SEASONAL ACTIVITY AT SOUTH POLAR REGIONS OF MARS LEADING TO A POTENTIAL EVOLUTION MODEL. C. Cesar¹, A. Pommerol¹, N. Thomas¹, C. J. Hansen², G. Portyankina³, ¹Physikalisches Institut, Universität Bern, Switzerland (camila.cesar@unibe.ch), ²Planetary Science Institute, Arizona, USA, ³University of Colorado, Boulder, CO, USA.

Introduction: During spring, the southern polar area of Mars is home to various seasonal activity commonly explained by the Kieffer model [1,2]. The formation of spots, fans, and araneiforms emanates from cold jets' activity when the CO₂ ice slab sublimes [3,4]. The detection of cold jets has not been successful with imagers such as HiRISE in regions where such features have been observed, which could indicate that eruptions occur at an earlier time of day than expected and/or that the dust opacity is not observable from orbit [5]. The arrival of the Colour and Stereo Surface Imaging System (CaSSIS) [6] offers high resolution multi-filter images with high sensitivity to colour contrasts and variability in acquisition time of day. Its nearly instantaneous stereo capability offers a unique perspective for studying atmospheric features coupled with surface sublimation processes.

CaSSIS has acquired more than 20000 images since the beginning of its science phase in 2018. From this database, 2522 images (counted on April 2021) have been obtained during southern spring at latitudes above 50°S. A selection of interesting regions has been identified and analyzed to pursue the goal of further testing and refining the Kieffer hypothesis.

Classification and evolution of spots: Repeated observations throughout martian seasons, give a fairly good overview of the deposits' evolution through time. In general, spots are recurrent in position every martian year [7], although their morphology changes from early spring to mid-spring. Spots have been observed with a bright halo in early spring, which then shift to the commonly known dark spot. Diverse morphologies of spots have been observed with CaSSIS for this study and helped put in place a new classification of spot deposits. Seven structures are differentiated using the albedo and colour variations within a given spot.

From the temporal information of each image acquired, several types of spots have been associated with a given period during springtime. At the end of winter/early spring spots display bright cores and/or brighter haloes as seen in Fig.1 cases B, C, D and G. Mid-spring and end of spring spots comprise mainly of cases A, E and F.

Some images have shown several structures coexisting while they are fundamentally at different evolution stages (dark spots alongside inverted spots). This indicates that spots are not limited to singular events and that a precaution is required when establishing a temporal sequence. The subtlety in this model is thus limited by our dataset.

Atmospheric features: Additionally, clouds well correlated with sublimation surface features have been identified, which led us to believe they could be coupled, as the Kieffer model suggests if they are indeed jets or remnants of jets. These atmospheric features have been observed in a few various locations without prior observations of cold jets. Further observations of similar processes in these areas are needed to compute an acceptable hypothesis.

From stereo observations, we can estimate a propagation speed for the clouds straightforwardly. By assuming a direct path between the position in stereo #1 and stereo #2, the distance travelled is then extracted using the pixel resolution (~4.5m/pixel). From this distance estimate, we then calculate a movement speed knowing that two stereo pairs are acquired 45s apart. From fig.2, two possible direction are plausible and the speeds are ranging from 11-35m/s and 17-30m/s.

From a single observation, this estimation can be obtained by using individually each filter, but only two filters are sensitive to atmospheric features (PAN and BLU) making the error quite high considering the factors of distance, direction and time between filters acquisition.
Conclusions and future work: Repeatable observations of the same region is an asset to establish an evolution model with respect to solar longitude (Ls). Thanks to this, a temporal evolution of spot deposits has been proposed to complement the Kieffer model, placing bright spots and inverted spots as the first stages of this evolution. This model is limited by the available coverage (in time and space) of CaSSIS images. In addition, atmospheric features have been observed coupled to sublimation features at the surface, which is promising for future observations.

As a new Martian southern spring is approaching (February 2022), a special observation campaign has been planned accordingly in hope to better constrain this model with additional data.

Acknowledgments: CaSSIS is a project of the University of Bern and funded through the Swiss Space Office via ESA’s PRODEX programme. The instrument hardware development was also supported by the Italian Space Agency (ASI) (ASI-INAF agreement no. I/018/12/0), INAF/Astronomical Observatory of Padova, and the Space Research Center (CBK) in Warsaw. Support from SGF (Budapest), the University of Arizona (Lunar and Planetary Lab.) and NASA are also gratefully acknowledged. Operations support from the UK Space Agency under grant ST/R003025/1 is also acknowledged.