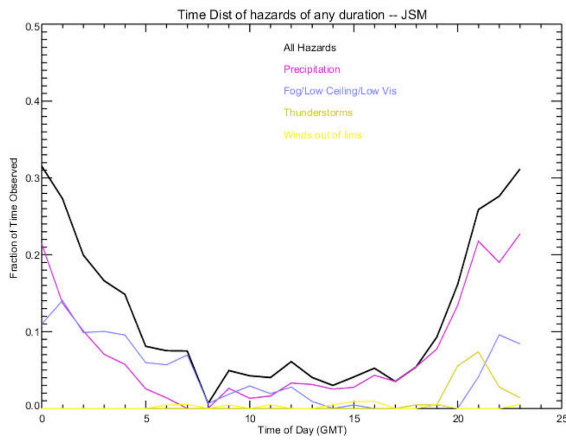
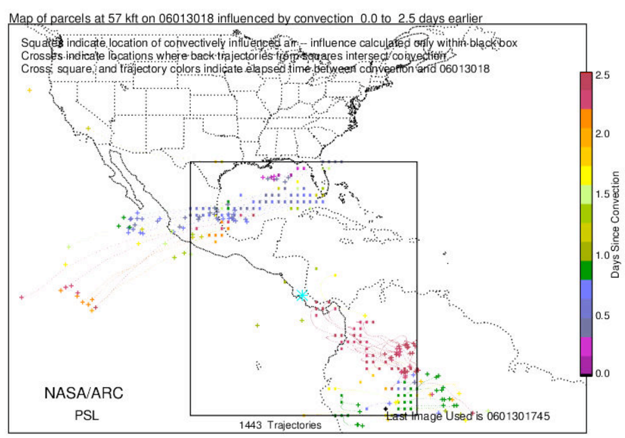
Meteorological Studies of the Upper Troposphere Lower Stratosphere Region

The purpose of this project is threefold. First we provide meteorological guidance to airborne field missions for NASA's Upper Atmospheric Research, Radiation Sciences, and Tropospheric Chemistry programs. Second, we are engaged in a modeling and data analysis of water vapor in the tropical tropopause region. Finally, we are investigating trace constituent transport in the middle and high latitude lowermost stratosphere.



Our meteorological support includes providing the science team with guidance on surface weather conditions that affect aircraft operations, flight planning support for enhanced science return, and climatological surveys used in site selection. Figure 1 includes an example of part of one kind of climatological survey we have done, a simple diurnal analysis of weather hazards for NASA's high flying aircraft at Juan Santa Maria Airport. It shows clearly that overall hazards peak at about 6pm local time with rain and thunderstorms starting around 1pm, followed by some incidence of fog, low ceiling, and low visibility. During the mission, we provide various products to the science team for flight planning purposes. One issue of interest is the evolution of air near the tropical tropopause after it has exited a tropical thunderstorm. An example of a product which locates such air is Figure 2, which shows what air at 57000 feet has come from a thunderstorm in the last 2 days (colored squares), how long ago the thunderstorm occurred (the color of the squares), and where the thunderstorm occurred (crosses connected to the colored squares by dotted lines). In this case, it is seen that thunderstorms over South America (red crosses) that occurred 2.5 days ago (red color) has affected air over northeastern South America and the isthmus of Panama.



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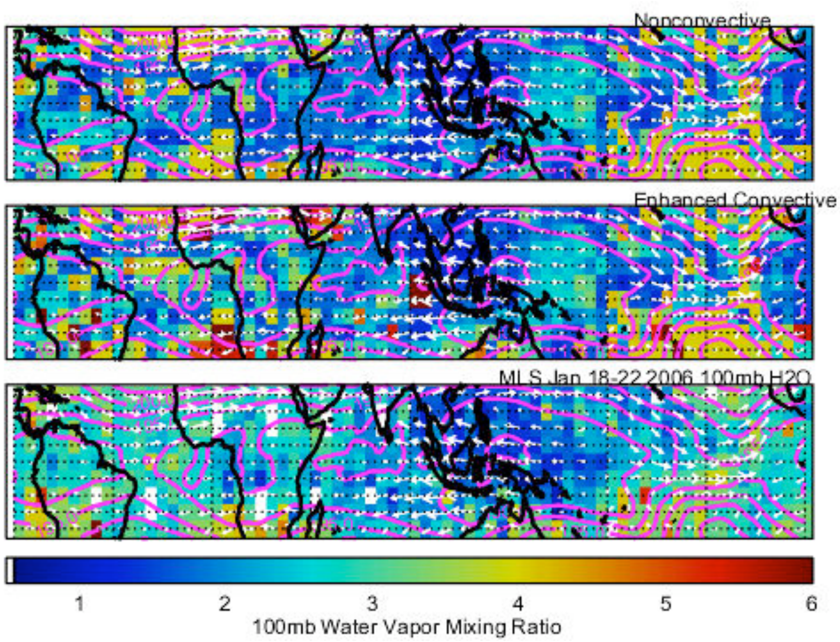
Water vapor at the tropical upper tropopause is important for two reasons. First, it governs the amount of water vapor entering the stratospheric ozone layer, and second, it affects the amount of radiation exiting the earth's climate system. Increased water increases ozone losses, and with the earth's climate changing, we need to understand this water vapor input well enough to understand and predict its changes in the ozone layer. Increased water at the tropical tropopause also affects cloud cover in some (as yet unknown) way, which will affect the amount of warming in the tropics. Along with a colleague in our division, we have developed a model that uses comprehensive microphysics, lagrangian dynamics with radiative heating, and parameterized convection to simulate the transport of water vapor, the formation of clouds, and the subsequent removal of water vapor. Figures 3 shows an example of a simulation of water vapor at the tropopause (about 10 miles above the surface in this case). The top two panels are two different simulations (the first not including thunderstorms, and the second including thunderstorms), while the bottom are observations. The agreement is clearly quite good, with the model simulating not only the overall water vapor average at these levels, but the horizontal features as well.



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