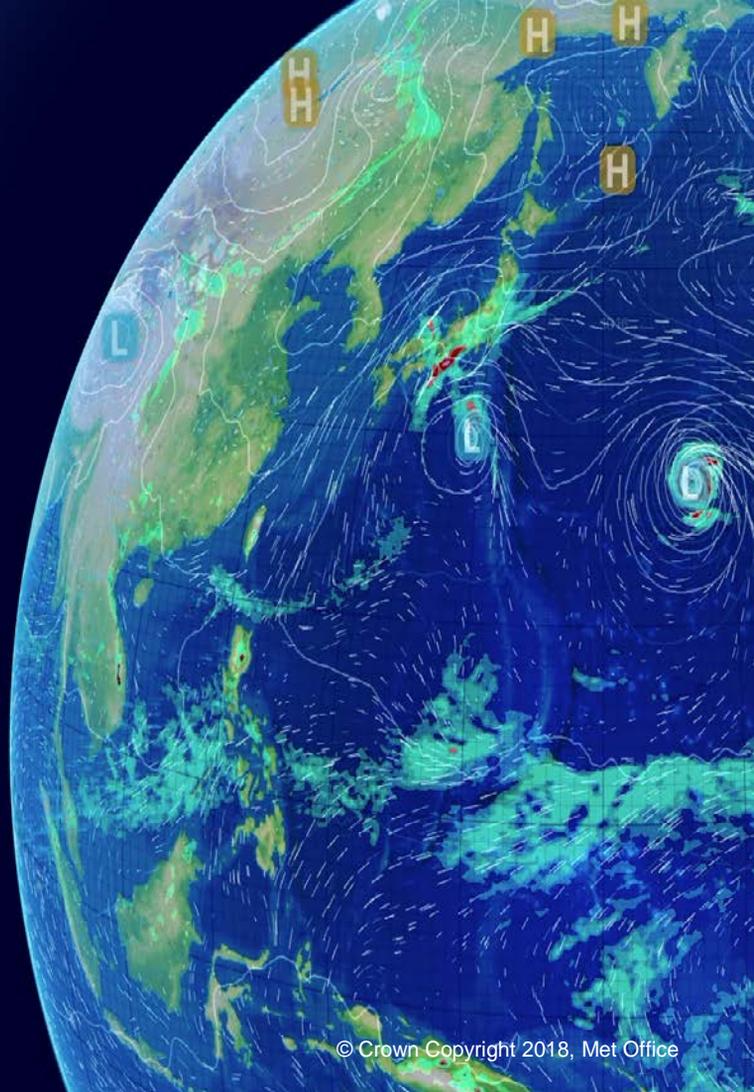


# Met Office RS92 to RS41 Transition Results

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Singapore, ICM-11

22<sup>nd</sup> May 2019



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# Tender Intercomparison Trial

- Initial intercomparison trials at Camborne in Aug-Sept 2015 as part of tender. Data submitted for comparison with NWP
  - 20 day, 18 night **RS92/RS41/Other** triple rigs successfully flown
  - 5 day, 5 night **RS92/RS92/RS41/RS41** quad rigs flown
  - 5 day, 5 night **RS92/RS92/Other/Other** quad rigs flown
  - 3 ozone day **RS92/RS41/Other** sequential flights flown
- RS41-SG was chosen to replace the RS92-SGPA in the UK and overseas (15 stations total)

# Triple Rig

(See SAT trial section for comparisons)

# Quad Rig

Day T	RS41-RS41	Mean diff -0.00 K	★	St.dev 0.09
Night T	RS41-RS41	Mean diff +0.01 K	★	St.dev 0.04
Day T	RS92-RS92	Mean diff -0.02 K		St.dev 0.20
Night T	RS92-RS92	Mean diff -0.02 K		St.dev 0.14
Day RH	RS41-RS41	Mean diff +0.04 %	★	St.dev 0.51
Night RH	RS41-RS41	Mean diff -0.03 %	★	St.dev 0.41
Day RH	RS92-RS92	Mean diff +0.36 %		St.dev 1.17
Night RH	RS92-RS92	Mean diff +0.66 %		St.dev 1.02
V	RS41-RS41	Mean diff -0.00 ms <sup>-1</sup>		St.dev 0.13
V	RS92-RS92	Mean diff -0.00 ms <sup>-1</sup>		St.dev 0.10

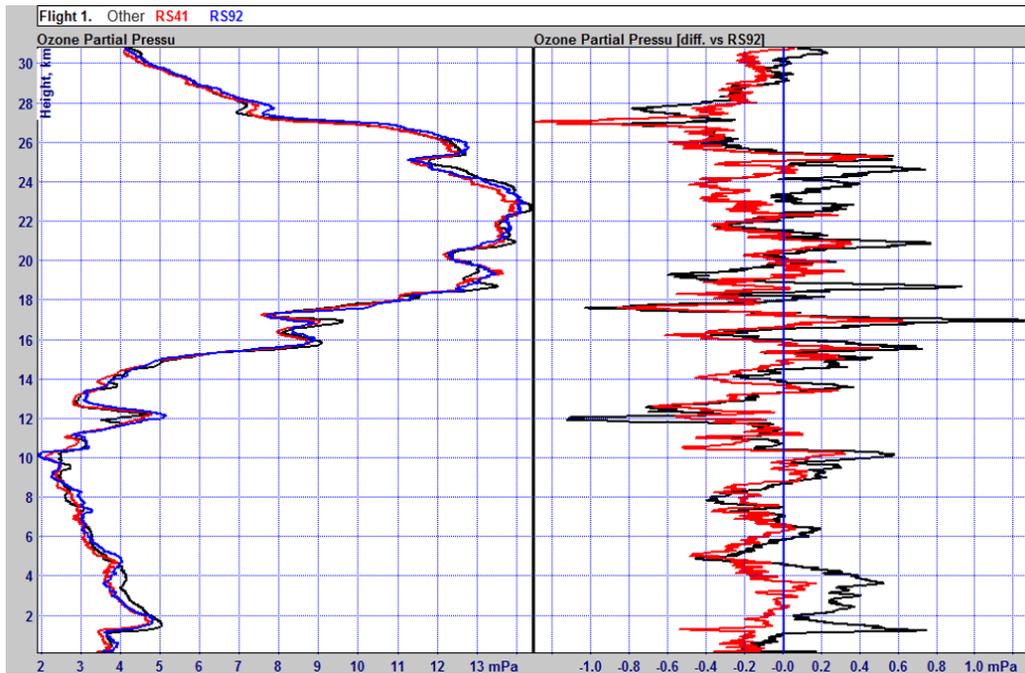
Note, RH comparison is only to 12 km T, V and RH are to 33 km



# Ozone



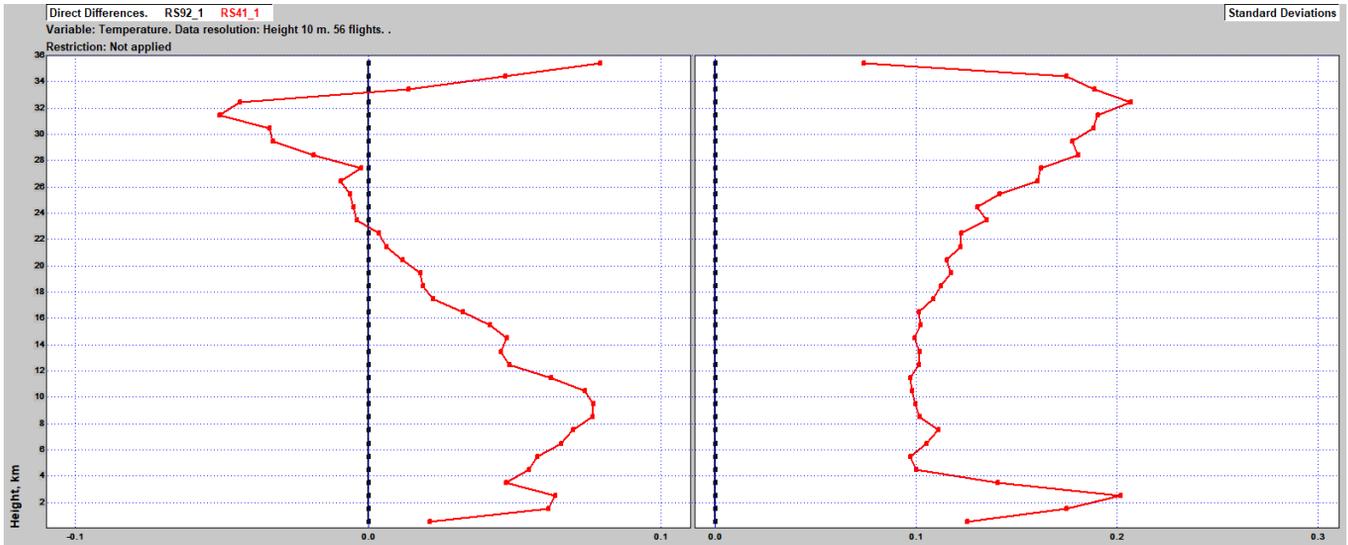
Sequential launching (~ 30 minute spacing) necessary due to weight and stage 3 preparation time



# Site Acceptance Test Trial (SAT)

- Following upgrade of Camborne to RS41, site acceptance test trails were performed at Camborne in June-August 2016
- 29 day, 30 night **RS92/RS41** dual rigs successfully flown. 56 Analysed here
  - Results appeared in agreement with tender trial flights
- Data submitted for NWP analysis vs. Met Office global model
  - T quality assessment showed no concerns

# Site Acceptance Tests: T



SAT  
 Initial Day T  
 Initial Night T

RS41-RS92  
 RS41-RS92  
 RS41-RS92

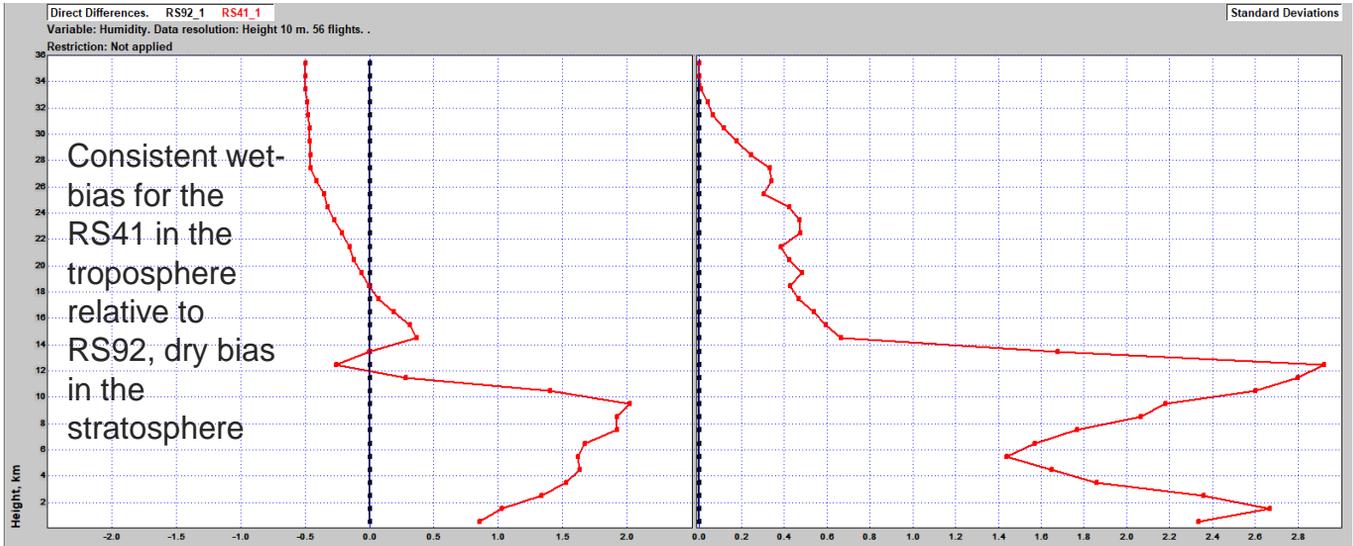
Mean diff +0.03 K  
 Mean diff +0.05 K  
 Mean diff +0.09 K

St.dev 0.14  
 St.dev 0.18  
 St.dev 0.13



Note, SAT to 36 km, Initial to 32 km

# Site Acceptance Tests: RH



SAT  
 Initial Day RH  
 Initial Night RH

RS41-RS92  
 RS41-RS92  
 RS41-RS92

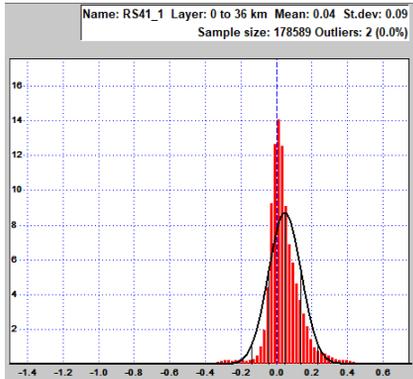
Mean diff +1.4 %  
 Mean diff +2.1 %  
 Mean diff +1.8 %

St.dev 2.2  
 St.dev 2.1  
 St.dev 2.1

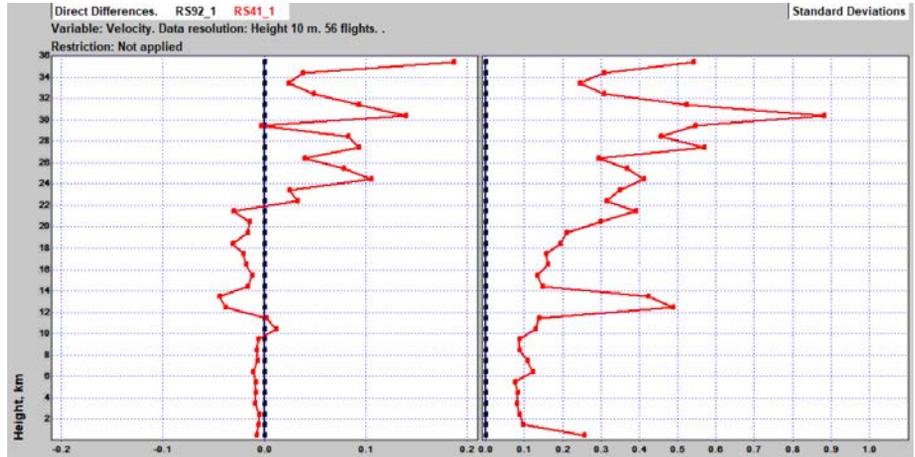


Note: Total values for comparison for RH shown only to 12 km

# Site Acceptance Tests: GPS



Pressure agreement was very good. Analysis different in SAT and Initial, so not included but results were similar



SAT Velocity	RS41-RS92	Mean diff +0.01 ms <sup>-1</sup>	St.dev 0.33
Initial Velocity	RS41-RS92	Mean diff -0.00 ms <sup>-1</sup>	St.dev 0.14

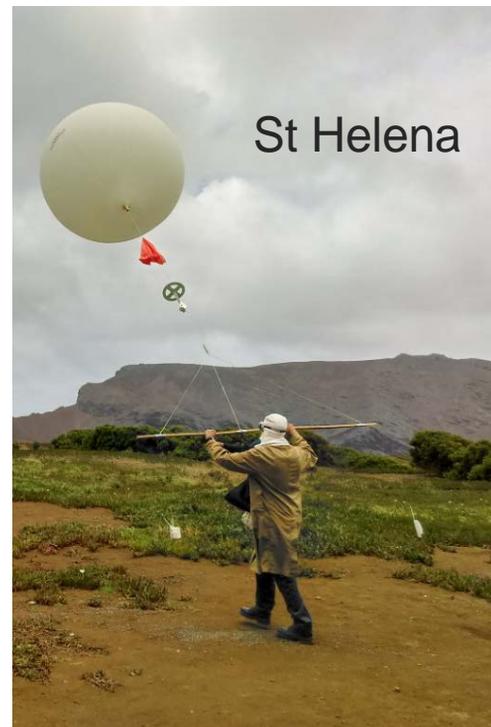
**Note: Higher St.dev caused by interpolation in stratosphere**

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SAT Pressure	RS41-RS92	Mean diff +0.04 hPa	St.dev 0.09
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# RS92-RS41 Climate trials

- Camborne (UK)
  - 51/52 successful flights
  - 04/2018 – 05/2019
  - 6 Were triple sonde flights including additional soft shell RS41
- St Helena (South Atlantic)
  - 51/52 successful flights
  - 12/2017 – 12/2018
- Rothera (Antarctica)
  - 48/52 successful flights
  - 05/2017 – 08/2018
- Most raw data files have been sent to GRUAN
- BUFR files from Camborne and St Helena available for NWP analysis



# RS41 soft shell intercomparison trials

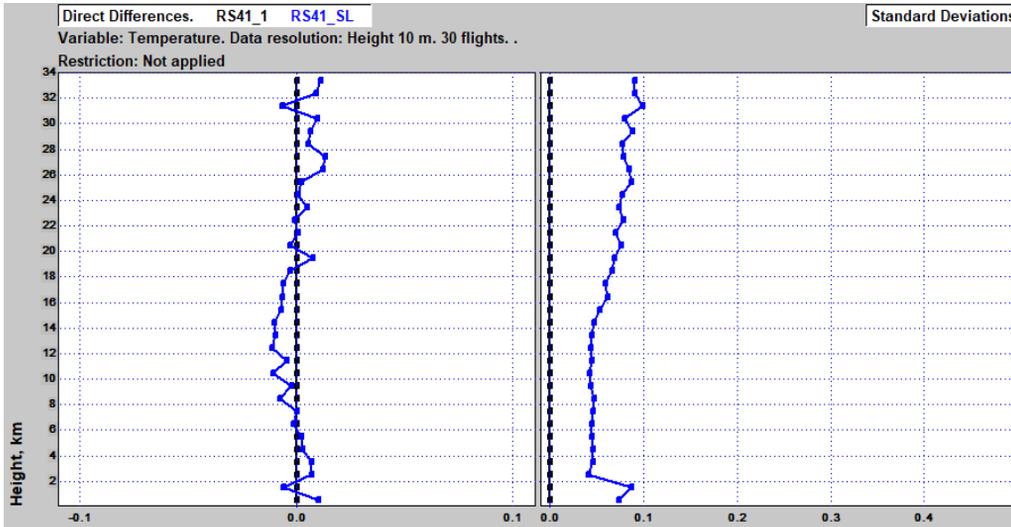
- 15 dual hard-shell vs. soft-shell flights total in two sets of trials (3, 12)
- No differences found in T or wind
- Small difference seen in RH with potentially a very small RH dry bias with the soft-shell design. However, the sample size was small so the results were not conclusive.
- Vaisala performed their own analysis of the dataset and concluded:

“... the reproducibility of humidity results is at the same level as the reproducibility in your campaign.

... we are confident that RS41 humidity results are not affected by the cover change.”

# RS41 soft shell intercomparison trials:

# T



Soft-RS41

RS41<sub>soft</sub>-RS41

Mean diff +0.00 K

St.dev 0.07

Initial Day T

RS41-RS41

Mean diff -0.00 K

St.dev 0.09

Initial Night T

RS41-RS41

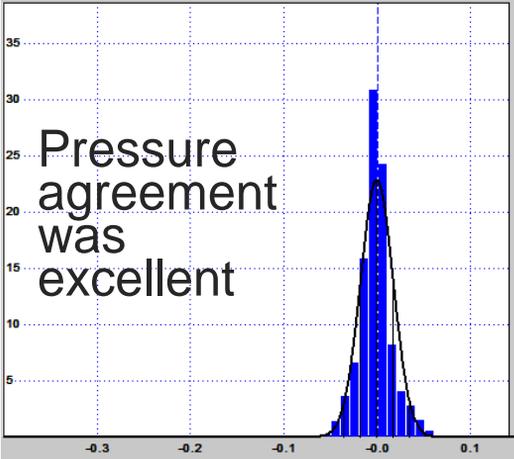
Mean diff +0.01 K

St.dev 0.04



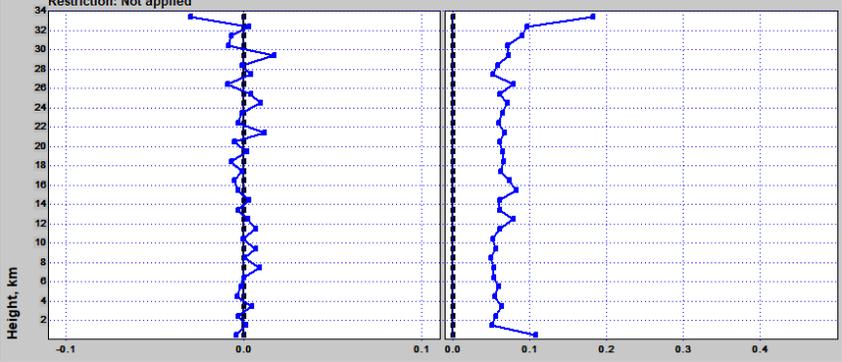
# RS41 soft shell intercomparison trials: GPS

Name: RS41\_SL Layer: 0 to 34 km Mean: -0.00 St.dev: 0.02  
Sample size: 34755 Outliers: 0 (0.0%)



Direct Differences. RS41\_1 RS41\_SL Standard Deviations

Variable: Velocity. Data resolution: Height 10 m. 30 flights. .  
Restriction: Not applied



Soft RS41  
Initial V

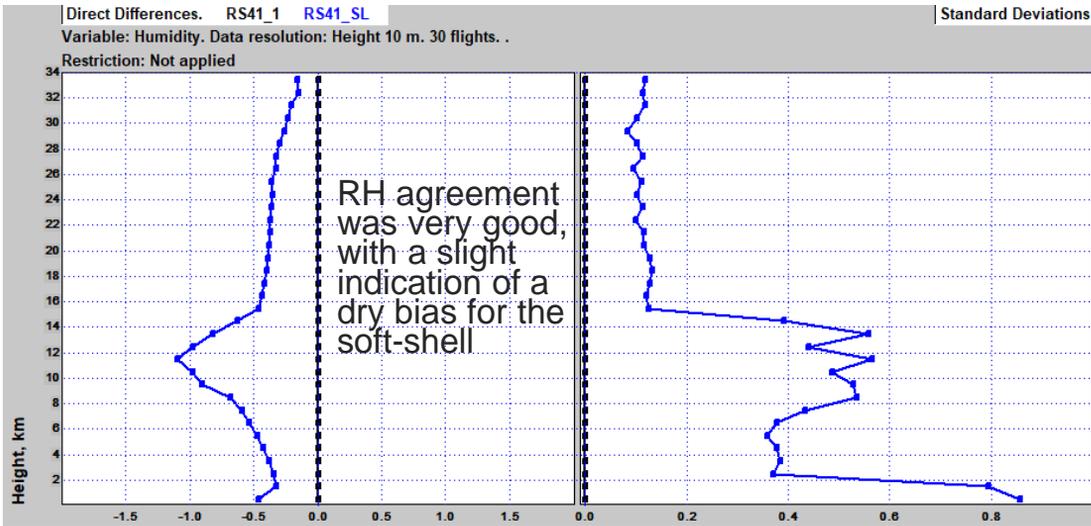
RS41<sub>soft</sub> - RS41  
RS41 - RS41

Mean diff -0.00 ms<sup>-1</sup>  
Mean diff -0.00 ms<sup>-1</sup>

St.dev 0.07  
St.dev 0.13



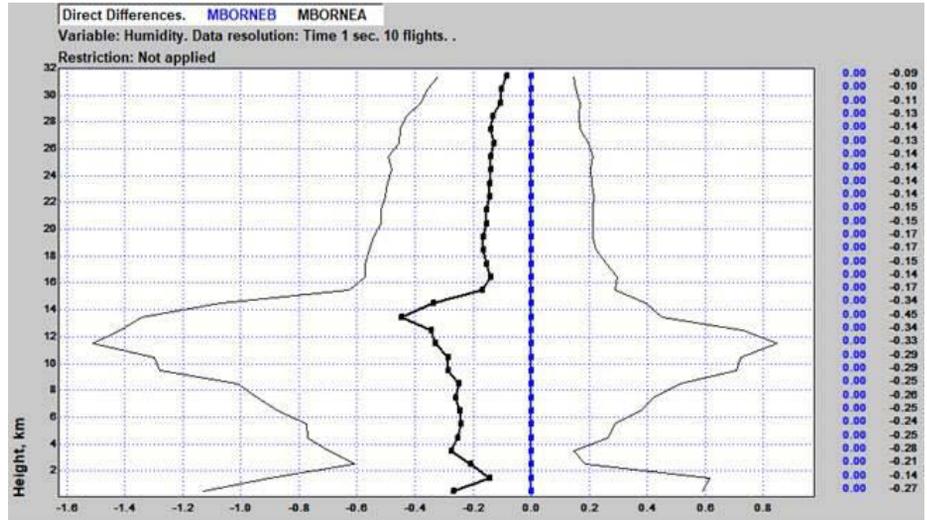
# RS41 soft shell intercomparison trials: RH



Soft-RS41	$RS41_{\text{soft}} - RS41$	Mean diff -0.48 %	St.dev 0.43	(to 34 km)
Soft-RS41	$RS41_{\text{soft}} - RS41$	Mean diff -0.62 %	St.dev 0.56	(to 12 km)
Initial Day RH	$RS41 - RS41$	Mean diff +0.04 %	St.dev 0.51	(to 12 km)
Initial Night RH	$RS41 - RS41$	Mean diff -0.03 %	St.dev 0.41	(to 12 km)

# RS41 soft shell intercomparison trials: RH

- Vaisala analysis eliminates about half of the magnitude of the dry bias
- Customers accepted performance of revised sonde design
- Performance will be monitored and further testing is possible if deemed necessary.
- Careful implementation to ensure clean switchover

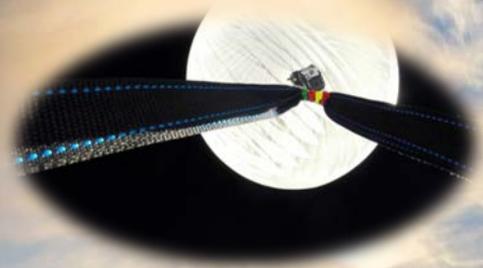


*Vaisala analysis of RH for 10 flights using GPS time-sync shows a smaller dry-bias than my analysis done using height sync*

# Summary

1. Initial trials recommended that the RS41 should replace the RS92, delivering a number of benefits. **SAT Started.**
2. Site acceptance test trials indicated no concerns. **RS41 deployed, climate trials started.**
3. **Climate dataset from 3 sites completed** and shared with GRUAN.
4. RS41 soft shell shows no difference from hard shell variant for T and wind, with only indications of a slight dry bias in RH. **Customers accept RS41 with soft shell.**
5. **No operational concerns with using the RS41-SG so far** 
6. **Overall, over 250 comparison flights successfully completed as part of our transition from RS92 to RS41**

# Questions?



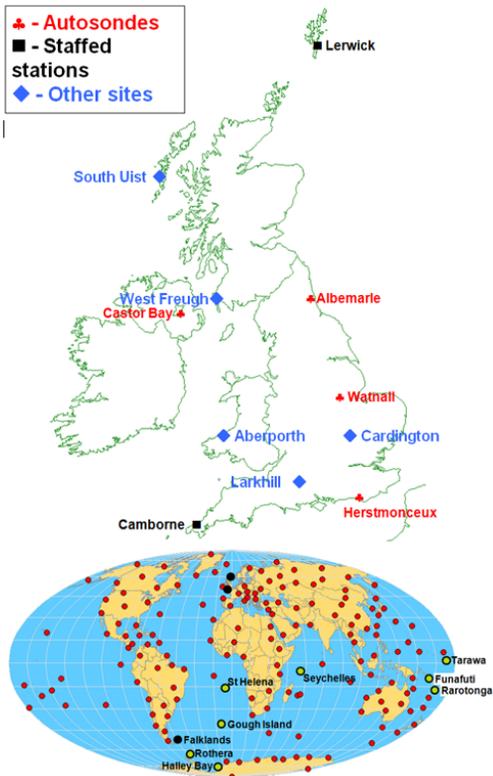
## Radiosonde Quick Reference

David Edwards 2018/02/08

PWS	Defence	Government Services	VCP
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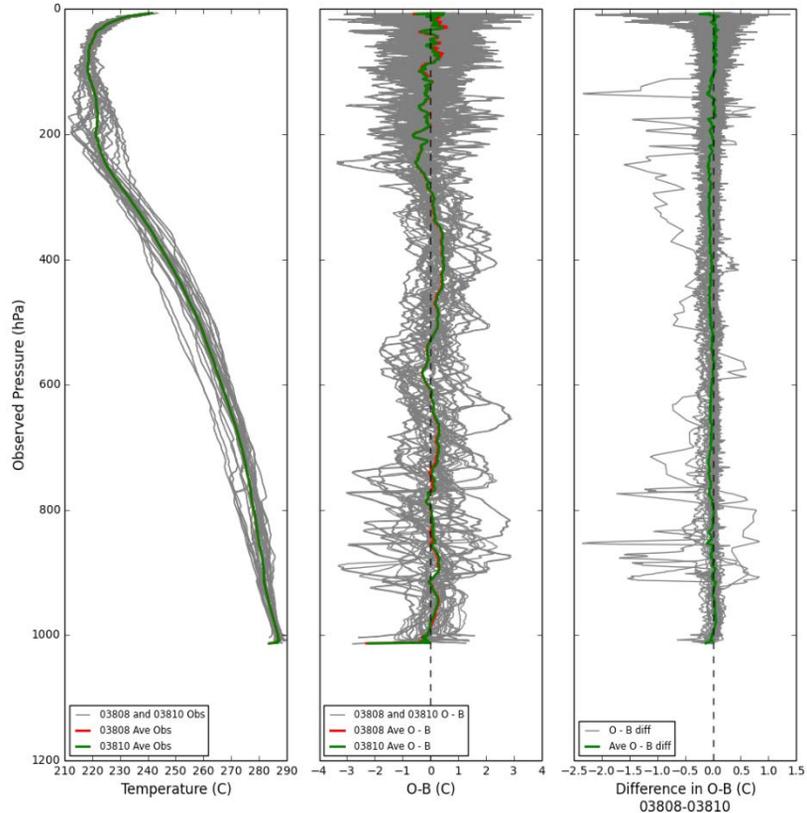
Station	WMO Number(s)	Launch Times	Balloon Type	Sonde Type
Camborne	03808	00, 12	1200, 800	RS41
Lerwick	03005	00, 12	1200, 800	RS41
Castor Bay	03918	00, (06, 12, 18)	350P	RS41
Albemarle	03238	00, (06, 12, 18)	350P	RS41
Watnall	03354	00, (06, 12, 18)	350P	RS41
Herstmonceux	03882	00, (06, 12, 18)	350P	RS41
Falklands	88889	00, (12)	350	RS41
Larkhill	03743	Irregular weekdays	100	RS41
Aberporth	03502	Irregular weekdays	100	RS41
South Uist	03023	Irregular	100	RS41
West Freugh	03132	Irregular	100	RS41
Pendine	Unknown	Irregular	Unknown	RS41
Halley Bay	89022	12	350	RS41
Rothera	89062	12	350	RS92, RS41 dev system
St Helena	61901	12	800	RS41
Gough Island	68906	00, 12	Unknown	BAT4G
Seychelles	63985	00	Unknown	RS41
Rarotonga	91843	00	Unknown	VCP Defunded, no ascents
Tarawa	91610	00	Unknown	RS41
Funafuti	91643	00	Unknown	RS41

- ◆ - Autosondes
- - Staffed stations
- ◆ - Other sites



# Site Acceptance Tests – NWP T Analysis

- Minimal differences seen between RS41 and RS92
- RS41 and RS92 in generally very good agreement with the model



# Notes on RS41 vs. RS92 Performance

## RS41 positives: ★

More precise for T, RH

Equivalent precision for P, V

T less susceptible to wet-bulbing

RH wet bias relative to RS92, closer agreement with NWP

RH faster response after cloud exit

RH less affected by stratospheric contamination

RH continuous sensor heating, no RH solar radiation correction assumption

No need for T calibration vs. external sensor

No need for RH calibration vs desiccant ★ ★