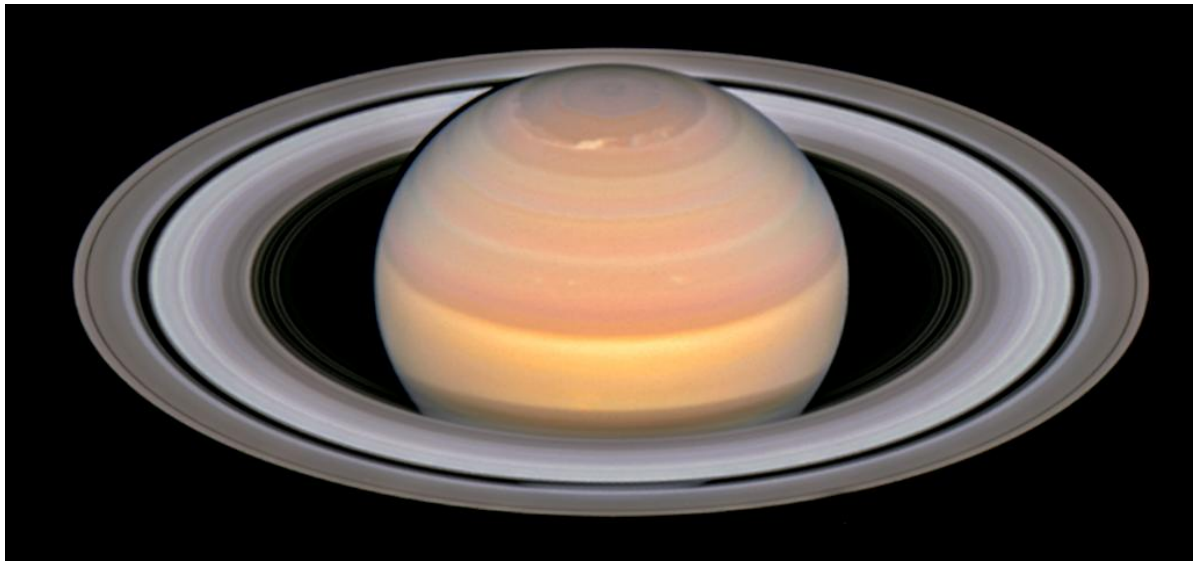
Universidad del País Vasco
Euskal Herriko Unibertsitatea

Grupo de Ciencias Planetarias

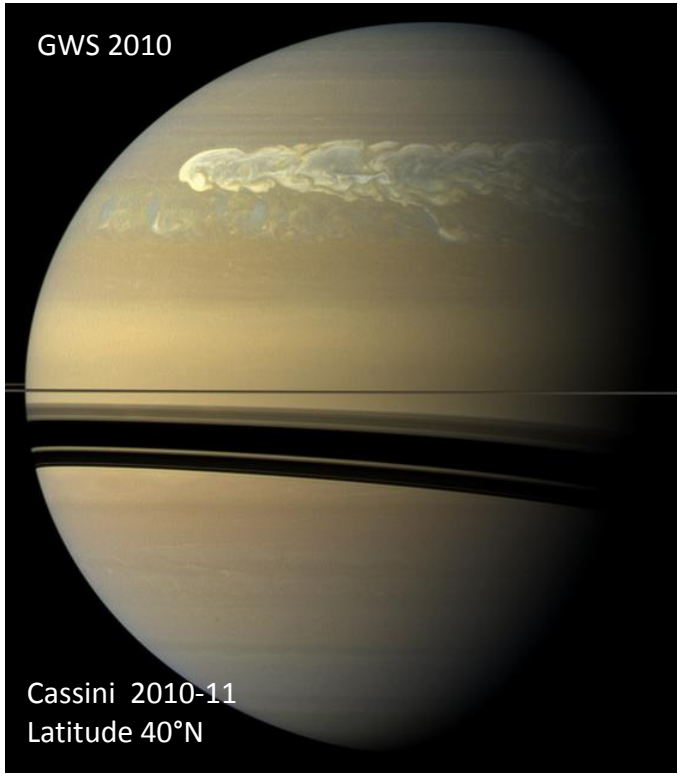
A new polar storm system in Saturn's atmosphere during 2018

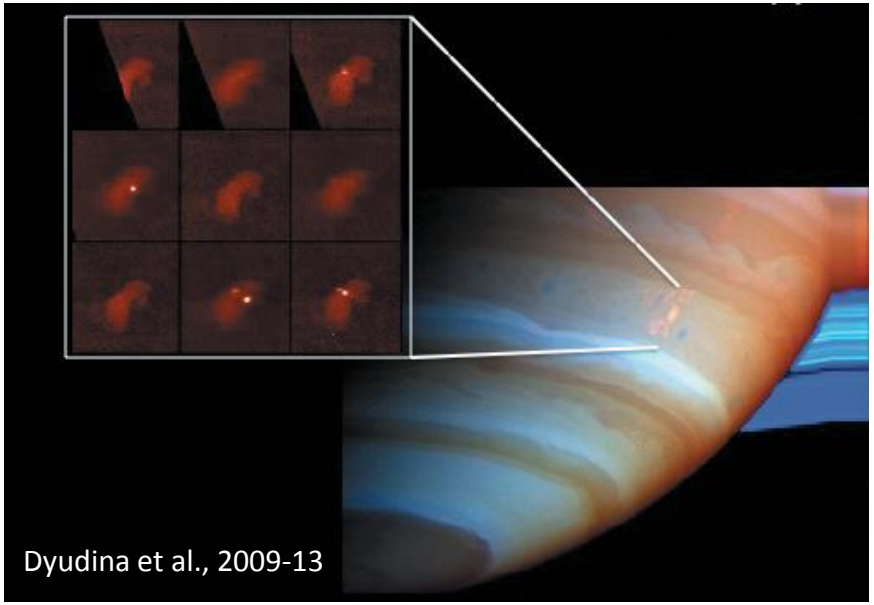


A. Sánchez-Lavega, R. Hueso, J. F. Rojas, T. del Río-Gaztelurrutia, E. García-Melendo, M. Soria Guerrero, J. Legarreta , J. F. Sanz-Requena, S. Pérez-Hoyos, A. A. Simon, M. Wong, J. M. Gómez-Forrellad, M. Delcroix and the PVOL & ALPO Japan Observers Team

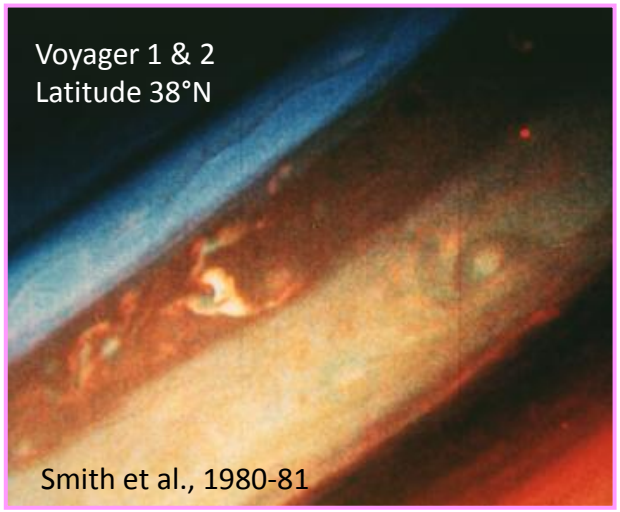
European Planetary Science Congress, Berlin, 18 September 2018

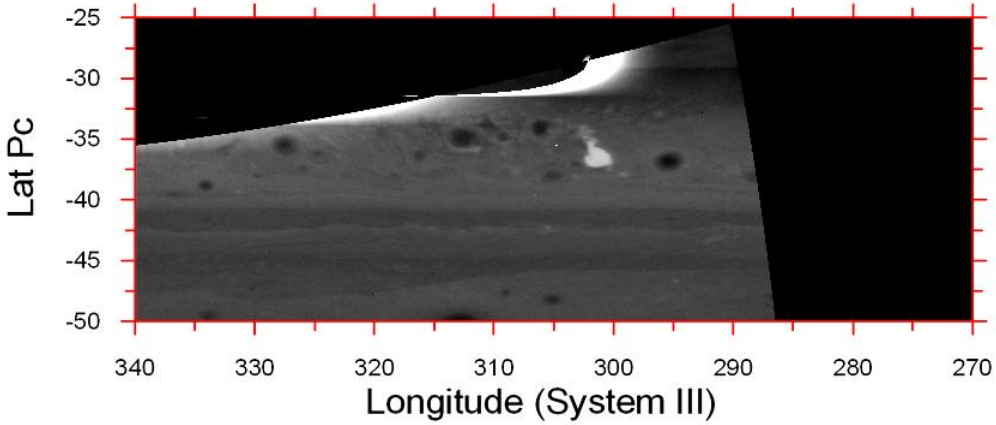
SATURN'S CONVECTIVE STORMS





Bright & irregular cloud systems ~ 2,000km

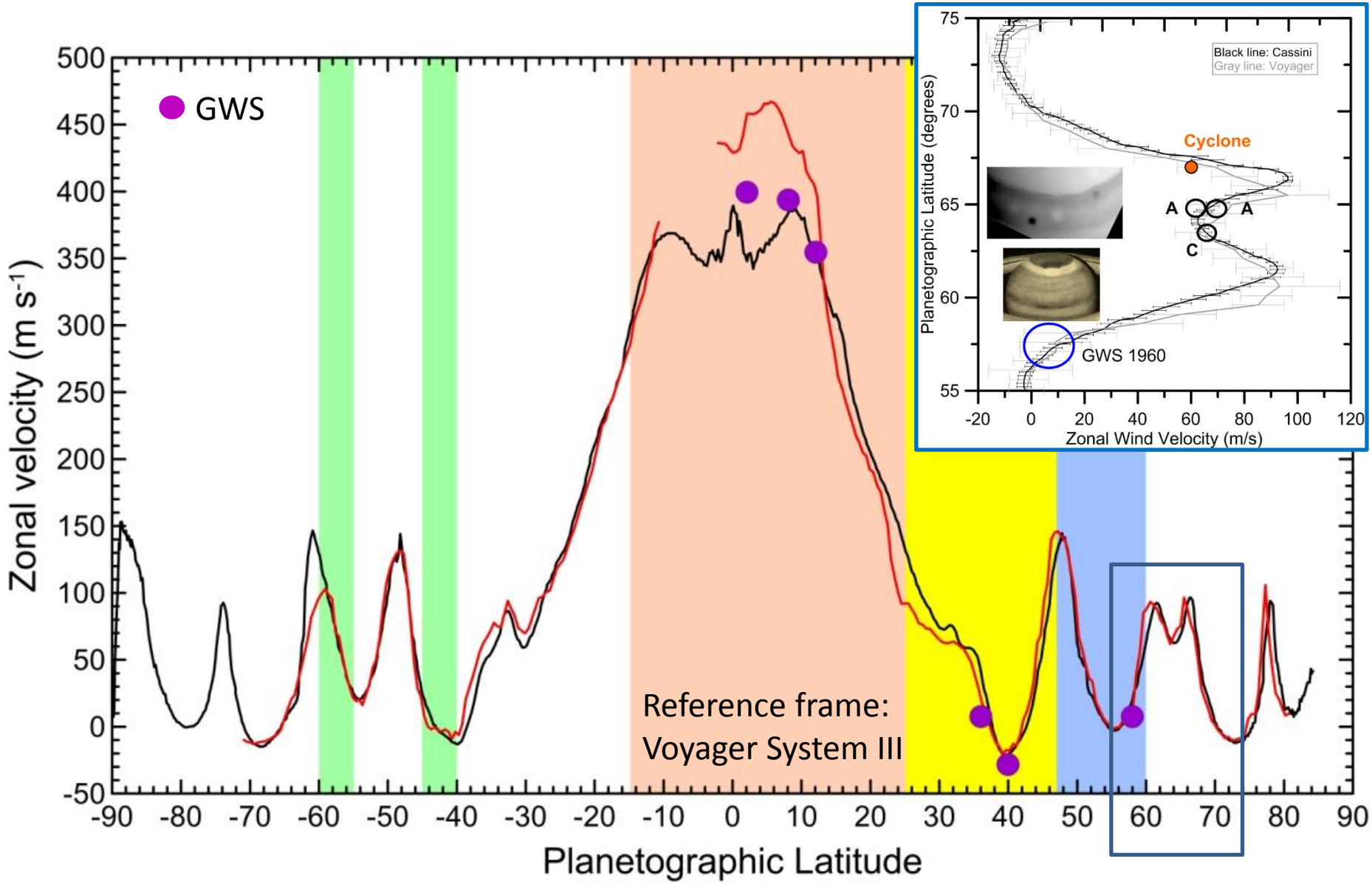




Associated lightening and radio emission (SED)
→ Moist convection (NH_3, H_2O)

Sánchez-Lavega & Battaner, 1987; Hueso & Sánchez-Lavega, 2004

STORMS IN THE WIND PROFILE AT CLOUD LEVEL

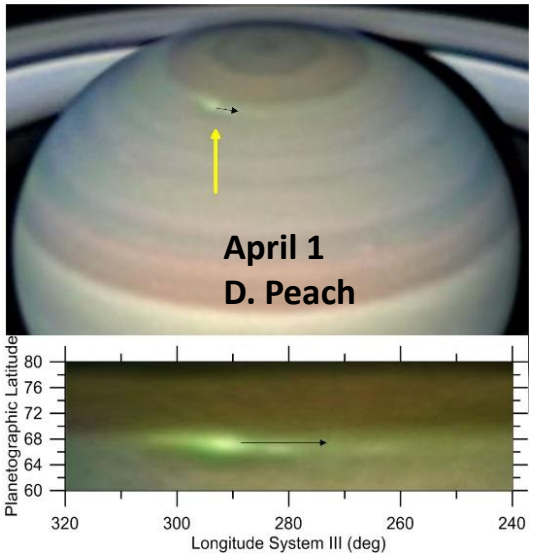


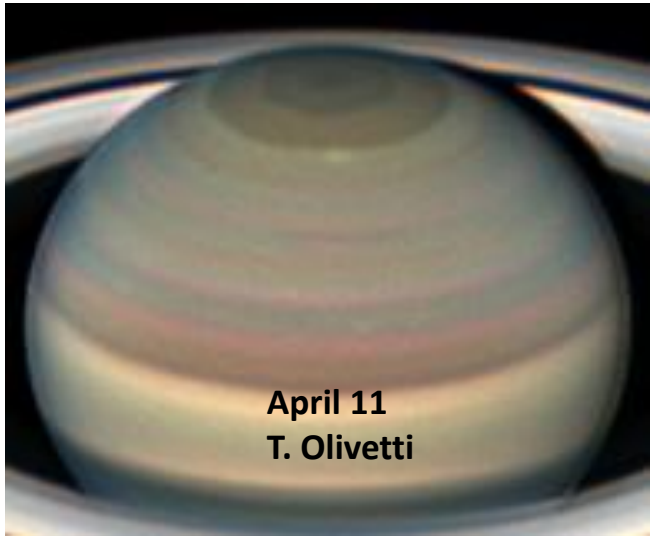
García-Melendo et al., 2011; Sánchez-Lavega et al., Saturn Cassini, CUP, 2018

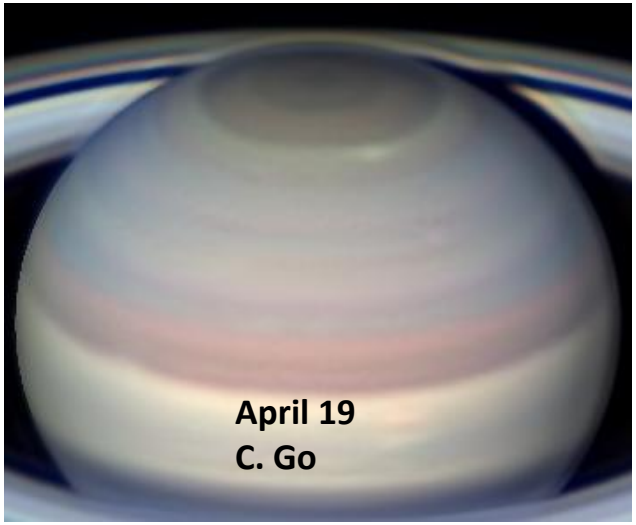
del Rio-Gaztelurrutia et al, 2017

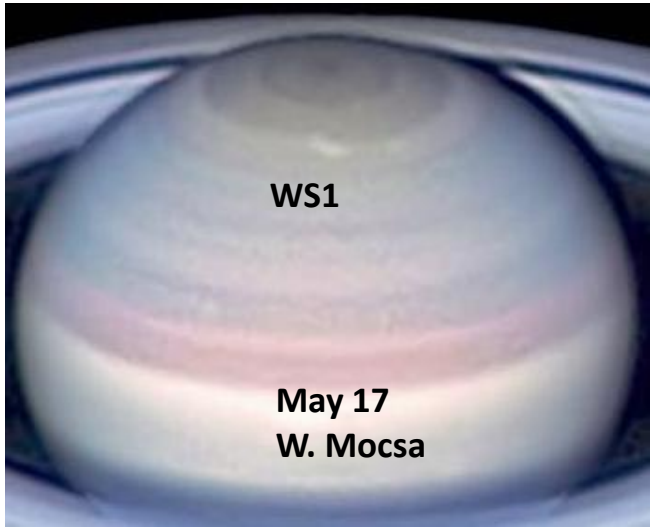
POLAR STORMS IN 2018: THE OBSERVATIONS

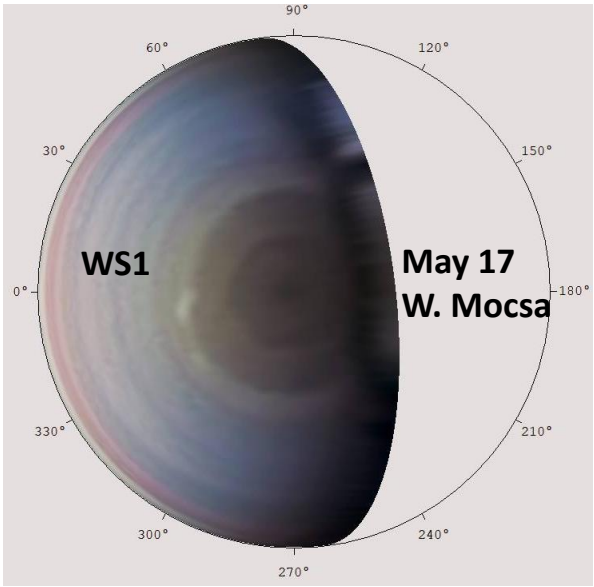
FIRST STORM WS1 – Planetographic latitude 67°N







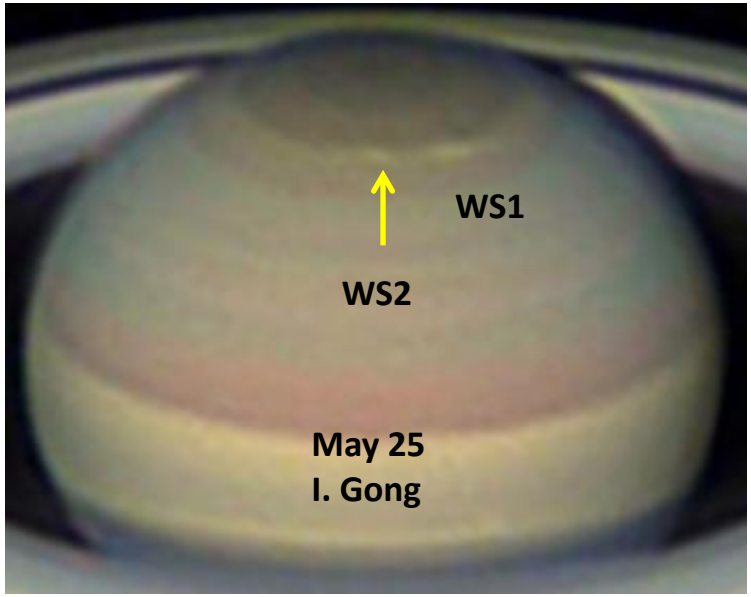


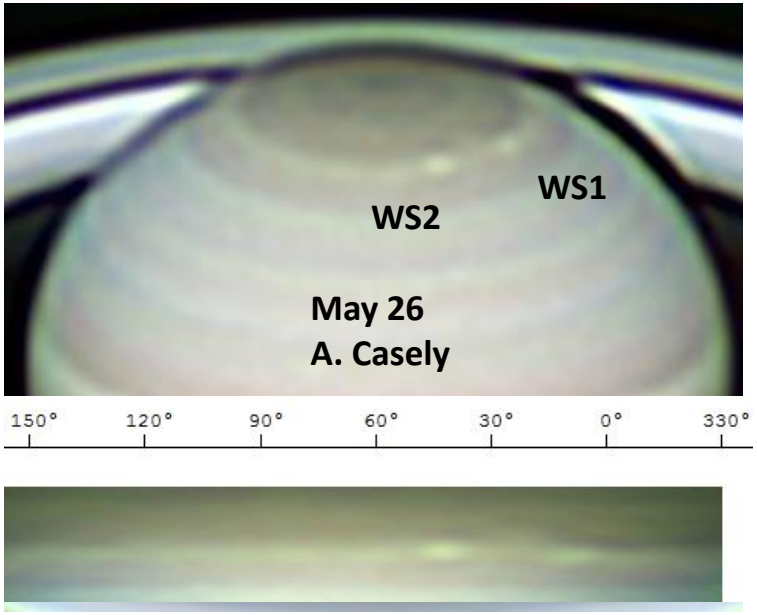


Length = 10° x Width = 4° → 4,400 x 1760 km

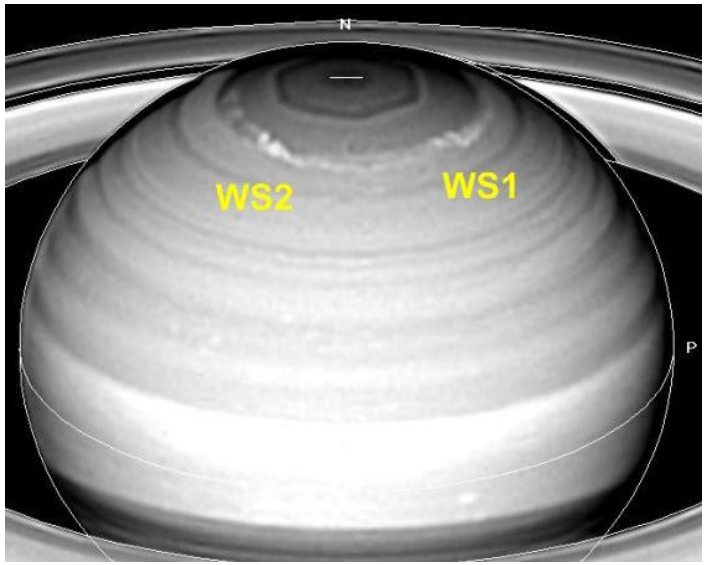
Drift in S-III Longitude = -11.55°/day

SECOND STORM WS2 (25 May, Δ t= 56 days - latitude 69°N)

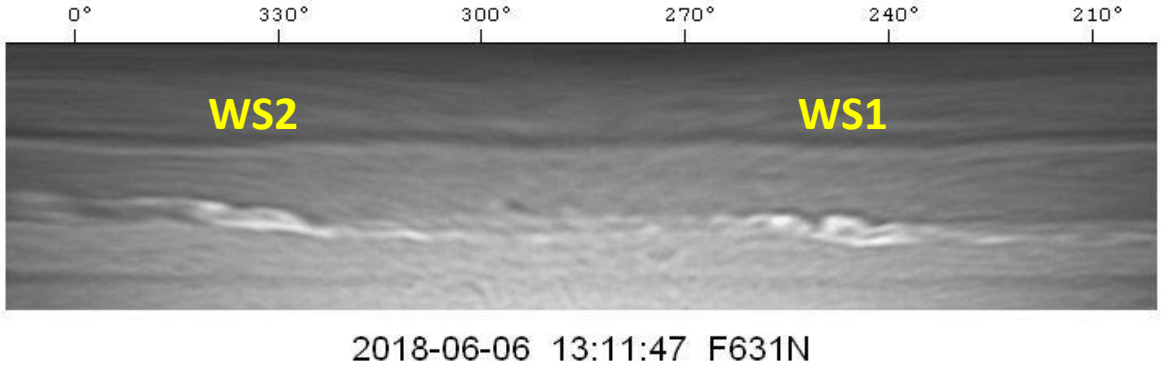




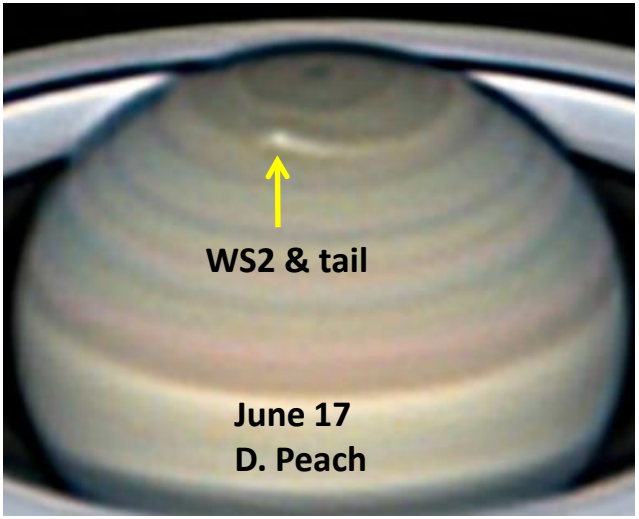
WS2: S-III Longitude drift = -3°/day

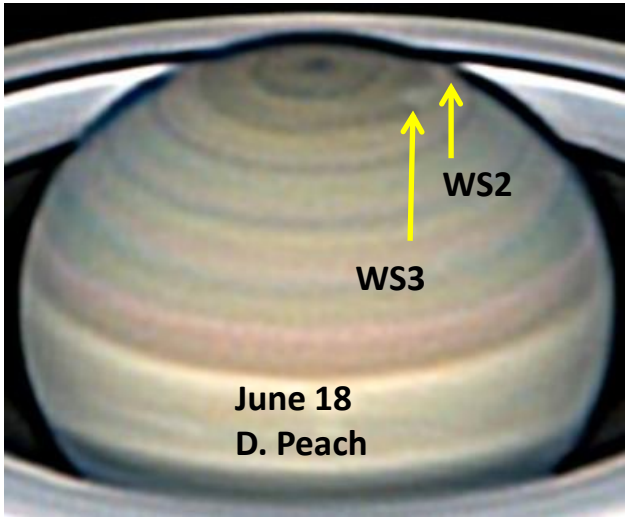


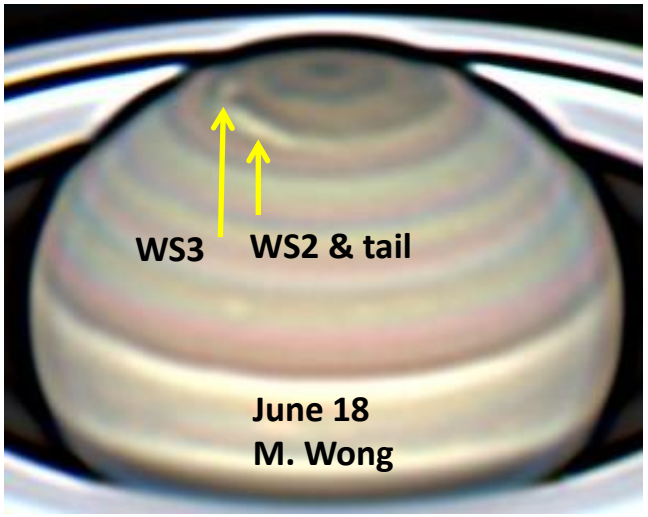
Hubble Space Telescope – WFPC (OPAL): 6-7 JUNE

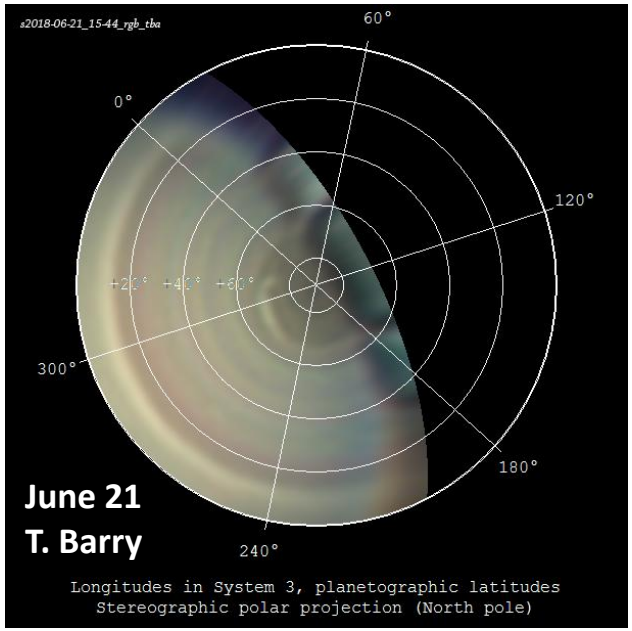


THIRD STORM WS3 (18 June, Δt = 81 days - latitude 72°N)

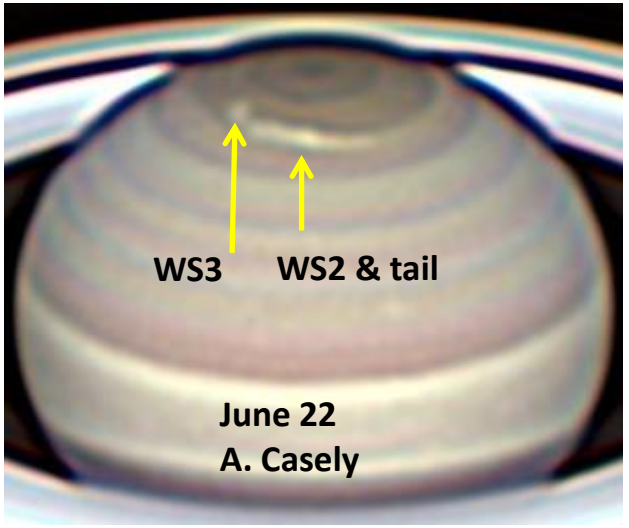


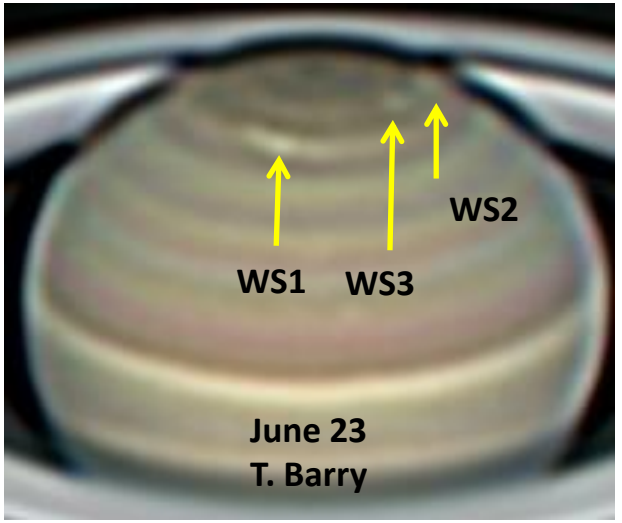




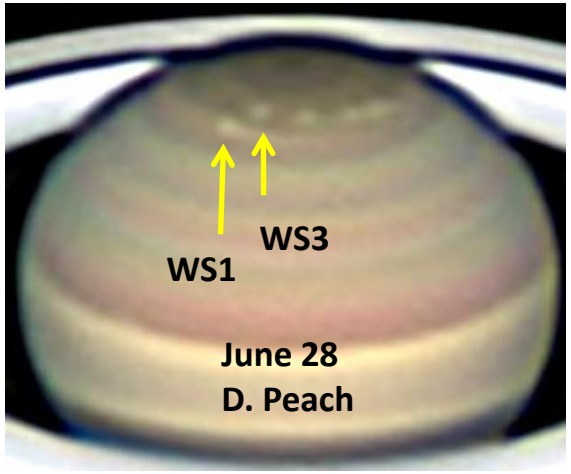


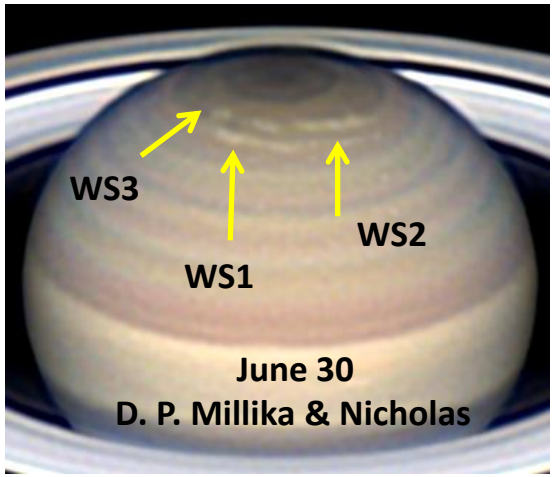
WS3: S-III Longitude drift = +1.28°/day

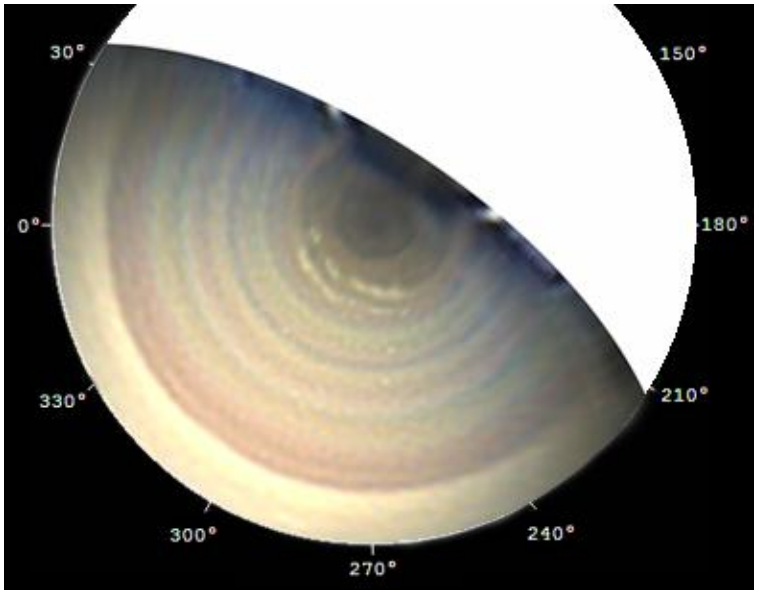




ENCOUNTER 1: WS1-WS3 (29 June, Δ t= 93 days)

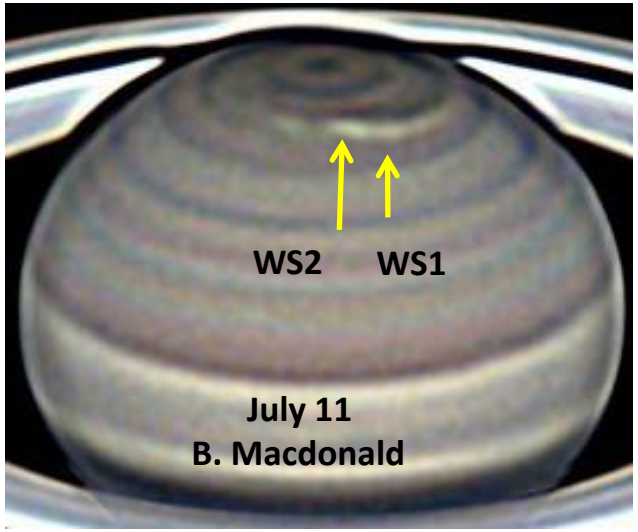


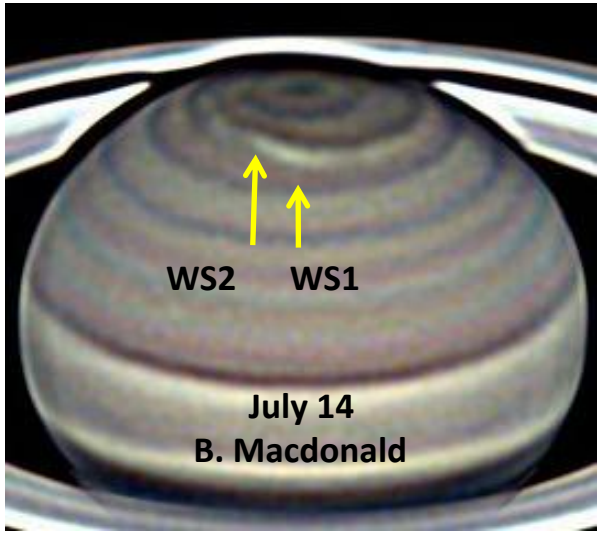


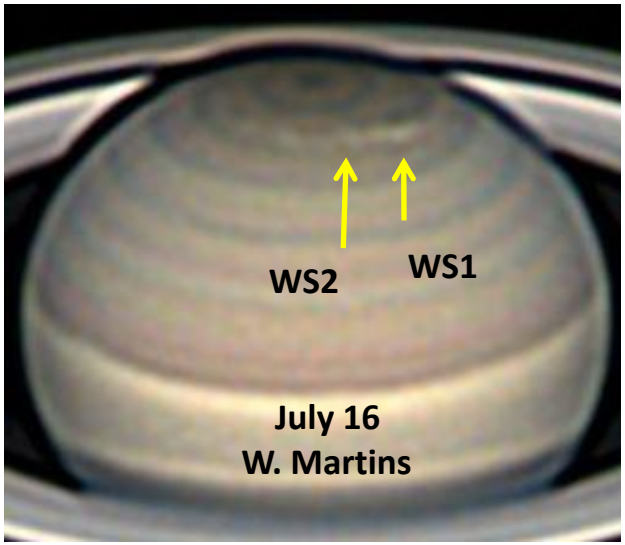


WS1-WS3 interaction→ zonal disturbance ΔL ~ 100°)

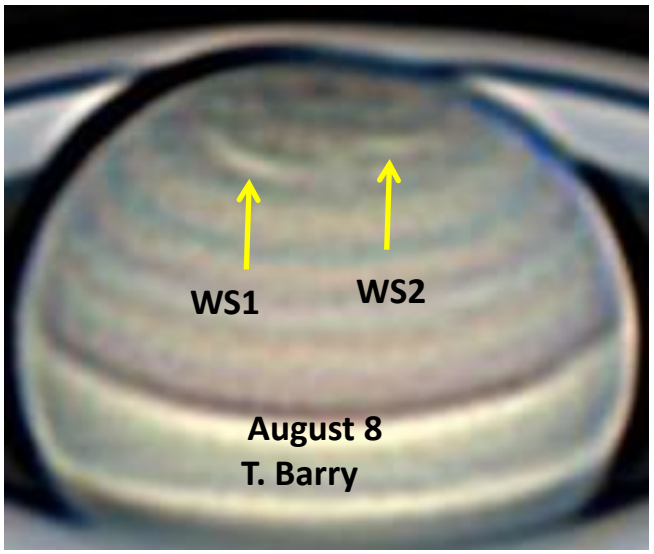
ENCOUNTER 2: WS1-WS2 (8 July, Δ t= 102 days)

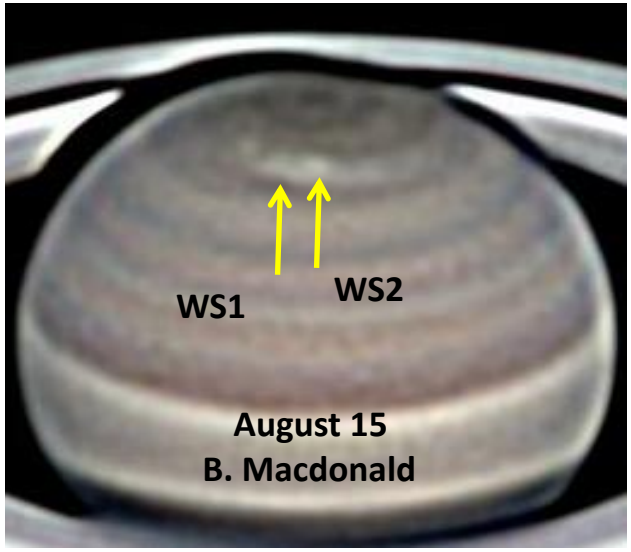


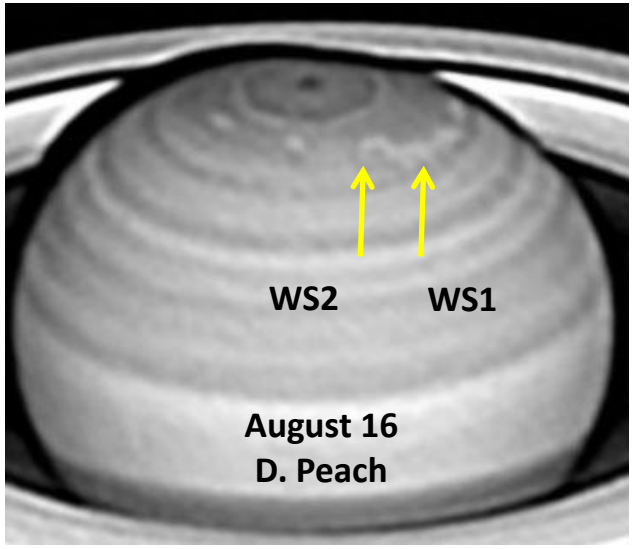


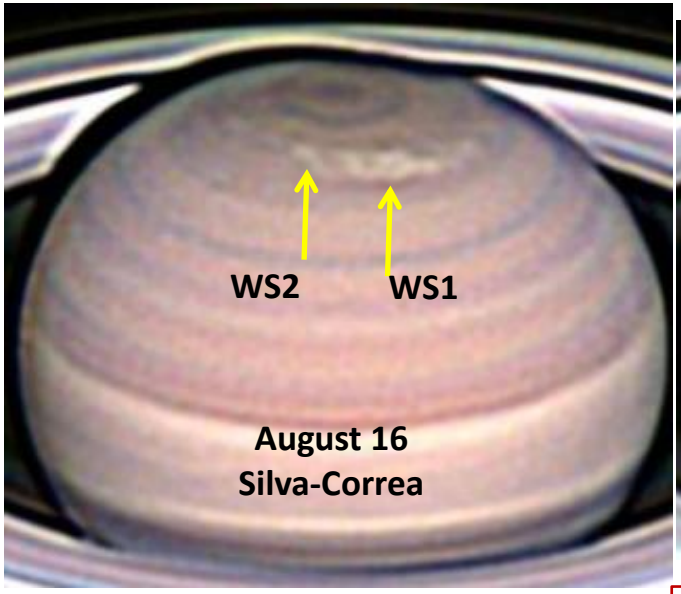


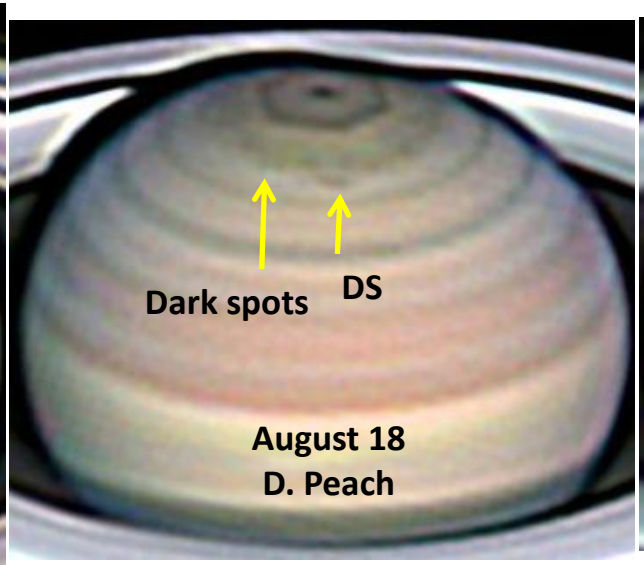
ENCOUNTER 3: WS1-WS2 (15 August, Δt = 140 days)





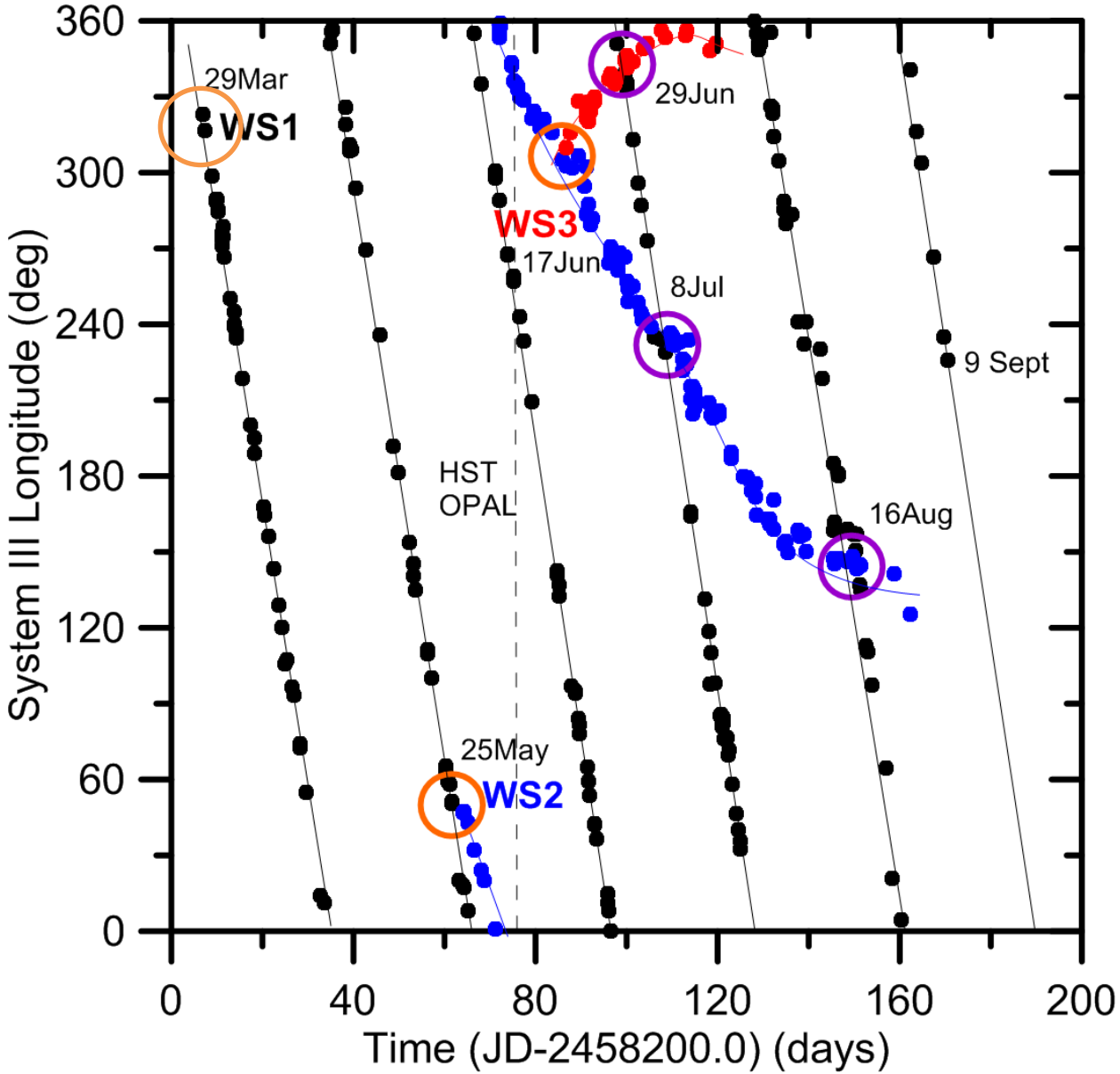






Zonal disturbance: Latitude = 67°, ΔL = 100°, λ = 7,500 km

S-III LONGITUDE DRIFT OF STORMS WS1 – WS2 – WS3

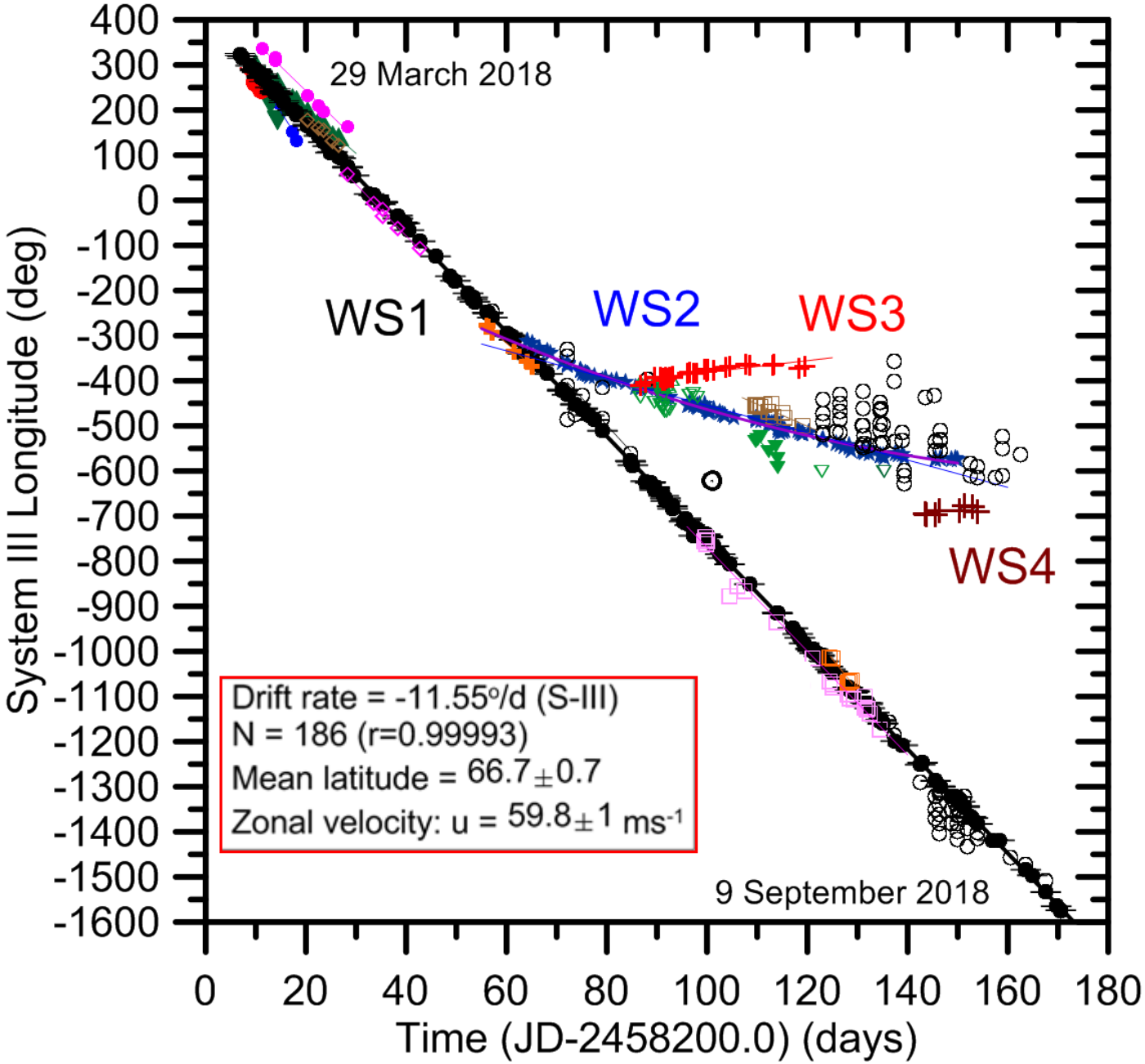


Data from:
ALPO Japan (repository)
PVOL 2 (repository)
HST-OPAL Program
Planetcam @ 2.2 m

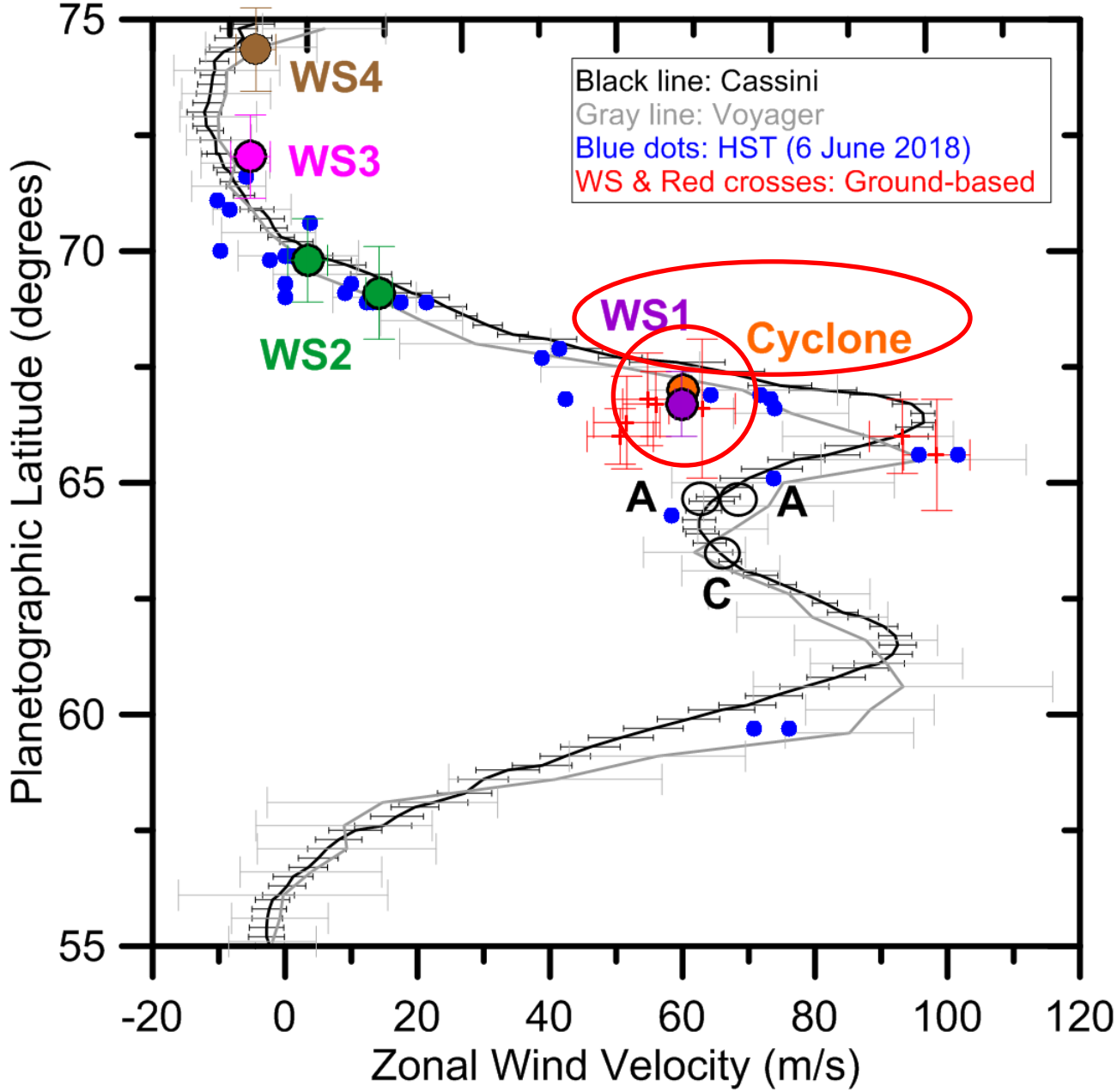
N. images analyzed: 320 (reprocessed)

Cloud tracking:
N. measurements ~ 1,500

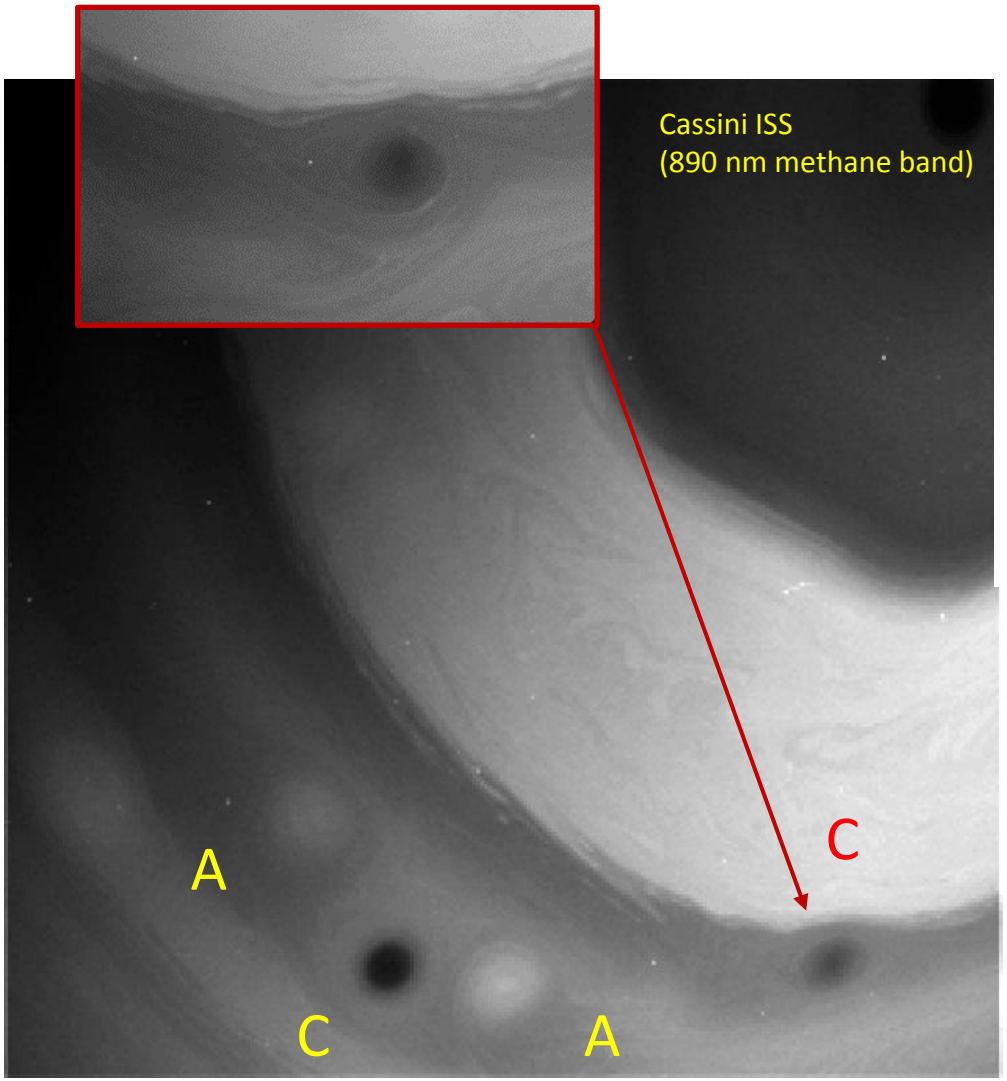
LONGITUDE DRIFT OF MAIN FEATURES

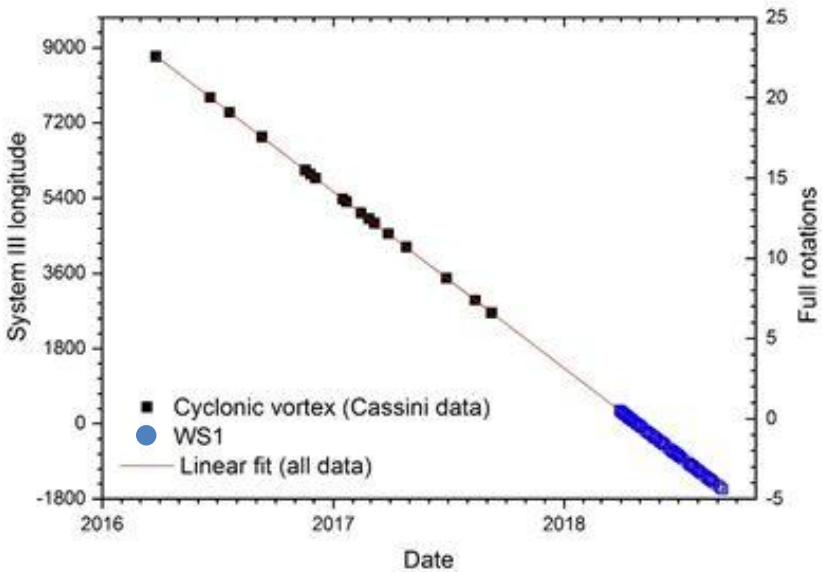


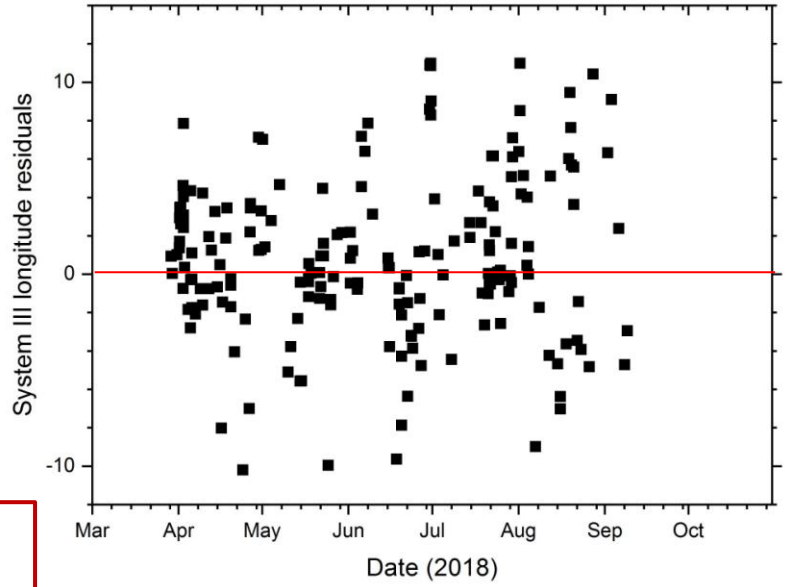
STORM MOTIONS & WIND PROFILE



WS1 FORMED INSIDE A CYCLONE



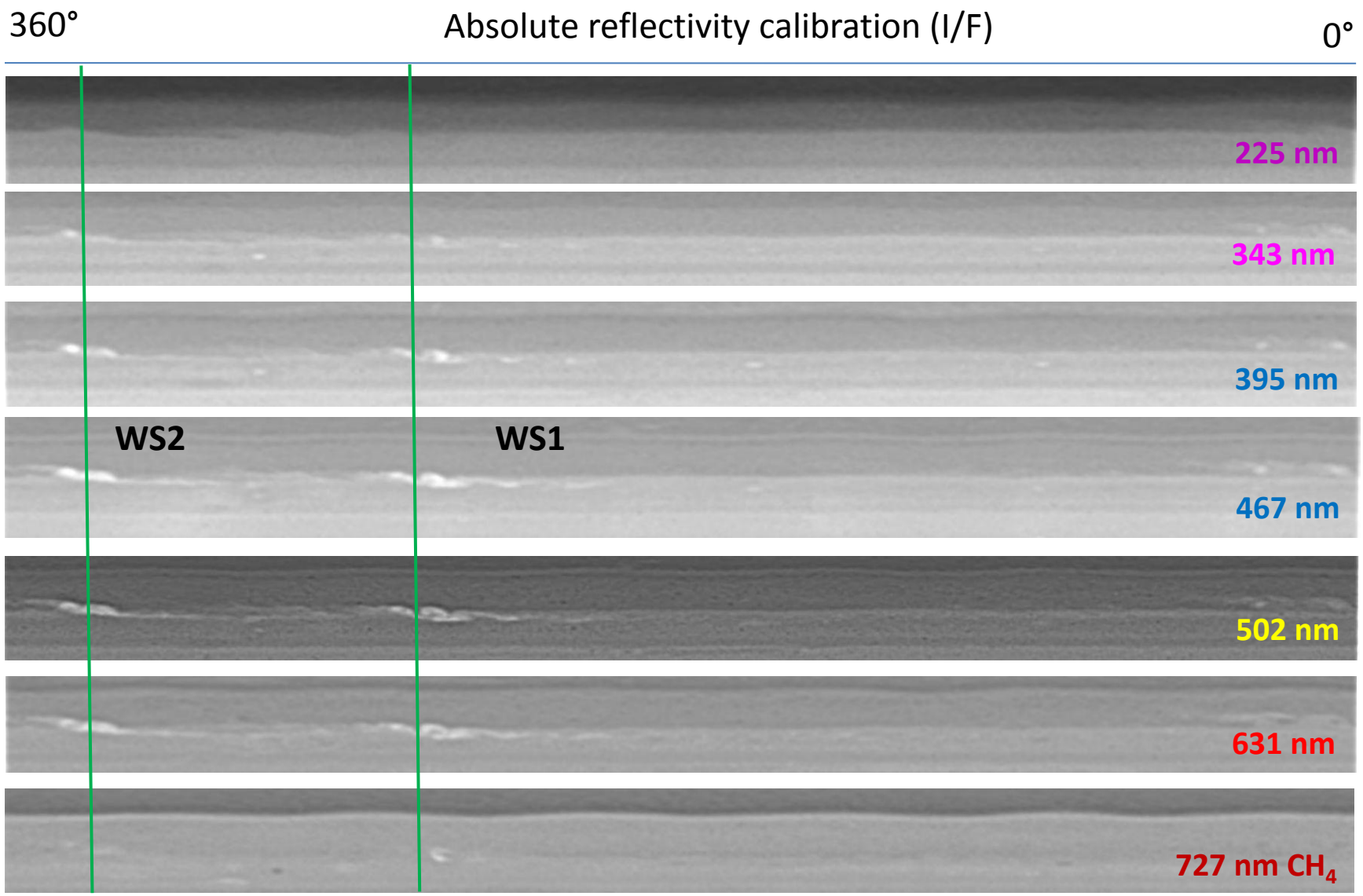




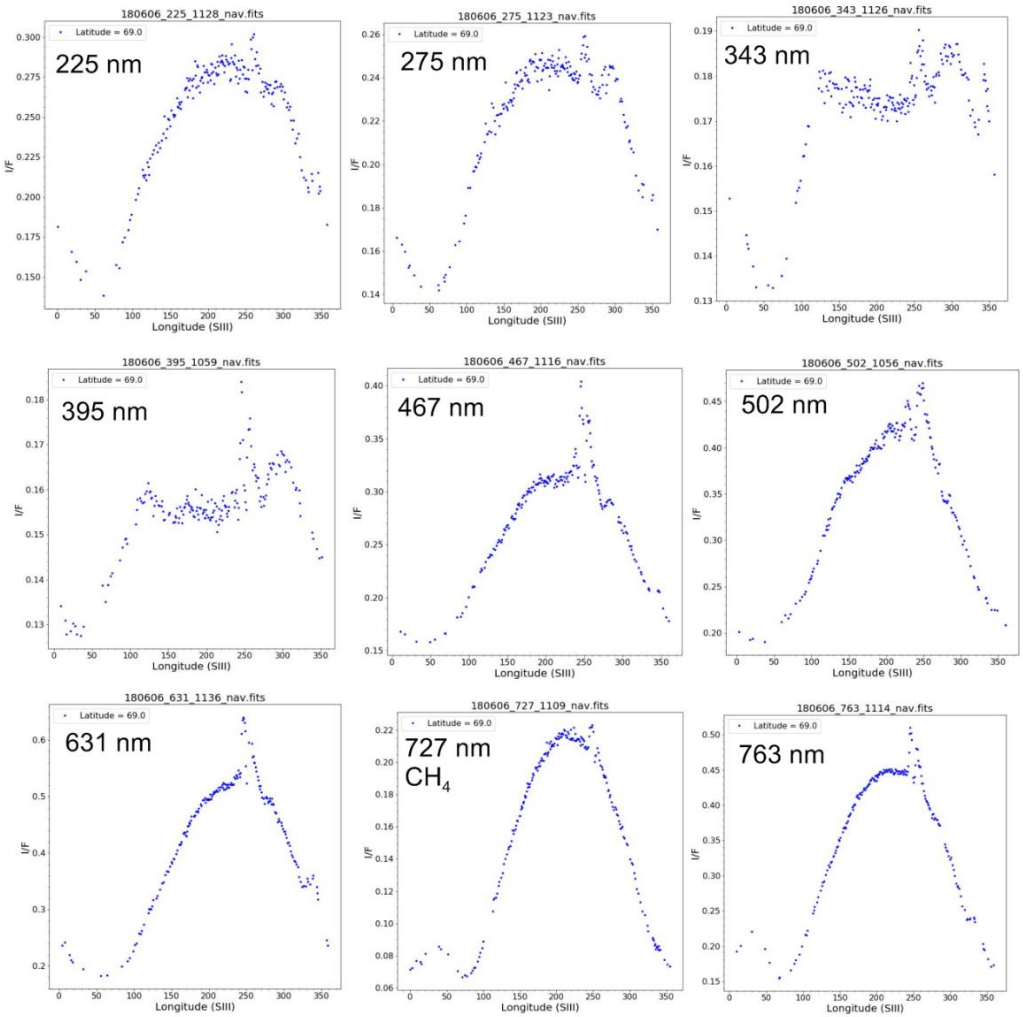
Observed in Jupiter cyclones:
South Equatorial Belt Disturbance 2010-11 (Fletcher et al., 2017)
South Temperate Belt (Iñurrigarro et al., Poster 13 –OPS4)

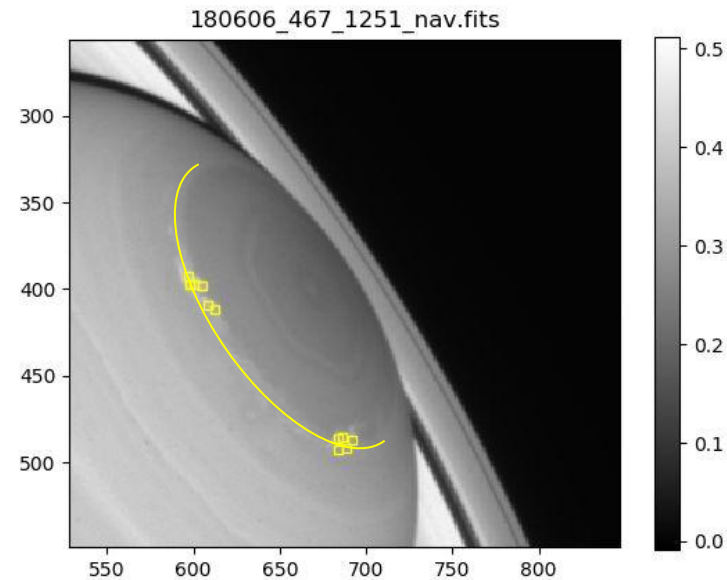
MODELS

STORMS AT WAVELENGTHS 225 nm – 727 nm (HST-WFPC)

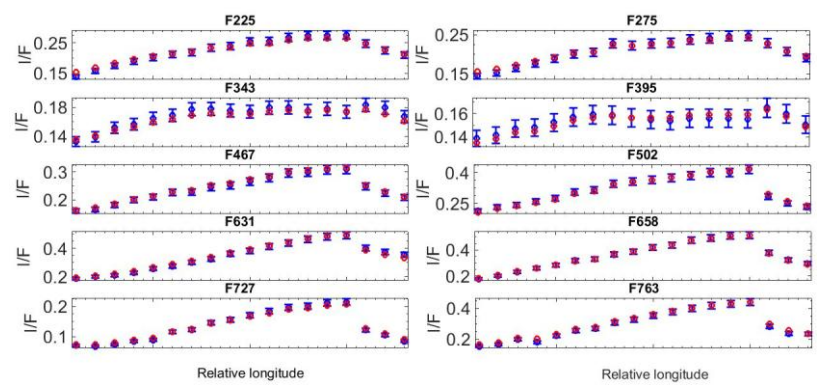


HST-WFPC 6-7 JUNE – RADIATIVE TRANSFER

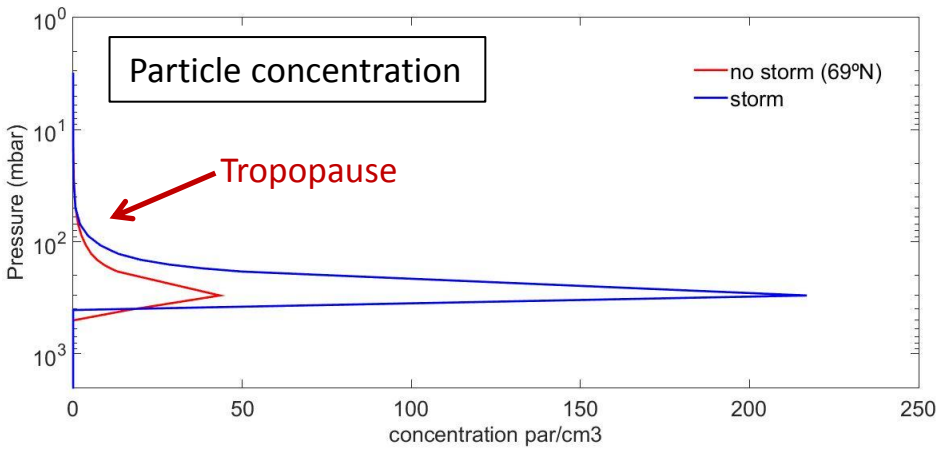


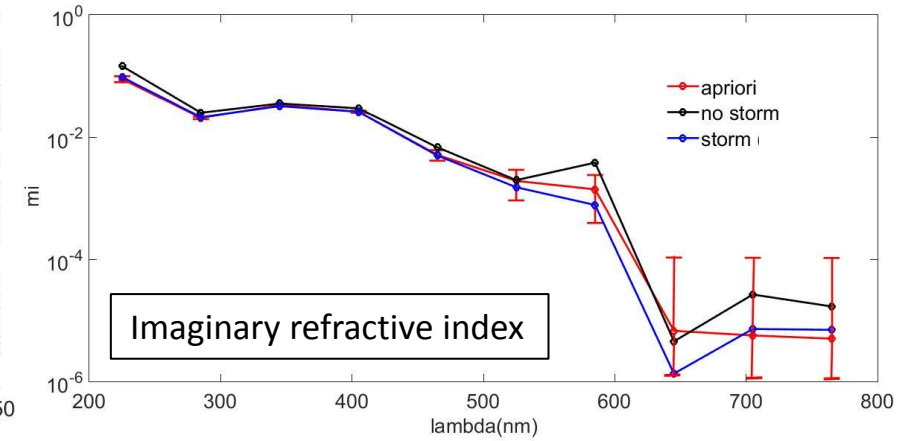


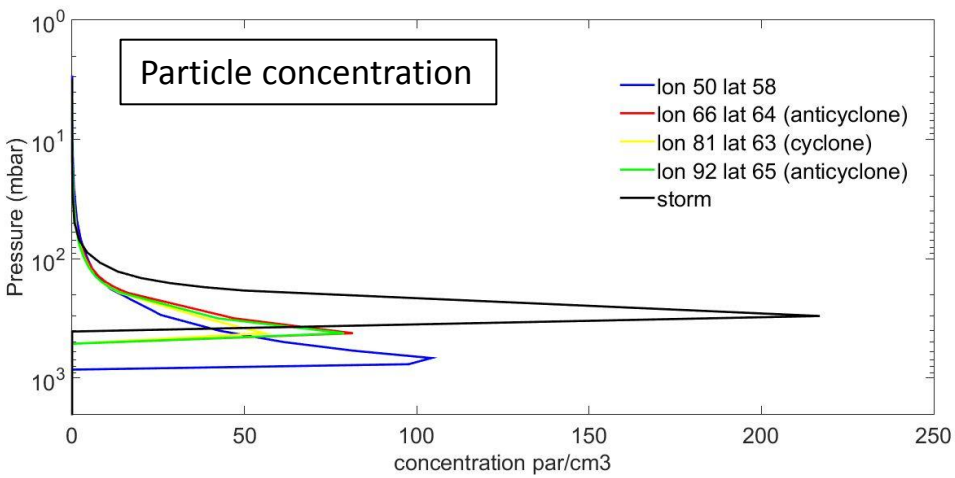
NEMESIS Radiative Transfer code
P. Irwin (U. Oxford)



HST-WFPC: 6-7 JUNE – RADIATIVE TRANSFER







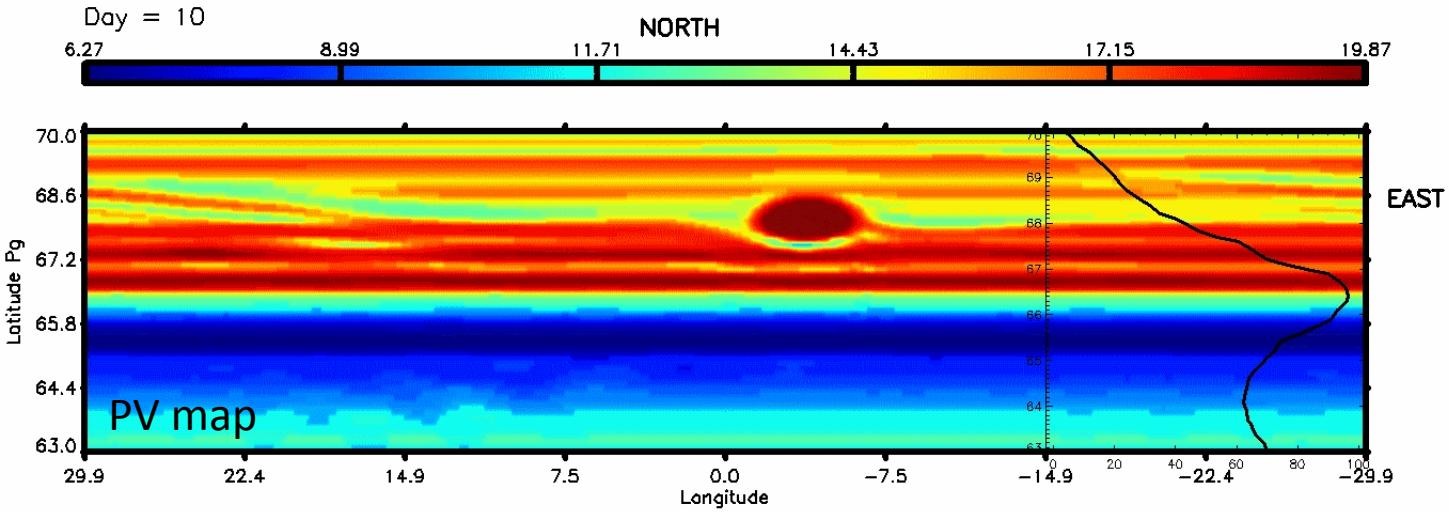
Parameter	Latitude 69°N (2018)	Storm WS1
τ (stratosphere)	0.02±0.01	0.04±0.01
τ (troposphere)	10.1±2	32.9±2
τ (cloud)	7.2±2	7.8±2
$P_{Haze\ (base)}$	320±50mbar	270±50 mbar
Haze thickness	33.3±2 km	30.2 ±2km
N_{max}	49±10 cm^{-3}	216±10 cm^{-3}
$H/H_{aerosol}$	0.47±0.1	0.34±0.1
Particle size (a)	0.10±0.1 µm	0.18±0.1 µm

Storm: brighter particles than surroundings in UV-red

DYNAMICS: NUMERICAL SIMULATIONS

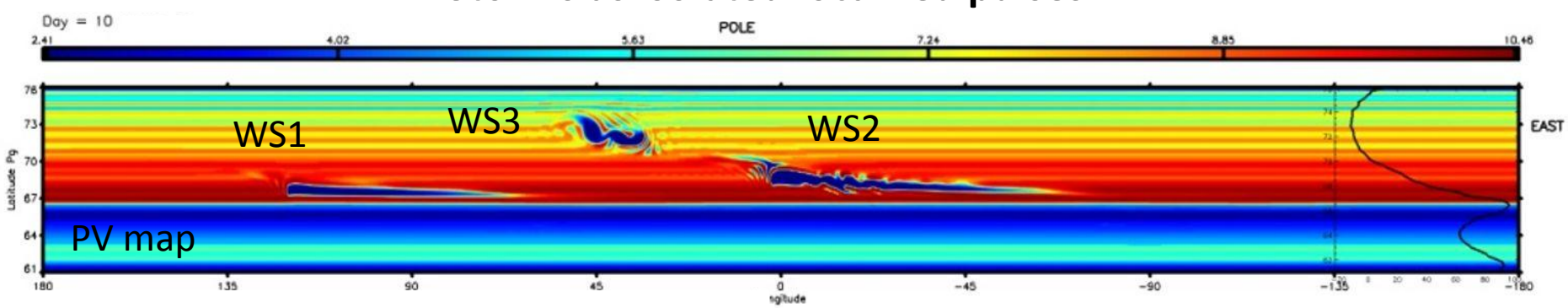
EPIC code (T. Dowling, U. Louisville): U(z), T(z), N(z), domain size, spatial resolution

Outburst inside a cyclone

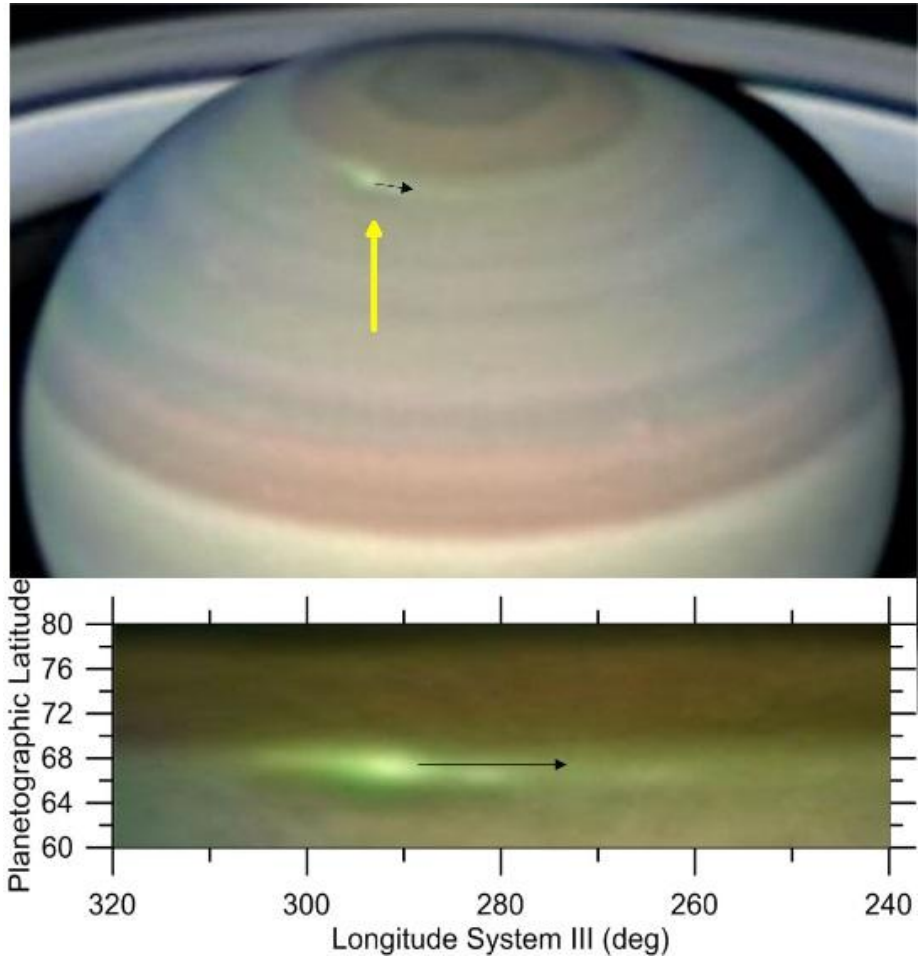


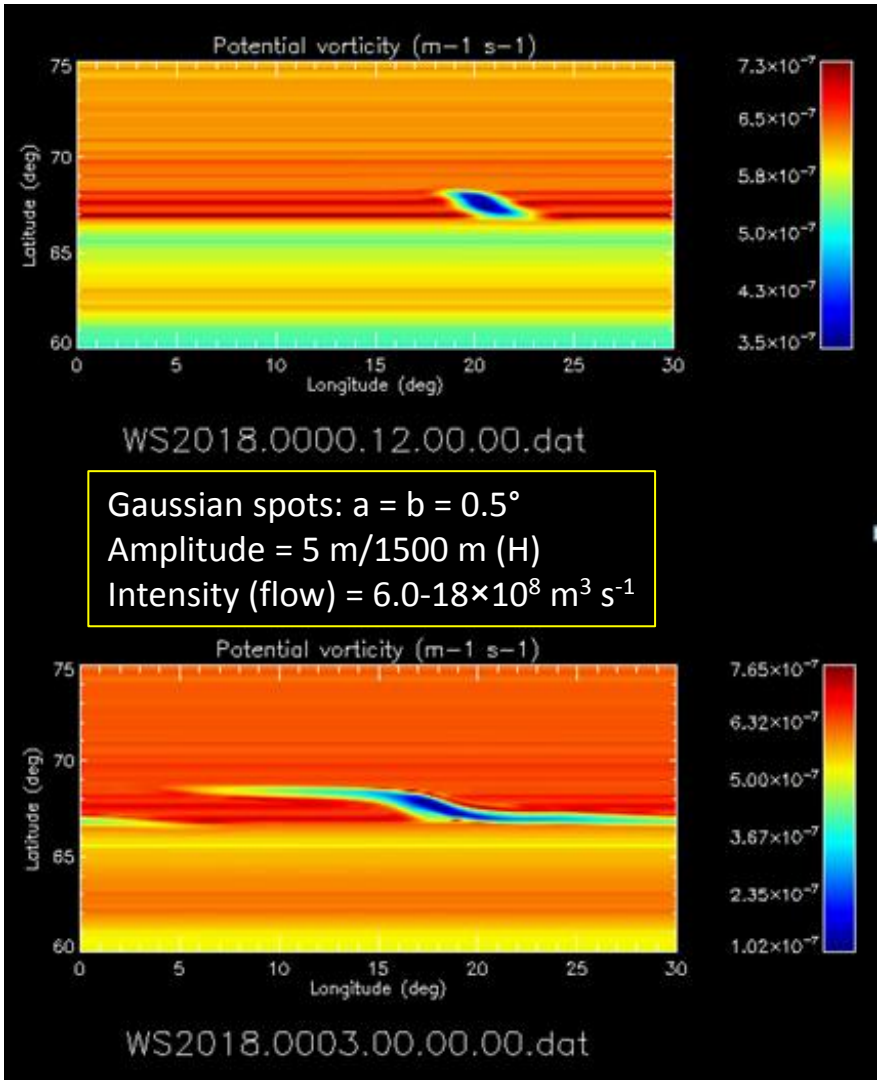
Pulse as a Gaussian spot (size = 0.35°) & Intensity = 1 - 20 W/ m^2

Storms as isolated localized pulses



DYNAMICS: NUMERICAL SIMULATIONS (SW)





Gaussian spots: a = b = 0.5°
Amplitude = 5 m/1500 m (H)
Intensity (flow) = 6.0-18×10^8 m^3 s^{-1}

COMPARISON TO GWS

Flow : 10^{10} - 10^{11} m^3 s^{-1} (GWS2010) - 10^{12} m^3 s^{-1} (GWS1990)
Amplitude: 200m/1500m - Gaussian size: 3.5°
→ Intensity: GWS = 100 x WS

Shallow Water - 1 layer model
García-Melendo & Sánchez-Lavega (2017)

DISCUSSION & CONCLUSION

- The bright spots can be explained if their cloud tops are at the tropopause (~ 100 mbar) with no overshooting, brighter and larger particles, and number density x 4 surrounding clouds.

- Dynamical models suggests they could be formed by moderate convective activity implying energies ~ 0.1- 0.01 those required to form a GWS.

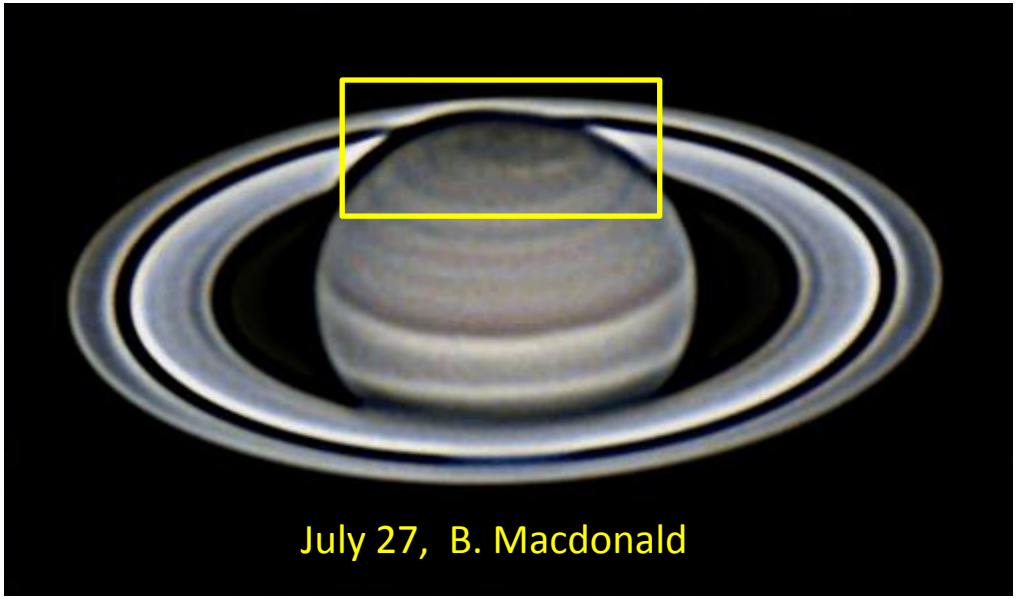
- The first storm emerged in a compact coherent cyclone representing another example of such phenomena as observed in Jupiter.

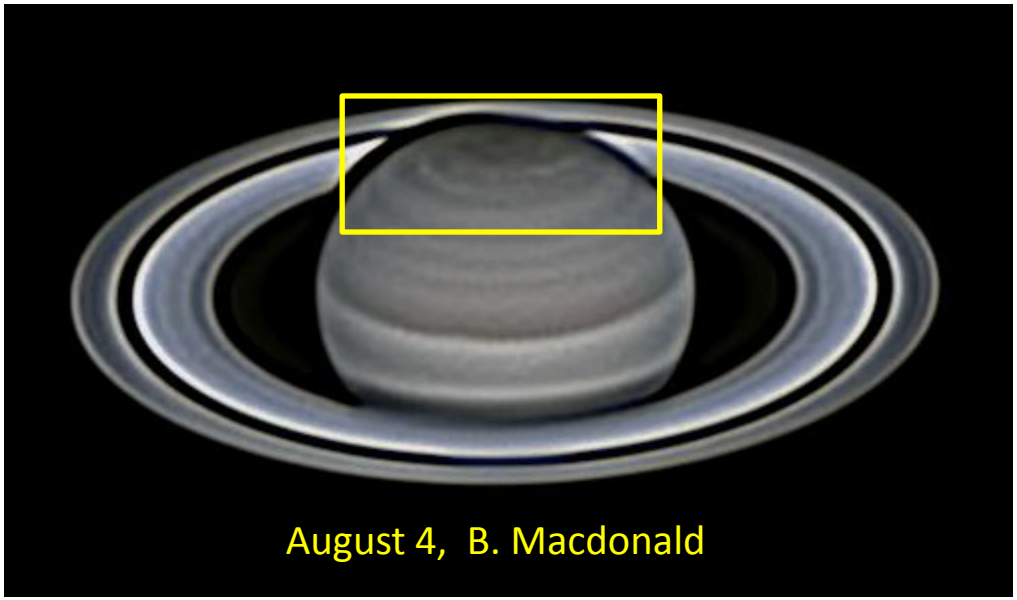
- This system of three interacting storms can be considered dynamically as an intermediate case of disturbance between a GWS planetary-scale phenomenon and the small-scale convective activity observed by Voyager 1 &2 and Cassini at northern and southern mid-latitudes, respectively.

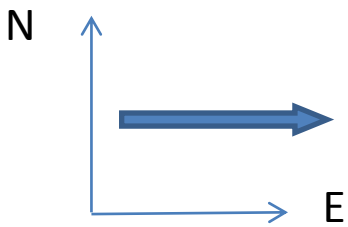
- This phenomenon looks like the one that occurred in 1994 at latitude 56°S (Sánchez-Lavega et al., Science, 271, 631. 1996).

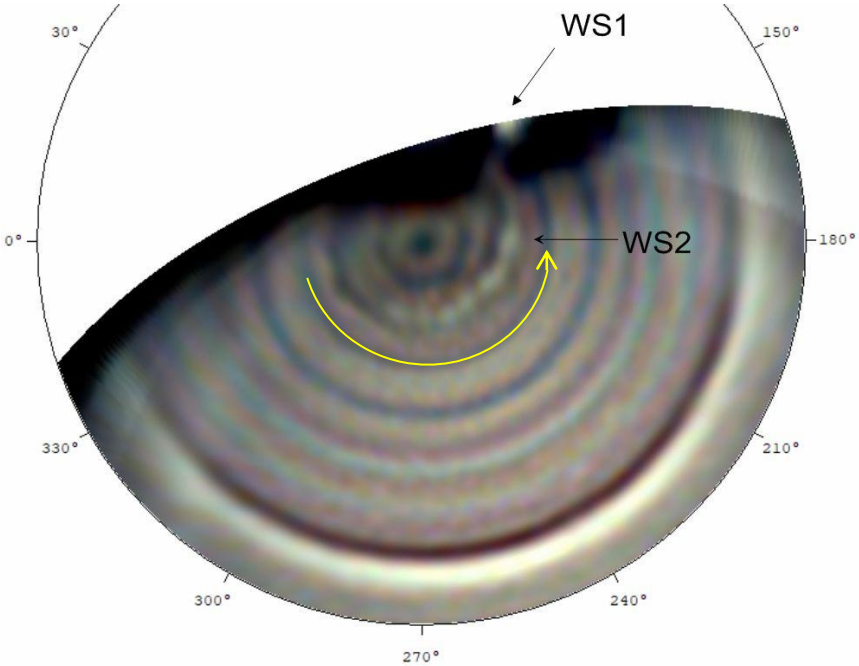
THANK YOU VERY MUCH
FOR YOUR ATTENTION

SATURN & STORMS IN ROTATION (2-3 hrs)









July 28, B. Macdonald

LONGITUDE & LATITUDE OF WS1