1.2 JAPANESE CONTRIBUTIONS TO MAP

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Japan contributed much to MAP in many branches. The MU radar, in operation during the MAP period, produced various novel possibilities in observations of middle atmosphere dynamics; possibilities which have been fairly well realized. Gravity wave saturation and its spectrum in the mesosphere have been observed successfully. Campaign observations by radars between Kyoto and Adelaide have been especially significant in tidal and planetary wave observations. In Antarctica, middle atmosphere observation of the dramatic behavior of aerosols in winter is well elucidated together with the ozone hole. Theoretical and numerical studies have been progressing actively since a time much earlier than MAP. Now it is pointed out that gravity waves play an important role in producing the weak-wind region in the stratosphere as well as the mesosphere.

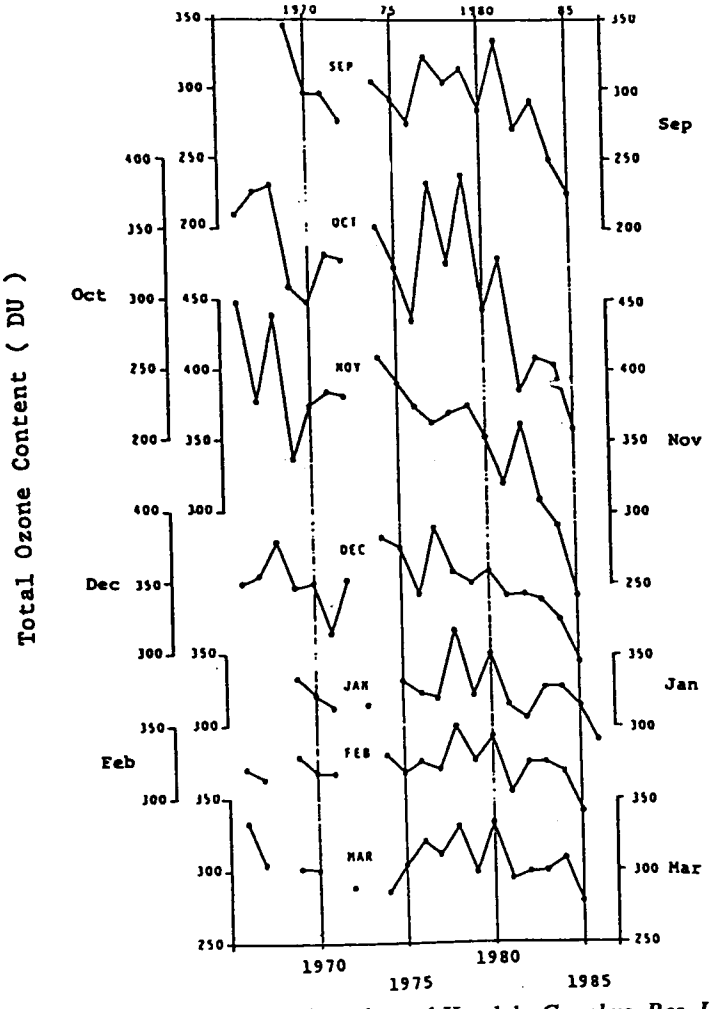

Figure 1. Ozone depletion at Antarctica [Iwasaka and Kondoh, *Geophys. Res. Lett, 14*, 87, 1987].

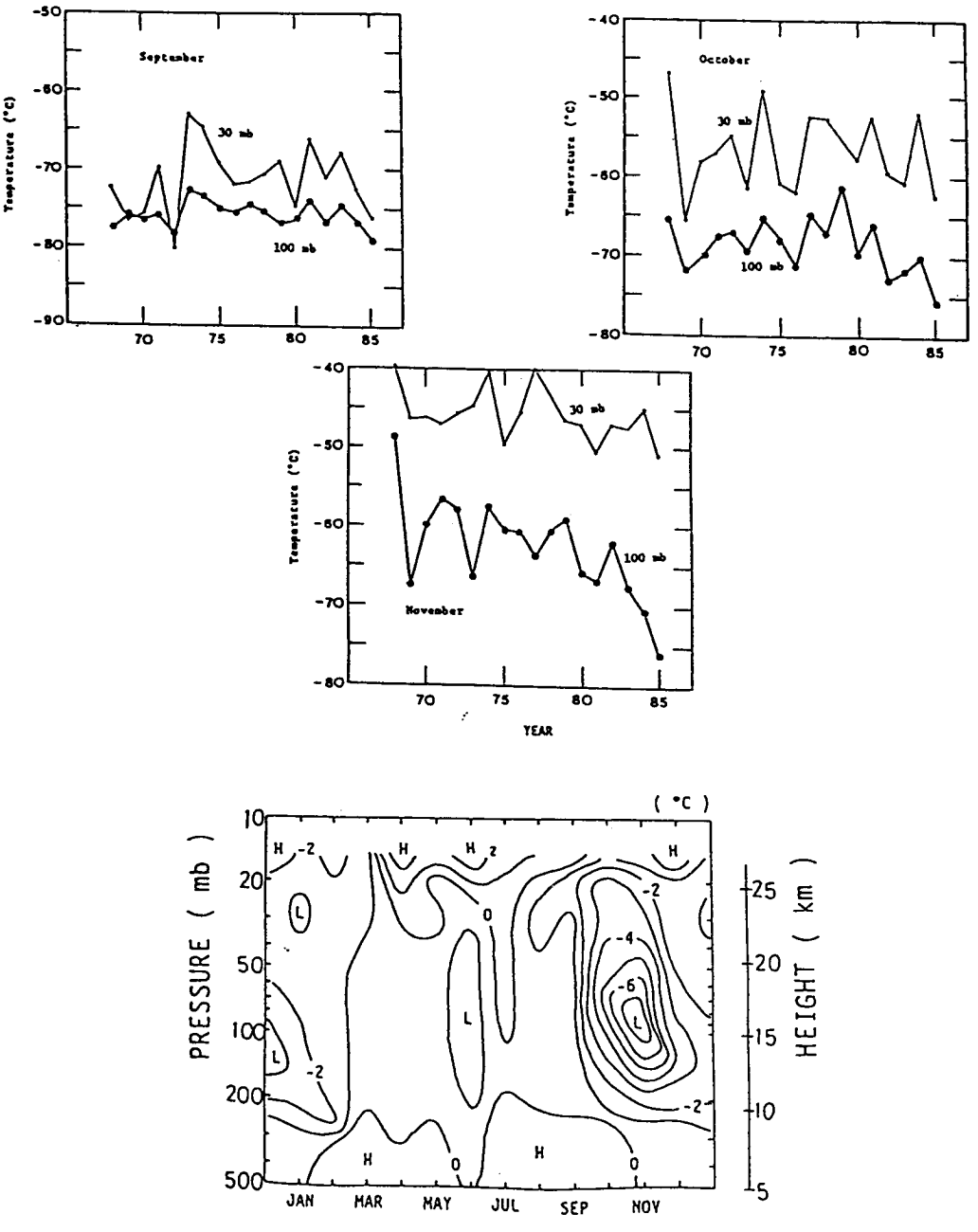

Figure 2. Temperature decreases remarkably from 1980 to 1985 in November at 100 mb height [Iwasaka and Kondoh, *Geophys. Res. Lett, 14,* 87, 1987].

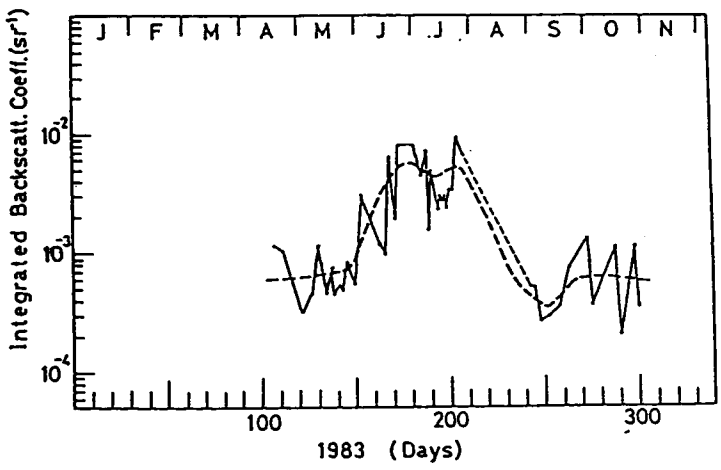

Figure 3. Aerosol is increased tremendously in winter [Iwasaka, *J.G.G., 38*, 99, 1986].

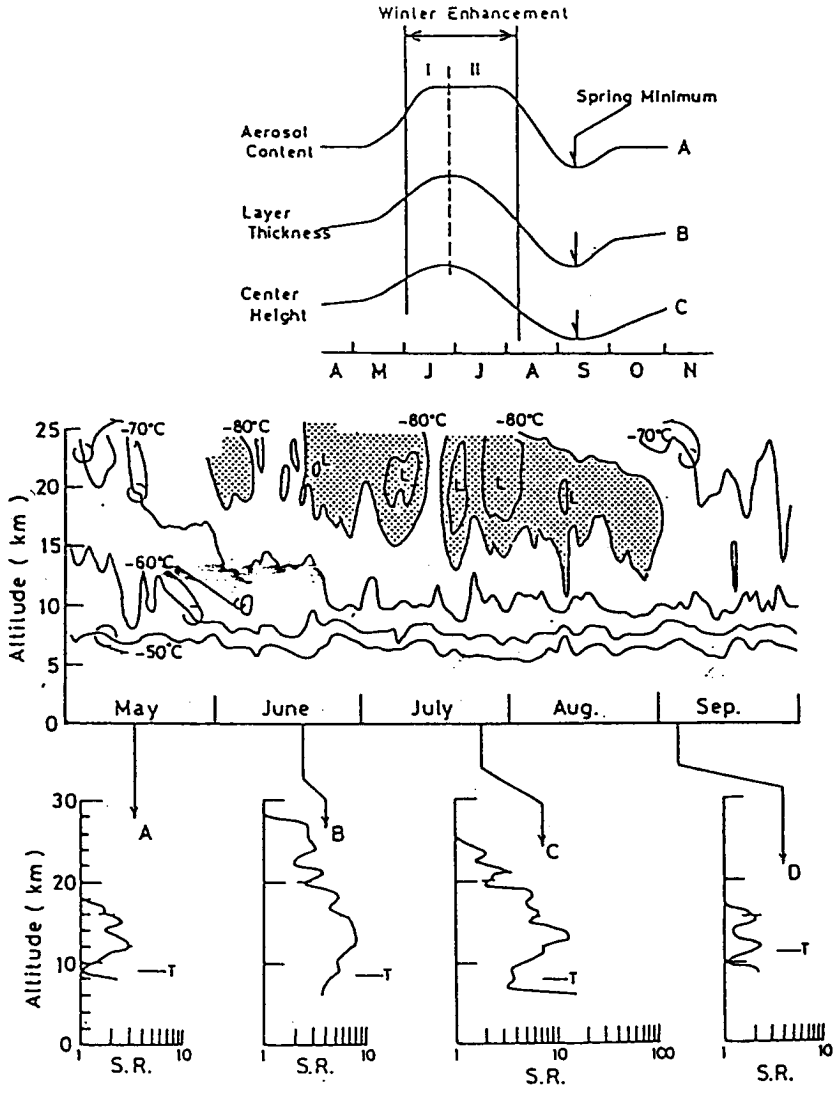

Figure 4. Note that the low temperature as (–80°) may cause the aerosol behavior as shown in the upper figure [Iwasaka, *J.G.G., 38*, 99, 1986]

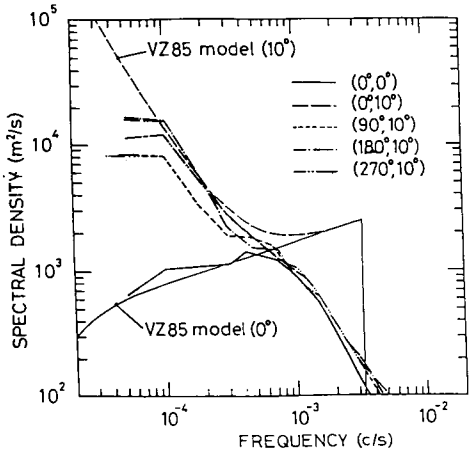

Figure 5. The frequency spectrum of line-of-sight velocity fluctuation for various radar beam directions: The VZ 85 model by VanZandt is also shown. No saturation is found in the spectrum shape [*Tsuda et al.*, 1988].

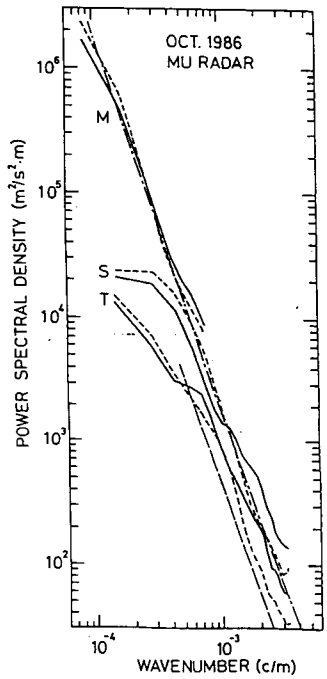

Figure 6. Saturated gravity wave vertical wave number spectrum observed by the MU radar: M, S,T, stand for the mesosphere, stratosphere and troposphere, respectively. The result is consistent with the saturated gravity wave spectrum with the dominant vertical scale 3.2 – 2.2 km, 10 km to the stratosphere and mesosphere. Similar experiment in 1987 gives the scale of the troposphere available in another experiment, as 5 km [*Tsuda et al.*, 1988].

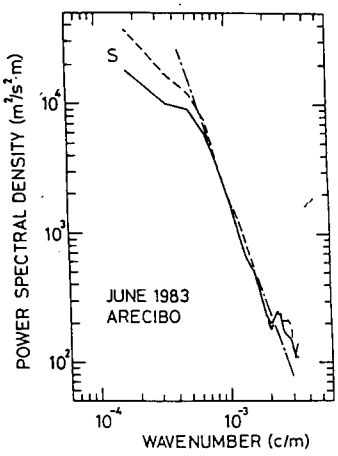

Figure 7. Similar to Figure 6 except at Arecibo only for the stratosphere which has the dominant vertical scale as 2 km [*Tsuda et al.*, 1988].

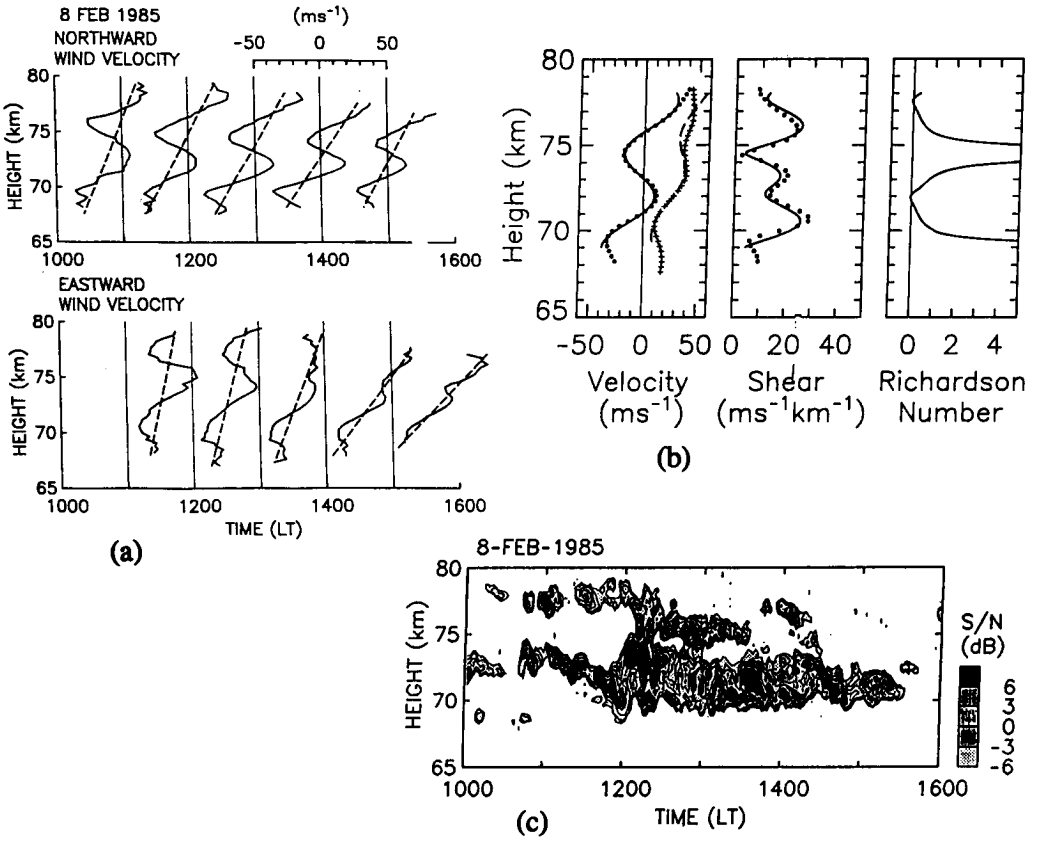

Figure 8. Observed quasi-monochromatic gravity wave which is saturated as noted by Richardson number etc. [Yamamoto et al., *J. Geophys. Res.*, *92*, 11993, 1987]. Note that the observed period is around 20 h (a) wind (b) shear and Richardson number (c) the MU radar echo.

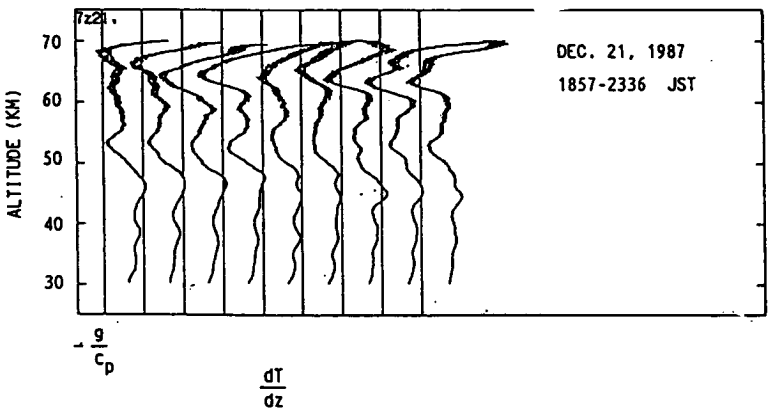

Figure 9. Lidar observation by Shibata [1988]. Temperature gradient, shown together with the adiabatic lapse rate, suggests a convective instability around 65 km height.