CLEAR FLAG AND RESULTS FOR NEAR CLEAR CASES

JOEL SUSSKIND

AIRS TEAM MEETING

JUNE 2001

PURPOSES OF CLEAR FLAG

- START UP IDENTIFICATION TO DETERMINE CHANNEL FREQUENCIES, SRF'S
  - SHOULD NOT INVOLVE RADIATIVE TRANSFER CALCULATIONS, RETRIEVALS
  - SHOULD NOT PRODUCE FALSE CLEAR
  - % YIELD LESS IMPORTANT

- IDENTIFICATION OF CASES TO BE USED BY DATA ASSIMILATORS
  - SHOULD BE FAST IF DONE FOR REAL TIME USE
  - FALSE CLEAR CASES SHOULD NOT HAVE LARGE ERRORS
  - MAXIMIZED YIELDS IS BETTER TO SHOW IMPACT

CLOUD CLEARING

$$R_{I,J} = \left(1 - \sum_K \alpha_{JK}\right) R_{I,CLR} + \sum_K \alpha_{JK} R_{I,CLDK}$$

CHANNEL I, FIELD OF VIEW J, CLOUD FRACTION α_{JK}

WE USE OBSERVATIONS IN 9 FIELDS OF VIEW TO OBTAIN $\hat{R}_I$

$$\hat{R}_I = \bar{R}_I + \sum_{K=1}^{9} \eta_K \left(\bar{R}_I - R_{I,K}\right) = \bar{R}_i + \sum_{K=1}^{9} \eta_K \Delta R_{I,K}$$

$\bar{R}_I$ = AVERAGE RADIANCE IN 9 SPOTS

UNCONSTRAINED SOLUTION

$$\eta = \left(\Delta R' N^{-1} \Delta R\right)^{-1} \Delta R' N^{-1} \Delta R_{CLR}$$

N = CHANNEL NOISE COVARIANCE MATRIX

$$\Delta R_{CLR} = R_{CLR,I} - \bar{R}_I$$

ΔR_{CLR} IS COMPUTED FROM A STATE THAT AGREES WITH AMSU RADIANCES

TRANSFORMATION OF COORDINATES

DIAGONALIZE $\Delta R' N^{-1} \Delta R$ BY THE TRANSFORMATION U

EQUIVALENT TO SELECTION OF NEW FIELDS OF VIEW $\Delta R^T = U \Delta R$

DETERMINE ONE CLOUD FORMATION FOR EACH SIGNIFICANT EIGENVALUE λ_K

FOR kmax SIGNIFICANT EIGENVALUES

$$\hat{R}_{I,CLR} = \bar{R}_I + \sum_{K=1}^{k\,max} \zeta_K \, \Delta R^T_{I,K}$$

WHERE

$$\zeta_K = \lambda_K^{-1} \left(\Delta R^{T'} N^{-1} \Delta R_{CLR} \right)_{K,1}$$

BETTER VALUES OF $R_{I,CLR}$ GIVE BETTER $\hat{R}_{I,CLR}$

$R_{I,CLR}$ SHOULD BE BASED ON AN UNBIASED PROFILE – AGREE WITH AMSU RADIANCES

DANGEROUS TO USE FORECAST GUESS – COULD BE BIASED

OUTLINE OF AIRS RETRIEVAL STEPS

PERFORM MICROWAVE ONLY RETRIEVAL

OBTAIN INITIAL CLEAR COLUMN RADIANCES

ASSIGN CLEAR FLAG

PERFORM AIRS REGRESSION GUESS

PERFORM MICROWAVE RETRIEVAL STARTING FROM AIRS REGRESSION GUESS

OBTAIN UPDATED CLEAR COLUMN RADIANCES

DO AIRS/AMSU RETRIEVALS

OBTAIN FINAL CLEAR COLUMN RADIANCES

REFINE AIRS/AMSU RETRIEVALS

APPLY REJECTION CRITERIA

CURRENT CLEAR FLAG

1) WE LOOK AT EIGENVALUES OF $\Delta R' N^{-1} \Delta R$ AFTER INITIAL CLOUD CLEARING (BEFORE REGRESSION)

CALL CASE CLOUDY IF $\lambda_{MAX} > \lambda_{THRESHOLD}$

$\lambda_{THRESHOLD}$ = 80 FOR OCEAN, AND 200 FOR LAND

ALLOWS FOR MORE SCENE VARIABILITY OVER LAND BECAUSE OF MORE SURFACE VARIABILITY

THIS DOES NOT INVOLVE PHYSICS AND IS QUICK

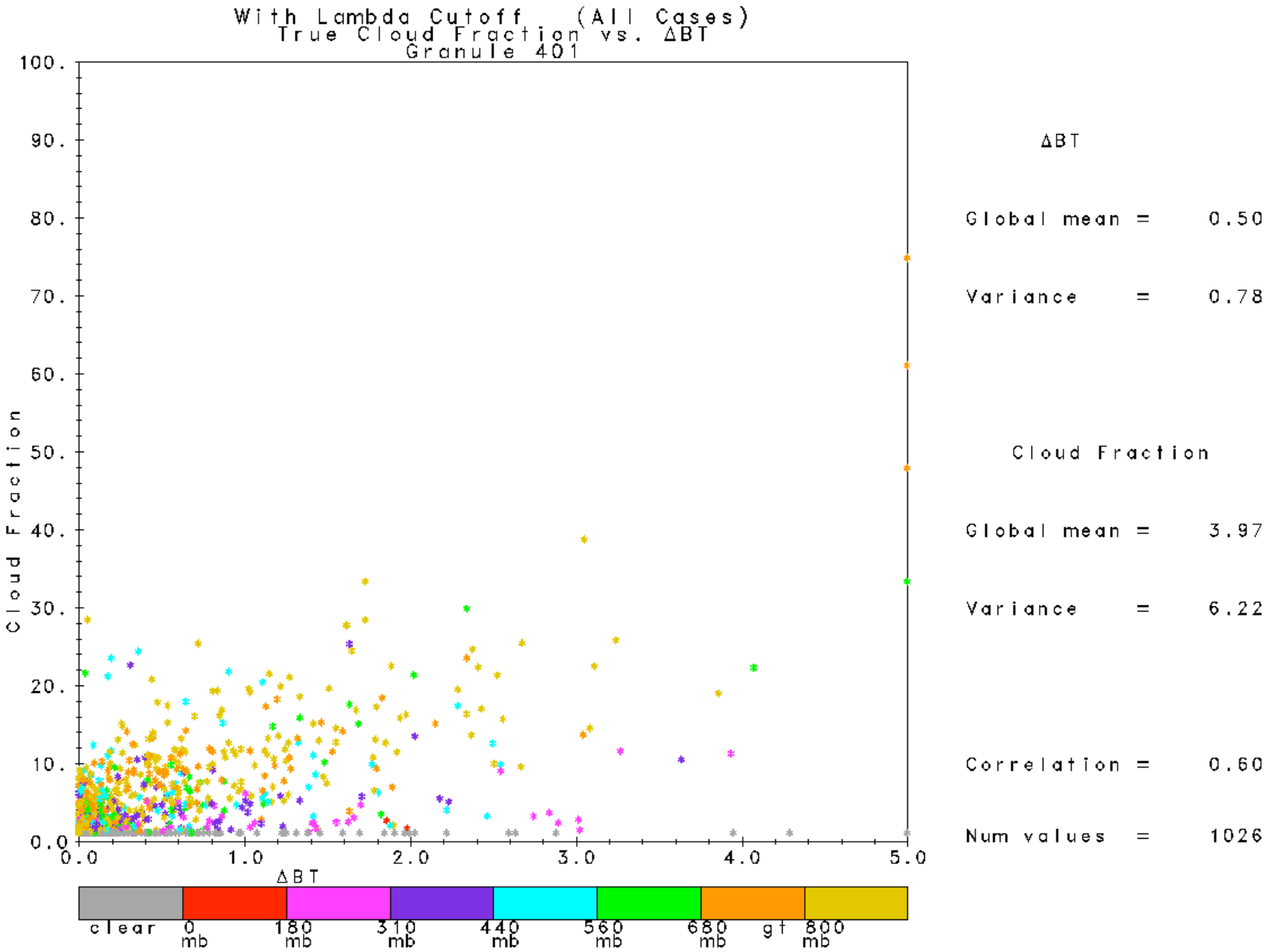
PROBLEM WITH OVERCAST CASES IF USED ALONE

NEED TO COMPARE OBSERVED WINDOW RADIANCES WITH VALUES COMPUTED FROM MICROWAVE RETRIEVAL OR DO 2)

2) WE ALSO LOOK AT INITIAL CORRECTION TO CLOUD CLEARED WINDOW RADIANCES (BEFORE REGRESSION)

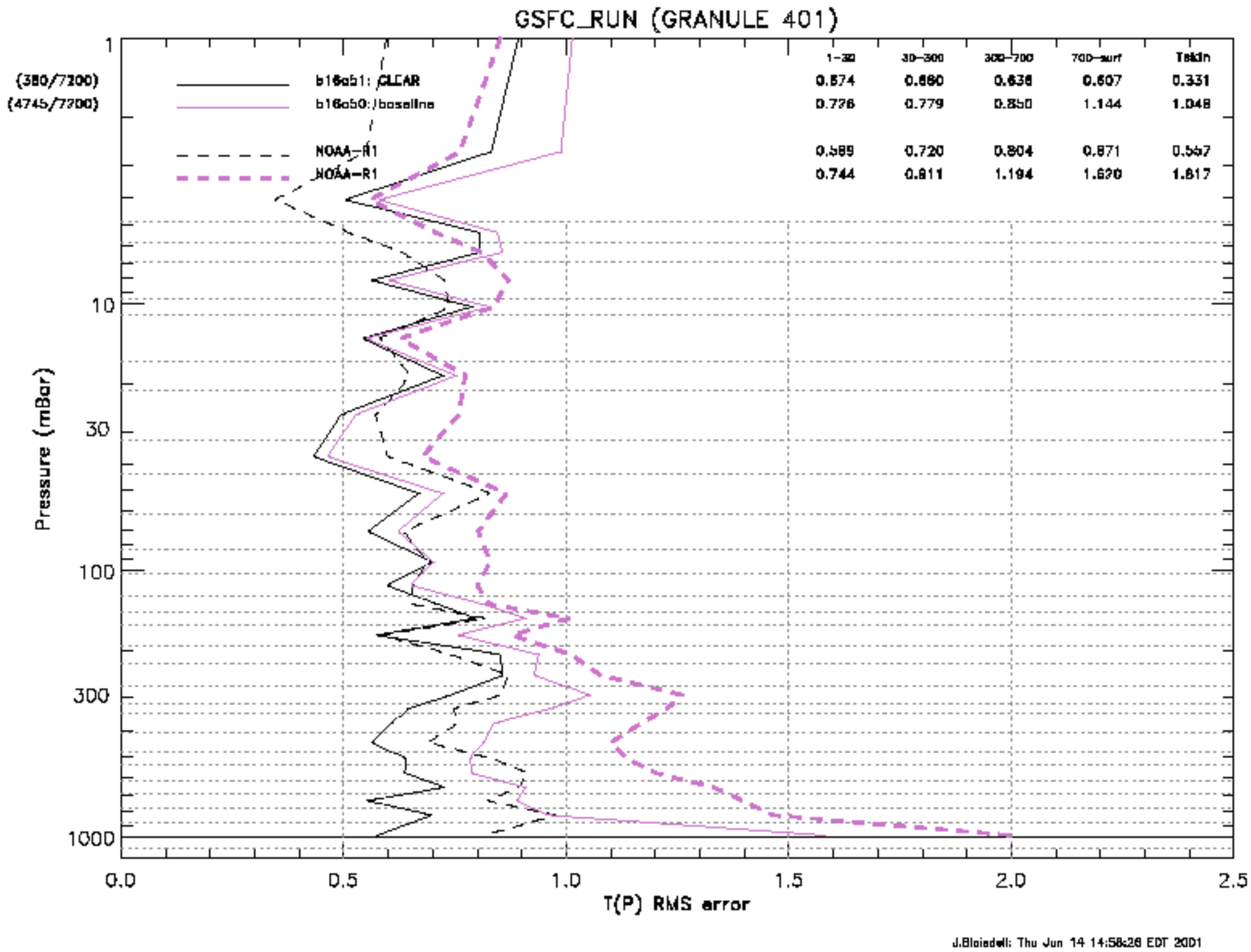
ΔBT = AVERAGE VALUE OF $BT_I - BT_I$ FOR CHANNELS BETWEEN 800 cm^{-1} AND 900 cm^{-1}

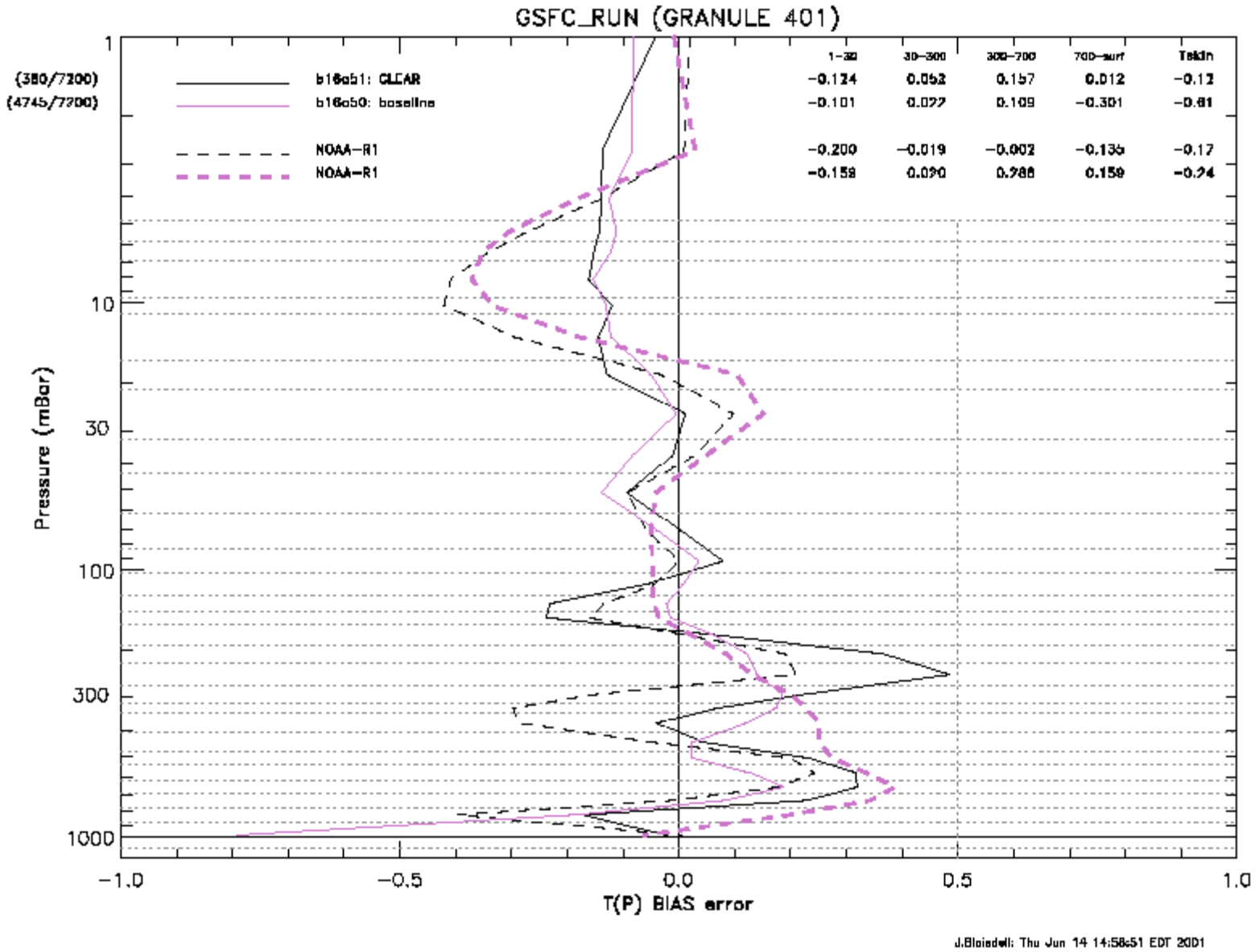
CALL CASE CLOUDY IF $|\Delta BT| > 0.1K$
THIS TEST IS FAST AND IMPROVES REJECTION OF FALSE CLEAR
THIS IS NOT GOOD FOR STARTUP IDENTIFICATION – INVOLVES PHYSICS

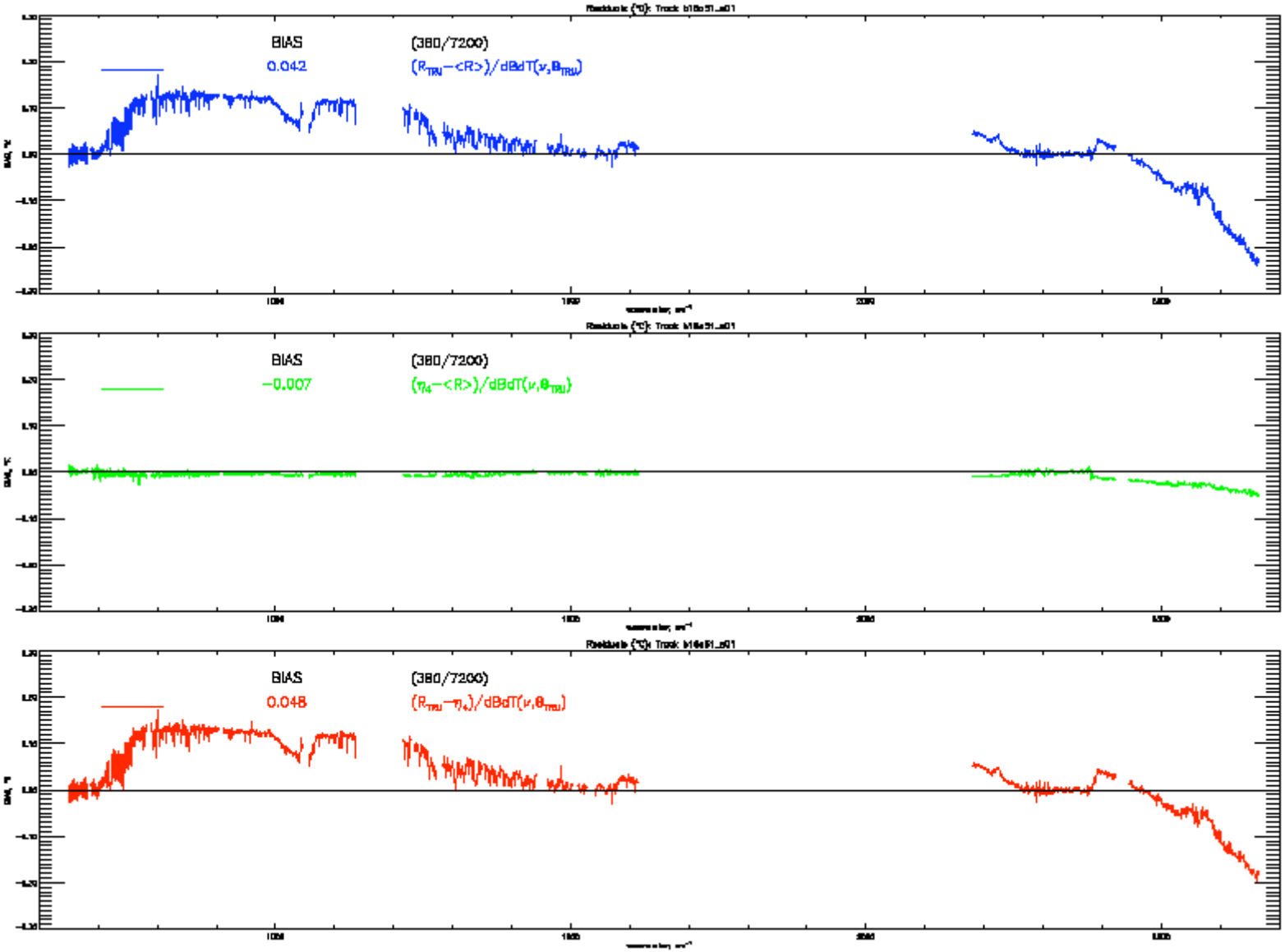

With Lambda Cutoff (All Cases)
True Cloud Fraction vs. ΔBT
Granule 401
Cloud Fraction
ΔBT
100.
90.
80.
70.
60.
50.
40.
30.
20.
10.
0.0
0.0
1.0
2.0
3.0
4.0
5.0
clear
0 mb
180 mb
310 mb
440 mb
560 mb
680 mb
gt 800 mb
ΔBT
Global mean = 0.50
Variance = 0.78
Cloud Fraction
Global mean = 3.97
Variance = 6.22
Correlation = 0.60
Num values = 1026

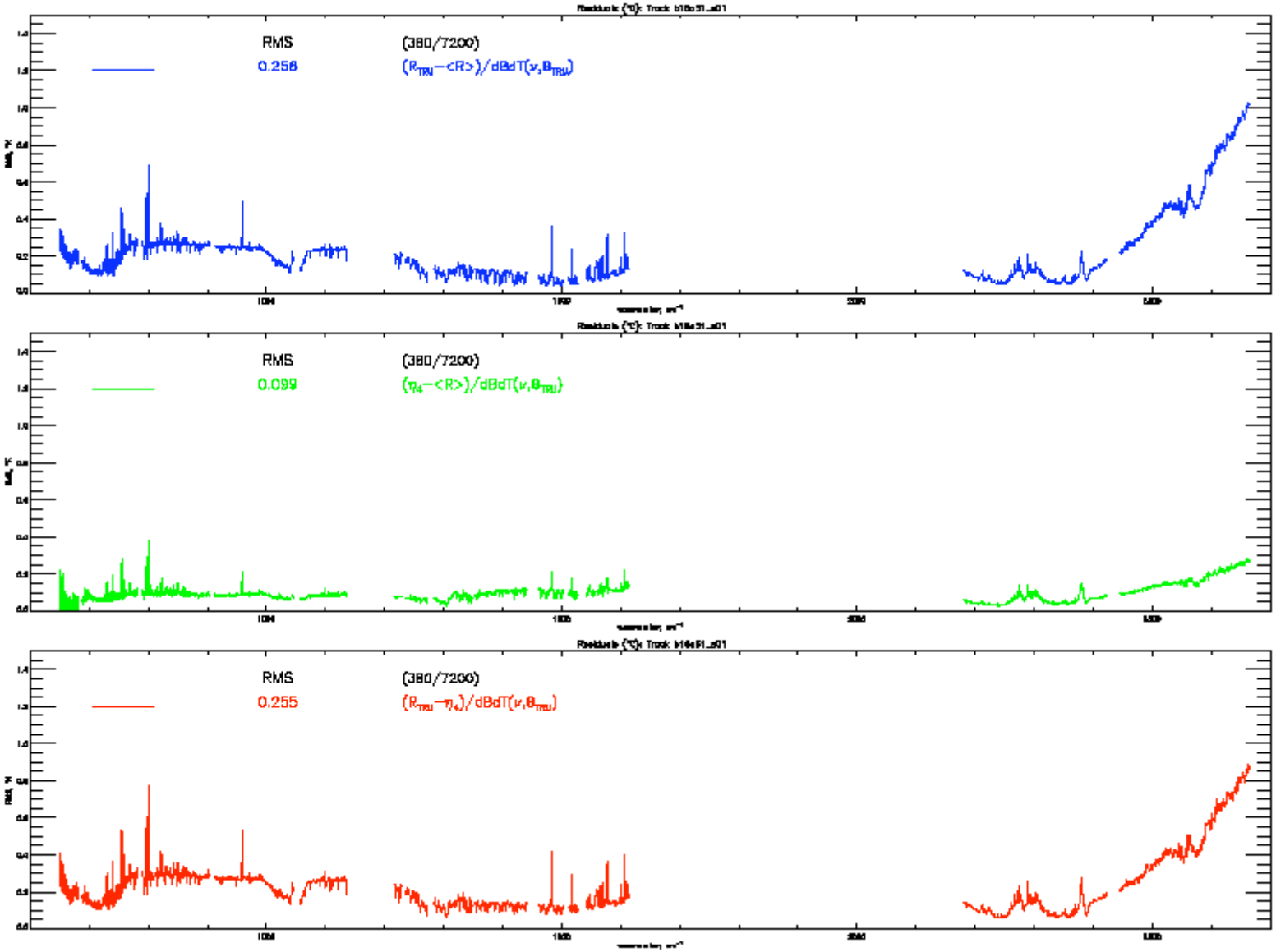
AVERAGE CLOUD FRACTION 1 SCAN LINE PER GRANULE

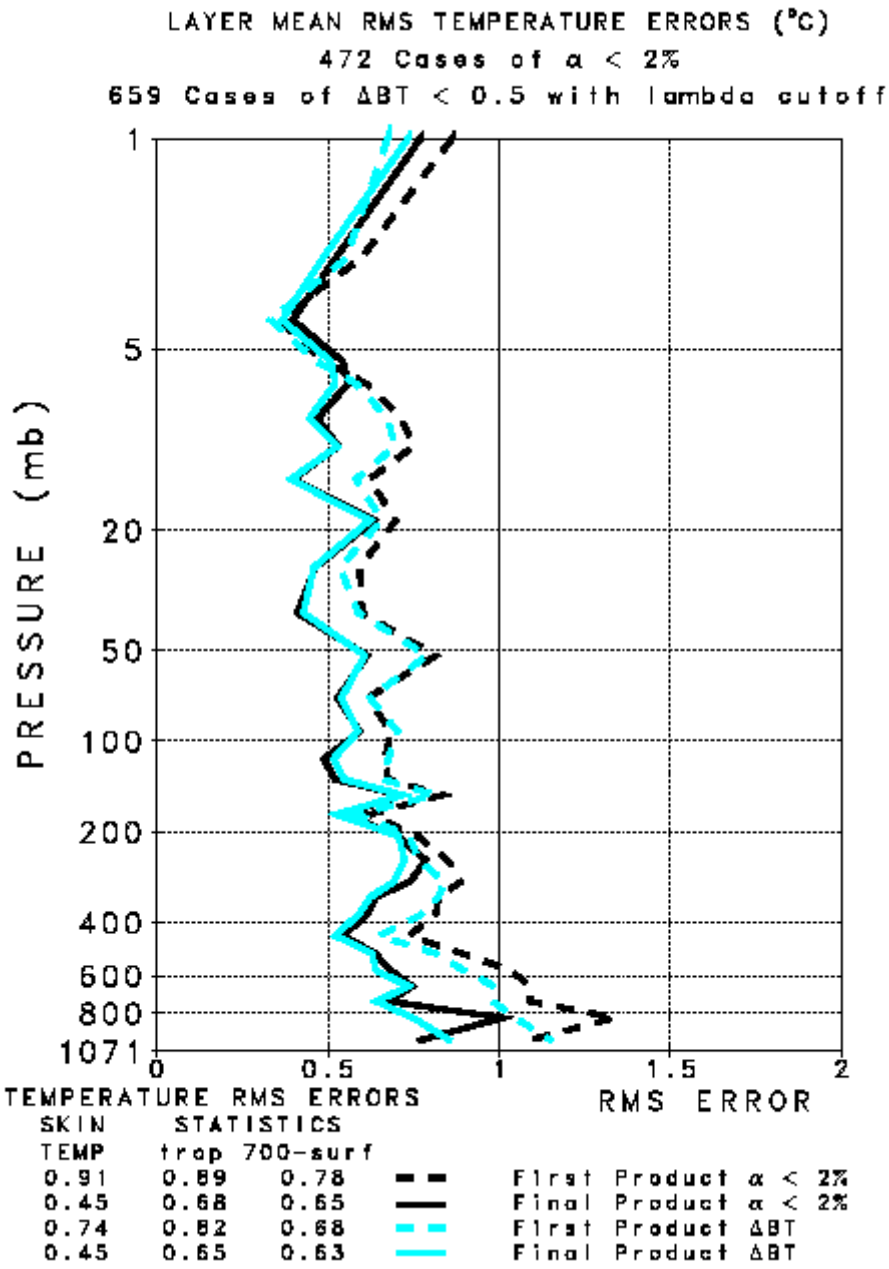
	$\Delta BT < 0.1K$ NUMBER	$\bar{\alpha}$	$\Delta BT < 0.5K$ NUMBER	$\bar{\alpha}$	$\Delta BT < 1K$, NO λ TEST NUMBER	$\bar{\alpha}$	TOTAL CASES NUMBER	$\bar{\alpha}$
OCEAN $\lambda < 80$								
CASES WHICH ARE "CLEAR" $\alpha_{TRUE} < 2\%$	219	0.41	273	0.49	339	0.55	354	0.56
CASES WHICH ARE "CLOUDY" $\alpha_{TRUE} > 2\%$	67	4.22	163	5.23	434	6.90	4268	47.75
ALL CASES	286	1.30	436	2.26	773	4.12	4622	43.20
LAND $\lambda < 200$								
CASES WHICH ARE CLEAR	109	0.32	196	0.35	293	0.37	363	0.42
CASES WHICH ARE CLOUDY	26	5.04	78	6.45	240	12.23	1997	48.80
ALL CASES	135	1.23	274	2.09	533	5.71	2360	41.36
LAND/OCEAN								
ALL CASES	421	1.28	710	2.20	1306	4.76	6982	43.20

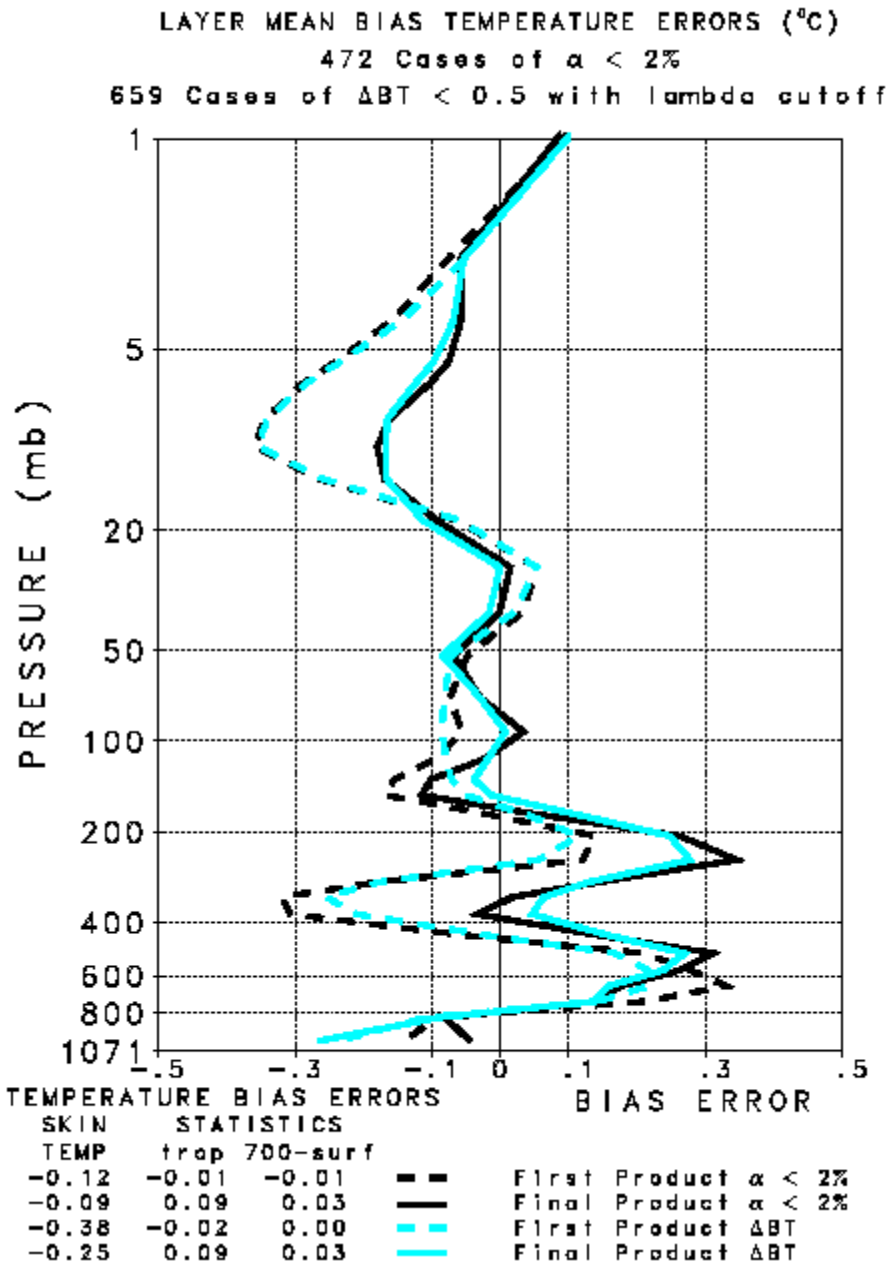

GSFC_RUN (GRANULE 401)
(380/7200)
(4745/7200)
b16a51: CLEAR
b16a50:/baseline
NOAA-R1
NOAA-R1
1-30 30-300 300-700 700-surf Tskin
0.574 0.660 0.636 0.607 0.331
0.776 0.779 0.850 1.144 1.048
0.689 0.720 0.804 0.871 0.567
0.744 0.811 1.194 1.620 1.617
Pressure (mBar)
1
10
30
100
300
1000
0.0
0.5
1.0
1.5
2.0
2.5
T(P) RMS error
J.Blaisdell: Thu Jun 14 14:58:26 EDT 2001

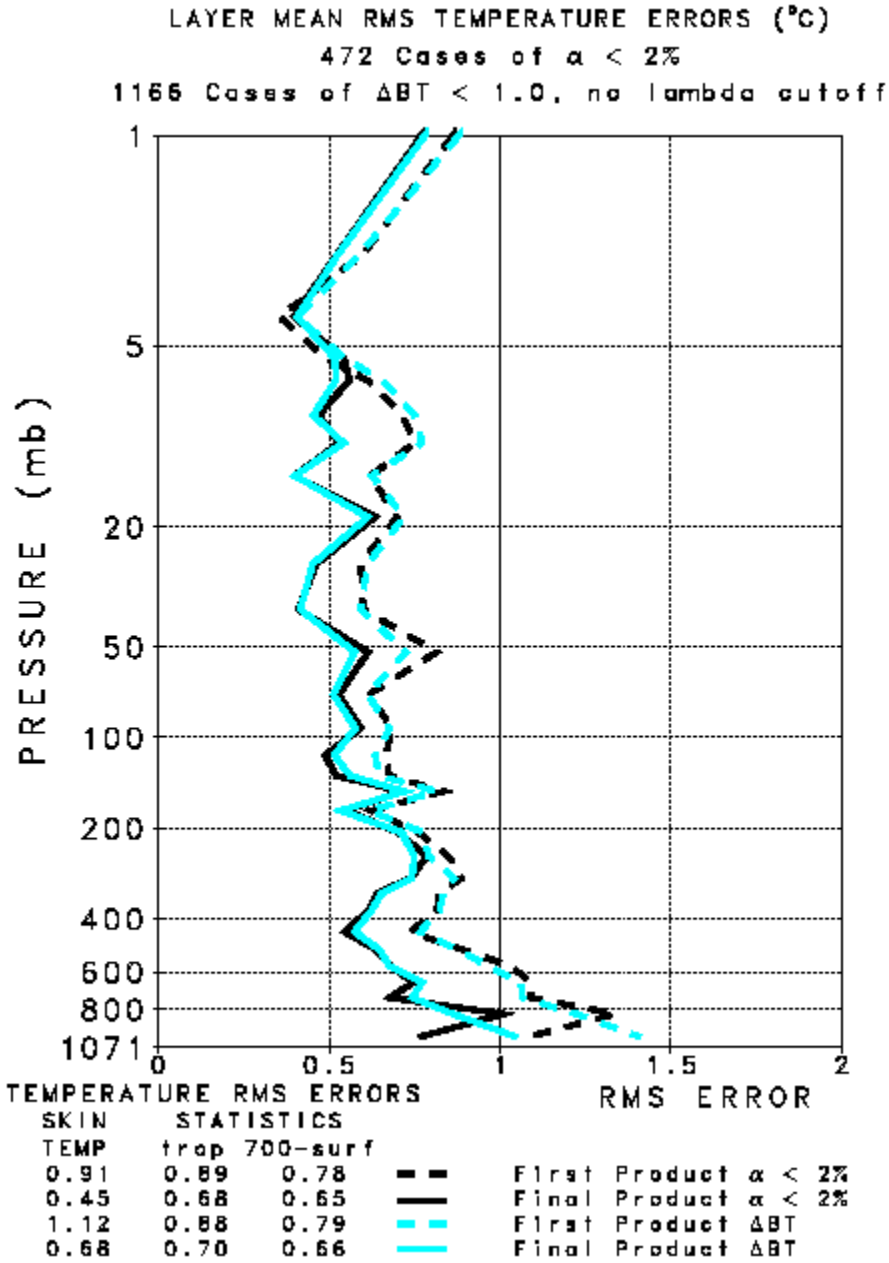

GSFC_RUN (GRANULE 401)
(380/7200)
(4745/7200)
b16a51: CLEAR
b16a50: baseline
NOAA-R1
NOAA-R1
1-30
30-300
300-700
700-surf
Tskin
-0.124 0.052 0.157 0.012 -0.12
-0.101 0.022 0.109 -0.301 -0.61
-0.200 -0.019 -0.002 -0.135 -0.17
-0.158 0.030 0.288 0.159 -0.24
Pressure (mBar)
1
10
30
100
300
1000
-1.0
-0.5
0.0
0.5
1.0
T(P) BIAS error
J.Bloisdell: Thu Jun 14 14:58:51 EDT 2001

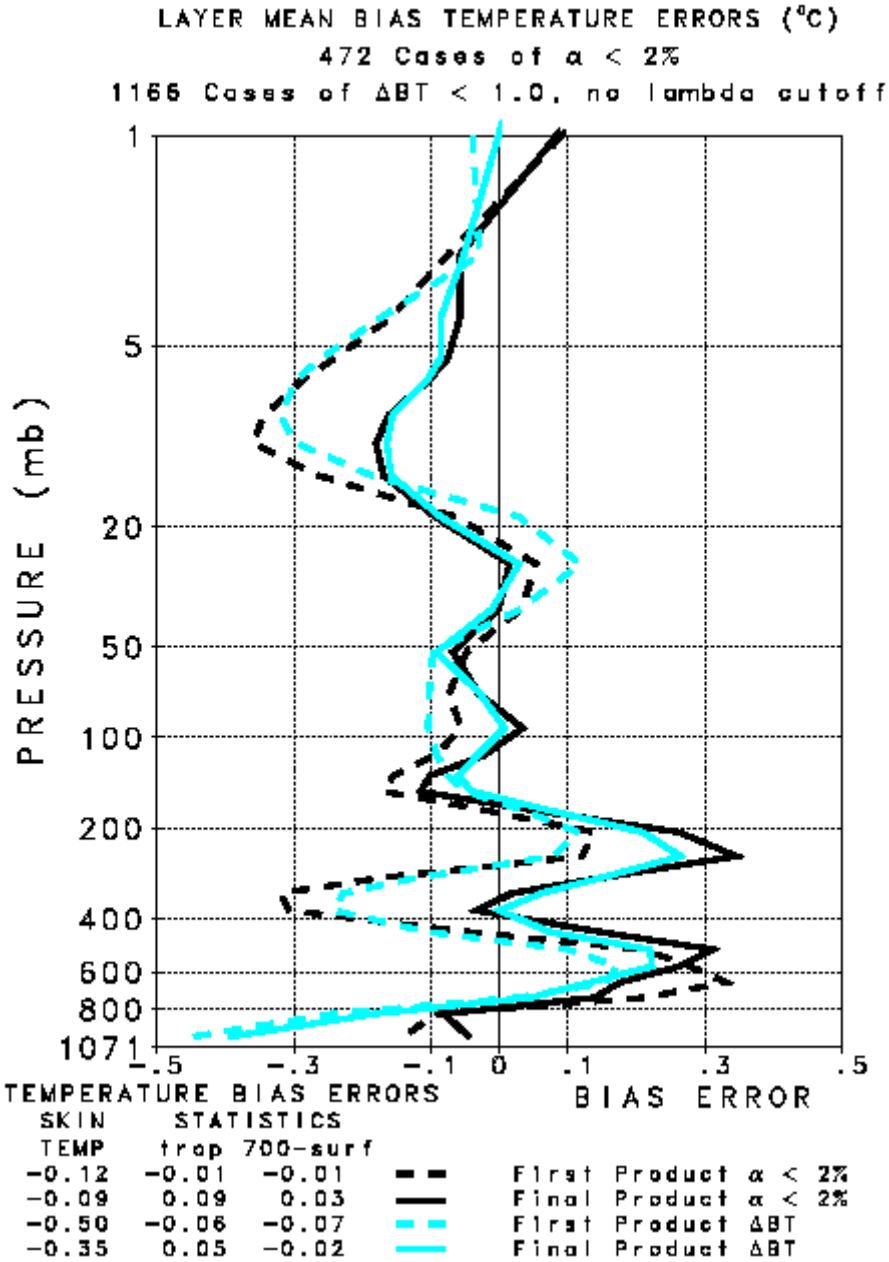

BIAS
0.042
(380/7200)
(R_TRU−<R>)/dBdT(ν,θ_TRU)
BIAS
−0.007
(380/7200)
(η_4−<R>)/dBdT(ν,θ_TRU)
BIAS
0.048
(380/7200)
(R_TRU−η_4)/dBdT(ν,θ_TRU)


RMS
0.256
(380/7200)
(R_TRU−<R>)/dBdT(ν,θ_TRU)
RMS
0.099
(380/7200)
(η_4−<R>)/dBdT(ν,θ_TRU)
RMS
0.255
(380/7200)
(R_TRU−η_4)/dBdT(ν,θ_TRU)


LAYER MEAN RMS TEMPERATURE ERRORS (°C)
472 Cases of α < 2%
659 Cases of ΔBT < 0.5 with lambda cutoff
PRESSURE (mb)
1
5
20
50
100
200
400
600
800
1071
0
0.5
1
1.5
2
RMS ERROR
TEMPERATURE RMS ERRORS
SKIN STATISTICS
TEMP trop 700-surf
0.91 0.89 0.78 First Product α < 2%
0.45 0.68 0.65 Final Product α < 2%
0.74 0.82 0.68 First Product ΔBT
0.45 0.65 0.63 Final Product ΔBT


LAYER MEAN BIAS TEMPERATURE ERRORS (°C)
472 Cases of α < 2%
659 Cases of ΔBT < 0.5 with lambda cutoff
PRESSURE (mb)
1
5
20
50
100
200
400
600
800
1071
-.5
-.3
-.1
0
.1
.3
.5
BIAS ERROR
TEMPERATURE BIAS ERRORS
SKIN TEMP
STATISTICS
trop
700-surf
-0.12 -0.01 -0.01 First Product α < 2%
-0.09 0.09 0.03 Final Product α < 2%
-0.38 -0.02 0.00 First Product ΔBT
-0.25 0.09 0.03 Final Product ΔBT


LAYER MEAN RMS TEMPERATURE ERRORS (°C)
472 Cases of α < 2%
1166 Cases of ΔBT < 1.0, no lambda cutoff
PRESSURE (mb)
1
5
20
50
100
200
400
600
800
1071
0
0.5
1
1.5
2
RMS ERROR
TEMPERATURE RMS ERRORS
SKIN TEMP
STATISTICS
trop 700-surf
0.91 0.89 0.78 First Product α < 2%
0.45 0.68 0.65 Final Product α < 2%
1.12 0.88 0.79 First Product ΔBT
0.68 0.70 0.66 Final Product ΔBT


LAYER MEAN BIAS TEMPERATURE ERRORS (°C)
472 Cases of α < 2%
1166 Cases of ΔBT < 1.0, no lambda cutoff
PRESSURE (mb)
1
5
20
50
100
200
400
600
800
1071
-.5
-.3
-.1
0
.1
.3
.5
BIAS ERROR
TEMPERATURE BIAS ERRORS
SKIN TEMP
STATISTICS
trop 700-surf
-0.12 -0.01 -0.01 First Product α < 2%
-0.09 0.09 0.03 Final Product α < 2%
-0.50 -0.06 -0.07 First Product ΔBT
-0.35 0.05 -0.02 Final Product ΔBT

WHAT TO DO ABOUT START-UP CLEAR FLAG

EIGEN VALUES OF $\Delta R^T N^{-1} \Delta R$ DO NOT INVOLVE PHYSICS, RETRIEVALS

CURRENT TEST USED ALONE LETS THROUGH TOO MANY CLOUD CONTAMINATED CASES

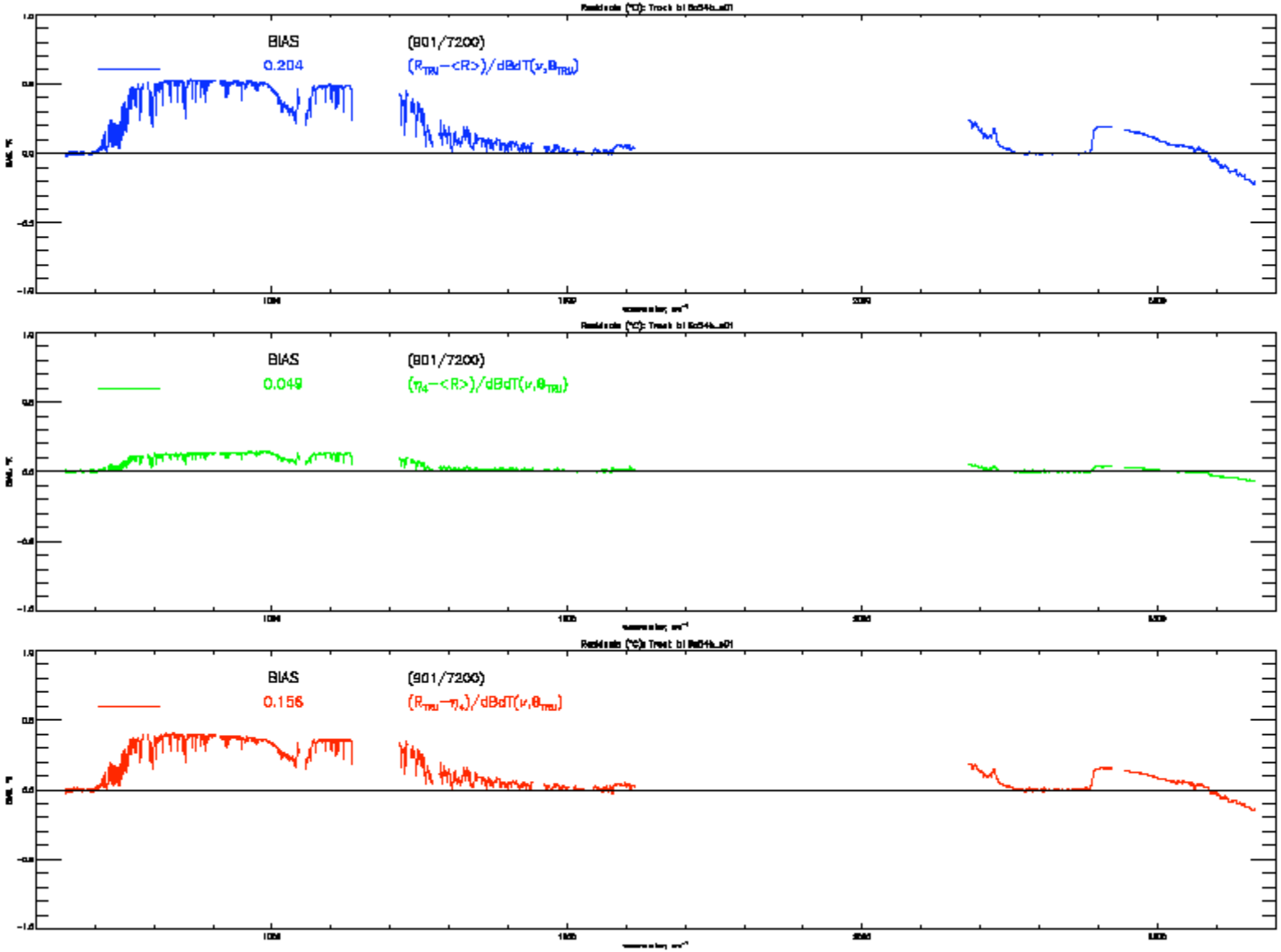
CAN LOWER THRESHOLDS FROM 200 FOR LAND, 80 FOR OCEAN

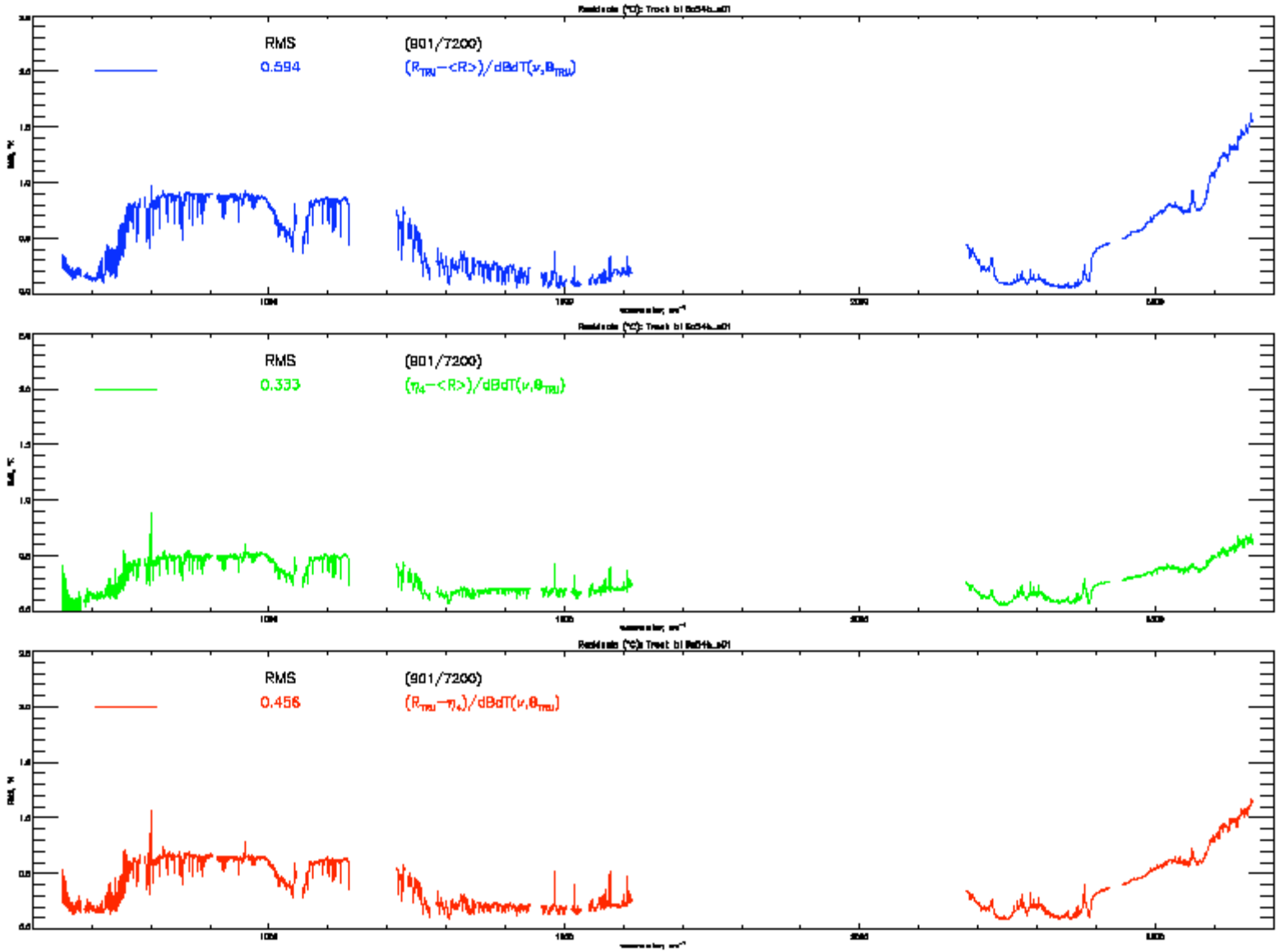
CAN ALSO COMPARE OBSERVED WINDOW BRIGHTNESS TEMPERATURES TO PREDICTED VALUES

FOR EXAMPLE, CALL CLEAR IF THRESHOLD IS PASSED AND

BT(2616 CM^{-1}) - FORECAST SST > -1K

WE HAVE NOT DONE THESE TESTS YET


BIAS
0.204
(901/7200)
(R_TRU−<R>)/dBdT(ν,θ_TRU)
BIAS
0.049
(901/7200)
(η_4−<R>)/dBdT(ν,θ_TRU)
BIAS
0.156
(901/7200)
(R_TRU−η_4)/dBdT(ν,θ_TRU)


RMS
0.594
(901/7200)
(R_TRU−<R>)/dBdT(ν,θ_TRU)
RMS
0.333
(901/7200)
(η_4−<R>)/dBdT(ν,θ_TRU)
RMS
0.456
(901/7200)
(R_TRU−η_4)/dBdT(ν,θ_TRU)

SUMMARY

CLEAR FLAG ALGORITHM WORKS EXTREMELY WELL

- AVERAGE CLOUD FRACTION IS 1.5%
- CLEAR BRIGHTNESS TEMPERATURE BIAS IS ABOUT 0.1K IN WINDOWS
- TIGHT TEST REQUIRES PHYSICS - NOT APPLICABLE UNTIL WE KNOW SRF'S

START UP CLEAR TEST CAN BE IMPROVED

- CLEAR BRIGHTNESS TEMPERATURE BIAS IS 0.4K IN WINDOWS
- BIAS IS LESS THAN 0.1K IN MUCH OF THE SOUNDING REGIONS

NEAR CLEAR RETRIEVALS ARE VERY ACCURATE

- RMS ERRORS ARE BETTER THAN 1K
- ROUGHLY 20% OF THE CASES
  - AVERAGE CLOUD FRACTION IS LESS THAN 5%

WE PRODUCE CLEAR COLUMN RADIANCES FOR ASSIMILATIONS TO USE

- METHOD IS QUICK AND DOES NOT REQUIRE A FULL RETRIEVAL