# 3.6 cm radio signal attenuation in Venus' lower and middle atmosphere observed by the Radio Science experiment VeRa onboard Venus Express

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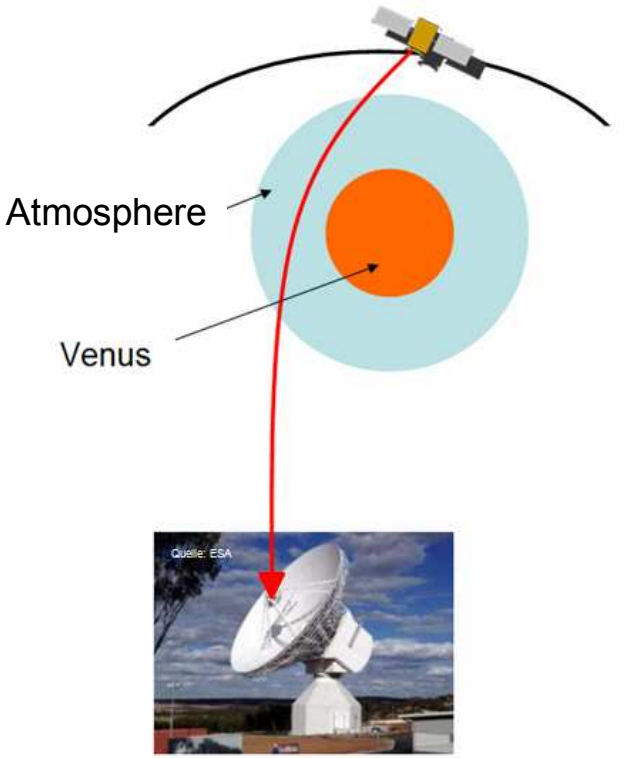
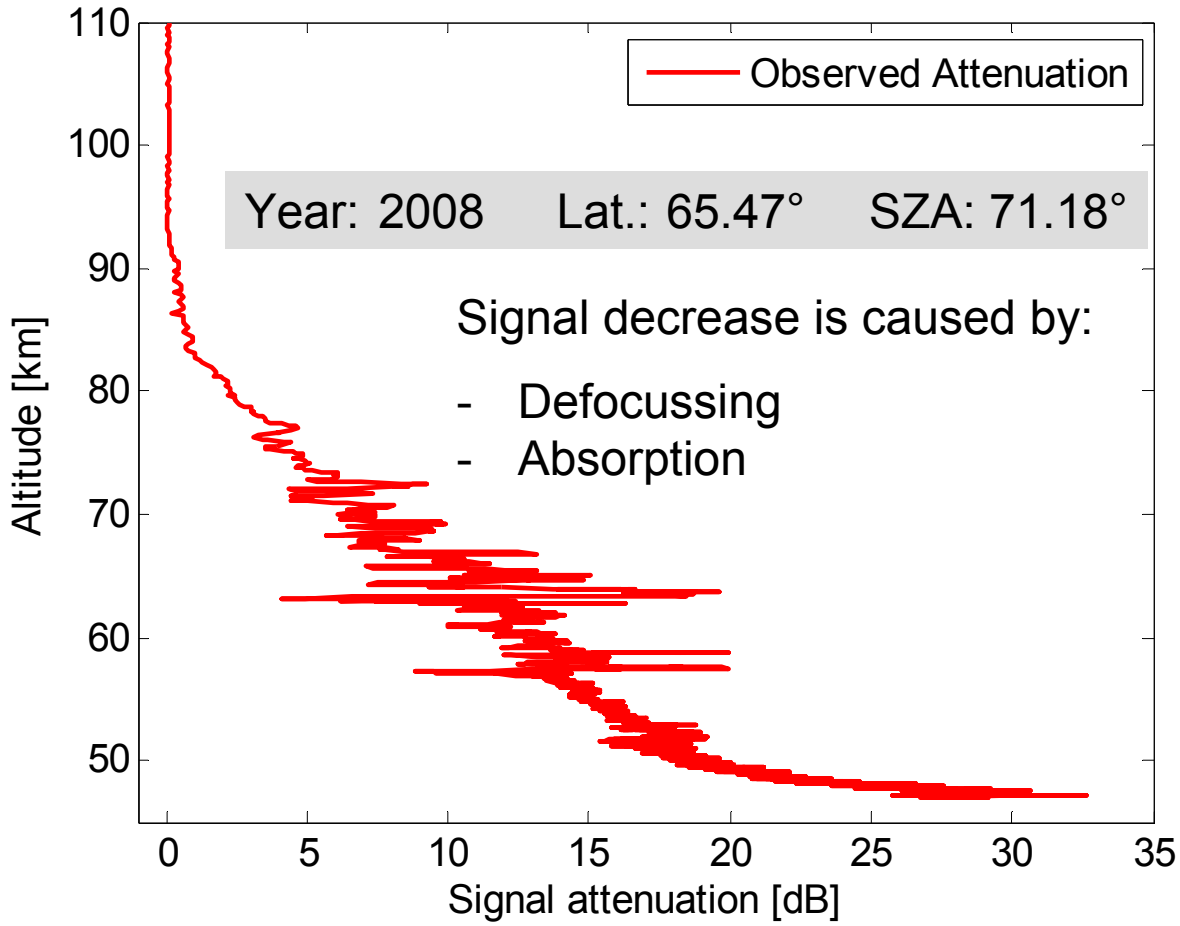
d) *Argelander Institut für Astronomie, Universität Bonn.*
e) *European Space Astronomy Center (ESAC), Villanueva, Spain.*

# Signal Attenuation



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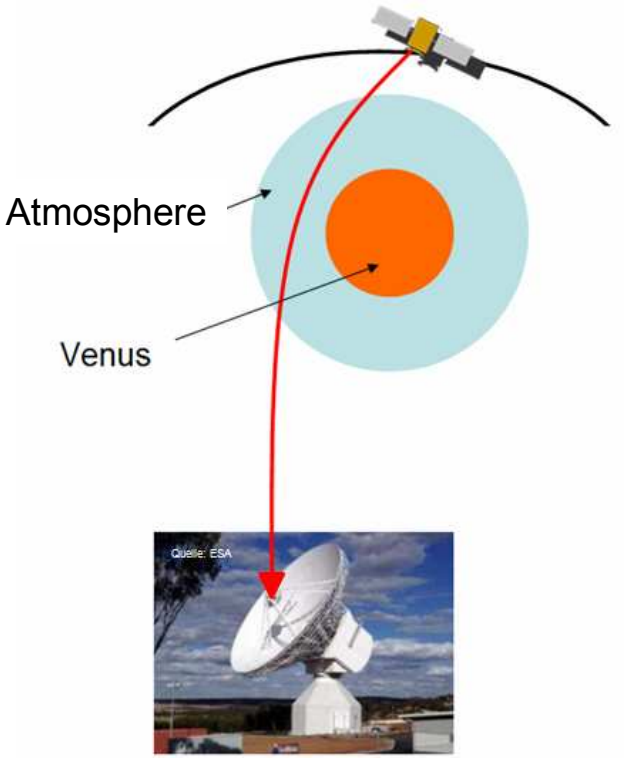


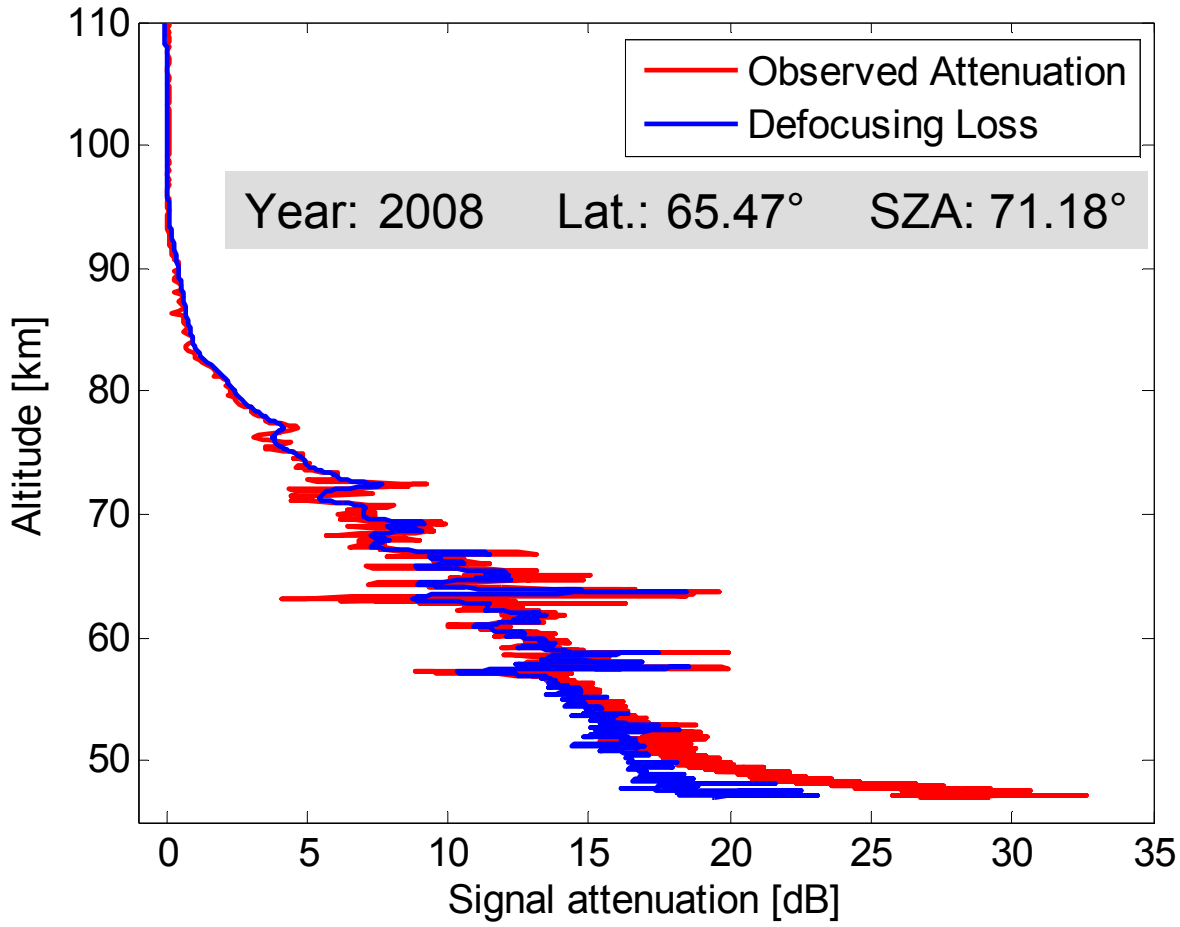

# Signal Attenuation

**Two altitude regions**:

a) Increased intensity variations above 55 km. Decrease in signal power is mainly caused by defocusing loss.

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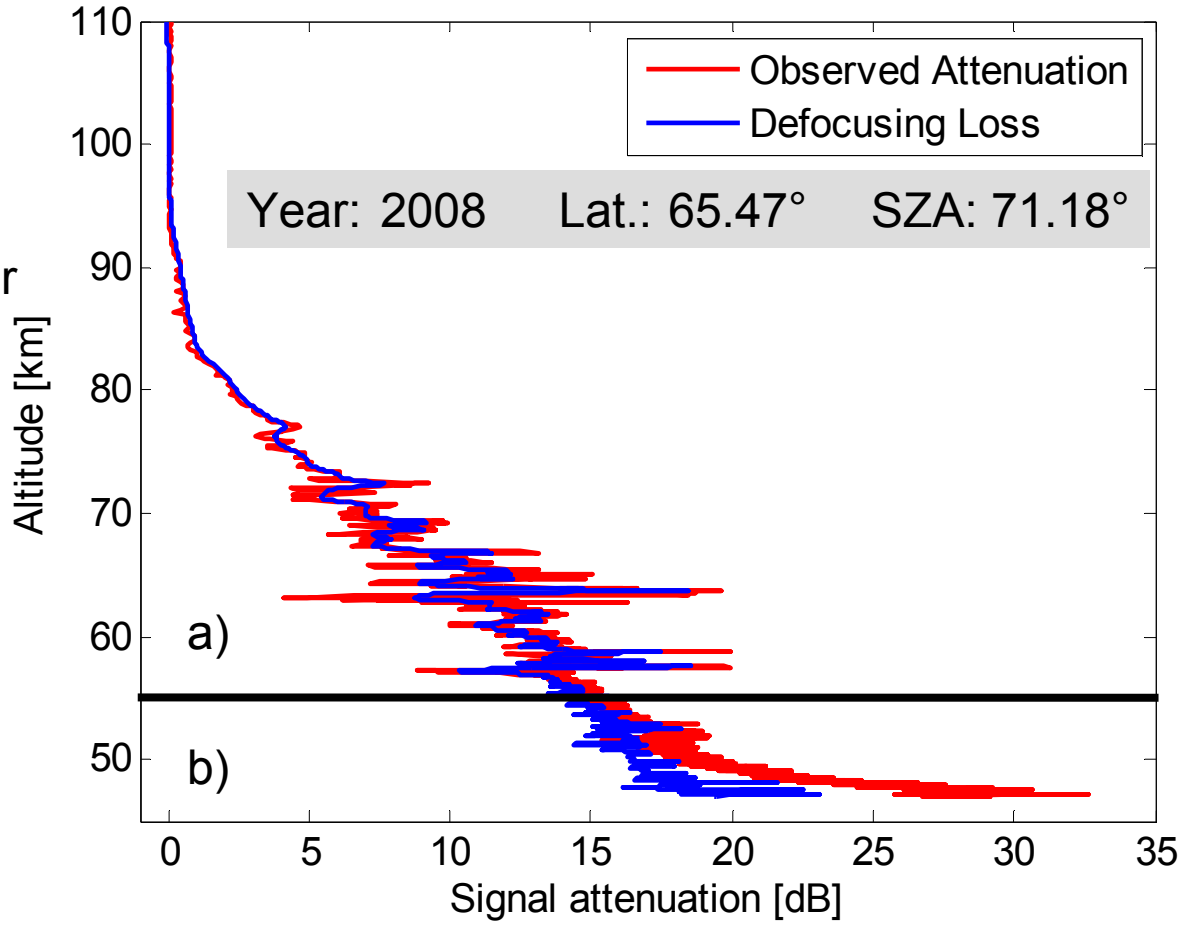
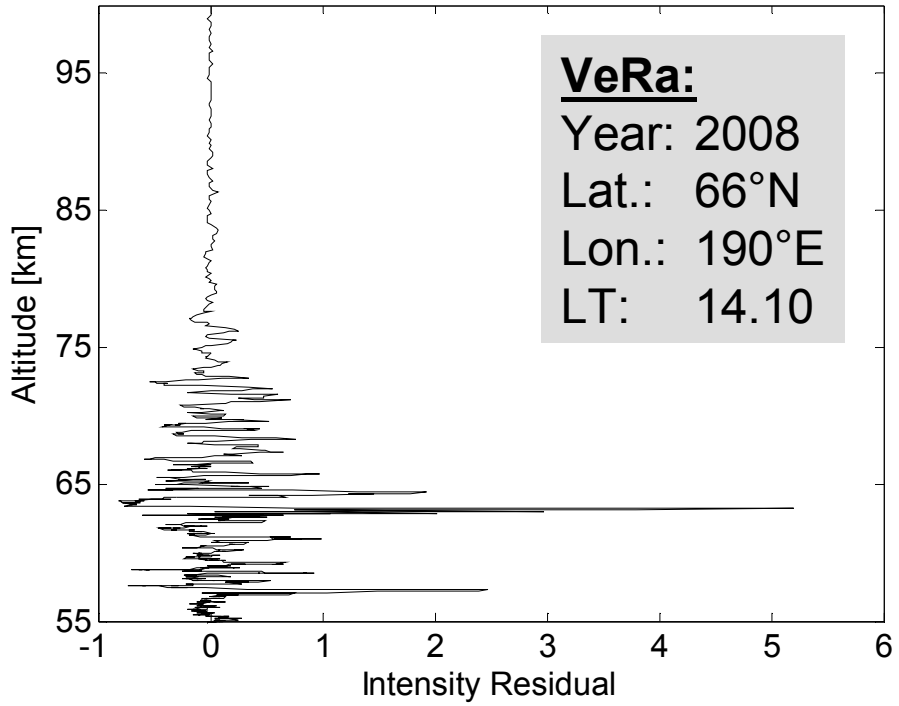
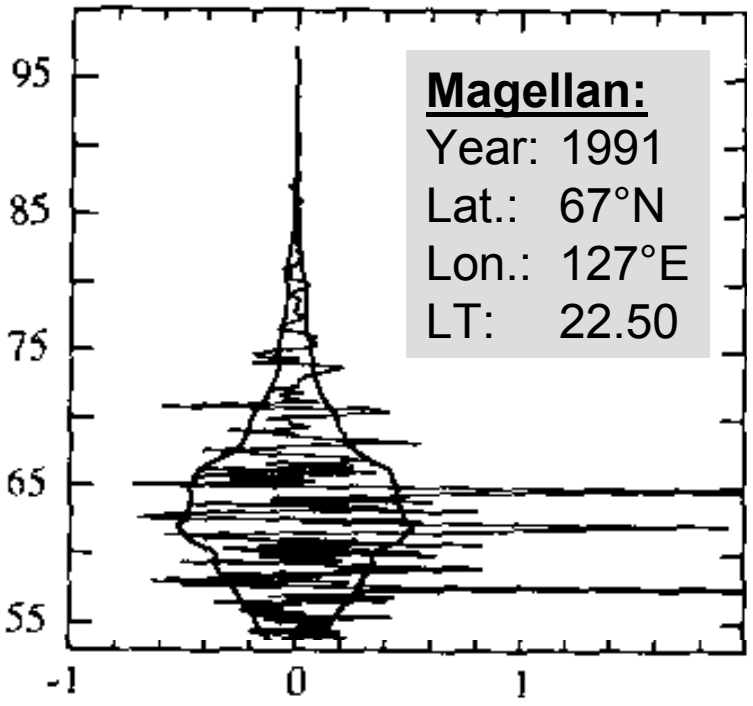


# a) Intensity Scintillations (> 55 km)

Spatial high pass filter was applied to isolate intensity scintillations

Maximal intensity scintillations are visible between 60 - 70 km altitude




Hinson and Jenkins, 1995

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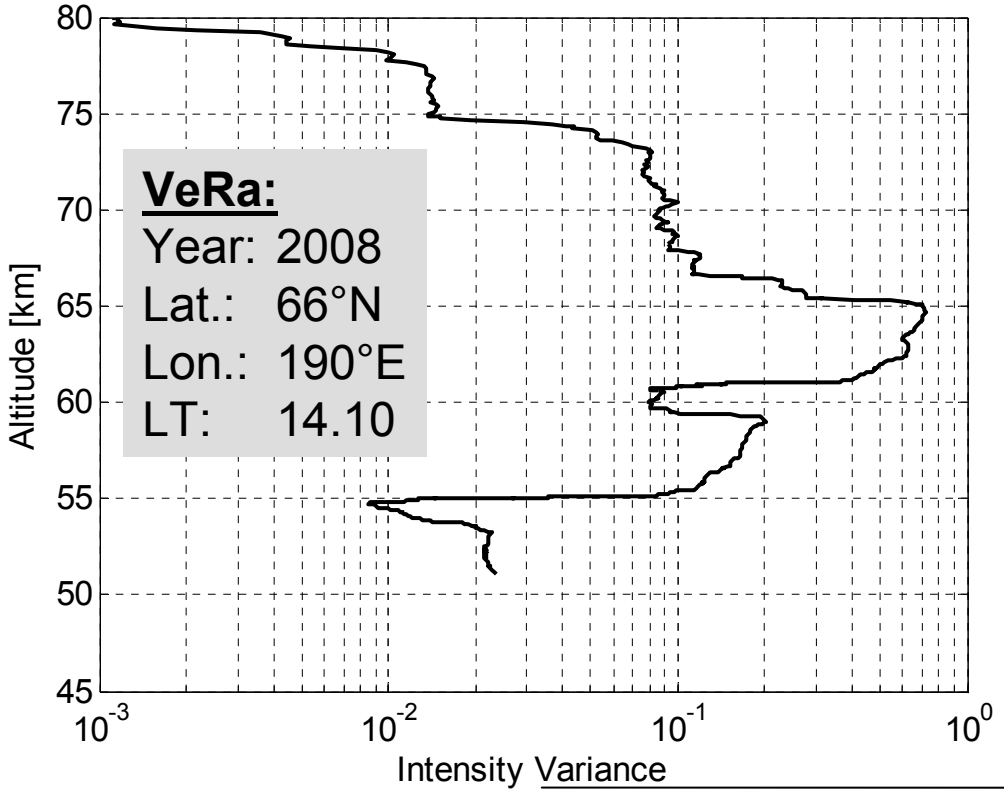
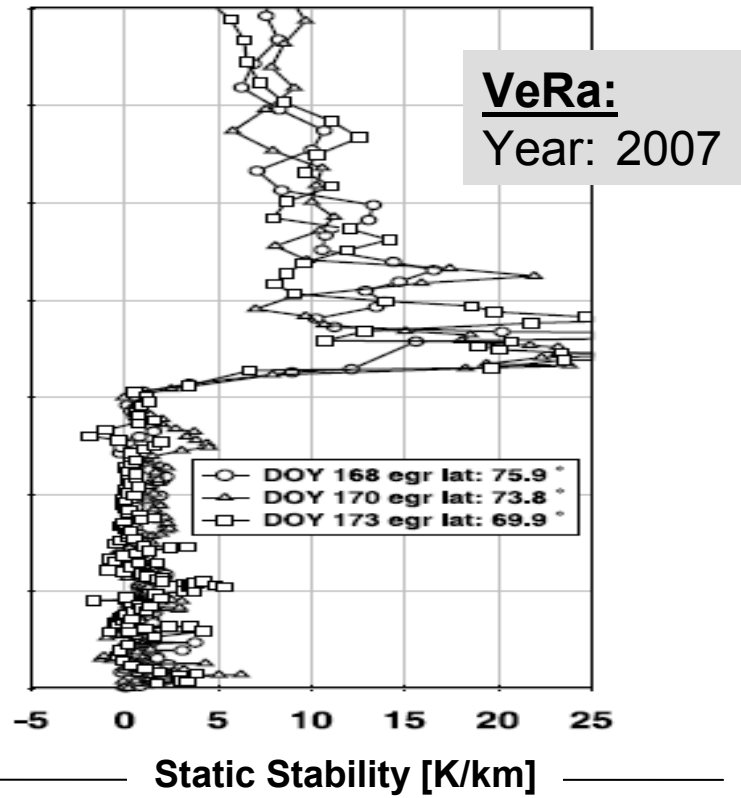



Tellmann et al., 2009



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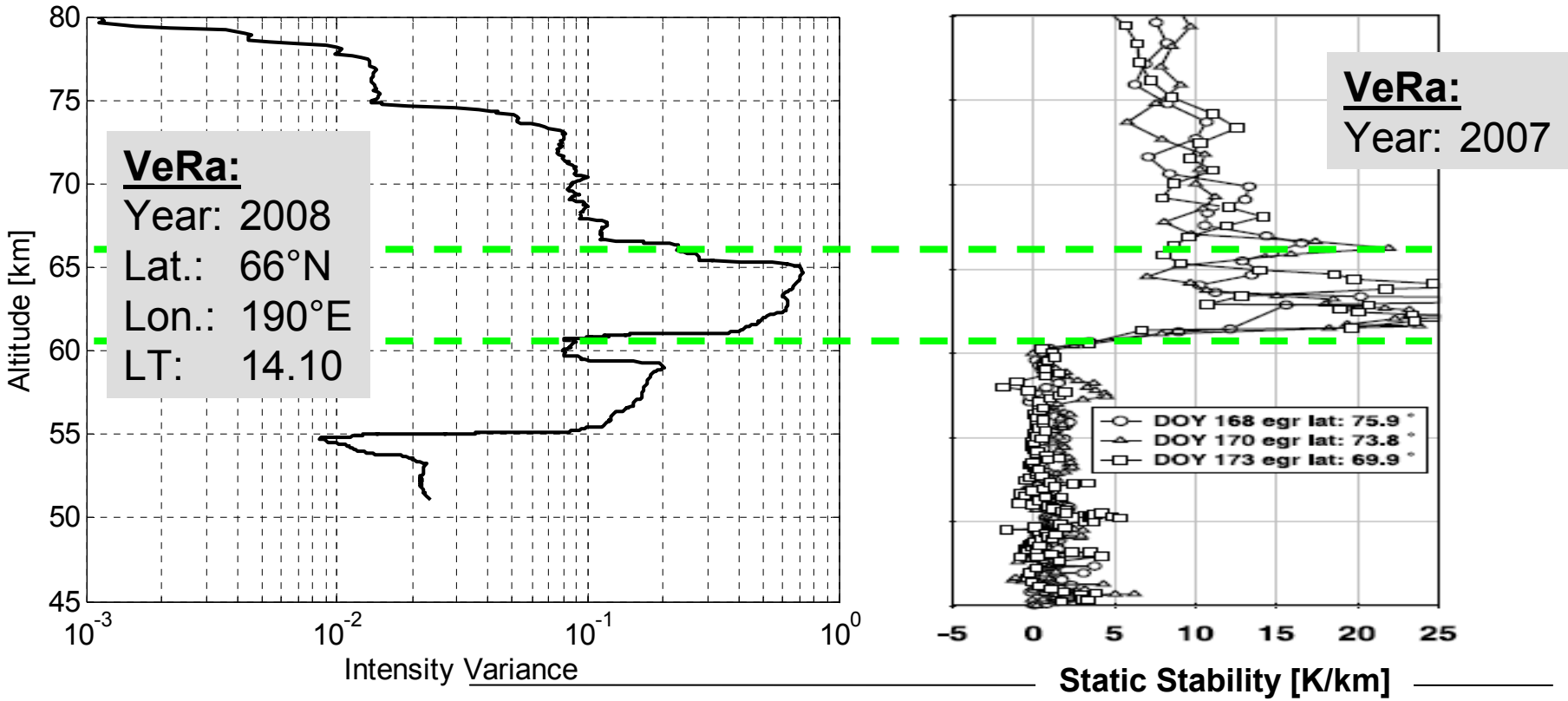

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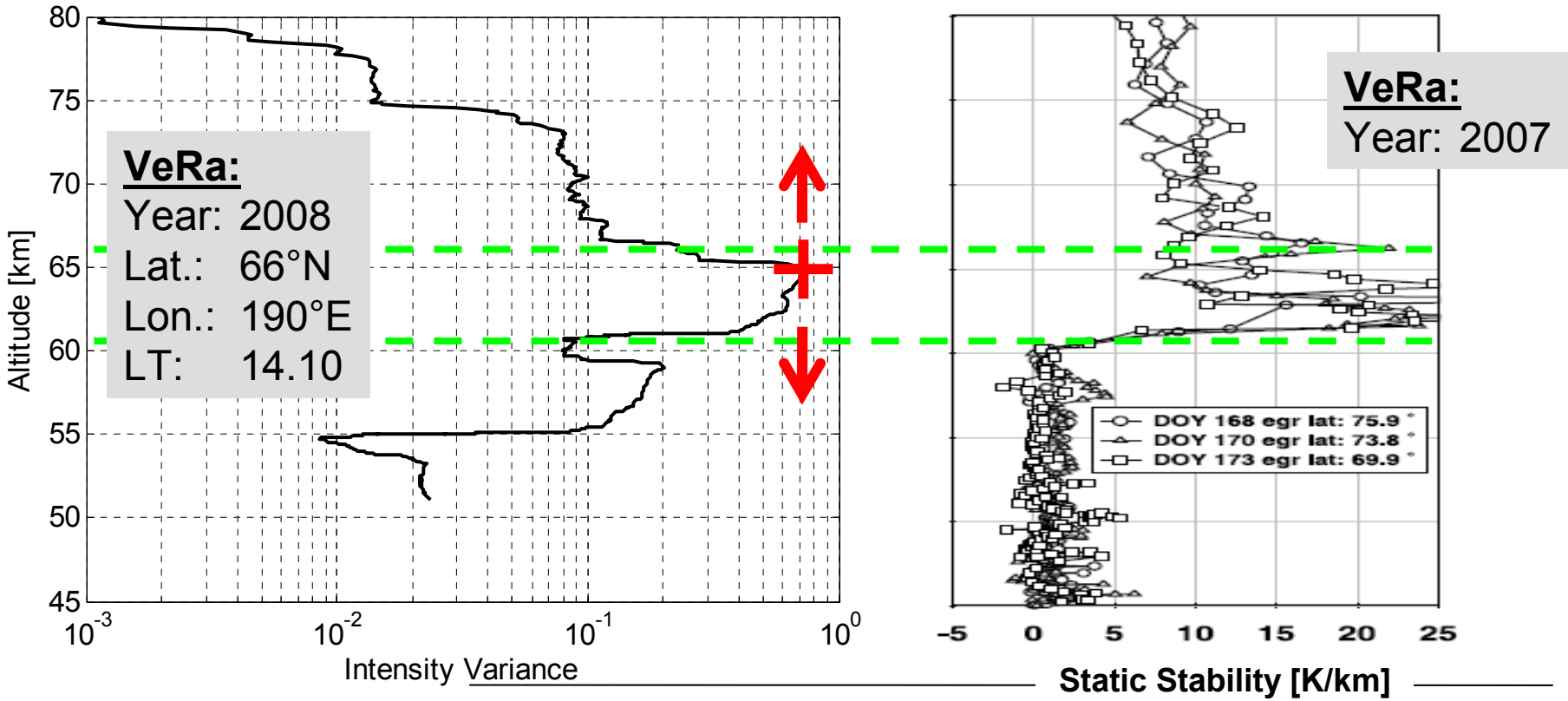

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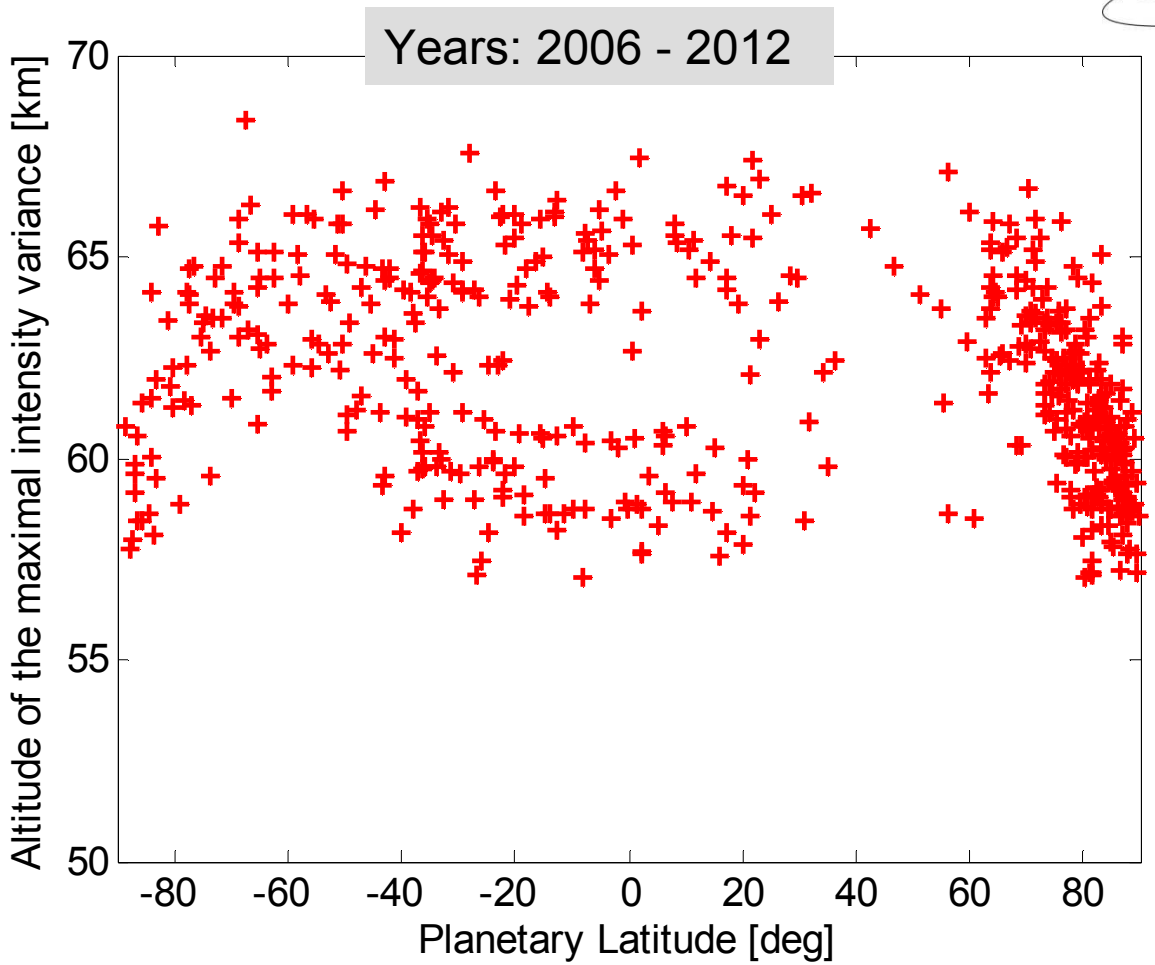

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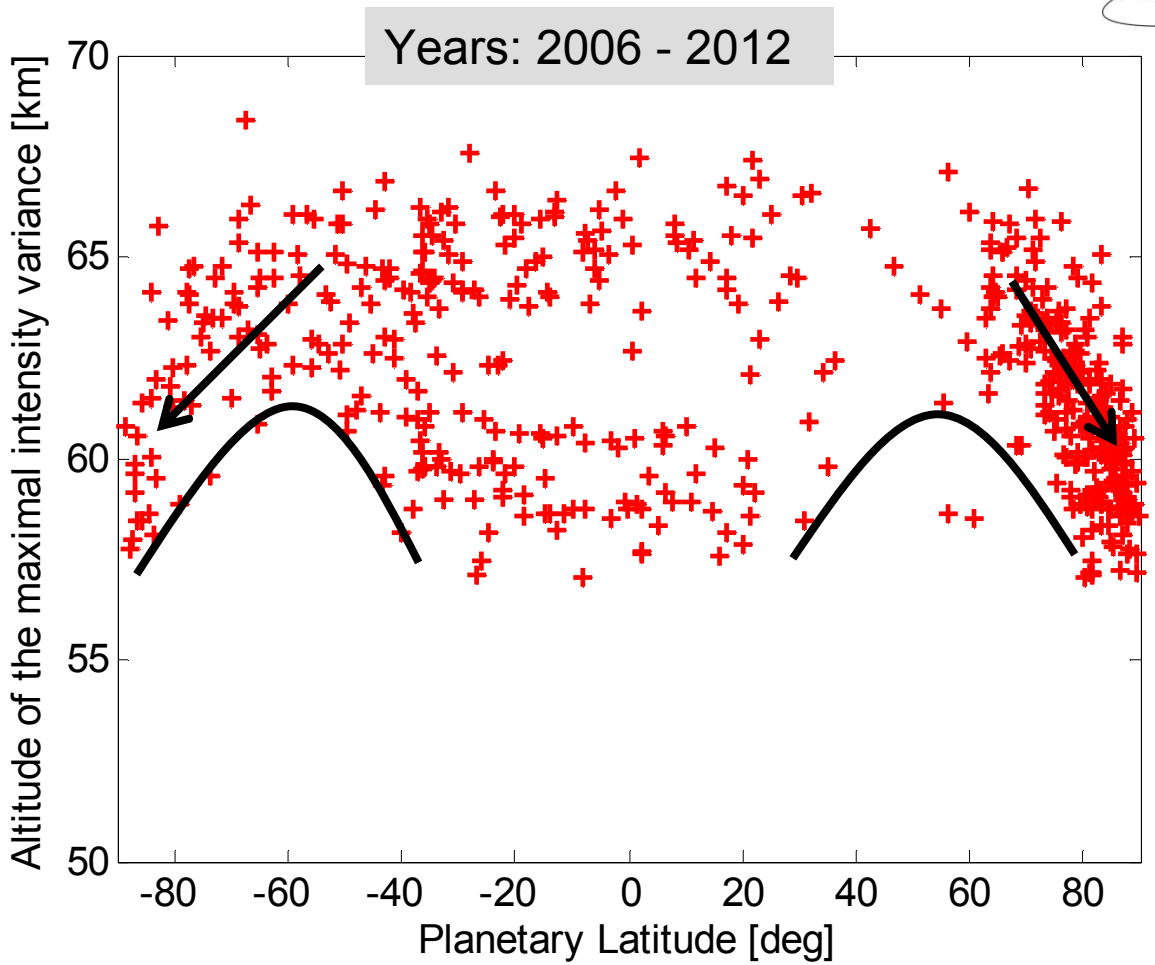

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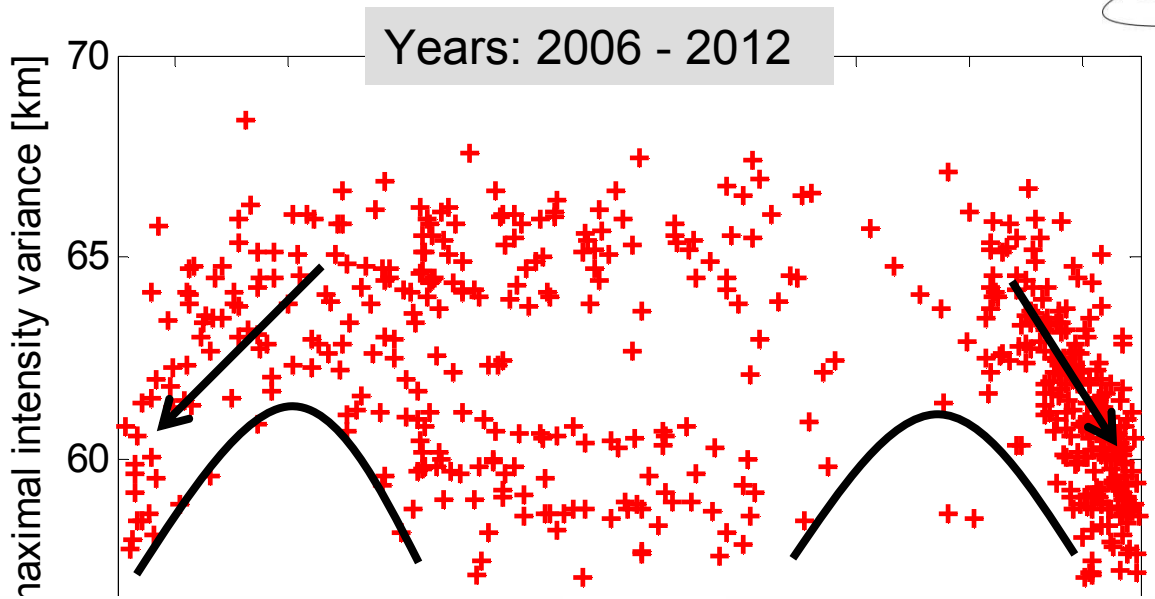


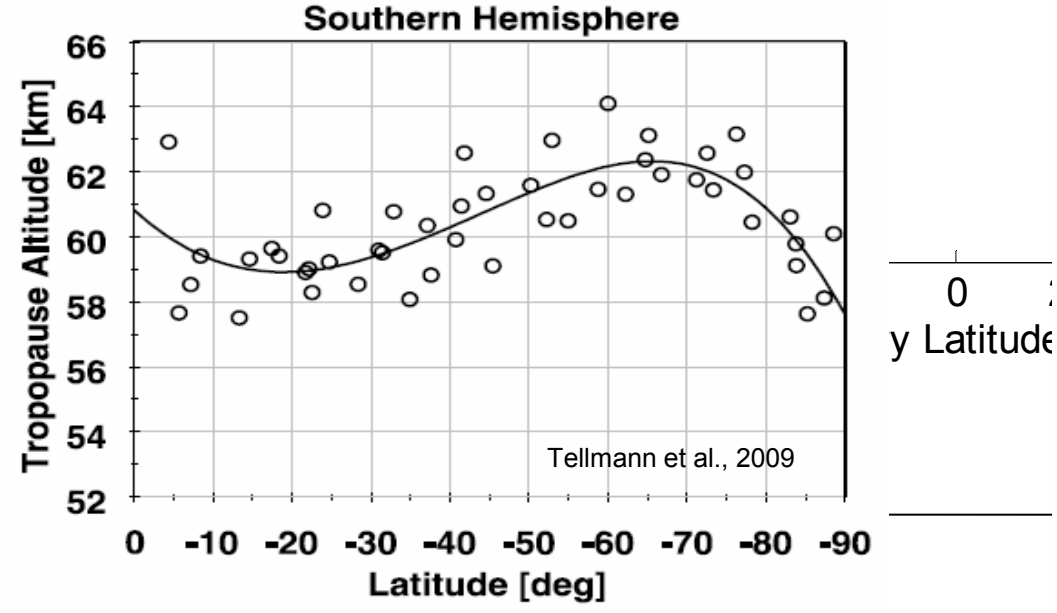


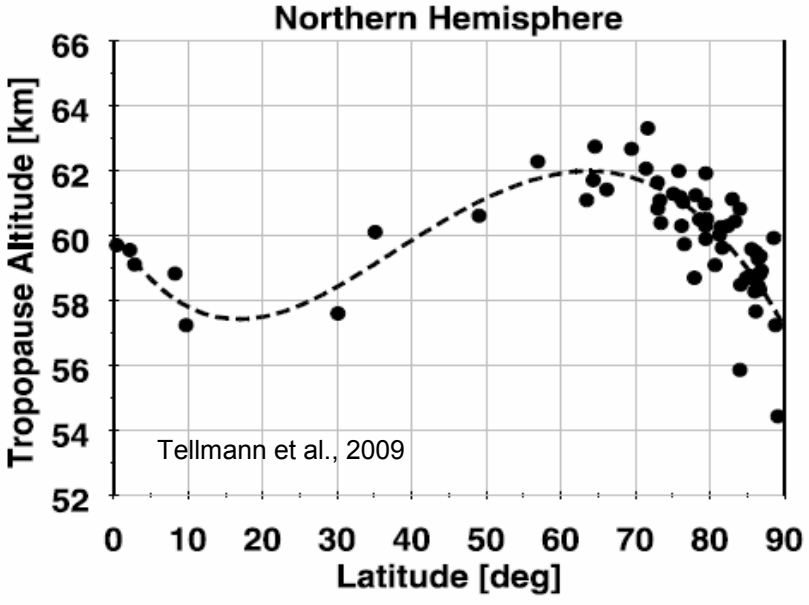

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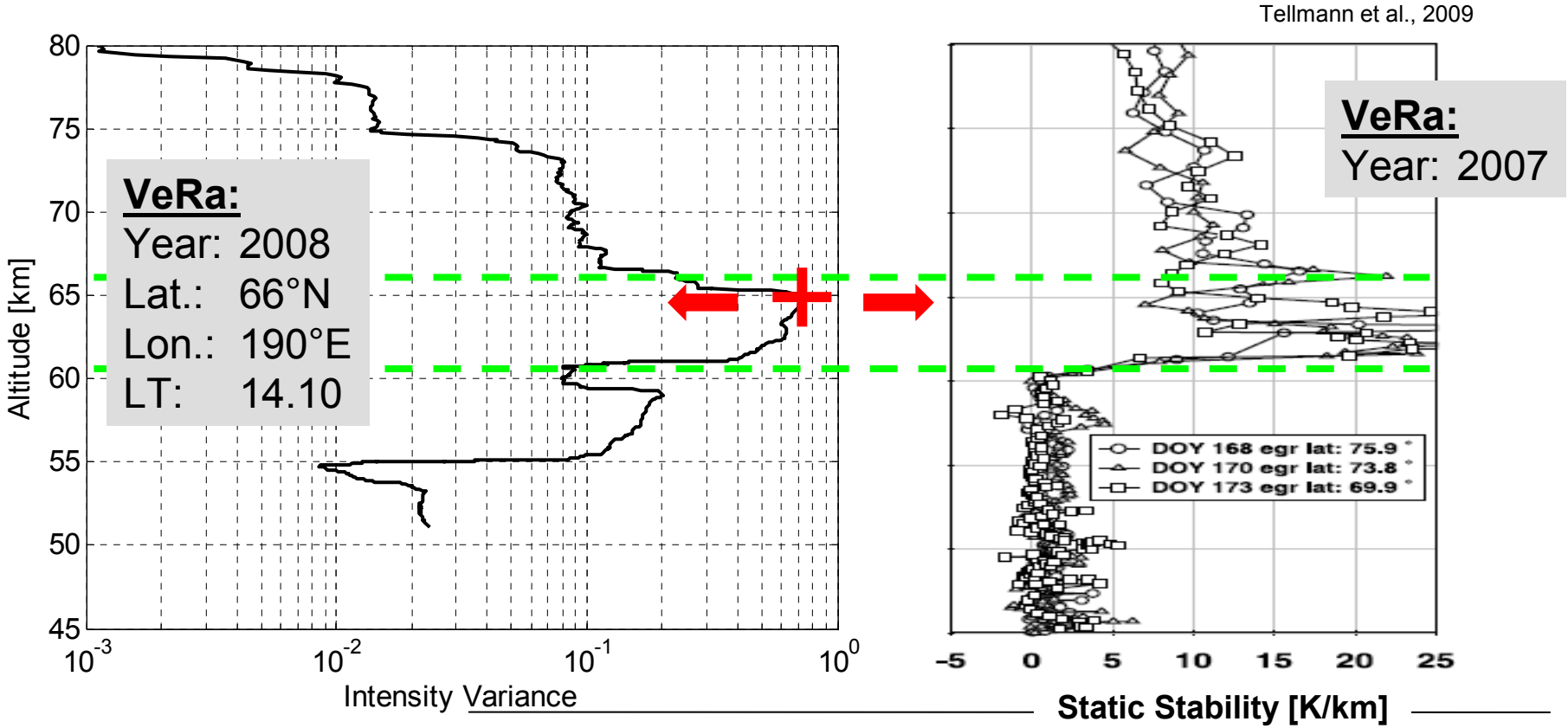

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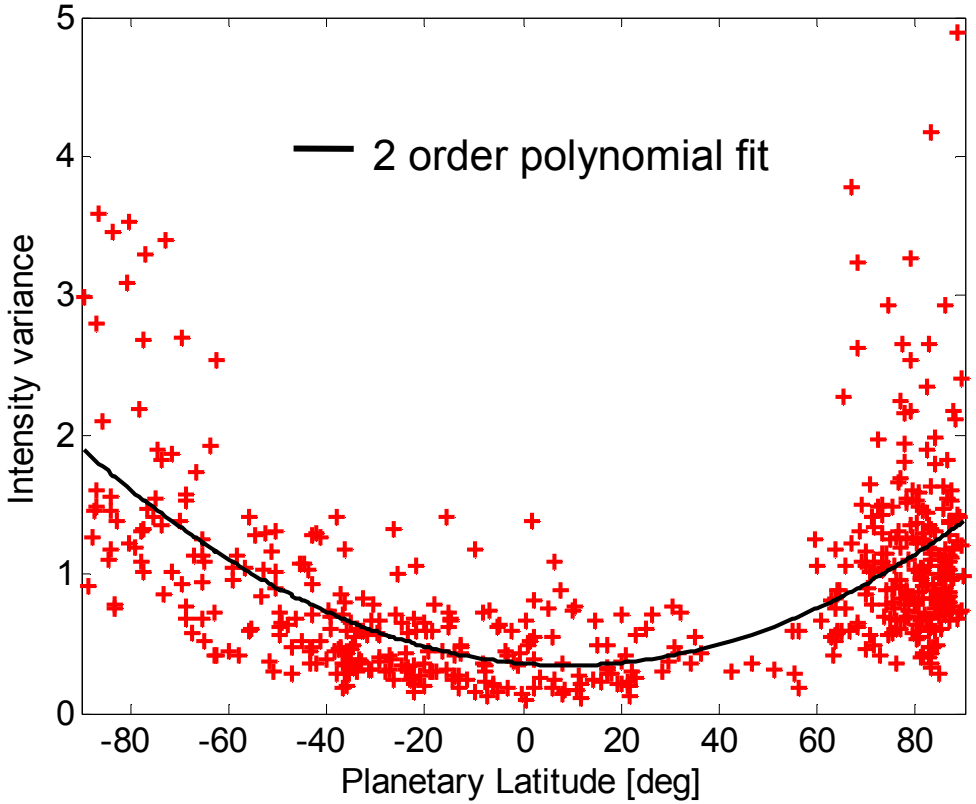
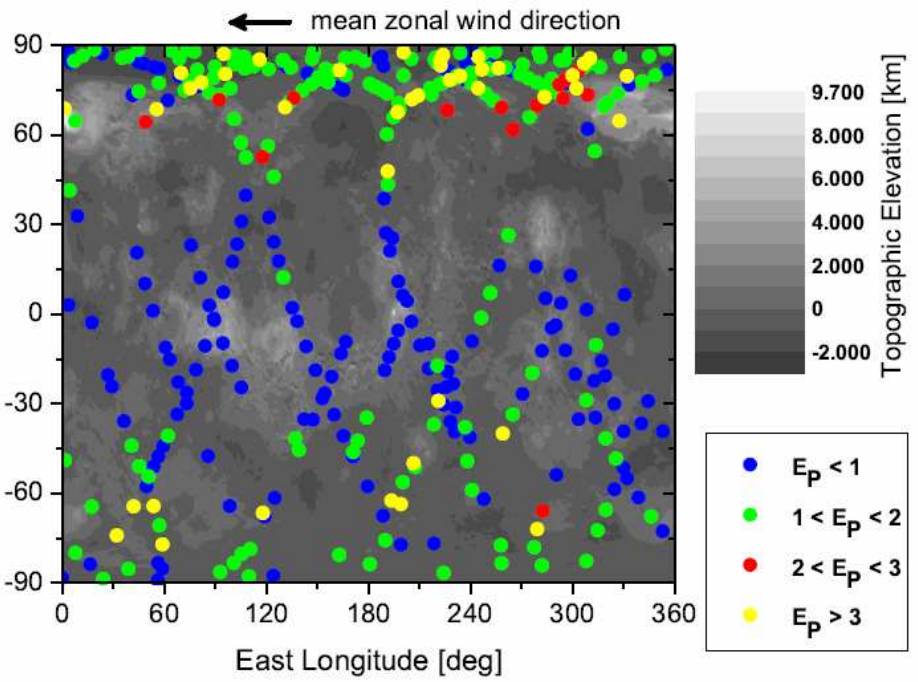
Increased intensity variations toward the polar regions




Potential energy density of gravity waves between 65 – 80 km altitude




Tellmann et al., 2012

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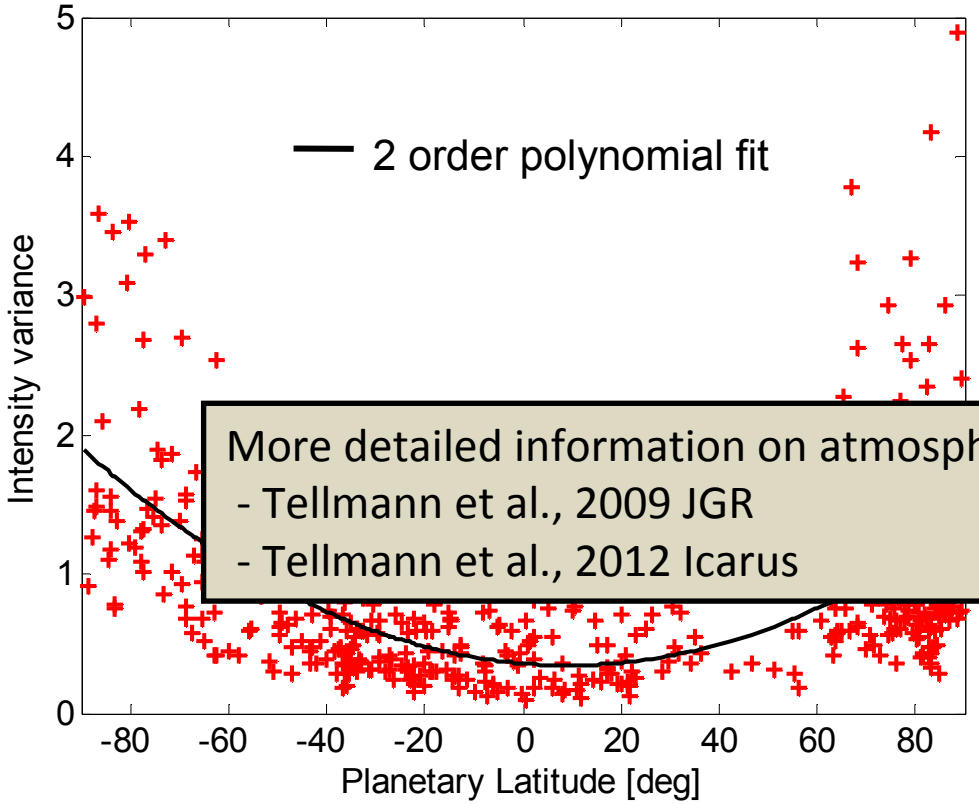


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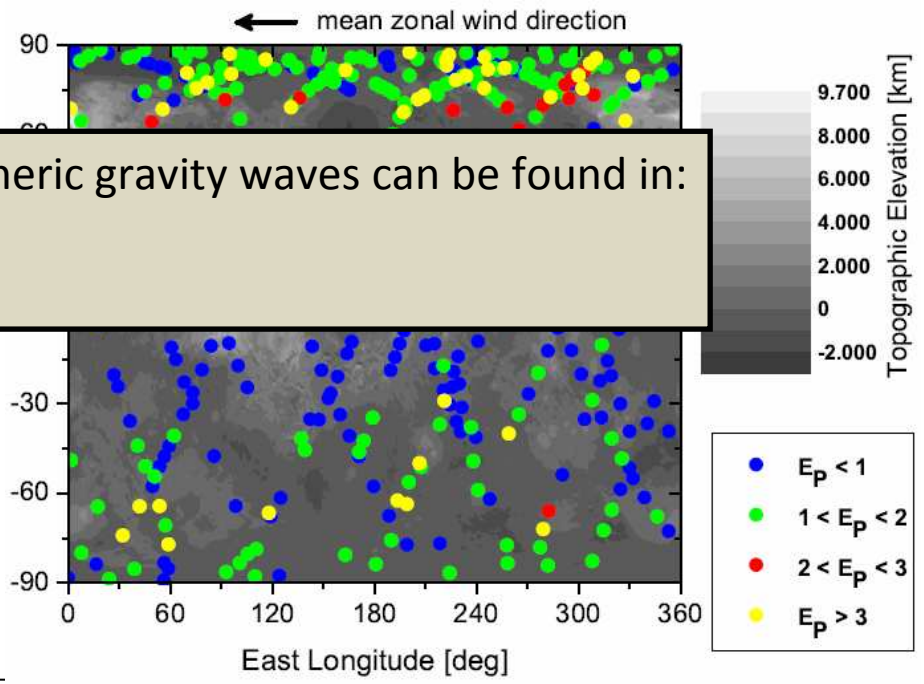


More detailed information on atmospheric gravity waves can be found in:
- Tellmann et al., 2009 JGR
- Tellmann et al., 2012 Icarus

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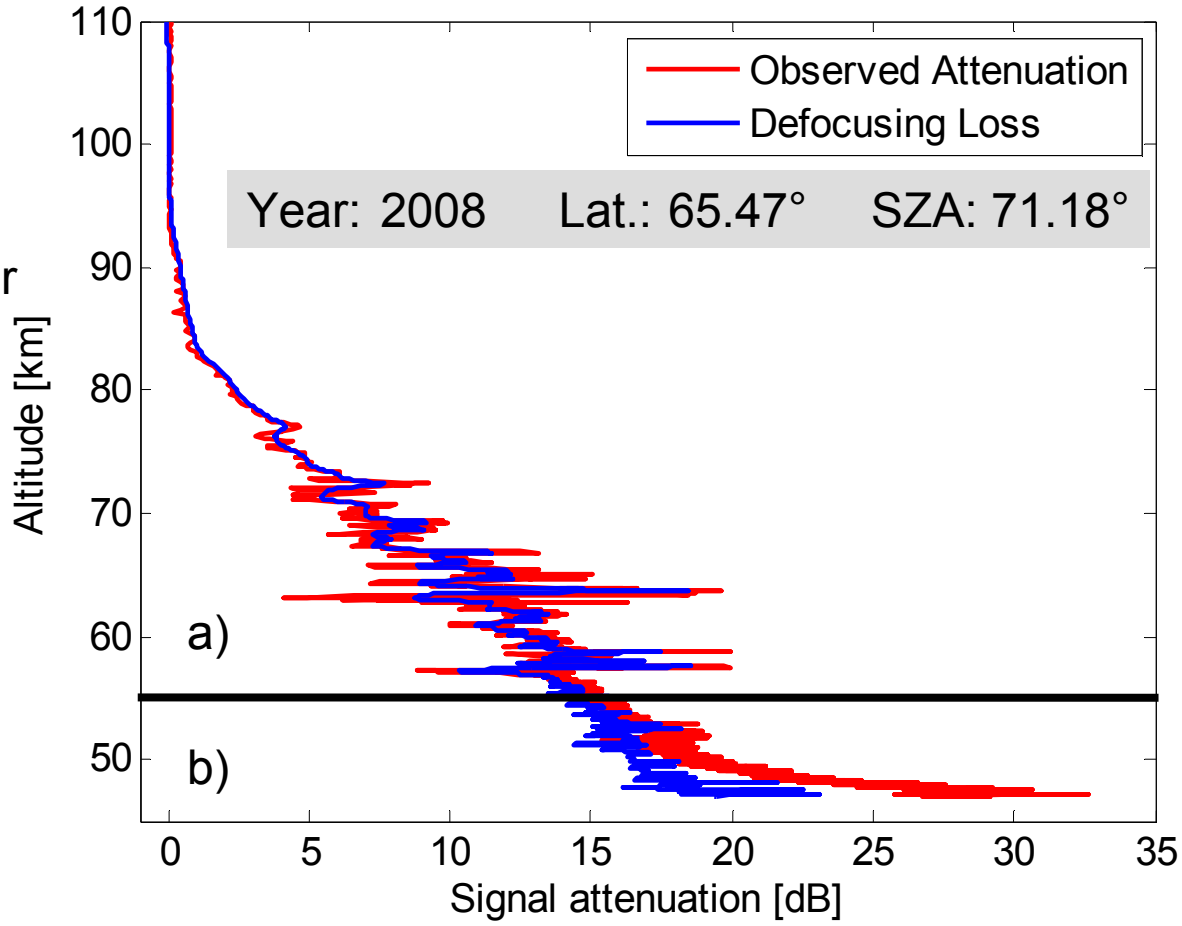

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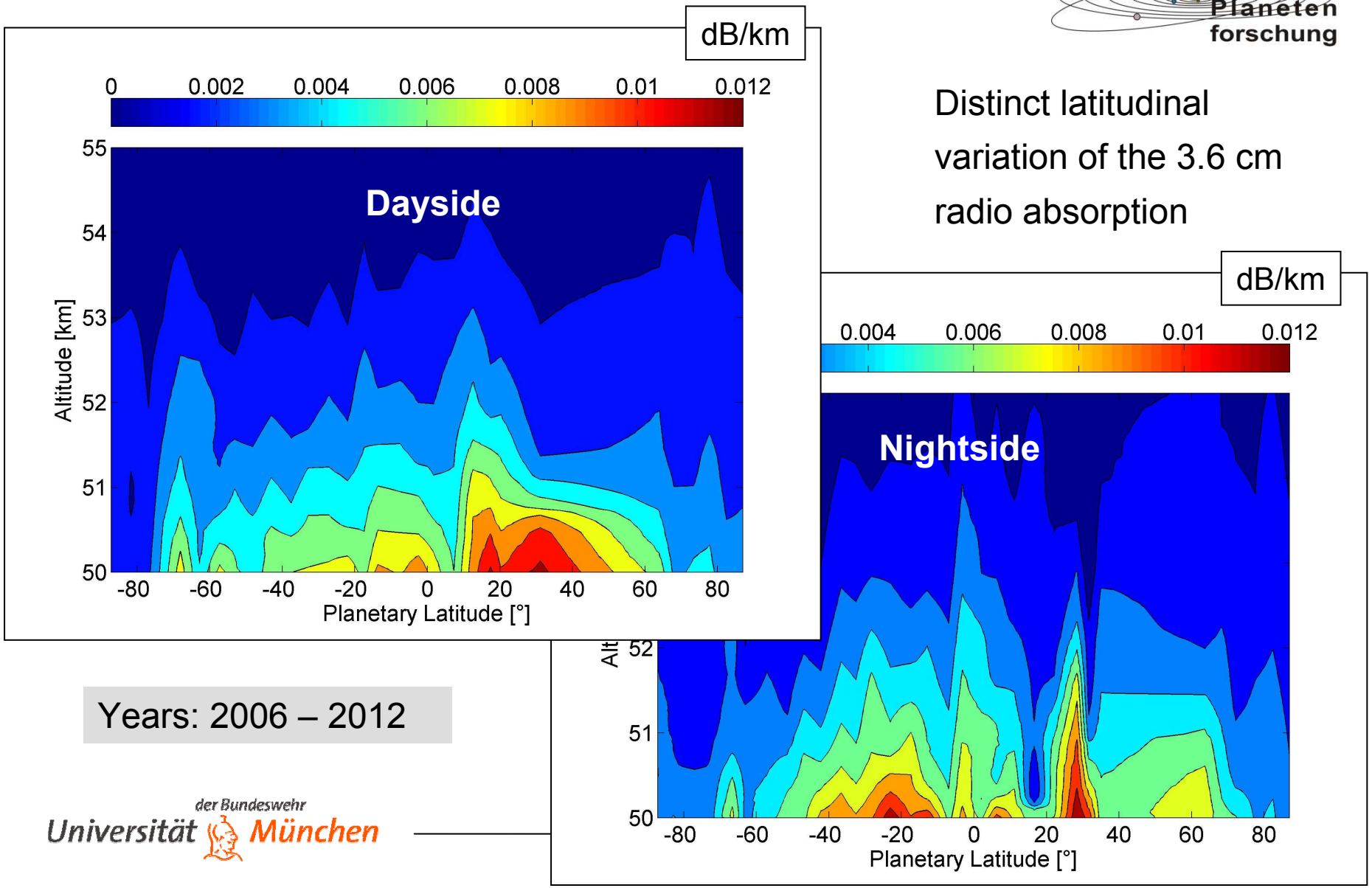
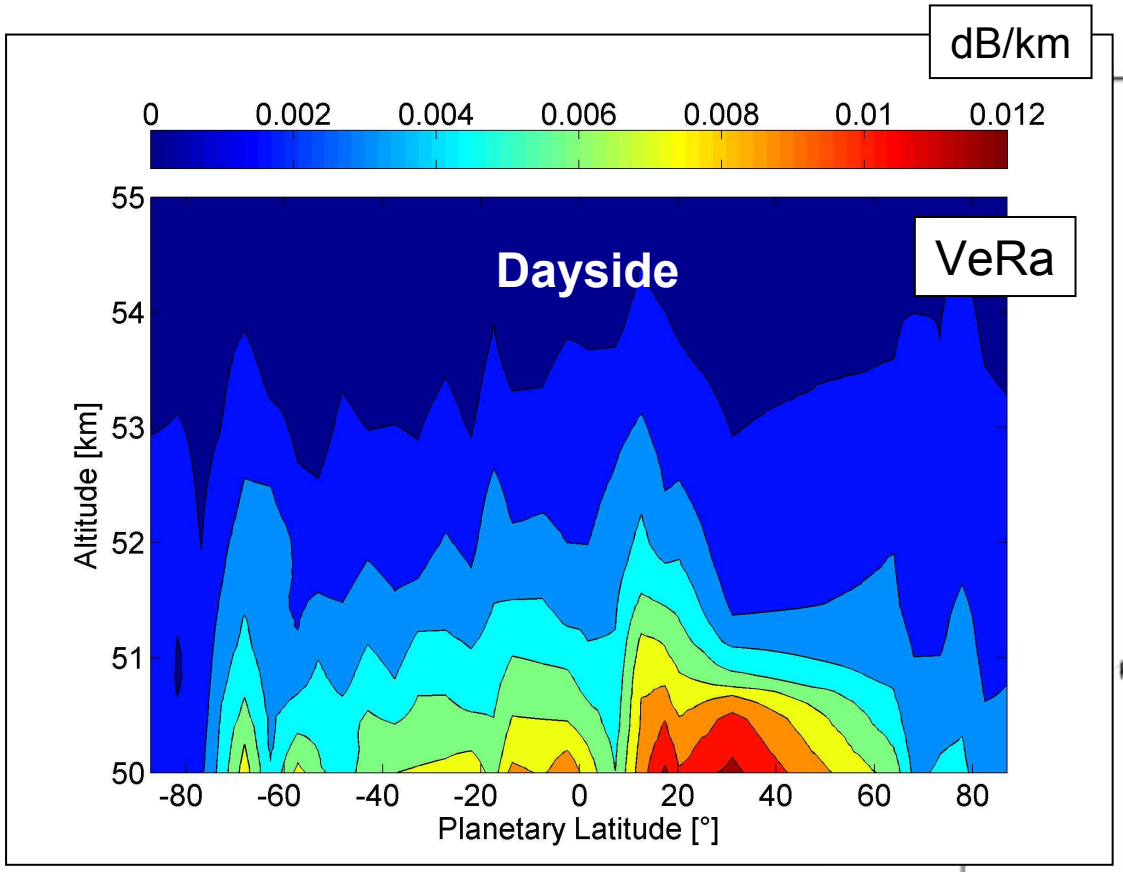
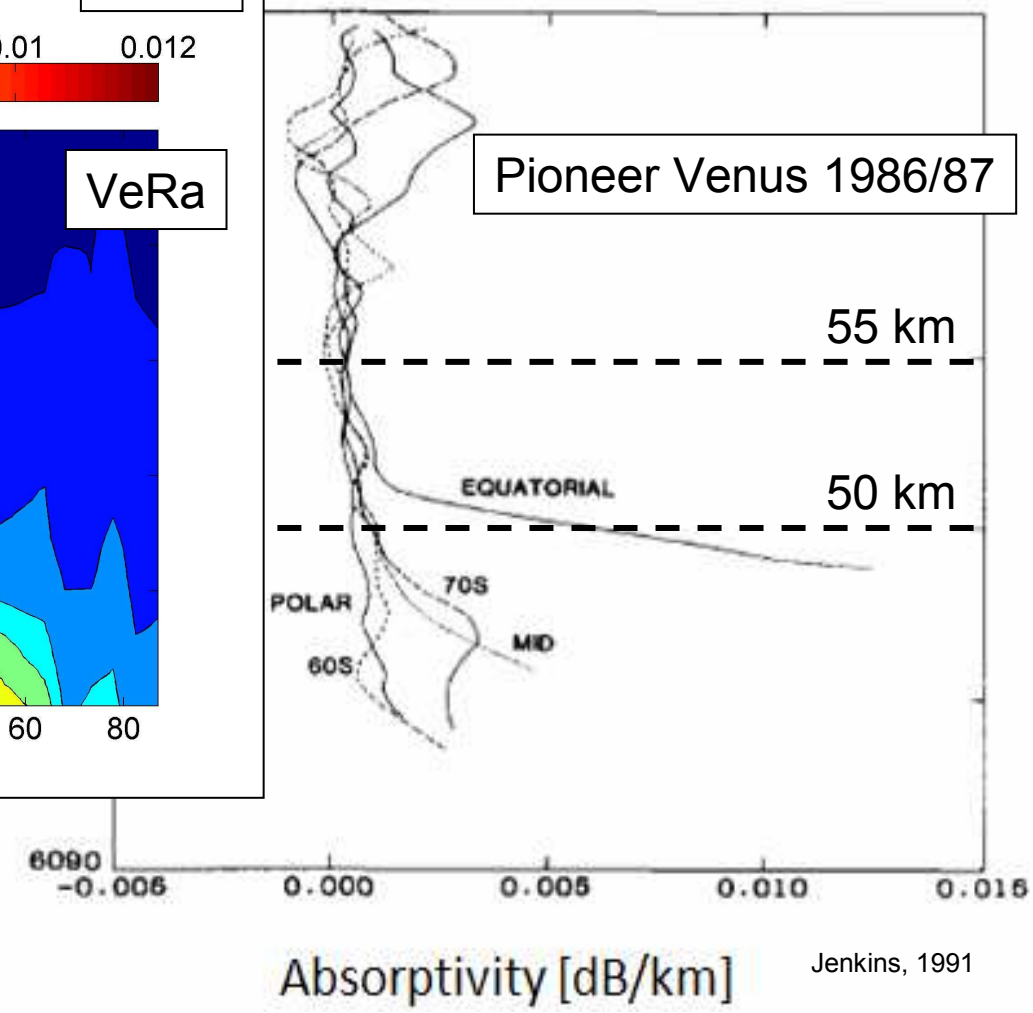



Distinct latitudinal variation of the 3.6 cm radio absorption

Years: 2006 – 2012

# b) Absorption (< 55 km)




Jenkins, 1991

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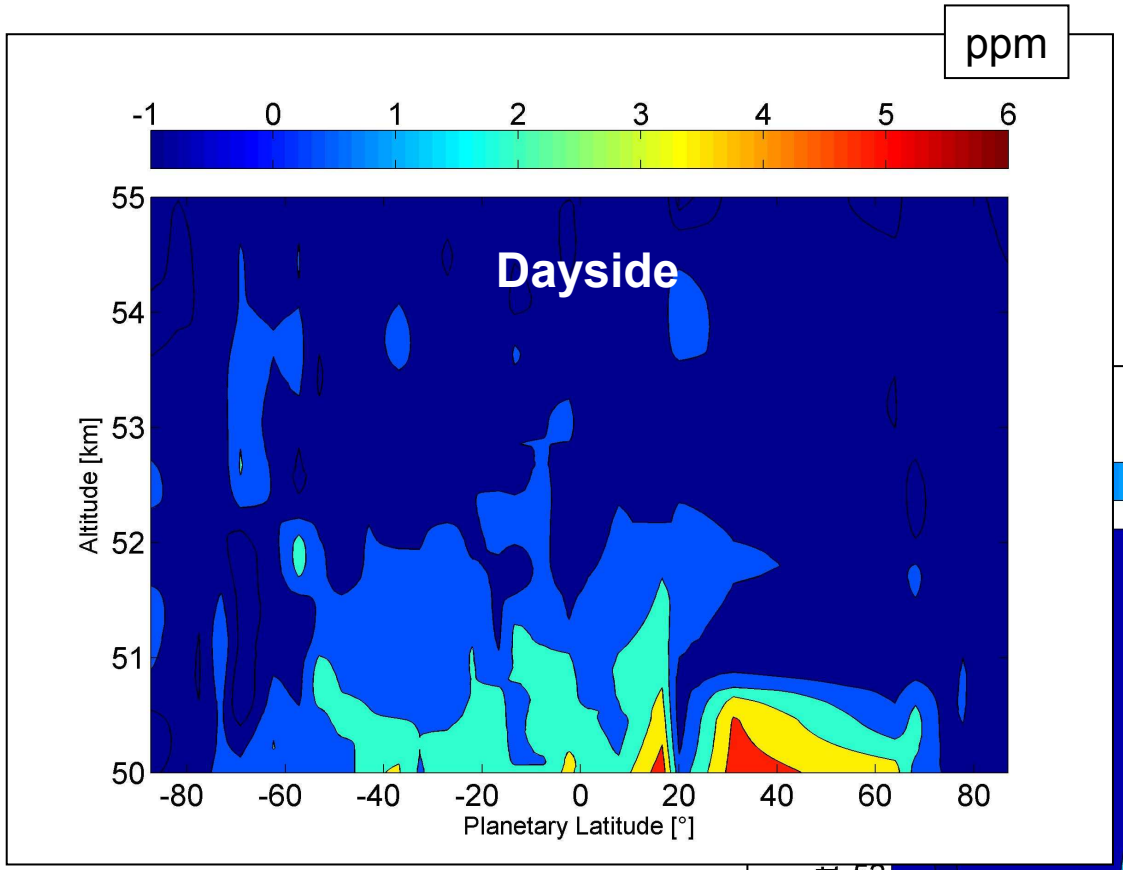
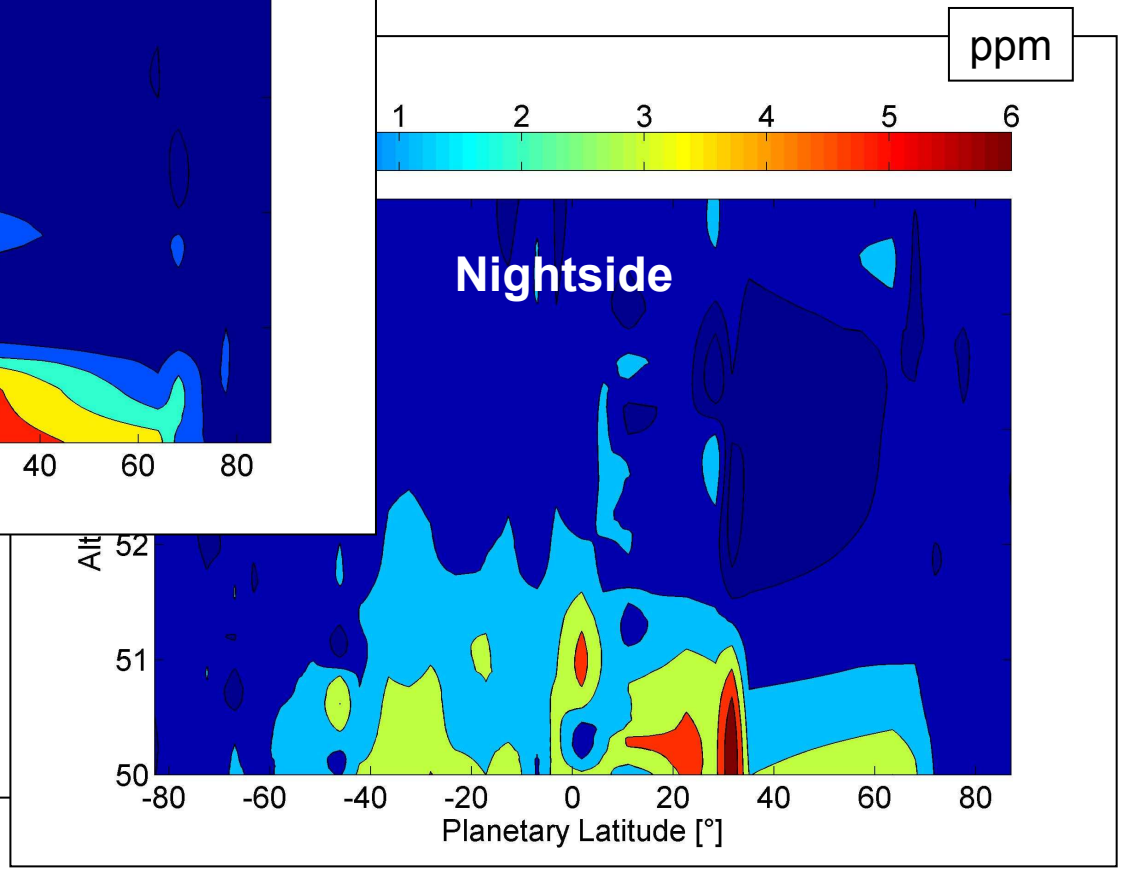



Increased sulfuric acid vapor abundance near the cloud base at low latitudes.

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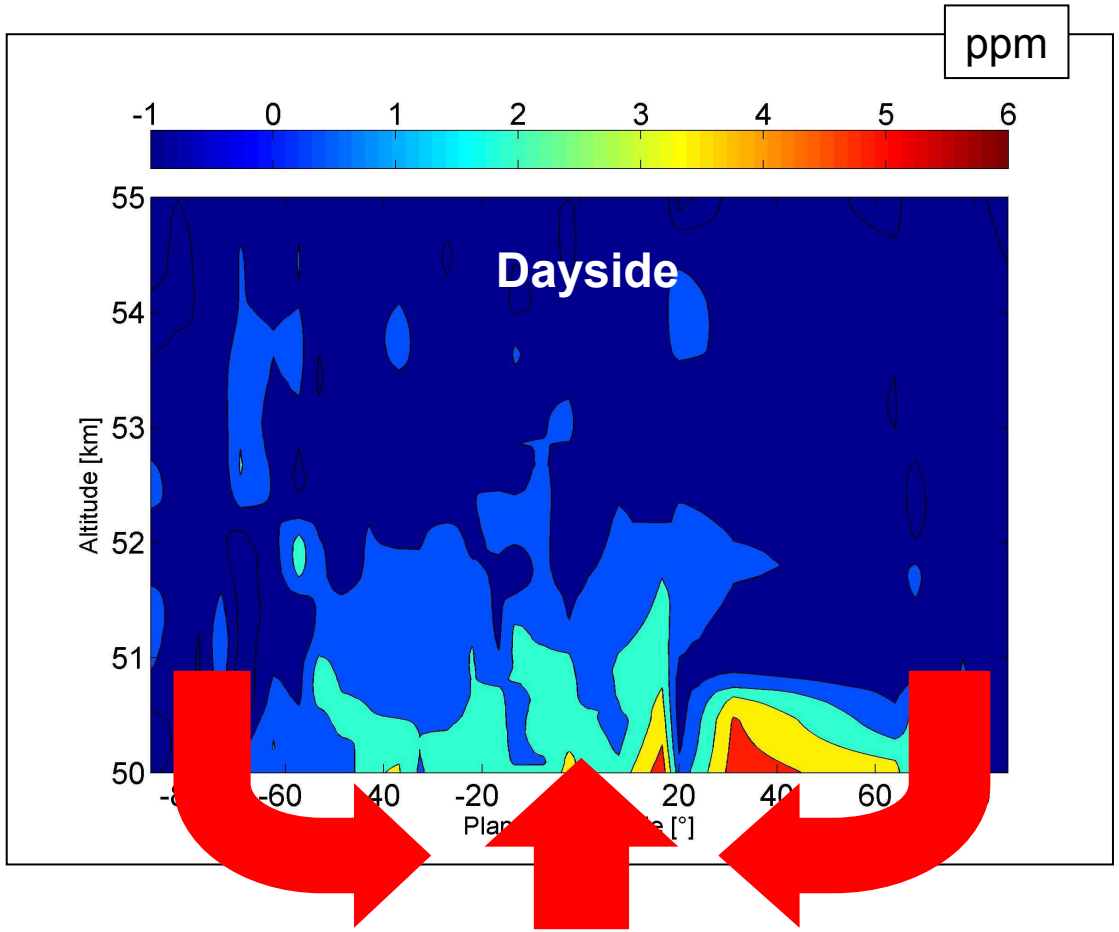


Increased sulfuric acid vapor abundance near the cloud base at low latitudes.

$H_2SO_4$ accumulation may be the result of the atmospheric dynamics.
→ Hadley Circulation

# Summary

- Increased Intensity scintillations above 55 km altitude, most likely caused by vertical propagating gravity waves.
- Distinct latitudinal variation of the wave activity.
- Absorption of radio waves above 55 km is weak or non-existent.
- Absorption of the radio signals can be used to determine the abundance of sulfuric acid vapor below 55 km:

| Venus Express: | | Mariner 10: | Magellan: |
|---|---|---|---|
| 50°N – 50°S | : 2 - 3 ppm | 2 - 3 ppm | |
| 50°N/S – 70°N/S | : 1 - 2 ppm | Lipa and Tyler, 1979; Kolodner and Steffes, 1998 | 1 - 2 ppm |
| > 70°N/S | : < 1 ppm | | Jenkins et al., 1994; Kolodner and Steffes, 1998 |