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The condensing CO2 Martian south polar cap

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The condensing CO_2 Martian south polar cap and the mechanisms of the CO_2 ice accumulation has been studied through the analysis of the PFS-MEX spectra acquired during the first two years of activity. This dataset covers more than a half Martian year, from Ls 330° to Ls 194°, allowing a detailed study of the CO_2 south polar cap formation speeds and mechanisms, especially during the fall season, which has been found to be of great importance for the explanation of the residual south polar cap asymmetry. In the early-fall season (Ls 0°-25°) the CO_2 condensation in the atmosphere is not allowed, the atmosphere being warmer than the saturation temperature, with some sporadic exceptions. The cap extends up to ∼70° S latitude and essentially consists of CO_2 frost deposits (direct vapour deposition). This is likely to be the situation up to the middle of the fall season, with the exception that the deposits will extend up to ∼60° S latitude. During the first half of the fall season, the cap edges advance symmetrically with a constant speed of about 10° of latitude per half Martian month, at every longitude. At Ls = 70° the cap is near to its maximum extension of ∼40° S latitude. It appears asymmetric, due to the presence of the two major Martian basins, Hellas and Argyrae, where the CO_2 frost can be stable at higher temperatures, thanks to the higher pressures inside the basins. In the Ls 50°-70° period, CO_2 snow falls are allowed exclusively in the western hemisphere where the atmospheric temperatures goes below the condensation temperature of the gaseous CO_2 at given altitudes. This confirms and extends what has been recently proposed by Colaprete et al., 2005: the south pole of Mars is characterized by two distinct regional climates, which are the main responsible for the Residual South Polar Cap asymmetry. As Colaprete et al. have shown, during the south winter, a wavenumber-one planetary wave establishes a low-pressure zone over much of the western hemisphere allowing a higher CO_2 condensation rate than in the high-pressure eastern hemisphere. Our results show strong evidence of the two regional climates on either side of the pole, which are thus confirmed as the main responsible of the RSPC asymmetry. We found that an important role is played by the fall season, when a huge amount of CO_2 ice is condensing: during this season the CO_2 condensation in the whole 1-50 Km atmospheric column over much of the eastern hemisphere is strictly forbidden, the cap here consisting of thin CO_2 frost deposits, while in the western hemisphere the atmospheric temperature is often below the saturation temperature, allowing huge CO_2 snow falls. Measured vertical temperature profiles are compared with those predicted by the Mars GCM model.