Musings on the UM AMIP stratosphere – or – how high is high enough for an AMIP run?

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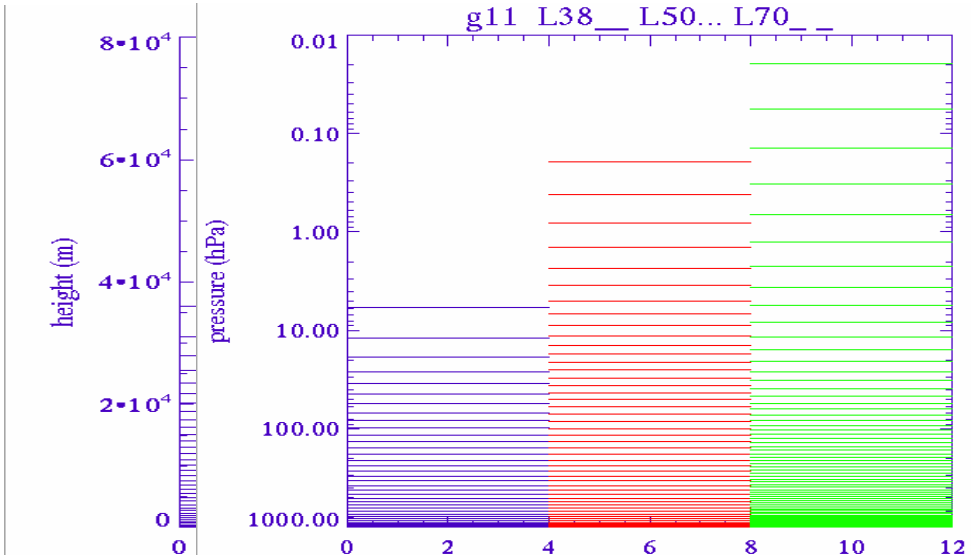
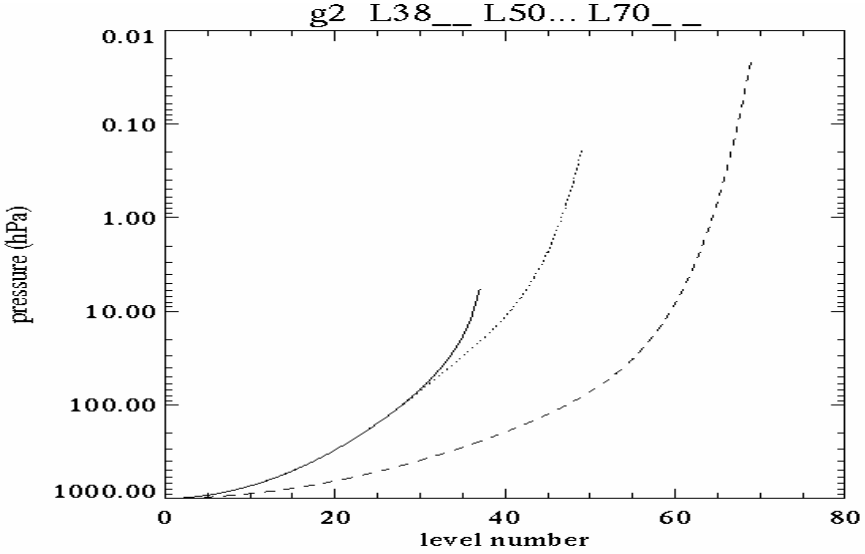
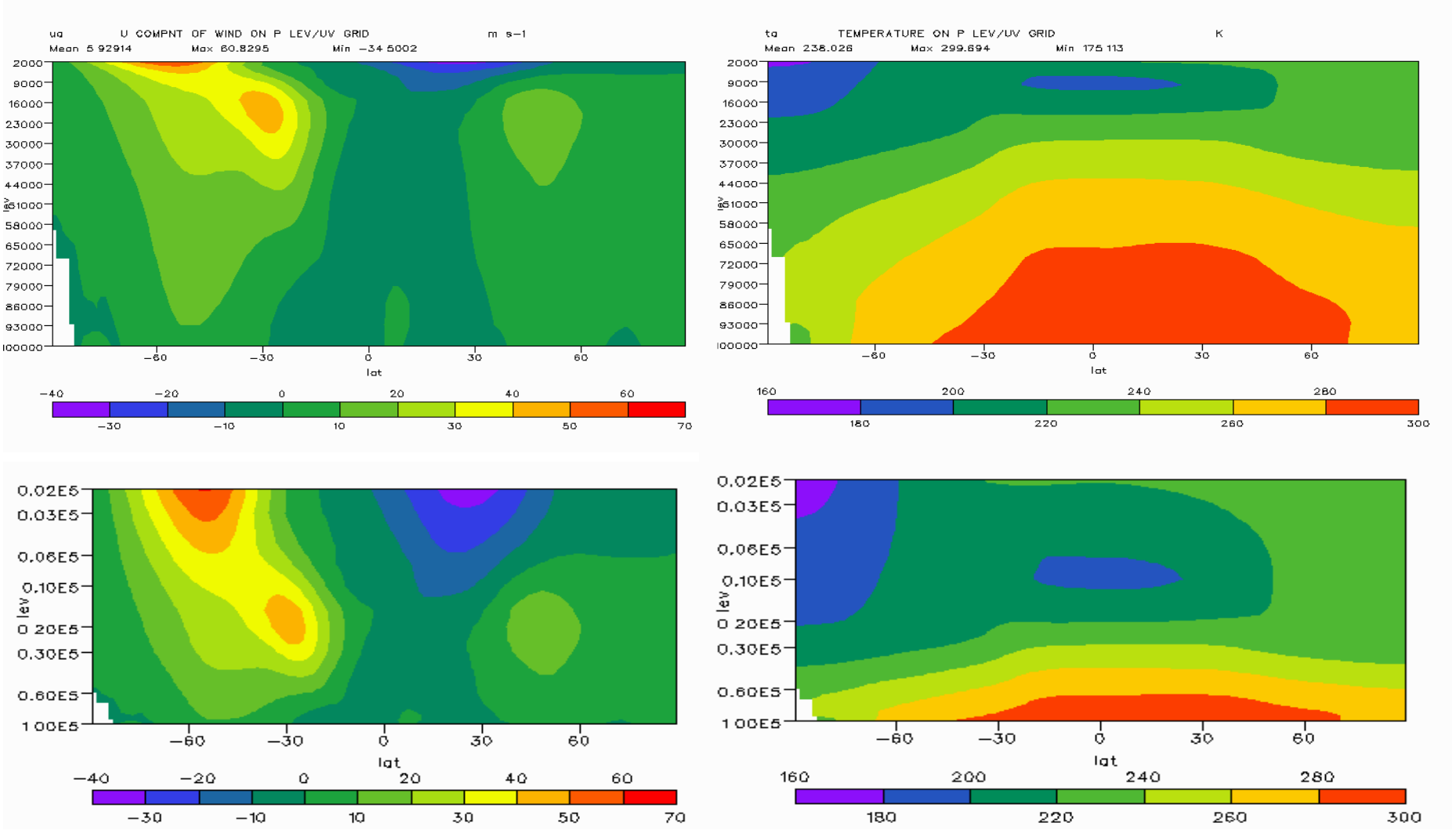
This is a brief discussion on the UM middle atmosphere as simulated in UM L38 runs, compared to extended top runs, with only slight reference to analysis of the present AMIP run. The main suggestion is that future AMIP simulation be configured with L50 to enable a better representation of the stratosphere.

The UM AMIP run was configured with L38 with a top at 36km (5 hPa), but only has one level above 10 hPa so dumping the top twp levels means useable data is only available from 20 hPa down. The standard UM L50 has a top of 60km (0.2 hPa) and usable data from 1 hPa (the stratopause) down. So L50 encompasses the stratosphere

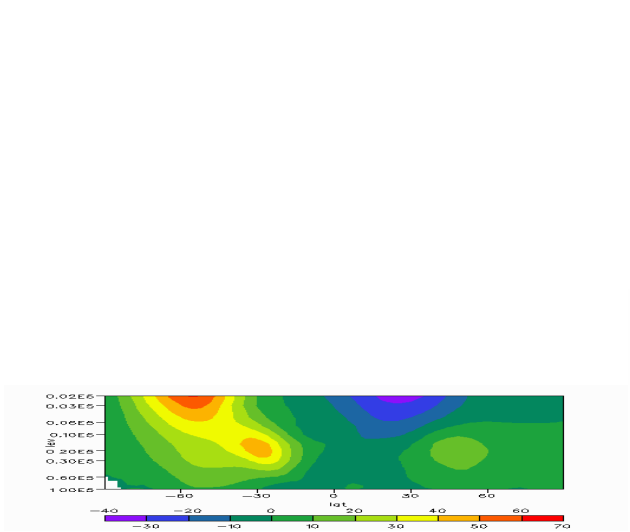


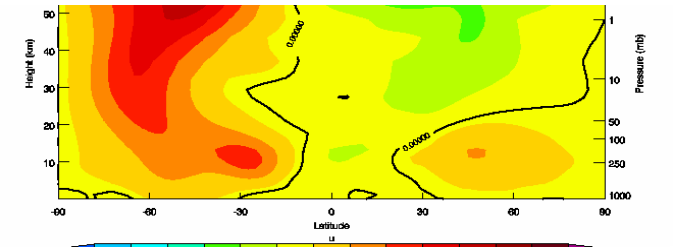


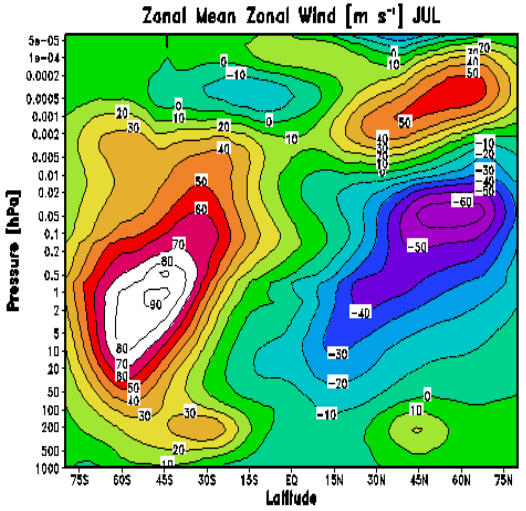
UM JULY zonal mean (left) U (right) T for UM AMIP L38

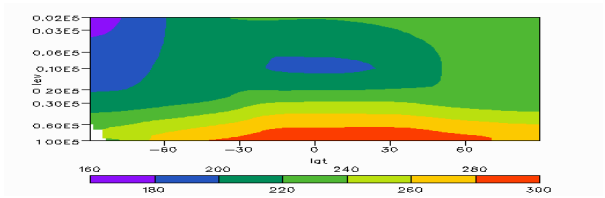


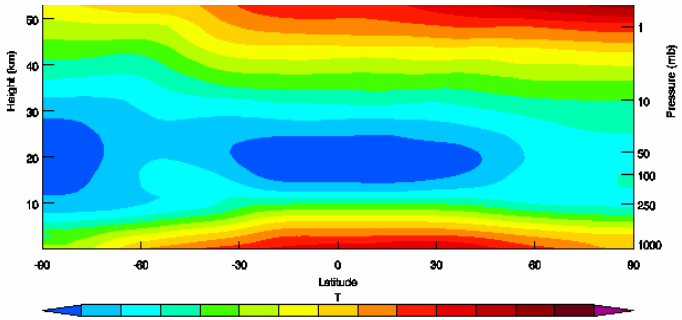
UM zonal mean (top) U (bottom) T for (left) UM AMIP L38 (middle) UM L50 (right) Randel climatology

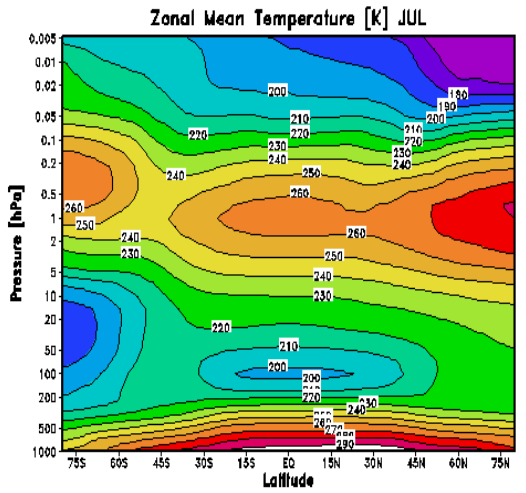




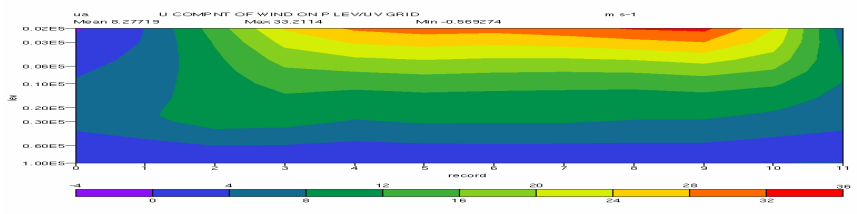


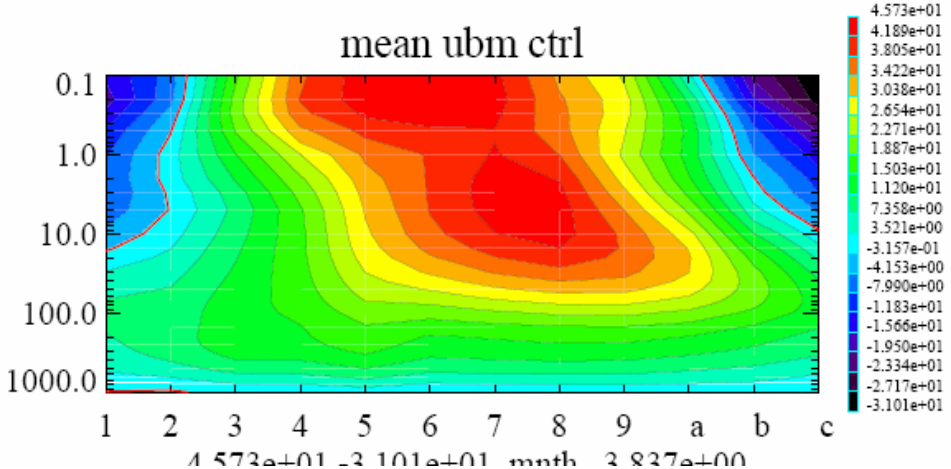


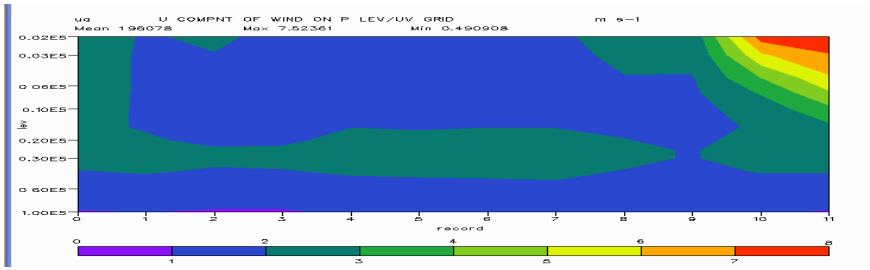


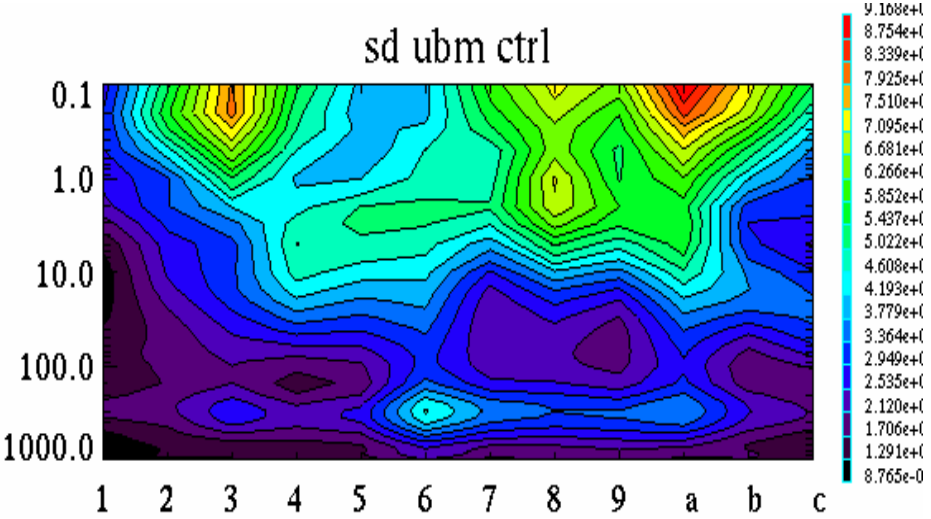


Time/height hovmoller over lat[90S:60S] for (left) UM AMIP L38 (right) UM L50x (top) mean u (bottom) sd u

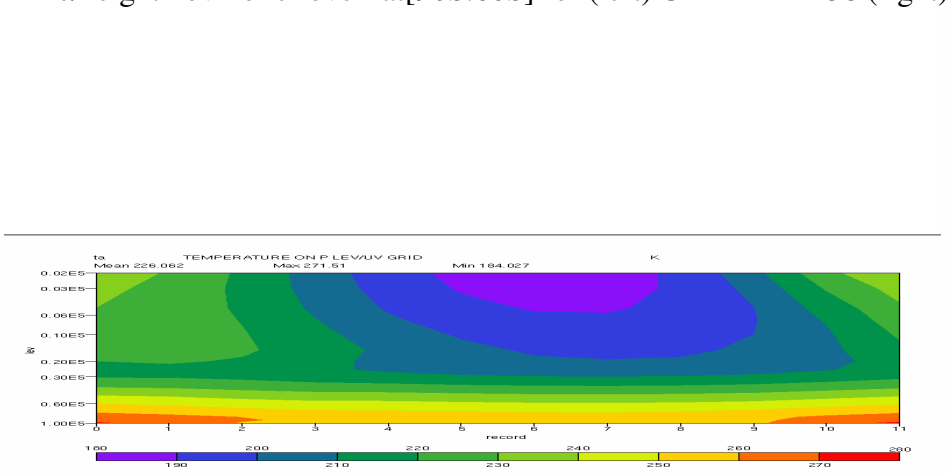


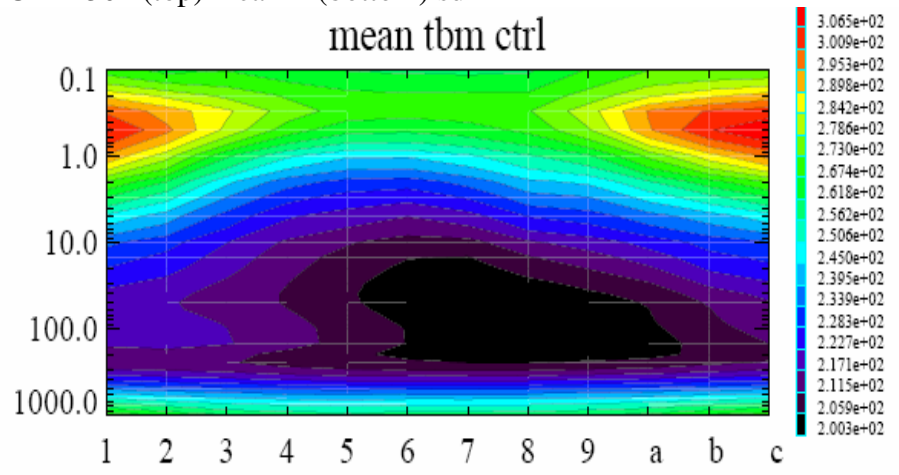


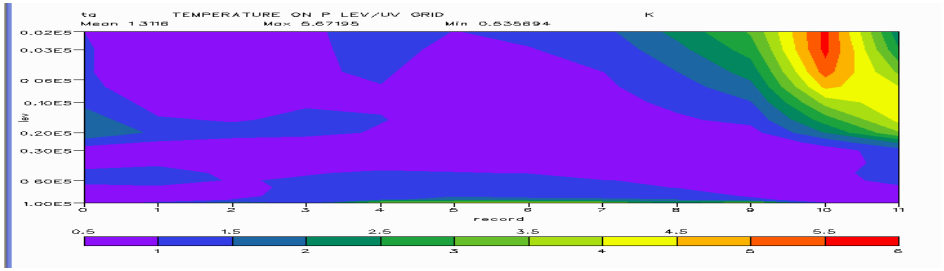


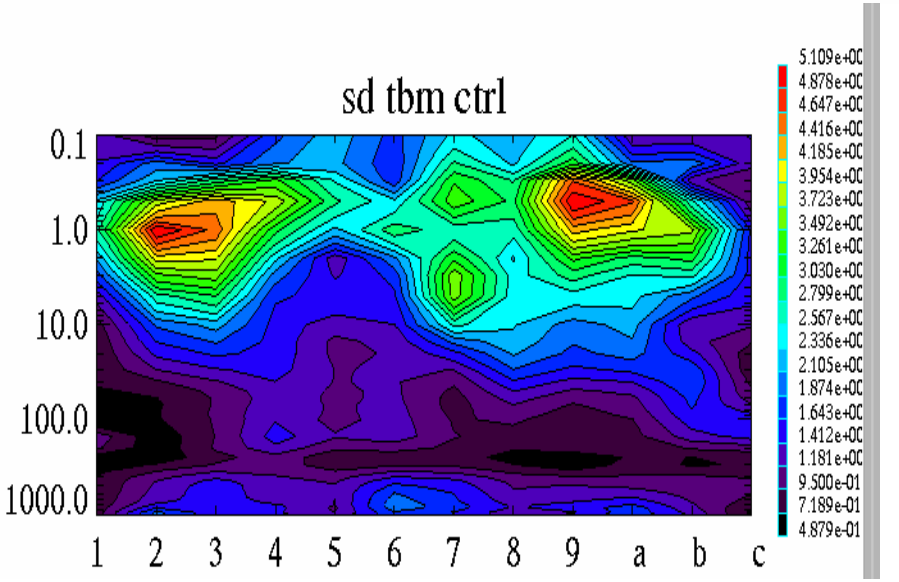


Time/height hovmoller over lat[90S:60S] for (left) UM AMIP L38 (right) UM L50x (top) mean T (bottom) sd T

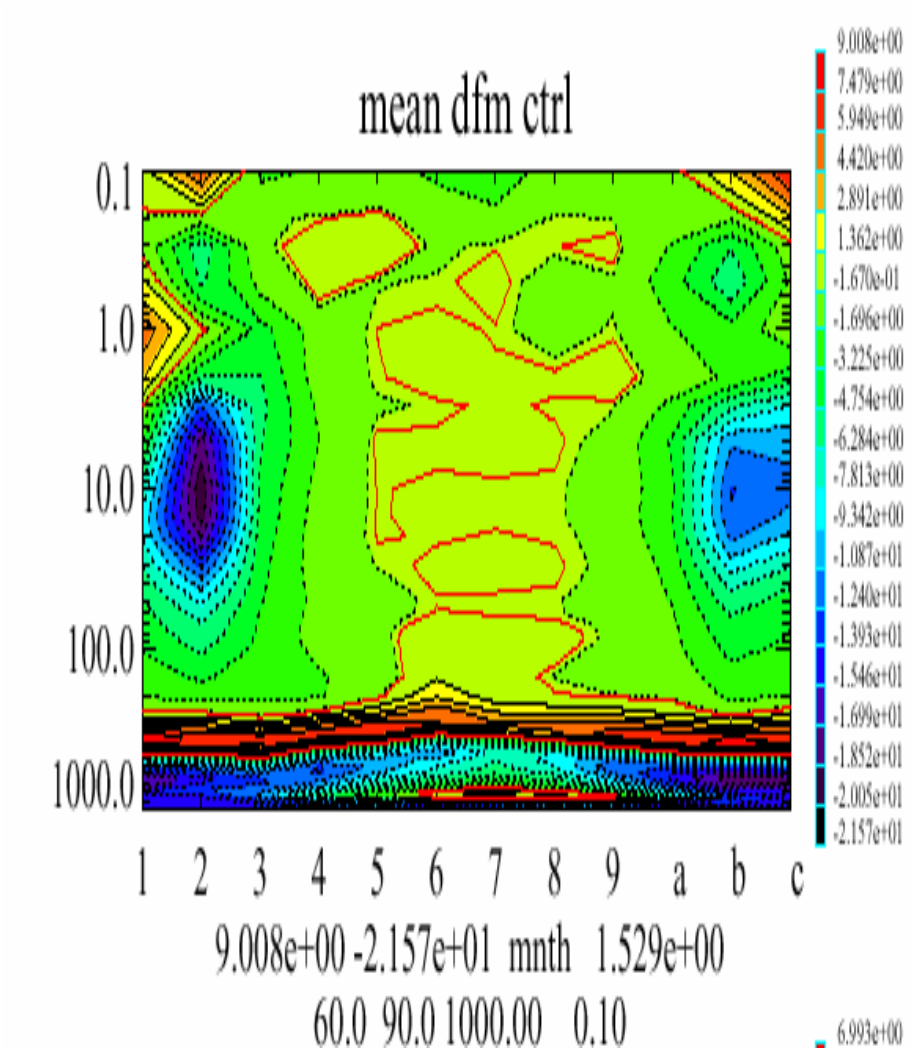


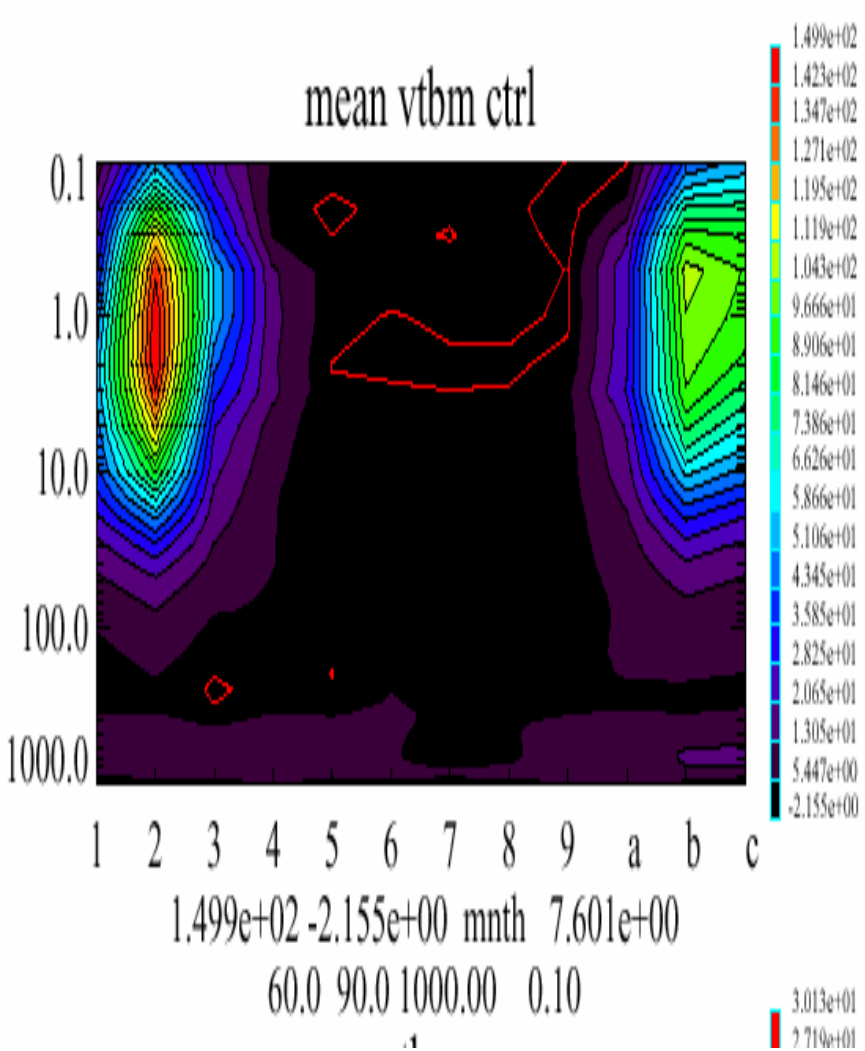




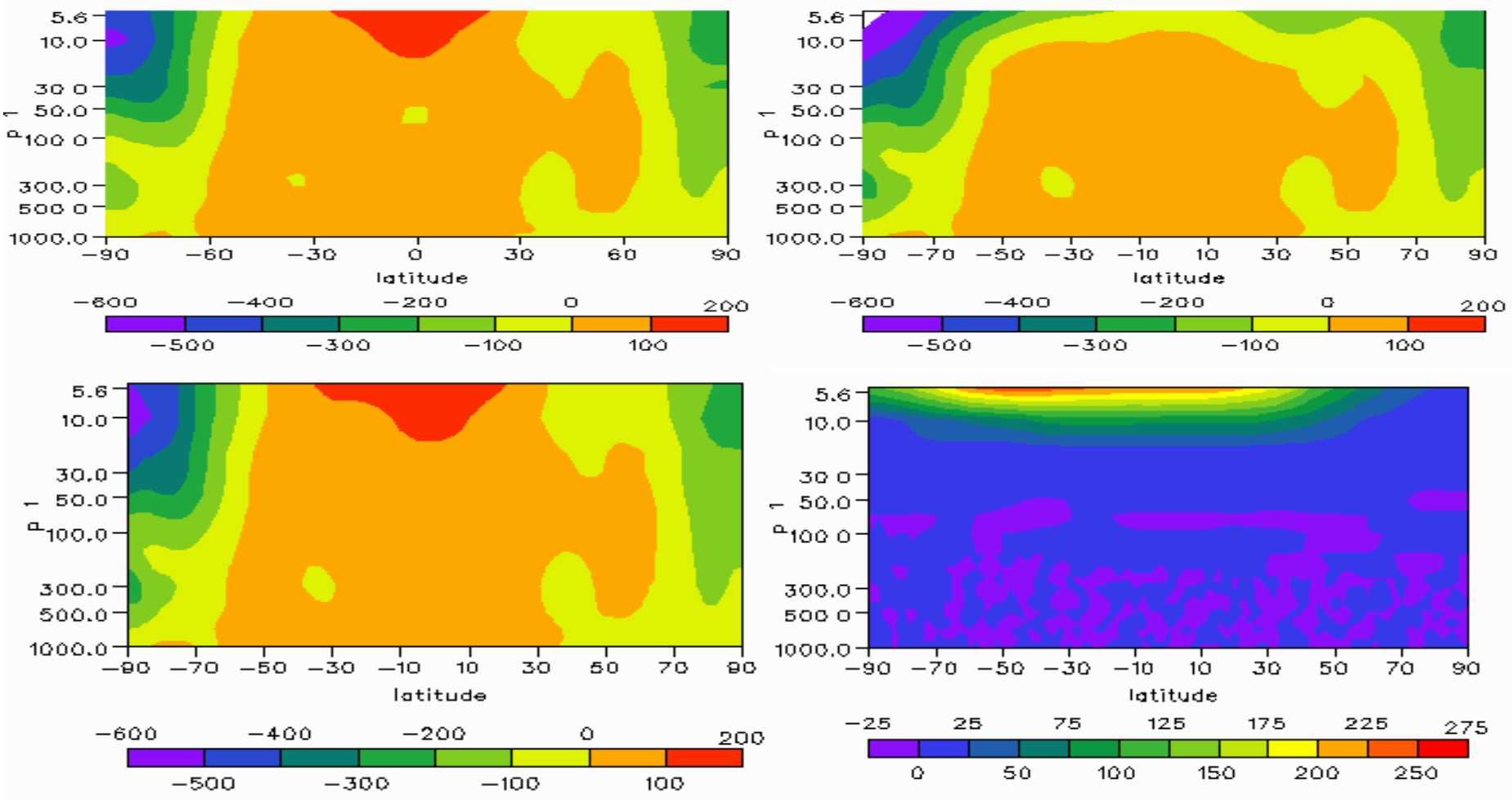


Raised lid L50x (time/ht) hovmoller av lat[60N,90N]: DF, vt

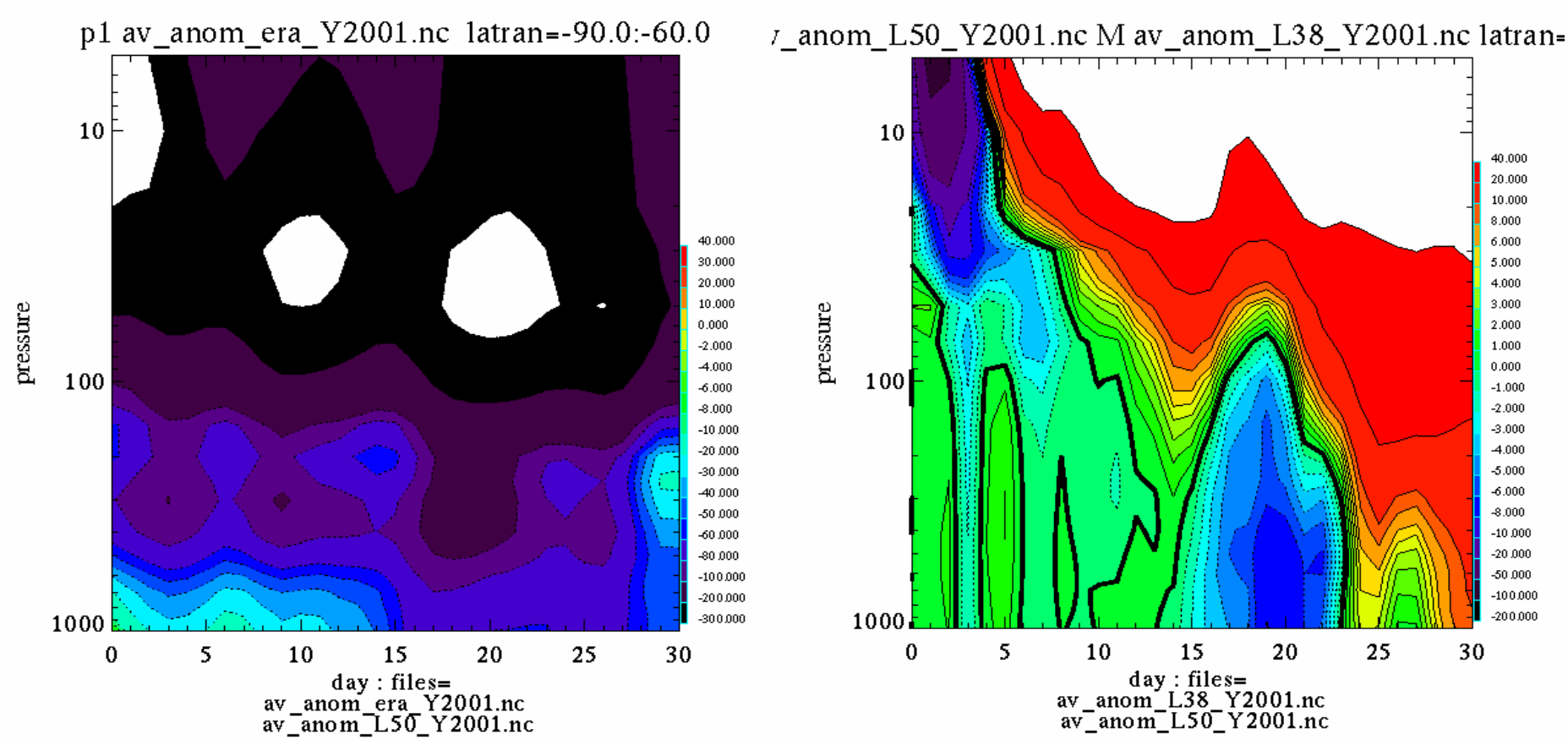




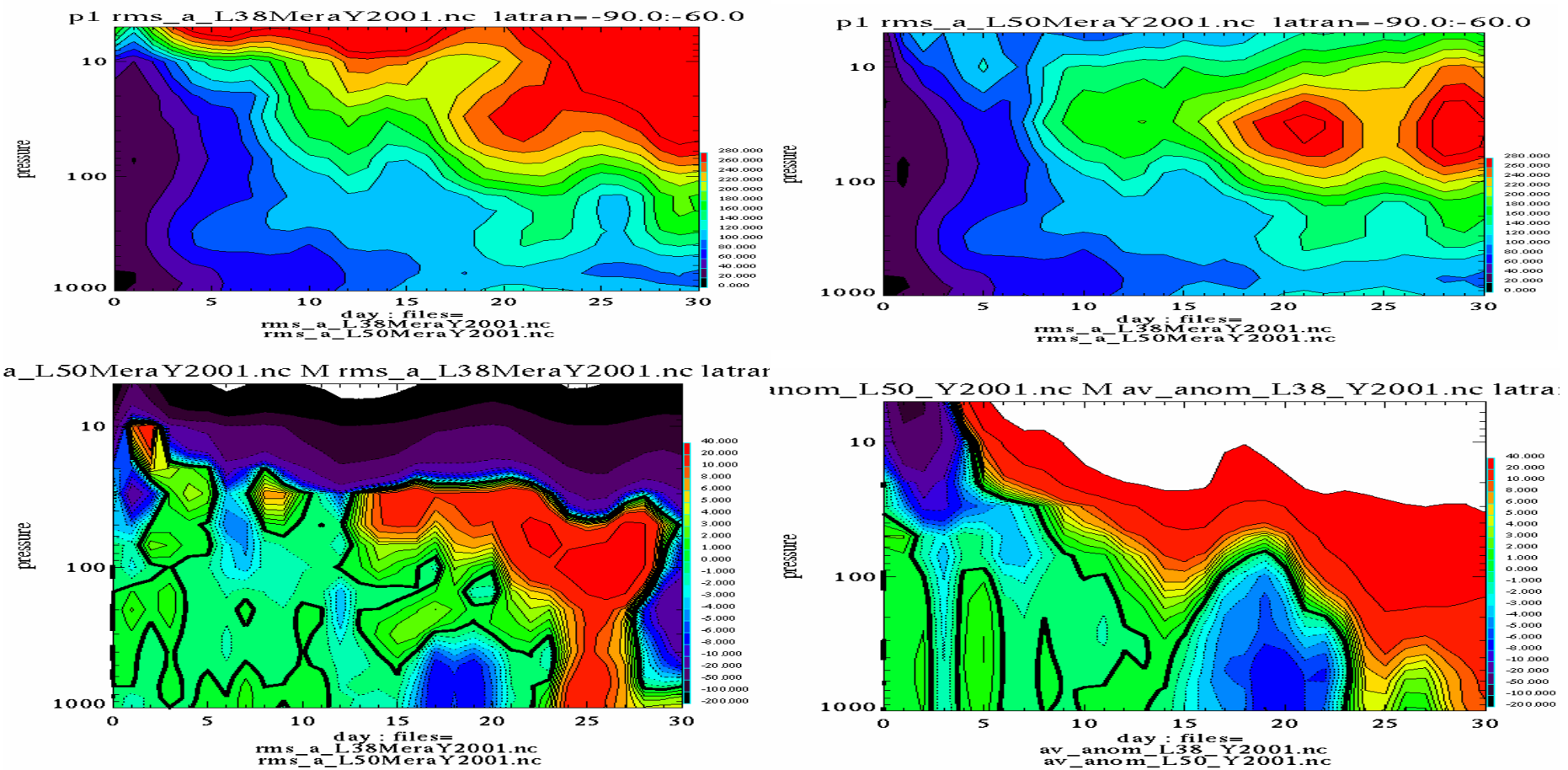
Compare L38 and L50 30day runs: Just the ic. The zonal mean of the geopotential height anom field ic for a typical ensemble day in Nov 2001 from (tl) era, (tr) L38, (bl) L50 and (br) the diff L50-L38. This plot only goes to 5 hPa, which is the top of the L38 run.



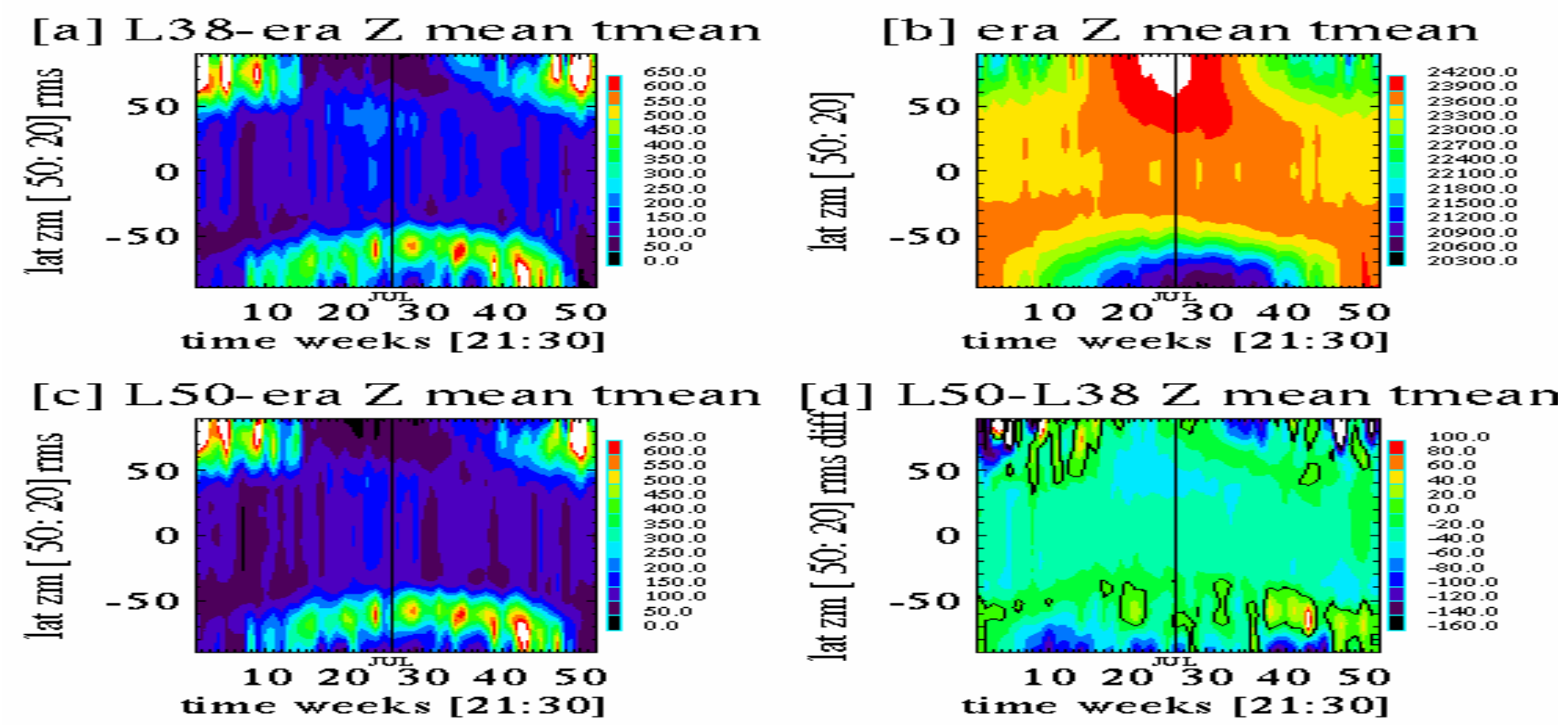
Downward control: The 2001 negative anomaly descends in the obs and this is simulated more realistically in the L50 run rather than the L38 run eg (left) the 2001 anomaly (model – climatology) logp/time plot using [era – era_clim] averaged over our 30 day forecast period starting on Nov 14 2001 and averaged over latitudes [90S:60S]; (right) the L50 – L38 difference, respectively. Note: both models were using L38ic



If you have a poorly resolved stratosphere then errors grow rapidly aloft and descend, less so when the stratosphere is well resolved eg This figure shows: [top left] The zonal mean of the rms of the L38-era geopotential height difference averaged over latitudes 90S-60S and plotted on forecast day/pressure level axes; [top right] The corresponding rms of the L50-era geopotential height difference; [bottom left] the difference between the last two plots i.e. rms(L50-era)-rms(L38-era); [bottom right] the anomaly plot difference.



This improvement can be seen throughout the year aloft eg This figure shows: [a] The rms of the zonal mean of the L38-era geopotential height difference, averaged from 50hPa to 20hPa and over forecast days 21 to 30, and plotted against latitude and weeks; [b] is the corresponding era geopotential height; [c] is the same as [a] but for L50-era quantities ie L50rms-L38rms. Note: the [21:30] refers to the forecast days that the quantities have been averaged over; in [d] the zero line is the black contour line; and, week26 is the start of July



This suggests that future AMIP runs be made with configurations which extend at least to L50=0.2 hPa (60 km) if stratospheric processes, and their interaction with the troposphere, are important.

Future work

- Do a UM L50 AMIP run and compare with L38 in detail
- Run AMIP with fixed SST and compare with the variable SST run