

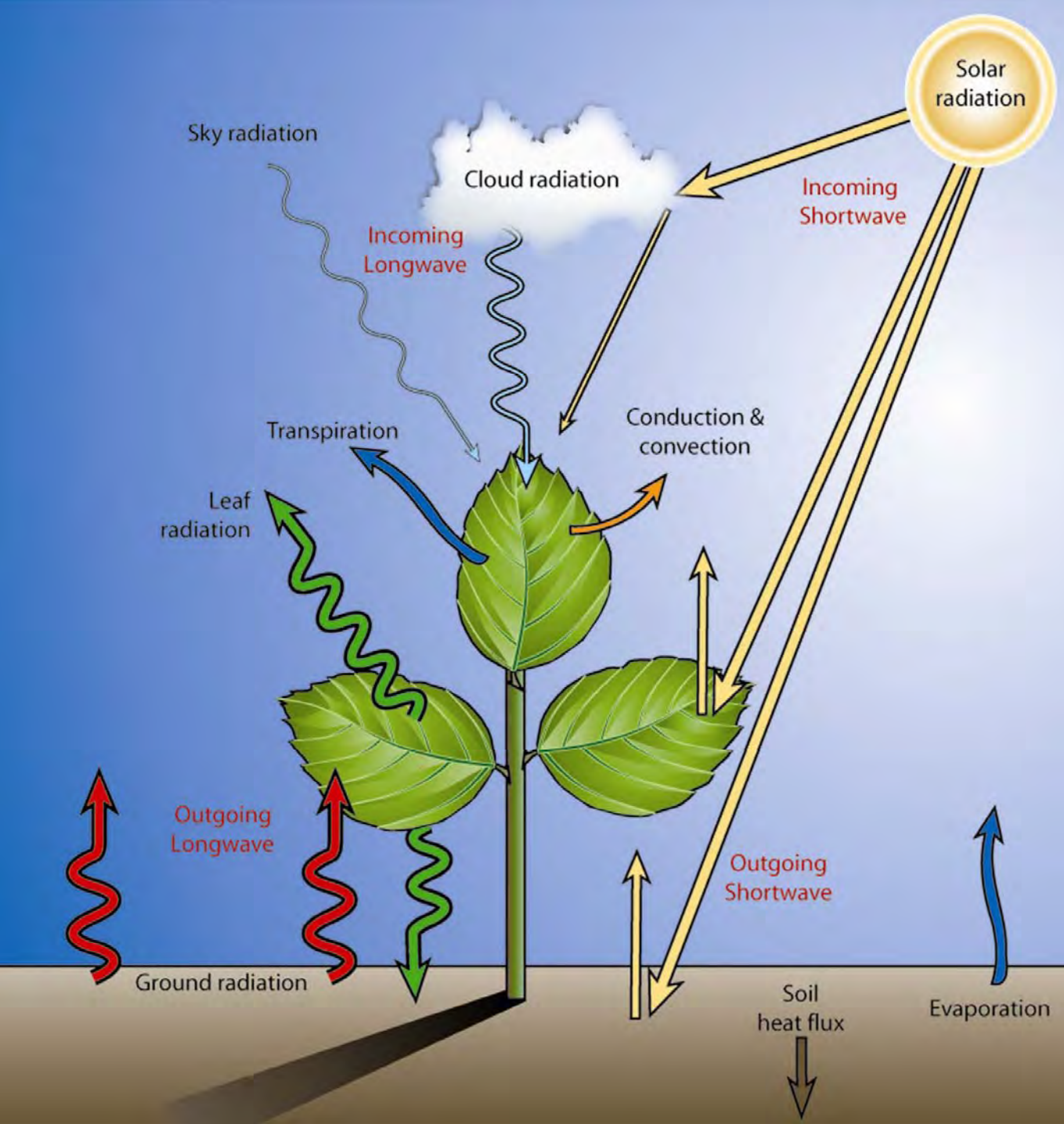
Comparison of Two New Net Radiometers



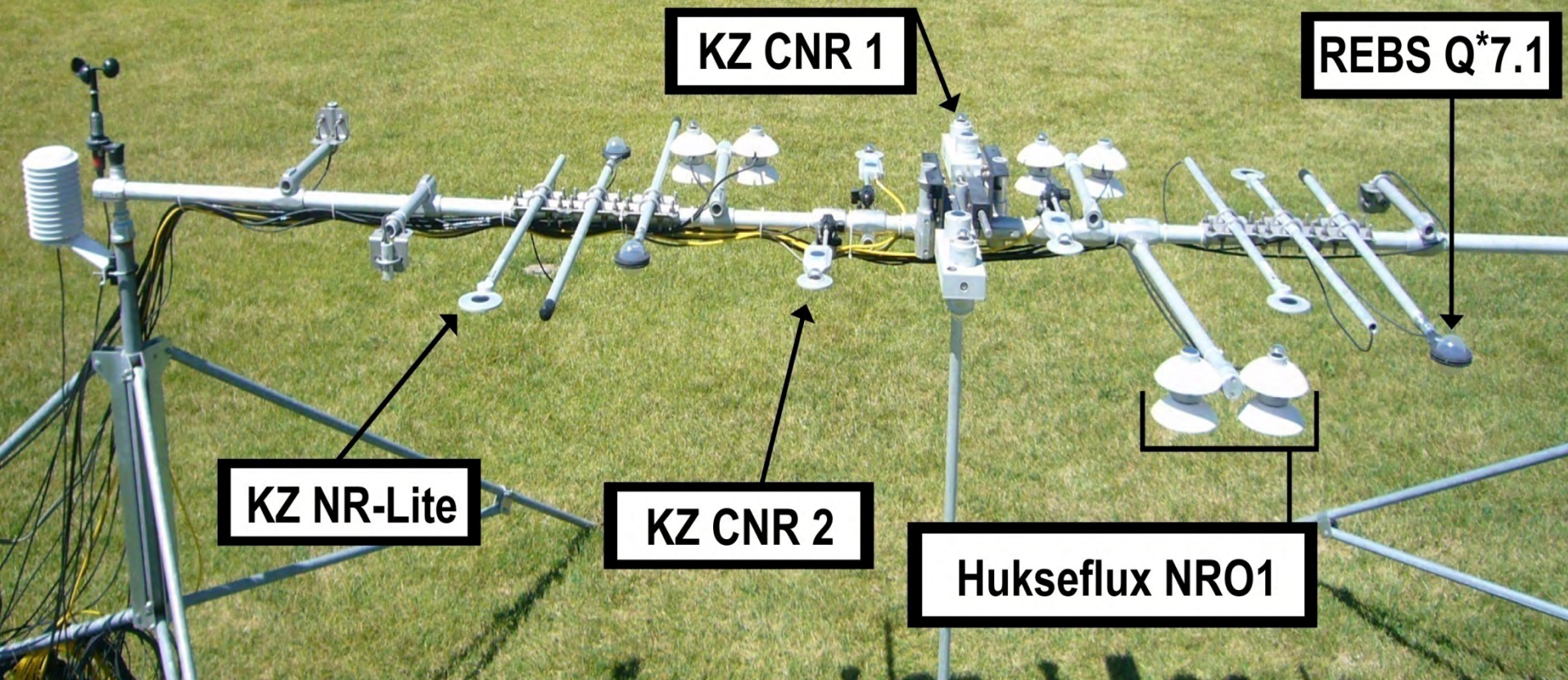
Mark Blonquist

Bert Tanner

Bruce Bugbee

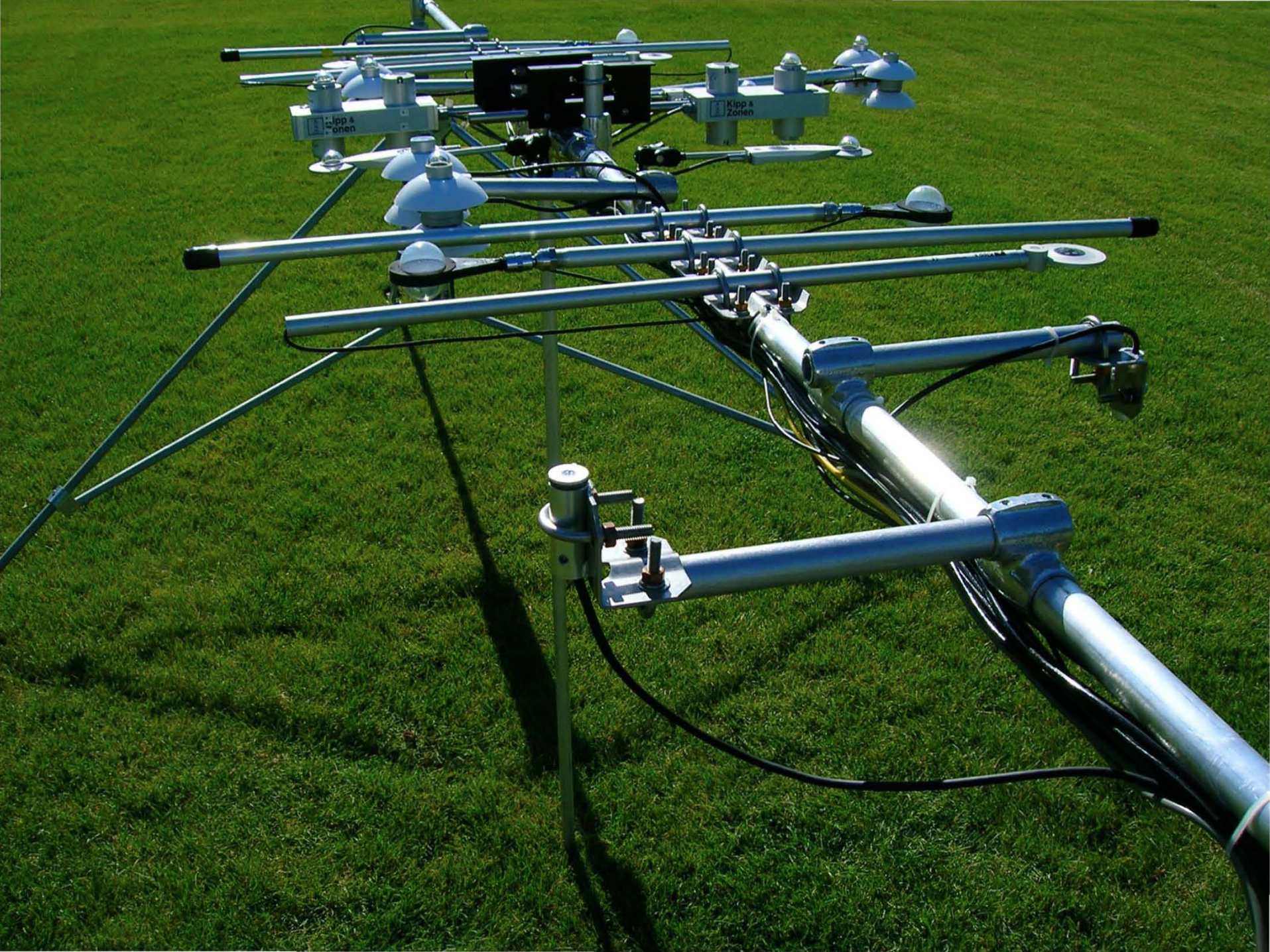


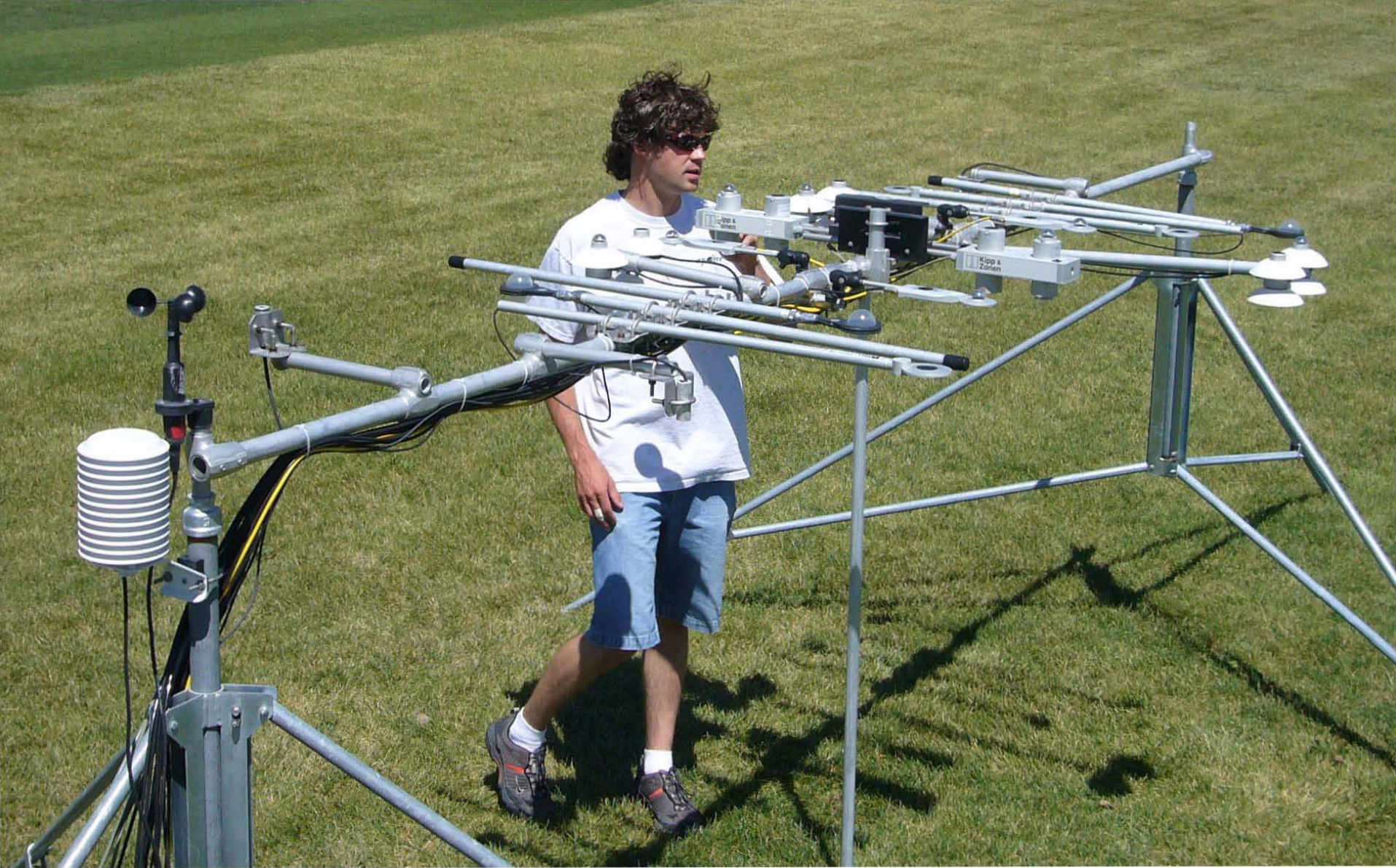
Energy Balance:
 $R_n = \lambda E + H + G$



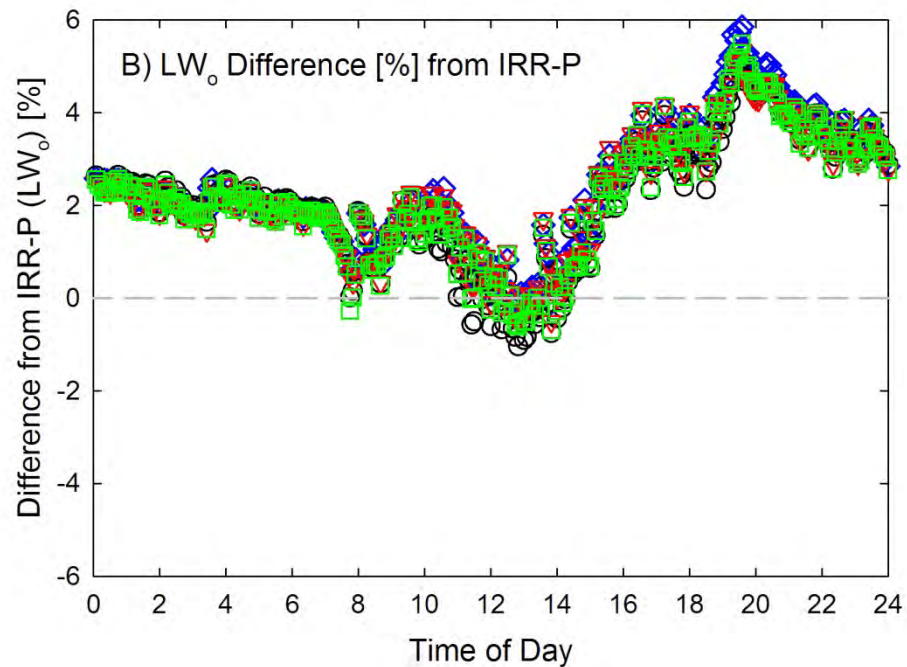
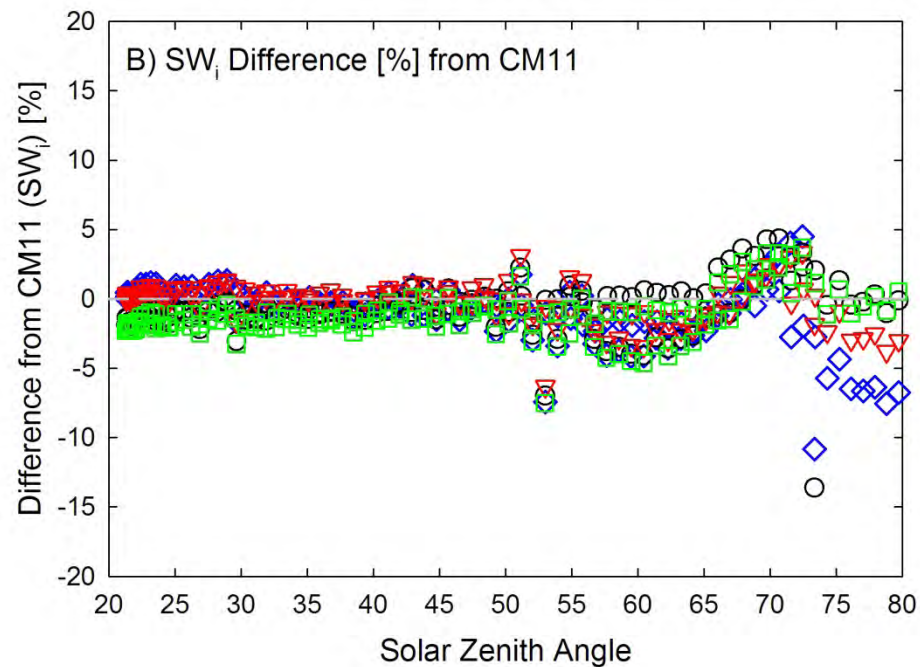
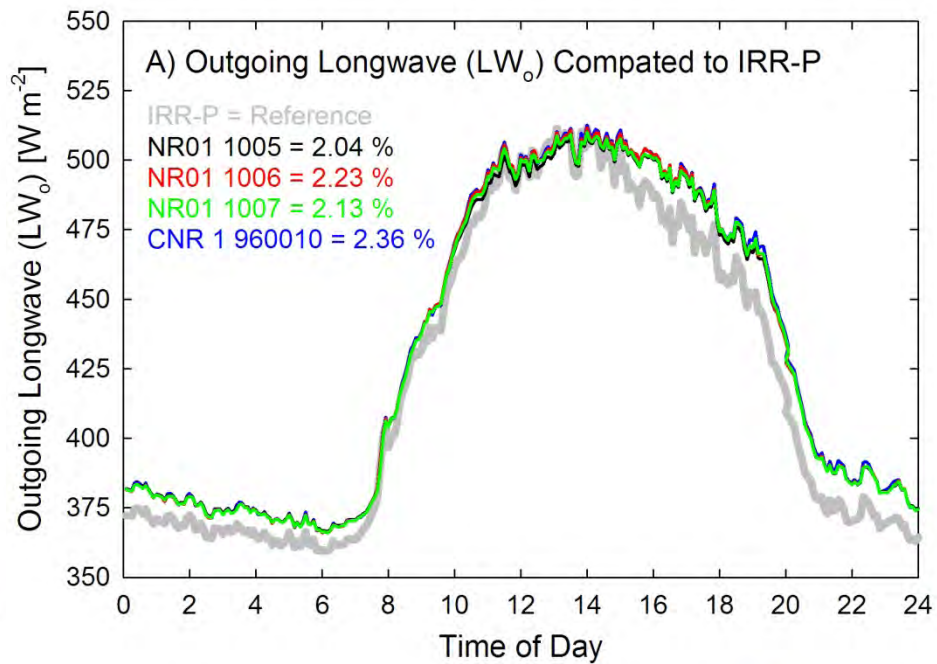
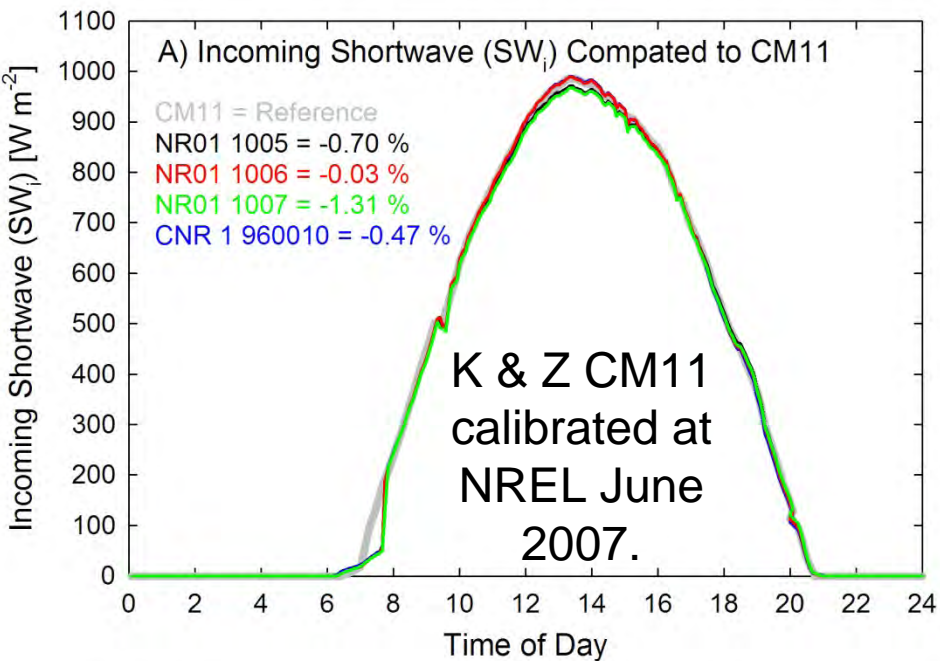
Manufacturer	Model	Cost [\$]	Replicates	Output
Kipp & Zonen	CNR 1	6400	2	SW_i, SW_o, LW_i, LW_o
Hukseflux	NR01	4500	3	SW_i, SW_o, LW_i, LW_o
Kipp & Zonen	CNR 2	2600	3	SW_n, LW_n
Kipp & Zonen	NR-Lite	1800	3	R_n
REBS	Q*7.1	1200	3	R_n

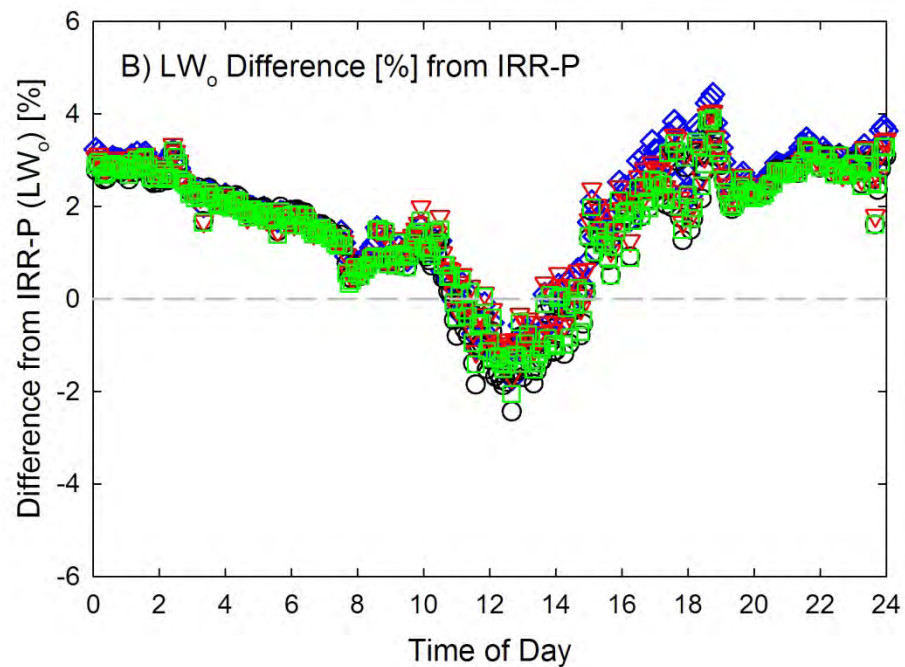
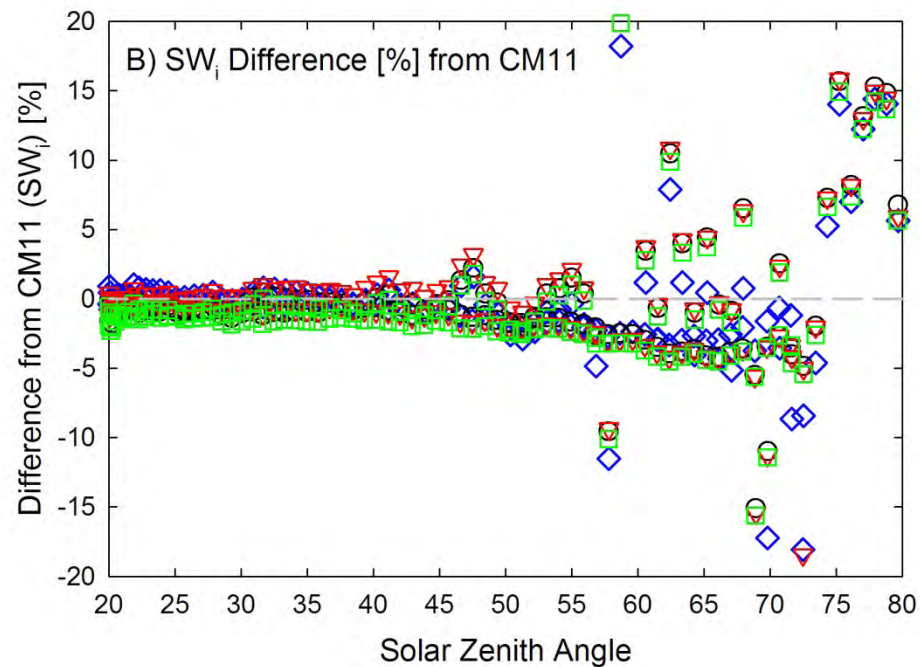
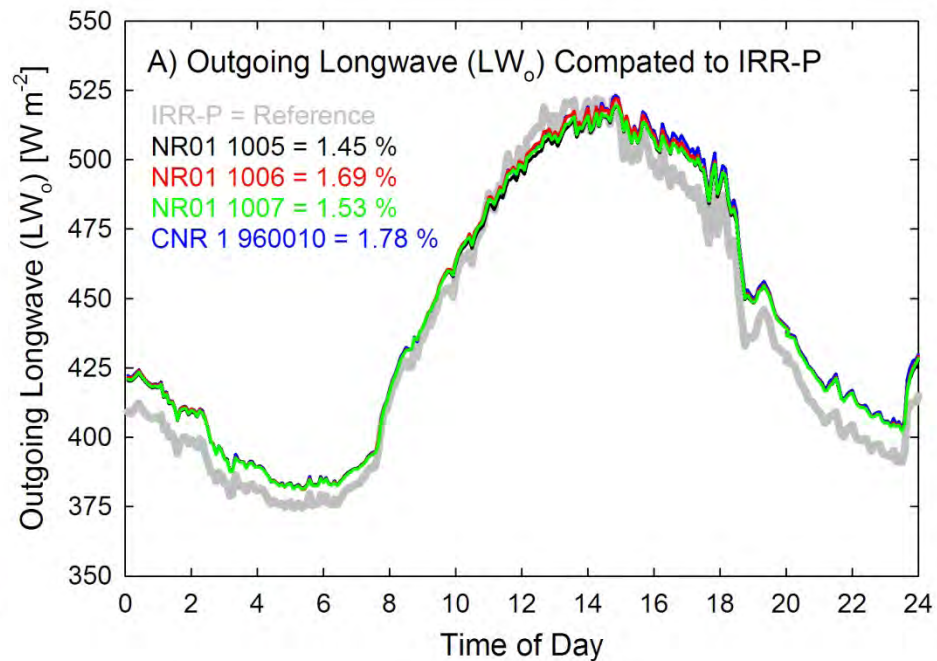
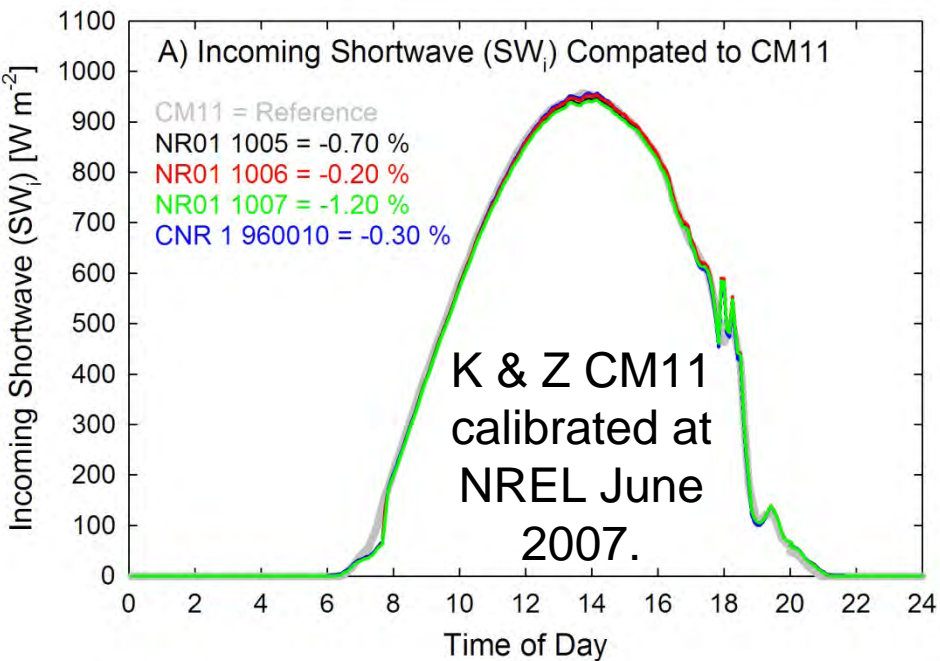






- Radiometers were cleaned and leveled following each irrigation (approximately every two days).
- Data during and following irrigation events (previous to cleaning and re-leveling) was filtered out.



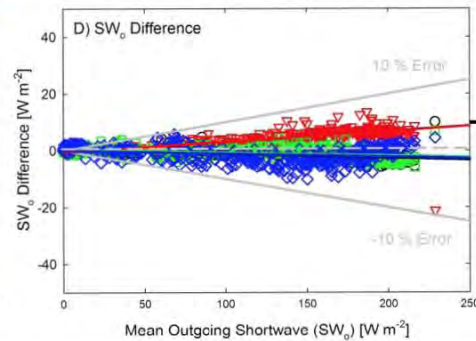
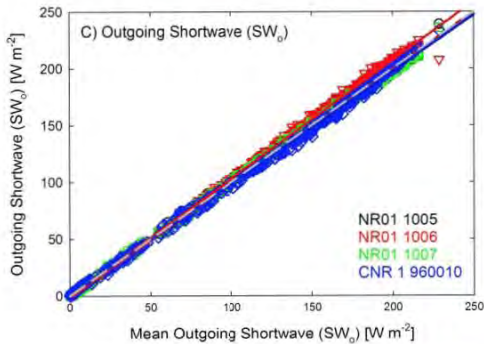
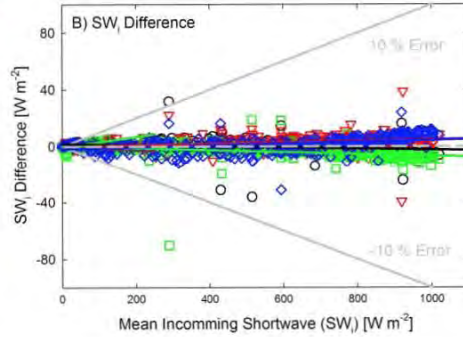
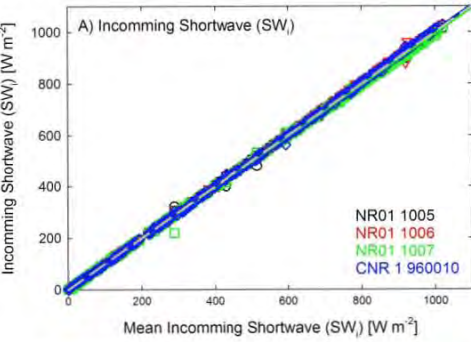


Blue = K & Z CNR 1

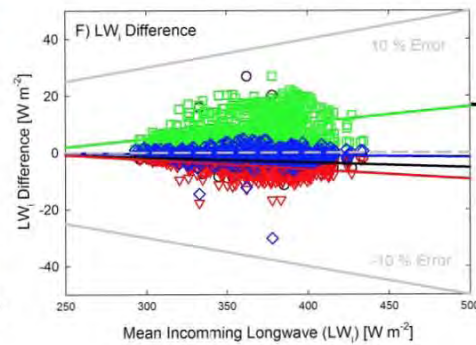
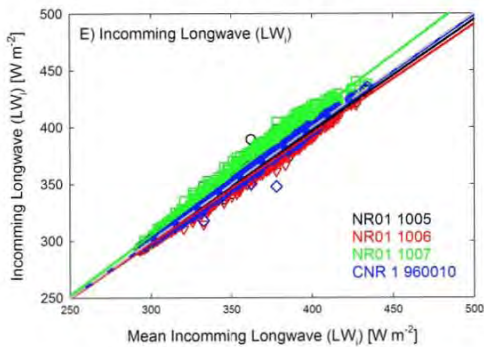
Black = HF NR01

Red = HF NR01

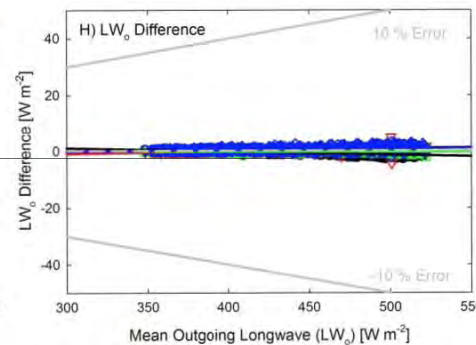
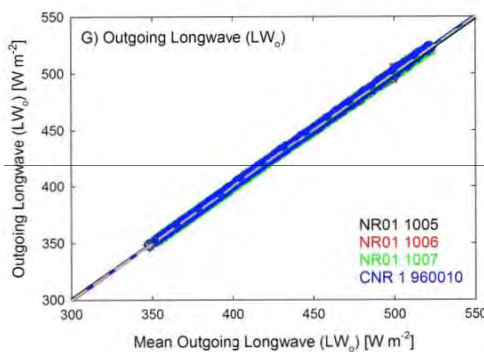
Green = HF NR01

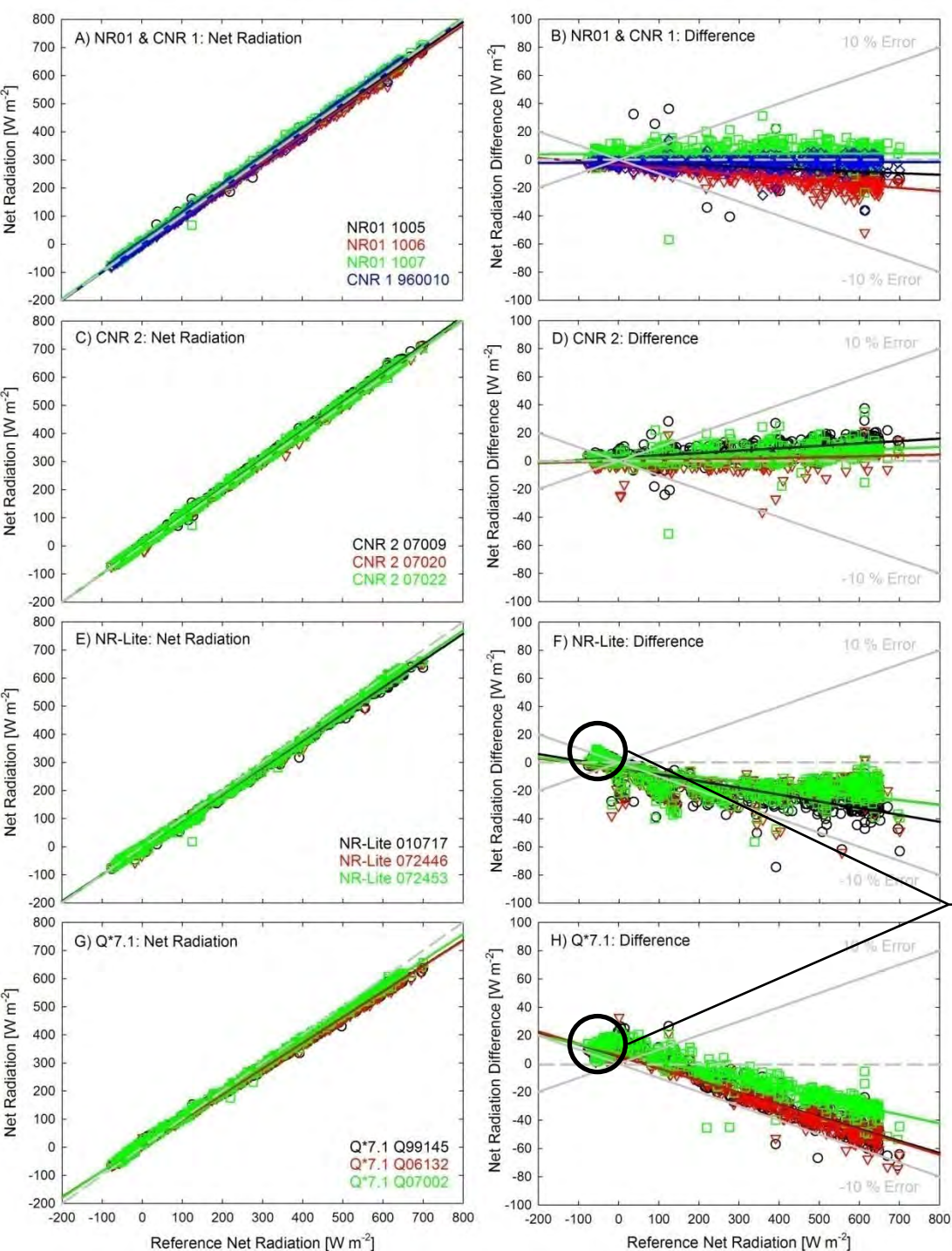


→ Sent back to Hukseflux for calibration check.



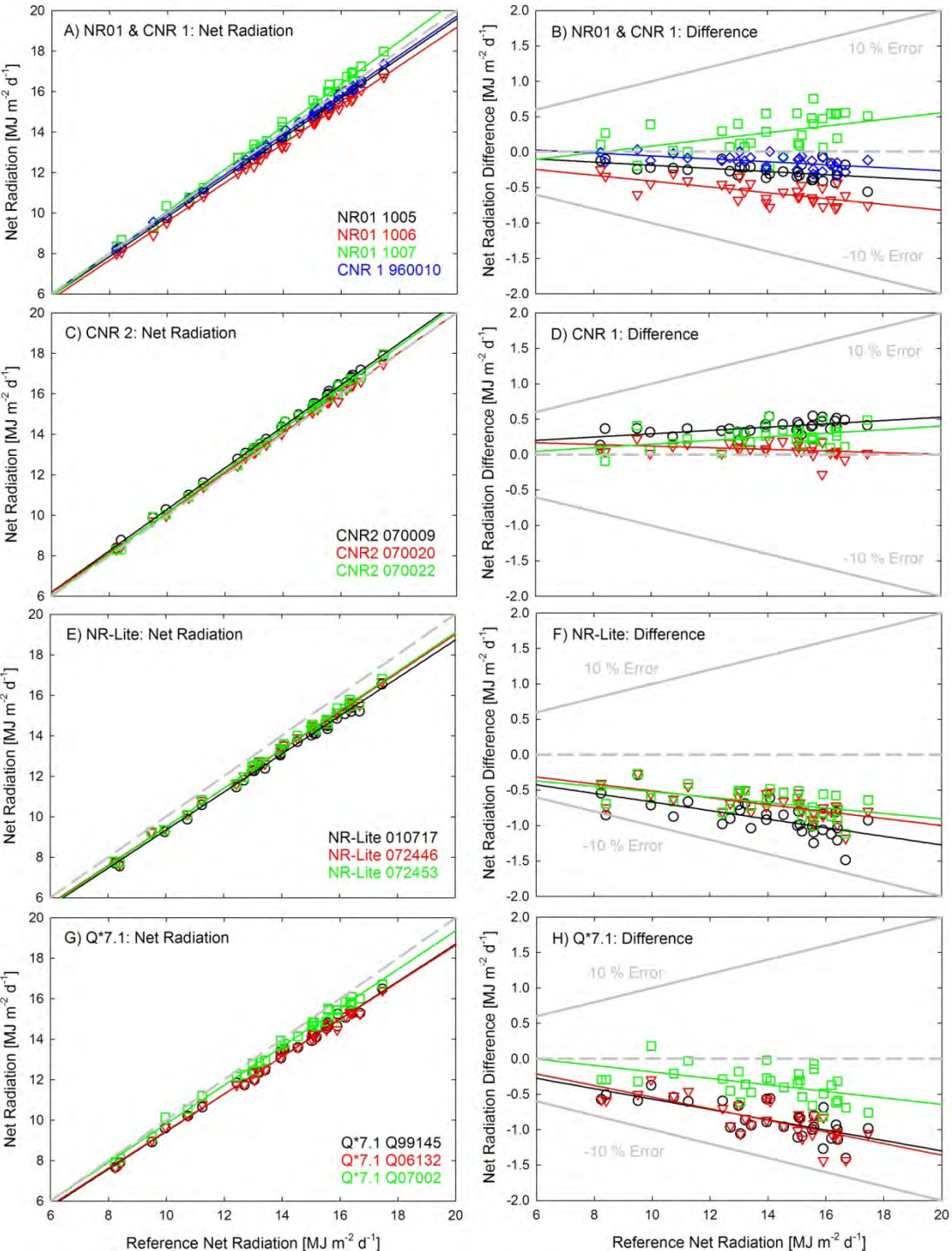
→ Sent back to Hukseflux for calibration check.





No standard for R_n measurement; reference for comparison is average of 2 CNR 1s, 3 NR01s, and 3 CNR 2s.

Offsetting error at night; indicates lesser sensitivity to longwave.

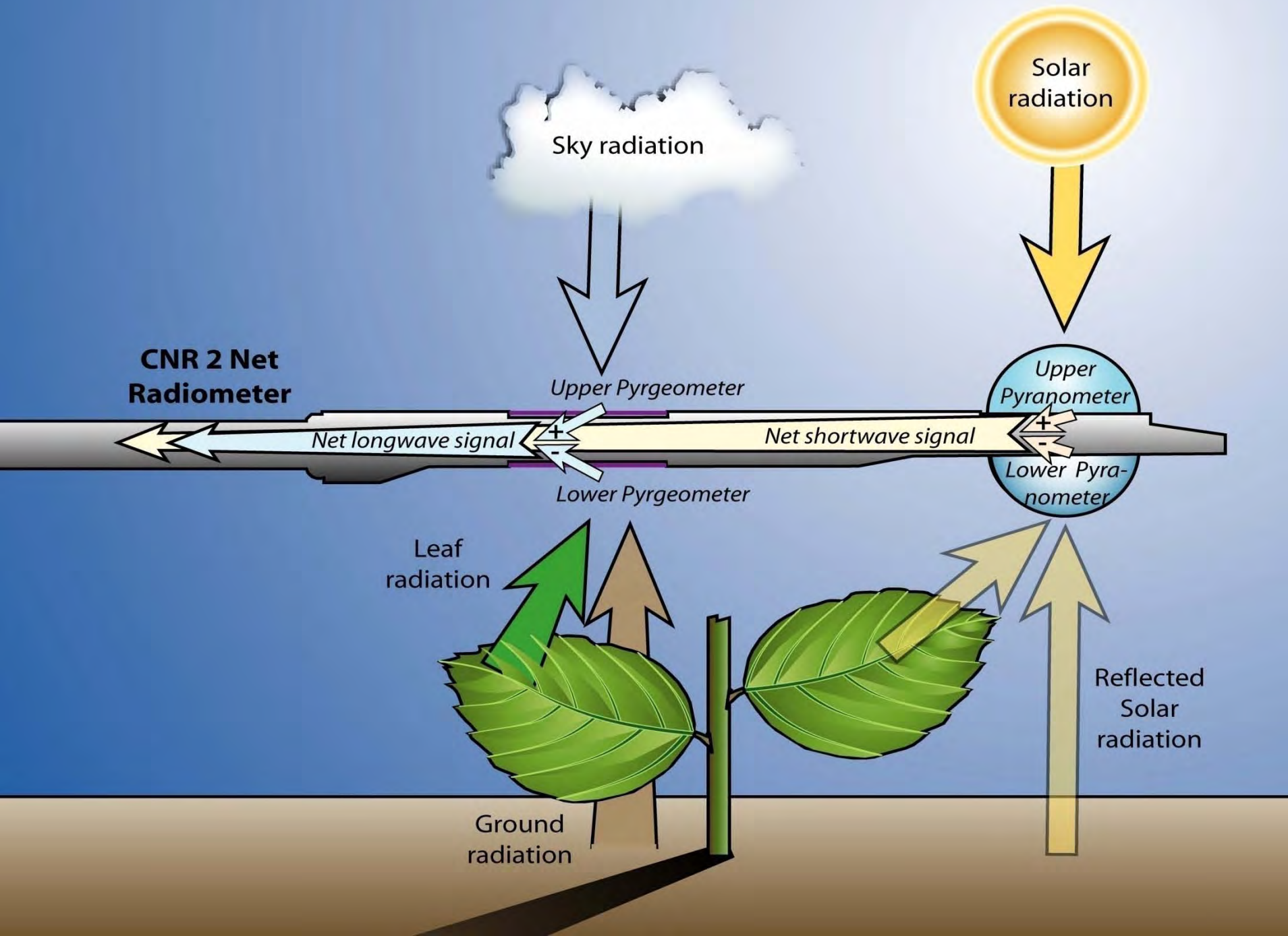


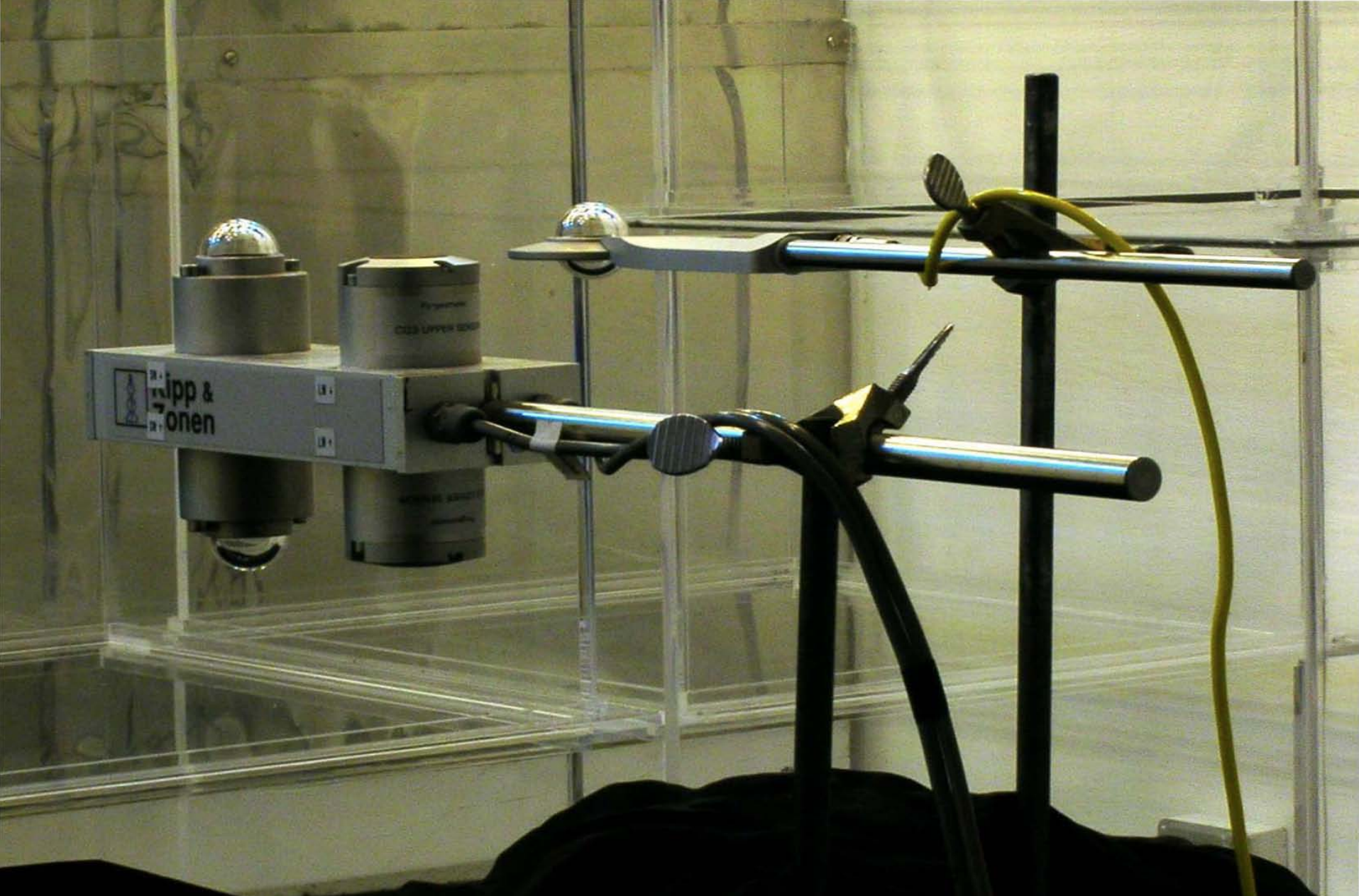
Model	Mean Slope	St. Dev. Slope
NR01	0.995	0.047
CNR 2	1.012	0.021
NR-Lite	0.951	0.012
Q*7.1	0.933	0.019

Kipp & Zonen CNR 2 Net Radiometer



- Four-way radiometer (four detectors), two net outputs (two thermopiles).
- NR-Lite and Q*7.1 are two-way radiometers (two detectors) with one net output (one thermopile).





CNR 2 Net Radiometer compared to CNR 1 Net Radiometer in growth chamber (HPS and MH lamps) at Crop Physiology Lab.



High Light
 $\Delta T = 2-5 \text{ }^\circ\text{C}$
(500 W m^{-2})

Low Light
 $\Delta T = 2-5 \text{ }^\circ\text{C}$
(250 W m^{-2})

**Upside
Down**
(250 W m^{-2})

Dark 1
 $\Delta T = 2-5 \text{ }^\circ\text{C}$
(0 W m^{-2})

Dark 2
 $\Delta T = 0 \text{ }^\circ\text{C}$
(0 W m^{-2})

CNR 1

**Net Short-
Wave**

427.0

225.0

-222.0

1.1

-0.5

**Net Long-
Wave**

2.0

-8.5

8.9

-9.8

-1.1

**Net
Radiation**

425.0

216.5

-213.1

-8.7

-1.6

CNR 2

**Net Short-
Wave**

422.0

218.0

-188.0

-5.9

0.8

**Net Long-
Wave**

8.0

-7.5

11.2

-13.1

1.1

**Net
Radiation**

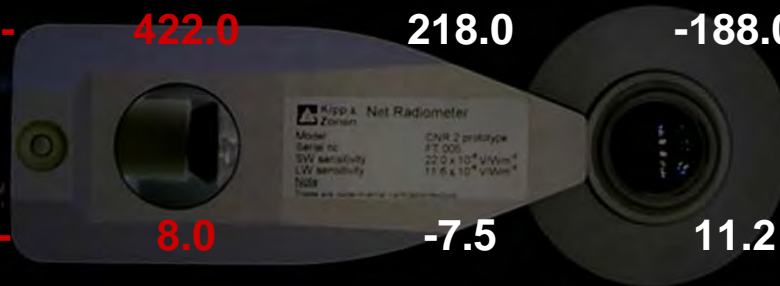
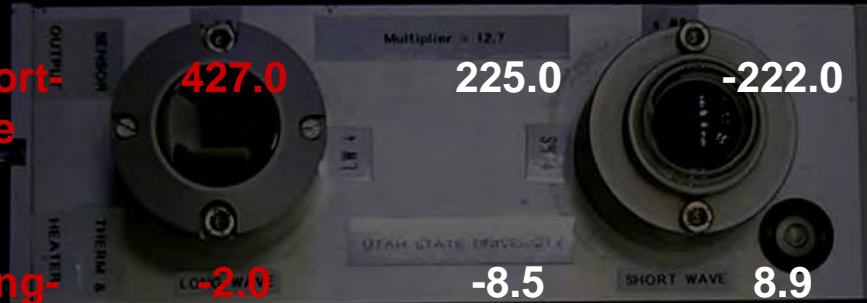
430.0

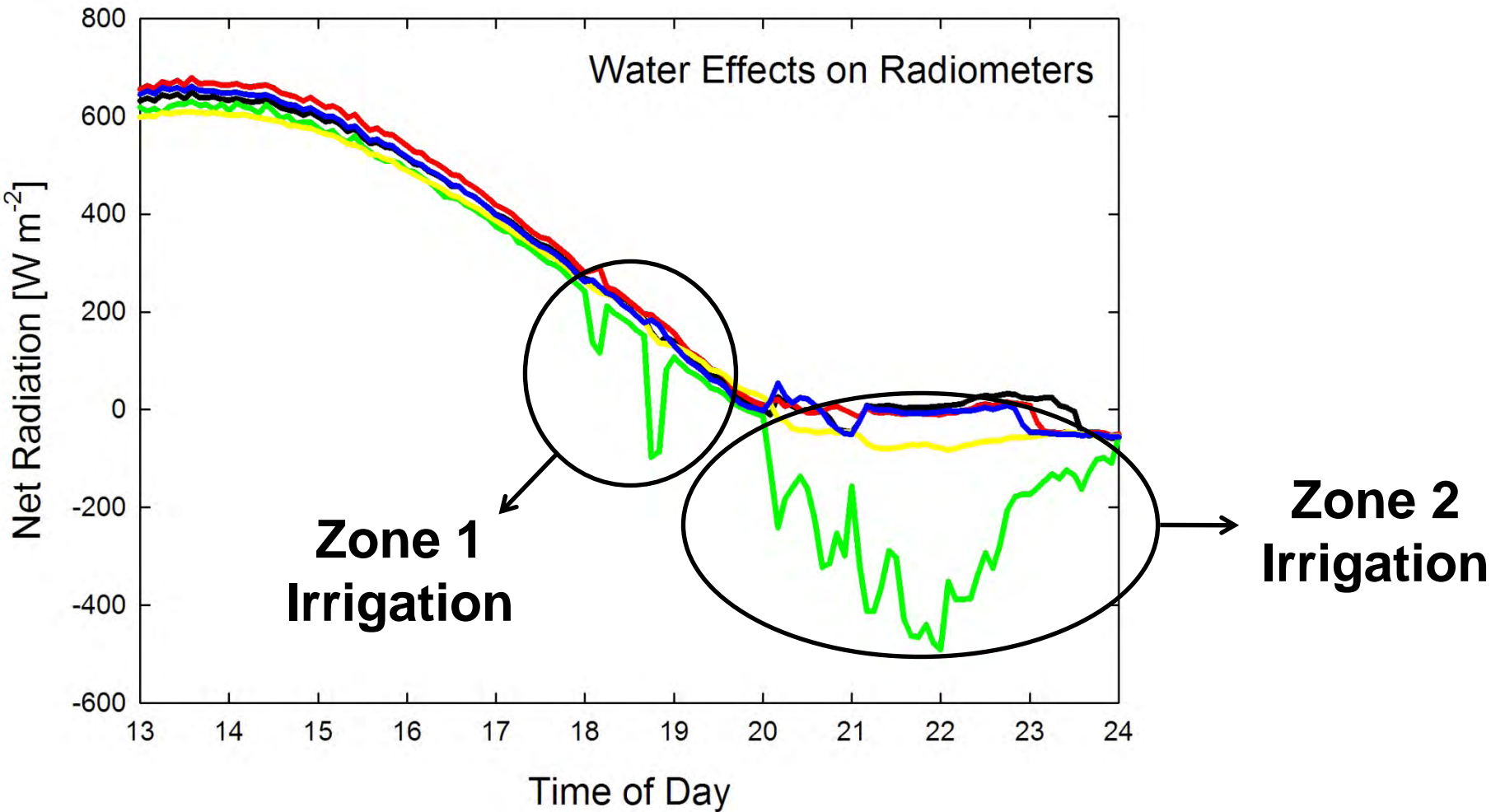
210.5

-176.8

-19.0

1.9





Blue = CNR 1, Black = NR01, Red = CNR 2,
Green = NR-Lite, Yellow = $Q*7.1$

Conclusions

- CNR 1 was the most accurate relative to the reference; waiting on recalibration.
- NR01 was accurate relative to the reference, but outliers (SW_o on 1006 and LW_i on 1007) caused high variability among reps.
- CNR 2 was accurate relative to the reference, but SW detectors are not matched as closely as LW detectors.
- NR-Lite had offsetting errors for day and night, resulting in reasonable, but low, values for daily total. It is less sensitive to LW compared to SW. Water on the detector surface makes the measurement unusable until complete evaporation.
- Q*7.1 had larger offsetting errors than the NR-Lite, also resulting in low daily totals. It is less sensitive to LW compared to SW.