Supplement: Impact of snow depth analysis bugs on the JRA-55 product (detailed version)

S1. List of files containing variables affected by the bugs

Table S1.1. List of files containing variables affected by the bugs (model grid data)

Category	Time range	Filename	Field parameter
Land surface analysis fields	6 hourly	anl_land.YYYYMMDDHH	Water equivalent of accumulated snow depth
	Monthly mean	anl_land.YYYYMM	
	Monthly variance	anl_land_var.YYYYMM	
	Daily mean smooth climatological normal	anl_land.clim8110.dayMMDD	
	Monthly mean climatological normal	anl_land.clim8110.monMM	
Snow depth analysis fields	Daily	anl_snow.YYYYMMDD18	Snow depth
	Monthly mean	anl_snow.YYYYMM_18	
	Monthly variance	anl_snow_var.YYYYMM_18	
	Daily mean smooth climatological normal	anl_snow.clim8110.dayMMDD	
	Monthly mean climatological normal	anl_snow.clim8110.monMM	
Land surface forecast fields	3 hourly	fcst_land.YYYYMMDDHH	Water equivalent of accumulated snow depth Snow depth
	Monthly mean	fcst_land.YYYYMM	
	Monthly variance	fcst_land_var.YYYYMM	
	Daily mean smooth climatological normal	fcst_land.clim8110.dayMMDD	
	Monthly mean climatological normal	fcst_land.clim8110.monMM	
Two-dimensional average diagnostic fields	3 hourly	fcst_phy2m.YYYYMMDDHH	Clear sky upward solar radiation flux (surface) Upward solar radiation flux (surface) Clear sky upward solar radiation flux (nominal top of atmosphere) Upward solar radiation flux (nominal top of atmosphere) Sensible heat flux
	Monthly mean	fcst_phy2m.YYYYMM	
	Monthly variance	fcst_phy2m_var.YYYYMM	
	Daily mean smooth climatological normal	fcst_phy2m.clim8110.dayMMDD	
	Monthly mean climatological normal	fcst_phy2m.clim8110.monMM	

Table S1.2. List of files containing variables affected by the bugs (1.25-degree latitude/longitude grid data)

Category	Time range	Filename	Field parameter
Land surface analysis fields	6 hourly	anl_land125.YYYYMMDDHH	Water equivalent of accumulated snow depth
	Monthly mean	anl_land125.YYYYMM	
	Monthly variance	anl_land125_var.YYYYMM	
	Daily mean smooth climatological normal	anl_land125.clim8110.dayMMDD	
	Monthly mean climatological normal	anl_land125.clim8110.monMM	
Snow depth analysis fields	Daily	anl_snow125.YYYYMMDD18	Snow depth
	Monthly mean	anl_snow125.YYYYMM_18	
	Monthly variance	anl_snow125_var.YYYYMM_18	
	Daily mean smooth climatological normal	anl_snow125.clim8110.dayMMDD	
	Monthly mean climatological normal	anl_snow125.clim8110.monMM	
Land surface forecast fields	3 hourly	fcst_land125.YYYYMMDDHH	Water equivalent of accumulated snow depth Snow depth
	Monthly mean	fcst_land125.YYYYMM	
	Monthly variance	fcst_land125_var.YYYYMM	
	Daily mean smooth climatological normal	fcst_land125.clim8110.dayMMDD	
	Monthly mean climatological normal	fcst_land125.clim8110.monMM	
Two-dimensional average diagnostic fields	3 hourly	fcst_phy2m125.YYYYMMDDHH	Clear sky upward solar radiation flux (surface) Upward solar radiation flux (surface) Clear sky upward solar radiation flux (nominal top of atmosphere) Upward solar radiation flux (nominal top of atmosphere) Sensible heat flux
	Monthly mean	fcst_phy2m125.YYYYMM	
	Monthly variance	fcst_phy2m125_var.YYYYMM	
	Daily mean smooth climatological normal	fcst_phy2m125.clim8110.dayMMDD	
	Monthly mean climatological normal	fcst_phy2m125.clim8110.monMM	

S2. Use of masking data

Masking data (JRA-55_mask_en.zip) are provided to specify grid points affected by the bugs for each of the symptoms described in JMA's notice of 18 December 2015. These are areas and periods with unrealistically deep snow values (Section 1) and grid points with errors in snow cover climatology interpolation (Section 2). Users are advised to check the masking data to determine potential impacts when using the affected variables specified in Section S1.

S2.1. Directory structure

JRA-55_mask_en_ja.zip contains compressed masking data (ZIP format) with the directory structure shown below.

```
Mask -+- mask1_LL125 -+- mask1_LL125_YYYYMM.dat (1-byte integer data)
                      +- ...
                      +- mask1_LL125.monthly.ctl
     +- mask1_TL319 -+- TL319_general.pdef
                      +- mask1_TL319_YYYYMM.dat (1-byte integer data)
                      +- ...
                      +- mask1_TL319.monthly.ctl
     +- mask2_LL125 -+- mask2_LL125_MM.dat     (1-byte integer data)
                      +- ...
                      +- mask2_LL125.monthly.ctl
     +- mask2_TL319 -+- TL319_general.pdef
                      +- mask2_TL319_MM.dat     (1-byte integer data)
                      +- ...
                      +- mask2_TL319.monthly.ctl

  YYYY: year, MM: month
  *.ctl  GrADS (see Subsection S2.3) control file
  *.pdef GrADS definition file for projection
```

S2.2. Data format

S2.2.1. Masking data for areas and periods with unrealistically deep snow values (1.25-degree latitude/longitude grid data) (mask1_LL125)

- Data type: 1-byte integer
- Values: 1 for grid points with errors and 0 for others
- File organization:
  The first 288 bytes of the files contain data for the 90th parallel north, starting from zero degrees longitude (the prime meridian) toward the east at intervals of 1.25 degrees. The remaining parallels follow at intervals of 1.25 degrees toward the south.
- File composition:
  Monthly files for the period from January 1958 to December 2014 (684 in total)

S2.2.2. Masking data for areas and periods with unrealistically deep snow values (model grid data) (mask1_TL319)

- Data type: as per mask1_LL125
- Values: as per mask1_LL125
- File organization:

The first 48 bytes of the files contain data for the northernmost parallel, starting from zero degrees longitude (the prime meridian) toward the east. The remaining parallels follow toward the south. The number of grid points in each parallel varies with latitude. For details of the latitude and the number of grid points in each parallel of the model grid, see the JRA-55 product users' handbook (Model grid data; http://jra.kishou.go.jp/JRA-55/index_ja.html#manual).

- File composition: as per mask1_LL125

S2.2.3. Masking data for grid points with errors in snow cover climatology interpolation (1.25-degree latitude/longitude grid data) (mask2_LL125)

- Data type: as per mask1_LL125
- Values: as per mask1_LL125
- File organization: as per mask1_LL125
- File composition:
  Monthly files from January to December (12 in total)

S2.2.4. Masking data for grid points with errors in snow cover climatology interpolation (model grid data) (mask2_TL319)

- Data type: as per mask1_LL125
- Values: as per mask1_LL125
- File organization: as per mask1_TL319
- File composition: as per mask2_LL125

S2.3. Application program for analysis and visual representation

Additional files (*.ctl, *.pdef) are also included to support handling of masking data with the Grid Analysis and Display System (GrADS; a free program for analysis and visual representation of geoscience data). With these files, masking data can be visualized as outlined below.

- Example of visual representation with masking data for areas and periods with unrealistically deep snow values (March 1988) (Fig. S2.1)

```
$ grads                  (Start up GrADS.)
> open "Masking data directory"/mask1_LL125.monthly.ctl
                         (Open the GrADS control file.)
> set time Mar1988       (Set the time to March 1988.)
> set gxout grfill       (Select "Filled grid boxes" as the graphics type.)
> set rbcols 0 2         (Select transparent (0) and red (2).)
> set clevs 0.5          (Set the threshold to 0.5.)
> display mask1          (Display masking data.)
```

Masking data for grid points with errors in snow cover climatology interpolation can be visualized in the same way as above.

For details of GrADS, see http://cola.gmu.edu/grads/grads.php.

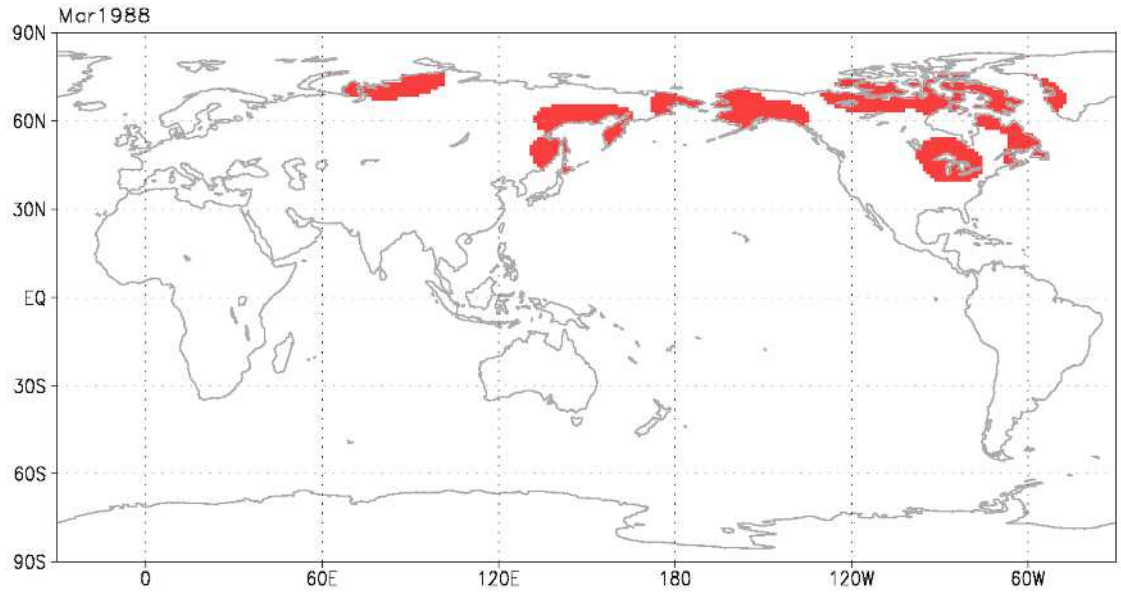

Fig. S2.1 Visual representation of masking data for areas and periods with unrealistically deep snow values (March 1988)
Areas affected by the bugs are shaded in red. Values are 1 in areas shaded in red and 0 in the rest.

S2.4. Checking for impacts on the variables listed in Section S1

- Snow depth (and water equivalent of accumulated snow depth)

Users are advised to check both the masking data for areas and periods with unrealistically deep snow values and the masking data for grid points with errors in snow cover climatology interpolation.

- Upward solar radiation flux

Users are advised to check the masking data for grid points with errors in snow cover climatology interpolation.

- Sensible heat flux

Users are advised to check the masking data for grid points with errors in snow cover climatology interpolation.

S3. Apology and correction regarding errors in JMA's notice of 18 December 2015

The errors detailed below appeared in the periods and grid points listed in JMA's notice of 18 December 2015. JMA apologizes for these issues.

- Periods of significant impact

Corrections for the periods listed in Section 1 tables

Area	For	Read
Subsection 1.2 Western Siberia Table 1.2, Area 1	1958/1959 to 1985/1986	1958 to 1985/1986
Subsection 1.2 Western Siberia Table 1.2, Area 2	1966/1967 to 1979/1980, 1987/1988	1958, 1966/1967 to 1979/1980, 1987/1988
Subsection 1.6 Northern Canada Table 1.6, Area 1	1976/1977	1977/1978
Subsection 1.8 Northeastern North America Table 1.8, Area 1	1958/1959 to 1990/1991, 1995/1996 to 1998/1999, 2003/2004 to 2005/2006	1958 to 1990/1991, 1995/1996 to 1998/1999, 2003/2004 to 2005/2006

The same errors also appeared in JRA-55_snow_bugs_list1_en.txt. The corrected ASCII file (JRA-55_snow_bugs_list1_corr_en.txt) should be used instead.

The corrected ASCII file contains investigation results for the period up to 2014, whereas the original ASCII file covered the period up to 2012. Results for the period after 2015 will be released once investigation is complete.

- List of grid points where snow depth values were found to be unrealistically low

The list for February in JRA-55_snow_bugs_list2_ja.txt was erroneously replaced with the list for January. The corrected ASCII file (JRA-55_snow_bugs_list2_corr_ja.txt) should be used instead.