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Title: Model Atmospheres for Stars and Brown Dwarfs

Abstract: *Since infrared observations of M dwarf stars (late 80's) and brown dwarfs (mid 90's) are available, one of the most important challenges in modeling their atmospheres as been a) a proper account of molecular opacitys, and b) the understanding of convection in theoptically thin part of their atmosphere. Model atmospheres and synthetic spectra (Allard PhDT '90, Allard & Hauschildt '95, Hauschildt, Allard & Baron '99, Allard et al. '01) based on molecular opacities improoving thought the years (Hot flames experiments by Ludwig 1972, Jorgensen et al. '94, Miller & Tennyson '94, Schwenke et al. 2002) have however failed to reproduce the relative strength and shapes on the water bands clearly seen and shaping the low resolution (R ≤ 300) infrared SEDs of M dwarfs. Yet the complexity of these atmospheres was only beginning to reveal itself. It was shown that their spectral properties was affected by the greenhouse effects of dust cloud formation below Teff=3000K. To understand these mechanisms, we have developed radiation hydrodynamic 2D model atmosphere simulations to study the formation of convection and forsterite dust in presence of hydrodynamical advection, condensation, and sedimentation across the M-L-T VLMs to BDs sequence (Teff=2800K to 900K, Freytag et al. 2010). We have discovered the formation of gravity waves as a driving mechanism for the formation of clouds in these atmospheres, and derived a rule for the velocity field versus atmospheric depth and Teff, which is relatively insensitive to gravity. This rule has been used in the construction of the model atmosphere grid BT-Settl (Allard et al. 2012a,b), based on the BT2 water vapor line list by Barber & Tennyson (2008), to determine the micro-turbulence velocity, the diffusion coefficient, and the advective mixing of molecules (including water vapor) as a function of depth. We have also compared the thermal profile of our 1D model to the averaged profile of the 2D and improoved our handling of convection, and calibrated the mixing length. This new BT-Settl model grid of atmospheres and synthetic spectra has been computed for 7,000K > Teff > 260K, 5.5 > logg > 0.0, and [M/H]= +0.5 to -2.5, and the reference solar abundances of Caffau et al. (2011). We found that the new models allow an improved (practically perfect) reproduction, for the first time, of the photometric and spectroscopic properties of M dwarfs, brown dwarfs, and extrasolar planets, and a smooth transition between the spectral type regimes. New interior and evolution models consitent with this revised BT-Settl grid are currently being published.*