The CSIRO ERA-40 2.5° x 2.5° archive

M. A. Collier

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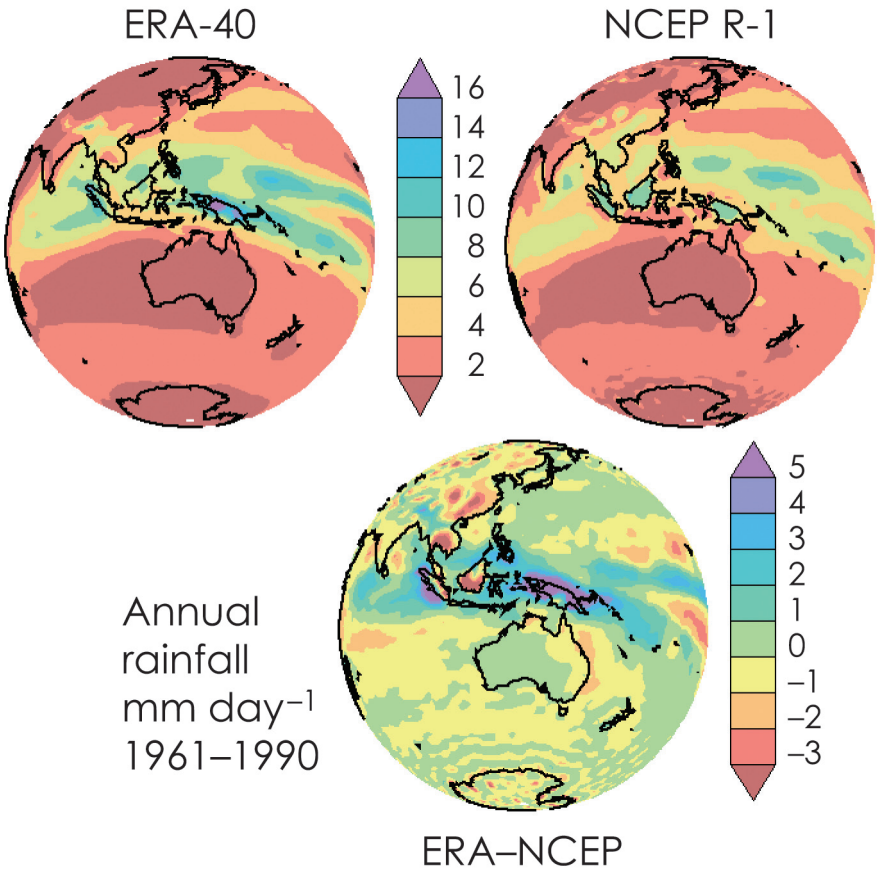

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The CSIRO ERA-40 2.5°×2.5° archive

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Contents

The CSIRO ERA-40 2.5°×2.5° archive

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Abstract

This report describes the atmospheric parameters available in the CSIRO (reduced resolution) ERA-40 2.5°×2.5° reanalysis archive, covering details of their primary (4-times daily GRIB) and processed (4-times daily and climatological netCDF) form. In addition, information relating to methods of accessing and displaying the data (for research and educational purposes) have been documented, as well as notes on software written to analyse, modify and maintain the archive.

1 Background

The key objectives of ERA-40 (*Kallberg*, 2004) are:

- to produce and promote the use of a comprehensive set of global analyses describing the state of the atmosphere and land and ocean-wave conditions during the 45 years from September 1957 to August 2002
- to foster European and international research by making the observations, the analyses and the study reports widely available

The atmospheric model used for ERA-40 has the identifier IFS CY23r4 and is comprehensively documented on the ECMWF website at `http://www.ecmwf.int/research/ifsdocs/CY23r4/index.html`. Briefly, it has 60 levels in the vertical, uses a T159 spherical-harmonic representation for the dynamical fields, and a reduced Gaussian grid with an approximately uniform 125 kilometre spacing for surface and other grid-point fields.

An essential part of the ERA-40 activity was the production of an archive of data (*Kallberg*, 2004), and it is the motivation of this report to describe the subset of this whole archive in GRIB form[1] that has been made available to the Australian weather and climate research community. ERA-40 GRIB data are given a identification code, as listed in the second column of Tables2, 3, 4 and 5, using ECMWF's local versions of GRIB code table 2 (version number 128), and available at `http://www.ecmwf.int/services/archive`, as given by *Kallberg* (2004). The parameters processed into netCDF form, including the 4-times daily, time invariant and climatological sets, will be of wide interest, as they are self describing, machine transparent, and immediately available to a wide range of software applications.

2 Raw GRIB data

Data were provided to CSIRO in GRIB format and were extracted from two magnetic tapes to hard disk, and subsequently backed-up through the tape migration system. Table 1 lists the contents of the unmodified directory structure under the directory cherax:~csncp/era40/raw

Only the GRIB files found under the sub-directories e4oper listed in Table 1 have been further processed and are described in this report, as these make up the 4-times daily parameters. GRIB files under e4moda and e4mnth are daily averaged monthly averages and 4-times daily monthly averages, respectively. These files are not of interest in this report as they have be generated from the 4-times daily (and invariant) parameters listed in Tables 2, 3, 4 and 5, part of the focus of the effort made for this report and described in Section 4.

[1] GRIdded Binary, a general purpose, bit-oriented data exchange format defined and used extensively by the World Meteorological Organisation, for more information please see "A Guide to GRIB" at `http://www-imk.fzk.de/asf/kasima/aktuelles/grib/index.html`

Sub-directory	Type	Frequency
tape1/dataserver/e4mnth/pl/1957..2002	monthly mean	4-times daily
tape1/dataserver/e4mnth/sfc/1957..2002	monthly mean	4-times daily
tape1/dataserver/e4moda/pl/1957..2002	monthly mean	daily average
tape1/dataserver/e4moda/sfc/1957..2002	monthly mean	daily average
tape1/dataserver/e4oper/invariant/albedo,fixed	6-hourly average/instantaneous	invariant
tape1/dataserver/e4oper/pl/19570901..19741001	6-hourly average/instantaneous	4-times daily
tape1/dataserver/e4oper/sfc19570901..20020801	6-hourly average/instantaneous	4-times daily
tape2/dataserver/e4oper/pl19741101..20020801	6-hourly average/instantaneous	4-times daily

Table 1: Raw GRIB files located on the CHERAX file system.

3 4-times daily and time invariant netCDF data

The Tcl-NAP script make_era40_tape.tcl, listed in Section 8, reads in the 4-times daily surface and pressure level files[2] to produce COARDS[3] conforming netCDF[4] files, which employ a similar metacode specification to that in the NCEP[5] reanalysis files described in Kalnay et al. (1996) and *Collier* (2000, 2004). This choice has been made primarily to allow existing users of the NCEP/NCAR reanalysis to be able to easily switch data input to ERA-40. The basic naming system for each netCDF file follows **var**.era40.**year**.nc where var includes a 4-digit pressure level specifier for the pressure level data, and a 4-digit year preceding the ".nc" suffix. Those parameters that are a function of time are resolved 4-times daily (0h, 6h, 12h and 18h UTC), and a complete year of data is written to a single file (for full years, either 1460 or 1464 times depending on whether the particular year is a leap year). All data are on a 2.5 by 2.5 degree horizontal grid (144 × 73 regular grid points) for each of the standard 23 pressure levels, see Section 7 for their exact definitions.

The Tcl-NAP script make_era40_invariant.tcl, listed in Section 8, reads in the invariant parameters shown in Table 5[6] to once again produce netCDF files.

These two sets of netCDF data have been put into a set of appropriately named output directories (*surface, level* and *invariant*).

4 Monthly and seasonal climatologies

Akin to earlier work performed with the NCEP/NCAR reanalysis (*Collier*, 2000, 2004), monthly and seasonal climatologies have been generated for research and educational applications. The metadata conventions used in the climatological netCDF files are similar to that used in the raw NCEP/NCAR reanalysis netCDF files, including the naming of dimensions and maintaining the original

[2]These input GRIB files have an 8 digit filename *YYYYMMDD*, corresponding to year (*YYYY*), month (*MM*) and day (*DD*).

[3]Cooperative Ocean/Atmosphere Research Data Service, developed in the 1990s, an updated specification of COARDS, called Climate and Forecast (CF) Metadata Convention, can be examined at `http://www.cgd.ucar.edu/cms/eaton/cf-metadata`

[4]Network Common Data Form `http://www.unidata.ucar.edu/packages/netcdf`

[5]National Centers for Environmental Prediction/ National Center for Atmospheric Research, `http://www.cdc.noaa.gov/cdc/reanalysis/reanalysis.shtml`

[6]these input GRIB files are named *albedo* and *fixed*. Note that albedo is infact a monthly climatological average of albedo and has 12 times unlike the other invariant fields which are not a function of time.

Parameter name	Code	Long name	Units
ci	031	Sea ice fraction	0 to 1
istl1	035	Sea ice temperature layer 1	K
istl2	036	Sea ice temperature layer 2	K
istl3	037	Sea ice temperature layer 3	K
istl4	038	Sea ice temperature layer 4	K
swvl1	039	Soil moisture level 1 (volumetric)	$m^3\ m^{-3}$
swvl2	040	Soil moisture level 2 (volumetric)	$m^3\ m^{-3}$
swvl3	041	Soil moisture level 3 (volumetric)	$m^3\ m^{-3}$
swvl4	042	Soil moisture level 4 (volumetric)	$m^3\ m^{-3}$
snw	044	Snow evaporation (accum.)	m
snm	045	Snow melt (accum.)	m
tcw	136	Total column water	kg m^{-2}
pwc	137	Total column water vapour	kg m^{-2}
st	139	Soil temperature level 1	K
sd	141	Snow depth	m
lsp	142	Large-scale precipitation (accum.)	m
cp	143	Convective precipitation (accum.)	m
sf	144	Snowfall[1] (accum.)	m
sshf	146	Surface sensible heat flux (accum.)	W m^{-2}
slhf	147	Surface latent heat flux	W m^{-2}
msl	151	Mean sea level pressure (accum.)	Pa
blh	159	Boundary layer height	m
tcc	164	Total cloud cover	0 to 1
10u	165	10 metre eastward wind component	m s^{-1}
10v	166	10 metre northward wind component	m s^{-1}
t2	167	2 metre temperature[2]	K
d2	168	2 metre dewpoint [3]	K

1 convective + stratiform
2 renamed variable from 2t
3 renamed variable from 2d

Table 2: Surface and single level parameters.

variable names where possible[7]. Unique time specification requires that separate files are needed to define the various types of climatologies. Monthly climatologies are available over the internet (in GRIB and an experimental netCDF form), and on the raw tapes as discussed in Section 2. Only climatologies generated from the 4-times daily data are described in this report. Significant (but not exhaustive) checking has shown that the are equivalent to those provided by ECMWF. Note that some care is required when interpreting the units of these new climatological files. For example, rainfall in the 4-times daily set, which is an accumulated parameter (expressed in units of metres) over the 6 hours of model integration, needs to be multiplied by the $dim\times4$ to get out the monthly accumulation, where *dim* is the number of days in the particular month. Alternatively, in this case, multiply by 4000 to get units of mm per day[8]. The benefit of having our own system to form climatologies is that it is a way of checking

[7]Some parameters needed to be renamed slightly to ensure that they can be read into standard software. These are listed at the end of Tables 2, 4 and 5

[8]Conversion from units of m of rain per 6 hour period

Parameter name	Code	Long name	Units
ssrd	169	Downward surface solar radiation (accum.)	W m^{-2}
dst	170	Soil temperature level 2	K
strd	175	Downward surface thermal raiation (accum.)	W m^{-2}
ssr	176	Surface solar radiation (accum.)	W m^{-2}
str	177	Surface thermal radiation (accum.)	W m^{-2}
tsr	178	Top solar radiation (accum.)	W m^{-2} s
ttr	179	Top thermal radiation (accum.)	W m^{-2} s
ewss	180	Eastward component of turblent stress (accum.)	N m^{-2} s
nsss	181	Northward component of turbulent stress (accum.)	N m^{-2} s
e	182	Evaporation (accum.)	m
cdst	183	Soil temperature level 3	K
lcc	186	Low cloud cover	0 to 1
mcc	187	Medium cloud cover	0 to 1
hcc	188	High cloud cover	0 to 1
lgws	195	Latitudinal component of gravity wave stress (accum.)	N m^{-2} s
mgws	196	Meridional component of gravity wave stress (accum.)	N m^{-2} s
ro	205	Runoff (accum.)	m
tco3	206	Total column ozone	kg m^{-2}
tsrc	208	Top solar radiation clear sky (accum.)	W m^{-2}
ttrc	209	Top thermal radiation clear sky (accum.)	W m^{-2}
ssrc	210	Surface solar radiation clear sky (accum.)	W m^{-2}
strc	211	Surface thermal radiation clear sky (accum.)	W m^{-2}
iews	229	Instantaneous eastward component of turbulent stress	N m^{-2}
inss	230	Instantaneous northward component of turbulent stress	N m^{-2}
ie	232	Instantaneous moisture flux (evaporation)	kg m^{-2}
stl4	236	Soil temperature level 4	K
tsn	238	Snow temperature	K

Table 3: Surface and single level parameters (continued).

for any problems with the 4-times daily GRIB *and* netCDF data, and provides a system whereby slightly different definitions of climatologies can be used (e.g. including alternative definitions of seasons, as presented in this report).

The CSIRO climatologies (calculated from 4-times daily 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 through the internet. In addition scripts are provided so that alternative climatological definitions can be formed. Much meteorological research depends upon seasonal analysis and for this reason seasonal climatologies are available. No figures of data in the archive are presented here, to keep this document compact. However, there is a comprehensive atlas available (*Kallberg*, 2004).

All time varying parameters in Tables 2, 3 and 4are available in a climatological form. These include seasonal and monthly climatologies for the period 1957-2002. It is straight forward (but time consuming when processing all raw files in the whole archive) to generate these climatologies for different periods, and the averaging period will be extended as/if future 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

Parameter name	Code	Long name	Units
pv	060	Potential vorticity	K m^2 kg^{-1} s^{-1}
za	129	Geopotential[1]	m^2 s^{-2}
ta	130	Temperature[2]	K
u	131	Eastward wind component	m s^{-2}
v	132	Northward wind component	m s^{-2}
q	133	Specific humidity	kg kg^{-1}
w	135	Vertical velocity	Pa s^{-1}
vo	138	Vorticity	s^{-1}
d	155	Divergence	s^{-1}
r	157	Relative humidity	%
o3	203	Ozone mass mixing ratio	kg kg^{-1}

1 renamed variable from z
2 renamed variable from t

Table 4: Pressure level parameters.

Parameter name	Code	Long name	Units
cvl	027	Low vegetation cover	0 to 1
cvh	028	High vegetation cover	0 to 1
tvl	029	Low vegetation type (table index)	-
tvh	030	High vegegation type (table index)	-
za	129	Surface geopotential[1]	m^2 s^{-2}
sdor	160	Standard deviation of orography	-
isor	161	Anistrophy of orography	-
anor	162	Angle of sub-grid scale orography	radian
slor	163	Slope of sub-grid scale orography	-
lsm	172	Land/sea mask	0 or 1
sr	173	Surface roughness	m
al	174	Albedo (climate)	0 to 1
lsrh	234	Log. surface roughness length (m) for heat	-

1 renamed variable from z

Table 5: Time invariant single level parameters.

(ym) and year-by-year seasonal (ys), as shown in Table 6. 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 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 there is a dependency on which months are available for each year. For the complete ERA-40 set, the number of seasons, as defined above, is perfectly defined from September 1957 to August 2002 (1 + (2001-1958+1)×4 + 3) = 180 complete seasons). 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 8, can be modified for different averaging requirements. Files containing the var-

ious climatologies can be found on CHERAX under the directories shown in Table 6, and illustrated in Figure 1.

Climatology type	Location on CHERAX	Filename
long-term monthly (lm)	~csncp/era40/c/1957-2002/l/m	**var**.lm.era40.1957-2002.nc
long-term seasonal (ls)	~csncp/era40/c/1957-2002/l/s	**var**.ls.era40.1957-2002.nc
year-by-year monthly (ym)	~csncp/era40/c/1957-2002/y/m	**var**.ym.era40.1957-2002.nc
year-by-year seasonal (ys)	~csncp/era40/c/1957-2002/y/s	**var**.ys.era40.1957-2002.nc

Table 6: ERA-40 monthly and seasonal fields for the long term climatology and for the individual years.

where

var is the variable name part of the (time-varying) files found in any of the tables in Section 2, for example, t2, w, and za.

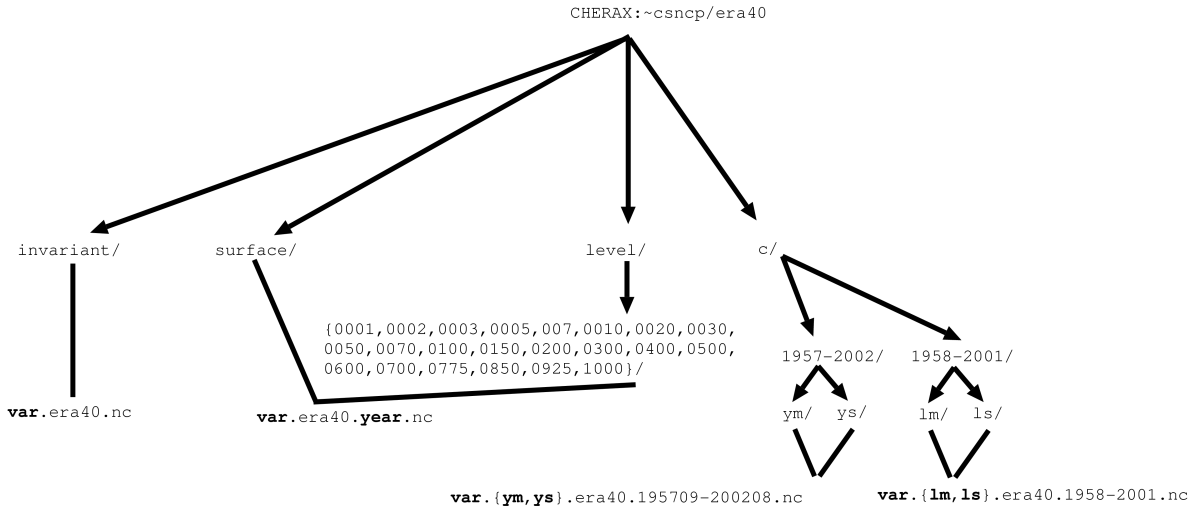

Figure 1: Tree diagram for the location of 4-times daily data, monthly and seasonal climatologies on CHERAX. Directories are identified with a "/" at end of name. Variable information (field, year, climatology type) is shown by bold text. Climatologies are located under the "c" directory. NetCDF files 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" on a Gregorian calendar and can be interpreted to a precise time with the appropriate software, for example, *Ferret*. The values for the time axis has been derived from the values in the original 4-times daily netCDF files for consistency.

5 Obtaining raw data, including downloading over internet

World-Wide-Web sites that are relevant to this document are

ECMWF Re-Analysis ERA-40:	`http://www.ecmwf.int/research/era`
ECMWF data services:	`http://www.ecmwf.int/products/data/archive/index.html`
Reduced resolution data:	`http://data.ecmwf.int/data/d/era40_daily`

Presently there is no intention to provide a Web page describing the contents of this report or the data contained in the archive.

6 the CSIRO ERA-40 2.5°×2.5° archive

The only practical way of obtaining data from the CSIRO ERA-40 2.5°×2.5° archive is to obtain an account on the storage/data processing machine CHERAX. It is easy to flood another users disk by requesting excessive amounts of migrated file through the unix dmget command. As it is not possible to remigrate another user's data (only to unmigrate), please use caution when requesting large amounts of data in this way, particularly when using file name wildcards. If you are unsure of how to use the dmget command, other have other system related questions, please consult the CSIRO/Bureau of Meteorology High Performance Scientific Computing (HPSC) help desk staff[9].

On CHERAX all archive data are found under the user account *csncp*, under the sub-directory era40. There are three main subdirectories in this account holding the 4-times daily and time invariant parameters for all years, specifically, *surface, level* and *invariant*. These parameters correspond to those given in Tables 2, 3, 4 and 5. For the 4-times daily data, each year of data in contained in a single file, as in the NCEP/NCAR reanalysis netCDF files.

All pressure level parameters (these are a function of pressure in addition to the usual time, latitude and longitude dimensions) have been written to files corresponding to each pressure level (hPa) using a script make_era40_tape.tcl described in Section 8. This approach is different to the NCEP/NCAR reanalysis data (*Collier*, 2000, 2004) where the raw data is written to files with all pressure level data, and a second set is formed from these where a single pressure level is kept in a separate file. This was motivated to avoid the large amounts of 'doubling-up' that occurred with the NCEP/NCAR reanalysis data, and to keep the average file size down per parameter[10]. For ERA-40, these can be found on CHERAX in the directory ~csncp/era40/level in one of the 23 sub-directories *0001 0002 0003 0005 0007 0010 0020 0030 0050 0070 0100 0150 0200 0250 0300 0400 0500 0600 0700 0775 0850 0925 and 1000*. Unlike the NCEP/NCAR reanalysis data, all ERA-40 parameters are defined for each of the (23) model levels.

[9] hpchelp@hpsc.csiro.au

[10] However, there are various methods for concatenating pressure levels together if required by certain types of analysis, for example, join_r-1, described in (*Collier*, 2004)

6.1 Processing and maintaining the CSIRO ERA-40 2.5°×2.5° archive

Although there are a number of public domain and proprietary softwares packages 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 powerful scripting language, a highly capable input-output data reading interface (including netCDF, reading and writing), and installed on all local machines to be able to directly read the ERA-40 raw (and processed) netCDF data.

A number of *Tcl-NAP* utilities have been written or installed to run on CHERAX to extract and analyse the CSIRO ERA-40 2.5°×2.5° archive. Software vital to the production of the archive is described briefly here and is 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 are indicated here although they can be accessed from other machines via disk mounts.

7 Horizontal and vertical grid definitions

7.1 east/west

	0	1	2	3	4	5	6	7	8	9
0	0.0	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5
1	25.0	27.5	30.0	32.5	35.0	37.5	40.0	42.5	45.0	47.5
2	50.0	52.5	55.0	57.5	60.0	62.5	65	67.5	70.0	72.5
3	75.0	77.5	80.0	82.5	85.0	87.5	90.0 9	2.5	95	97.5
4	100.0	102.5	105.0	107.5	110.0	112.5	115.0	117.5	120.0	122.5
5	125.0	127.5	130.0	132.5	135.0	137.5	140.0	142.5	145.0	147.5
6	150.0	152.5	155.0	157.5	160.0	162.5	165.0	167.5	170.0	172.5
7	175.0	177.5	180.0	182.5	185.0	187.5	190.0	192.5	195.0	197.5
8	200.0	202.5	205.0	207.5	210.0	212.5	215.0	217.5	220.0	222.5
9	225.0	227.5	230.0	232.5	235.0	237.5	240.0	242.5	245.0	247.5
10	250.0	252.5	255.0	257.5	260.0	262.5	265.0	267.5	270.0	272.5
11	275.0	277.5	280.0	282.5	285.0	287.5	290.0	292.5	295.0	297.5
12	300.0	302.5	305.0	307.5	310.0	312.5	315.0	317.5	320.0	322.5
13	325.0	327.5	330.0	332.5	335.0	337.5	340.0	342.5	345.0	347.5
14	350.0	352.5	355.0	357.5						

Table 7: 144 values of Longitude east of the Greenwhich Meridian (degrees), defining the grid locations of the fields in the CSIRO ERA-40 archive.

7.2 north/south

	0	1	2	3	4	5	6	7	8	9
0	90.0	87.5	85.0	82.5	80.0	77.5	75.0	72.5	70.0	67.5
1	65.0	62.5	60.0	57.5	55.0	52.5	50.0	47.5	45.0	42.5
2	40.0	37.5	35.0	32.5	30.0	27.5 2	5.0	22.5	20.0	17.5
3	15.0	12.5	10.0	7.5	5.0	2.5	0.0	-2.5	-5.0	-7.5
4	-10.0	-12.5	-15.0	-17.5	-20.0	-22.5	-25.0 -	27.5	-30.0	-32.5
5	-35.0	-37.5	-40.0	-42.5	-45.0	-47.5	-50.0	-52.5	-55.0	-57.5
6	-60.0	-62.5	-65.0	-67.5	-70.0	-72.5	-75.0	-77.5	-80.0	-82.5
7	-85.0	-87.5	-90.0							

Table 8: 73 values of Latitude north and south of the equator (degrees), defining the grid locations of the fields in the CSIRO ERA-40 archive.

7.3 vertical

	0	1	2	3	4	5	6	7	8	9
0	0001.0	0002.0	0003.0	0005.0	0007.0	0010.0	0020.0	0030.0	0050.0	0070.0
1	0100.0	0150.0	0200.0	0250.0	0300.0	0400.0	0500.0	0600.0	0700.0	0775.0
2	0850.0	0925.0	1000.0							

Table 9: 23 values pressure (hPa), defining the vertical grid of the fields in the CSIRO ERA-40 archive.

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Disclaimer

The CSIRO ERA-40 2.5°×2.5° archive data may be modified or updated at any time without any prior warning. Users of this data set are urged to check and reassure themselves of its numerical integrity and applicability to their individual research applications. If you have any questions regarding this document or data described within, please contact the author.

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8 Appendix: Tcl/NAP scripts

The following Tcl-NAP scripts[11] are located on CHERAX under the directory ~csncp/tcl_fun. These can be copied and modified to suit individual needs. A brief description of a procedures function is provided at the beginning of each script, or can be gathered from its file name. In summary, top-level scripts make_era40_tape and make_era40_invariant (see description in Section 3) produce netCDF files from the raw grib files. Top-level script run_era40_clims (see description in Section 4) generates monthly and seasonal netCDF climatologies from 4-times daily input netCDF files.

8.1 era40_info

```
#CSIRO Australia
#Mark Collier December 01 2005
#Modified     December 01 2005

nap "title = ‘4x daily ERA40 reanalysis‘" $title netcdf $tdir/$ofil
:title

nap "institution = ‘CSIRO (CSIRO Atmospheric Research, Melbourne, Australia)‘"
$institution netcdf $tdir/$ofil :institution

nap "source = ‘ECMWF (2000): atmosphere: spectral (T159L60)‘"
$source netcdf $tdir/$ofil :source

nap "contact = ‘Mark Collier (Mark.Collier@csiro.au)‘"
$contact netcdf $tdir/$ofil :contact

nap "project_id = ‘ERA40‘"
$project_id netcdf $tdir/$ofil :project_id

nap "experiment_id = ‘ERA40‘"
$experiment_id netcdf $tdir/$ofil :experiment_id

nap "realization = 1"
$realization netcdf $tdir/$ofil :realization

nap "conventions = ‘COARDS‘"
$conventions netcdf $tdir/$ofil :Conventions

nap "references = ‘The ERA-40 archive by Kellberg, Simmons, Uppala and Fuentes, 2004:
http://www.ecmwf.int/publications/library/ecpublications/_pdf/era40/ERA40_PRS17.pdf‘"
$references netcdf $tdir/$ofil :references

nap "comment = ‘The three dimensional variational technique will be applied using
the T159L60 version of the Integrated Forecasting System to produce the analyses
every six hours. Analysis involves comprehensive use of satellite data, starting
```

[11] Note that procedure names are only given here, actual Tcl-NAP file names end in the ".tcl" suffix

```
from the early Vertical Temperature Profile Radiometer data in 1972, then later
including TOVS, SSM/I, ERS and ATOVS data. Cloud Motion Winds will be used from
1979 onwards. ERA-40 products will also revitalize the use of data from past field
experiments such as the 1974 Atlantic Tropical Experiment of the Global Atmospheric
Research Program, GATE, 1979 FGGE, 1982 Alpine Experiment, ALPEX and more recent
1992-1993 TOGA-COARE. Most of the older observations for ERA-40 have been made
available by NCAR.‘"
$comment netcdf $tdir/$ofil :comment

nap "history =
’Date/Time stamp=
[exec date -u "+year:%Y:month:%m:day:%d:hour:%H:minute:%m:second:%S:UTC"].
Processed from model output using tcl-nap version [info tclversion].’"
$history netcdf $tdir/$ofil :history

nap "platform = ‘Model‘"
$platform netcdf $tdir/$ofil :platform
```

8.2 era40_table_lookup

```
proc era40_table_lookup {id} {
#CSIRO Australia
#Mark Collier December 01 2005
#Modified     December 01 2005

#provide parameter details

set tb /cs/datastore/csdar/csncp/era40/lookup.txt

set file [open $tb]

set line "0"

set cnt 0
while {$cnt>=0} {

set iid [string trimleft [lindex [split $line :] 0] 0]

if {$iid == $id} {

set vn [lindex [split $line :] 1]
set un [lindex [split $line :] 2]
set sn [lindex [split $line :] 3]

lappend vals $vn
lappend vals $un
lappend vals $sn

close $file
return $vals

} else {
set line [gets $file]

if {[eof $file] == 1} {
set vals "Error Error Error"
return $vals
}

}

incr cnt
};#cnt

};#era40_table_lookup
```

8.3 era40_tape

```
#CSIRO Australia
#Mark Collier December 01 2005
#Modified     December 01 2005

#give filesystem location of input grib files

if {$type == "pl"} {

  if {$ynow <= 1973} {
    set idir /cs/datastore/csdar/csncp/era40/raw/grib/tape1/dataserver/e4oper/$type

  } elseif {$ynow == 1974} {

    if {$mnow <= 10} {
    set idir /cs/datastore/csdar/csncp/era40/raw/grib/tape1/dataserver/e4oper/$type
    } else {
    set idir /cs/datastore/csdar/csncp/era40/raw/grib/tape2/dataserver/e4oper/$type
    }

  } else {
    set idir /cs/datastore/csdar/csncp/era40/raw/grib/tape2/dataserver/e4oper/$type
  }

} else {
set idir /cs/datastore/csdar/csncp/era40/raw/grib/tape1/dataserver/e4oper/$type
};#type
```

8.4 long_term_era40

```
proc long_term_era40_new {ivar_tmp iper hsel ybeg yend odir} {
#CSIRO Australia
#Mark Collier June 01 2005
#Modified     June 01 2005

#generate long term monthly (iper=12) or seasonal (iper=4) 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 ~col414/.tclshrc
source ~csncp/tcl_fun/getti.tcl
source ~csncp/tcl_fun/get_era40_dir_new.tcl
source ~col414/tcl_fun/dmget_tcl.tcl

########P R E A M B L E#################################################################

set lats {30.0 -30.0};set lons {160.0 200.0}
set lats {90.0 -90.0};set lons {0.0 360.0}

########N O  U S E R #  C H A N G E S #  B E L O W  # H E R E###################

set tdir /work/inter

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

if {[string first . $ivar_tmp] > 0} {
set ivar_str [string range $ivar_tmp 0 [expr [string first . $ivar_tmp]-1]]
} else {
set ivar_str $ivar_tmp
}

set idir /cs/datastore/csdar/csncp/era40/[get_era40_dir_new $ivar_tmp]

if {$ybeg == $yend} {
set yran "$ybeg"
} else {
set yran "$ybeg-$yend"
}

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 $ivar_tmp.era40.$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.era40.$yran.nc"
} elseif {$iper == 12 } {

if {$hsel == 0} {
set ofil "$ivar_tmp.lm.era40.0000.$yran.nc"
} elseif {$hsel == 1} {
set ofil "$ivar_tmp.lm.era40.0600.$yran.nc"
} elseif {$hsel == 2} {
set ofil "$ivar_tmp.lm.era40.1200.$yran.nc"
} elseif {$hsel == 3} {
set ofil "$ivar_tmp.lm.era40.1800.$yran.nc"
} elseif {$hsel == 4} {
set ofil "$ivar_tmp.lm.era40.$yran.nc"
} else {
puts "hsel must be between 0 and 4, not $hsel."
return
}

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

puts "Output file=$odir/$ofil"

dmget_tcl $ifils

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

set ifil $ivar_tmp.era40.$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 "lat = [nap_get netcdf $idir/$ifil latitude]"
nap "lon = [nap_get netcdf $idir/$ifil longitude]"

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 = f32(ivar*0)"
nap "c1 = f32(ivar*0)"

nap "out = f32(ivar)"

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

set vatts {long_name units missing_value}

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

catch {[nap_get netcdf $tdir/$ofil $ivar_str:missing_value] netcdf \
$tdir/$ofil $ivar_str:_FillValue}
```

```
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

set gatts {title institution source contact project_id experiment_id
realization Conventions refernces comment history platform}

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

nap "units = ‘hours since 1-1-1 00:00:0.0‘" $units netcdf
$tdir/$ofil time:units

};#ybeg

#return

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]

if {$hsel == 0} {
nap "ntind=$ntbegm1..[expr $ntendm1-3]...4"
} elseif {$hsel == 1} {
nap "ntind=[expr $ntbegm1+1]..[expr $ntendm1-2]...4"
} elseif {$hsel == 2} {
nap "ntind=[expr $ntbegm1+2]..[expr $ntendm1-1]...4"
} elseif {$hsel == 3} {
```

```
nap "ntind=[expr $ntbegm1+3]..[expr $ntendm1]...4"
} elseif {$hsel == 4} {
nap "ntind=$ntbegm1..$ntendm1"
} else {
nap "ntind=$ntbegm1..$ntendm1"
puts "hsel must be between 0 and 4, not $hsel."
return
}

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

set skip 0

if { $iper == 4 } {

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

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

};#iper

puts "ynow,mnow,inow,skip=$ynow,$mnow,$inow,$skip"

if { $skip == 0 } {

if { $rank == 3 } {
nap "v1 = [nap_get netcdf $idir/$ifil $ivar_str \
"$ntind,$lat_ind,$lon_ind"]"
} else {
nap "v1 = [nap_get netcdf $idir/$ifil $ivar_str \
"$ntind,,$lat_ind,$lon_ind"]"
}

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(v2*0+[lindex $ndays $mnowm1])"
nap "c3 = i32(ivar*0)"
```

```
if { $rank == 3 } {
$c3 set value c2 "$inow,,"
} else {
$c3 set value c2 "$inow,,,"
}

nap "c1 = c1 + c3"

};#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

file rename $tdir/$ofil $odir/$ofil

}
```

8.5 lookup.txt

```
001 :STRF :Stream Function :m**2 s**-1 :-
002 :VPOT :Velocity Potential :m**2 s**-1 :-
003 :PT :Potential Temperature :K :-
004 :EQPT :Equivalent Potential Temperature :K :-
005 :SEPT :Saturated Equivalent Potential Temperature :K :-
006 :None :Reserved for Metview :- :-
007 :None :Reserved for Metview :- :-
008 :None :Reserved for Metview :- :-
009 :None :Reserved for Metview :- :-
010 :None :Reserved for Metview :- :-
011 :UDVW :u-component of Divergent Wind :m s**-1 :-
012 :VDVW :v-component of Divergent Wind :m s**-1 :-
013 :URTW :u-component of Rotational Wind :m s**-1 :-
014 :VRTW :v-component of Rotational Wind :m s**-1 :-
015 :None :Reserved for Metview :- :-
016 :None :Reserved for Metview :- :-
017 :None :Reserved for Metview :- :-
018 :None :Reserved for Metview :- :-
019 :None :Reserved for Metview :- :-
020 :None :Reserved for Metview :- :-
021 :UCTP :Unbalanced component of temperature :K :-
022 :UCLN :Unbalanced component of lnsp :- :-
023 :UCDV :Unbalanced component of divergence :s**-1 :-
024 :None :Reserved for future unbalanced components :- :-
025 :None :Reserved for future unbalanced components :- :-
026 :CL :Lake cover :0 to 1 :-
027 :CVL :Low vegetation cover :0 to 1 :-
028 :CVH :High vegetation cover :0 to 1 :-
029 :TVL :Type of low vegetation :- :-
030 :TVH :Type of high vegetation :- :-
031 :CI :Sea ice cover :0 to 1 :-
032 :ASN :Snow albedo :0 to 1 :-
033 :RSN :Snow density :kg**-3 :-
034 :SSTK :Sea surface temperature :K :Absolute
035 :ISTL1 :Ice surface temperature layer 1 :K :-
036 :ISTL2 :Ice surface temperature layer 2 :K :-
037 :ISTL3 :Ice surface temperature layer 3 :K :-
038 :ISTL4 :Ice surface temperature layer 4 :K :-
039 :SWVL1 :Volumetric soil water layer 1 :m**3 m**-3 :-
040 :SWVL2 :Volumetric soil water layer 2 :m**3 m**-3 :-
041 :SWVL3 :Volumetric soil water layer 3 :m**3 m**-3 :-
042 :SWVL4 :Volumetric soil water layer 4 :m**3 m**-3 :-
043 :SLT :Soil Type :- :-
044 :SNW :Snow evaporation (accum.) :m : Mark Collier defined this check
045 :SNM :Snow melt (accum.) :m :Mark Collier defined this check
051 :MX2T24 :Max 2m temp :K :During previous 24 hours
052 :MN2T24 :Min 2m temp :K :During previous 24 hours
```

```
053 :to 59 - Unused :- :-
060 :PV :Potential vorticity :K m**2 kg**-1 s**-1 :-
061 :to 126 - Unused :- :-
127 :AT :Atmospheric tide :- :Not GRIB data
128 :BV :Budget values :- :Not GRIB data
129 :Z :Geopotential :m**2 s**-2 :At the surface: orography
130 :T :Temperature :K :-
131 :U :U-velocity :m s**-1 :-
132 :V :V-velocity :m s**-1 :-
133 :Q :Specific humidity :kg kg**-1 :-
134 :SP :Surface pressure :Pa :-
135 :W :Vertical velocity :Pa s**-1 :-
136 :TCW :Total column water :kg m**-2 :-
137 :PWC :Precipitable water content :kg m**-2 :-
138 :VO :Vorticity (relative) :s**-1 :-
139 :ST :Surf.temp/soil temp level 1 :K :Soil temp level 1 from 930804
140 :SSW :Surf soil wet/soil wet level 1 :m of water :Soil wet level 1 from 930803
141 :SD :Snow depth :m of water :-
142 :LSP :Large scale precipitation :m :Accumulated since start of forecast
143 :CP :Convective precipitation :m :Accumulated since start of forecast
144 :SF :Snow fall :m of water equivalent :Accumulated since start of forecast
145 :BLD :Boundary layer dissipation :W m**-2 s :Accumulated since start of forecast
146 :SSHF :Surface sensible heat flux :W m**-2 s :Accumulated since start of forecast
147 :SLHF :Surface latent heat flux :W m**-2 s :Accumulated since start of forecast
148 :SS/CHNK :Surface stress/Charnock :- :Charnock (from 980519)
149 :SNR :Surface net radiation :- :-
150 :TNR :Top net radiation :- :-
151 :MSL :Mean sea level pressure :Pa :-
152 :LNSP :Log surface pressure :- :-
153 :SWHR :Short wave heating rate :K :-
154 :LWH :Long wave heating rate :K :-
155 :D :Divergence :s**-1 :-
156 :GH :Height :m :Geopotential
157 :R :Relative humidity :% :-
158 :TSP :Tendency of surface pressure :Pa s**-1 :-
159 :BLH :Boundary layer height :m :-
160 :SDOR :Standard deviation of orography :- :-
161 :ISOR :Anisotropy of subgrid scale orography - -
162 :ANOR :Angle of subgrid scale orography :- :-
163 :SLOR :Slope of subgrid scale orography :- :-
164 :TCC :Total cloud cover :0 to 1 :-
165 :10U :10 metre u wind component :m s**-1 :-
166 :10V :10 metre v wind component :m s**-1 :-
167 :2T :2 metre temperature :K :-
168 :2D :2 metre dewpoint temperature :K :-
169 :SSRD :Surface solar radiation downwards :W m**-2 s :Accumulated since
     start of forecast
170 :DST :Deep soil tmp/soil temp level 2 :K :Soil temp level 2 from 930804
171 :DSW :Deep soil wet/soil wet level 2 :m of water Soil wet level 2 from 930803.
     Scaled to depth of surf. Water in layer 7cm deep.
```

```
172 :LSM :Land/sea mask :0, 1 :-
173 :SR :Surface roughness :m :-
174 :AL :Albedo :- :-
175 :STRD :Surface thermal radiation downwards :W m**-2 s :Accumulated
     since start of forecast
176 :SSR :Surface solar radiation :W m**-2 s :Accumulated since start of forecast
177 :STR :Surface thermal radiation :W m**-2 s :Accumulated since start of forecast
178 :TSR :Top solar radiation :W m**-2 s :Accumulated since start of forecast
179 :TTR :Top thermal radiation :W m**-2 s :Accumulated since start of forecast
180 :EWSS :East/West surface stress :N m**-2 s :Accumulated since start of forecast
181 :NSSS :North/South surface stress :N m**-2 s :Accumulated since start of forecast
182 :E :Evaporation: m of water :Accumulated since start of forecast
183 :CDST :Clim deep soil tmp/soil tmp level 3 :K Soil tmp level 3 from 930804
184 :CDSW :Clim deep soil wet/soil wet level 3 :m of water :Soil wet level 3
     from 930803. Scaled to depth of surf. Water in layer 7cm deep.
185 :CCC :Convective cloud cover :0 to 1 :-
186 :LCC :Low cloud cover :0 to 1 :-
187 :MCC :Medium cloud cover :0 to 1 :-
188 :HCC :High cloud cover :0 to 1 :-
189 :SUND :Sunshine duration :s :-
190 :EWOV :EW component subgrid orographic variance :m**2 :-
191 :NSOV :NS component subgrid orographic variance :m**2 :-
192 :NWOV :NWSE component subgrid orographic variance :m**2 :-
193 :NEOV :NESW component subgrid orographic variance :m**2 :-
194 :BTMP :Brightness temperature :K :-
195 :LGWS :Lat. component of gravity wave stress :N m**-2 s :Accumulated
     since start of forecast
196 :MGWS :Meridional component gravity wave stress :N m**-2 s :Accumulated
     since start of forecast
197 :GWD :Gravity wave dissipation :W m**-2 s :Accumulated since start of forecast
198 :SRC :Skin reservoir content :m of water :-
199 :VEG :Percentage of vegetation :% :-
200 :VSO :Variance of sub-grid scale orography :m**2 :-
201 :MX2T :Max 2m temp since previous post-processing :K :-
202 :MN2T :Min 2m temp since previous post-processing :K :-
203 :O3 :Ozone mass mixing ratio :kg kg**-1 :-
204 :PAW :Precip. analysis weights :- :-
205 :RO :Runoff* :m :Accumulated since start of forecast
206 :TCO3 :Total column ozone :Dobson (kg m**-2) :-
207 :10SI :10m. Windspeed (irresp of dir.) :m s**-1 :-
208 :TSRC :Top net solar radiation clear sky :W m**-2 :-
209 :TTRC :Top upward thermal radiation clear sky :W m**-2 :-
210 :SSRC :Surface net solar radiation clear sky :W m**-2 :-
211 :STRC :Surface net thermal radiation clear sky :W m**-2 :-
212 :SI :Solar insulation :W m**-2 :-
213 :- :Unused :- :-
214 :DHR :Diabatic heating by radiation* :K :-
215 :DHVD :Diabatic heating by vertical diffusion :K :-
216 :DHCC :Diabatic heating by cumulus convection :K :-
217 :DHLC :Diabatic heating large-scale condensation :K :-
```

```
218 :VDZW :Vertical diffusion of zonal wind :m s**-1 :-
219 :VDMW :Vertical diffusion of meridional wind :m s**-1 :-
220 :EWGD :EW gravity wave drag :m s**-1 :-
221 :NSGD :NS gravity wave drag :m s**-1 :-
222 :CTZW :Convective tendency of zonal wind :m s**-1 :-
223 :CTMW :Convective tendency of meridional wind :m s**-1 :-
224 :VDH :Vertical diffusion of humidity :kg kg**-1 :-
225 :HTCC :Humidity tendency by cumulus convection :kg kg**-1 :-
226 :HTLC :Humidity tendency large-scale condensation :kg kg**-1 :-
227 :CRNH :Change from removing negative humidity :kg/kg s-1 :-
228 :TP :Total precipitation :m :Field not archived
229 :IEWS :Instantaneous X surface stress :N m**-2 :-
230 :INSS :Instantaneous Y surface stress :N m**-2 :-
231 :ISHF :Instantaneous surface Heat Flux :W m**-2 :-
232 :IE :Instantaneous Moisture Flux :kg m**-2 s :Evaporation
233 :ASQ :Apparent Surface Humidity :kg kg**-1 :-
234 :LSRH :Log of surface roughness length for heat :- :-
235 :SKT :Skin Temperature :K :-
236 :STL4 :Soil temperature level 4 :K :-
237 :SWL4 :Soil wetness level 4 :m :-
238 :TSN :Temperature of snow layer :K :-
239 :CSF :Convective snow-fall :m of water equivalent :Accumulated
     since start of forecast
240 :LSF :Large scale snow-fall :m of water equivalent :Accumulated
     since start of forecast
241 :ACF :Accumulated cloud fraction tendency :(-1 to 1) :-
242 :ALW :Accumulated liquid water tendency :(-1 to 1) :-
243 :FAL :Forecast albedo :- :-
244 :FSR :Forecast surface roughness :m :-
245 :FLSR :Forecast log of surface roughness for heat :- :-
246 :CLWC :Cloud liquid water content :kg kg**-1 :-
247 :CIWC :Cloud ice water content :kg kg**-1 :-
248 :CC :Cloud cover :0 to 1 :-
249 :AIW :Accumulated ice water tendency :-1 to 1) :-
250 :ICE :Ice Age :(0 first-year, 1 multi-year) :1,0 0 first-year, 1 multi-year
251 :ATTE :Adiabatic tendency of temperature :K :-
252 :ATHE :Adiabatic tendency of humidity :kg kg**-1 :-
253 :ATZE :Adiabatic tendency of zonal wind :m s**-1 :-
254 :ATMW :Adiabatic tendency of meridional wind :m s**-1 :-
255 :- :Indicates a missing value :- :-
```

8.6 make_era40_invariant

```
#!/cs/datastore/csdar/dav480/tcl/bin/tclsh
#CSIRO Australia
#Mark Collier June 01 2005
#Modified     June 01 2005

#generate nc files from grib files of invariant type

source ~/.tclshrc
source ~col414/tcl_fun/pad10.tcl
source ~col414/tcl_fun/pad10000.tcl
source ~col414/tcl_fun/dmget_tcl.tcl
source ~csncp/era40/era40_table_lookup.tcl

########P R E A M B L E ############################################################

set PID [pid]

set tdir /work/inter/csncp
set idir /cs/datastore/csdar/csncp/era40/raw/grib/tape1/dataserver/e4oper/invariant
set odir /cs/datastore/csdar/csncp/era40/invariant

########N O  U S E R #  C H A N G E S #  B E L O W  # H E R E###################

nap "latitude = f64(90 .. -90...  -2.5)"
nap "longitude = f64(0 .. 357.5 ...  2.5)"
$latitude set unit degrees_north
$longitude set unit degrees_east

set times {372.0 1080.0 1776.0 2508.0 3240.0 3972.0 4716.0 5448.0 6180.0
6912.0 7644.0 8388.0}

set ifil albedo
file mkdir $tdir
set nt 1
for {set cnt 1} {$cnt <= 12} {incr cnt} {
set ntm1 [expr $nt-1]
nap "time = f64({[lindex $times $ntm1]})"
$time set unit "hours since 1-1-1 00:00:0.0"
set t1 [exec [glob ~/bin/wgrib] -nh -4yr -bin -d $cnt $idir/$ifil -o $tdir/dump.$PID]
puts "t1=$t1"
set t2 [split $t1 :]
set t3 [lindex $t2 4]
set t4 [string trimleft $t3 "kpds5="]
set vals [era40_table_lookup $t4]
set ovar [string trimleft [string trimright [string tolower [lindex $vals 0]]]]


if {$ovar == "z"} {
```

```
set ovar "za"
}

set ofil $ovar.era40.nc
puts "Output = $ofil"

set file [open $tdir/dump.$PID]
nap "in1 = [nap_get binary $file f32]"
close $file

file delete -force $tdir/dump.$PID
nap "in2 = reshape(in1,{1 73 144})"
$in2 set coo time latitude longitude
$in2 set dim time latitude longitude

nap "mask = (in2==9.999e+20)"
nap "mask = (in2==1.0e+21)"
nap "mask = f32(in2>9.999e+20)"
$mask set missing 1.0
nap "in3 = in2+mask"
$in3 set missing 1e20
$in3 set label "[string trimleft [string trimright [lindex $vals 1]]]"
$in3 set unit "[string trimleft [string trimright [lindex $vals 2]]]"

if {$nt == 1} {
file delete -force $odir/$ofil
file delete -force $tdir/$ofil
};#nt=1

$in3 netcdf -unlimited -index "$ntm1,," $tdir/$ofil $ovar
$time netcdf -unlimited -index "$ntm1" $tdir/$ofil time

if {$nt == 1} {
nap "missing_value = f32(1e20)"
$missing_value netcdf $tdir/$ofil $ovar:missing_value
source ~csncp/era40/era40_info.tcl
};#nt=1

incr nt
};#cnt

file rename $tdir/$ofil $odir/$ofil

set ifil fixed
file mkdir $tdir
for {set cnt 1} {$cnt <= 12} {incr cnt} {
set cntm1 [expr $cnt-1]
set t1 [exec [glob ~/bin/wgrib] -nh -4yr -bin -d $cnt $idir/$ifil -o $tdir/dump.$PID]
puts "t1=$t1"
set t2 [split $t1 :]
```

```
set t3 [lindex $t2 4]
set t4 [string trimleft $t3 "kpds5="]
set vals [era40_table_lookup $t4]
set ovar [string trimleft [string trimright [string tolower [lindex $vals 0]]]]
set ofil $ovar.era40.nc
puts "Output = $ofil"

set file [open $tdir/dump.$PID]
nap "in1 = [nap_get binary $file f32]"
close $file

file delete -force $tdir/dump.$PID
nap "in2 = reshape(in1,{73 144})"
$in2 set coo latitude longitude
$in2 set dim latitude longitude

nap "mask = (in2==9.999e+20)"
nap "mask = (in2==1.0e+21)"
nap "mask = f32(in2>9.999e+20)"
$mask set missing 1.0
nap "in3 = in2+mask"
$in3 set missing 1e20
$in3 set label "[string trimleft [string trimright [lindex $vals 1]]]"
$in3 set unit "[string trimleft [string trimright [lindex $vals 2]]]"

file delete -force $odir/$ofil
file delete -force $tdir/$ofil

$in3 netcdf $tdir/$ofil $ovar

nap "missing_value = f32(1e20)"
$missing_value netcdf $tdir/$ofil $ovar:missing_value
source ~csncp/era40/era40_info.tcl

file rename $tdir/$ofil $odir/$ofil

};#cnt

return
exit
```

8.7 make_era40_tape

```
#!/cs/datastore/csdar/dav480/tcl/bin/tclsh
#CSIRO Australia
#Mark Collier April 01 2005
#Modified     April 01 2005

#generate nc files from grib files of either pressure level or surface
#parameter types

source ~/.tclshrc
source ~col414/tcl_fun/pad10.tcl
source ~col414/tcl_fun/pad10000.tcl
source ~col414/tcl_fun/dmget_tcl.tcl
source ~csncp/era40/era40_table_lookup.tcl

########P R E A M B L E ##################################################################

set restart 90574;#restart from part-way through
set restart 0;#start new files from scratch
set restart [expr 11*23*(526-1)];#restart from part-way through

if {$restart > 0} {
puts "Might have to manually move across output files,
once completed, with a restart."
}

set PID [pid]

set tdir /cs/datastore/csdar/csncp/era40/tmp
while {[file exists $tdir] == 1} {
set tdir /cs/datastore/csdar/csncp/era40/tmp/
[clock format [clock seconds] -format "%Y%m%d%H%M%S"]
}
file mkdir $tdir

set tdir /cs/datastore/csdar/csncp/era40/tmp/20050722115125

set record_size 21240;#think this is the same for pl/sfc and all input files.

file mkdir $tdir

#choose either pl or sfc
set type sfc
set type pl

########N O  U S E R #  C H A N G E S #  B E L O W  # H E R E###################

set ofils ""
```

```
set pls {1 2 3 5 7 10 20 30 50 70 100 150 200 250 300 400 500 600 700 775 850 925 1000}

if {$type == "pl"} {
set numvar [expr 11*[llength $pls]]
set com 3
} elseif {$type == "sfc"} {
set numvar 54
set com 2
} else {
puts "Don't know that type."
return
}

set numvarm1 [expr $numvar-1]

set ndm_leap {31 29 31 30 31 30 31 31 30 31 30 31}
set ndm_noleap {31 28 31 30 31 30 31 31 30 31 30 31}

foreach n $ndm_leap {
lappend ndm_leapm1 [expr $n-1]
};#n
foreach n $ndm_noleap {
lappend ndm_noleapm1 [expr $n-1]
};#n

nap "latitude = f64(90 .. -90...  -2.5)"
nap "longitude = f64(0 .. 357.5 ...  2.5)"

proc int_hour {y m} {
set ndm_leap {31 29 31 30 31 30 31 31 30 31 30 31}
set ndm_noleap {31 28 31 30 31 30 31 31 30 31 30 31}

foreach n $ndm_leap {
lappend ndm_leapm1 [expr $n-1]
};#n
foreach n $ndm_noleap {
lappend ndm_noleapm1 [expr $n-1]
};#n
set i [expr 17145984]

for {set ynow 1957} {$ynow <= $y} {incr ynow} {

set leap [[nap $ynow%4]]

if {$leap == 0} {
set ndm $ndm_leapm1
} else {
set ndm $ndm_noleapm1
}
```

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

if {$ynow == $y && $mnow == $m} {
return $i
}

for {set dnow 0} {$dnow <= [lindex $ndm $mnowm1]} {incr dnow} {
incr i 24
};#dnow

};#mnow
};#ynow
};#int_hour

set ybeg 1957;set ymbeg 9;nap "time = f64{[int_hour $ybeg 1]}"
set yend 2002;set ymend 8;#WHOLE SET

$latitude set unit degrees_north
$longitude set unit degrees_east
$time set unit "hours since 1-1-1 00:00:0.0"

for {set ynow $ybeg} {$ynow <= $yend} {incr ynow} {
#catch {unset ofils}
set nt 1

set mbeg 1
set mend 12

if {$ynow == $ybeg} {
set mbeg $ymbeg
} else {
set mbeg 1
}

if {$ynow == $yend} {
set mend $ymend
} else {
set mend 12
}

for {set mnow $mbeg} {$mnow <= $mend} {incr mnow} {
set ifil ${ynow}[pad10 ${mnow}]01


source ~csncp/era40/era40_tape.tcl

if {[file exists $idir/$ifil] != 1} {
puts "Error: $idir/$ifil non-existent."
return
```

```
}

lappend ifils $idir/$ifil
};#mnow

puts "dmgetting $ifils..."
dmget_tcl $ifils

set tnt 1
for {set mnow $mbeg} {$mnow <= $mend} {incr mnow} {
set vnt 1
set offset 0

source ~csncp/era40/era40_tape.tcl

set mnowm1 [expr $mnow-1]

set ifil ${ynow}[pad10 ${mnow}]01

puts "ifil=$idir/$ifil"

if {[file exists $idir/$ifil] == 1} {
puts $idir/$ifil
}

set leap [[nap $ynow%4]]

if {$leap == 0} {
set ndm $ndm_leapm1
} else {
set ndm $ndm_noleapm1
}

for {set dnow 0} {$dnow <= [lindex $ndm $mnowm1]} {incr dnow} {

for {set hnow 0} {$hnow <= 3} {incr hnow} {

set ntm1 [expr $nt-1]

for {set vnow 0} {$vnow <= $numvarm1} {incr vnow} {

if {$tnt >= $restart} {
set t1 [exec [glob ~csncp/bin/wgrib] -nh -4yr -bin -p $offset $idir/$ifil
-o $tdir/dump.$PID]
puts "t1=$t1"

set t2 [split $t1 :]
set t3 [lindex $t2 4]
set t4 [string trimleft $t3 "kpds5="]
```

```
if {$type == "pl"} {
set plev [pad10000 [string trimleft [string trimright [string trimright
[lindex $t2 11] "mb"]]]]
nap "level = f64{$plev}"
$level set unit hPa
}

set vals [era40_table_lookup $t4]

set ovar [string trimleft [string trimright [string tolower [lindex $vals 0]]]]

if {$ovar == "10u"} {
set ovar "u10"
} elseif {$ovar == "10v"} {
set ovar "v10"
} elseif {$ovar == "2d"} {
set ovar "d2"
} elseif {$ovar == "2t"} {
set ovar "t2"
} elseif {$ovar == "t"} {
set ovar "ta"
} elseif {$ovar == "z"} {
set ovar "za"
}

if {$type == "pl"} {
set odir /cs/datastore/csdar/csncp/era40/level/$plev
file mkdir $odir
set ofil $ovar.$plev.era40.$ynow.nc
} else {
set odir /cs/datastore/csdar/csncp/era40/surface
set ofil $ovar.era40.$ynow.nc
}
puts "$tdir/$ofil $vals"

set file [open $tdir/dump.$PID]
nap "in1 = [nap_get binary $file f32]"
close $file

file delete -force $tdir/dump.$PID

if {$type == "pl"} {
nap "in2 = reshape(in1,{1 1 73 144})"
$in2 set coo time level latitude longitude
$in2 set dim time level latitude longitude
} else {
nap "in2 = reshape(in1,{1 73 144})"
$in2 set coo time latitude longitude
$in2 set dim time latitude longitude
}
```

```
nap "mask = (in2==9.999e+20)"
nap "mask = (in2==1.0e+21)"
nap "mask = f32(in2>9.999e+20)"
$mask set missing 1.0
nap "in3 = in2+mask"
$in3 set missing 1e20
$in3 set label "[string trimleft [string trimright [lindex $vals 1]]]"
$in3 set unit "[string trimleft [string trimright [lindex $vals 2]]]"

if {$nt == 1} {
file delete -force $odir/$ofil
file delete -force $tdir/$ofil
  lappend ofils $odir/$ofil
};#nt=1

$in3 netcdf -unlimited -index "$ntm1[commas $com]" $tdir/$ofil $ovar
$time netcdf -unlimited -index "$ntm1" $tdir/$ofil time

if {$nt == 1} {
  if {$type == "pl"} {
  nap "positive = ‘down‘"
  $positive netcdf $tdir/$ofil level:positive
  }

nap "missing_value = f32(1e20)"
$missing_value netcdf $tdir/$ofil $ovar:missing_value

source ~csncp/era40/era40_info.tcl

};#nt=1

};#restart

incr tnt
incr vnt
incr offset $record_size

};#vnow

nap "time = time + 6.0"

incr nt

};#hnow

};#dnow

};#mnow
```

```
foreach f $ofils {
set justfile [string range $f [expr [string last / $f]+1] end]
puts "Copying $tdir/$justfile to $f..."
  if {$ynow > 1957 && $ynow < 2002} {
  set shape [nap_get netcdf -shape $tdir/$justfile time]
    if {$shape != 1460 && $shape != 1464} {
    puts "Something wrong as not right number of times in file."
    return
    }
}
file copy -force $tdir/$justfile $f
file delete -force $tdir/$justfile

};#f
unset ofils

};#ynow

return
exit
```

8.8 run_era40_clims

```
#!/cs/datastore/csdar/dav480/tcl/bin/tclsh
#CSIRO Australia
#Mark Collier June      21 2005
#Modified     September 21 2005

#generate long_term and year_by_year climatologies

source ~csncp/.tclshrc
source ~csncp/tcl_fun/long_term_era40_new.tcl
source ~csncp/tcl_fun/year_by_year_era40.tcl

source ~csncp/tcl_fun/pad10.tcl
source ~csncp/tcl_fun/getti.tcl
source ~csncp/tcl_fun/get_era40_dir_new.tcl
source ~csncp/tcl_fun/get_era40_dir.tcl
source ~col414/tcl_fun/dmget_tcl.tcl

catch {exec mkdir $::env(TMPDIR)}

########P R E A M B L E ############################################################

set ybeg 1958;set yend 2001;set mbeg 1;set mend 12
set ybeg 1957;set yend 2002;set mbeg 9;set mend 8

########N O  U S E R #  C H A N G E S #  B E L O W  # H E R E###################

lappend tvec $ybeg $mbeg $yend $mend

if {$ybeg > $yend} {
puts "ybeg>yend"
return
}

set period 4
set period 12

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

set levs {1000 0925 0850 0775 0700 0600 0500 0400 0300
0250 0200 0150 0100 0070 0070 0050 0030 0020 0010 0007
0005 0003 0002 0001}
```

```
set 3dv {ta d o3 pv q r u v vo w za}

catch {unset vars}
foreach l $levs {
foreach v $3dv {
lappend vars $v.$l

};#v
};#l

set vars {blh cdst ci cp d2 dst e ewss hcc ie iews inss istl1
istl2 istl3 istl4 lcc lgws lsp mcc mgws msl nsss pwc ro sd sf
slhf snm snw sshf ssr ssrc ssrd st stl4 str strc strd swvl1
swvl2 swvl3 swvl4 t2 tcc tco3 tcw tsn tsr tsrc ttr ttrc u10 v10}

if {$mbeg != 1} {
set ybegl [expr $ybeg+1]
} else {
set ybegl $ybeg
}

if {$mend != 12} {
set yendl [expr $yend-1]
} else {
set yendl $yend
}

puts "sss"
foreach f $vars {
puts $vars
if {$ybegl == $yendl} {
set odir /cs/datastore/csdar/csncp/era40/c/$ybegl/l/$per_str
set ofil $f.l$per_str.era40.$ybegl.nc
} else {
set odir /cs/datastore/csdar/csncp/era40/c/$ybegl-$yendl/l/$per_str
set ofil $f.l$per_str.era40.$ybegl-$yendl.nc
}
file mkdir $odir

if { [file exists $odir/$ofil] == 0 } {

long_term_era40_new $f $period 4 $ybegl $yendl $odir

}
if {$ybeg == $yend} {
set odir /cs/datastore/csdar/csncp/era40/c/$ybeg/y/$per_str
} else {
set odir /cs/datastore/csdar/csncp/era40/c/$ybeg-$yend/y/$per_str
}
```

```
set ofil $f.y${per_str}.era40.${ybeg}[pad10 $mbeg]-${yend}[pad10 $mend].nc
file mkdir $odir
if { [file exists $odir/$ofil] == 0 } {
year_by_year_era40 $f $period 4 $tvec $odir
}
puts $odir
puts $ofil
}

return
exit
```

8.9 year_by_year_era40

```
proc year_by_year_era40_new {ivar_tmp iper hsel tvec odir} {
#CSIRO Australia
#Mark Collier June 01 2005
#Modified     June 01 2005

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

source ~col414/.tclshrc

########P R E A M B L E ############################################################

set lats {30.0 -30.0};set lons {160.0 200.0}
set lats {90.0 -90.0};set lons {0.0 360.0}

########N O  U S E R #  C H A N G E S #  B E L O W  # H E R E###################

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

puts $tdir

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

set ybeg [lindex $tvec 0];set yend [lindex $tvec 2]
set mbeg [lindex $tvec 1];set mend [lindex $tvec 3]

if {$ybeg > $yend } {
puts "ybeg > yend"
return
} elseif {$mbeg < 1 || $mbeg > 12 || $mend < 1 || $mend > 12} {
puts "problem with mbeg, mend."
return
}

set ivar $ivar_tmp

if {[llength [split $ivar_tmp .]] == 2} {
set ivar_str [lindex [split $ivar_tmp .] 0]
} else {
set ivar_str $ivar
}
```

```
set idir /cs/datastore/csdar/csncp/era40/[get_era40_dir_new $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 $ivar_tmp.era40.$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 "$ivar_tmp.ys.era40.$ybeg[pad10 $mbeg]-$yend[pad10 $mend].nc"

} elseif {$iper == 12 } {

if {$hsel == 0} {
set ofil "$ivar_tmp.ym.era40.0000.$ybeg[pad10 $mbeg]-$yend[pad10 $mend].nc"
} elseif {$hsel == 1} {
set ofil "$ivar_tmp.ym.era40.0600.$ybeg[pad10 $mbeg]-$yend[pad10 $mend].nc"
} elseif {$hsel == 2} {
set ofil "$ivar_tmp.ym.era40.1200.$ybeg[pad10 $mbeg]-$yend[pad10 $mend].nc"
} elseif {$hsel == 3} {
set ofil "$ivar_tmp.ym.era40.1800.$ybeg[pad10 $mbeg]-$yend[pad10 $mend].nc"
} elseif {$hsel == 4} {
set ofil "$ivar_tmp.ym.era40.$ybeg[pad10 $mbeg]-$yend[pad10 $mend].nc"
} else {
puts "hsel must be between 0 and 4, not $hsel."
return
}

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

puts "Output file=$odir/$ofil"

dmget_tcl "$ifils"
```

```
set iexit 0

set ibeg 0

set inow_dmp 0

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

if {$ynow == $ybeg} {
set ibeg 0
}

if {$ynow == $ybeg} {
nap "ts3 = f64{[expr 12-$mbeg+1]#0}"
nap "tc2 = f64{[expr 12-$mbeg+1]#0}"
} elseif {$ynow == $yend} {
nap "ts3 = f64{$mend#0}"
nap "tc2 = f64{$mend#0}"
} else {
nap "ts3 = f64{$iper#0}"
nap "tc2 = f64{$iper#0}"
}

set ifil $ivar_tmp.era40.$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 {$ynow > $ybeg && $ynow < $yend} {
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} {
set iend [expr $ibeg+12-$mbeg]
} elseif {$ynow == $yend} {
set iend [expr $ibeg+$mend-1]
} else {
set iend [expr $ibeg+$iperm1]
}

if { $ynow == $ybeg} {

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

```
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 "c1 = f32(ivar*0)"

nap "out = f32(ivar)"

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

set vatts {long_name units missing_value}

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

set gatts {title institution source contact project_id experiment_id
realization Conventions refernces comment history platform}

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

#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}
}

if {$ynow == $ybeg} {
set m1st $mbeg;set mlst 12
} elseif {$ynow == 2002} {
set m1st 1;set mlst $mend
} else {
set m1st 1;set mlst 12
}

set ntbeg 1
for {set mnow $m1st} {$mnow <= $mlst} {incr mnow} {
puts "mnow=$mnow"
set mnowm1 [expr $mnow-1]

if {$ynow == $ybeg} {
set inow [expr [getti $mnowm1 $iper]-($mbeg-1)]
} else {
set inow [getti $mnowm1 $iper]
}

if { $mnow == 4 && $iper == 4 || ($ynow == $yend && $mnow == $mend && $iper == 4)} {
incr inow_dmp
} elseif {($mnow == 12 && $iper == 12)}  {
incr inow_dmp
```

```
} elseif {($ynow == $yend && $mnow == $mend && $iper == 12)} {
incr inow_dmp
set iexit 1
}

puts "inow=$inow inow_dmp=$inow_dmp"

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

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

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

if {$hsel == 0} {
nap "ntind=$ntbegm1..[expr $ntendm1-3]...4"
} elseif {$hsel == 1} {
nap "ntind=[expr $ntbegm1+1]..[expr $ntendm1-2]...4"
} elseif {$hsel == 2} {
nap "ntind=[expr $ntbegm1+2]..[expr $ntendm1-1]...4"
} elseif {$hsel == 3} {
nap "ntind=[expr $ntbegm1+3]..[expr $ntendm1]...4"
} elseif {$hsel == 4} {
nap "ntind=$ntbegm1..$ntendm1"
} else {
nap "ntind=$ntbegm1..$ntendm1"
puts "hsel must be between 0 and 4, not $hsel."
return
}

nap "ts0 = [nap_get netcdf $idir/$ifil time \
"$ntind"]"

nap "ts1 = am(ts0)"

if {$ynow == $ybeg} {
nap "ts2 = f64{[expr 12-$mbeg+1]#0}"
} elseif {$ynow == $yend} {
nap "ts2 = f64{$mend#0}"
} else {
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 = [nap_get netcdf $idir/$ifil $ivar_str \
"$ntind,$lat_ind,$lon_ind"]"
} else {
nap "v1 = [nap_get netcdf $idir/$ifil $ivar_str \
"$ntind,,$lat_ind,$lon_ind"]"
}

nap "v2 = am(v1)*[lindex $ndays $mnowm1]"
nap "v3 = (ivar*0)"

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

nap "ivar = ivar + v3"

nap "c2 = i32(v2*0+[lindex $ndays $mnowm1])"
nap "c3 = i32(v3*0)"

if { $rank == 3 } {
$c3 set value c2 "$inow,,"
} else {
$c3 set value c2 "$inow,,,"
}

nap "c1 = c1 + c3"

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

puts "ibeg,iend=$ibeg,$iend"

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

if {$ynow == $ybeg} {
nap "ts3 = f64{[expr 12-$mbeg+1]#0}"
nap "tc2 = f64{[expr 12-$mbeg+1]#0}"
} elseif {$ynow == $yend} {
```

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

if {$iexit == 1} {
file rename $tdir/$ofil $odir/$ofil
return
}

set inow_dmp 0
}

set ntbeg [expr $ntend+1]

};#mnow

set ibeg [expr $iend+1]
};#ynow

file rename $tdir/$ofil $odir/$ofil

return
}
```

CSIRO Marine and Atmospheric Research Papers

No. 1 **Whetton, P.H., McInnes, K.L., Jones, R.N., Hennessy, K.J., Suppiah, R., Page, C.M., Bathols, J. and Durack P.J.** Australian Climate Change Projections for Impact Assessment and Policy Application. 2005 (still to be published). Electronic edition only.

No. 2 **Frederiksen, J.S. and Frederiksen C.** Decadal Changes in Southern Hemisphere Winter Cyclogenesis. 2006 (still to be published). Electronic edition only.