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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Diurnal and annual variations of meteor rates at the Arctic circle" *by* W. Singer et al.

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1. General Comments: This paper (Singer et al., 2004) represents a valuable addition to our knowledge of the diurnal and annual variations of meteor rates in the northern hemisphere, and therefore our understanding of an important source of metal atoms and condensation nuclei in certain atmospheric regions. This important data set represents near continuous operation over two years. The location of this SKiYMET radar just above the Arctic Circle in Norway provides the means of separating the contributions we get from the northern ecliptic hemisphere. The finding of a significant peak in meteor rate in June which appears due to sporadic meteors with radiants high in the northern ecliptic hemisphere and with moderate geocentric speeds is an important finding which deserves further attention by future researchers. The lack of clear evidence of radiants from some of the expected major meteor showers (like the Beta

Taurids and Zeta Perseids in June) is surprising.

2. Specific Comments:

2.1 Radar Height and Velocity Sensitivity: Several places in the paper reference is made to the height sensitivity of the radar system and in section one it is stated that the system is sensitive to meteors at heights from 78 to 120 km. However, no quantitative estimate of the sensitivity of the radar with height of meteor ablation is given. Since meteors of different velocities and compositions ablate at different heights, it is critical to know the height sensitivity of the instrument in order to assess what fraction of the entire meteoroid complex is not being observed. While, as pointed out, the efficiency of ionization goes up by more than the third power with velocity, the greater heights of these fast meteors also lead to more rapid loss of the trail radar return through interference effects. While a precise height (or velocity) sensitivity plot is difficult, some quantitative measure should be provided. The observed height distribution seems to imply only weak detection of the high velocity meteor component.

2.2 Do Radio Meteor Observed Rates Reflect True Incidence of Meteoroid Material: An important question is whether the observed annual variations in meteor rates detected by the radar represent the true variation in influx of meteoroid material, or are there other factors which play a significant role. The paper implies that the two are strongly correlated. A question which should be considered is whether seasonal differences in the atmospheric density profile, or in the atmospheric scale height at meteor altitudes, contributes to the observed annual variations in meteor rates. It has been known for some time that radar meteor rates and solar activity are inversely correlated (e.g. Ellyett, 1977, Simek and Pecina 2002, Lindblad 2003) and the most likely explanation is that the observed meteor rate varies according to the change in atmospheric density gradient at meteor ablation heights (Ellyett and Kennewell, 1980; Lindblad 2003). It should be noted that Lindblad (2003) reports not only long term solar cycle correlations, but also correlations with solar wind sectors. Campbell-Brown and Jones (2003) have recently considered the effects of meteoroid fragmentation on radar detection (us-

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ing similar radar technology), and these effects may bias the observed meteors toward meteors with certain physical structures and compositions.

2.3 Placing the Results in Context: The paper provides an excellent data set. The scientific value of the work would be considerably extended if there was a more complete treatment of past research on diurnal and annual meteor rates, with a critical comparison with these results. This comment is not a place to do a complete review, but I would cite some examples of the important literature not reflected in the paper. Millman (1963) provides an analysis based on five years of near continuous operation by a northern hemisphere meteor radar system. The results reported there agree with the June peak reported in this paper. Yrjola and Jenniskens (1998) have published an extensive account of northern hemisphere meteoroid streams observed by radar. It would be interesting to search for some of the contributors to northern hemisphere meteor rates reported in that paper. Diurnal meteor rate effects have recently been studied by Ohnishi et al. (2001). Schmude (1998) has studied annual meteor rate variations from visual observations, with the result that generally a slightly higher rate is found during the second half of the year (of course this study would be blind to the influence of the daytime showers). In terms of a theoretical understanding of the importance of the different model sources at different times in the year, the important foundation paper by Stohl (1969) should also be noted. Finally, it would be interesting to compare these northern hemisphere results with those reported from a one year meteor radar study for the southern hemisphere (e.g. Ellyett and Keay, 1963).

3. Technical Corrections None

4. References:

Campbell-Brown, M., Jones, J., 2004, Mon. Not. R. astr. Soc., 343, 775-780, ŞDetermining the initial radius of meteor trains: fragmentationŤ

Ellyett, C., 1977, J. Geophys. Res., 82, 1455-1462, ŞSolar influences on meteor rates and atmospheric density variations at meteor heightsŤ

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Ellyett, C., Keay, C.S.L., 1963, Mon. Not. R. astr. Soc., 125, 325-346, ŞSouthern hemisphere meteor ratesŤ

Ellyett, C.D., Kennewell, J.A., 1980, Nature, 287, 521-522, ŞRadar meteor rates and atmospheric density changesŤ

Lindblad, B.A.„ 2003, ESA SP-535, 755-759, ŞSolar control of meteor radar ratesŤ

Millman, P.M., 1963, JRASC, 57, 181-183, ŞAnnual variation in radar meteorsŤ

Ohnishi, K. et al., 2001, ESA SP-495, 435-440, ŞThe Earth rotation and revolution effect on the daily and annual variation of sporadic meteor echoŤ

Schmude, R.W., 1998, Icarus, 135, 496-500, ŞSeasonal changes in sporadic meteor ratesŤ

Simek, M., Pecina, P., 2002, Earth Moon Planets, 88, 115-122, ŞRadar sporadic meteor rates and solar activityŤ

Singer, W., WeiB, J., von Zahn, U., 2004, Atmos. Chem. Phys. Discuss., 4, 1-20 ŞDiurnal and annual variations of meteor rates at the Arctic circleŤ

Stohl, J., 1969, Contr. Astron. Obs. Skalnate Pleso, 4., 46-62, ŞThe Diurnal and annual variations of sporadic meteorsŤ

Yrjola, I., Jenniskens, P., 1998, Astron. Astrophys., 330, 739-752, ŞMeteor stream activity VI A survey of annual meteor activity by means of forward meteor scatteringŤ

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