ATMOSPHERIC DATA ASSIMILATION WITH THE EMIRATES MARS MISSION.

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The Emirates Mars Mission (EMM) entered orbit around Mars on 9 February 2021 and began its one-Mars-year science phase in May 2021. Its three instruments, the Emirates Mars InfraRed Spectrometer (EMIRS), Emirates eXploration Imager (EXI), and Emirates Mars Ultraviolet Spectrometer (EMUS), are designed to observe Mars simultaneously from the near-surface to the exosphere over a complete annual cycle (Amiri et al., 2022). EMM is unique among Mars orbiters because its high orbit (20,000 $\times$ 43,000 km altitude) means it can observe the whole of one hemisphere at a time, and observe the complete diurnal cycle in 10 sols.

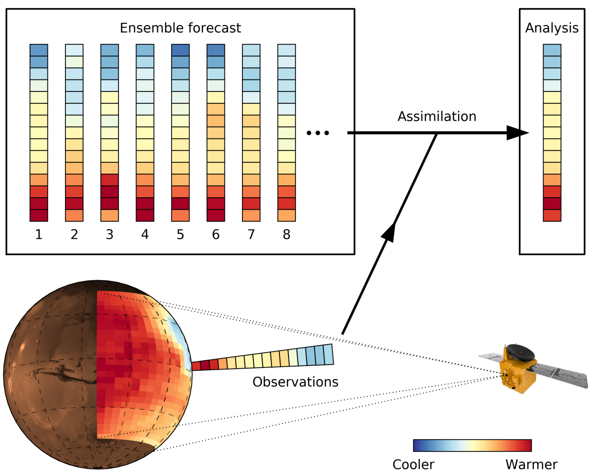

Fig. 1. Schematic illustrating ensemble data assimilation using EMM atmospheric retrievals. Figure reproduced from Almatroushi et al. (2021).

Because of its unique orbit, EMM promises to be an excellent platform for making observations that can be combined with numerical models using data assimilation. This process combines observations with a numerical model in a statistically robust way, to produce analyses that are closer to the true atmospheric state than either forecast or observations alone. In this presentation we will discuss the role data assimilation plays in Mars atmospheric science, the uniqueness and importance of EMM observations to Mars data assimilation, and our first results assimilating atmospheric temperatures from EMIRS into the LMD Mars Global Climate Model (Forget et al. 1999).

EMIRS is a thermal infrared spectrometer that operates in the 6–50 μm wavelength range (Edwards et al. 2021). Our assimilation uses the Local Ensemble Transform Kalman Filter (Hunt et al., 2007) with an ensemble of 36 numerical simulations. We currently assimilate atmospheric temperature retrievals from EMIRS between 0.75–4.75 pressure scale heights above the surface. The process is illustrated schematically in Fig. 1.

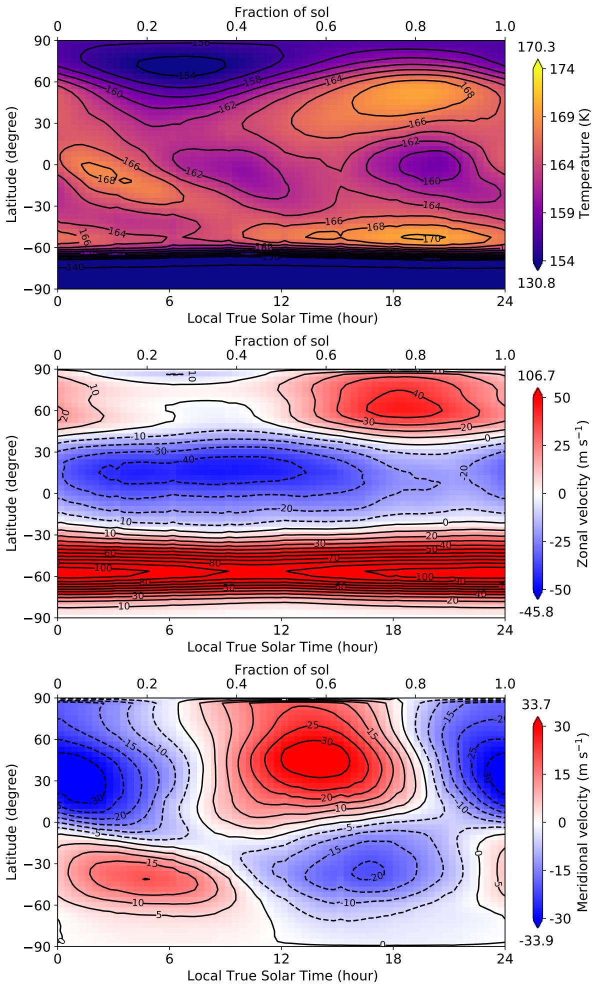

Fig. 2. Assimilation showing diurnal cycle of (from top) temperature, zonal velocity, and meridional velocity, at 30 Pa, averaged over $L_s = 60 - 90^\circ$ during MY36.

We ran the assimilation over the early part of EMM's science phase, from MY36 $L_s = 57.4 - 93.0°$, using atmospheric temperatures to update the model temperature field (directly), and the horizontal winds, surface pressure, and dust mass mixing ratio and number (indirectly). Our presentation will cover highlights from this first assimilation period, such as the extended coverage of the instrument in space and local time, coherent atmospheric structures visible in EXI images that are reproduced by the assimilation, and the diurnal cycle of unobserved variables. Fig. 2 illustrates this third point, showing the diurnal cycle of temperature, zonal velocity, and meridional velocity at 30 Pa averaged over $L_s = 60 - 90°$.

References

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