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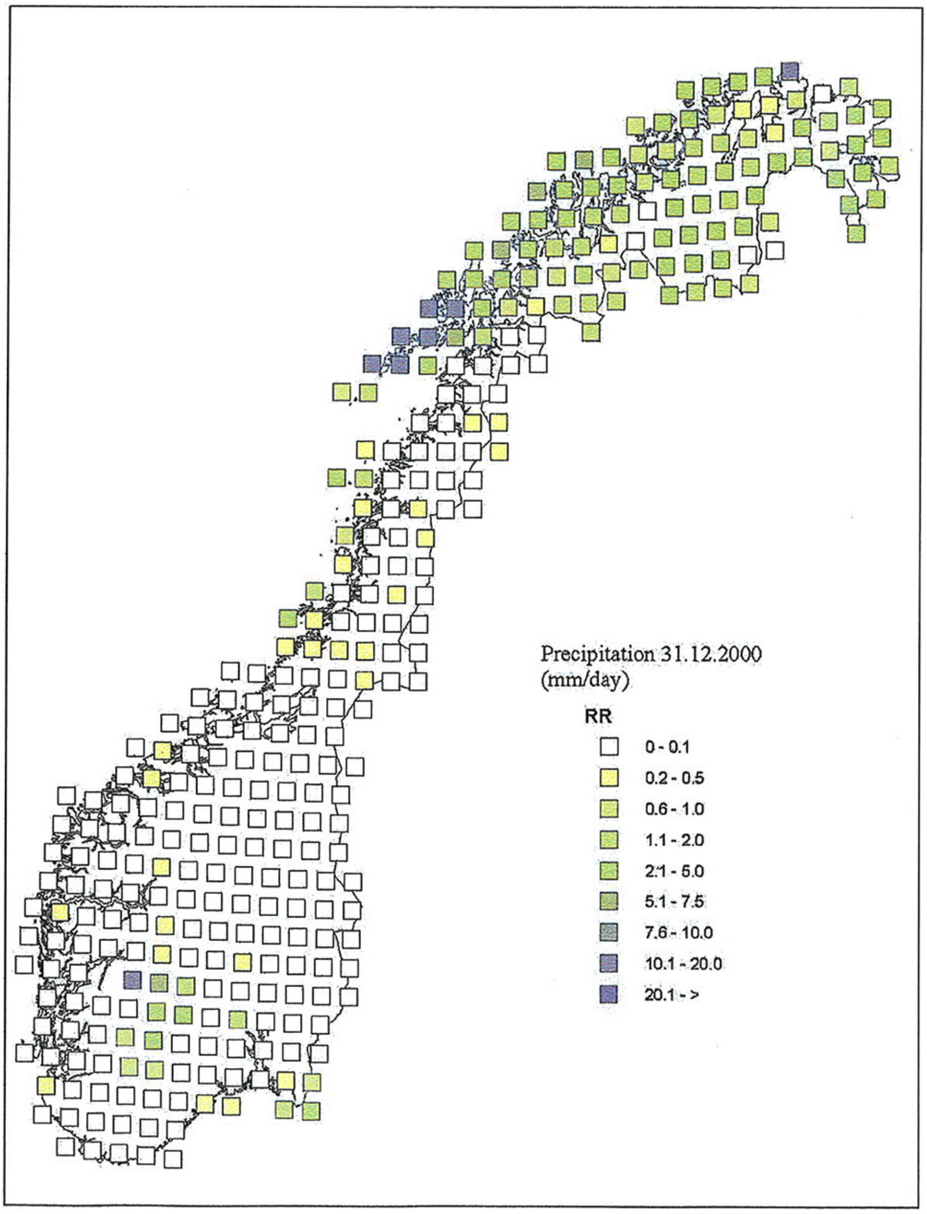
Report 12/02

KLIMA

Gridding observed precipitation for verification of ECMWF-forecasts

Ole Einar Tveito



met.no REPORT

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REPORT NO.

12/02 KLIMA

DATE:

16. December 2002.

TITLE:

An application for estimating gridded precipitation for evaluation of ECMWF-forecasts; technical description.

AUTHOR:

Ole Einar Tveito

PROJECT CONTRACTORS:

European Centre for Medium-Range Weather Forecasting (ECMWF)
Norwegian Meteorological Institute

SUMMARY:

An approach for estimating daily precipitation sums representing ECMWF grid locations is described. The approach is taking advantage of novel GIS techniques and spatial interpolation algorithms. The presented application is a flexible and robust approach for estimating areal precipitation for large areas (>1000 km^2).

KEYWORDS:

Precipitation, spatial analysis, geographical information systems (GIS).

SIGNATURES:

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Introduction.

In this report an application for estimating gridded daily precipitation for the purpose of evaluation of ECMWF-precipitation forecasts is presented. The application is a result of a decision at the 51st session of the ECMWF council in December 1999, and commissioned by Director David Burridge in February 2001.

The data commissioned were monthly reports of daily precipitation over the ECMWF grid meshes N128 and N256, based on data observed at the high resolution networks of each country. The ECMWF-grid meshes have a resolution of approximately 80 x 80 km^2 and 40 x 40 km^2 respectively. ECMWF expected averaged values from typically 5-10 stations within each grid cell.

The climatology division at the Norwegian Meteorological Institute (*met.no*) applies novel GIS techniques for establishing gridded climatology. Such techniques are also used for this application.

This report describes the data used, the ECMWF grid resolution and the approach for estimating averaged daily precipitation within these gridcells based on daily precipitation from the Norwegian precipitation station network.

Precipitation data.

All available data from the Norwegian station network is used. The number of stations will change over time due to changes in the network. For year 2000, which was used for testing, approximately 340 stations with daily measurements were available.

In Norway the precipitation day is defined as 06 UTC – 06 UTC. The precipitation is dated on the day when it is observed, meaning that daily precipitation dated e.g. 14. August is the precipitation accumulated between 06 UTC 13.August and 06 UTC 14.August.

The daily precipitation values are selected from the *met.no* climate database using a standard data report application[1]. The resulting report was used as input to an ArcInfo AML-script for further analysis.

ECMWF grid meshes.

For verification purposes ECMWF commissioned areally averaged precipitation for two model resolutions, T511 and T255. These are using the grid meshes N256 and N128 respectively. In this chapter N256 is used as an example, the N128 grid mesh is treated similar.

The ECMWF N256 grid mesh is described on the ECMWF web pages[2]. The grid mesh is a gaussian grid latitude/longitude grid. The spacing of the latitudes is not regular. However, the spacing of the lines of latitude is symmetrical about the Equator. A grid is usually referred to by its 'number' N, which is the number of lines of latitude between a Pole and the Equator.

In the reduced grids used by ECMWF, the number of points on each latitude row is chosen so that the local east-west grid length remains approximately constant for all latitudes, with the restriction that the number should be suitable for the Fast Fourier Transform used to interpolate spectral fields to grid point fields.

The resolution of the grid mesh is fixed. The positions of the gridcells along the latitudes are however not. In the application described here, fixed coordinates for the grid mesh are, based on the description on the ECMWF web pages. The grid is centered along the Greenwich meridian (0° E/W). The mesh as it is appears over the North Atlantic and Europe is shown in figure 1.

The ECMWF N256-grid does not coincide easily with the regular grids used by *met.no* climatology division. It does not either fit easily with projection where regular grids can be established easily within a GIS. In the chosen approach this problem is omitted by using focal

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[1] In this case the ***nedboer***-program at *met.no* climate division was used. The report file is used as input to further analysis.

[2] *http://www.ecmwf.int/publications/manuals/libraries/interpolation/n256FIS.html*
(and http://www.ecmwf.int/publications/manuals/libraries/interpolation/n128FIS.html*)*

functions around each grid location to estimate average precipitation values. This is a flexible and robust approach.

The Climatology division at *met.no* has as a principal objective to establish gridded climatologies for Norway. The standard geographic projection for environmental mapping in Norway is the Universe Transform Mercator projection. Norway is spread over a number of longitudes, covering 4 local UTM zones. For national mapping zone 33N is used. At present WGS84 (EUREF89) is used as datum. This projection is used also in this application.

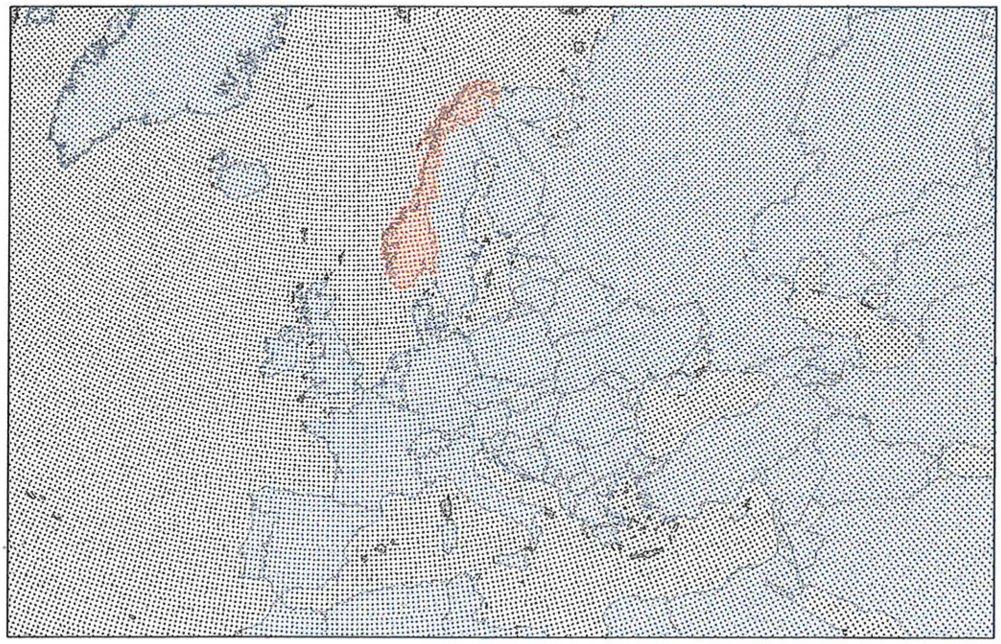

Figure 1: The ECMWF N256 grid-mesh coordinates over the North Atlantic and Europe established for the *met.no* application. The orange dots are the points for which daily precipitation values are estimated.

Interpolation of daily precipitation, T511.

Estimating average daily precipitation representative for the 40 x 40 km^2 grid cells of the ECMWF forecast model is related to the problem of estimating areal precipitation in hydrology. One of the most traditional methods in this respect is the Thiessen method. This is basically a weighted nearest neighbour approach, where polygons are established defining he neighbourhood of each precipitation stations. The weight of each precipitation stations inside an area is equal to the proportion of the total area covered by the station polygons. In this approach Thiessen polygons are established. An example (1.January 2000) of such polygons is shown in figure 2, and the colour represents the precipitation value. These polygon values are transformed into a grid with resolution 2x2 km^2, and this grid is then again filtered by calculating the average within a 20 km distance around each grid cell (Figure 3). The reason for doing this is that when projecting the gridded daily precipitation to the ECMWF grid mesh coordinates, the nearest grid estimate will be chosen. By applying a smoothed surface, the most representative value (for a 40x40 km^2 domain) will found. Figure 4 shows the smoothed surface for 1. January 2000, and figure 5 the projected ECMWF grid values.

Interpolation of daily precipitation, T255.

The T255 model resolution is using the N128 grid mesh. This grid has a resolution of about 80 x 80 km^2. The same procedure as for N256 is used, only changing the averaging distance according to the grid resolution.

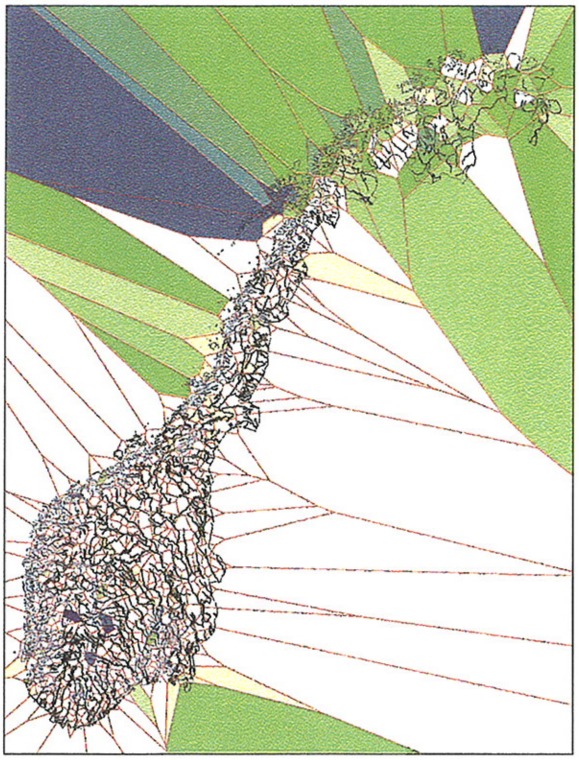

Figure 2: Thiessen polygons for the 1.January 2000 daily precipitation.

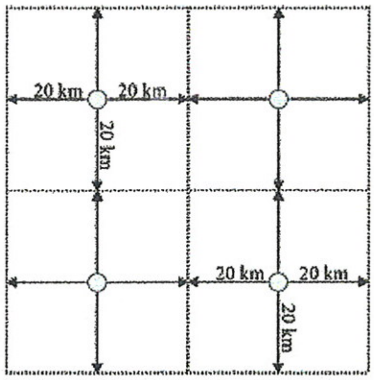

Figure 3: Averaging domain for each grid location.

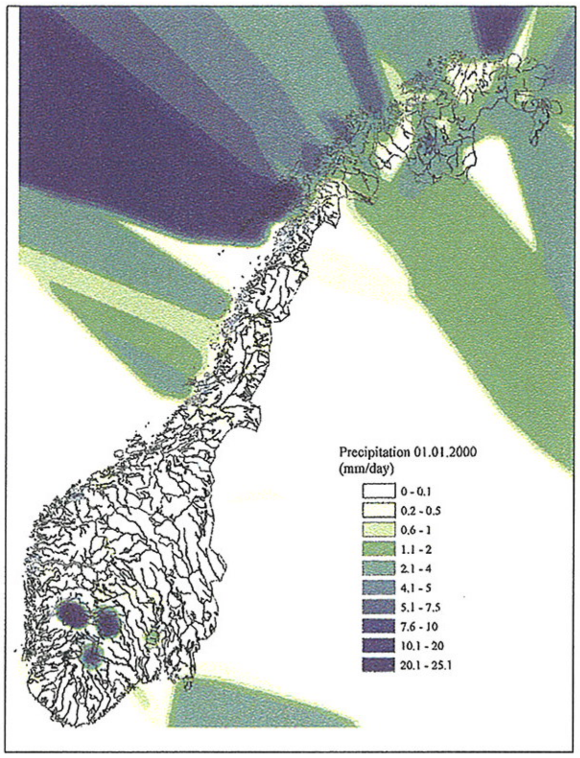

Figure 4: Smoothed grid representation of the 1.January 2000 daily precipitation.

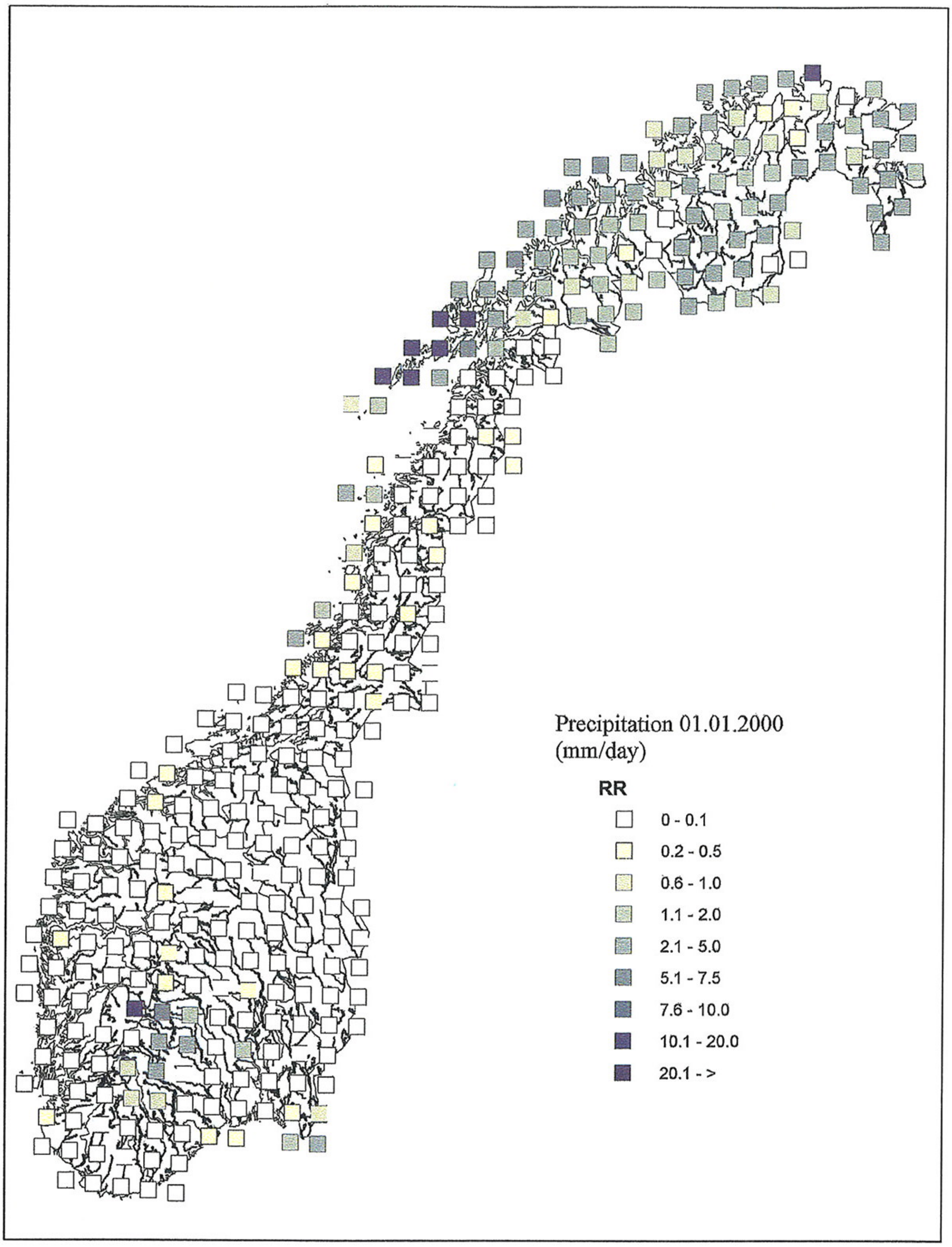

Figure 5: ECMWF grid point values of observed precipitation 1. January 2000.

Reporting format.

The application produces monthly reports, which is presented as simple ASCII-files. The file content and format is as follows.

Line	Content	Format
1	Year, Month, Number of gridpoints (N)[3]	3i6
2	Latitude, Longitude[4], Daily precipitation values for the first grid point	2f6.2, 31f6.1
3	Latitude, Longitude, Daily precipitation values for the second grid point	2f6.2, 31f6.1
.		2f6.2, 31f6.1
.		2f6.2, 31f6.1
N+1	Latitude, Longitude, Daily precipitation values for the n[th] grid point	2f6.2, 31f6.1

An example of a report is given at next page. Missing values are shown as –9.9. Such values may appear when a grid-point is outside the smoothed precipitation field.

Acknowledgements.

The author would like thank Dr. Anna Ghelli, Dr. Francois Lalaurette (both ECMWF) and Eirik Førland (met.no) for useful suggestions and comments.

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[3] Number of grid points (number of lines) is included if a counter is used to stop reading the file instead of the EOF-marker.

[4] Given as decimal degrees.

EXAMPLE OF A MONTHLY REPORT.

2000	1	339																														
71.12	28.00	0.2	0.0	0.0	0.0	0.0	2.1	1.8	0.7	8.4	3.6	6.4	1.8	0.7	3.4	2.7	0.6	0.2	3.5	2.3	0.9	1.5	2.1	0.6	0.4	1.4	8.3	3.8	1.8	3.1	0.2	0.8
71.12	27.00	0.1	0.1	0.1	0.0	0.1	3.7	3.1	0.2	6.2	6.6	5.0	2.5	1.8	7.7	5.2	0.3	11.7	2.5	5.6	9.4	2.7	3.9	7.2	1.3	13.5	6.3	9.6	14.7	6.6	1.9	2.8
71.12	26.00	0.0	0.2	0.2	0.0	0.2	4.2	3.5	0.1	5.5	7.6	4.6	2.7	2.2	9.2	6.0	0.2	15.6	2.1	6.7	12.3	3.1	4.5	9.5	1.6	17.7	5.6	11.6	19.1	7.8	2.5	3.4
71.12	25.00	0.6	0.1	0.1	1.1	1.3	1.5	1.1	0.3	3.1	7.8	2.8	5.8	3.1	4.4	5.6	1.3	8.9	0.9	2.6	19.8	2.7	2.0	12.1	3.1	6.6	5.9	8.8	8.6	3.9	4.3	12.8
70.77	30.00	0.0	4.5	0.0	0.0	0.0	0.1	3.0	0.3	4.2	0.0	0.4	0.9	0.6	1.5	0.2	0.5	0.6	5.1	4.0	0.8	3.2	2.1	1.8	1.0	0.7	2.3	1.4	4.2	0.9	0.0	0.0
71.12	24.00	1.0	0.0	0.0	2.0	2.2	0.6	0.3	0.5	2.9	5.9	2.8	8.9	4.4	3.4	7.1	2.2	5.4	0.6	1.5	29.0	3.2	1.5	16.7	0.1	3.3	7.7	10.1	6.2	3.2	6.4	9.4
70.77	29.00	0.0	0.1	0.0	0.0	0.0	0.1	1.4	0.0	0.9	0.3	3.3	1.7	3.0	0.7	0.3	0.0	1.6	0.9	2.3	0.6	5.5	4.1	4.3	0.3	7.0	0.6	4.2	9.3	2.9	0.1	0.8
70.77	28.00	0.0	0.0	0.0	0.0	0.0	0.9	1.6	0.0	5.9	3.0	4.0	3.9	1.5	3.4	3.0	0.3	0.6	2.1	1.6	5.0	4.1	6.4	4.0	0.1	4.9	3.9	4.9	14.8	3.5	0.6	5.5
70.77	27.00	0.0	0.0	0.0	0.0	0.2	1.2	1.5	0.0	3.1	5.0	1.3	1.1	0.5	1.5	0.9	0.3	1.6	0.5	3.9	2.7	2.6	2.5	4.5	1.7	4.5	4.0	8.8	6.6	1.9	0.2	1.7
70.42	31.00	0.0	0.0	0.1	0.2	0.3	0.4	13.0	0.3	6.6	0.0	0.2	1.1	0.1	0.5	0.0	3.2	1.9	1.6	1.6	1.1	3.6	2.4	1.0	0.6	1.4	1.4	3.2	0.2	2.0	1.5	7.0
70.77	26.00	0.0	0.0	0.0	0.0	0.1	0.7	0.5	0.0	1.4	12.3	0.7	0.4	0.4	1.3	0.7	0.1	8.2	0.3	1.1	2.0	0.5	0.8	2.0	9.8	3.2	1.8	4.4	3.7	1.4	0.3	24.8
70.77	25.00	0.1	0.0	0.0	0.1	0.7	0.6	0.2	0.1	0.2	13.5	1.4	0.5	0.4	1.0	1.1	0.3	9.2	0.4	1.1	3.0	0.6	0.7	3.4	11.6	1.0	2.2	2.4	2.6	1.6	0.8	29.3
70.42	30.00	0.0	2.2	0.0	0.0	0.1	0.1	3.8	0.4	2.7	0.0	0.3	0.6	0.2	2.5	0.1	0.4	0.4	2.6	1.9	0.4	3.7	0.9	0.9	0.5	0.2	1.2	0.8	4.3	0.4	0.3	1.6
70.77	24.00	0.2	0.0	0.0	0.4	3.2	4.1	1.6	0.1	0.6	10.9	5.4	1.7	2.5	8.6	4.2	0.4	6.7	0.3	5.5	16.7	4.2	3.5	15.3	0.1	4.3	12.6	9.9	13.2	10.0	1.7	5.8
70.42	29.00	0.0	0.5	0.0	0.0	0.4	0.3	3.0	1.3	3.5	0.0	1.6	1.3	0.4	0.9	1.2	0.8	2.2	1.0	0.7	0.1	1.0	0.6	3.6	1.5	3.0	2.0	4.1	3.0	4.3	1.5	1.7
70.77	23.00	0.0	0.0	0.0	0.0	4.0	4.6	1.9	0.0	0.0	12.5	5.3	0.2	2.1	8.7	2.9	0.0	7.5	0.1	6.7	13.9	3.8	3.3	12.4	1.5	4.2	14.5	8.6	13.7	9.5	0.4	6.4
70.77	22.00	0.0	0.0	0.0	0.0	6.2	3.0	1.3	0.0	0.0	15.2	2.1	0.6	2.0	3.1	0.0	0.0	10.1	0.0	7.6	13.0	0.6	0.0	0.0	8.7	2.3	16.9	2.0	8.0	0.0	0.0	12.7
70.42	28.00	0.0	0.0	0.0	0.0	0.4	0.4	1.5	1.1	3.2	0.0	1.2	0.6	0.0	1.4	2.1	1.4	2.9	0.0	0.5	0.0	0.8	0.5	4.8	2.5	4.0	2.7	5.5	4.1	7.1	1.4	2.6
70.42	27.00	0.0	0.0	0.7	0.0	0.3	1.3	3.3	0.3	2.1	0.4	1.4	0.4	0.1	0.1	1.3	0.2	1.6	0.1	4.7	0.3	2.3	1.4	4.5	1.7	2.3	3.3	8.9	4.4	1.2	0.4	0.8
70.07	30.72	0.0	0.1	0.1	0.1	0.4	0.1	5.6	0.3	2.6	0.0	0.3	0.4	0.0	3.0	0.0	0.3	0.8	0.8	0.2	2.0	4.4	0.3	0.7	0.1	1.1	0.4	0.4	4.4	0.3	0.7	4.4
70.42	26.00	0.0	0.0	0.5	1.3	0.4	1.4	0.7	0.1	2.1	2.7	1.8	0.2	0.2	0.3	1.4	0.4	2.6	0.1	3.2	1.2	0.8	1.0	6.9	0.5	2.7	4.1	7.0	3.5	3.5	0.5	2.0
70.42	25.00	0.0	0.0	0.0	0.4	2.1	1.4	0.5	0.2	0.7	8.3	4.3	0.0	0.5	1.6	2.6	0.9	5.1	1.3	4.0	4.1	0.8	2.2	9.2	0.8	3.4	6.3	8.4	7.6	4.2	1.9	0.8
70.07	29.76	0.0	0.2	0.0	0.0	0.4	0.3	5.2	1.3	2.8	0.0	1.2	1.5	0.3	1.9	0.0	0.0	0.8	1.0	0.2	0.0	2.7	0.0	1.5	0.0	1.0	0.6	1.2	3.5	0.1	1.1	2.4
70.42	24.00	0.0	0.0	0.0	0.0	1.2	2.8	2.2	0.3	0.2	21.4	4.3	0.0	1.9	7.0	4.2	1.5	6.8	1.4	7.0	9.9	2.5	2.6	14.2	0.9	3.4	9.9	8.5	17.9	8.8	1.9	4.3
70.07	28.80	0.0	0.0	0.0	0.0	0.6	0.7	6.1	0.7	2.3	0.0	1.0	1.2	0.1	3.0	0.1	0.2	1.5	0.4	0.4	0.0	4.2	0.6	1.4	0.1	0.6	0.6	1.1	8.2	0.2	1.0	2.9
70.42	23.00	0.0	0.0	0.0	0.0	3.1	3.1	2.6	0.1	0.2	22.5	2.3	0.2	2.2	7.5	2.3	1.7	7.7	0.1	8.1	12.3	2.2	1.5	10.0	3.0	3.6	14.9	8.6	17.9	5.2	0.8	9.1
70.42	22.00	0.0	0.0	0.0	0.0	6.2	3.0	1.3	0.0	0.0	15.4	2.1	0.6	2.0	3.1	0.0	0.0	10.0	0.0	7.5	12.8	0.7	0.1	0.1	8.5	2.3	16.7	2.1	8.0	0.2	0.0	12.5
70.07	27.84	0.1	0.0	0.1	0.4	1.3	4.4	2.5	0.8	5.3	0.0	1.9	1.7	0.0	0.1	0.5	1.3	3.6	0.6	1.3	0.1	0.3	1.7	3.0	0.6	1.4	1.8	2.1	1.0	0.4	2.7	4.9
70.42	21.00	0.0	0.0	0.0	0.2	4.6	1.3	0.5	0.0	0.8	10.1	1.7	1.0	1.2	3.5	2.0	2.2	10.7	0.1	10.1	7.3	3.4	1.5	1.1	2.9	1.5	10.6	2.1	5.1	3.0	2.0	6.7
70.42	20.00	0.0	0.0	0.0	0.9	3.9	0.4	0.3	0.1	1.3	3.0	1.4	1.6	0.8	3.4	2.3	3.4	10.2	0.0	11.1	4.5	7.4	2.3	1.2	0.0	0.5	4.3	1.0	2.3	3.2	2.8	2.7
70.42	19.00	0.0	0.2	0.0	3.1	4.2	0.5	2.0	0.5	1.2	6.8	4.5	3.4	1.4	1.7	1.6	4.1	9.5	0.1	9.1	5.2	20.8	2.9	0.5	0.0	0.8	5.3	1.5	1.3	1.1	2.0	1.4
70.07	26.88	0.0	0.0	0.4	0.6	0.0	6.2	1.8	1.2	3.2	0.4	1.4	0.1	0.1	0.1	0.7	1.6	1.4	0.7	1.2	0.0	0.8	0.1	2.5	1.1	2.2	2.5	2.9	2.1	1.1	3.2	4.4
69.72	30.72	0.1	0.7	0.4	0.2	2.1	0.2	10.5	1.6	9.5	0.1	1.4	1.5	0.1	0.0	0.0	0.0	3.0	3.5	0.1	9.4	2.5	0.1	3.0	0.0	5.0	1.5	0.4	0.4	0.3	3.0	8.0
70.07	25.92	0.0	0.0	0.6	1.1	0.0	0.6	2.3	1.8	1.0	2.7	1.6	0.1	0.1	0.0	1.0	0.7	2.7	0.2	2.8	0.5	0.5	0.5	5.6	0.0	2.7	3.2	3.5	2.5	2.5	1.7	1.9
70.07	24.96	0.0	0.1	0.1	0.1	0.1	0.1	1.3	0.0	0.1	5.1	1.8	0.0	0.0	0.0	0.1	0.1	1.9	0.1	2.2	0.0	0.2	0.0	5.2	0.0	0.6	0.3	1.9	5.0	0.4	0.6	0.6
69.72	29.76	0.1	1.0	0.3	0.1	1.5	1.0	6.0	1.7	7.5	0.0	0.7	1.4	0.0	0.0	0.0	0.0	1.6	2.2	0.5	0.3	0.7	0.1	3.5	0.2	4.3	3.0	0.4	0.1	0.2	1.0	7.1
70.07	24.00	0.0	0.1	0.3	0.0	1.0	0.7	1.4	0.1	0.6	10.1	1.2	0.0	0.6	1.5	1.8	0.8	2.3	0.7	3.0	3.0	1.4	2.2	8.5	0.1	2.6	3.5	4.7	8.1	4.0	1.3	3.1
69.72	28.80	0.3	0.0	0.0	0.0	1.3	1.1	6.7	1.2	7.3	0.0	1.2	1.0	0.0	0.6	0.0	0.0	2.0	0.6	0.0	0.0	0.8	0.0	0.3	0.0	4.4	4.3	0.7	1.7	0.0	2.7	5.2
70.07	23.04	0.0	0.0	0.0	0.0	2.5	0.7	0.3	0.0	0.9	15.0	0.8	0.1	0.2	1.4	1.6	0.4	1.7	0.7	2.8	2.8	3.6	4.2	6.5	0.0	3.3	4.4	4.9	6.7	6.0	1.4	4.2
70.07	22.08	0.0	0.0	0.0	0.0	3.4	1.5	0.0	0.0	1.5	24.0	1.8	0.3	0.2	3.1	0.9	1.2	3.7	0.0	4.4	3.1	6.2	4.4	4.4	0.1	4.3	8.6	6.8	6.3	7.3	1.8	4.0
70.07	21.12	0.0	0.0	0.0	0.0	3.6	1.0	1.2	0.0	0.9	61.5	9.0	1.9	2.0	2.4	7.7	4.8	16.7	2.4	9.2	4.9	6.0	1.9	4.0	0.0	8.5	40.3	15.4	14.6	12.6	2.8	10.2
70.07	20.16	0.0	0.0	0.0	0.3	3.9	0.5	0.9	0.2	0.9	28.8	5.4	2.5	3.0	3.5	4.6	3.6	17.0	0.7	8.3	5.9	8.3	2.7	1.5	0.2	3.3	19.3	9.0	7.7	7.2	2.2	7.3
70.07	19.20	0.0	0.1	0.0	1.4	4.5	0.4	1.5	0.4	2.1	16.6	5.3	3.9	3.8	3.8	3.6	4.0	18.8	0.1	8.4	6.9	12.8	3.3	0.6	0.3	1.2	11.0	7.2	5.6	4.6	1.5	5.9
70.07	18.24	0.0	0.0	0.2	3.1	6.5	0.3	2.4	0.3	8.6	12.1	5.9	6.1	4.2	5.7	6.2	7.4	27.2	0.5	17.0	8.4	5.2	3.0	2.9	0.0	0.9	10.3	8.7	11.0	6.6	1.3	6.0
69.72	25.92	0.0	0.2	0.4	0.6	0.3	0.1	6.4	2.0	3.4	1.0	1.6	1.4	0.0	0.0	0.2	2.1	2.9	2.0	0.5	0.1	0.0	0.0	2.2	0.0	3.1	2.2	1.6	1.1	0.5	3.1	4.7
69.37	30.00	0.2	0.7	0.8	0.0	0.6	0.1	5.4	1.7	5.4	0.3	1.4	1.3	0.0	0.0	0.2	0.0	2.7	0.2	0.7	0.0	1.2	0.0	3.7	1.7	1.7	6.2	1.4	0.0	0.1	1.5	7.8
69.72	24.96	0.0	0.7	0.9	0.3	1.2	0.1	4.2	0.1	3.0	1.3	1.3	0.4	0.0	0.0	0.7	2.3	3.5	0.5	1.3	1.1	0.2	0.0	4.6	0.0	1.8	1.6	1.8	1.8	0.3	1.9	2.5
69.72	24.00	0.0	0.4	1.9	0.2	1.1	0.4	3.1	1.0	2.3	1.4	1.3	0.0	0.5	0.0	1.2	2.0	3.7	0.4	2.5	1.4	0.8	0.6	9.3	0.0	3.3	2.9	4.2	2.0	1.1	2.6	1.1
69.37	29.06	0.2	0.4	0.8	0.0	0.4	0.2	6.9	1.8	8.1	0.4	1.5	1.5	0.1	0.0	0.4	0.1	3.6	0.2	0.2	0.1	0.2	0.0	1.9	0.0	3.9	6.9	1.8	0.0	0.0	2.4	7.1
69.72	23.04	0.0	0.1	1.5	0.0	2.6	0.1	0.8	2.0	1.1	6.2	0.2	0.0	0.2	0.2	1.0	1.0	1.1	0.5	3.4	1.5	2.4	1.7	7.4	0.1	1.6	1.0	5.7	2.4	1.8	1.7	2.9
69.72	22.08	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.0	0.0	14.3	0.1	0.0	0.7	1.0	1.5	3.3	0.6	0.1	7.1	0.6	2.0	0.9	5.3	0.6	3.4	3.0	9.8	4.2	2.7	0.1	2.0
69.72	21.12	0.0	0.0	0.0	0.0	0.3	1.7	0.3	0.0	0.2	15.8	1.0	0.1	0.6	4.5	3.9	0.8	4.5	1.0	7.3	2.5	2.5	1.1	3.2	0.9	3.4	9.2	16.7	4.6	2.0	0.7	5.9
69.72	20.16	0.0	0.0	0.0	0.0	3.2	1.0	0.4	0.1	4.8	21.3	2.4	1.6	2.2	3.6	3.4	2.5	23.6	2.0	9.2	6.0	5.1	0.7	2.1	0.0	5.5	15.3	14.8	12.1	5.9	0.5	7.8
69.72	19.20	0.0	0.0	0.2	3.2	5.4	1.4	1.5	0.2	5.7	18.1	4.4	4.1	4.8	5.7	6.8	5.7	32.5	3.2	15.7	9.8	4.3	1.8	2.4	0.0	2.7	18.9	14.6	13.1	9.9	1.0	10.3
69.72	18.24	0.0	0.0	0.5	4.4	4.6	0.7	1.2	0.8	5.2	12.5	4.7	6.7	5.7	8.3	6.6	9.1	22.5	2.9	17.7	9.2	8.8	2.2	4.2	0.0	1.2	15.1	8.4	10.2	8.1	1.0	7.4
69.72	17.28	0.0	0.0	0.2	5.4	0.9	0.7	0.2	1.6	0.7	10.3	3.5	7.2	5.3	8.7	5.5	10.5	10.7	3.4	16.4	7.6	12.8	1.5	4.5	0.0	1.0	14.1	4.2	7.1	7.1	0.7	5.7
69.37	26.25	0.0	0.1	0.5	0.2	0.2	0.1	5.7	0.6	1.8	0.0	0.5	0.5	0.0	0.0	0.1	0.5	4.8	0.6	0.1	0.1	0.0	0.0	1.5	0.0	0.7	0.4	0.4	0.3	0.2	2.7	10.2
69.37	25.31	0.0	0.2	1.1	0.0	0.4	0.2	5.5	1.0	2.6	0.1	0.4	0.2	0.0	0.0	0.4	0.4	5.3	0.0	0.6	0.2	0.1	0.0	2.6	0.0	0.6	0.2	0.2	0.0	0.2	3.0	7.2
69.37	24.38	0.0	0.3	2.4	0.1	2.0	0.0	5.5	0.7	2.8	0.3	0.6	0.0	0.0	0.0	0.6	1.0	6.9	0.3	1.1	1.0	0.1	0.0	3.5	0.0	0.9	1.1	0.3	0.1	0.0	2.6	2.5
69.01	29.06	0.2	0.5	1.0	0.0	0.2	0.0	7.0	1.9	8.1	0.5	1.5	1.6	0.1	0.0	0.5	0.1	3.9	0.1	0.3	0.1	0.2	0.0	2.3	0.0	3.6	7.4	2.0	0.0	0.0	2.3	7.4
69.37	23.44	0.0	0.2	2.6	0.0	3.6	0.0	1.7	2.7	2.0	1.1	0.3	0.0	0.0	0.3	0.4	0.5	2.4	0.4	1.6	1.4	1.8	0.5	5.7	0.0	0.1	0.1	3.7	0.0	0.0	3.2	3.0