
Status of the MOD07 atmospheric profile algorithm

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MOD07 algorithm updates for Collection 6

- Update the radiative transfer model (pCRTM -> CRTM V1.2 -> V 2.0.2)
- Remove TPW bias adjustment in the final TPW product
- Apply H₂O/CO₂/O₃ channel spectral shifts
- Update NEDR for both Terra and Aqua
- Update surface emissivity spectra to the current version in the training database
- Make the Aqua and Terra DAAC code uniform
- Modify definition of TPW low and TPW high to enable calculation of 3 layer water vapor means. The new layers are: (Low) sfc-680 and (high) 440-Top (10hPa)
- Improve QA/QC flags & QA usefulness and fix Confidence flag bug
- Update output file: adding offset/scale factor usage, list of pressure levels, mixing ratio profile, fixing K-index valid range, changing surface temperature to skin temperature

Update the CRTM Forward Model

- **Versions:**

- prototypeCRTM (COL5 MOD07)
- CRTM V1.2/**V2.0.2** (pre-COL6 MOD07)

- **To be able to apply the H₂O/CO₂/O₃ band spectral shifts in the forward model calculation, the spectral and transmittance coefficients have to be recomputed by the CRTM Team.**

Acknowledgement for the CRTM Team for their very helpful collaboration

- The instrument specific spectral and transmittance coefficients are not supported for pCRTM & CRTM V1.2 anymore.
- **Bug fixed** only in V 2.0.2 regarding the MODIS SRFs (interpolation scheme, sensor order <-> product order)

- **CRMT V2.0.2 has two transmittance algorithms for gaseous absorption**

- ODAS (**O**ptical **D**epth in **A**bsorber **S**pace). – *not updated the last couple of years*
 - A “compact” version of the OPTRAN model.
 - H₂O, O₃ absorption only.
- **ODPS** (**O**ptical **D**epth in **P**ressure **S**pace).
 - Optical depths computed on a fixed pressure grid.
 - Better fitting statistics.
 - More trace gases: CO₂, CH₄, N₂O.
 - Enables incorporation of Zeeman model (requires fixed pressure grid).

The following SRF shifts were suggested by the earlier **AIRS**-MODIS comparison study (Tobin et al, 2006):

Applied in **CRTM V1.2**

Band	Aqua Shift (cm-1)
27	5
28	2
30	0
34	0.8
35	0.8
36	1

The following SRF shifts were suggested by the recent **IASI**-MODIS comparison study (Tobin, Moeller, Quinn):

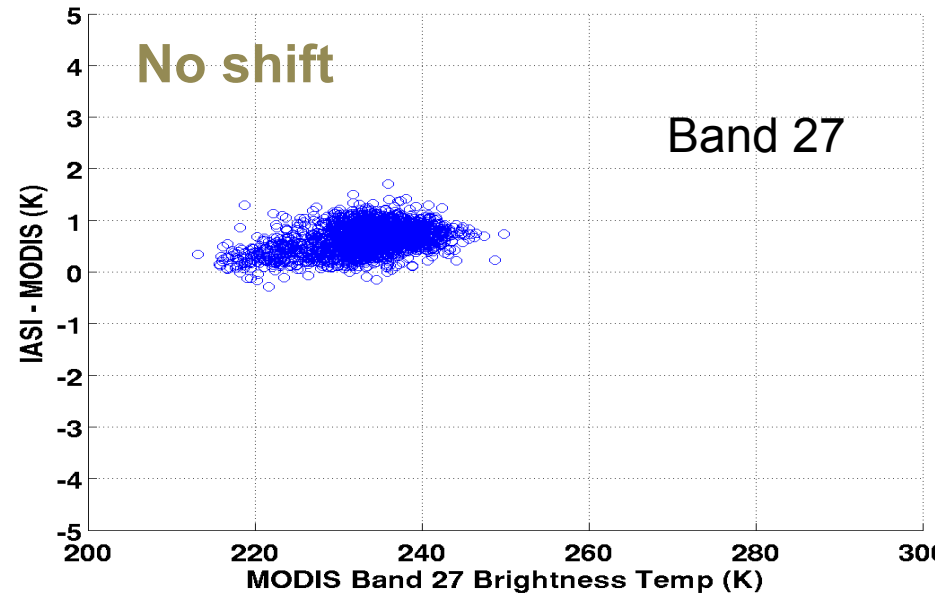
Applied in **CRTM V2.0.2** (ODAS and ODPS)

Band	Terra Shift (cm-1)	Aqua Shift (cm-1)
27	4	5->4
28	2	2->0
30	1	0
34	0.8	0.8
35	0.8	0.8
36	1	1

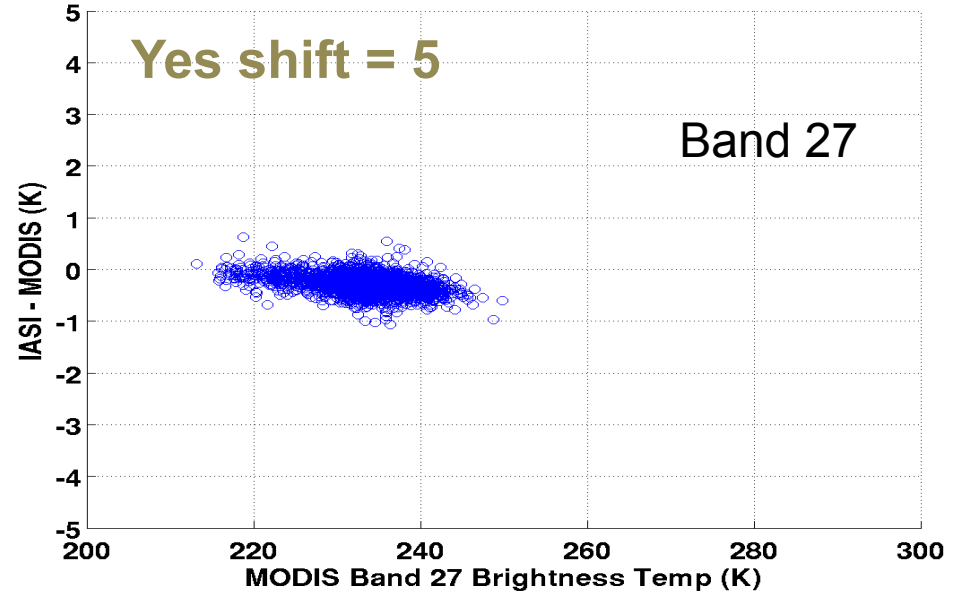
SRF Investigation using IASI – MODIS BT Comparison for 2009

by C. Moeller, G. Quinn and D. Tobin **AQUA/MODIS Band 27&28**

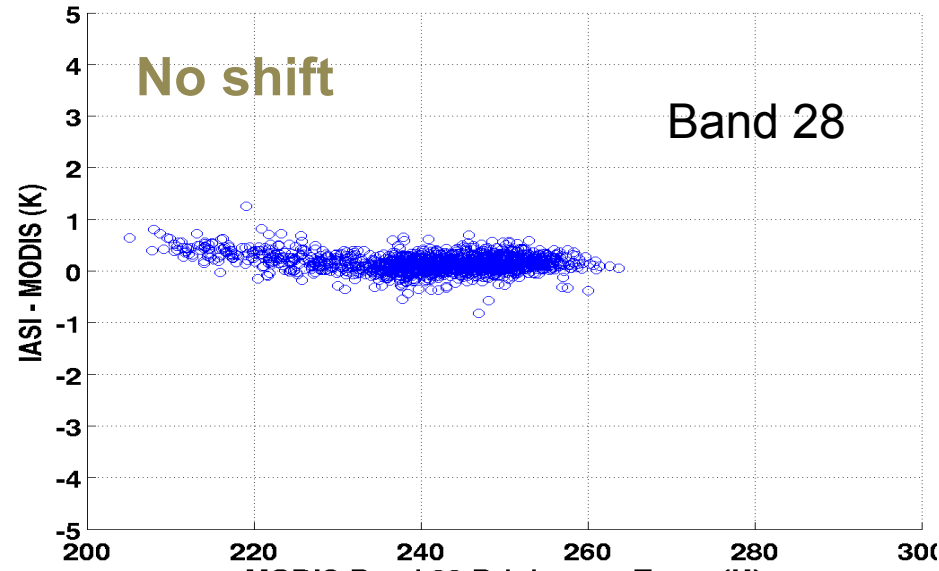
2009 SNOs: IASI - Aqua MODIS Band 27 Det 5 MS 1 A0=0 No Shi



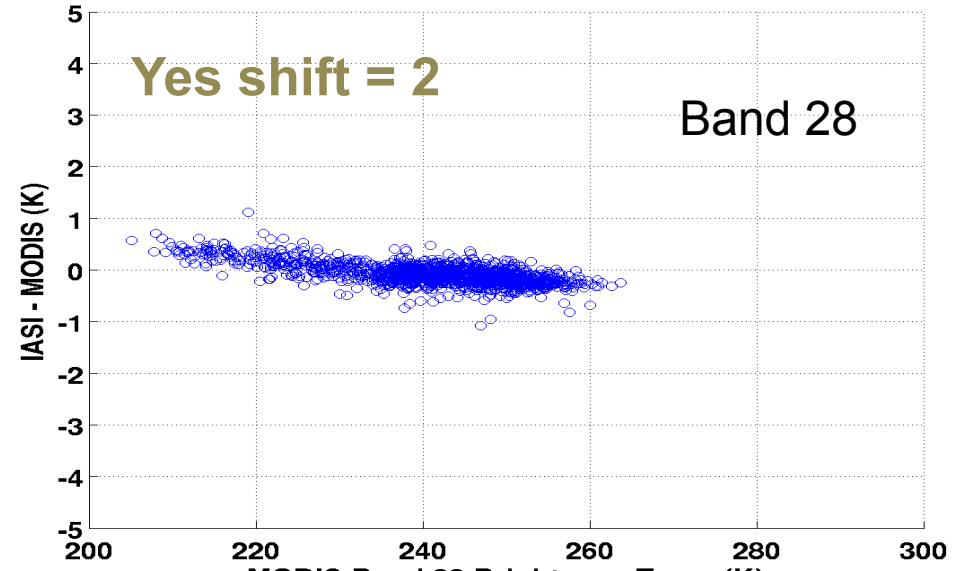
2009 SNOs: IASI - Aqua MODIS Band 27 Det 5 MS 1 A0=0 Shift2



2009 SNOs: IASI - Aqua MODIS Band 28 Det 5 MS 1 A0=0 No Shi



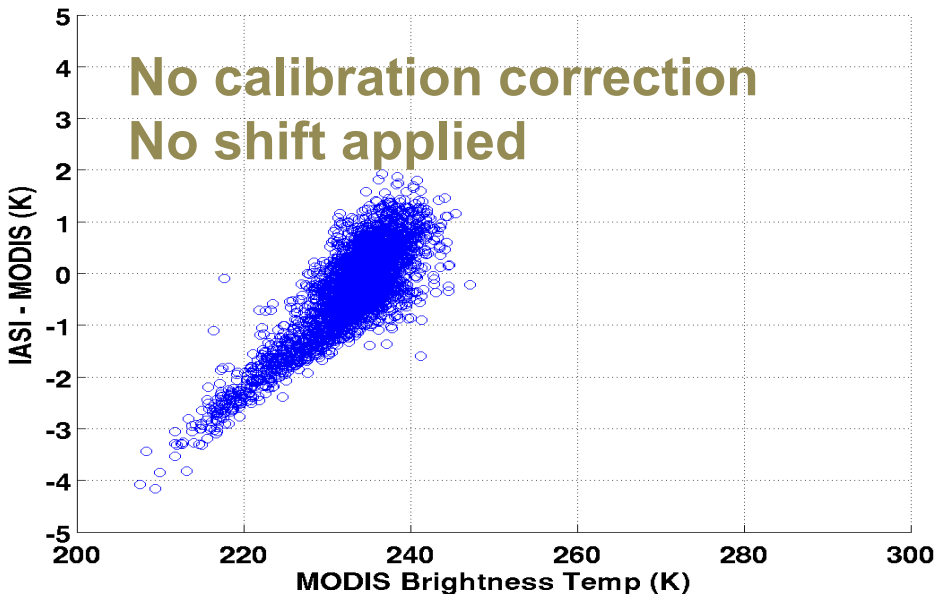
2009 SNOs: IASI - Aqua MODIS Band 28 Det 5 MS 1 A0=0 Shift2



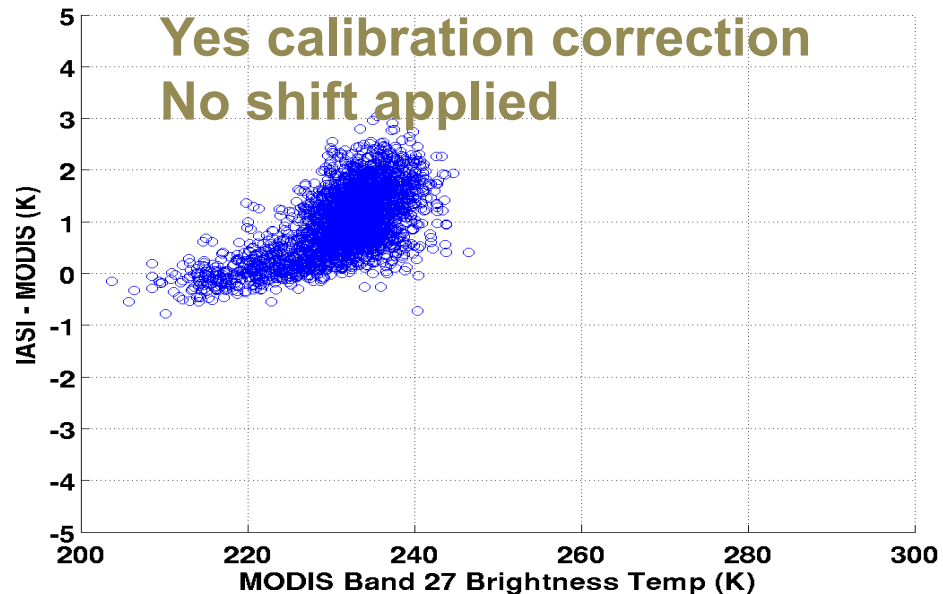
SRF Investigation using IASI – MODIS BT Comparison for 2009

by C. Moeller, G. Quinn and D. Tobin **Terra/MODIS/Band 27**

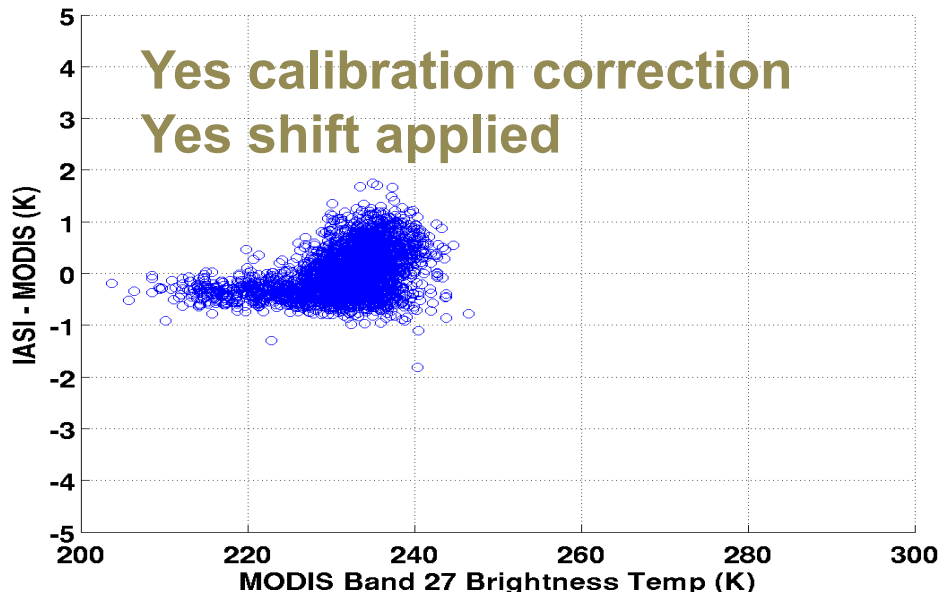
2009 SNOs: IASI - Terra MODIS Band 27 Det 5 MS 1



2009 SNOs: IASI - Terra MODIS Band 27 Det 5 MS 1 A0=0 No Shift



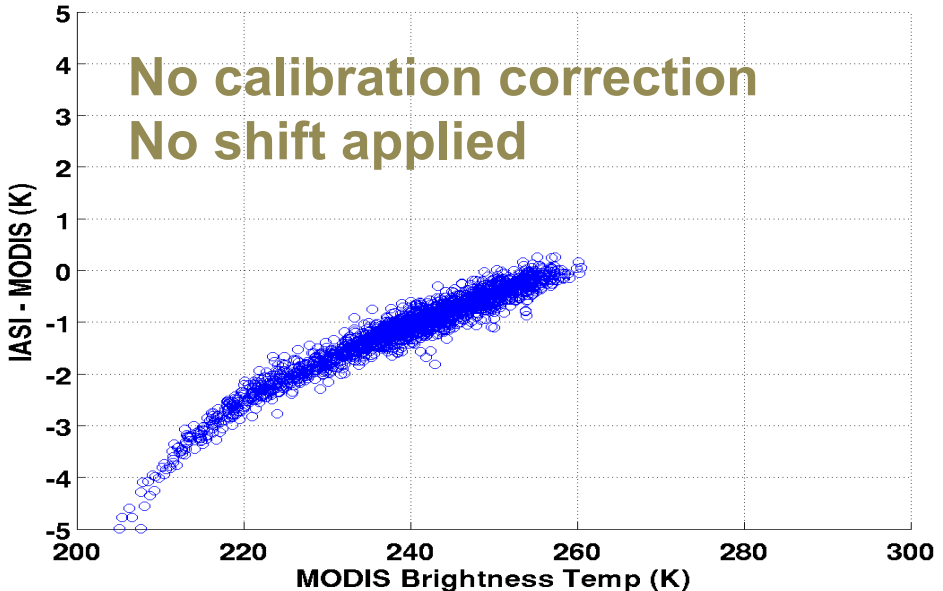
2009 SNOs: IASI - Terra MODIS Band 27 Det 5 MS 1 A0=0 Shift2



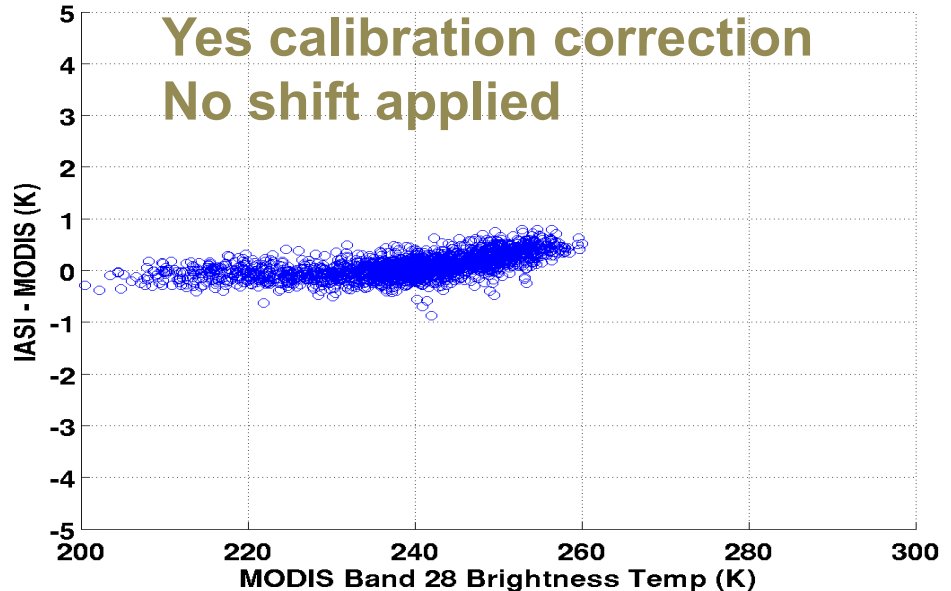
SRF Investigation using IASI – MODIS BT Comparison for 2009

by C. Moeller, G. Quinn and D. Tobin **Terra/MODIS/Band 28**

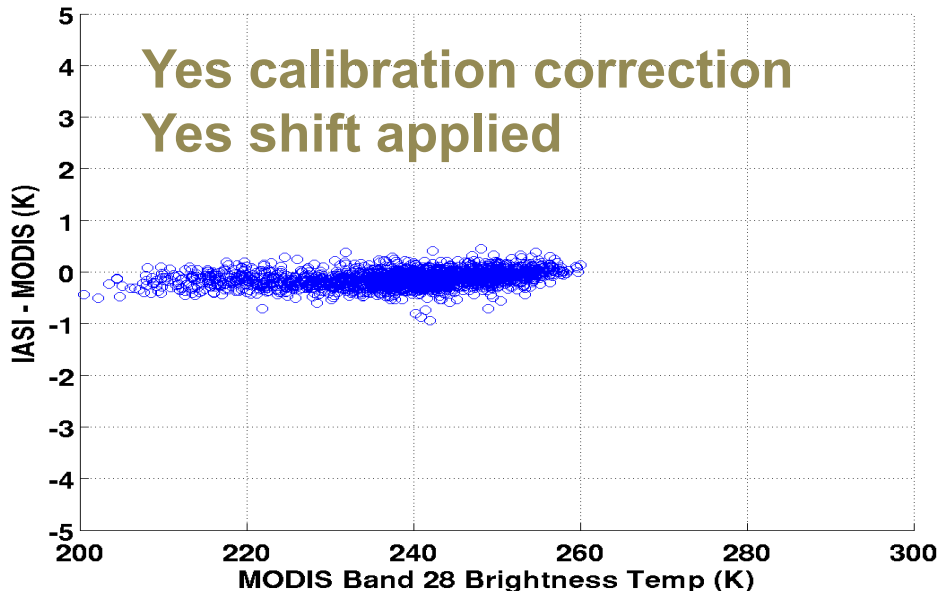
2009 SNOs: IASI - Terra MODIS Band 28 Det 5 MS 1



2009 SNOs: IASI - Terra MODIS Band 28 Det 5 MS 1 A0=0 No Shift



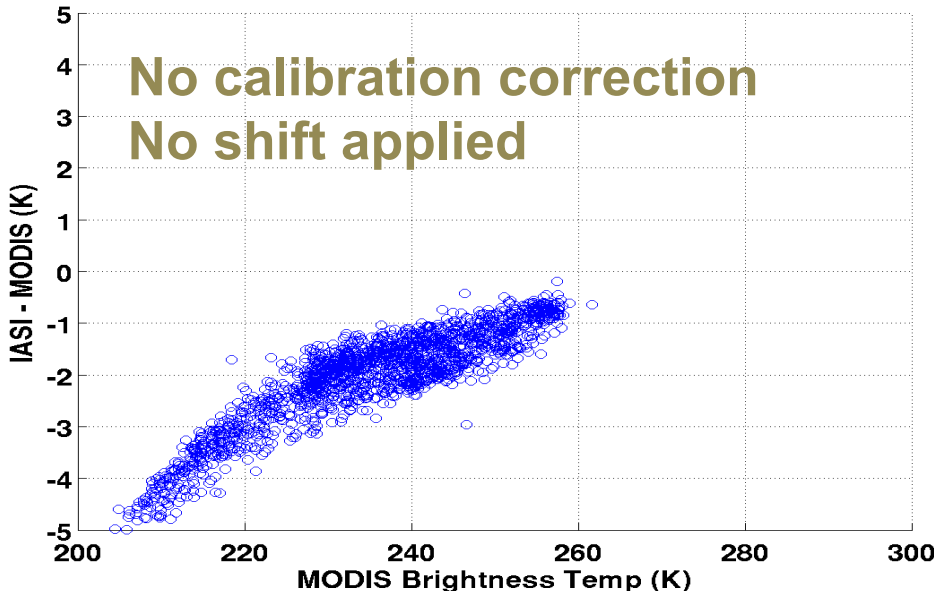
2009 SNOs: IASI - Terra MODIS Band 28 Det 5 MS 1 A0=0 Shift2



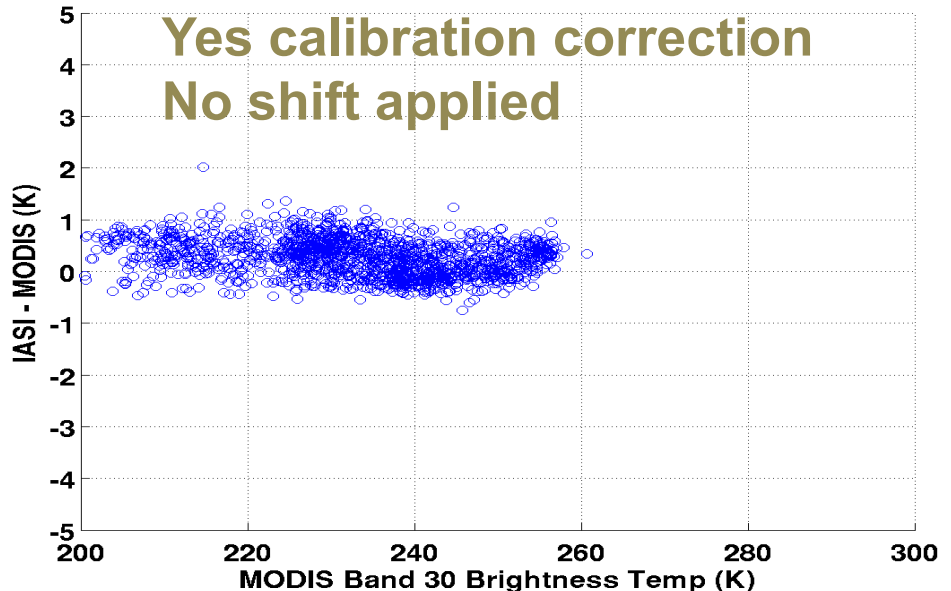
SRF Investigation using IASI – MODIS BT Comparison for 2009

by C. Moeller, G. Quinn and D. Tobin **Terra/MODIS/Band 30**

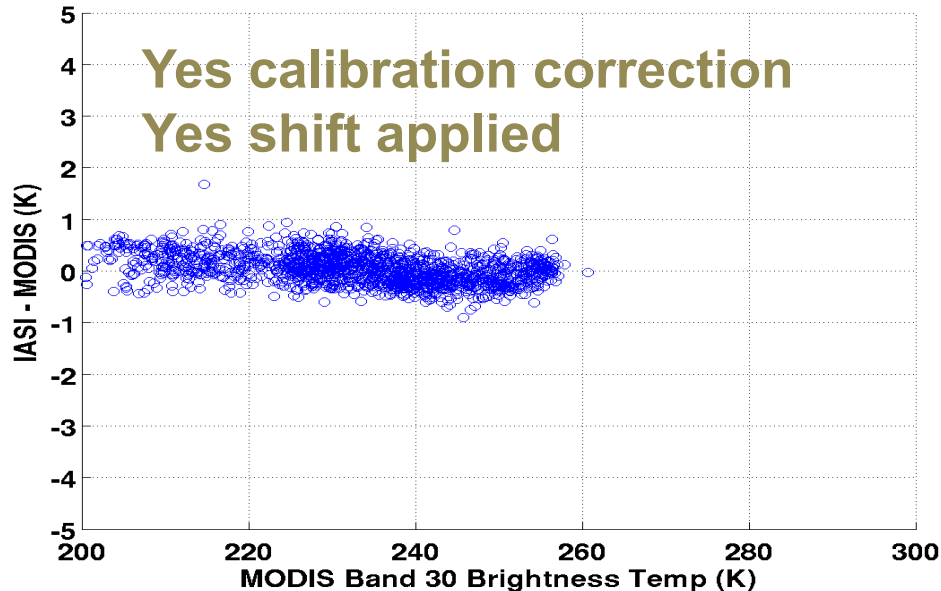
2009 SNOs: IASI - Terra MODIS Band 30 Det 4 MS 1



2009 SNOs: IASI - Terra MODIS Band 30 Det 4 MS 1 A0=0 No Shift



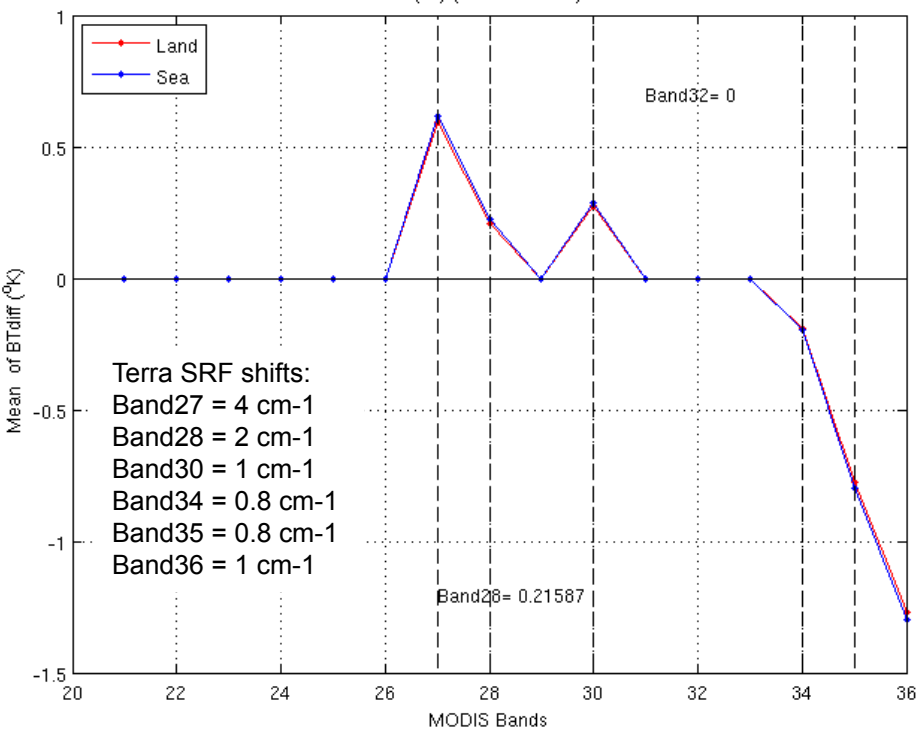
2009 SNOs: IASI - Terra MODIS Band 30 Det 4 MS 1 A0=0 Shift2



Mean of BT differences (using original – shifted SRFs) of MODIS IR bands for 15704 clear sky training profiles (SeeBor V 5.1) calculated by CRTM 2.0.2 (ODPS)

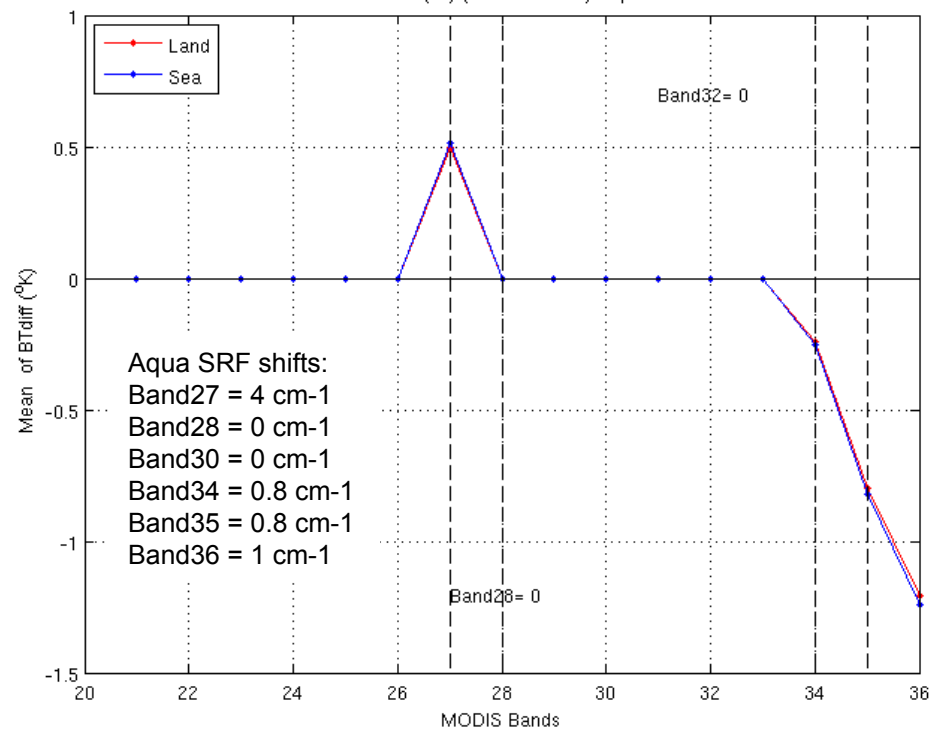
Terra

Mean of BTdiff (°K) (no shift - shift) terra ODPS



Aqua

Mean of BTdiff (°K) (no shift - shift) aqua ODPS



Local and global TOZ and TPW

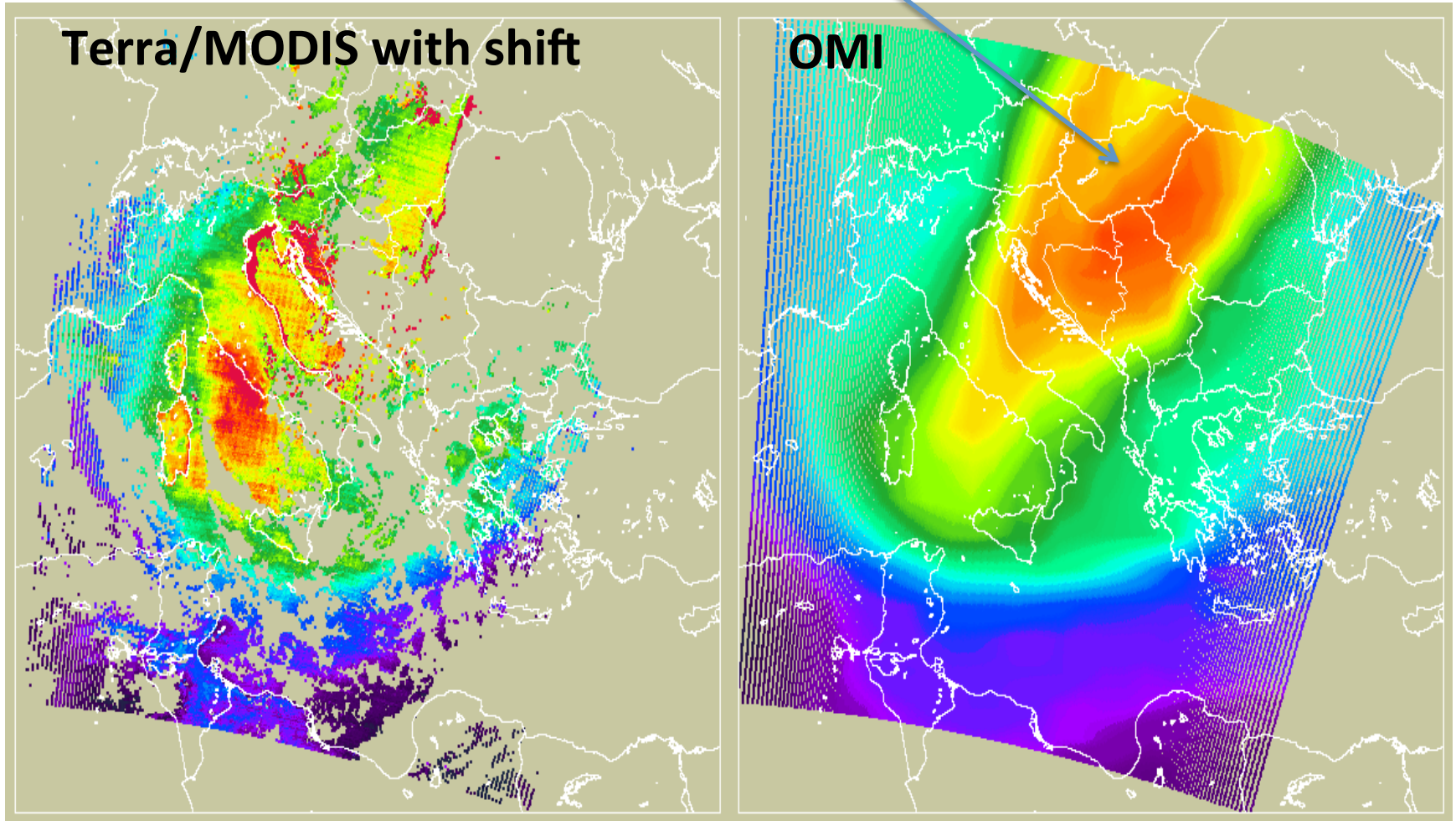
Test runs:

- Col5 (pCRTM)
- CRTM V1.2 no shifts
- CRTM V1.2 with shifts (for Aqua only) – Col6 Aqua
- CRTM V2.0.2 /ODAS / no shifts
- CRTM V2.0.2 /ODAS / with shifts
- CRTM V2.0.2 /ODPS / no shifts
- CRTM V2.0.2 /ODPS /with shifts

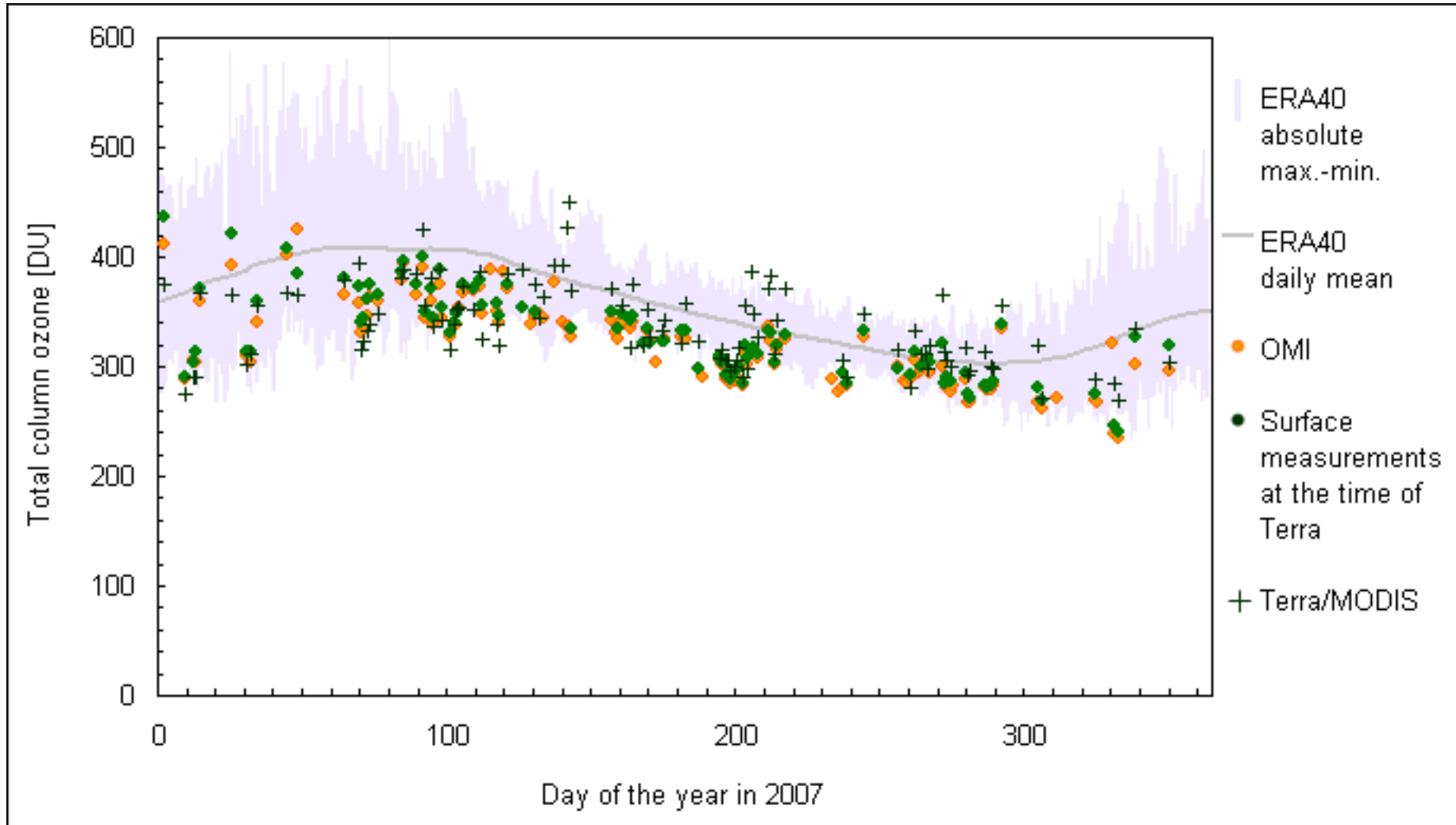
MOD07 TOZ comparison with ground-based Brewer Spectrophotometer measurements and TOMS/OMI data over Budapest, HU during 2007



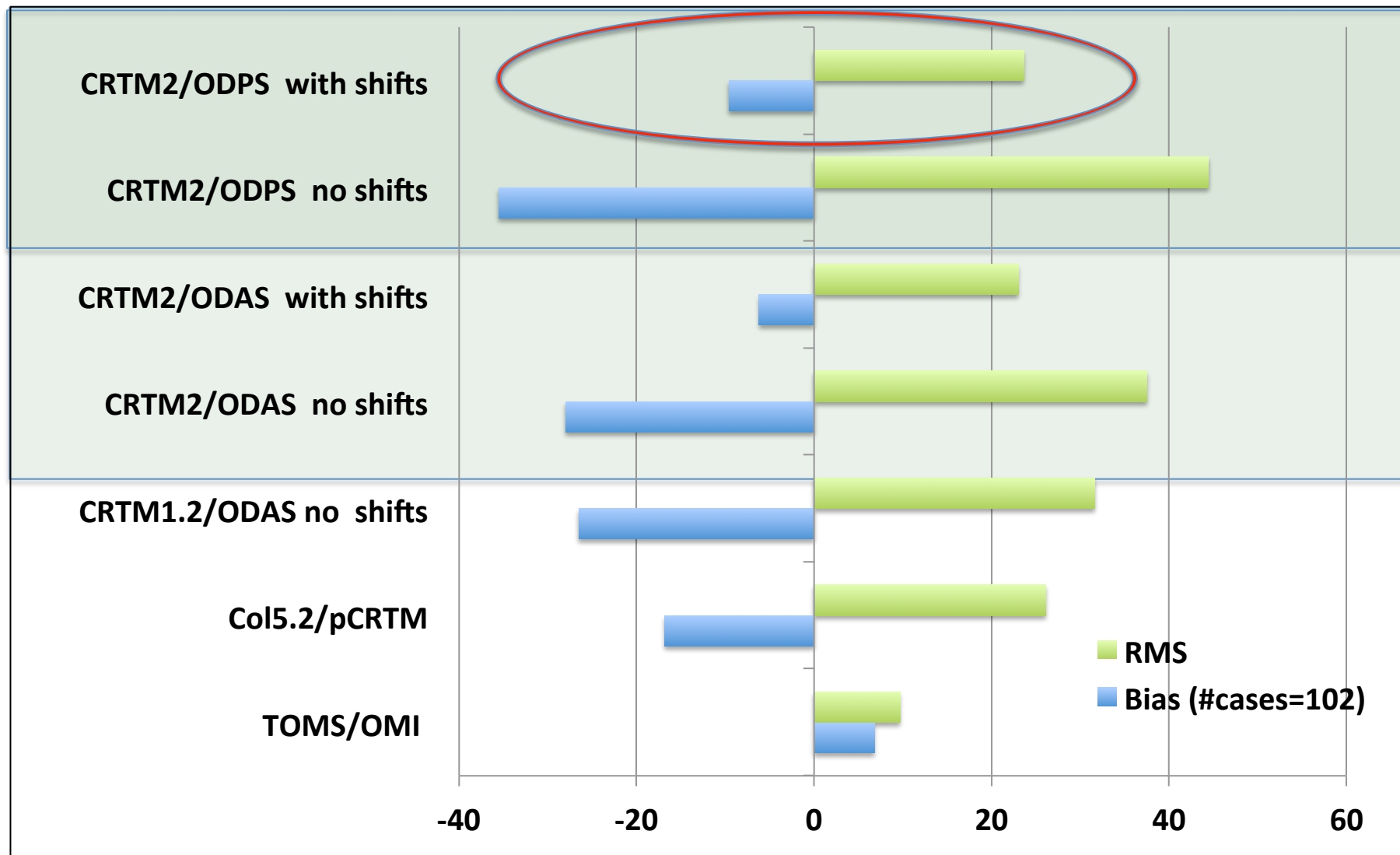
April 14 2007 at 09:50 UTC



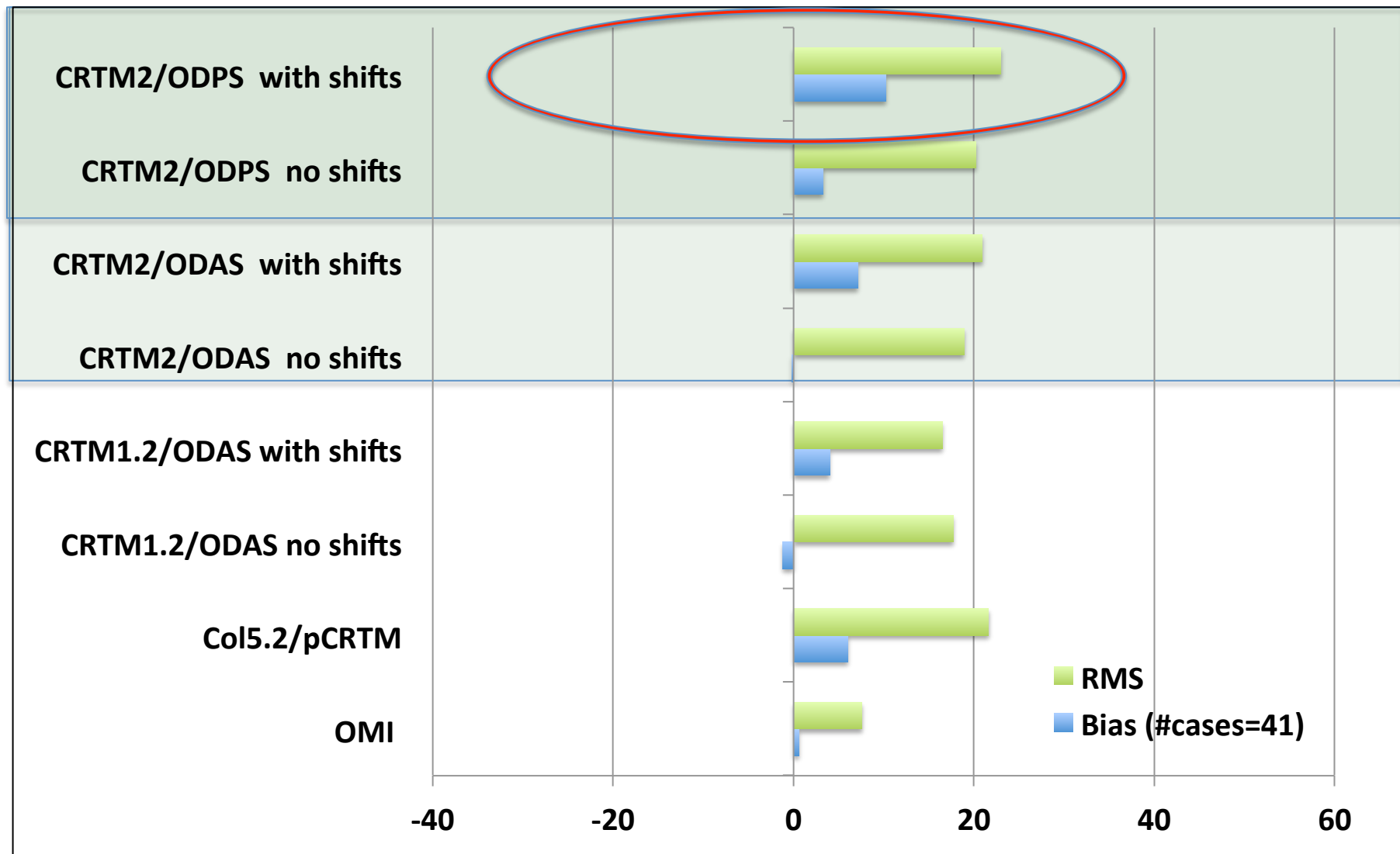
Time series of Total Ozone observations for the year 2007 over Budapest, Hungary.



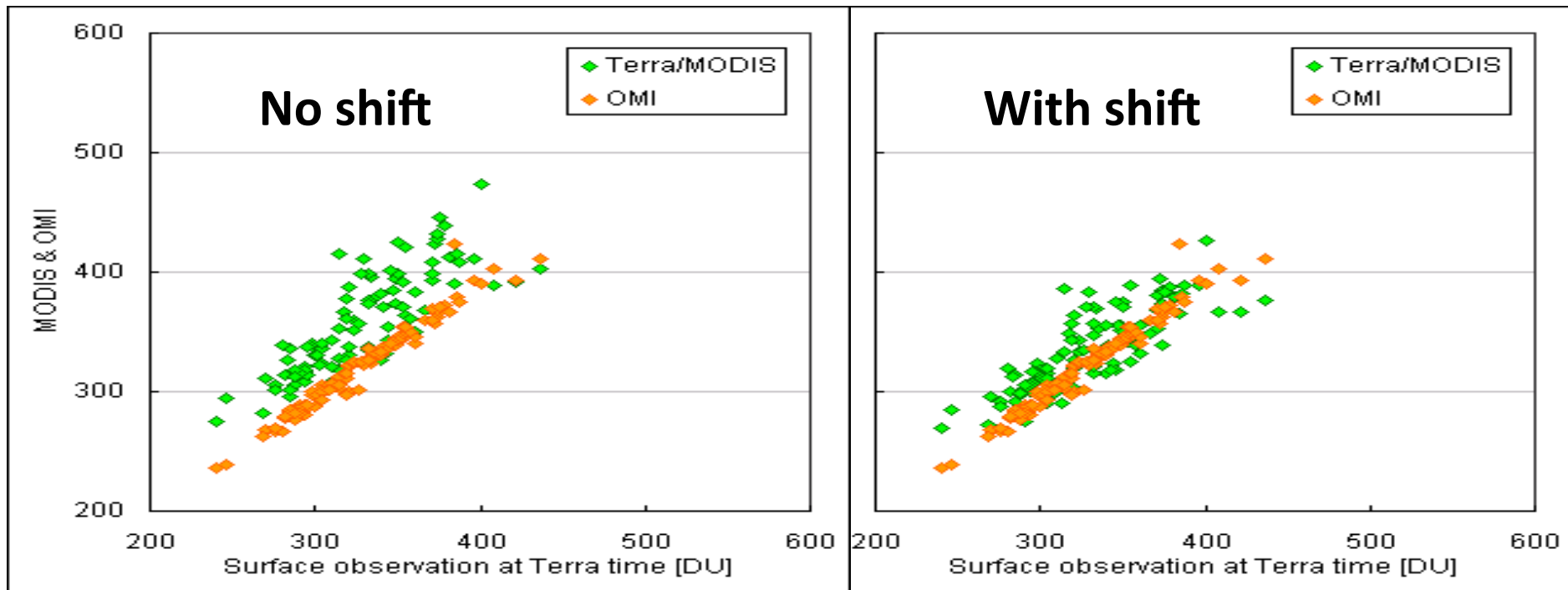
The impact of the Terra H2O/CO2/O3 channel spectral shifts on MOD07 TOZ over Budapest, HU: Comparison with ground-based Brewer Spectrophotometer measurements



The impact of the Aqua H2O/CO2 channel spectral shifts on MOD07 TOZ over Budapest, HU: Comparison with ground-based Brewer Spectrophotometer measurements



Scatter plot of Terra/MODIS and OMI Total Ozone vs. ground-based Brewer Measurements for 2007 at Budapest, Hungary

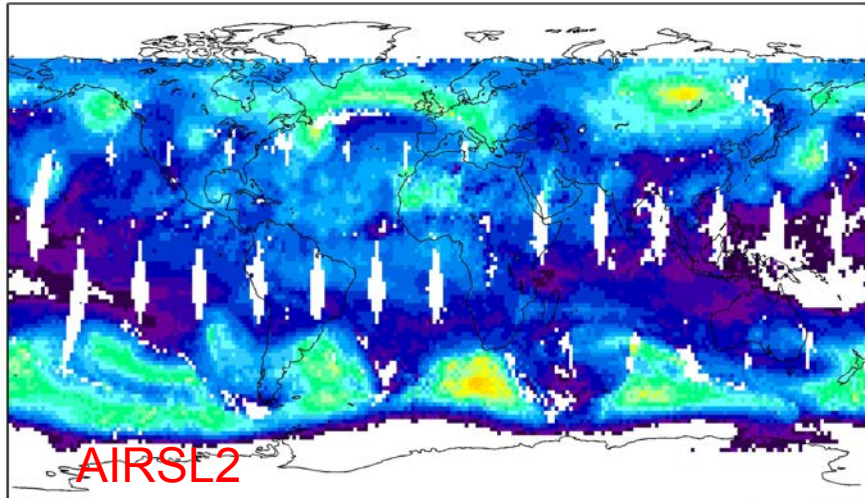


Global comparison:

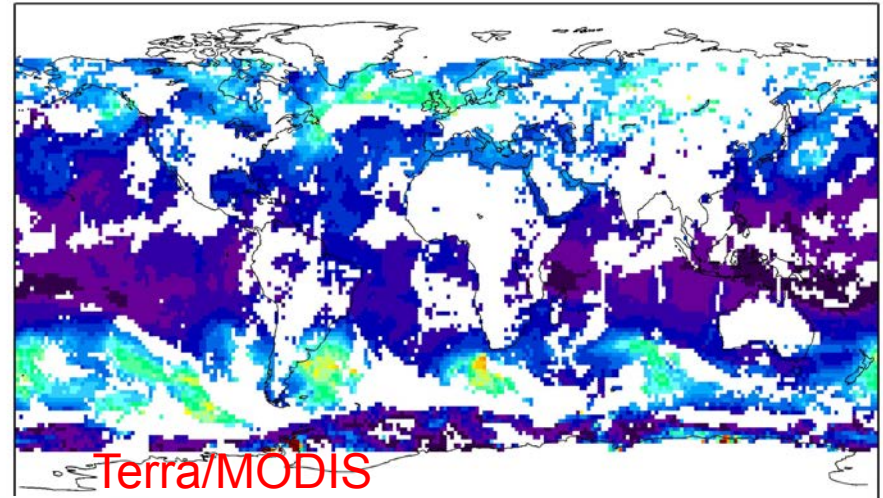
talk: A general space-time gridding tool etc... by Nadia Smith

Global TOZ Comparison on August 28, 2006

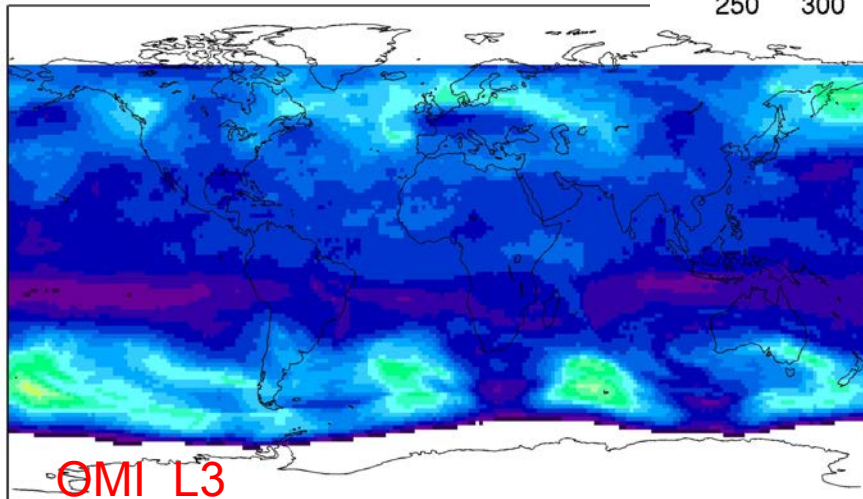
2006240: aqua/AIRS Level 2 oz



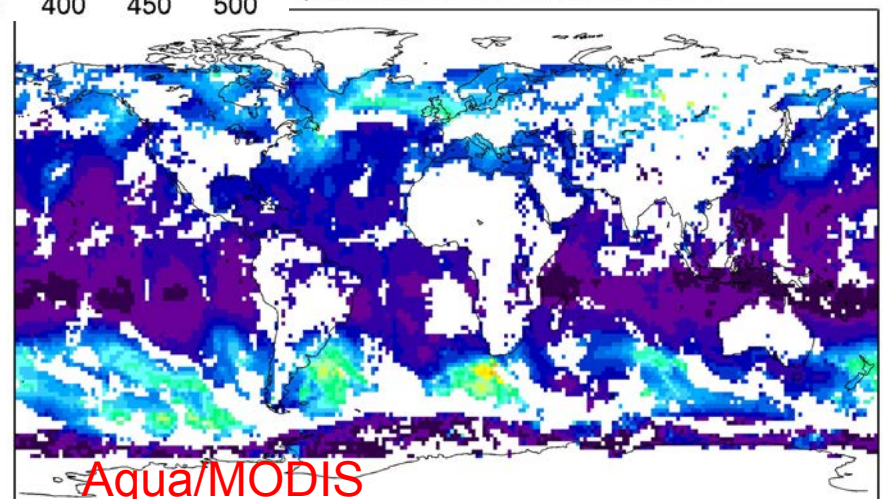
2006240 terr/MODIS COL6 w shifts ODPS oz



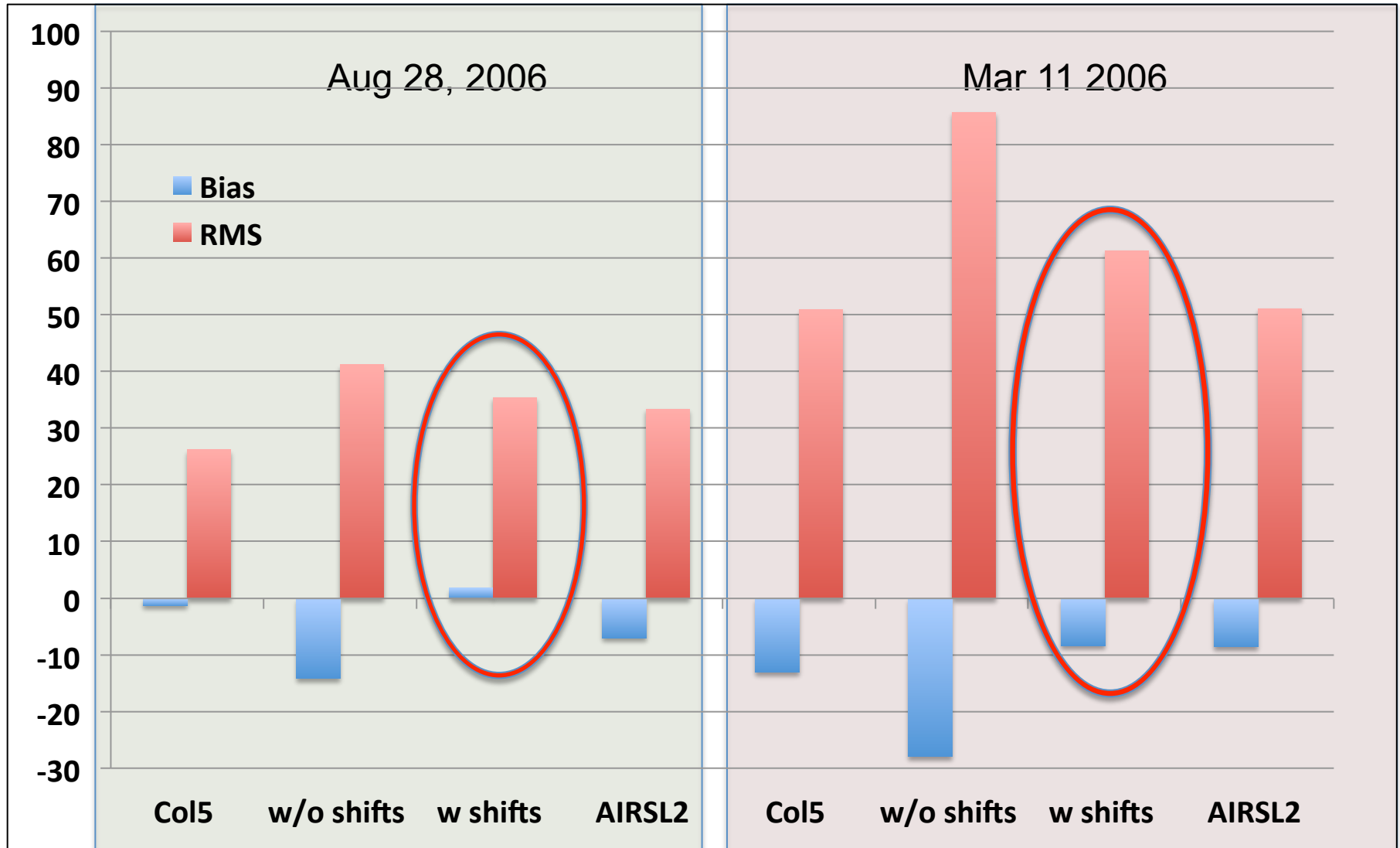
2006240: OMI L3 oz



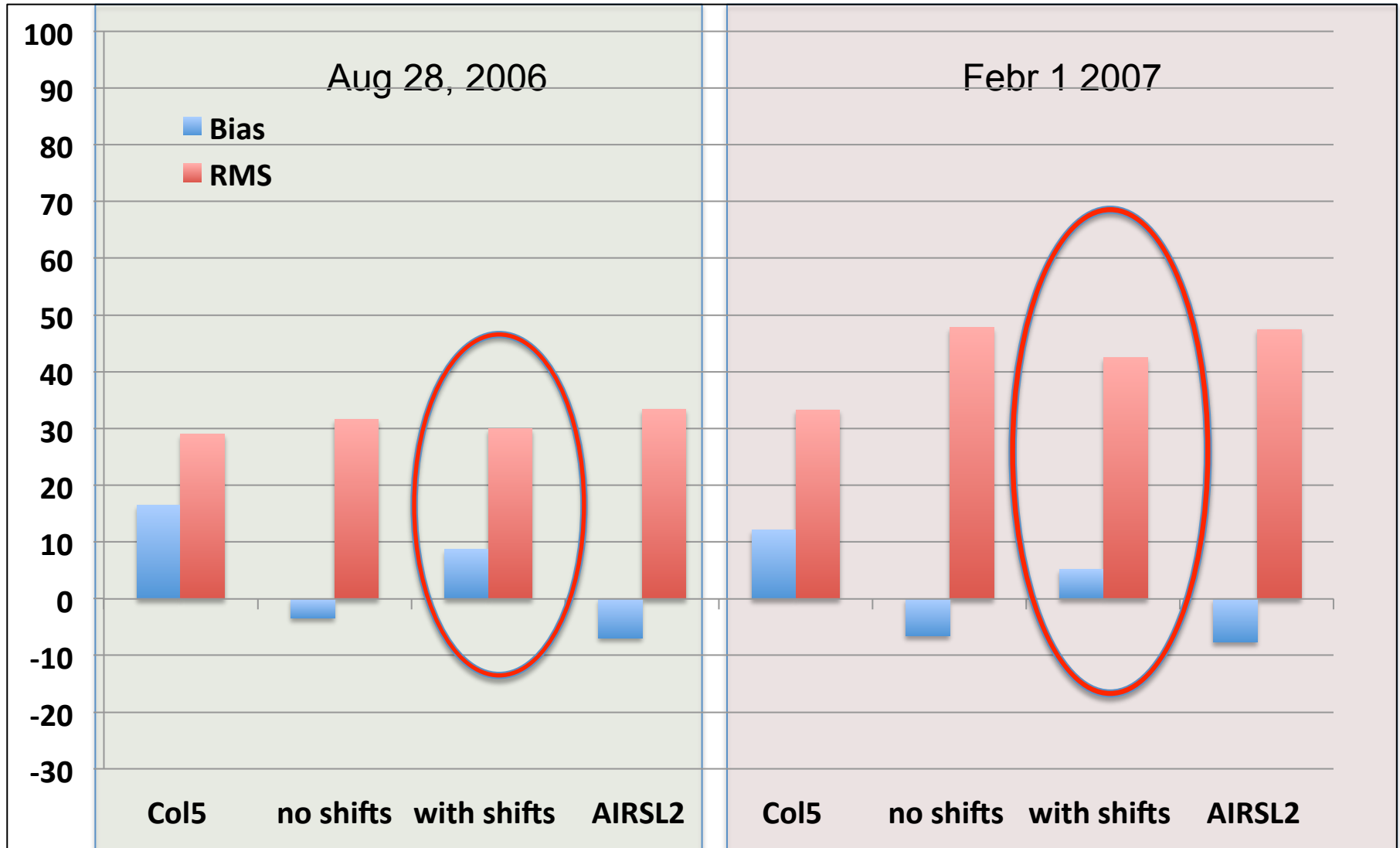
2006240: aqua/MODIS COL6 w shifts ODPS oz



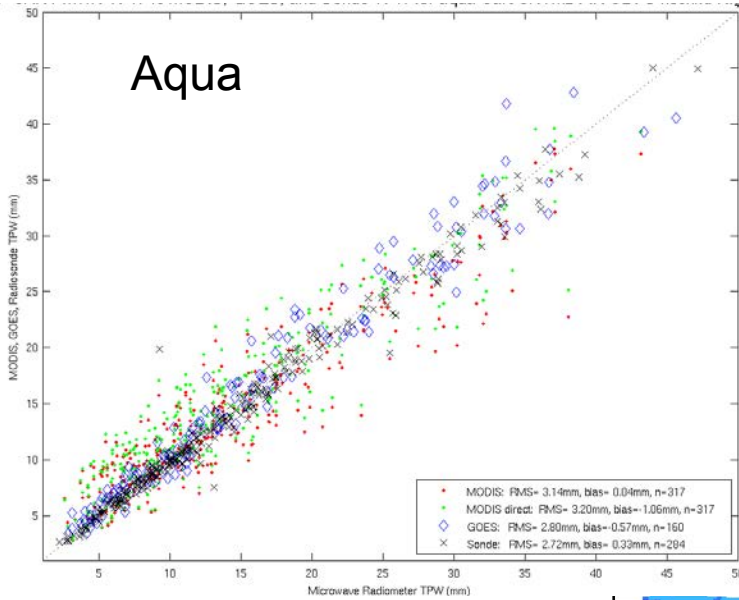
Globally gridded TOZ [DU] comparison of Terra/MODIS and AIRS with OMI (1.5 x 1.5 degree grid)



Globally gridded TOZ [DU] comparison of Aqua/MODIS and AIRS with OMI (1.5 x 1.5 degree grid)



TPW comparison with ground-based observations at the SGP CART site

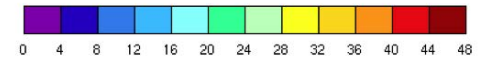
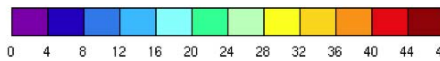
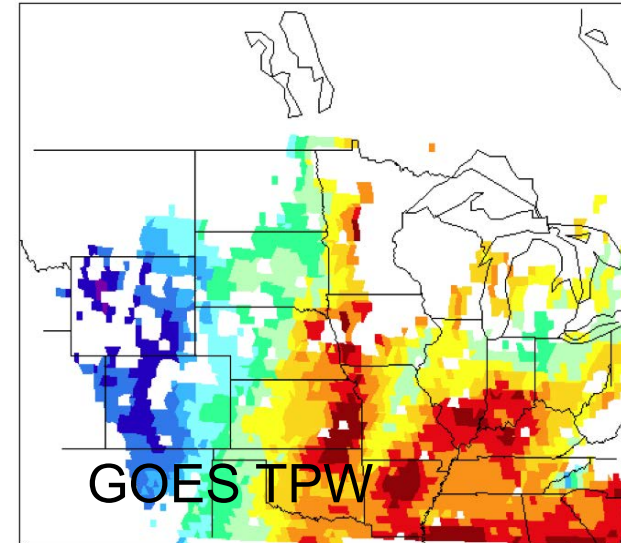
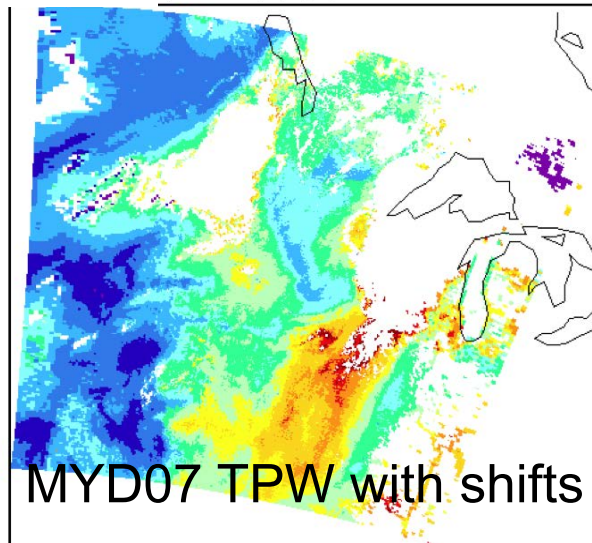


Comparison of total precipitable water (mm) at the ARM SGP site from MODIS (red), GOES-8 and -12 (blue), and radiosonde (black), with the ground-based ARM SGP microwave radiometer for 317 clear sky Aqua cases and 345 Terra cases from 4/2001 to 8/2005.

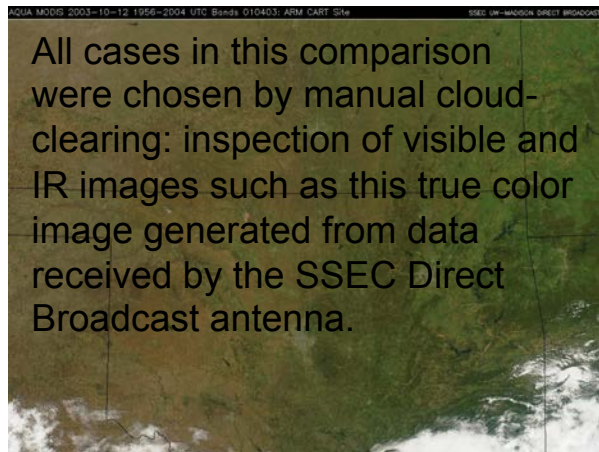
TPW field at July 3, 2003 at 0800 UTC

scipitable Water Vapor (mm) : AquaMODIS 03Jul03 JD 184 0835 UTC

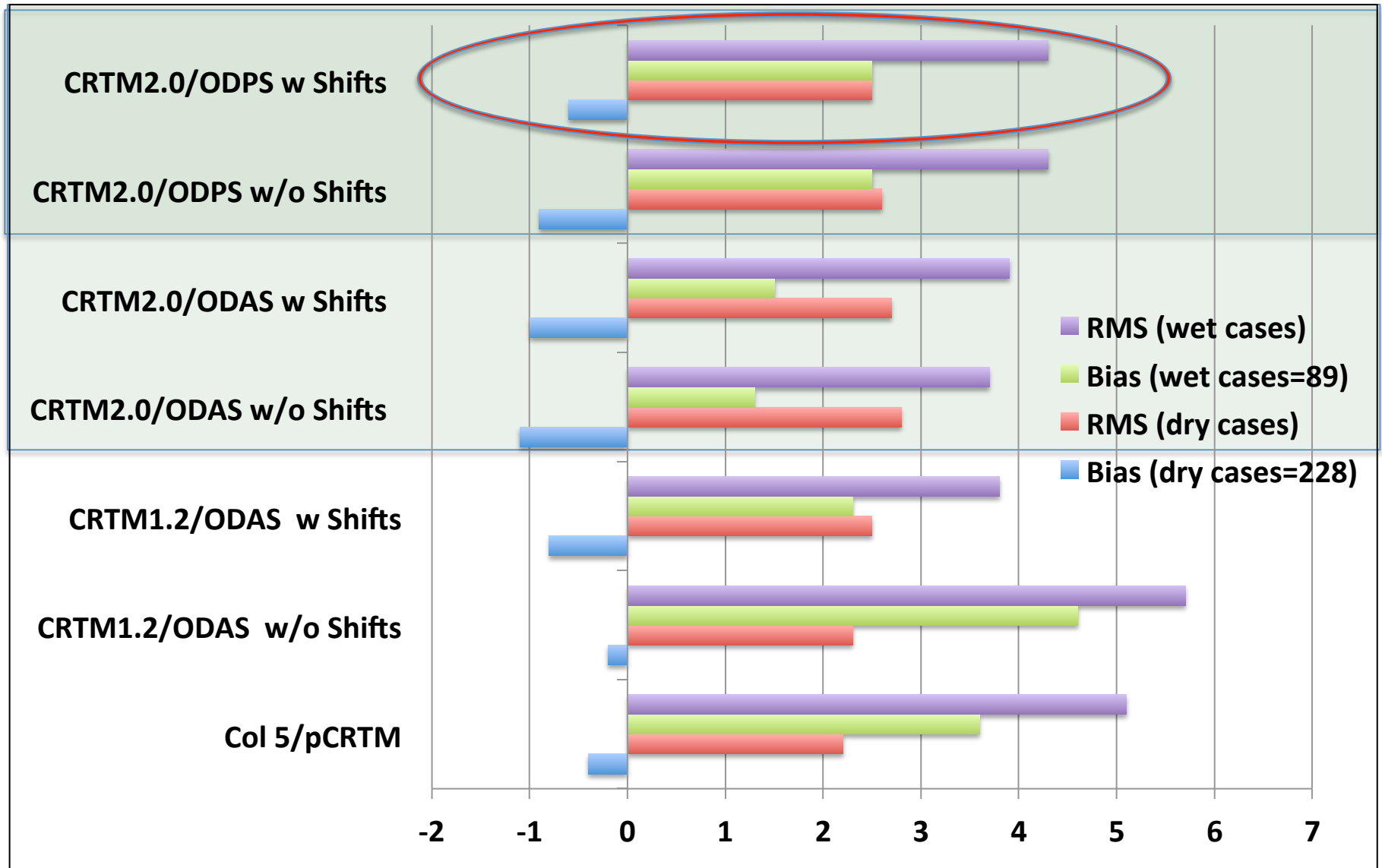
GOES Total Precipitable Water (mm) : GOES-12 03Jul03 JD 184 08 UTC



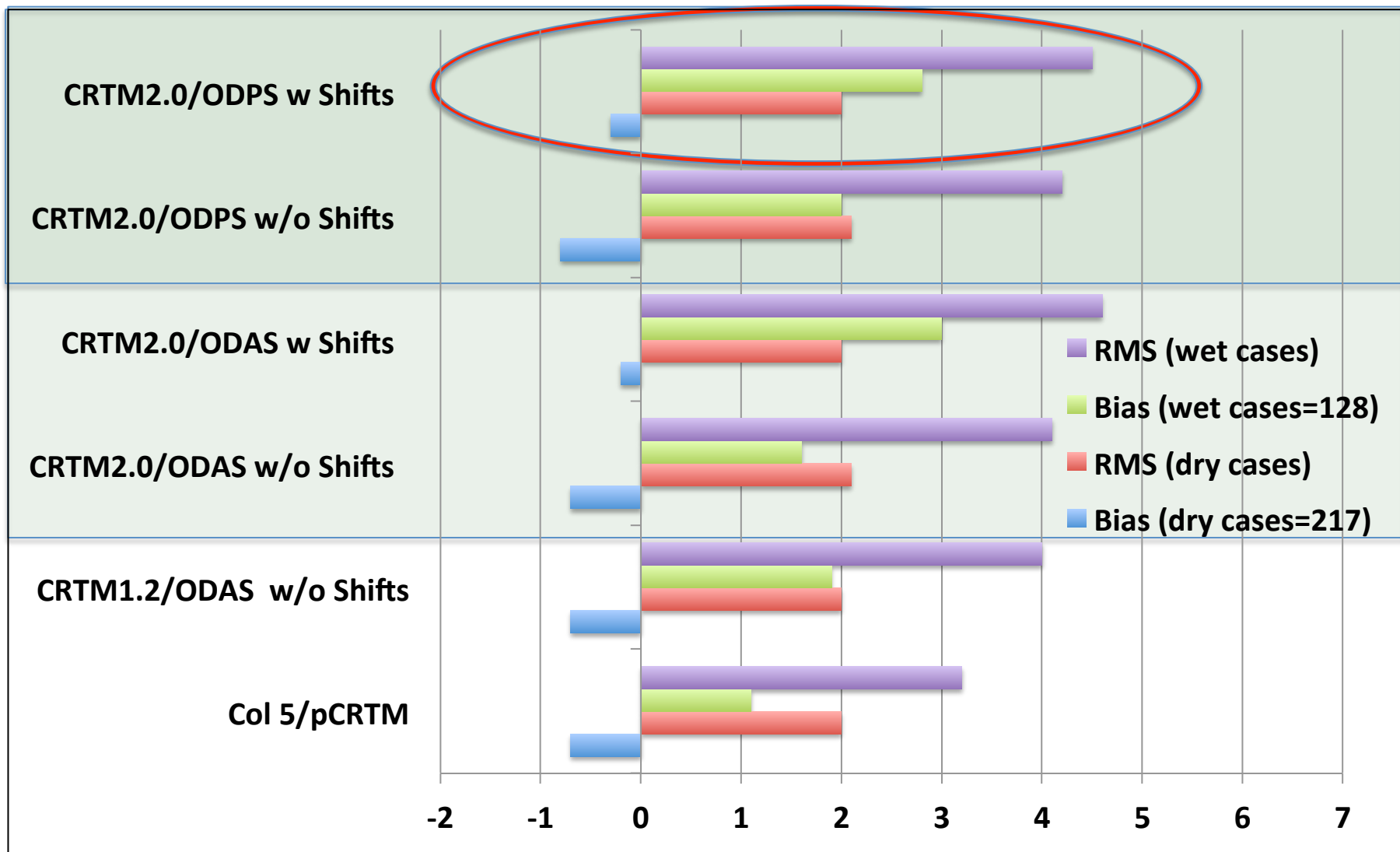
All cases in this comparison were chosen by manual cloud-clearing: inspection of visible and IR images such as this true color image generated from data received by the SSEC Direct Broadcast antenna.



The impact of the Aqua H₂O/CO₂ channel spectral shifts on the MYD07 TPW over the SGP Cart site Comparison to MWR (MWR – MYD07)



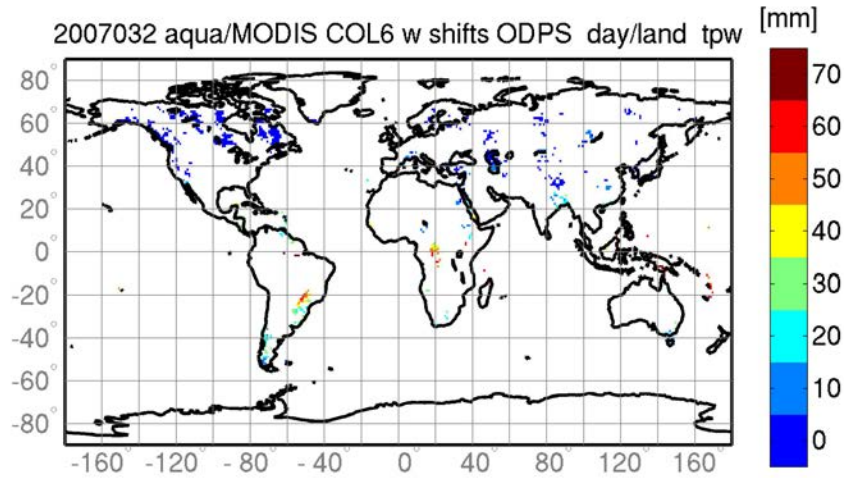
The impact of the Terra H2O/CO2/O3 channel spectral shifts on the M)D07 TPW over the SGP Cart site Comparison to MWR (MWR – MOD07)



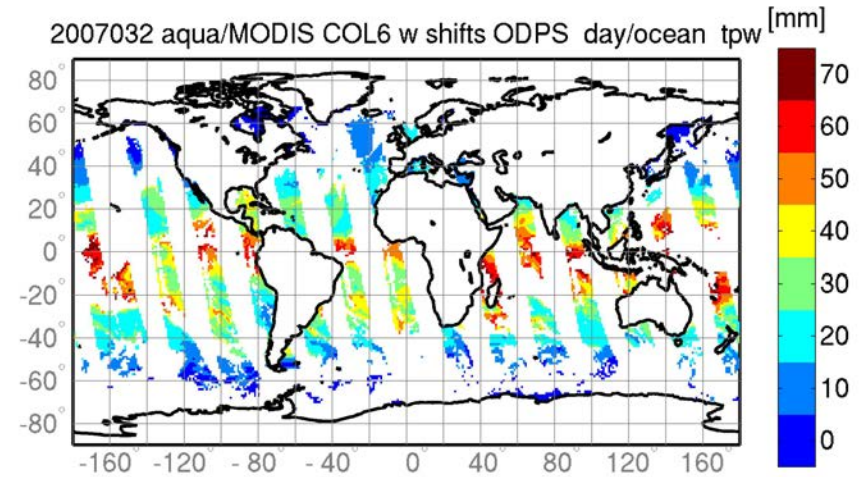
Global clear-sky TPW retrievals on 1 December 2004.

Results resampled and averaged to a $1^\circ \times 1^\circ$ latitude-longitude grid.

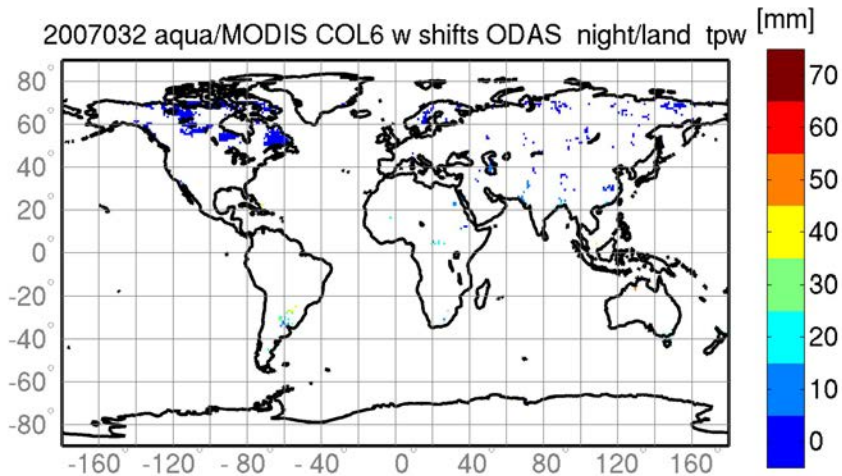
Daytime/Land



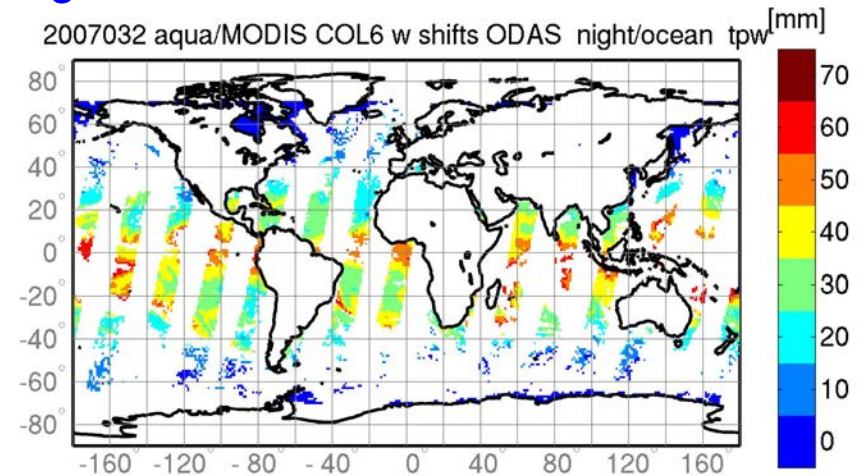
Daytime/Ocean



Nighttime/Land



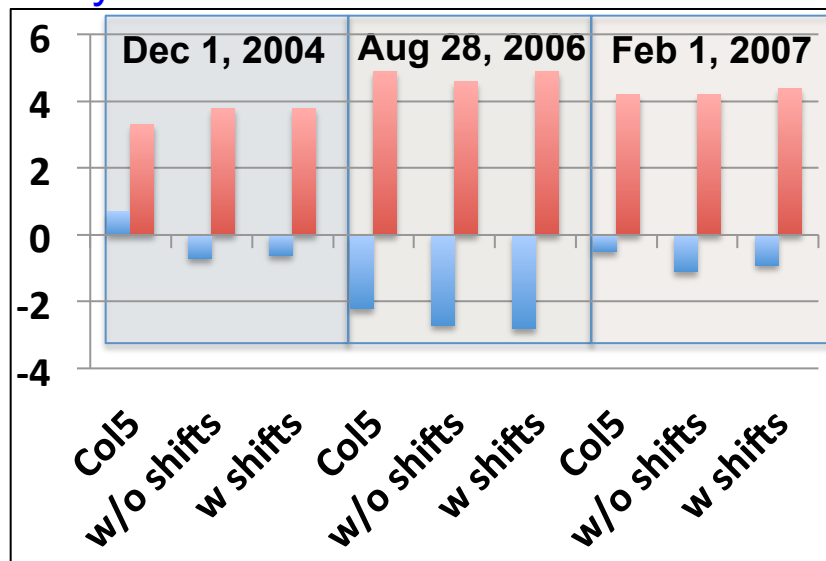
Nighttime/Ocean



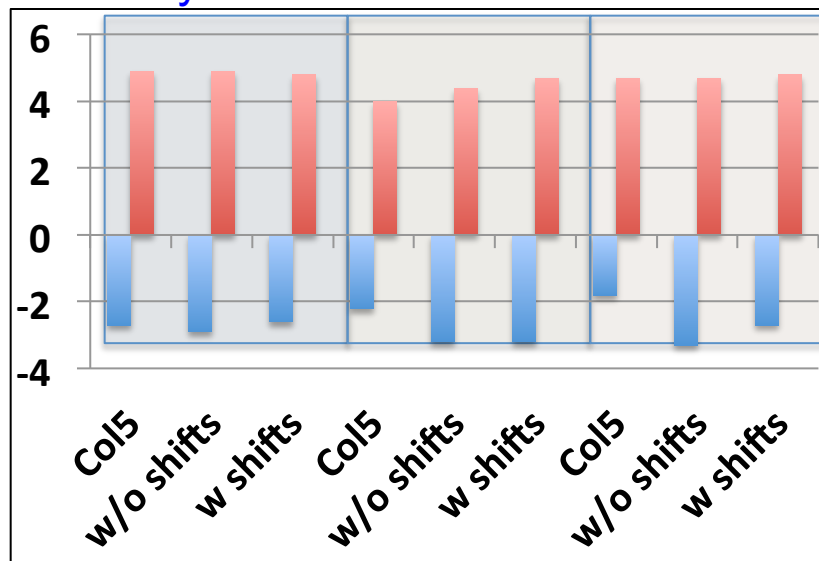
Globally gridded **TPW** comparison of MODIS with AIRS

(MODIS min(obs) = 10 angle (viewing angle < 42))

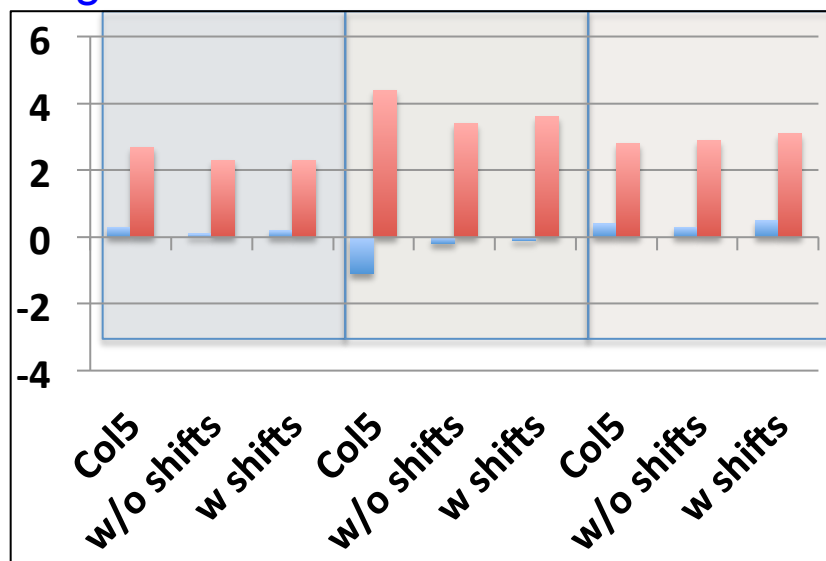
Daytime/Land



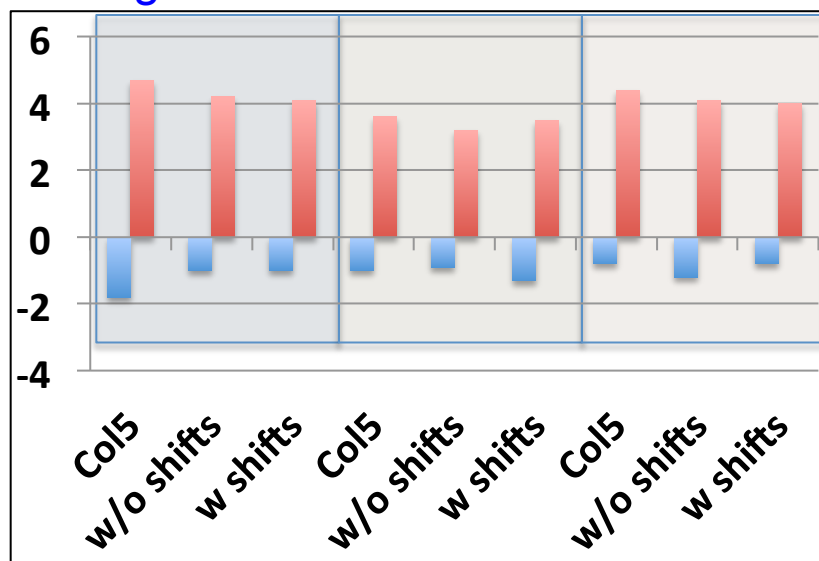
Daytime/Ocean



Nighttime/Land



Nighttime/Ocean



Conclusions I.

- IASI (earlier AIRS) vs MODIS BT differences show that MODIS H₂O and (Terra only) O₃ channels are more opaque while the CO₂ channels are less opaque.
- Additionally, the TERRA/MODIS IR channels (Band 20-30) show strong warm BT biases in cold cases, which can be corrected by the adjustment of the calibration offset coefficients.
- In this study we compared the two available CRTM V2.0.2 transmittance algorithms. Based on this study and discussions with the CRTM Team, the RTTOV-type (called **ODPS**) algorithm with **CRTM V2.0.2** will be used in the future for the forward model calculation of the C6 MOD07 algorithm.
- **TOZ**: Overall, application of Terra spectral shifts shows significant improvement (reduced bias and rms) for MOD07 TOZ products in both the local (Budapest, Hungary) and global validation studies. The Aqua TOZ is also positively effected on the global scale by the H₂O/CO₂ spectral shifts.

Conclusions II.

- **TPW: Terra** spectral shifts increased the biases over the SGP Cart site → *suggesting that negative shifts and cal. corrected C6 L1b data should be tested.*
- Application of **Aqua** spectral shifts improved MYD07 TPW products (reduced bias) for the dry cases at the SGP cart site but did not affect the wet cases and the global statistics.
- In our earlier study (using CRTM V1.2/ODAS) a significant positive improvement was realized for the Aqua/MODIS TPW over the SGP Cart site by applying the Band 27 & 28 spectral shifts -> *suggesting that the Band28 shift be applied as well.*
- **C02 band spectra shifts: YES**, these will be applied based on the MOD06 studies.
- **Terra O3 band spectral shift : YES**, it will be applied based on the local (Budapest, HU) and global validation with OMI and AIRSL2.
- **H2O band (27&28) spectral shifts: ?** Additional testing has started: adding Band28 for Aqua and trying negative shifts for Terra

Future Work

- Investigate the following spectral shifts:

Band	Terra Shift (cm-1)	Aqua Shift (cm-1)
27	-4?	4
28	-2?	2?
30	1	0
34	0.8	0.8
35	0.8	0.8
36	1	1

- Investigate the impact of the corrected calibration offset coefficients (A=0) on the **TERRA**/MOD07 products.

Later Future plan (after Collection 6)

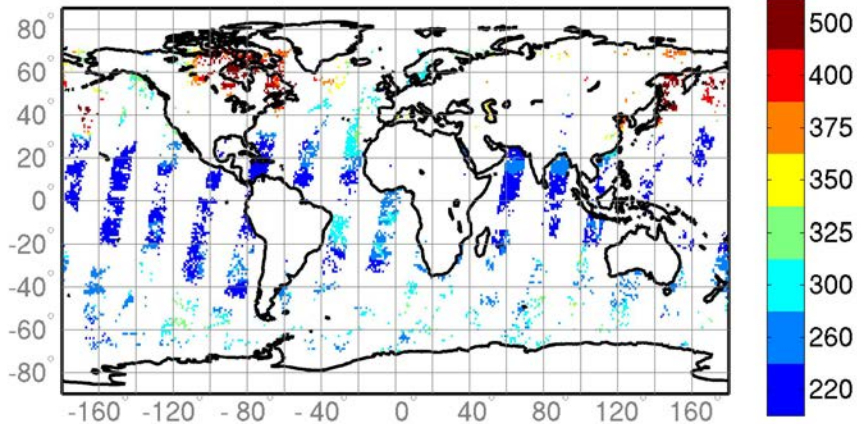
- Investigate the atmospheric profile products at one kilometer resolution.
- Study possibilities for switching from the synthetic statistical regression method to a physical retrieval algorithm. (adaptation of the legacy GOES-R Stand Alone ABI Atmospheric Profile Algorithm)

Backup slides

Effect of the A=0 Calibration Correction of the L1B data on the MOD07 TPW over the SGP Cart Site

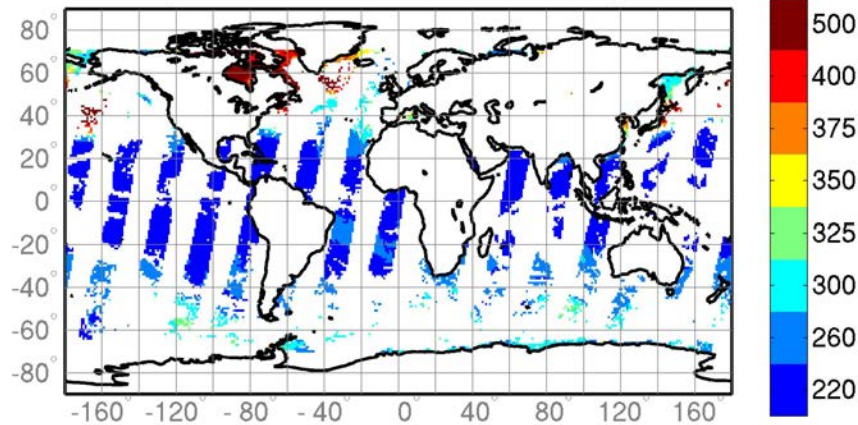
TERRA CRTM2.0 ODPS Calibr. Correct.	SRF shift	DRY (TPW<15mm) (173)		WET (TPW >=15mm)(93)		ALL (266 cases)	
		Bias	RMS	Bias	RMW	Bias	RMS
no	no	-0.7	2.1	2.3	4.4	0.4	3.1
yes	no	-0.01	2.1	2.9	4.5	1.0	3.1
yes	yes	0.1	2.1	3.2	4.7	1.2	3.2

2007032: aqua/AIRS Level 2 night/ocean oz

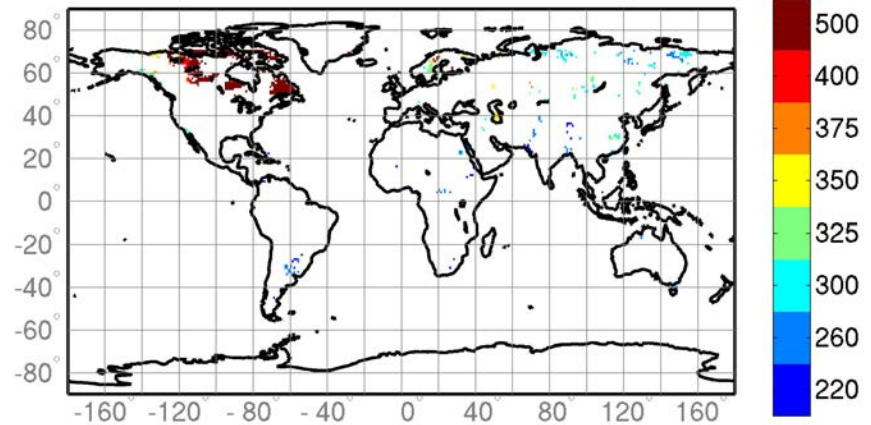


Global clear-sky TOZ retrievals on Feb 1, 2007, resampled and averaged to a 1° latitude-longitude grid.

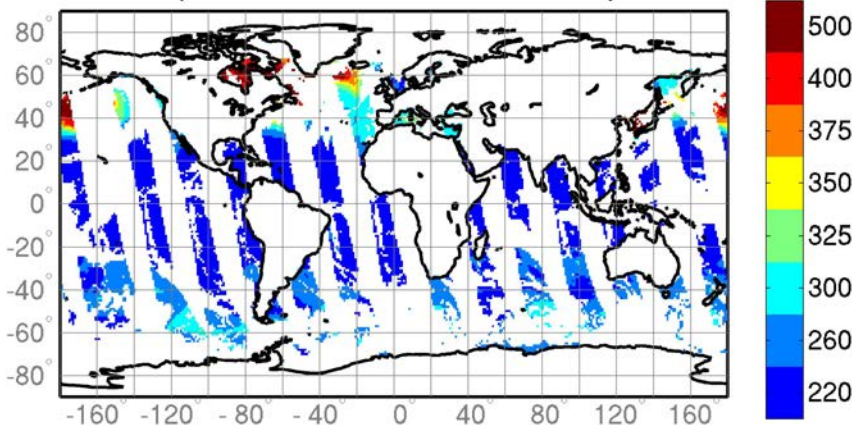
2007032 aqua/MODIS COL6 w/o shifts ODPS night/ocean oz [DU]



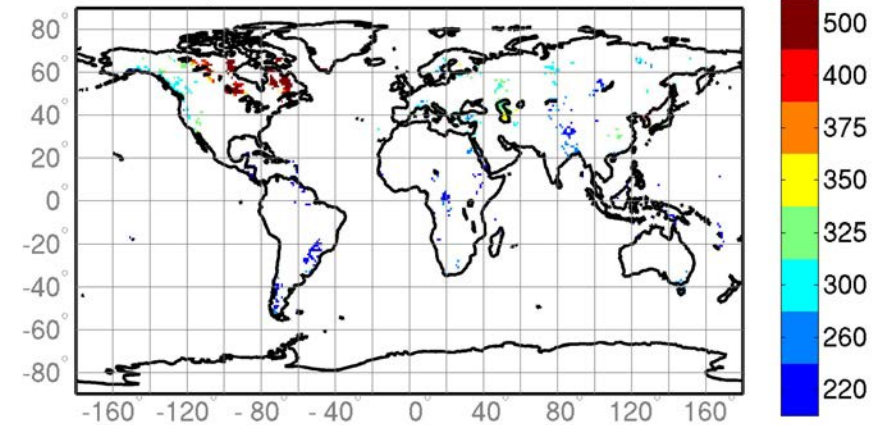
2007032 aqua/MODIS COL6 w/o shifts ODPS night/land oz [DU]



2007032 aqua/MODIS COL6 w shifts ODPS day/ocean oz [DU]



2007032 aqua/MODIS COL6 w shifts ODPS day/land oz [DU]



Globally gridded TOZ comparison of MODIS with AIRS

(MODIS min(obs) = 10 angle (viewing angle < 42))

Terra Time TOZ [DU] DAYTIME	AIRS-MOD07 CoI5 bias σ stdev		AIRS-MOD07 (CRTM2.0/ODPS)	
	Land	Ocean	Land	Ocean
2006070: no shifts	10±40 (ns=92)	-9±32 (NS=1970)	-36±77 (ns=92)	-10±53 (ns=1972)
: with shifts	N/A	N/A	7±56 (ns=92)	7±34 (ns=1972)
2006240: no shifts	-1±20 (ns=134)	3±19 (ns=1980)	-14±33 (ns=134)	-6±29 (ns=1980)
: with shifts	N/A	N/A	2±30 (ns=134)	9±29 (ns=1980)
NIGHTTIME				
2006070: no shifts	10±47 (ns=60)	-3±22 (ns=1614)	-59±82 (ns=60)	2±29 (ns=1614)
: with shifts	N/A	N/A	-20±57 (ns=60)	13±23 (ns=1614)
2006240: no shifts	4±17 (ns=56)	-3±16 (ns=1911)	-4±18 (ns=56)	-13±25 (ns=1911)
: with shifts	N/A	N/A	9±15 (ns=56)	-2±28 (ns=1911)

Globally gridded TOZ comparison of MODIS with AIRS

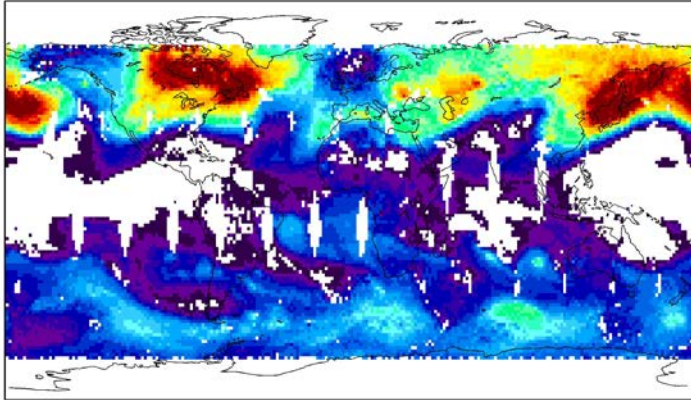
(MODIS min(obs) = 10 angle (viewing angle < 42))

Aqua Time TOZ [DU] DAYTIME	AIRS-MYD07 Col5 bias [DU] stdev		AIRS-MYD07 (CRTM2.0/ODPS)	
	Land	Ocean	Land	Ocean
2006240: no shifts	21±16 (ns=250)	22±19 (ns=4406)	6±19 (ns=249)	7±18 (ns=4346)
: with shifts	N/A	N/A	14±19 (ns=249)	18±19 (ns=4492)
2007032: no shifts	31±42 (ns=208)	16±30 (ns=4444)	13±39 (ns=208)	7±27 (ns=4447)
: with shifts	N/A	N/A	23±41 (ns=208)	16±27 (ns=3558)
NIGHTTIME				
2006240: no shifts	17±16 (ns=90)	18±20 (ns=3767)	3±19 (ns=109)	5±21 (ns=3873)
: with shifts	N/A	N/A	13±18 (ns=11)	16±20 (ns=3880)
2007032: no shifts	24±62 (ns=110)	14±33 (ns=3545)	-42±115 (ns=110)	7±30 (ns=3558)
: with shifts	N/A	N/A	-18±100 (ns=110)	16±30 (ns=3558)

Global TOZ Comparison on February 1, 2007

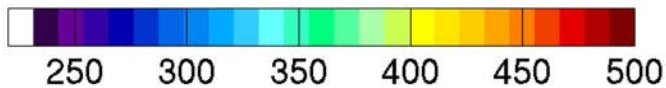
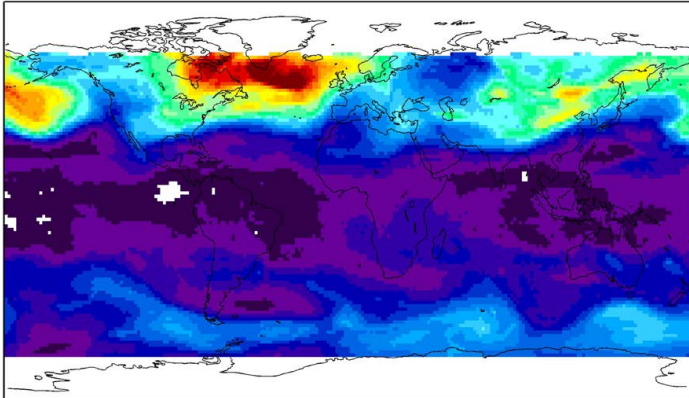
AIRSL2

2007032: aqua/AIRS Level 2 oz

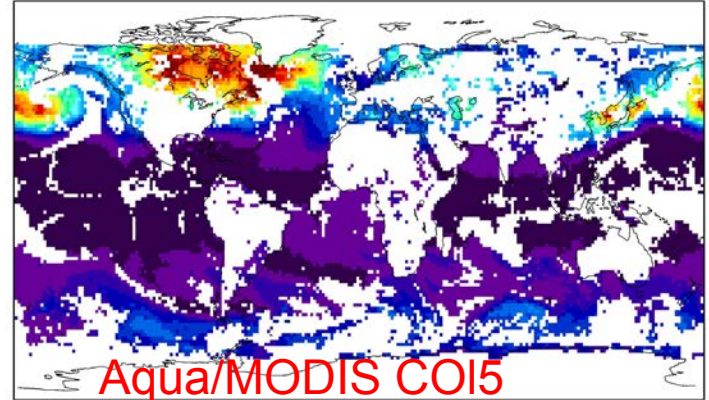


OMI_L3

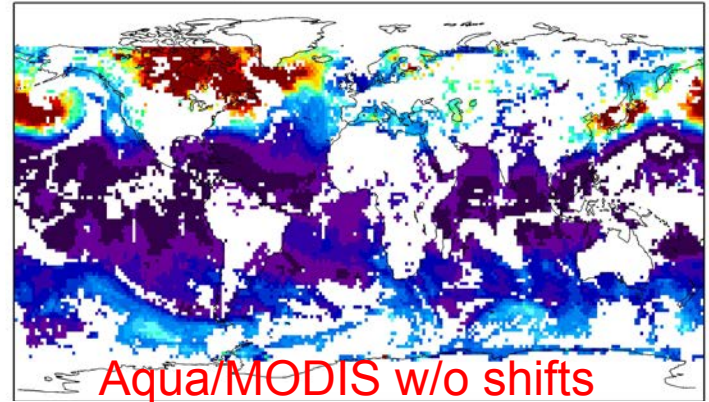
2007032: OMI L3 oz



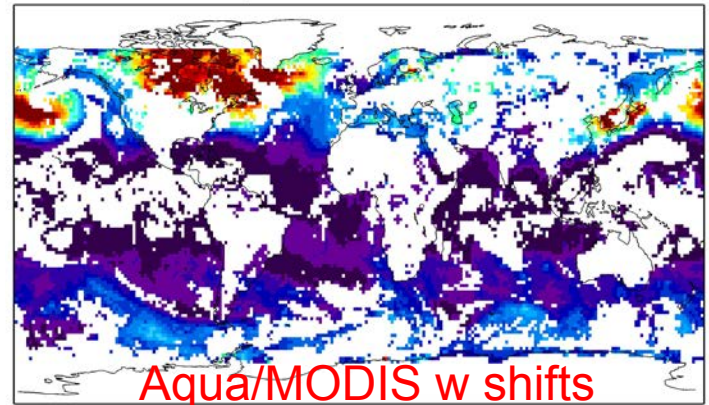
2007032 aqua/MODIS Col5 oz



2007032 aqua/MODIS COL6 w/o shifts ODPS oz



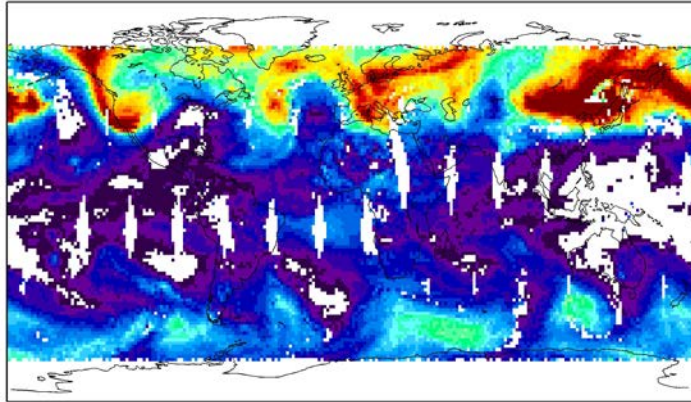
2007032 aqua/MODIS COL6 w shifts ODPS oz



Global TOZ Comparison on March 11, 2006

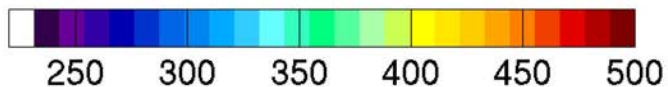
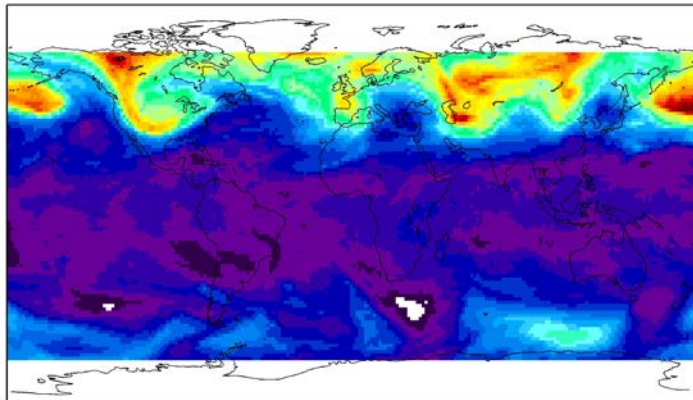
AIRSL2

2006070: terr/AIRS Level 2 oz

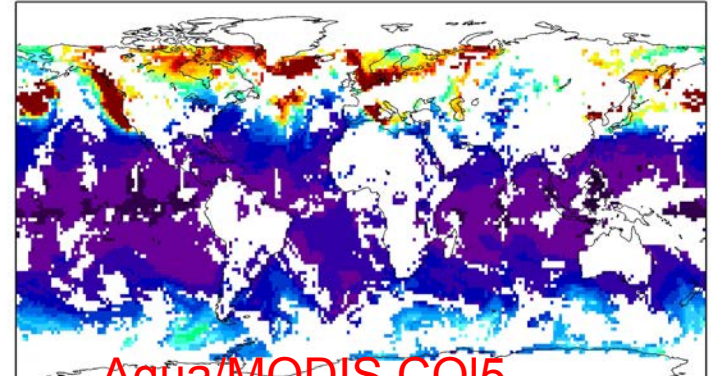


OMI_L3

2006070: OMI L3 oz

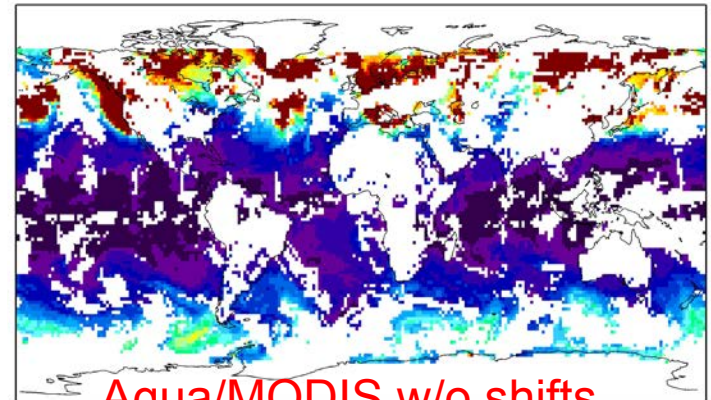


2006070 terr/MODIS Col5 oz



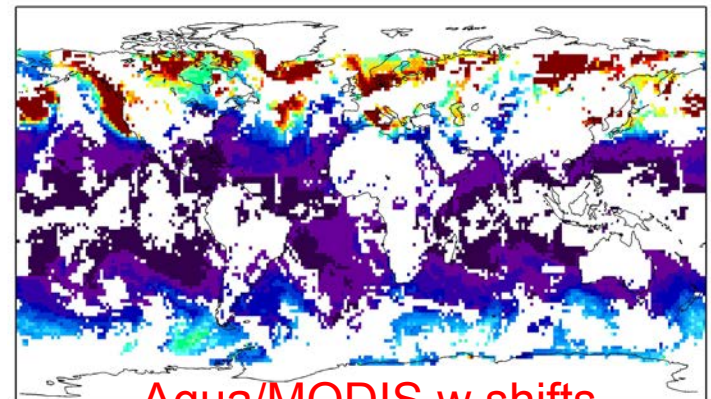
Aqua/MODIS Col5

2006070 terr/MODIS COL6 w/o shifts ODPS oz



Aqua/MODIS w/o shifts

2006070 terr/MODIS COL6 w shifts ODPS oz



Aqua/MODIS w shifts

The impact of the **Aqua** H₂O/CO₂ channel spectral shifts on the MYD07 TPW over the SGP Cart site

Comparison to MWR (MWR – MOD07)

Aqua/ Versions / FM/ TM	SRF shift	DRY (TPW<15mm)(228)		WET (TPW >=15mm)(89)		ALL (317 cases)	
		Bias	RMS	Bias	RMS	Bias	RMS
Col 5/pCRTM	No	-0.4	2.2	3.6	5.1	0.8	3.3
CRTM1.2/ ODAS	No	-0.2	2.3	4.6	5.7	1.1	3.6
CRTM1.2/ ODAS	Yes	-0.8	2.5	2.3	3.8	0.1	3.0
CRTM2.0/ ODAS	No	-1.1	2.8	1.3	3.7	-0.4	3.1
CRTM2.0/ ODAS	Yes	-1.0	2.7	1.5	3.9	-0.3	3.1
CRTM2.0/ ODPS	No	-0.9	2.6	2.5	4.3	0.04	3.1
CRTM2.0/ ODPS	Yes	-0.6	2.5	2.5	4.3	0.2	3.1

The impact of the **Terra** H2O/CO2/O3 channel spectral shifts on MYD07 TPW over the SGP cart site: Comparison with MWR TPW (MWR-MOD07)

TERRA/ versions /FM/ TM	SRF shift	DRY (TPW<15mm)(217)		WET (TPW >=15mm)(128)		ALL (345 cases)	
		Bias	RMS	Bias	RMW	Bias	RMS
Col 5/pCRTM	No	-0.7	2.0	1.1	3.2	-0.04	2.5
CRTM1.2/ ODAS	No	-0.7	2.0	1.9	4.0	0.3	2.9
CRTM2.0/ ODAS	No	-0.7	2.1	1.6	4.1	0.2	3.0
CRTM2.0/ ODAS	Yes	-0.2	2.0	3.0	4.6	1.0	3.2
CRTM2.0/ ODPS	No	-0.8	2.1	2.0	4.2	0.2	3.0
CRTM2.0/ ODPS	Yes	-0.3	2.0	2.8	4.5	0.9	3.2

Effect of the A=0 Calibration Correction of the L1B data on the MOD07 TPW over the SGP Cart Site Comparison with MWR TPW (MWR-MOD07)

TERRA CRTM2.0 ODPS Calibr. Correct.	SRF shift	DRY (TPW<15mm) (173)		WET (TPW >=15mm)(93)		ALL (266 cases)	
		Bias	RMS	Bias	RMW	Bias	RMS
no	no	-0.7	2.1	2.3	4.4	0.4	3.1
yes	no	-0.01	2.1	2.9	4.5	1.0	3.1

MODIS warmer than IASI -> CalCorrection-> Decreasing the BTs -> less WV ->

The impact of the Terra H2O/CO2/O3 channel spectral shifts on MOD07 TOZ over Budapest, HU

Satellite-based TOZ vs. Surface Brewer Measurements (Brewer –MODIS)	Bias [DU]	Stdev [DU]	RMSE [DU]
OMI at Terra overpass times	6.8	6.9	9.7
Terra Col5.2/pCRTM	-16.8	20.0	26.1
Terra Col6 /CRTM1.2/ODAS no shifts	-26.5	17.3	31.6
Terra Col6/CRTM2/ODAS no shifts	-28.0	24.9	37.5
Terra Col6/CRTM2/ODAS with shifts	-6.2	22.1	23.0
Terra Col6/CRTM2/ODPS no shifts	-35.5	26.7	44.4
Terra Col6/CRTM2/ODPS with shifts	-9.6	21.6	23.6

Terra case nb= 102

The impact of the Aqua H2O/CO2 channel spectral shifts on MYD07 TOZ over Budapest, HU

Satellite-based TOZ vs. Surface Brewer Measurements (Brewer –MODIS)	Bias [DU]	Stdev [DU]	RMSE [DU]
OMI at Aqua overpass times	0.6	7.5	7.6
Aqua Col5.2/pCRTM	6.0	20.8	21.6
Aqua Col6/CRTM1.2/ODAS no shifts	-1.2	17.6	17.7
Aqua Col6/CRTM1.2/ODAS with shifts	4.0	16.0	16.5
Aqua Col6/CRTM2/ODAS no shifts	-0.2	18.9	18.9
Aqua Col6/CRTM2/ODAS with shifts	7.1	19.6	20.9
Aqua Col6/CRTM2/ODPS no shifts	3.3	19.9	20.2
Aqua Col6/CRTM2/ODPS with shifts	10.2	20.6	23.0

Aqua case nb= 41

Globally gridded TOZ comparison of Aqua/MODIS and AIRS with OMI on a 1.5 x 1.5 degree grid

Aqua/Day	Versions	Bias	Stdev	RMS	Case#
2006240	Col5	16.5	24.0	29.1	13904
	noshifts	-3.4	31.5	31.6	14018
	wshifts	8.7	28.7	30.0	14177
	AIRSL2	-6.9	32.7	33.4	20892
2007032	Col5	12.2	31.0	33.3	12823
	Noshifts	-6.5	47.4	47.8	12830
	Wshifts	5.2	42.1	42.5	12830
	AIRSL2	-7.6	46.8	47.5	20569

Globally gridded TOZ comparison of Terra/MODIS and AIRS with OMI on a 1.5 x 1.5 degree grid

Terra/Day	Versions	Bias	Stdev	RMS	Case#
2006070	Col5	-13.0	49.2	50.9	12173
	noshifts	-27.9	81.0	85.7	12303
	wshifts	-8.3	60.8	61.3	12303
	AIRSL2	-8.5	50.42	51.1	20926
2006240	Col5	-1.3	26.1	26.2	13135
	Noshifts	-14.1	38.7	41.2	13135
	Wshifts	1.8	35.4	35.4	13135
	AIRSL2	-7.0	32.7	33.4	20892

Globally gridded **TPW** comparison of MODIS with AIRS

(MODIS min(obs) = 10 angle (viewing angle < 42))

Aqua TPW [mm] DAYTIME	AIRS-MOD07 (Col. 5) bias σ stdev		AIRS-MOD07 (Col. 6) bias σ stdev	
	Land	Ocean	Land	Ocean
2004336: no shift	0.7 σ 3.3 (223)	-2.7 σ 4.9 (3958)	-0.7 σ 3.8 (275)	-2.9 σ 4.9 (3949)
: with shifts	N/A	N/A	-0.6 σ 3.8 (275)	-2.6 σ 4.8 (3949)
2006240: no shift	-2.2 σ 4.9 (250)	-2.2 σ 4.0 (4413)	-2.7 σ 4.6 (249)	-3.2 σ 4.4 (4352)
: with shifts	N/A	N/A	-2.8 σ 4.9 (249)	-3.2 σ 4.7 (4498)
2007032: no shift	-0.5 σ 4.2 (210)	-1.8 σ 4.7 (4447)	-1.1 σ 4.2 (210)	-3.3 σ 4.7 (4450)
: with shifts	N/A	N/A	-0.9 σ 4.4 (210)	-2.7 σ 4.8 (4450)

Globally gridded **TPW** comparison of MODIS with AIRS

(MODIS min(obs) = 10 angle (viewing angle < 42))

Aqua TPW [mm] NIGHTTIME	AIRS-MOD07 (Col. 5) bias σ stdev		AIRS-MOD07 (Col. 6) bias σ stdev	
	Land	Ocean	Land	Ocean
2004336: no shift	0.3 σ 2.7 (154)	-1.8 σ 4.7 (3294)	0.1 σ 2.3 (330)	-1.0 σ 4.2 (3282)
: with shifts	N/A	N/A	0.2 σ 2.3 (330)	-1.0 σ 4.1 (3282)
2006240: no shifts	-1.1 σ 4.4 (91)	-1.0 σ 3.6 (3811)	-0.2 σ 3.4 (110)	-0.9 σ 3.2 (3916)
: with shifts	N/A	N/A	-0.1 σ 3.6 (111)	-1.3 σ 3.5 (3923)
2007032: no shifts	0.4 σ 2.8 (112)	-0.8 σ 4.4 (3572)	0.3 σ 2.9 (112)	-1.2 σ 4.1 (3585)
: with shifts	N/A	N/A	0.5 σ 3.1 (112)	-0.8 σ 4.0 (3585)