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Detecting weekly cycles in model-derived and observation time series with Fourier-based techniques.

Graham Weedon (1), Olivier Boucher (2), and Johannes Quaas (3)

(1) Met Office Hadley Centre, Joint Centre for Hydrometeorological Research, Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB, United Kingdom (graham.weedon@metoffice.gov.uk), (2) Met Office Hadley Centre, Fitzroy Road, Exeter EX1 3PB, United Kingdom, (3) Max Planck Institute for Meteorology, Bundestrasse 53, 20146 Hamburg, Germany

Weekly cycles in atmospheric pollutant emissions and aerosol loadings have been proposed to influence surface and atmospheric processes, possibly inducing a weekly cycle in some meteorological variables over industrial regions. In order to understand such cycles and their impacts, it is important to have credible methods for detecting genuine, but comparatively weak, periodic signals in observational and model-derived time series.

Here we review standard methods based on the Fourier Transform for detecting and investigating such signals. Estimation of power (variance) spectra requires appropriate, non-aliased, robust methods for locating the, typically autoregressive, background spectrum and evaluation of periodic signal significance using parametric and non-parametric methods. Once regular signals are detected in pairs of variables (e.g. aerosol optical depth and near-surface temperature), cross-spectral analysis can be used to investigate the evolving coherency (frequency-specific correlation) and phase (relative timing) relationships. Combined with visualization via band-pass filtering these techniques are illustrated with examples of European observational and model-derived time series. We will in particular revisit the analysis done by Quaas et al. (Exploiting the weekly cycle as observed over Europe to analyse aerosol indirect effects in two climate models, Atmos. Chem. Phys., 9, 8493-8501, 2009).