jan. 2004

  Uncertainty ±2.5 $W.m^{-2}$

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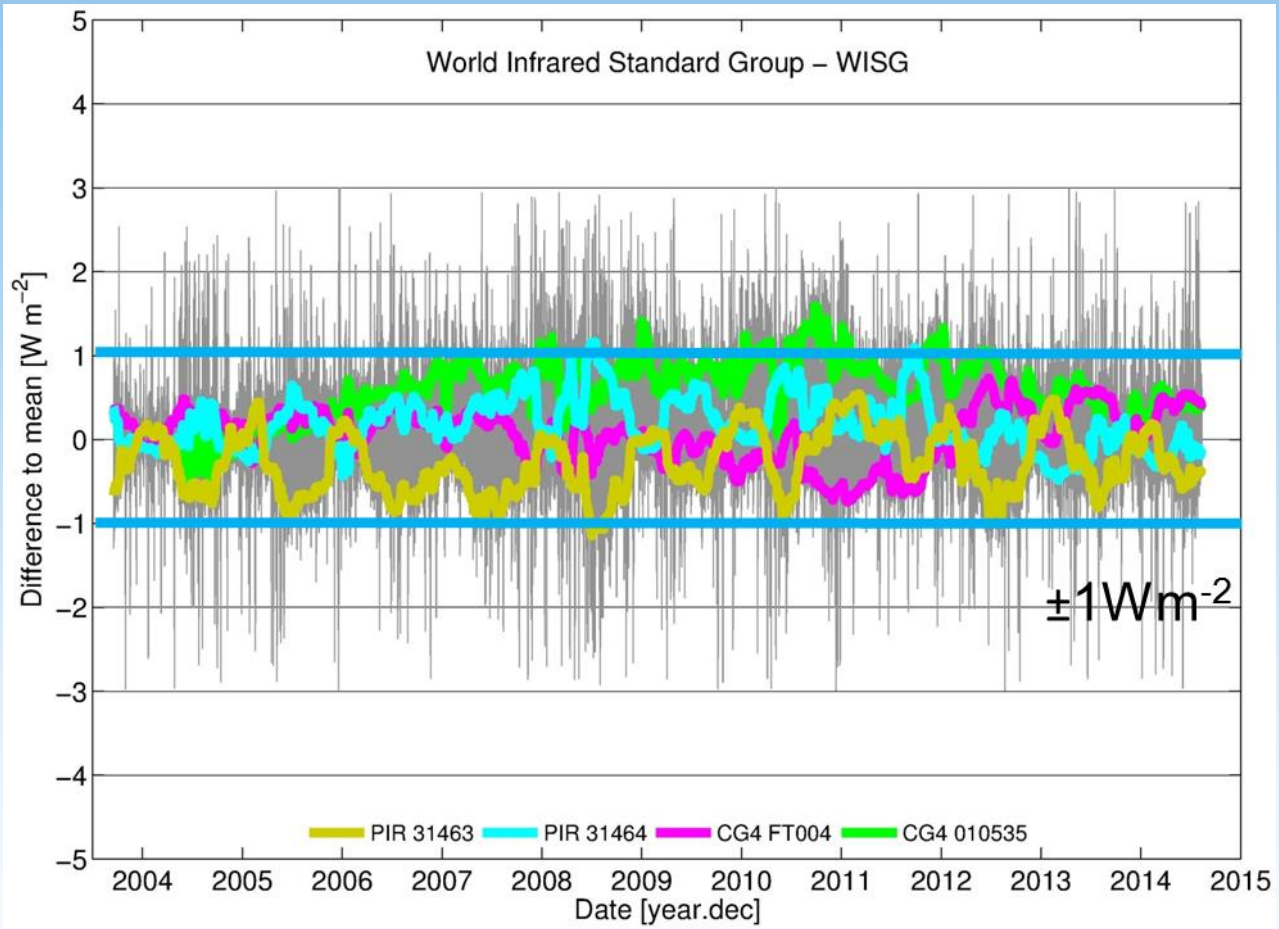
# World Infra-Red Standard Group (WISG)




Night average differences of DLR between the WISG pyrgeometers relative to their average. The thick lines represent a monthly running average.

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# World Infra-Red Standard Group (WISG)

- **WISG is complemented by 2 pyrgeos without IWV dependence:**
  - Since Feb. 2008, CG4 030669 (FT006 body, 030669 dome), unofficial "$WISG_5$".
  - Since Nov. 2011, CGR4 110390 (no solar-blind filter), unofficial "$WISG_6$".

- **Observations in *Gröbner et al*. (JGR, 2015), suggest that the WISG may eventually need to be re-calibrated against other transfer standards (IRIS/ACP/others …) due to:**
  - IWV dependence of Eppley PIR and pre-2003 K&Z CG4 when IWV<~10 mm.
  - A scale offset (up to -5 $W.m^{-2}$) of the WISG due to its calibration dating back to IPASRC-I and II.

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**How will these aspects potentially affect BSRN long-wave irradiance time-series?**

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# BSRN Pyrgeometer Statistics (Dec. 2015)

## BSRN PYRGEOMETER INSTRUMENT TYPES

| | Eppley PIR | K&Z CG4 | K&Z CGR4 | Total |
|---|---|---|---|---|
| N | 188 | 15 | 20 | 223 |
| % (of total) | 84.3 | 6.7 | 9.0 | 100 |

## BSRN PYRGEOS WITH IWV DEPENDENCY

| | Eppley PIR | K&Z CG(R)4 | Total |
|---|---|---|---|
| N | 188 | 35 | 223 |
| N (IWV depend)* | 188 | 10 | 198 |
| % | 100 | 29 | 89 |

* Assuming all PIR and pre-2003 CG4(<SN 030646) are affected.

"Supported" by numerous 1-season calibs wrt WISG.

## BSRN PYRGEOS WITH DIRECT TRACEABILITY TO WISG (ie CALIBRATED AT PMOD/WRC)

| | Eppley PIR | K&Z CG(R)4 | Total |
|---|---|---|---|
| N | 188 | 35 | 223 |
| N (dir. traceable) | 47 | 11 | 58 |
| % | 25 | 31 | 26 |

Note: Data from PMOD Archive

Note: Percentages are definite and not upper or lower limits

## BSRN PYRGEOS WITH INDIRECT TRACEABILITY TO WISG (ie CALIBRATED VIA A REF. PYRGEO)

| | Eppley PIR Confirmed so far | K&Z CG(R)4 Confirmed so far | Total Confirmed so far |
|---|---|---|---|
| N | 188 | 35 | 223 |
| N (indir. traceable) | 40 | 24 | 64 |
| % | 21 | 69 | 29 |

Note: Percentages are lower limits

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# BSRN Pyrgeometer Statistics (Dec. 2015)

**DIRECT AND INDIRECT TRACEABILITY TO WISG**

| | Eppley PIR | K&Z CG(R)4 | Total |
|---|---|---|---|
| N | 188 | 35 | 223 |
| N (total traceable) | 87 | 35 | 122 |
| % | 46 | 100 | 55 |

**Summary**

- At least 55% BSRN pyrgeos currently have calib directly/indirectly traceable to WISG.
- Hence, max of 45% BSRN pyrgeos have calibrations traceable to BBs and other institutes.
- Users (those asked so far) have confirmed that WISG calibrations were implemented asap.
- Portions of BSRN time-series may still be based on BB calibrations.
- Note: Statistics refer to *N* of pyrgeos and not data-months in BSRN archive.

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# BSRN Pyrgeometer Statistics (Dec. 2015)

**DIRECT AND INDIRECT TRACEABILITY TO WISG**

| | Eppley PIR | K&Z CG(R)4 | Total |
|---|---|---|---|
| N | 188 | 35 | 223 |
| N (total traceable) | 87 | 35 | 122 |
| % | 46 | 100 | 55 |

**The "Big" Picture**

The number of pyrgeos (used for atmos meas) outside BSRN is potentially large:

- Currently 223 pyrgeos in BSRN archive since inauguration in 1992.
- PMOD/WRC has calibration records of ~220 pyrgeos (122 PIR, 98 K&Z) since 1993. Only 58 from BSRN.
- Worldwide number of Eppleys and K&Z currently in use for atmos meas?

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# BSRN Pyrgeometer Statistics (Dec. 2015)

| Station | | preBSRN | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | WISG | | | | | | | | | | | |
| Alert | ALE | | | | | | | | | | | | | | 5 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 3 | | | |
| Alice Springs | ASP | | | | | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 9 | |
| Barrow | BAR | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 2 | | | | | |
| Bermuda | BER | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | | | |
| Billings | BIL | | | 4 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 4 | | | |
| **Bondville** | **BON** | | | | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 6 | | | | | | |
| **Boulder, SURFRAD** | **BOS** | | | | | 5 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 6 | | | | | | |
| Boulder | BOU | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 7 | | | |
| Brasilia | BRB | | | | | | | | | | | | | | | | 8 | 10 | 4 | 12 | 12 | 12 | 6 | 12 | 9 | |
| **Cabauw** | **CAB** | | | | | | | | | | | | | | | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | |
| Camborne | CAM | | | | | | | | | | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 2 | | | | | | 12 | |
| **Carpentras** | **CAR** | | | | | | 4 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | |
| **Chesapeake Light** | **CLH** | | | | | | | | | | 8 | 12 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 1 |
| **Cener** | **CNR** | | | | | | | | | | | | | | | | | | | 6 | 12 | 12 | 12 | 2 | | |
| Cocos Island | COC | | | | | | | | | | | | | | 3 | 10 | 8 | 12 | 12 | 12 | 12 | 12 | 9 | 4 | 9 | |
| De Aar | DAA | | | | | | | | | 7 | 6 | 12 | 11 | 12 | 1 | | | | | | | | | | | |
| Darwin | DAR | | | | | | | | | | | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 3 | | | |
| Desert Rock | DRA | | | | | | | | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 6 | | | | | | |
| Concordia Station | DOM | | | | | | | | | | | | | | | | 12 | 12 | 12 | 12 | 2 | | | | | |
| Darwin Met Office | DWN | | | | | | | | | | | | | | | | | | 12 | 12 | 12 | 12 | 12 | 9 | 9 | |
| Eureka | EUR | | | | | | | | | | | | | | | | | 4 | 12 | 12 | 12 | 12 | | | | |
| Southern Great Plains | E13 | | | | 12 | 7 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 12 | 12 | 4 | | | |
| Florianopolis | FLO | | | | 6 | 12 | 12 | 10 | 12 | 12 | 9 | 12 | 12 | 12 | 12 | 12 | | | | | | | | 4 | 12 | 1 |
| Fort Peck | FPE | | | | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 6 | | | | | | |
| Fukuoka | FUA | | | | | | | | | | | | | | | | | | | | 9 | 12 | 12 | 12 | 11 | |
| Goodwin Creek | GCR | | | | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 6 | | | | | | |
| Gobabeb | GOB | | | | | | | | | | | | | | | | | | | | | | 8 | 12 | 12 | |
| **Neumayer Station** | **GVN** | 121 | 9 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 1 | |
| Ilorin | ILO | | 4 | 12 | 8 | 7 | 12 | 12 | 6 | 12 | 12 | 12 | 7 | 12 | 12 | 7 | | | | | | | | | | |
| Ishigakijima | ISH | | | | | | | | | | | | | | | | | | | | 9 | 12 | 12 | 12 | 11 | |
| Izana | IZA | | | | | | | | | | | | | | | | | | | 10 | 12 | 12 | 12 | 12 | 12 | 1 |
| Kwajalein | KWA | | 9 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | | | | | |
| Lauder | LAU | | | | | | | | 5 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 12 | 12 | 12 | 12 | 9 | |
| Lerwick | LER | | | | | | | | | | 12 | 12 | 12 | 12 | 11 | 11 | 12 | 4 | | | | | | | 12 | |
| Lindenberg | LIN | | | | 3 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 4 | | | | | | | | |
| Langley Research Center | LRC | | | | | | | | | | | | | | | | | | | | | | | | | |
| Momote | MAN | | | | | | 3 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 10 | | |
| Minamitorishima | MNM | | | | | | | | | | | | | | | | | | | | 9 | 12 | 12 | 12 | 11 | |
| Nauru Island | NAU | | | | | | | | 2 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 9 | | |
| **Ny-Ålesund** | **NYA** | | 5 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | | |
| Palaiseau | PAL | | | | | | | | | | | | | 7 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | | |
| **Payerne** | **PAY** | | 3 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 5 | | | | |
| Rock Springs | PSU | | | | | | | | 7 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 6 | | | | | | |
| Petrolina | PTR | | | | | | | | | | | | | | | | 1 | 7 | 4 | 12 | 12 | 12 | 12 | 12 | 9 | |
| Regina | REG | | | | | 12 | 12 | 12 | 12 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | | | | |
| Rolim de Moura | RLM | | | | | | | | | | | | | | | | | 2 | | | | | | | | |
| Sapporo | SAP | | | | | | | | | | | | | | | | | | | | 9 | 12 | 12 | 12 | 11 | |
| Sede Boqer | SBO | | | | | | | | | | | | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 9 | | | |
| São Martinho da Serra | SMS | | | | | | | | | | | | | | | | 9 | 12 | 7 | 12 | 12 | 12 | 12 | 12 | 9 | |
| Sonnblick | SON | | | | | | | | | | | | | | | | | | | | | | | 12 | 12 | |
| Solar Village | SOV | | | | | | | | 3 | 12 | 12 | 12 | 12 | | | | | | | | | | | | | |
| South Pole | SPO | | 12 | 12 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | |
| Sioux Falls | SXF | | | | | | | | | | | | | 7 | 12 | 12 | 12 | 12 | 12 | 6 | | | | | | |
| Syowa | SYO | | | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 8 | | |
| Tamanrasset | TAM | | | | | | | | | | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | |
| **Tateno** | **TAT** | | | | | | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | |
| Tiksi | TIK | | | | | | | | | | | | | | | | | | | | 7 | 12 | 12 | 8 | | |
| **Toravere** | **TOR** | | | | | | | | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | |
| Xianghe | XIA | | | | | | | | | | | | | | | 12 | 12 | 12 | 12 | 12 | 12 | | | | | |
| Historical station | Eismitte | 1 | | | | | | | | | | | | | | | | | | | | | | | | |

- Pyrgeometer calibration history of several stations analysed so far.
- Yellow = BB calibs traceable to manuf/inst
- Light orange = BB calibs directly/indirectly traceable to PMOD/WRC BB.
- Dark orange = BB/outdoor calibs directly/indirectly traceable to PMOD/WRC WISG.

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# Closer Look at IWV Dependence and Scale Offset of Reference and BSRN Pyrgeos

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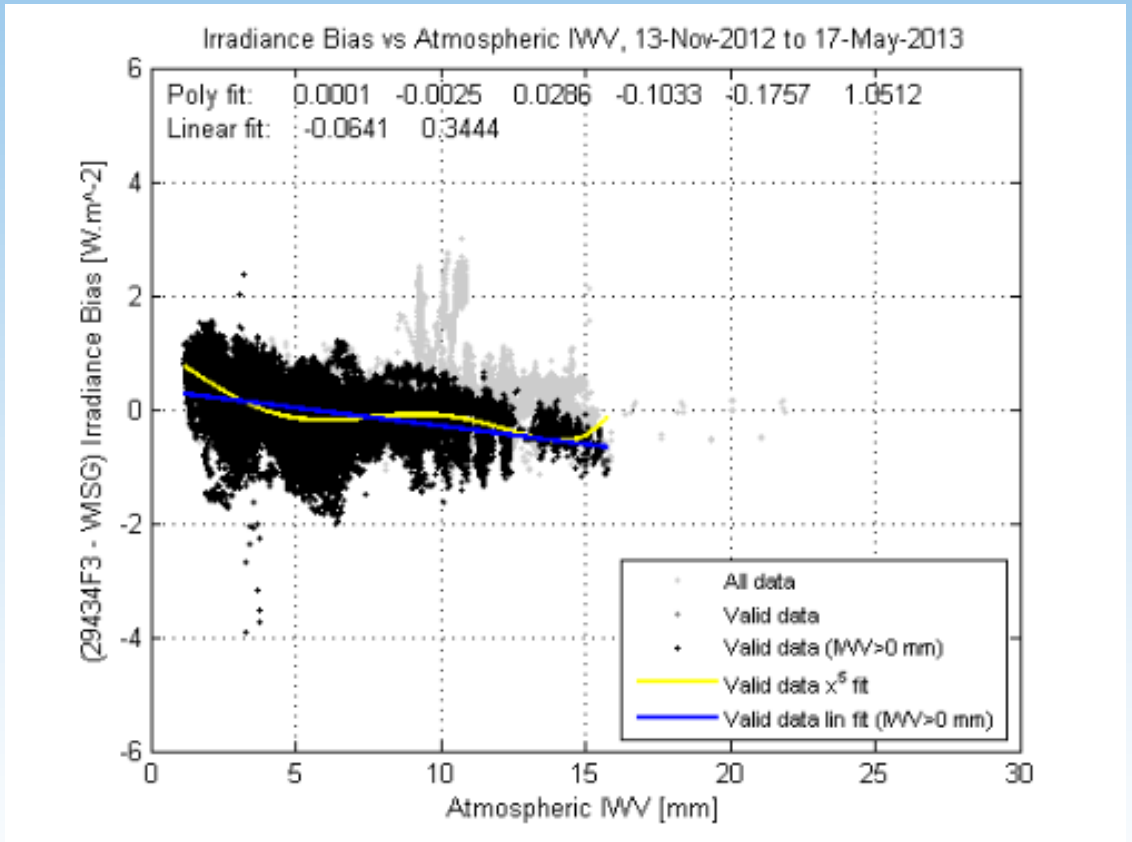
# IWV Dependence of Eppley Pyrgeos: Previous 3-Season Meas from PMOD/WRC Archive

**PMOD/WRC**
**PIR 29434**

Too few measurements for IWV>10 mm

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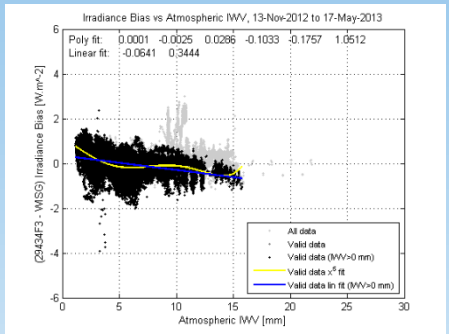
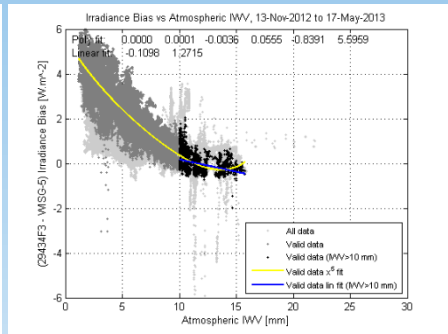
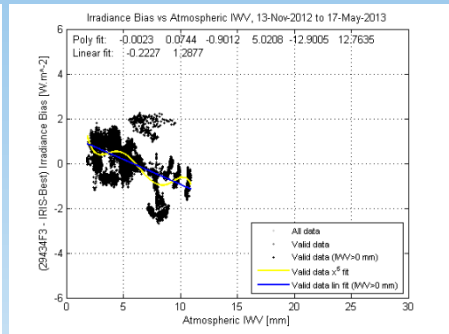
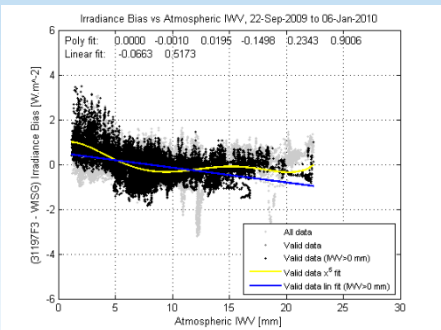
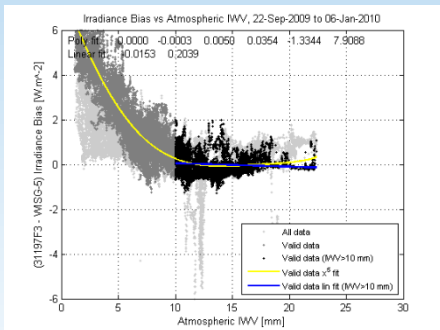
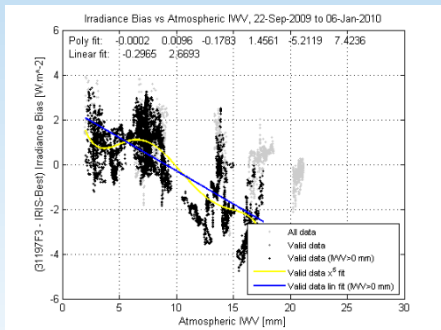
# IWV Dependence of Eppley Pyrgeos: Previous 3-Season Meas from PMOD/WRC Archive

| | WISG Calib | $WISG_5$ Calib | IRIS Calib |
|---|---|---|---|
| **PMOD/WRC PIR 29434**<br>Too few measurements for IWV>10 mm |  |  |  |
| **NREL PIR 31197**<br>Too few measurements for IWV>10 mm |  |  |  |

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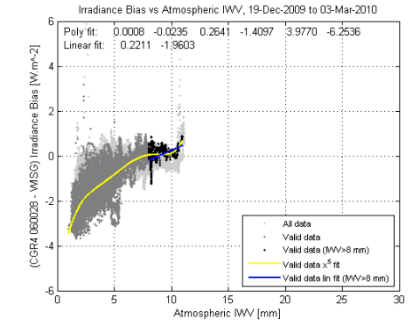
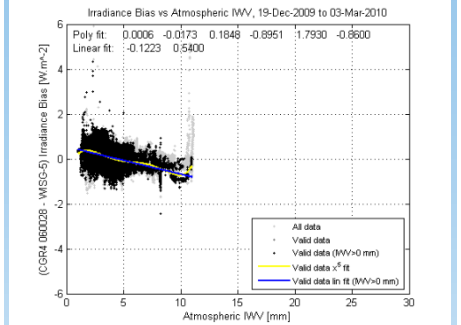
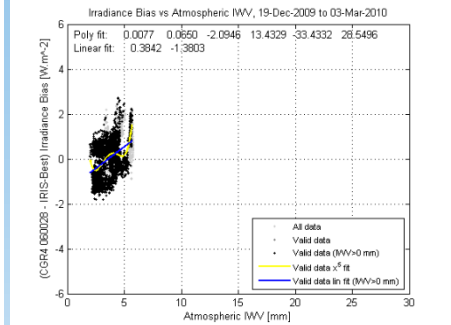
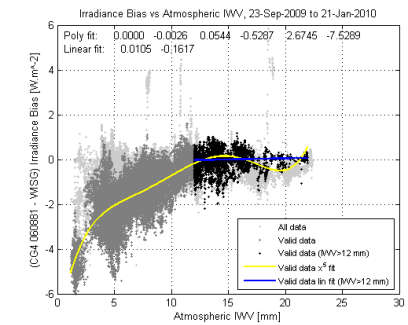
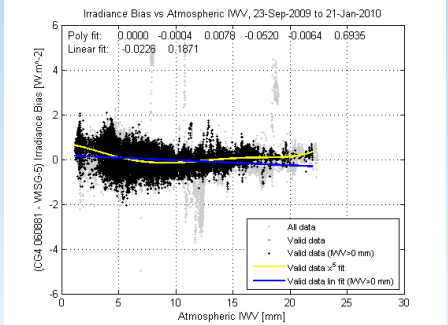
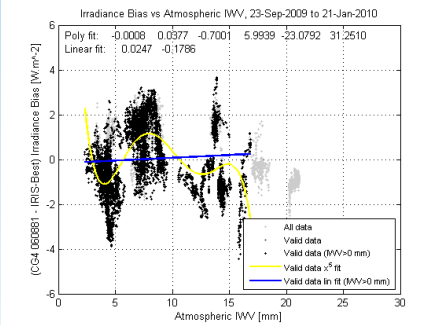
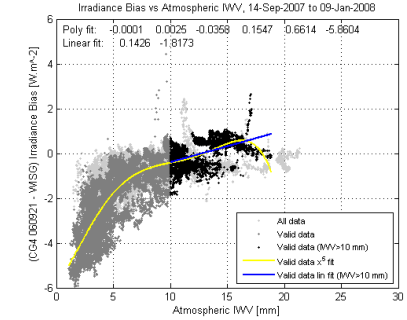
# IWV Dependence of K&Z Pyrgeos: Previous 3-Season Meas from PMOD/WRC Archive

| | WISG Calib | $WISG_5$ Calib | IRIS Calib |
|---|---|---|---|
| **DWD CGR4 060028** Too few measurements for IWV>5 mm |   |   |   |
| **NREL CG4 060881** Too few measurements for IWV>10 mm |   |   |   |
| **BOM CG4 060921** Too few measurements for IWV>10 mm |   | $WISG_5$ meas. only available after Feb. 2008 | IRIS outdoor meas. only available after June 2008 |

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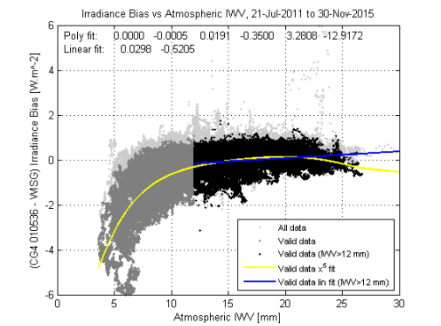
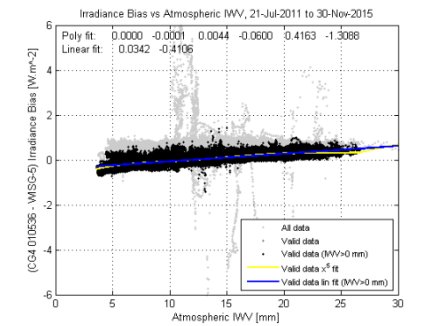
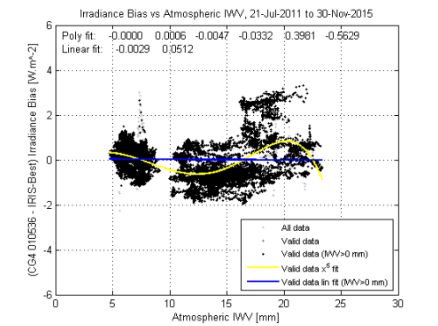
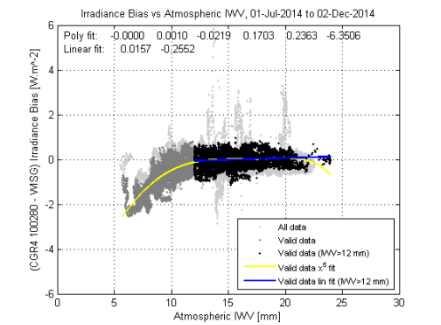
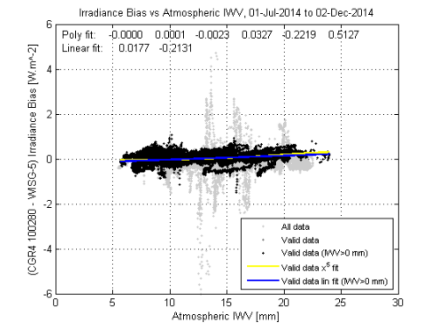
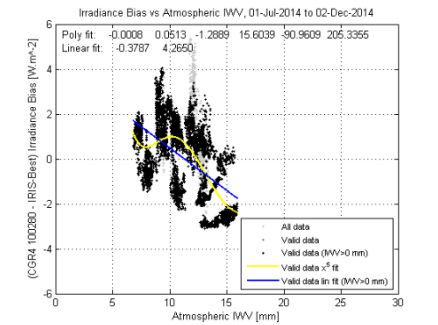
# IWV Dependence of K&Z Pyrgeos: Previous 3-Season Meas from PMOD/WRC Archive

**K&Z Ref CG4 010536**

- 2011 and 2015 periods combined
- New dome since 2005

**K&Z Ref CGR4 100280**

| WISG Calib | $WISG_5$ Calib | IRIS Calib |
|---|---|---|
|  |  |  |
|  |  |  |



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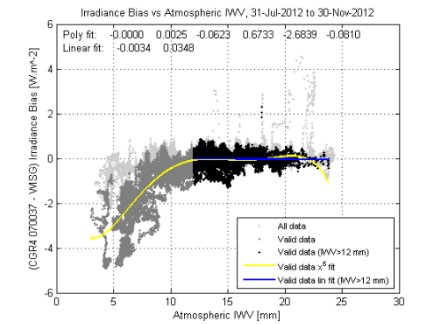
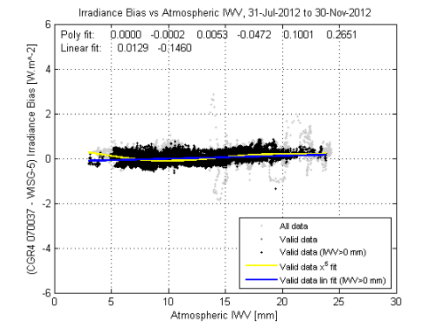
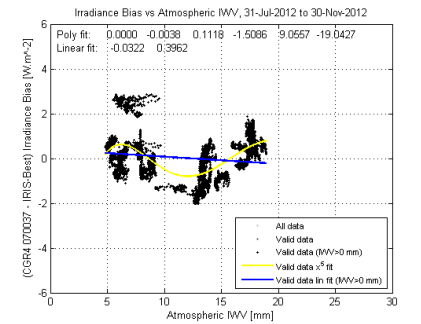
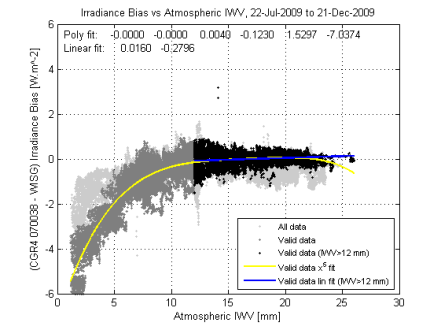
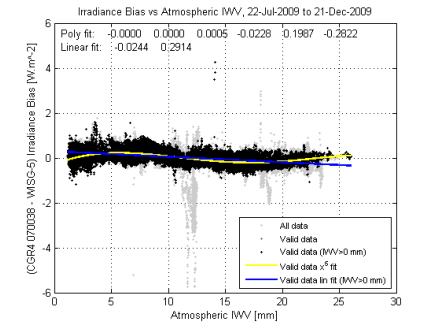
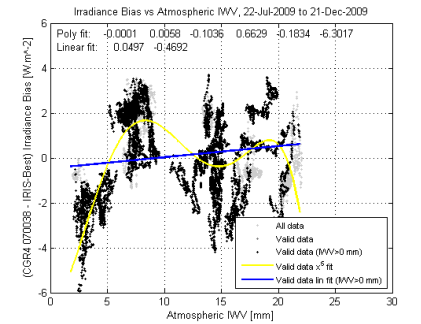
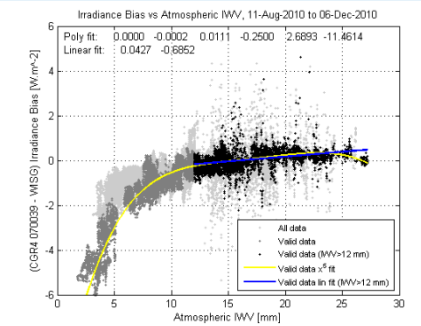
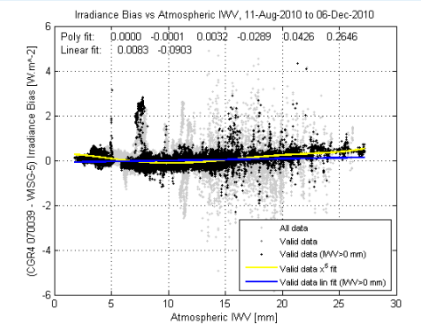
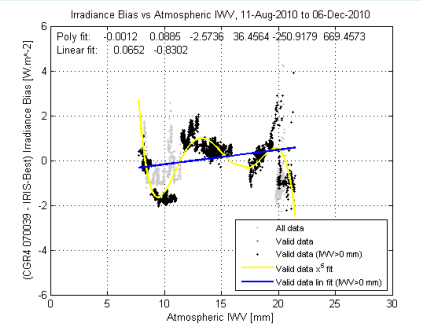
# IWV Dependence of K&Z Pyrgeos: Previous 3-Season Meas from PMOD/WRC Archive

| | WISG Calib | $WISG_5$ Calib | IRIS Calib |
|---|---|---|---|
| **JMA CGR4 070037** |  |  |  |
| **JMA CGR4 070038** |  |  |  |
| **JMA CGR4 070039** Too few measurements for the whole IWV range |  |  |  |



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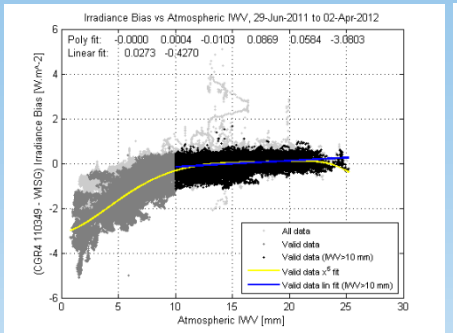
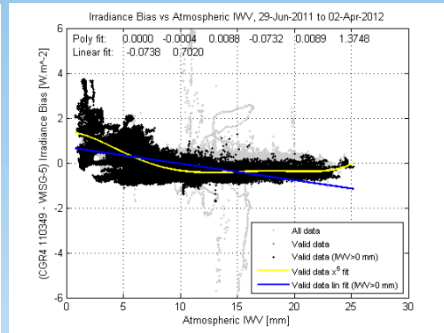
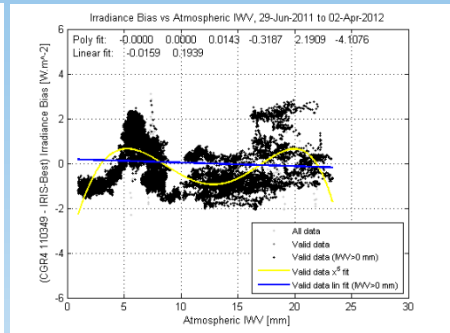
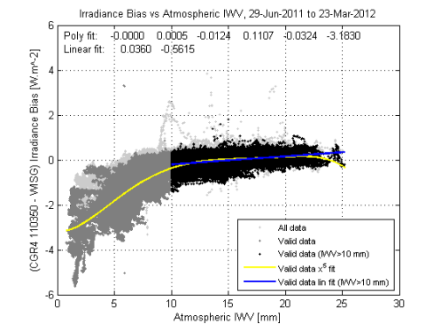
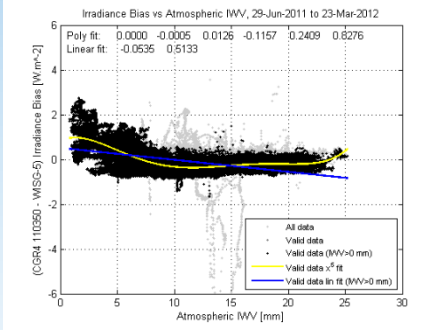
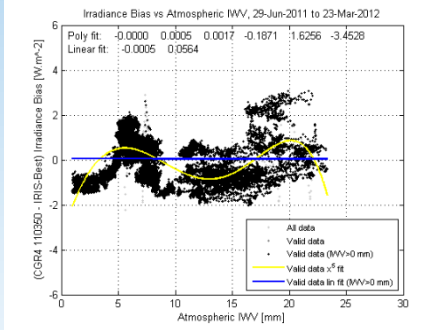
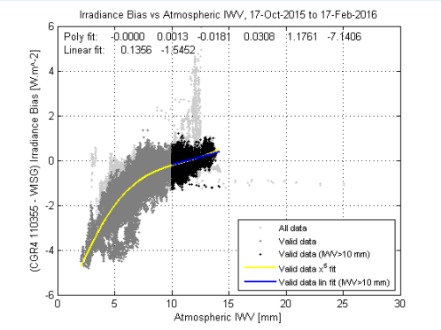
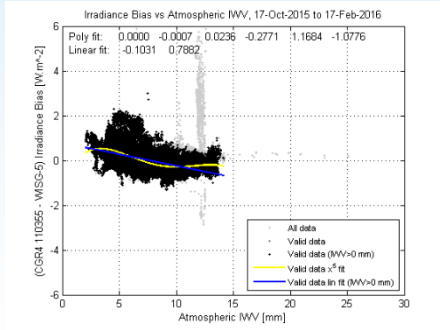
# IWV Dependence of K&Z Pyrgeos: Previous 3-Season Meas from PMOD/WRC Archive

| | WISG Calib | $WISG_5$ Calib | IRIS Calib |
|---|---|---|---|
| **SMHI CGR4 110349** |   |   |   |
| **SMHI CGR4 110350** |   |   |   |
| **MCH CGR4 110355**<br><br>BSRN pyrgeo at PAY<br><br>Measurements are ongoing at PMOD to obtain data for a full 3-season calibration. Graphs show status up to Feb. 2016. |   |   | |

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# IWV Dependence of Pyrgeos: Summary of 3-Season Meas at PMOD/WRC

| | Meas >90 days | Meas >90 days AND Meas over IWV = 2 – 25 mm range |
|---|---|---|
| PIR | 7 | 4[a] |
| CG(R)4 | 21 | 14[b] |

[a] **(1 Customer, 2 WISG, 1 PMOD/WRC),** [b] **(10 Customer, 2 WISG, "WISG5" and "WISG6")**

- Autumn-Winter-Spring period long enough but very often too few valid data points to fully characterise IWV dependence of pyrgeos.

- Characteristics of IWV dependence:
  - Range[c] of IWV dependence: IWV < ~10 mm
  - Slope of IWV dependence (IWV < 10 mm): -0.5 $W.m^{-2}.mm^{-1}$ (IWV)

- IWV dependence related to pyrgeo dome, but comprehensive explanation still missing. Spectral dome transmission? Dome coating?

[c] The range IWV < 2 mm not observed at PMOD/WRC. Is linear or exponential behavior expected? No BSRN station with simultaneous PIR/pre-2003 CG4 and CG4(R)4 and with low potential IWV found so far.

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# IWV Dependence of Pyrgeos: Conclusions

- More pyrgeos, especially PIR, should have longer meas (preferably >2 years) to better characterise/confirm IWV dependence.

  Other stations* may have simultaneous PIR/pre-2003 CG4 and post-2004 CG(R)4 meas?

- Is a "general" correction for IWV dependence possible?

  We believe so, despite some variability.

- Unlikely that BSRN pyrgeos will be sent to PMOD/WRC for a 3-season calib → general IWV correction is only realistic option.

- All 188 PIR and 10 CG4 BSRN pyrgeos are most prob. affected.

* Following have submitted PIR and CG4 to BSRN but presently unknowm whether meas were simultaneous (CAR, LAU,LER, PAY, SYO, TAT).

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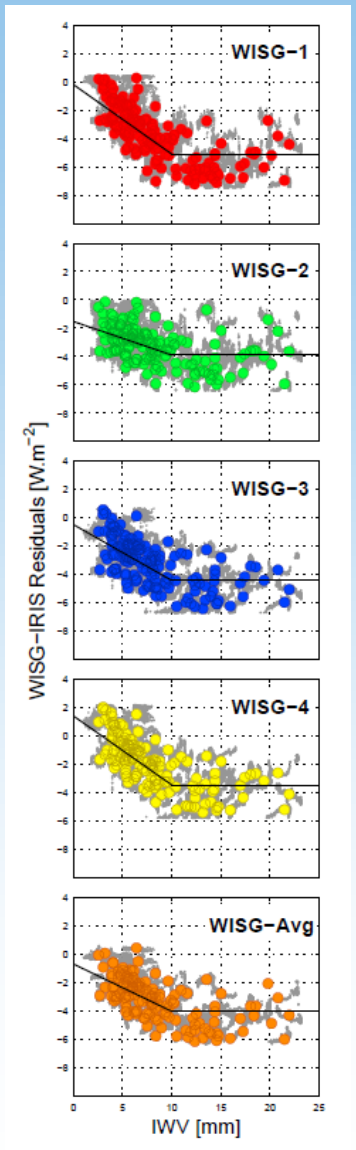
# Scale Offset of Pyrgeos: WISG and IRIS Long-Term Measurements




IRIS measurements from 2011 - 2015

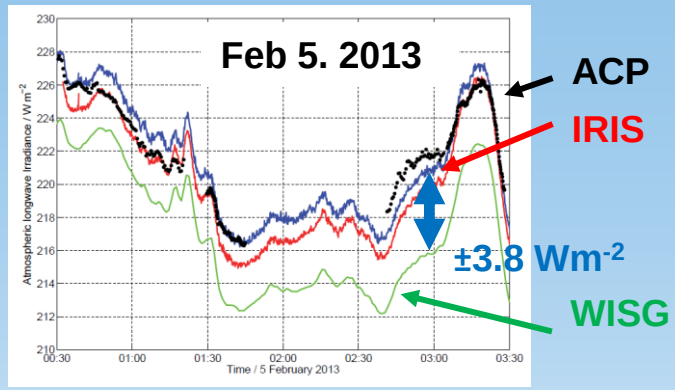



**Table 2.** Summary of the Dependence of the WISG Pyrgeometers With Respect to IRIS#4 Obtained From Measurements Spanning the Period August 2011 to December 2013[a]

| Instrument | Offset (IWV > 10 mm) (W m$^{-2}$) | Slope (IWV < 10 mm) (W m$^{-2}$ IWV$^{-1}$) |
|---|---|---|
| WISG 1 | −6.1 | −0.52 |
| WISG 2 | −4.7 | −0.21 |
| WISG 3 | −5.5 | −0.45 |
| WISG 4 | −4.5 | −0.55 |
| WISG | −5.1 | −0.42 |

**Table 3.** Operational and Suggested Sensitivities of the WISG Pyrgeometers as Retrieved for the Period August 2011 to December 2013 With Respect to IRIS#4[a]

| | | Sensitivity (μV W$^{-1}$ m$^2$) | | |
|---|---|---|---|---|
| Instrument | Operational | Offset IWV > 10 mm | Slope/1 cm IWV IWV < 10 mm | Maximal Relative Change in % |
| WISG 1 | 3.53 | 3.80 | −0.25 | −5.3 |
| WISG 2 | 3.58 | 3.79 | −0.14 | −3.0 |
| WISG 3 | 12.3 | 13.2 | −1.0 | −6.1 |
| WISG 4 | 9.59 | 10.1 | −0.75 | −5.9 |

[a]The slope of the new sensitivities are given per 10 mm IWV, while the relative changes are calculated for the lowest observed IWV at Davos of 2 mm.

*Gröbner et al. (JGR, 2015)*

- **PIR and pre-2003 CG4**

  Up to +4 W.m$^{-2}$ too high when IWV >10 mm
  (latest 2011-2015 data)

- **IRIS and post-2003 CG4**

  Results to within ±1 W.m$^{-2}$

- **Necessary to keep WISG as a transfer standard as:**

  IRIS/ACP/… are not "all-weather" radiometers.

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# Scale Offset of Pyrgeos: Conclusions wrt BSRN

- Only $WISG_{1\text{-}4}$ and $WISG_{5\text{-}6}$ have long-term measurements wrt IRIS.
- A scale correction can be applied by using the WISG as a re-calibrated transfer standard wrt IRIS/ACP/XYZ ($WISG_{IRIS}$).
- Calculate new sensitivity C using raw data from previous PMOD/WRC calibrations.
- All 188 BSRN PIR pyrgeos are assumed to be affected.
- All 35 BSRN CG(R)4 pyrgeos are assumed to be affected.

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# Pyrgeo Stability and Traceability

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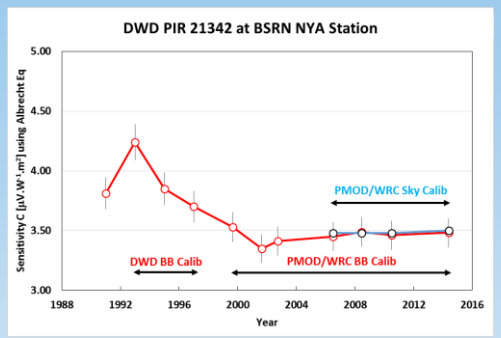
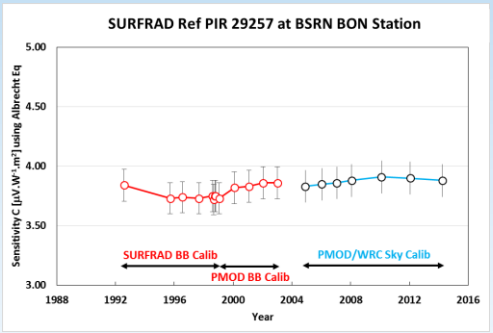
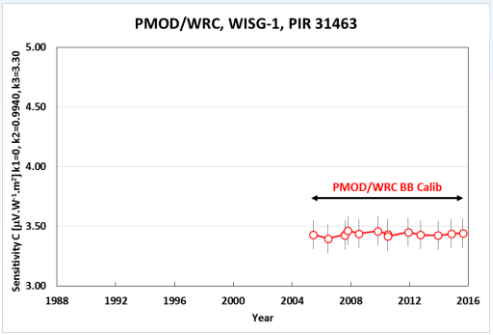
# Pyrgeo Calib Stability from PMOD/WRC Archives: Sensitivity C Calculated with Albrecht Eq

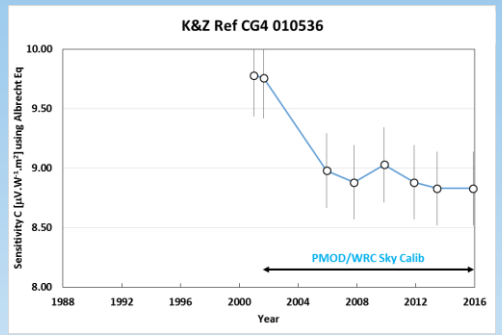
## Eppley PIR

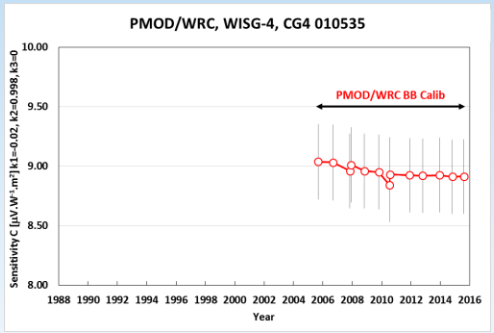



## Kipp & Zonen CG(R)4




- Albrecht eq (k1=0, k2=1, k3=constant for PIR). Vertical bars = uncert. (3.5%).

- Ref pyrgeos or those with a long calibration history are shown. Others include:

| | |
|---|---|
| **AWI Potsdam** | PIR 28858, 28859, 28895, 28897 |
| **SURFRAD** | PIR 29255, 29257, 29258 |
| **WISG** | PIR 31463, 31464<br>CG4 FT004, CG4 010535 |
| **K&Z** | CG4 010536 |

- Ref pyrgeos from large institutes calib at PMOD/WRC on a regular basis ie 1 – 3 yrs.

- However, most pyrgeos calibrated every 2 – 5 yrs or on sporadic basis.

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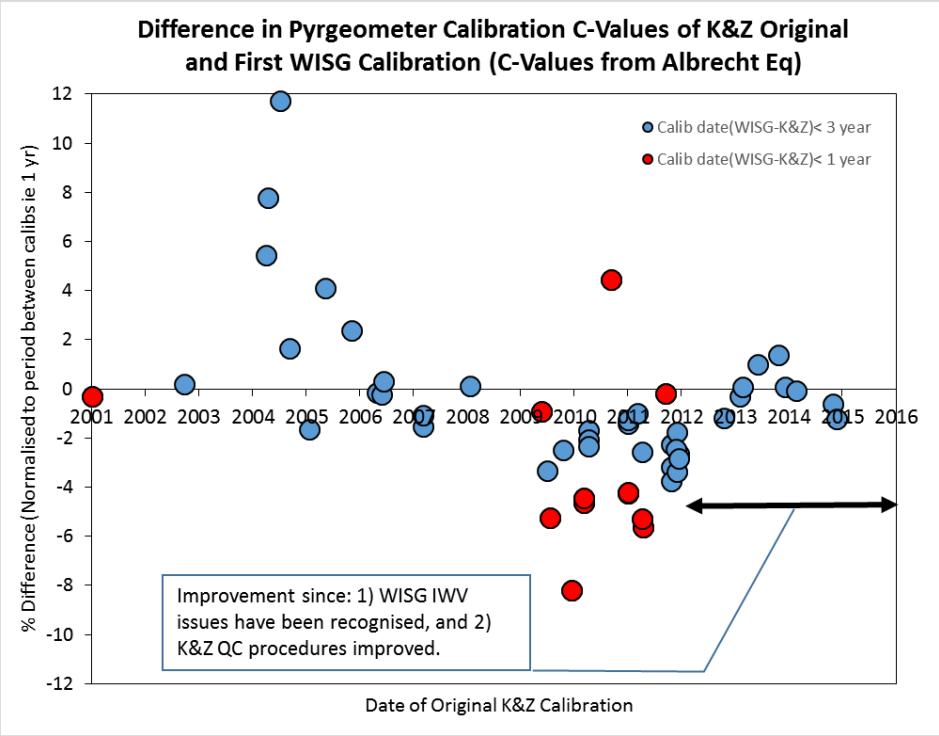
# How Good has Transfer of WISG Calibration been to Commercial Pyrgeometers?

An estimate for CG(R)4 by comparing original K&Z with first WISG calibration.




- Calib procedures? … Not really.
  - PMOD/WRC: clear sky/partially cloudy night-time.
  - K&Z: night-time, clear (net LR > -40 $W.m^{-2}$).
- Sensor degredation? Not really.
  - WISG CG4s illustrate drift «1%/year
- Scale changes before WISG established?
- IWV issues during any part of the "traceability chain".
- Recent improvements (now +/- 1.5%) due to:
  - Intro of IWV criterion at PMOD/WRC since Apr. 2012.
  - K&Z intro of stricter QC procedures has helped reduce the standard deviation.

* Eppley ref and WISG comparison conducted during IPCs but lack of new Eppley PIR calibrated at PMOD/WRC prevents a more comprehensive overview.
NOTE: Only WISG calibs CG4 and CGR4s (N=17, 42; no multiple entries) within 3 years of orig. K&Z calib incl. using Albrecht eq (ie $k_1$=0, $k_2$=1). Only 4 pyrgeos are in BSRN.
NOTE: 3-season = calibration period during autumn-winter-spring

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# Updating BSRN Long-Wave Time-Series

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# BSRN Long-Wave Radiation Archives: Possible Procedure to Update Time-Series

- If BSRN pyrgeos not traceable to WISG then correction not possible.
- If BSRN pyrgeos are traceable:
  - PMOD/WRC re-determines pyrgeometer sensitivity C wrt $WISG_{IRIS}$, using previous calibration data.
  - BSRN Users re-calculate long-wave time-series using new sensitivity C based on $WISG_{IRIS}$.
  - If pyrgeos have an IWV dependence, then apply correction to long-wave time-series based on IWV time-series.
- Submit corrected time-series to BSRN, and adhere to the BSRN archiving guidelines … Easy/difficult … probably controversial ???
- However, at this early stage, emphasis on procedures rather than application of corrections.

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# Outlook for Current Project (Finish Dec. 2016)

- Publish findings and present report to CIMO Task Group.

- Feedback from the BSRN community is very welcome !!!

**Thanks for your attention**

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# Extra Slides

# What are the Consequences of Adopting the IRIS/ACP/XYZ as new Transfer Standards? Global Radiation Budget

- DLR would potentially increase by +4.0 $W.m^{-2}$ (clear-sky, IWV>10 mm) but cloudiness occurs at almost all stations except perhaps at eg Alice Springs(!)
- Next Task: Obtain raw data and IWV climatology for several representative stations, and re-calculate DLR time-series.
- Final Task: Possibly see if Martin Wild could run a preliminary Surface Budget experiment to see the effect (if any).

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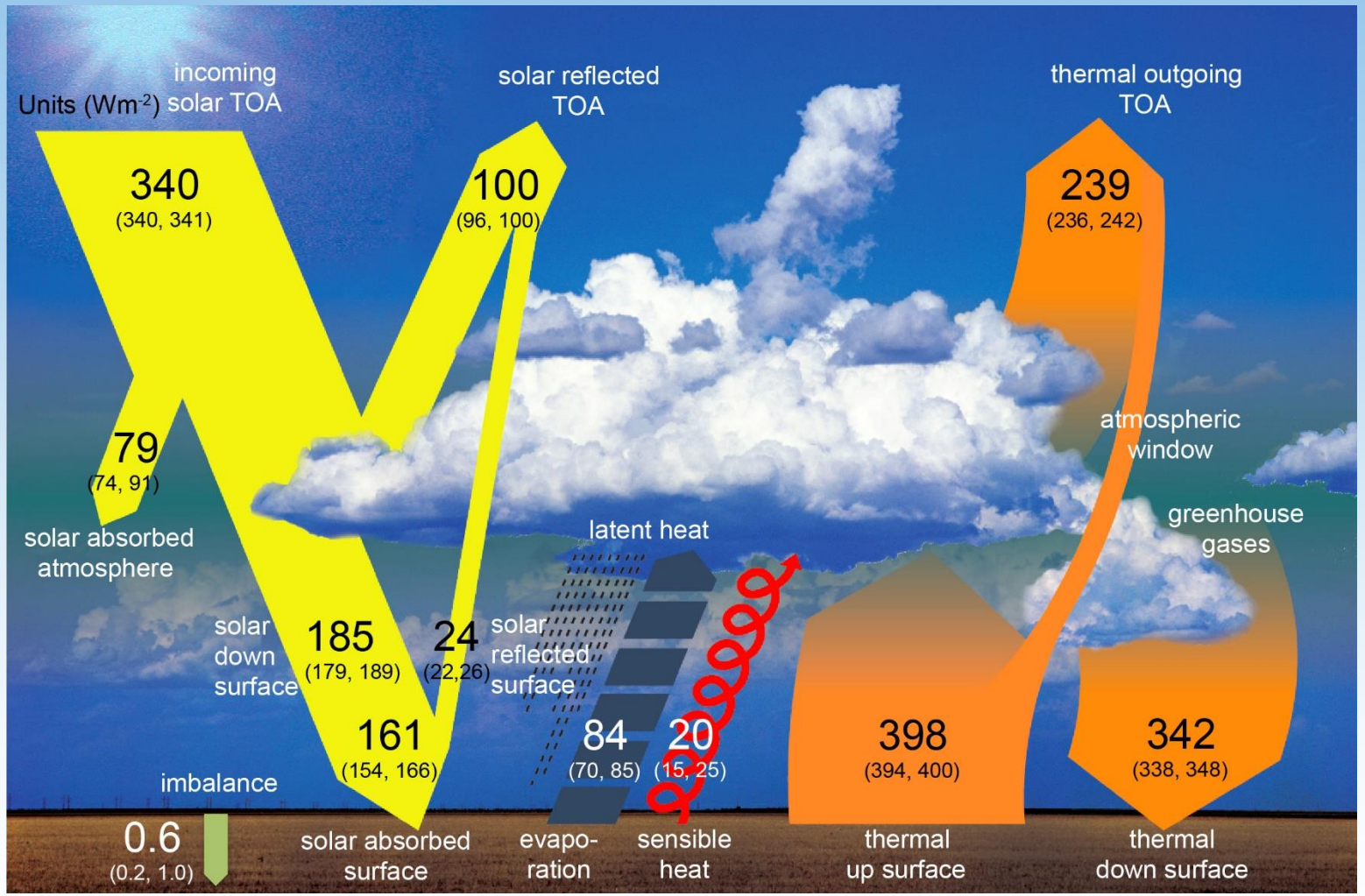
# What are the Consequences of Adopting the IRIS/ACP/XYZ as new Transfer Standards? Global Radiation Budget




[Figure from IPCC 2013].

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