

PDR-Model Comparison

Lorentz Center Leiden

Benchmark Problem Results

M.Röllig

Participating Models

<i>Model Name</i>	<i>Authors</i>
Aikawa	<i>H.-H. Lee, E. Herbst, G. Pineau des Forets, J. Le Bourlot, Y. Aikawa, N. Kuboi</i>
Bensch	<i>H. Störzer, B. Köster, M. Zilinsky, U. Leuenhagen, S.Jeyakumar, F. Bensch</i>
CLOUDY	<i>Gary J. Ferland, Peter van Hoof, Nick P. Abel, Gargi Shaw</i>
COSTAR	<i>I. Kamp, F. Bertoldi, G.-J. van Zadelhoff</i>
HTBKW	<i>D. Hollenbach, A.G.G.M. Tielens, M.G. Burton, M.J. Kaufman, M.G. Wolfire</i>
KOSMA	<i>H. Störzer, B. Köster, M. Zilinsky, U. Leuenhagen, S.Jeyakumar, M.Röllig</i>
Lee96mod	<i>H.-H. Lee, E. Herbst, G. Pineau des Forets, E. Roueff, J. Le Bourlot</i>
Leiden	<i>J. Black, E. van Dishoeck, D. Jansen and B. Jonkheid</i>
Meijerink	<i>R.Meijerink, M.Spaans</i>
Meudon	<i>J. Le Bourlot, E. Roueff, F. Le Petit</i>
Sternberg	<i>A.Sternberg, A.Dalgarno</i>
UCL_PDR	<i>S. Viti, Wing-Fai Thi, Tom Bell</i>

Benchmark Calculations

- standard chemistry:

31 species

H, H⁺, H₂, H₂⁺, H₃⁺, O, O⁺, OH⁺, OH, O₂, O₂⁺,
H₂O, H₂O⁺, H₃O⁺, C, C⁺, CH, CH⁺, CH₂,
CH₂⁺, CH₃, CH₃⁺, CH₄, CH₄⁺, CH₅⁺, CO, CO⁺,
HCO⁺, He, He⁺, e⁻

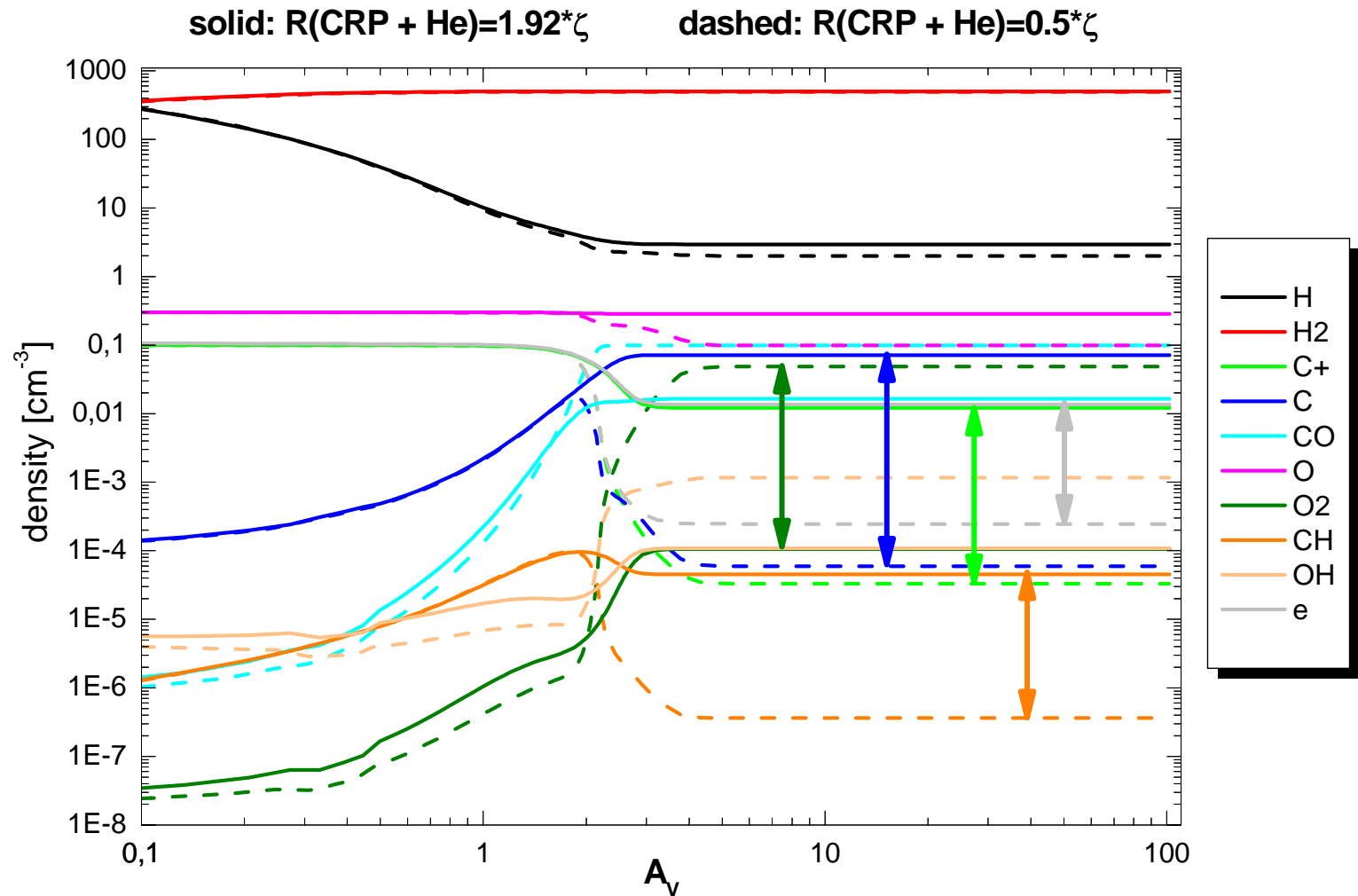
elemental abundances

He=0.1, C=1.0x10⁻⁴, O=3.0x10⁻⁴

standardized chemical network

PAH's switched off

Influence of **one single** CRP rate



Benchmark Calculations

- standard radiation field

normalized to Draine field(1978)

cosmic-ray ionization: $\zeta=5 \times 10^{-17} \text{ s}^{-1}$

visual extinction: $A_V=6.289 \times 10^{-22} \times N_{\text{Htotal}}$

dust attenuation: $\tau_{UV}=3.02 \times A_V$

Benchmark Calculations

Requested Quantities

For the species: H, H₂, C⁺, C, CO, O, O₂, CH, OH, e⁻

1. local absolute volume densities (cm⁻³) vs. depth
2. column densities (cm⁻²) vs. depth
3. dissociation/ionization rates (s⁻¹) vs. depth for H₂, C, CO
4. local cooling/heating rates (erg s⁻¹ cm⁻³)
fine structure lines of CII(158m), OI(63μ,146μ), and
CI(610μ,370μ), and photoelectric grain heating
5. gas and dust temperature for models F5-F8

Benchmark Calculations

F1 completed by all 12 groups

F2-F4 complete by 10 groups

F5-F8 completed by 8 groups (some with numerical 'noise')

CLOUDY uses different chemical network

KOSMA/Bensch use spherical geometry

results for Lee96mod are for $t=10^8$ yrs

<p>F1 T=const $n=10^3 \text{ cm}^{-3}, \chi=10$</p>	<p>F2 T=const $n=10^3 \text{ cm}^{-3}, \chi=10^5$</p>
<p>F3 T=const $n=10^{5.5} \text{ cm}^{-3}, \chi=10$</p>	<p>F4 T=const $n=10^{5.5} \text{ cm}^{-3}, \chi=10^5$</p>
<p>F5 T=variable $n=10^3 \text{ cm}^{-3}, \chi=10$</p>	<p>F6 T=variable $n=10^3 \text{ cm}^{-3}, \chi=10^5$</p>
<p>F7 T=variable $n=10^{5.5} \text{ cm}^{-3}, \chi=10$</p>	<p>F8 T=variable $n=10^{5.5} \text{ cm}^{-3}, \chi=10^5$</p>

Preliminary Results

overview plots of the benchmark runs will be available online as PDF files:

<http://www.ph1.uni-koeln.de/~roellig/>

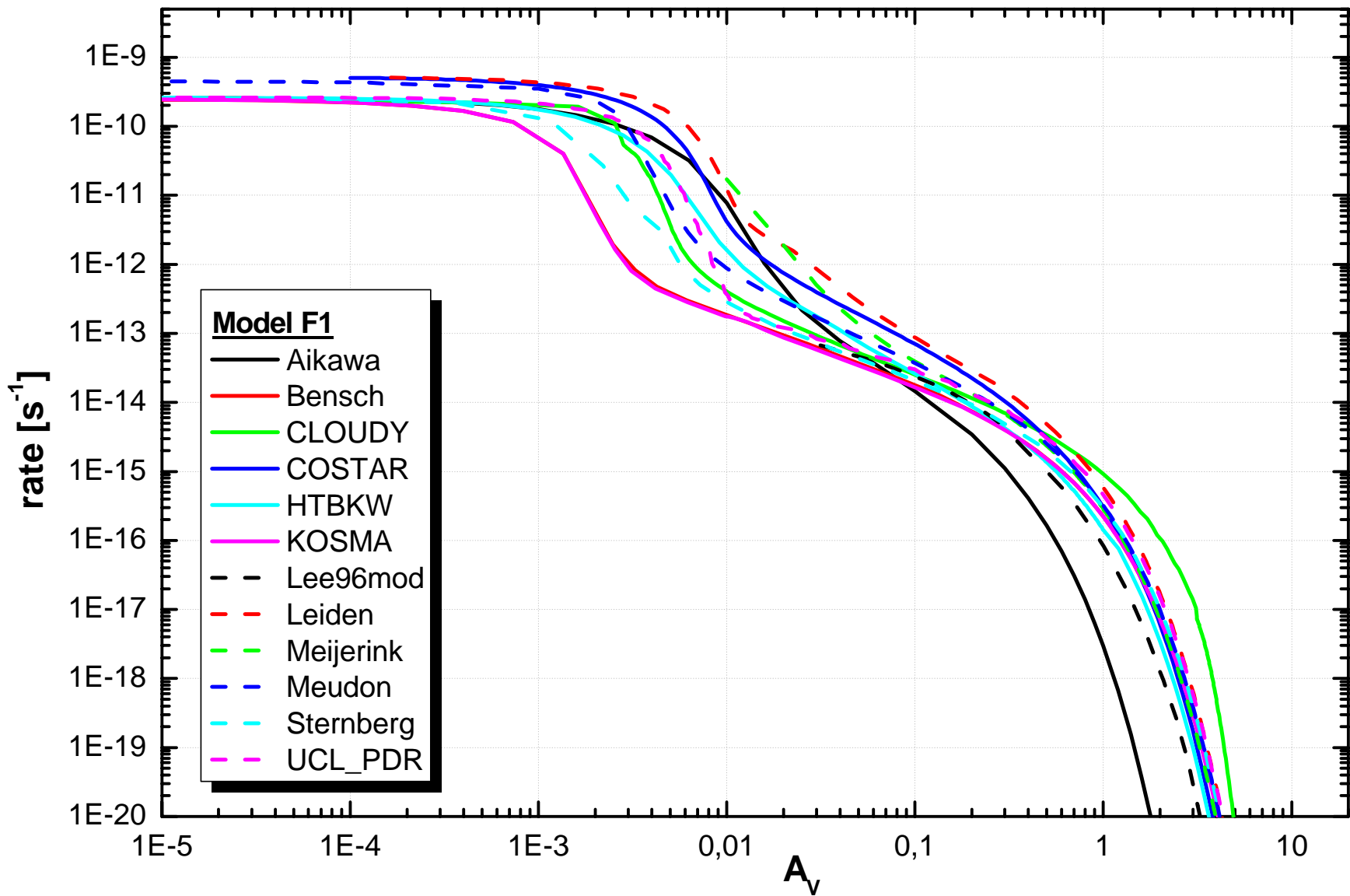
Model Results F1-F8

- photoreaction rates
- densities
- heating/cooling rates
- surface brightnesses

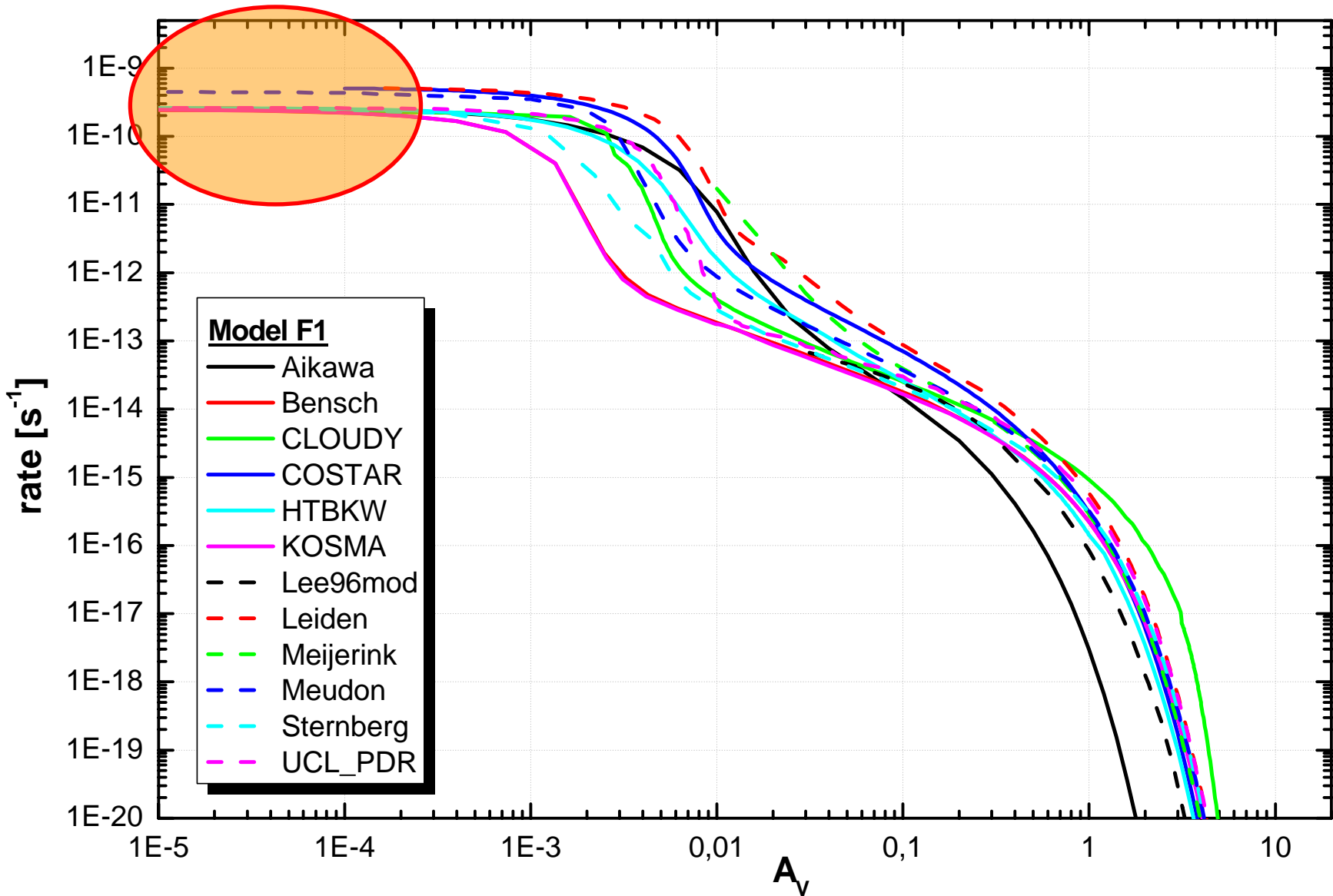
Model Results F1-F8

- photoreaction rates
- densities
- heating/cooling rates
- surface brightnesses

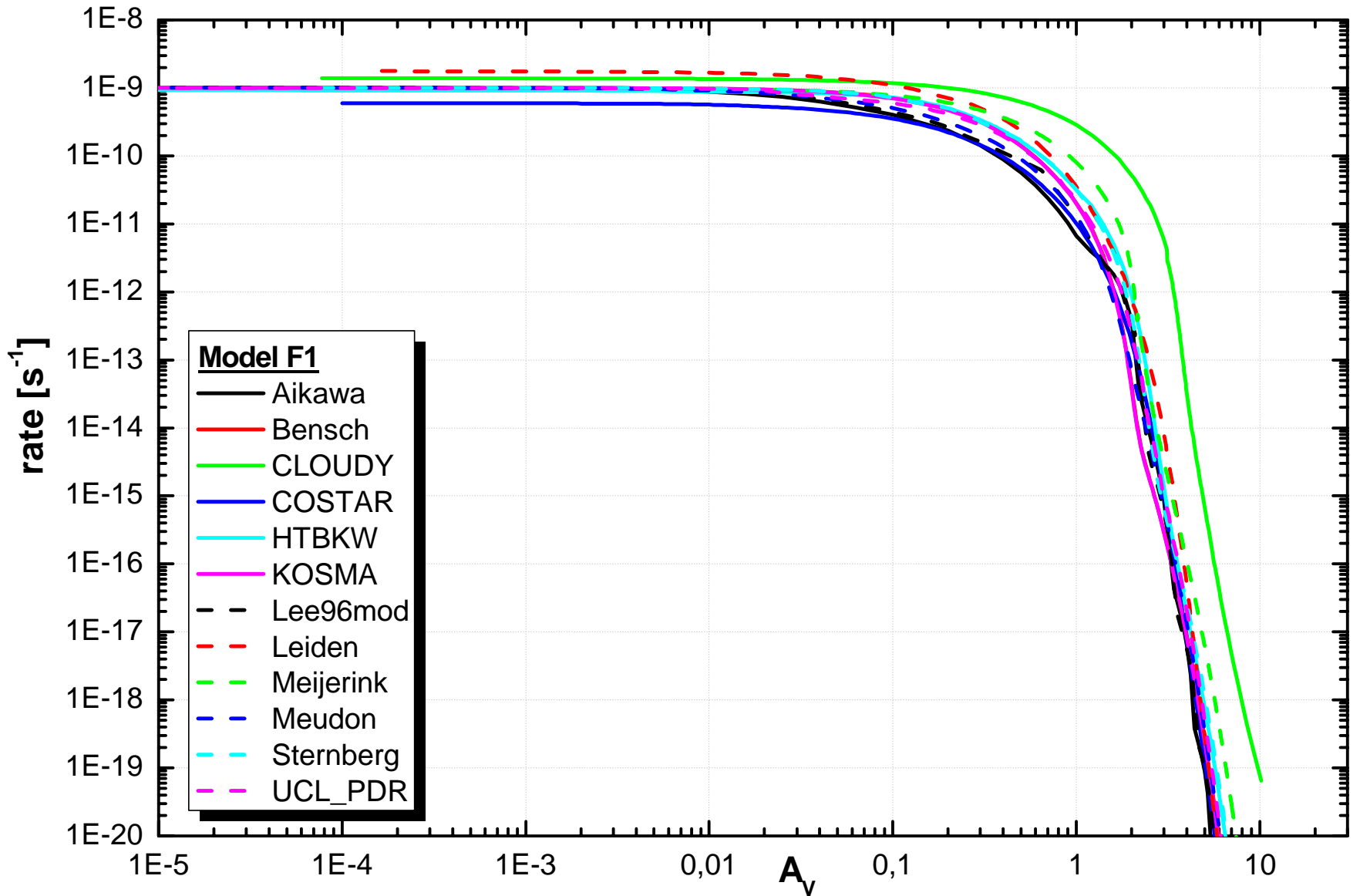
H₂ photodissociation rate - $n = 10^3 \text{ cm}^{-3}$, $\chi = 10$



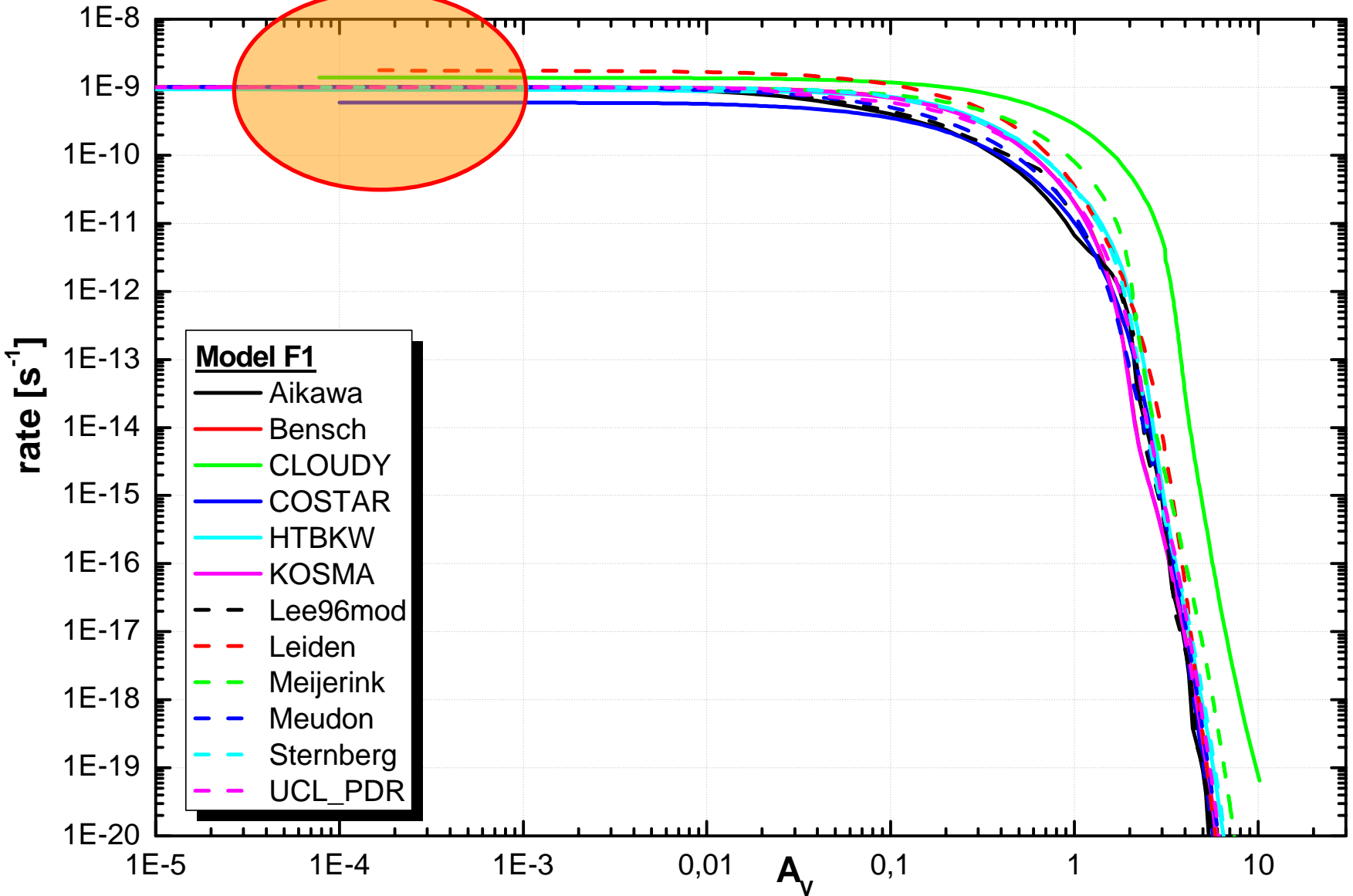
H₂ photodissociation rate - $n = 10^3 \text{ cm}^{-3}$, $\chi = 10$



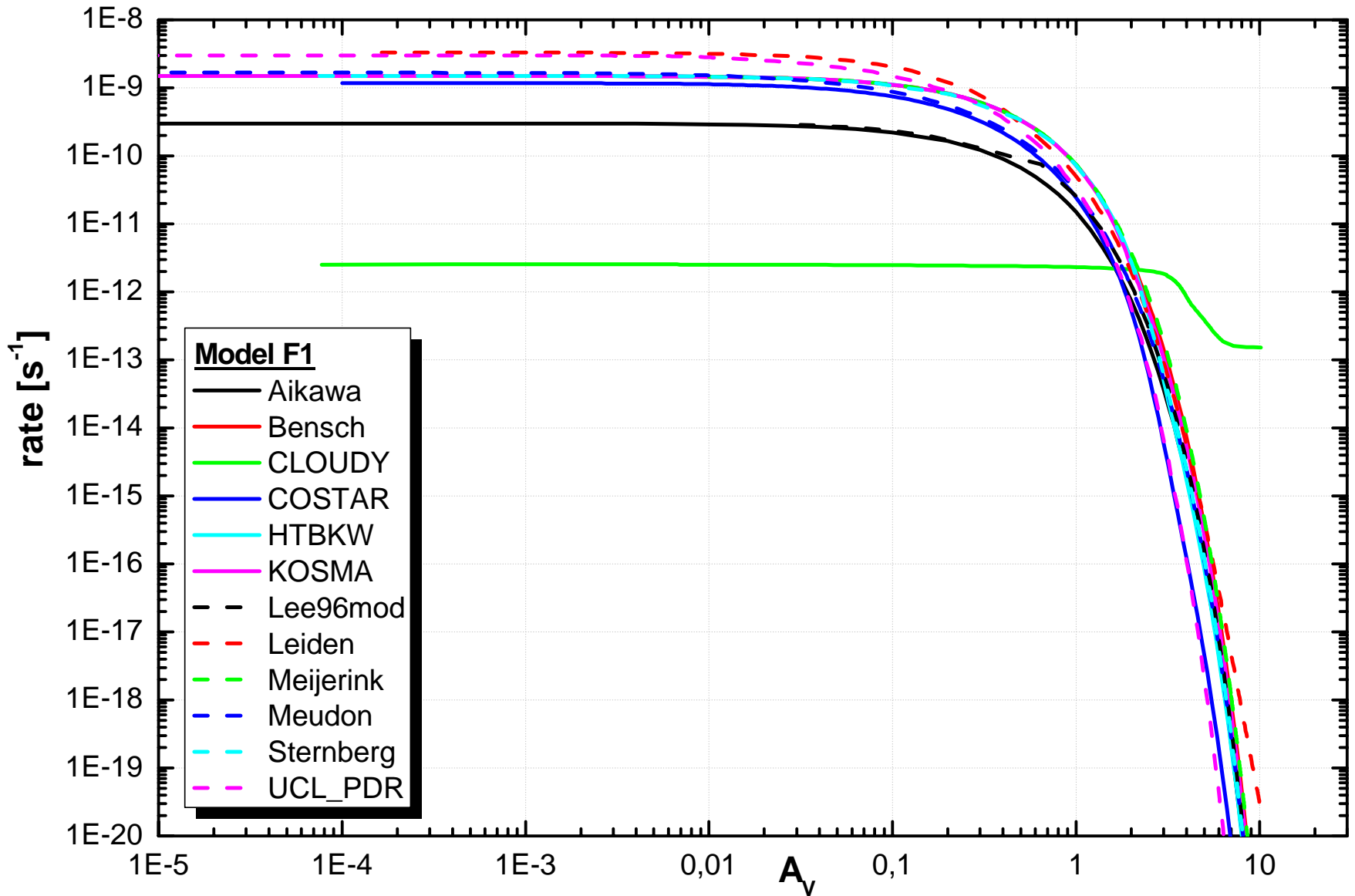
CO photodissociation rate - $n = 10^3 \text{ cm}^{-3}$, $\chi = 10$



CO photodissociation rate - $n = 10^3 \text{ cm}^{-3}$, $\chi = 10$



Cl ionization rate - $n = 10^3 \text{ cm}^{-3}$, $\chi = 10$



Cl ionization rate - $n = 10^3 \text{ cm}^{-3}$, $\chi = 10$

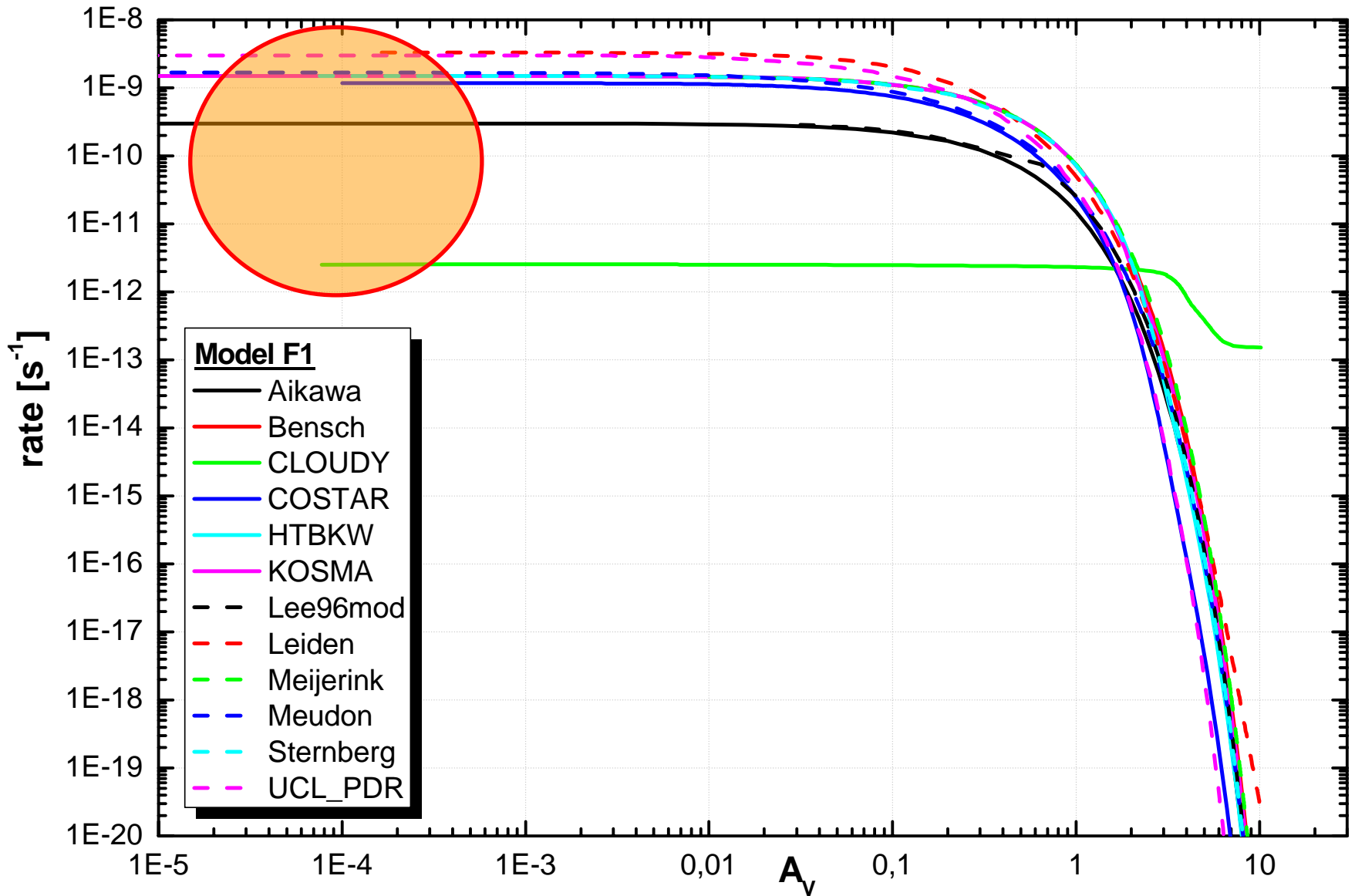


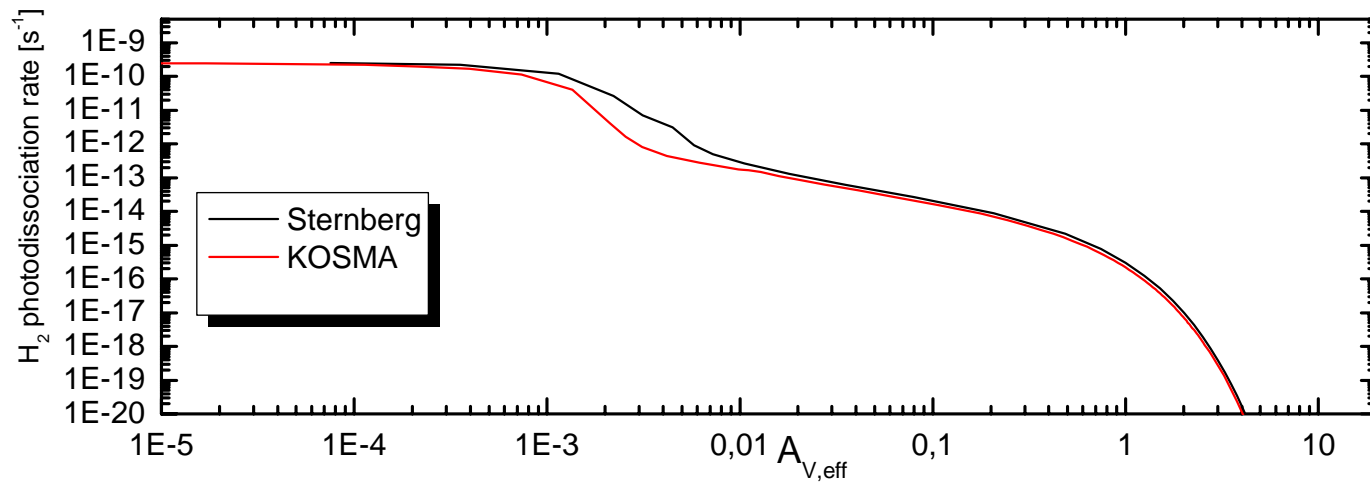
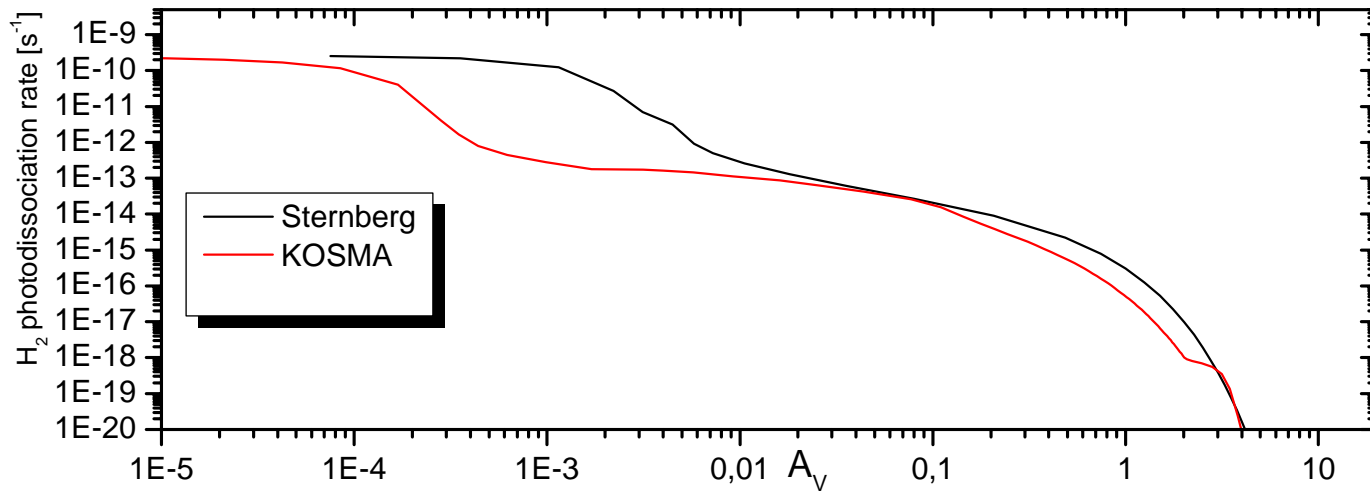
Photo-rates at first data point

Modell	z	AV	H2	CO	CI	H2/Sternb	CO/Sternb	CI/Sternb
Aikawa	0,00E+00	0	2,59E-10	1,00E-09	3,00E-10	1,01E+00	1,00E+00	2,00E-01
Bensch	0,00E+00	0	2,47E-10	1,00E-09	1,50E-09	9,59E-01	1,00E+00	1,00E+00
CLOUDY	1,23E+14	7,74E-05	2,32E-10	1,38E-09	2,53E-12	9,02E-01	1,38E+00	1,69E-03
COSTAR	0,00E+00	0	5,18E-10	5,99E-10	1,17E-09	2,02E+00	5,99E-01	7,80E-01
HTBKW	4,77E+10	3,00E-08	2,60E-10	1,00E-09	1,50E-09	1,01E+00	1,00E+00	1,00E+00
KOSMA	1,00E+06	1,79E-11	2,47E-10	9,65E-10	1,50E-09	9,63E-01	9,65E-01	1,00E+00
Lee96mod	5,00E+16	3,15E-02	6,74E-14	7,51E-10	2,86E-10	2,62E-04	7,51E-01	1,91E-01
Leiden	1,86E+14	1,65E-04	5,07E-10	1,77E-09	3,32E-09	1,97E+00	1,77E+00	2,21E+00
Meijerink	0,00E+00	0,00E+00	2,59E-10	1,00E-09	1,50E-09	1,01E+00	1,00E+00	1,00E+00
Meudon	7,90E+10	5,00E-08	4,46E-10	1,01E-09	1,68E-09	1,74E+00	1,01E+00	1,12E+00
Sternberg	0,00E+00	0,00E+00	2,57E-10	1,00E-09	1,50E-09	1,00E+00	1,00E+00	1,00E+00
UCL_PDR	1,70E+12	1,07E-06	2,59E-10	1,00E-09	3,00E-09	1,01E+00	1,00E+00	2,00E+00

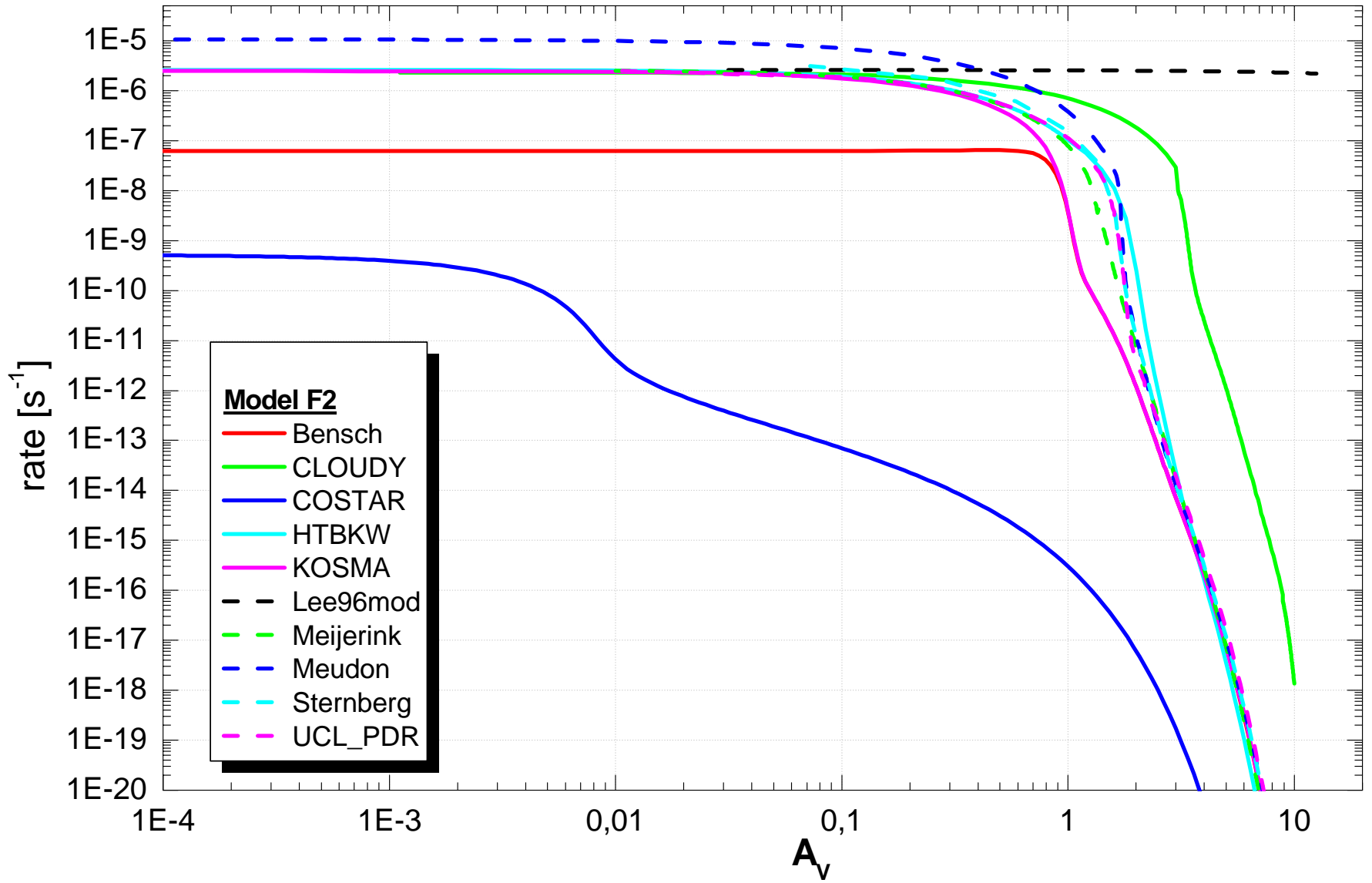
Photo-rates at $z=5 \times 10^{16}$ cm

Modell	z	AV	H2	CO	CI	H2/Sternb	CO/Sternb	CI/Sternb
Aikawa	5,00E+16	3,20E-02	1,33E-13	6,80E-10	2,74E-10	1,89E+00	7,49E-01	2,04E-01
Bensch	5,00E+16	1,00E-01	1,70E-14	7,04E-10	1,08E-09	2,41E-01	7,75E-01	8,06E-01
CLOUDY	5,00E+16	3,10E-02	8,71E-14	1,30E-09	2,54E-12	1,24E+00	1,43E+00	1,90E-03
COSTAR	5,00E+16	3,20E-02	3,65E-13	4,97E-10	1,01E-09	5,18E+00	5,47E-01	7,54E-01
HTBKW	5,00E+16	3,10E-02	1,66E-13	8,54E-10	1,38E-09	2,35E+00	9,41E-01	1,03E+00
KOSMA	5,00E+16	1,00E-01	1,54E-14	6,80E-10	1,08E-09	2,18E-01	7,49E-01	8,06E-01
Lee96mod	5,00E+16	3,15E-02	6,74E-14	7,51E-10	2,86E-10	9,56E-01	8,27E-01	2,14E-01
Leiden	5,00E+16	2,60E-02	1,12E-12	1,54E-09	2,91E-09	1,59E+01	1,70E+00	2,17E+00
Meijerink	4,77E+16	3,00E-02	5,04E-13	9,28E-10	1,37E-09	7,15E+00	1,02E+00	1,02E+00
Meudon	5,00E+16	3,20E-02	1,60E-13	7,53E-10	1,28E-09	2,27E+00	8,29E-01	9,55E-01
Sternberg	5,00E+16	3,20E-02	7,05E-14	9,08E-10	1,34E-09	1,00E+00	1,00E+00	1,00E+00
UCL_PDR	5,00E+16	3,20E-02	7,94E-14	7,74E-10	2,30E-09	1,13E+00	8,52E-01	1,72E+00

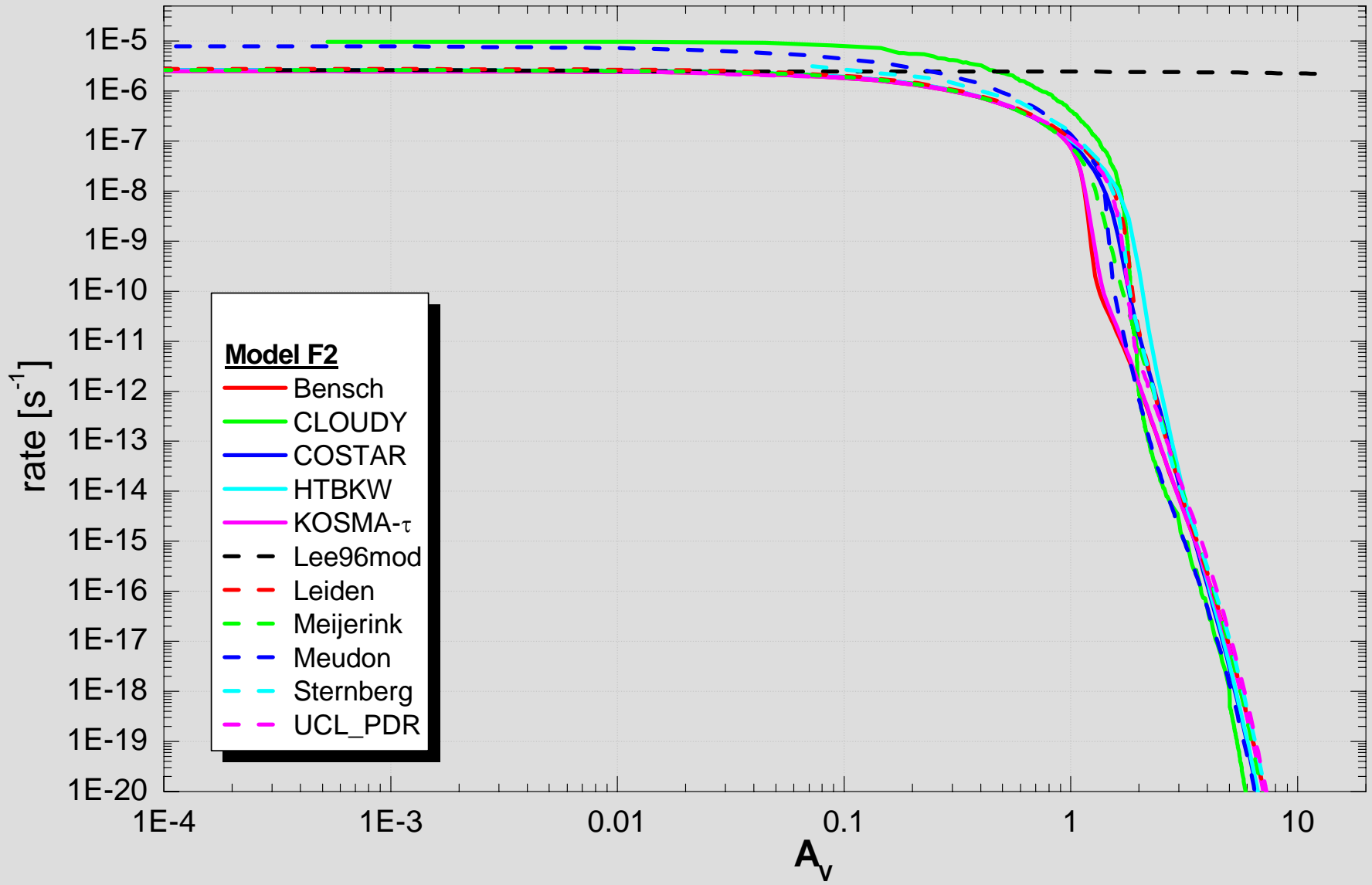
Transformation $A_V - A_{V,eff}$



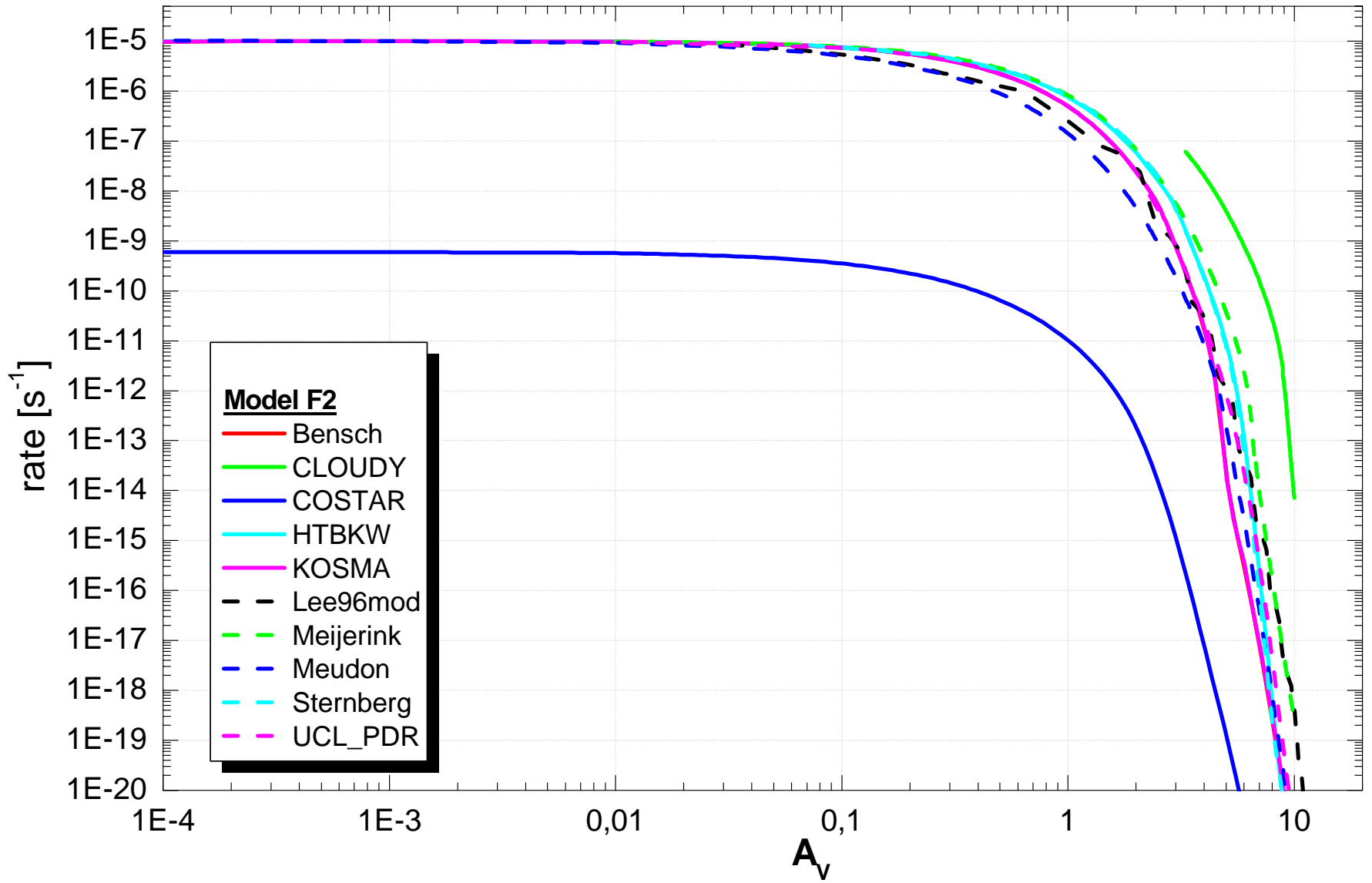
H₂ dissociation rate - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



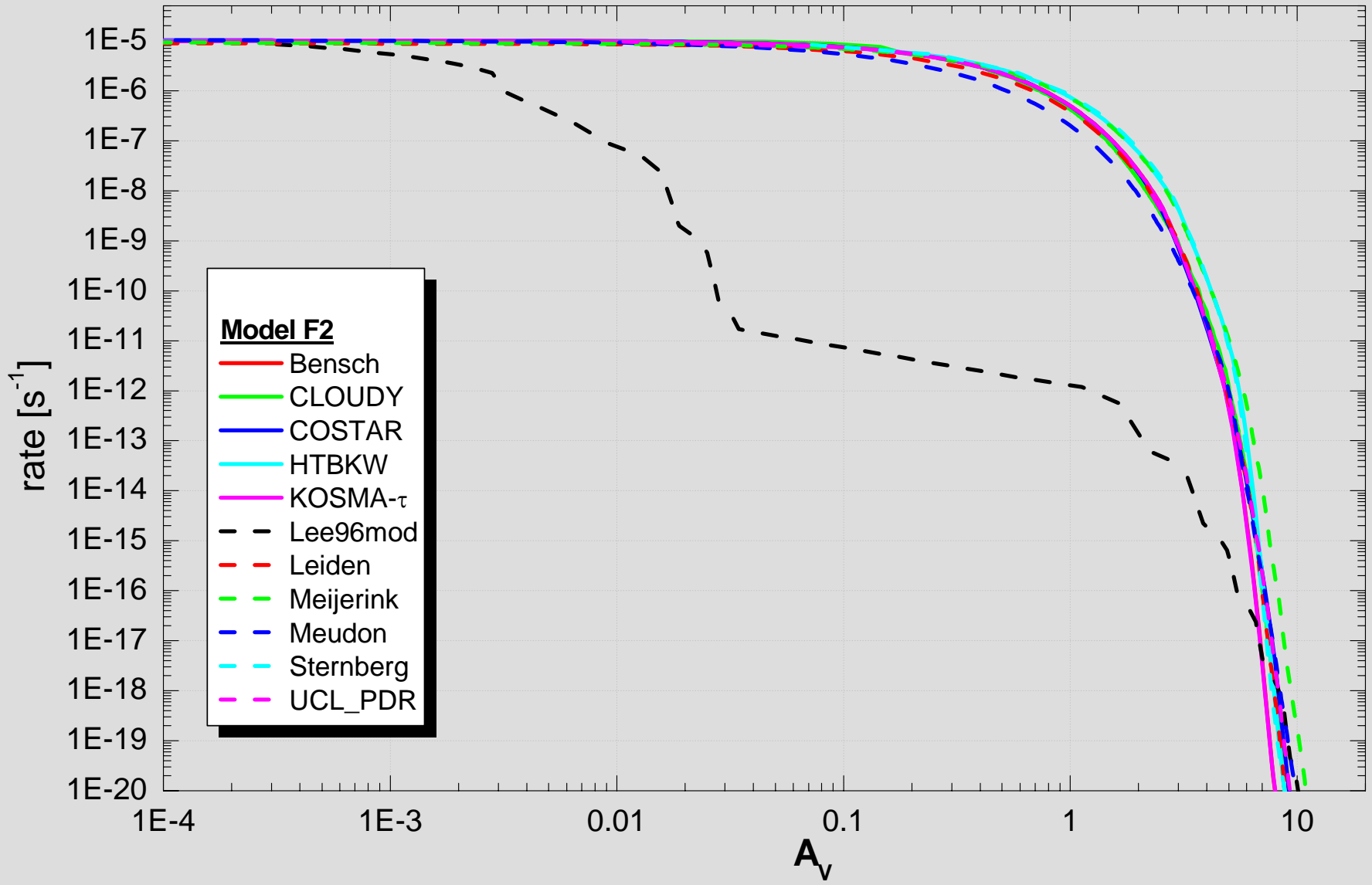
H₂ dissociation rate - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



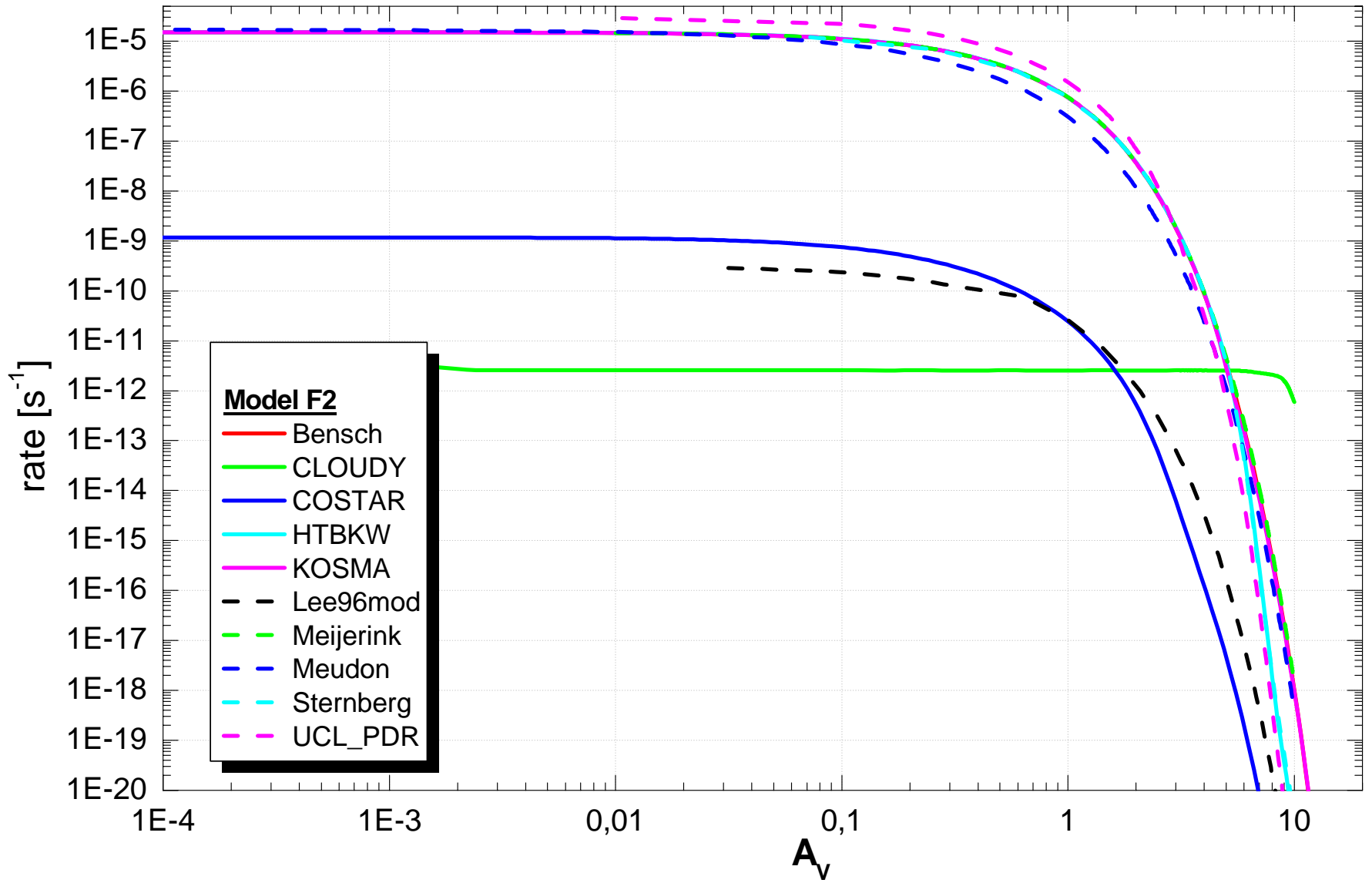
CO dissociation rate - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



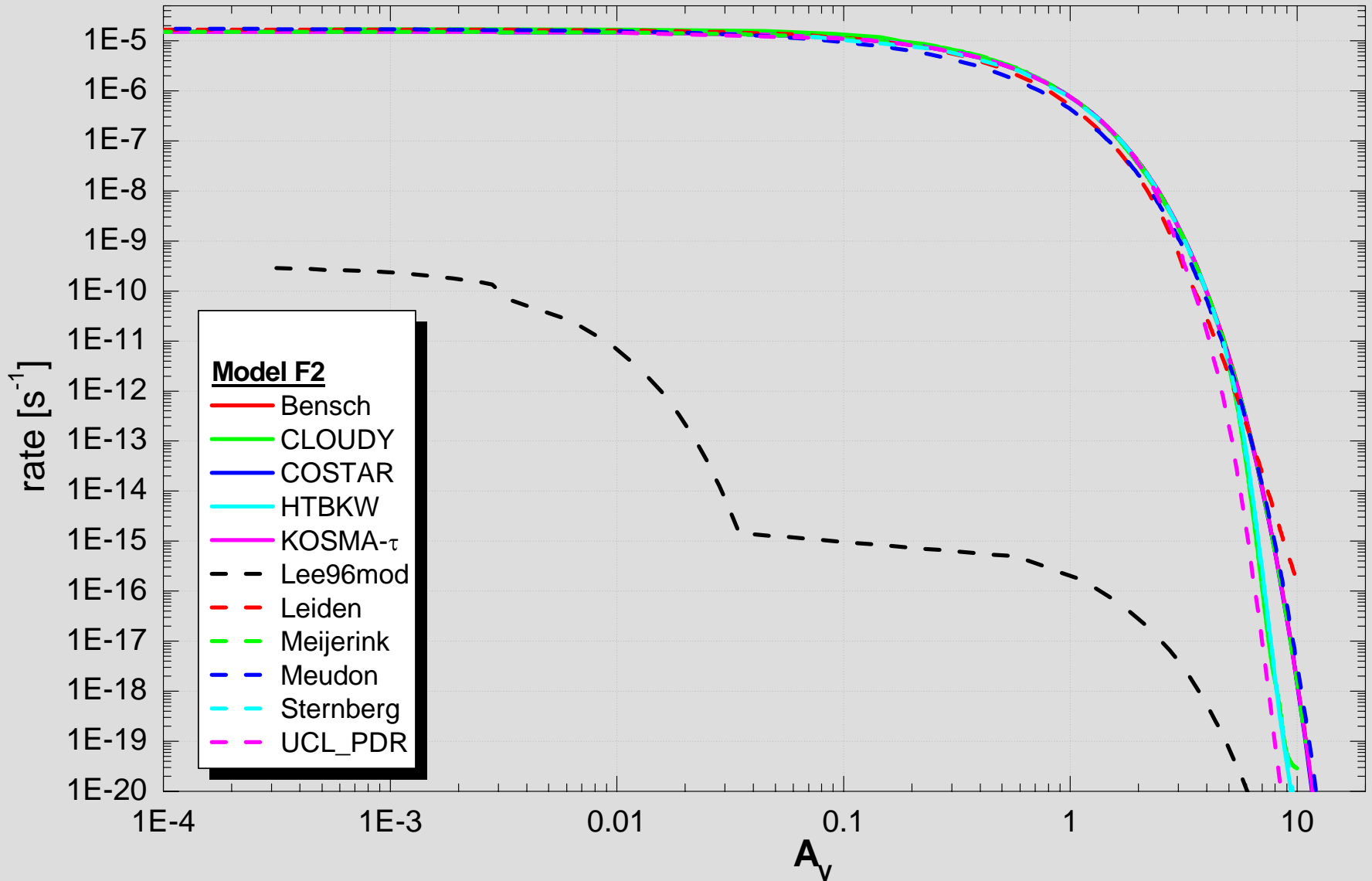
CO dissociation rate - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



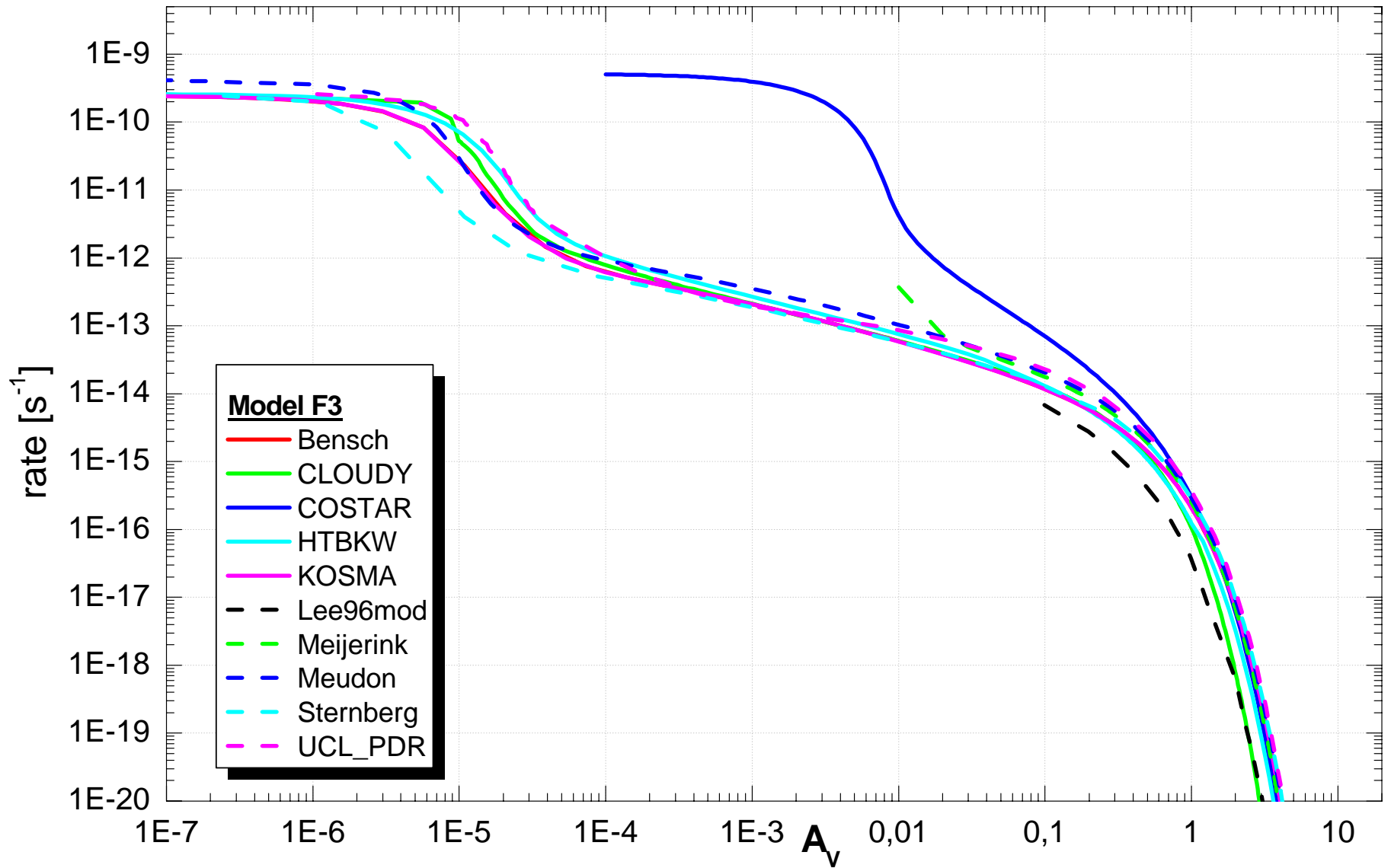
C ionization rate - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



C ionization rate - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



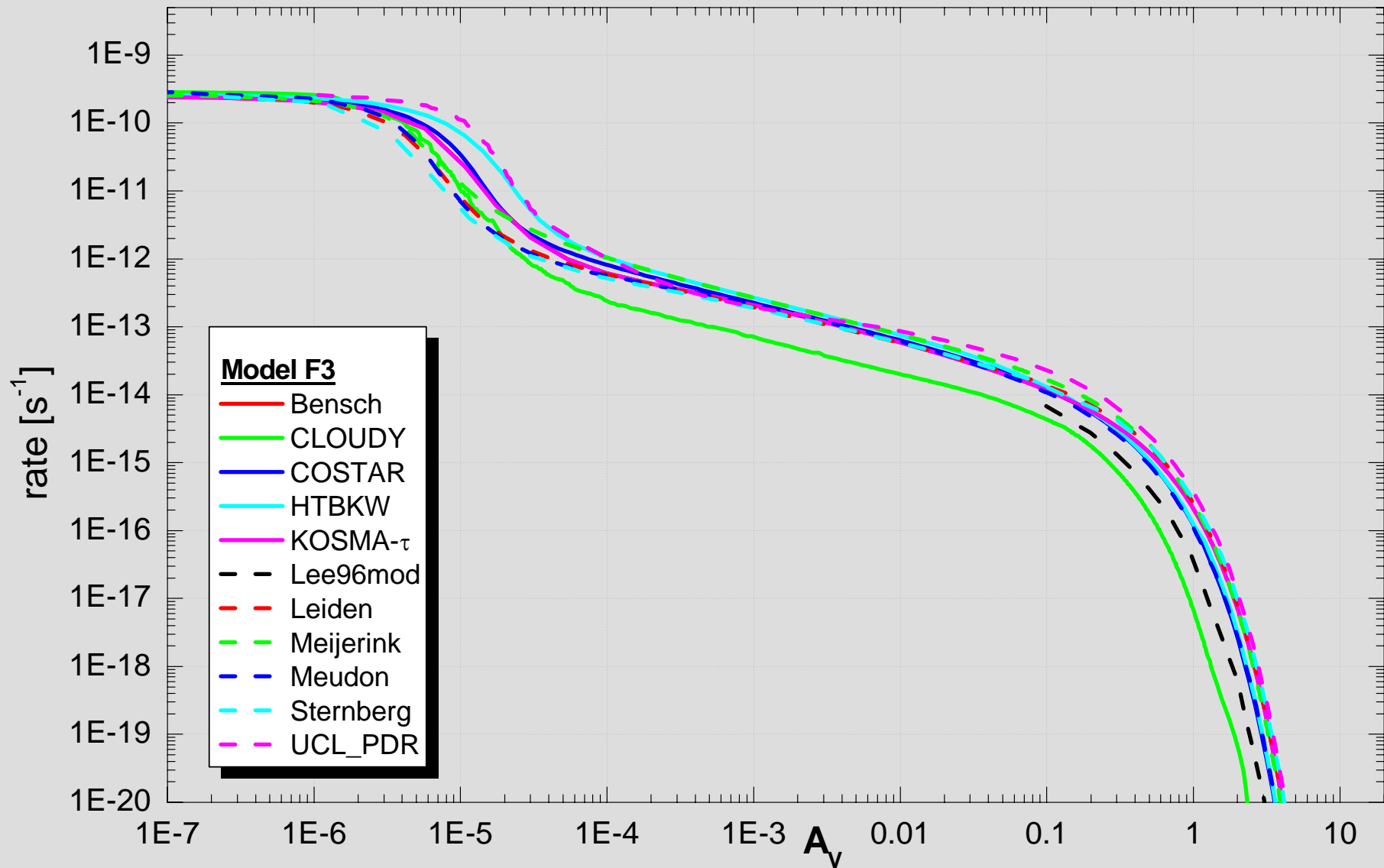
H₂ dissociation rate - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



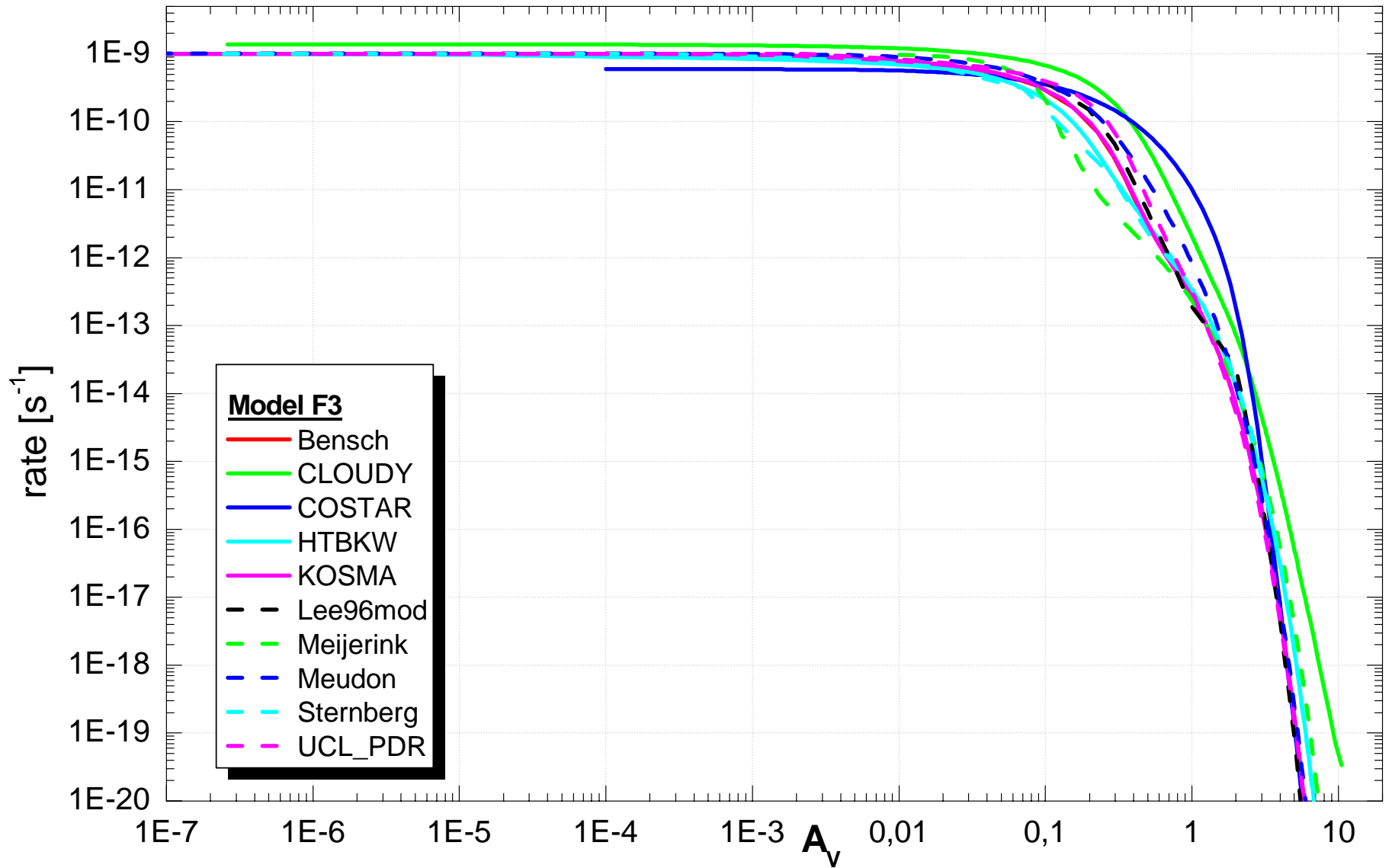
5.-8. April, 2004

PDR Model Comparison

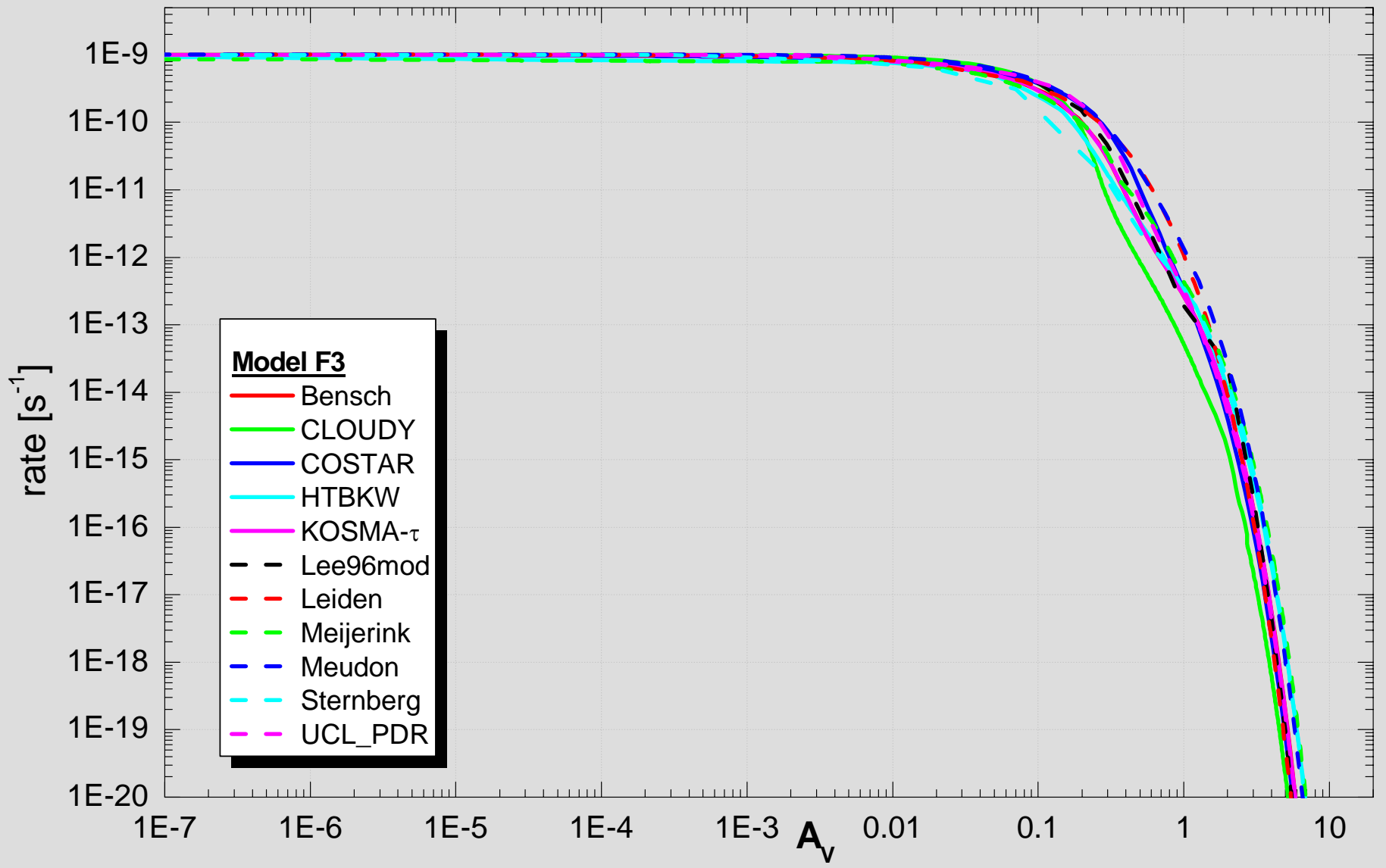
H₂ dissociation rate - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



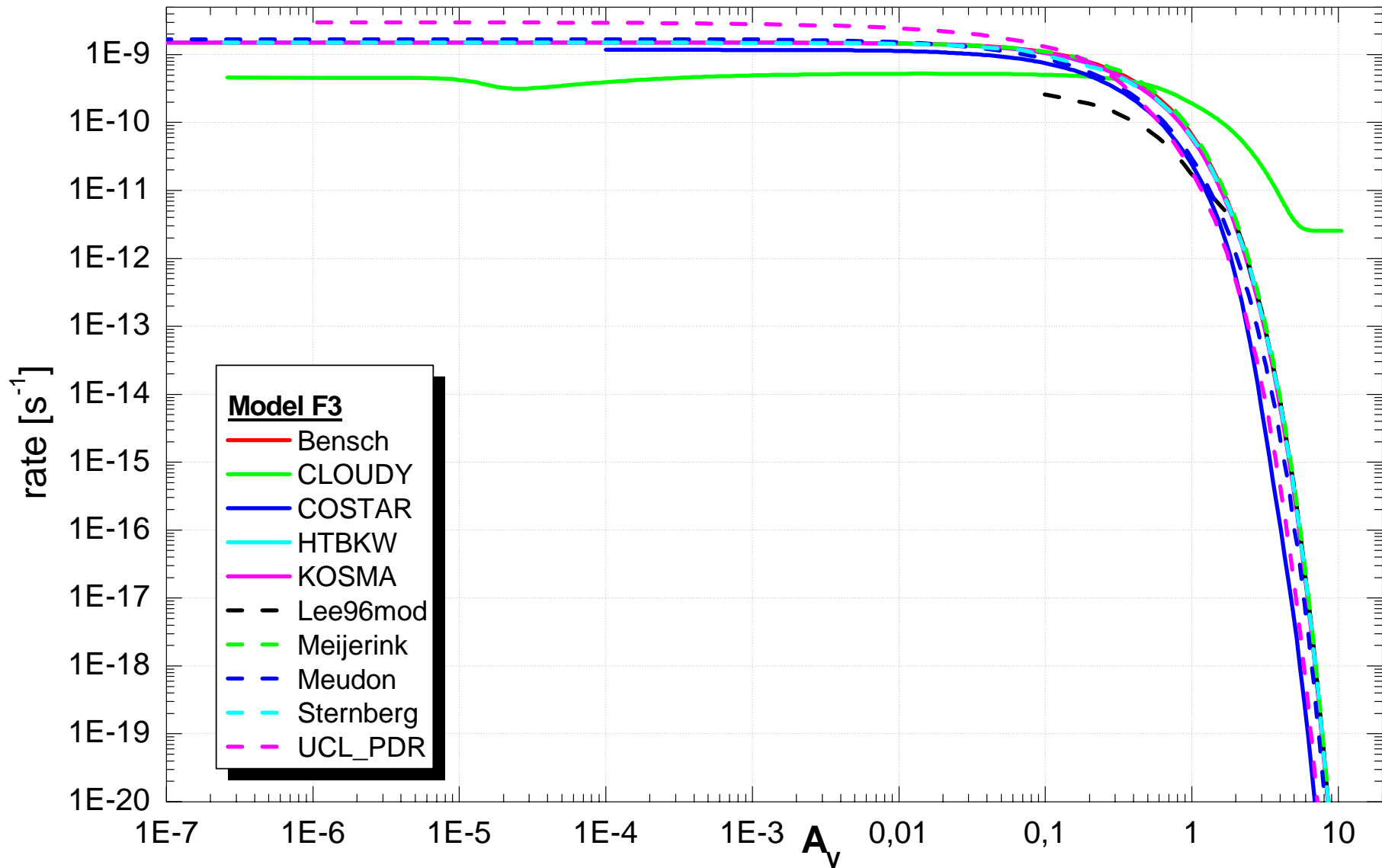
CO dissociation rate - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



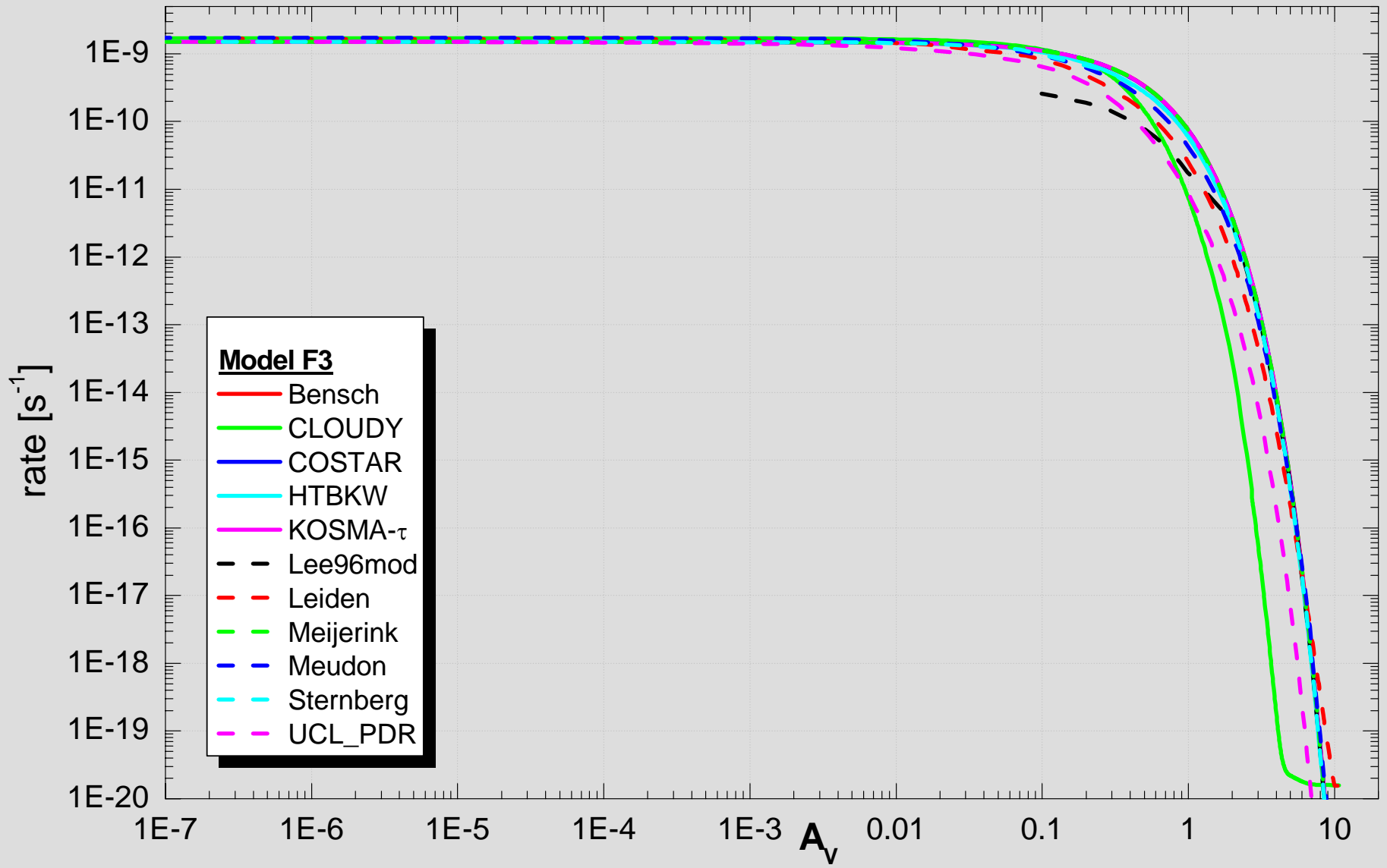
CO dissociation rate - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



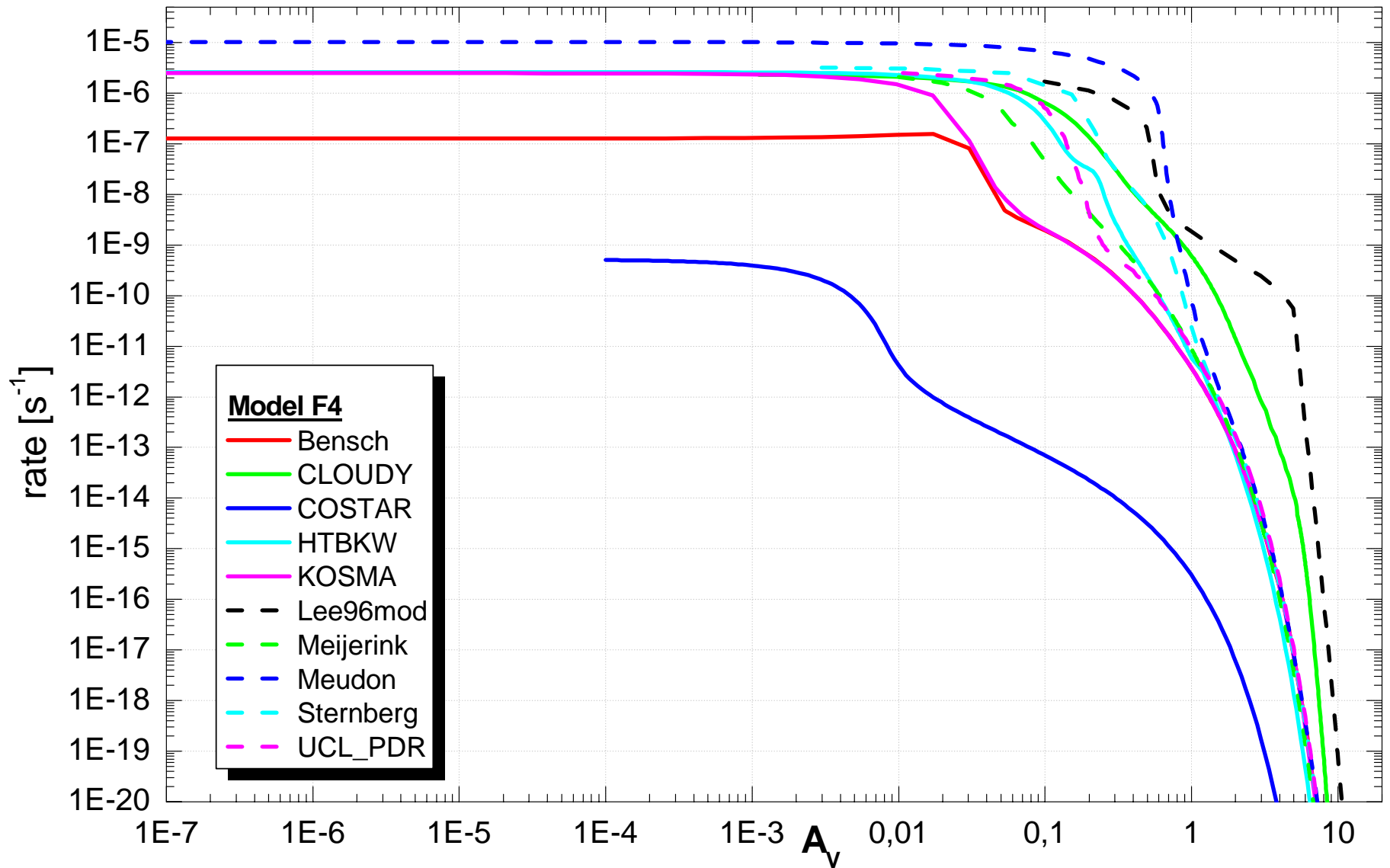
C ionization rate - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



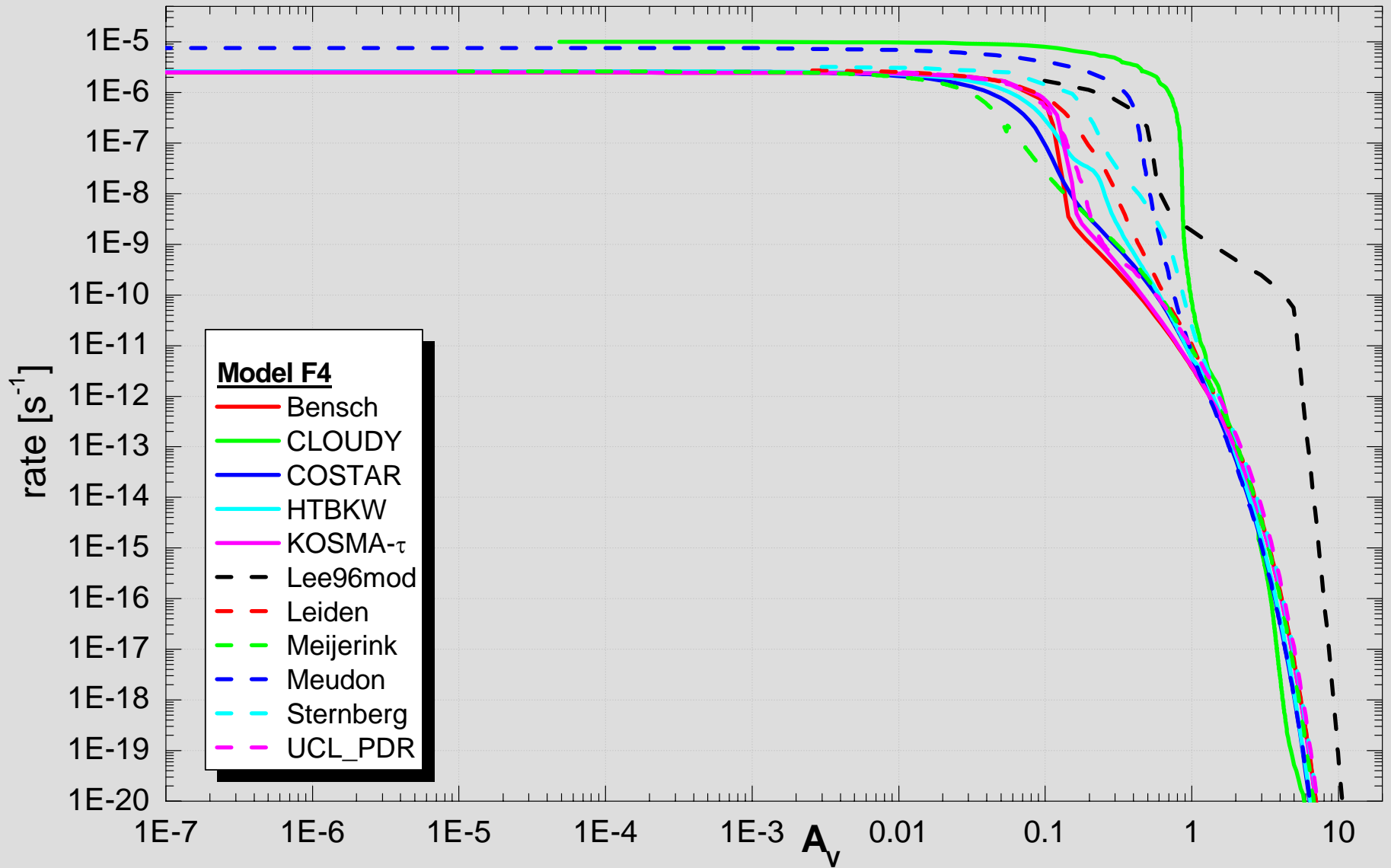
C ionization rate - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



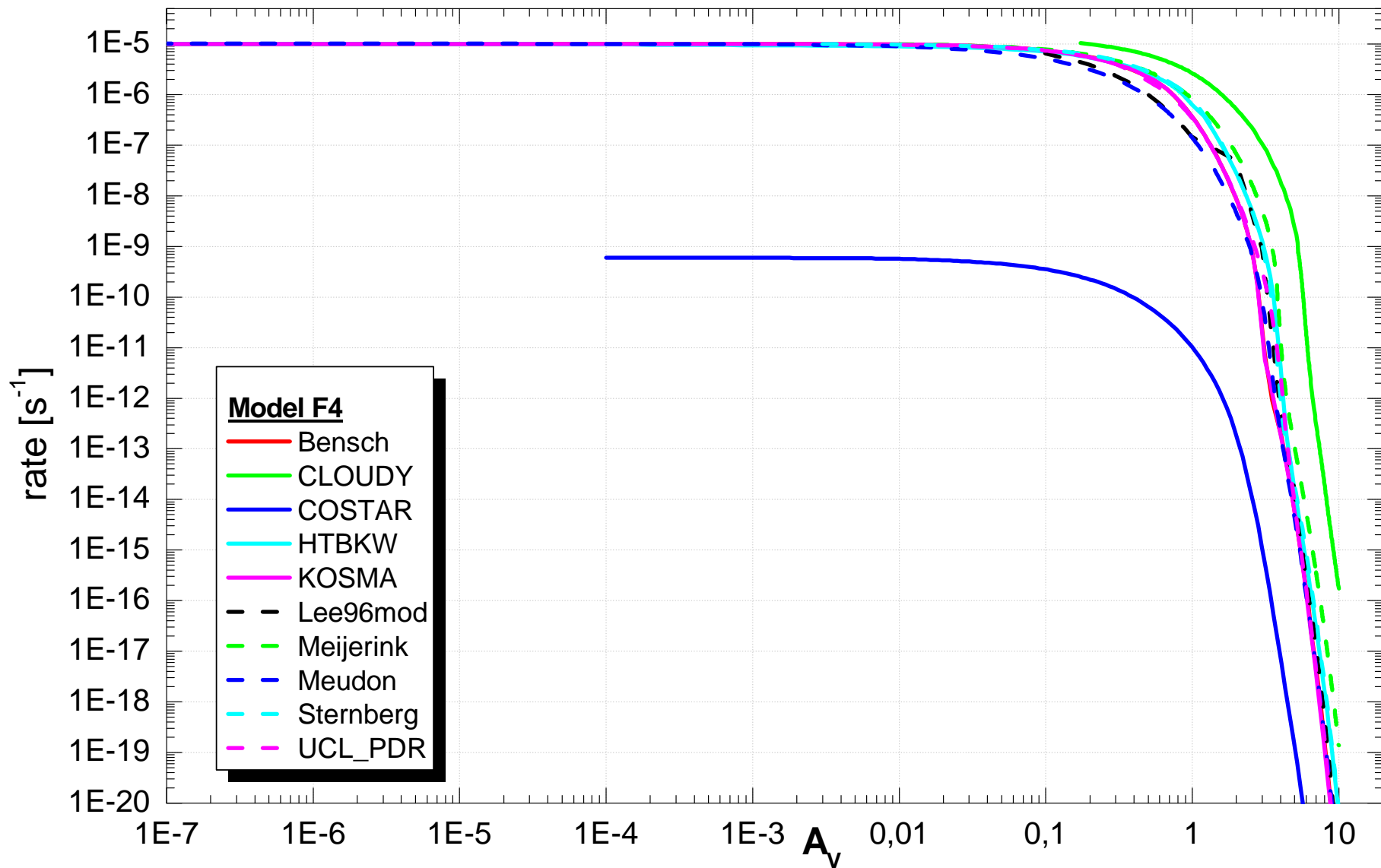
H₂ dissociation - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



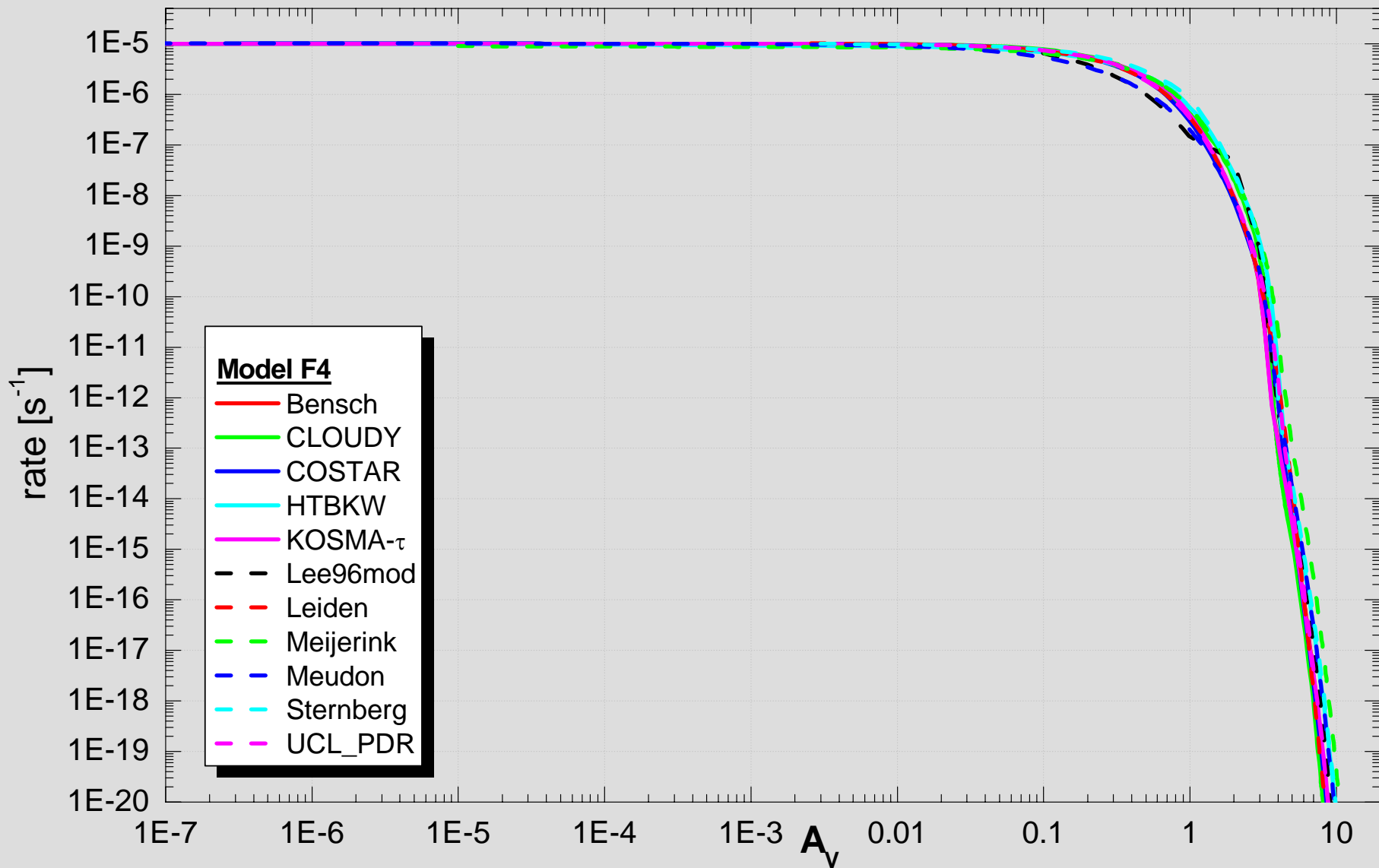
H₂ dissociation - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



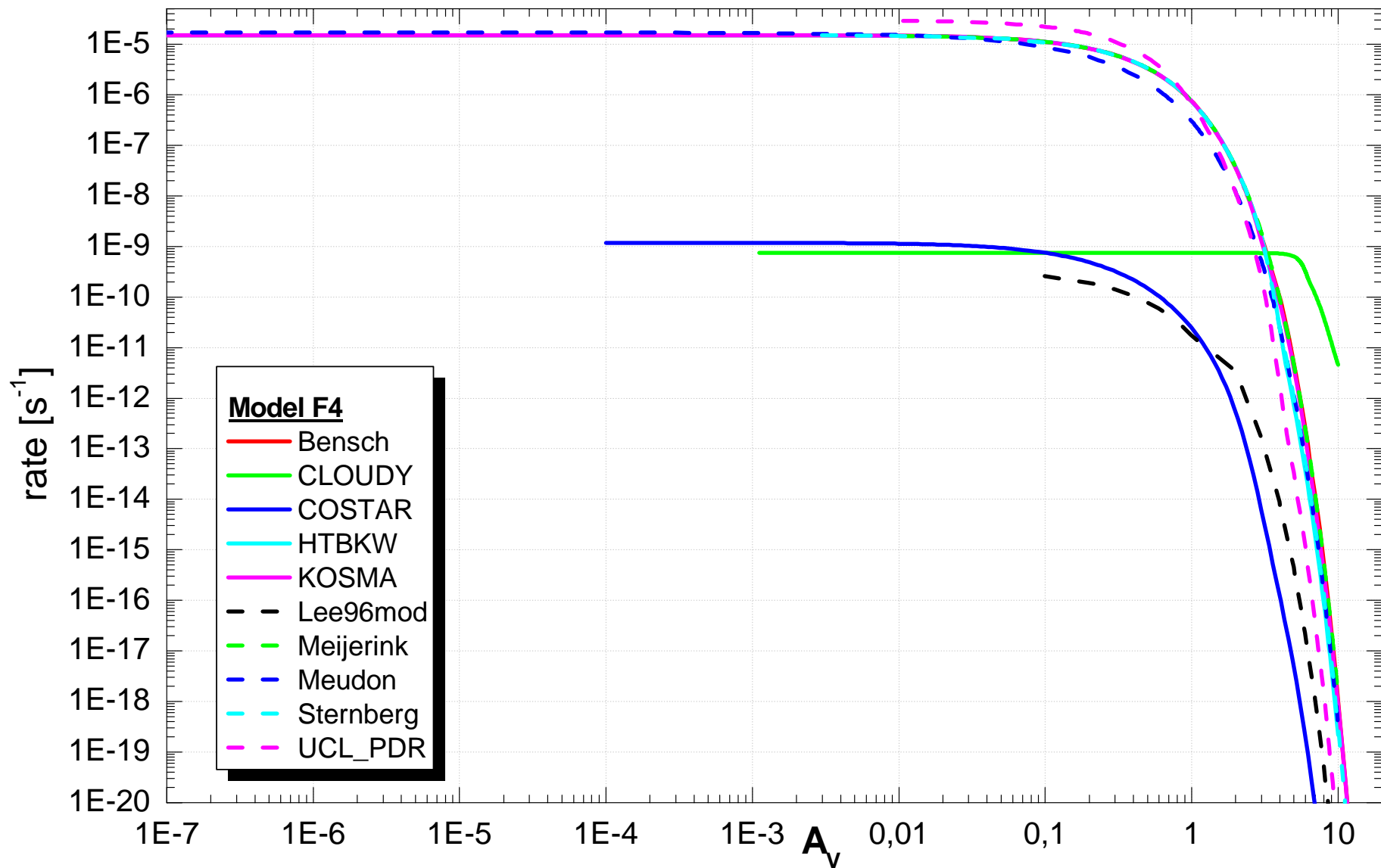
CO dissociation - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



CO dissociation - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



C ionization - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



C ionization - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$

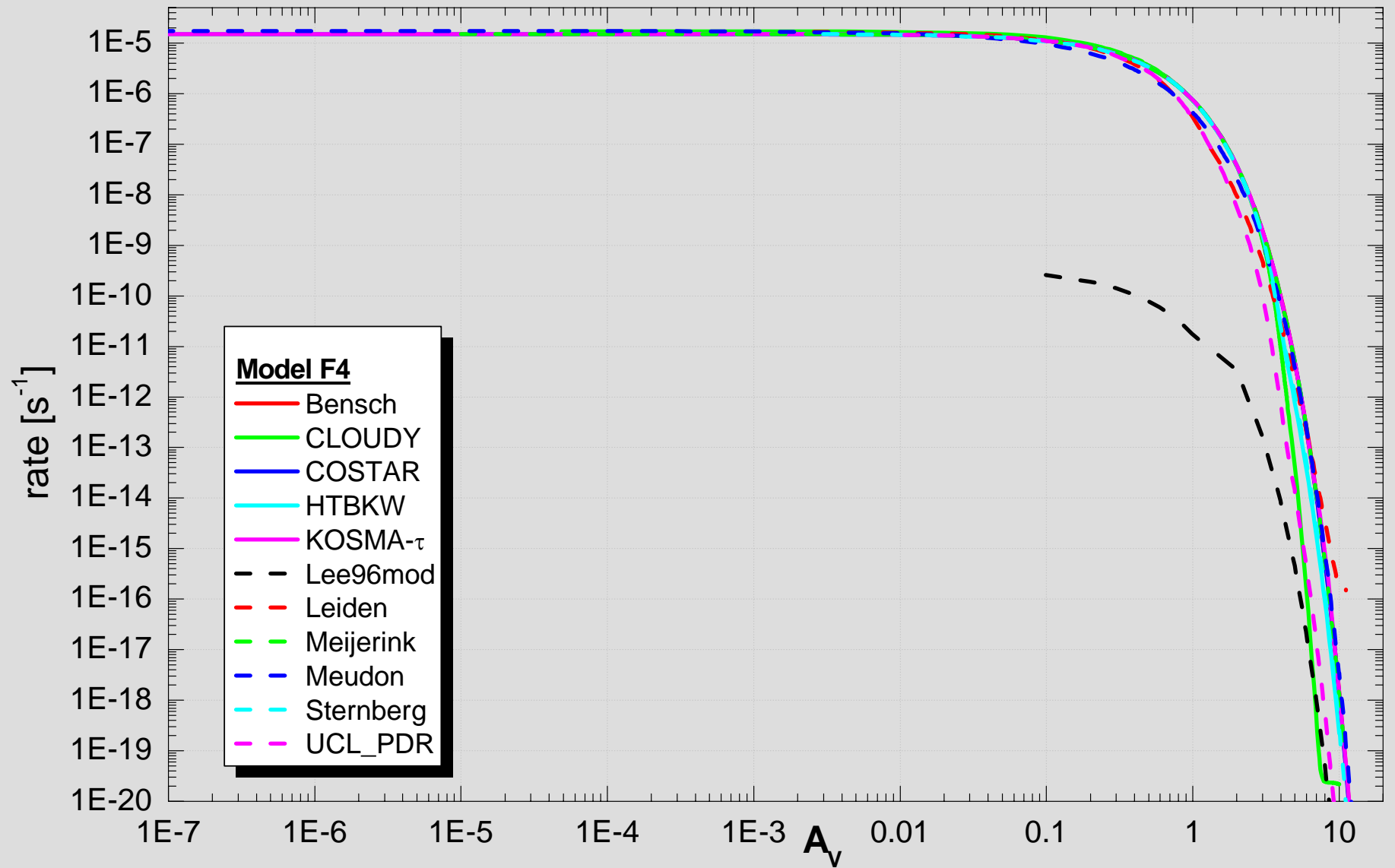
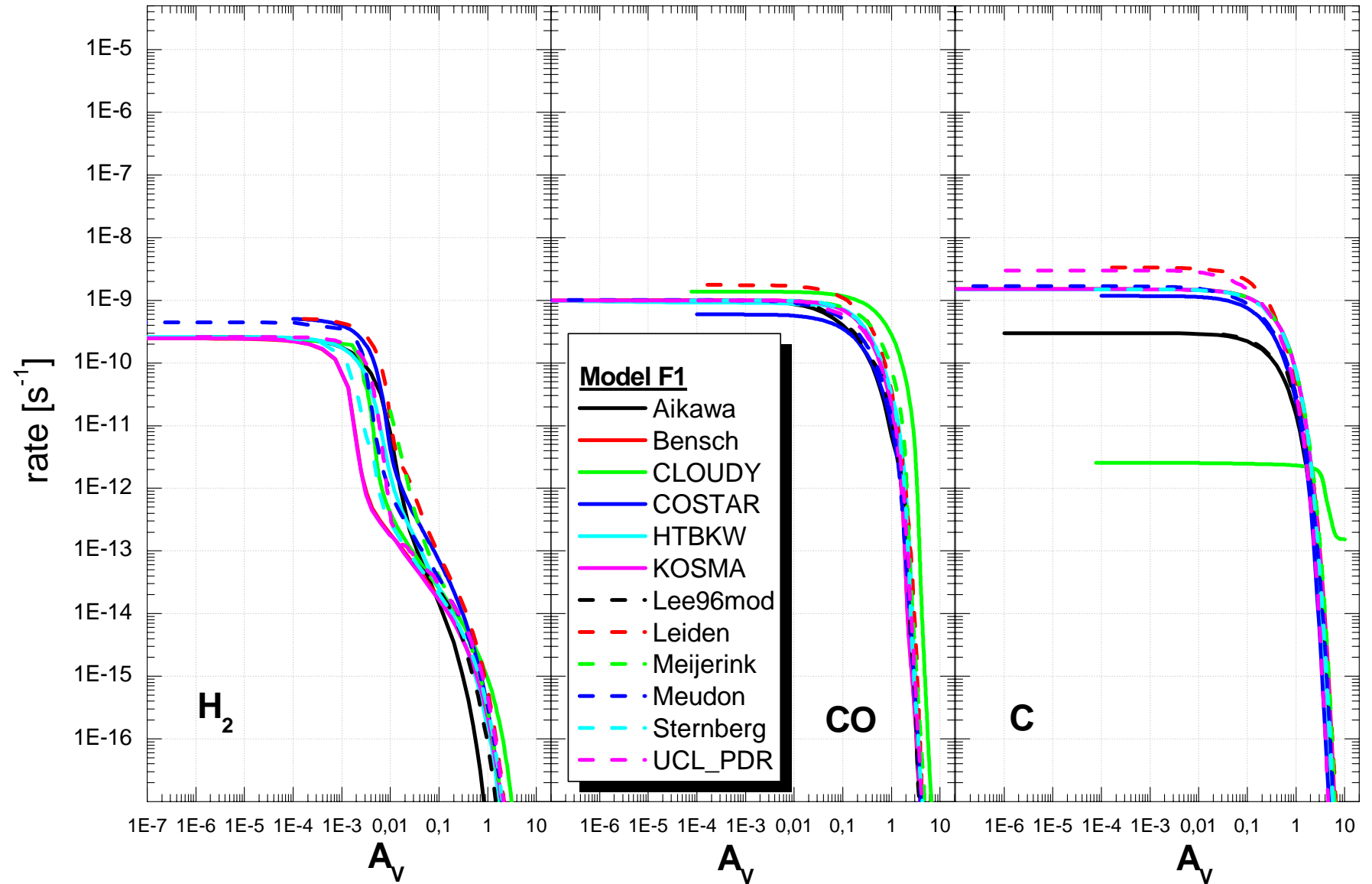


photo rates - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



5.-8. April, 2004

PDR Model Comparison

photo rates - $n=10^3 \text{ cm}^{-3}$, $\chi=10$

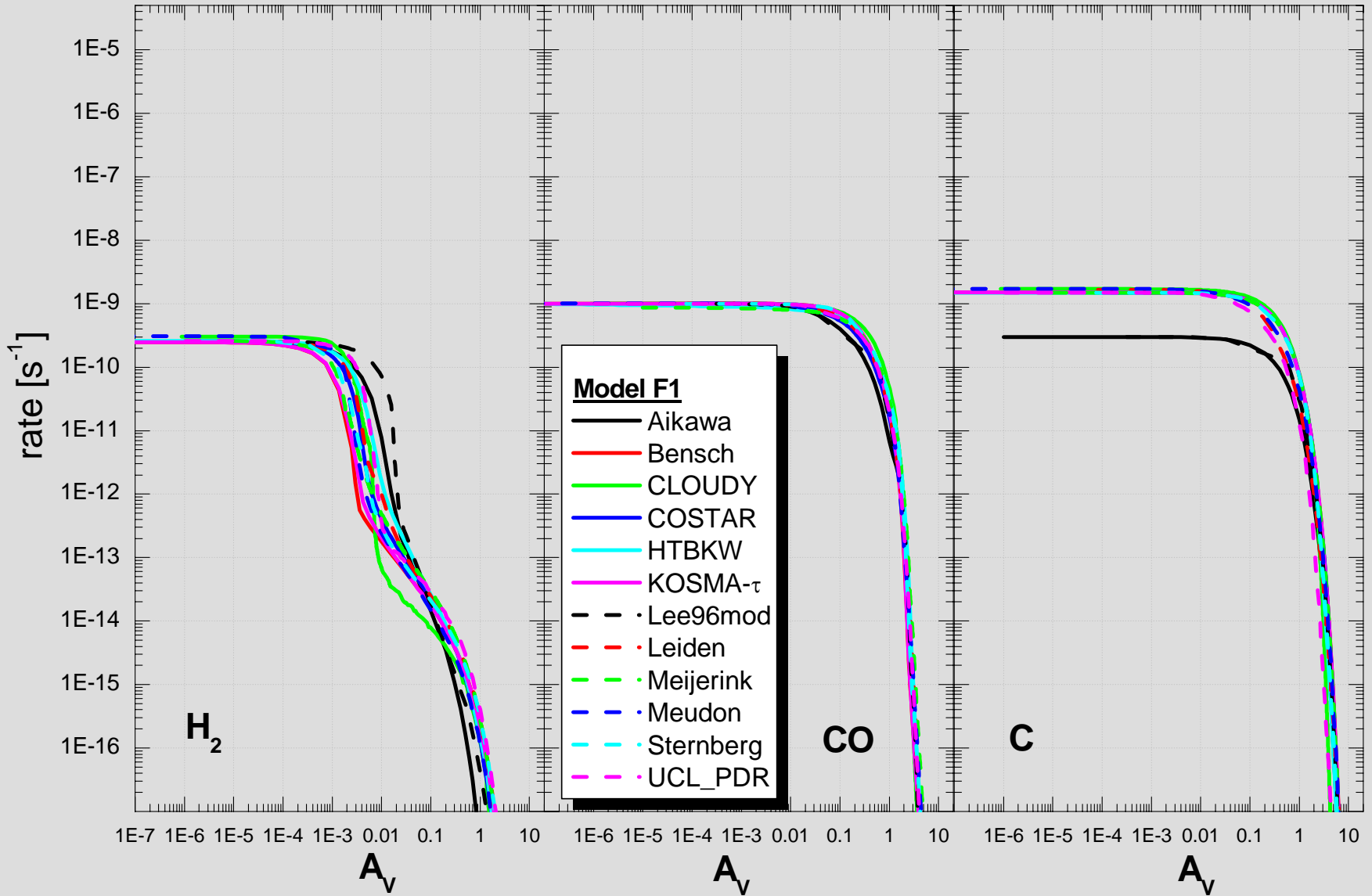
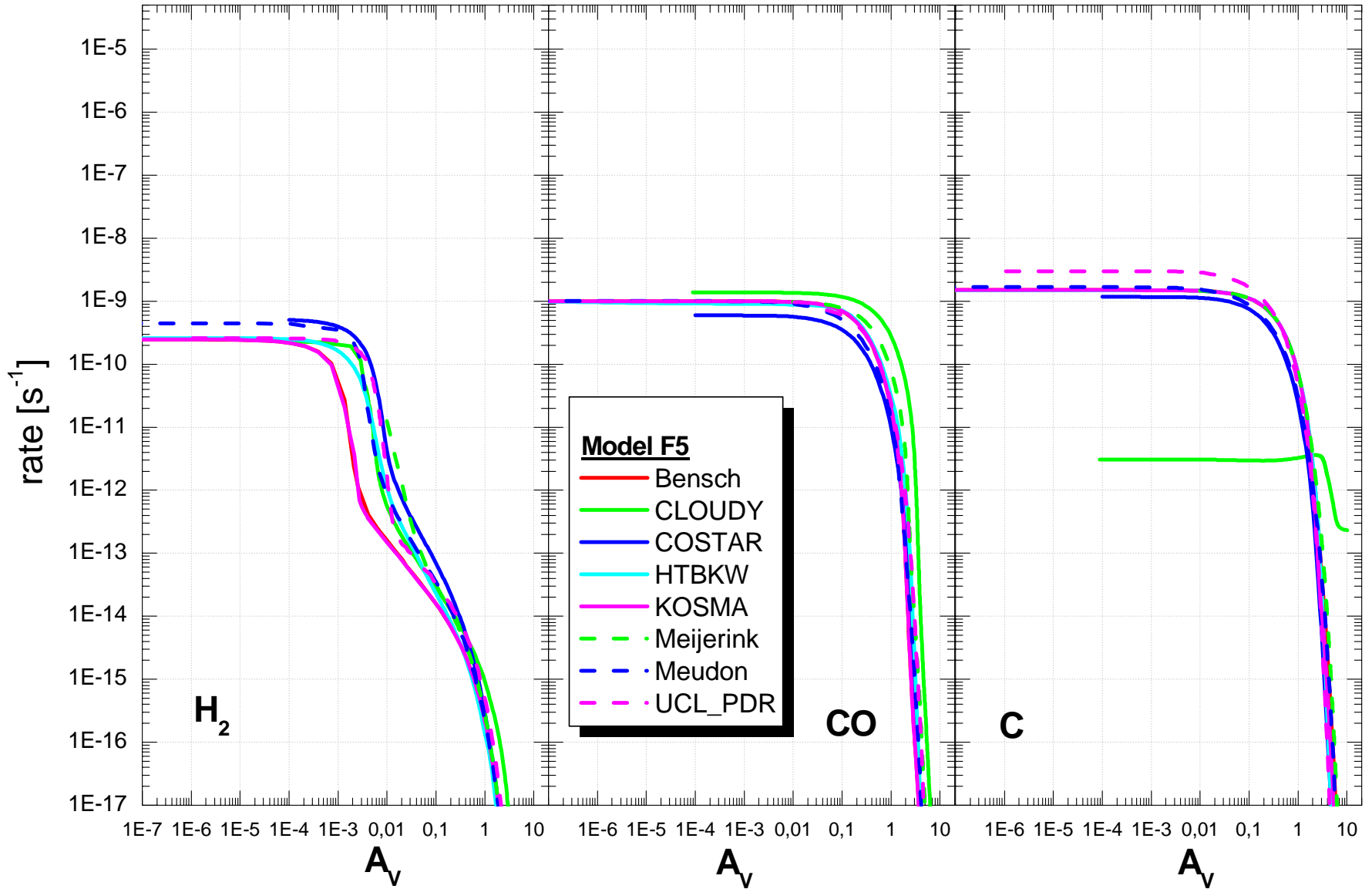


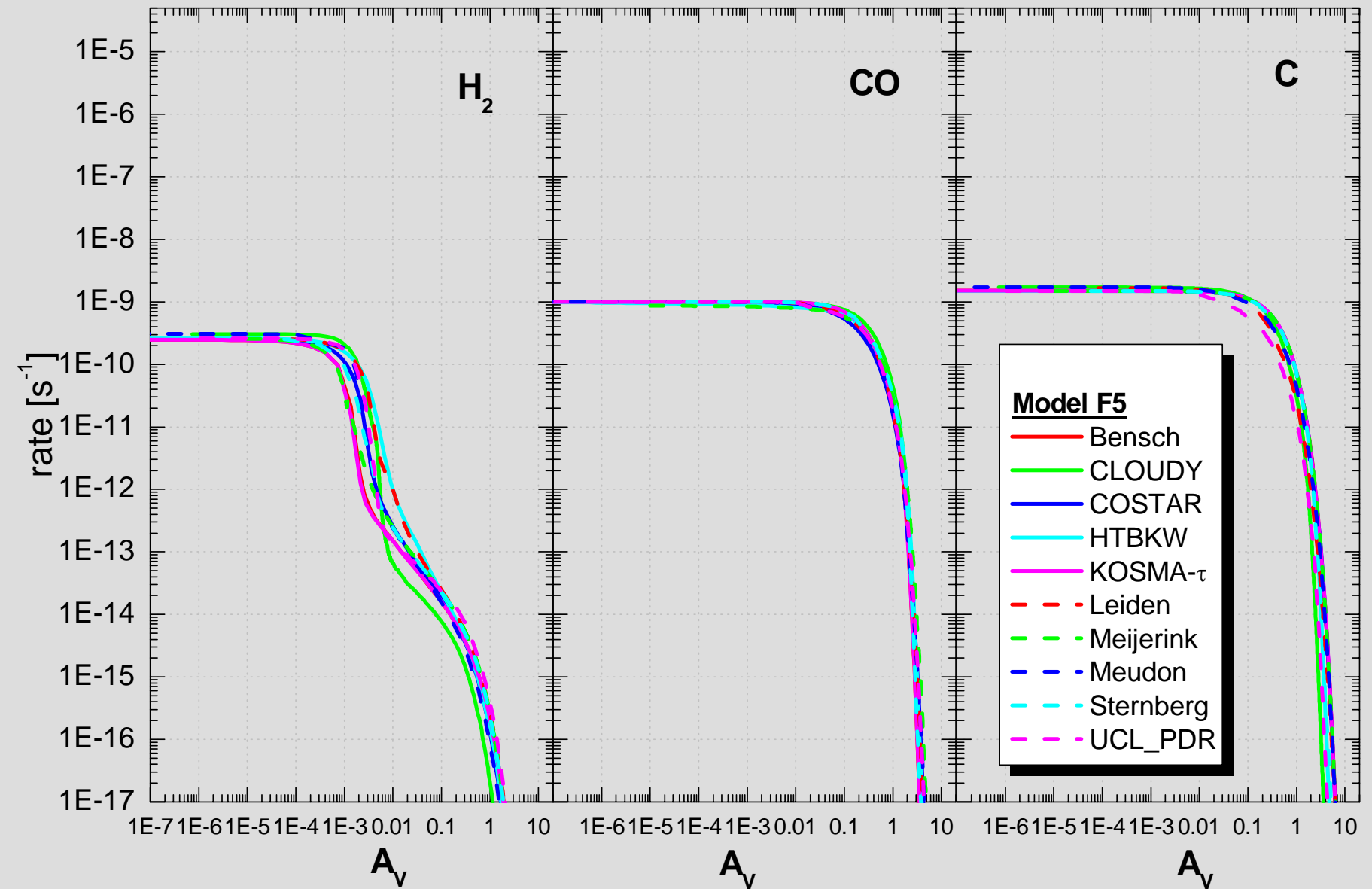
photo rates - $n=10^3 \text{ cm}^{-3}$, $\chi=10$, variable T



5.-8. April, 2004

PDR Model Comparison

photo rates - $n=10^3 \text{ cm}^{-3}$, $\chi=10$, variable T



5.-8. April, 2004

PDR Model Comparison

photo rates - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$

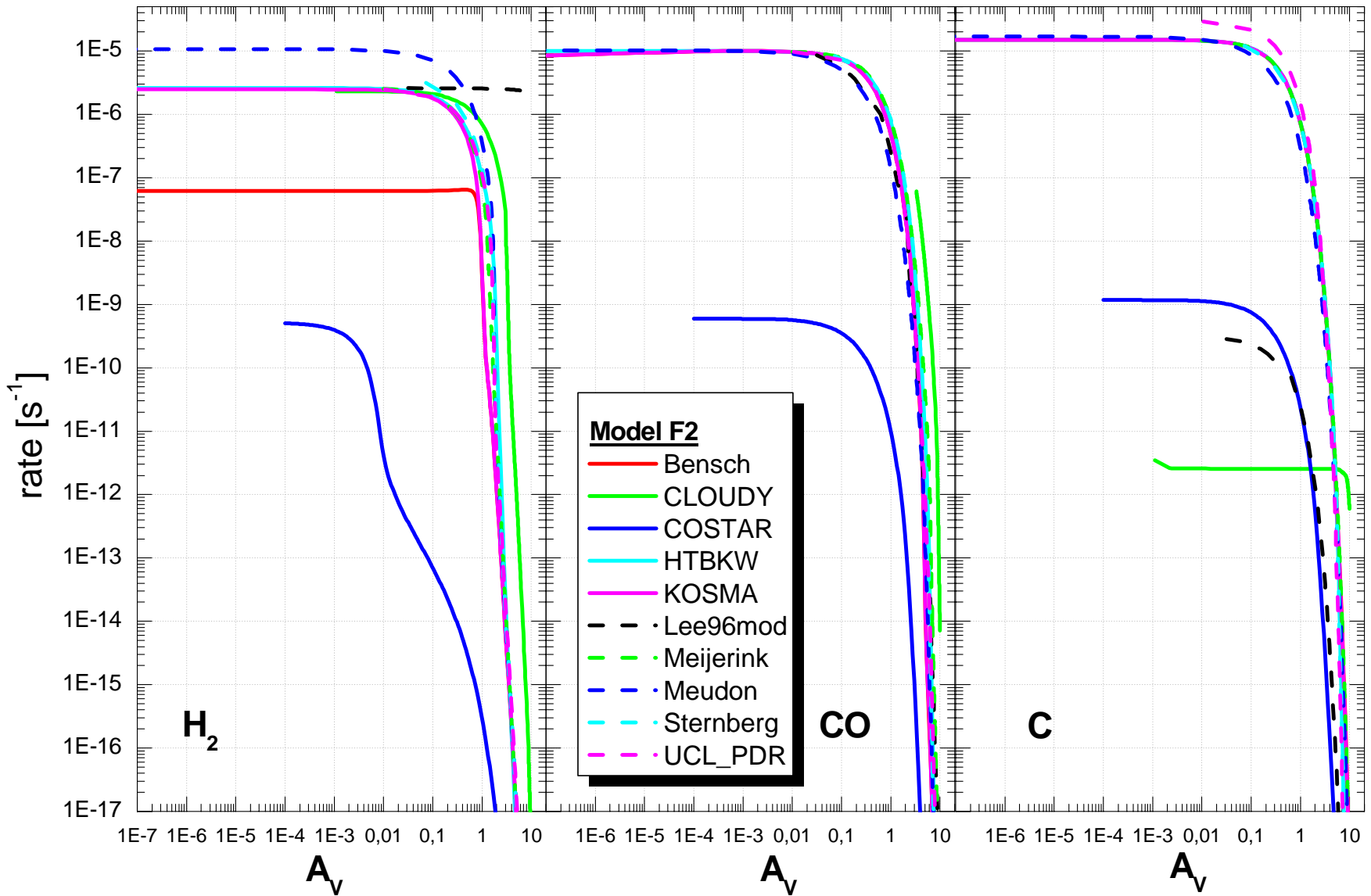
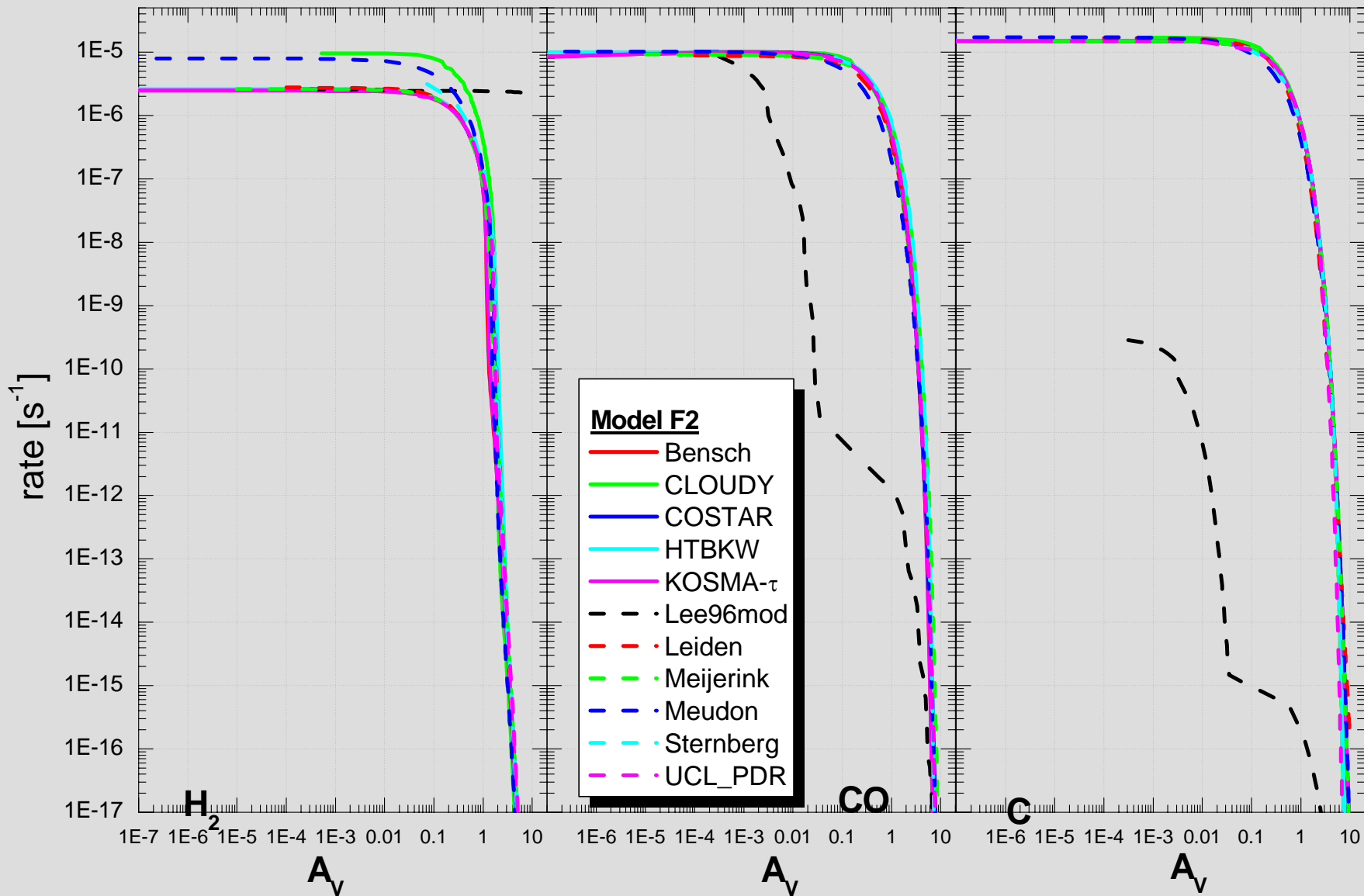


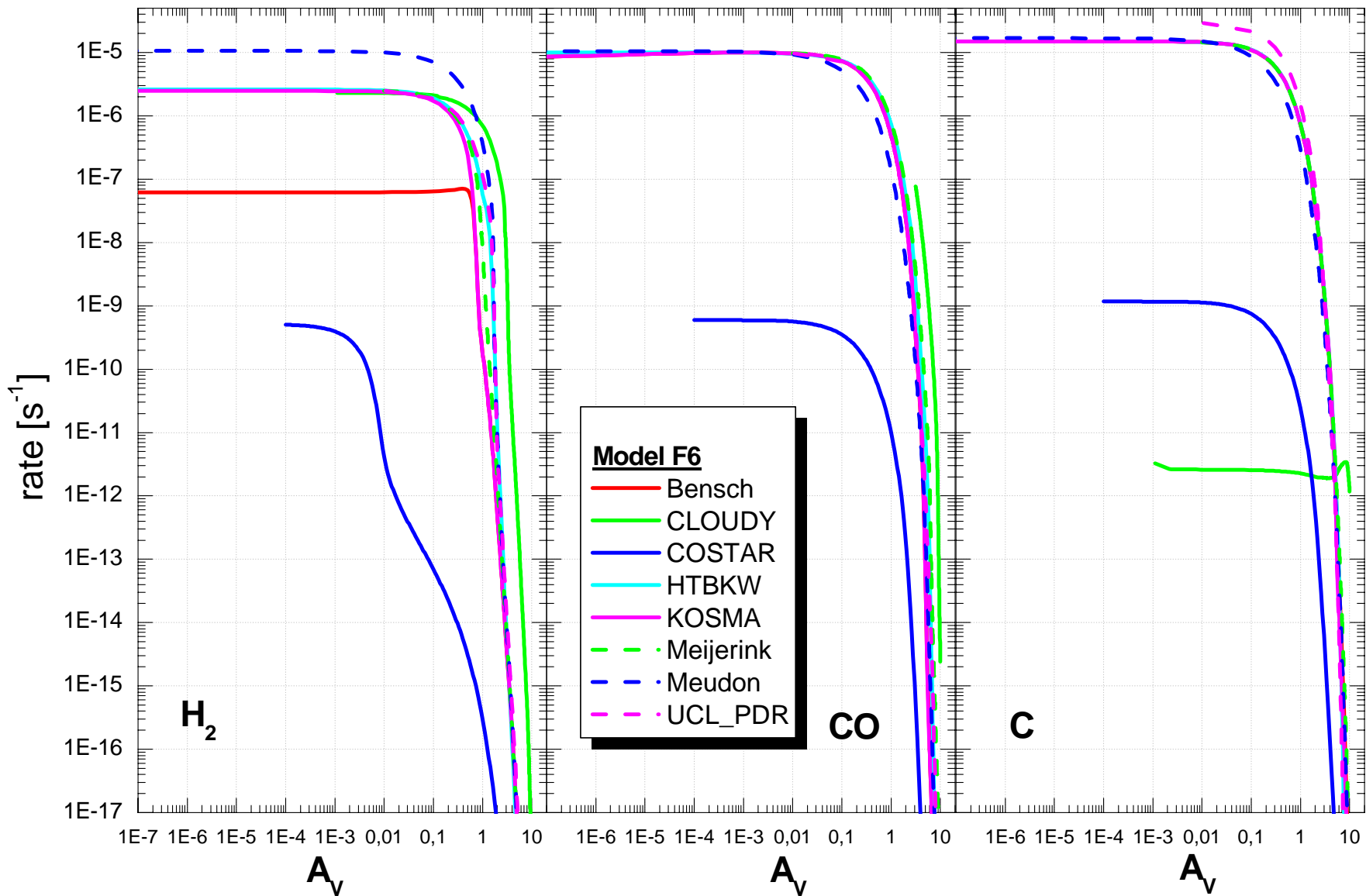
photo rates - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



5.-8. April, 2004

PDR Model Comparison

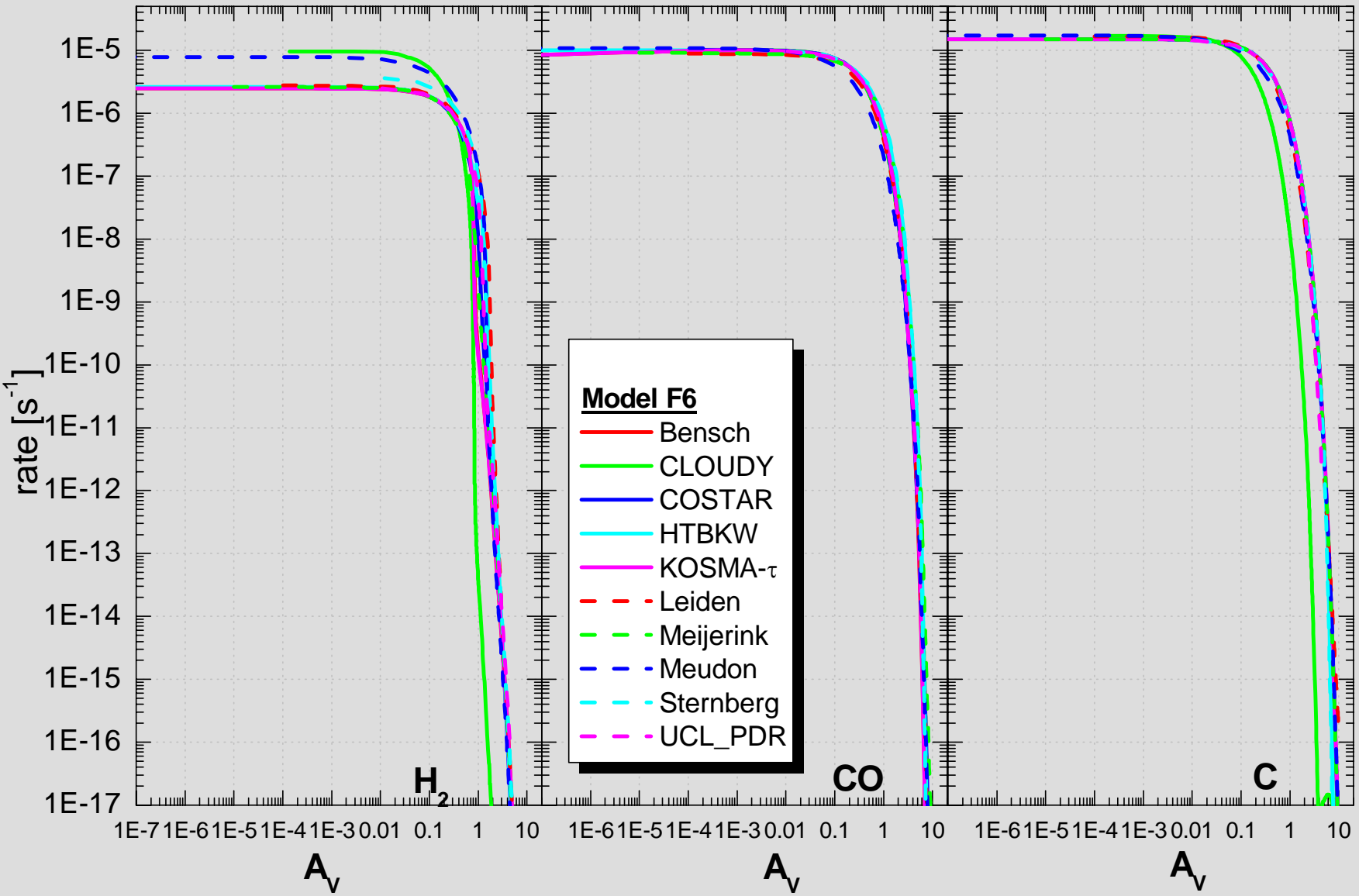
photo rates - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

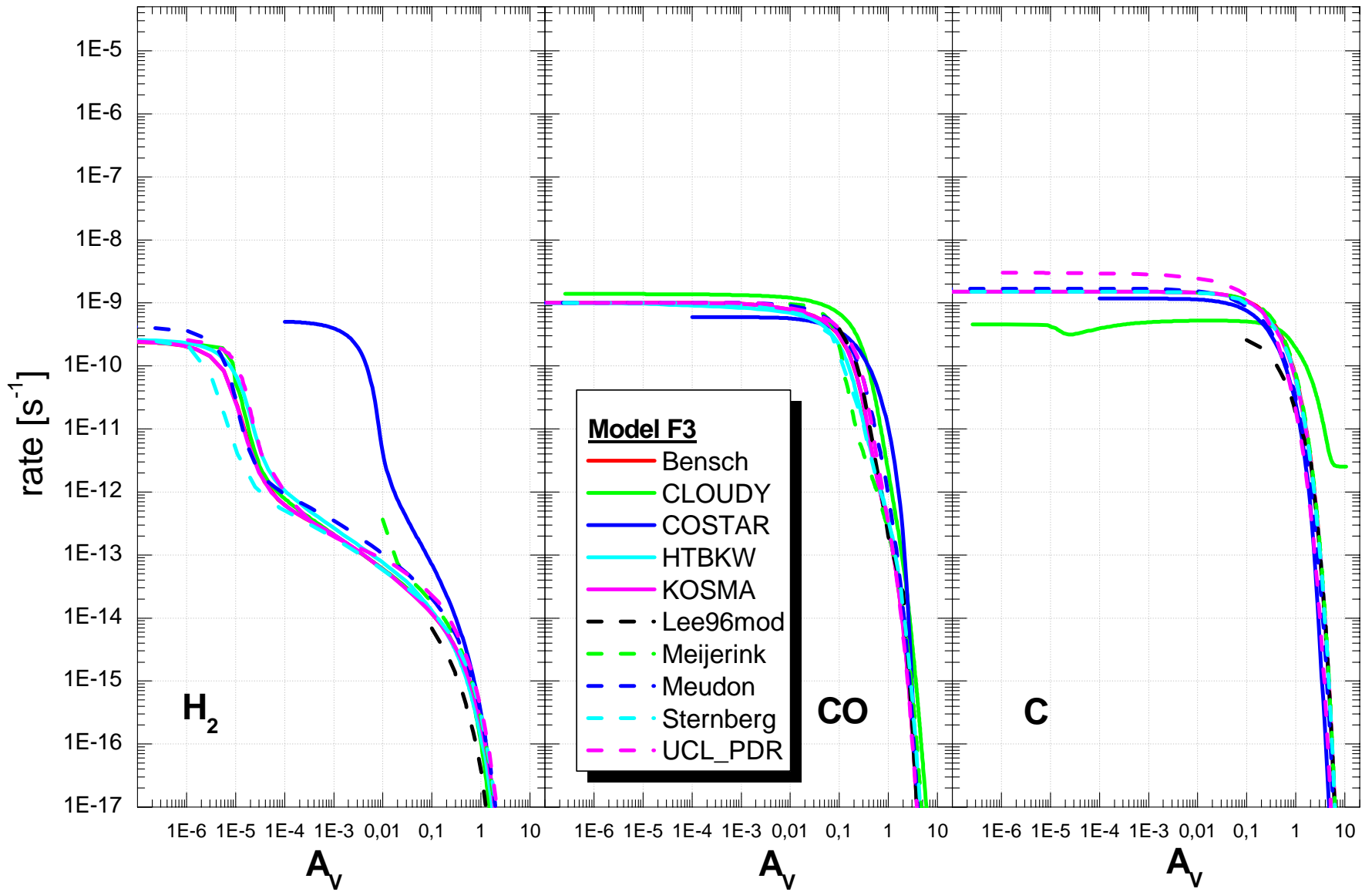
photo rates - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

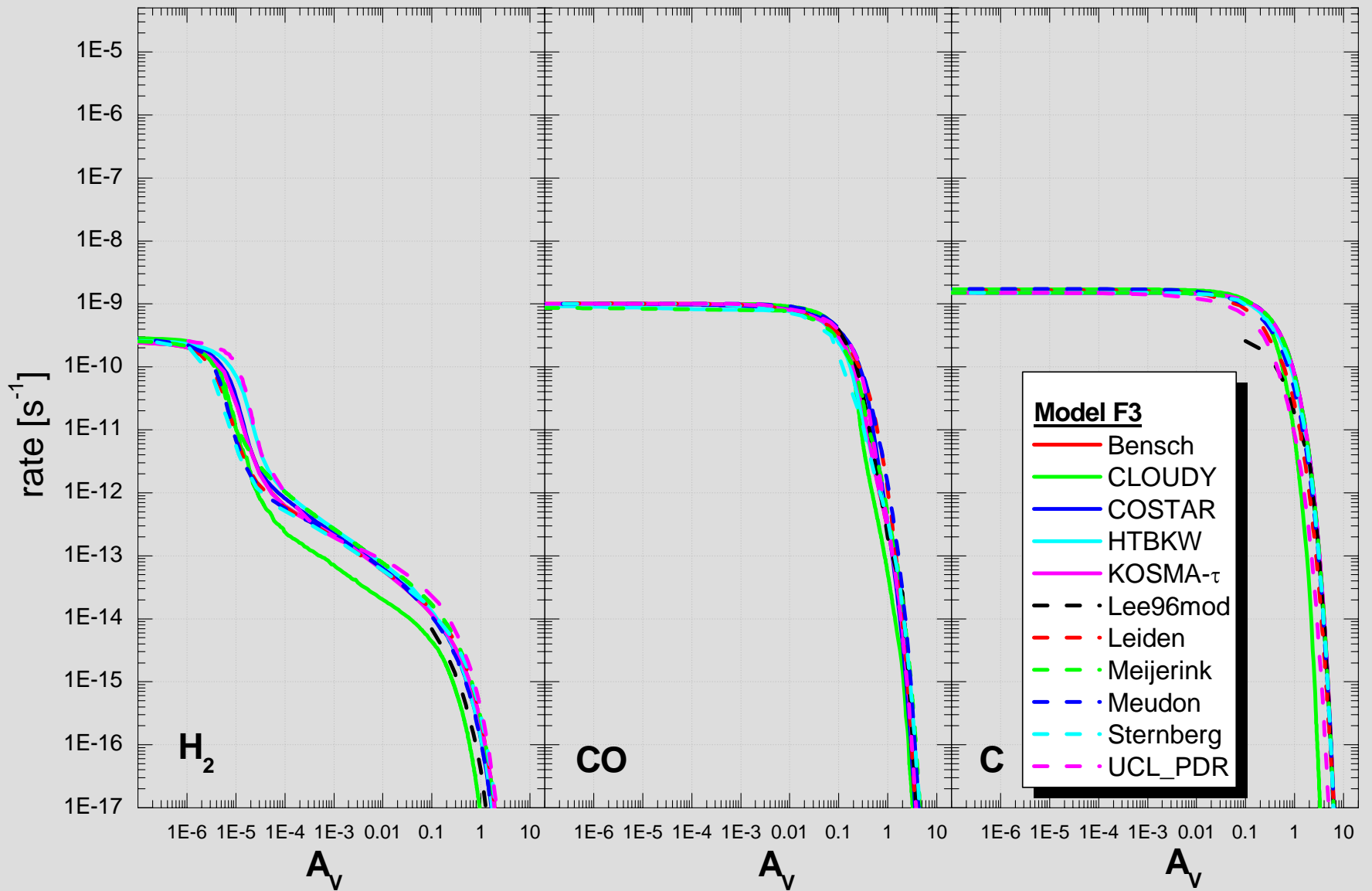
photo rates - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



5.-8. April, 2004

PDR Model Comparison

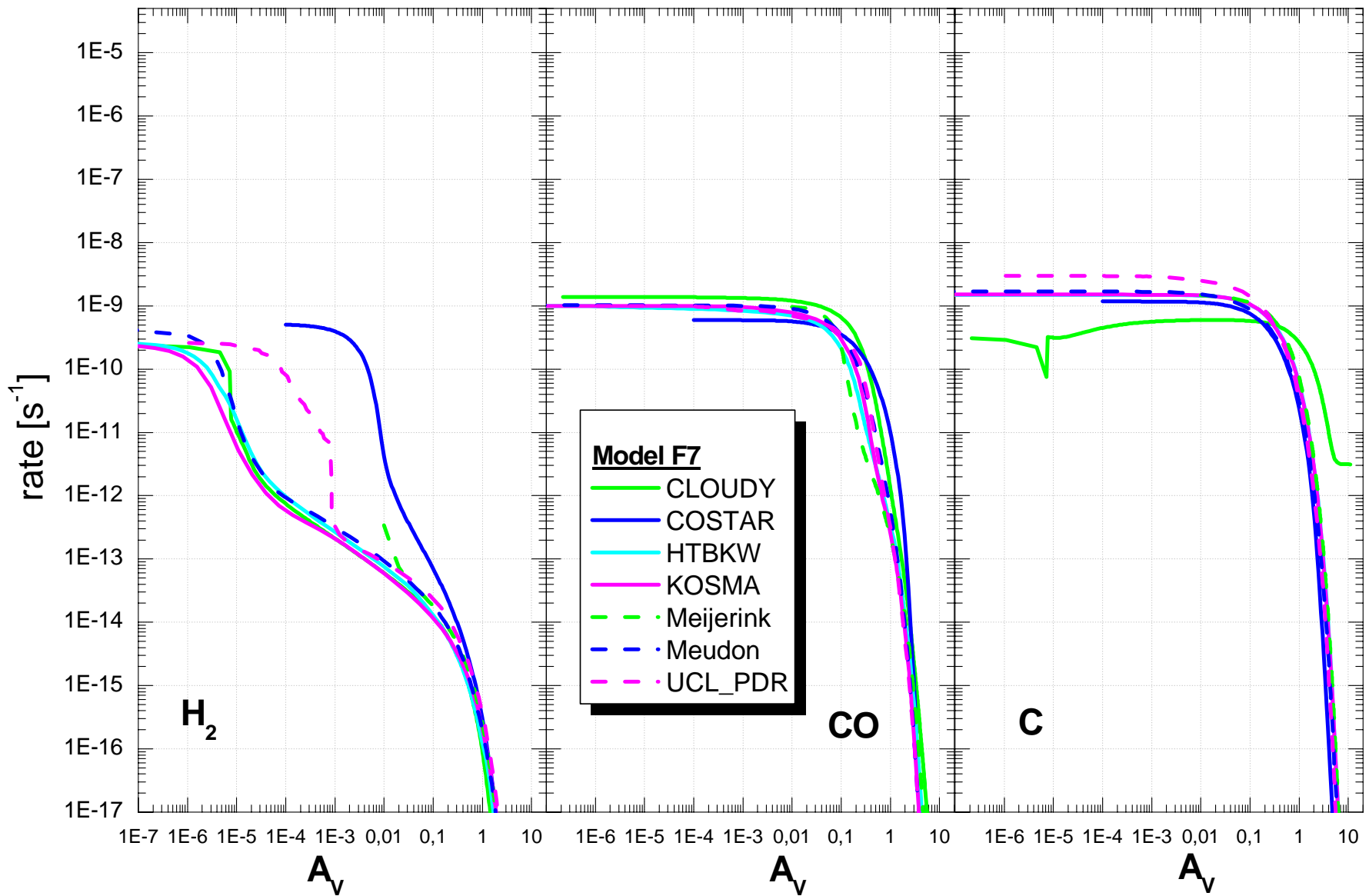
photo rates - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



5.-8. April, 2004

PDR Model Comparison

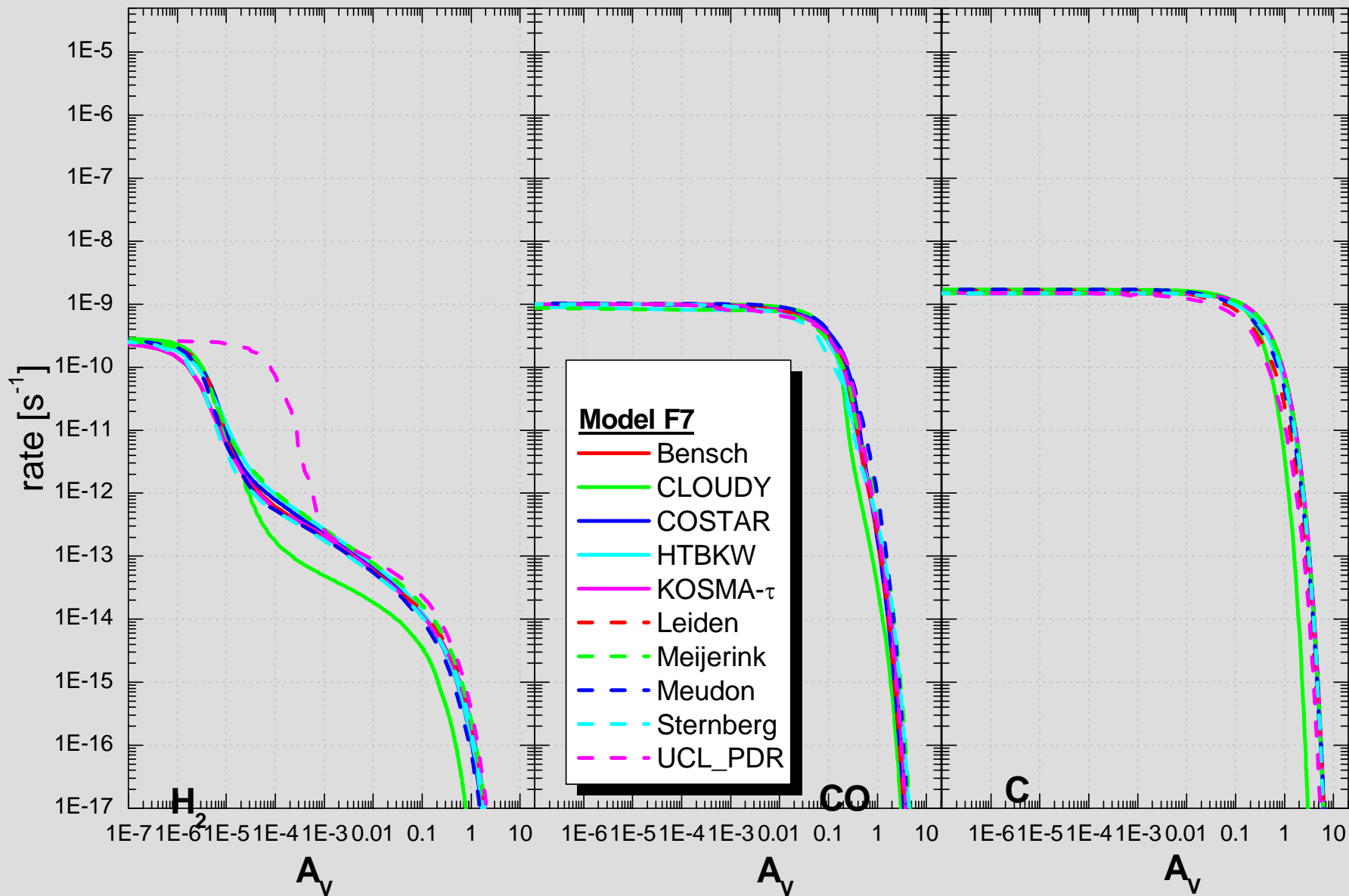
photo rates - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^1$, variable T



5.-8. April, 2004

PDR Model Comparison

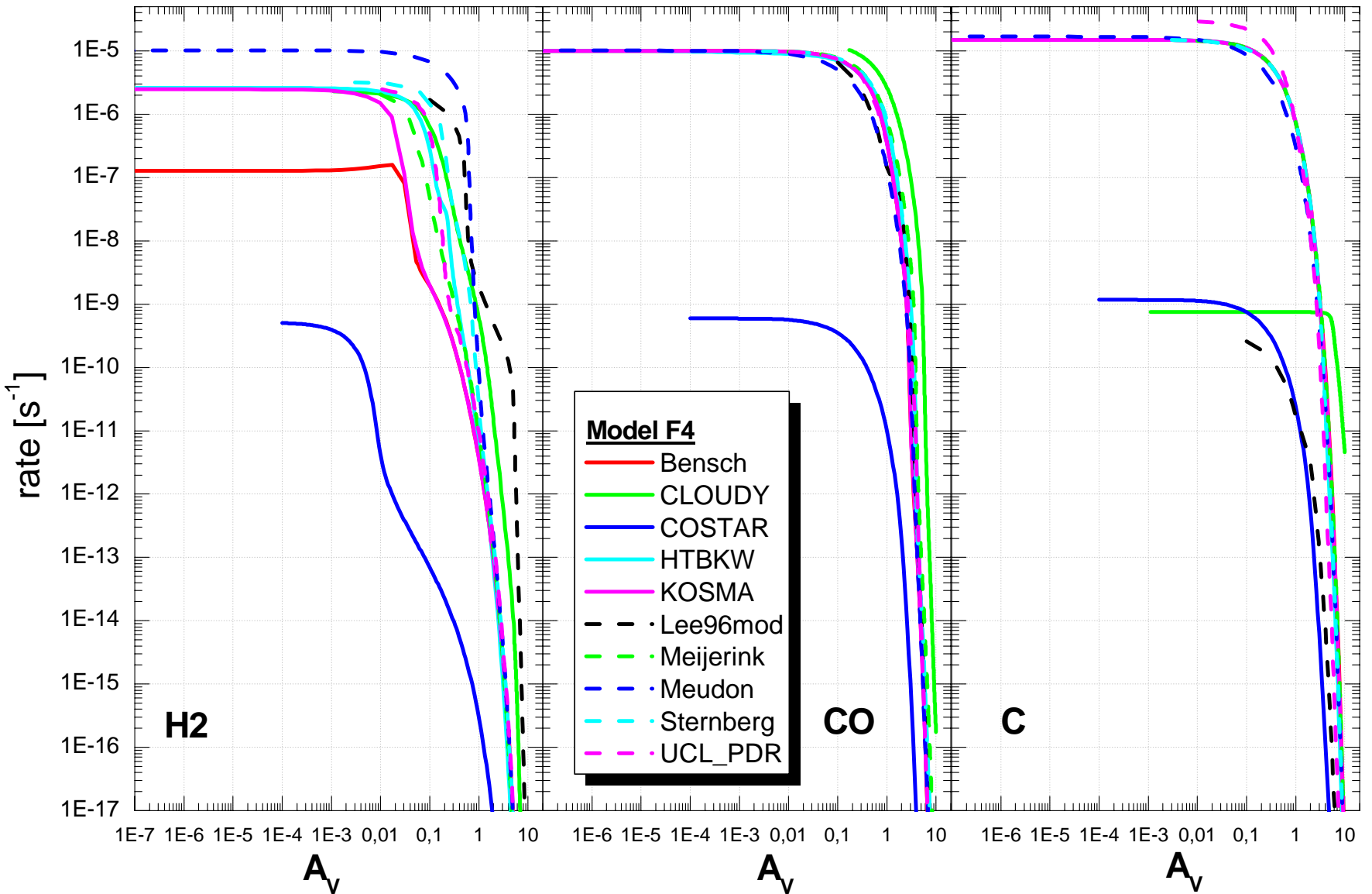
photo rates - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^1$, variable T



5.-8. April, 2004

PDR Model Comparison

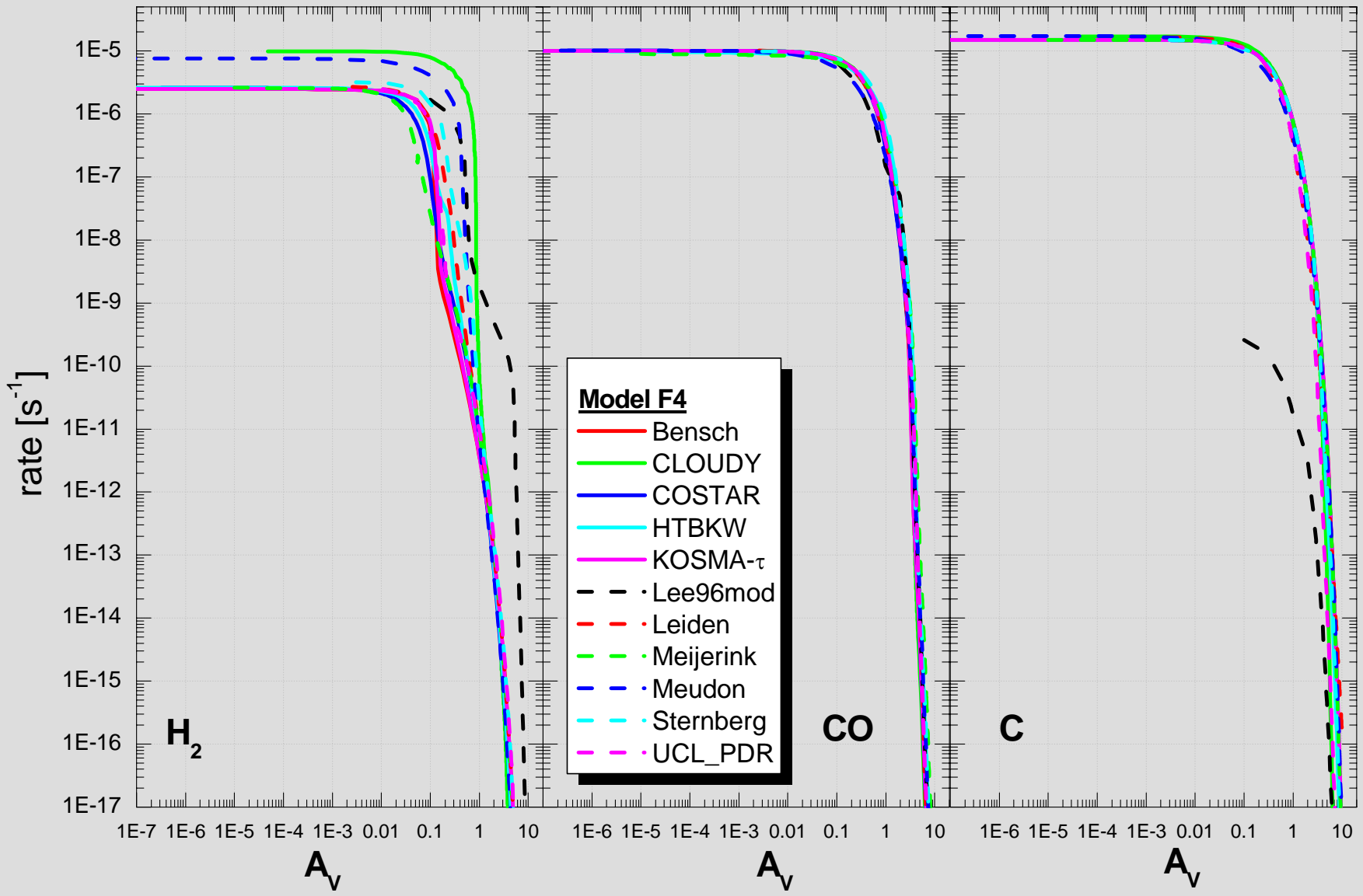
photo rates - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



5.-8. April, 2004

PDR Model Comparison

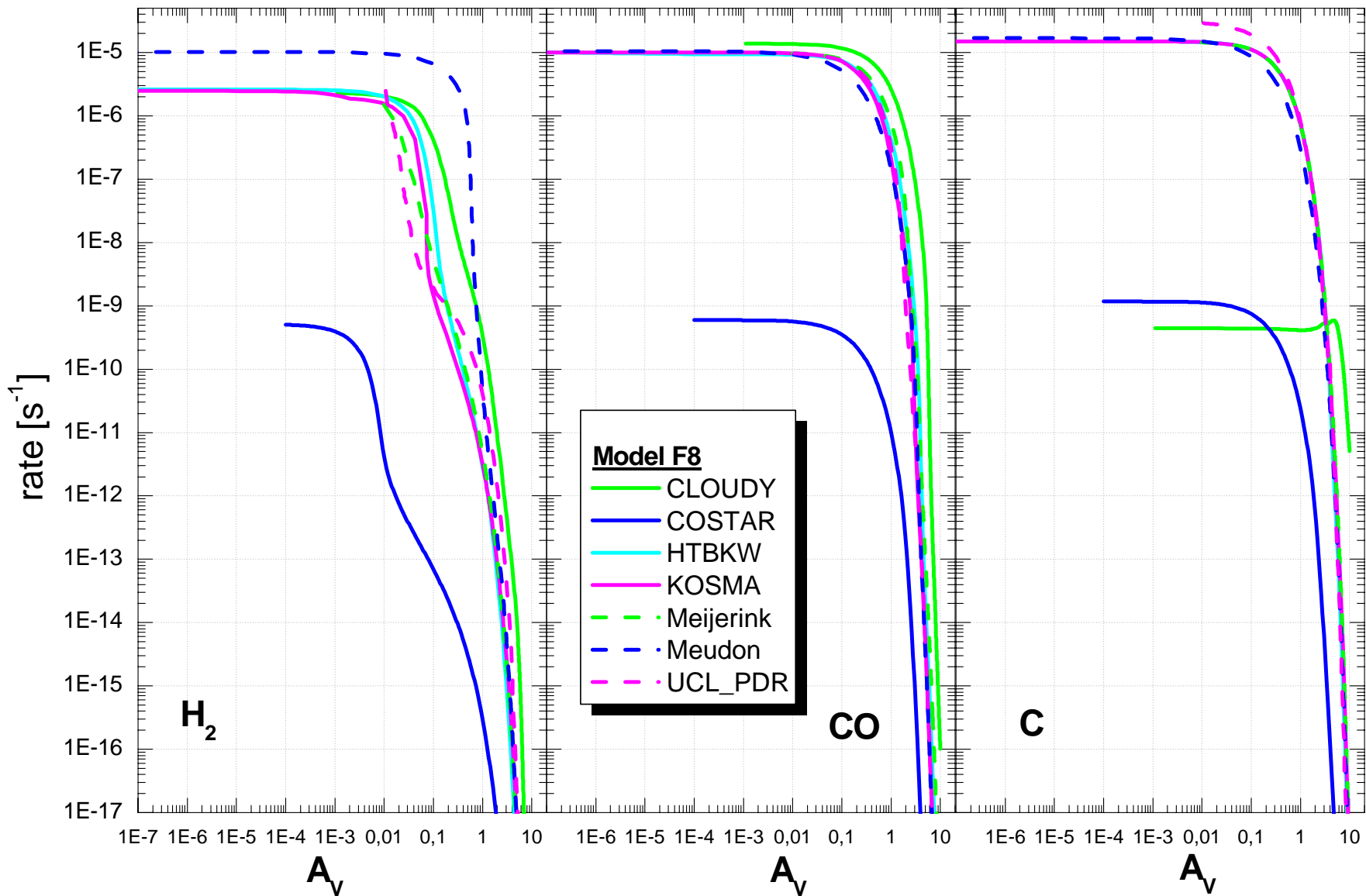
photo rates - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



5.-8. April, 2004

PDR Model Comparison

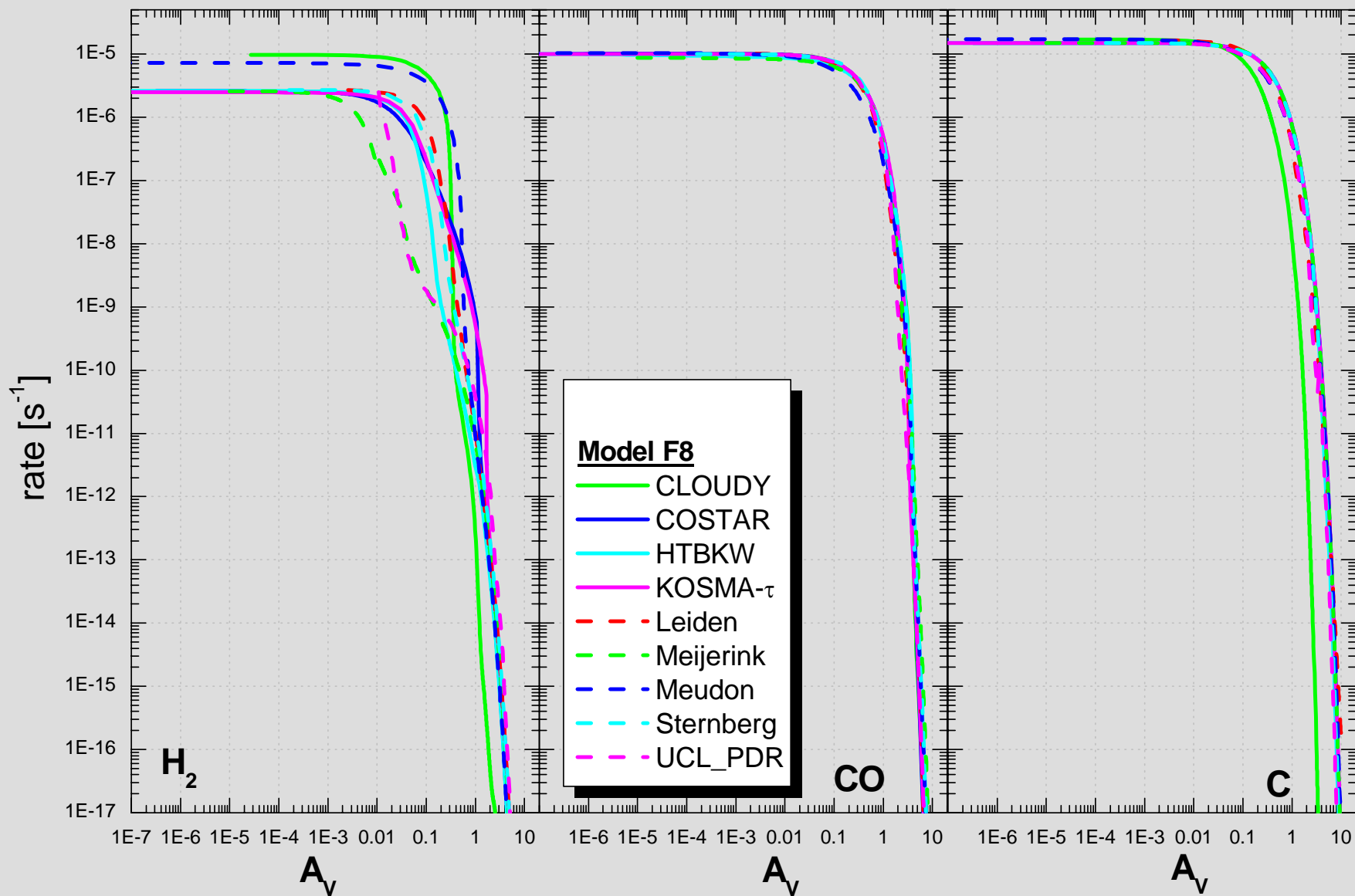
photo rates - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

photo rates - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

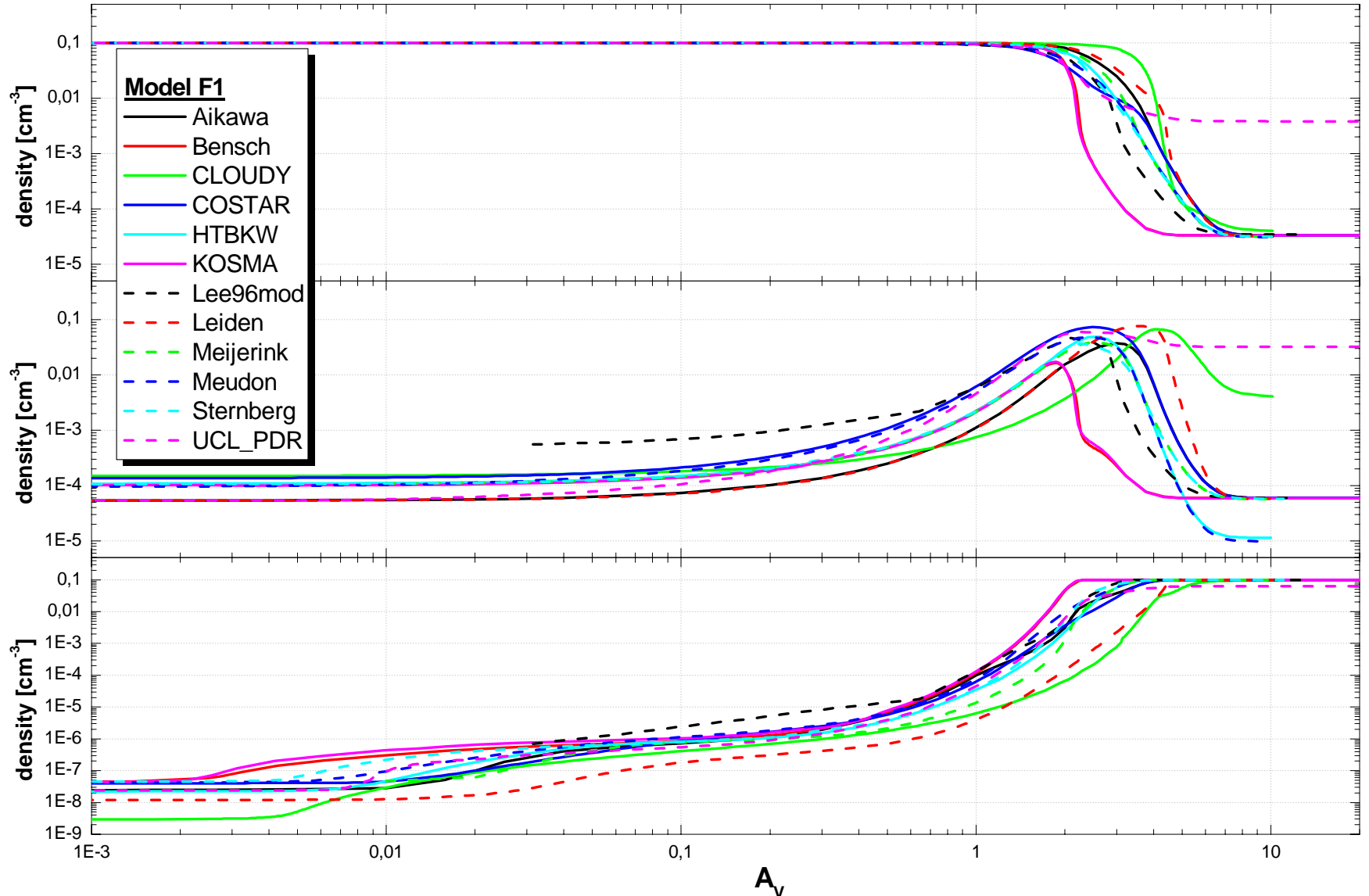
PDR Model Comparison

Model Results F1-F4

- photoreaction rates
- **densities**
- heating/cooling rates
- surface brightnesses

C⁺, C, and CO density

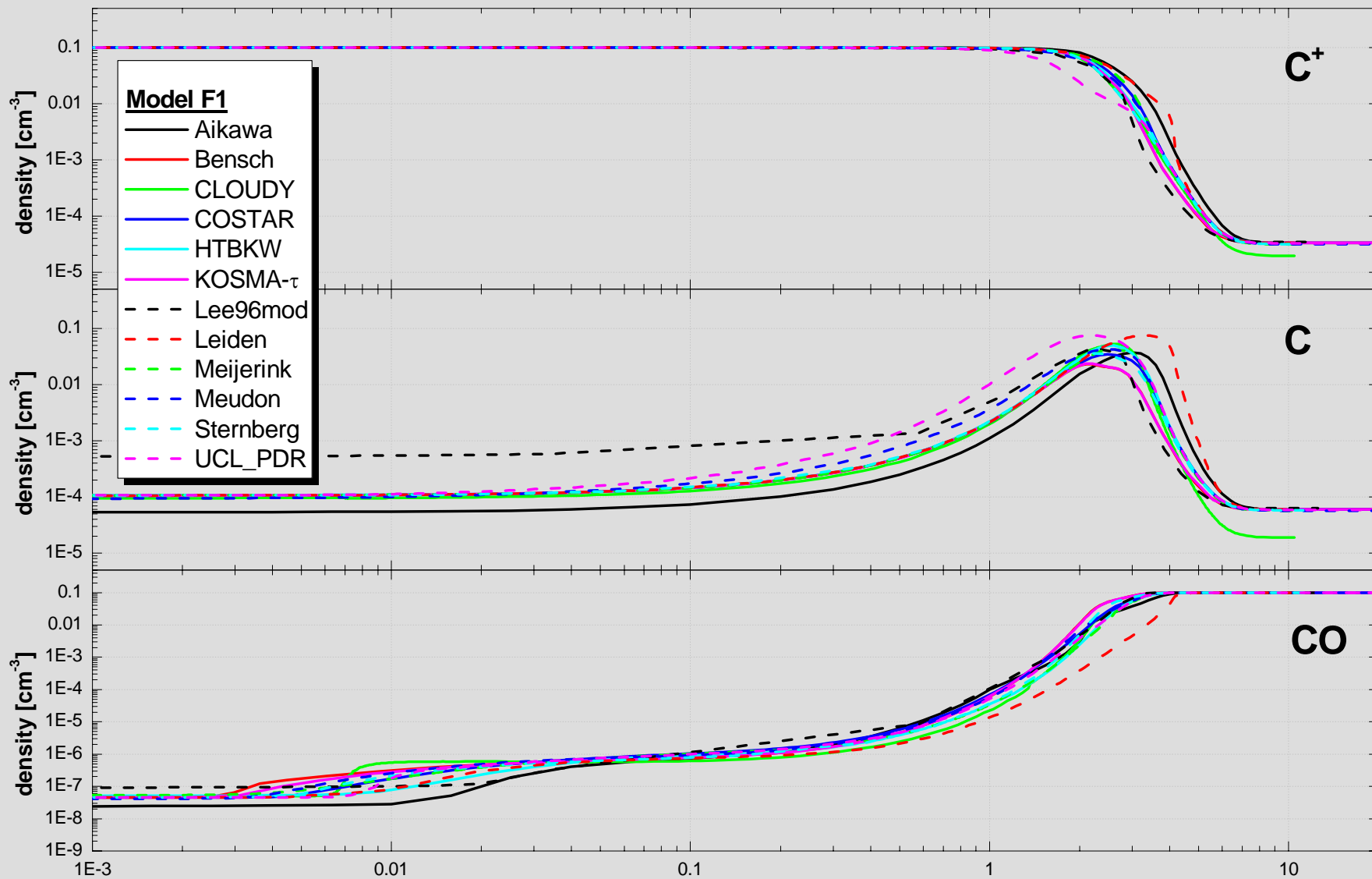
C⁺, C, CO density - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



5.-8. April, 2004

PDR Model Comparison

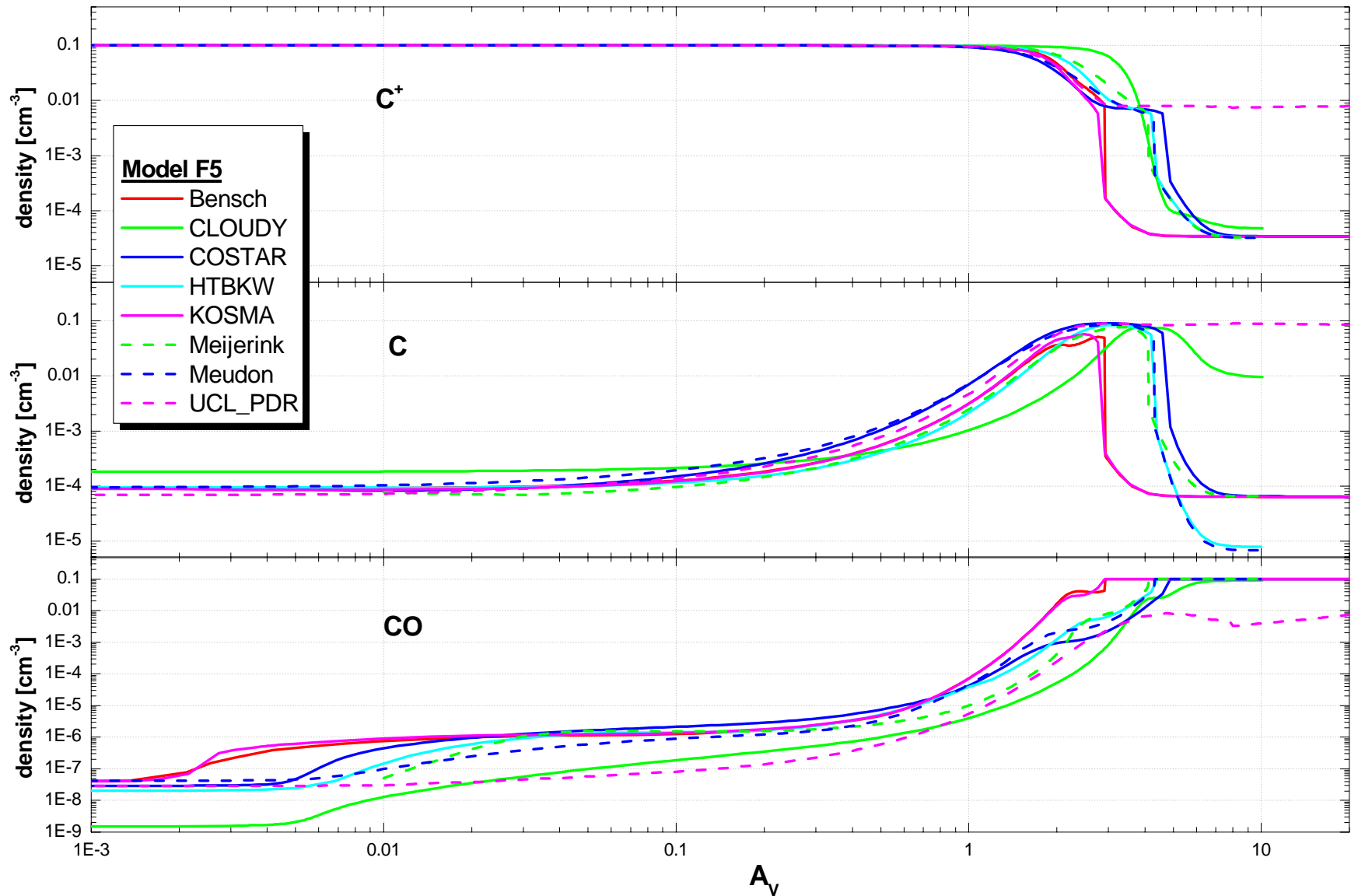
C⁺, C, CO density - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



5.-8. April, 2004

PDR Model Comparison

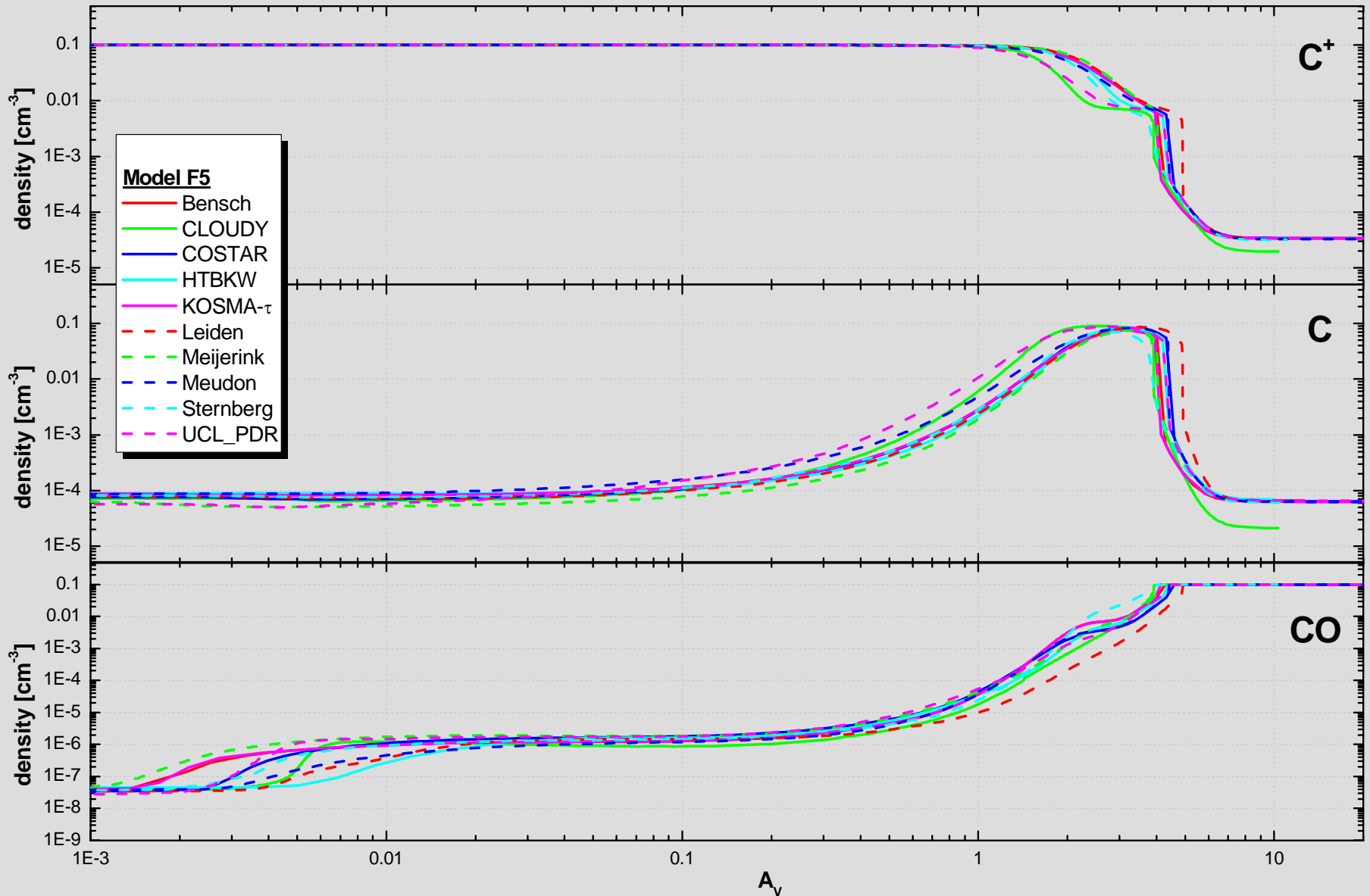
C⁺, C, CO density - $n=10^3 \text{ cm}^{-3}$, $\chi=10$, variable T



5.-8. April, 2004

PDR Model Comparison

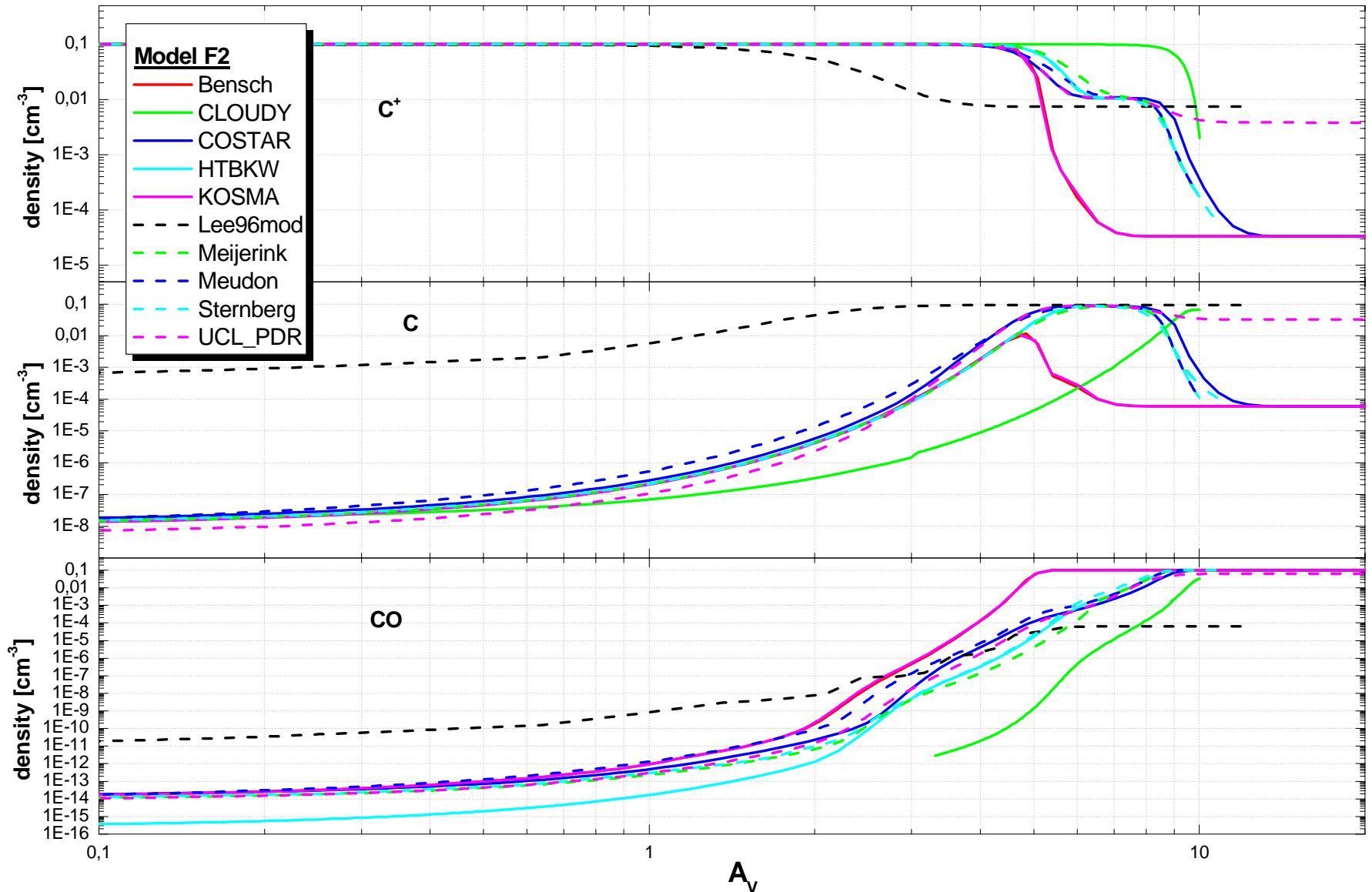
C⁺, C, CO density - $n=10^3 \text{ cm}^{-3}$, $\chi=10$, variable T



5.-8. April, 2004

PDR Model Comparison

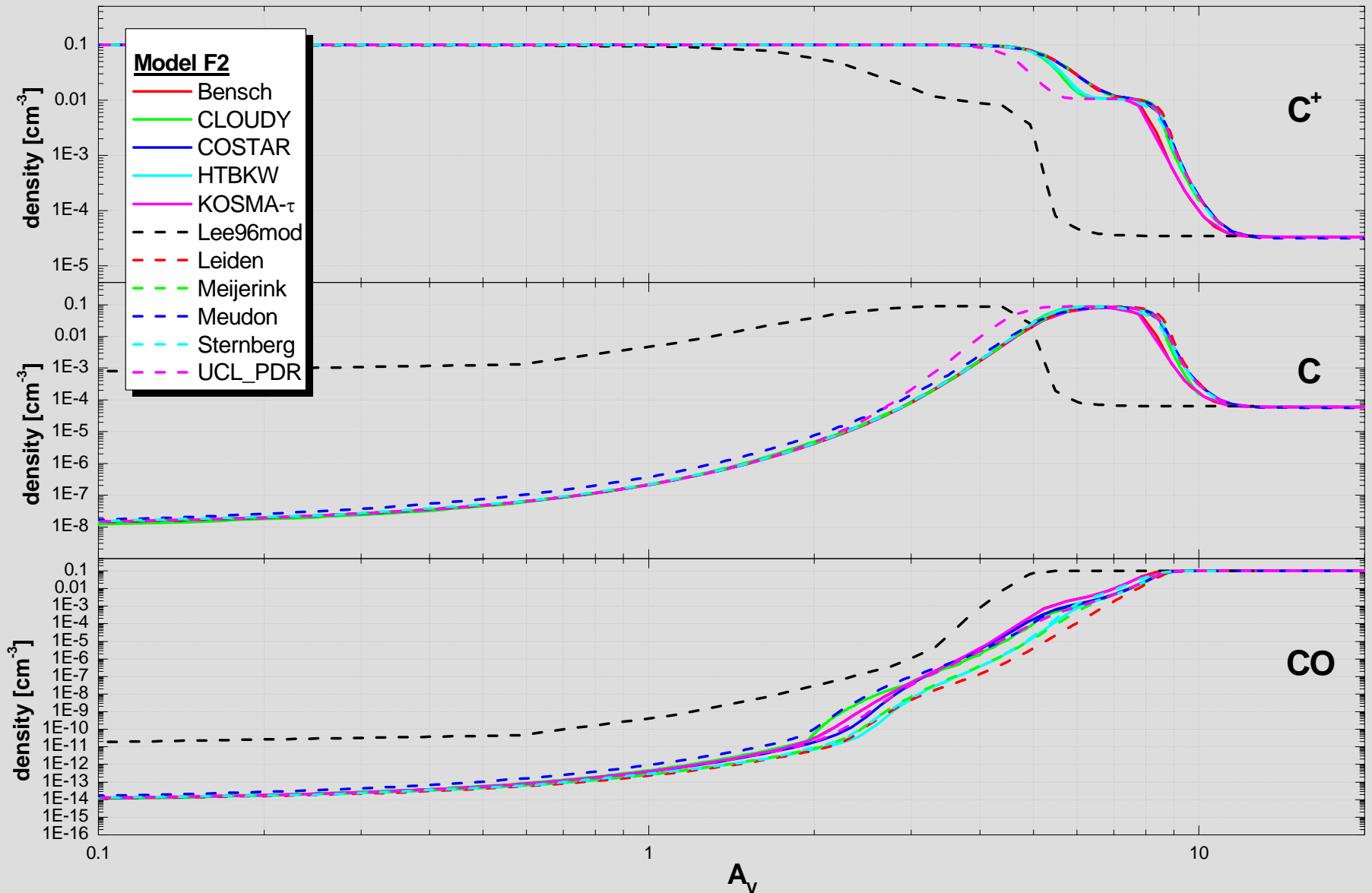
C⁺, C, CO density - $n=10^3 \text{ cm}^{-3}$, $\chi = 10^5$



5.-8. April, 2004

PDR Model Comparison

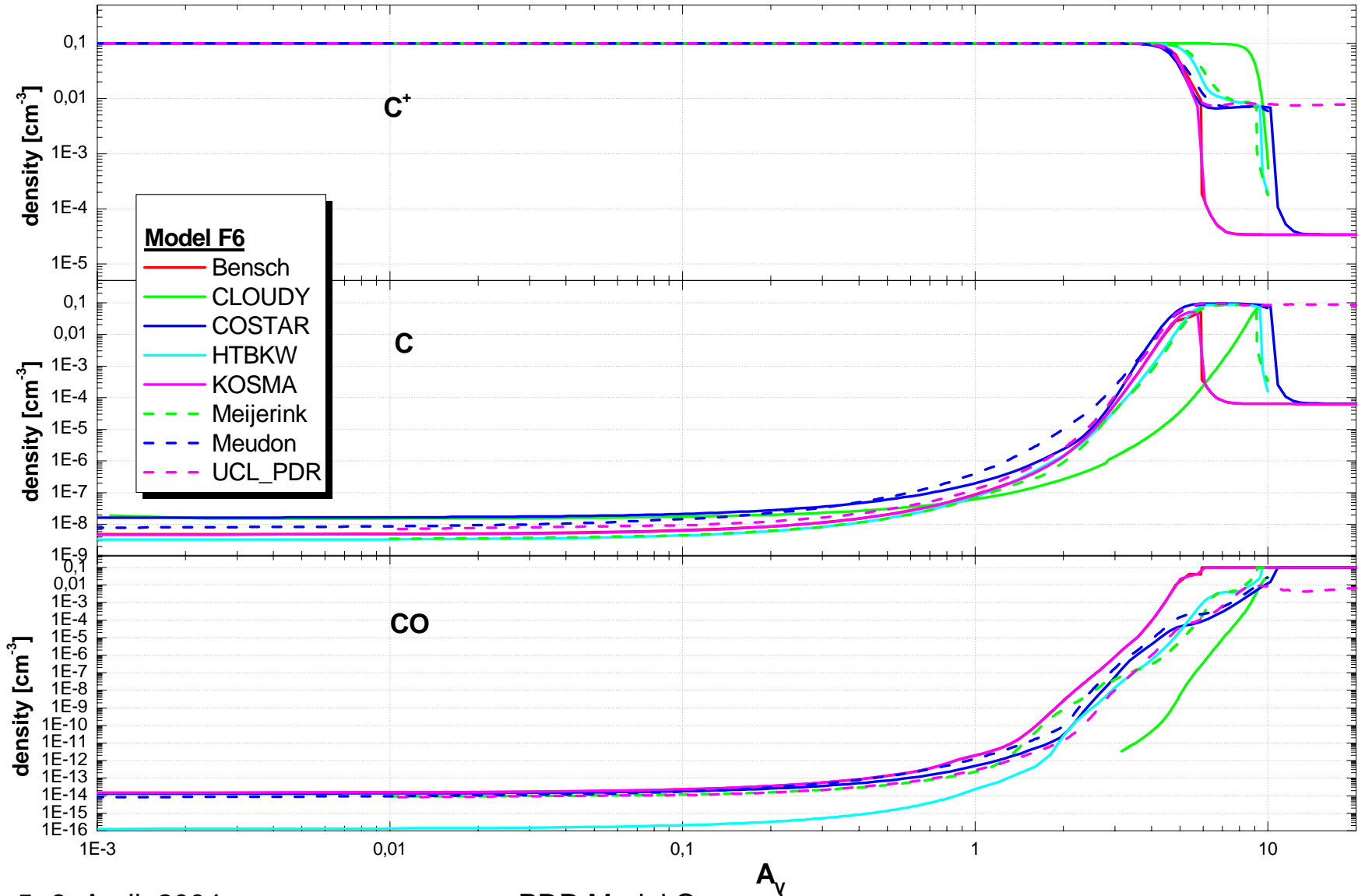
C⁺, C, CO density - $n=10^3 \text{ cm}^{-3}$, $\chi = 10^5$



5.-8. April, 2004

PDR Model Comparison

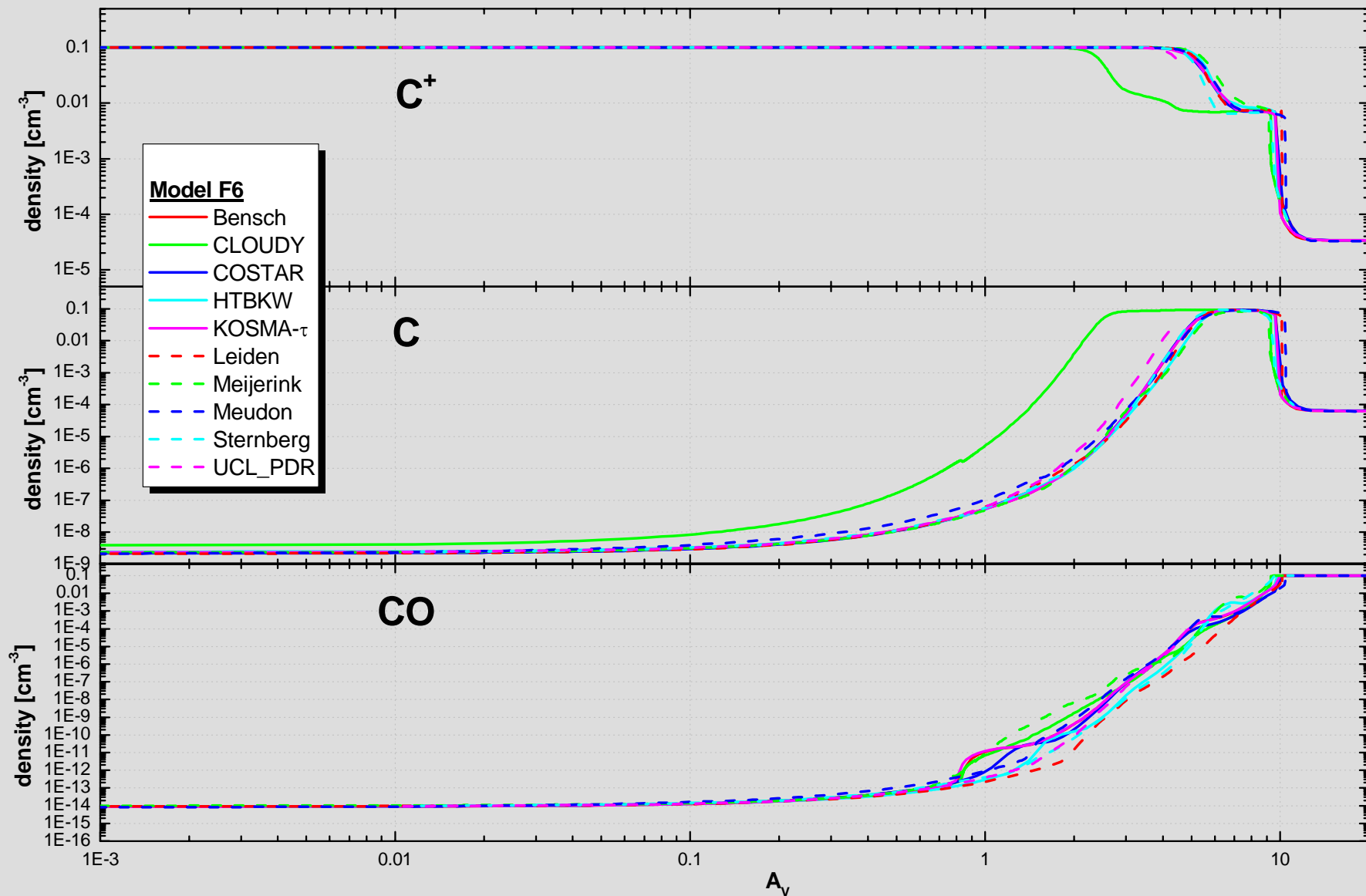
C⁺, C, CO density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

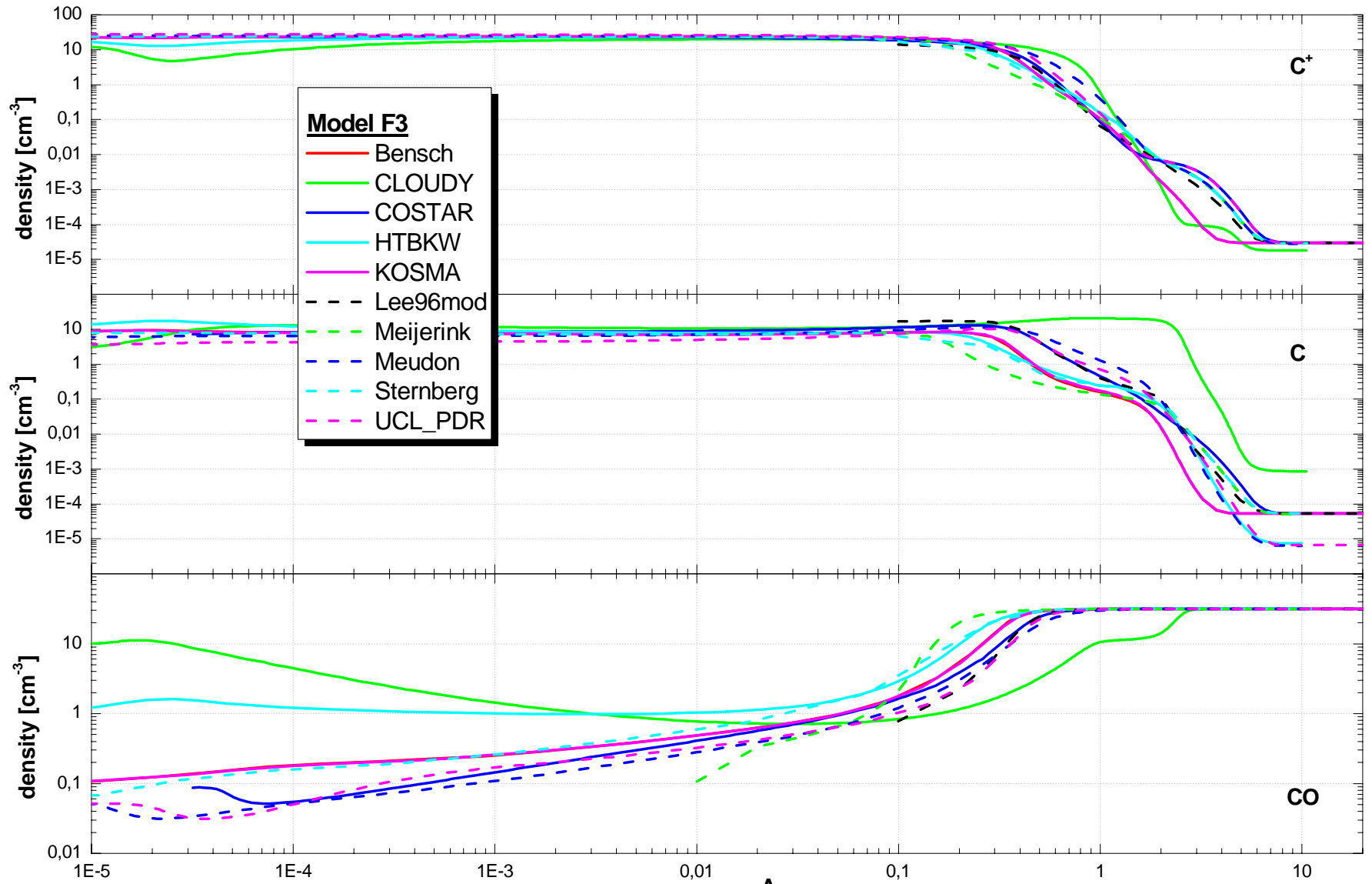
C⁺, C, CO density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

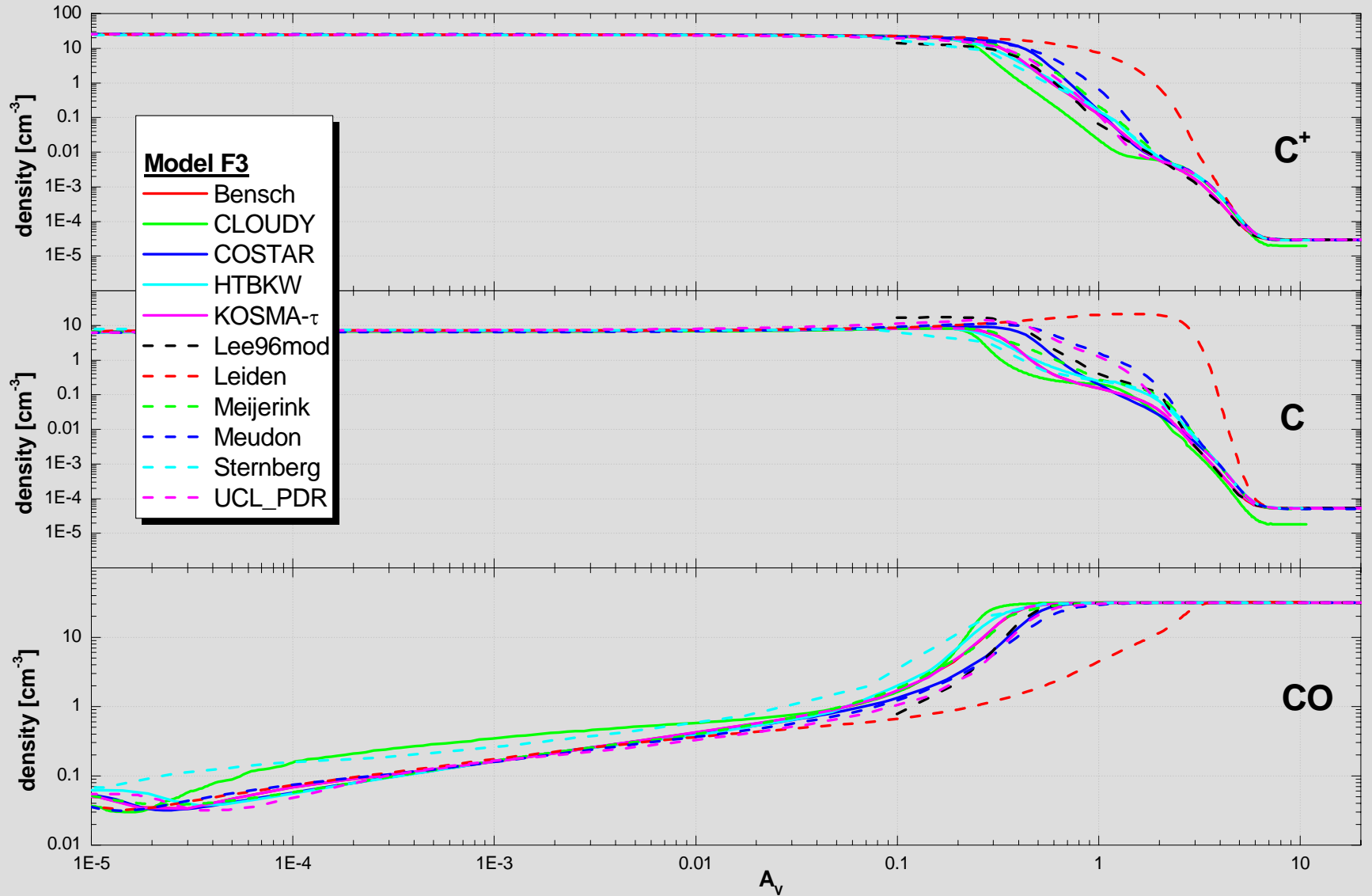
C⁺, C, CO density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



5.-8. April, 2004

PDR Model Comparison

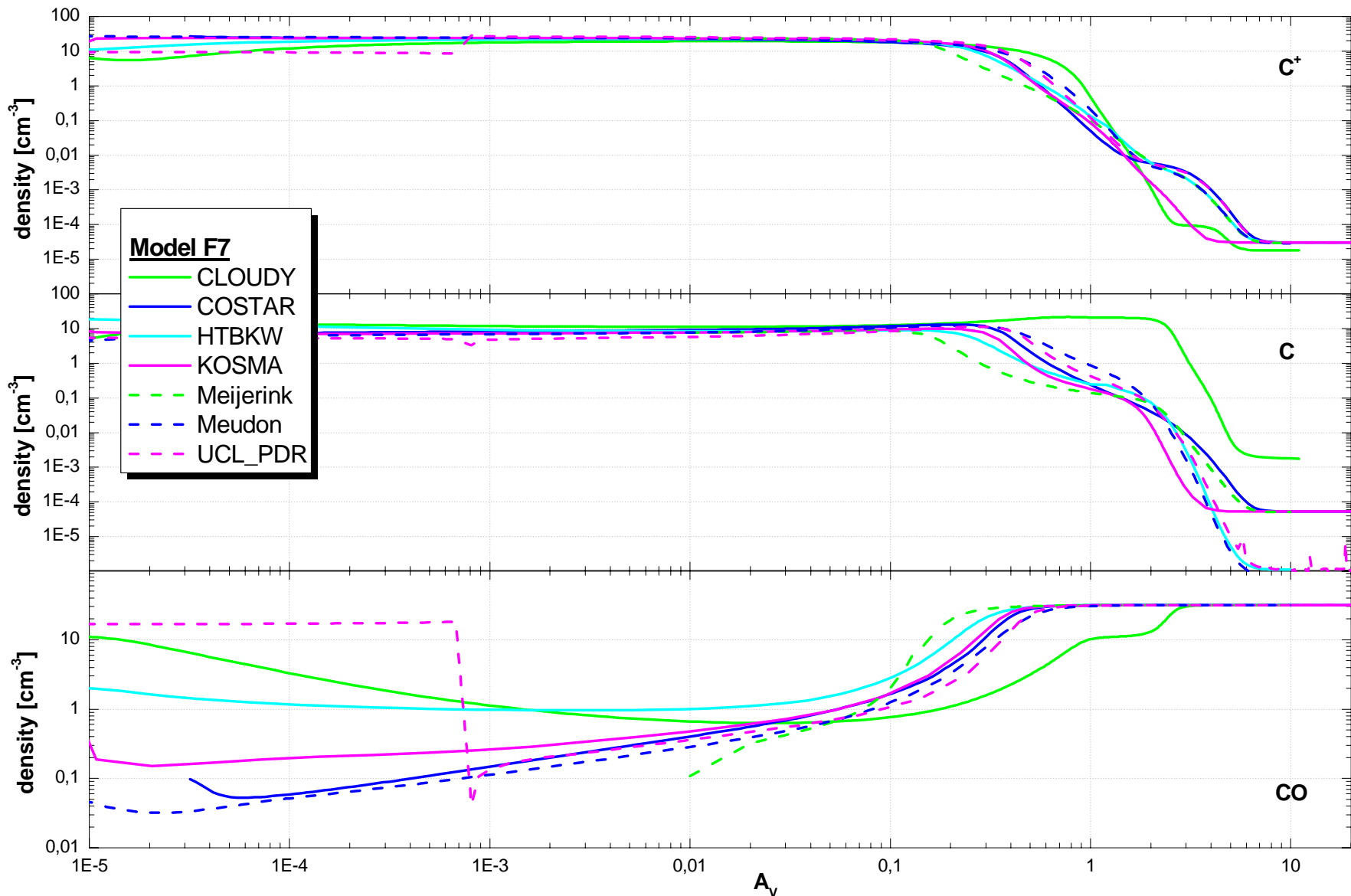
C⁺, C, CO density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



5.-8. April, 2004

PDR Model Comparison

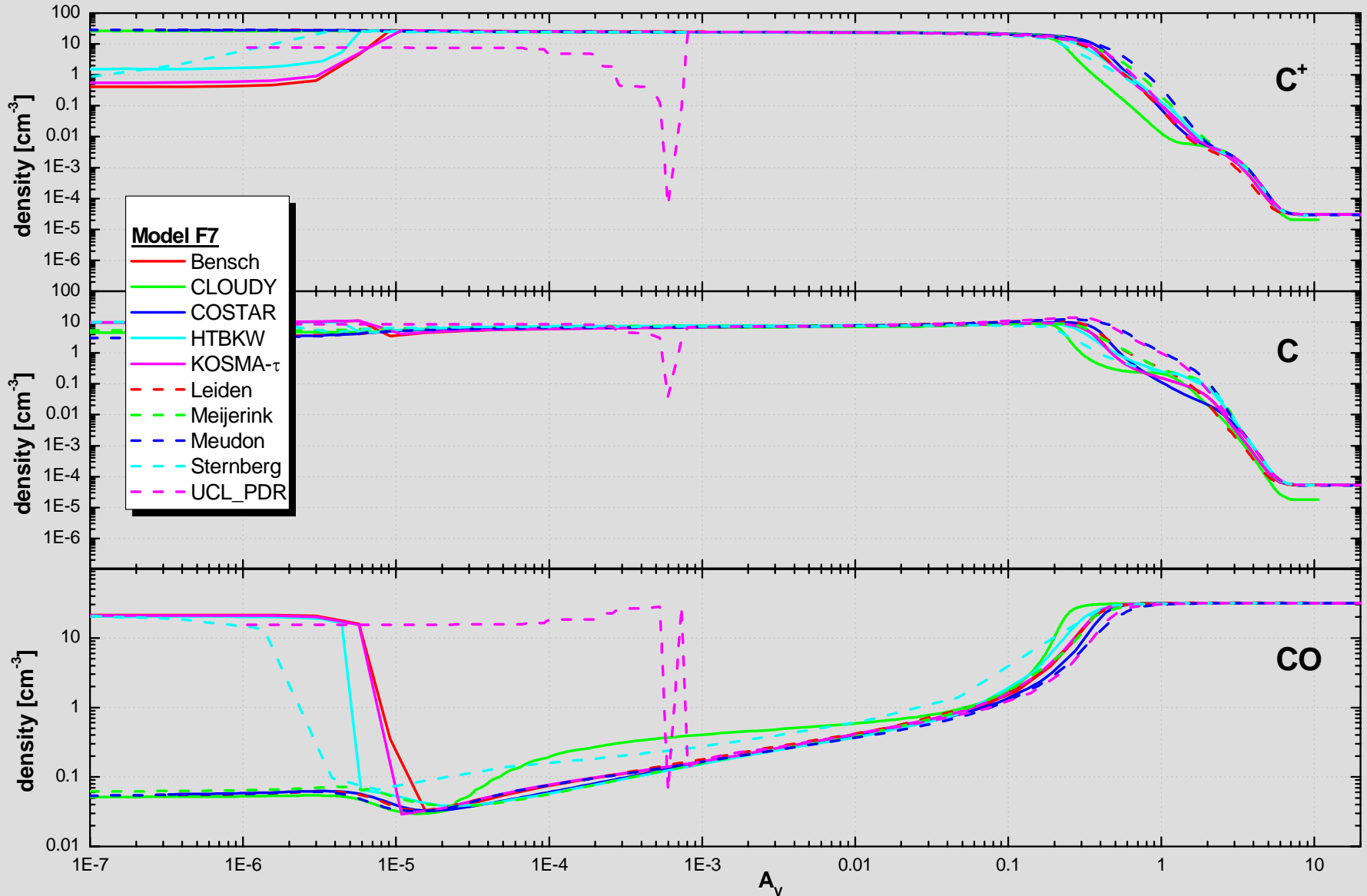
C⁺, C, CO density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^1$, variable T



5.-8. April, 2004

PDR Model Comparison

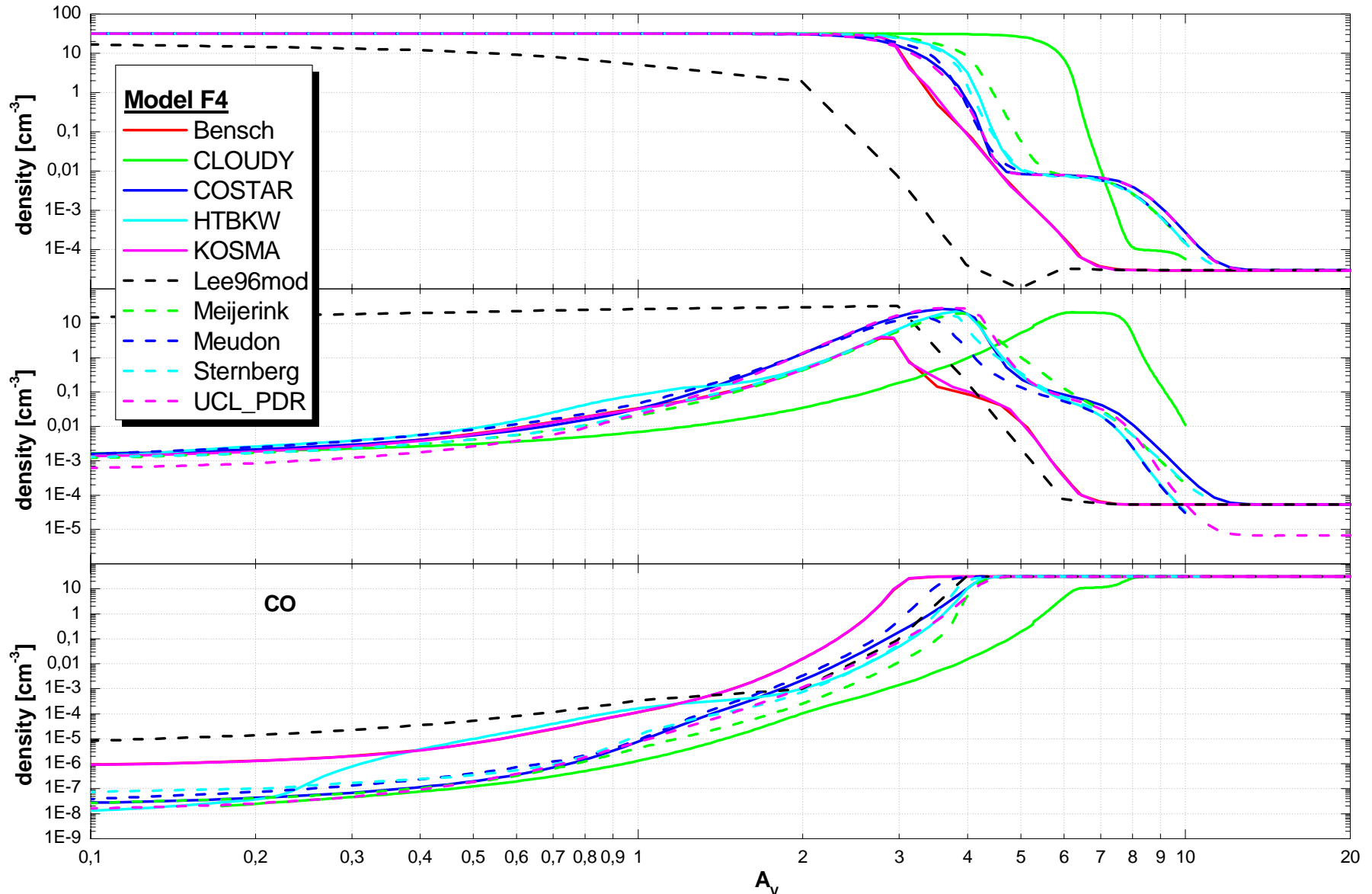
C⁺, C, CO density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^1$, variable T



5.-8. April, 2004

PDR Model Comparison

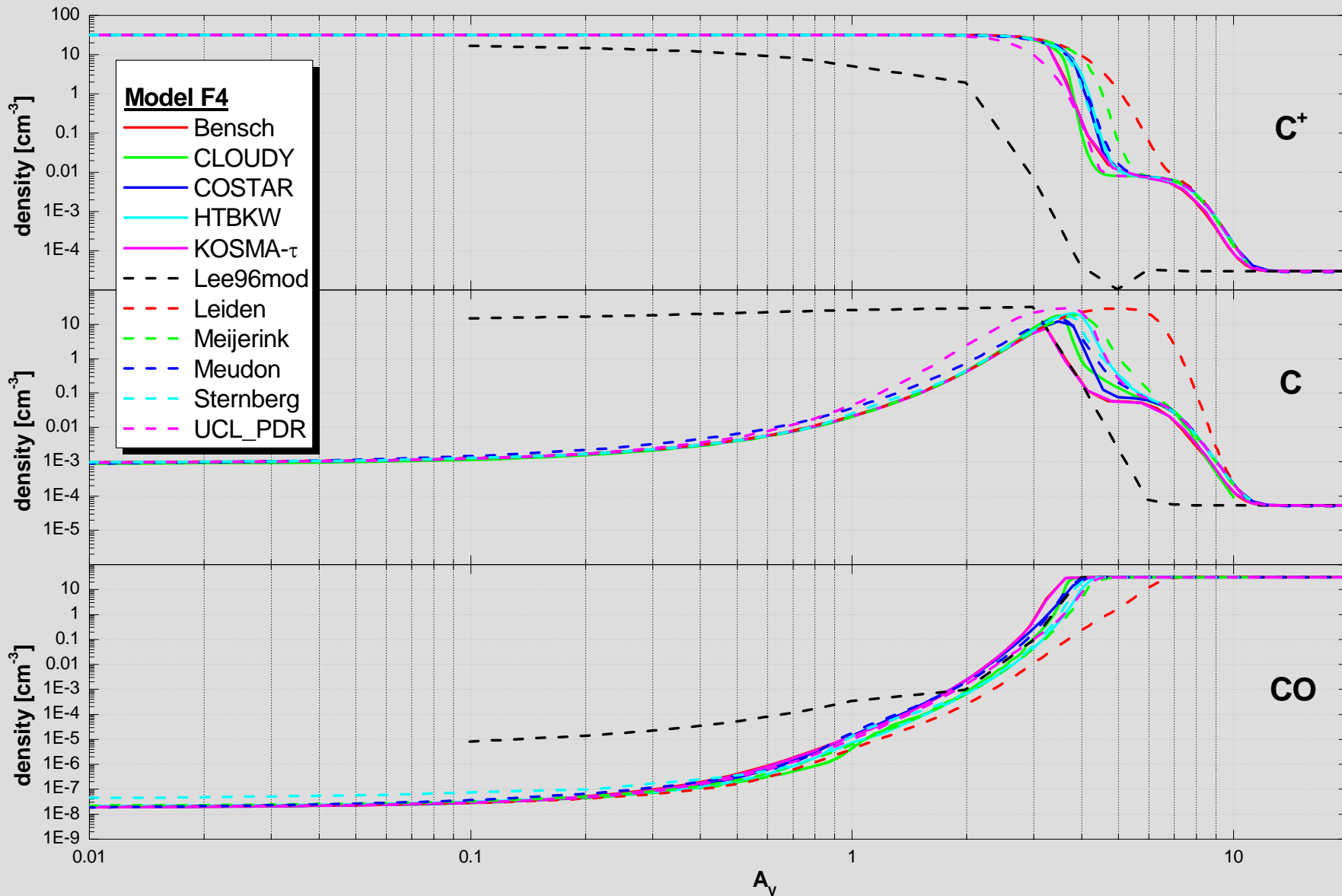
C⁺, C, CO density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



5.-8. April, 2004

PDR Model Comparison

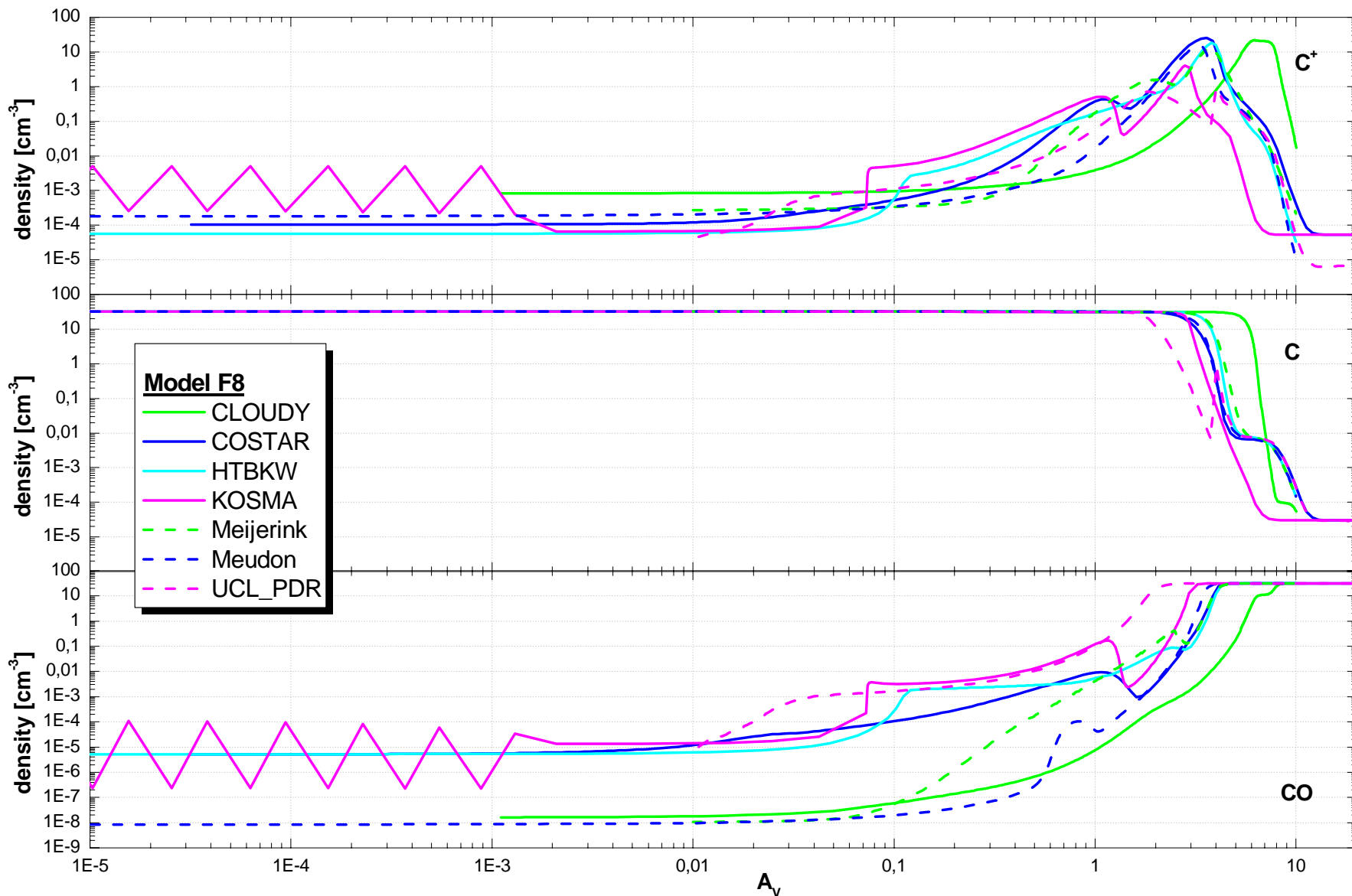
C⁺, C, CO density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



5.-8. April, 2004

PDR Model Comparison

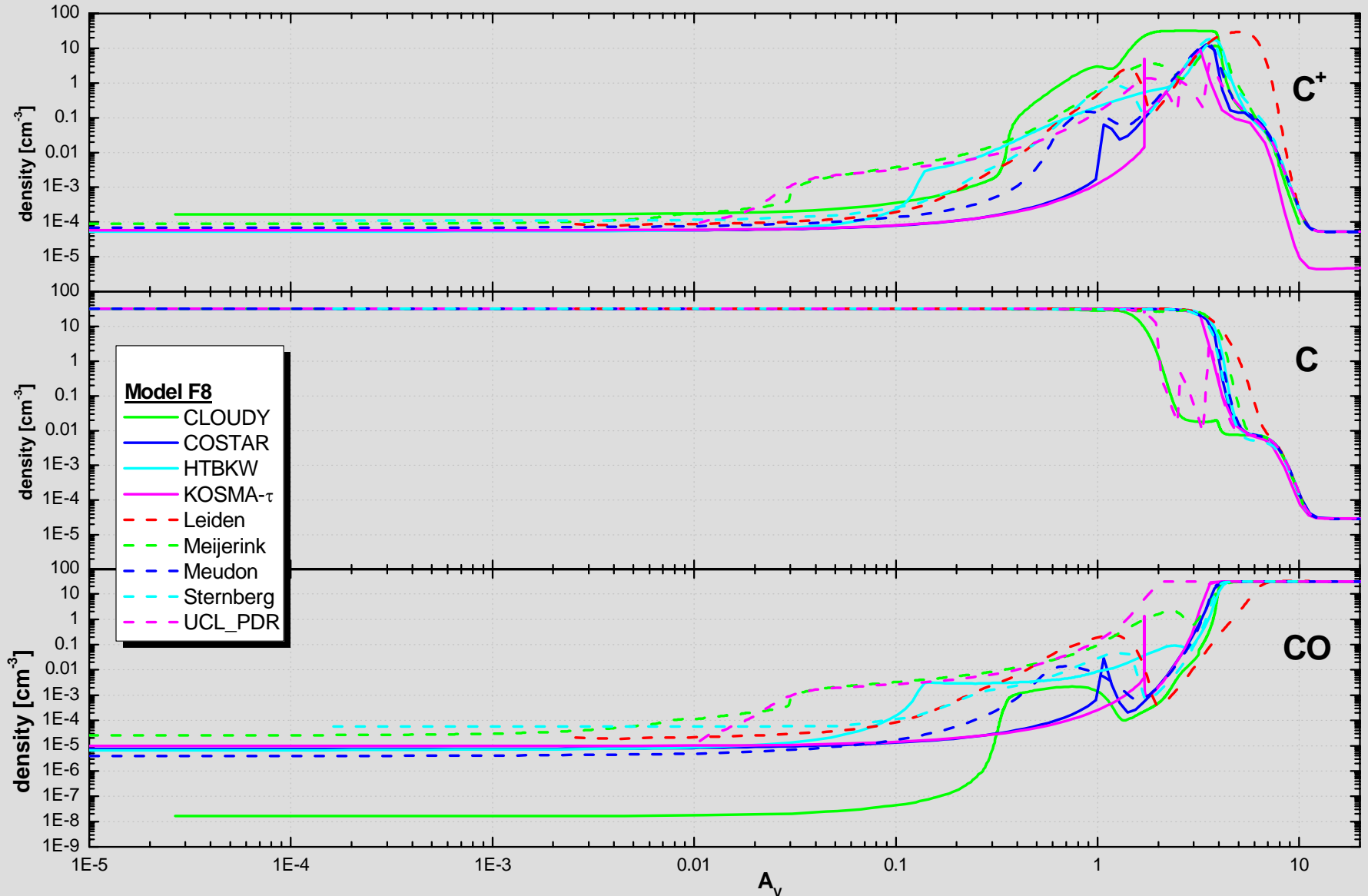
C⁺, C, CO density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

C⁺, C, CO density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$, variable T

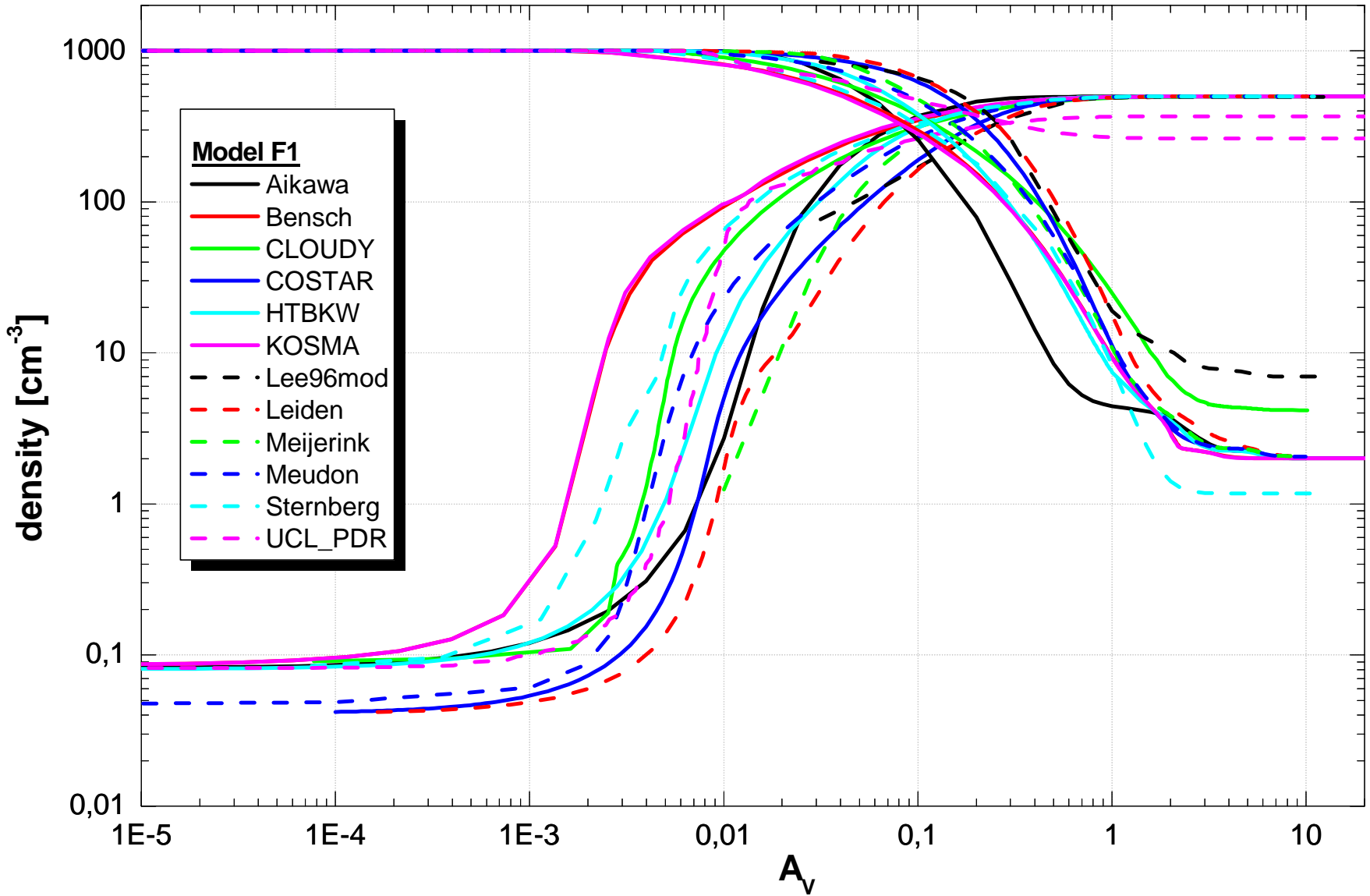


5.-8. April, 2004

PDR Model Comparison

H and H₂ density

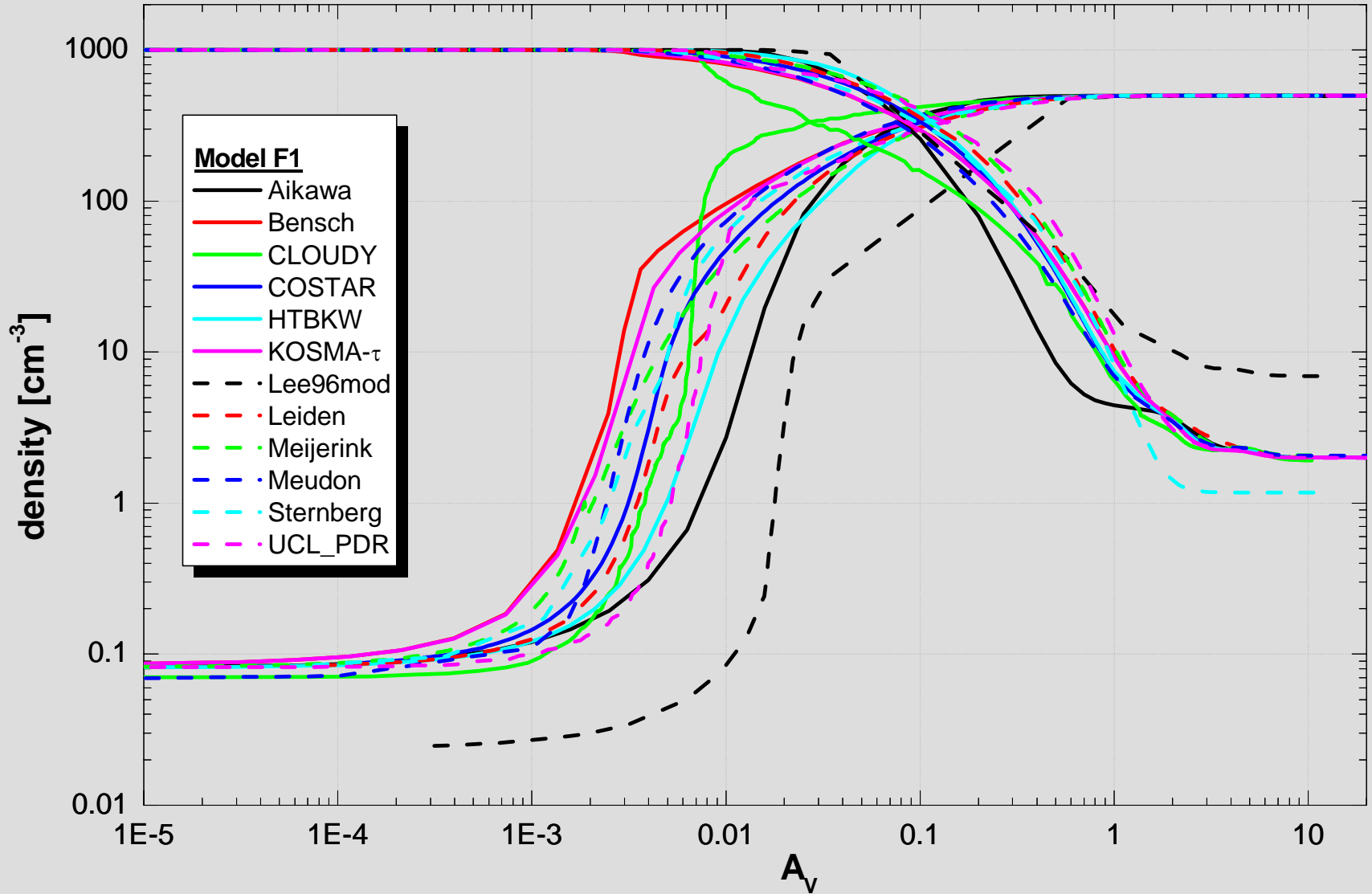
H density - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



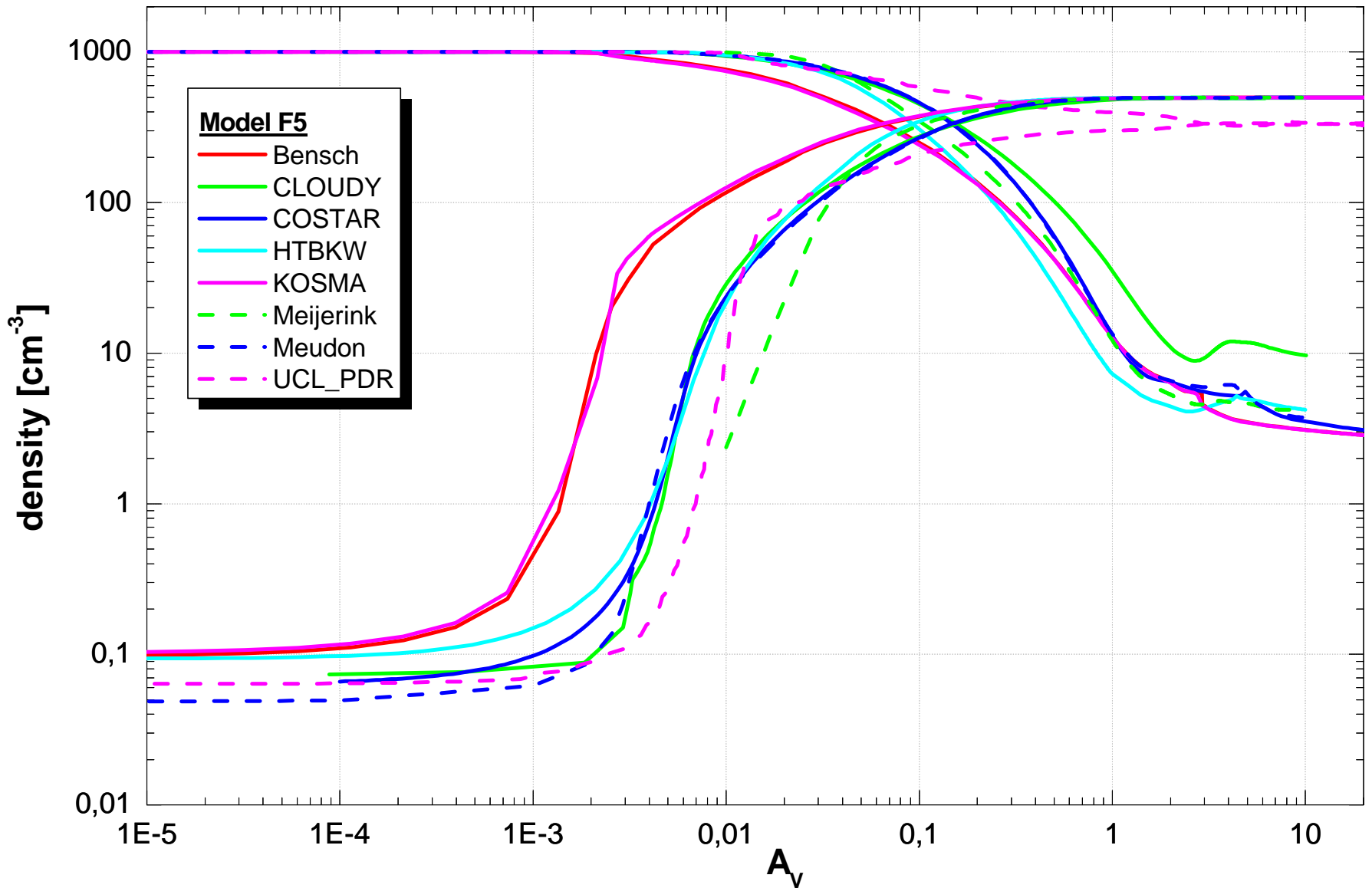
5.-8. April, 2004

PDR Model Comparison

H density - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



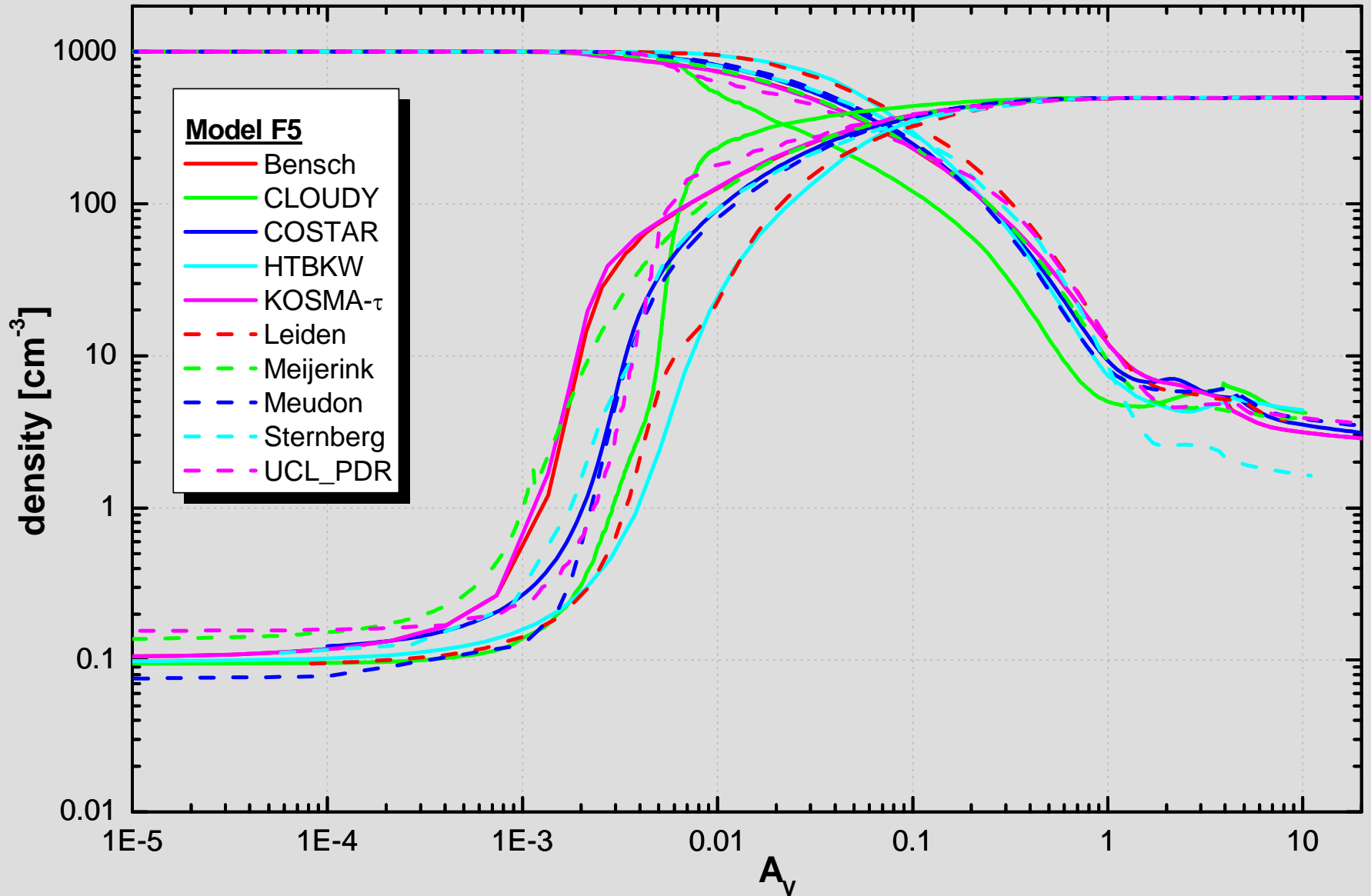
H and H₂ density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^1$, variable T



5.-8. April, 2004

PDR Model Comparison

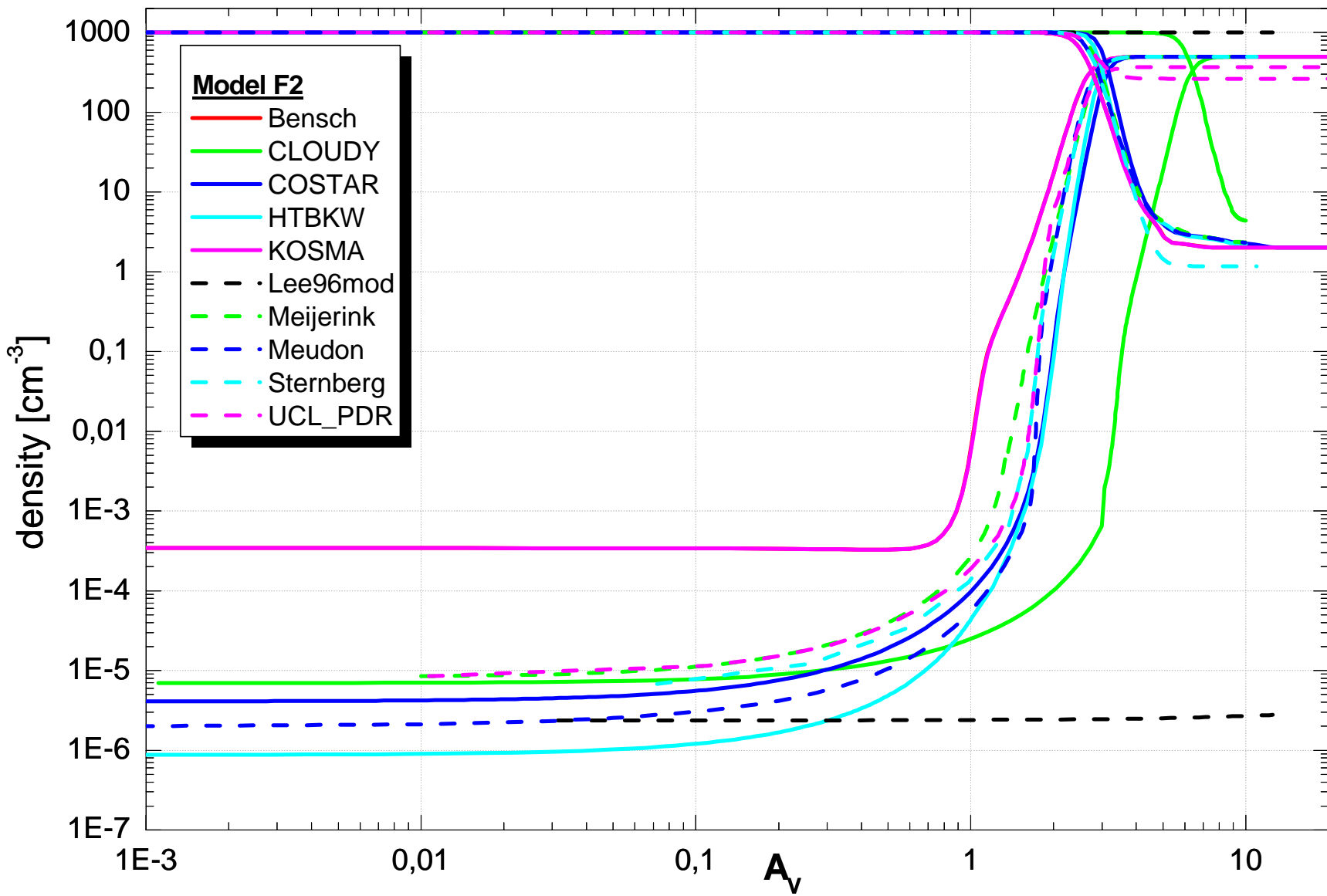
H and H₂ density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^1$, variable T



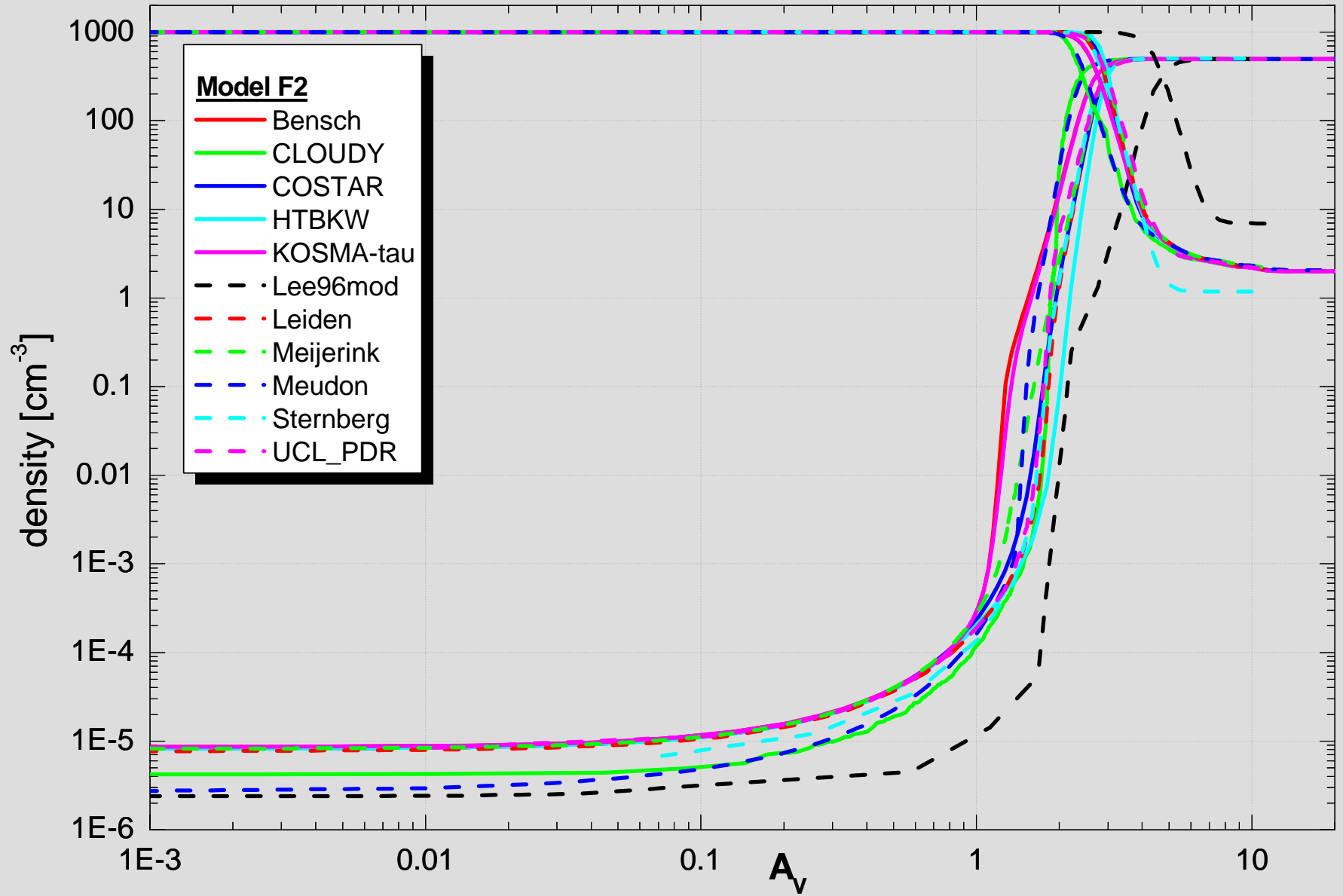
5.-8. April, 2004

PDR Model Comparison

H and H₂ density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



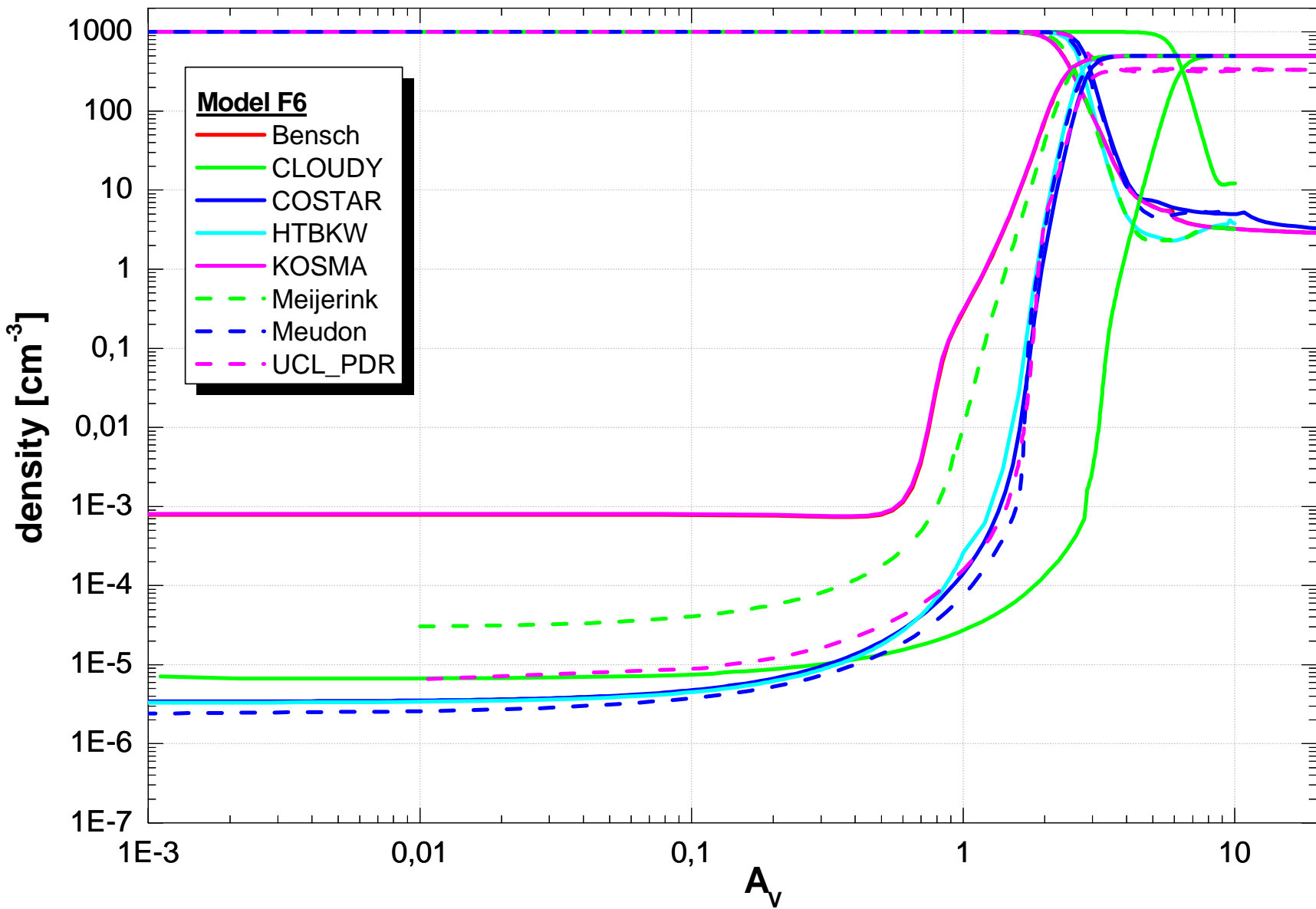
H and H₂ density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



5.-8. April, 2004

PDR Model Comparison

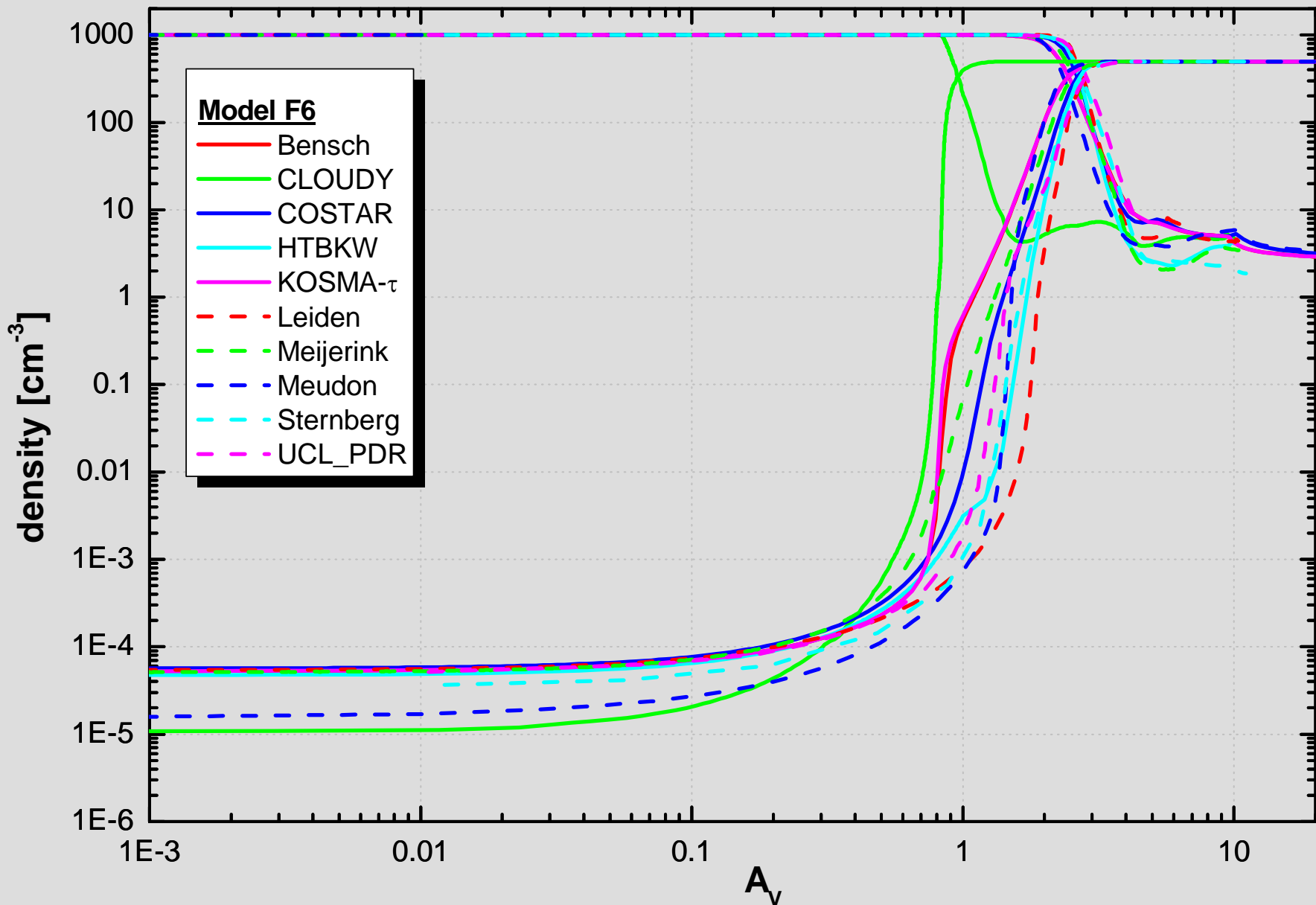
H and H₂ density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

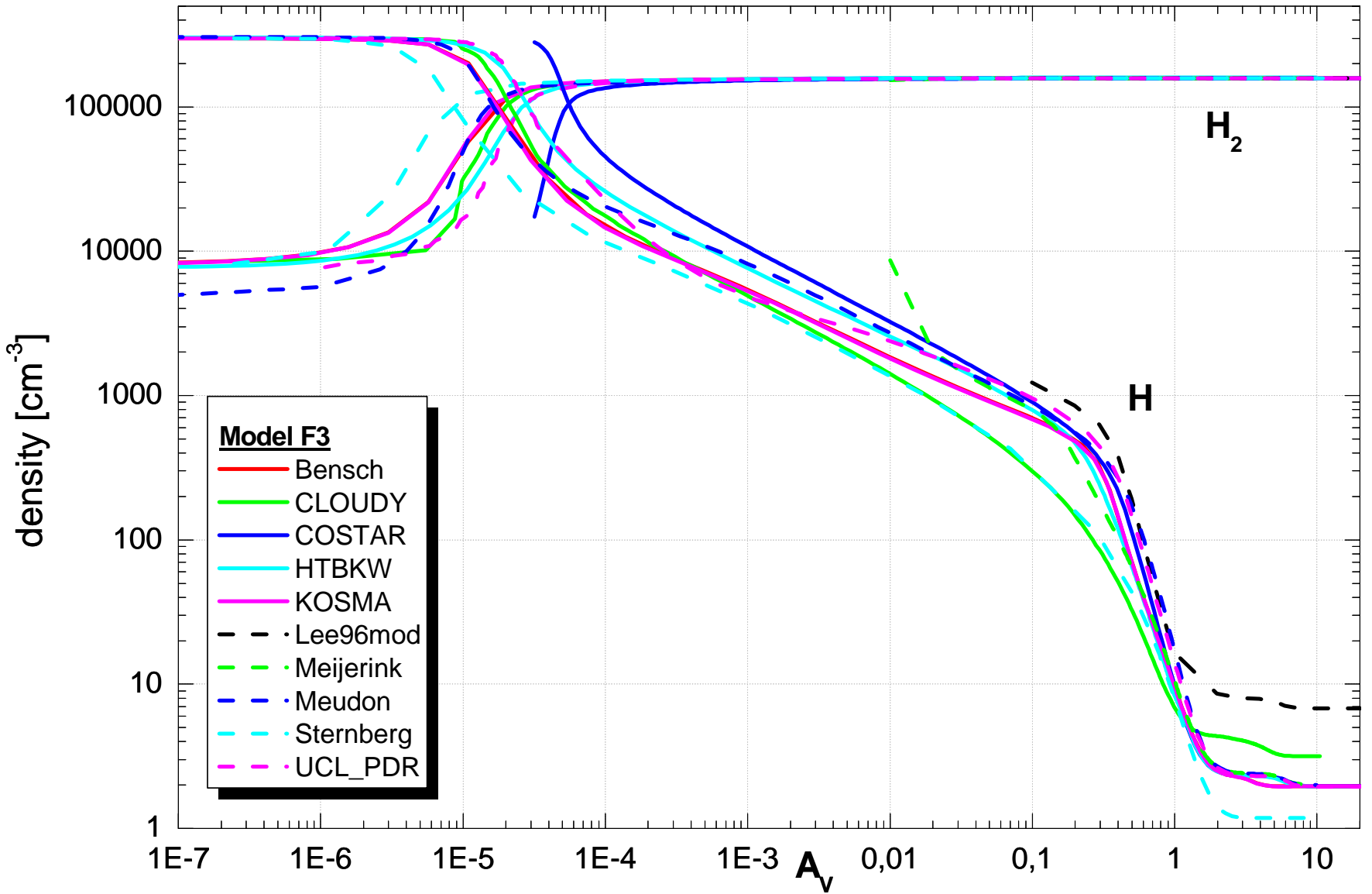
H and H₂ density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$, variable T



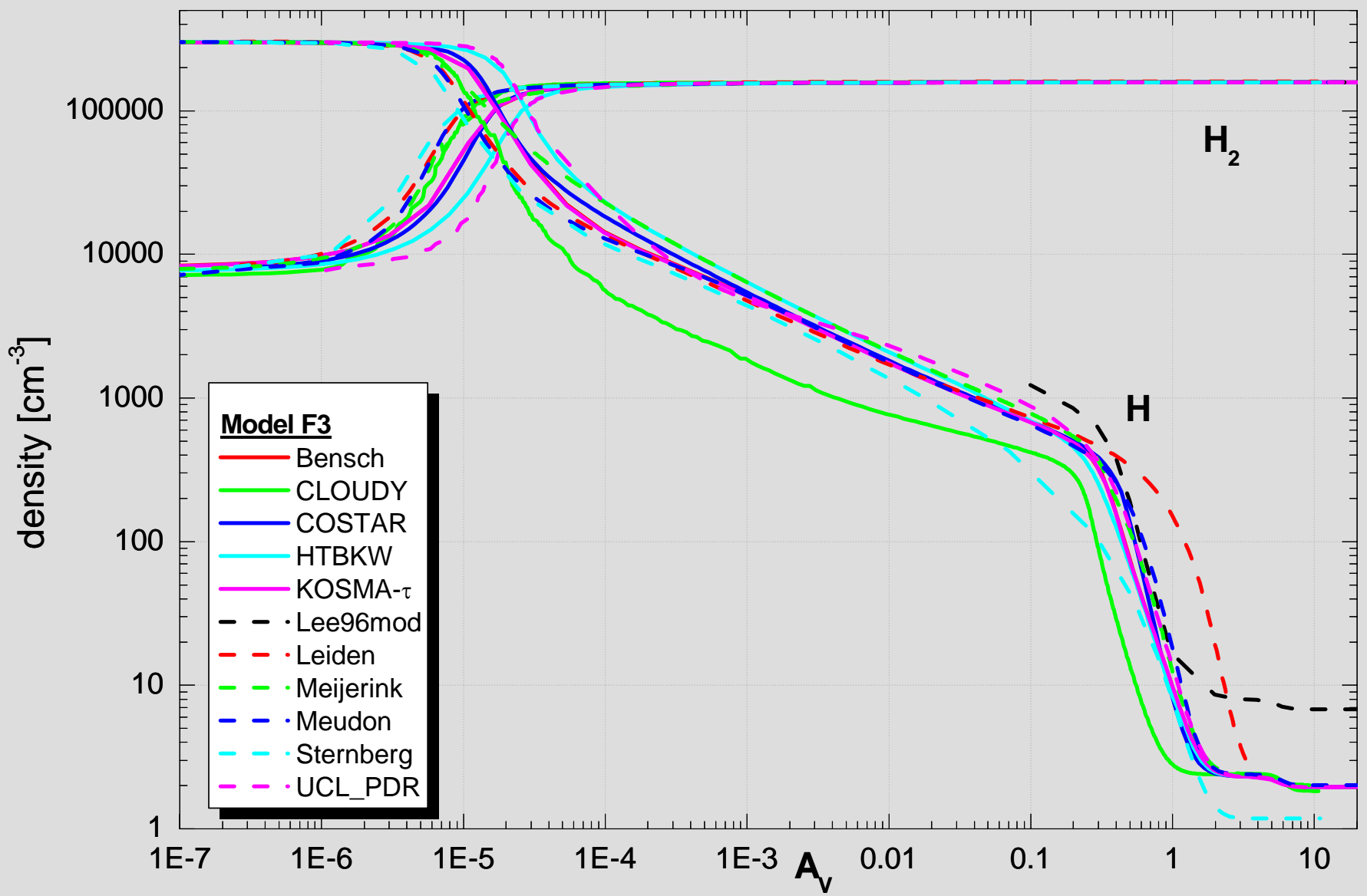
5.-8. April, 2004

PDR Model Comparison

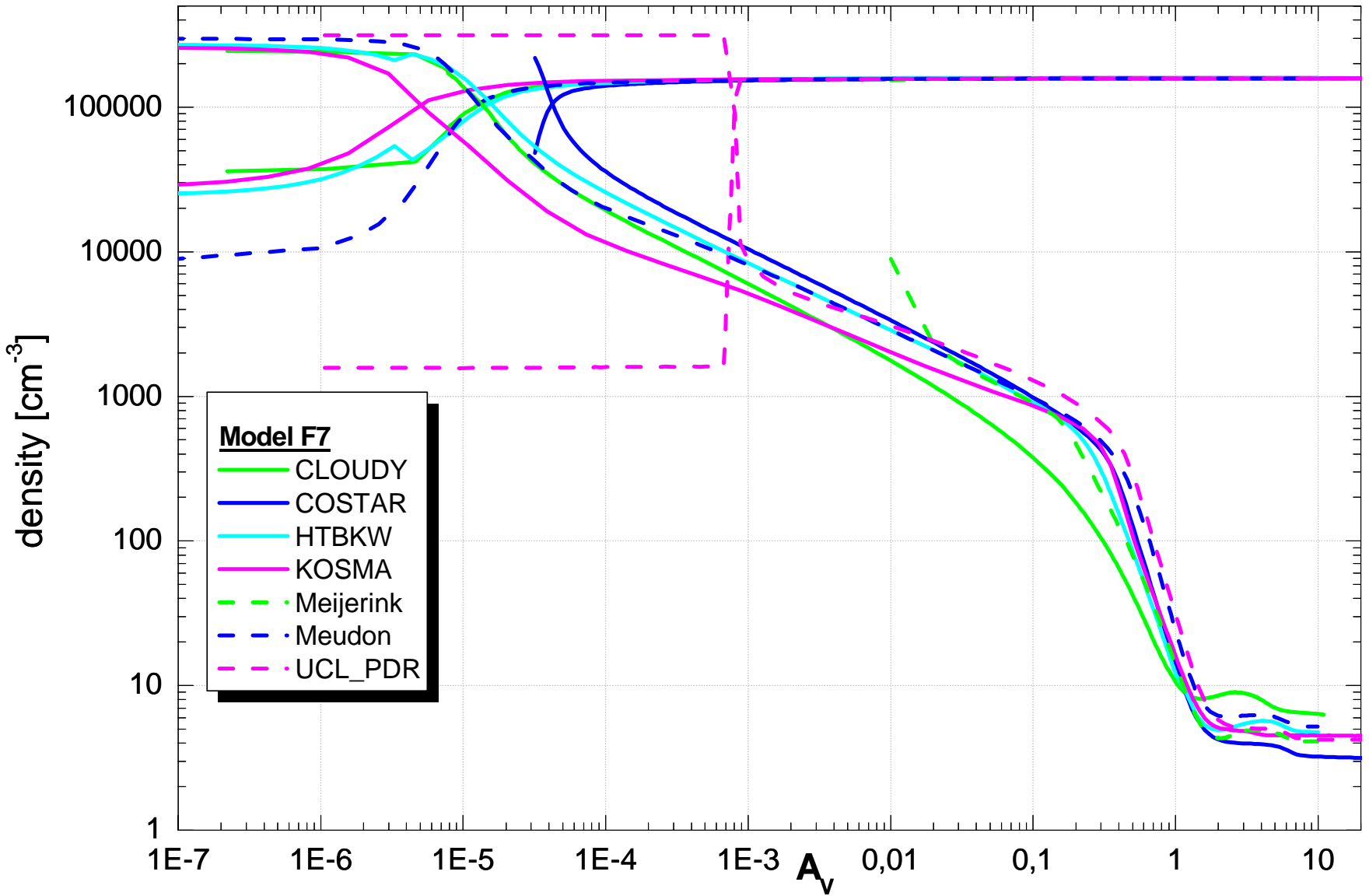
H and H₂ density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



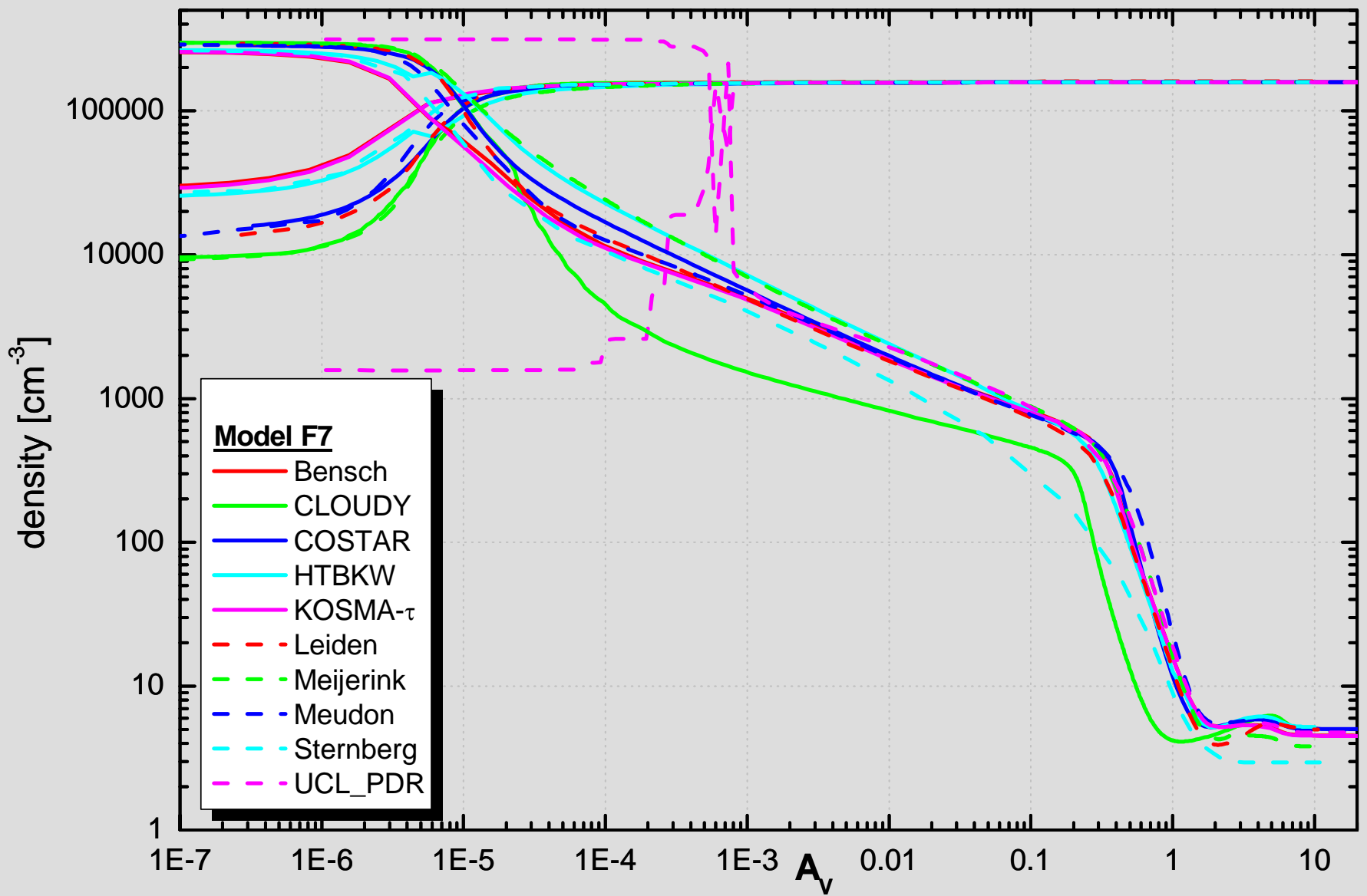
H and H₂ density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



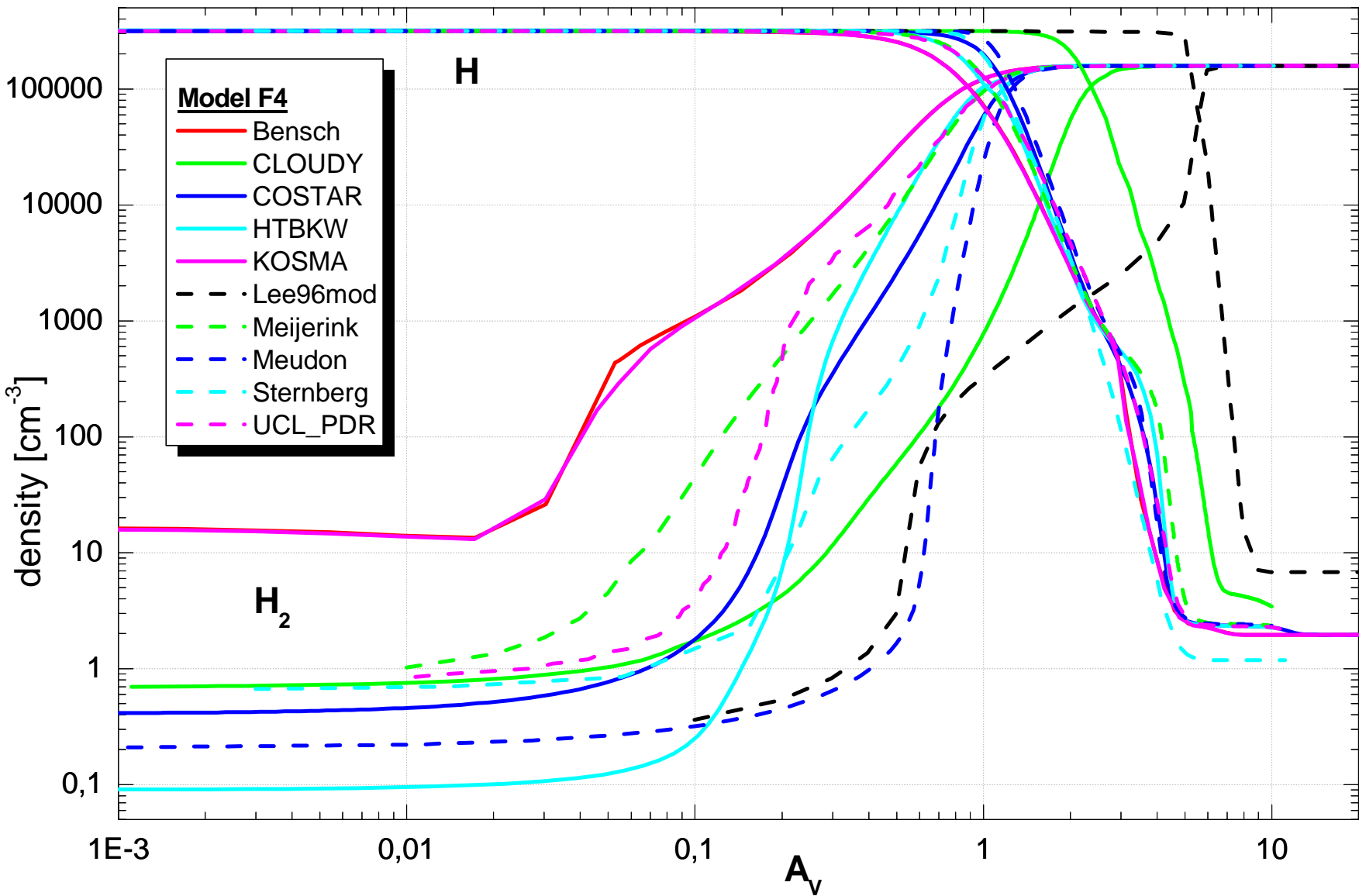
H and H₂ density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^1$, variable T



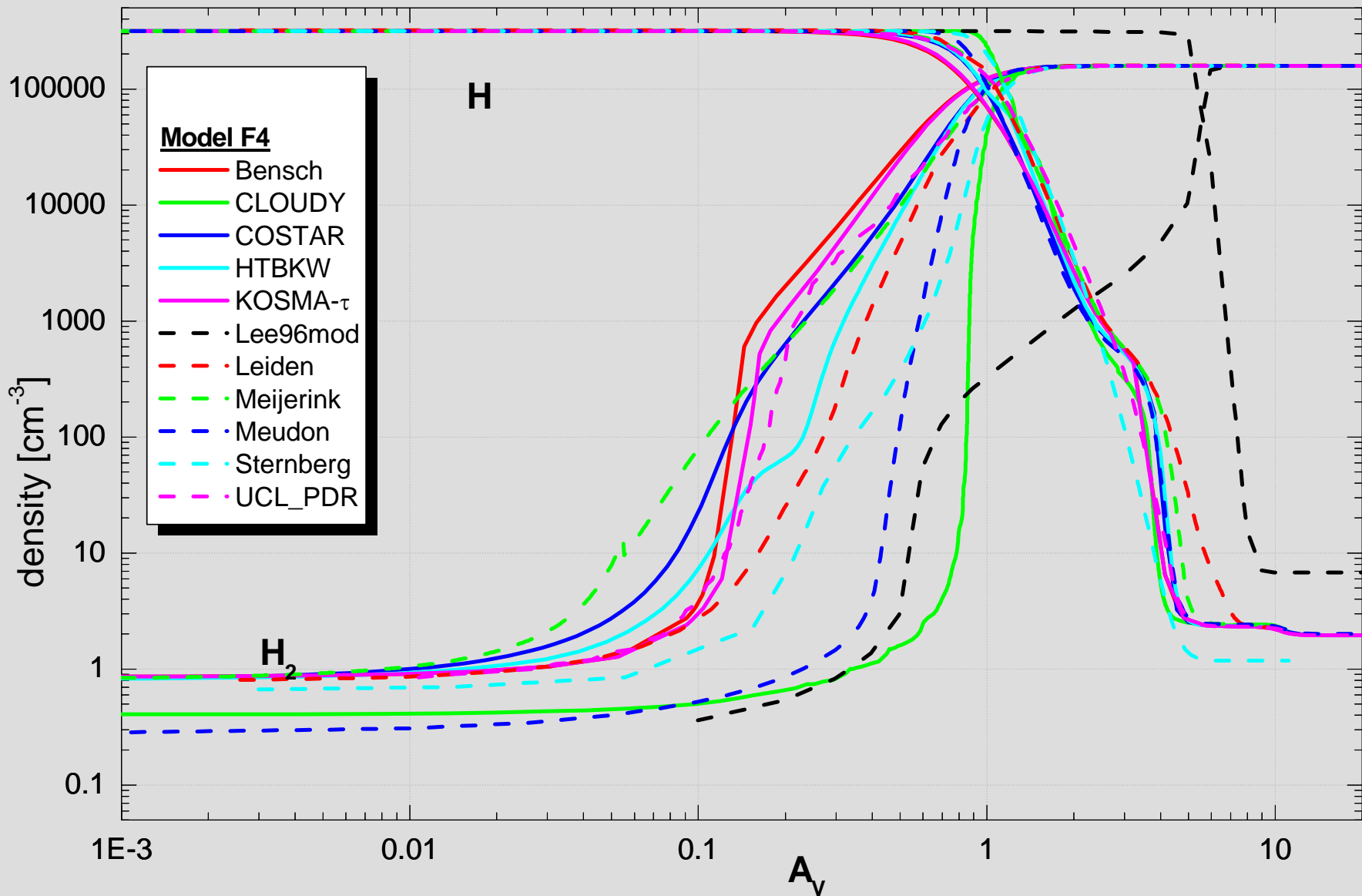
H and H₂ density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^1$, variable T



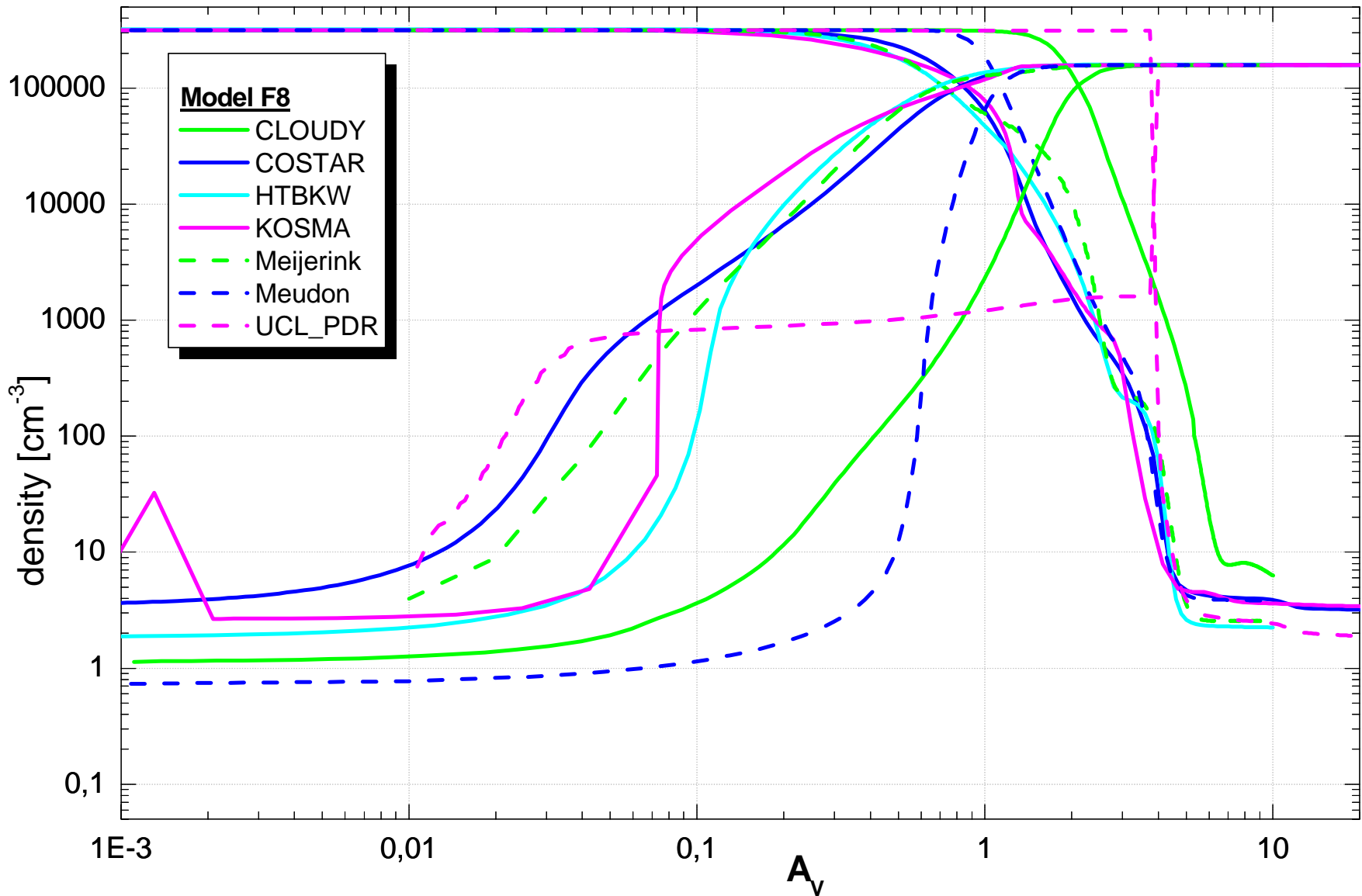
H and H₂ density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



H and H₂ density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



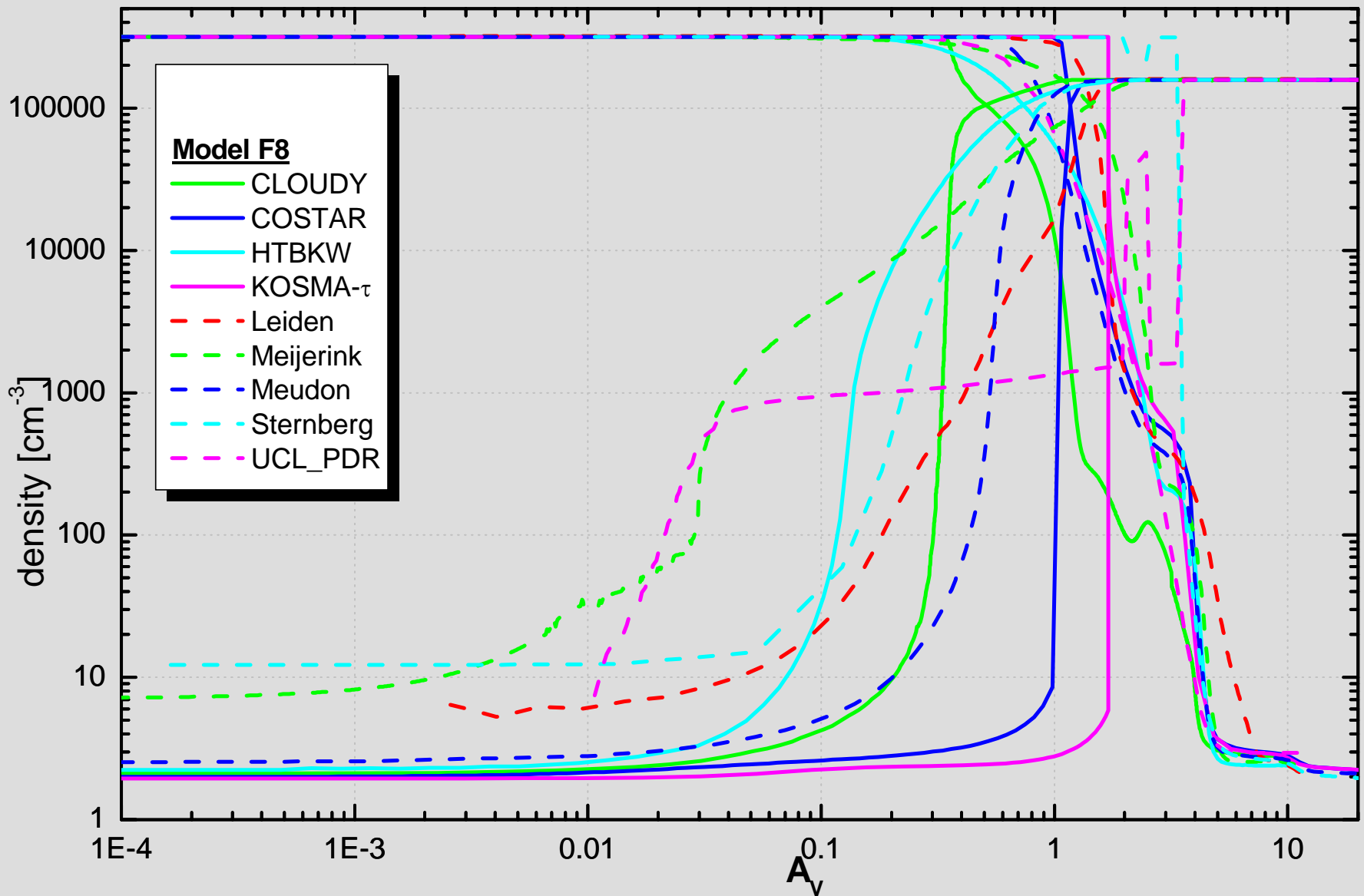
H and H₂ density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

H and H₂ density - $n=10^{5.5}$ cm⁻³, $\chi=10^5$, variable T

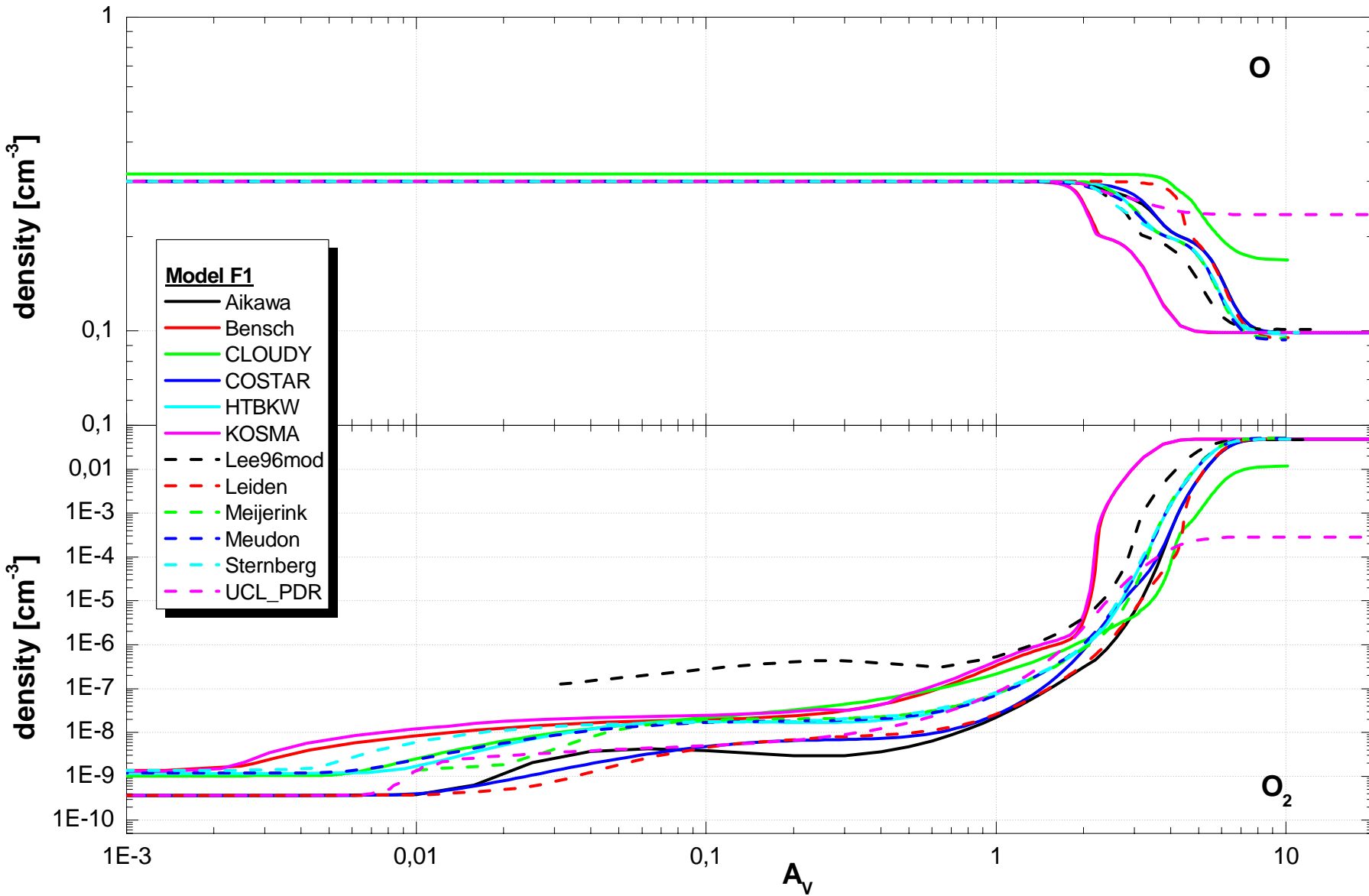


5.-8. April, 2004

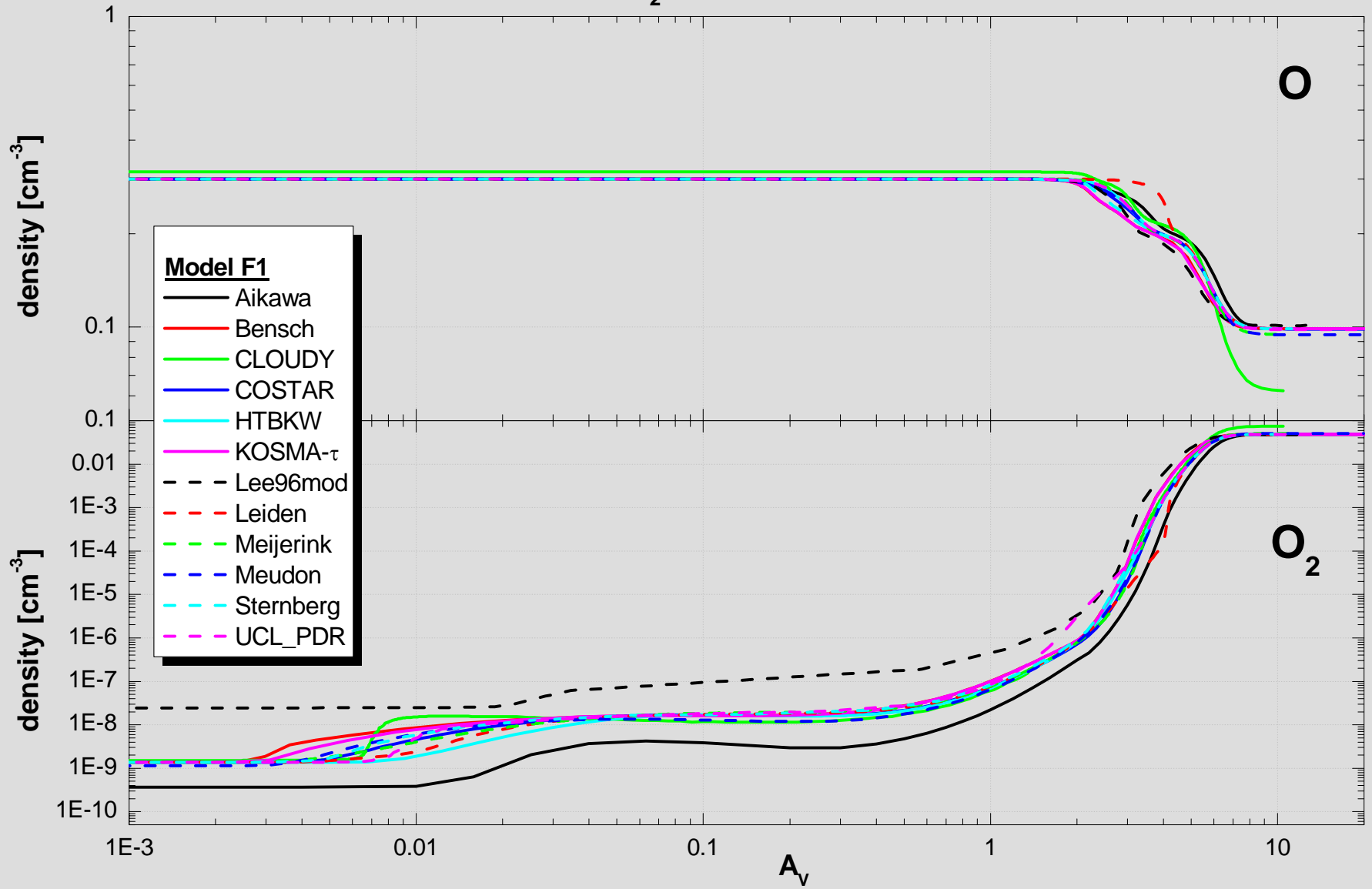
PDR Model Comparison

O and O₂ density

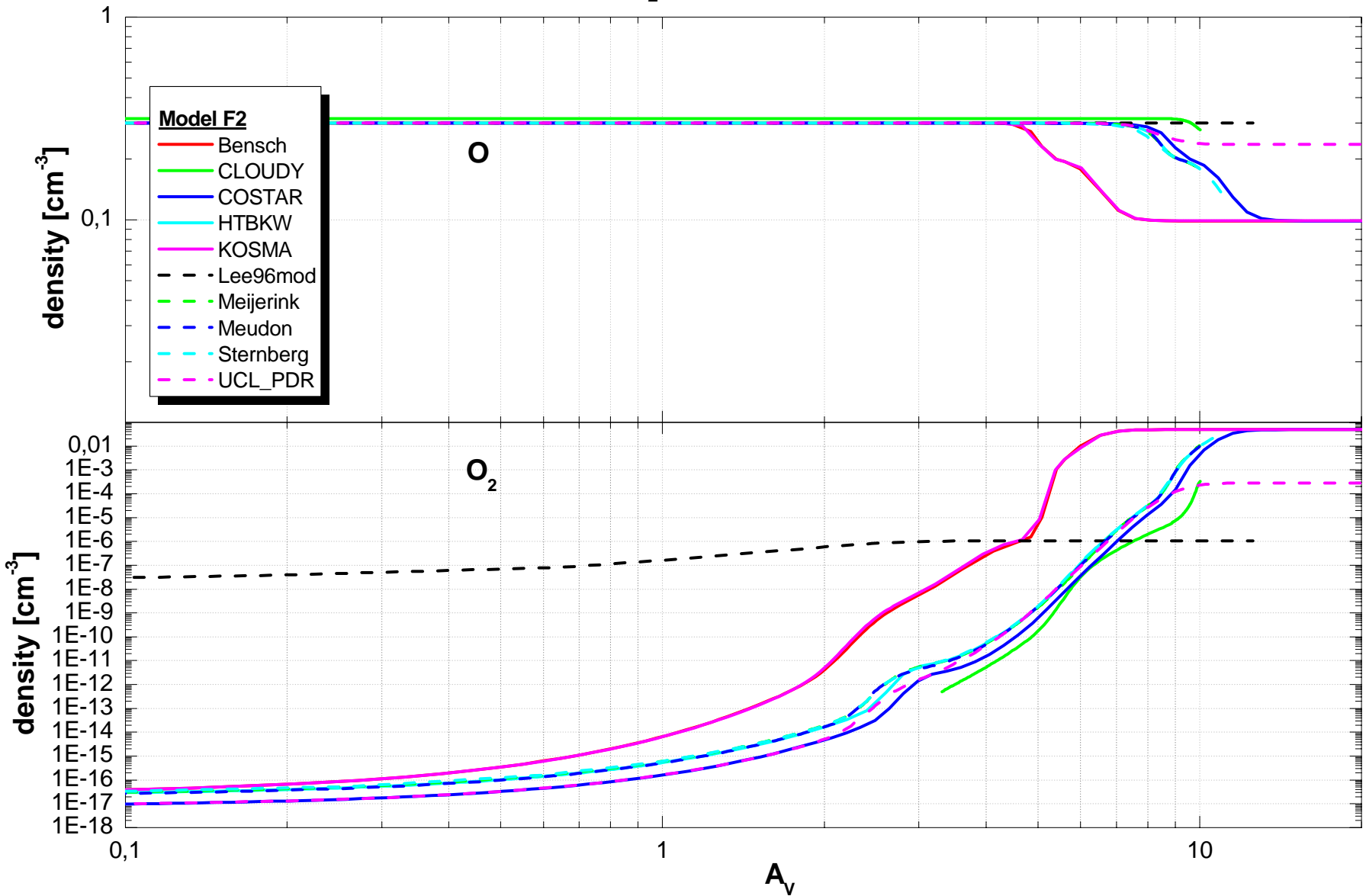
O and O₂ density - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



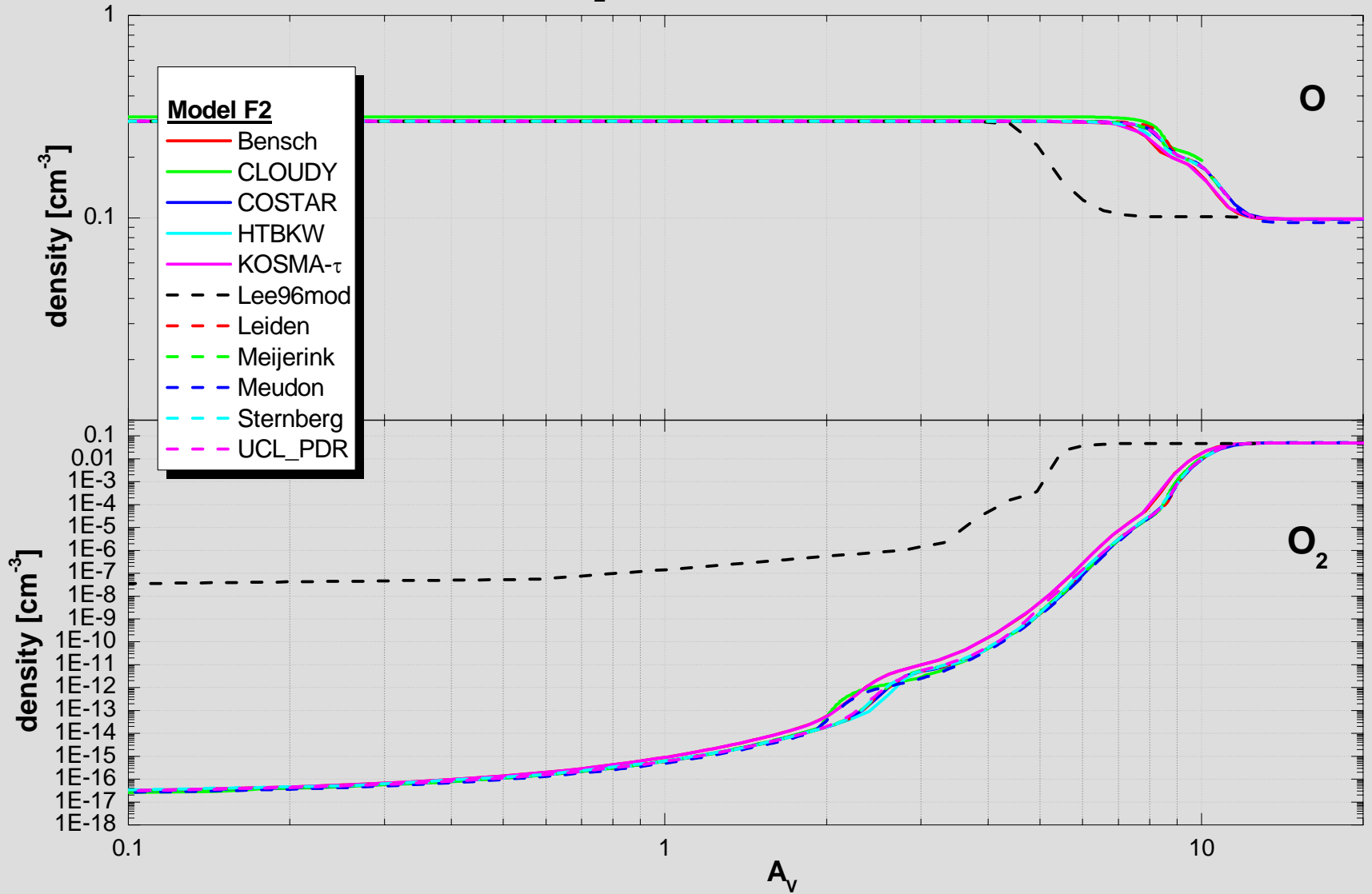
O and O₂ density - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



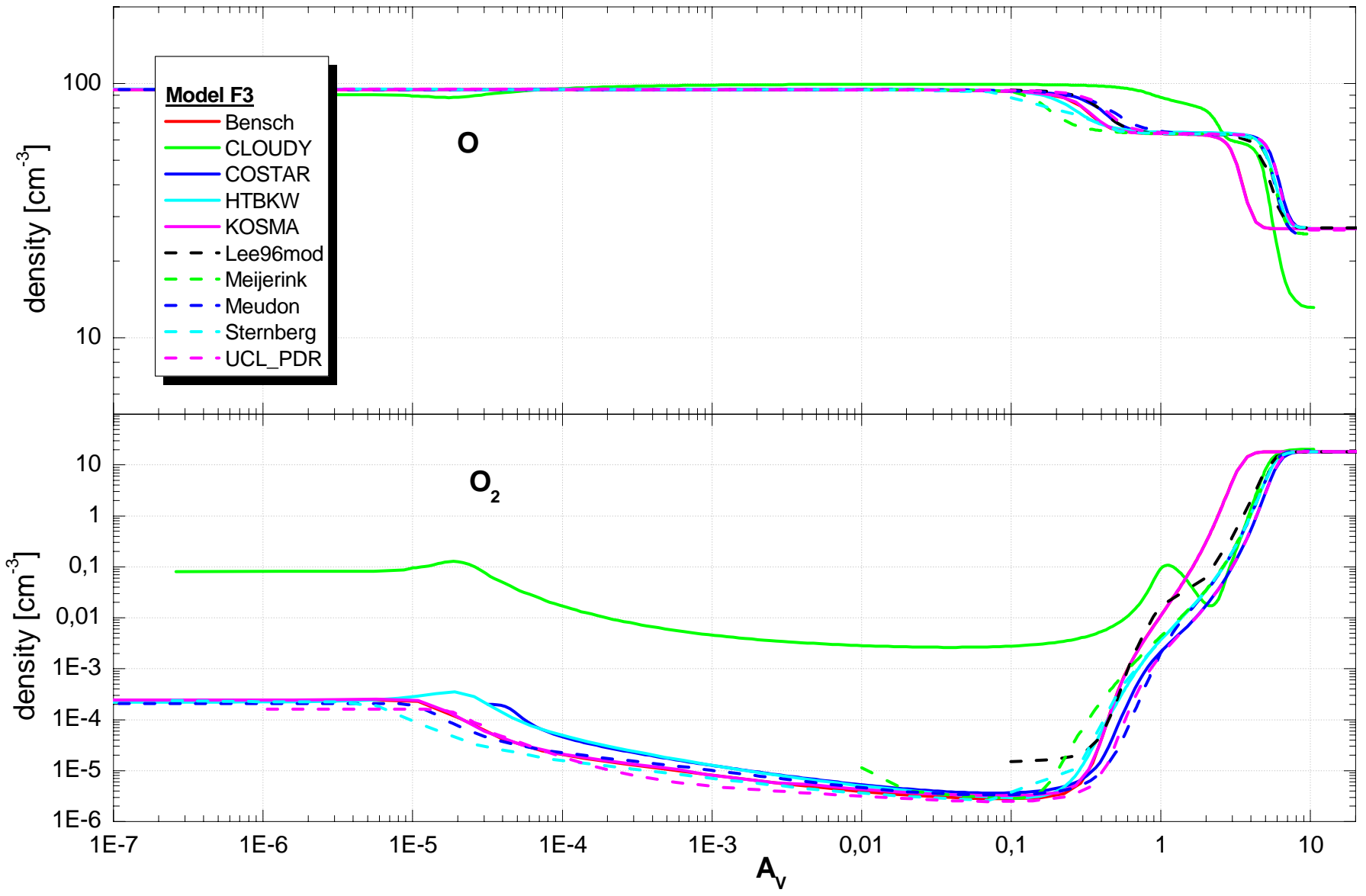
O and O₂ density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



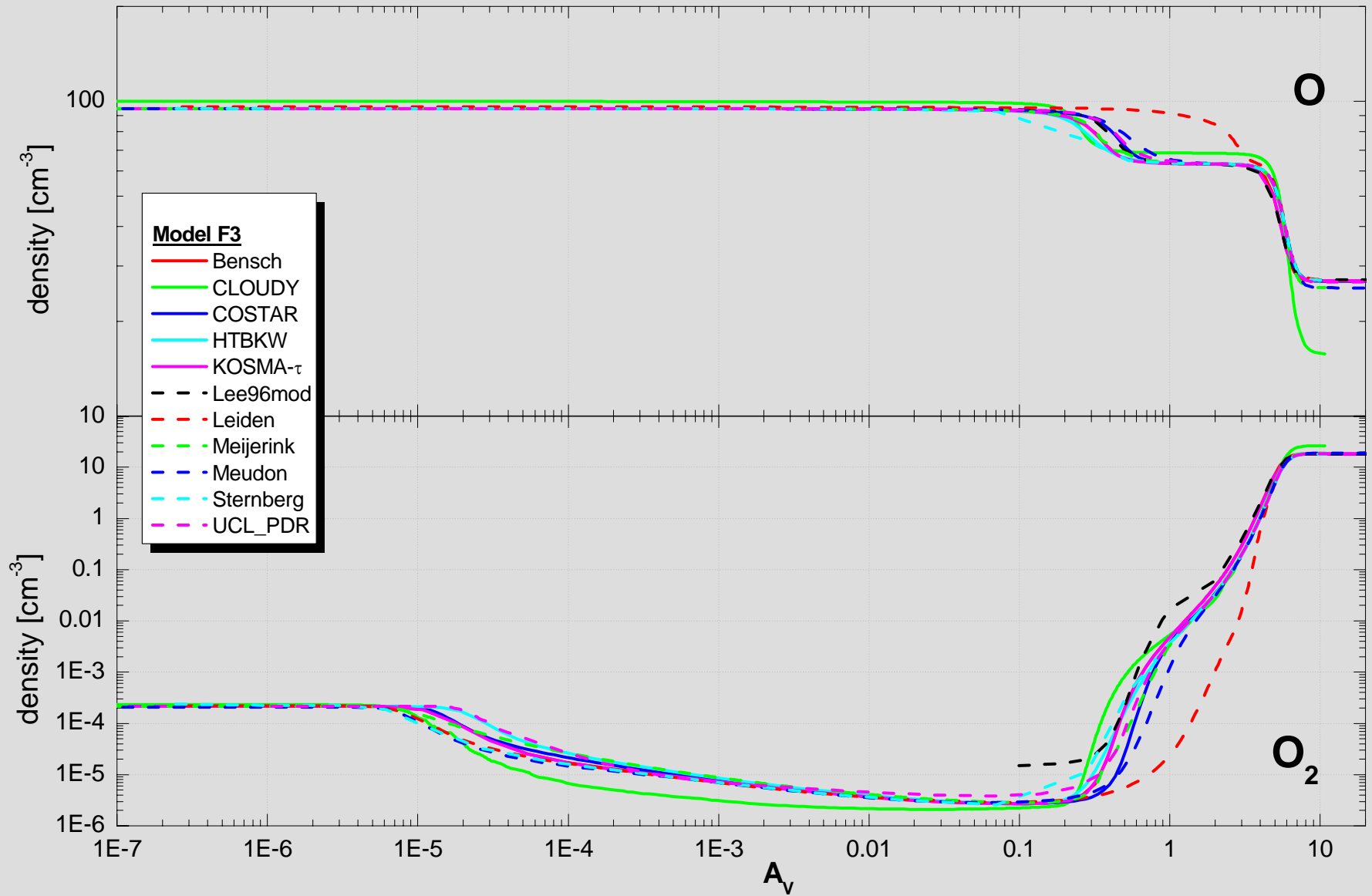
O and O₂ density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



O and O₂ density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



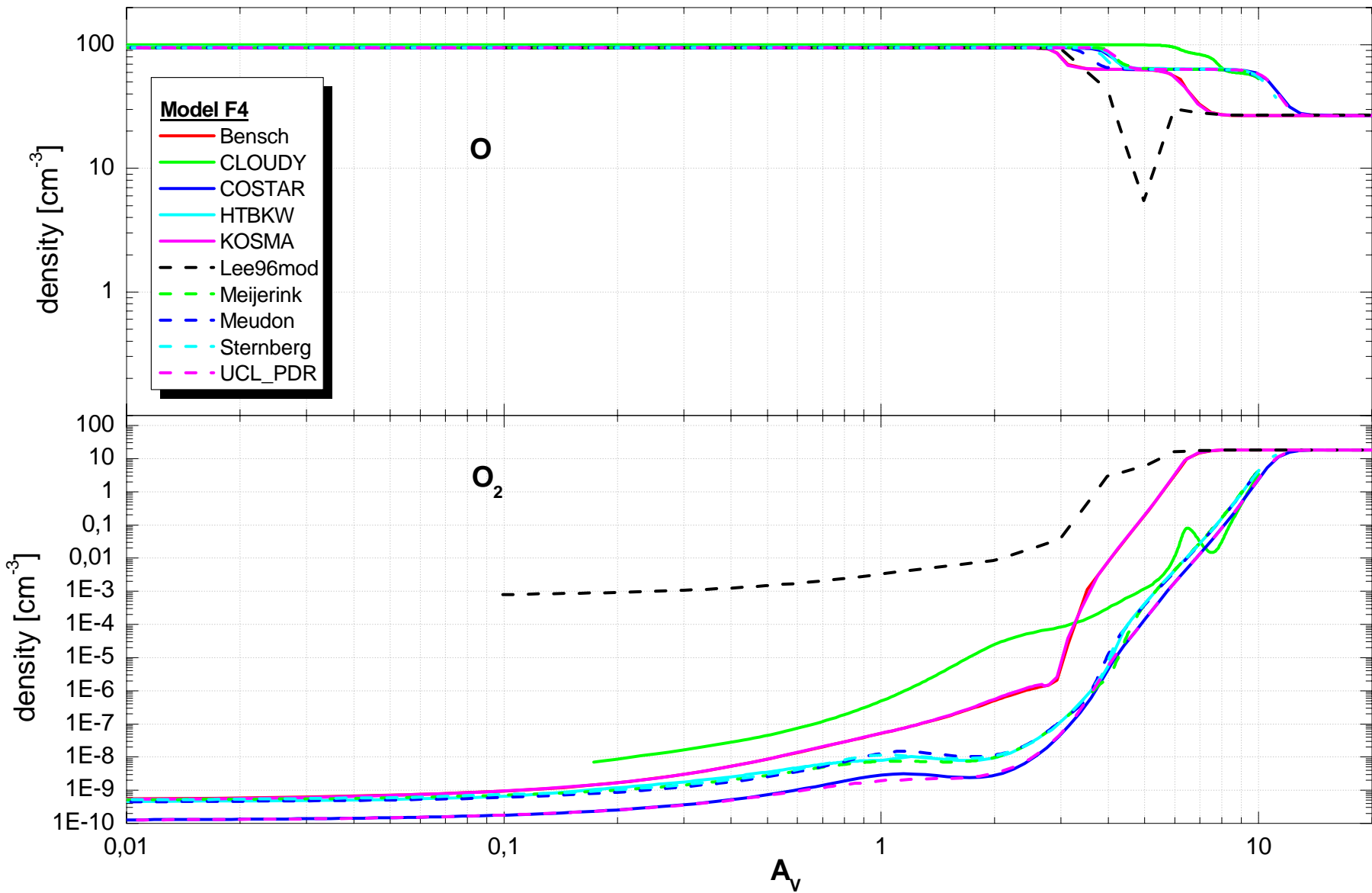
O and O₂ density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



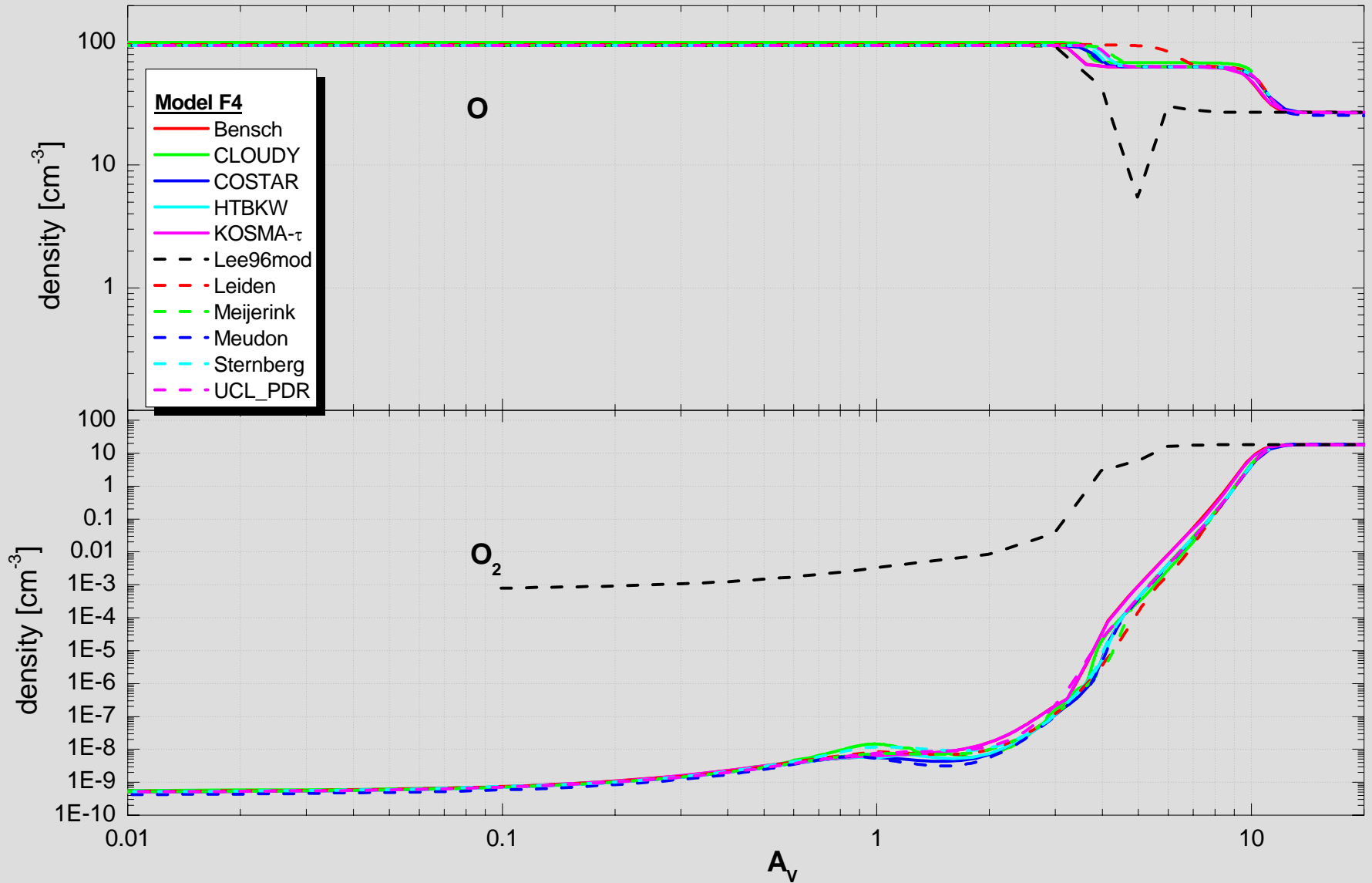
5.-8. April, 2004

PDR Model Comparison

O and O₂ density - $n = 10^{5.5} \text{ cm}^{-3}$, $\chi = 10^5$

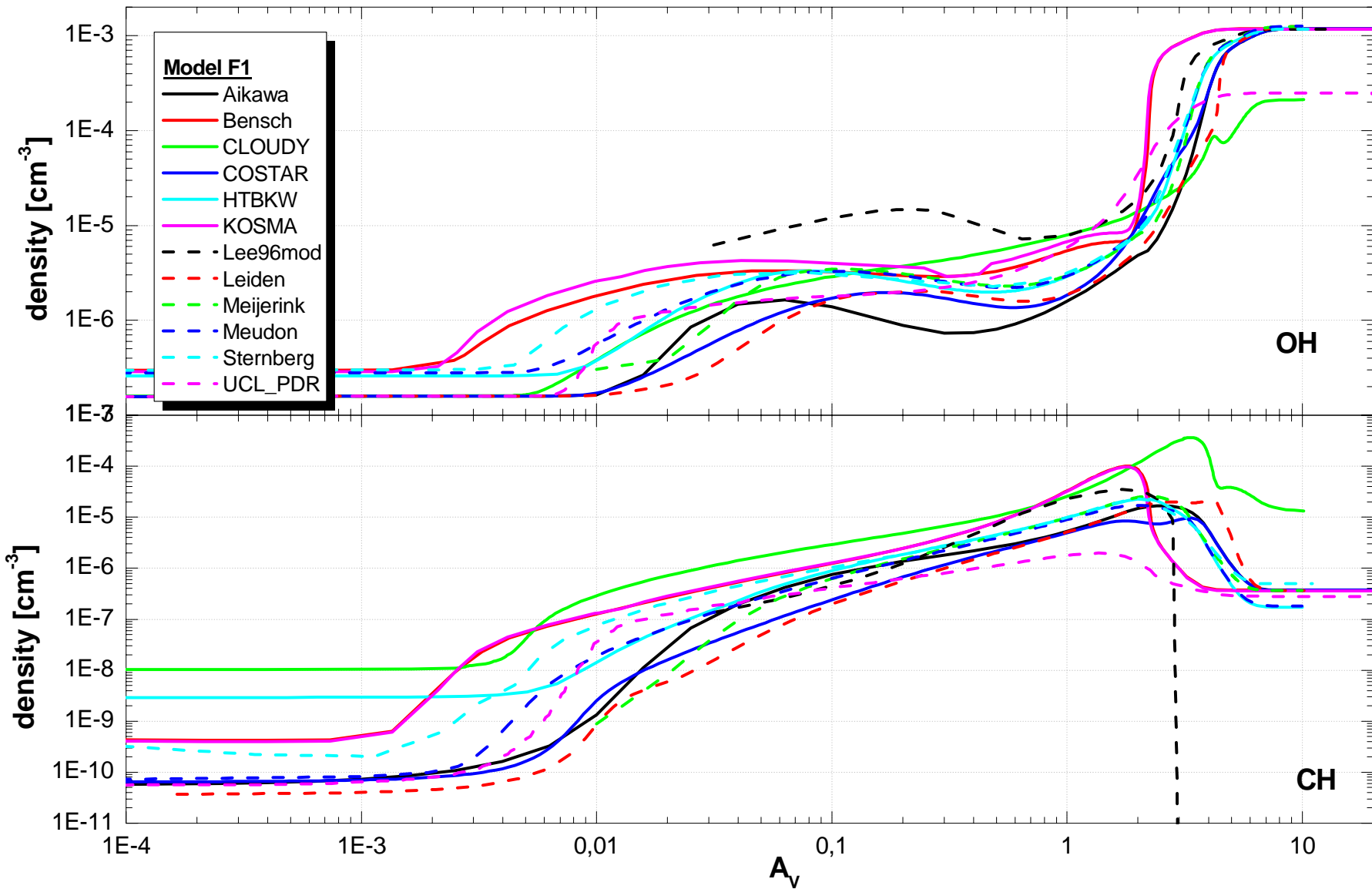


O and O₂ density - $n = 10^{5.5} \text{ cm}^{-3}$, $\chi = 10^5$

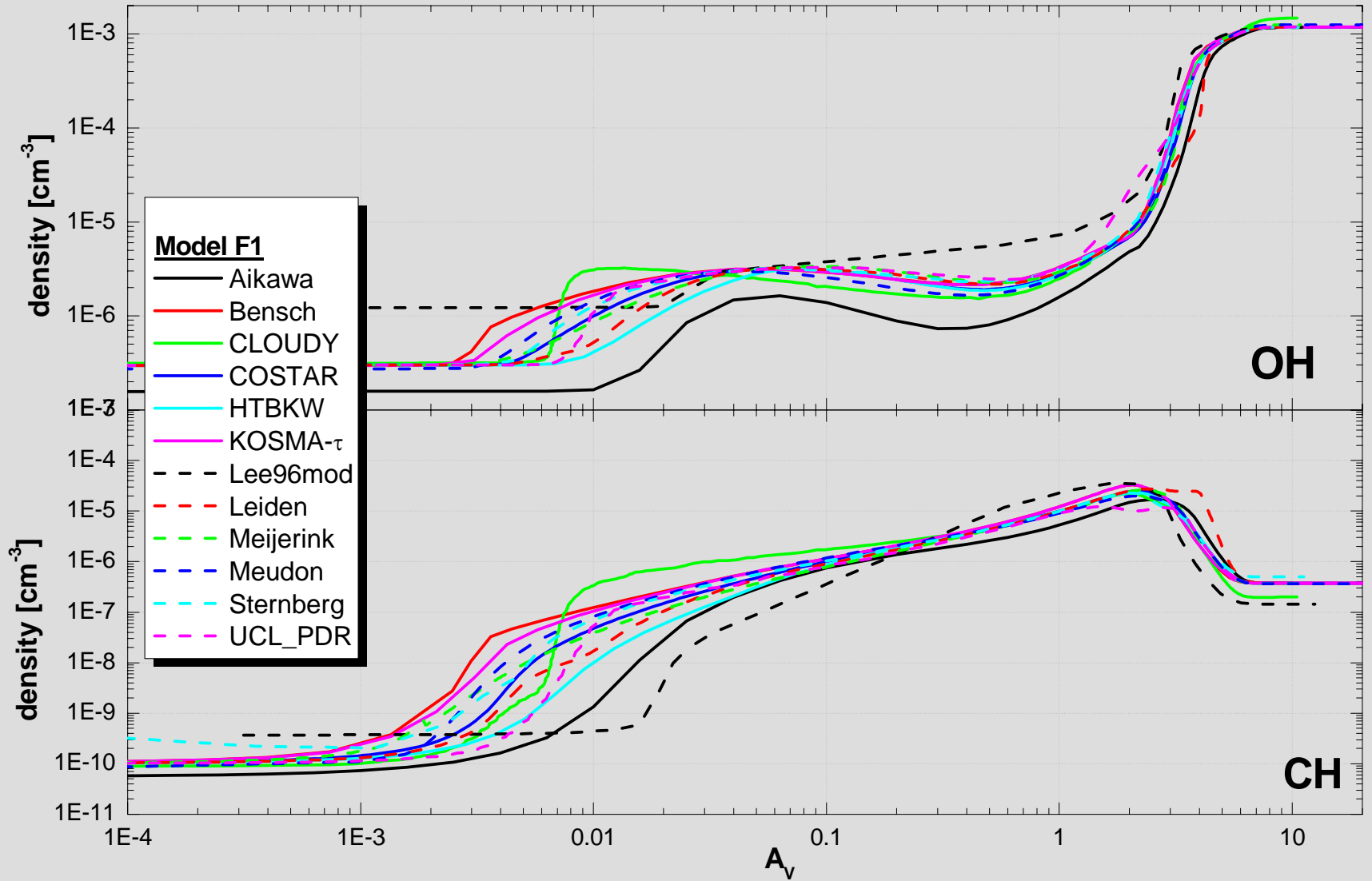


OH and CH density

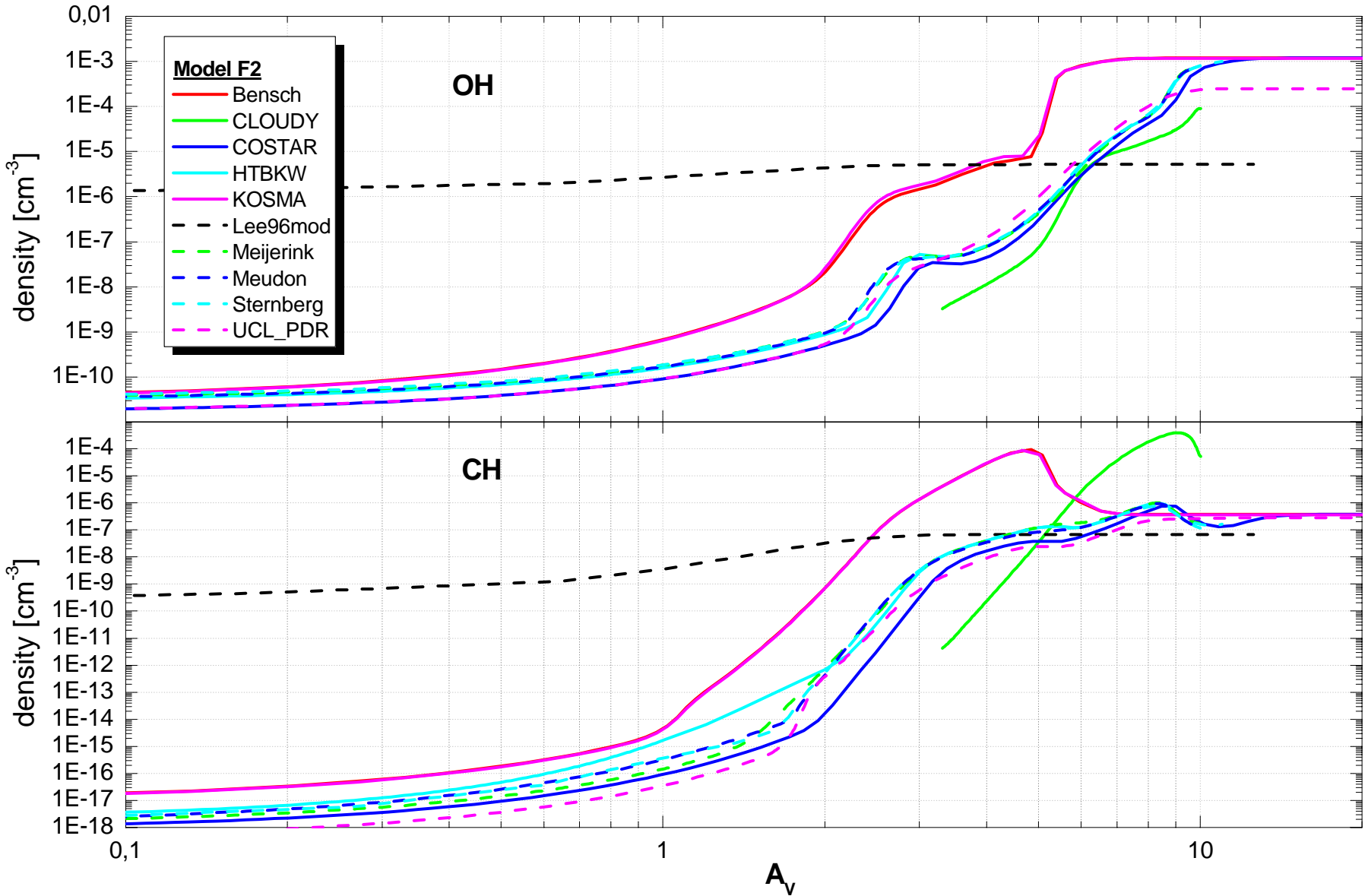
OH and CH density - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



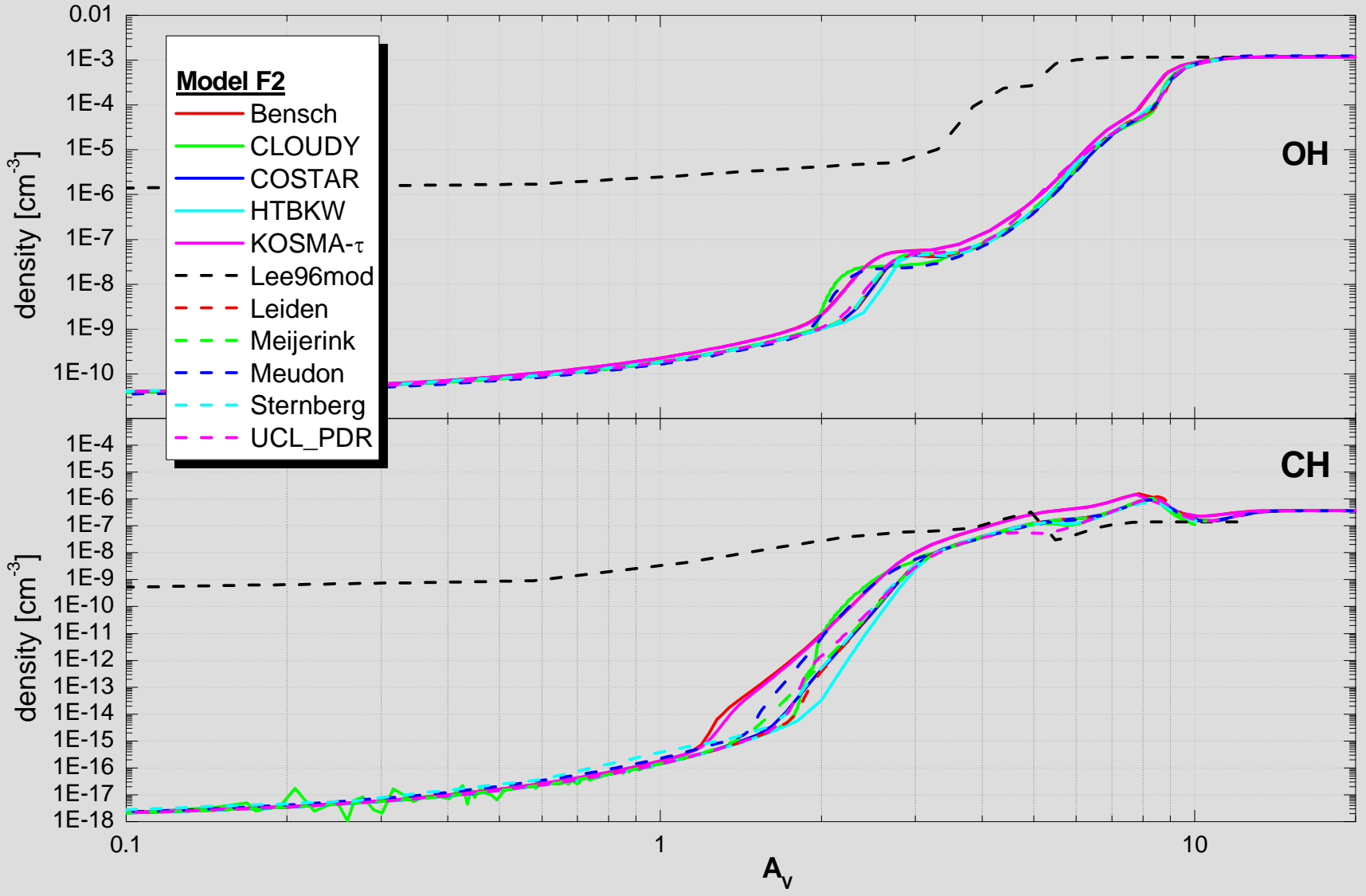
OH and CH density - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



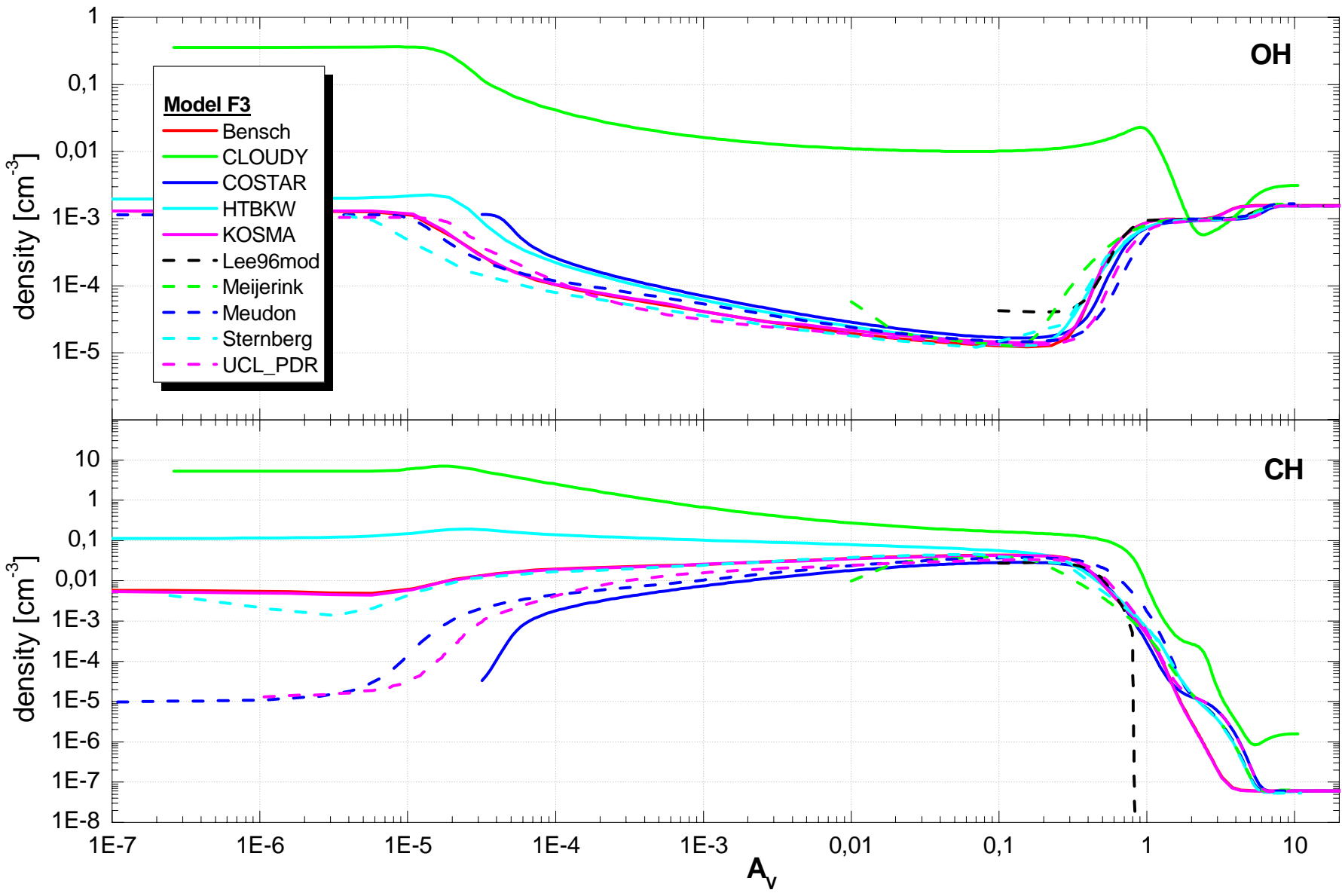
OH and CH density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



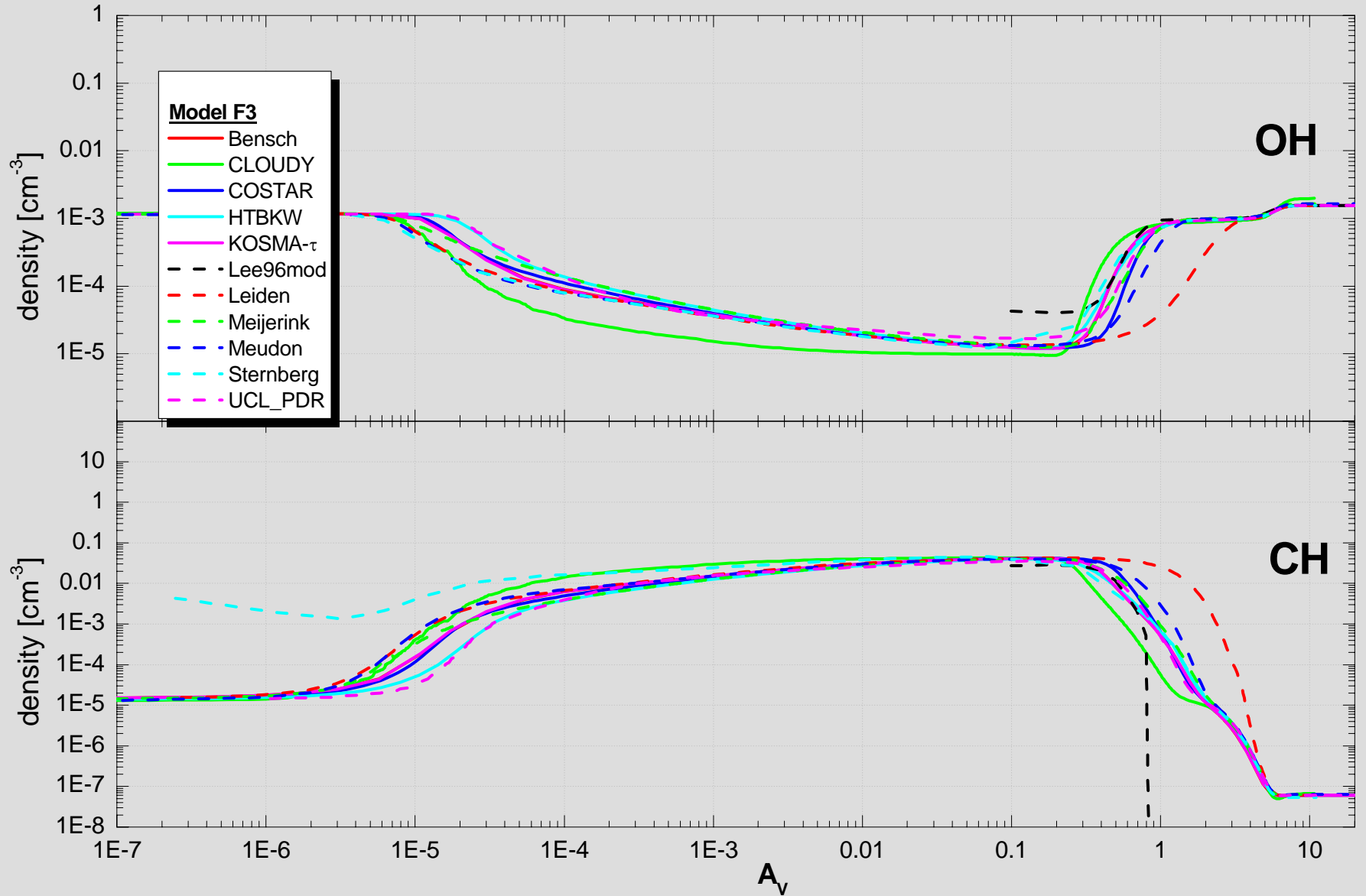
OH and CH density - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



OH and CH density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



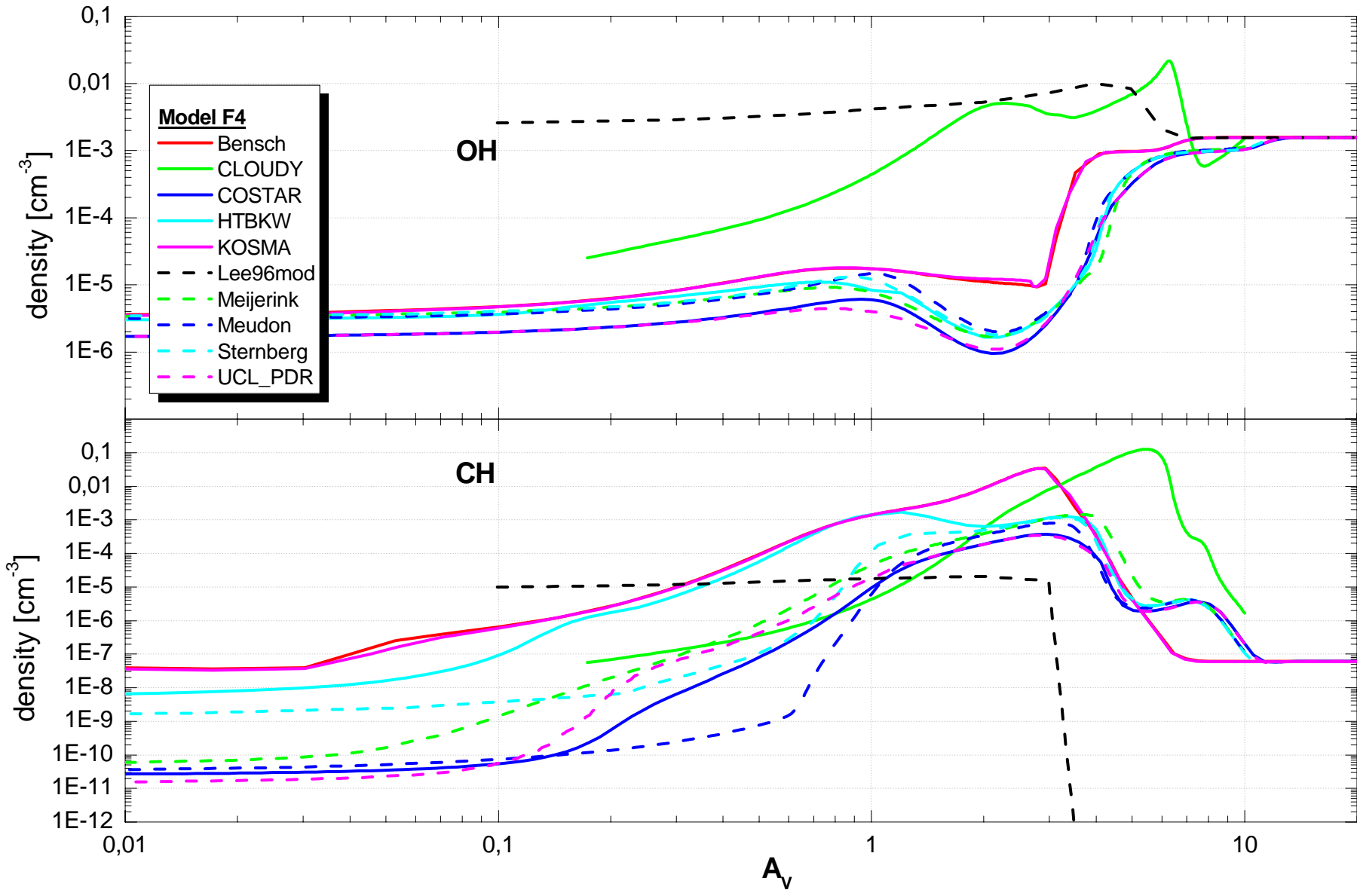
OH and CH density - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



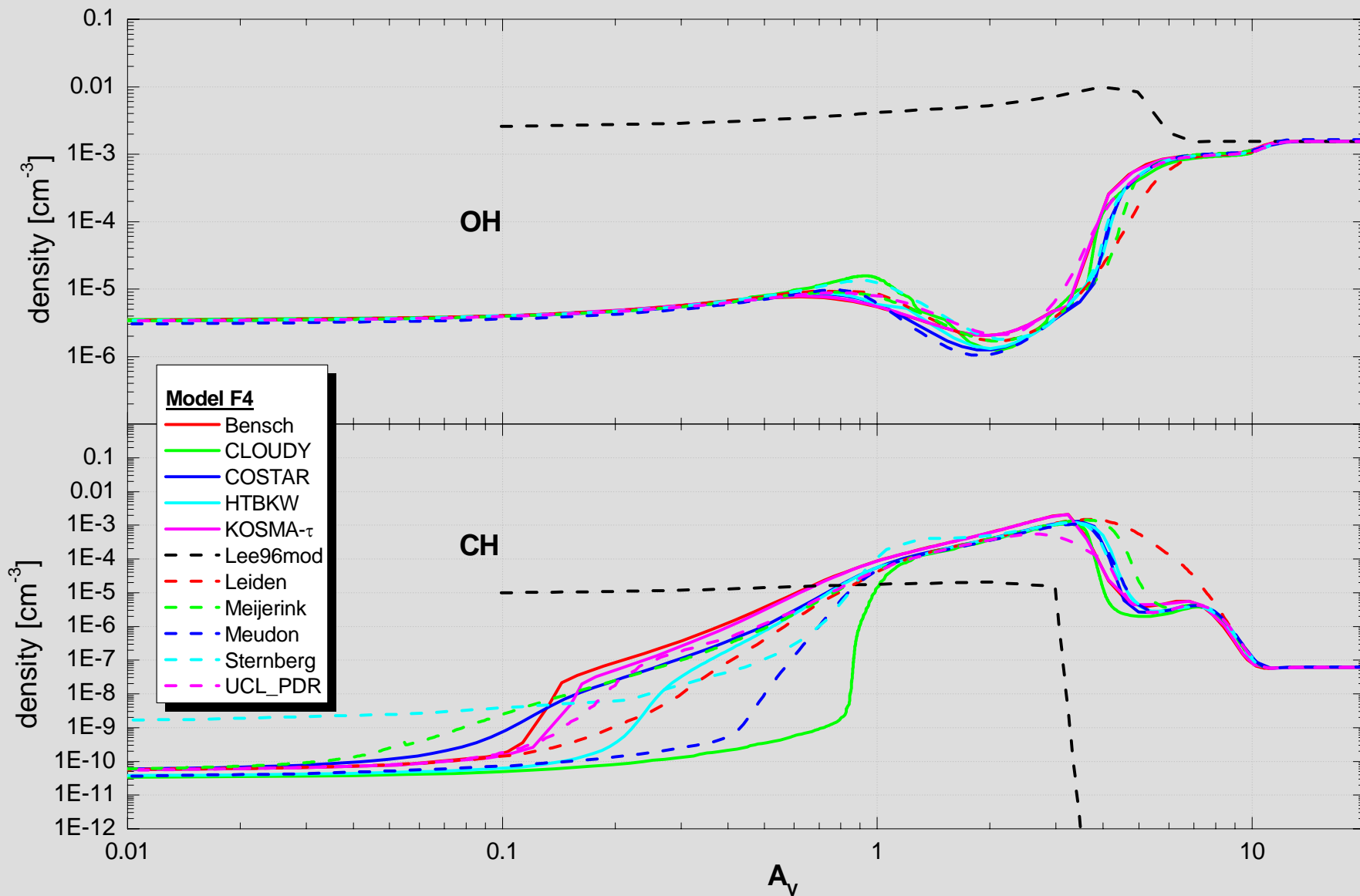
5.-8. April, 2004

PDR Model Comparison

OH and CH density - $n = 10^{5.5} \text{ cm}^{-3}$, $\chi = 10^5$



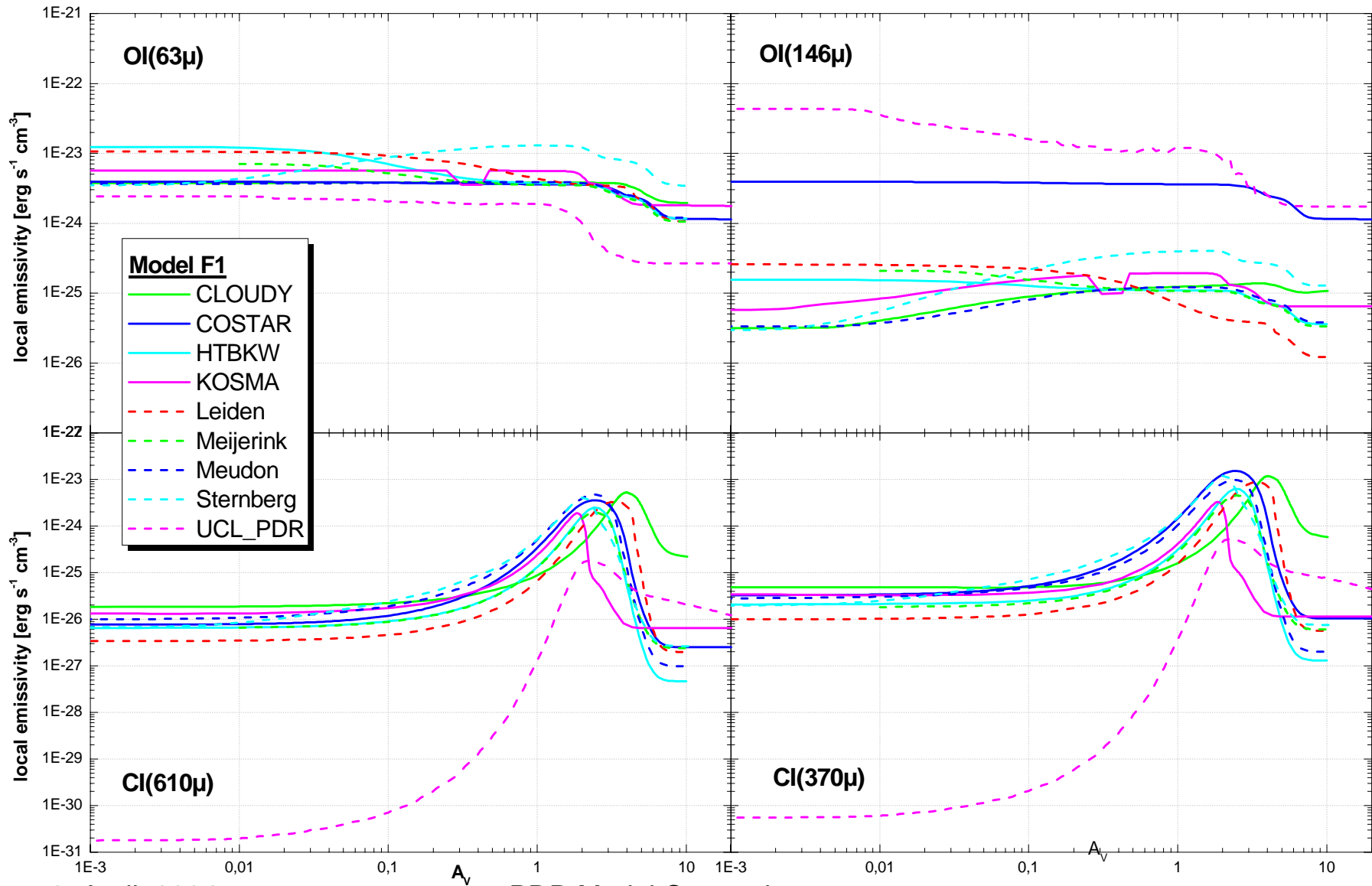
OH and CH density - $n = 10^{5.5} \text{ cm}^{-3}$, $\chi = 10^5$



Model Results F1-F8

- photoreaction rates
- densities
- heating/cooling rates
- surface brightnesses

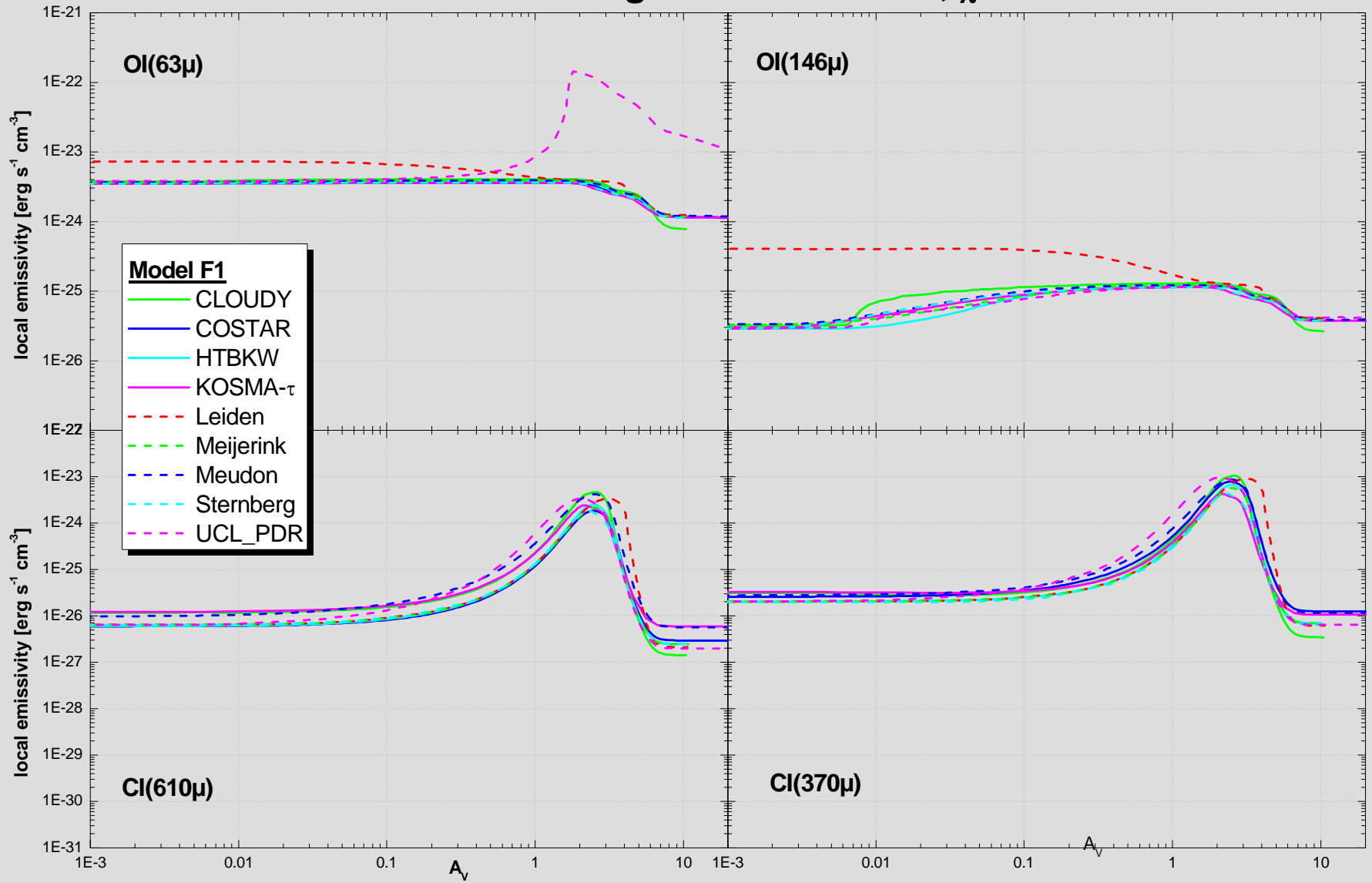
O I and C I cooling lines - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



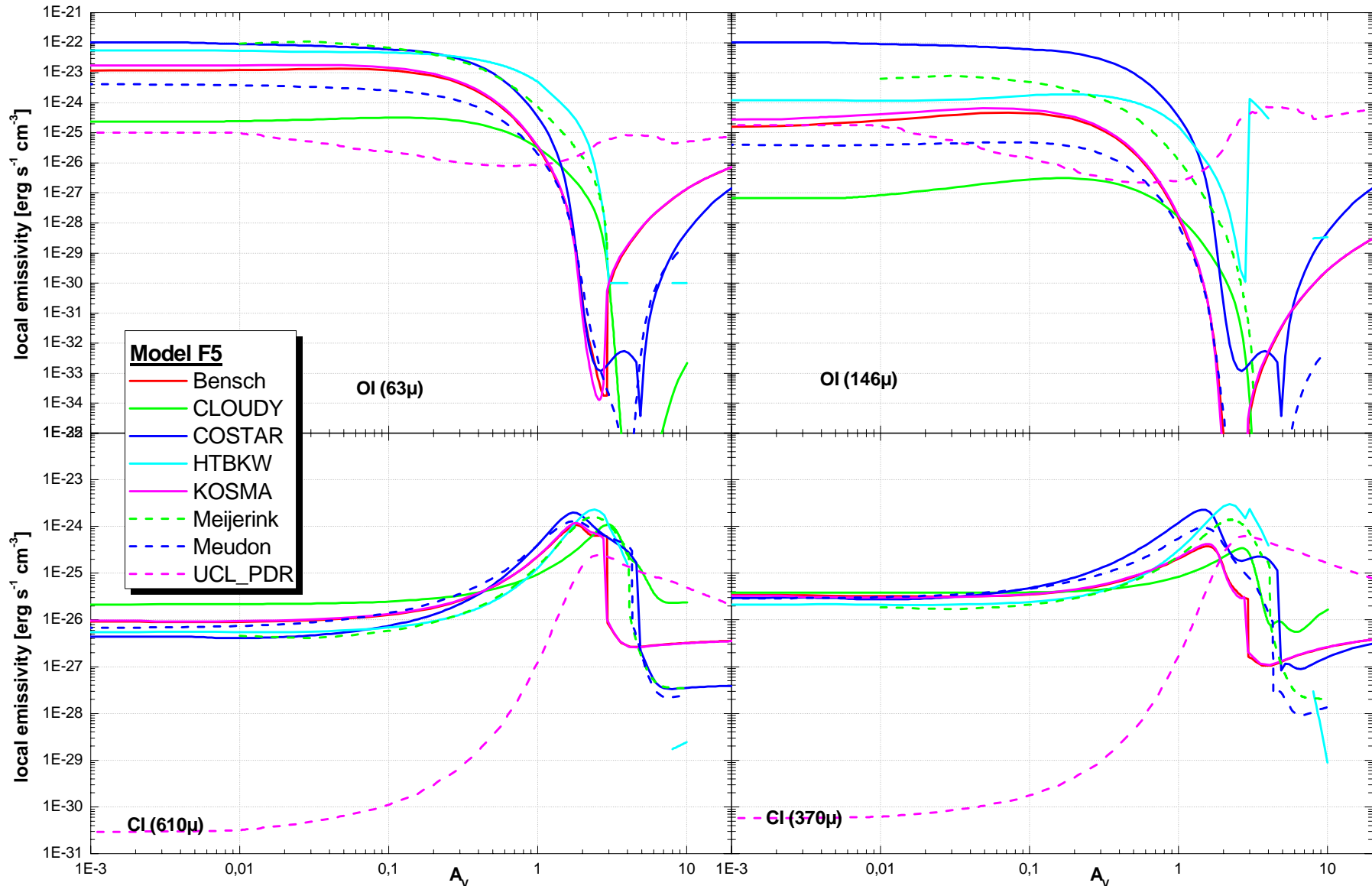
5.-8. April, 2004

PDR Model Comparison

OI an CI cooling lines - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



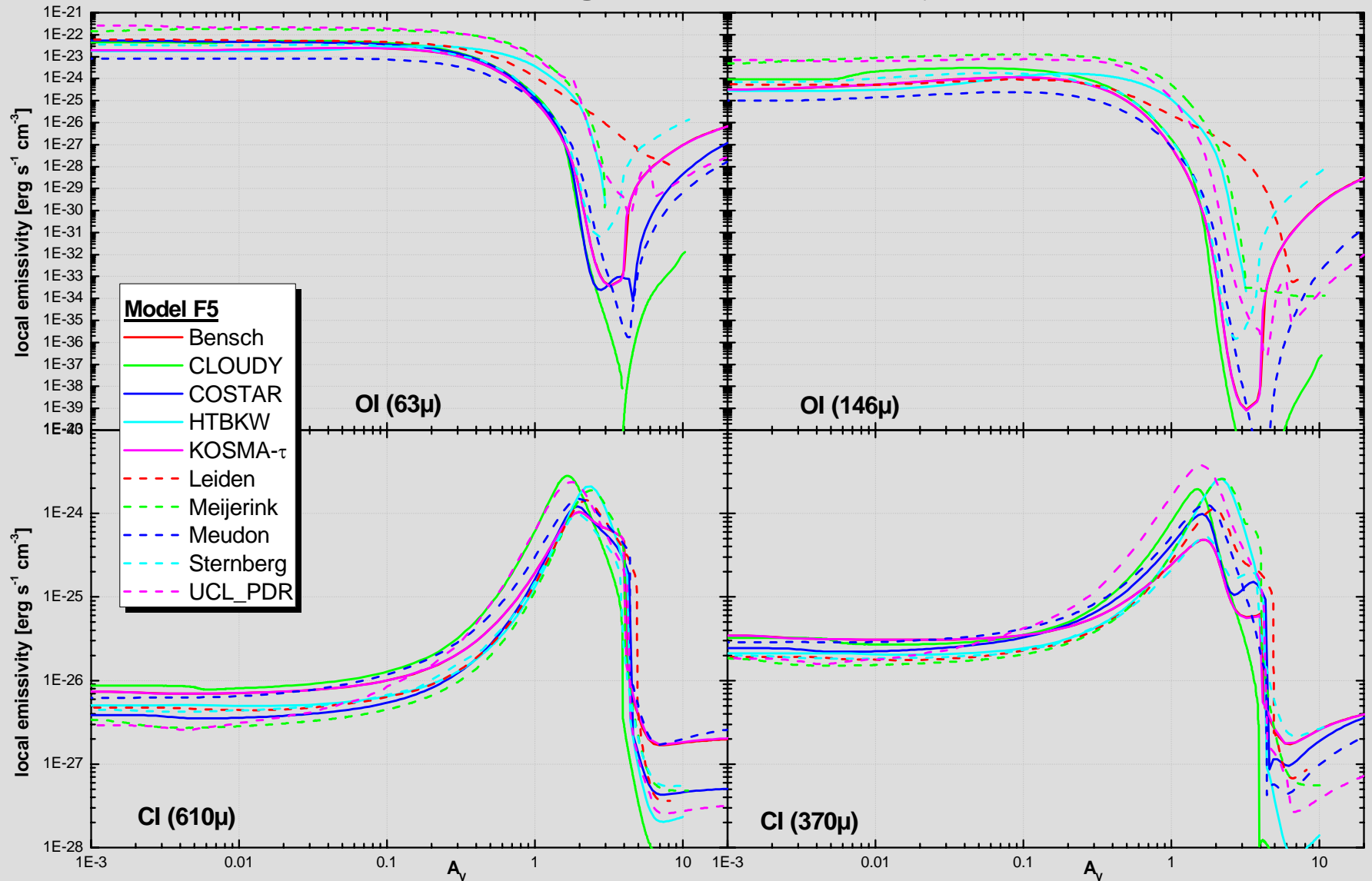
OI and CI cooling lines - $n=10^3 \text{ cm}^{-3}$, $\chi=10^1$, variable T



5.-8. April, 2004

PDR Model Comparison

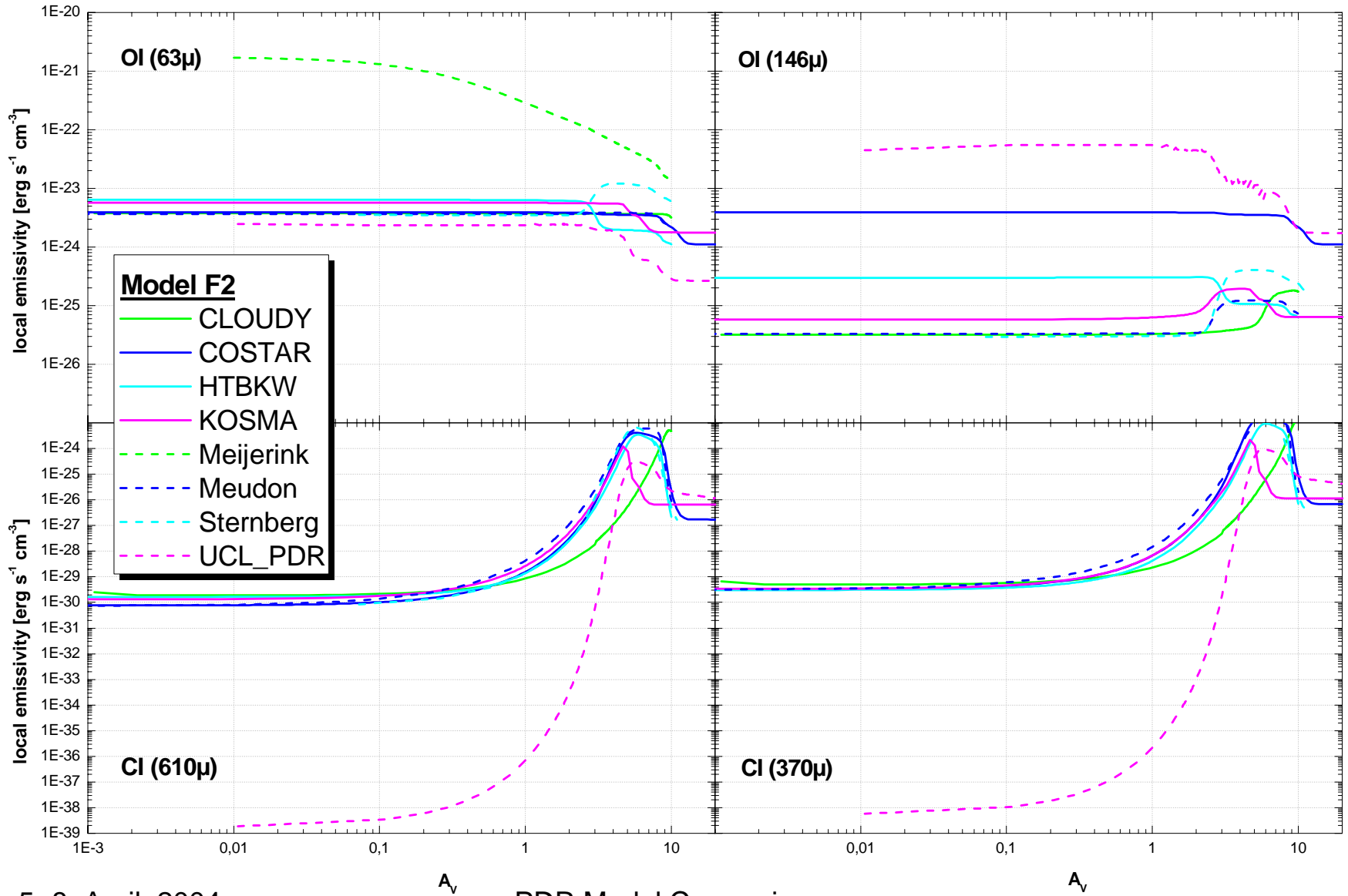
OI and CI cooling lines - $n=10^3 \text{ cm}^{-3}$, $\chi=10^1$, variable T



5.-8. April, 2004

PDR Model Comparison

O I and Cl cooling lines - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



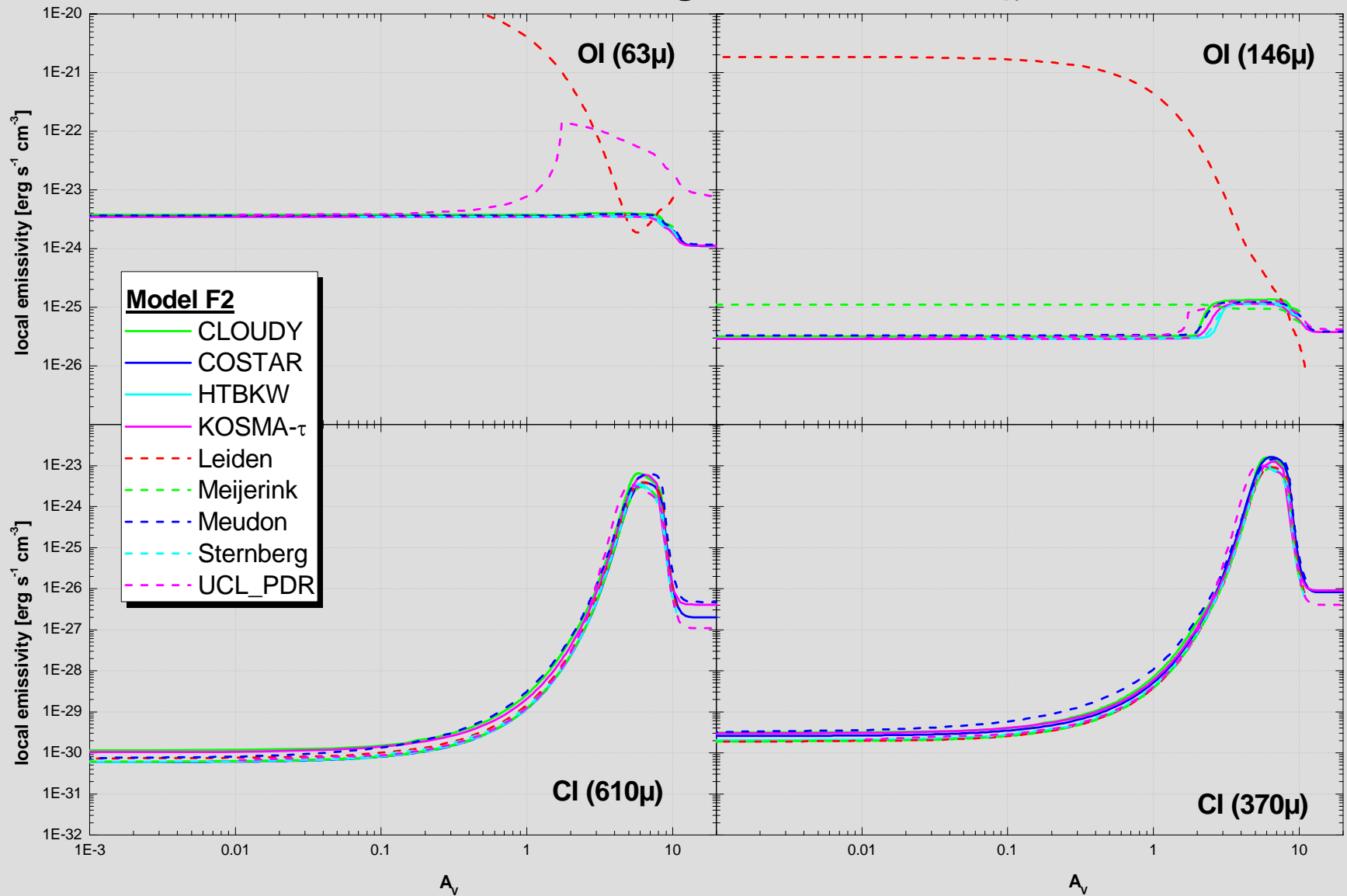
5.-8. April, 2004

A_V

PDR Model Comparison

A_V

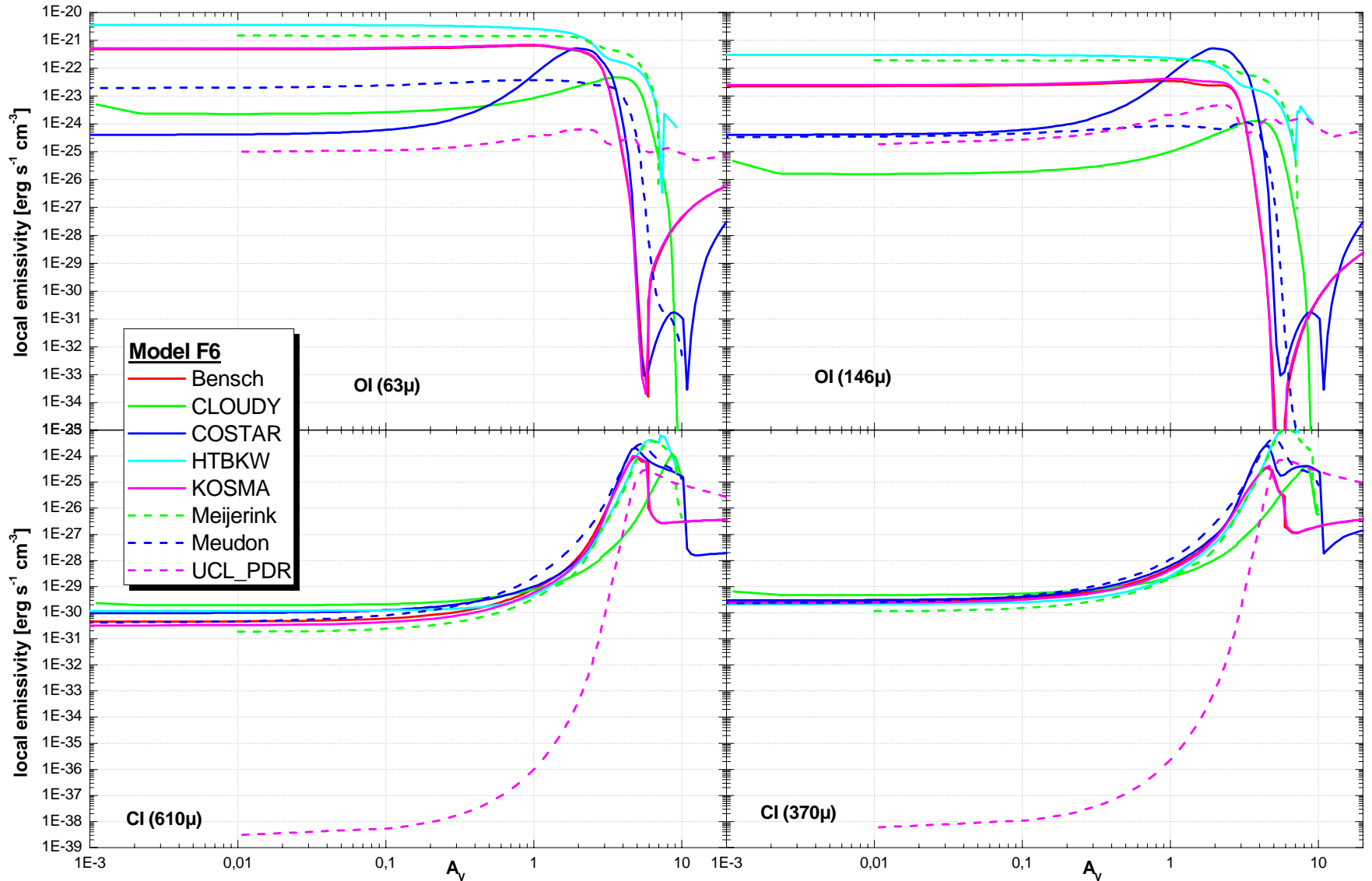
OI an CI cooling lines - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



5.-8. April, 2004

PDR Model Comparison

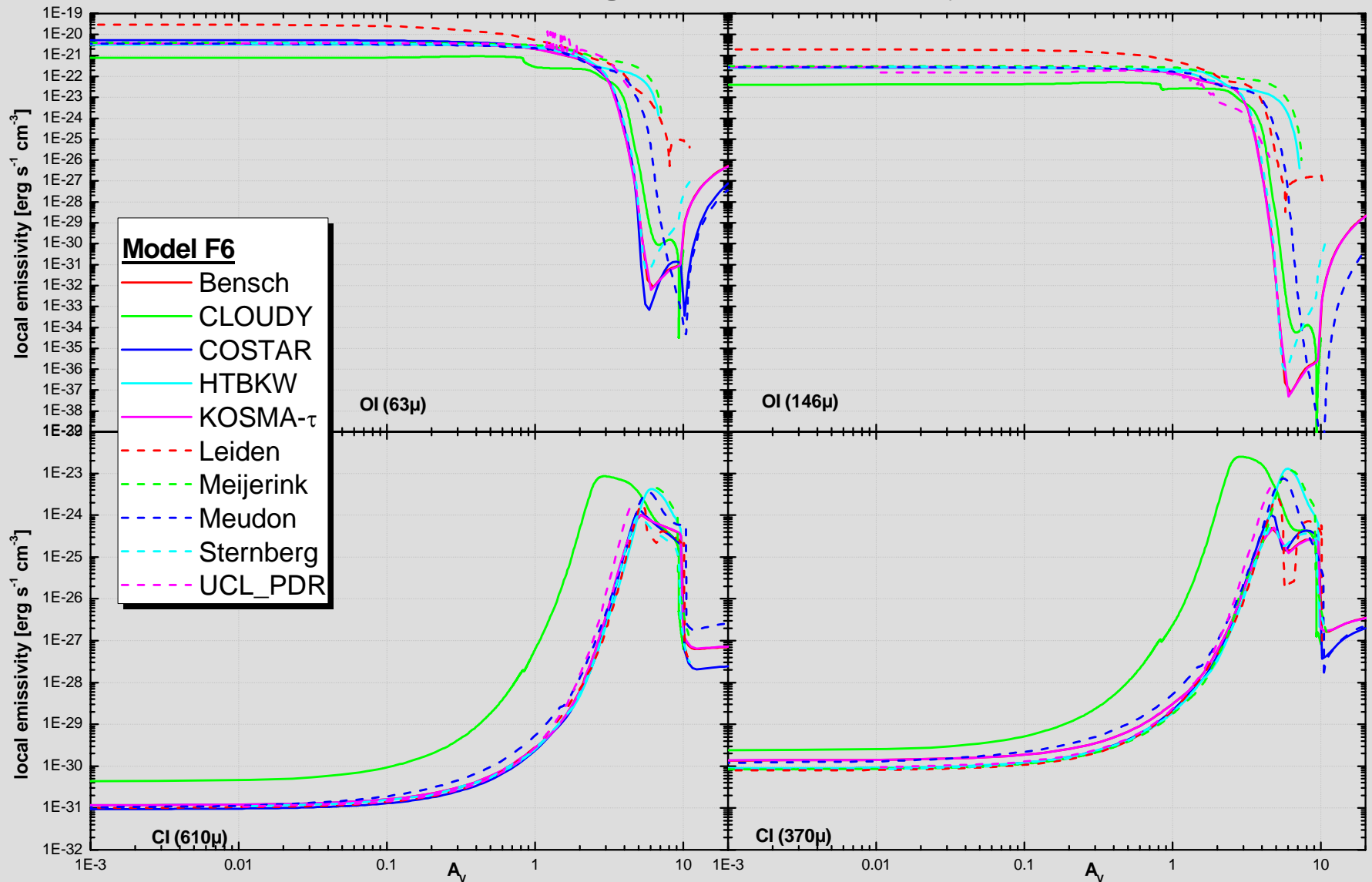
O I and Cl cooling lines - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

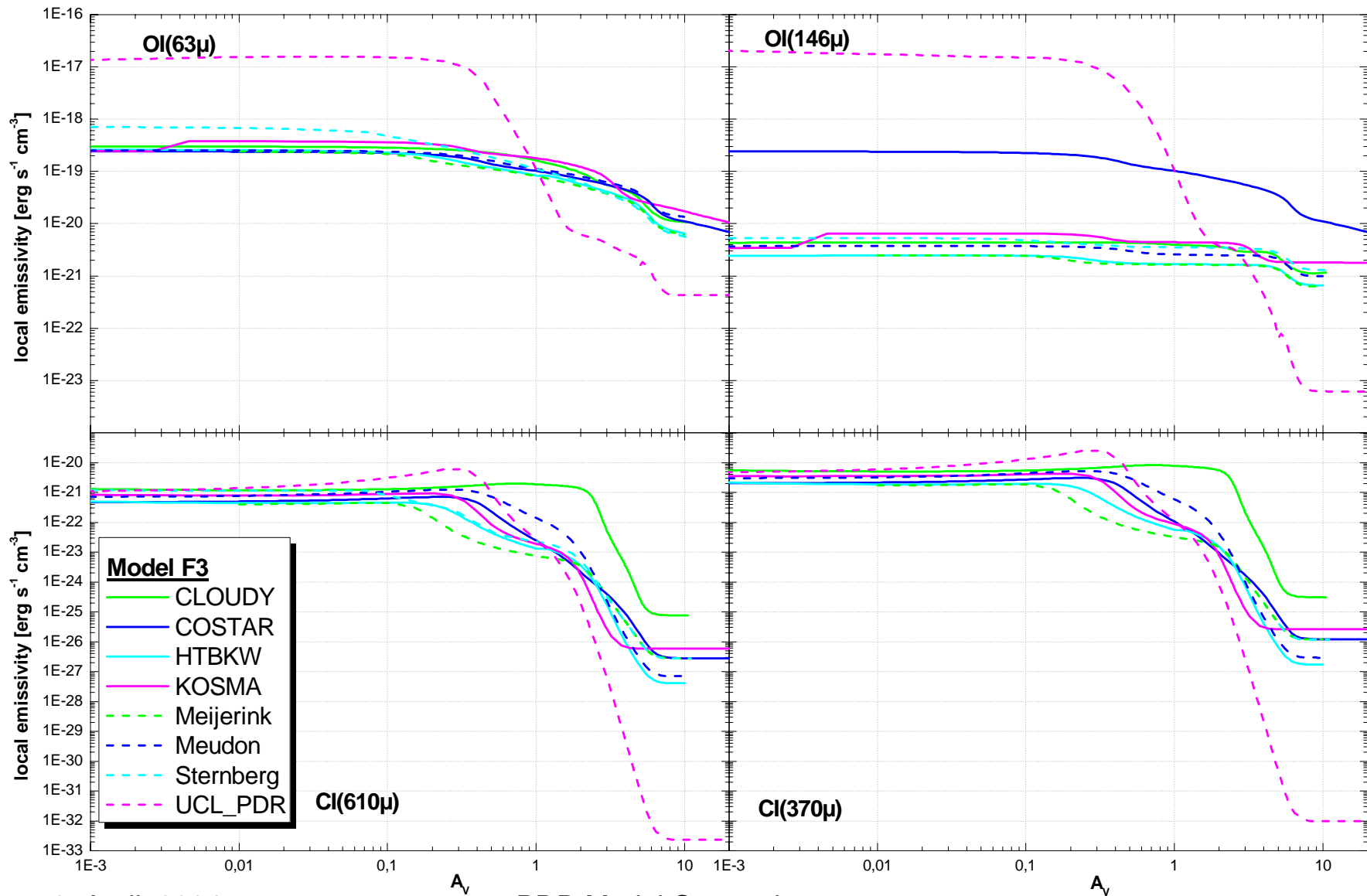
O I and C I cooling lines - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

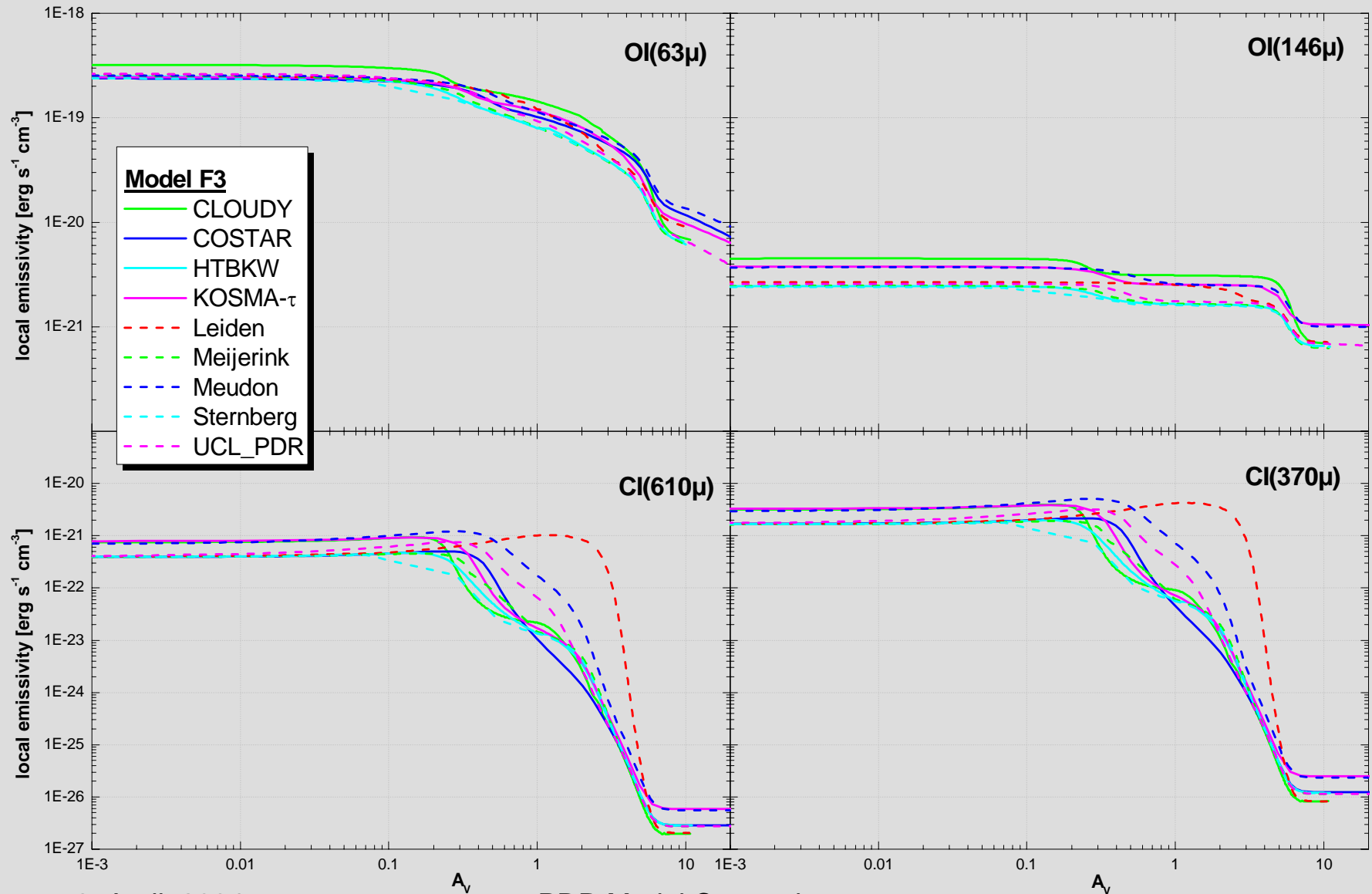
O I and Cl I cooling lines - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



5.-8. April, 2004

PDR Model Comparison

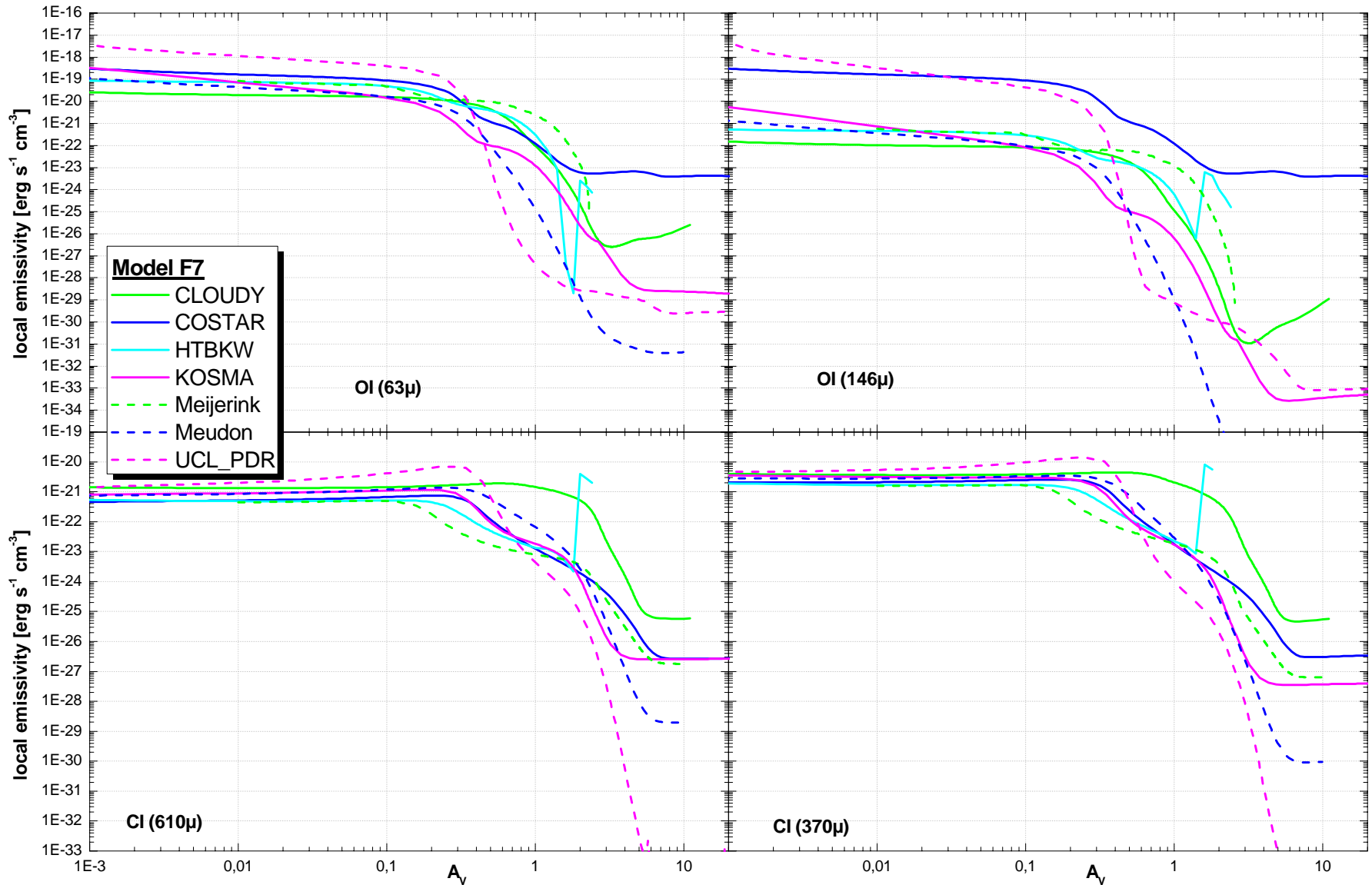
O I and C I cooling lines - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



5.-8. April, 2004

PDR Model Comparison

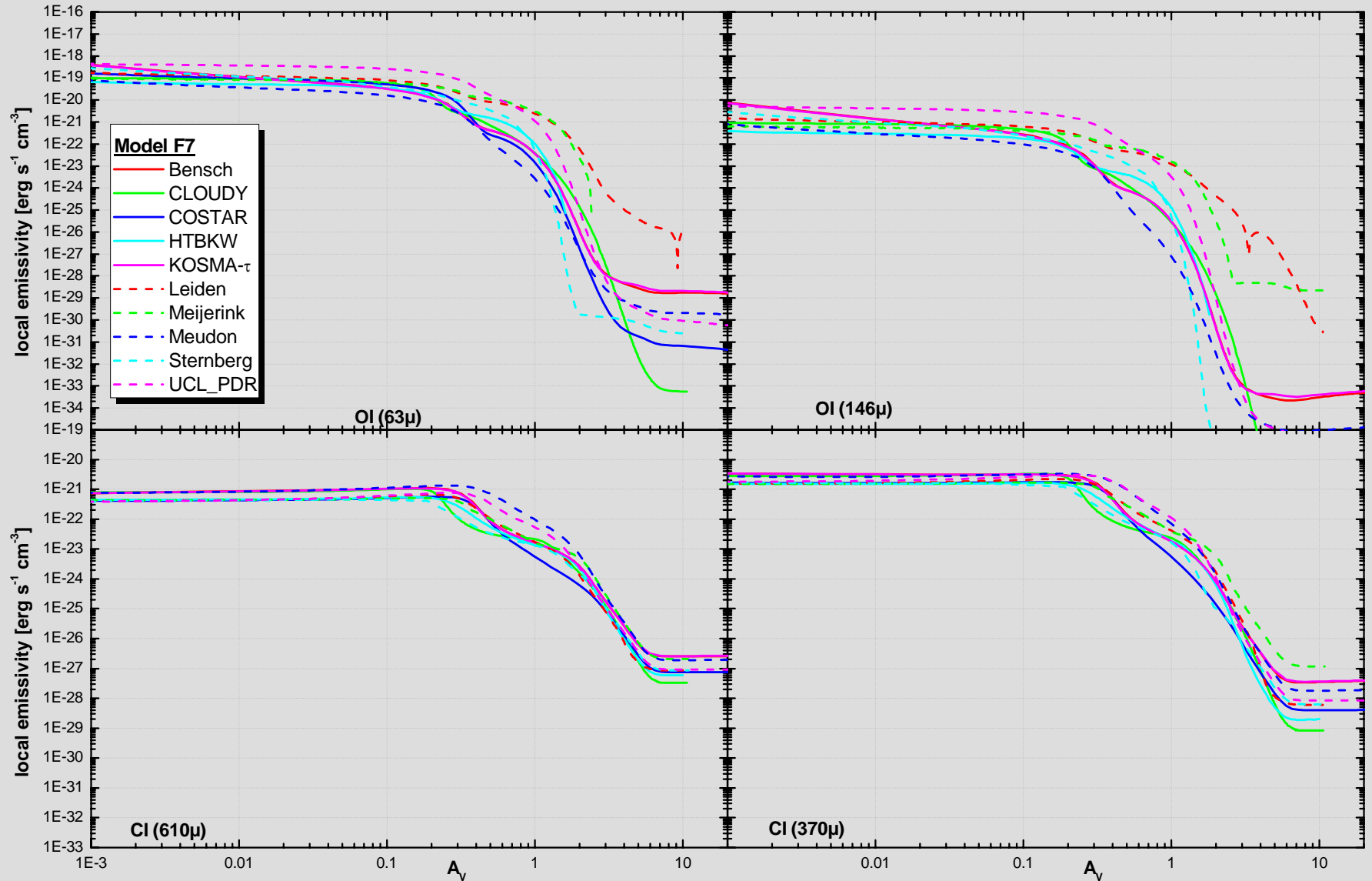
O I and C I cooling lines - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^1$, variable T



5.-8. April, 2004

PDR Model Comparison

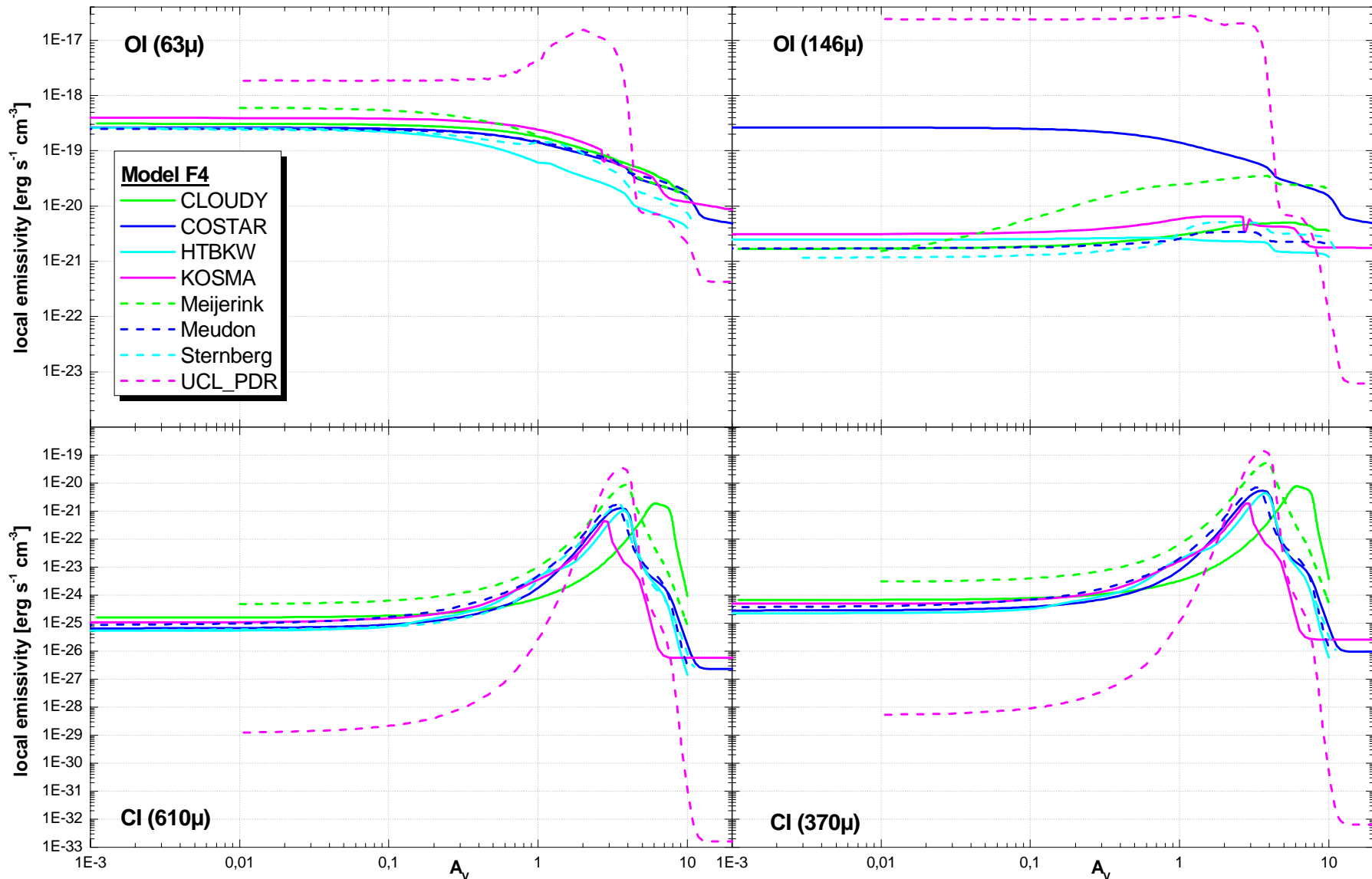
O I and C I cooling lines - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^1$, variable T



5.-8. April, 2004

PDR Model Comparison

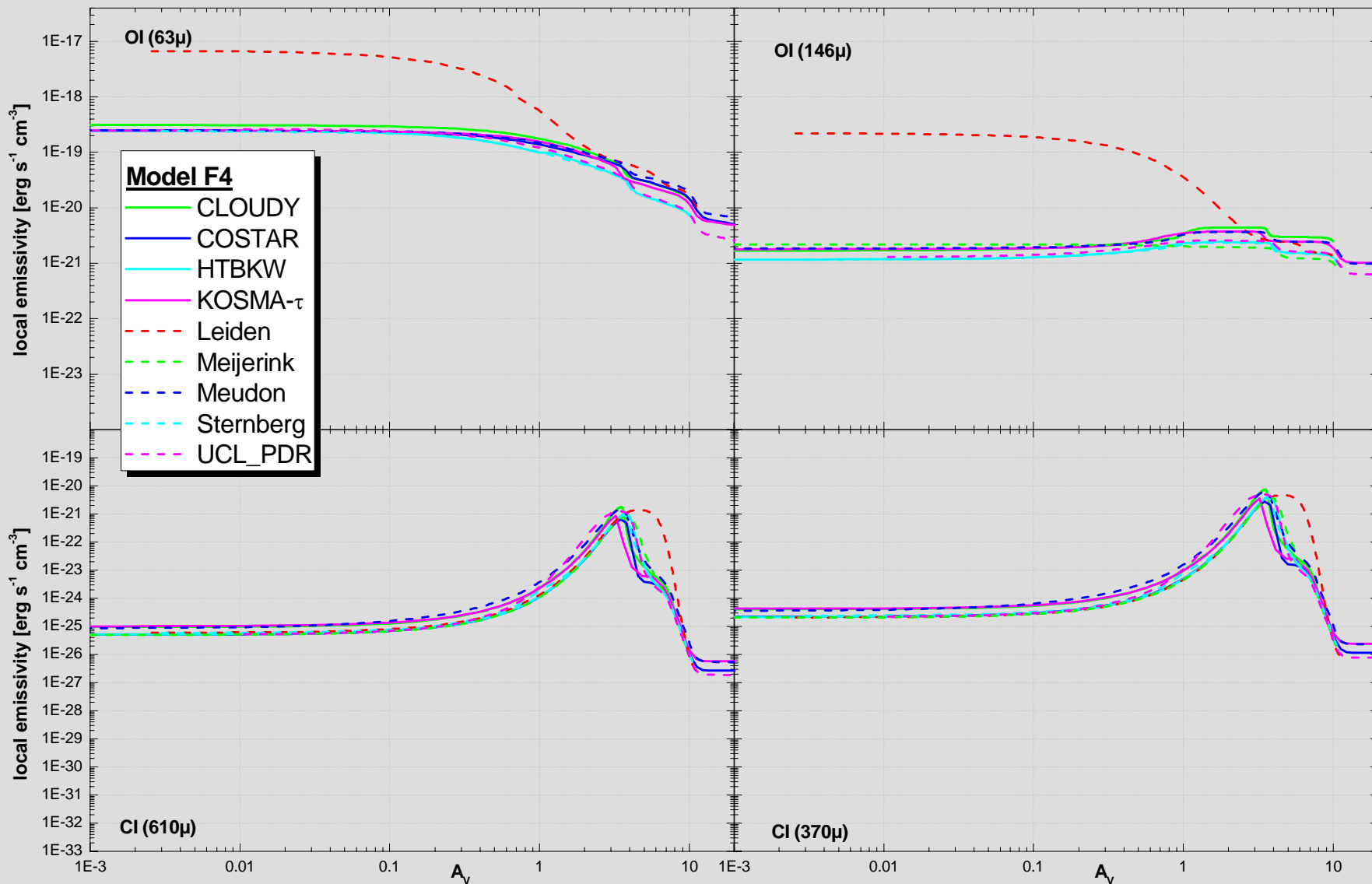
OI and CI cooling lines - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



5.-8. April, 2004

PDR Model Comparison

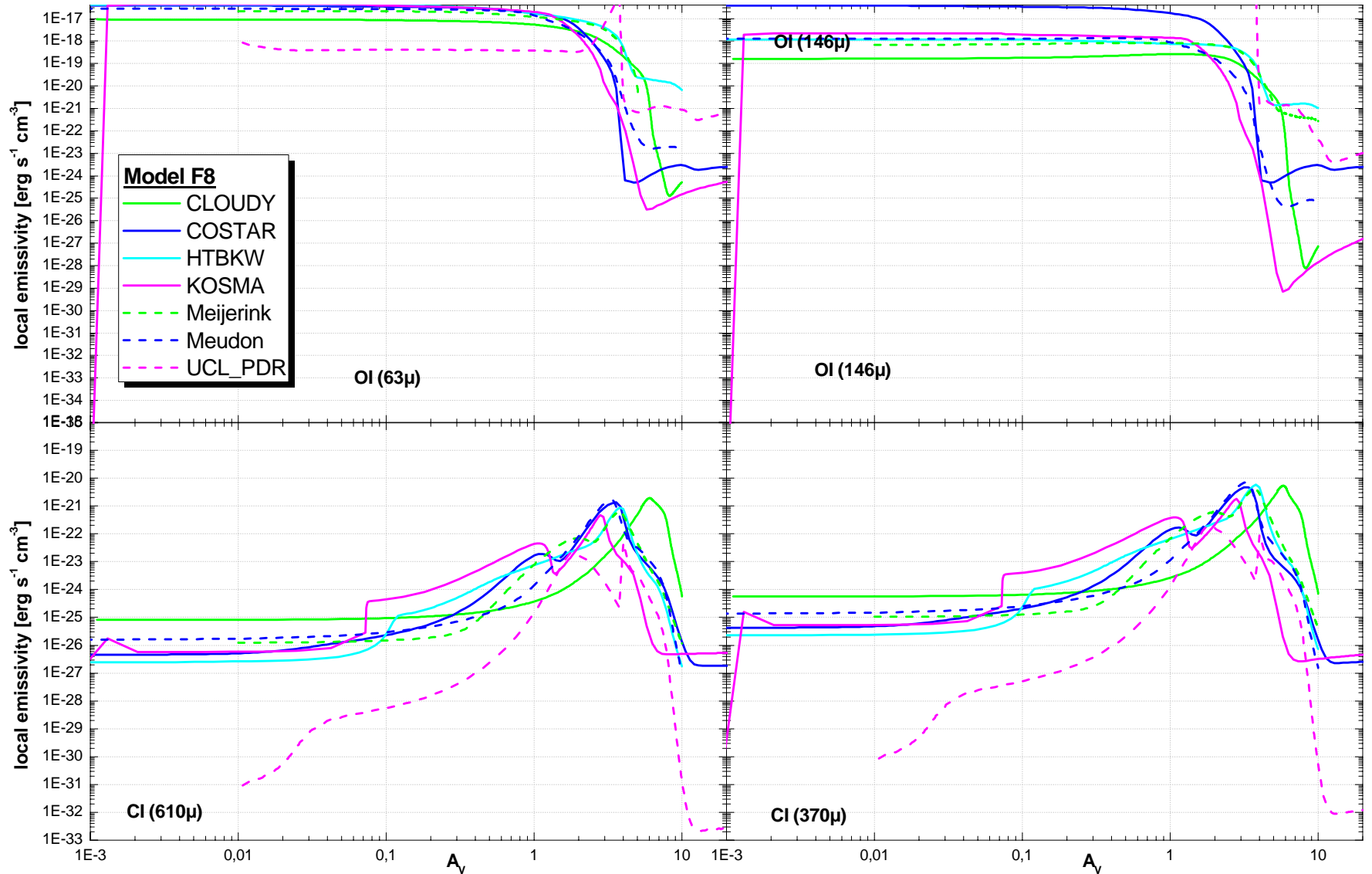
OI and CI cooling lines - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



5.-8. April, 2004

PDR Model Comparison

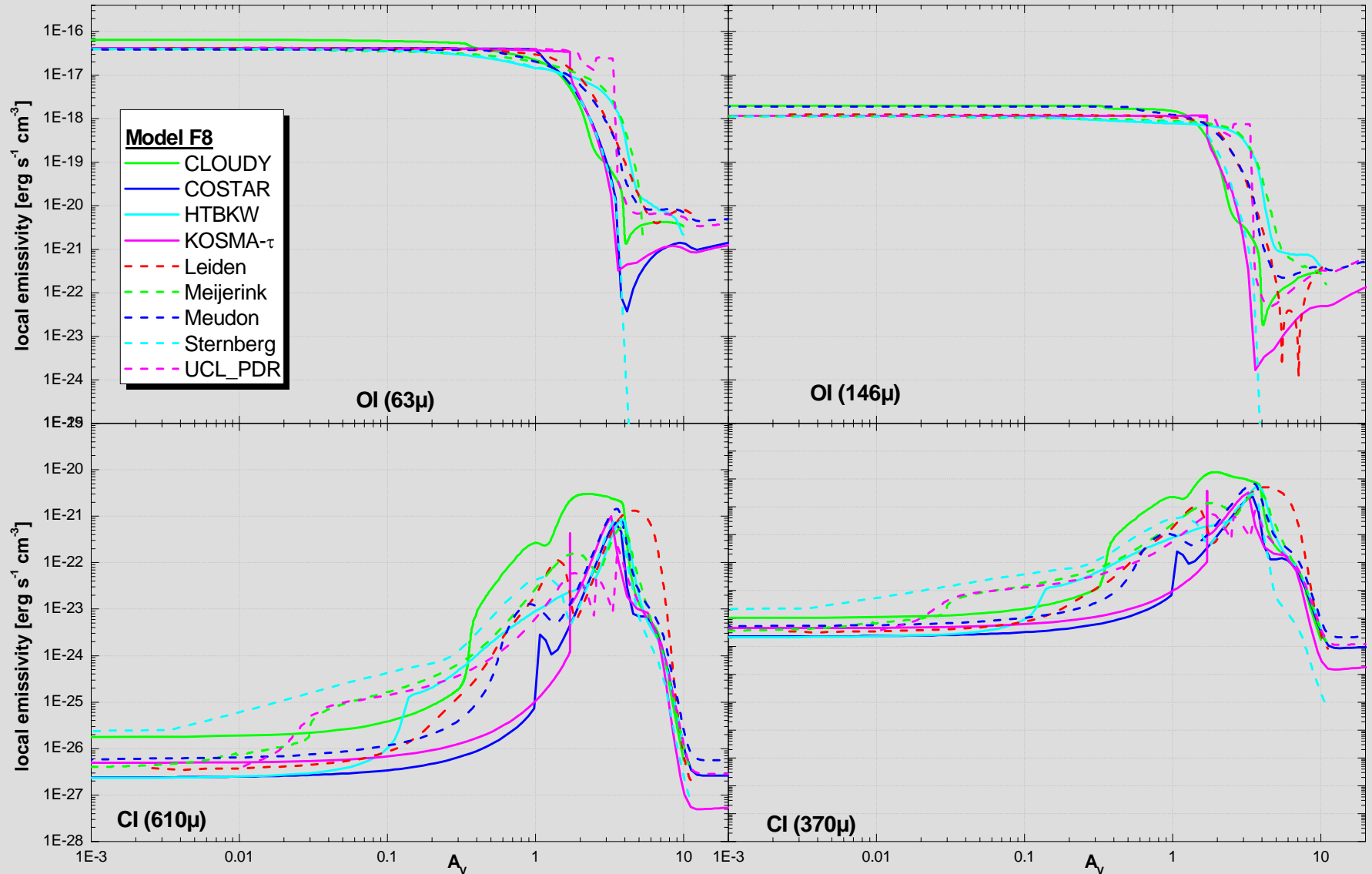
O I and C I cooling lines - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

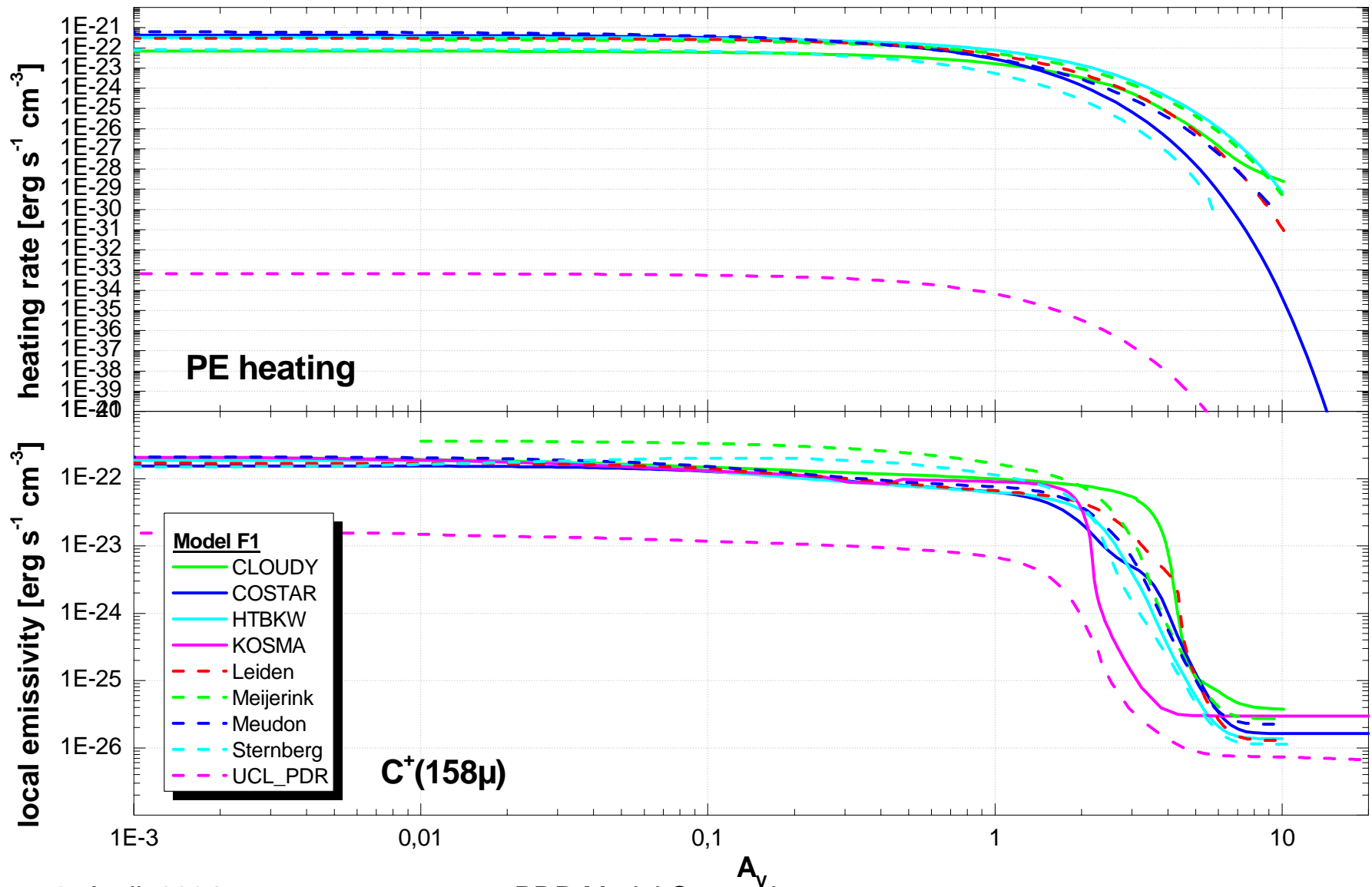
OI and CI cooling lines - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$, variable T



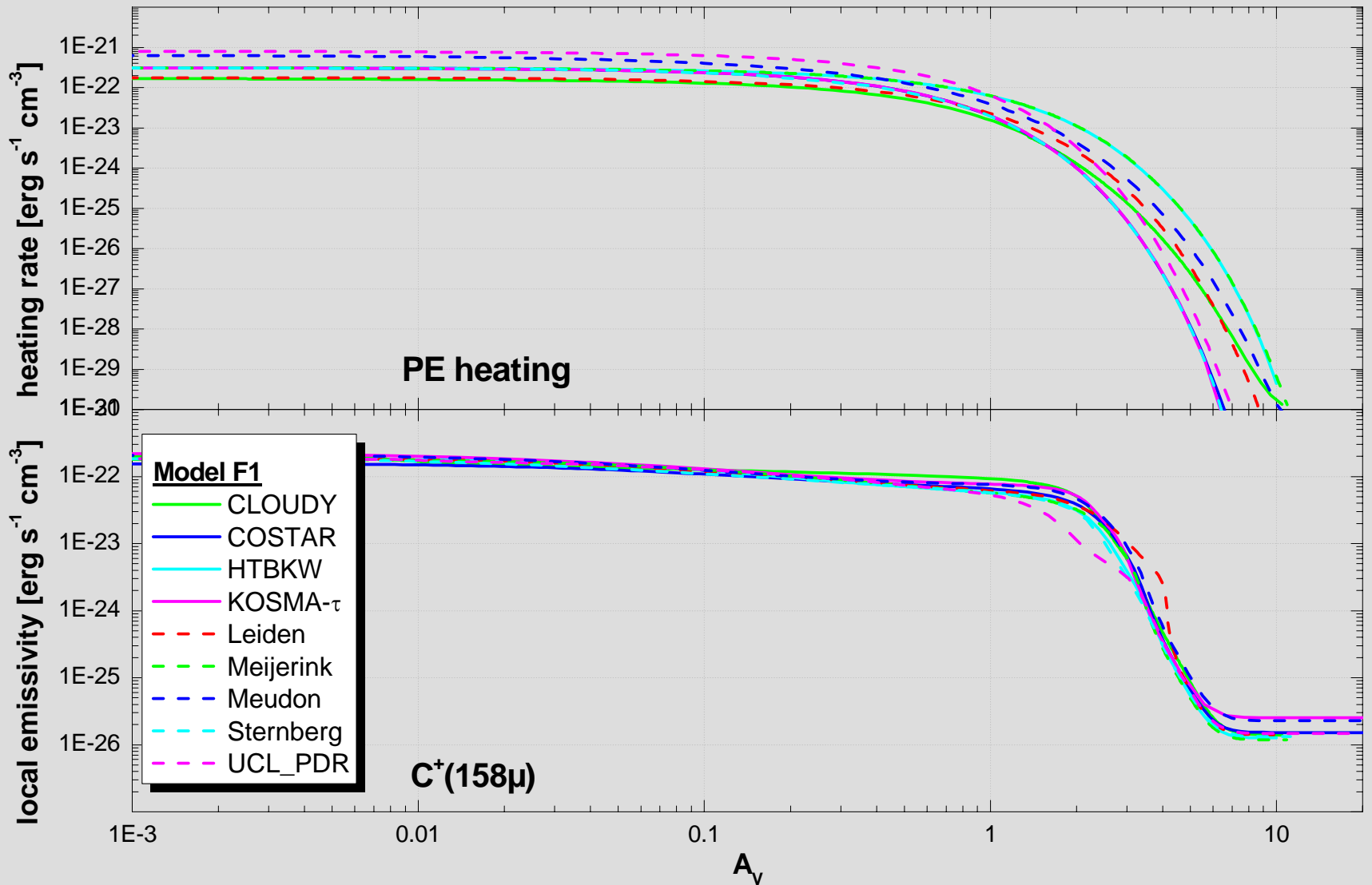
5.-8. April, 2004

PDR Model Comparison

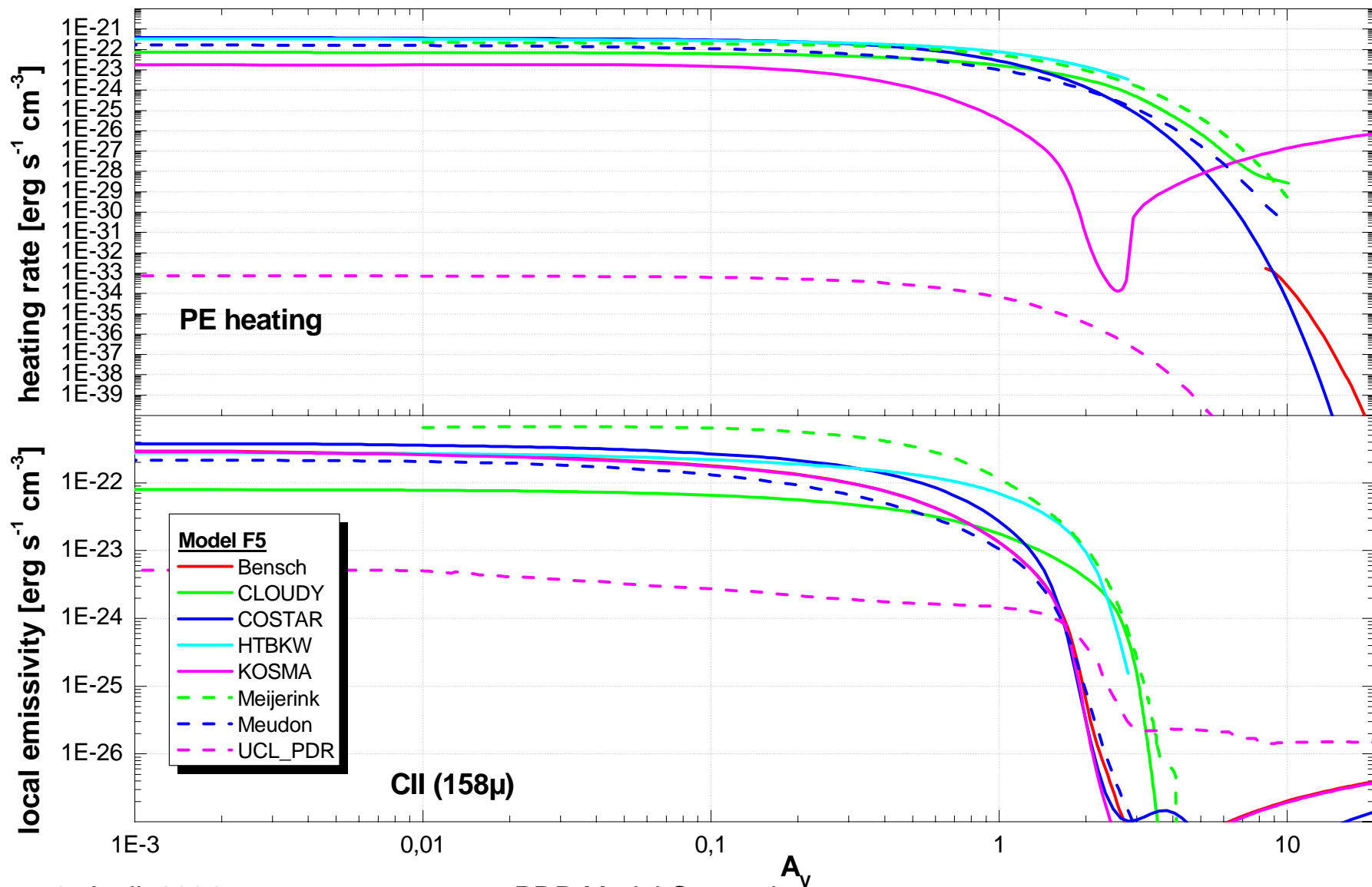
C⁺ (158μ) cooling and PE heating - n=10³ cm⁻³, χ=10



C⁺ (158 μ) cooling and PE heating - $n=10^3 \text{ cm}^{-3}$, $\chi=10$



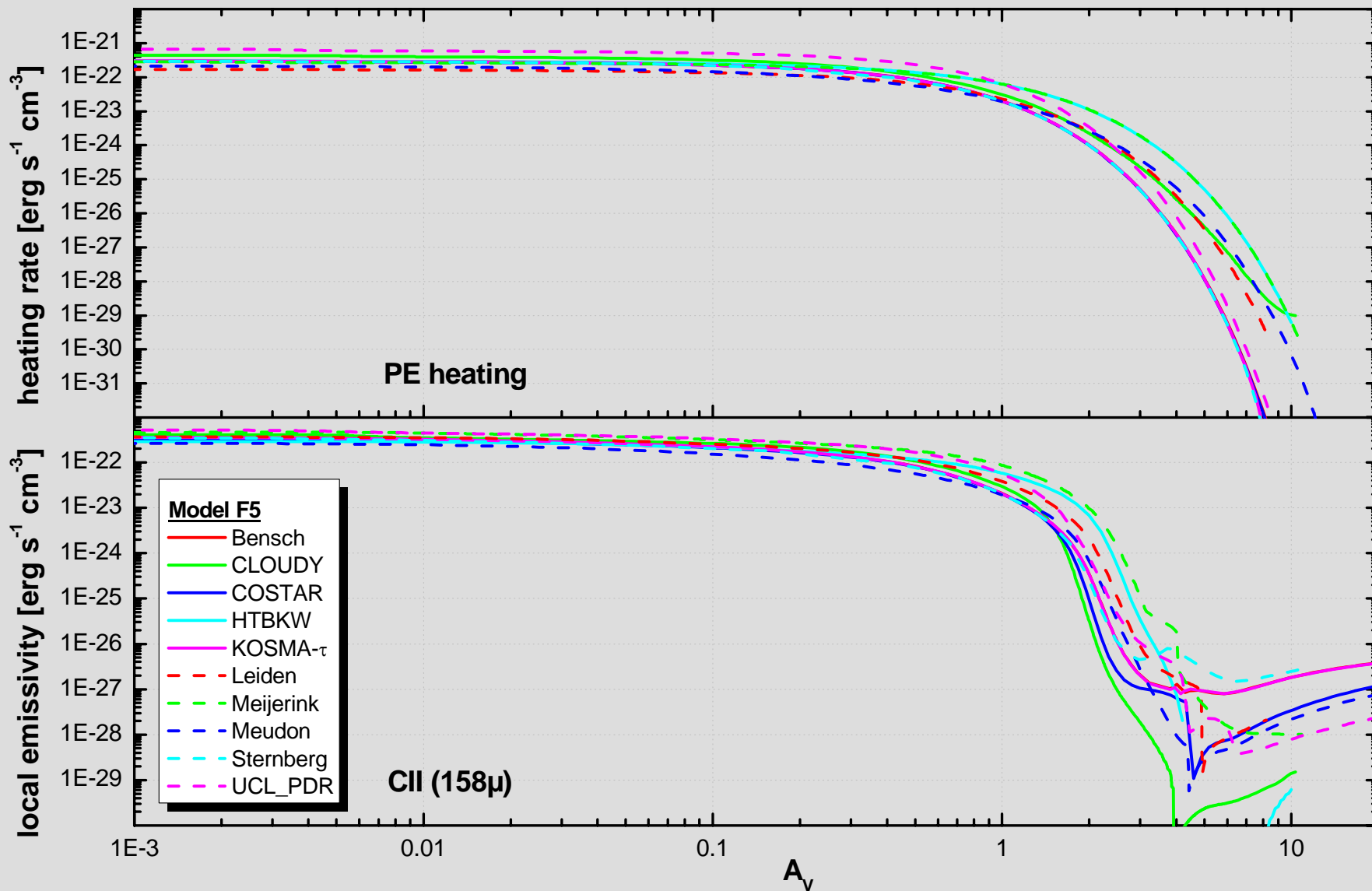
C⁺(158μ) cooling and PE heating - n=10³ cm⁻³, χ=10¹, variable T



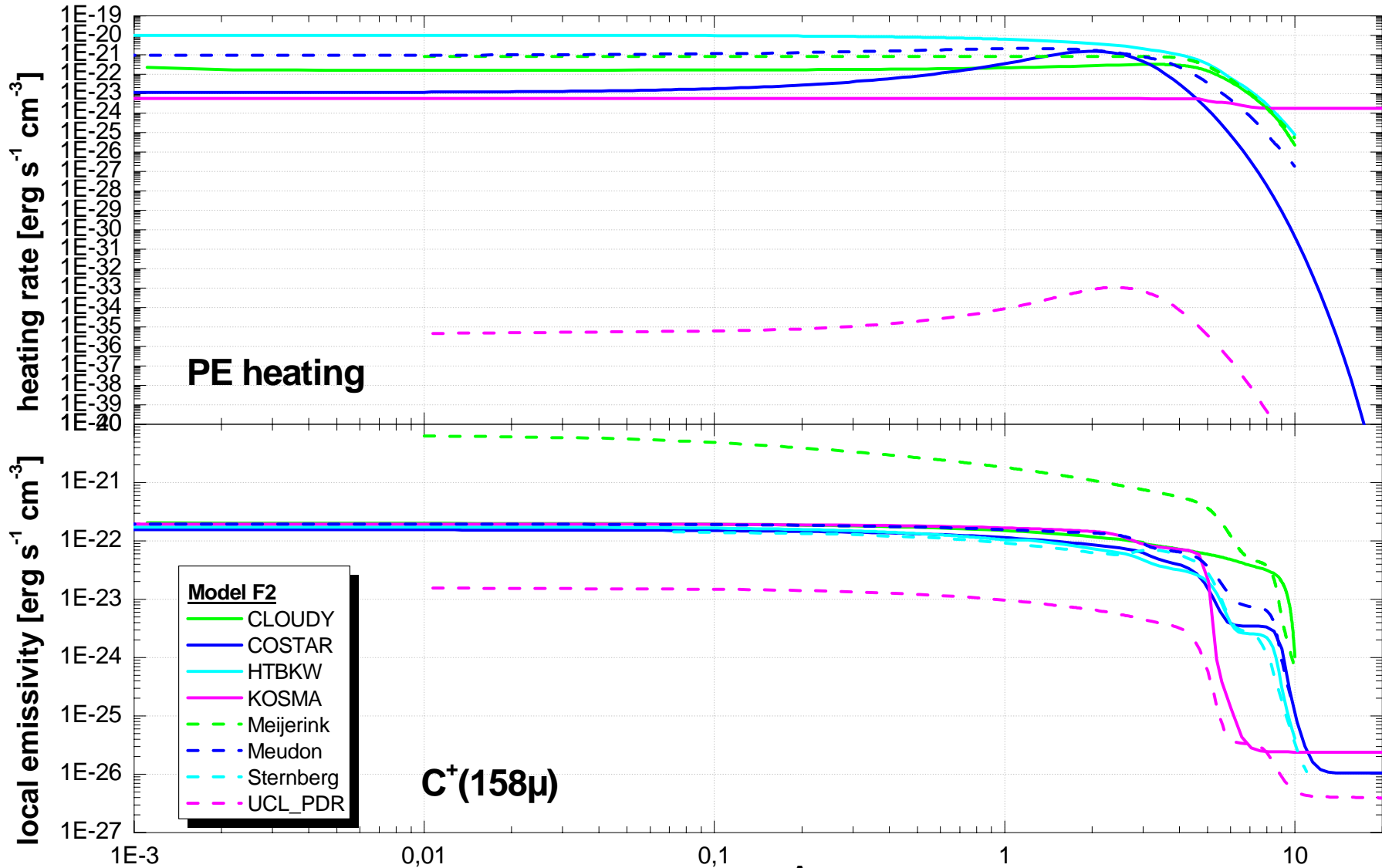
5.-8. April, 2004

PDR Model Comparison

C⁺(158μ) cooling and PE heating - n=10³ cm⁻³, χ=10¹, variable T



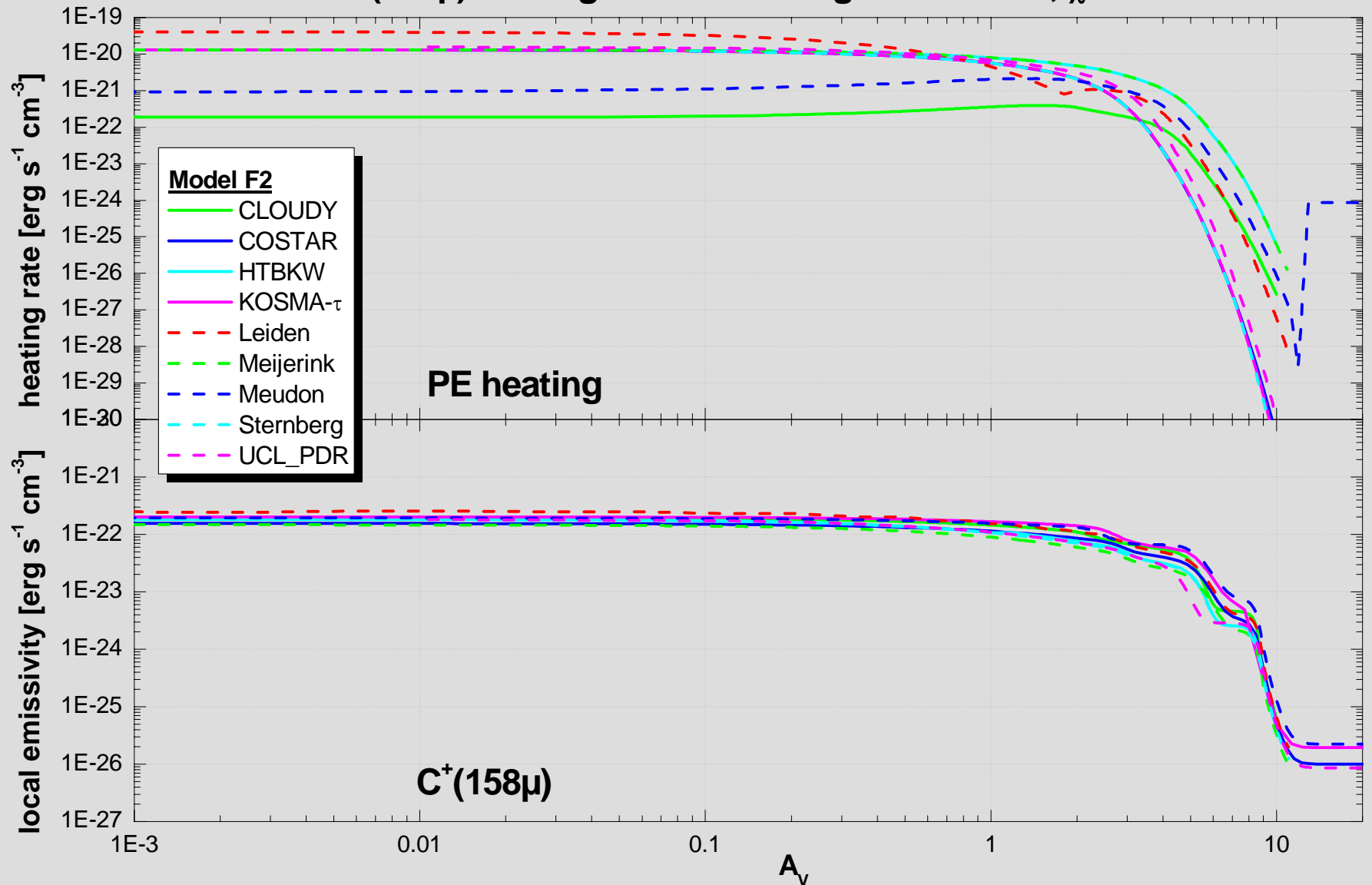
C⁺(158μ) cooling and PE heating - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



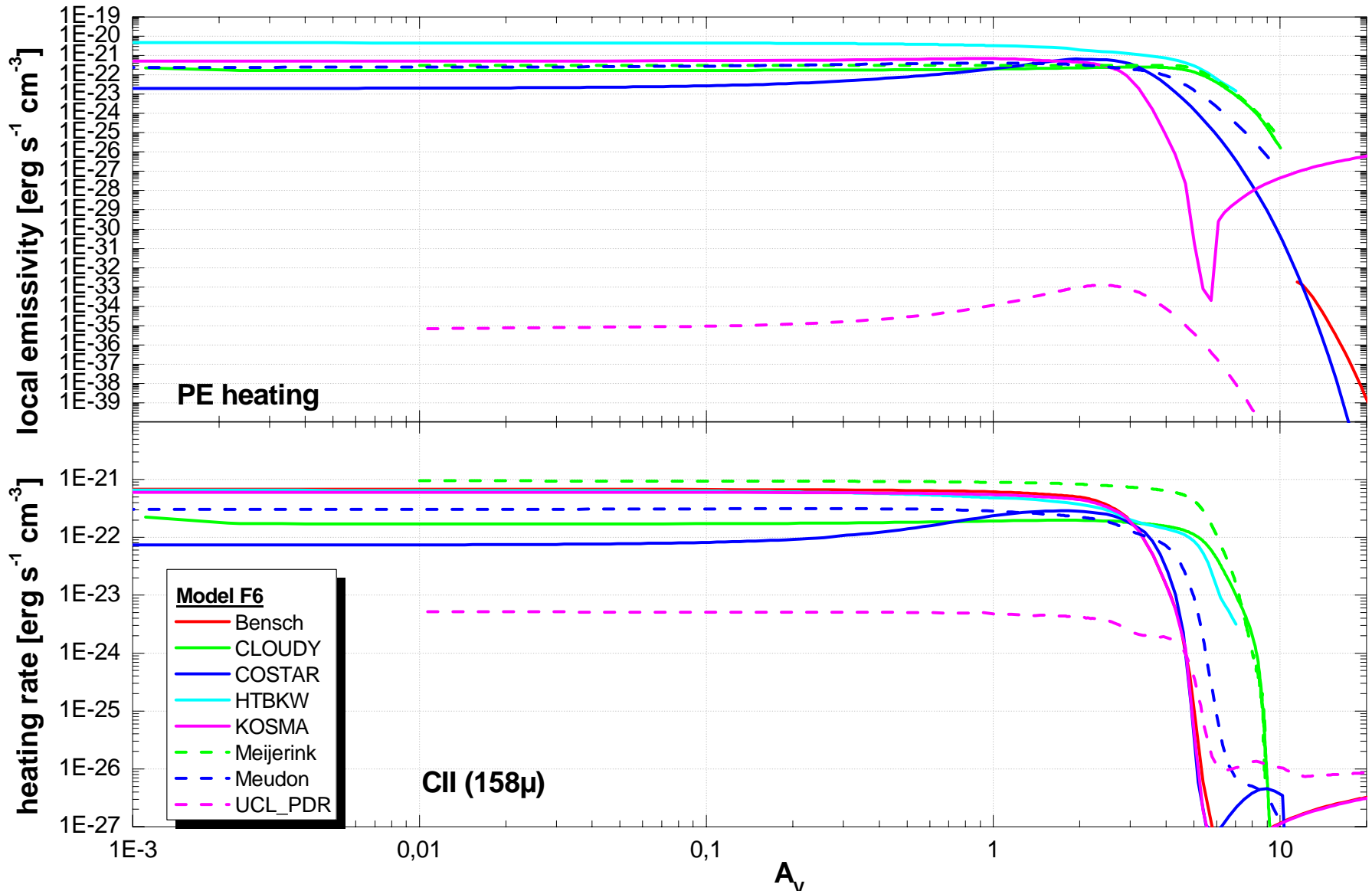
5.-8. April, 2004

PDR Model Comparison A_V

$C^+(158\mu)$ cooling and PE heating - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$



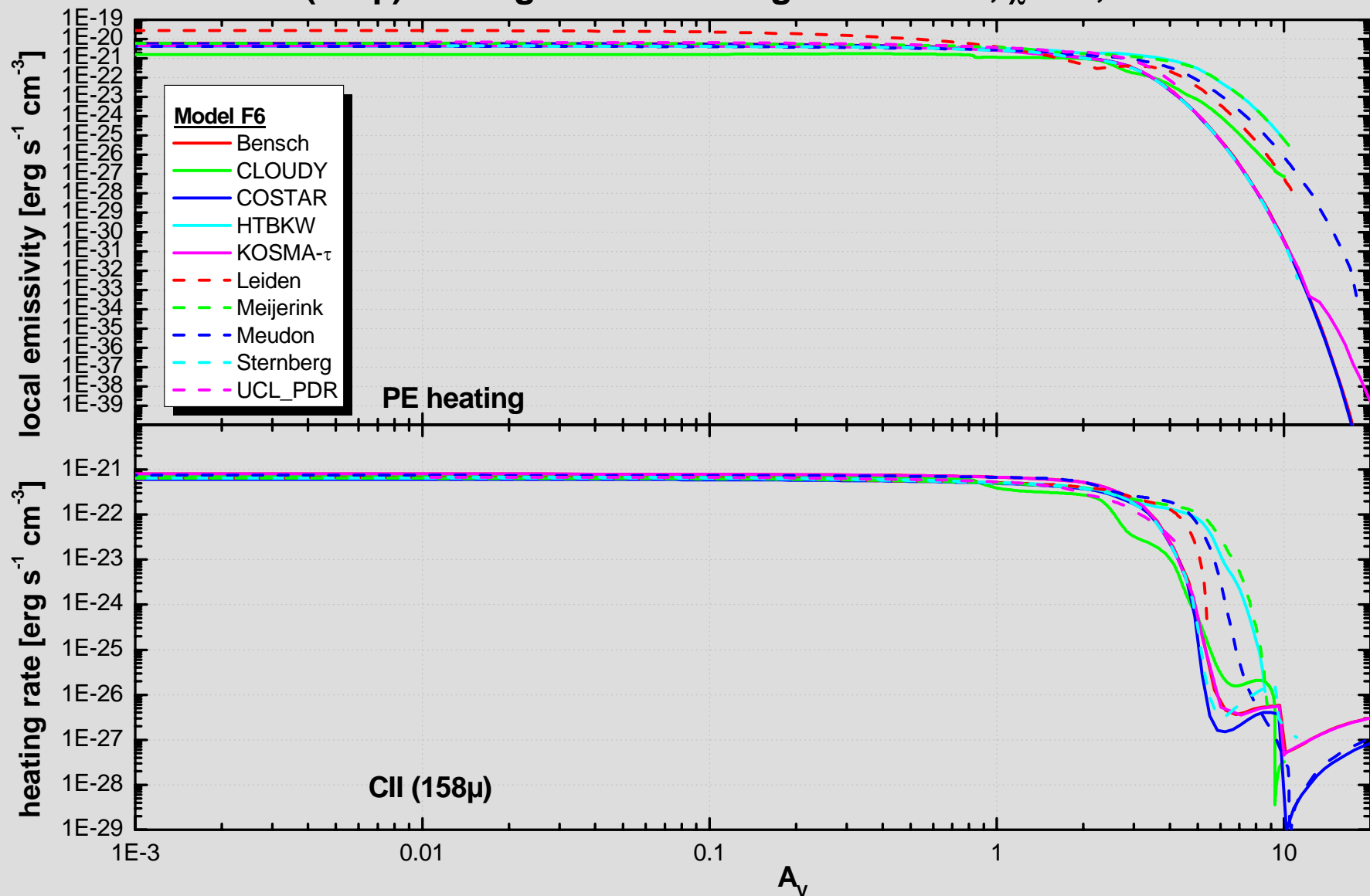
C⁺(158μ) cooling and PE heating - n=10³ cm⁻³, χ=10⁵, variable T



5.-8. April, 2004

PDR Model Comparison

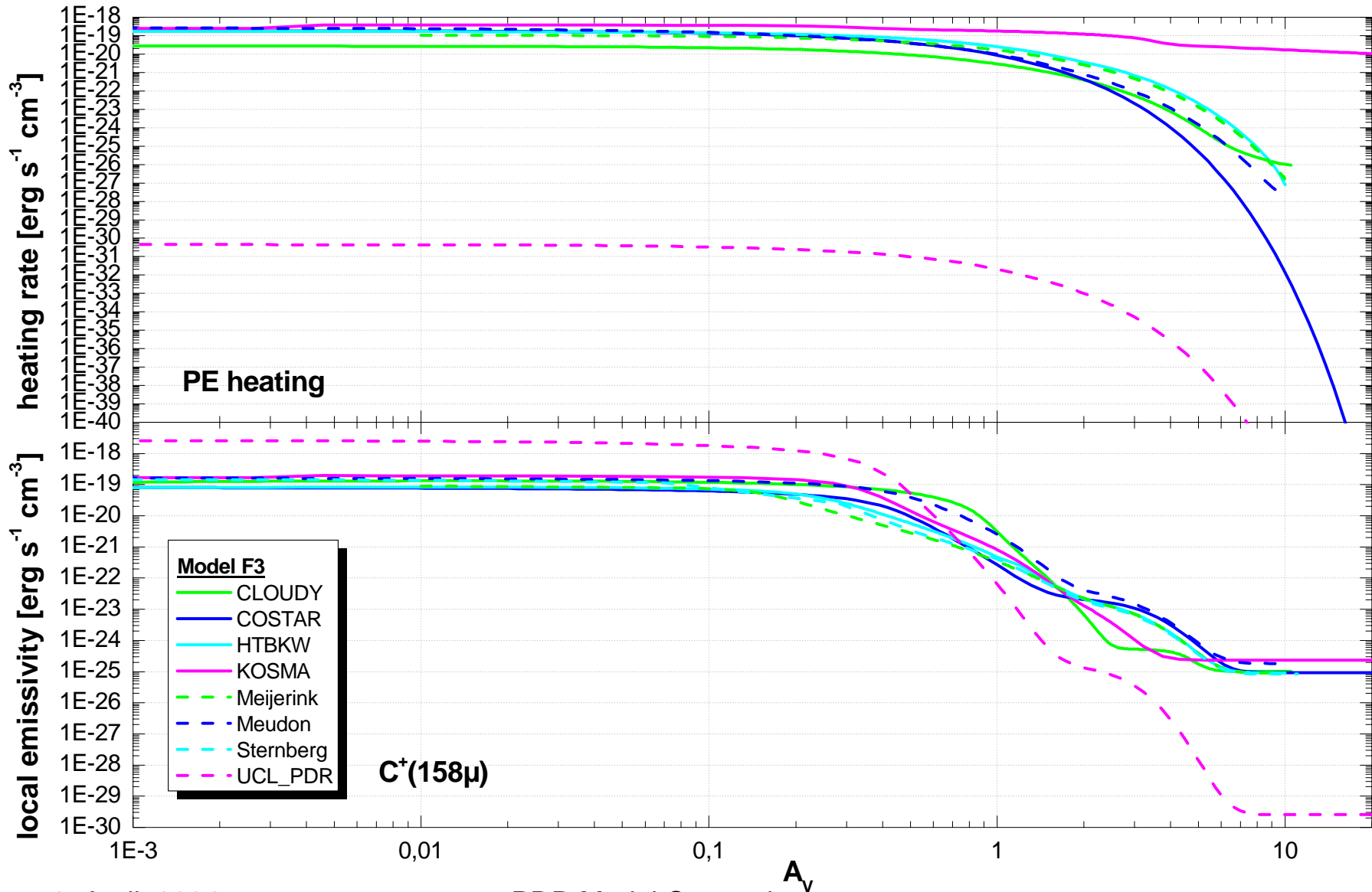
C⁺(158μ) cooling and PE heating - $n=10^3 \text{ cm}^{-3}$, $\chi=10^5$, variable T



PE heating

CII (158μ)

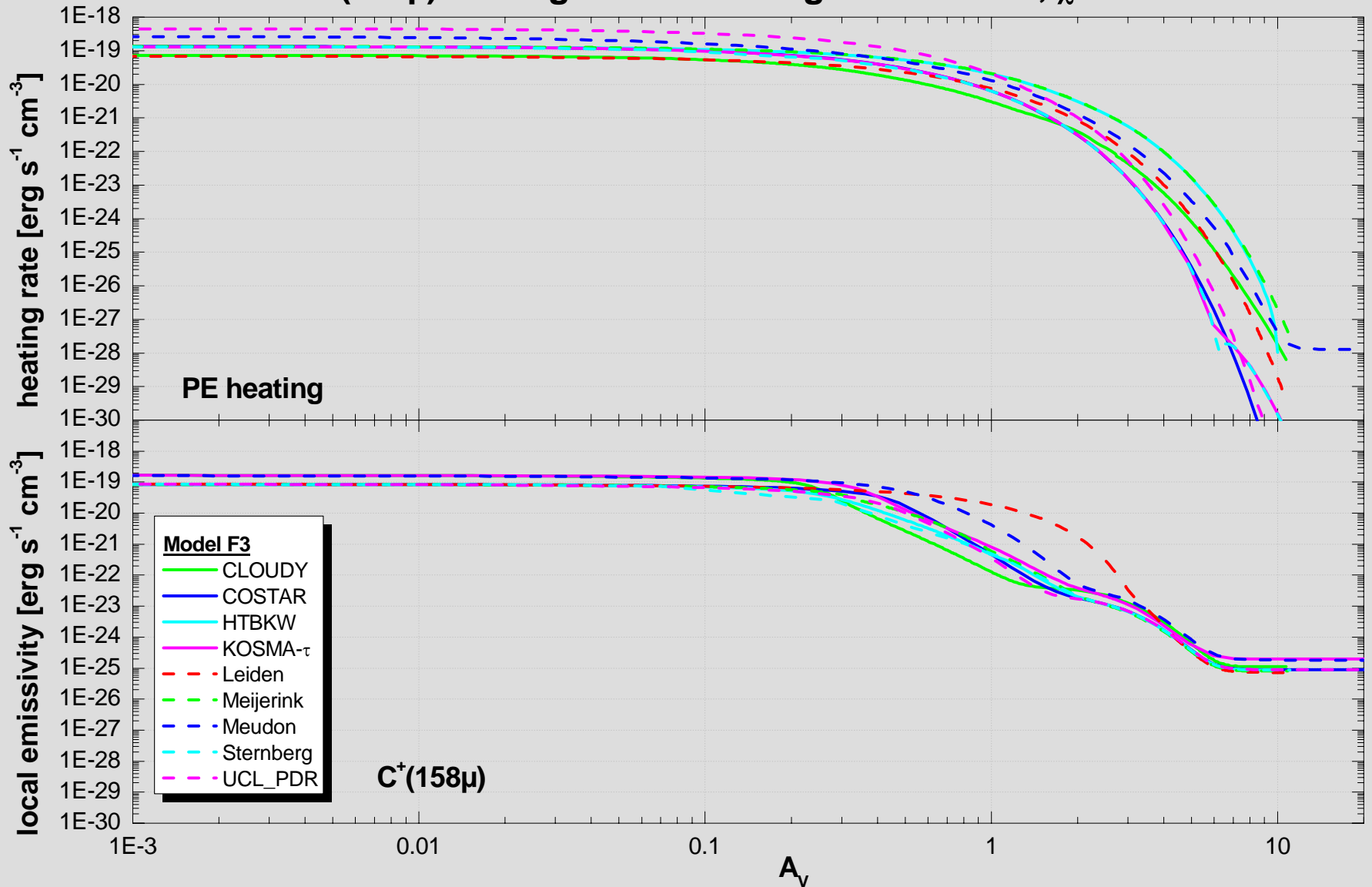
$C^+(158\mu)$ cooling and PE heating - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



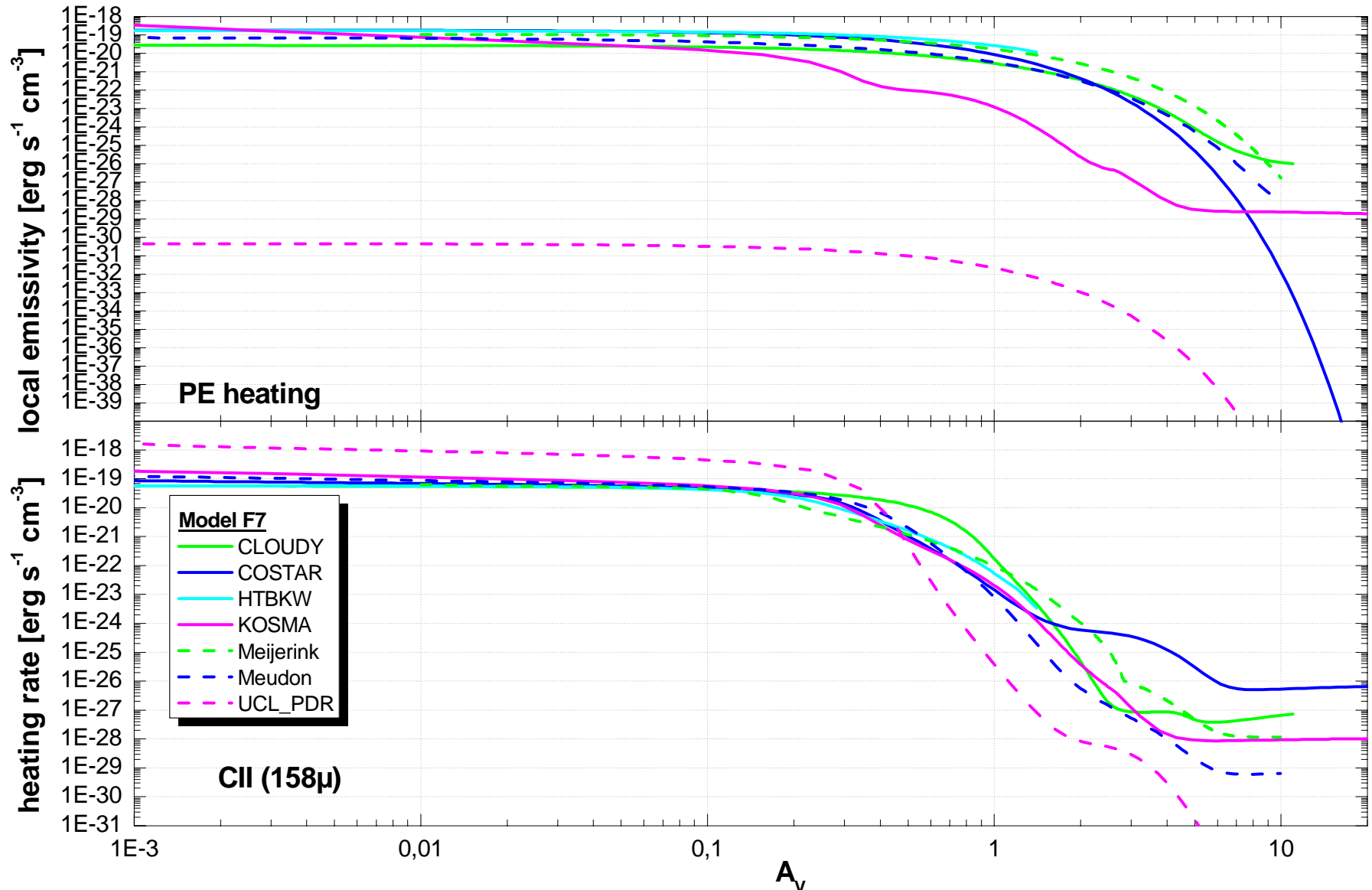
5.-8. April, 2004

PDR Model Comparison

C⁺(158μ) cooling and PE heating - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10$



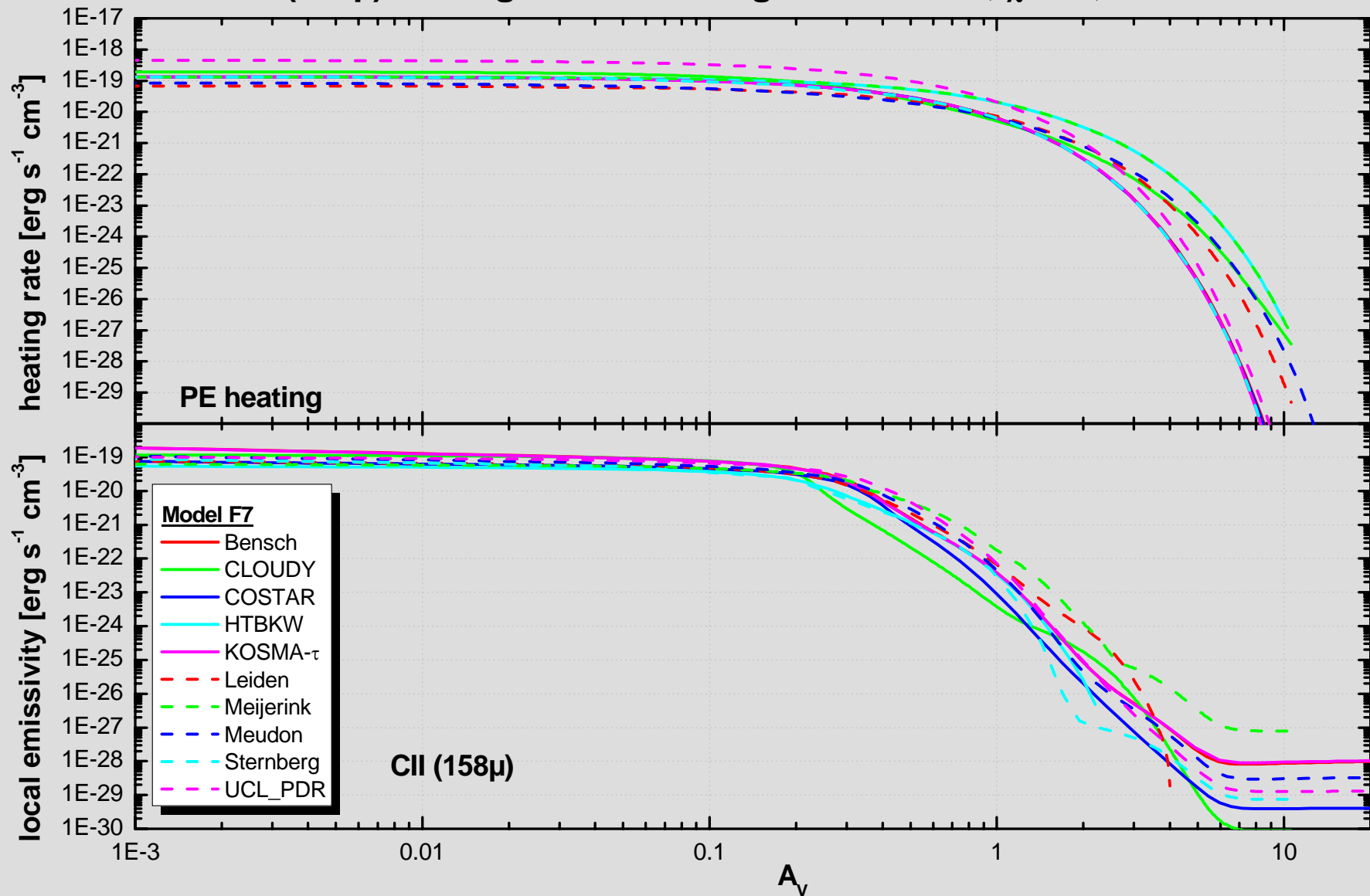
C⁺(158μ) cooling and PE heating - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^1$, variable T



5.-8. April, 2004

PDR Model Comparison

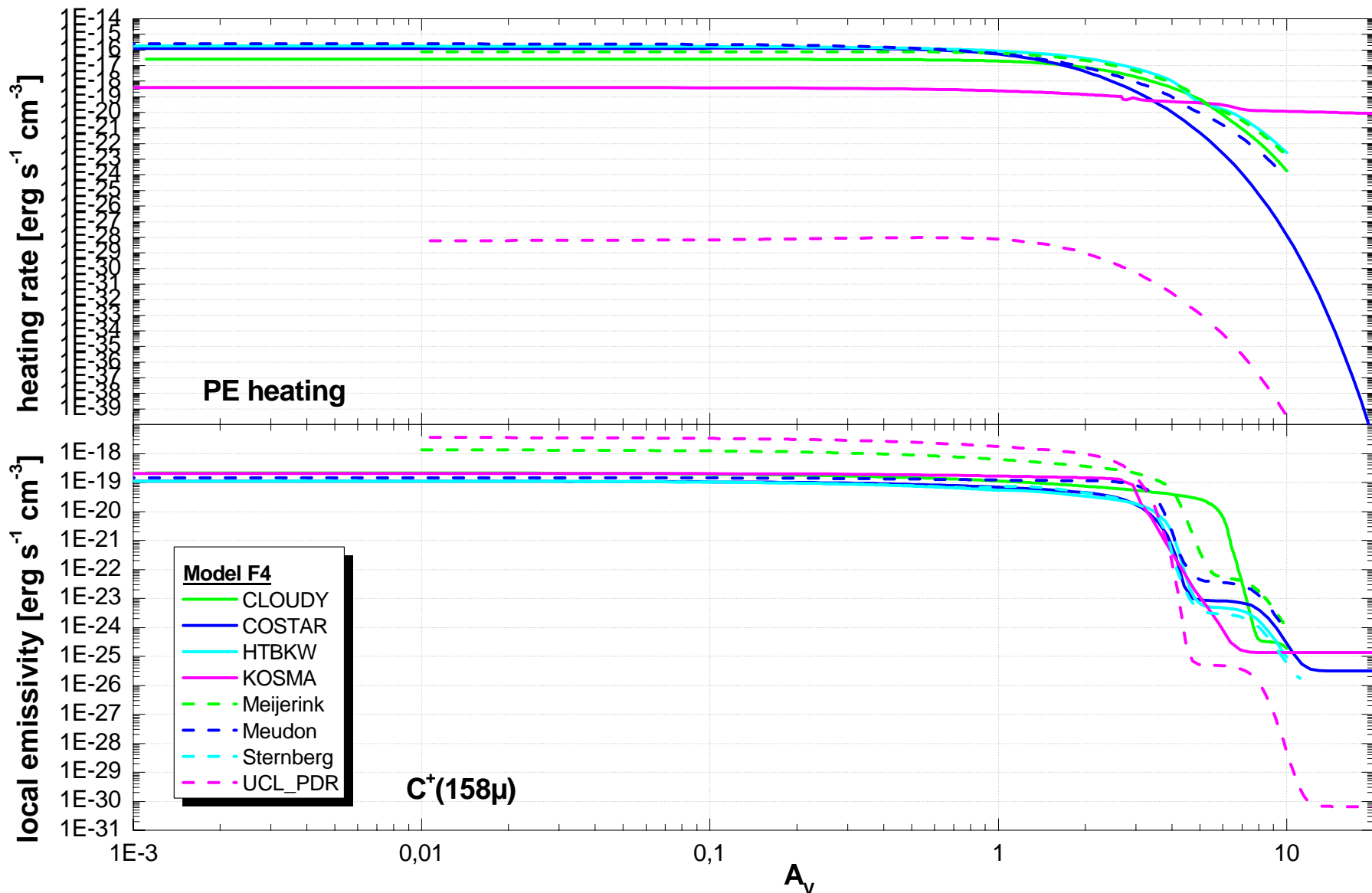
C⁺(158μ) cooling and PE heating - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^1$, variable T



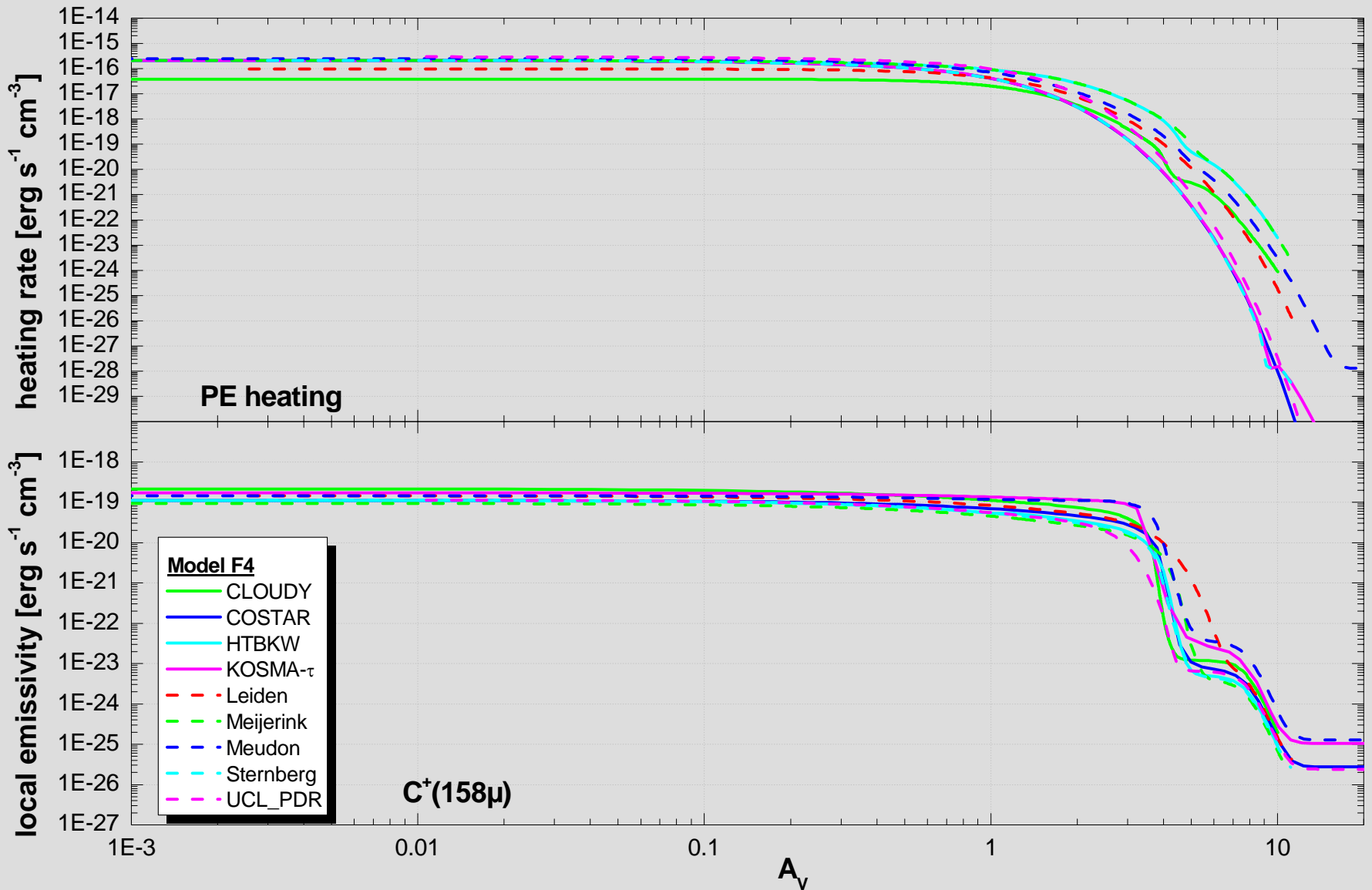
5.-8. April, 2004

PDR Model Comparison

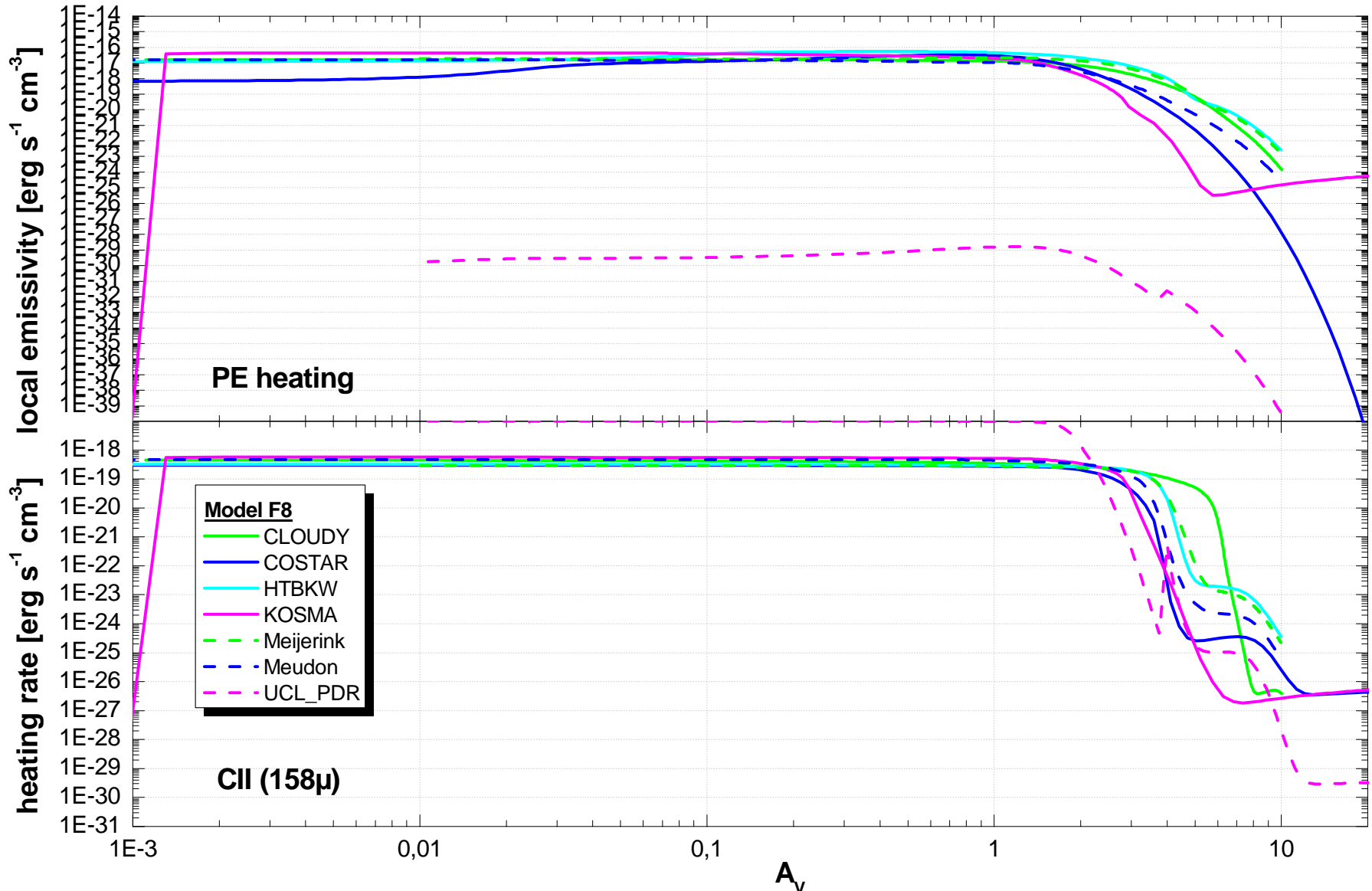
C⁺(158μ) cooling and PE heating - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



$C^+(158\mu)$ cooling and PE heating - $n=10^{5.5} \text{ cm}^{-3}$, $\chi=10^5$



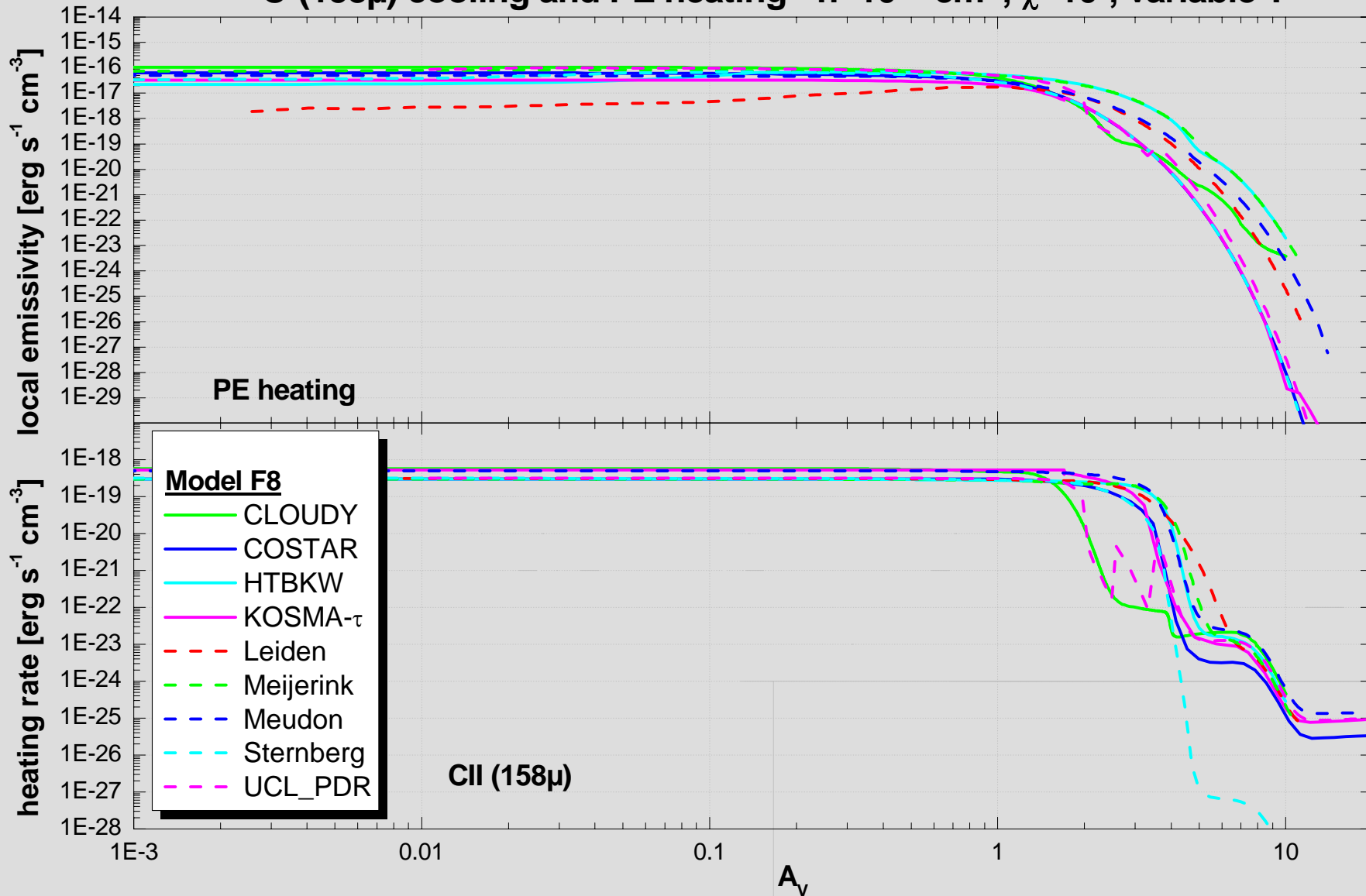
C⁺(158μ) cooling and PE heating - $n=10^{5.5}$ cm⁻³, $\chi=10^5$, variable T



5.-8. April, 2004

PDR Model Comparison

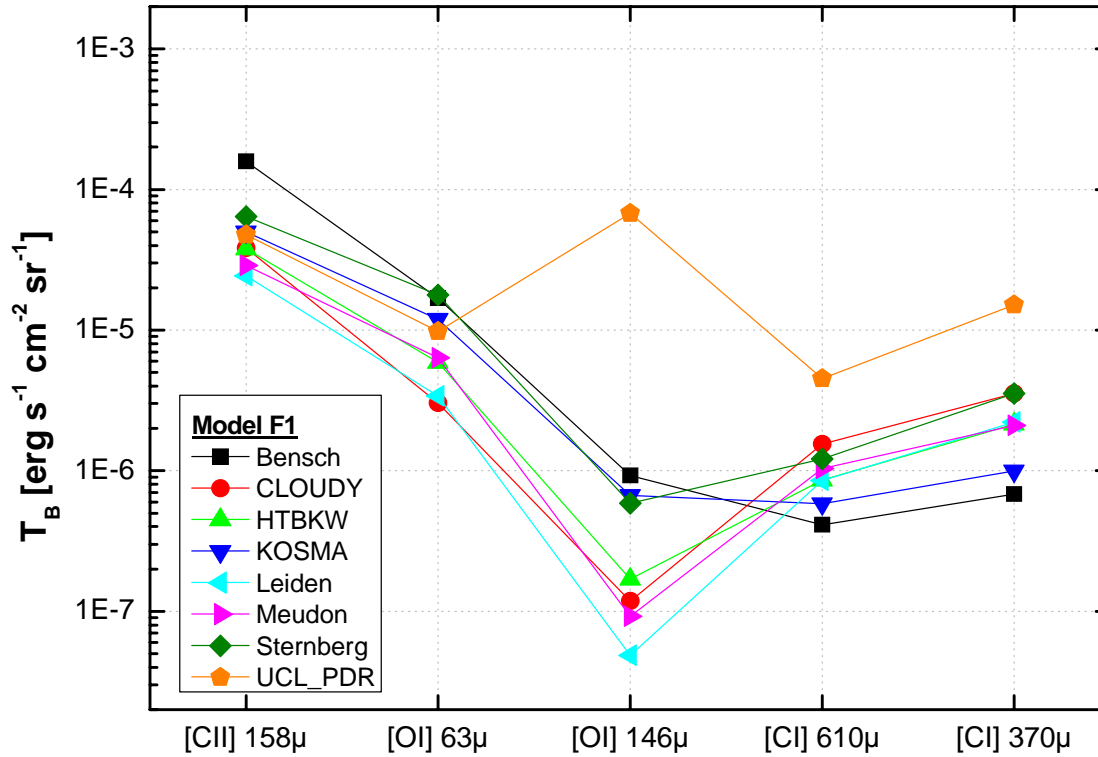
C⁺(158μ) cooling and PE heating - $n=10^{5.5}$ cm⁻³, $\chi=10^5$, variable T



Model Results F1-F8

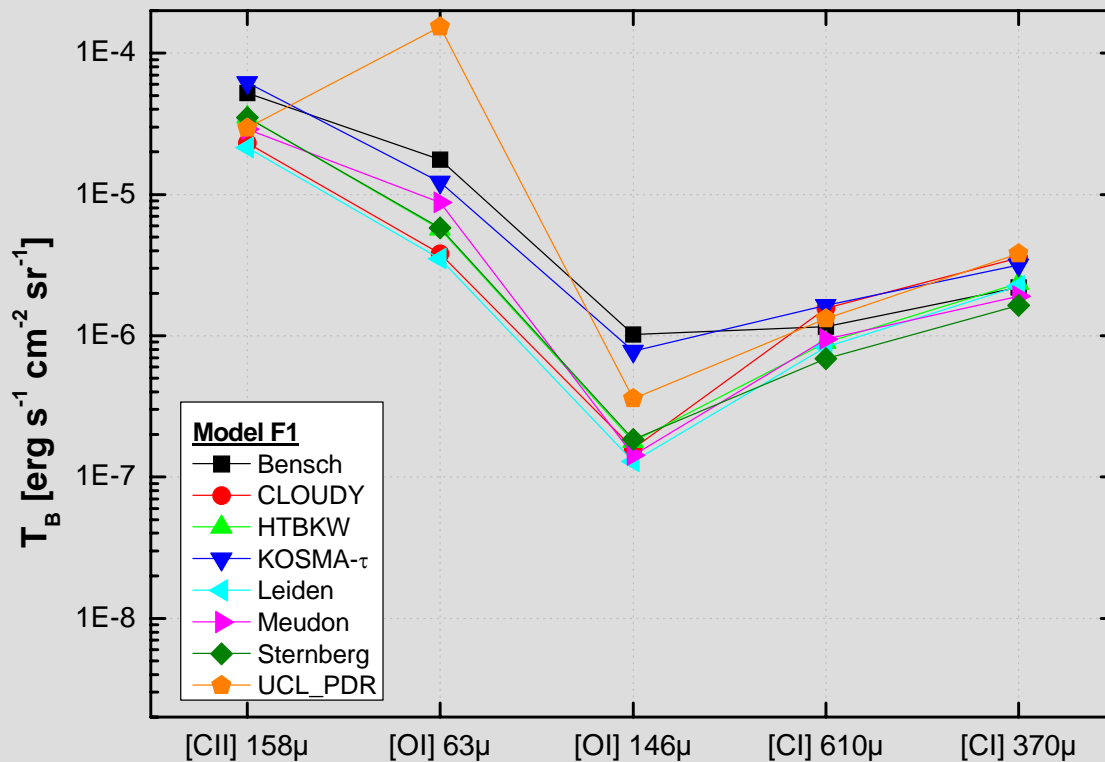
- photoreaction rates
- densities
- heating/cooling rates
- surface brightnesses

surface brightness - $n=10^3 \text{ cm}^{-3}$, $\chi = 10$



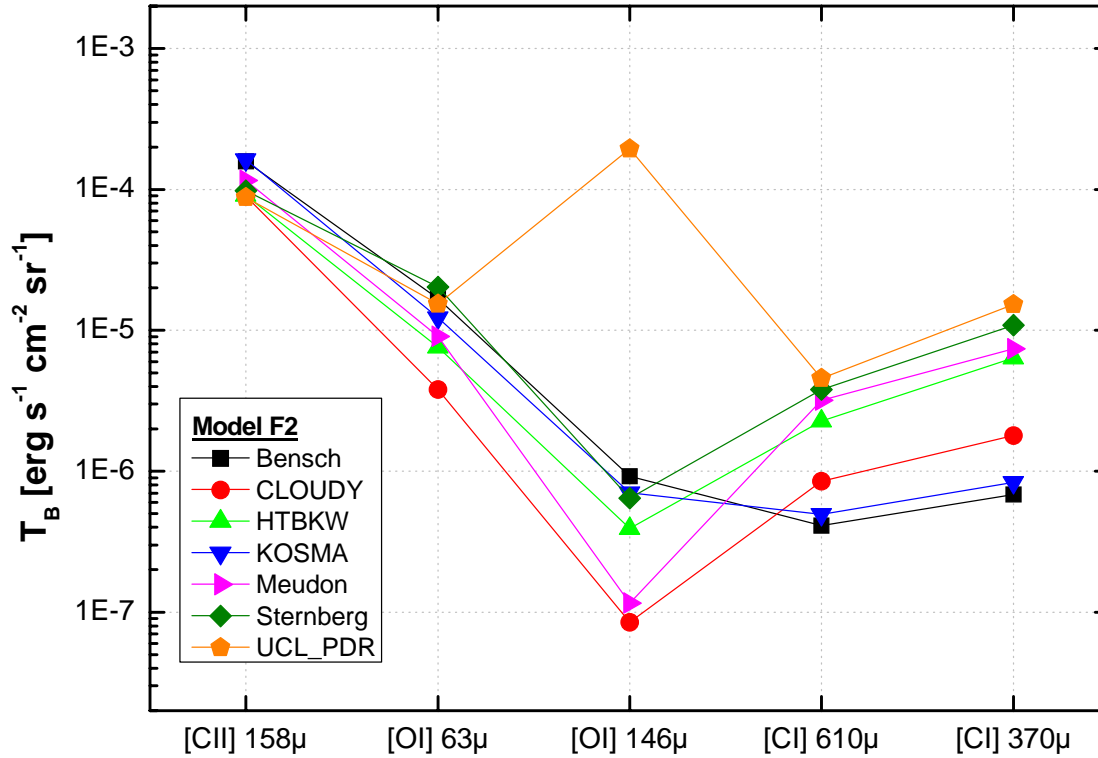
	Bensch	CLOUDY	HTBKW	KOSMA	Leiden	Meudon	Sternberg	UCL_PDR
[CII] 158μ	1,58E-04	3,83E-05	3,79E-05	5,00E-05	2,43E-05	2,88E-05	6,42E-05	4,77E-05
[OI] 63μ	1,68E-05	3,02E-06	5,89E-06	1,19E-05	3,39E-06	6,34E-06	1,78E-05	9,77E-06
[OI] 146μ	9,24E-07	1,18E-07	1,70E-07	6,69E-07	4,86E-08	9,23E-08	5,88E-07	6,76E-05
[CI] 610μ	4,11E-07	1,55E-06	8,59E-07	5,84E-07	8,51E-07	1,04E-06	1,21E-06	4,51E-06
[CI] 370μ	6,82E-07	3,54E-06	2,15E-06	9,94E-07	2,21E-06	2,10E-06	3,54E-06	1,51E-05

surface brightness - $n=10^3 \text{ cm}^{-3}$, $\chi = 10$



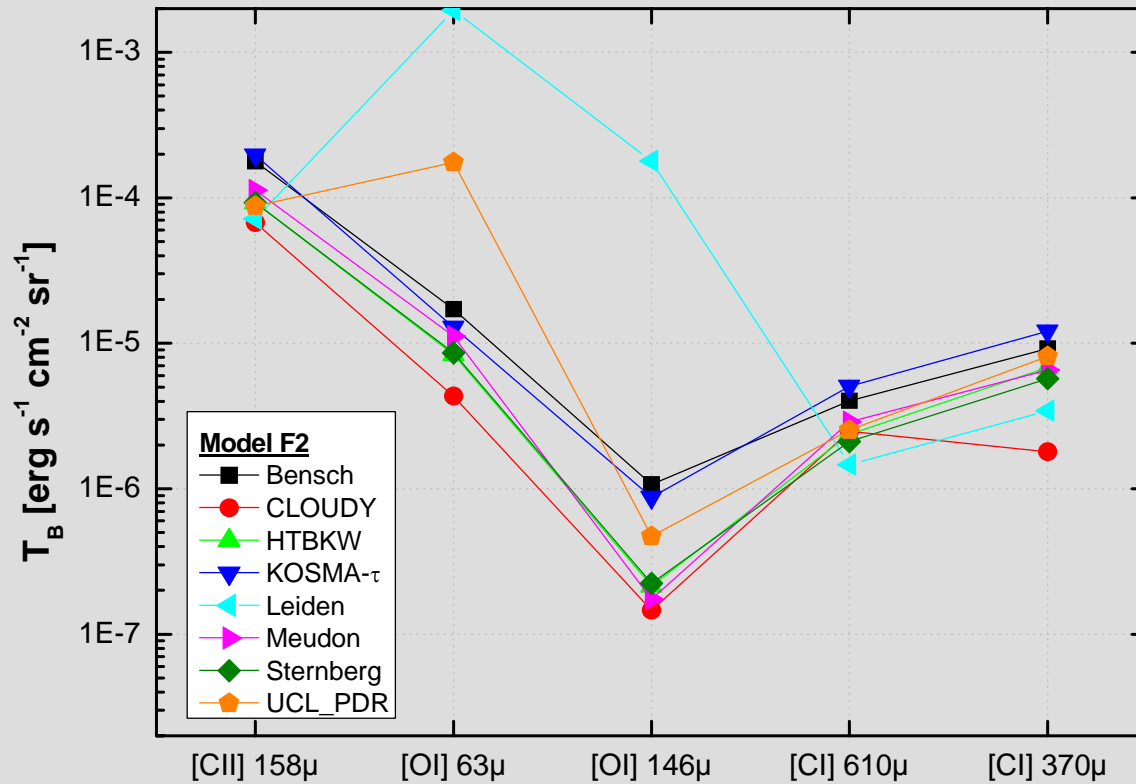
	Bensch	CLOUDY	HTBKW	KOSMA	Leiden	Meudon	Sternberg	UCL_PDR
[CII] 158 μ	5.22E-5	2.31E-5	3.51E-5	6.19E-5	2.14E-5	2.90E-5	3.51E-5	2.96E-5
[OI] 63 μ	1.76E-5	3.80E-6	5.67E-6	1.22E-5	3.50E-6	8.78E-6	5.80E-6	1.53E-4
[OI] 146 μ	1.02E-6	1.60E-7	1.79E-7	7.79E-7	1.29E-7	1.43E-7	1.85E-7	3.59E-7
[CI] 610 μ	1.16E-6	1.56E-6	8.96E-7	1.63E-6	8.31E-7	9.44E-7	6.88E-7	1.32E-6
[CI] 370 μ	2.2E-6	3.56E-6	2.36E-6	3.16E-6	2.25E-6	1.90E-6	1.64E-6	3.81E-6

surface brightness - $n=10^3 \text{ cm}^{-3}$, $\chi = 10^5$



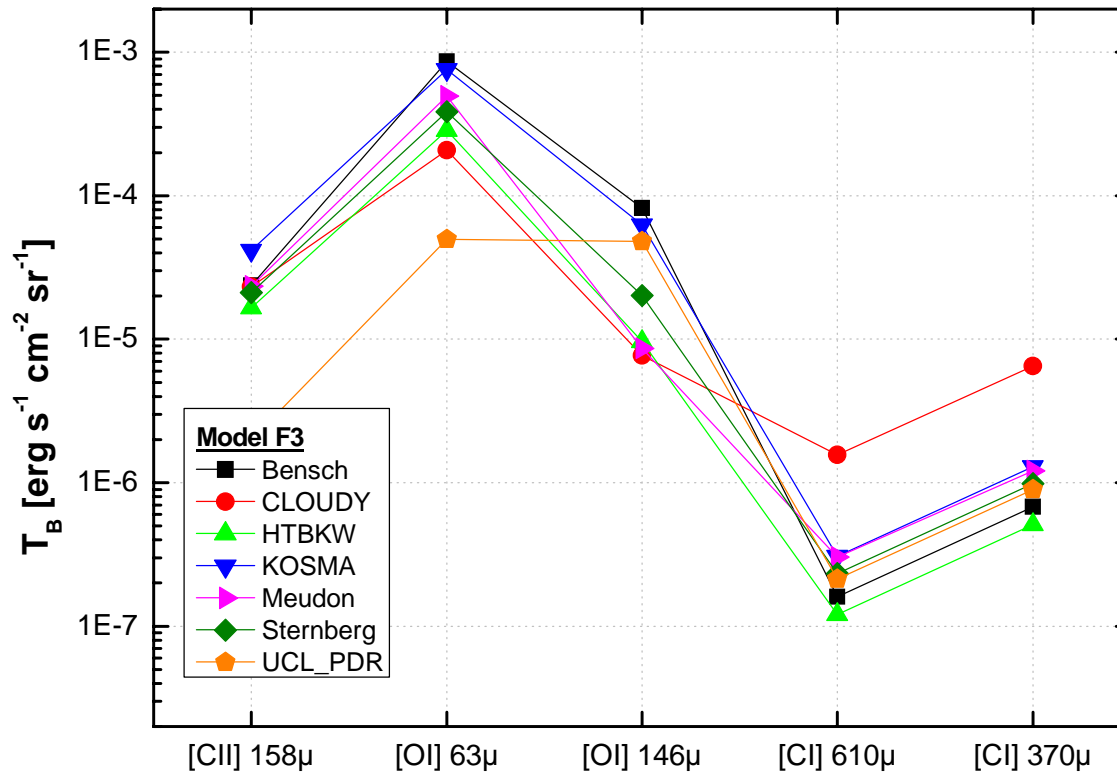
	Bensch	CLOUDY	HTBKW	KOSMA	Meudon	Sternberg	UCL_PDR
$[\text{CII}] 158\mu$	1,58E-04	8,93E-05	9,10E-05	1,63E-04	1,16E-04	9,78E-05	8,77E-05
$[\text{OI}] 63\mu$	1,68E-05	3,80E-06	7,59E-06	1,23E-05	9,08E-06	2,03E-05	1,54E-05
$[\text{OI}] 146\mu$	9,24E-07	8,48E-08	3,93E-07	7,01E-07	1,16E-07	6,43E-07	1,94E-04
$[\text{CI}] 610\mu$	4,11E-07	8,53E-07	2,28E-06	4,93E-07	3,20E-06	3,81E-06	4,56E-06
$[\text{CI}] 370\mu$	6,82E-07	1,79E-06	6,35E-06	8,35E-07	7,41E-06	1,09E-05	1,53E-05

surface brightness - $n=10^3 \text{ cm}^{-3}$, $\chi = 10^5$



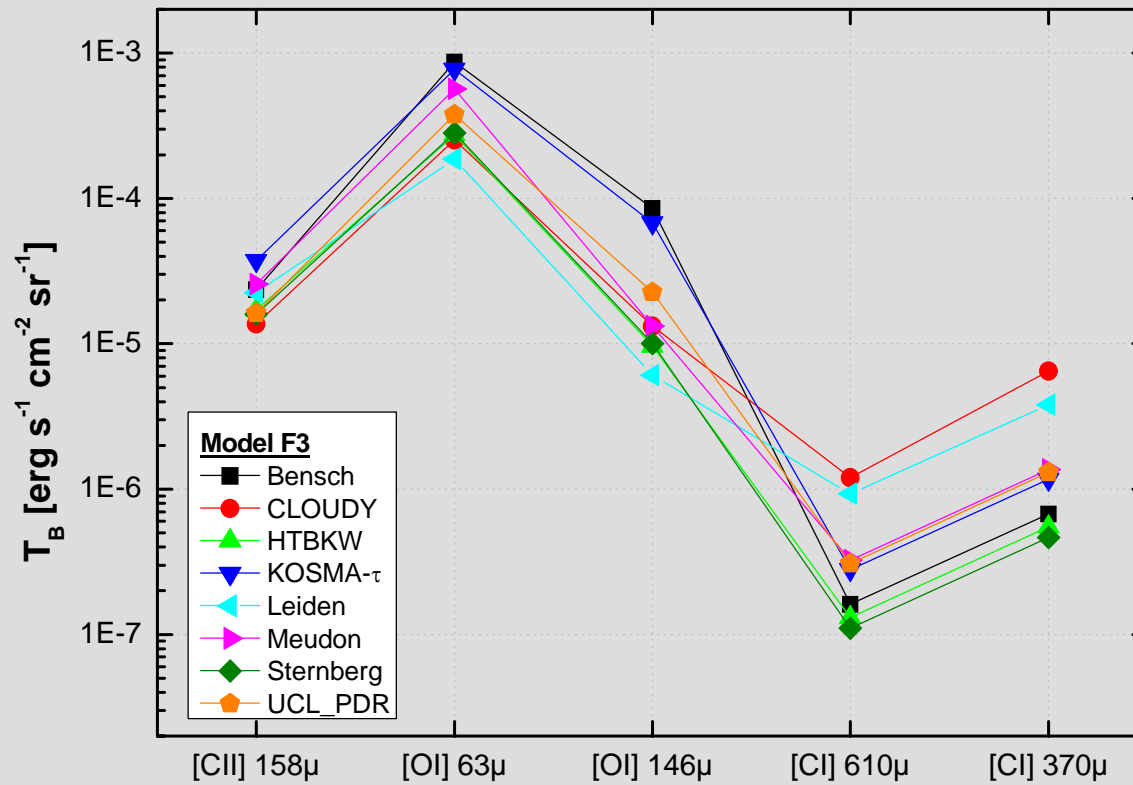
	Bensch	CLOUDY	HTBKW	KOSMA	Leiden	Meudon	Sternberg	UCL_PDR
[CII] 158μ	1.78E-4	6.72E-5	9.29E-5	1.97E-4	7.18E-5	1.13E-4	9.28E-5	8.77E-5
[OI] 63μ	1.71E-5	4.31E-6	8.35E-6	1.29E-5	0.00194	1.12E-5	8.58E-6	1.75E-4
[OI] 146μ	1.07E-6	1.46E-7	2.15E-7	8.71E-7	1.79E-4	1.73E-7	2.23E-7	4.72E-7
[CI] 610μ	4.01E-6	2.49E-6	2.36E-6	5.04E-6	1.46E-6	2.89E-6	2.11E-6	2.54E-6
[CI] 370μ	9.2E-6	1.79E-6	6.82E-6	1.22E-5	3.43E-6	6.53E-6	5.73E-6	8.13E-6

surface brightness - $n=10^{5.5} \text{ cm}^{-3}$, $\chi = 10^1$



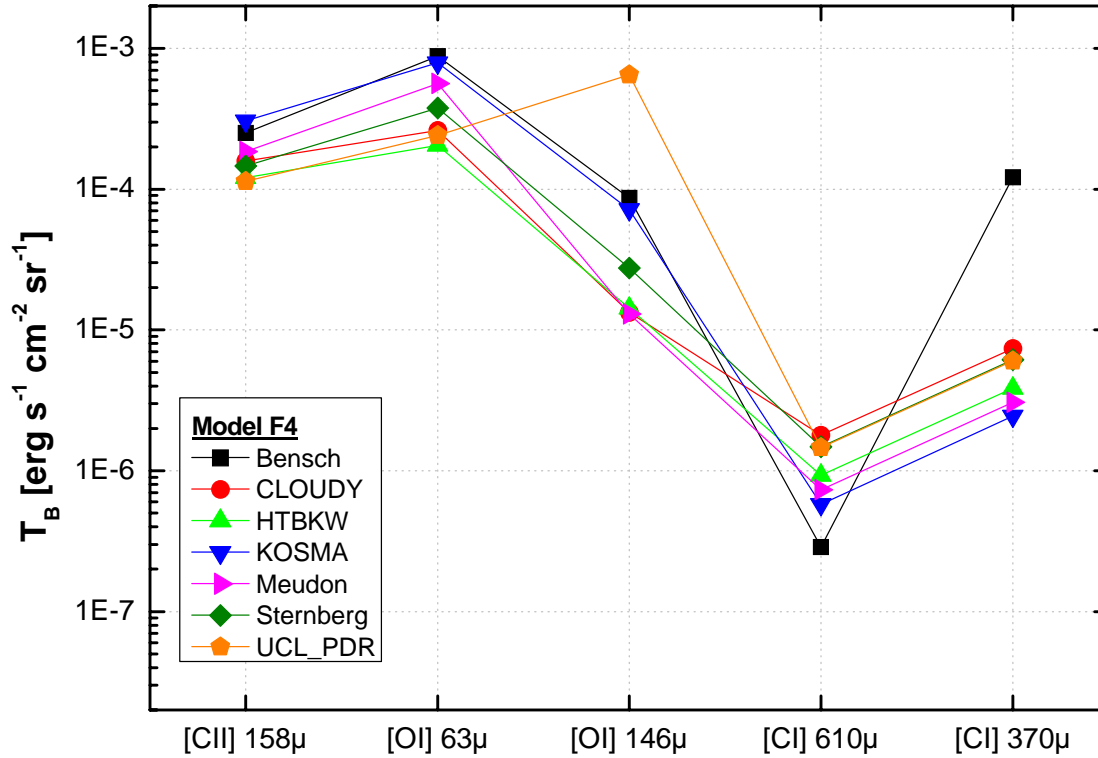
	Bensch	CLOUDY	HTBKW	KOSMA	Meudon	Sternberg	UCL_PDR
[CII] 158 μ	2,37E-05	2,32E-05	1,66E-05	4,17E-05	2,34E-05	2,12E-05	1,98E-06
[OI] 63 μ	8,64E-04	2,08E-04	2,85E-04	7,57E-04	4,94E-04	3,84E-04	4,98E-05
[OI] 146 μ	8,23E-05	7,70E-06	9,65E-06	6,26E-05	8,63E-06	2,02E-05	4,81E-05
[CI] 610 μ	1,60E-07	1,57E-06	1,20E-07	3,07E-07	3,03E-07	2,33E-07	2,13E-07
[CI] 370 μ	6,78E-07	6,49E-06	5,11E-07	1,30E-06	1,21E-06	9,86E-07	9,00E-07

surface brightness - $n=10^{5.5} \text{ cm}^{-3}$, $\chi = 10^1$



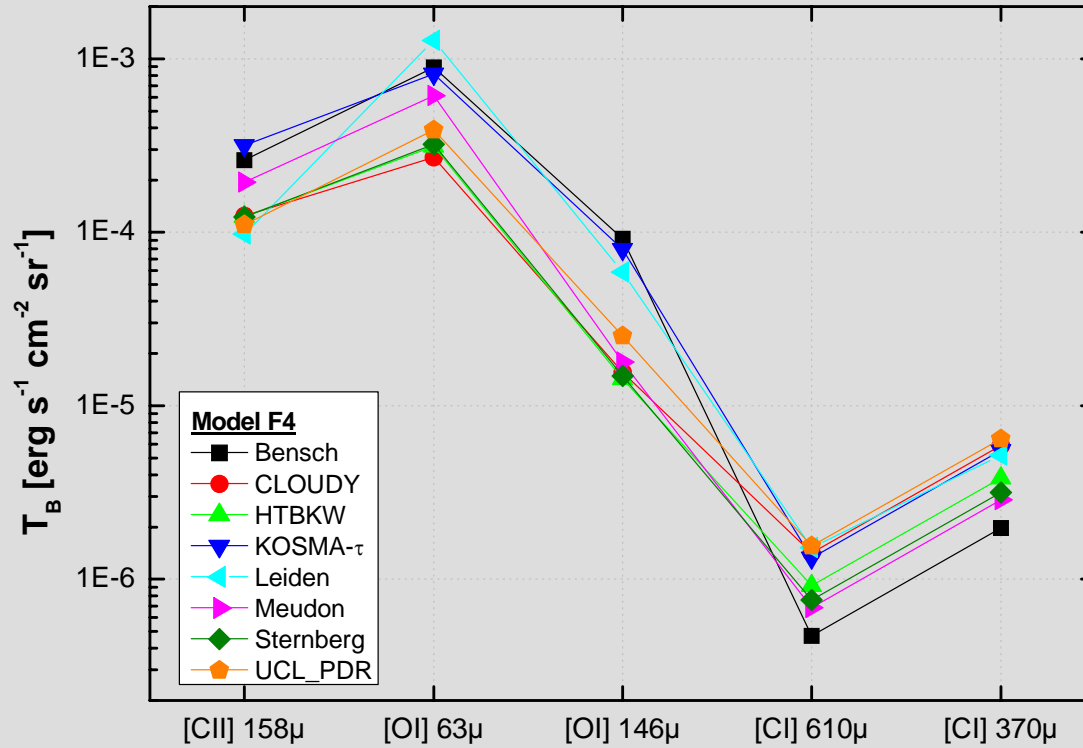
	Bensch	CLOUDY	HTBKW	KOSMA	Leiden	Meudon	Sternberg	UCL_PDR
[CII] 158 μ	2.35E-5	1.37E-5	1.72E-5	3.74E-5	2.25E-5	2.58E-5	1.60E-5	1.63E-5
[OI] 63 μ	8.7E-4	2.52E-4	2.75E-4	7.75E-4	1.87E-4	5.65E-4	2.81E-4	3.77E-4
[OI] 146 μ	8.55E-5	1.33E-5	9.61E-6	6.81E-5	6.06E-6	1.32E-5	1.00E-5	2.27E-5
[CI] 610 μ	1.61E-7	1.20E-6	1.31E-7	2.79E-7	9.27E-7	3.25E-7	1.11E-7	3.08E-7
[CI] 370 μ	6.76E-7	6.49E-6	5.5E-7	1.17E-6	3.82E-6	1.36E-6	4.64E-7	1.30E-6

surface brightness - $n=10^{5.5} \text{ cm}^{-3}$, $\chi = 10^5$



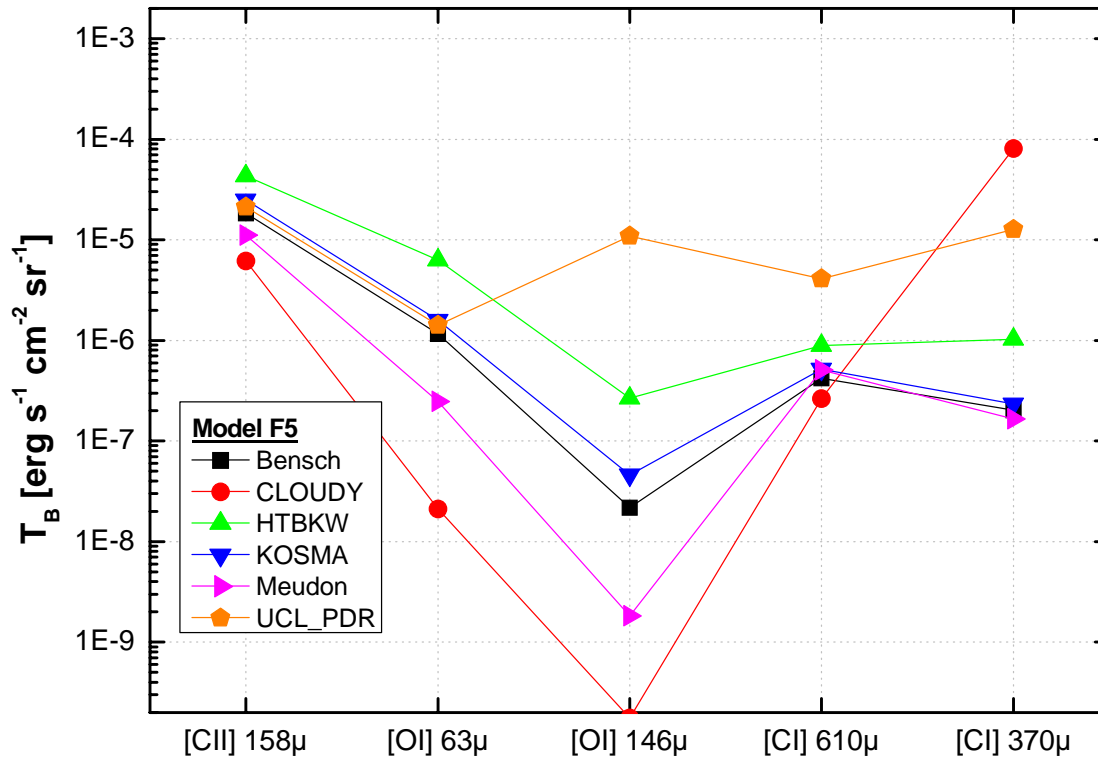
	Bensch	CLOUDY	HTBKW	KOSMA	Meudon	Sternberg	UCL_PDR
[CII] 158μ	2,51E-04	1,59E-04	1,21E-04	3,06E-04	1,85E-04	1,46E-04	1,14E-04
[OI] 63μ	8,78E-04	2,61E-04	2,05E-04	7,88E-04	5,64E-04	3,76E-04	2,42E-04
[OI] 146μ	8,65E-05	1,33E-05	1,42E-05	7,15E-05	1,30E-05	2,76E-05	6,48E-04
[CI] 610μ	2,88E-07	1,80E-06	9,26E-07	5,78E-07	7,33E-07	1,48E-06	1,46E-06
[CI] 370μ	1,22E-04	7,41E-06	3,87E-06	2,44E-06	3,06E-06	6,16E-06	6,04E-06

surface brightness - $n=10^{5.5} \text{ cm}^{-3}$, $\chi = 10^5$

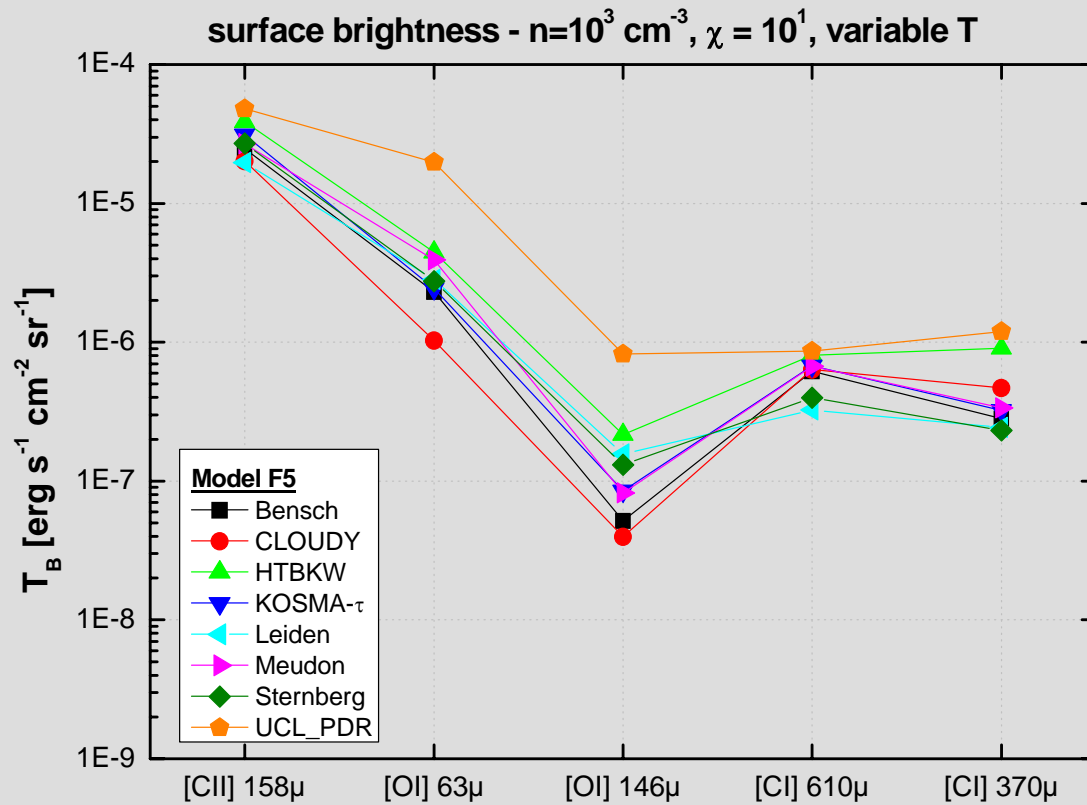


	Bensch	CLOUDY	HTBKW	KOSMA	Leiden	Meudon	Sternberg	UCL_PDR
$[\text{CII}] 158\mu$	2.6E-4	1.24E-4	1.23E-4	3.17E-4	9.76E-5	1.94E-4	1.22E-4	1.11E-4
$[\text{OI}] 63\mu$	8.89E-4	2.70E-4	3.12E-4	8.17E-4	0.00128	6.14E-4	3.21E-4	3.89E-4
$[\text{OI}] 146\mu$	9.17E-5	1.56E-5	1.43E-5	7.98E-5	5.87E-5	1.78E-5	1.49E-5	2.53E-5
$[\text{CI}] 610\mu$	4.71E-7	1.42E-6	9.20E-7	1.33E-6	1.52E-6	6.85E-7	7.60E-7	1.56E-6
$[\text{CI}] 370\mu$	1.97E-6	5.89E-6	3.82E-6	5.53E-6	5.17E-6	2.86E-6	3.16E-6	6.43E-6

surface brightness - $n=10^3 \text{ cm}^{-3}$, $\chi = 10^1$, variable T

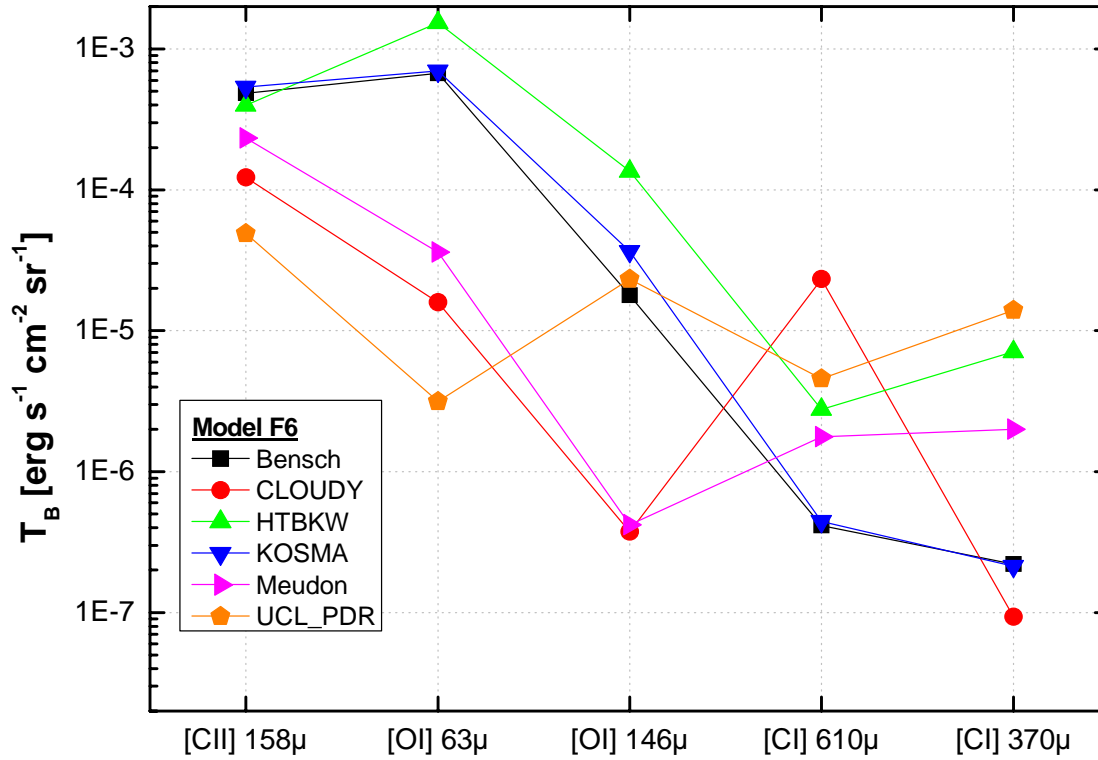


	Bensch	CLOUDY	HTBKW	KOSMA	Meudon	UCL_PDR
[CII] 158μ	1,84E-05	6,20E-06	4,33E-05	2,50E-05	1,11E-05	2,11E-05
[OI] 63μ	1,16E-06	2,11E-08	6,29E-06	1,59E-06	2,46E-07	1,42E-06
[OI] 146μ	2,17E-08	1,77E-10	2,66E-07	4,59E-08	1,82E-09	1,09E-05
[CI] 610μ	4,22E-07	2,64E-07	8,88E-07	5,19E-07	5,10E-07	4,10E-06
[CI] 370μ	2,03E-07	8,10E-05	1,03E-06	2,33E-07	1,65E-07	1,27E-05



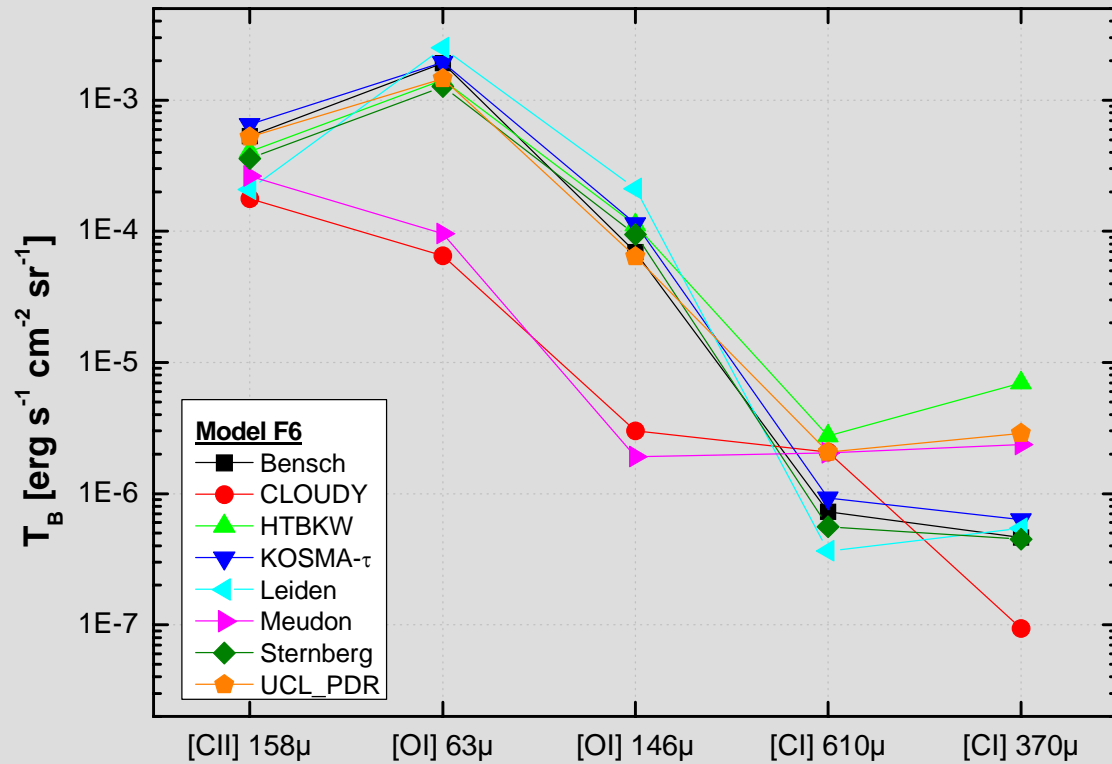
	Bensch	CLOUDY	HTBKW	KOSMA	Leiden	Meudon	Sternebrg	UCL_PDR
[CII] 158μ	2.47E-5	2.02E-5	3.86E-5	3.12E-5	1.97E-5	2.68E-5	2.70E-5	4.80E-5
[OI] 63μ	2.31E-6	1.03E-6	4.46E-6	2.44E-6	2.83E-6	3.90E-6	2.75E-6	1.98E-5
[OI] 146μ	5.19E-8	3.97E-8	2.17E-7	8.50E-8	1.56E-7	8.21E-8	1.31E-7	8.25E-7
[CI] 610μ	6.17E-7	6.38E-7	8.08E-7	6.75E-7	3.25E-7	6.70E-7	3.99E-7	8.64E-7
[CI] 370μ	2.81E-7	4.67E-7	9.06E-7	3.22E-7	2.43E-7	3.35E-7	2.32E-7	1.19E-6

surface brightness - $n=10^3 \text{ cm}^{-3}$, $\chi = 10^5$, variable T



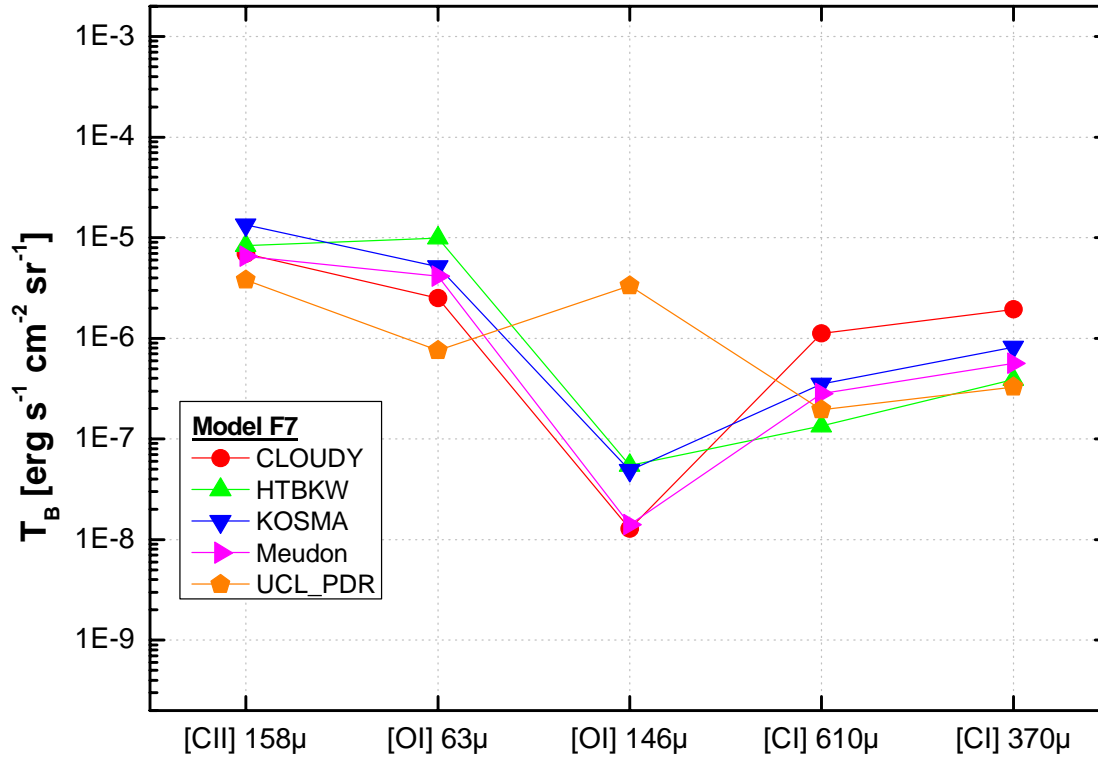
	Bensch	CLOUDY	HTBKW	KOSMA	Meudon	UCL_PDR
[CII] 158 μ	4,86E-04	1,22E-04	3,98E-04	5,39E-04	2,34E-04	4,89E-05
[OI] 63 μ	6,72E-04	1,59E-05	1,54E-03	6,98E-04	3,61E-05	3,15E-06
[OI] 146 μ	1,78E-05	3,74E-07	1,36E-04	3,67E-05	4,20E-07	2,32E-05
[CI] 610 μ	4,13E-07	2,32E-05	2,77E-06	4,42E-07	1,76E-06	4,57E-06
[CI] 370 μ	2,20E-07	9,34E-08	7,08E-06	2,13E-07	1,99E-06	1,40E-05

surface brightness - $n=10^3 \text{ cm}^{-3}$, $\chi = 10^5$, variable T



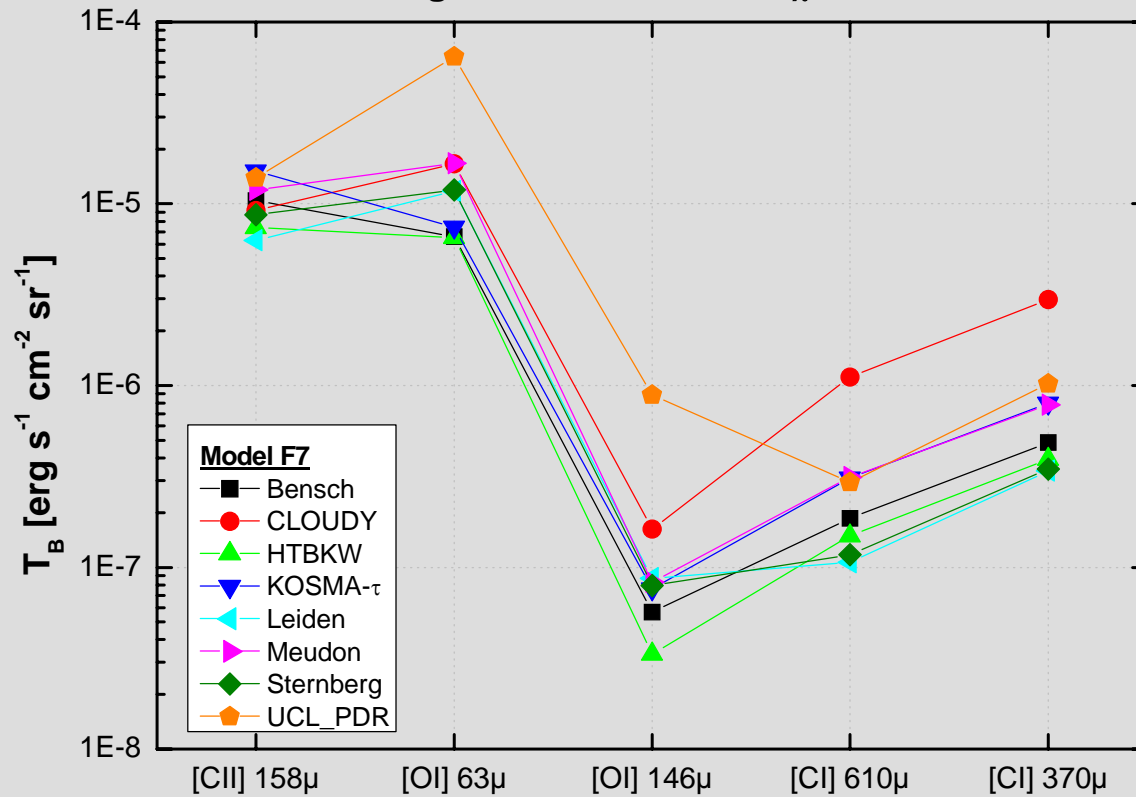
	Bensch	CLOUDY	HTBKW	KOSMA	Leiden	Meudon	Sternberg	UCL_PDR
[CII] 158 μ	5.33E-4	1.78E-4	4.05E-4	6.53E-4	2.09E-4	2.64E-4	3.59E-4	5.23E-4
[OI] 63 μ	0.00191	6.49E-5	0.00143	0.00195	0.00251	9.60E-5	0.00127	0.00146
[OI] 146 μ	6.94E-5	3.02E-6	1.12E-4	1.14E-4	2.11E-4	1.91E-6	9.48E-5	6.40E-5
[CI] 610 μ	7.26E-7	2.07E-6	2.75E-6	9.28E-7	3.66E-7	2.05E-6	5.60E-7	2.07E-6
[CI] 370 μ	4.62E-7	9.34E-8	7.00E-6	6.33E-7	5.43E-7	2.37E-6	4.47E-7	2.89E-6

surface brightness - $n=10^{5.5} \text{ cm}^{-3}$, $\chi = 10^1$, variable T

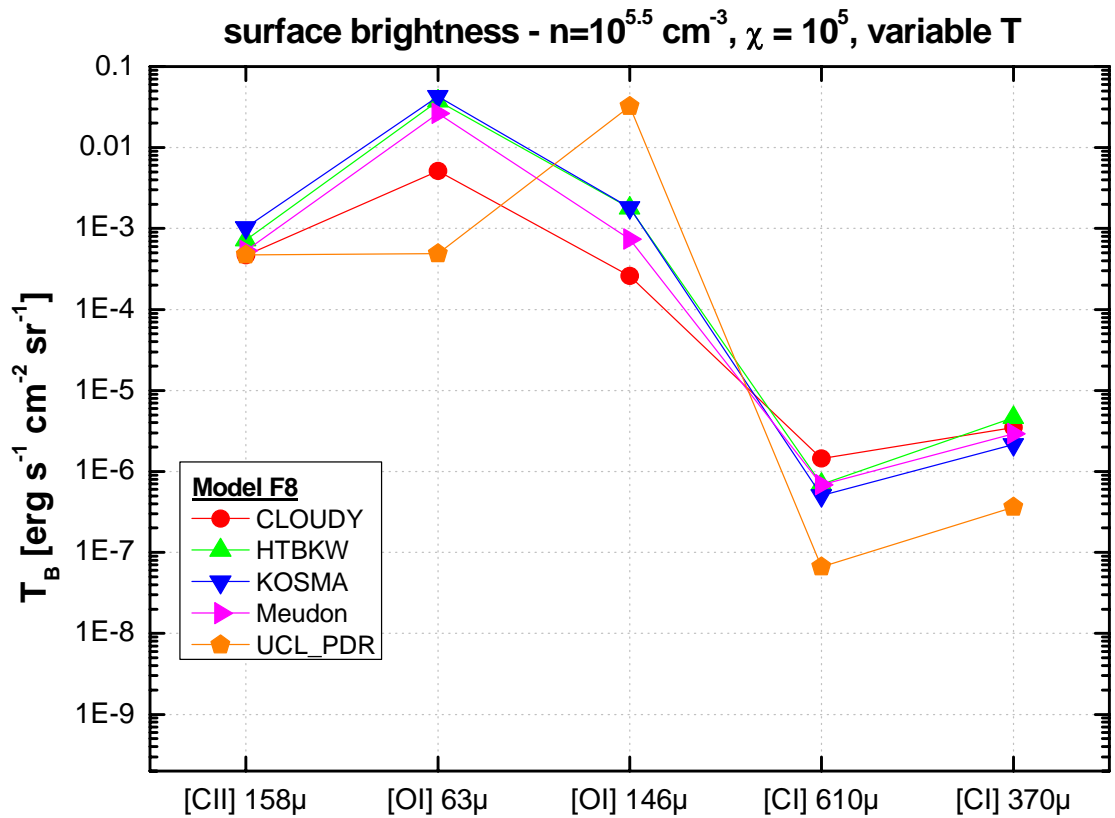


	CLOUDY	HTBKW	KOSMA	Meudon	UCL_PDR
[CII] 158μ	6,92E-06	8,32E-06	1,35E-05	6,51E-06	3,80E-06
[OI] 63μ	2,50E-06	9,92E-06	5,14E-06	4,13E-06	7,57E-07
[OI] 146μ	1,28E-08	5,44E-08	4,89E-08	1,41E-08	3,32E-06
[CI] 610μ	1,12E-06	1,35E-07	3,52E-07	2,83E-07	1,94E-07
[CI] 370μ	1,93E-06	3,90E-07	8,19E-07	5,67E-07	3,29E-07

surface brightness - $n=10^{5.5} \text{ cm}^{-3}$, $\chi = 10^1$, variable T

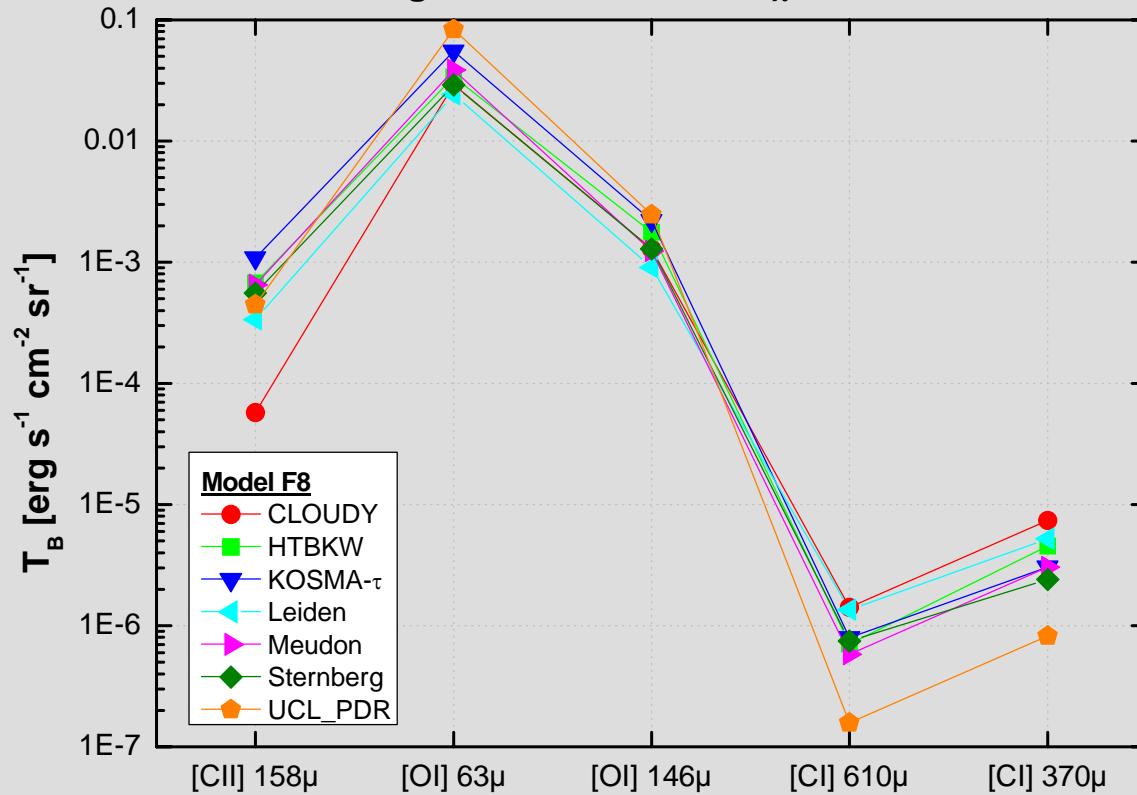


	Bensch	CLOUDY	HTBKW	KOSMA- τ	Leiden	Meudon	Sternberg	UCL_PDR
[CII] 158 μ	1.04E-5	9.21E-6	7.39E-6	1.51E-5	6.28E-6	1.19E-5	8.73E-6	1.39E-5
[OI] 63 μ	6.59E-6	1.66E-5	6.53E-6	7.45E-6	1.18E-5	1.67E-5	1.19E-5	6.44E-5
[OI] 146 μ	5.67E-8	1.62E-7	3.34E-8	7.62E-8	8.7E-8	8.27E-8	7.96E-8	8.88E-7
[CI] 610 μ	1.86E-7	1.12E-6	1.49E-7	3.11E-7	1.06E-7	3.13E-7	1.17E-7	2.94E-7
[CI] 370 μ	4.86E-7	2.98E-6	3.94E-7	9.00E-7	3.40E-7	7.82E-7	3.465E-7	1.02E-6



	CLOUDY	HTBKW	KOSMA	Meudon	UCL_PDR
[CII] 158μ	4,65E-04	7,18E-04	1,03E-03	5,32E-04	4,72E-04
[OI] 63μ	5,10E-03	3,76E-02	4,28E-02	2,65E-02	4,91E-04
[OI] 146μ	2,58E-04	1,80E-03	1,80E-03	7,36E-04	3,22E-02
[CI] 610μ	1,45E-06	6,96E-07	5,03E-07	6,85E-07	6,62E-08
[CI] 370μ	3,49E-06	4,65E-06	2,15E-06	2,94E-06	3,64E-07

surface brightness - $n=10^{5.5} \text{ cm}^{-3}$, $\chi = 10^5$, variable T

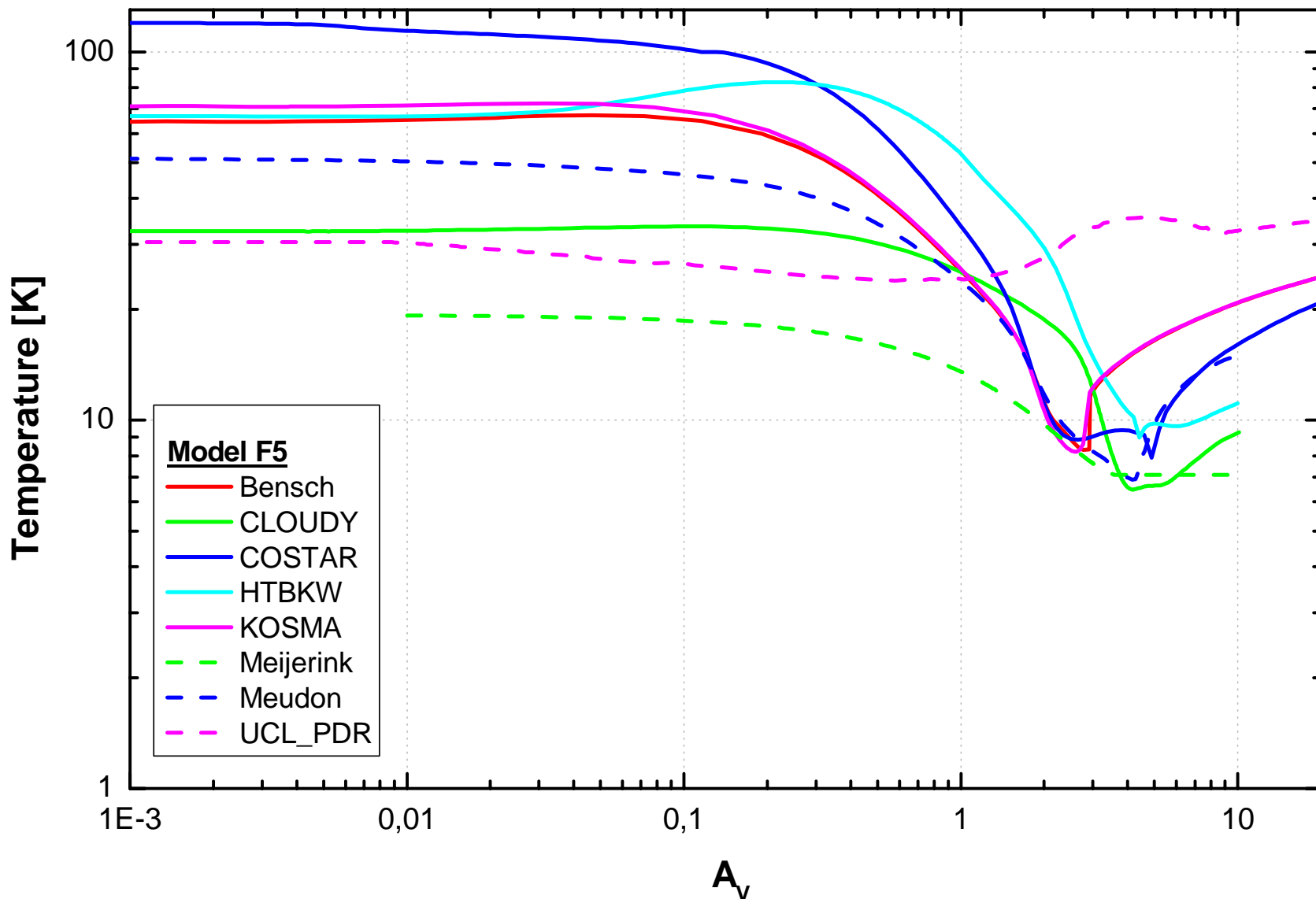


	Bensch	CLOUDY	HTBKW	KOSMA- τ	Leiden	Meudon	Sternberg	UCL_PDR
[CII] 158 μ		5.74E-5	6.79E-4	0.00108	3.37E-4	6.50E-4	5.57E-4	4.45E-4
[OI] 63 μ		0.02923	0.03377	0.05526	0.02422	0.03845	0.02895	0.08385
[OI] 146 μ		0.00128	0.00177	0.0022	9.07E-4	0.00123	0.00129	0.00246
[CI] 610 μ		1.42E-6	7.07E-7	7.97E-7	1.35E-6	5.79E-7	7.46E-7	1.58E-7
[CI] 370 μ		7.41E-6	4.55E-6	3.05E-6	5.24E-6	3.06E-6	2.41E-6	8.21E-7

Model Results F5-F8

- temperature

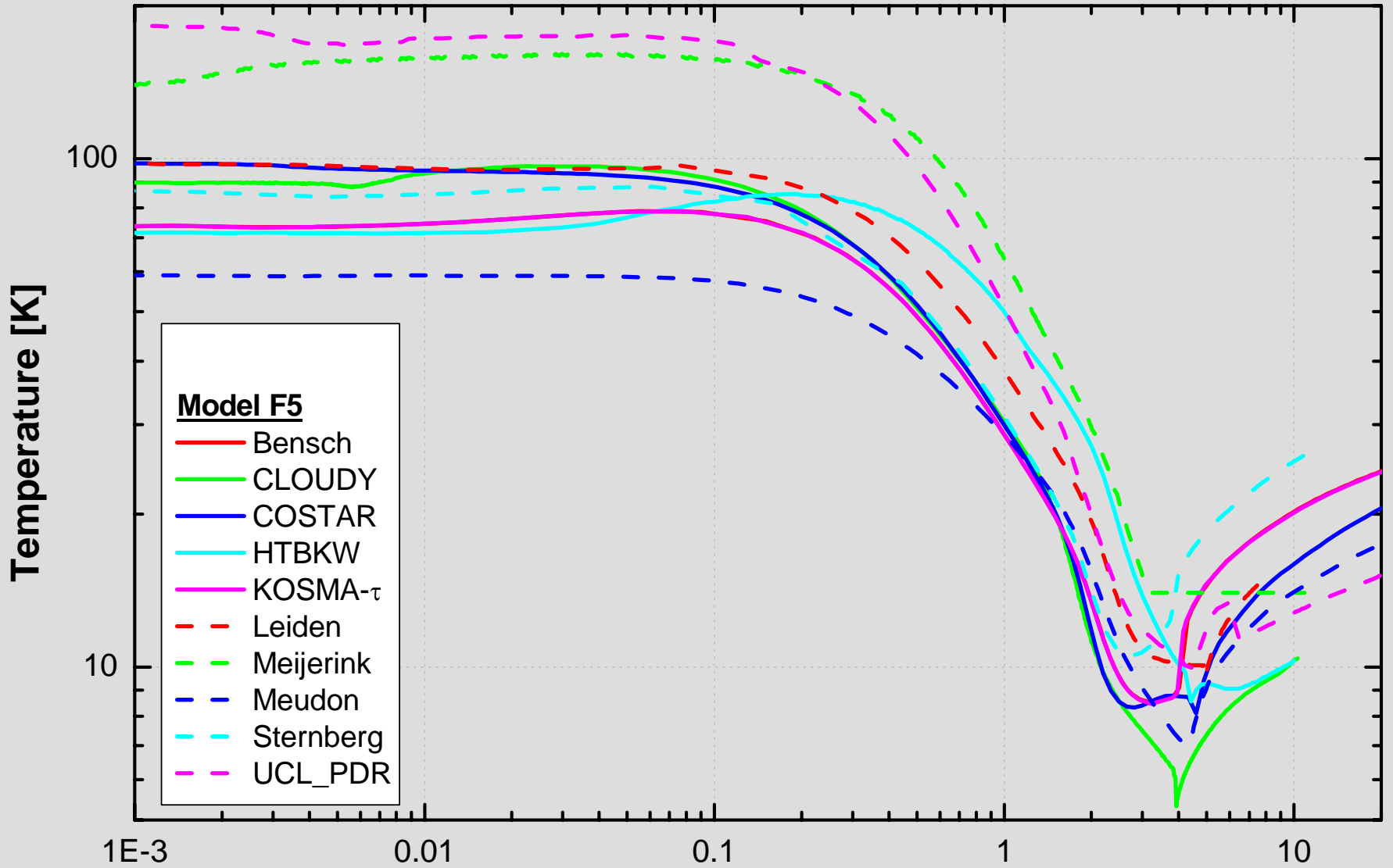
$T_{\text{gas}} - n=10^3 \text{ cm}^{-3}, \chi = 10$



5.-8. April, 2004

A_V
PDR Model Comparison

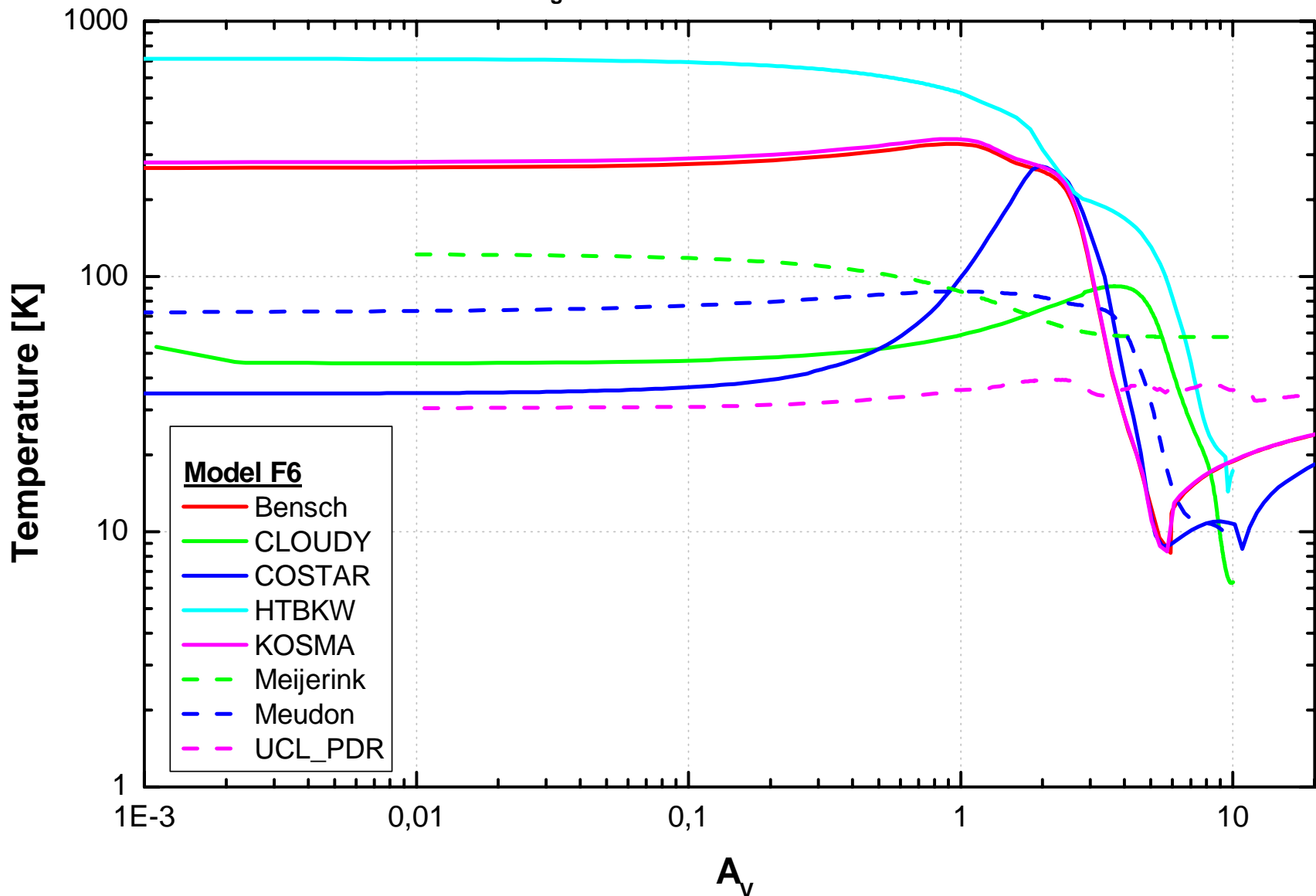
$T_{\text{gas}} - n=10^3 \text{ cm}^{-3}, \chi = 1, \text{ variable } T$



5.-8. April, 2004

A_v
PDR Model Comparison

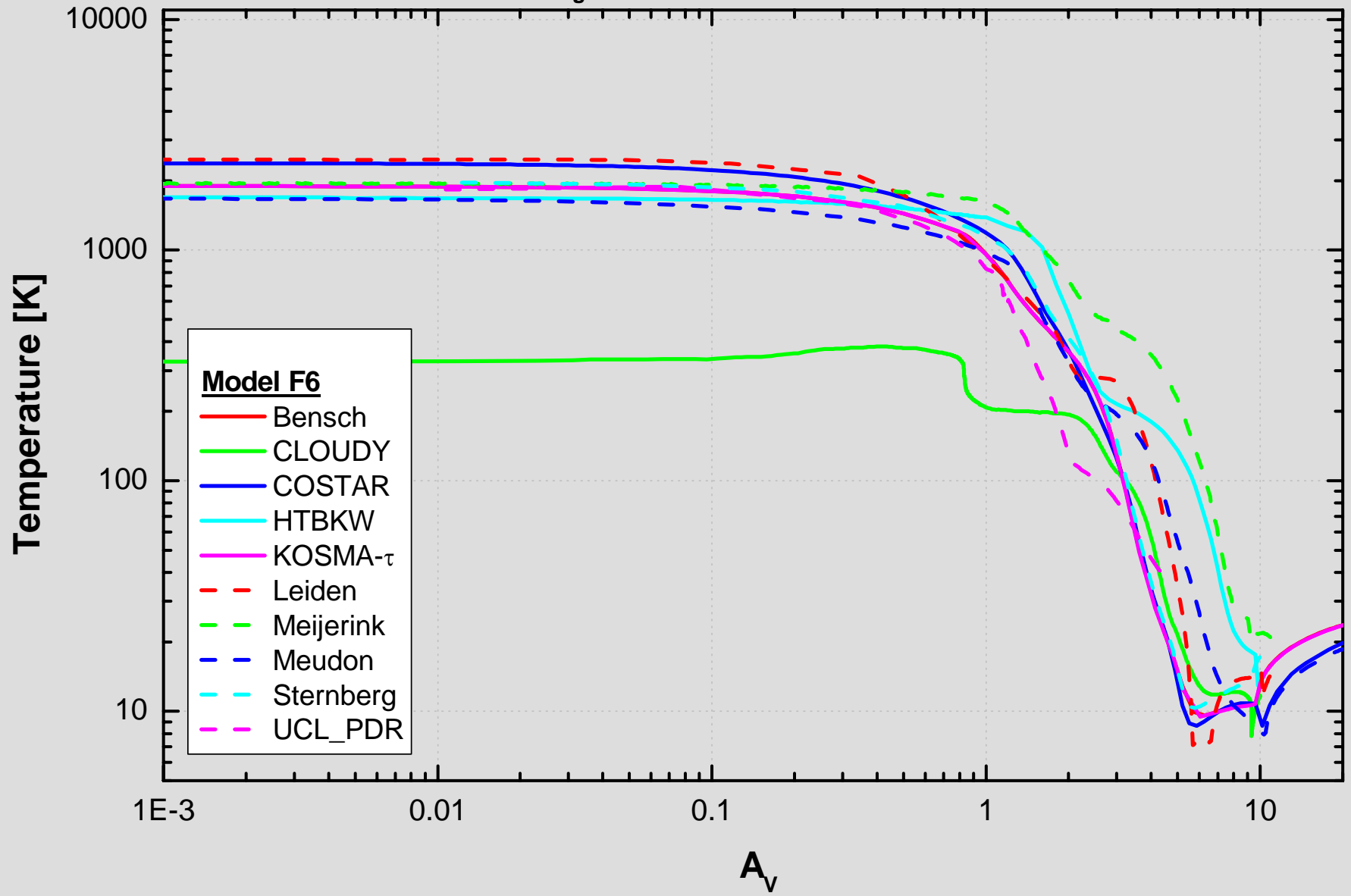
$$T_{\text{gas}} - n=10^3 \text{ cm}^{-3}, \chi = 10^5$$



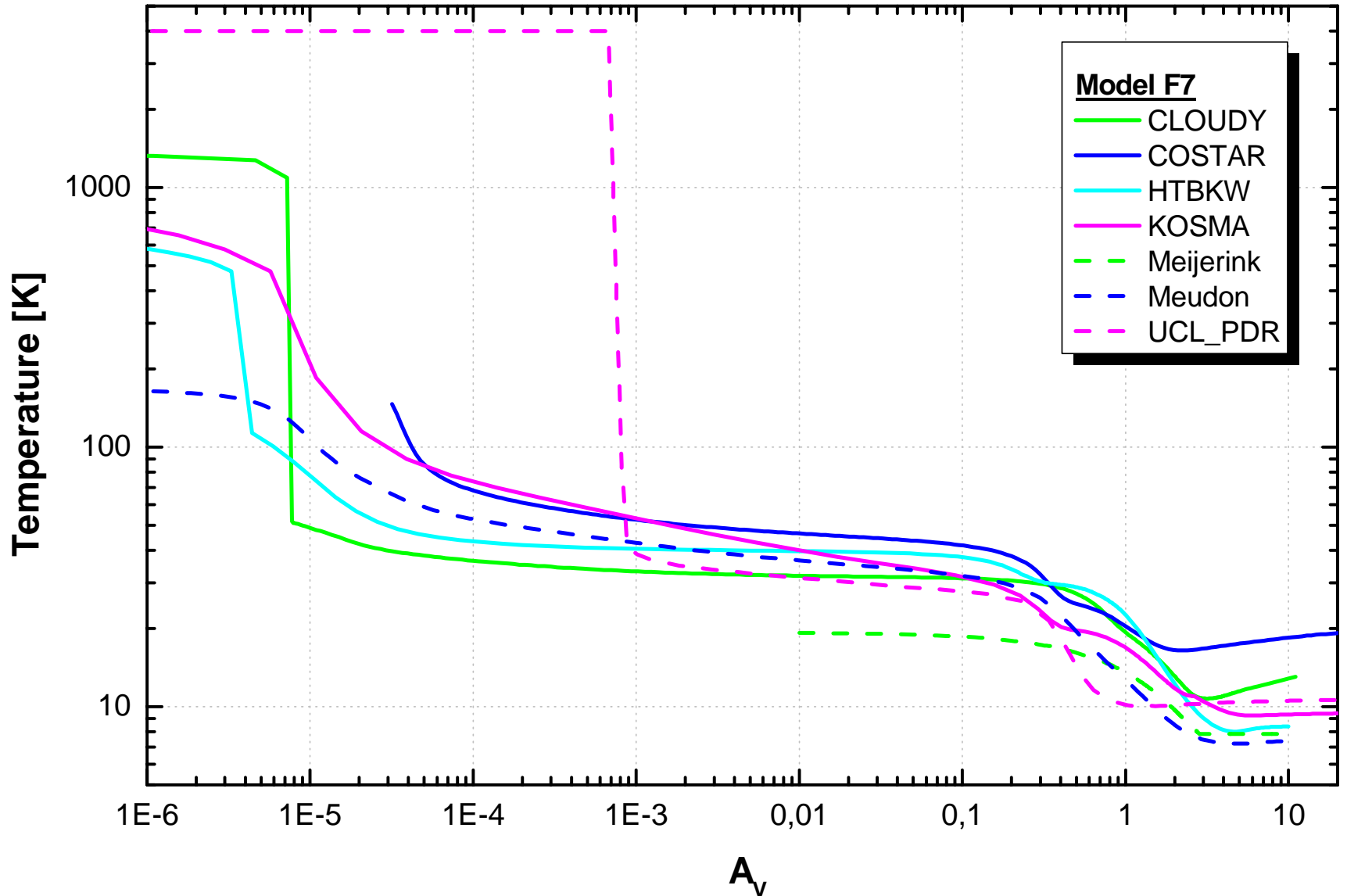
5.-8. April, 2004

PDR Model Comparison

$T_{\text{gas}} - n=10^3 \text{ cm}^{-3}, \chi = 10^5$



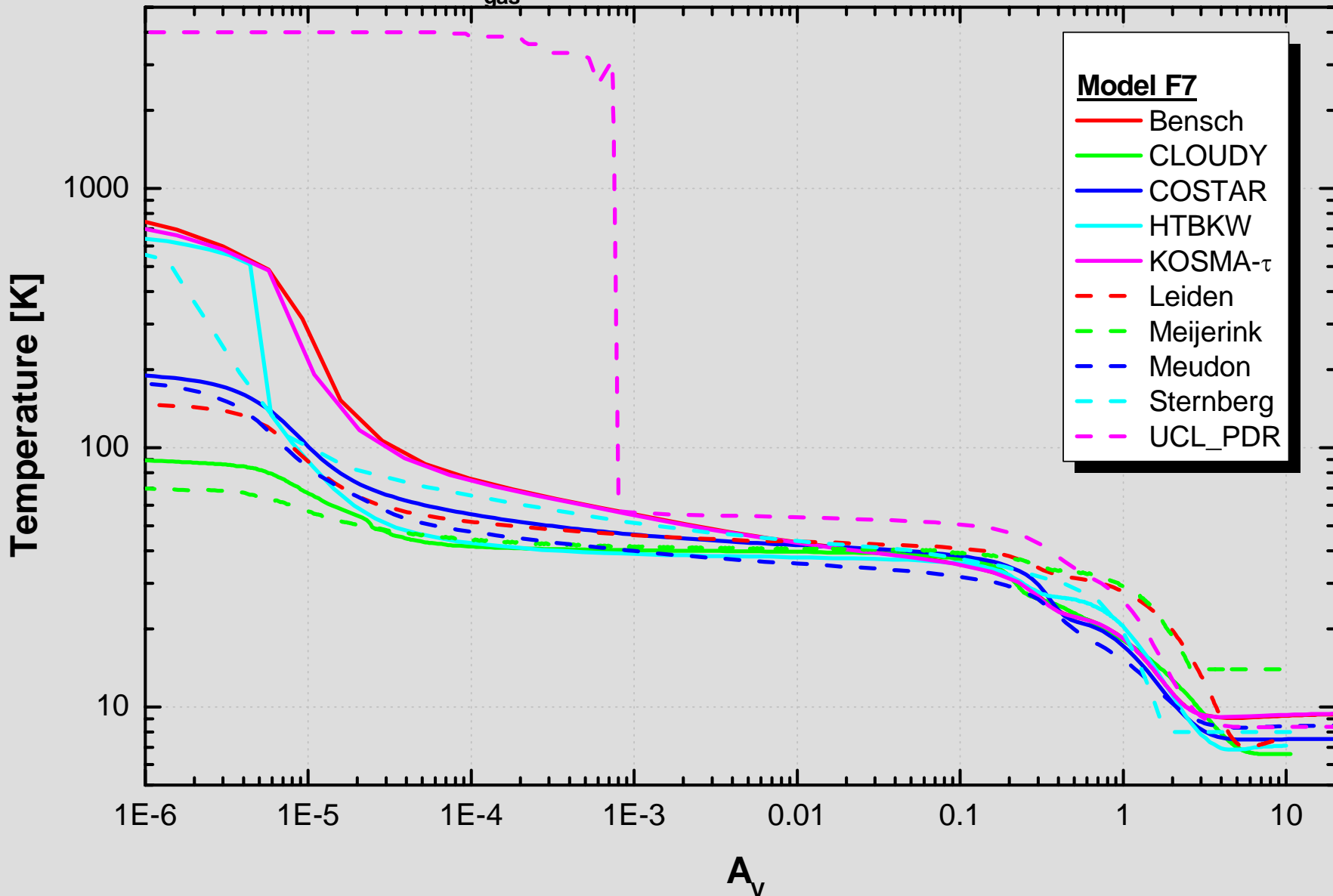
$$T_{\text{gas}} - n=10^{5.5} \text{ cm}^{-3}, \chi=10^1$$



5.-8. April, 2004

PDR Model Comparison

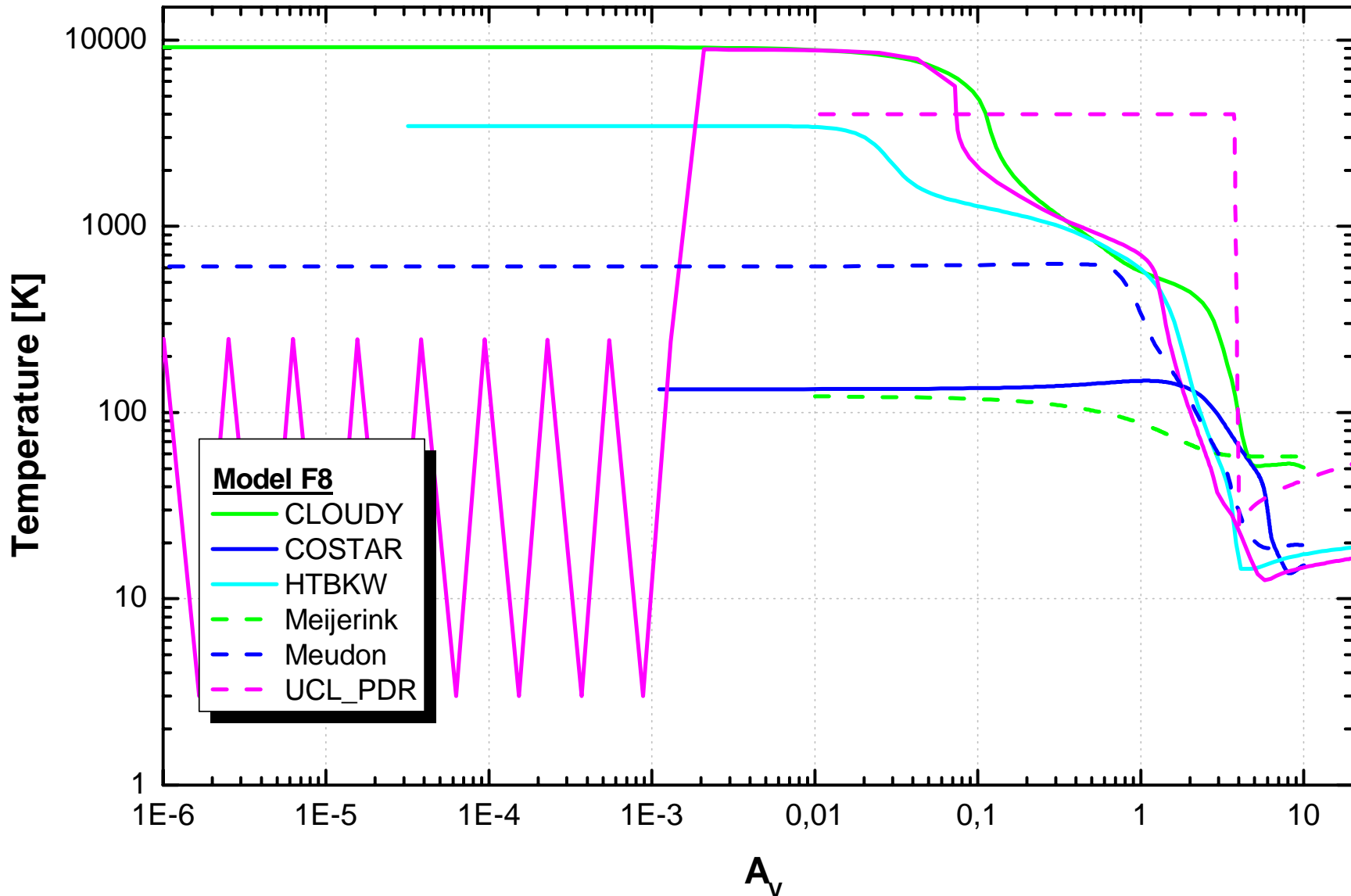
$T_{\text{gas}} - n=10^{5.5} \text{ cm}^{-3}, \chi=10^1, \text{ variable } T$



5.-8. April, 2004

PDR Model Comparison

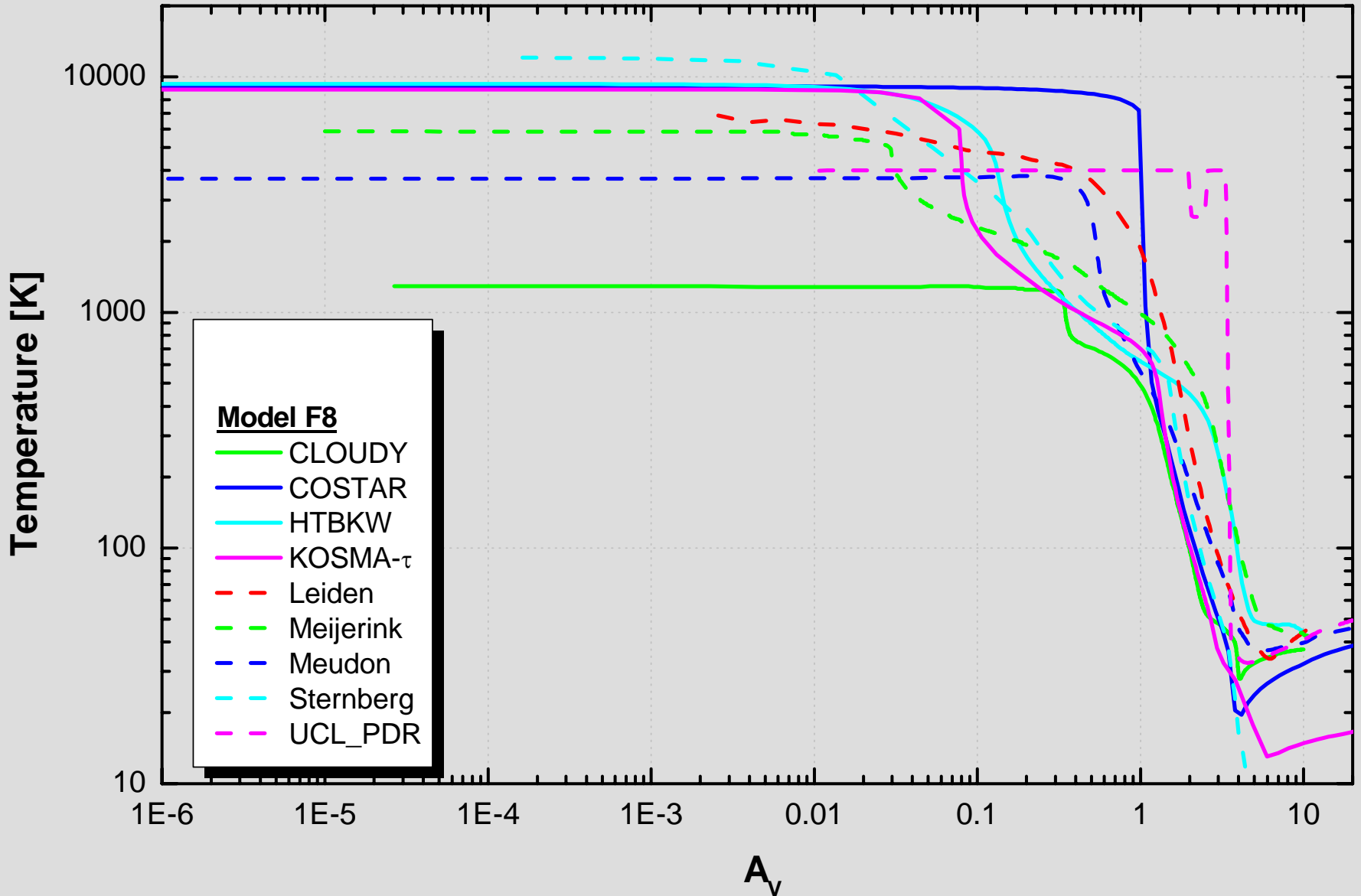
$$T_{\text{gas}} - n=10^{5.5} \text{ cm}^{-3}, \chi=10^5$$



5.-8. April, 2004

PDR Model Comparison

$$T_{\text{gas}} - n=10^{5.5} \text{ cm}^{-3}, \chi=10^5$$



5.-8. April, 2004

PDR Model Comparison