

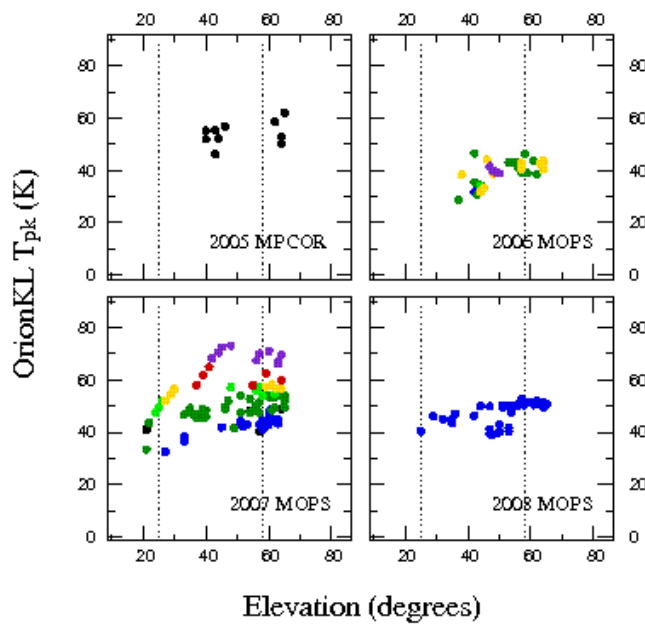
Calibration

Standard Spectra

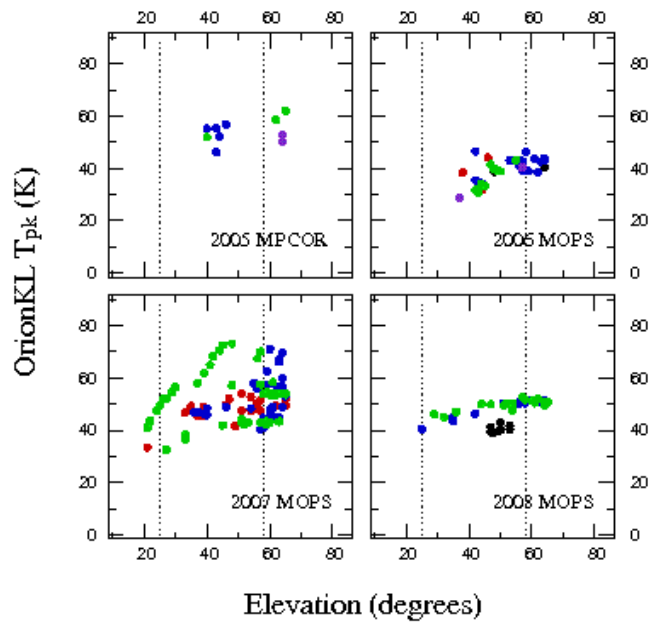
These plots show the peak brightness (TA* units) of Orion KL versus elevation. The different panels refer to different years (2005-2008).

The different colours refer to different frequency setups for MOPS (i.e. Tsys is only measured once for each 2GHz block, but the relative position of the 138MHz spectral line window where the data is recorded will depend on the centre frequency that you have chosen for the entire 8GHz band). The variation in colour from blue -> green -> red -> purple shows increasing centre frequency. For Orion KL in 2007, the green dots indicate $\nu_c=111550\text{MHz}$, the blue dots indicate $\nu_c = 111480\text{ MHz}$. Other colours represent ν_c increments of roughly 100MHz.

- Orion KL calibration scans: 2005 to 2008:



There is also some obvious variation by month in 2008 (here the coloured dots indicate different months of observation, black = June):



Comparing the Ori KL peak T scans over the elevation range of the actual LMC observations to SEST standard spectra of [OriKL?](#) ($T_{a^*}=71.1\text{K} + \text{SEST nmb} = 0.70 \rightarrow T_{\text{mb}} = 101.6\text{K}$), I estimated the following extended beam efficiency factors for Mopra:

- 2005: 0.54
- 2006_f1 (111970): 0.38
- 2006_f2 (111550): 0.40
-
- 2007: 0.47 (derived from green points only, i.e. $\nu_c=111550$ MHz and not the testing scans where I varied ν_c)
- 2008 June: 0.40
- 2008 July+: 0.49

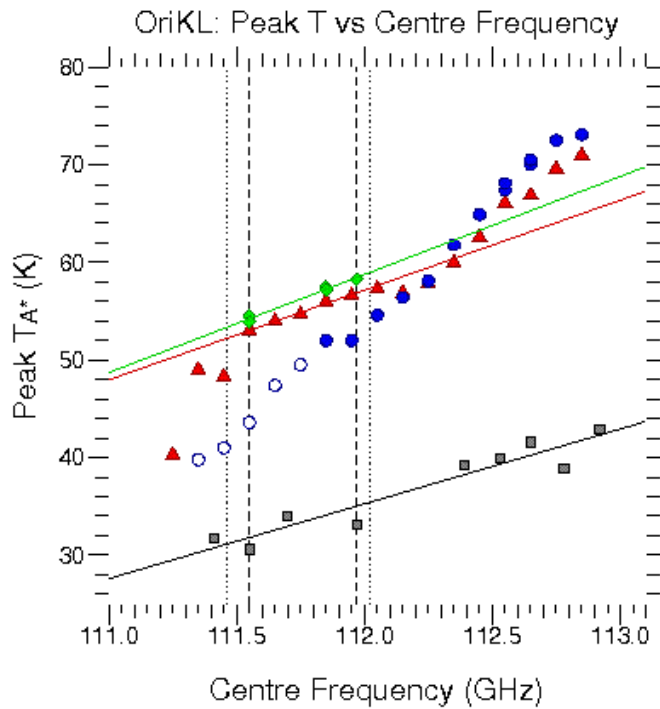
However, these factors assume that the survey data is recorded with exactly the same setup as the calibrations, which is not the case. Two issues may be important:

i) Calibration scans prior to 2008 were recorded with a different (and variable!) ν_c to the observations.

ii) The sky frequency of the ^{12}CO line itself is Doppler shifted to a different window within the 2GHz block. I.e. the line is shifted to ~ 115170 MHz for the LMC, but is at ~ 115265 MHz for Orion KL.

In this test, I recorded spectra for [OriKL?](#) with different MOPS ν_c settings. Different coloured points == different tests, dotted lines - LMC

observing vcen setting, dashed lines = OriKL? vcen settings.



Straight line linear fits to the 2007 vc test data:

- i) 2007-08-06/07: 0.92 K per 100 MHz (red dots)
- ii) 2007-09-27: 1.00 K per 100 MHz (green dots)

Average for 2007 - 0.96K per 100MHz. Note that I did not fit to the blue points, because many of these scans were taken at low elevation.

Conclusion 1: Tpk of OriKL? scans recorded at 111550 MHz would have had measured Tpk values 0.87K lower if they had been recorded at 111460 MHz. In this case, new 2007 nxb = 0.46

(Reality check: Erik took scans at 111480 MHz in 2007. The average tpk for these scans was 5.6K lower than 111550 MHz scans (Erik nxb = 0.42)... but the lines are at the edge of the zoom window - how good were the baseline fits?)

Conclusion 2 : If sky frequency of OriKL? line (115269 MHz) was at the same frequency as the average LMC sky frequency 115169 MHz, the Tpk of OriKL? scans would have been lower again by 0.96K. Combined effect of a & b is that nxb in 2007 --> 0.45 (Erik --> 0.41)

Straight line linear fits to the 2006 vc test data (using all grey points):

- i) 2006-09-26: 0.77K per 100 MHz

Conclusion 1: Tpk of Orion scans recorded at 111970 MHz would have measured Tpk values 0.4K HIGHER if they were recorded at 112020 MHz. In this case, new 2006_f1 nxb = 0.39.

Conclusion 2: Tpk of Orion scans recorded at 111550 MHz would have measured Tpk values 0.7K LOWER if they were recorded at 111460 MHz. In this case, new 2006_nxb_f2 = 0.39

Conclusion 3: If sky frequency of OriKL? line (115269 MHz) was at the same frequency as the average LMC sky frequency 115169 MHz, the Tpk of OriKL? scans would have been LOWER by 0.77K. Combined effect is 2006_f1 nxb = 0.38 and 2006_f2_nxb=0.39.

Second effect should also be important for 2008+ data. Assuming that these follow the dependence observed in 2007, the new nxb factors would be 2008 June nxb = 0.39, 2008 July + nxb = 0.48.

In summary:

- 2005: 0.54
- 2006_f1 (111970): 0.38
- 2006_f2 (111550): 0.39
- 2007: 0.45
- June 2008: 0.39
- 2008 July+: 0.48

Note that I assume 2005 data is unaffected by the offset between the observing and calibration line frequency. nxb was determined by Ladd et al. for the old Mopra system, so it seemed better to stick to the official value.

I also looked at some maps of Orion KL. There seemed to be a small difference in the peak flux of Orion in the OTF maps compared to the position switched scans, i.e. the peak brightness in the maps is lower. I decided not to worry about this, because this flux is probably "smeared" around rather than truly missing, i.e. it will still get accounted for in the calculation of the cloud's total CO luminosity.

Note that in practice I used these efficiency factors for my (end 2008) reduction:

- 2005: 0.54
- 2006: 0.35
- 2007: 0.43
- 2008: 0.45

Comparison with published SEST results

NOT SURE WHEN I DID THIS COMPARISON (relative to nxb fiddling described above)

I compared the linewidth, peak brightness and integrated intensity of approximately 40 positions where we have Mopra data with SEST results published in Chin et al. (1997), Kutner et al. (1997), Johansson et al. (1998) and Israel et al. (2003).

Overall, it seems that the linewidths with the two telescopes are consistent (SEST = 1.0 +/- 0.2 Mopra). However, the average peak and integrated fluxes measured with SEST are about 15% higher than the Mopra measurements.

Older Stuff (refers to data processed pre-October 2007 using nxb=0.55)

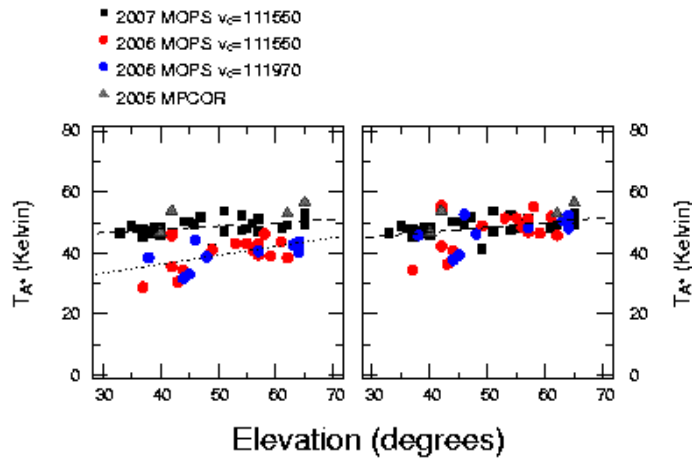
Yoji and I have been looking into the calibration of the Mopra LMC data from 2005 (MPCOR & POCS), 2006 (MOPS) and 2007 (MOPS).

Orion KL Scans

There is a ~15% offset between the data taken with MOPS in 2006, and data taken with MPCOR in 2005 and MOPS in 2007. Unfortunately, no Orion KL scans were obtained with POCS in October 2005.

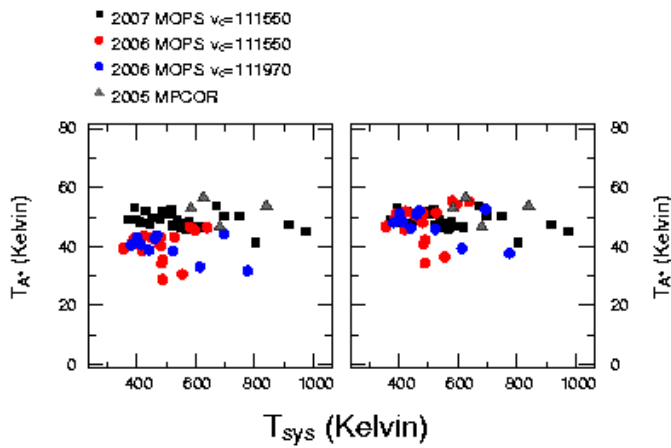
There is a weak dependence on the peak 12CO flux of Orion with elevation. At low elevation (~30 deg), the flux is reduced by about ~15% compared to high elevation (~60 deg). There is some suggestion that the elevation dependence was stronger in 2006 than in 2007, although it's hard to say for sure from the calibration scans alone.

- Peak 12CO flux vs elevation for Orion KL. The plot on the right uses a correction fraction of 1.15 for the 2006 scans.



There is no obvious trend between the peak 12CO flux of Orion with time of day, month, or observing system temperature.

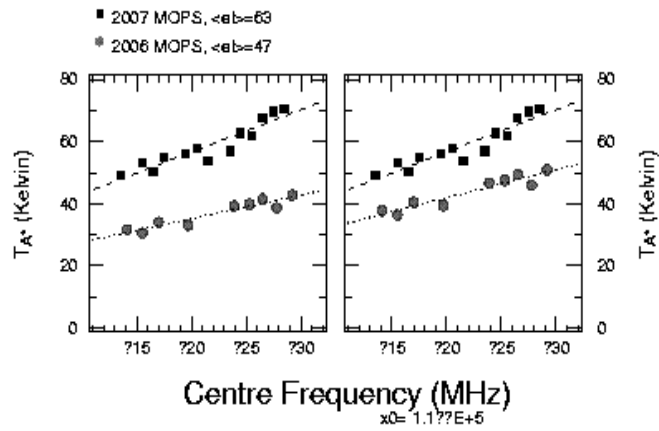
- Peak 12CO flux vs system temperature for Orion KL. The plot on the right uses a correction factor of 1.15 for the 2006 scans.



For MOPS observations, the peak 12CO flux of Orion varies with the centre frequency of the MOPS 8GHz band. At an elevation of ~ 63 degrees in 2007, Orion's flux varied from 49K when $\nu_c=111350$ MHz to 71K when $\nu_c=112850$ MHz. At an elevation of ~ 47 degrees in 2006, Orion's flux varied from 31K when $\nu_c=111550$ MHz to 43K when $\nu_c=112920$ MHz. Both peak flux vs centre frequency scans indicate a variation of $\sim 30\%$ over this frequency range.

For M172, we observed with $\nu_c=111970$ MHz for the early part of 2006, and with $\nu_c=111550$ MHz for all of 2007 and the later part of 2006. For the peak flux vs centre frequency data, the variation in Orion's flux between these two centre frequency settings is $\sim 5\%$. This is smaller than the scatter in the 2006 Orion KL calibration data.

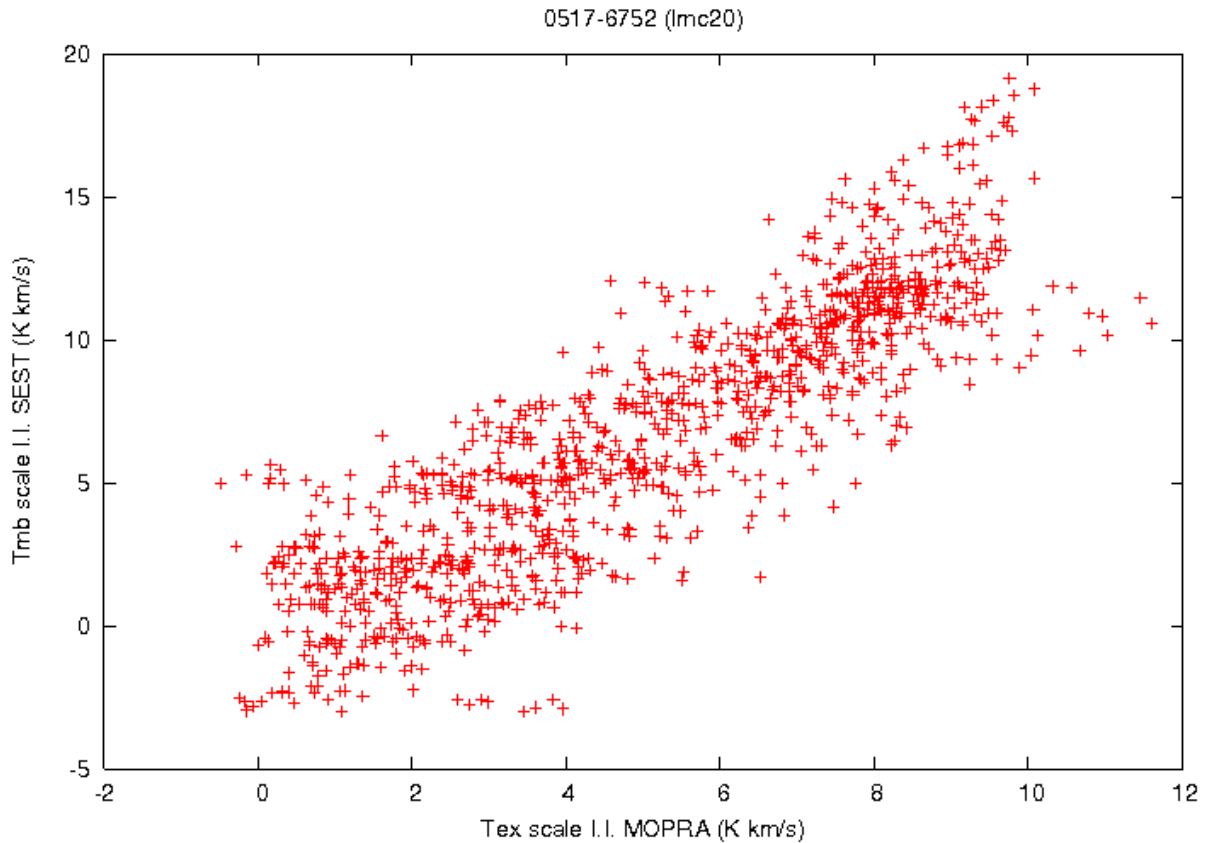
- Peak 12CO flux vs centre frequency for Orion KL. The plot on the right includes a correction factor of 1.15 for the 2006 scans.



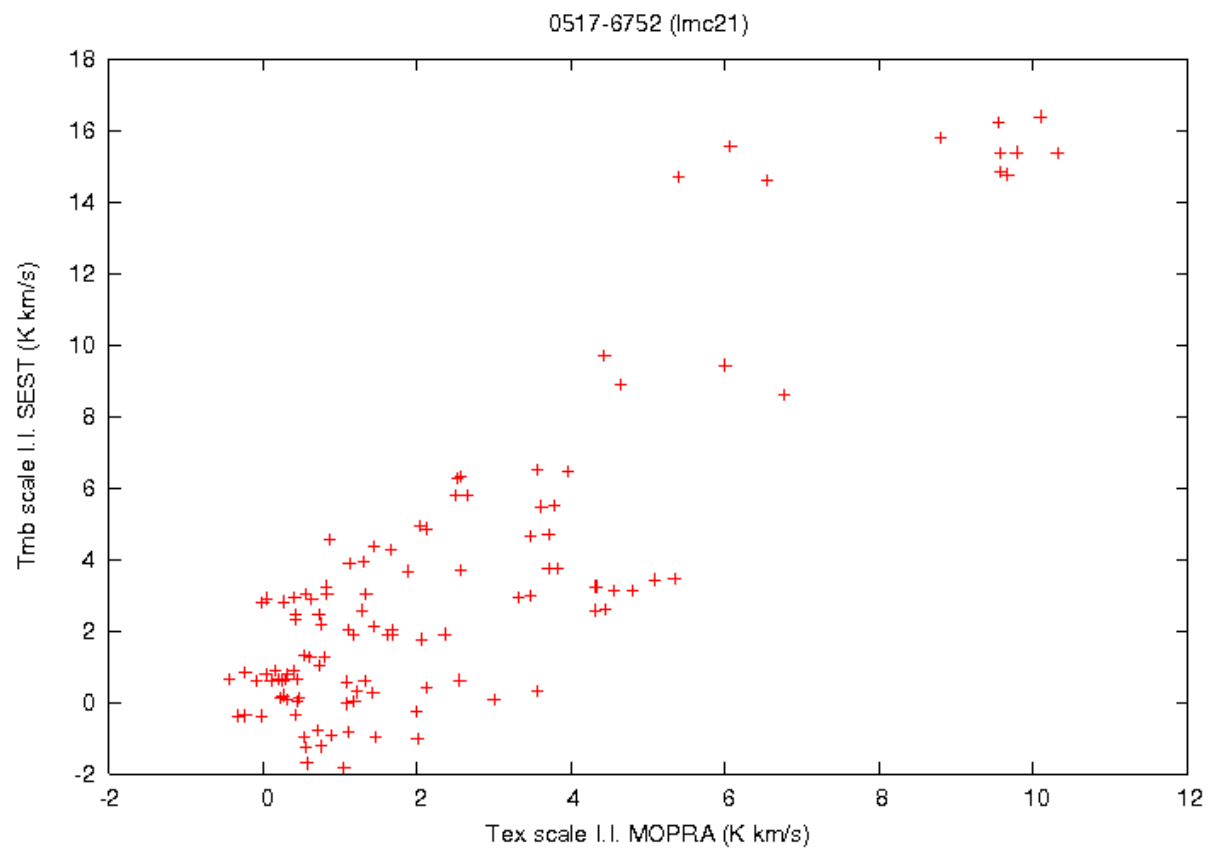
Comparison with SEST data

Yoji has compared the integrated intensity of molecular clouds observed with Mopra to SEST data for the same clouds. The Mopra data is on the Txb scale, and has not been corrected for the observed offset between 2006 and 2007, or any elevation dependence. The Mopra data is on the Txb scale. We should probably redo these plots once we have applied the necessary corrections to the Mopra data.

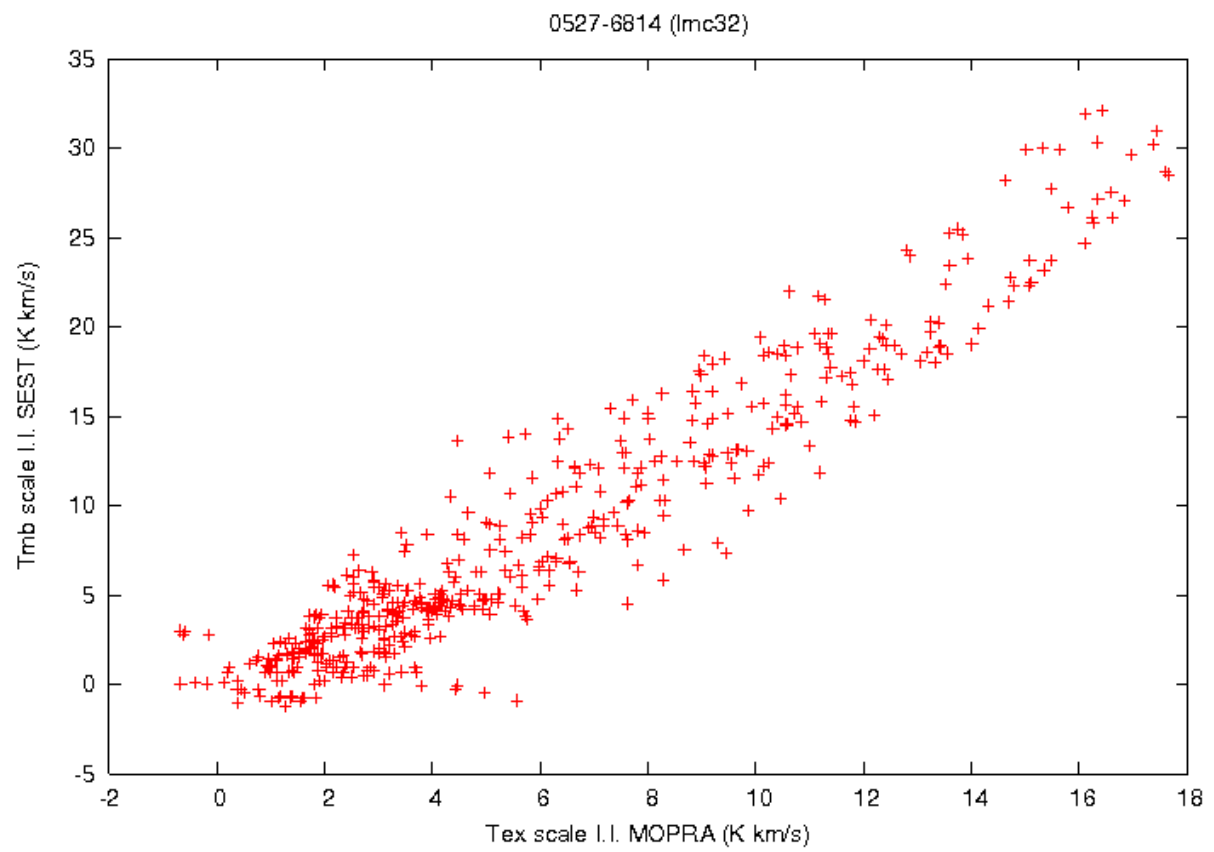
- LMC20:



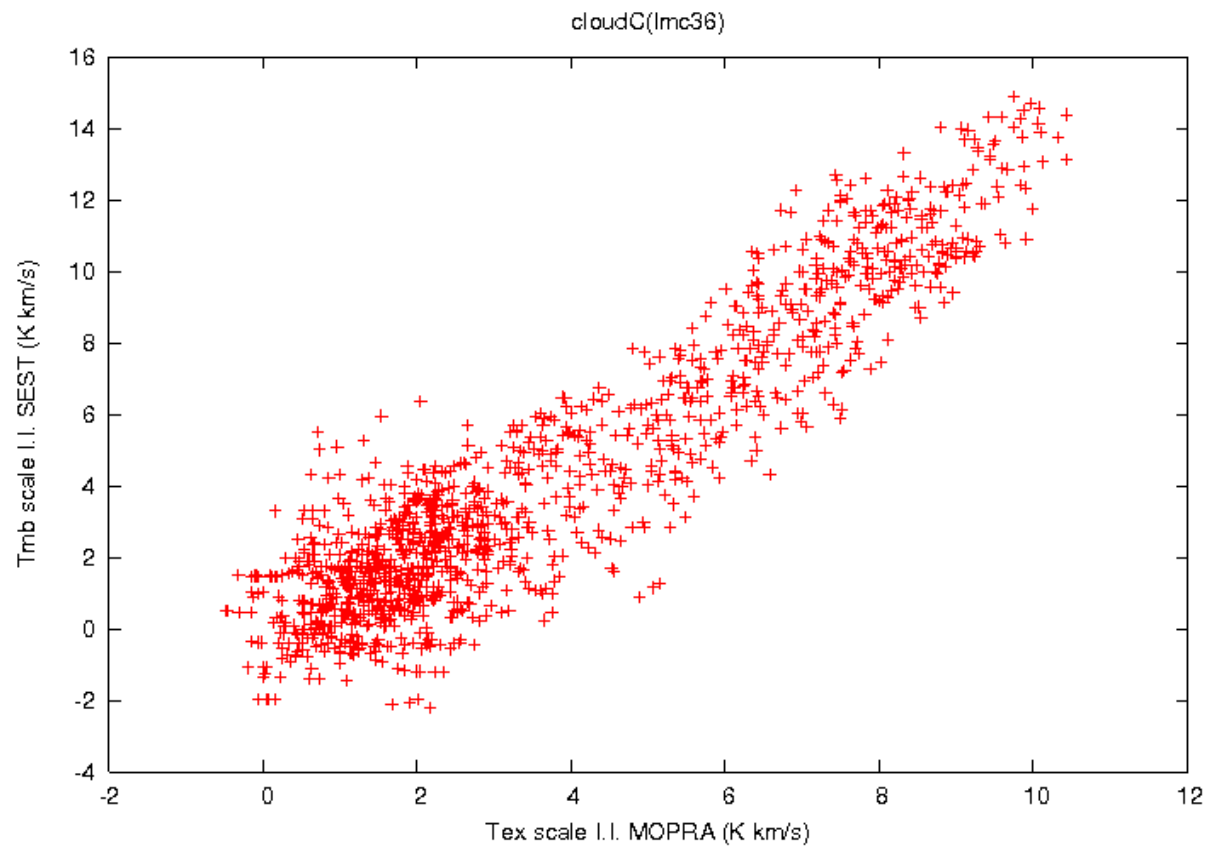
- LMC21:



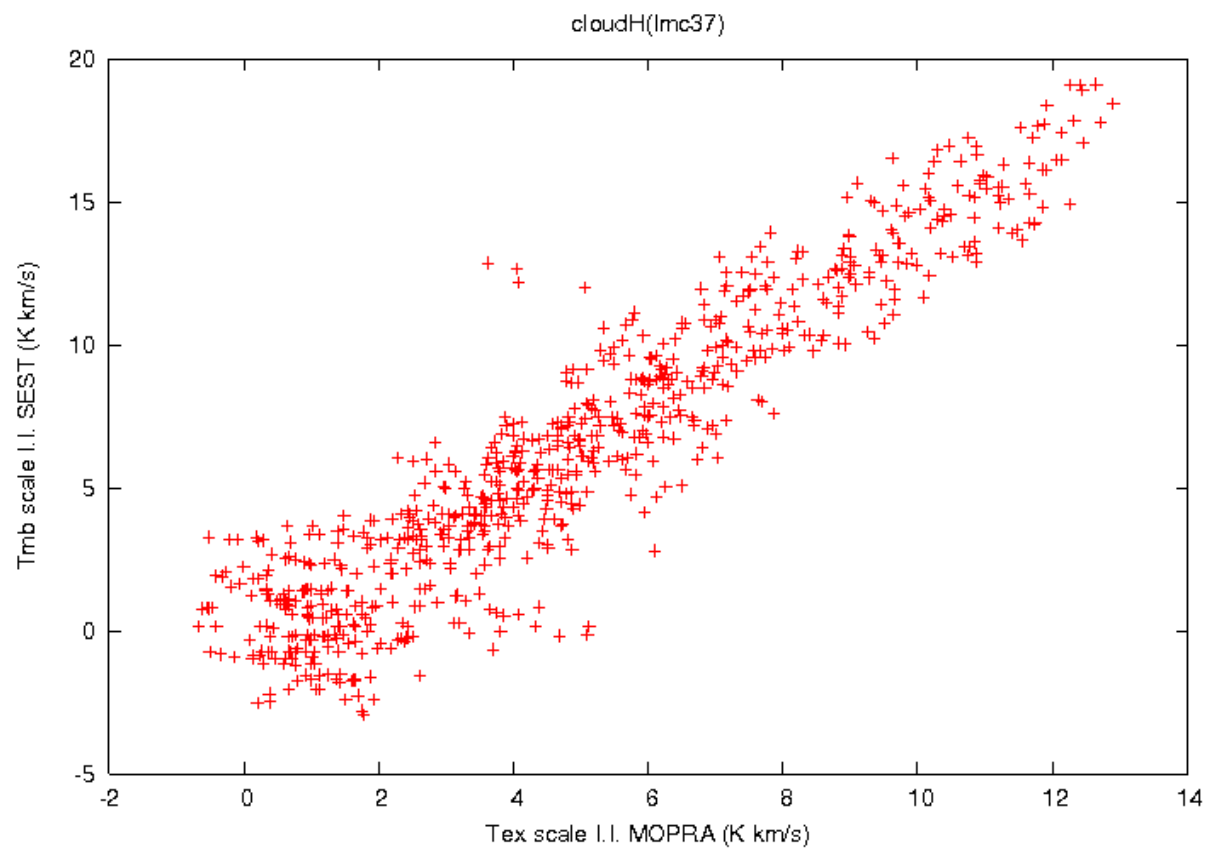
- LMC32:



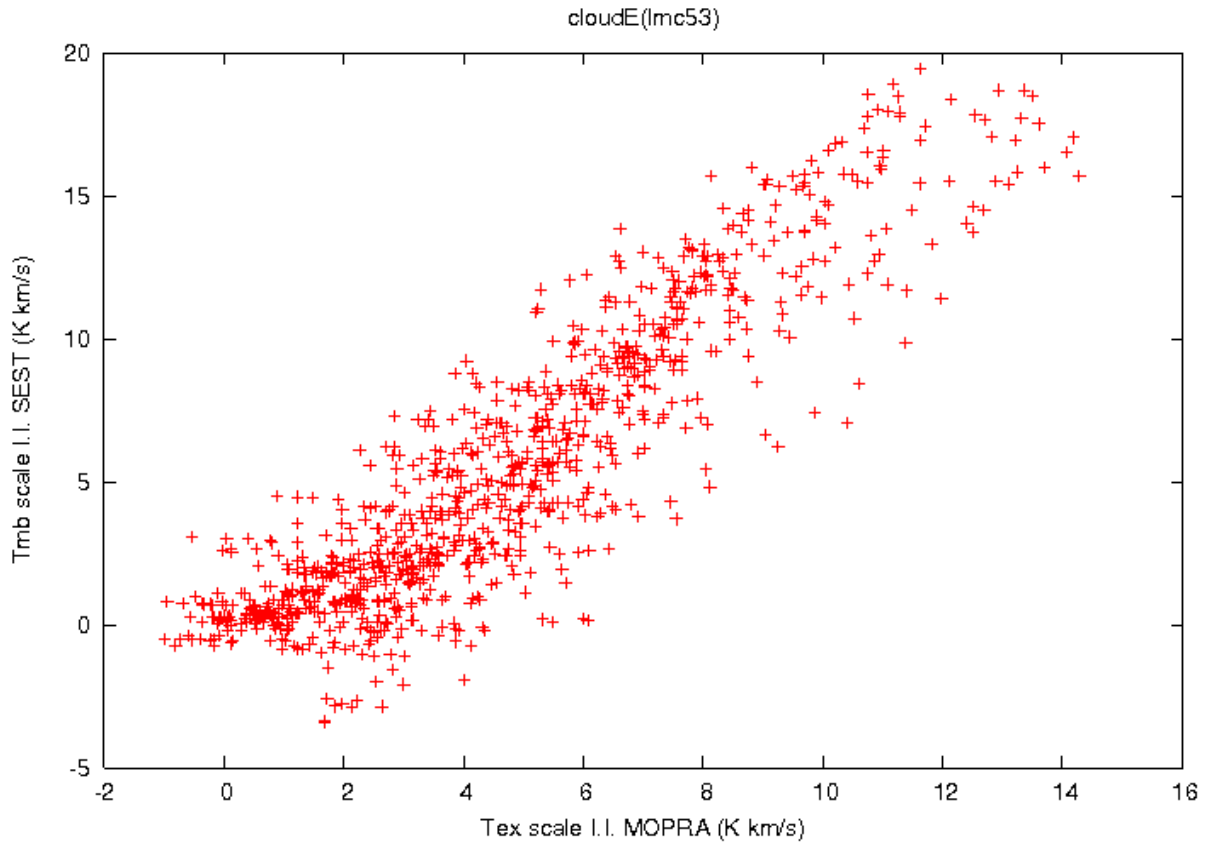
- LMC36:



- LMC37:



- LMC53:



Mopra Data from Different Years

I have been comparing integrated intensity maps of individual fields where we have Mopra data from different years. The offset between 2006 and 2007 is apparent in the LMC maps, although there is some scatter (which seems to correspond OKish with differences in elevation for the observations).

For each plot, the solid line shows a 1:1 correlation. The dashed lines show a weighted least squares fit and the ordinary least squares bisector.

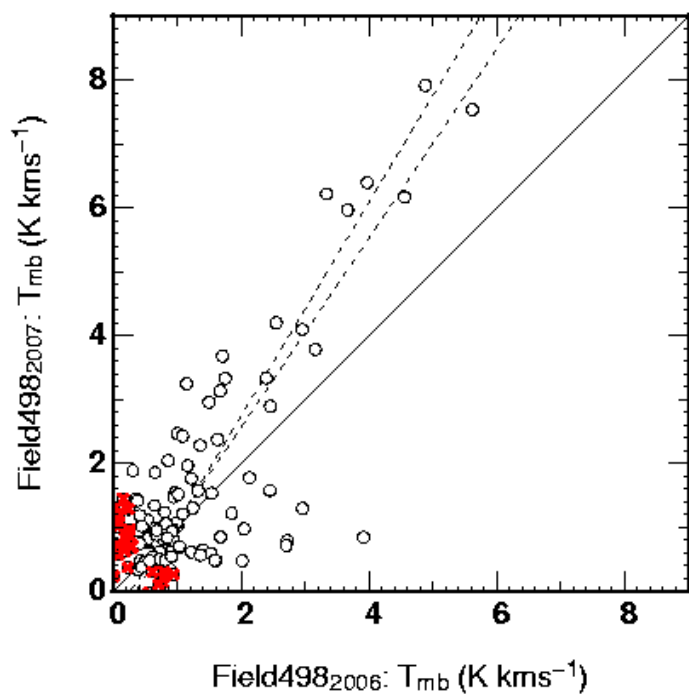
Take home message: on average, MOPS07 = 1.12 x MOPS06; POCS05 = 1.00 x MOPS06; MPCOR = 1.75 x MOPS06

Example (2006 vs 2007 data): Field 498

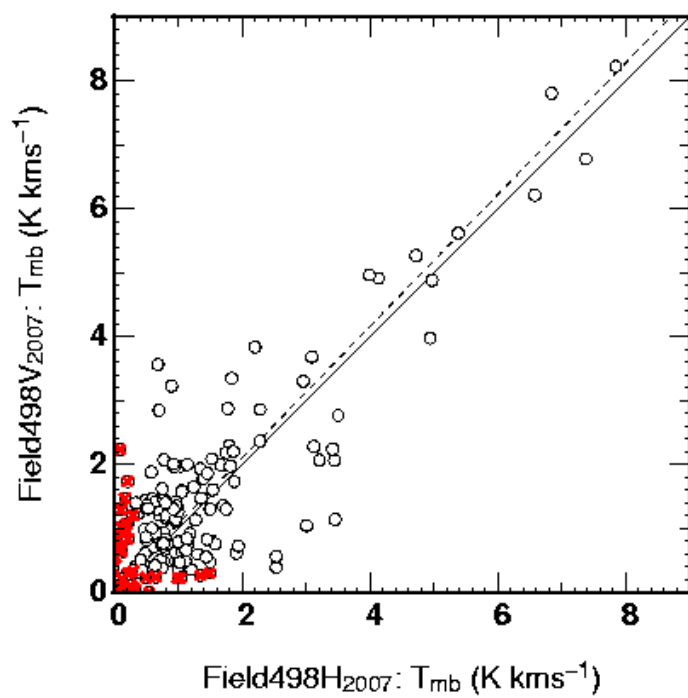
This field is a nice example because the 12CO emission is relatively strong and positioned in the centre of the field. Most of the 2006 data were taken at low elevation, and most of the 2007 data were taken at high elevation.

Field Name	Tsys	El	rms	complete?
498H 2006	700 K	el~29	0.84	half: scans 1 to 20
498H 2006	554 K	el~49	0.63	half: scans 15 to end
498V 2006	475K	el~32	0.51	Y
498H 2007	515	51	0.61	Y
498V 2007	500	51	0.57	Y

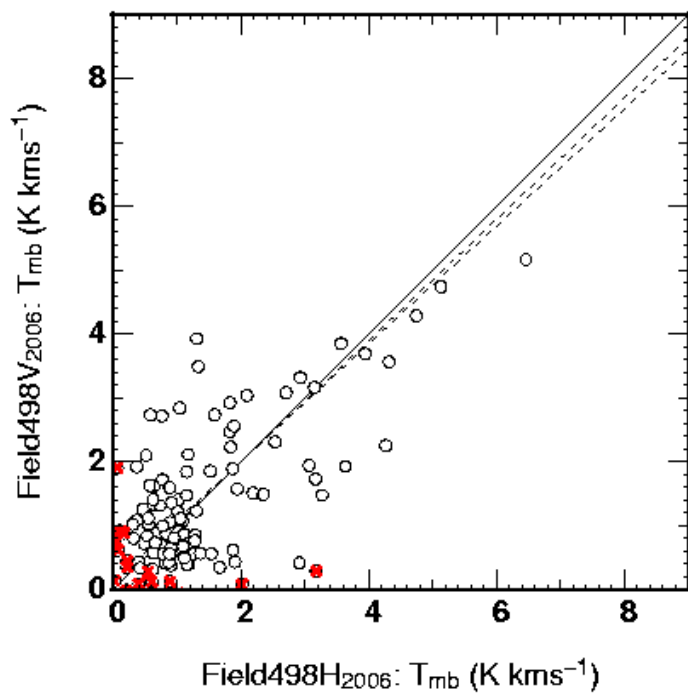
- Field498: all 2006 data vs all 2007 data. Slope of OLSB = 1.5



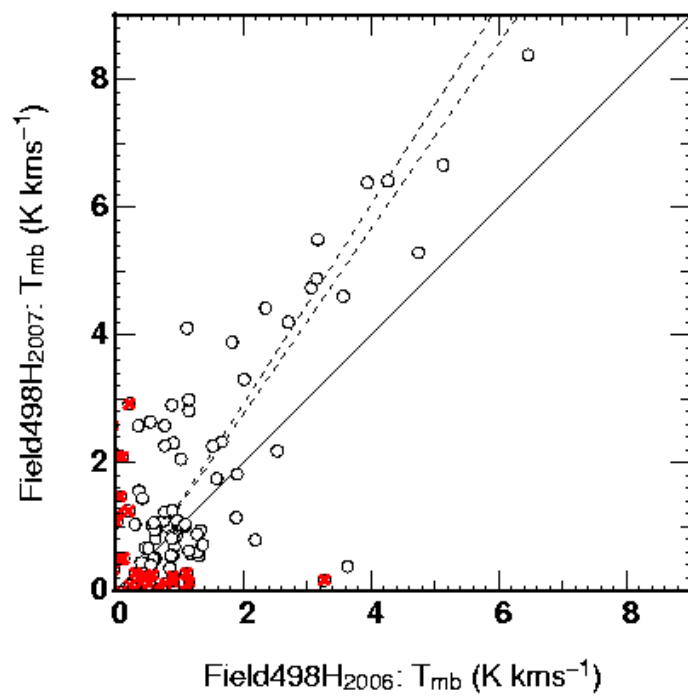
- Field498: 2007 H scan vs 2007 V scan. Slope of OLSB = 1.0



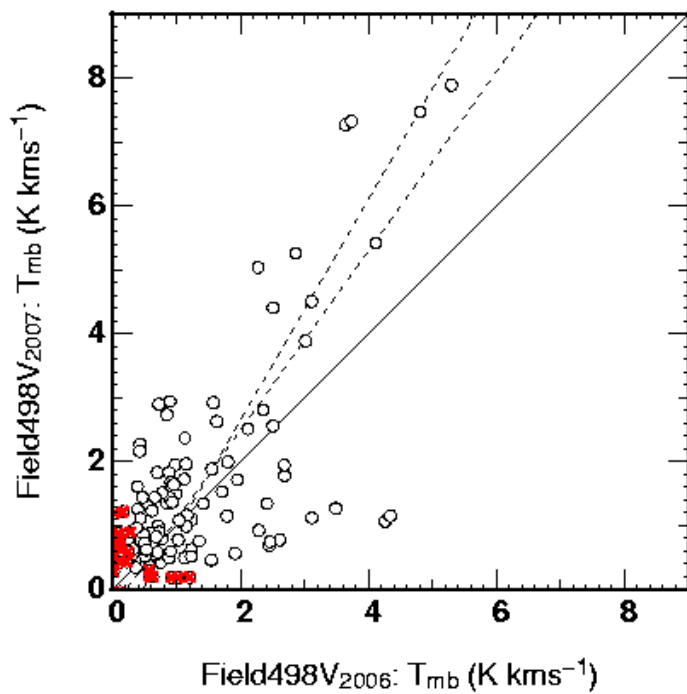
- Field498: 2006 H scan vs 2006 V scan. Slope of OLSB = 0.9



- Field498: 2006 H scan vs 2007 H scan. Slope of OLSB = 1.5



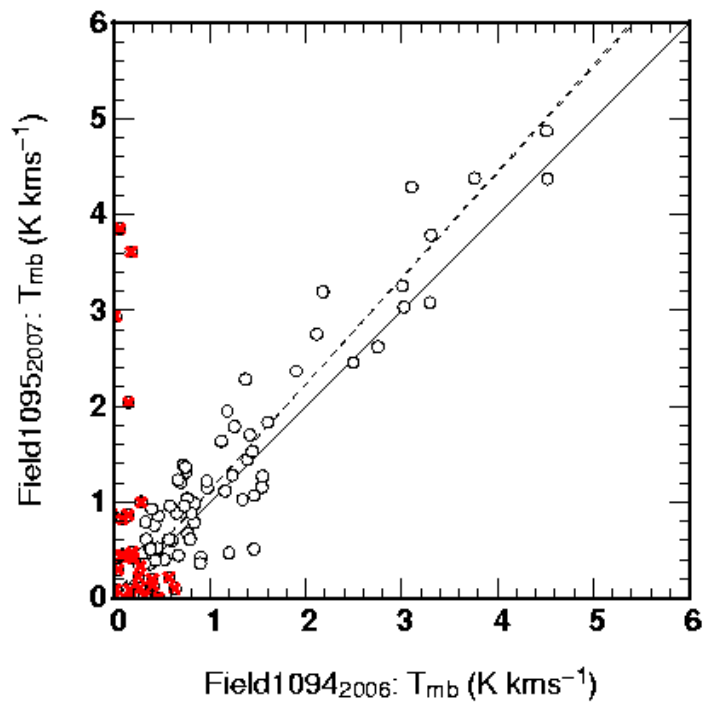
- Field 498: 2006 V scan vs 2007 V scan. Slope of OLSB = 1.4



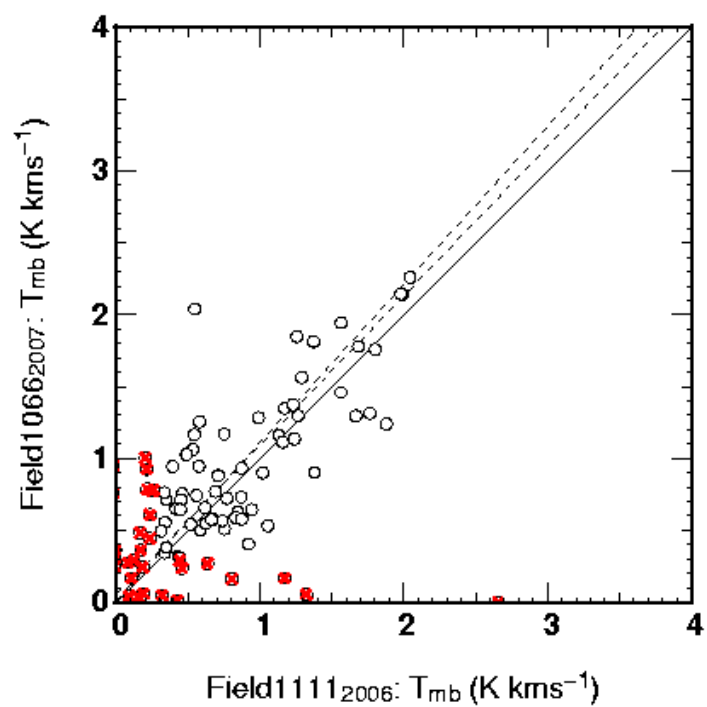
Other Fields (2006 vs 2007)

Not surprisingly, other fields don't show such an obvious trend.

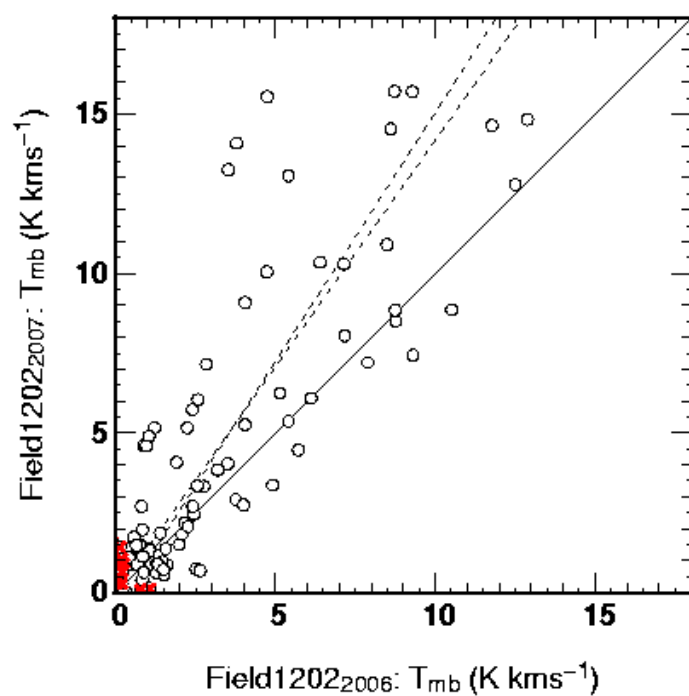
- Field1095: all 2006 vs all 2007. Slope of OLSB = 1.1. All data taken at similar elevation (~40-50).



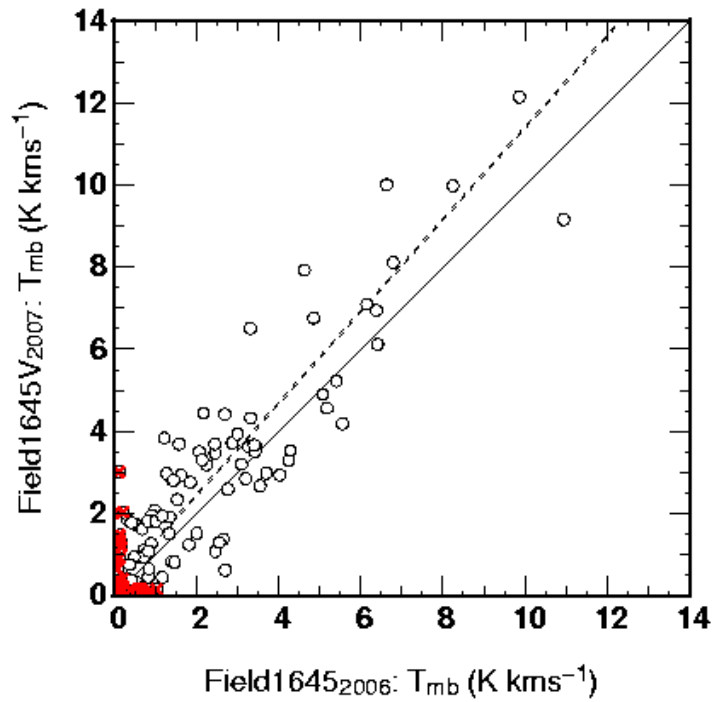
- Field1111: all 2006 vs all 2007. Slope of OLSB = 1.0. Data taken at el~42 in 2006, and el~28, 46 & 52 in 2007.



- Field1202: all 2006 vs all 2007. Slope of OLSB = 1.4. Data taken at el~35&51 in 2006, and el~37 in 2007.



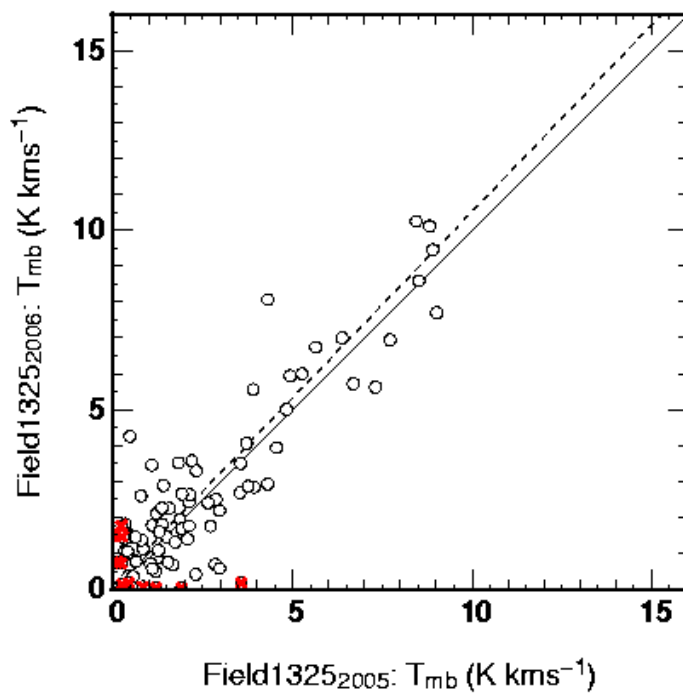
- Field1645: all 2006 vs all 2007. Slope of OLSB = 1.1. All data taken at similar elevation (~45).



Example (POCS 2005 vs 2006 data): Field 1325

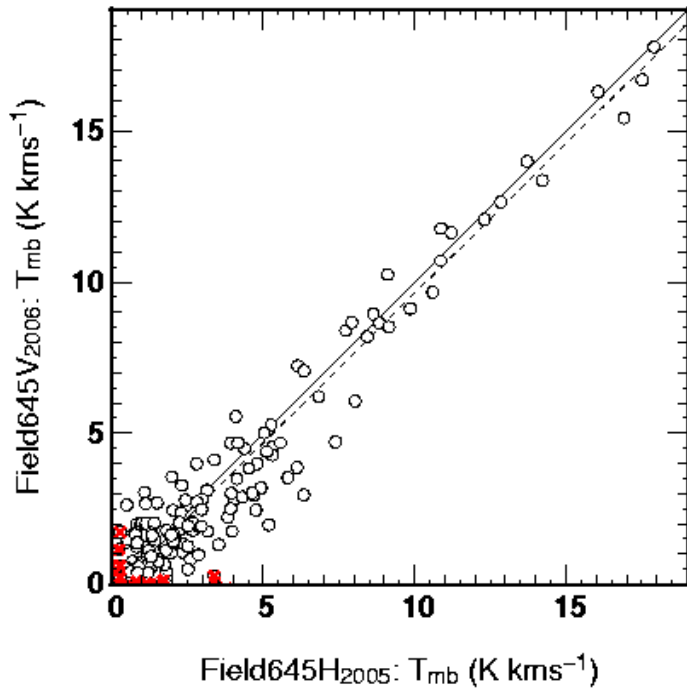
Again, this field is a nice example because the ^{12}CO emission is relatively strong and positioned in the centre of the field. The data in 2005 and 2006 were taken at similar elevations.

- Field1325: all 2005 vs all 2006. Slope of OLSB = 1.0

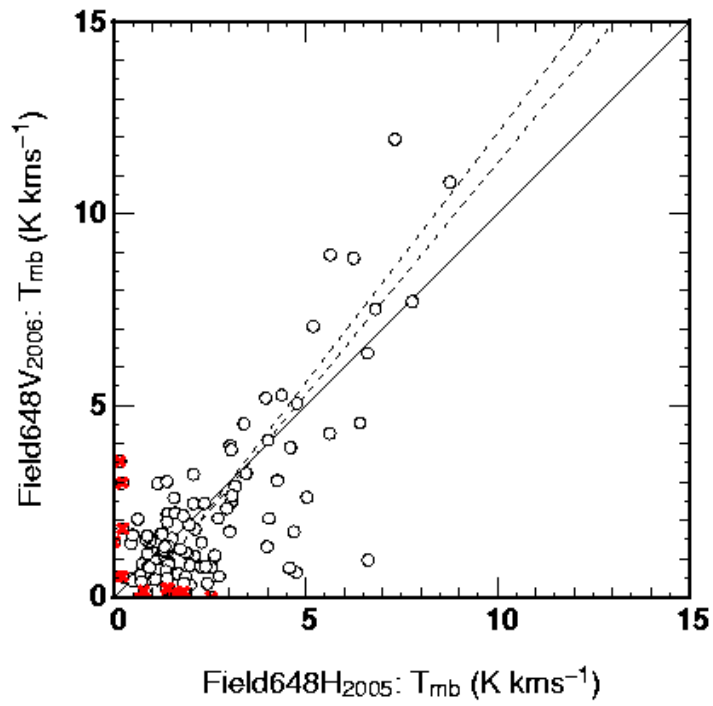


Other Fields (POCS 2005 vs 2006)

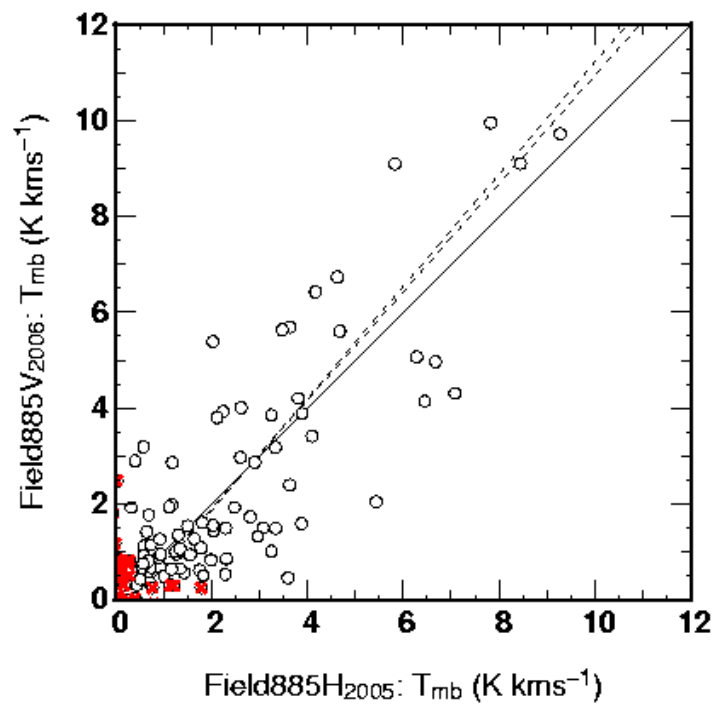
- Field645: all 2005 vs all 2006. Slope OLSB = 1.0



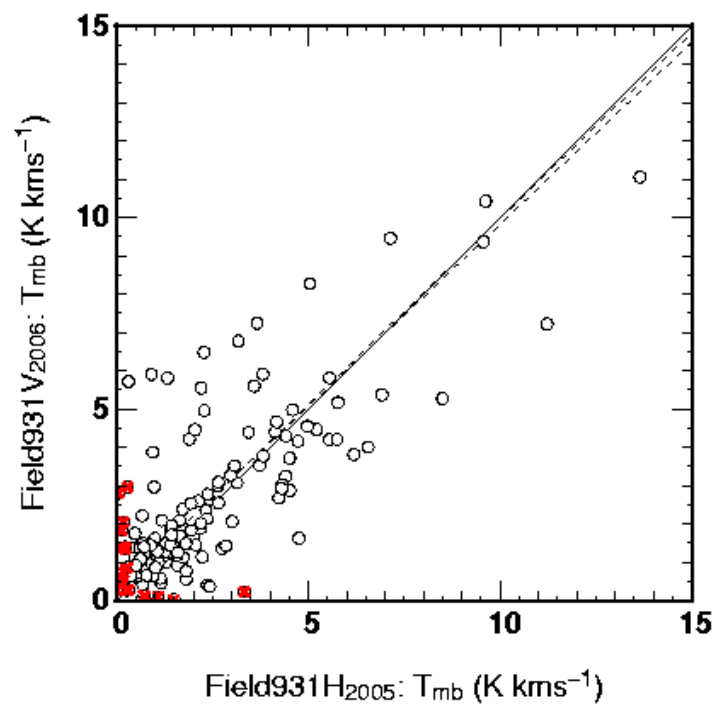
- Field648: all 2005 vs all 2006. Slope OLSB = 1.2



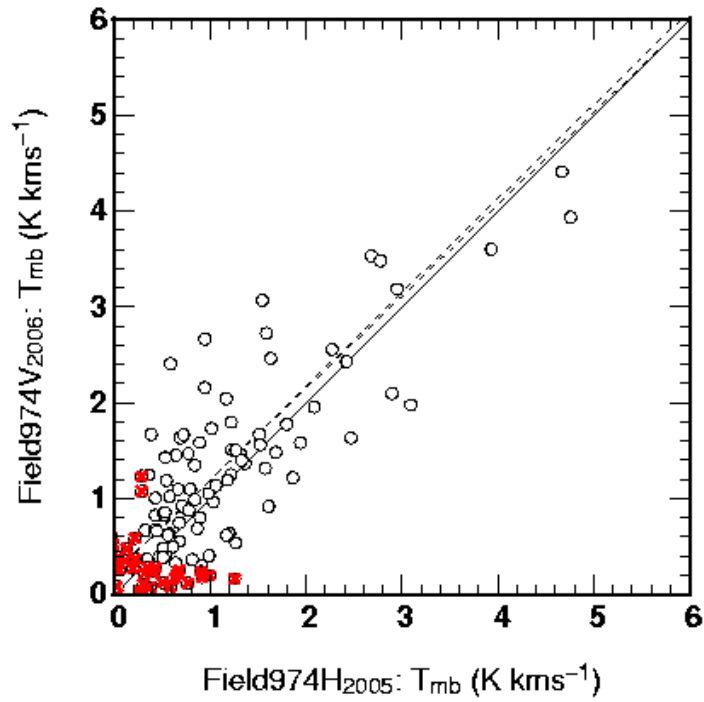
- Field885: all 2005 vs all 2006. Slope OLSB = 1.1



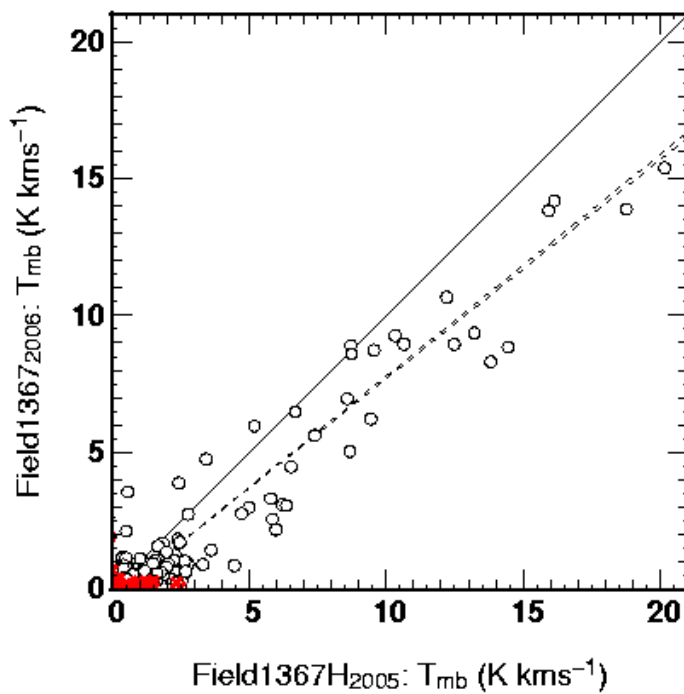
- Field931: all 2005 vs all 2006. Slope OLSB = 1.0



- Field974: all 2005 vs all 2006. Slope OLSB = 1.0



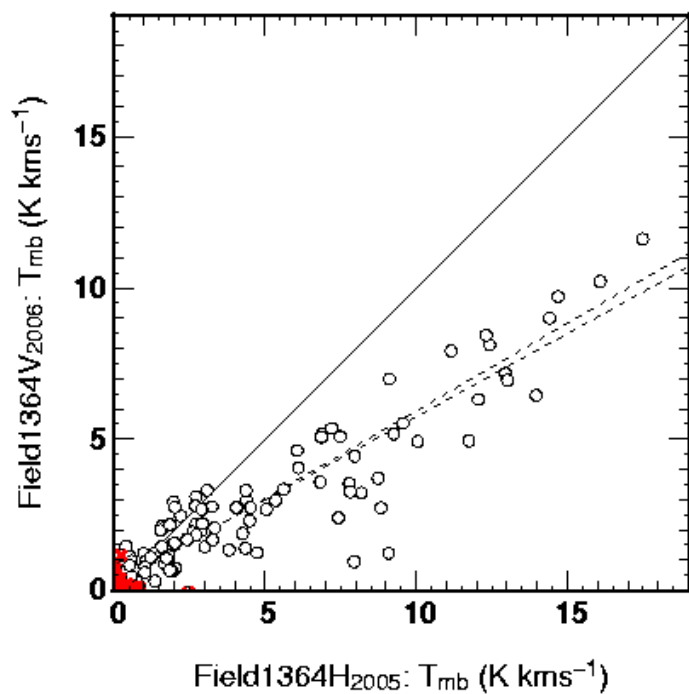
- Field1367: all 2005 vs all 2006. Slope OLSB = 0.8



Example (MPCOR 2005 vs 2006 data): Field 1364

Field 1364 is a nice example because the 12CO emission is relatively strong and positioned in the centre of the field. The data in 2005 and 2006 were taken at similar elevations.

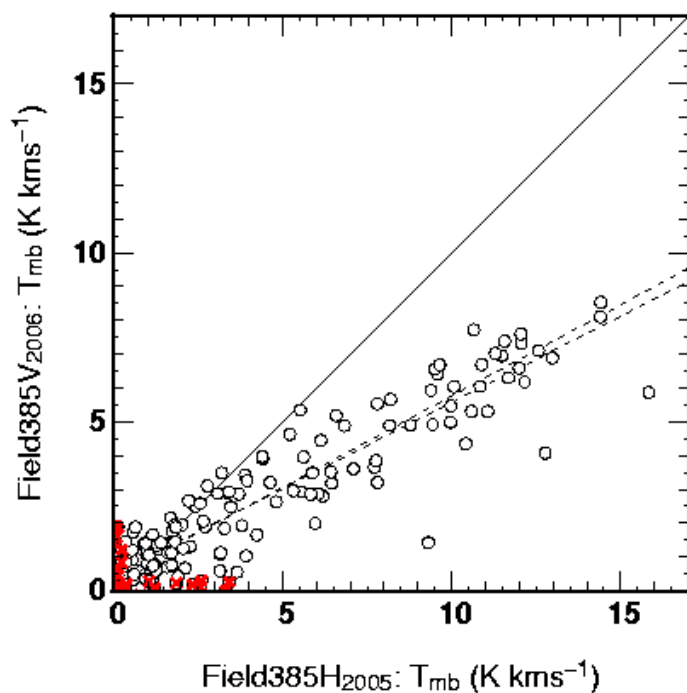
* Field1364: all 2005 (MPCOR) vs all 2006. Slope OLSB = 0.6



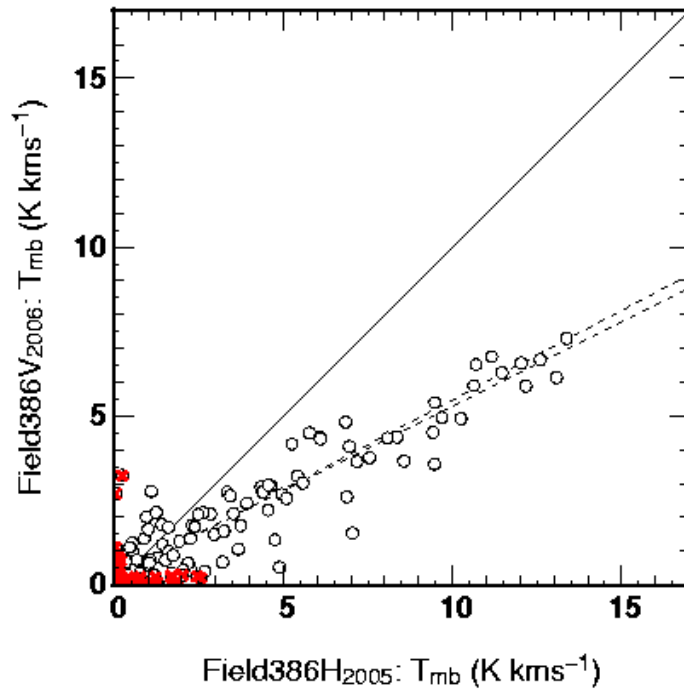
Other Fields (MPCOR 2005 vs 2006)

The difference between MPCOR and MOPS06 is evident for all fields where we have the appropriate data.

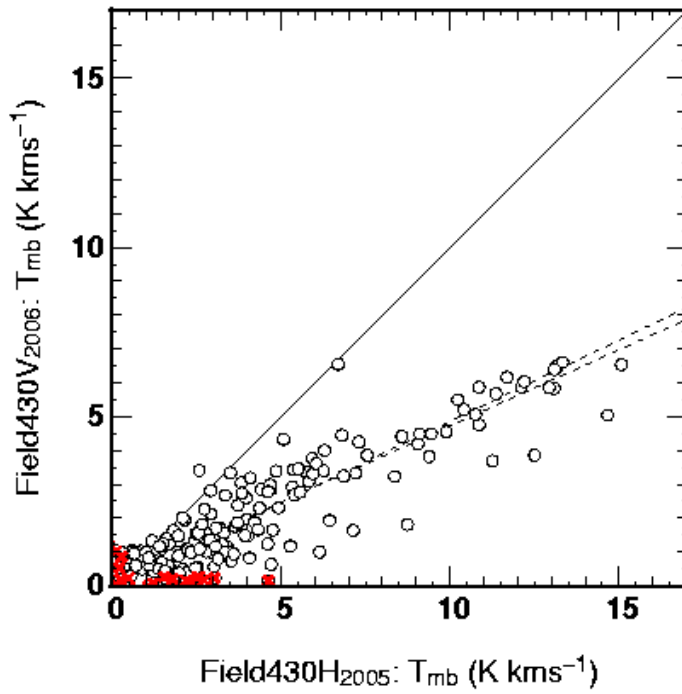
- Field385: all 2005 (MPCOR) vs all 2006. Slope OLSB = 0.5



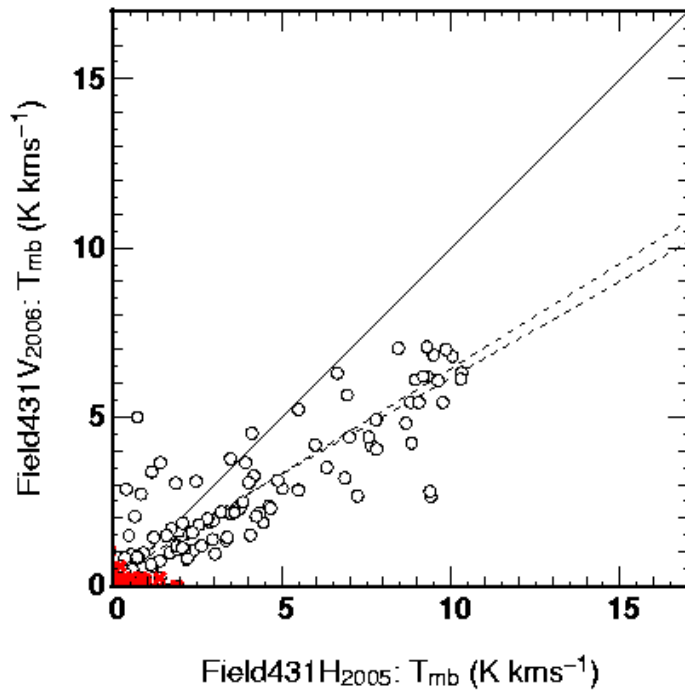
- Field386: all 2005 (MPCOR) vs all 2006. Slope OLSB = 0.5



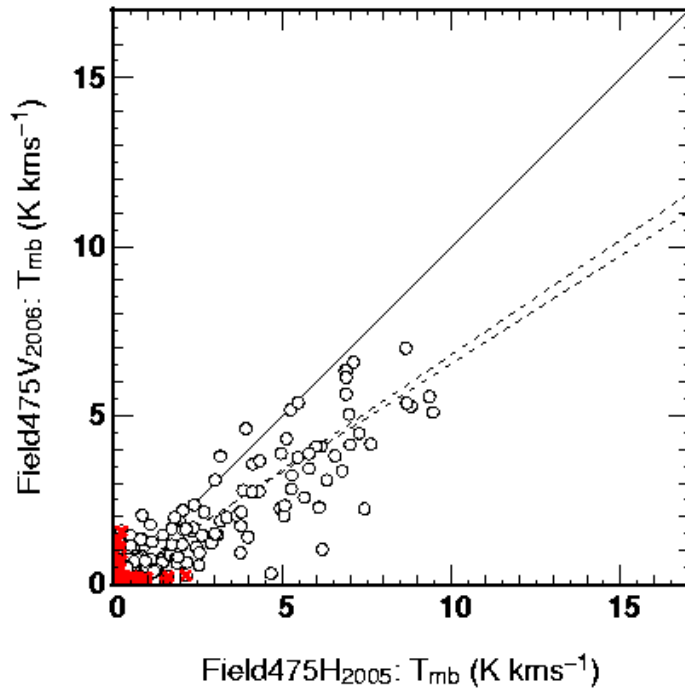
- Field430: all 2005 (MPCOR) vs all 2006. Slope OLSB = 0.5



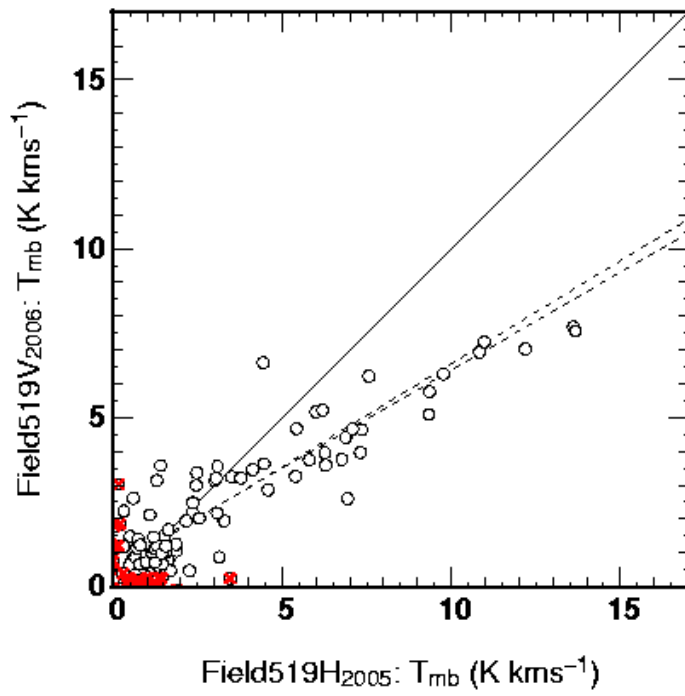
- Field431: all 2005 (MPCOR) vs all 2006. Slope OLSB = 0.6



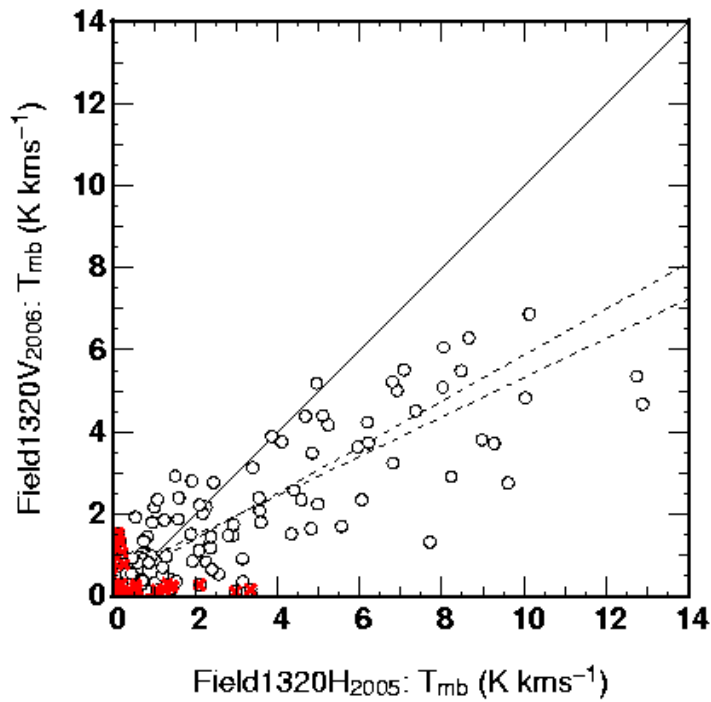
- Field475: all 2005 (MPCOR) vs all 2006. Slope OLSB = 0.7



- Field519: all 2005 (MPCOR) vs all 2006. Slope OLSB = 0.6



- Field1320: all 2005 (MPCOR) vs all 2006. Slope OLSB = 0.6



N159 comparison

For 2007 only, we made some 1' x 1' maps of N159W[?]. Yoji compared the peak flux in the cubes at (05:39:36, -69:45:34) to the value obtained with a position-switched observation at SEST.

Source	RA(2000)	dec (2000)	Date	Efficiency	TA	rms	Tr
Johansson1994	5:39:36.1	-69:45:34.9	1987-1993	0.74			6.8
MOPRA	5:39:35.3	-69:45:28.1	2005				6.15
SEST0008, 0108	5:39:36.1	-69:45:34.9	2000-2001	0.8	5.3	0.47	6.6

MOPRA2007	5:39:36.2	-69:45:33.7	0723_0518	0.4	2.1	5.3
MOPRA2007	5:39:36.1	-69:45:33.6	0723_0524	0.4	2.12	5.3
MOPRA2007	5:39:36.1	-69:45:35.4	0723_0531	0.4	1.94	4.9
MOPRA2007	5:39:36.1	-69:45:34.9	0723_0537	0.4	2.08	5.2
MOPRA2007	5:39:36.1	-69:45:33.8	0723_0550	0.4	2.01	5.0
MOPRA2007	5:39:36.3	-69:45:35.2	0723_2136	0.4	2.42	6.1
MOPRA2007	5:39:36.0	-69:45:34.9	0723_2143	0.4	2.31	5.8
MOPRA2007	5:39:36.0	-69:45:35.1	0802_0146	0.4	2.24	5.6
MOPRA2007	5:39:36.0	-69:45:34.5	0802_0153	0.4	2.37	5.9
MOPRA2007	5:39:36.0	-69:45:35.0	0802_0159	0.4	2.6	6.5
MOPRA2007	5:39:36.0	-69:45:35.3	0806_0153	0.4	2.57	6.4

Attached Files

	Attachment	Action	Size	Date	Who	Comment
	Field1094_2006.Field1095_2007.Tmb.png	manage	6.0 K	03 Oct 2007 - 15:20	AnnieHughes	Field1095: all 2006 vs all 2007
	Field1111_2006.Field1066_2007.Tmb.png	manage	6.1 K	03 Oct 2007 - 15:20	AnnieHughes	Field1111: all 2006 vs all 2007
	Field1202_2006.Field1202_2007.Tmb.png	manage	5.9 K	03 Oct 2007 - 15:20	AnnieHughes	Field1202: all 2006 vs all 2007
	Field1320H_2005.Field1320V_2006.Tmb.png	manage	6.4 K	03 Oct 2007 - 15:20	AnnieHughes	Field1320: all 2005 (MPCOR) vs all 2006
	Field1325_2005.Field1325_2006.Tmb.png	manage	5.8 K	03 Oct 2007 - 15:20	AnnieHughes	Field1325: all 2005 vs all 2006
	Field1364H_2005.Field1364V_2006.Tmb.png	manage	6.0 K	03 Oct 2007 - 15:20	AnnieHughes	Field1364: all 2005 (MPCOR) vs all 2006
	Field1367H_2005.Field1367_2006.Tmb.png	manage	5.8 K	03 Oct 2007 - 15:20	AnnieHughes	Field1367: all 2005 vs all 2006
	Field1645_2006.Field1645V_2007.Tmb.png	manage	6.2 K	03 Oct 2007 - 15:20	AnnieHughes	Field1645: all 2006 vs all 2007
	Field385H_2005.Field385V_2006.Tmb.png	manage	6.3 K	03 Oct 2007 - 15:20	AnnieHughes	Field385: all 2005 (MPCOR) vs all 2006
	Field386H_2005.Field386V_2006.Tmb.png	manage	5.9 K	03 Oct 2007 - 15:20	AnnieHughes	Field386: all 2005 (MPCOR) vs all 2006
	Field430H_2005.Field430V_2006.Tmb.png	manage	6.2 K	03 Oct 2007 - 15:20	AnnieHughes	Field430: all 2005 (MPCOR) vs all 2006
	Field431H_2005.Field431V_2006.Tmb.png	manage	5.9 K	03 Oct 2007 - 15:20	AnnieHughes	Field431: all 2005 (MPCOR) vs all 2006
	Field475H_2005.Field475V_2006.Tmb.png	manage	5.9 K	03 Oct 2007 - 15:20	AnnieHughes	Field475: all 2005 (MPCOR) vs all 2006
	Field498H_2006.Field498H_2007.Tmb.png	manage	6.0 K	03 Oct 2007 - 15:20	AnnieHughes	Field498: 2006 H scan vs 2007 H scan
	Field498H_2006.Field498V_2006.Tmb.png	manage	6.0 K	03 Oct 2007 - 15:20	AnnieHughes	Field498: 2006 H scan vs 2006 V scan
	Field498H_2007.Field498V_2007.Tmb.png	manage	6.3 K	03 Oct 2007 - 15:20	AnnieHughes	Field498: 2007 H scan vs 2007 V scan
	Field498V_2006.Field498V_2007.Tmb.png	manage	6.2 K	03 Oct 2007 - 15:20	AnnieHughes	Field 498: 2006 V scan vs 2007

				15:20	V scan
	Field498_2006.Field498_2007.Tmb.png	manage	6.1 K	03 Oct 2007 - 15:20	AnnieHughes Field498: all 2006 vs all 2007
	Field519H_2005.Field519V_2006.Tmb.png	manage	5.7 K	03 Oct 2007 - 15:20	AnnieHughes Field519: all 2005 (MPCOR) vs all 2006
	Field645H_2005.Field645V_2006.Tmb.png	manage	6.0 K	03 Oct 2007 - 15:20	AnnieHughes Field645: all 2005 vs all 2006
	Field648H_2005.Field648V_2006.Tmb.png	manage	6.0 K	03 Oct 2007 - 15:20	AnnieHughes Field648: all 2005 vs all 2006
	Field885H_2005.Field885V_2006.Tmb.png	manage	6.1 K	03 Oct 2007 - 15:20	AnnieHughes Field885: all 2005 vs all 2006
	Field931H_2005.Field931V_2006.Tmb.png	manage	6.1 K	03 Oct 2007 - 15:20	AnnieHughes Field931: all 2005 vs all 2006
	Field974H_2005.Field974V_2006.Tmb.png	manage	6.2 K	03 Oct 2007 - 15:20	AnnieHughes Field974: all 2005 vs all 2006
	Ta_Tsys.png	manage	4.2 K	03 Oct 2007 - 15:20	AnnieHughes Peak 12CO flux vs system temperature for Orion KL
	Ta_elev.png	manage	4.4 K	03 Oct 2007 - 15:20	AnnieHughes Peak 12CO flux vs elevation for Orion KL
	Ta_vc.png	manage	4.3 K	03 Oct 2007 - 15:20	AnnieHughes Peak 12CO flux vs centre frequency for Orion KL
	lmc20_ii.png	manage	10.5 K	03 Oct 2007 - 15:20	AnnieHughes LMC20
	lmc21_ii.png	manage	5.1 K	03 Oct 2007 - 15:20	AnnieHughes LMC21
	lmc32_ii.png	manage	7.4 K	03 Oct 2007 - 15:20	AnnieHughes LMC32
	lmc36_ii.png	manage	10.3 K	03 Oct 2007 - 15:20	AnnieHughes LMC36
	lmc37_ii.png	manage	8.7 K	03 Oct 2007 - 15:20	AnnieHughes LMC37
	lmc53_ii.png	manage	9.4 K	03 Oct 2007 - 15:20	AnnieHughes LMC53
	m17sw_cal.png	manage	3.9 K	23 Oct 2007 - 02:26	AnnieHughes M17SW? calibration scans: 2006 and 2007
	ori_vc_freq.png	manage	8.1 K	26 Mar 2010 - 12:08	AnnieHughes
	orikl_peak_vc.png	manage	8.2 K	04 Apr 2010 - 17:24	AnnieHughes
	orikl_4years_bymonth.png	manage	7.9 K	25 Mar 2010 - 11:20	AnnieHughes
	orikl_4years_vc.png	manage	8.2 K	25 Mar 2010 - 11:20	AnnieHughes
	orikl_cal.png	manage	5.5 K	23 Oct 2007 - 02:26	AnnieHughes OrionKL? calibration scans: 2005 to 2007

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