

Experimental Doppler-limited spectra of the ν_2 bands of H_2^{16}O , H_2^{17}O , H_2^{18}O , and HDO by Fourier-transform spectroscopy: secondary wave-number standards between 1066 and 2296 cm^{-1}

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Received July 17, 1982

More than 2000 absolute wave numbers of 7 vibrational bands of H_2^{16}O , H_2^{17}O , H_2^{18}O , and HDO (natural abundance) measured with a Fourier interferometer between 1066 and 2296 cm^{-1} are provided, with the greatest uncertainty about $50 \times 10^{-6} \text{ cm}^{-1}$ (1.5 MHz). These experimental values extracted from 12 different absorption spectra reveal a much greater consistency and are consequently given in inverse centimeters to the sixth decimal place. The spectral range covered corresponds to a large zone for which experimental accurate data were almost nonexistent. The precise knowledge of these strong atmospheric ν_2 bands is of interest for astronomical studies. It will also improve with complementary recent similar work on N_2O , the calibration of diode lasers, and Fourier-transform and classical spectrometers and will facilitate the coincidence search with laser radiation. For convenience, the wave numbers of the lines and their absolute uncertainty are given with their rotational and vibrational assignments and their experimental half-widths and intensities.

1. INTRODUCTION

The gas-phase water molecule has an intense ν_2 band covering a broad spectral area centered at 1595 cm^{-1} . Knowledge of this band and the surrounding ones is of interest for various purposes. Earth atmosphere studies require accurate information on the profiles, which is also of importance for the understanding of planetary and stellar atmospheres and interstellar clouds. In the laboratory, where parasitic absorption of the strongest features may induce error or misunderstanding in the measurements, the ν_2 band is often considered a troublesome partner for many spectroscopic techniques, such as laser and classical spectrometry. On the other hand, well-measured positions of these lines could be helpful for accurate calibration of spectral scales or, for instance, for easier search for coincidences in laser investigations. Nevertheless, the parameters available up to now on this bending ν_2 band are mostly due to theoretical predictions, obtained first from the early work of Benedict¹ and then from the extensive study of Camy-Peyret and Flaud.² The latest recorded experimental spectrum of the 6.3- μm bands of water vapor surprisingly is 26 years old. It was recorded by Dalby and Nielsen,³ and since then no additional experimental information in this spectral region has been provided. The improvement in the predicted lines, positions, and intensities^{2,4} has, however, been significant. This is due mainly to the theoretical progress made in the treatment of the vibration rotation of asymmetric rotors and to the availability in other spectral ranges of several Fourier spectra.⁵⁻⁷ Although they are extremely useful for numerous applications, the calculated positions of the ν_2 and the corresponding hot bands are often not accurate enough for calibration purposes since the error affecting these positions sometimes can reach almost 0.01 cm^{-1} . The extension of the working spectral range of the

Fourier interferometer of the Laboratoire d'Infrarouge from 5.5 to 10 μm made possible new measurements of the H_2^{16}O , H_2^{17}O , H_2^{18}O , and HDO bands reported in this paper. The lack of accurate secondary wave-number standards is particularly felt in this region by diode-Fourier-transform and classical spectroscopists. This is the main reason for undertaking this work, in which the aim is to provide accurate absolute wave numbers between 1100 and 2300 cm^{-1} . Moreover, the location of these lines makes a good complement to a recently published set of standards of N_2O (Ref. 8) located between 1100 and 1350 cm^{-1} , which is a spectral area where the density of water lines is small.

2. EXPERIMENT

The data are extracted from 12 different absorption spectra, the characteristics of which are given in Table 1. The optical white source is a global located in front of a White-type cell. Detectors are He-cooled Cu-doped Ge. The lower limit of the spectral range is about 10 μm . This is because the beam splitter is made of CaF_2 . The absorbing path-pressure product is not easy to determine. In fact, although from the source to the detectors the entire optical path equal to about 16 m is evacuated, some water remains in the residual air, the pressure of which is of the order of 0.1 Torr. If one assumes that the hygroscopic saturation is maximum and that a selective efficiency of the pumping increases the relative amount of H_2O by a factor of 3, then the pressure of the remaining water could be of the order of 10^{-2} Torr. This rough hypothesis applies to the first eight spectra of Table 1. In fact, all these spectra were recorded for the study of other molecules (N_2O , HN_3 , DN_3 , SiD_4). This is not true for the four remaining runs dealing only with H_2O . In this last case the

Table 1. Spectral Characteristics of the H₂O Absorption Spectra^a

Spectrum Number	Free Spectral Range (cm ⁻¹)	Number of Samples	Apodized Res. (10 ⁻³ cm ⁻¹)	Absorption Parameters	
				<i>L</i> (m)	<i>P</i> (10 ⁻³ Torr)
1556	0 – 2781	1,035,520	5.4	16	10
1574	0 – 2781	1,035,520	5.4	16	10
1575	0 – 2781	1,035,520	5.4	16	10
1588	1473 – 2947	496,384	5.9	16	10
1589	1473 – 2947	548,864	5.4	16	10
1590	1473 – 2947	483,840	6.1	16	10
1591	1473 – 2947	399,616	7.4	16	10
1598	0 – 2834	1,055,488	5.4	16	10
1600	0 – 2834	1,055,232	5.4	32.17	456
1601	0 – 2834	608,256	9.3	32.17	670
1603	0 – 2834	855,808	6.6	44.17	1,490
1604	0 – 2834	1,055,232	5.4	24.17	1,370

^a *L* and *P* are rough estimates for the eight first spectra.

absorption parameters are more precise since the residual water has a length-times-pressure (*L* × *P*) product at least 10² times less than the corresponding product given in the cell itself. Care has been taken to avoid possible pressure-shift effects on the lines by limiting the maximum pressure to about 1.5 Torr.

Figure 1 shows part of spectrum number 1603, which has the highest *L* × *P* product (see Table 1). It is a zoom-type presentation. The upper line represents the entire spectrum under a low resolution of 0.34 cm⁻¹. The intermediate resolution of 87 × 10⁻³ cm⁻¹ is shown on a narrower range on the second trace, and the full-resolution (6.7 × 10⁻³ cm⁻¹) plot

of a small part of the spectrum is given on the bottom line. The CO 1–0 band calibrating the wave-number scale⁹ is measured at the same time and under the same optical conditions in order to reduce the systematic possible shifts in the measurements of H₂O profiles. It is visible on the low-resolution plot as the ν₃ band of CO₂. The middle trace shows the central part of the ν₂ band of H₂O. The individual lines seen on the high-resolution drawing belong to four different isotopic species: H₂¹⁶O, H₂¹⁸O, H₂¹⁷O, and HD¹⁶O. Although the sample is of approximately natural abundance, it is obvious that under the present *L* × *P* conditions all these isotopic species are easily measurable. The isotopic shift can be

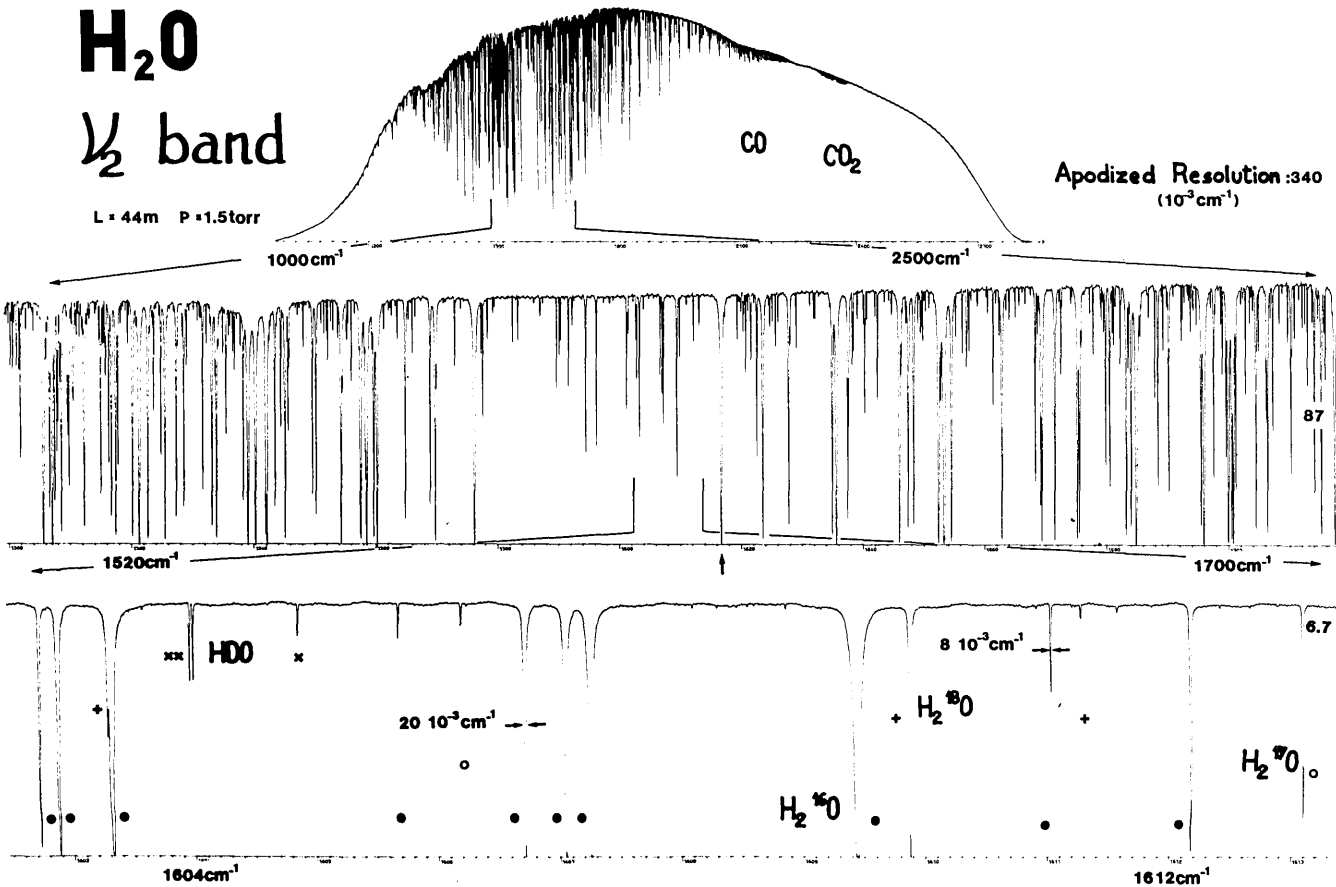


Fig. 1. Spectrum number 1603. Zoom-type presentation. The resolution improves from the upper to the lower trace. Isotopic species H₂¹⁷O, H₂¹⁸O, and HD¹⁶O are readily measurable.

Table 2. Observed Vibrational Transitions^a

Band Num- ber	Isotopic Species	Transitions						Observed												Num- ber of Lines		
								From				At		To				At				
		ν_1'	ν_2'	$\nu_3'-\nu_1''$	ν_2''	ν_3''	J'	K_A'	$K_C'-J''$	$K_A''K_C''$	(cm ⁻¹)	J	K_A'	$K_C'-J''$	$K_A''K_C''$	(cm ⁻¹)						
1	161	0	1	0	0	0	0	9	0	9	10	3	8	1066	12	3	10	11	0	11	2265	880
2	161	0	2	0	0	1	0	7	4	3	8	5	4	1268	8	3	6	7	0	7	2043	248
3	161	0	0	1	0	1	0	4	1	3	5	1	4	2026	6	2	4	5	2	3	2296	32
4	161	1	0	0	0	1	0	2	2	1	3	3	0	1881	5	4	1	4	3	2	2251	21
5	181	0	1	0	0	0	0	5	0	5	6	3	4	1267	7	7	0	6	6	1	2052	311
6	171	0	1	0	0	0	0	6	2	5	7	3	4	1315	6	6	1	5	5	0	1985	202
7	162	0	1	0	0	0	0	6	4	3	7	5	2	1191	7	6	2	6	5	1	1740	431

^a The isotopic species H₂¹⁶O, H₂¹⁷O, H₂¹⁸O, and HDO are given, respectively, as 161, 171, 181, and 162. The total number of observed lines is 2125.

appreciated from the two strongest lines of H₂¹⁸O and H₂¹⁷O of the bottom row. They have the same rotational assignment ($J'K_A'K_C' - J'', K_A'', K_C'' = 110-101$) in their corresponding ν_2 bands. The similar transition of H₂¹⁶O is marked with an arrow on the intermediate scale. In the case of HDO the identically assigned line is far away, located at 1422.692 cm⁻¹ according to the rules of the isotopic shift in triatomic molecules (see Ref. 10). The number of H₂O lines detected in this spectrum 1603 is 1597, which is smaller than the total number (2125) given in Table 2. This means that the intense lines, which are saturated according to the $L \times P$ product, are not measured in this spectrum.

Table 2 reports the observed bands and their spectral extension. It can be seen that only H₂¹⁶O has three hot bands with their corresponding ν_2 , which is the only transition observable for the three other isotopic species. The 2125 lines extend from 1066 to 2296 cm⁻¹. In fact, in our spectra, 65 additional lines of the band 100-000 of HDO were also present from 2563 to 2723 cm⁻¹. They were retained by the selection tests reported in Section 3. However, since they are (1) covering only a small portion of this band, (2) rather far from the ν_2 band, and (3) already measured with a Fourier interferometer,¹¹ they are not given in Tables 2 and 3. Extensive work on HDO and D₂O has since been undertaken. Exhaustive spectra of the ν_2 and corresponding hot bands of HDO and D₂O have been recorded with the interferometer at the Laboratoire d'Infrarouge and are now under study by Camy-Peyret *et al.*¹²

3. TREATMENT OF THE DATA AND RESULTS

The wave number, the half-width, the intensity, the quality of the symmetry, and the signal-to-noise ratio of each line appearing in each spectrum are automatically measured and stored on a magnetic tape. The first step of the treatment of these lines is their identification as H₂O lines, followed by their selection into a restricted set of high-quality data. Since one transition is generally measured in several spectra, its mean value must be obtained. This needs a weighting procedure. The final step of the treatment is to determine the accuracy of the resulting wave numbers. The great amount of data implies that all these operations are made automatically as much as possible.

The original set of wave numbers used to extract the H₂¹⁶O, H₂¹⁷O, and H₂¹⁸O lines from the spectra is taken from Ref. 4. Only the lines with an intensity $I > 0.5 \times 10^{-24}$ cm⁻¹/mol cm⁻² were necessary and used. This simplified the finding

procedure and avoided false detections. No such data were available for HDO, which is also present in several spectra. Camy-Peyret and Flaud¹³ provided us with a list of these lines, the corresponding wave numbers of which are taken in spectrum number 1603 and included in the reference file. To be selected, a line was subjected to four tests. It first has to be located not farther than $\pm 8 \times 10^{-3}$ cm⁻¹ from a reference line. This number was determined by taking into account the expected maximum error on the wave numbers of the reference file. With 10×10^{-3} instead of 8×10^{-3} cm⁻¹, the number of additional detected lines is negligible (only 0.04% of the whole). The measured half-width $d\sigma$ (total width at mid-height) must then be smaller than 12×10^{-3} cm⁻¹ if its relative intensity ($I_0 - I/I_0$) (I_0 , intensity of the source background; I , intensity of the top of the line) is smaller than 0.9. For ($I_0 - I/I_0$) between 0.9 and 1, $d\sigma$ is smaller than 20×10^{-3} cm⁻¹. The third test consists of an examination of a criterion of symmetry of the profile. If the line is considered asymmetrical, it is not retained. The last test bears on the signal-to-noise ratio, which must be greater than 10. Consequently, after this selection, one is then almost certain to retain the lines that belong to H₂O. Moreover, these lines do not overlap neighboring transitions. The saturation of their profile when it occurs is only weak, and the position of their axis of symmetry can only be slightly perturbed by the noise. In practice, about 7500 measurements were retained and condensed into 2125 mean values.

In order to perform the weighted mean value leading to the wave numbers given in Table 3, the determination of a weight for each selected line must be done. The uncertainty u that is due to the noise on the position of a profile having an half-width of $d\sigma$ and a signal-to-noise ratio of S/N is

$$u = \frac{\pi}{8} \frac{d\sigma}{S/N}.$$

The quantity u is determined for each selected line. The corresponding weight g is

$$g = \frac{1}{u^2}.$$

If the wave number of a transition is measured in n spectra, the resulting mean value σ is obtained¹⁴ by the relation

$$\sigma = \frac{\sum_{i=1}^n g_i \sigma_i}{\sum_{i=1}^n g_i}, \quad (1)$$

Table 3. Absolute Wave Numbers of the ν_2 Bands of Water

1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
1066.154350	315					9	0	9	10	3	8	1	161	1280.696312	85				107	60	6	1	5	7	2	6	7	162	
1099.678984	263					9	2	7	10	5	6	1	161	1280.917204	75				132	61	8	0	8	9	0	9	7	162	
1101.450495	245					6	2	5	7	5	2	1	161	1281.161444	55				242	62	9	8	2	10	9	1	1	161	
1106.743722	129					9	1	8	10	4	7	1	161								9	8	1	10	9	2	1	161	
1120.831899	407					8	2	6	9	5	5	1	161	1281.264213	83				110	61	7	2	5	8	2	6	7	162	
1121.231923	113					8	0	8	9	3	7	1	161	1281.454881	73				131	61	8	1	8	9	1	9	7	162	
1135.745157	81					8	1	8	9	2	7	1	161	1281.817685	89				92	60	8	1	8	9	0	9	7	162	
1137.425672	100					7	2	5	8	5	4	1	161	1282.806502	332						8	4	5	9	5	4	5	181	
1149.469026	87					8	1	7	9	4	6	1	161	1283.609406	142				54	62	8	3	6	9	3	7	7	162	
1152.444112	99					9	2	8	10	3	7	1	161	1283.757221	65				172	61	3	1	3	4	2	2	7	162	
1165.369775	93					5	2	3	6	5	2	1	161	1284.305946	50				607	66	3	1	2	4	4	1	1	161	
1173.718283	78					10	3	8	11	4	7	1	161	1284.898233	72				138	61	7	1	6	8	1	7	7	162	
1186.714287	411					11	4	8	12	5	7	1	161	1286.028740	53				285	64	6	1	6	6	4	3	1	161	
1187.021656	59					7	1	6	8	4	5	1	161	1286.693355	268						10	1	9	10	4	6	1	161	
1191.132979	203					6	4	3	7	5	2	7	162	1287.011631	289						6	5	2	6	6	1	7	162	
1191.214431	210					6	4	2	7	5	3	7	162							6	5	1	6	6	0	7	162		
1193.513790	109					5	5	0	6	6	1	7	162	1287.403386	51				1000	92	8	4	5	9	5	4	1	161	
						5	5	1	6	6	0	7	162	1287.639176	52				373	62	2	2	1	3	3	0	7	162	
1196.191847	373					7	3	4	8	4	5	7	162	1288.018826	52				367	62	2	2	0	3	3	1	7	162	
1198.178259	52					7	1	7	8	2	6	1	161	1288.141947	65				179	64	7	3	4	8	4	5	2	161	
1206.020109	115					5	4	2	6	5	1	7	162							5	1	4	9	6	2	5	7	162	
1206.036436	108					117	60	5	4	1	6	5	2	7	162	1288.250249	49	257	64	985	83	8	5	4	9	6	3	1	161
1206.366596	140					98	60	6	3	4	7	4	3	7	162	1288.886870	49			829	70	8	5	3	9	6	4	1	161
1208.739348	142					90	64	6	3	3	7	4	4	7	162	1290.536185	49			921	74	8	6	3	9	7	2	1	161
1211.235776	54					506	63	4	1	4	5	4	1	161	1290.559212	49			637	65	8	6	2	9	7	3	1	161	
1212.246954	31					987	77	8	2	7	9	3	6	1	161	1291.348231	125			61	64	6	4	3	7	5	2	2	161
1213.007246	338					11	5	7	12	6	6	1	161	1291.905627	287						6	5	2	7	6	1	2	161	
1214.958404	148					8	1	8	8	4	5	1	161	1292.372005	77				105	62	9	9	1	10	10	0	1	161	
1215.484391	168					6	2	5	7	3	4	7	162							9	9	0	10	10	1	1	161		
1218.519932	50					778	68	6	1	5	7	4	4	1	161	1292.827150	100			70	62	6	3	4	7	4	3	2	161
1219.147177	515					11	6	6	12	7	5	1	161	1292.959802	213				76	62	7	3	4	8	3	5	7	162	
1220.344753	137					82	60	11	6	5	12	7	6	1	161	1293.289512	68			149	62	7	0	7	8	1	8	7	162
1221.048705	60					278	64	4	4	0	5	5	1	7	162	1293.315804	74			128	61	7	2	6	8	2	7	7	162
						4	4	1	5	5	0	7	162	1293.745072	317						8	4	4	9	4	5	7	162	
1221.817820	90					141	63	5	3	3	6	4	2	7	162	1293.961501	126			59	59	9	1	9	9	2	8	7	162
1222.625461	87					133	61	5	3	2	6	4	3	7	162	1293.980845	61			194	62	7	0	7	8	0	8	7	162
1224.891283	259					11	7	4	12	8	5	1	161	1294.920730	60				196	61	7	1	7	8	1	8	7	162	
1224.977992	52					496	64	9	3	7	10	4	6	1	161	1295.612131	67			148	60	7	1	7	8	0	8	7	162
1225.006478	49					935	74	6	0	6	7	3	5	1	161	1296.408780	59			215	64	4	1	3	5	2	4	7	162
1225.551515	52					472	63	10	4	7	11	5	6	1	161	1296.490427	49			830	70	8	7	2	9	8	1	1	161
1226.103782	90					126	62	11	5	6	12	6	7	1	161						8	7	1	9	8	2	1	161	
1226.944288	226					5	1	5	6	2	4	7	162	1296.709705	49				923	76	8	4	4	9	5	5	1	161	
1229.363916	157					65	67	9	0	9	9	3	6	1	161	1296.777923	65			164	61	6	2	4	7	2	5	7	162
1232.732568	421					7	2	5	8	3	6	7	162	1297.183450	57				235	68	14	0	14	15	1	15	1	161	
1236.295600	83					133	62	5	2	4	6	3	7	162						14	1	14	15	0	15	1	161		
1237.076934	63					209	62	4	3	2	5	4	1	7	162	1297.206022	60			205	62	6	1	5	7	1	6	7	162
1237.279027	64					212	60	4	3	1	5	4	2	7	162	1298.156738	98			80	63	7	3	5	8	3	6	7	162
1239.219376	32					405	63	10	5	6	11	6	5	1	161	1299.219151	262			45	65	5	4	2	5	5	1	7	162
1239.997798	88					129	68	6	2	4	7	3	5	7	162	1299.234430	319					5	4	1	5	5	0	7	162
						8	2	7	8	5	4	1	161	1299.980261	141						6	4	3	6	5	2	7	162	
1240.597552	371					11	0	11	12	0	12	7	162	1300.053455	141						6	4	2	6	5	1	7	162	
1242.799514	57					10	6	5	11	7	4	1	161	1300.838885	131				62	63	9	0	9	9	1	8	7	162	
1243.190749	93					98	62	10	6	4	11	7	5	1	161	1300.938932	153			44	63	7	4	4	7	5	3	7	162
1244.138471	49	180	63			985	80	11	9	2	12	10	3	1	161	1301.198212	166					7	4	3	7	5	2	7	162
						5	1	4	6	4	3	1	161	1302.696302	419						7	3	5	8	4	4	5	181	
1244.803277	69					167	62	10	5	5	11	6	6	1	161	1302.819046	225					8	4	4	8	5	3	7	162
1248.446405	76					136	65	10	7	4	11	8	3	1	161	1303.325013	379					9	4	6	9	5	5	7	162
1248.463438	174					10	7	3	11	8	4	1	161	1304.285946	255						6	3	3	7	4	4	2	161	
1251.349646	80					136	64	3	1	3	4	4	0	1	161	1304.699215	208					7	2	6	8	1	7	7	162
1253.346201	138					71	69	7	1	7	7	4	4	1	161	1305.483591	50			567	64	8	8	1	9	9	0	1	161
1253.448580	267					9	2	7	10	2	8	7	162							8	8	0	9	9	1	1	161		
1253.924273	366					6	1																						

Table 3. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1316.129912	71			115	62	5	4	1	6	5	2	2	161	1350.204370	55			303	62	3	1	3	3	2	2	7	162	
1316.257339	70			130	62	5	3	2	5	4	1	7	162	1350.258860	57			257	62	3	2	2	4	2	3	7	162	
1316.413933	113			58	69	8	3	6	8	4	5	7	162	1350.750648	105			69	62	6	3	3	7	4	4	5	181	
1316.453130	85			93	61	7	3	5	7	4	4	7	162	1351.570485	55			308	64	4	2	3	5	3	2	2	161	
1316.782137	82			109	65	8	0	8	8	1	7	7	162	1352.348995	51			556	66	11	2	9	12	3	10	1	161	
1316.608929	54			320	64	2	1	1	3	2	2	7	162	1352.390814	64			162	61	7	2	5	7	3	4	7	162	
1316.972767	52	674	68	1000	119	7	4	3	8	5	4	1	161	1354.579258	58			239	62	2	1	2	2	2	1	7	162	
1317.132607	55			283	62	5	0	5	6	1	6	7	162	1354.846044	53	701	70	1000	127	6	3	3	7	4	4	1	161	
1317.700567	67			149	60	7	1	7	7	2	6	7	162	1355.210186	61			200	64	5	2	3	6	3	4	2	161	
1318.112742	75			119	61	6	3	3	6	4	2	7	162	1355.437066	55			309	63	3	1	3	4	0	4	7	162	
1318.929829	56			1000	149	6	2	5	7	3	4	1	161	1355.736660	54			342	63	2	1	1	3	1	2	7	162	
1319.229562	54			316	64	10	3	7	11	4	8	1	161	1355.988595	69			139	62	8	1	7	8	2	6	7	162	
1319.433545	54			327	62	5	0	5	6	0	6	7	162	1356.038919	486					10	1	10	10	2	9	2	161	
1320.055944	51	470	66	1000	109	5	1	5	6	2	4	1	161	1356.155764	98			76	62	12	4	9	13	3	10	1	161	
1320.327579	114			61	60	5	3	3	6	4	2	2	161	1356.626567	76			114	63	8	2	6	8	3	5	7	162	
1320.869058	50	248	63	976	81	7	7	0	8	8	1	1	161	1356.759492	125			57	64	4	4	0	5	4	1	7	162	
1321.083697	57			225	61	5	2	4	6	2	5	7	162	1356.773982	122			62	62	4	4	1	5	4	2	7	162	
1321.144850	86			91	63	7	3	4	7	4	3	7	162	1356.844215	81			106	63	5	2	4	6	3	3	5	181	
1321.428190	83			97	62	8	2	7	8	3	6	7	162	1357.137129	174					5	5	1	6	5	2	7	162	
1321.877848	54			319	62	5	1	5	6	1	6	7	162	1357.161732	57			253	68	5	5	1	6	6	0	5	181	
1322.558202	95			80	63	6	2	4	6	5	1	1	161	1358.026952	52	296	65	1000	89	11	0	11	12	1	12	1	161	
1323.334734	50	212	62	941	80	9	3	6	10	4	7	1	161	1358.050231	51			892	74	11	1	11	12	0	12	1	161	
1323.529008	106			75	64	6	2	5	7	1	6	7	162	1358.464187	53			415	63	2	0	2	3	0	3	7	162	
1324.178791	56			269	62	5	1	5	6	0	6	7	162	1358.578824	53			388	65	8	1	7	8	4	4	1	161	
1324.349770	63			177	64	5	3	2	6	4	3	2	161	1358.722220	414					9	1	8	10	2	9	2	161	
1324.809127	53			330	64	4	1	3	5	1	4	7	162	1358.860709	72			117	62	5	4	2	6	5	1	5	181	
1325.608665	222					13	2	11	14	3	12	1	161	1358.906438	105			70	65	9	2	7	9	3	6	7	162	
1325.662204	114			61	63	8	3	5	8	4	4	7	162	1359.081114	54			303	62	5	4	1	6	5	2	5	181	
1325.822899	115			59	60	6	4	3	7	4	4	7	162	1359.171603	73			121	62	3	3	1	4	3	2	7	162	
1326.031366	53			337	62	1	1	1	2	2	0	7	162	1359.565265	451					5	2	4	6	3	3	6	171	
1326.135141	58			186	62	13	1	12	14	2	13	1	161	1360.512100	54			349	63	5	0	5	5	1	4	7	162	
1326.331576	95			67	63	13	2	12	14	1	13	1	161	1360.846074	336					5	4	2	6	5	1	6	171	
1326.357683	67			145	61	7	2	6	7	3	5	7	162	1360.914659	54			364	64	1	0	1	2	1	2	7	162	
1326.852600	67			134	61	5	3	2	6	3	3	7	162	1361.014007	51			867	73	11	1	10	12	2	11	1	161	
1327.071446	63			154	63	14	1	14	14	2	13	1	161	1361.084664	57	986	93	1000	168	5	5	1	6	6	0	1	161	
1327.599380	112			59	63	14	0	14	14	1	13	1	161	1361.796540	52			553	66	11	2	10	12	1	11	1	161	
1327.735911	74			124	64	4	1	4	5	2	3	2	161	1362.604060	55	847	74	1000	153	5	2	4	6	3	1	1	161	
1327.844881	53			342	65	9	1	8	9	4	5	1	161	1362.928897	56			277	63	12	1	1	2	2	0	7	162	
1327.948542	59			208	61	6	1	6	6	2	5	7	162	1363.063031	53	857	73	1000	137	11	3	9	12	2	10	1	161	
1328.096881	54			334	63	4	0	4	5	1	5	7	162	1363.114558	56					5	2	1	2	3	1	3	7	162
1328.273850	68			143	63	5	3	3	6	3	4	7	162	1363.264110	57	964	86	1000	191	5	4	1	6	5	2	1	161	
1328.638448	394			362	63	13	3	11	14	2	12	1	161	1363.564466	111			54	63	9	0	9	10	1	10	2	161	
1329.274063	51			948	81	8	3	5	9	4	6	1	161	1363.834528	295					9	1	9	10	0	10	2	161	
1329.905092	53			198	63	6	2	5	6	3	4	7	162	1363.905793	97			75	63	4	2	3	5	1	4	7	162	
1329.931992	64			252	61	4	2	2	5	2	3	7	162	1363.951412	67			139	63	5	3	3	6	4	2	5	181	
1330.094254	56					9	3	6	9	4	5	7	162	1363.977790	61			197	63	2	2	0	3	2	1	7	162	
1331.015615	53			384	63	4	0	4	5	0	5	7	162	1365.257214	503					5	1	5	5	1	4	7	162	
1332.015615	53			293	62	5	2	4	5	3	3	7	162	1365.301397	60			200	63	2	2	1	3	2	2	7	162	
1332.293330	58			380	62	10	1	9	10	2	8	7	162	1365.865651	54			391	64	3	1	2	3	2	1	7	162	
1332.470723	246					7	0	7	7	1	6	7	162	1366.160940	226					5	3	3	6	4	2	6	171	
1332.578992	66			163	62	6	5	2	7	6	1	5	181	1367.574626	55			325	63	6	1	5	6	2	4	7	162	
1332.735151	79			96	61	7	2	5	7	5	2	1	161	1367.992410	516					9	2	7	10	3	8	5	181	
1332.757374	78			303	64	6	5	1	7	6	2	5	181	1368.209204	53			421	64	4	1	3	4	2	2	7	162	
1333.489323	60			214	64	4	1	4	4	4	1	1	161	1368.627843	56	898	76	1000	159	5	3	3	6	4	2	1	161	
1333.654835	58			234	61	4	2	3	4	3	2	7	162	1368.928893	60			215	63	4	1	4	5	2	3	5	181	
1333.693277	180					10	2	8	10	5	5	1	161	1369.023031	53			400	65	5	1	4	5	2	3	7	162	
1334.277049	63			179	63	3	2	2	3	3	1	7	162	1369.422012	54			362	65	5	3	2	6	4	3	5	181	
1334.310735	66			148	62	6	4	3	7	5	2	5	181	1369.531720	70			132	64	4	2	2	5	3	3	2	161	
1334.592110	449					6	5	2	7	6	1	6	171	1369.828001	51			804	70	12	1	12	12	2	11	1	161	
1335.375941	126			56	63	6	4	2	7	5	3	5	181	1369.953272	53			457	65	12	0	12	12	1	11	1	161	
1335.458181	242			75	61	6	6	0	7	7	0																	

Table 3. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
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1388.483779	52				727	71	6	1	5	6	4	2	1	161	1424.874491	54				423	66	3	2	2	4	3	1	5	181
							5	1	4	5	4	1	5	181	1425.845261	55				341	64	12	1	11	12	2	10	1	161
1388.864411	249						14	1	13	14	2	12	1	161	1426.024789	54				456	65	2	1	1	2	0	2	7	162
1389.016469	131				42	62	9	1	8	10	2	9	5	181	1426.131642	258						9	1	9	9	2	8	5	181
1389.910740	52				590	67	4	3	2	5	4	1	5	181	1426.440916	64				147	66	6	2	5	7	1	6	2	161
1390.231370	91				78	63	6	2	4	7	3	5	5	181	1426.610549	54				540	69	3	1	2	4	2	3	2	161
1390.522136	52				915	79	5	1	4	5	4	1	1	161	1427.196631	81				82	62	9	0	9	9	1	8	5	181
1390.758623	52				804	71	11	1	11	11	2	10	1	161	1427.268426	75				102	66	3	2	2	4	3	1	6	171
1391.026768	52	217	67		974	85	11	0	11	11	1	10	1	161	1427.849999	370						7	3	4	7	3	5	7	162
1391.326255	56				271	63	4	3	1	5	4	2	5	181	1428.271463	54	488	69	1000	111		8	3	6	9	2	7	1	161
1392.066254	62				166	63	4	3	2	5	4	1	6	171	1428.679229	61				179	65	7	0	7	7	1	6	2	161
1392.157655	69				116	62	9	0	9	10	1	10	5	181	1429.411555	87				77	63	7	2	6	8	1	7	1	161
1393.439885	104				62	63	4	3	1	5	4	2	6	171	1429.945392	61	984	100				3	2	2	4	3	1	5	181
1393.880440	53				533	67	4	2	3	5	3	2	5	181	1430.742382	54				431	65	7	0	7	8	1	0	5	181
1394.446270	62	573	69				9	1	8	10	2	9	1	161	1430.864242	268						7	3	4	6	4	3	7	162
1394.474820	63	991	104				4	3	2	5	4	1	1	161	1431.231258	61				177	65	7	1	7	8	0	8	5	181
1394.496599	60	768	73				6	2	4	7	3	5	1	161	1431.491102	66				139	63	6	1	5	7	2	6	5	181
1394.784983	328						9	0	9	10	1	10	6	171	1431.600126	54				445	65	3	1	2	3	0	3	7	162
1395.802899	59	980	87				4	3	1	5	4	2	1	161	1432.347266	506						7	2	6	8	1	7	6	171
1396.097922	234						3	1	3	2	2	0	7	162	1432.412308	114						6	1	6	5	4	1	1	161
1396.324311	142						4	2	3	5	3	2	6	171	1433.203624	55	766	72	1000	129		9	0	9	9	1	8	1	161
1396.394966	66				147	64	2	1	2	2	1	1	7	162	1433.446958	74				108	66	7	0	7	8	1	8	6	171
1397.320969	67				140	63	2	1	2	2	1	1	7	162	1433.608971	55	220	66		977	91	4	0	4	4	3	1	1	161
1397.575873	52	255	68		985	89	9	2	8	10	1	9	1	161	1433.663037	126				50	71	4	1	3	4	4	7	162	
1397.733292	54	859	75	1000	136		9	0	9	10	1	10	1	161	1433.696899	58				248	64	2	1	2	1	1	1	7	162
1397.843834	53	549	69	1000	108		9	1	9	10	0	10	1	161	1433.928669	188				34	66	6	1	5	7	2	6	6	171
1399.204587	63	990	105				4	2	3	5	3	2	1	161	1433.962068	145				40	72	7	1	7	8	0	8	6	171
1400.087358	83				86	66	8	1	8	8	2	7	2	161	1434.273507	75				280	65	3	2	1	4	3	2	6	171
1400.540358	54				380	65	5	2	3	6	3	4	5	181	1434.286221	69				329	64	2	0	2	1	0	1	7	162
1400.942655	57				238	65	7	0	7	8	1	8	2	161	1434.656287	68				134	65	4	1	3	3	2	2	7	162
1401.065216	213						4	2	2	3	3	1	7	162	1434.687450	56				335	82	9	2	8	8	5	3	1	161
1401.964475	96				72	63	5	2	4	5	2	3	7	162								4	4	0	4	4	1	7	162
1402.055821	81				92	68	7	1	7	8	0	8	2	161								4	4	1	4	4	0	7	162
1402.640356	83				95	67	5	2	3	6	3	4	6	171	1434.929080	66				133	64	5	4	2	5	4	1	7	162
1402.804108	56				272	64	1	1	1	1	0	0	7	162	1434.960411	67				132	63	5	4	1	5	4	2	7	162
1403.462556	52				851	75	9	3	7	10	2	8	1	161	1435.176264	90				72	65	6	4	3	6	4	2	7	162
1403.813943	196						7	2	6	8	1	7	2	161	1435.215153	422						8	4	5	8	4	4	7	162
1404.168888	56				283	66	5	1	4	6	5	2	2	161	1435.300384	56				307	64	1	1	1	0	0	0	7	162
1404.229043	166				37	64	2	2	1	3	1	2	7	162	1435.649935	55	753	72	1000	131		7	2	6	8	1	7	1	161
1404.273390	104				60	63	4	1	4	3	2	1	7	162	1435.887670	150				37	63	7	4	3	7	4	4	7	162
1404.445222	253						8	0	8	8	1	7	2	161	1436.233556	54				536	69	5	0	5	6	1	6	2	161
1404.596520	162						8	0	7	9	2	8	5	181	1436.480612	61	984	98				7	0	7	8	1	8	1	161
1404.990296	61	973	96				5	2	3	6	3	4	1	161	1436.653875	57	918	78	1000	165		6	1	5	7	2	6	1	161
1405.726387	163				37	69	10	1	10	10	2	9	5	181	1436.818589	66	987	122				3	2	1	4	3	2	1	161
1406.150866	69				113	63	13	2	12	13	3	11	1	161	1436.928636	62				395	66	3	0	3	2	1	2	7	162
1406.429564	514						8	1	8	7	4	3	1	161	1437.026489	57	924	82	1000	168		7	1	7	8	0	8	1	161
1406.726678	344						12	5	8	13	4	9	1	161	1438.807985	124				45	70	14	3	12	14	4	11	1	161
1407.164363	55				295	65	13	1	12	13	2	11	1	161	1439.701572	58				238	63	2	1	1	1	1	0	7	162
1407.905977	74				131	62	4	2	3	4	2	2	7	162	1439.889056	55				358	65	4	1	3	4	0	4	7	162
1408.391770	56				270	63	1	1	0	1	1	1	7	162	1440.573147	56				288	66	6	1	6	6	2	5	2	161
1408.529853	53				678	70	2	2	1	3	3	0	2	161	1440.700004	58				237	66	5	1	5	6	0	6	2	161
1408.657383	118				56	63	5	1	5	4	2	2	7	162	1441.086301	224						8	2	7	7	3	4	7	162
1408.829353	192						6	1	6	5	2	3	7	162	1441.344171	53				718	71	11	2	10	11	3	9	1	161
1409.717912	307						6	3	4	5	4	1	7	162	1441.540818	215				72	65	8	2	7	8	3	6	2	161
1409.759511	55				333	66	2	2	0	3	3	1	2	161	1441.558694	56				314	67	2	1	1	3	2	2	2	161
1409.969033	53	501	69	1000	109		8	1	7	9	2	8	1	161	1442.710385	401						3	0	3	3	3	0	5	181
1410.114542	73				100	62	8	2	7	9	1	8	5	181	1442.826413	54				523	67	5	1	4	6	2	5	5	181
1410.236042	58				225	63	3	2	2	3	2	1	7	162	1443.235390	105				57	61								

Table 3. Continued

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1458.267356	64	990	111			2	2	0	3	3	1	1	161	1488.534273	70					117	65	6	3	3	6	2	4	7	162				
1458.300355	69	413	68			10	2	9	10	3	8	1	161	1488.630891	71					110	63	6	2	5	6	1	6	7	162				
1458.374316	96					3	2	2	2	2	1	7	162	1488.865797	181							10	0	10	9	3	7	1	161				
1459.261287	62	981	96			4	1	3	5	2	4	1	161	1488.917308	59							234	65	5	2	4	4	2	3	7	162		
1459.420185	55					3	1	3	2	2	2	7	162	1489.050276	58	928	82	1000	165			8	2	7	8	3	6	1	161				
1459.608067	54					736	73	1	0	2	2	1	2	161	1489.302818	57	830	76	1000	152			6	3	4	7	2	5	1	161			
1459.755348	61					186	63	3	2	1	2	2	0	7	162	1489.842311	63	974	108			6	1	6	6	2	3	1	161				
1459.889376	172							8	3	6	8	4	3	2	161	1490.040697	169	107	66			4	1	4	5	0	5	5	181				
1460.435219	65							7	2	5	7	1	6	7	162	1490.826093	64	994	111			4	0	4	5	1	5	1	161				
1461.911960	59					247	66	2	1	2	3	2	1	6	171	1491.233954	58					298	66	2	2	0	1	1	7	162			
1462.102685	271							8	4	5	8	5	4	2	161	1491.390779	56	292	68	999	97	10	3	8	10	4	7	1	161				
1462.365493	61					180	66	13	2	11	13	3	10	1	161	1491.517229	119					46	68	8	2	6	7	3	5	7	162		
1462.528558	512							7	4	4	7	5	3	2	161	1492.308904	59					232	66	6	0	6	6	1	5	5	181		
1462.563452	64					160	65	2	2	1	2	1	2	7	162	1492.521467	67					129	64	5	3	2	5	2	3	7	162		
1462.631525	56					381	65	4	0	4	3	0	3	7	162	1492.965758	57					375	68	4	1	4	5	0	5	6	171		
1462.658955	102					61	69	6	4	3	6	5	2	2	161	1493.277327	55					575	70	1	1	1	2	2	0	5	181		
1462.732212	273							5	4	2	5	5	1	2	161	1494.869120	61					229	64	5	2	3	4	2	2	7	162		
1462.844157	100					61	64	5	4	1	5	5	0	2	161	1495.038287	273							9	3	6	9	4	3	2	161		
1463.173382	285							6	4	2	6	5	1	2	161	1495.401311	118					47	68	6	0	6	6	1	5	6	171		
1463.376138	498							6	5	2	6	6	1	2	161	1495.506345	57					313	66	12	4	9	12	5	8	1	161		
1464.106749	190							7	3	5	7	4	4	2	161	1495.612075	56					548	70	2	1	2	2	2	1	2	161		
1464.227465	149					36	67	7	4	3	7	5	2	2	161	1495.685646	68					125	64	4	3	1	4	2	2	7	162		
1464.458854	58					252	66	6	2	5	6	3	4	2	161	1495.884241	64					159	67	1	1	1	2	2	0	6	171		
1464.905433	67	982	124			2	1	2	3	2	3	2	1	1	161	1496.249268	68	984	135					4	1	4	5	0	5	1	161		
1465.177821	54	171	68			960	85	10	1	9	10	2	8	1	161	1496.428107	58					408	68	5	2	3	5	3	2	2	161		
1465.545754	70					119	65	7	1	7	7	2	6	5	181	1496.561442	131					46	66	8	1	7	8	0	8	7	162		
1466.584852	65					144	67	6	3	4	6	4	3	2	161	1497.621000	76					93	63	3	3	0	3	2	1	7	162		
1466.778239	54					801	73	3	1	2	4	2	3	5	181	1497.881040	56					456	67	7	0	7	6	1	6	7	162		
1466.838270	113					56	63	7	2	5	6	3	4	7	162	1497.968682	408							10	2	8	10	1	9	7	162		
1466.909821	61					196	64	3	2	2	3	1	3	7	162	1498.380258	55					769	75	1	0	1	2	1	2	2	161		
1467.025348	175					35	66	8	1	7	8	2	6	2	161	1498.585820	63					174	64	7	1	6	6	2	5	7	162		
1467.472799	55					502	67	12	3	10	12	4	9	1	161	1498.803541	64	1000	113					1	1	1	2	2	0	1	161		
1467.646080	53					743	74	3	0	3	4	1	4	2	161	1498.875086	61	973	90					6	0	6	6	1	5	1	161		
1467.676782	54					790	73	5	0	5	6	1	6	5	181	1499.269803	77					92	65	3	3	1	3	2	2	7	162		
1467.797872	89					73	65	5	3	3	5	4	2	2	161	1499.828513	57					334	68	4	0	4	4	1	3	2	161		
1467.982549	82					79	65	6	6	0	6	6	1	7	162	1500.159312	35	126	71			912	82	1	1	0	2	2	1	5	181		
						6	6	6	1	6	6	0	7	162	1500.181932	83					221	66	7	0	7	6	0	6	7	162			
1468.267184	61					185	65	4	3	2	4	4	1	2	161	1500.546307	56	268	68			996	97	9	3	7	9	4	6	1	161		
1468.346360	169					39	89	7	6	1	7	6	2	7	162	1500.765696	57					326	66	5	1	5	5	2	4	5	181		
								7	6	2	7	6	1	7	162	1500.838723	66					138	64	5	3	2	4	3	1	7	162		
								9	2	8	9	3	7	5	181	1501.116239	58					306	66	3	2	2	2	1	1	7	162		
1469.108588	114					70	67	4	3	1	4	4	0	2	161	1501.188754	55	135	66			918	82	3	0	3	4	1	4	5	181		
1469.265636	57					289	66	3	1	2	4	2	3	6	171	1501.248765	56					504	69	4	2	3	3	1	4	5	181		
1469.366090	55					516	67	5	0	5	4	1	4	7	162	1501.614689	67					356	68	11	4	8	11	5	7	1	161		
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1469.858821	81					85	63	8	2	6	8	1	7	7	162	1501.813250	53					456	69	7	1	7	6	0	6	7	162		
1470.007947	55					523	67	4	1	4	3	0	3	7	162	1501.842603	57	874	78	1000	156	7	2	6	7	3	5	1	161				
1470.046791	57					316	65	7	0	7	7	1	6	5	181	1501.892123	103					115	66	6	2	4	6	3	3	2	161		
1470.086787	55					434	67	5	1	5	6	0	6	5	181	1502.089818	70					122	65	5	3	3	5	2	4	7	162		
1470.429040	57					284	66	5	0	5	6	1	6	6	171	1502.151866	69					106	66	8	3	6	8	4	5	5	181		
1470.586835	61					194	67	5	3	2	5	4	1	2	161	1502.286468	70							8	2	6	8	3	5	2	161		
1471.482041	57	886	78			7	1	7	7	2	6	1	6	1	161	1502.432603	181							447	68	1	1	0	2	2	1	6	171
1471.482041	57	980	129			3	1	2	4	2	3	1	6	1	161	1502.727833	56					101	66	10	1	10	9	2	7	1	161		
1472.051353	67					6	3	4	7	2	3	2	1	6	1	161	1503.218475	73					77	66	5	1	5	5	2	4	6	171	
1472.373821	268					194	64	4	2	3	4	1	4	7	162	1503.527092	86							8	1	7	8	2	6	6	171		
1472.759824	61					103	64	5	1	5	6	0	6	6	171	1503.655441	493					47	65	9	4	6	9	5	5				

Table 3. Continued

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1510.485791	110			62	64	12	6	7	12	7	6	1	161	1533.706687	57	129	68	896	85	2	1	2	3	0	3	5	181	
1510.533224	57	666	72	1000	124	6	4	2	6	5	1	1	161	1533.916918	70	988	121			3	2	1	3	0	3	0	1	161
1510.618854	57			984	99	7	6	1	7	7	0	1	161	1534.178739	58			401	68	4	2	2	4	3	1	5	181	
1510.898932	56			502	73	3	2	1	2	1	2	7	162	1534.313881	134			44	65	3	2	2	4	1	3	6	171	
1511.029122	56			612	70	8	0	8	7	1	7	7	162	1534.565183	126			43	66	8	3	5	8	4	4	5	131	
1511.239021	60			194	66	3	1	3	4	0	4	5	181	1534.935878	57			828	73	1	0	1	1	0	2	161		
1511.486281	56			604	72	11	6	5	11	7	4	1	161	1535.091280	77			94	63	7	3	4	6	3	3	7	162	
1511.594732	62			174	65	5	3	3	5	4	2	5	181	1535.159678	73			106	64	8	1	7	7	1	6	7	162	
1511.800167	64			151	64	8	1	8	7	1	7	7	162	1535.384483	57			536	70	4	0	4	4	1	3	5	181	
1511.859987	58			309	68	2	1	1	2	2	0	2	161	1535.433071	79			201	64	10	0	10	9	1	9	7	162	
1511.939200	57			436	68	10	5	5	10	6	4	1	161	1535.479376	58	737	76	995	142	9	2	7	9	3	6	1	161	
1512.060142	57			407	67	4	3	2	4	4	1	5	181	1535.689569	107			54	68	10	1	10	9	1	9	7	162	
1512.211010	57	768	75	1000	136	3	2	2	4	1	3	2	161	1535.795809	94			56	67	10	0	10	9	0	9	7	162	
1512.306795	70	999	125			7	4	3	7	5	2	1	161	1535.888170	57			474	69	1	0	1	2	1	2	6	171	
1512.453103	158			77	66	6	2	5	6	3	4	1	161	1536.052328	62			203	65	10	1	10	9	0	9	7	162	
1512.680709	58			300	65	6	3	4	6	4	3	6	171	1536.149515	61			226	68	6	1	5	5	4	2	1	161	
1512.755436	59			257	68	5	1	4	4	4	1	1	161	1536.482151	77			92	67	4	2	2	4	3	1	6	171	
1512.858892	287			46	63	5	4	2	4	4	1	7	162	1536.561751	57			793	76	2	1	2	2	2	1	5	181	
1512.872072	123			51	66	5	4	1	4	4	0	7	162	1536.810116	58			399	69	2	1	2	3	0	3	6	171	
1512.906539	61			191	64	6	2	4	5	2	3	7	162	1536.851158	59			303	67	6	1	5	6	2	4	5	181	
1513.084333	57			381	66	8	1	8	7	0	7	7	162	1536.875509	57			715	74	11	4	7	11	5	6	1	161	
1513.197883	63			168	66	4	3	1	4	4	0	5	181	1537.235835	73			114	64	9	1	8	8	2	7	7	162	
1513.813505	138			39	74	5	3	3	5	4	2	6	171	1537.812766	57			596	72	6	0	6	5	3	3	1	161	
1514.045305	63			178	66	3	1	3	4	0	4	6	171	1538.063725	381					11	9	2	11	10	1	1	161	
1514.254653	73			103	64	4	3	2	4	4	1	6	171	1538.250119	59	149	72	921	87	5	0	5	4	3	2	1	161	
1514.662517	56			723	72	5	0	5	5	1	4	5	181	1538.290983	62	960	89	1000	199	3	2	2	4	1	3	1	161	
1514.772104	365			13	6	7	13	7	6	1	1	161	1538.481833	68			145	65	4	0	4	4	1	3	6	171		
1514.858087	58			303	66	5	2	4	5	3	3	5	181	1539.014615	66	554	73			8	3	3	8	4	4	1	161	
1514.901039	332			43	68	5	3	3	6	2	4	5	181	1539.060772	78	984	157			4	2	2	4	3	1	1	161	
1514.987769	62	984	96			6	3	4	6	4	3	1	161	1539.202155	77			301	71	2	1	2	2	2	1	6	171	
1515.291832	56			760	75	3	1	2	3	2	1	2	161	1539.304976	237			66	68	8	2	6	8	3	5	5	181	
1515.362311	152					4	3	1	4	4	0	6	171	1539.557612	137					6	4	2	6	3	3	7	162	
1515.467382	56			787	74	4	1	4	4	2	3	5	181	1539.983942	164			80	67	6	1	5	6	2	4	6	171	
1515.778997	57	323	68	994	102	8	4	4	8	5	3	1	161	1540.194492	61			707	75	5	2	3	5	3	2	5	181	
1515.858049	37			436	68	11	5	6	11	6	5	1	161	1540.300144	73	993	143			2	1	2	3	0	3	1	161	
1516.090404	230			32	72	11	7	5	11	8	4	1	161	1540.735099	63			203	65	7	2	6	6	1	5	7	162	
1516.138596	85			71	68	11	7	4	11	8	3	1	161	1540.793142	117			49	66	5	4	1	5	3	2	7	162	
1516.293632	63	945	84			5	3	3	5	4	2	1	161	1541.632392	139			46	64	6	4	3	6	3	4	7	162	
1516.427876	67			176	66	10	7	4	10	8	3	1	161	1541.954576	70	996	115			4	0	4	4	1	3	1	161	
1516.708329	63	1000	101			4	3	2	4	4	1	1	161	1542.031709	58	115	70	868	81	11	3	8	11	4	7	1	161	
1516.766108	59			681	73	2	0	2	3	1	3	5	181	1542.160161	70	990	132			2	1	2	2	2	1	1	161	
1516.827021	73					9	7	3	9	8	2	1	161	1542.538073	62			227	67	5	2	3	5	3	2	6	171	
1517.252789	56			542	69	9	7	2	9	8	1	1	161	1542.725657	71			122	68	12	4	8	12	5	7	1	161	
1517.431283	65	993	117			3	0	3	3	1	2	2	161	1543.490608	64	976	99			6	1	5	6	2	4	1	161	
1517.673318	70			117	63	8	7	2	8	8	1	1	161	1543.732177	68			136	68	2	2	1	3	1	2	2	161	
1517.783175	61	938	84			3	1	3	4	0	4	1	161	1543.833229	147			35	65	6	5	2	5	5	1	7	162	
1518.187795	59			285	67	6	3	3	5	3	2	7	162	1543.897739	118			50	69	4	3	2	5	2	3	2	161	
1518.386808	65			147	63	5	3	2	5	4	1	6	171	1544.382969	64			257	68	6	2	4	6	3	3	5	181	
1518.649928	65			152	65	5	3	2	5	4	1	6	171	1544.435482	59	641	71	999	131	9	3	6	9	4	5	1	161	
1519.018038	70					4	3	1	4	4	0	1	161	1544.492780	59			371	68	7	2	5	7	3	4	5	181	
1519.350720	56			833	78	7	4	4	8	3	5	1	161	1544.704389	80			87	67	13	4	9	13	5	8	1	161	
1519.557487	61			210	67	2	0	2	3	1	3	6	171	1545.157043	71	986	121			5	2	3	5	3	2	1	161	
1520.153506	63	987	103			5	3	2	5	4	1	1	161	1545.389691	60			280	66	3	3	1	2	2	0	7	162	
1520.184886	65	992	97			7	2	6	6	2	7	162	1545.655644	59	731	75	1000	142	8	2	6	8	3	5	1	161		
1520.249242	57	155	76	944	87	8	1	7	7	2	6	7	162	1545.759454	60			280	66	3	3	0	2	2	1	7	162	
1520.318939	60					5	3	3	6	2	4	6	171	1545.806189	57	118	72	907	84	10	3	7	10	4	6	1	161	
1520.458971	68			130	67	13	3	10	13	4	9	1	161	1545.964145	194					6	4	3	7	3	4	5	181	
1520.769380	61			216	67	7	4	4	8	3	5	1	161	1546.587793	96			60	68	6	4	3	8	2	7	7	162	
1520.954269	64			167	65	2	0	2	3	1	3	6	171	1546.868577	102			60	68	9	2	4	6	3	3	6	171	
1521.234953	68	974	129			5	3	2	5	4																		

Table 3. Continued

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1561.770994	144			33	65	8	4	4	7	4	3	7	162	1619.988499	63			232	70	2	1	1	2	0	2	6	171
1562.132676	61			243	66	4	3	1	3	2	2	7	161	1620.336294	60			642	73	3	2	1	3	1	2	2	161
1562.261512	117			44	71	10	1	9	9	4	6	1	161	1620.469876	62			276	70	4	2	2	4	1	3	2	161
1562.369520	79			90	67	4	1	4	3	2	1	2	161	1620.787563	60	339	72	995	109	4	4	1	5	3	2	1	161
1562.610438	62			214	68	8	1	7	7	4	4	1	161	1621.124210	63			238	70	4	1	3	4	0	4	2	161
1563.231648	82			82	69	9	2	7	8	5	4	1	161	1621.509597	61			316	69	10	2	9	9	3	6	1	161
1563.545651	58			767	74	2	0	2	2	1	1	5	181	1621.585622	60			476	71	2	0	2	1	1	1	5	181
1563.662784	144					9	3	7	8	3	6	7	162	1621.620548	60			840	81	6	5	2	7	4	3	1	161
1564.876638	65	1000	107			1	1	1	2	0	2	1	161	1622.106721	94			89	71	5	2	3	4	3	2	2	161
1565.210189	113			50	67	9	2	7	8	2	6	7	162	1622.598112	63	909	86	1000	175	4	2	3	3	3	0	1	161
1565.371674	60			308	68	9	1	8	8	4	5	1	161	1623.559507	71	1000	128			2	2	0	2	1	1	2	161
1565.710026	144					10	6	5	11	5	6	1	161							2	1	1	2	0	2	1	161
1566.023640	58	168	70	954	89	7	4	3	8	3	6	1	161	1623.826748	66			178	68	8	6	3	9	5	4	1	161
1566.489348	60			265	68	2	0	2	2	1	1	6	171	1624.528732	72			122	68	2	0	2	1	1	1	6	171
1567.423834	84			76	65	10	2	9	9	1	8	7	162	1624.711771	60			512	72	6	2	4	7	1	7	1	161
1568.940222	67	988	99			2	2	1	3	1	2	1	161	1624.787746	71			123	70	4	1	3	3	2	2	2	161
1569.789049	74	991	129			2	0	2	2	1	1	1	161	1624.899510	336					11	3	9	10	2	8	7	162
1570.022848	59	196	72	954	89	1	0	1	1	1	0	5	181	1625.136184	60			496	72	6	5	1	7	4	4	1	161
1570.096180	137			41	65	13	1	13	12	0	12	7	162	1625.650961	60			916	86	4	4	0	5	3	3	1	161
1571.485369	144			39	68	9	3	6	8	3	5	7	162	1625.736862	213					7	2	5	6	1	6	7	162
1572.928551	58			544	71	1	0	1	1	1	0	6	171	1626.059549	61			458	72	5	2	3	5	1	4	2	161
1572.981772	58	150	69	938	88	6	3	3	7	2	6	1	161	1626.161724	92			66	70	8	6	2	9	5	5	1	161
1573.156469	295					12	2	11	11	3	8	1	161	1627.827866	72	1000	115			2	0	2	1	1	1	1	161
1573.311528	301					11	2	10	10	2	9	7	162	1628.060323	60			596	72	1	1	1	0	0	0	5	181
1573.952267	63			194	65	5	3	3	4	2	2	7	162	1629.061713	60			901	85	3	1	2	3	0	3	5	181
1574.296399	324					11	1	10	10	1	9	7	162	1631.315306	67			171	69	1	1	1	0	0	0	6	171
1574.449113	101			58	70	4	2	3	3	3	0	2	161	1631.922578	61			406	70	3	1	2	2	2	1	5	181
1574.574283	567					4	3	1	5	2	4	2	161	1632.166936	61			417	71	3	1	2	3	0	3	6	171
1576.185813	84	983	156			1	0	1	1	1	0	1	161	1632.786755	107			53	67	4	2	2	3	3	1	5	181
1577.275357	58	141	72	920	86	7	3	4	8	2	7	1	161	1633.466269	408					5	3	3	4	4	0	5	181
1577.583295	60	641	74	1000	136	5	3	2	6	2	5	1	161	1634.559300	79			97	71	3	1	2	2	2	1	6	171
1577.722726	330					2	2	0	3	1	3	2	161	1634.736893	83			100	65	6	4	3	5	3	2	7	162
1577.822663	113			53	65	11	2	10	10	1	9	7	162	1634.751788	267			53	69	5	2	4	4	3	1	5	181
1578.316729	58			742	76	7	1	7	6	2	4	1	161	1634.967510	70	998	124			1	1	1	0	0	0	1	161
1578.636756	236					9	4	5	8	4	4	7	162	1635.652235	76	991	151			3	1	2	3	0	3	1	161
1578.971655	250					10	3	8	9	3	7	7	162	1635.814425	62			483	73	4	0	4	3	1	3	2	161
1579.218886	530					10	6	4	11	5	7	1	161	1637.512188	68	998	111			3	1	2	2	2	1	1	161
1579.247472	62			224	69	8	5	3	9	4	6	1	161	1637.682127	62	652	76	999	139	4	2	2	3	3	1	1	161
1579.474272	64			180	66	5	3	2	4	2	3	7	162	1637.811316	110			51	64	5	3	2	4	4	1	5	181
1581.118739	251					14	0	14	13	1	13	7	162	1638.273913	61	300	71	985	105	3	2	3	4	4	0	5	181
1581.389020	213					10	2	8	9	2	7	7	162	1638.408071	169	117	72			3	2	1	3	1	2	5	181
1581.702272	262					4	3	1	5	2	4	5	181							6	2	4	6	1	2	5	181
1582.471593	58			894	83	6	4	2	7	3	5	1	161	1639.084225	61			427	72	2	2	1	2	1	2	2	161
1582.993723	257					3	3	1	4	2	2	5	181	1640.078129	61			516	71	4	2	2	4	1	3	5	181
1583.356656	58			796	79	1	1	0	1	0	1	2	161	1640.310561	62	682	77	991	140	5	2	4	4	3	1	1	161
1583.417770	259					10	2	8	9	5	5	1	161	1640.436318	61			433	72	9	2	0	8	3	5	1	161
1584.228207	192					12	1	11	11	2	10	7	162	1640.649511	61			460	70	2	2	0	2	1	1	5	181
1585.384013	488					7	5	2	7	4	3	7	162	1641.969312	62			387	71	3	2	1	3	1	2	6	171
1585.831847	471					6	5	1	6	4	2	7	162	1642.386694	62	621	75	996	133	5	3	2	4	4	1	1	161
1585.910393	425					6	5	2	6	4	3	7	162	1643.527691	70			137	68	4	2	2	4	1	3	6	171
1585.981908	67			146	66	6	3	4	5	2	3	7	162	1644.525836	131			117	70	2	2	0	2	1	1	6	171
1586.994474	61			258	69	2	0	2	1	1	1	2	161	1644.627929	73			43	70	8	3	5	7	2	6	7	162
1587.462394	74			108	67	3	2	1	4	1	1	2	161	1644.688473	62			338	71	5	1	4	5	0	5	2	161
1588.480808	233					4	2	2	3	3	1	2	161	1645.969683	75	991	145			3	2	1	3	1	2	1	161
1588.942873	194					12	2	11	11	1	10	7	162	1646.028553	132	154	73	949	90	3	0	3	2	1	2	5	181
1589.218732	239					6	1	6	5	2	3	5	181	1646.282542	61	159	73	949	90	2	1	2	1	0	1	5	181
1589.708701	59	434	71	1000	117	4	3	1	5	2	4	1	161	1646.453708	77			103	69	6	2	5	5	3	2	5	181
1590.146821	59	173	70	948	91	5	4	2	6	3	3	1	161	1647.020233	62			408	70	4	1	3	4	0	4	5	181
1590.381712	59			467	71	2	1	1	2	0	2	2	161	1647.404498	30	987	119			4	2	2	4	1	3	1	161
1590.404522	63			224	69	8	3	5	9	2	8	1	161	1647.562502	61			719	75	5	2	3	5	1	4	5	181</

Table 3. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
1668.966529	151					5	2	3	4	3	2	6	171	1709.654042	65				829	106	4	2	3	3	1	2	2	161	
1669.168664	67	996	102			4	1	3	3	2	2	1	161					79	67	9	3	7	8	4	4	1	161		
1669.230843	64			541	73	5	1	4	5	0	5	5	181	1710.024579	93					8	3	6	9	0	9	1	161		
1669.393321	73	1000	132			3	1	3	2	0	2	1	161	1710.199392	66	967	93	968	197	5	3	3	5	2	4	1	161		
1671.302382	107			63	71	6	1	5	6	0	6	2	161	1710.330543	63	142	72	923	89	6	1	6	5	0	5	5	181		
1671.453201	67	975	95			5	2	3	4	3	2	1	161	1710.607232	360					8	5	3	7	4	0	7	162		
1671.509521	68	1000	108			3	2	2	3	1	3	1	161	1710.767071	66					6	3	4	6	2	5	5	181		
1671.709898	65			251	69	4	0	4	3	1	3	6	171	1710.768444	64					6	3	4	6	2	5	5	181		
1672.193194	70			150	70	5	1	4	5	0	5	6	171	1711.462663	406					9	2	7	9	1	8	2	161		
1672.475565	62	370	72	995	114	6	3	3	5	4	2	1	161	1711.517893	70					6	0	6	5	1	5	6	171		
1672.605173	65			234	69	7	3	4	7	2	5	5	181	1712.043864	63					8	4	4	7	5	3	1	161		
1674.127614	64			245	69	6	6	1	7	5	2	1	161	1712.491437	64					10	3	8	9	4	5	1	161		
1674.316331	74			110	72	6	6	0	7	5	3	1	161	1712.923026	64	483	74	992	127	8	2	6	8	1	7	1	161		
1675.173120	72	987	134			4	0	4	3	1	3	1	161	1713.078289	250					7	2	6	7	1	7	2	161		
1675.296330	63			526	73	5	3	2	5	2	3	5	181	1713.664506	65					459	73	6	1	6	5	0	5	161	
1675.363515	227			32	76	6	3	3	6	2	4	6	171	1713.709434	71					186	71	8	0	6	7	1	7	2	161
1675.515487	70	988	122			5	1	4	5	0	5	1	161	1714.034097	69	993	105			6	2	5	6	1	6	1	6	171	
1675.639820	62			686	77	2	2	1	1	1	0	2	161	1714.473941	75					149	70	3	2	2	2	1	1	6	171
1675.687163	125			106	72	5	2	4	5	1	5	2	161	1714.548919	108					64	70	6	3	4	6	2	5	6	171
1675.780774	62			638	74	4	2	3	4	1	4	5	181	1714.610413	65					452	73	8	1	8	7	0	7	2	161
1675.826226	76			109	70	4	3	1	4	2	2	2	161	1715.155473	72	998	127			6	0	6	5	1	5	1	161		
1676.299012	106			54	69	7	3	4	7	2	5	6	171	1715.588808	64					798	79	10	4	6	10	3	7	1	161
1676.947930	434					6	0	6	5	1	5	2	161	1715.688302	65					482	75	3	2	1	2	1	2	2	161
1677.223632	63			385	72	6	0	6	5	1	5	2	161	1715.847653	64	400	74	993	120	9	4	5	9	3	0	1	161		
1677.750878	62	196	71			4	1	4	3	0	3	5	181	1716.996899	74					160	70	7	1	6	7	0	7	5	181
1678.983454	63			329	70	7	5	3	6	6	0	1	161	1717.405892	77	995	152			32	70	6	1	6	5	0	5	1	161
1679.109532	62			674	76	7	5	2	6	6	1	1	161	1717.711741	328					255	71	7	1	6	6	2	5	1	161
1679.238028	393					7	4	3	6	5	2	5	181	1718.050536	68							3	2	2	2	1	1	1	161
1679.265237	67			186	70	4	2	3	4	1	4	6	171	1718.612056	72	1000	124			6	3	4	6	2	5	1	161		
1679.385821	71			136	70	5	3	2	5	2	3	6	171	1718.801218	69	994	103					6	3	4	6	2	5	1	161
1679.468202	62			893	82	4	3	2	5	0	5	1	161	1719.764776	84					108	71	7	4	3	7	3	4	5	181
1679.542496	100			60	69	6	5	2	5	4	1	7	162	1720.058611	177					33	70	7	1	6	7	0	7	6	171
1679.559829	97			60	68	6	5	1	5	4	2	7	162	1721.532870	64	324	76	968	115	8	4	4	8	3	5	1	161		
1679.711507	63			364	73	5	3	3	6	0	6	1	161	1722.537671	115					57	71	7	3	5	7	2	6	5	181
1679.816537	65	942	91			7	3	4	6	2	4	1	161	1722.647456	64					635	77	11	4	7	11	3	8	1	161
1680.465850	67	975	99			7	3	4	7	2	5	1	161	1723.046587	70					200	71	5	2	4	4	1	3	2	161
1680.701998	103					8	3	5	8	2	6	5	181	1723.487066	66	951	91	990	185	7	1	6	7	0	7	1	161		
1680.875704	62					7	4	4	6	5	1	1	161	1723.920769	67					204	71	6	1	5	5	2	4	5	181
1681.091424	64			861	101	4	1	4	3	0	3	6	171	1724.290728	64					755	80	10	3	7	10	2	8	1	161
						6	1	6	5	0	5	2	161	1724.480957	305							7	4	3	7	3	4	6	171
1681.304016	67			250	71	3	3	0	3	2	1	2	161	1724.804285	149					52	68	6	6	0	5	5	1	7	162
1681.411073	66			259	70	4	3	1	4	2	2	5	181									6	6	1	5	5	0	7	162
1682.174699	63	277	73			7	3	5	6	4	2	1	161	1724.919920	115					56	69	7	2	6	7	1	7	5	181
1682.243935	66			298	71	2	2	0	1	1	1	2	161	1725.375152	508							8	1	7	8	0	8	2	161
1682.348069	68			224	70	7	2	5	7	1	6	5	181	1725.519379	165					35	71	7	4	3	7	3	4	2	161
1683.176368	71	999	127			4	2	3	4	1	4	1	161	1726.213217	585							7	3	5	7	2	6	6	171
1683.540839	63	203	73	986	105	7	4	3	6	5	2	1	161	1726.394882	64					852	83	7	0	7	6	1	6	5	181
1683.934917	76	990	120			5	3	2	5	2	3	1	161	1726.726431	64					834	82	4	2	3	3	1	2	5	181
1684.035561	81					4	1	4	3	0	3	1	161	1726.816921	109					66	70	6	1	5	5	2	4	6	171
1685.186910	242			53	76	7	2	5	7	1	6	6	171	1727.297393	65					511	73	7	1	7	6	0	6	5	181
1685.390974	66			319	72	3	3	1	4	0	4	1	161	1727.411881	64					572	75	9	4	6	8	5	3	1	161
1685.469002	63			495	73	6	3	4	7	0	7	1	161	1727.756185	111					63	72	6	4	2	6	3	3	5	181
1685.520604	120					4	3	1	4	2	2	6	171	1727.832456	68					245	70	9	5	5	8	6	2	1	161
1685.610187	79			119	69	8	4	5	8	1	8	1	161	1728.284217	540							7	2	6	7	1	7	6	171
1686.409754	432					9	4	5	8	3	6	7	162	1729.434963	65					557	75	9	5	4	8	6	3	1	161
1686.618034	87			91	69	7	4	4	8	1	7	1	161	1729.692820	66					345	71	7	0	7	6	1	6	6	171
1686.723065	88			89	70	3	3	1	3	2	2	2	161	1729.782986	60	878	85	984	171	7	4	3	7	3	4	1	161		
1686.820366	63			513	72	3	3	0	3	2	1	5	181	1730.055366	70	981	103					6	1	5	5	2	4	1	161
1687.074371	63	536	75	995	131	8	3	5	8	2	6	1	161	1730.142007	115					149	73	4	4	1	5	1	4	1	161
1688.378913	68	976	98			7	2	5	7	1	6	1	161	1730.239367	100					64	69	9	6	4	8	7	1	161	
1688.930114	78			125	69	6	1																						

Table 3. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1747.651031	70			229	71	8	1	8	7	0	7	6	171	1795.148326	313			47	77	10	2	9	9	1	8	2	161
1747.727642	66	827	83	993	137	5	4	2	5	3	3	1	161	1795.369582	71			215	70	9	1	8	8	2	7	5	181
1747.904461	86			104	72	7	2	6	6	1	5	2	161	1795.902325	67	743	81	987	149	5	5	0	5	4	1	1	161
1747.976475	118			59	69	10	0	10	9	1	9	2	161	1796.026884	67	383	76	987	120	5	5	1	5	4	2	1	161
1748.184339	74			150	71	10	1	10	9	0	9	2	161	1796.132889	67	711	81	992	146	6	5	2	6	4	3	1	161
1748.655997	72	1000	117			5	2	4	4	1	3	1	161	1796.297971	67	237	75	982	108	7	5	3	7	4	4	1	161
1749.403195	67	954	93	993	189	6	4	3	6	3	4	1	161	1796.408174	330					5	3	2	5	0	5	5	181
1749.713062	136			47	69	8	4	5	8	3	6	5	181	1796.473507	124			50	74	12	5	8	11	6	5	1	161
1750.323846	65			513	73	7	1	6	6	2	5	5	181	1796.498277	492					7	5	2	7	4	3	2	161
1750.375542	65			654	78	11	3	8	11	2	9	1	161	1796.592210	82			118	73	5	3	3	4	2	2	2	161
1750.984513	71	1000	111			8	0	8	7	1	7	1	161	1796.924857	67	337	77	990	117	8	5	4	8	4	5	1	161
1751.003479	69	769	81			8	2	7	8	1	8	1	161	1797.474143	196					11	0	11	10	1	10	6	171
1751.423623	73	996	130			8	1	8	7	0	7	1	161	1798.134225	68			341	73	11	3	9	11	2	10	1	161
1751.854750	170			38	75	13	5	8	13	4	9	1	161	1798.591330	67			708	80	9	5	5	9	4	6	1	161
1751.882691	67			342	72	10	5	6	9	6	3	1	161	1798.650330	285					5	5	0	5	4	1	2	161
1752.814143	65	507	77	996	129	7	4	4	7	3	3	1	161	1798.723846	135			43	72	9	1	8	8	2	7	6	171
1753.390166	78			134	69	7	1	6	6	2	5	6	171	1798.957652	322					6	5	2	6	4	3	2	161
1753.600957	129			48	74	12	5	7	12	4	8	1	161	1799.161052	73	991	117			4	3	1	3	2	2	1	161
1753.821965	65			672	77	6	2	5	5	1	4	5	181	1800.039098	97					9	2	8	8	1	7	5	181
1754.117398	81			105	70	10	6	5	9	7	2	1	161	1801.324834	68	938	92	970	166	11	0	11	10	1	10	1	161
1754.420576	148			39	73	10	6	4	9	7	3	1	161	1801.362411	67	651	79	988	137	11	1	11	10	0	10	1	161
1756.155574	77			134	71	10	5	5	9	6	4	1	161	1801.679522	70					5	3	3	4	2	2	5	181
1756.455924	85			107	74	4	2	2	3	1	3	2	161	1801.929826	67					10	5	6	10	4	7	1	161
1756.819248	72	990	122			7	1	6	6	2	5	1	161	1802.480134	69	972	100	975	190	9	1	8	8	2	7	1	161
1757.025048	69			264	73	3	3	1	2	2	0	2	161	1803.648328	395					9	2	8	8	1	7	6	171
1757.592374	71			206	71	6	2	5	5	1	4	6	171	1804.610690	284					5	4	1	6	1	6	1	161
1758.333439	65			578	76	3	3	0	2	2	1	2	161	1805.146817	67	339	78	991	120	5	3	2	5	0	5	1	161
1758.581925	66	619	77	991	137	8	4	3	8	3	6	1	161	1805.325776	81			124	74	5	2	3	4	1	4	2	161
1759.315565	130			49	72	13	4	9	13	3	10	1	161	1805.894277	115			58	72	5	3	3	4	2	2	6	171
1760.096172	73			387	74	11	5	6	11	4	7	1	161	1805.926454	115			58	71	13	3	10	13	2	11	1	161
1760.961000	66			509	72	9	0	9	8	1	8	1	161	1806.374785	103			71	70	9	2	7	8	3	6	5	181
1761.045798	66	171	72	958	96	9	3	7	9	2	8	1	161	1807.479841	78					11	5	7	11	4	8	1	161
1761.128849	70			219	70	3	3	0	8	0	8	5	181	1807.703762	68	792	84	985	153	9	2	8	8	1	7	1	161
1761.291129	433					3	3	0	3	0	3	5	181	1808.372374	73			189	72	12	4	9	12	3	10	1	161
1761.828918	74	986	132			6	2	5	5	1	4	1	161	1809.655157	67			754	82	11	1	10	11	0	11	1	161
1762.003422	75			169	71	8	2	7	7	1	6	2	161	1809.295268	68			395	74	11	2	10	11	0	11	1	161
1762.670108	66			514	73	3	3	1	2	2	0	5	181	1810.129474	108			65	71	12	1	12	11	0	11	5	181
1762.694154	83			109	73	11	4	8	10	5	5	1	161	1810.390776	307					11	1	10	10	2	9	2	161
1764.151839	65			851	84	3	3	0	2	2	1	5	181	1810.628610	72	996	108			5	3	3	4	2	2	1	161
1764.335422	77			128	70	9	0	9	8	1	8	6	171	1810.997843	73			196	73	6	3	4	5	2	3	2	161
1764.514163	138					9	1	9	8	0	8	6	171	1812.282564	68	740	83	983	154	9	2	7	8	3	6	1	161
1764.597977	99			72	78	11	0	11	10	1	10	2	161	1813.050780	83			113	74	12	2	10	12	1	11	1	161
1764.699848	252					11	1	11	10	0	10	2	161	1813.378835	498					13	6	7	13	5	8	1	161
1765.380681	65			751	81	10	2	8	10	1	9	1	161	1814.715104	70			284	74	5	3	2	4	2	3	2	161
1766.728607	78			133	71	3	3	1	2	2	0	6	171	1815.450662	161			37	73	10	1	9	9	2	8	5	181
1767.092230	65	137	78	905	90	9	4	6	9	3	7	1	161	1815.568414	84			105	71	12	5	8	12	4	9	1	161
1767.262304	70			231	71	7	2	6	6	1	5	5	181	1816.059381	68			410	73	6	3	4	5	2	3	5	181
1767.912016	66	448	75	988	123	9	1	8	9	0	9	1	161	1816.655944	320					12	5	7	11	6	6	1	161
1767.987966	91			94	71	9	1	8	8	2	7	2	161	1817.152041	69			369	76	11	4	7	10	5	6	1	161
1768.120603	72	1000	118			9	0	9	8	1	8	1	161	1817.451986	81	366	78			12	0	12	11	1	11	1	161
1768.183858	76			351	75	3	3	0	2	2	1	6	171	1817.469139	72	723	81			12	1	12	11	0	11	1	161
1768.312437	68	978	98	989	189	9	1	9	8	0	8	1	161	1817.673161	70			284	73	12	3	10	12	2	11	1	161
1769.349791	257					9	2	7	8	3	6	2	161	1817.729441	83			108	71	10	2	9	9	1	8	5	181
1770.384024	66	185	76	962	98	2	8	9	1	9	1	161	1820.364954	88			100	71	6	3	4	5	2	3	6	171	
1770.447907	271					6	5	2	7	2	5	1	161	1821.318344	230			28	74	10	2	9	9	1	8	6	171
1770.854534	67	258	75	981	110	3	3	0	3	0	3	1	161	1821.374454	67			716	82	10	3	7	9	4	6	1	161
1770.948023	67			391	74	10	5	5	10	4	6	1	161	1821.834908	68			517	75	5	3	2	4	2	3	5	181
1771.287914	73	1000	124			3	3	1	2	2	0	1	161	1822.094547	73			213	73	5	2	3	4	1	4	5	181
1771.449291	264			55	74	7	2	6	6	1	5	6	171	1822.424282	164					7	3	5	6	2	4	2	161
1771.883952	95			77	71	12	4	9	11	5	6	1	161	1822.761083	68	525	79	984	131	10	1	9	9	2	8	1	161
1772.714537	81	993																									

Table 3. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1849.641576	131			52	73				14	1	14	13	0	13	1	161												
1851.847596	372								13	5	8	12	6	7	1	161												
1852.405410	68			847	90				5	4	1	5	1	4	1	161												
1853.875295	325								12	2	11	11	1	10	5	181												
1854.122933	74			219	74				4	4	0	4	1	3	1	161												
1856.260127	69			609	80				6	4	2	6	1	5	1	161												
1856.917615	290								14	3	12	14	2	13	1	161												
1857.625790	134								7	4	3	7	1	6	5	181												
1858.272818	74			211	73				12	4	8	11	5	7	1	161												
1858.366827	175								5	4	2	4	3	1	5	181												
1858.478328	129			97	70				4	3	2	3	0	3	5	181												
1858.519557	69	427	78	982	129				6	3	3	3	2	4	5	181												
1859.703956	69			776	86				9	3	7	8	2	6	1	161												
1859.865813	69			494	76				5	4	1	4	3	2	5	181												
1860.916794	69	113	79	896	90				12	1	11	11	2	10	1	161												
1861.532022	70	302	77	977	113				12	2	11	11	1	10	1	161												
1861.850373	394								6	2	4	5	1	5	2	161												
1862.196188	321								6	3	3	5	2	4	6	171												
1862.783932	145			43	76				5	4	2	4	3	1	6	171												
1862.923893	76	274	63						4	3	2	3	0	3	6	171												
1862.956343	98			77	73				5	4	2	4	3	1	2	161												
1864.056866	69			731	85				15	0	15	14	1	14	1	161												
1864.171669	74			223	74				15	1	15	14	0	14	1	161												
1864.328918	82			124	72				5	4	1	4	3	2	2	161												
1865.970889	564								4	3	2	3	0	3	2	161												
1866.316687	468			31	77				14	2	13	14	1	14	1	161												
1866.381321	71	898	91	977	179				6	3	3	5	2	4	1	161												
1867.853179	74	978	103						5	4	2	4	3	1	1	161												
1867.925484	69			846	89				7	4	3	7	1	6	1	161												
1868.054450	70	529	79	987	142				4	3	2	3	0	3	1	161												
1868.727836	70	238	77	973	110				11	2	9	10	3	8	1	161												
1869.346040	76	1000	126						5	4	1	4	3	2	1	161												
1870.805324	70	508	79	988	135				10	3	8	9	2	7	1	161												
1876.632120	70			655	82				7	3	4	7	0	7	1	161												
1877.777362	216			29	81				6	2	4	5	1	5	5	181												
1879.019709	71			319	75				16	0	16	15	0	15	1	161												
1879.298180	69			890	91				13	1	12	12	1	11	1	161												
1879.599191	70			569	78				13	2	12	12	1	11	1	161												
1879.785152	72			306	74				6	4	3	5	3	2	5	181												
1881.078935	530			2	2	1			6	2	1	3	3	0	4	161												
1884.393390	111			71	77				6	4	3	5	3	2	6	171												
1884.565589	71	471	80	981	137				6	2	4	5	1	5	1	161												
1885.021200	83			130	74				6	4	3	5	3	2	2	161												
1885.301679	70			852	89				11	3	9	10	2	8	1	161												
1885.770044	87			117	73				6	4	2	5	3	3	5	181												
1888.800218	73			270	76				8	4	4	8	1	7	1	161												
1889.569808	74	996	114						6	4	3	5	3	2	1	161												
1890.207415	271			6	4	2	5		6	4	2	5	3	3	6	171												
1891.551355	123			56	72				7	3	4	6	2	5	2	161												
1892.598424	71			516	79				12	2	10	11	3	9	1	161												
1894.357506	128			51	73				11	7	4	11	6	5	1	161												
1894.653973	74			221	75				8	7	1	8	6	2	1	161												
1894.684085	71			516	78				8	7	2	8	6	3	1	161												
1894.905084	432			5	3	3			5	3	3	4	0	4	5	181												
1895.197801	72	904	92	975	179				6	4	2	5	3	3	1	161												
1895.244781	84			307	74				9	7	2	9	6	3	1	161												
1895.379811	85			118	75				9	7	3	9	6	4	1	161												
1895.514076	105			183	75				12	3	9	11	4	8	1	161												
1895.738735	82			138	74				10	7	4	10	6	5	1	161												
1897.372789	74			236	74				14	1	13	13	2	12	1	161												
1897.521673	71			538	78				14	2	13	13	1	12	1	161												
1897.852564	120			59	76				7	4	4	6	3	3	5	181												
1898.666248	134			51	74				13	4	9	12	5	8	1	161												
1901.759954	70			858	90				12	3	10	11	2	9	1	161												
1903.980337	304			7	4	4			7	4	4	6	3	3	2	161												
1904.355420	71			976	117				5	3	3	4	0	4	1	161												
1904.761283	83			133	75				4	4	1	4	1	4	1	161												
1906.066946	315			7	3	4			7	3	4	6	2	5	6	171												
1907.681425	82			138	73				5	5	1	4	4	0	5	181												
1907.712930	72			351	74				5	5	0	4	4	1	5	181												
1907.959558	71	704	83	977	157				7	4	4	6	3	3	1	161												
1908.128602	267			18	0	18			18	0	18	17	1	17	1	161												
1909.964317	72	884	93	978	183				18	1	18	17	0	17	1	161												
1911.869369	93			73	74																							

Table 3. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
2090.361732	245					8	7	1	7	6	2	1	161	2193.039301	503					3	3	0	2	2	1	4	161		
2092.350784	281					5	5	1	4	2	2	1	161	2194.381583	167			44	85	11	4	8	10	1	9	1	161		
2095.057503	651					3	2	1	3	1	2	4	161	2200.306106	126					11	2	9	10	1	10	1	161		
2097.367518	79					5	2	3	5	1	4	4	161	2205.217851	86			206	81	9	9	0	8	8	1	1	161		
2100.433142	79					9	3	7	8	0	8	1	161							9	9	1	8	8	0	1	161		
2105.780780	128					323	82	9	4	6	8	1	7	1	161	2206.656656	171				2	0	2	1	0	1	3	161	
2106.347060	84					58	76	5	5	0	4	2	3	1	161	2208.738067	229				11	3	9	10	0	10	1	161	
2107.546709	89					162	80	6	5	2	5	2	3	1	161	2208.889058	171			38	85	2	1	1	1	0	3	161	
2114.425982	79					123	81	11	6	6	10	5	5	1	161	2210.524329	383				8	5	3	7	2	6	1	161	
2114.983372	79					323	83	11	6	5	10	5	6	1	161	2211.531851	525				13	4	9	12	3	10	1	161	
2115.016499	78					411	82	9	7	3	8	6	2	1	161	2211.606004	375				11	8	4	10	7	3	1	161	
2116.224021	135					777	92	9	7	2	8	6	3	1	161	2211.631448	128			57	81	11	8	3	10	7	4	1	161
2121.268387	102					48	79	12	5	7	11	4	8	1	161	2212.540917	385				11	5	7	10	2	8	1	161	
2123.168913	79					85	78	7	5	3	6	2	4	1	161	2213.407513	536				12	3	9	11	2	10	1	161	
2124.887291	84					62	102	3	1	3	3	1	2	3	161	2214.360622	223				3	2	2	2	2	1	3	161	
2131.632011	79	1000	117			177	81	7	4	3	6	1	6	1	161	2218.526951	142				3	1	3	2	1	2	3	161	
2136.143745	79					983	137	6	3	4	6	2	5	4	161	2225.865351	292				3	0	3	2	0	2	3	161	
						841	96	8	8	1	7	7	0	1	161	2227.402262	263				4	4	1	3	3	0	4	161	
								8	8	0	7	7	1	1	161	2231.137489	113			72	83	10	9	2	9	8	1	1	161
2136.671395	186					36	91	6	5	1	5	2	4	1	161					10	9	1	9	8	2	1	161		
2137.223607	81					267	82	8	5	4	7	2	5	1	161	2233.212582	367				3	1	2	2	1	1	3	161	
2137.331238	353							3	2	2	3	2	1	3	161	2235.640789	502				12	8	5	11	7	4	1	161	
2137.372077	257							0	0	0	1	0	1	3	161	2236.265165	625				4	2	3	3	2	2	3	161	
2138.188785	101					112	78	10	2	8	9	1	9	1	161	2237.778129	323				4	1	4	3	1	3	3	161	
2139.328710	80					415	84	10	7	4	9	6	3	1	161	2242.734770	160			61	88	4	0	4	3	0	3	161	
2139.479348	85					168	80	10	7	3	9	6	4	1	161	2246.031130	332				12	4	9	11	1	10	1	161	
2139.814681	227					35	92	12	6	6	11	5	7	1	161	2246.787814	196				4	2	2	3	2	1	3	161	
2139.928866	80							2	1	2	2	1	1	3	161	2249.855415	438				12	5	8	11	2	9	1	161	
2145.467449	81					332	83	10	4	7	9	1	8	1	161	2251.425997	451				5	4	1	4	3	2	4	161	
2147.405884	85					184	81	11	3	8	10	2	9	1	161	2255.299589	163				5	1	5	4	1	4	3	161	
2148.189099	289							2	2	1	1	1	0	4	161	2255.390867	155			50	83	4	1	3	3	1	2	3	161
2151.193269	199							1	1	1	1	1	0	3	161	2255.446179	290				9	5	4	8	2	7	1	161	
2152.558387	82					265	81	10	3	8	9	0	9	1	161	2256.618023	285				11	9	3	10	8	2	1	161	
2154.999844	79					69	64	2	2	0	1	1	1	4	161					11	9	2	10	8	3	1	161		
2156.564531	106							9	5	5	8	2	6	1	161	2257.457979	200				5	2	4	4	2	3	3	161	
2161.726150	80					539	87	9	8	2	8	7	1	1	161	2258.692391	485				5	0	5	4	0	4	3	161	
								9	8	1	8	7	2	1	161	2265.314246	336				12	3	10	11	0	11	1	161	
2163.430850	87					152	80	11	7	4	10	6	5	1	161	2272.989567	566				6	1	6	5	1	5	3	161	
2171.256188	102					91	81	7	5	2	6	2	5	1	161	2274.429635	678				5	1	4	4	1	3	3	161	
2172.324370	463							2	1	1	2	1	2	3	161	2274.711300	188				6	0	6	5	0	5	3	161	
2175.037281	428							6	1	6	5	0	5	4	161	2289.894346	266				6	1	5	5	1	4	3	161	
2178.902068	620							4	2	3	3	1	2	4	161	2296.731350	287				6	2	4	5	2	3	3	161	
2181.344375	90					141	83	10	5	6	9	2	7	1	161														
2185.278564	152							12	7	6	11	6	5	1	161														

^a Columns 1, absolute wave number in inverse centimeters; columns 2, uncertainty (10^{-6} cm^{-1}); columns 3 and 4, experimental relative intensity ($I_0 - I/I_0$) $\times 10^3$ and half-width (10^{-4} cm^{-1}) of spectrum 1556; columns 5 and 6, same values as in columns 3 and 4 for spectrum 1600; columns 7 through 12, J' , K_A' , K_C' , J'' , K_A'' , and K_C'' ; columns 13, band number, columns 14, isotopic assignment: 161, H_2^{16}O ; 171, H_2^{17}O ; 181, H_2^{18}O ; and 162, HDO.

where g_i and σ_i represent the weight and the wave number, respectively, of the transition in the spectrum i .

The resulting uncertainty ϵ affecting the wave number σ is given by

$$\epsilon = \left(\sum_{i=1}^n g_i \right)^{-1/2}. \quad (2)$$

Relations (1) and (2) must be used carefully. In fact, it would be meaningless to condense data without checking their consistency. For instance, the measurements in two different spectra $i = 1, 2$ of the same transition obtained with $u_1 = u_2$, that is, with similar error bars but with $|\sigma_1 - \sigma_2| > u_1$, that is, with a distance between the respective positions greater than the error bars, cannot give a resulting uncertainty through relation (2). To avoid such situations careful checks similar to the ones widely described in Ref. 9 have been done, leading in practice to the removal of only 25 measurements from the whole of 7500.

The absolute uncertainty $\Delta\sigma$ of each wave number is determined by taking into account the possible systematic errors that may affect the spectra and the uncertainty of the standards of CO used to calibrate the wave-number scale. These values have been already given⁹ and are equal to $10^{-8} \times \sigma$ and $3.5 \times 10^{-8} \sigma$. Consequently $\Delta\sigma$, in column 2 of Table 3, is obtained by the following relation:

$$\Delta\sigma = \sigma \left[\left(\frac{\epsilon}{\sigma} \right)^2 + (10^{-8})^2 + (3.5 \cdot 10^{-8})^2 \right]^{1/2}.$$

The main contribution to $\Delta\sigma$ in fact comes from the uncertainty of the CO standards, which are derived from the

krypton line, the primary standard of length located in the visible portion of the spectrum. Numerous lines of Table 3 actually have much less uncertainty. More than half of the transitions (1209) have $\epsilon < 50 \times 10^{-6} \text{ cm}^{-1}$. Among those about half (533) have $\epsilon < 20 \times 10^{-6} \text{ cm}^{-1}$. However, the lowest uncertainty given in Table 3 is $49 \times 10^{-6} \text{ cm}^{-1}$. This shows once again that it is desirable to use more-appropriate standards, which should be located in the infrared instead of the visible spectrum. This has been discussed and illustrated in Ref. 15, in which one can find more details. As a matter of fact, the consistency of the results presented here is really much better than their quoted uncertainty. It is generally well expressed in units of the last digit, which corresponds to 30 kHz. An example of this consistency is given in Ref. 8 for N_2O spectra, which are partly concerned with some of the H_2O spectra under discussion.

The absolute wave numbers and their corresponding uncertainties are given in Table 3. For the sake of convenience, in order to have a description of the transitions precise enough to be of practical use, columns 3–6 give information on the shape of the profiles. The measured intensity $10^3 \times (I_0 - I/I_0)$ and width at midheight of the lines appearing, respectively, in a low and high $L \times P$ product spectrum (more precisely, the numbers 1556 and 1600) are given with a precision of about 10%. The corresponding temperatures of the samples are 24 and 25°C. This table presents, in the remaining columns, the rotational quantum numbers $J K_A K_C$ of the higher- and lower-energy levels involved in the transition as obtained from Ref. 4. When several assignments are possible, they are all given. In the case of HDO these assignments have been provided to us by Camy-Peyret and

Flaud. The band number defined in Table 2 and the isotopic species are expressed in the last two columns.

ACKNOWLEDGMENT

I gratefully acknowledge assistance in computational work from J. Collet. Warm thanks are due to C. Camy-Peyret and J. M. Flaud, who provided the HDO assignments and a file of their atlas.

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