Spatial distribution and evolution of N_2 ice on Triton

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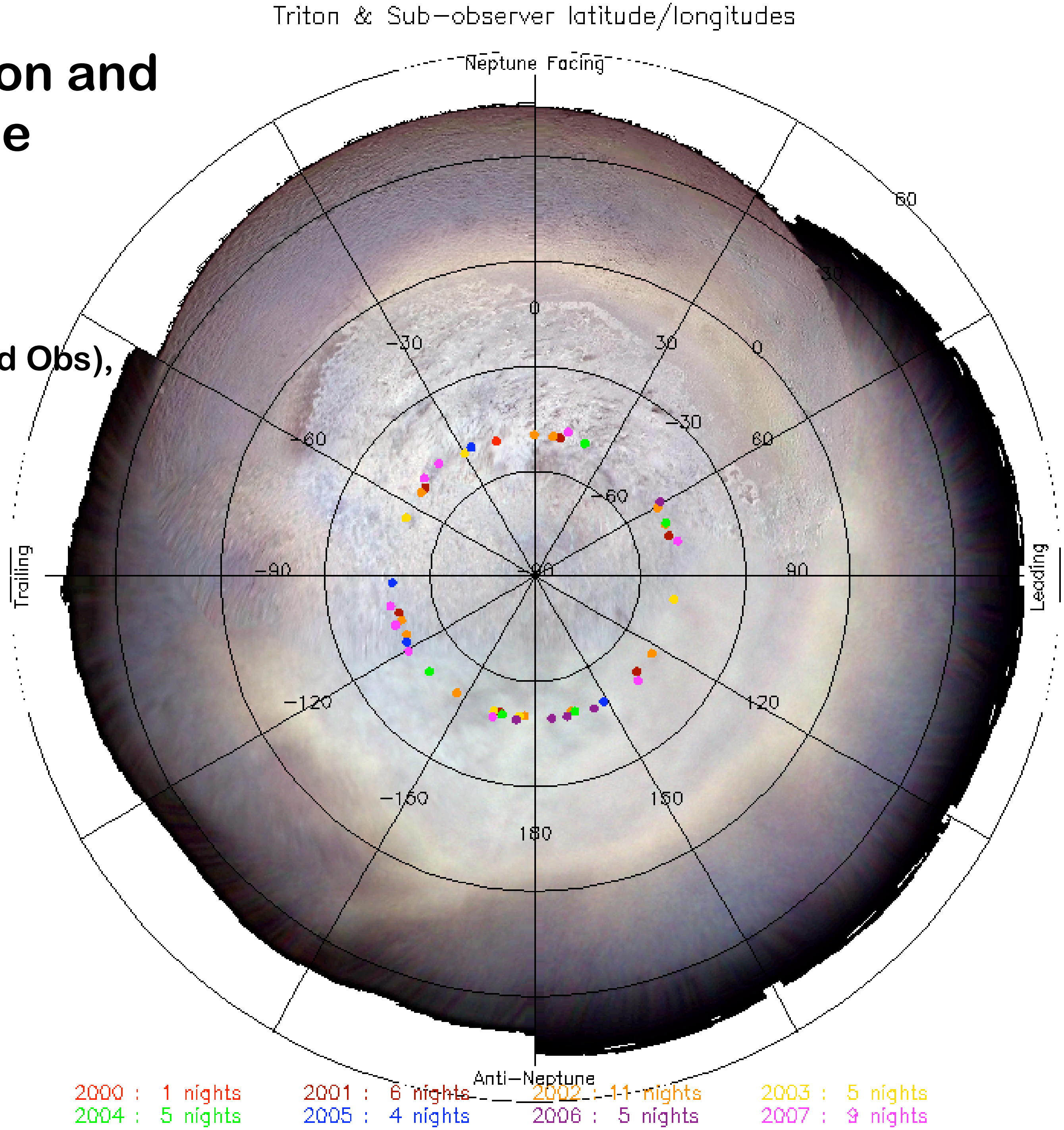
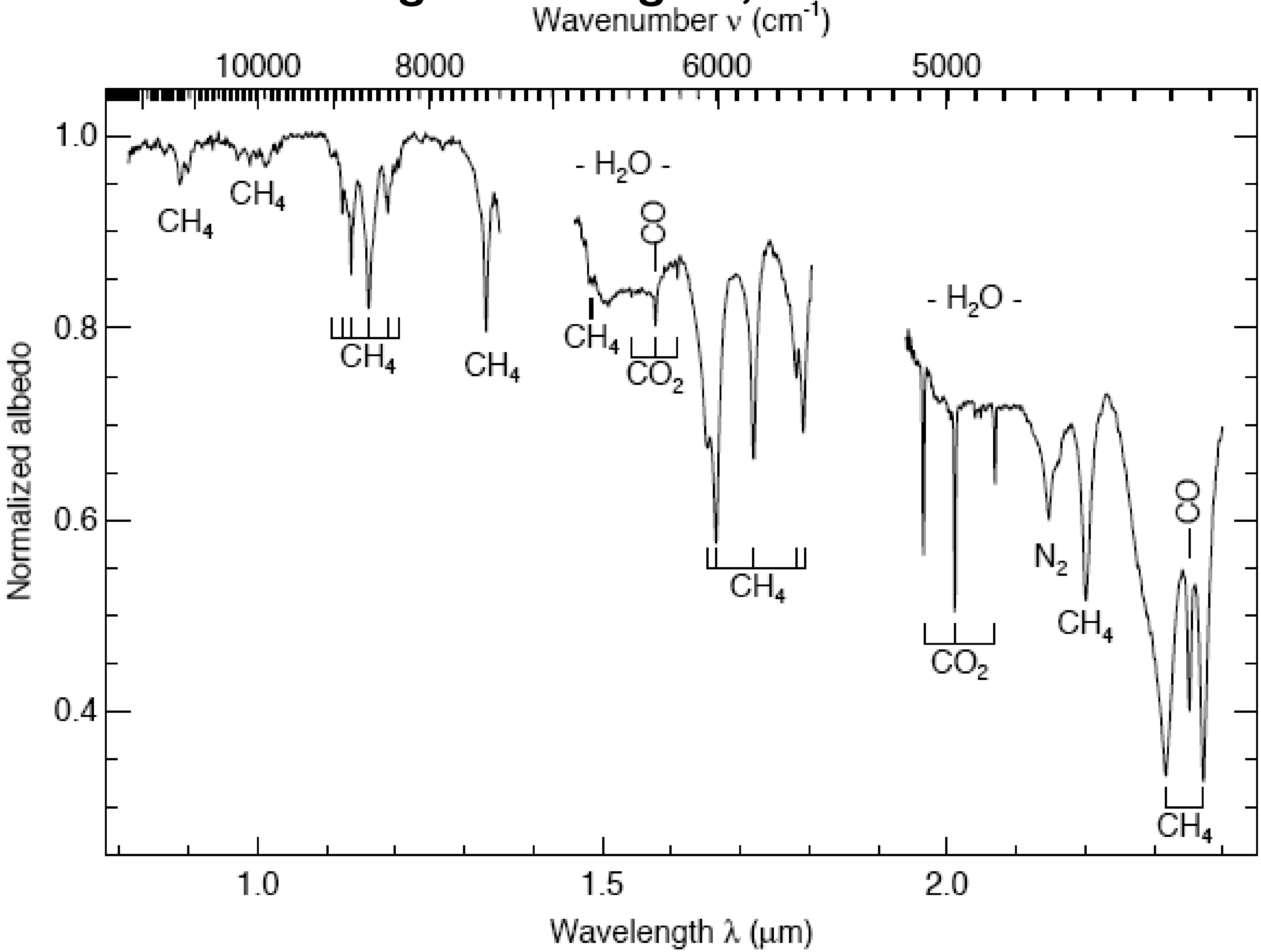
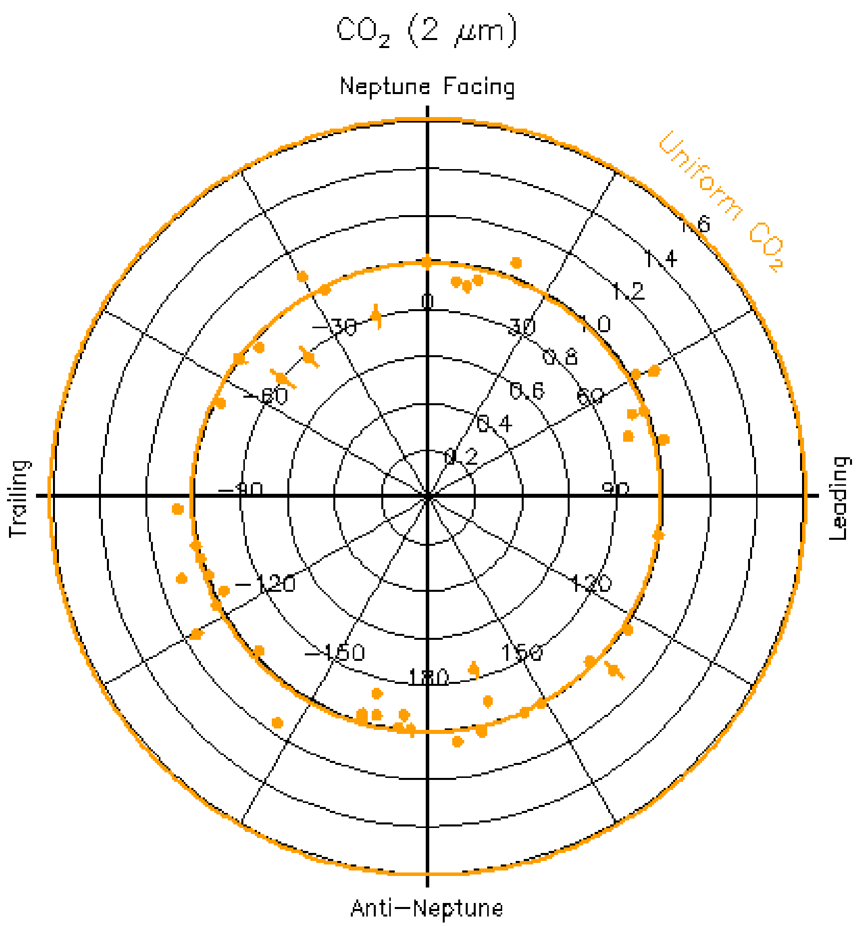


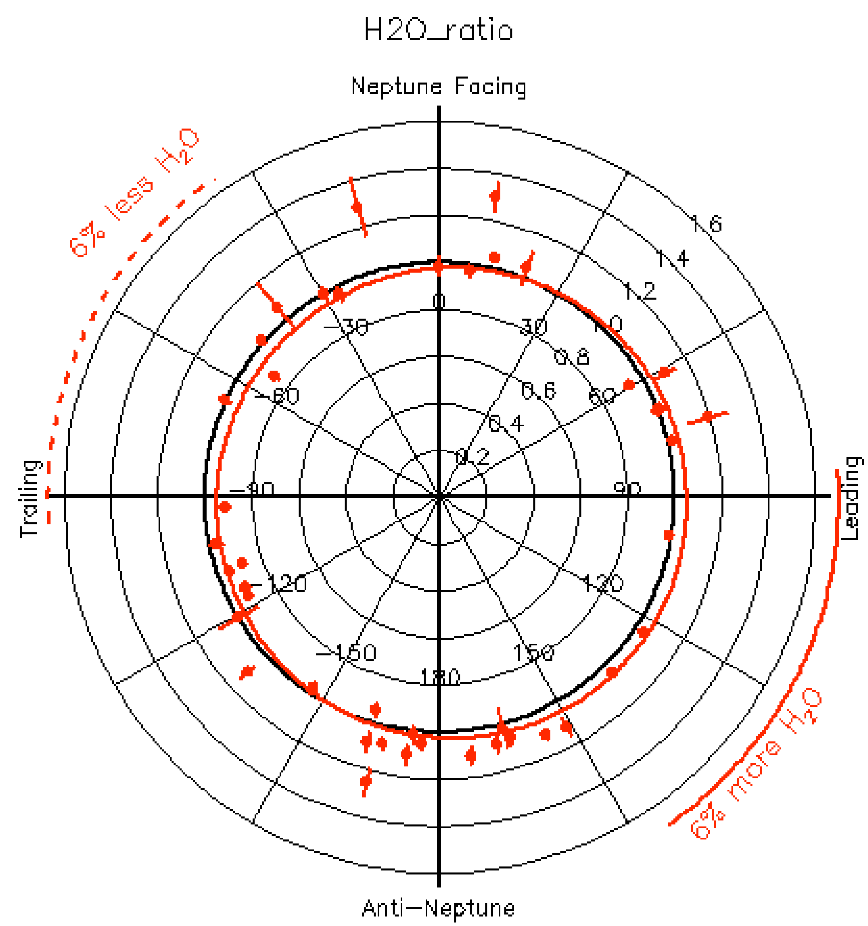
IRTF/SpeX spectrum of Triton, average of 46 nights, 2000-2007



The bedrock: H_2O and CO_2

H_2O and CO_2 are non-volatile at Triton's temperatures.
H_2O shows a small variation with longitude (11±2% peak-to-peak), while CO_2 shows a no variation (2±2% peak-to-peak)

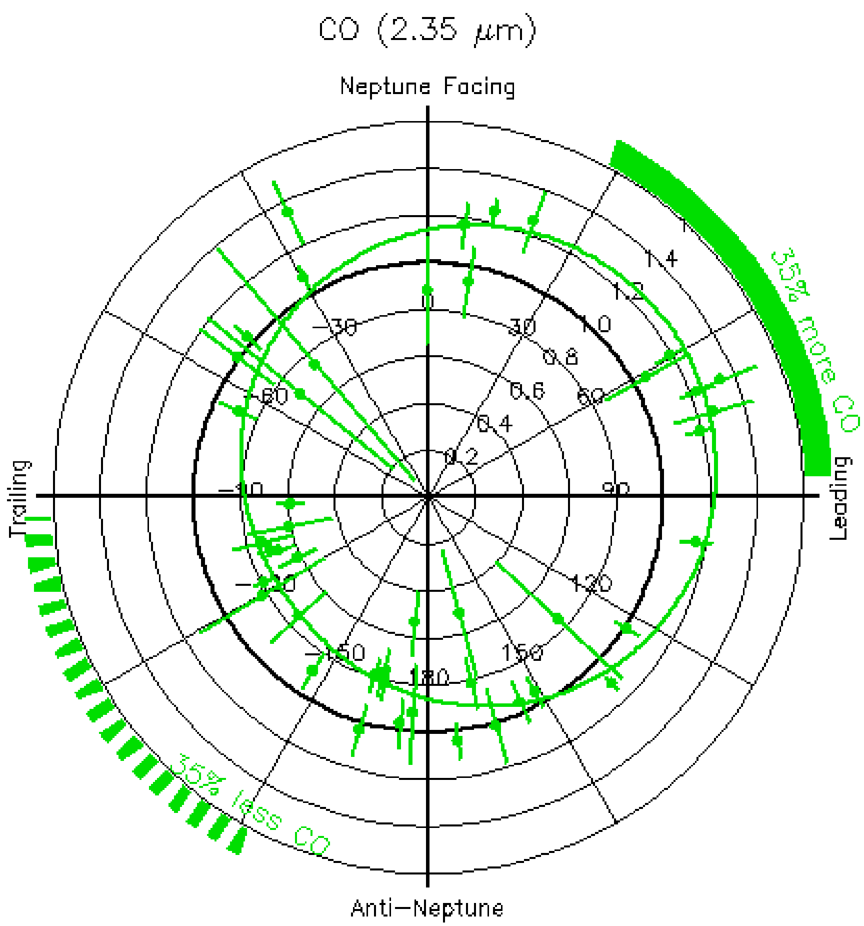


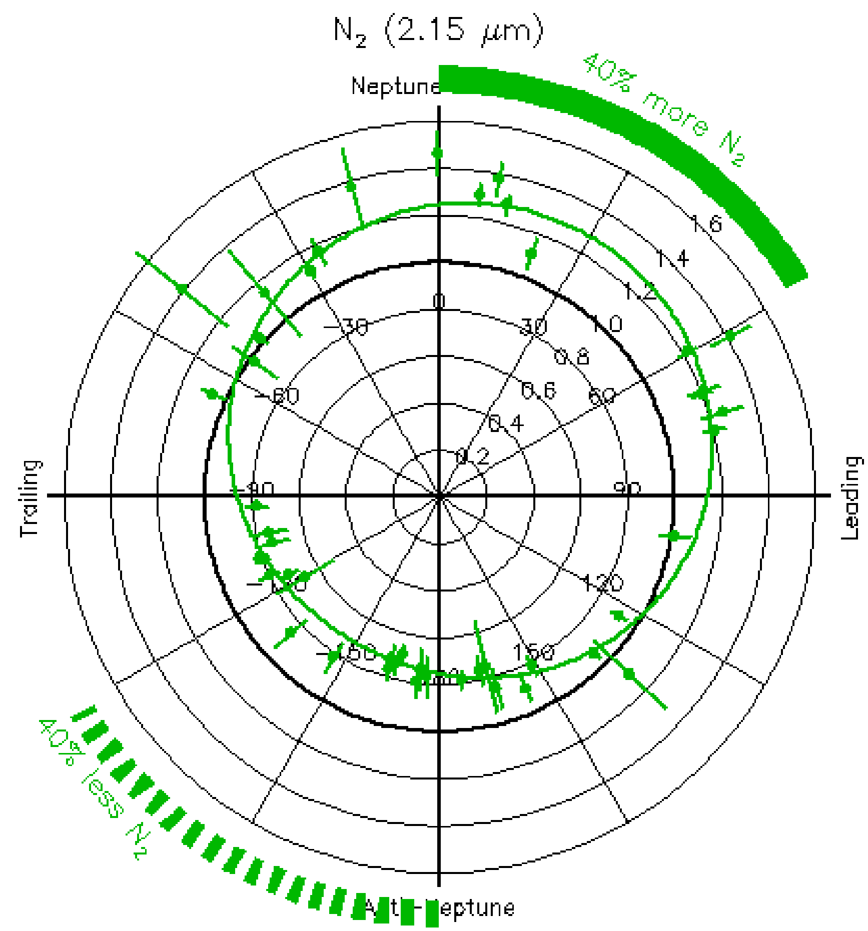


The highly volatile ices: N_2 and CO

N_2 is the most volatile species on Triton's surface, and so it is the dominant species in Triton's atmosphere, and details of emissivity, the N_2 ice distribution, and albedo controls Triton's surface pressure.

CO and N_2 can mix at any ratio, and their vapor pressures are similar, so it is not surprising to see them vary together.



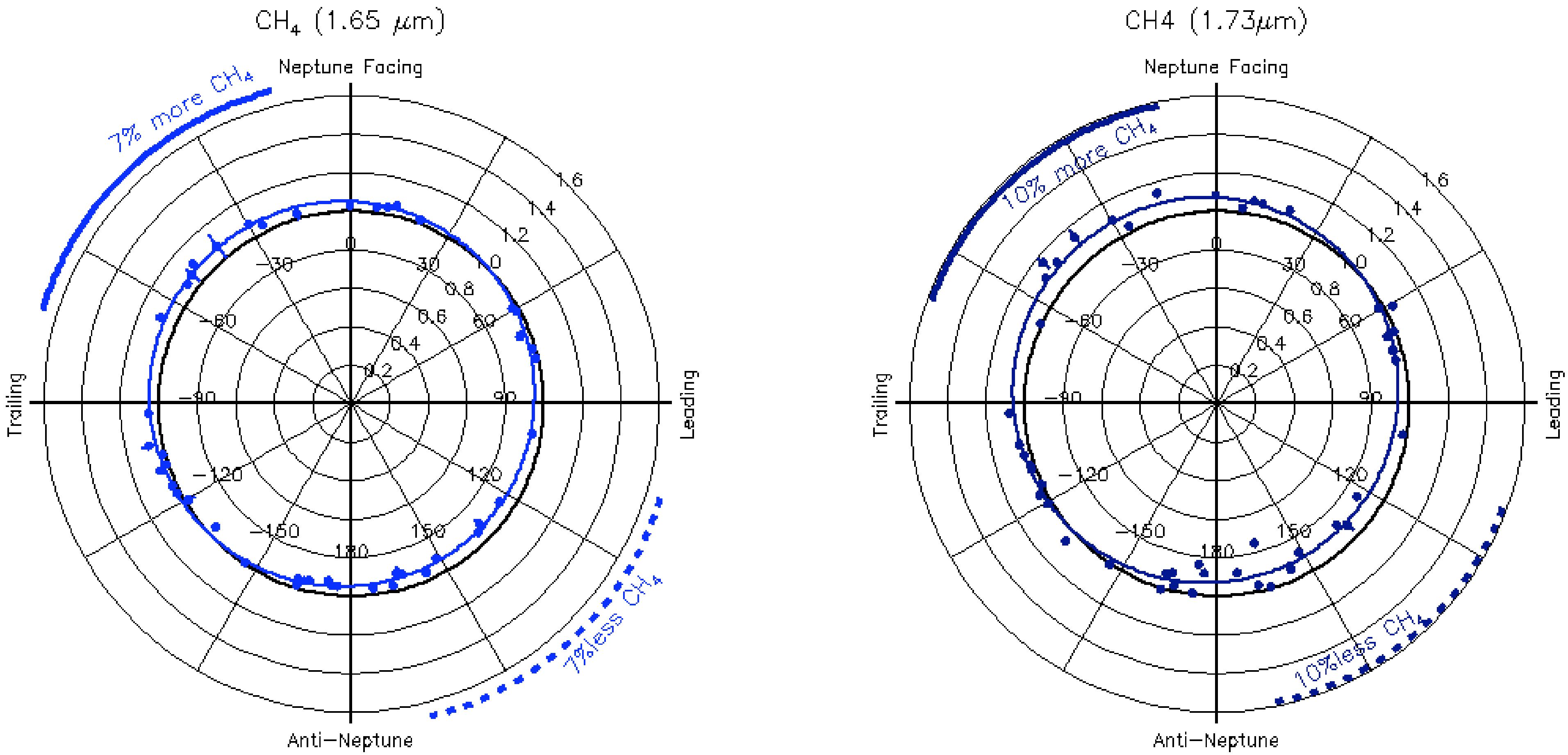


Widespread CH_4 (from strong bands)

Strong bands of CH_4 (e.g., 1.65, 1.73 µm) are sensitive to shallow films or to dilute amounts, as well as to higher concentrations.

This widespread CH_4 shows some variation, depending on the band (~17±2% peak-to-peak)

The CH_4 does *not* peak at the same longitudes as N_2, so the N_2:CH_4 mixing ratio must vary with location.

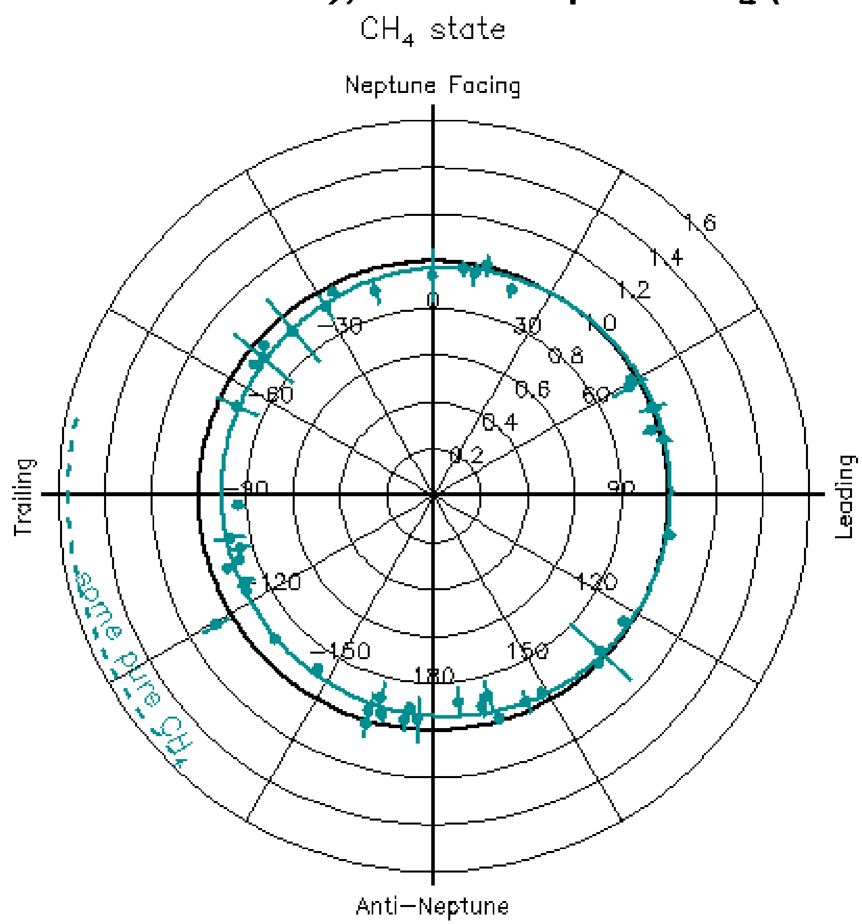


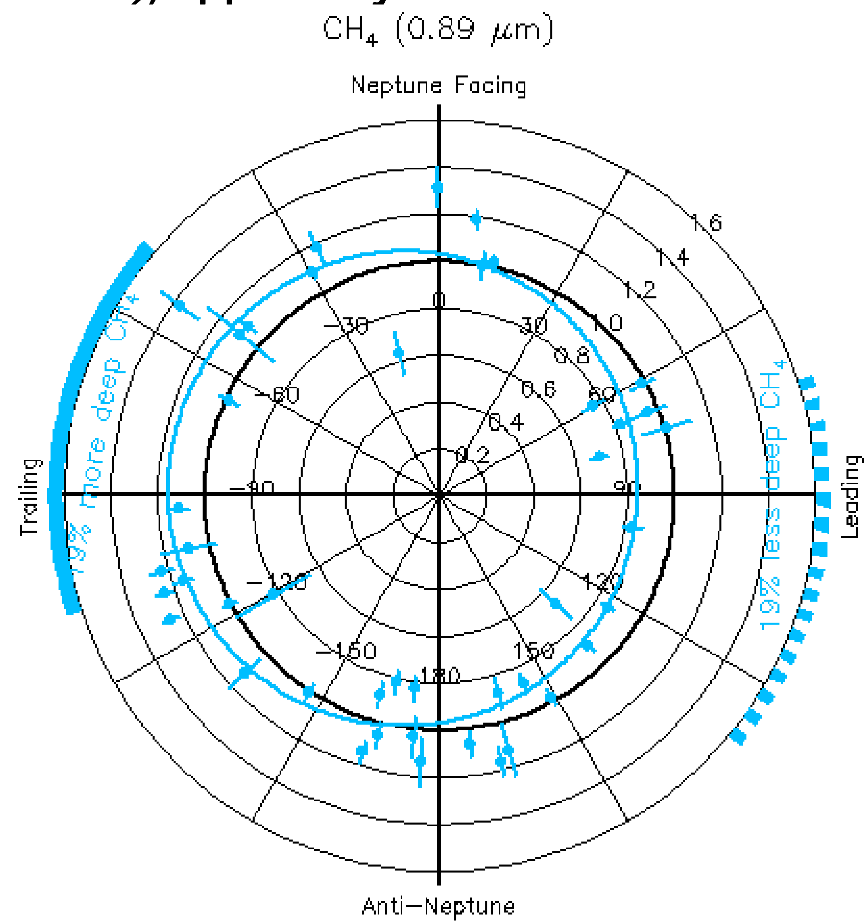
Localized relatively concentrated CH_4 (from weak bands & band shifts)

Weak bands of CH_4 (e.g., 0.89 μm) are sensitive to deeper layers or to concentrated amounts.

This "deep" CH_4 shows more variation than the "shallow" CH_4 (~38±6% peak-to-peak, vs. 15±1% for the 1.65 μm band)

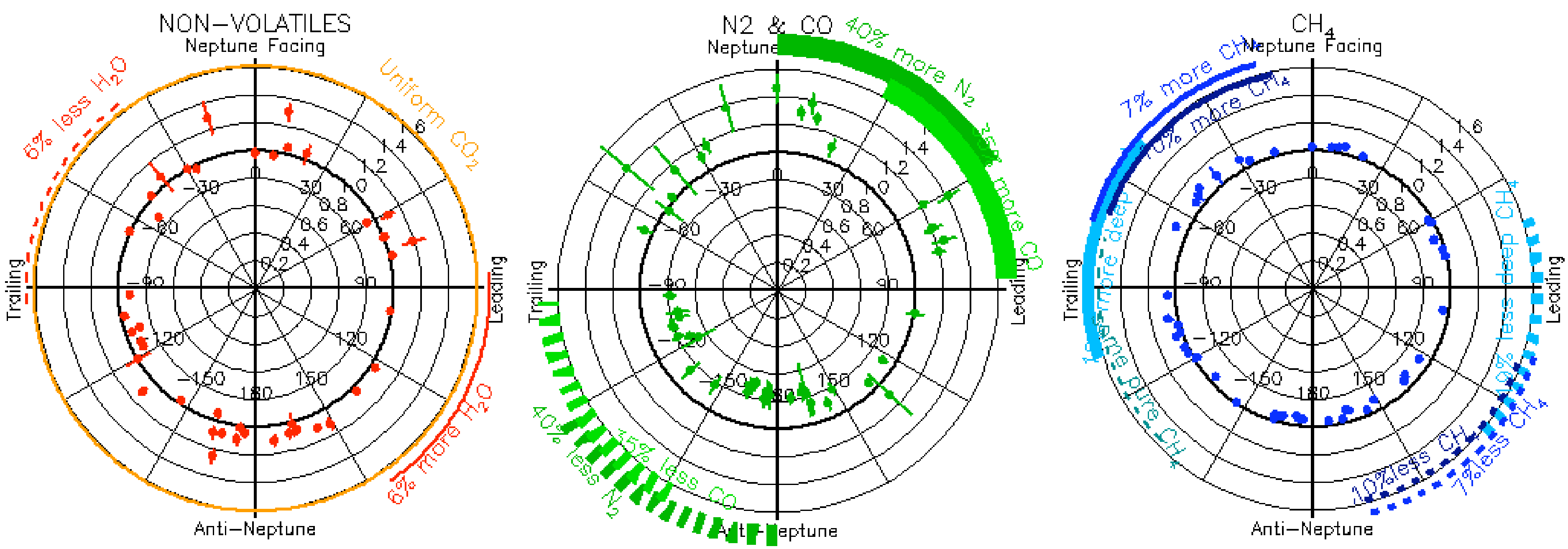
CH_4 lines shift with wavelength when CH_4 is a diluted in N_2. Nearly all of the CH_4 on Triton is diluted in N_2, but some pure CH_4 (or CH_4 with trace N_2) apparently exists near -120°

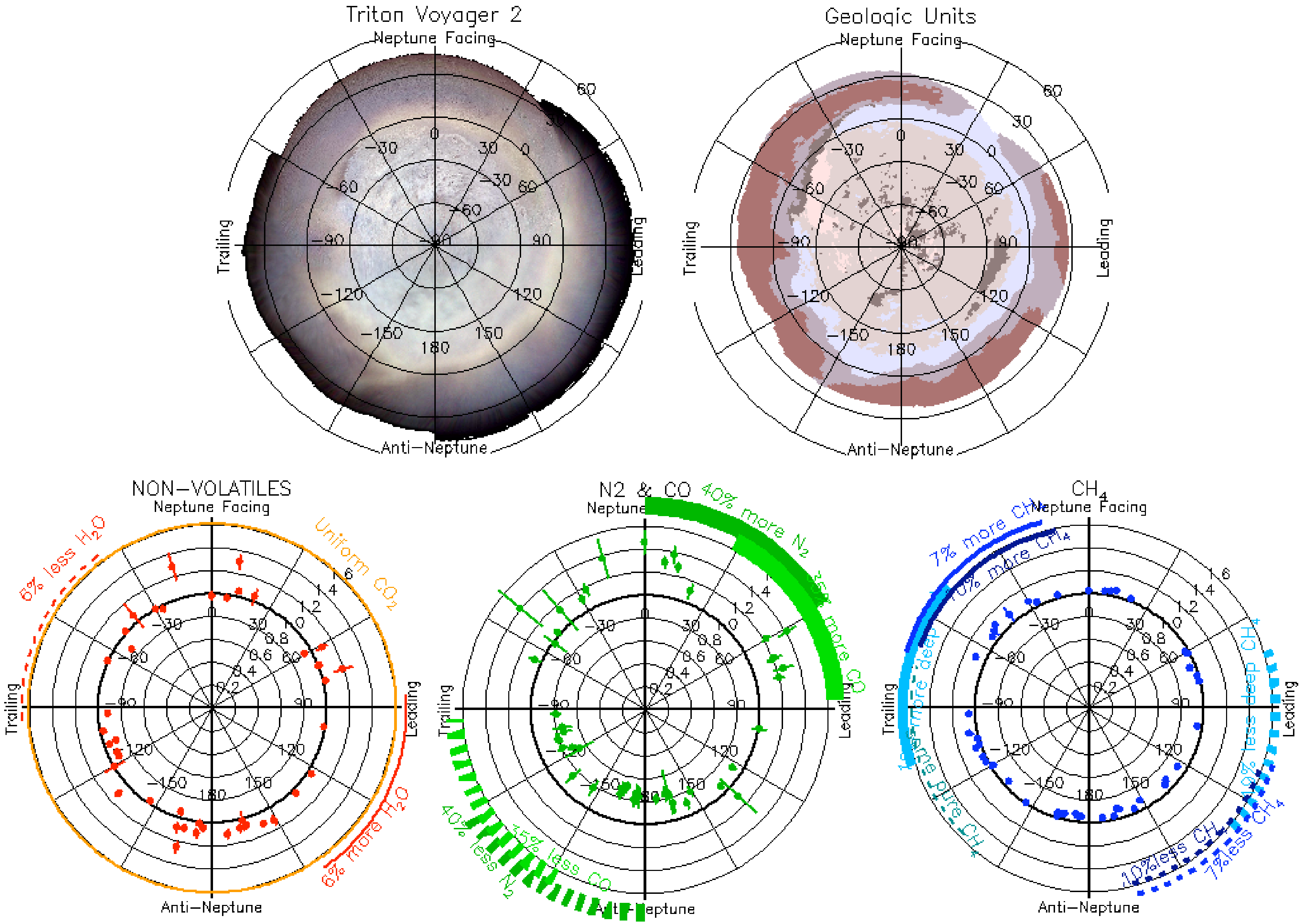




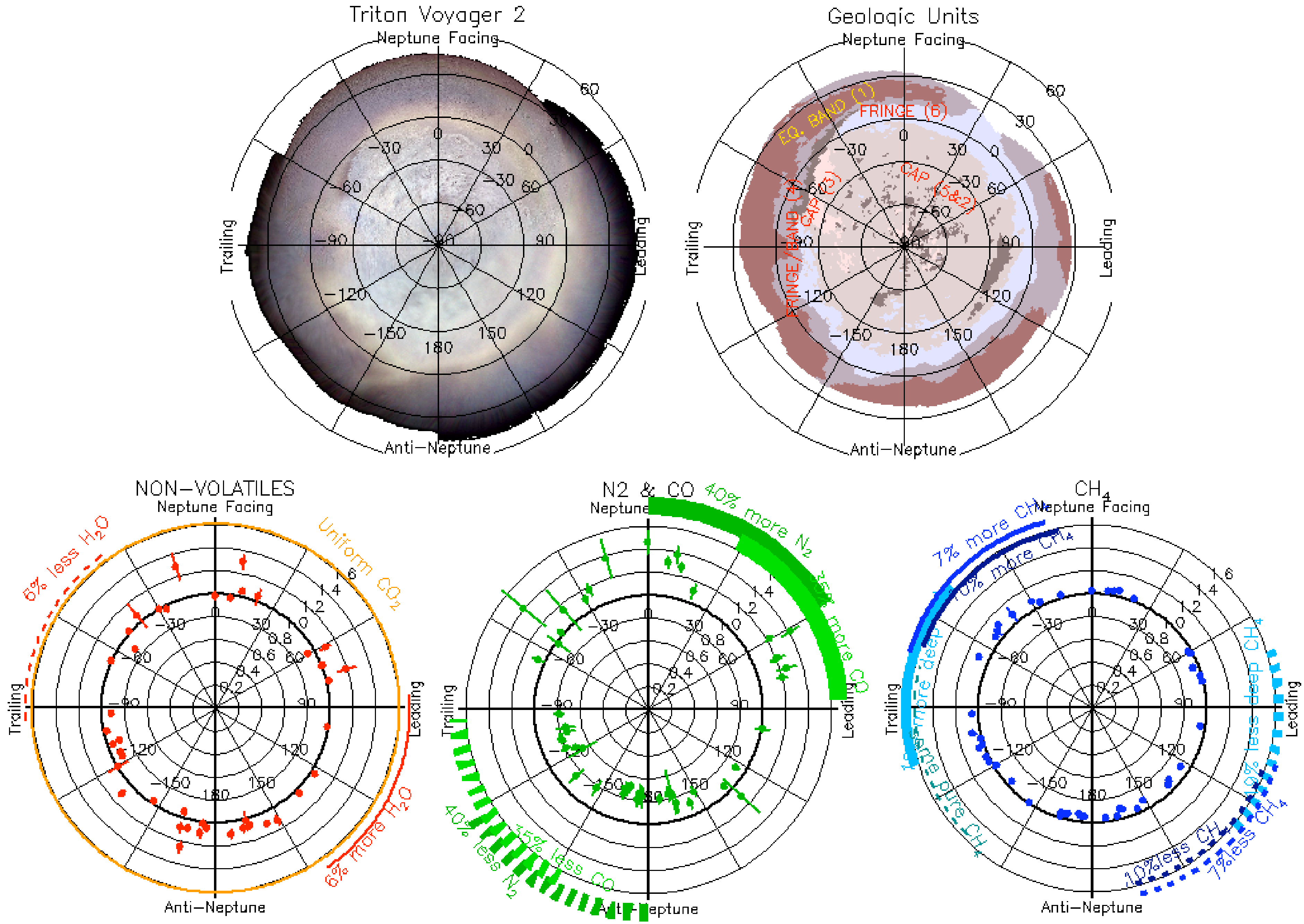
Summary of longitudinal correlations

- **N_2 and CO are strongly correlated**
- **H_2O is weakly anticorrelated with wide-spread CH_4**
- **CH_4 is *not* correlated with N_2**
- **Purer CH_4 is weakly anti-correlated with N_2**



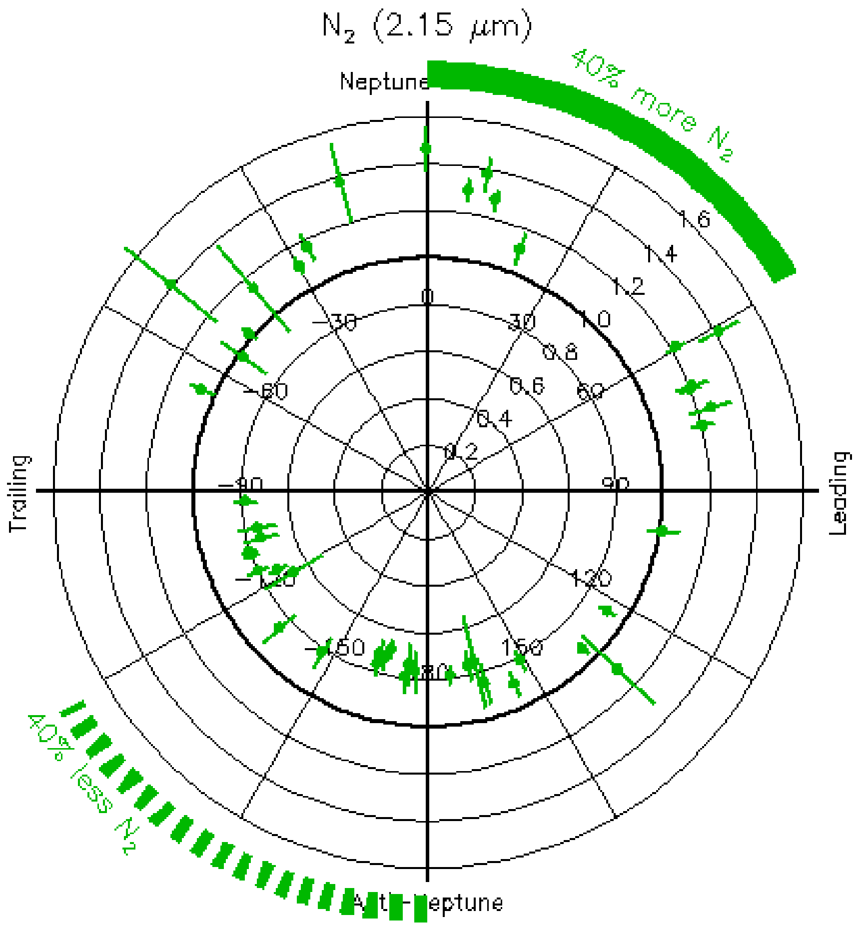


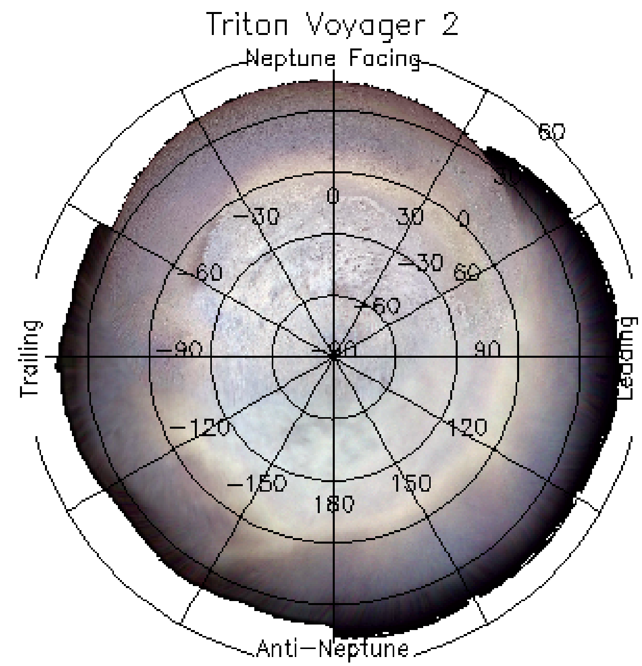
Triton Voyager 2
Neptune Facing
Anti−Neptune
Trailing
Leading
Geologic Units
Neptune Facing
Anti−Neptune
Trailing
Leading
NON−VOLATILES
Neptune Facing
Anti−Neptune
Trailing
Leading
6% less H2O
Uniform CO2
6% more H2O
N2 & CO
Neptune
Anti−Neptune
Trailing
Leading
40% more N2
35% more CO
40% less N2
35% less CO
CH4
Neptune Facing
Anti−Neptune
Trailing
Leading
7% more CH4
10% more CH4
10% less CH4
7% less CH4

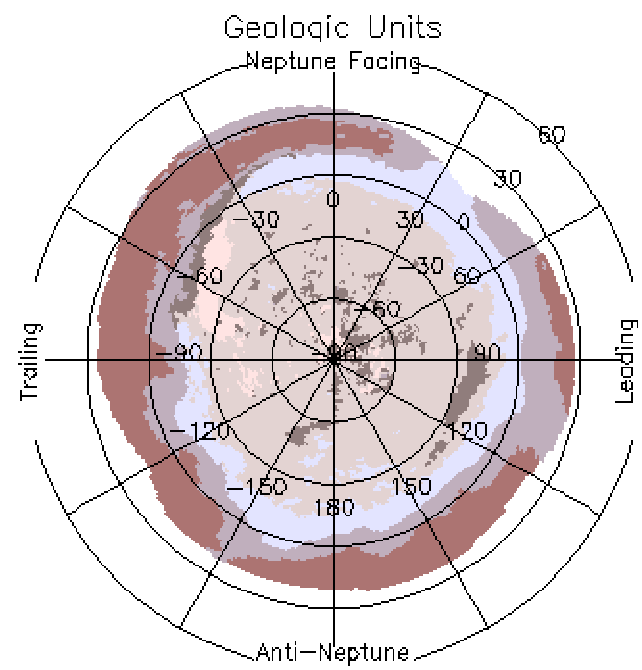


Triton Voyager 2
Neptune Facing
Anti–Neptune
Trailing
Leading
Geologic Units
EQ. BAND (1)
FRINGE (6)
CAP (5&2)
CAP (3)
FRINGE / BAND (4)
NON–VOLATILES
6% less H2O
Uniform CO2
6% more H2O
N2 & CO
40% more N2
35% more CO
40% less N2
35% less CO
CH4
7% more CH4
10% more CH4
10% less CH4
7% less CH4

The N_2 variation doesn't directly relate to the geologic units identified by McEwen et al. 1990.



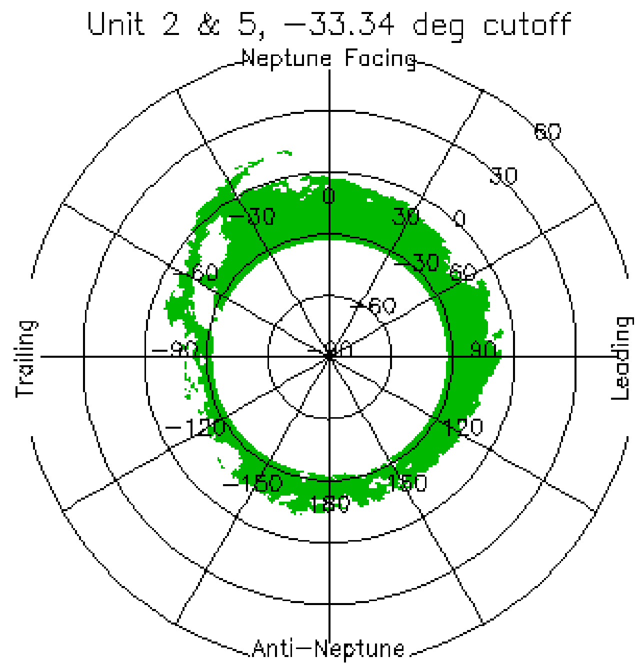


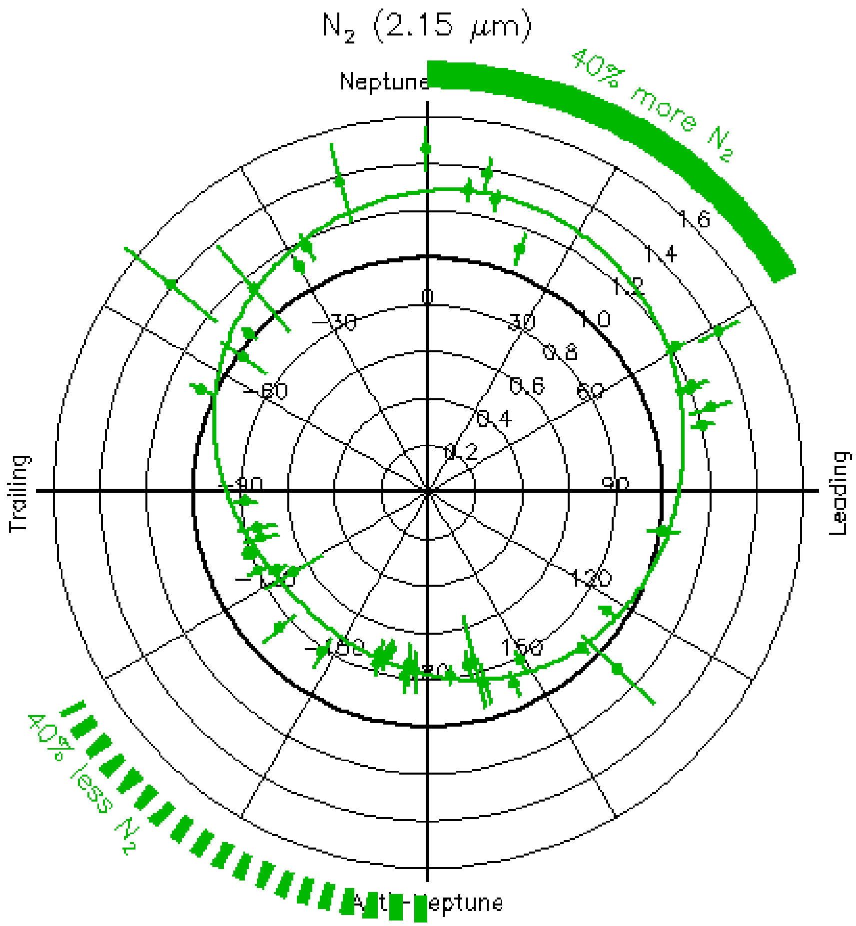


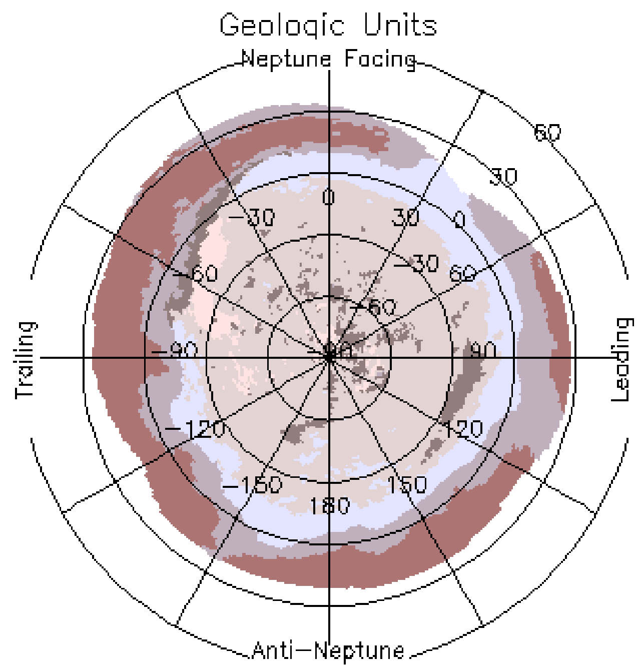
The N_2 variation doesn't directly relate to the geologic units identified by McEwen et al. 1990.

Excellent matches to the N_2 variation can be made from the cap units with a denuded pole.

Other models work well too: including the fringe or not, or assuming detectable N_2 only where diurnally averaged insolation is below a threshold.

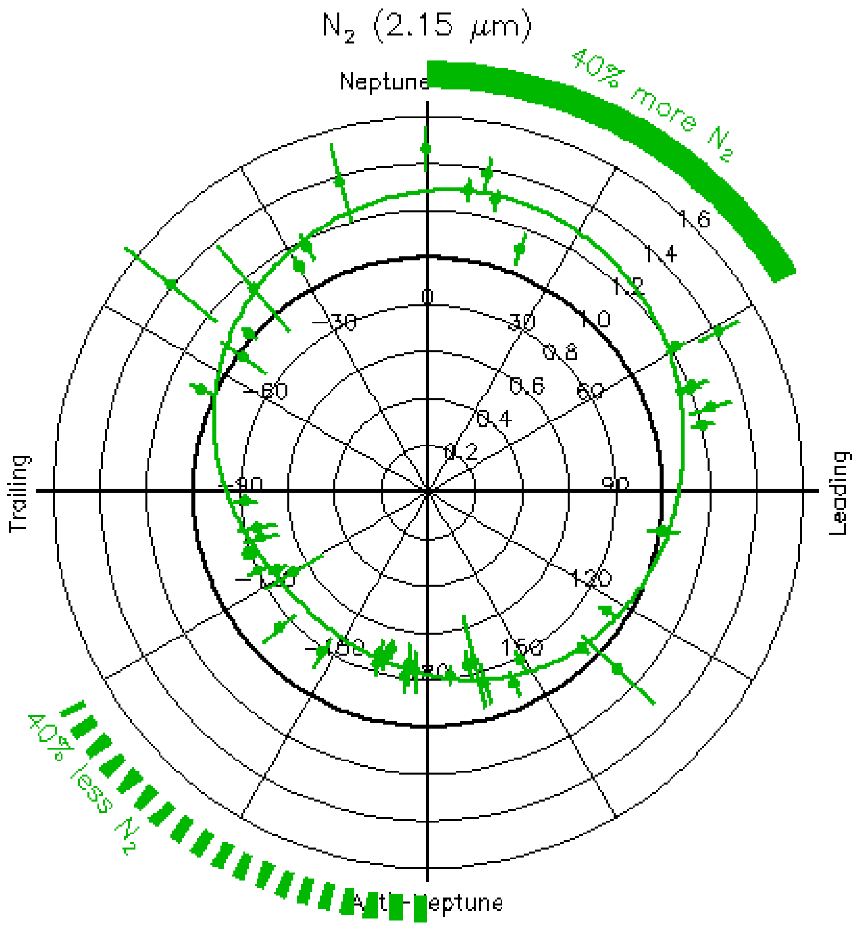


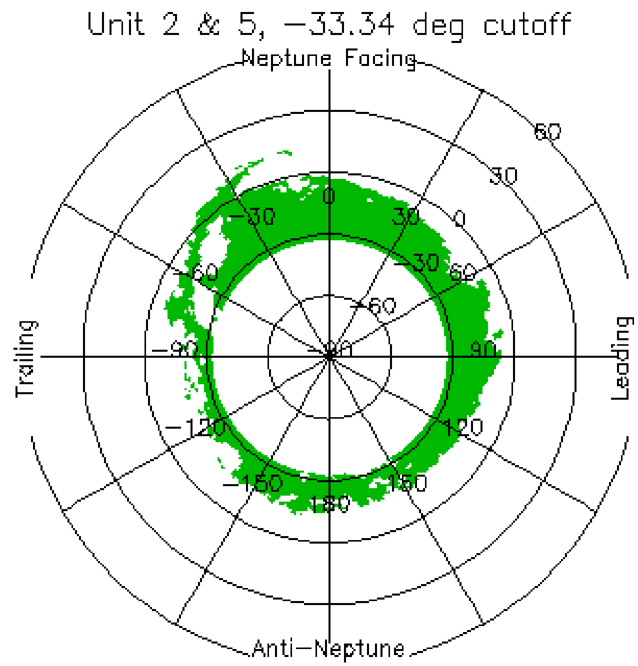


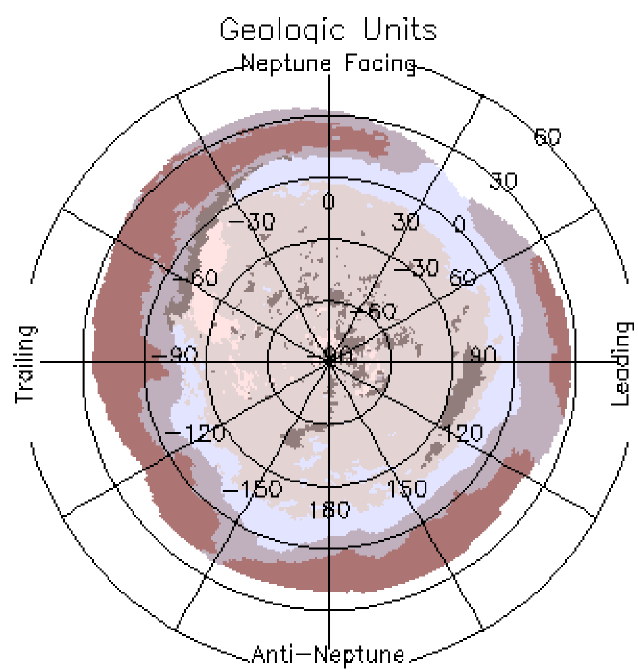


But consider the atmosphere...

- **If the N_2 is on the winter hemisphere, how can the emissivity be low enough (~0.2) to match Triton's surface pressure (corresponding to a N_2 ice temperature of ~38K)?**
- **If the N_2 is *not* at the winter pole, why not? Is there a heating affect from an internal heat source?**



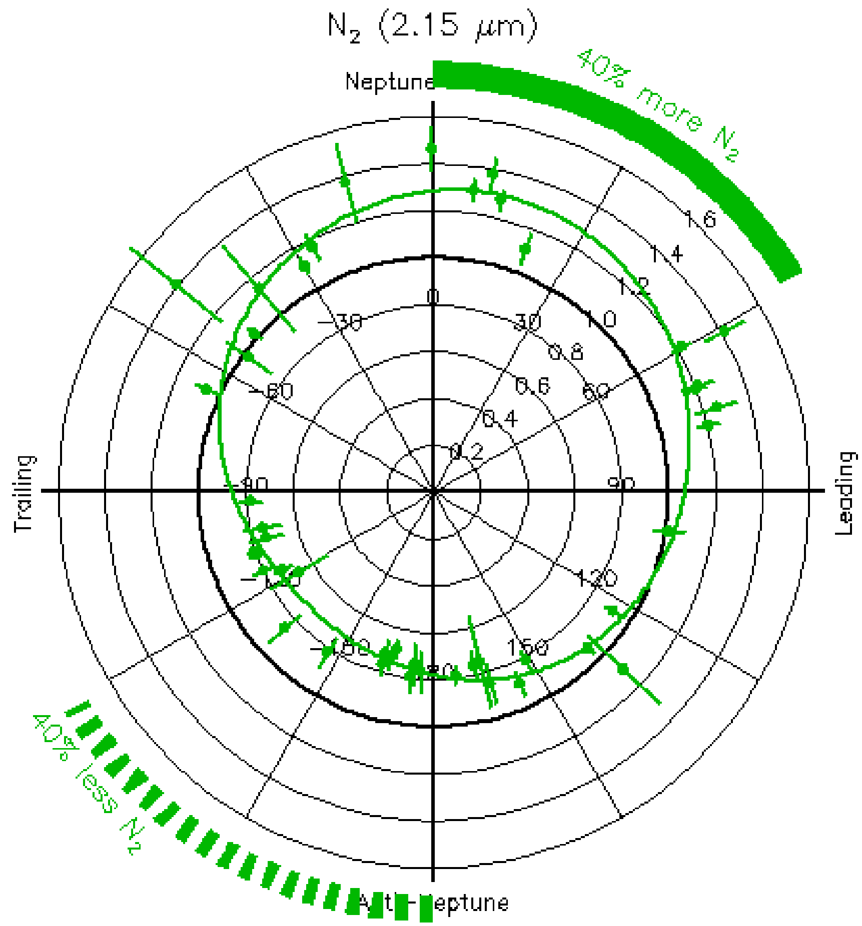


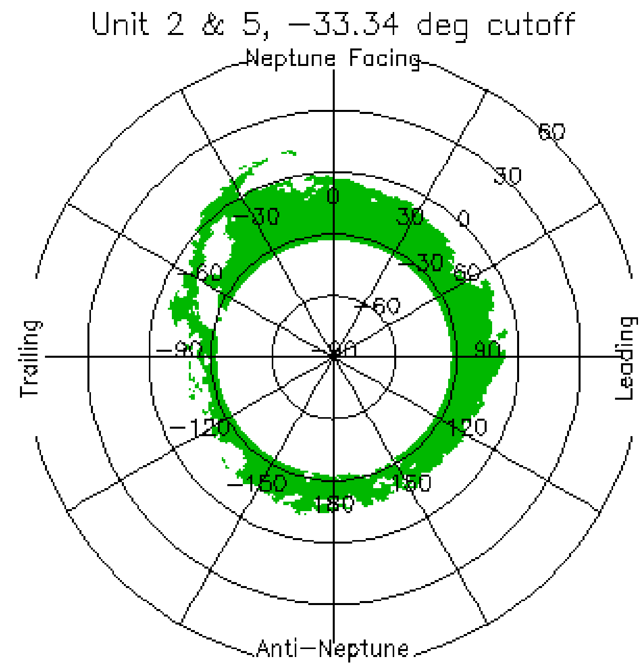


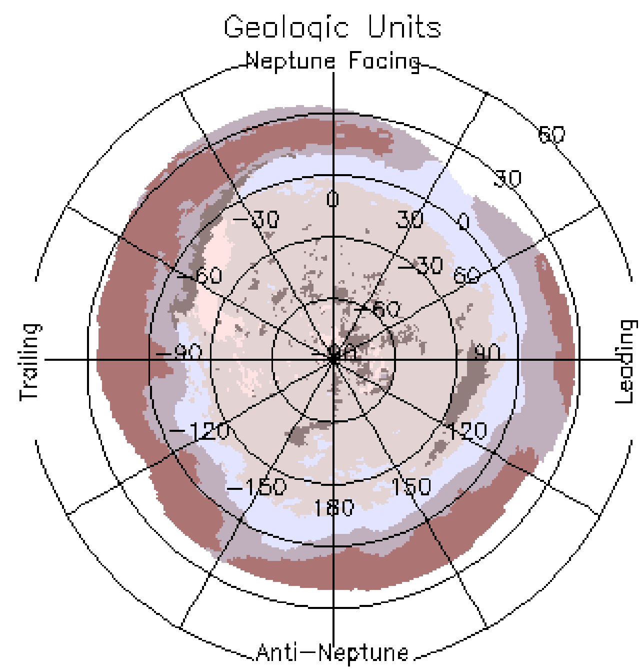
How much fine-grained N_2 (which is not detectable at 2.15 µm) can we hide on the southern hemisphere?

- **The wide-spread CH_4 is diluted in the N_2 argues for "invisible southern N_2." (For example: mm-sized at the pole and cm-sized at the edge.)**
- **The emissivity needed for 38 K is reasonable.**

The denuded pole shows no obvious signature of the difference in N_2 texture in the Voyager images.







Food for thought
(and requests for lab data)

- How does the detectability of N_2 depend on whether it is a sublimation or condensation site?
- Does the CH_4 spectrum in N_2:CO:CH_4 differ from that in N_2:CH_4?
- How does the emissivity of N_2 ice depend on CO and CH_4 concentrations, the rate of sublimation or condensation, and age?
- What are the sticking coefficients of N_2, CO, and CH_4 with respect to the various units?
- How do CO and CH_4 diffuse through N_2?