Third International Conference **CONSOLFOOD**2020

Advances in Solar Thermal Food Processing

22-23-24 January 2020

INSTITUTE OF ENGINEERING; UNIVERSITY OF ALGARVE; CAMPUS DA PENHA; FARO-PORTUGAL

Thermo-optical performance of a solar funnel cooker

Carrillo-Andrés, A.[1], Apaolaza-Pagoaga, X. [1], Ruivo C. [2], Serrano-Casares, F. [1], Domínguez-Muñoz, F. [1]

[1] University of Málaga (Spain)
[2] University of Algarve (Portugal)

The study

Funnel solar cookers are simple, effective and have multiple advantages

But there is limited data available in scientific literature about their thermo-optical performance

Study parts:

1-Analyze the optical performance (Antonio Carrillo's presentation)

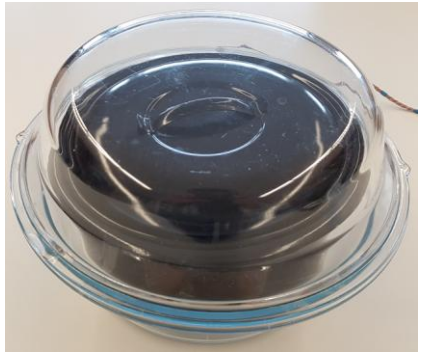
2-Thermal model (work in progress)

3-Experimental study

Experimental setup: Funnel solar cooker

3 identical solar cookers

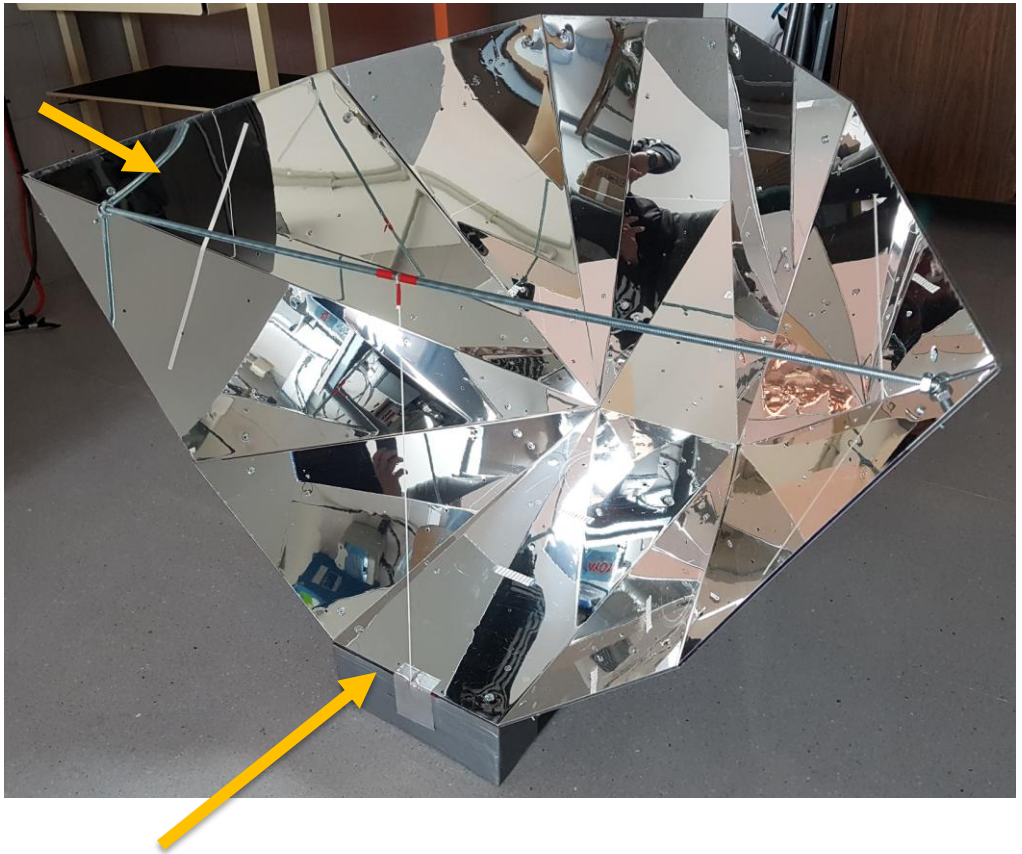
Panels-Funnel



Receiver

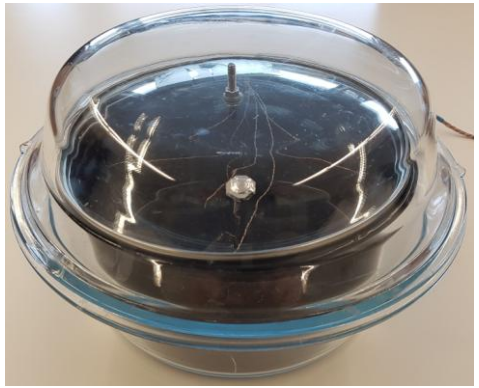
Experimental setup: Panels-Funnel

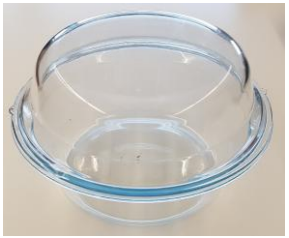
Material:
-Aluminium composite panel
-Reflectance: 0.85



8cm thickness XPS insulator

Experimental setup: Receiver





Washing machine door glass
Mass: 2239g

Pot
Mass: 580g
Height:10cm
Diameter:20cm
Capacity:2,5l

Optical properties (Work in progress)
- Emissivity
- Absorptivity
- Reflectance
- …

Metallic pot cover
Mass: 252g

Glass pot cover
Mass: 372g

Materials and methods: Instrumentation

Temperature measurement sensors

- 5 Thermocouples in water
- 1 TC air
- 3 TC pot
- 1 TC pot cover

Local weather station

-Horizontal global radiation pyrometer
-40º global radiation pyrometer
-Ambient thermometer
-Anemometer

Weather station

Materials and methods: methods

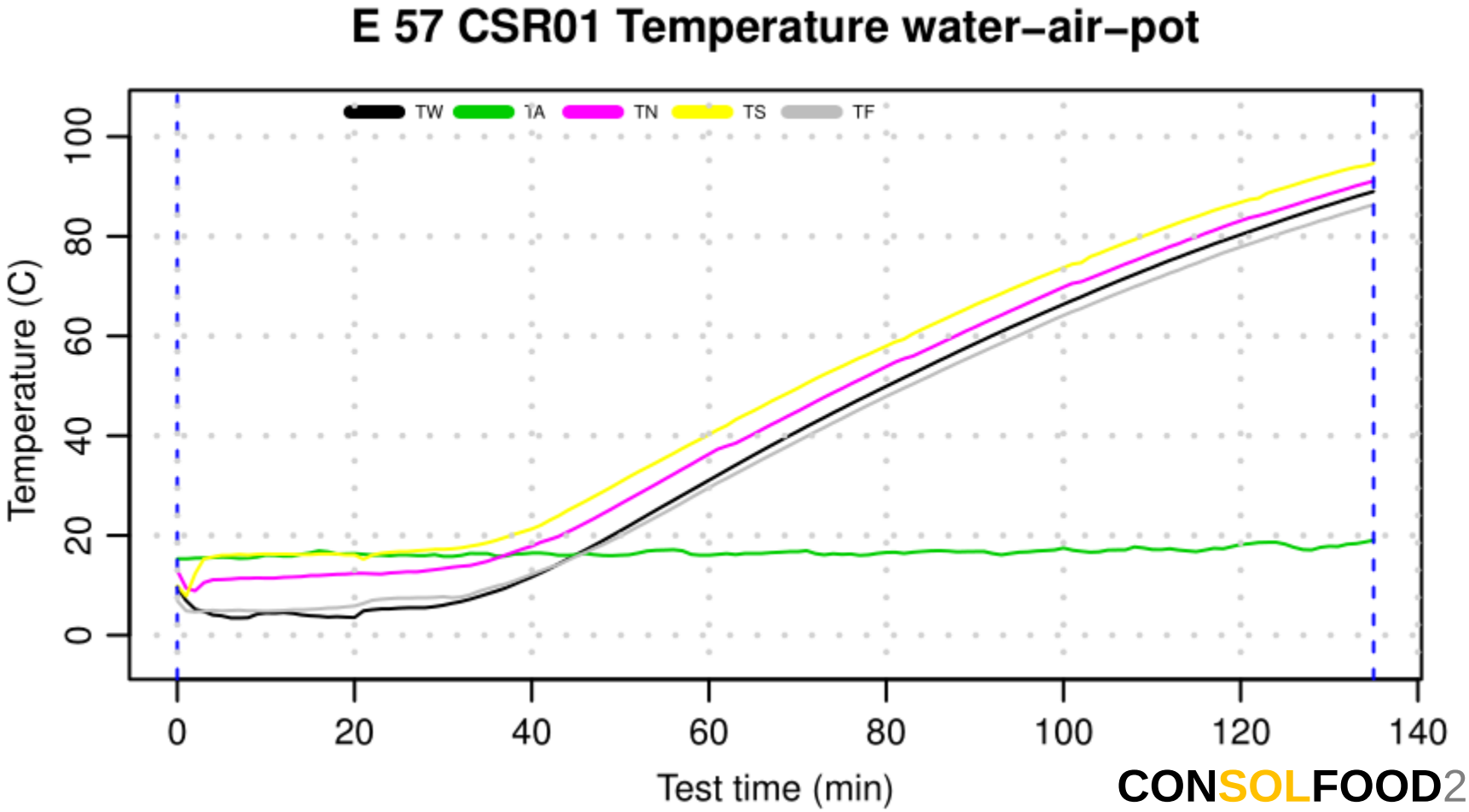
Standard: ASAE S580 (Ref. Funk 2000)

Most Important variables

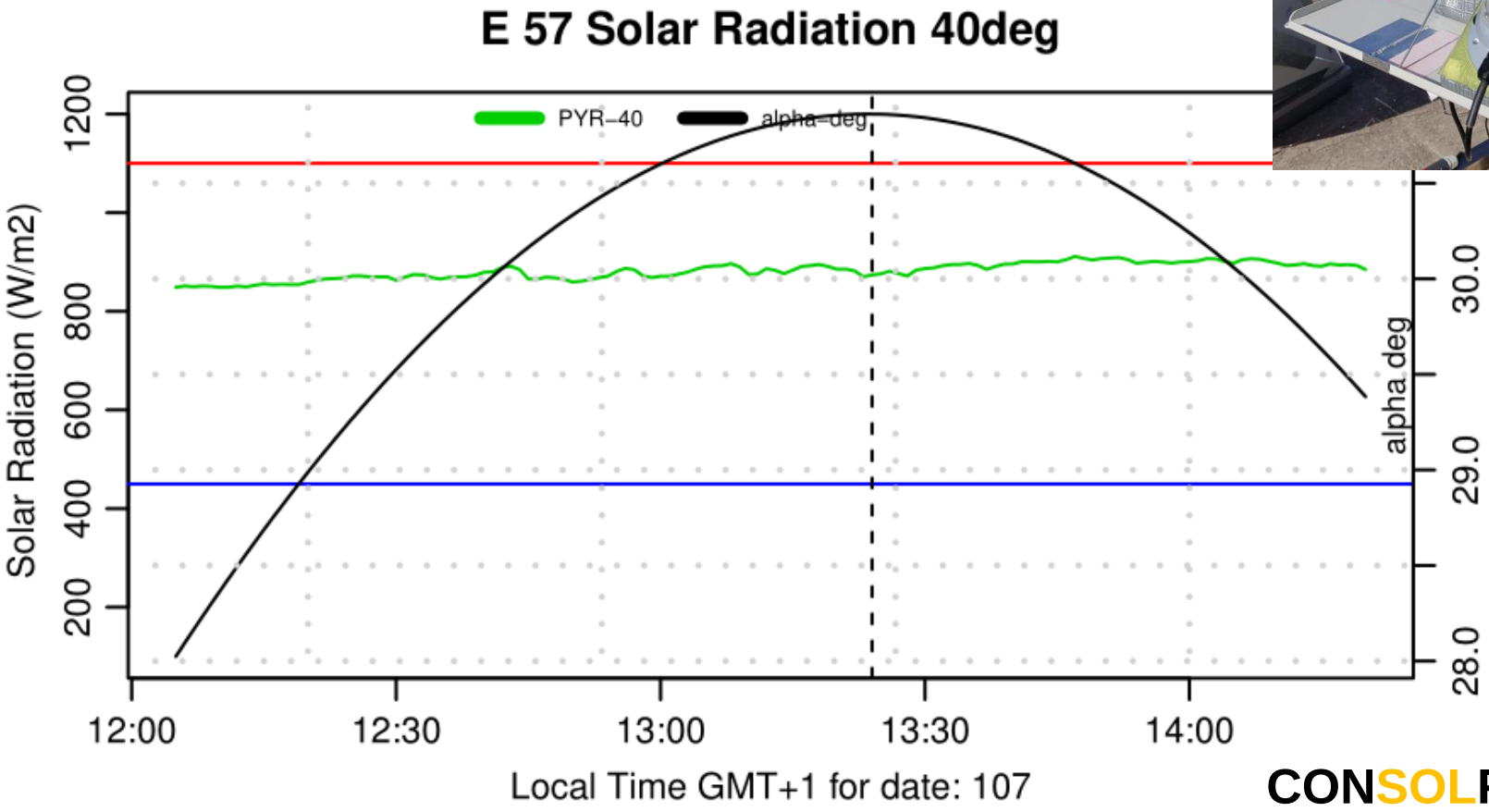
Uncontrolled (weather) variables

- Wind (avg. less than 1.0m/s & max less than 2.5m/s)
- Insolation (between 450W/m2 -1100W/m2 & variation less than 100W/m2 during a 10-min)
- Solar altitude and azimuth (between 10:00 and 14:00 solar time)

Materials and methods: test data



Materials and methods: test data



Materials and methods: test analysis

Analyze of the results according to the standard (ASAE S580, Ref. Funk 2000)

- Calculating cooking power

$$P_i = \frac{T_2 - T_1}{600} * m * C_{pw}$$

- Standardizing cooking power (to be corrected to standard insolation of 700 W/m2)

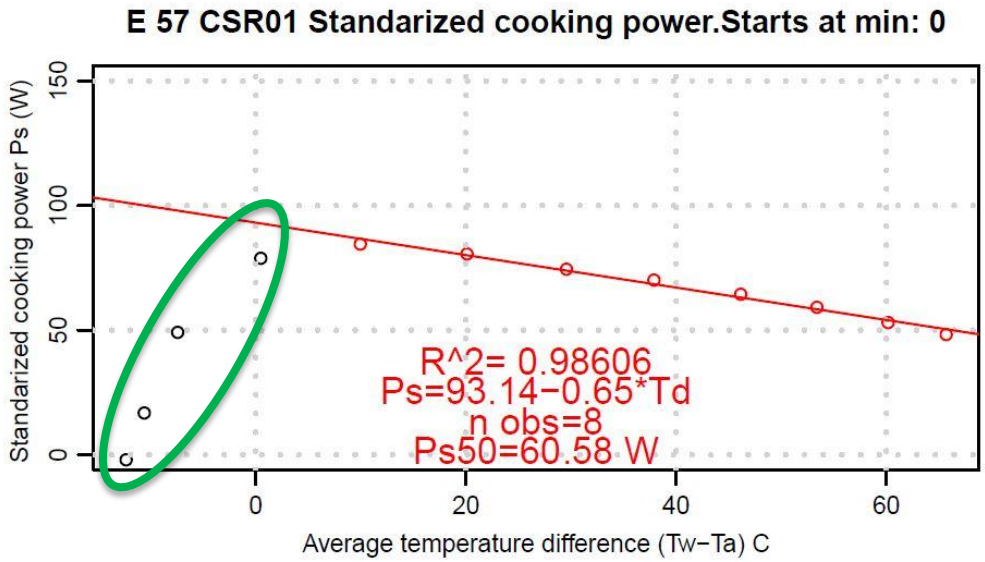
$$P_{si} = P_i * \frac{700}{G_i}$$

G_i : average insolation i $(\frac{W}{m^2})$.

Materials and methods: test analysis

Protocol: ASAE S580 (Ref. Funk 2000)

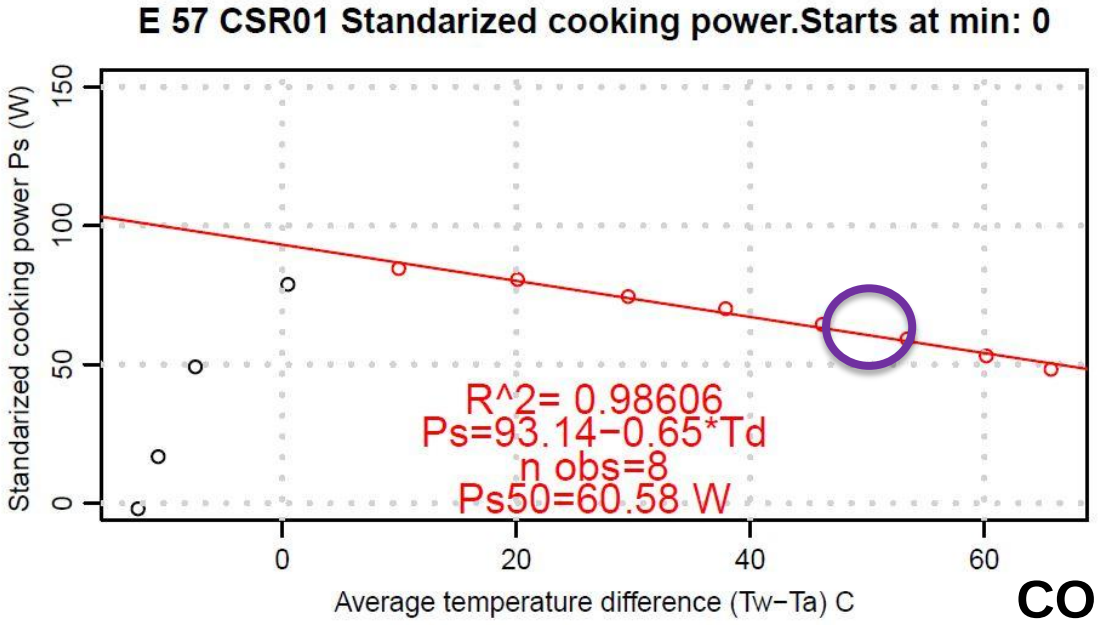
- Plotting (The standardized cooking power (W) is to be plotted against the temperature difference (ºC))
- - A linear regression



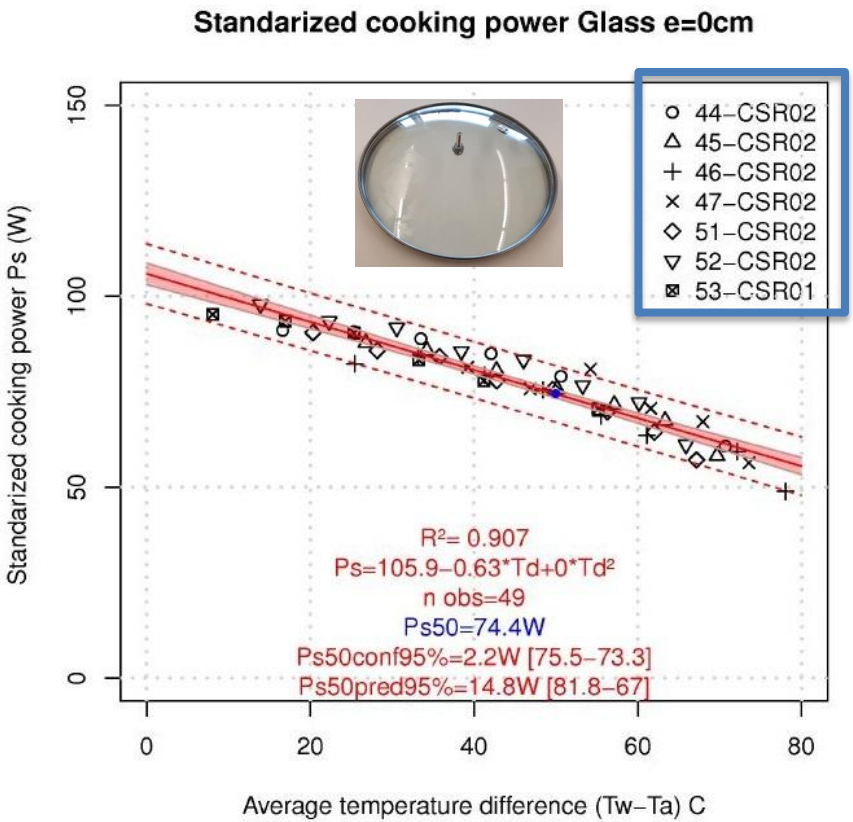
Materials and methods: test analysis

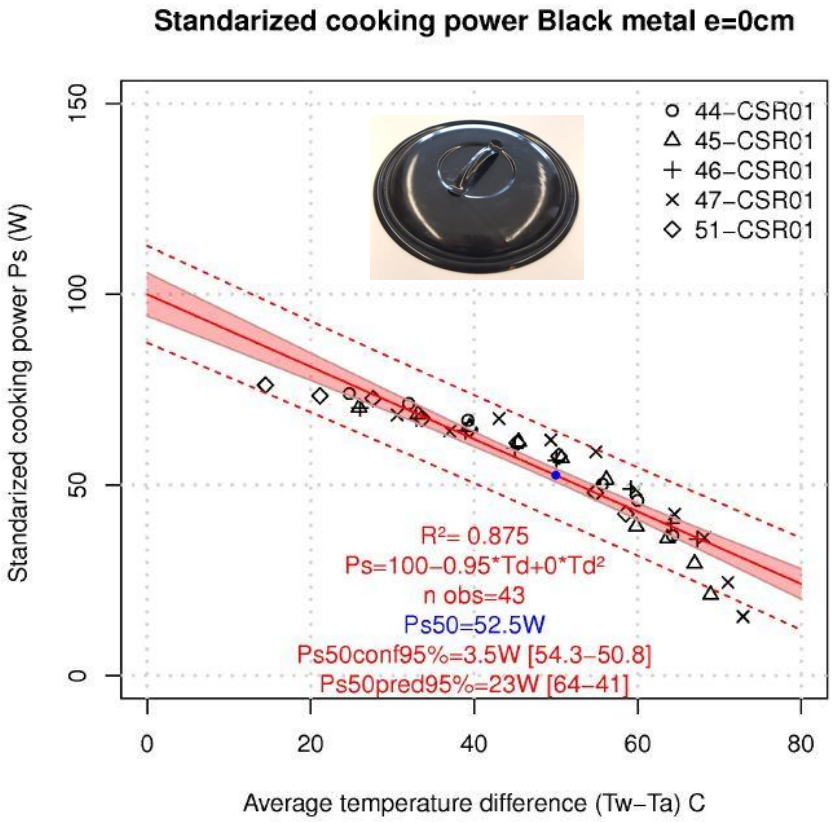
Protocol: ASAE S580 (Ref. Funk 2000)

- Single measure of performance (The value for standardized cooking power (W) is to be computed for a temperature difference of 50ºC)

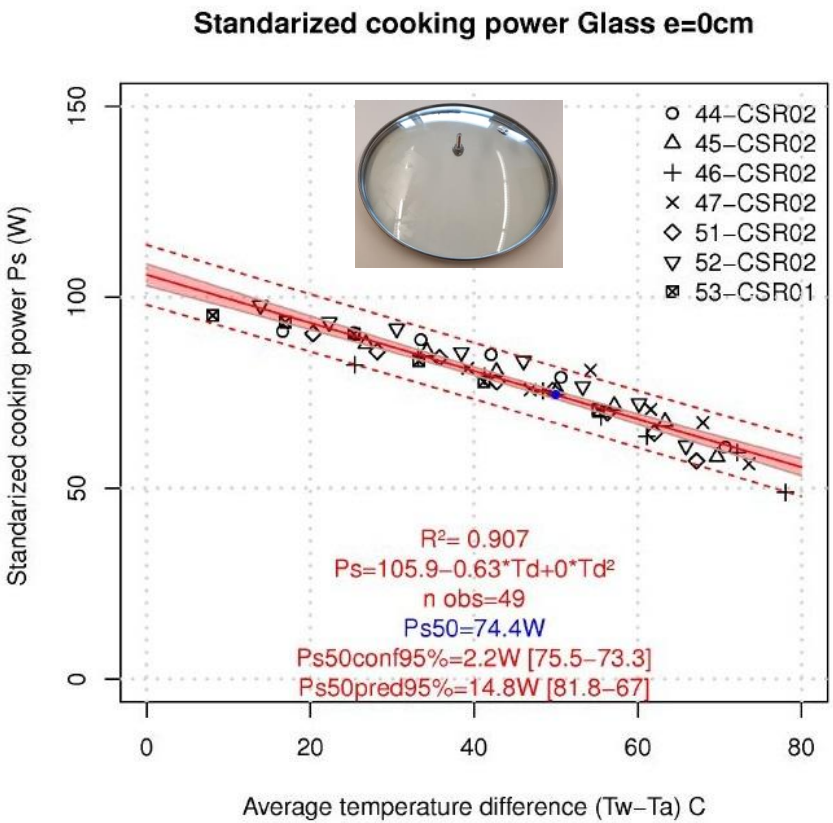


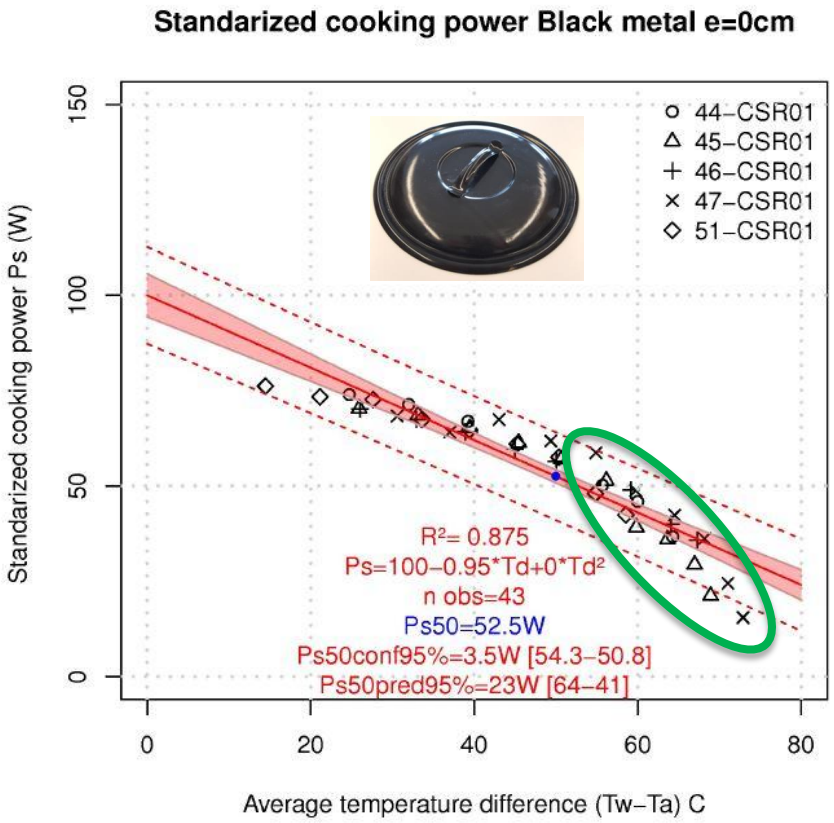
Experimental Results



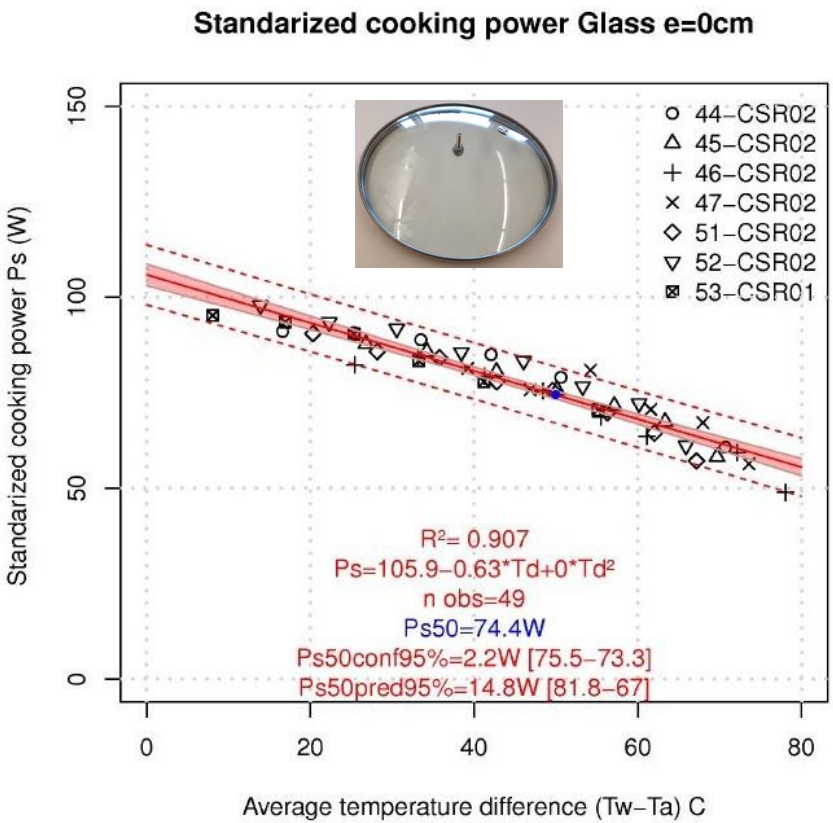


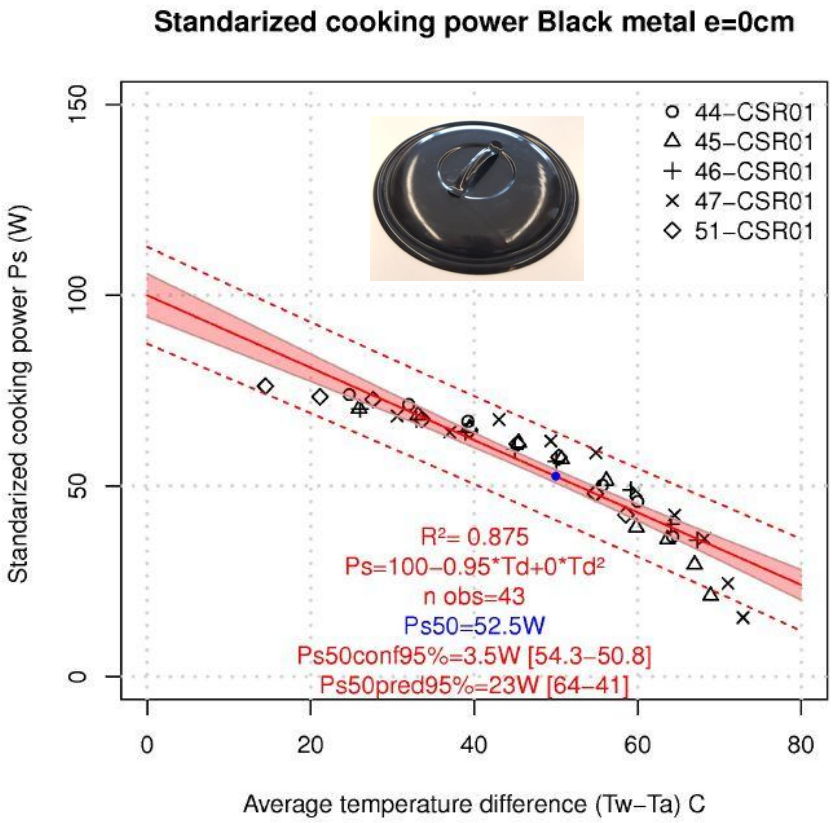
Experimental Results





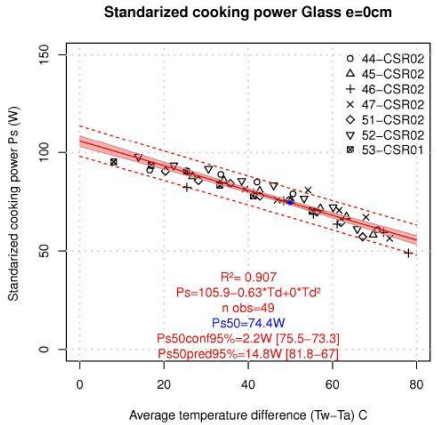
Experimental Results

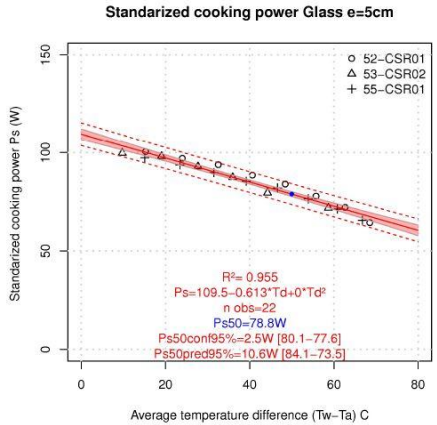


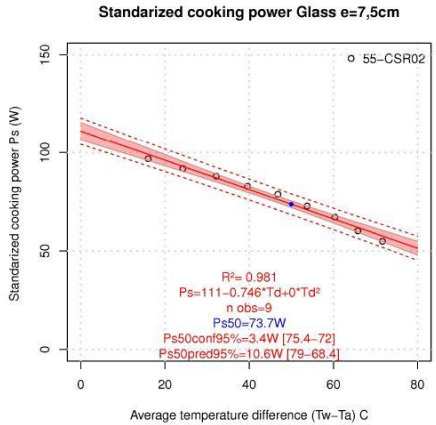


Experimental Results

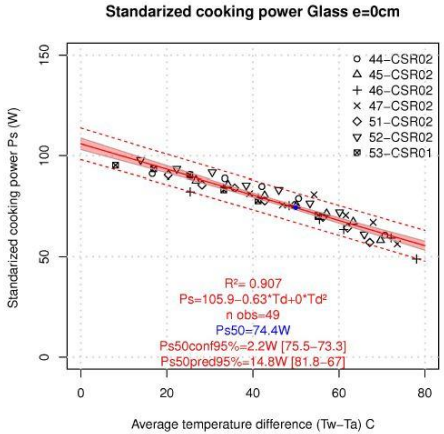
Receiver s have been raised

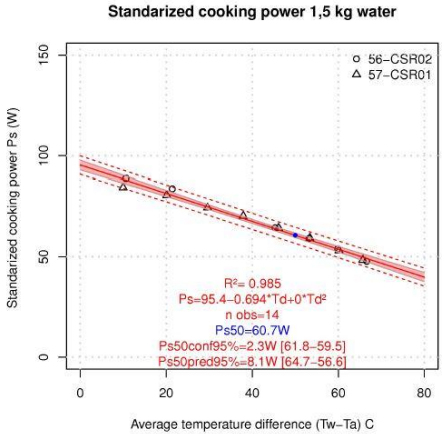


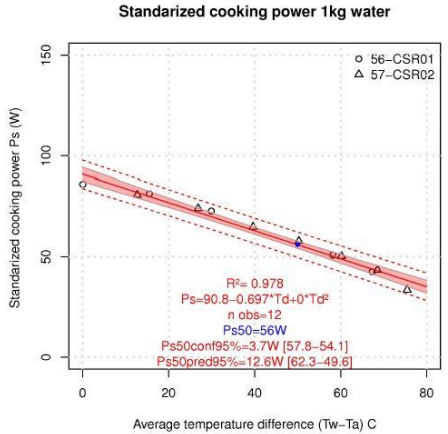




Different water loads







Conclusions and perspectives

- Thermal performance parameters for several configurations of a typical solar funnel cooker have been determined following standard ASAE S580.
- Results are robust and repeatable
- Configuration with glass cover and elevated receiver performs better
- Thermal performance is better with high water load
- Future work: characterize other configurations such as summer configuration, different fluids, receivers, reflector area, materials, etc.