Rayleigh and Resonance Lidar Studies of the Arctic Middle Atmosphere

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[12].[Measurements in the stratosphere, mesosphere and thermosphere]

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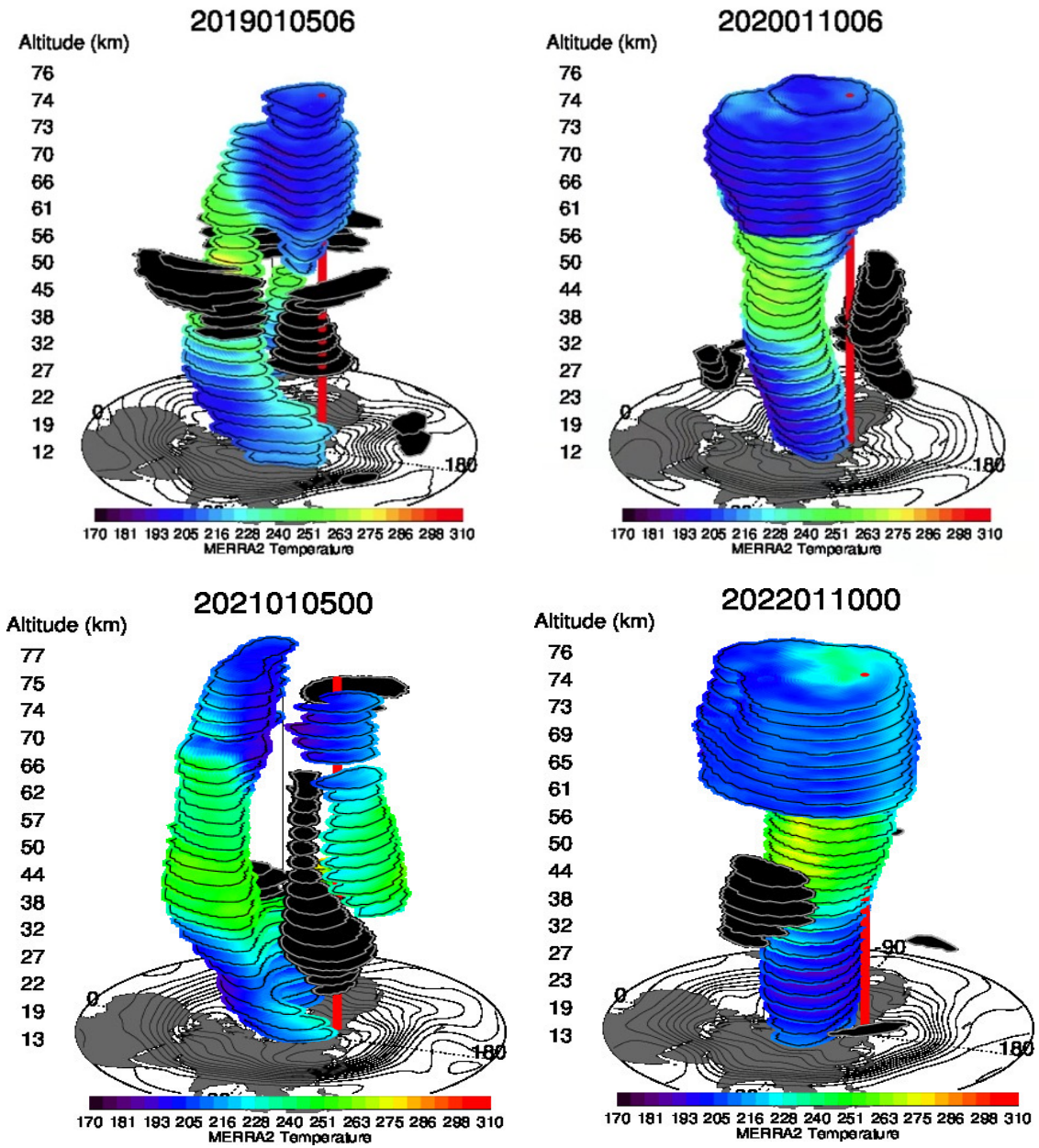
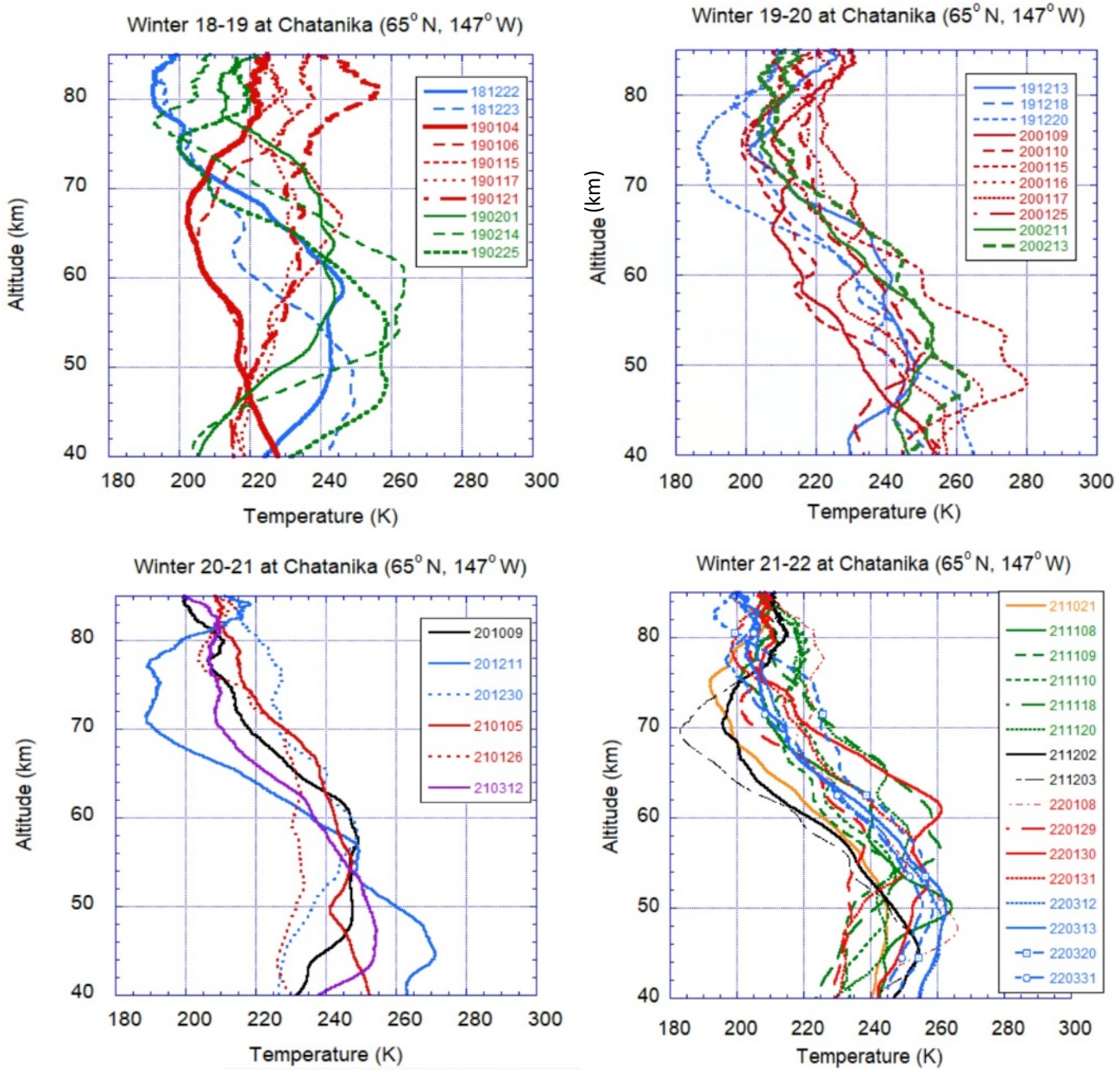
POLAR VORTEX



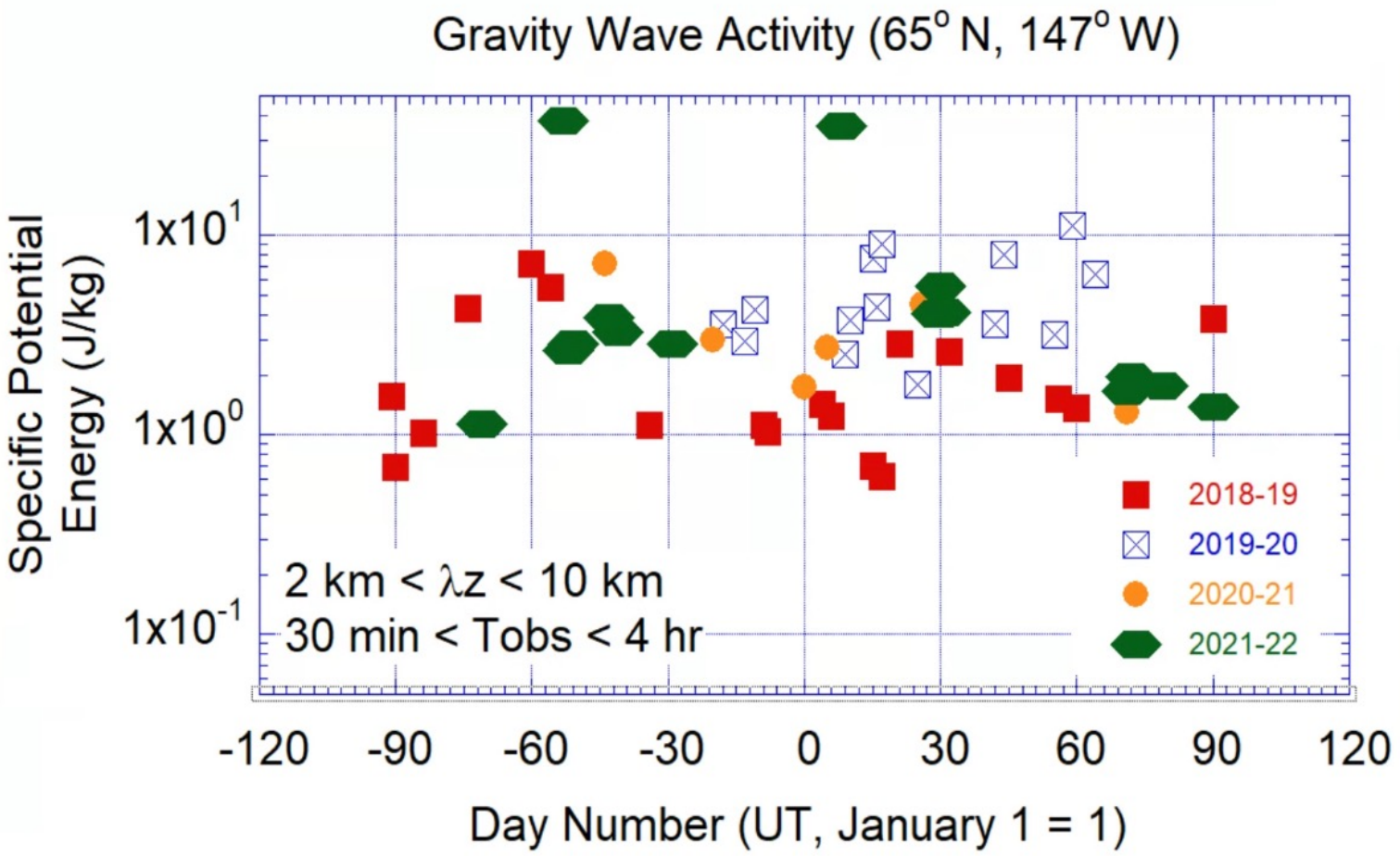
The figures on the left show the polar vortices on chosen nights in winters 2018-19 (Top left), 2019-20 (Top right), 2020-21 (Bottom left), 2021-22 (Bottom right) in the middle atmosphere at Chatanika, Alaska. In the winters of Sudden Stratosphere Warming (SSW) there is a split vortex or vortex displacement whereas the vortex remains intact in the quiet winters of 2019-20 and 2021-22.

TEMPERTAURE PROFILE



Temperature profiles at Chatanika, Ak are shown in the figures on the left. The stratopause disappears during the SSW period and then appears at an elevated altitude. The stratopause comes back to its normal position at the end of the SSW. During the non-SSW years, the stratopause always remains in its normal position.

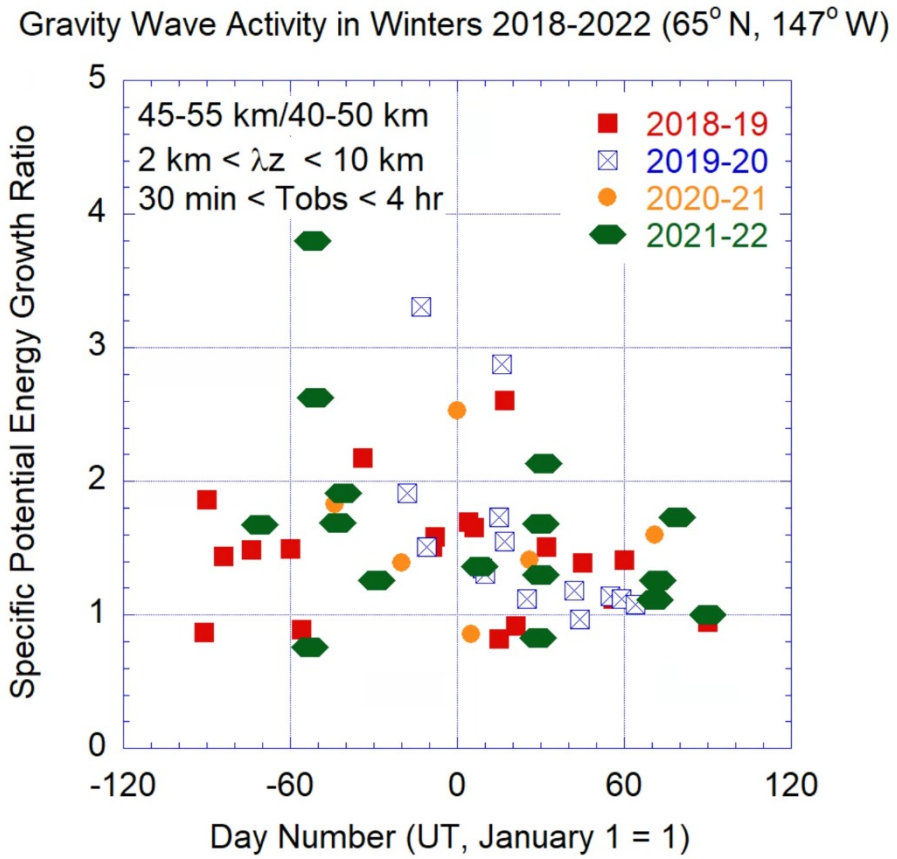
GRAVITY WAVE ACTIVITY



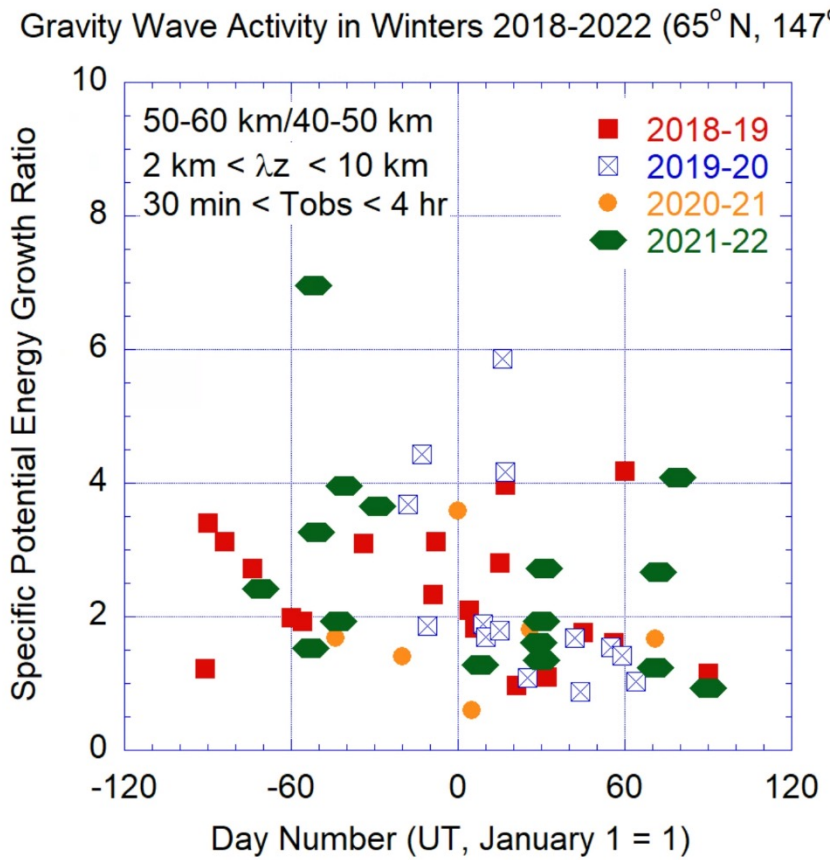
Specific potential energy (SPE) is a measure of gravity wave activity in the atmosphere. The figure on the left shows the SPE in four winters. In this case, only waves with 2km to 10 km wavelength and period in between 30 mins and 4 hours are taken into consideration. The mean SPE in 2018-19, 2019-20, 2020-21 and 2021-22 are 2.19, 5.15, 3.41 and 7.13 J/kg, respectively.

GROWTH RATIO

GR1

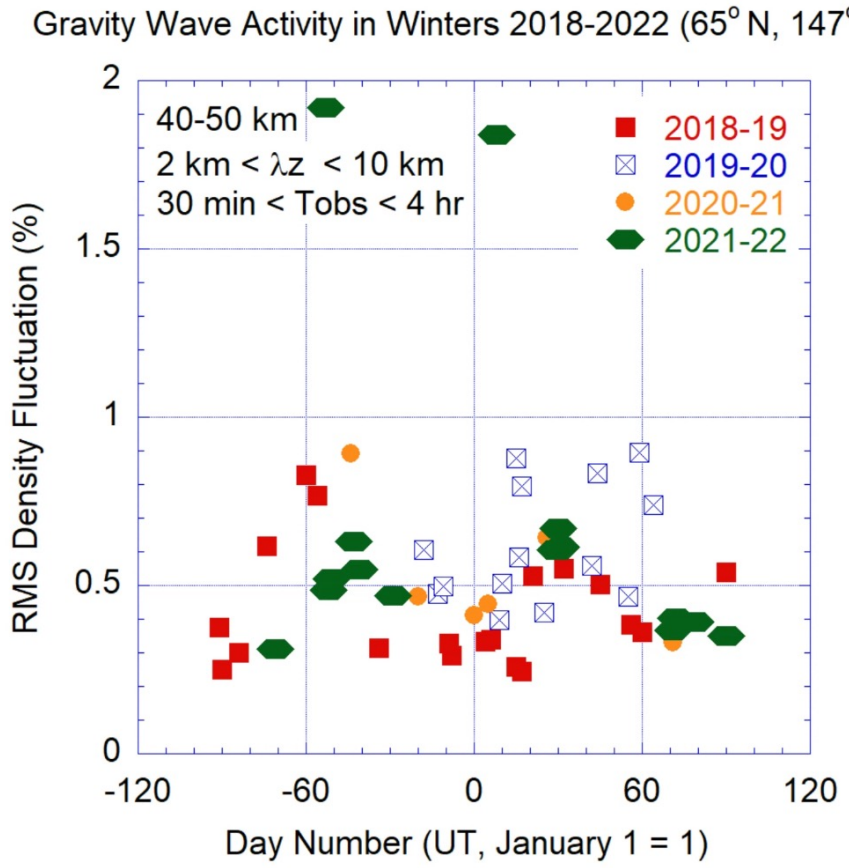


GR 2

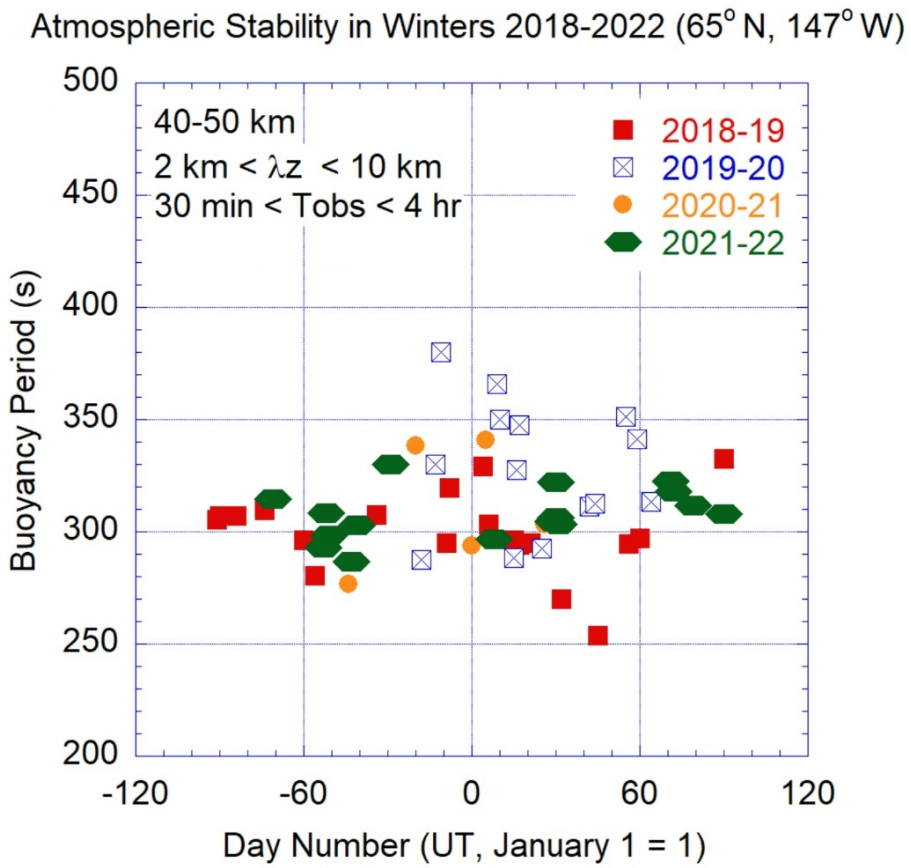


YEAR	MEAN GR 1	MEAN GR 2
2018-19	1.44	2.33
2019-20	1.58	2.35
2020-21	1.60	1.78
2021-22	1.63	2.60

RMS DENSITY FLUCTUATION AND ATMOSPHERIC STABILITY



In the above figure the rms density fluctuation averaged over 40-50 km is shown as a function of day number. The mean values in 2018-19, 2019-20, 2020-21 and 2021-22 are 0.42, 0.62, 0.53 and 0.67, respectively.



In the above figure the buoyancy period averaged over 40-50 km is shown as a function of day number. The mean values in 2018-19, 2019-20, 2020-21 and 2021-22 are 300 s, 328 s, 312 s and 308 s, respectively.

CONCLUSION

1) Vortex displacement is observed during the SSW periods in 2018-19 and 2020-21 winters. However, the polar vortex remains intact in the quiet winters of 2019-20 and 2021-22.

2) The stratopause disappears during the peak of SSW and reappears again around 80 km before returning to its normal position at the end of SSW.

3) The gravity wave activity is lower in the SSW winters compared to the ones when there is no SSW.

4) Even though there is not much difference in the mean buoyancy periods in different winters, the period is more during the SSW (First week of January in 2019 and 2021) compared to other days of the same winter. This indicates to a more unstable background atmosphere during SSWs.

5) The rms density fluctuates more in the non-SSW winters compared to the SSW winters.