DSJRA-55 Product Users' Handbook

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Change record

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1. Introduction

To help clarify climatic characteristics (such as trends of extreme phenomena) and support case studies on extreme meteorological events in Japan, the Japan Meteorological Agency (JMA) conducted DSJRA-55 (a regional downscaling based on the Japanese 55-year Reanalysis (JRA-55, Kobayashi et al. 2015) for initial and boundary conditions) for the period from 1958 to 2012 to produce a climate dataset with a horizontal resolution of 5 km that appropriately represents phenomena associated with Japan’s uneven terrain (Kayaba et al. 2016). This handbook provides an overview of the product derived from DSJRA-55.

2. Downscaling method

The DSJRA-55 product is based on time integration from six-hourly JRA-55 analysis fields as initial conditions with the JMA operational Meso-Scale Model (MSM) as of November 2012 (JMA 2013).

These initial conditions do not incorporate cloud physics variables for the MSM. As certain integration hours are needed for the MSM to produce appropriate precipitation data from such initial conditions, there is a tendency for insufficient production of precipitation data at the beginning of forecast integrations. One way to circumvent this issue is to perform a spin-up run covering a period of three to six hours immediately

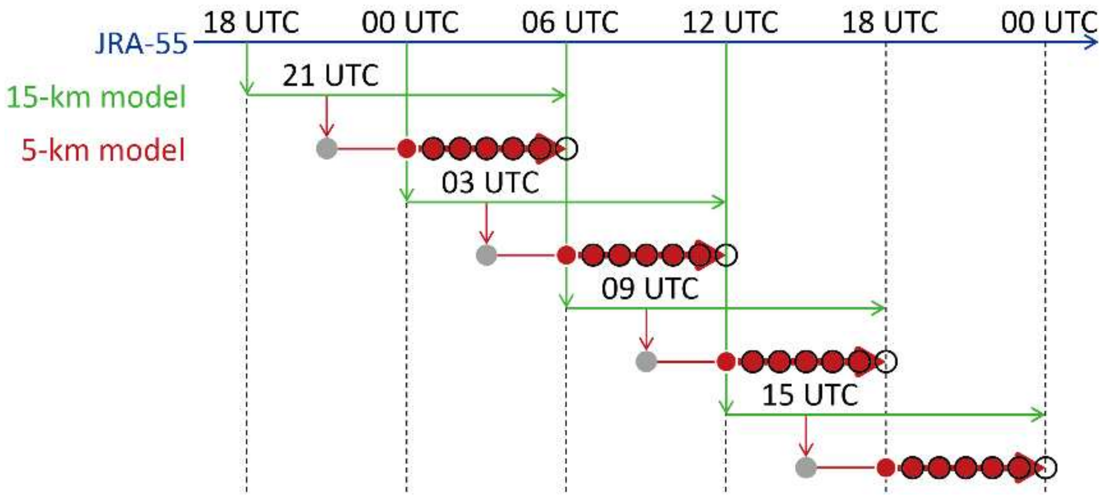

Figure 2-1 Timelines illustrating the flow of DSJRA-55 calculation

Grey dots: output hours for boundary conditions; red dots: starting hours of averaging periods for average diagnostic fields; black circles: output hours for instantaneous fields. The first three hours immediately after the start of forecasts are allotted to spin-up runs both for the 15-km resolution MSM (as per the 5-km resolution MSM, except with a horizontal resolution of 15 km) and the 5-km resolution MSM.

after the start of forecasts. JRA-55 analysis fields, which have a horizontal resolution of 55 km, are also too coarse for the initial and boundary conditions adopted for the 5-km resolution MSM, and terrain differences would produce non-negligible noise in forecast fields. Thus, boundary conditions with intermediate resolution are necessary for areas in between. Accordingly, in DSJRA-55, the 15-km resolution MSM (as per the 5-km resolution MSM except with a horizontal resolution of 15 km) is first employed in the formulation of 12-hour forecasts from JRA-55 analysis fields. Next, 3- to 12-hour forecast fields are used as initial and boundary conditions for 9-hour forecasts based on the 5-km MSM. Data on the resulting 3- to 9-hour forecast fields are then provided in the form of the DSJRA-55 product (Figure 2-1). It should be noted that DSJRA-55 consists of 6 – 12 h forecasts with respect to the JRA-55 analysis, and may therefore contain forecast errors equivalent to those observed in 6 – 12 h forecasts of the operational MSM (JMA 2013).

3. File format

The DSJRA-55 product is encoded in Gridded Binary (GRIB) Edition 2 format (WMO 2015) except for latitude/longitude information (Lambert5km_latlon) (Section 6.2). Output is category-based at hourly and six-hourly intervals.

Latitude/longitude information is saved in 4-byte big-endian floating-point format.

4. File names

DSJRA-55 product file names follow the convention shown in Table 4-1, and each file contains one time-step data point. Dates in file names are in UTC. Table 4-2 shows sample file names (for 1st January 1981, 03 UTC).

Table 4-1 Naming convention

Type	Filename
2D fields	<category>.<year><month><day><hour>
3D fields	<category>_<parameter>.<year><month><day><hour>

Table 4-2 Sample file names (1st January 1981, 03 UTC)

Type	Filename
2D fields	bnd_land.1981010103 bnd_surf.1981010103 fcst_land.1981010103 fcst_phy2m.1981010103 fcst_surf.1981010103 kind.1981010103 kind_phy.1981010103
3D fields	fcst_p_tmp.1981010103 fcst_p_depr.1981010103 fcst_p_totcon.1981010103 fcst_p_ugrd.1981010103 fcst_p_vgrd.1981010103 fcst_p_vvel.1981010103 fcst_p_dzdt.1981010103 fcst_p_relv.1981010103 fcst_p_hgt.1981010103 fcst_p_cdca.1981010103

5. Output parameters[1]

5.1. Land surface boundary conditions (bnd_land)

Land surface boundary conditions (Table 5-1) are output at the initial time of each forecast (at 03, 09, 15 and 21 UTC as indicated by the gray dots in Figure 2-1) and kept constant during each forecast (for nine hours).

Table 5-1 Parameter of land surface boundary conditions (bnd_land)

Code figures	Parameter	Units
2, 0, 1	Surface roughness	m

5.2. Surface boundary conditions (bnd_surf)

Surface boundary conditions (Table 5-2) are output at the initial time of each forecast (at 03, 09, 15 and 21 UTC as indicated by the gray dots in Figure 2-1) and kept constant during each forecast (for nine hours).

Table 5-2 Parameter of surface boundary conditions (bnd_surf)

Code figures	Parameter	Units
0, 19, 1	Albedo	%

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[1] The code figures in the tables indicate discipline, parameter category and parameter number.

5.3. Land surface forecast fields (fcst_land)

Soil temperature to a depth of 0.04 m (Table 5-3) for land areas and sea surface temperature for sea areas are output on an hourly basis.

Table 5-3 Parameter of land surface forecast fields (fcst_land)

Code figures	Parameter	Units	Note
2, 3, 18	Soil temperature	K	Soil temperature of the layer within the depth of 0.04 m over land and sea surface temperature over sea

5.4. Isobaric forecast fields (fcst_p)

The parameters listed in Table 5-4 are vertically interpolated onto the isobaric surfaces listed in Section 9.1 except relative vorticity, which is interpolated onto the 850, 700 and 500 hPa isobaric surfaces only. These fields are output every hour.

Table 5-4 Parameters of isobaric forecast fields (fcst_p)

Code figures	Parameter	Units	Filename
0, 0, 0	Temperature	K	fcst_p_tmp
0, 0, 7	Dewpoint depression (or deficit)	K	fcst_p_depr
0, 1, 80	Total condensate	kg kg^{-1}	fcst_p_totcon
0, 2, 2	u-component of wind	m s^{-1}	fcst_p_ugrd
0, 2, 3	v-component of wind	m s^{-1}	fcst_p_vgrd
0, 2, 8	Vertical velocity (pressure)	Pa s^{-1}	fcst_p_vvel
0, 2, 9	Vertical velocity (geometric)	m s^{-1}	fcst_p_dzdt
0, 2, 12	Relative vorticity	s^{-1}	fcst_p_relv
0, 3, 5	Geopotential height	gpm	fcst_p_hgt
0, 6, 7	Cloud amount	%	fcst_p_cdca

5.5. Two-dimensional average diagnostic fields (fcst_phy2m)

Two-dimensional average diagnostic fields (Table 5-5) are produced every hour.

Dates in file names indicate the beginning of the averaging period.

Table 5-5 Parameters of two-dimensional average diagnostic fields (fcst_phy2m)

Code figures	Parameter	Units	Level
0, 0, 10	Latent heat net flux	$W\ m^{-2}$	Ground or water surface
0, 0, 11	Sensible heat net flux	$W\ m^{-2}$	Ground or water surface
0, 1, 52	Total precipitation rate	$kg\ m^{-2}\ s^{-1}$	Ground or water surface
0, 1, 65	Rain precipitation rate	$kg\ m^{-2}\ s^{-1}$	Ground or water surface
0, 1, 66	Snow precipitation rate	$kg\ m^{-2}\ s^{-1}$	Ground or water surface
0, 1, 75	Graupel (snow pellets) precipitation rate	$kg\ m^{-2}\ s^{-1}$	Ground or water surface
0, 4, 7	Downward short-wave radiation flux	$W\ m^{-2}$	Ground or water surface
0, 4, 8	Upward short-wave radiation flux	$W\ m^{-2}$	Ground or water surface
0, 5, 3	Downward long-wave radiation flux	$W\ m^{-2}$	Ground or water surface
0, 5, 4	Upward long-wave radiation flux	$W\ m^{-2}$	Ground or water surface
0, 4, 7	Downward short-wave radiation flux	$W\ m^{-2}$	Nominal top of the atmosphere
0, 4, 8	Upward short-wave radiation flux	$W\ m^{-2}$	Nominal top of the atmosphere
0, 5, 4	Upward long-wave radiation flux	$W\ m^{-2}$	Nominal top of the atmosphere

5.6. Two-dimensional instantaneous diagnostic fields (fcst_surf)

Two-dimensional instantaneous diagnostic fields (Table 5-6) are produced every hour.

Table 5-6 Parameters of two-dimensional instantaneous diagnostic fields (fcst_surf)

Code figures	Parameter	Units	Level
0, 2, 17	Momentum flux, u-component	$N\ m^{-2}$	Ground or water surface
0, 2, 18	Momentum flux, v-component	$N\ m^{-2}$	Ground or water surface
0, 3, 0	Pressure	Pa	Ground or water surface
0, 3, 18	Planetary boundary layer height	m	Ground or water surface
0, 6, 3	Low cloud cover	%	Surface to 0.85 * P_s
0, 6, 4	Medium cloud cover	%	0.85 * P_s to min(500 hPa, 0.68 * P_s)
0, 6, 5	High cloud cover	%	min(500 hPa, 0.68 * P_s) to 100 hPa
0, 1, 3	Precipitable water	$kg\ m^{-2}$	Entire atmosphere
0, 1, 69	Total column integrated cloud water	$kg\ m^{-2}$	Entire atmosphere
0, 6, 1	Total cloud cover	%	Entire atmosphere
0, 3, 0	Pressure	Pa	Mean sea level
0, 0, 0	Temperature	K	1.5 m
0, 0, 7	Dewpoint depression (or deficit)	K	1.5 m
0, 2, 2	u-component of wind	$m\ s^{-1}$	10 m
0, 2, 3	v-component of wind	$m\ s^{-1}$	10 m

5.7. Land and sea surface conditions

Land and sea surface conditions are kept constant during each forecast (for nine hours). There are two types of land and sea surface conditions: one for instantaneous fields (land surface forecast fields, isobaric forecast fields and two-dimensional instantaneous diagnostic fields) and the other for average fields (two-dimensional average diagnostic fields). Both are stored as hourly data and, their content is identical for all hours except 00, 06, 12 and 18 UTC. The difference arises from the fact that the initial time differs between the two at these hours, with instantaneous fields (black circles in Figure 2-1) being nine-hour forecasts started nine hours previously and average fields (red dots in Figure 2-1) being forecasts averaged over three to four hours with a start time three hours before. At hours other than 00, 06, 12 and 18 UTC, surface conditions for instantaneous and average fields are identical.

5.7.1. Land and sea surface conditions for instantaneous fields (kind)

The land and sea surface conditions for instantaneous fields (kind) (Table 5-7) can be used to check land and sea surface conditions for land surface forecast fields (fcst_land), isobaric forecast fields (fcst_p) and two-dimensional instantaneous diagnostic fields (fcst_surf).

Details of the Meso-Scale Model surface conditions (KIND) in Table 5-7 are given in Section 7.1.

Table 5-7 Parameter of land and sea surface conditions for instantaneous fields (kind)

Code figures	Parameter	Units
2,192, 0	Meso-Scale Model surface condition (KIND)	(Code table JMA4.10)

5.7.2. Land and sea surface conditions for average fields (kind_phy)

The land and sea surface conditions for average fields (kind_phy) (Table 5-8) can be used to check land and sea surface conditions for two-dimensional average diagnostic fields (fcst_phy2m).

Details of the Meso-Scale Model surface conditions (KIND) in Table 5-7 are given in Section 7.1.

Table 5-8 Parameter of land and sea surface conditions for average fields (kind_phy)

Code figures	Parameter	Units
2,192, 0	Meso-Scale Model surface condition (KIND)	(Code table JMA4.10)

6. Invariant data

6.1. Topographical information (Lambert5km_land)

Table 6-1 shows the parameters of topographical information (Lambert5km_land).

Table 6-1 Parameters of topographical information (Lambert5km_land)

Code figures	Parameter	Units	Level
2, 0, 0	Land cover (0 = sea, 1 = land)	Proportion	Ground or water surface
2, 0, 7	Model terrain height	m	Ground or water surface

6.2. Latitude/longitude information (Lambert5km_latlon)

Latitude/longitude information (Lambert5km_latlon) (Table 6-2) is saved in 4-byte big-endian floating-point format. Details of the grid are given in Section 8.

Table 6-2 Parameters of latitude/longitude information (Lambert5km_latlon)

Byte No.	Parameter	Units
(1)～(721*577)	Latitude	Degree
(721*577+1)～(2*721*577)	Longitute	Degree

7. Code table

7.1. Code table JMA4.10: Meso-Scale Model surface conditions (KIND)

The surface conditions listed in Table 7-1 are defined for DSJRA-55.

Table 7-1 Code table JMA4.10: Meso-Scale Model surface conditions (KIND)

Code figure	Meaning
0	Reserved
1	Land with no snow
2	Sea with no ice
3	Snow over land
4	Sea ice
5-254	Reserved
255	Missing

8. Grid

Table 8-1 describes the grid used for the MSM.

Table 8-1 Grid

Map projection	Lambert conformal conic
Shape of the Earth	Earth assumed spherical with radius = 6371 km
Nx – number of points along the x-axis	721
Ny – number of points along the y-axis	577
Longitude of meridian parallel to y-axis along which latitude increases as the y-coordinate increases	140 °E
Grid length	5 km
Scanning mode	The first 721 words contain data for the northernmost line, starting from the west edge toward the east at intervals of 5 km. The remaining lines follow at intervals of 5 km toward the south.
First latitude from the pole at which the secant cone cuts the sphere	60 °N
Second latitude from the pole at which the secant cone cuts the sphere	30 °N
Reference grid point (position from the west edge on the x-axis, position from the north edge on the y-axis)	(489, 409)
Latitude/longitute of the reference grid point	(140 °E, 30 °N)

9. Vertical coordinates

9.1. Isobaric coordinates

Isobaric fields are produced for 16 isobaric surfaces (1000, 975, 950, 925, 900, 850, 800, 700, 600, 500, 400, 300, 250, 200, 150 and 100 hPa) except for relative vorticity, which is produced only for 850, 700 and 500 hPa.

10. Physical constants

Table 10-1 shows the fundamental physical constants used in the MSM.

Table 10-1 Physical constants

Quantity	Value
Stefan-Boltzmann constant σ	5.67×10^{-8} W m^{-2} K^{-4}
Earth's radius	6.371×10^{6} m
Angular speed of Earth's rotation	7.292×10^{-5} rad s^{-1}
Gravitational acceleration	9.80665 m s^{-2}
Gas constant for dry air	287.05 J K^{-1} kg^{-1}
Specific heat of dry air at constant pressure c_p	1004.675 J K^{-1} kg^{-1}
Specific heat of water	4187.0 J K^{-1} kg^{-1}
Specific heat of ice	2093.0 J K^{-1} kg^{-1}
Latent heat of vaporization	2.5×10^{6} J kg^{-1}
Latent heat of fusion	3.336×10^{5} J kg^{-1}
Solar constant	1367 W m^{-2}

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