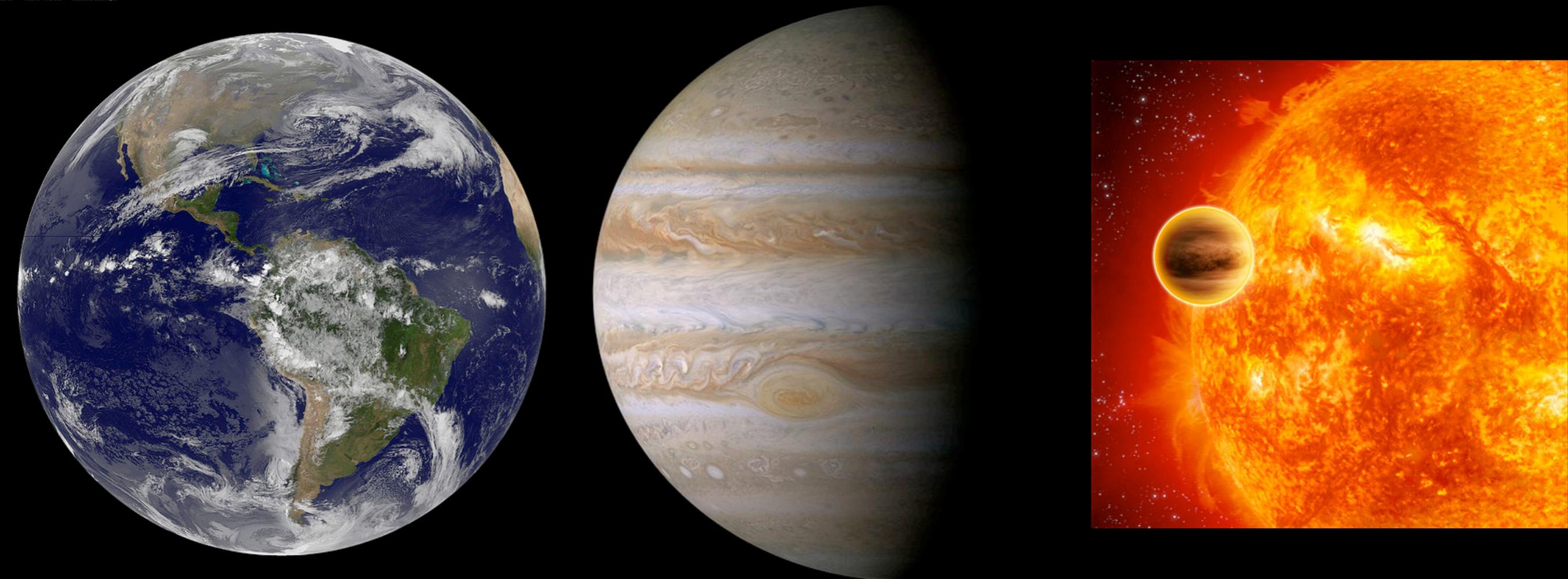


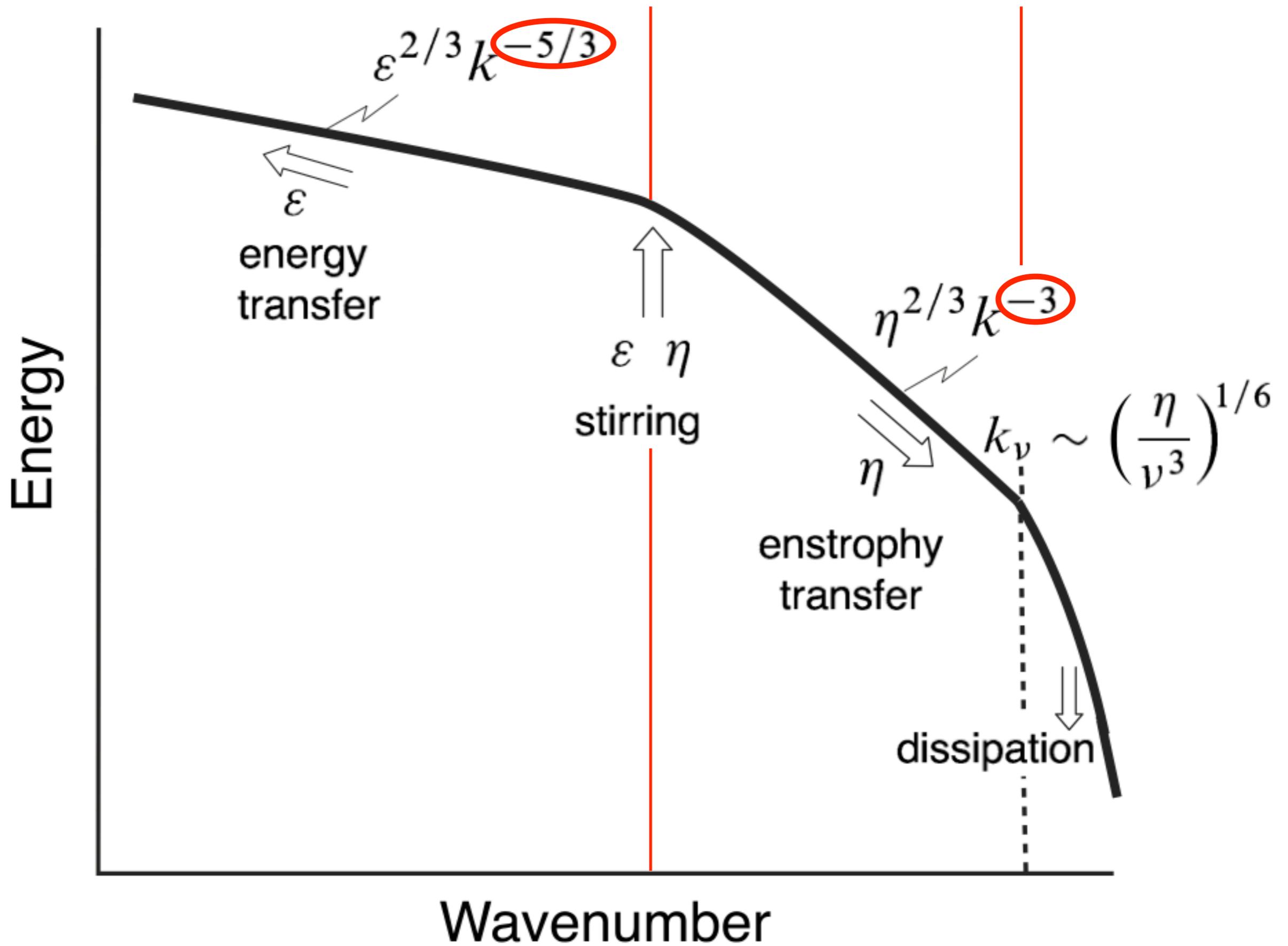
Inverse Energy Cascades in Terrestrial, Jovian, and Exoplanet Atmospheres

05 12 10014 11:45 UTC NASA/GIC GOES-R/Earth



David S. Choi and Adam P. Showman
University of Arizona, Dept. of Planetary Sciences

Credit: (L) NASA/GSFC/GOES/NOAA, (M) NASA/JPL/SSI, (R) ESA - C. Carreau



(Figure 8.7 from Vallis, 2006)

A Climatology of Atmospheric Wavenumber Spectra of Wind and Temperature Observed by Commercial Aircraft

G. D. NASTROM

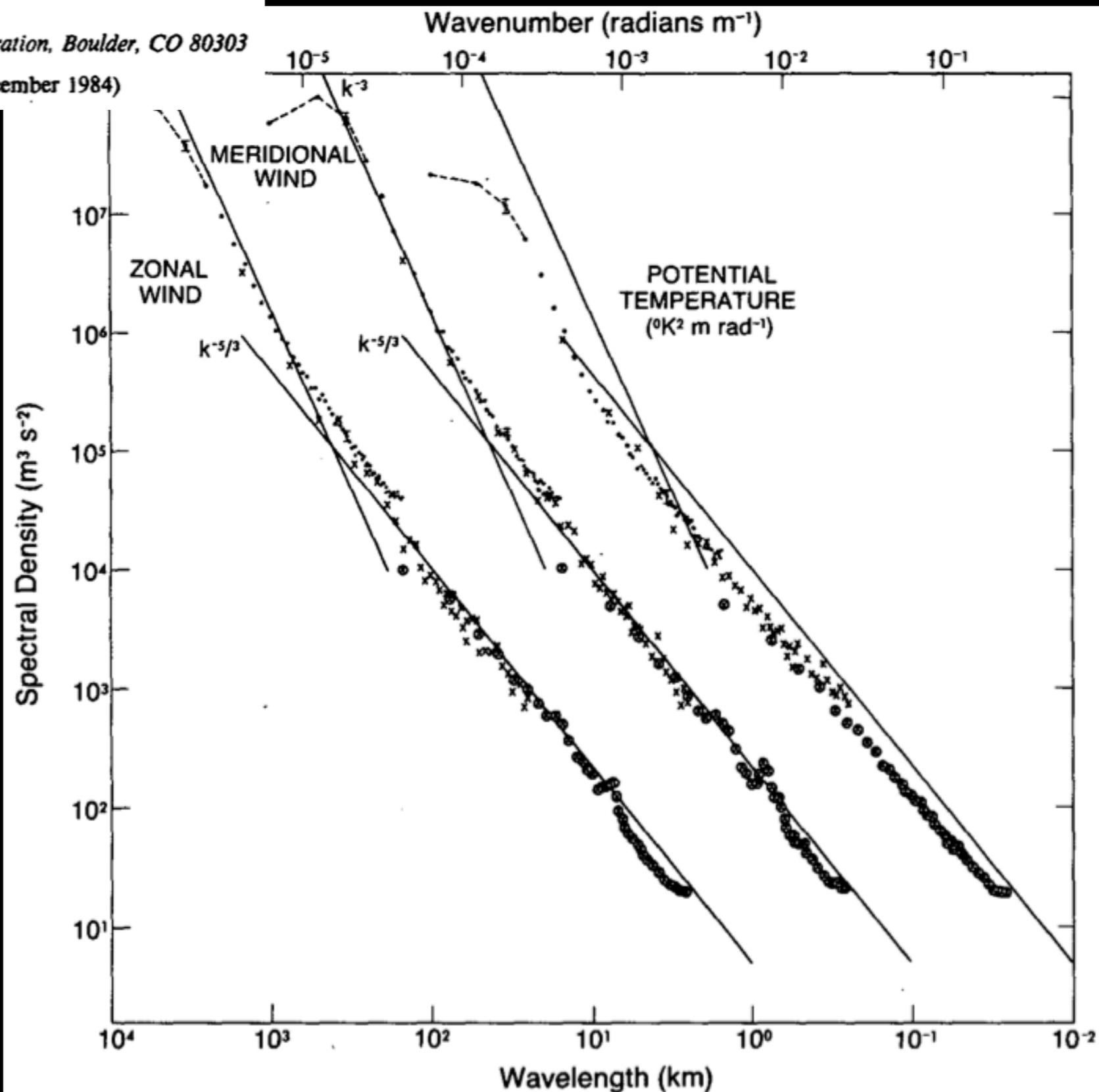
Control Data Corporation, Minneapolis, MN 55440

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(Manuscript received 2 April 1984, in final form 4 December 1984)

(Nastrom and
Gage, 1985)



Questioning Inverse Cascade in Earth's Atmosphere

What is the energy source?

What are the sinks?

**The k^{-3} and $k^{-5/3}$ Energy Spectrum of Atmospheric Turbulence:
Quasigeostrophic Two-Level Model Simulation**

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(Manuscript received 22 March 2001, in final form 26 September 2002)

**A theory for the atmospheric energy spectrum:
Depth-limited temperature anomalies
at the tropopause**

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Communicated by Andrew J. Majda, New York University, New York, NY, June 30, 2006 (received for review May 23, 2006)

(Tung and Orlando, 2003) | (Tulloch and Smith, 2006)

The nature of large-scale turbulence in the Jovian atmosphere

Mitchell, J. L.

Jupiter's Tropospheric Thermal Emission

II. Power Spectrum Analysis and Wave Search

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Brightness power spectral distribution and waves in Jupiter's upper cloud and hazes

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(Mitchell, 1982) (Harrington et al., 1996) (Barrado-Izagirre et al., 2009)

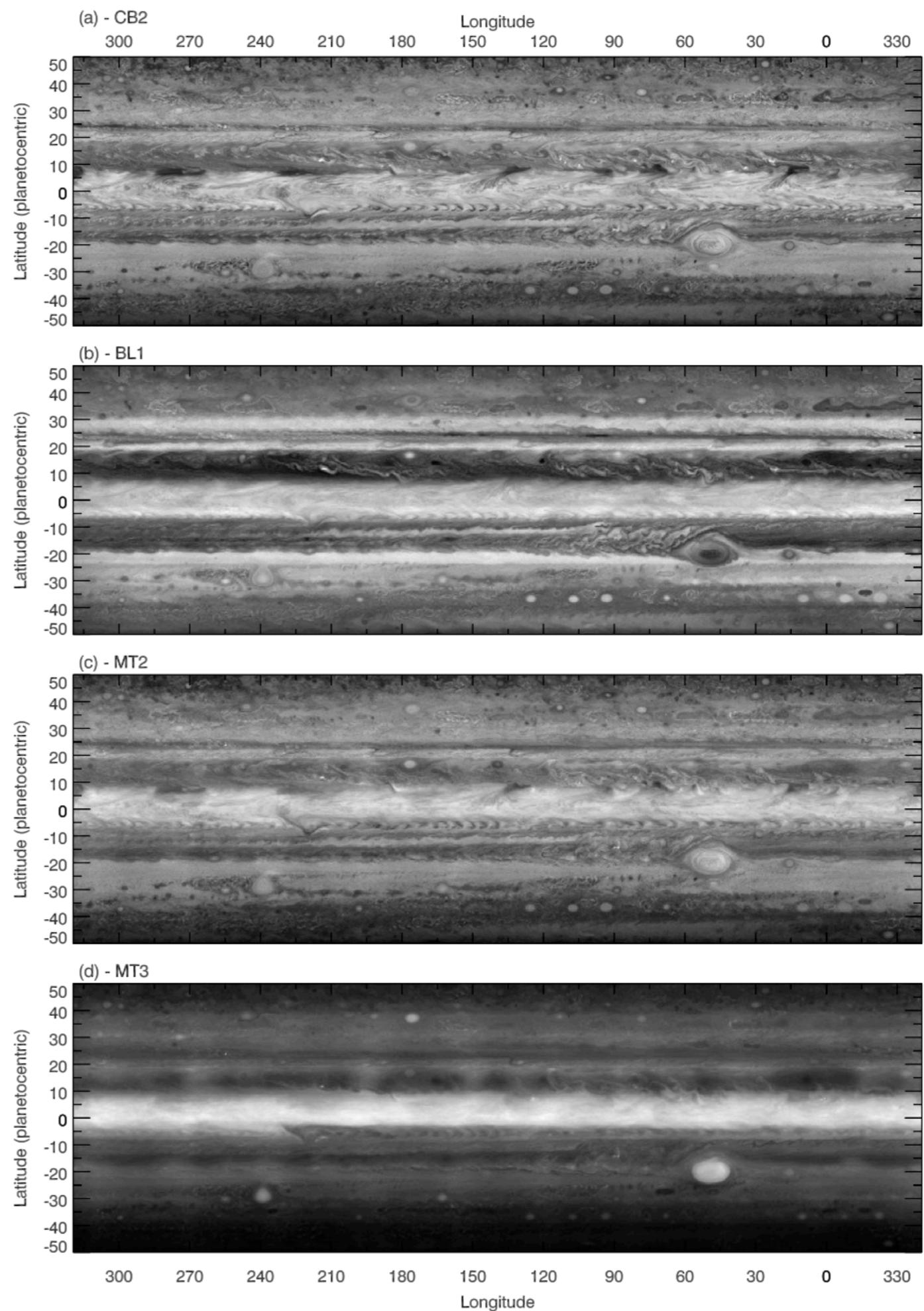
Cassini ISS Data

Near-infrared
[CB2, 756 nm]

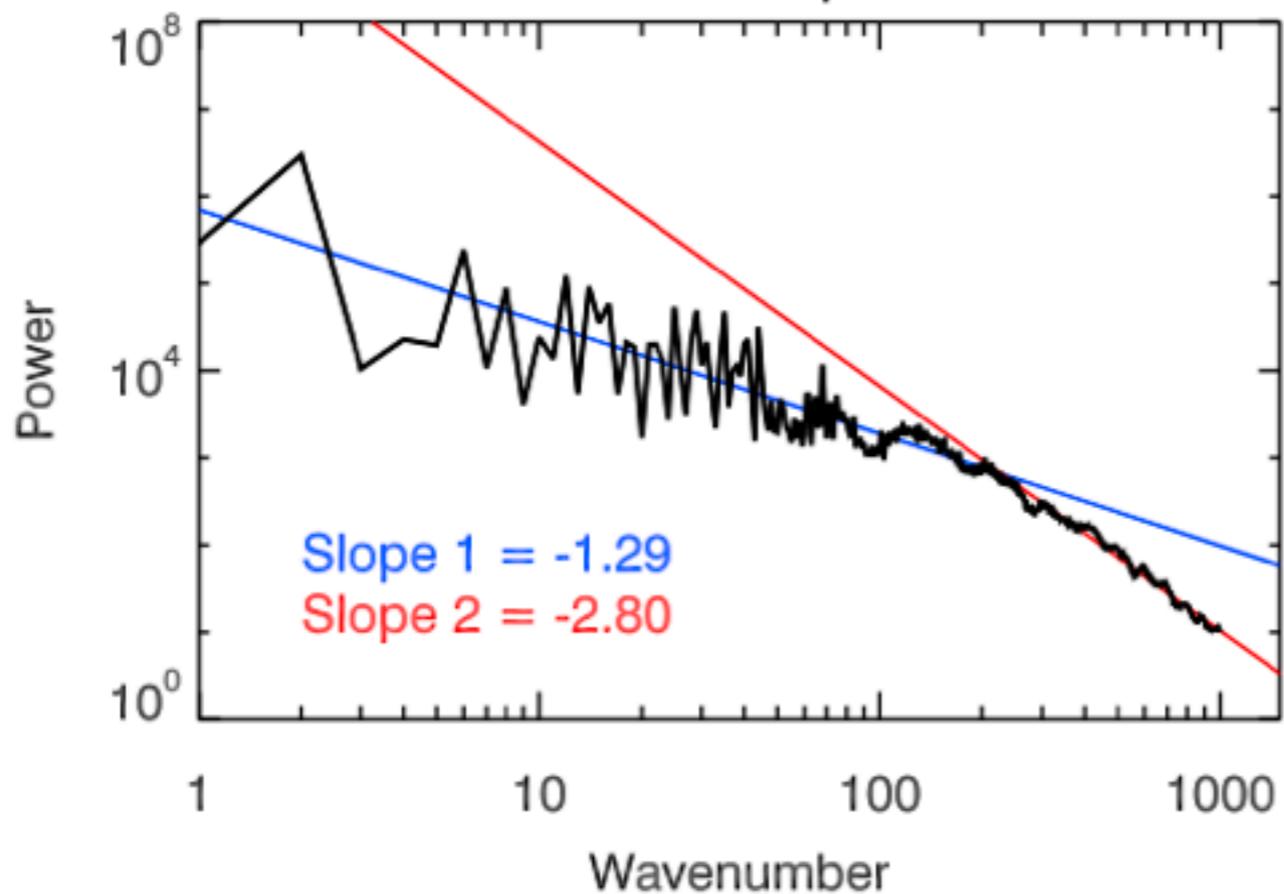
Visible Blue
[BL1, 455 nm]

Methane
[MT2, 727 nm]

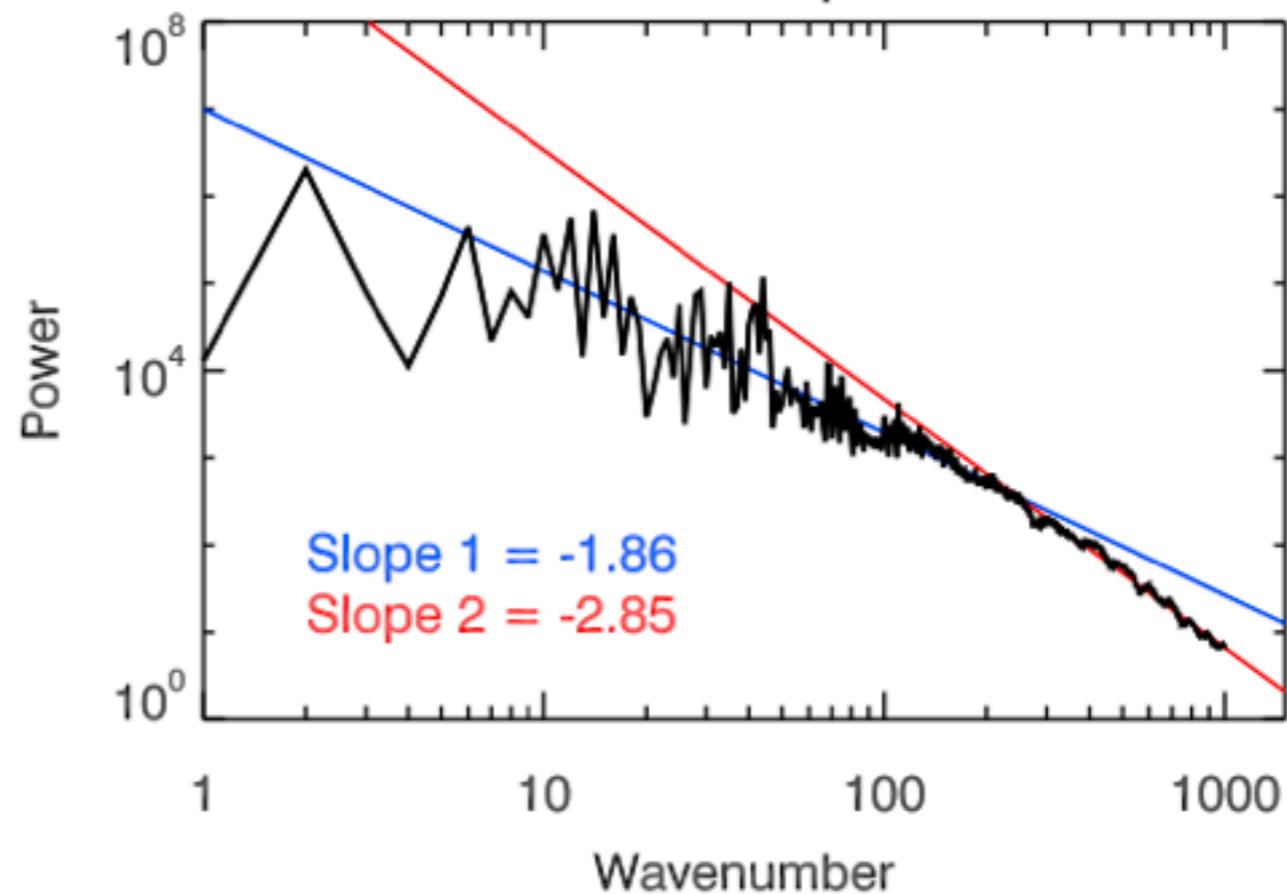
Methane
[MT3, 889 nm]



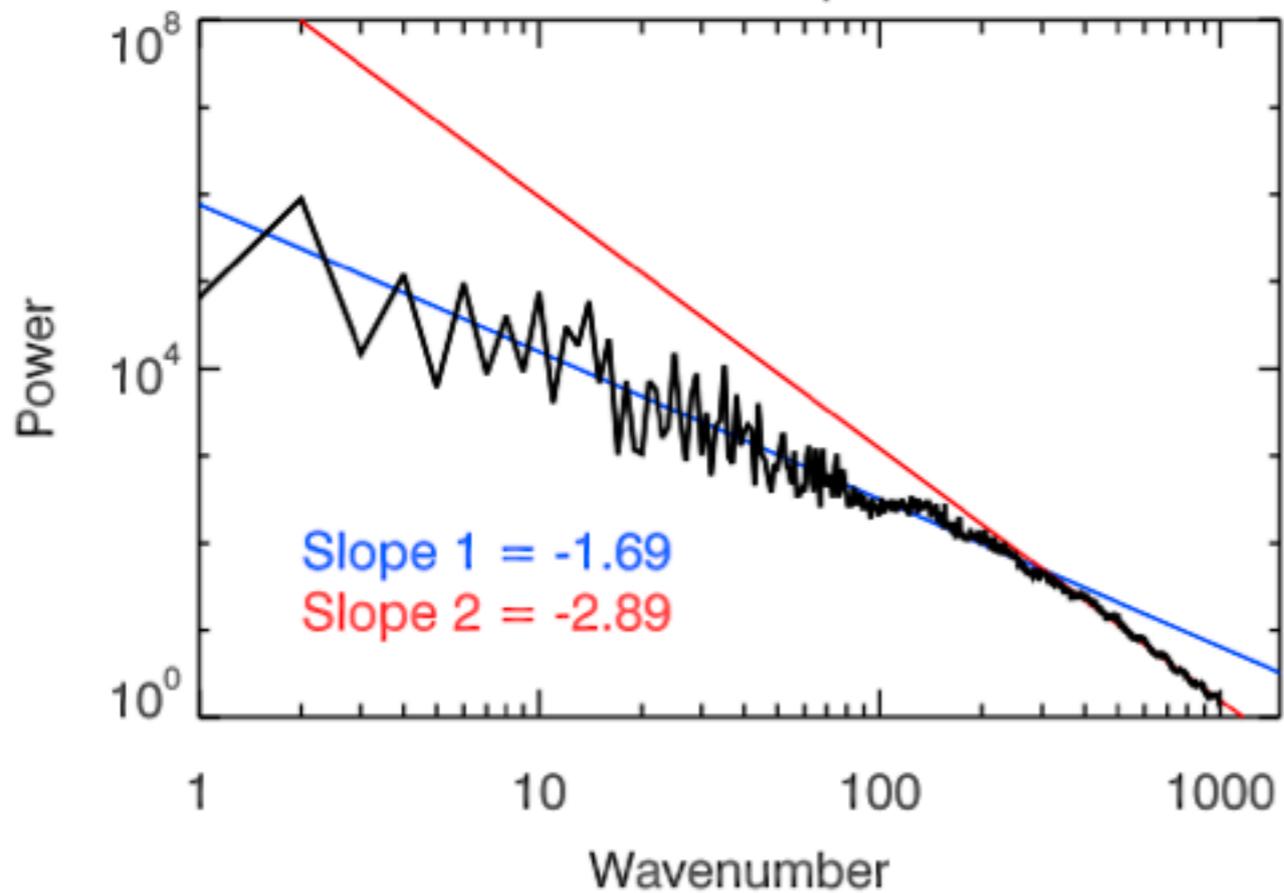
CB2 1 Power Spectrum



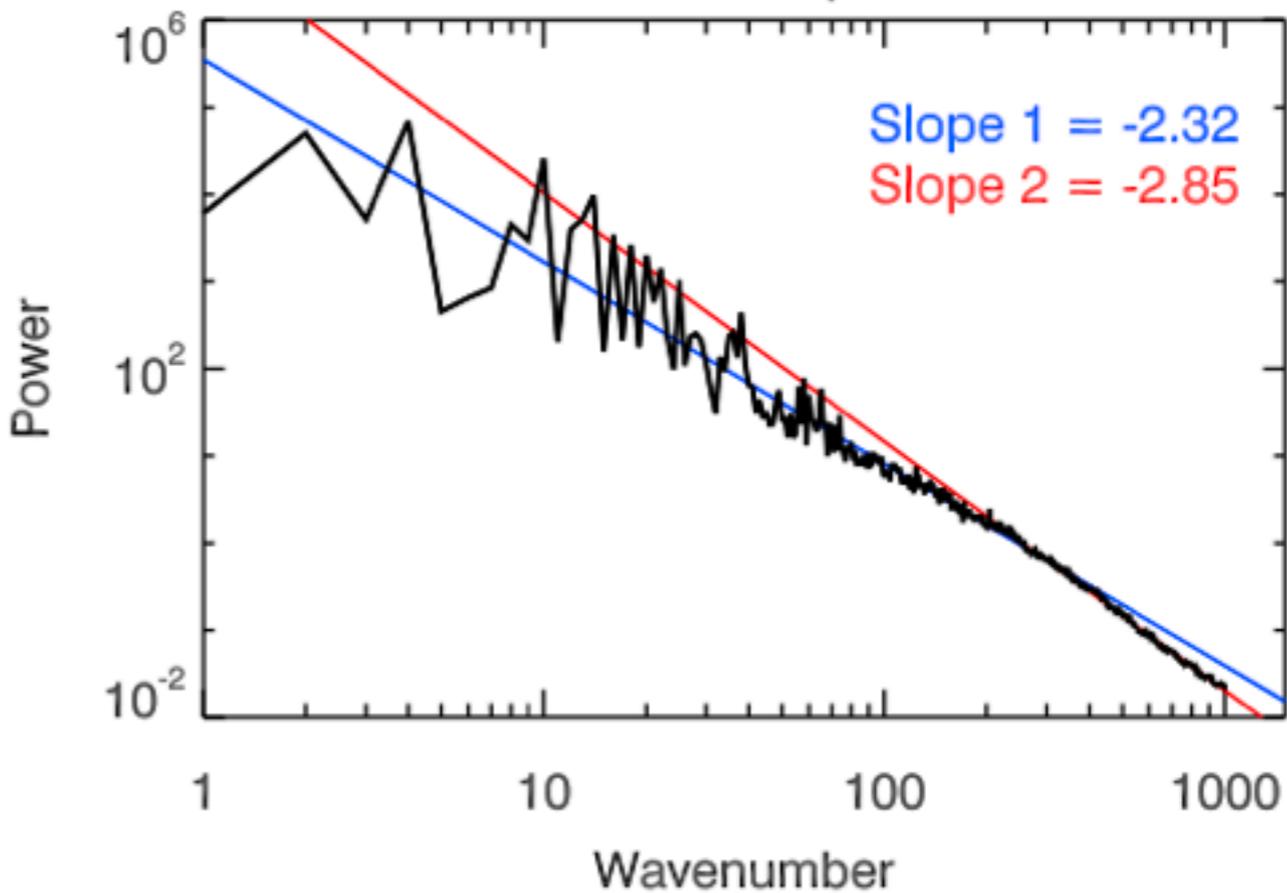
BL1 1 Power Spectrum

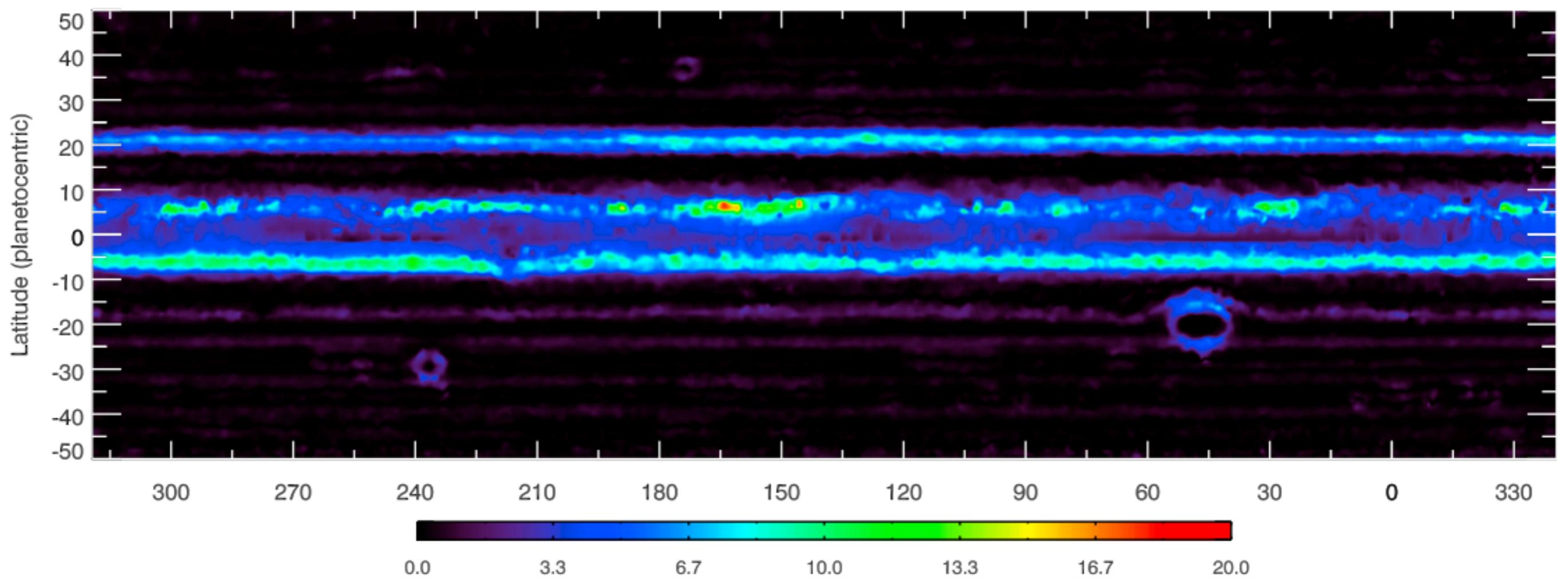
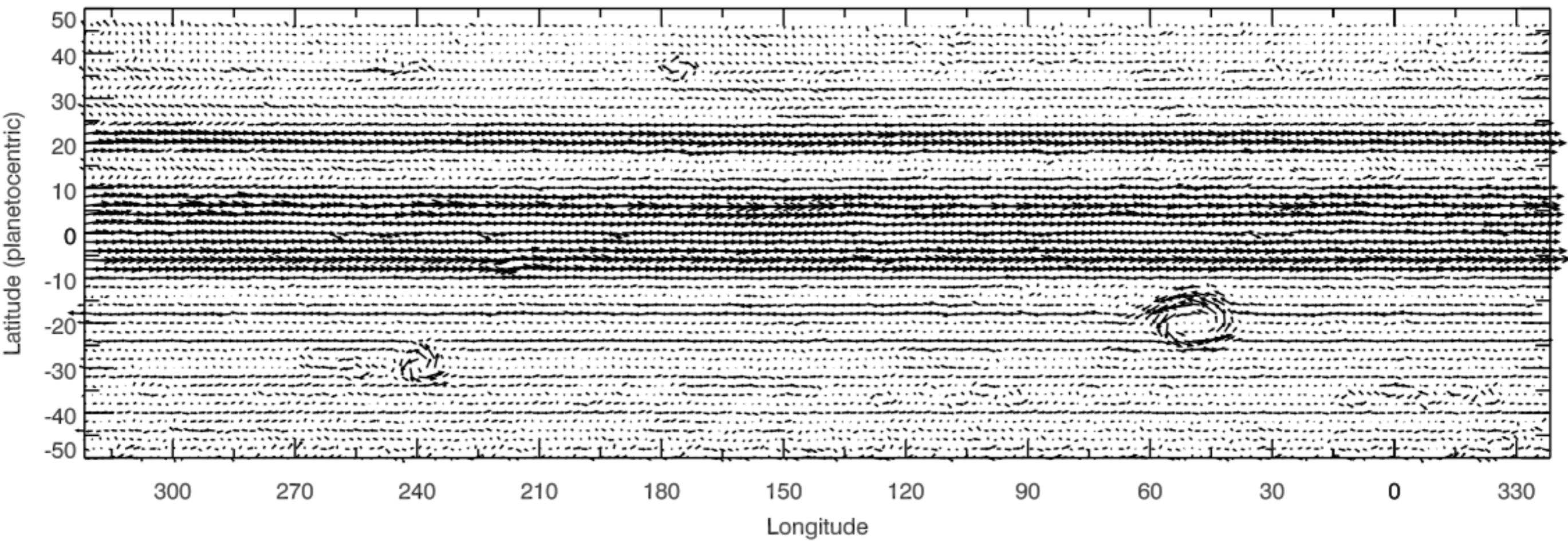


MT2 1 Power Spectrum

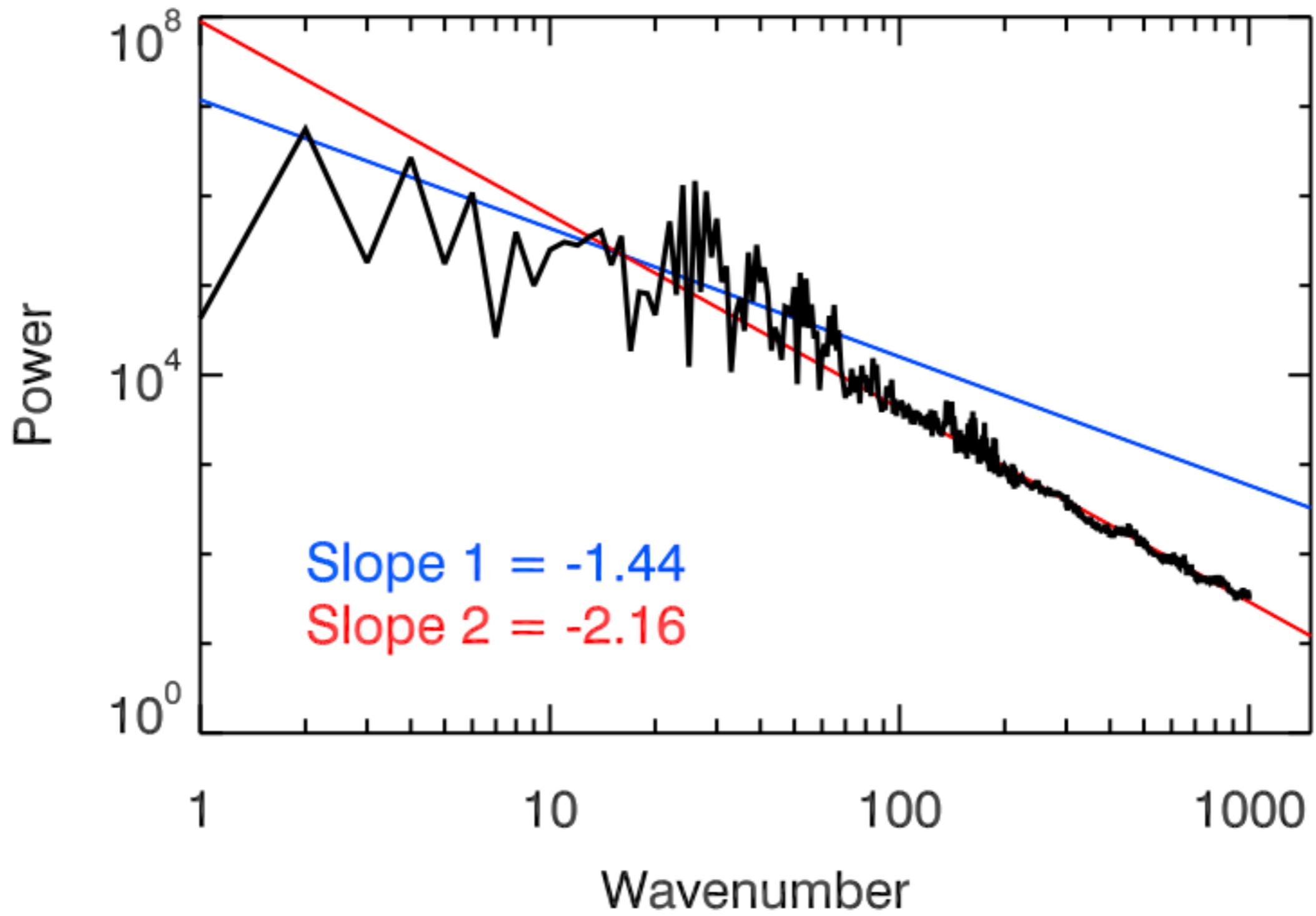


MT3 1 Power Spectrum

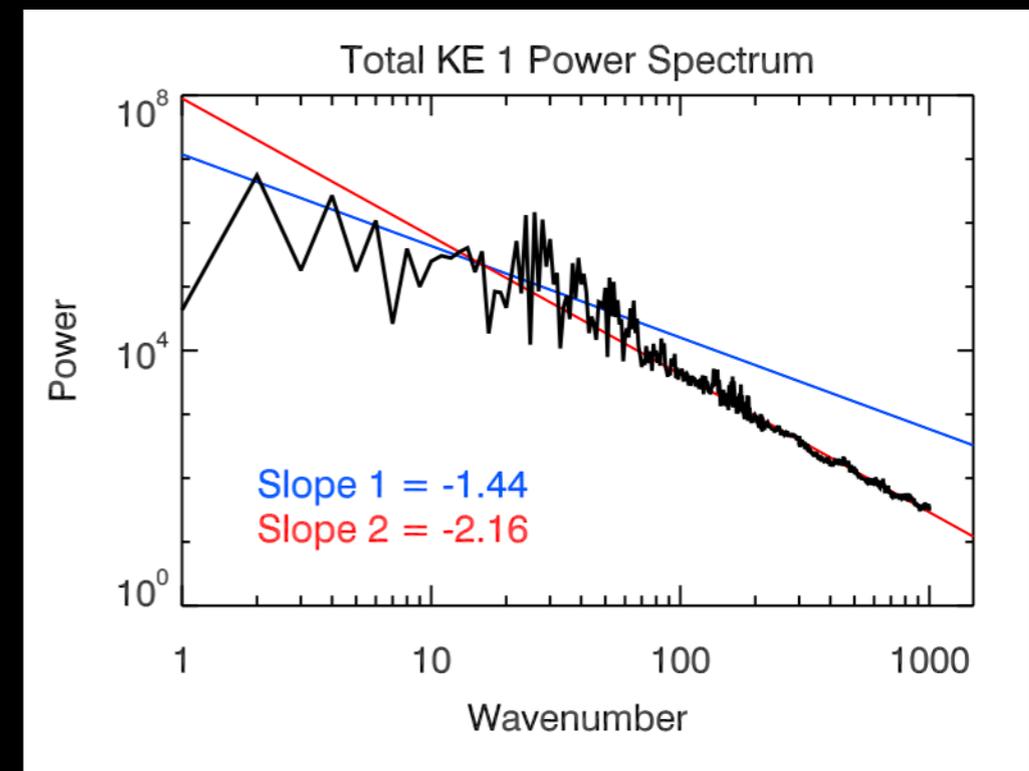
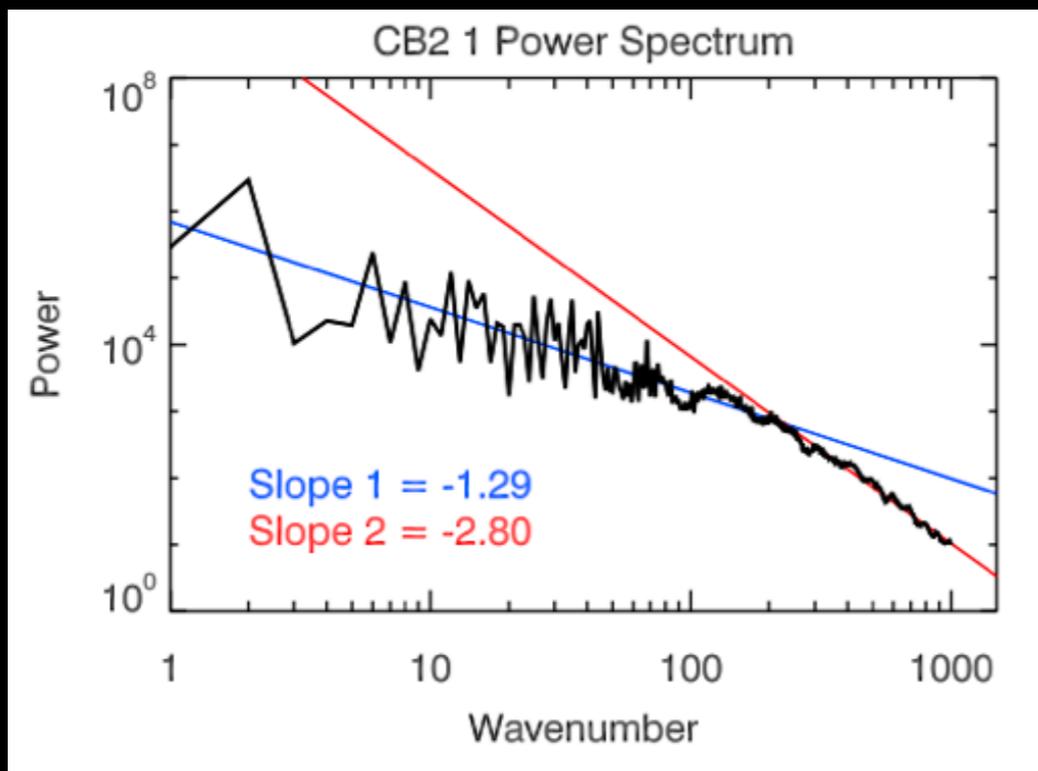
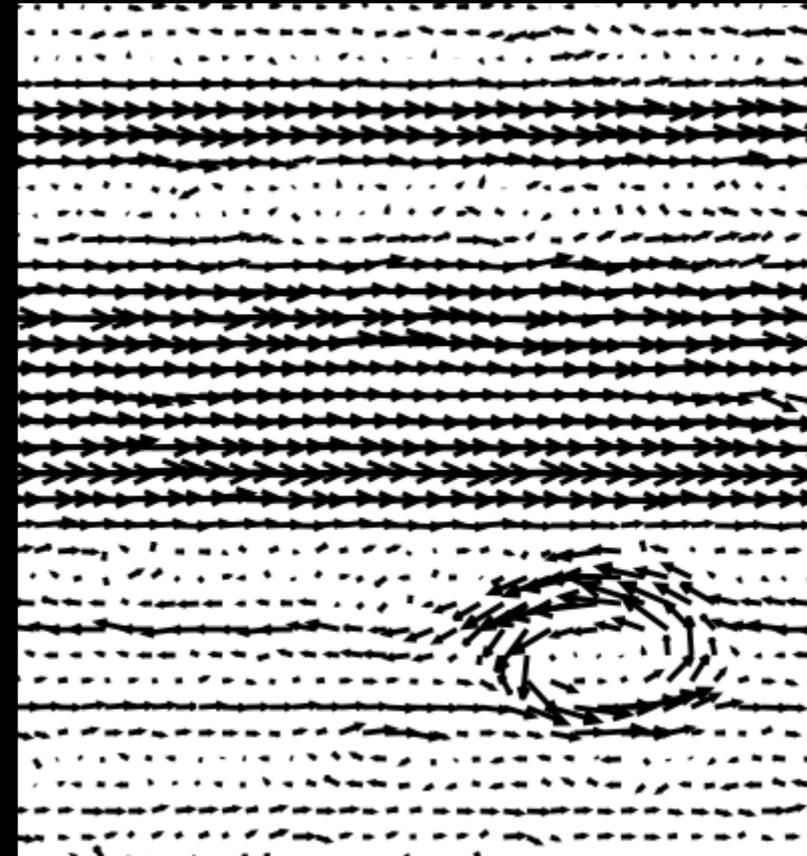
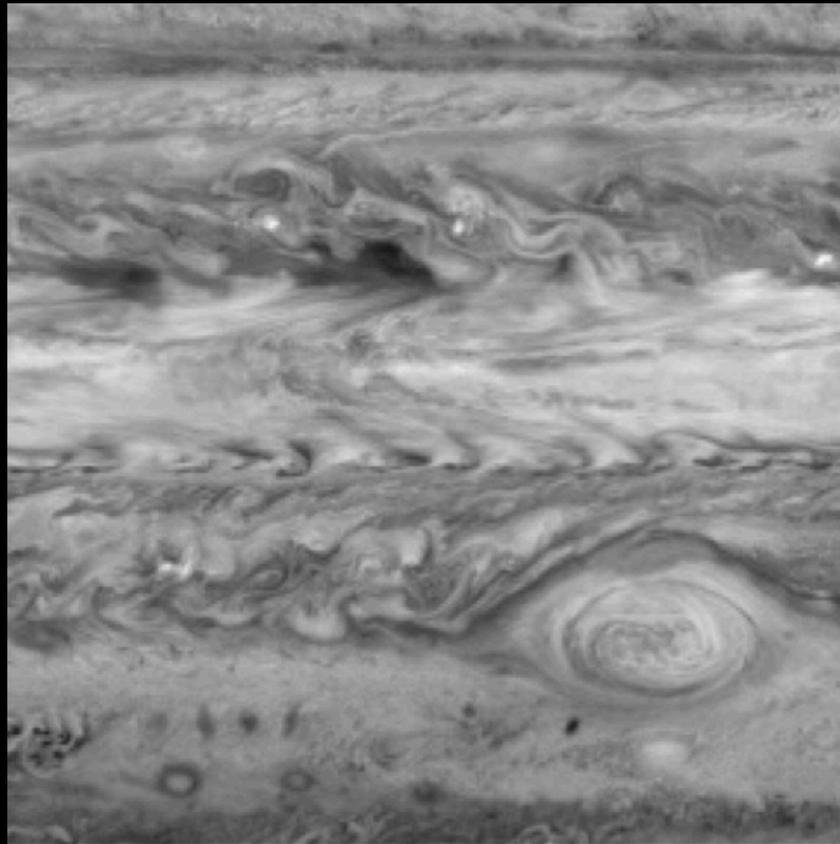




Total KE 1 Power Spectrum



Is the spectrum of cloud patterns a good proxy for the underlying dynamics?



Is an inverse energy cascade present
in hot Jupiters?

If so, what are the observational implications?

Thank you!

Extra Slides

Conclusions

Earth's atmosphere exhibits *apparent* evidence for an inverse energy cascade, but seems unlikely to be real.

There is **suggestive evidence** from power spectra for an inverse energy cascade within Jupiter's atmosphere.

Inverse energy cascade is likely not present in Hot Jupiter atmospheres, but if so it may be observable.

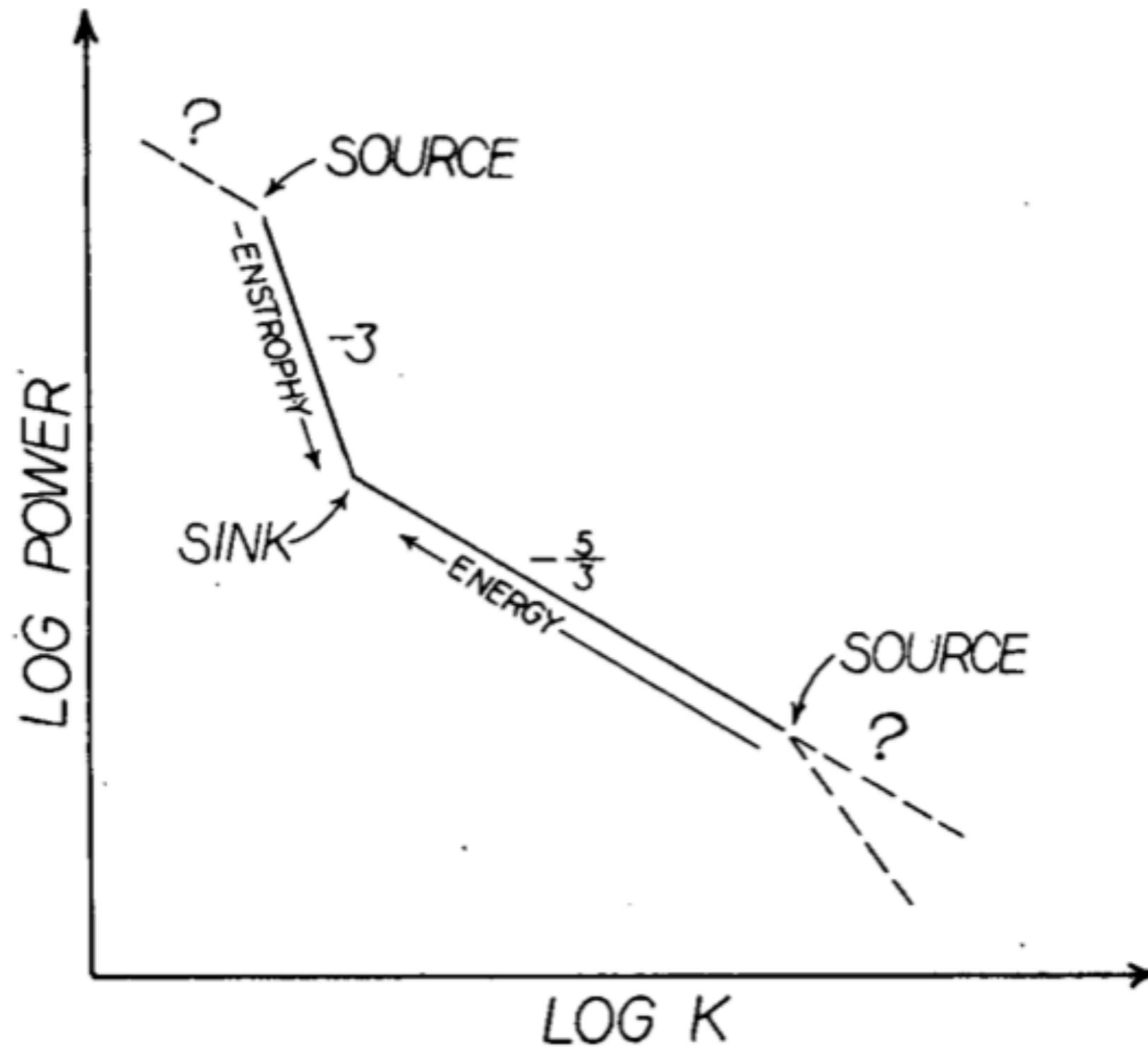


FIG. 4. Graph illustrating the wavenumber power laws that are discussed in the text. The direction of the flow of energy and enstrophy are shown together with the various sources and sinks.

(Larsen, 1982)

**Nature of the Atmospheric Dynamics on Venus from Power Spectrum
Analysis of Mariner 10 Images**

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(Manuscript received 6 March 1978, in final form 3 May 1978)

**Cloud brightness distribution and turbulence in Venus
using Galileo violet images**

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(Travis, 1978) (Peralta et al., 2007)

Universal n^{-5} spectrum of zonal flows on giant planets

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(Received 3 November 2000; accepted 30 March 2001)

(Galperin et al., 2001)