

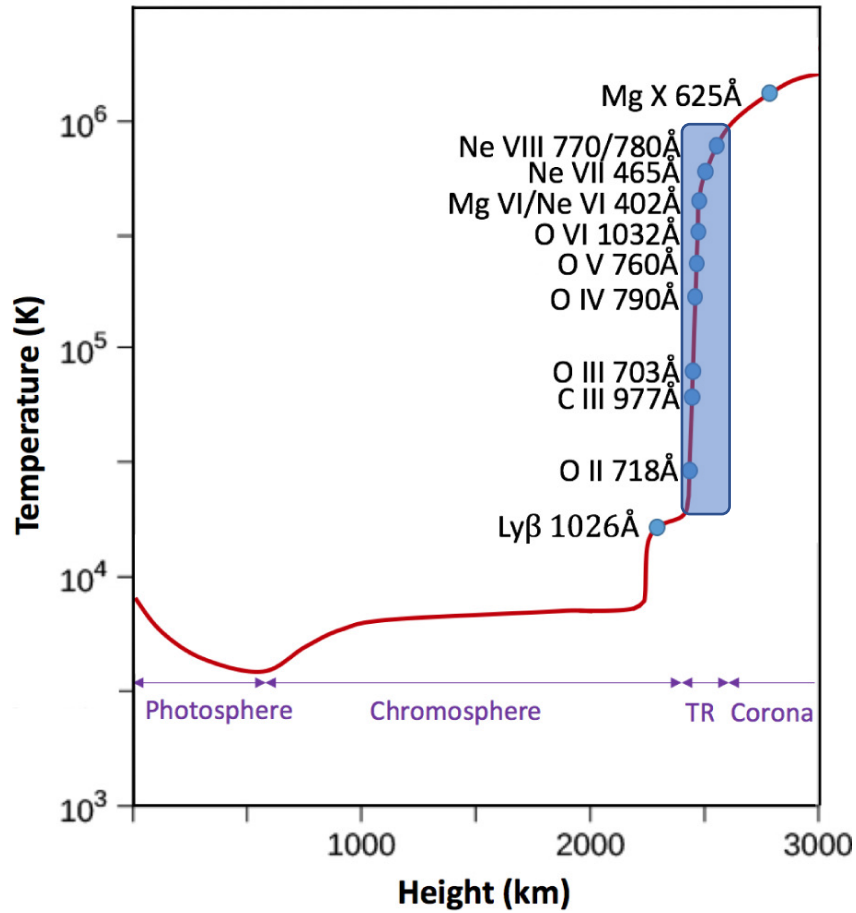
Doppler shifts of spectral lines formed in the solar transition region and corona

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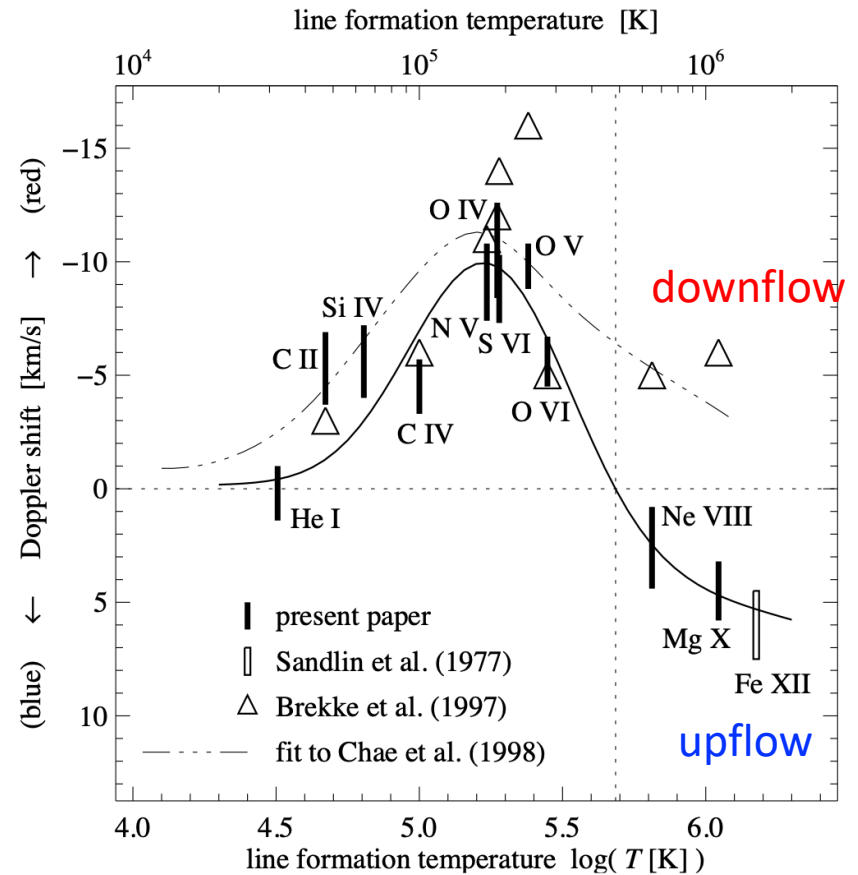
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Solar transition region

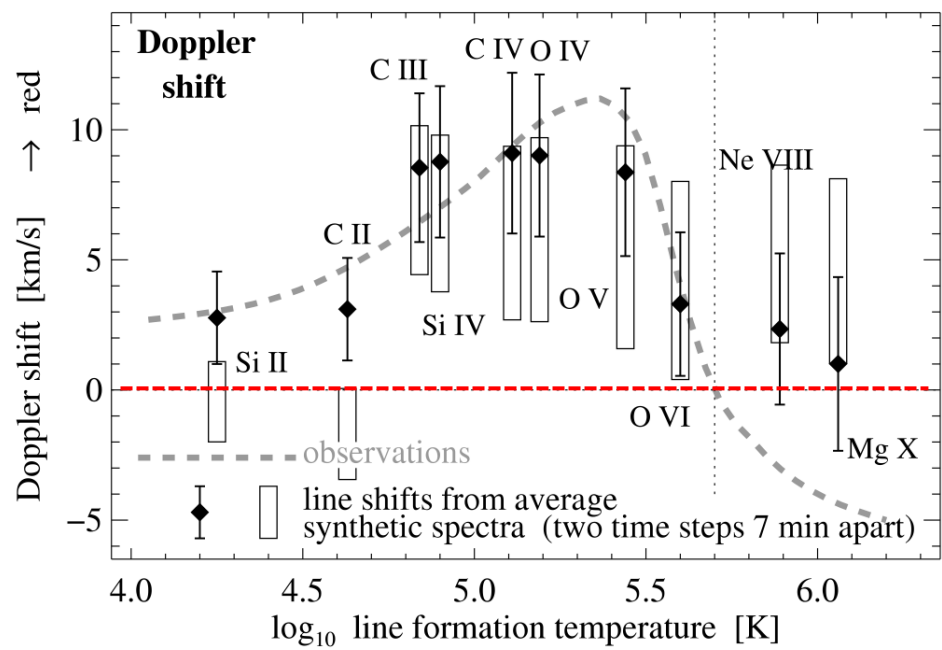


Tian 2017, RAA

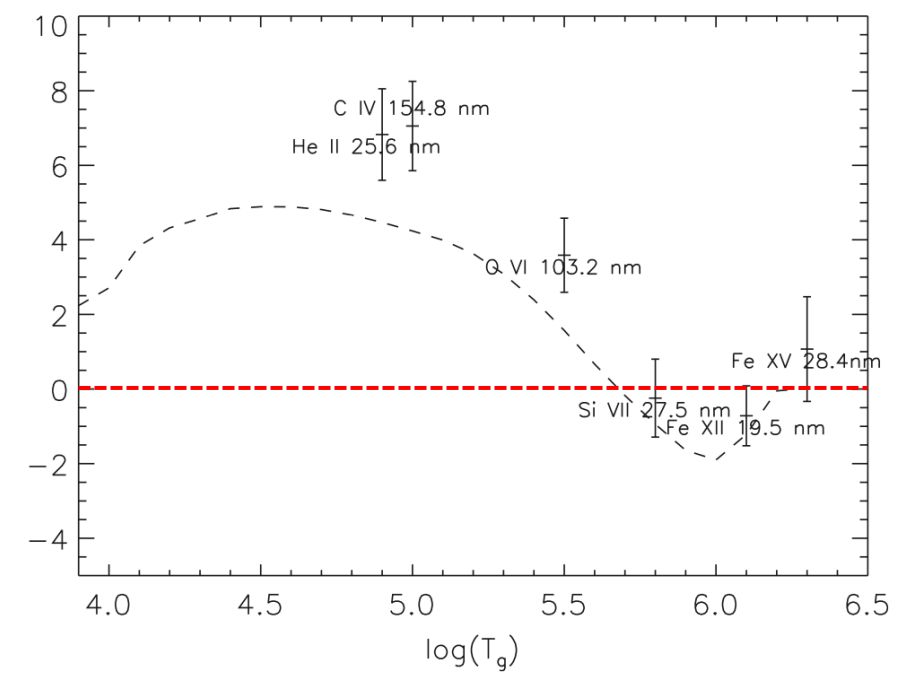


Peter & Judge 1999, ApJ

Doppler shifts of spectral lines in previous 3D models



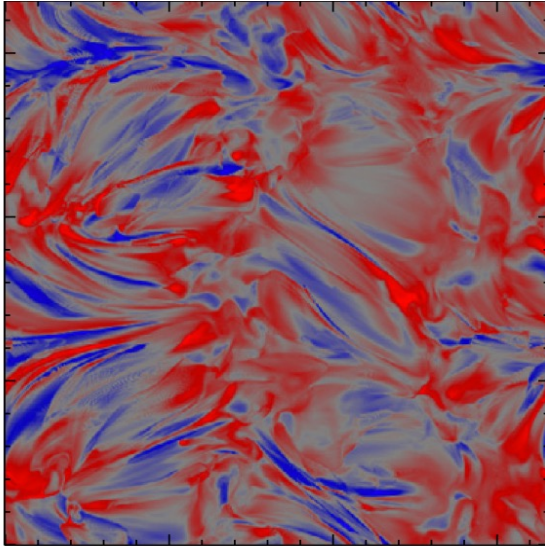
Peter et al. 2006, ApJ



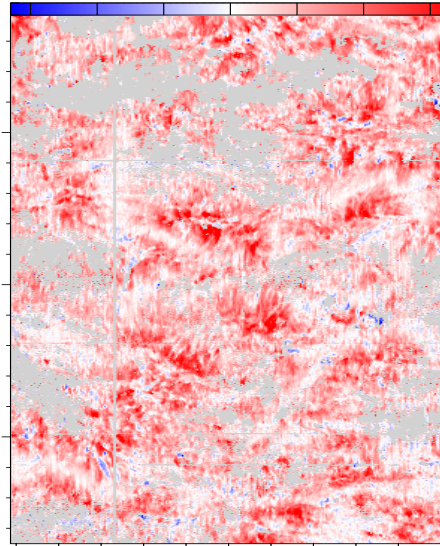
Hansteen et al. 2010, ApJ

Doppler shifts of the transition region line

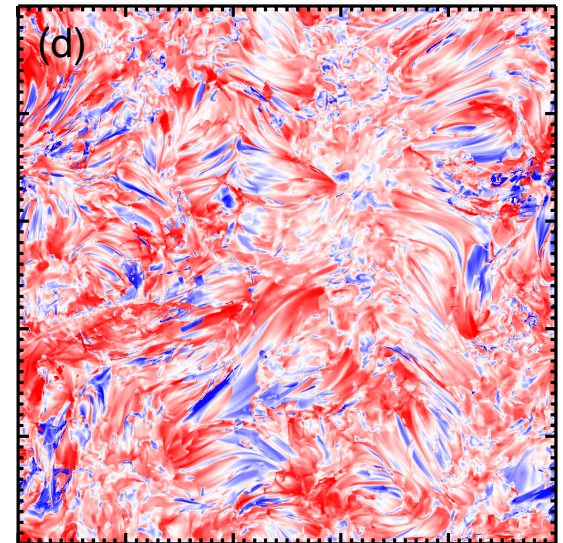
Previous model



IRIS observations



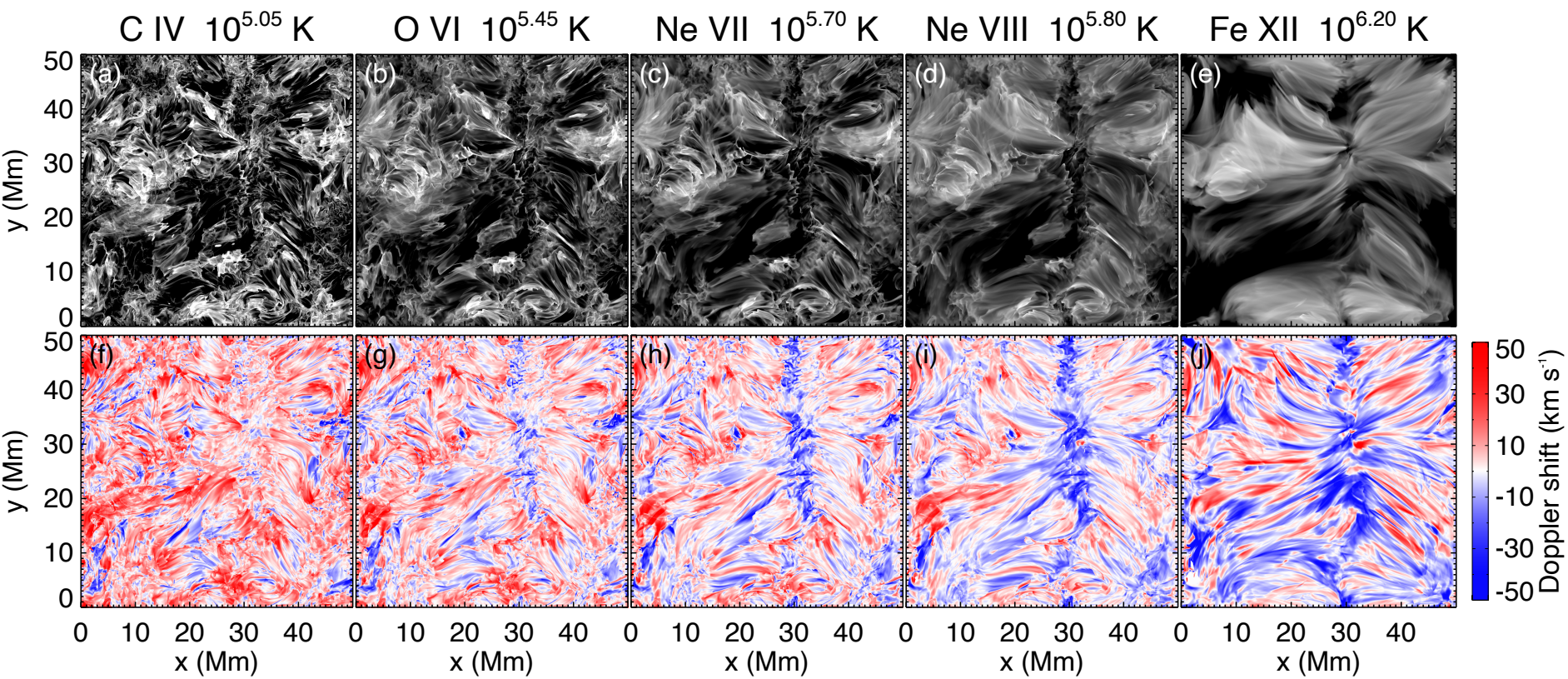
Current model



Hansteen et al. 2010, ApJ

- We constructed a radiation MHD model extending from the upper convection zone to the lower corona.
- The diffusivity is much less in our model, and it self-consistently maintains network fields and allows a steady corona of 1 MK.
- The model shows a clear imbalance of area coverage of redshifts in the transition region.

Maps of intensity and Doppler shifts for different lines

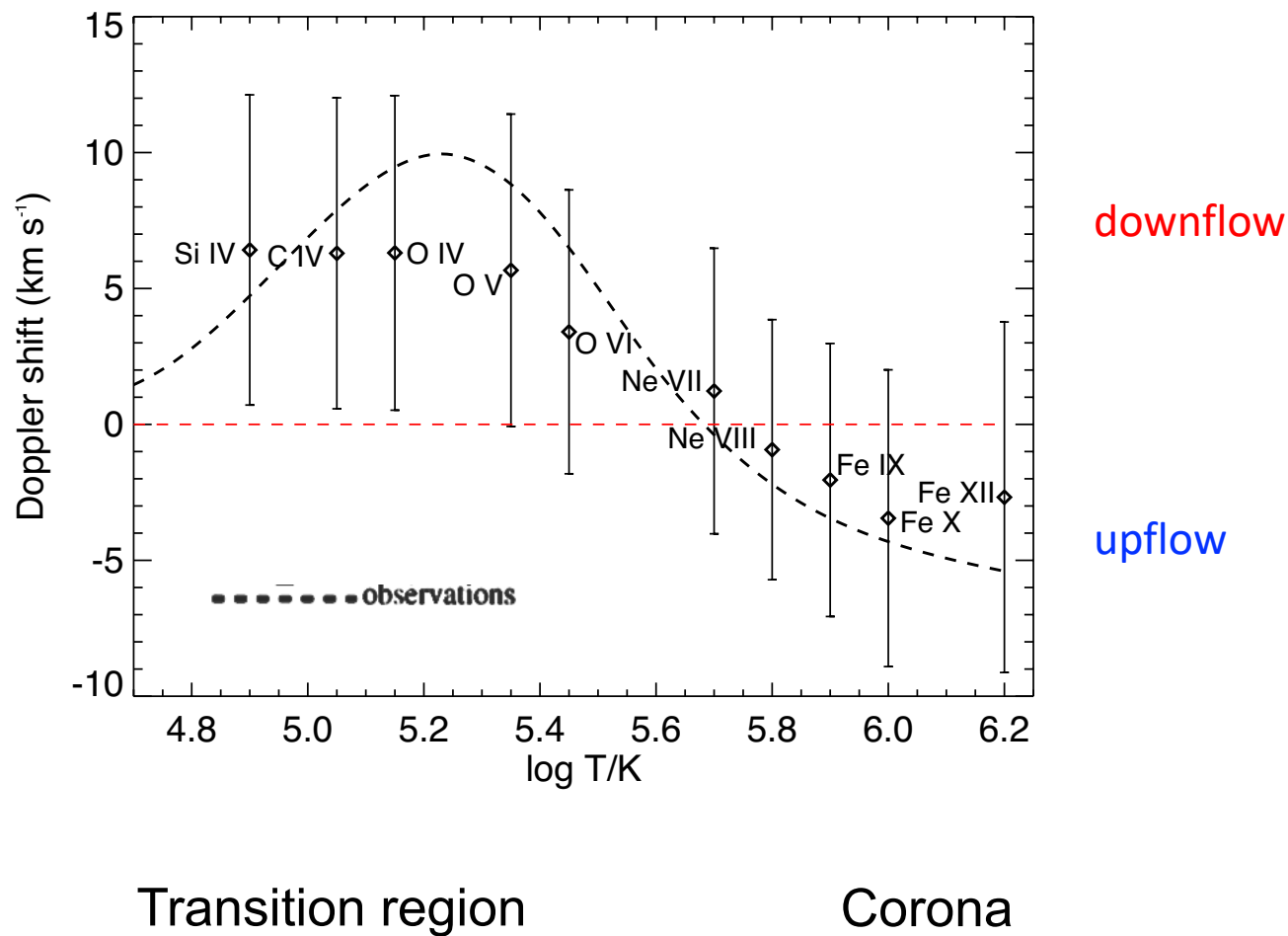


Transition region Corona

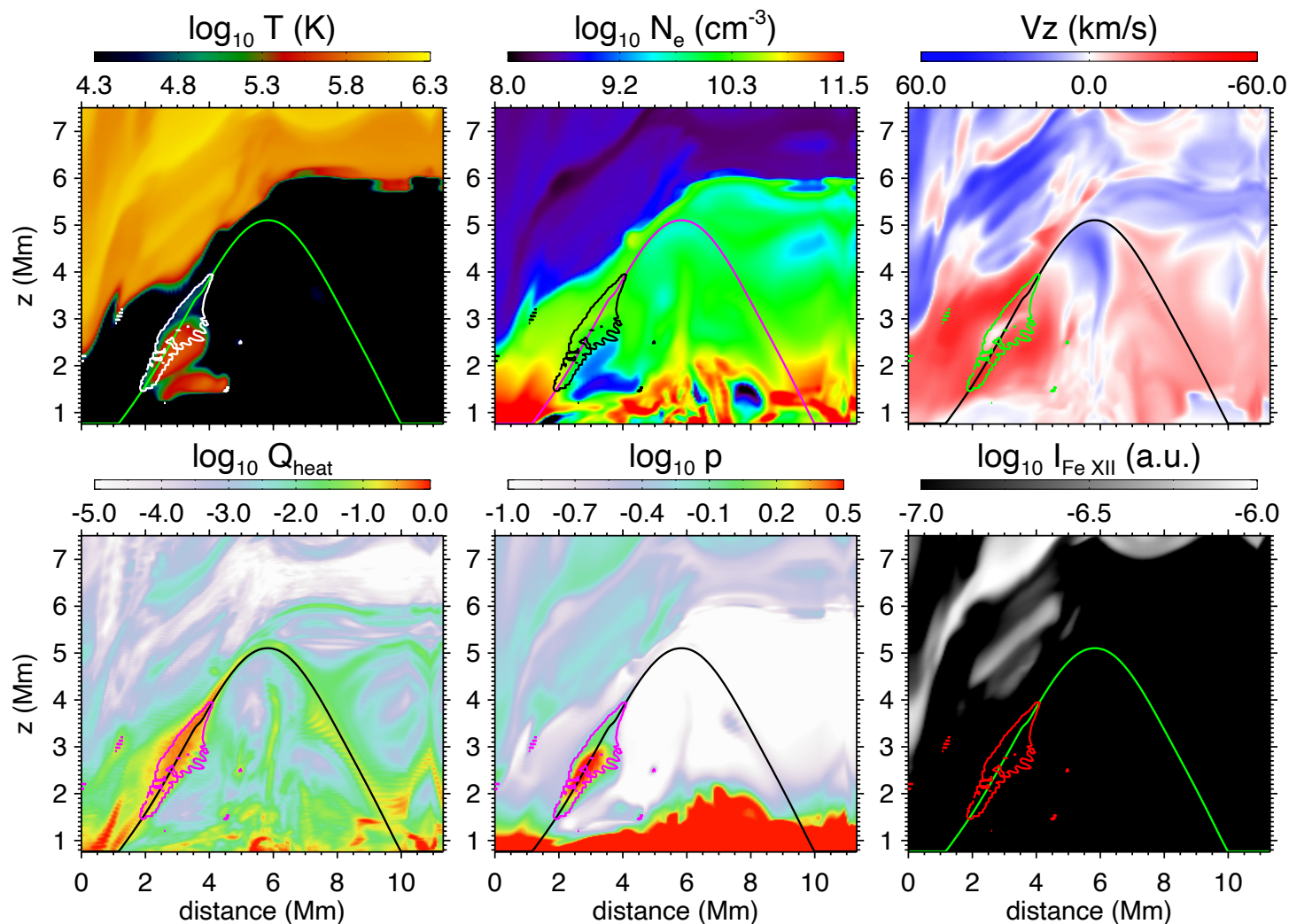
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redshifts blueshifts

Doppler shifts of different lines

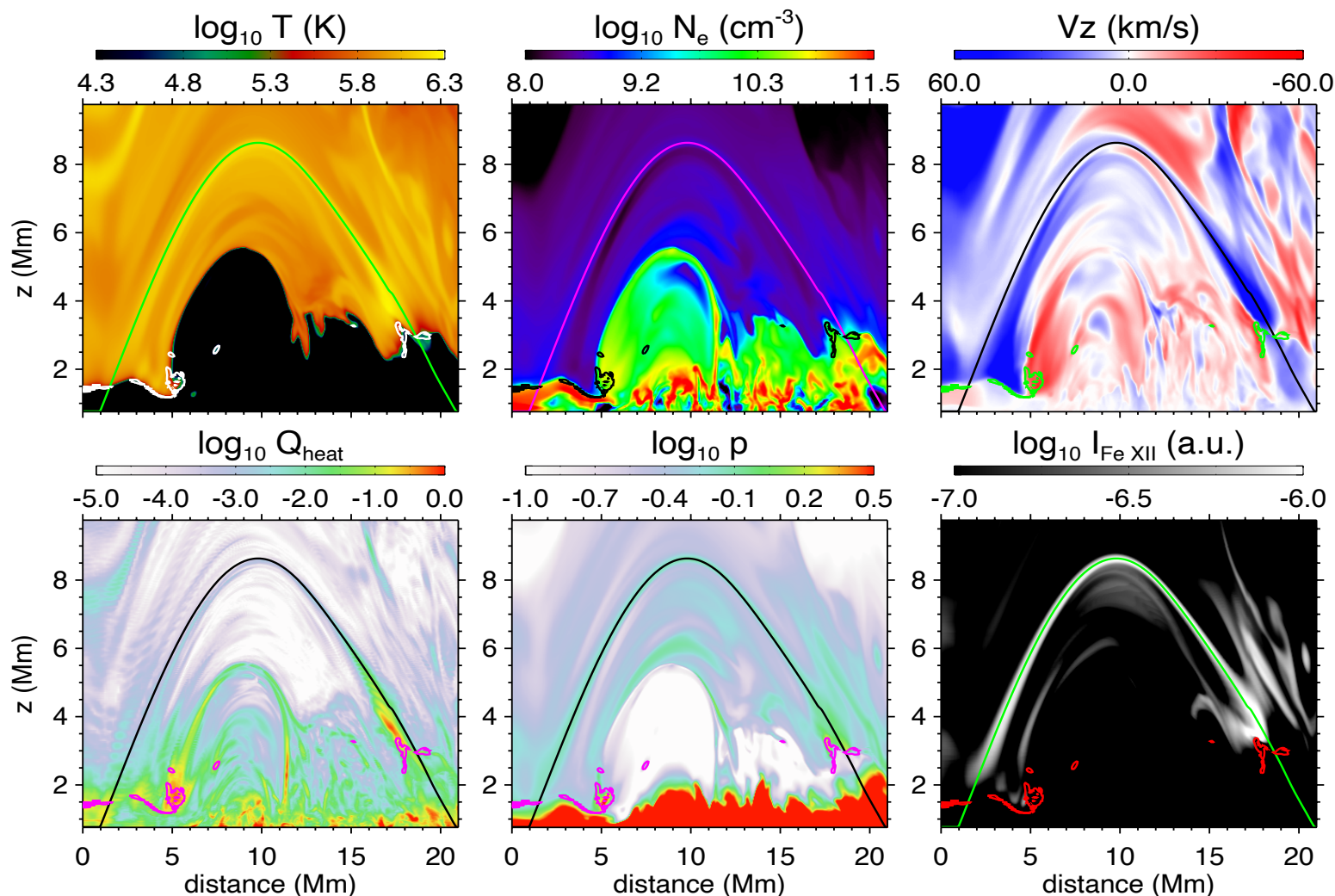


Processes contributing to Doppler shifts



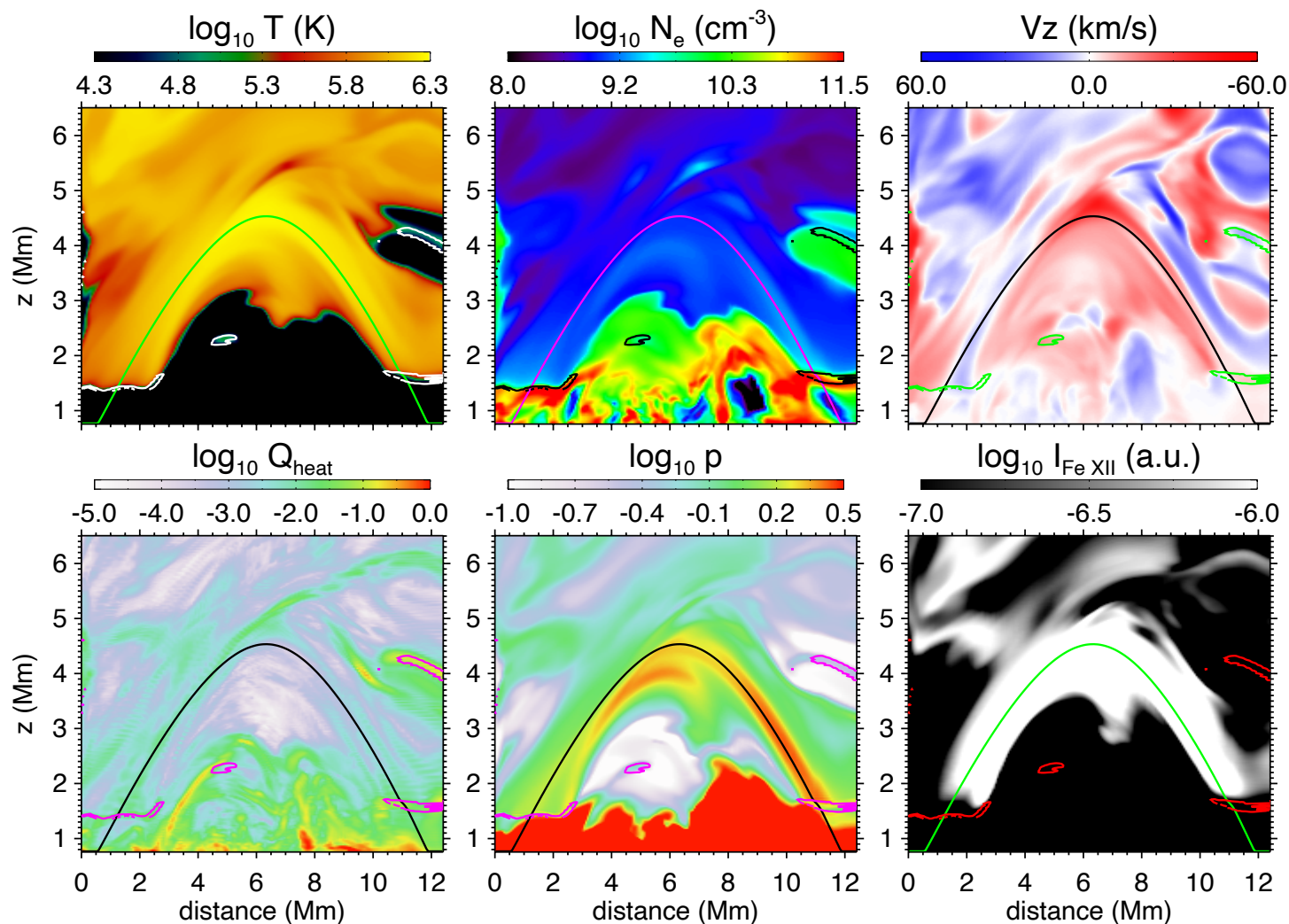
- ① transition region brightenings unrelated to coronal emission (30%)

Processes contributing to Doppler shifts



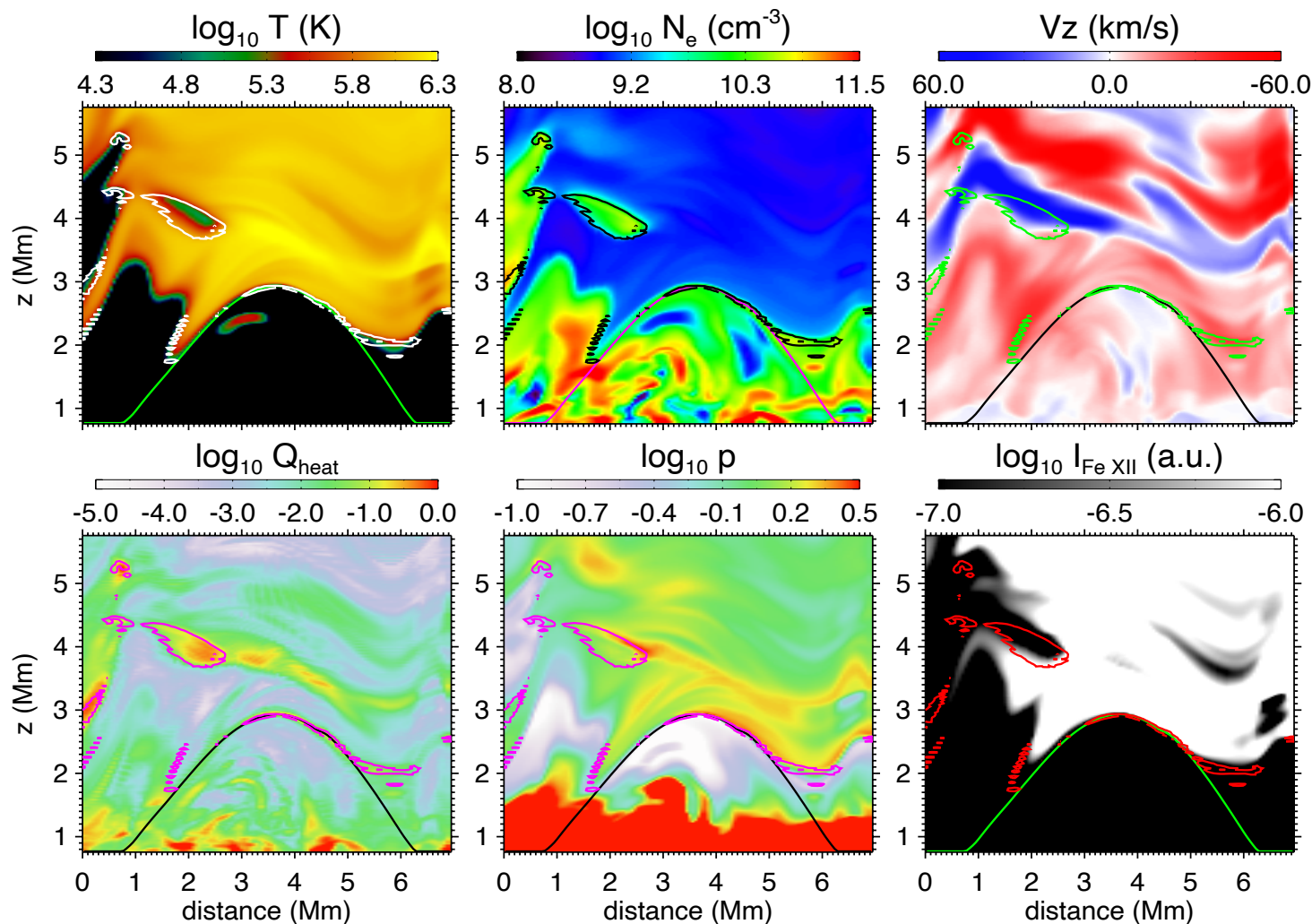
② pressure enhancement in the transition region (>50%)

Processes contributing to Doppler shifts



③ siphon-type flows (a few examples)

Processes contributing to Doppler shifts



④ boundaries between cold and hot plasma(14%)

Conclusions

- We constructed a 3D radiation MHD model, in which network fields and a steady corona of 1 MK is self-consistently maintained.
- Our model reproduces the observed change of average Doppler shifts from redshift in the transition region to blueshift in the corona.
- The model shows a clear imbalance of area coverage of redshifts versus blueshifts in the transition region.
- We determine that (at least) four processes generate the systematic Doppler shifts (see Chen et al. 2022, A&A, 661, A94)
 - pressure enhancement in the transition region
 - transition region brightenings unrelated to coronal emission
 - boundaries between cold and hot plasma
 - siphon-type flows.

Thanks!