NR01 cleaning test

I just used the opportunity of staging for ARTSE to evaluate the effect of not cleaning our radiometers during Perdigao. All of the Perdigao radiometers were packed without being cleaned, to enable this test to be done. However, it is possible that the stretchy film that is part of the NR01 packing may have wiped some stuff off of the domes. Two of these NR01s were brought back (by me) by hand – the rest are still in the seatainer.

Round 1 (27 Jul 2017)

Today (27 July), which is partly cloudy with boundary-layer Cu, we installed NR01 #7 at approximately 13:00 (local). At approximately 14:43, I cleaned it during a period when the sun disk was clear of clouds. The order was: wetting Rsw.in, Rlw.in, Rlw.out, Rsw.out, then wiping in the same order. At the end of this cleaning, I added water to the wetness sensor, left the water on for about 10s, and wiped it clean, just as an indicator flag. I ran rserial during this cleaning on a laptop.

From the rserial output, I see Rsw.in change from about 926 W/m2 before cleaning to 912 W/m2 after. Thus, the effect of the dirt/pollen/smoke/oil/etc. was an enhancement of incoming solar radiation by about 1.4%. Obviously, the primary effect of the dirt was to enlarge the image of the solar disk. This effect will be difficult to model and thus correct the data. It would have been a good idea to measure the direct and diffuse radiation separately. When I measure the other NR01, I'll also take data using the shadowing paddle.

Round 2 (1 Aug 2017)

Continuing the ARTSE piggy-back, also tested NR01 #12 at about 11:20 on 1 Aug 2017 with nearly clear skies. This time the procedure was:

- make sure data were being recorded on USB stick
- nevertheless, also logged data through minicom, with rserial running
- ran in clear skies for a while
- shaded Rsw.in for 20s with a paddle. (forgot this time that I should crouch down to prevent my head from being visible to radiometers)
- shaded Rlw.in for 20s with paddle
- added water to wetness sensor to indicate cleaning
- wetted and wiped Rsw.in
- same to Rlw.in (was visibly dirty)
- same to Rlw.out
- same to Rsw.out
- dry-wiped Rsw.in
- same to Rlw.in
- same to Rlw.out
- same to Rsw.out
- wiped dry the wetness sensor (showed total time cleaning was 175s)
- shaded Rsw.in for 20s with paddle
- shaded Rlw.in for 20s with paddle

All of this is to try to get the effect of cleaning separately for direct and diffuse radiation (though we don't expect much change on Rlw), since previous data showed that a correction model might need to treat direct and diffuse separately.

In this case, the results were:

- Rsw.in total before/after: 887/887 (no change)
- Rsw.in diffuse before/after: 101.5/102.5
- Rlw.in total before/after: 371.8/370.4
- Rlw.in diffuse before/after: 374/372

All of these changes are quite small, <1%. In the case of Rlw.in, my head in the field of view may have affected the results. Thus, this radiometer did not require this full procedure and we will not have to correct its data. Nevertheless, we should repeat this procedure on all the other radiometers when they return.

Also notable is that the diffuse effect on Rlw.in was small – under 2 W/m2 for a change in Rsw of 785 W/m2, or a "swcor" value of < 0.25%. The Epply PIRs we tested in 2003 had values from 0.2–1.9%. Thus, the NR01 Rlw is pretty good.

Round 3 (18 Sep 2017)

Approximately same procedure as Round 2, now with the remaining NR01s from the seatainer. All but 2 Rsw.in values were lower after cleaning, however most data were taken during the afternoon when light was decreasing. Time series were logged through minicom capture. I used yet another new paddle, this one with aluminum tape (shiny) towards the sun, electricians tape (black) towards the sensor.

The final table with the analysis so far:

Sensor ID	Rsw. in before	Rsw. in after	Extrapolated change	(before-change)/after (%)	Rsw diff before	Rsw diff after	Rlw before	Rlw after	before /after (%)	Rlw diff before	Rlw diff after	diff/normal before (%)	diff /normal after (%)
1	837.6	834.7	-2.0	0.6	69.5	65.3	365.3	360.9	1.2	362.5	359.0	-0.8	-0.5
2	750.0	736.5	25.0	-1.6	68.9	57.3	334.7	337.9	-0.9	336.8	347.3	0.6	2.8
3	861.2	858.5	-0.8	0.4	78.6	71.7	334.1	336.5	-0.7	340.0	340.4	1.8	1.2
4	688.5	669.2	14.9	0.7	68.2	58.4	355.4	352.5	0.8	353.6	349.7	-0.5	-0.8
5	834.4	835.0	-11.0	1.2	72.5	67.4	334.1	335.4	-0.4	336.0	339.7	0.6	1.3
6	850.1	844.0	-6.8	1.5	72.1	64.6	345.1	343.3	0.5	346.1	345.9	0.3	0.8
7	926	912	-	1.5	-	-	-	-	-	-	-	-	-
8	638.5	633.3	8.1	-0.5	62.6	54.3	347.8	347.5	0.1	349.7	348.8	0.5	0.4

9	721.0	713.9	11.7	-0.6	67.3	64.1	335.8	336.8	-0.3	341.8	343.2	1.8	1.9
10	728.5	715.4	11.4	0.2	65.4	58.3	346.4	347.5	-0.3	349.6	351.9	0.9	1.3
11	623.0	606.0	1.0	2.6	61.6	53.7	340.3	341.7	-0.4	339.8	338.6	-0.1	-0.9
12	887	887	-	0.0	101.5	102.5	371.8	370.4	0.4	374	372	0.6	0.4
13	681.0	662.2	13.7	0.8	68.4	63.0	342.6	343.7	-0.3	344.9	346.0	0.7	0.7
14	854.6	858.3	-20.7	2.0	74.0	69.5	338.2	339.1	-0.3	336.9	339.9	-0.4	0.2

These data support the following conclusions:

1. The maximum change in Rsw.in due to cleaning was 2.6%.
2. The sense of all but 3 of the Rsw.in errors was less radiation after cleaning. Thus, the "sparkle" effect seems to have dominated over shading.
3. The maximum change in Rlw.in due to cleaning was 1.2%. Most changes were quite small and were both positive and negative, i.e. not systematic.
4. The maximum change of Rlw.in due to direct shading (the "f" correction) was 2.8%, but all but 2 sensors showed an increase of Rlw with decreasing Rsw. This suggests that the difference was due to the measurement method (paddle being too close?). I don't understand this result.
5. Cleaning did not have a <major> change on the f-correction values.

Overall, not terrible results, though radiation to 2% certainly isn't up to our usual standards. My time trend analysis could be improved, but probably won't change the general trend here.

Next step – repeat these tests on the 4-component sensors!