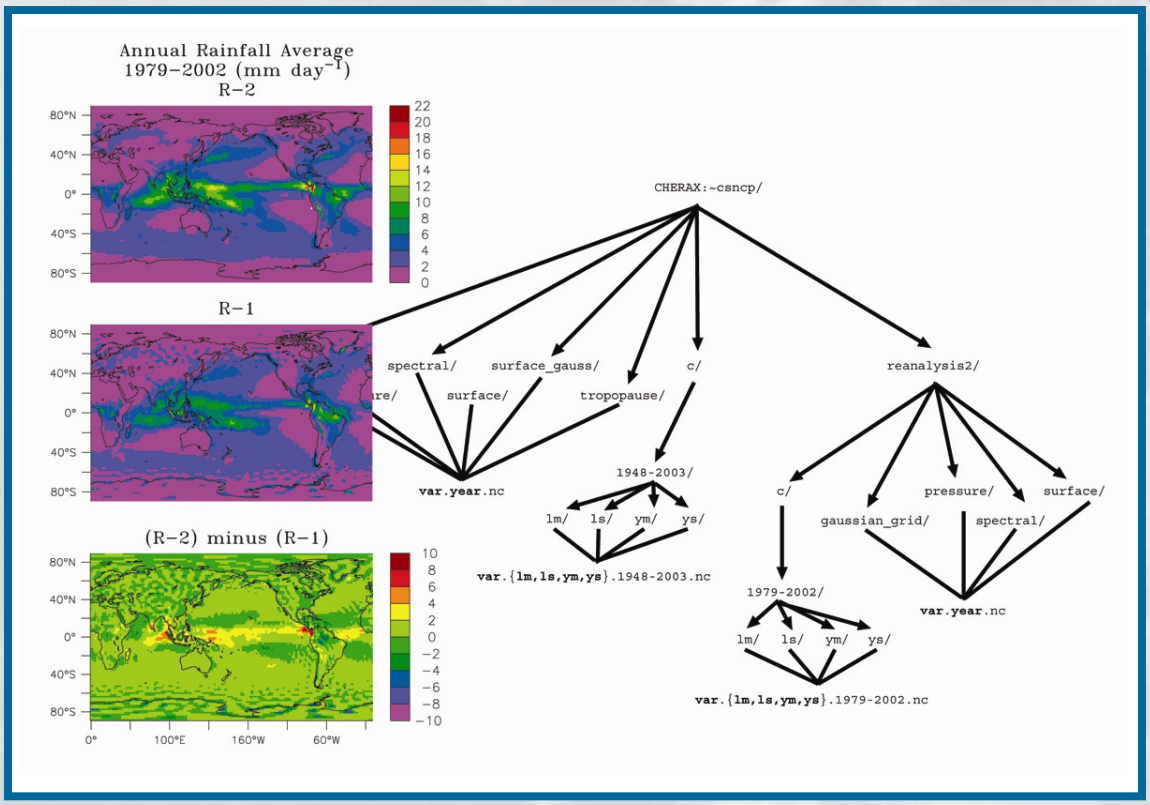
The CSIRO NCEP/NCAR/DOE R-1/R-2 archive

Mark A. Collier
CSIRO Atmospheric Research



CSIRO

Atmospheric Research

CSIRO Atmospheric Research Technical Paper No.68

Collier, M. A.
The CSIRO NCEP/NCAR/DOE R-1 R-2 archive.

ISBN 0 643 06887 2.

1. Numerical weather forecasting - Mathematical models. 2. Atmospheric circulation - Mathematical models. 3. Climatology - Mathematical models. I. CSIRO. Division of Atmospheric Research. II. Title. (Series : CSIRO Atmospheric Research technical paper (Online) ; no. 68).

551.51

Address and contact details: CSIRO Atmospheric Research
Private Bag No. 1, Aspendale Victoria 3195 Australia
Ph: (+61 3) 9239 4400; fax: (+61 3) 9239 4444
e-mail: ar-enquiries@csiro.au

CSIRO Atmospheric Research Technical Papers may be issued out of sequence. From July 2000, all new Technical Papers will appear on the web of CSIRO Atmospheric Research.

The CSIRO NCEP/NCAR/DOE R-1/R-2 archive

Mark A Collier

CSIRO Atmospheric Research Technical Paper No. 68

Contents

List of Tables

The CSIRO NCEP/NCAR/DOE *R-1/R-2* archive

M.A. Collier

CSIRO Atmospheric Research
PMB 1, Aspendale, Victoria 3195
Australia

April 2004

1 Abstract

This report describes the atmospheric variables available in the CSIRO NCEP/NCAR/DOE *R-1/R-2* reanalysis archive, covering details in their raw and processed (climatological) form. In addition, information relating to methods of accessing and displaying the data for scientific exploration have been documented, as well as notes on software written to analyse, modify and maintain the archive.

2 Background

The U.S. National Center for Environmental Protection (NCEP) in partnership with the Department of Energy (DOE) began a new major reanalysis project (hereafter *R-2*) in 1998 after their well-known NCEP-NCAR (National Center for Atmospheric Research) reanalysis project from a few years earlier (hereafter *R-1*, Kalnay et al. (1996); Kislter et al. (2001)) began to show limited applicability to some important atmospheric research studies according to Kanamitsu et al. (2002). The new reanalysis *R-2*[1] would readdress model and human errors identified in the old reanalysis *R-1*. Several error fixes were introduced in going from *R-1* to *R-2*, most importantly the Southern Hemisphere bogus data problem (1979-1992) that rendered *R-1* almost unusable for Southern Hemisphere extratropical investigations for the affected years. The oceanic albedo was too high by a factor of about two for the entire reanalysis period, may have affected the Southern more than the Northern Hemisphere because of the greater proportion of ocean surface. Other errors were found with the snow-cover analysis, discontinuities in the relative humidity and cloudiness relationship table and a snow-melt term and the presence of an undesired "spectral snow" feature. The comprehensive overhaul of the model physics in going to *R-2* was brought about by the reanalysis project "piggy-backing" on computer code and expertise gained from the NCEP operational model upgrades. A range of enhancements and upgrades to the fixed fields, including desert albedo, sea-ice and sea-surface temperatures, ozone, snow cover and the carbon-dioxide level provide added realism to the forcings and physical parameterisations according to Kanamitsu et al. (2002).

Output of the NCEP *R-1* product continues to be released to the present day, however, *R-2* has only been performed for the years of 1979-2002 for detailed evaluation. To this date, significant improvements have been identified between *R-1* and *R-2*, however, the team behind this effort point out that it will be some time before a new generation reanalysis product will be available. For this reason *R-2* is unlikely to be available for the full period of *R-1* (i.e. the years 1948 to 1978) and it is unclear whether *R-2* will be continued beyond 2002, or another project may replace it. *R-1*, and in turn *R-2*, provide a method of making significant steps towards the objective of releasing a major reanalysis system from NCEP every decade or so, to maintain a leading-edge collection of data for climate and weather investigators. Some deficiencies have been identified in the production of *R-2* and these have been documented, and will continue to be reported by the community as it is applied to solving unique weather and climate problems.

The raw data have been put into a set of appropriately named directories found on the data migration facility of the CSIRO/Bureau of Meteorology Joint High Performance Computing and Communications Center (HPCCC) located at the Melbourne headquarters of the Bureau of Meteorology. More details can be found in Section 5.1. For *R-1* these sub-directories, in alphabetical order, are other_gauss, pressure, spectral, surface, surface_gauss and tropopause, which match the names used by NCEP in their anonymous server. For *R-2* other_gauss and surface_gauss have been merged into gaussian_grid, and tropopause data do not exist at this point in time. All variables that are a function of time are resolved every 6 hours (0h, 6h, 12h and 18h UTC), and a complete year of data is written to a single file (either 1460 or 1464 times depending on whether

[1] also referred to as NCEP-DOE Atmospheric Intercomparison Project (AMIP-II) reanalysis, an international activity to which it contributes

the particular year is a leap year). The pressure data are on a 2.5 by 2.5 degree horizontal grid (144 × 73 regular grid points) for each of the 17 pressure levels[2]. The surface and tropopause data are also on a 2.5 by 2.5 degree horizontal grid (144 × 73 regular grid points). The surface_gauss and other_gauss (or gaussian_grid in *R-2*) data have an approximate 1.8 by 1.8 degree horizontal grid (192 × 94 Gaussian grid points or approximately 200 km horizontal spacing). The spectral data is in coefficient form, there are 4032 for the T62 model resolution. .

Continuing on from earlier work of Collier (2000) monthly and seasonal climatologies have been generated for general weather and climate research applications. A number of improvements have been made from the previous set[3], including a reduction in their overall size and to improve clarity in their names and internal data structure. Significantly, the internal conventions used in the climatological *netCDF* files follows more naturally the conventions used in the raw files, including the naming of dimensions and maintaining the original variable names. This has meant that separate files are needed to define the various types of climatologies, which will be discussed in detail in Section 4. Monthly climatologies are available over the internet from the U.S. National Weather Service Climate Prediction Center at http://wesley.wwb.noaa.gov/ncep_data, however, for most purposes researchers require direct access to the files from their processing software or models.

The CSIRO NCEP/NCAR/DOE *R-1/R-2* climatologies (calculated from 6-hourly data) are meant primarily for internal use by CSIRO employees who can readily and directly access them through computer code or scripts without needing to transfer or manually download. In addition scripts are provided so that alternative averaging periods can be chosen, or, if necessary, different climatological definitions can be formed. Much meteorological research depends upon seasonal analysis and for this reason seasonal climatologies are available and are discussed in more detail in Section 4. These climatologies have been reformed for *R-1* so that they can be conveniently and accurately compared with *R-2*. Variance statistics have not been included as these only add to the size of the climatology files, and its calculation is made easy with the availability of long-term and year-by-year means, described here. Nor are any figures drawn of climatologies to keep this document compact, although differences between *R-1* and *R-2* will be of great interest to researchers.

[2]there are 28 vertical levels in the assimilation model

[3]any gaps/errors with these files may not be filled/fixed and so it is advised that people migrate to the new climatologies described in this report

3 6-hourly raw data

Locations of 6-hourly raw data in *netCDF* form are illustrated in Section 4, Figure 1.

3.1 other_gauss

variable/file	units	*R-1* years	*R-2* years	horizontal resolution
csulf.ntat.gauss.**year**.nc	W m^{-2}	1948-2003	N/A	192 × 94 gaussian
csusf.ntat.gauss.**year**.nc	W m^{-2}	1948-2003	N/A	192 × 94 gaussian
dswrf.ntat.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
pres.hcb.gauss.**year**.nc	Pa	1948-2003	1979-2002	192 × 94 gaussian
pres.hct.gauss.**year**.nc	Pa	1948-2003	1979-2002	192 × 94 gaussian
pres.lcb.gauss.**year**.nc	Pa	1948-2003	1979-2002	192 × 94 gaussian
pres.lct.gauss.**year**.nc	Pa	1948-2003	1979-2002	192 × 94 gaussian
pres.mcb.gauss.**year**.nc	Pa	1948-2003	1979-2002	192 × 94 gaussian
pres.mct.gauss.**year**.nc	Pa	1948-2003	1979-2002	192 × 94 gaussian
tcdc.eatm.gauss.**year**.nc	%	1948-2003	1979-2002	192 × 94 gaussian
ulwrf.ntat.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
uswrf.ntat.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian

Table 1: Variables located in CHERAX:~csncp/{other_gauss,reanalysis2/gaussian_grid}. Note that these directories are the physical disk locations of the *R-1/R-2* data, respectively.

where

csult.ntat: clear sky upward longwave flux at nominal top of atmosphere
csusf.ntat: clear sky upward solar flux at nominal top of atmosphere
dswrf.ntat: downward solar radiation flux at nominal top of atmosphere
pres.hcb: high cloud bottom pressure
pres.hct: high cloud top pressure
pres.lcb: low cloud bottom pressure
pres.lct: low cloud top pressure
pres.mcb: middle cloud bottom pressure
pres.mct: middle cloud top pressure
tcdc.eatm: total cloud cover
ulwrf.ntat: upward longwave radiation flux at nominal top of atmosphere
uswrf.ntat: upward solar radiation flux at nominal top of atmosphere

For example, the *netCDF* files CHERAX:~csncp/other_gauss/pres.hcb.2000.gauss.nc and CHERAX:~csncp/reanalysis2/gaussian_grid/pres.hcb.2000.gauss.nc are the 6-hourly high cloud bottom pressure for *R-1* and *R-2*, respectively, for the year 2000.

3.2 pressure

variable/file	units	*R-1* years	*R-2* years	horizontal resolution	vertical resolution
air.**year**.nc	K	1948-2003	1979-2002	144 × 73 regular	17 pressure
hgt.**year**.nc	m	1948-2003	1979-2002	144 × 73 regular	17 pressure
omega.**year**.nc	Pa s^{-1}	1948-2003	1979-2002	144 × 73 regular	12 pressure
rhum.**year**.nc	%	1948-2003	1979-2002	144 × 73 regular	8 pressure
shum.**year**.nc	kg kg^{-1}	1948-2003	N/A	144 × 73 regular	8 pressure
uwnd.**year**.nc	m s^{-1}	1948-2003	1979-2002	144 × 73 regular	17 pressure
vwnd.**year**.nc	m s^{-1}	1948-2003	1979-2002	144 × 73 regular	17 pressure

Table 2: Variables located in CHERAX:~csncp/{pressure,reanalysis2/pressure}. Note that these directories are the physical disk locations of the *R-1/R-2* data, respectively.

where
air: air temperature
hgt: geopotential height
omega: vertical velocity
rhum: relative humidity
shum: sensible humidity
uwnd: east-west velocity
vwnd: north-south velocity

For example, the *netCDF* CHERAX:~csncp/pressure/air.2000.nc and CHERAX:~csncp/reanalysis2/gaussian_grid/air.2000.nc are the 6-hourly air temperature for *R-1* and *R-2*, respectively, at all 17 pressure levels for the year 2000.

3.3 spectral

variable/file	units	*R-1* years	*R-2* years	horizontal resolution
div.spec.**year**.nc	s^{-1}	1948-2003	1979-2002	4032 coefficient
orog.spec.nc	m	N/A	N/A	4032 coefficient
pres.spec.**year**.nc	nlog(centibars)	1948-2003	1979-2002	4032 coefficient
shum.spec.**year**.nc	kg kg^{-1}	1948-2003	1979-2002	4032 coefficient
vair.spec.**year**.nc	K	1948-2003	1979-2002	4032 coefficient
vort.spec.**year**.nc	s^{-1}	1948-2003	1979-2002	4032 coefficient

Table 3: Variables located in CHERAX:~csncp/{spectral,reanalysis2/spectral}. Note that these directories are the physical disk locations of the *R-1/R-2* data, respectively.

where
div.spec: spectral coefficients for divergence
orog.spec: spectral coefficients for orography
pres.spec: spectral coefficients for pressure
shum.spec: spectral coefficients for specific humidity
vair.spec: spectral coefficients for air temperature
vort.spec: spectral coefficients for vorticity

3.4 surface

variable/file	units	*R-1* years	*R-2* years	horizontal resolution
hgt.sfc.nc	N/A	N/A	N/A	144 × 73 regular
land.nc	N/A	N/A	N/A	144 × 73 regular
lftx.sfc.**year**.nc	K	1948-2003	N/A	144 × 73 regular
lftx4.sfc.**year**.nc	K	1948-2003	N/A	144 × 73 regular
pres.sfc.**year**.nc	Pa	1948-2003	1979-2002	144 × 73 regular
pr_wtr.eatm.**year**.nc	kg m^{-2}	1948-2003	1979-2002	144 × 73 regular
slp.**year**.nc	Pa	1948-2003	1979-2002	144 × 73 regular

Table 4: Variables located in CHERAX:~csncp/{surface,reanalysis2/surface}. Note that these directories are the physical disk locations of the *R-1/R-2* data, respectively. The variable mslp is used for slp in *R-2*. The variable land is useful for defining values of other variables over land or sea which are defined on the same horizontal grid.

where
hgt.sfc: geopotential height at surface
land: land-sea mask of surface
lftx.sfc: surface lifted index
lftx4.sfc: best (4-layer) lifted index
pres.sfc: surface pressure
pr_wtr.eatm: precipitable water for entire atmosphere
slp/mslp: sea level pressure

3.5 surface_gauss

variable/file	units	*R-1* years	*R-2* years	horizontal resolution
air.2m.gauss.**year**.nc	K	1948-2003	1979-2002	192 × 94 gaussian
cfnlf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	N/A	192 × 94 gaussian
cfnsf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	N/A	192 × 94 gaussian
cprat.sfc.gauss.**year**.nc	kg m^{-2} s^{-1}	1948-2003	1979-2002	192 × 94 gaussian
csdlf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
csdsf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	N/A	192 × 94 gaussian
csusf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	N/A	192 × 94 gaussian
dlwrf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
dswrf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
gflux.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
icec.sfc.gauss.**year**.nc	fraction	1948-2003	1979-2002	192 × 94 gaussian
land.sfc.gauss.nc	N/A	N/A	N/A	192 × 94 gaussian
lhtfl.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
nbdsf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	N/A	192 × 94 gaussian
nddsf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	N/A	192 × 94 gaussian
nlwrs.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	N/A	192 × 94 gaussian
nswrs.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
pevpr.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
prate.sfc.gauss.**year**.nc	kg m^{-2} s^{-1}	1948-2003	1979-2002	192 × 94 gaussian
pres.sfc.gauss.**year**.nc	Pa	1948-2003	1979-2002	192 × 94 gaussian

Table 5: Variables located in CHERAX:~csncp/{surface_gauss,reanalysis2/gaussian_grid}. Note that these directories are the physical disk locations of the *R-1/R-2* data, respectively. The variable land is useful for defining values of other variables over land or sea which are defined on the same horizontal grid.

where

air.2m: air temperature at 2 m above surface
cfnlf.sfc: cloud forcing net longwave flux at surface
cfnsf.sfc: cloud forcing net solar flux at surface
cprat.sfc: convective precipitation rate at surface
csdlf.sfc: clear sky downward longwave flux at surface
csdsf.sfc: clear sky downward solar flux at surface
csusf.sfc: clear sky upward solar flux at surface
dlwrf.sfc: downward longwave radiation flux at surface
dswrf.sfc: downward solar radiation flux at surface
gflux.sfc: ground heat flux
icec.sfc: ice concentration at surface
land.sfc: land-sea mask of surface
lhtfl.sfc: latent heat net flux at surface
nbdsf.sfc: near infrared beam downward solar flux at surface
nddsf.sfc: near infrared diffuse downward solar flux at surface
nlwrs.sfc: net longwave radiation flux at surface
nswrs.sfc: net shortwave radiation flux at surface
pevpr.sfc: potential evaporation rate at surface
prate.sfc: precipitation rate at surface
pres.sfc: surface pressure
runof.sfc: water runoff at surface

variable/file	units	*R-1* years	*R-2* years	horizontal resolution
runof.sfc.gauss.**year**.nc	kg m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
sfcr.sfc.gauss.**year**.nc	m	1948-2003	N/A	192 × 94 gaussian
shtfl.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
shum.2m.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
skt.sfc.gauss.**year**.nc	K	1948-2003	1979-2002	192 × 94 gaussian
soilw.0-10cm.gauss.**year**.nc	fraction	1948-2003	1979-2002	192 × 94 gaussian
soilw.10-200cm.gauss.**year**.nc	fraction	1948-2003	1979-2002	192 × 94 gaussian
tmax.2m.gauss.**year**.nc	K	1948-2003	1979-2002	192 × 94 gaussian
tmin.2m.gauss.**year**.nc	K	1948-2003	1979-2002	192 × 94 gaussian
tmp.0-10cm.gauss.**year**.nc	K	1948-2003	1979-2002	192 × 94 gaussian
tmp.10-200cm.gauss.**year**.nc	K	1948-2003	1979-2002	192 × 94 gaussian
tmp.300cm.gauss.**year**.nc	K	1948-2003	N/A	192 × 94 gaussian
uflx.sfc.gauss.**year**.nc	N m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
ugwd.sfc.gauss.**year**.nc	N m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
ulwrf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
uswrf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
uwnd.10m.gauss.**year**.nc	m s^{-1}	1948-2003	1979-2002	192 × 94 gaussian
vbdsf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	N/A	192 × 94 gaussian
vddsf.sfc.gauss.**year**.nc	W m^{-2}	1948-2003	N/A	192 × 94 gaussian
vflx.sfc.gauss.**year**.nc	N m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
vgwd.sfc.gauss.**year**.nc	N m^{-2}	1948-2003	1979-2002	192 × 94 gaussian
vwnd.10m.gauss.**year**.nc	m s^{-1}	1948-2003	1979-2002	192 × 94 gaussian
weasd.sfc.gauss.**year**.nc	kg m^{-2}	1948-2003	1979-2002	192 × 94 gaussian

Table 6: Variables located in CHERAX:~csncp/{surface_gauss,reanalysis2/gaussian_grid} (cont.). Note that these directories are the physical disk locations of the *R-1/R-2* data, respectively.

where

sfcr.sfc: surface roughness
shtfl.sfc: sensible heat net flux at surface
shum.2m: specific humidity at 2 m above surface
skt.sfc: sea/land skin temperature
soilw.0-10cm: volumetric soil moisture between 0-10 cm below ground level
soilw.10-200cm: volumetric soil moisture between 10-200 cm below ground level
tmax.2m: maximum temperature at 2 m above surface
tmin.2m: minimum temperature at 2 m above surface
tmp.0-10cm: temperature between 0-0.1 m below ground level
tmp.10-200cm: temperature between 0.1-2 m below ground level
tmp.300cm: temperature at 3 m below ground level
uflx.sfc: east-west momentum flux at surface
ugwd.sfc: zonal gravity wave stress at surface
ulwrf.sfc: upward longwave radiation flux at surface
uswrf.sfc: upward solar radiation flux at surface
uwnd.10m: east-west velocity at 10 m above surface
vbdsf.sfc: visible beam downward solar flux at surface
vddsf.sfc: visible diffuse downward solar flux at surface
vflx.sfc: north-south momentum flux at surface
vgwd.sfc: meridional gravity wave stress at surface
vwnd.10m: north-south velocity at 10 m above surface
weasd.sfc: water equivalent of accumulated snow depth at surface

3.6 tropopause

variable/file	units	*R-1* years	*R-2* years	horizontal resolution
air.tropp.**year**.nc	K	1948-2003	N/A	144 × 73 regular
pres.tropp.**year**.nc	K	1948-2003	N/A	144 × 73 regular

Table 7: Variables located in CHERAX:˜csncp/tropopause.

where
air.tropp: air temperature at tropopause
pres.tropp: pressure at tropopause

4 Monthly and seasonal climatologies

All variables in Tables 1, 2, 4, 5, 6 and 7 are available in a climatological form. These include seasonal and monthly climatologies for the period 1948-2003 for the *R-1* data and 1979-2001 for the *R-2* data. It is straight forward (but time-consuming when processing all variables in the whole archive) to generate these climatologies for different periods, and the averaging period will be extended as future/past years become available. For every variable there are four types of average *netCDF* files that are referred to as long-term monthly (*lm*), long-term seasonal (*ls*), year-by-year monthly (*ym*) and year-by-year seasonal (*ys*), as shown respectively in Table 8. The four seasons are referred to with the abbreviations DJF (December, January and February average), MAM (March, April and May average), JJA (June, July and August average) and SON (September, October and November average). By *long-term* it is meant monthly or seasonal averages over the entire averaging year period. By *year-by-year* it is meant monthly or seasonal averages for each individual year. The annual and monthly means are naturally defined for all complete reanalysis years, however, the seasonal definitions cross over different years and therefore in the *year-by-year seasonal* case the first season of the first year (DJF 1948) and the last season of the final year (DJF of 2003) are included in the output file but are averages over the available months (2 and 1, respectively). In all other averages (i.e. long term) all 4-times daily observations for all relevant days are included when forming the average. Scripts for doing this processing, described in Section 5.3, can be modified for different averaging requirements. Files containing the various climatologies can be found on CHERAX under the directories shown in Table 8, and illustrated in Figure 1.

climatology type	location on CHERAX	filename
	R-1	
long-term monthly (lm)	~csncp/c/1948-2003/l/m	**variable_name**.lm.1948-2003.nc
long-term seasonal (ls)	~csncp/c/1948-2003/l/s	**variable_name**.ls.1948-2003.nc
year-by-year monthly (ym)	~csncp/c/1948-2003/y/m	**variable_name**.ym.1948-2003.nc
year-by-year seasonal (ys)	~csncp/c/1948-2003/y/s	**variable_name**.ys.1948-2003.nc
	R-2	
long-term monthly (lm)	~csncp/reanalysis2/c/1979-2002/l/m	**variable_name**.lm.1979-2002.nc
long-term seasonal (ls)	~csncp/reanalysis2/c/1979-2002/l/s	**variable_name**.ls.1979-2002.nc
year-by-year monthly (ym)	~csncp/reanalysis2/c/1979-2002/y/m	**variable_name**.ym.1979-2002.nc
year-by-year seasonal (ys)	~csncp/reanalysis2/c/1979-2002/y/s	**variable_name**.ys.1979-2002.nc

Table 8: *R-1/R-2* long-term and year-by-year, monthly and seasonal climatologies.

where

variable_name is the variable name part of the (time-varying) files found in any of the tables in Section 5, for example, slp, pr_wtr.eatm, and weasd.sfc.gauss.

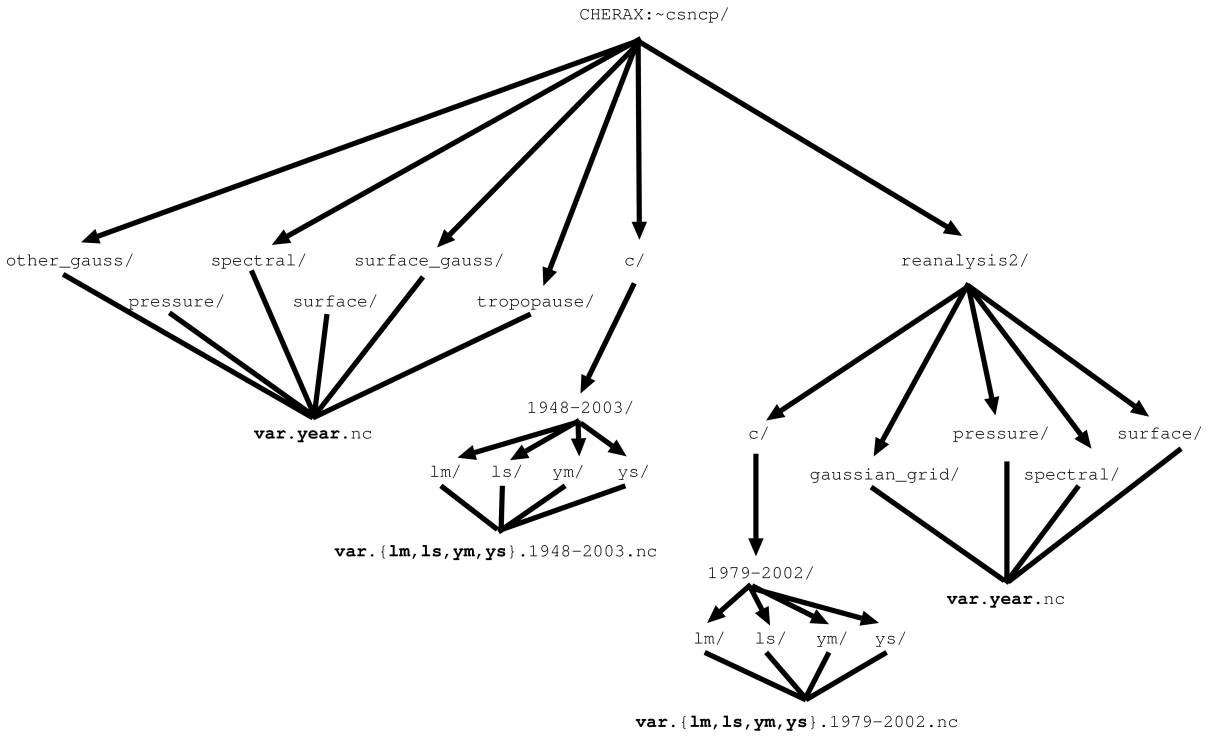


Figure 1: Tree diagram for the location of 6-hourly data, monthly and seasonal climatologies on CHERAX. Directories are identified with a "\" at end of name. Variable information (field, year, climatology type) is shown by bold text. Climatologies are located under "c" directories for both *R-1* and *R-2*. *NetCDF* files are identified with a ".nc" at end of a file name.

The *netCDF* time units in these climatological files is described as "hours since 1800-1-1 00:00:0.0" and can be interpreted to an exact averaged reanalysis

time with the appropriate software, for example, *Ferret*. The values for the time axis has been derived from the values in the original 6-hourly *netCDF* files for consistency.

5 Obtaining raw *R-1/R-2* data

3W[4] links that are relevant to this document are shown in Table 4.

NOAA-CIRES CDC 3W page:	http://www.cdc.noaa.gov/cdc/reanalysis/reanalysis.shtml
NCEP/NCAR reanalysis 3W page:	http://wesley.wwb.noaa.gov/reanalysis.html
NCAR 3W page:	http://www.ncar.ucar.edu/
ECMWF ERA-40 3W page:	http://www.ecmwf.int/research/era/

NOAA-CIRES CDC was the source location for the raw 6-hourly data, see Section 5.2 for further details.

5.1 the CSIRO NCEP/NCAR/DOE *R-1/R-2* archive

The only practical way of obtaining data from this CSIRO NCEP/NCAR/DOE *R-1/R-2* archive is to own an account on the storage/data processing machine CHERAX. For users of the NEC supercomputers the archive under the csncp account can be accessed across the network under the directory /cs/datastore/u/csdar/csncp (or ~csncp under unix). As it is not currently possible to put other accounts data back onto disk (i.e. re-migrate), please consider the consequences of extracting large quantities of data from tape to disk at any one time. If you are unsure, please consult the CSIRO/Bureau of Meteorology Joint HPCCC help staff[5].

On CHERAX all archive data are found under the user account **csncp**. There are five main subdirectories in this account holding the 4-times daily fields for all years, specifically: other_gauss, pressure, spectral, surface, surface_gauss and tropopause. These names correspond by name to Tables 1, 2, 3, 4, 5, 6 and 7, respectively. Data have been divided up into years, and these are represented as a four digit number in the filename as can be located in the tables shown in Section 5.

All pressure level fields (these are a function of pressure in addition to the usual time, level, latitude and longitude dimensions) have been divided into files corresponding to each pressure level using scripts described in Section /refsec.proc. This could be convenient for specific types of analysis where not all levels are required at once. These can be found on CHERAX in the directory ~csncp/level,~csncp/reanalysis2/level in one of the 17 sub-directories (padded out to 4 characters), namely, *0010, 0020, 0030, 0050, 0070, 0100, 0150, 0200, 0250, 0300, 0400, 0500, 0600, 0700, 0850, 0925, and 1000*. These names correspond to pressure levels (in hPa) from which the data were extracted. Note that variables **rhum** and **shum** are defined only for the eight lowest atmospheric pressure levels, and **omega** for the twelve lowest levels.

[4] common shortening of WWW
[5] hpchelp@hpc.csiro.au

5.2 the NOAA-CIRES CDC archive

The most recent *R-1* (*R-2*) reanalysis data files can be downloaded directly from the anonymous ftp server, ftp://archive.cdc.noaa.gov in the subdirectory Datasets/ncep.reanalysis (Datasets/ncep.reanalysis2) for all years. Within are the sub-directories other_gauss, pressure, spectral, surface, surface_gauss, tropopause (gaussian_grid, pressure, spectral, surface), which include the 4-times daily files that are described in this document. Every few months the current year reanalysis data are downloaded to the HPCCC storage system, however, this cannot be guaranteed to be always up-to-date.

5.3 processing and maintaining the CSIRO NCEP/NCAR/DOE *R-1/R-2* archive

Although there are a number of public domain and proprietary softwares for processing and manipulating *netCDF* files, discussions here will only relate to processing undertaken with Harvey Davies' (Harvey.Davies@csiro.au) *NAP* extension of *Tcl* (*Tcl-nap*). Comprehensive information can be found on the web at http://tcl-nap.sourceforge.net. This software has the three main features in the context of this archive, a sophisticated scripting language, and highly capable input-output interface (including *netCDF*, reading and writing), and installed to be able to directly read the *R-1* and *R-2* raw *netCDF* data.

A number of *Tcl-nap* utilities have been written or installed to run on CHERAX in *Tcl-nap* to extract and analyse the CSIRO NCEP/NCAR/DOE *R-1/R-2* archive. Software pertinent to the production of the archive are also described briefly here and are located in CHERAX:~csncp/tcl_fun, the directory name is short for *Tcl* functions (or procedures as they are known in *Tcl*). Locations relative to CHERAX's filesystem will be indicated here although they can be accessed from other machines via disk mounts.

The pressure level data in Table 2 were split into files representative of each pressure level using the *Tcl-nap* Scripts[6] 1 and 2 for splitting pressure level data from the *R-1* and *R-2* data, respectively.

$$CHERAX : \tilde{}csncp/tcl\_fun/split\_\text{r-1}.tcl \tag{1}$$

$$CHERAX : \tilde{}csncp/tcl\_fun/split\_\text{r-2}.tcl \tag{2}$$

Data in this form are often more convenient to work with than the full-level data. For example,

split_r-1 shum 1948 2003

split_r-2 hgt 1979 2002

will join 8 levels of specific humidity data from *R-1* between 1948 and 2003, and 17 levels of geopotential height data from *R-2* between 1979 and 2002,

[6] these scripts are normally executed by the manager of the archive.

respectively.

For convenience of processing all pressure level variables for all years *Tcl-nap* Scripts[7] 3 and 4 have been written to find and process any missing cases (variables/years/levels) for *R-1* and *R-2*, respectively. These call upon Scripts 1 and 2, respectively.

$$CHERAX : \tilde{}csncp/tcl\_fun/run\_split\_\text{r-1}.tcl \tag{3}$$

$$CHERAX : \tilde{}csncp/tcl\_fun/run\_split\_\text{r-2}.tcl \tag{4}$$

File gaps in the output directory, for whatever reason (e.g. system crash during execution of *Tcl-nap* scripts), can be filled by performing several executions of *Tcl-nap* Scripts 3 and 4 until subsequent passes locate no further gaps.

However, if you prefer to process full-level data, for example from the split-level climatologies, then you can reassemble them using the *Tcl-nap* Scripts 5 and 6 for the *R-1* and *R-2* data, respectively. This can be easily modified to reassemble climatology data described in Section 4.

$$CHERAX : \tilde{}csncp/tcl\_fun/join\_\text{r-1}.tcl \tag{5}$$

$$CHERAX : \tilde{}csncp/tcl\_fun/join\_\text{r-2}.tcl \tag{6}$$

For example,

join_r-1 shum 1948 2003

join_r-2 hgt 1979 2002

will separate 8 levels of specific humidity data from *R-1* between 1948 and 2003, and 17 levels of geopotential height data from *R-2* between 1979 and 2002, respectively.

The *long-term monthly* and *long-term seasonal* climatologies described in Section 4 were computed with the *Tcl-nap* Scripts 7 and 8 (listed in Section 8.7 and 8.8) for *R-1* and *R-2*, respectively. .

$$CHERAX : \tilde{}csncp/tcl\_fun/long\_term\_\text{r-1}.tcl \tag{7}$$

$$CHERAX : \tilde{}csncp/tcl\_fun/long\_term\_\text{r-2}.tcl \tag{8}$$

Year-by-year monthly and *year-by-year seasonal* climatologies were computed with the *Tcl-nap* Scripts 9 and 10 (listed in Section 8.9 and 8.10) for *R-1* and *R-2*, respectively.

[7] these scripts are normally executed by the manager of the archive.

$$CHERAX : \tilde{}csncp/tcl\_fun/year\_by\_year\_\text{r-1}.tcl \tag{9}$$

$$CHERAX : \tilde{}csncp/tcl\_fun/year\_by\_year\_\text{r-2}.tcl \tag{10}$$

For example,

long_term_r-1 uwnd.0500 12 1961 1990 /tmp

year_by_year_r-2 4 prate.sfc.gauss 1981 2000 /tmp

will generate long-term monthly averages of zonal wind at 500 hPa for *R-1* between 1961 and 1990, and year-by-year seasonal averages of precipitation rate for *R-2* between 1981 and 2000, respectively, and put them into the /tmp directory.

To help facilitate the generation of these climatologies the *Tcl-nap* Scripts 11 and 12 listed in Section 8.11 and 8.12 processes all variables over a specified range of years, for *R-1* and *R-2*, respectively.

$$CHERAX : \tilde{}csncp/tcl\_fun/calc\_clim\_\text{r-1}.tcl \tag{11}$$

$$CHERAX : \tilde{}csncp/tcl\_fun/calc\_clim\_\text{r-2}.tcl \tag{12}$$

These call upon Scripts 7 and 8, respectively. As an example, the *Tcl-nap* Script 13 (listed in Section 8.13).

$$CHERAX : \tilde{}csncp/tcl\_fun/calc\_anom\_\text{r-1}.tcl \tag{13}$$

has been provided to illustrate how monthly or seasonal anomalies may be computed from their long-term monthly mean and year-by-year monthly means.

5.4 miscellaneous *Tcl-nap* scripts

Several *Tcl-nap* scripts are now briefly described as they are required for the above mentioned *Tcl-nap* scripts to function, and are not part of the standard *Tcl-nap* installation.

CHERAX:~csncp/tcl_fun/get_r-1_dir.tcl: this procedure (listed in Section 8.14) provides the *R-1* sub-directory based on a given variable name (requires one character argument and returns a character variable).

CHERAX:~csncp/tcl_fun/get_r-2_dir.tcl this procedure (listed in Section 8.15) provides the *R-2* sub-directory based on a given variable name (requires one character argument and returns a character variable).

CHERAX:~csncp/tcl_fun/gettti.tcl this procedure (listed in Section 8.16) provides appropriate time index for monthly or seasonal data processing (requires two integer arguments and returns and integer variable).

CHERAX:~csncp/tcl_fun/pad10000.tcl: this procedure (listed in Section 8.17) provides "0" padding for integers up to 9999 (requires one integer argument and

returns a character variable).

On CHERAX the data analysis and visualisation package *Ferret* can directly read any of the *R-1* and *R-2* raw data or derived climatologies described in this report. For complete information about this tool look at the 3W page:

WWW: http://ferret.pmel.noaa.gov/Ferret/

6 Horizontal and vertical dimension definitions

6.1 longitude dimension - 192 values

0, 1.875, 3.75, 5.625, 7.5, 9.375, 11.25, 13.125, 15, 16.875, 18.75, 20.625, 22.5, 24.375, 26.25, 28.125, 30, 31.875, 33.75, 35.625, 37.5, 39.375, 41.25, 43.125, 45, 46.875, 48.75, 50.625, 52.5, 54.375, 56.25, 58.125, 60, 61.875, 63.75, 65.625, 67.5, 69.375, 71.25, 73.125, 75, 76.875, 78.75, 80.625, 82.5, 84.375, 86.25, 88.125, 90, 91.875, 93.75, 95.625, 97.5, 99.375, 101.25, 103.125, 105, 106.875, 108.75, 110.625, 112.5, 114.375, 116.25, 118.125, 120, 121.875, 123.75, 125.625, 127.5, 129.375, 131.25, 133.125, 135, 136.875, 138.75, 140.625, 142.5, 144.375, 146.25, 148.125, 150, 151.875, 153.75, 155.625, 157.5, 159.375, 161.25, 163.125, 165, 166.875, 168.75, 170.625, 172.5, 174.375, 176.25, 178.125, 180, 181.875, 183.75, 185.625, 187.5, 189.375, 191.25, 193.125, 195, 196.875, 198.75, 200.625, 202.5, 204.375, 206.25, 208.125, 210, 211.875, 213.75, 215.625, 217.5, 219.375, 221.25, 223.125, 225, 226.875, 228.75, 230.625, 232.5, 234.375, 236.25, 238.125, 240, 241.875, 243.75, 245.625, 247.5, 249.375, 251.25, 253.125, 255, 256.875, 258.75, 260.625, 262.5, 264.375, 266.25, 268.125, 270, 271.875, 273.75, 275.625, 277.5, 279.375, 281.25, 283.125, 285, 286.875, 288.75, 290.625, 292.5, 294.375, 296.25, 298.125, 300, 301.875, 303.75, 305.625, 307.5, 309.375, 311.25, 313.125, 315, 316.875, 318.75, 320.625, 322.5, 324.375, 326.25, 328.125, 330, 331.875, 333.75, 335.625, 337.5, 339.375, 341.25, 343.125, 345, 346.875, 348.75, 350.625, 352.5, 354.375, 356.25, 358.125

6.2 latitude dimension - 94 values

88.542, 86.6531, 84.7532, 82.8508, 80.9473, 79.0435, 77.1394, 75.2351, 73.3307, 71.4262, 69.5217, 67.6171, 65.7125, 63.8079, 61.9033, 59.9986, 58.0939, 56.1893, 54.2846, 52.3799, 50.4752, 48.5705, 46.6658, 44.7611, 42.8564, 40.9517, 39.047, 37.1422, 35.2375, 33.3328, 31.4281, 29.5234, 27.6186, 25.7139, 23.8092, 21.9044, 19.9997, 18.095, 16.1902, 14.2855, 12.3808, 10.47604, 8.57131, 6.66657, 4.76184, 2.8571, 0.952368, -0.952368, -2.8571, -4.76184, -6.66657, -8.57131, -10.47604, -12.3808, -14.2855, -16.1902, -18.095, -19.9997, -21.9044, -23.8092, -25.7139, -27.6186, -29.5234, -31.4281, -33.3328, -35.2375, -37.1422, -39.047, -40.9517, -42.8564, -44.7611, -46.6658, -48.5705, -50.4752, -52.3799, -54.2846, -56.1893, -58.0939, -59.9986, -61.9033, -63.8079, -65.7125, -67.6171, -69.5217, -71.4262, -73.3307, -75.2351, -77.1394, -79.0435, -80.9473, -82.8508, -84.7532, -86.6531, -88.542

6.3 longitude dimension - 144 values

0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50, 52.5, 55, 57.5, 60, 62.5, 65, 67.5, 70, 72.5, 75, 77.5, 80, 82.5, 85, 87.5,

90, 92.5, 95, 97.5, 100, 102.5, 105, 107.5, 110, 112.5, 115, 117.5, 120, 122.5, 125, 127.5, 130, 132.5, 135, 137.5, 140, 142.5, 145, 147.5, 150, 152.5, 155, 157.5, 160, 162.5, 165, 167.5, 170, 172.5, 175, 177.5, 180, 182.5, 185, 187.5, 190, 192.5, 195, 197.5, 200, 202.5, 205, 207.5, 210, 212.5, 215, 217.5, 220, 222.5, 225, 227.5, 230, 232.5, 235, 237.5, 240, 242.5, 245, 247.5, 250, 252.5, 255, 257.5, 260, 262.5, 265, 267.5, 270, 272.5, 275, 277.5, 280, 282.5, 285, 287.5, 290, 292.5, 295, 297.5, 300, 302.5, 305, 307.5, 310, 312.5, 315, 317.5, 320, 322.5, 325, 327.5, 330, 332.5, 335, 337.5, 340, 342.5, 345, 347.5, 350, 352.5, 355, 357.5

6.4 latitude dimension - 73 values

90.0, 87.5, 85.0, 82.5, 80.0, 77.5, 75.0, 72.5, 70.0, 67.5, 65.0, 62.5, 60.0, 57.5, 55.0, 52.5, 50.0, 47.5, 45.0, 42.5, 40.0, 37.5, 35, 32.5, 30.0, 27.5, 25.0, 22.5, 20.0, 17.5, 15.0, 12.5, 10.0, 7.5, 5.0, 2.5, 0.0, -2.5, -5.0, -7.5, -10.0, -12.5, -15.0, -17.5, -20.0, -22.5, -25.0, -27.5, -30.0, -32.5, -35, -37.5, -40.0, -42.5, -45.0, -47.5, -50.0, -52.5, -55.0, -57.5, -60.0, -62.5, -65.0, -67.5, -70.0, -72.5, -75.0, -77.5, -80.0, -82.5, -85.0, -87.5, -90.0

6.5 pressure level dimension - 17 values

0010.0, 0020.0, 0030.0, 0050.0, 0070.0, 0100.0, 0150.0, 0200.0, 0250.0, 0300.0, 0400.0, 0500.0, 0600.0, 0700.0, 0850.0, 0925.0, 1000.0

6.6 sigma levels dimension - 28 values

0.995, 0.9821, 0.9644, 0.9425, 0.9159, 0.8838, 0.8458, 0.8014, 0.7508, 0.6943, 0.6329, 0.5681, 0.5017, 0.4357, 0.372, 0.3125, 0.2582, 0.2101, 0.1682, 0.1326, 0.1028, 0.0782, 0.058, 0.0418, 0.0288, 0.0183, 0.0101, 0.0027

7 Acknowledgments

I would like to thank the NOAA-CIRES CDC, Boulder, Colorado, for their ongoing assistance. *Tcl-nap* training and software development was provided by Harvey Davies. Generous assistance and resources have been provided by the staff of the CSIRO/Bureau of Meteorology Joint HPCCC.

If you would like to receive any news relevant to the CSIRO NCEP/NCAR/DOE *R-1/R-2* archive via e-mail, please send a request to the author and you will be added to the recipient list.

References

Kalnay, E., M. Kanamitsu, R. Kistler, W. Collins, D. Deaven, L. Gandin, M. Iredell, S. Saha, G. White, J. Woollen, Y. Zhu, M. Chelliah, W. Ebisuzaki, W. Higgins, J. Janowiak, K.C. Mo, C. Ropelewski, J. Wang, A. Leetmaa, R. Reynolds, R. Jenne and **D. Jospher** 1996: The NCEP/NCAR 40-Year Reanalysis Project. *Bull. Amer. Meteor. Soc.*, **3**, 437–471.

Kistler, R., E. Kalnay, W. Collins, S. Saha, G. White, J. Woollen, M. Chelliah, W. Ebisuzaki, M. Kanamitsu, V. Kousky, H. van den

Dool, R. Jenne and M. Fiorino 2001: The NCEP-NCAR 50-year Reanalysis: Monthly Means CD-ROM and Documentation. *Bull. Amer. Meteor. Soc.*, **82**, 247–267.

M.A. Collier 2000: THE CSIRO NCEP reanalysis archive. *CSIRO Atmospheric Research Internal Paper*, **17**, 1–193.

Kanamitsu, M., W. Ebisuzaki, J. Woollen, S-K. Yang, J.J. Hnilo, M. Fiorino and **G.L. Potter** 2002: NCEP-DEO AMIP-II Reanalysis ($R-2$). *Bull. Amer. Meteor. Soc.*, **3**, 437–471.

8 Appendix: Tcl/NAP scripts

8.1 split_r-1

```
########BEGIN - SPLIT_R-1.TCL#########################################################
proc split_r-1 {ivar ybeg yend} {
#CSIRO Australia
#Mark Collier January 2004

#split NCEP r-1 pressure level data into individual pressure levels.

source ~csmac/.tclshrc
source ~csmac/tcl_fun/pad10000.tcl

if {[info exists ::env(TMPDIR)]} {
set tdir $TMPDIR
} else {
puts "Must set TMPDIR."
return
}

set ivar_str $ivar

set ifils 0;set iret 0
unset ifils
for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {
set ifil $ivar_str.$ynow.nc
if { [file exists $idir/$ifil] == 0 } {
incr iret
puts "Input file $idir/$ifil doesn't exist"
}
lappend ifils $idir/$ifil
}
if {$iret != 0} {
return
}

for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {

set ifil $ivar_str.$ynow.nc

puts "input file=$idir/$ifil"

set shape [nap_get netcdf -shape $idir/$ifil $ivar_str]
set dimen [nap_get netcdf -dimension $idir/$ifil $ivar_str]
set rank [nap_get netcdf -rank $idir/$ifil $ivar_str]

set levs [[nap_get netcdf $idir/$ifil level] -c -1]

if { [lindex $shape 0] != 1460 && [lindex $shape 0] != 1464 } {
puts "Problem with number of times in $idir/$ifil at year $ynow."
return
}
```

```
nap "t1 = [nap_get netcdf $idir/$ifil time]"

nap "lat = [nap_get netcdf $idir/$ifil lat]"
nap "lon = [nap_get netcdf $idir/$ifil lon]"

nap "yone = $lat@@[lindex $lats 0]"
nap "ynnn = $lat@@[lindex $lats 1]"
nap "xone = $lon@@[lindex $lons 0]"
nap "xnnn = $lon@@[lindex $lons 1]"

nap "lat_ind = $yone..$ynnn"
nap "lon_ind = $xone..$xnnn"

for {set lnow 1} {$lnow <= [lindex $shape 1]} {incr lnow} {
puts "level now=$lnow"

set lnowm1 [expr $lnow-1]

set ofil $ivar.[pad10000 [lindex $levs $lnowm1]].$ynow.nc
set odir /cs/u/csdar/csncp/level/[pad10000 [lindex $levs $lnowm1]]

puts "output file=$odir/$ofil"

file delete $tdir/$ofil

set leap [[nap $ynow%4]]

if { $leap == 0 } {
set ndays {31 29 31 30 31 30 31 31 30 31 30 31}
} else {
set ndays {31 28 31 30 31 30 31 31 30 31 30 31}
}

set ntbeg 1
for {set mnow 1} {$mnow <= 12} {incr mnow} {
puts "month now=$mnow"
set mnowm1 [expr $mnow-1]

set ntend [expr $ntbeg+[lindex $ndays $mnowm1]*4-1]

set ntbegm1 [expr $ntbeg-1]
set ntendm1 [expr $ntend-1]

puts "ntbeg,ntend=$ntbeg,$ntend"

nap "v1 = [nap_get netcdf $idir/$ifil $ivar_str \
"$ntbegm1..$ntendm1,{$lnowm1},$lat_ind,$lon_ind" 1]"

$v1 netcdf -unlimited -index "$ntbegm1..$ntendm1,,," $tdir/$ofil $ivar_str

set ntbeg [expr $ntend+1]

#mnow
```

```
}

set var_list $dimen
lappend var_list $ivar_str
puts $var_list

foreach var $var_list {
set var_len [expr [string length $var]+1]
set strings [nap_get netcdf -list $idir/$ifil $var:]
set natts [llength $strings]

set atts ""
for {set cnt 1} {$cnt <= [llength $strings]} {incr cnt} {
set cntm1 [expr $cnt-1]
set atts_tmp1 [lindex $strings $cntm1]
set att_len [string length $atts_tmp1]
set atts "$atts [string range $atts_tmp1 $var_len $att_len]"
}

for {set cnt 1} {$cnt <= [llength $atts]} {incr cnt} {
set cntm1 [expr $cnt-1]
set att [lindex $atts $cntm1]
[nap_get netcdf $idir/$ifil $var:$att] netcdf ${tdir}/${ofil} $var:$att
}
}

set atts [nap_get netcdf -list $idir/$ifil ^:]

for {set cnt 1} {$cnt <= [llength $atts]} {incr cnt} {
set cntm1 [expr $cnt-1]
set att [lindex $atts $cntm1]
[nap_get netcdf $idir/$ifil $att] netcdf ${tdir}/${ofil} $att
}

nap "history = ‘created by Mark Collier CSIRO [date_time_now]‘"
$history netcdf ${tdir}/${ofil} :history

$t1 netcdf -unlimited $tdir/$ofil time

exec /bin/mv $tdir/$ofil $odir/$ofil

#lnow
}

#ynow
}

return
}
########END - SPLIT_R-1.TCL############################################################
```

8.2 split_r-2

```
########BEGIN - SPLIT_R-2.TCL#########################################################
proc split_r-2 {ivar ybeg yend} {
#CSIRO Australia
#Mark Collier February 2004

#split NCEP r-2 pressure level data into individual pressure levels.

source ~csmac/.tclshrc
source ~csmac/tcl_fun/pad10000.tcl

if {[info exists ::env(TMPDIR)]} {
set tdir $TMPDIR
} else {
puts "Must set TMPDIR."
return
}

set ivar_str $ivar

set ifils 0;set iret 0
unset ifils
for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {
set ifil $ivar_str.$ynow.nc
if { [file exists $idir/$ifil] == 0 } {
incr iret
puts "Input file $idir/$ifil doesn't exist"
}
lappend ifils $idir/$ifil
}
if {$iret != 0} {
return
}

for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {

set ifil $ivar_str.$ynow.nc

puts "input file=$idir/$ifil"

set shape [nap_get netcdf -shape $idir/$ifil $ivar_str]
set dimen [nap_get netcdf -dimension $idir/$ifil $ivar_str]
set rank [nap_get netcdf -rank $idir/$ifil $ivar_str]

set levs [[nap_get netcdf $idir/$ifil level] -c -1]

if { [lindex $shape 0] != 1460 && [lindex $shape 0] != 1464 } {
puts "Problem with number of times in $idir/$ifil at year $ynow."
return
}

nap "t1 = [nap_get netcdf $idir/$ifil time]"
```

```
nap "lat = [nap_get netcdf $idir/$ifil lat]"
nap "lon = [nap_get netcdf $idir/$ifil lon]"

nap "yone = $lat@@[lindex $lats 0]"
nap "ynnn = $lat@@[lindex $lats 1]"
nap "xone = $lon@@[lindex $lons 0]"
nap "xnnn = $lon@@[lindex $lons 1]"

nap "lat_ind = $yone..$ynnn"
nap "lon_ind = $xone..$xnnn"

for {set lnow 1} {$lnow <= [lindex $shape 1]} {incr lnow} {
puts "level now=$lnow"

set lnowm1 [expr $lnow-1]

set ofil $ivar.[pad10000 [lindex $levs $lnowm1]].$ynow.nc
set odir /cs/u/csdar/csncp/reanalysis2/level/[pad10000 [lindex $levs $lnowm1]]

puts "output file=$odir/$ofil"

file delete $tdir/$ofil

set leap [[nap $ynow%4]]

if { $leap == 0 } {
set ndays {31 29 31 30 31 30 31 31 30 31 30 31}
} else {
set ndays {31 28 31 30 31 30 31 31 30 31 30 31}
}

set ntbeg 1
for {set mnow 1} {$mnow <= 12} {incr mnow} {
puts "month now=$mnow"
set mnowm1 [expr $mnow-1]

set ntend [expr $ntbeg+[lindex $ndays $mnowm1]*4-1]

set ntbegm1 [expr $ntbeg-1]
set ntendm1 [expr $ntend-1]

puts "ntbeg,ntend=$ntbeg,$ntend"

nap "v1 = [nap_get netcdf $idir/$ifil $ivar_str \
"$ntbegm1..$ntendm1,{$lnowm1},$lat_ind,$lon_ind" 1]"

$v1 netcdf -unlimited -index "$ntbegm1..$ntendm1,,," $tdir/$ofil $ivar_str

set ntbeg [expr $ntend+1]

#mnow
}
```

```
set var_list $dimen
lappend var_list $ivar_str
puts $var_list

foreach var $var_list {
set var_len [expr [string length $var]+1]
set strings [nap_get netcdf -list $idir/$ifil $var:]
set natts [llength $strings]

set atts ""
for {set cnt 1} {$cnt <= [llength $strings]} {incr cnt} {
set cntm1 [expr $cnt-1]
set atts_tmp1 [lindex $strings $cntm1]
set att_len [string length $atts_tmp1]
set atts "$atts [string range $atts_tmp1 $var_len $att_len]"
}

for {set cnt 1} {$cnt <= [llength $atts]} {incr cnt} {
set cntm1 [expr $cnt-1]
set att [lindex $atts $cntm1]
[nap_get netcdf $idir/$ifil $var:$att] netcdf ${tdir}/${ofil} $var:$att
}
}

set atts [nap_get netcdf -list $idir/$ifil ^:]

for {set cnt 1} {$cnt <= [llength $atts]} {incr cnt} {
set cntm1 [expr $cnt-1]
set att [lindex $atts $cntm1]
[nap_get netcdf $idir/$ifil $att] netcdf ${tdir}/${ofil} $att
}

nap "history = ‘created by Mark Collier CSIRO [date_time_now]‘"
$history netcdf ${tdir}/${ofil} :history

$t1 netcdf -unlimited $tdir/$ofil time

exec /bin/mv $tdir/$ofil $odir/$ofil

#lnow
}

#ynow
}

return
}
########END - SPLIT_R-2.TCL############################################################
```

8.3 join_r-1

```
########BEGIN - JOIN_R-1.TCL#########################################################
proc join_r-1 {ivar ybeg yend idir odir} {
#CSIRO Australia
#Mark Collier January 2004

#join NCEP r-1 pressure level data from individual pressure level files.

source ~csmac/.tclshrc
source ~csmac/tcl_fun/pad10000.tcl

if {[info exists ::env(TMPDIR)]} {
set tdir $TMPDIR
} else {
puts "Must set TMPDIR."
return
}

if { [file isdirectory $odir] == 0 } {
puts "Output directory doesn't exist"
return
}

set ivar_str $ivar

for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {

set ofil $ivar_str.$ynow.nc

puts "output file=$odir/$ofil"

file delete $tdir/$ofil

set ifils [glob $idir/$ivar_str.????.$ynow.nc]

set levs 0;unset levs
for {set lnow 1} {$lnow <= [llength $ifils]} {incr lnow} {
set lnowm1 [expr $lnow-1]
set ifil [lindex $ifils $lnowm1]
set lbeg [expr [string length $idir]+[string length $ivar_str]+2]
set lend [expr $lbeg+3]
lappend levs [string range $ifil $lbeg $lend]
}

catch {exec /cs/u/csdar/csmac/portal/bin/dmget_farrer "$ifils"}

set leap [[nap $ynow%4]]

if { $leap == 0 } {
set ndays {31 29 31 30 31 30 31 31 30 31 30 31}
} else {
set ndays {31 28 31 30 31 30 31 31 30 31 30 31}
}
```

```
set ifil $ivar.[lindex $levs 0].$ynow.nc

nap "t1 = [nap_get netcdf $idir/$ifil time]"

set shape [nap_get netcdf -shape $idir/$ifil $ivar_str]
set dimen [nap_get netcdf -dimension $idir/$ifil $ivar_str]
set rank [nap_get netcdf -rank $idir/$ifil $ivar_str]

nap "v1 = [nap_get netcdf $idir/$ifil $ivar_str \
"{0},{0},," 1]"

nap "time = [nap_get netcdf $idir/$ifil time "{0}"]"
nap "lat = f32([nap_get netcdf $idir/$ifil lat])"
nap "lon = f32([nap_get netcdf $idir/$ifil lon])"
nap "level = f32({${levs}})"

set newshape [lreplace $shape 0 1 1 [llength $levs]]

nap "v2 = reshape((v1-v1)/(v1-v1),{$newshape})"

$v2 set dim time level lat lon
$v2 set coo time level lat lon

$v2 netcdf -unlimited $tdir/$ofil $ivar_str

set ntbeg 1
for {set mnow 1} {$mnow <= 12} {incr mnow} {
puts "month now=$mnow"
set mnowm1 [expr $mnow-1]

set ntend [expr $ntbeg+[lindex $ndays $mnowm1]*4-1]

set ntbegm1 [expr $ntbeg-1]
set ntendm1 [expr $ntend-1]

puts "ntbeg,ntend=$ntbeg,$ntend"

for {set lnow 1} {$lnow <= [llength $levs]} {incr lnow} {

set lnowm1 [expr $lnow-1]

set ifil $ivar.[lindex $levs $lnowm1].$ynow.nc

puts "input file=$idir/$ifil"

nap "v1 = [nap_get netcdf $idir/$ifil $ivar_str \
"$ntbegm1..$ntendm1,,," 1]"

$v1 netcdf -unlimited -index "$ntbegm1..$ntendm1,${lnowm1},," \
$tdir/$ofil $ivar_str

#lnow
```

```
}

set ntbeg [expr $ntend+1]

#mnow
}

nap "t1 = [nap_get netcdf $idir/$ifil time]"

$t1 netcdf -unlimited $tdir/$ofil time

set ifil $ivar.[lindex $levs 0].$ynow.nc

#copy attributes...

set var_list $dimen
lappend var_list $ivar_str
puts $var_list

foreach var $var_list {
set var_len [expr [string length $var]+1]
set strings [nap_get netcdf -list $idir/$ifil $var:]
set natts [llength $strings]

set atts ""
for {set cnt 1} {$cnt <= [llength $strings]} {incr cnt} {
set cntm1 [expr $cnt-1]
set atts_tmp1 [lindex $strings $cntm1]
set att_len [string length $atts_tmp1]
set atts "$atts [string range $atts_tmp1 $var_len $att_len]"
}

for {set cnt 1} {$cnt <= [llength $atts]} {incr cnt} {
set cntm1 [expr $cnt-1]
set att [lindex $atts $cntm1]
[nap_get netcdf $idir/$ifil $var:$att] netcdf ${tdir}/${ofil} $var:$att
}
}

set atts [nap_get netcdf -list $idir/$ifil ^:]

for {set cnt 1} {$cnt <= [llength $atts]} {incr cnt} {
set cntm1 [expr $cnt-1]
set att [lindex $atts $cntm1]
[nap_get netcdf $idir/$ifil $att] netcdf ${tdir}/${ofil} $att
}

nap "history = ‘created by Mark Collier CSIRO [date_time_now]‘"
$history netcdf ${tdir}/${ofil} :history

exec /bin/mv $tdir/$ofil $odir/$ofil

#ynow
```

```
}

return
}
########END - JOIN_R-1.TCL#############################################################
```

8.4 join_r-2

```
########BEGIN - JOIN_R-2.TCL#########################################################
proc join_r-2 {ivar ybeg yend idir odir} {
#CSIRO Australia
#Mark Collier January 2004

#join NCEP r-2 pressure level data from individual pressure level files.

source ~csmac/.tclshrc
source ~csmac/tcl_fun/pad10000.tcl

if {[info exists ::env(TMPDIR)]} {
set tdir $TMPDIR
} else {
puts "Must set TMPDIR."
return
}

if { [file isdirectory $odir] == 0 } {
puts "Output directory doesn't exist"
return
}

set ivar_str $ivar

for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {

set ofil $ivar_str.$ynow.nc

puts "output file=$odir/$ofil"

file delete $tdir/$ofil

set ifils [glob $idir/$ivar_str.????.$ynow.nc]

set levs 0;unset levs
for {set lnow 1} {$lnow <= [llength $ifils]} {incr lnow} {
set lnowm1 [expr $lnow-1]
set ifil [lindex $ifils $lnowm1]
set lbeg [expr [string length $idir]+[string length $ivar_str]+2]
set lend [expr $lbeg+3]
lappend levs [string range $ifil $lbeg $lend]
}

catch {exec /cs/u/csdar/csmac/portal/bin/dmget_farrer "$ifils"}

set leap [[nap $ynow%4]]

if { $leap == 0 } {
set ndays {31 29 31 30 31 30 31 31 30 31 30 31}
} else {
set ndays {31 28 31 30 31 30 31 31 30 31 30 31}
}
```

```
set ifil $ivar.[lindex $levs 0].$ynow.nc

nap "t1 = [nap_get netcdf $idir/$ifil time]"

set shape [nap_get netcdf -shape $idir/$ifil $ivar_str]
set dimen [nap_get netcdf -dimension $idir/$ifil $ivar_str]
set rank [nap_get netcdf -rank $idir/$ifil $ivar_str]

nap "v1 = [nap_get netcdf $idir/$ifil $ivar_str \
"{0},{0},," 1]"

nap "time = [nap_get netcdf $idir/$ifil time "{0}"]"
nap "lat = f32([nap_get netcdf $idir/$ifil lat])"
nap "lon = f32([nap_get netcdf $idir/$ifil lon])"
nap "level = f32({${levs}})"

set newshape [lreplace $shape 0 1 1 [llength $levs]]

nap "v2 = reshape((v1-v1)/(v1-v1),{$newshape})"

$v2 set dim time level lat lon
$v2 set coo time level lat lon

$v2 netcdf -unlimited $tdir/$ofil $ivar_str

set ntbeg 1
for {set mnow 1} {$mnow <= 12} {incr mnow} {
puts "month now=$mnow"
set mnowm1 [expr $mnow-1]

set ntend [expr $ntbeg+[lindex $ndays $mnowm1]*4-1]

set ntbegm1 [expr $ntbeg-1]
set ntendm1 [expr $ntend-1]

puts "ntbeg,ntend=$ntbeg,$ntend"

for {set lnow 1} {$lnow <= [llength $levs]} {incr lnow} {

set lnowm1 [expr $lnow-1]

set ifil $ivar.[lindex $levs $lnowm1].$ynow.nc

puts "input file=$idir/$ifil"

nap "v1 = [nap_get netcdf $idir/$ifil $ivar_str \
"$ntbegm1..$ntendm1,,," 1]"

$v1 netcdf -unlimited -index "$ntbegm1..$ntendm1,${lnowm1},," \
$tdir/$ofil $ivar_str

#lnow
```

```
}

set ntbeg [expr $ntend+1]

#mnow
}

nap "t1 = [nap_get netcdf $idir/$ifil time]"

$t1 netcdf -unlimited $tdir/$ofil time

set ifil $ivar.[lindex $levs 0].$ynow.nc

#copy attributes...

set var_list $dimen
lappend var_list $ivar_str
puts $var_list

foreach var $var_list {
set var_len [expr [string length $var]+1]
set strings [nap_get netcdf -list $idir/$ifil $var:]
set natts [llength $strings]

set atts ""
for {set cnt 1} {$cnt <= [llength $strings]} {incr cnt} {
set cntm1 [expr $cnt-1]
set atts_tmp1 [lindex $strings $cntm1]
set att_len [string length $atts_tmp1]
set atts "$atts [string range $atts_tmp1 $var_len $att_len]"
}

for {set cnt 1} {$cnt <= [llength $atts]} {incr cnt} {
set cntm1 [expr $cnt-1]
set att [lindex $atts $cntm1]
[nap_get netcdf $idir/$ifil $var:$att] netcdf ${tdir}/${ofil} $var:$att
}
}

set atts [nap_get netcdf -list $idir/$ifil ^:]

for {set cnt 1} {$cnt <= [llength $atts]} {incr cnt} {
set cntm1 [expr $cnt-1]
set att [lindex $atts $cntm1]
[nap_get netcdf $idir/$ifil $att] netcdf ${tdir}/${ofil} $att
}

nap "history = ‘created by Mark Collier CSIRO [date_time_now]‘"
$history netcdf ${tdir}/${ofil} :history

exec /bin/mv $tdir/$ofil $odir/$ofil

#ynow
```

```
}

return
}
########END - JOIN_R-2.TCL#############################################################
```

8.5 run_split_r-1

```
#!/cs/u/csdar/cshld/portal/tcl/bin/tclsh
#CSIRO Australia
#Mark Collier January 2004

#split all NCEP r-1 pressure level data into individual levels

source ~csmac/.tclshrc
source ~csmac/tcl_fun/split_r-1.tcl

set idir /cs/u/csdar/csncp/level

set c "";unset c
set d "";unset d
set e "";unset e

set ybeg 1948;set yend 2003

set var {rhum omega uwnd vwnd air hgt}

for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {

foreach a $var {

if { $a == "rhum" || $a == "shum" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300}
foreach b $levs {
lappend c $idir/$b/$a.$b.$ynow.nc
}

set d 0
foreach b $levs {
if { [file exists $idir/$b/$a.$b.$ynow.nc ] == 0 } {
incr d
}
}
unset c
if {$d > 0} {
puts "$a $ynow"
split_r-1 $a $ynow $ynow
}

} elseif { $a == "omega" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 0250 0200 0150 0100}
foreach b $levs {
lappend c $idir/$b/$a.$b.$ynow.nc
}

set d 0
foreach b $levs {
if { [file exists $idir/$b/$a.$b.$ynow.nc ] == 0 } {
```

```
incr d
}
}
unset c
if {$d > 0} {
puts "$a $ynow"
split_r-1 $a $ynow $ynow
}

} else {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 \
0250 0200 0150 0100 0070 0050 0030 0020 0010}
foreach b $levs { lappend c
$idir/$b/$a.$b.$ynow.nc }

set d 0
foreach b $levs {
if { [file exists $idir/$b/$a.$b.$ynow.nc ] == 0 } {
incr d
}
}
unset c
if {$d > 0} {
puts "$a $ynow"
split_r-1 $a $ynow $ynow
}

}

#a
}

#ynow
}

return
exit
```

8.6 run_split_r-2

```
#!/cs/u/csdar/cshld/portal/tcl/bin/tclsh
#CSIRO Australia
#Mark Collier February 2004

#split all NCEP r-2 pressure level data into individual levels

source ~csmac/.tclshrc
source ~csmac/tcl_fun/split_r-2.tcl

set idir /cs/u/csdar/csncp/reanalysis2/level

set c "";unset c
set d "";unset d
set e "";unset e

set ybeg 1979;set yend 2002

set var {rhum omega uwnd vwnd air hgt}

for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {

foreach a $var {

if { $a == "rhum" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300}
foreach b $levs {
lappend c $idir/$b/$a.$b.$ynow.nc
}

set d 0
foreach b $levs {
if { [file exists $idir/$b/$a.$b.$ynow.nc ] == 0 } {
incr d
}
}
unset c
if {$d > 0} {
puts "$a $ynow"
split_r-2 $a $ynow $ynow
}

} elseif { $a == "omega" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 0250 0200 0150 0100}
foreach b $levs {
lappend c $idir/$b/$a.$b.$ynow.nc
}

set d 0
foreach b $levs {
if { [file exists $idir/$b/$a.$b.$ynow.nc ] == 0 } {
```

```
incr d
}
}
unset c
if {$d > 0} {
puts "$a $ynow"
split_r-2 $a $ynow $ynow
}

} else {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 \
0250 0200 0150 0100 0070 0050 0030 0020 0010}
foreach b $levs { lappend c
$idir/$b/$a.$b.$ynow.nc }

set d 0
foreach b $levs {
if { [file exists $idir/$b/$a.$b.$ynow.nc ] == 0 } {
incr d
}
}
unset c
if {$d > 0} {
puts "$a $ynow"
split_r-2 $a $ynow $ynow
}

}

#a
}

#ynow
}

return
exit
```

8.7 long_term_r-1

```
########BEGIN - LONG_TERM_R-1.TCL################################################
proc long_term_r-1 {ivar_tmp iper ybeg yend odir} {
#CSIRO Australia
#Mark Collier January 2004

#generate long term monthly (iper=12) or seasonal (iper=4) climatological averages
#note that first 2 months and last month of raw data is left out
#as it does not strictly contribute to the climatological definition.

source ~csmac/.tclshrc
source ~/tcl_fun/getti.tcl
source ~/tcl_fun/get_r-1_dir.tcl

if {[info exists ::env(TMPDIR)]} {
set tdir $TMPDIR
} else {
puts "Must set TMPDIR."
return
}

if { [file isdirectory $odir] == 0 || [file isdirectory $tdir] == 0 } {
puts "Output directory doesn't exist"
return
}

set ivar [string range $ivar_tmp 0 [expr [string first . $ivar_tmp]-1]]
if { $ivar == "" } {
set ivar $ivar_tmp
}

set ivar_str $ivar
set idir /cs/u/csdar/csncp/[get_ncep_dir $ivar_tmp]

set iperm1 [expr $iper-1]

set ifils 0;set iret 0
unset ifils
for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {
set ifil $ivar_tmp.$ynow.nc
if { [file exists $idir/$ifil] == 0 } {
incr iret
puts "Input file $idir/$ifil doesn't exist"
}
lappend ifils $idir/$ifil
}
if {$iret != 0} {
return
}

if { $iper == 4 } {
set ofil "$ivar_tmp.ls.$ybeg-$yend.nc"
} elseif {$iper == 12 } {
```

```
set ofil "$ivar_tmp.lm.$ybeg-$yend.nc"
} else {
puts "dont know that period."
exit
}

puts "output file=$odir/$ofil"

catch {exec /cs/u/csdar/csmac/portal/bin/dmget_farrer "$ifils"}

for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {

set ifil $ivar_tmp.$ynow.nc

puts "input file=$idir/$ifil"

set shape [nap_get netcdf -shape $idir/$ifil $ivar_str]
set dimen [nap_get netcdf -dimension $idir/$ifil $ivar_str]
set rank [nap_get netcdf -rank $idir/$ifil $ivar_str]

if { [lindex $shape 0] != 1460 && [lindex $shape 0] != 1464 } {
puts "Problem with number of times in $idir/$ifil at year $ynow."
return
}

if { $ynow == $ybeg} {

nap "sf = [nap_get netcdf $idir/$ifil $ivar_str:scale_factor]"
nap "offset = [nap_get netcdf $idir/$ifil $ivar_str:add_offset]"

nap "lat = [nap_get netcdf $idir/$ifil lat]"
nap "lon = [nap_get netcdf $idir/$ifil lon]"

nap "yone = $lat@@[lindex $lats 0]"
nap "ynnn = $lat@@[lindex $lats 1]"
nap "xone = $lon@@[lindex $lons 0]"
nap "xnnn = $lon@@[lindex $lons 1]"

nap "lat_ind = $yone..$ynnn"
nap "lon_ind = $xone..$xnnn"

if { $iper == 4 } {
if { $rank == 3 } {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str "0..$iperm1,$lat_ind,$lon_ind"]"
} else {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str "0..$iperm1,,$lat_ind,$lon_ind"]"
}
} elseif {$iper == 12 } {
if { $rank == 3 } {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str "0..$iperm1,$lat_ind,$lon_ind"]"
} else {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str "0..$iperm1,,$lat_ind,$lon_ind"]"
}
```

```
}

nap "ivar = f64(isMissing(ivar)*0)"
nap "c1 = i32(isMissing(ivar)*0)"

nap "out = i16(ivar)"

file delete $tdir/$ofil
$out netcdf -unlimited $tdir/$ofil $ivar_str

set vatts {long_name units add_offset scale_factor missing_value var_desc \
dataset level_desc statistic parent_stat}

foreach a $vatts {
catch {[nap_get netcdf $idir/$ifil $ivar_str:$a] netcdf \
$tdir/$ofil $ivar_str:$a}
#a
}

set tatts {units long_name}

foreach d $dimen {
foreach a $tatts {
catch {[nap_get netcdf $idir/$ifil $d:$a] netcdf \
$tdir/$ofil $d:$a}
#a
}
#d
}

nap "history = ‘created by Mark Collier CSIRO [date_time_now]‘"
$history netcdf ${tdir}/${ofil} $ivar_str:history

#ybeg
}

set leap [[nap $ynow%4]]

if { $leap == 0 } {
set ndays {31 29 31 30 31 30 31 31 30 31 30 31}
} else {
set ndays {31 28 31 30 31 30 31 31 30 31 30 31}
}

set ntbeg 1
for {set mnow 1} {$mnow <= 12} {incr mnow} {
set mnowm1 [expr $mnow-1]

set inow [getti $mnowm1 $iper]

set ntend [expr $ntbeg+[lindex $ndays $mnowm1]*4-1]

set ntbegm1 [expr $ntbeg-1]
```

```
set ntendm1 [expr $ntend-1]

set skip 0

if { $iper == 4 } {

if { $ynow == $ybeg && $mnow <= 2 } {
incr skip
}

if { $ynow == $yend && $mnow == 12 } {
incr skip
}

#iper
}

if { $skip == 0 } {

if { $rank == 3 } {
nap "v1 = [$offset] + [$sf]*[nap_get netcdf $idir/$ifil $ivar_str \
"$ntbegm1..$ntendm1,$lat_ind,$lon_ind" 1]"
} else {
nap "v1 = [$offset] + [$sf]*[nap_get netcdf $idir/$ifil $ivar_str \
"$ntbegm1..$ntendm1,,$lat_ind,$lon_ind" 1]"
}

nap "v2 = am(v1)"

nap "v3 = (ivar*0)"

if { $rank == 3 } {
$v3 set value v2 "$inow,,"
} else {
$v3 set value v2 "$inow,,,"
}

nap "ivar = ivar + v3*[lindex $ndays $mnowm1]"

nap "c2 = i32(isPresent(v3/v3)*[lindex $ndays $mnowm1])"

nap "c1 = c1 + c2"

#skip
}

set ntbeg [expr $ntend+1]

#mnow
}

#ynow
}
```

```
nap "ivar = ivar / c1"

if { $iper == 4 } {
nap "days = {15.5 104.5 196.5 288.0}"
} elseif { $iper == 12 } {
nap "days = {15.5 45.0 74.0 104.5 135.0 165.5 196.5 227.0 257.5 288.0 318.5 349.5}"
}

nap "ts3 = (days-1)*24.0"

$ivar netcdf -unlimited $tdir/$ofil $ivar_str
$ts3 netcdf -unlimited $tdir/$ofil time

exec /bin/mv $tdir/$ofil $odir/$ofil

return
}
########END - LONG_TERM_R-1.TCL#####################################################
```

8.8 long_term_r-2

```
########BEGIN - LONG_TERM_R-2.TCL################################################
proc long_term_r-2 {ivar_tmp iper ybeg yend odir} {
#CSIRO Australia
#Mark Collier February 2004

#generate long term monthly (iper=12) or seasonal (iper=4) climatological averages
#note that first 2 months and last month of raw data is left out
#as it does not strictly contribute to the climatological definition.

source ~csmac/.tclshrc
source ~csmac/tcl_fun/getti.tcl
source ~csmac/tcl_fun/get_r-2_dir.tcl

if {[info exists ::env(TMPDIR)]} {
set tdir $TMPDIR
} else {
puts "Must set TMPDIR."
return
}

if { [file isdirectory $odir] == 0 } {
puts "Output directory doesn't exist"
return
}

set ivar [string range $ivar_tmp 0 [expr [string first . $ivar_tmp]-1]]
if { $ivar == "" } {
set ivar $ivar_tmp
}

set ivar_str $ivar
set idir /cs/u/csdar/csncp/reanalysis2/[get_ncep2_dir $ivar_tmp]

set iperm1 [expr $iper-1]

set ifils 0;set iret 0
unset ifils
for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {
set ifil $ivar_tmp.$ynow.nc
if { [file exists $idir/$ifil] == 0 } {
incr iret
puts "Input file $idir/$ifil doesn't exist"
}
lappend ifils $idir/$ifil
}
if {$iret != 0} {
return
}

if { $iper == 4 } {
set ofil "$ivar_tmp.ls.$ybeg-$yend.nc"
} elseif {$iper == 12 } {
```

```
set ofil "$ivar_tmp.lm.$ybeg-$yend.nc"
} else {
puts "dont know that period."
exit
}

puts "output file=$odir/$ofil"

catch {exec /cs/u/csdar/csmac/portal/bin/dmget_farrer "$ifils"}

for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {

set ifil $ivar_tmp.$ynow.nc

puts "input file=$idir/$ifil"

set shape [nap_get netcdf -shape $idir/$ifil $ivar_str]
set dimen [nap_get netcdf -dimension $idir/$ifil $ivar_str]
set rank [nap_get netcdf -rank $idir/$ifil $ivar_str]

if { [lindex $shape 0] != 1460 && [lindex $shape 0] != 1464 } {
puts "Problem with number of times in $idir/$ifil at year $ynow."
return
}

if { $ynow == $ybeg} {

nap "sf = [nap_get netcdf $idir/$ifil $ivar_str:scale_factor]"
nap "offset = [nap_get netcdf $idir/$ifil $ivar_str:add_offset]"

nap "lat = [nap_get netcdf $idir/$ifil lat]"
nap "lon = [nap_get netcdf $idir/$ifil lon]"

nap "yone = $lat@@[lindex $lats 0]"
nap "ynnn = $lat@@[lindex $lats 1]"
nap "xone = $lon@@[lindex $lons 0]"
nap "xnnn = $lon@@[lindex $lons 1]"

nap "lat_ind = $yone..$ynnn"
nap "lon_ind = $xone..$xnnn"

if { $iper == 4 } {
if { $rank == 3 } {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str "0..$iperm1,$lat_ind,$lon_ind"]"
} else {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str "0..$iperm1,,$lat_ind,$lon_ind"]"
}
} elseif {$iper == 12 } {
if { $rank == 3 } {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str "0..$iperm1,$lat_ind,$lon_ind"]"
} else {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str "0..$iperm1,,$lat_ind,$lon_ind"]"
}
```

```
}

nap "ivar = f64(isMissing(ivar)*0)"
nap "c1 = i32(isMissing(ivar)*0)"

nap "out = i16(ivar)"

file delete $tdir/$ofil
$out netcdf -unlimited $tdir/$ofil $ivar_str

set vatts {long_name units add_offset scale_factor missing_value var_desc \
dataset level_desc statistic parent_stat}

foreach a $vatts {
catch {[nap_get netcdf $idir/$ifil $ivar_str:$a] netcdf \
$tdir/$ofil $ivar_str:$a}
#a
}

set tatts {units long_name}

foreach d $dimen {
foreach a $tatts {
catch {[nap_get netcdf $idir/$ifil $d:$a] netcdf \
$tdir/$ofil $d:$a}
#a
}
#d
}

nap "history = ‘created by Mark Collier CSIRO [date_time_now]‘"
$history netcdf ${tdir}/${ofil} $ivar_str:history

#ybeg
}

set leap [[nap $ynow%4]]

if { $leap == 0 } {
set ndays {31 29 31 30 31 30 31 31 30 31 30 31}
} else {
set ndays {31 28 31 30 31 30 31 31 30 31 30 31}
}

set ntbeg 1
for {set mnow 1} {$mnow <= 12} {incr mnow} {
set mnowm1 [expr $mnow-1]

set inow [getti $mnowm1 $iper]

set ntend [expr $ntbeg+[lindex $ndays $mnowm1]*4-1]

set ntbegm1 [expr $ntbeg-1]
```

```
set ntendm1 [expr $ntend-1]

set skip 0

if { $iper == 4 } {

if { $ynow == $ybeg && $mnow <= 2 } {
incr skip
}

if { $ynow == $yend && $mnow == 12 } {
incr skip
}

#iper
}

if { $skip == 0 } {

if { $rank == 3 } {
nap "v1 = [$offset] + [$sf]*[nap_get netcdf $idir/$ifil $ivar_str \
"$ntbegm1..$ntendm1,$lat_ind,$lon_ind" 1]"
} else {
nap "v1 = [$offset] + [$sf]*[nap_get netcdf $idir/$ifil $ivar_str \
"$ntbegm1..$ntendm1,,$lat_ind,$lon_ind" 1]"
}

nap "v2 = am(v1)"

nap "v3 = (ivar*0)"

if { $rank == 3 } {
$v3 set value v2 "$inow,,"
} else {
$v3 set value v2 "$inow,,,"
}

nap "ivar = ivar + v3*[lindex $ndays $mnowm1]"

nap "c2 = i32(isPresent(v3/v3)*[lindex $ndays $mnowm1])"

nap "c1 = c1 + c2"

#skip
}

set ntbeg [expr $ntend+1]

#mnow
}

#ynow
}
```

```
nap "ivar = ivar / c1"

if { $iper == 4 } {
nap "days = {15.5 104.5 196.5 288.0}"
} elseif { $iper == 12 } {
nap "days = {15.5 45.0 74.0 104.5 135.0 165.5 196.5 227.0 257.5 288.0 318.5 349.5}"
}

nap "ts3 = (days-1)*24.0"

$ivar netcdf -unlimited $tdir/$ofil $ivar_str
$ts3 netcdf -unlimited $tdir/$ofil time

exec /bin/mv $tdir/$ofil $odir/$ofil

return
}
########END - LONG_TERM_R-2.TCL#####################################################
```

8.9 year_by_year_r-1

```
########BEGIN - YEAR_BY_YEAR_R-1.TCL##############################################
proc year_by_year_r-1 {ivar_tmp iper ybeg yend odir} {
#CSIRO Australia
#Mark Collier January 2004

#generate year-by-year monthly (iper=12) or seasonal (iper=4) climatological averages

source ~csmac/.tclshrc
source ~/tcl_fun/getti.tcl
source ~/tcl_fun/get_ncep_dir.tcl

if {[info exists ::env(TMPDIR)]} {
set tdir $TMPDIR
} else {
puts "Must set TMPDIR."
return
}

if { [file isdirectory $odir] == 0 } {
puts "Output directory doesn't exist"
return
}

set ivar [string range $ivar_tmp 0 [expr [string first . $ivar_tmp]-1]]

if { $ivar == "" } {
set ivar $ivar_tmp
}

set ivar_str $ivar
set idir /cs/u/csdar/csncp/[get_ncep_dir $ivar_tmp]

set iperm1 [expr $iper-1]
set iperm2 [expr $iper-2]

set ifils 0;set iret 0
unset ifils
for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {
set ifil $ivar_tmp.$ynow.nc
if { [file exists $idir/$ifil] == 0 } {
incr iret
puts "Input file $idir/$ifil doesn't exist"
}
lappend ifils $idir/$ifil
}
if {$iret != 0} {
return
}

if { $iper == 4 } {

set ofil "$ivar_tmp.ys.$ybeg-$yend.nc"
```

```
} elseif {$iper == 12 } {


set ofil "$ivar_tmp.ym.$ybeg-$yend.nc"

} else {
puts "dont know that iper."
exit
}

puts "output file=$odir/$ofil"

catch {exec /cs/u/csdar/csmac/portal/bin/dmget_farrer "$ifils"}

set ibeg 0

set inow_dmp 0

for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {

nap "ts3 = f64{$iper#0}"
nap "tc2 = f64{$iper#0}"

set ifil $ivar_tmp.$ynow.nc

puts "input file=$idir/$ifil"

set shape [nap_get netcdf -shape $idir/$ifil $ivar_str]
set dimen [nap_get netcdf -dimension $idir/$ifil $ivar_str]
set rank [nap_get netcdf -rank $idir/$ifil $ivar_str]

if { [lindex $shape 0] != 1460 && [lindex $shape 0] != 1464 } {
puts "Problem with number of times in $idir/$ifil at year $ynow."
return
}

set iend [expr $ibeg+$iperm1]

if { $ynow == $ybeg} {

nap "sf = [nap_get netcdf $idir/$ifil $ivar_str:scale_factor]"
nap "offset = [nap_get netcdf $idir/$ifil $ivar_str:add_offset]"

nap "lat = [nap_get netcdf $idir/$ifil lat]"
nap "lon = [nap_get netcdf $idir/$ifil lon]"

nap "yone = $lat@@[lindex $lats 0]"
nap "ynnn = $lat@@[lindex $lats 1]"
nap "xone = $lon@@[lindex $lons 0]"
nap "xnnn = $lon@@[lindex $lons 1]"

nap "lat_ind = $yone..$ynnn"
```

```
nap "lon_ind = $xone..$xnnn"

if { $rank == 3 } {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str \
"$ibeg..$iend,$lat_ind,$lon_ind"]"
} else {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str \
"$ibeg..$iend,,$lat_ind,$lon_ind"]"
}

nap "ivar = f64(isMissing(ivar)*0)"
nap "c1 = i32(isMissing(ivar)*0)"

nap "out = i16(ivar)"

file delete $tdir/$ofil
$out netcdf -unlimited $tdir/$ofil $ivar_str

set vatts {long_name units add_offset scale_factor \
missing_value var_desc \
dataset level_desc statistic parent_stat}

foreach a $vatts {
catch {[nap_get netcdf $idir/$ifil $ivar_str:$a] netcdf \
$tdir/$ofil $ivar_str:$a}
#a
}

set tatts {units long_name}

foreach d $dimen {
foreach a $tatts {
catch {[nap_get netcdf $idir/$ifil $d:$a] netcdf \
$tdir/$ofil $d:$a}
#a
}
#d
}

nap "history = ‘created by Mark Collier CSIRO [date_time_now]‘"
$history netcdf ${tdir}/${ofil} $ivar_str:history

#ybeg1
} else {

if { $rank == 3 } {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str \
"$ibeg..$iend,$lat_ind,$lon_ind"]"
} else {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str \
"$ibeg..$iend,,$lat_ind,$lon_ind"]"
}
```

```
nap "ivar = f64(isMissing(ivar)*0)"
nap "c1 = i32(isMissing(ivar)*0)"

nap "out = i16(ivar)"

$out netcdf -unlimited -index "$ibeg..$iend" $tdir/$ofil $ivar_str

#ybeg2
}

set leap [[nap $ynow%4]]

if { $leap == 0 } {
set ndays {31 29 31 30 31 30 31 31 30 31 30 31}
} else {
set ndays {31 28 31 30 31 30 31 31 30 31 30 31}
}

set ntbeg 1
for {set mnow 1} {$mnow <= 12} {incr mnow} {
set mnowm1 [expr $mnow-1]

set inow [getti $mnowm1 $iper]

if { $inow == 3 && $iper == 4 } {
incr inow_dmp
} elseif {$inow == 11 && $iper == 12} {
incr inow_dmp
}

set ntend [expr $ntbeg+[lindex $ndays $mnowm1]*4-1]

set ntbegm1 [expr $ntbeg-1] set ntendm1 [expr $ntend-1]

nap "ts0 = [nap_get netcdf $idir/$ifil time \
"$ntbegm1..$ntendm1"]"

nap "ts1 = am(ts0)"

nap "ts2 = f64{$iper#0}"

$ts2 set value ts1 "$inow"

nap "ts3 = ts3 + ts2*[lindex $ndays $mnowm1]"

nap "tc1 = i32(isPresent(ts2/ts2)*[lindex $ndays $mnowm1])"

nap "tc2 = tc2 + tc1"


if { $rank == 3 } {
nap "v1 = [$offset] + [$sf]*[nap_get netcdf $idir/$ifil $ivar_str \
"$ntbegm1..$ntendm1,$lat_ind,$lon_ind" 1]"
```

```
} else {
nap "v1 = [$offset] + [$sf]*[nap_get netcdf $idir/$ifil $ivar_str \
"$ntbegm1..$ntendm1,,$lat_ind,$lon_ind" 1]"
}

nap "v2 = am(v1)"

nap "v3 = (ivar*0)"

if { $rank == 3 } {
$v3 set value v2 "$inow,,"
} else {
$v3 set value v2 "$inow,,,"
}

nap "ivar = ivar + v3*[lindex $ndays $mnowm1]"

nap "c2 = i32(isPresent(v3/v3)*[lindex $ndays $mnowm1])"

nap "c1 = c1 + c2"

if { $iper == 4 && $inow_dmp == 3 || $iper == 12 && $inow_dmp == 1 } {
nap "ivar = ivar / c1"
nap "ts3 = ts3 / tc2"

if { $rank == 3 } {
$ivar netcdf -unlimited -index "$ibeg..$iend,," $tdir/$ofil $ivar_str
} else {
$ivar netcdf -unlimited -index "$ibeg..$iend,,," $tdir/$ofil $ivar_str
}

$ts3 netcdf -unlimited -index "$ibeg..$iend" $tdir/$ofil time
nap "ts3 = f64{$iper#0}"
nap "tc2 = f64{$iper#0}"
set inow_dmp 0
}

set ntbeg [expr $ntend+1]

#mnow }

set ibeg [expr $ibeg+$iper]
#ynow
}

exec /bin/mv $tdir/$ofil $odir/$ofil

return
}
########END - YEAR_BY_YEAR_R-1.TCL################################################
```

8.10 year_by_year_r-2

```
########BEGIN - YEAR_BY_YEAR_R-2.TCL################################################
proc year_by_year_r-2 {ivar_tmp iper ybeg yend odir} {
#CSIRO Australia
#Mark Collier February 2004

#generate year-by-year monthly (iper=12) or seasonal (iper=4) climatological averages

source ~csmac/.tclshrc
source ~/tcl_fun/getti.tcl
source ~/tcl_fun/get_r-2_dir.tcl

if {[info exists ::env(TMPDIR)]} {
set tdir $TMPDIR
} else {
puts "Must set TMPDIR."
return
}

if { [file isdirectory $odir] == 0 } {
puts "Output directory doesn't exist"
return
}

set ivar [string range $ivar_tmp 0 [expr [string first . $ivar_tmp]-1]]

if { $ivar == "" } {
set ivar $ivar_tmp
}

set ivar_str $ivar
set idir /cs/u/csdar/csncp/reanalysis2/[get_ncep2_dir $ivar_tmp]

set iperm1 [expr $iper-1]
set iperm2 [expr $iper-2]

set ifils 0;set iret 0
unset ifils
for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {
set ifil $ivar_tmp.$ynow.nc
if { [file exists $idir/$ifil] == 0 } {
incr iret
puts "Input file $idir/$ifil doesn't exist"
}
lappend ifils $idir/$ifil
}
if {$iret != 0} {
return
}

if { $iper == 4 } {

set ofil "$ivar_tmp.ys.$ybeg-$yend.nc"
```

```
} elseif {$iper == 12 } {


set ofil "$ivar_tmp.ym.$ybeg-$yend.nc"

} else {
puts "dont know that iper."
exit
}

puts "output file=$odir/$ofil"

catch {exec /cs/u/csdar/csmac/portal/bin/dmget_farrer "$ifils"}

set ibeg 0

set inow_dmp 0

for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {

nap "ts3 = f64{$iper#0}"
nap "tc2 = f64{$iper#0}"

set ifil $ivar_tmp.$ynow.nc

puts "input file=$idir/$ifil"

set shape [nap_get netcdf -shape $idir/$ifil $ivar_str]
set dimen [nap_get netcdf -dimension $idir/$ifil $ivar_str]
set rank [nap_get netcdf -rank $idir/$ifil $ivar_str]

if { [lindex $shape 0] != 1460 && [lindex $shape 0] != 1464 } {
puts "Problem with number of times in $idir/$ifil at year $ynow."
return
}

set iend [expr $ibeg+$iperm1]

if { $ynow == $ybeg} {

nap "sf = [nap_get netcdf $idir/$ifil $ivar_str:scale_factor]"
nap "offset = [nap_get netcdf $idir/$ifil $ivar_str:add_offset]"

nap "lat = [nap_get netcdf $idir/$ifil lat]"
nap "lon = [nap_get netcdf $idir/$ifil lon]"

nap "yone = $lat@@[lindex $lats 0]"
nap "ynnn = $lat@@[lindex $lats 1]"
nap "xone = $lon@@[lindex $lons 0]"
nap "xnnn = $lon@@[lindex $lons 1]"

nap "lat_ind = $yone..$ynnn"
```

```
nap "lon_ind = $xone..$xnnn"

if { $rank == 3 } {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str \
"$ibeg..$iend,$lat_ind,$lon_ind"]"
} else {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str \
"$ibeg..$iend,,$lat_ind,$lon_ind"]"
}

nap "ivar = f64(isMissing(ivar)*0)"
nap "c1 = i32(isMissing(ivar)*0)"

nap "out = i16(ivar)"

file delete $tdir/$ofil
$out netcdf -unlimited $tdir/$ofil $ivar_str

set vatts {long_name units add_offset scale_factor \
missing_value var_desc \
dataset level_desc statistic parent_stat}

foreach a $vatts {
catch {[nap_get netcdf $idir/$ifil $ivar_str:$a] netcdf \
$tdir/$ofil $ivar_str:$a}
#a
}

set tatts {units long_name}

foreach d $dimen {
foreach a $tatts {
catch {[nap_get netcdf $idir/$ifil $d:$a] netcdf \
$tdir/$ofil $d:$a}
#a
}
#d
}

nap "history = ‘created by Mark Collier CSIRO [date_time_now]‘"
$history netcdf ${tdir}/${ofil} $ivar_str:history

#ybeg1
} else {

if { $rank == 3 } {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str \
"$ibeg..$iend,$lat_ind,$lon_ind"]"
} else {
nap "ivar = [nap_get netcdf $idir/$ifil $ivar_str \
"$ibeg..$iend,,$lat_ind,$lon_ind"]"
}
```

```
nap "ivar = f64(isMissing(ivar)*0)"
nap "c1 = i32(isMissing(ivar)*0)"

nap "out = i16(ivar)"

$out netcdf -unlimited -index "$ibeg..$iend" $tdir/$ofil $ivar_str

#ybeg2
}

set leap [[nap $ynow%4]]

if { $leap == 0 } {
set ndays {31 29 31 30 31 30 31 31 30 31 30 31}
} else {
set ndays {31 28 31 30 31 30 31 31 30 31 30 31}
}

set ntbeg 1
for {set mnow 1} {$mnow <= 12} {incr mnow} {
set mnowm1 [expr $mnow-1]

set inow [getti $mnowm1 $iper]

if { $inow == 3 && $iper == 4 } {
incr inow_dmp
} elseif {$inow == 11 && $iper == 12} {
incr inow_dmp
}

set ntend [expr $ntbeg+[lindex $ndays $mnowm1]*4-1]

set ntbegm1 [expr $ntbeg-1]
set ntendm1 [expr $ntend-1]

nap "ts0 = [nap_get netcdf $idir/$ifil time \
"$ntbegm1..$ntendm1"]"

nap "ts1 = am(ts0)"

nap "ts2 = f64{$iper#0}"

$ts2 set value ts1 "$inow"

nap "ts3 = ts3 + ts2*[lindex $ndays $mnowm1]"

nap "tc1 = i32(isPresent(ts2/ts2)*[lindex $ndays $mnowm1])"

nap "tc2 = tc2 + tc1"


if { $rank == 3 } {
nap "v1 = [$offset] + [$sf]*[nap_get netcdf $idir/$ifil $ivar_str \
```

```
"$ntbegm1..$ntendm1,$lat_ind,$lon_ind" 1]"
} else {
nap "v1 = [$offset] + [$sf]*[nap_get netcdf $idir/$ifil $ivar_str \
"$ntbegm1..$ntendm1,,$lat_ind,$lon_ind" 1]"
}

nap "v2 = am(v1)"

nap "v3 = (ivar*0)"

if { $rank == 3 } {
$v3 set value v2 "$inow,,"
} else {
$v3 set value v2 "$inow,,,"
}

nap "ivar = ivar + v3*[lindex $ndays $mnowm1]"

nap "c2 = i32(isPresent(v3/v3)*[lindex $ndays $mnowm1])"

nap "c1 = c1 + c2"

if { $iper == 4 && $inow_dmp == 3 || $iper == 12 && $inow_dmp == 1 } {
nap "ivar = ivar / c1"
nap "ts3 = ts3 / tc2"

if { $rank == 3 } {
$ivar netcdf -unlimited -index "$ibeg..$iend,," $tdir/$ofil $ivar_str
} else {
$ivar netcdf -unlimited -index "$ibeg..$iend,,," $tdir/$ofil $ivar_str
}

$ts3 netcdf -unlimited -index "$ibeg..$iend" $tdir/$ofil time
nap "ts3 = f64{$iper#0}"
nap "tc2 = f64{$iper#0}"
set inow_dmp 0
}

set ntbeg [expr $ntend+1]

#mnow
}

#puts [$ivar shape]

set ibeg [expr $ibeg+$iper]
#ynow
}

exec /bin/mv $tdir/$ofil $odir/$ofil

return
}
```

```
########END - YEAR_BY_YEAR_R-2.TCL##############################################
```

8.11 calc_clim_r-1

```
#!/cs/u/csdar/cshld/portal/tcl/bin/tclsh
#CSIRO Australia
#Mark Collier January 2004

#calculate long_term and year_by_year NCEP r-1 monthly/seasonal climatologies

source ~csncp/.tclshrc
source ~csmac/tcl_fun/long_term_r-1.tcl
source ~csmac/tcl_fun/year_by_year_r-1.tcl

set ybeg 1948;set yend 2003

foreach period {12 4} {

if {$period == 4} {
set per_str "s"
} elseif {$period == 12} {
set per_str "m"
} else {
puts "period must be 4 or 12."
return
}

foreach f {csulf.ntat.gauss csusf.ntat.gauss dswrf.ntat.gauss pres.hcb.gauss \
pres.hct.gauss pres.lcb.gauss pres.lct.gauss pres.mcb.gauss pres.mct.gauss \
tcdc.eatm.gauss ulwrf.ntat.gauss uswrf.ntat.gauss} {
set odir /cs/u/csdar/csncp/c/$ybeg-$yend/l/$per_str
if { [file exists $odir/$f.l$per_str.$ybeg-$yend.nc] == 0 } {
long_term_ncep $f $period $ybeg $yend $odir
}
set odir /cs/u/csdar/csncp/c/$ybeg-$yend/y/$per_str
if { [file exists $odir/$f.y$per_str.$ybeg-$yend.nc] == 0 } {
year_by_year_ncep $f $period $ybeg $yend $odir
}
}

foreach f {lftx.sfc lftx4.sfc pr_wtr.eatm pres.sfc slp} {
set odir /cs/u/csdar/csncp/c/$ybeg-$yend/l/$per_str
if { [file exists $odir/$f.l$per_str.$ybeg-$yend.nc] == 0 } {
long_term_ncep $f $period $ybeg $yend $odir
}
set odir /cs/u/csdar/csncp/c/$ybeg-$yend/y/$per_str
if { [file exists $odir/$f.y$per_str.$ybeg-$yend.nc] == 0 } {
year_by_year_ncep $f $period $ybeg $yend $odir
}
}

foreach f {air.2m.gauss cfnlf.sfc.gauss cfnsf.sfc.gauss cprat.sfc.gauss \
csdlf.sfc.gauss csdsf.sfc.gauss csusf.sfc.gauss dlwrf.sfc.gauss \
dswrf.sfc.gauss gflux.sfc.gauss icec.sfc.gauss lhtfl.sfc.gauss \
nbdsf.sfc.gauss nddsf.sfc.gauss nlwrs.sfc.gauss nswrs.sfc.gauss \
pevpr.sfc.gauss prate.sfc.gauss pres.sfc.gauss runof.sfc.gauss \
```

```
sfcr.sfc.gauss shtfl.sfc.gauss shum.2m.gauss skt.sfc.gauss \
soilw.0-10cm.gauss soilw.10-200cm.gauss tmax.2m.gauss tmin.2m.gauss \
tmp.0-10cm.gauss tmp.10-200cm.gauss tmp.300cm.gauss uflx.sfc.gauss \
ugwd.sfc.gauss ulwrf.sfc.gauss uswrf.sfc.gauss uwnd.10m.gauss \
vbdsf.sfc.gauss vddsf.sfc.gauss vflx.sfc.gauss vgwd.sfc.gauss \
vwnd.10m.gauss weasd.sfc.gauss} {
set odir /cs/u/csdar/csncp/c/$ybeg-$yend/l/$per_str
if { [file exists $odir/$f.l$per_str.$ybeg-$yend.nc] == 0 } {
long_term_ncep $f $period $ybeg $yend $odir
}
set odir /cs/u/csdar/csncp/c/$ybeg-$yend/y/$per_str
if { [file exists $odir/$f.y$per_str.$ybeg-$yend.nc] == 0 } {
year_by_year_ncep $f $period $ybeg $yend $odir
}
}

foreach f {air.tropp pres.tropp} {
set odir /cs/u/csdar/csncp/c/$ybeg-$yend/l/$per_str
if { [file exists $odir/$f.l$per_str.$ybeg-$yend.nc] == 0 } {
long_term_ncep $f $period $ybeg $yend $odir
}
set odir /cs/u/csdar/csncp/c/$ybeg-$yend/y/$per_str
if { [file exists $odir/$f.y$per_str.$ybeg-$yend.nc] == 0 } {
year_by_year_ncep $f $period $ybeg $yend $odir
}
}

set var {rhum shum omega uwnd vwnd air hgt}

foreach a $var {

if { $a == "rhum" || $a == "shum" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300}
foreach b $levs {
lappend c $a.$b
}

} elseif { $a == "omega" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 0250 0200 0150 0100}
foreach b $levs {
lappend c $a.$b
}

} else {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 \
0250 0200 0150 0100 0070 0050 0030 0020 0010}
foreach b $levs {
lappend c $a.$b
}
```

```
}

}

foreach f $c {
set odir /cs/u/csdar/csncp/c/$ybeg-$yend/l/$per_str
if { [file exists $odir/$f.l$per_str.$ybeg-$yend.nc] == 0 } {
long_term_ncep $f $period $ybeg $yend $odir
}
set odir /cs/u/csdar/csncp/c/$ybeg-$yend/y/$per_str
if { [file exists $odir/$f.y$per_str.$ybeg-$yend.nc] == 0 } {
year_by_year_ncep $f $period $ybeg $yend $odir
}
}

}

return
exit
```

8.12 calc_clim_r-2

```
#!/cs/u/csdar/cshld/portal/tcl/bin/tclsh
#CSIRO Australia
#Mark Collier January 2004

#calculate long_term and year_by_year NCEP r-2 monthly/seasonal climatologies

source ~csncp/.tclshrc
source ~csmac/tcl_fun/long_term_r-2.tcl
source ~csmac/tcl_fun/year_by_year_r-2.tcl

set ybeg 1979;set yend 2002

foreach period {12 4} {

if {$period == 4} {
set per_str "s"
} elseif {$period == 12} {
set per_str "m"
} else {
puts "period must be 4 or 12."
return
}

foreach f {pr_wtr.eatm pres.sfc mslp} {
set odir /cs/u/csdar/csncp/reanalysis2/c/$ybeg-$yend/l/$per_str
if { [file exists $odir/$f.l$per_str.$ybeg-$yend.nc] == 0 } {
long_term_ncep2 $f $period $ybeg $yend $odir
}
set odir /cs/u/csdar/csncp/reanalysis2/c/$ybeg-$yend/y/$per_str
if { [file exists $odir/$f.y$per_str.$ybeg-$yend.nc] == 0 } {
year_by_year_ncep2 $f $period $ybeg $yend $odir
}
}

foreach f {air.2m.gauss cfnlf.sfc.gauss cfnsf.sfc.gauss cprat.sfc.gauss \
csdlf.sfc.gauss csdsf.sfc.gauss csusf.sfc.gauss dlwrf.sfc.gauss \
dswrf.ntat.gauss dswrf.sfc.gauss gflux.sfc.gauss icec.sfc.gauss \
lhtfl.sfc.gauss pevpr.sfc.gauss prate.sfc.gauss pres.hcb.gauss \
pres.hct.gauss pres.lcb.gauss pres.lct.gauss pres.mcb.gauss \
pres.mct.gauss pres.sfc.gauss runof.sfc.gauss shtfl.sfc.gauss \
shum.2m.gauss skt.sfc.gauss soilw.0-10cm.gauss soilw.10-200cm.gauss \
tcdc.eatm.gauss tmax.2m.gauss tmin.2m.gauss tmp.0-10cm.gauss \
tmp.10-200cm.gauss uflx.sfc.gauss ugwd.sfc.gauss ulwrf.ntat.gauss \
ulwrf.sfc.gauss uswrf.ntat.gauss uswrf.sfc.gauss uwnd.10m.gauss \
vflx.sfc.gauss vgwd.sfc.gauss vwnd.10m.gauss weasd.sfc.gauss} {
set odir /cs/u/csdar/csncp/reanalysis2/c/$ybeg-$yend/l/$per_str
if { [file exists $odir/$f.l$per_str.$ybeg-$yend.nc] == 0 } {
long_term_ncep2 $f $period $ybeg $yend $odir
}
set odir /cs/u/csdar/csncp/reanalysis2/c/$ybeg-$yend/y/$per_str
if { [file exists $odir/$f.y$per_str.$ybeg-$yend.nc] == 0 } {
year_by_year_ncep2 $f $period $ybeg $yend $odir
```

```
}
}

set var {rhum omega uwnd vwnd air hgt}

foreach a $var {

if { $a == "rhum" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300}
foreach b $levs {
lappend c $a.$b
}

} elseif { $a == "omega" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 0250 0200 0150 0100}
foreach b $levs {
lappend c $a.$b
}

} else {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 \
0250 0200 0150 0100 0070 0050 0030 0020 0010}
foreach b $levs {
lappend c $a.$b
}

}

}

foreach f $c {
set odir /cs/u/csdar/csncp/reanalysis2/c/$ybeg-$yend/l/$per_str
if { [file exists $odir/$f.l$per_str.$ybeg-$yend.nc] == 0 } {
long_term_ncep2 $f $period $ybeg $yend $odir
}
set odir /cs/u/csdar/csncp/reanalysis2/c/$ybeg-$yend/y/$per_str
if { [file exists $odir/$f.y$per_str.$ybeg-$yend.nc] == 0 } {
year_by_year_ncep2 $f $period $ybeg $yend $odir
}
}

}

return
exit
```

8.13 calc_anom_r-1

```
#!/cs/u/csdar/cshld/portal/tcl/bin/tclsh
#CSIRO Australia
#Mark Collier January 2004

#calculate year_by_year NCEP r-1 monthly/seasonal anomalies

source ~csmac/.tclshrc
source ~csmac/tcl_fun/anom_r-1.tcl

set ybeg 1948;set yend 2003;set cbeg 1948;set cend 2003

foreach f {csulf.ntat.gauss csusf.ntat.gauss dswrf.ntat.gauss pres.hcb.gauss
pres.hct.gauss pres.lcb.gauss pres.lct.gauss pres.mcb.gauss pres.mct.gauss
tcdc.eatm.gauss ulwrf.ntat.gauss uswrf.ntat.gauss} {
set odir /tmp/csncp
anom_ncep $f 12 $ybeg $yend $cbeg $cend $odir
}

foreach f {lftx.sfc lftx4.sfc pr_wtr.eatm pres.sfc slp} {
set odir /tmp/csncp
anom_ncep $f 12 $ybeg $yend $cbeg $cend $odir
}

foreach f {air.2m.gauss cfnlf.sfc.gauss cfnsf.sfc.gauss cprat.sfc.gauss \
csdlf.sfc.gauss csdsf.sfc.gauss csusf.sfc.gauss dlwrf.sfc.gauss \
dswrf.sfc.gauss gflux.sfc.gauss icec.sfc.gauss lhtfl.sfc.gauss \
nbdsf.sfc.gauss nddsf.sfc.gauss nlwrs.sfc.gauss nswrs.sfc.gauss \
pevpr.sfc.gauss prate.sfc.gauss pres.sfc.gauss runof.sfc.gauss \
sfcr.sfc.gauss shtfl.sfc.gauss shum.2m.gauss skt.sfc.gauss \
soilw.0-10cm.gauss soilw.10-200cm.gauss tmax.2m.gauss \
tmin.2m.gauss tmp.0-10cm.gauss tmp.10-200cm.gauss tmp.300cm.gauss \
uflx.sfc.gauss ugwd.sfc.gauss ulwrf.sfc.gauss uswrf.sfc.gauss \
uwnd.10m.gauss vbdsf.sfc.gauss vddsf.sfc.gauss vflx.sfc.gauss \
vgwd.sfc.gauss vwnd.10m.gauss weasd.sfc.gauss} {
anom_ncep $f 12 $ybeg $yend $cbeg $cend $odir }

foreach f {air.tropp pres.tropp} {
set odir /tmp/csncp
anom_ncep $f 12 $ybeg $yend $cbeg $cend $odir
}

set var {rhum shum omega uwnd vwnd air hgt}

foreach a $var {

if { $a == "rhum" || $a == "shum" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300}
foreach b $levs {
lappend c $a.$b
}
```

```
} elseif { $a == "omega" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 0250 0200 0150 0100}
foreach b $levs {
lappend c $a.$b
}

} else {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 \
0250 0200 0150 0100 0070 0050 0030 0020 0010}
foreach b $levs {
lappend c $a.$b
}

}

}

foreach f $c {
set odir /tmp/csncp
anom_ncep $f 12 $ybeg $yend $cbeg $cend $odir
}

return
exit
```

8.14 get_r-1_dir

```
########BEGIN - GET_R-1_DIR.TCL#####################################################
proc get_r-1_dir {v} {
#CSIRO Australia
#Mark Collier January 2004

if { [lsearch {air hgt omega rhum shum uwnd vwnd} $v] >= 0 } {
set d "pressure";return $d
}

if { [lsearch {csulf.ntat.gauss csusf.ntat.gauss dswrf.ntat.gauss pres.hcb.gauss \
pres.hct.gauss pres.lcb.gauss pres.lct.gauss pres.mcb.gauss pres.mct.gauss \
tcdc.eatm.gauss ulwrf.ntat.gauss uswrf.ntat.gauss} $v] >= 0 } {
set d "other_gauss";return $d
}

if { [lsearch {lftx.sfc lftx4.sfc pr_wtr.eatm pres.sfc slp} $v] >= 0 } {
set d "surface";return $d
}

if { [lsearch {air.2m.gauss cfnlf.sfc.gauss cfnsf.sfc.gauss cprat.sfc.gauss \
csdlf.sfc.gauss csdsf.sfc.gauss csusf.sfc.gauss dlwrf.sfc.gauss dswrf.sfc.gauss \
gflux.sfc.gauss icec.sfc.gauss lhtfl.sfc.gauss nbdsf.sfc.gauss nddsf.sfc.gauss \
nlwrs.sfc.gauss nswrs.sfc.gauss pevpr.sfc.gauss prate.sfc.gauss pres.sfc.gauss \
runof.sfc.gauss sfcr.sfc.gauss shtfl.sfc.gauss shum.2m.gauss skt.sfc.gauss \
soilw.0-10cm.gauss soilw.10-200cm.gauss tmax.2m.gauss tmin.2m.gauss \
tmp.0-10cm.gauss tmp.10-200cm.gauss tmp.300cm.gauss uflx.sfc.gauss \
ugwd.sfc.gauss ulwrf.sfc.gauss uswrf.sfc.gauss uwnd.10m.gauss vbdsf.sfc.gauss \
vddsf.sfc.gauss vflx.sfc.gauss vgwd.sfc.gauss vwnd.10m.gauss weasd.sfc.gauss} $v] >= 0 } {
set d "surface_gauss";return $d
}

if { [lsearch {air.tropp pres.tropp} $v] >= 0 } {
set d "tropopause";return $d
}

set var {rhum shum omega uwnd vwnd air hgt}

foreach a $var {

if { $var == "rhum" || $var == "shum" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300}
foreach b $levs {
lappend c $a.$b
}

} elseif { $var == "omega" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 0250 0200 0150 0100}
foreach b $levs {
lappend c $a.$b
}
```

```
} else {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 \
0250 0200 0150 0100 0070 0050 0030 0020 0010}
foreach b $levs {
lappend c $a.$b
}

}

}

if { [lsearch $c $v] >= 0 } {
set d "level/[string range $v [expr [string first . $v]+1] [expr [string length $v]-1]]"
return $d
}

set d "error"

return $d
}
########END - GET_R-1_DIR.TCL############################################################
```

8.15 get_r-2_dir

```
########BEGIN - GET_R-2_DIR.TCL#####################################################
proc get_r-2_dir {v} {
#CSIRO Australia
#Mark Collier February 2004

if { [lsearch {air hgt omega rhum uwnd vwnd} $v] >= 0 } {
set d "pressure";return $d
}

if { [lsearch {pr_wtr.eatm pres.sfc mslp} $v] >= 0 } {
set d "surface";return $d
}


if { [lsearch {air.2m.gauss cfnlf.sfc.gauss cfnsf.sfc.gauss cprat.sfc.gauss \
csdlf.sfc.gauss csdsf.sfc.gauss csusf.sfc.gauss dlwrf.sfc.gauss dswrf.ntat.gauss \
dswrf.sfc.gauss gflux.sfc.gauss icec.sfc.gauss lhtfl.sfc.gauss pevpr.sfc.gauss \
prate.sfc.gauss pres.hcb.gauss pres.hct.gauss pres.lcb.gauss pres.lct.gauss \
pres.mcb.gauss pres.mct.gauss pres.sfc.gauss runof.sfc.gauss shtfl.sfc.gauss \
shum.2m.gauss skt.sfc.gauss soilw.0-10cm.gauss soilw.10-200cm.gauss tcdc.eatm.gauss \
tmax.2m.gauss tmin.2m.gauss tmp.0-10cm.gauss tmp.10-200cm.gauss uflx.sfc.gauss \
ugwd.sfc.gauss ulwrf.ntat.gauss ulwrf.sfc.gauss uswrf.ntat.gauss uswrf.sfc.gauss \
uwnd.10m.gauss vflx.sfc.gauss vgwd.sfc.gauss vwnd.10m.gauss weasd.sfc.gauss} $v] >= 0 } {
set d "gaussian_grid";return $d
}

set var {rhum omega uwnd vwnd air hgt}

foreach a $var {

if { $var == "rhum" || $var == "shum" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300}
foreach b $levs {
lappend c $a.$b
}

} elseif { $var == "omega" } {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 0250 0200 0150 0100}
foreach b $levs {
lappend c $a.$b
}

} else {

set levs {1000 0925 0850 0700 0600 0500 0400 0300 \
0250 0200 0150 0100 0070 0050 0030 0020 0010}
foreach b $levs { lappend c $a.$b }

}
```

```
}

if { [lsearch $c $v] >= 0 } {
set d "level/[string range $v [expr [string first . $v]+1] [expr [string length $v]-1]]"
return $d
}

set d "error"

return $d
}
########END - GET_R-2_DIR.TCL#############################################################
```

8.16 getti

```
proc getti {m p} {
#CSIRO Australia
#Mark Collier January 2004

if { $p == 12 } {
set i $m
} else {
if { $m <= 1} {
set i 0
} elseif { $m <= 4 } {
set i 1
} elseif { $m <= 7 } {
set i 2
} elseif { $m <= 10 } {
set i 3
} elseif { $m <= 11 } {
set i 0
}
}
return $i
#getti
}
########END - GETTI.TCL#############################################################
```

8.17 pad10000

```
proc pad10000 {v} {
#CSIRO Australia
#Mark Collier January 2004

if { $v < 10} {
set i 000$v
} elseif { $v < 100 } {
set i 00$v
} elseif { $v < 1000 } {
set i 0$v
} elseif { $v < 10000 } {
set i $v
} else {
puts "Argument must be 0<i<10000."
return
}
return $i
#pad10000
}
########END - PAD10000.TCL############################################################
```

CSIRO Atmospheric Research Technical papers

Complete List

(Series title changed from CSIRO Division of Atmospheric Technical papers at number 38)

No. 1 **Galbally, I.E., Roy, C.R., O'Brien, R.S., Ridley, B.A., Hastie, D.R., Evans, W.J.F., McElroy, C.T., Kerr, J.B., Hyson, P., Knight, W. and Laby, J.E.** Measurements of trace composition of the Austral stratosphere: chemical and meteorological data. 1983. 31 pp.

No. 2 **Enting, I.G.** Error analysis for parameter estimates from constrained inversion. 1983. 18 p.

No. 3 **Enting, I.G. and Pearman, G.I.** Refinements to a one-dimensional carbon cycle model. 1983. 35 pp.

No. 4 **Francey, R.J., Barbetti, M., Bird, T., Beardsmore, D., Coupland, W., Dolezal, J.E., Farquhar, G.D., Flynn, R.G., Fraser, P.J., Gifford, R.M., Goodman, H.S., Kunda, B., McPhail, S., Nanson, G., Pearman, G.I., Richards, N.G., Sharkey, T.D., Temple, R.B. and Weir, B.** Isotopes in tree rings. 1984. 86 pp.

No. 5 **Enting, I.G.** Techniques for determining surface sources from surface observations of atmospheric constituents. 1984. 30 pp.

No. 6 **Beardsmore, D.J., Pearman, G.I. and O'Brien, R.C.** The CSIRO (Australia) Atmospheric Carbon Dioxide Monitoring Program: surface data. 1984. 115 pp.

No. 7 **Scott, J.C.** High speed magnetic tape interface for a microcomputer. 1984. 17 pp.

No. 8 **Galbally, I.E., Roy, C.R., Elsworth, C.M. and Rabich, H.A.H.** The measurement of nitrogen oxide (NO, NO2) exchange over plant/soil surfaces. 1985. 23 pp.

No. 9 **Enting, I.G.** A strategy for calibrating atmospheric transport models. 1985. 25 pp.

No. 10 **O'Brien, D.M.** TOVPIX: software for extraction and calibration of TOVS data from the high resolution picture transmission from TIROS-N satellites. 1985. 41 pp.

No. 11 **Enting, I.G. and Mansbridge, J.V.** Description of a two-dimensional atmospheric transport model. 1986. 22 pp.

No. 12 **Everett, J.R., O'Brien, D.M. and Davis, T.J.** A report on experiments to measure average fibre diameters by optical fourier analysis. 1986. 22 pp.

No. 13 **Enting, I.G.** A signal processing approach to analysing background atmospheric constituent data. 1986. 21 pp.

No. 14 **Enting, I.G. and Mansbridge, J.V.** Preliminary studies with a two-dimensional model using transport fields derived from a GCM. 1987. 47 pp.

No. 15 **O'Brien, D.M. and Mitchell, R.M.** Technical assessment of the joint CSIRO/Bureau of Meteorology proposal for a geostationary imager/sounder over the Australian region. 1987. 53 pp.

No. 16 **Galbally, I.E., Manins, P.C., Ripari, L. and Bateup, R.** A numerical model of the late (ascending) stage of a nuclear fireball. 1987. 89 pp.

No. 17 **Durre, A.M. and Beer, T.** Wind information prediction study: Annaburroo meteorological data analysis. 1989. 30 pp. + diskette.

No. 18 **Mansbridge, J.V. and Enting, I.G.** Sensitivity studies in a two-dimensional atmospheric transport model. 1989. 33 pp.

No. 19 **O'Brien, D.M. and Mitchell, R.M.** Zones of feasibility for retrieval of surface pressure from observations of absorption in the A band of oxygen. 1989. 12 pp.

No. 20 **Evans, J.L.** Envisaged impacts of enhanced greenhouse warming on tropical cyclones in the Australian region. 1990. 31 pp. [Out of print]

No. 21 **Whetton, P.H. and Pittock, A.B.** Australian region intercomparison of the results of some general circulation models used in enhanced greenhouse experiments. 1991. 73 pp. [Out of print]

No. 22 **Enting, I.G.** Calculating future atmospheric CO2 concentrations. 1991. 32 pp. available electronically

No. 23 **Kowalczyk, E.A., Garratt, J.R. and Krummel, P.B.** A soil-canopy scheme for use in a numerical model of the atmosphere 1D stand-alone model. 1992. 56 pp.

No. 24 **Physick, W.L., Noonan, J.A., McGregor, J.L., Hurley, P.J., Abbs, D.J. and Manins, P.C.** LADM: A Lagrangian Atmospheric Dispersion Model. 1994. 137 pp.

No. 25 **Enting, I.G.** Constraining the atmospheric carbon budget: a preliminary assessment. 1992. 28 pp. Available electronically

No. 26 **McGregor, J.L., Gordon, H.B., Watterson, I.G., Dix, M.R. and Rotstayn, L.D.** The CSIRO 9-level atmospheric general circulation model. 1993. 89 pp.

No. 27 **Enting, I.G. and Lassey, K.R.** Projections of future CO2. with appendix by R.A. Houghton. 1993. 42 pp. Available electronically

No. 28 [Not published]

No. 29 **Enting, I.G., Trudinger, C.M., Francey, R.J. and Granek, H.** Synthesis inversion of atmospheric CO2 using the GISS tracer transport model. 1993. 44 pp.

No. 30 **O'Brien, D.M.** Radiation fluxes and cloud amounts predicted by the CSIRO nine level GCM and observed by ERBE and ISCCP. 1993. 37 pp.

No. 31 **Enting, I.G., Wigley, T.M.L. and Heimann, M.** Future emissions and concentrations of carbon dioxide: key ocean/atmosphere/land analyses. 1994. 120 pp. available electronically

No. 32 **Kowalczyk, E.A., Garratt, J.R. and Krummel, P.B.** Implementation of a soil-canopy scheme into the CSIRO GCM regional aspects of the model response. 1994. 59 pp.

No. 33 **Prata, A.J.** Validation data for land surface temperature determination from satellites. 1994. 40 pp.

No. 34 **Dilley, A.C. and Elsum, C.C.** Improved AVHRR data navigation using automated land feature recognition to correct a satellite orbital model. 1994. 22 pp.

No. 35 **Hill, R.H. and Long, A.B.** The CSIRO dual-frequency microwave radiometer. 1995. 16 pp.

No. 36 **Rayner, P.J. and Law, R.M.** A comparison of modelled responses to prescribed CO2 sources. 1995. 84 pp.

No. 37 **Hennessy, K.J.** CSIRO Climate change output. 1998. 23 pp.

No. 38 **Enting, I.G.** Attribution of greenhouse gas emissions, concentrations and radiative forcing. 1998. 29 pp. Available electronically

No. 39 **OBrien, D.M. and Tregoning, P.** Geographical distributions of occultations of GPS satellites viewed from a low earth orbiting satellite. 1998. 23 pp.

No. 40 **Enting, I.G.** Characterising the temporal variability of the global carbon cycle. 1999. 23 pp. Available electronically

No. 41 **Enting, I.G. and Law, R.M.** Characteristing Historical Responsibility for the Greenhouse Effect, 2002. 50 pp. Electronic edition only

No. 42 **Mitchell, R.M.** Calibration status of the NOAA AVHRR solar reflectance channels: CalWatch revision 1. 1999. 20 pp.

No. 43 **Hurley, P.J.** The Air Pollution Model (TAPM) Version 1: technical description and examples. 1999. 41 pp. Available electronically

No. 44 **Frederiksen, J.S., Dix, M.R. and Davies, A.G.** A new eddy diffusion parameterisation for the CSIRO GCM. 2000. 31 pp.

No. 45 **Young, S.A.** Vegetation canopy lidar studies. 2000. 35 pp. Electronic edition only.

No. 46 **Prata, A.J.** Global Distribution of Maximum Land Surface Temperature Inferred from Satellites: Implications for the Advanced Along Tracking Scan Radiometer. 2000. 30 pp. Electronic edition only.

No. 47 **Prata, A.J.** Precipitable water retrieval from multi-filtered shadowband radiometer measurements. 2000. 14 pp. Electronic edition only.

No. 48 **Prata, A.J., Grant, I.F.** Determination of mass loadings and plume heights of volcanic ash clouds from satellite data. 2001. 39 pp. Electronic edition only.

No. 49 **OBrien, D.M.** Numerical calculation of the transfer of polarized radiation by a scattering and absorbing atmosphere. 2001. 65 pp. Electronic edition only.

No. 50 **R.L. Law, Vohralik, P.F.** Methane sources from mass-balance inversions: Sensitivity to transport. 2001 27 pp. Electronic edition only.

No. 51 **Meyer, C.P., Galbally, I.E., Wang, Y.P., Weeks, I.A., Jamie, I., Griffith, D.W.T.** Two automatic chamber techniques for measuring soil-atmosphere exchanges of trace gases and results of their use in the OASIS field experiment. 2001. 33 pp. Electronic edition only.

No. 52 **Mitchell, R.M.** In-flight characteristics of the space count of NOAA AVHRR channels 1 and 2. 2001. 24 pp. Electronic edition only.

No. 53 **Young, S.A.** An investigation into the performance of algorithms used to retrieve cloud parameters from LITE lidar data, and implications for their use with PICASSO-CENA lidar data. 2001. Electronic edition only.

No 54 [Not published]

No. 55 **Hurley, P.** The Air Pollution Model (TAPM) Version 2. Part 1. Technical Description. 2002. Electronic edition only.

No. 56 **Enting, I.G. and Trudinger C.M.** Modelling earth system change. 1, Validating parameterisations for attribution calculations. 2002. Electronic edition only.

No. 57 **Hurley, P., Physick, W.L. and Luhar, A.K.** The Air Pollution Model (TAPM) Version 2. Part 2. Summary of some verification studies. 2002. Electronic edition only.

No. 58 [Not published]

No. 59 **Frederiksen, J.S., Collier, M.A., and Watkins A.B.** Ensemble Prediction Methods based on Fast Growing Perturbations. 2002. Electronic edition only.

No. 60 **Gordon, H.B., Rotstayn, L.D., McGregor, J.L., Dix, M.R., Kowalczyk, E.A., O'Farrell, S.P., Waterman, L.J., Hirst, A.C., Wilson, S.G., Collier, M.A., Watterson, I.G. and Elliott, T.I.** The CSIRO Mk3 Climate System Model. 2002. Electronic edition only.

No. 61 **Graetz, R.D.** The net carbon dioxide flux from biomass burning on the Australian continent. 2002. Electronic edition only.

No. 62 **Enting, I.G.** Inverse problems in earth system science: A complex systems perspective. 2002. Electronic edition only.

No. 63 [Not published]

No. 64 **Graetz, R.D., and Skjemstad J.O.** The charcoal sink of biomass burning on the Australian continent. 2003. Electronic edition only.

No. 65 **Young, S.A.** Interpretations of the performance of the hybrid extinction retrieval algorithms (HERA) during the CALIPSO Build 2 tests.

No. 66 [In preparation]

No. 67 **Mitchell, R.M, Campbell, S.K., and Daniel P.J.** Selection of a Radiance Source for the Radiometric Calibration Facility at the CSIRO Earth Observation Centre 2004. Electronic edition only.