Byrd Polar Research Center

Polar Meteorology Group

The Ohio State University

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# Investigation of summer low cloud prediction in AMPS

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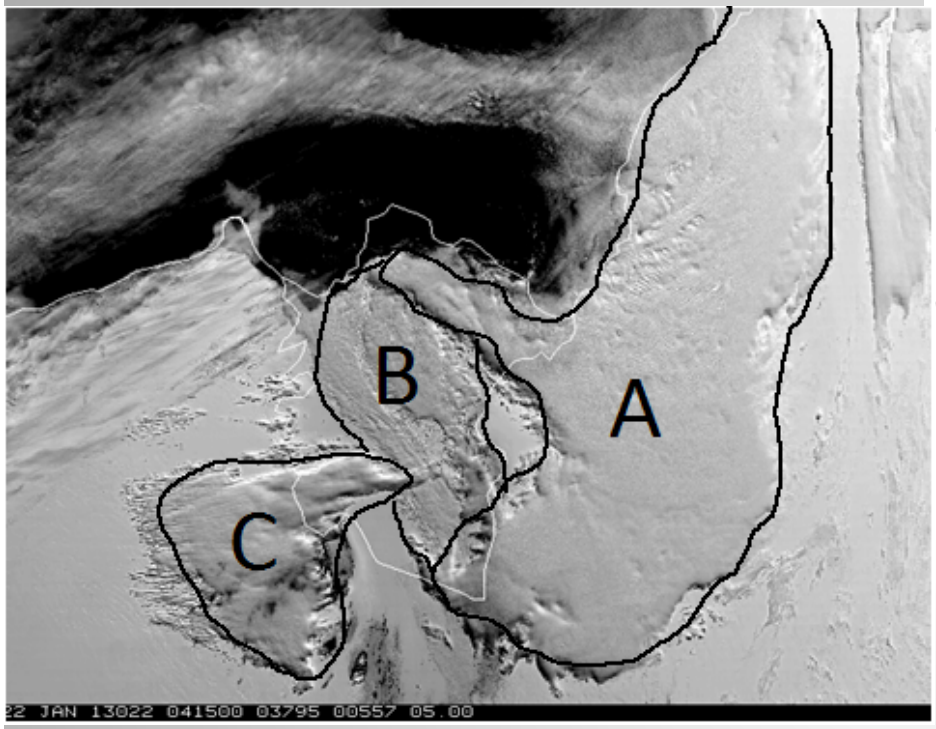
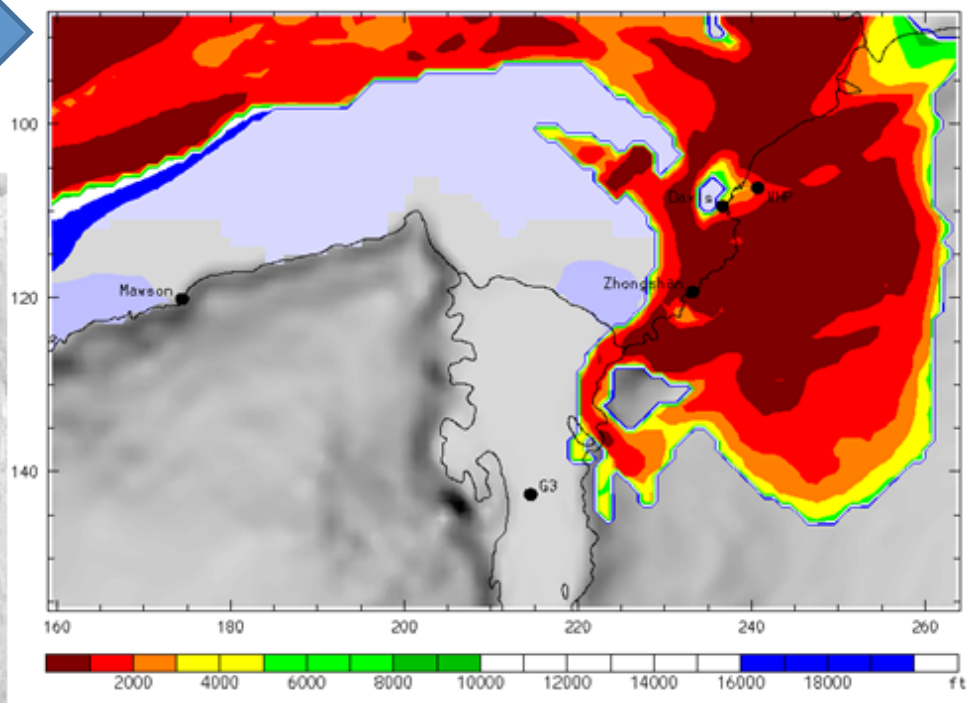
# Case study – Prydz Bay Low

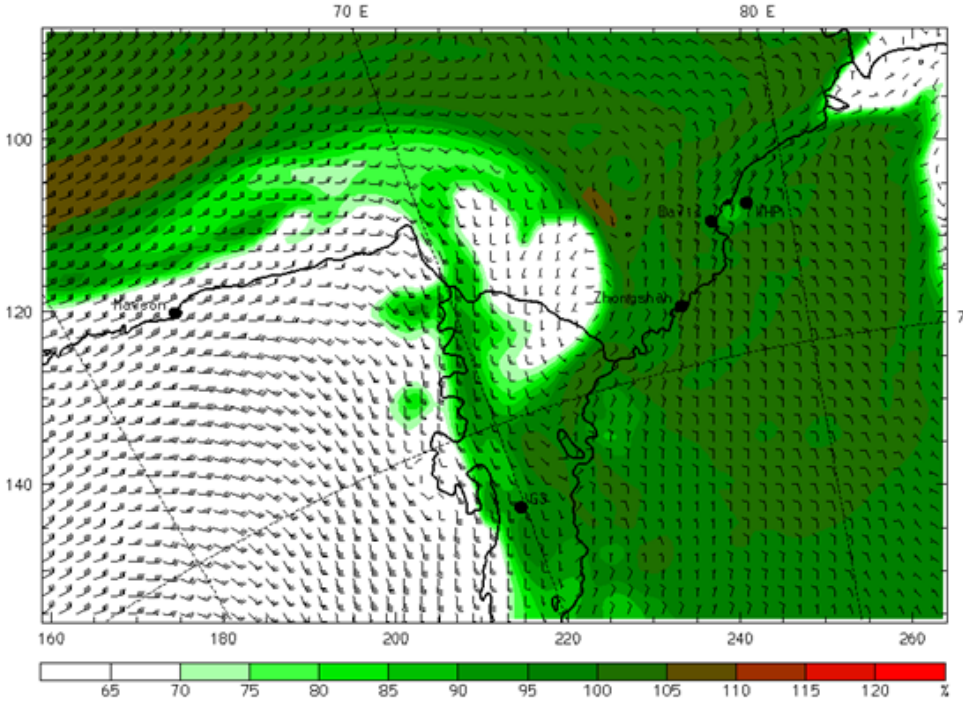
- Prydz Bay Low – commonly occurring mesolow which brings low cloud and precipitation to Davis Station and nearby Amery Ice Shelf (AIS).
- Previous work investigated the Stoelinga-Warner algorithm which is used to generate the AMPS cloud base product and is based on hydrometeor quantities.
- Case study of Prydz Bay Low event of 22 Jan 2013 shows adequate moisture in AMPS but inadequate amounts of cloud hydrometeors.

AMPS cloud base product

MODIS Terra satellite visible image

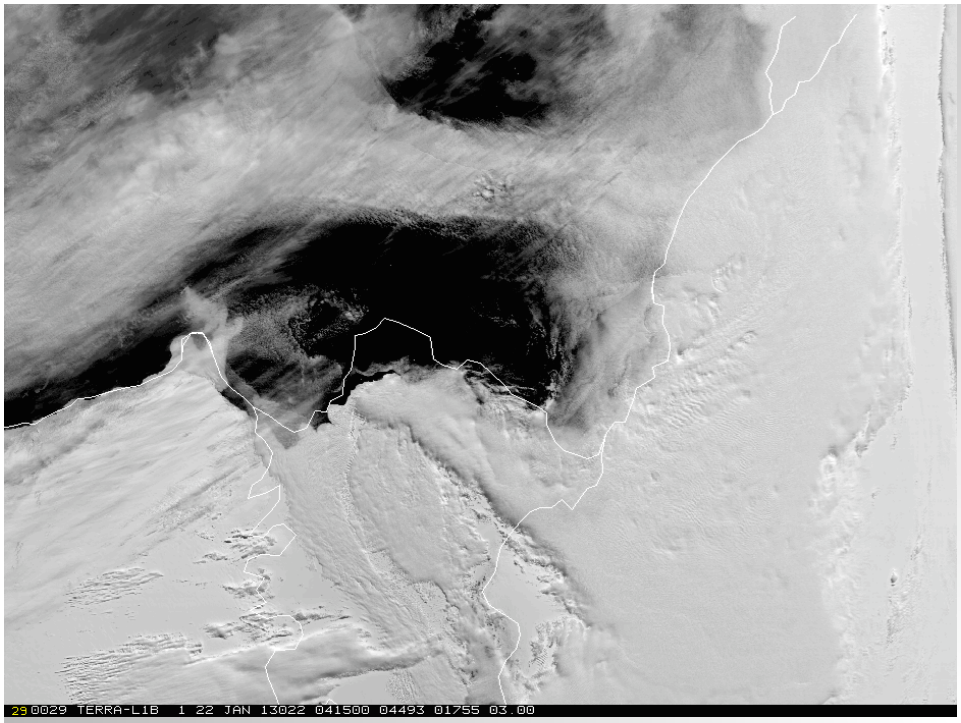


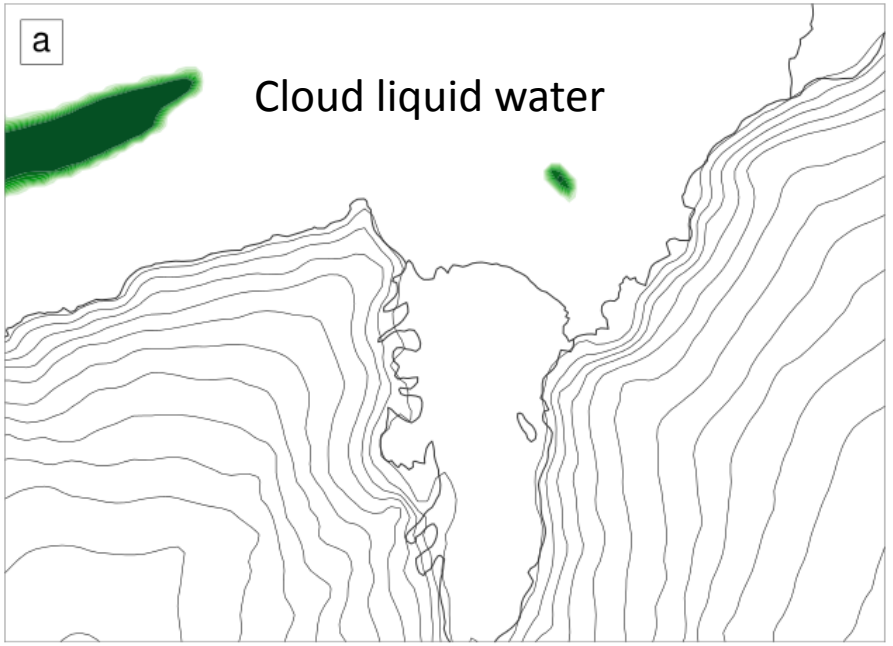



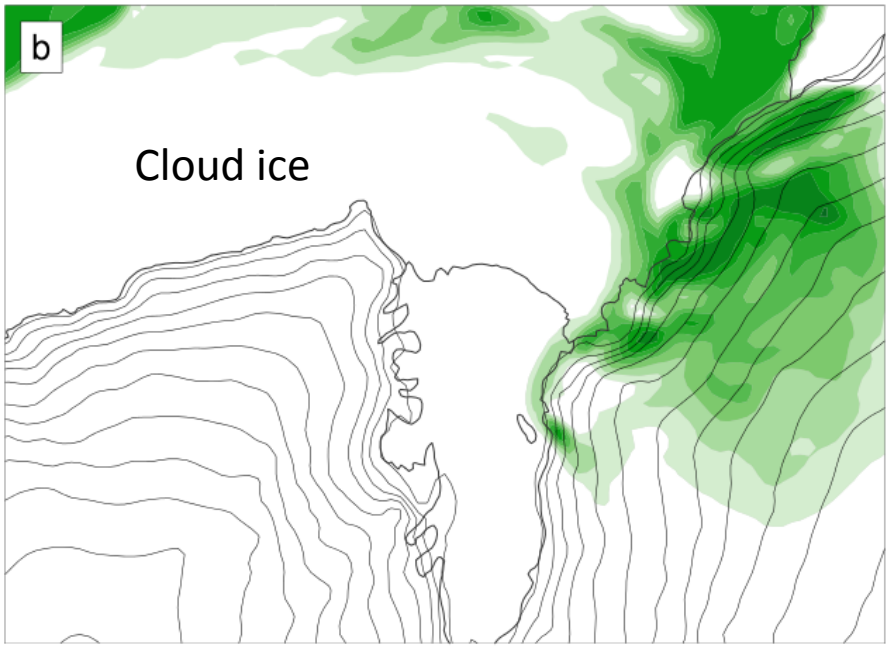



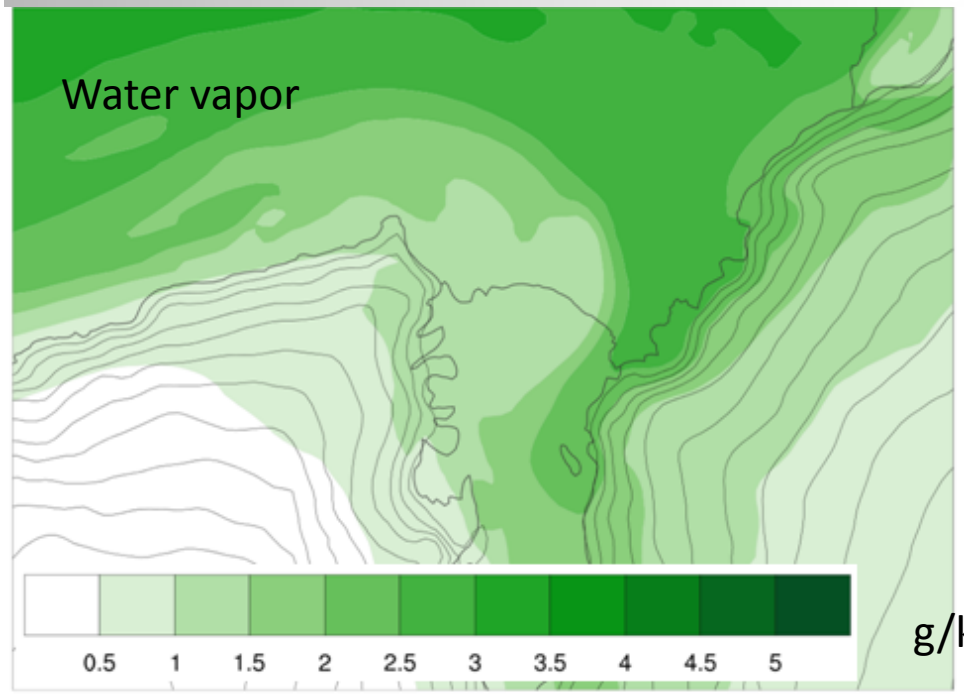

Cloud east of AIS (A) identified by model. Cloud over AIS (B) not identified by cloud algorithm but low level moisture present. Insufficient model moisture for cloud west of AIS (C).

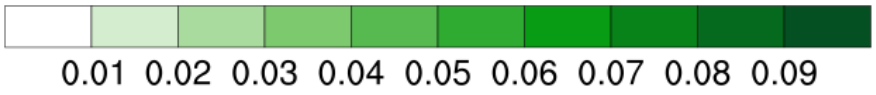
AMPS low level RH product


29 0029 TERRA-L1B 1 22 JAN 13022 041500 04493 01755 03.00


a
Cloud liquid water

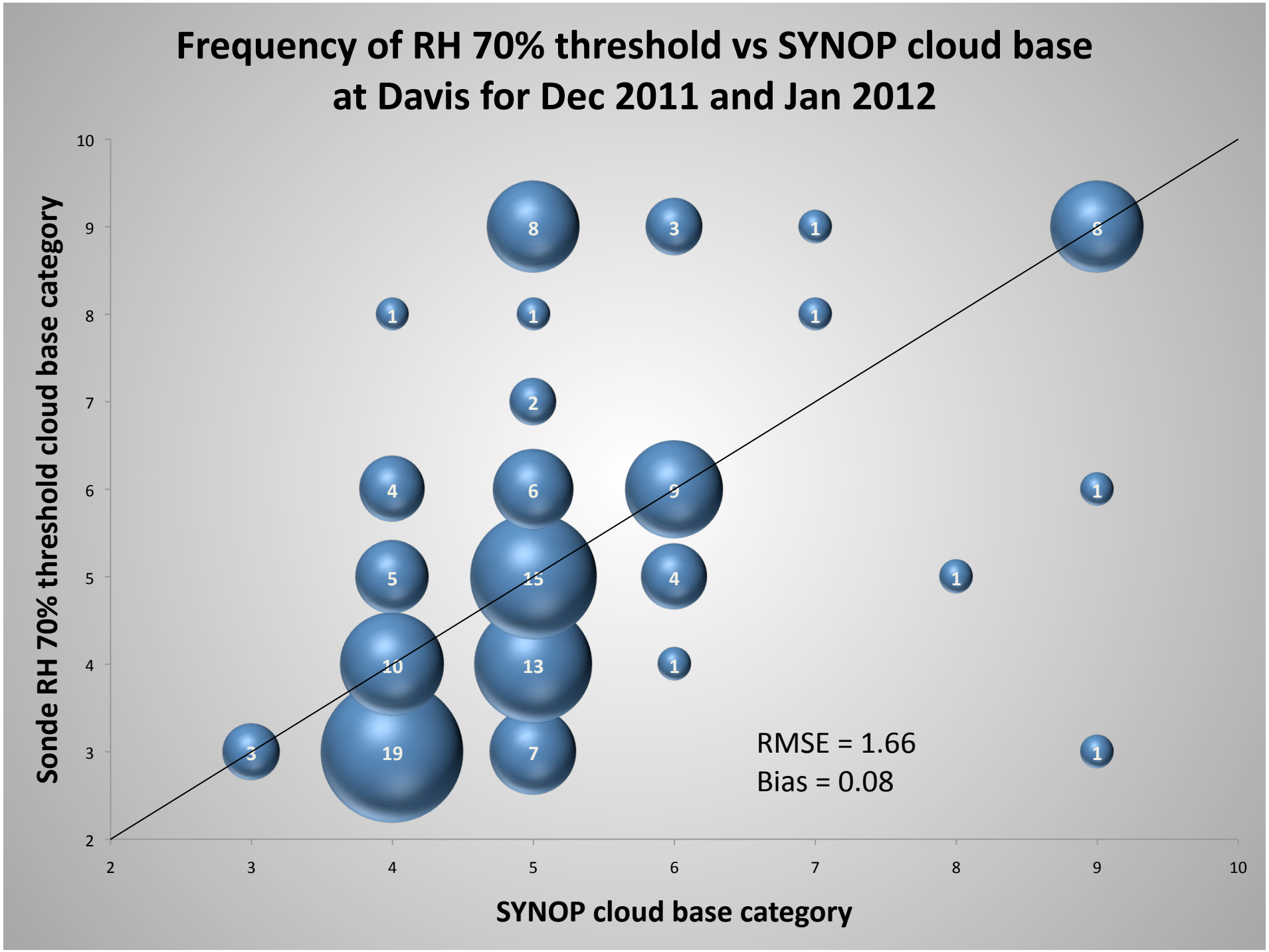

b
Cloud ice

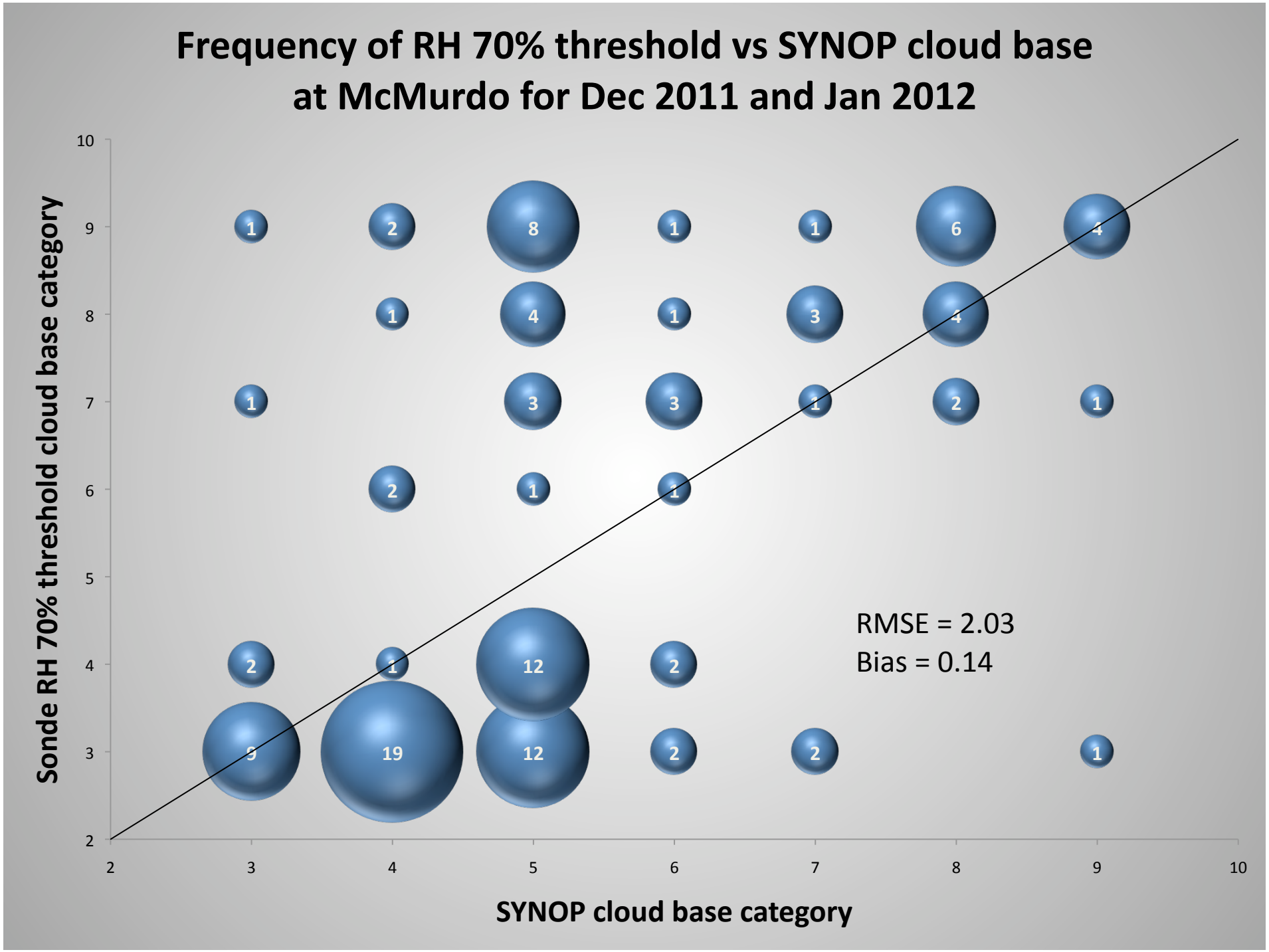

Water vapor
0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
g/kg


0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09

# Comparison of sonde RH to SYNOP and LIDAR observations

- The case study suggested that RH can be a reasonable predictor of low cloud.
- This section compares radiosonde RH to cloud base heights from manual SYNOP and LIDAR observations.
- Study conducted for summer (Dec 2011 and Jan 2012) and shoulder (Oct/Nov 2011 and Feb/Mar 2012) seasons.
- Comparison based on WMO SYNOP cloud base categories, i.e., observer cloud base height estimates, using the lowest recorded cloud base regardless of amount.


Frequency of RH 70% threshold vs SYNOP cloud base at Davis for Dec 2011 and Jan 2012
Sonde RH 70% threshold cloud base category
SYNOP cloud base category
RMSE = 1.66
Bias = 0.08
10
9
8
7
6
5
4
3
2
2
3
4
5
6
7
8
9
10
8
3
1
1
1
8
1
2
4
6
9
1
5
15
4
1
10
13
1
3
19
7
1


Frequency of RH 70% threshold vs SYNOP cloud base at McMurdo for Dec 2011 and Jan 2012
Sonde RH 70% threshold cloud base category
SYNOP cloud base category
RMSE = 2.03
Bias = 0.14
10
9
8
7
6
5
4
3
2
2
3
4
5
6
7
8
9
10
1
2
8
1
1
6
4
1
4
1
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1
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1
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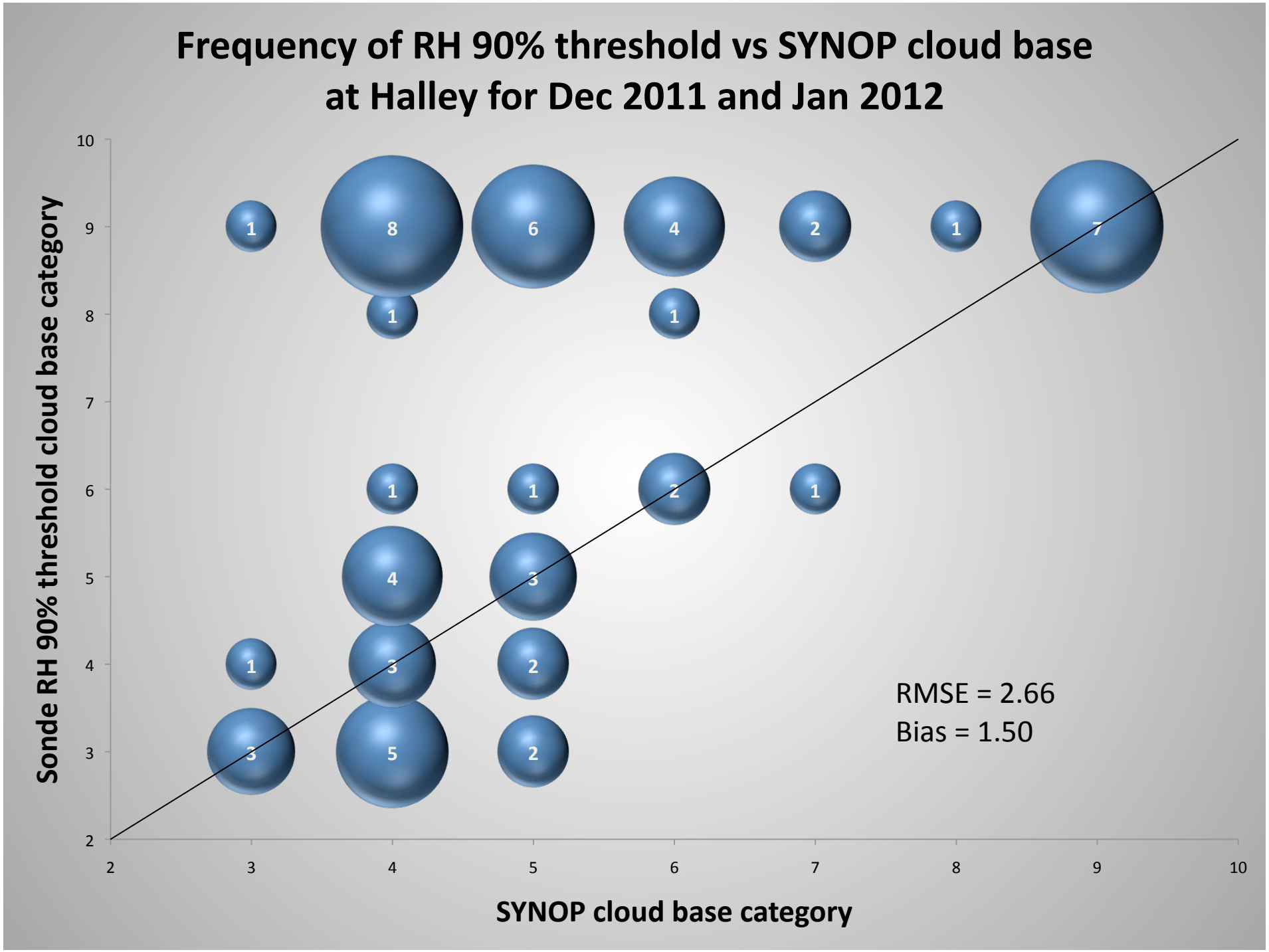
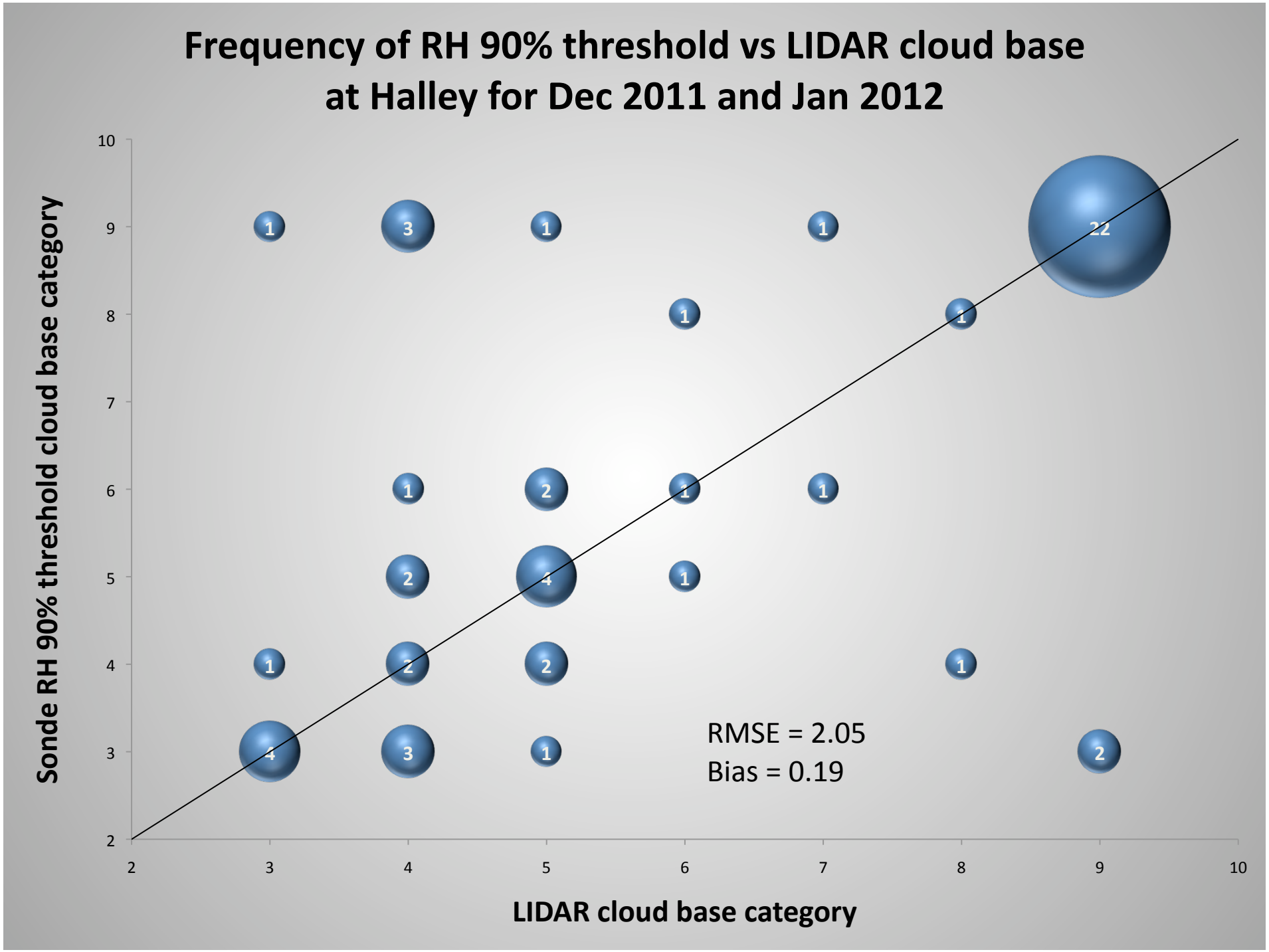
1
1
2
12
2
9
19
12
2
2
1


Frequency of RH 90% threshold vs SYNOP cloud base at Halley for Dec 2011 and Jan 2012
Sonde RH 90% threshold cloud base category
SYNOP cloud base category
RMSE = 2.66
Bias = 1.50
10
9
8
7
6
5
4
3
2
2
3
4
5
6
7
8
9
10
1
8
6
4
2
1
7
1
1
1
2
1
4
3
1
3
2
3
5
2


Frequency of RH 90% threshold vs LIDAR cloud base at Halley for Dec 2011 and Jan 2012
Sonde RH 90% threshold cloud base category
LIDAR cloud base category
RMSE = 2.05
Bias = 0.19
2
3
4
5
6
7
8
9
10
1
3
1
1
22
1
1
1
2
1
1
2
4
1
1
2
2
1
4
3
1
2

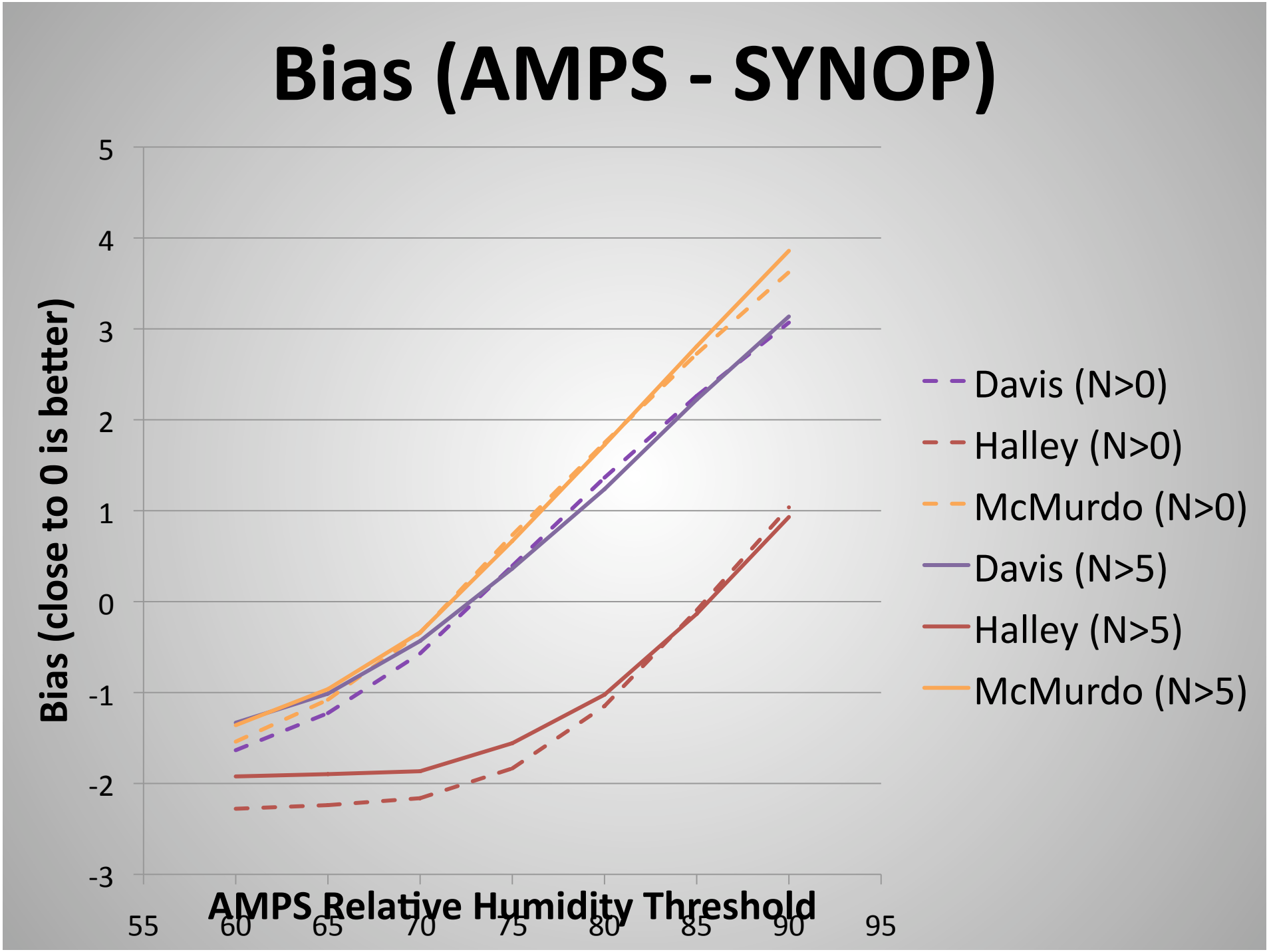
# Comparison of AMPS model RH to SYNOP observations

- Conclusions that can be drawn from the comparison about the ability of RH threshold as a predictor of low cloud base height :
  - Davis – good predictor at 70% RH
  - McMurdo – reasonable predictor at 70% RH
  - Halley – reasonable predictor at 90% RH
- Next step: verification of AMPS RH as a predictor of low cloud base height.

# Verification statistics

- Study conducted for summer (Dec/Jan) and shoulder (Oct/Nov and Feb/Mar) seasons for 2009/10, 2010/11 and 2011/12. Only summer shown here.
- Model cloud levels derived from AMPS relative humidity at various thresholds.
- Comparison of AMPS against SYNOPs (throughout the day) for any cloud reported (N>0) and broken or greater cloud coverage (N>=5).

# Bias (AMPS - SYNOP)



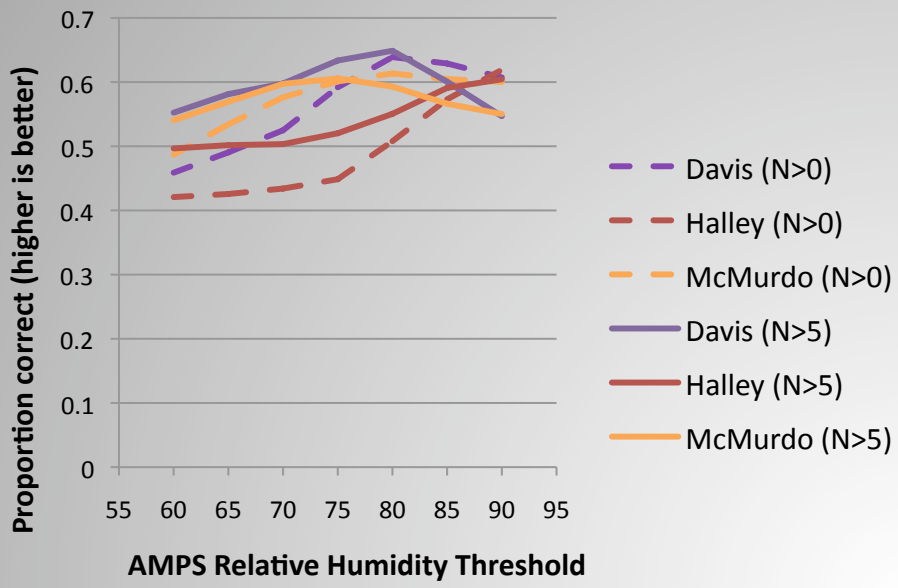
# Low cloud detection verification

- Low cloud defined as <2000ft (600m), a significant threshold for aviation operations
- Matrix of events

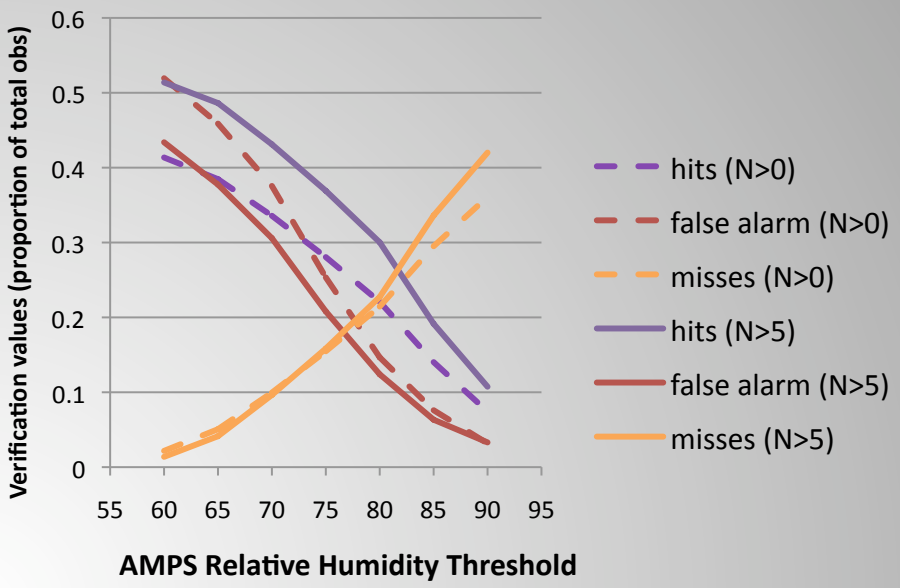
| | **Observed** | **Not Observed** |
|---|---|---|
| **Forecast** | (a) Hits | (b) False alarms |
| **Not forecast** | (c) Misses | (d) |

- Proportion correct = (a + d) / total

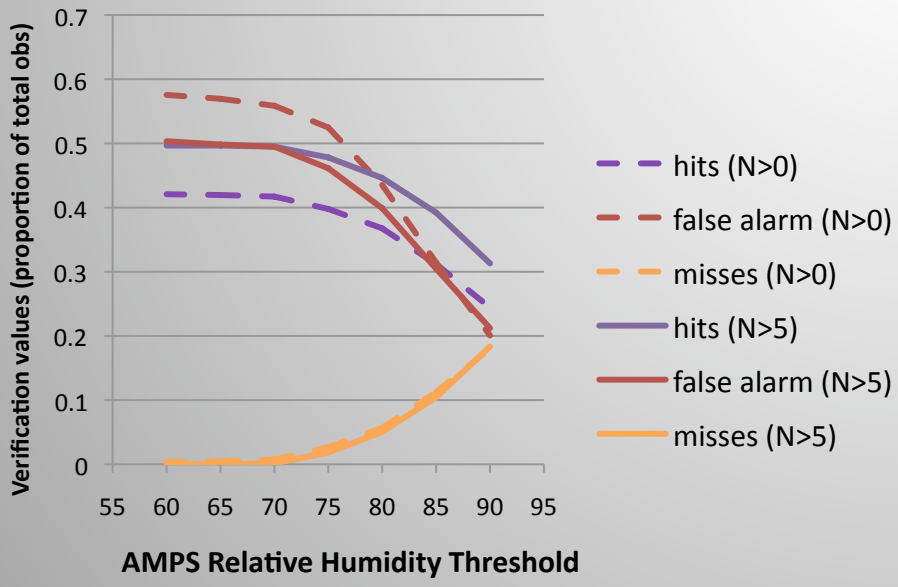
## Proportion correct



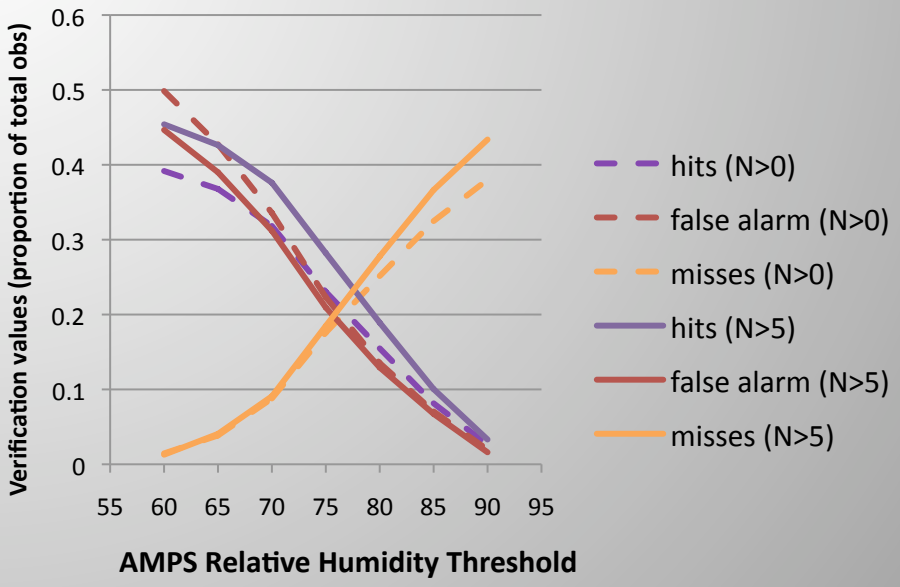

## Davis




## Halley




## McMurdo



# Verification

- “Best” RH thresholds for model cloud base forecasts varies according to metric used, but is higher at Halley compared with Davis and McMurdo, consistent with results from Part 2.
- RH threshold as a predictor of low cloud base height performs best at Davis, then at McMurdo, with the poorest results at Halley. This is also consistent with results from Part 2.

# Conclusions

- RH can be a useful predictor of cloud base locally, but a single threshold is not applicable continent-wide.
- RH as a low cloud predictor consistently performed better at Davis. This may be due to local effects such as station elevation or local wind regimes.
- The results for Davis are also consistent with the study by Inoue et. al. (2015).
- The variation between sites suggests that changes to the cloud microphysics scheme for hydrometeor prediction will need to consider factors in addition to the RH.

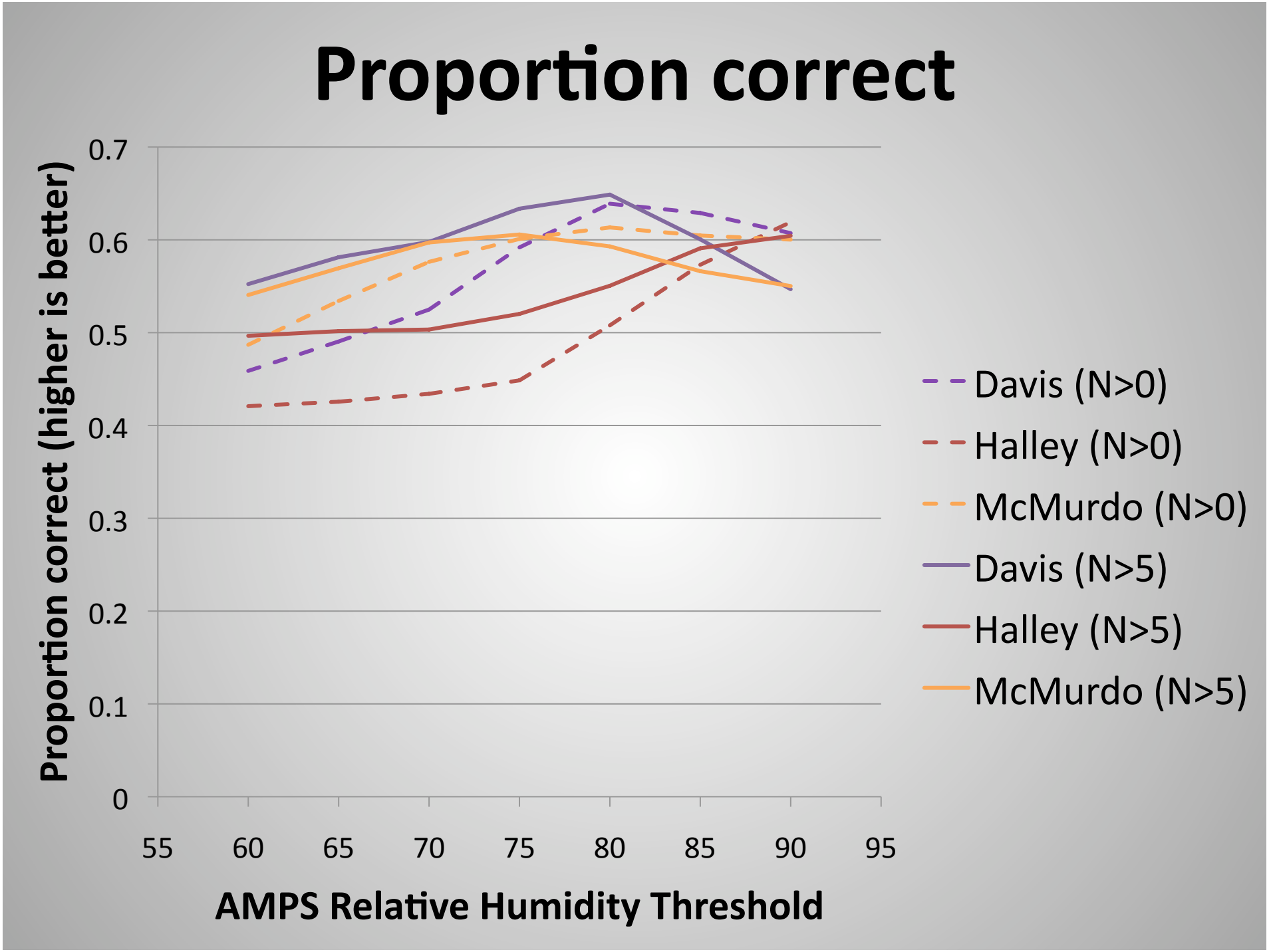
# Next steps

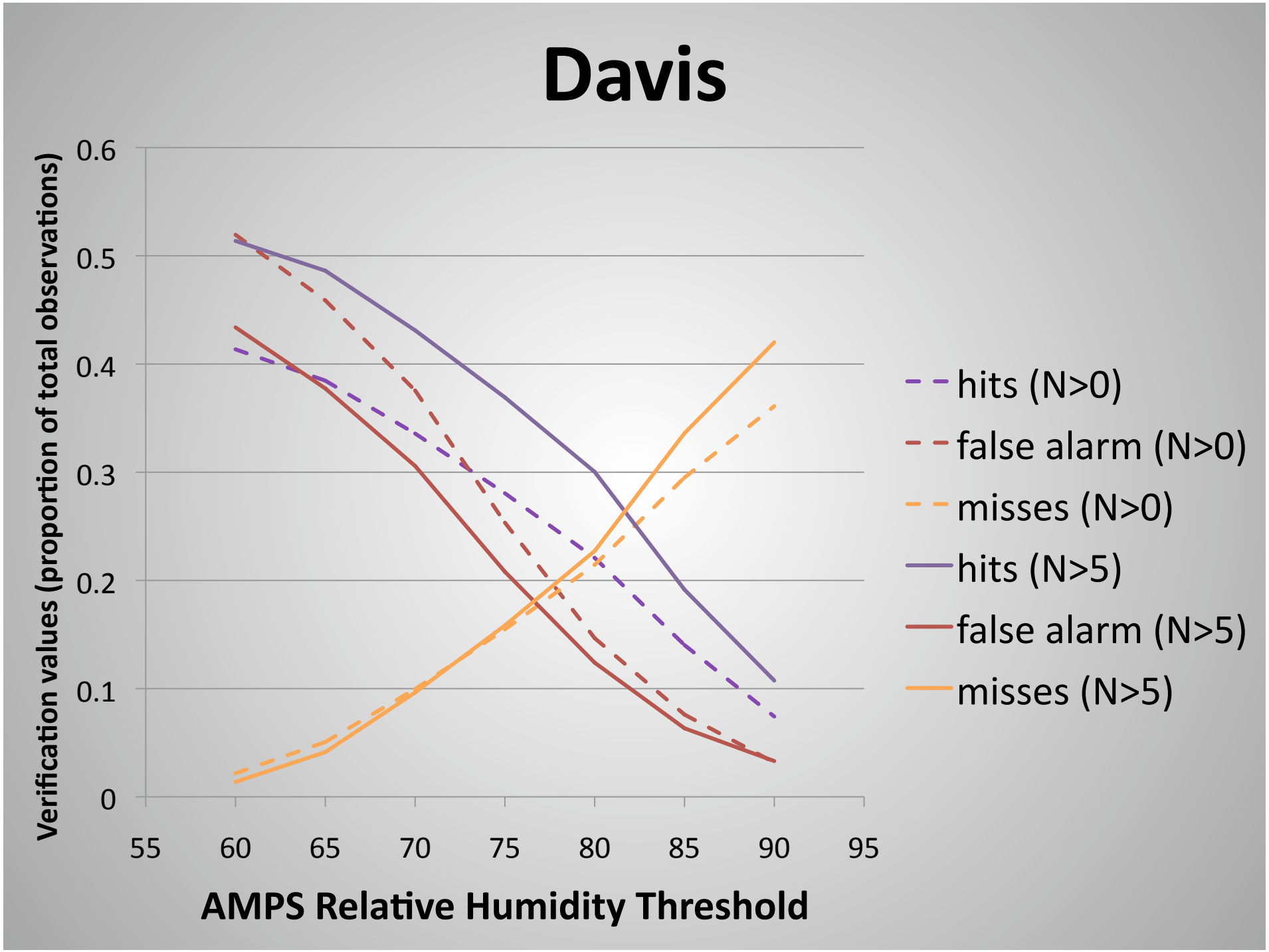
- Complete verification statistics for shoulder seasons.
- Understand the reasons for the differences in cloud base height prediction skill between the stations.
- Investigate the cloud microphysics scheme to improve the prediction of cloud hydro-meteors.

# Acknowledgements

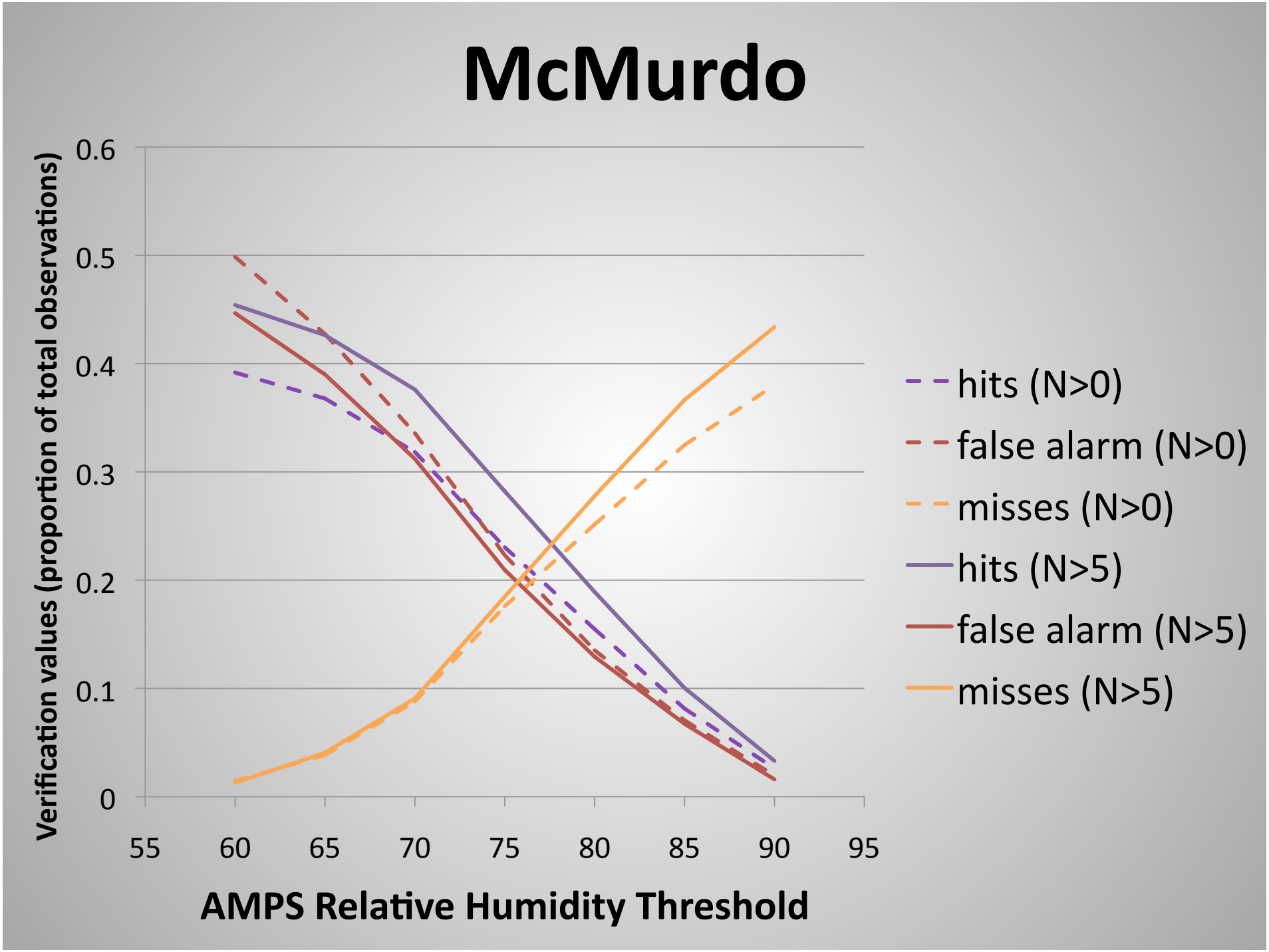

- The authors thank Steve Colwell of the British Antarctic Survey for assistance with obtaining Halley data.
- This work was supported by the National Science Foundation grant GRT00032749 via UCAR.

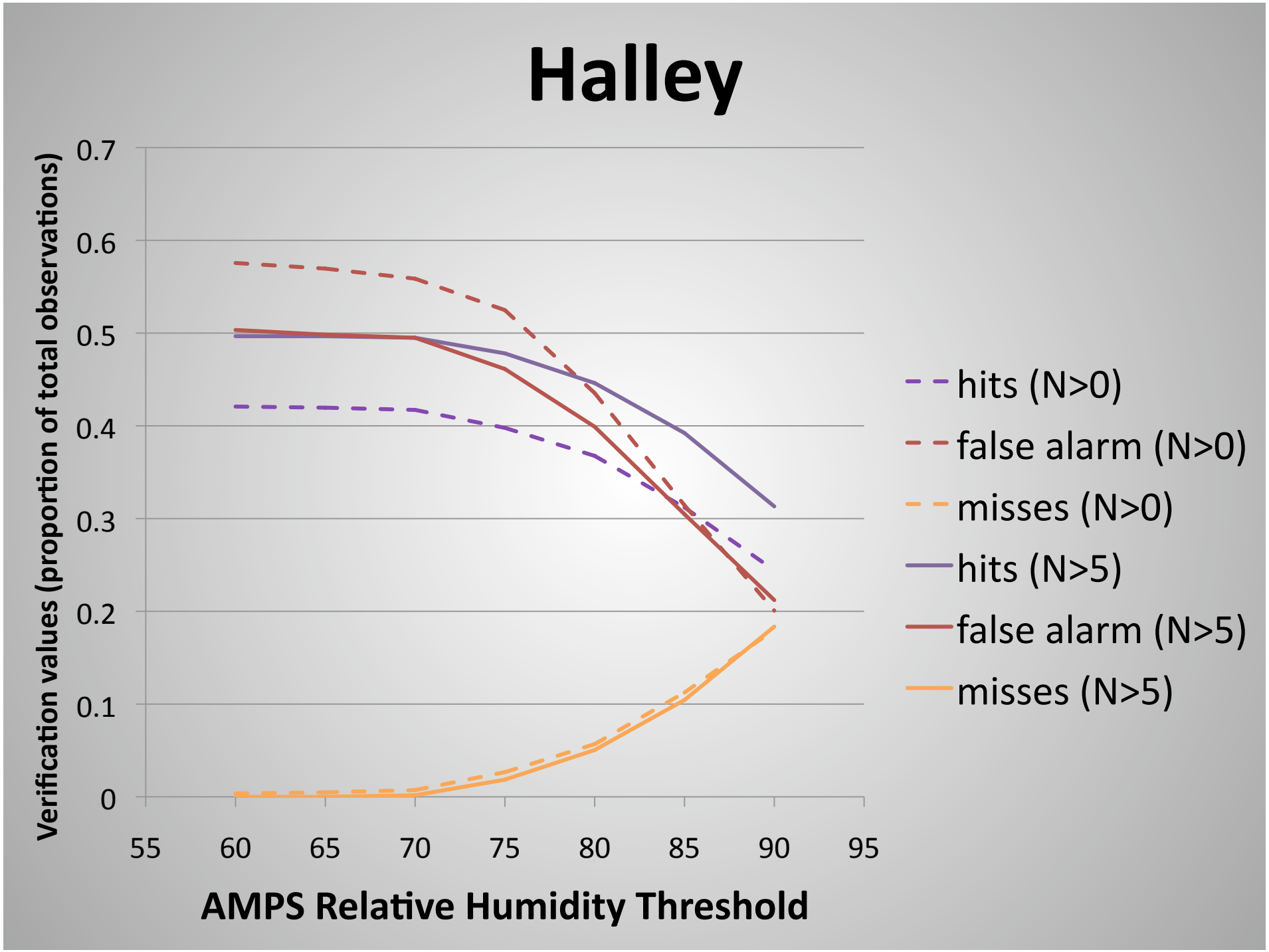

# Proportion correct

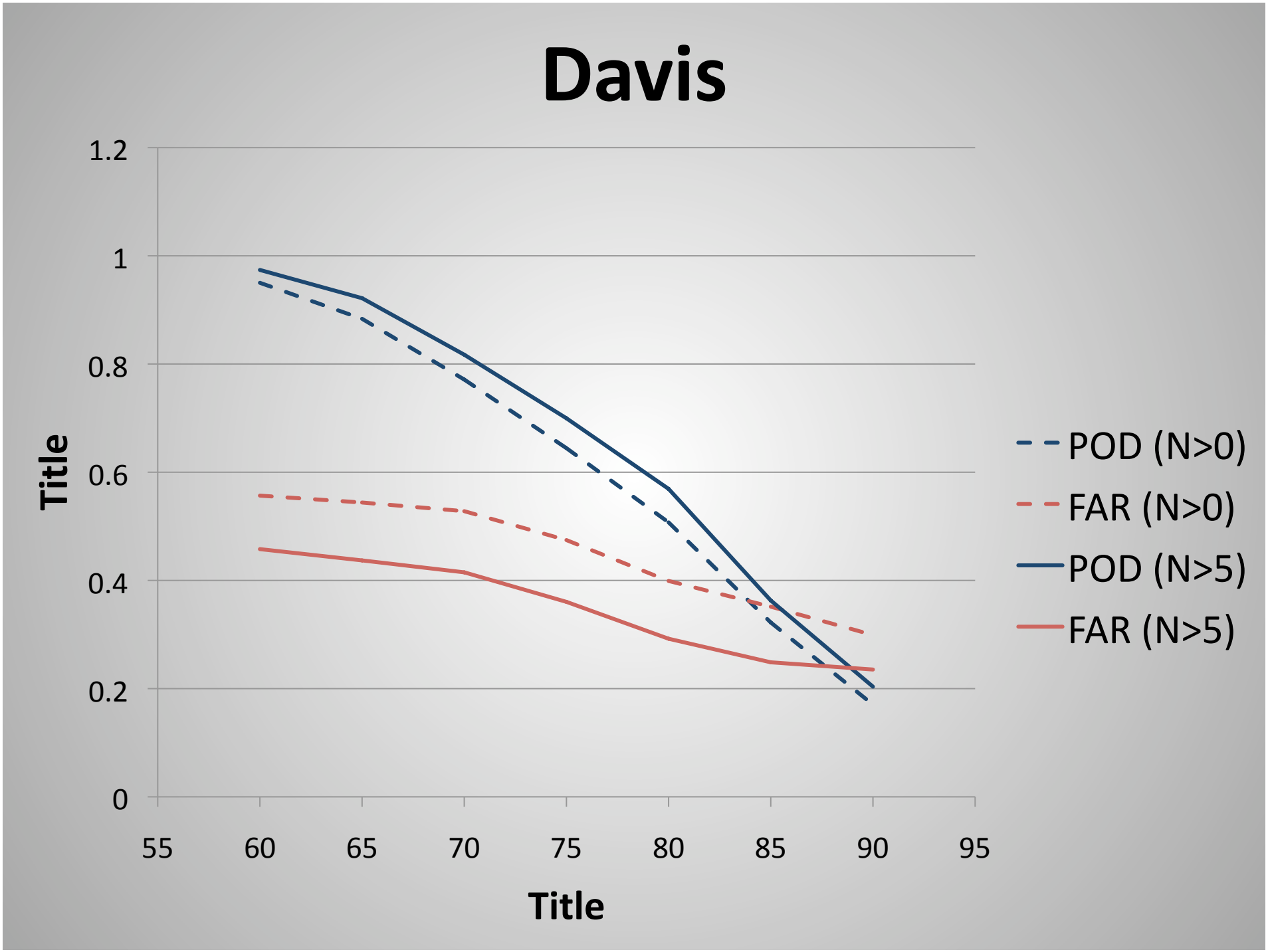


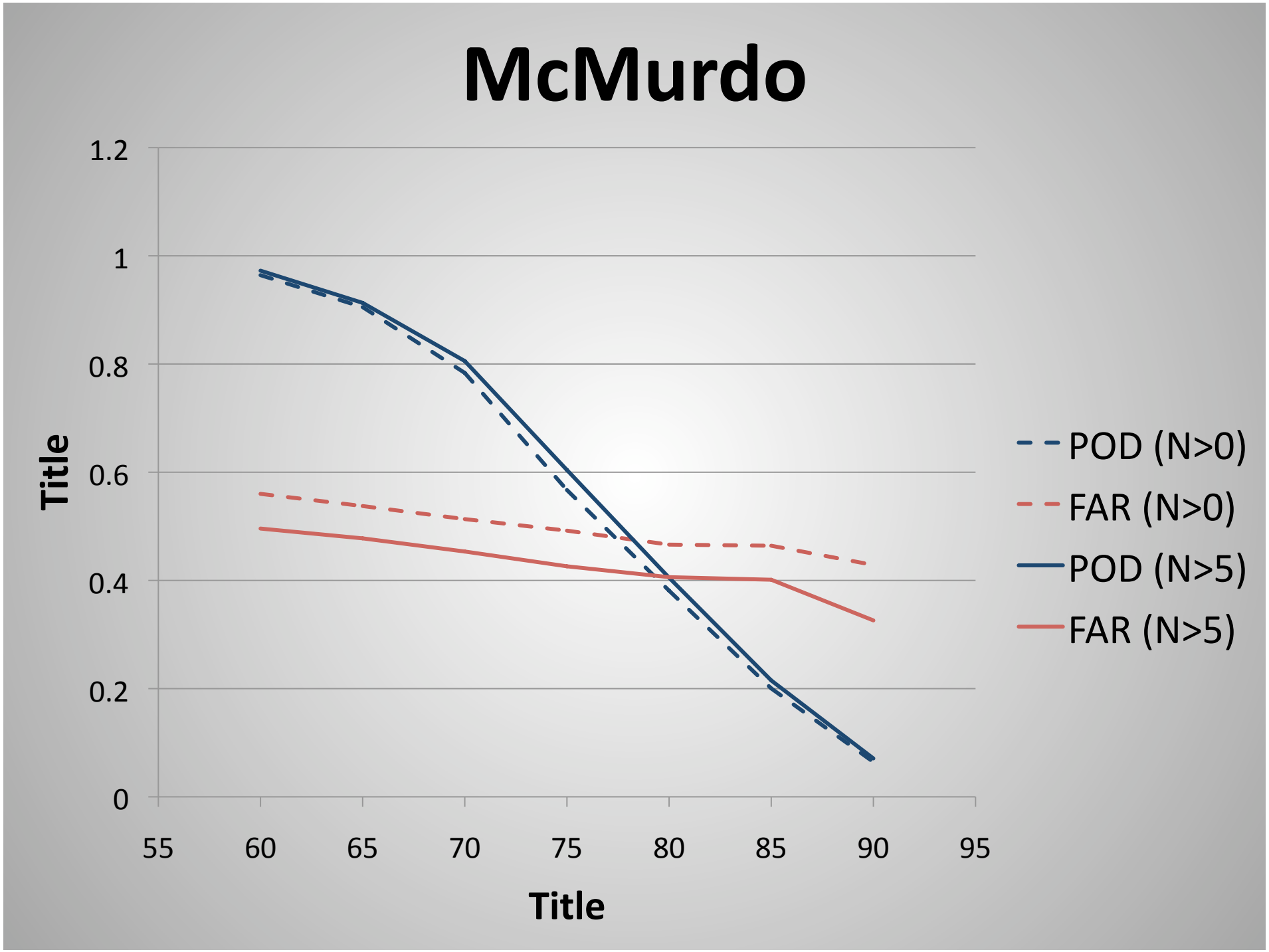

Davis
Verification values (proportion of total observations)
0.6
0.5
0.4
0.3
0.2
0.1
0
55
60
65
70
75
80
85
90
95
AMPS Relative Humidity Threshold
hits (N>0)
false alarm (N>0)
misses (N>0)
hits (N>5)
false alarm (N>5)
misses (N>5)

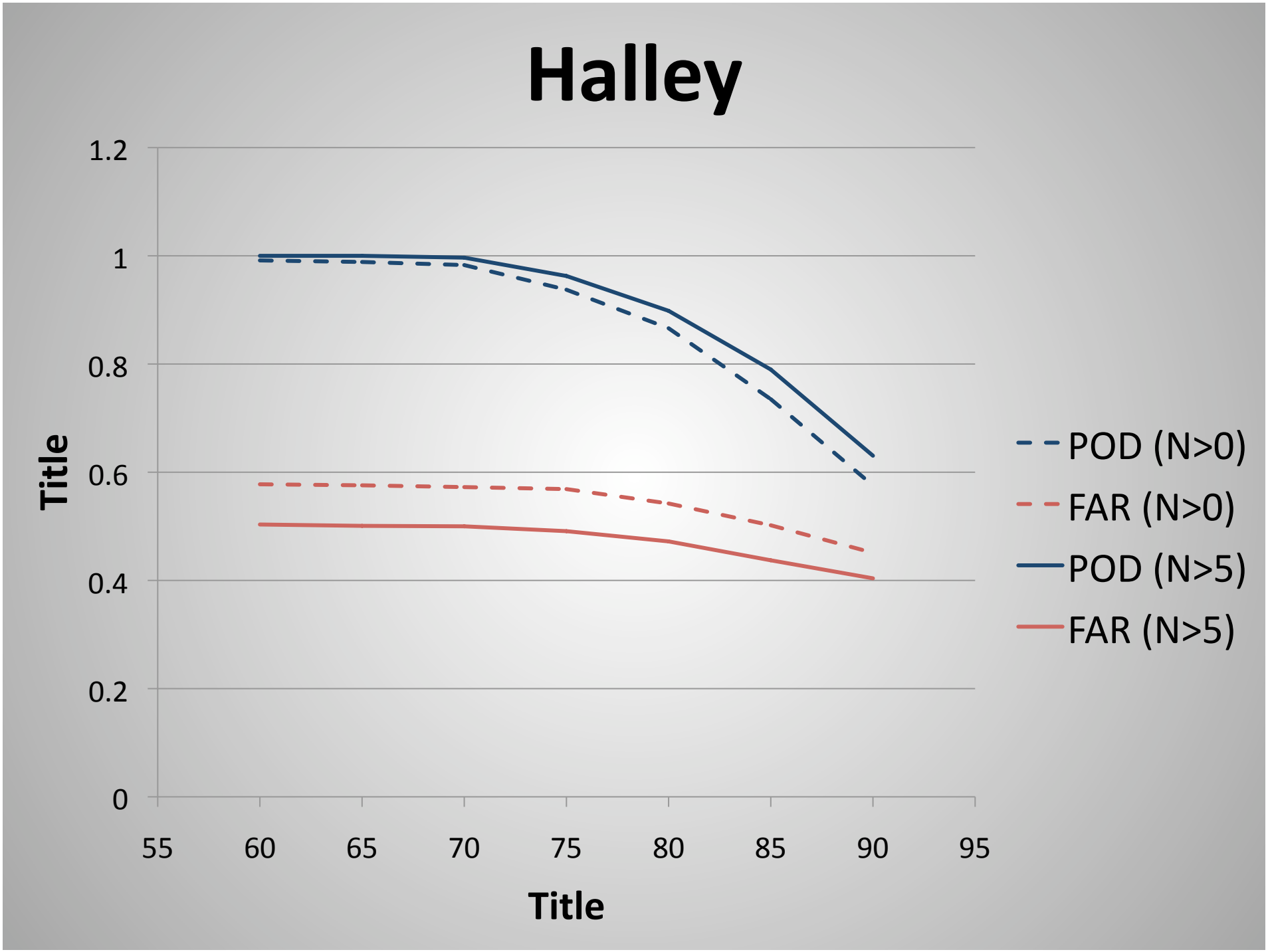
# McMurdo


Verification values (proportion of total observations)
0.6
0.5
0.4
0.3
0.2
0.1
0
55
60
65
70
75
80
85
90
95
AMPS Relative Humidity Threshold
hits (N>0)
false alarm (N>0)
misses (N>0)
hits (N>5)
false alarm (N>5)
misses (N>5)

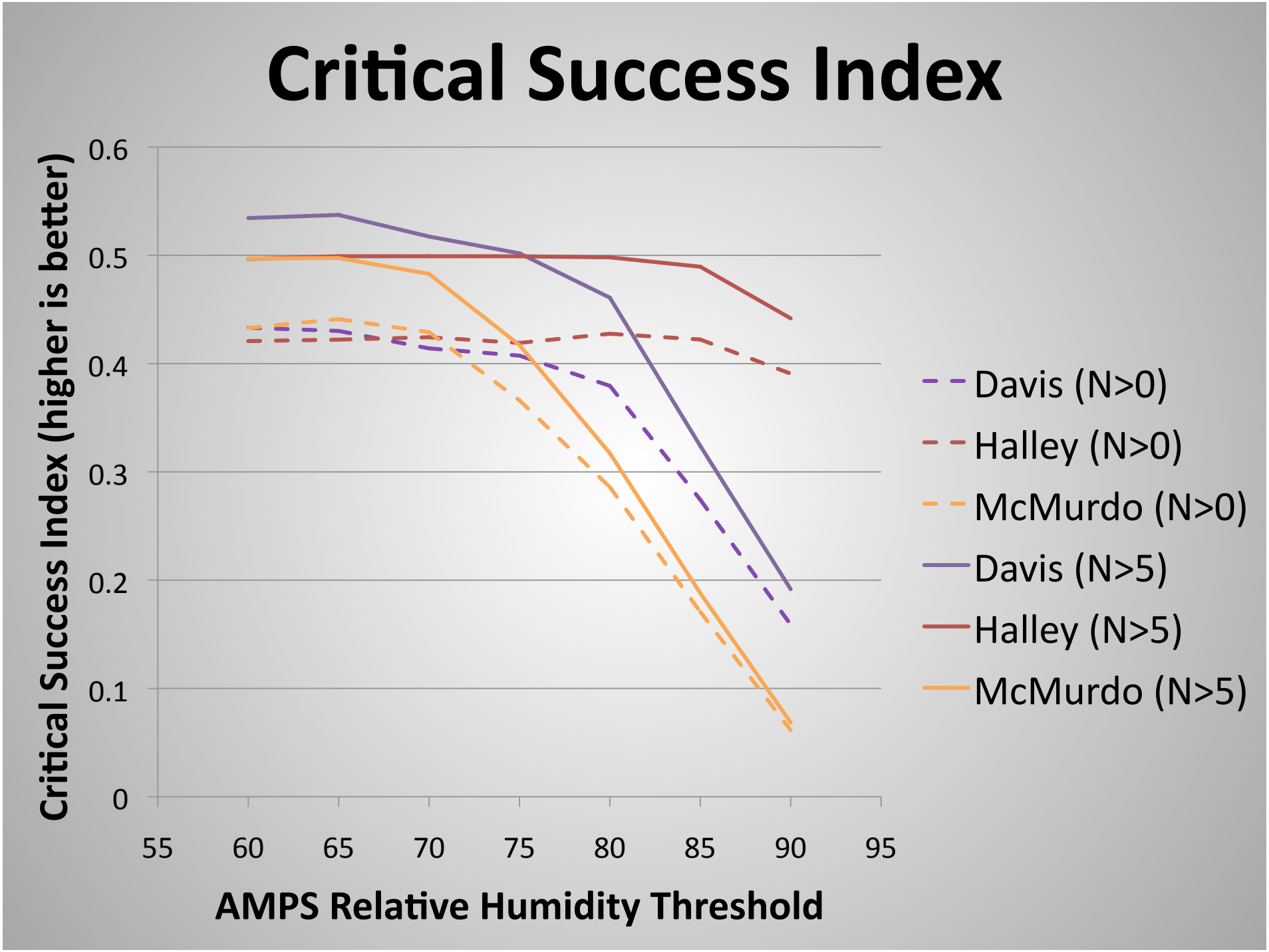

Halley
Verification values (proportion of total observations)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
55
60
65
70
75
80
85
90
95
AMPS Relative Humidity Threshold
hits (N>0)
false alarm (N>0)
misses (N>0)
hits (N>5)
false alarm (N>5)
misses (N>5)


Davis
1.2
1
0.8
0.6
0.4
0.2
0
Title
55
60
65
70
75
80
85
90
95
Title
POD (N>0)
FAR (N>0)
POD (N>5)
FAR (N>5)


McMurdo
1.2
1
0.8
0.6
0.4
0.2
0
Title
55
60
65
70
75
80
85
90
95
Title
POD (N>0)
FAR (N>0)
POD (N>5)
FAR (N>5)


Halley
1.2
1
0.8
0.6
0.4
0.2
0
Title
55
60
65
70
75
80
85
90
95
Title
POD (N>0)
FAR (N>0)
POD (N>5)
FAR (N>5)

# Critical Success Index



# Gerrity Skill Score