SUPPLEMENTARY INFORMATION

Table S1. List of IOPW-PVOL contributors and their instruments

Author	Location	Telescope Aperture(cm)	Filters
D. Parker	USA	40.6	rgb,ir,ch4,uv
A. Wesley	Australia	40.5	rgb, ch4, uv
T. Barry	Australia	40.6	rgb, l, ir
T. Kumamori	Japan	28	lrgb
T. Akutsu	Philippines	35.5	lrgb
B. Combs	USA	35.5	lrgb
J. Phillips	USA	25.4	rgb
E. Morales	Puerto Rico	30	rgb
J. Beltran	Spain	45.7	ir, rgb, lrgb
S. Buda	Australia	40.5	r, rgb
G. Jolly	USA	35.6	rgb
S. Ghomizadeh	Iran	23.5	rgb
J. Sussenbach	Netherlands	28	rgb, l ,cl
C. Go	Philippines	28	rgb
A. Kazemoto	Japan	30.8	rgb
F. J. Melillo	USA	20.3	rgb
J.J. Poupeau	France	35	rgb, r
D.P. Milika	Australia	28	rgb
K. Yunoki	Japan	26	rgb
F. Carvalho	Brazil	25.4	rgb
P. Casquinha	Portugal	35.6	rgb
M. Delcroix	France	25.4	rgb, ir
T. Ikemura	Japan	38	rgb
M. Lecompte	UK	35.5	rgbir, rgb
P. Maxson	USA	25	rgb
D. Peach	UK	35	rgb
T. Tranter	Australia	25	rgb
S. Walker	USA	31.8	rgb
T. Wilson	USA	24.5	rgb

The IOPW-PVOL database (ref. 30) is located at http://www.pvol.ehu.es/pvol/
The ALPO-Japan database is located at: http://alpo-j.asahikawa-med.ac.jp/indexE.htm.

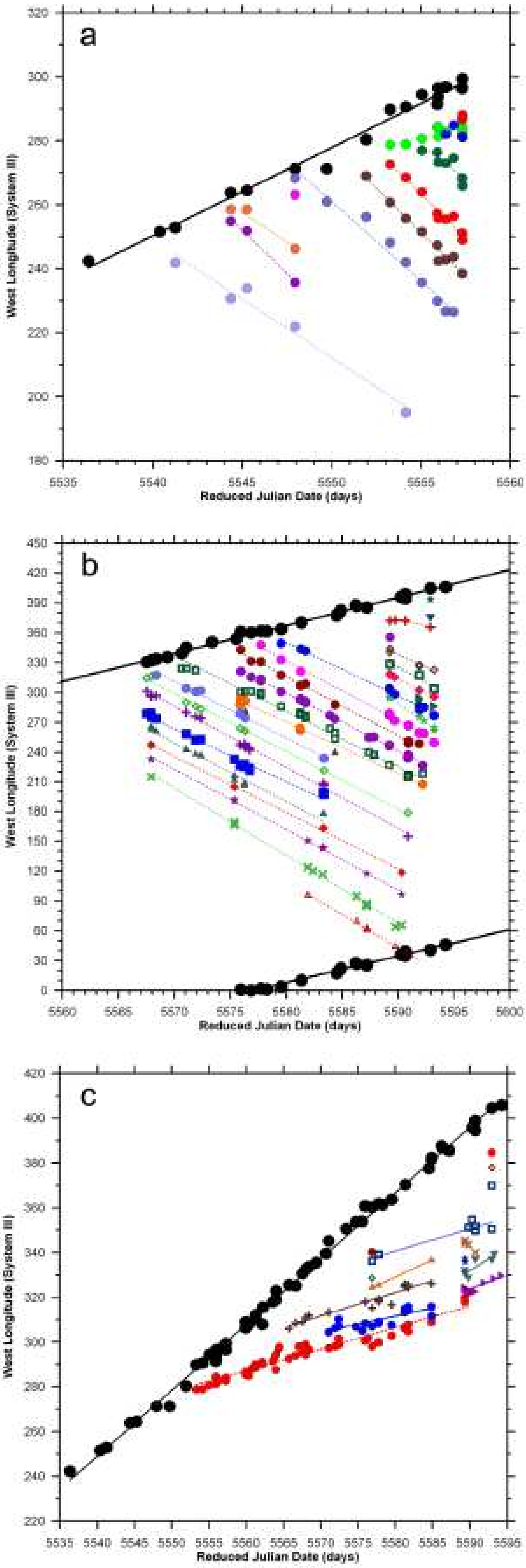
a
West Longitude (System III)
320
300
280
260
240
220
200
180
5535
5540
5545
5550
5555
5560
Reduced Julian Date (days)
b
West Longitude (System III)
450
420
390
360
330
300
270
240
210
180
150
120
90
60
30
0
5560
5565
5570
5575
5580
5585
5590
5595
5600
Reduced Julian Date (days)
c
West Longitude (System III)
420
400
380
360
340
320
300
280
260
240
220
5535
5540
5545
5550
5555
5560
5565
5570
5575
5580
5585
5590
5595
Reduced Julian Date (days)

Figure S1. Longitude Motions in System III of GWS disturbance features. Nearly daily tracking was performed on the most prominent individual features pertaining to the GWS disturbance (individual points and linear fits). The storm head was always present (black dots in all figures). Panels (a) and (b) show the development and tracking of several features in the storm southern branch (38ºN to 31ºN latitude): (a) from December 5, 2010 to January 7, 2011; (b) from January 7 to February 1, 2011. Panel (c) shows tracking of the northern branch (41º to 44º latitude) from December 5, 2010 to February 1, 2011. Time is given in a reduced Julian Date (Julian date □ 2450000, in days). Image navigation, features tracking and photometry measurements were performed using the LAIA software (refs. 11, S1). Further details on this software and download of a free version are at: http://www.astrogea.org/soft/laia/laia.htm.

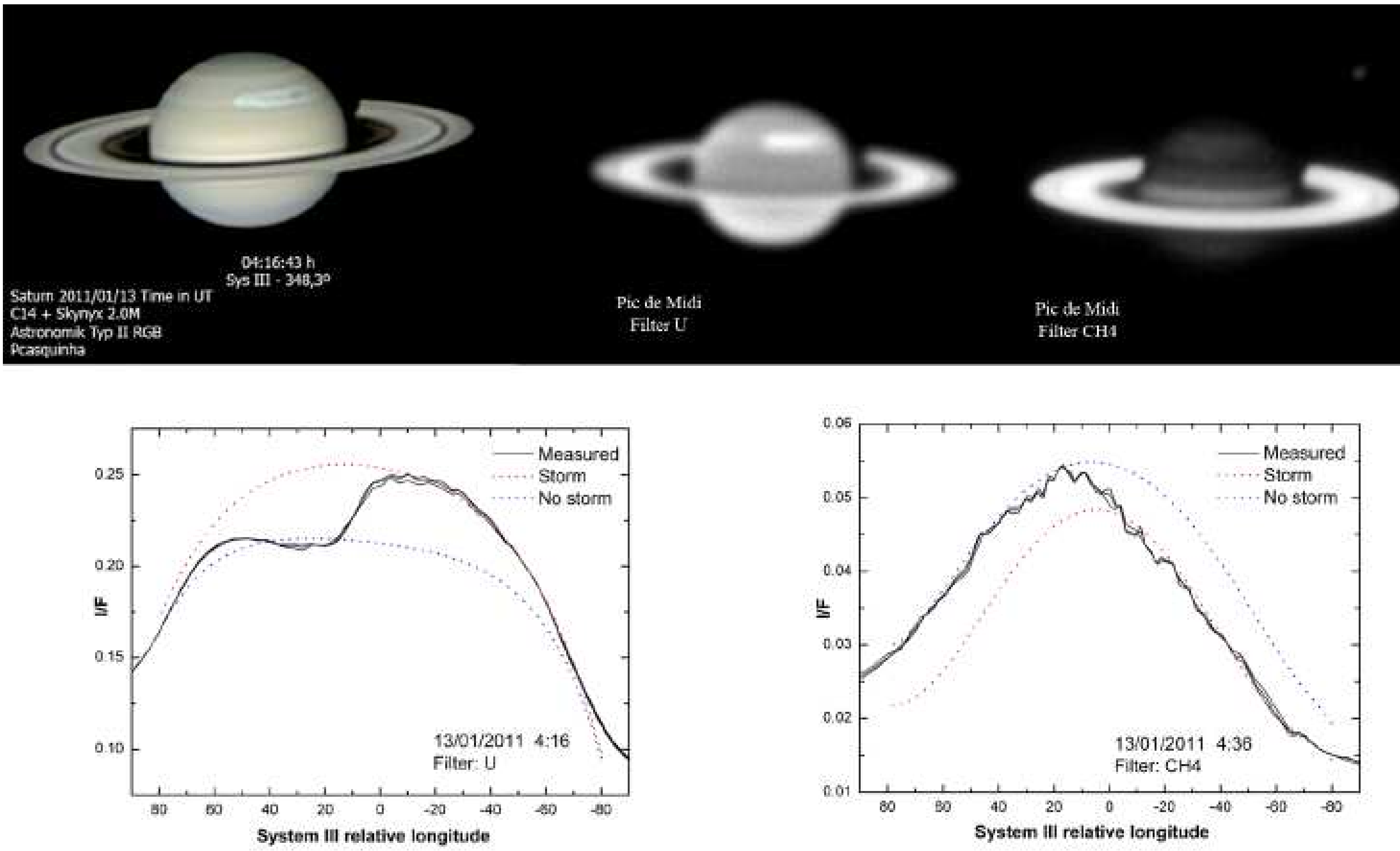

Figure S2. Multi-spectral images of the GWS and Photometry. We obtained images of the GWS core with a variety of broad and narrow band filters centered in the continuum (cont) and in methane absorption bands (CH4) at effective wavelengths (in nm): 370 and 375 (UV), 480 (B), 537, 580 (V), 650 (R), 624 (CH4-cont), 727 (CH4), 883 (CH4-cont), 883-889 (CH4), 914 (CH4-cont) and 954 (CH4-cont). Upper panel shows images of Saturn and the GWS disturbance in the visible (color, left), ultraviolet (center), and methane absorption band at 883 nm (right). Absolute calibration was performed using an area of ring B at the ansae (S2) with the methane absorption coefficients at these wavelengths obtained from integration of the filter transmission curves (S3). The vertical cloud structure in the storm head (41ºN latitude) and adjacent regions were retrieved from separated fits of the measured absolute reflectivity (as a function of wavelength and center to limb variation) to that produced by a model formed by a thin stratospheric haze above a thick troposheric haze located at the top of a cloud deck (lower panels) (ref. 19-20). Two examples are shown for filters in ultraviolet (UV, left) and a methane band filter (883 nm, right). The continuous line are the measured reflectivity and the dashed lines are the model fits to the storm area (red) and to the quiescent, no stormy background atmosphere (dashed blue). At 375 nm (UV) the Rayleigh unit optical depth is reached at the altitude level of pressure 730 mbar and in the methane band at 883 nm unit optical depth for absorption is at the altitude level 110 mbar (ref. 17). According to the model, the GWS cloud is brighter and denser than surrounding haze, it has an optical depth τ = 50 with single scattering albedo for the particles ω_0 = 0.86 (375 nm) and ω_0 = 0.999 (883 nm) compared to the adjacent (quiescent) haze that has τ = 20 and ω_0 = 0.78 (375 nm) and ω_0 = 0.985 (883 nm).

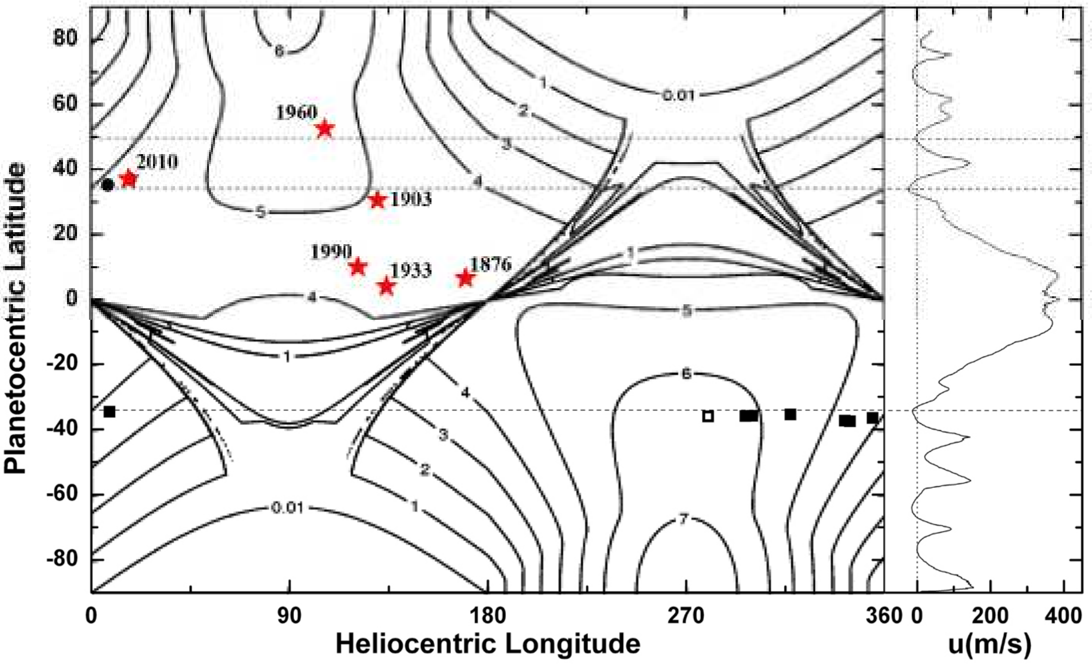

Figure S3. Map of the insolation (Wm^{-2}) at top of Saturn's atmosphere along a Saturn year with observed convective storms marked (left part), and with the zonal wind profile (right part). Red stars are for the GWS events with the year of apparition indicated. Black squares and dots represent the observations of small-scale convective storms during the Voyager (1980-81) and Cassini (2004-2009) periods. The GWS have been observed at three different latitudes (one per Saturn year) (ref. 5-6): three cases were in the Equator at seasons L_S = 170º (in 1876), L_S = 134º (1933), L_S = 121º (1990), two at mid-northern latitudes L_S = 130º (in 1903), L_S = 16º (the present one) and one at sub-polar latitudes L_S = 106º (in 1960). Here L_S is Saturn's heliocentric longitude measured from the spring equinox at L_S = 0º. Previous to the 2010 event, the GWS outbreaks occurred in northern hemisphere summertime (L_S = 90º - 180º). The present one resembles that of 1903 that took place in a close latitude (36º N) within the same westward jet but at a much early springtime seasonal epoch. Although a bias exist in the observational coverage of both hemispheres of Saturn due to the rotation axis tilt and blocking by the rings and their shadows, the GWS outburst clearly points to be triggered by the seasonal forcing. A long-term survey of Saturn's atmosphere images obtained during last ten years using the IOPW-PVOL and Hubble Space Telescope databases together with Cassini public images (2004-2009), indicates that mid-scale convective storm activity occurred at a much lower intensity (smaller sizes and less bright storms) and was restricted to similar latitude in the southern hemisphere over a westward jet. No storms were reported in the visible areas of the northern hemisphere during this period. The GWS 2010 is the first observed event of this type in the new season.

References

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S2. Sánchez Lavega, A., Lecacheux J., Colas F., Laques P. Photometry of Saturn's 1990 Equatorial Disturbance, *Icarus*, **108**, 158 - 168 (1994)

S3. Karkoschka, E., Tomasko, M. G. Methane absorption coefficients for the jovian planets from laboratory, Huygens and HST data, *Icarus*, **205,** 674-694 (2010)