Recent improvements to model processes radiation and ozone in the Met Office NWP and Climate middle atmosphere GCM.

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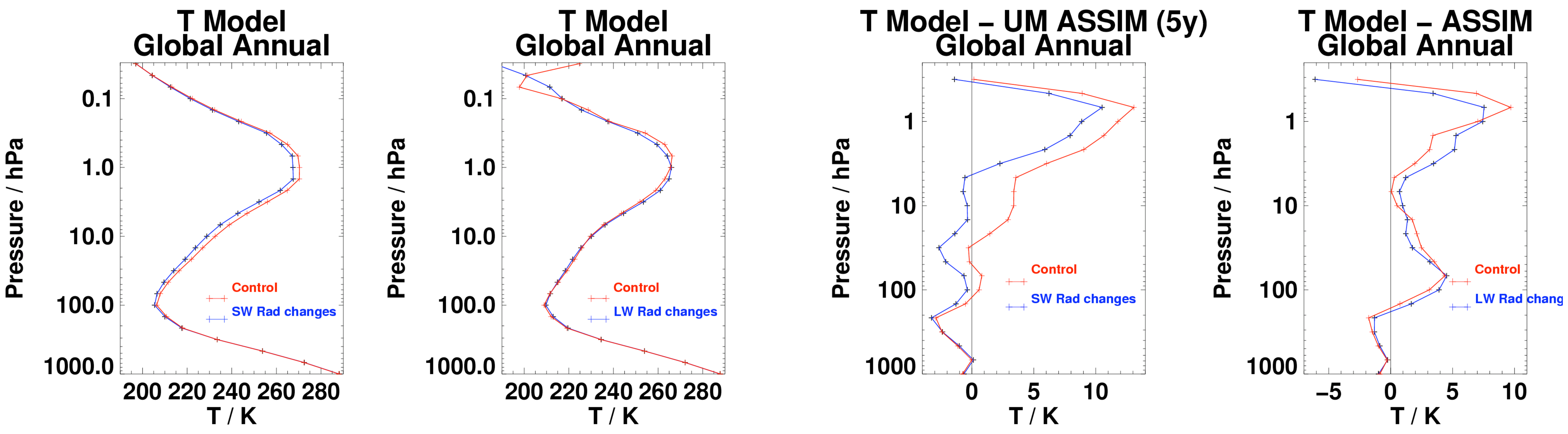
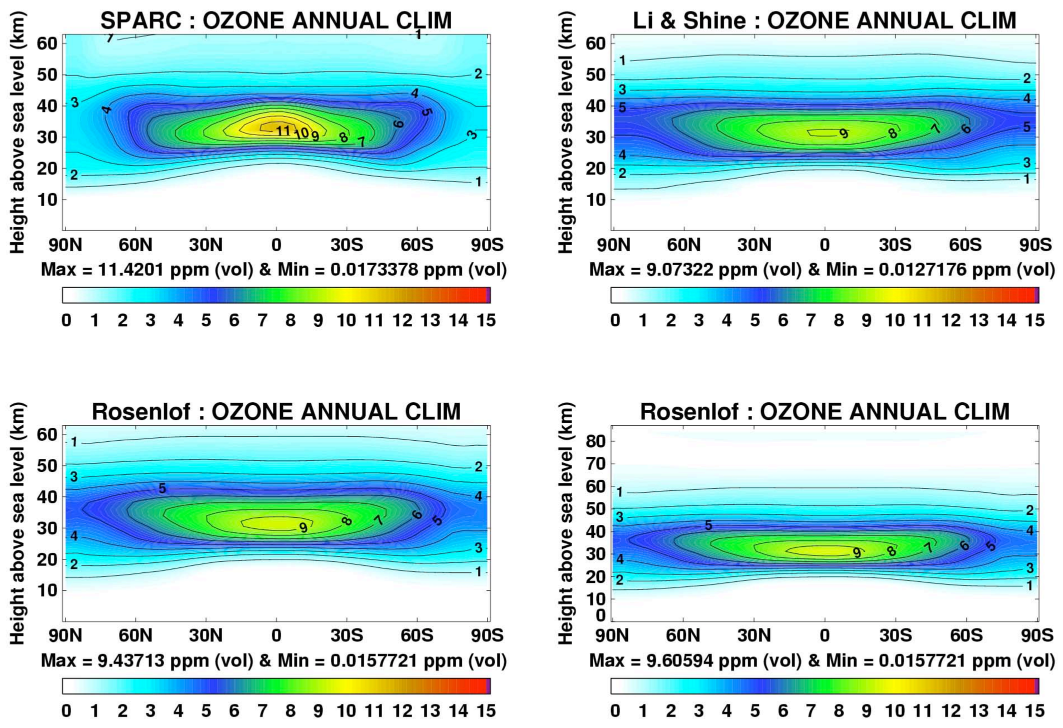
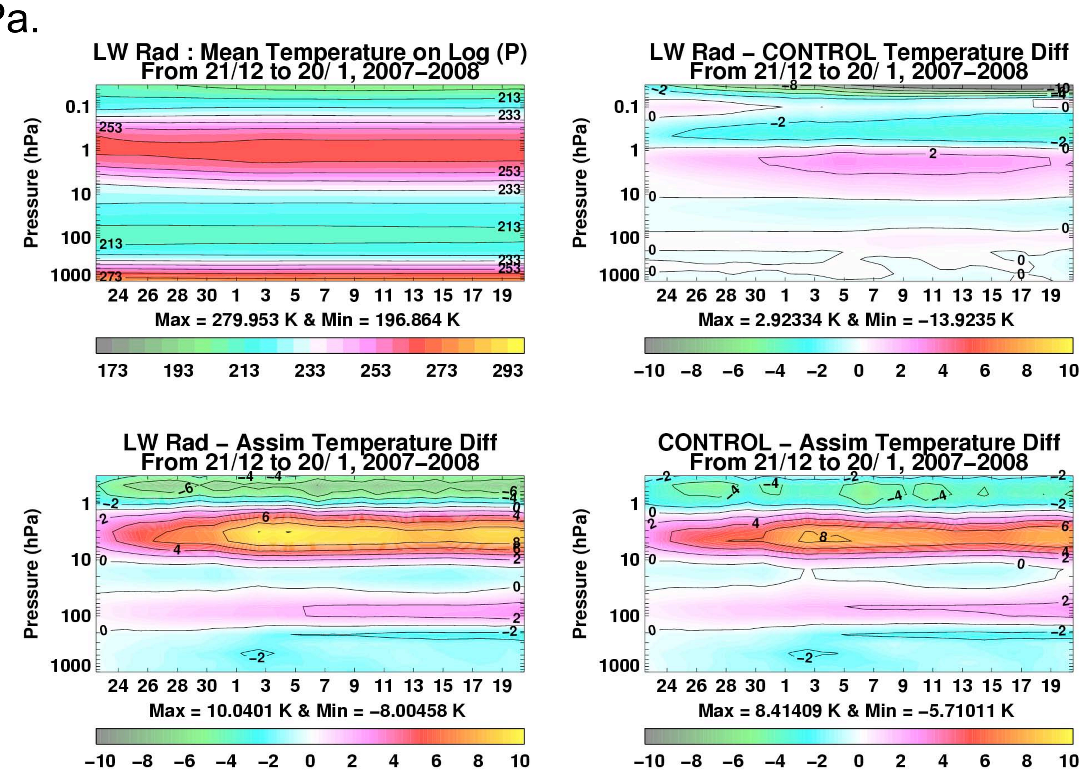




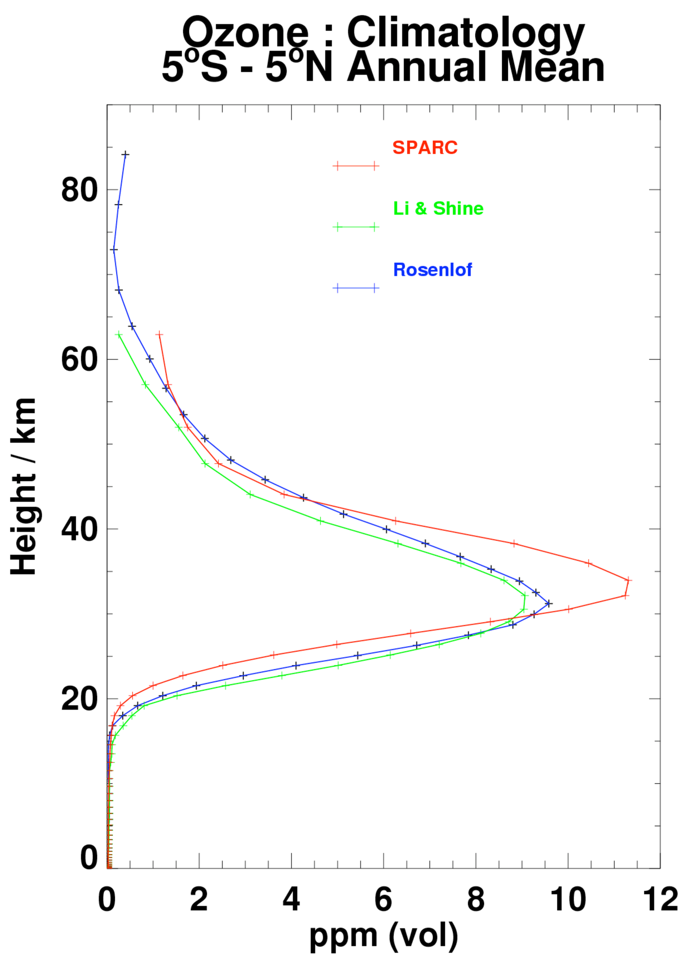
Radiation changes

Radiation schemes designed for use in tropospheric general circulation models (GCMs) have been shown to contain errors in their treatment of shortwave absorption by stratospheric water vapour [1] and the low pressure treatment of strong absorption lines of ozone, carbon dioxide and water vapour in the longwave [2]. A package of changes based upon the HadCM3 climate configuration indicated a clear potential for reduced global and annual mean temperature errors in the middle atmosphere due to shortwave changes (above). Changes to the solar spectrum and database for water vapour absorption introduced for the HadGEM climate configuration required a revision of the work, which is in progress. Meanwhile a more limited set of changes to longwave ozone and carbon dioxide absorption bands, which do not depend upon the choice of database, has made significant improvements to the HadGEM global and annual mean temperature profile above 1hPa.



NWP impact

Longwave radiation changes to ozone and carbon dioxide absorption have been tested in a 30-day forecast configuration based on the Met Office operational system and initialised from an analysis field at 0Z on 21 December 2007. Further testing within a 4D-VAR assimilation test suite is in progress. At 0.05hPa (below left) a strong cooling relative to the control, also seen in the global and annual mean temperature, is rapidly established. At 50hPa, the changes appear generally to reduce the drift of the free-running model from the daily analyses. However, in line with the global and annual mean picture, errors with respect to the analyses can actually deteriorate at other heights (above). Some of the errors may relate to aspects of the radiation such as the treatment of water vapour or other radiatively active gases, particularly where absorption lines from different species overlap, that may be addressed better when the revised HadGEM package of changes is ready. Nevertheless, even a fully consistent set of improvements to radiative absorption could lead to increased errors if the distributions of radiatively active constituents such as ozone are themselves inaccurate. This emphasises the importance of combining improvements both to the radiation processes and to the method of representing the ozone distribution for optimum results.



Ozone climatologies

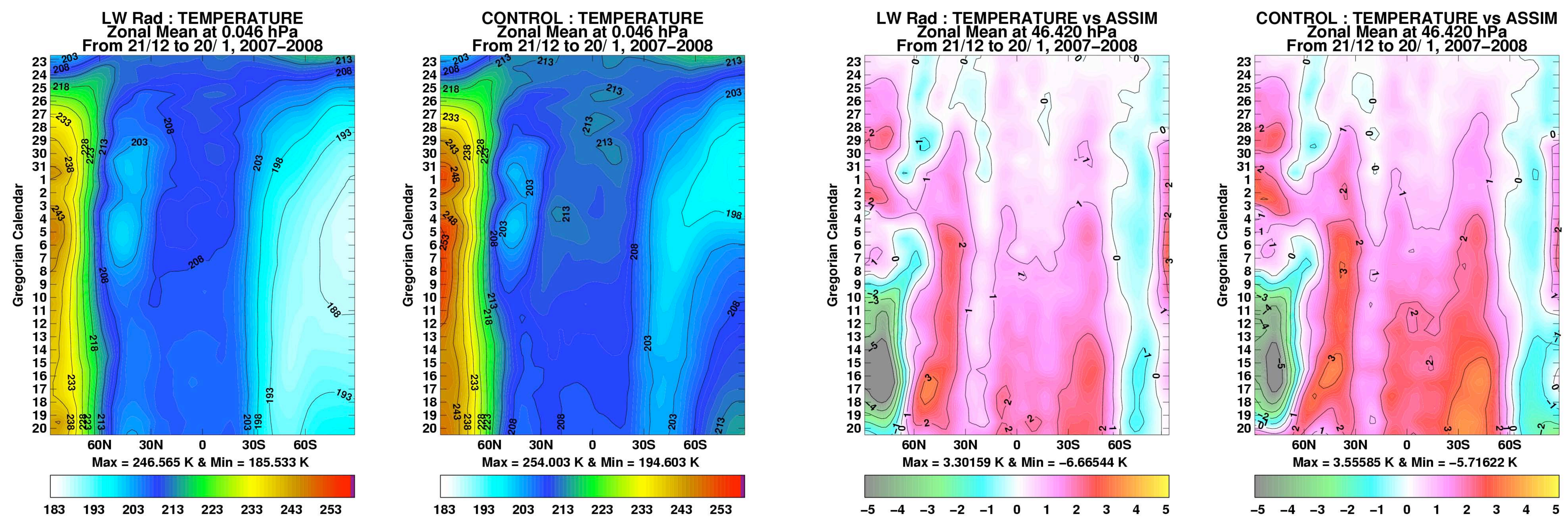
Comparison of the annual mean SPARC ozone climatology against the Met Office operational climatology of Li and Shine and a new climatology (from Rosenlof and co-workers) shows that the SPARC maximum concentration is significantly higher (above). A closer inspection of profiles in the equatorial region shows that SPARC actually has the lowest ppm (vol) concentrations in the lower stratosphere between 16 and 32km as its peak is around 5km higher than the other two.

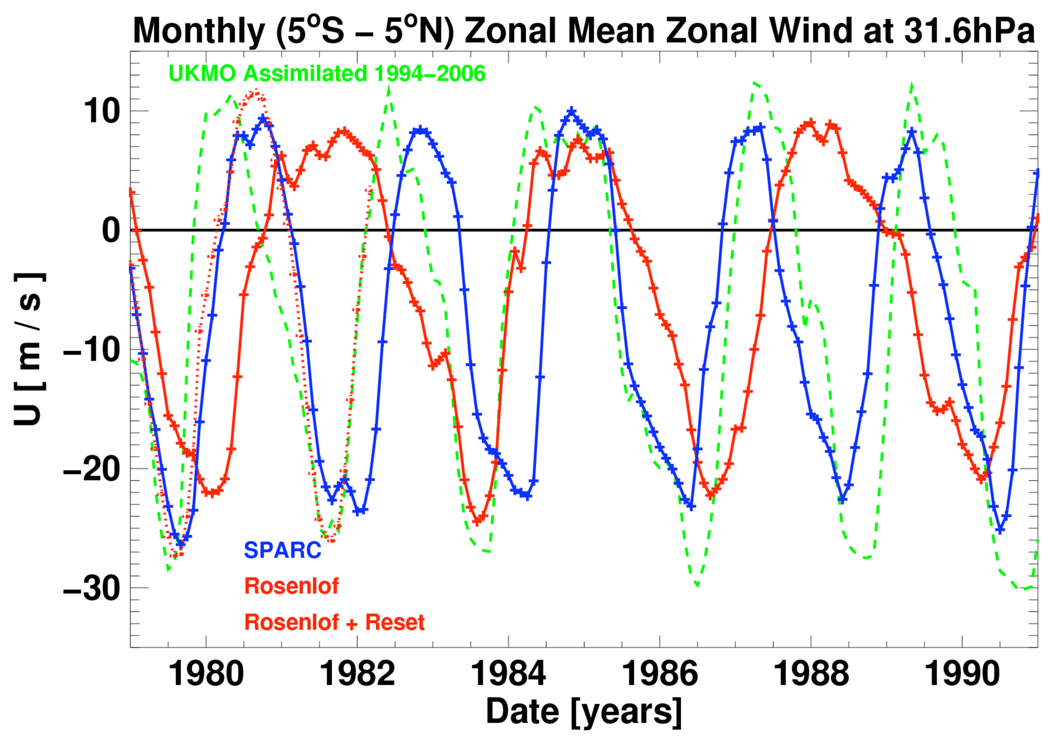
Climate impact

Changes to the ozone climatology can be seen to affect the periodicity of the Quasi-Biennial Oscillation in the zonal wind (below right). The HadGEM2–A/L60 climate configuration of the MetUM, which is run in a standard atmosphere-only AMIPII experiment, uses an ozone climatology based upon the SPARC dataset. Replacing this with the Rosenlof ozone climatology results in a longer period QBO. Comparison with a 12-year period of assimilated observations from the UKMO operational analysis shows reasonable agreement in mean period for the standard SPARC run although the analysis shows greater variability between periods and a tendency for larger amplitude. As agreement with the QBO period has been used as a constraint upon the strength of parametrized non-orographic gravity waves propagating into the stratosphere, there is scope for increasing this strength in order to improve agreement with the Rosenlof climatology. Early results from a run with Rosenlof climatology and reset gravity wave strengths (below, dotted) show good agreement with QBO period and some indication of improved amplitude as well.

References

[1] W.Zhong & J.D.Haigh (2003) *Geophys.Res.Lett.*, **30,** doi:10.1029/2002GL016042
[2] W.Zhong & J.D.Haigh (2001) *Atmos. Sci. Lett.*, **1**, doi:10.1006/asle.2000.0022





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