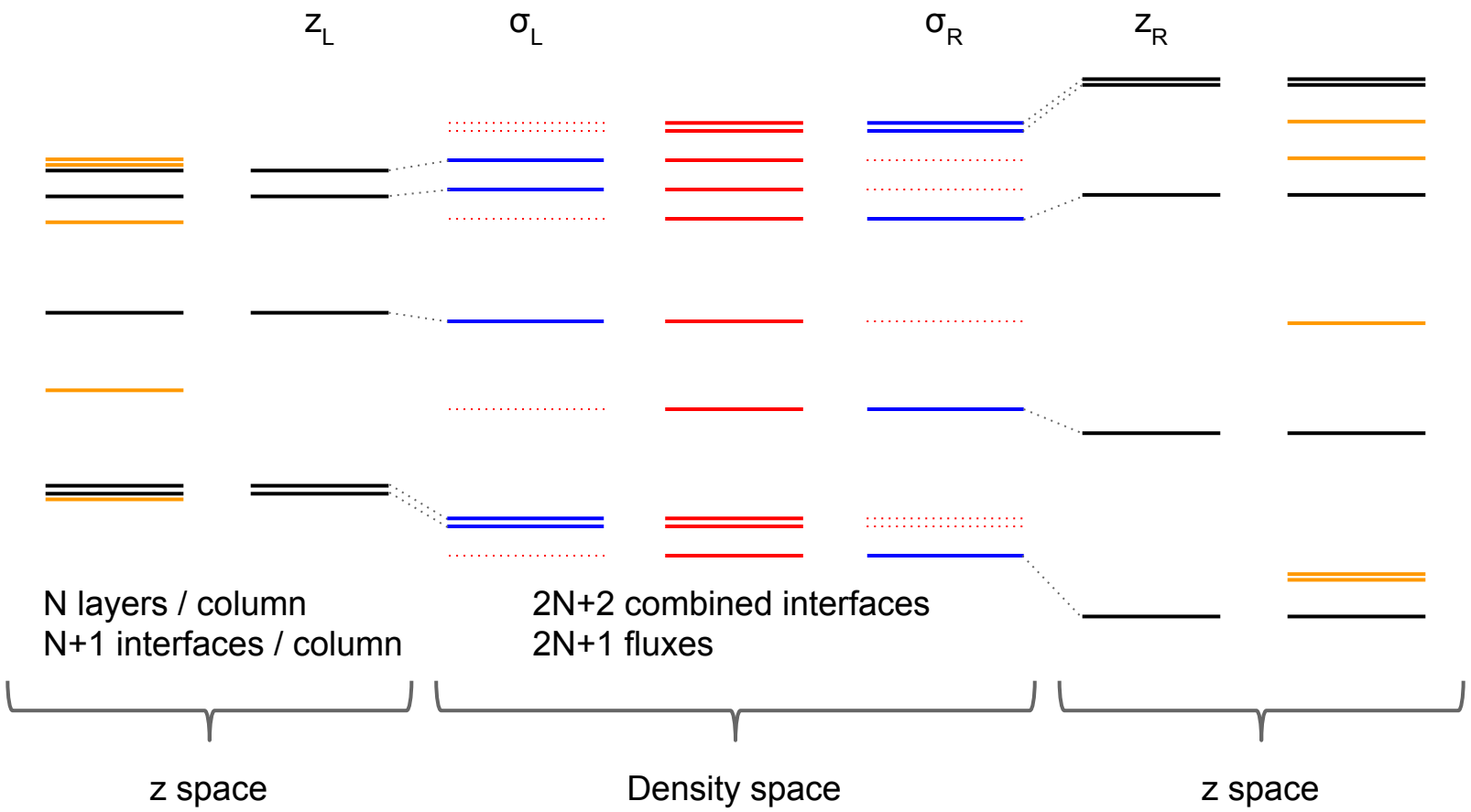
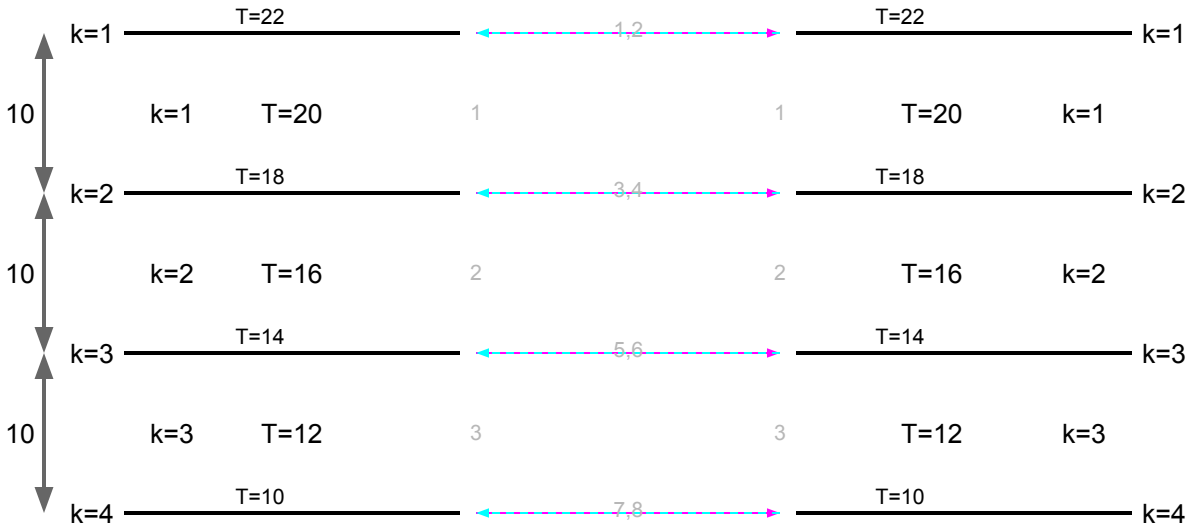

z_L
σ_L
σ_R
z_R
N layers / column
N+1 interfaces / column
2N+2 combined interfaces
2N+1 fluxes
z space
Density space
z space

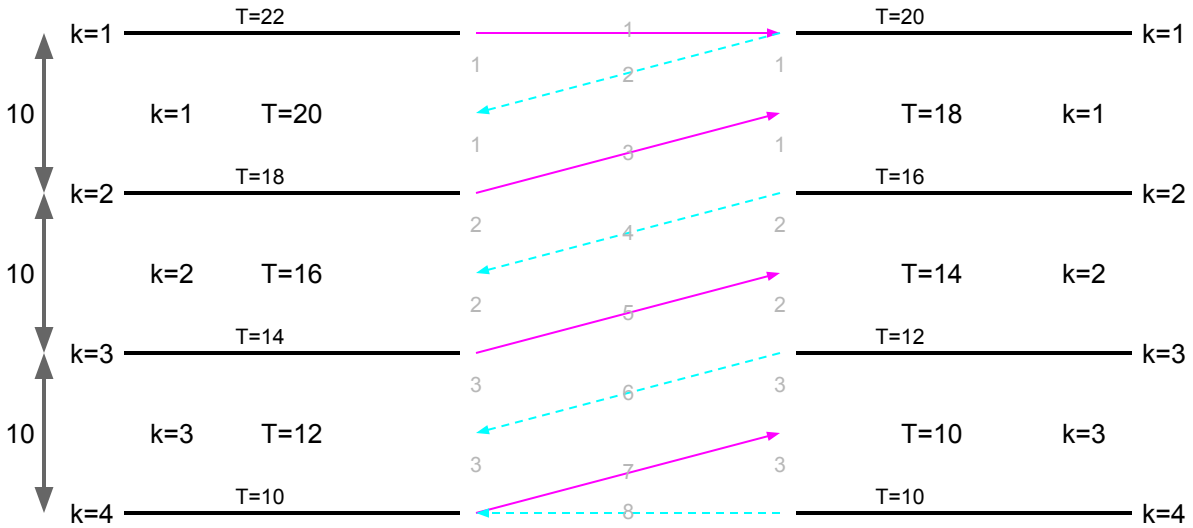
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	1	1	0	0
3	2	2	0	0
4	2	2	0	0
5	3	3	0	0
6	3	3	0	0
7	3	3	1	1
8	3	3	1	1



k_L	h_{eff}
1	0
2	10
3	0
4	10
5	0
6	10
7	0

Identical columns

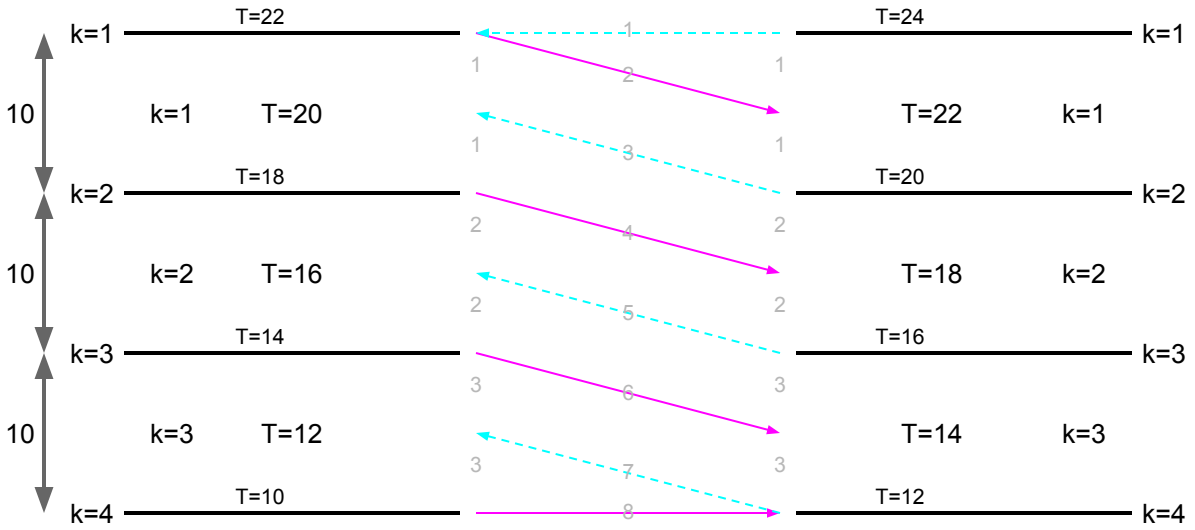
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	1	1	0.5	0
3	2	1	0	0.5
4	2	2	0.5	0
5	3	2	0	0.5
6	3	3	0.5	0
7	3	3	1	0.5
8	3	3	1	1



k_L	h_{eff}
1	0
2	5
3	5
4	5
5	5
6	5
7	0

Slightly cooler on right

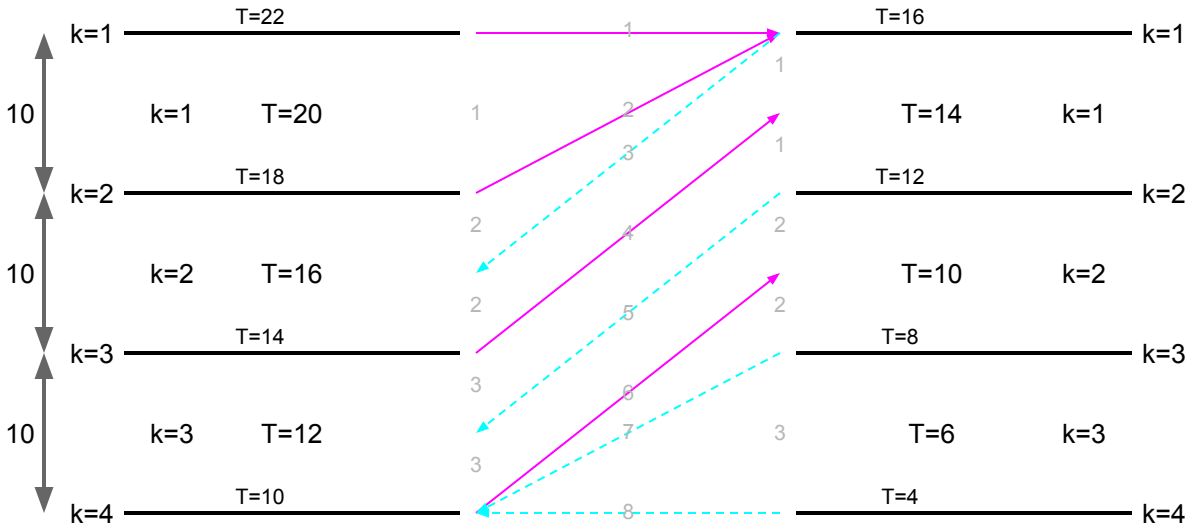
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	1	1	0	0.5
3	1	2	0.5	0
4	2	2	0	0.5
5	2	3	0.5	0
6	3	3	0	0.5
7	3	3	0.5	1
8	3	3	1	1



k_L	h_{eff}
1	0
2	5
3	5
4	5
5	5
6	5
7	0

Slightly warmer on right

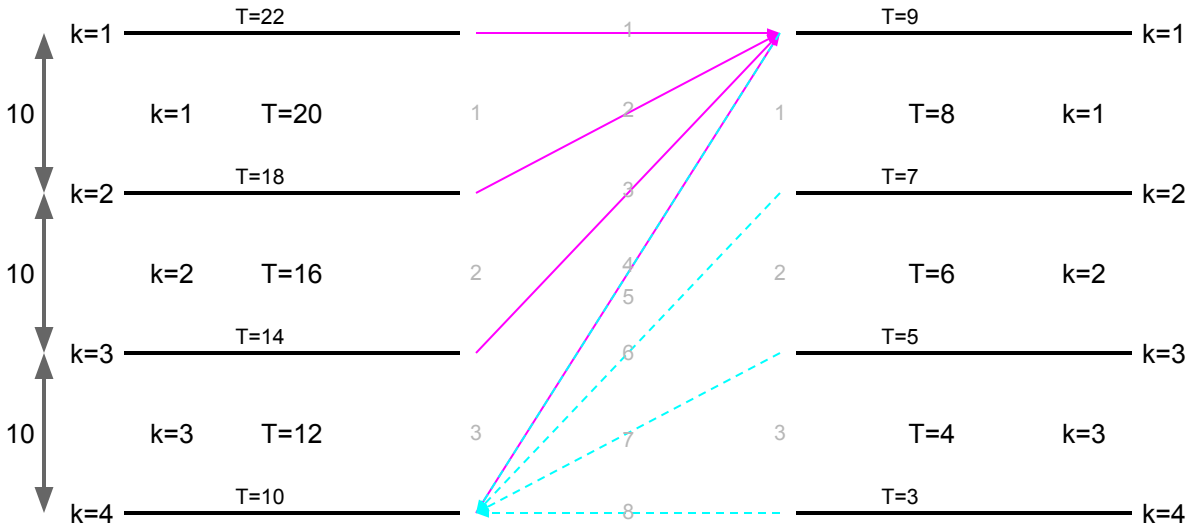
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	2	1	0	0
3	2	1	0.5	0
4	3	1	0	0.5
5	3	2	0.5	0
6	3	2	1	0.5
7	3	3	1	0
8	3	3	1	1



k_L	h_{eff}
1	0
2	0
3	5
4	5
5	5
6	0
7	0

Somewhat cooler on right

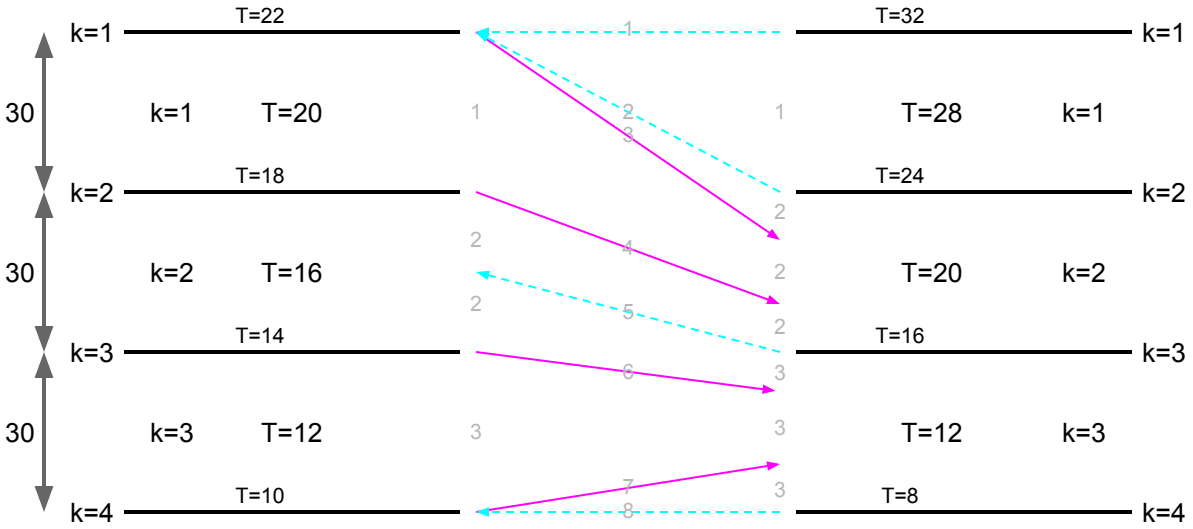
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	2	1	0	0
3	3	1	0	0
4	3	1	1	0
5	3	1	1	0
6	3	2	1	0
7	3	3	1	0
8	3	3	1	1



k_L	h_{eff}
1	0
2	0
3	0
4	0
5	0
6	0
7	0

Much cooler on right

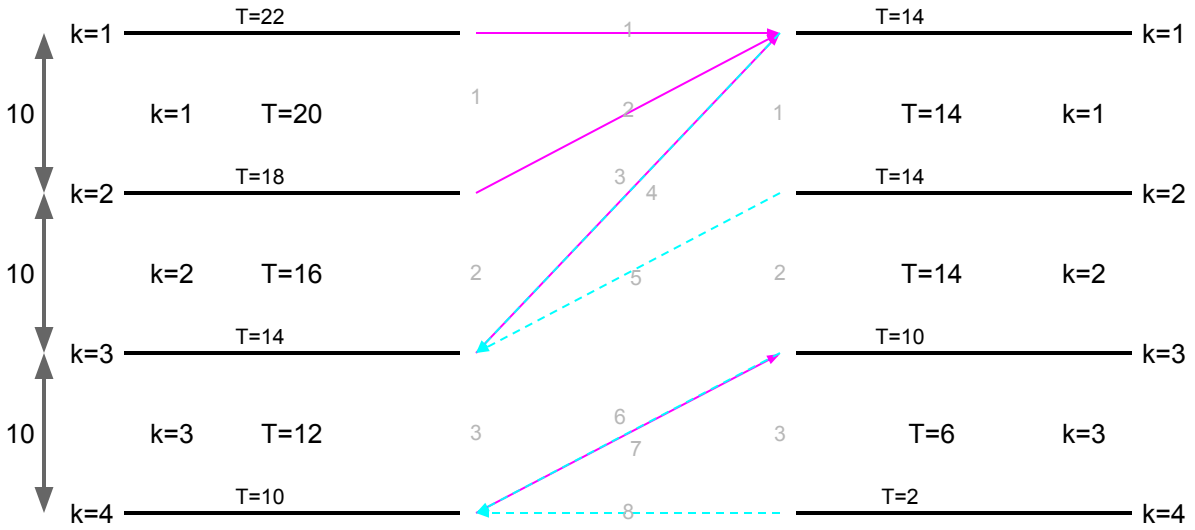
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	1	2	0	0
3	1	2	0	0.25
4	2	2	0	0.75
5	2	3	0.5	0
6	3	3	0	0.25
7	3	3	1	0.75
8	3	3	1	1



k_L	h_{eff}
1	0
2	0
3	20
4	10
5	10
6	20
7	0

More strongly stratified on right

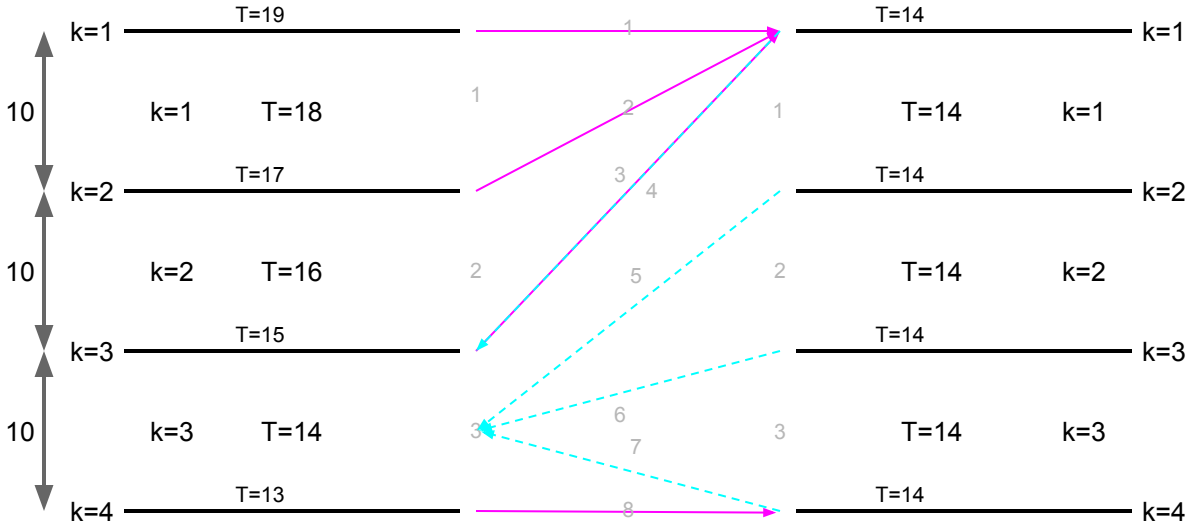
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	2	1	0	0
3	3	1	0	0
4	3	1	0	0
5	3	2	0	0
6	3	3	1	0
7	3	3	1	0
8	3	3	1	1



k_L	h_{eff}
1	0
2	0
3	0
4	0
5	10
6	0
7	0

Mixed layer on right

k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	2	1	0	0
3	3	1	0	0
4	3	1	0	0
5	3	2	0	0
6	3	3	1	0
7	3	3	1	0
8	3	3	1	1

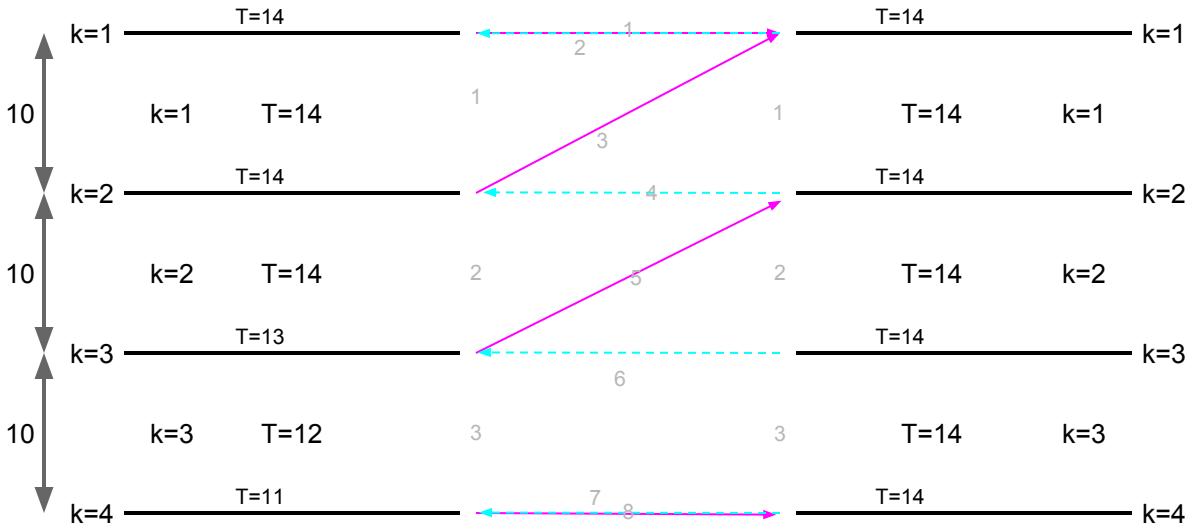


k_L	h_{eff}
1	0
2	0
3	0
4	0
5	10
6	0
7	0

Deep mixed layer on right

THIS IS CURRENTLY THE WRONG SOLUTION!!!

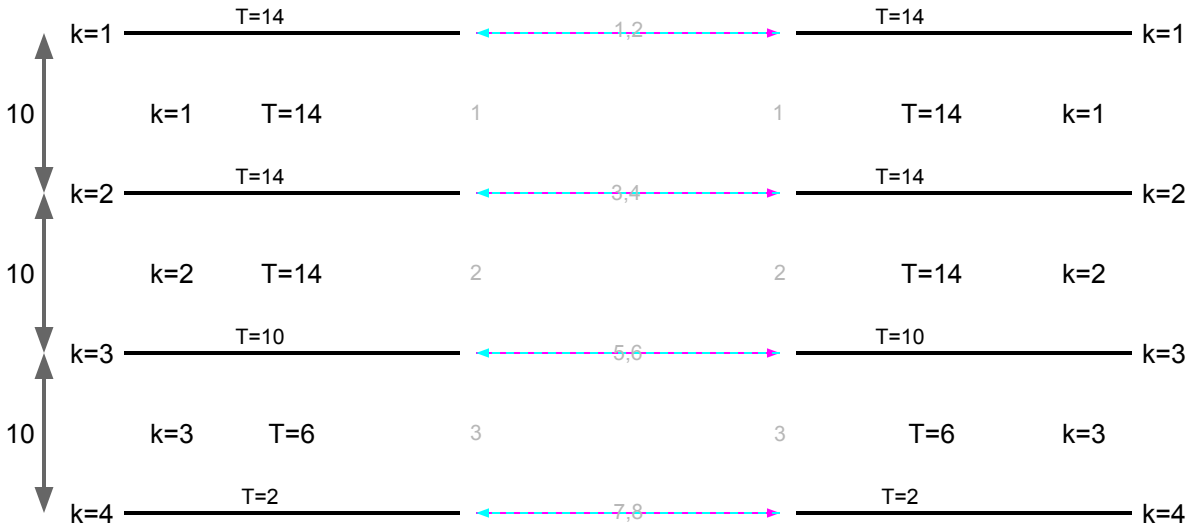
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	2	1	0	0
3	3	1	0	0
4	3	1	0	0
5	3	2	0	0
6	3	3	1	0
7	3	3	1	0
8	3	3	1	1



k_L	h_{eff}
1	0
2	0
3	0
4	0
5	10
6	0
7	0

Shallow and deep mixed layers

k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	1	1	0	0
3	2	2	0	0
4	2	2	0	0
5	3	3	0	0
6	3	3	0	0
7	3	3	1	1
8	3	3	1	1

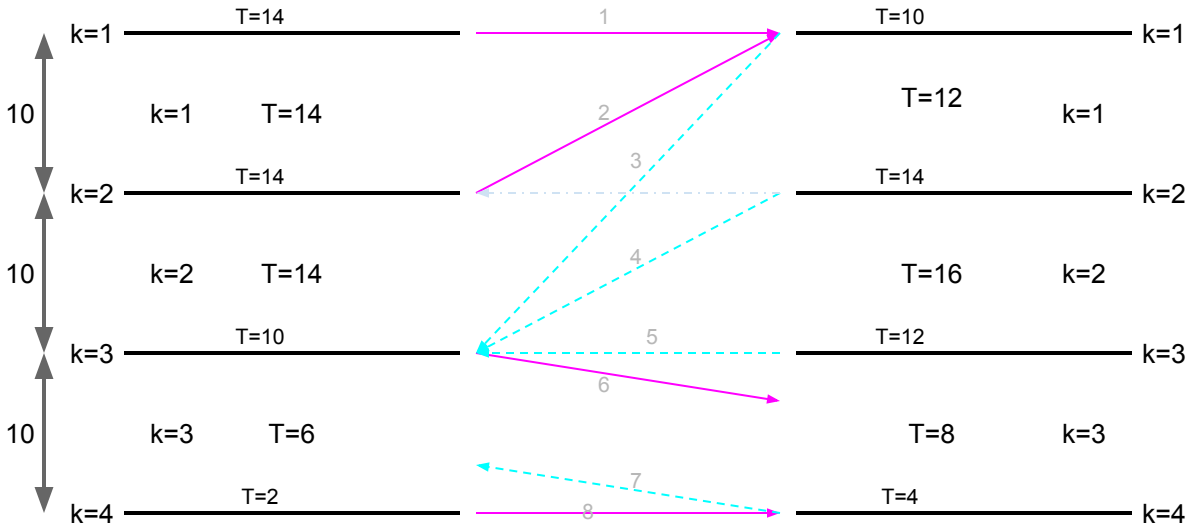


k_L	h_{eff}
1	0
2	10
3	0
4	10
5	0
6	10
7	0

Identical columns with mixed layer

THIS IS CURRENTLY THE WRONG SOLUTION!!!

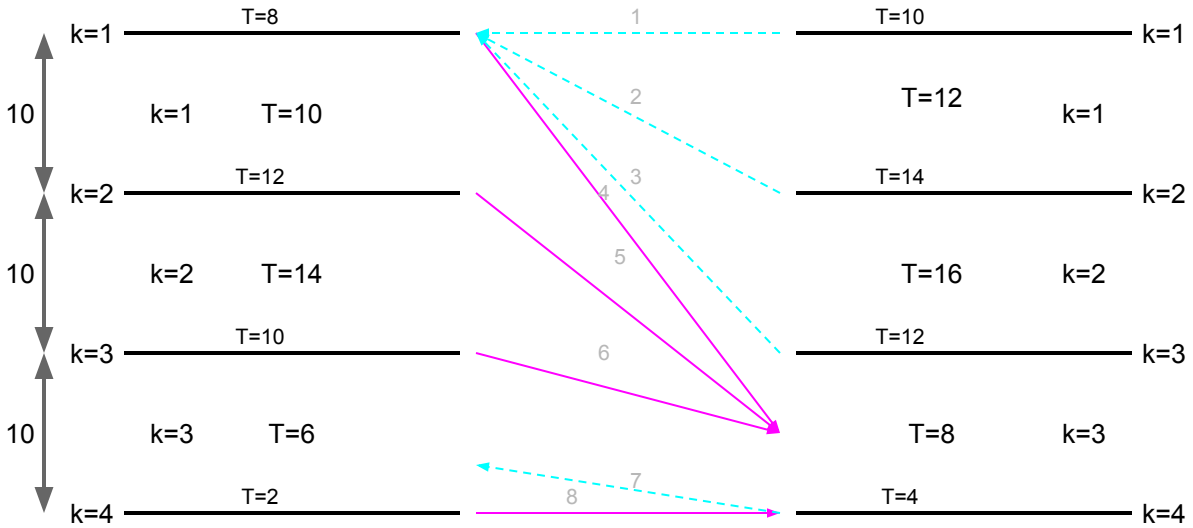
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	2	1	0	0
3	3	1	0	0
4	3	2	0	0
5	3	3	0	0
6	3	3	0	0.25
7	3	3	.75	1
8	3	3	1	1



k_L	h_{eff}
1	0
2	0
3	0
4	0
5	0
6	7.5
7	0

Right column with unstable mixed layer

k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	1	2	0	0
3	1	3	0	0
4	1	3	0	0.5
5	2	3	0	0.5
6	3	3	0	0.5
7	3	3	.75	1
8	3	3	1	1



k_L	h_{eff}
1	0
2	0
3	0
4	0
5	0
6	6
7	0

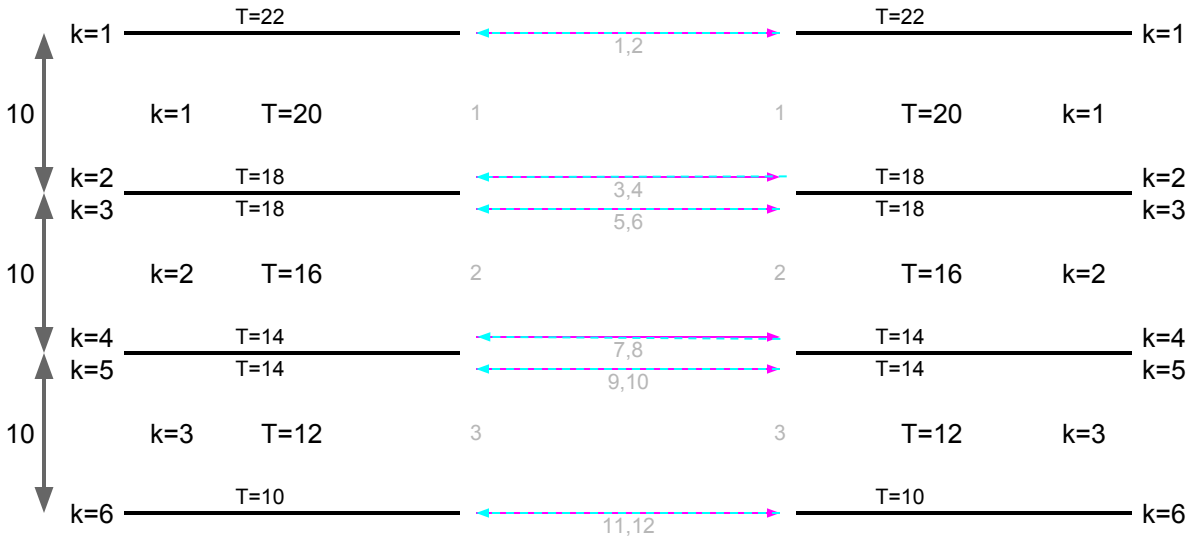
```
2x5x7.5/(5+7.5)
=2x5x3/2/(1+3/2)
=6
```

Two unstable mixed layers

DISCONTINUOUS

follow

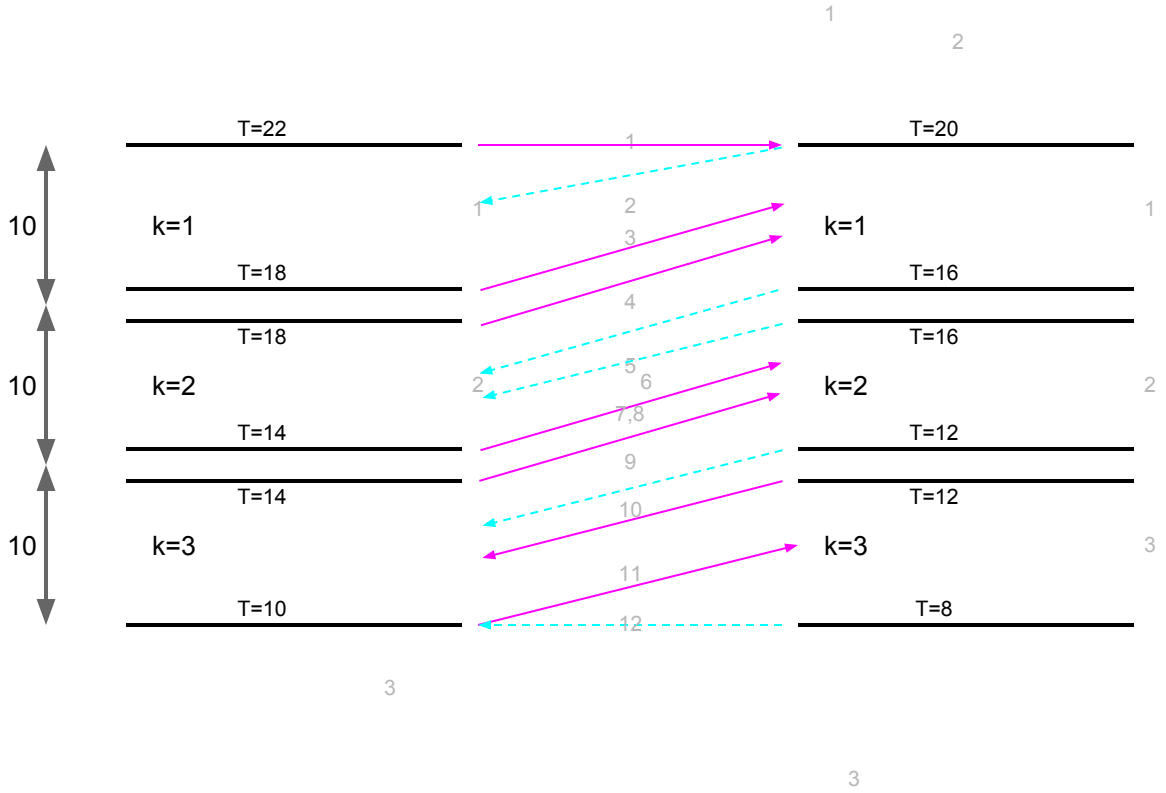
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	1	1	0	0
3	1	1	1	1
4	1	1	1	1
5	2	2	0	0
6	2	2	0	0
7	2	2	1	1
8	2	2	1	1
9	3	3	0	0
10	3	3	0	0
11	3	3	1	1
12	3	3	1	1



k_L	h_{eff}
1	0
2	0
3	10
4	0
5	0
6	0
7	10
8	0
9	0
10	0
11	10
12	0

Identical columns discontinuous reconstruction

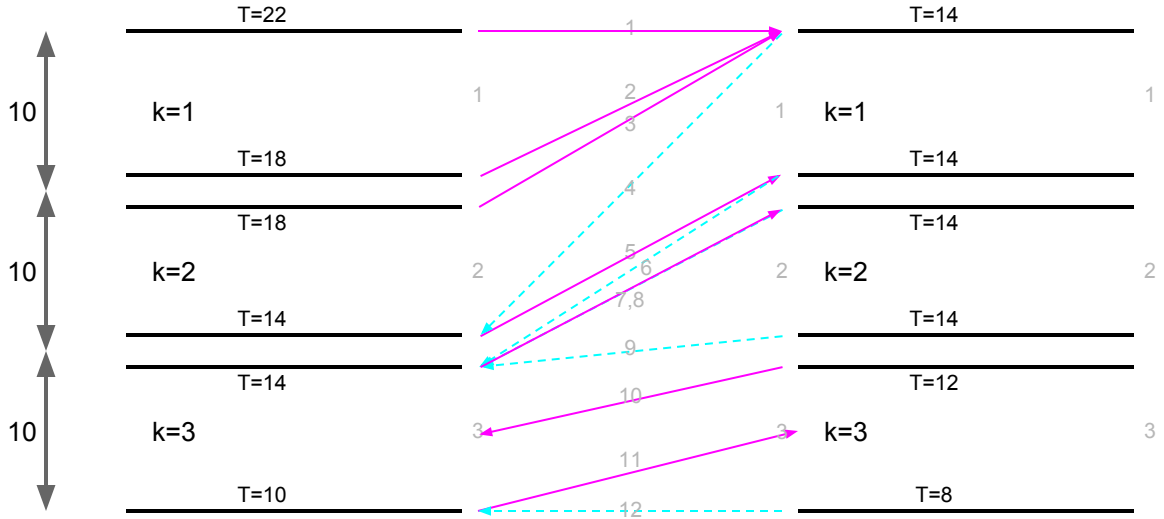
k_i	k_l	k_r	p_l	p_r
1	1	1	0.	0.
2	1	1	1.	0.
3	2	1	0.	0.
4	2	1	1.	0.
5	2	1	1.	1.
6	3	1	0.	1.
7	3	2	0.	0.
8	3	2	0.	0.
9	3	2	0.	1.
10	3	3	0.5	0.
11	3	3	1.	0.5
12	3	3	1.	1.



k_L	h_{eff}
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	5
11	0

Baroclinic zone

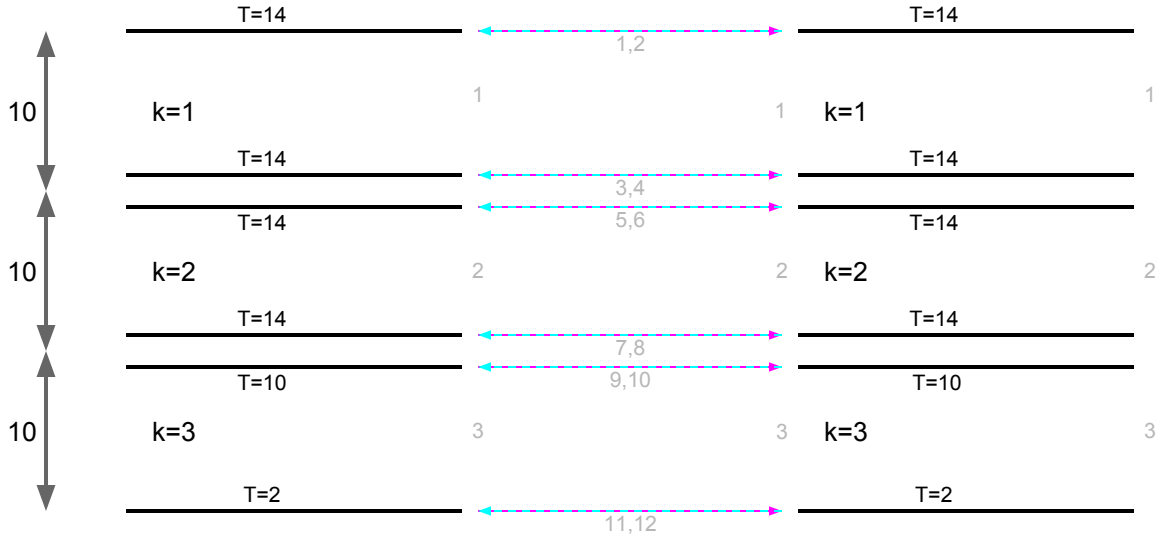
k_i	k_l	k_r	p_l	p_r
1	1	1	0.	0.
2	1	1	1.	0.
3	2	1	0.	0.
4	2	1	1.	0.
5	2	1	1.	1.
6	3	1	0.	1.
7	3	2	0.	0.
8	3	2	0.	0.
9	3	2	0.	1.
10	3	3	0.5	0.
11	3	3	1.	0.5
12	3	3	1.	1.



k_L	h_{eff}
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	5
11	0

Mixed layer on right discontinuous

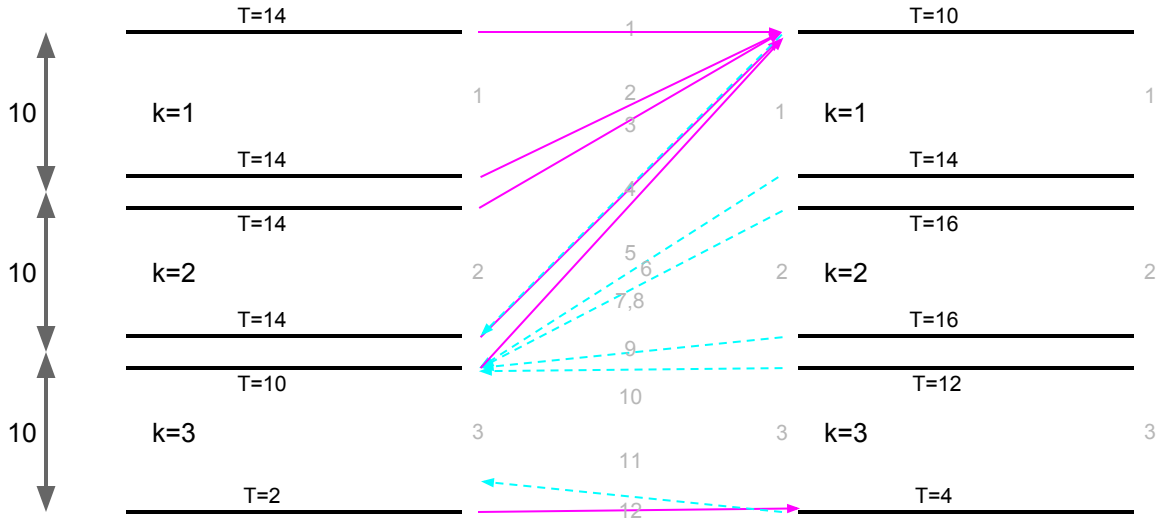
k_i	k_l	k_r	p_l	p_r
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				



Identical columns mixed layer discontinuous

k_L	h_{eff}
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

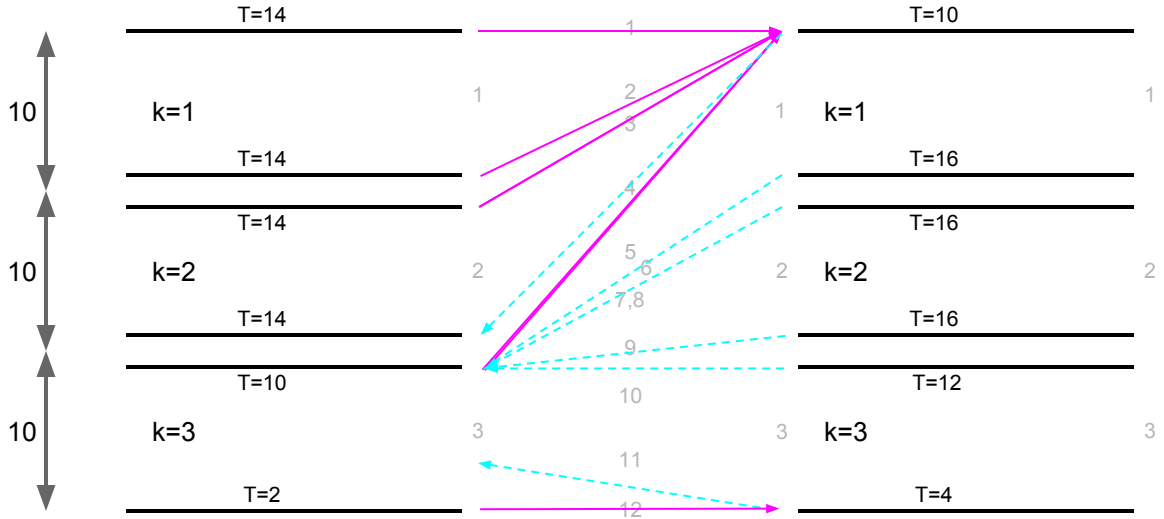
k_i	k_l	k_r	p_l	p_r
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				



Mixed layer on left, unstable mixed layer right discontinuous

k_L	h_{eff}
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

k_i	k_l	k_r	p_l	p_r
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

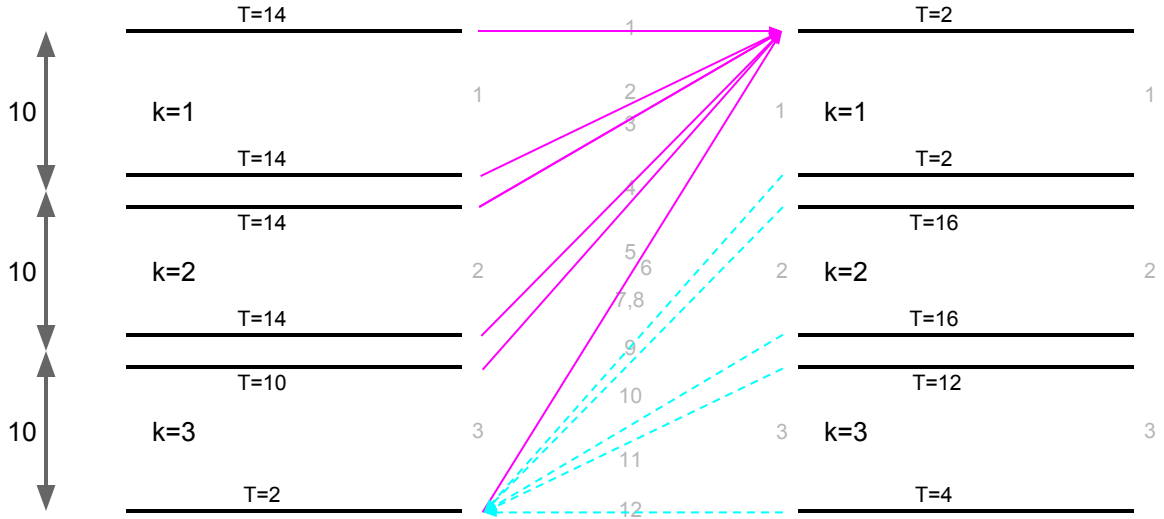


Mixed layer on left, unstable mixed layer right (warmer than left)

k_L	h_{eff}
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

k_i	k_l	k_r	p_l	p_r
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

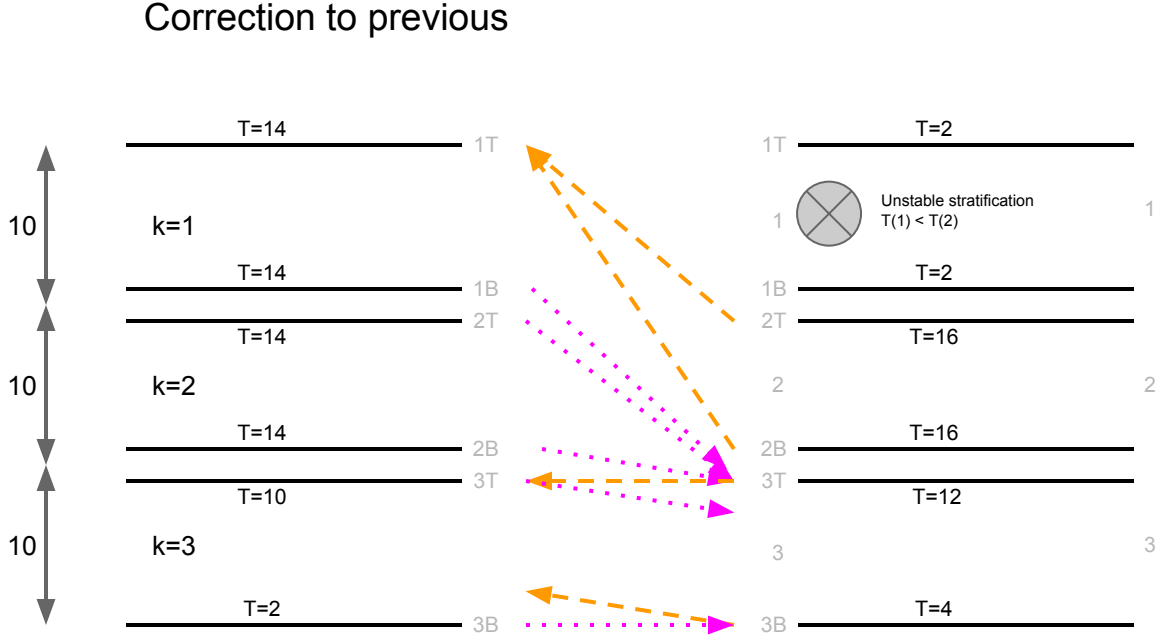
THIS IS WRONG TOO



Mixed layer on left, unstable mixed layer right (cooler than left)

k_L	h_{eff}
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

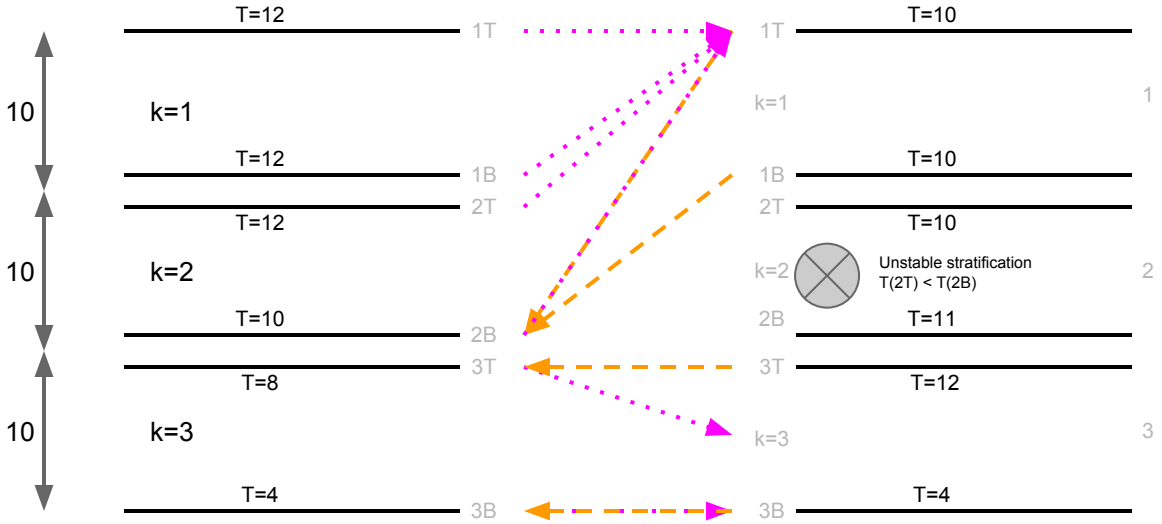
k_i	k_l	k_r	p_l	p_r
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				



Mixed layer on left, unstable mixed layer right (cooler than left)

k_L	h_{eff}
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

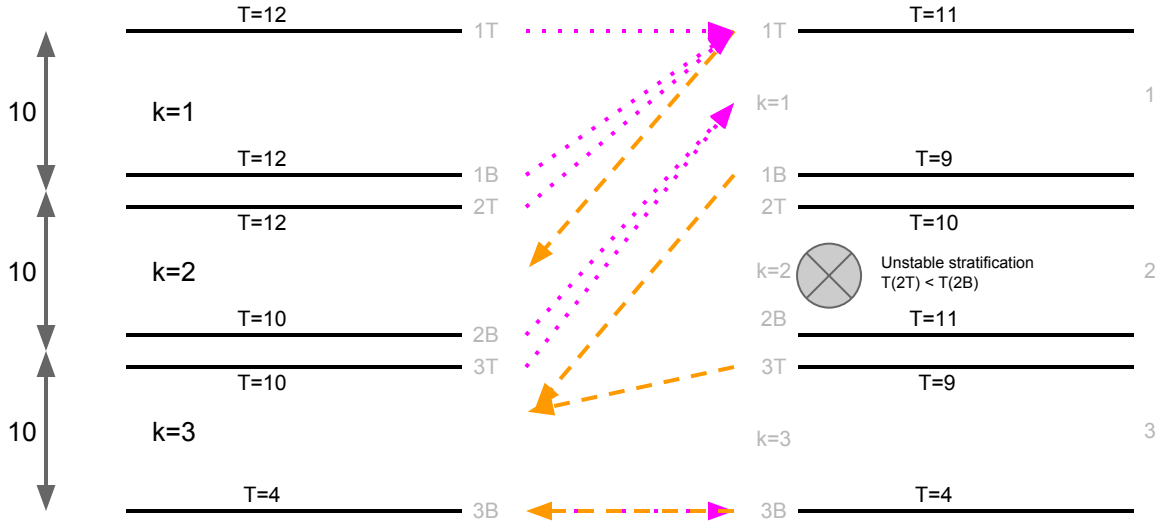
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	1	1	1	0
3	2	1	0	0
4	2	1	1	0
5	2	1	1	0
6	2	1	1	1
7	3	3	0	0
8	3	3	0	0.5
9	3	3	1	1
10	3	3	1	1
11	-	-	-	-
12	-	-	-	-



k_L	h_{eff}
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	6.7
9	0
10	-
11	-

Mixed layer on left, unstable mixed layer right

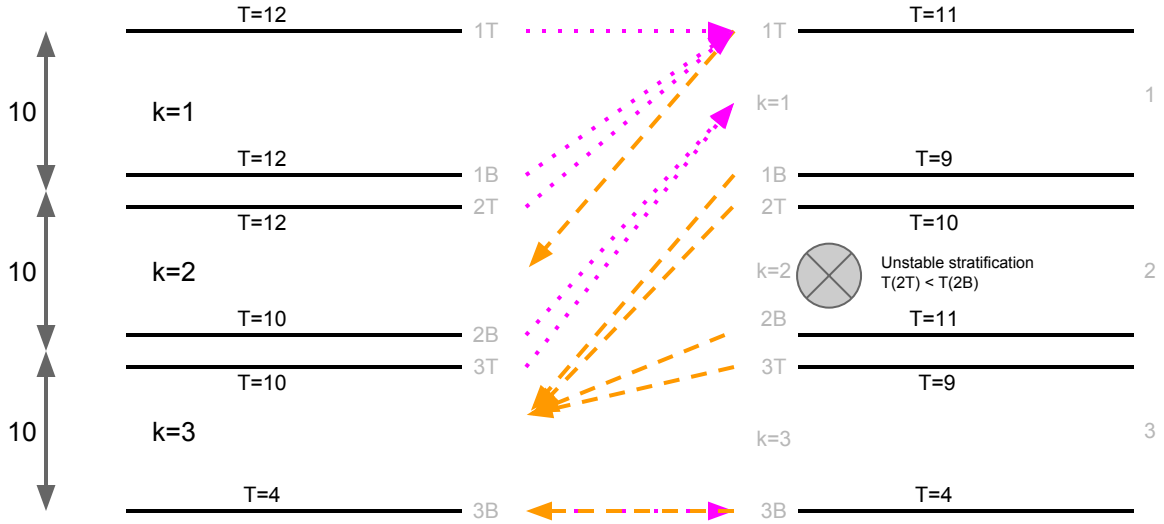
k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	1	1	1	0
3	2	1	0	0
4	2	1	1	0
5	2	1	1	0
6	2	1	1	1
7	3	3	0	0
8	3	3	0	0.5
9	3	3	1	1
10	3	3	1	1
11	-	-	-	-
12	-	-	-	-



k_L	h_{eff}
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	6.7
9	0
10	-
11	-

Option 1: Mixed layer on left, unstable layer in middle on right

k_i	k_l	k_r	p_l	p_r
1	1	1	0	0
2	1	1	1	0
3	2	1	0	0
4	2	1	1	0
5	2	1	1	0
6	2	1	1	1
7	3	3	0	0
8	3	3	0	0.5
9	3	3	1	1
10	3	3	1	1
11	-	-	-	-
12	-	-	-	-

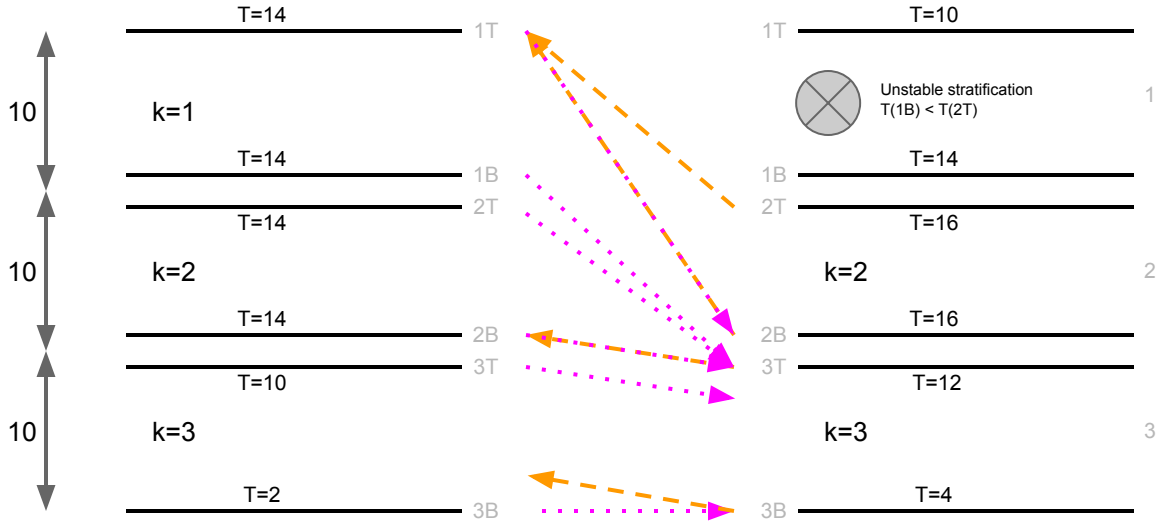


k_L	h_{eff}
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	6.7
9	0
10	-
11	-

Option 2: Mixed layer on left, unstable layer in middle on right

k_i	k_l	k_r	p_l	p_r
1	1	2	0	0
2	1	2	0	1
3	1	2	1	1
4	1	3	1	0
5	2	3	1	0
6	2	3	1	0
7	2	3	1	0
8	3	3	0	0.25
9	3	3	0.75	1
10	3	3	1	1
11	-	-	-	-
12	-	-	-	-

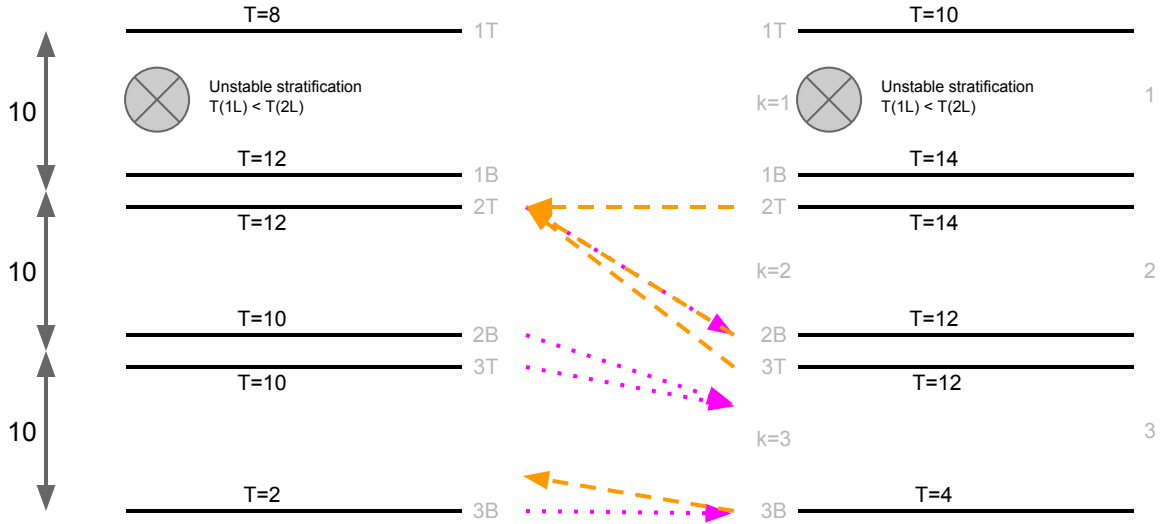
Proposed Solution



k_L	h_{eff}
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	8
9	0
10	-
11	-

Mixed layer on left, unstable mixed layer right

k_i	k_l	k_r	p_l	p_r
1	2	2	0	0
2	2	2	0	1
3	2	2	0	1
4	2	3	0	0
5	2	3	1	0.2
6	3	3	0	0.2
7	3	3	0.8	1
8	3	3	1	1
9	-	-	-	-
10	-	-	-	-
11	-	-	-	-
12	-	-	-	-

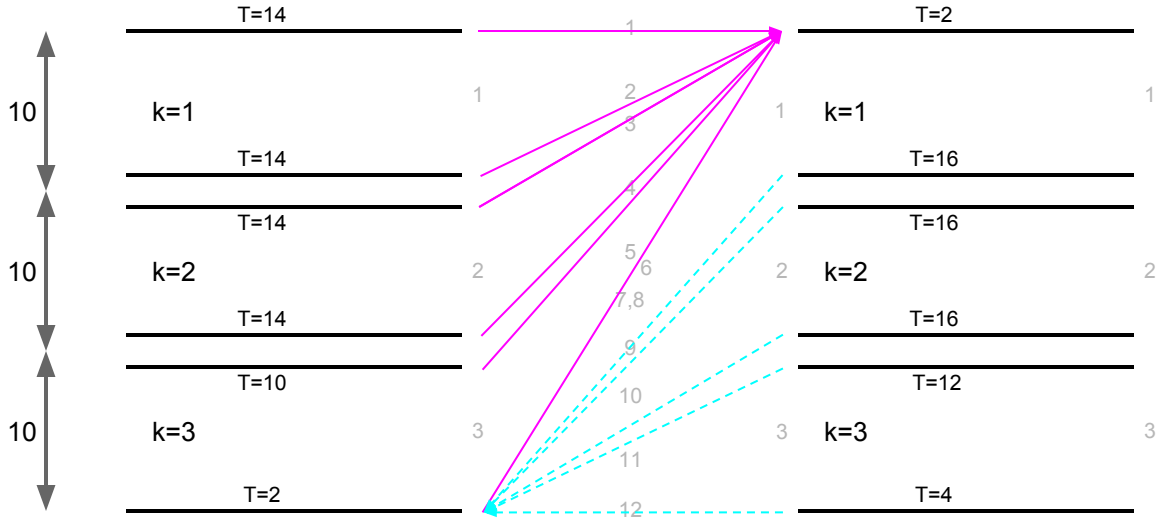


k_L	h_{eff}
1	0
2	0
3	0
4	3.33
5	0
6	8
7	0
8	-
9	-
10	-
11	-

Two unstable mixed layers

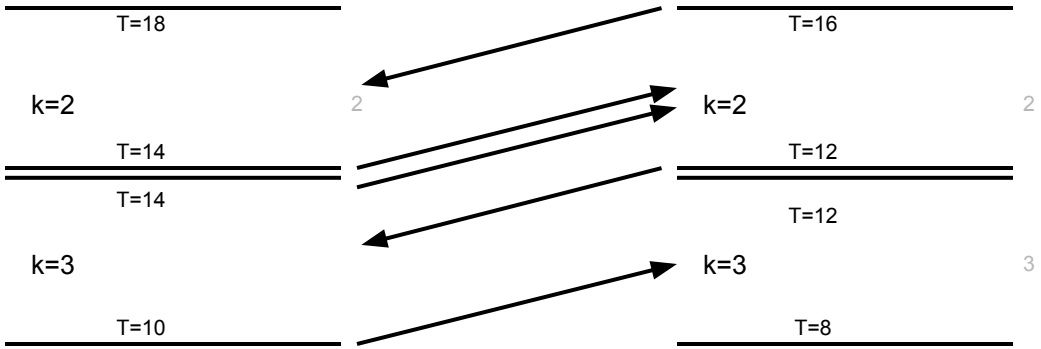
k_i	k_l	k_r	p_l	p_r
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

THIS IS WRONG TOO



Mixed layer on left, unstable mixed layer right (cooler than left)

k_L	h_{eff}
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	



Necessity for flux limiters

Baroclinic zone