Skin Temperature Measurements for the Saildrone

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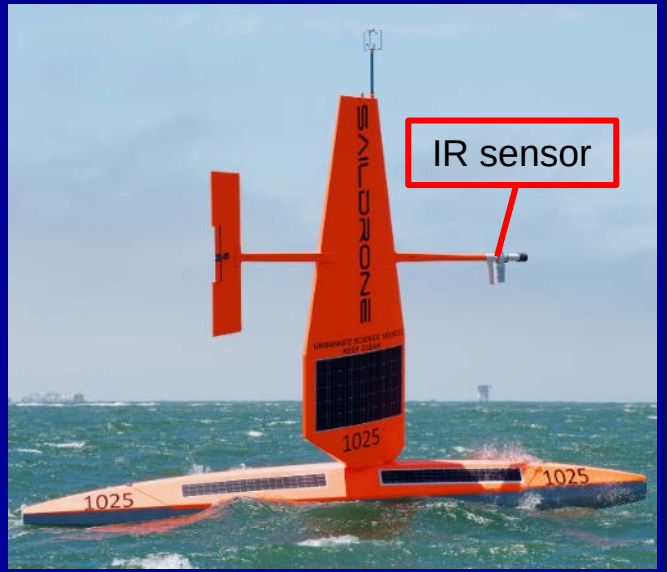
Richard Jenkins, Saildrone

Challenges for T_{skin} from saildrone

- Downlooking radiometer only
- No external calibration
- Large effective θ_{inc} range
  - Heel angles up to 40º
  - Angle varies with boom position
- Need low power, simple operation



saildrone

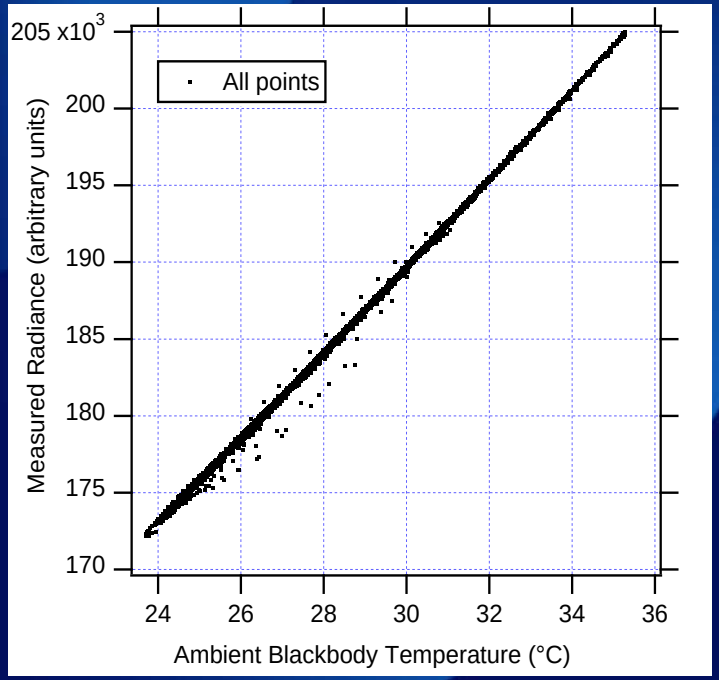
Calibration

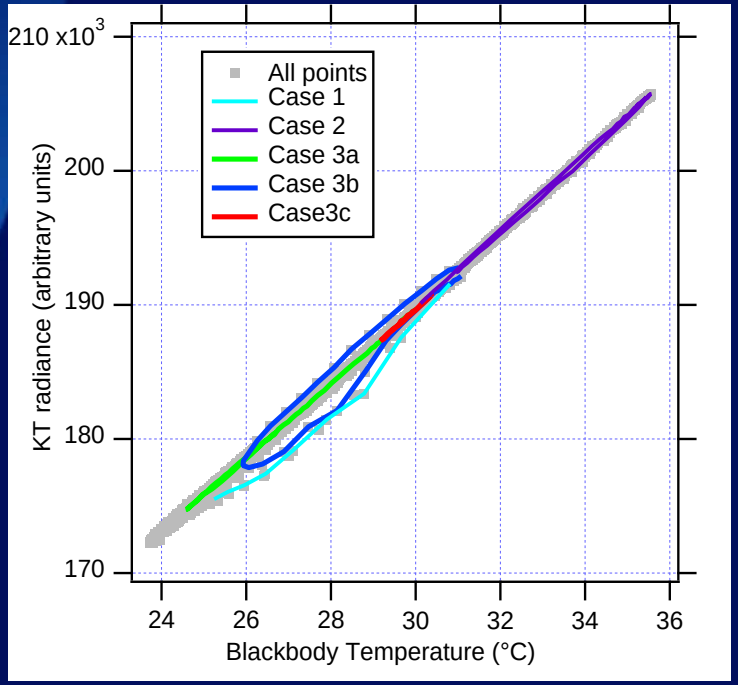
- Simplify Calibration
  - Not enough power for hot BB
  - Is ambient BB only adequate?
- Use 2016 SPURS-2 ROSR data
  - Examine performance using ambient BB only
  - Suggest improved stability over past 20 years
  - Brief comparison with saildrone

Sky Measurement

- Add separate uplooking radiometer
  - No mirror (power, weather, simplify)
  - Uncalibrated, modify lens
  - Allows better downlooking protection
- Test of bow mounted sensors in 2019
  - Chosen to mitigate additional boom angle effect
  - $\theta = 50^{o}$

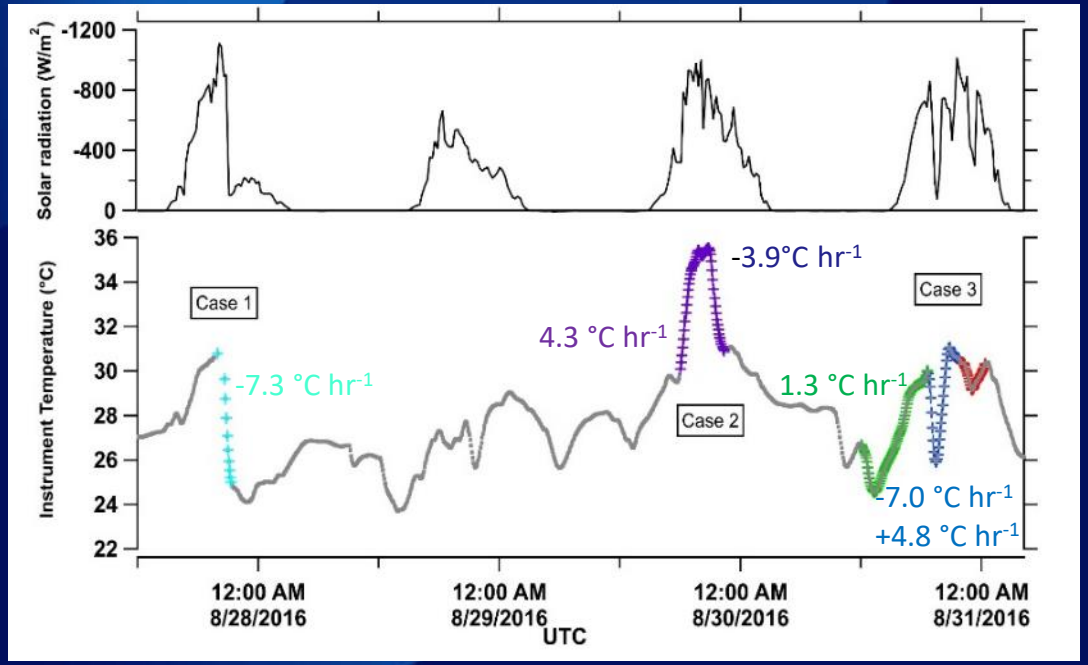
ROSR Ambient BB Calibration

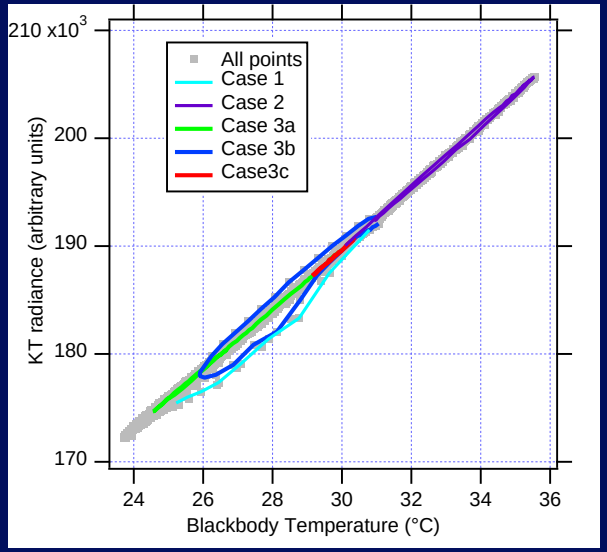




SPURS-2 Cruise: 36 days, over 10,000 measurements

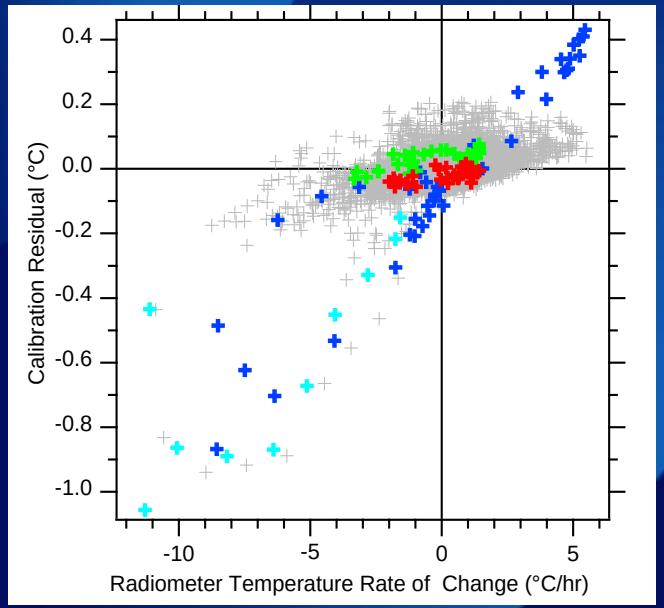
Drift with $T_{instrument}$ Rate of Change

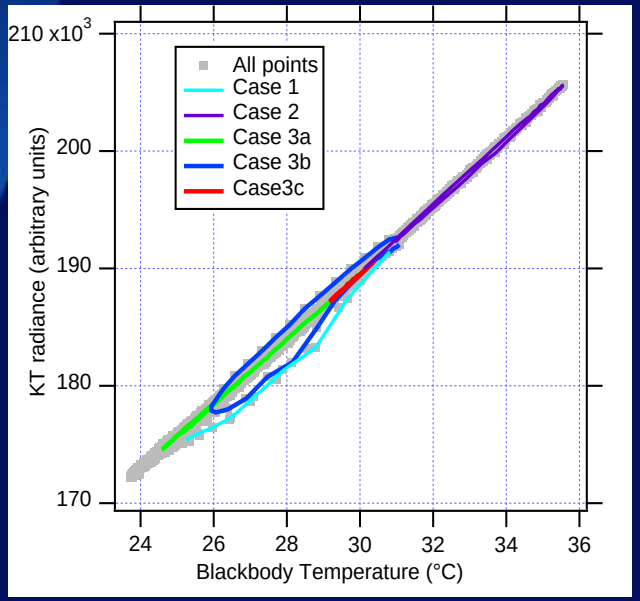




Stable for ± 4.5 °C hr^{-1}

Residual vs Rate of Change



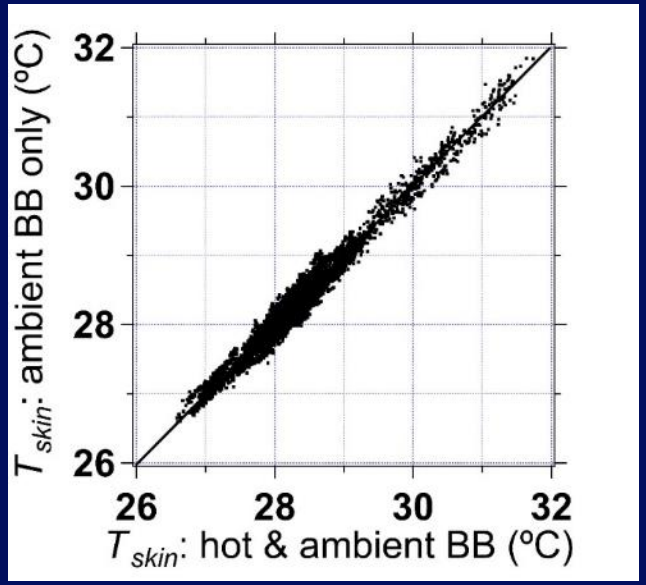


Residual from linear fit to calibration data

ROSR: 1-pt vs 2-pt Calibration

SPURS-2 Cruise

Mean difference:	-0.03 °C
Std. Deviation:	0.13 °C
Minimum:	-0.45 °C
Maximum:	0.42 °C



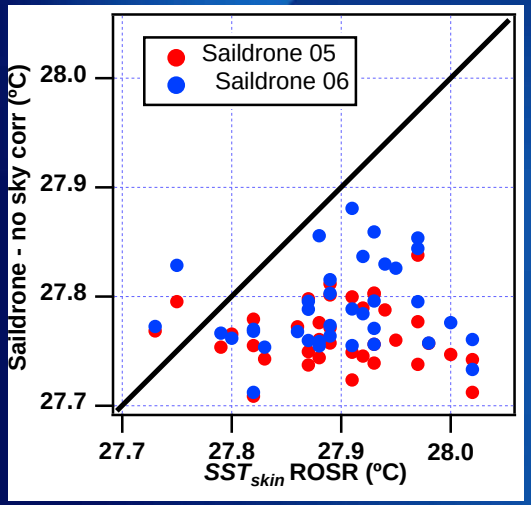
Comparable to intercomparison of independent instruments

Quantity	Mean	Std dev	Min	Max
$T_{ISAR} - T_{CIRIMS}$	0.00	0.13	−0.64	0.52
$T_{ISAR} - T_{MAERI}$	−0.08	0.15	−0.84	1.01
$T_{MAERI} - T_{CIRIMS}$	0.08	0.15	−1.15	1.10

Jessup and Branch [2008]

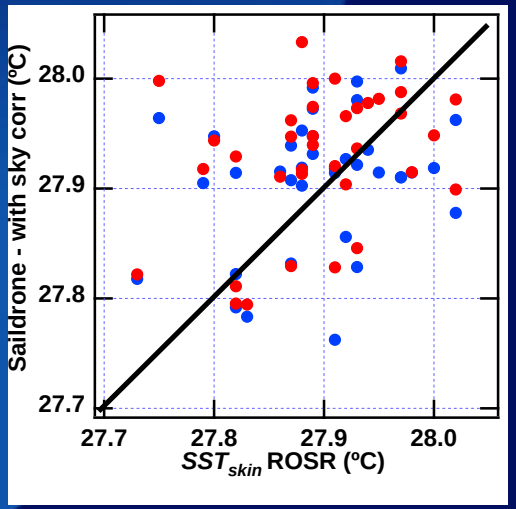
T_{skin}: Saildrone versus ROSR

T_{bright}



RMSE: 0.15 & 0.13 °C

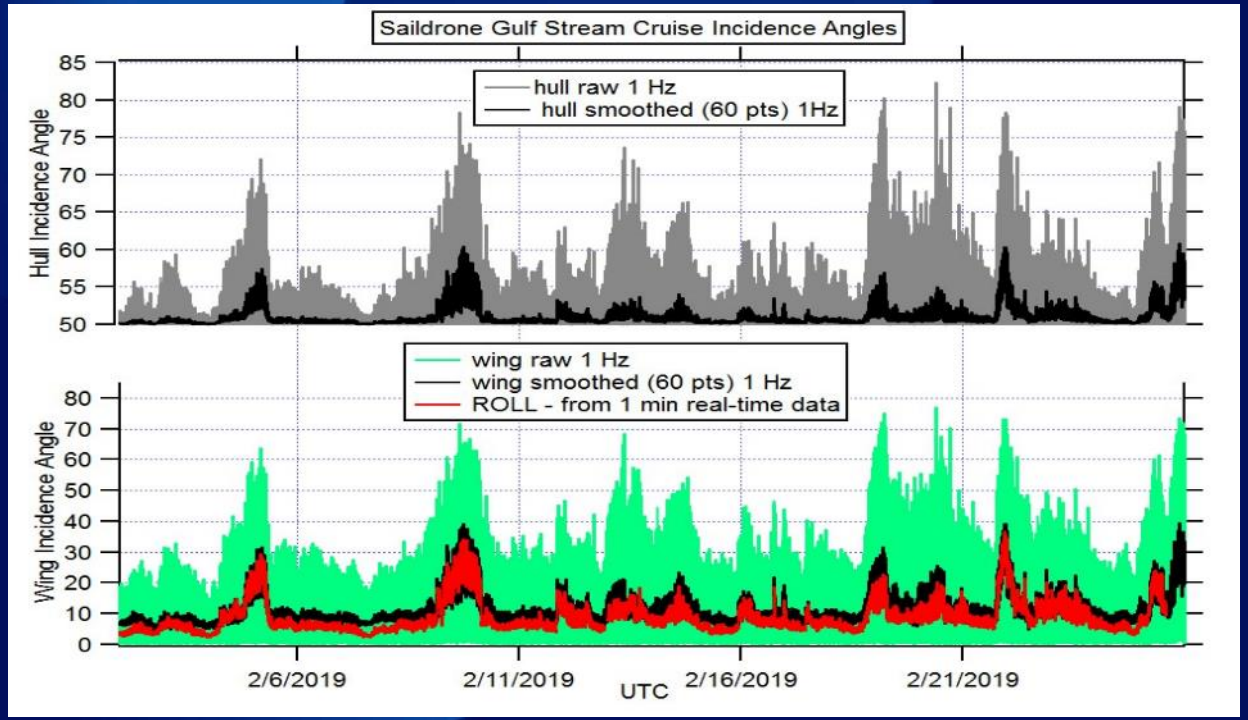
T_{skin}



RMSE: 0.09 & 0.10 °C

- Factory calibration
- Saildrone sky correction using ROSR sky data

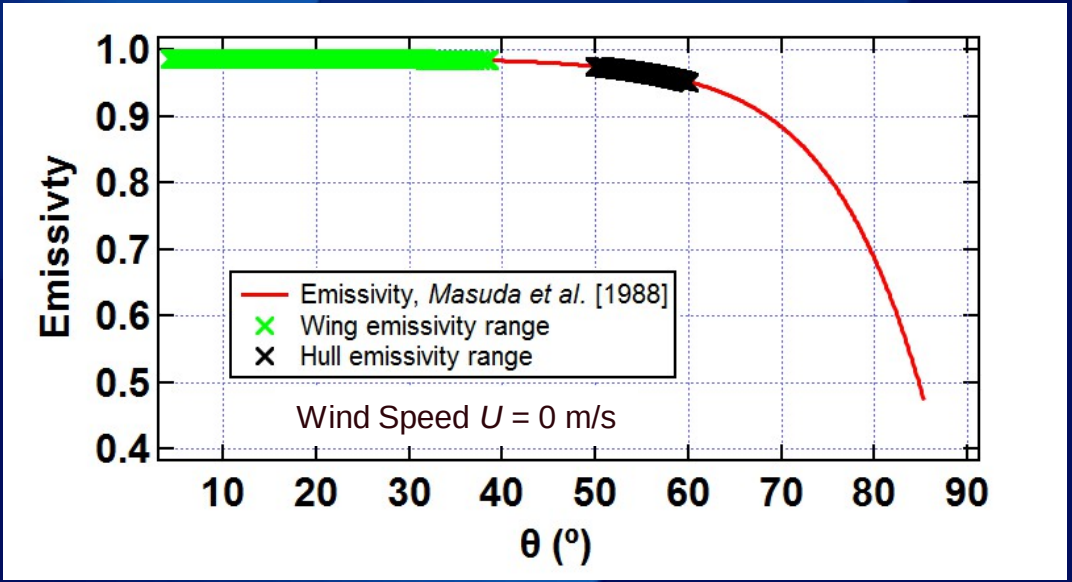
Effective θ_{inc} for Wing and Hull

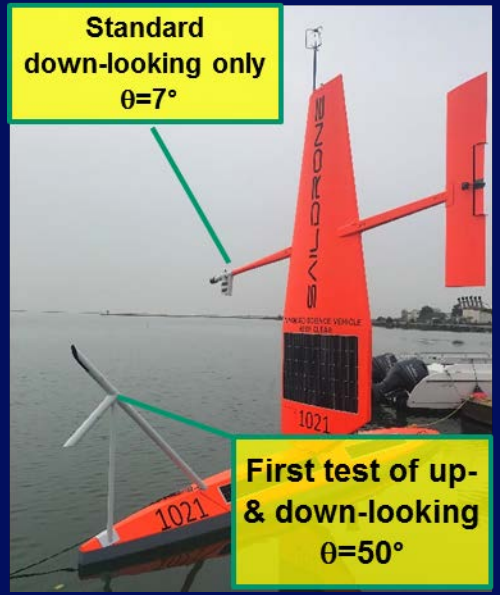


Derived from IMU

Gulf Stream Cruise: 1 month

T_{skin} from Wing versus Hull

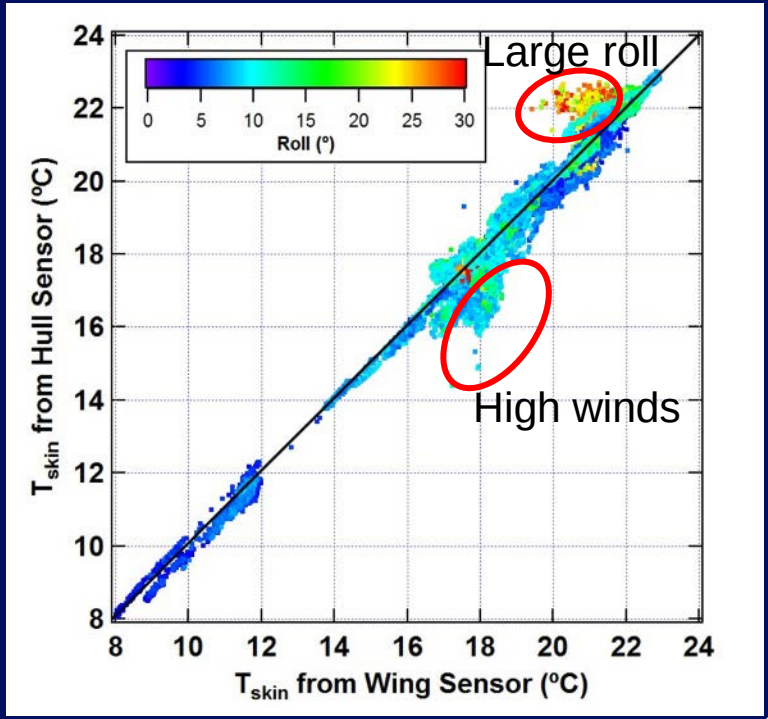




T_{skin} from Hull versus Wing

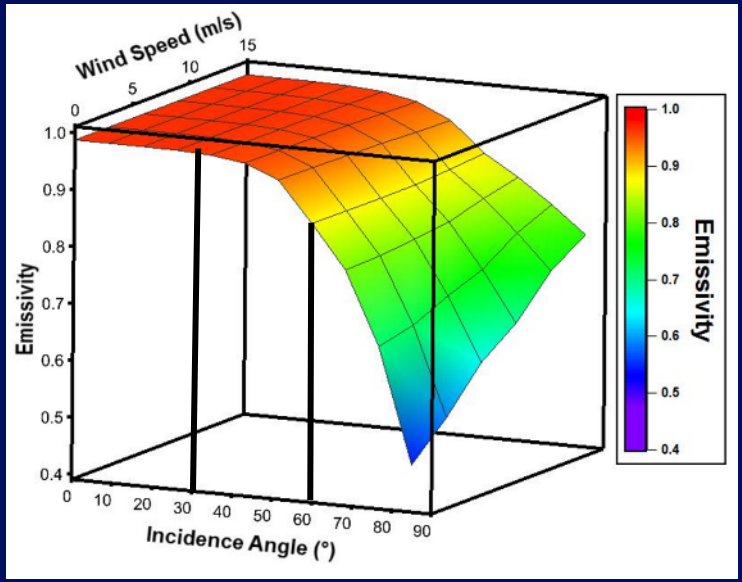
Sky correction using hull measurement

- Mean Difference: 0.08 ºC
- Standard Deviation: 0.40 ºC
- Greatest difference
  - Large roll
  - High wind speed
  - Likely emissivity effect



Emissivity Effects

- Decreases with θ
- Wind speed *U* dependence
  - 0-30º : negligible effect
  - 30-60º: decreases with *U*
  - > 60º : increases with *U*



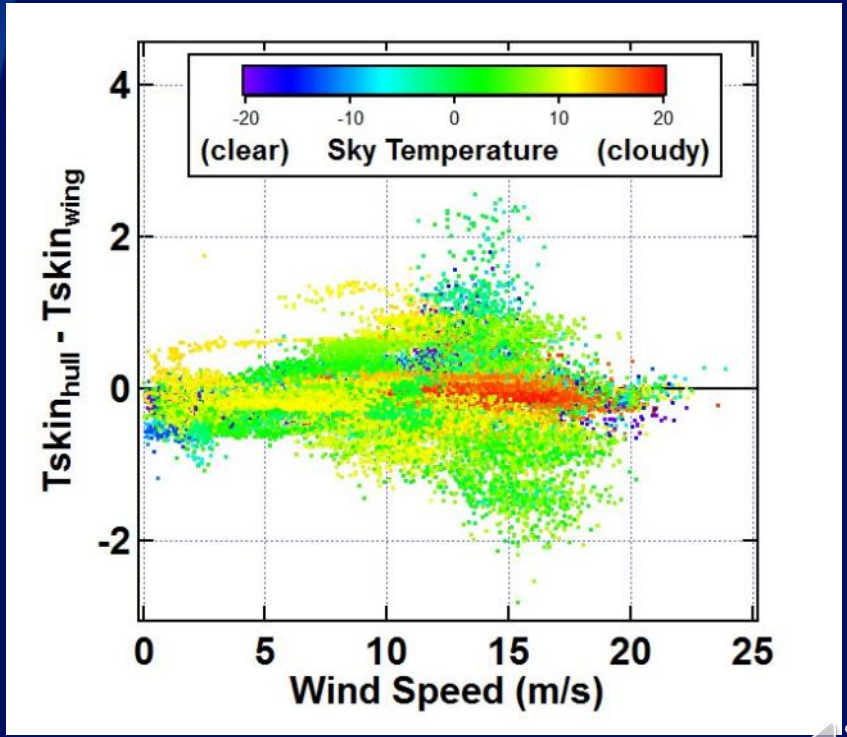
Sky Correction at High Winds

Cloudy or clear:

Minimal effect

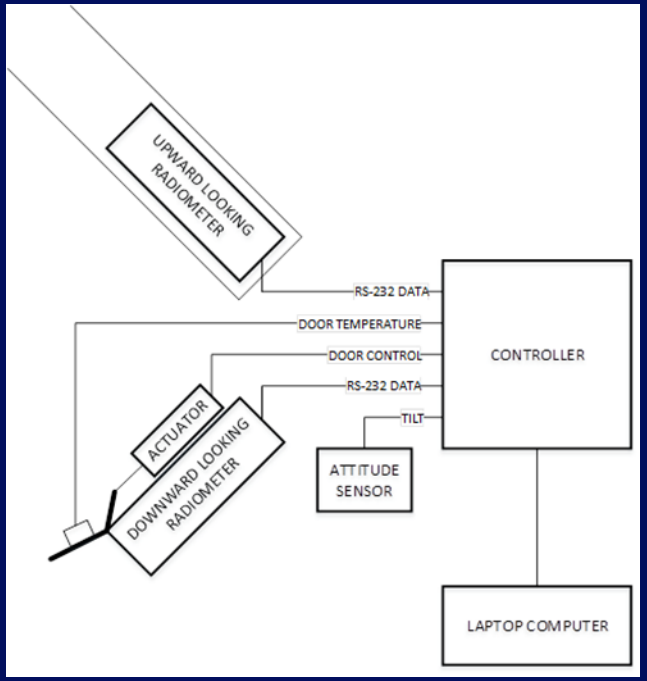
Partly cloudy:

Large +/- errors



Conclusion

- Sensor stability suggests ambient BB calibration adequate
- Housing for radiometer with door for ambient BB calibration
- Wing location minimizes heel effect due to smaller θ
- Saildrone plans to add an uplooking wing radiometer
- Prototype under development for simplified calibration system



BB on door