Verification of the Japanese 55-year Reanalysis "JRA-55" quality

focused on the various time scale variability of the stratospheric temperature and the atmospheric flow on the isentropic surface in the troposphere

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Improvement in the stratospheric temperature

A large temperature bias in the lower stratosphere was significantly reduced comparing to those in JRA-25. Temperature bias in the lower stratosphere is small during not only the period B (years from 1980 to 20??) but also the period A (years from 1958 to 19??), and monthly scale variability in global mean temperature is stable. In addition, it is noteworthy that QBO and sub-monthly scale phenomena, such as SSW are well reproduced even during 1960s.

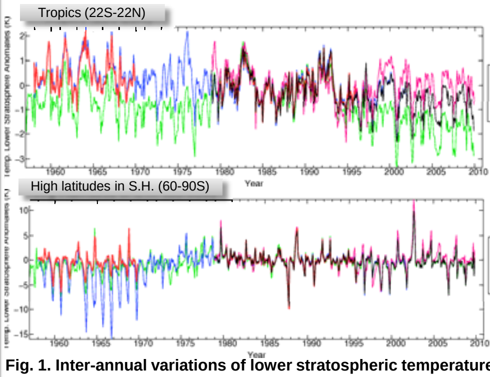

Fig. 1. Inter-annual variations of lower stratospheric temperature anomalies from (1985-1994 mean). Unit: K

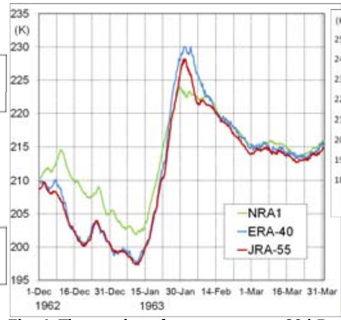

Fig. 4. Time series of temperature at 30 hPa, in 60-90N, during 1962 – 1963.

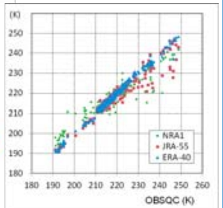

Fig. 5. Scatter diagram of observational and analyses temperature at 30 hPa, during 1962 – 1963.

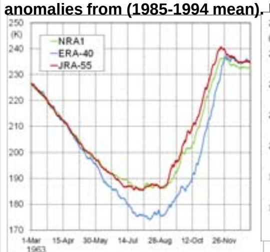

Fig. 2. Time series of temperature at 30 hPa, in 60-90S, during 1963.

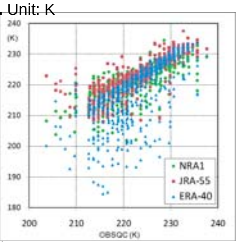

Fig. 3. Scatter diagram of observational and analyses temperature at 30 hPa, during 1963.

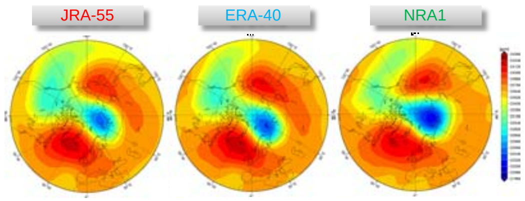

Fig. 6. 30-hPa geo-potential heights on 31 January 1963 00 UTC in the northern hemisphere. Unit: gpm

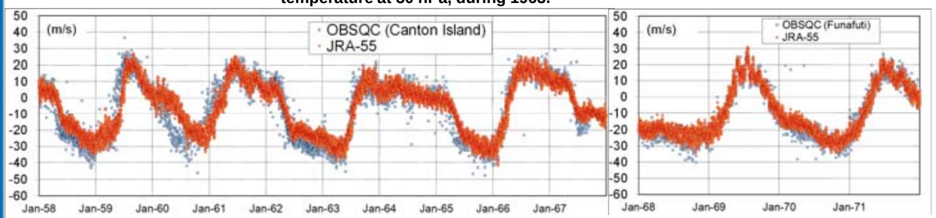

Fig. 7. Time series of zonal wind at 30 hPa near E.Q. during 1958-1967 (Left), 1968-1971 (Right) . Unit: m/s

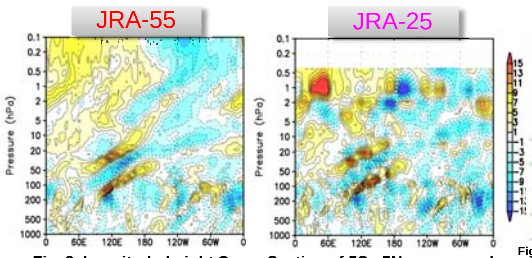

Fig. 8. Longitude-height Cross Section of 5S - 5N mean zonal wind difference between 20 and 19 March. Unit: m/s

At shorter time-scale, equatorial waves can be detected more clearly in JRA-55. It seems to be excited by remarkable convective activities in the western Pacific Ocean in March when the QBO was in the transition stage from easterly to westerly phase.

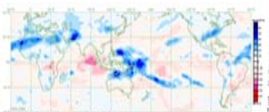

Fig. 9. 17 – 21 March 1980 mean OLR anomaly from 1981-2010 climatological mean. Unit: w/m^2

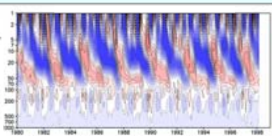

Fig. 10. Time-Height cross section of zonal wind (5S-5N, zonal mean) during 1980-1998. Unit: m/s

Atmospheric flow on the isentropic surface

The atmospheric flow in JRA-55 is much smoother than that in JRA-25. The distribution of isentropic potential vorticity (IPV) increments exhibits the whole decrease of IPV increments in JRA-55. Quite higher consistent rate in JRA-55 than that in JRA-25 in the region from sub-tropics to mid-latitudes. IPV tendency terms in JRA-55 are more reasonable than that in JRA-25. In particular, IPV tendency by radiation processes is more reasonable than that in JRA-25.

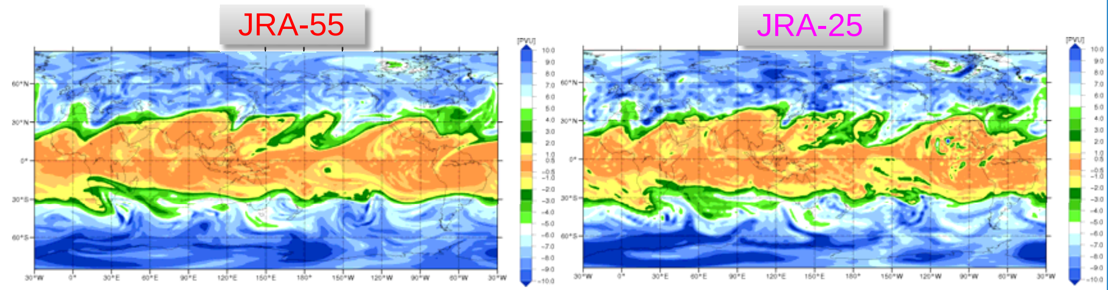

Fig. 11. IPV (Isentropic Potential Vorticity) map at 360 K (4 June 1983 12UTC) . Unit: PVU (1PVU=$10^{-6}m^2s^{-1}K\ kg^{-1}$)

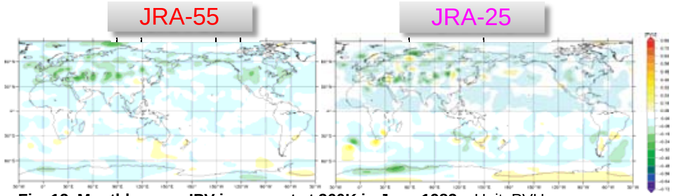

Fig. 12. Monthly mean IPV increment at 360K in June 1983. Unit: PVU

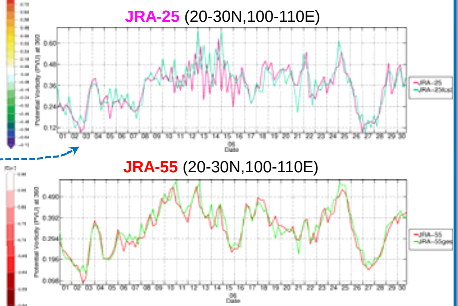

Fig.14 Regional averaged IPV analysis and model first Guess at 360K in June 1983. Unit: PVU

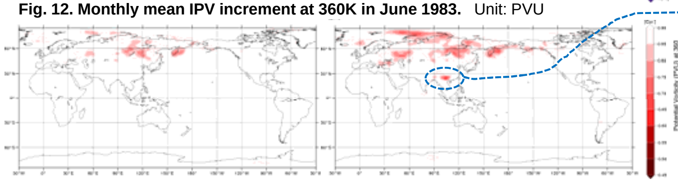

Fig. 13. Correlation Coefficients between Analysis and model first Guess in 6-hourly IPV at 360K field during June 1983.

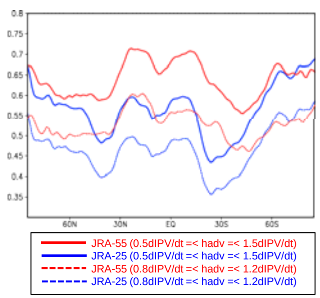

Fig.15. Comparison of Consistent Rate of the 12-hr IPV tendency term to the advection term at 360K field during June 1983

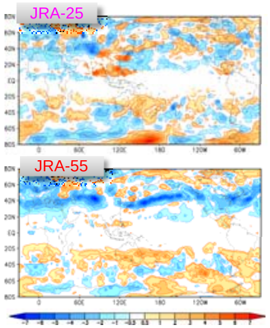

Fig. 16. 4-weekly IPV tendency terms by heating at 360K centered 30 June 1983.

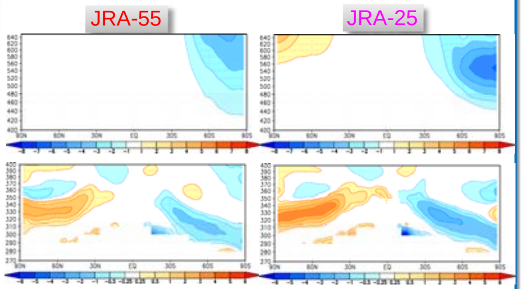

Fig. 17. Latitude-Height Cross Section of 4-weekly IPV tendency by radiation processes centered 30 June 1983

Previous studies have shown that Ertel's potential vorticity conserves for adiabatic, frictionless motion, and acts as a tracer of the atmospheric flow on an isentropic surface. Therefore, it is reasonable to verify the representation of the atmospheric flow and circulation in reanalyses using products on the isentropic surface. In addition, it has been pointed out that potential vorticity on the isentropic surface is changed by the diabatic heating processes, for example, convective heating and radiation processes.

Calculation of IPV tendency by diabatic heating processes (Hoskins et al. 1985)

$$\left(\frac{\partial}{\partial t} + v \cdot \nabla_\theta\right)P = P^2 \partial(\dot{\theta} P^{-1})/\partial\theta$$

Reference

Hoskins, B. J., M. E. McIntyre and A. W. Robertson, 1985: On the use and significance isentropic potential vorticity maps . Quart. J. Roy. Meteor. Soc., 111, 877-946.

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