Comparing Different Uses of MODIS Data in AIRS Retrievals

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Three Approaches to Clouds

- Version 6: Cloud clearing with Neural Network first guess and multiple cloud formations
- MODCC: Cloud clearing with clear estimation based on MODIS clear pixels in AIRS FOV
- Irion: Single Footprint retrieval with clouds in the forward model

η Determination for Operational Cloud Clearing

$$R^{s}_{CCR}(n) = \overline{R(n)} + \sum_{j=1}^{N_\eta}\left(\overline{R(n)} - R_{N_f+1-j}(n)\right)\eta^{s}_{j}$$

Find η's that minimize noise in the cloud cleared radiances

$$R^{s}_{n,est} - \overline{R}_n = S^{s}_{n,j}\eta^{s}_{j}$$

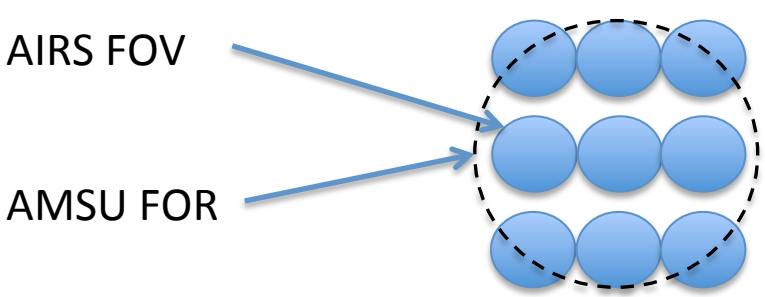
A first guess geophysical state is determined from a neural network which is forward modeld to determine R_{est}

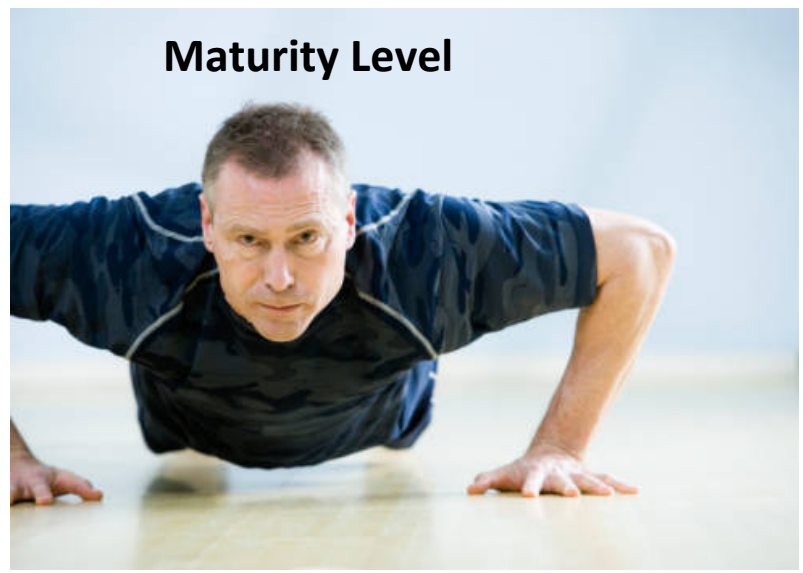
$$S^{s}_{n,j} = \begin{pmatrix} \overline{R}_1 - R_{1,9} & \cdots & \overline{R}_1 - R_{1,1} \\ \cdots & \cdots & \cdots \\ \overline{R}_N - R_{N,9} & \cdots & \overline{R}_N - R_{N,1} \end{pmatrix}$$

Channels

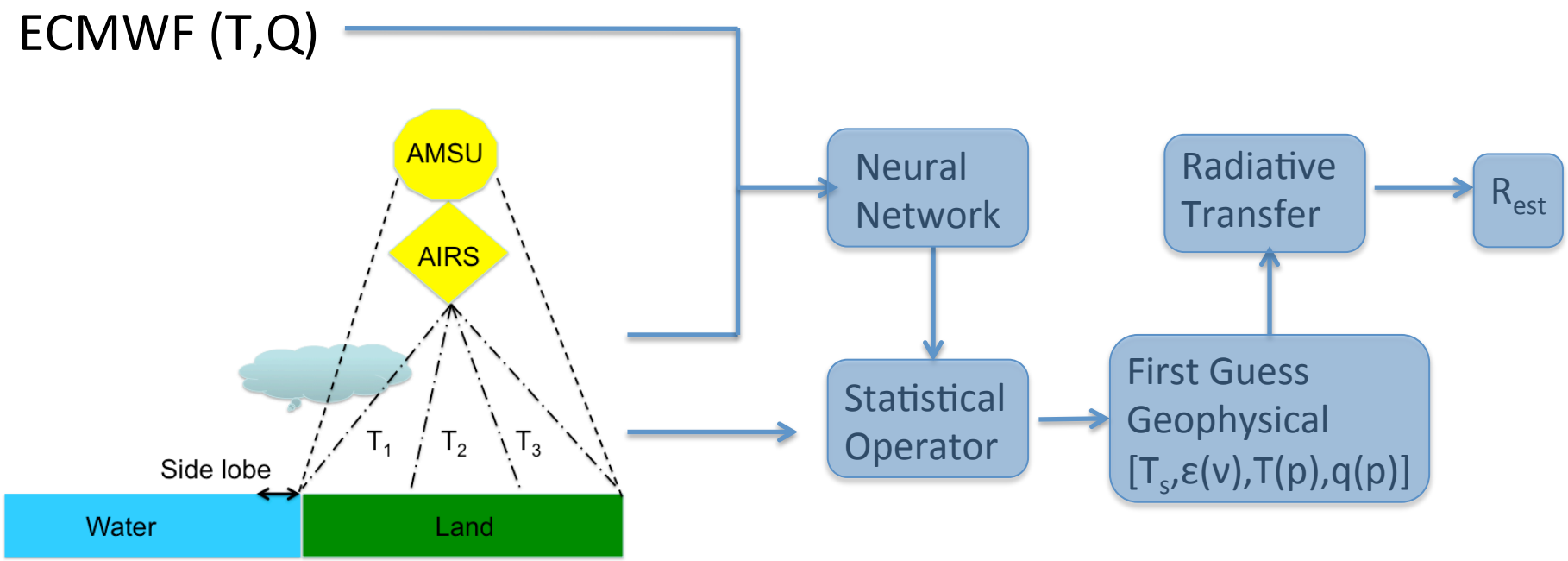
AIRS Fields of view

"AIRS Golfball"



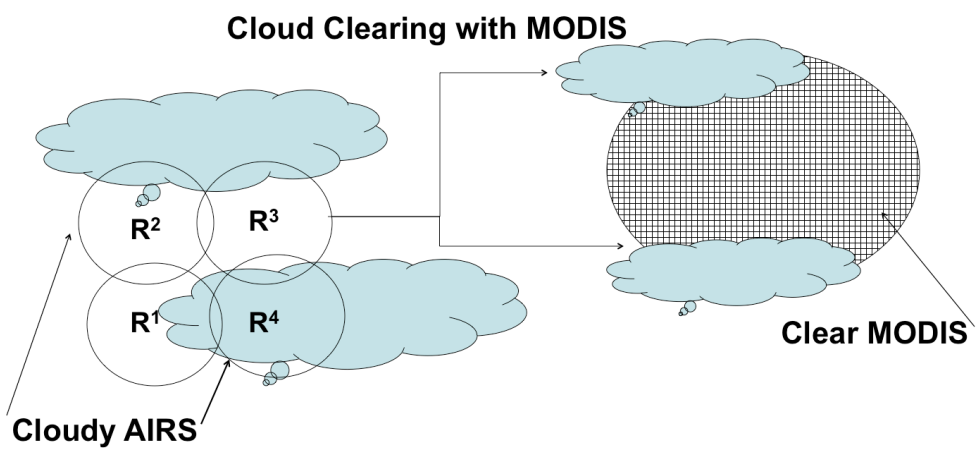


Determining Estimated Clear Radiance (R_{est})



- Use of radiative transfer requires error estimations for each geophysical term
- This may cause an overestimation of the error covariance term (Weights from previous slide)
- Use of AMSU increases accuracy of neural network
- Cloud clearing iterates, and R_{est} is determined from previous geophysical state

MODIS CLOUD Clearing



1. Identify and aggregate clear MODIS pixels inside AIRS FOV
2. Spectrally convolve AIRS to MODIS bands 31 and 32
3. Determine η
4. Cloud clear AIRS
5. Quality control based on chi-square between AIRS CCR and MODIS Clear and noise amplification

$$R_{est} = R^1 + \eta(R^1 - R^2)$$

Weights

$$W^{s}_{n,n'} = \left(\frac{NAF * I_{n,n'}}{N_a} \right)^{-1}$$

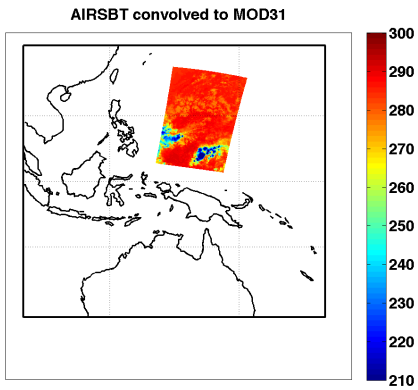
Maturity Level

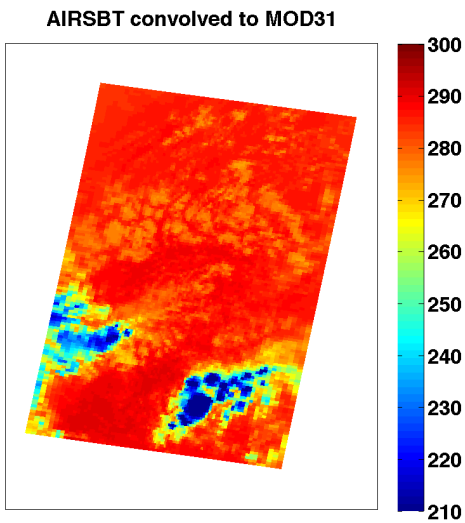
Irion Single Footprint Retrievals

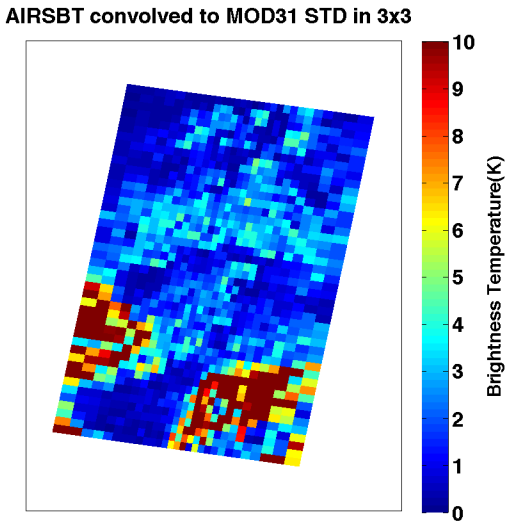
- MODIS provides cloud optical depth, cloud top pressure, and temperature
- Optimal estimation retrieval for temperature, H_2O, and O_3
- Scattering version of SARTA to compute Jacobians

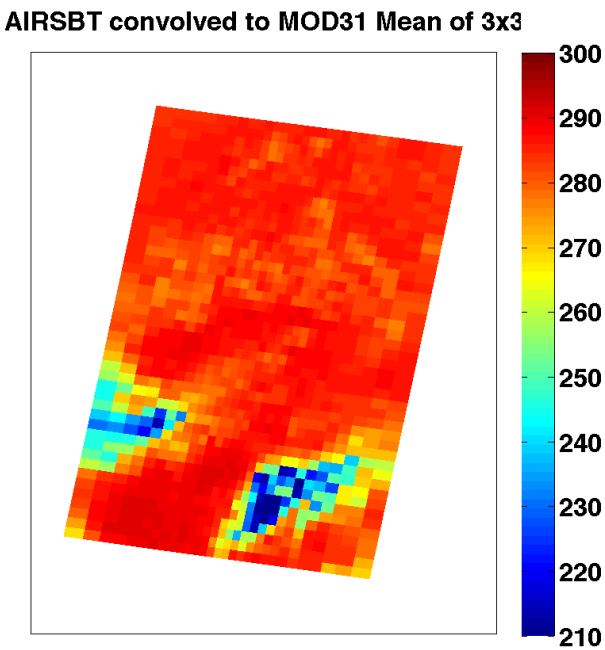
Maturity Level

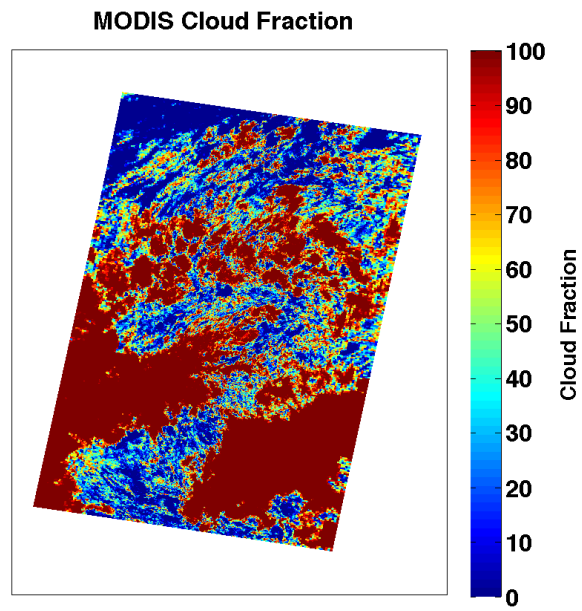
Study Site 20130203





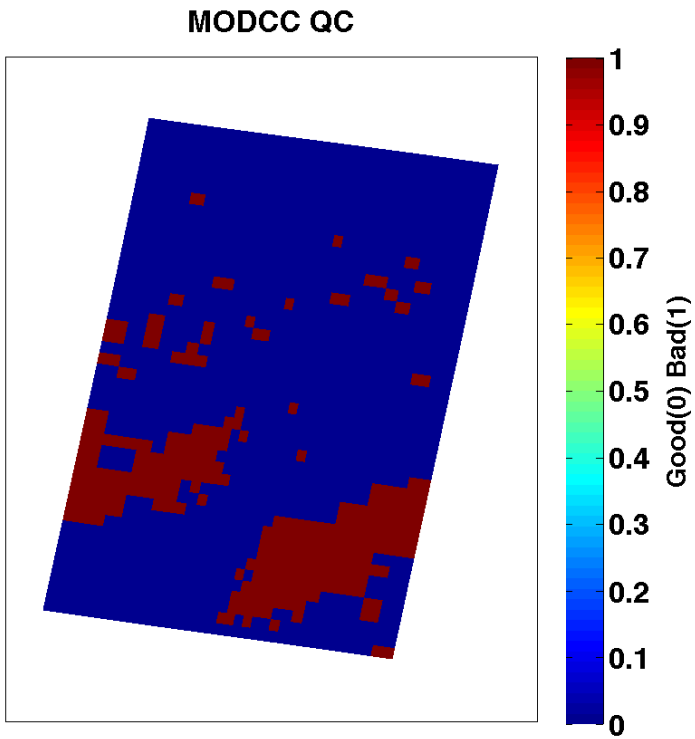


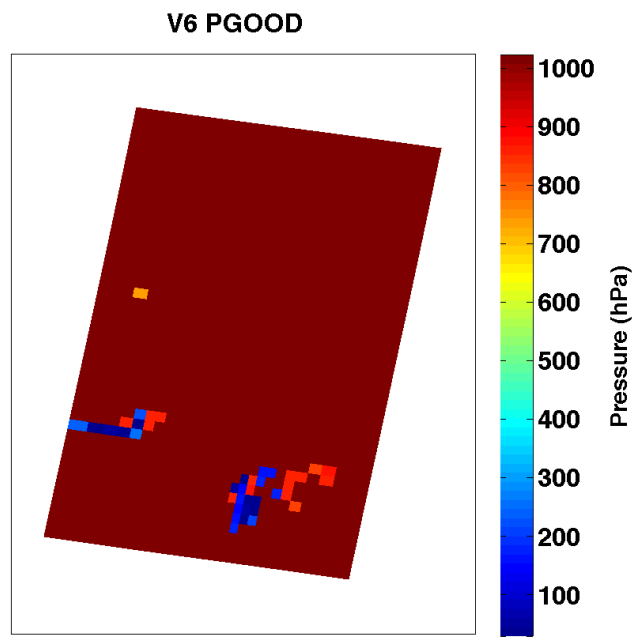




Granule Quality Flags

- V6 PGOOD is at the surface except for cold clouds with high cloud fractions
- MODCC has less successful retrievals



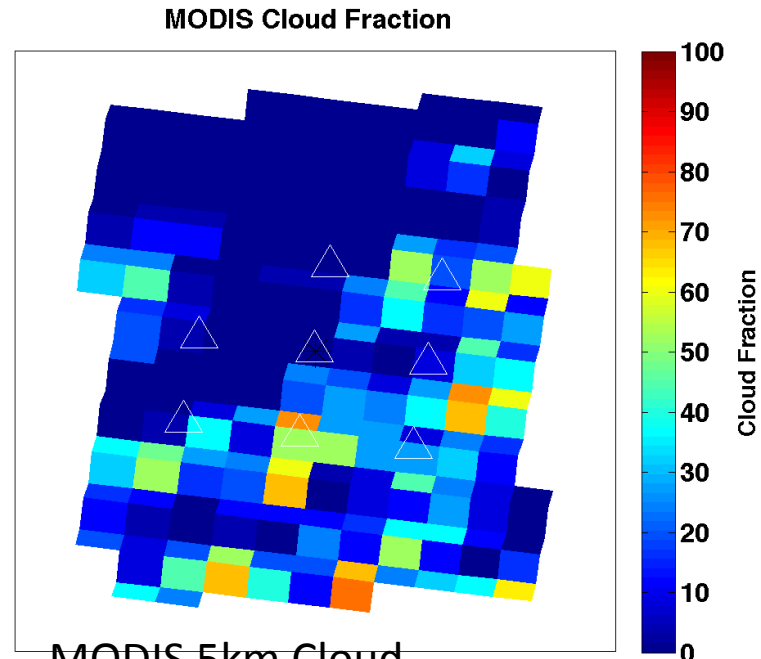


- MODCC quality flag is a primitive version based on the v4 Mid tropospheric qc flag
- Retrieval fails when cloud field is overcast

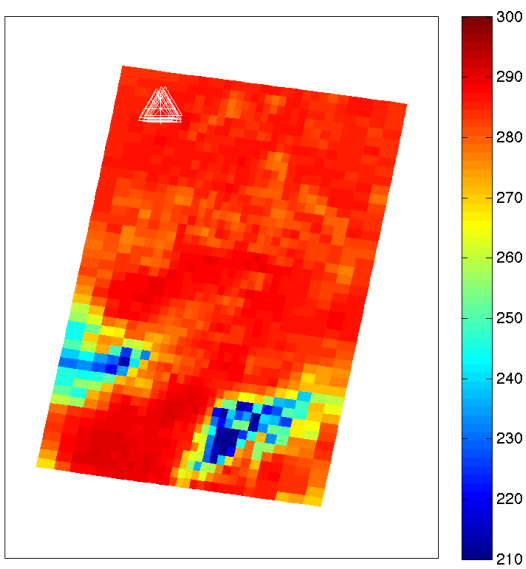
Case 1 Lowest

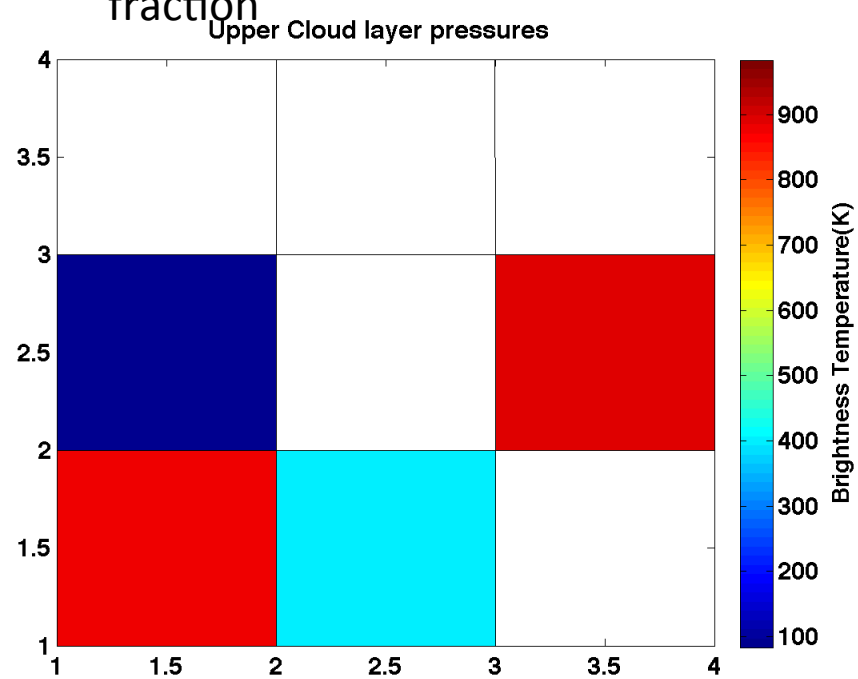
Statistics

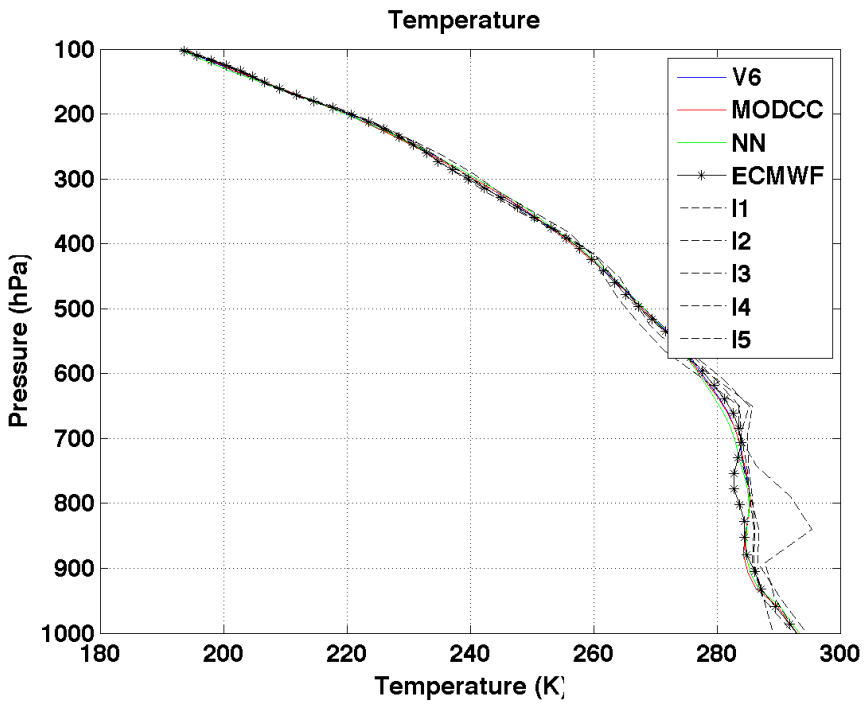
AIRS2MOD31 STD	= .2866 K
PGOOD	= 1022 hPa
MODCC	= 0 (maybe fail?)
V6 Tsurf	= 296.2 K
MODCC Tsurf	= 296.6 K
ECMWF Tsurf	= 296.3 K

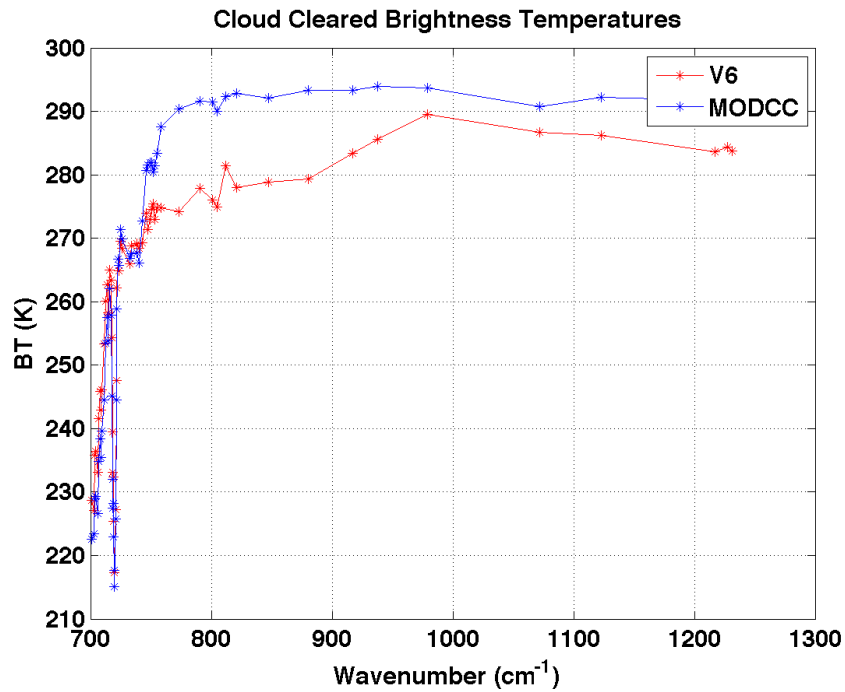


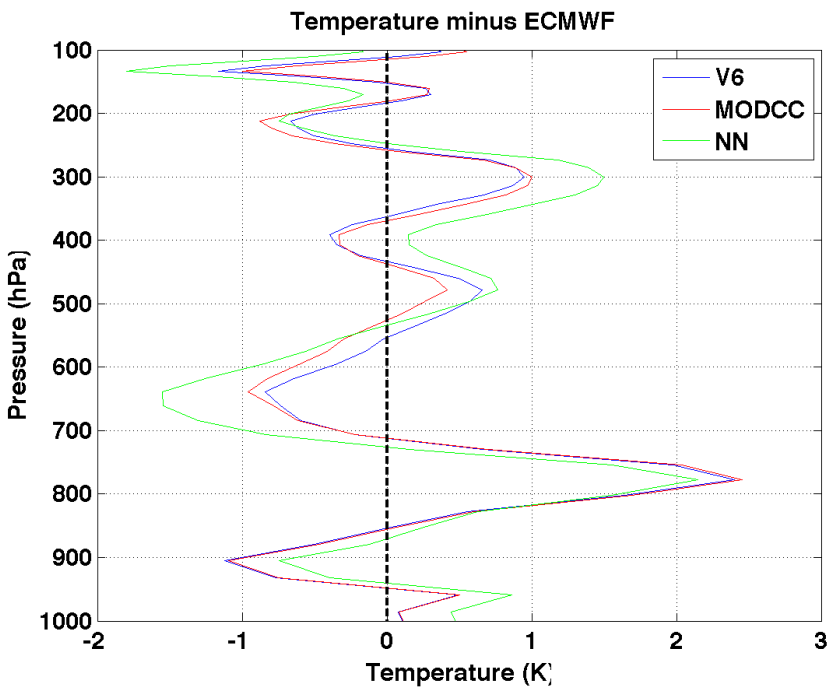
MODIS 5km Cloud fraction

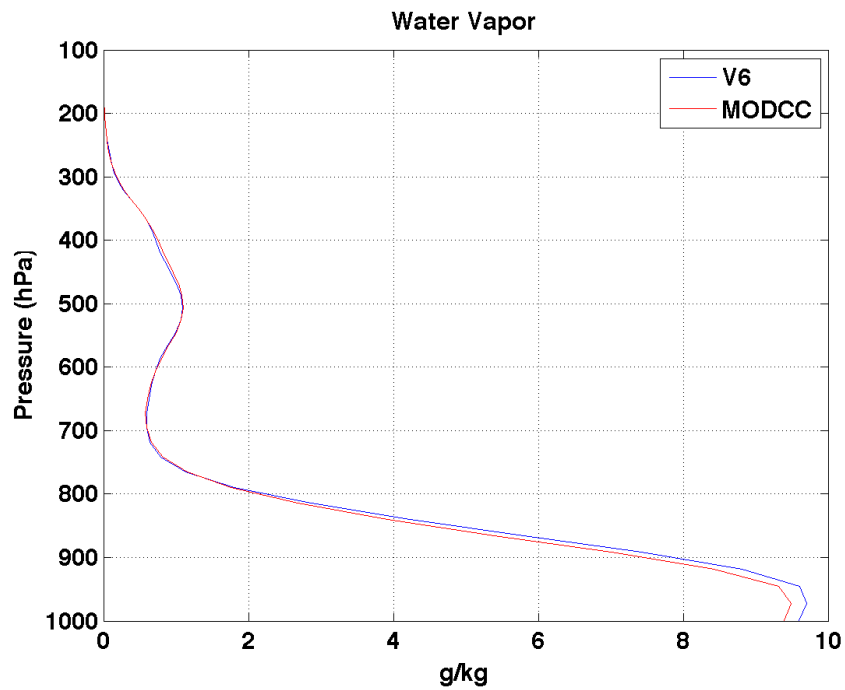





Temperature
Pressure (hPa)
Temperature (K)
V6
MODCC
NN
ECMWF
I1
I2
I3
I4
I5


Cloud Cleared Brightness Temperatures
BT (K)
Wavenumber (cm-1)
V6
MODCC

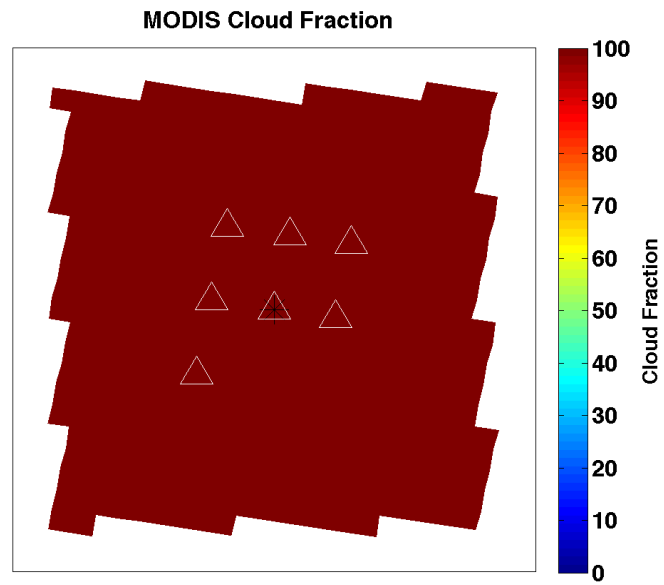

Temperature minus ECMWF
Pressure (hPa)
Temperature (K)
V6
MODCC
NN

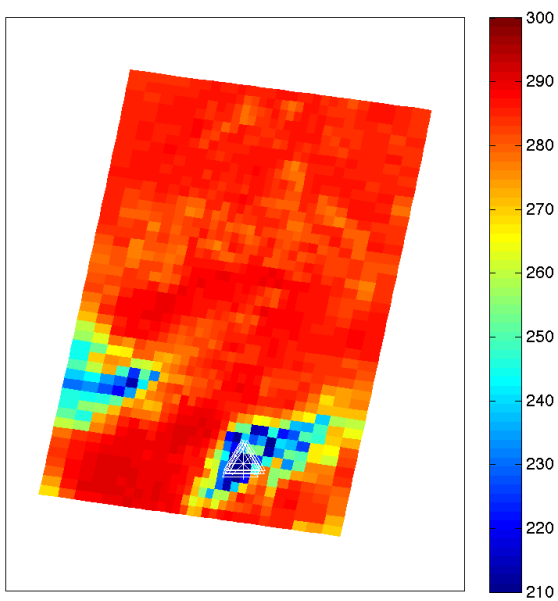

Water Vapor
Pressure (hPa)
g/kg
V6
MODCC

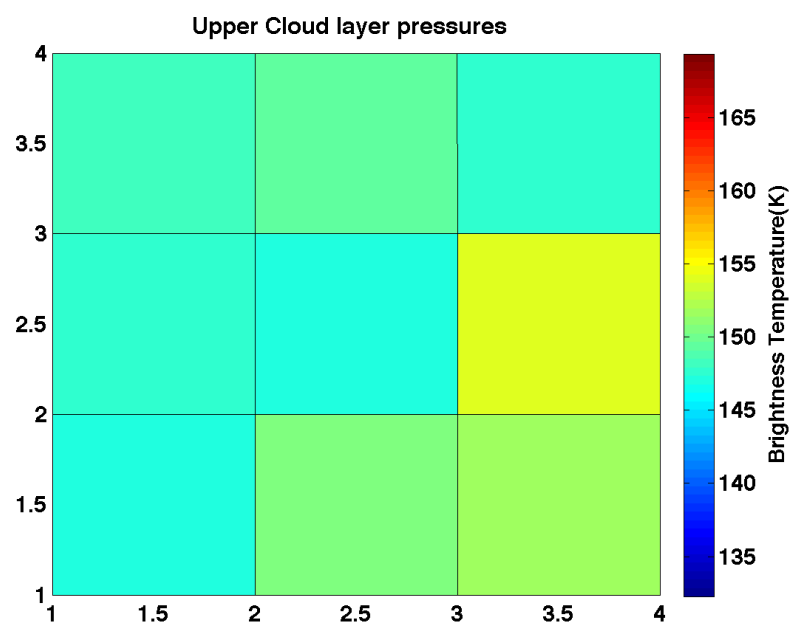
Case 2

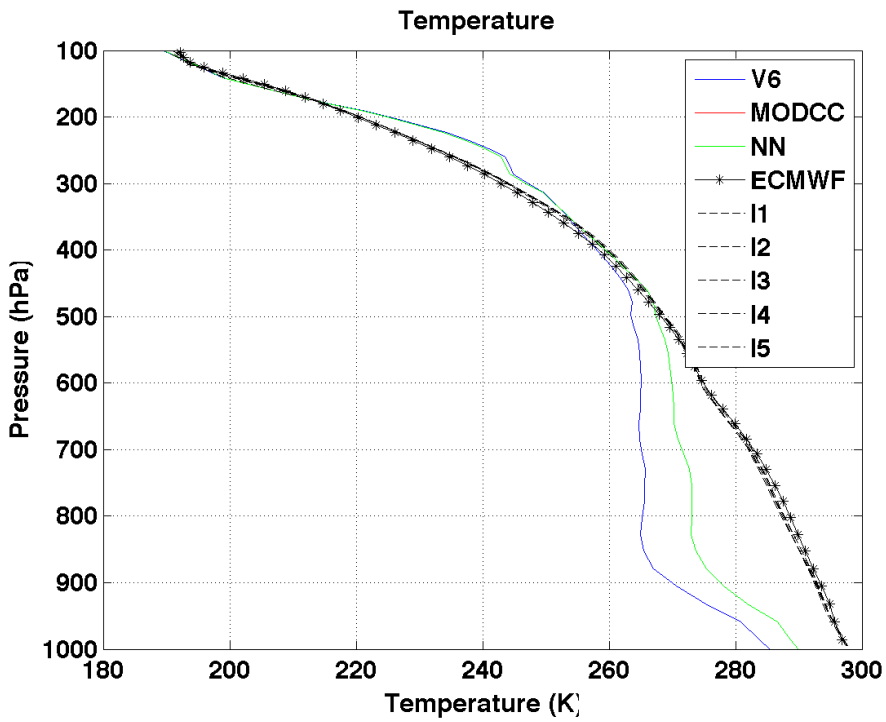
Statistics

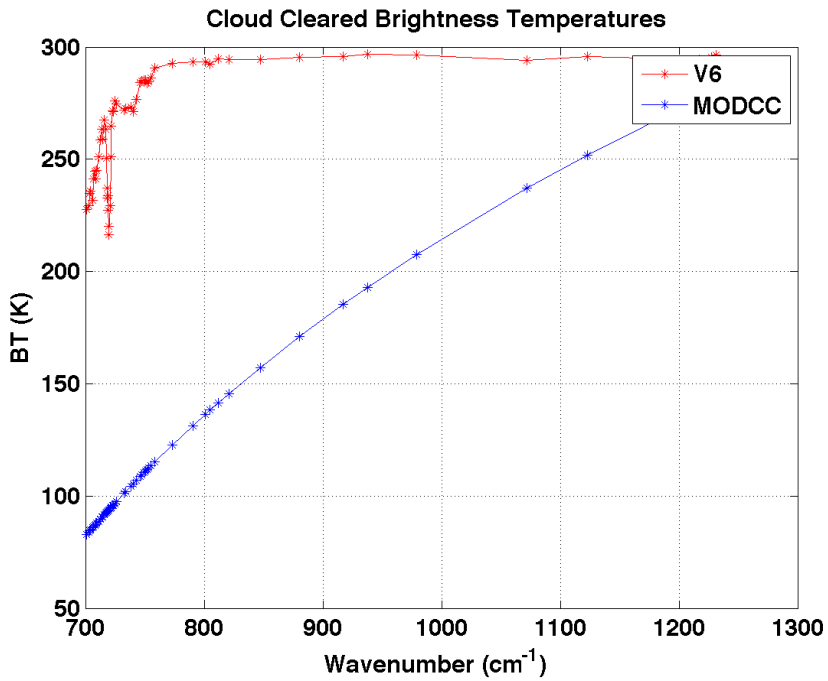
AIRS2MOD31 STD	= .8869 K
PGOOD	= 56 hPa
MODCC	= 1 (fake success)
V6 Tsurf	= 278.4 K
MODCC Tsurf	= 306.1 K
ECMWF Tsurf	= 301.9 K

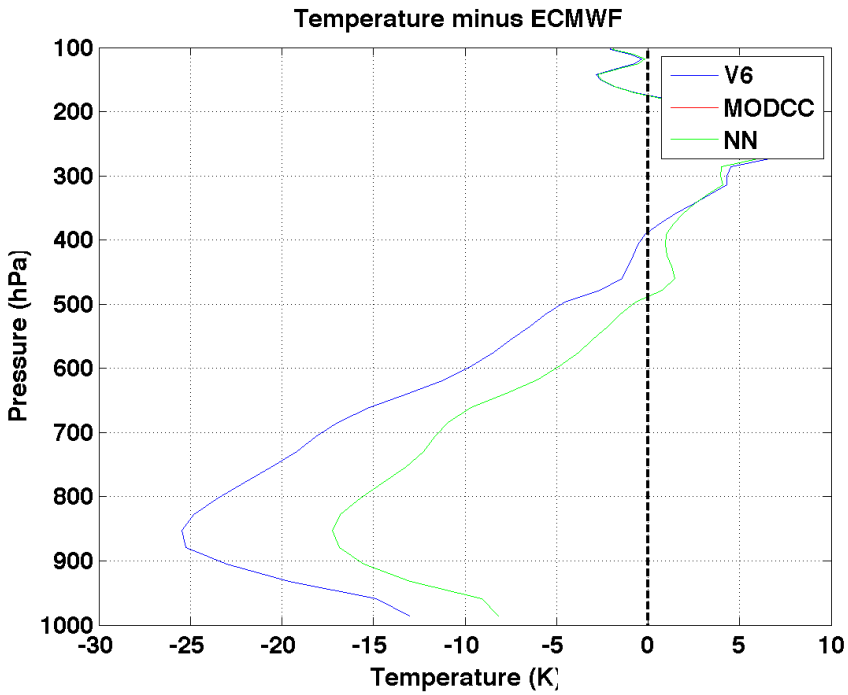


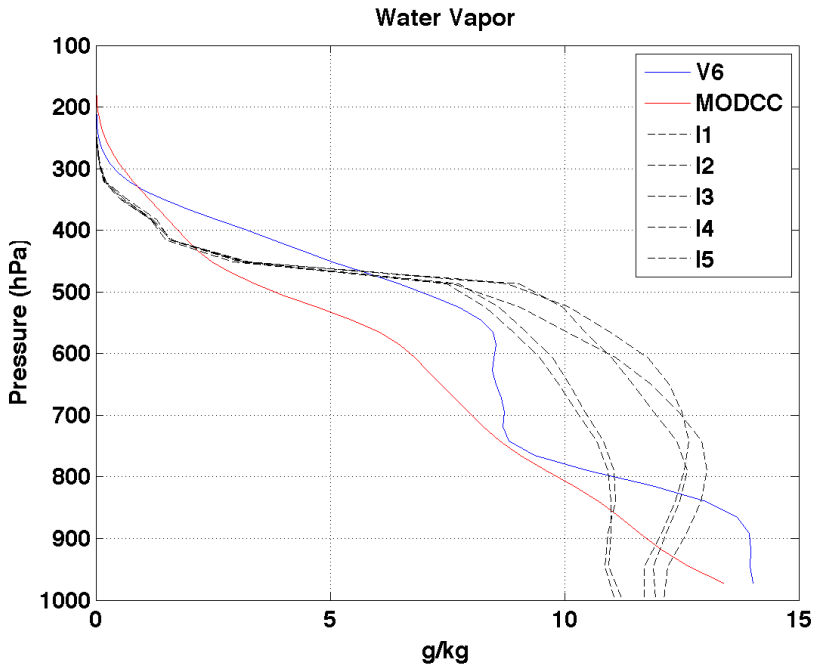





Temperature
Pressure (hPa)
Temperature (K)
V6
MODCC
NN
ECMWF
I1
I2
I3
I4
I5


Cloud Cleared Brightness Temperatures
BT (K)
Wavenumber (cm-1)
V6
MODCC

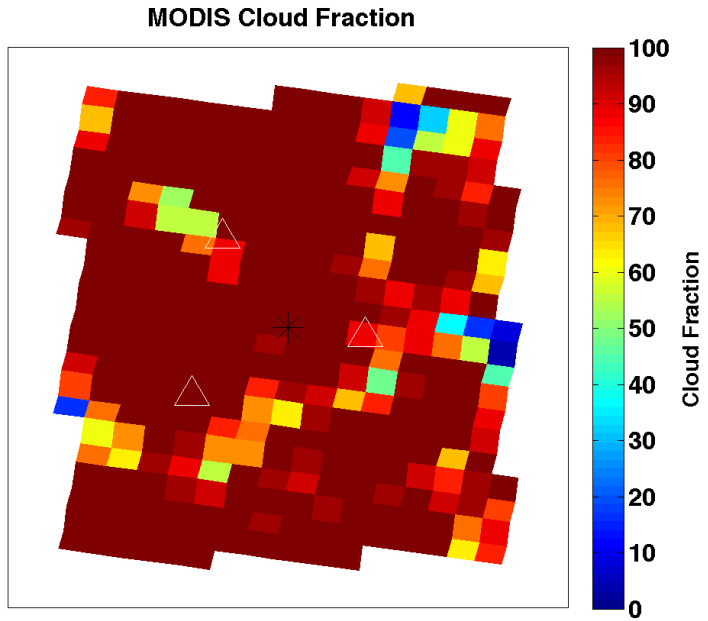

Temperature minus ECMWF
Pressure (hPa)
Temperature (K)
V6
MODCC
NN

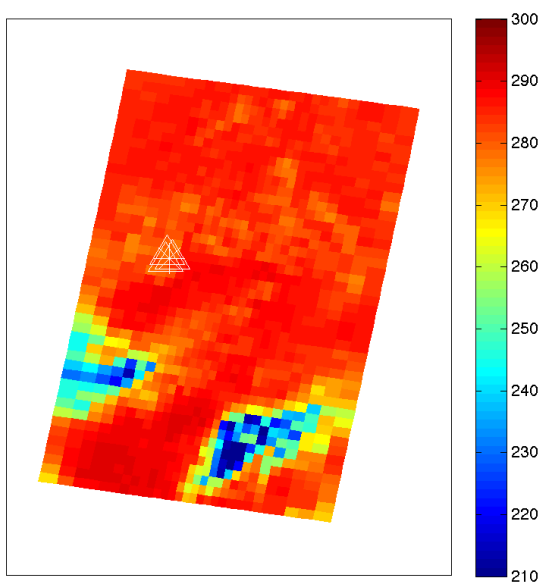

Water Vapor
Pressure (hPa)
g/kg
V6
MODCC
I1
I2
I3
I4
I5

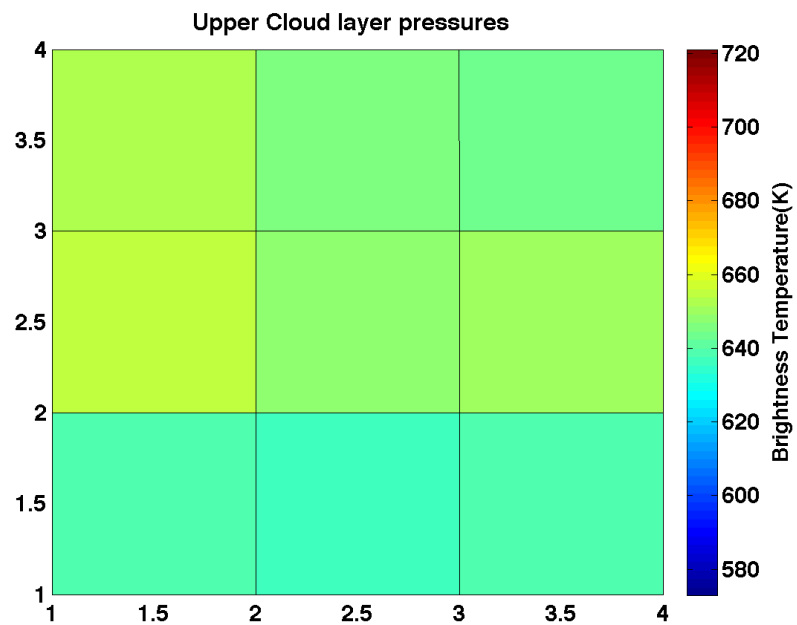
Case 3

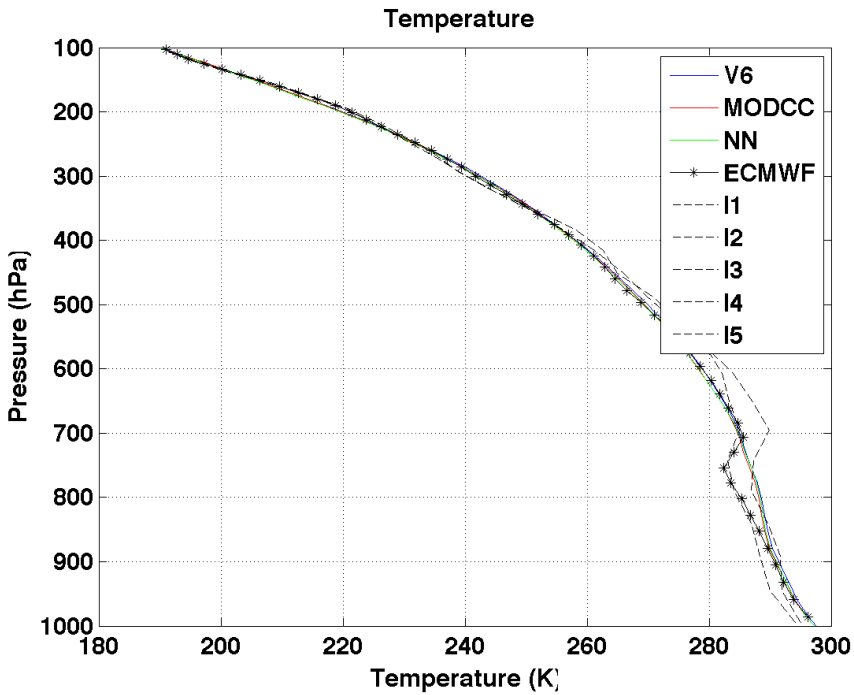
Statistics

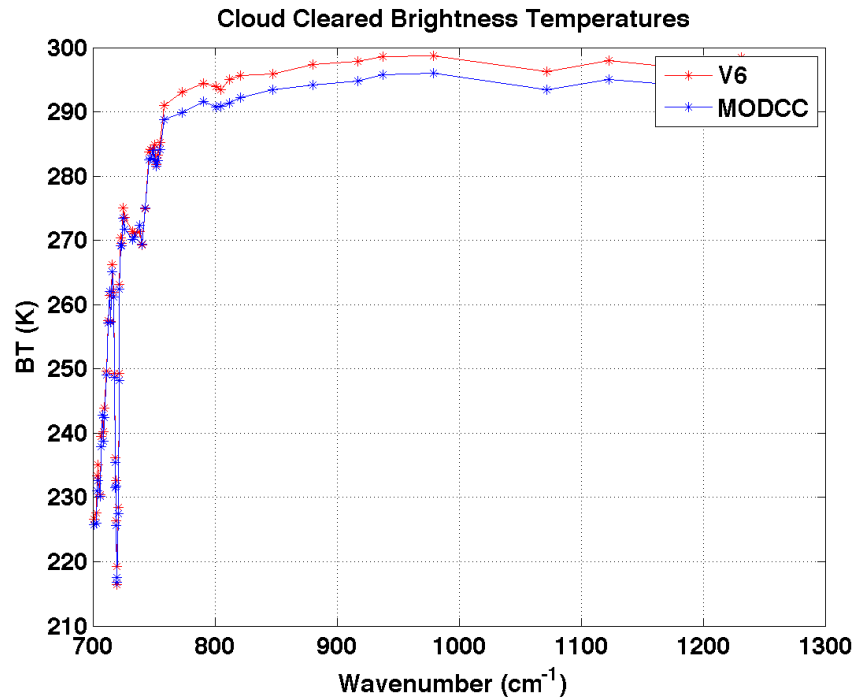
AIRS2MOD31 STD = 2.165 K
PGOOD = 1016 hPa
MODCC = 1(success)
V6 Tsurf = 304.0 K
MODCC Tsurf = 300.7 K
ECMWF Tsurf = 299.8 K

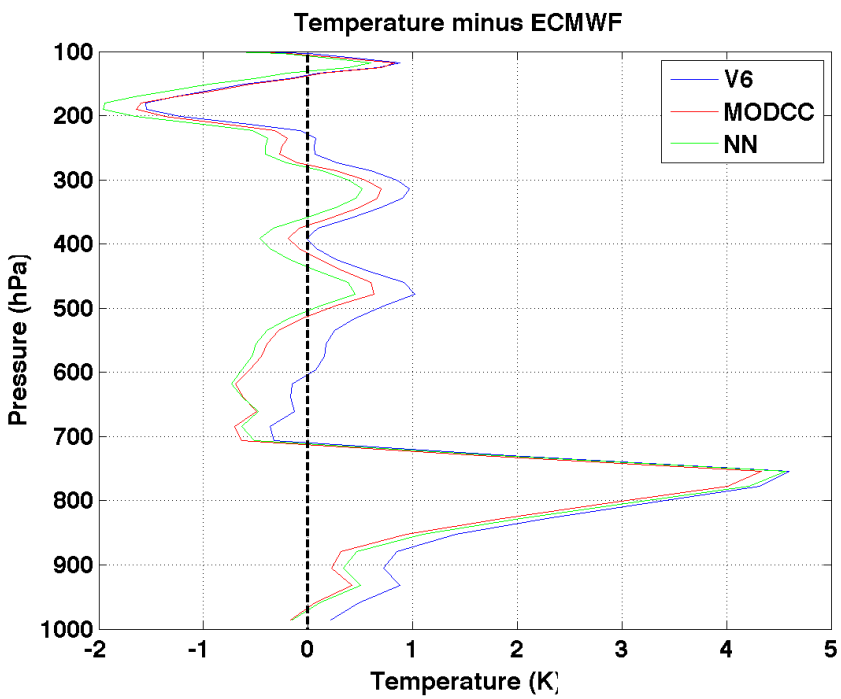


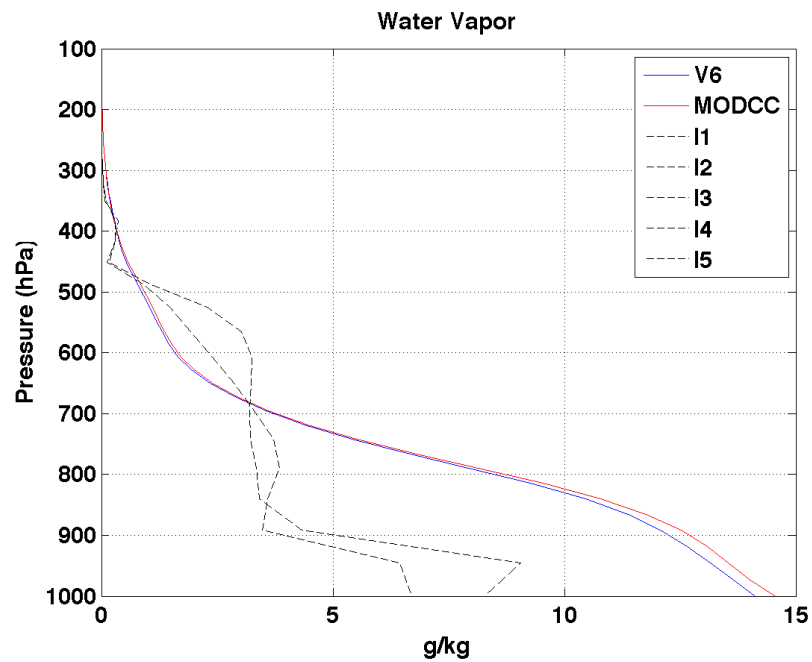





Temperature
Pressure (hPa)
Temperature (K)
V6
MODCC
NN
ECMWF
I1
I2
I3
I4
I5


Cloud Cleared Brightness Temperatures
BT (K)
Wavenumber (cm-1)
V6
MODCC

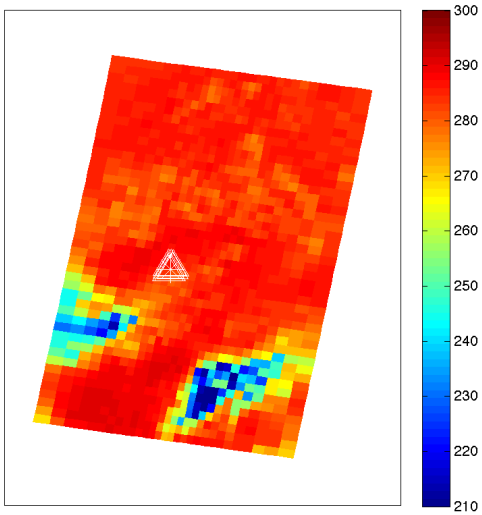

Temperature minus ECMWF
Pressure (hPa)
Temperature (K)
V6
MODCC
NN

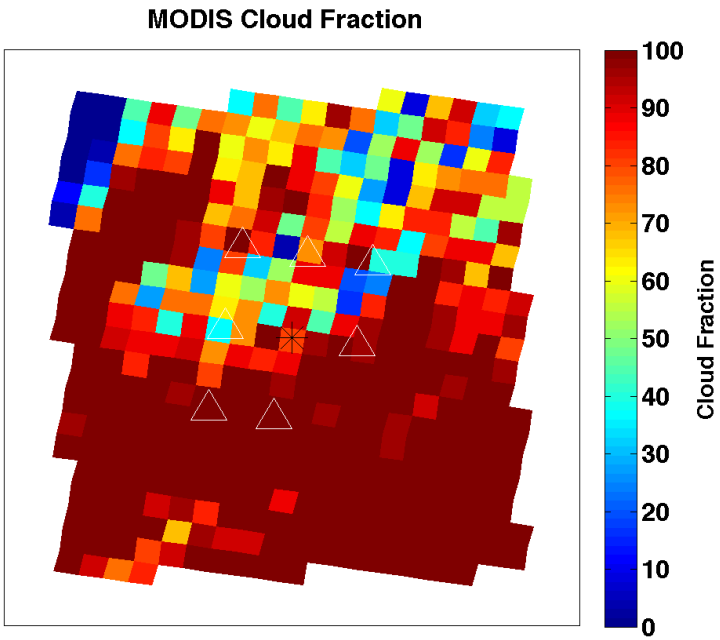

Water Vapor
Pressure (hPa)
g/kg
V6
MODCC
I1
I2
I3
I4
I5

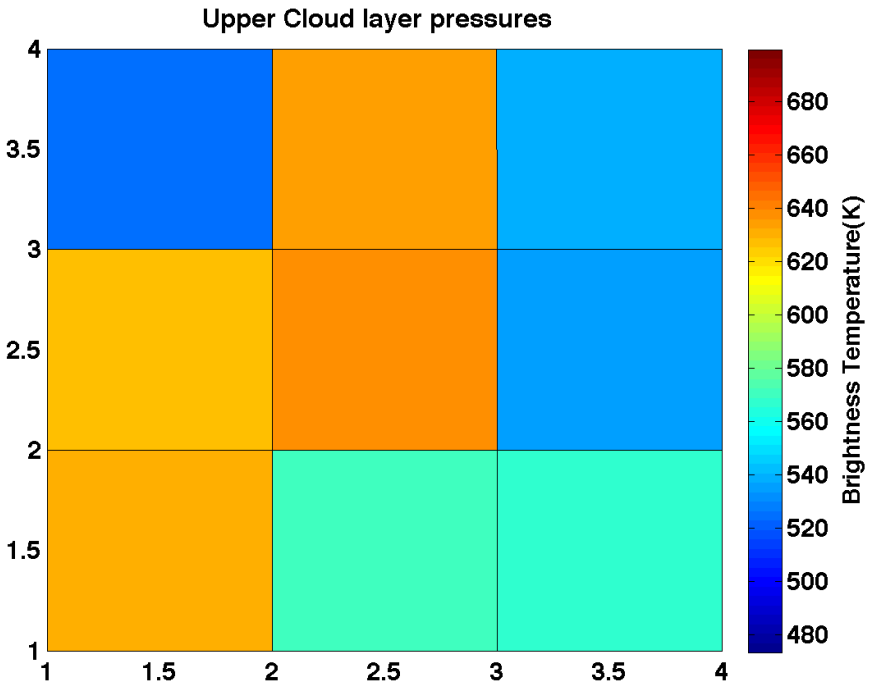
Case 4

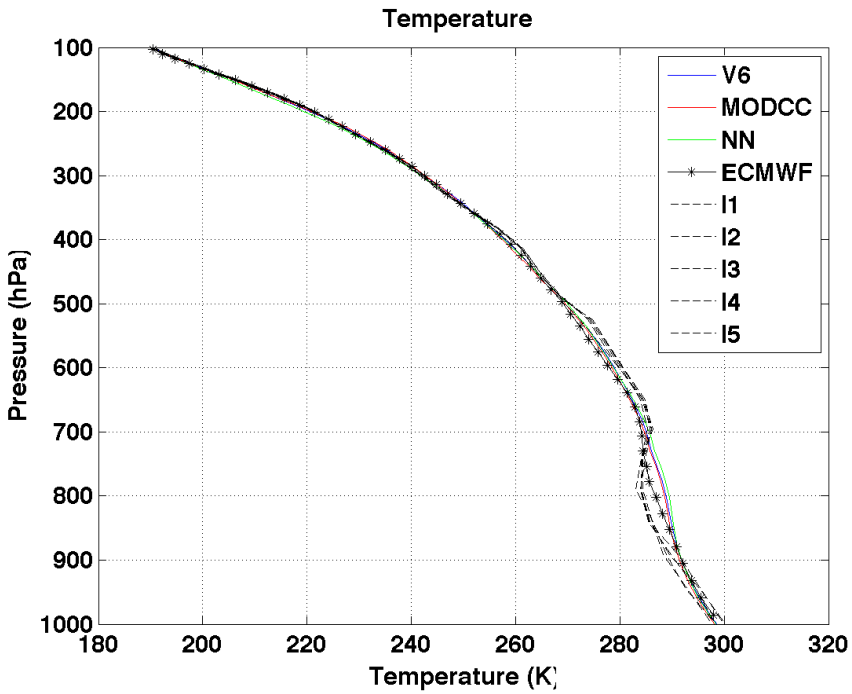
Statistics

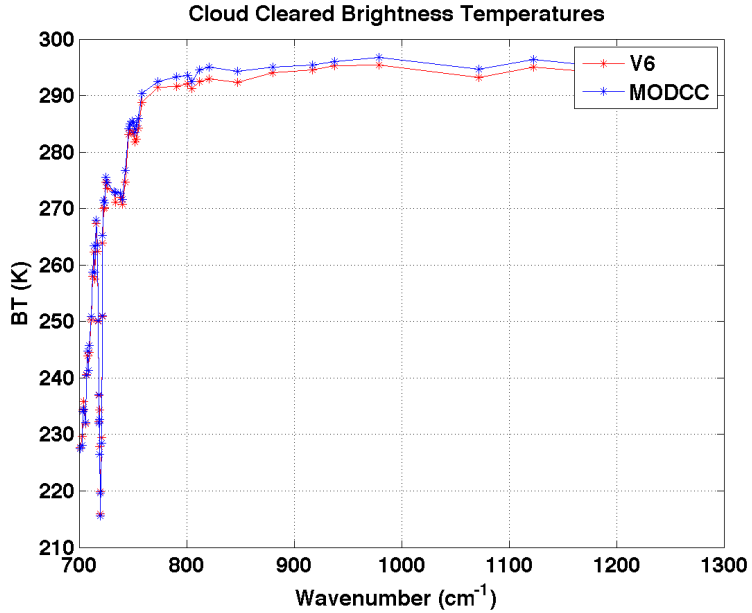
AIRS2MOD31 STD = 2.712 K
PGOOD = 1014 hPa
MODCC = 1 (success)
V6 Tsurf = 302.5 K
MODCC Tsurf = 300.9 K
ECMWF Tsurf = 301.0 K

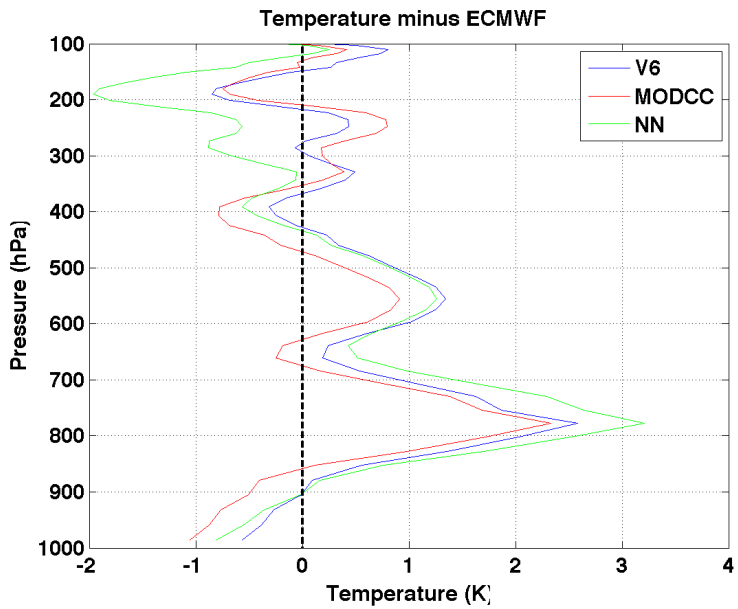


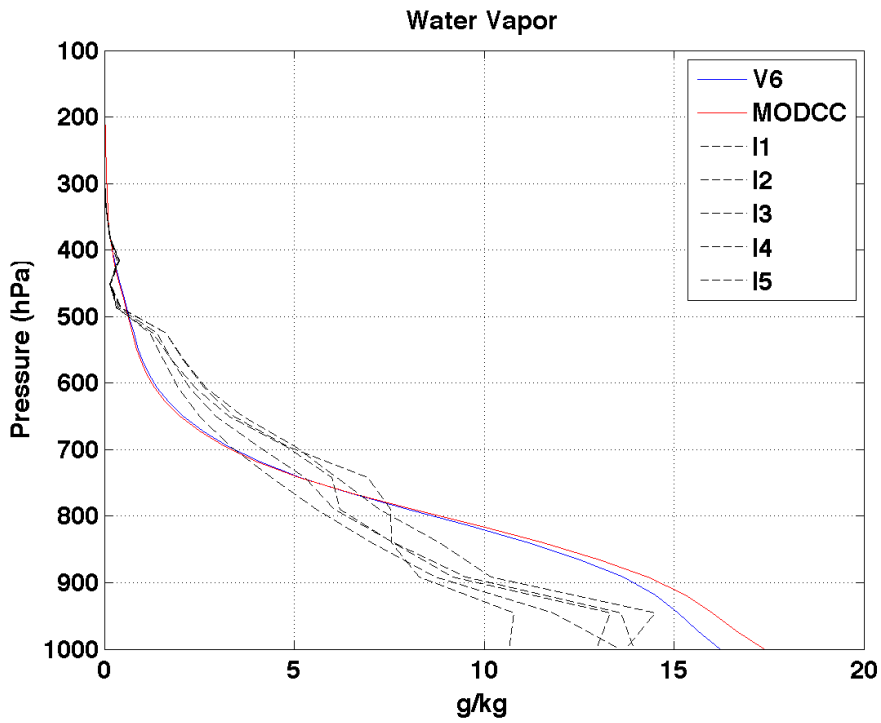





Temperature
Pressure (hPa)
Temperature (K)
V6
MODCC
NN
ECMWF
I1
I2
I3
I4
I5


Cloud Cleared Brightness Temperatures
BT (K)
Wavenumber (cm-1)
V6
MODCC

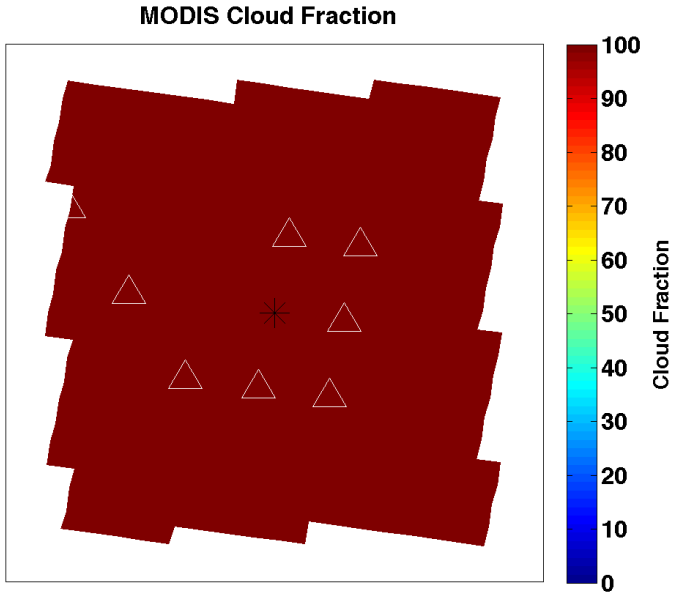

Temperature minus ECMWF
Pressure (hPa)
Temperature (K)
V6
MODCC
NN

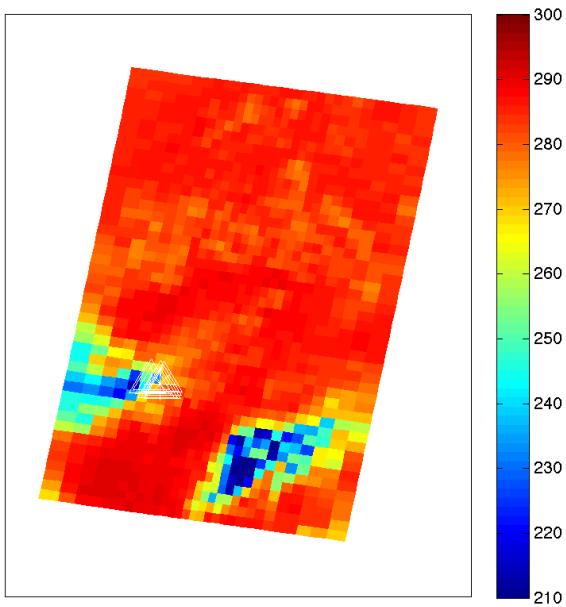

Water Vapor
Pressure (hPa)
g/kg
V6
MODCC
I1
I2
I3
I4
I5

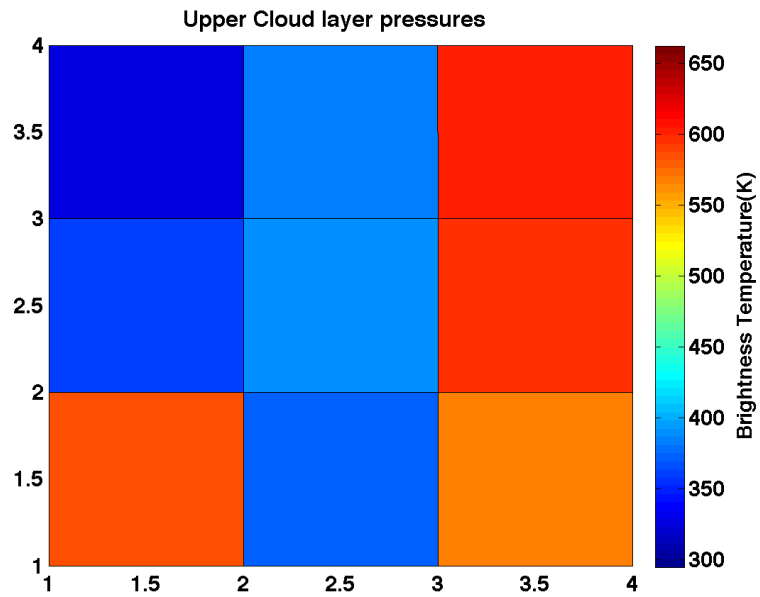
Case 5

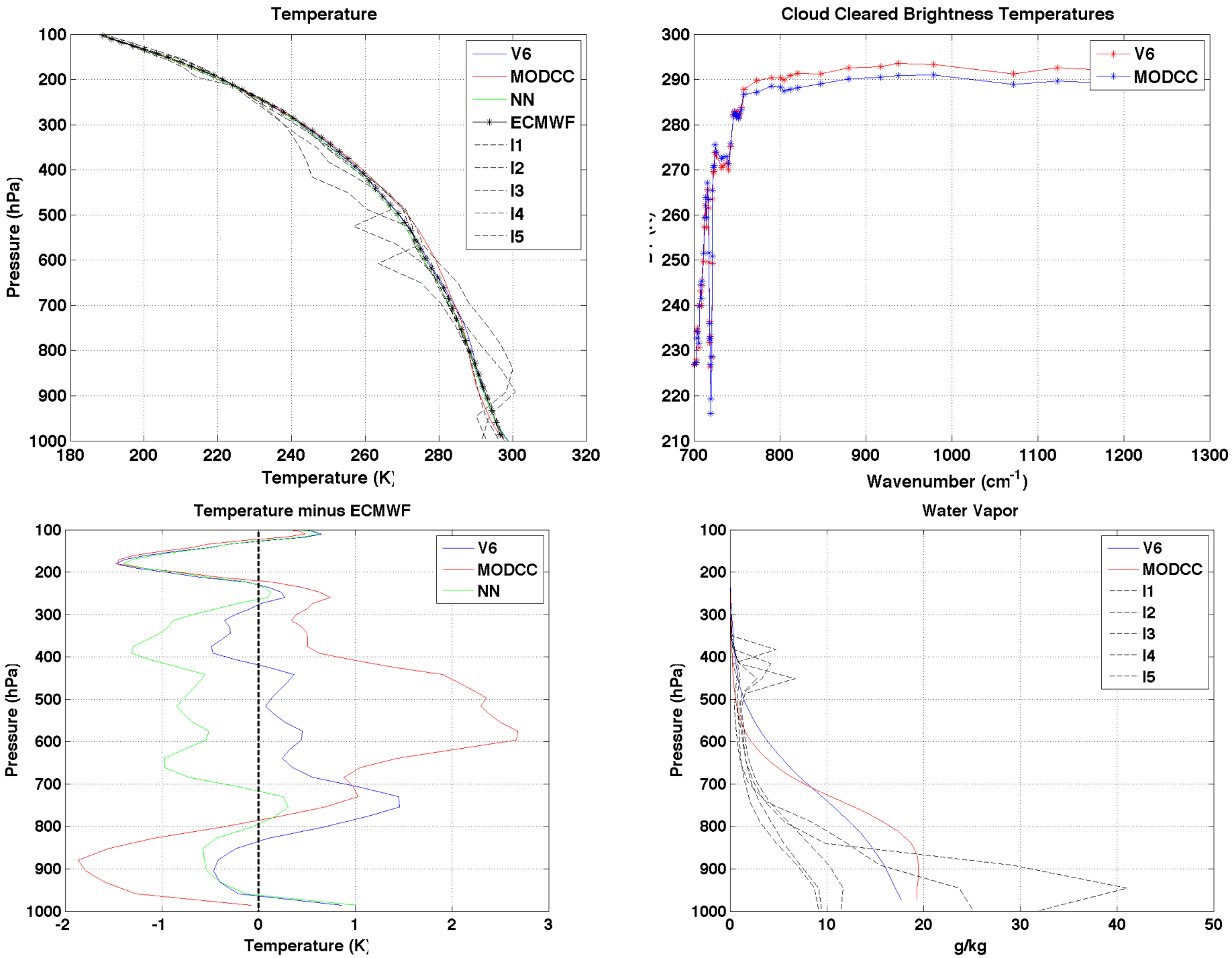
Statistics

AIRS2MOD31 STD = 6.786 K
PGOOD = 1013 hPa
MODCC = 1 (success)
V6 Tsurf = 299.0 K
MODCC Tsurf = 294.5 K
ECMWF Tsurf = 301.3 K





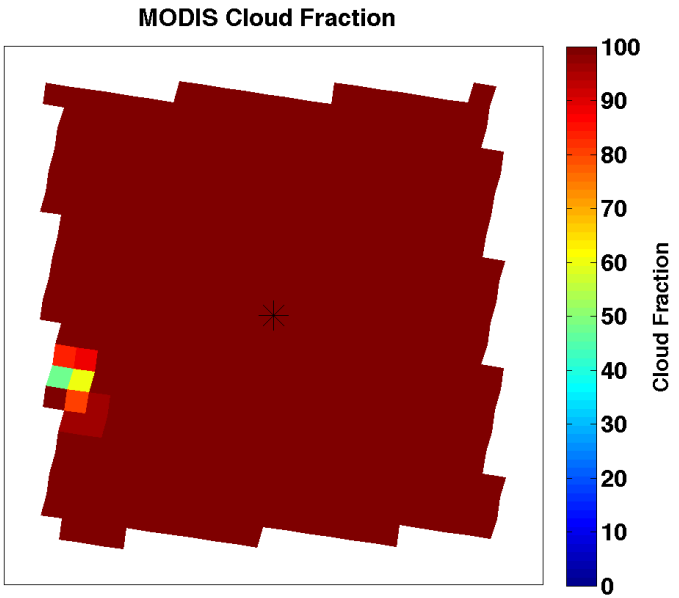


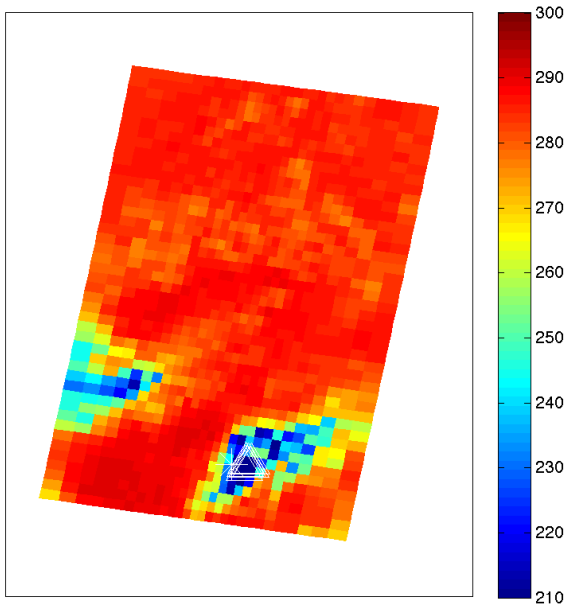

Temperature
Pressure (hPa)
Temperature (K)
V6
MODCC
NN
ECMWF
I1
I2
I3
I4
I5
Cloud Cleared Brightness Temperatures
Wavenumber (cm-1)
V6
MODCC
Temperature minus ECMWF
Pressure (hPa)
Temperature (K)
V6
MODCC
NN
Water Vapor
Pressure (hPa)
g/kg
V6
MODCC
I1
I2
I3
I4
I5

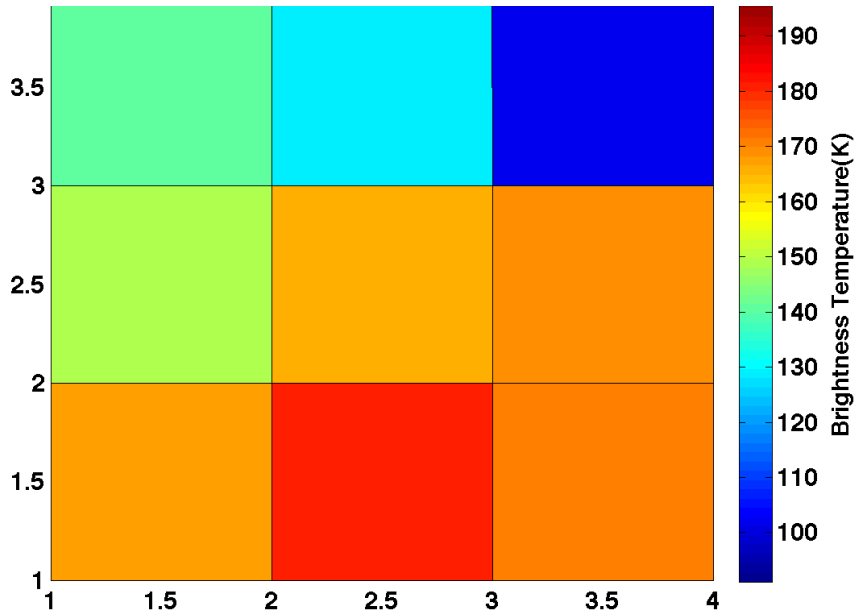
Case 6

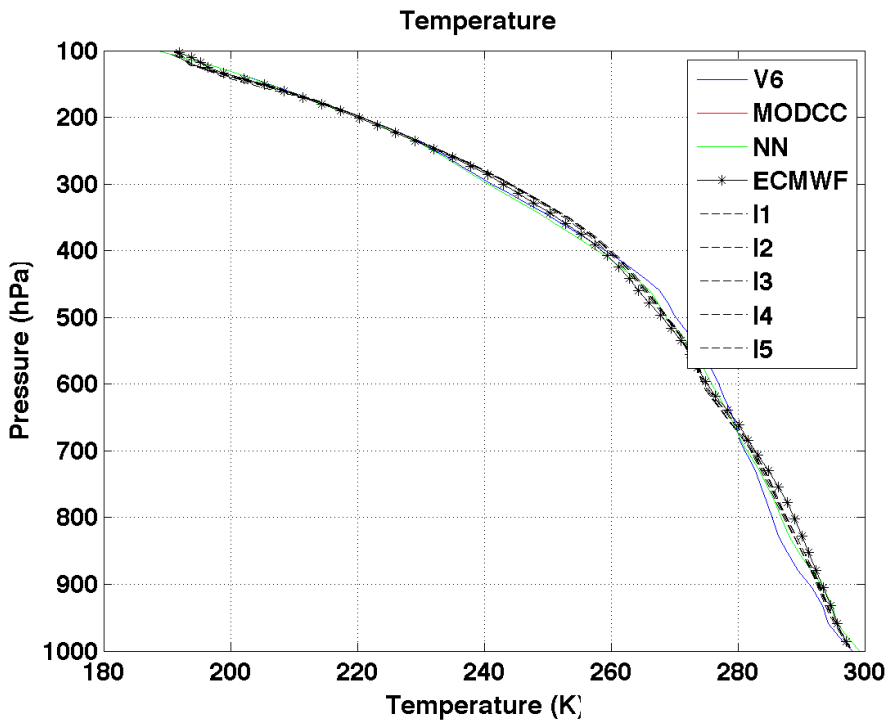
Statistics

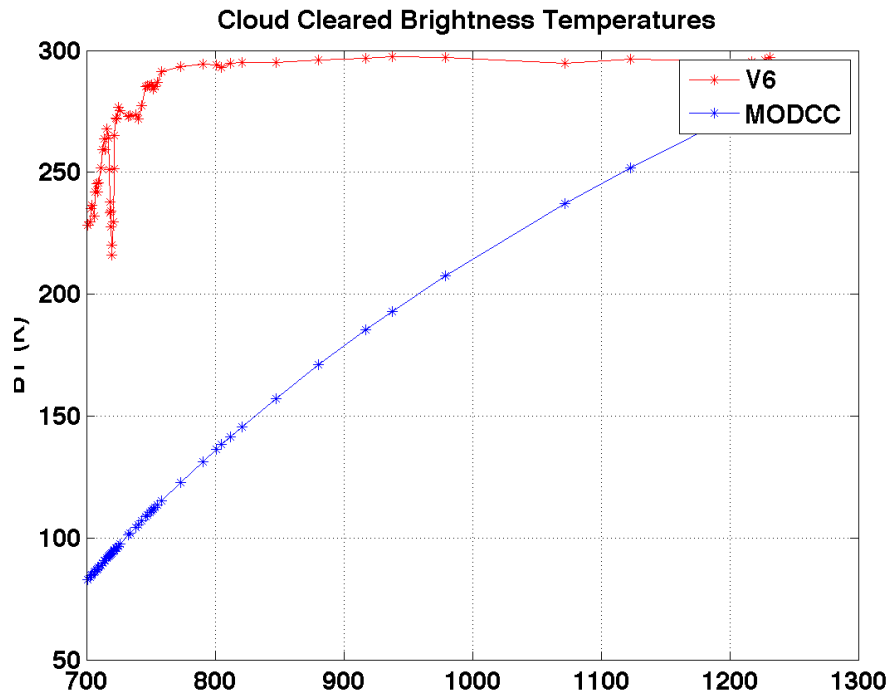
AIRS2MOD31 STD = 9.461 K
PGOOD = 1011 hPa
MODCC = 1 (fake success)
V6 Tsurf = 295.1 K
MODCC Tsurf = 302.3 K
ECMWF Tsurf = 301.6 K

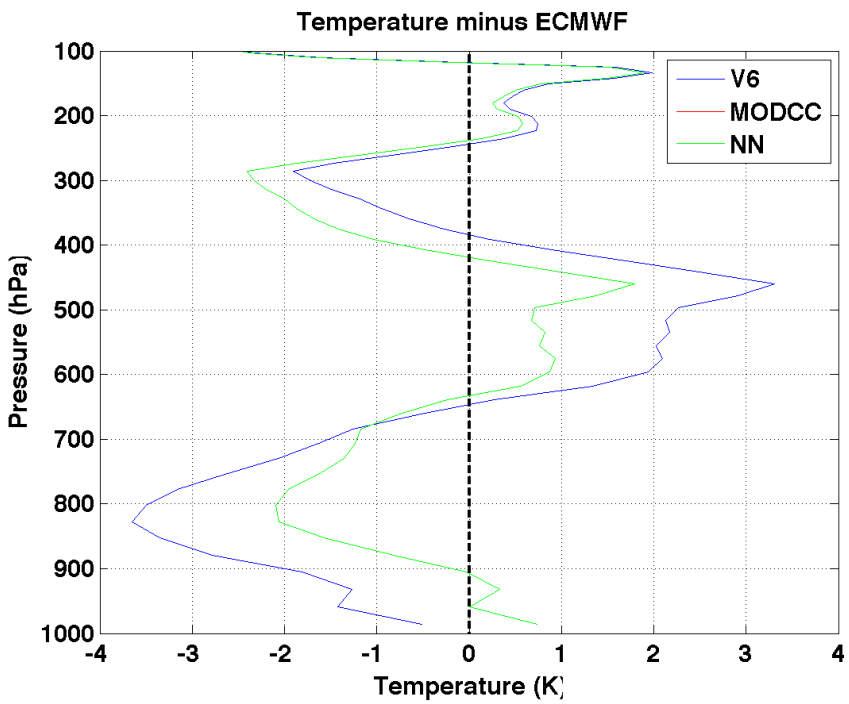


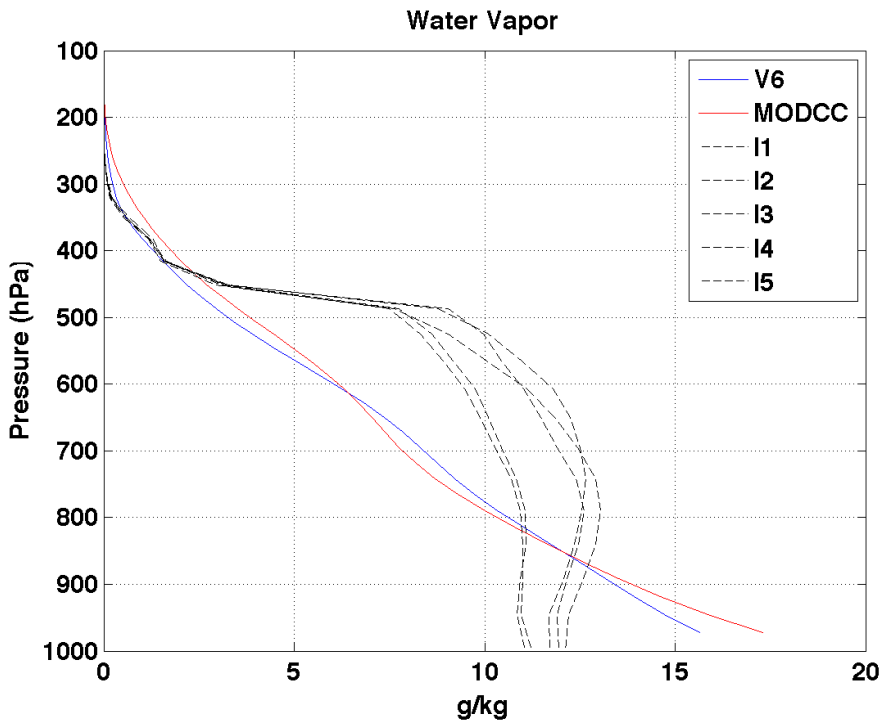





Temperature
Pressure (hPa)
Temperature (K)
V6
MODCC
NN
ECMWF
I1
I2
I3
I4
I5


Cloud Cleared Brightness Temperatures
V6
MODCC

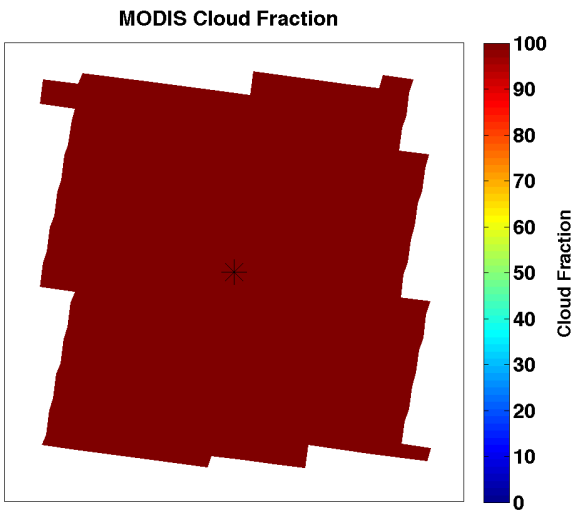

Temperature minus ECMWF
Pressure (hPa)
Temperature (K)
V6
MODCC
NN

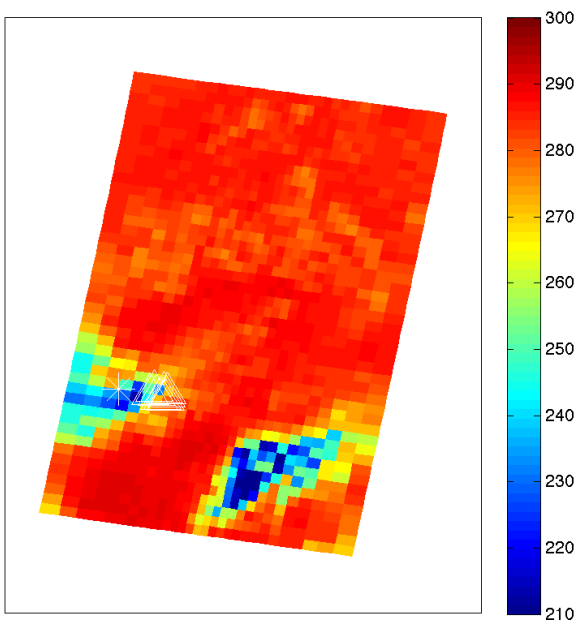

Water Vapor
Pressure (hPa)
g/kg
V6
MODCC
I1
I2
I3
I4
I5

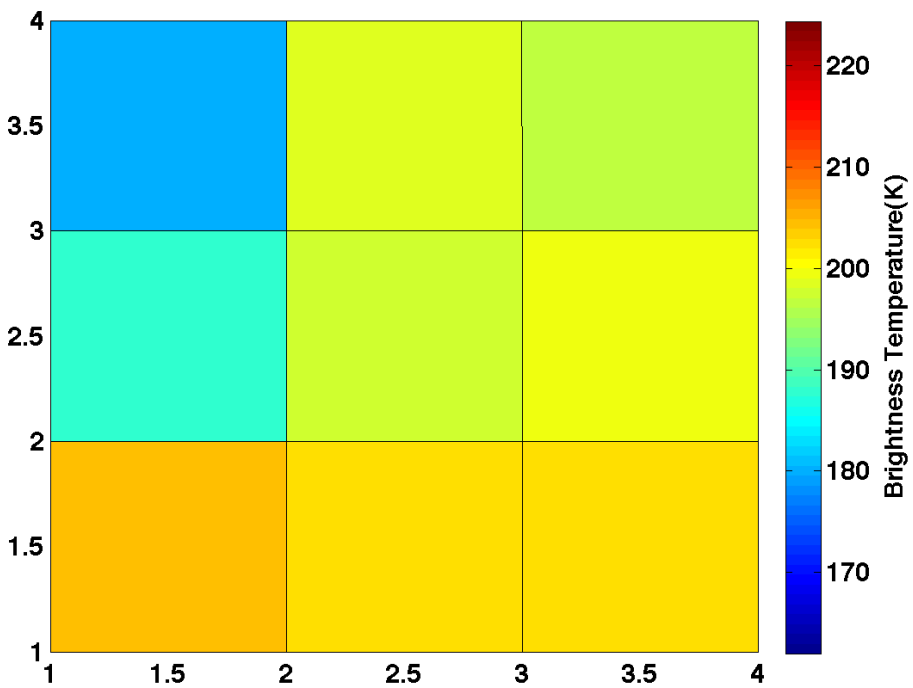
Case 7

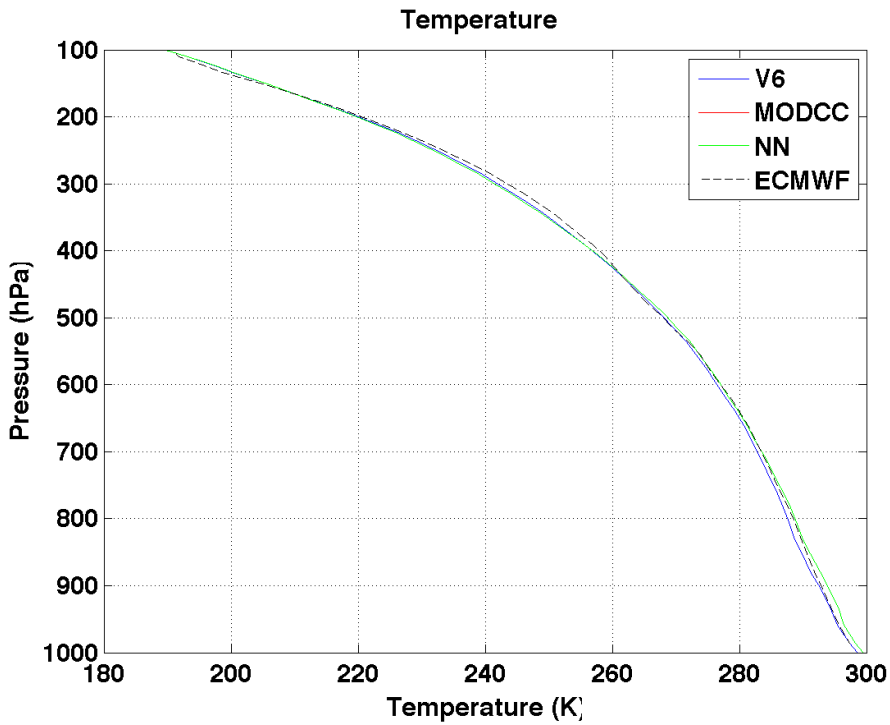
Statistics

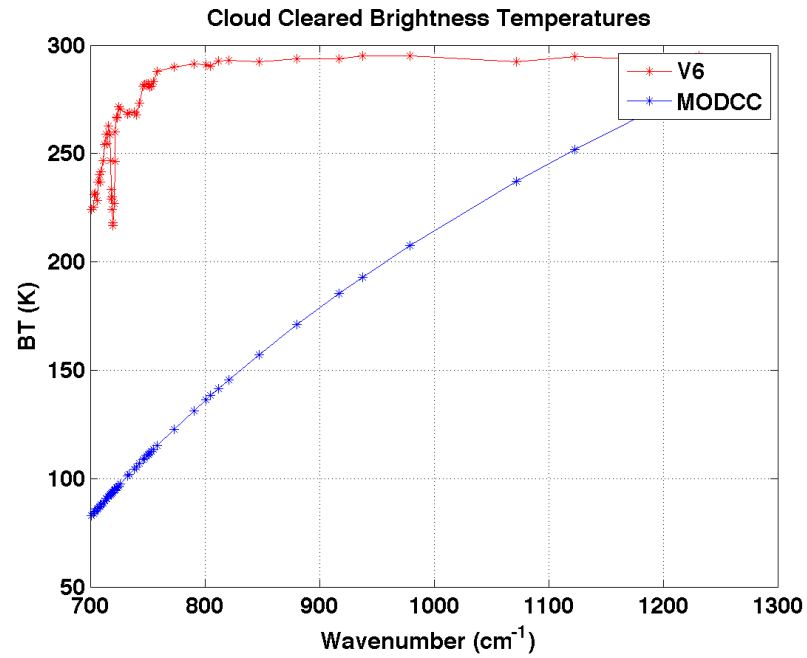
AIRS2MOD31 STD = 10.52 K
PGOOD = 1013 hPa
MODCC = 1 (fake success)
V6 Tsurf = 294.8 K
MODCC Tsurf = 301.3 K
ECMWF Tsurf = 301.2 K

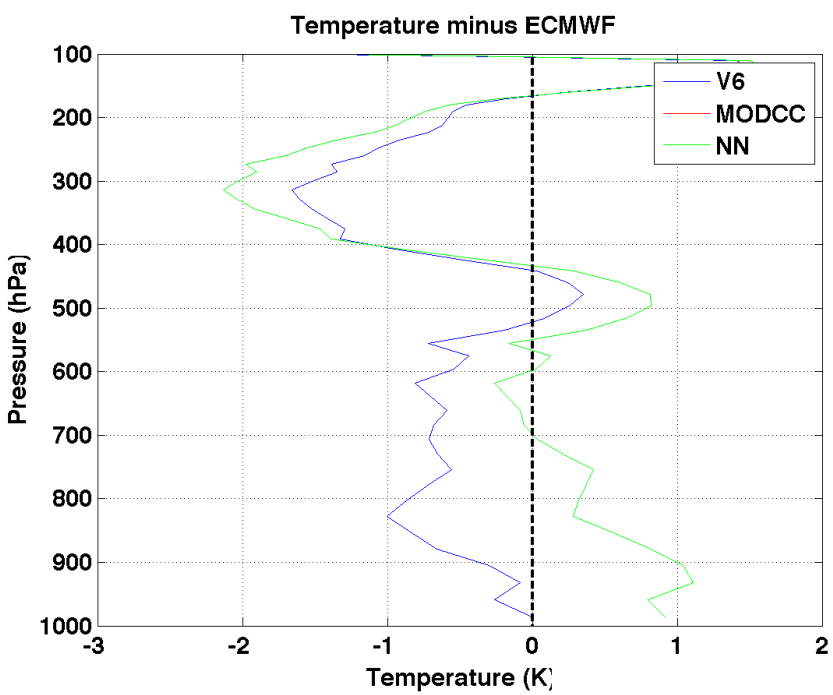


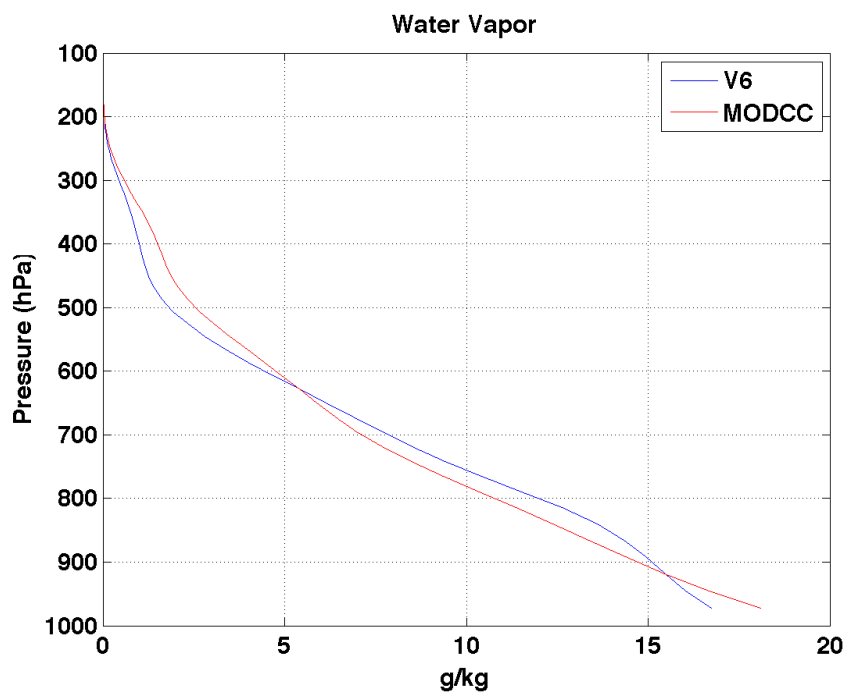





Temperature
V6
MODCC
NN
ECMWF
Pressure (hPa)
Temperature (K)
100
200
300
400
500
600
700
800
900
1000
180
200
220
240
260
280
300


Cloud Cleared Brightness Temperatures
V6
MODCC
BT (K)
Wavenumber (cm-1)
300
250
200
150
100
50
700
800
900
1000
1100
1200
1300

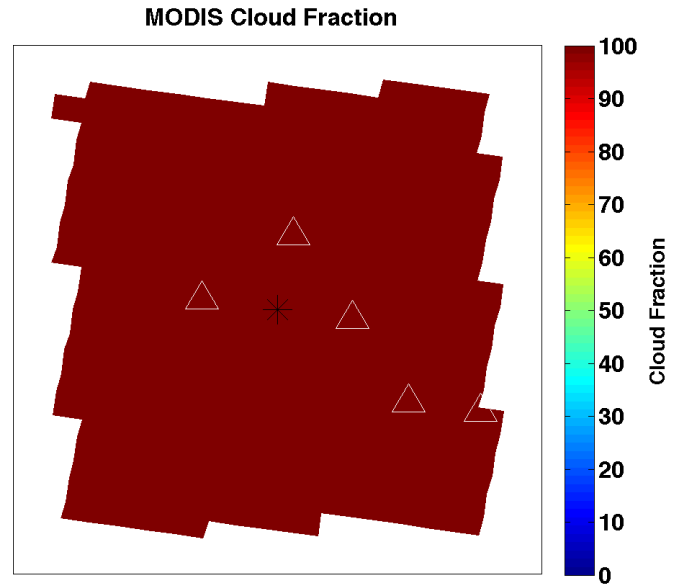

Temperature minus ECMWF
V6
MODCC
NN
Pressure (hPa)
Temperature (K)
100
200
300
400
500
600
700
800
900
1000
-3
-2
-1
0
1
2

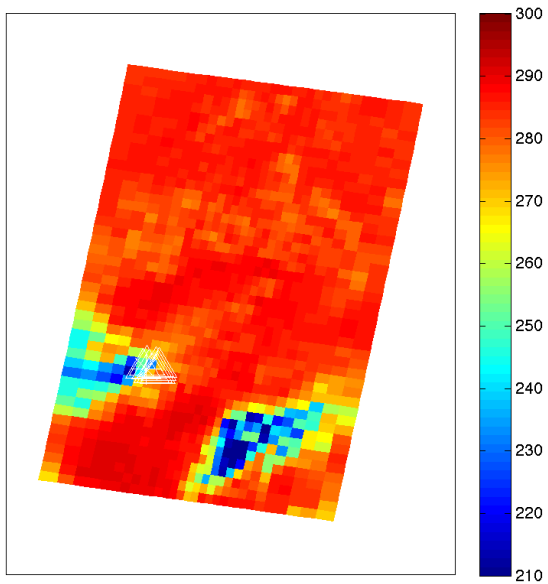

Water Vapor
V6
MODCC
Pressure (hPa)
g/kg
100
200
300
400
500
600
700
800
900
1000
0
5
10
15
20

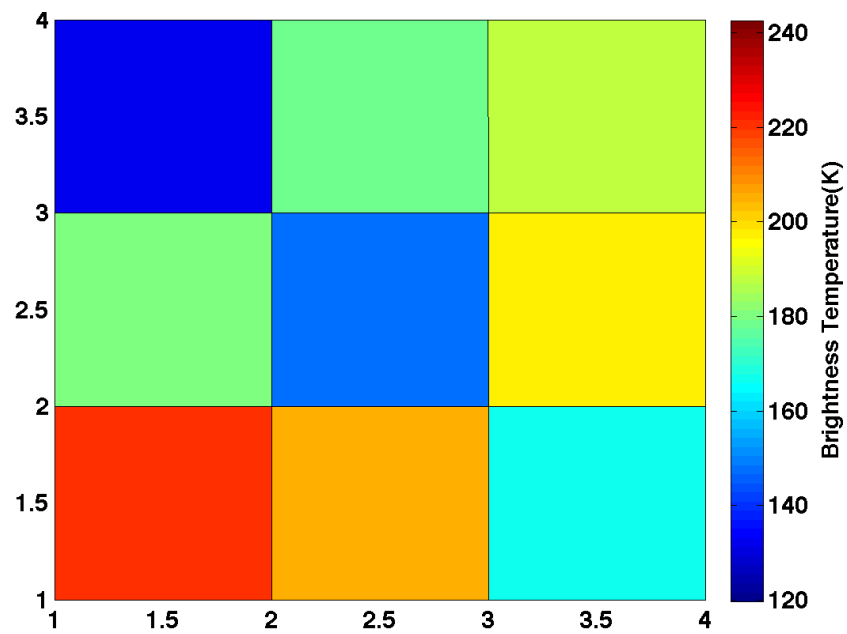
Case 8

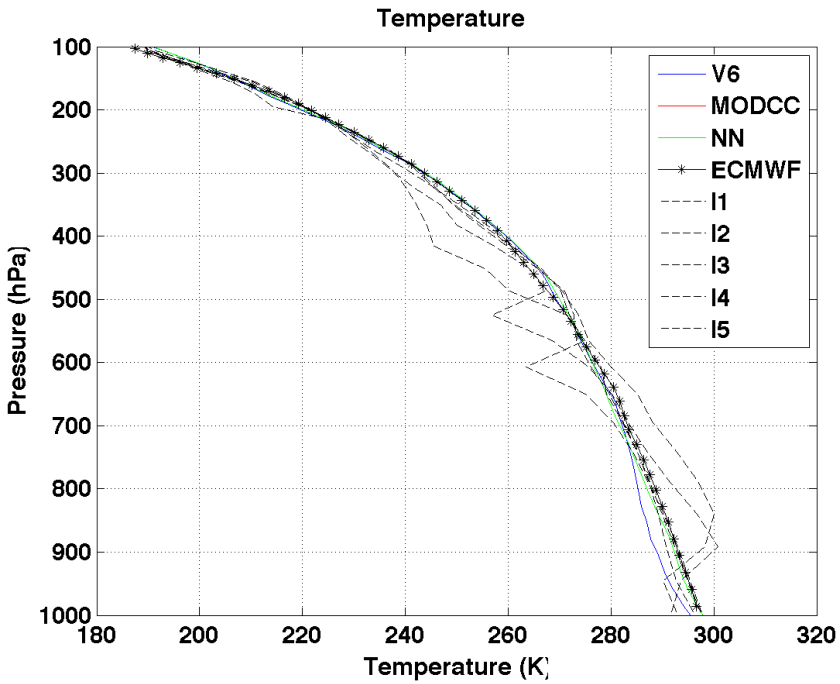
Statistics

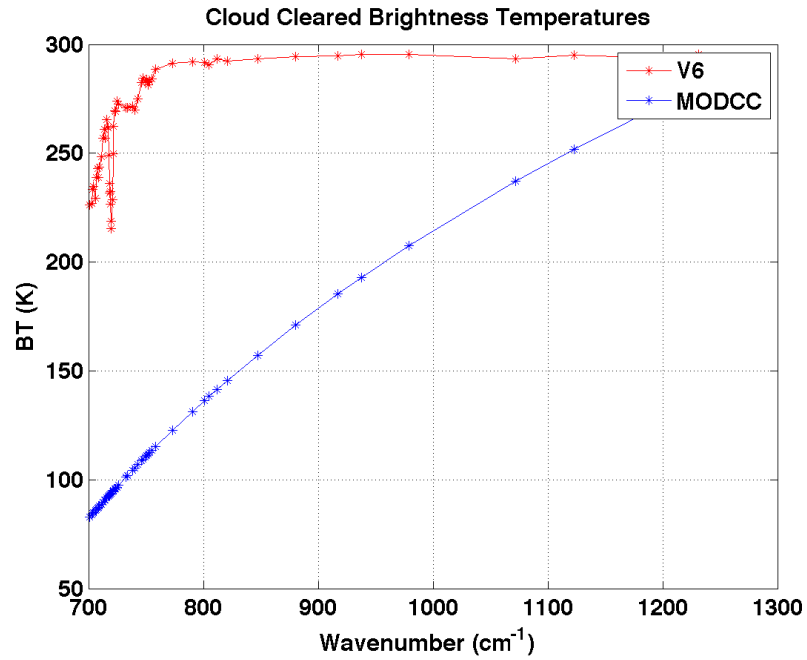
AIRS2MOD31 STD = 22.78 K
PGOOD = 852.8 hPa
MODCC = 1(fake success)
V6 Tsurf = 283.8 K
MODCC Tsurf = 300.2 K
ECMWF Tsurf = 301.2 K

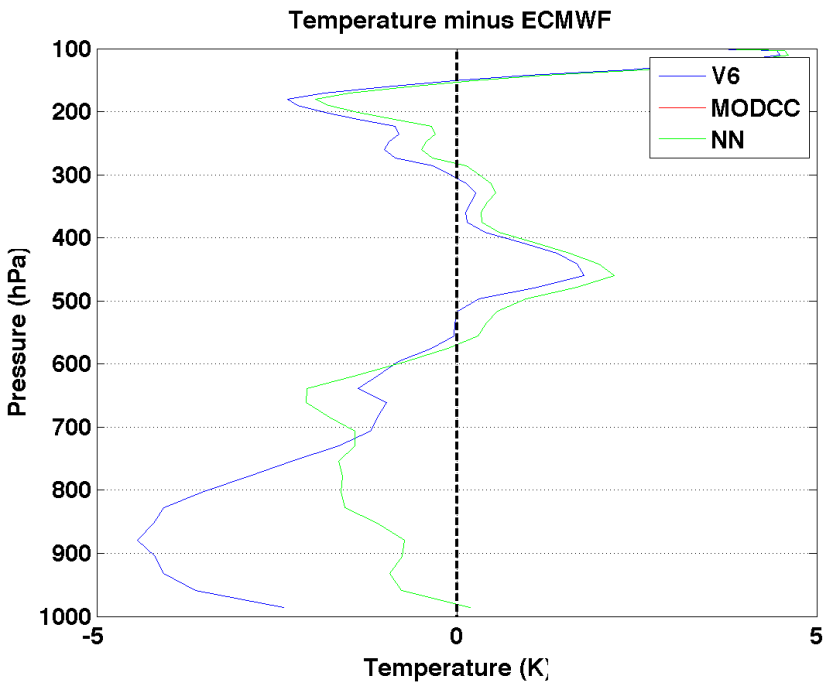


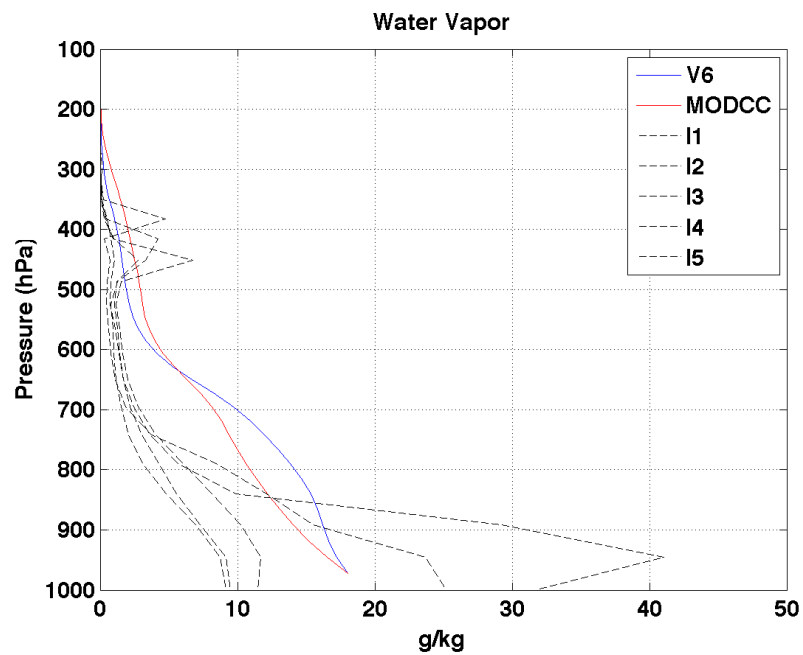





Temperature
Pressure (hPa)
Temperature (K)
V6
MODCC
NN
ECMWF
I1
I2
I3
I4
I5


Cloud Cleared Brightness Temperatures
BT (K)
Wavenumber (cm-1)
V6
MODCC


Temperature minus ECMWF
Pressure (hPa)
Temperature (K)
V6
MODCC
NN


Water Vapor
Pressure (hPa)
g/kg
V6
MODCC
I1
I2
I3
I4
I5

Observations From Study

- MODCC Showed improved skin measurements relative to ECMWF for low heterogeneity fields
- QC flag for MODCC Could be imroved
- V6 shows improved temperature retrievals and coverage relative to MODCC for overcast conditions
- Irion's single FOV retrieval shows ability in overcast low heterogeniety fields where both V6 and MODCC have little success