The Colors of Saturn in 2023

By Christophe Pellier https://www.planetary-astronomy-and-imaging.com/en/

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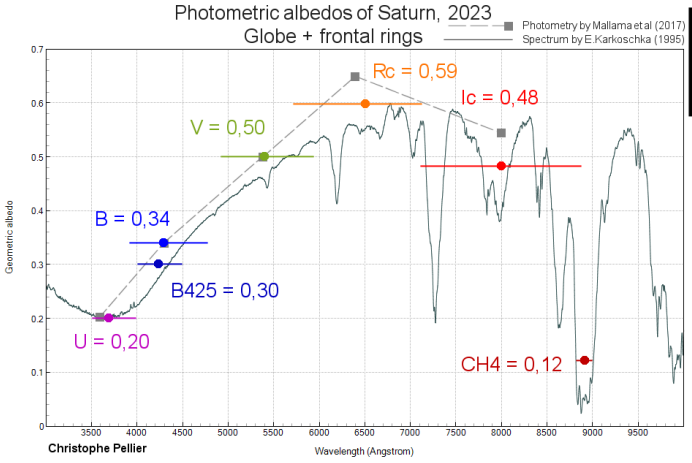
Photometry and images

In comparison with Jupiter, the difficulty of Saturn comes from the rings that almost always partially mask the globe. I have dedicated much time to read some scientific literature in the hope of finding equations to deal with this problem, but I didn't find how to do this. However, since I am working on disk resolved images, it is then possible to isolate the globe from the adjacent rings, letting only the part that passes in front of the disk. This is not a problem for the photometric calibration, in that case the frontal rings are just considered as a particular "banding domain". However, it makes comparison with historical references less accurate.

The values found are none the less right on track of the expected values from U to V. They are lower in R and IR, but this likely due to the fact that Saturn is approaching equinox, and the globe is getting less red, and less bright, during the process - values in R and IR are getting closer to the Karkoschka's spectrum that has been made in 1995 right when Saturn was at equinox. The albedo of 12% in CH4 is obviously affected by the bright rings.

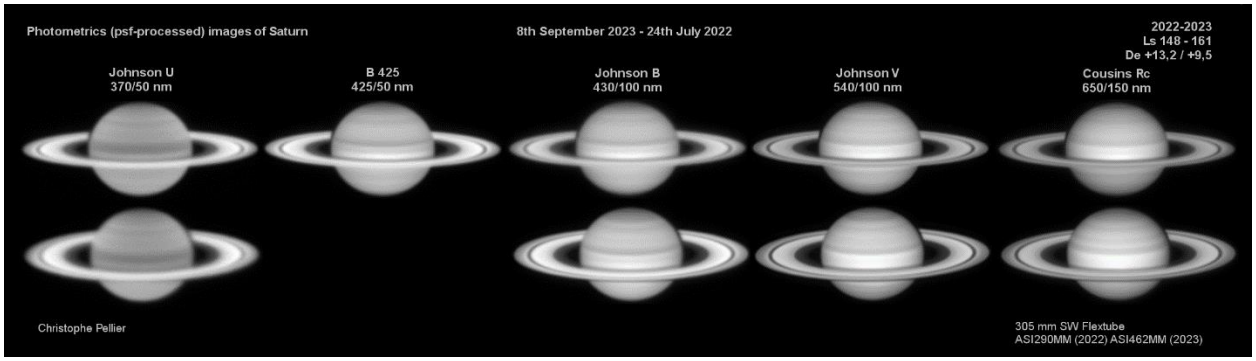
I am adding comparisons of images from 2022 but I did not make a photometric calibration back then.

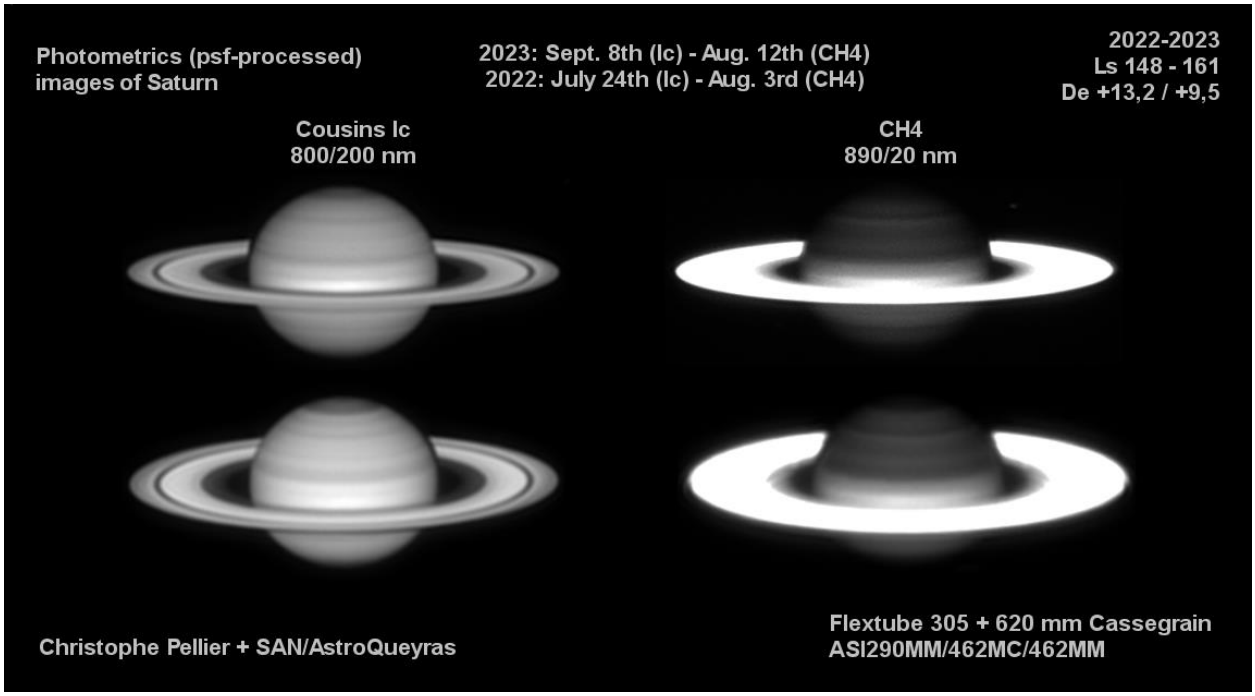
As for Mars, the calibration of the B425 filter is obtained through homemade magnitudes calculated from spectroscopy and looks also correct.

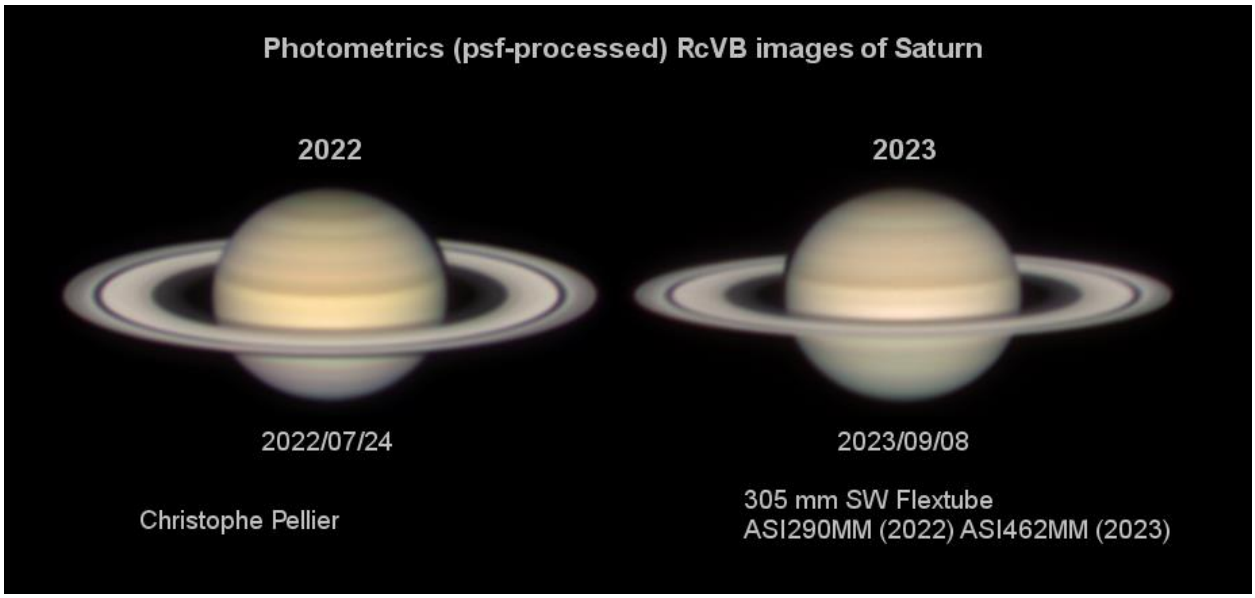


Reference stars :
8 Cap (B9IV), nu. Aqr (K0III)
305 mm SW Flextube + ASI462MM

	APPARENT MAGNITUDES						
	U	B425	B	V	Rc	Ic	CH4
08/09/23	2,59	2,79	1,86	0,77	0,20		
14/09/23					0,22	0,10	4,09
	NORMALIZED MAGNITUDES + references						
08/09/23	-7,10	-6,92	-7,85	-8,93	-9,51		
14/09/23					-9,52	-9,64	-5,65
References	-7,08		-7,84	-8,91	-9,59	-9,74	
	ALBEDO + references						
08/09/23	0,203	0,301	0,336	0,502	0,591		
14/09/23					0,597	0,484	0,122
References	0,203	-	0,339	0,499	0,646	0,543	-




Photometrics (psf-processed)
images of Saturn
2023: Sept. 8th (Ic) - Aug. 12th (CH4)
2022: July 24th (Ic) - Aug. 3rd (CH4)
2022-2023
Ls 148 - 161
De +13,2 / +9,5
Cousins Ic
800/200 nm
CH4
890/20 nm
Christophe Pellier + SAN/AstroQueyras
Flextube 305 + 620 mm Cassegrain
ASI290MM/462MC/462MM


Photometrics (psf-processed) RcVB images of Saturn
2022
2023
2022/07/24
2023/09/08
Christophe Pellier
305 mm SW Flextube
ASI290MM (2022) ASI462MM (2023)

April 28, 2024

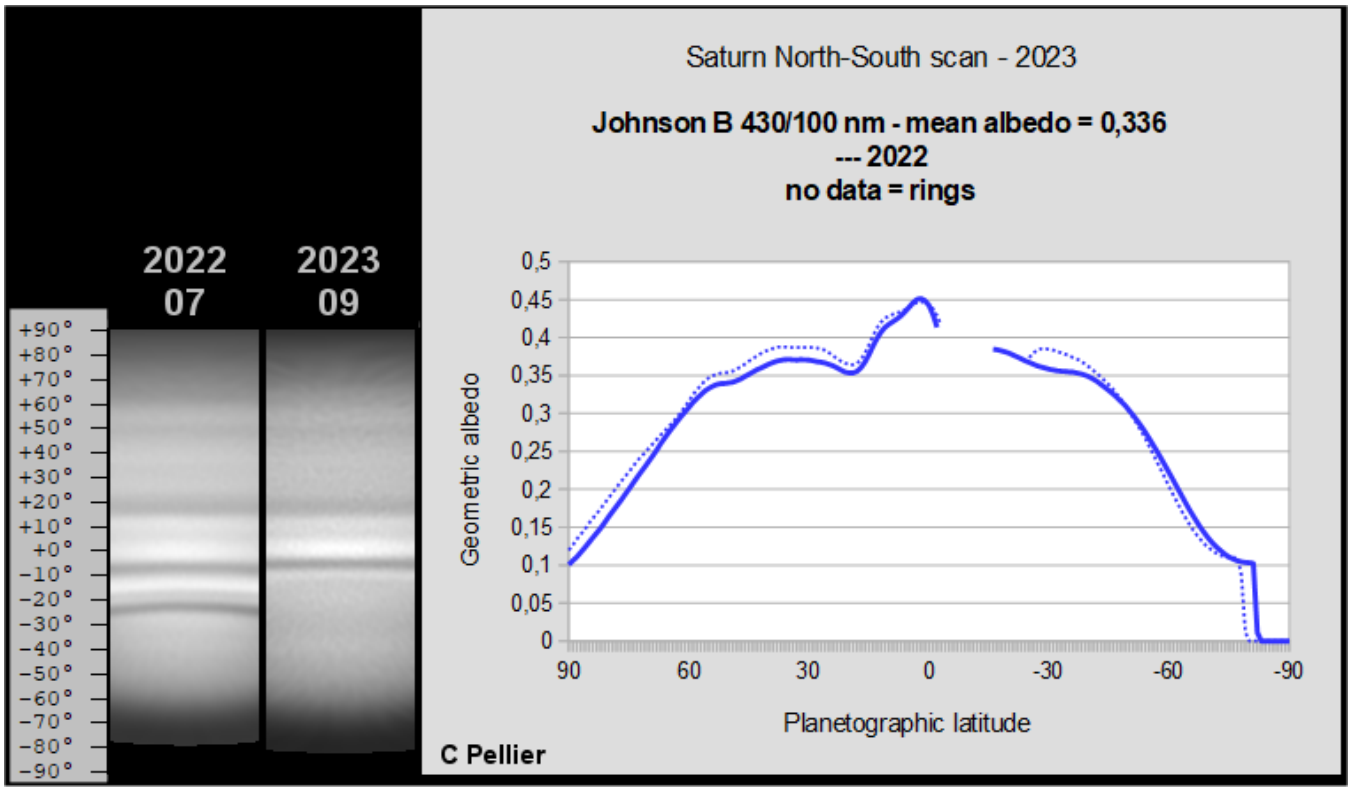
North-Souths Scans

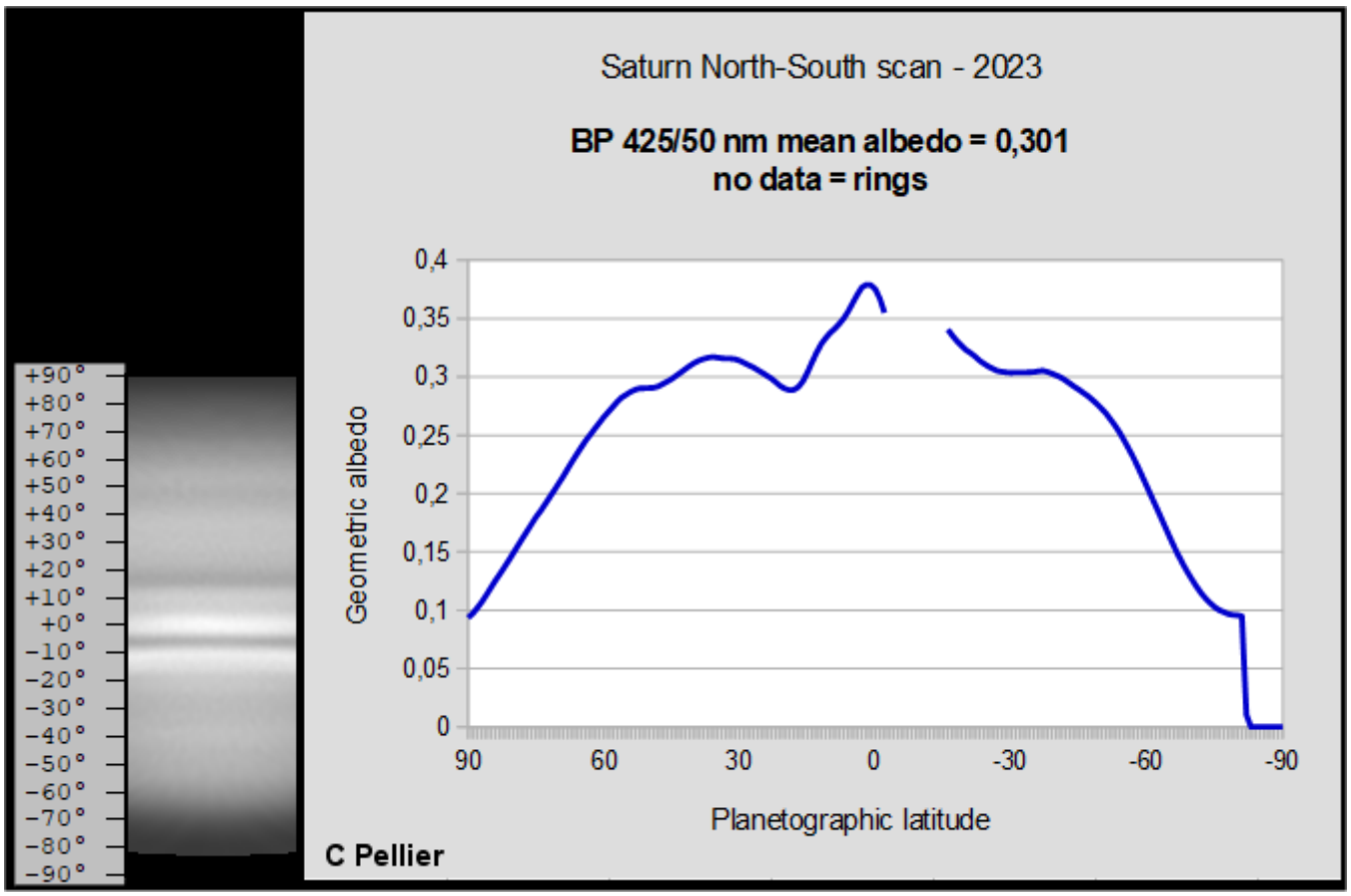
Polar scans are scaled by calculating the albedo of the southern part of the equatorial zone (same method as for Jupiter). I have calculated the scans for 2022 as well, and scaled them with the same value of albedo for the EZs, since I think it may not have changed in just one year; the method has its limits but I did not perform photometry in 2022.

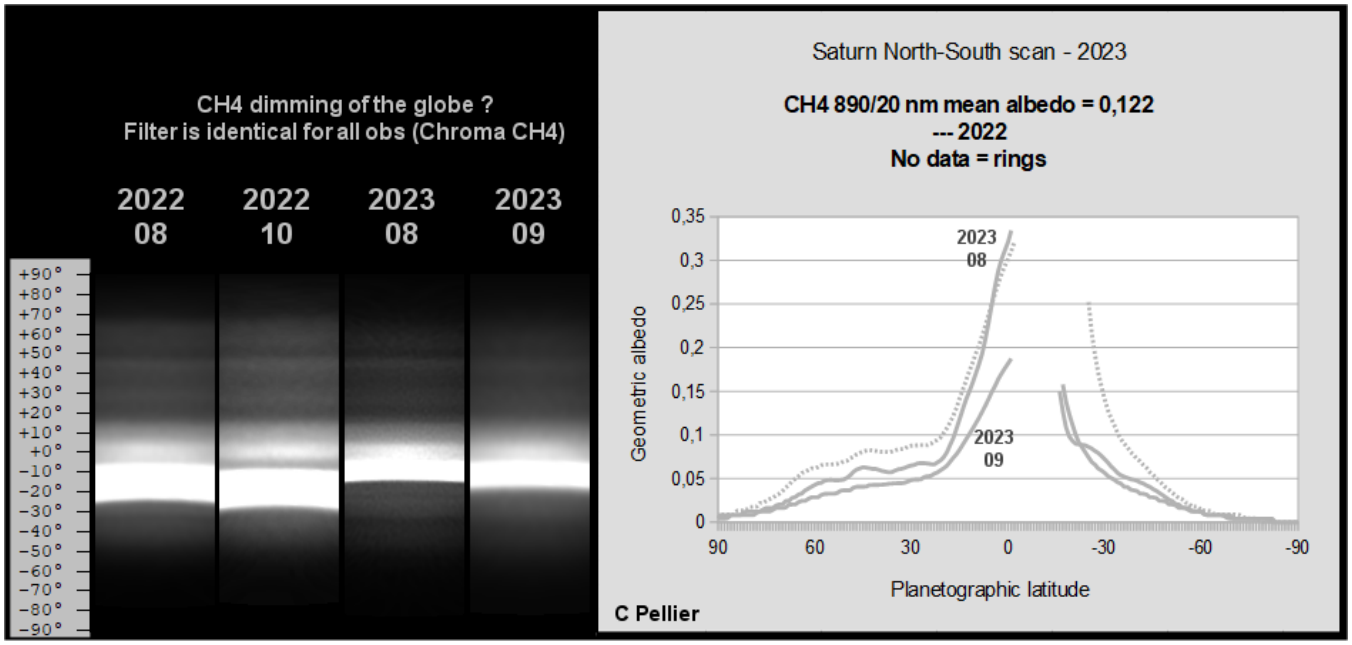
With the approach of the equinox, we expect to see the southern hemisphere brighten, and the northern one dim. This is indeed what can be seen in red light. However, in blue light, BOTH hemispheres have dimmed, which explains why it lost its noticeable blue tint of 2021-2022. On the other hand, the south hemisphere looks to have brightened noticeably in visible/green light, which explains why the overall southern tint turned to a pale green in 2023!

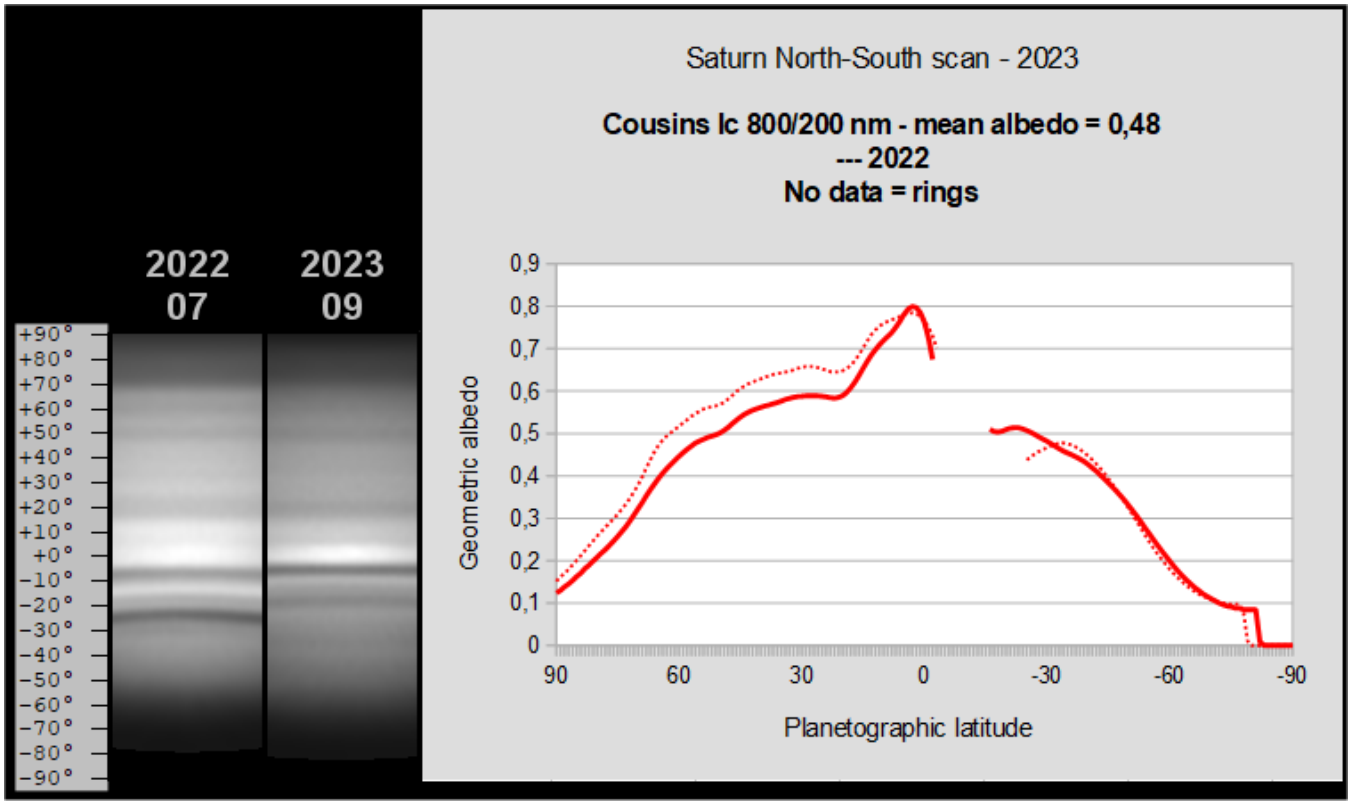
More surprising, however, are the results in infrared, that may show a noticeable dimming of the north hemisphere in the I band, and a dimming of the whole globe in CH4! This may be an incorrect result due to the fact that I did not undertake photometry in 2022. However, when I look at images I do feel that it is true.

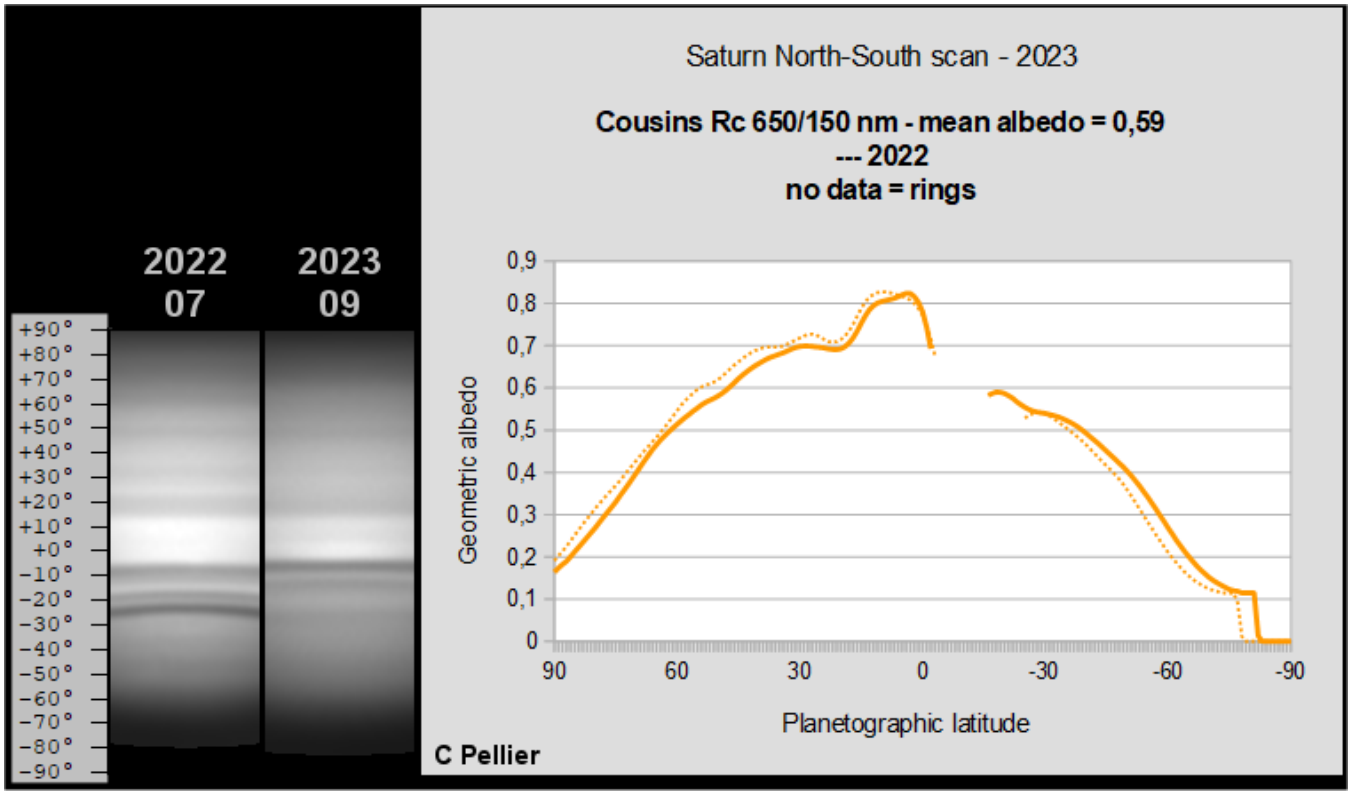
Do we have additional data about this from HST or other sources?

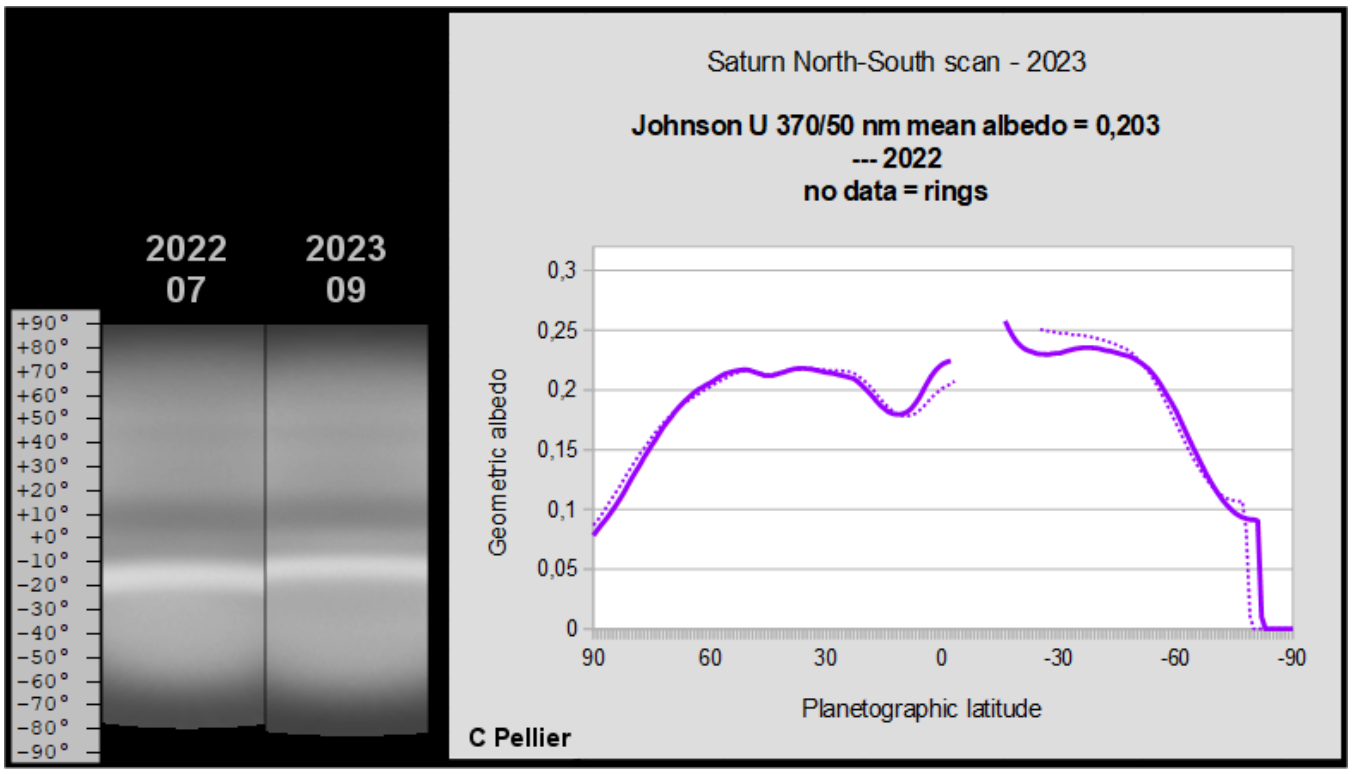


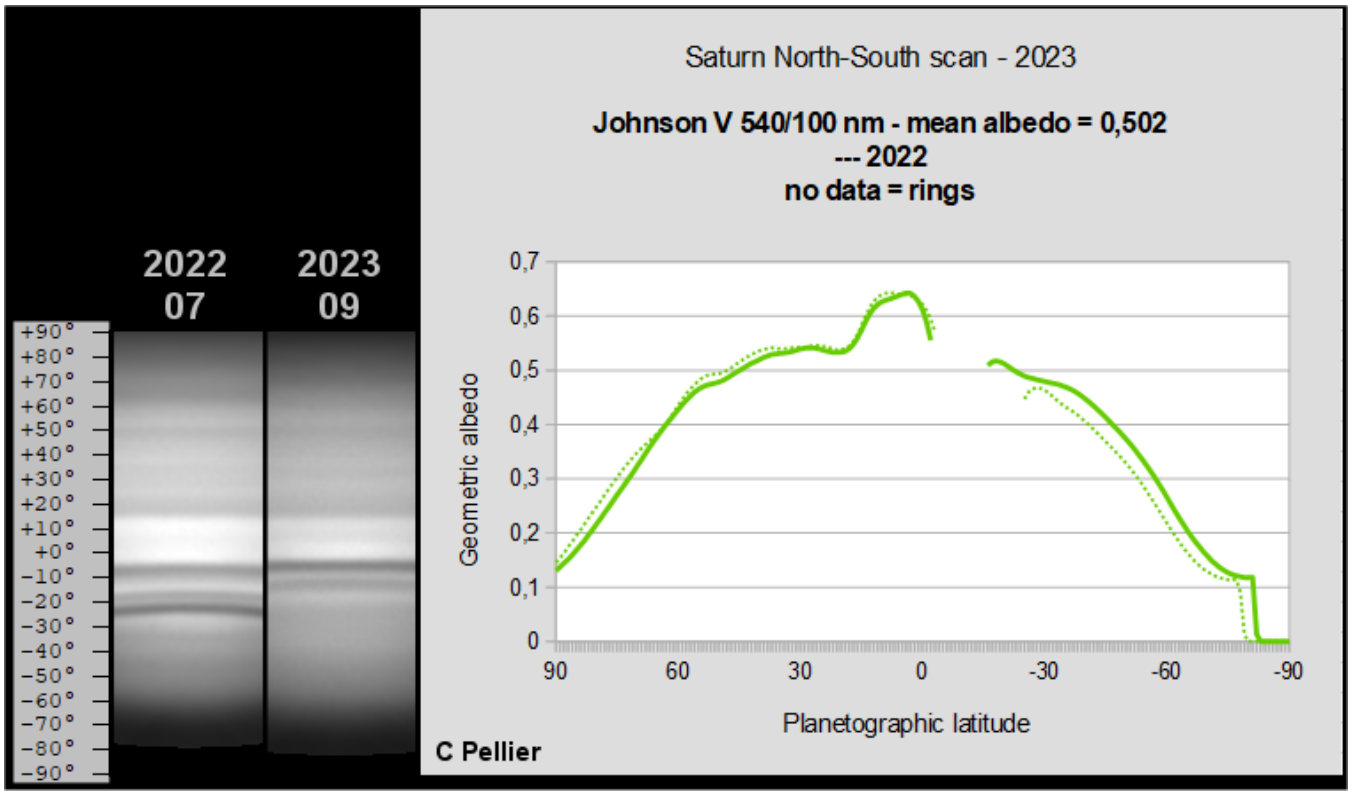

Saturn North-South scan - 2023
BP 425/50 nm mean albedo = 0,301
no data = rings
Geometric albedo
0,4
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
90
60
30
0
-30
-60
-90
Planetographic latitude
C Pellier
+90°
+80°
+70°
+60°
+50°
+40°
+30°
+20°
+10°
+0°
-10°
-20°
-30°
-40°
-50°
-60°
-70°
-80°
-90°


CH4 dimming of the globe ?
Filter is identical for all obs (Chroma CH4)
2022 08
2022 10
2023 08
2023 09
Saturn North-South scan - 2023
CH4 890/20 nm mean albedo = 0,122
--- 2022
No data = rings
Geometric albedo
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
2023 08
2023 09
90
60
30
0
-30
-60
-90
Planetographic latitude
C Pellier
+90°
+80°
+70°
+60°
+50°
+40°
+30°
+20°
+10°
+0°
-10°
-20°
-30°
-40°
-50°
-60°
-70°
-80°
-90°


2022
07
2023
09
+90°
+80°
+70°
+60°
+50°
+40°
+30°
+20°
+10°
+0°
-10°
-20°
-30°
-40°
-50°
-60°
-70°
-80°
-90°
Saturn North-South scan - 2023
Cousins Ic 800/200 nm - mean albedo = 0,48
--- 2022
No data = rings
Geometric albedo
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
90
60
30
0
-30
-60
-90
Planetographic latitude


2022
07
2023
09
+90°
+80°
+70°
+60°
+50°
+40°
+30°
+20°
+10°
+0°
-10°
-20°
-30°
-40°
-50°
-60°
-70°
-80°
-90°
Saturn North-South scan - 2023
Cousins Rc 650/150 nm - mean albedo = 0,59
--- 2022
no data = rings
Geometric albedo
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
90
60
30
0
-30
-60
-90
Planetographic latitude
C Pellier


2022
07
2023
09
+90°
+80°
+70°
+60°
+50°
+40°
+30°
+20°
+10°
+0°
−10°
−20°
−30°
−40°
−50°
−60°
−70°
−80°
−90°
Saturn North-South scan - 2023
Johnson U 370/50 nm mean albedo = 0,203
--- 2022
no data = rings
Geometric albedo
0,3
0,25
0,2
0,15
0,1
0,05
0
90
60
30
0
-30
-60
-90
Planetographic latitude
C Pellier


2022
07
2023
09
+90°
+80°
+70°
+60°
+50°
+40°
+30°
+20°
+10°
+0°
−10°
−20°
−30°
−40°
−50°
−60°
−70°
−80°
−90°
Saturn North-South scan - 2023
Johnson V 540/100 nm - mean albedo = 0,502
--- 2022
no data = rings
Geometric albedo
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
90
60
30
0
-30
-60
-90
Planetographic latitude
C Pellier

May 22, 2024

Indices and More UV Data

Here are more UV data and some indices, where dividing one band with another brings interesting stuff.

1) Since last year I'm using a shorter UV-pass filter than the Chroma Bessel U, the Asahi 340. Used with the T620 AstroQueyras without barlow at an altitude of 3000 meters, the filter successfully detected the increase of albedo of the planet before 350 nm. Actually, on that band, the southern hemisphere around 40°S is brighter than the rings! My photometry of that filter failed (the only one) so I have evaluated the expected value by looking at the Saturn spectrum inside the band pass of the filter. While in the U band the albedo is around 20%, though in the UV340 it raises to 0,22.

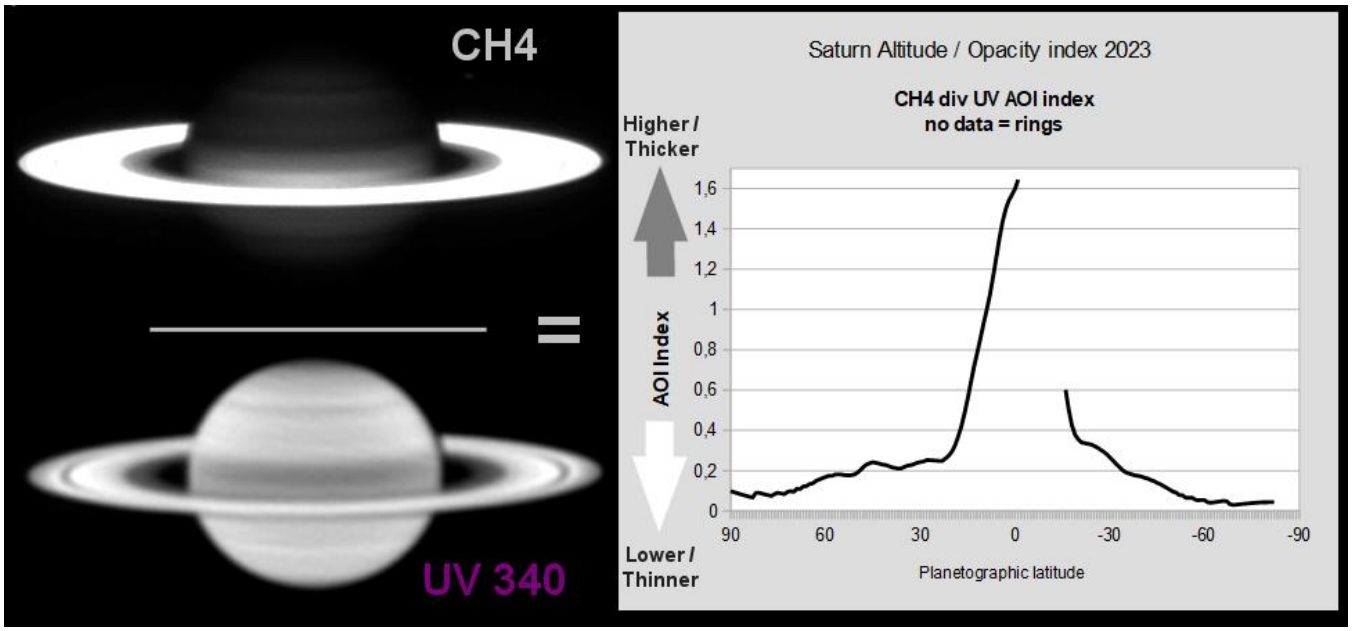
The Chroma U used at the AstroQueyras Observatory looks to produce more contrast between the EZ and the rest of the globe, maybe because at that good site, shorter wavelengths are caught, despite the filter and the camera being exactly the same.

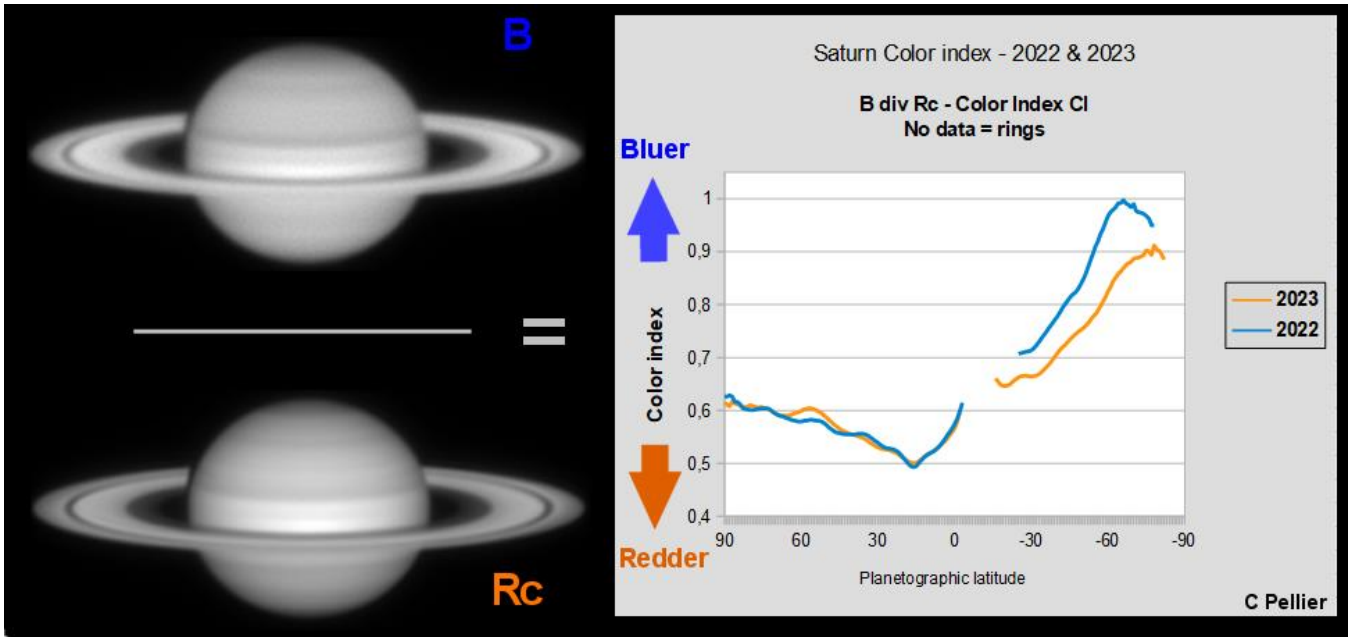
Then, in the scientific literature (Karkoschka, Sanchez-Lavega...) we find 2 indices:

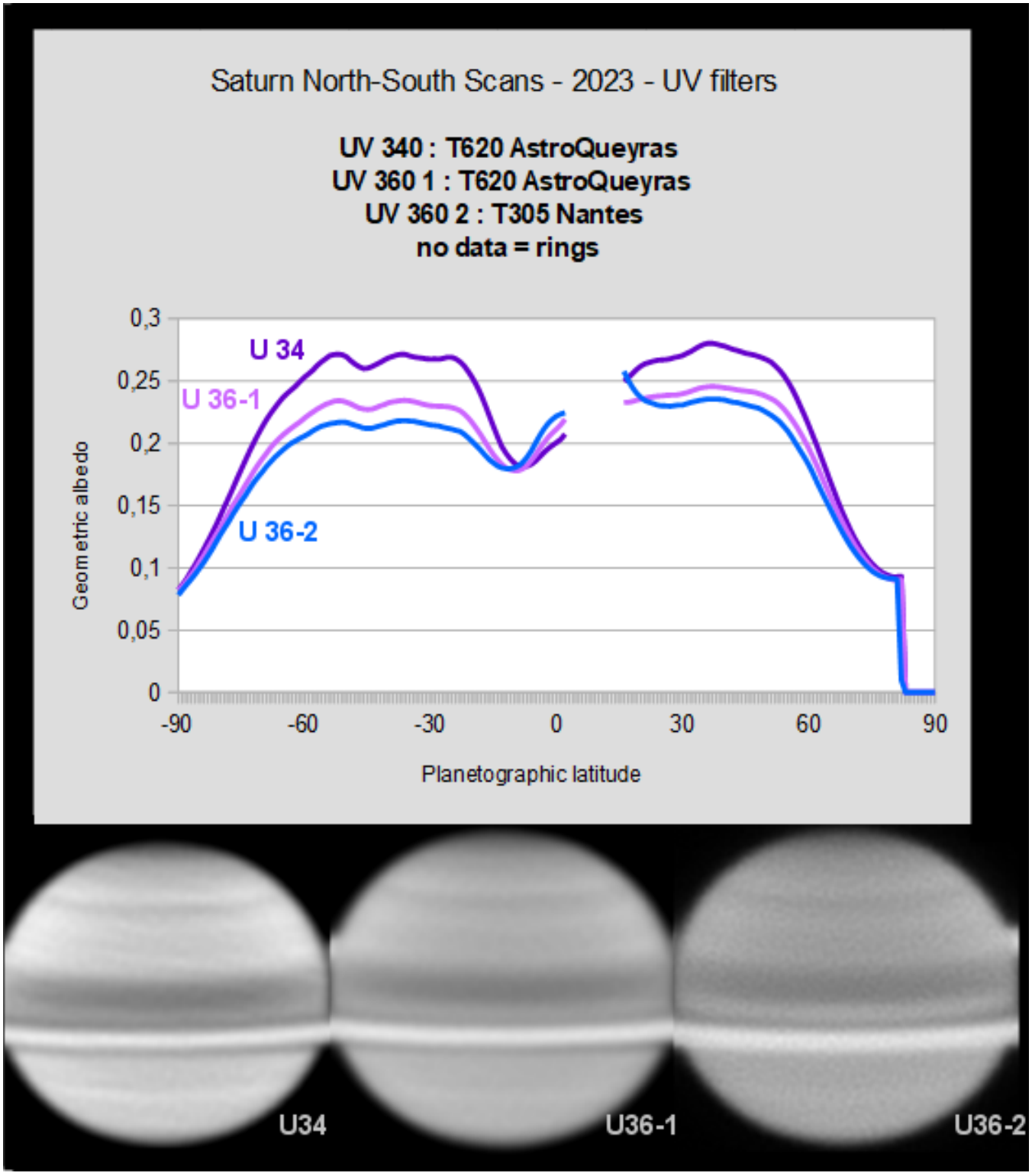
2) Dividing blue by red produces a color index, where we measure how red or how blue are the Saturn latitudes. The index correctly shows that the southern winter hemisphere was noticeably bluer over the past years, and it also correctly shows that it has reddened in 2023 in comparison with 2022 (from blue to green).

(*Let's see how it turns in 2024, the winter hemisphere looks bluer to me than last year so far...*)

3) Dividing CH4 by UV. This should be done with a UVB filter (in the literature we find data from the F275M HST filter), but of course it is impossible from the ground. As opposed to Jupiter, the aspect of Saturn in UVA is much closer to that of UVB, so I tried it anyway. This index measures how high/opaque are the clouds, and it's no surprise that the Equatorial Zone is occupied by noticeably higher and thicker clouds than elsewhere. Again, I don't know if it is acceptable on Saturn to measure this index through UVA ?




B
=
Rc
Saturn Color index - 2022 & 2023
B div Rc - Color Index CI
No data = rings
Bluer
Redder
Color index
1
0,9
0,8
0,7
0,6
0,5
0,4
90
60
30
0
-30
-60
-90
Planetographic latitude
2023
2022
C Pellier


Saturn North-South Scans - 2023 - UV filters
UV 340 : T620 AstroQueyras
UV 360 1 : T620 AstroQueyras
UV 360 2 : T305 Nantes
no data = rings
U 34
U 36-1
U 36-2
Geometric albedo
0,3
0,25
0,2
0,15
0,1
0,05
0
-90
-60
-30
0
30
60
90
Planetographic latitude
U34
U36-1
U36-2