The Lorenz energy cycle in simulated rotating annulus flows

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Supplementary Material

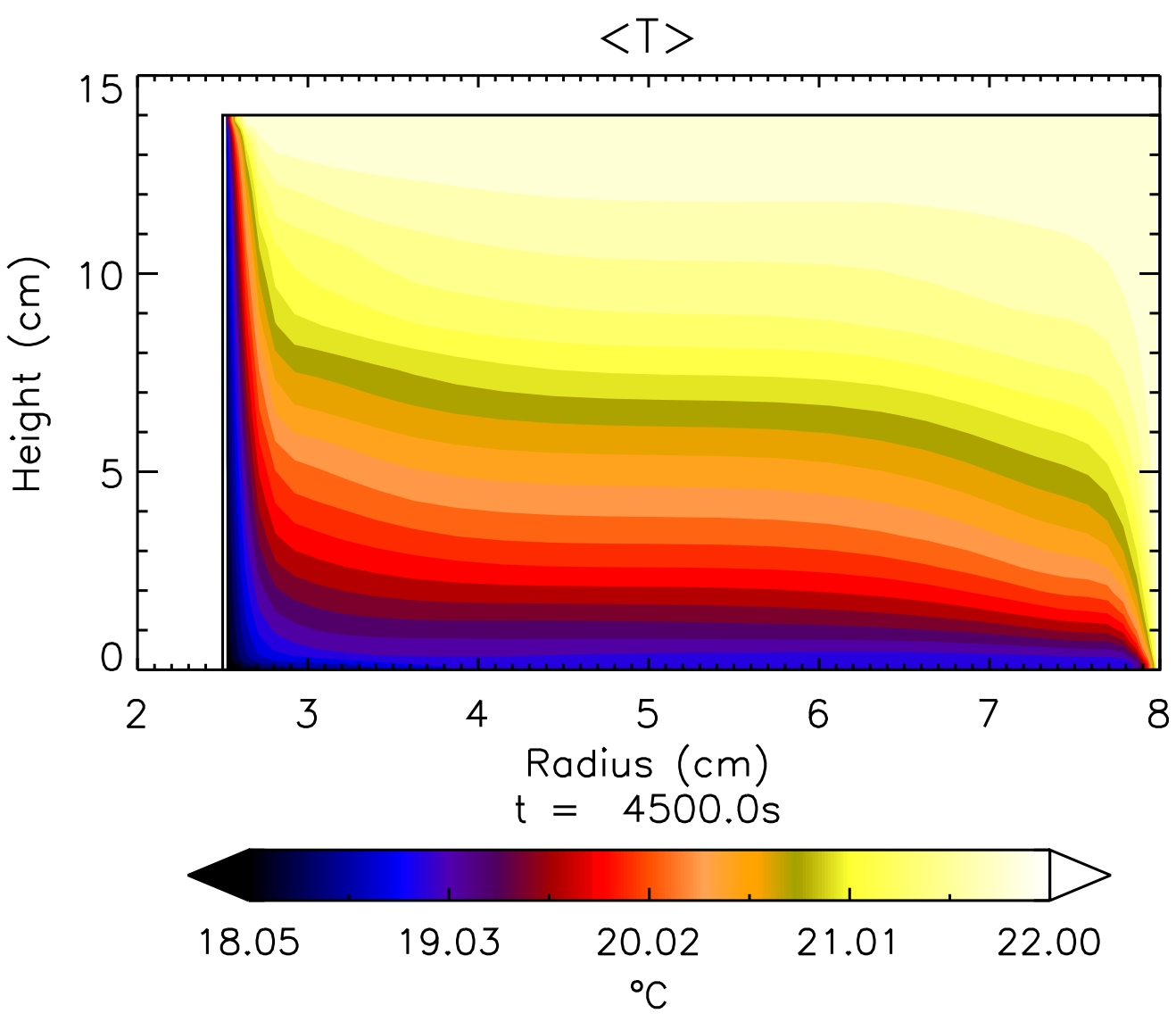
3S run at 4500s

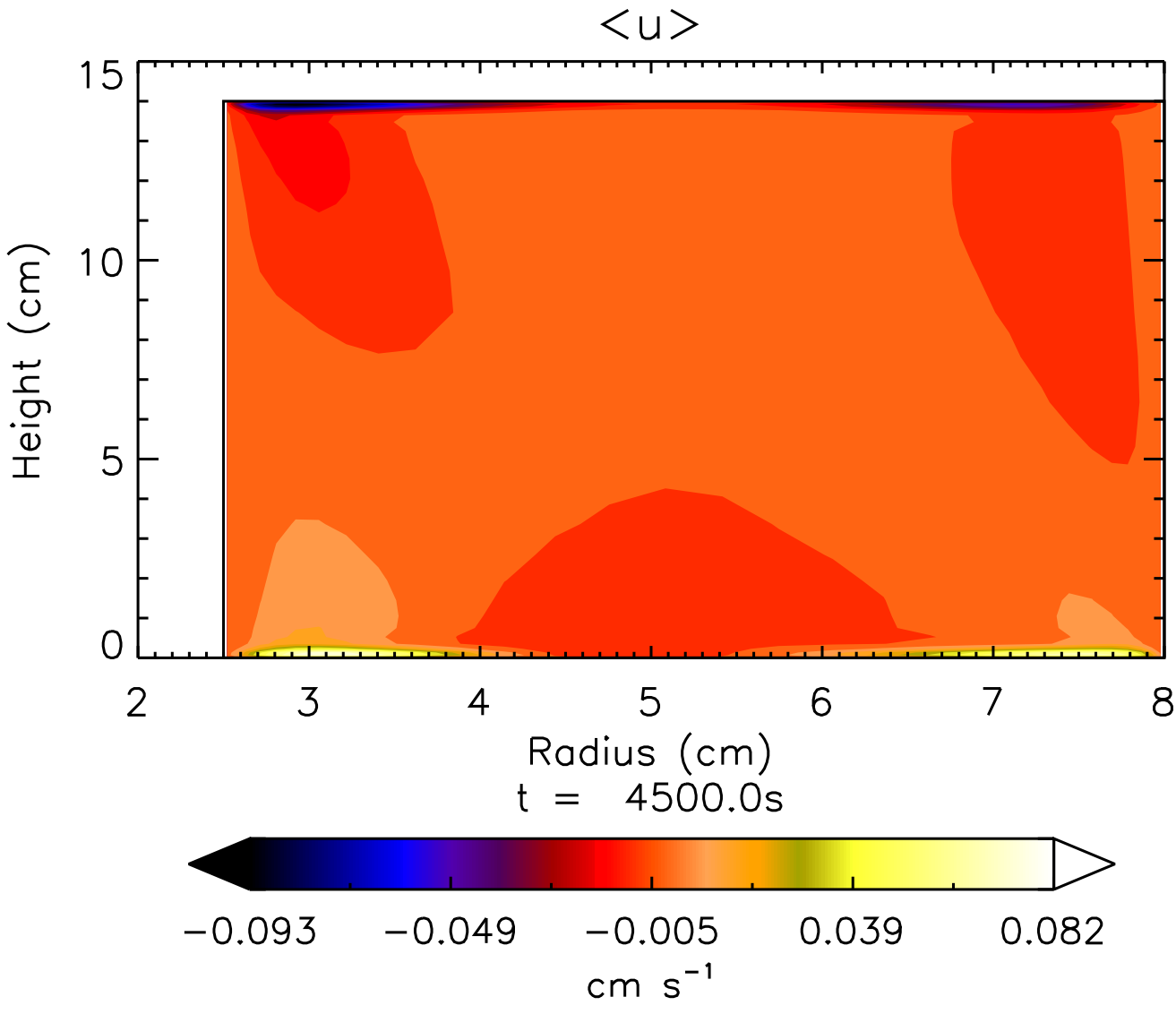
This file contains additional contour plots in the (R, z) plane, line plots showing horizontal means as a function of z, and time series.

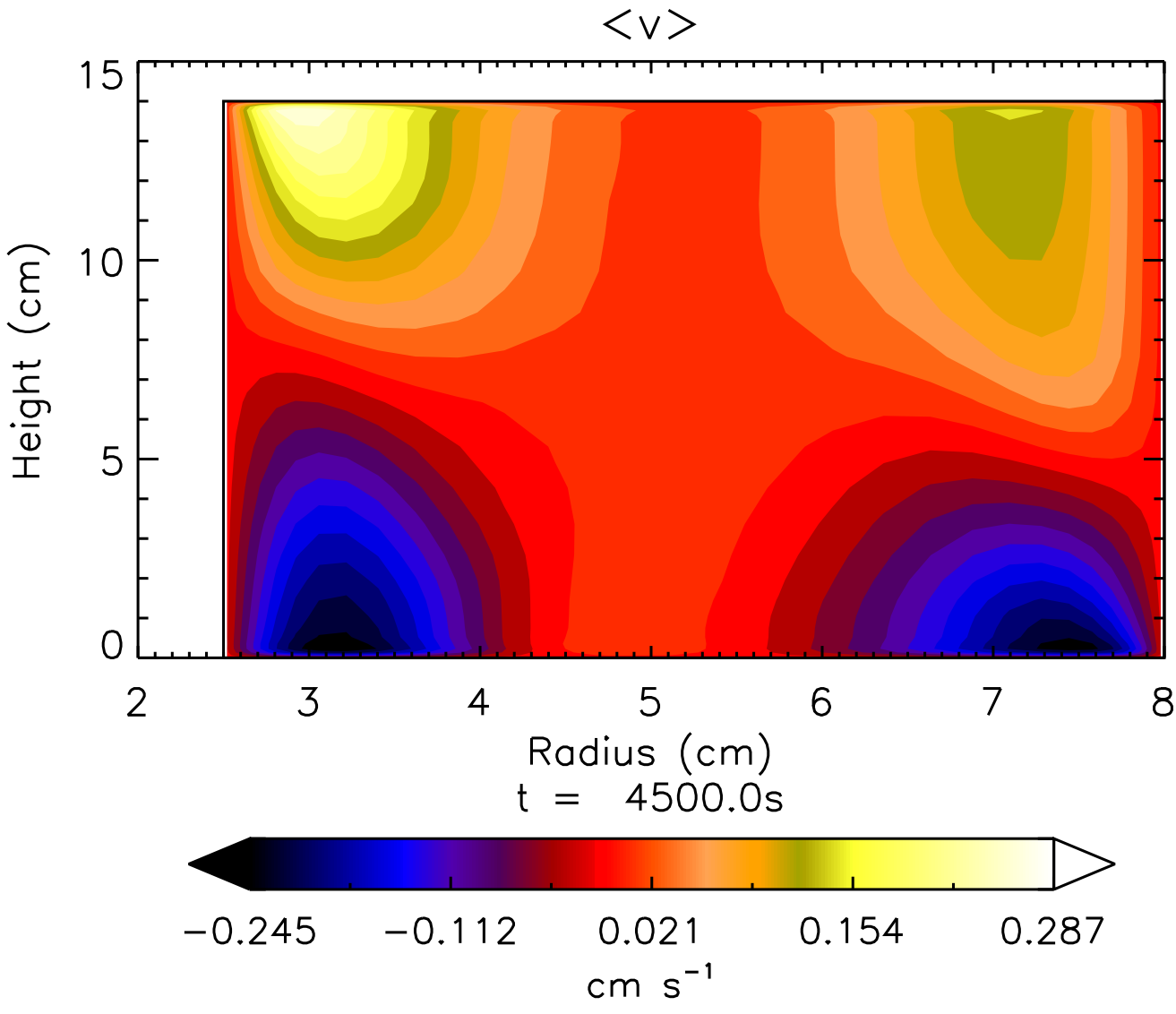
Because of limitations in the plotting language, the notation for means is different in this document compared with the main paper:

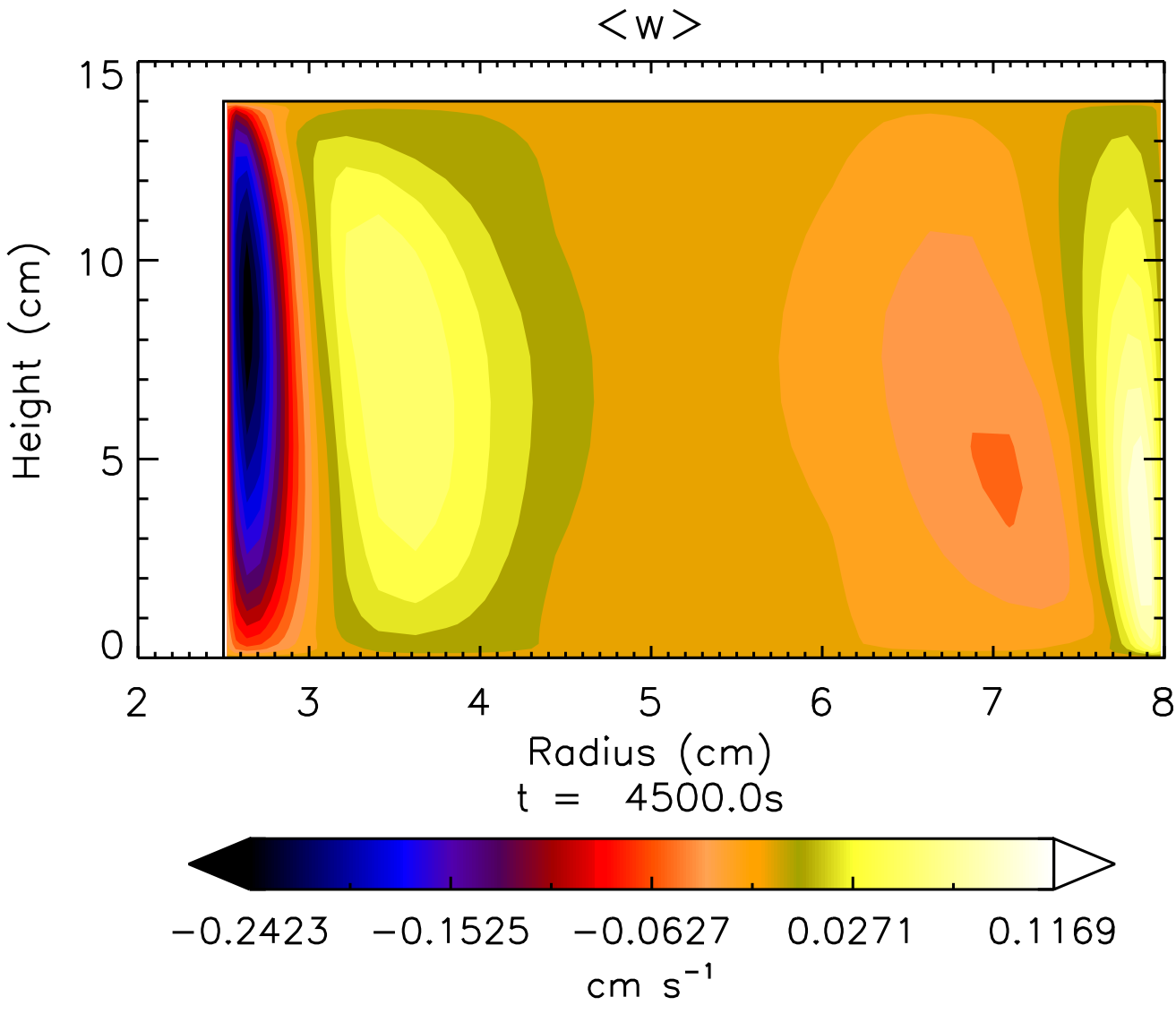
- A zonal or azimuthal mean is displayed as $\langle x \rangle$ ($\overline{x}$ in the main paper).
- A horizontal mean is displayed as $|x|$ ($\tilde{x}$ in the main paper).

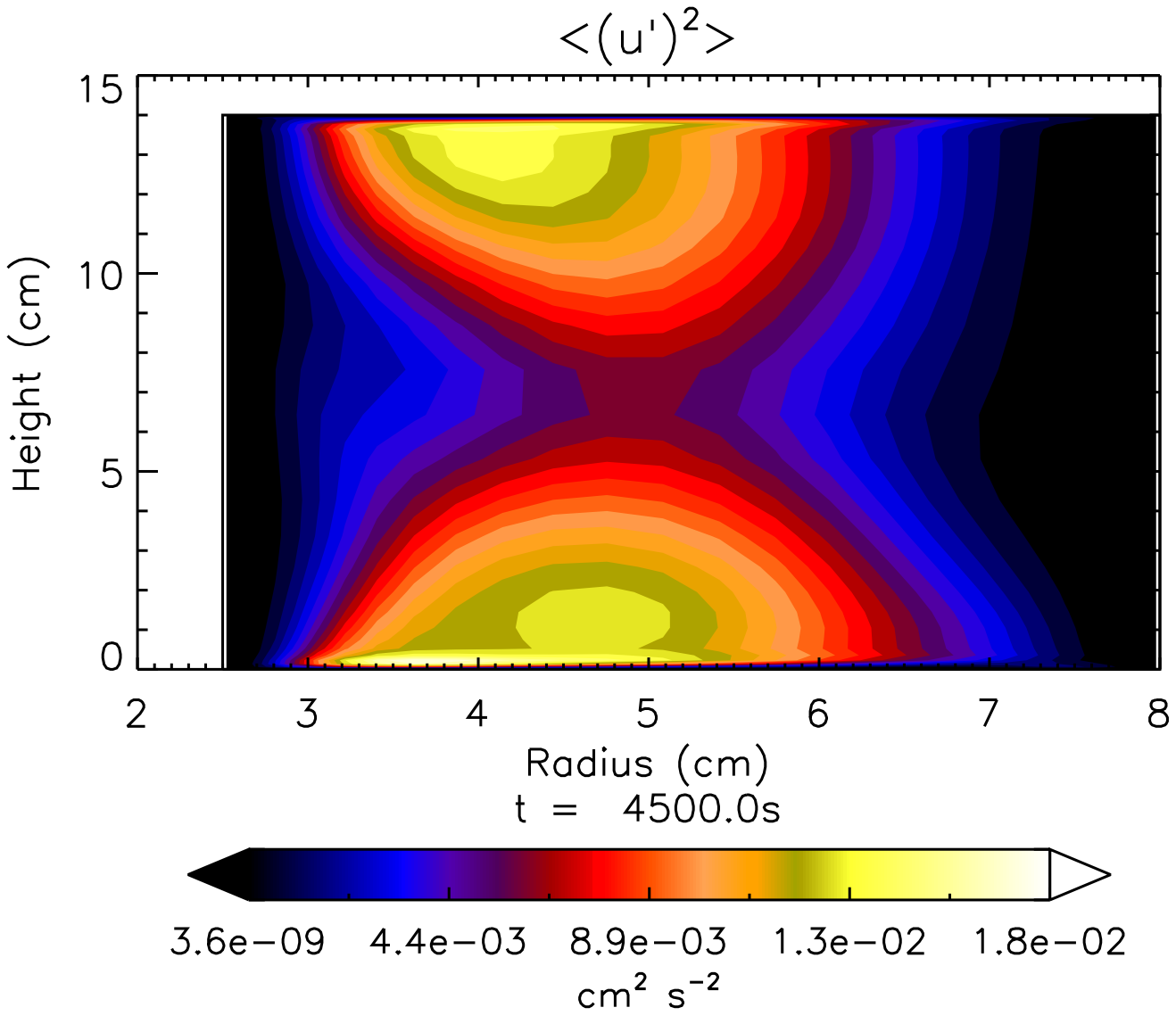
Eddy fields use the same notation as the main paper.

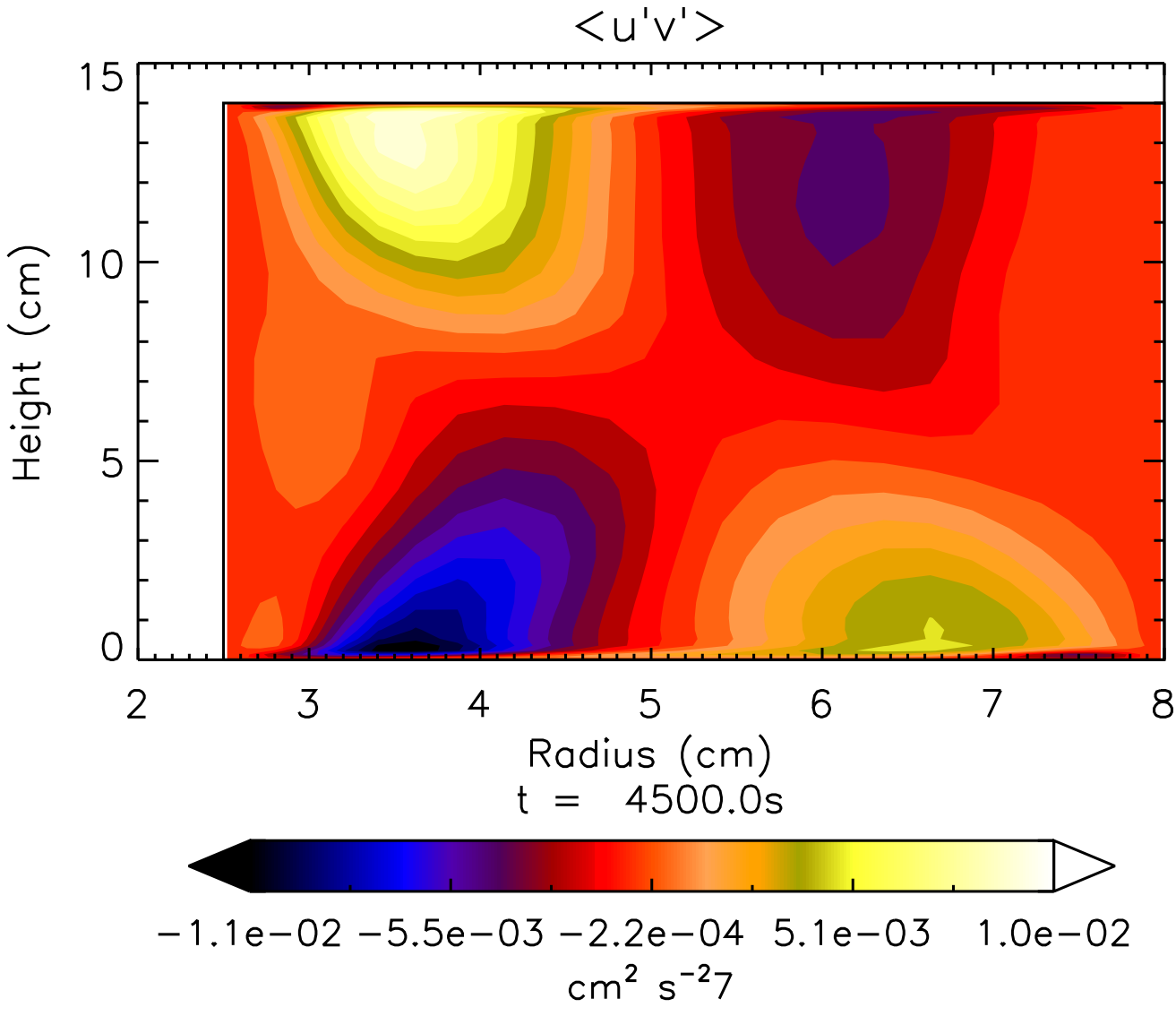

<T>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
18.05
19.03
20.02
21.01
22.00
°C

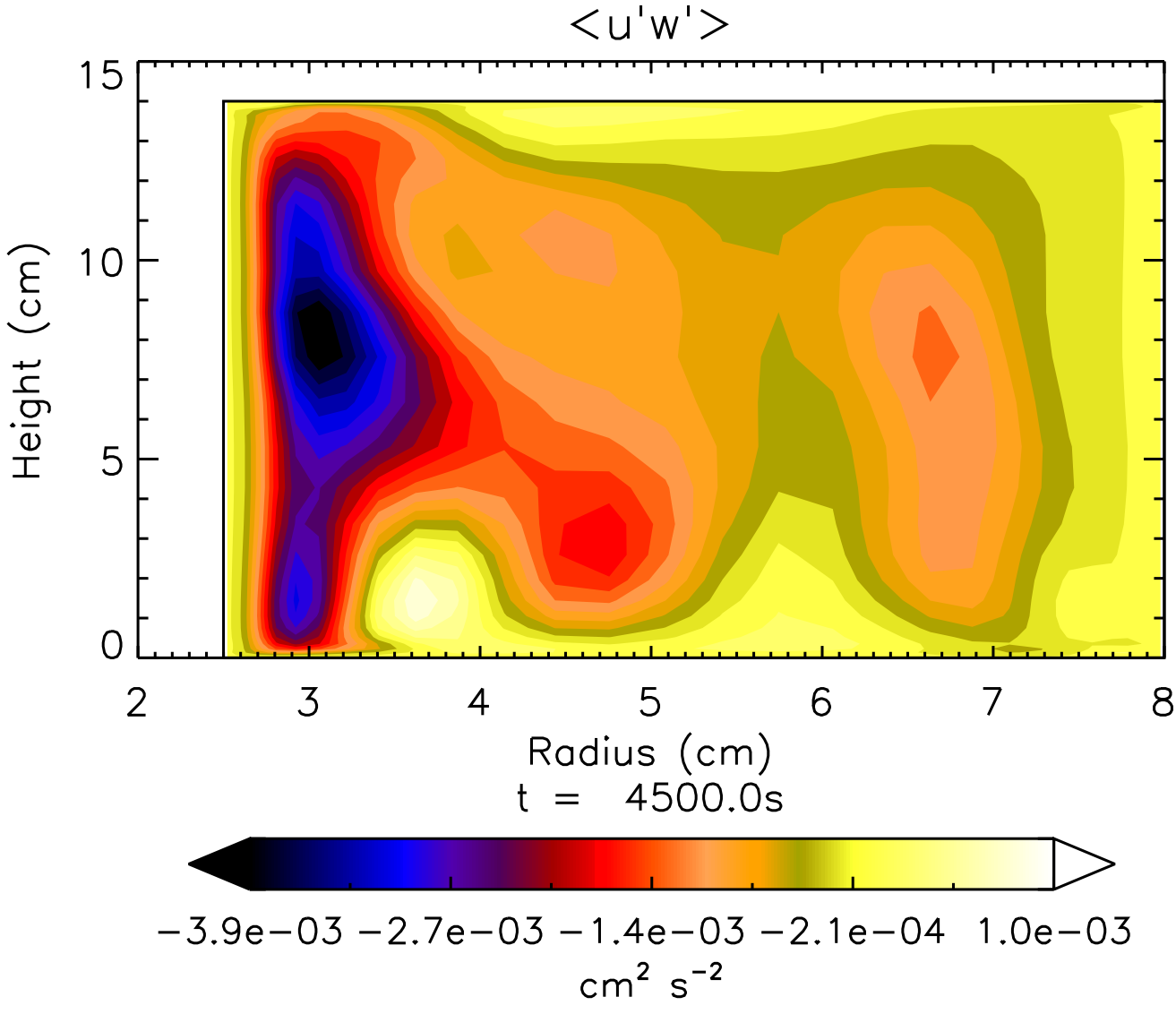

<u>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−0.093
−0.049
−0.005
0.039
0.082
cm s^{-1}

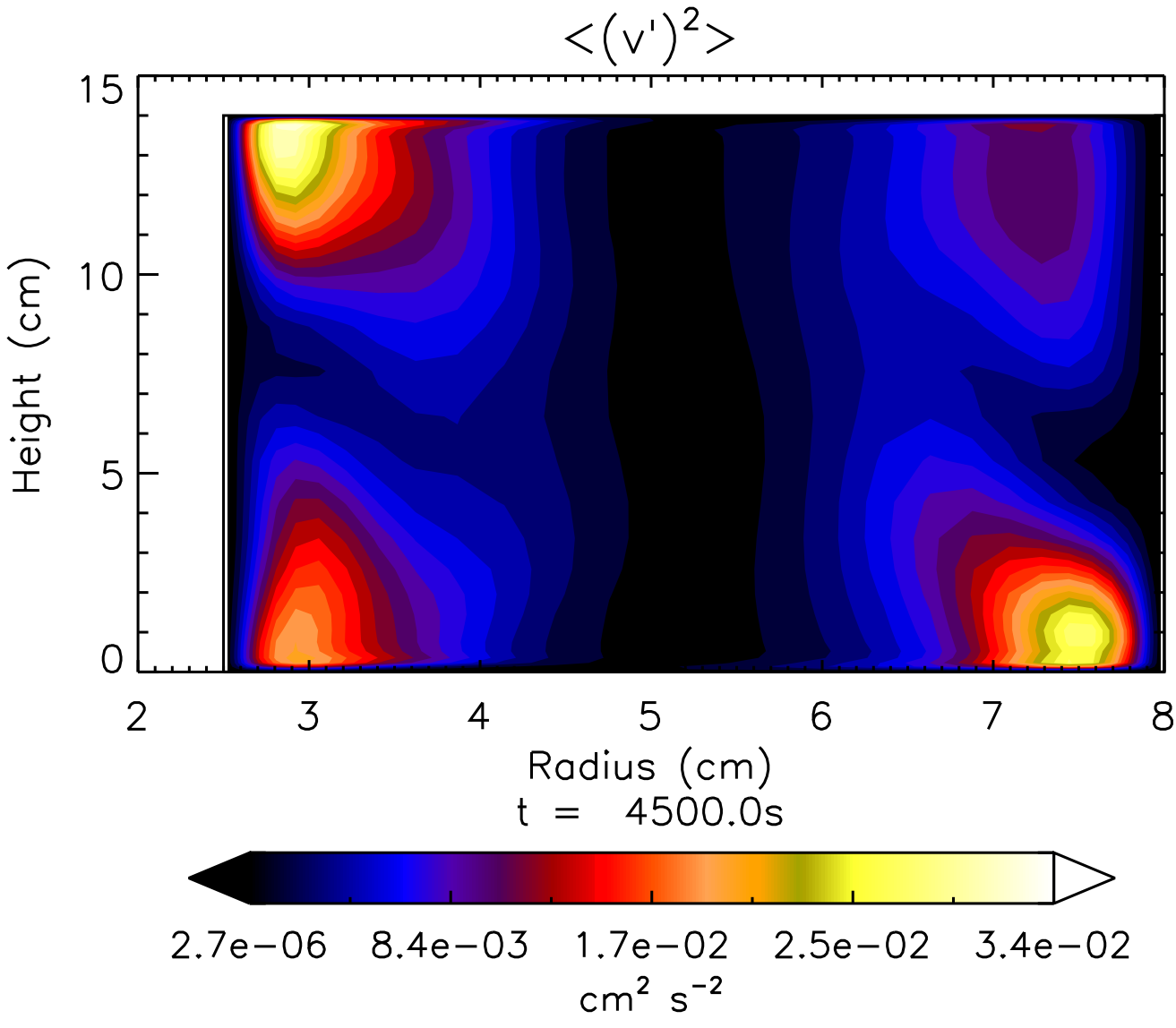

<v>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−0.245
−0.112
0.021
0.154
0.287
cm s⁻¹

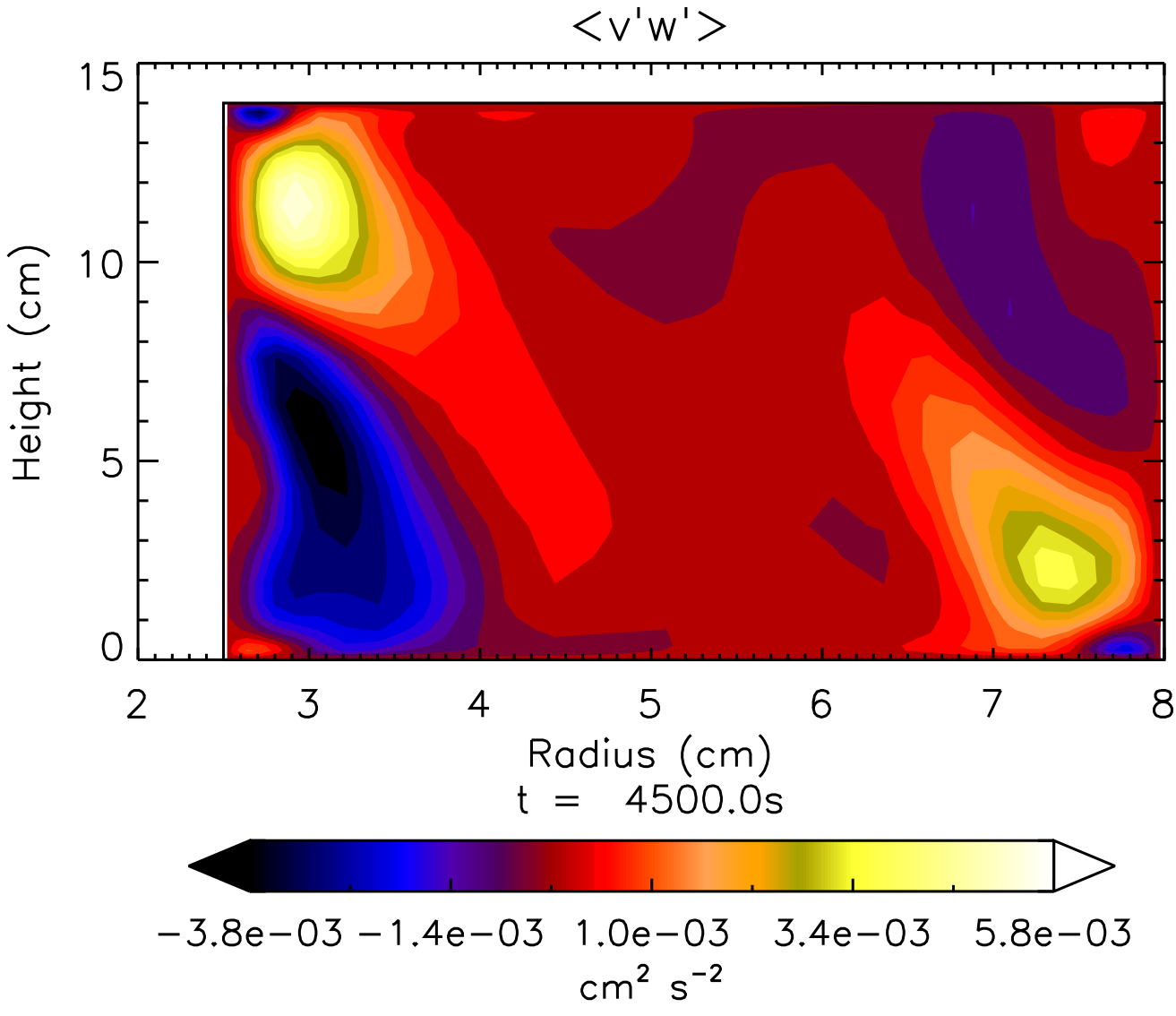

<w>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−0.2423
−0.1525
−0.0627
0.0271
0.1169
cm s⁻¹

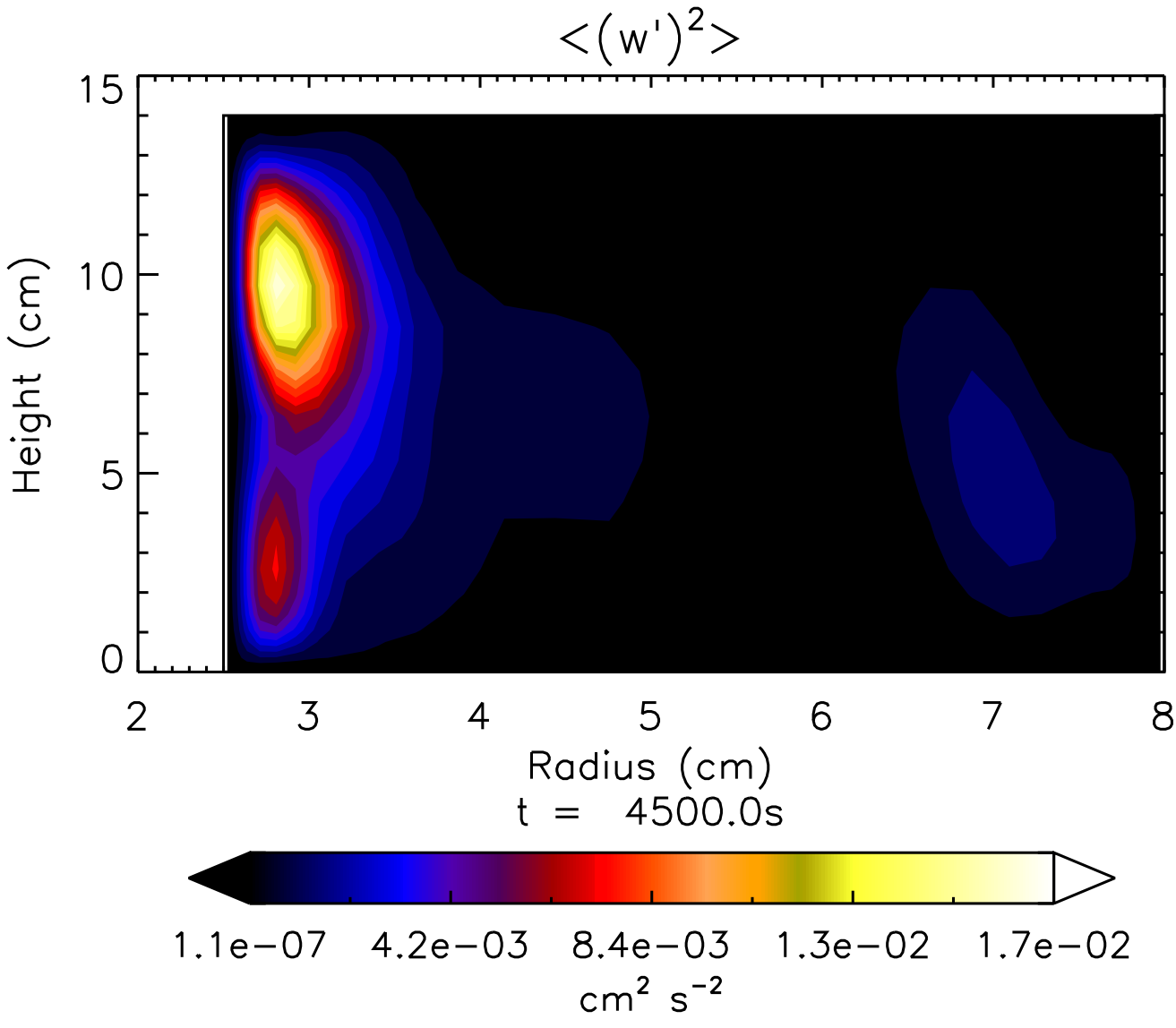

<(u')^2>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
3.6e−09
4.4e−03
8.9e−03
1.3e−02
1.8e−02
cm² s⁻²

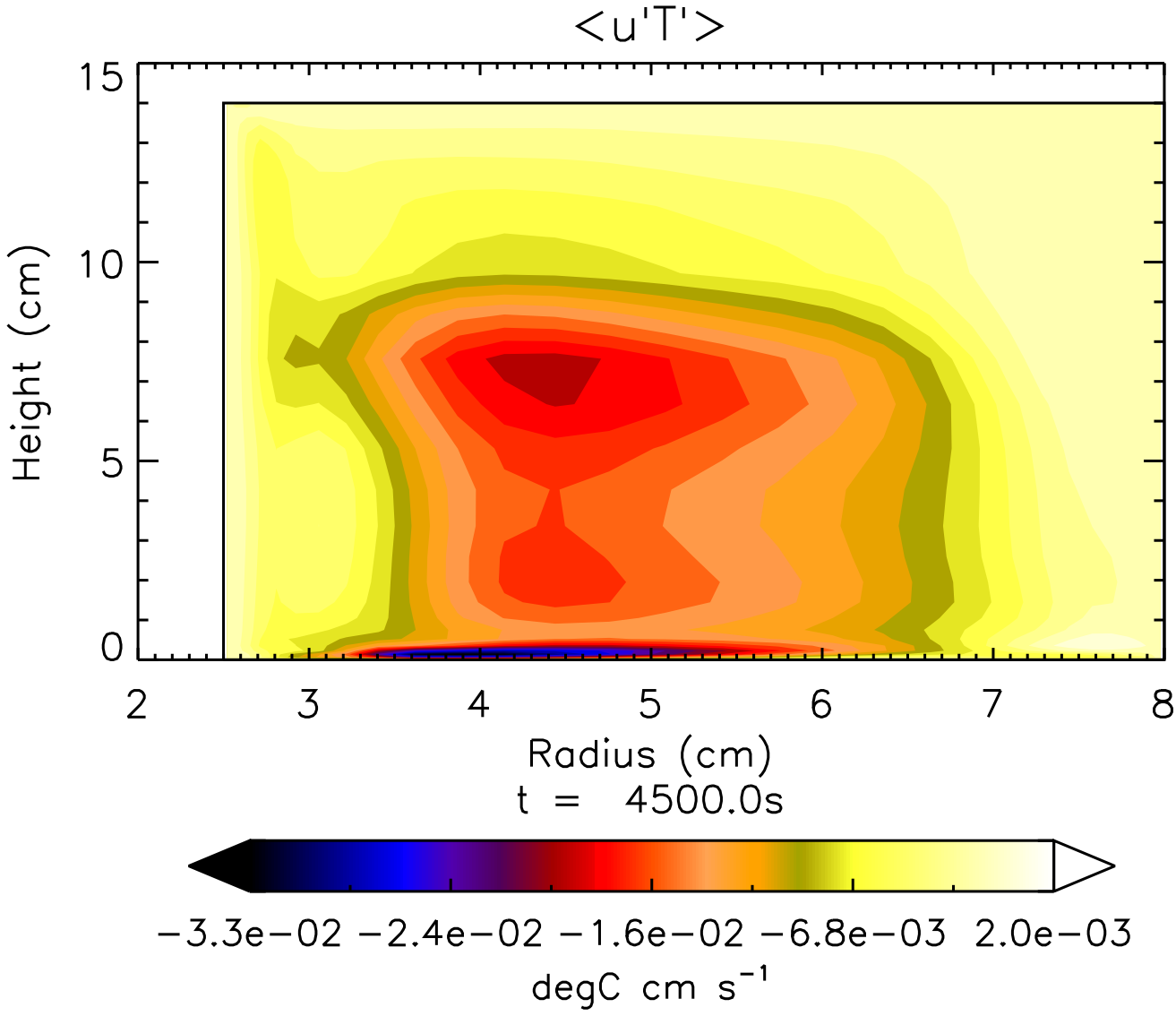

<u'v'>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−1.1e−02 −5.5e−03 −2.2e−04 5.1e−03 1.0e−02
cm² s⁻²7

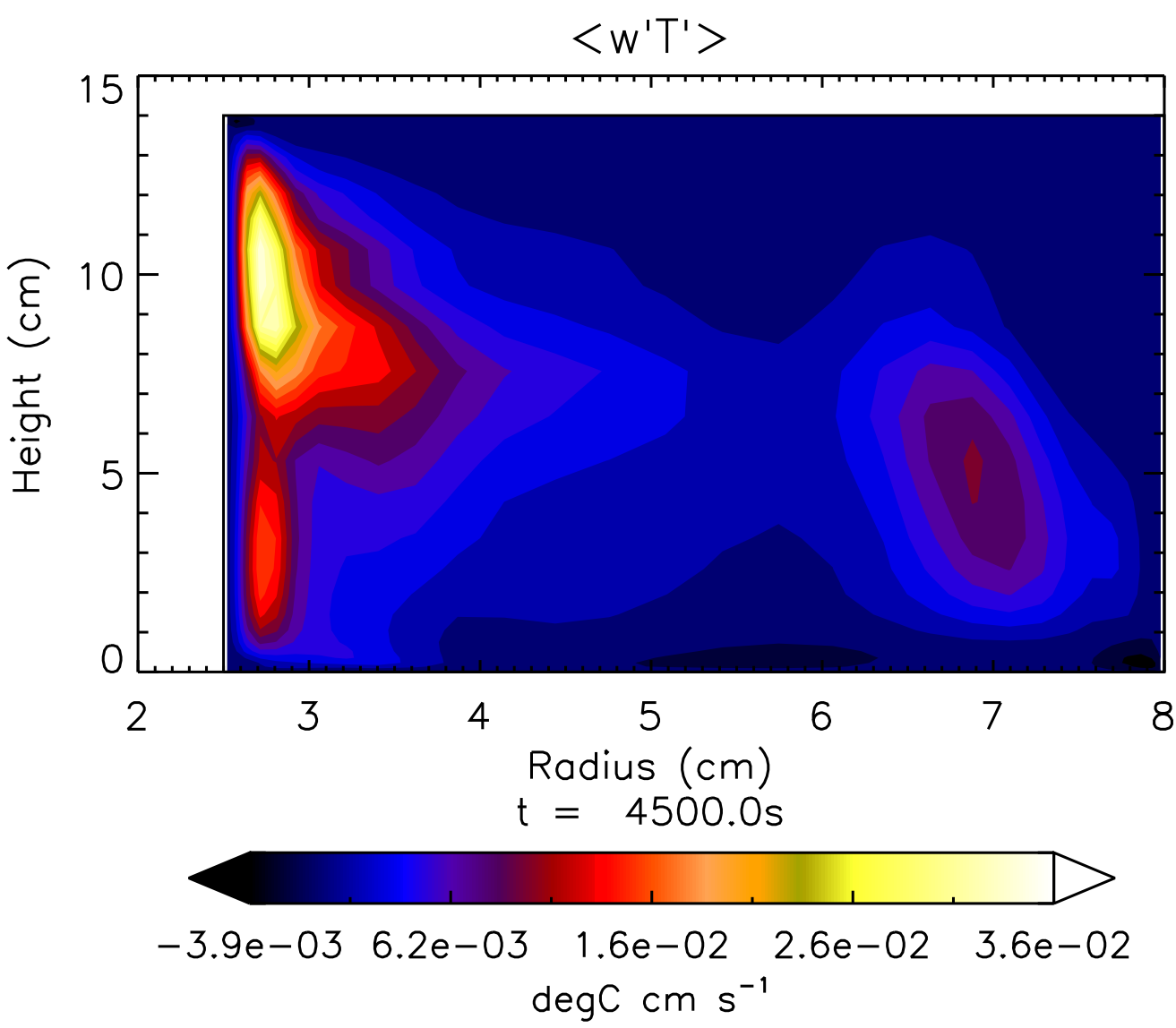

<u'w'>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−3.9e−03 −2.7e−03 −1.4e−03 −2.1e−04 1.0e−03
cm² s⁻²

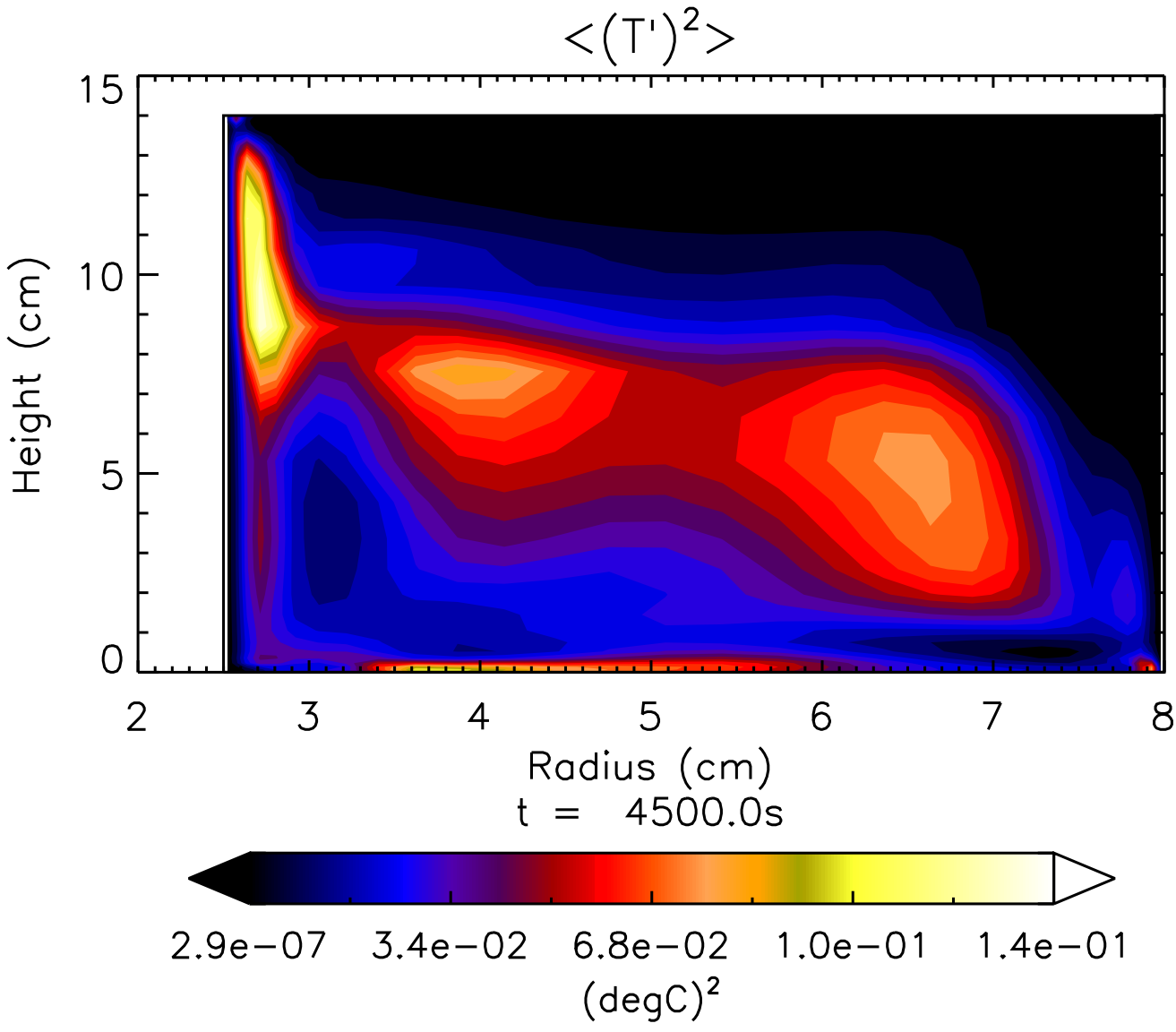

<(v')^2>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
2.7e−06
8.4e−03
1.7e−02
2.5e−02
3.4e−02
cm² s⁻²

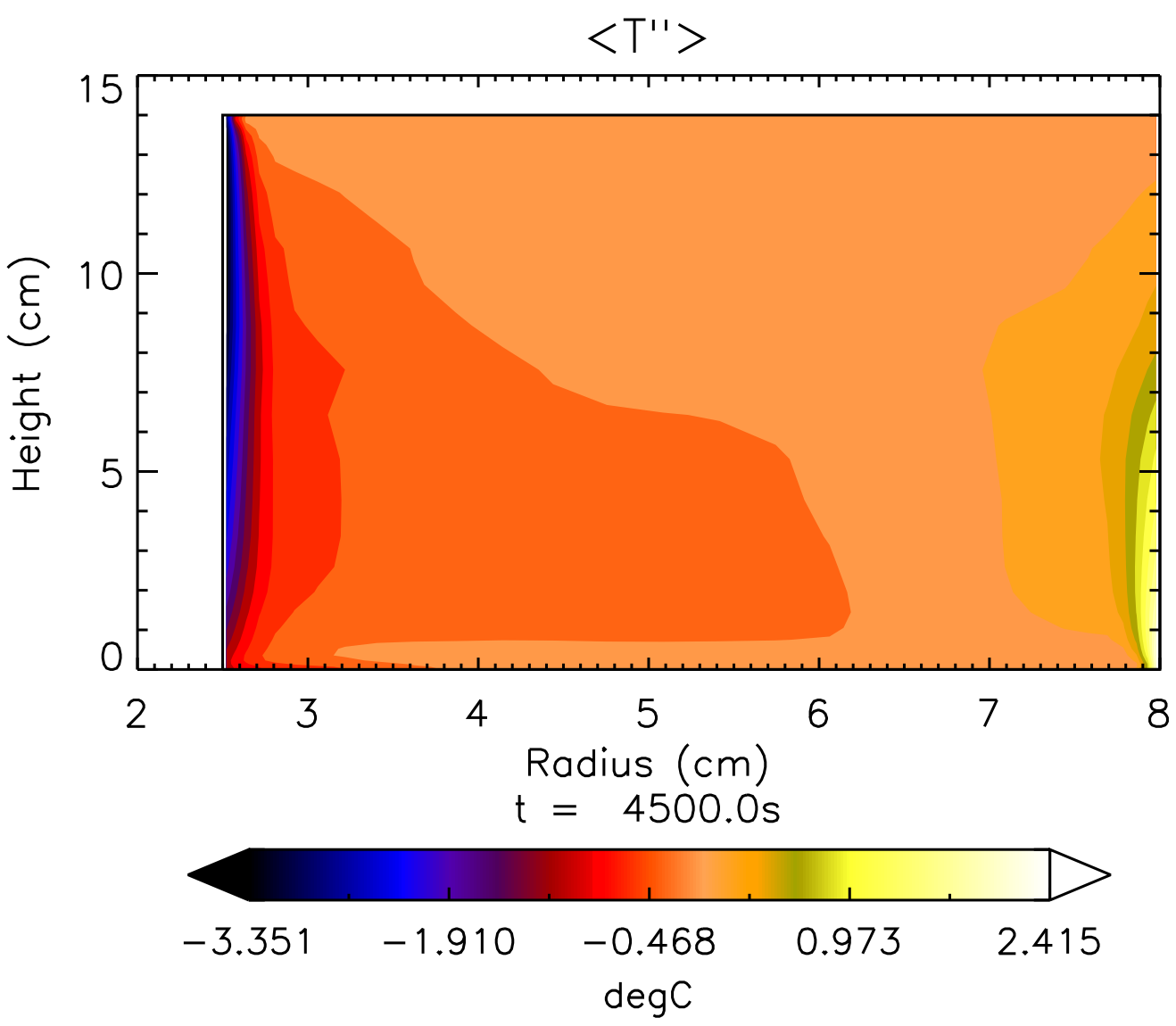

<v'w'>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−3.8e−03 −1.4e−03 1.0e−03 3.4e−03 5.8e−03
cm² s⁻²

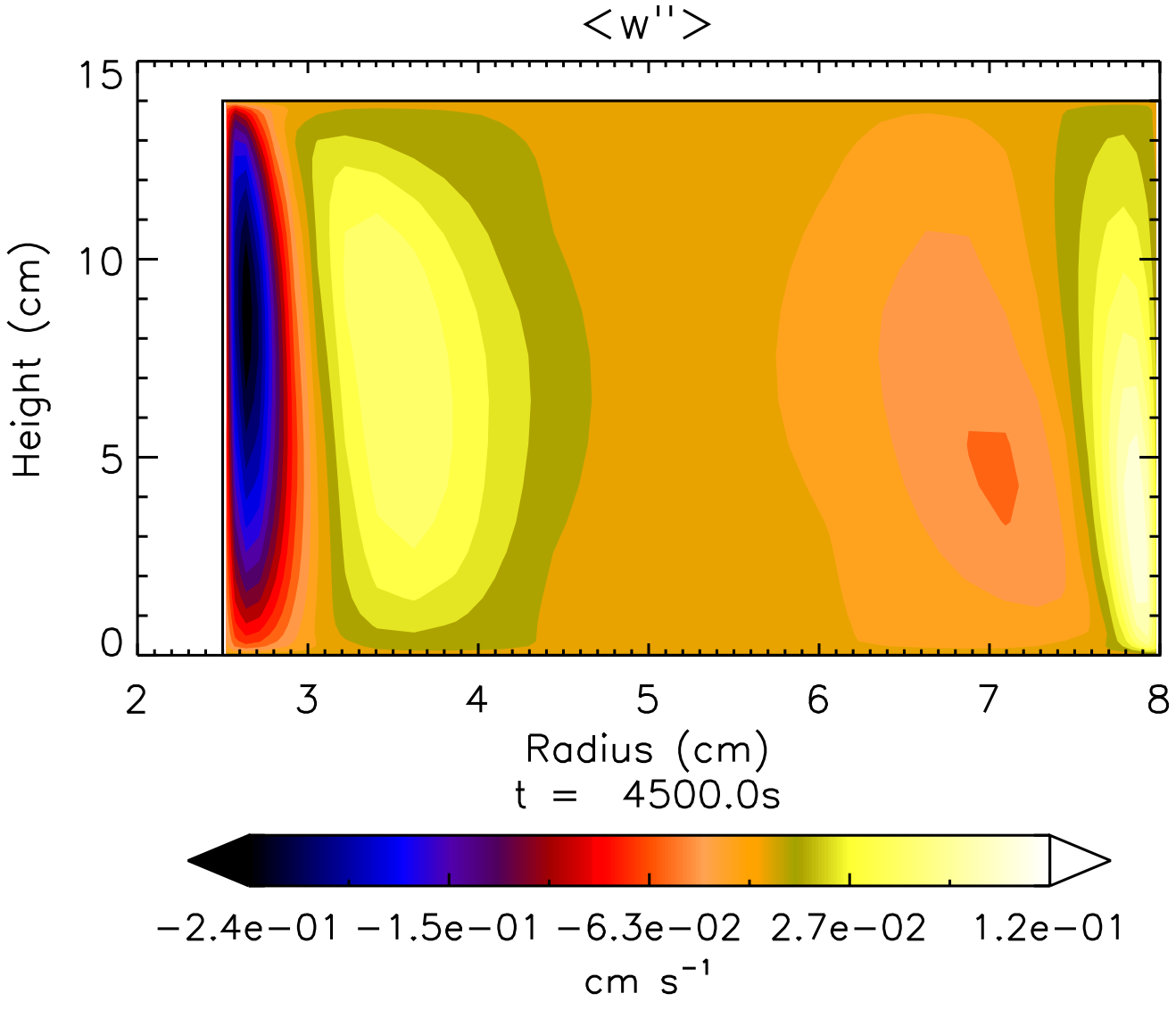

<(w')^2>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
1.1e−07
4.2e−03
8.4e−03
1.3e−02
1.7e−02
cm² s⁻²

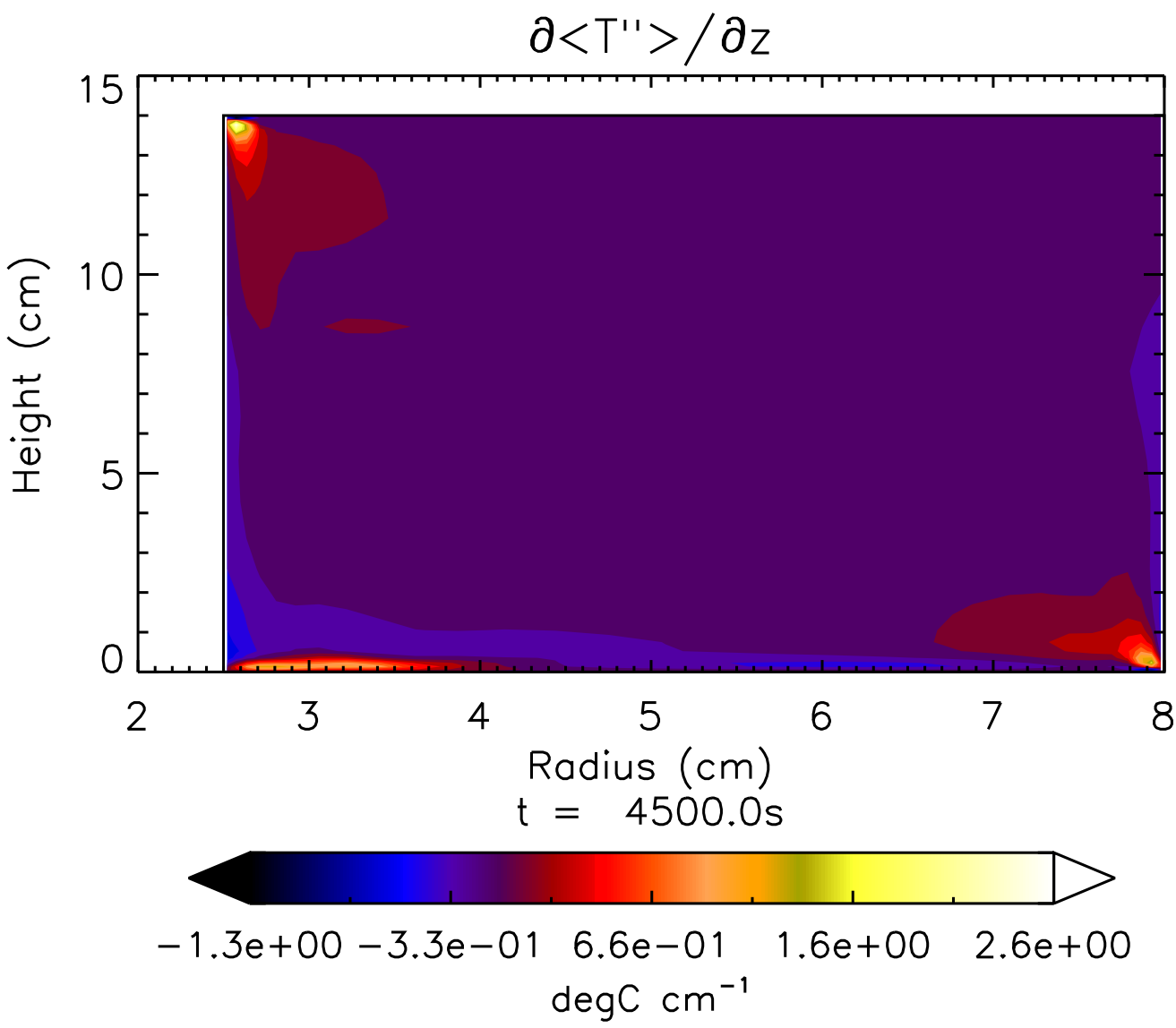

<u'T'>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−3.3e−02 −2.4e−02 −1.6e−02 −6.8e−03 2.0e−03
degC cm s^{-1}

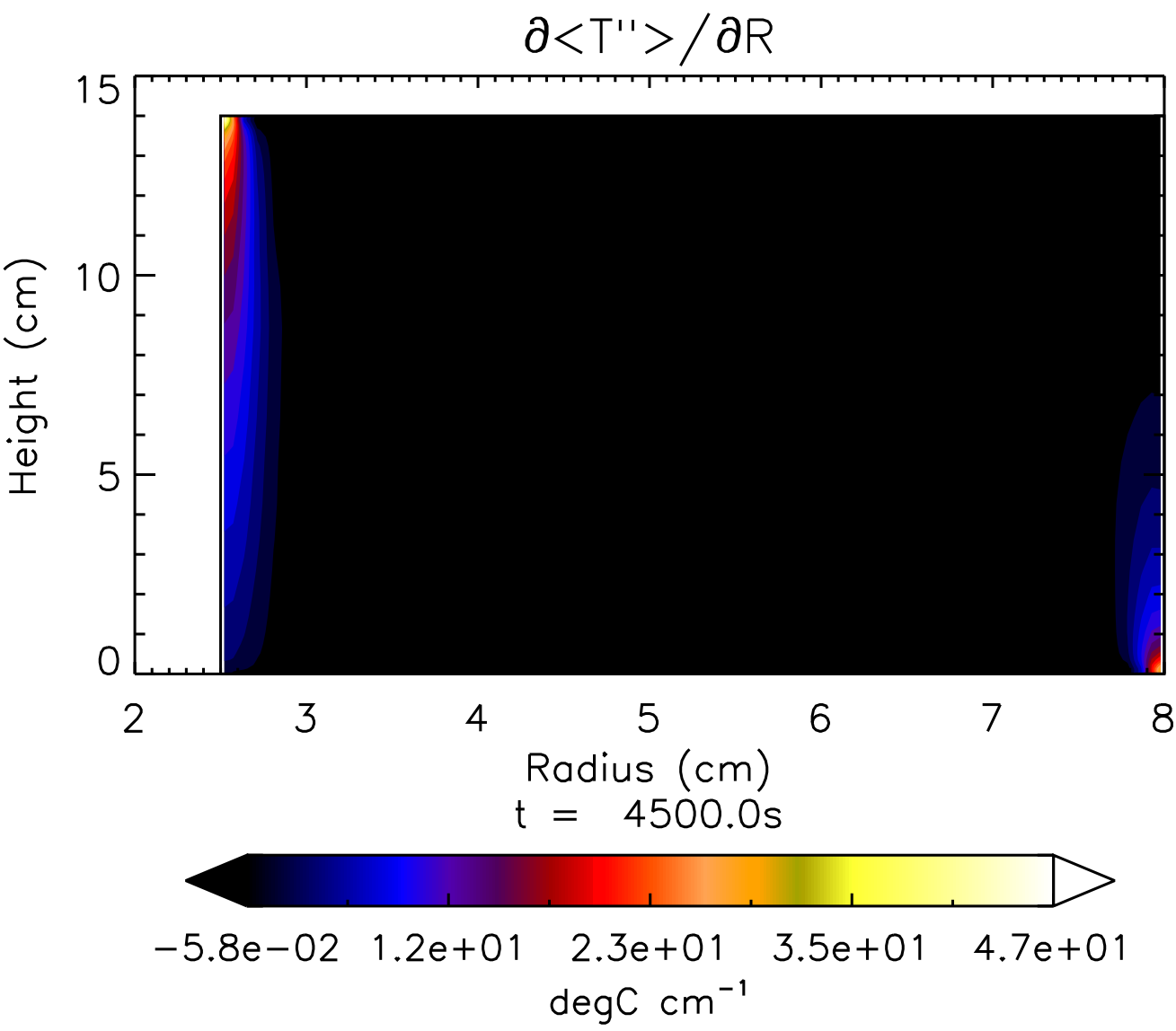

<w'T'>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−3.9e−03
6.2e−03
1.6e−02
2.6e−02
3.6e−02
degC cm s^{-1}

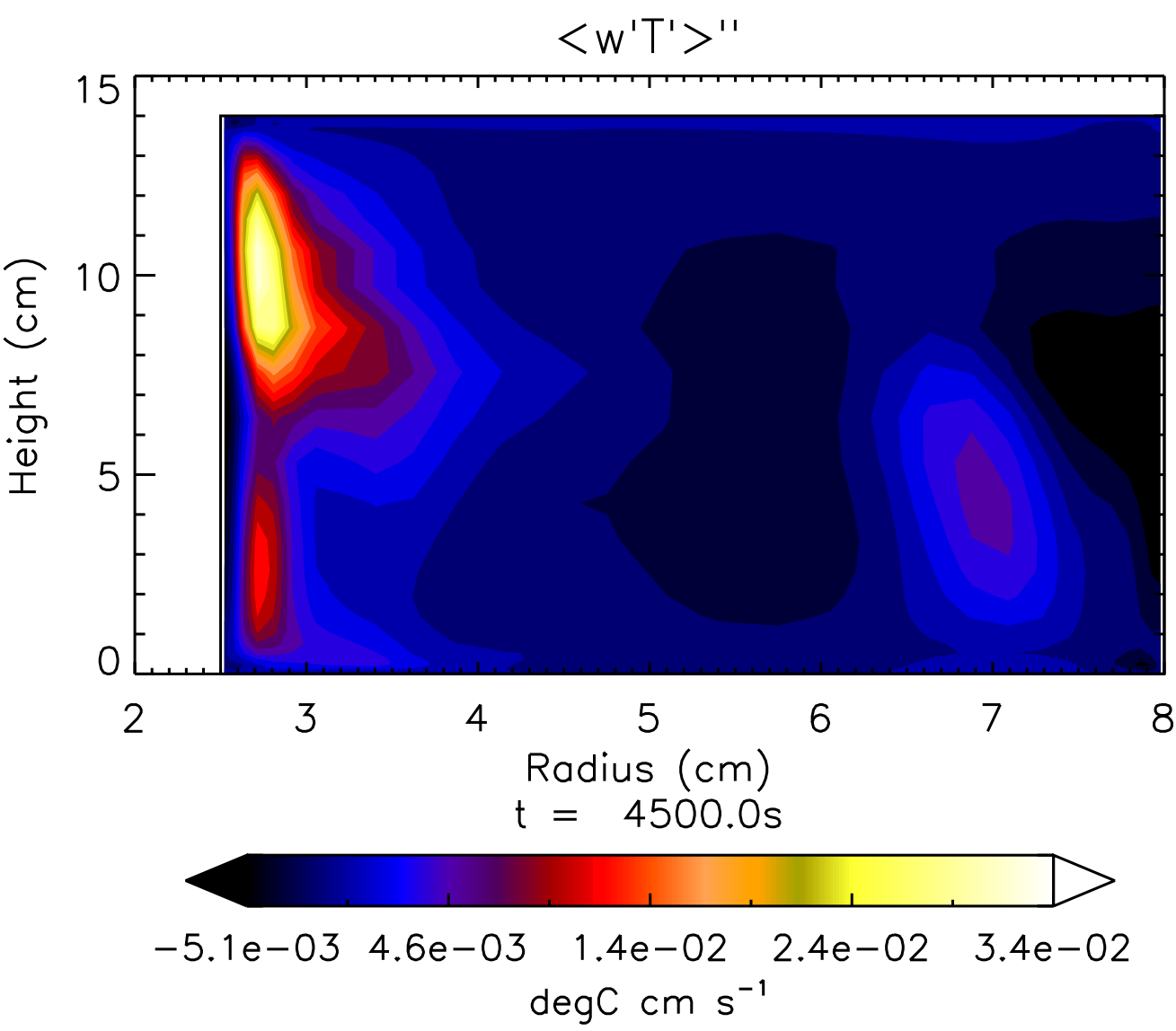

<(T')²>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
2.9e−07
3.4e−02
6.8e−02
1.0e−01
1.4e−01
(degC)²

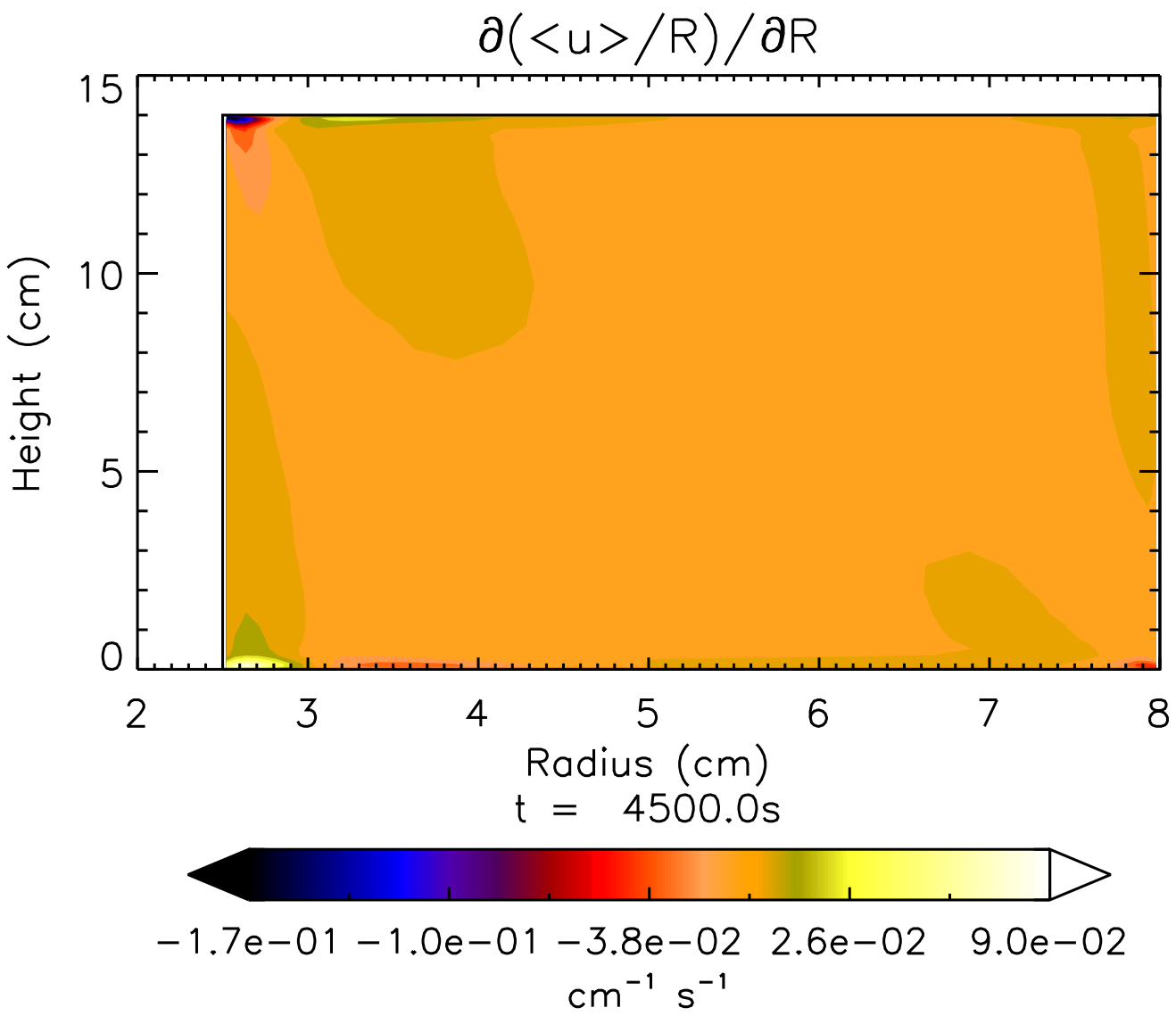

<T''>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−3.351
−1.910
−0.468
0.973
2.415
degC

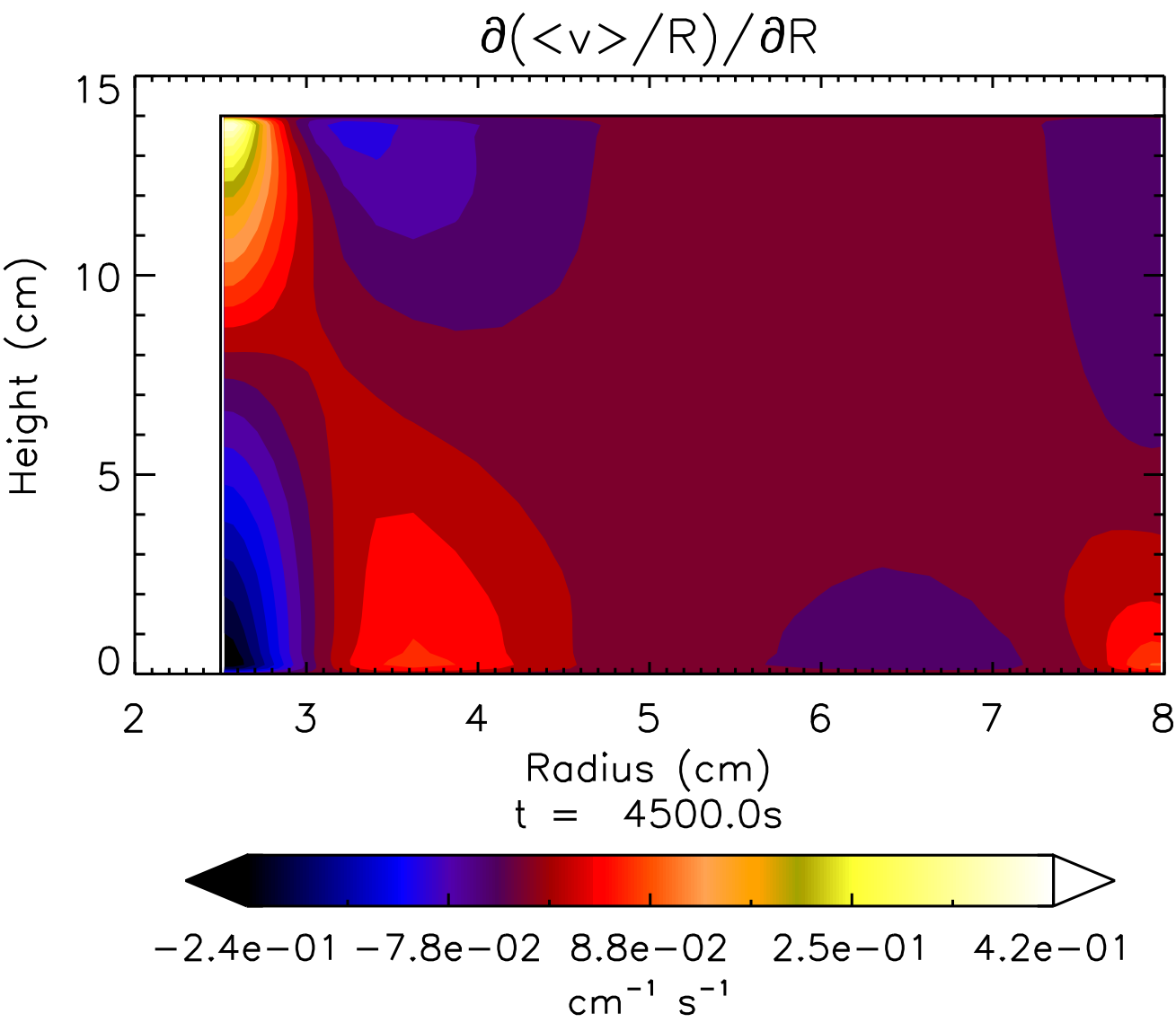

<w''>
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−2.4e−01 −1.5e−01 −6.3e−02 2.7e−02 1.2e−01
cm s⁻¹

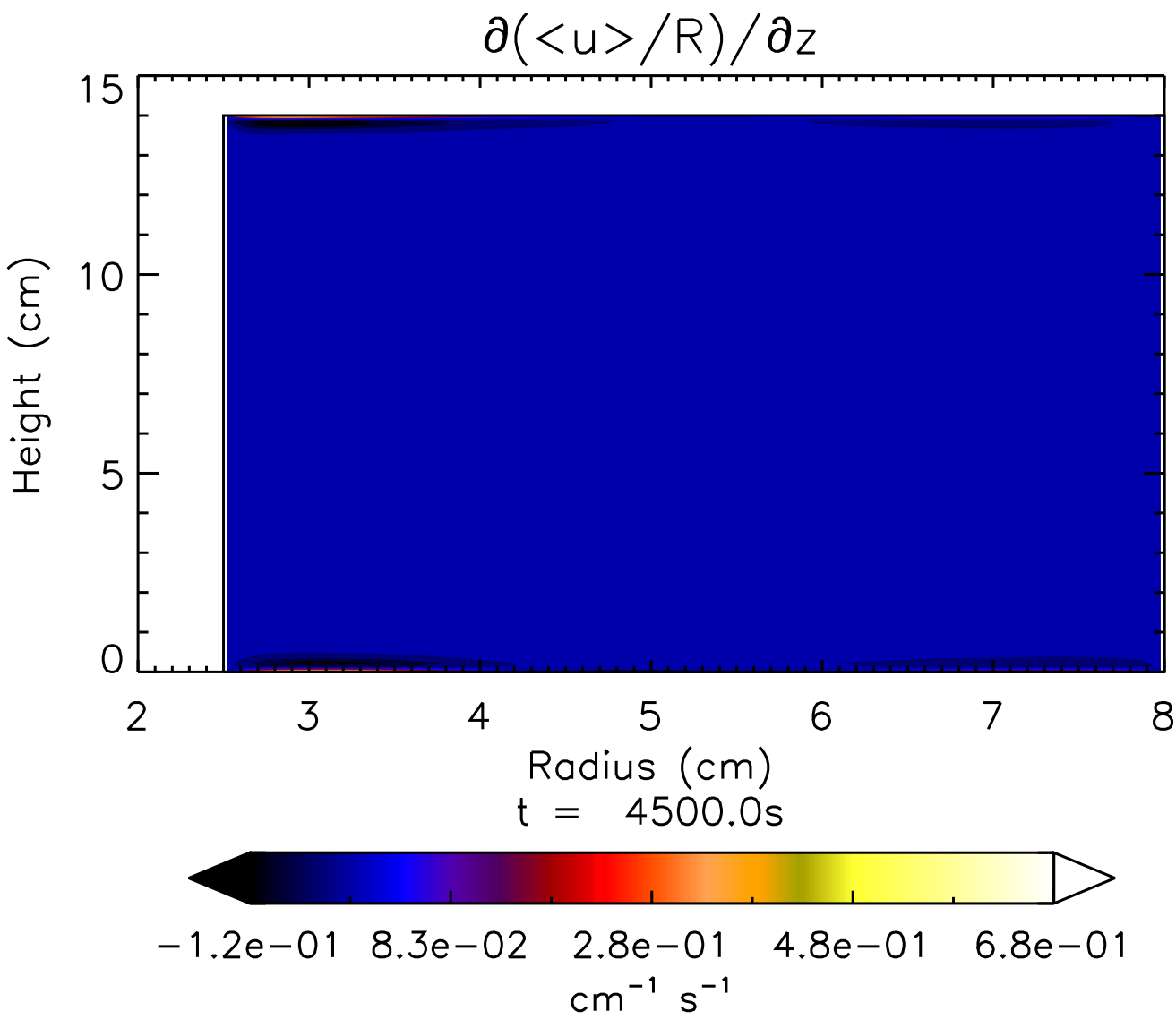

∂<T''>/∂z
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−1.3e+00 −3.3e−01 6.6e−01 1.6e+00 2.6e+00
degC cm⁻¹

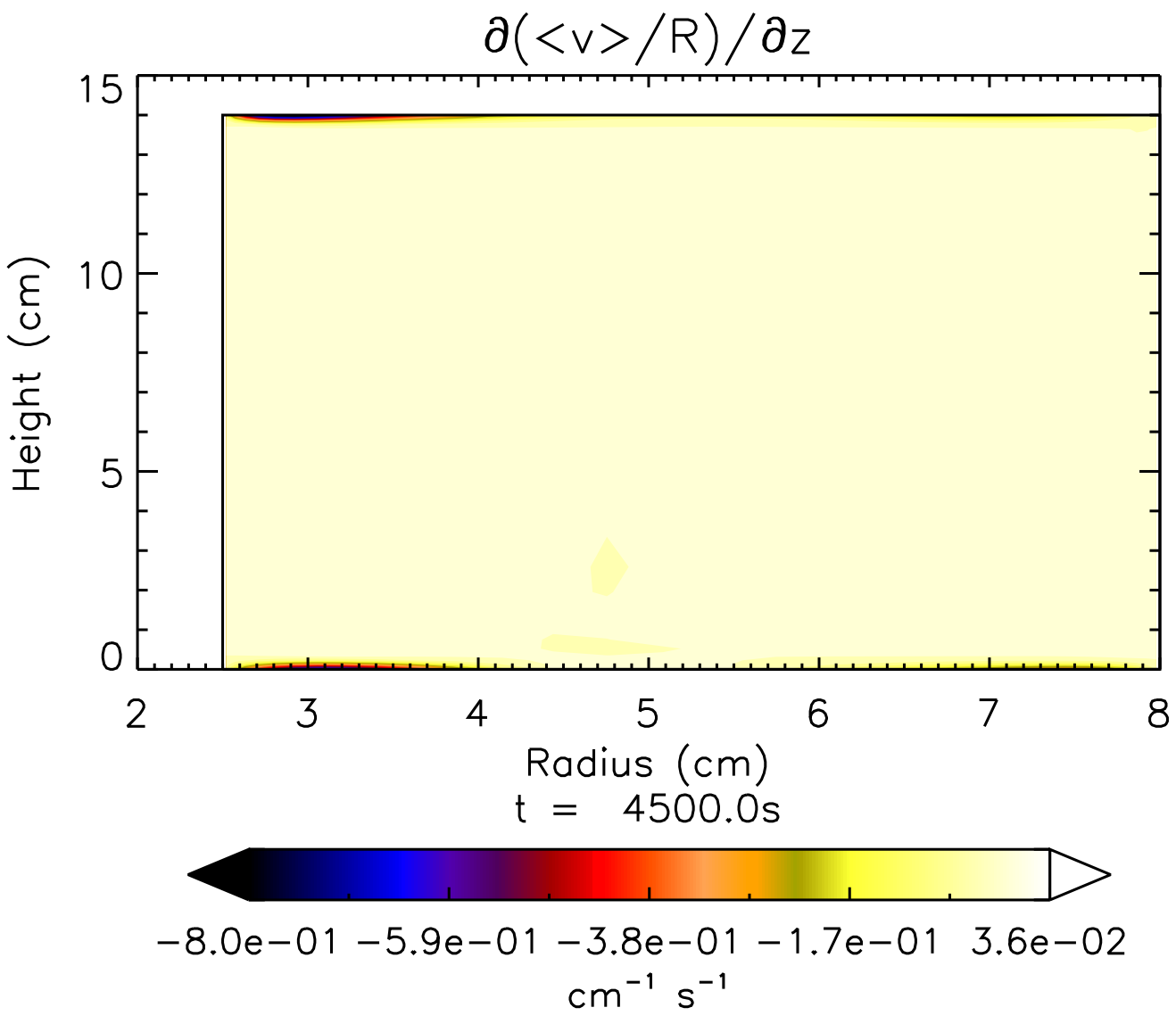

∂<T''>/∂R
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−5.8e−02
1.2e+01
2.3e+01
3.5e+01
4.7e+01
degC cm⁻¹

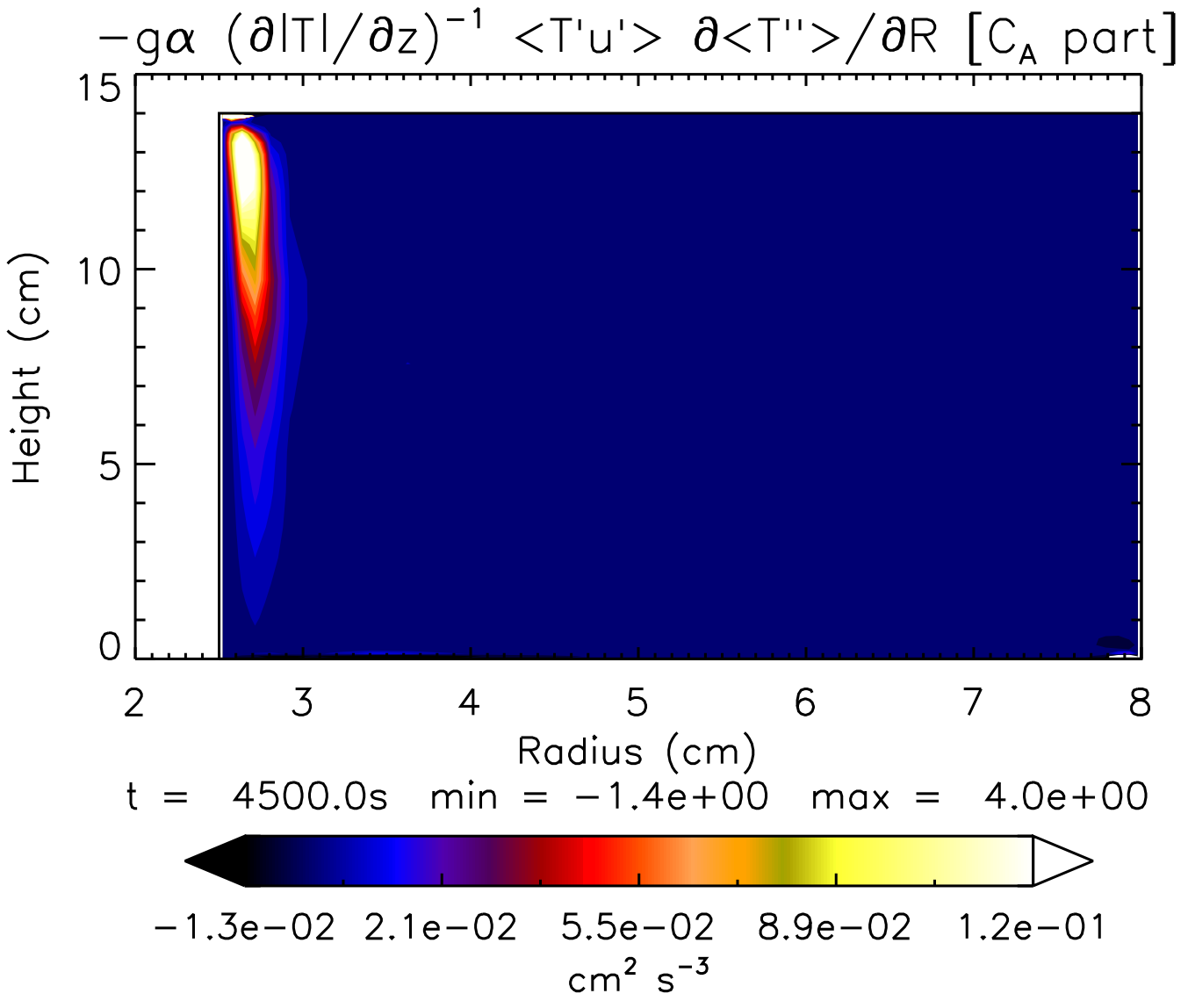

<w'T'>''
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−5.1e−03
4.6e−03
1.4e−02
2.4e−02
3.4e−02
degC cm s^{-1}

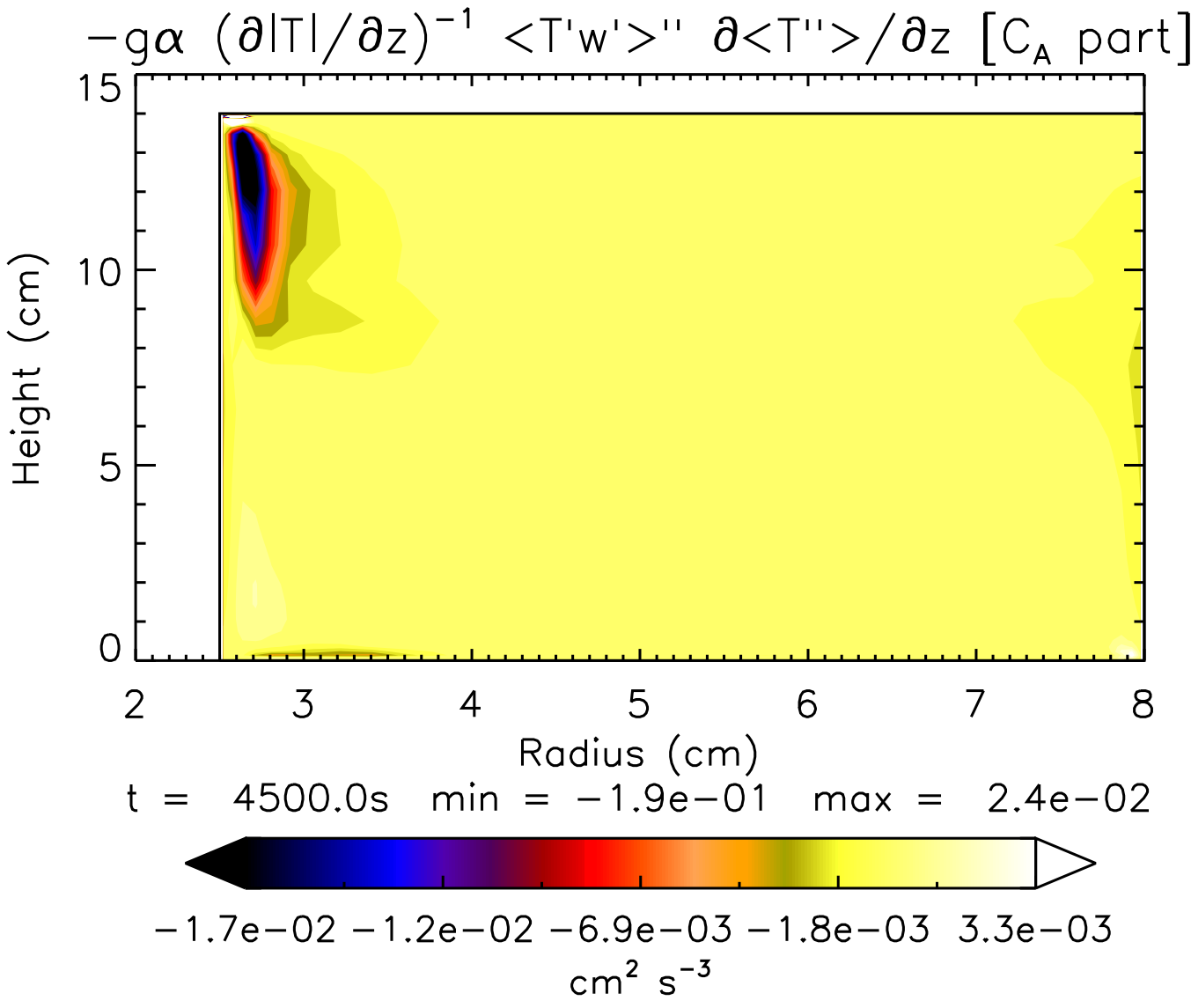

∂(<u>/R)/∂R
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−1.7e−01 −1.0e−01 −3.8e−02 2.6e−02 9.0e−02
cm⁻¹ s⁻¹

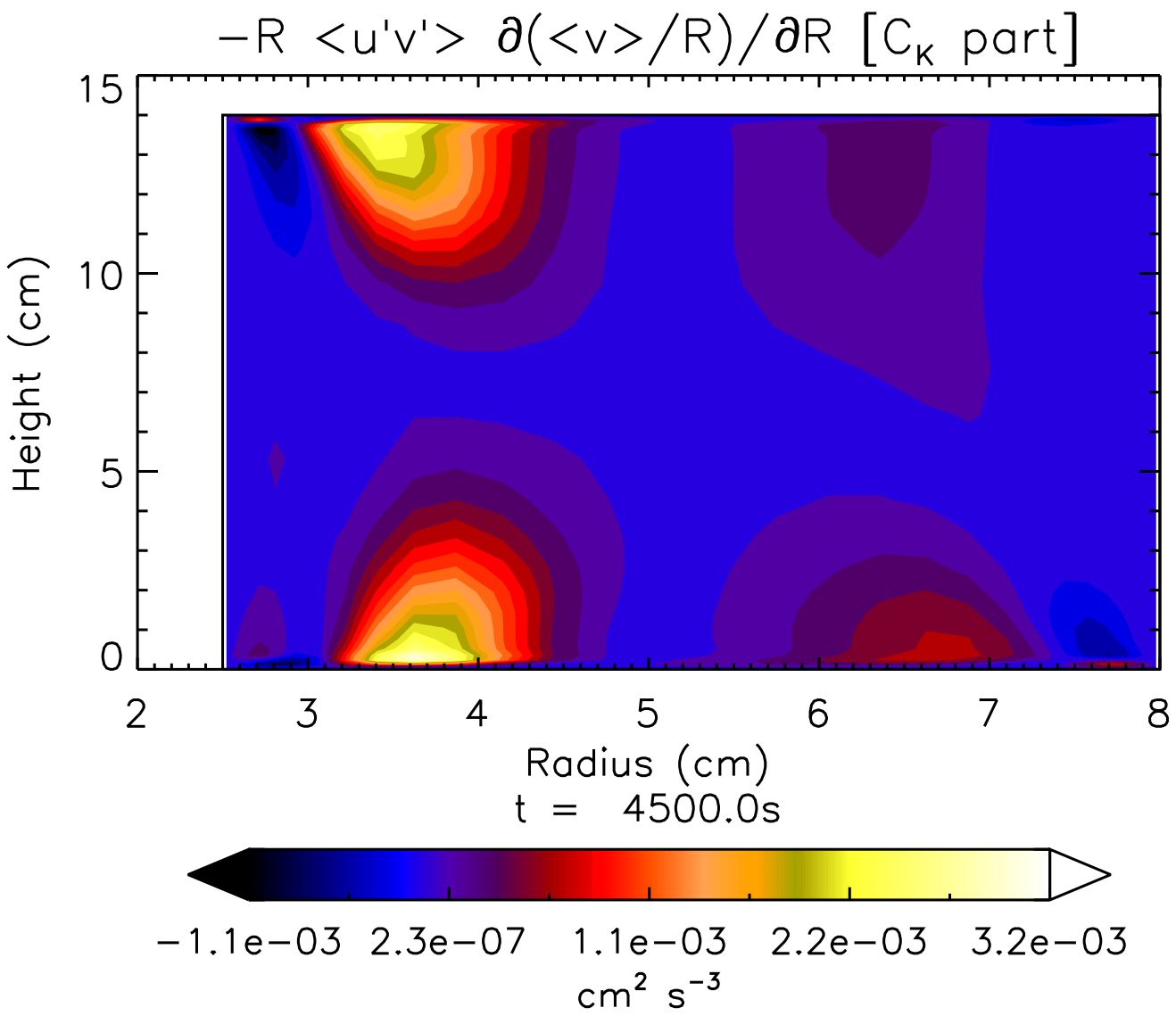

∂(<v>/R)/∂R
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−2.4e−01 −7.8e−02 8.8e−02 2.5e−01 4.2e−01
cm⁻¹ s⁻¹

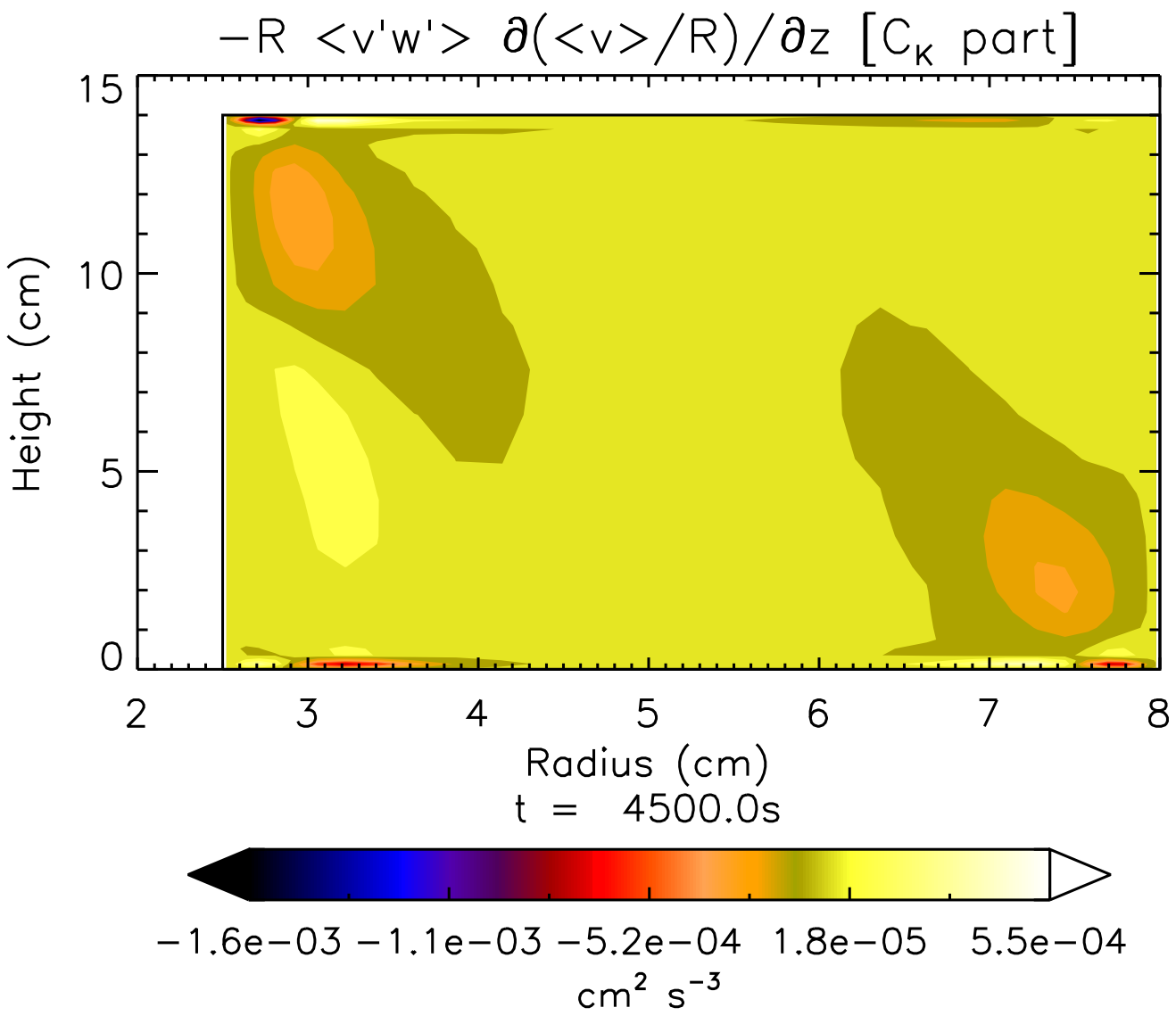

∂(<u>/R)/∂z
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−1.2e−01
8.3e−02
2.8e−01
4.8e−01
6.8e−01
cm⁻¹ s⁻¹

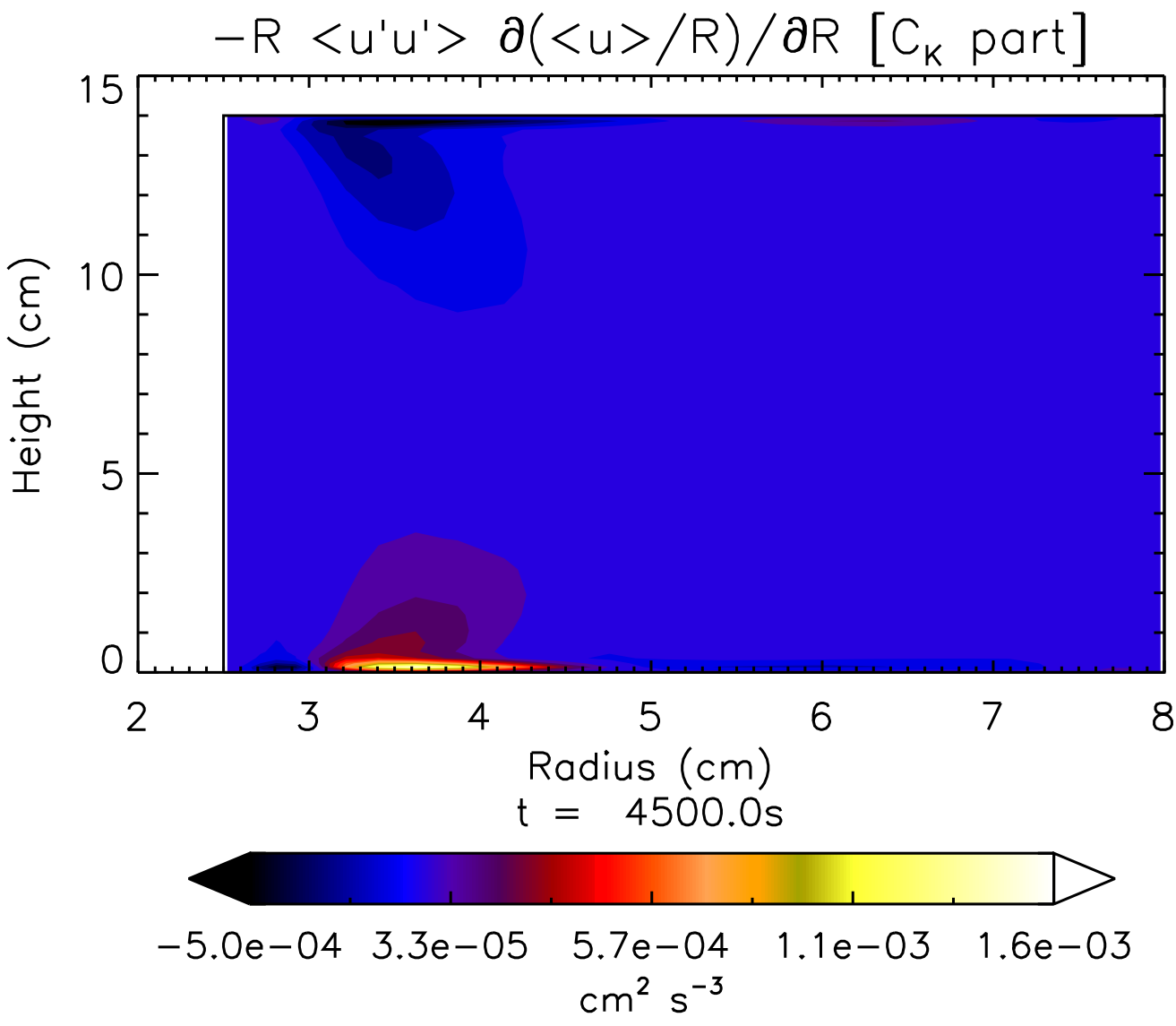

∂(<v>/R)/∂z
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−8.0e−01 −5.9e−01 −3.8e−01 −1.7e−01 3.6e−02
cm⁻¹ s⁻¹

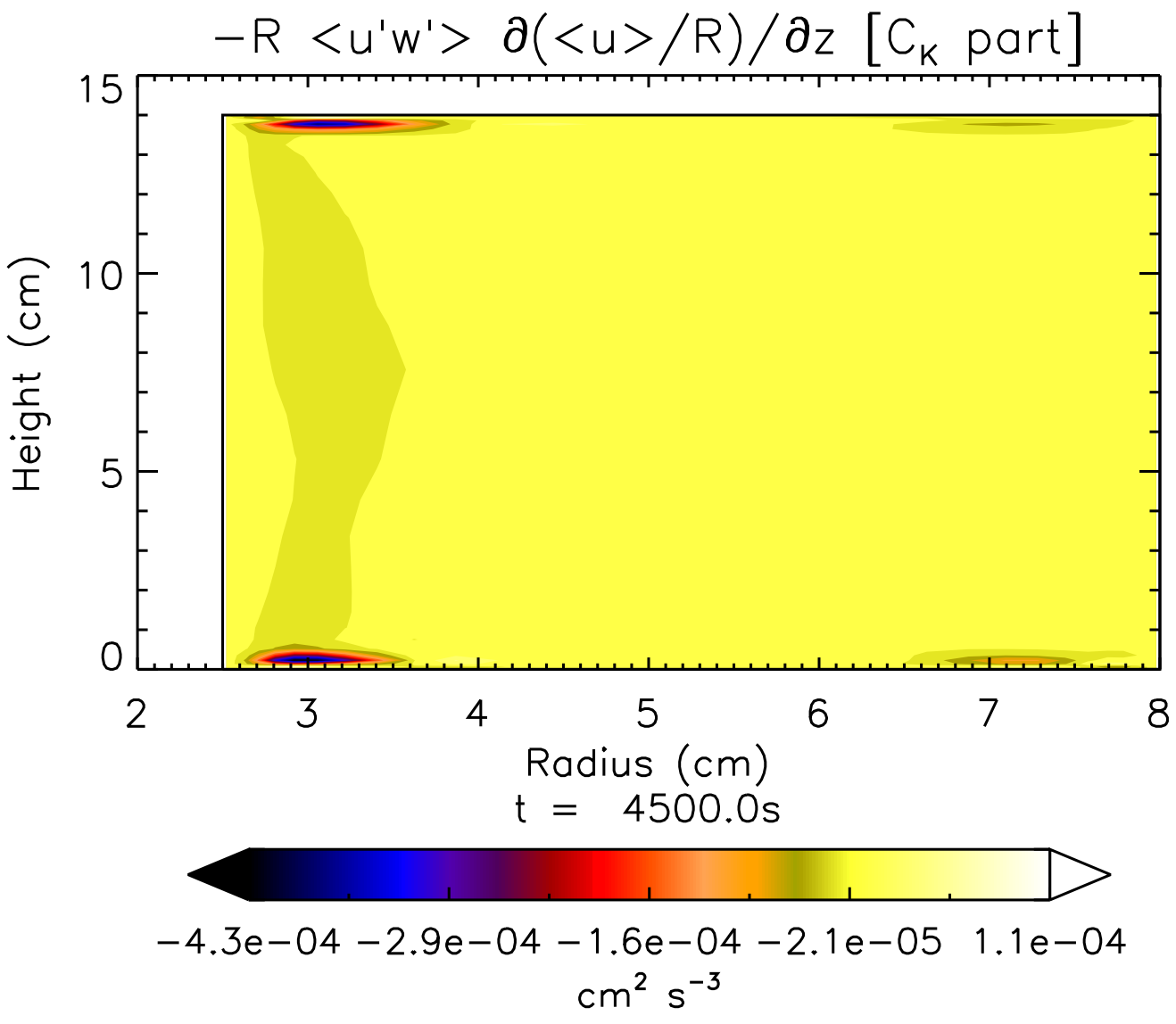

−gα (∂|T|/∂z)^−1 <T'u'> ∂<T''>/∂R [C_A part]
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s min = −1.4e+00 max = 4.0e+00
−1.3e−02
2.1e−02
5.5e−02
8.9e−02
1.2e−01
cm² s⁻³

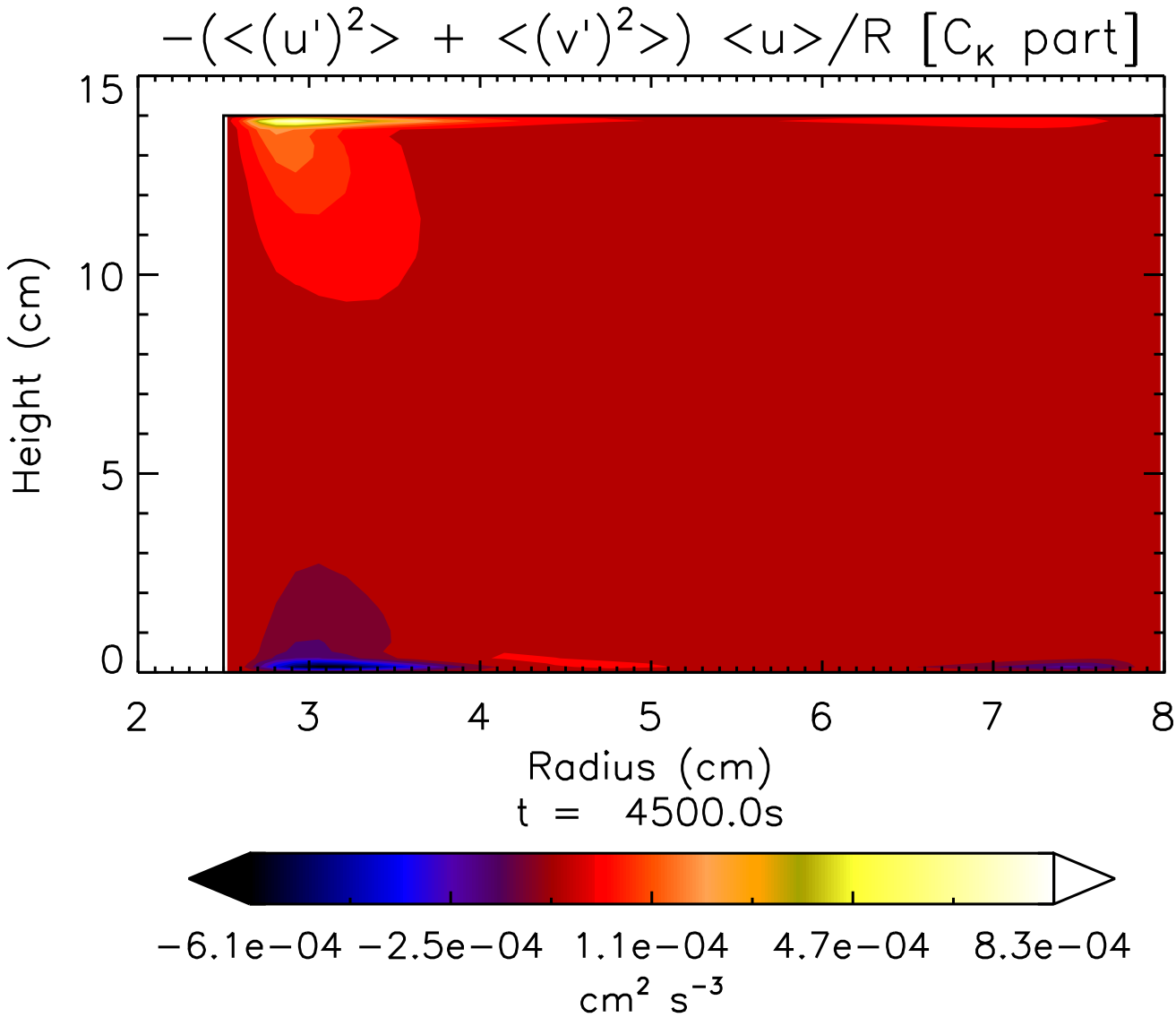

−gα (∂|T|/∂z)^−1 <T'w'>'' ∂<T''>/∂z [C_A part]
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s min = −1.9e−01 max = 2.4e−02
−1.7e−02 −1.2e−02 −6.9e−03 −1.8e−03 3.3e−03
cm² s⁻³

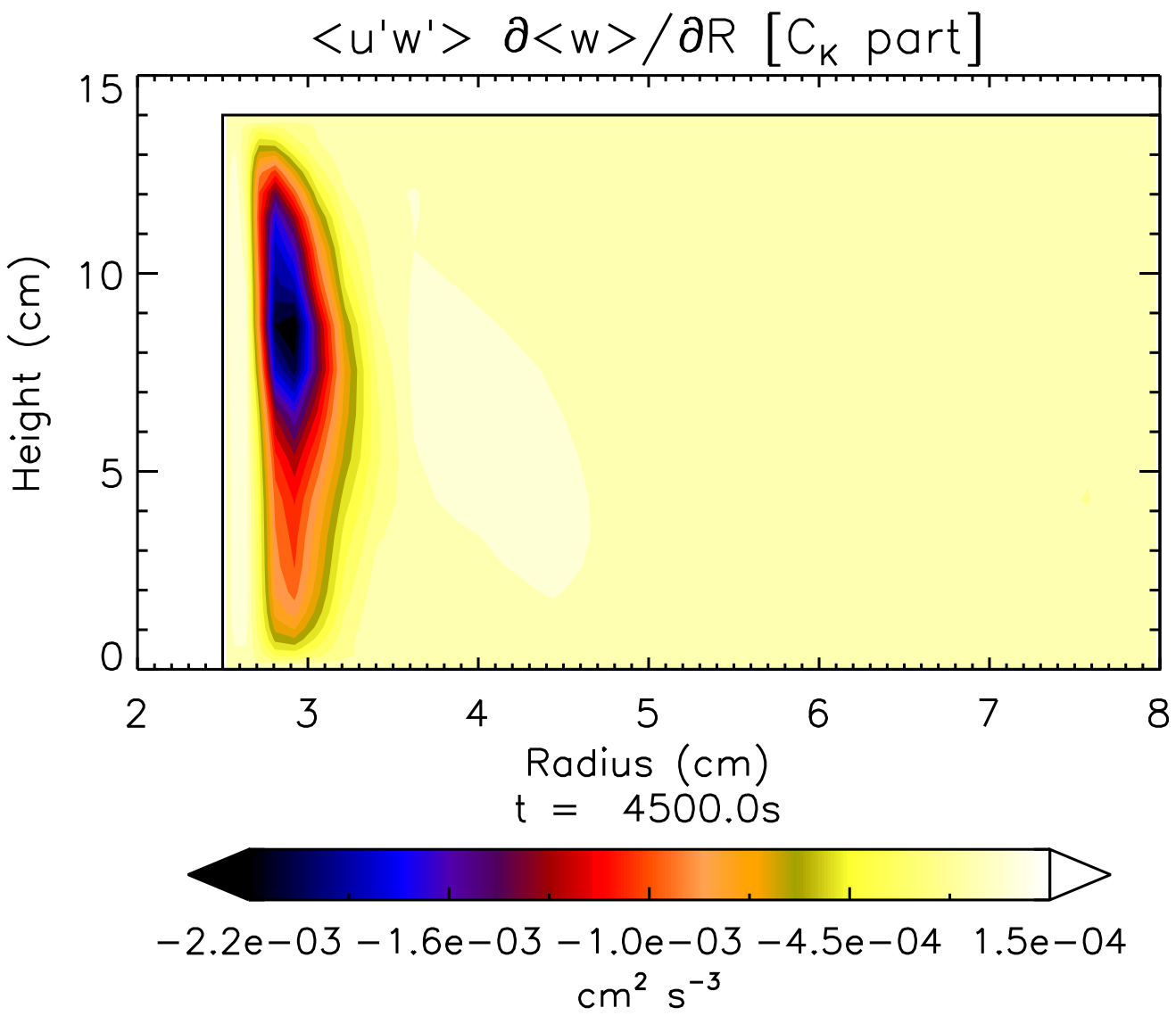

−R <u'v'> ∂(<v>/R)/∂R [C_K part]
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−1.1e−03
2.3e−07
1.1e−03
2.2e−03
3.2e−03
cm² s⁻³

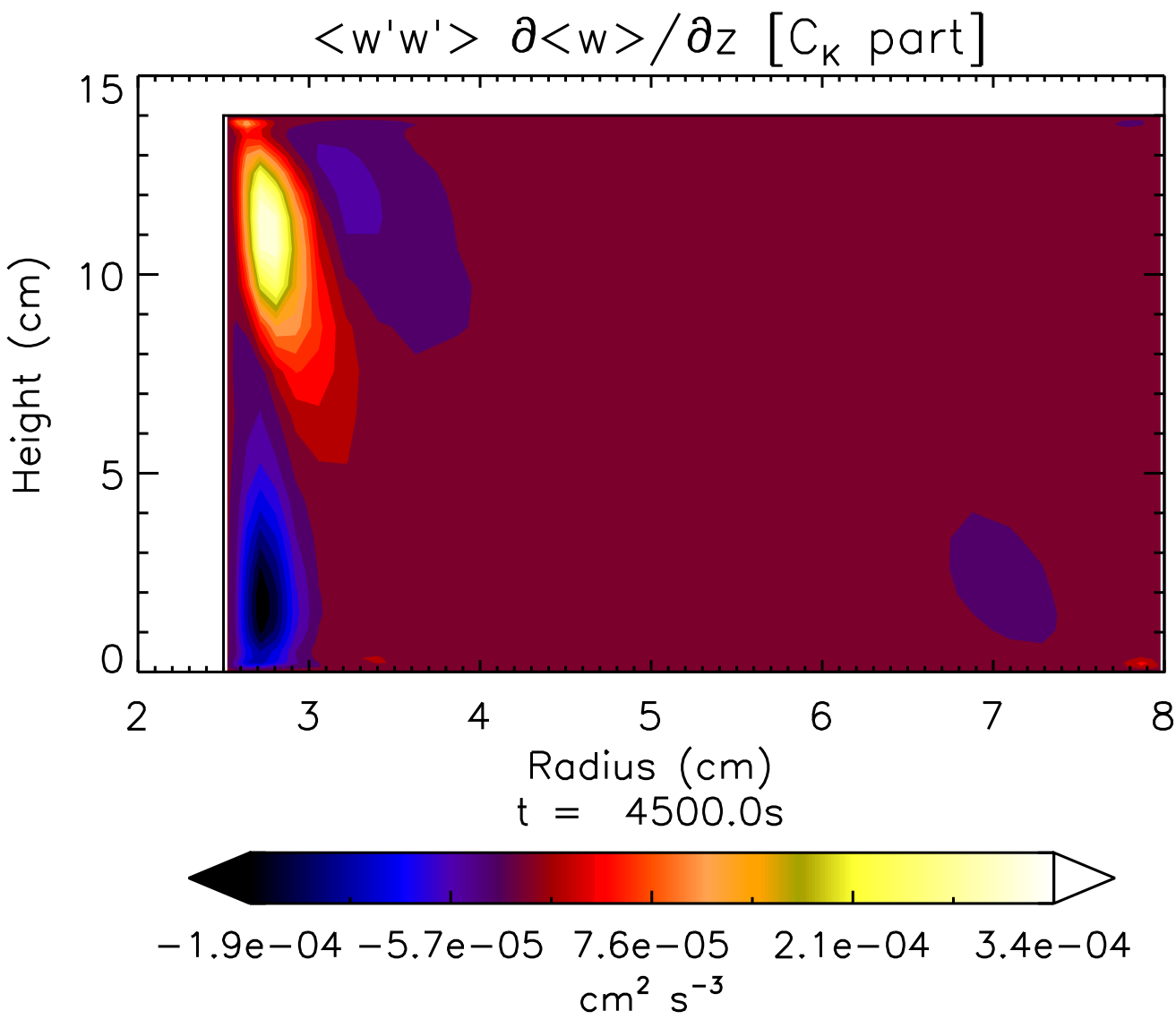

−R <v'w'> ∂(<v>/R)/∂z [C_K part]
Height (cm)
0
5
10
15
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−1.6e−03 −1.1e−03 −5.2e−04 1.8e−05 5.5e−04
cm² s⁻³

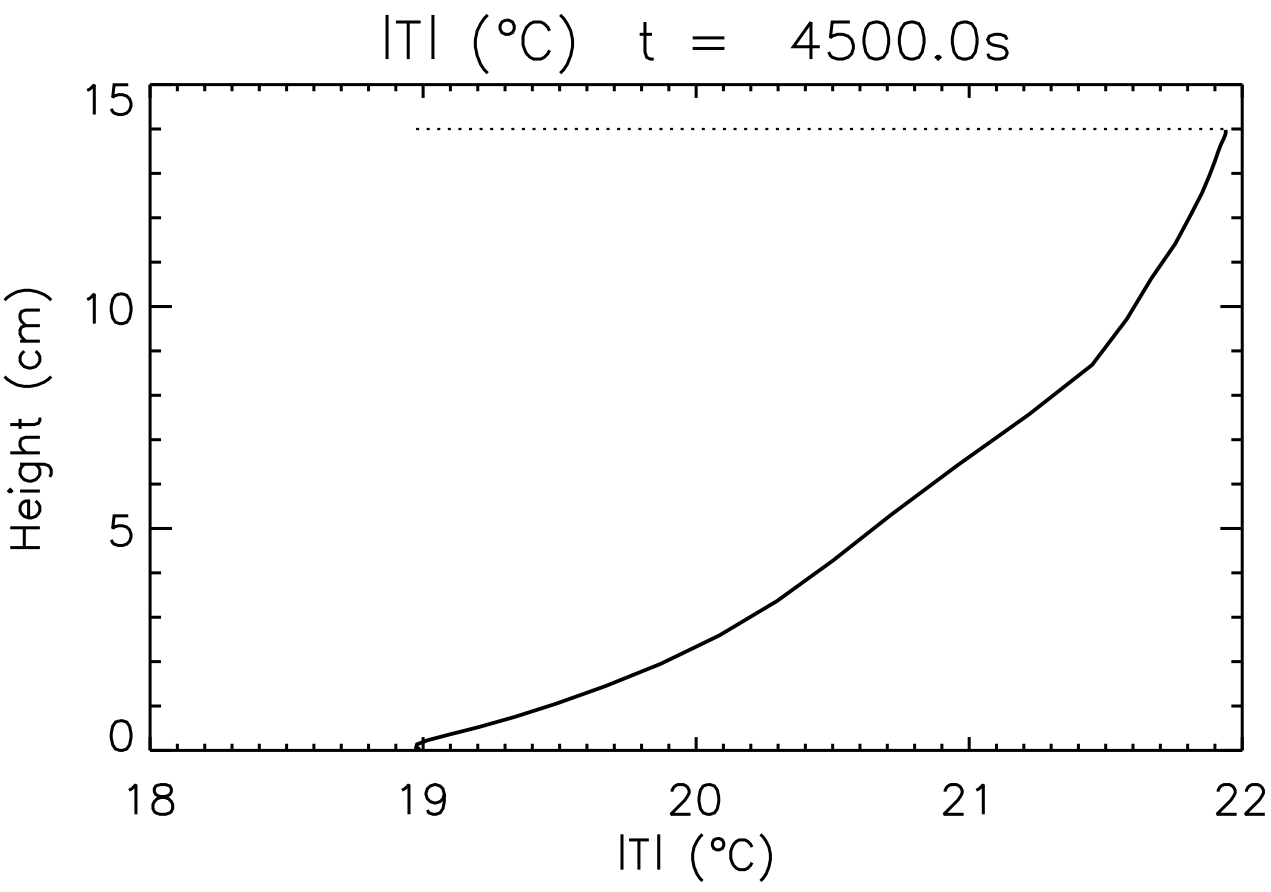

−R <u'u'> ∂(<u>/R)/∂R [C_K part]
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−5.0e−04
3.3e−05
5.7e−04
1.1e−03
1.6e−03
cm² s⁻³

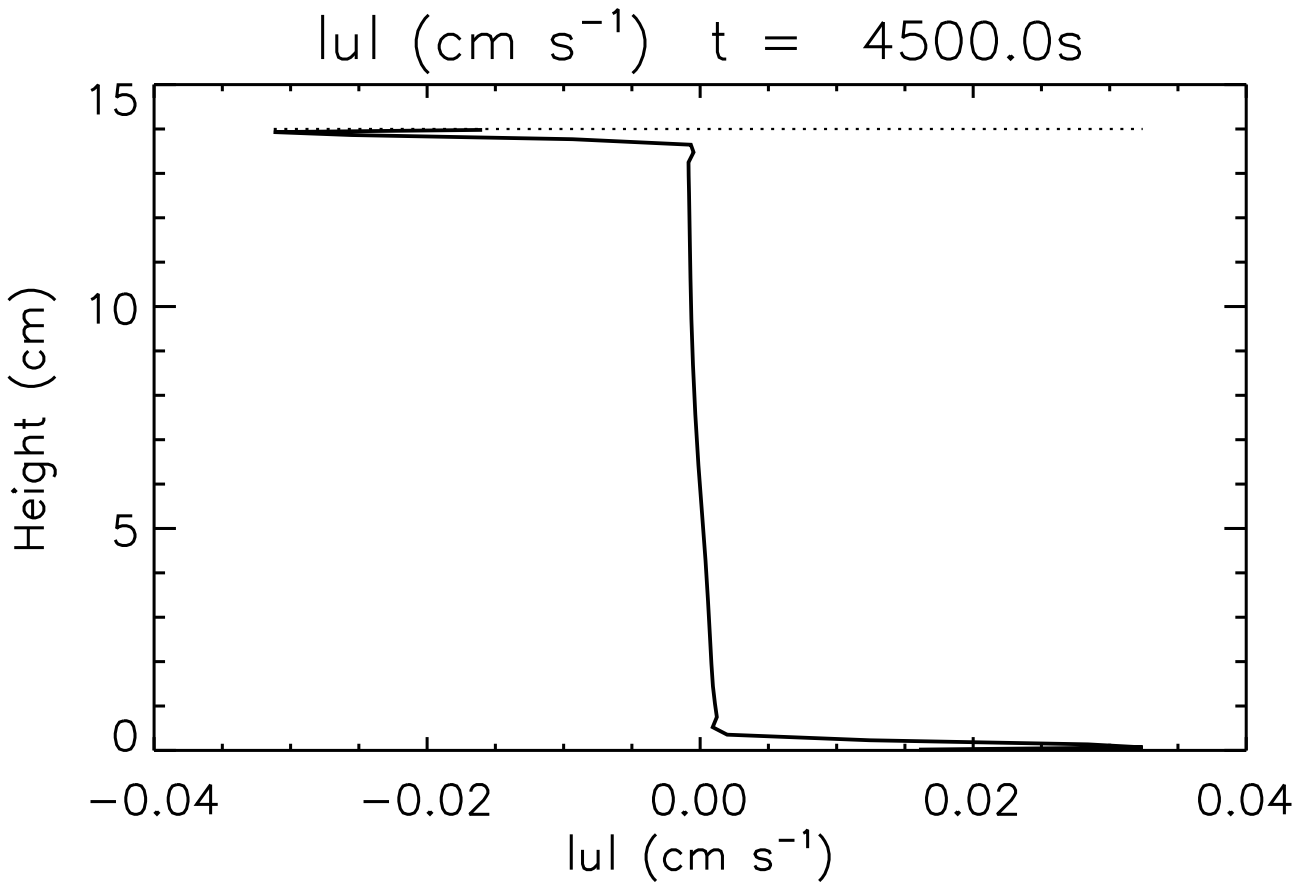

−R <u'w'> ∂(<u>/R)/∂z [Cκ part]
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−4.3e−04 −2.9e−04 −1.6e−04 −2.1e−05 1.1e−04
cm² s⁻³

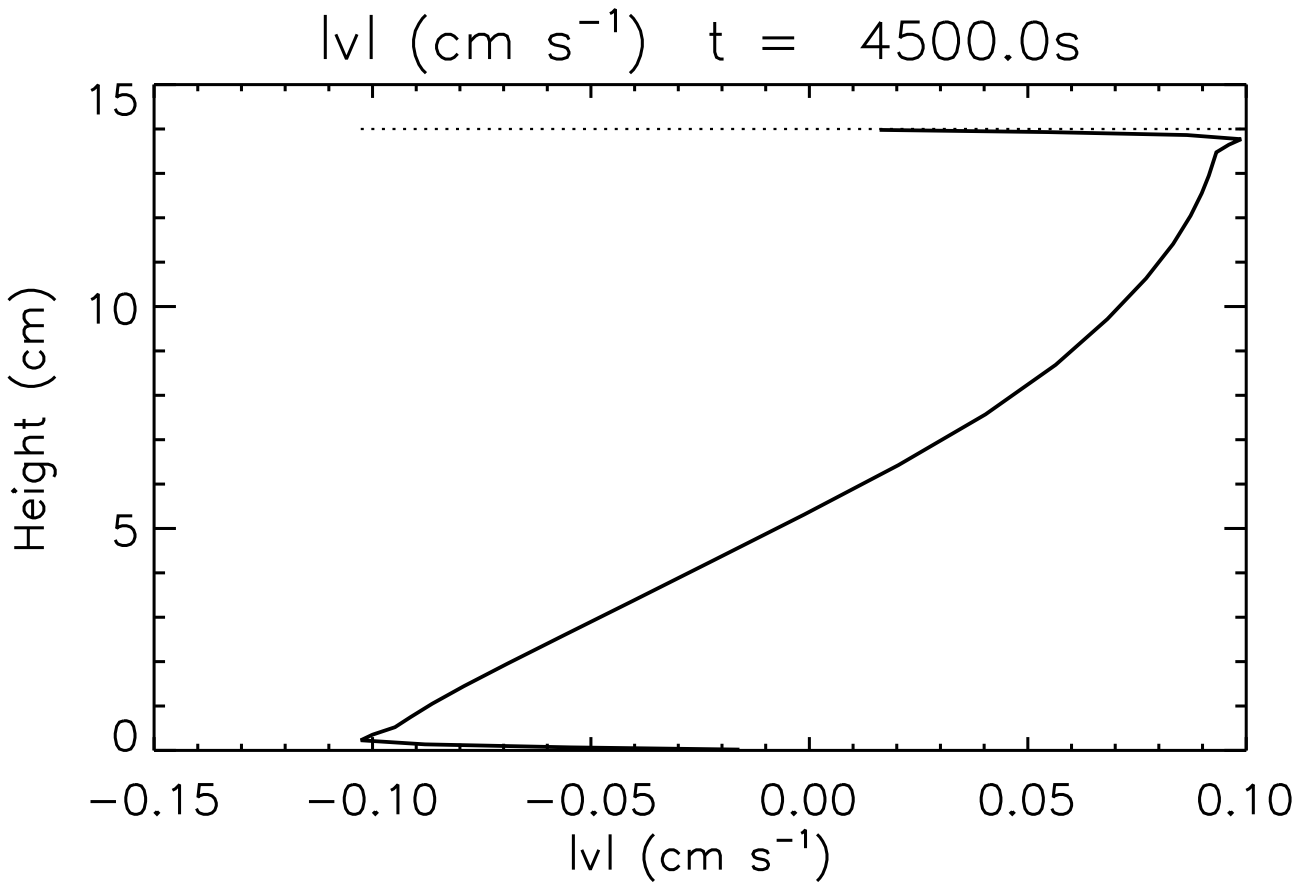

−(<(u')²> + <(v')²>) <u>/R [C_K part]
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−6.1e−04 −2.5e−04 1.1e−04 4.7e−04 8.3e−04
cm² s⁻³

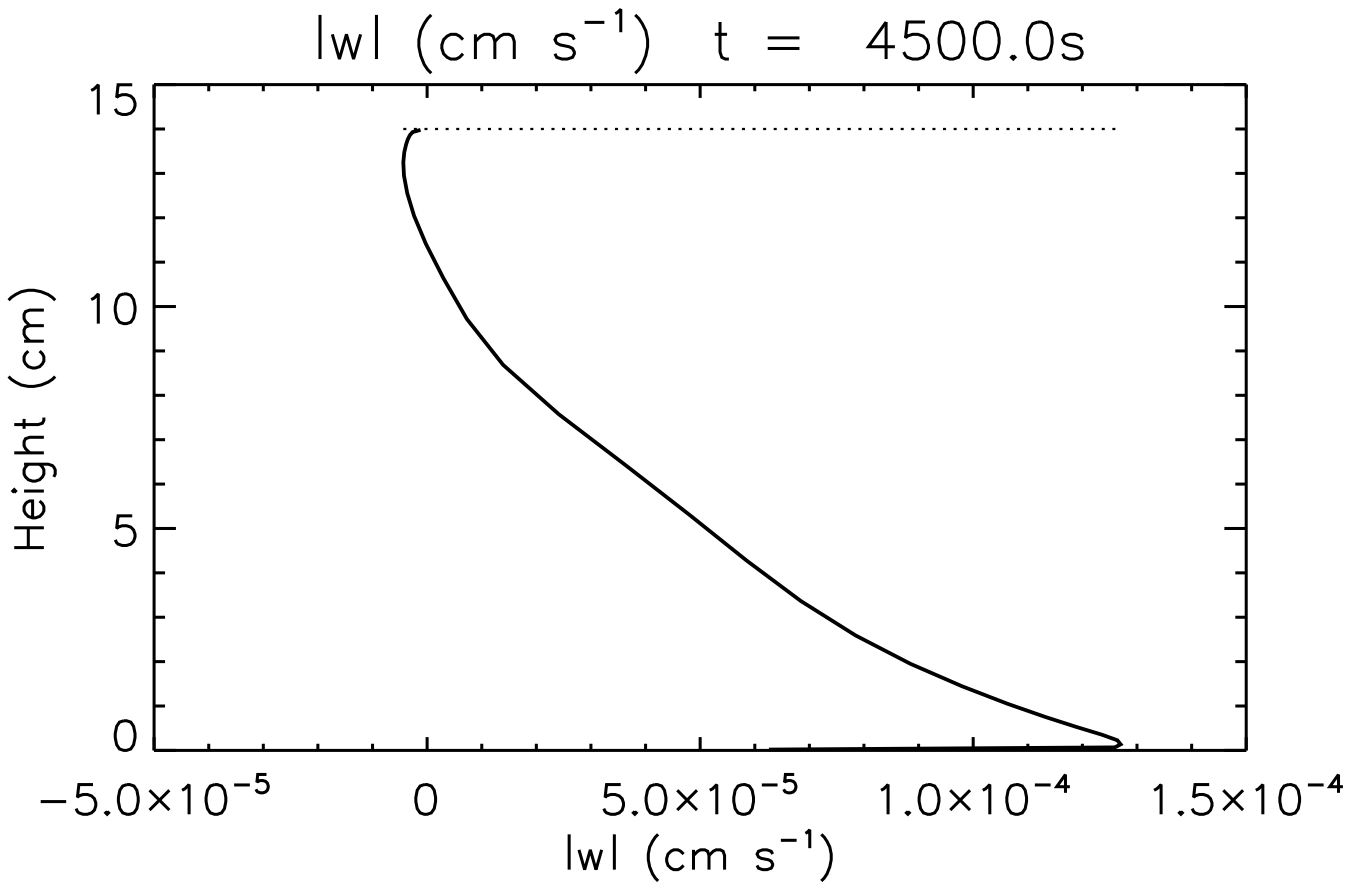

<u'w'> ∂<w>/∂R [C_K part]
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−2.2e−03 −1.6e−03 −1.0e−03 −4.5e−04 1.5e−04
cm² s⁻³

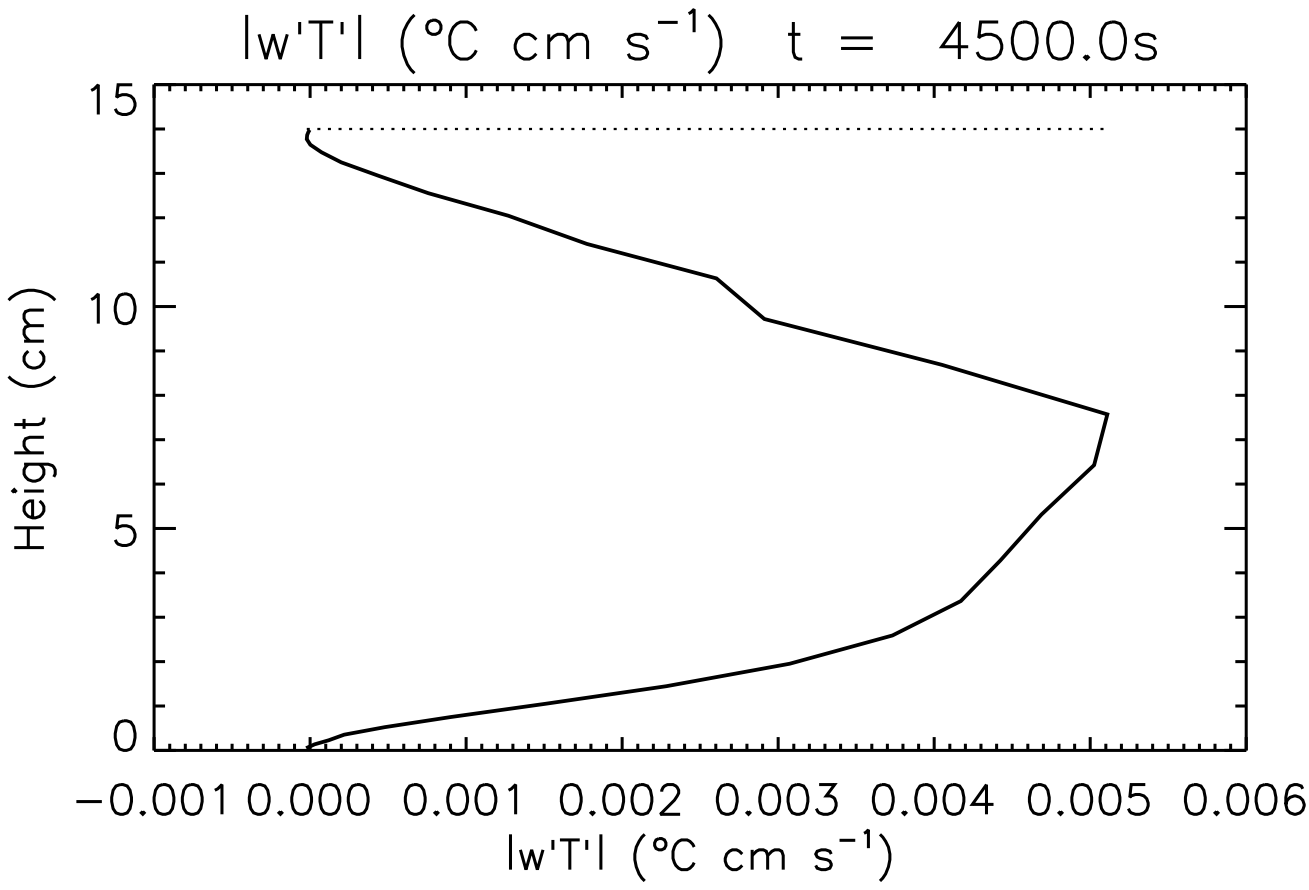

<w'w'> ∂<w>/∂z [C_K part]
15
10
5
0
Height (cm)
2
3
4
5
6
7
8
Radius (cm)
t = 4500.0s
−1.9e−04 −5.7e−05 7.6e−05 2.1e−04 3.4e−04
cm² s⁻³

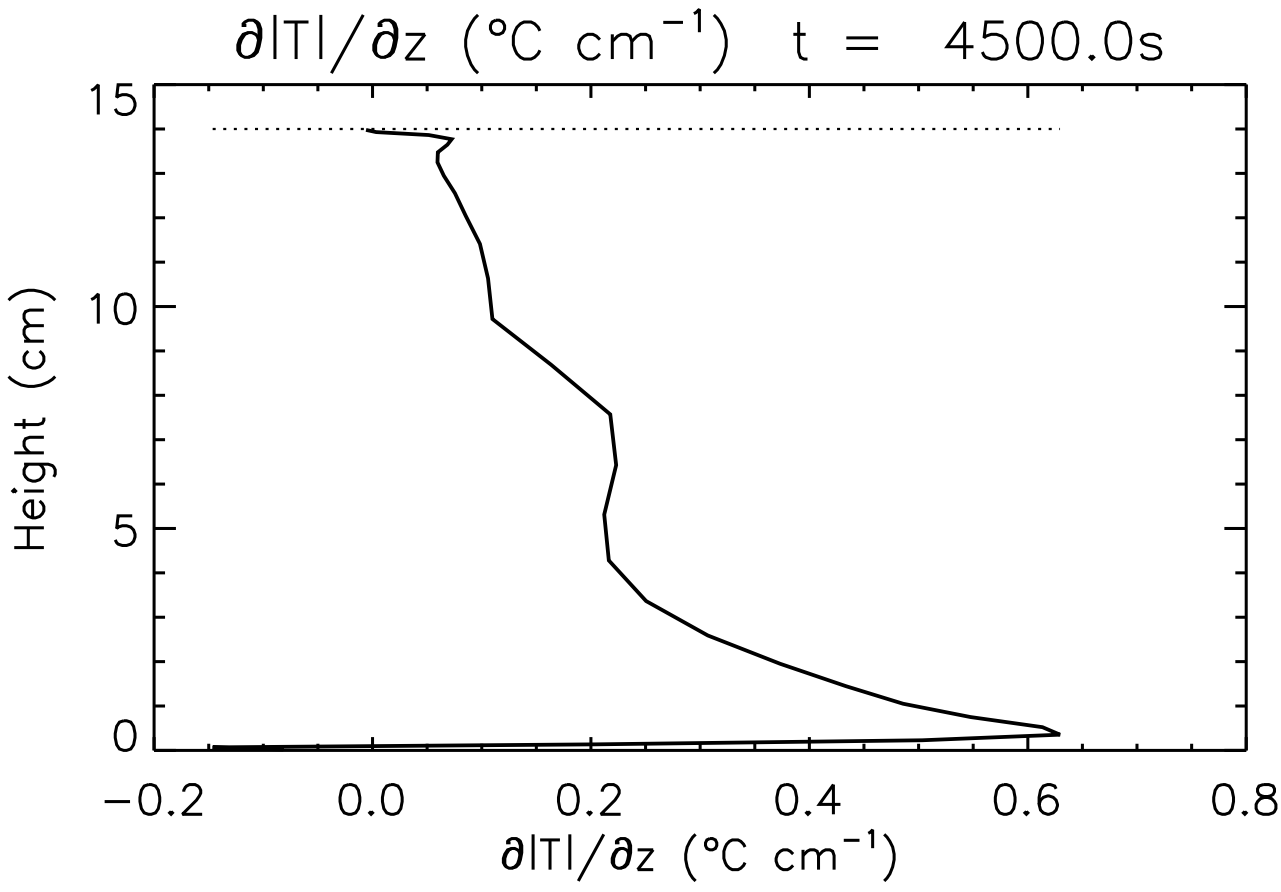

|T| (°C) t = 4500.0s
15
10
5
0
Height (cm)
18
19
20
21
22
|T| (°C)

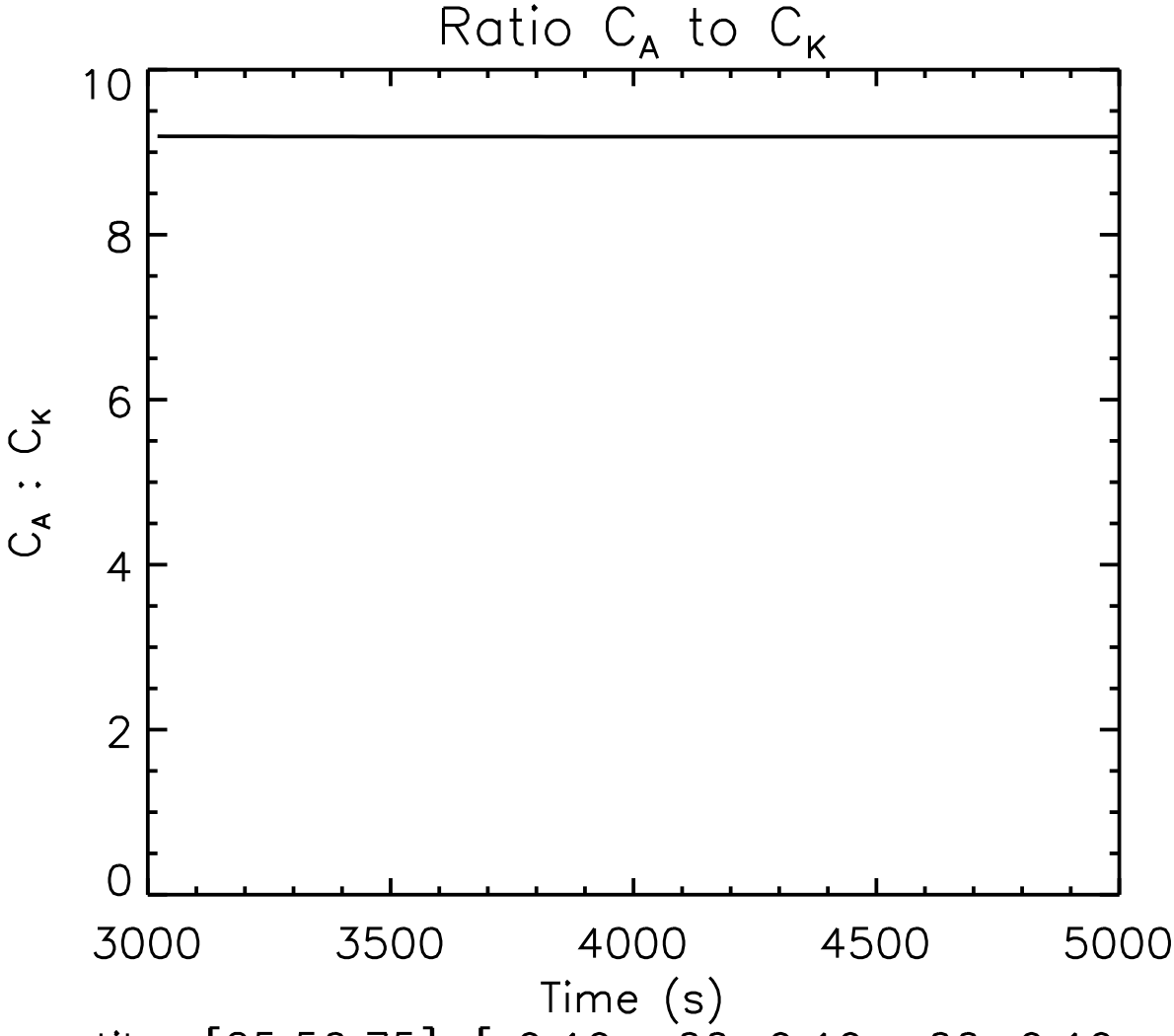

lul (cm s^{-1}) t = 4500.0s
Height (cm)
15
10
5
0
−0.04
−0.02
0.00
0.02
0.04
lul (cm s^{-1})


|v| (cm s^{-1}) t = 4500.0s
15
10
5
0
Height (cm)
−0.15
−0.10
−0.05
0.00
0.05
0.10
|v| (cm s^{-1})

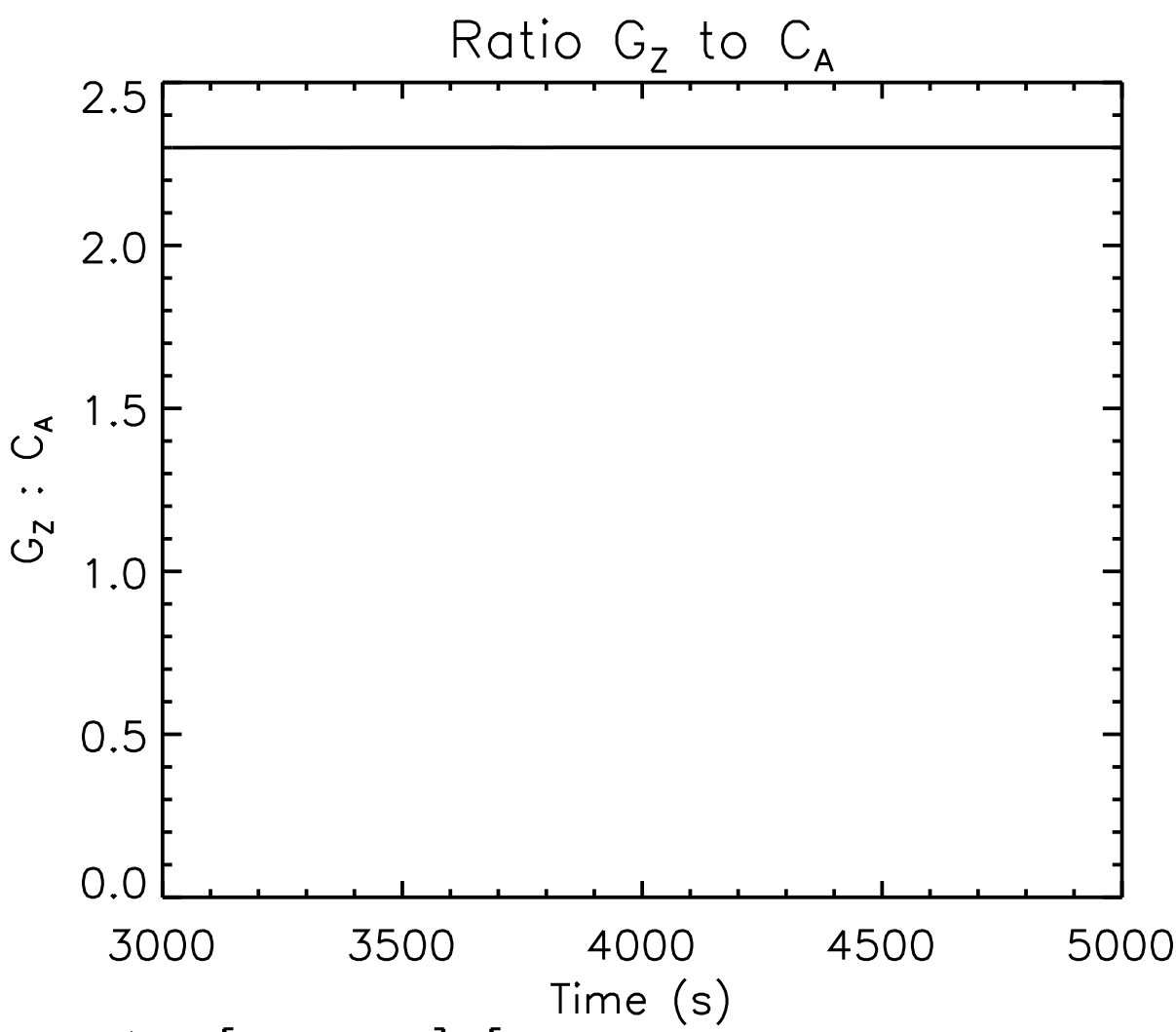

|w| (cm s^{-1}) t = 4500.0s
15
10
5
0
Height (cm)
−5.0×10^{-5}
0
5.0×10^{-5}
1.0×10^{-4}
1.5×10^{-4}
|w| (cm s^{-1})


|w'T'| (°C cm s^{-1}) t = 4500.0s
Height (cm)
15
10
5
0
−0.001
0.000
0.001
0.002
0.003
0.004
0.005
0.006
|w'T'| (°C cm s^{-1})

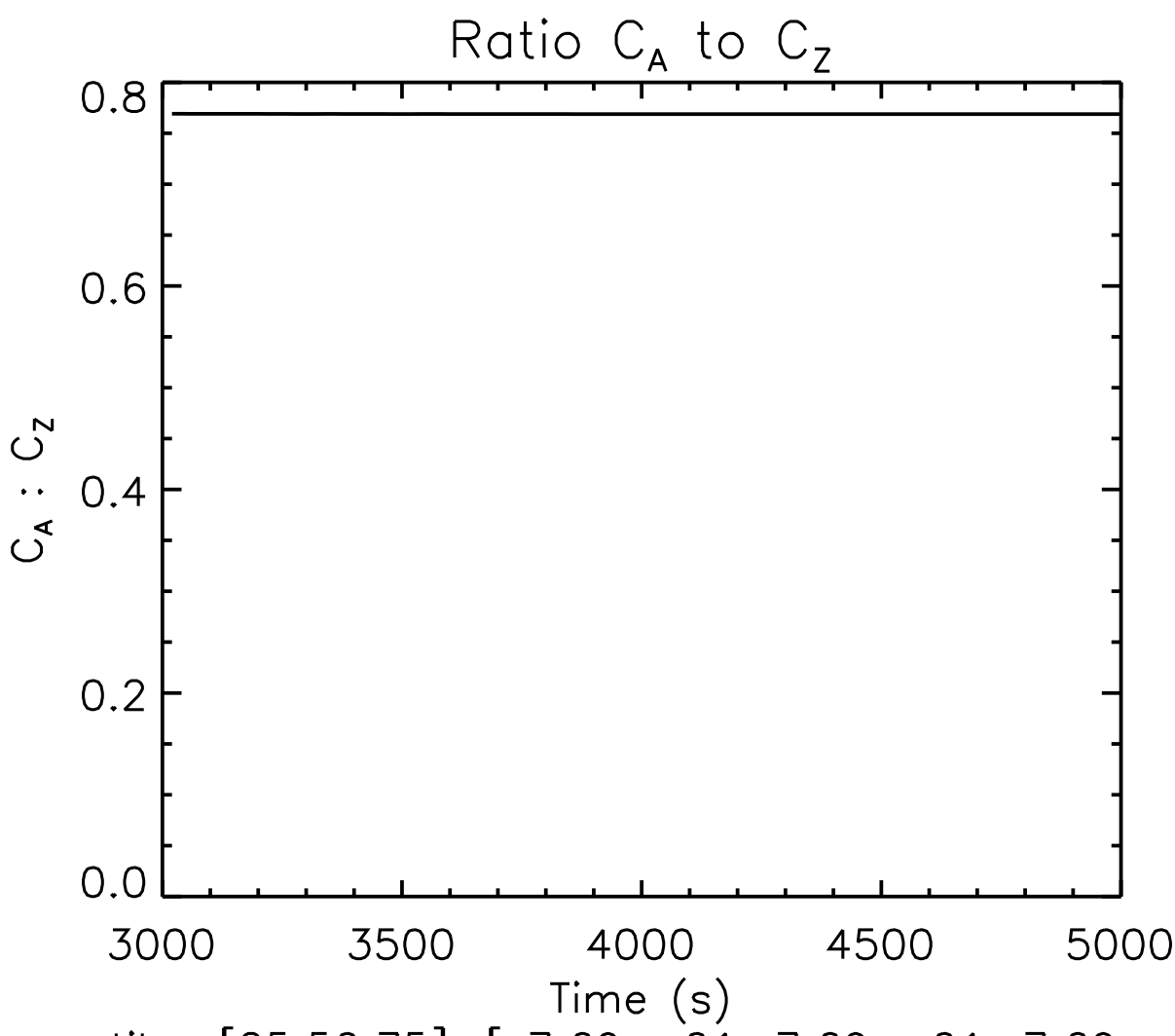

∂|T|/∂z (°C cm⁻¹) t = 4500.0s
15
10
5
0
Height (cm)
−0.2
0.0
0.2
0.4
0.6
0.8
∂|T|/∂z (°C cm⁻¹)



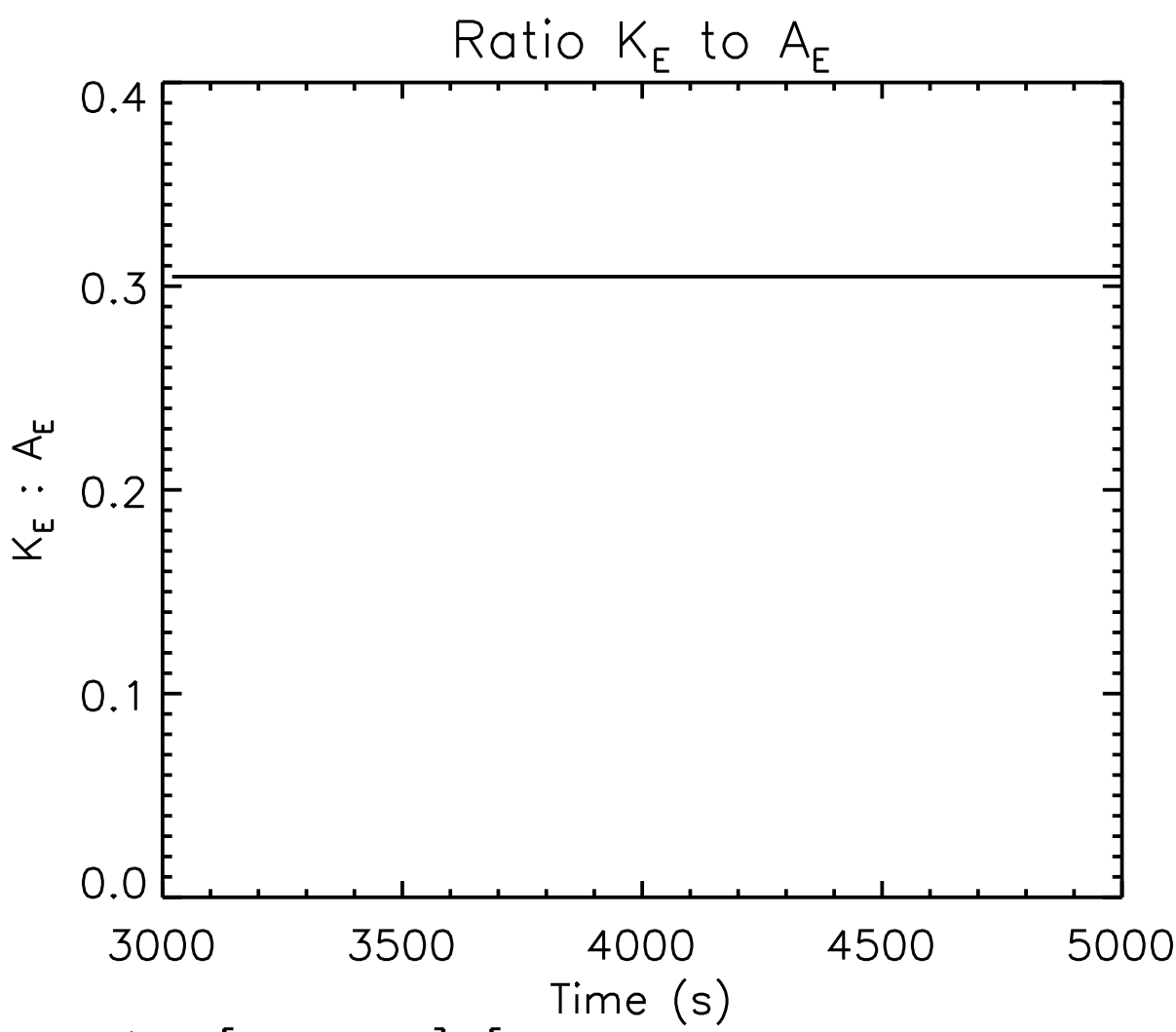
Percentiles [25,50,75]=[9.19e+00, 9.19e+00, 9.19e+00]



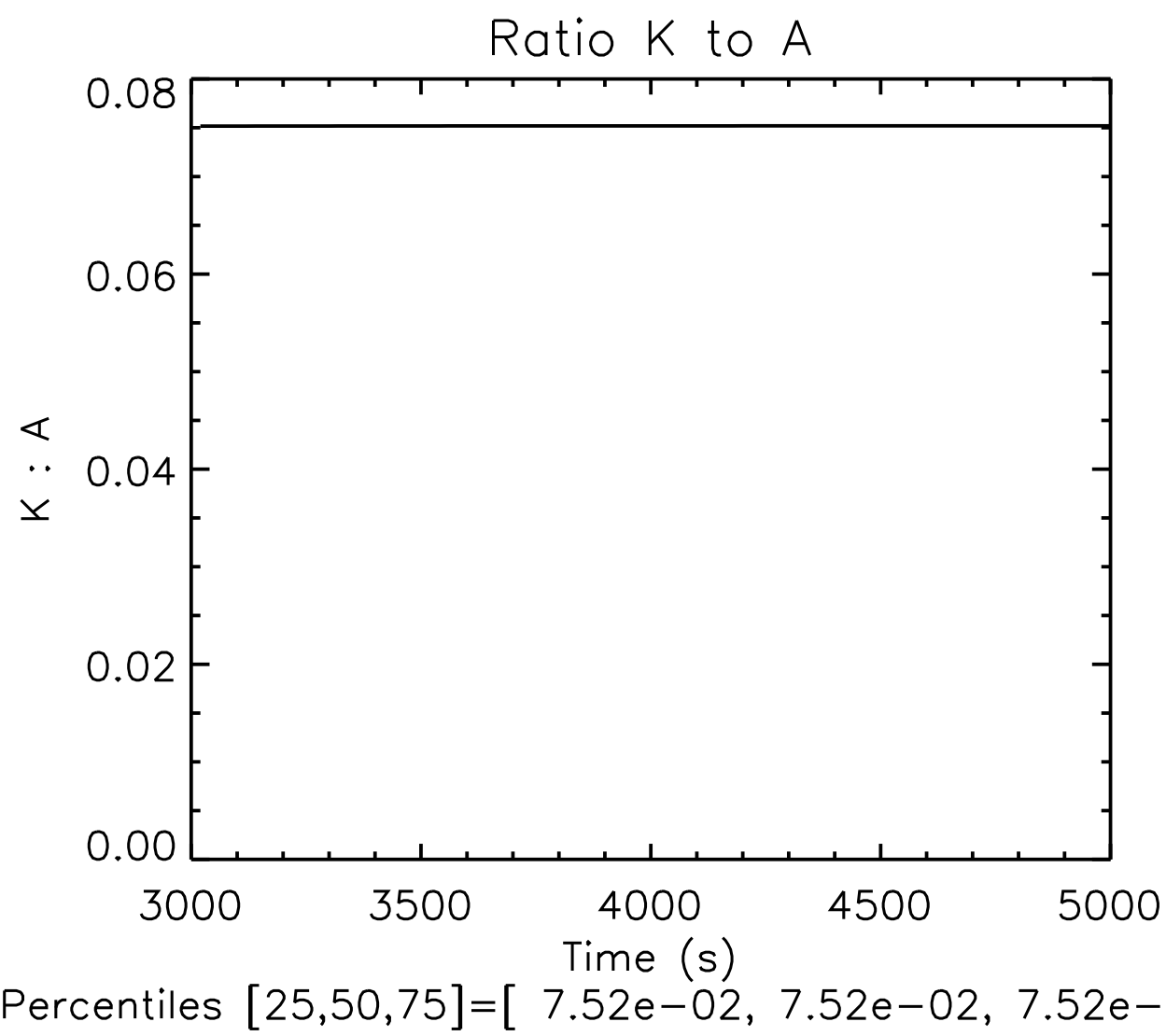
Percentiles [25,50,75]=[2.30e+00, 2.30e+00, 2.30e+00]



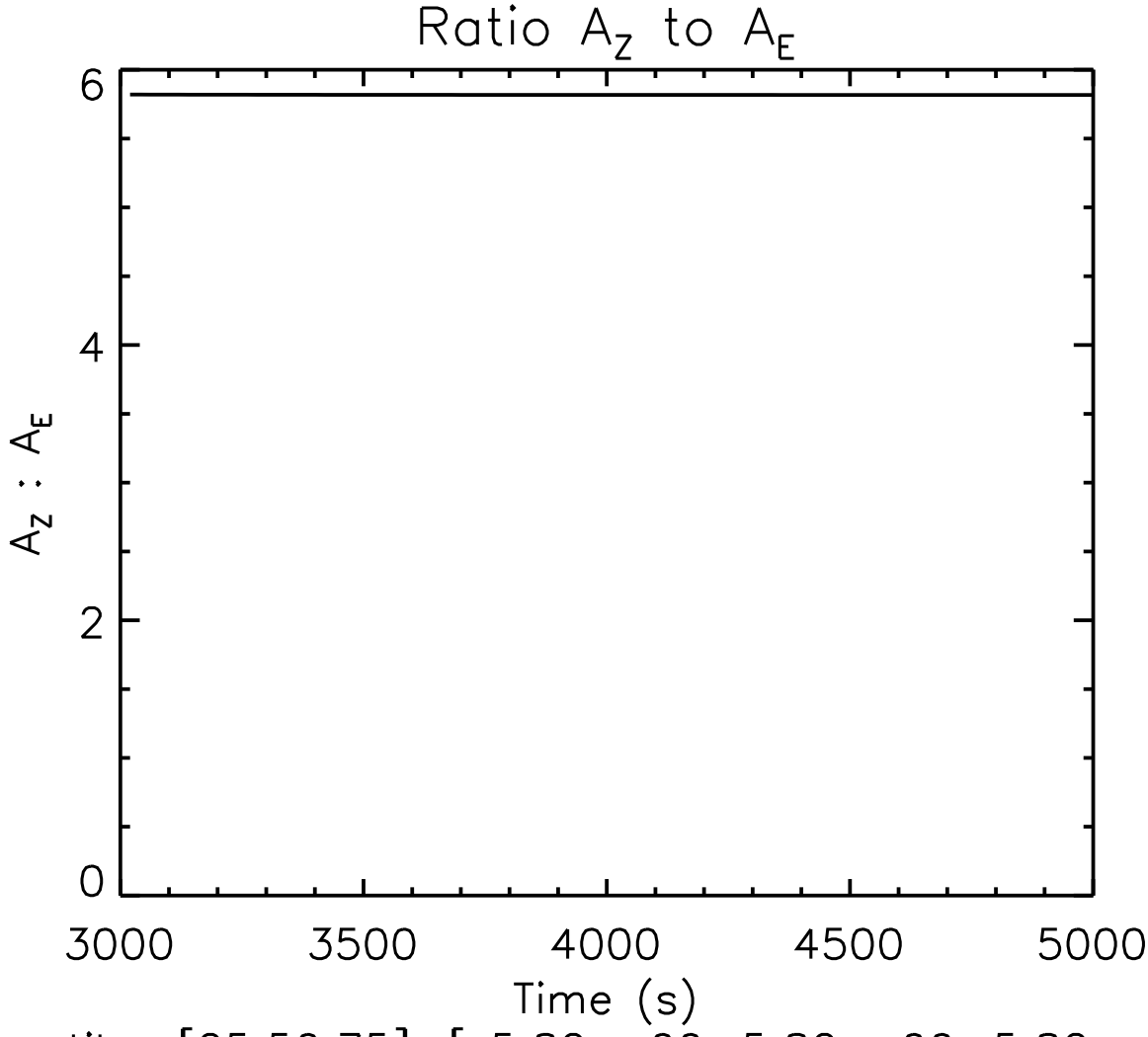
Percentiles [25,50,75]=[7.69e−01, 7.69e−01, 7.69e−01]



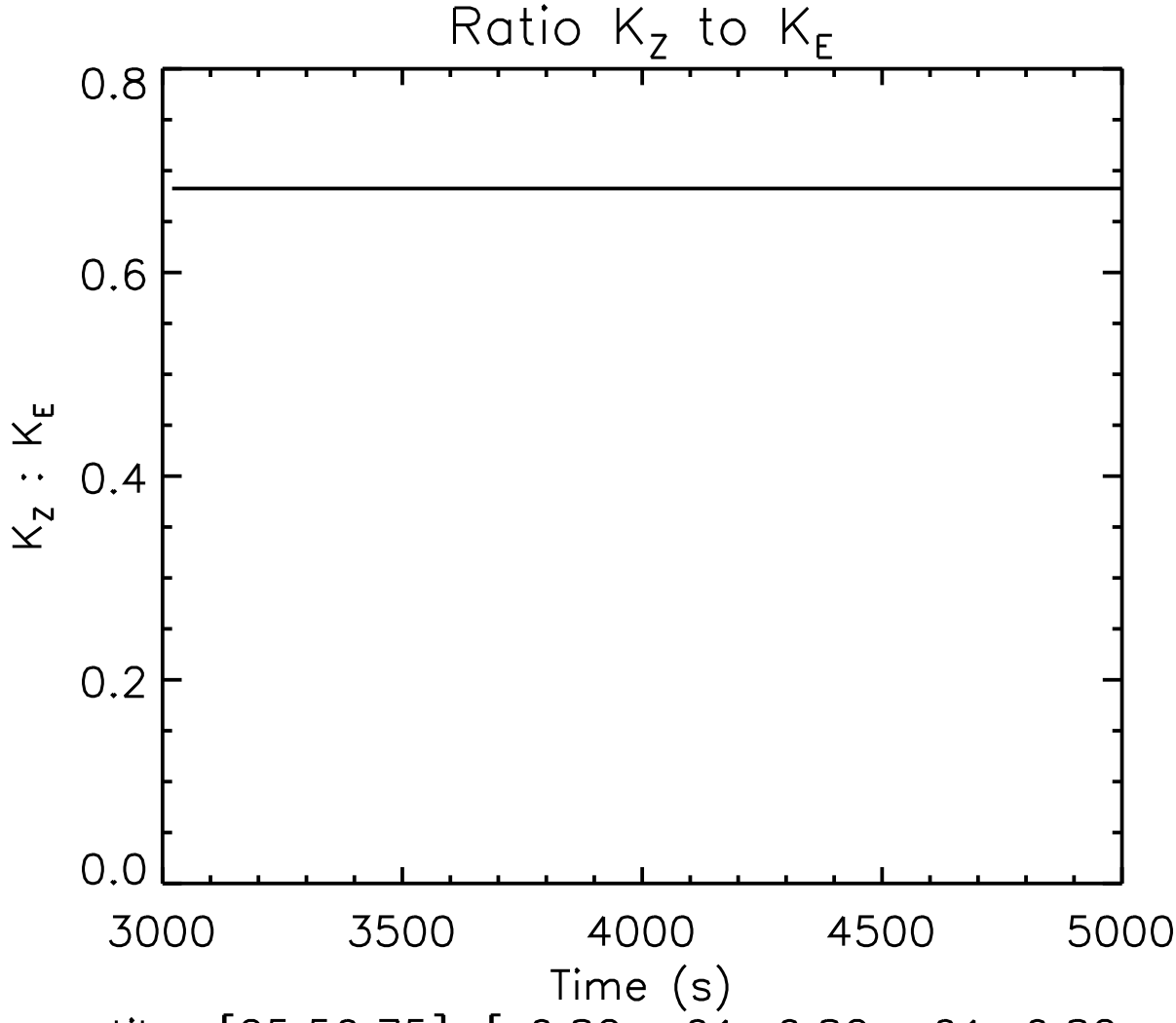
Percentiles [25,50,75]=[3.05e−01, 3.05e−01, 3.05e−01]



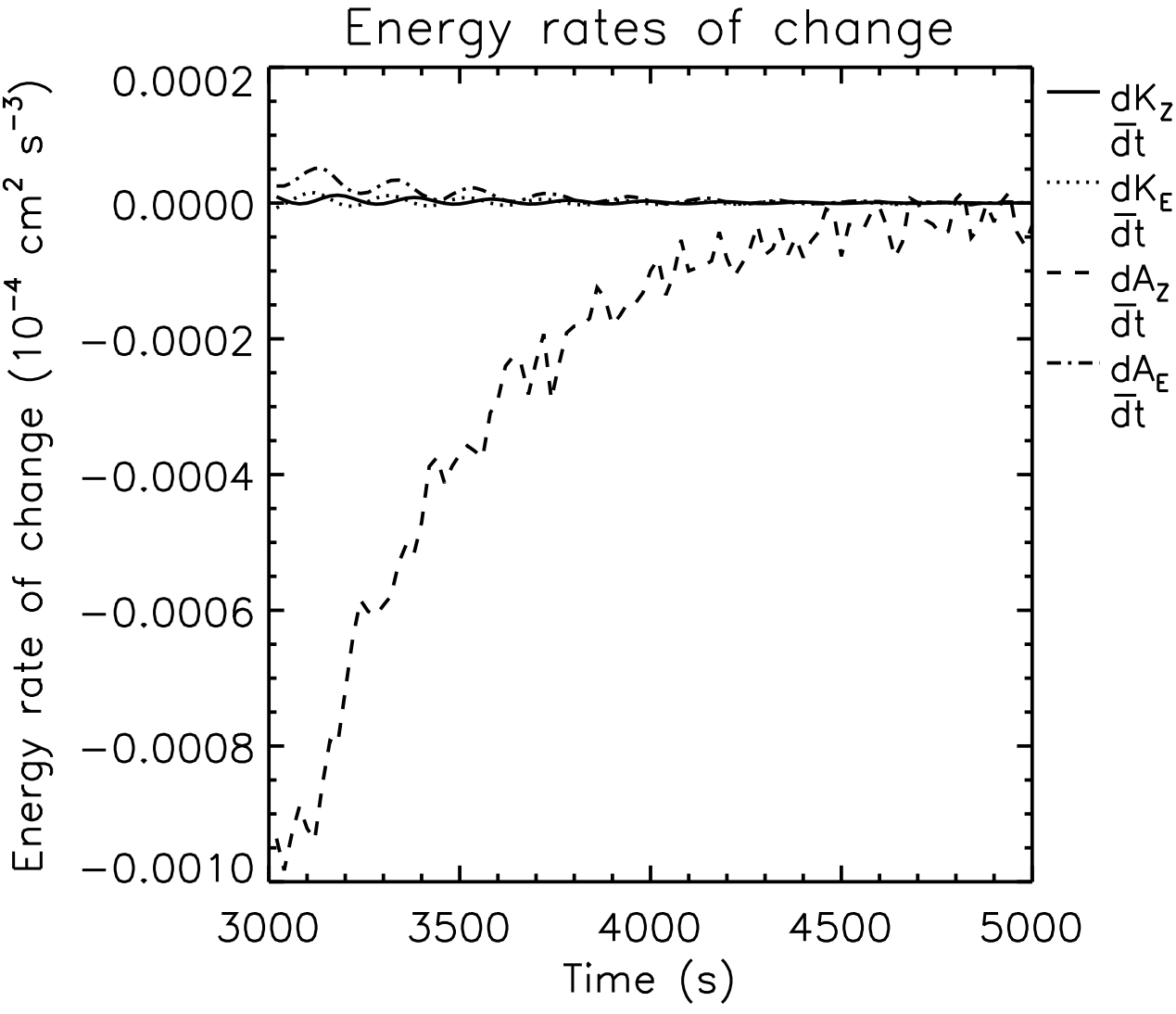
Percentiles [25,50,75]=[7.52e−02, 7.52e−02, 7.52e−02]



Percentiles [25,50,75]=[5.82e+00, 5.82e+00, 5.82e+00]



Percentiles [25,50,75]=[6.82e−01, 6.82e−01, 6.82e−01]


Energy rates of change
0.0002
0.0000
−0.0002
−0.0004
−0.0006
−0.0008
−0.0010
Energy rate of change (10^{-4} cm^2 s^{-3})
3000
3500
4000
4500
5000
Time (s)
$\frac{dK_Z}{dt}$
$\frac{dK_E}{dt}$
$\frac{dA_Z}{dt}$
$\frac{dA_E}{dt}$