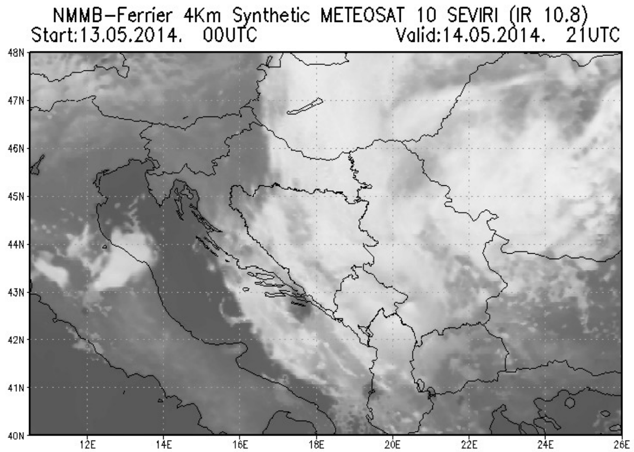
Verification of NMMB model using METEOSAT SEVIRI data

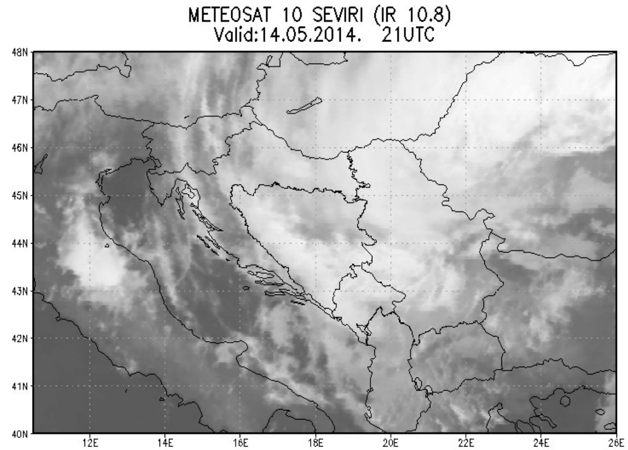
Bojan Kašić and Miloš Lompar
EWGLAM 6th October 2015

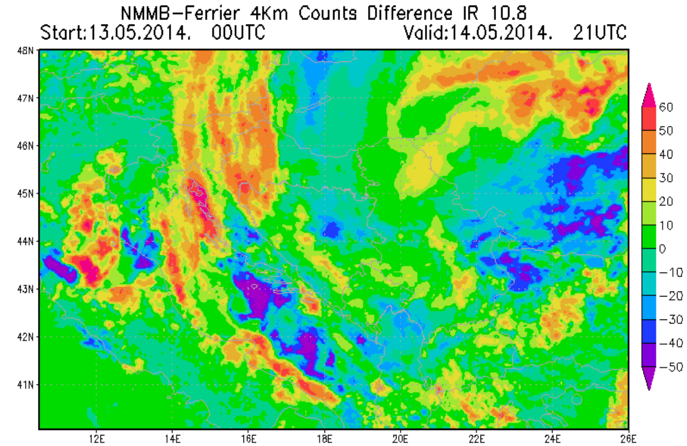
Motivation

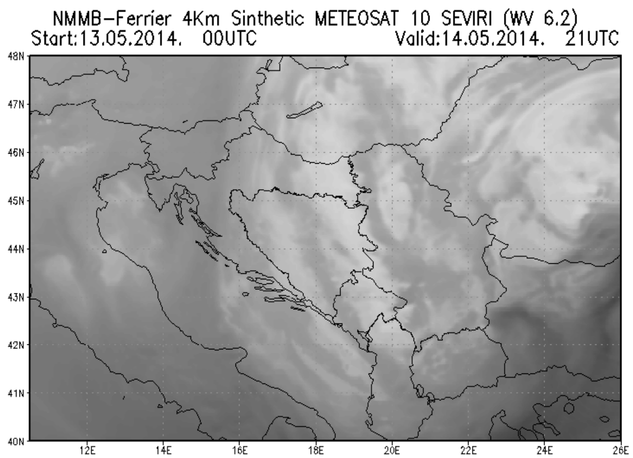
- ECMWF made first synthetic satellite image 1991
- Help forecasters to get insight into model accuracy
- Help NWP to select correct setup and parameterization options

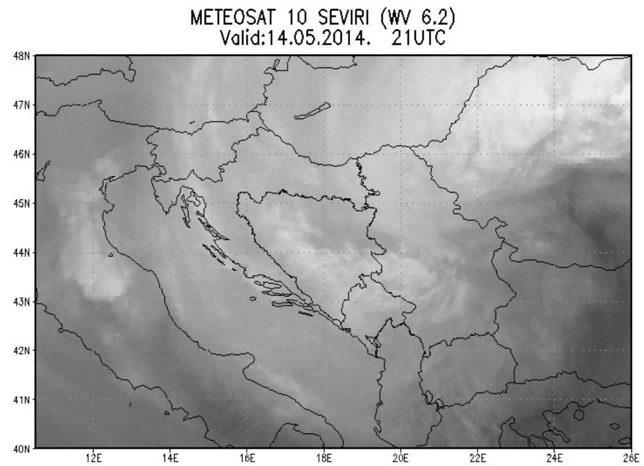
Motivation

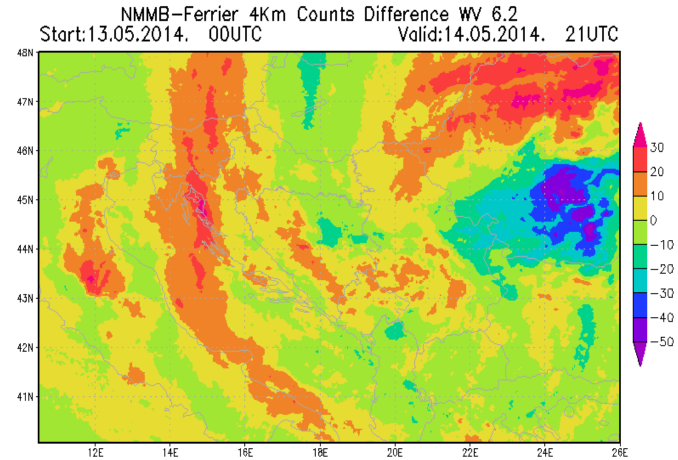

NMMB-Ferrier 4Km Synthetic METEOSAT 10 SEVIRI (IR 10.8)
Start:13.05.2014. 00UTC Valid:14.05.2014. 21UTC


METEOSAT 10 SEVIRI (IR 10.8)
Valid:14.05.2014. 21UTC


NMMB-Ferrier 4Km Counts Difference IR 10.8
Start:13.05.2014. 00UTC Valid:14.05.2014. 21UTC

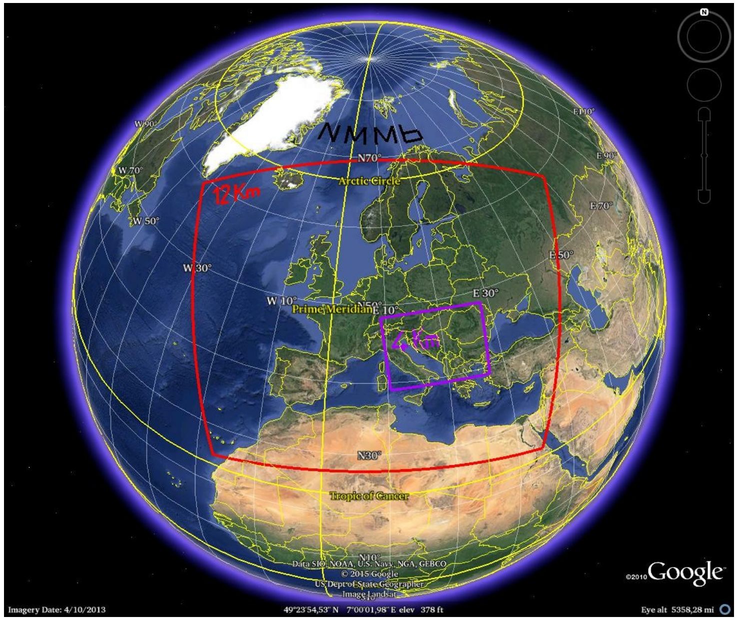

NMMB-Ferrier 4Km Sinthetic METEOSAT 10 SEVIRI (WV 6.2)
Start:13.05.2014. 00UTC Valid:14.05.2014. 21UTC

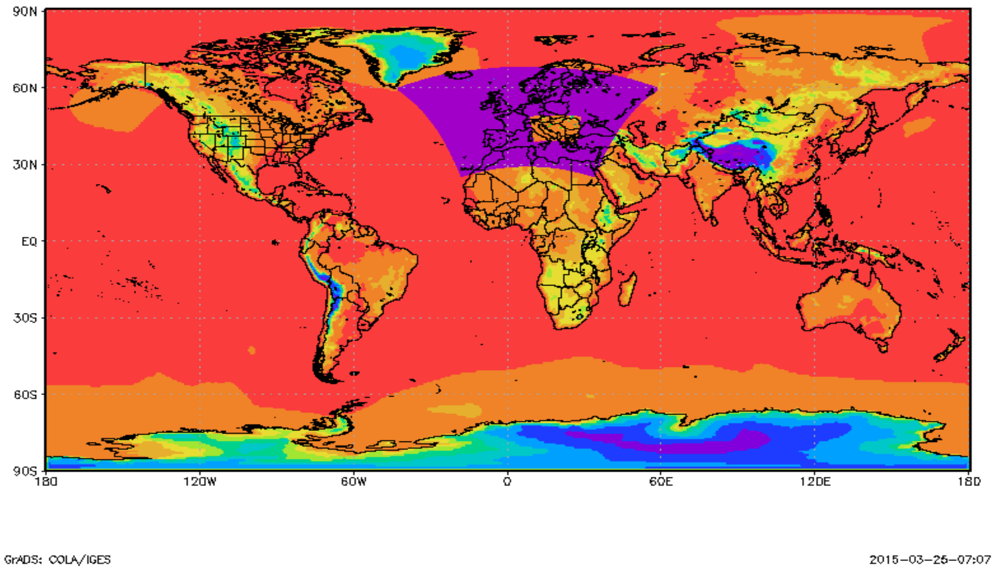

METEOSAT 10 SEVIRI (WV 6.2)
Valid:14.05.2014. 21UTC


NMMB-Ferrier 4Km Counts Difference WV 6.2
Start:13.05.2014. 00UTC Valid:14.05.2014. 21UTC

Model

- NMMB
  - Global, 0.47°x0.33°, 64 vertical layers, model top is 10 mb surface, i.c. GFS-analysis, 00/12 UTC,
  - Regional, 1-way nasting:
    - horizontal resolution 12 Km, 64 vertical layers; forecast period 120h; NMMB-glob b.c
    - 4 Km, 64 vertical layers; 72h ahead, no convection parametrization
- CRTM incorporated into UPP
  - uses model predicted cloud, moisture, and surface fields as input
  - Allow users to make direct comparisons between satellite observations and model forecast
  - Adjusted to calculate synthetic Radiance, Brightness Temperature, and Counts for SEVIRI sensor
  - 7 channels **(wv6.2**, wv7.3, ir8.7, ir9.7, **ir10.8**, ir12, ir13.4)
  - Thompson and Ferrier – single moment (only predict mas-mixing ratio) schemes. CRTM has to specify droplet size distribution in order to calculate radiation properties.

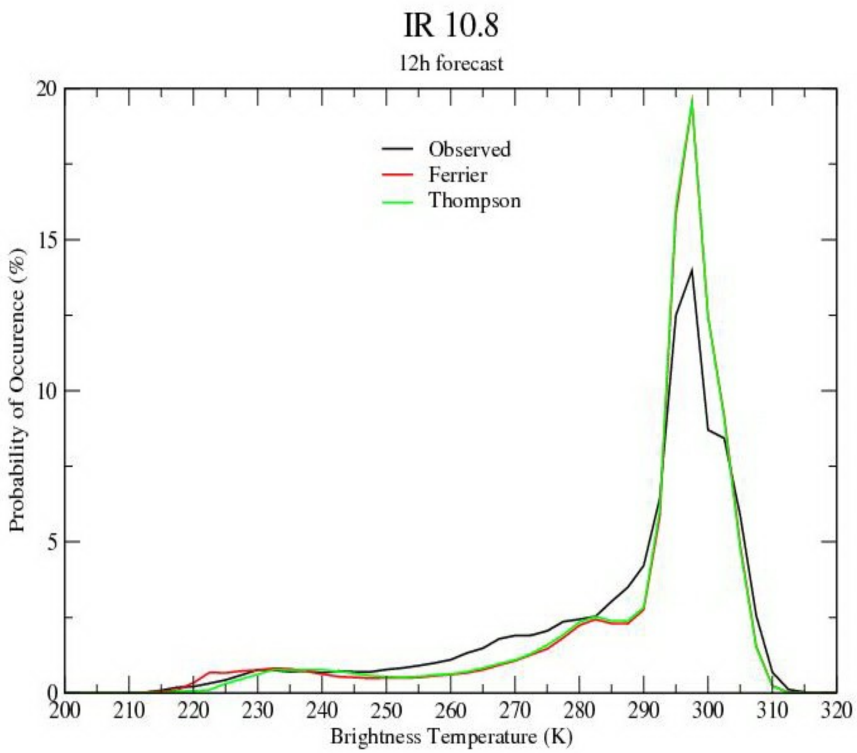




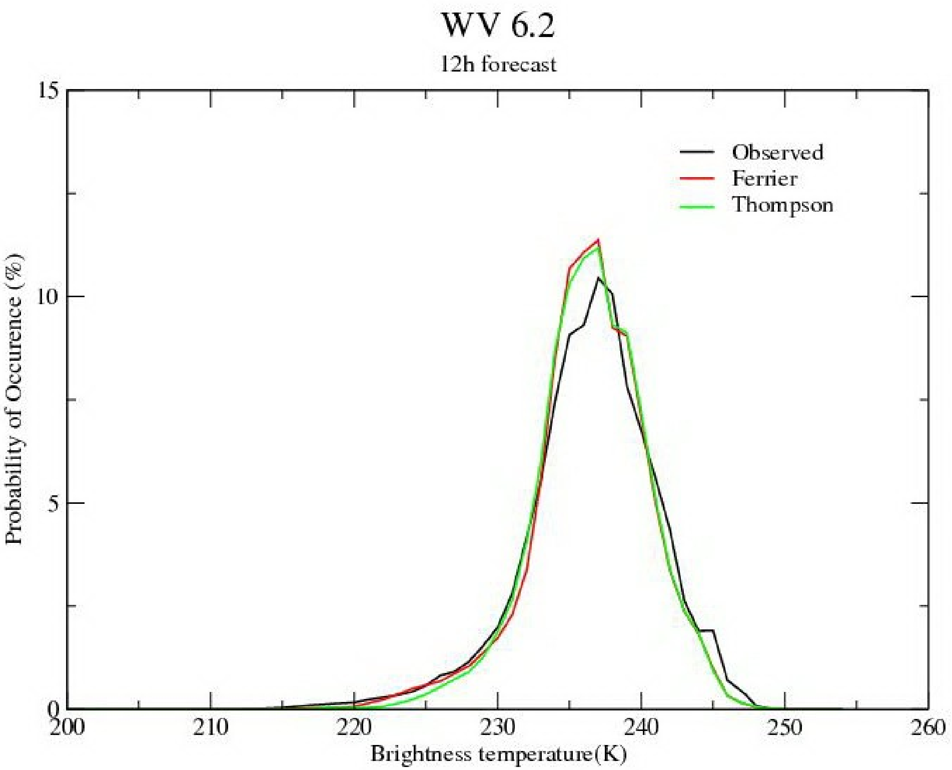
Methods of validation

- Histogram based technique
- Standard verification scores: Bias, False Alarm Ratio, Threat Score, Probability of Detection
- 6.2μm and 10.8μm
- Two different microphysics parameterization: New-Ferrier and Thompson
- Seasonal verification (summer 2015) and a case study (floods in may 2014)

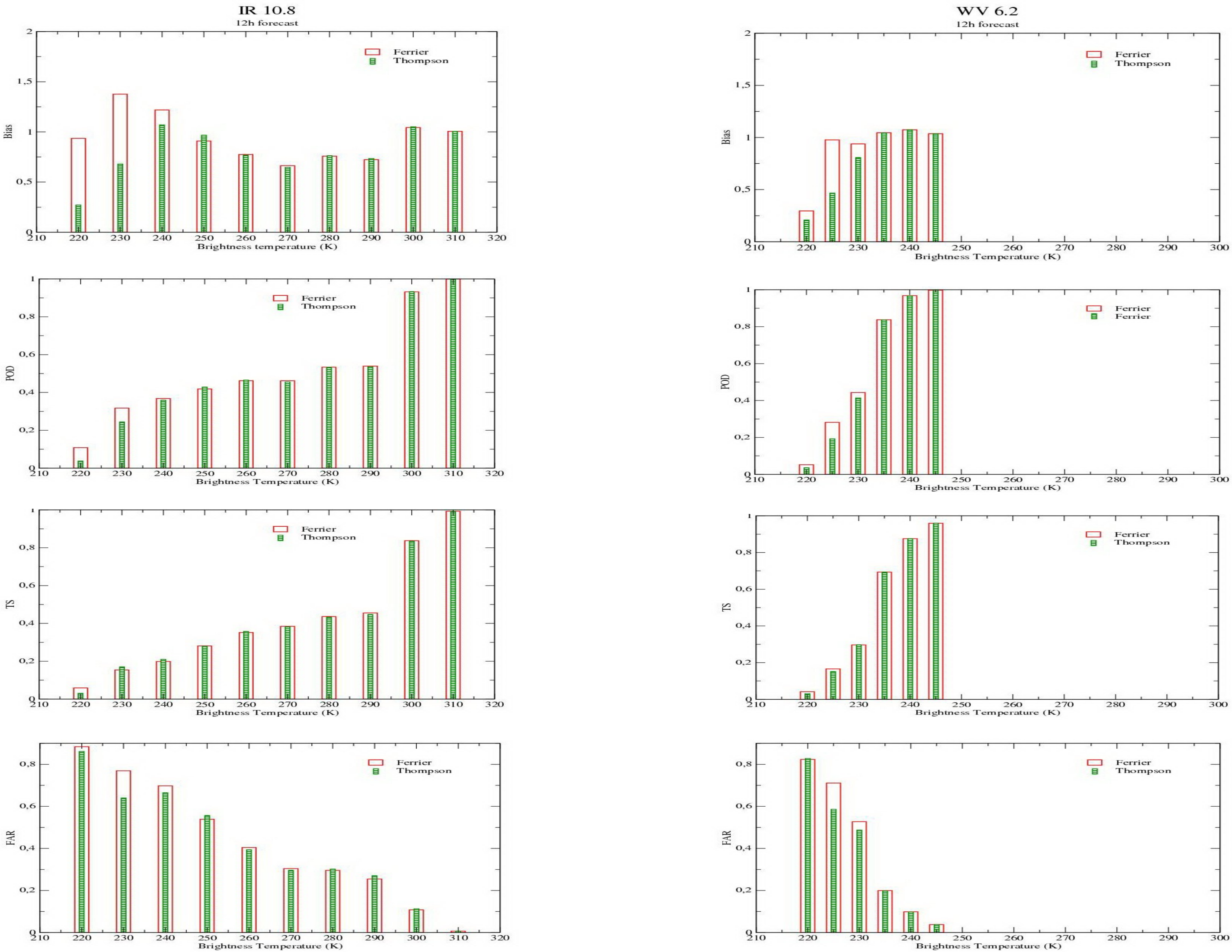
Results

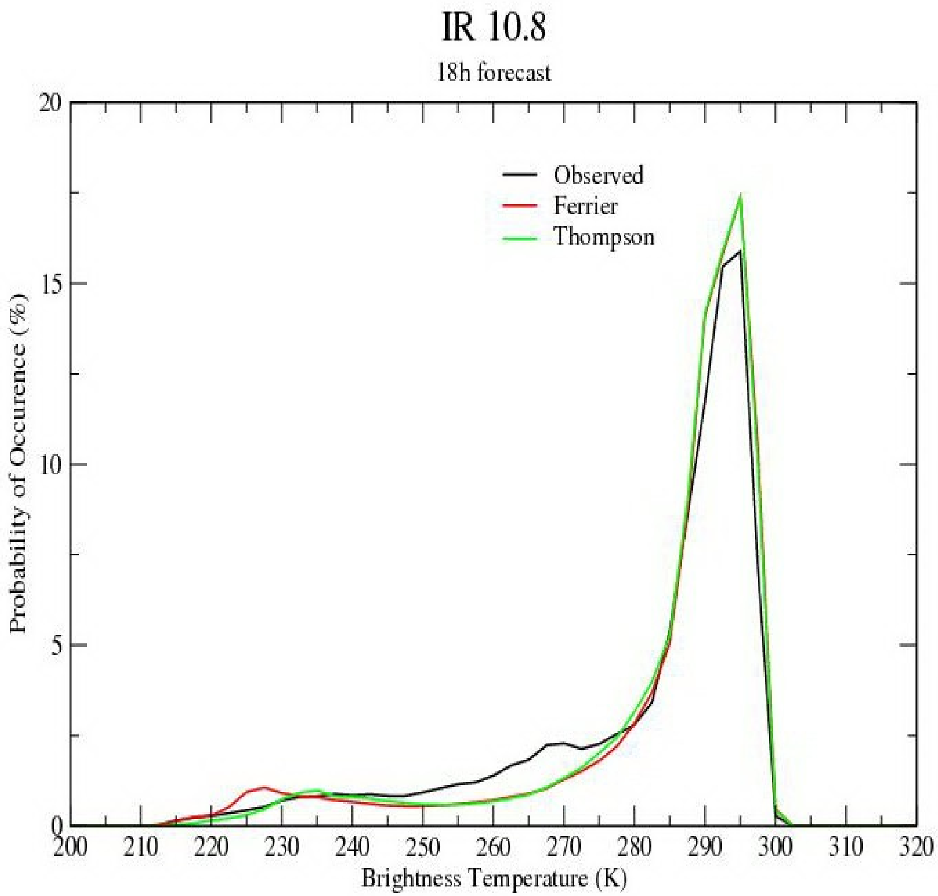


IR 10.8
12h forecast
Observed
Ferrier
Thompson
Probability of Occurence (%)
Brightness Temperature (K)
0
5
10
15
20
200
210
220
230
240
250
260
270
280
290
300
310
320

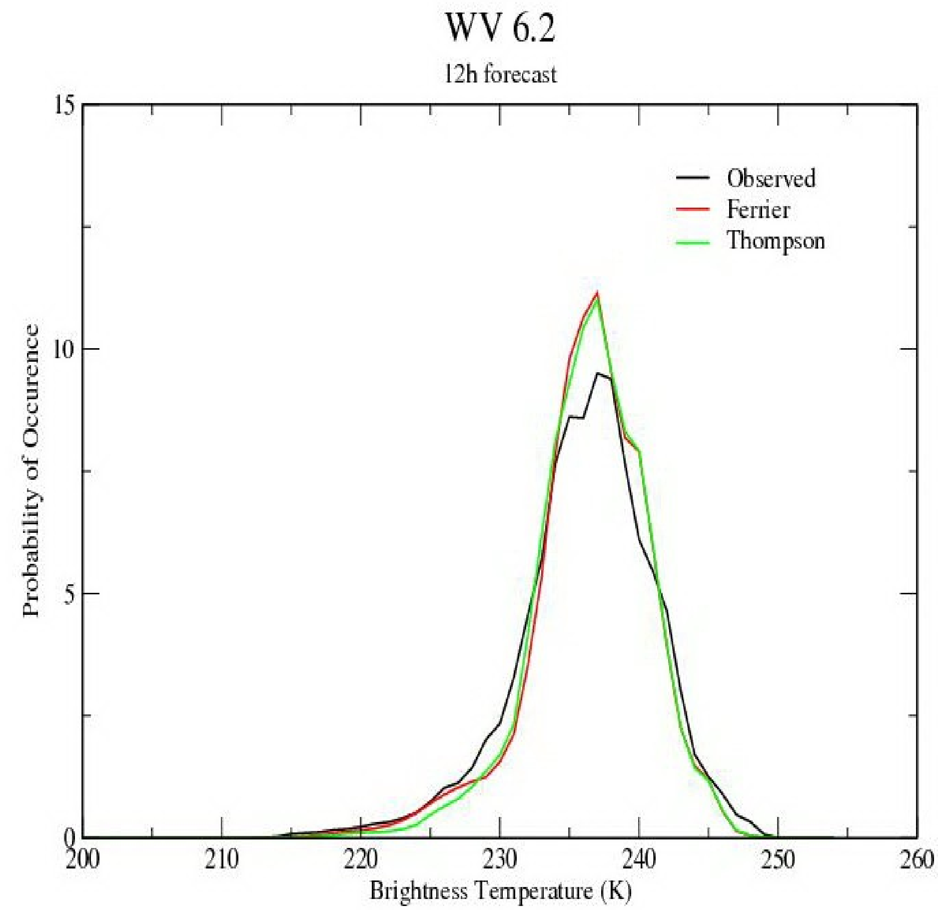


WV 6.2
12h forecast
Observed
Ferrier
Thompson
Probability of Occurence (%)
Brightness temperature(K)
0
5
10
15
200
210
220
230
240
250
260

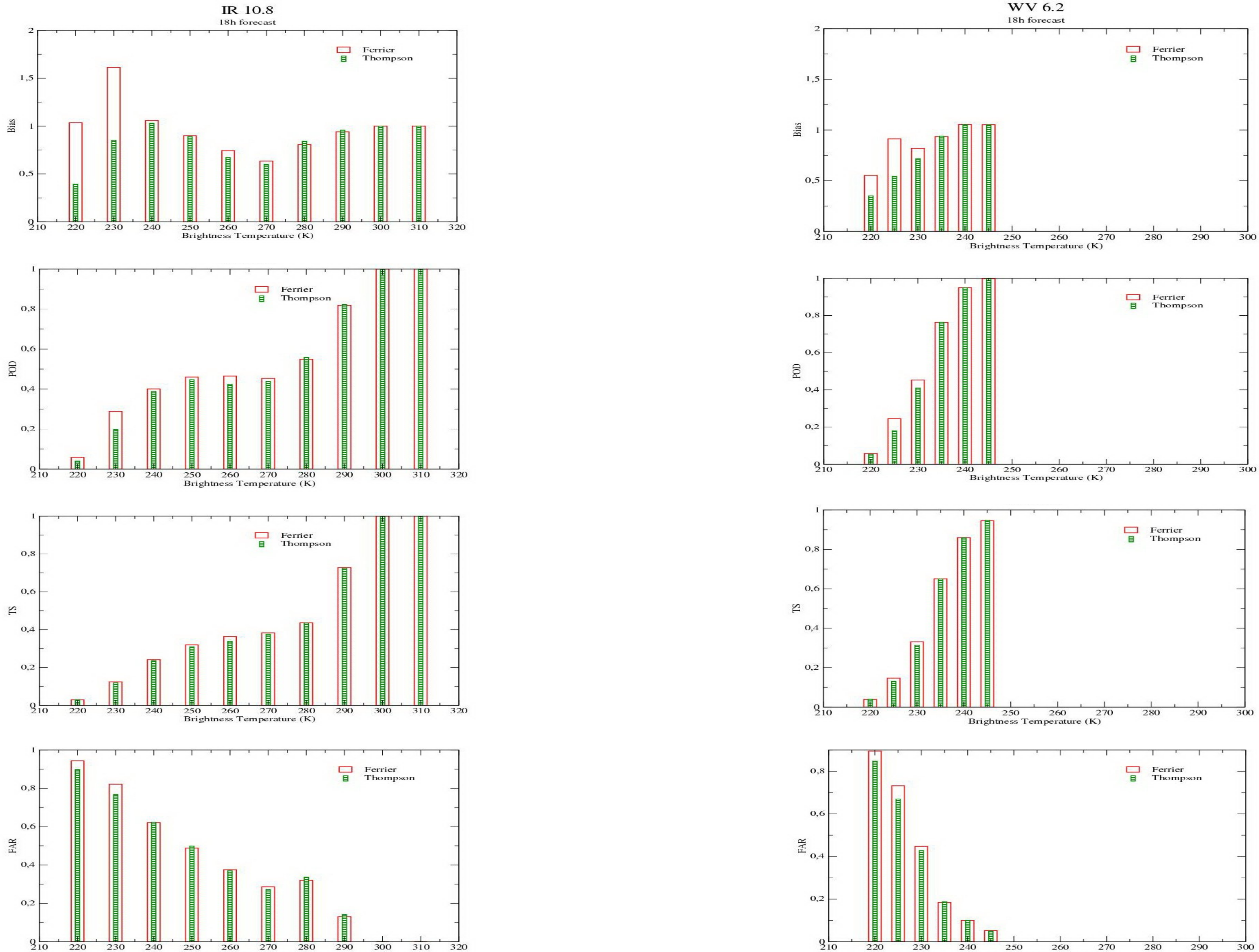

IR 10.8
12h forecast
WV 6.2
12h forecast
Ferrier
Thompson
Bias
POD
TS
FAR
Brightness temperature (K)
Brightness Temperature (K)

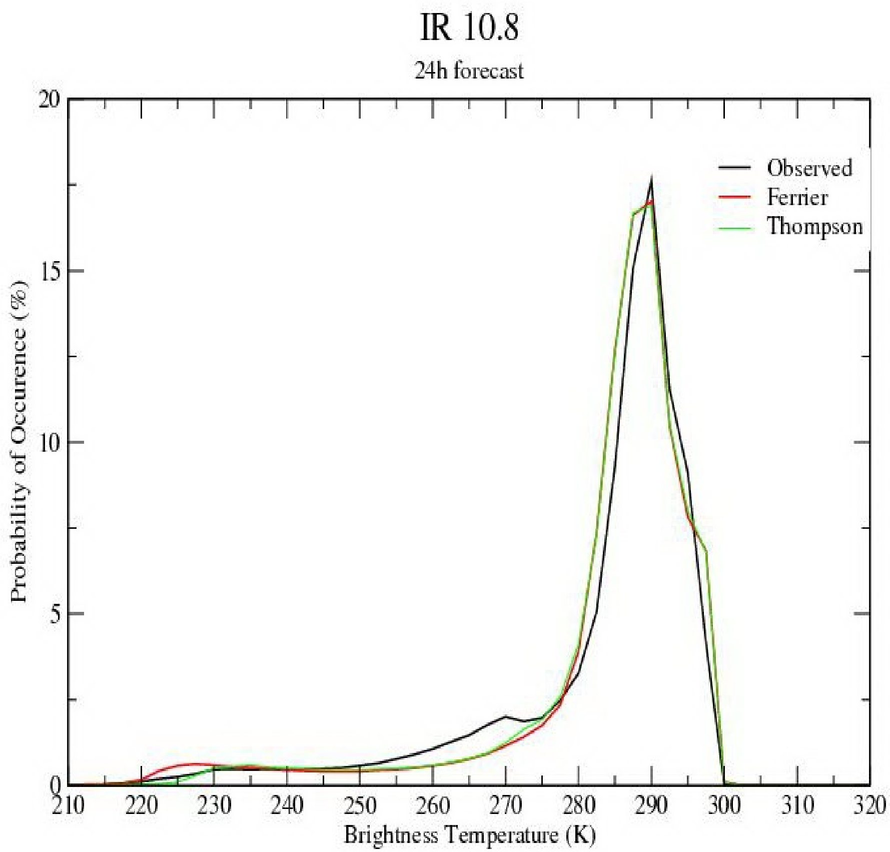


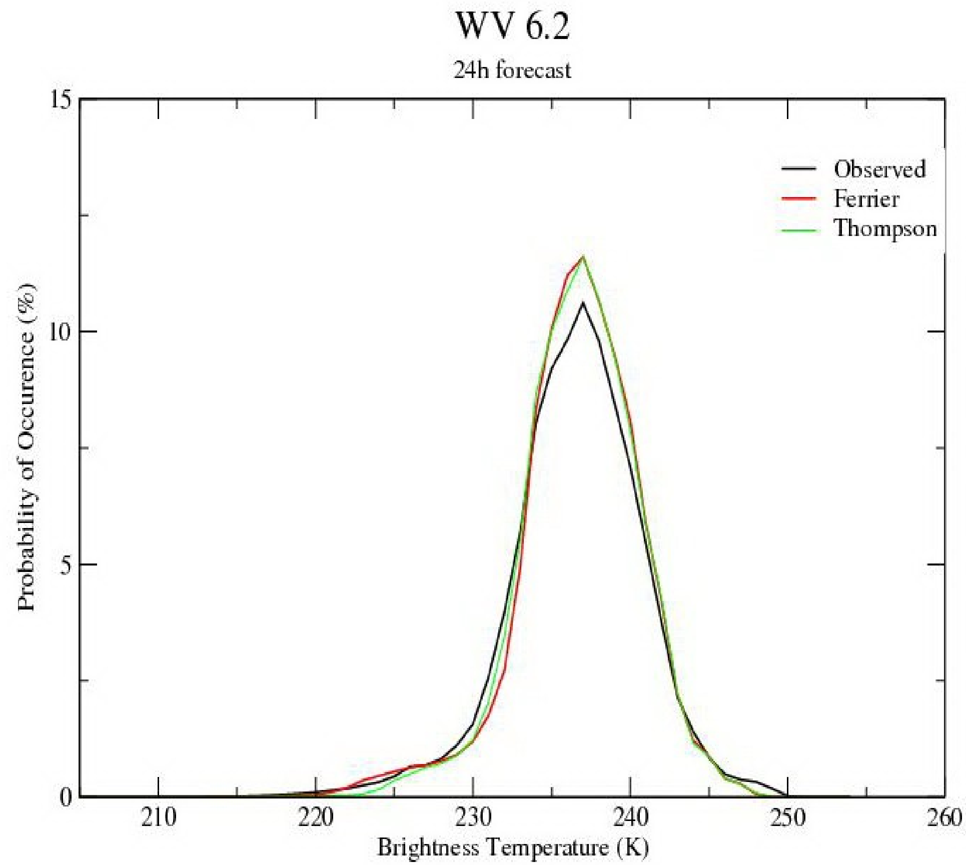
IR 10.8
18h forecast
Observed
Ferrier
Thompson
Probability of Occurence (%)
Brightness Temperature (K)

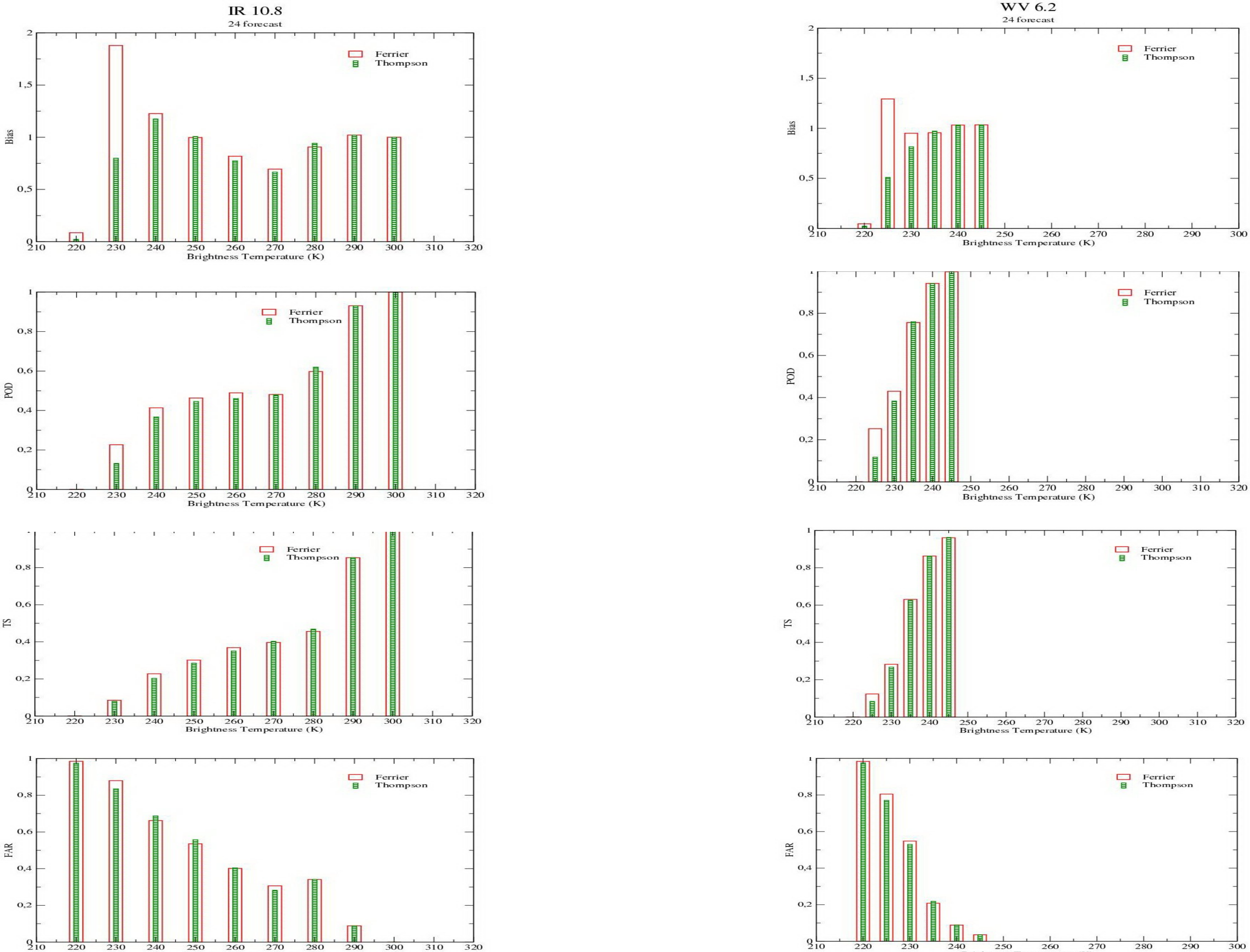


WV 6.2
12h forecast
Observed
Ferrier
Thompson
Probability of Occurence
Brightness Temperature (K)

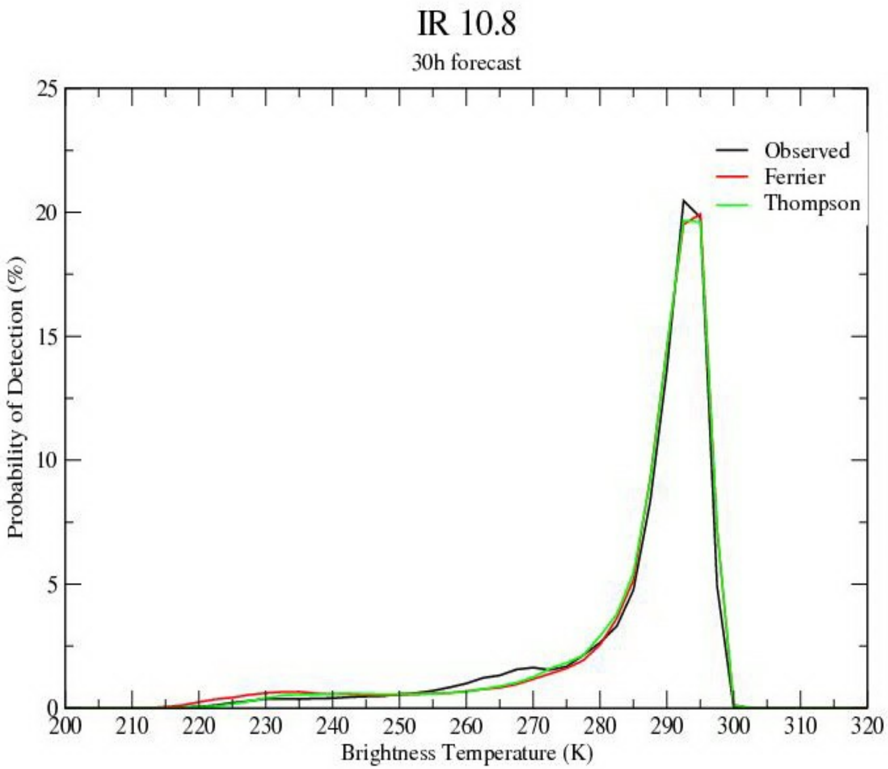

IR 10.8
18h forecast
WV 6.2
18h forecast
Ferrier
Thompson
Bias
POD
TS
FAR
Brightness Temperature (K)

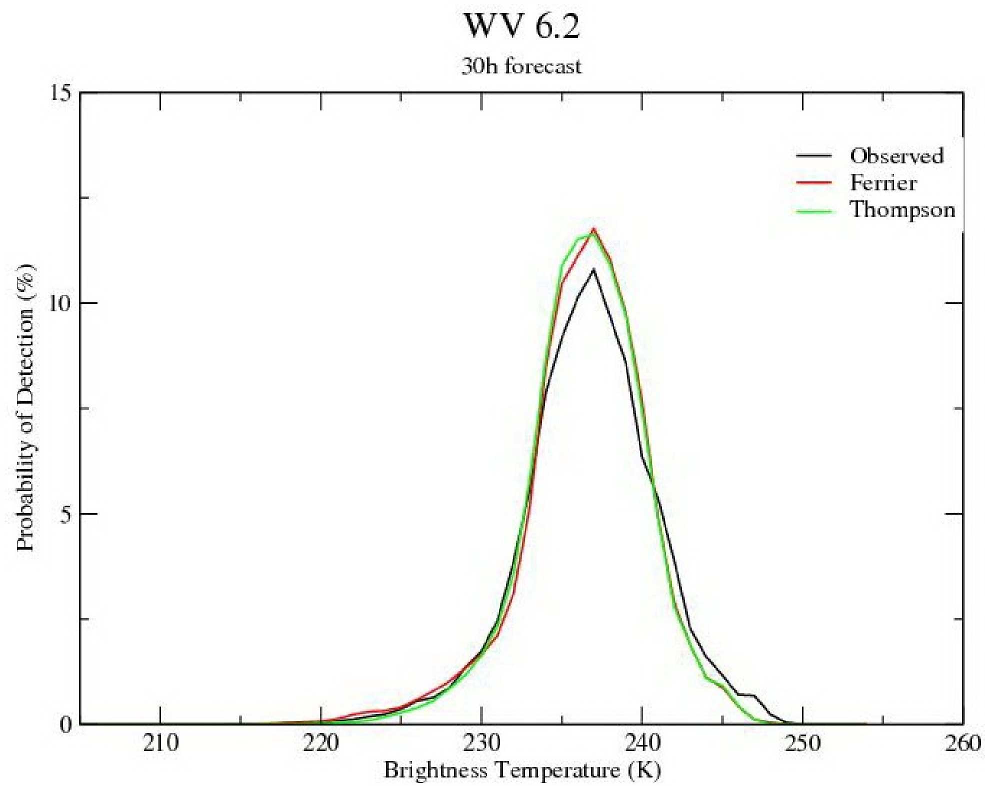

IR 10.8
24h forecast
Observed
Ferrier
Thompson
Probability of Occurence (%)
Brightness Temperature (K)
0
5
10
15
20
210
220
230
240
250
260
270
280
290
300
310
320

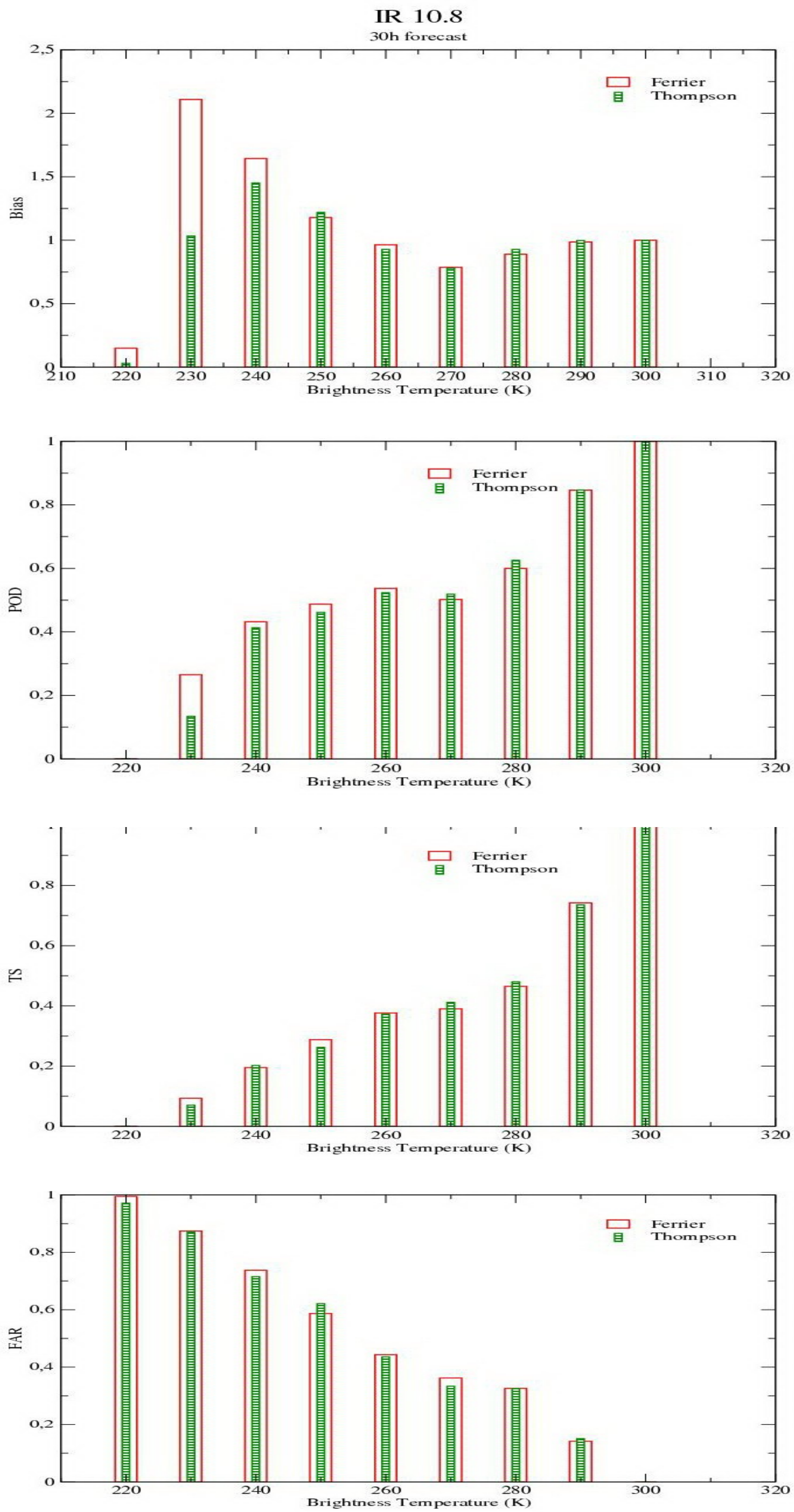

WV 6.2
24h forecast
Observed
Ferrier
Thompson
Probability of Occurence (%)
Brightness Temperature (K)
0
5
10
15
210
220
230
240
250
260

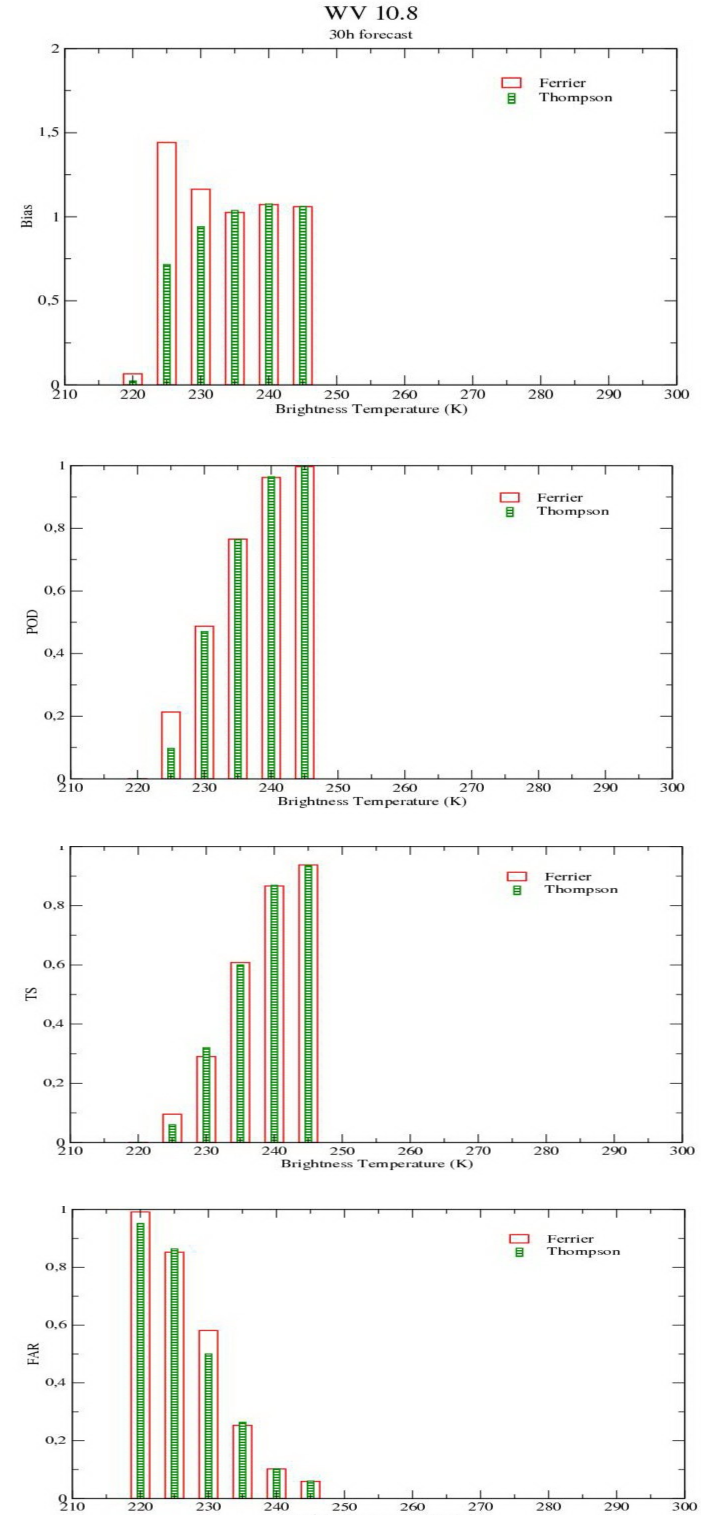


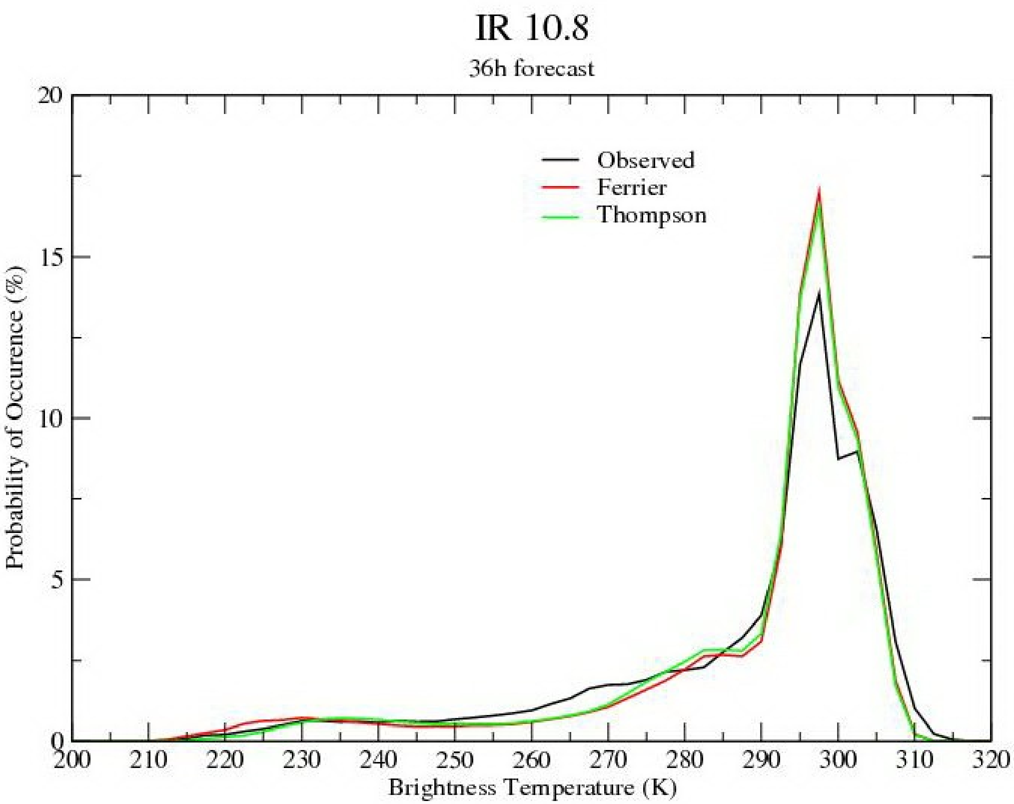
IR 10.8
24 forecast
WV 6.2
24 forecast
Ferrier
Thompson
Bias
POD
TS
FAR
Brightness Temperature (K)

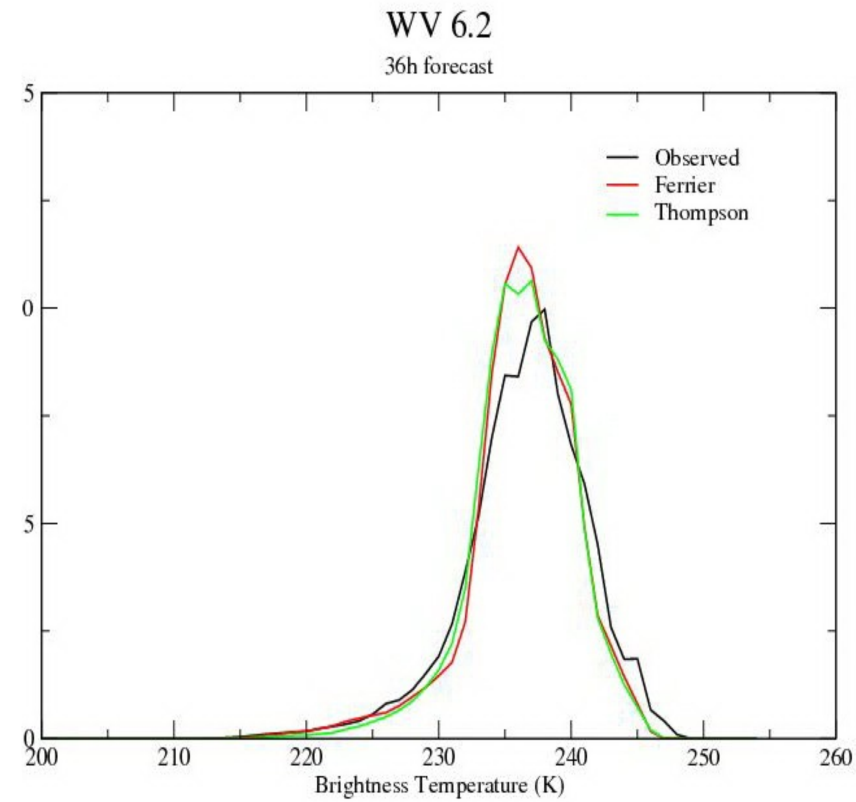

IR 10.8
30h forecast
Observed
Ferrier
Thompson
Probability of Detection (%)
Brightness Temperature (K)
0
5
10
15
20
25
200
210
220
230
240
250
260
270
280
290
300
310
320

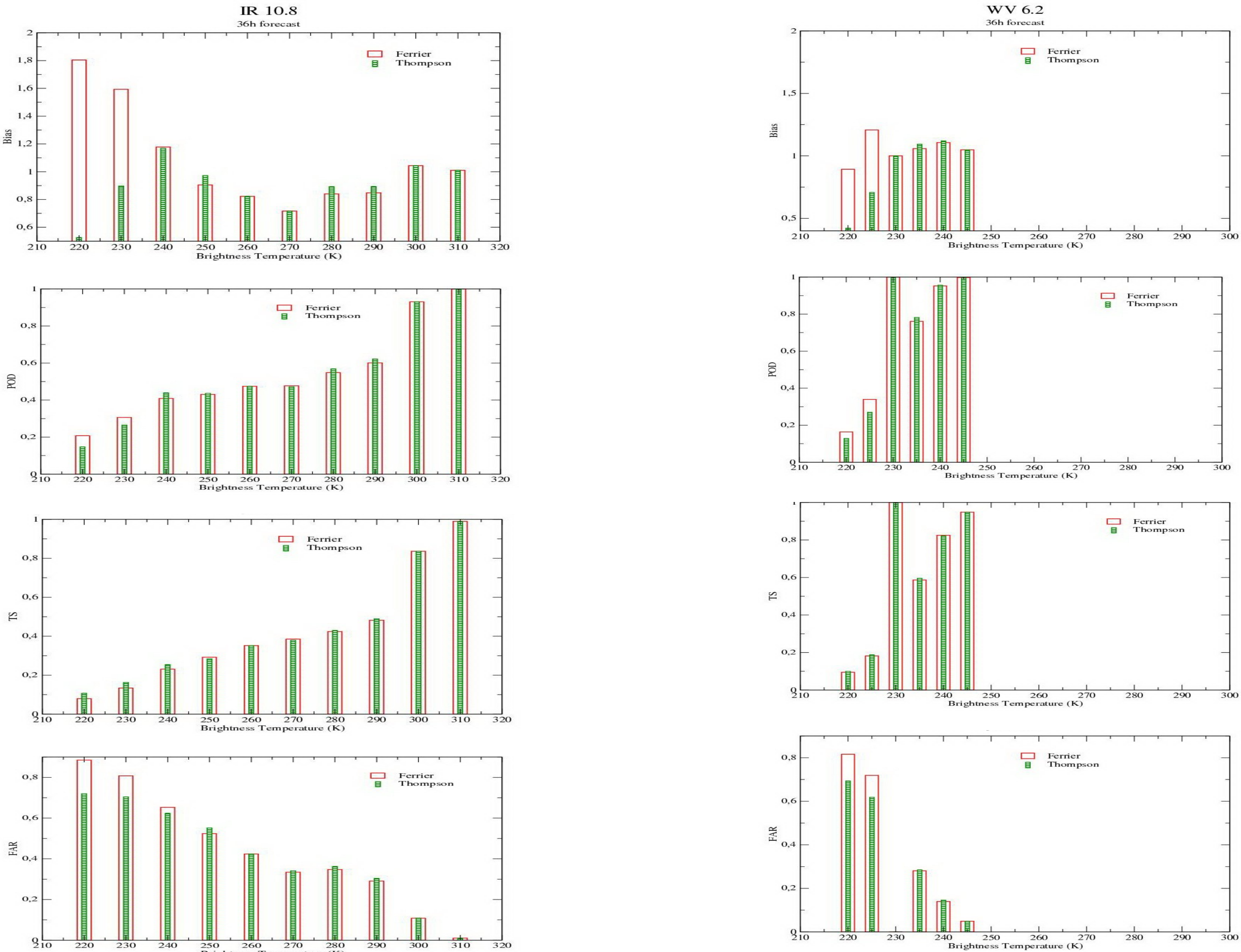

WV 6.2
30h forecast
Observed
Ferrier
Thompson
Probability of Detection (%)
Brightness Temperature (K)
0
5
10
15
210
220
230
240
250
260


IR 10.8
30h forecast
Ferrier
Thompson
Bias
POD
TS
FAR
Brightness Temperature (K)

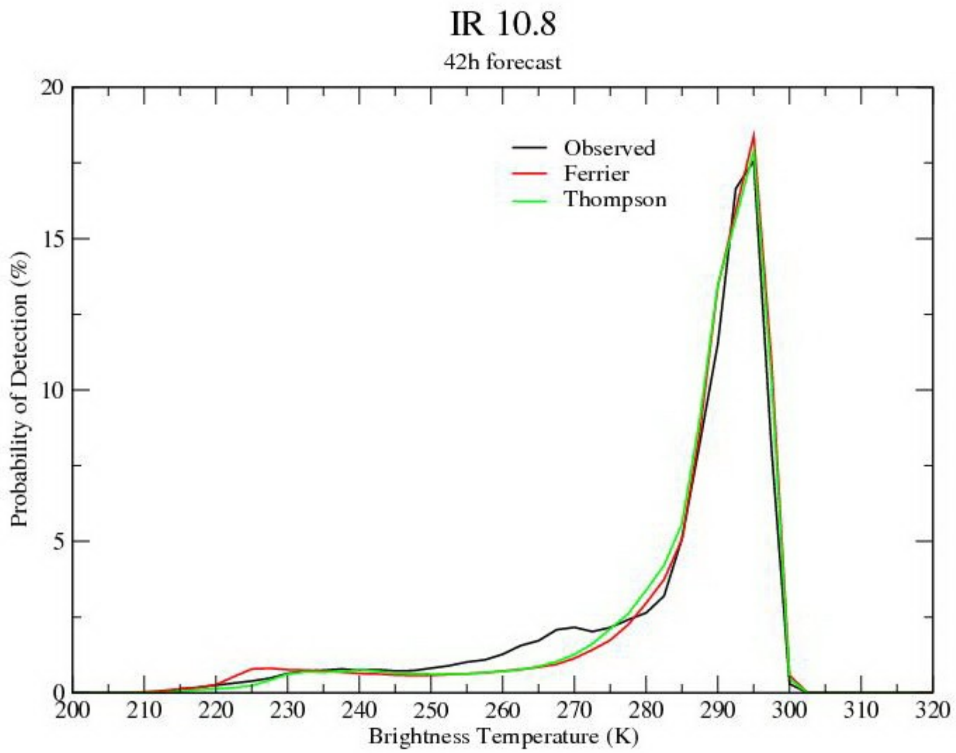

WV 10.8
30h forecast
Ferrier
Thompson
Bias
POD
TS
FAR
Brightness Temperature (K)

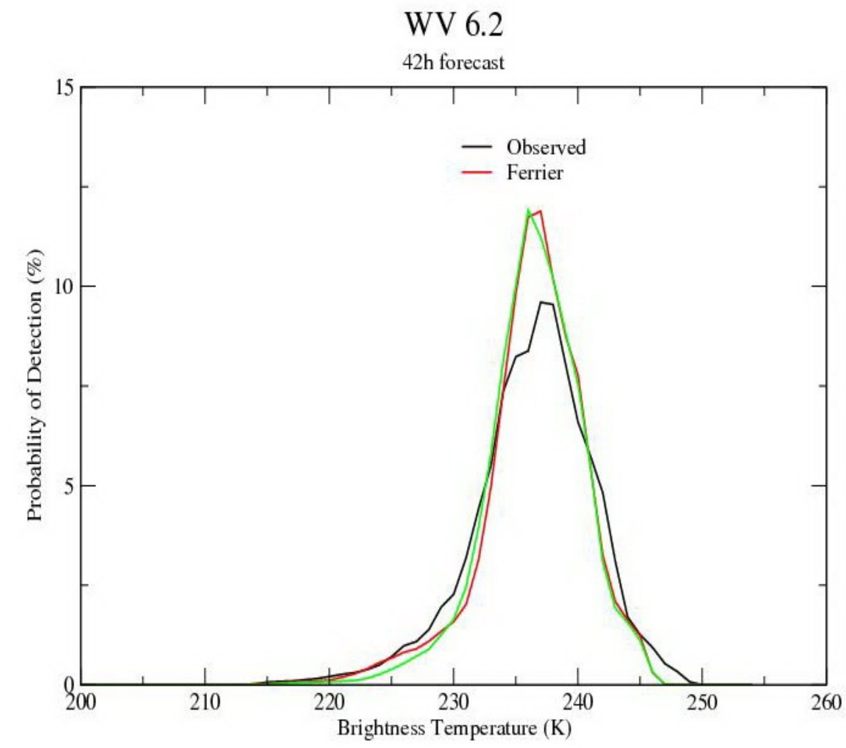

IR 10.8
36h forecast
Observed
Ferrier
Thompson
Probability of Occurence (%)
20
15
10
5
0
200
210
220
230
240
250
260
270
280
290
300
310
320
Brightness Temperature (K)

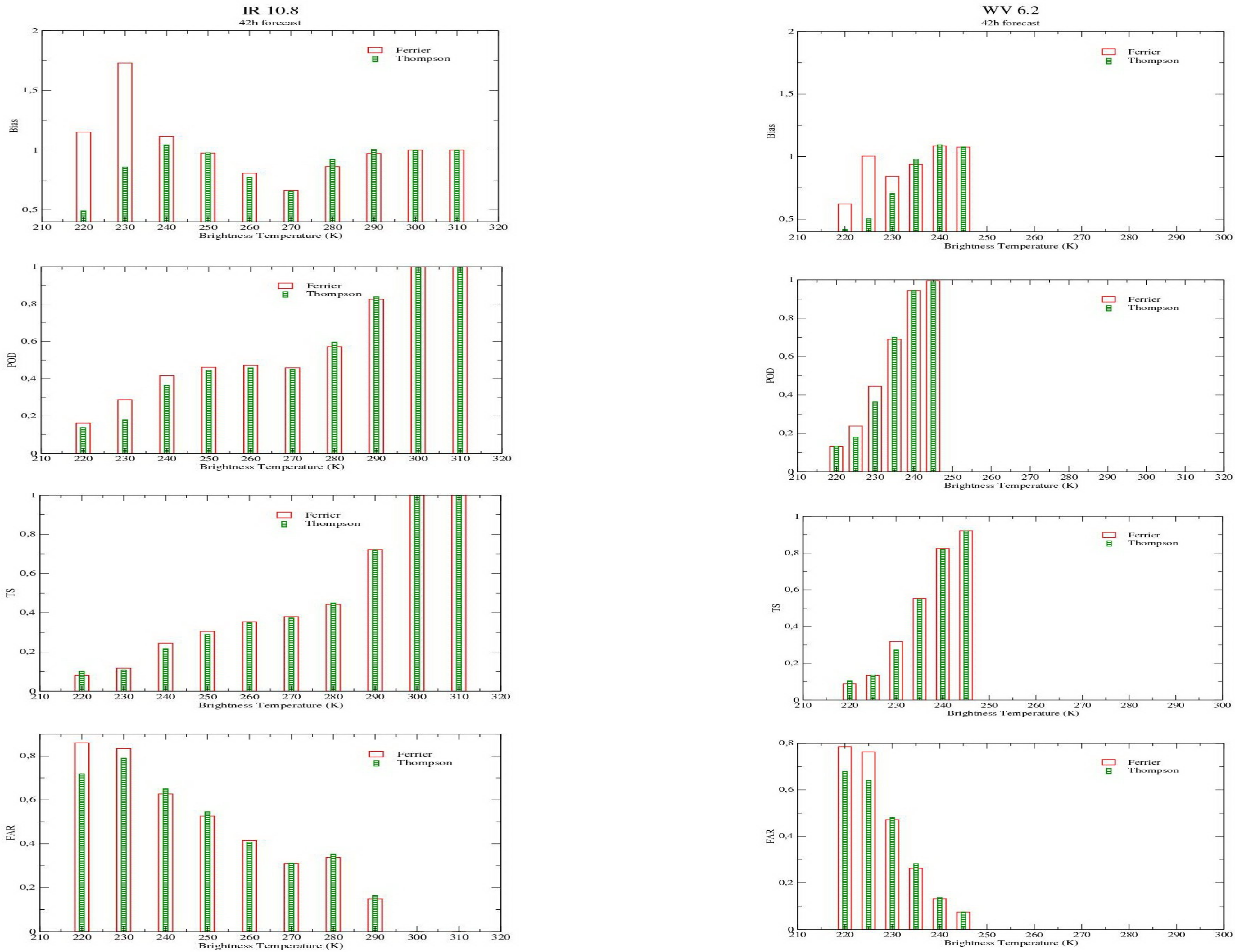

WV 6.2
36h forecast
Observed
Ferrier
Thompson
5
0
5
0
200
210
220
230
240
250
260
Brightness Temperature (K)

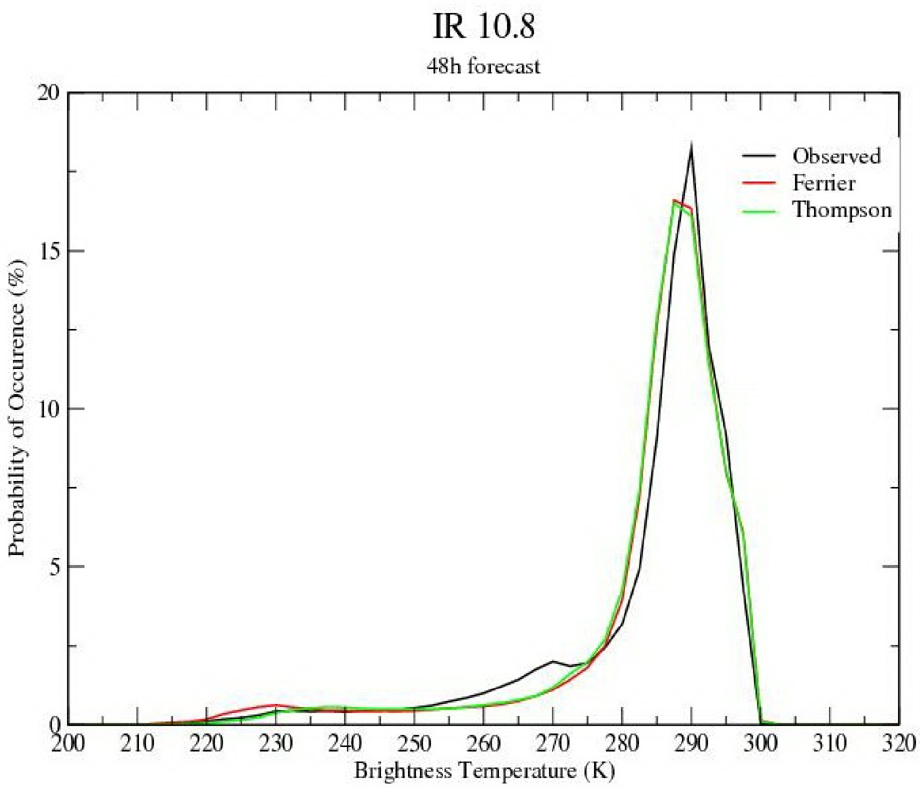


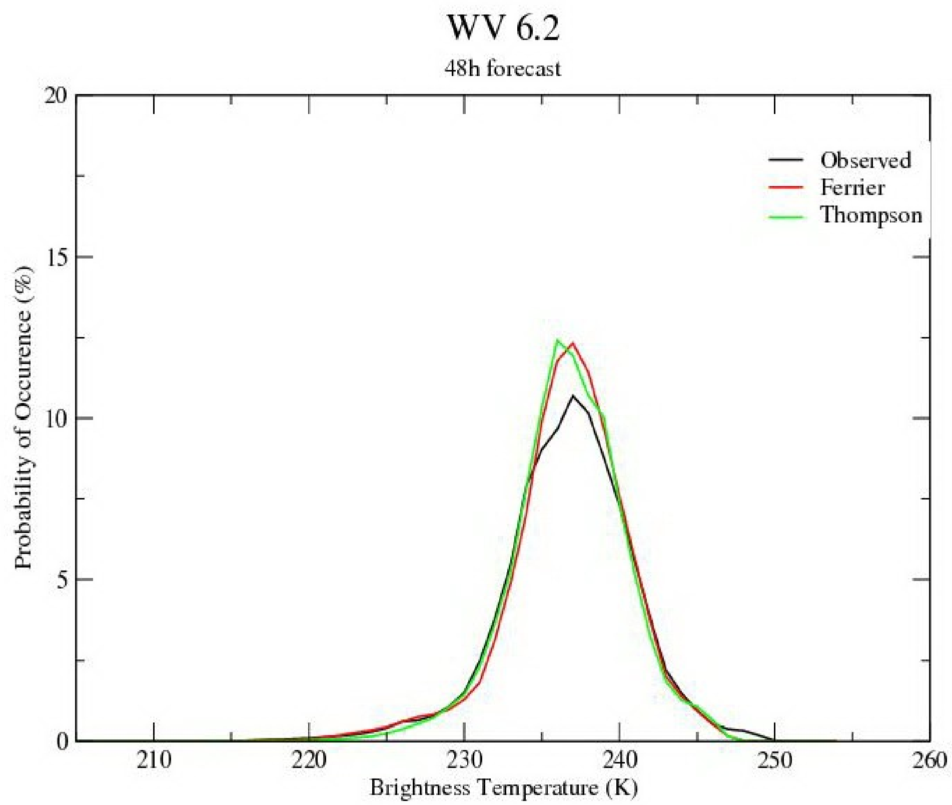
IR 10.8
36h forecast
WV 6.2
36h forecast
Ferrier
Thompson
Bias
POD
TS
FAR
Brightness Temperature (K)

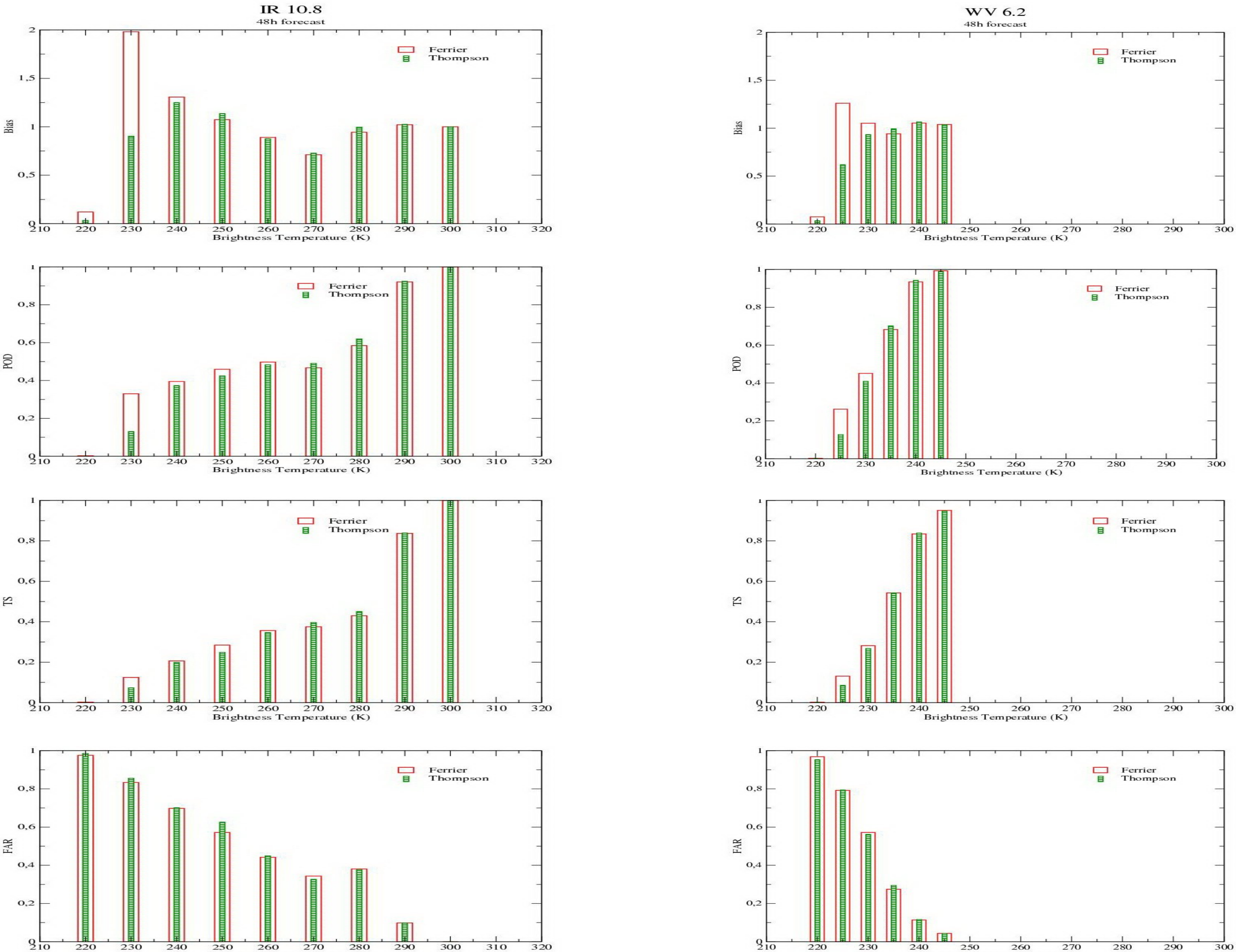

IR 10.8
42h forecast
Observed
Ferrier
Thompson
Probability of Detection (%)
Brightness Temperature (K)
0
5
10
15
20
200
210
220
230
240
250
260
270
280
290
300
310
320


WV 6.2
42h forecast
Observed
Ferrier
Probability of Detection (%)
Brightness Temperature (K)
0
5
10
15
200
210
220
230
240
250
260


IR 10.8
42h forecast
WV 6.2
42h forecast
Ferrier
Thompson
Bias
POD
TS
FAR
Brightness Temperature (K)

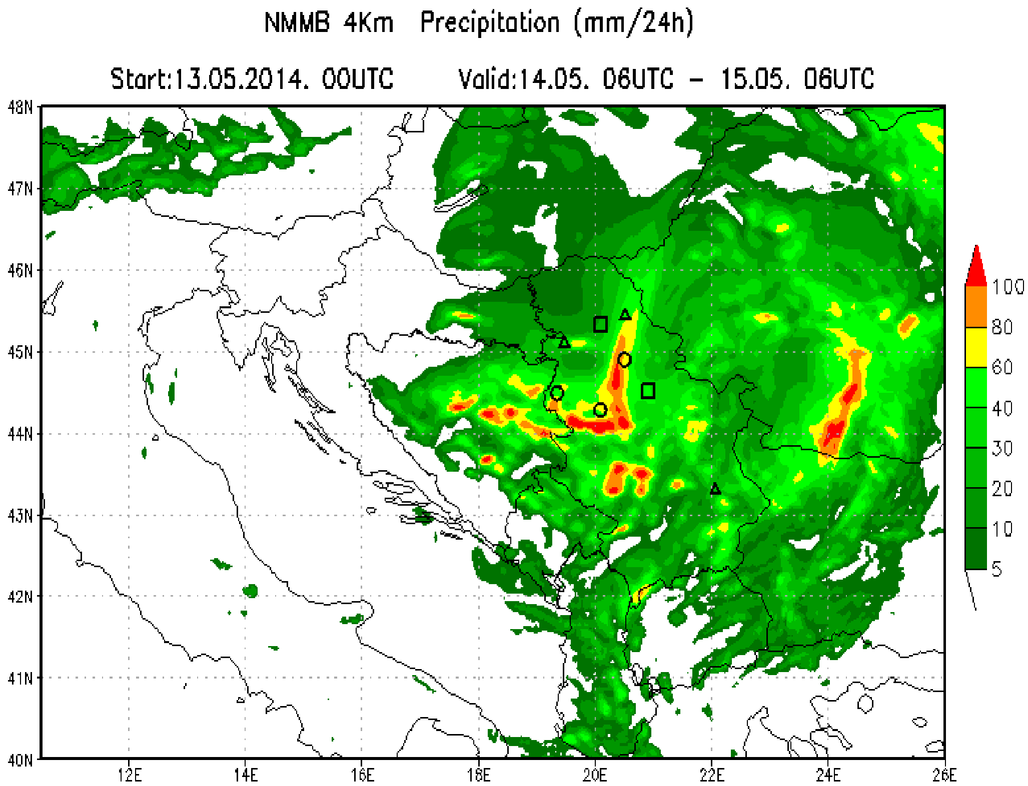

IR 10.8
48h forecast
Observed
Ferrier
Thompson
Probability of Occurence (%)
Brightness Temperature (K)
0
5
10
15
20
200
210
220
230
240
250
260
270
280
290
300
310
320

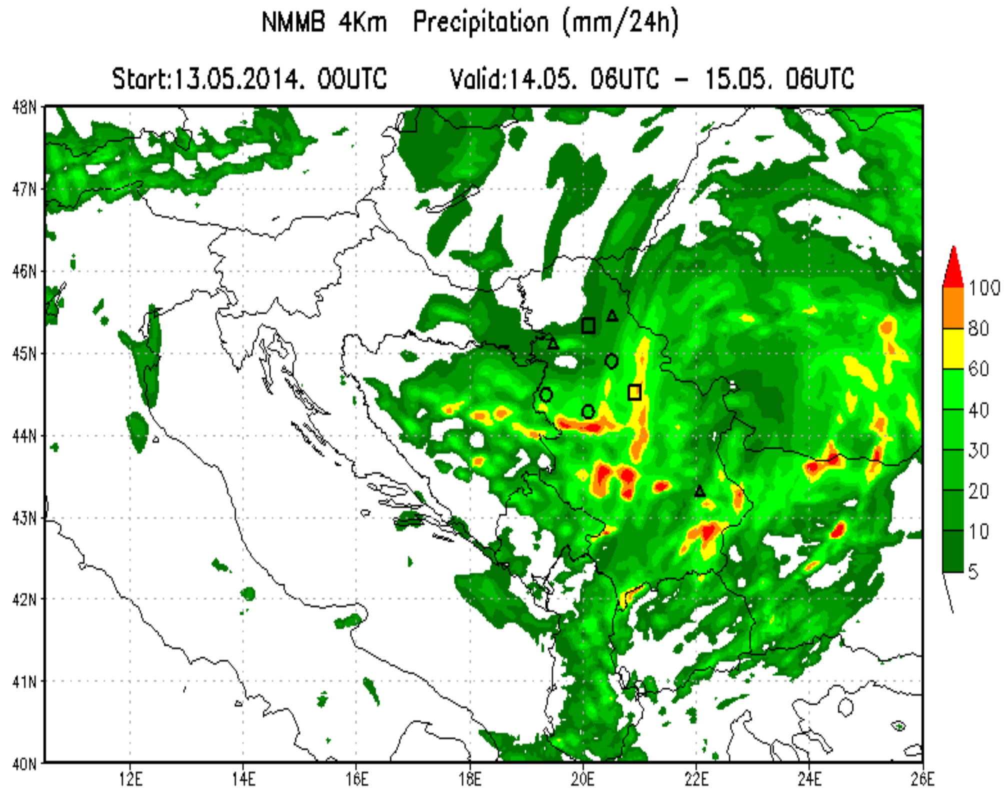

WV 6.2
48h forecast
Observed
Ferrier
Thompson
Probability of Occurence (%)
Brightness Temperature (K)
0
5
10
15
20
210
220
230
240
250
260



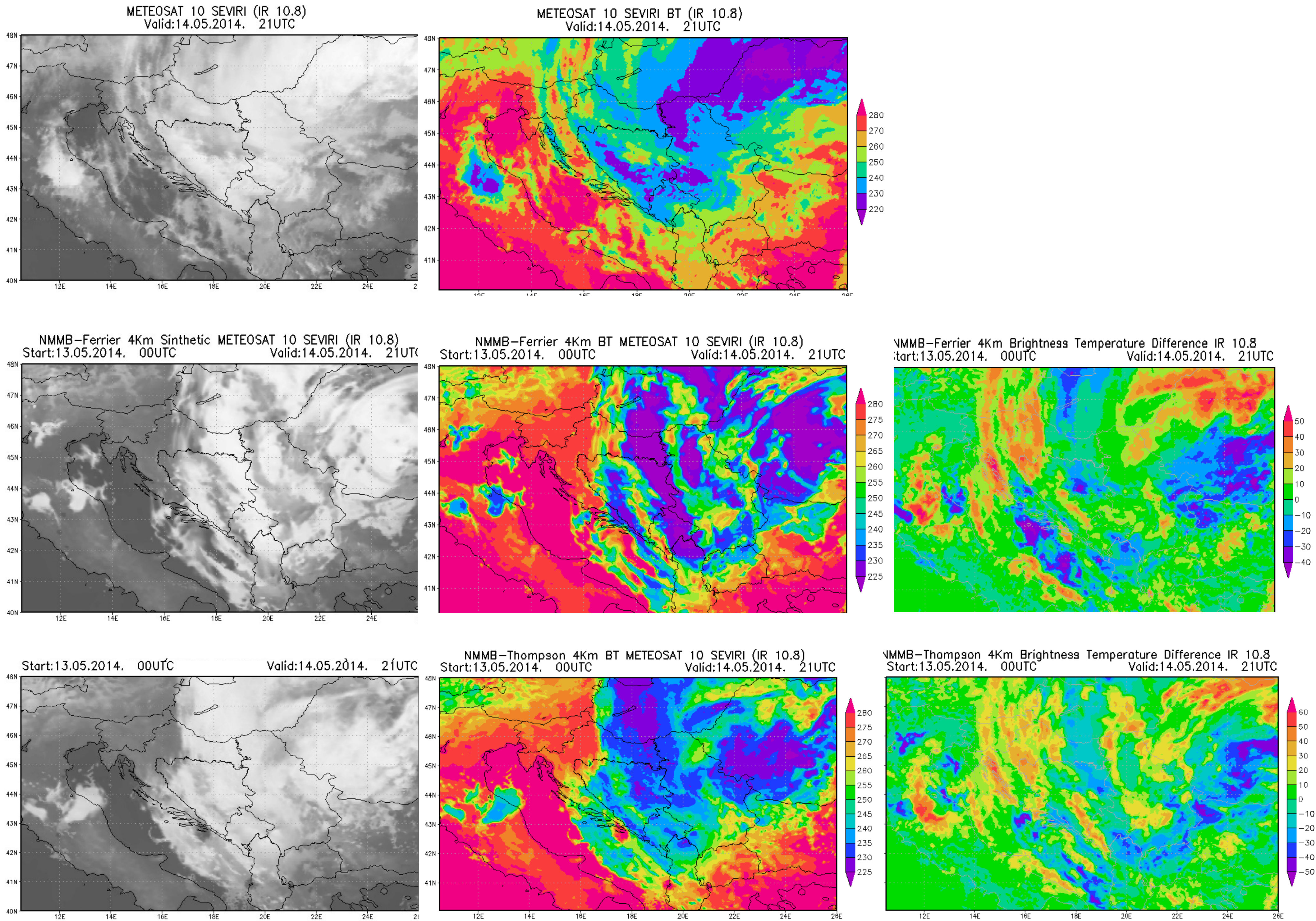
IR 10.8
48h forecast
WV 6.2
48h forecast
Ferrier
Thompson
Bias
POD
TS
FAR
Brightness Temperature (K)

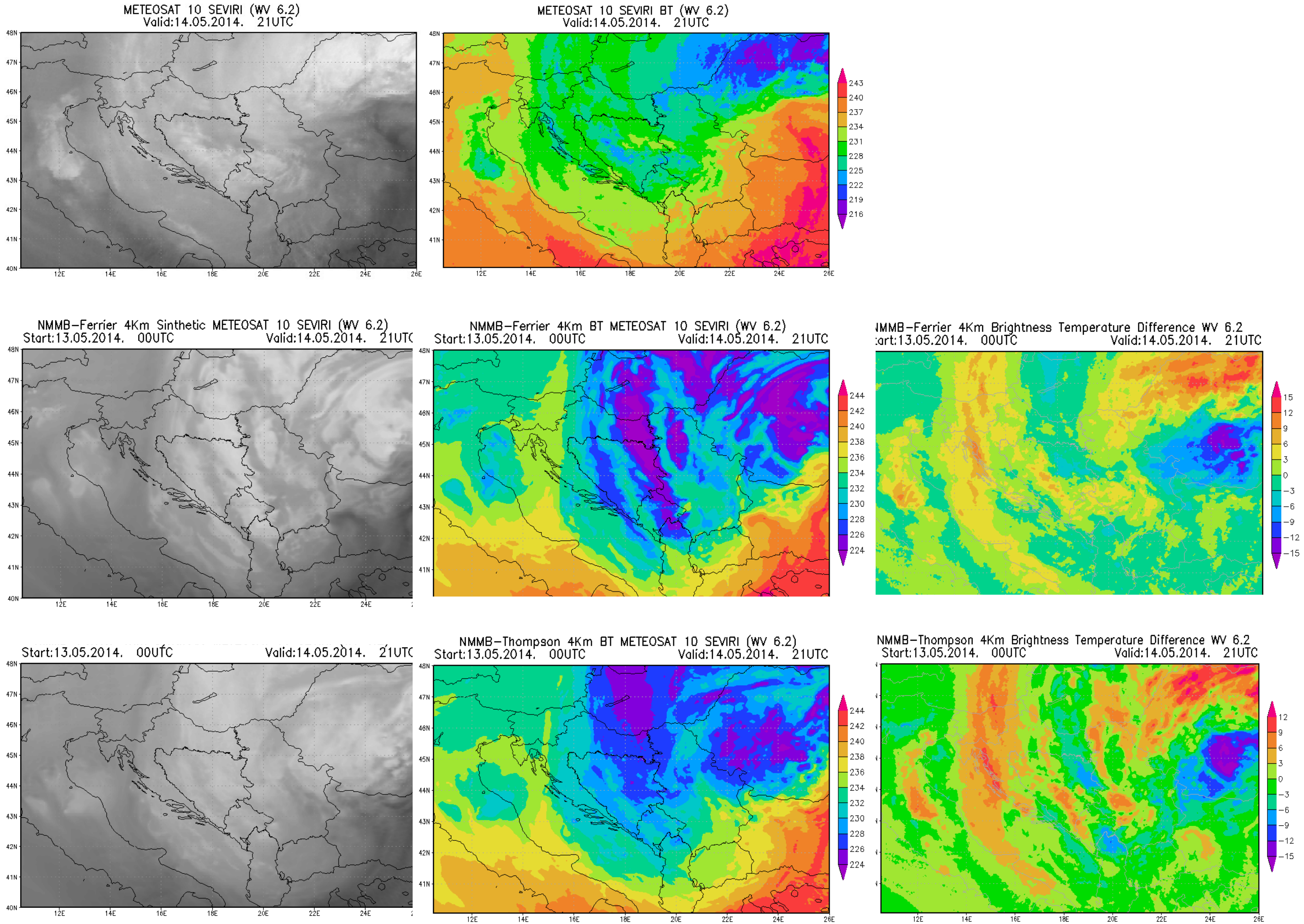
Case study

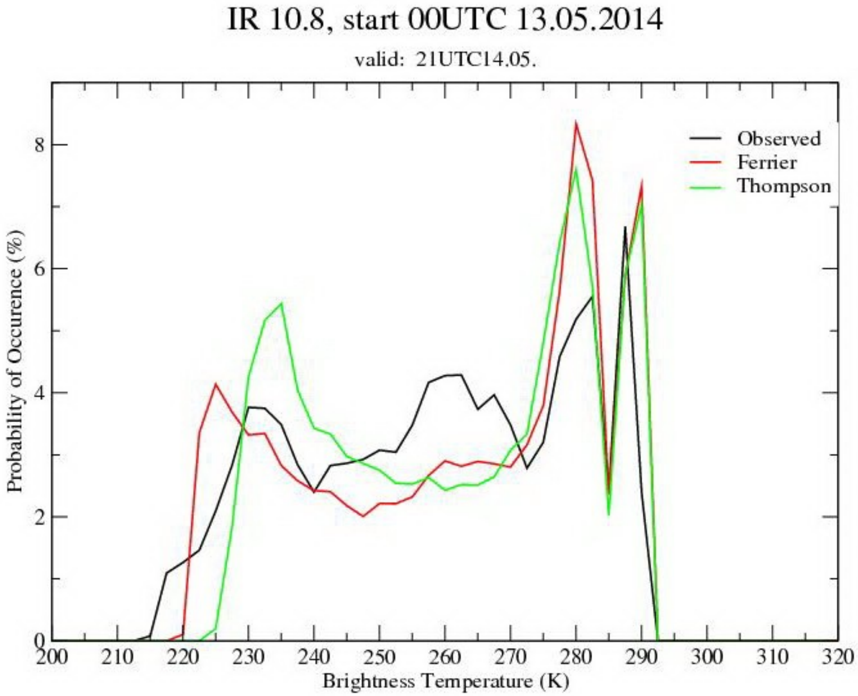


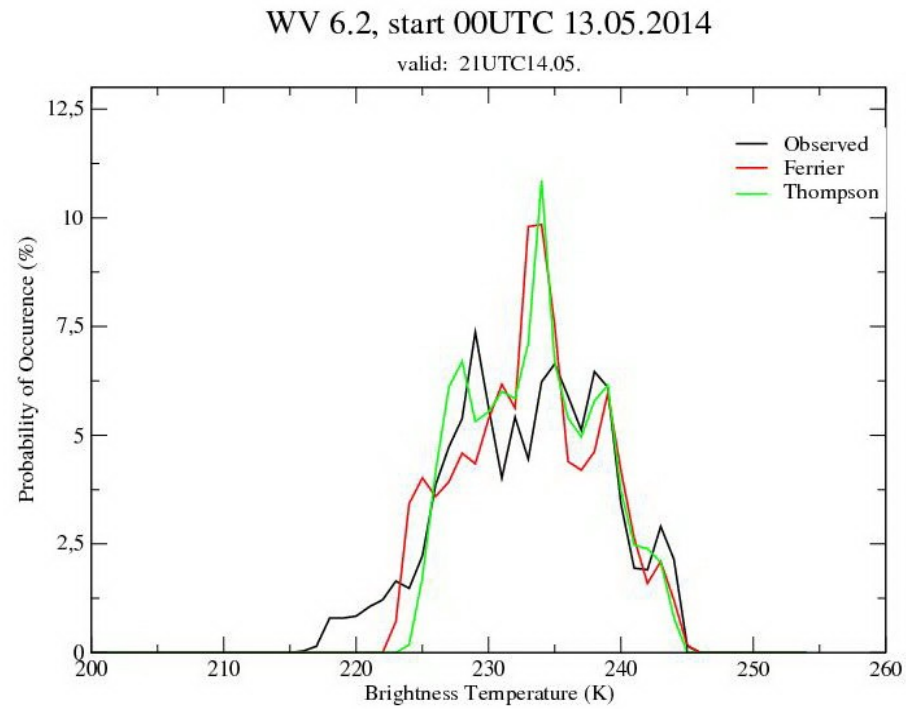


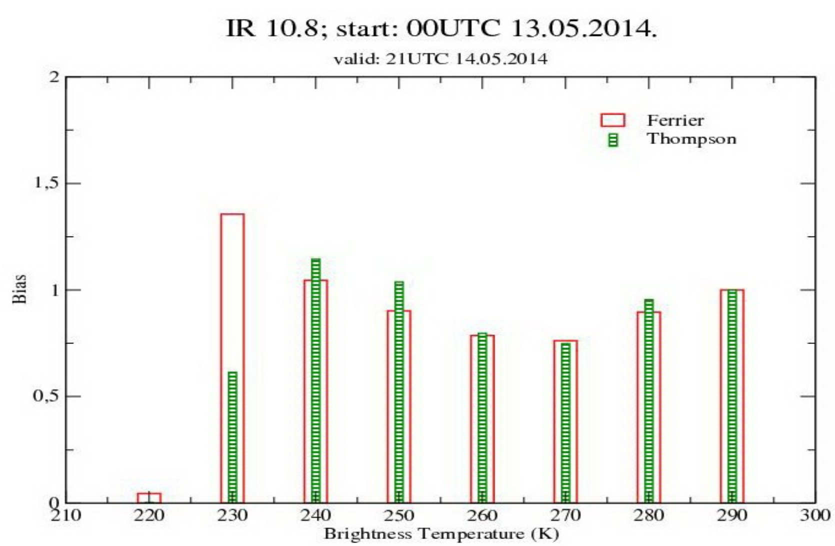
- Circles > 100mm
- Squares > 80mm
- Triangles > 60mm

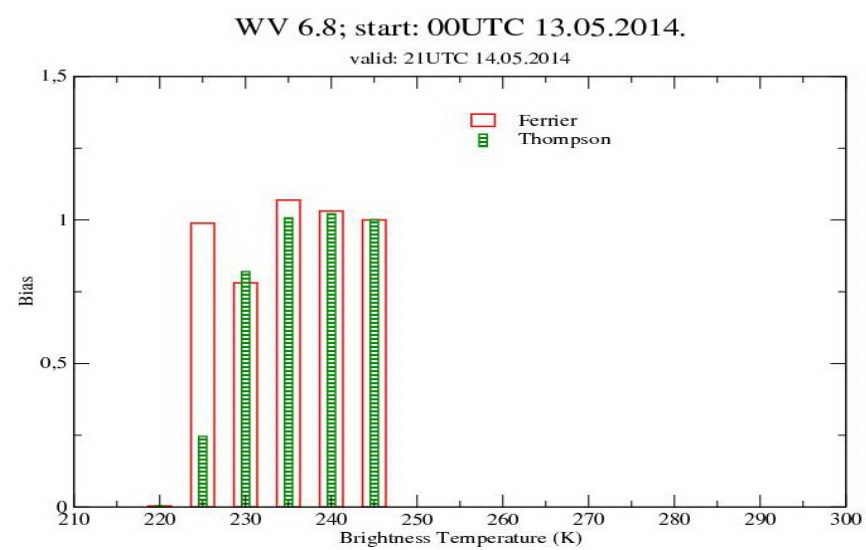

METEOSAT 10 SEVIRI (IR 10.8)
Valid:14.05.2014. 21UTC
METEOSAT 10 SEVIRI BT (IR 10.8)
Valid:14.05.2014. 21UTC
NMMB-Ferrier 4Km Sinthetic METEOSAT 10 SEVIRI (IR 10.8)
Start:13.05.2014. 00UTC
Valid:14.05.2014. 21UTC
NMMB-Ferrier 4Km BT METEOSAT 10 SEVIRI (IR 10.8)
Start:13.05.2014. 00UTC
Valid:14.05.2014. 21UTC
NMMB-Ferrier 4Km Brightness Temperature Difference IR 10.8
Start:13.05.2014. 00UTC
Valid:14.05.2014. 21UTC
Start:13.05.2014. 00UTC
Valid:14.05.2014. 21UTC
NMMB-Thompson 4Km BT METEOSAT 10 SEVIRI (IR 10.8)
Start:13.05.2014. 00UTC
Valid:14.05.2014. 21UTC
NMMB-Thompson 4Km Brightness Temperature Difference IR 10.8
Start:13.05.2014. 00UTC
Valid:14.05.2014. 21UTC


METEOSAT 10 SEVIRI (WV 6.2)
Valid:14.05.2014. 21UTC
METEOSAT 10 SEVIRI BT (WV 6.2)
Valid:14.05.2014. 21UTC
NMMB-Ferrier 4Km Sinthetic METEOSAT 10 SEVIRI (WV 6.2)
Start:13.05.2014. 00UTC Valid:14.05.2014. 21UTC
NMMB-Ferrier 4Km BT METEOSAT 10 SEVIRI (WV 6.2)
Start:13.05.2014. 00UTC Valid:14.05.2014. 21UTC
NMMB-Ferrier 4Km Brightness Temperature Difference WV 6.2
Valid:14.05.2014. 21UTC
Start:13.05.2014. 00UTC Valid:14.05.2014. 21UTC
NMMB-Thompson 4Km BT METEOSAT 10 SEVIRI (WV 6.2)
Start:13.05.2014. 00UTC Valid:14.05.2014. 21UTC
NMMB-Thompson 4Km Brightness Temperature Difference WV 6.2
Start:13.05.2014. 00UTC Valid:14.05.2014. 21UTC


IR 10.8, start 00UTC 13.05.2014
valid: 21UTC14.05.
Observed
Ferrier
Thompson
Probability of Occurence (%)
Brightness Temperature (K)


WV 6.2, start 00UTC 13.05.2014
valid: 21UTC14.05.
Observed
Ferrier
Thompson
Probability of Occurence (%)
Brightness Temperature (K)


IR 10.8; start: 00UTC 13.05.2014.
valid: 21UTC 14.05.2014
Ferrier
Thompson
Bias
Brightness Temperature (K)


WV 6.8; start: 00UTC 13.05.2014.
valid: 21UTC 14.05.2014
Ferrier
Thompson
Bias
Brightness Temperature (K)

Summary

- Both schemes have pros and cons.
- Model tends to over-predict clear sky conditions and to under-predict low and medium depth clouds during warmest time of a day.
- Ferrier scheme gives deeper clouds / more high-tops clouds then Thompson.
- Skill does not decrease during first 48 hours of forecast.
- It takes time for model to create clouds (12h forecast has the worst scores).
- Model tends to predict moderate amount of water vapor in the troposphere more often then observed, under-predicts situations with extremely low wv.
- Histograms, because standard scores are bad if modeled clouds are shifted a bit.
- Satellite images could be useful as addition to more conventional verification methods.
- IR 10.8 channel is in strong correlation with SFC temp. It can be used for verification where measurements are not available.

Questions

- bojan.kasic@hidmet.gov.rs