ATMOSPHERIC MODELING OF THE MARTIAN POLAR REGIONS: CRISM EPF COVERAGE DURING THE SOUTH POLAR SPRING RECESSION. A.J. Brown[1,2] , P.C. McGuire[3] and M. J. Wolff[4]. [1]SETI Institute, 515 N. Whisman Rd Mountain View, CA 94043, abrown@arc.nasa.gov, [2]Space Sciences Division, NASA Ames Research Center, Moffett Field, CA 94035, [3]McDonnell Center for the Space Sciences, Washington University in St. Louis, MO 63130, [4]Space Science Institute, Boulder, CO 80301. Author website: http://abrown.seti.org

Introduction: The Martian polar regions are the most dynamic on the planet. Up to 33% of the Martian atmosphere participates in the growth and recession of the Martian seasonal ice caps, which are dominated by CO_2 [1]. We seek to gain further insight into the coupled atmospheric-surface interactions during the southern spring recession of 2007, which was observed by the CRISM instrument [2].

CRISM has the ability to take 'gimballed' observations of the surface as it passes over a target, thus creating what is termed an Emission Phase Function 'EPF' measurement (Figure 1) [3]. We report here on our initial investigations of the EPF polar observations and our attempts to model dust and ices suspended in the atmosphere and soil and ice covered surface.

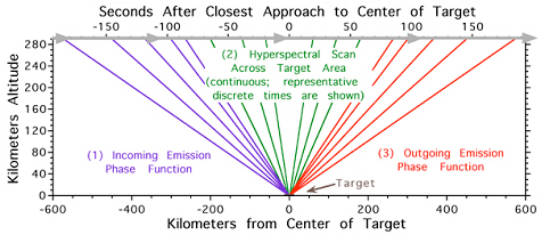

Figure 1. Schematic of a CRISM EPF observation.

CRISM: CRISM is a visible-infrared (0.4-3.9μm) imaging spectrometer that is now in orbit around Mars [3] and has been collecting data since November 2006. CRISM takes EPF measurements with 544 channels and 11 geometries (in Figure 1 all the green lines represent just 1 of these geometries). EPF measurements are also taken before and after each Full Resolution Targeted (FRT), Half Resolution Long (HRL) and Half Resolution Short (HRS) observation.

EPF dataset: During the Martian south polar spring of 2006 (for the period covering L_s 152-320), the CRISM team obtained 398 EPF, 766 FRT, 48 HRL and 81 HRS observations (Table 1). EPF observations are taken in a repeating grid around the pole [3].

Methods: Our intention is to carry out an initial assessment of the Martian polar atmosphere and surface during the southern spring recession. We will divide the EPFs into latitudinal ranges covering different parts of the season. Our aim is to get a qualitative estimate of dust and aerosol and surface variation during the period between L_s 150-360.

Earth DOY 2007	L_s	*EPF*	*FRT*	*HRL*	*HRS*
06_352-5	[152-159)	8			
006-016	[160-168)	9			
016-033	[168-176)	3		3	1
033-044	[176-183)	10	6	3	4
044-059	[183-192)	20	17	1	6
059-073	[192-200)	8	20	1	5
073-086	[200-208)	2	14		1
086-101	[208-217)	25	27		24
101-115	[217-225)	*17*	*29*	11	12
115-116	[225-234)		4	1	
132-142	[234-243)		36		3
142-156	[243-252)	27	*42*	*5*	8
156-171	[252-261)	3	37	7	2
171-185	[261-270)	*12*	48	4	1
188-198	[270-278)	124	30	2	2
199-212	[278-286)	*43*	30		
213-225	[286-295)	*49*	*138*	1	6
227-240	[295-303)	22	*111*	2	2
241-250	[303-312)		*112*	4	
250-267	[312-319)	*16*	*65*	3	4

Table 1. Totals of CRISM observations relevant to this study. Counts in italics indicate some missing geometries. Each line corresponds to the two week MRO planning cycle. DOY column gaps are when CRISM collected no data at the south pole.

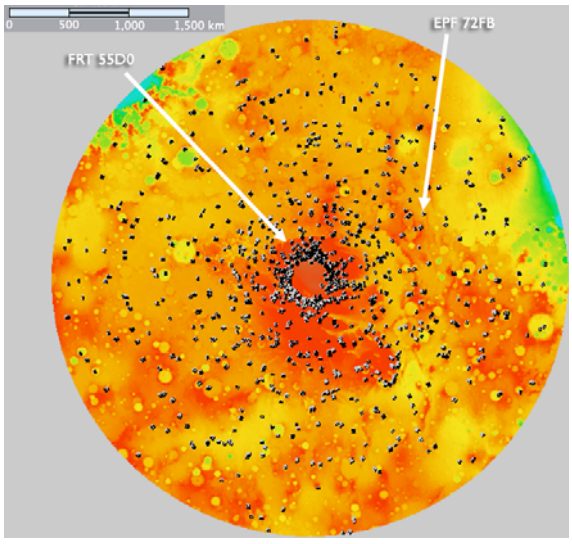

Figure 2. Map of the south polar region (stereographic projection, >55°S, central meridian up) showing location of the CRISM EPF observations overlain on MOLA background.

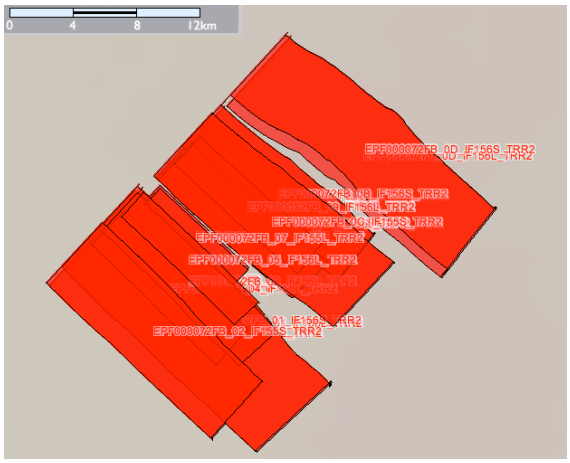

Figure 3. Spatial coverage of the eleven overlapping elements of CRISM EPF observation 72FB. Note the variation in spatial position and horizontal width.

Example EPFs: To demonstrate our retrieval technique, we have chosen one FRT observation, 55D0 and one EPF observation, 72FB (Figure 3). We have plotted the incidence on flux (I/F) measurement in the CRISM channel at 599 nm as a function of phase angle (Figure 4 and 5).

Radiative transfer model: As a first step to understanding the emission phase function data, we have neglected the effects of multiple and anisotropic scattering. e used a simple model based on the Lommel-Seeliger law[4], demonstrating how an isotropic reflector would behave under similar conditions.

$$Y(i,e,g) = \frac{1}{4\pi}\frac{\mu\mu_0}{\mu+\mu_0}$$

where i,e and g are the incidence, emission and phase angles, μ and μ_0 are the cosine of the emission and incidence angles. A floating baseline was necessary to more closely match the observations, indicating an additive atmospheric contribution to observations.

We are currently working on a model based on DISORT [5,6] in order to simulate the EPF data retrieved and will report these results at the meeting.

Results: Figures 4 and 5 demonstrate the EPF curves for two observations (red triangles). The lat, long and incidence angle are given in the title of the figures – note the earlier observation was taken at an extremely low sun angle and there is considerable spread in the I/F. The FRT image has more continuous coverage (Figure 4) whereas the EPF observations have large gaps at 40-50 and 60-85° phase angle. The model falls short in several important ways:

1. it cannot match the observed kink in the phase curve of the FRT centered at g=65.
2. it is a poor match for forward scattering measurements (g>90) in both observations.

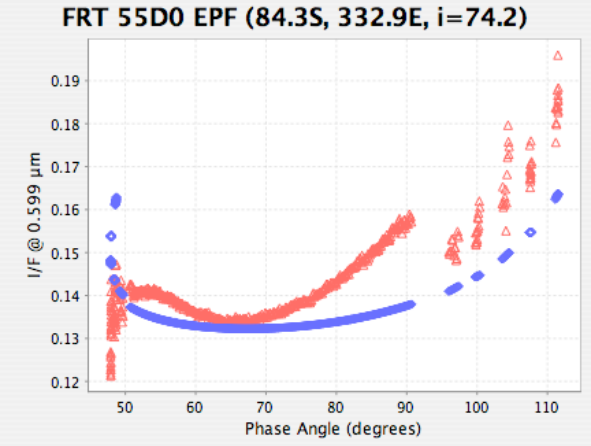

Figure 4. I/F in channel at 599nm v. phase angle for EPF observation 55D0 (red triangles) and model (blue diamonds).

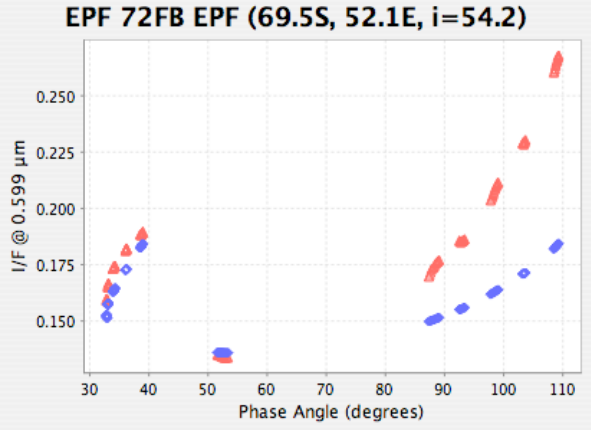

Figure 5. I/F in channel at 599nm v. phase angle for EPF observation 72FB (red triangles) and model (blue diamonds).

Conclusion: We have analysed the CRISM EPF data from one Martian spring recession – Mars Year 28 (2007). CRISM has now collected data extending well into the southern summer and we intend to continue our research into further EPF sequences covering an entire year at the south and the north polar regions. We anticipate this work will lead seasonal maps of dust and ice aerosol densitites in the south polar region which will lead to improvements in quantitative determinations of CRISM surface reflectance spectra [7].

References: [1] Hourdin, F. et al. (1993) *JAS* 50 p. 3625 [2] Brown, A. et al. (2007) *AGU* #P33A-1016 [3] Murchie, S. et al. (2007) *JGR* 112 [4] Fairbairn, M. (2005) *JRASC* 99, 92 [5] Wolff, M. et al. (2007) *7th Mars*, #3121 [6] Stamnes, K. et al. (1988) *AO* 27, 2502 [7] McGuire, P. et al. (2008) submitted to *TGARS*.

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