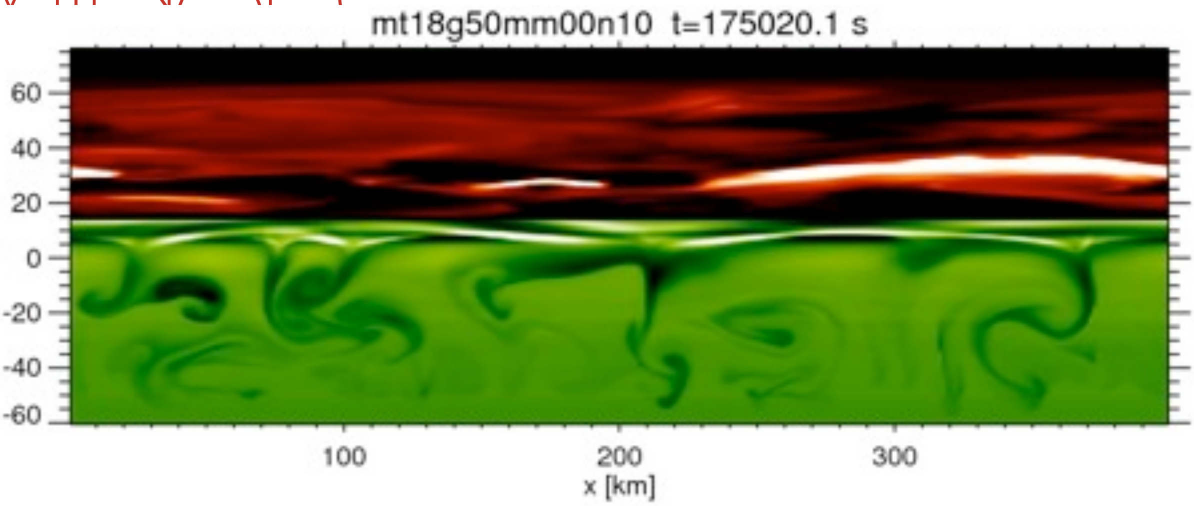

A 36 hrs 2D RHD simulation of a Teff=1600K brown dwarf atmosphere with logg=5.0. The box is W350 X H80 km, and shown are the entropy and the dust density in green and red color coding respectively.

FROM STARS TO BROWN DWARFS & PLANETS

by France Allard

The atmospheres of Very Low Mass Stars (VLMs), Brown Dwarfs (BDs), and Extrasolar Giant Planets (EGPs) are the site of the formation of molecules and dust, salts and ices clouds, which control their spectroscopic properties, cooling rate, radius and brightness evolution. Brown dwarfs evolve from stellar-like properties (Te ~ 3000K, magnetic activity, spots, flares, mass loss) to planet-like properties (Te < 500K, electron degeneracy of the interior, cloud formation, dynamical molecular transport, gravity waves) while retaining, due to their fully convective interior, larger rotational velocities (≥ 30 km/s i.e. P < 4 hrs versus 11 hrs for Jupiter and 3 hrs for tidally locked EGPs). Models accounting for all this complexity are therefore essential to understand the evolutive properties, and to interpret the observations of these objects.

I am, with Peter H. Hauschildt (Hamburg Obs.), and Edward Baron (Oklahoma Univ.), an author of the **PHOENIX** radiative transfer code serving throughout the HR diagram to model the spectral properties of SNs and novae, as well as stars and planets.

While the pure gas-phase based **PHOENIX** ***NextGen*** model atmospheres (Allard & Hauschildt 1995, Allard et al. 1997, Hauschildt et al. 1999) have allowed a certain understanding of the VLMs, the ***AMES-Dusty*** models (Allard et al. 2001), based on dust formation in equilibrium with the gas phase, have allowed the characterization of the near-IR photometric properties of M and L-type brown dwarfs, while playing a key role in the determination of the mass of brown dwarfs and Planetary Mass Objects (PMOs) in the field and in young stellar clusters. These models have also served in the study of the spectral properties of EGPs observed by transit (Barman et al. 2001, 2002 and 2005), culminating with the discovery of water vapor in these atmospheres (Barman 2007, 2008).

We present here a new model atmosphere grid for VLMs, BDs, PMOs, and EGPs named ***BT-Settl*** (Allard et al. 2011), which includes a cloud model and dynamical molecular transport, based on mixing information from 2D Radiation Hydrodynamic (RHD) simulations of cloud formation through the stellar to PMOs regimes (8500K to 700K using the **CO5BOLD** RHD code; Freytag et al. 2010, 2011).

These simulations have been a extended to 3D with boxes sampling a small fraction of the surface (1/204 RJup, 1/254,000 SJup) for brown dwarf cases along the spectral sequence (2600K, 2200K, and 1500K), in preparation for 3D star-in-the-box brown dwarf simulations accounting for cloud formation and rotation necessary for the study of an eventual surface variability (with rotation) of the brown dwarfs. Rotation may also alter the mixing properties of the atmospheres, affecting the cloud formation as we currently understand it in these objects.