DEFINING THE OPTIMUM ORBIT AND OBSERVING STRATEGY FOR THE ASSIMILATION OF ATMOSPHERIC DATA

M.R. Patel[1]
[1]The Open University, Milton Keynes, U.K. (manish.patel@open.ac.uk).

Introduction: Missions to date have attempted to balance mission-level engineering constraints with available resources in order to achieve the most appropriate orbit relevant to fulfil the science objectives of the mission. For remote sensing missions concerned with the atmosphere, 4D mapping of the atmosphere is typically a high priority objective. The types of orbit achieved by these missions around Mars has varied, having been driven by differing science objectives and resources/capabilities available at the time. Instrument capabilities also provide a 'restriction' in terms of coverage and cadence of observations, and thus the choice of orbit and operational observation strategy couple together to define the resulting coverage profile.

The continued development of Mars Global Circulation models (e.g. [1] among others) has led to a powerful combination of observations and modelling analysis available to researchers, and more and more frequently observation and assimilation (e.g. [2]) are becoming the standard approach for science analysis. Whilst all missions will inevitably be driven by a balance of priorities between global-level and targeted observations, consideration of an orbit type that is optimised for the assimilation of observations into a GCM is likely to be of increasing importance in the design of future missions to study the martian atmosphere.

This need results in a series of questions to be answered. For example, given the range of possible orbits and observation strategies, what is the best combination we have had to date to provide the most effective set of data for reanalysis? Given the ability to start from scratch, what would be the ideal combination of orbit and observation strategy to produce the 'best' data set for assimilation?

Previous orbits and observations: A summary of orbit properties for current active Mars missions is presented here.

Mission	Inclination	Periapsis	Apoapsis	Local time
ODY	93°	201 km	500 km	Fixed
MEx	86°	298 km	10,107 km	Varies
MRO	93°	250 km	316 km	Fixed
MOM	150°	421 km	76,993	Varies
MAVEN	75°	150 km	6,200 km	Varies
TGO	74°	365 km	420 km	Varies

Discussion points: The following aspects, among others, are presented for consideration and discussion on the subject of defining the optimum orbit and observation strategy for maximising the knowledge that can be gained from assimilation of the data.

Orbit type. Orbit eccentricity is a key factor to consider. For the purpose of data assimilation and global coverage, is a regular repeated coverage more advantageous than varying altitude and mixture of high/low spatial coverage?

Measurement resolution. The spatial resolution needed for capturing sufficient information on atmospheric transport and dynamics will vary depending upon the process under investigation. Defining the necessary spatial resolution for major dynamical processes will help define the minimum instrumental properties required. In addition to spatial resolution, the temporal resolution for major processes also needs to be defined – what is the minimum timestep of observation needed to assimilate information in a meaningful manner?

Local time of observations. The Mars missions listed above have included observations performed at both a fixed local time, and also variable local times. Which approach is better from the perspective of data assimilation? Does this change for different processes under consideration?

Ground track repeat period. A frozen orbit is generally considered the optimal configuration for global level monitoring. In terms of time periods, what duration is considered too long before the ground track closes? Is a fast (order of weeks) return to the ground track starting point for repeated observations preferred, or a slower return to the starting point? What is the preferred balance between ground track separation per orbit, compared to time to return to the starting point (short orbit closure periods result in larger ground track gaps, and vice versa).

Observation strategy. In terms of instrument operations, are condensed bursts of observations with gaps between bursts preferred, or a continual measurements at a lower rate?

Conclusions: The above points are intended as a starting point for a discussion into defining the optimum orbit type and observing strategy for future missions where assimilation of atmospheric data will be a high science priority.

References: [1] Forget, F., F. et al (1999), *J. Geophys. Res.*, 104, 24,155–24,176. [2] Holmes et al (2018), Icarus, 302, 308-318.