K. User's guide to running the model

K-1. Getting started

The UNIX combined model environment is supplied by a tar file *mrinpd.tgz* To decompress and expand the code, type the following commands:

gzip -cd *mrinpd.tgz* | tar -xvf -

The following subdirectories are found in the directory *mrinpd***.

shl** : unix shell script

srcenv : source program for environment settings

src** : source program for model run

srcplt : source program for plot job (1)

card : parameter card to control jobs

data : data file for radiation, etc.

shlplt2 : unix shell script for plot job (2)

srcplt : source program for plot job (2)

@data : temporary dataset to store output data

@src997lib : temporary dataset to store object modules

K-2. Setting the orography file

K-2-1 Simple orography for ideal test

The Unix shell for preparing a simple orography file for an ideal test is in shl**/#orbel**. The following is an example of the shell script (shl997/#orbel32an) for model size (32,32,NZ).

```
cd srcenv
echo'     PARAMETER (NX=32,NY=32)'>zsize.h
f90 -o org3232.out org3dm.f
  org3232.out<<EOF
  &NAMORG
  IXTST=1,IXTEN=32,JYMST=1,JYMEN=32,XCENT=16.5,YCENT=16.5,
  PWX=3.0,PWY=3.0,ZTOP=100.0,THETA=0.0,LTBDRY=0,
  FLAT=0., FLON=140., FZLAND=0.1
  &END
  &NAMSST
  PTGRDS=288.3
  &END
  &NAMPRJ
  NPROJC='DES'
  &END
EOF
mv fort.50 ../@data/org.bell32an
```

The namelists as the input parameter are as follows:

1) Namelist &NAMORG

Name	Type	Meaning	Default	remarks
IXTST	int	start number for x-direction	1	
IXTEN	int	end number for x-direction	NX	

Name	Type	Meaning	Default	remarks
JYMST	int	start number for y-direction	1	
JYMEN	int	end number for y-direction	NX	
XCENT	real	location of mountain top in x-direction	NX/2	x_0 in (J1-2-1)/Δx
YCENT	real	location of mountain top in y-direction	NY/2	y_0 in (J1-2-1)/Δy
PWX	real	half width in x-direction	···	a in (J1-2-1)/Δx
PWY	real	half width in y-direction	···	b in (J1-2-1)/Δy
ZTOP	real	mountaintop height	···	h_m in (J1-2-1)
THETA	real	angular of rotation	0.	no other choice
LTBDRY	real	lateral boundary condition	0	1 : cyclic for x-direction 2 : cyclic for x- and y-directions
FLAT	real	latitude (degree)	0.0	
FLON	real	longitude (degree)	140.0	
FZLAND	real	roughness length (m)	0.1	

2) Namelist &NAMSST

Name	Type	Meaning	Default	remarks
PTGRDS	real	potential temperature at sea surface (K)	---	not used in ordinary setting

3) Namelist &NAMPRJ

Name	Type	Meaning	Default	remarks
NPROJC	c*4	map projection	'DES'	Descart coordinate

The output file is stored in @data/org.bell** (fort.50), and its format is described in J-1-1.

K-2-2 Real orography for arbitrary conformal projection

Setting of the real orography file is performed using gtopo30 dataset. To decompress and expand the dataset, type the following commands :

gzip -cd *mrinpd.tgz* | tar -xvf -

In the directory *gtopo30*, *step2.dx10.sh* is a sample shell script for 10 km resolution real orography around Kyushu.

```
step2 -F'PORT(STDUF)'<domain.card.LMN102.dx10
mv fort.80 ../mrinpd997/@data/org.kyushu.102dx10
```

Here, domain.card specifies namelist for orography information such as the domain size, horizontal resolution, map projection, *etc*..

```
&NAMDOM
  NX= 102
  NY= 102
  NPROJC='LMN'
  DX= 10000.
  DY= 10000.
  SLAT= 32.5
  SLON= 140.
  FLATC= 32.5
```

```
   FLONC= 130.5
   XI= 61.
   XJ= 165.
   XLAT= 30.
   XLON= 140.
 &END
```

The contents of the namelist is as follows:

1) Namelist &NAMDOM

Name	Type	Meaning	Default	remarks
NX	int	model array size x-direction		…
NY	int	model array size y-direction		…
NPROJC	c*4	map projection	…	'PSN': Polar stereo 'LMN': Lambert 'MER': Mercator
DX	real	data resolution x-direction (m)	…	
DY	real	data resolution y-direction (m)	…	
SLAT	real	standard latitude	…	φ_0 in J1-3-2
SLON	real	standard longitude	…	λ_0 in J1-3-1
FLATC	real	latitude of map's center	…	
FLONC	real	longitude of map's center	…	
XI	int	grid number x-direction of (XLAT,XLON)	…	dummy if FLATC is specified
XJ	real	grid number y-direction of (XLAT,XLON)	…	dummy if FLATC is specified
XLAT	real	latitude of standard point	…	dummy if FLATC is specified
XLON	real	Longitude of standard point	…	dummy if FLATC is specified

A temporary file is output in mrinpd**/@data/org.kyushu102.dx10 (fort.80), whose format is same as in J-1-1. By running shlplt2/zsls.sh, a postscript file can be made in @data/zs.ps (fort.60) to monitor the model domain. Figure K2-2-1 shows the domain and orography made in the example shell script.

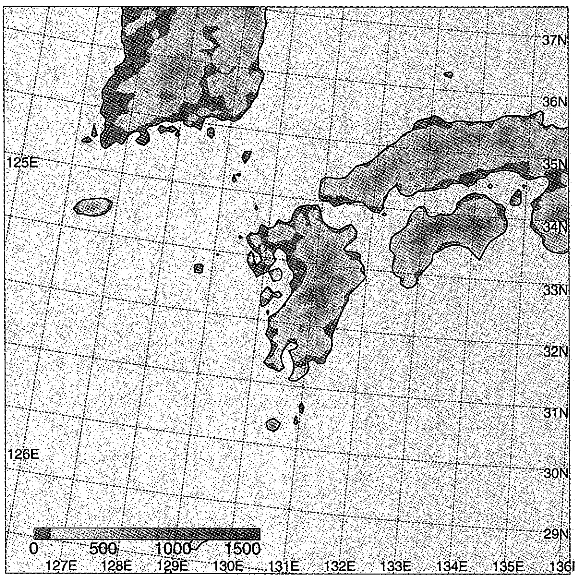

Fig. K2-2-1 Domain and orography produced in the example shell script in K-2-2.

K-3. File conversion for nesting

K-3-1. Nesting with RSM

The Unix shell for file conversion for nesting with RSM is in ../shl/#nflrsm**. The following is an example of the shell script (shl997/#nflmprsm) for model size (102,102,38).

```
echo '#*----- Compile -----'
setenv DATE y9906.d2500
  cd srcenv
  f90 -O3 -c nflutlty2.f nflutplt1.f nflutnpd2.f
echo' PARAMETER (NX=102,NY=102,NZ=38)'>mdlsize.h
  f90 -O3 nflmprsm.f nflutlty2.o nflutplt1.o nflutnpd2.o ../srcplt/nflutplt2.o ..
/srcplt/plotpswk.o -o nflmprsm102.out
cd ..
echo '#*----- convert to Arakawa-C, z* coordinate -----'
rm fort.*
ln -s  @data/@rsmdata.org fort.10
ln -s  @data/@rsmdata.gpv fort.11
ln -s  @data/@rsmdata.sfc fort.12
ln -s  @data/@rsmdata.phy fort.13
ln -s  data/MAPJPN fort.43
ln -s  @data/org.kyushu.102dx10 fort.51
ln -s  data/PSDATA fort.9
srcenv/nflmprsm102.out <<EOF
  &NAMMAPO
  SCALE=3000.,FLSTP=10.,XSW=20.,YSW=20.
  &END
  &NAMMAPI
  FLATSI=25.5, FLATNI=39.5, FLONWI=125.0, FLONEI=140.5, SCALEI=1000.,
  SLONI=140., SLATI=32.5, FLSTPI=2., XSWI=20., YSWI=20., IFILEI=51,
  NPROJC='LMN'
  &END
  &NAMORGI
  FLATC=32.5, FLONC=130.5, DX=10000., DY=10000.,
  THI=0., NXIN=102, NYIN=102, IWDTH=5, IMERG=5, GRMAX=0.15
  &END
  &NAMGRDI
  DXI=10000., DX1I=10000., DX2I=10000., IX1I=10, IX2I=20,
  DYI=10000., DY1I=10000., DY2I=10000., IY1I=10, IY2I=20,
  DZI=1120., DZ1I=40., DZ2I=1120., IZ1I=38, IZ2I=38
  &END
  &NAMNEST
  KTST=9, KTEN=15, KTDEL=3,
  &END
EOF
mv fort.23 @data/uvptq.102.$DATE
mv fort.25 @data/ptgrd.102.$DATE
```

The dataset @rsm** are obtained by running shl997/#readrsm, and their format is described in J-2-1. The namelists as the input parameter are as follows:

1) Namelist &NAMMAPO

This namelist defines the map to show the forecast of RSM.

Name	Type	Meaning	Default	remarks
SCALE	real	scale of map projection	···	

Name	Type	Meaning	Default	remarks
XSW	real	x position of under-left of map	…	
FLSTP	real	interval for depict latitude and longitude lines	…	
YSW	real	y position of under-left of map	…	

2) Namelist &NAMMAPI

This namelist defines the map to show the domain of NHM.

Name	Type	Meaning	Default	remarks
FLATSI	real	latitude of under-left of map	…	
FLATNI	real	latitude of upper-right of map	…	
FLONWI	real	longitude of under-left of map	…	
FLONEI	real	longitude of upper-right of map	…	
SCALEI	real	scale of map projection	…	
SLONI	real	standard latitude	…	φ_0 in J1-3-2
SLATI	real	standard longitude	…	λ_0 in J1-3-1
FLSTPI	real	interval for depict latitude and longitude lines	…	
XSWI	real	x position of under-left of map	…	
YSWI	real	y position of under-left of map	…	
IFILEI	int	device number for output file	51	
NPROJC	c*4	map projection	…	'PSN': Polar stereo 'LMN': Lambert 'MER': Mercator

3) Namelist &NAMORGI

This namelist transfers domain information of the NHM orography. The parameter values must be consistent with the namelist NAMORG of the orography setting.

Name	Type	Meaning	Default	remarks
FLATC	real	center latitude (degree)		
FLONC	real	center longitude (degree)		
DX	real	x-direction resolution (m)	…	
DY	real	y-direction resolution (m)	…	
THI	real	angular of rotation	0.	no ther choice
NXIN	int	model array size in x-direction	NX	
NYIN	int	model array size in y-direction	NY	
IWIDTH	int	width of rim to use the RSM orography	>4	
IMERG	int	width of rim to merge the RSM orography	>4	
GRMAX	real	maximum steepness of orography		

4) Namelist &NAMGRDI

This namelist is to define the grid structure of NHM.

Name	Type	Meaning	Default	remarks
DXI	real	x-direction grid distance (m)		
DX1I	real	x-direction left-most grid distance (m)	DXI	Dx_l in D-4 in Ikawa and Saito (1991)
DX2I	real	x-direction right-most grid distance (m)	DXI	Dx_r in D-4 in Ikawa and Saito (1991)
IX1I	int	start index for constant grid distance (x-direction)	…	i_l in D-4 in Ikawa and Saito (1991)
IX2I	int	start index for constant grid distance (x-direction)	…	i_r in D-4 in Ikawa and Saito (1991)
DYI	real	y-direction grid distance (m)		
DY1I	real	y-direction left-most grid distance (m)	DYI	
DY2I	real	x-direction rihgt-most grid distance (m)	DYI	
IY1I	int	start index for constant grid distance (y-direction)	…	
IY2I	int	start index for constant grid distance (y-direction)	…	
DZI	real	z-direction grid distance	…	
DZ1I	real	grid distance at lowest level (m)	…	
DZ2I	real	grid distance at highest level (m)	DZI	
IZ1I	int	start index for constant grid distance (z-direction)	1	
IZ2I	int	end index for constant grid distance (z-direction)	NZ	

5) Namelist &NAMNEST

This namelist defines the period of the nesting run.

Name	Type	Meaning	Default	remarks
KTST	int	Start time of nesting in terms of the forecast time of RSM	…	
KTEN	int	End time of nesting	…	
KTDEL	int	Time interval of RSM GPV	3	

A postscript file is made in @data/nflmprsm.ps (fort.60) to monitor the file conversion. Figure K3-1-1 indicates the domain and orography of RSM and the nonhydrostatic model for the sample shell script. Figure K3-1-2 shows the RSM forecast at KT=12 and for monitoring the file conversion.

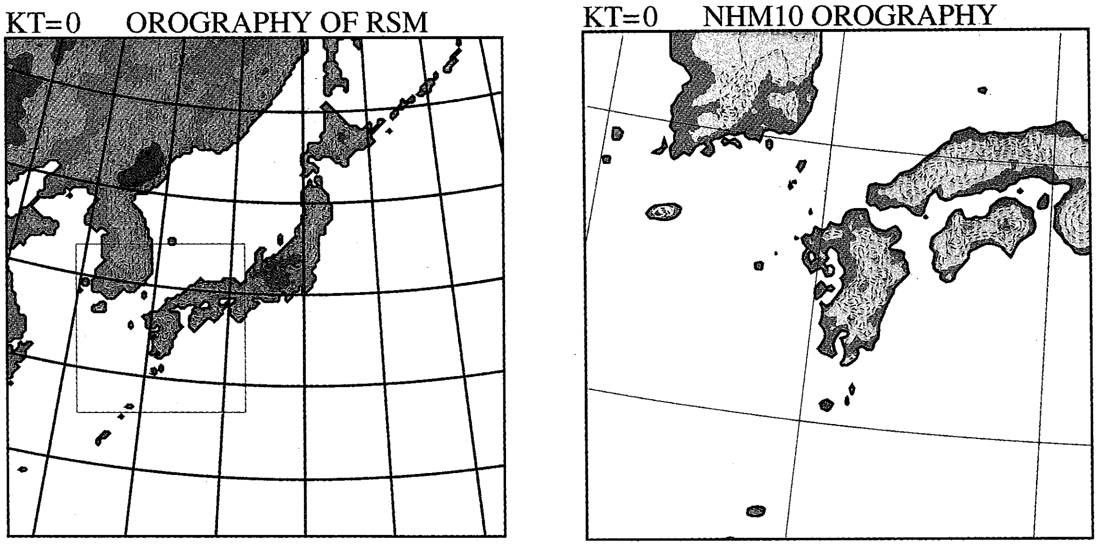

Fig. K3-1-1 Domain and orography of NHM monitored in the file conversion.

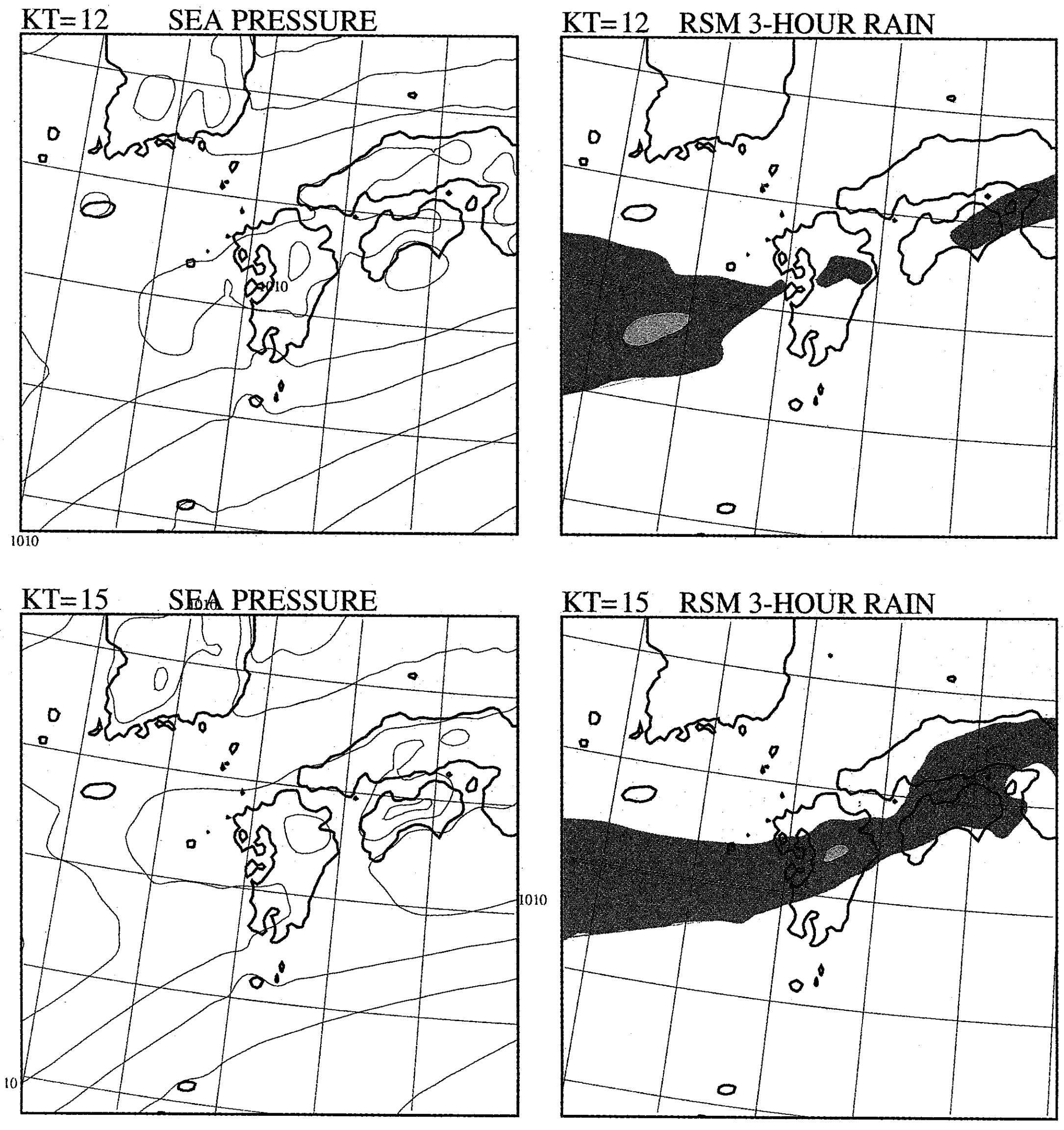

Fig. K3-1-2 RSM forecast (surface pressure and three-hour precipitation) at 1200 UTC and 1500 UTC 1999 Jun 25 for monitoring.

K-3-2. Self-nesting

A Unix shell of file conversion for self-nesting is also prepared (shl997/#nflmpnhm); it converts the model output files J-3-1 or J-3-2 to the boundary file described in J-2-1-d. This utility is available for double- or triple-nesting with RSM as well as a nesting run within the stand-alone run of the nonhydrostatic model.

K-4. Model run

K-4-1. Stand alone run

An example of the shell script for 2 km resolution linear mountain waves (shl997/#glmwv3232) is as follows.

```
echo '#### Compile started ####'
cd src997-2000
  mv ../@src997lib/*.o .
  cp prm.inc32 prm.inc
  rm mainy2.o comm.o wrtfct.o subhevi.o
make
mv*.o ../@src997lib
mv a.out ../@src997lib/main32.out
#------------------------------------------------------------
cd ..
rm fort.50
ln -s @data/org.bell32an fort.50
echo '#### Time integration started ####'
time @src997lib/main32.out<card/LMWV32HI
# time @src997lib/main32.out<card/LMWV32HE
  mv fort.8 @data/strmts2.list
  mv fort.62 @data/strmts2.lmwv.file1
echo '#### Time integration end ####'
  rm fort.*
```

The control parameter card (card/LMWV32HI) for above example is as follows:

```
3-DIM SIMULATION OF STEADY-STATE LINEAR MOUNTAIN WAVE OVER A
BELL-SHAPED MOUNTAIN
NX,NY,NZ=32,32,32, DX=2000.0M, DZ=40 - 1240M OPEN BOUNDARY CONDITION
  &NAMMSW
  MSWSYS( 1)=0, MSWSYS( 2)=1, MSWSYS( 3)=2, MSWSYS( 4)=2, MSWSYS( 5)=2,
  MSWSYS( 6)=-1,MSWSYS( 7)=1, MSWSYS( 8)=0, MSWSYS( 9)=3, MSWSYS(10)=0,
  MSWSYS(11)=0, MSWSYS(12)=2, MSWSYS(13)=0, MSWSYS(14)=0, MSWSYS(15)=2,
  MSWSYS(16)=0, MSWSYS(17)=2, MSWSYS(18)=2, MSWSYS(19)=0, MSWSYS(20)=1,
  MSWSYS(21)=0, MSWSYS(22)=0, MSWSYS(23)=0, MSWSYS(24)=0, MSWSYS(25)=0,
  MSWSYS(26)=0, MSWSYS(27)=0, MSWSYS(28)=0, MSWSYS(29)=0, MSWSYS(30)=0
  &END
  &NAMPAR
  ITST= 1, ITEND=120, ISTRMT=30, ISTRRS=1000, ITOUT=5000, ITCHK=5000,
  DT=30.0, DX=2000.0, DY=2000.0, DZ=1240.0, PTRF=300.0, PRESRF=100000.0
  &END
  &NAMGRD
  DXL=2000.0, DXR=2000.0, IX1=20,I X2=40, DYL=2000.0, DYR=2000.0,
  IY1=20, IY2=40, DZL=40.0, DZR=1240.0, IZ1=32, IZ2=32
  &END
  &NAMVAL
  RATIOI=0.5, RATIOO=0., RATIO2=0., RUVNI=0.5, RUVNO=0., RUVN2=0.,
  FNLTR=0.0, IDIFX=0, DIFNL=0.0, DIF2D=60.0, ASTFC=0.2,
  STDLON=140.0, STDLAT=0.0, KZDST=24, KZDEN=32,
```

```
  RLDMPX=0.0, RLDMPZ=30.0, RLDMPO=0.0,
  PTGRDS=288.3, PTGRDR=0.0, PTGRDL=0.0,
  ITGROW=0, UBIAS=0.0, VBIAS=0.0, ITSST=0, EOVER=0.5
  &END
  &NAMNST
  KTSTO=6, KTENO=12, KTDTO=3, DTRATIO=3600.,
  ALPHA=0.5, ITRMX=20000, RLXCON=1.0E-4, OVERLX=1.8
  &END
  &NAMRAD
  DTRADS=300.0
  &END
  &NAMPTG
  DAY0=90.0, GTIME0=0.0, ALBEDL=0.2, ALBEDS=0.6, WETL=0.1, WETS=1.0
  &END
  IN      Z(M)     U(M/S)     V(M/S)      PT(K)     RH(%)    QC(G/KG)    QR(G/KG)
   1       0.0        8.0        0.0      288.3       0.0         0.0         0.0
   2    3900.0        8.0        0.0      300.0       0.0         0.0         0.0
   3   11900.0        8.0        0.0      324.0       0.0         0.0         0.0
   4   19900.0        8.0        0.0      348.0       0.0         0.0         0.0
   5   20100.0        8.0        0.0      348.6       0.0         0.0         0.0
99
  &NAMKDD
  KDD( 1)=1, KDD( 2)=1, KDD( 3)=1, KDD( 4)=2, KDD( 5)=1,
  KDD( 6)=0, KDD( 7)=0, KDD( 8)=0, KDD( 9)=0, KDD(10)=1,
  KDD(11)=0, KDD(12)=0, KDD(13)=0, KDD(14)=0, KDD(15)=0,
  KDD(16)=0, KDD(17)=1, KDD(18)=0, KDD(19)=0, KDD(20)=0,
```

The control parameter card (card/LMWV32HE) is an alternative card for HE-VI scheme, where MSWSYS(15)=1 and MSWSYS(20)=2 are set instead of MSWSYS(15)=2 and MSWSYS(20)=1.

K-4-2. Nesting run with RSM

Following is an example of the shell script (shl997/#grsm10238) for nesting run with RSM by model size (102, 102, 38).

```
# nesting simulation with RSM (102,102,38)
unlimit datasize
unlimit stacksize
setenv DATE y9906.d2500
echo '#### Compile started ####'
cd src997-2000
  mv ../@src997lib/*.o .
  cp prm.inc102 prm.inc
  rm mainy2.o comm.o wrtfct.o subhevi.o
make
  mv*.o ../@src997lib
  mv a.out ../@src997lib/main102.out
cd ..
#------------------------------------------------------------
  rm fort.*
ln -s  @data/uvptq.102.$DATE fort.23
ln -s  @data/ptgrd.102.$DATE fort.25
ln -s  @data/org.102dx10.$DATE fort.50
ln -s  data/BANDCNX fort.90
echo '#### Time integration started ####'
time @src997lib/main102.out<card/RSM10238
```

```
#time @src997lib/main102.out<card/RSM102HE
  mv fort.62 @data/rsm102dx10.$DATE
#
echo '#### END ####'
  rm fort.*
```

The example of the control parameter card (card/RSM10238) for nesting is as follows:

```
MRI/NPD UNIFIED NONHYDROSTAIC MODEL NESTING RUN
10 KM RESOLUTION WITH REAL OROGRAPHY
NX,NY,NZ=102,102,38, DX=10000.0M, DZ=40 - 1120M, NESTING WITH RSM20
  &NAMMSW
  MSWSYS( 1)=1, MSWSYS( 2)=1, MSWSYS( 3)=2, MSWSYS( 4)=2, MSWSYS( 5)=2,
  MSWSYS( 6)=-2,MSWSYS( 7)=1, MSWSYS( 8)=1, MSWSYS( 9)=3, MSWSYS(10)=0,
  MSWSYS(11)=0, MSWSYS(12)=7, MSWSYS(13)=8, MSWSYS(14)=0, MSWSYS(15)=2,
  MSWSYS(16)=0, MSWSYS(17)=2, MSWSYS(18)=1, MSWSYS(19)=0, MSWSYS(20)=1,
  MSWSYS(21)=1, MSWSYS(22)=0, MSWSYS(23)=2, MSWSYS(24)=0, MSWSYS(25)=1,
  MSWSYS(26)=2, MSWSYS(27)=0, MSWSYS(28)=0, MSWSYS(29)=0, MSWSYS(30)=0
  &END
  &NAMPAR
  ITST=1, ITEND=1080, ISTRMT=540, ISTRRS=1621, ITOUT=5000, ITCHK=5000,
  DT=20.0, DX=10000.0, DY=10000.0, DZ=1120.0, PTRF=300.0, PRESRF=100000.0
  &END
  &NAMGRD
  DXL=10000.0, DXR=10000.0, IX1=20, IX2=40, DYL=10000.0, DYR=10000.0,
  IY1=20, IY2=40, DZL=40.0, DZR=1120.0, IZ1=38, IZ2=38
  &END
  &NAMVAL
  RATIOI=1.0, RATIOO=0.5, RATIO2=0.5, RUVNI=1.0, RUVNO=0.5, RUVN2=0.5,
  FNLTR=0.0, IDIFX=10, DIFNL=150.0, DIF2D=60.0, ASTFC=0.2,
  STDLON=140.0, STDLAT=32.5, KZDST=30, KZDEN=38,
  RLDMPX=60.0, RLDMPZ=60.0, RLDMPO=0.0,
  PTGRDS=288.3, PTGRDR=0.0, PTGRDL=0.0,
  ITGROW=0, UBIAS=0.0, VBIAS=0.0,I TSST=0,E OVER=0.5
  &END
  &NAMNST
  KTSTO=09, KTENO=15, KTDTO=3, DTRATIO=3600.,
  ALPHA=0.5, ITRMX=20000, RLXCON=3.0E-4, OVERLX=1.8
  &END
  &NAMRAD
  DTRADS=300.0
  &END
  &NAMPTG
  DAY0=90.0, GTIME0=0.0, ALBEDL=0.2, ALBEDS=0.6, WETL=0.1, WETS=1.0
  &END
  IN       Z(M)    U(M/S)    V(M/S)      PT(K)     RH(%)  QC(G/KG)  QR(G/KG)
   1        0.0       8.0       0.0      288.3       0.0       0.0       0.0
   2     3900.0       8.0       0.0      300.0       0.0       0.0       0.0
   3    11900.0       8.0       0.0      324.0       0.0       0.0       0.0
   4    19900.0       8.0       0.0      348.0       0.0       0.0       0.0
   5    20100.0       8.0       0.0      348.6       0.0       0.0       0.0
 99
  &NAMKDD
  KDD( 1)=1, KDD( 2)=1, KDD( 3)=1, KDD( 4)=2, KDD( 5)=1,
  KDD( 6)=1, KDD( 7)=1, KDD( 8)=0, KDD( 9)=0, KDD(10)=1,
  KDD(11)=0, KDD(12)=0, KDD(13)=0, KDD(14)=0, KDD(15)=0,
  KDD(16)=0, KDD(17)=1, KDD(18)=0, KDD(19)=0, KDD(20)=0,
```

```
KDD(21)=0, KDD(22)=0, KDD(23)=0, KDD(24)=0,
KDD(25)=0, KDD(26)=0
&END
```

K-4-3. Control parameter card

The specification of model run can be controlled by the control parameter card. Its contents are as follows.

1) First three lines (3A80) in the control parameter card are for user's comments.

2) Namelist &NAMMSW

This namelist sets the mode switch for basic condition of the model.

	Meaning	Value	Contents	Remarks
MSWSYS(1)	Lower boundary condition for momentum flux	0	free-slip	
		1	non-slip	
MSWSYS(2)	out flow lateral boundary condition for normal wind	1	Orlanski-type	no other choice
MSWSYS(3)	eigen function	0	read stored file	
		1	make by Jacobi method	for variable grid
		2	make using tri-gonometrical function	for uniform grid distance
MSWSYS(4)	out flow lateral boundary condition for wind component parallel to the boundary	0	use the value at inner closest point	
		1	Orlanski-radiation condition	
		2	extrapolate for space and time	
MSWSYS(5)	lateral boundary condition for turbulent energy and vari-ables in cloud physics	0	use the value at inner closest point	
		1	Orlanski-radiation condition	
		2	extrapolate for space and time	
MSWSYS(6)	Definition of density ($\rho G^{1/2}$)	-2	fully compressible (consider map factor)	
		-1	fully compressible	
		0	use the value of the reference atmosphere	anelastic/quasi-compressible
		1	Bousinesq approximation	
MSWSYS(7)	computation of wind at lateral boundary	1	time integration	no other choice
MSWSYS(8)	Coriolis parameter	0	not consider	
		1	consider $f_3=2\omega\sin\varphi$ only	
		2	full evaluation	
MSWSYS(9)	number of iteration in pressure equation solver	1	no iteration	for case of no orography or non-slip condition in elastic model

	Meaning	Value	Contents	Remarks
		3	three times iteration	
MSWSYS(10)	dimension of model	0	three-dimension	
		1	two-dimension	
MSWSYS(11)	upper boundary condition	0	free slip, rigid wall	no other choice
MSWSYS(12)	start-up procedure	0	mountain grow	until ITGROW
		1	wind grow	until ITGROW
		2	pre-existing wind and mountain	
		3	read pre-existing files	currently, not available
		4	nesting ($\omega=0$ at all levels)	
		5	nesting (ω is converted from w)	
		6	nesting (ω from continuity equation)	
		7	nesting (ω from continuity equation, $\omega=0$ at lateral boundary)	
MSWSYS(13)	ground temperature	0	no heat and moisture flux	
		1	vary by sin function	amplitude PTGRDR
		2	predict ground temperature	method of RSM
		3	predict ground temperature	consider ground steepness
		4	predict ground temperature	consider orographic shadow
		5	predict ground temperature	consider both 3 and 4
		6	predict ground temperature with atmospheric radiation	method of RSM
		7	predict ground temperature with atmospheric radiation	consider ground steepness
		8	predict ground temperature with atmospheric radiation	use cloud water and cloud ice
		9	predict ground temperature with atmospheric radiation	8+ consider ground steepness
MSWSYS(14)	lateral boundary condition	0	open for both x- and y-directions	
		1	open for x-direction periodic for y-direction	
		2	periodic for both x- and y-directions	
		−1	open for x-direction free-slip rigid wall for y-direction	
		−2	rigid wall for both x- and y-directions	
MSWSYS(15)	buoyancy	0	split and linearized	for anelastic model (AE)
		1	split but not linearized	for HE-VI scheme
		2	density perturbation	for HI-VI scheme

	Meaning	Value	Contents	Remarks
MSWSYS(16)	initial wind component	0	multiply $\rho G^{1/2}$	
		1	not multiply $\rho G^{1/2}$	for double nesting
MSWSYS(17)	outflow boundary condition for θ	0	use inner closest value	
		1	Orlanski-radiation condition	
		2	extrapolate for time and space	
MSWSYS(18)	cloud physics	2	dry model	
		1	Warm rain	
		0	Cold rain	predict *Ni*
		−1	Cold rain	predict *Ni, Ns*
		−2	Cold rain	predict *Ni, Ns, Ng*
MSWSYS(19)	turbulent closure model	0	level 2.5	no other choice
MSWSYS(20)	basic equation	−1	anelastic, hydrostatic	
		0	Anelastic (AE)	
		1	Elastic (HI-VI)	
		2	Elastic (HE-VI)	
MSWSYS(21)	fall-out of rain	0	Euler Scheme	
		1	Box-Lagrangian Scheme	
MSWSYS(22)	convection	0	not parameterized	
		1	cloud physics and convective adjustment	condensation in parameterization becomes cloud water
		2	cloud physics and convective adjustment	condensation in parameterization becomes precipitation instantly
		3	convective adjustment and large scale condensation only	not predict *Qc* and *Qr*
		4	large scale condensation only	not predict *Qc* and *Qr*
MSWSYS(23)	boundary condition for pressure	0	no sponge layers	
		1	Rayleigh-damping in upper layer	
		2	Rayleigh-damping in upper layer and near lateral boundary	
MSWSYS(25)	lateral boundary relaxation for *U, V, W* and θ	0	no boundary relaxation	
		1	boundary relaxation by Rayleigh-damping	
MSWSYS(26)	mass flux through lateral boundaries	0	no adjustment	
		1	adjust to preservetotal mass	
		2	adjust following mean pressure of mother model	effective in case of nesting

	Meaning	Value	Contents	Remarks
		3	adjust monitoring total mass	currently not available
MSWSYS(27)	vertical grid distance	0	stretching according to DZL, ZDR, IZ1, IZ2 in Namelist & NAMGRD	see sub.VRGDIS
		1	arbitrary setting of height of scalar level	see sub.SETVRG
MSWSYS(28)	advection scheme	0	second order, centered, flux form	
		1	horizontally upstream first order, advective form	advection scheme except wind component
		2	horizontally second order, centered advective form	
		3	horizontally upstream third order advective form	
		4	horizontally fourth order, centered advective form	
		5	horizontally fourth order, centered advective form	advection scheme except wind component
MSWSYS(29)	subgrid evaporation	0	not consider	
		1	consider by predicting cloud amount	see G-1-4
MSWSYS(30)	flux correction for advection	0	not employed	
		1	for U, V, W and Qv	
		2	for U, V, W, θ and Qv	
		3	for U, V and W	

3) Namelist &NAMPAR

This namelist sets basic parameters such as the time step.

Name	Type	Meaning	Default	remarks
ITST	int	start time step	1	restart when greater than 1
ITEND	int	end time step	…	
ISTRMT	int	time step interval of GPV out put	…	
ITOUT	int	time step interval of monitoring list	…	
ITCHK	int	time step interval of check	…	
DT	int	time step increment (s)	…	
DX	real	x-direction grid distance (m)	…	
DY	real	y-direction grid distance (m)	…	
DZ	real	z-direction grid distance (m)	…	set DZR when variable grid
PTRF	real	base of potential temperature	300.	θ in prognostic variables is the difference from PTRF
PRESRF		base of pressure for Exner function (Pa)	100000.	

4) Namelist &NAMGRD

This namelist is for setting of the variable grid distances. In case of nesting, the values must be consistent with those of the namelist NAMGRDI in K-3.

Name	Type	Meaning	Default	remarks
DXL	real	x-direction left-most grid distance (m)	DX	
DXR	real	x-direction right-most grid distance (m)	DX	
IX1	int	start index for constant grid distance (x-direction)	…	
IX2	int	start index for constant grid distance (x-direction)	…	
DYL	real	y-direction left-most grid distance (m)	DY	
DYR	real	y-direction right-most grid distance (m)	DY	
IY1	int	start index for constant grid distance (y-direction)	…	
IY2	int	start index for constant grid distance (y-direction)	…	
DZL	real	grid distance at lowest level (m)	…	
DZR	real	grid distance at highest level (m)	DZ	
IZ1	int	start index for constant grid distance (z-direction)	1	
IZ2	int	end index for constant grid distance (z-direction)	NZ	

5) Namelist &NAMVAL

This namelist specifies some basic values for the boundary conditions and other model options.

Name	Type	Meaning	Default	remarks
RATIOI	real	weighting parameter at inflow boundary	0.5–1.0	α_{in} in (F2-2-6)
RATIOO	real	weighting parameter at outflow boundary	0.0–1.0	α_{out1} in (F2-2-6)
RATIO2	real	weighting parameter at outflow boundary	0.0–1.0	α_{out2} in (F2-2-6)
RUVNI	real	weighting parameter at inflow boundary	0.5–1.0	β_{in} in (F2-2-10)
RUVNO	real	weighting parameter at outflow boundary	0.0–1.0	β_{out1} in (F2-2-10)
RUVN2	real	weighting parameter at outflow boundary	0.0–1.0	β_{out2} in (F2-2-10)
FNLTR	real	start index for constant grid distance (y-direction)	…	
IDIFX	int	width of lateral boundary relaxation sponge layers	0	
DIFNL	real	coefficient for nonlinear numerical damping	0.	m_{NL} in (G4-1)
DIF2D	real	coefficient for 4-th order numerical damping	90.	m_{2D} in (G4-2)
ASTFC	real	coefficient for Asselins time filter	0.2	ν in (G4-3)
STDLON	real	standard longitude (λ_0)	140.0	see Fig. J1-3-1, 2

Name	Type	Meaning	Default	remarks
STDLAT	real	standard latitude (φ_0)	36.0	see (C1-3-2)
KZDST	int	start index for upper Rayleigh damping layer (z-direction)	NZ-8	zd in (F3-3) is ZRP(KZDST)
KZDEN	int	end index for upper Rayleigh damping layer (z-direction)	NZ	
RLDMPX	real	coefficients for lateral boundary relaxation	0.0	m_R in (F2-4-1)
RLDMPZ	real	coefficients for upper Rayleigh damping layer	90.0	m_{Rz} in (F3-2-1)
RLDMPO	real	coefficients for whole domain Rayleigh damping	0.0	
PTGRDS	real	sea surface potential temperature (K)	288.0	
PTGRDR	real	amplitude for diurnal change of ground potential temperature (K)	0.0	
PTGRDL	real	ground surface potential temperature (K)	0.0	Deviation from PTGRDS
ITGROW	int	end time step for wind grow initiation	0	
UBIAS	real	bias for u (m/s)	0.0	
VBIAS	real	bias for v (m/s)	0.0	
ITSST	int	start time step of elastic equation	0	
EOVER	real	coefficient for implicit treatment for HI-VI	0.5	α in (C3-1-6)

6) Namelist &NAMNST

This namelist specifies some basic values for nesting.

Name	Type	Meaning	Default	remarks
KTSTO	int	start time of nesting file	0	
KTENO	int	end time of nesting file	24	
KTDTO	int	interval of nesting file	3	
DTRATIO	real	unit of nesting file (s)	3600.	
ALPHA	real	ratio of weighting parameter at variational calculus	0.5	α_1/α_2 in (E2-3-7)
ITRMX	int	maximum iteration number for successive over relaxation in variational calculus	20000	
RLXCON	real	Minimum to stop the iteration	1.0E-4	
OVERLX	real	coefficients in over relaxation	1.8	

7) Namelist &NAMRAD

This namelist specifies time interval of radiation calculation.

Name	Type	Meaning	Default	remarks
DTRADS	real	time interval of radiation calculation (s)	300.	

8) Namelist &NAMPTG

This namelist specifies some basic values for calculation of ground temperature when the model is not nested.

Name	Type	Meaning	Default	remarks
DAY0	real	day at it=0	…	
GTIME0	real	time at it=0 (UTC)	24	
ALBEDL	real	ground albedo	0.2	
ALBEDS	real	sea albedo	0.6	not used currently
WETL	real	ground wetness	0.1	
WETS	real	sea surface wetness	1.0	

9) Vertical profile

In the stand-alone run (K-4-1), a horizontally uniform atmosphere is used for initial and boundary conditions. A vertical profile is given by lines of numbers that specify u (m/s), v (m/s), θ (K), RH (relative humidity ; %, or mixing ratio ; g/Kg), Q_c (g/Kg) and Q_r (g/Kg) at the denoted altitudes from ground level z (m). The value at each model grid point is determined by linear interpolation. When MSWSYS(27)=1 is given in the namelist & NAMMSW, the model plane height is set by z in the prameter card.

10) Namelist &NAMKDD

This namelist specifies the kind of data stored in the model output file (J-3-1 or J-3-2). Details of data kind of each number are given by comment lines at the bottom of the parameter card.

K-5. Visualization

Several tools for visualizing simulation results are provided. Since these are written in Fortran language, they can be used with any workstation or personal computer employing Unix OS. The figures are output as a postscript file, which can be seen on a display by using the 'gs' Unix command. Tools producing a postscript file are also written in Fortran language and are described in Kato (2001).

K-5-1 Plot job (1)

The Unix shell for plot utility (1) is in ../shl**/#p**. This job is based on the plot utility described in Chapter E in Ikawa and Saito (1991), but multiple figures can be depicted by a postscript file in one page with shade patterns. The following is an example of the shell script (shl997/#plmw3232) for plotting mountain waves of model size (32,32,32).

```
#   plmw3232 excecute plot job, and make ps.file
echo '#/*----- Compilie Started -----'
cd srcplt
echo ' PARAMETER (LX=32, LY=32, LZ=32)'>psize.h
rm PLOTMAIN.o a.out
make
cd ../shl997
#echo '#/*----- PLOT STARTED -----'
```

```
rm fort.*
ln -s ../card/PDLMWV32 fort.31
ln -s ../@data/org.bell32an fort.50
ln -s ../@data/strmts2.lmwv.file1  fort.62
ln -s ../data/PSDATA fort.99
../srcplt/a.out<../card/LMWV32HI
mv fort.60 ../@data/lmwv32.ps
rm fort.*
```

The plot parameter card card/PDLMWV32 is as follows:

```
4       DEVISE(2--XY       4--GLASER)
 20000 24000 130 156    2          CANVAS
   60
11                           DATA KIND W (I2)

   10                        INTVAL      1 CM/S     (0.1*I5)

2 16     1   32     1     31       10      90      1      (I1,I3,X,7I5)
@
5
   90
11                           DATA KIND W
   10                        INTVAL      1 CM/S
2 16     1   32     1     31       10      50      1      (I1,I3,X,7I5)
@
5
  120
11                           DATA KIND W
   10                        INTVAL      1 CM/S
2 16     1   32     1     31       10      10      1      (I1,I3,X,7I5)
@
4
11                           DATA KIND W
   10                        INTVAL      1 CM/S
1  7     1   32     1     32       55      10      1      (I1,I3,X,7I5)
@
1
1  9     1   32     1     32       55      50      1
@
1
1 12     1   32     1     32       55      90      1
@
9
```

The above parameters are basically similar to E-4 in Ikawa and Saito (1991), but "change parameter" after the @ mark is modified as follows:

1. CHANGE THE POSITION OF CROSS SECTION
2. CHANGE KIND OF DAT AS IN SMALL ITEM
3. CHANGE COMPUTER TIME STEP
4. SAME AS IN 2, BUT VSTERM IS NOT CALLED
5. SAME AS IN 3, BUT VSTERM IS NOT CALLED
6. SAME AS IN 2, BUT DEPICT SHADE PATTERN
7. SAME AS IN 3, BUT DEPICT SHADE PATTERN

8. SAME AS IN 4, BUT DEPICT SHADE PATTERN
9. END OF PLOT

The postscript file made in @data/lmwv32.ps (fort.60) is shown in Fig. K5-1-1. The UNIX shell script and relevant input card for a nesting run with RSM are in shl997/#prsm10238 and card/PD10238, respectively, and the result is shown in Fig. K5-1-2

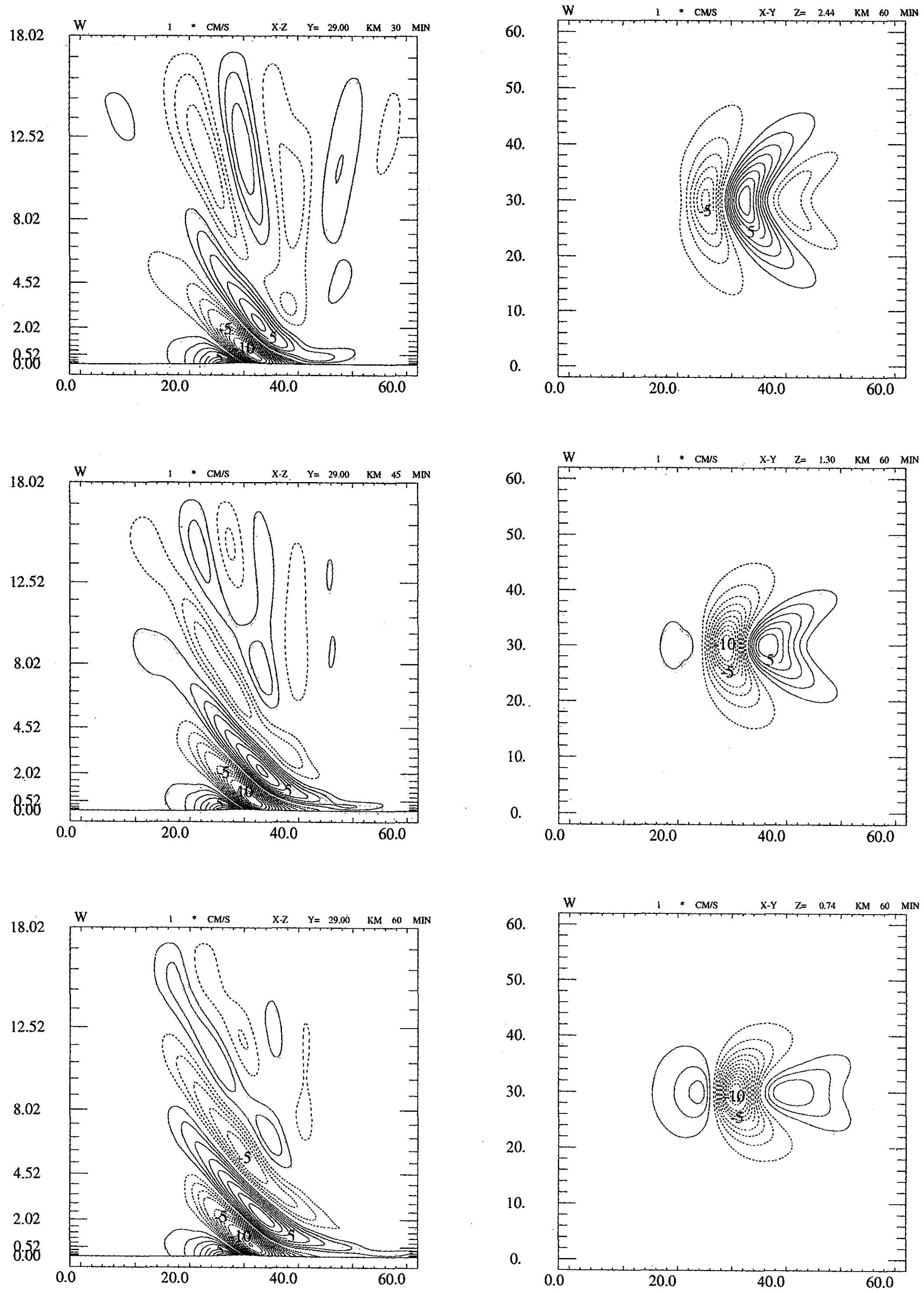

Fig. K5-1-1 Linear mountain waves simulated by the sample script described in K-4-1.
Left: Vertical section of w through mountain top at t=30, 45, 60 min.
Right: Horizontal cross-section of w at t=60 min at z=2.44, 1.30, 0.74 km.

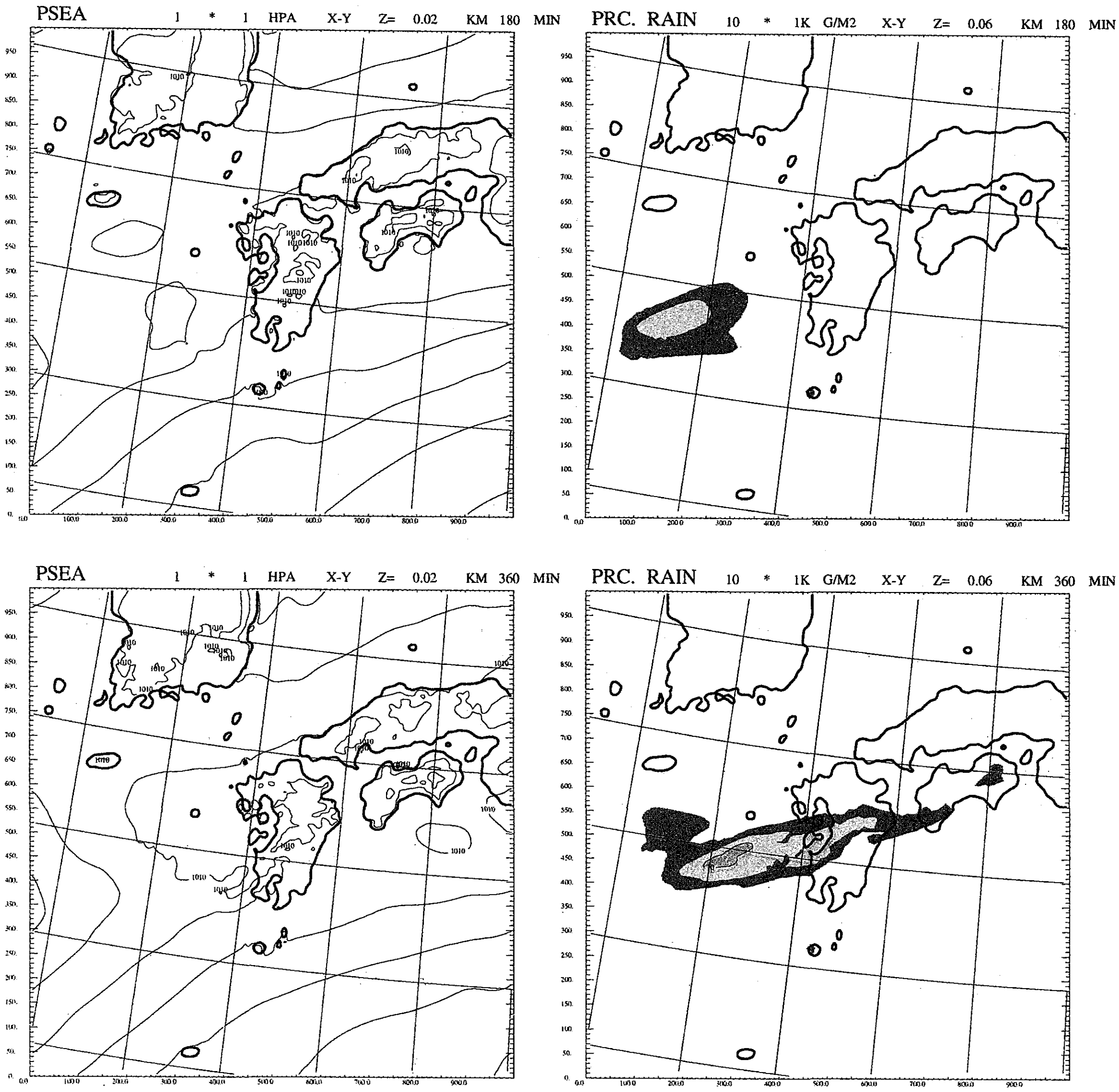

Fig. K5-1-2 NHM forecast (surface pressure and three hour precipitation) at 1200 UTC and 1500 UTC 1999 Jun 25 corresponding to Fig. K3-1-2.

K-5-2. Plot job (2)

The plot job introduced in this subsection is valid for a model output file compressed by using integer*2 (see J-3-2).

(a) Horizontal fields

The horizontal field on the terrain-following coordinate can be drawn by using shlplt2/cd**.sh. The results are output as a postscript file in @data/cd.**.dx10.ps (fort.60). The following shell (shlplt2/cd102.dx10.sh) is an example of the simulation with model size (102,102,38). For different model sizes, replace the numbers in parameters in c$NUM.f with those for the expected model size. The model output file is linked to fort.62. When the output file produced in the restart run is used, it is linked to fort.63. The output file for the next restart run is then linked to fort.64. An example shell is shown in Fig. K5-2-1.

```
#!/bin/csh

setenv DATE y9906.d2500
```

```
cd srcplt2
echo '  PARAMETER(NX=102, NY=102, NZ=38, NXC=NX, NYC=NY)'>cd_dim.h
f90 cdmain.f cdraws.f cutility.f ../srcplt/plotpswk.o -o cd.out

cd ../shlplt2
rm fort.62
ln -s ../@data/rsm102dx10.$DATE fort.62
../srcplt2/cd.out  <<EOF
    0                    0                    0    1.0    -1        2.5    4    /
MDRAIN,MDMAX,MDBAR,CDLTLN,MDUV,CUV,ISP
    1            0            0            0                                  /
MDCOL(0:SHADE,1:COLOR),MDMES,MDLINE,MDWHITE
  0.05   0.4   0.05   0.2        / XB1,YB1,XB2,YB2(POSITION OF BAR)
540  1080 540    1    6    C     / ITST,ITEN,ITD,NIT1,NRP,CRGB
    2    3   0     1   32.5    0 / NDX,NDY,IPST,IPDT,STLAT,NELASTIC
   1 102   1   102   2  RAIN 10.0 0.0 10.0 / IST,IEN,JST,JEN,KEN,MSYS,CD
   1 102   1   102   5  RH    2.0 30.0 100.0 / IST,IEN,JST,JEN,KEN,MSYS,CD
   1 102   1   102  18  RH    2.0 30.0 100.0 / IST,IEN,JST,JEN,KEN,MSYS,CD
   1 102   1   102   2  SLP  0.2 1008.0 1011.0 / IST,IEN,JST,JEN,KEN,MSYS,CD
   1 102   1   102   5  PTE  1.0 325.0 350.0 / IST,IEN,JST,JEN,KEN,MSYS,CD
   1 102   1   102  18  PTE  1.0 325.0 350.0 / IST,IEN,JST,JEN,KEN,MSYS,CD
EOF
mv fort.60 ../@data/cd.$DATE.dx10.ps
rm fort.*
```

Name	Type	Meaning
MDRAIN	INT	0
MDMAX	INT	1 : drawing maximum value 0 : not drawing
MDBAR	INT	0
CDLTLN	REAL	Interval degree of drawing latitude and longitude 0.0 : not drawing
MDUV	INT	Vertical level of plotting wind vectors 0 : not drawing -1 : same level of drawing field.
CUV	REAL	Amplitude ($m\ s^{-1}$) of wind vectors for a horizontal grid
ISP	INT	Grid interval of plotting wind vectors
MDCOL	INT	0
MDMES	INT	1 : plotting grid marks at every boundaries 0 : plotting the horizontal scale
MDLINE	INT	0
MDWHITE	INT	0 : using black color for drawing coastal lines, wind vectors, etc 1 : using white color
MDNANAME	REAL	0.0
X0,Y0,XM,YM	REAL	Left-bottom position, width and height for NDX=NDY=1
ITST	INT	Starting time step for drawing 0 must be set for time step=1
ITEN	INT	Ending time step for drawing
ITD	INT	Interval of time step for drawing
NIT1	INT	1 : not changing the page for drawing the other field 0 : changing the page

Name	Type	Meaning
NRP	INT	Numbers of drawing field
CRGB	CHAR	A : painting field with optional values and color or hatch pattern (Refer the following remark1) B : painting field with gray scale C : coloring field automatically N : plotting contours
NDX	INT	Dividing numbers of panel in a x-direction
NDY	INT	Dividing numbers of panel in a y-direction
IPST	INT	0
IPDT	INT	1
STLAT	REAL	Standard latitude
NELASTIC	INT	0 : Using map factors 1 : Not using map factors
IST	INT	Left position for drawing field
IEN	INT	Right position for drawing field
JST	INT	Bottom position for drawing field
JEN	INT	Top position for drawing field
KEN	INT	Vertical level for drawing field
MSYS	CHAR	Kind of drawing field (Refer to remark 2 below.)
CD	REAL	Contour interval for CRGB='N' Divided interval value for CRGB='B','C' Default for CRGB='A' Amplitude ($m\ s^{-1}$) of wind vectors for a horizontal grid for MSYS='UV'
CDST	REAL	Starting value for painting field Default for CRGB='A', 'N'
CDEN	REAL	Ending value for painting field Default for CRGB='A', 'N'

Remark 1. When CRGB is set to 'A', on the next line of 'IST,IEN,----', color and/or hatch index and boundary values must be inserted as follows.

$N\ I_1\ B_1\ I_2\ B_2$ ---- $I_N\ B_N\ I_{N+1}$,

where N is the number of boundary values, I_I color and/or hatch indexes, and B_I boundary values. Here $B_N > B_{N-1} >$ ---- $> B_1$ must be satisfied. Color and hatch indexes are presented in Kato (2000).

Remark 2. The kinds of drawing fields are shown below. Predicted values must be output by selecting the parameter card file KDD (see I-3).

MSYS	KIND	MSYS	KIND
PT	Potential temperature (K)	T	Temperature (°C)
PTE	Equivalent PT (K)	PTGRD	Ground PT (K)
RADPT	PT time change due to atmospheric radiation ($K\ s^{-1}$)	U	x-directional wind ($m\ s^{-1}$)
V	y-directional wind ($m\ s^{-1}$)	W	Vertical wind ($cm\ s^{-1}$)
VEL	Horizontal wind speed ($m\ s^{-1}$)	VOL	Horizontal vorticity ($10^{-4}\ s^{-1}$)

MSYS	KIND	MSYS	KIND
SLP	Sea-level pressure (*hPa*)	UV	Horizontal wind vectors
DP	Pressure disturbance from the basic state (*Pa*)	P	Pressure (*hPa*)
ETURB	Turbulence energy (*J*)	QC	Mixing ratio of cloud water ($g\ kg^{-1}$)
QR	Mixing ratio of rainwater (0.1 $g\ kg^{-1}$)	QCI	Mixing ratio of cloud ice (0.1 $g\ kg^{-1}$)
QH	Mixing ratio of graupel (0.1 $g\ kg^{-1}$)	QS	Mixing ratio of snow (0.1 $g\ kg^{-1}$)
RH	Relative humidity (%)	RAIN	Rainfall intensity ($mm\ h^{-1}$)
PREC	Precipitation intensity ($mm\ h^{-1}$)	SNOW	Snowfall intensity ($mm\ h^{-1}$)

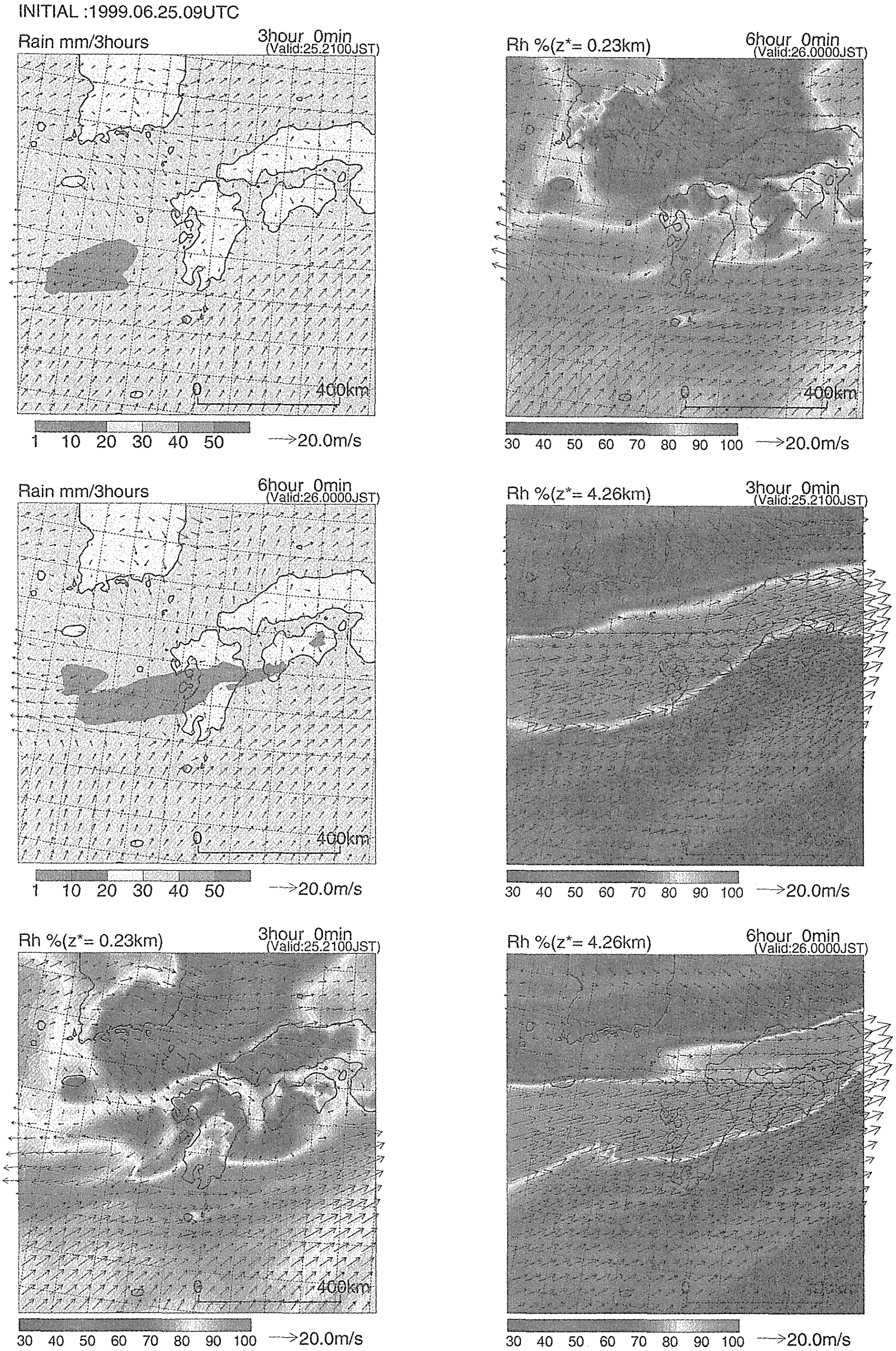

Fig. K5-2-1 NHM forecast (three hour precipitation and Relative humidity) at 1200 UC and 1500 UTC 1999 Jun 25 corresponding to Fig. K5-1-2.

(b) Vertical fields

The vertical field can be drawn by using the unix shell shlplt2/vd**.sh. The results are output as a postscript file in @data/vd.**.ps (fort.60). The following shell is an example (shlplt2/vd102.dx10.sh) of the simulation with model size (102,102,38). For a different model size, replace the numbers in the parameters in v$NUM.f with those for the expected model size. The model output file is linked to fort.62. When the output file produced in the restart run is used, it is linked to fort.63. The output file for the next restart run is then linked to fort.64. An example shell is shown in Fig. K5-2-2.

```
#!/bin/csh

setenv DATE y9906.d2500

cd srcplt2
echo '      PARAMETER(MX=102, MY=102, MZ=38, NXC=MX, NYC=MY)'>vd_dim.h
echo '      PARAMETER(NX=102, NY=102, NZ=38)'>>vd_dim.h
f90 vdmain.f vdraws.f vutility.f ../srcplt/plotpswk.o -o vd.out

cd ../shlplt2
rm fort.62
ln -s ../@data/rsm102dx10.$DATE fort.62
../srcplt2/vd.out  <<EOF
         1     0     1     5.0   / MDVL,MDMAX,MDUV,CDUV
  540   1080   540    1    2  C / ITST,ITEN,ITD,NIT1,NRP,CRGB
    2     2     0     1 32.5  0 / NDX,NDY,IPST,IPDT,STLAT,NELSTIC
  72 81   100   20   27  RH     5.0  30.0 100.0 / IST,IEN,JST,JEN,KEN,MSYS,CD
  72 81   100   20   27  PTE    2.0 330.0 350.0 / IST,IEN,JST,JEN,KEN,MSYS,CD
/*
//* MDVL=1 : DRAWING VALUES OF CONTOUR, MDMAX=1 : DRAWING THE MAXIMUM VALUE
//* MDUV : LEVEL OF UVPLOT, CUV : CONTOUR INTERVAL OF UVPLOT
//* MDUV=1 : DRAWING UVW, >1 : DRAWING UV WITH INTERVAL OF MDUV GRIDS
//* CDUV : ARROW STANDARD(MDUV=1)  OR CONTOUR INTERVAL OF VEL(MDUV>1)
EOF
mv fort.60 ../@data/vd.$DATE.dx10.ps
rm fort.*
```

Name	Type	Meaning
MDVL	INT	1 : drawing contour values 0 : not drawing
MDMAX	INT	1 : drawing maximum value 0 : not drawing
MDUV	INT	1 : plotting wind vectors on the cross section >1 : plotting horizontal arrows every MDUV grids 0 : not drawing
CDUV	REAL	Amplitude ($m\ s^{-1}$) of wind vectors for a horizontal grid for MDUV>1
ITST	INT	Starting time step for drawing 0 must be set for time step=1
ITEN	INT	Ending time step for drawing
ITD	INT	Interval of time step for drawing
NIT1	INT	1 : not changing the page for drawing the other field 0 : changing the page

Name	Type	Meaning
NRP	INT	Numbers of drawing field
CRGB	CHAR	A : painting field with optional values and color or hatch pattern (Refer the following remark1) B : painting field with gray scale C : coloring field automatically N : plotting contours
NDX	INT	Dividing numbers of panel in a x-direction
NDY	INT	Dividing numbers of panel in a y-direction
IPST	INT	0
IPDT	INT	1
STLAT	REAL	Standard latitude
NELASTIC	INT	0 : using map factors 1 : not using map factors
IST	INT	Left position in a x-direction for drawing field (IST≦IEN)
IEN	INT	Right position in a x-direction for drawing field
JST	INT	Left position in a y-direction for drawing field
JEN	INT	Right position in a y-direction for drawing field
KEN	INT	Vertical top level for drawing field
MSYS	CHAR	Kind of drawing field (Refer the following remark2)
CD	REAL	Contour interval for CRGB='N' Divided interval value for CRGB='B','C' Default for CRGB='A' Amplitude ($m\ s^{-1}$) of wind vectors for a horizontal grid for MSYS='UW','VW','UVW'
CDST	REAL	Starting value for painting field Default for CRGB='A', 'N'
CDEN	REAL	Ending value for painting field Default for CRGB='A', 'N'

Remark 1) Refer the remark1 in K5.2(a).

Remark 2) Kinds of drawing field are shown as follows. Predicted values must be output by selecting the parameter card file KDD (see, I-3).

MSYS	KIND	MSYS	KIND
PT	Potential temperature (K)	T	Temperature ($C°$)
PTE	Equivalent PT (K)	U	x-directional wind ($m\ s^{-1}$)
V	y-directional wind ($m\ s^{-1}$)	W	Veritical wind ($cm\ s^{-1}$)
UW	Wind vectors in x- and z-direction	VW	Wind vectors in y- and z-direction
UVW	Wind vectors on the cross section	UV	Horizontal wind arrow
VEL	Horizontal wind speed ($m\ s^{-1}$)	TE	Turbulence energy (J)
DP	Pressure disturbance from the basic state (hPa)	QC	Mixing ratio of cloud water ($g\ kg^{-1}$)
QR	Mixing ratio of rainwater (0.1 $g\ kg^{-1}$)	QCI	Mixing ratio of cloud ice (0.1 $g\ kg^{-1}$)
QH	Mixing ratio of graupel (0.1 $g\ kg^{-1}$)	QS	Mixing ratio of snow (0.1 $g\ kg^{-1}$)
RH	Relative humidity (%)	STB	Brunt-Vaisala frequency (0.01 s^{-1})

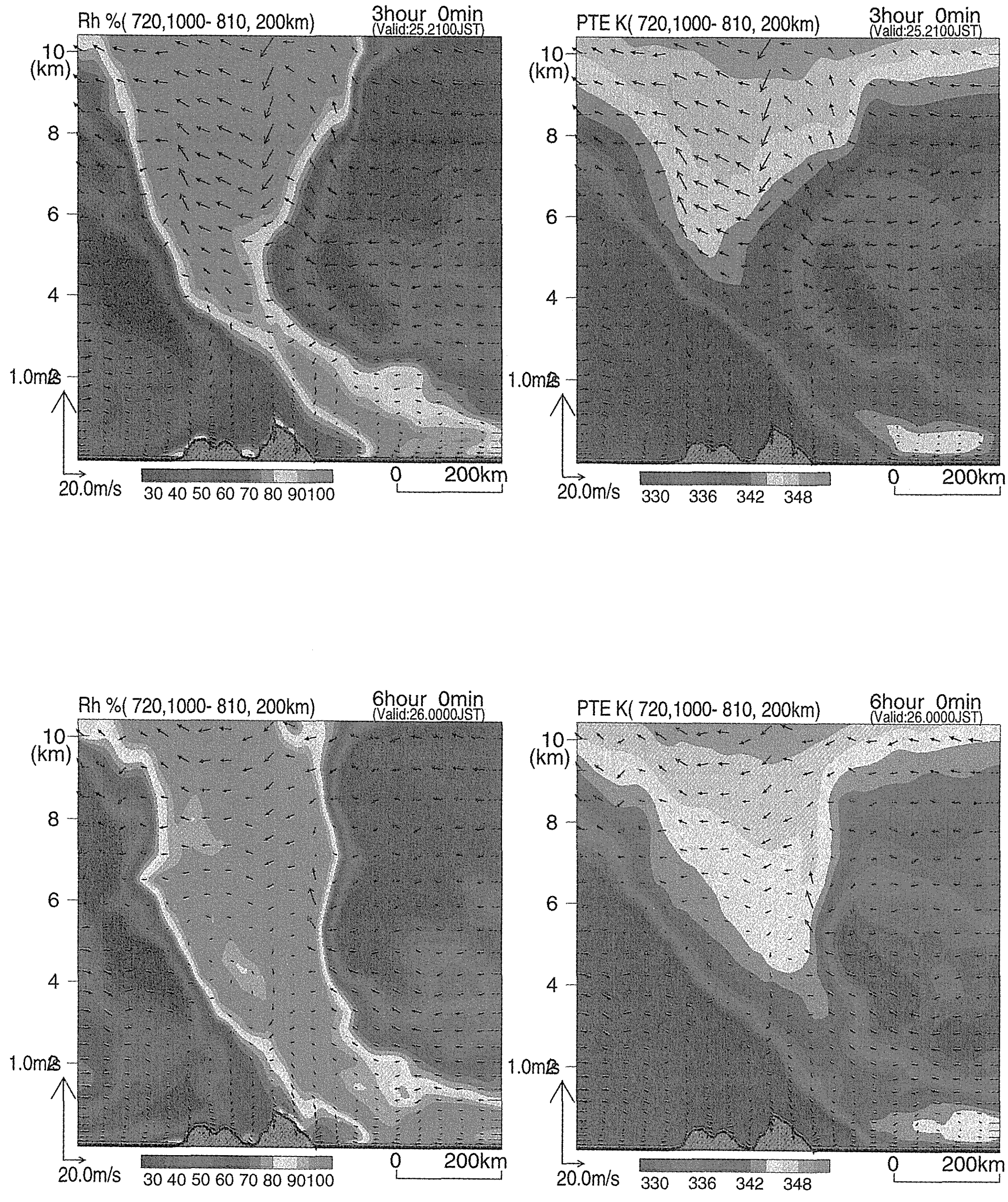

Fig. K5-2-2 Vertical profile of NHM forecast (relative humidity and equivalent potential temperature) at 1200 UC and 1500 UTC 1999 Jun 21.