# CROSS DRIVE: Interactive and Immersive Exploration of 3D Time-Dependent Mars Atmospheric Data in Distributed Teams

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## Mars Atmospheric Phenomena

Atmospheric phenomena of Mars can be highly dynamic and have daily and seasonal variations. Planetary-scale wavelike disturbances, for example, are frequently observed in Mars' polar winter atmosphere. Possible sources of the wave activity were suggested to be dynamical instabilities and quasi-stationary planetary waves, i.e., waves that arise predominantly via zonally asymmetric surface properties.

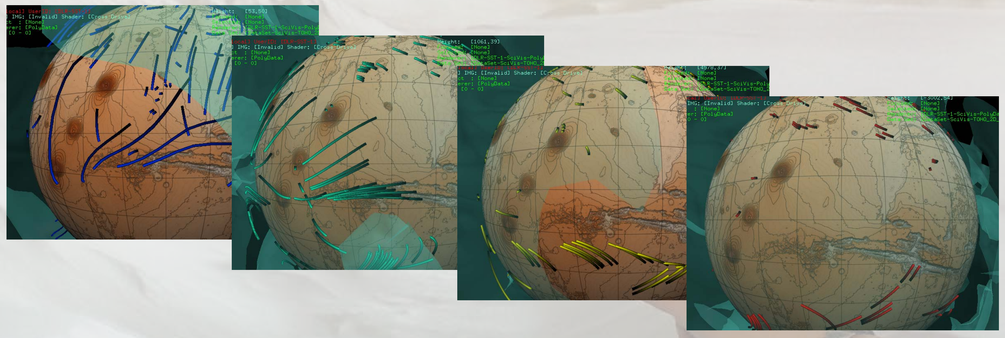
For a comprehensive understanding of these phenomena,

- single layers of altitude have to be analyzed carefully and
- relations between different atmospheric quantities and
- interaction with the surface of Mars have to be considered.

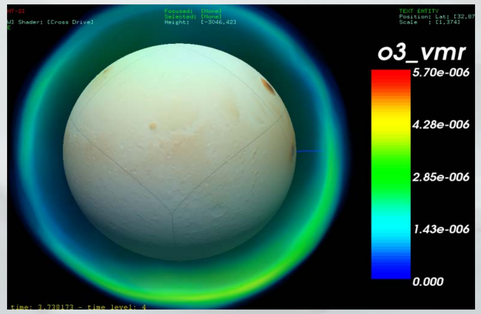
**Temperature vertical profiles over the *Hellas Basin* from PFS 3D dataset. The position is interactively selected with a VR-based Flystick which results in an dynamically changing 2D diagram plot.**

## Virtual Reality based Science Data Exploration

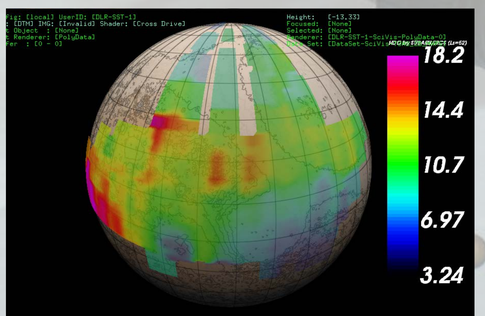
The CROSS DRIVE project addresses the presentation of atmospheric data with a global view by means of virtual reality (VR) techniques. Complex orbiter data from spectrometer and observation data from Earth are combined with global circulation models and high-resolution terrain data / images from MEX or MRO instruments. Scientists can interactively extract features from those datasets and can change visualization parameters in real-time in order to emphasize findings. Stereoscopic views allow for perception of the actual 3D behavior of Mars's atmosphere.



**Animated pathlines integrated through the GCM dataset using the Wind vector field. The color shows particle age since seeded. Additionally, the scalar vertical wind field of the GEM-Mars GCM is used to extract time dependent iso-surfaces visualized with a transparency.**




**GCM Volume Rendering. Transfer function can interactively be modified by an ext. GUI.**




**HDO map at Ls=52 from earth-based telescope observation (SUBARU/IRCS).**

## Distributed Workspaces

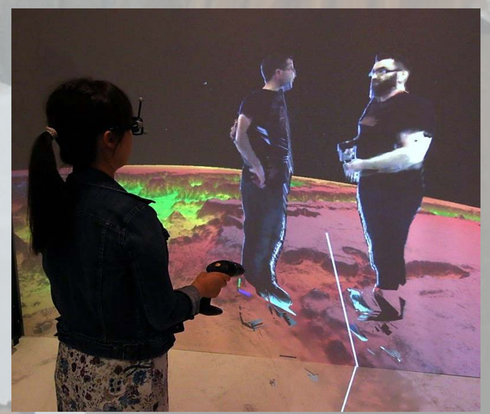
Workspaces at different locations can be connected which enables discussions between distributed working groups. The workspace can scale from virtual reality systems to expert desktop applications and on to web-based project portals.

## Collaboration

Any change of the feature set (annotations, cutplanes, volume rendering, etc.) within the VR is immediately exchanged between all connected users. Thus, everybody is always aware of what is visible and being discussed. The conversation is supported by audio. And interaction is controlled by a moderator managing turn-taking presentations.

## Avatars and Telepresence

If multiple virtual environments are connected, the scientists are represented by different embodiments in order to improve the collaboration. These range from simple annotations to complex avatars using tele-presence technology to reconstruct the users in 3D.



**Local user in an immersive virtual environment (DLR) interacts with two reconstructed video avatars which are recorded in a remote virtual environment (Salford) by means of a video camera array.**

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