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Predictions of the mutual events of the Uranian satellites occurring in 2006–2009⋆

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ABSTRACT

Context. Every 42 years, the Earth and the Sun pass through the equatorial plane of Uranus allowing observations of mutual occultations and eclipses of the main satellites of Uranus. The next opportunity will occur in 2006–2009.
Aims. Such events are uncommon and very rare, and they allow us to accurately determine the inclinations of the orbits of the satellites, which is usually difficult. However, in order to be able to observe, we need accurate predictions.
Methods. To find these predictions, we developed a new dynamical model based on the most recent astrometric observations of the satellites.
Results. This paper provides predictions of these events using two different models for the motion of the satellites, along with information useful for the observations. Data on the predictions of the events are available on the web server of the IMCCE at ftp.imcce.fr/pub/ephem/satel/pheura07.
Conclusions. We therefore encourage professional and amateur astronomers to join the network of observers to get as many observations as possible.

Key words. planets and satellites: general – eclipses – occultations – ephemerides

1. Introduction

The best-known mutual events are those of the Galilean satellites, which occur every six years and which have been extensively observed since 1973. Such observation campaigns show how to observe and how to use the data that provide astrometric relative positions of the satellites with high accuracy. Improvements in detectors have made it possible to observe the events of the main satellites of Uranus, which are fainter that the Galilean ones. The orbits of the Uranian satellites have little known inclinations due to a geocentric polar view of the system from Earth most of the time, and they may be accurately determined through observations of the mutual events.

To predict these events, we used the early model of Laskar & Jacobson (1987, GUST86) and a new one based on more recent observations named LA06 described below.

2. The mutual events

Since the Uranian satellites have their orbits almost in the same plane, mutual events occur regularly when the Earth (for the occultations) and the Sun (for the eclipses) pass through the common orbital plane of the satellites. This plane corresponds closely to the equatorial plane of Uranus. This occurrence takes place at the “equinox” on Uranus, i.e. when the uranocentric declination of the Sun (and the Earth, which appears to be very close to the Sun as seen from Uranus) are near zero. Table 1 shows the variation of these uranocentric declinations in Cols. (2) and (3): the best period for large, deep, mutual events appear to be May 2007 to February 2008. Fortunately, the opposition of Uranus with the Sun occurs in the middle of the period, allowing observations during almost all the period. Note that the declination of Uranus will be between –4 and –8 degrees allowing observations as well in the northern hemisphere as in the southern. The opposition will occur in September when days and nights have the same length everywhere on Earth.

The description of the mutual eclipses and occultations have been made in previous papers, especially in technical notes available on the web site of the IMCCE at the address http://www.imcce.fr/pheura07 or in Arlot (1999).

The occultations consist in the arrival of the disk of the occulting satellite on the one of the occulted satellite. Therefore, the amount of light received by an Earth-based observer decreases and then increases during the event. The eclipses correspond to the arrival of the eclipsed satellite in the shadow cone of the eclipsing satellite. In that case, only the eclipsed satellite may be observed, leading, in some cases, to a total eclipse (the complete disappearance of the eclipsed satellite). During the occurrence of the mutual events, the magnitude of the events will be small at the beginning and the end of the period (the uranocentric declinations of the Earth and the Sun is not yet zero, and the satellites are not exactly on the same line as seen from the Earth (or the Sun). In contrast, the magnitude of the events will be greater for the zero value of the uranocentric declination of the Earth and the Sun. Observers should be aware that the signal-to-noise ratio will be larger for deep phenomena.

⋆ Tables 7–28 are only available in electronic form at http://www.edpsciences.org

Table 1. Observability of the mutual events.

Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)
2006	May	–4.	–6.	1	–	70	–7.
	June	–3.	–5.5	3	–	100	–6.5
	July	–3.	–5.5	2	–	130	–7.
	August	–3.5	–5.	–	–	160	–7.
	September	–4.	–4.5	–	-	173	–7.5
	October	–6.	–4.5	–	–	142	–8.
	November	–6.5	–4.	–	–	112	–8.5
	December	–7.	–4.	–	–	82	–8.
2007	January	–6.	–3.5	–	–	52	–8.
	February	–5.	–3.	–	–	23	–7.
	March	–3.5	–3.	5	–	5	–7.
	April	–1.5	–2.5	9	5	34	–6.
	May	–0.5	–2.5	12	5	61	–5.5
	June	0.5	–2.	2	7	90	–5.5
	July	1	–2.	2	9	120	–5.
	August	–0.5	–1.5	16	5	150	–5.5
	September	–1.	–1.	6	4	183	–6.
	October	–2.	–1.	3	10	152	–6.5
	November	–2.5	–0.5	–	11	122	–7.
	December	–3.	0.	–	34	85	–7.
2008	January	–2.	0.	9	2	52	–6.5
	February	0.	0.5	18	3	23	–6.
	March	1.	1.	1	–	6	–5.
	April	3.	1.	–	1	34	–4.5
	May	4.	1.5	–	1	34	–4.5
	June	5.	2.	–	–	90	–4.
	July	5.	2.	–	1	119	–4.
	August	4.	2.5	1	2	14	–4.
	September	3.	3.	–	–	118	–4.
	October	2.	3.	1	–	152	–5.
	November	1.5	3.5	–	–	121	–5.
	December	1.	4.	2	–	90	–5.

(1): Month; (2): Uranocentric declination of the Earth to the nearest half-degree; (3): Uranocentric declination of the Sun to the nearest half-degree; (4): Number of occurring occultations; (5): Number of occurring eclipses; (6): Angular distance Sun-Uranus (elongation to the nearest degree); (7): Declination of Uranus in degrees (to the nearest half-degree).

3. The eclipses and events by the planet Uranus

As it occurs regularly with the Galilean satellites, the satellites of Uranus will present occultations by the disk of Uranus, eclipses by its shadow, transits of the satellites on the disk of the planet and transits of the shadows of the satellites on this disk. Note that only eclipses and maybe the transits of the shadows of the satellites on the disk of the planet are easily observable. Eclipses may be interesting for infrared observations of the eclipsed satellites and we will publish the dates soon (Thuillot et al. 2006). For our purpose, we used the dates of these events for the elimination of the mutual events that are not observable due to the presence of the planet Uranus.

4. The predictions for 2006–2009

Before predicting the events, we have to find or build accurate ephemerides, then use an algorithm such as the previous one used for the former predictions of mutual events.

4.1. The dynamical models used for the calculations

Predicting these events requires the use of an accurate orbital model of the Uranian satellites, especially for the inclinations of the satellites, because the mutual events are very sensitive to the relative latitudes of the satellites on the equator of Uranus. The difference of a few hundredths of an arcsecond in the relative positions of the Uranian satellites may affect whether the event will occur or not. Unfortunately, the models of motions are built using observations mostly performed when the Uranian system was seen from its pole, leading to incorrect determination of the orbit inclinations. Therefore, we used two different ephemerides based upon two different sets of observations and two different dynamical models. The first one is from the Laskar-Jacobson theory (Laskar 1986; Laskar & Jacobson 1987) based on observations from 1911 to 1986 (referenced by GUST86 below).

The second model is a preliminary version of new ephemerides for the Uranian system that are described in Lainey & Arlot (2006). These preliminary ephemerides were developed by means of NOE (Numerical Orbit and Ephemerides) software to model the orbital motion of the satellites. This code was developed at the Royal Observatory of Belgium mainly for the purpose of natural-satellite ephemerides and applied successfully to the Martian moons (Lainey et al. 2006). It is an *N*-body code that incorporates highly sensitive modeling and that can generate partial derivatives. The latter ones are needed to fit the initial positions, velocities, and other parameters (masses, J_2, J_4, ...) to the observational data. The numerical procedure used is actually very similar to the one presented in Taylor (1998). This new model introduces the Uranian gravity field by means of C_{20} and C_{40} coefficients borrowed from (French et al. 1988) and the solar perturbation using DE406 ephemerides (Standish 1998). The masses of the Uranian system were taken from (Jacobson et al. 1992) and the Uranian precession from IAU 2000 (Seidelmann et al. 2002). A large set of 11 359 observations (Miranda: 1922; Ariel: 2227; Umbriel: 2230; Titania: 2483; Oberon: 2497) covering the period 1948–2003 was used (cf. Tables 2–4). During the fit procedure, only the initial position and velocity components of each satellite were adjusted in this preliminary version. Weights were introduced using a former estimation of each observationally set accuracy. Intersatellite positions were considered. Tables 2–4 present the post-fit residuals of all the observations used. Note that some sets of data include too few observations to provide confident statistical data.

We present the predictions using the ephemerides from both GUST86 and LA06. Are they confident enough that they will find the mutual events? We know that the precision (internal error) of GUST86 is from 10 to 100 km for a ten-year period. The precision of LA06 is around 10 m. The accuracy (external error) of GUST86 is shown by recent observations (Stone & Harris 2000) to be around 0.1 arcsec. The accuracy of LA06 has been around 0.05 arcsec (cf. Table 2) for recent observations. Events should be more accurately predicted using LA06, but the observations of the mutual events will be able to confirm the predictions or not.

4.2. The predictions of the events

The calculations for the prediction of the events differ for the occultations and for the eclipses. For the occultations, we determinate the time of the first contact, maximum, and last contact of the two disks of the satellites as seen from the Earth. For the eclipses, we do not consider that they are occultations as seen from the Sun because of the light-time, but that they are occultations of the Sun as seen from the eclipsed satellites. Therefore, we calculate the first and last contacts of the eclipsed satellite with the penumbral and umbral cones and the time of the minimum distance to the axis of the cones. The relative positions

Table 2. Values of the mean ν and standard deviations σ on right ascension and declination in arcsecond for each satellite residuals, N being the number of observations used by satellite (1/2).

Observations	ν_α	σ_α	ν_δ	σ_δ	N	Satellite
1983–1998	0.0040	0.0668	0.0095	0.1084	1536	Ariel
Veiga et al. (2003)	0.0005	0.0665	0.0136	0.1081	1526	Umbriel
	0.0017	0.0680	0.0145	0.1086	1541	Titania
	0.0049	0.0745	0.0048	0.1113	1541	Oberon
	–0.0130	0.2317	–0.0493	0.4350	1320	Miranda
1987–1994	0.0137	0.3018	–0.0187	0.3339	106	Titania
Chanturiya et al. (2002)	0.0439	0.3270	0.0116	0.3220	103	Oberon
1998–2000	–0.0012	0.0994	0.0013	0.0859	156	Titania
Stone (2001)	–0.0304	0.1209	–0.0014	0.0870	175	Oberon
1999	–0.0100	0.0150	0.3376	0.1454	3	Ariel
Owen (1999)	–0.0103	0.0229	–0.2032	0.1025	3	Umbriel
	0.0926	0.0731	–0.0707	0.0122	3	Titania
	–0.0723	0.0590	–0.0638	0.0386	3	Oberon
2001	–0.0534	0.0320	0.2146	0.0213	3	Umbriel
Owen (2001)	0.0209	0.0154	–0.1504	0.0189	3	Titania
	0.0325	0.0229	–0.0642	0.0085	3	Oberon
2003	–0.0166	0.0332	0.0520	0.0152	6	Titania
McNaught et al. (2003)	0.0166	0.0332	–0.0520	0.0152	6	Oberon

Table 3. Values of the mean ν and standard deviations σ on right ascension and declination in arcsecond for each satellite residuals, N being the number of observations used by satellite (2/2).

Observations	ν_α	σ_α	ν_δ	σ_δ	N	satellite
1984–1986	0.0025	0.0240	–0.0021	0.0175	34	Ariel
Walker et al. (1988)	–0.0014	0.0236	–0.0008	0.0284	33	Umbriel
	–0.0039	0.0238	0.0032	0.0250	34	Titania
	–0.0051	0.0210	–0.0015	0.0288	34	Oberon
	0.0668	0.0771	0.0096	0.1348	4	Miranda
1981–1985	–0.0050	0.1149	0.0523	0.0779	76	Miranda
Pascu et al. (1987)						
1979–1983	–0.0024	0.0384	0.0052	0.0424	88	Ariel
Harrington et al. (1984)	–0.0014	0.0525	–0.0005	0.0528	85	Umbriel
	0.0070	0.0417	0.0043	0.0368	86	Titania
	0.0010	0.0446	0.0023	0.0478	88	Oberon
	–0.0118	0.1032	–0.0330	0.0907	30	Miranda
1977–1982	–0.0042	0.0583	0.0047	0.0622	343	Ariel
Veillet (1983)	0.0020	0.0627	0.0004	0.0635	340	Umbriel
	–0.0049	0.0506	0.0046	0.0575	343	Titania
	–0.0122	0.0459	–0.0004	0.0556	345	Oberon
	0.0290	0.0997	–0.0138	0.0926	230	Miranda
1981	–0.0070	0.1136	–0.0436	0.1144	78	Miranda
Veillet (1983)						
1975–1977	0.0231	0.0813	–0.0092	0.0761	28	Ariel
Walker et al. (1978)	0.0111	0.0707	0.0196	0.0711	28	Umbriel
	–0.0081	0.1031	–0.0051	0.0734	28	Titania
	0.0021	0.0989	0.0090	0.1066	28	Oberon
	–0.0145	0.2755	–0.0293	0.1924	26	Miranda
1948–1964	–0.0146	0.1429	–0.0039	0.2240	91	Ariel
Van Biesbroek (1970)	–0.0006	0.1084	–0.0056	0.1531	108	Umbriel
	–0.0195	0.0918	0.0173	0.1067	111	Titania
	0.0199	0.1174	0.0131	0.1712	107	Oberon
	0.0254	0.1713	–0.0422	0.2349	56	Miranda

Table 4. Values of the mean ν and standard deviations σ on right ascension and declination in kilometer for each satellite residuals, N being the number of observations used by satellite.

Observations	ν_α	σ_α	ν_δ	σ_δ	N	Satellite
Voyager spacecraft	5.7127	167.9445	–17.8164	126.0864	104	Ariel
	–6.9729	123.4155	–36.7124	176.7181	103	Umbriel
	7.5183	169.6452	–18.7155	144.8990	66	Titania
	–43.2894	298.7594	64.9974	257.9211	64	Oberon
	–76.9123	222.9315	–73.5024	248.1126	102	Miranda

Table 5. Albedoes used for the calculation of the magnitude drop.

	Satellites	V-band	R-band
U-5	Miranda	0.307	0.310
U-1	Ariel	0.350	0.374
U-2	Umbriel	0.189	0.185
U-3	Titania	0.232	0.234
U-4	Oberon	0.205	0.230

of the cones and the satellites are calculated carefully taking the light-time into account. In some cases, the relative velocity of the two satellites or of the eclipsed satellite with reference to the cones is very small or has non linear variations. This induces some errors in determining the times of the beginning and end of these events.

The magnitude drops are provided in several forms: first the flux drop in units of flux (0 = no decrease of light; 1 = total disappearance of the object) and second in magnitude units that more understandable for human eyes (0 = no decrease of light, unchanged magnitude of the object(s); n = increase in magnitude at the maximum of the event). We calculated the drop depending on the albedoes of the implied satellites in the bands V and R, which are commonly used by observers. Table 5 provides the values used for the albedoes. Note the strong difference between Ariel and Umbriel leading to a large influence on the flux drop. These values are deduced from the papers by Helfenstein et al. (1988), Buratti et al. (1990, 1991), and Karkoshka (1997, 2001).

4.3. The data

The predictions of the mutual events were made using the two models LA06 and GUST86 and are available in electronic form on the CDS server and also on the web site of the IMCCE at the address `ftp://ftp.imcce.fr/pub/ephem/satel/pheura07`. Tables 7–18 provide the data for the best events, the most observable, first for LA06 and second for GUST86. Tables 19 to 27, available in an electronic form and also at the ftp address above, provide more events that may not occur since they are not predicted by both ephemerides LA06 and GUST86. One will be able to see the discrepancies in the predictions. These last tables provide the data as follows:

Cols. 1–3: date of the maximum of the event.

Cols. 4–6: nature of the event: 1 OC 2 means that satellite 1 occults satellite 2, while 3 EC 4 means that satellite 3 eclipses satellite 4, etc.

Col. 7: P stands for partial, A for annular, T for total, p for eclipse by the penumbra, and c for conjunction.

Cols. 8–10: h, min, s in TT of the maximum of the event calculated with LA06 ephemeris.

Cols. 11–13: h, min, s in TT of the maximum of the event calculated with GUST86 ephemeris.

Col. 14: apparent separation from the occulted or eclipsed satellite to the limb of Uranus in uranian radii.
Since the inclinations of the orbital planes are not well known, because the observations used to build the theories we mainly performed when the Uranian system was observed from its pole, the grazing events are not certain to be grazing! They might well be deep events or non existent... Note that an event occurs or not, depending on an error in the apparent separation of about 0.01 arcsec, since the errors on the ephemerides is more likely 0.1 arcsec! As a result, the possible events are events calculated by including the possibility of such an error on the positions of the satellites.

The data of Tables 7 to 18 (more probable events) are as follows:

Cols. 1–3: date of the maximum of the event;

Cols. 4–6: nature of the event: 1 OC 2 means that satellite 1 occults satellite 2, while 3 EC 4 means that satellite 3 eclipses satellite 4, etc.

Col. 7: P stands for partial, A for annular, T for total, p for eclipse by the penumbra and c for conjunction.

Cols. 8–10: h, min, s in UTC of the beginning of the occultation or of the eclipse by the penumbra.

Cols. 11–13: h, min, s in TT of the maximum of the event.

Col. 14: duration of the event in seconds; duration of the eclipse by the shadow; no duration is indicated for grazing events or an eclipse by the penumbra.

Col. 15: apparent distance from the occulted or eclipsed satellite to the limb of Uranus in Uranian radii.

Col. 16: flux drop in unit of flux in the R-band (0 = no flux drop; 1 = disappearance of the object); the flux drop is calculated relative to both implied satellites for occultation and to only the eclipsed satellite for the eclipses.

Col. 17: magnitude drop in magnitude unit in the R-band (0 = no magnitude drop; n = increase in the magnitude) for both implied satellites together for occultations and only for the eclipsed satellite for eclipses.

Col. 18: magnitude drop in magnitude unit in the R-band (0 = no magnitude drop; n = increase in the magnitude) for both implied satellites together either for occultations and for the eclipses.

Col. 19: magnitude drop in magnitude unit in the V-band (0 = no magnitude drop; n = increase in the magnitude) for both satellites together for occultations and for only the eclipsed satellite for the eclipses.

Col. 20: magnitude drop in magnitude unit without albedo corrections (0 = no magnitude drop; n = increase in the magnitude) for both satellites together for occultations and for only the eclipsed satellite for the eclipses.

Col. 21: impact parameter in arcsec.

Note that for total eclipses, the magnitude drop is infinite, so we put asterisks in the tables in that case.

The dates are provided in terrestrial time (TT) since the UTC for this period is not available yet. The difference TT – UTC will, however, be nearly 66 s in 2006. Note that observations will be recorded with reference to UTC, so don't forget to subtract 66 s of time from the predicted times – if 66 s is confirmed – to get the observing time. In any case, due to the uncertainties in the ephemerides, start at least 15 min before the beginning of the event.

The predictions of the events are available for the two models, first for LA06 and second for GUST86. The comparison between the two ephemerides leads to several conclusions:

– the deviation between LA06 and GUST86 may reach 500 km (0.04 arcsec) either in longitude (change in the midtime of

the event) or in latitude (change in the magnitude drop of the event);
- most of the events have their midtimes predicted within 5 min of time with LA06 and GUST86, but some larger differences may occur for singular configurations of the satellites (for example, 30 min of time for the occultation of U-2 by U-1 on August 25, 2007);
- among the main events, 11 events predicted using LA06 are not seen using GUST86 and many events have a difference of 50% for their flux drop.

The only observation of some events (they occur or not) will be sufficient to provide information on the relative inclinations of the orbits. A more complete analysis of the differences between LA and GUST is provided in Arlot & Lainey (2006). In the next subsections, we provide more information on the visibility and on the observability of these events.

4.4. The visibility and observability of the events

Since they occur anytime and since their duration is, usually, only a few minutes long, the events are observable only from selected sites where Uranus is visible. The declination of Uranus during the occurrence of the mutual events will be near –4 to –8 degrees. Therefore, the observations will be slightly easier in the Southern hemisphere but also observable in the Northern one. Table 6 provides the number of events observable from some selected sites around the world. We considered that an event is observable when the Sun is more than 10 degrees under the horizon and Uranus is more than 15 degrees above the horizon and the satellites at more than one Uranian radius from the limb of the planet.

Note that grazing events (Col. 2) may be observable or not because of the sensitivity of these events to the inclinations of the orbital planes of the satellites. We considered that an event is grazing only when its observability depends on the possible error in the ephemerides. Thus, if a signal is detected during such an event, one will get valuable information. Note also that the total or annular events will present light curves with a flat step allowing analysis of the scattering law of the light on the surfaces of the satellites. Short events or faint events (the magnitude of which is less than ten percent) will be difficult to catch because of the low signal-to-noise ratio, and observers will need near perfect photometric conditions. The long events (one hour or more) are interesting too, but the observers must take the changing elevation of Uranus on the sky into account: the event must end before Uranus sets. The observers may be aware that the predicted times may have an error of several minutes in some cases. This difference between the observation and the prediction contains useful information for improving the theoretical models of the satellite motions. Therefore, the observations must start at least 15 min (or more for long events) before the predicted beginning and must be referred to UTC within one tenth of a second. The predictions are made from the center of the Earth. Since the events are topocentric, we should have to make corrections for the diurnal parallax. However, due to the distance between the Earth and the Uranian satellites, this correction is negligible.

Will we be certain we will observe the events? The comparison of the different sets of predictions may give information on the uncertainties. Christou (2005) published predictions using GUST86 and obtained results similar to ours within a few tenths of a second of time, which shows that we used similar models for the phenomena. Our results using the LA06 model show some discrepancies that may reach 30 min for the timing and 50% for the magnitude drop. Therefore, some events predicted with GUST86 are not predicted by LA06 and vice versa. This shows the interest of these observations: the magnitude drop should be measured carefully in order to deduce data on the inclinations of the orbits of the satellites.

Information on the visibility of the events from any site of observation is provided on the web site of IMCCE at the address given below.

Table 6. Visibility of the mutual events depending on the site of observation.

Observatory	(1)	(2)
Cape Town (South Africa)	68	26
Siding Spring (Australia)	62	25
Catania (Italy)	61	25
Brasopolis (Brazil)	57	17
Barcelona (Spain)	56	20
ESO-La Silla (Chile)	55	21
Pic du Midi (France)	53	19
Kavalur (India)	52	25
Purple Mountain (China)	52	24
Haute-Provence (France)	52	21
Nauchny (Ukraine)	52	21
Mauna Kea, Hawaii (USA)	52	19
Mc Donald (USA)	52	18
Bucarest (Romania)	51	25
Stuttgart (Germany)	51	22
Torino (Italy)	51	21
Canarian Islands (Spain)	51	12
Zelenchuk (Russia)	50	22
Buenos-Aires (Argentina)	50	17
Paris (France)	48	19
Uccle (Belgium)	48	19
Dodaira (Japan)	48	18
Pekin (China)	47	20
Berlin (Germany)	45	19
Washington DC (USA)	43	17
Topeka Kansas (USA)	39	13
Moscow (Russia)	38	20

(1): All events, even grazing; (2): events easily observable occurring at more than one Uranian radius from the limb of the planet.

5. The observations of the mutual events

Observation of the mutual events consists in recording the light flux as a function of time using a photometric receptor. At present, CCDs are the most common detectors used for this type of observation. Note that the Uranian satellites have such a magnitude that the observation is not easy and it needs a large telescope (at least an aperture of 60 cm). Miranda has a magnitude of 16.5, Ariel 14.4, Umbriel 14.8, Titania 13.8, and Oberon 14.2. In order to have a good signal-to-noise ratio, each frame should have an exposure time around 5 s with a 1 m telescope. Intensified cameras may help to decrease the time exposure but will degrade the photometric accuracy. Then, short events needing shorter frames will be observable only with larger telescopes.

Each image must be dated in UTC within an accuracy of 0.1 s that corresponds, according to the velocities of the satellites, to an astrometric accuracy on the order of 1 km for the relative position of the satellites (corresponds to 0.1 mas in geocentric position).

The advantage of two-dimensional receptors is the possibility of getting several satellites in the field. This will help for the photometric reduction, as we will see below. Other types of detectors may be used, such as single-channel photoelectric photometers for fast photometry in several spectral bands. Photographic or visual observations will not be possible. Technical notes on the use of several types of detectors are available by request from the authors or on the web server of IMCCE at the address given below.

Most of time, the raw light-curves are difficult to analyze without a specific photometric reduction. Since we only need relative photometry the recorded magnitude drop is measured in reference to the magnitude of the satellites before and after the event. However, it is important to record a reference object not affected by the event at the same time. Using a two-dimensional receptor will allow the observer to simultaneously record both the satellites involved in the event and another uninvolved satellite with constant brightness. Only for long events it will be necessary to take the rotation of the satellites into account. A two-dimensional detector will also record the sky background simultaneously. Then, the reduction will easily solve the problems related to light clouds or to the variation in the elevation of the observed bodies in the sky, as well as to the brightness of the sky background before sunrise or after sunset. If using a single-channel receptor, the observer will need to alternatively record the sky background and a reference object either during the event for a long event (more than 20 min) or just before and after the event for a short event. One should consult the technical notes explaining how to perform this calibration (Arlot 2002).

In order to optimize the observations and to catch the maximum number of phenomena, we propose to organize a campaign of observations so as to coordinate the observing sites as we did for the Galilean and Saturnian satellites. Such campaigns, as organized in the past, allowed publication of a very complete catalogue of data such as in Arlot et al. (1997) for the 1991 occurrence and in Arlot et al. (2005) and Emelianov et al. (2000) for the 1997 occurrence. The reader is encouraged to join our campaign of observations, to contact the authors at `arlot@imcce.fr`, and to get information on the campaign of observations from the web address `www.imcce.fr/pheura07`.

6. The interest of the observations

6.1. Astrometry and dynamics of the Uranian satellites: the accuracy

The goal of the observation of the mutual phenomena of the Uranian satellites is to obtain astrometric data leading to relative positions of the satellites with high accuracy. Observations of the mutual events have been shown to be more accurate than direct photographic or CCD ones. Measurement of the magnitude drop at the time of the minimum distance corresponds to the time of this minimum distance. Thanks to the absence of an atmosphere on the satellites, we will appreciate the sharpness of the light curves. The mutual events should easily lead to a positional accuracy of at least 100 km, i.e. an astrometric geocentric accuracy of 10 mas.

The accuracy of the observations of the mutual events does not depend on the distance of the observed objects, in contrast to direct astrometric observations whose accuracy in angle (arcsec) corresponds to larger separations near Uranus than near Jupiter. However, the Uranian satellites are fainter than the Jovian ones, so it will be necessary to use larger telescopes that provide a good signal-to-noise ratio in order to get the same astrometric accuracy than for the Jovian satellites.

Such observed positions help to fit the dynamical models of the motions of the satellites. Their accuracy allows better determination of the inclinations and eccentricities. The Voyager 2 spacecraft has some precise observations, but during too short an interval of time to be able to determine orbital parameters with sufficient acuracy. For that, we need accurate observations over a long interval of time as provided by the mutual events together with ground-based observations since 1787. These events have never been observed and are a challenge for the next years.

6.2. Planetology: analysis of the surfaces and constraints on the internal structures

Looking for a better reduction of the mutual phenomena of the Galilean satellites, Vasundhara et al. (1996) demonstrated that a new reduction considering that the satellites are not uniform disks may help to improve the accuracy of the data. Surface effects were suspected to be non-negligible when observing the mutual events presenting light curves with an asymmetrical aspect. Taking the surface effects into account for the reduction allows the determination of unknowns related to planetological parameters, such as the porosity and the rugosity of the surfaces of the satellites themselves, implying different scattering laws affecting the observed light curves.

On the other hand, our dynamical model LA06 contains parameters depending on tidal effects on the satellites, which may be fit thanks to new accurate data such as observations of mutual events. This may provide constraints on the internal structure of the satellites.

7. Conclusion

The occurrence of the mutual events in 2006–2009 is particularly favorable because of the opposition of Uranus when the mutual events are the most numerous (i.e., when the uranocentric declination of the Sun and the Earth is at a minimum). We encourage observers to make the most of their observations during this occurrence in order to complete the collections of ground-based data. Such events are very promising after experiences with similar events occurring in the Jovian and Saturnian systems. Moreover, valuable information on the inclination of the orbits of the satellites will be deduced from these events. We look forward to performing observations so as to obtain highly accurate astrometric data.

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References

Arlot, J. E. 1999, Proc. of the 5th workshop PHEMU97, held in Catania, Italy on March 4–6, 1997, ed. J.-E. Arlot, & C. Blanco (Paris: IMC Éditions), 59
Arlot, J. E. 2002, Technical notes Phemu (Paris: IMCCE)
Arlot, J.-E., Ruatti, C., Thuillot, W., et al. 1997, A&AS, 125, 399
Buratti, B., & Mosher, J. 1991, Icarus, 90, 1
Buratti, B., Wong, F., & Mosher, J. 1990, Icarus, 84, 203
Chanturya, Kisseleva, Emalianov: 2002, Izvestia Pulkovo, 216 349
Christou, A. 2005, Icarus, 178, 171
Emelianov, N. V., & Berejnoi, A. A., Vashkovjak, S. N., et al. 2000, A&AS, 141, 433
Harrington, R. S., & Walker, R. L. 1984, AJ, 89, 889
Helfenstein, P., Veverka, J., & Thomas, P. C. 1988, Icarus, 74, 231
Jacobson, R. A. 1992, A&AS, 96, 549
Jacobson, R. A., Campbell, J. K., Taylor, A. H., & Synnott, S. P. 1992, The masses of Uranus and its major satellites from Voyager tracking data and earth-based Uranian satellite data, AJ, 103, 2068

Karkoschka, E. 1997, Icarus, 125, 348
Karkoschka, E. 2001, Icarus, 151, 51
Lainey, V., & Arlot, J. E. 2006, New ephemerides of the Uranian satellites, A&A, in preparation
Lainey, V., Dehant, V., & Pätzold, M. 2006, First numerical ephemerides of the Martian moons, A&A, submitted
Laskar, J. 1986, A general theory for the Uranian satellites, A&A, 166, 349
Laskar, J., & Jacobson, R. A. 1987, GUST86 - an analytical ephemeris of the Uranian satellites, A&A, 188, 212
Lainey, V., & Arlot, J. E. 2006, Eclipses of the satellites of Uranus in 2006–2009, in preparation
McNaught, R. H., & Garradd, G. J. 2003, NSDC Comm. UM008
Owen, W. M. 1999 and 2001, NSDC Comm. UM004 and UM005
Pascu, D., Seidelmann, P. K., Schmidt, R. E., Santos, E. Y., & Hershey, Y. L. 1987, AJ, 93, 963
Seidelmann, P. K., Abalakin, V. K., Bursa, M., et al. 2002, Celes. Mech., 82, 83
Standish, E. 1998, JPL Internal memorandum
Stone, R. C. 2000, AJ, 120, 2124
Stone, R. C. 2001, AJ, 122, 2723
Stone, R. C., & Harris, A. 2000, AJ, 119, 1985
Taylor, D. B. 1998, A&A, 330, 362
Thuillot, W., et al. 2006, Infrared observations of eclipsed satellites of Uranus, in preparation
Van Biesbroek, G. 1970, Comm. to Lunar and Planetary laboratory, 8, 179
Vasundhara, R., Arlot, J.-E., & Descamps, P. 1996, Proc., 172, IAU Symp., ed. S. Ferraz Mello, B. Morando, & J.-E. Arlot (Kluwer Acad. Pub.), 423
Veiga, C. H., Martins, R. V., Veillet, C., & Lazzaro, D. 1987, A&AS, 70, 325
Veiga, C. H., Vieira Martins, R., & Andrei, A. H. 2003, AJ, 125, 2714
Veillet, C. 1983, Ph.D. University of Paris VI
Walker, R. L., & Harrington, R. S. 1988, AJ, 95, 1562
Walker, R. L., Christy, J. W., & Harrington, R. S. 1978, AJ, 83, 838

Online Material

Table 7. Mutual events of the 2006–2008 period: main events predicted with LA06 (1/6).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	Flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2006 5 5	5 OC 1 P	10 23 5.	10 26 41.	432	3.9	0.157	0.185	0.185	0.172	0.101	0.035
2006 5 11	1 OC 5 P	17 34 10.	17 36 19.	259	3.9	0.072	0.081	0.081	0.085	0.091	0.037
2006 6 3	1 OC 5 P	10 4 57.	10 8 43.	451	3.8	0.062	0.069	0.069	0.073	0.078	0.039
2006 6 16	1 OC 5 T	0 37 9.	0 39 14.	251	3.8	0.130	0.152	0.152	0.160	0.171	0.001
2006 6 22	5 OC 1 P	8 19 20.	8 20 41.	161	3.4	0.122	0.142	0.142	0.132	0.078	0.040
2006 7 2	5 OC 1 A	9 41 3.	9 46 40.	674	3.7	0.256	0.322	0.322	0.298	0.171	0.018
2006 7 8	1 OC 5 P	16 38 12.	16 40 54.	323	4.0	0.110	0.126	0.126	0.133	0.142	0.031
2006 7 15	5 OC 1 P	0 6 12.	0 8 4.	225	3.8	0.178	0.213	0.213	0.198	0.116	0.035
2007 3 10	1 OC 5 T	4 31 41.	4 33 56.	270	3.8	0.130	0.152	0.152	0.160	0.171	0.001
2007 3 16	5 OC 1 P	12 13 24.	12 14 37.	146	3.5	0.080	0.090	0.090	0.084	0.050	0.042
2007 3 25	1 OC 5 T	12 17 2.	12 18 9.	135	0.6	0.130	0.152	0.152	0.160	0.171	0.002
2007 3 26	5 OC 1 P	13 54 25.	14 0 45.	760	3.6	0.227	0.279	0.279	0.259	0.150	0.027
2007 4 1	1 EC 5 P	20 38 12.	20 41 28.	352	4.0	0.707	1.332	0.099	1.332	1.332	0.033
2007 4 8	5 EC 1 A	4 2 42.	4 5 32.	314	3.8	0.163	0.193	0.167	0.193	0.193	0.009
2007 4 14	1 EC 5 T	11 45 40.	11 48 5.	262	3.6	1.000	*****	0.144	*****	*****	0.008
2007 4 20	5 EC 1 A	19 33 7.	19 34 49.	177	3.1	0.163	0.193	0.167	0.193	0.193	0.019
2007 4 22	1 OC 5 P	12 36 40.	12 37 58.	157	2.6	0.130	0.151	0.151	0.159	0.170	0.023
2007 4 24	2 OC 1 P	6 22 24.	6 27 20.	592	6.2	0.084	0.095	0.095	0.092	0.070	0.060
2007 4 27	1 EC 5 P	3 27 0.	3 28 21.	152	2.8	0.707	1.334	0.100	1.334	1.334	0.032
2007 4 28	5 OC 1 P	20 29 43.	20 30 59.	152	3.0	0.169	0.201	0.201	0.187	0.110	0.034
2007 4 30	1 OC 2 P	11 22 35.	11 27 42.	613	6.2	0.241	0.300	0.300	0.321	0.491	0.017
2007 4 30	3 OC 2 T	4 40 5.	4 45 4.	598	8.5	0.214	0.261	0.261	0.282	0.476	0.003
2007 4 30	5 EC 1 A	20 10 26.	20 14 27.	453	3.9	0.164	0.194	0.168	0.194	0.194	0.005
2007 5 3	1 OC 3 A	2 16 9.	2 25 46.	1175	6.1	0.327	0.430	0.430	0.438	0.470	0.000
2007 5 3	1 OC 3 P	12 50 58.	13 4 25.	1613	1.0	0.313	0.407	0.407	0.415	0.445	0.019
2007 5 3	2 OC 1 P	9 12 31.	9 14 49.	276	3.6	0.650	1.139	1.139	1.081	0.724	0.002
2007 5 3	2 OC 3 A	8 34 49.	8 37 44.	350	3.2	0.329	0.434	0.434	0.442	0.476	0.010*
2007 5 3	4 OC 1 P	21 36 16.	21 38 46.	300	3.1	0.217	0.266	0.266	0.260	0.211	0.047
2007 5 3	4 OC 3 P	23 39 44.	23 43 35.	463	2.3	0.408	0.569	0.569	0.589	0.712	0.002
2007 5 4	1 OC 3 P	8 6 12.	8 10 0.	456	6.3	0.063	0.071	0.071	0.072	0.077	0.069
2007 5 4	4 OC 2 P	19 7 53.	19 10 41.	337	4.1	0.127	0.147	0.147	0.158	0.253	0.042
2007 5 5	1 OC 2 P	0 35 53.	0 37 32.	197	0.8	0.111	0.128	0.128	0.136	0.199	0.043
2007 5 6	2 OC 1 P	17 2 31.	17 5 54.	406	6.1	0.208	0.253	0.253	0.244	0.183	0.045
2007 5 7	1 EC 5 P	3 36 33.	3 38 49.	233	3.9	0.427	0.604	0.059	0.604	0.604	0.040
2007 5 11	5 OC 4 P	11 44 37.	11 47 8.	302	3.8	0.066	0.074	0.074	0.065	0.064	0.047
2007 5 29	1 EC 5 T	19 47 2.	19 51 11.	464	3.9	1.000	*****	0.144	*****	*****	0.017

Table 8. Mutual events of the 2006–2008 period: main events predicted with LA06 (2/6).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	Flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2007 6 1	1 EC 5 P	10 49 39.	10 50 51.	85	2.4	0.114	0.131	0.015	0.131	0.131	0.050
2007 6 7	5 EC 1 P	18 45 2.	18 46 5.	90	1.8	0.075	0.085	0.074	0.085	0.085	0.040
2007 6 14	1 EC 5 P	2 43 20.	2 44 27.	104	1.4	0.699	1.304	0.098	1.304	1.304	0.032
2007 6 20	5 EC 1 A	10 40 49.	10 42 2.	119	0.7	0.164	0.194	0.168	0.194	0.194	0.019
2007 6 26	1 EC 5 T	18 40 30.	18 41 44.	123	0.3	1.000	*****	0.144	*****	*****	0.011
2007 6 27	5 EC 1 P	19 20 30.	19 24 18.	418	3.9	0.117	0.135	0.118	0.135	0.135	0.033
2007 6 29	2 EC 5 T	19 5 36.	19 7 54.	236	3.5	1.000	*****	0.270	*****	*****	0.018
2007 7 1	5 EC 2 A	21 18 2.	21 19 51.	182	3.0	0.162	0.192	0.147	0.192	0.192	0.012
2007 7 3	2 EC 5 T	23 37 14.	23 38 58.	173	2.8	1.000	*****	0.270	*****	*****	0.001
2007 7 6	5 EC 2 A	1 54 15.	1 55 53.	160	2.3	0.163	0.194	0.148	0.194	0.194	0.006
2007 7 8	2 EC 5 T	4 16 37.	4 18 10.	153	2.1	1.000	*****	0.270	*****	*****	0.003
2007 7 10	5 EC 2 A	6 36 57.	6 38 24.	139	1.6	0.164	0.195	0.149	0.195	0.195	0.015
2007 7 12	2 EC 5 T	9 0 14.	9 1 37.	132	1.3	1.000	*****	0.270	*****	*****	0.016
2007 7 12	5 OC 3 A	3 38 14.	3 45 46.	890	1.3	0.099	0.113	0.113	0.111	0.096	0.004
2007 7 14	5 EC 2 P	11 23 5.	11 24 15.	99	0.8	0.112	0.129	0.099	0.129	0.129	0.034
2007 7 16	2 EC 5 P	13 47 1.	13 48 3.	78	0.5	0.413	0.579	0.103	0.579	0.579	0.040
2007 7 22	1 EC 5 P	2 39 3.	2 39 48.	82	0.2	0.153	0.180	0.021	0.180	0.180	0.048
2007 7 26	1 EC 5 P	18 59 54.	19 3 31.	381	3.9	0.384	0.526	0.053	0.526	0.526	0.041
2007 7 30	5 OC 4 P	11 1 4.	11 8 25.	864	2.5	0.069	0.078	0.078	0.069	0.068	0.049
2007 8 5	4 OC 2 P	13 43 30.	13 57 10.	1682	8.5	0.075	0.084	0.084	0.090	0.142	0.061
2007 8 6	1 OC 5 T	10 34 19.	10 36 16.	235	3.6	0.130	0.152	0.152	0.160	0.171	0.001
2007 8 6	4 OC 2 P	0 48 33.	1 8 25.	2334	3.9	0.123	0.142	0.142	0.153	0.245	0.046
2007 8 13	1 OC 2 P	3 1 24.	3 6 38.	627	6.3	0.264	0.333	0.333	0.356	0.551	0.014
2007 8 13	1 OC 4 P	13 23 5.	13 25 30.	289	2.0	0.180	0.216	0.216	0.196	0.242	0.046
2007 8 14	2 OC 1 P	20 10 7.	20 12 4.	234	1.6	0.461	0.671	0.671	0.644	0.460	0.021
2007 8 14	2 OC 4 P	1 31 56.	1 34 49.	346	7.1	0.094	0.107	0.107	0.097	0.119	0.065
2007 8 14	2 OC 5 P	22 55 56.	22 57 34.	194	3.3	0.128	0.149	0.149	0.157	0.168	0.026
2007 8 15	2 OC 3 A	9 12 57.	9 17 18.	523	8.0	0.329	0.434	0.434	0.442	0.476	0.007
2007 8 16	1 OC 2 P	11 29 9.	11 31 20.	262	2.9	0.322	0.422	0.422	0.453	0.722	0.002
2007 8 19	2 OC 1 P	7 52 58.	8 0 17.	877	6.2	0.318	0.415	0.415	0.400	0.295	0.036
2007 8 20	5 OC 2 P	13 51 43.	13 58 46.	879	3.5	0.103	0.118	0.118	0.121	0.137	0.032

Table 9. Mutual events of the 2006–2008 period: main events predicted with LA06 (3/6).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	Flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2007 8 22	2 EC 5 T	14 59 40.	15 3 54.	450	3.9	1.000	*****	0.270	*****	*****	0.014
2007 8 24	1 OC 2 P	12 17 12.	12 23 47.	790	6.1	0.080	0.091	0.091	0.096	0.140	0.054
2007 8 24	5 EC 3 A	13 41 40.	13 44 15.	228	2.7	0.096	0.110	0.097	0.110	0.110	0.026
2007 8 25	1 OC 2 P	6 50 50.	7 35 43.	13073	3.2	0.095	0.108	0.108	0.115	0.167	0.050
2007 9 1	5 EC 1 P	18 6 4.	18 7 6.	93	1.2	0.097	0.110	0.096	0.110	0.110	0.036
2007 9 6	3 EC 5 T	20 25 42.	20 27 28.	157	0.1	1.000	*****	0.126	*****	*****	0.028
2007 9 8	1 EC 5 T	2 4 39.	2 6 1.	139	1.7	1.000	*****	0.144	*****	*****	0.009
2007 9 14	5 EC 1 P	10 2 1.	10 3 15.	119	2.3	0.124	0.144	0.125	0.144	0.144	0.032
2007 9 22	1 EC 5 P	18 22 26.	18 27 26.	550	3.8	0.651	1.142	0.091	1.142	1.142	0.034
2007 9 29	5 OC 1 P	1 20 20.	1 22 11.	221	3.9	0.067	0.075	0.075	0.070	0.042	0.048
2007 10 7	2 EC 5 T	18 0 23.	18 1 54.	148	2.1	1.000	*****	0.270	*****	*****	0.013
2007 10 8	1 OC 5 T	0 42 56.	0 44 12.	152	1.7	0.130	0.152	0.152	0.160	0.171	0.002
2007 10 9	5 EC 2 P	20 23 2.	20 24 23.	139	2.5	0.110	0.126	0.097	0.126	0.126	0.034
2007 10 11	5 OC 1 A	16 36 3.	16 37 52.	219	3.5	0.257	0.322	0.322	0.298	0.171	0.017
2007 10 12	3 EC 5 T	0 1 25.	0 3 25.	179	1.9	1.000	*****	0.126	*****	*****	0.027
2007 10 12	4 EC 5 T	9 48 35.	9 52 15.	332	3.6	1.000	*****	0.137	*****	*****	0.019
2007 10 18	1 OC 5 P	0 28 21.	0 29 35.	148	3.1	0.071	0.080	0.080	0.084	0.090	0.039
2007 10 21	1 EC 2 P	22 46 7.	23 4 59.	2138	0.5	0.211	0.257	0.079	0.257	0.257	0.054
2007 10 21	5 EC 1 A	18 6 50.	18 13 28.	754	3.7	0.165	0.196	0.169	0.196	0.196	0.017
2007 10 26	1 EC 5 T	1 25 41.	1 27 24.	180	3.1	1.000	*****	0.144	*****	*****	0.010
2007 11 2	5 EC 3 A	20 30 24.	20 32 48.	244	2.8	0.096	0.109	0.097	0.109	0.109	0.016
2007 11 11	1 EC 3 P	2 58 30.	3 8 24.	998	0.6	0.114	0.132	0.069	0.132	0.132	0.069
2007 11 19	1 EC 5 T	18 2 1.	18 10 9.	924	3.6	1.000	*****	0.144	*****	*****	0.017
2007 11 21	2 EC 1 P	16 45 33.	16 48 13.	257	5.2	0.164	0.194	0.126	0.194	0.194	0.057
2007 11 23	4 EC 2 P	5 57 58.	6 2 34.	190	9.1	0.063	0.071	0.022	0.071	0.071	0.082
2007 11 24	1 EC 2 P	15 34 37.	15 37 12.	239	5.3	0.125	0.145	0.046	0.145	0.145	0.061
2007 11 27	1 EC 2 P	22 51 12.	22 54 6.	301	4.8	0.407	0.568	0.159	0.568	0.568	0.037
2007 11 28	1 EC 3 P	1 38 13.	1 42 20.	400	5.9	0.198	0.240	0.122	0.240	0.240	0.056
2007 11 29	2 EC 3 A	12 44 7.	12 50 43.	678	8.9	0.494	0.740	0.459	0.740	0.740	0.017
2007 11 29	2 EC 4 P	19 3 26.	19 7 16.	277	7.3	0.119	0.137	0.091	0.137	0.137	0.067
2007 11 30	1 EC 5 P	8 52 24.	8 54 28.	218	3.4	0.869	2.204	0.124	2.204	2.204	0.028
2007 11 30	2 EC 1 P	21 32 41.	21 36 17.	386	5.7	0.453	0.656	0.390	0.656	0.656	0.035

Table 10. Mutual events of the 2006–2008 period: main events predicted with LA06 (4/6).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	Flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2007 11 30	3 EC 4 P	18 35 34.	18 49 49.	1473	15.6	0.729	1.419	0.465	1.419	1.419	0.023
2007 12 2	1 EC 2 P	13 37 53.	13 39 49.	186	0.2	0.459	0.667	0.181	0.667	0.667	0.033
2007 12 2	3 EC 2 P	17 12 50.	17 15 45.	283	2.3	0.576	0.931	0.208	0.931	0.931	0.041
2007 12 3	3 EC 1 P	12 5 1.	12 9 4.	415	5.0	0.934	2.947	0.617	2.947	2.947	0.014
2007 12 4	2 EC 1 P	5 3 43.	5 6 20.	273	4.2	0.774	1.616	0.787	1.616	1.616	0.012
2007 12 6	4 EC 1 P	3 21 18.	3 24 43.	310	3.5	0.526	0.811	0.321	0.811	0.811	0.042
2007 12 6	4 EC 2 P	6 0 30.	6 4 16.	340	4.7	0.611	1.025	0.238	1.025	1.025	0.036
2007 12 6	4 EC 3 P	13 52 58.	13 58 3.	476	7.9	0.640	1.108	0.442	1.108	1.108	0.022
2007 12 7	1 EC 2 P	3 29 6.	3 33 39.	494	6.0	0.756	1.532	0.316	1.532	1.532	0.014
2007 12 7	1 EC 3 P	13 2 51.	13 5 33.	256	1.3	0.394	0.544	0.257	0.544	0.544	0.031
2007 12 8	2 EC 1 A	19 54 50.	19 56 57.	214	0.8	0.814	1.824	0.847	1.824	1.824	0.002
2007 12 8	2 EC 3 P	1 54 51.	1 58 54.	374	7.3	0.218	0.267	0.179	0.267	0.267	0.054
2007 12 10	1 EC 2 P	11 15 8.	11 17 35.	250	3.7	0.697	1.298	0.288	1.298	1.298	0.017
2007 12 11	3 EC 1 P	13 13 32.	13 15 58.	238	0.8	0.450	0.649	0.254	0.649	0.649	0.050
2007 12 11	3 EC 2 P	4 44 14.	4 47 41.	353	4.9	0.880	2.304	0.337	2.304	2.304	0.018
2007 12 12	1 EC 4 A	14 41 44.	14 44 42.	275	1.0	0.557	0.883	0.365	0.883	0.883	0.002
2007 12 12	2 EC 4 A	16 32 54.	16 36 14.	318	1.7	0.547	0.859	0.503	0.859	0.859	0.006
2007 12 12	3 EC 4 A	1 6 16.	1 11 1.	415	3.3	0.716	1.367	0.455	1.367	1.367	0.005
2007 12 13	2 EC 1 A	9 5 12.	9 10 48.	624	6.2	0.910	2.609	1.011	2.609	2.609	0.002
2007 12 15	1 EC 2 P	2 13 22.	2 15 20.	189	1.5	0.425	0.601	0.166	0.601	0.601	0.036
2007 12 15	1 EC 3 P	14 2 20.	14 5 33.	302	4.7	0.180	0.216	0.110	0.216	0.216	0.059
2007 12 16	2 EC 1 P	17 31 50.	17 33 46.	223	3.1	0.267	0.338	0.213	0.338	0.338	0.048
2007 12 17	2 EC 5 T	7 29 48.	7 32 17.	257	3.6	1.000	*****	0.270	*****	*****	0.016
2007 12 17	4 EC 3 A	14 13 50.	14 21 24.	750	13.9	0.781	1.650	0.569	1.650	1.650	0.002
2007 12 19	1 EC 2 P	14 19 30.	14 27 18.	869	6.2	0.790	1.693	0.332	1.693	1.693	0.012
2007 12 19	3 EC 2 P	16 40 8.	16 43 51.	331	7.2	0.285	0.364	0.098	0.364	0.364	0.062
2007 12 21	2 EC 1 P	8 29 22.	8 31 6.	130	2.2	0.072	0.081	0.053	0.081	0.081	0.067
2007 12 24	2 EC 1 P	18 46 27.	18 56 3.	1082	6.1	0.472	0.694	0.410	0.694	0.694	0.034

Table 11. Mutual events of the 2006–2008 period: main events predicted with LA06 (5/6).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	Flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2007 12 25	2 EC 1 P	10 19 32.	10 50 17.	3591	1.4	0.917	2.697	1.024	2.697	2.697	0.005
2007 12 25	2 EC 1 P	17 6 5.	17 29 29.	2673	5.2	0.820	1.862	0.858	1.862	1.862	0.011
2007 12 28	3 EC 2 P	5 43 43.	5 47 31.	248	8.8	0.066	0.074	0.022	0.074	0.074	0.083
2007 12 30	1 EC 2 P	23 25 60.	23 30 25.	456	6.3	0.132	0.154	0.049	0.154	0.154	0.061
2008 1 4	1 EC 5 P	16 15 35.	16 17 42.	218	3.7	0.554	0.876	0.077	0.876	0.876	0.037
2008 1 6	3 EC 2 P	2 33 11.	3 19 41.	5478	6.9	0.186	0.224	0.063	0.224	0.224	0.071
2008 1 6	3 EC 2 P	5 7 33.	6 27 53.	6062	5.5	0.175	0.209	0.059	0.209	0.209	0.072
2008 1 6	1 OC 5 T	15 27 11.	15 29 5.	228	3.6	0.130	0.152	0.152	0.160	0.171	0.001
2008 1 9	1 OC 5 T	7 27 19.	7 28 29.	140	1.3	0.130	0.152	0.152	0.160	0.171	0.002
2008 1 23	5 OC 1 P	0 2 47.	0 5 24.	315	3.9	0.099	0.113	0.113	0.105	0.063	0.040
2008 1 24	1 OC 5 T	15 57 36.	15 58 42.	132	0.8	0.130	0.152	0.152	0.160	0.171	0.002
2008 1 27	2 OC 5 T	12 34 48.	12 36 2.	147	0.2	0.129	0.150	0.150	0.158	0.169	0.003
2008 1 29	5 OC 2 A	15 0 42.	15 1 56.	149	0.6	0.126	0.146	0.146	0.149	0.169	0.008
2008 1 31	2 OC 5 P	17 22 46.	17 23 56.	139	1.0	0.127	0.148	0.148	0.156	0.167	0.024
2008 2 2	5 OC 2 P	19 47 56.	19 49 1.	131	1.4	0.096	0.109	0.109	0.112	0.126	0.031
2008 2 4	2 OC 5 P	22 8 11.	22 9 11.	119	1.8	0.064	0.072	0.072	0.075	0.081	0.038
2008 2 7	5 OC 2 P	0 31 58.	0 33 3.	129	2.2	0.069	0.077	0.077	0.079	0.089	0.036
2008 2 8	1 EC 5 T	23 29 6.	23 32 12.	342	3.9	1.000	*****	0.144	*****	*****	0.008
2008 2 9	2 OC 5 P	2 49 50.	2 51 6.	151	2.6	0.100	0.114	0.114	0.121	0.129	0.030
2008 2 11	5 OC 2 A	5 10 5.	5 11 39.	188	2.9	0.126	0.146	0.146	0.149	0.169	0.016
2008 2 13	2 OC 5 T	7 24 14.	7 25 60.	212	3.2	0.129	0.150	0.150	0.158	0.169	0.002
2008 2 15	2 OC 3 A	10 18 3.	10 58 16.	5263	4.3	0.329	0.434	0.434	0.442	0.476	0.011
2008 2 15	2 OC 3 A	17 35 2.	18 14 17.	4503	7.6	0.329	0.434	0.434	0.442	0.476	0.010*
2008 2 18	1 OC 2 P	23 41 27.	23 43 20.	226	2.8	0.134	0.157	0.157	0.167	0.246	0.037
2008 2 19	3 OC 1 T	17 53 21.	17 56 17.	353	3.7	0.427	0.605	0.605	0.590	0.470	0.004
2008 2 20	2 OC 1 P	21 4 6.	21 30 11.	3516	5.0	0.636	1.097	1.097	1.043	0.702	0.003
2008 2 21	2 OC 1 P	19 35 10.	19 44 44.	1132	6.1	0.654	1.152	1.152	1.094	0.731	0.001
2008 2 21	2 OC 1 P	2 9 21.	2 48 44.	4355	2.0	0.642	1.114	1.114	1.059	0.711	0.002
2008 2 23	4 OC 2 P	20 24 22.	20 27 2.	319	5.6	0.075	0.085	0.085	0.091	0.143	0.056
2008 3 15	1 OC 5 P	6 25 20.	6 28 26.	372	3.9	0.103	0.118	0.118	0.124	0.132	0.030
2008 4 13	5 EC 1 A	5 59 59.	6 3 54.	433	4.0	0.164	0.194	0.168	0.194	0.194	0.014
2008 4 23	2 EC 5 P	18 56 52.	19 2 34.	584	3.8	0.712	1.350	0.185	1.350	1.350	0.033

Table 12. Mutual events of the 2006–2008 period: main events predicted with LA06 (6/6).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	Flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2008 5 7	3 EC 5 P	13 24 46.	13 29 59.	465	0.8	0.483	0.716	0.059	0.716	0.716	0.053
2008 5 29	5 EC 3 P	15 21 40.	15 27 49.	585	1.6	0.064	0.072	0.064	0.072	0.072	0.047
2008 7 15	5 EC 1 P	11 37 18.	11 42 1.	512	3.9	0.111	0.128	0.111	0.128	0.128	0.034
2008 8 12	1 EC 5 T	22 15 8.	22 27 58.	1472	3.2	1.000	*****	0.144	*****	*****	0.010
2008 8 19	5 EC 2 A	9 4 21.	9 16 35.	1334	1.8	0.161	0.191	0.146	0.191	0.191	0.020
2008 8 23	5 OC 2 A	21 6 52.	21 16 38.	1215	1.7	0.126	0.146	0.146	0.149	0.169	0.024
2008 10 30	5 OC 4 A	15 56 15.	16 1 2.	575	0.3	0.103	0.118	0.118	0.104	0.103	0.021
2008 12 13	5 OC 1 A	3 11 17.	3 16 23.	611	3.8	0.256	0.322	0.322	0.298	0.171	0.020*
2008 12 19	2 EC 5 P	16 53 36.	16 59 57.	637	0.8	0.331	0.436	0.082	0.436	0.436	0.043
2008 12 23	5 OC 4 A	6 13 2.	6 18 7.	611	0.5	0.103	0.118	0.118	0.104	0.103	0.010
2009 1 11	1 OC 5 P	3 3 22.	3 7 48.	533	3.7	0.064	0.072	0.072	0.075	0.080	0.038
2009 1 11	1 OC 5 T	16 31 17.	16 37 43.	764	3.7	0.130	0.152	0.152	0.160	0.171	0.001
2009 6 11	1 EC 5 T	18 39 36.	19 1 8.	2477	2.2	1.000	*****	0.144	*****	*****	0.014
2009 12 2	1 EC 5 T	8 27 28.	8 53 6.	2962	1.9	1.000	*****	0.144	*****	*****	0.002

Table 13. Mutual events of the 2006–2008 period: main events predicted with GUST86 (1/6).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2006 5 5	5 OC 1 P	10 24 38.	10 26 19.	202	3.9	0.014	0.016	0.016	0.015	0.009	0.051
2006 5 11	1 OC 5 c		17 36 10.		3.9						0.1
2006 6 3	1 OC 5 P	10 3 3.	10 7 44.	562	3.8	0.128	0.149	0.149	0.157	0.168	0.025
2006 6 16	1 OC 5 T	0 36 55.	0 39 12.	273	3.8	0.130	0.152	0.152	0.160	0.171	0.001
2006 6 22	5 OC 1 c		8 20 56.		3.4						0.1
2006 7 2	5 OC 1 A	9 40 0.	9 45 50.	700	3.7	0.256	0.322	0.322	0.298	0.171	0.004
2006 7 8	1 OC 5 T	16 37 33.	16 40 39.	372	4.0	0.130	0.152	0.152	0.160	0.171	0.001
2006 7 15	5 OC 1 P	0 8 3.	0 8 15.	24	3.8	0.000	0.000	0.000	0.000	0.000	0.058
2007 3 10	1 OC 5 P	4 32 7.	4 33 54.	214	3.8	0.075	0.084	0.084	0.089	0.094	0.035
2007 3 16	5 OC 1 A	12 13 4.	12 14 50.	213	3.5	0.257	0.322	0.322	0.298	0.171	0.021
2007 3 25	1 OC 5 P	12 17 46.	12 18 25.	78	0.6	0.027	0.030	0.030	0.031	0.033	0.045
2007 3 26	5 OC 1 P	13 53 39.	13 59 20.	681	3.6	0.167	0.198	0.198	0.185	0.108	0.033
2007 4 1	1 EC 5 P	20 38 37.	20 41 2.	231	4.0	0.186	0.224	0.025	0.224	0.224	0.047
2007 4 8	5 EC 1 P	4 3 5.	4 5 39.	278	3.8	0.148	0.174	0.151	0.174	0.174	0.027
2007 4 14	1 EC 5 P	11 45 58.	11 48 7.	227	3.6	0.813	1.822	0.115	1.822	1.822	0.030
2007 4 20	5 EC 1 P	19 33 31.	19 35 5.	150	3.1	0.055	0.061	0.053	0.061	0.061	0.043
2007 4 22	1 OC 5 P	12 37 24.	12 38 15.	102	2.6	0.033	0.036	0.036	0.038	0.040	0.044
2007 4 24	2 OC 1 P	6 20 4.	6 25 39.	671	6.2	0.131	0.152	0.152	0.147	0.112	0.054
2007 4 27	1 EC 5	3 27 45.	3 28 31.		2.8	0.006	0.006	0.001	0.006	0.006	0.058
2007 4 28	5 OC 1 P	20 30 46.	20 31 16.	61	3.0	0.010	0.010	0.010	0.010	0.006	0.052
2007 4 30	1 OC 2 P	11 21 20.	11 26 28.	617	6.2	0.259	0.325	0.325	0.348	0.537	0.013
2007 4 30	3 OC 2 P	4 37 51.	4 42 44.	585	8.5	0.201	0.244	0.244	0.263	0.440	0.020
2007 4 30	5 EC 1 A	20 10 22.	20 14 12.	429	3.9	0.164	0.194	0.168	0.194	0.194	0.018
2007 5 3	1 OC 3 P	2 12 58.	2 22 3.	1108	6.1	0.274	0.348	0.348	0.354	0.379	0.027
2007 5 3	1 OC 3 P	12 57 18.	13 9 45.	1493	1.0	0.218	0.267	0.267	0.272	0.290	0.037
2007 5 3	2 OC 1 P	9 11 59.	9 14 2.	246	3.6	0.294	0.378	0.378	0.365	0.270	0.035
2007 5 3	2 OC 3 A	8 32 48.	8 35 45.	353	3.2	0.329	0.434	0.434	0.442	0.476	0.000
2007 5 3	4 OC 1 P	21 34 53.	21 37 28.	309	3.1	0.246	0.307	0.307	0.300	0.243	0.043
2007 5 3	4 OC 3 A	23 36 54.	23 40 45.	463	2.3	0.409	0.570	0.570	0.591	0.714	0.000
2007 5 4	1 OC 3 P	8 2 22.	8 7 39.	634	6.3	0.214	0.261	0.261	0.266	0.284	0.038
2007 5 4	4 OC 2 P	19 5 31.	19 8 36.	370	4.1	0.201	0.244	0.244	0.263	0.435	0.021
2007 5 5	1 OC 2 P	0 34 48.	0 36 43.	230	0.8	0.244	0.304	0.304	0.325	0.498	0.016
2007 5 6	2 OC 1 P	17 1 29.	17 4 51.	403	6.1	0.203	0.246	0.246	0.238	0.179	0.045
2007 5 7	1 EC 5 P	3 35 57.	3 38 43.	302	3.9	0.975	4.017	0.140	4.017	4.017	0.023
2007 5 11	5 OC 4 c		11 45 34.		3.8						0.1
2007 5 29	1 EC 5 T	19 46 18.	19 50 35.	481	3.9	1.000	*****	0.144	*****	*****	0.005

Table 14. Mutual events of the 2006–2008 period: main events predicted with GUST86 (2/6).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	Flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2007 6 1	1 EC 5 P	10 49 40.	10 51 3.	139	2.4	0.944	3.125	0.135	3.125	3.125	0.023
2007 6 7	5 EC 1 A	18 45 3.	18 46 26.	140	1.8	0.163	0.194	0.168	0.194	0.194	0.011
2007 6 14	1 EC 5 T	2 43 23.	2 44 43.	136	1.4	1.000	*****	0.144	*****	*****	0.003
2007 6 20	5 EC 1 A	10 41 8.	10 42 24.	127	0.7	0.164	0.195	0.169	0.195	0.195	0.011
2007 6 26	1 EC 5 P	18 40 50.	18 42 1.	115	0.3	0.973	3.902	0.139	3.902	3.902	0.020
2007 6 27	5 EC 1 A	19 19 38.	19 23 51.	471	3.9	0.163	0.194	0.168	0.194	0.194	0.023
2007 6 29	2 EC 5 P	19 5 20.	19 7 23.	200	3.5	0.670	1.203	0.173	1.203	1.203	0.033
2007 7 1	5 EC 2 P	21 17 33.	21 19 29.	191	3.0	0.129	0.150	0.115	0.150	0.150	0.030
2007 7 3	2 EC 5 P	23 37 1.	23 38 38.	156	2.8	0.950	3.256	0.255	3.256	3.256	0.021
2007 7 6	5 EC 2 A	1 54 15.	1 55 41.	131	2.3	0.135	0.158	0.121	0.158	0.158	0.029
2007 7 8	2 EC 5 P	4 16 33.	4 17 56.	127	2.1	0.843	2.008	0.223	2.008	2.008	0.027
2007 7 10	5 EC 2 P	6 37 10.	6 38 16.	126	1.6	0.068	0.076	0.059	0.076	0.076	0.041
2007 7 12	2 EC 5 P	9 0 30.	9 1 29.	107	1.3	0.269	0.341	0.066	0.341	0.341	0.045
2007 7 12	5 OC 3 A	3 45 11.	3 52 21.	860	1.3	0.099	0.113	0.113	0.111	0.096	0.012
2007 7 14	5 EC 2 c		11 24 6.		0.8						0.1
2007 7 16	2 EC 5 c		13 47 54.		0.5						0.1
2007 7 22	1 EC 5 c		2 40 5.		0.2						0.1
2007 7 26	1 EC 5 P	18 58 30.	19 2 41.	457	3.9	0.718	1.374	0.101	1.374	1.374	0.033
2007 7 30	5 OC 4 P	11 11 6.	11 17 4.	715	2.5	0.044	0.049	0.049	0.043	0.043	0.055
2007 8 5	4 OC 2 P	13 42 56.	13 52 20.	1159	8.5	0.022	0.025	0.025	0.026	0.041	0.08*
2007 8 6	1 OC 5 P	10 34 41.	10 36 24.	205	3.6	0.108	0.124	0.124	0.131	0.139	0.031
2007 8 6	4 OC 2 P	0 56 35.	1 11 39.	1807	3.9	0.049	0.054	0.054	0.058	0.091	0.07*
2007 8 13	1 OC 2 P	3 0 5.	3 5 15.	620	6.3	0.235	0.291	0.291	0.311	0.475	0.019
2007 8 13	1 OC 4 P	13 21 24.	13 24 4.	321	2.0	0.301	0.389	0.389	0.350	0.440	0.022
2007 8 14	2 OC 1 P	20 9 22.	20 11 20.	235	1.6	0.483	0.717	0.717	0.688	0.488	0.018
2007 8 14	2 OC 4 P	1 29 4.	1 32 32.	417	7.1	0.193	0.233	0.233	0.211	0.262	0.044
2007 8 14	2 OC 5 T	22 55 29.	22 57 15.	212	3.3	0.129	0.150	0.150	0.158	0.169	0.002
2007 8 15	2 OC 3 A	9 10 48.	9 15 10.	523	8.0	0.329	0.434	0.434	0.442	0.476	0.004
2007 8 16	1 OC 2 P	11 28 24.	11 30 30.	252	2.9	0.222	0.273	0.273	0.291	0.442	0.022
2007 8 19	2 OC 1 P	7 53 21.	7 58 32.	622	6.2	0.085	0.097	0.097	0.094	0.072	0.065
2007 8 20	5 OC 2 P	13 48 27.	13 54 6.	692	3.5	0.054	0.061	0.061	0.062	0.070	0.043

Table 15. Mutual events of the 2006–2008 period: main events predicted with GUST86 (3/6).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	Flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2007 8 22	2 EC 5 T	14 58 6.	15 2 15.	440	3.9	1.000	*****	0.270	*****	*****	0.016
2007 8 24	1 OC 2 P	12 14 45.	12 21 51.	852	6.1	0.109	0.126	0.126	0.133	0.195	0.047
2007 8 24	5 EC 3 A	13 40 55.	13 43 30.	227	2.7	0.096	0.110	0.097	0.110	0.110	0.026
2007 8 25	1 OC 2 P	7 14 5.	7 54 56.	9944	3.2	0.033	0.036	0.036	0.039	0.055	0.07*
2007 9 1	5 EC 1 A	18 6 9.	18 7 27.	132	1.2	0.164	0.194	0.168	0.194	0.194	0.009
2007 9 6	3 EC 5 T	20 25 7.	20 26 59.	173	0.1	1.000	*****	0.126	*****	*****	0.012
2007 9 8	1 EC 5 T	2 5 0.	2 6 19.	133	1.7	1.000	*****	0.144	*****	*****	0.017
2007 9 14	5 EC 1 p	10 2 39.	10 3 35.		2.3	0.006	0.006	0.006	0.006	0.006	0.055
2007 9 22	1 EC 5 P	18 20 51.	18 26 7.	587	3.8	0.839	1.983	0.119	1.983	1.983	0.029
2007 9 29	5 OC 1 P	1 19 34.	1 22 4.	300	3.9	0.185	0.222	0.222	0.206	0.121	0.035
2007 10 7	2 EC 5 P	18 0 20.	18 1 45.	133	2.1	0.888	2.377	0.236	2.377	2.377	0.025
2007 10 8	1 OC 5 P	0 43 20.	0 44 28.	136	1.7	0.127	0.147	0.147	0.155	0.166	0.03*
2007 10 9	5 EC 2 c		20 24 6.		2.5						0.1
2007 10 11	5 OC 1 A	16 36 12.	16 38 6.	228	3.5	0.257	0.322	0.322	0.298	0.171	0.003
2007 10 12	3 EC 5 P	0 0 55.	0 2 46.	129	1.9	0.365	0.492	0.044	0.492	0.492	0.056
2007 10 12	4 EC 5 T	9 47 17.	9 51 0.	344	3.6	1.000	*****	0.137	*****	*****	0.006
2007 10 18	1 OC 5 c		0 29 44.		3.1						0.1
2007 10 21	1 EC 2 P	22 53 5.	23 11 32.	2087	0.5	0.199	0.241	0.075	0.241	0.241	0.055
2007 10 21	5 EC 1 A	18 5 29.	18 12 8.	756	3.7	0.165	0.196	0.169	0.196	0.196	0.014
2007 10 26	1 EC 5 P	1 25 50.	1 27 40.	190	3.1	0.766	1.579	0.108	1.579	1.579	0.031
2007 11 2	5 EC 3 A	20 29 37.	20 31 60.	203	2.8	0.070	0.079	0.070	0.079	0.079	0.045
2007 11 11	1 EC 3 P	3 1 53.	3 13 30.	1237	0.6	0.234	0.289	0.145	0.289	0.289	0.052
2007 11 19	1 EC 5 T	18 0 3.	18 8 1.	903	3.6	1.000	*****	0.144	*****	*****	0.017
2007 11 21	2 EC 1 P	16 44 53.	16 47 19.	217	5.2	0.100	0.114	0.075	0.114	0.114	0.064
2007 11 23	4 EC 2 p	5 57 6.	5 59 38.		9.1	0.005	0.005	0.002	0.005	0.005	0.096
2007 11 24	1 EC 2 c		15 36 11.		5.3						0.1
2007 11 27	1 EC 2 P	22 50 29.	22 53 11.	274	4.8	0.280	0.356	0.107	0.356	0.356	0.047
2007 11 28	1 EC 3 P	1 35 55.	1 40 28.	466	5.9	0.346	0.462	0.223	0.462	0.462	0.038
2007 11 29	2 EC 3 A	12 41 30.	12 48 11.	691	8.9	0.526	0.810	0.496	0.810	0.810	0.003
2007 11 29	2 EC 4 p	19 2 9.	19 4 57.		7.3	0.026	0.029	0.019	0.029	0.029	0.088
2007 11 30	1 EC 5 T	8 52 22.	8 54 38.	226	3.4	1.000	*****	0.144	*****	*****	0.009
2007 11 30	2 EC 1 P	21 33 4.	21 35 23.	185	5.7	0.048	0.053	0.035	0.053	0.053	0.070

Table 16. Mutual events of the 2006–2008 period: main events predicted with GUST86 (4/6).

Date (TT) Of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	Flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2007 11 30	3 EC 4 P	18 32 16.	18 46 34.	1482	15.6	0.762	1.558	0.491	1.558	1.558	0.020
2007 12 2	1 EC 2 P	13 37 18.	13 38 57.	114	0.2	0.065	0.073	0.024	0.073	0.073	0.068
2007 12 2	3 EC 2 P	17 10 38.	17 13 41.	265	2.3	0.356	0.478	0.124	0.478	0.478	0.057
2007 12 3	3 EC 1 P	12 3 26.	12 7 28.	410	5.0	0.882	2.320	0.572	2.320	2.320	0.020
2007 12 4	2 EC 1 P	5 2 59.	5 5 31.	280	4.2	0.593	0.975	0.545	0.975	0.975	0.025
2007 12 6	4 EC 1 P	3 20 33.	3 23 23.	201	3.5	0.174	0.208	0.096	0.208	0.208	0.070
2007 12 6	4 EC 2 P	5 58 46.	6 2 8.	272	4.7	0.311	0.405	0.115	0.405	0.405	0.058
2007 12 6	4 EC 3 P	13 50 4.	13 55 8.	475	7.9	0.636	1.097	0.438	1.097	1.097	0.023
2007 12 7	1 EC 2 P	3 28 38.	3 32 30.	400	6.0	0.275	0.349	0.105	0.349	0.349	0.048
2007 12 7	1 EC 3 A	13 1 21.	13 4 11.	277	1.3	0.517	0.789	0.352	0.789	0.789	0.006
2007 12 8	2 EC 1 P	19 54 16.	19 56 13.	187	0.8	0.453	0.655	0.390	0.655	0.655	0.034
2007 12 8	2 EC 3 P	1 52 13.	1 56 44.	445	7.3	0.418	0.587	0.374	0.587	0.587	0.029
2007 12 10	1 EC 2 A	11 14 13.	11 16 42.	257	3.7	0.832	1.936	0.353	1.936	1.936	0.001
2007 12 11	3 EC 1 P	13 12 7.	13 14 41.	238	0.8	0.590	0.969	0.348	0.969	0.969	0.041
2007 12 11	3 EC 2 P	4 42 2.	4 45 32.	359	4.9	0.945	3.148	0.366	3.148	3.148	0.009
2007 12 12	1 EC 4 A	14 40 21.	14 43 17.	268	1.0	0.485	0.720	0.311	0.720	0.720	0.017
2007 12 12	2 EC 4 A	16 30 44.	16 34 3.	315	1.7	0.508	0.770	0.458	0.770	0.770	0.014
2007 12 12	3 EC 4 A	1 3 10.	1 7 56.	416	3.3	0.721	1.387	0.459	1.387	1.387	0.003
2007 12 13	2 EC 1 P	9 4 22.	9 9 38.	580	6.2	0.528	0.815	0.470	0.815	0.815	0.030
2007 12 15	1 EC 2 A	2 12 17.	2 14 27.	220	1.5	0.810	1.805	0.343	1.805	1.805	0.002
2007 12 15	1 EC 3 P	14 0 60.	14 3 56.	253	4.7	0.110	0.127	0.066	0.127	0.127	0.069
2007 12 16	2 EC 1 P	17 30 47.	17 32 59.	220	3.1	0.513	0.782	0.454	0.782	0.782	0.030
2007 12 17	2 EC 5 T	7 29 21.	7 31 49.	254	3.6	1.000	*****	0.270	*****	*****	0.019
2007 12 17	4 EC 3 A	14 10 56.	14 18 30.	749	13.9	0.775	1.618	0.563	1.618	1.618	0.004
2007 12 19	1 EC 2 P	14 17 41.	14 25 26.	862	6.2	0.706	1.331	0.292	1.331	1.331	0.017
2007 12 19	3 EC 2 P	16 37 50.	16 41 37.	338	7.2	0.305	0.396	0.105	0.396	0.396	0.061
2007 12 21	2 EC 1 P	8 28 13.	8 30 19.	206	2.2	0.520	0.796	0.461	0.796	0.796	0.029
2007 12 24	2 EC 1 P	18 44 52.	18 53 54.	1010	6.1	0.362	0.489	0.300	0.489	0.489	0.042

Table 17. Mutual events of the 2006–2008 period: main events predicted with GUST86 (5/6).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	Flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2007 12 25	2 EC 1 P	10 26 20.	10 57 47.	3675	1.4	0.910	2.611	1.011	2.611	2.611	0.006
2007 12 25	2 EC 1 P	17 0 3.	17 24 14.	2764	5.2	0.814	1.827	0.848	1.827	1.827	0.011
2007 12 28	3 EC 2 p	5 42 2.	5 45 5.		8.8	0.027	0.030	0.009	0.030	0.030	0.090
2007 12 30	1 EC 2 P	23 25 1.	23 29 0.	395	6.3	0.086	0.098	0.032	0.098	0.098	0.065
2008 1 4	1 EC 5 T	16 15 21.	16 17 50.	268	3.7	1.000	*****	0.144	*****	*****	0.020
2008 1 6	3 EC 2 p	2 36 41.	3 3 6.		6.9	0.013	0.014	0.004	0.014	0.014	0.091
2008 1 6	3 EC 2 p	6 19 52.	6 27 53.		5.5	0.001	0.001	0.000	0.001	0.001	0.095
2008 1 6	1 OC 5 P	15 27 39.	15 29 9.	180	3.6	0.068	0.076	0.076	0.080	0.085	0.037
2008 1 9	1 OC 5 P	7 28 3.	7 28 47.	88	1.3	0.034	0.038	0.038	0.040	0.042	0.044
2008 1 23	5 OC 1 P	0 3 11.	0 5 2.	223	3.9	0.033	0.037	0.037	0.035	0.021	0.048
2008 1 24	1 OC 5 T	15 57 51.	15 59 2.	141	0.8	0.130	0.152	0.152	0.160	0.171	0.002
2008 1 27	2 OC 5 P	12 35 11.	12 36 0.	97	0.2	0.046	0.052	0.052	0.054	0.058	0.041
2008 1 29	5 OC 2 P	15 0 46.	15 1 50.	129	0.6	0.107	0.123	0.123	0.126	0.142	0.029
2008 1 31	2 OC 5 T	17 22 37.	17 23 52.	150	1.0	0.129	0.150	0.150	0.158	0.169	0.003
2008 2 2	5 OC 2 A	19 47 32.	19 48 52.	158	1.4	0.126	0.146	0.146	0.149	0.169	0.006
2008 2 4	2 OC 5 T	22 7 43.	22 9 6.	165	1.8	0.129	0.150	0.150	0.158	0.169	0.002
2008 2 7	5 OC 2 A	0 31 24.	0 32 50.	173	2.2	0.126	0.146	0.146	0.149	0.169	0.001
2008 2 8	1 EC 5 T	23 29 1.	23 32 8.	344	3.9	1.000	*****	0.144	*****	*****	0.007
2008 2 9	2 OC 5 T	2 49 25.	2 50 55.	182	2.6	0.129	0.150	0.150	0.158	0.169	0.002
2008 2 11	5 OC 2 A	5 9 52.	5 11 23.	182	2.9	0.126	0.146	0.146	0.149	0.169	0.021
2008 2 13	2 OC 5 P	7 24 36.	7 25 42.	132	3.2	0.038	0.042	0.042	0.044	0.047	0.043
2008 2 15	2 OC 3 A	10 23 57.	11 5 28.	5479	4.3	0.329	0.434	0.434	0.442	0.476	0.006
2008 2 15	2 OC 3 P	17 24 56.	18 7 51.	4655	7.6	0.323	0.423	0.423	0.431	0.464	0.02*
2008 2 18	1 OC 2 P	23 40 60.	23 42 28.	175	2.8	0.052	0.058	0.058	0.062	0.089	0.056
2008 2 19	3 OC 1 P	17 51 59.	17 54 51.	345	3.7	0.393	0.542	0.542	0.529	0.424	0.021
2008 2 20	2 OC 1 P	20 59 7.	21 23 59.	3311	5.0	0.550	0.868	0.868	0.830	0.577	0.011
2008 2 21	2 OC 1 P	19 33 41.	19 42 33.	1064	6.1	0.370	0.501	0.501	0.483	0.352	0.027
2008 2 21	2 OC 1 T	2 19 44.	2 57 19.	4190	2.0	0.663	1.181	1.181	1.120	0.745	0.001
2008 2 23	4 OC 2 P	20 21 57.	20 24 44.	334	5.6	0.089	0.102	0.102	0.109	0.172	0.051
2008 3 15	1 OC 5 P	6 25 43.	6 28 3.	278	3.9	0.039	0.043	0.043	0.045	0.048	0.042
2008 4 13	5 EC 1 A	5 59 42.	6 3 45.	449	4.0	0.164	0.194	0.168	0.194	0.194	0.001
2008 4 23	2 EC 5 c		18 59 53.		3.8						0.1

Table 18. Mutual events of the 2006–2008 period: main events predicted with GUST86 (6/6).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Begins at h m s (8 9 10)	Maximum h m s (11 12 13)	Dur. s (14)	Dist. (UR) (15)	Flux *R* (16)	Magn. *R* (17)	Magn. *R* 2 sat (18)	Magn. *V* (19)	Magn. no alb. (20)	Impact param. (″) (21)
2008 5 7	3 EC 5 P	13 32 14.	13 36 11.	209	0.8	0.132	0.153	0.016	0.153	0.153	0.064
2008 5 29	5 EC 3 P	15 28 51.	15 34 32.	505	1.6	0.044	0.049	0.043	0.049	0.049	0.053
2008 7 15	5 EC 1 A	11 35 53.	11 41 20.	605	3.9	0.165	0.195	0.169	0.195	0.195	0.021
2008 8 12	1 EC 5 T	22 12 35.	22 24 9.	1317	3.2	1.000	*****	0.144	*****	*****	0.021
2008 8 19	5 EC 2 P	9 16 57.	9 26 44.	1024	1.8	0.102	0.117	0.090	0.117	0.117	0.036
2008 8 23	5 OC 2 A	21 16 58.	21 27 22.	1304	1.7	0.126	0.146	0.146	0.149	0.169	0.024
2008 10 30	5 OC 4 A	16 1 49.	16 6 17.	535	0.3	0.103	0.118	0.118	0.104	0.103	0.033
2008 12 13	5 OC 1 A	3 10 22.	3 15 21.	597	3.8	0.256	0.322	0.322	0.298	0.171	0.018
2008 12 19	2 EC 5 P	17 0 22.	17 7 39.	775	0.8	0.643	1.119	0.166	1.119	1.119	0.035
2008 12 23	5 OC 4 A	6 18 53.	6 23 33.	559	0.5	0.103	0.118	0.118	0.104	0.103	0.028
2009 1 11	1 OC 5 P	3 2 22.	3 6 14.	464	3.7	0.043	0.048	0.048	0.050	0.054	0.042
2009 1 11	1 OC 5 T	16 29 44.	16 36 20.	776	3.7	0.130	0.152	0.152	0.160	0.171	0.001
2009 6 11	1 EC 5 T	18 47 57.	19 10 52.	2636	2.2	1.000	*****	0.144	*****	*****	0.010
2009 12 2	1 EC 5 T	8 44 39.	9 6 29.	2504	1.9	1.000	*****	0.144	*****	*****	0.021

Table 19. Mutual events of the 2006–2008 period: eventual events predicted with LA06 and GUST86 (1/10).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	maximum LA06 h m s (8 9 10)	maximum GUST86 h m s (11 12 13)	Dist. (UR) (14)
2006 5 18	5 Oc 1 c	1 7 38.	1 7 51.	3.7
2006 5 24	1 Oc 5 c	8 53 47.	8 53 53.	3.4
2006 6 9	5 Oc 1 c	17 5 26.	17 5 26.	3.9
2006 6 28	1 Oc 5 c	16 11 57.	16 12 5.	3.1
2006 7 31	1 Oc 5 c	9 35 52.	9 34 17.	3.6
2006 8 6	5 Oc 1 c	16 13 23.	16 13 20.	3.9
2007 2 2	1 Ec 5 c	21 27 57.	21 27 41.	3.9
2007 2 9	5 Ec 1 c	4 58 9.	4 58 18.	3.8
2007 2 25	1 Ec 5 c	14 15 51.	14 14 33.	3.7
2007 3 3	5 Ec 1 c	21 3 25.	21 3 19.	3.9
2007 3 3	5 Oc 1 c	21 3 7.	21 3 2.	3.9
2007 3 10	1 Ec 5 c	4 34 28.	4 34 26.	3.8
2007 3 16	5 Ec 1 c	12 15 26.	12 15 40.	3.5
2007 3 19	5 Oc 1 c	4 18 19.	4 18 40.	1.1
2007 3 22	1 Ec 5 c	20 6 0.	20 6 9.	3.2
2007 3 22	1 Oc 5 c	20 4 55.	20 5 2.	3.2
2007 4 9	1 Oc 5 c	20 45 10.	20 45 27.	1.5
2007 4 11	3 Oc 5 c	14 40 41.	14 39 48.	3.0
2007 4 13	5 Oc 4 c	17 29 17.	17 28 26.	2.9
2007 4 16	5 Oc 1 P	4 41 55.	4 42 15.	2.1
2007 4 18	1 Oc 2 P	4 7 2.	3 57 36.	4.8
2007 4 18	1 Oc 2 P	7 48 26.	7 48 26.	2.7
2007 4 19	1 Oc 2 c	2 10 29.	2 8 16.	6.2
2007 4 20	2 Oc 5 c	8 52 31.	8 47 9.	3.1
2007 4 21	3 Oc 2 c	12 46 14.	12 45 2.	8.9
2007 4 24	1 Oc 5 c	14 1 39.	13 58 35.	3.4
2007 4 28	2 Oc 1 c	18 21 0.	18 20 17.	1.6
2007 4 28	3 Oc 1 c	22 14 46.	22 13 24.	4.1
2007 4 29	3 Oc 5 c	14 49 40.	14 49 1.	2.2
2007 5 3	5 Ec 1 P	11 22 6.	11 22 25.	2.3
2007 5 5	1 Oc 5 c	4 21 38.	4 21 49.	3.4

Table 20. Mutual events of the 2006–2008 period: eventual events predicted with LA06 and GUST86 (2/10).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Maximum LA06 h m s (8 9 10)	Maximum GUST86 h m s (11 12 13)	Dist. (UR) (14)
2007 5 8	3 Oc 1 c	10 26 30.	10 25 7.	3.5
2007 5 9	3 Oc 4 c	12 20 26.	12 17 29.	13.4
2007 5 9	1 Oc 2 c	15 30 5.	15 29 11.	4.2
2007 5 9	1 Ec 5 c	19 19 40.	19 19 55.	1.9
2007 5 10	1 Oc 4 c	9 32 59.	9 31 18.	5.4
2007 5 11	1 Oc 4 c	14 2 28.	14 14 16.	4.8
2007 5 11	5 Oc 1 c	12 5 40.	12 5 50.	3.7
2007 5 12	1 Oc 2 c	22 56 1.	22 55 2.	5.7
2007 5 13	5 Ec 1 c	11 16 30.	11 16 42.	3.5
2007 5 15	2 Oc 1 c	21 34 53.	21 34 7.	4.7
2007 5 16	5 Ec 1 c	3 16 31.	3 16 53.	1.2
2007 5 19	1 Ec 5 c	19 5 1.	19 5 8.	3.3
2007 5 22	1 Ec 5 c	11 15 53.	11 16 9.	0.8
2007 5 23	5 Oc 1 P	14 9 58.	14 5 18.	3.0
2007 5 26	5 Ec 1 c	2 55 22.	2 55 41.	2.8
2007 6 3	5 Oc 1 c	3 48 46.	3 49 1.	3.4
2007 6 5	5 Ec 1 c	3 7 49.	3 7 51.	3.8
2007 6 9	1 Oc 5 P	11 35 2.	11 35 7.	3.7
2007 6 11	1 Ec 5 c	10 47 5.	10 47 5.	3.7
2007 6 15	5 Oc 1 c	19 10 36.	19 10 39.	3.9
2007 6 17	5 Ec 1 c	18 31 59.	18 32 14.	3.2
2007 6 20	5 Oc 2 c	1 21 44.	1 21 0.	3.9
2007 6 21	1 Oc 5 c	14 14 11.	14 13 6.	2.6
2007 6 22	2 Oc 1 c	6 41 51.	6 38 57.	5.8
2007 6 22	2 Oc 5 c	3 15 55.	3 14 47.	3.9
2007 6 23	5 Ec 2 c	12 55 24.	12 54 10.	3.9
2007 6 24	1 Ec 5 c	2 24 18.	2 24 27.	2.9
2007 6 25	2 Ec 5 c	14 54 4.	14 53 8.	3.9
2007 6 27	5 Ec 2 P	16 54 22.	16 53 50.	3.6
2007 6 30	5 Ec 1 c	10 17 20.	10 17 39.	2.4
2007 7 3	5 Oc 4 P	16 56 34.	17 1 28.	0.8

Table 21. Mutual events of the 2006–2008 period: eventual events predicted with LA06 and GUST86 (3/10).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	maximum LA06 h m s (8 9 10)	maximum GUST86 h m s (11 12 13)	Dist. (UR) (14)
2007 7 4	1 Ec 5 c	2 40 35.	2 40 24.	3.5
2007 7 6	1 Ec 5 c	18 14 23.	18 14 36.	13.4
2007 7 8	5 Oc 1 c	11 4 6.	11 4 18.	4.2
2007 7 13	5 Ec 1 c	2 11 1.	2 11 21.	1.9
2007 7 14	1 Oc 5 c	18 43 29.	18 43 28.	5.4
2007 7 19	1 Ec 5 c	10 10 12.	10 10 29.	4.8
2007 7 22	5 Ec 2 c	21 0 51.	21 0 45.	3.7
2007 7 24	2 Ec 5 c	23 24 11.	23 24 8.	5.7
2007 7 25	5 Ec 1 c	18 8 39.	18 9 1.	3.5
2007 7 28	5 Ec 1 c	10 38 40.	10 39 2.	4.7
2007 7 31	1 Oc 2 c	15 37 42.	15 36 40.	1.2
2007 7 31	5 Oc 1 c	2 47 40.	2 47 56.	3.3
2007 8 2	5 Ec 1 c	2 10 51.	2 10 48.	0.8
2007 8 3	1 Ec 5 c	18 37 51.	18 38 10.	3.0
2007 8 3	3 Oc 5 c	12 46 24.	12 43 49.	2.8
2007 8 6	2 Oc 1 P	21 23 6.	21 22 10.	3.4
2007 8 7	1 Oc 3 c	8 9 48.	8 15 4.	3.8
2007 8 7	5 Ec 1 c	10 8 8.	10 8 31.	3.7
2007 8 8	1 Oc 2 c	13 58 13.	13 57 21.	3.7
2007 8 8	1 Oc 3 c	2 16 52.	2 14 20.	3.9
2007 8 10	2 Oc 1 c	5 16 55.	5 16 11.	3.2
2007 8 10	5 Ec 1 c	2 35 36.	2 35 57.	3.9
2007 8 12	3 Oc 1 c	4 47 43.	4 46 19.	2.6
2007 8 12	3 Oc 4 P	11 59 50.	11 56 47.	5.8
2007 8 12	5 Oc 2 c	20 44 33.	20 44 13.	3.9
2007 8 13	1 Ec 5 c	18 8 34.	18 8 53.	3.9
2007 8 15	5 Ec 3 c	23 59 23.	23 58 52.	2.9
2007 8 17	5 Oc 2 c	1 14 23.	1 13 53.	3.9
2007 8 18	4 Oc 3 c	4 48 9.	4 45 29.	3.6
2007 8 20	5 Ec 1 c	2 8 4.	2 8 27.	2.4
2007 8 20	3 Oc 1 P	5 31 38.	5 30 21.	0.8

Table 22. Mutual events of the 2006–2008 period: eventual events predicted with LA06 and GUST86 (4/10).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Maximum LA06 h m s (8 9 10)	Maximum GUST86 h m s (11 12 13)	Dist. (UR) (14)
2007 8 20	3 Oc 2 c	17 29 11.	17 27 7.	1.4
2007 8 21	1 Oc 2 c	2 30 57.	2 30 6.	2.3
2007 8 22	2 Oc 1 c	17 46 11.	17 45 26.	2.4
2007 8 22	5 Oc 1 c	18 26 55.	18 27 13.	2.8
2007 8 23	2 Oc 3 c	23 28 57.	23 26 17.	9.1
2007 8 24	5 Ec 2 c	16 49 8.	16 48 12.	3.9
2007 8 24	5 Ec 1 P	18 41 13.	18 40 27.	3.8
2007 8 25	1 Ec 2 c	7 23 30.	7 35 27.	3.1
2007 8 26	1 Ec 5 c	10 8 9.	10 8 28.	0.6
2007 8 26	2 Ec 5 c	18 52 34.	18 51 48.	3.8
2007 8 27	5 Oc 4 c	1 4 49.	1 4 10.	2.3
2007 8 29	1 Oc 5 c	2 20 35.	2 20 48.	3.2
2007 8 30	2 Oc 1 c	17 21 54.	17 20 34.	6.3
2007 9 2	5 Ec 3 c	4 17 33.	4 15 41.	3.9
2007 9 2	5 Oc 3 c	4 17 58.	4 16 4.	3.9
2007 9 8	1 Oc 5 P	2 6 11.	2 6 29.	1.7
2007 9 14	5 Oc 1 c	10 3 53.	10 4 13.	2.3
2007 9 14	5 Oc 2 c	15 39 53.	15 39 47.	0.5
2007 9 15	3 Ec 5 c	9 59 33.	9 58 55.	1.7
2007 9 15	3 Oc 5 P	10 0 54.	10 0 17.	1.7
2007 9 20	1 Ec 5 c	17 59 37.	17 59 52.	2.7
2007 9 20	5 Ec 3 c	3 40 32.	3 39 60.	0.8
2007 9 21	5 Oc 1 c	17 9 21.	17 9 44.	0.4
2007 9 22	1 Oc 5 P	18 27 31.	18 26 16.	3.8
2007 9 23	3 Ec 5 c	23 51 40.	23 50 40.	3.2
2007 9 24	5 Oc 1 c	9 39 56.	9 40 18.	0.6
2007 9 27	5 Ec 1 c	1 52 51.	1 53 8.	3.2

Table 23. Mutual events of the 2006–2008 period: eventual events predicted with LA06 and GUST86 (5/10).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Maximum LA06 h m s (8 9 10)	Maximum GUST86 h m s (11 12 13)	Dist. (UR) (14)
2007 9 29	2 Ec 5 c	8 30 20.	8 30 16.	0.5
2007 9 30	1 Ec 5 c	17 38 52.	17 39 10.	1.1
2007 10 1	5 Ec 2 c	10 54 59.	10 54 51.	0.9
2007 10 1	5 Oc 1 c	16 44 55.	16 45 16.	2.1
2007 10 2	3 Ec 5 c	15 17 14.	15 13 24.	3.9
2007 10 3	2 Ec 5 c	13 17 24.	13 17 21.	1.3
2007 10 5	1 Oc 5 P	8 55 10.	8 55 6.	3.8
2007 10 5	5 Ec 2 P	15 41 20.	15 41 12.	1.7
2007 10 5	5 Ec 4 c	21 27 26.	21 20 16.	1.5
2007 10 7	5 Ec 1 c	1 37 43.	1 38 4.	1.7
2007 10 11	2 Ec 5 c	22 41 22.	22 41 9.	2.8
2007 10 11	3 Ec 2 c	10 38 15.	10 43 12.	2.8
2007 10 13	1 Ec 5 c	9 36 13.	9 36 31.	2.2
2007 10 14	5 Oc 1 c	8 43 2.	8 43 25.	1.1
2007 10 19	5 Ec 1 P	17 32 35.	17 32 55.	2.7
2007 10 19	5 Ec 4 c	19 23 30.	19 22 53.	1.5
2007 10 21	1 Ec 2 P	14 2 36.	13 59 3.	5.6
2007 10 21	5 Ec 2 c	17 18 23.	17 16 19.	3.9
2007 10 22	1 Ec 2 c	13 23 53.	13 21 11.	6.0
2007 10 24	5 Oc 1 c	8 22 56.	8 23 16.	2.7
2007 10 27	2 Ec 1 c	17 51 56.	17 50 25.	6.3
2007 10 28	1 Oc 5 c	1 3 22.	1 3 3.	4.0
2007 11 1	5 Ec 1 c	9 17 49.	9 18 4.	3.5
2007 11 2	1 Ec 2 c	23 6 6.	23 4 53.	6.3
2007 11 3	5 Oc 1 c	8 31 10.	8 31 17.	3.8
2007 11 8	4 Ec 5 c	7 27 25.	7 25 31.	3.9
2007 11 9	2 Ec 1 c	4 50 3.	4 48 60.	6.0
2007 11 10	1 Ec 3 c	14 51 8.	14 47 47.	6.3
2007 11 11	1 Ec 3 c	20 46 13.	20 43 31.	6.2
2007 11 15	1 Ec 2 P	10 44 10.	10 43 8.	5.7
2007 11 15	3 Ec 1 c	23 19 19.	23 17 54.	3.6
2007 11 17	1 Ec 5 c	17 7 46.	17 8 2.	2.6
2007 11 18	2 Ec 1 c	9 26 55.	9 26 6.	4.8

Table 24. Mutual events of the 2006–2008 period: eventual events predicted with LA06 and GUST86 (6/10).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Maximum LA06 h m s (8 9 10)	Maximum GUST86 h m s (11 12 13)	Dist. (UR) (14)
2007 11 19	2 Ec 3 c	0 58 16.	0 55 19.	9.2
2007 11 21	4 Ec 2 c	21 36 33.	21 39 3.	2.6
2007 11 24	3 Ec 1 c	0 4 4.	0 2 44.	2.4
2007 11 24	3 Ec 5 c	16 27 59.	16 26 35.	3.7
2007 11 24	5 Ec 1 c	1 2 22.	1 2 40.	3.0
2007 11 28	1 Ec 4 c	6 30 53.	6 26 41.	6.4
2007 11 28	1 Ec 4 c	15 48 3.	15 53 4.	2.6
2007 11 29	1 Ec 4 P	15 17 3.	15 14 53.	5.7
2007 12 6	4 Ec 5 c	1 48 6.	1 47 24.	2.8
2007 12 6	5 Ec 1 c	16 39 48.	16 39 59.	3.7
2007 12 13	2 Ec 5 c	3 4 21.	3 4 5.	3.0
2007 12 15	5 Ec 2 c	5 21 2.	5 20 42.	3.3
2007 12 16	2 Ec 3 c	13 58 3.	13 56 1.	5.1
2007 12 18	5 Ec 1 c	18 7 4.	18 2 37.	3.4
2007 12 19	5 Ec 2 c	9 40 41.	9 39 55.	3.8
2007 12 20	2 Ec 5 c	19 55 28.	19 52 9.	3.8
2007 12 21	3 Ec 1 c	0 19 58.	0 17 56.	6.0
2007 12 22	1 Ec 2 c	23 48 11.	23 47 19.	2.5
2007 12 24	5 Ec 3 P	9 28 29.	9 18 33.	3.6
2007 12 25	1 Ec 3 c	2 14 26.	2 12 58.	2.8
2007 12 25	1 Ec 4 c	12 54 1.	12 52 29.	3.0
2007 12 25	2 Ec 4 c	13 2 15.	13 0 0.	3.0
2007 12 27	1 Ec 2 c	14 48 46.	14 47 54.	2.8
2007 12 27	1 Oc 5 c	15 31 32.	15 31 46.	2.4
2007 12 29	2 Ec 1 c	6 5 32.	6 4 44.	1.8
2007 12 29	5 Ec 1 c	8 30 18.	8 30 34.	3.4
2007 12 31	4 Ec 2 c	23 33 51.	23 31 38.	5.6
2007 12 31	5 Oc 1 c	7 47 26.	7 47 29.	3.9
2008 1 1	4 Ec 1 c	0 36 28.	0 34 46.	5.2
2008 1 2	2 Ec 1 c	21 1 40.	21 0 52.	3.4
2008 1 2	5 Oc 1 c	23 28 43.	23 29 5.	1.8
2008 1 4	1 Ec 2 c	12 22 25.	12 21 33.	1.2

Table 25. Mutual events of the 2006–2008 period: eventual events predicted with LA06 and GUST86 (7/10).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Maximum LA06 h m s (8 9 10)	Maximum GUST86 h m s (11 12 13)	Dist. (UR) (14)
2008 1 6	2 Ec 1 c	5 4 39.	5 3 27.	6.2
2008 1 7	1 Ec 4 c	18 4 43.	17 31 19.	5.5
2008 1 7	2 Ec 4 c	11 9 33.	11 6 55.	8.3
2008 1 7	3 Ec 1 c	2 36 57.	3 0 45.	2.3
2008 1 7	3 Ec 1 c	10 1 54.	9 50 7.	5.9
2008 1 9	1 Ec 2 c	3 18 11.	3 17 15.	4.0
2008 1 10	5 Ec 1 c	23 54 0.	23 54 2.	3.9
2008 1 12	1 Ec 2 c	10 50 28.	10 49 23.	5.9
2008 1 12	5 Oc 1 P	23 16 18.	23 16 34.	3.3
2008 1 13	4 Ec 3 c	6 57 11.	6 54 13.	15.6
2008 1 14	4 Ec 2 c	2 20 49.	2 19 2.	9.0
2008 1 14	4 Ec 2 P	20 10 23.	20 12 43.	1.7
2008 1 15	2 Ec 1 c	9 26 11.	9 25 21.	4.5
2008 1 15	5 Oc 1 c	15 27 47.	15 28 9.	0.7
2008 1 15	3 Ec 5 c	22 40 32.	22 38 31.	3.9
2008 1 16	1 Ec 5 c	18 15 55.	18 13 0.	3.1
2008 1 19	1 Oc 5 c	7 10 3.	7 10 16.	2.9
2008 1 21	1 Ec 2 c	15 39 8.	15 38 8.	5.0
2008 1 22	5 Ec 4 c	7 20 23.	7 18 18.	3.9
2008 1 27	2 Ec 1 c	21 39 24.	21 38 33.	5.5
2008 1 28	5 Oc 3 c	9 36 40.	9 36 8.	1.4
2008 1 29	1 Oc 5 c	7 26 6.	7 25 54.	3.9
2008 1 30	5 Oc 1 c	23 57 56.	23 58 19.	1.4
2008 2 2	3 Oc 5 c	3 6 10.	3 5 39.	1.2
2008 2 2	5 Ec 1 c	15 52 58.	15 53 10.	3.7
2008 2 3	1 Ec 2 c	3 43 14.	3 42 8.	5.8
2008 2 5	5 Oc 3 c	23 23 42.	23 22 48.	2.9
2008 2 6	1 Oc 5 c	7 56 40.	7 56 59.	1.9

Table 26. Mutual events of the 2006–2008 period: eventual events predicted with LA06 and GUST86 (8/10).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Maximum LA06 h m s (8 9 10)	Maximum GUST86 h m s (11 12 13)	Dist. (UR) (14)
2008 2 9	2 Ec 1 c	9 27 26.	9 26 24.	6.1
2008 2 14	1 Oc 3 c	9 19 56.	9 19 25.	6.2
2008 2 14	2 Oc 3 c	2 38 44.	2 35 53.	9.1
2008 2 14	5 Oc 3 c	14 20 2.	14 17 35.	3.9
2008 2 15	1 Ec 2 c	15 3 49.	15 2 18.	6.3
2008 2 15	1 Oc 2 P	15 5 39.	15 4 7.	6.3
2008 2 15	1 Oc 3 P	15 23 19.	15 20 37.	6.3
2008 2 15	5 Oc 2 P	9 41 39.	9 41 8.	3.5
2008 2 15	5 Oc 3 P	9 34 23.	9 33 11.	3.6
2008 2 17	2 Oc 1 c	8 25 33.	8 24 47.	1.7
2008 2 17	2 Oc 5 c	11 47 53.	11 47 18.	3.7
2008 2 18	1 Oc 4 c	8 39 5.	8 37 14.	5.2
2008 2 18	3 Oc 4 c	14 28 43.	14 25 39.	7.6
2008 2 18	5 Ec 2 c	22 39 33.	22 33 33.	3.4
2008 2 18	5 Oc 2 c	22 29 57.	22 25 13.	3.5
2008 2 18	5 Oc 4 c	5 3 34.	5 2 5.	3.7
2008 2 19	5 Ec 2 c	13 49 42.	13 48 51.	3.9
2008 2 20	1 Oc 5 c	23 49 3.	23 48 14.	3.9
2008 2 20	2 Ec 1 c	21 28 46.	21 22 44.	5.0
2008 2 21	2 Ec 1 c	2 12 44.	2 58 8.	2.4
2008 2 21	2 Ec 1 c	19 43 11.	19 41 3.	6.1
2008 2 21	2 Ec 5 c	15 34 3.	15 32 26.	3.9
2008 2 23	1 Oc 2 P	14 42 41.	14 41 47.	2.4
2008 2 24	2 Oc 3 c	14 14 20.	14 11 49.	8.9
2008 2 24	4 Oc 1 c	20 28 51.	20 27 26.	2.7
2008 2 25	2 Oc 1 c	5 58 59.	5 57 60.	2.2
2008 2 27	1 Oc 2 P	0 8 10.	0 6 25.	6.2
2008 3 8	3 Ec 5 c	4 8 47.	4 4 1.	3.9
2008 3 8	3 Oc 5 c	4 7 35.	4 2 47.	3.9
2008 3 8	5 Ec 1 c	23 6 35.	23 6 40.	3.9
2008 3 8	5 Oc 1 c	23 6 16.	23 6 22.	3.9
2008 3 15	1 Ec 5 c	6 29 40.	6 29 16.	3.9

Table 27. Mutual events of the 2006–2008 period: eventual events predicted with LA06 and GUST86 (9/10).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Maximum LA06 h m s (8 9 10)	Maximum GUST86 h m s (11 12 13)	Dist. (UR) (14)
2008 3 15	5 Oc 4 P	14 24 34.	14 29 21.	3.9
2008 4 19	1 Oc 5 c	12 28 13.	12 26 3.	3.5
2008 4 23	2 Oc 5 c	14 16 10.	14 24 10.	1.0
2008 5 12	1 Ec 5 c	5 38 48.	5 38 34.	3.9
2008 5 18	5 Oc 1 c	12 5 27.	12 4 3.	3.6
2008 6 16	1 Ec 5 c	12 5 21.	12 4 10.	3.8
2008 7 14	5 Ec 1 c	22 26 51.	22 24 31.	3.4
2008 8 13	1 Ec 5 c	11 21 51.	11 21 5.	3.9
2008 9 10	5 Ec 1 c	22 28 59.	22 26 41.	2.9
2008 9 10	5 Oc 1 c	22 31 13.	22 28 59.	2.9
2008 10 19	3 Oc 5 c	21 9 46.	21 17 40.	1.7
2008 10 22	2 Ec 5 c	21 54 53.	22 2 52.	0.7
2008 10 23	2 Oc 5 c	3 7 28.	3 4 57.	3.8
2008 10 29	1 Oc 2 c	5 10 29.	5 20 35.	1.9
2008 11 8	5 Oc 1 c	10 27 16.	10 27 1.	4.0
2008 11 14	1 Oc 5 c	3 31 37.	3 30 34.	3.9
2008 12 7	1 Oc 5 c	10 10 7.	10 9 46.	4.0
2008 12 13	5 Ec 1 c	16 25 26.	16 23 37.	3.3
2008 12 19	2 Oc 5 c	12 31 8.	12 27 12.	3.7
2008 12 25	1 Oc 2 c	21 37 29.	21 45 24.	1.2
2009 1 2	5 Oc 3 c	8 46 36.	8 55 25.	2.1
2009 2 9	5 Oc 1 c	3 0 1.	2 58 4.	3.6
2009 2 17	5 Oc 2 c	17 36 9.	17 46 7.	1.8
2009 2 22	5 Oc 2 c	5 22 6.	5 32 2.	1.6
2009 4 8	5 Ec 1 c	3 20 54.	3 15 38.	2.9
2009 4 8	5 Oc 1 c	5 12 4.	5 25 53.	1.6
2009 5 7	1 Ec 5 c	3 20 52.	3 21 19.	2.6
2009 5 7	1 Oc 5 c	4 5 49.	4 11 37.	2.1

Table 28. Mutual events of the 2006–2008 period: eventual events predicted with LA06 and GUST86 (10/10).

Date (TT) of maximum year mth day Cols. (1 2 3)	Event (4 5 6 7)	Maximum LA06 h m s (8 9 10)	Maximum GUST86 h m s (11 12 13)	Dist. (UR) (14)
2009 7 10	5 Ec 1 c	17 7 30.	17 17 27.	1.3
2009 11 3	5 Ec 1 c	10 44 50.	10 55 0.	0.8
2009 11 3	5 Oc 1 c	7 8 40.	7 5 8.	3.3
2009 12 2	1 Oc 5 c	7 12 10.	7 11 22.	3.0
2010 2 4	5 Oc 1 c	22 19 27.	22 28 11.	1.5
2010 3 5	1 Ec 5 c	20 42 10.	20 50 26.	0.7
2010 3 5	1 Oc 5 c	20 44 47.	20 53 14.	0.7
2010 4 3	5 Ec 1 c	19 18 12.	19 26 18.	0.4
2010 5 2	1 Ec 5 P	17 50 29.	17 58 56.	0.3
2010 5 31	5 Ec 1 c	16 20 27.	16 29 14.	0.8
2010 6 29	1 Ec 5 c	14 42 43.	14 53 1.	1.2
2010 11 27	1 Oc 5 c	22 44 49.	22 53 31.	0.1
2010 12 26	5 Oc 1 c	21 24 34.	21 29 35.	0.3
2011 1 24	1 Oc 5 c	19 58 5.	20 8 18.	0.9