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Simultaneous retrieval of daytime O(^{3}P) and O_3 concentrations in the altitude interval 80 – 100 km.

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We propose methods of simultaneously independent retrievals of the key components of Mesosphere and Lower Thermosphere (MLT) [O_3] and [O(^{3}P)]. The altitude profile of ozone concentration, [O_3], can be measured by direct method of the measurement of absorbing radiation from the Sun or the stars in the UV range of the spectrum. However, this method is most often realized in twilight. Retrieval of daytime [O_3] depends on a prior information about the O(^{3}P) altitude profile. Vice versa, atomic oxygen concentration, [O(^{3}P)], is usually retrieved from the measured values of [O_3]. The problem of independent and simultaneous retrieval of [O_3] and [O(^{3}P)] can be solved by using individual proxy for each of the target component. Using a sensitivity study and uncertainty analysis of the contemporary model of O_3 and O_2 photolysis in the MLT, YM2011, we determined that populations of three excited electronic-vibrational levels O_2(b1, v = 0, 1, 2) and of metastable O(1D) atom depend on [O(^{3}P)] and [O_3] concentrations.
For [O(^{3}P)] retrieval the following transitions should be used: O_2(b1, v') –> O_2(X3, v") which produce emissions: (a) at 780.4 nm in the band (v' = 2, v" = 2) and at 697.0 nm in the band (2, 1) with the uncertainty of retrieval smaller than 30% for the whole altitude range 80 - 100 km; (b) at 771.0 nm in the band (1, 1), 688.4 nm in the band (1, 0) and at 874.4 nm in the band (1, 2) with the uncertainty of retrieval about 30% above 90 km.
For [O_3] retrieval the following transitions should be used: O_2(b1, v') –> O_2(X3, v") which produce emissions: (c) at 762.1 nm in the band (0, 0) and at 864.7 nm in the band (0, 1) with the uncertainty of retrieval 20 - 25% for the altitude range 80 - 85 km and smaller than 20% in the interval 85 - 95 km; (d) in the line of O(1D) 630.0 nm with the uncertainty of retrieval 10 - 15% in the interval 80 - 95 km. Above 95 km the uncertainty of [O_3] retrieval grows and reaches up to 80% at 100 km for all suggested proxies. For simultaneously [O_3] and [O(^{3}P)] retrievals the observations of above mentioned emissions (a) or (b) and (c) or (d) could be used.