TWP SCM forcing data derived from NWP analyses

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1 Introduction

Forcing data, suitable for use with single column models (SCMs) and cloud resolving models (CRMs), have been derived from NWP analyses for the ARM (Atmospheric Radiation Measurement) Tropical Western Pacific (TWP) sites of Manus Island and Nauru. This document describes the technical aspects of these data, including the file formats and variable naming conventions. A detailed description of how the data sets were generated, including validations against observations, can be found in *Hume and Jakob* [2005] (included on the forcing data distribution media).

2 File format and conventions.

2.1 File names

The forcing data are stored in NetCDF format. Information on NetCDF can be found at http://www.unidata.ucar.edu/software/netcdf/. As described

in *Hume and Jakob* [2005], four separate forcing data sets were generated from ERA-40 reanalyses [*Uppala et al*, 2005], operational ECMWF analyses [*Gregory et al.*, 2000], the Bureau of Meteorology GASP model [*Seaman et al.*, 1995] and NCEP reanalyses [*Kanamitsu et al.*, 2002] respectively. The data cover the complete 1999-2000 period, in six hour time increments. Eight data files (four for Manus Island, and four for Nauru) are included on the distribution media, and use the following file naming convention:

`forcing_[analysis]_[site].nc`

where `[analysis]` is the name of the NWP data set which was used to generate the forcing data, and is one of `era40` (ERA-40 reanalyses), `ecmwf` (operational ECMWF analyses), `gasp` (Bureau of Meteorology operational GASP analyses) or `ncep` (NCEP reanalyses). `[site]` is the name of the site which the forcing data are for, and is either `manus` (Manus Island) or `nauru` (Nauru).

2.2 Dimensions

The data in the NetCDF files lie on four dimensions. Each dimension has a corresponding coordinate variable. The dimensions and coordinate variables are described in Table 1.

Dimension	Description	Coordinate variable units
`time`	Time forcing data are valid	seconds since 1970-01-01T00:00:00Z
`levels`	Vertical dimension	hPa or sigma (see 2.2.1 below)
`i`	First horizontal dimension	None (see 2.2.2 below)
`j`	Second horizontal dimension	None (see 2.2.2 below)

Table 1: Dimensions in the NetCDF forcing data files.

2.2.1 Vertical dimension

For the ERA-40, ECMWF and NCEP derived forcing data, the vertical dimension represents the model pressure levels, and has units of hPa. There

are respectively 23, 15 and 17 pressure levels in the ERA-40, ECMWF and NCEP derived forcing data. In the case of the GASP derived forcing data, the vertical dimension represents the model's 29 sigma levels. The sigma levels do not have fixed pressure values (the pressure of each sigma level will vary as the surface pressure varies). The pressures of the sigma levels at any point in time can be found in the `prs` variable.

2.2.2 Horizontal dimensions

The forcing data supplied on the distribution media do not actually need horizontal dimensions, since they represent a single column at either Manus Island or Nauru. Consequently, the `i` and `j` dimensions in the forcing data files have length 1. The variables `lon2d` and `lat2d` lie on the `i` and `j` dimensions, and contain the longitude and latitude of the site which the forcing data are for.

Note that while the forcing data supplied here are only for two points in the TWP, NWP derived forcing data are available for most of the tropical Pacific. These larger forcing data sets make use of the horizontal dimensions. The reason for not calling the horizontal dimensions lat and lon is that the horizontal grid points are not necessarily regularly spaced in latitude and longitude (although all the forcing data sets created by the authors do in fact have regularly spaced latitudes and longitudes). The large tropical Pacific forcing data sets can be obtained from the author (t.hume@bom.gov.au).

2.3 Variables

Each forcing data file contains a number of variables. These should be sufficient to meet at least the minimum forcing data requirements for a SCM. The variables are described in Table 2 below.

Name	Dimensions	Type	Description
time	time	double	Time coordinate variable
levels	levels	double	Vertical coordinate variable
i	i	int	First horizontal coordinate variable
j	j	int	Second horizontal coordinate variable
lon2d	i, j	float	Longitudes of horizontal grid points
lat2d	i, j	float	Latitudes of horizontal grid points
prs	time, levels, i, j	float	Pressure of the vertical levels
spsfc	time, i, j	float	Surface pressure
sktsfc	time, i, j	float	Surface temperature
zsfc	time, i, j	float	Surface geopotential
tprs	time, levels, i, j	float	Upper air temperature
uprs	time, levels, i, j	float	East-west wind component
vprs	time, levels, i, j	float	North-south wind component
wprs	time, levels, i, j	float	Vertical velocity
qprs	time, levels, i, j	float	Specific humidity
tadvprs	time, levels, i, j	float	Horizontal advective tendency of tprs
qadvprs	time, levels, i, j	float	Horizontal advective tendency of qprs

Table 2: Variables in the forcing data files.

2.3.1 Units and other variable attributes

Each variable has a number of associated attributes describing metadata such as the units, long name, and missing value. A complete listing of the attributes in the forcing data file can be obtained using the NetCDF `ncdump` utility.

References

Gregory. D., J.-J. Morcrette, C. Jakob, A. C. M. Beljaars, and T. Stockdale (2000), Revision of convection, radiation and cloud schemes in the ECMWF Integrated Forecasting System, *Q. J. R. Meteorol. Soc.*, *126*, 1685-1710.

Hume, T. and C. Jakob (2005), Ensemble single column modelling (ESCM) in the tropical western Pacific: Forcing data sets and uncertainty analysis, *J. Geophys. Res.*, *110*, D13109, doi:10.1029/2004JD005704.

Kanamitsu, M., W. Ebisuzaki, J. Woollen, S.-K. Yang, J. J. Hnilo, M. Fiorino and G. L. Potter (2002), NCEP-DOE AMIP-II Reanalysis (R-2), *Bull. Am. Meteorol. Soc.*, *83*, 1631-1643.

Seaman, R., W. Bourke, P. Steinle, T. Hart, G. Embery, M. Naughton, and L. Rikus (1995), Evolution of the Bureau of Meteorology's Global Assimilation and Prediction System. Part 1: Analysis and initialisation, *Aust. Meteorol. Mag.*, *44*, 1-18.

Uppala, S. M., P. W. Kållberg, A. J. Simmons, U. Andrae, V. Da Costa Bechtold, M. Fiorino, J. K. Gibson, J. Haseler, A. Hernandez, G. A. Kelly, X. Li, K. Onogi, S. Saarinen, N. Sokka, R. P. Allan, E. Andersson, K. Arpe, M. A. Balmaseda, A. C. M. Beljaars, L. Van De Berg, J. Bidlot, N. Bormann, S. Caires, F. Chevallier, A. Dethof, M. Dragosavac, M. Fisher, M. Fuentes, S. Hagemann, E. Hólm, B. J. Hoskins, L. Isaksen, P. A. E. M. Janssen, R. jenne, A. P. McNally, J. -F. Mahfouf, J. -J Morcrette, N. A. Rayner, R. W. Saunders, P. Simon, A. Sterl, K. E. Trenberth, A. Untch, D. Vasiljevic, P. Viterbo and J. Woollen (2005), The ERA-40 re-analysis, *Quarterly Journal of the Royal Meteorological Society, 131,* 2961-3012, doi:10.1256/qj.04.176.