Seasonal variation of neutral gases in Titan's ionosphere

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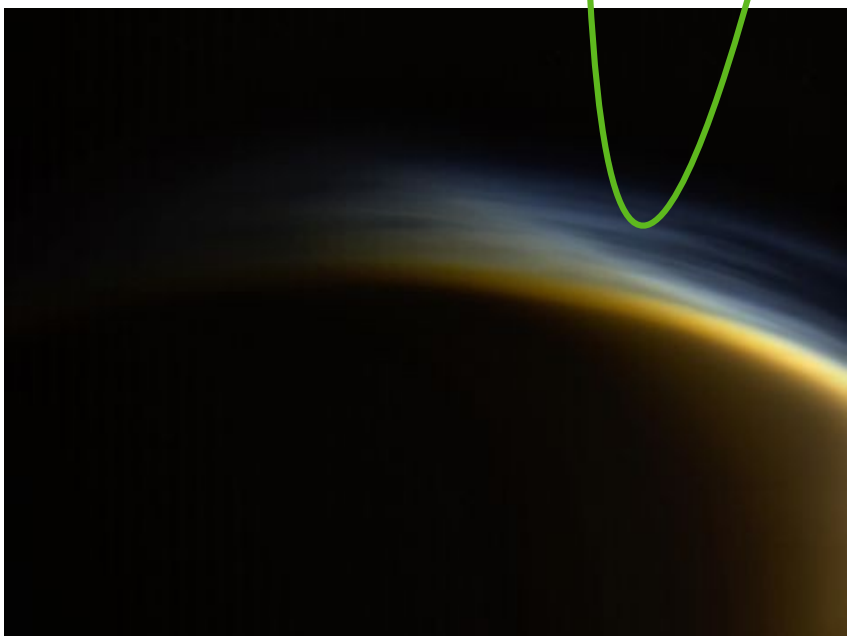
Titan's ionosphere

Ionosphere = ionized part of the upper atmosphere

Space environment

Way up high...

A typical Titan flyby



1500 km

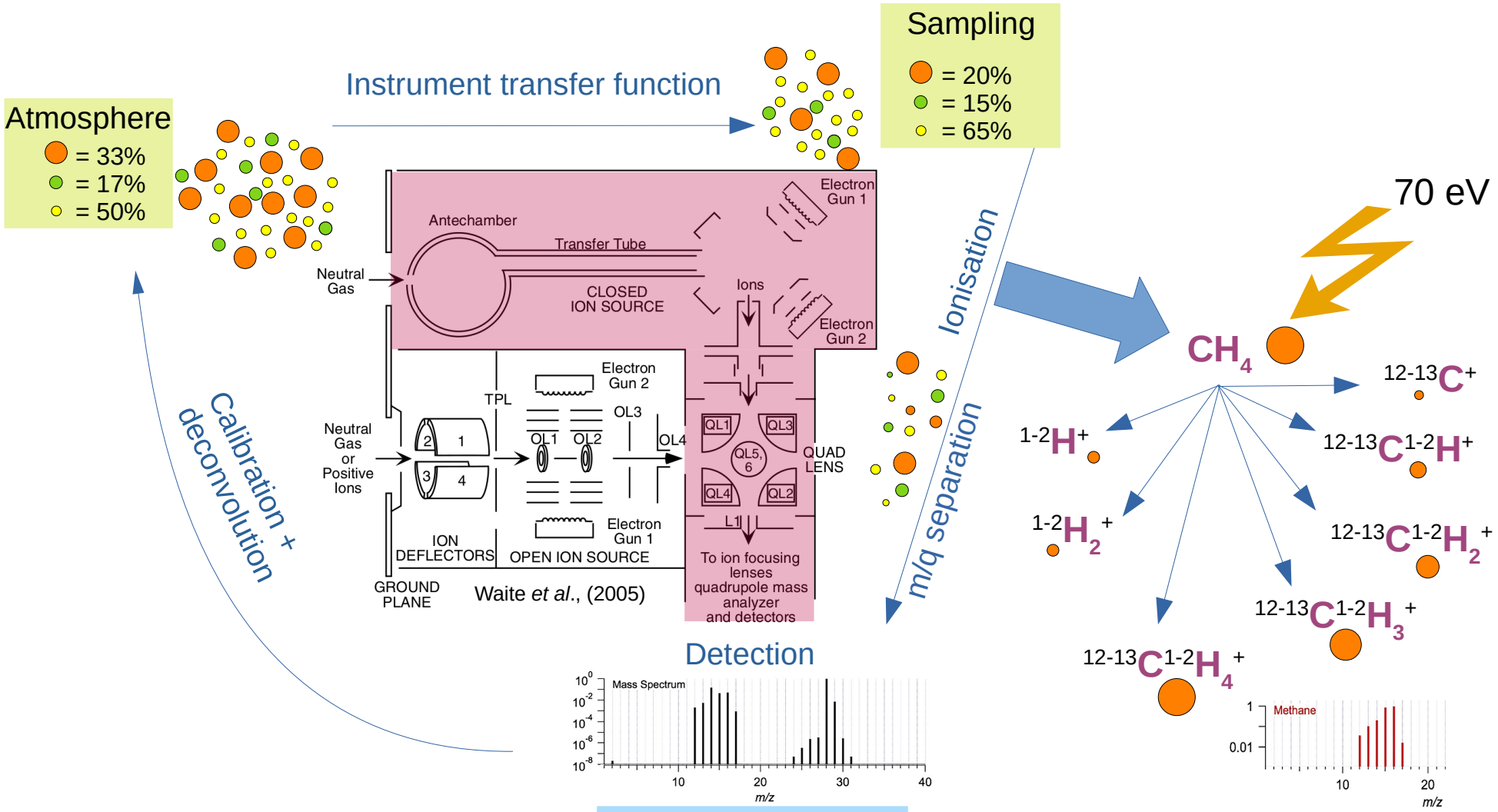
Our focus

950 km

Lower atmosphere

Ionosphere
(**gases** + e^- + ions + aerosols)

Ions and Neutral Mass Spectrometer (INMS)



Deconvolution code (Gautier *et al*, 2020)

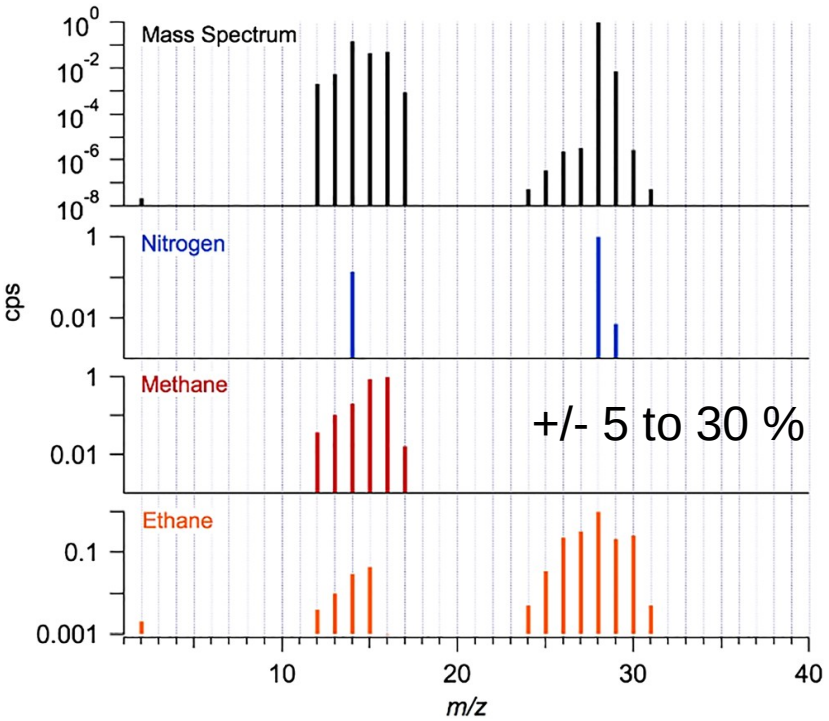
1: INMS calibration processes (Cui *et al* 2009, 2012 ; Teolis *et al* 2015 ; Magee *et al* 2009 ; Mandt *et al* 2009, 2012)

2: Select fragmentation patterns of expected species you want to study
→ (here N_2, CH_4, H_2, Ar, Ne)

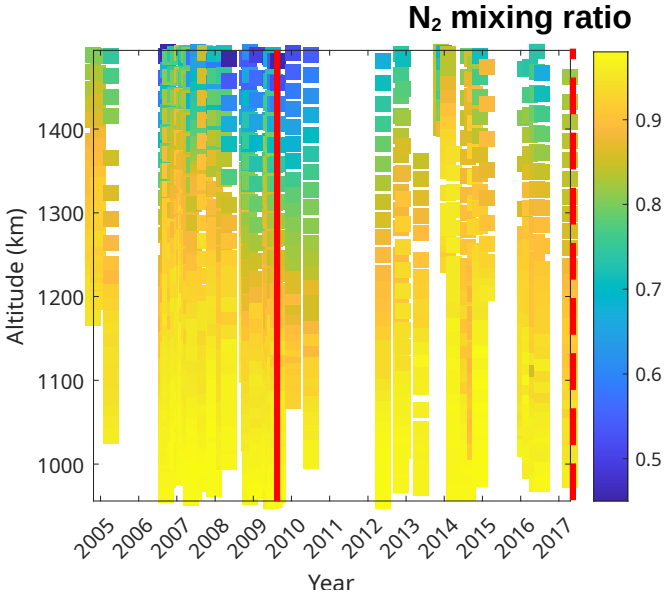
3: Adjust the authorized error & limits

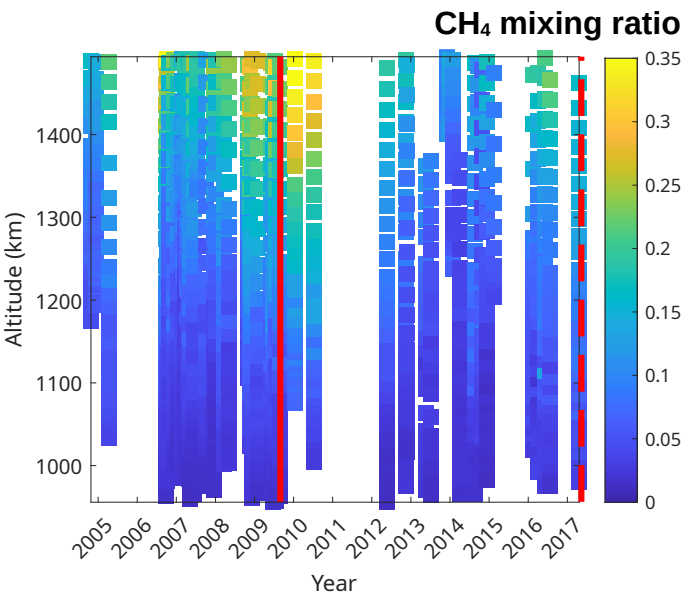
4: Run the Deconvolution code

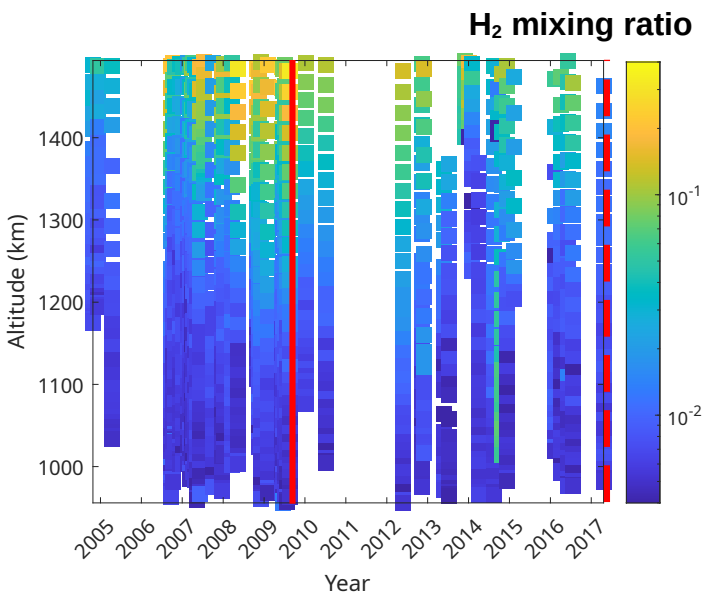
5: Average of 5% best results to get mixing ratios

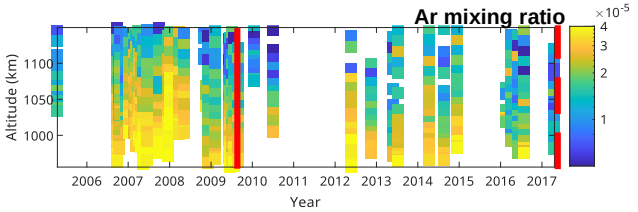


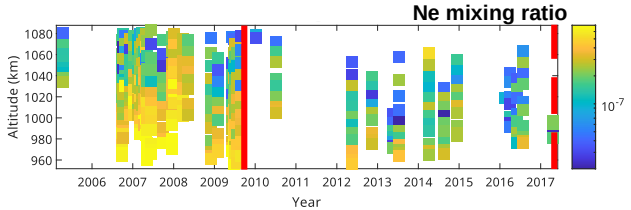
Results











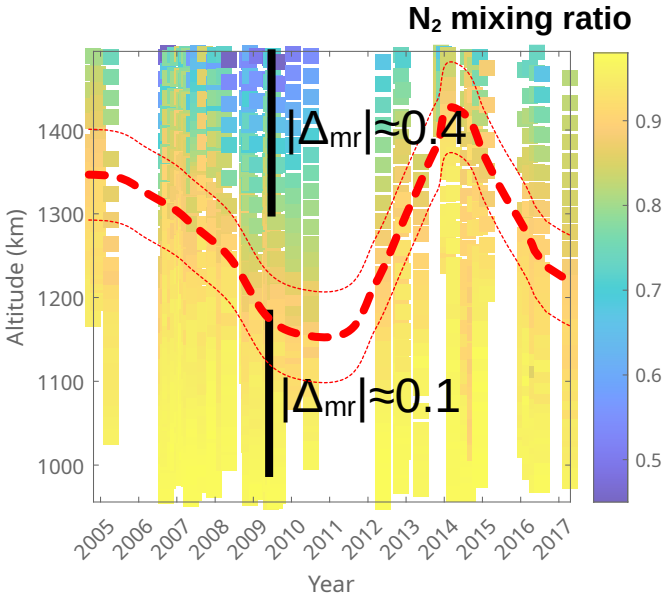
CH_4, H_2 ↗ with altitude **(lighter gases)**

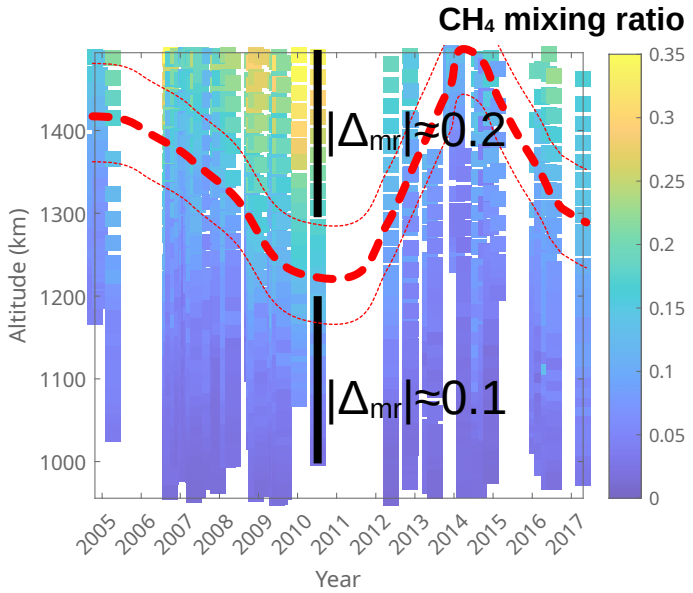
N_2, Ar, Ne ↘ with altitude **(heavier gases)**

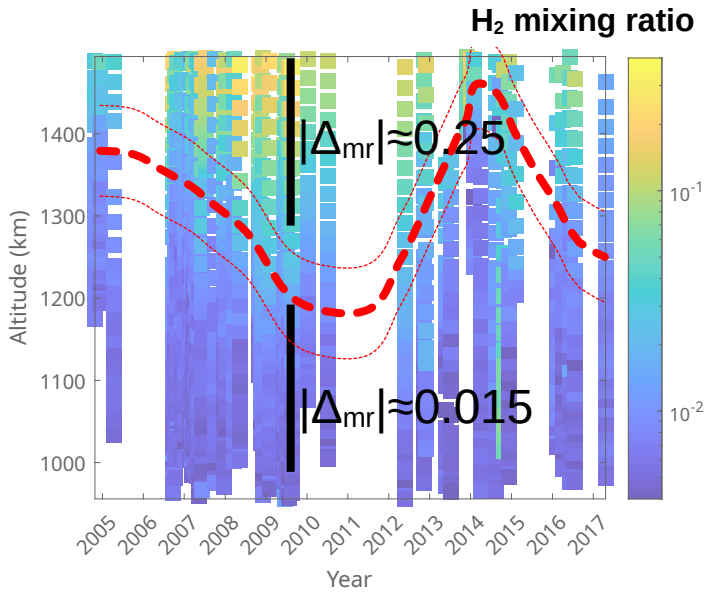
Vernal equinox (august 2009)

Summer solstice (may 2017)

Results







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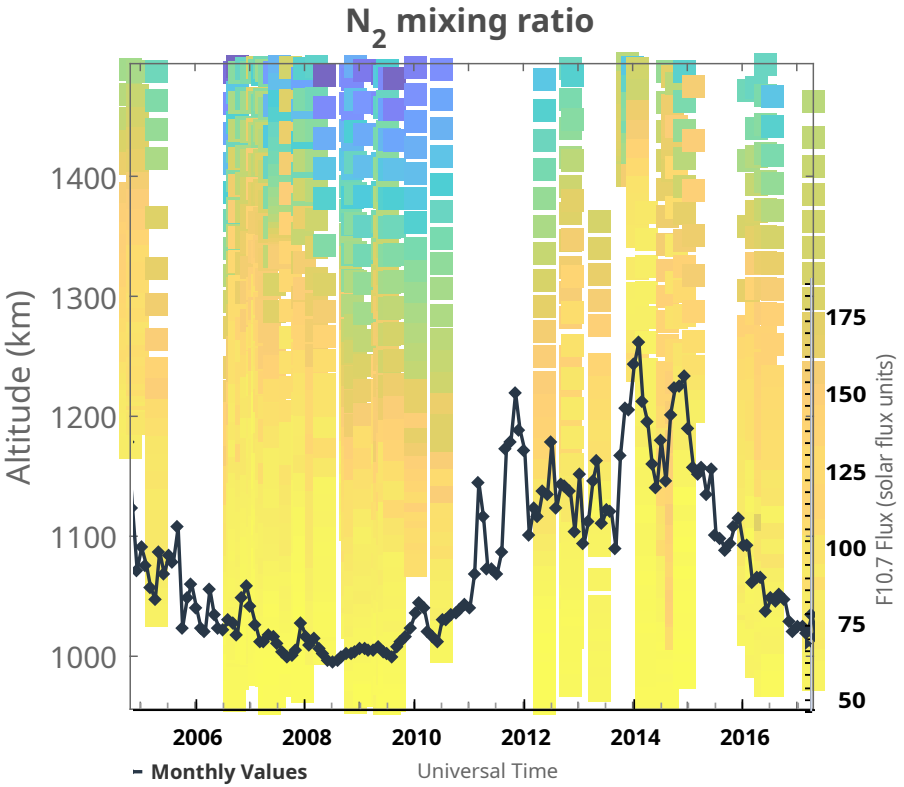
⇨ **Homopauses with seasonal variation**

Results



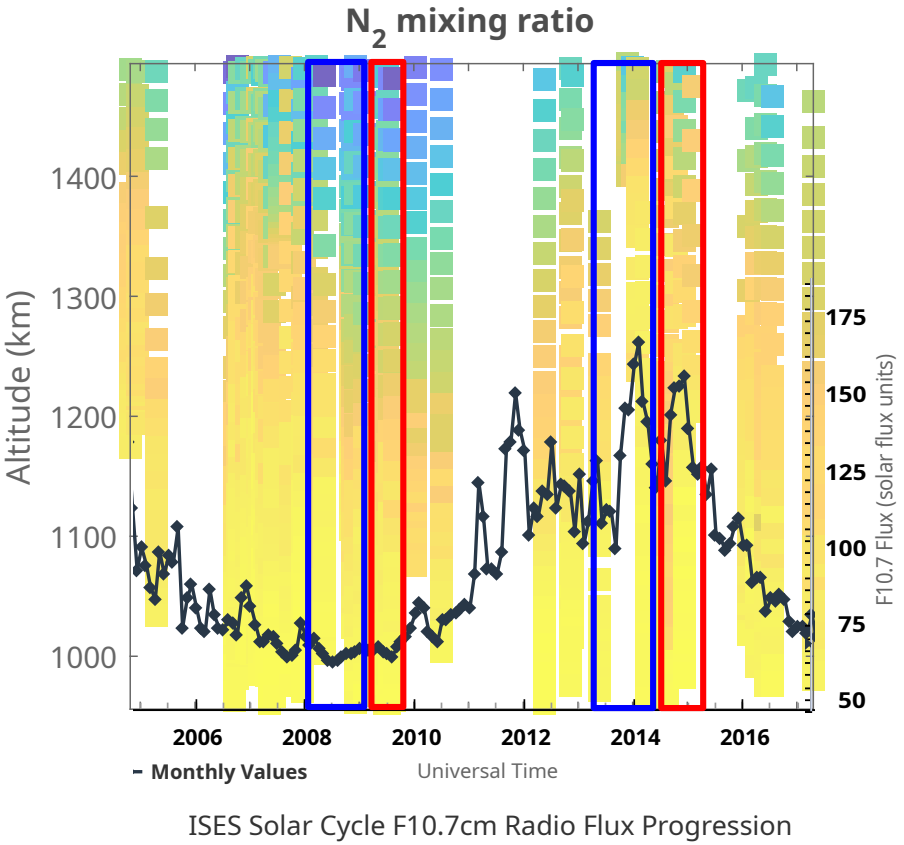
ISES Solar Cycle F10.7cm Radio Flux Progression

Strong correlation with solar flux

↗ solar flux = ↗ photodissociation of CH_4

= ↗ N_2 mixing ratio

Results



Strong correlation with solar flux

↗ solar flux = ↗ photodissociation of CH_4

= ↗ N_2 mixing ratio

Weak correlation with Saturn magnetosphere

(E. Royer *et al.*, EPSC 2020)

Saturn 12h dayside (close to the magnetopause)

Saturn 24h nightside (inside the magnetotail)

Magnetic field intensity = ↗ photodissociation

= ↗ N_2 mixing ratio

Conclusion & Future investigations

Solar cycle influences **greatly** Titan ionosphere neutral composition & photodissociation (more than Titan lat/long/dayside/nightside flyby conditions)

Weak influence of **Saturn magnetosphere** (close to magnetopause → more photodissociation)

Homopause shifting with solar cycle (1300 km +/- 150 km) and specie

What's next ?

More traces species (hydrocarbons…) + link with CIRS results & previous Titan INMS papers

Models to deconvolve/simulate the influences of the seasons, the solar cycle, the magnetosphere and flyby parameters (lat/long/Titan time/solar zenith angle..) on the gases mixing ratio/photodissociation (Any volunteers ?)

What do we need ?

A permanent spacecraft around Titan to observe it at least for 1 Saturn year