Year	Month	Day	Ref.	Year	Month	Day	Ref.	Year	Month	Day	Ref.
1814	9	11	F	1830	4	24	F	1833	9	1	F
1817	2	8	S	1830	5	19	F	1833	9	17	F
1817	2	9	F	1830	8	20	F	1833	10	12	F
1817	2	10	F	1830	9	7	F	1833	12		Mo
1817	2	18	S	1830	9	8	F	1834	8		Mo
1817	9	19	F	1830	9	10	F	1834	9		Mo
1818	1	11	S	1830	9	12	F	1834	10		Mo
1819	2	23	S	1830	9	17	F	1834	11	3	F
1819	3	12	S	1830	9	20	F	1834	12	21	F
1819	10	12	F	1830	10	5	F	1834	12	22	F
1819	10	15	F	1830	10	9	F	1835	1	4	F
1819	10	17	F	1830	10	16	F	1835	2	7	F
1819	12	14	F	1830	10	17	F	1835	2	27	F
1820	1	14	F	1830	11	1	F	1835	8		Mo
1820	4		Mo	1830	11	4	F	1835	11	16	F
1820	12	4	F	1830	12	7	F	1835	11	17	F
1821	3	25	F	1830	12	11	F	1835	11	18	F
1821	7		Mo	1830	12	12	F	1835	11	19	F
1821	11	26	F	1830	12	14	F	1835	12	3	R
1822	10	28	M	1830	12	25	F	1836	2		Mo
1825	2	5	B	1831	1	6	F	1836	4	22	F
1826	3	29	F	1831	1	7	S	1836	5		Mo
1826	4	29	F	1831	1	8	F	1836	7		Mo
1827	1	9	F	1831	1	10	F	1836	9		Mo
1827	1	18	F	1831	1	11	F	(1836	10	4)	P
1827	2	17	F	1831	1	12	R	1836	10	11	F
1827	9	8	F	1831	1	14	F	1836	10	12	F
1827	9	9	F	1831	1	18	P	1836	10	18	S
1827	9	25	S	1831	1	20	R	1837	1	25	F
1827	9	26	S	1831	2	14	F	1837	1	26	F
1827	9	27	S	1831	3	6	F	1837	2	13	F
1827	10	6	F	1831	3	7	F	1837	2	14	F
1827	11	18	F	1831	3	8	F	1837	2	18	S
1828	7	5	F	1831	3	11	F	1837	3	15	R
1828	9	8	S	1831	3	13	F	1837	3	29	P
1828	9	9	S	1831	4	19	F	1837	3	30	P
1828	9	29	F	1831	4	20	F	1837	4	5	P
1828	9	30	F	1831	7		Mo	1837	4	6	F
1828	12	1	F	1831	8	3	F	1837	5		Mo
1828	12	26	F	1831	9	26	R	1837	6		Mo
1829	3	22	F	1831	10	29	F	1837	7	1	F
1829	6	1	F	1831	12	9	F	1837	7	2	F
1829	7	25	F	1832	8		Mo	1837	7	28	S
1829	8	25	F	1832	9	17	F	1837	8	25	F
1829	9	19	F	1832	9	23	F	1837	9	23	F
1829	12		Mo	1832	11	1	F	1837	9	29	F
1830	2	19	F	1833	3	21	F	1837	10	6	F
1830	4	19	F	1833	8	6	F	1837	10	18	F

Day	Ref.
1	F
17	F
12	F
	Mo
	Mo
	Mo
	Mo
3	F
21	F
22	F
4	F
7	F
27	F
	Mo
16	F
17	F
18	F
19	F
3	R
	Mo
22	F
	Mo
	Mo
	Mo
4)	P
11	F
12	F
18	S
25	F
26	F
13	F
14	F
18	S
15	R
29	P
30	P
5	P
6	F
	Mo
	Mo
1	F
2	F
28	S
25	F
23	F
29	F
6	F
18	F

Year	Month	Day	Ref.	Year	Month	Day	Ref.	Year	Month	Day	Ref.
1837	10	21	F	1841	2	24	F	1845	9	25	F
1837	10	22	F	1841	3	22	F	1845	9	26	F
1837	11	5	R	1841	4		Mo	1845	11	5	F
1837	11	12	S	1841	6	15	F	1845	12	3	F
1837	11	14	F	1841	8	2	F	1845	12	4	F
1837	12		Mo	1841	8	10	F	1846	1		Mo
1838	1	29	F	1841	8	23	F	1846	2	25	F
1838	2		Mo	1841	9	10	F	1846	8	28	F
1838	3		Mo	1841	9	12	F	1846	9	13	F
1838	4	29	F	1841	9	18	F	1846	9	21	F
1838	6	26	F	1841	9	25	F	1846	9	22	F
1838	8		Mo	1841	10	14	F	1846	10	24	F
1838	9	13	F	1841	10	25	F	1846	11	13	F
1838	9	15	S	1841	11	15	F	1846	11	17	F
1838	9	16	S	1841	11	18	F	1846	11	26	S
1838	11	12	F	1841	12	1	F	1846	11	27	S
1838	11	13	F	1841	12	15	F	1847	3	17	F
1839	1	2	F	1841	12	24	F	1847	3	19	F
1839	1	6	F	1842	1	2	F	1847	9	24	F
1839	1	10	F	1842	3	7	F	1847	9	26	F
1839	1	12	F	1842	3	10	F	1847	9	29	F
1839	1	14	F	1842	4		Mo	1847	10	13	F
1839	1	18	F	1842	7	3	F	1847	10	14	F
1839	1	19	F	1842	10	16	F	1847	10	17	F
1839	2		Mo	1842	10	18	F	1847	10	23	F
1839	5	5	F	1842	11	24	F	1847	10	24	F
1839	5	7	F	1843	3	13	F	1847	10	25	F
1839	8	30	F	1843	3	14	M	1847	11	1	F
1839	9	1	F	1843	3	18	S	1847	11	2	F
1839	9	2	S	1843	3	20	S	1847	11	11	F
1839	9	3	S	1843	4	5	F	1847	11	17	F
1839	9	4	S	1843	4	6	F	1847	11	19	F
1839	10	22	F	1843	5	6	F	1847	11	22	F
1840	1	3	F	1843	8	3	F	1847	11	25	F
1840	2	6	F	1843	12	8	F	1847	12	8	F
1840	4	24	F	1843	12	12	F	1847	12	16	F
1840	5	23	B	1844	1	13	F	1847	12	17	S
1840	5	29	F	1844	1	19	F	1847	12	18	F
1840	7	5	F	1844	2	20	F	1847	12	19	S
1840	8	19	S	1844	4	17	F	1847	12	20	F
1840	9	21	F	1844	8	1	F	1848	1	11	F
1840	10	22	F	1844	8	9	F	1848	1	16	F
1840	10	29	F	1844	12	8	F	1848	1	20	F
1840	11		Mo	1844	12	29	F	1848	1	25	S
1840	12	21	S	1845	8	25	F	1848	1	27	S
1840	12	24	F	1845	8	29	F	1848	1	28	F
1840	12	28	F	1845	8	30	F	1848	2	20	F
1841	1	24	F	1845	9	24	F	1848	2	21	S

Year	Month	Day	Ref.	Year	Month	Day	Ref.	Year	Month	Day	Ref.
1848	2	22	S	1848	11	26	F	1850	2	18	F
1848	2	24	F	1848	11	28	F	1850	2	23	S
1848	2	25	S	1848	11	30	F	1850	2	26	S
1848	2	26	S	1848	12	13	F	1850	3	9	F
1848	3	19	F	1848	12	17	F	1850	3	10	F
1848	3	20	F	1848	12	21	F	1850	3	11	F
1848	3	31	F	1848	12	22	F	1850	4	5	F
1848	4	2	F	1848	12	27	F	1850	4	6	F
1848	4	3	F	1849	1	14	F	1850	5	12	S
1848	4	5	F	1849	1	15	F	1850	6	4	F
1848	4	6	F	1849	1	22	F	1850	6	5	F
1848	4	7	F	1849	1	27	F	1850	6	13	F
1848	4	17	F	1849	2	18	F	1850	6	27	F
1848	4	29	F	1849	2	19	S	1850	7	5	F
1848	5		Mo	1849	2	20	F	1850	7	12	F
1848	7	8	F	1849	2	21	F	1850	7	27	F
1848	7	11	F	1849	2	22	F	1850	7	28	F
1848	7	24	F	1849	2	23	F	1850	8	6	F
1848	8	28	F	1849	2	24	F	1850	9	6	F
1848	9	4	F	1849	2	25	S	1850	9	10	F
1848	9	18	F	1849	2	26	F	1850	9	13	F
1848	9	30	F	1849	2	27	S	1850	9	14	F
1848	10	11	P	1849	3	16	F	1850	9	18	F
1848	10	17	S	1849	3	17	F	1850	9	28	F
1848	10	18	F	1849	3	18	F	1850	10	1	F
1848	10	19	F	1849	5	13	F	1850	10	2	F
1848	10	20	F	1849	6	26	F	1850	10	3	F
1848	10	22	S	1849	6	30	F	1850	10	5	F
1848	10	23	F	1849	8	11	F	1850	10	8	F
1848	10	24	F	1849	8	18	F	1850	10	9	F
1848	10	25	F	1849	9	3	F	1850	10	15	F
1848	10	26	F	1849	9	16	F	1850	10	29	F
1848	10	27	F	1849	9	27	F	1850	11	2	F
1848	10	28	F	1849	10	1	F	1850	11	3	F
1848	10	29	F	1849	10	15	F	1850	11	9	F
1848	10	30	F	1849	10	21	F	1850	11	10	F
1848	10	31	F	1849	10	22	S	1850	11	12	F
1848	11	5	F	1849	10	23	F	1850	11	14	F
1848	11	6	F	1849	10	24	F	1850	11	15	F
1848	11	14	F	1849	11	5	S	1850	11	21	F
1848	11	17	S	1849	11	19	F	1850	12	23	F
1848	11	18	F	1849	11	24	S	1850	12	26	F
1848	11	19	F	1850	1	31	F	1850	12	27	F
1848	11	21	S	1850	2	3	F	1851	1	1	F
1848	11	22	S	1850	2	6	F	1851	1	5	F
1848	11	23	F	1850	2	9	F	1851	1	9	F
1848	11	24	F	1850	2	11	F	1851	1	24	F
1848	11	25	F	1850	2	12	F	1851	2	1	F

Day	Ref.
18	F
23	S
26	S
9	F
10	F
11	F
5	F
6	F
12	S
4	F
5	F
13	F
27	F
5	F
12	F
27	F
28	F
6	F
6	F
10	F
13	F
14	F
18	F
28	F
1	F
2	F
3	F
5	F
8	F
9	F
15	F
29	F
2	F
3	F
9	F
10	F
12	F
14	F
15	F
21	F
23	F
26	F
27	F
1	F
5	F
9	F
24	F
1	F

Year	Month	Day	Ref.	Year	Month	Day	Ref.	Year	Month	Day	Ref.
1851	2	2	F	1851	12	8	F	1852	4	20	F
1851	2	5	F	1851	12	13	F	1852	4	22	F
1851	2	6	F	1851	12	18	F	1852	4	23	F
1851	2	7	F	1851	12	21	F	1852	5	3	F
1851	2	9	F	1851	12	22	F	1852	6	11	F
1851	2	10	F	1851	12	23	F	1852	7	3	F
1851	2	11	F	1851	12	25	F	1852	7	6	F
1851	2	18	F	1851	12	26	R	1852	7	10	F
1851	2	19	F	1851	12	28	F	1852	7	13	F
1851	2	20	F	1851	12	29	F	1852	7	14	F
1851	2	23	F	1852	1	17	F	1852	8	8	F
1851	2	24	F	1852	1	19	F	1852	8	10	F
1851	3	7	F	1852	1	20	F	1852	9	4	F
1851	3	8	F	1852	1	21	F	1852	9	11	F
1851	3	10	F	1852	1	22	F	1852	9	12	F
1851	3	14	F	1852	1	23	F	1852	9	13	F
1851	3	18	F	1852	1	25	F	1852	9	17	F
1851	4	7	F	1852	1	30	F	1852	9	18	F
1851	4	18	F	1852	2	15	F	1852	9	19	F
1851	4	21	F	1852	2	16	F	1852	9	20	F
1851	6	20	F	1852	2	17	F	1852	9	21	F
1851	8	17	S	1852	2	18	F	1852	9	29	F
1851	8	21	F	1852	2	19	R	1852	10	5	F
1851	8	24	F	1852	2	20	F	1852	10	13	F
1851	8	29	F	1852	2	21	F	1852	10	18	F
1851	8	30	F	1852	2	23	F	1852	10	23	F
1851	9	4	F	1852	2	25	F	1852	11	3	F
1851	9	6	F	1852	2	26	F	1852	11	10	F
1851	9	7	F	1852	2	27	F	1852	11	11	F
1851	9	14	F	1852	2	28	F	1852	11	12	F
1851	9	15	F	1852	3	2	F	1852	11	13	S
1851	9	22	F	1852	3	5	F	1852	11	17	S
1851	9	24	F	1852	3	12	F	1852	11	30	F
1851	9	27	F	1852	3	15	F	1852	12	6	F
1851	9	28	F	1852	3	17	F	1852	12	8	F
1851	9	29	S	1852	3	20	F	1852	12	9	F
1851	9	30	S	1852	3	21	F	1852	12	12	F
1851	10	2	S	1852	3	25	F	1852	12	14	F
1851	10	3	F	1852	3	26	F	1852	12	15	F
1851	10	4	F	1852	3	28	F	1852	12	18	F
1851	10	15	F	1852	3	31	F	1852	12	20	F
1851	10	18	F	1852	4	1	F	1853	1	2	F
1851	10	28	F	1852	4	8	F	1853	1	4	F
1851	10	29	F	1852	4	9	F	1853	1	5	F
1851	11	17	F	1852	4	12	F	1853	1	7	F
1851	11	20	F	1852	4	14	F	1853	1	8	F
1851	11	30	F	1852	4	15	F	1853	1	12	F
1851	12	6	F	1852	4	18	F	1853	1	31	F

Year	Month	Day	Ref.
1853	2	14	F
1853	2	15	F
1853	2	16	F
1853	2	17	F
1853	2	23	F
1853	2	27	F
1853	2	28	F
1853	3	7	F
1853	3	8	F
1853	3	17	F
1853	4	5	F
1853	4	6	F
1853	4	7	F
1853	4	8	F
1853	4	24	F
1853	5	4	F
1853	5	24	F
1853	6		Mo
1853	7	2	F
1853	7	12	F
1853	8	26	F
1853	9	1	F
1853	9	2	S
1853	9	3	F
1853	9	28	F
1853	10	17	F
1853	10	25	F
1853	10	31	F
1853	11	1	F
1853	11	2	F
1853	11	8	F
1853	11	9	F
1853	11	10	F
1853	11	22	F
1853	12	5	F
1853	12	6	F
1853	12	8	F
1853	12	23	F
1853	12	24	S
1853	12	25	S
1853	12	26	S
1853	12	28	F
1854	1	2	R
1854	2	10	F
1854	4	14	F
1854	6	24	F
1854	7	15	S
1854	9	26	F
1855	3	12	S
1855	10	16	F
1857	5	6	S
1857	9		Mo
1857	12	17	S
1857	12	22	S
1858	3	13	F
1858	3	14	F
1858	4	9	S
1858	4	10	F
1858	4	11	F
1858	5	7	F
1858	5	8	F
1858	12	4	S
1859	1	30	F
1859	2	9	F
1859	2	22	F
1859	2	23	S
1859	2	24	F
1859	2	25	F
1859	2	26	F
1859	3	2	F
1859	3	26	F
1859	3	27	F
1859	3	29	F
1859	3	30	F
1859	3	31	F
1859	4	1	F
1859	4	7	F
1859	4	21	S
1859	4	22	F
1859	4	23	F
1859	4	28	F
1859	4	29	F
1859	8	4	JZ
1859	8	28	R
1859	8	29	S
1859	8	30	F
1859	8	31	F
1859	9	1	S
1859	9	2	S
1859	9	3	R
1859	9	4	F
1859	9	5	F
1859	9	6	F
1859	9	24	S
1859	9	27	F
1859	10	1	S
1859	10	2	S
1859	10	12	R
1859	10	17	F
1859	10	18	F
1859	10	19	F
1859	12	6	F
1859	12	13	F
1860	2	12	F
1860	3	12	F
1860	3	18	F
1860	3	26	F
1860	4	9	F
1860	4	12	F
1860	4	13	F
1860	4	16	F
1860	8	7	S
1860	8	8	S
1860	8	9	F
1860	8	10	F
1860	8	11	S
1860	8	12	F
1860	8	13	F
1860	8	25	F
1860	9	6	F
1860	9	7	F
1860	9	8	F
1860	12	8	F
1861	1	24	F
1861	2	12	S
1861	2	27	S
1861	3	1	F
1861	3	4	F
1861	3	9	S
1861	3	19	S
1861	3	25	S
1861	4	7	F
1861	4	15	F
1861	7	23	JZ
1861	10	10	F
1861	11	7	F
1861	12	2	F
1861	12	4	F
1861	12	19	F
1861	12	20	F
1861	12	26	F
1862	1	18	F
1862	2	8	F
1862	2	21	F

Day	Ref.
2	S
12	R
17	F
18	F
19	F
6	F
13	F
12	F
12	F
18	F
26	F
9	F
12	F
13	F
16	F
7	S
8	S
9	F
10	F
11	S
12	F
13	F
25	F
6	F
7	F
8	F
8	F
24	F
12	S
27	S
1	F
4	F
9	S
19	S
25	S
7	F
15	F
23	JZ
10	F
7	F
2	F
4	F
19	F
20	F
26	F
18	F
8	F
21	F

Year	Month	Day	Ref.	Year	Month	Day	Ref.	Year	Month	Day	Ref.
1862	2	22	F	1864	3	7	F	1866	3	16	F
1862	3	1	F	1864	3	10	F	1866	3	17	F
1862	3	4	F	1864	4	5	F	1866	4	9	F
1862	3	14	F	1864	4	27	F	1866	5	14	F
1862	3	24	F	1864	5	3	F	1866	5	19	F
1862	3	25	F	1864	5	9	F	1866	8	11	F
1862	3	27	F	1864	7	12	F	1866	10	1	F
1862	4	3	F	1864	8	2	F	1866	10	2	F
1862	5	1	F	1864	8	6	F	1866	10	3	F
1862	5	2	F	1864	8	17	F	1866	10	4	F
1862	5	19	F	1864	8	31	F	1866	10	5	F
1862	5	20	F	1864	9	25	F	1866	11	1	F
1862	7	19	S	1864	10	8	F	1866	11	10	F
1862	7	26	F	1864	10	19	F	1866	11	26	F
1862	7	27	F	1864	11	9	F	1866	11	29	F
1862	8	4	F	1864	11	29	F	1866	12	10	F
1862	8	19	F	1864	12	23	F	1867	1	28	F
1862	8	21	F	1864	12	24	F	1867	5	4	F
1862	8	24	F	1865	1	17	F	1867	8	26	F
1862	8	28	F	1865	1	24	F	1867	9	25	F
1862	8	29	F	1865	1	29	F	1867	9	26	F
1862	9	2	F	1865	2	17	F	1867	10	28	F
1862	9	11	F	1865	2	18	F	1868	5		Mo
1862	9	24	S	1865	2	21	F	1868	7	6	M
1862	10	11	F	1865	2	22	F	1868	11	14	F
1862	12	14	S	1865	2	23	F	1868	11	19	F
1862	12	25	F	1865	3	18	F	1869	1	7	F
1863	1	12	F	1865	3	20	F	1869	1	12	F
1863	1	25	F	1865	3	21	F	1869	2	3	F
1863	2	9	F	1865	3	22	F	1869	2	5	F
1863	2	22	F	1865	4	16	F	1869	2	14	F
1863	3	4	F	1865	7	18	F	1869	3	6	F
1863	4	9	F	1865	7	19	F	1869	3	7	F
1863	4	19	F	1865	8	2	F	1869	3	12	F
1863	5	9	F	1865	8	14	F	1869	3	13	F
1863	6	22	F	1865	8	18	F	1869	3	31	F
1863	8	17	F	1865	8	19	F	1869	4	1	F
1863	10	8	F	1865	8	25	F	1869	4	2	F
1863	11	1	F	1865	8	26	F	1869	4	15	S
1863	11	9	F	1865	9	16	F	1869	4	16	F
1863	11	11	F	1865	9	26	F	1869	4	17	F
1863	11	13	F	1865	10	31	F	1869	5	5	F
1863	11	29	F	1865	11	8	F	1869	5	8	F
1863	12	11	F	1865	11	14	F	1869	5	9	F
1863	12	14	F	1866	2	7	F	1869	5	13	S
1864	2	1	F	1866	2	12	F	1869	5	29	R
1864	2	9	F	1866	3	7	F	1869	6	7	F
1864	3	6	F	1866	3	14	F	1869	6	29	F

Year	Month	Day	Ref.	Year	Month	Day	Ref.	Year	Month	Day	Ref.
1869	7	29	F	1870	3	3	F	1870	11	17	F
1869	8	5	F	1870	3	13	F	1870	11	18	F
1869	8	10	F	1870	3	22	F	1870	11	19	R
1869	9	3	F	1870	3	24	F	1870	11	21	F
1869	9	4	F	1870	3	25	F	1870	11	22	F
1869	9	5	F	1870	3	28	F	1870	11	27	S
1869	9	11	F	1870	3	30	F	1870	12	15	F
1869	9	27	F	1870	4	5	S	1870	12	16	F
1869	9	28	F	1870	4	18	F	1870	12	17	F
1869	9	29	F	1870	4	23	F	1871	1	13	R
1869	10	1	F	1870	4	25	F	1871	1	15	F
1869	10	5	F	1870	5	19	F	1871	2	10	F
1869	10	6	S	1870	5	20	R	1871	2	11	F
1869	10	18	F	1870	8	19	F	1871	2	12	S
1869	10	21	F	1870	8	20	F	1871	2	13	F
1869	10	25	R	1870	8	21	F	1871	2	14	F
1869	11	3	F	1870	9	2	F	1871	2	15	F
1869	11	9	S	1870	9	3	F	1871	3	14	F
1869	11	10	F	1870	9	4	F	1871	3	16	F
1869	12	7	F	1870	9	18	F	1871	3	17	F
1869	12	12	R	1870	9	19	JB	1871	3	18	F
1869	12	15	F	1870	9	21	F	1871	3	22	F
1869	12	30	F	1870	9	22	F	1871	3	23	F
1870	1	1	F	1870	9	23	F	1871	4	1	F
1870	1	2	F	1870	9	24	R	1871	4	8	F
1870	1	3	F	1870	9	25	F	1871	4	9	F
1870	1	4	F	1870	9	26	F	1871	4	10	F
1870	1	6	F	1870	9	27	F	1871	4	11	F
1870	1	8	F	1870	9	30	F	1871	4	13	F
1870	1	20	F	1870	10	1	F	1871	4	14	S
1870	1	26	F	1870	10	3	F	1871	4	15	F
1870	1	28	F	1870	10	14	R	1871	4	16	F
1870	1	29	F	1870	10	15	F	1871	4	17	F
1870	1	30	F	1870	10	17	F	1871	4	18	F
1870	1	31	F	1870	10	18	F	1871	4	19	F
1870	2	1	F	1870	10	20	F	1871	4	22	F
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1870	2	3	F	1870	10	22	F	1871	5	8	F
1870	2	4	F	1870	10	23	R	1871	5	17	F
1870	2	11	F	1870	10	24	S	1871	5	18	F
1870	2	12	F	1870	10	25	S	1871	5	19	F
1870	2	17	F	1870	10	26	F	1871	5	22	F
1870	2	21	F	1870	10	27	F	1871	5	26	F
1870	2	23	F	1870	10	28	F	1871	6	7	F
1870	2	25	JZ	1870	10	29	F	1871	6	12	F
1870	2	27	F	1870	11	1	F	1871	6	14	F
1870	2	28	F	1870	11	8	F	1871	6	16	F
1870	3	1	F	1870	11	14	F	1871	6	18	F

Day	Ref.
17	F
18	F
19	R
21	F
22	F
27	S
15	F
16	F
17	F
13	R
15	F
10	F
11	F
12	S
13	F
14	F
15	F
14	F
16	F
17	F
18	F
22	F
23	F
1	F
8	F
9	F
10	F
11	F
13	F
14	S
15	F
16	F
17	F
18	F
19	F
22	F
23	F
8	F
17	F
18	F
19	F
22	F
26	F
7	F
12	F
14	F
16	F
18	F

Year	Month	Day	Ref.	Year	Month	Day	Ref.	Year	Month	Day	Ref.
1871	6	27	F	1872	4	1	F	1892	9	12	S
1871	8	10	F	1872	4	2	F	1893	7	15	BF
1871	8	11	F	1872	4	3	F	1894	2	23	JB
1871	8	21	F	1872	4	6	F	1894	2	28	JB
1871	8	23	F	1872	4	7	F	1894	3	30	S
1871	8	24	F	1872	4	10	F	1894	3	31	S
1871	9	7	F	1872	4	11	F	1894	4	6	S
1871	10	10	F	1872	4	12	F	1894	4	7	S
1871	10	13	F	1872	4	13	F	1894	7	9	JB
1871	10	14	JB	1872	4	14	F	1894	9	7	JB
1871	11	2	S	1872	4	15	F	1894	9	8–9	JB
1871	11	3	R	1872	6	20	JZ	1894	9	25	JB
1871	11	5	R	1872	7	7	F	1894	11	23	BF
1871	11	9	F	1872	7	28	F	1894	12	20	BF
1871	11	10	F	1872	8	3	F	1894	12	23	JB
1871	11	14	F	1872	8	6	R	1895	1	17	BF
1871	11	20	F	1872	8	14	F	1895	2	14	BF
1871	12		Mo	1872	9		Mo	1895	3	13–14	JB
1872	1	10	JZ	1872	10		Mo	1895	4	11	BF
1872	1	11	JZ	1872	11		Mo	1895	4	23	BF
1872	1	30	F	1872	11		Mo	1895	11	9	JB
1872	2	2	F	1872	12		Mo	1895	11	11	JB
1872	2	3	F	1873	1		Mo	1896	3	4	JB
1872	2	4	S	1873	1		Mo	1896	9	15	JB
1872	2	5	F	1873	3		Mo	1897	1	2	JB
1872	2	6	F	1874	2	4	S	1897	8	19	Ba
1872	2	8	F	1874	9	20	S	1897	12	20	Ba
1872	2	9	F	1874	10		Mo	1898	1	15	Ba
1872	2	11	R	1877	9	29	R	1898	1	16	Ba
1872	2	17	F	1877	12	29	S	1898	3	8	JB
1872	2	26	F	1878	3	11	S	1898	3	14	Ba
1872	2	27	F	1880	10	27	R	1898	3	15	Ba
1872	3	1	F	1880	11		Mo	1898	3	19	Ba
1872	3	4	F	1881	1		Mo	1898	5	3	Ba
1872	3	5	F	1882	4	16	Ba	1898	8	12	Ba
1872	3	6	F	1882	10	2	R	1898	9	2	Ba
1872	3	7	F	1882	11	17	P	1898	9	7	Ba
1872	3	8	F	1883	11		Mo	1898	9	9	S
1872	3	10	F	1885	3		Mo	1898	9	10	S
1872	3	11	F	1886	6	23	JB	1898	9	12	Ba
1872	3	12	F	1886	7	22	JB	1898	9	15	Ba
1872	3	14	F	1887	2	12	JB	1898	10	10	JB
1872	3	16	F	1889	11	26	JB	1898	11	11	Ba
1872	3	20	F	1892	2	14	S	1898	12	3	R
1872	3	27	F	1892	3	6	JB	1898	12	13	Ba
1872	3	29	F	1892	4	25	JB	1898	12	15	BF
1872	3	30	F	1892	8	12	S	1899	1	28	Ba
1872	3	31	F	1892	8	23	S	1899	2	11	Ba

Year	Month	Day	Ref.	Year	Month	Day	Ref.	Year	Month	Day	Ref.
1899	2	12	BF	1899	6	29	Ba	1899	11	3	Ba
1899	5	1	Ba	1899	8	5	Ba	1899	12		BF
1899	5	4	Ba	1899	9	15	Ba	1900	4	30	Ba
1899	6	28	Ba	1899	9	26	Ba	1900	5	4	Ba

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Day	Ref.
3	Ba
	BF
30	Ba
4	Ba

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II–4. LONG-TERM VARIATION OF OCCURRENCE OF POLAR AURORAE FROM 1000 TO 1900 IMPLYING CHANGES OF SOLAR ACTIVITY

Attention to the secular variation of solar activity in the years 1000–1848 has been paid in the treatment of historical observations of big sunspots (seen with naked eye), further of aurorae in our catalogue (in the preliminary version) and used results by M. Stuiver [5] on variation of the ^{14}C isotope in tree-rings of old trees (Křivský [6]). The results in this papaer differ only slightly from definitive results about aurorae presented here for the period 1000–1900.

During the whole period 1000–1900 3 878 days with auroras <55 °N were confirmed, however, due to the civilization factors only 322 were observed from the year 1000 to 1499 (roughly to the beginning of effect of letter-print). As a result of civilization factors the series is considerably inhomogeneous, although all the maxima and minima (see Fig. 1, the bottom curve), similar to those on the sunspot (Křivský [6]) and ^{14}C-curves (Fig. 1), can be seen on the curve of aurora days for the forty-year intervals which were not homogenized.

We shall inquire into the civilization factors affecting the amount of observations and attempt to homogenize the series by defining them. The increase in the number of preserved reports of the occurrence of auroras is influenced by a number of factors, some of which act gradually, others very rapidly. There is the factor of the increasing number of chroniclers and popular scripturalists, and their contact with observers; the factor of increasing probability that chronicles and records will be preserved with time (both apply to the period 1000–1500); the letter-print factor acted rapidly (more frequent records of reports on events, together with more probability of conserving them until the present); enchanced interest in natural phenomena in connection with the Renaissance, with travelling and discovery developed more slowly; founding of stations and observatories, and their records, the use of printed celandars, newspapers and the higher informativeness associated with them, as well as the possibility of transmitting news from a larger area into the conservation centre (for recording in a chronicle or printing) all had a quick and substantial effect. Events of war in the main cultural centres of human society had a negative and temporary effect. The positive factors listed above are responsible for gradual, as well as rapid, irregular increases in the number of reports on conspicuous events such as the aurora.

In the attempt to homogenize the series of data, it was assumed that nearly all auroras were recorded roughly after 1700 (or 1720). The printing factor of the letter-print came to bear after the year 1500. The factors will be at roughly the same level during the period from the year 1000 to 1500 (see the bottom unreduced curve in Fig. 1). Drawing on the factors mentioned above, the

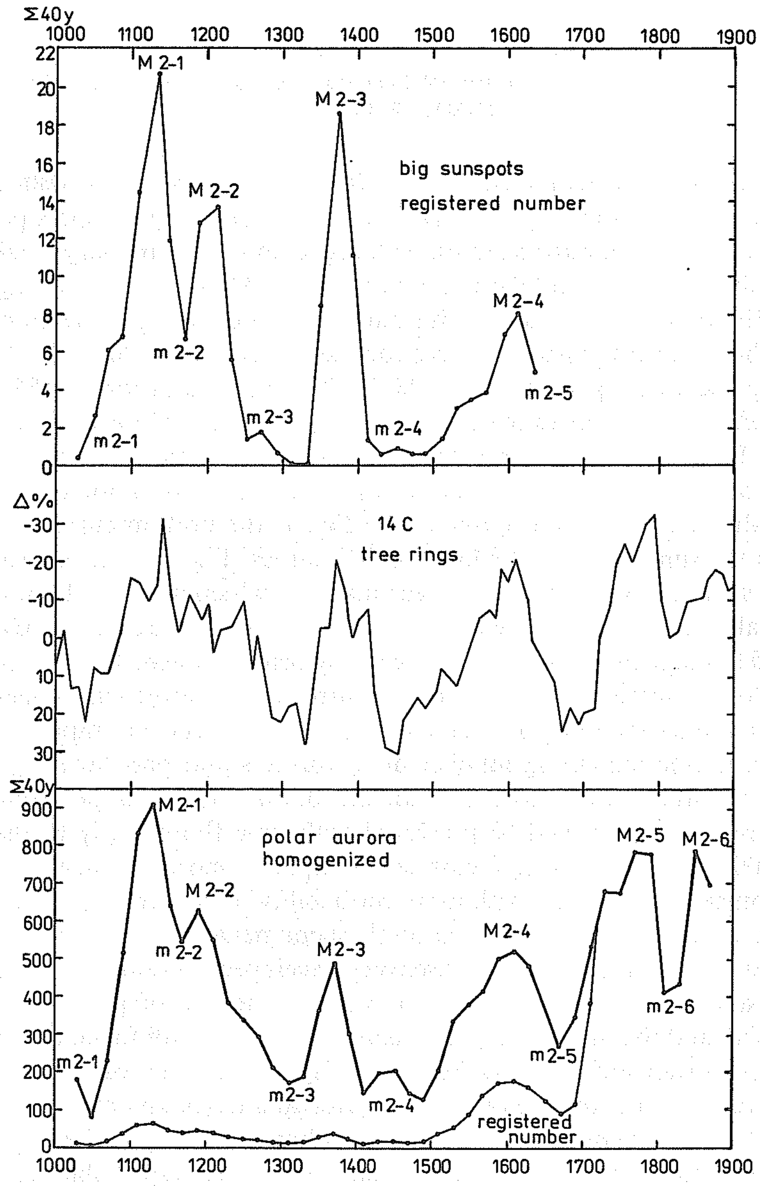

Fig. 1. Long-term fluctuations of three solar activity indexes: 40 years sums of big sunspot observations by naked eye (statistically elaborated), maxima (M) and minima (m) with numbering are indicated; ^{14}C deviation in % from tree-rings (Stuiver [5]); 40 years sums of northern polar-aurora observations (statistically elaborated and homogenized) and 40 years sums of northern polar-aurora registered numbers without homogenization.

number of observations were adjusted by period as follows: the forty-year sums of series "a" (beginning in the year 1000) for the period 1000–1479 were multiplied by the factor 14.3, for the period 1480–1559 by the factor 6.2, for the period 1560–1719 by the factor 3.1, no adjustment after 1720 to 1879; the forty-year sums of series "b" (beginning with the year 1020) for the period 1020–1499 multiplied by the factor 14.3, for the period 1500–1539 by the factor 6.2, for the period 1540–1699 by the factor 3.1, no adjustment after 1700 to 1899.

Description of the method for construction of curve for the manifestation of secular variations: Forty-year sums of two series were made as in the case of big sunspots (in Křivský [6]); one series began with the year 1000 (a), the other with the year 1020 (b). The resultant curve (Fig. 1) was constructed from $\frac{1}{2}(\sum 40_a + \sum 40_b)$, (in each case from values adjacent in time), and the value obtained was located at the time centre between the single values $\sum 40_a$ and $\sum 40_b$, so that simple gliding and smoothing were ensured. The resultant curve is marked "polar aurora, homogenized" in Fig. 1.

II-5. SECULAR MAXIMA AND MINIMA

The maxima "M" of the second millenium "2" are marked on the curve of aurorae (Fig. 1) in the order they occurred in the millenium: M2-1 is a very conspicuous maximum around the year 1130, the subsidiary M2-2 is in the descending phase following M2-1 around the year 1190, the next M2-3, quite sharp but of short duration, around the year 1370, another smaller one M2-4 around the year 1610, the next M2-5 in 1720–1780 and the last 2-6 around 1860. The minima "m" of the second millenium "2" are also marked in the order they occurred in the millenium: m2-1 around 1040, the second subsidiary m2-2 (on the downslope) occured about 1160, the third m2-3 is broader and is located between the years 1270–1330, the fourth m2-4 is between the years 1410–1500 (referred to as Spörer's), the fifth m2-5 (referred to as Maunder's) about the year 1670, the further m2-6 around the year 1820 and the last m2-7 after 1880.

The interval of extremes M2-1, m2-2 and M2-2 (1100–1220) as a whole could also be considered one large maximum with a subsidiary minimum m2-2.

II-6. DISCUSSION OF THE RESULTS

The existence of the individual secular maxima and minima of the polar aurora is indubitable with a view to the behaviour of the other indices, big sunspots (in [6]) and ^{14}C (Fig. 1), and the roughly quantitative characteristics of these extremes are most probably also real.

The comparison of the polar aurora with the ^{14}C-curve with reversed scale (Stuiver [5]), on which the location of the extremes agrees also with those on the "big sunspot" curve (in Křivský [6]), indicates that the long-term fluctuations of the variable incidence of modulated level of cosmic rediation at the Earth's atmosphere and the resulting variable production of ^{14}C (conserved in tree-rings) within the millenium are caused by the condition of solar activity as the primary process [7]; disturbances in the Earth's magnetosphere and high atmosphere (which is represented by the curve of aurora occurrence) are derived which logically corresponds to the well-known mechanism of the causal sequence of the individual complex process.

These results, founded on the statistical treatment of long series of data, agree

Fig. 2. Satellite image of aurora over western Canada on January 5, 1973 from the altitude about 830 km. The lights of Minneapolis can be seen at the right center edge and those of Los Angeles at lower left. (DAPP Satellite, Environmental Data Service, U. S. Dep. of Commerce, Nov. 1973).

with individual processes and mechanism, known earlier: large sunspot groups on the Sun with flares → magnetoplasmic clouds from the Sun into interplanetary space → these decrease the level of cosmic radiation penetrating to the Earth which in turn decreases the production of ^{14}C in the Earth's atmosphere – the clouds from the Sun simultaneously interact and disturb the Earth's magnetosphere and thus create conditions for the generation of auroras [8].

Ein vnerhörtes Wunderzeichen/welches ist gesehen worden
auff Kuttenberg/in der Kron Böhem/auch sonst in andern Stätten vnd Flecken herumb/
den 12. Januarij/vier stund in die Nacht/ vnd gewehret biß nach 8. Jnn der Wolcken
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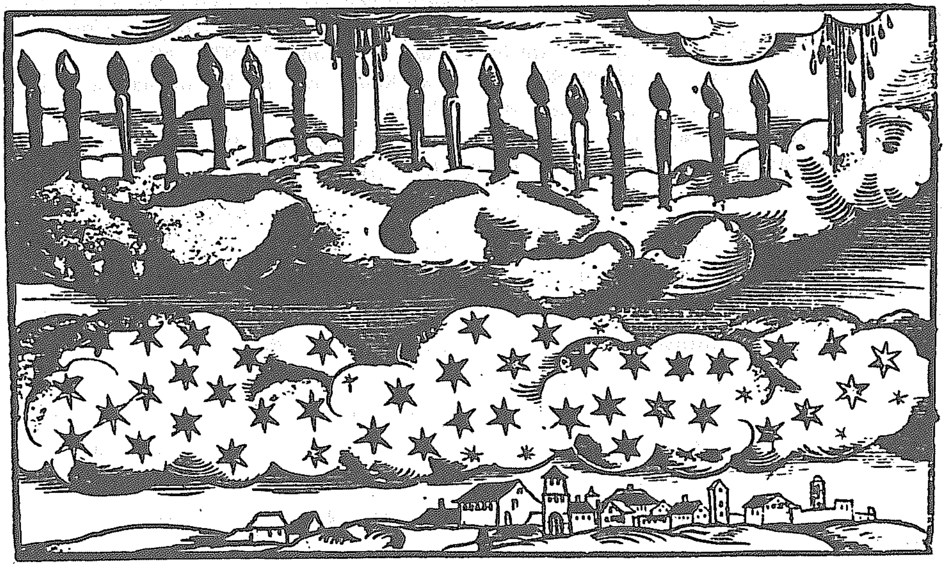

Fig. 3. The woodcut of polar-aurora on January 12, 1570 above town Kuttenberg (Kutná Hora) in Bohemia (Czechoslovakia). The description is in German and in Gothic-letter.

Authors would like to thank Prof. Naoshi Fukushima of University of Tokyo for his kind recommandations and exceptional interest.

A note added in proofs (July 1988):
During the last years the present Catalogue of polar aurorae has been supplemented. To day, it list about 5000 polar aurorae. The supplement will be published.

The Catalogue was used to study periodicities (9).
Several tens copies of Catalogue have been sent to scientists who asked for it.

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PART III

SECULAR SOLAR ACTIVITY IN RELATION TO THE CLIMATE FLUCTUATIONS IN THE MIDDLE EUROPE

III-1. THE PROBLEM

In connection with the secular solar activity cycle, it is indicated that similar fluctuations are displayed by the long-term variation of precipitation [1]. This relation may, understandably, display negative or positive correlation, or a phase shift in various areas of the Earth, because the climatic effect of solar activity on the troposphere is undoubtedly via atmospheric circulation. As regards Central Europe, it was found using the observations of the Prague-Klementinum observatory [1], that the solar secular precipitation minimum occured at the time of the secular solar activity maximum and vice versa. Should this relation persist for centuries, the atmospheric precipitation should display secular minima at the time of the observed secular maxima of solar activity [2], i. e. in the intervals of the years 1080–1150, 1180–1250, 1350–1400, 1520–1620, 1700–1780, 1850–1870. At the time of secular activity minima [2], precipitation should display secular maxima, i. e. in the intervals of the years ~1020, (~1180), 1410–1550, 1630–1700, 1800–1830.

The same applies to the temperature which also depends on the general character of circulation above a particular area of the Earth. If mostly cool periods (e. g. the 2nd half of the 17th century) are connected with distinct minima of solar activity in NW Europe, one would logically expect mostly warm periods (e. g. the end of the 11th to the beginning of the 13th centuries) to occur over equally extensive areas at the time of distinct secular maxima of solar activity. According to past research and also our preliminary conclusions, it would seem that this was indeed so [3].

For obvious reasons, it is very difficult to sabstitute for processed series of meteorological data in the deliberations on climate fluctations, i. e. precipitation and temperature observations prior to the year 1800 when, with a very few exceptions, no regular observations were being made, or the observations were not preserved. Archival and other records of abnormally dry or wet years, or of good or poor hartvests, usually only contain sporadic data of an exceptional nature. One cannot assume, for example, the existence of a distinctly wet 20-year period just on the basis of a few sporadic reports about the wet character of individual years. The alternation of character of the weather in the individual years is of a stochastic nature, and a particular effect (or trend) is only manifest over a number of years with this particular prevailing character, i. e. not just isolated occurrences of abnormally dry or wet years, but of years which were not anomalous enough to draw the attention of the chronicler and warrant recording, but which were more numerous. Besides, we know that, for example, a distinctly dry period, lasting say 20 or more years, may be "interrupted" several times by years in which floods may have occurred due to large amounts of precipitation; and this is the anomaly the chronicler will have recorded. If the records about the nature of the weather or of the quality of the harvest during the years are more systematic, the problem is easier. All this has to be borne in mind before analysing the weather and climatic character of whole groups of years according to historical verbal descriptions, in order to trace the climatic secular extremes.

As regards the observations of secular solar activity and secular variation of precipitation in Czechoslovakia, the great difficulty is in that written reports on the weather are sporadic up to about the beginning of the 16th century and, therefore, we have had rely on socalled indirect proof from records such as the beginning of the harvest, vine gathering, architecture, introduction of thermophilic plants, dendroclimatology, etc. Unfortunately, it must be said that even indirect proof is difficult to obtain, because a systematic research has not been begun yet in Czechoslovakia. What has been said also applies to the written sources, especially of the 16th and 17th centuries. Although we know that there were daily weather observations in Bohemia in these centuries, which were recorded (e. g. the diaries of Borboni and Kepler), we still do not know how many of these diaries still exist and, in particular, where they are deposited. Moreover, the daily records of weather are very valuable for studying climate fluctuations, because the records can be used to calculate the number frequencies and these can be processed by means of suitable statistical methods and the results compared with current climatic conditions. Thus, Brahe's observations from Hven from the years 1582 to 1597 [4] as well as those of other authors have been processed.

For these reasons, the results of observations of the occurrence of secular extremes of precipitation in dependence on the extremes of solar activities in Bohemia, with regard to chronology, can only be approximate. As regards the basic fluctuation curves, we must necessarily reckon with an uncertainty of ± 50 years, and in the intermediate intervals with ± 10 years. However, we must admit that the objective facts pertaining to the fluctuation of the European climate are, in their consequences, more or less distinctly manifested also in our materials, direct and indirect, provided, of course, these fluctuations actually occured in Czechoslovakia.

One should also realize that the results adopted from the sources of one region cannot be generalized without first being critically analyzed. For example, relatively large changes of temperature may occur on a relatively small area in severe winters when the position of high pressure regions does not change and at the time of passage of active fronts. These difficulties are encountered in reconstructing the weather in periods, in which we had to relay on indirect proof. In Czechoslovakia, for example, this concerns the period of the Hussite wars. One chronicler emphasized that the participations of some meeting were unable to reach Prague because of the vast amount of show, whereas we know that at the time filed regiments were diligently attacking a castle in North Bohemia. Considering the lack of enthusiasm of medieval armies to wage war in winter and that the siege of a rock aerie under adverse weather conditions must have been very difficult, the chronicler's report must be viewed with exceptional caution.

III-2. BASIC CHARACTERISTICS OF THE FLUCTUATION OF THE CLIMATE IN BOHEMIA AND EUROPE AFTER THE YEAR 1000

With a view to the difficulties mentioned above, one may, nevertheless, claim that the secular precipitation minima between 1100 and 1200, around 1250 and in the years 1350 to 1400 are realistic. They partly fall within the period which is referred to in the literature as the secondary or also medieval climate optimum [5, 6]. It stretches from the year 900 or 1000 to 1250 or 1300. One wet period (1310 to 1350) and one warmer and drier period (1360 to 1400) are mantioned in the 14th century.

Authors consider the whole period from 1100 to 1400 to be relatively warm and dry, this being particularly so in the 11th and 12th centuries. They assume that cooler and wetter decades occurred sporadically in the 11th and 12th century but more frequently in the 13th and 14th. These periods cannot be determined more accurately using the material now available. There are fragments of data which can be found in old written reports.

Evidence in favour of the warmer and drier climate in Bohemia in the 11th to 14th centuries is, e. g. the colonization of the northern frontier areas in the 12th and 13th centuries and the more intensiven introduction of the grape vine in Central and North Bohemia in the middle of the 14th century. The colonization of North Bohemia is related to a large number of special phenomena. For example the gradual desiccation of the large Komorany lake. This was a lake of the same type as the Neusiedler Lake southeast of Vienna. Around the year 1600, the Komorany lake still covered an area of more than 56 sq . km. A lake of this size may desiccate or, under suitable conditions, even dry out completely. The much larger Neusiedler Lake (area in 1854 356 sq . km.) did this in the warm decade and secular precipitation minimum of 1856–1871, drying out completely. In 1140, a large monastery was founded in Doksany, apparently under favourable conditions; the name is derived from the pre-Slavonic name dogz, which indicates a place located in an inundated area of a river. Cosmas chronicle [7, 8] indicates that Bohemia was an afforested country (in the 11th century the primeval forest went as far as Brevnov, now a part of Prague), rich in waters and swamps. Only long periods of dry and warm climate could have enabled the penetration of colonists into the frontier forests and swamps. The founding of the royal town of Most in a former inundated area of the Komorany Lake at that time seems to prove this.

Also the introduction of rational vine growing in the middle of the 14th century must been connected with a longer warm period (in the Litomerice area grape vine was grown at least since the 12th century); the summers were apparently mostly warm or even hot, the precipitation small, spring and autumn frosts were rare, and the autumns sunny. One should bear in mind that the vine-growing region was very close to the vegetation boundary of vine cultivation and that it stretched as far as Usti n. L., Teplice and to the east as far as the Česká Lípa area as late as in the 1st half of the 16th century. The Most and Usti wines were then very well known. The grapes were not grown for ornamental purposes (as was the case to the north near the Baltic), but for the domestic and foreign markets. The winter and summer temperatures were at least the same as in the period of recent warming in the years 1901–1950 (new attempts to grow vine in the Most area), but possibly even 0.5 °C higher; indeed, an increase in temperature of 0.5 °C during the vegetation period represents a displacement of the vegetation boundary by about 135 km to the north.

The period from about 1429 to 1465 is considered to be particularly unfavourable. However, we are unable to comment on it because no comprehensive material is available.

Relatively abundant data were available for the years 1519 to 1541 (lower reaches of the Ohre River). Indirect evidence (unusually early beginnings of harvests, excellent wines, locust raids, etc.) indicate that warm to hot and dry years were namely 1521, 1523, 1530–1534, 1536, 1538–1542, 1546, 1548 and 1554. Flohn's opinion [9] that the summer of 1540 was perhaps the warmest and driest of the whole millenium, need not apply to Bohemia, but it is certainly characteristic of this period. The thermal vegetation constant for grape vine must be at least 2400°. For wines of superior quality, like the recent years of 1947, 1959, 1961, but also probably 1531, 1532, etc., had a much higher constant, 2700°, and this is close to the value in the French vine-growing areas.

Based on the above, the authors are of the opinion that the climate improved significantly in Bohemia in the 1st half of the 16th century (after 1520), and that the summers were warm to hot and amount of precipitation small.

This improvement in the climate (in Bohemia this may have lasted until 1560) was followed by a marked deterioration which is referred to in England, with perhaps a slight measure of exaggeration, as the "small ice age" [5, 6]. It has several significant features: 1 – the advance of glaciers in the years 1590 to 1610 and another advance around the year 1645; glaciers were also observed to advance in Norway; 2 – A decrease in winter temperatures as documented in

Switzerland (1546–1576) and Denmark (1582–1597). The drop is estimated at 1.5 to 2 °C. 3 – Unusually adverse ice conditions in the Sunda Straits and prevaling SE currents (Tycho's observations in Uranienborg on Hven); 4 – A period of extremely cold years in northern Scandinavia (documented for the years 1611–1630). Judging by items 3 and 4, it seems probable that the situation was caused by the frequent occurrence of a blocking high pressure over Scandinavia; 5 – High water level in the Caspian Sea, as well as in the lakes of North Italy (since 1595).

Based on the above, one may assume that the whole situation was caused by a more frequent occurrence and growth of polar cyclones, by a displacement of the paths of depression more to the south, which could have resulted in a shift of the zone of intertropical convergence towards the equator. Intensification of meridional exchange may be assumed, as well as more frequent penetration of cold air into the central and western Mediterranean (an increase in the number frequency of so-called "historical" storms in the Mediterranean).

In Bohemia, this period is characterozed at first by conspicuous extremes (at the turn of the 16th and 17th century) and it seems that it was not until the 1st half of the 17th century that the climate became cooler and wetter. In the first phase, the numbers of mild and severe winters seem to be equal; towards the end of the 16th, but mainly in the 1st half of the 17th century the number of severe winters increased. A typical feature is the increased frequency and intensity of spring frosts, not only in May, but also in June. The grape vine yield curve displays a decrease, the minimum occurring perhaps in the years 1630–1660. The decrease in yields and deterioration in the quality of wines would indicate cooler and rainier summers in this period. Also the advance of the East Alpine glaciers is connected with cloudier and colder summers, with frequent precipitation; all this contributes to the increase in the albedo of the ice surface and to the decrease of ablation. However, the variability of annual precipitation plays a smaller role than the alternation of summer temperatures, cloudiness, etc., with regard to the glacier balance of glaciated regions.

A marked change occurred in the twenties of the 18th century, when, according to the English, an interglacial period occurred with new warming. The authors are of the opinion that the so-called "small ice age" ended in Bohemia around 1720. The improvement, reflected in Central Europe in warm summerrs and mild winters, culminated around 1750 when East Alpines glaciers receded to their maximum. In Bohemia this period is characterized by the introduction and cultivation of thermophillic plants in the north of the country (e. g. almond trees).

A new change in the climate with a number of circulation anomalies, in evidence especially in winter (these perhaps also include the "great winter" of 1739–1740) as well as partial movements of the East Alpine glaciers around the years 1770 and 1790) was responsible for cooling. This period ended, at least in the southern parts of Central Europe (Vienna, Prague, Hohenpeissenberg, Bale, Jena) with a relatively warm period in the years 1775 to 1811. This was followed by a period of distinctly bad years in Central Europe, connected with the recorded secular maximum of precipitation [1], which lasted roughly until the middle of the 19th century. This bad period culminated in the years 1812–1821.

The secular minimum of precipitation, as is known, occurred after the middle of the 19th century [1]. In Bohemia it was connected with a marked warming and a very dry period from about 1856 to 1875 (catastrophic draughts, shipping on the Elbe came to a halt, etc.). The situation is illustrated by a series of excellent vintages in warm years: 1857–1859, 1861, 1862, 1865, 1868; the summer of 1860 was an exception. The driest period was 1861–1865. This dry period was then followed by a number of rainy years from 1876 to 1894 which culminated in 1886–1890.

The authors have only mentioned the basic features of the fluctuations of climate in Bohemia. A more detailed analysis is outside the scope of this study and will be published elsewhere after further data have been collected.

From what has been said, we may draw the conclusion that the principal long-term maxima of occurrence of aurorae (= maxima of solar activity) are mostly related to periods of drier climate (or warmer climate), the minima of aurorae to periods of wetter (or colder) climate. It has been proved that the climax of the so-called climatic optimum in the 11th and 12th centuries is related to exceptionally high solar activity, and the climax of the so-called small ice age (in the 17th century) is related to very low solar activity; very much the same applies to the periods of shorter fluctuations in the 14th and 15th centuries.

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