Appendix A – Data Sources & Management

Structure of Appendix A

This appendix will cover in detail the data sources and structures utilized during the completion of this report. The appendix will cover each of the data sources in the below table.

Summary of Data Sources and Structures

1) Acid Rain/OTC Program Hourly Emissions Data
2) eGrid Plant and Unit Metadata
3) SEPA Solar Generation Information
4) Solar Resource Information
   a. ISIS and SURFRAD networks
   b. CONFRRM
5) FERC Total Load Information
6) FERC Subregion Spatial Information
7) National Emissions Inventory Information

For each data source, the following items will be discussed.

- Relevant metadata of the original source including availability, data format, etc.
- Process of retrieval
- Methods of data management including reliability checks, data patching, data conformity issues, etc.

The analysis database used was a MySQL database (version 3.23)[1] on an IBM Intellistation running RedHat Linux 9. For scripting both Perl (version 5.x)[2] for Windows and PHP (version 4.3.2)[3] were used. The data server can be found at http://agrea2.mit.edu/. All of the data was stored in a database called "agrea-egrid" unless otherwise noted.

Code used in the completion of any of the tasks is included in Appendix C and is referenced as appropriate.

Data Sources

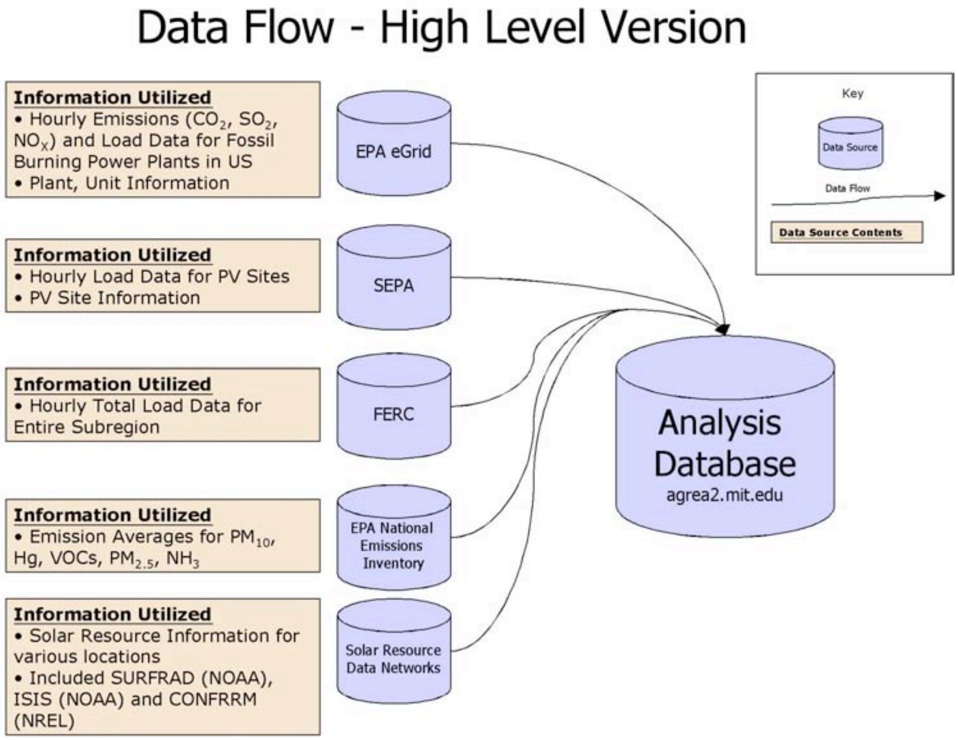
1) Acid Rain/OTC Program Hourly Emissions Data

Summary

The Acid Rain/OTC Program Hourly Emissions Data (referred to as eGrid Hourly Data) was the core of the analysis data. The raw hourly emissions files are used to create the emissions information presented by the EPA eGrid program.

[1] See http://www.mysql.com
[2] See http://www.perl.com
[3] See http://www.php.net

Figure A.1. Integration of Data Sources into the Relational Database



Relevant Metadata

Online Availability

eGrid Program:
http://www.epa.gov/cleanenergy/egrid.htm

Raw Data Files:
http://www.epa.gov/airmarkets/emissions/raw/index.html

Data Format

EDR (or Electronic Data Reporting) format 2.1. For documentation, see http://www.epa.gov/airmarkets/reporting/edr21/index.html.

Latest Update

Hourly emissions files are updated on a quarterly basis on about a four month delay. The latest available update during analysis was the fourth quarter of 2002.

Time Span of Data Retrieved
First Quarter 1998 – Fourth Quarter 2002

Process of Retrieval

EPA stores the raw data file in a compressed file that can be opened only through use of an "exploding" program, outside the functionality of the common file extraction tools. The "explode" program is dependent on the Windows platform and is available for download from the EPA website.

The files are stored in a simple hierarchy on the website by quarter. The files were retrieved use the WGET program.

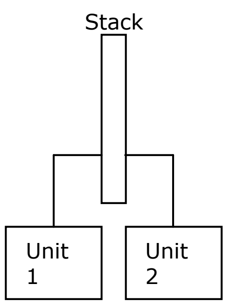
Data Management

Converting from EDR to an Relational Database

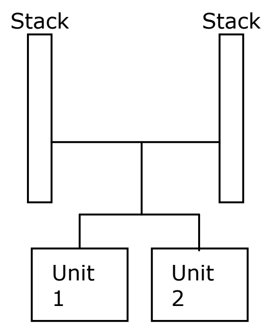
With downloads restricted to a Windows box, the initial pass at the data was completing using Perl. The purpose of the Perl scripts were to a) solve the common stack and multiple stack problem b) convert all of the EDR format data into valid SQL statements, and c) arrange all of the plant's individual quarters into a set of files per plant containing all the available data: one for operational (load, heat rate, and operating time) and one each for emissions (CO2, SO2, NOx).

The common stack and multiple stack problem exists because some units share stacks. Since emissions measurements are taken at the stack, while generation and heat rate information is taken at the unit, units are not directly accountable for emissions when in the EDR format. The solution was to allot to the emissions to each unit according to its heat rate input.

Case 1: Common Stack



Case 2: Multiple Stacks



In Case 1, the emissions allotted to Unit 1 would be equal to the emissions from Stack 1 times the ratio of Unit 1 heat rate input to the total heat rate inputs of Unit's 1 and 2. In Case 2, the emissions allotted to Unit 1 would be equal to the emission from Stack 1 plus the emissions from Stack 2 times the ratio of Unit 1 heat rate input to the total heat rate inputs of Unit's 1 and 2. This type of allotment was completed for all units with common or multiple stacks.

The conversion of the data from EDR formats to SQL statements was straight-forwarded data processing. Operational data was made into INSERT statements and emissions data made into UPDATE statements, as each is stored separately in the EDR format. On the next page is a before and after example for the operational data.

The movement of plant files into a single file for all years preceded the organization of all files into subregion folders. This process will be detailed later when looking at the eGrid plant and unit metadata.

The scripts used in this process were written in Perl and can be found in Appendix C – (parseone.pl, parsetwo.pl, parsethree.pl, parsefour.pl). See also Appendix C under Perl Program Execution for more detail.

Before

```
10000054412002V2.1
102NRG  - DEVON        544         0900907518CTD983902065   ELECTRIC UTILITY    4911CT009
4112300730633
…
3007     020101001.00     0          101.6
3007     020101011.00     0           55.1
3007     020101021.00     0           81.5
3007     020101031.00     0          126.6
```

After

```
INSERT INTO CRNE(TSTAMP,PLANT,UNIT,UOPTIME,GULDO,HHIRDO,FFACT) VALUES ('01/01/02
00:00:00',000544,7     ,1.00,     0,  101.6,null);
INSERT INTO CRNE(TSTAMP,PLANT,UNIT,UOPTIME,GULDO,HHIRDO,FFACT) VALUES ('01/01/02
01:00:00',000544,7     ,1.00,     0,   55.1,null);
INSERT INTO CRNE(TSTAMP,PLANT,UNIT,UOPTIME,GULDO,HHIRDO,FFACT) VALUES ('01/01/02
02:00:00',000544,7     ,1.00,     0,   81.5,null);
INSERT INTO CRNE(TSTAMP,PLANT,UNIT,UOPTIME,GULDO,HHIRDO,FFACT) VALUES ('01/01/02
03:00:00',000544,7     ,1.00,     0,  126.6,null);
```

Loading into Relational Database

After conversion, the data was transferred via FTP to the database server (AGREA2). There it was loaded into the MySQL database using a PHP script (loaddata_local_single.php). The script was designed to load one subregion at a time.

<u>Data Patching and Conformity</u>

Removing Outliers

Before any patching was conducted, the data was checked for outliers. Since little quality assurance appeared to be completed on the raw data utilized, the desire was to remove clear data input errors and numbers beyond the realm of feasibility. Other statistical outliers would be removed during analysis. The removal was accomplished by looking at each measurement on the unit level. Any values bigger than twice the 95th percentile value were set to null. These were then patched using the logic described below. The results from patching are in Table A.1 below.

Identifying

Additional identifying information was desired for each unit on an hourly basis. This data was as follows:

- Load state
- 60 day rolling max load for the unit
- The change in load from the previous unit-hour
- Flag designating unit-hour as “load shape following”
- Fuel type burned in the hour

Table A.1. Summary of Outliers Removed

Subregion	Outliers Removed	Total Data Points	Percentage Outlier
CALI *	3	910224	0.000
ECMI	493	4364721	0.011
ECOV *	388	2920346	0.013
ERCT *	64	975535	0.007
FRCC	314	7482590	0.004
MAAC	2836	10898586	0.026
MANN	648	3936856	0.016
MANS	1460	8312712	0.018
MAPP **	3758	8157928	0.046
NEWE	371	4810211	0.008
NWGB	2	2717346	0.000
NWPN	3	1082789	0.000
NYAS ***	2119	6201621	0.034
ROCK	1002	3183654	0.031
SPSO	1721	5676559	0.030
SRMV	493	4744379	0.010
SPNO	333	2277274	0.015
SRSO	597	7009773	0.009
SRVC	137	6880256	0.002
WSSW	96	3405714	0.003
SRTV	213	4781439	0.004

* Number reported for CALI, ECOV, and ERCT are from samples of the data.
** 80% of outliers from MAPP come from a single plant
*** 70% of outliers from NYAS come from two plants

The load state, load shape following flag, and fuel type were determined as described previously in this report. The 60-day rolling max load represents the maximum unit load from +/- 30 days from the given hour. This element is used in the load state determination. The change in load from the previous unit-hour is simply the absolute value of the previous hour's load minus the current hour's load. This is used in the solar generation allotment per unit analysis.

Patching

As outlined in the EDR documentation each unit must report a measured or calculated emissions number. There are exceptions to the reporting requirement such as when measuring equipment is down or unreliable. For the purposes of this analysis a "square" dataset was required. In essence, the analysis required that every unit that has a heat rate input or load information for a given hour should have an associated emissions number.

Therefore, if this number was not supplied in the EDR file is was assigned a number based on statistical averages for that unit, or "patched." The averages were taken as average emission rates per unit of heat input (i.e. CO2/Heat Rate). The below matrix shows the granularity to which the averages were taken:

Table A.2. Emissions Patching Matrix

		Unit Load State			
		Full Load	Spinning Reserve	Standby	Turning Off / On
Quarter of the year	1	x	x	x	x
	2	x	x	x	x
	3	x	x	x	x
	4	x	x	x	x

The patching matrix was completed in this way to ensure that any seasonal or load state variations in emissions output were maintained. To ensure that outliers were not perpetuated during the patching process a minimum sample size for which an average was acceptable was implemented. For this analysis the minimum was set at 20 data points. The patching process went through the following logic:

- Query existing subregion table to find an average rate (i.e. CO2/HHIRDO) filtering by load state and quarter.
    - If number of valid hours is greater than 20, use the filtered population average.
    - If not, query existing subregion table to find an average rate filtering only by load state.
        - If number of valid hours retrieved is greater than 20, use the filtered population average.
        - If not, query the PLANT table to find average annual emissions rate. (This will always exist.)

The code behind the data management and patching logic can be found in Appendix C - (calculate_hourly_identifiers.php and patchdata_easy.php).

Note that only states participating in the NOX Budget Trading Program are required to report NOX emissions in the EDR format[4]. Also, the mercury information was patched using this algorithm. This means all mercury data is patched from unit averages from the eGrid 2002 spreadsheets. This is similar to the way in which NEI emissions were tallied. See Data Source 7 in this Appendix.

The units for the data remain the same in the database as they were in the EDR data formats.

[4] See http://www.epa.gov/airmarkt/fednox/index.html

Table A.3. Degree of Patching by NERC Subregion

Subregion	Percent of Heat Rate Patched	Percent of Load Patched	Percent of SO_2 Patched	Percent of NO_X Patched	Percent of CO_2 Patched
CALI	0.00	2.66	1.35	100.00	0.86
ECOV	0.06	3.54	2.13	50.14	1.38
ECMI	0.12	18.55	2.94	99.29	0.59
ERCT	0.01	2.71	6.00	90.99	2.03
FRCC	0.01	2.06	9.64	100.00	19.28
MANS	0.04	15.77	1.57	100.00	0.75
MANN	0.01	14.29	1.19	100.00	0.32
MAPP	0.06	6.13	1.59	99.96	0.31
MAAC	10.29	24.54	38.43	18.27	47.21
NEWE *	0.03	15.54	36.80	13.34	41.14
NWGB	0.00	0.00	6.37	100.00	20.71
NWPN	0.00	0.01	4.03	100.00	3.22
NYAS	3.89	38.45	37.93	21.63	37.27
ROCK	0.01	0.11	2.90	100.00	1.86
SRVC	0.02	9.35	1.14	100.00	1.85
WSSW	0.12	0.16	5.06	100.00	2.73
SPNO	0.03	1.60	3.67	100.00	5.68
SPSO	0.18	3.19	8.02	99.99	3.99
SRMV	0.02	3.92	2.73	100.00	5.98
SRSO	0.15	1.12	4.13	100.00	3.98
SRTV	0.01	0.79	0.45	99.72	0.74

* NEWE numbers are based on only a sample of the data.

Storage Structure

The hourly emissions information is stored in a single table per subregion. The data format is as follows:

Table A.4. Unit-Hour Record Structure

Field	Type	Null	Default	Description
TSTAMP	datetime	No	0000-00-00 00:00:00	Hour of emissions and load measurements
PLANT	smallint(6)	No	0	Plant ID
UNIT	varchar(6)	No	0	Unit ID
UOPTIME	float	Yes	*NULL*	Fraction of hour in operation (fraction)
GULDO	float	Yes	*NULL*	Gross Unit Load during operation (MW)
HHIRDO	float	Yes	*NULL*	Hourly Heat Input Rate During Operation (mmBTU)
FFACT	float	Yes	*NULL*	F-factor (units vary from unit to unit, see FFACTORS table)
CO2	float	Yes	*NULL*	CO2 Emissions in hour (tons)
SO2	float	Yes	*NULL*	SO2 Emissions in hour (lbs)
NOX	float	Yes	*NULL*	NOX Emissions in hour (lbs)
LOADSTATE	smallint(6)	Yes	-1	Identifying flag for unit load state (1=Full Load, 2= Spinning Reserve, 3=Standby, 4=Turning On/Off
RollingMaxLoad	float	Yes	*NULL*	Rolling 60 day GULDO maximum
IsLoadFollowing	tinyint(4)	Yes	*NULL*	Identifying flag to show whether unit is load following in given hour (1=yes, 2=no)
DeltaUnitLoad	Float	Yes	*NULL*	Change in load from the previous hour (absolute value)
FuelType	Varchar(1)	Yes	*NULL*	Two-letter abbreviation identifying the fuel type burned in the hour (see GEN_KEYS table for descriptions of the abbreviations).

2) eGrid Plant and Unit Metadata

Summary

The eGrid Plant and Unit Metadata is the contextual information contained about each individual plant and unit, including locations, owners, operators, annual average emissions, etc. This information was contained in the eGrid 2002 spreadsheets. The spreadsheet obtained much of their data from the Energy Information Administration (EIA) Documents 860A and 860B.

Relevant Metadata

Online Availability

eGrid Program:
http://www.epa.gov/cleanenergy/egrid.htm

Spreadsheet Files:
http://www.epa.gov/cleanenergy/egrid/egrid2002spreadsheets.zip

Data Format

Excel 2000 Spreadsheet

Latest Update

The eGrid 2002 spreadsheets contain data for the year 2000. There is a two-year delay.

Process of Retrieval

Spreadsheets are zipped and available for easy download from the EPA website.

Data Management

Loading Spreadsheets

The spreadsheets in their basic form can be accepted as relational data. The individual sheets where saved as comma separated value files and then loaded into MySQL using the LOAD DATA INFILE method. The SQL to do this is available in Appendix C in the SQL query script "loading_queries.txt." Only the EGRDPLNT for Plant level information and EGRDGEN for Generator or Unit level information sheets were utilized.

Mismatched Unit Identifiers

A major problem with the EGRDGEN sheet was that the unit names contained in the hourly raw emissions data files were different in some cases than the generator names contained in the EGRDGEN sheet. In many cases, the units had to be hand matched. Examples of unit name disconnect:

GENID in EGRDGEN	Unit Name in eGrid Hourly Data
UN10	10
BHB1	1
001	1

While regular expression comparisons accomplished some of the work, the process of matching the different unit names was, on the whole, manual.

The SQL script used to assist this process can be found in Appendix C ("selecting_queries_unit_matching.txt").

Missing Plants and Units

Occasionally there were plant numbers and / or unit names that existed in the hourly emissions data that did not exist in the summary spreadsheets. In this case, entries were manually input Plant and Generator tables. The plants were given data based on the information in the hourly emissions data and geographical location deciphered from the latitude-longitude values. The units were given values of unit from the same plant with similar operational numbers where applicable.

In general, the plants and units were missing because they had come online after the end of 2000. Therefore, the eGrid2002 spreadsheet did not have information regarding these plants. Other times, the reason for omission could not be determined. All of the plants and units that were missing are designated in the database. In the PLANT table the field SEQPLNT00 (originally a sequence number mapping to previous years data) was given a value of –1. In the Generator table, the field SEQGEN00 was used.

Also of note is the fact the Generator table contains only the plants and units that were loaded from the hourly emissions data, and the number of fields is pared down from that of the EGRDGEN table. The PLANT table is pared from the EGRDPLNT table but contains all plants including the missing plants added.

3) SEPA Solar Generation Information

Summary

Schott Applied Power provided the solar generation information. Ruel Little was the contact for the data. SEPA solar sites were installed across the country from 1996 – 2001. Schott collected generation data from each site as well as solar resource information and other measurements that varied site to site.

Relevant Metadata

Online Availability

SEPA Program:

Unavailable

Data Files:

Unavailable

Data Format

Zipped comma-separated value files

Data files nomenclature: <sitename><year><month>.zip

Latest Update

Through 2002.

Process of Retrieval

The data were delivered by Ruel Little of Schott Applied Power in the form of a CD.

Data Management

The data provided by Ruel Little came with a spreadsheet that contained a) a list of the solar sites and b) a list of the fields for each solar sites. The number and content of the fields vary from site to site. The lists are stored in the SOLAR_SITES and SOLAR_FIELDS tables respectively. The zipped data files, one for each site-month, were loaded using a PHP script found in Appendix C – (load_solar.php). The solar information was recorded at 15-minute intervals. This is summarized during loading to yield hourly data taking the averages of each value.

Integrity Checks

Several data integrity checks were completed on loaded solar information. The logic applied is as follows:

- Temperature values less than –50 are set to null.
- Negative plane of array irradiance measurements are set to null.
- Irradiance values greater than 1200 are set to 1200.
- Generation values less than –100 are set to null.
- Generation values greater than 10 times the system STC/DC rating are set to 0.9 * system STC/DC rating * irradiance.

Summarizations

The data is loaded into one table per solar site. Since it is handy to have all of the sites listed in a single table, but every site has a different number of fields, a subregion solar table was created using only the essential solar generation information (date and time, generation, irradiance, temperature, and wind speed). Further, the total solar generation at any given hour within the subregion was created into a new table. In total, there are two solar tables per subregion (<subregion>_SOLAR and <subregion>_SOLAR_TOTAL), plus a table for each site. The site tables, since they are so numerous, are stored separate database, "agrea-solar". The scripts for creating the SOLAR_SITES, SOLAR_FIELDS, and <subregion>_SOLAR_TOTAL tables can be found in the Appendix C – (loading_queries_solar.txt).

4) Solar Resource Information

Summary

The solar resource information was desired so as to create simulated solar sites in regions where no SEPA solar installations exist. Several solar resource data networks had to be utilized to assure full coverage of all NERC subregions.

They are:

- The National Oceanographic and Atmospheric Administration (NOAA) Surface Radiation (SURFRAD) Network
- The NOAA ISIS Network
- National Renewable Energy Laboratories' (NREL) Cooperative Network for Renewable Resource Monitoring (CONFRRM)

Relevant Metadata

Online Availability

SURFRAD Program:
http://www.srrb.noaa.gov/surfrad/index.html

SURFRAD Data Files:
ftp://ftp.srrb.noaa.gov/pub/data/surfrad/

ISIS Program
http://www.srrb.noaa.gov/isis/index.html

ISIS Data Files:
ftp://ftp.srrb.noaa.gov/pub/data/isis/

CONFRRM Program:
http://rredc.nrel.gov/solar/new_data/confrrm/confrrm_index.html

CONFRRM Data Files:
Various subdirectories under Program website

Data Format

Various, generally fixed delimited text files (see network documentation)

Latest Update

For selected sites data through 2002 was taken. Most site information is updated monthly on the networks.

Process of Retrieval

The retrieval and processing script for all three networks was the same. For the SURFRAD and ISIS network, the script establishes an anonymous FTP connection, prompting the user for location and year, locates the necessary files and loads them according to the individual networks data format definitions (see the README files at the above mentioned FTP sites). For the CONFRRM site, the script uses HTTP to transfer files and loads according to the CONFRRM data description (see description.html as the website mentioned above). The script functionality for CONFRRM is limited, since the various sites within the network have both a different file tree structure and different fields contained within the data files. See also Appendix C – (solar_resource_load.php).

Data Management

The resource data from the networks was taken at various time intervals. These intervals were summarized into hourly data using hourly averages. Quality assurance by the networks placed high negative values (usually a value like –9999) in places where the data quality could not be insured. These value were patched using a separate PHP script. The hours were patched with the monthly average for that hour (excluding the QA placeholder value). A resource site list was manually created from the various metadata obtain from the resource networks. See Appendix C – (solar_resource_patch.php and resource_loading_queries.txt).

Simulation

The software used to run the solar generation simulation was Maui Solar PV Design Pro (see http://www.mauisolarsoftware.com) from the Maui Solar Energy Software Corporation (MSESC). PV Design Pro required input in a specific data structure from a Microsoft Access 97 database. The input fields and the corresponding fields from the respective resource networks are shown in Table A.5.

Temperature data was not available for ISIS network sites and some CONFRRM network sites. As a backup, National Weather Service (NWS) data from the various sites was used for the simulation. Only daily maximum and minimums are tracked by the NWS, thus a simple conversion was used to convert these two numbers in to hourly information.

Assuming the minimum temperatures occurs at 6AM and the maximum occurs at 6PM, the hourly temperature was obtained using:

$$T_{hour} = 0.5*(T_{min}+T_{max}) - 0.5*(T_{max}-T_{min})*\sin((t_{Hour\ of\ Day}/24)*2\Pi)$$

When NWS temperature data was unavailable, typical meteorological year (TMY) data from MSESC databases was used. The effects of temperature data are second order to PV production, thus these approximations are assumed adequate for model input.

The simulation also required a measurement for Horizontal Extraterrestial Radiation (HER). This value correlates directly with the zenith angle of the sun at a particular site. Thus, approximations for HER are made from calculations from the zenith angle which was available from both the SURFRAD and ISIS networks. For CONFRRM network sites, the TMY data for HER was taken from the closest available site available in the MSESC databases. The approximation is adequate for model input since HER does not vary much from year to year.

These databases were created from the various sites resource tables and the resource site list table and then run through the PV Design Pro simulation. The output from the simulation was another Access 97 database with an extensive amount of information. This was exported wholly to the MySQL database via ODBC. The resulting tables (named sr<resource_abbreviation><two-digit-year>) were then summarized into <subregion>_SOLAR and <subregion>_SOLAR_TOTAL tables, conforming to the previous defined structure. See Appendix C – (resource_loading_queries.txt).

Table A.5. Solar Resource Data Field Conversion

MSESC Data Measurement (Field name)	**Units**	**SURFRAD measurement (Field name)**	**ISIS Field**	**CONFRRM Field**
Horizontal Extraterrestrial Radiation (HER)	W/m^2	Solar Zenith Angle (zen) [Conv: 1353*cos(zen)]	Solar Zenith Angle (SOLZEN) [Conv: 1353*cos(SOLZEN)	TMY data from nearest MSESC site
Global Horizontal Radiation (GHR)	W/m^2	Down-welling Solar Radiation (dw_psp)	Global Shortwave (Global)	Global Horizontal Irradiance (PSP)
Direct Normal Radiation (DNR)	W/m^2	Direct Solar (direct)	Direct beam irradiance (NIP)	Direct Normal Irradiance
Diffuse Horizontal Radiation (DHR)	W/m^2	Diffuse Solar (diffuse)	Diffuse shortwave irradiance (Diff)	Diffuse Horizontal Irradiance
Dry Bulb Temperature (DBT)	Tenth of ^{o}C	10-meter air tempature (temp) [Conv: temp/10]	NWS or TMY approximation	Air Temperature or TMY data from nearest MSESC site

5) Total Load Information

Summary

Total subregion load information was desired to analyze the load growth over time and to compare total load to the aggregated load of the eGrid fossil plants. The total load information is also essential to the load shape following logic. This information was taken from the Federal Energy Regulatory Commission (FERC). For a few select subregions (the ones whose boundaries mirror those of an ISO), total load information was taken directly from the ISO website. All of the load information, however, is provided by FERC mandate. FERC compiles total load data through Form. No. 714 the "Annual Electric Control and Planning Area Report." The files are compressed in self-extracting zipped files grouped by year and NERC region; they contain subdirectories for each respondent. All electric utilities with planning area annual peak demand greater than 200 MW must file hourly load data. The data is not uniformly formatted and some was missing.

Relevant Metadata

Online Availability

FERC data files:

http://www.ferc.gov/docs-filing/eforms/form-714/data.asp

ISO-New England historical hourly load data (NEWE):

http://www.iso-ne.com/Historical_Data/eei_loads.html

New York ISO historical hourly load data (NYAS):

http://www.nyiso.com/markets/index.html#NYCAInfo

PJM historical hourly load data (MAAC):

http://www.pjm.com/pub/account/loadhryr/index.html

ERCOT historical hourly load data (ERCT):

http://www.ercot.com/drp.htm

Data Format

Various

Latest Update

Year 2002 data was posted as of August 2003.

Process of Retrieval

The vast majority of total load information was downloaded manually using HTTP from the FERC website. Because of the self-extracting zip files the download and initial sorting of data had to be done on a Windows platform.

Data Management

NERC Subregion Designation

The total load information is not summarized into the subregions designated by NERC. To categorize the load information, individual utilities and power control areas had to be classified into NERC subregions. This categorization was completely manual, investigating PCA locations when necessary.

Coordination with FERC

There were numerous misnamed, corrupt, and missing data files within the self-extracting zip files for subregions. Most of these inconsistencies were solved through communication with FERC (Sandra Russell Sandra.Russell@ferc.gov). Some communication with the individual regions was also necessary. Only one inconsistency was not resolved: the missing data from Western Area Power Administration's Rocky Mountain Region (WACM) control area for 1998 and 1999.

Adding Total Load Information

When the manual summarization was complete, the data was transferred to AGREA2 via FTP and loaded in MySQL using the LOAD DATA INFILE method. In addition to the FERC total load information, the total eGrid load and the total eGrid "load following" load numbers were added to the <subregion>_TOTAL_LOAD table. See Appendix C – (loading_total_load_data.txt).

Data Caveats

The total load data were compiled into subregions using current information available from the North American Electric Reliability Council (NERC) on the location of power control areas. The regional power control area designations available from NERC were last updated in October of 2002. The power control areas that reported data to the Federal Energy Regulatory Commission (FERC) changed slightly from 1998 through 2002. The power control areas also were not grouped into the same NERC regions for each year. For the purposes of this analysis, the power control areas were grouped into subregions as consistently as the available data permitted, using the NERC designations.

For years after 1999, a list of respondents was not available. The number of planning areas in each sub-region year to year could therefore not be quantified. Planning areas that did not match closely names of power control areas were placed into sub-regions by general geography, not necessarily by electric system structure. In general, the shape and relative magnitudes of the total load is what was desired for this analysis. The data obtained from FERC adequately fulfills this criteria.

6) NERC Subregion Spatial Information

Summary

The North American Electric Reliability Council (NERC) designates subregions. The spatial boundaries were desired for analysis with geographical information systems (GIS) software. Manually combining USA geopolitical boundary data and images of subregions from both NERC and the Energy Information Administration (EIA) created the spatial data. For more details please see the GIS metadata file in Appendix C.

7) National Emissions Inventory Information

Summary

The EPA National Emissions Inventory (NEI) contains annual emission totals for stationary sources (including electricity generation and all other industries) for a number of pollutants not included in the eGrid hourly emissions data (PM10, PM2.5, VOCs, and NH3) as well as some emissions included in eGrid (like NOX and SO2). While mercury (Hg) was included in this information, the eGrid mercury averages were used instead during the patching process explained under Data Source 2 of this Appendix. Annual emission totals are reported every three years starting in 1996. A majority of plants in the eGrid data can be matched with a plant in the NEI data (> 70%).

Relevant Metadata

Online Availability

NEI:

http://www.epa.gov/ttn/chief/net/index.html

Data Files:

http://www.epa.gov/air/data/

Data Format

CSV files

Latest Update

Year 1999 data was available as of August 2003. Year 2001 data is expected in 2004.

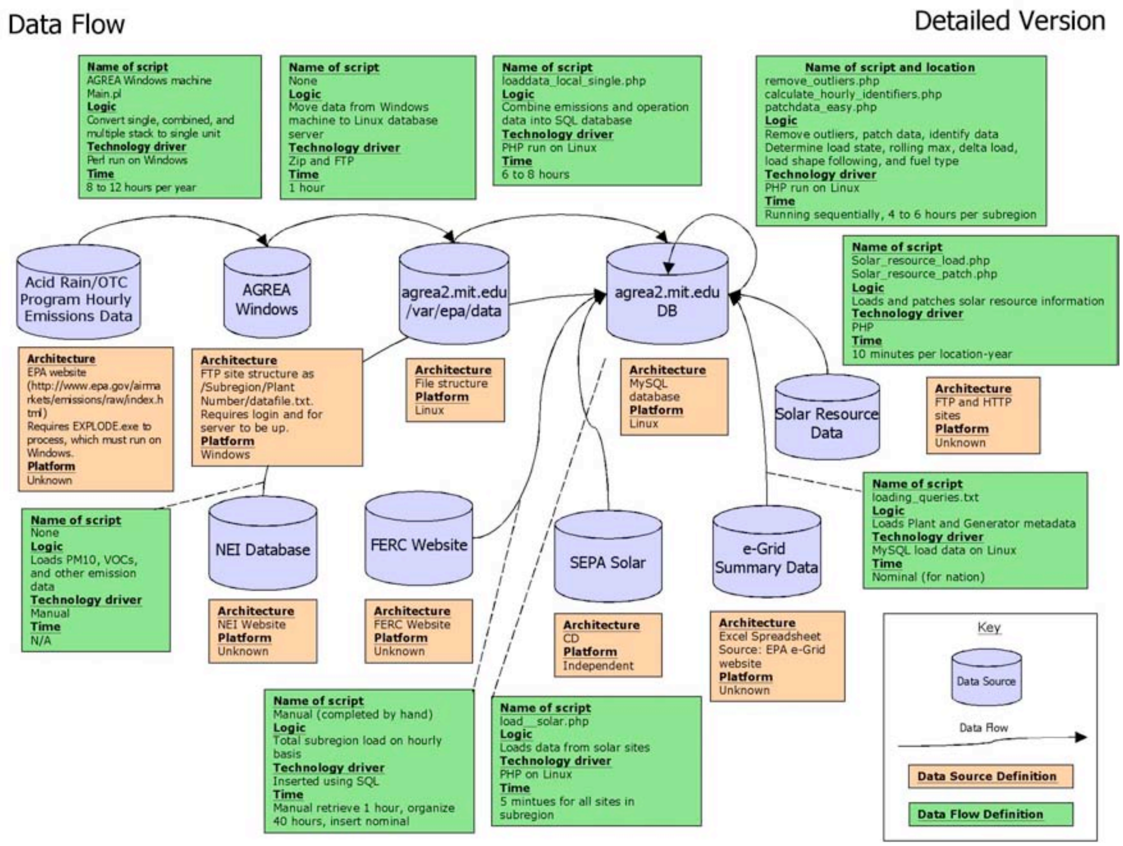
Process of Retrieval

The data were retrieved using the Environmental Protection Agency's (EPA) AirData website. The data were retrieved from a database called the National Emissions Trends database that is now a part of the NEI database. The Reports and Maps function on the website generated CSV files for download. The EPA organizes the data by Standard Industrial Code (SIC for Electric Services is 4911), by state, county, and by EPA plant code. Unit-level data were not available. The EPA plant code does not match the ORISPL (Office of Regulatory Information System Plant) code used in the eGrid hourly data to identify plants and units. ORISPL is the identifier used by the DOE and EIA. The latitude and longitude designations for the plants also did not match exactly. The plants were thus matched manually after sorting by state and county codes. The plant names, addresses, latitudes, longitudes, and SO2 emissions were used to confirm matches.

Data Management

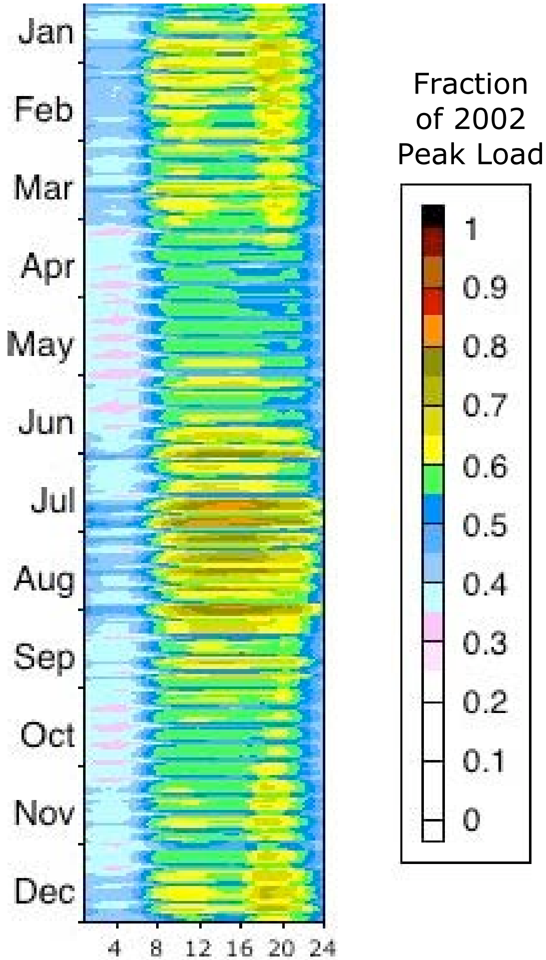
In the interest of saving data space, only the rate tables were stored in AGREA2. To do this, yearly averages for subregions were created in the EGRID_SUMMARY_BY_YEAR table. The rate table was created by joining the NEI data to the eGrid summary data and doing simple emissions per heat input rate determinations. The result can be joined to any subregion table and multiplied by the hourly heat rate to yield an estimated hourly emissions number. This is similar to the third option in the patching of the originally hourly emissions data.

Figure A.2. Integration of Data Sources into the Relational Database (Detailed Version)



Appendix B Section I – NERC Subregion Total Load Profiles for 1998 through 2002

Total Load Profiles



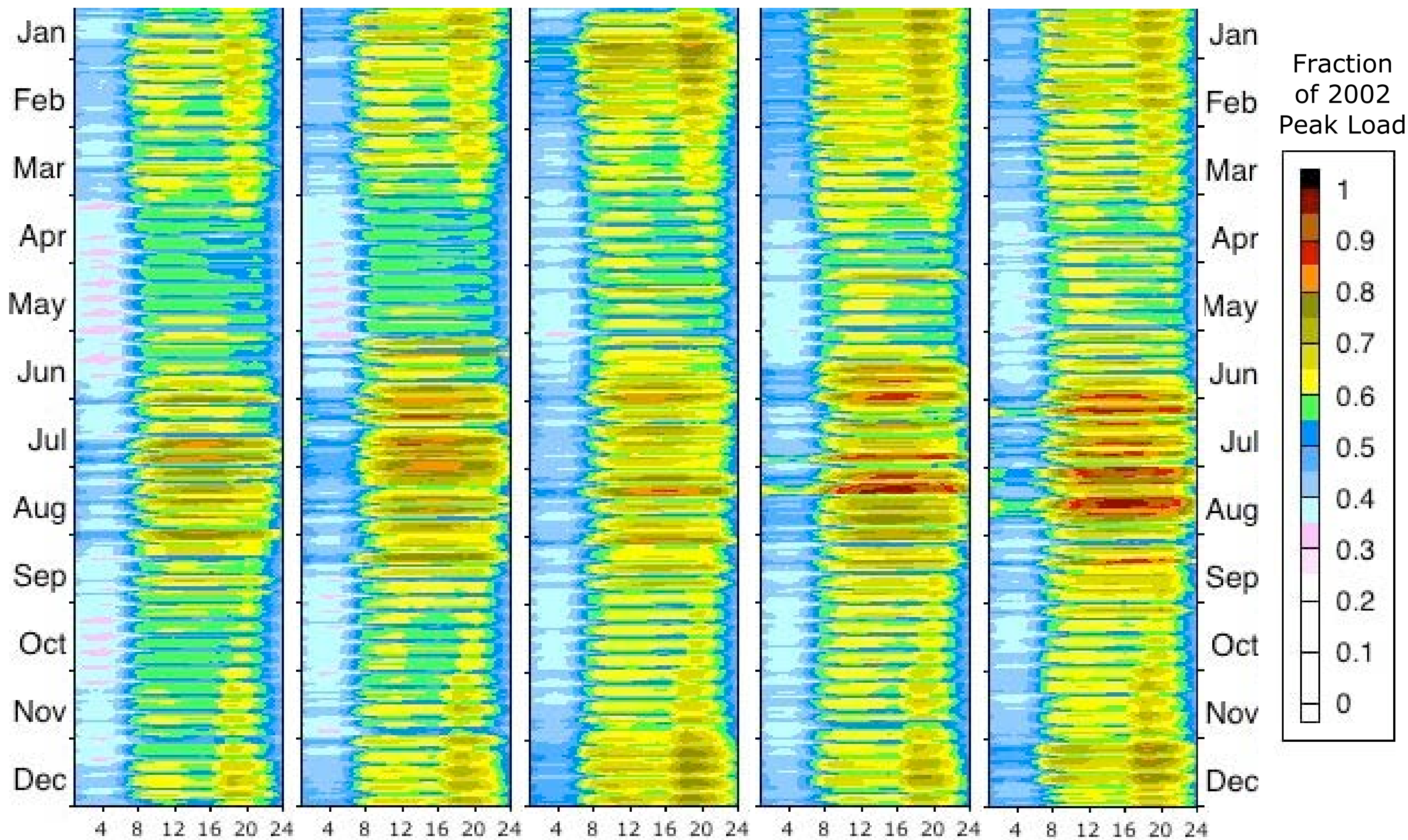
	1998
Net (TWh)	116
Peak (GW)	21

Contour plots show normalized NERC Subregion demand for each year from 1998 through 2002. Each year is normalized to the maximum hourly load in 2002 so that load growth from year to year is evident.

Below the contour plot is a small table that displays the total subregion load for each year in TWh (Net) and the maximum hourly load for each year in GW (Peak).

Five plots are shown for each subregion, one plot for each year from 1998 through 2002.

Total Load Profiles – 1998 through 2002
NEWE (New England) – (365 days x 24 hours)

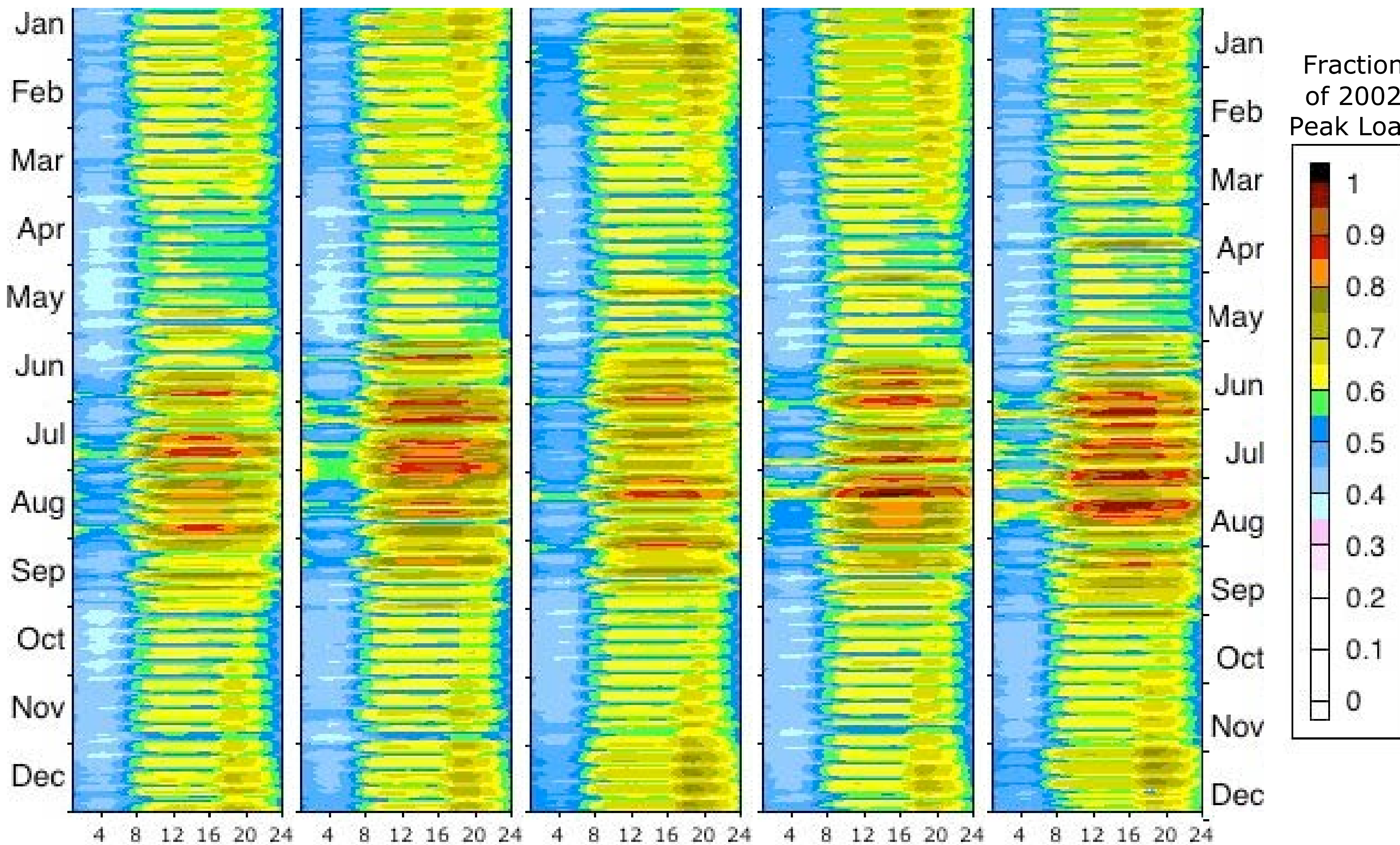


	1998	1999	2000	2001	2002
Net (TWh)	116	122	125	126	127
Peak (GW)	21	23	22	25	25

Figure BI - 1. NEWE Total Load Profile

Contour plots show hourly total load in NEWE (New England) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

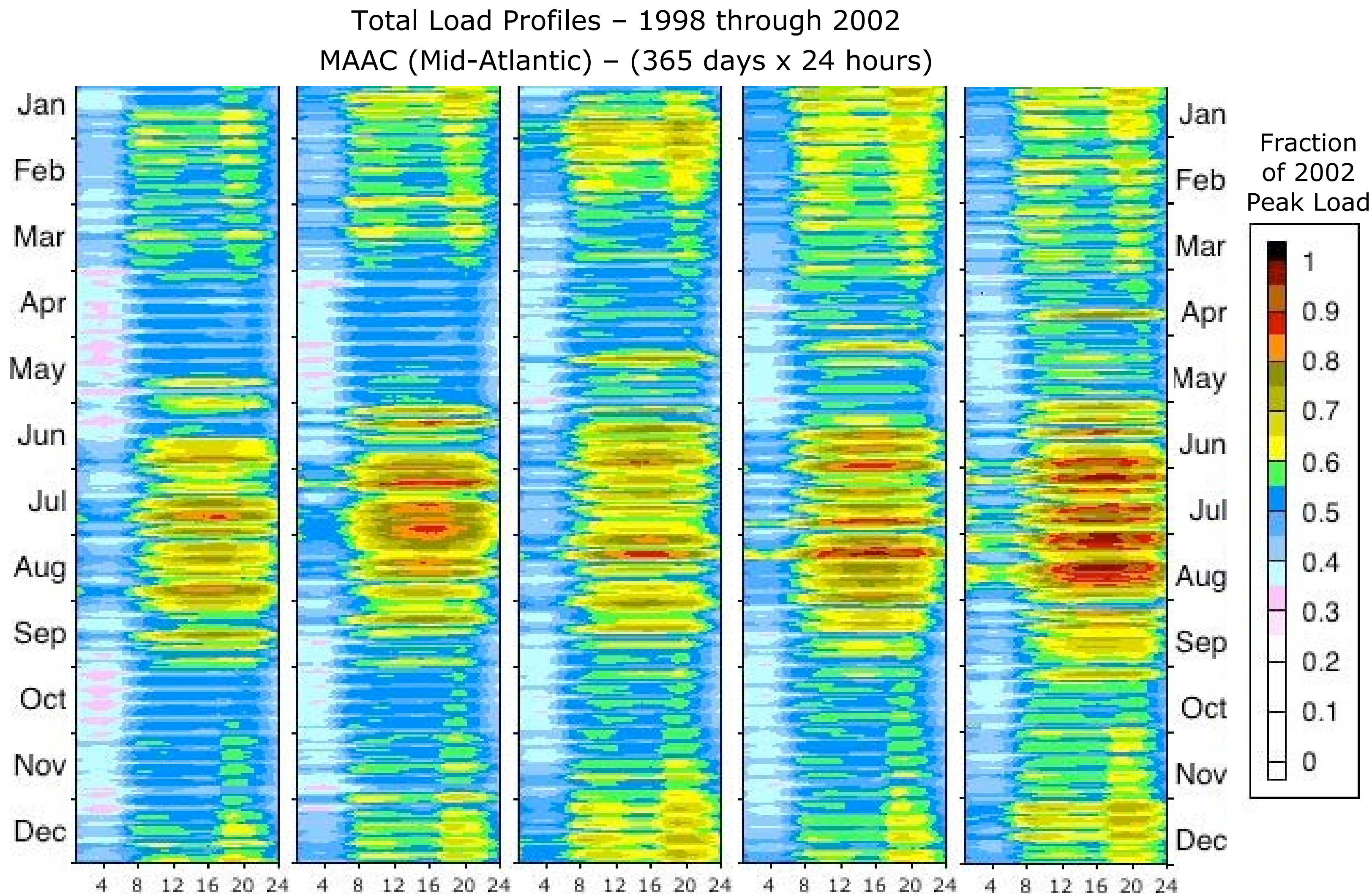
Total Load Profiles – 1998 through 2002
NYAS (New York) – (365 days x 24 hours)



	1998	1999	2000	2001	2002
Net (TWh)	151	156	157	157	159
Peak (GW)	28	30	28	31	31

Figure BI - 2. NYAS Total Load Profiles

Contour plots show hourly total load in NYAS (New York) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

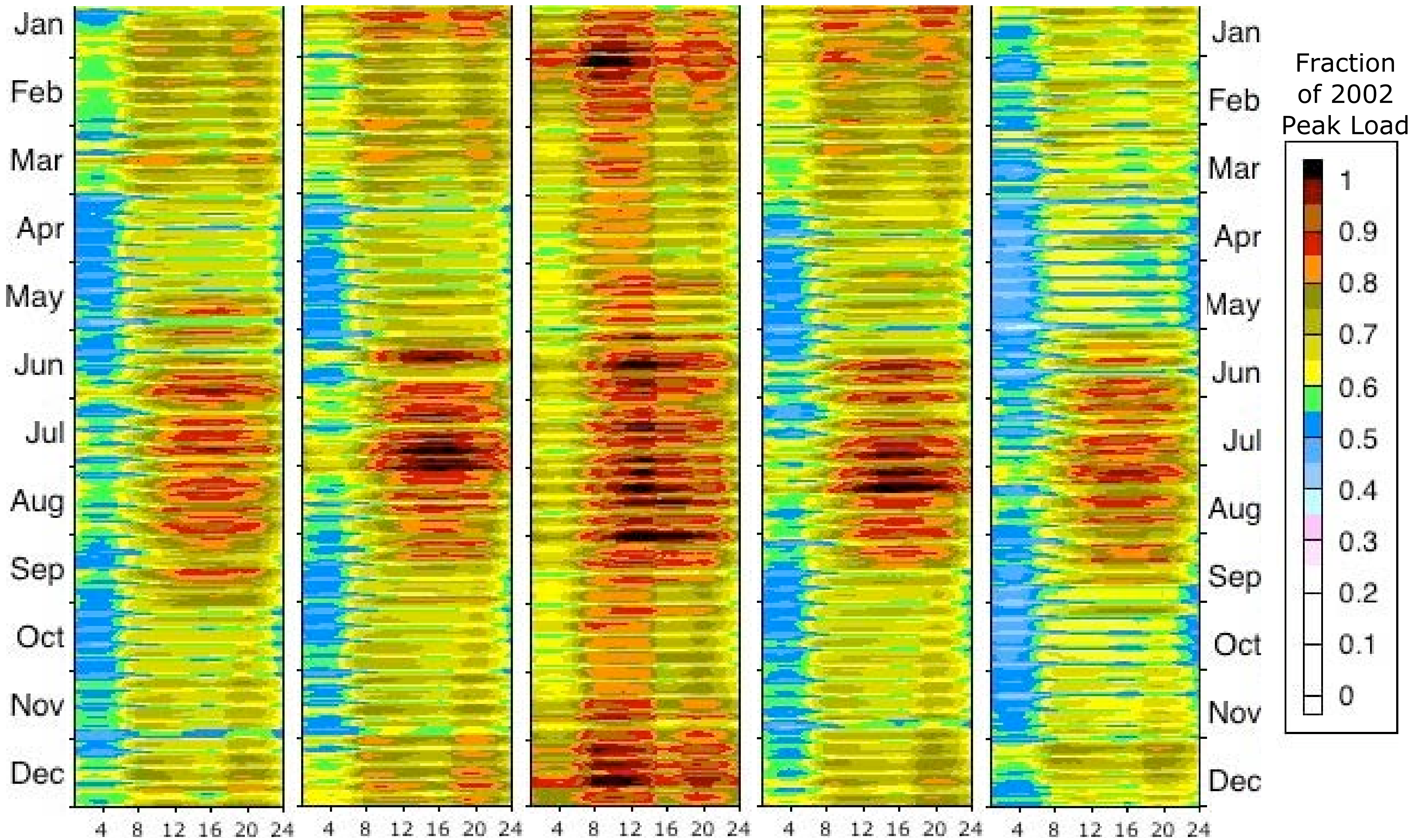


	1998	1999	2000	2001	2002
Net (TWh)	249	260	265	265	276
Peak (GW)	48	52	49	54	56

Figure BI - 3. MAAC Total Load Profiles

Contour plots show hourly total load in MAAC (Mid-Atlantic) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

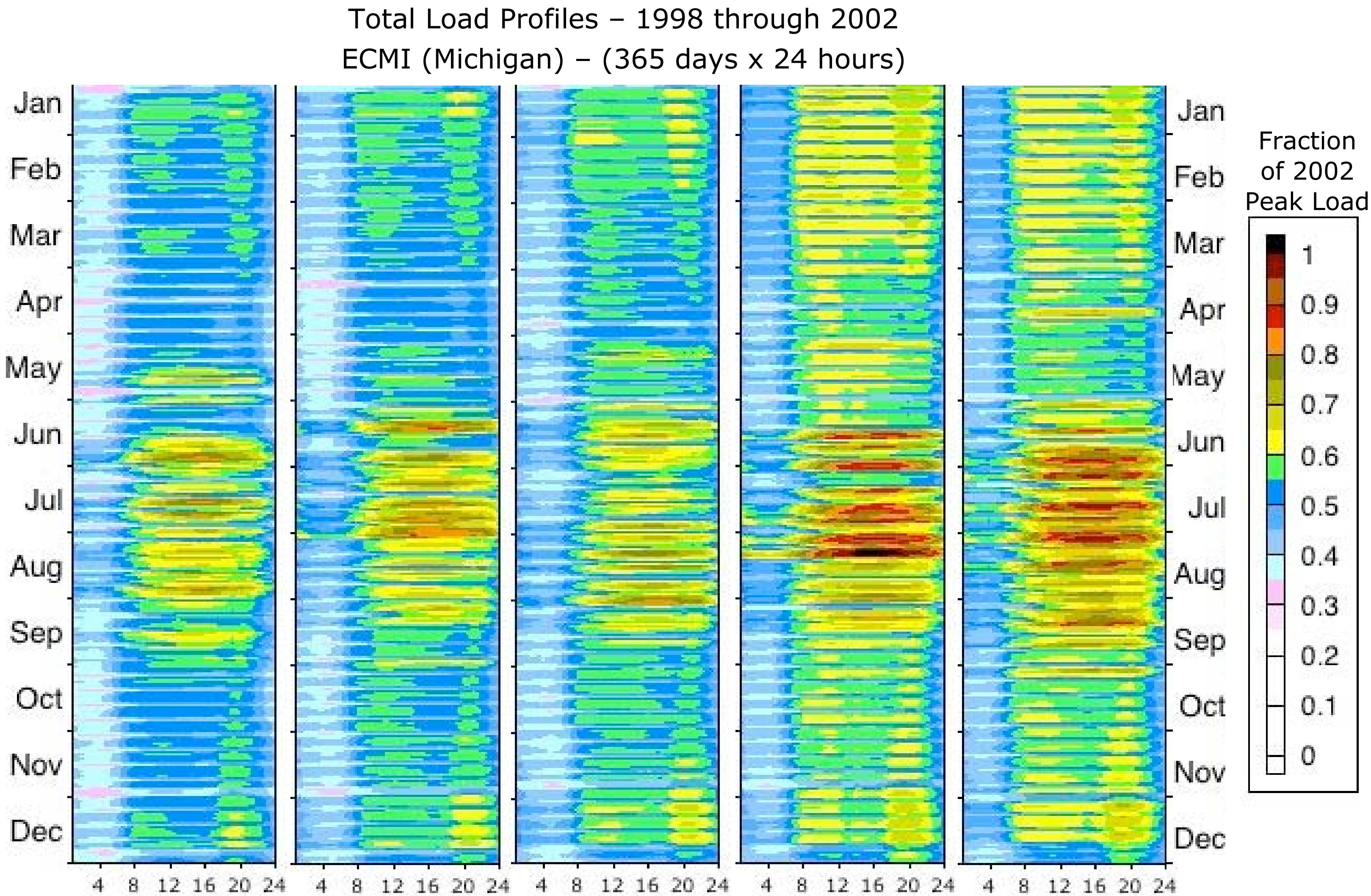
Total Load Profiles – 1998 through 2002
ECOV (Ohio Valley) – (365 days x 24 hours)



	1998	1999	2000	2001	2002
Net (TWh)	447	462	517	459	420
Peak (GW)	78	83	85	84	77

Figure BI - 4. ECOV Total Load Profiles

Contour plots show hourly total load in ECOV (Mid-Atlantic) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

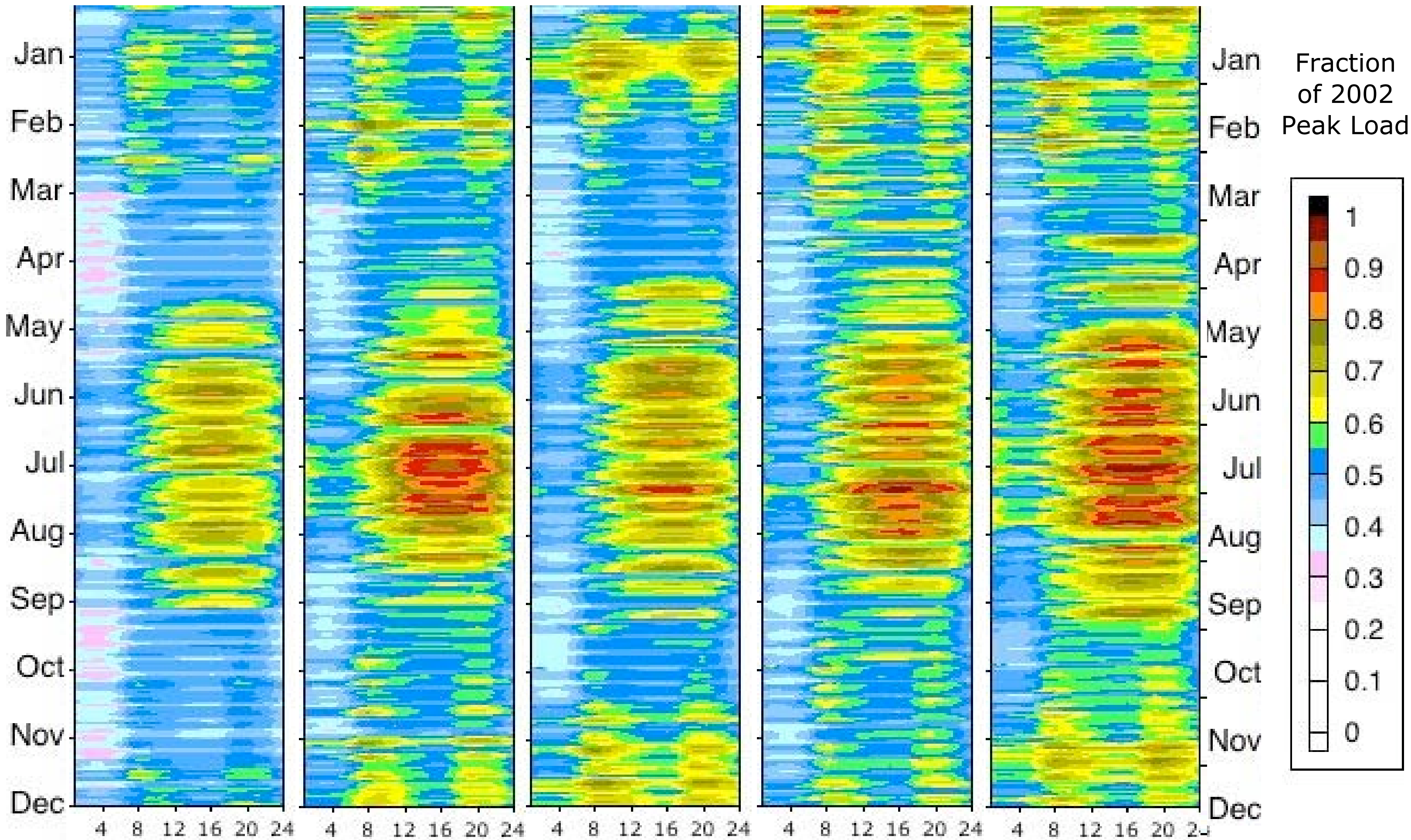


	1998	1999	2000	2001	2002
Net (TWh)	92	95	96	104	105
Peak (GW)	18	18	18	22	21

Figure BI - 5. ECMI Total Load Profiles

Contour plots show hourly total load in ECMI (Michigan) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

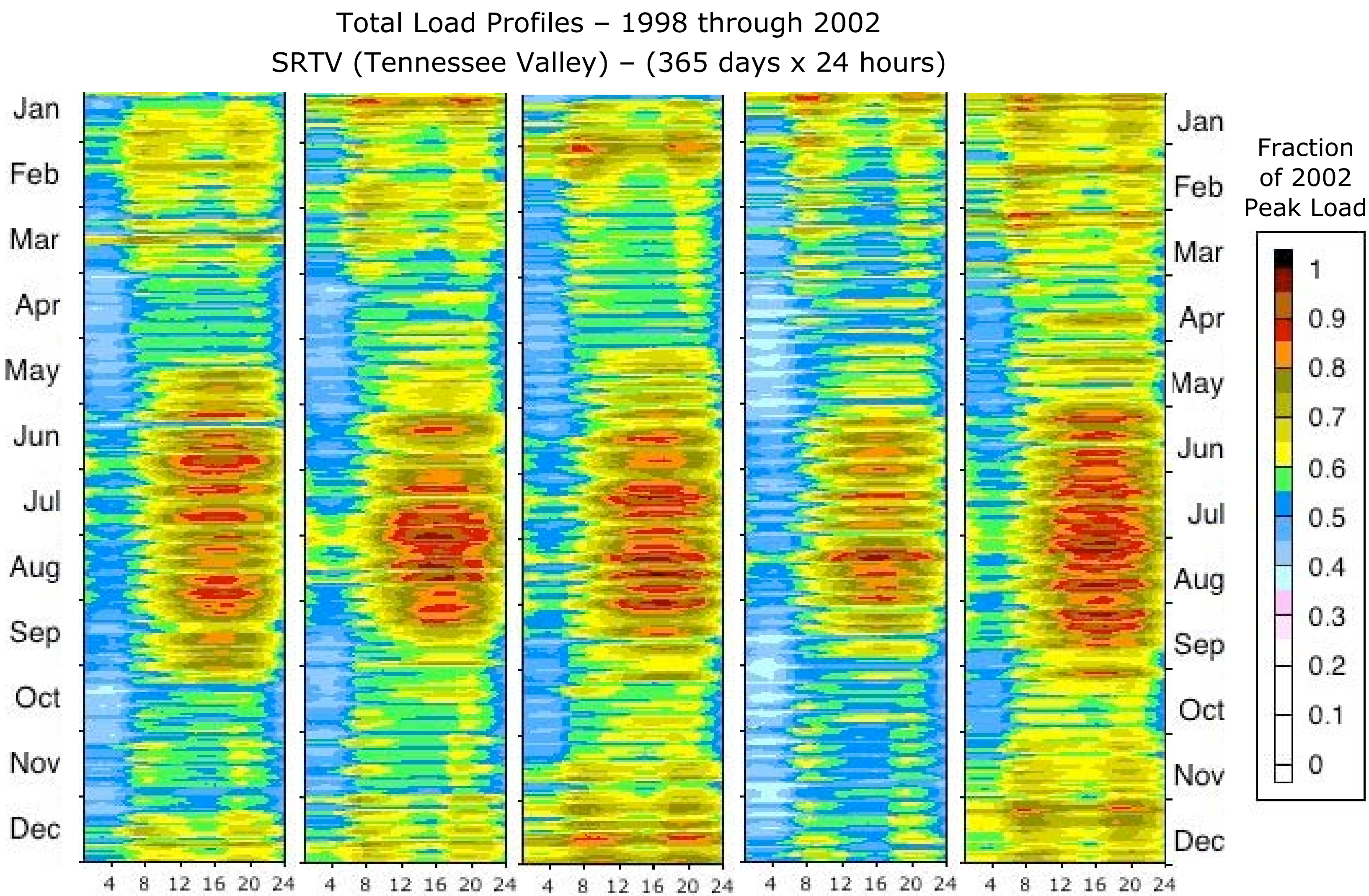
Total Load Profiles – 1998 through 2002
SRVC (Virginia/Carolinas) – (365 days x 24 hours)



	1998	1999	2000	2001	2002
Net (TWh)	255	284	279	287	304
Peak (GW)	47	54	52	56	58

Figure BI - 6. SRVC Total Load Profiles

Contour plots show hourly total load in SRVC (Virginia/Carolinas) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

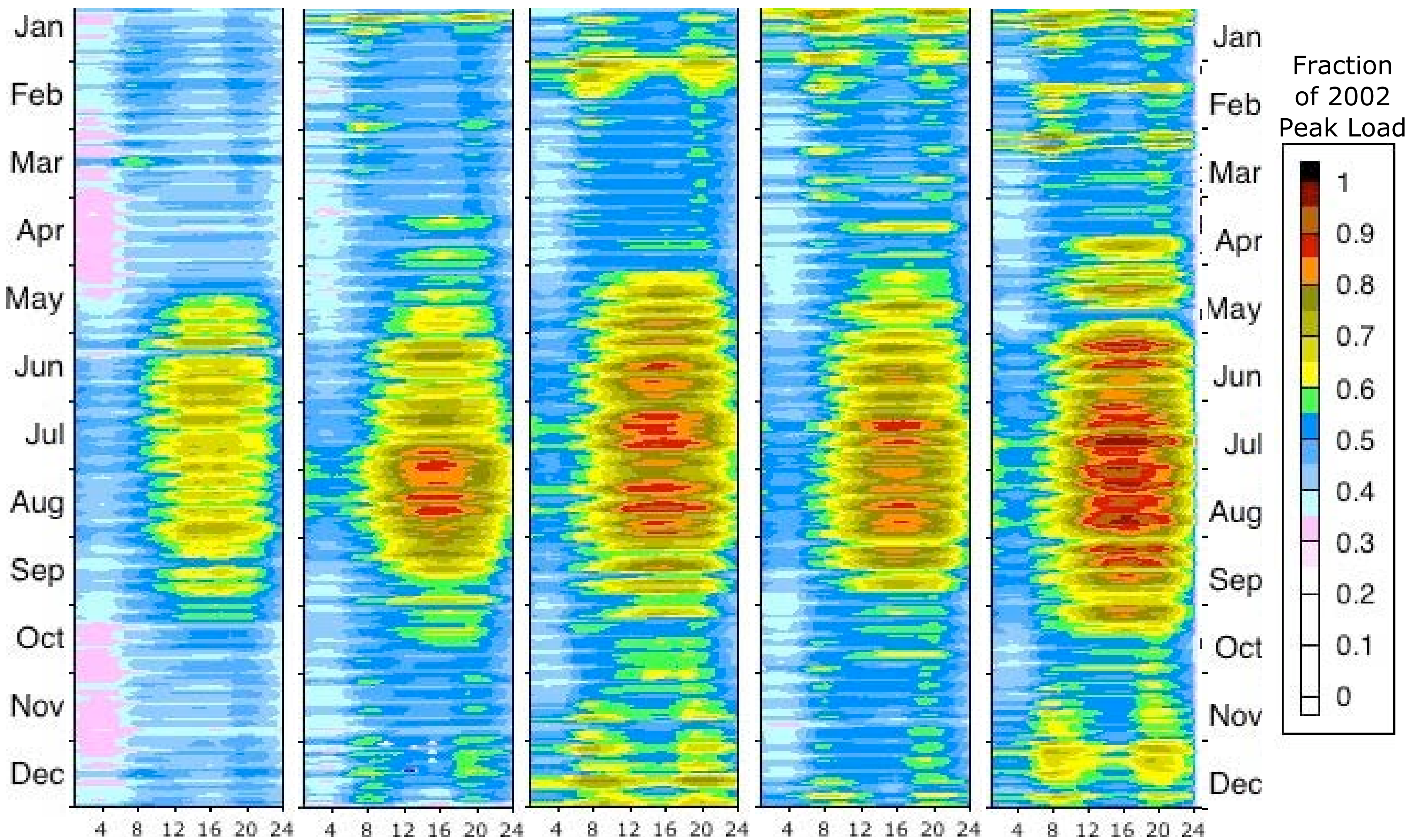


	1998	1999	2000	2001	2002
Net (TWh)	152	155	160	157	166
Peak (GW)	27	28	29	27	29

Figure BI - 7. SRTV Total Load Profiles

Contour plots show hourly total load in SRTV (Tennessee Valley) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

Total Load Profiles – 1998 through 2002
SRSO (Southeast) – (365 days x 24 hours)

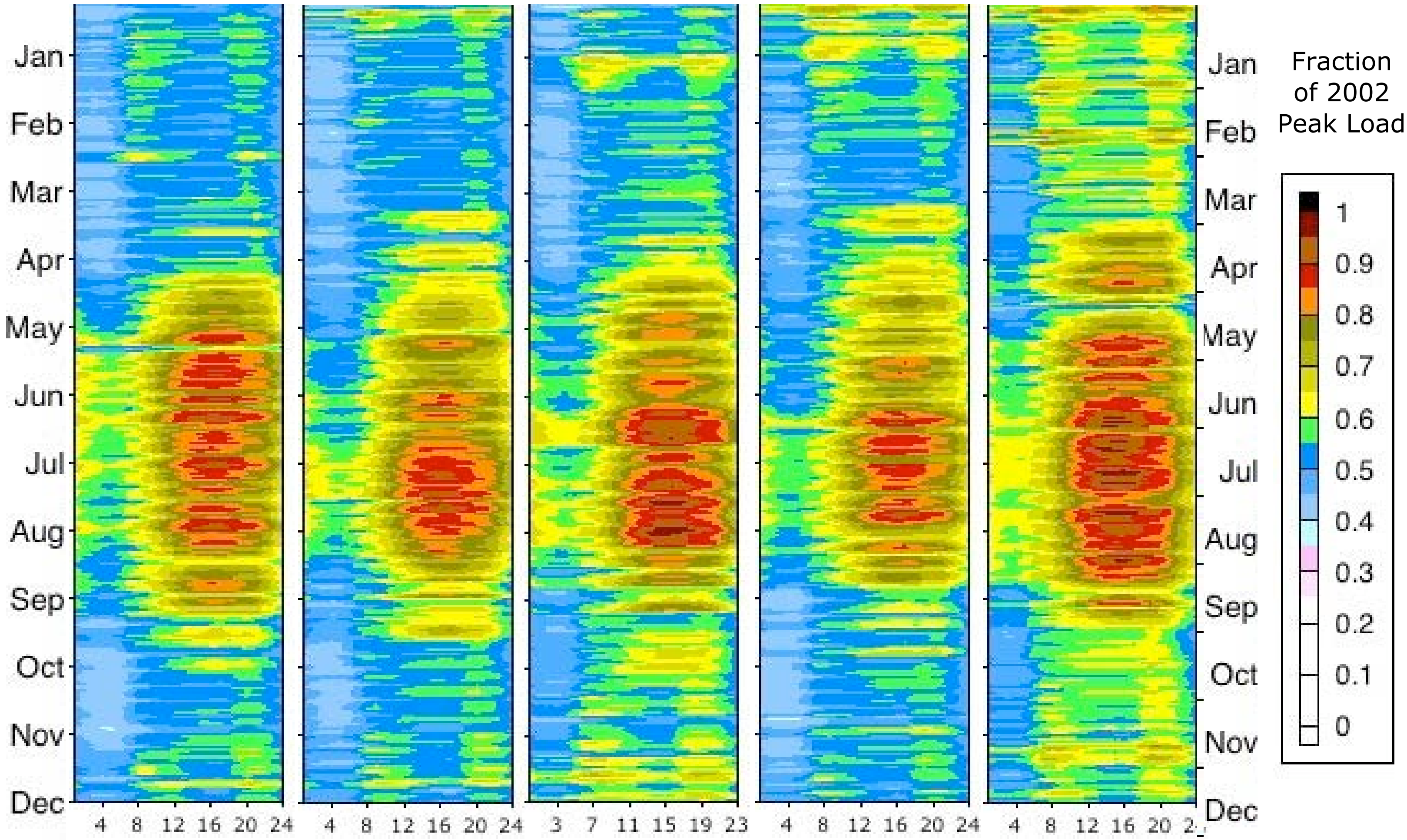


	1998	1999	2000	2001	2002
Net (TWh)	181	202	222	211	228
Peak (GW)	33	40	41	40	44

Figure BI - 8. SRSO Total Load Profiles

Contour plots show hourly total load in SRSO (Southeast) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

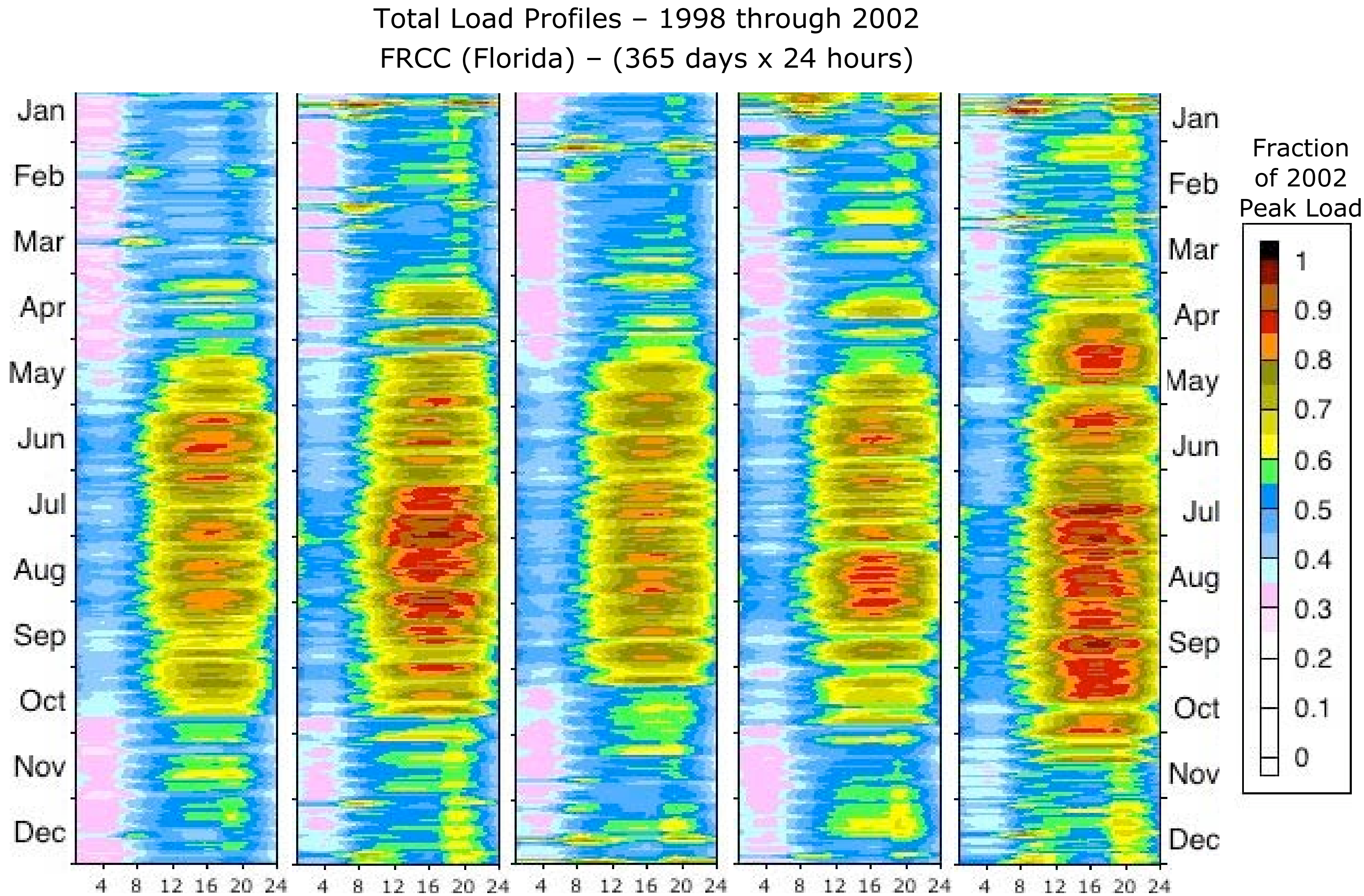
Total Load Profiles – 1998 through 2002
SRMV (Mississippi Valley) – (365 days x 24 hours)



	1998	1999	2000	2001	2002
Net (TWh)	120	119	124	119	130
Peak (GW)	22	22	23	22	23

Figure BI - 9. SRMV Total Load Profiles

Contour plots show hourly total load in SRMV (Mississippi Valley) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

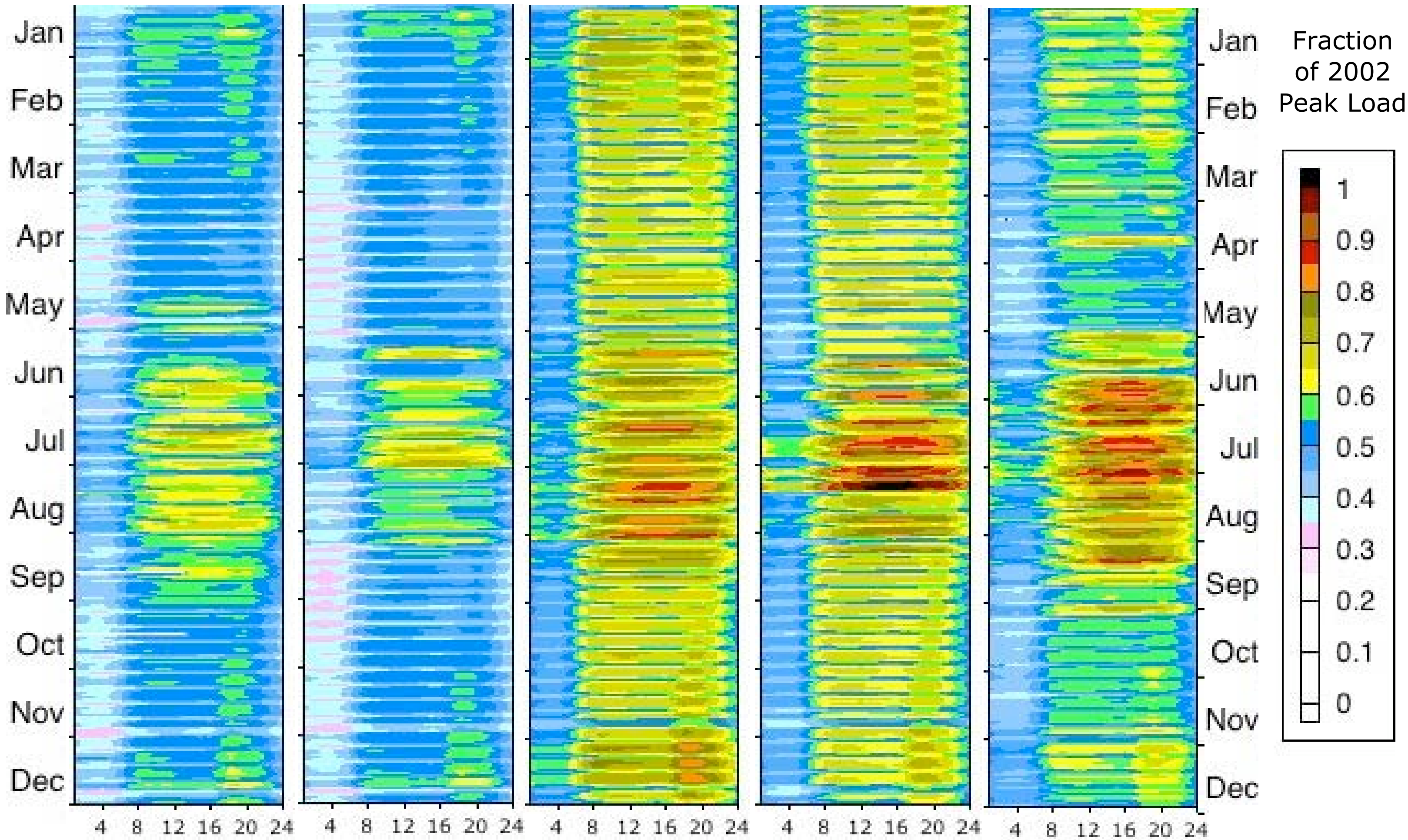


	1998	1999	2000	2001	2002
Net (TWh)	166	183	172	174	194
Peak (GW)	32	37	33	35	37

Figure BI - 10. FRCC Total Load Profiles

Contour plots show hourly total load in FRCC (Florida) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

Total Load Profiles – 1998 through 2002
MANN (Wisconsin) – (365 days x 24 hours)

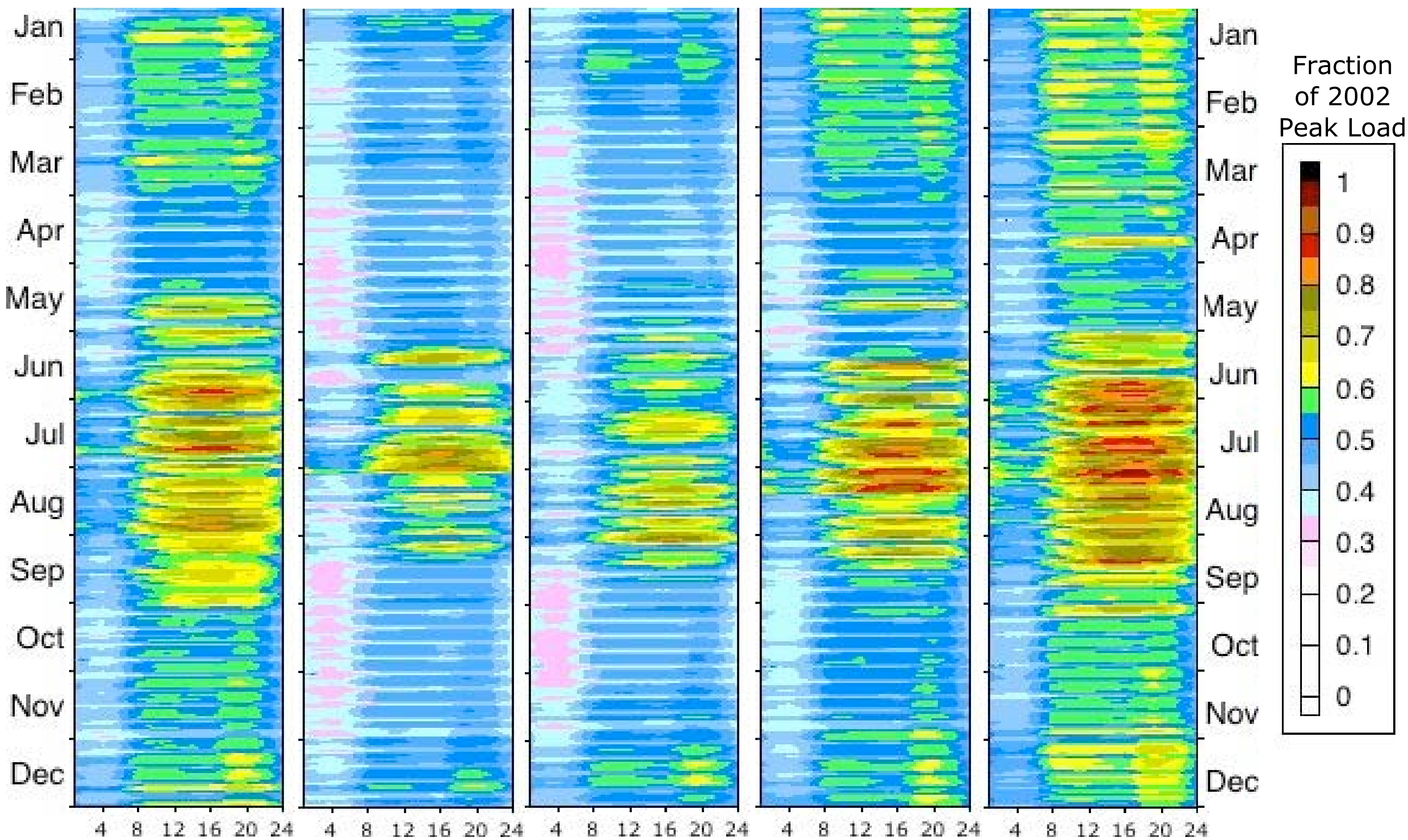


	1998	1999	2000	2001	2002
Net (TWh)	52	50	65	63	65
Peak (GW)	9	9	12	12	12

Figure BI - 11. MANN Total Load Profiles

Contour plots show hourly total load in MANN (Wisconsin) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

Total Load Profiles – 1998 through 2002
MANS (Illinois) – (365 days x 24 hours)

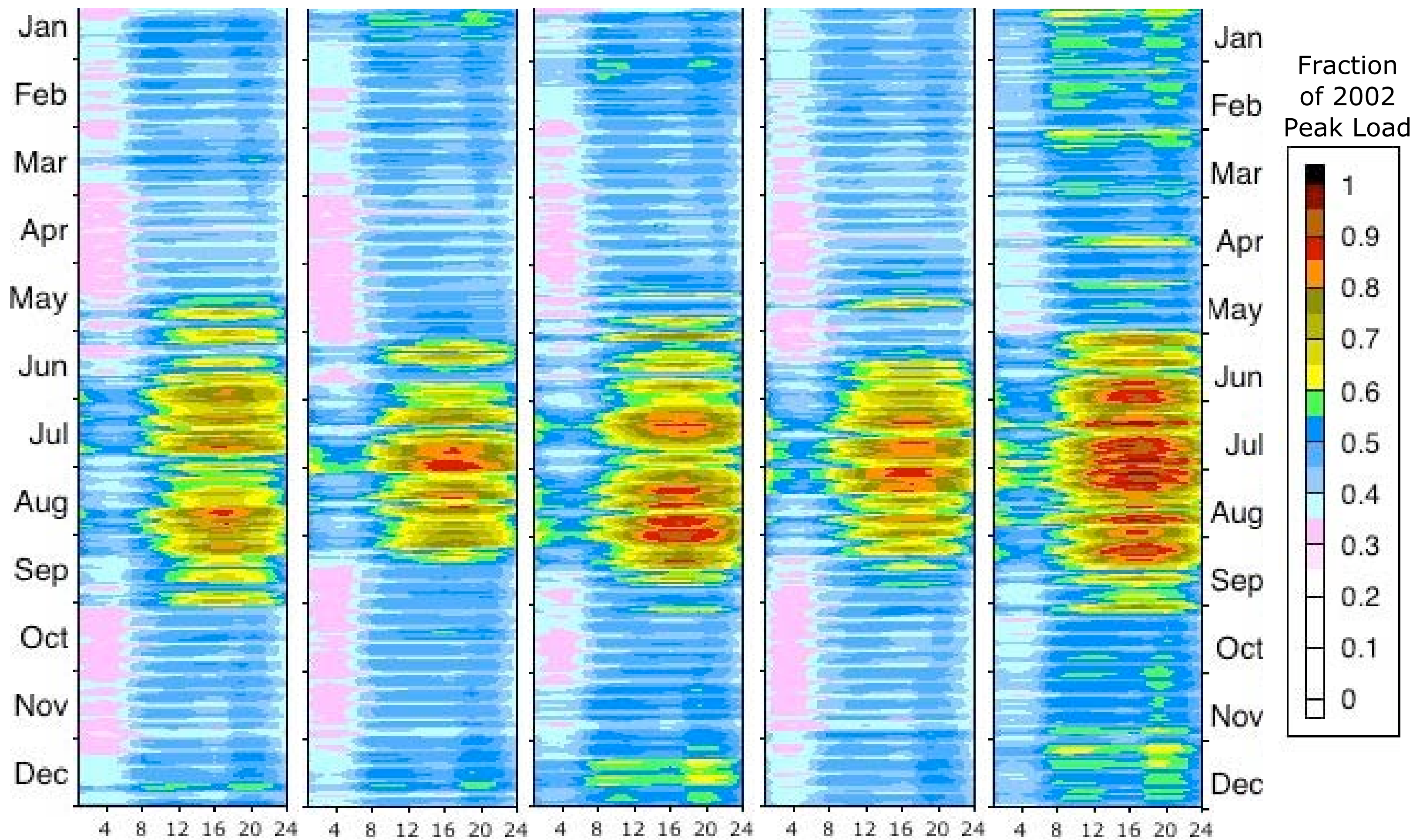


	1998	1999	2000	2001	2002
Net (TWh)	207	180	182	203	220
Peak (GW)	40	38	37	42	45

Figure BI - 12. MANS Total Load Profiles

Contour plots show hourly total load in MANS (Illinois) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

Total Load Profiles – 1998 through 2002
SPNO (Kansas) – (365 days x 24 hours)

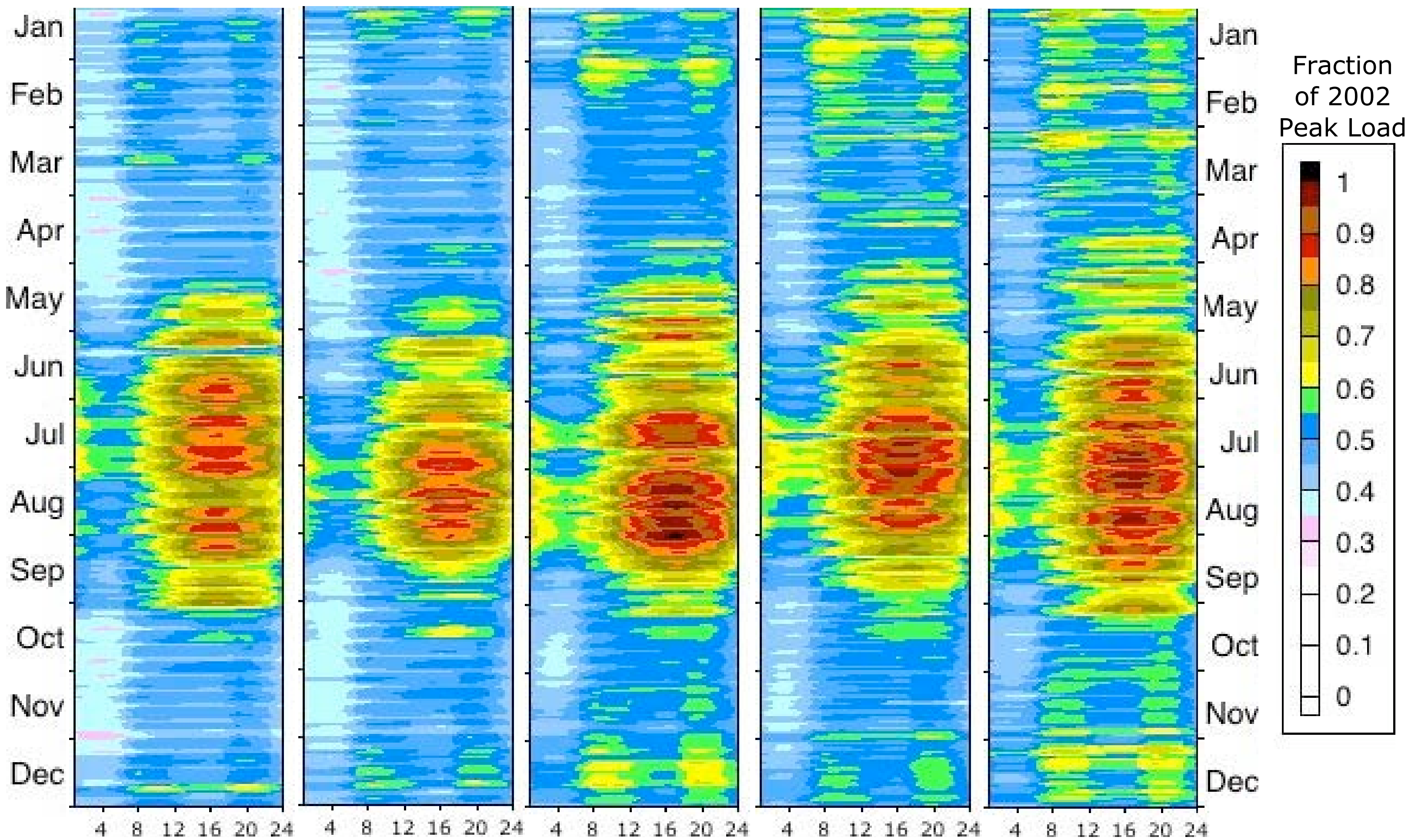


	1998	**1999**	**2000**	**2001**	**2002**
Net (TWh)	55	55	58	55	63
Peak (GW)	12	12	12	12	13

Figure BI - 13. SPNO Total Load Profiles

Contour plots show hourly total load in SPNO (Kansas) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

Total Load Profiles – 1998 through 2002
SPSO (Oklahoma) – (365 days x 24 hours)

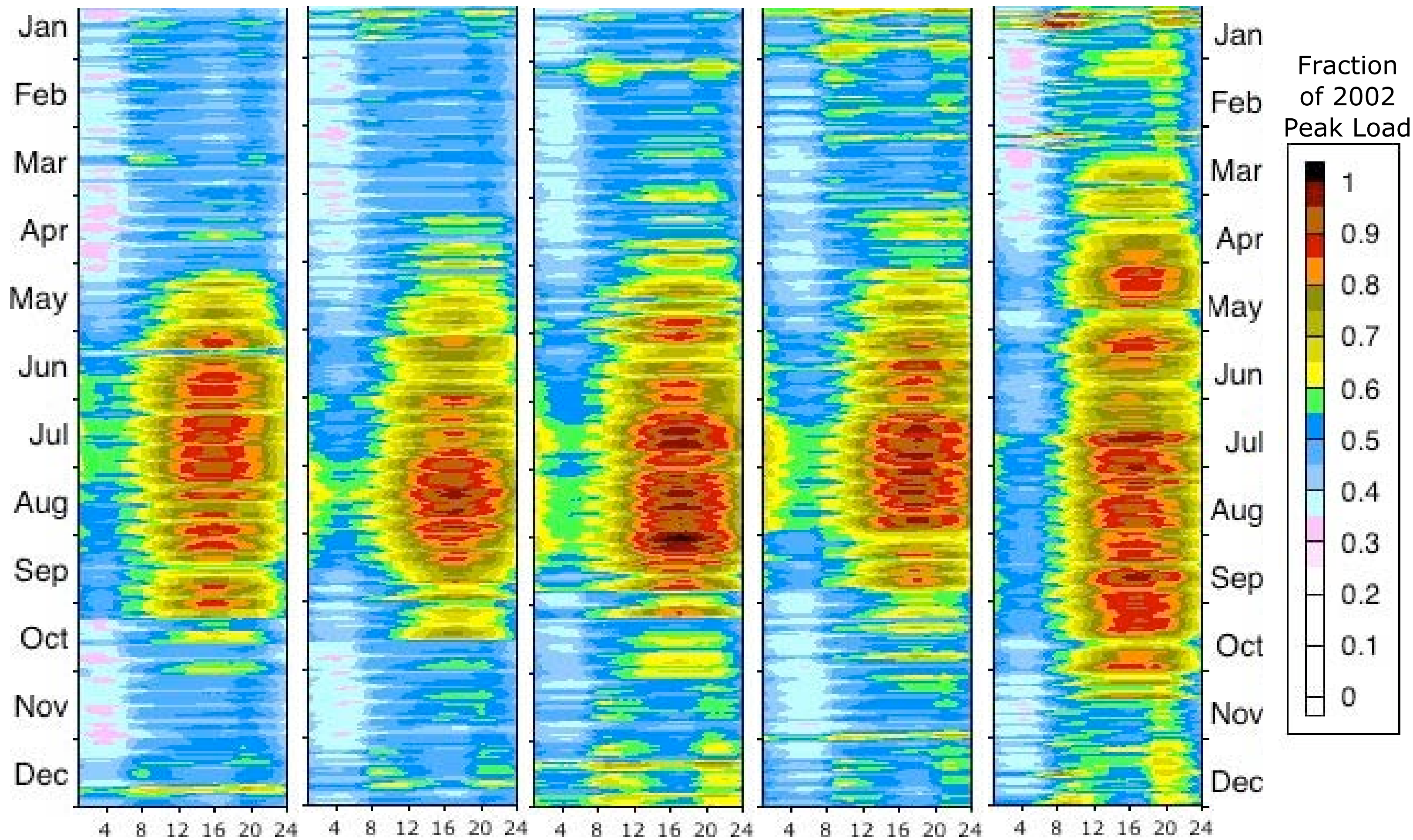


	1998	1999	2000	2001	2002
Net (TWh)	115	112	123	122	127
Peak (GW)	23	23	25	24	25

Figure BI - 14. SPSO Total Load Profiles

Contour plots show hourly total load in SPSO (Oklahoma) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

Total Load Profiles – 1998 through 2002
ERCT (Texas) – (365 days x 24 hours)

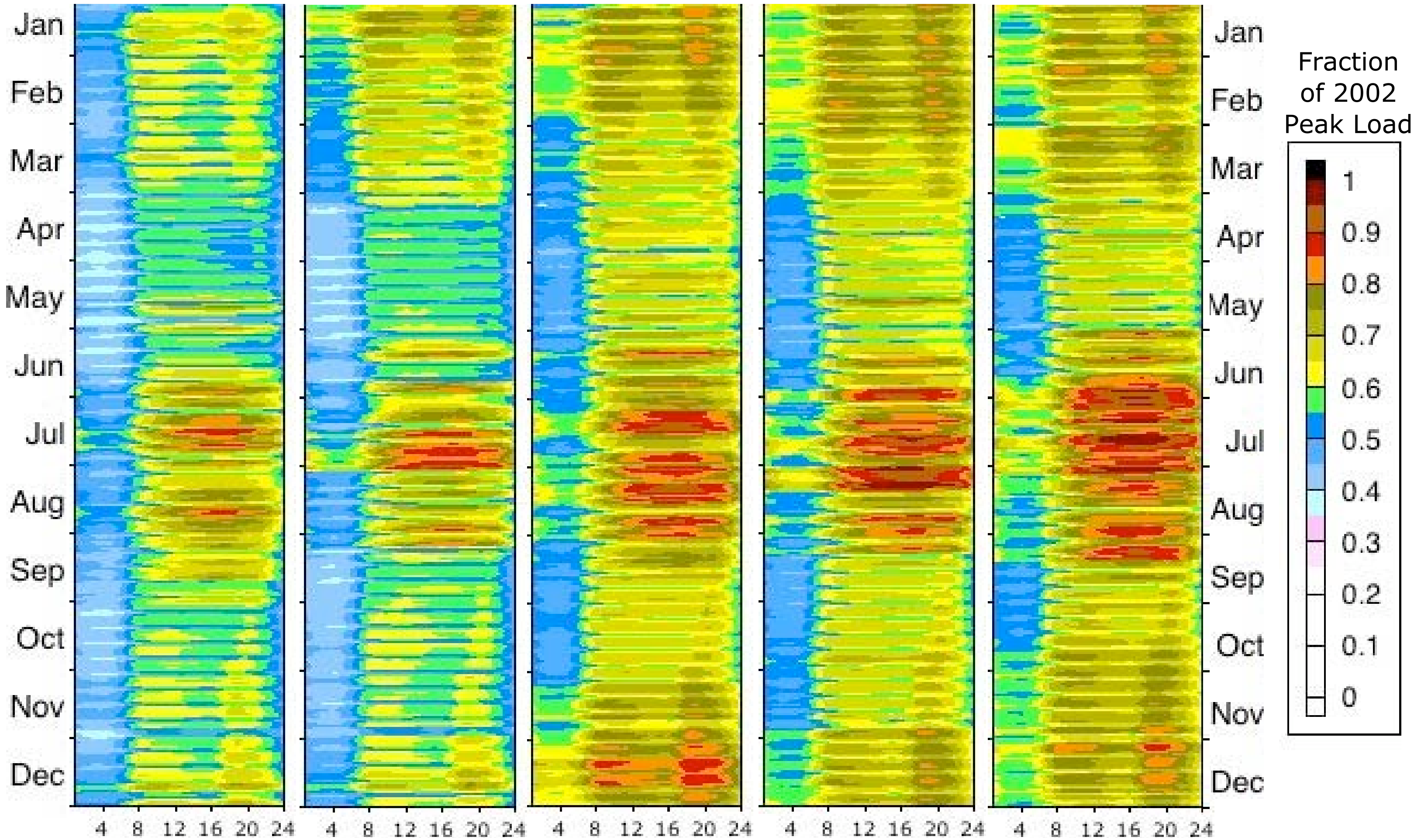


	1998	1999	2000	2001	2002
Net (TWh)	267	266	285	277	280
Peak (GW)	54	55	58	55	56

Figure BI - 15. ERCT Total Load Profiles

Contour plots show hourly total load in ERCT (Texas) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

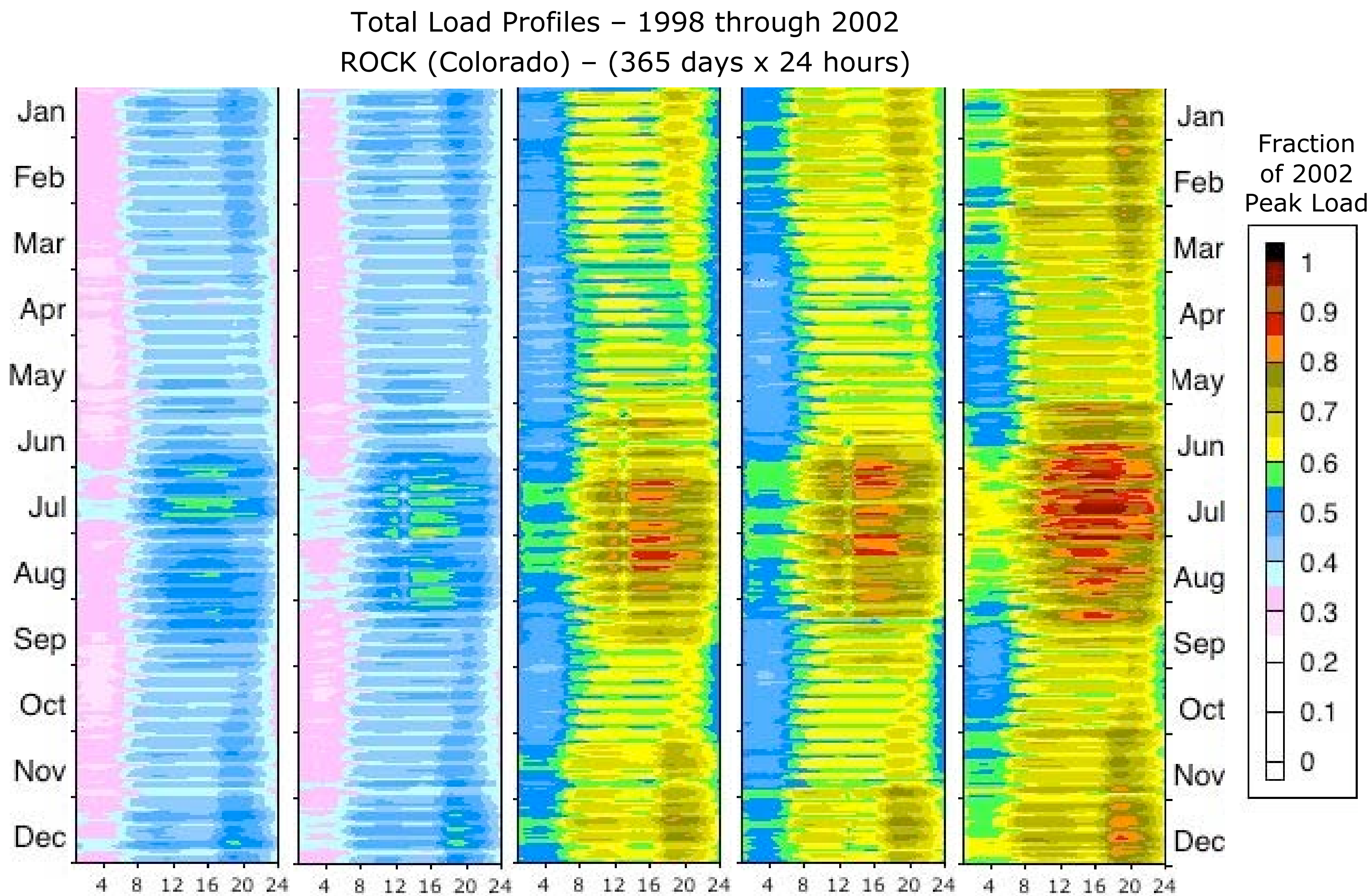
Total Load Profiles – 1998 through 2002
MAPP (Northern Plains) – (365 days x 24 hours)



	1998	1999	2000	2001	2002
Net (TWh)	160	164	187	185	192
Peak (GW)	29	30	31	32	32

Figure BI - 16. MAPP Total Load Profiles

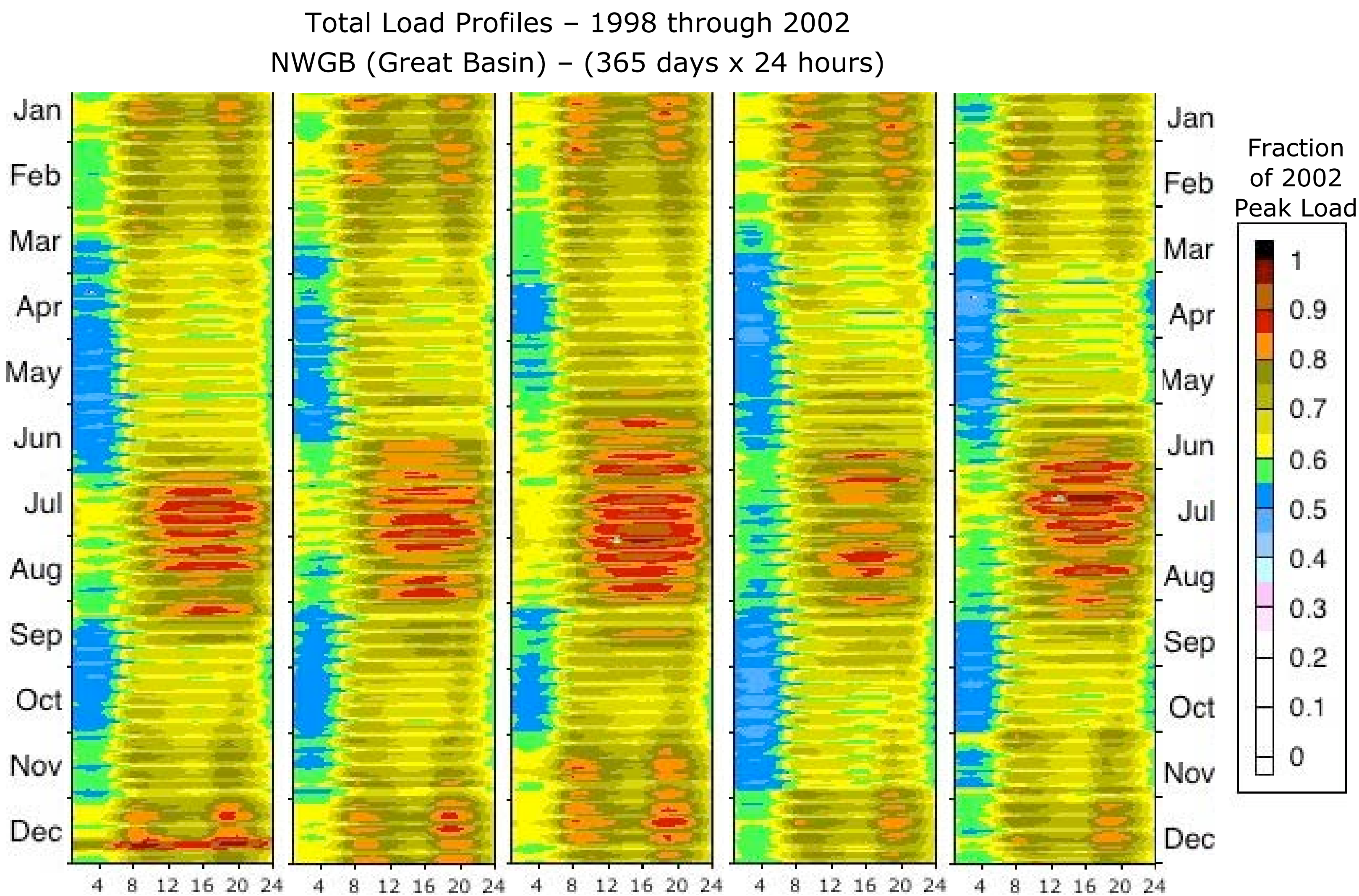
Contour plots show hourly total load in MAPP (Northern Plains) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.



	1998	1999	2000	2001	2002
Net (TWh)	40	41	59	60	66
Peak (GW)	7	7	10	10	11

Figure BI - 17. ROCK Total Load Profile

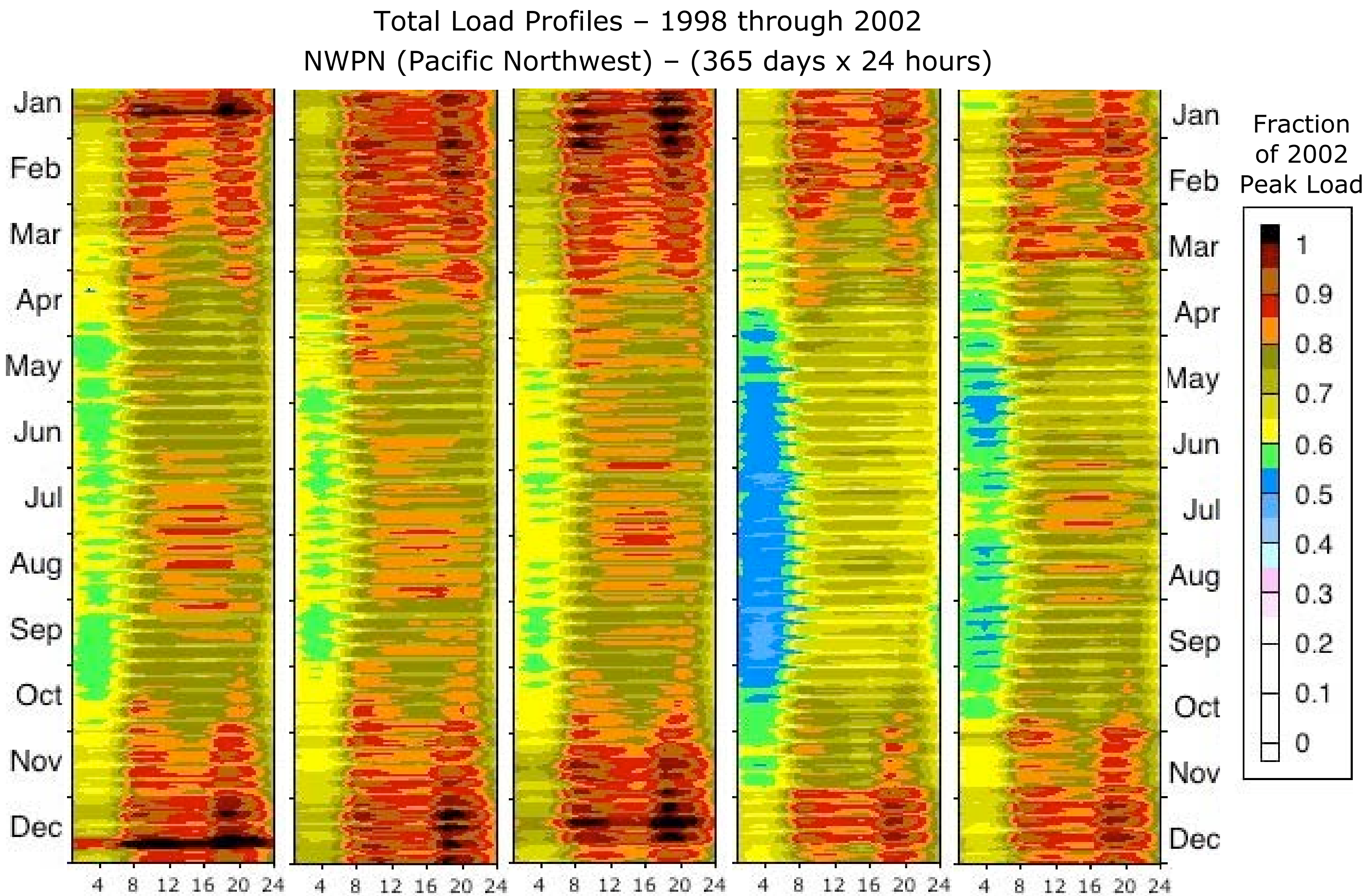
Contour plots show hourly total load in ROCK (Colorado) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot. Western Area Power Administration Rocky Mountain Region control area data is missing from 1998 and 1999.



	1998	1999	2000	2001	2002
Net (TWh)	100	102	105	99	99
Peak (GW)	17	16	17	15	17

Figure BI - 18. NWGB Total Load Profiles

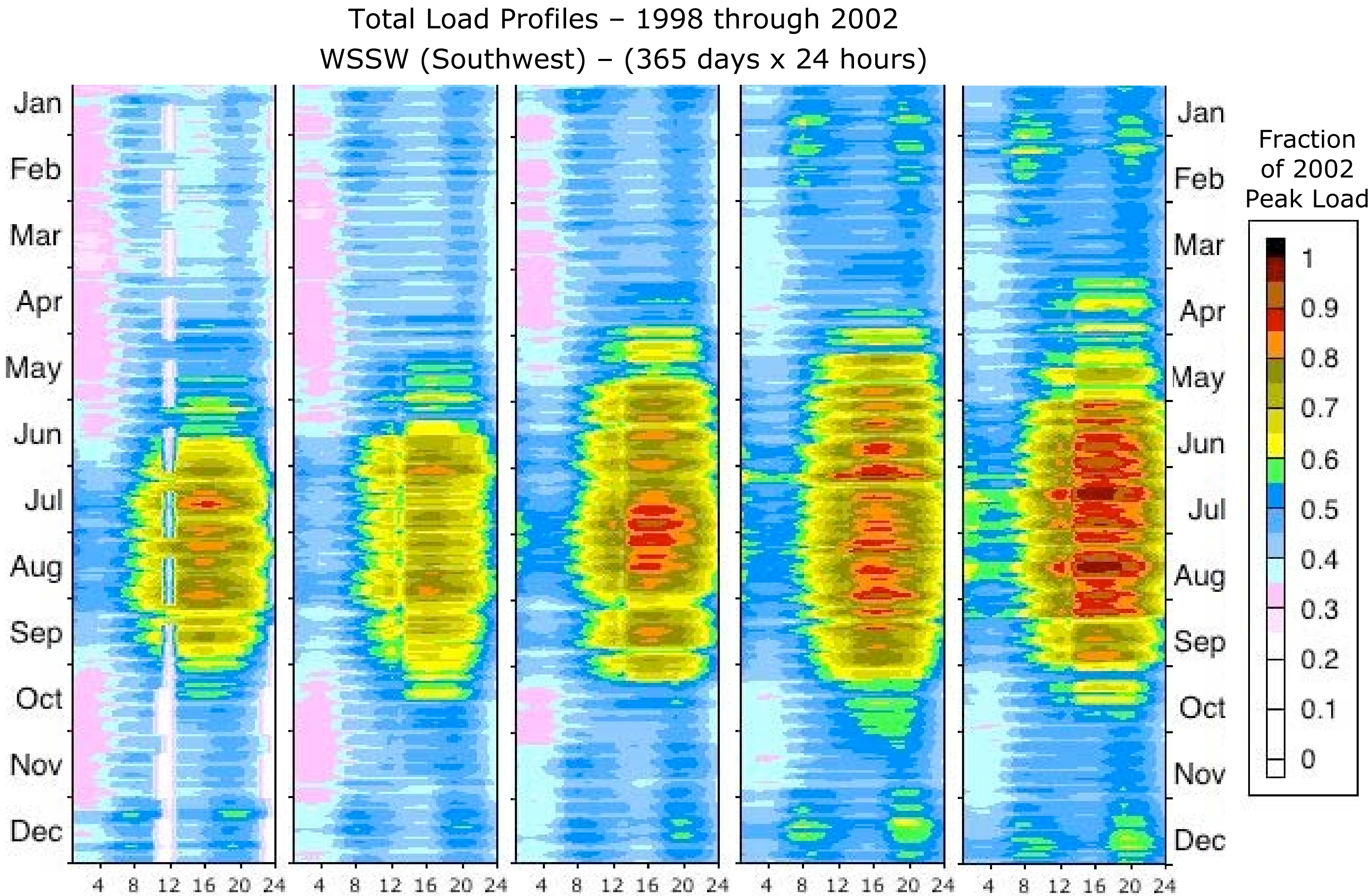
Contour plots show hourly total load in NWGB (Great Basin) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.



	1998	1999	2000	2001	2002
Net (TWh)	240	245	248	222	232
Peak (GW)	42	39	40	36	36

Figure BI - 19. NWPN Total Load Profiles

Contour plots show hourly total load in NWPN (Pacific Northwest) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.



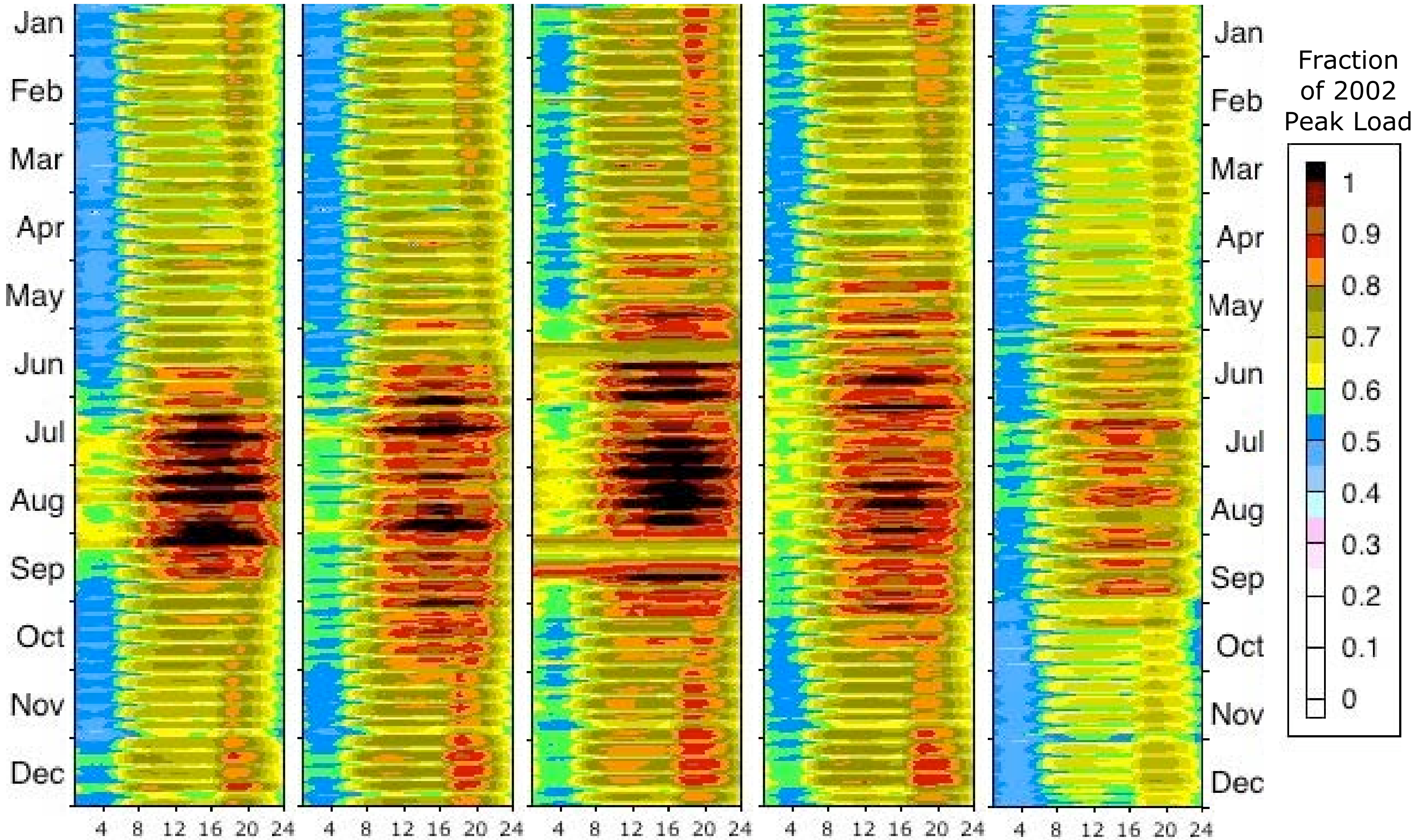
	1998	1999	2000	2001	2002
Net (TWh)	91	95	103	109	112
Peak (GW)	20	20	21	22	23

Figure BI - 20. WSSW Total Load Profiles

Contour plots show hourly total load in WSSW (Southwest) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

Total Load Profiles – 1998 through 2002

CALI (California) – (365 days x 24 hours)



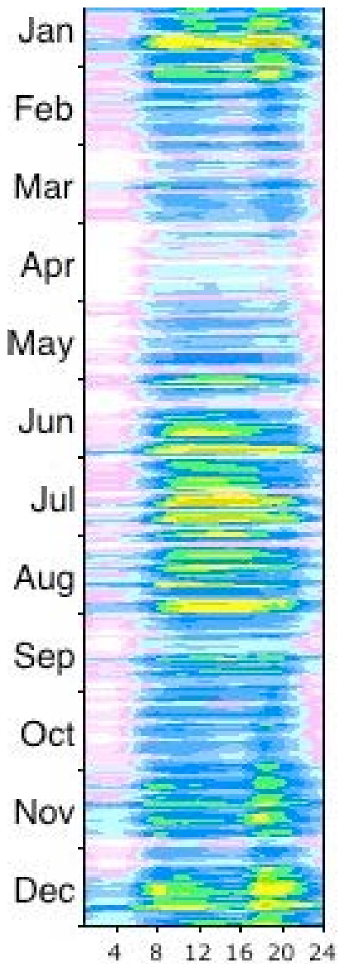
	1998	1999	2000	2001	2002
Net (TWh)	256	260	278	267	238
Peak (GW)	53	53	51	48	42

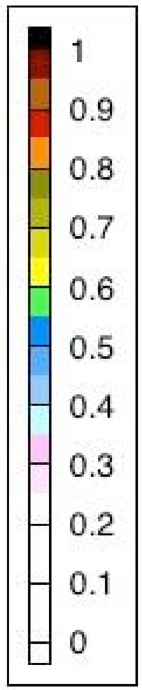
Figure BI - 21. CALI Total Load Profiles

Contour plots show hourly total load in CALI (California) for the years 1998 through 2002. All data is normalized to the peak hourly load of 2002. Annual peak (GW) and net (TWh) load for each year are noted below the corresponding plot.

Appendix B Section II – NERC Subregion eGrid Fossil Generation Profiles for 1998 to 2002

eGrid Generation Profiles



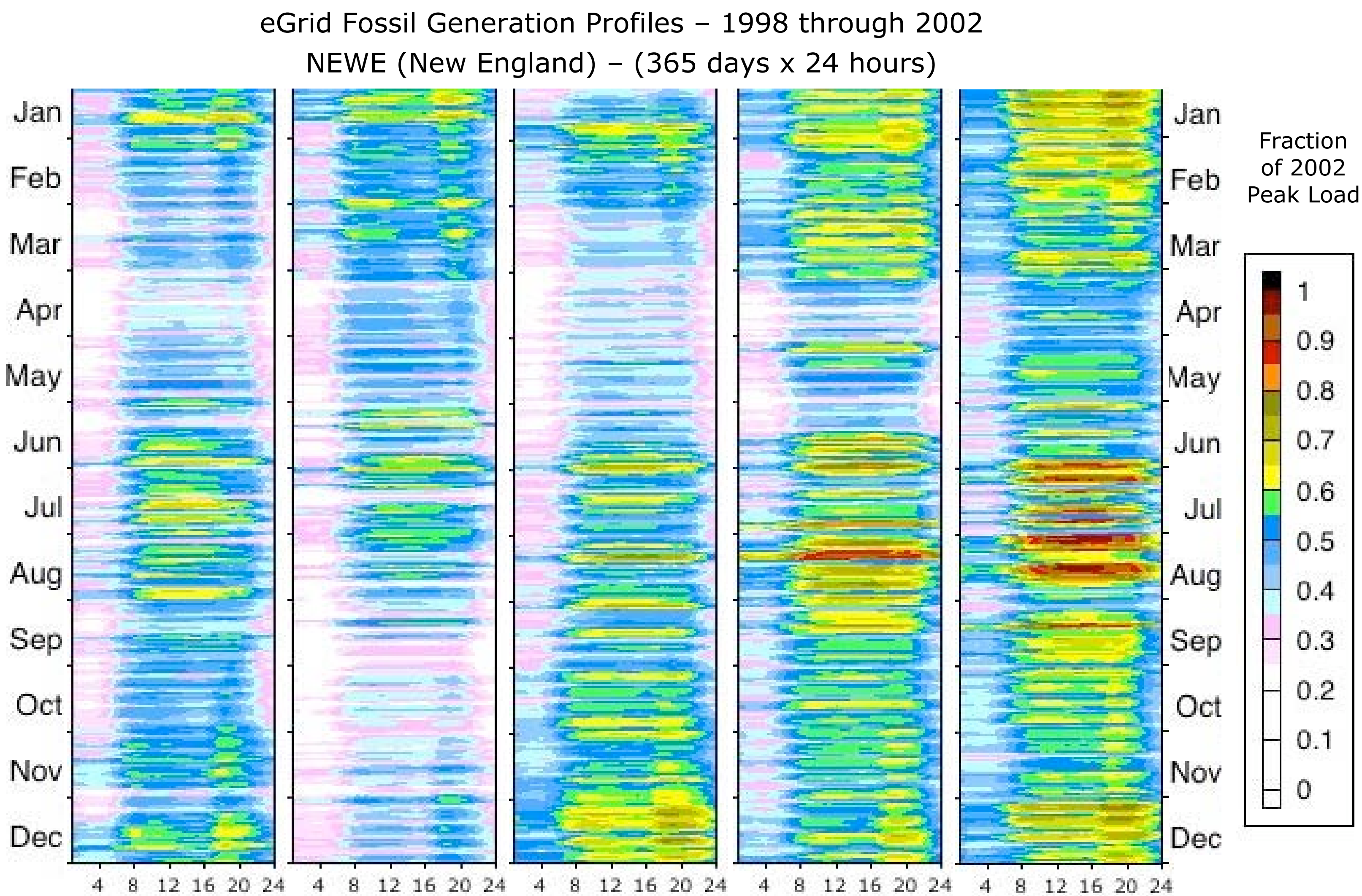


Contour plots show normalized eGrid generation for each year from 1998 through 2002. Each year is normalized to the maximum hourly load in 2002 so that load growth is evident.

Below the contour plot is a chart that displays the total subregion eGrid fossil generation for each year in TWh (Gross) and the maximum hourly generation for each year in GW (Peak).

Five plots are shown for each subregion, one plot for each year from 1998 through 2002.

	1998
Gross (TWh)	52
Peak (GW)	10

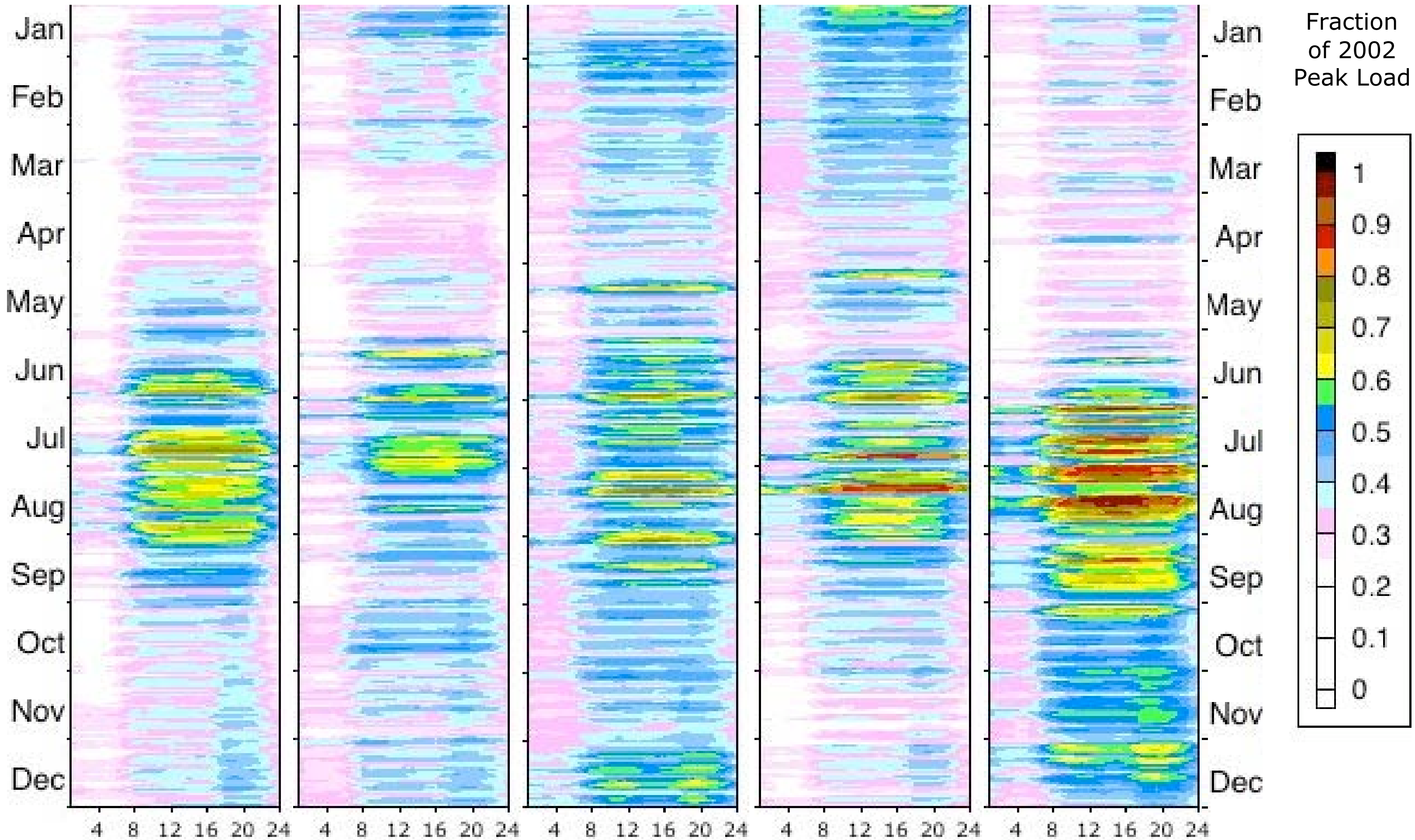


	1998	1999	2000	2001	2002
Gross (TWh)	52	49	56	62	67
Peak (GW)	10	10	12	13	14

Figure BII - 1. NEWE eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in NEWE (New England) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

eGrid Fossil Generation Profiles – 1998 through 2002
NYAS (New York) – (365 days x 24 hours)

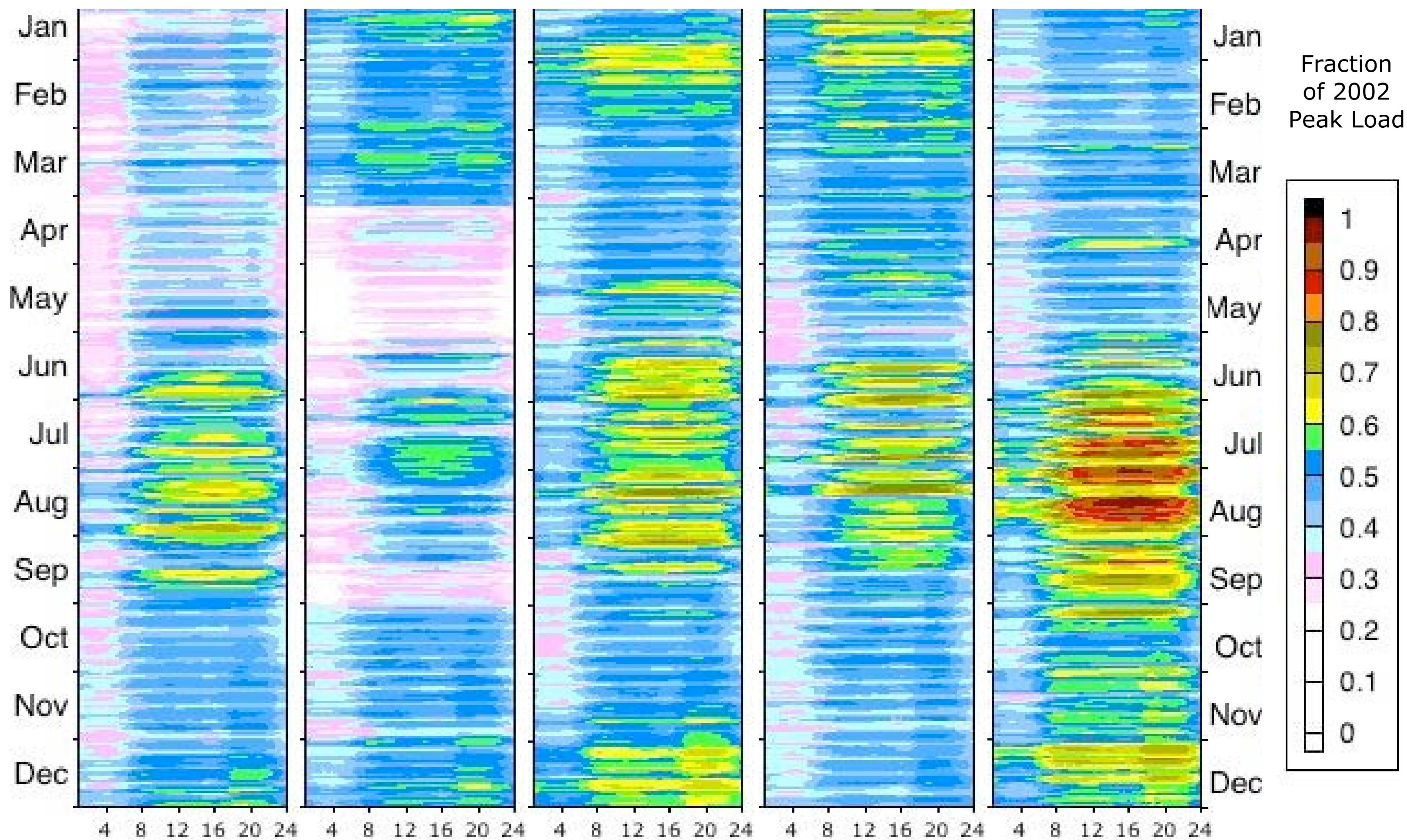


	1998	1999	2000	2001	2002
Gross (TWh)	56	56	65	62	66
Peak (GW)	14	13	15	17	18

Figure BII - 2. NYAS eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in NYAS (New York) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

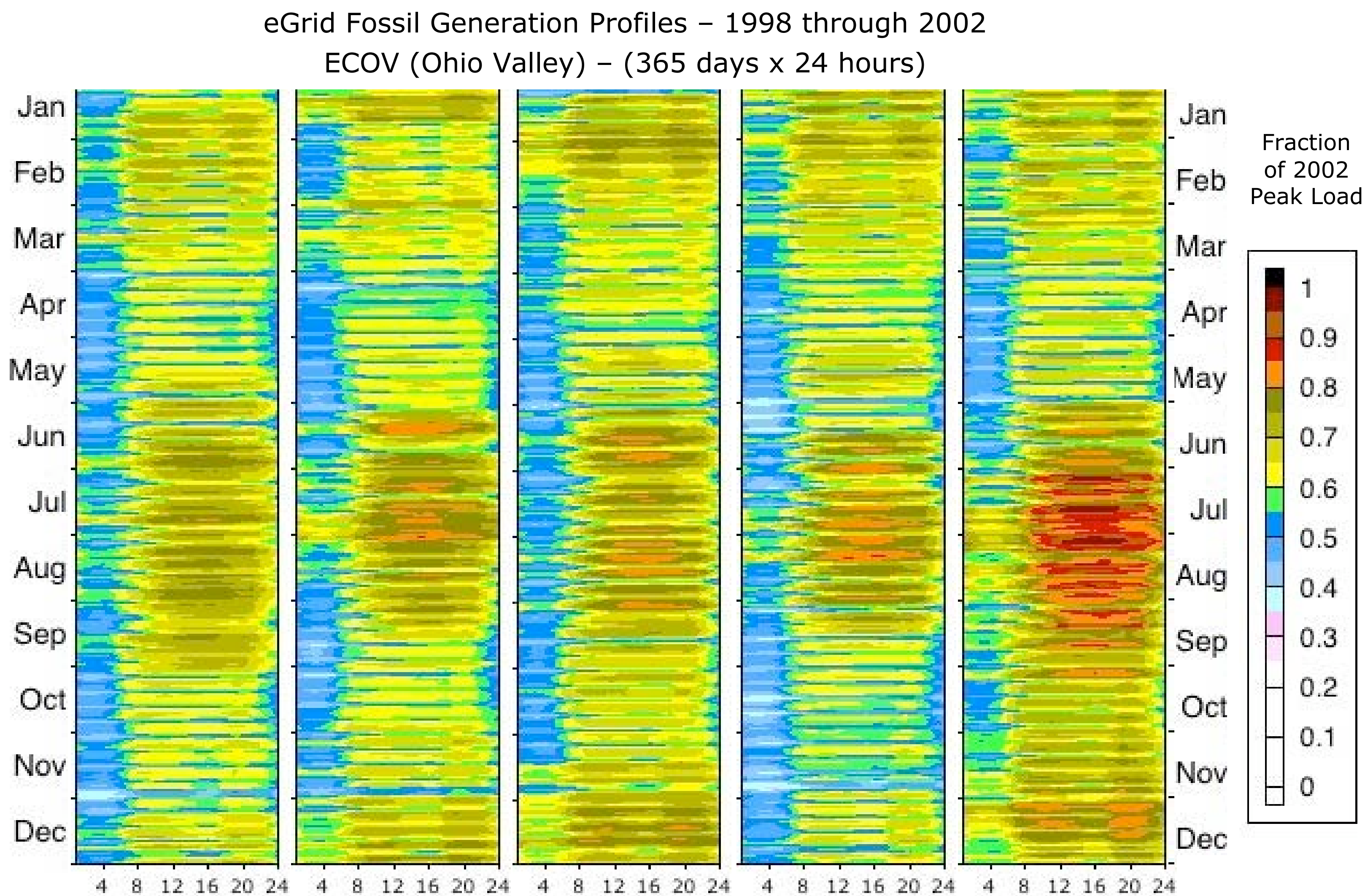
eGrid Fossil Generation Profiles – 1998 through 2002
MAAC (Mid-Atlantic) – (365 days x 24 hours)



	1998	1999	2000	2001	2002
Gross (TWh)	146	141	171	164	178
Peak (GW)	29	24	32	33	39

Figure BII - 3. MAAC eGrid Fossil Generation Profiles

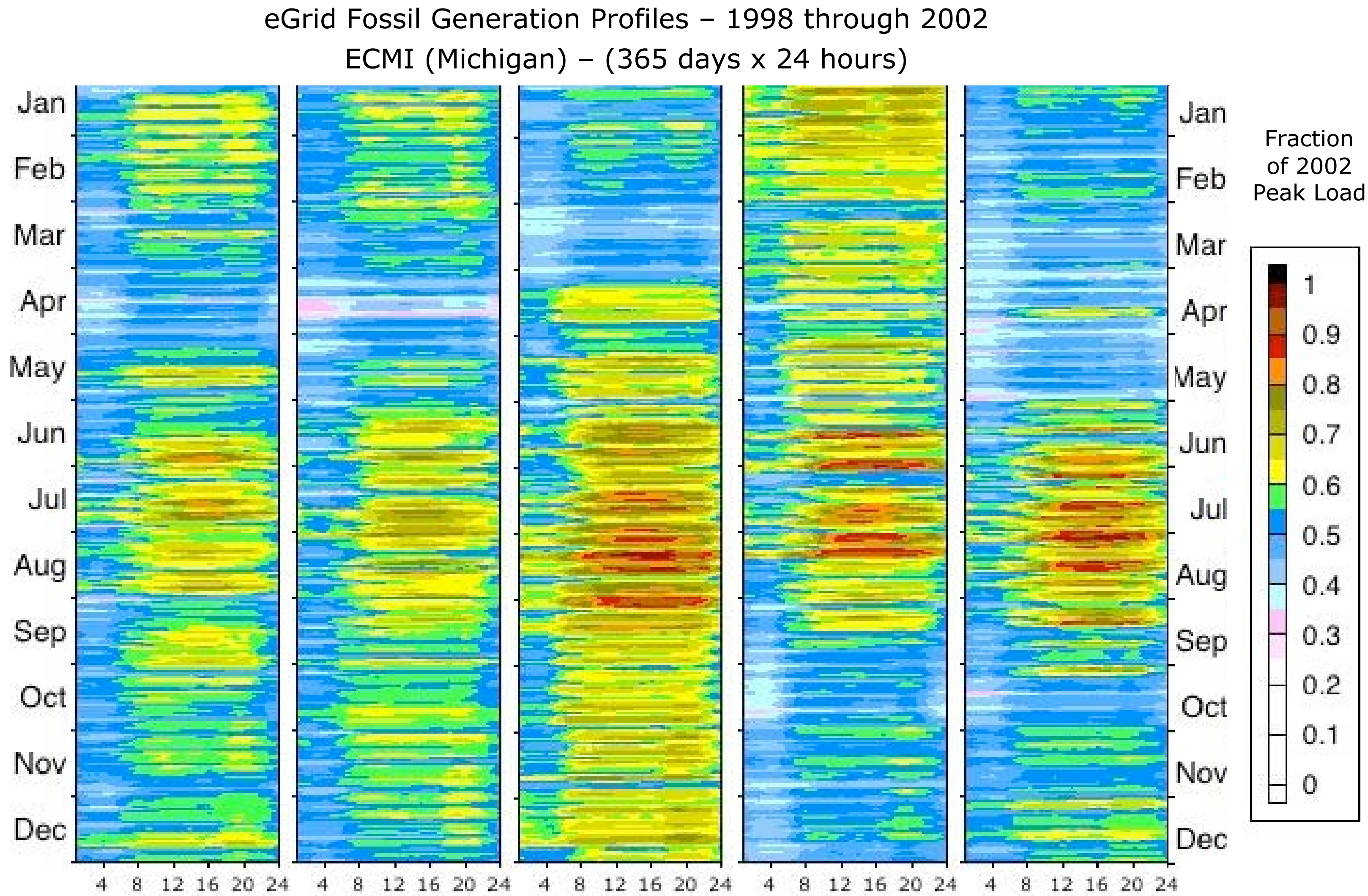
Contour plots show hourly eGrid fossil generation in MAAC (Mid-Atlantic) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.



	1998	1999	2000	2001	2002
Gross (TWh)	405	410	422	399	441
Peak (GW)	61	65	64	65	76

Figure BII - 4. ECOV eGrid Fossil Generation Profiles

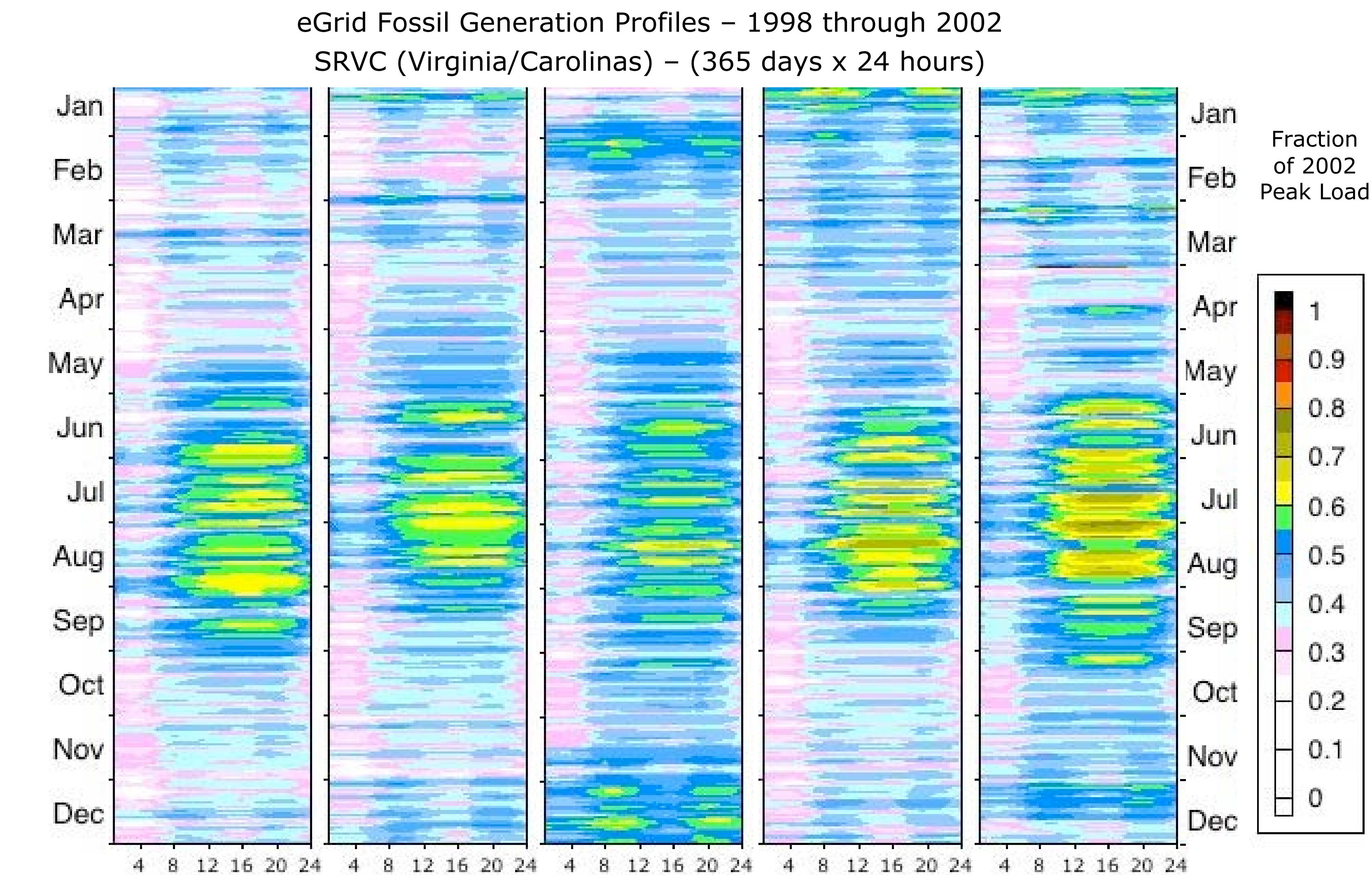
Contour plots show hourly eGrid fossil generation in ECOV (Mid-Atlantic) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.



	1998	1999	2000	2001	2002
Gross (TWh)	72	72	80	76	71
Peak (GW)	13	12	15	15	15

Figure BII - 5. ECMI eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in ECMI (Michigan) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.



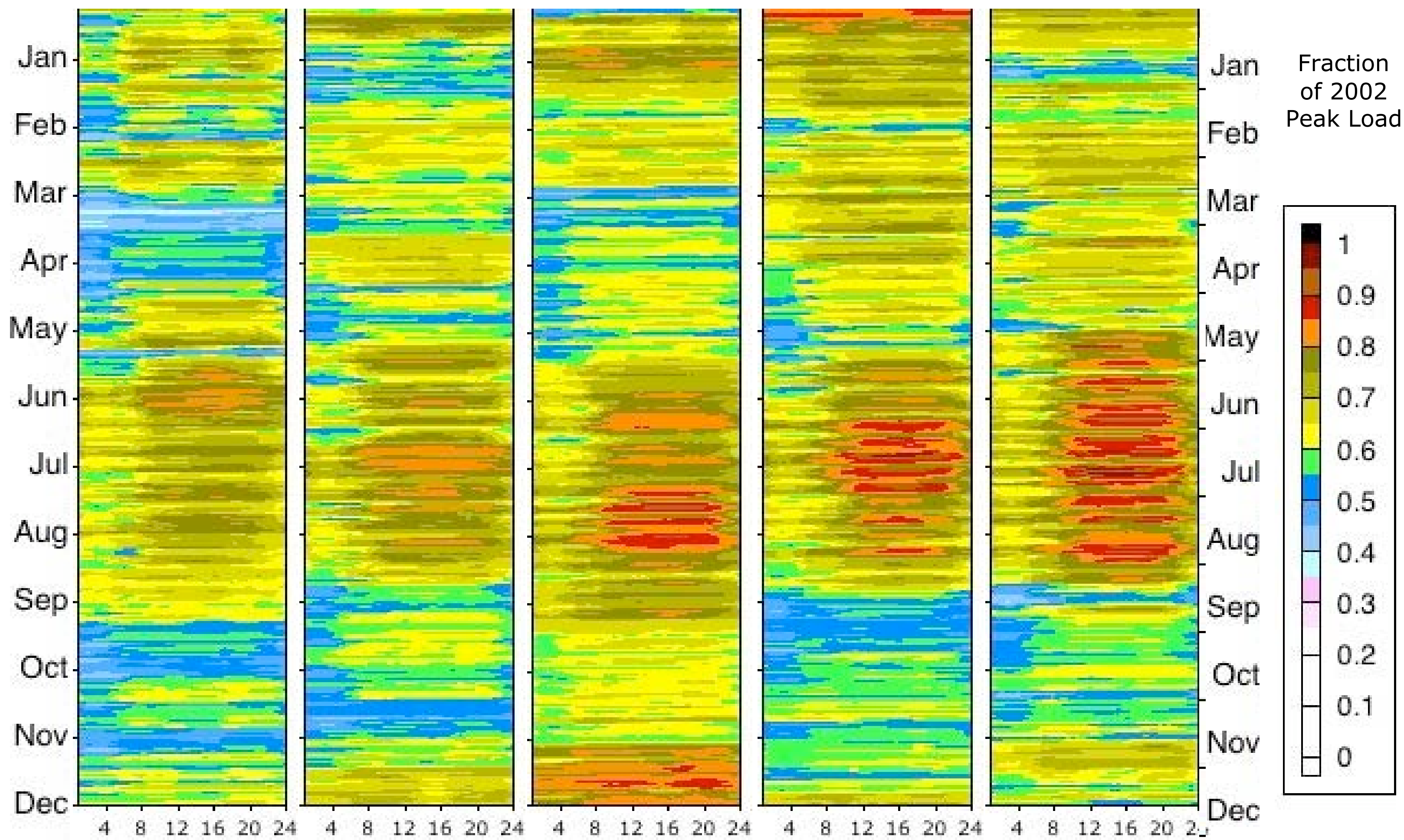
	1998	1999	2000	2001	2002
Gross (TWh)	146	147	157	152	160
Peak (GW)	27	27	28	31	42

Figure BII - 6. SRVC eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in SRVC (Virginia/Carolinas) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

eGrid Fossil Generation Profiles – 1998 through 2002

SRTV (Tennessee Valley) – (365 days x 24 hours)

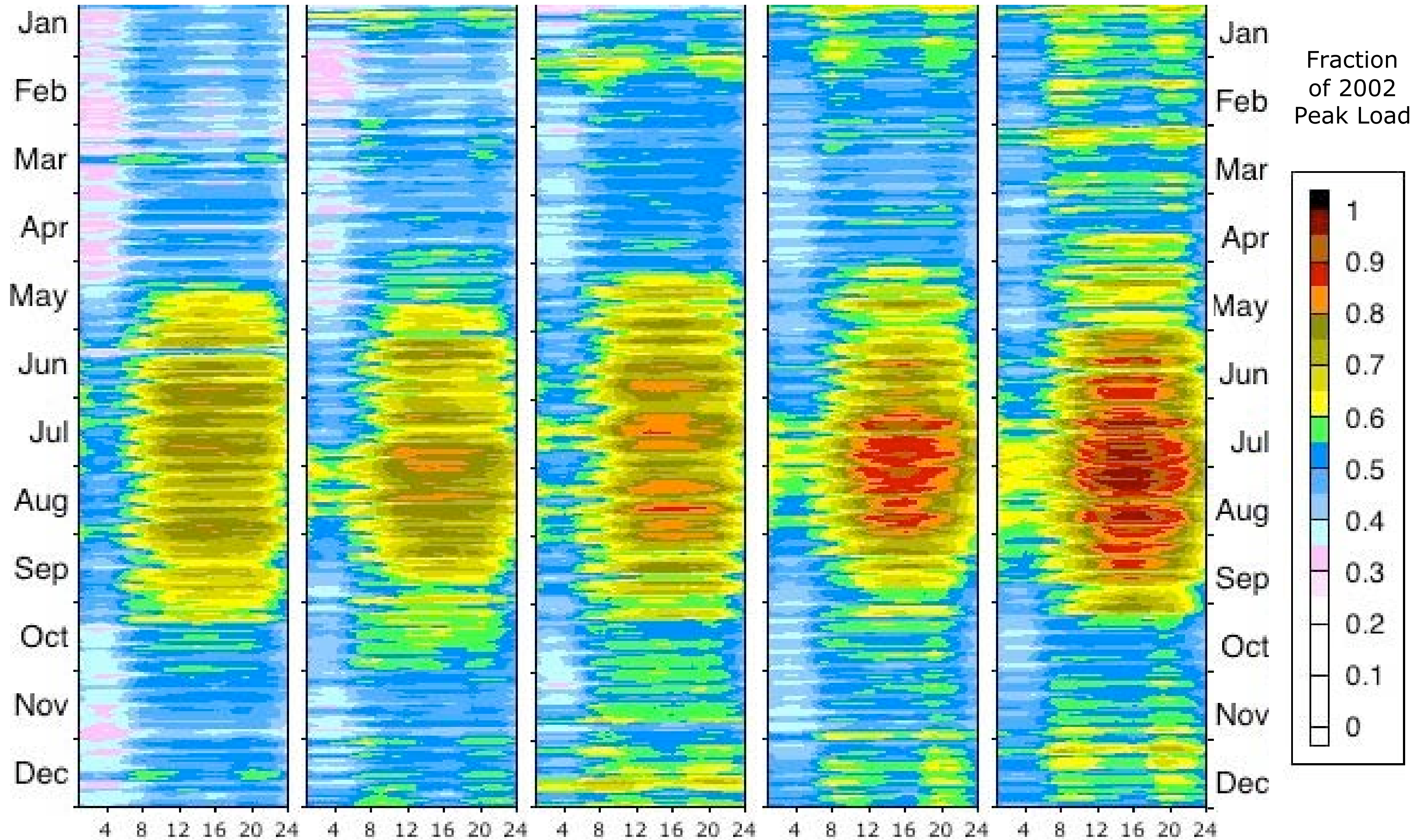


	1998	1999	2000	2001	2002
Gross (TWh)	97	100	107	104	105
Peak (GW)	15	15	17	18	18

Figure BII - 7. SRTV eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in SRTV (Tennessee Valley) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

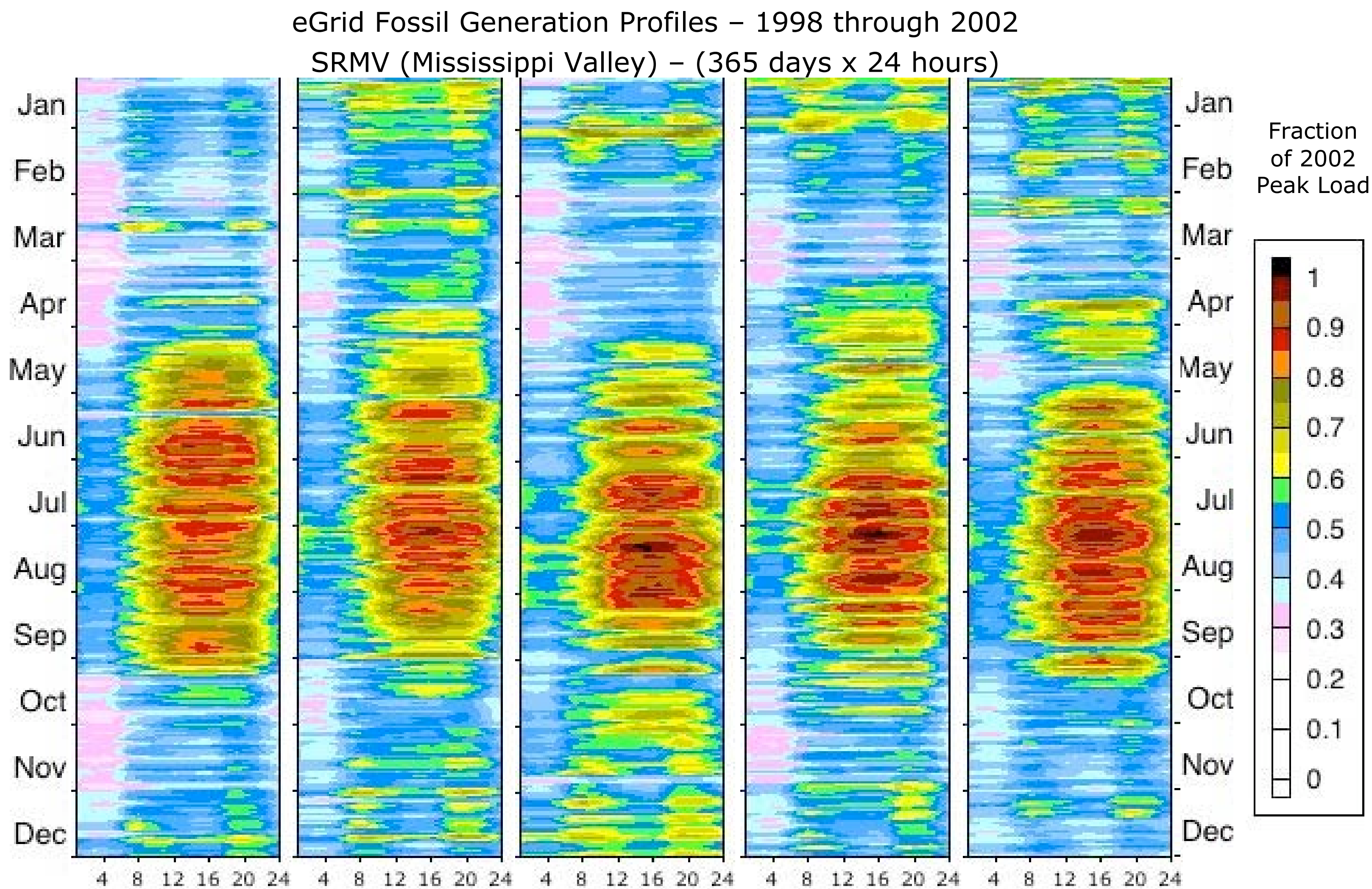
eGrid Fossil Generation Profiles – 1998 through 2002
SRSO (Southeast) – (365 days x 24 hours)



	1998	1999	2000	2001	2002
Gross (TWh)	169	173	185	182	191
Peak (GW)	30	31	32	36	37

Figure BII - 8. SRSO eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in SRSO (Southeast) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.



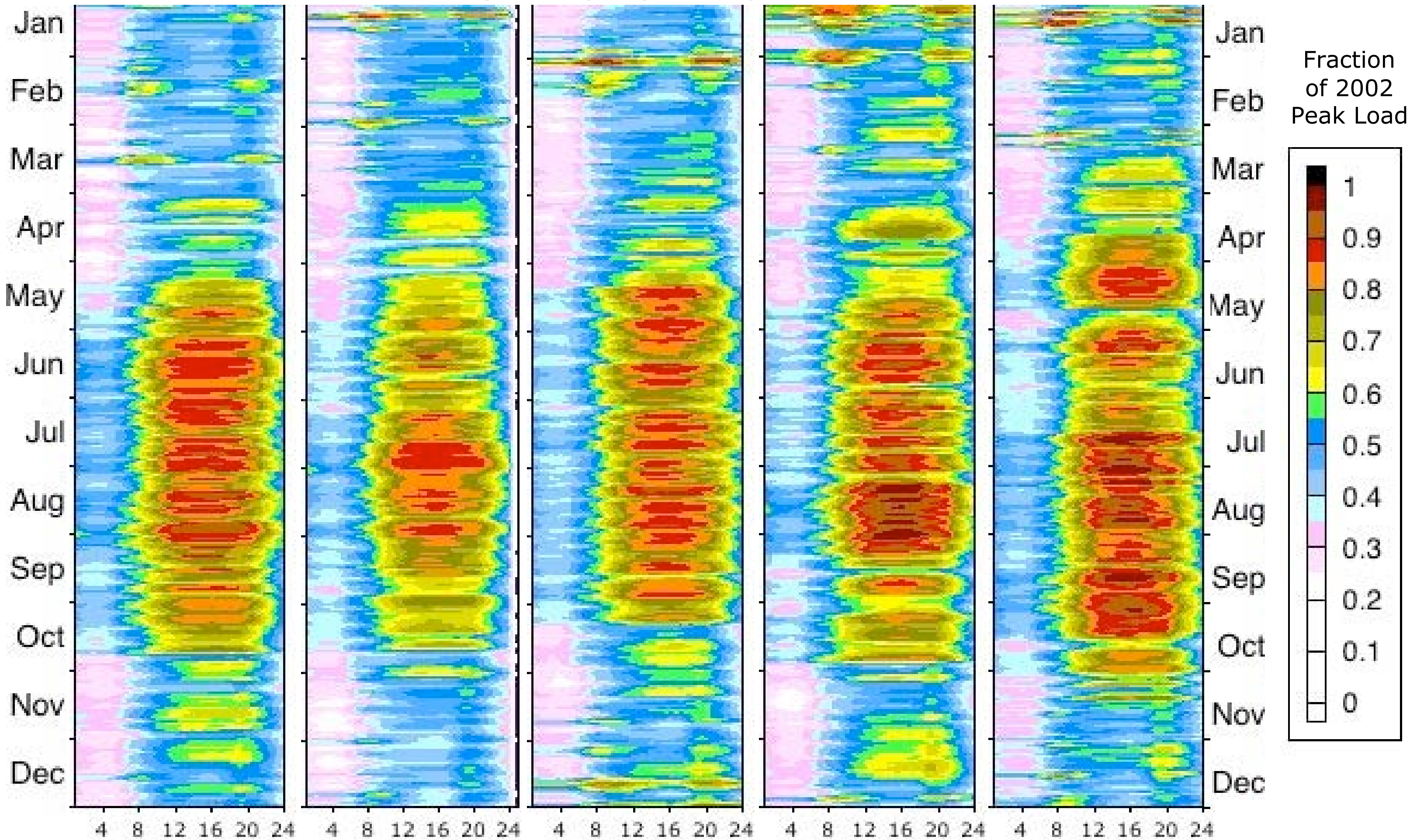
	1998	1999	2000	2001	2002
Gross (TWh)	103	109	109	107	107
Peak (GW)	22	22	23	23	22

Figure BII - 9. SRMV eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in SRMV (Mississippi Valley) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

eGrid Fossil Generation Profiles – 1998 through 2002

FRCC (Florida) – (365 days x 24 hours)

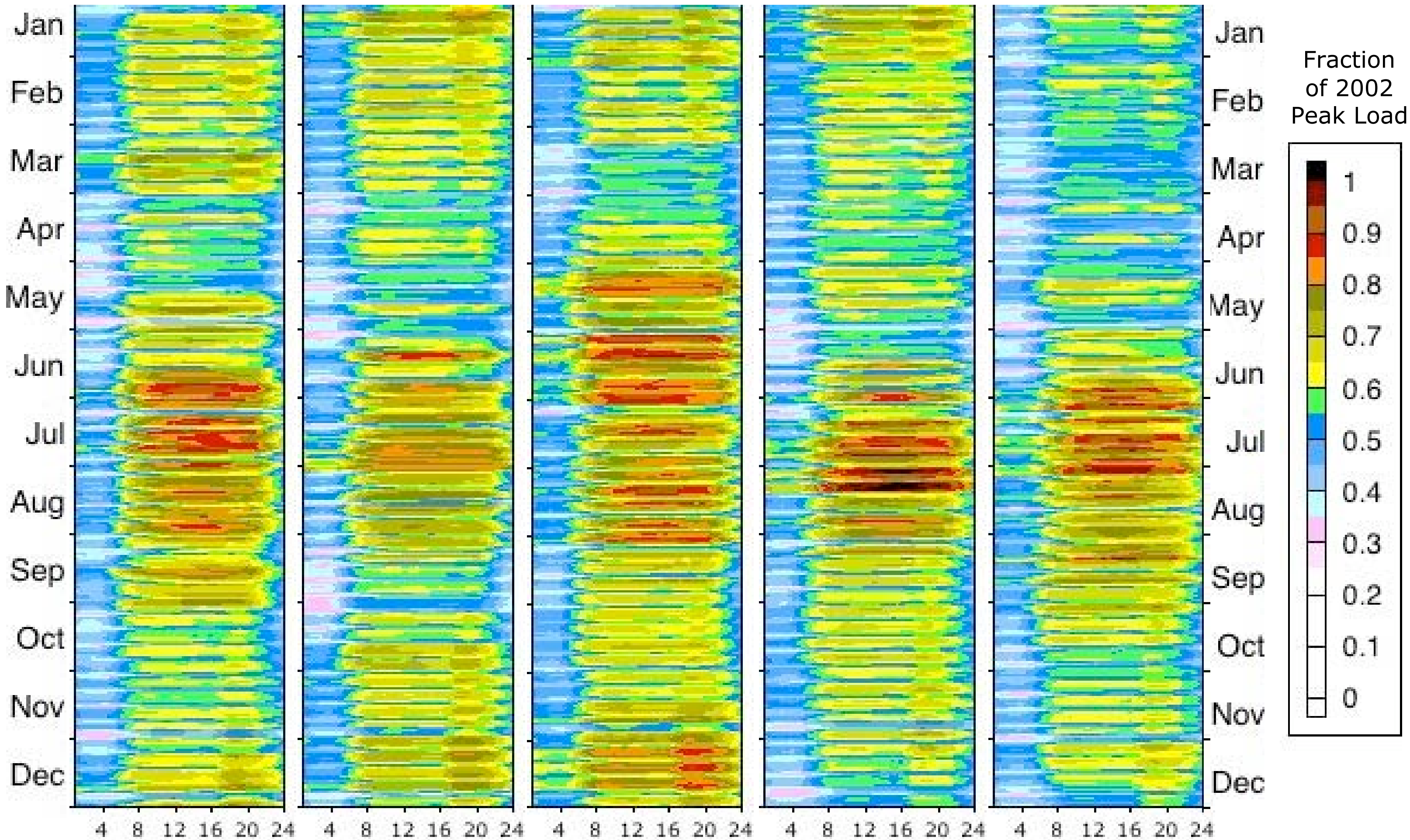


	1998	1999	2000	2001	2002
Gross (TWh)	130	124	131	134	137
Peak (GW)	26	25	27	27	28

Figure BII - 10. FRCC eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in FRCC (Florida) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

eGrid Fossil Generation Profiles – 1998 through 2002
MANN (Wisconsin) – (365 days x 24 hours)

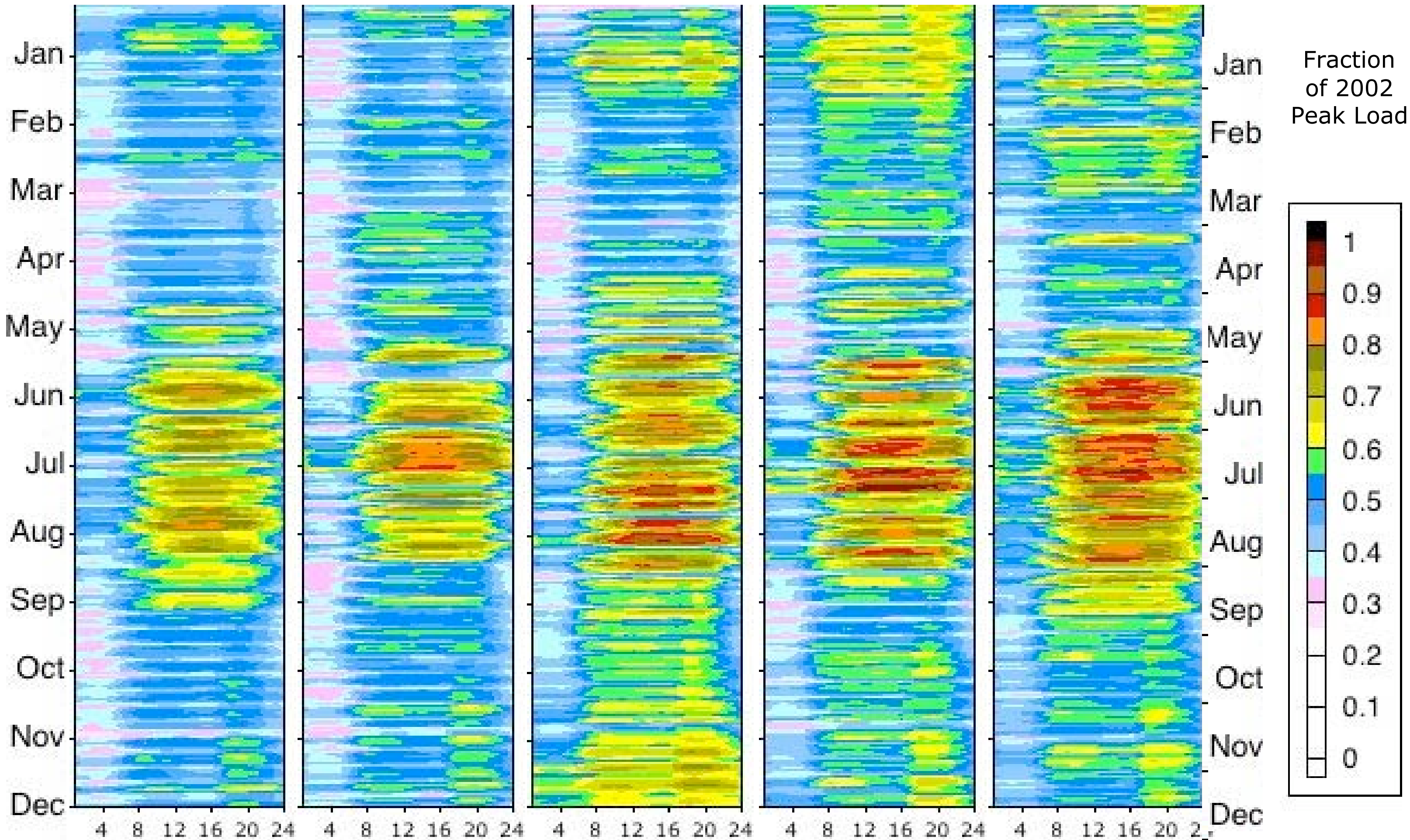


	1998	1999	2000	2001	2002
Gross (TWh)	45	45	48	45	44
Peak (GW)	8	8	9	9	9

Figure BII - 11. MANN eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in MANN (Wisconsin) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

eGrid Fossil Generation Profiles – 1998 through 2002
MANS (Illinois) – (365 days x 24 hours)



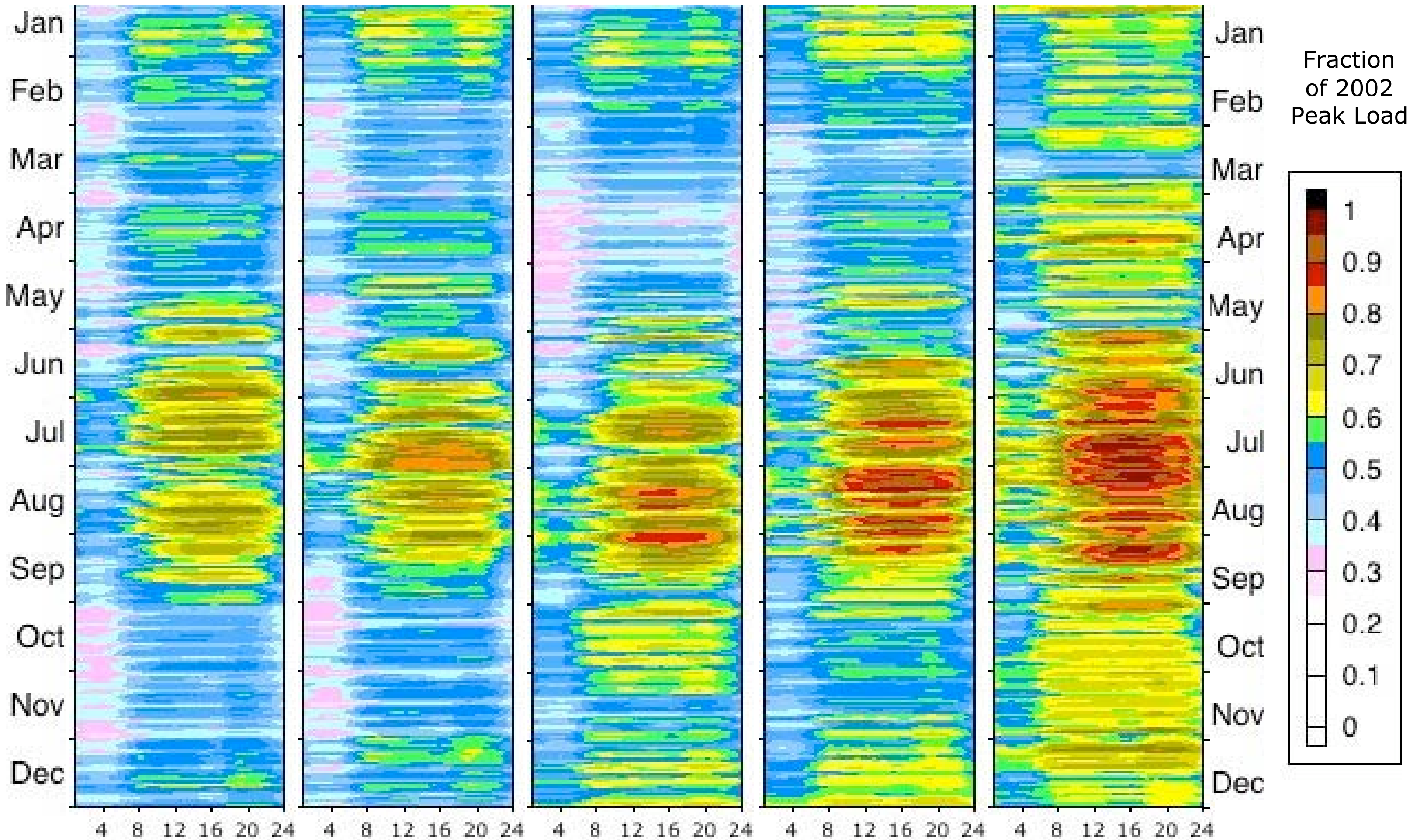
	1998	1999	2000	2001	2002
Gross (TWh)	121	121	133	133	136
Peak (GW)	23	25	27	28	28

Figure BII - 12. MANS eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in MANS (Illinois) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

eGrid Fossil Generation Profiles – 1998 through 2002

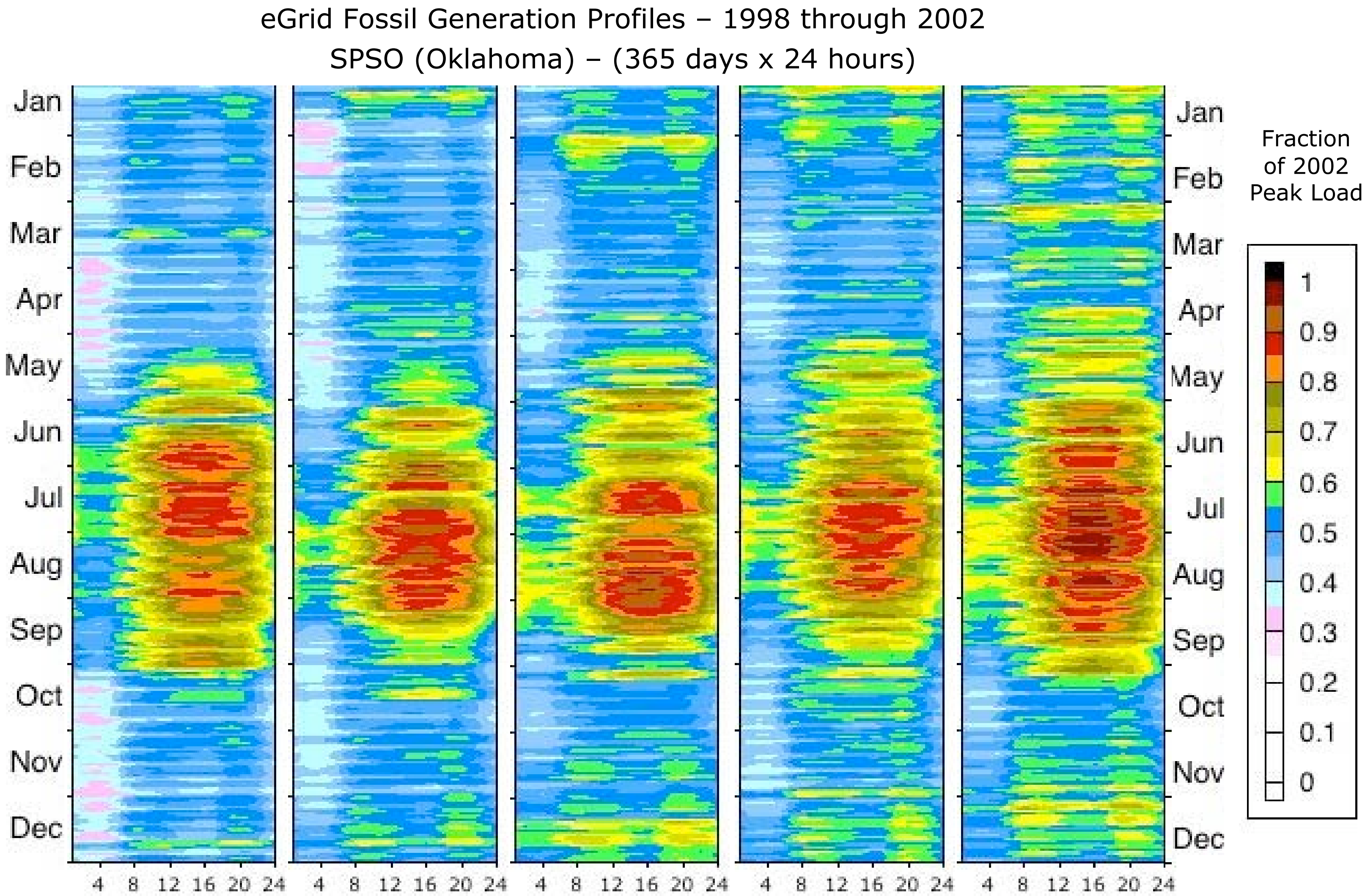
SPNO (Kansas) – (365 days x 24 hours)



	1998	1999	2000	2001	2002
Gross (TWh)	45	45	47	49	56
Peak (GW)	8	9	9	10	10

Figure BII - 13. SPNO eGrid Fossil Generation Profiles

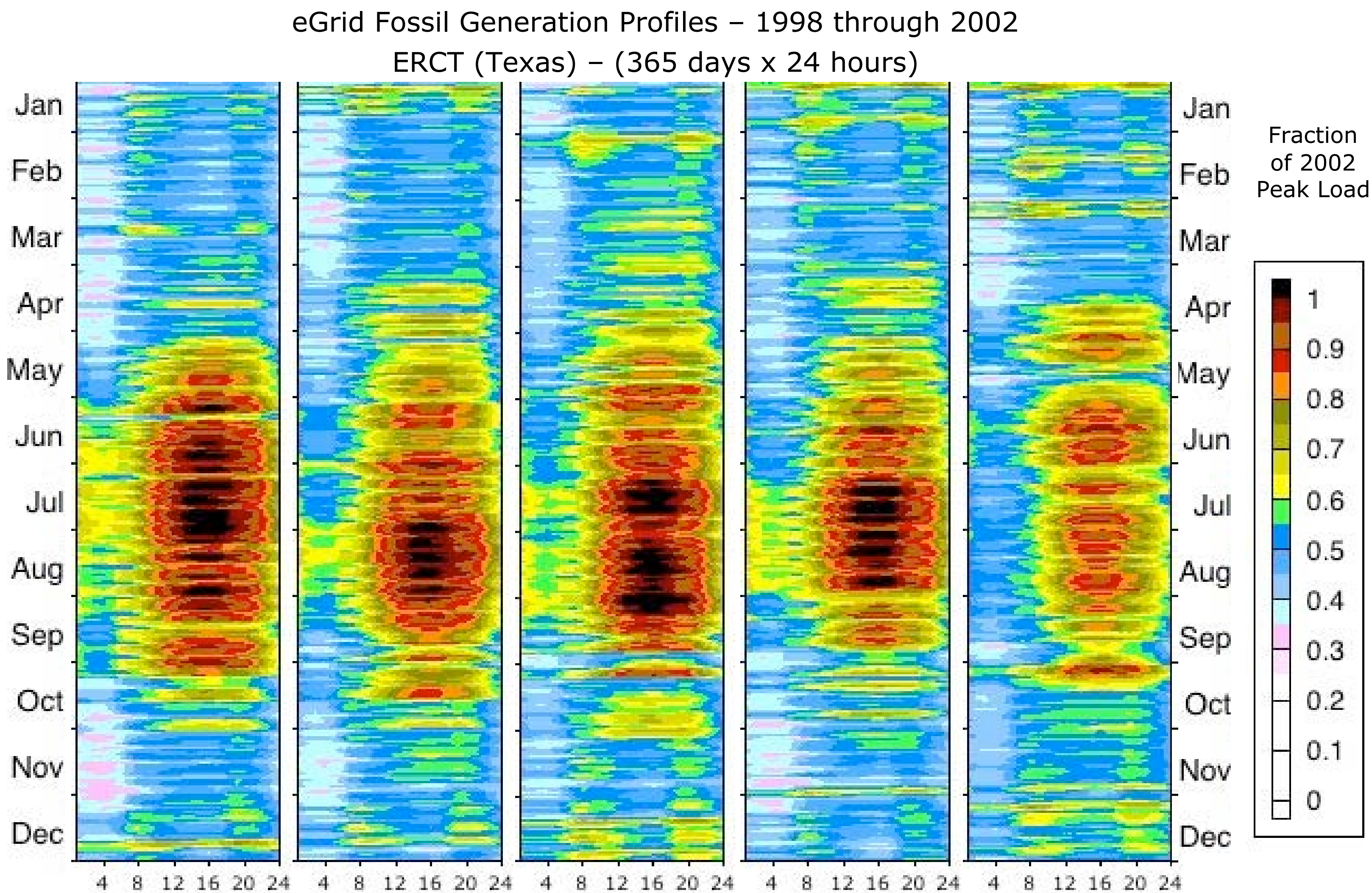
Contour plots show hourly eGrid fossil generation in SPNO (Kansas) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.



	1998	1999	2000	2001	2002
Gross (TWh)	112	112	119	117	125
Peak (GW)	22	23	24	22	24

Figure BII - 14. SPSO eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in SPSO (Oklahoma) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

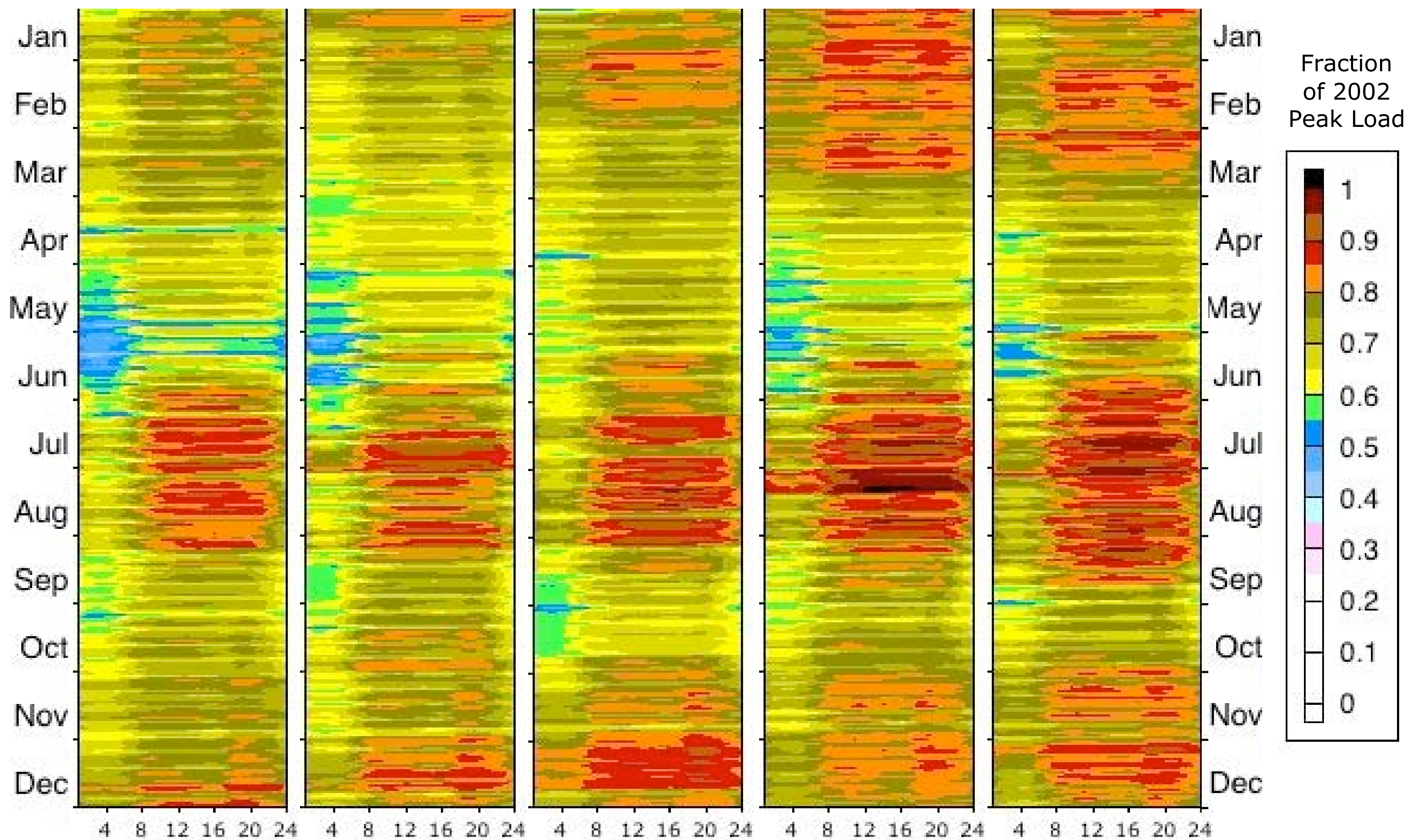


	1998	1999	2000	2001	2002
Gross (TWh)	216	213	222	209	208
Peak (GW)	44	44	45	45	42

Figure BII - 15. ERCT eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in ERCT (Texas) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

eGrid Fossil Generation Profiles – 1998 through 2002
MAPP (Northern Plains) – (365 days x 24 hours)

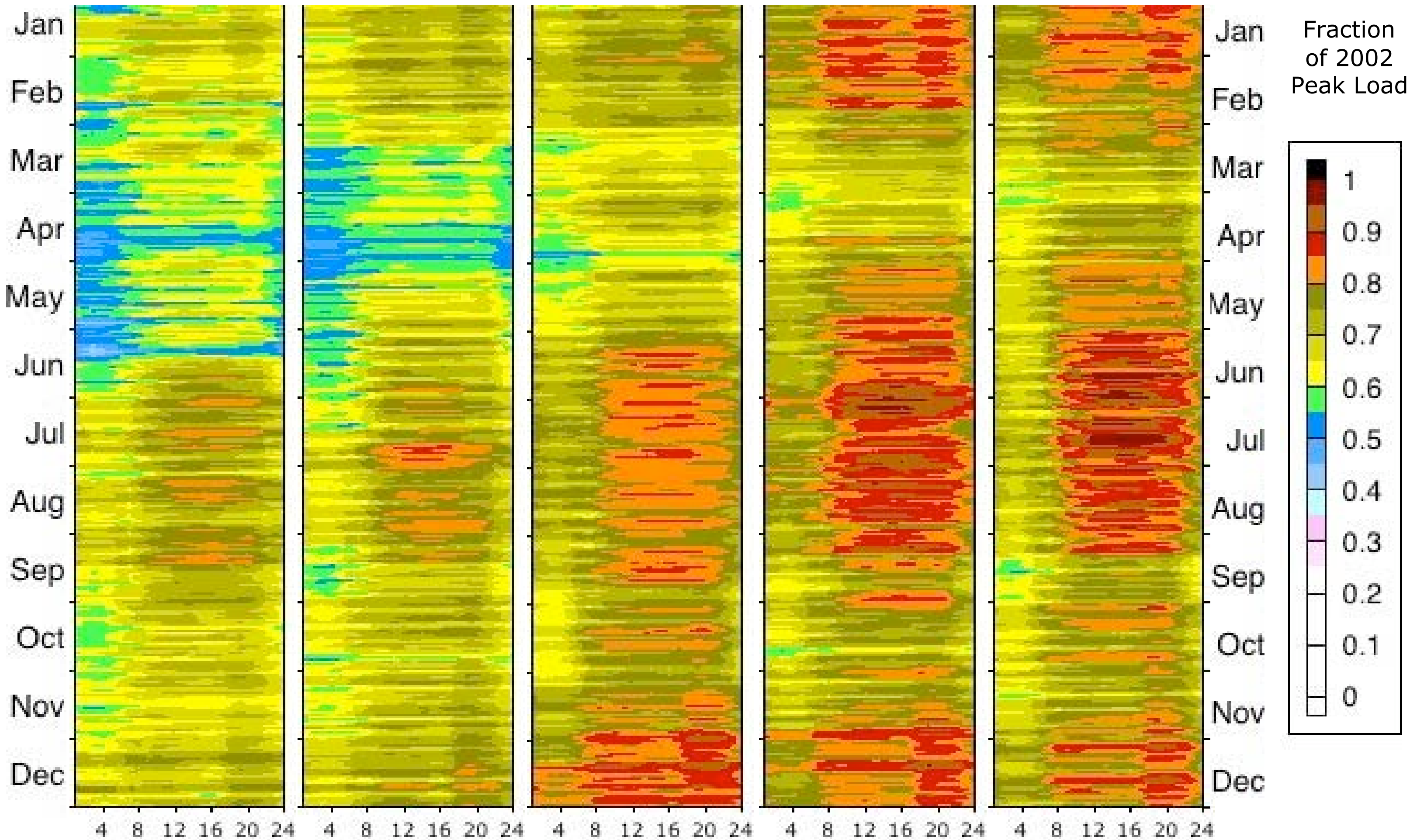


	1998	1999	2000	2001	2002
Gross (TWh)	151	150	157	160	162
Peak (GW)	22	23	23	25	24

Figure BII - 16. MAPP eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in MAPP (Northern Plains) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

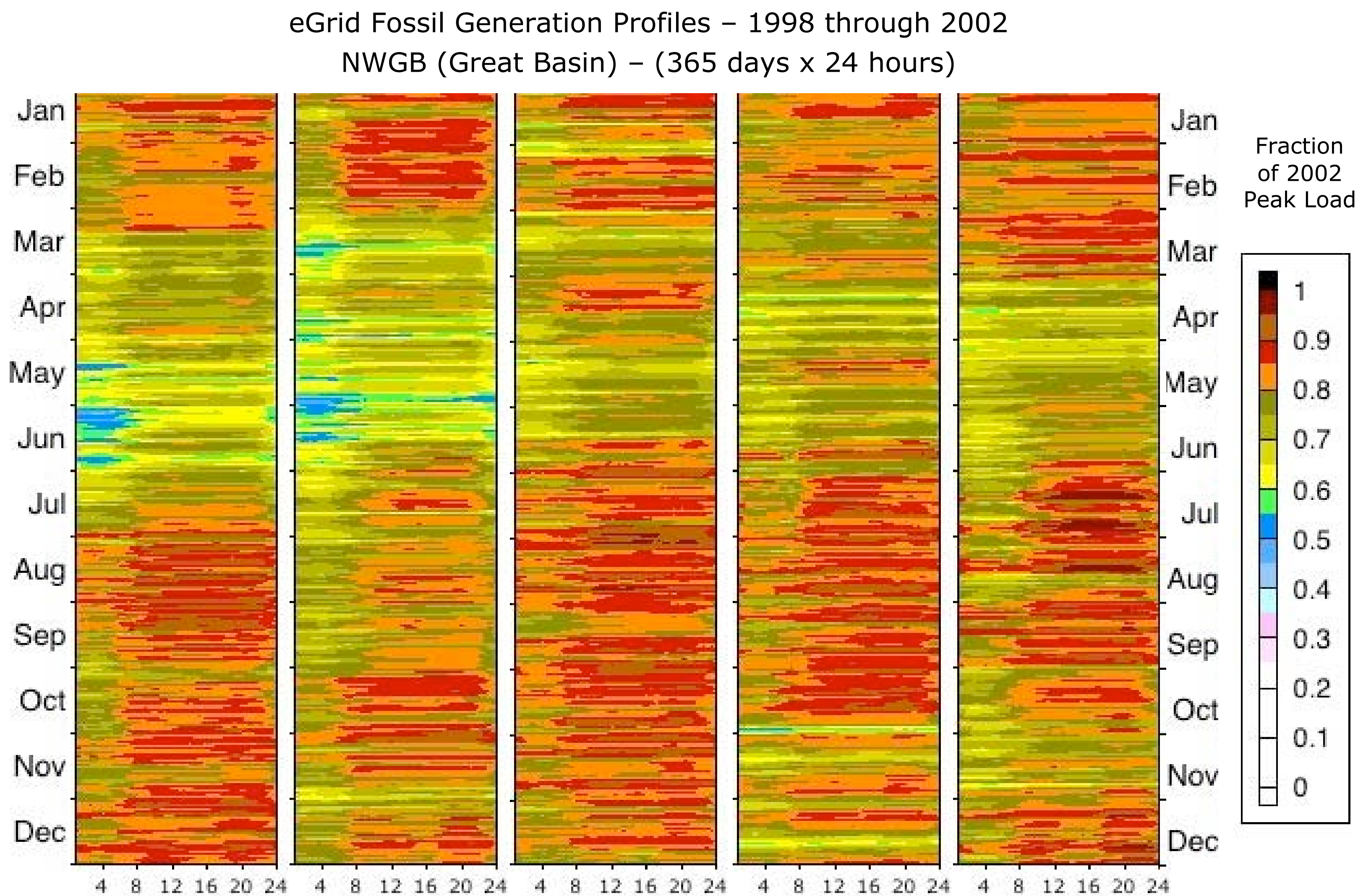
eGrid Fossil Generation Profiles – 1998 through 2002
ROCK (Colorado) – (365 days x 24 hours)



	1998	1999	2000	2001	2002
Gross (TWh)	45	46	51	53	53
Peak (GW)	7	7	7	8	8

Figure BII - 17. ROCK eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in ROCK (Colorado) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

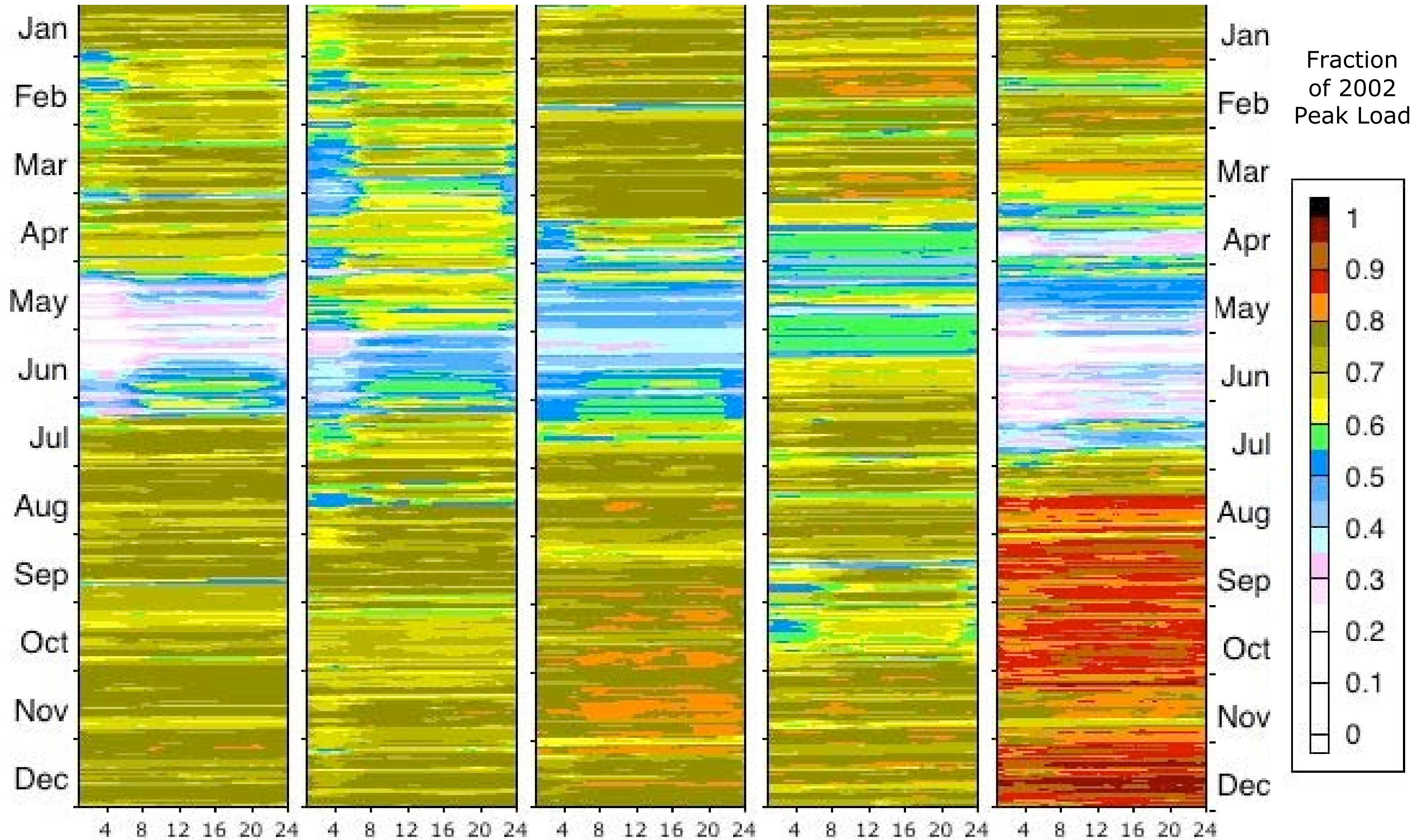


	1998	1999	2000	2001	2002
Gross (TWh)	44	43	46	45	45
Peak (GW)	6	6	6	6	7

Figure BII - 18. NWGB eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in NWGB (Great Basin) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

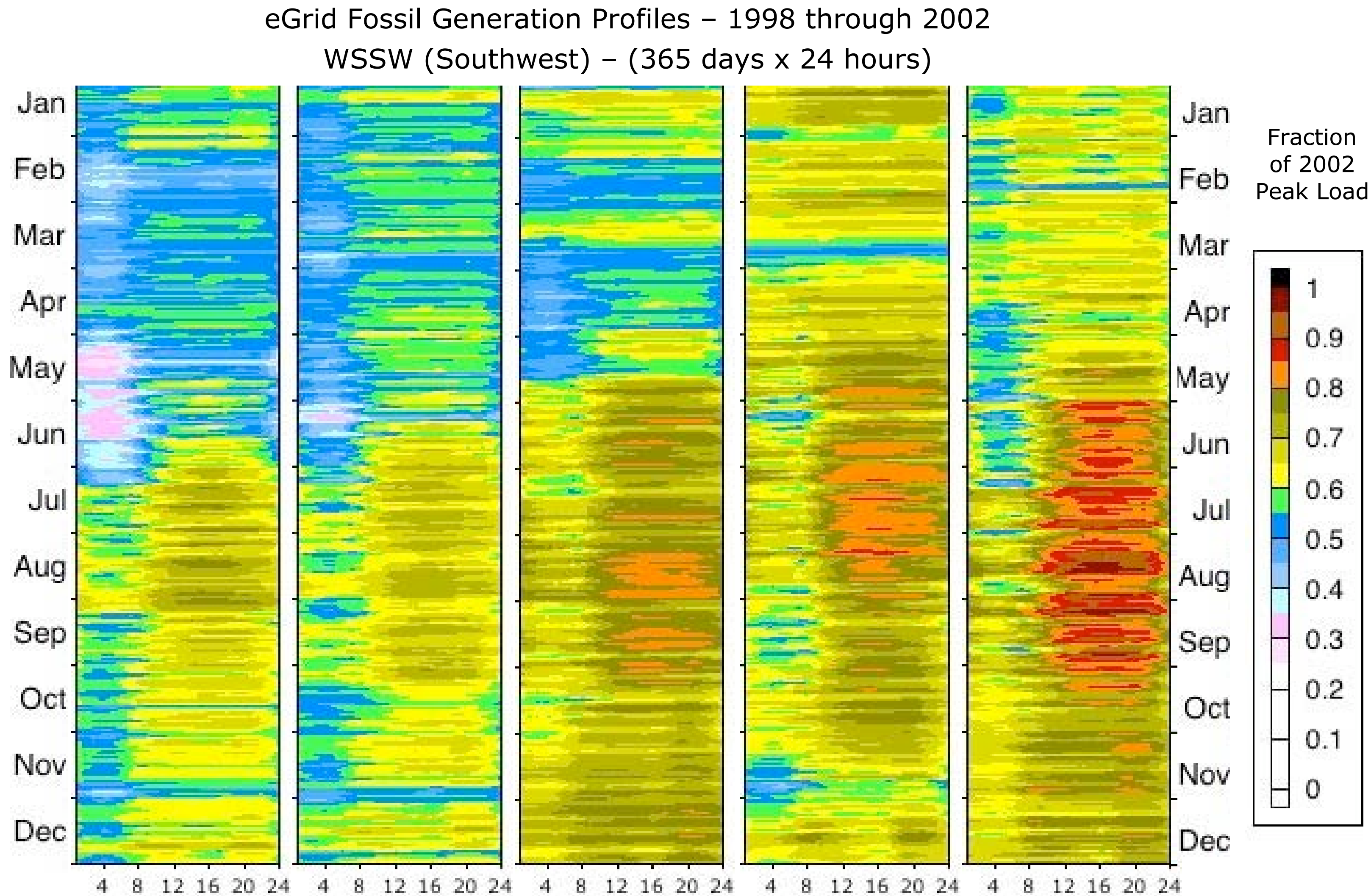
eGrid Fossil Generation Profiles – 1998 through 2002
NWPN (Pacific Northwest) – (365 days x 24 hours)



	1998	1999	2000	2001	2002
Gross (TWh)	35	35	37	37	36
Peak (GW)	5	5	5	5	6

Figure BII - 19. NWPN eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in NWPN (Pacific Northwest) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.



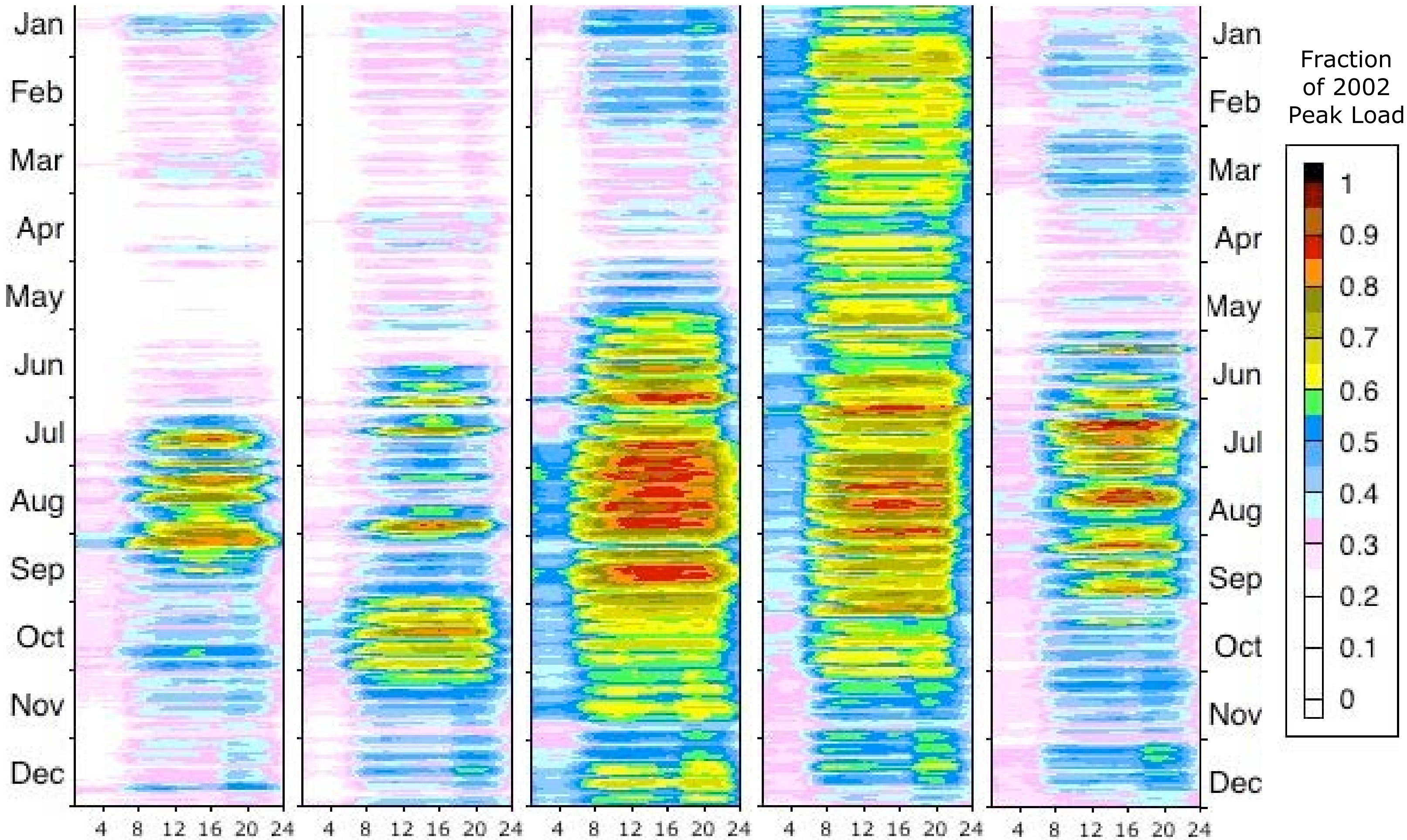
	1998	1999	2000	2001	2002
Gross (TWh)	73	76	86	88	90
Peak (GW)	12	11	12	13	15

Figure BII - 20. WSSW eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in WSSW (Southwest) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.

eGrid Fossil Generation Profiles – 1998 through 2002

CALI (California) – (365 days x 24 hours)



	1998	1999	2000	2001	2002
Gross (TWh)	60	65	93	105	75
Peak (GW)	19	19	21	20	22

Figure BII - 21. CALI eGrid Fossil Generation Profiles

Contour plots show hourly eGrid fossil generation in CALI (California) for the years 1998 through 2002. All data are normalized to the peak hourly load of 2002. Annual peak (GW) and Gross (TWh) load for each year are noted below the corresponding plot.