

Announcement for the Study Group of  
The International Society of Biometeorology

# **Applications and Limitations of Climate Change Scenarios**

The International Society of Biometeorology has set up a Study Group to evaluate scenarios of possible global warming as envisaged by climate models. The main emphasis will be to identify useful information in the model-generated scenarios and to analyze the implications of this information for impact studies.

The Study Group invites participants from all fields of biometeorology, such as human health, indoor climate management, building design, urban design, regional and transport planning, agroclimatology and forestry, water resource management, and insect distribution, desertification or soil conservation sciences. The strategy of the Study Group is to distribute scenarios generated by the spectrum of climate models of the Max-Planck-Institut für Meteorologie in Hamburg to the participants. These scenarios will allow for an assessment of the effect of different spatial resolution and for the natural variability of climate, as opposed to an expected "change" signal. The distribution of these scenarios is subject to certain restrictions. Only a limited number of variables will be supplied. Participants are encouraged to keep in contact with climatologists while working with the scenarios.

Results obtained by the participants will be presented at a special symposium at the next congress of the International Society of Biometeorology in 1996 in Ljubljana (Slovenia). On that occasion the scenarios used will be critically reviewed and requirements for future scenarios will be discussed between biometeorologists and climate researchers.

Interested scientists are invited to contact one of the chairmen of the Study Group for further information:

## Chairmen

Dr Andris Auliciems  
ACRU  
The University of Queensland  
Brisbane  
Australia 4072  
  
Tel: (61) 7 365 3535  
Fax: (61) 7 365 3561  
E-mail: andris@cassandra.acru.uq.oz.au

Dr Hans von Storch  
Max-Planck-Institut für Meteorologie  
Bundesstraße 55  
D-20146 Hamburg  
Germany  
  
Tel: (49) 40 41173 232  
Fax: (49) 40 41173 298  
E-mail: storch@dkrz.d400.de

## **Contents**

Announcement ISB Study Group

Bibliography

List of files and programs

Gaussian latitudes and land-sea masks for T21, T42 and T106 resolution

Sample plots

- control run T21
- "scenario A" run T21
- time slice T21 "3xCO<sub>2</sub>"
- time slice T42 "3xCO<sub>2</sub>"
- time slice T106 "2xCO<sub>2</sub>"

**"Applications and Limitations of Climate Change Scenarios" International Society of Biometeorology, Study Group SG9**

The study group aims to promote a series of impact studies of global warming as envisaged by climate change models. The main emphasis will be to identify in the model-generated scenarios the useful information and to analyze the implications of this information for impact studies. The tentative nature of such scenarios is recognised and the exercise is treated as a speculative one, but one that might nevertheless help focus on possible problems facing human kind, and one that might allow a more integrated view of the future than commonly available.

With such reservations in mind, we anticipate that assessments may range between "...with the presently available information estimating the impact of climate change on system A is not meaningful...", as one extreme, and "...the mean response of system B will likely be of the order of  $x \pm y$  per decade" as the other extreme. Naturally the latter type of assessment would provide substance for further discussion.

The process involved in the study will be as follows. Several grids will be produced from a number of climate runs, with simulated monthly (January and July) mean temperatures and precipitation fields from a number of climate model runs. These numerical experiments have been conducted with the "ECHAM" atmospheric General Circulation Model (GCM) by the Max-Planck-Institut für Meteorologie in Hamburg and by the Swiss Climate Program in Lugano and Zürich. In all publications proper reference must be made to Prof. Bengtsson of the Max-Planck-Institut für Meteorologie in Hamburg and Prof. Omoura of the Eidgenössische Technische Hochschule in Zürich.

1. From a "control" run, to simulate the present climate, different climatologies are offered to contain multi-year averages but also monthly means from individual months.

2. These data enable individual impact studies to check how well, in respect to their particular distributions, present climate is reproduced by the climate model. Anomalies may be calculated to test the likely sensitivity of future impact assessments.
3. The control run data enable the assessment of impacts of the "natural variability" unconnected to any man-made climate change. Since climate varies for natural reasons (such as internal dynamical processes such as El Niño, Little Ice Age, but also non-climatic factors such as volcanic activity) it makes sense to compare the effect of such natural variations against man-made climate change. Certainly, the model products we are offering, will not allow for a detailed specification of the characteristics of such natural variations, but we believe that first estimates of the relative importance may be obtained.
4. From two sets of "time slice experiments", climate change scenarios for the 50 year and 100 year horizons (using the IPCC "business-as-usual" scenario trace gas emissions increases, with an annual increase of about 1%) are available. In the year 50, or numerically 2035, the CO<sub>2</sub> concentrations have doubled compared to pre-industrial levels. Therefore the output of these experiments are labelled "2xCO<sub>2</sub>". Similarly, the CO<sub>2</sub>-concentrations after 100 years, or in the year "2085", have tripled and the experiment is labelled "3xCO<sub>2</sub>".
6. We provide grids from such model runs with "T21", "T42" resolution and with a "T106" resolution. T21, which is the resolution of the full climate model, operates with a nominal resolution of about 600 by 600 km<sup>2</sup>, T42 with a grid of about 300 by 300 km<sup>2</sup>, whereas T106 has a nominal resolution of about 100 by 100 km<sup>2</sup>.
7. We hope that the above will enable the preparation of mapping the various potential impacts and their uncertainties. Subsequently we propose to apply Geographic Information Systems routines to analyze and integrate the global and regional impact patterns.
8. We now invite offers of contributions from all fields of biometeorology, including human health, indoor climate management, building design, urban design, regional and transport planning, agroclimatology and forestry, water resource management, insect distributions, desertification and soil conservation, and all those phenomena whose presentday

distributions and impacts can be assessed, and which can be speculated upon for the future.

We distribute the model data by e-mail. Interested scientists contact Hans von Storch ([storch@dkrz.d400.de](mailto:storch@dkrz.d400.de)) to arrange the delivery. The data are supplied under some conditions, namely

- that the data are used exclusively for purposes covered by the ISB Study Group 9.
- that the data are not further distributed.
- that all results obtained are reported on the 1996 ISB conference in Ljubljana, and
- that copies of all publications are sent to the chairmen of the Study Group, Andris Auliciems and Hans von Storch.

Most data are available now. The data from the "2xCO<sub>2</sub> time slice experiments with T21 and T42 GCMs as well as "3xCO<sub>2</sub>" with T106 are not yet available.

9. The aim is to present the resulting assessments in a similar format, certainly on identical grids, at a special symposium at the ISB Ljubljana Congress in 1996, and publish in either as grouped papers in a special edition of the International Journal of Biometeorology or in Climate Research, or in a separate volume edited by ourselves.

The following background information might be useful:

- a) Full climate models require the interaction of an ocean and an atmospheric model. Such models are the only tools to infer the global-scale expected changes in the atmosphere and the ocean. To gain better insight in the regional aspects, though, "time slice experiments" are done with only an atmospheric model with a horizontal resolution much better than in regular climate models. In the "time slice experiments" the required information about the state of the ocean and the sea ice is taken from the basic climate model runs. An optimal solution would be to run fully coupled high-resolution atmosphere-ocean models. But the need for compromising spatial resolution and computational costs leads to the "time-slice" set-up which, even though suboptimal, is (hoped to be) capable to infer regional details sufficiently well.

- b) Scenarios, with a spatial resolution such as T42 or T106, have not been available in the past. Instead, standard scenarios, as derived from, for instance, the GISS model output, operate with 750 by 1000 km<sup>2</sup>, or from models with a T21-like resolution.
- c) Note that we use the term "grid" instead of "maps" - GCM results are presented in the form of maps, but are in reality defined only on a grid - and differently from regular maps there is no subgrid-scale information to be recovered by spatial interpolation techniques. (For the various pitfalls in the use of model-generated scenarios, see, for instance, the paper "Inconsistencies at the Interface of Climate Impact Studies and Global Climate Research" given by von Storch at the 13<sup>th</sup> International Congress of Biometeorology in 1993 (available upon request).
- d) A useful example of how to process the scenarios may be the paper by Auliciems at the 13<sup>th</sup> ISB Congress at Calgary entitled "Thermoregulatory Adaptation to Global Warming - Winners and Losers" (available upon request).
- e) A similar exercise is presently planned by the IPCC - but IPCC plans to distribute only maps of expected changes, so that scientists have no opportunity to assess the models' abilities to reproduce the present climate or to deal with the natural variability of the climate system.

#### Chairmen of ISB9

Dr Andris Auliciems, ACRU, The University of Queensland, Brisbane, Australia 4072, tel 61 7 365 3535, fax 61 7 365 3561 e-mail [andris@cassandra.acru.uq.oz.au](mailto:andris@cassandra.acru.uq.oz.au)

Dr Hans von Storch, Max-Planck-Institut für Meteorologie,  
Bundesstrasse 55, D-20 146 Hamburg, Germany, tel 49 40 41173 232,  
fax 49 40 41173 298, e-mail [storch@dkrz.d400.de](mailto:storch@dkrz.d400.de)

## Bibliography

- Cubasch, U., Hasselmann, K., Höck, H., Maier-Reimer, E., Mikolajewicz, U.  
Santer, B. D. and Sausen, R., (1992) Time-dependent  
greenhouse warming computations with a coupled ocean-  
atmosphere model. *Climate Dynamics* 8, 55-69
- Cubasch, U., Hegerl, G., Hellbach, A., Höck, H., Mikolajewicz, U., Santer, B. D.  
and Voss, R. (1994): A climate change simulation starting  
at an early time of industrialization. *Climate Dynamics* (im  
Druck)
- Giorgi and Mearns, (1991). Approaches to the simulation of regional  
climate change: A review. *Rev. of Geophysics* 29, 191-216
- Grotch, S. L. and MacCracken, M. C. (1991) The use of general circulation  
models to predict regional climate change. *J. Climate* 4,  
286-303
- Gyalistras, D., von Storch, H., Fischlin, A. and Beniston, M.(1994) Linking  
GCM-simulated climatic changes to ecosystems models.  
Case studies of statistical downscaling in the Alps. *Climate  
Research* (in press)
- Hewitson, B. C. and Crane, R. G. L. (1992), Large-scale atmospheric controls  
on local precipitation in tropical Mexico. *Geophys.  
Res.Letters*, 19, 1835-1838
- von Storch, H. (1993): Inconsistencies at the interface of climate impact  
studies and global climate research, Proc. 13th Inter-  
national Congress of Biometeorology, Calgary, Canada  
(1993)
- von Storch, H., Zorita, E. and Cubasch, U. (1993), Downscaling of global  
climate change estimates to regional scales: An application  
to Iberian rainfall in wintertime. *J. Climate* 6, 1161-1171
- Zorita, E., J. P. Hughes, D. P. Lettenmaier and H. von Storch (1995):  
Stochastic characterization of regional circulation pattern  
for climate model diagnosis and estimation of local  
precipitation. *J. Climate* (in press)

## **Availability of Climate Change Data on Unix System**

The data are available on internet with the address 136.172.122.32 under the account number ISB\_SG9. To get the actual password please contact Hans von Storch. The data are in the root directory /scr/ISB\_SG9.

The data are output of five different experiments:

- 1) 100-year control experiment (see Cubasch et al., 1992)
- 2) Scenario A experiment (see Cubasch et al., 1992)
- 3) time slice experiments in three different resolutions
  - a) T21 (1985, 2085)
  - b) T42 (1985, 2085) (the "1985-case" is an "AMIP-run")
  - c) T106 (1985, 2035) (see Bengtsson et al., 1984 a, b)

Each file contains data for January and July, a 't' ('p') at the beginning of the name indicates files containing temperature (precipitation) data. All data files (marked with an ending .Z) are packed with help of the UNIX routine "compress". The UNIX routine "uncompress" returns ASCII format with 8F7.2 for temperature and 8F6.2 for precipitation. The ASCII data can be read by the following FORTRAN-programs:

- tread.21.f (T21 resolution, temperature)
- tread.42.f (T42 resolution, temperature)
- tread.106.f (T106 resolution, temperature)
- pread.21.f (T21 resolution, precipitation)
- pread.42.f (T42 resolution, precipitation)
- pread.106.f (T106 resolution, precipitation)

We also provide files which contain the grid definitions. They are named -

- GRID21 (T21 resolution).
- GRID42 (T42 resolution)
- GRID106 (T106 resolution)

They can be read by the same read routines.

Following is the list of filenames according to their experiments group.

## LIST OF DATA FILES

(1) Control run T21

(a) 20-year averages

Precipitation:      p.ctrl.28.Z  
                        p.ctrl.48.Z  
                        p.ctrl.68.Z  
                        p.ctrl.88.Z  
                        p.ctrl.108.Z

Temperature:        t.ctrl.28.Z  
                        t.ctrl.48.Z  
                        t.ctrl.68.Z  
                        t.ctrl.88.Z  
                        t.ctrl.108.Z

(b) individual years of the control run

Precipitation:      p.sing.17.Z  
                        p.sing.23.Z  
                        p.sing.40.Z  
                        p.sing.51.Z  
                        p.sing.84.Z  
                        p.sing.99.Z

Temperature:        t.sing.17.Z  
                        t.sing.23.Z  
                        t.sing.40.Z  
                        t.sing.51.Z  
                        t.sing.84.Z  
                        t.sing.99.Z

(2) Szenario A T21

Precipitation: p.sza.2035.Z  
p.sza.2085.Z

Temperature: t.sza.2035.Z  
t.sza.2085.Z

(3) Time Slice Experiments T21

(a) 30-year-average "1985"

Precipitation: p.tsl21.mean.1985.Z  
Temperature: t.tsl21.mean.1985.Z

(b) individual years "1985"

Precipitation: p.tsl21.17.1985.Z  
p.tsl21.26.1985.Z  
p.tsl21.5.1985.Z

Temperature: t.tsl21.17.1985.Z  
t.tsl21.26.1985.Z  
t.tsl21.5.1985.Z

(c) 30-year-average "2085"

Precipitation: p.tsl21.mean.2085.Z  
Temperature: t.tsl21.mean.2085.Z

(d) individual years "2085"

Precipitation: p.tsl21.17.2085.Z  
p.tsl21.26.2085.Z  
p.tsl21.5.2085.Z

Temperature: t.tsl21.17.2085.Z  
t.tsl21.26.2085.Z  
t.tsl21.5.2085.Z

(4) Time Slice Experiments T42

(a) 15-year-average "1985"

Precipitation: p.tsl42.mean.1985.Z  
Temperature: t.tsl42.mean.1985.Z

(b) individual years "1985"

Precipitation: p.tsl42.23.1985.Z

Temperature: t.tsl42.23.1985.Z

(c) 30-year-average "2085"

Precipitation: p.tsl42.mean.2085.Z  
Temperature: t.tsl42.mean.2085.Z

(d) individual years "2085"

Precipitation: p.tsl42.17.2085.Z  
p.tsl42.26.2085.Z  
p.tsl42.5.2085.Z

Temperature: t.tsl42.17.2085.Z  
t.tsl42.26.2085.Z  
t.tsl42.5.2085.Z

(5) Time slice Experiments T106

(a) 5-year-average "1985"

Precipitation: p.tsl106.mean.1985.Z  
Temperature: t.tsl106.mean.1985.Z

(b) one individual year "1985"

Precipitation: p.tsl106.03.1985.Z  
Temperature: t.tsl106.03.1985.Z

(c) 5-year-average "2035"

Precipitation: p.tsl106.mean.2035.Z  
Temperature: t.tsl106.mean.2035.Z

(d) one individual year "2035"

Precipitation: p.tsl106.03.2035.Z  
Temperature: t.tsl106.03.2035.Z

940826  
103059

1

## tread.21.f

```
PROGRAM TREADT21
C
C***** *TREADT21* READS TEMPERATURE DATA WRITTEN IN ASCII Format,
C      T21 resolution
C
C      M. Junge,          *MPIHH*,        05.08.94
C      LAST MODIFIED:
C
C      parameter (nxatm = 64, nyatm = 32)
C      real fieldjan(nxatm,nyatm),fieldjul(nxatm,nyatm),
C      $      alon(nxatm),alat(nyatm)
C      character latitude*8, longitude*9
C
C
C      open (11, file = 'GRID21', form = 'formatted')
C      read (11,'(A8)') latitude
C      read (11,100) (alat(jy), jy = 1, nyatm)
C      read (11,'(A9)') longitude
C      read (11,200) (alon(jx), jx = 1, nxatm)
100   format(16F8.3)
200   format(16F9.3)
      close(11)

      open (22,file='t.ts121.26',form='formatted')
      do jy = 1,nyatm
         read (22,300) (fieldjan(jx,jy),jx=1,nxatm)
      end do
      do jy = 1,nyatm
         read (22,300) (fieldjul(jx,jy),jx=1,nxatm)
      end do
300   format(8F7.2)
      end
```

470826  
0941759

pread.21.f

1

```
PROGRAM PREADT21
C
C***** *PREADT21* READS PRECIPITATION DATA WRITTEN IN ASCII Format,
C      T21 resolution.
C
C      M. Junge,          *MPIHH*,          05.08.94
C      LAST MODIFIED:
C
parameter (nxatm = 64, nyatm = 32)
real fieldjan(nxatm,nyatm),fieldjul(nxatm,nyatm),
$      alon(nxatm),alat(nyatm)
character latitude*8, longitude*9
C
open (11, file = 'GRID21', form = 'formatted')
read (11,'(A8)') latitude
read (11,100) (alat(jy), jy = 1, nyatm)
read (11,'(A9)') longitude
read (11,200) (alon(jx), jx = 1, nxatm)
100 format(16F8.3)
200 format(16F9.3)
close(11)

open (22,file='p.ts121.26',form='formatted')
do jy = 1,nyatm
  read (22,300) (fieldjan(jx,jy),jx=1,nxatm)
end do
do jy = 1,nyatm
  read (22,300) (fieldjul(jx,jy),jx=1,nxatm)
end do
300 format(8F6.2)
end
```

## pread.42.f

```
PROGRAM PREADT42
C
C**** *PREADT42* READS PRECIPITATION DATA WRITTEN IN ASCII Format,
C      T42 resolution.
C
C      M. Junge,          *MPIHH*,           05.08.94
C      LAST MODIFIED:
C
parameter (nxatm = 128, nyatm = 64)
real fieldjan(nxatm,nyatm),fieldjul(nxatm,nyatm),
$      alon(nxatm),alat(nyatm)
character latitude*8, longitude*9
C
open (11, file = 'GRID42', form = 'formatted')
read (11,'(A8)') latitude
read (11,100) (alat(jy), jy = 1, nyatm)
read (11,'(A9)') longitude
read (11,200) (alon(jx), jx = 1, nxatm)
100 format(16F8.3)
200 format(16F9.3)
close(11)

open (22,file='p.ts142.26',form='formatted')
do jy = 1,nyatm
  read (22,300) (fieldjan(jx,jy),jx=1,nxatm)
end do
do jy = 1,nyatm
  read (22,300) (fieldjul(jx,jy),jx=1,nxatm)
end do
300 format(8F6.2)
end
```

04/08/26  
10:38:25

tread.42.f



```
PROGRAM TREADT42
C
C***** *TREADT42* READS TEMPERATURE DATA WRITTEN IN ASCII Format,
C      T42 resolution.
C
C      M. Junge,          *MPIHH*,           05.08.94
C      LAST MODIFIED:
C
parameter (nxatm = 128, nyatm = 64)
real fieldjan(nxatm,nyatm),fieldjul(nxatm,nyatm),
$      alon(nxatm),alat(nyatm)
character latitude*8, longitude*9
C
open (11, file = 'GRID42', form = 'formatted')
read (11,'(A8)') latitude
read (11,100) (alat(jy), jy = 1, nyatm)
read (11,'(A9)') longitude
read (11,200) (alon(jx), jx = 1,nxatm)
100 format(16F8.3)
200 format(16F9.3)
close(11)

open (22,file='t.ts142.26',form='formatted')
do jy = 1,nyatm
    read (22,300) (fieldjan(jx,jy),jx=1,nxatm)
end do
do jy = 1,nyatm
    read (22,300) (fieldjul(jx,jy),jx=1,nxatm)
end do
300 format(8F7.2)
end
```

## tread.106.f

```
PROGRAM TREADT106
C
C***** *TREADT106* READS TEMPERATURE DATA WRITTEN IN ASCII Format,
C      T106 resolution
C
C      M. Junge,          *MPIHH*,           05.08.94
C      LAST MODIFIED:
C
parameter (nxatm = 320, nyatm = 160)
real fieldjan(nxatm,nyatm),fieldjul(nxatm,nyatm),
S      alon(nxatm),alat(nyatm)
character latitude*8,longitude*9
C
open (11, file = 'GRID106', form = 'formatted')
read (11,'(A8)') latitude
read (11,100) (alat(jy), jy = 1, nyatm)
read (11,'(a9)') longitude
read (11,200) (alon(jx), jx = 1,nxatm)
100 format(16F8.3)
200 format(16F9.3)
close(11)

open (22,file='t.ts1106.mean',form='formatted')
do jy = 1,nyatm
  read (22,300) (fieldjan(jx,jy),jx=1,nxatm)
end do
do jy = 1,nyatm
  read (22,300) (fieldjul(jx,jy),jx=1,nxatm)
end do
300 format(8F7.2)
end
```

94/08/26  
10:34:57

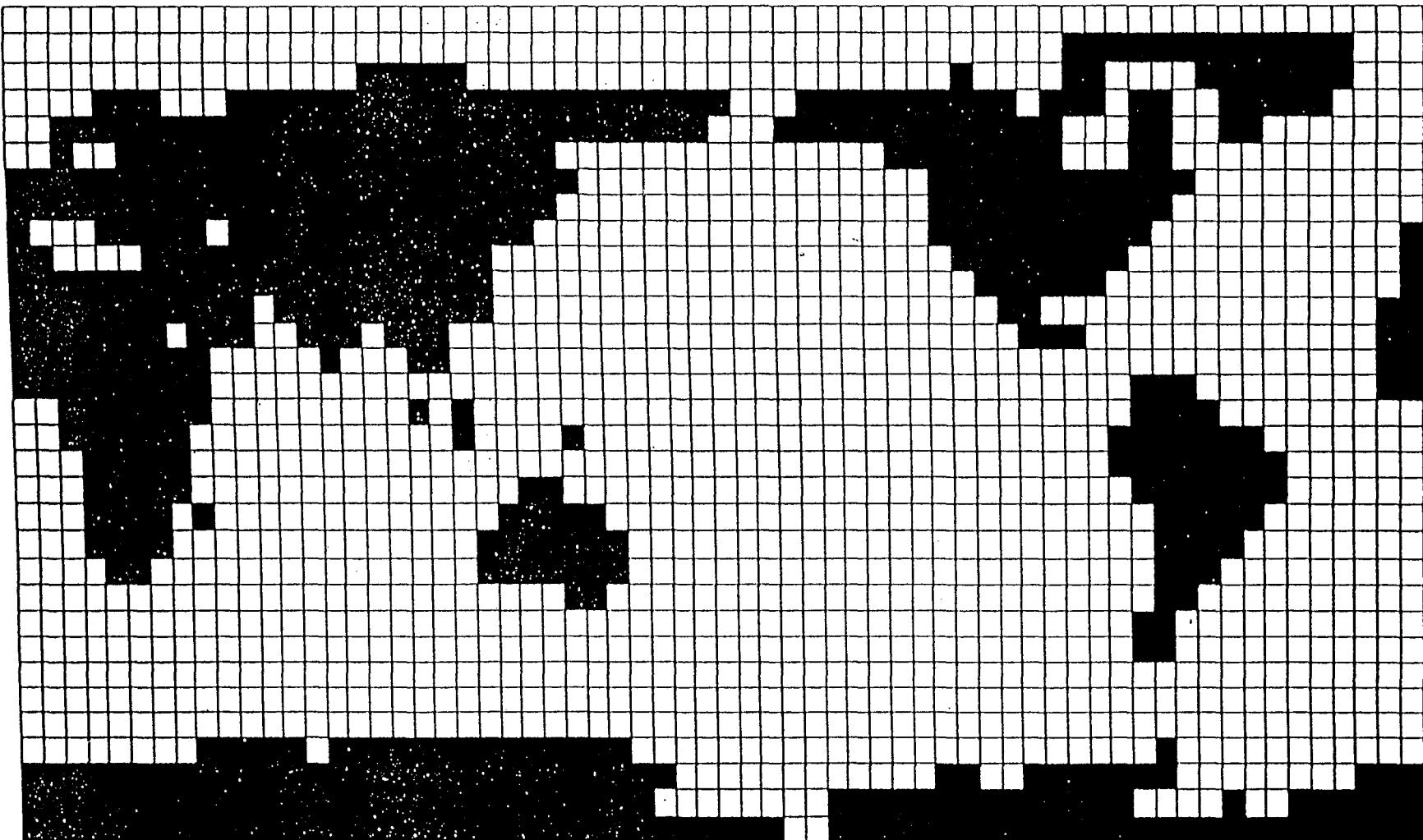
pread.106.f

1

```
PROGRAM PREADT106
C
C***** *PREADT106* READS PRECIPITATION DATA WRITTEN IN ASCII Format,
C      T106 resolution.
C
C      M. Junge,          *MPIHH*,        05.08.94
C      LAST MODIFIED:
C
parameter (nxatm = 320, nyatm = 160)
real fieldjan(nxatm,nyatm),fieldjul(nxatm,nyatm),
$      alon(nxatm),alat(nyatm)
character latitude*8, longitude*9
C
open (11, file = 'GRID106', form = 'formatted')
read (11,'(A8)') latitude
read (11,100) (alat(jy), jy = 1,nyatm)
read (11,'(A9)') longitude
read (11,200) (alon(jx), jx = 1,nxatm)
100 format(16F8.3)
200 format(16F9.3)
close(11)

open (22,file='p.ts1106.mean',form='formatted')
do jy = 1,nyatm
    read (22,300) (fieldjan(jx,jy),jx=1,nxatm)
end do
do jy = 1,nyatm
    read (22,300) (fieldjul(jx,jy),jx=1,nxatm)
end do
300 format(8F6.2)
end
```

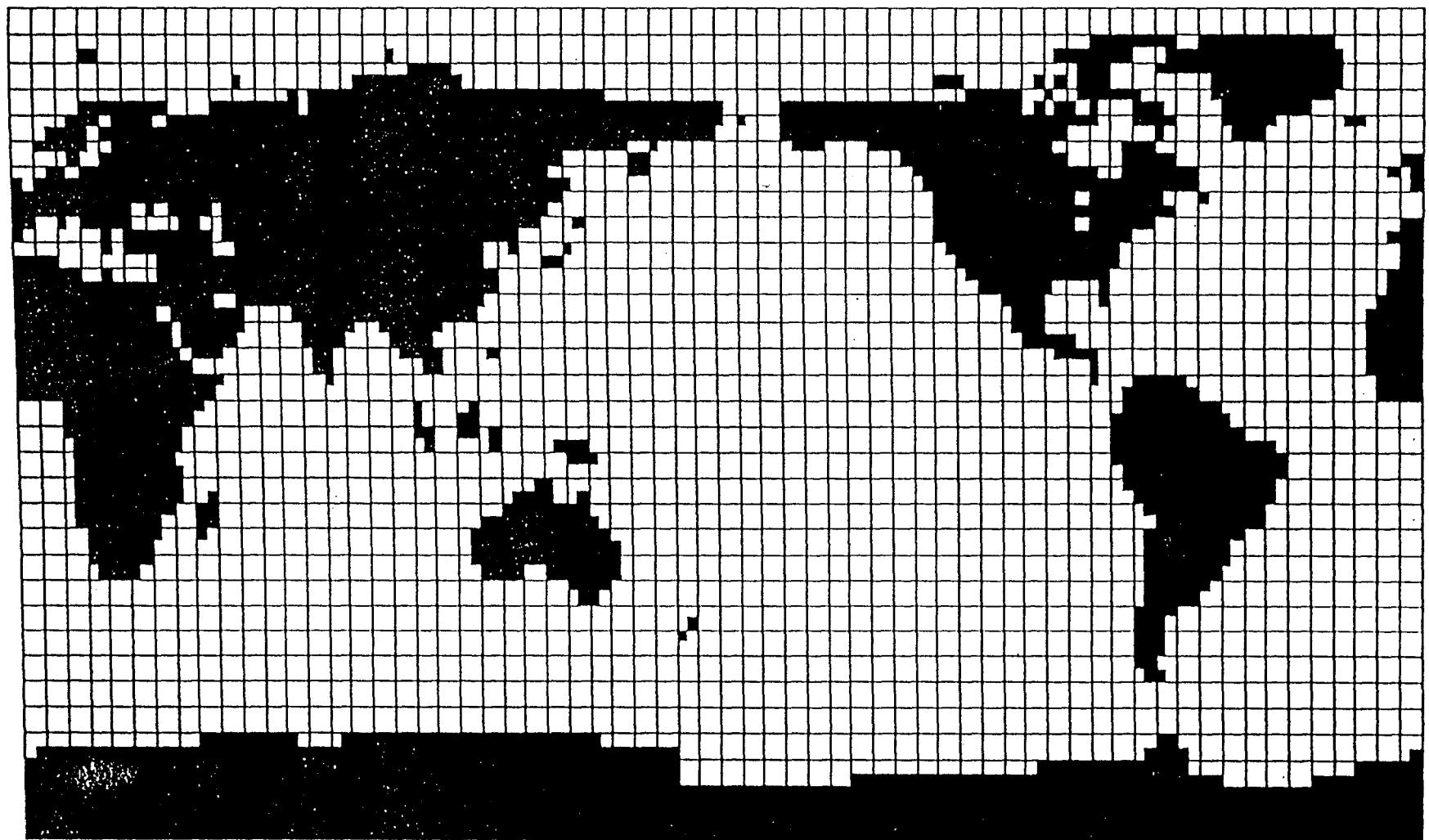
LAND-SEA MASKS FOR ECHAM3-TRUNCATIONS



Land-sea mask for T21 model truncation

THE "GAUSSIAN" LATITUDES FOR T21-TRUNCATION

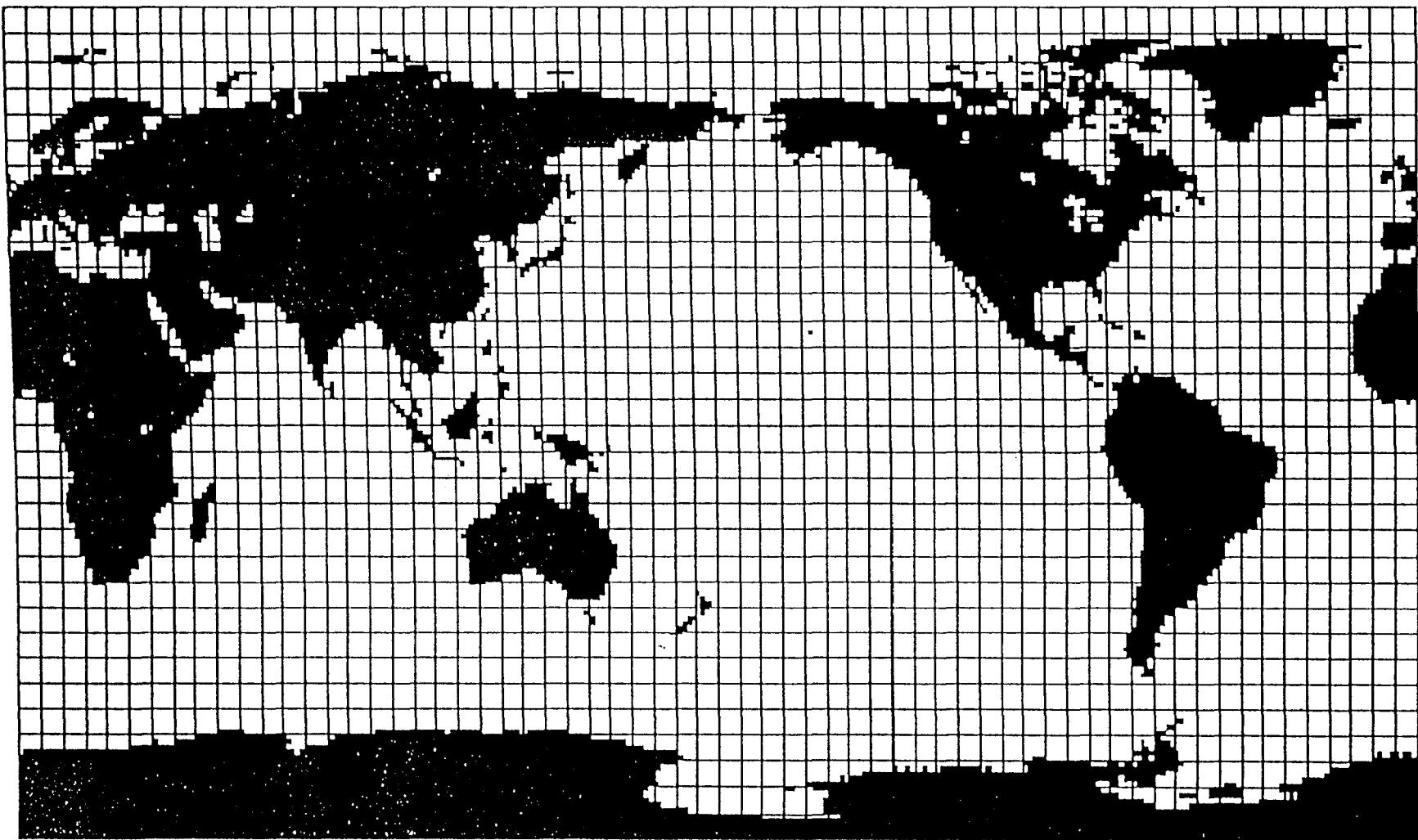
No. from North pole (ILAT)	No. in the model (IROW)	Latitude ( $^{\circ}$ )	No. from North pole (ILAT)	No. in the model (IROW)	Latitude ( $^{\circ}$ )
1	1	85.760	9	17	41.532
2	3	80.268	10	19	35.995
3	5	74.744	11	21	30.457
4	7	69.212	12	23	24.919
5	9	63.678	13	25	19.382
6	11	58.142	14	27	13.844
7	13	52.606	15	29	8.306
8	15	47.069	16	31	2.768



Land-sea mask for T42 model truncation

THE "GAUSSIAN" LATITUDES FOR T42-TRUNCATION

No. from North pole (ILAT)	No. in the model (IROW)	Latitude ( $^{\circ}$ )	No. from North pole (ILAT)	No. in the model (IROW)	Latitude ( $^{\circ}$ )
1	1	87.863	17	33	43.254
2	3	85.096	18	35	40.463
3	5	82.312	19	37	37.673
4	7	79.525	20	39	34.882
5	9	76.736	21	41	32.091
6	11	73.947	22	43	29.301
7	13	71.157	23	45	26.510
8	15	68.367	24	47	23.720
9	17	65.577	25	49	20.929
10	19	62.787	26	51	18.138
11	21	59.997	27	53	15.348
12	23	57.206	28	55	12.557
13	25	54.416	29	57	9.767
14	27	51.625	30	59	6.976
15	29	48.835	31	61	4.185
16	31	46.044	32	63	1.395



Land-sea mask for T106 model truncation

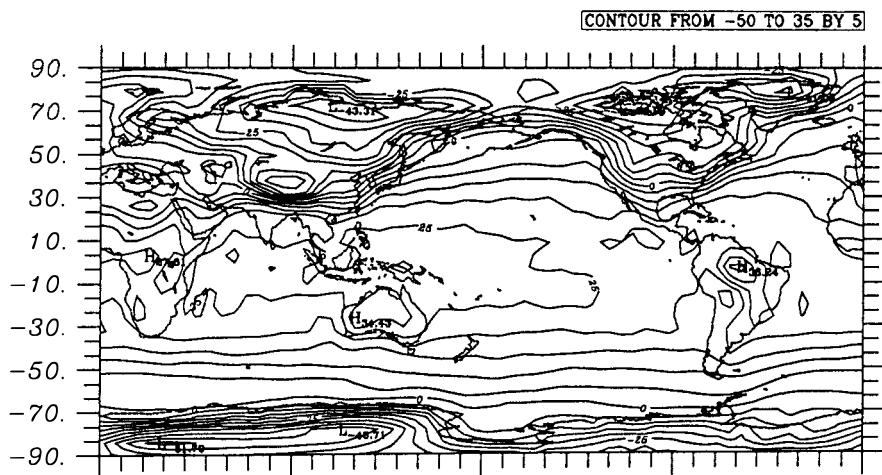
THE "GAUSSIAN" LATITUDES FOR T106-TRUNCATION

No. from North pole (ILAT)	No. in the model (IROW)	Latitude ( $^{\circ}$ )	No. from North pole (ILAT)	No. in the model (IROW)	Latitude ( $^{\circ}$ )
1	1	89.141	41	81	44.298
2	3	88.029	42	83	43.177
3	5	86.910	43	85	42.055
4	7	85.790	44	87	40.934
5	9	84.669	45	89	39.812
6	11	83.548	46	91	38.691
7	13	82.427	47	93	37.569
8	15	81.306	48	95	36.448
9	17	80.185	49	97	35.326
10	19	79.063	50	99	34.205
11	21	77.942	51	101	33.083
12	23	76.821	52	103	31.962
13	25	75.699	53	105	30.840
14	27	74.578	54	107	29.719
15	29	73.457	55	109	28.597
16	31	72.335	56	111	27.476
17	33	71.214	57	113	26.355
18	35	70.092	58	115	25.233
19	37	68.971	59	117	24.112
20	39	67.849	60	119	22.990
21	41	66.728	61	121	21.869
22	43	65.606	62	123	20.747
23	45	64.485	63	125	19.626
24	47	63.363	64	127	18.504
25	49	62.242	65	129	17.383
26	51	61.120	66	131	16.261
27	53	59.999	67	133	15.140
28	55	58.878	68	135	14.018
29	57	57.756	69	137	12.897

No. from North pole (ILAT)	No. in the model (IROW)	Latitude ( $^{\circ}$ )	No. from North pole (ILAT)	No. in the model (IROW)	Latitude ( $^{\circ}$ )
30	59	56.635	70	139	11.775
31	61	55.513	71	141	10.654
32	63	54.392	72	143	9.532
33	65	53.270	73	145	8.411
34	67	52.149	74	147	7.289
35	69	51.027	75	149	6.168
36	71	49.906	76	151	5.046
37	73	48.784	77	153	3.925
38	75	47.663	78	155	2.803
39	77	46.541	79	157	1.682
40	79	45.420	80	159	0.560

Temperature  
Control Run T21  
20-year-average:years 9 - 28

LATITUDE



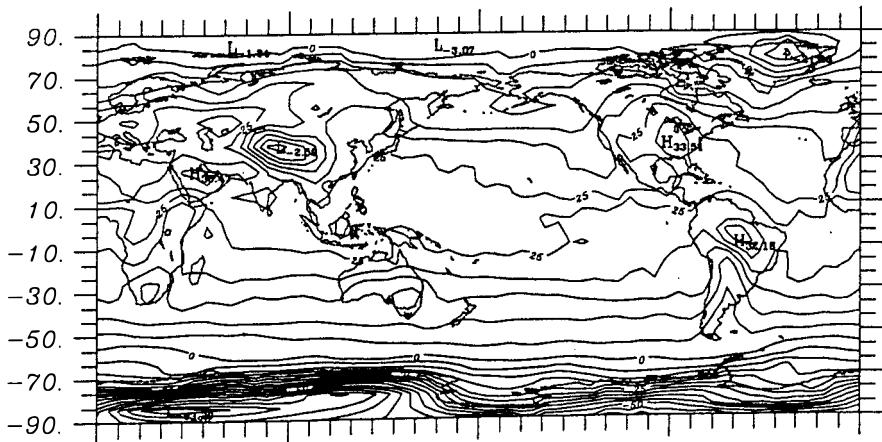
LONGITUDE (east)

JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 26.10 deg.C

CONTOUR FROM -80 TO 35 BY 5

LATITUDE



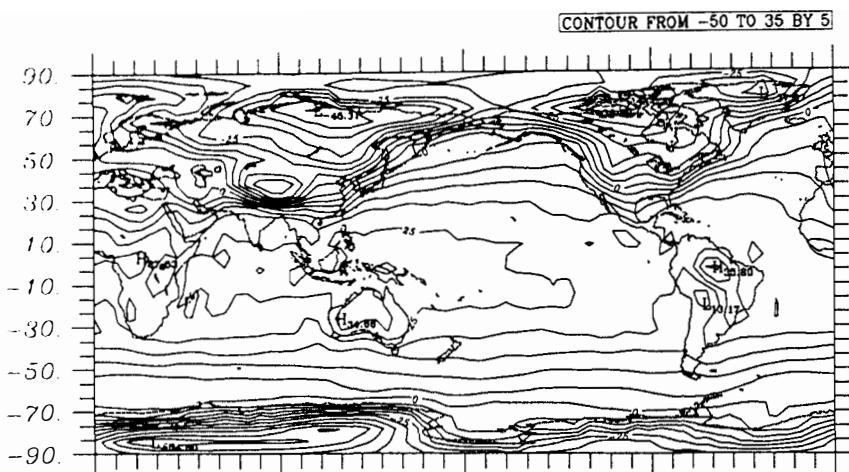
LONGITUDE (east)

JULY

Temperature at: 2.77(lat), 180.00 (lon): 26.16 deg.C

Temperature  
Control Run T21  
20-year-average: years 29 - 48

LATITUDE



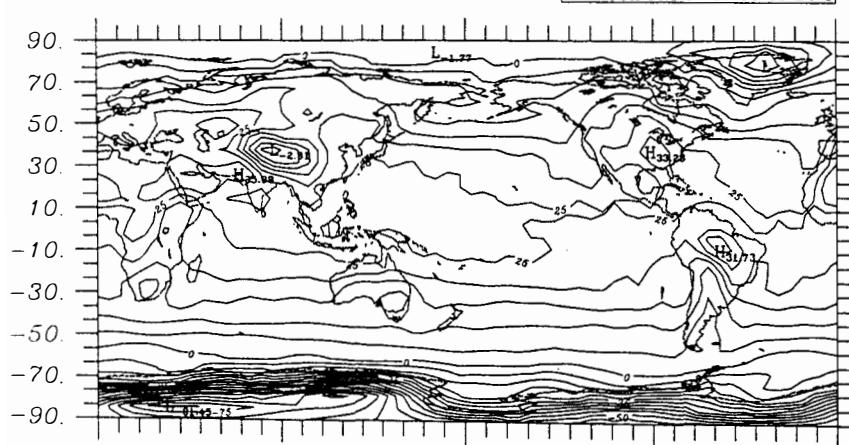
JANUARY

LONGITUDE (east)

Temperature at: 2.77(lat), 180.00 (lon): 25.88 deg.C

CONTOUR FROM -80 TO 35 BY 5

LATITUDE



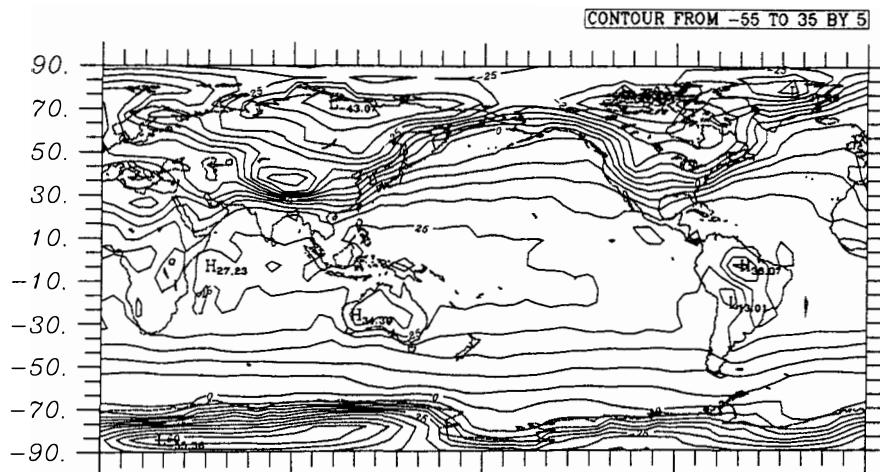
LONGITUDE (east)

JULY

Temperature at: 2.77(lat), 180.00 (lon): 25.90 deg.C

Temperature  
Control Run T21  
20-year-average: years 49 - 68

LATITUDE



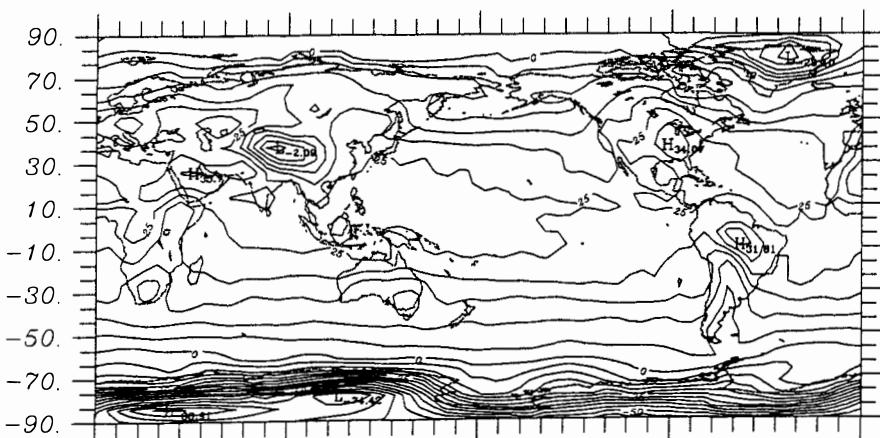
JANUARY

LONGITUDE (east)

Temperature at: 2.77(lat), 180.00 (lon): 25.88 deg.C

CONTOUR FROM -80 TO 35 BY 5

LATITUDE



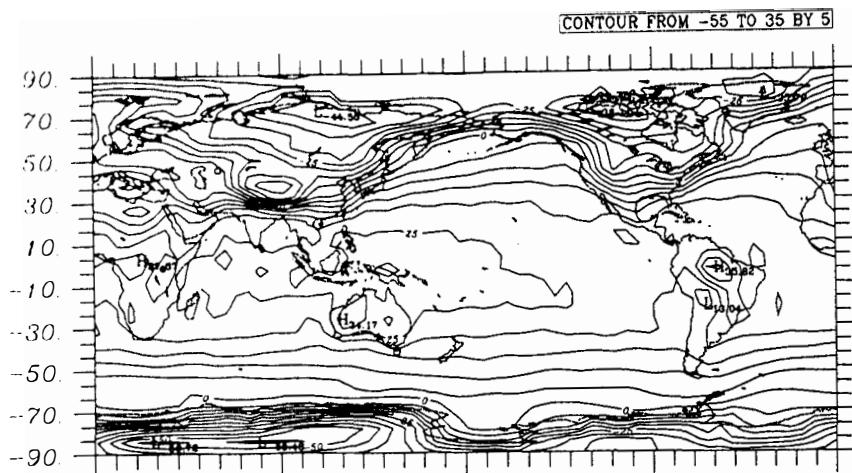
LONGITUDE (east)

JULY

Temperature at: 2.77(lat), 180.00 (lon): 25.87 deg.C

Temperature  
Control Run T21  
20-year-average: years 69 - 88

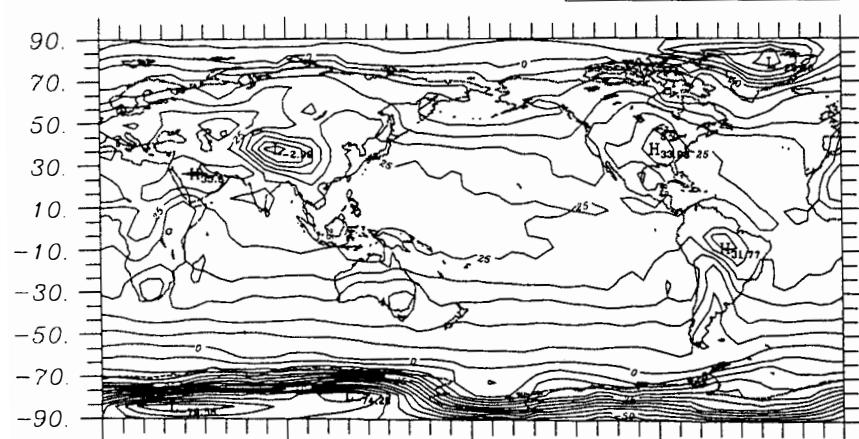
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 25.81 deg.C

LATITUDE

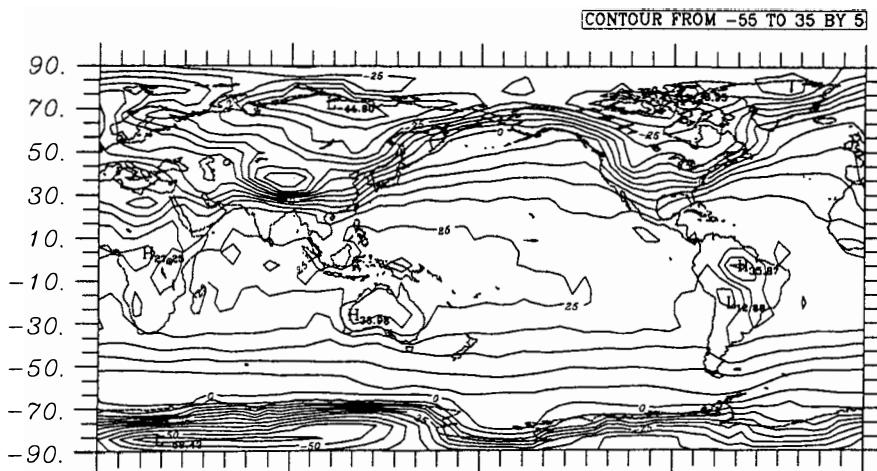


JULY

Temperature at: 2.77(lat), 180.00 (lon): 25.77 deg.C

Temperature  
Control Run T21  
20-year-average: years 89 - 108

LATITUDE

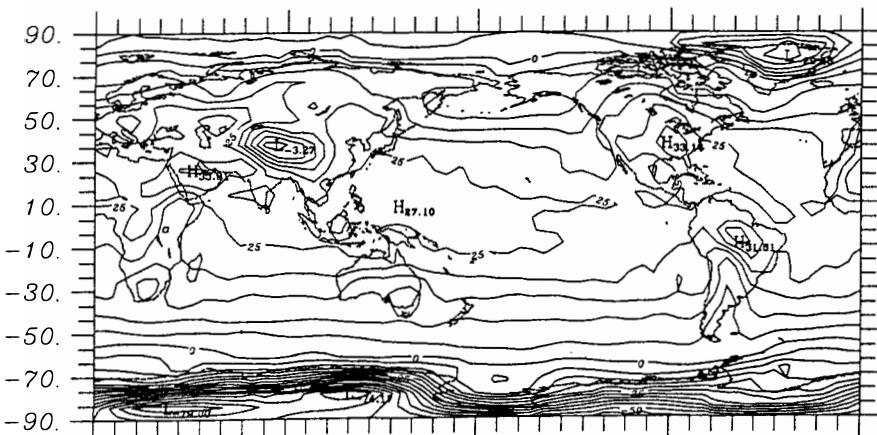


LONGITUDE (east)

JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 25.74 deg.C

CONTOUR FROM -75 TO 35 BY 5



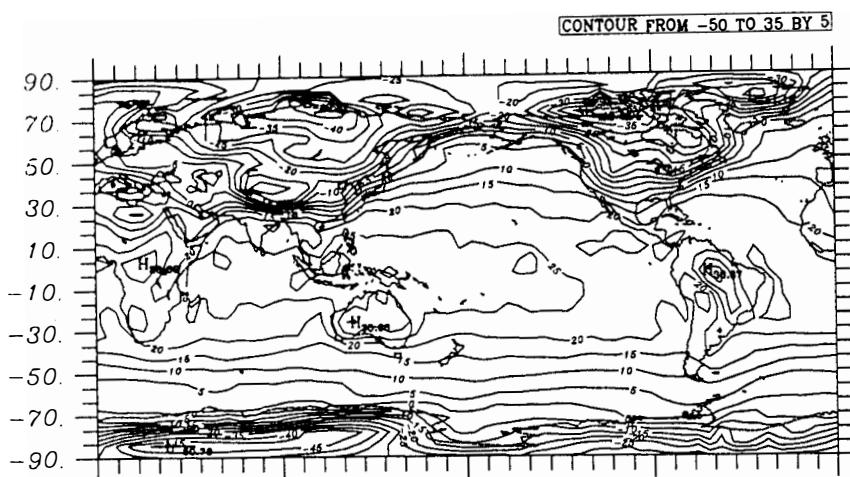
LONGITUDE (east)

JULY

Temperature at: 2.77(lat), 180.00 (lon): 25.76 deg.C

Temperature  
Control Run T21  
Year 17 of Integration

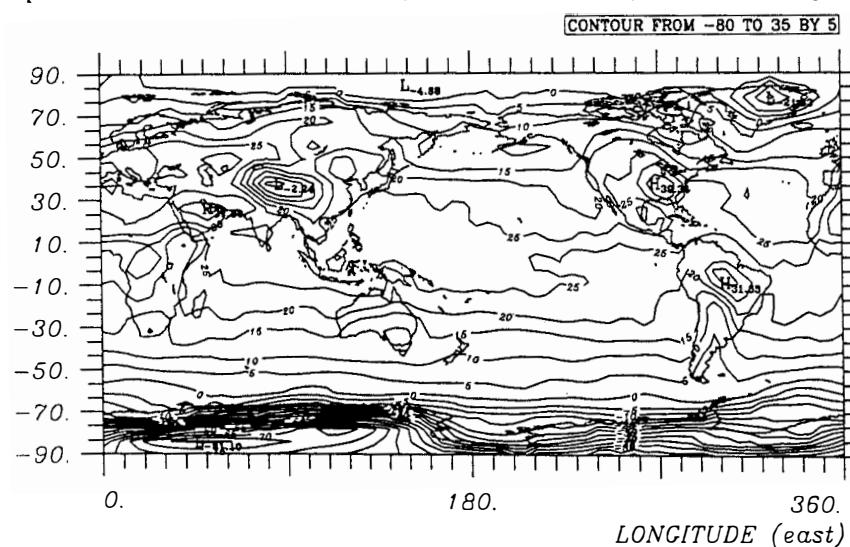
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 26.06 deg.C

LATITUDE

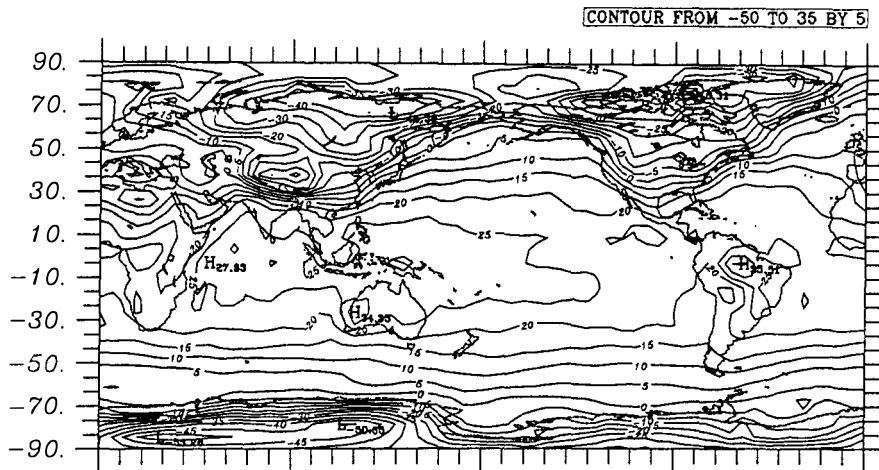


JULY

Temperature at: 2.77(lat), 180.00 (lon): 26.07 deg.C

Temperature  
Control Run T21  
Year 23 of Integration

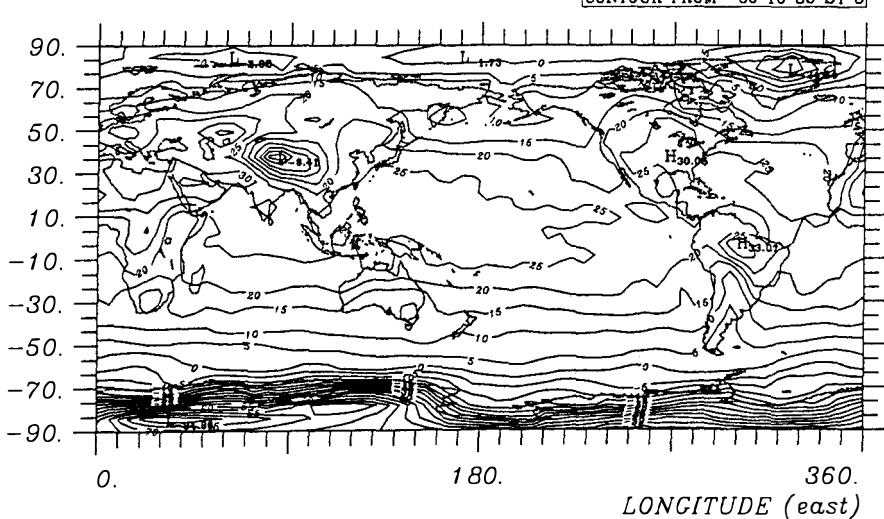
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 25.50 deg.C

LATITUDE

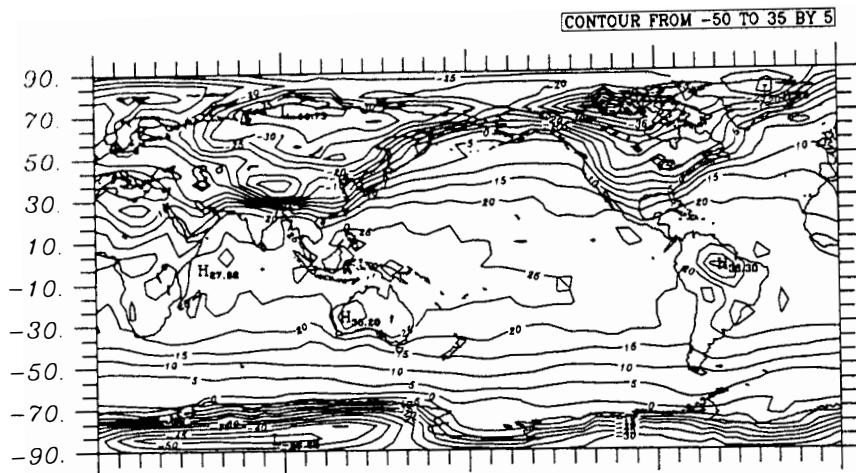


JULY

Temperature at: 2.77(lat), 180.00 (lon): 26.13 deg.C

Temperature  
Control Run T21  
Year 40 of Integration

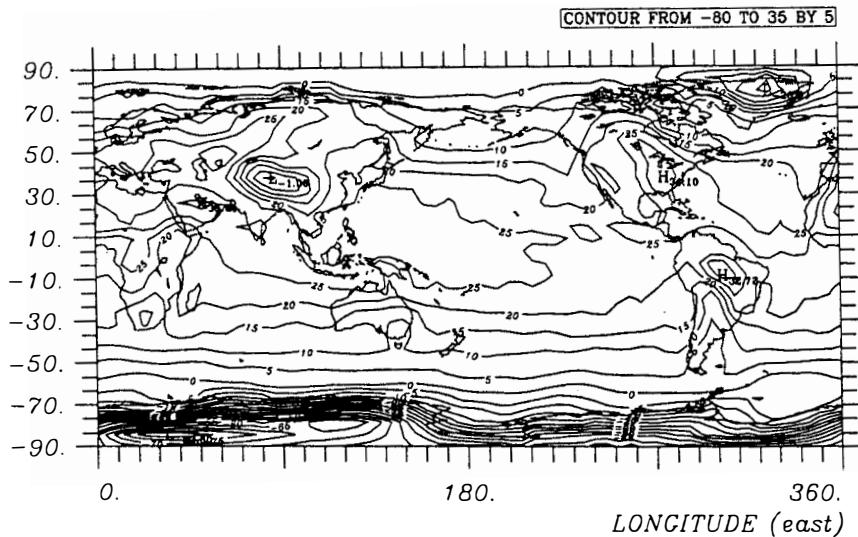
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 25.64 deg.C

LATITUDE

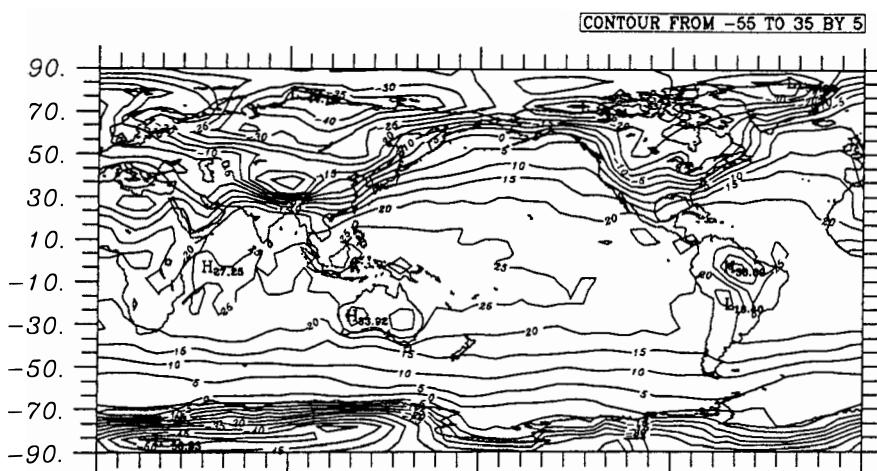


JULY

Temperature at: 2.77(lat), 180.00 (lon): 25.85 deg.C

Temperature  
Control Run T21  
Year 51 of Integration

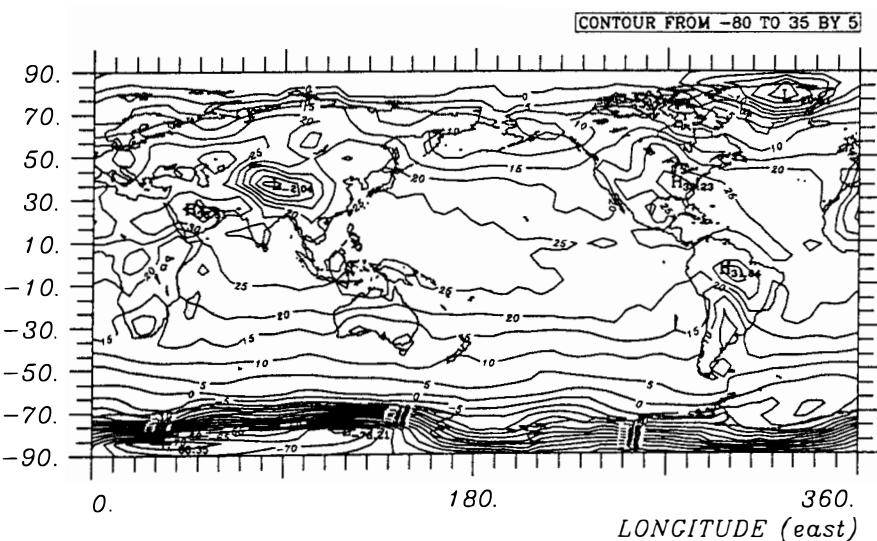
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 25.68 deg.C

LATITUDE

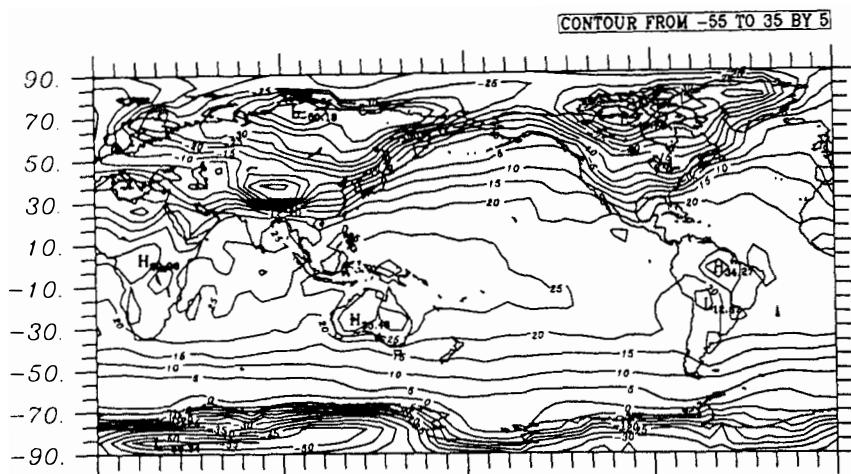


JULY

Temperature at: 2.77(lat), 180.00 (lon): 25.88 deg.C

Temperature  
Control Run T21  
Year 84 of Integration

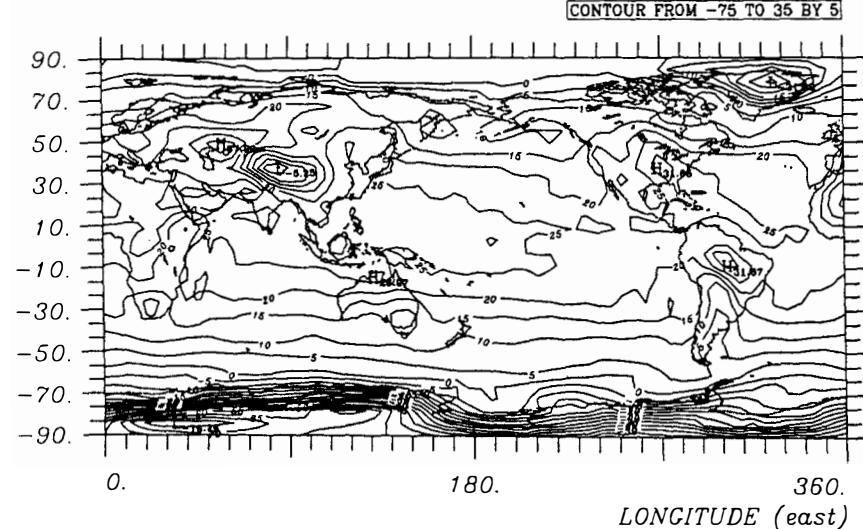
LATITUDE'



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 26.08 deg.C

LATITUDE

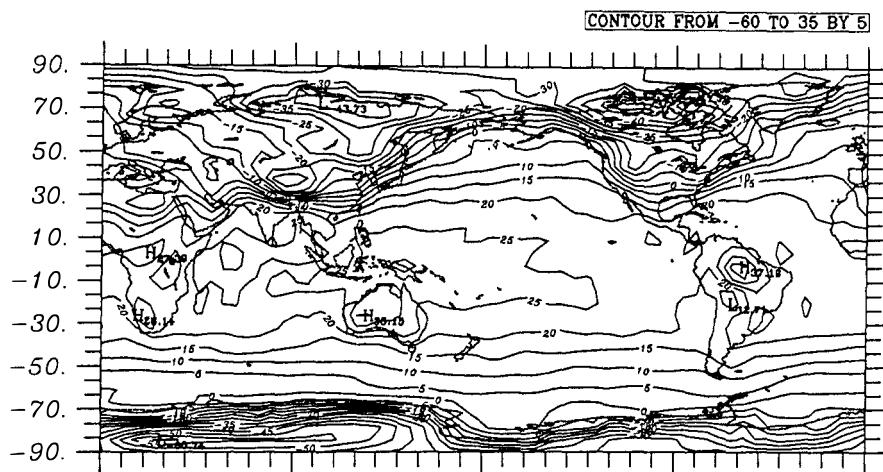


JULY

Temperature at: 2.77(lat), 180.00 (lon): 25.51 deg.C

Temperature  
Control Run T21  
Year 99 of Integration

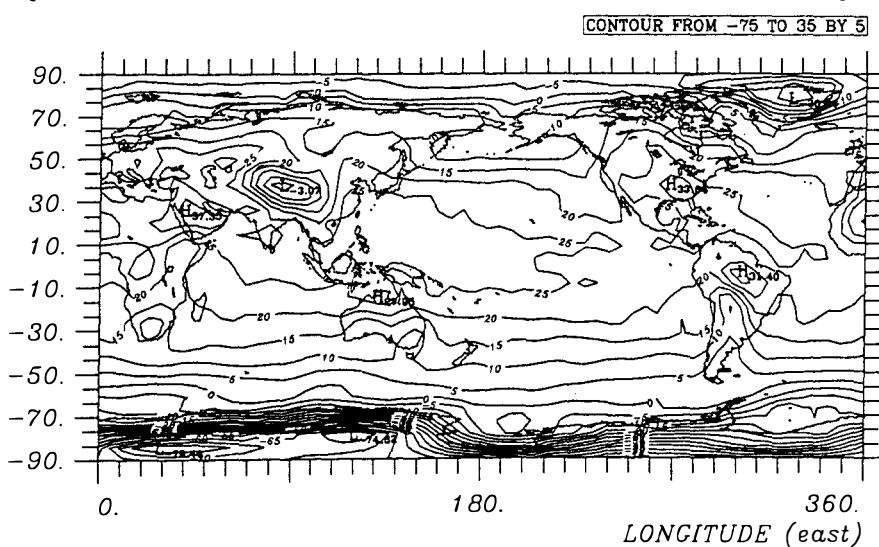
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 25.83 deg.C

LATITUDE

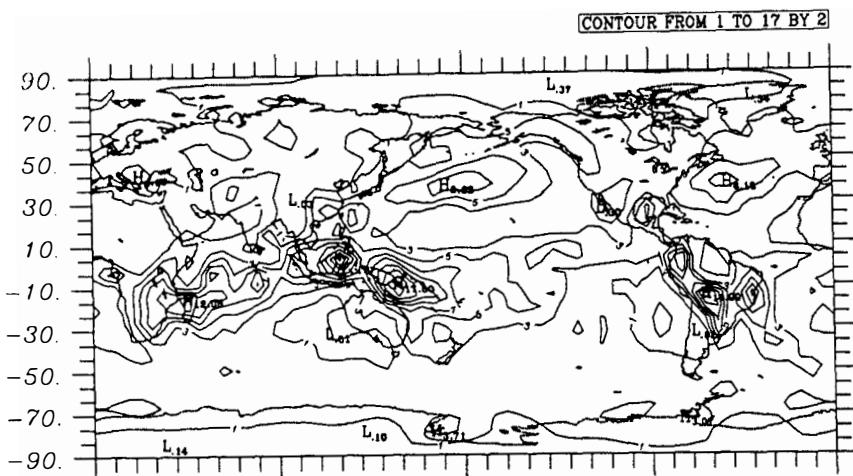


JULY

Temperature at: 2.77(lat), 180.00 (lon): 25.58 deg.C

Precipitation  
Control Run T21  
20-year-average: years 9 to 28

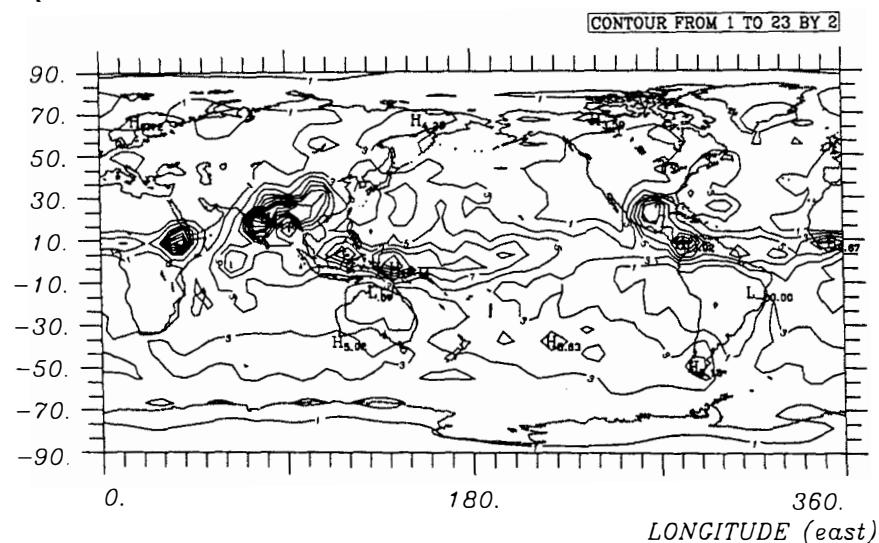
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 4.68 mm/day

LATITUDE

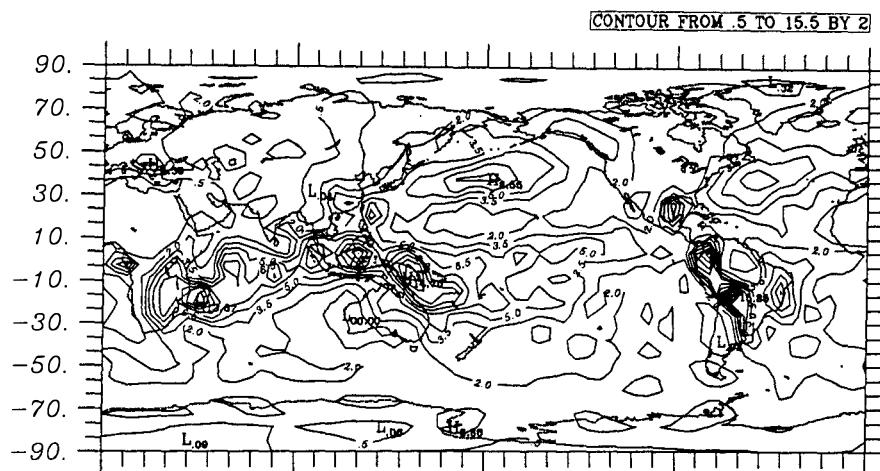


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 8.58 mm/day

Precipitation  
Control Run T21  
20-year-average: years 29 to 48

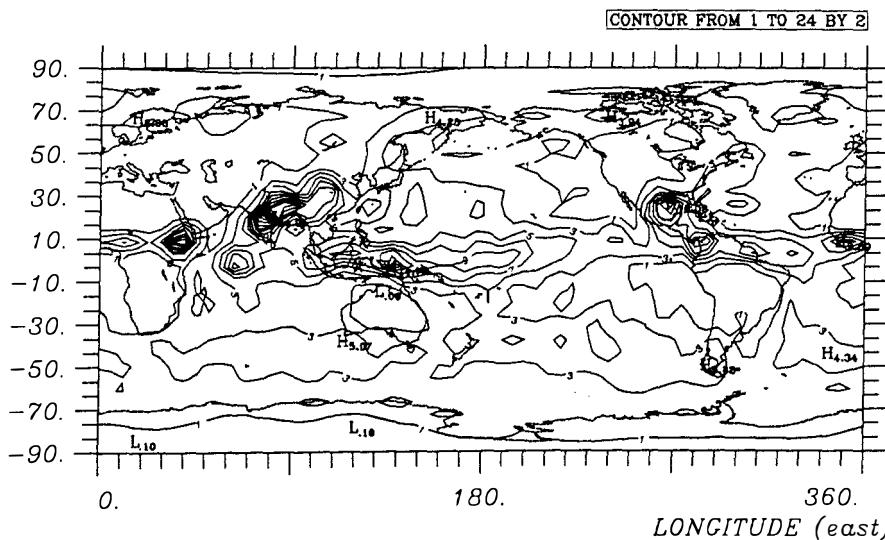
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 4.77 mm/day

LATITUDE

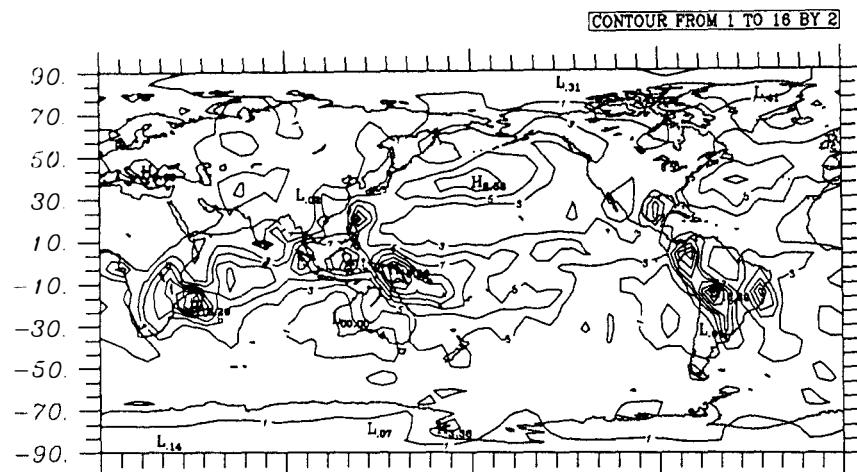


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 9.11 mm/day

Precipitation  
Control Run T21  
20-year-average: years 49 to 68

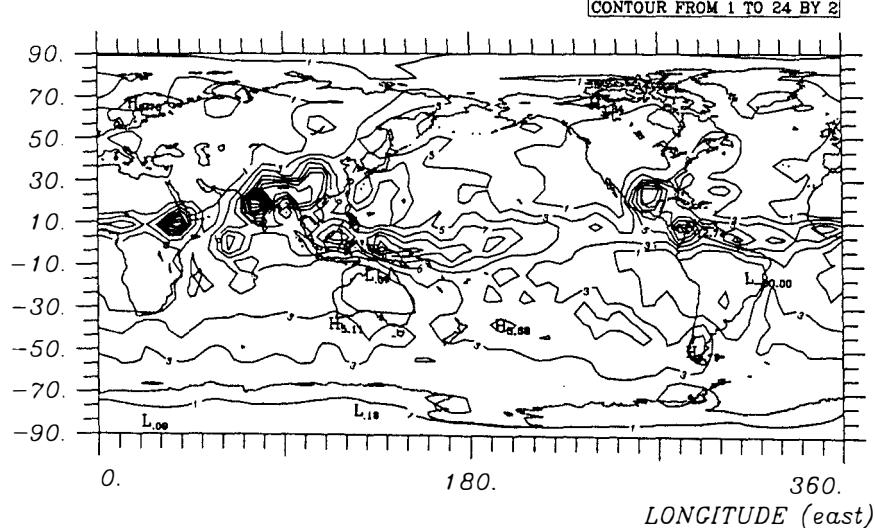
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 5.01 mm/day

LATITUDE

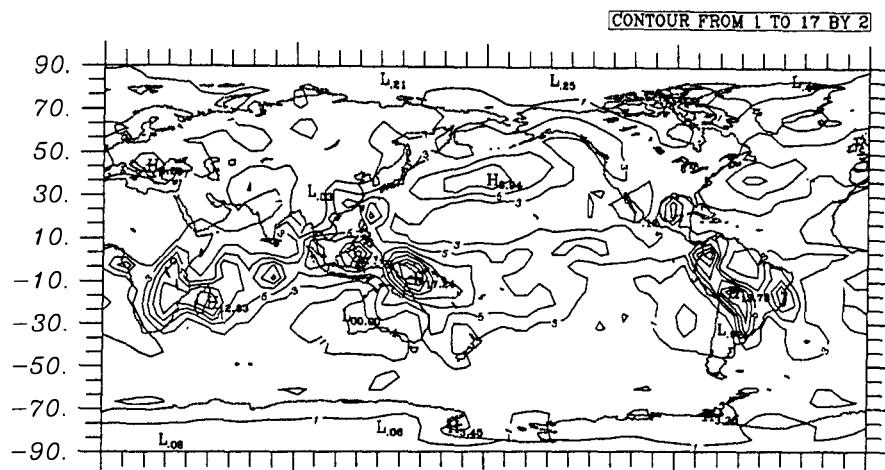


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 8.56 mm/day

Precipitation  
 Control Run T21  
 20-year-average: years 69 to 88

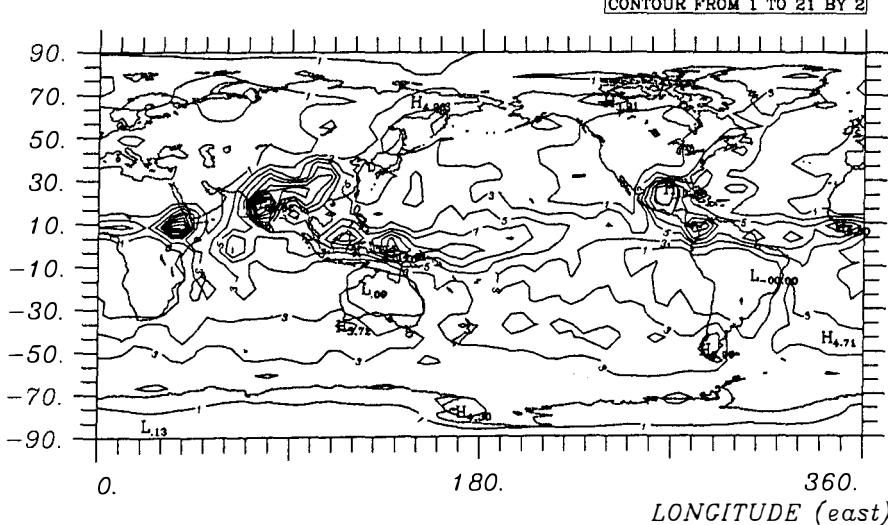
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 4.23 mm/day

LATITUDE

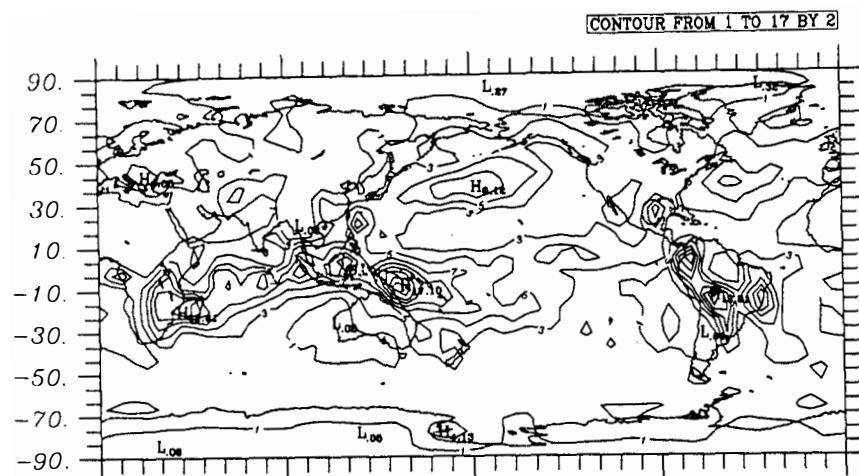


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 8.55 mm/day

Precipitation  
Control Run T21  
20-year-average: years 89 to 108

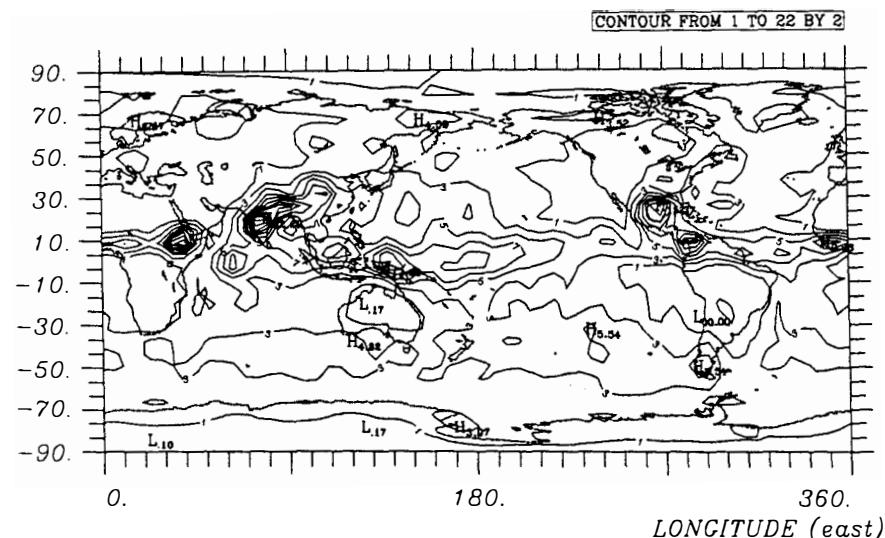
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 4.36 mm/day

LATITUDE

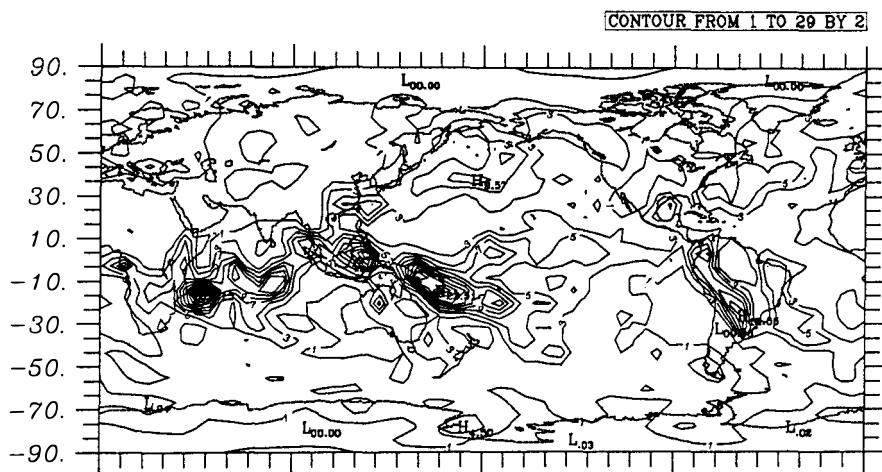


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 9.58 mm/day

Precipitation  
Control Run T21  
Year 17 of Integration

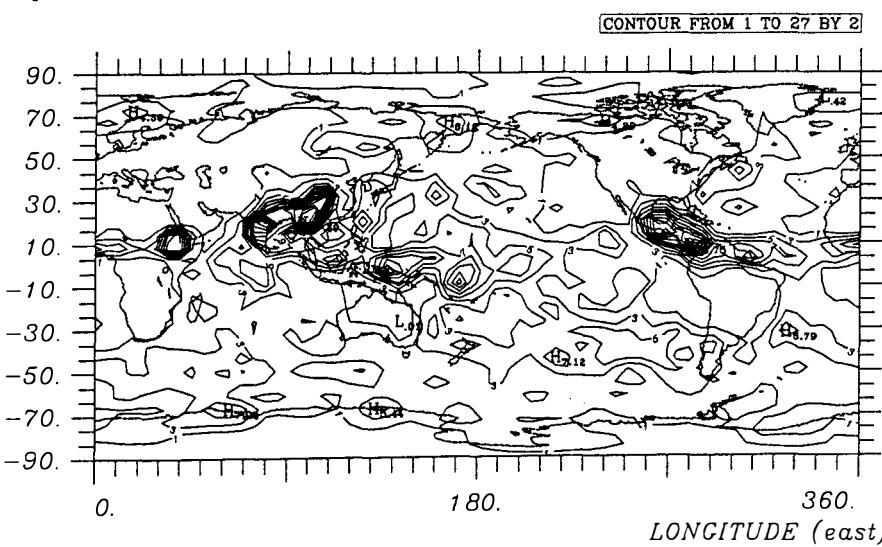
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 10.54 mm/day

LATITUDE

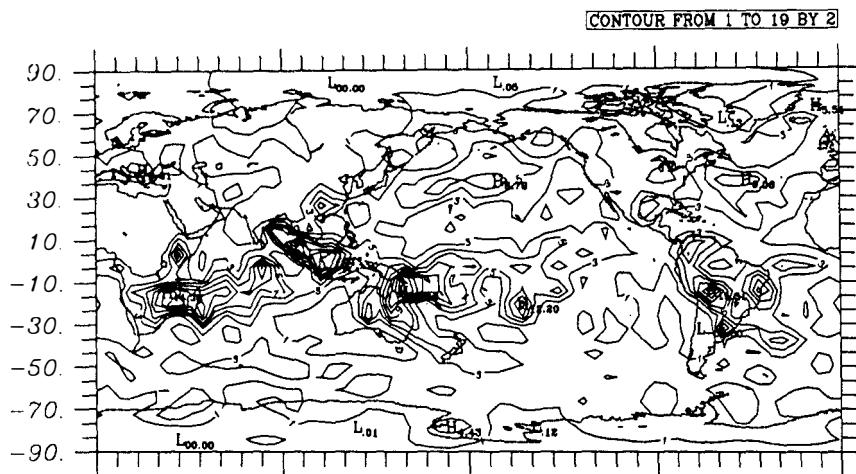


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 5.88 mm/day

Precipitation  
Control Run T21  
Year 23 of Integration

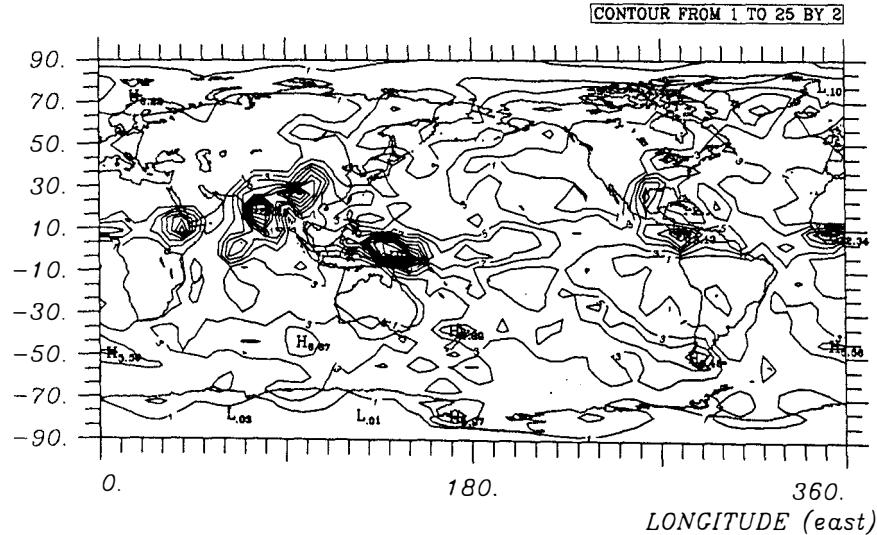
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 5.34 mm/day

LATITUDE

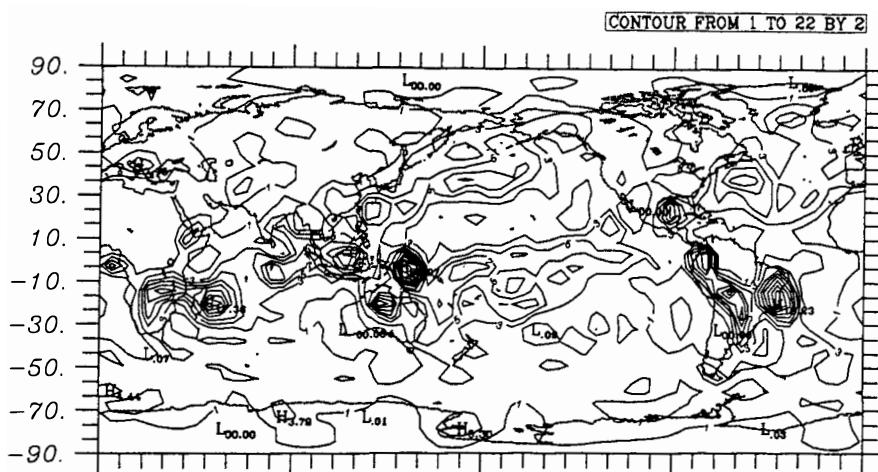


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 8.14 mm/day

Precipitation  
Control Run T21  
Year 40 of Integration

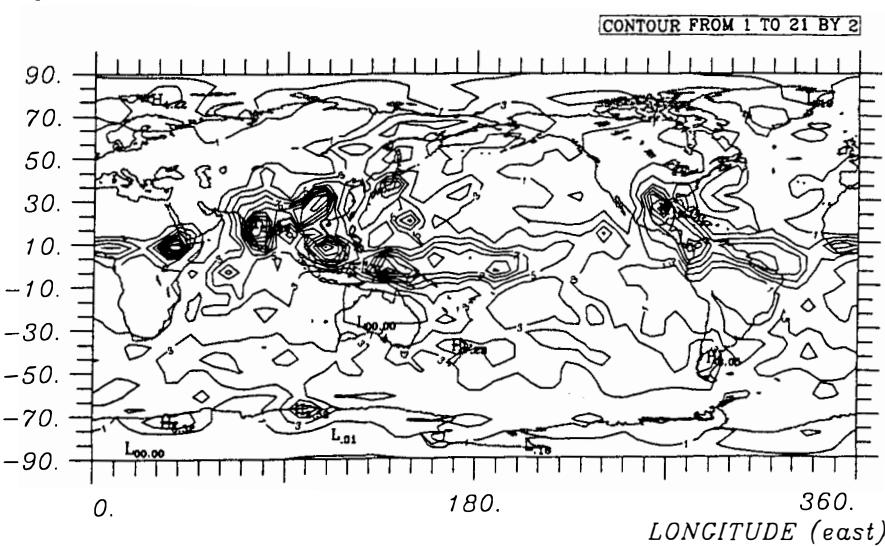
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 6.62 mm/day

LATITUDE

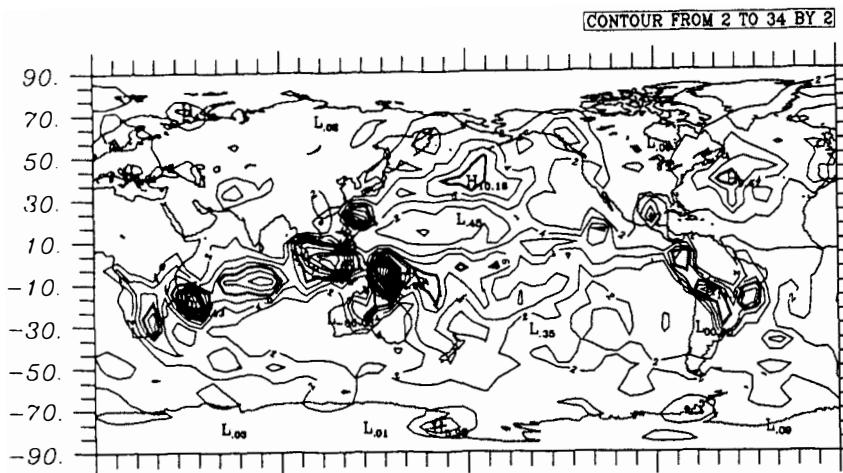


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 10.13 mm/day

Precipitation  
Control Run T21  
Year 51 of Integration

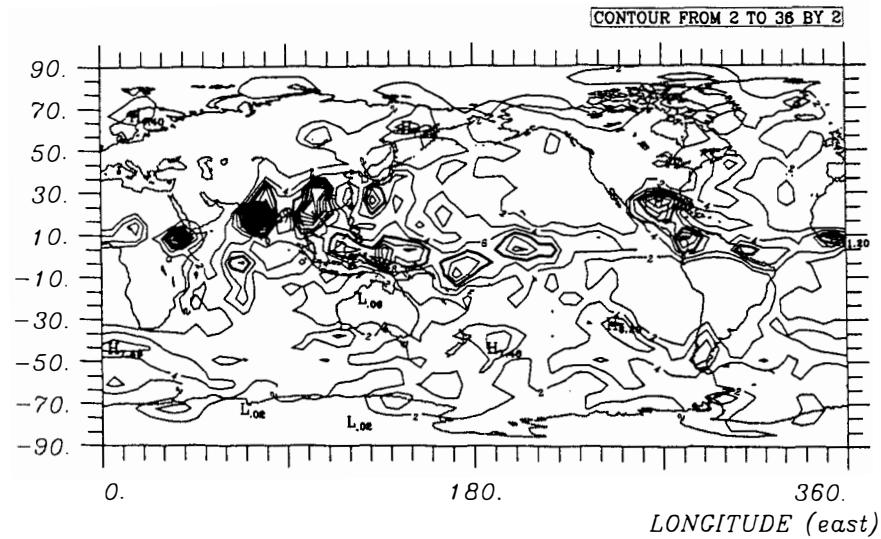
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 4.16 mm/day

LATITUDE

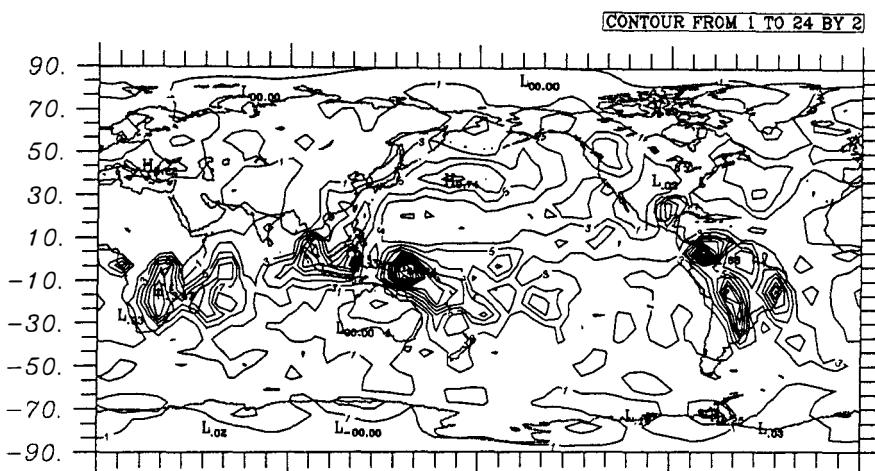


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 6.85 mm/day

Precipitation  
Control Run T21  
Year 84 of Integration

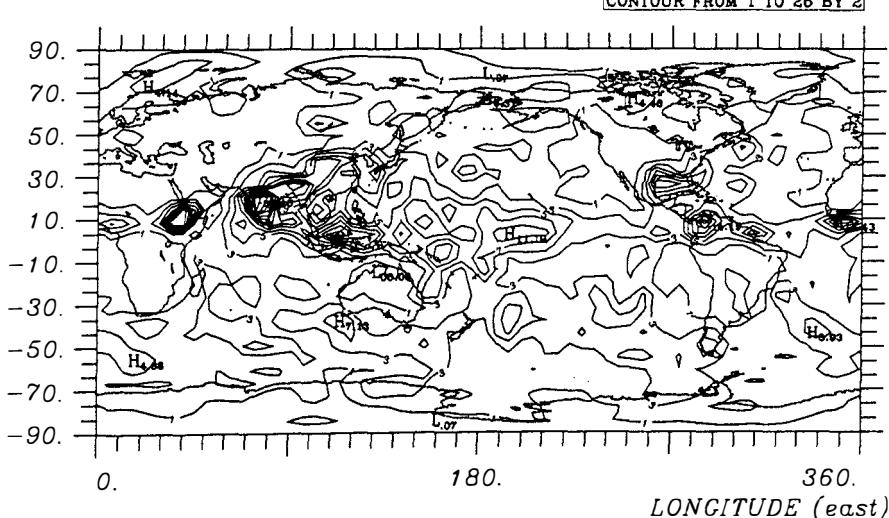
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 5.55 mm/day

LATITUDE

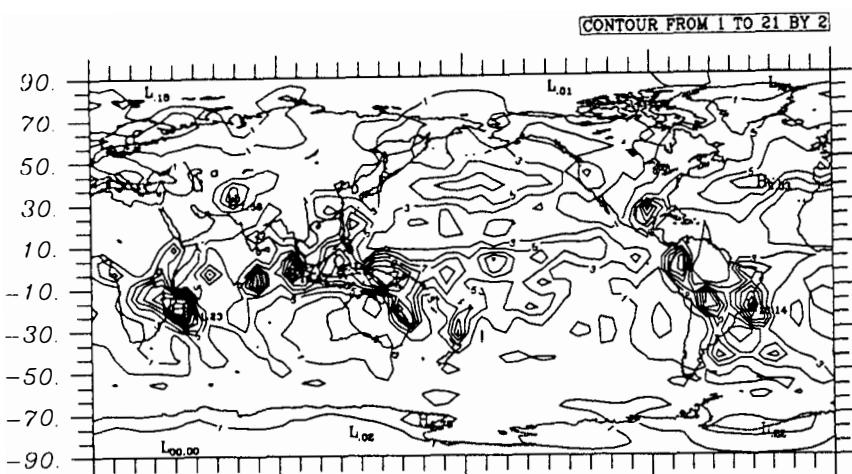


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 7.75 mm/day

Precipitation  
Control Run T21  
Year 99 of Integration

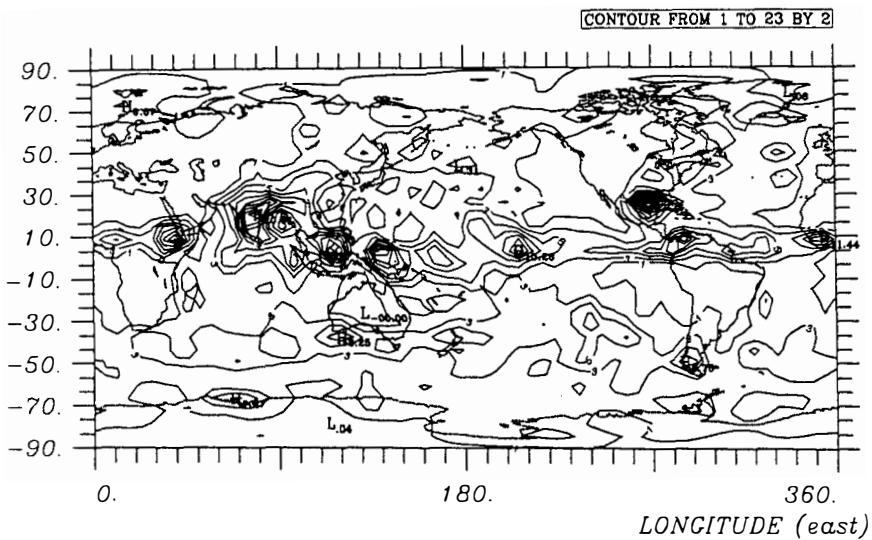
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 5.10 mm/day

LATITUDE

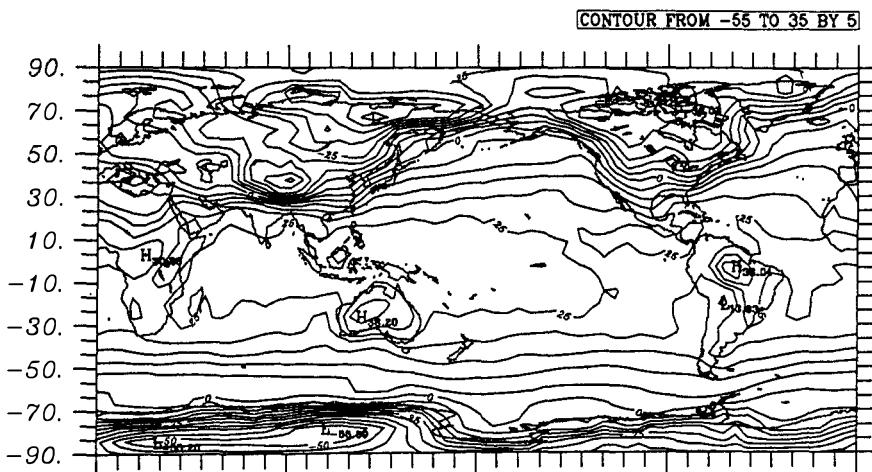


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 5.99 mm/day

Temperature  
Scenario A T21  
Year 2035

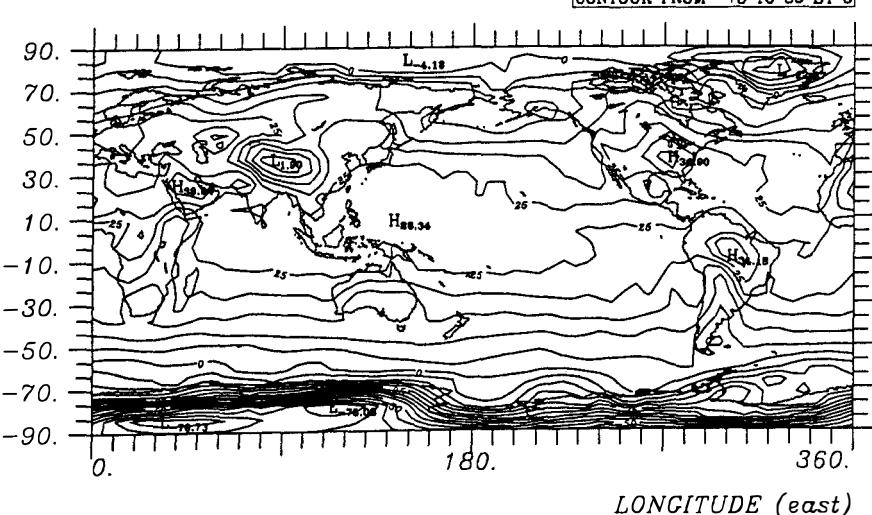
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 26.73 deg.C

LATITUDE

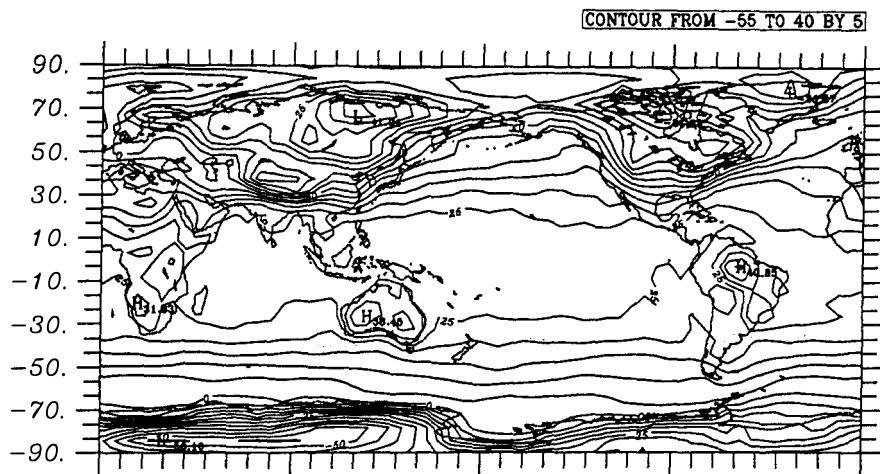


JULY

Temperature at: 2.77(lat), 180.00 (lon): 26.59 deg.C

Temperature  
Scenario A T21  
Year 2085

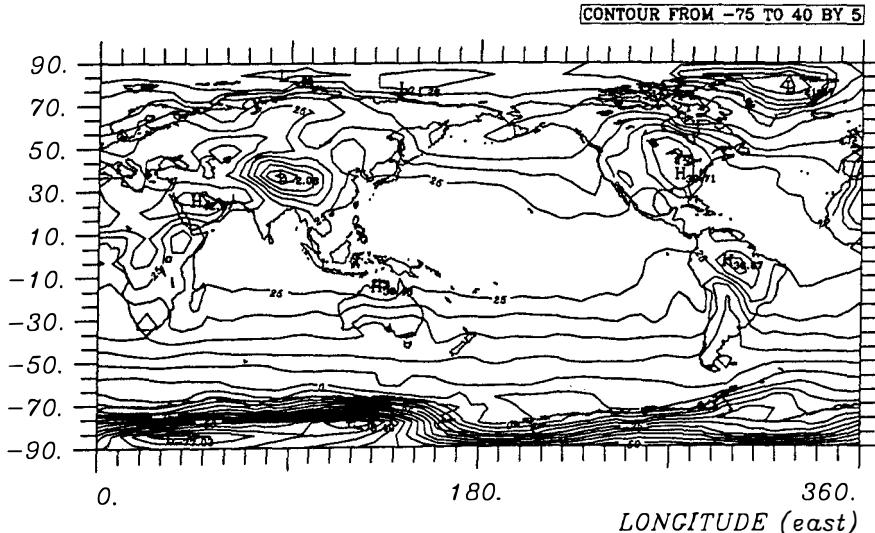
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 28.06 deg.C

LATITUDE

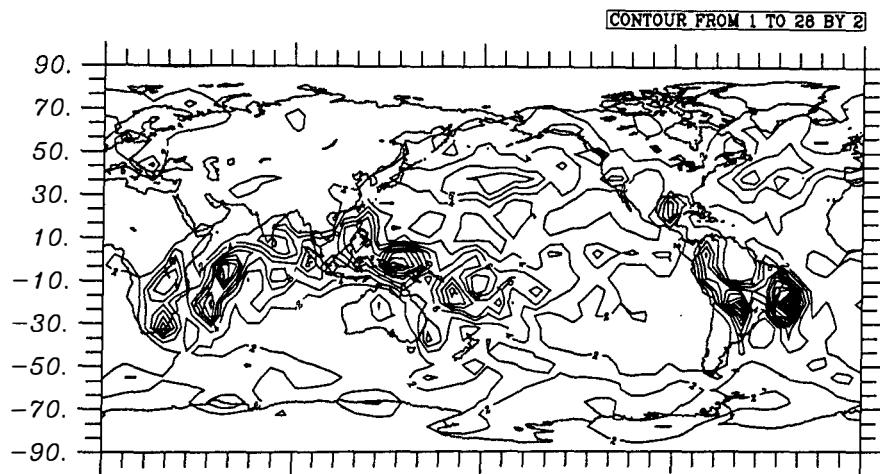


JULY

Temperature at: 2.77(lat), 180.00 (lon): 27.92 deg.C

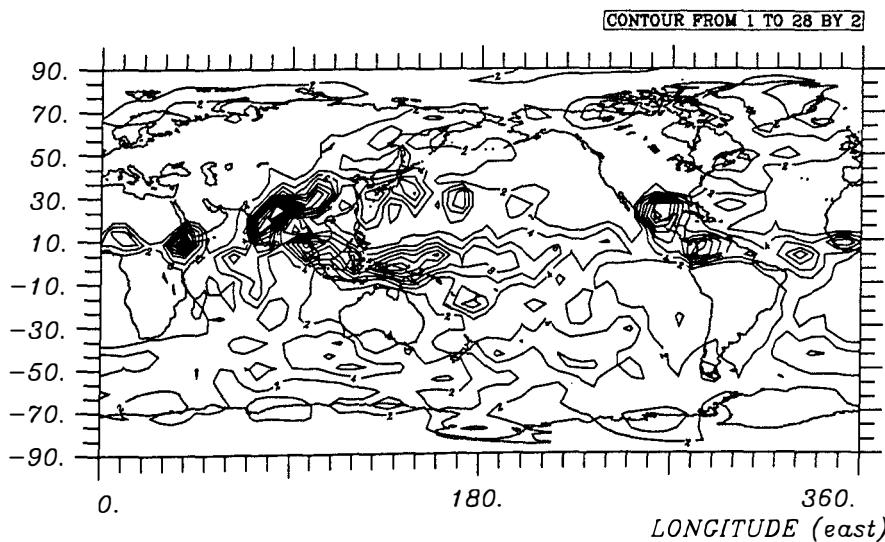
Precipitation  
Scenario A T21  
Year 2035

LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 3.42 mm/day

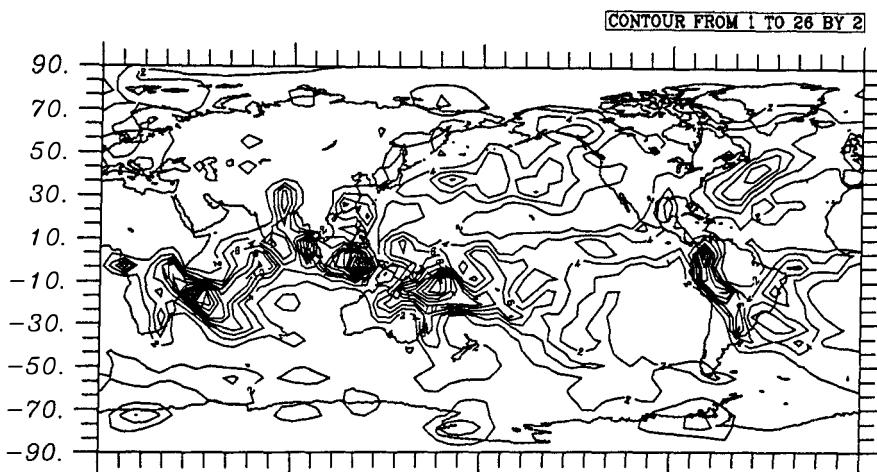


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 8.91 mm/day

Precipitation  
Scenario A T21  
Year 2085

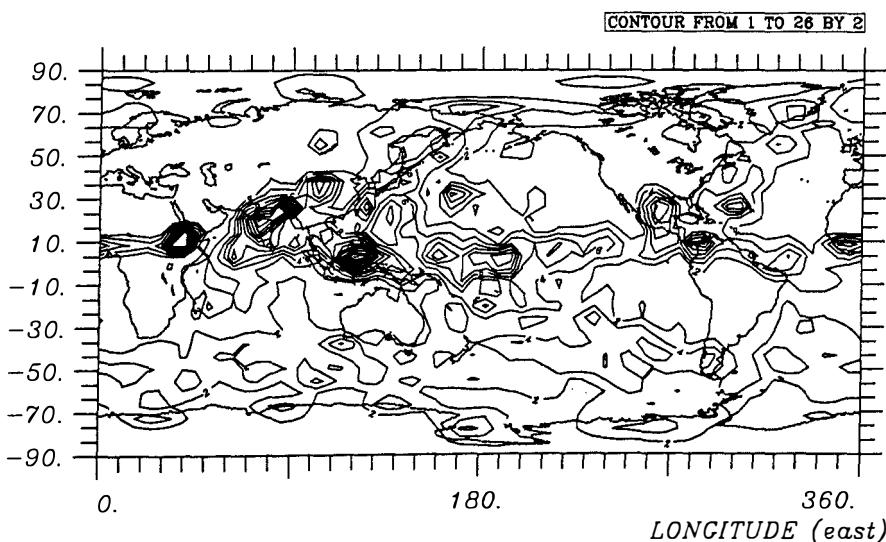
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 9.24 mm/day

LATITUDE

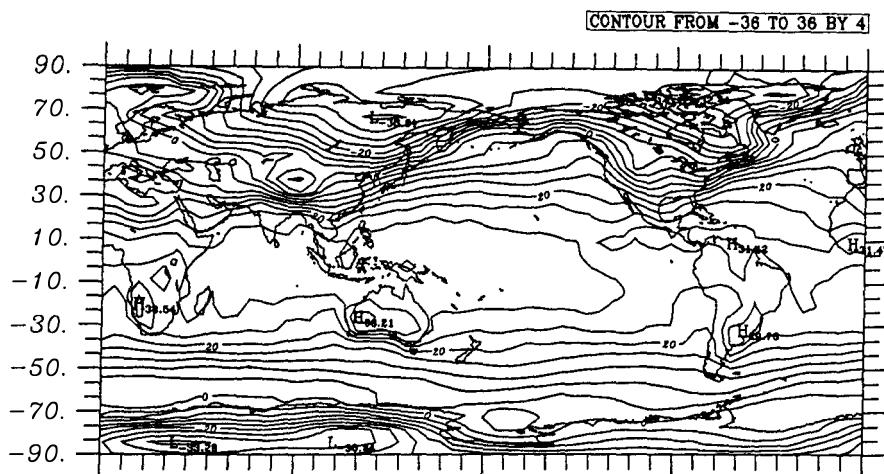


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 13.72 mm/day

Temperature  
Time Slice Experiment T21  
30-year-average

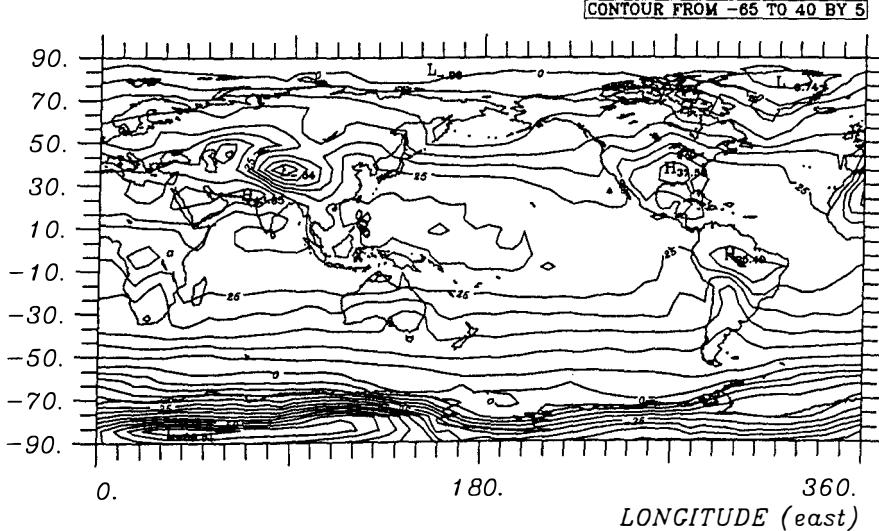
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 30.38 deg.C

LATITUDE

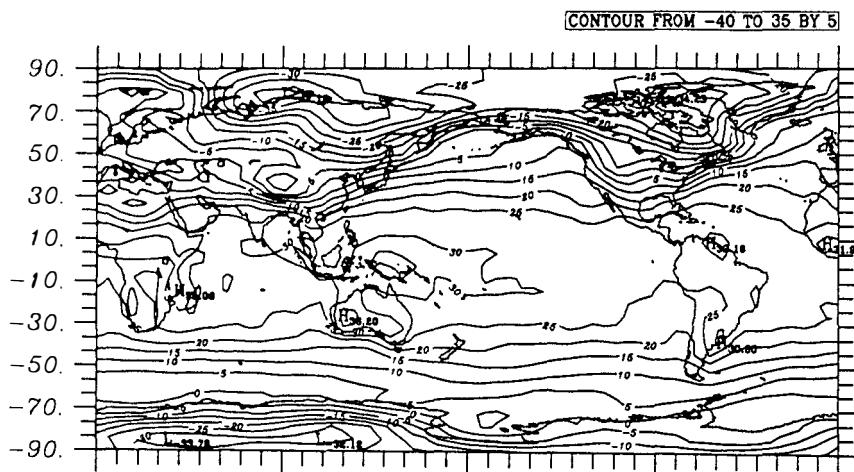


JULY

Temperature at: 2.77(lat), 180.00 (lon): 30.53 deg.C

Temperature  
Time Slice Experiment T21 (3CO<sub>2</sub>)  
Year 5 of Integration

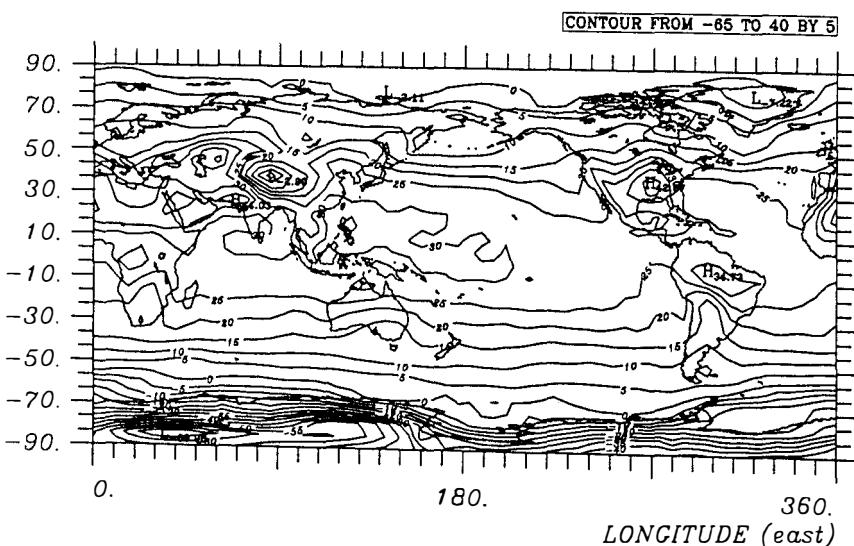
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 30.41 deg.C

LATITUDE

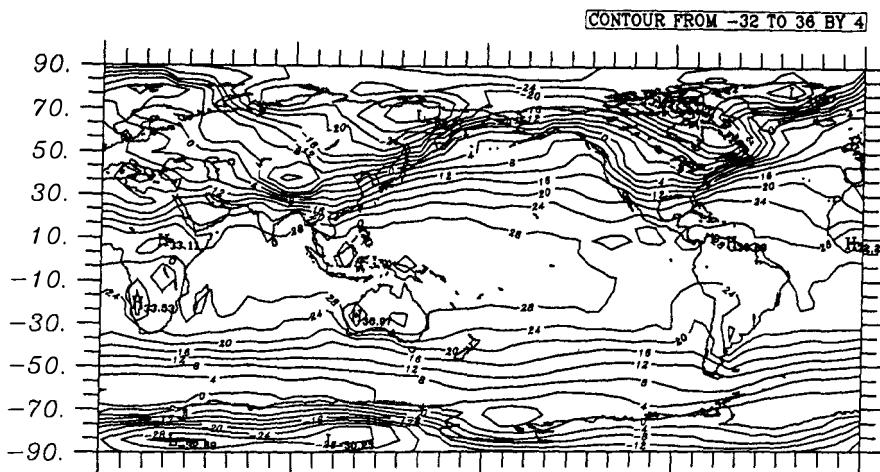


JULY

Temperature at: 2.77(lat), 180.00 (lon): 30.18 deg.C

Temperature  
Time Slice Experiment T21 (3C02)  
Year 17 of Integration

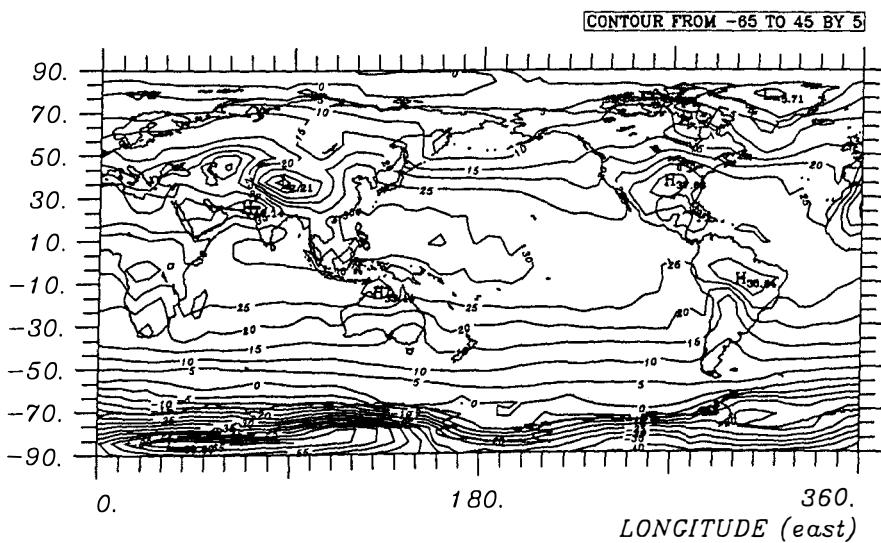
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 30.43 deg.C

LATITUDE

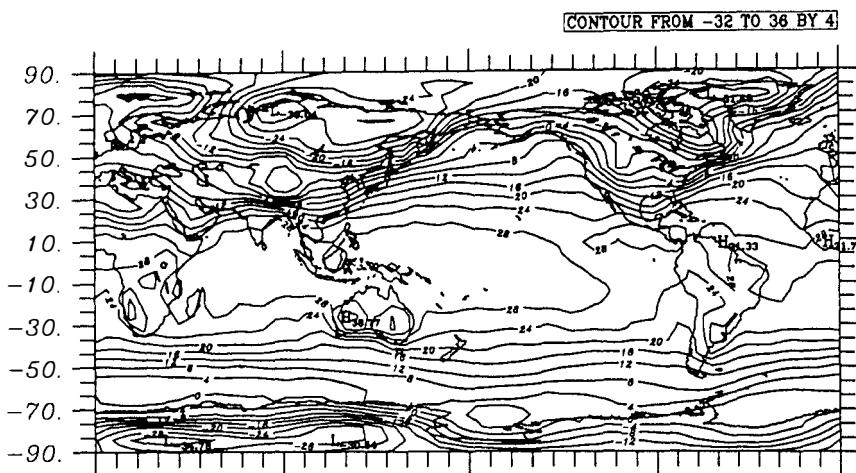


JULY

Temperature at: 2.77(lat), 180.00 (lon): 30.68 deg.C

Temperature  
Time Slice Experiment T21 (3CO<sub>2</sub>)  
Year 26 of Integration

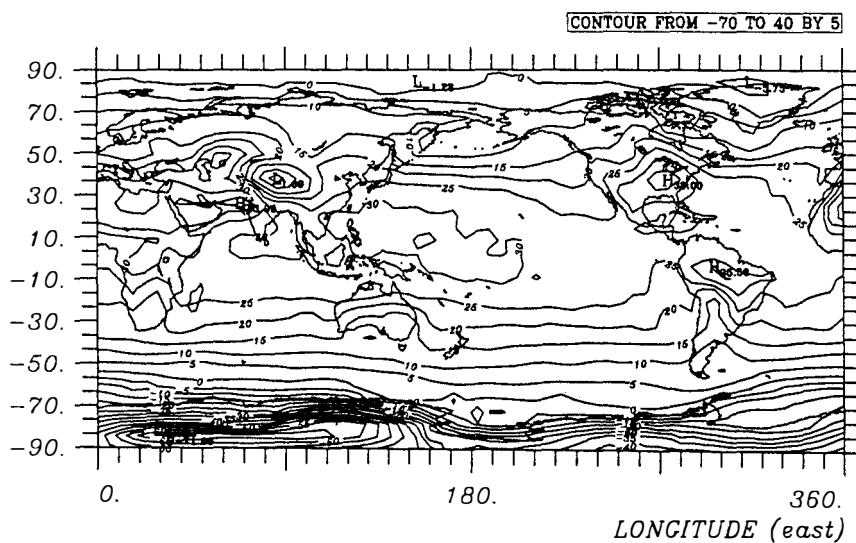
LATITUDE



JANUARY

Temperature at: 2.77(lat), 180.00 (lon): 30.31 deg.C

LATITUDE

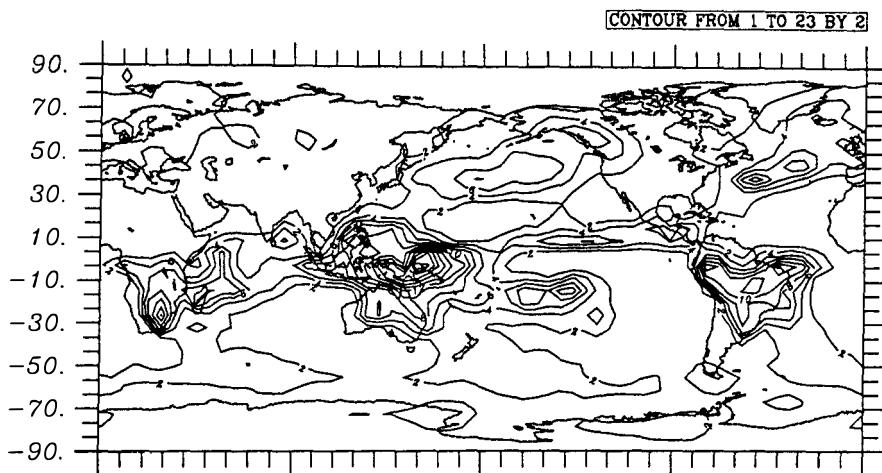


JULY

Temperature at: 2.77(lat), 180.00 (lon): 30.72 deg.C

Precipitation  
Time Slice Experiment T21  
30-year-average

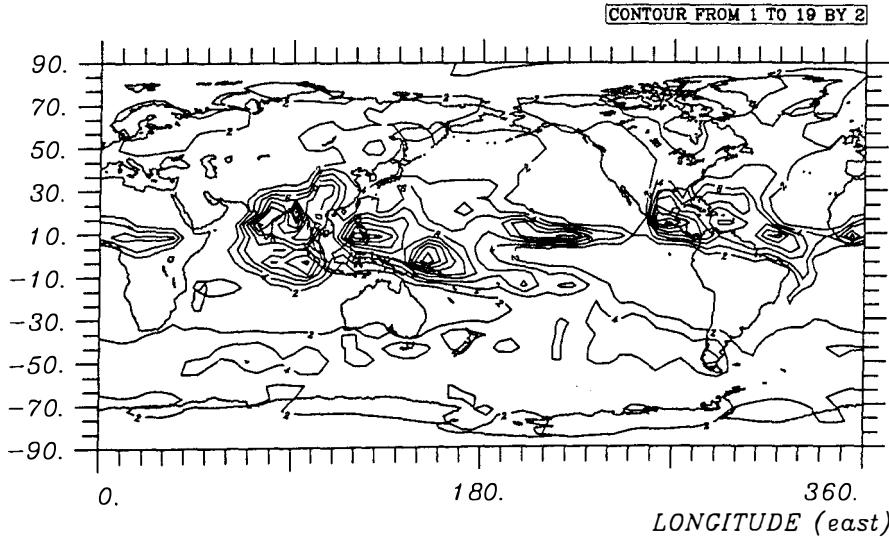
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 4.64 mm/day

LATITUDE

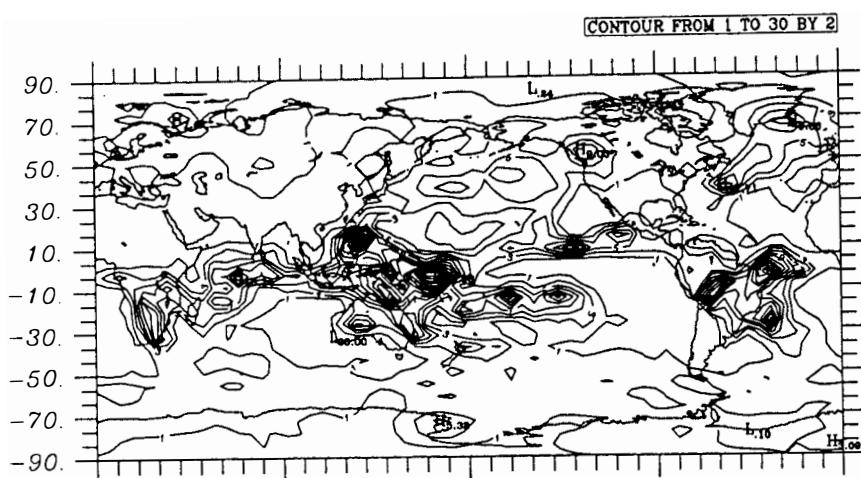


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 4.04 mm/day

Precipitation  
Time Slice Experiment T21 (3CO<sub>2</sub>)  
Year 5 of Integration

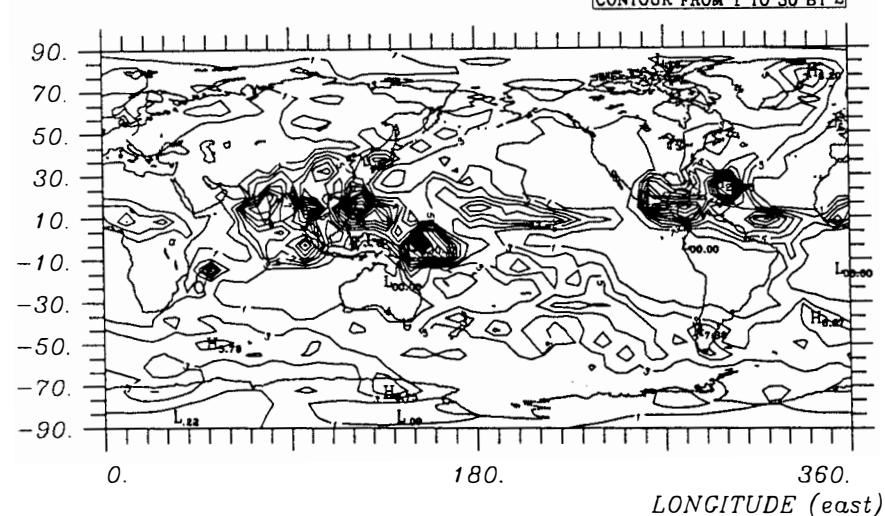
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 4.48 mm/day

LATITUDE

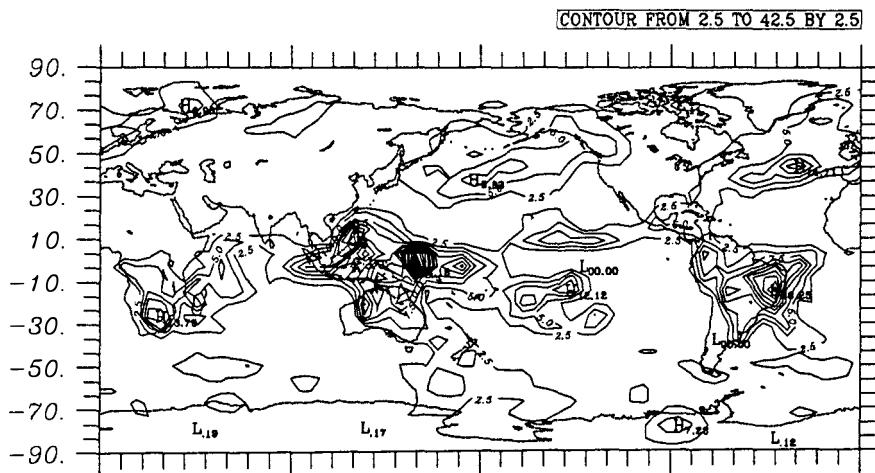


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 3.88 mm/day

Precipitation  
 Time Slice Experiment T21 (3CO<sub>2</sub>)  
 Year 17 of Integration

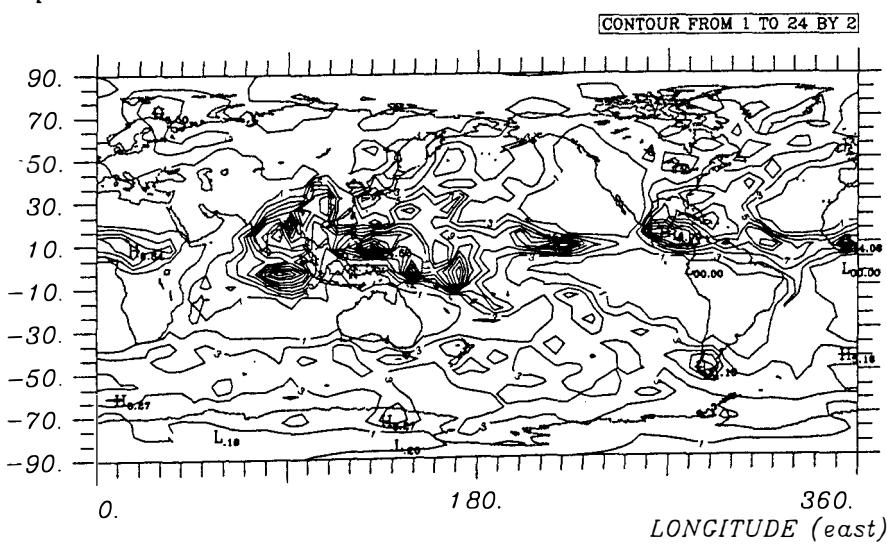
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 3.14 mm/day

LATITUDE

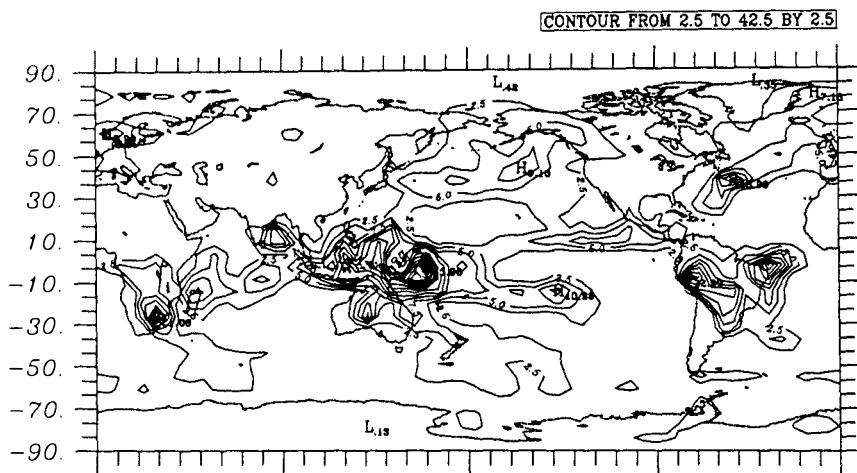


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 5.49 mm/day

Precipitation  
Time Slice Experiment T21 (3C02)  
Year 26 of Integration

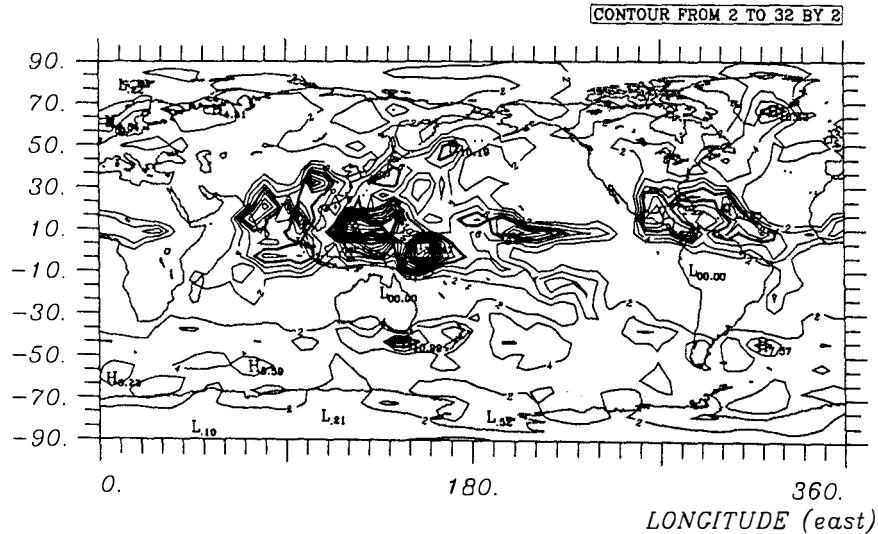
LATITUDE



JANUARY

Precipitation at: 2.77(lat), 180.00 (lon): 5.66 mm/day

LATITUDE

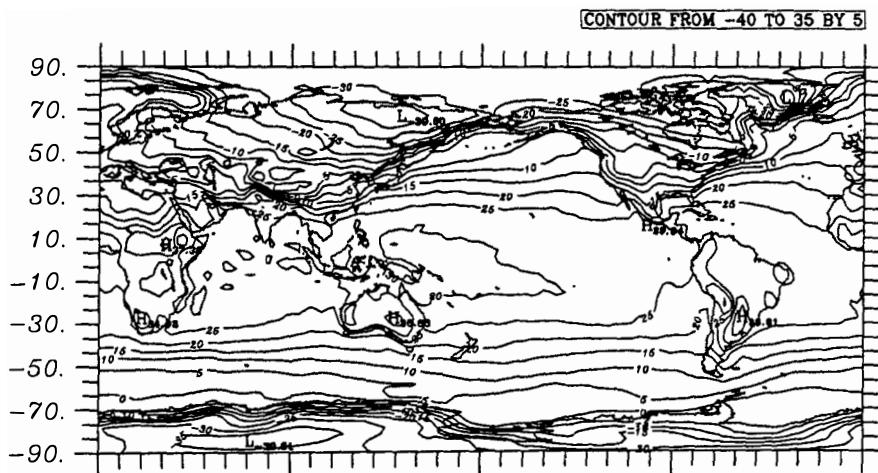


JULY

Precipitation at: 2.77(lat), 180.00 (lon): 5.78 mm/day

Temperature  
Time Slice Experiment T42 (3CO<sub>2</sub>)  
30-year-average

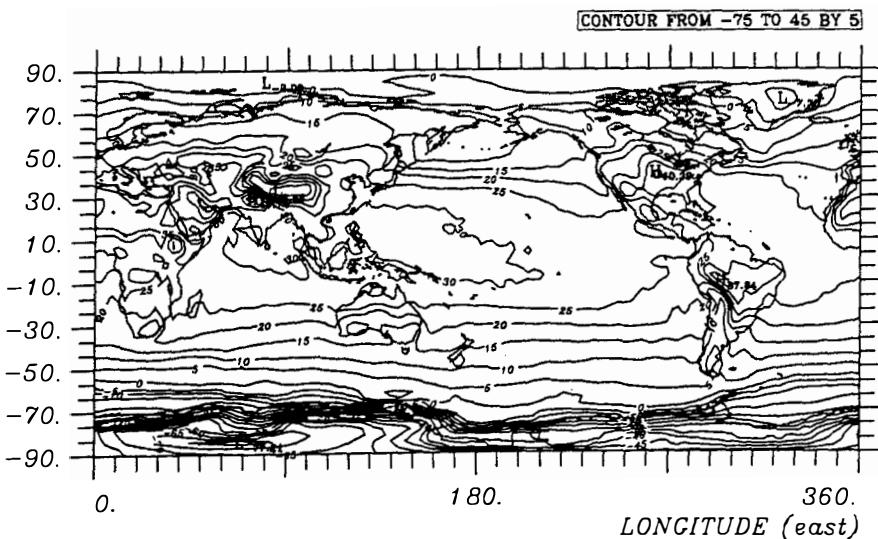
LATITUDE



JANUARY

Temperature at: -43.25(lat), 90.00 (lon): 12.47 deg.C

LATITUDE

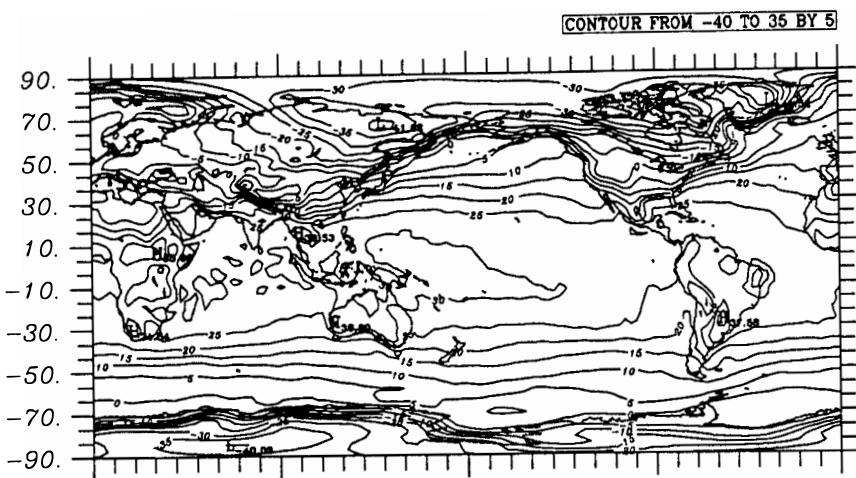


JULY

Temperature at: -43.25(lat), 90.00 (lon): 10.43 deg.C

Temperature  
Time Slice Experiment T42 (3C02)  
Year 5 of Integration

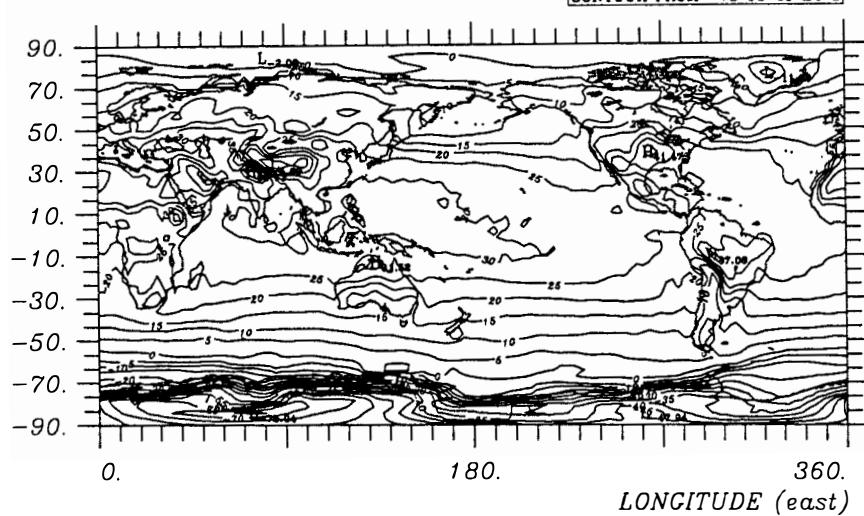
LATITUDE



JANUARY

Temperature at: -43.25(lat), 90.00 (lon): 12.26 deg.C

LATITUDE

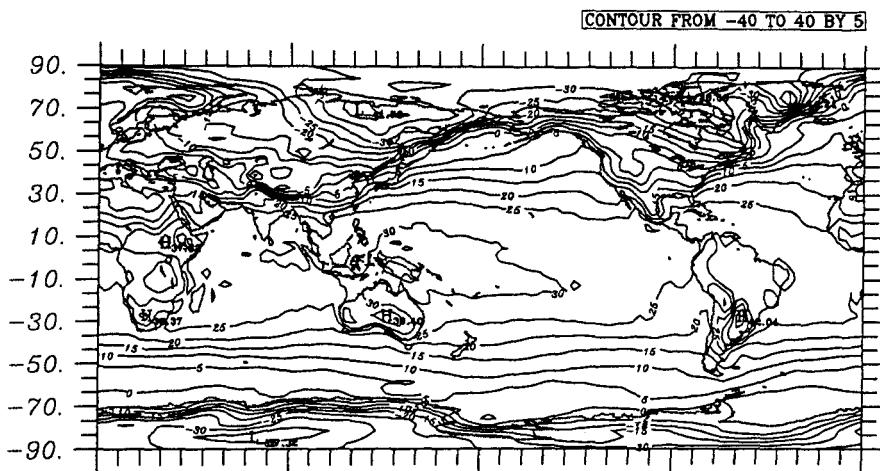


JULY

Temperature at: -43.25(lat), 90.00 (lon): 9.98 deg.C

Temperature  
Time Slice Experiment T42 (3CO<sub>2</sub>)  
Year 17 of Integration

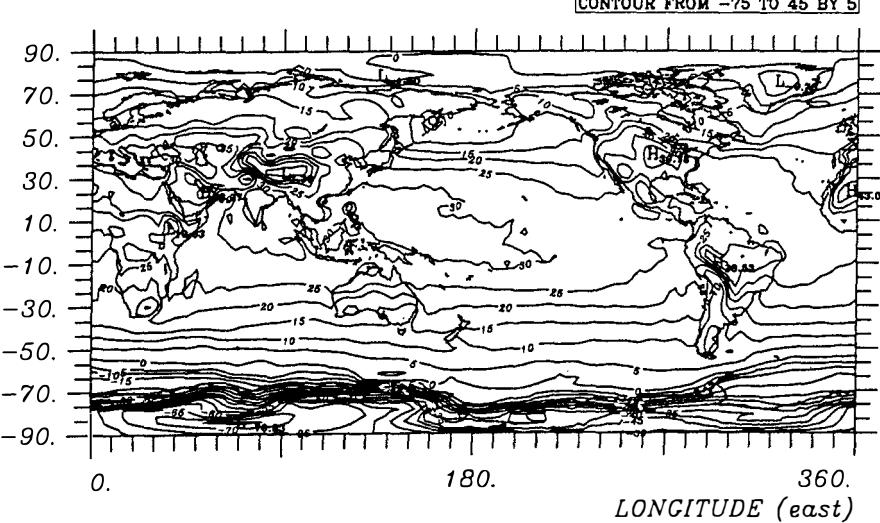
LATITUDE



JANUARY

Temperature at: -43.25(lat), 90.00 (lon): 12.71 deg.C

LATITUDE

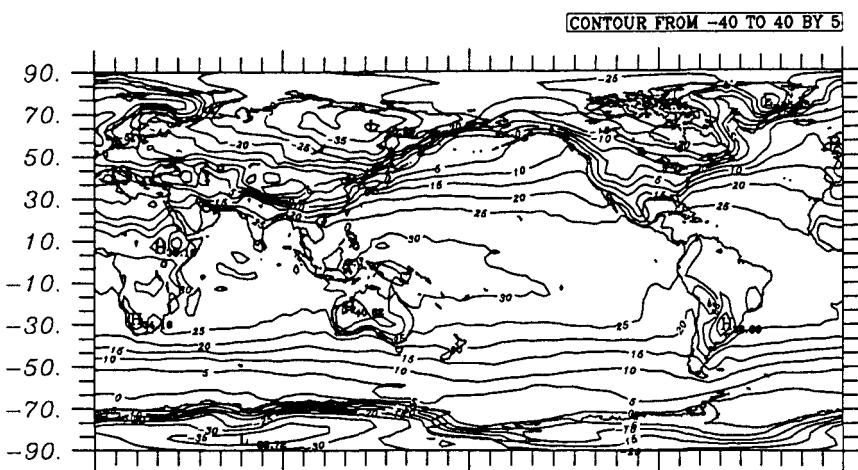


JULY

Temperature at: -43.25(lat), 90.00 (lon): 10.67 deg.C

Temperature  
Time Slice Experiment T42 (3C02)  
Year 26 of Integration

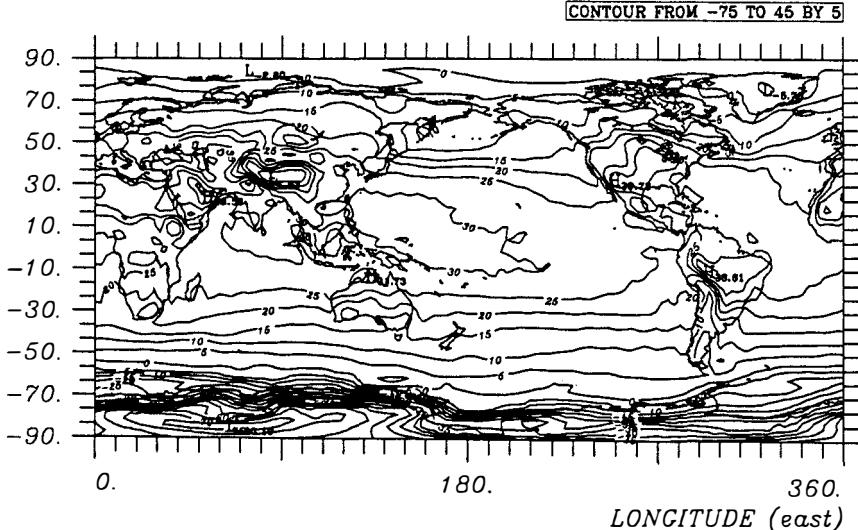
LATITUDE



JANUARY

Temperature at: -43.25(lat), 90.00 (lon): 12.58 deg.C

LATITUDE

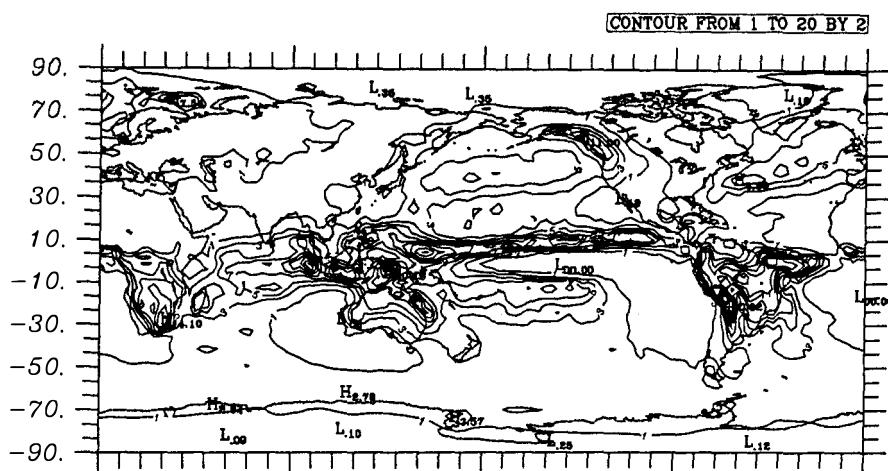


JULY

Temperature at: -43.25(lat), 90.00 (lon): 10.30 deg.C

Precipitation  
 Time Slice Experiment T42 (3C02)  
 30-year-average

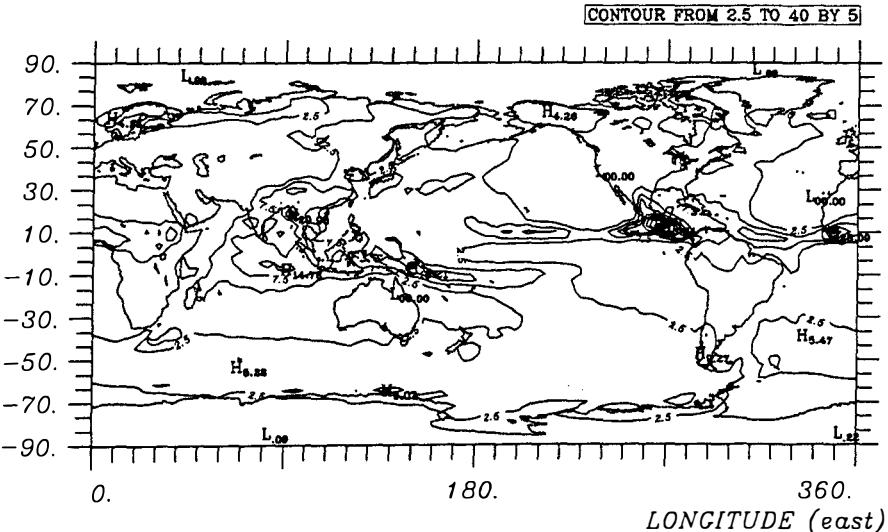
LATITUDE



JANUARY

Precipitation at: -43.25(lat), 90.00 (lon): 1.02 mm/day

LATITUDE

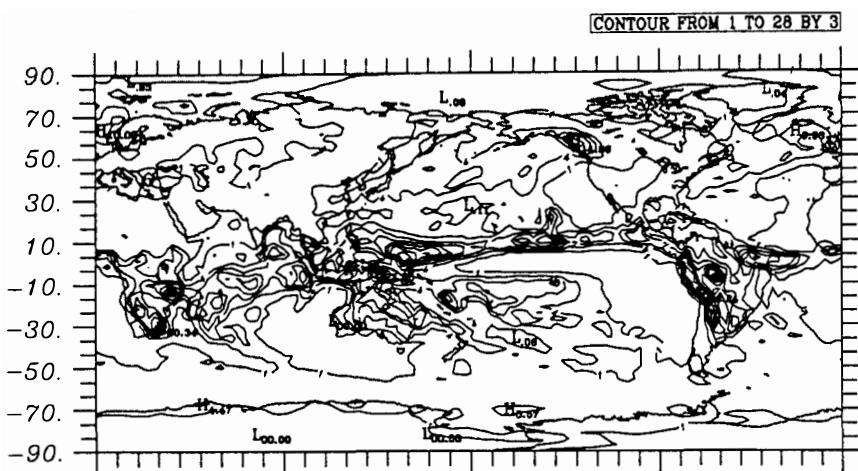


JULY

Precipitation at: -43.25(lat), 90.00 (lon): 3.90 mm/day

Precipitation  
Time Slice Experiment T42 (3C02)  
Year 5 of Integration

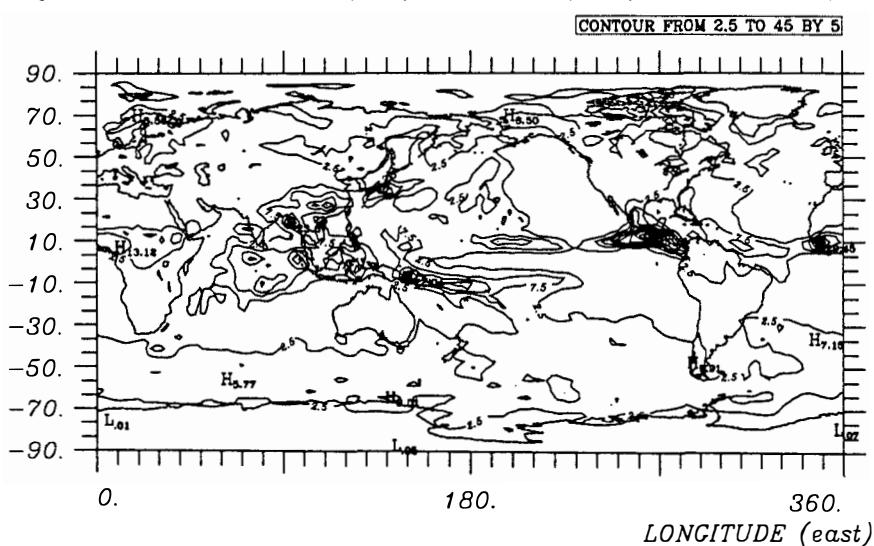
LATITUDE



JANUARY

Precipitation at: -43.25(lat), 90.00 (lon): 1.09 mm/day

LATITUDE

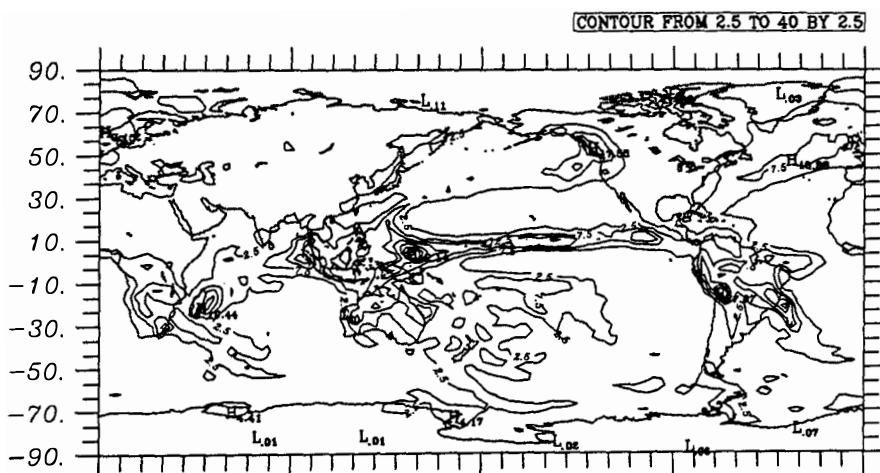


JULY

Precipitation at: -43.25(lat), 90.00 (lon): 3.44 mm/day

Precipitation  
 Time Slice Experiment T42 (3C02)  
 Year 17 of Integration

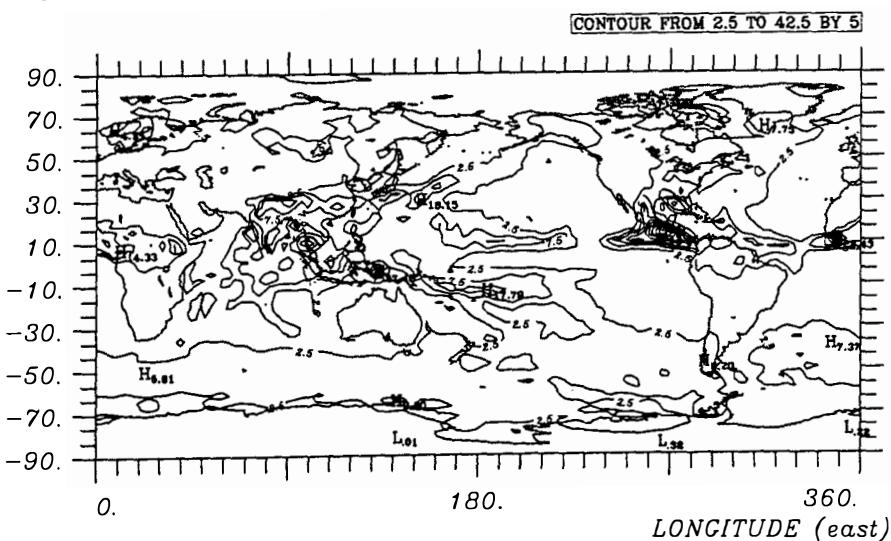
LATITUDE



JANUARY

Precipitation at: -43.25(lat), 90.00 (lon): 1.72 mm/day

LATITUDE

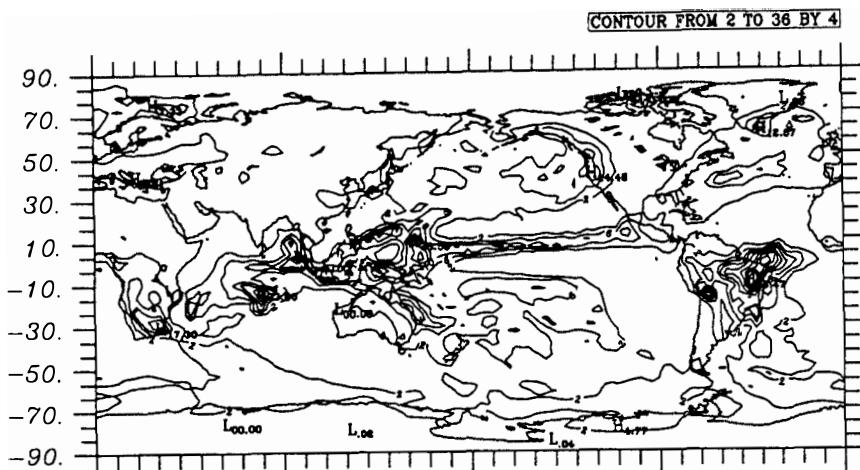


JULY

Precipitation at: -43.25(lat), 90.00 (lon): 4.10 mm/day

Precipitation  
Time Slice Experiment T42 (3C02)  
Year 26 of Integration

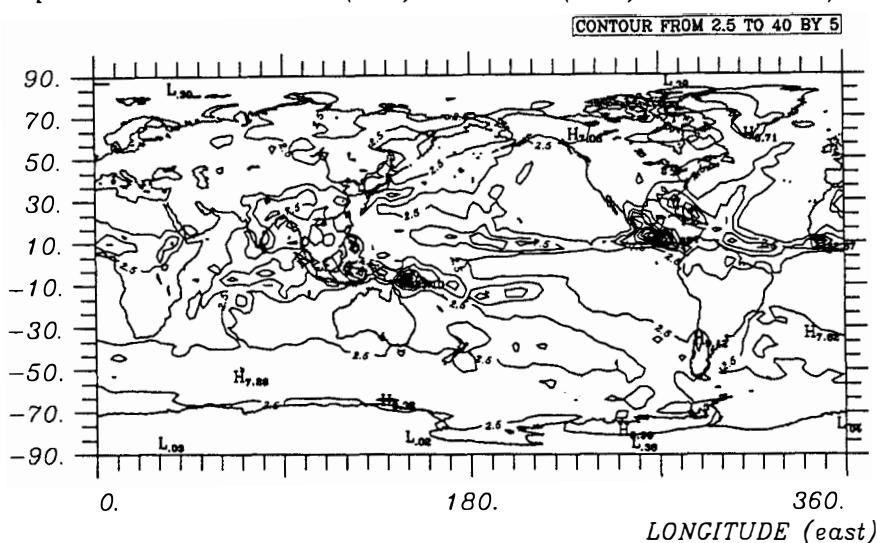
LATITUDE



JANUARY

Precipitation at: -43.25(lat), 90.00 (lon): 0.42 mm/day

LATITUDE

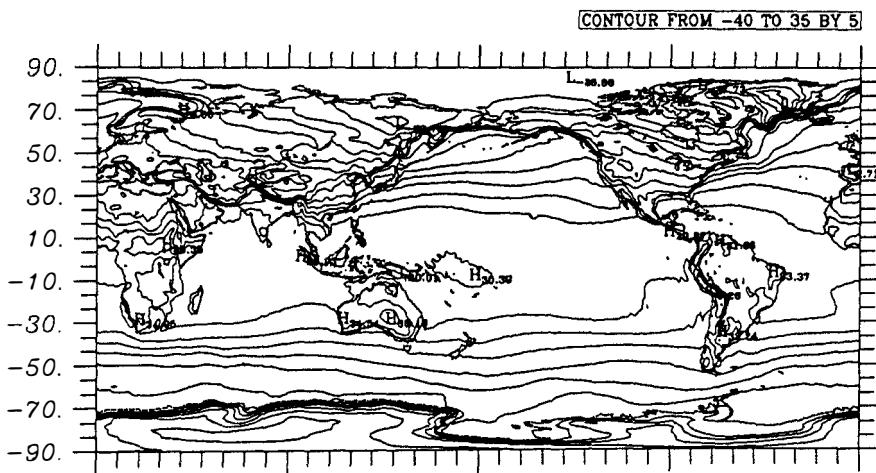


JULY

Precipitation at: -43.25(lat), 90.00 (lon): 3.61 mm/day

Temperature  
Time Slice Experiment T106  
5-year-average

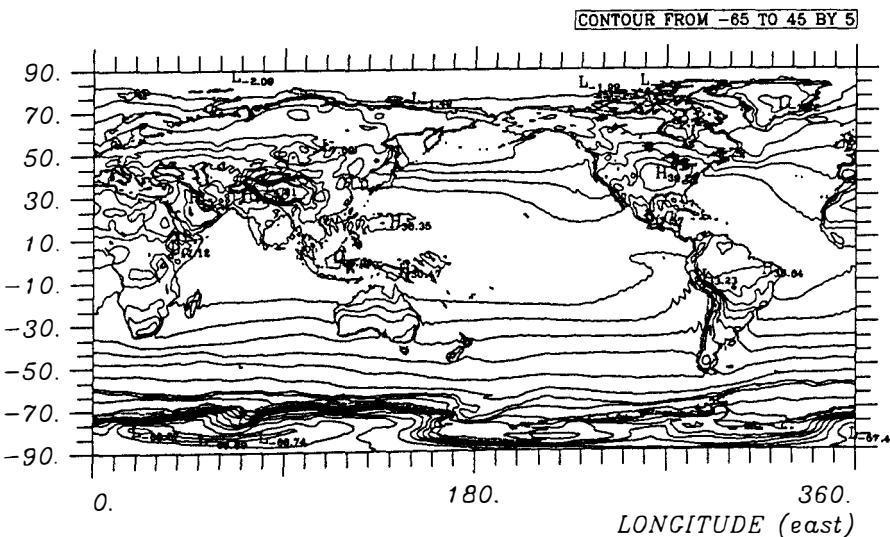
LATITUDE



JANUARY

Temperature at: -71.21(lat), 36.00 (lon): -12.80 deg.C

LATITUDE

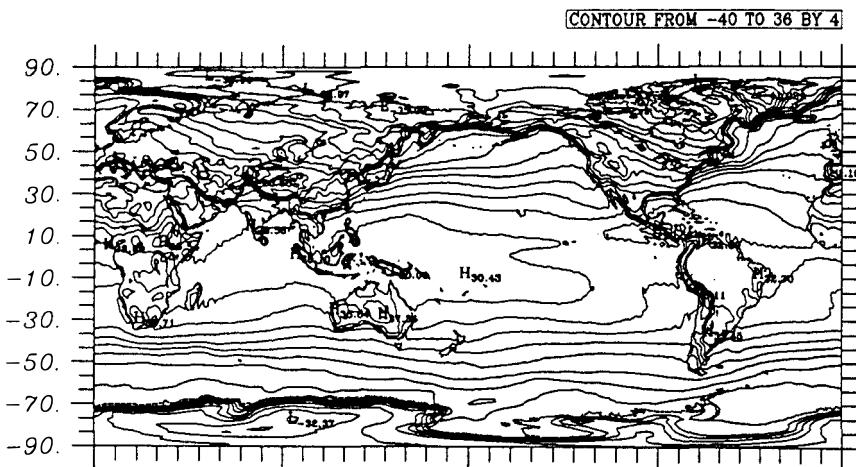


JULY

Temperature at: -71.21(lat), 36.00 (lon): -34.16 deg.C

Temperature  
Time Slice Experiment T106  
Year 3 of Integration

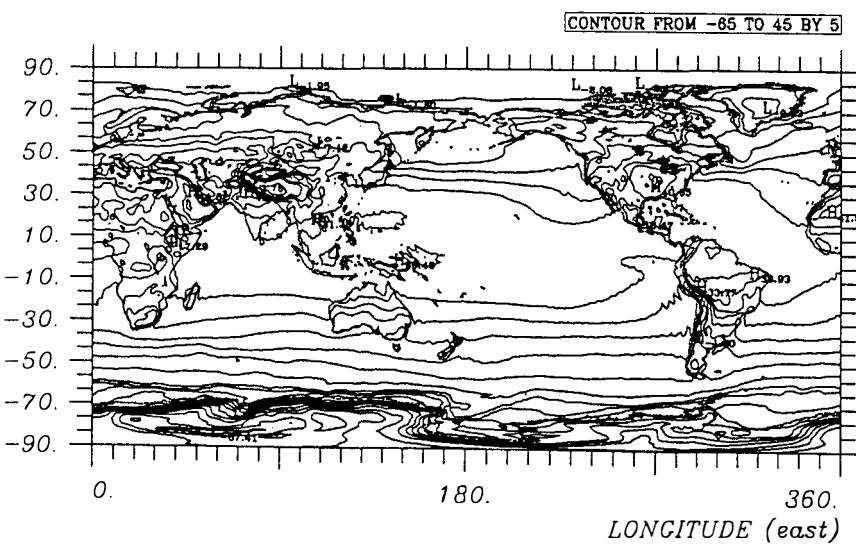
LATITUDE



JANUARY

Temperature at: -71.21(lat), 36.00 (lon): -11.13 deg.C

LATITUDE

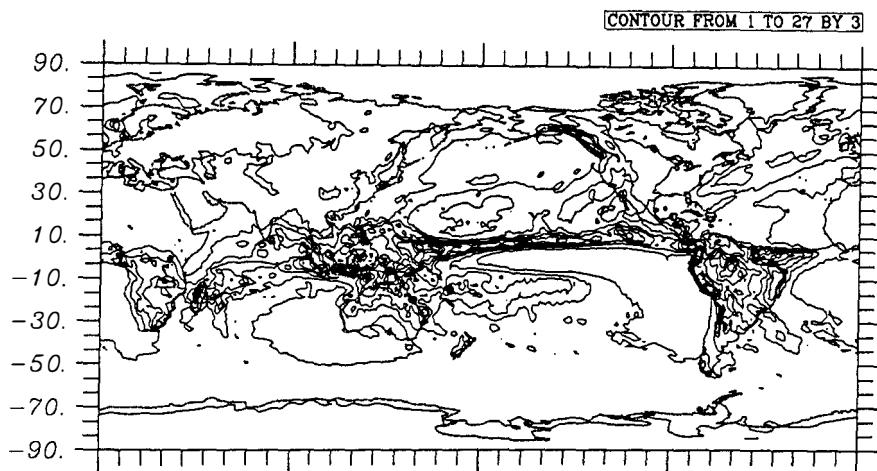


JULY

Temperature at: -71.21(lat), 36.00 (lon): -34.52 deg.C

Precipitation  
Time Slice Experiment T106  
5-year-average

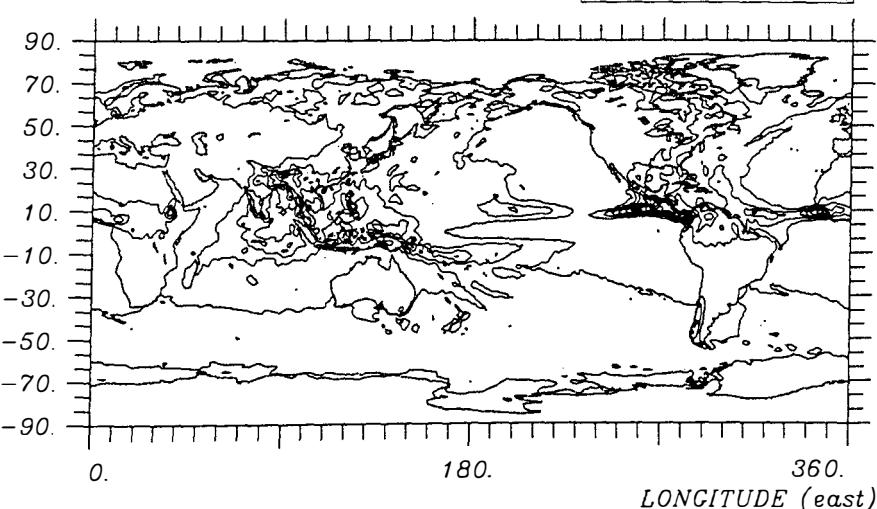
LATITUDE



JANUARY

Precipitation at: -71.21(lat), 36.00 (lon): 1.31 mm/day

LATITUDE



JULY

Precipitation at: -71.21(lat), 36.00 (lon): 0.31 mm/day