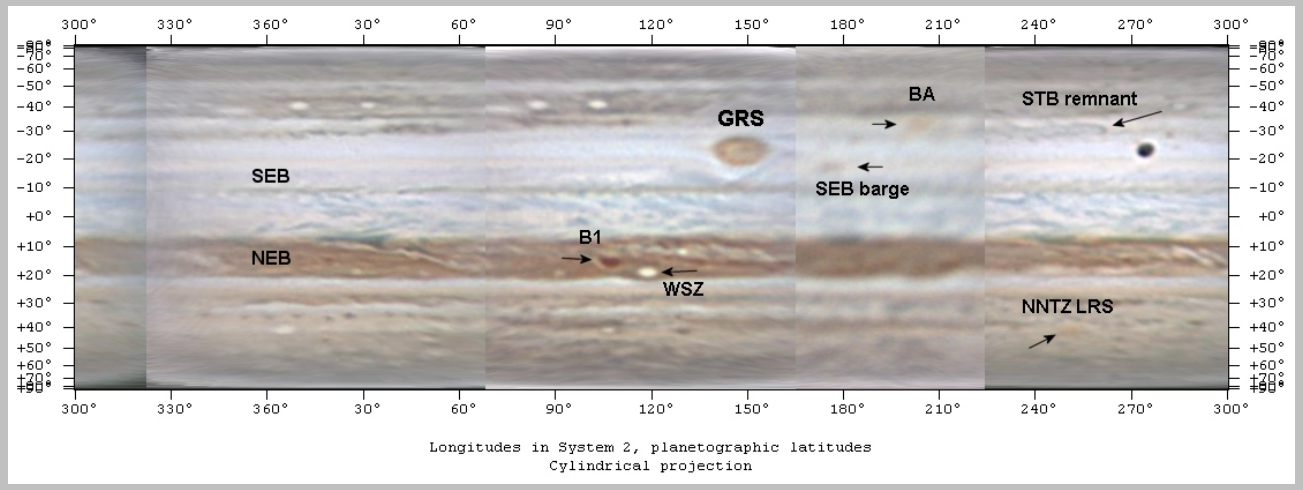
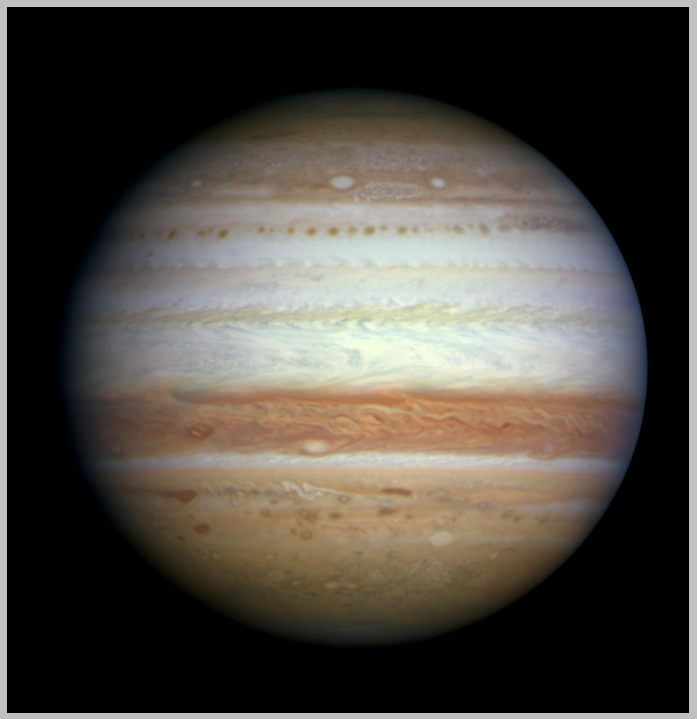




THE OBSERVATION OF JUPITER

Christophe Pellier

THE WORLD OF PLANETARY ASTRONOMY AND IMAGING

"*The observation of Jupiter*" is a guide of the blog

The World of Planetary Astronomy and Imaging

You can share it freely if you just quote my name and the blog;)

Summary

I : Introduction to Jupiter

II : The main cycles of activity

III : An history of red spots

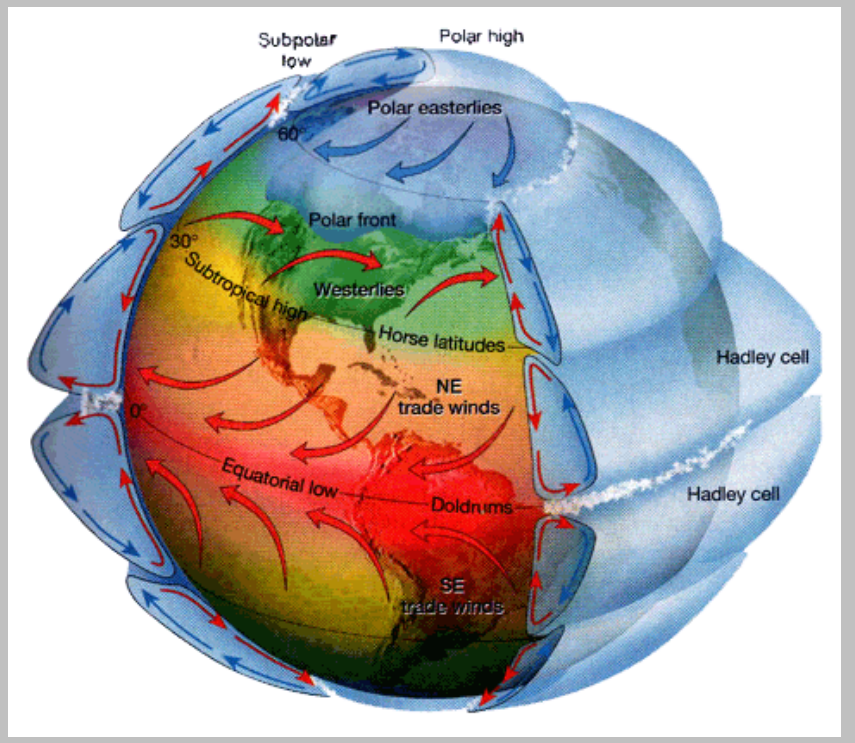
I : Introduction to Jupiter

Even if the jovian cloud system looks widely different from that of the Earth, its atmosphere can be described with the usual notions of the meteorology : high and low pressure systems, jetstreams, convection and air masses...

I – Introduction to Jupiter

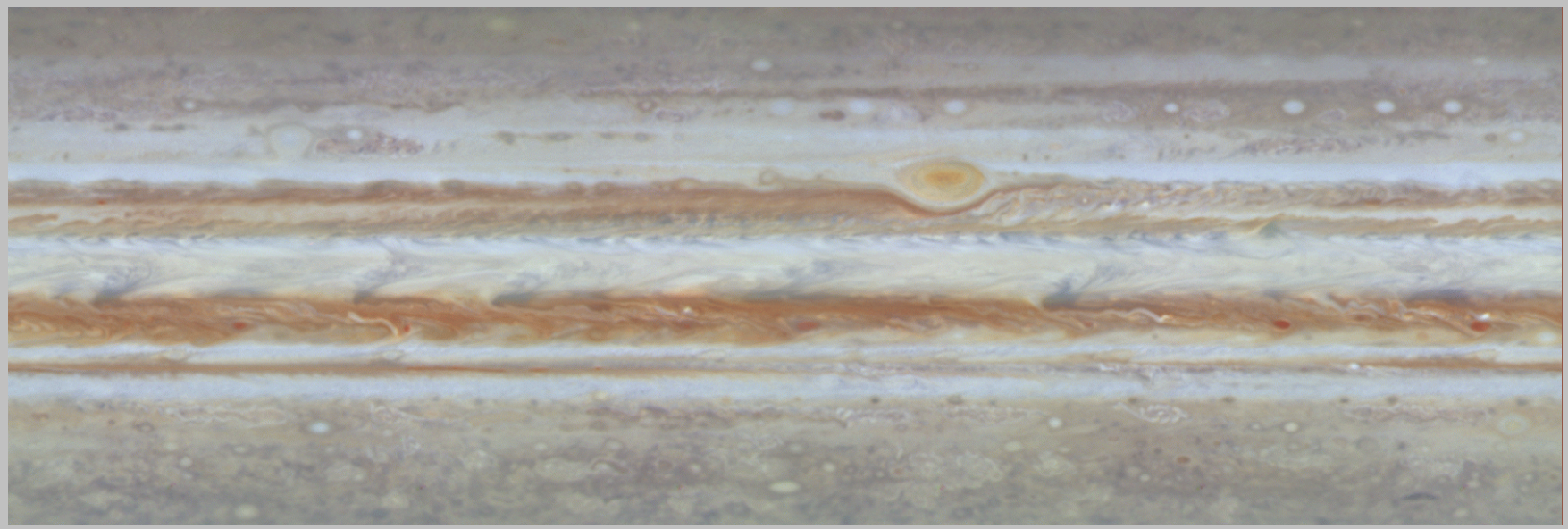
BELTS, ZONES AND VORTICES

Global view of the planet in cylindrical projection. The belts (dark) and the zones (bright) are forming convective cells equivalent to the terrestrial Hadley cells, and permit the circulation of air masses between the poles and the equator



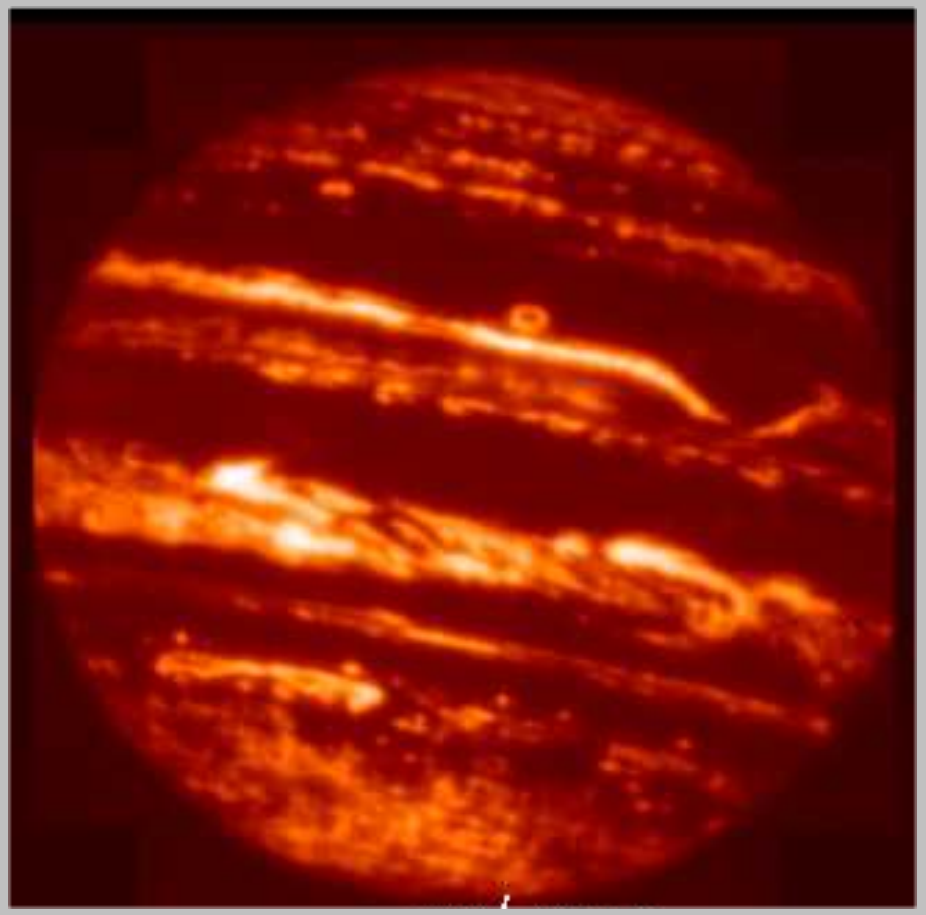
Jupiter map: Cassini

Earth schema (c) la.climatologie.free.fr .



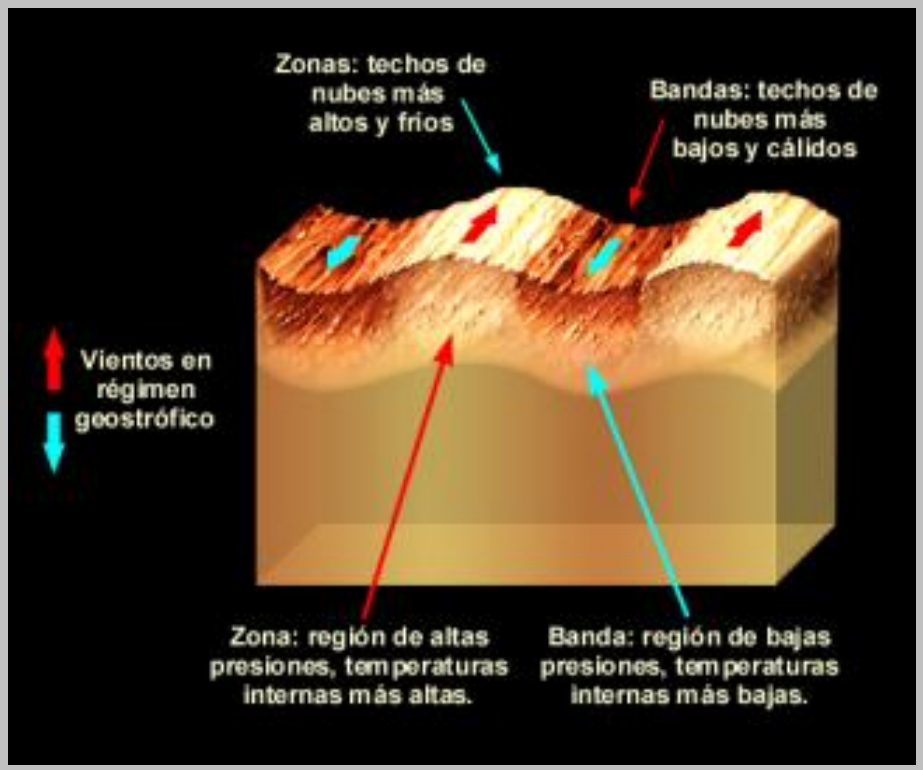
I – Introduction to Jupiter

BELTS, ZONES AND VORTICES



Jupiter image taken in infrared at 4,78µ, showing the thermal emission from the interior of the planet. Note that the heat is escaping through belts.
Image IRTF/Hawaï

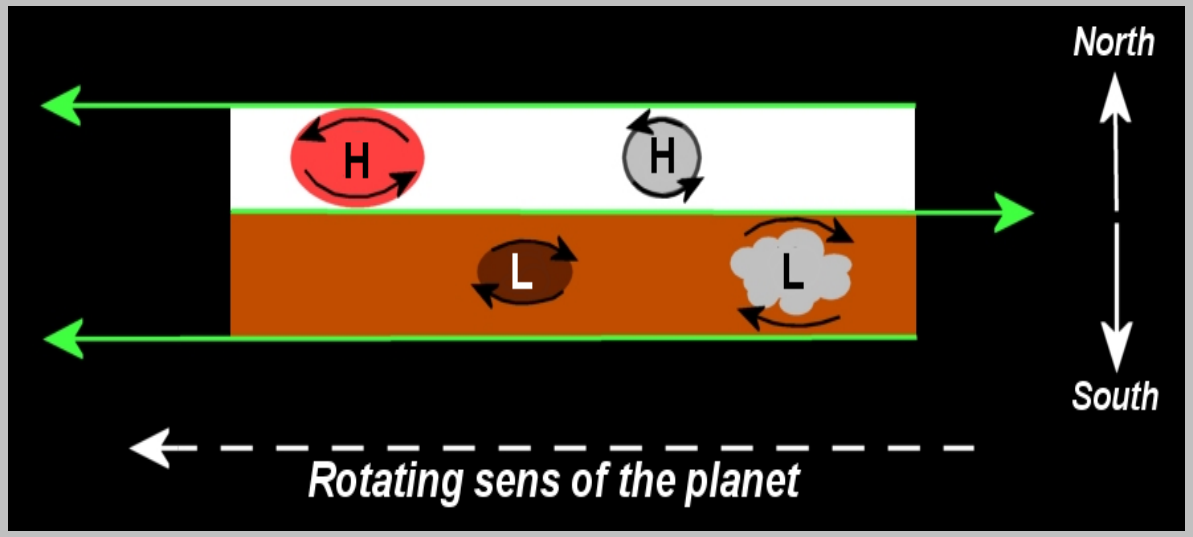
Belts correspond to the descending part of the convective cell, and zones are the ascending part.
The dark belts are then low pressure regions, with low altitude clouds, warm and dry air.
Zones are composed of whitish ammoniac clouds, condensed thanks to the cooler temperatures found at higher altitude.



Schema of belts and zones.
(c) GEA astrogea.org

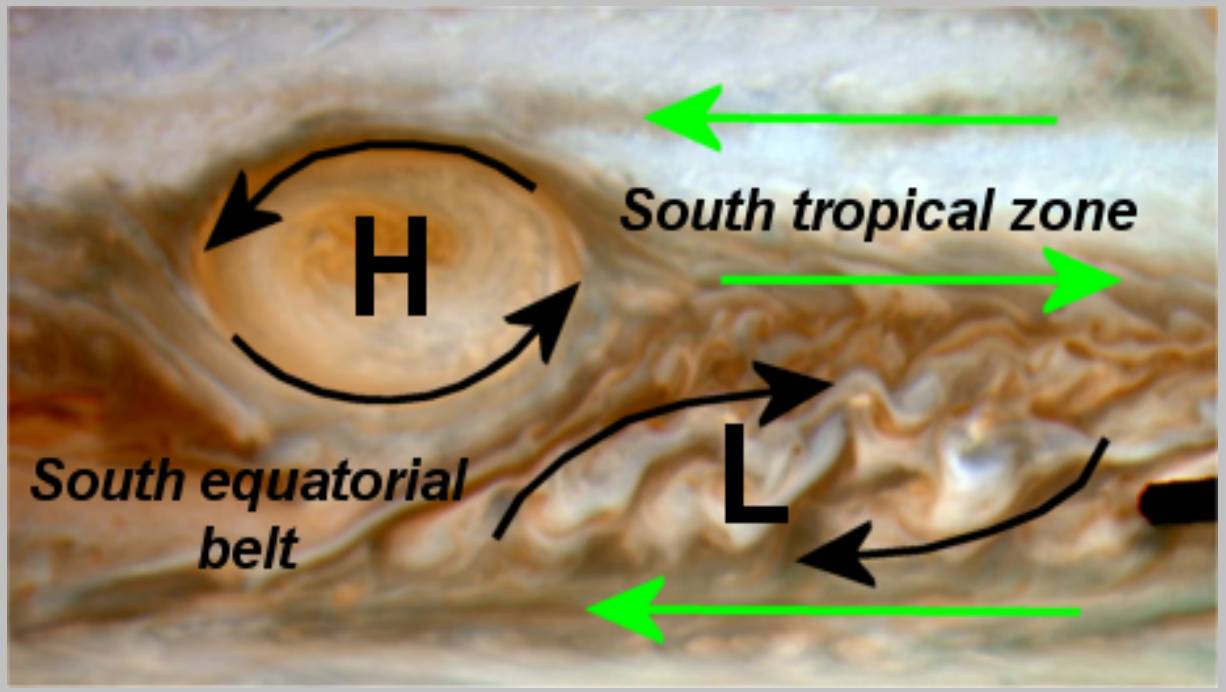
I – Introduction to Jupiter

BELTS, ZONES AND VORTICES



A belt and a zone form a complete system of circulation. They are bordered by jetstreams (in green) Between each jetstream, vortices are "rolling" in the same sens : anticyclones (H) are forming inside the bright zones, and cyclones (L) in the belts. There is no exception to this.

Example : the south tropical/equatorial domain. Image HST



II : The main cycles of activity

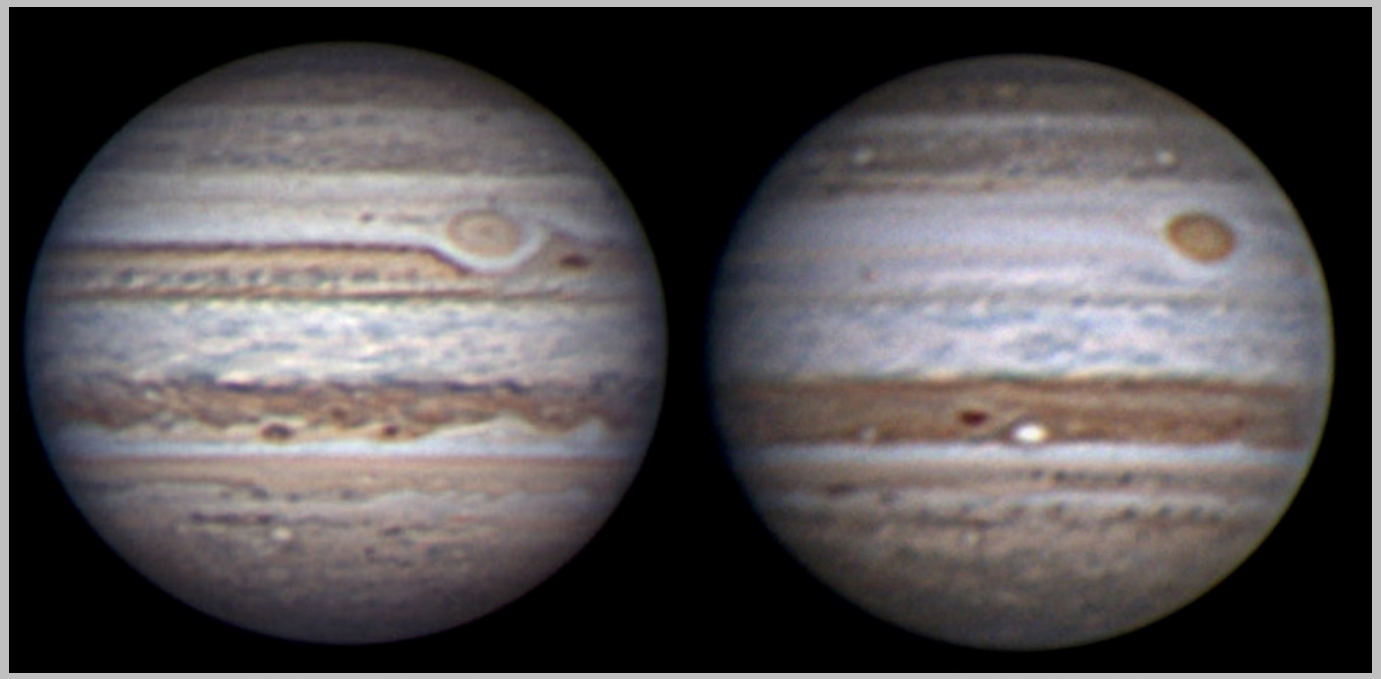
The messy aspect of the planet lets a feeling of chaos and disorder...

Yet cycles of activity than can be at least partially forecasted have been identified

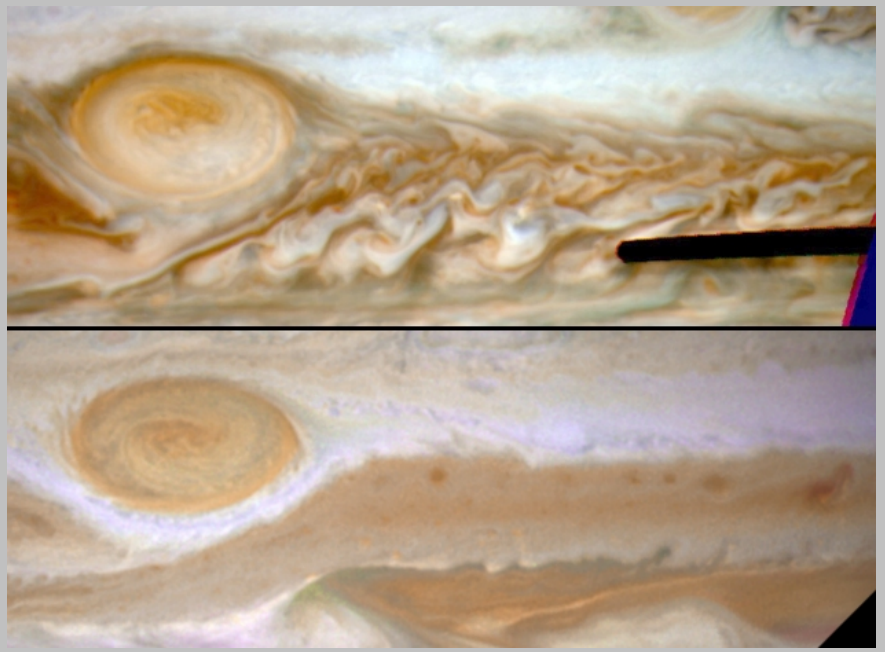
- The 15 years cycle of the SEB
- The 4 years cycle of the NEB
- The 12 years cycle of the NTB

II– The main cycles of activity

THE CYCLE OF THE SOUTH EQUATORIAL BELT



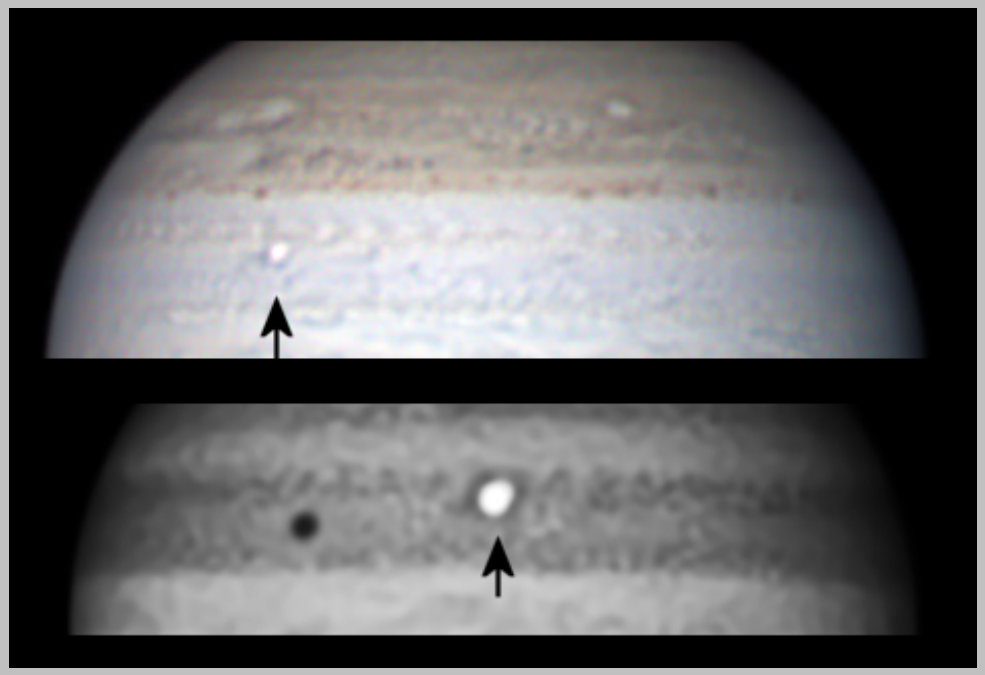
Twice every 15 years, the SEB is fading.
The cooling of the belt looks to be the cause of the phenomenon (remember belts let the internal heat escape to space)
Comparaison 2009/2010 by Tomio Akutsu.



The fading of the belt can be forecasted thanks to the stop of the convective activity that stirs the clouds during the normal state. The belt takes on a smooth aspect and begins to lose its color as white ammoniac clouds are slowy condensing above the brown haze...
Images HST 2006 and 2007

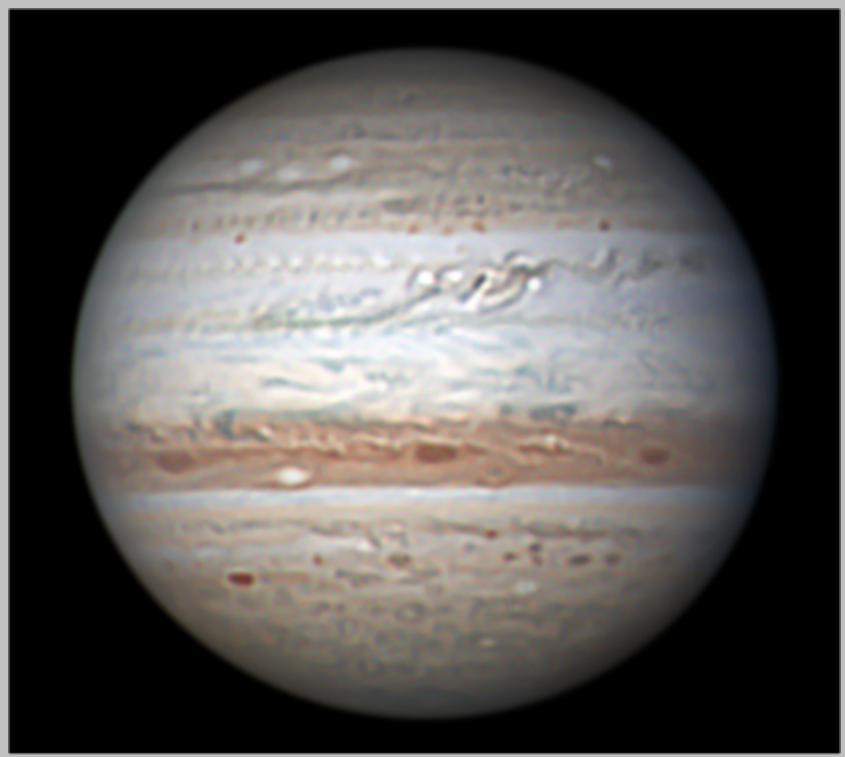
II– The main cycles of activity

THE CYCLE OF THE SOUTH EQUATORIAL BELT



Convection inside the SEB resumes after a few months, when a bright spot appears in the middle of the belt. This is a powerful cumulonimbus growing from a deeper and warmer layer of water-vapor clouds.

Images from November 10th, 2010, by Don Parker, two days after the star of the revival. The methan-band image below shows that the spot is an eruptive plume of high altitude.



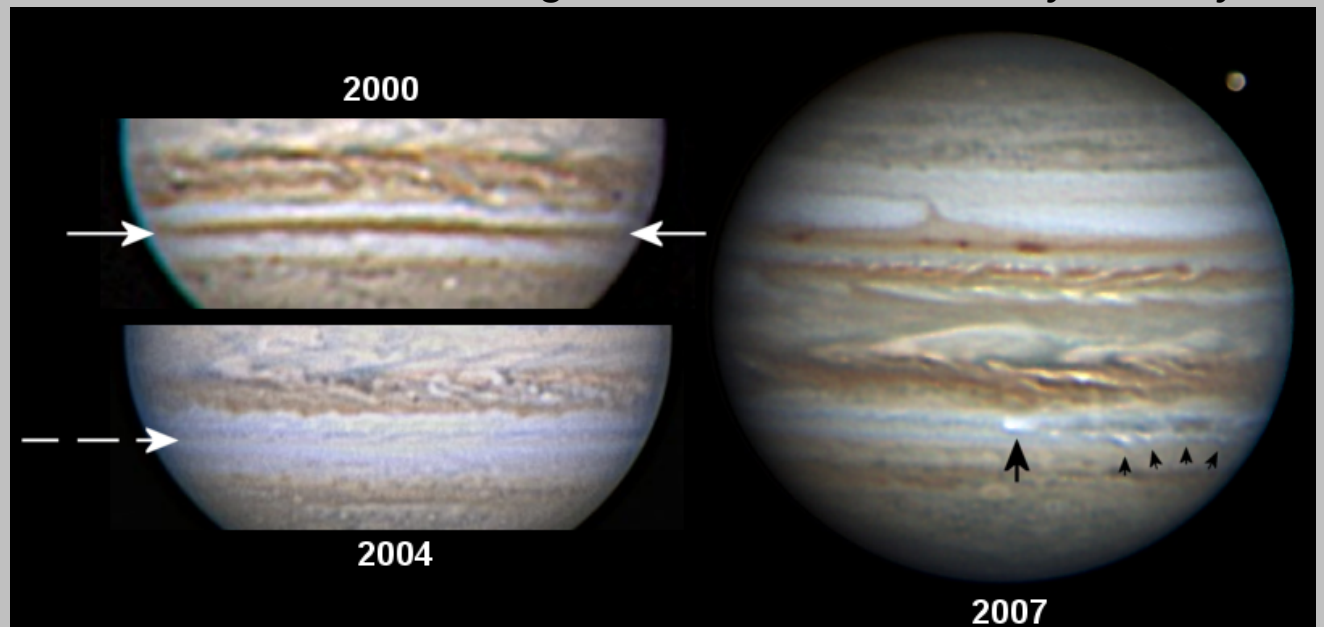
December 10th, 2010 : the revival of convection is intense.

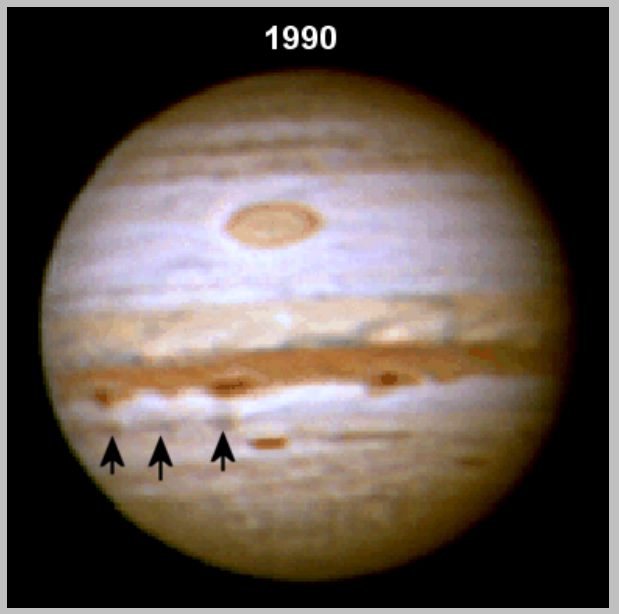
II– The main cycles of activity

THE TWO OTHER IDENTIFIED CYCLES...

The North equatorial belt (NEB) has a very regular cycle and it can be easily forcasted. Every four years, it looks to invade the adjacent North tropical zone (NtrZ). In its widest state, the NEB develops an array of dark (cyclonic) and white (anticyclonic) spots. *Images : Xavier Dupont, Jean-Jacques Poupeau, Jean-Pierre Prost*

The case of the North temperate belt (NTB) is more complexe. It fades once every 10 to 12 years roughly, in the same way as the SEB. The revival is identical, starting with bright convective clouds... and most of the time it happens within a few months of a SEB revival ! *Images Don Parker, Anthony Wesley, Nordic optical telescope (NOT)*





III : The red spots of Jupiter

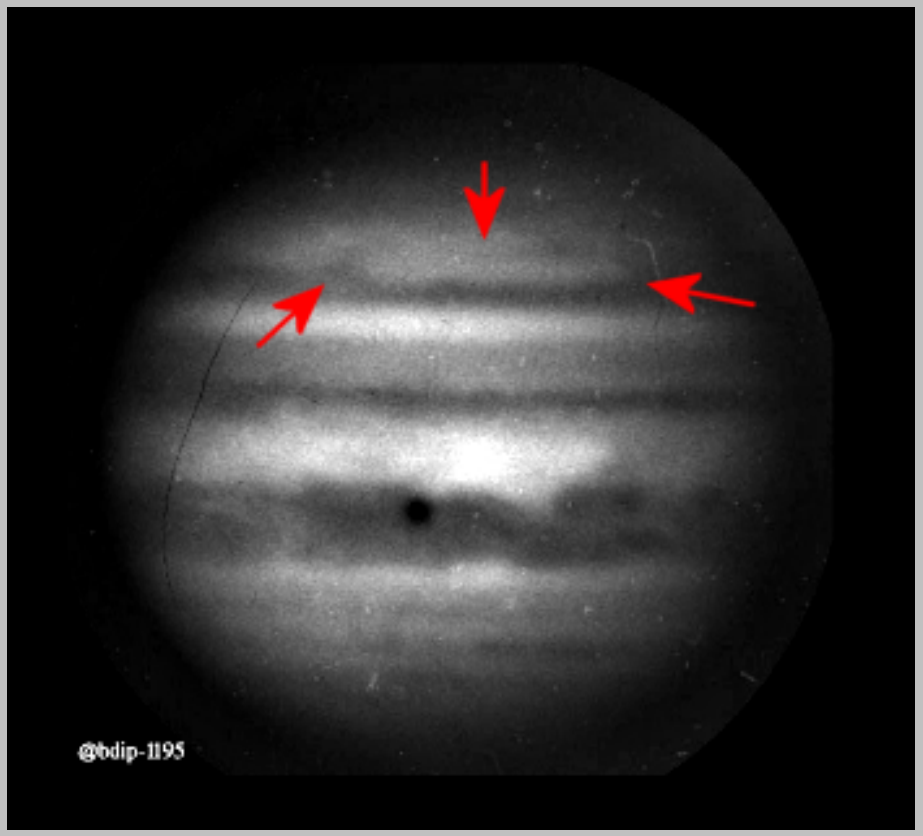
Apart of the main cycles of activity, we follow on Jupiter the evolution of several noticeable cloud structures...

The Great red spot is without doubt the most emblematic.

... but despite its impressive size and longevity, it is not the only red spot that we can see on the planet !

III – The red spots of Jupiter

THE HISTORY OF OVAL BA...

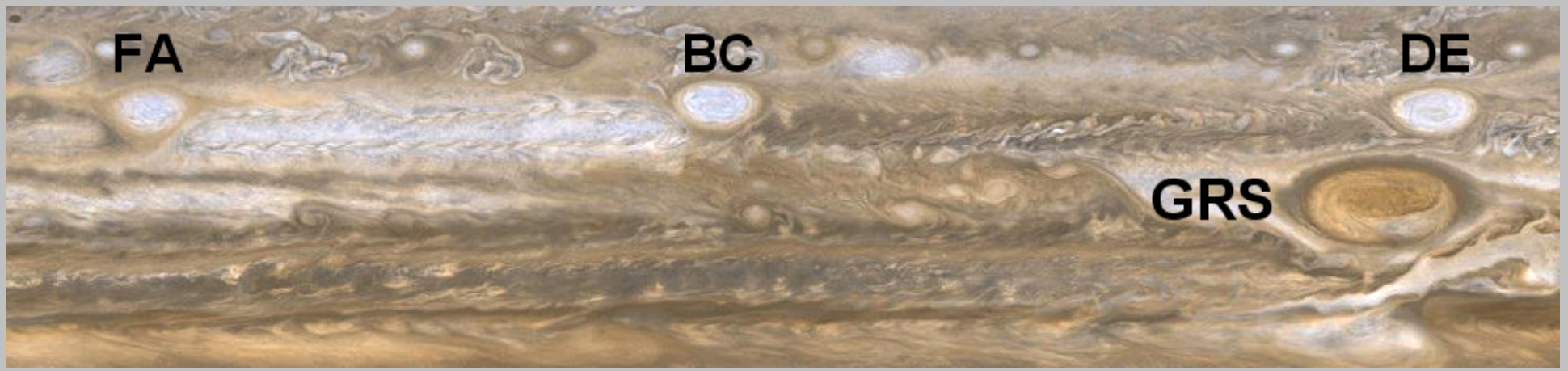


Between 1939 and 1950, three big anticyclonic cells appear in the STZ, and progressively contract to form the "white oval spots" (WOS)

At left : image of one of the cells taken at the Pic du Midi in 1945 April.
© BDIP

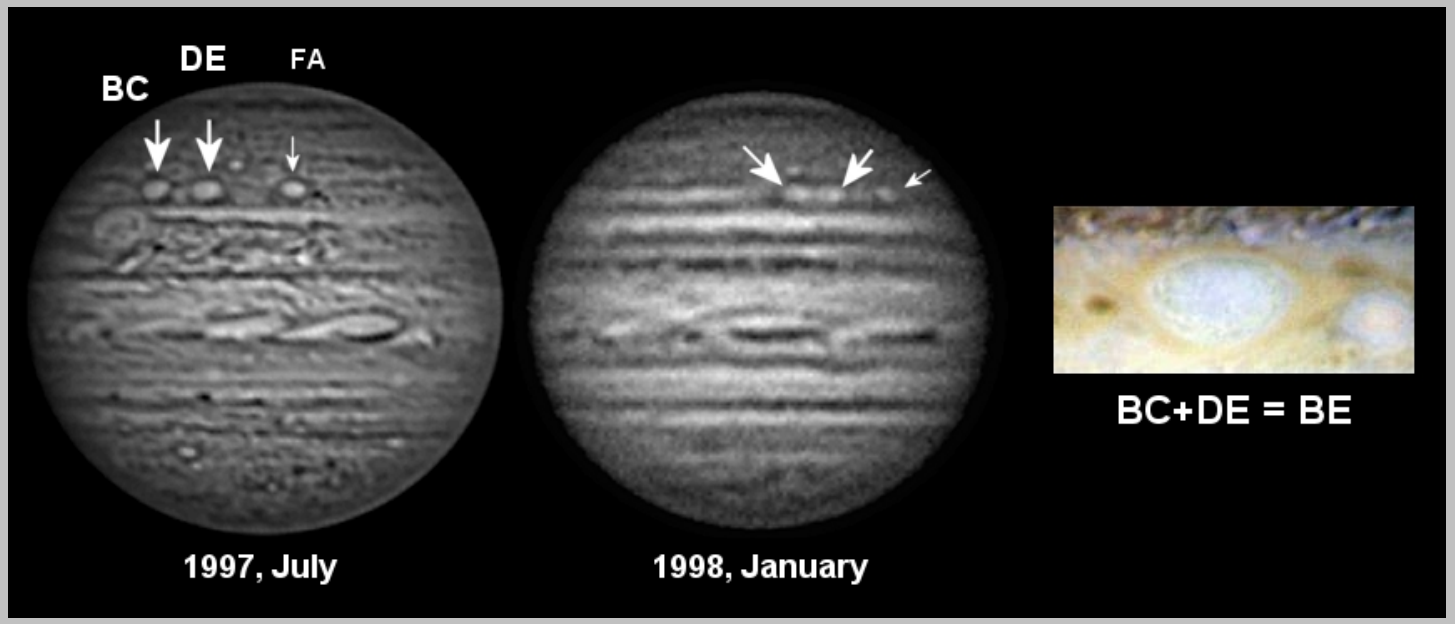
The three WOS are called BC, DE, FA. They are the biggest structures on Jupiter following the GRS.

Below : Voyager image in 1979

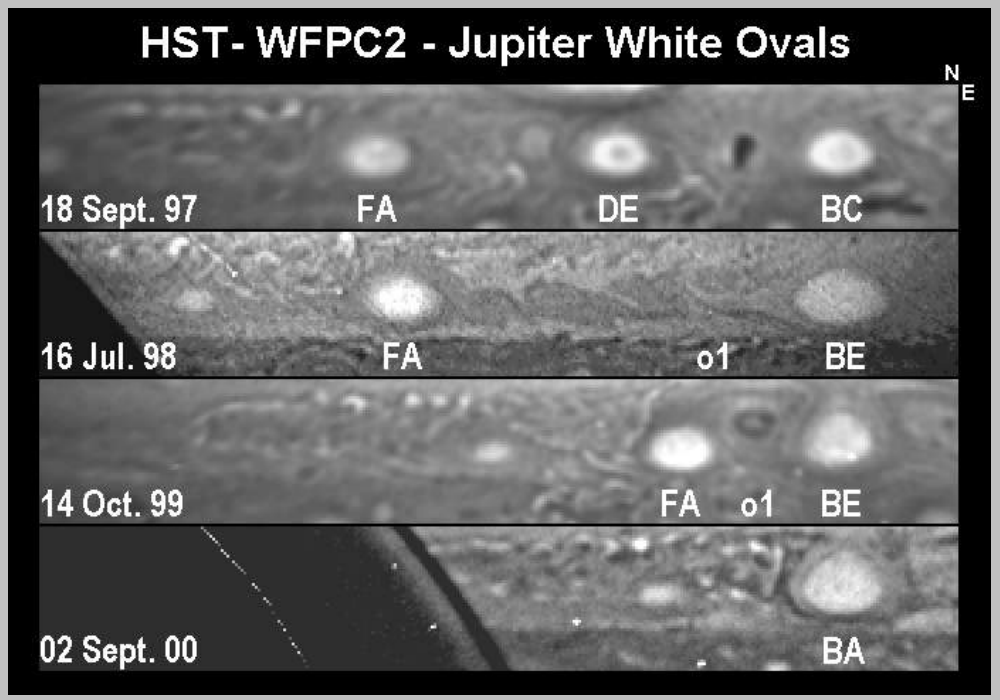


III – The red spots of Jupiter

THE HISTORY OF OVAL BA...



After 60 years of existence, at the end of the XXth century, the three WOS merged into a single spot : oval BA



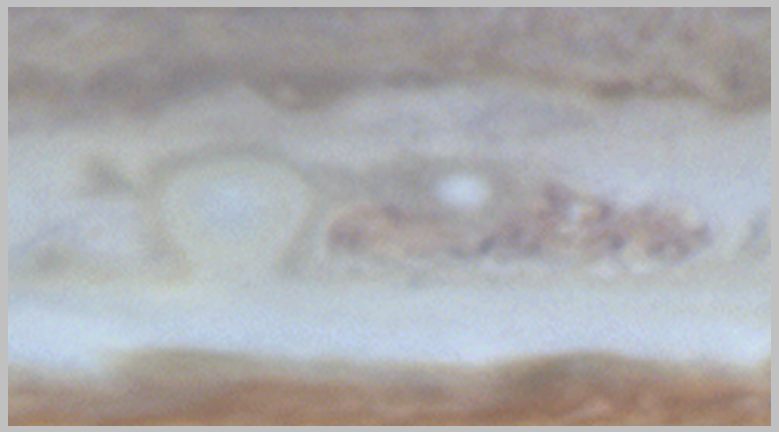
Above : the merging of BC and DE in 1998, as seen by the Pic du Midi and the Galileo orbiter

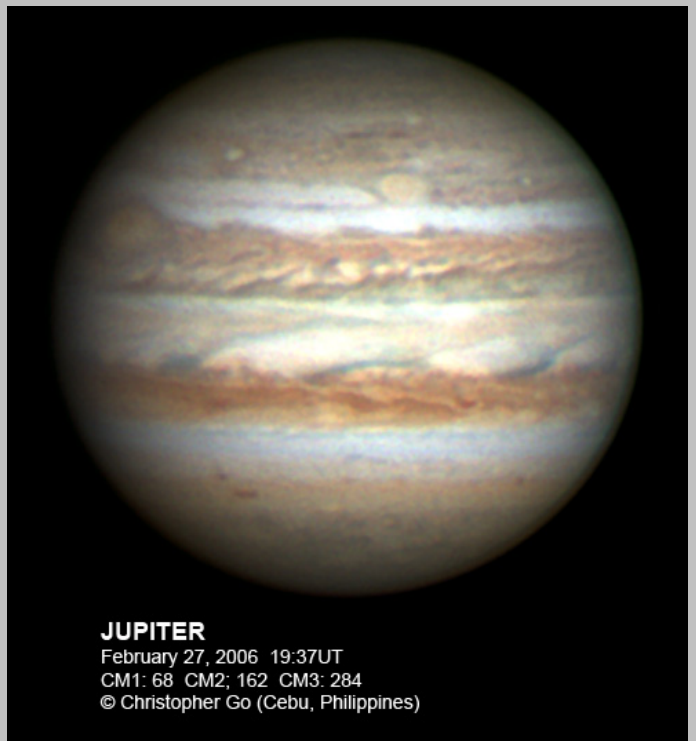
Below : BE is merging with FA in 2000 March to give birth to BA. Images HST

III – The red spots of Jupiter

THE HISTORY OF OVAL BA...

In 2006, BA took on an unexpected reddish color that none of the previous WOS ever had.
This tint turned it into a "little red spot" and BA has then been nicknamed sometimes *Red spot junior*.
This event revealed that the GRS is only the greatest representative of what is known today to be a particular class of jovian objects, with at least 3 members : long-lived reddish anticylonic storms

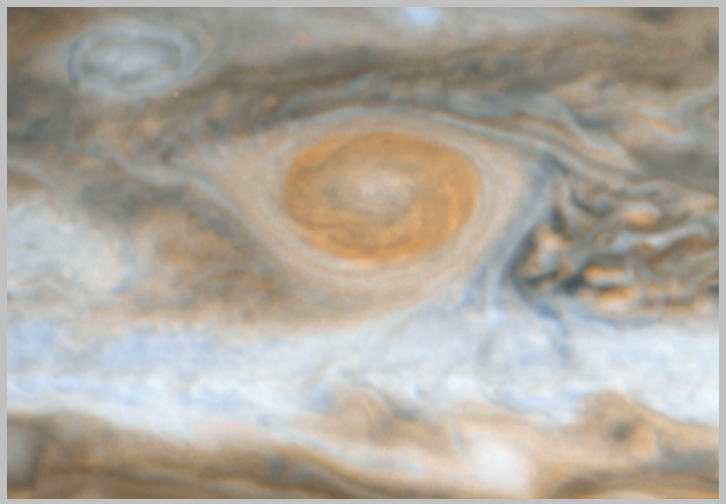




Images : at upper right, the still whitish BA oval as seen by Cassini during 2000 fall, only a few months after its birth.

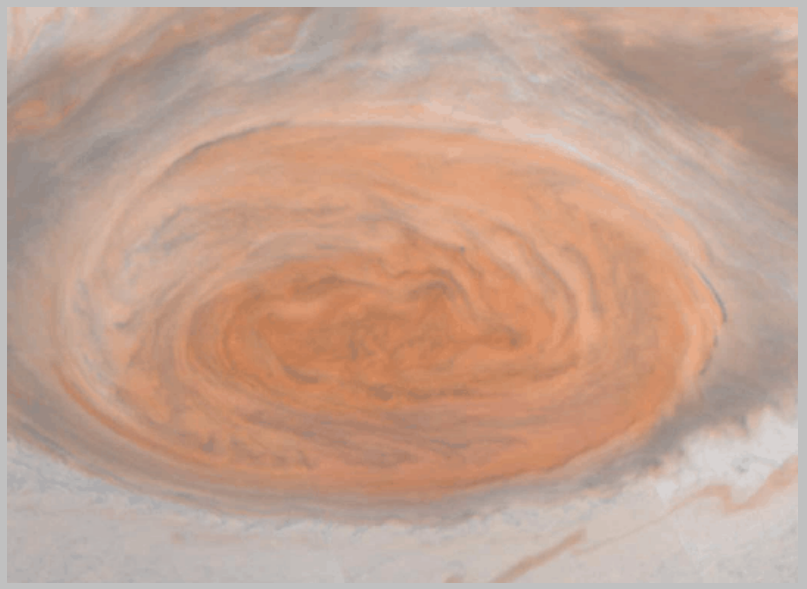
At left : discovery image by Christopher Go in 2006 February, showing the change of color.

At right : HST image of 2006 April. Compare to Cassini !

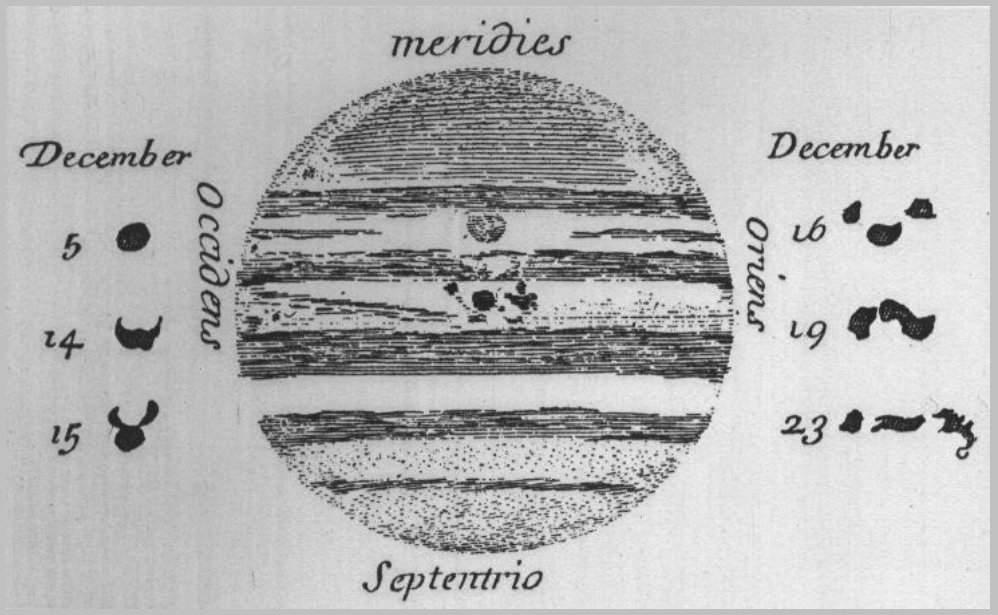


III – The red spots of Jupiter

THE HISTORY OF THE GREAT RED SPOT



The GRS by the Cassini probe



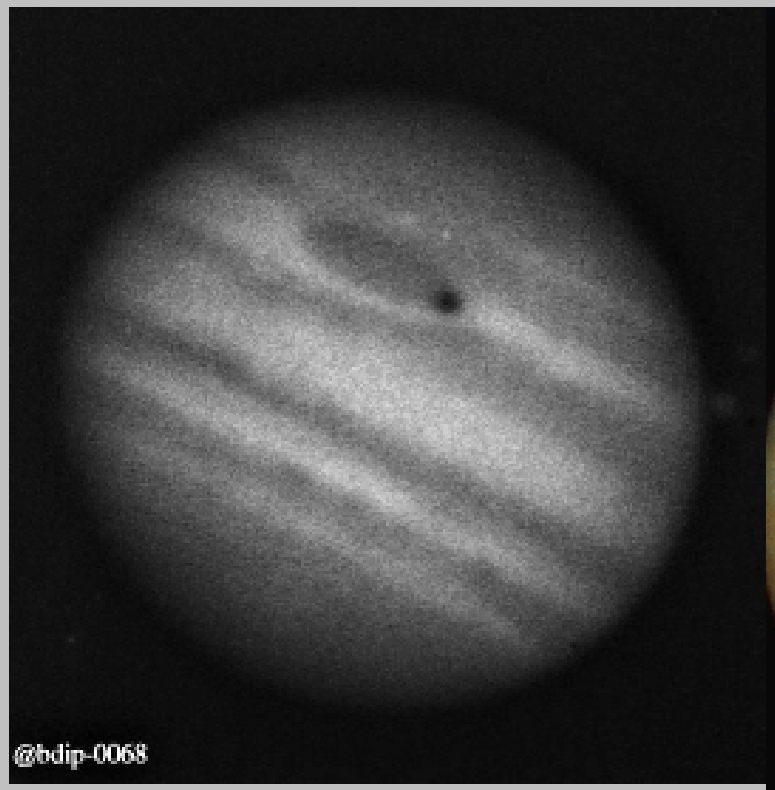
Drawing by Cassini in 1691

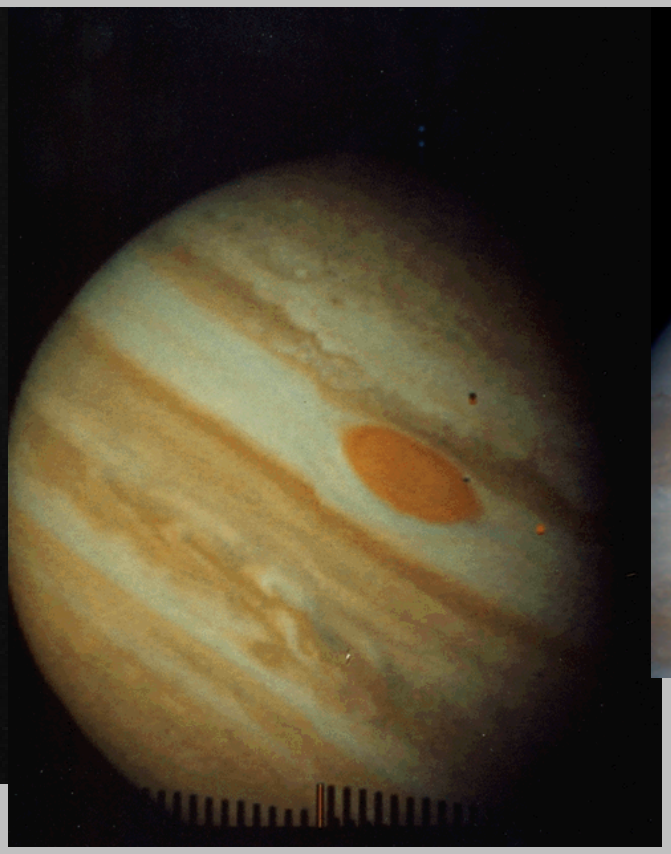
The origin of the GRS is undetermined ; when did it appear really ?

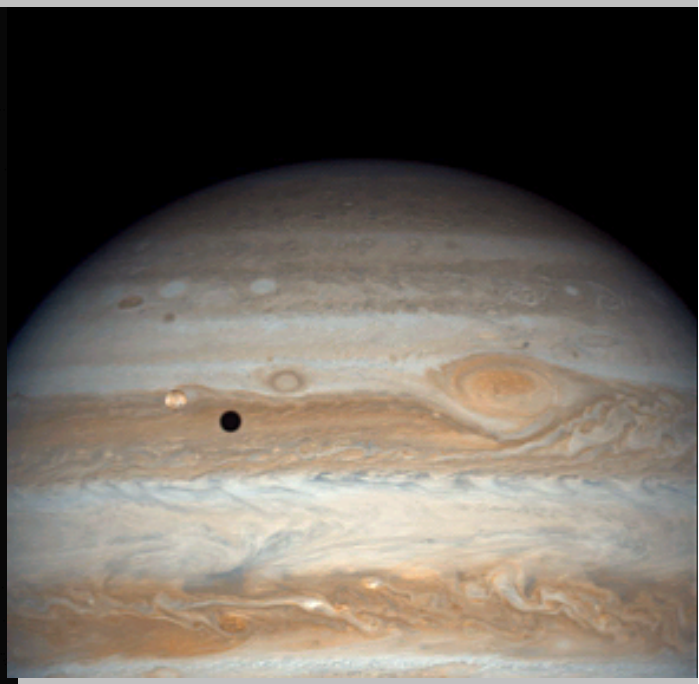
After the observations by Cassini up to the early XVIIth century, the spot he drew have not been observed during more than one century, and it is only in 1831 that it was guessed again on a sketch by S.H Swabe. The Cassini spot, from the drawings and measurements made by then, was much smaller and slower than the one we see today (study made by John Rogers in his book "The giant planet Jupiter").

III – The red spots of Jupiter

THE HISTORY OF THE GREAT RED SPOT







1891
Lick Observatory
Length = 35000 km

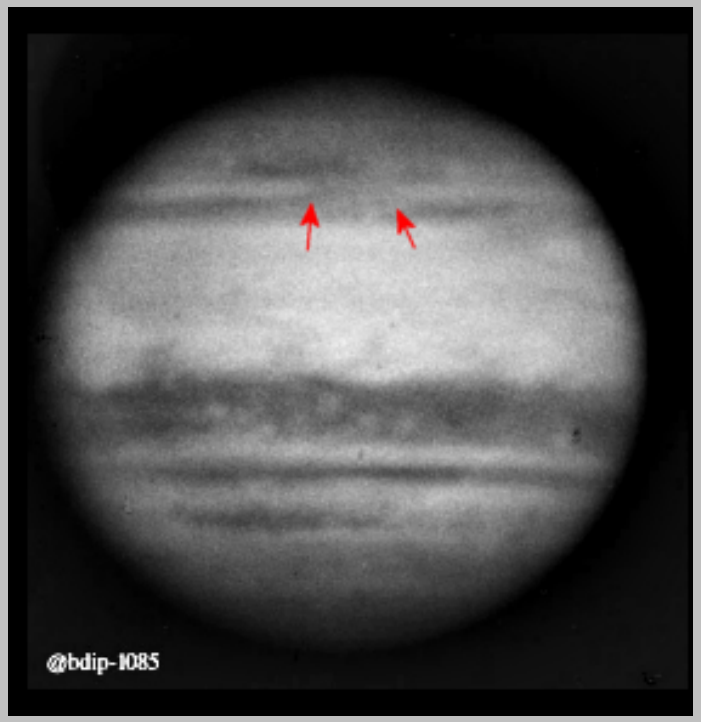
1973
Pioneer
Length = 25000 km

2000
Cassini
Length = 18000 km

Since its (re)discovery during the first half of the XIXth century, the GRS did not stop shrinking and slowering its drift rate.

III – The red spots of Jupiter

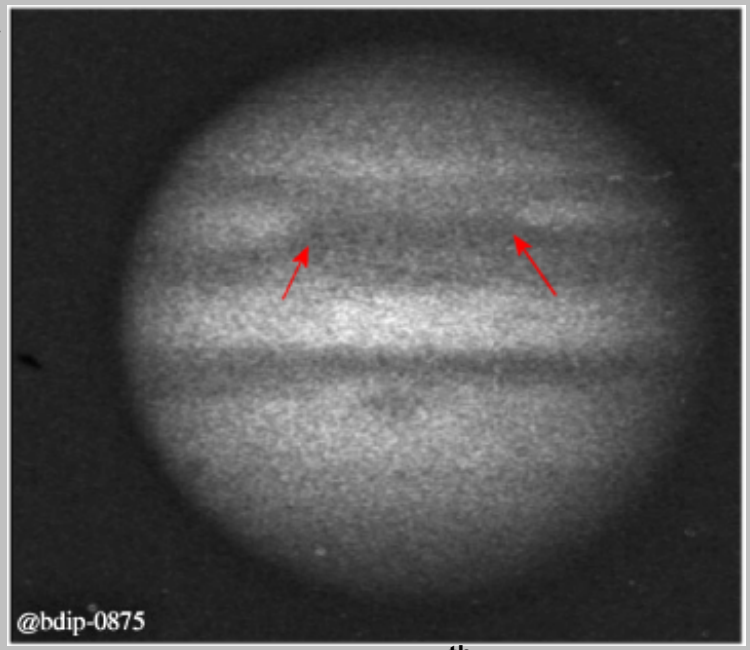
THE HISTORY OF THE GREAT RED SPOT



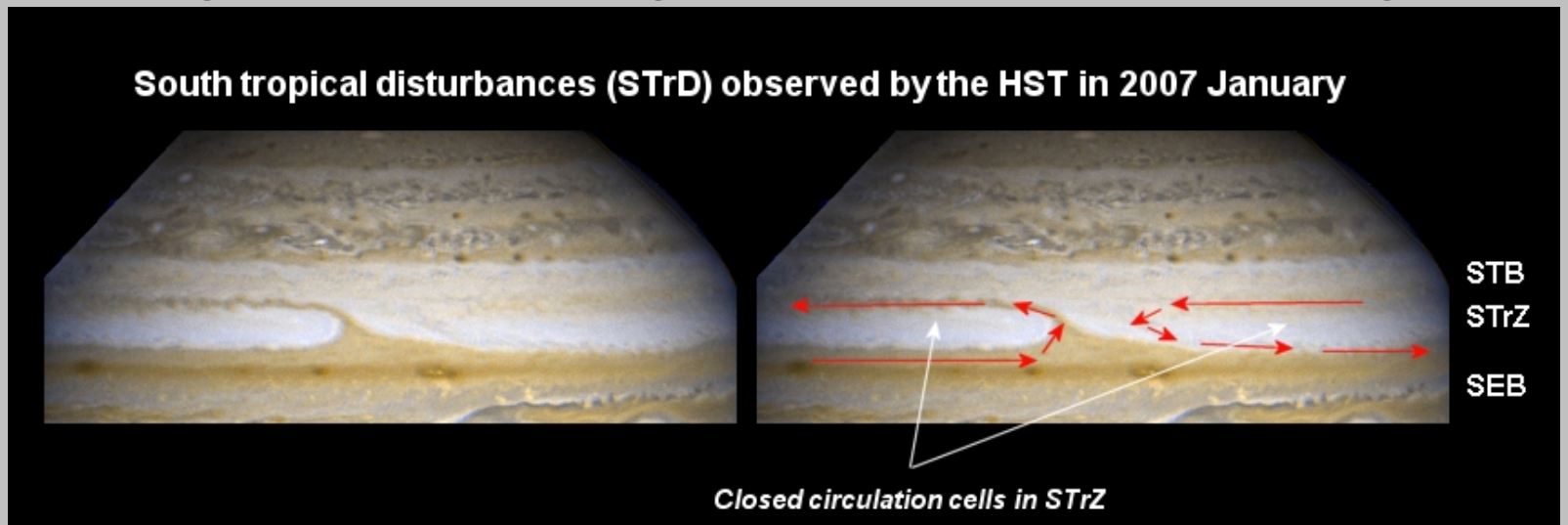
October 20th, 1941 (Pic)
Arrows point the edges of two cells forming the WOS in STZ

By analogy with the history of the great STZ ovals, the GRS might have been forming through a contracting high-pressure cell in the STrZ. Disturbances sources of such cells have been imaged several times in history.

Credit for that theory : John Rogers

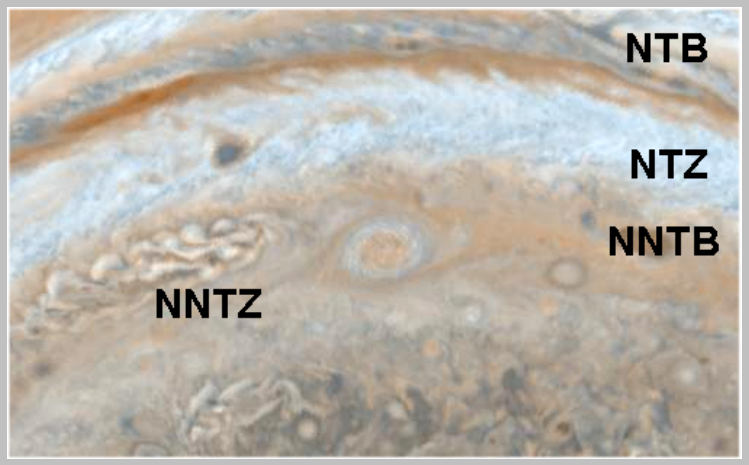


April 21th, 1908 (Lowell)
Arrows point the edges of a corresponding disturbance in STrZ



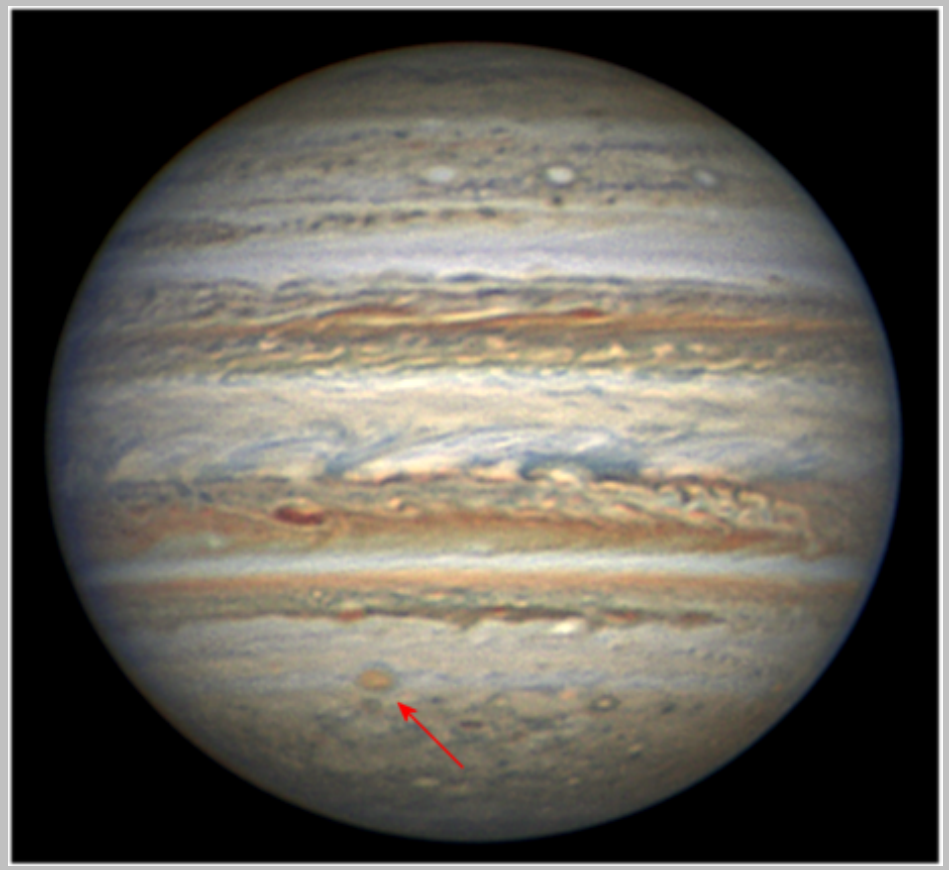
III – The red spots of Jupiter

MORE RED SPOTS !



At left : the NNTZ Red spot imaged by Cassini in 2000

Lower left : The NNTZ RS in 2012. Image by Regis De Benedictis



There are today at least three red spots on Jupiter. The 3rd one, the NNTZ RS, has been existing at least since 1993 (and had some predecessors – (c) BAA).

In 2008 we also saw an ephemerous little red spot in the STrZ.

HST 2008