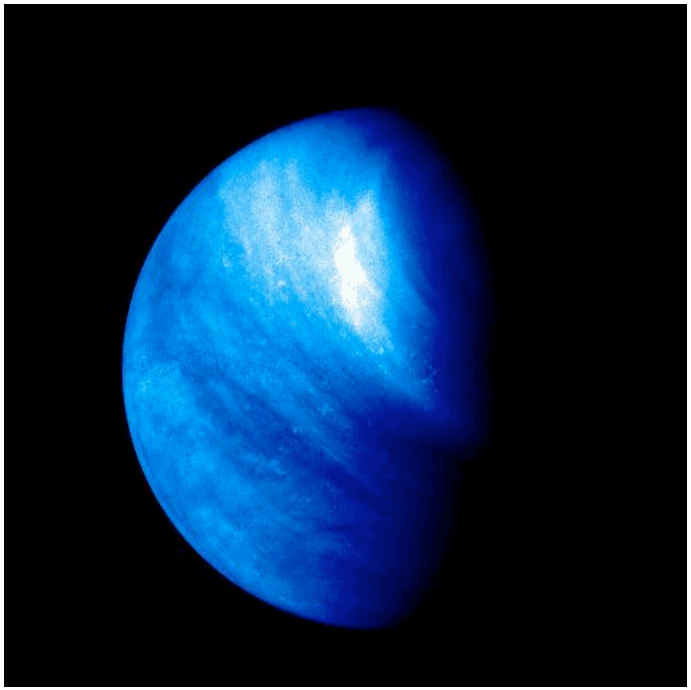


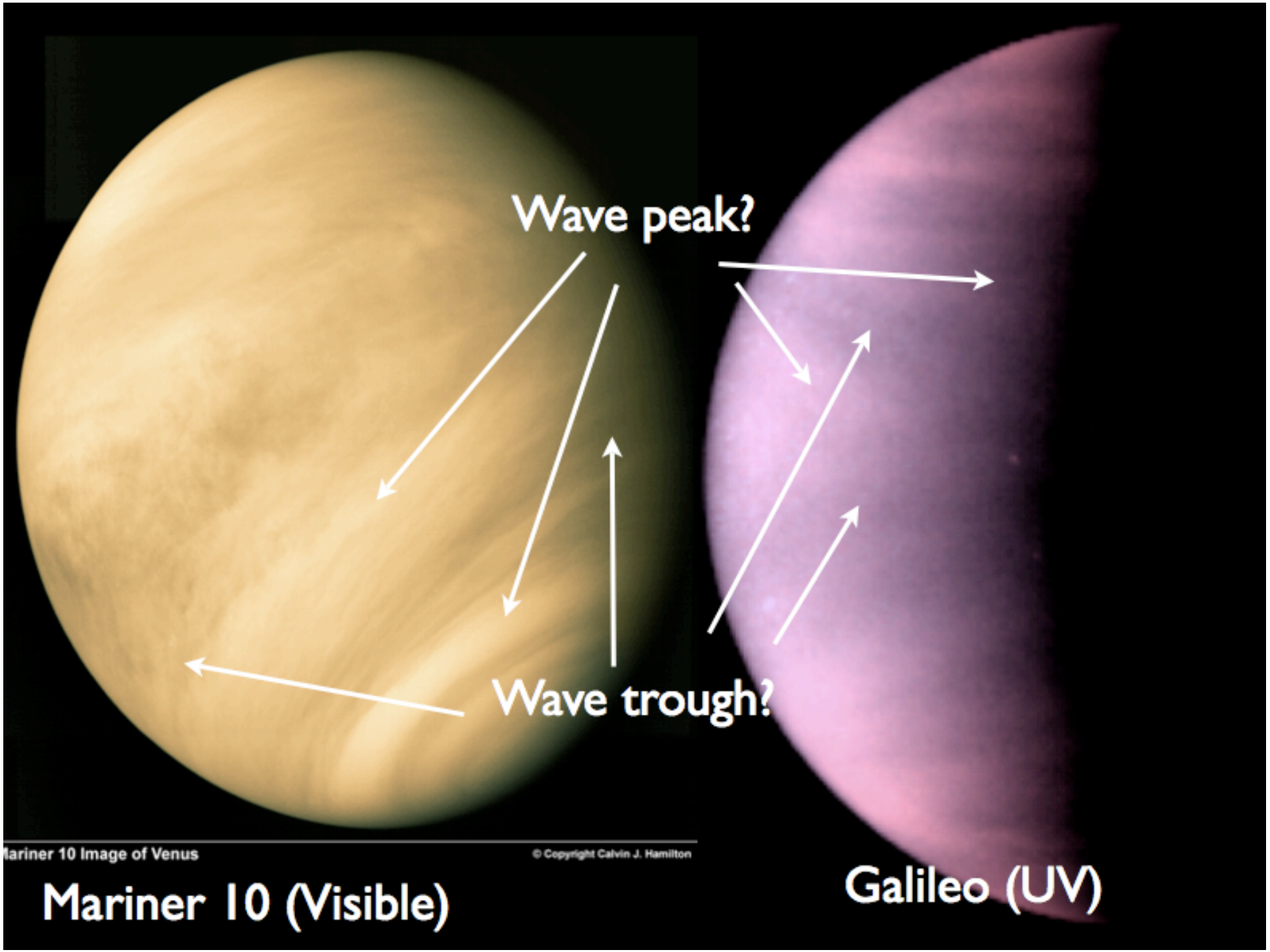
The Open University

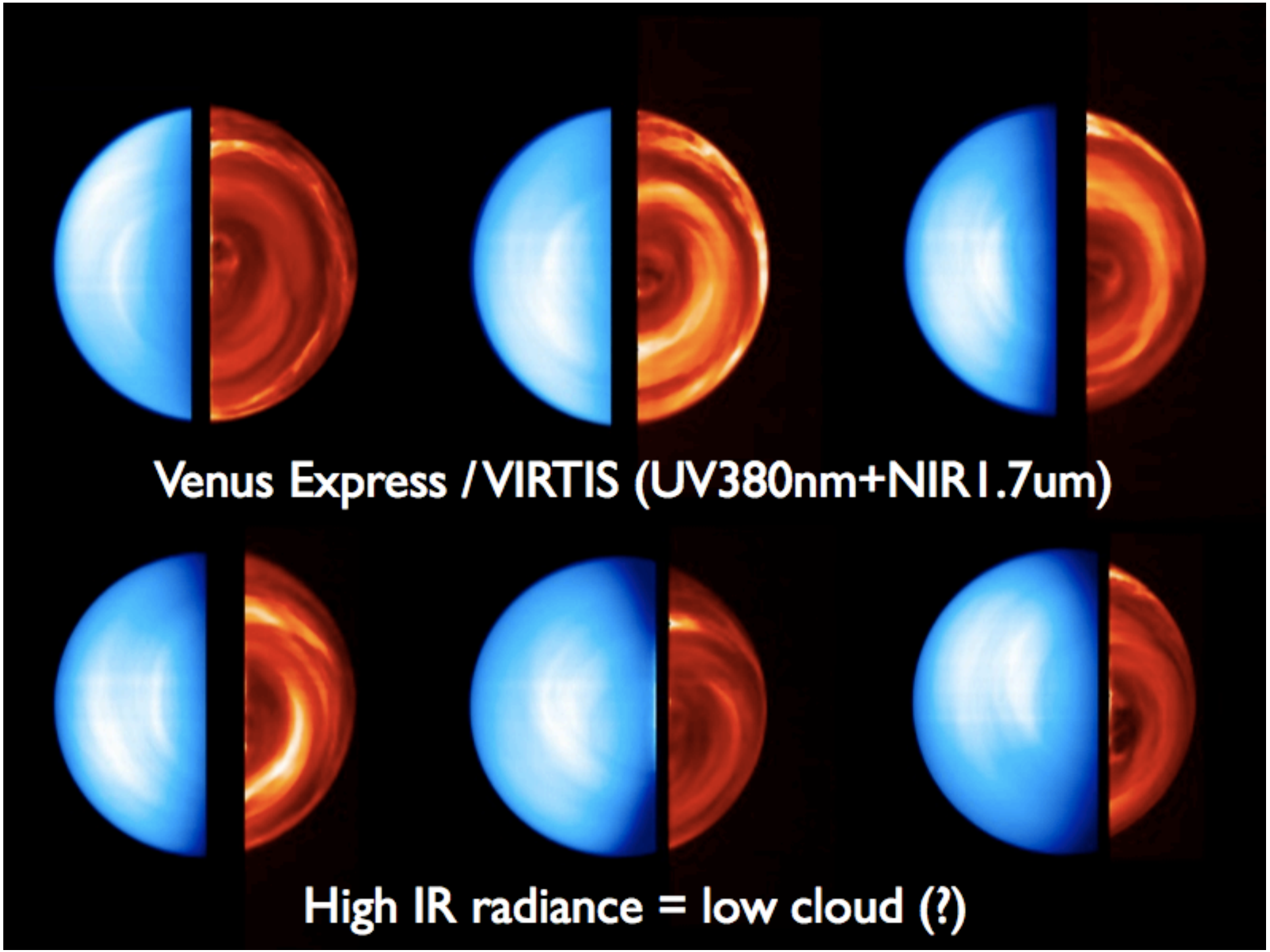
UK Venus modelling work and plans

Stephen Lewis, The Open University
Peter Read, Oxford University
Christopher Lee, Caltech (previously Oxford)

Mars general circulation modelling

- Mars GCM development from SGCM in 1989, since 1993 full GCM with LMD, Paris
- Mars GCM inter-comparisons
  - 5 international workshops (Williamsburg, Nov 2008)
- Mars Climate Database, sponsored by ESA/ESTEC with LMD, Oxford, OU, Granada
  - Based on GCM output statistics
  - Online and as DVD
- Data assimilation for Mars
  - TES/MGS assimilations over 3 Mars Years
  - MCS/MRO plans


Wave peak?
Wave trough?
lariner 10 Image of Venus
© Copyright Calvin J. Hamilton
Mariner 10 (Visible)
Galileo (UV)


Venus Express / VIRTIS (UV380nm+NIR1.7um)
High IR radiance = low cloud (?)

Venus ‘simple’ GCM outline

- Based on the UKMO Unified Model (Earth AGCM)
  - Arakawa B grid, η (hybrid) vertical levels
- Typically 5°x5° horizontal resolution, ~3km vertical resolution (0-90km)
- Horizontal diffusion (no vertical diffusion)
- Newtonian cooling and Rayleigh friction
- Options
  - topography
  - diurnal cycle
  - radiatively inactive cloud scheme
  - grey radiation scheme

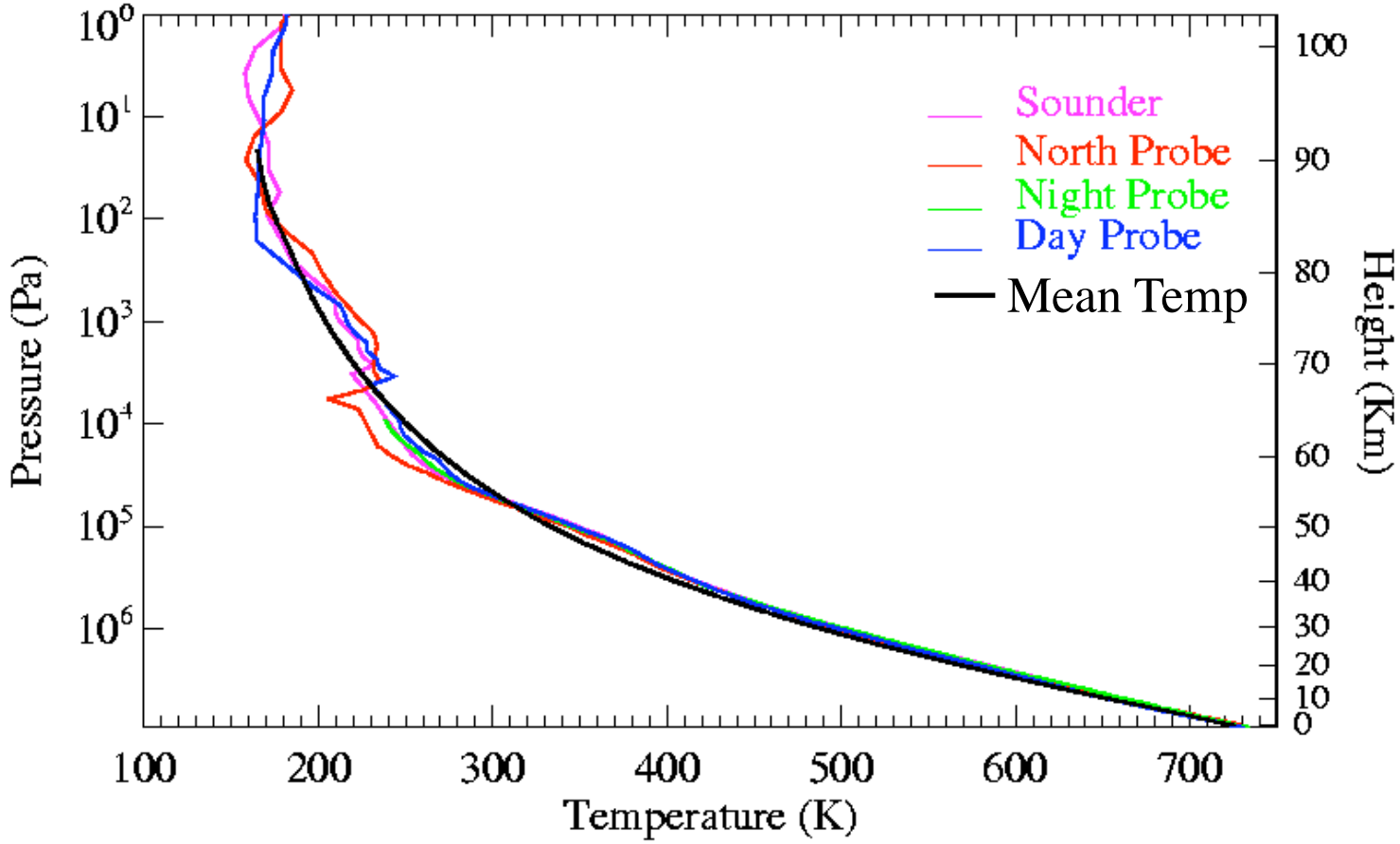
Publications on UK Venus SGCM

- Lee, C.; Lewis, S. R.; Read, P. L. (2005) “A numerical model of the atmosphere of Venus”, *Advances in Space Research* **36 (11),** 2142–2145, doi:10.1016/j.asr.2005.03.120.
- Lee, C.; Lewis, S. R.; Read, P. L. (2007) “Superrotation in a Venus general circulation model”, *Journal of Geophysical Research* **112 (E4),** E04S11.1–10, doi:10.1029/2006JE002874.
- Lee, C.; Lewis, S. R.; Read, P. L. (2008) “A bulk cloud parameterization in a Venus general circulation model”, *Icarus,* in preparation.
- Copies also available from Open Research Online http://oro.open.ac.uk/

Linearized cooling

$$T_0 = \overline{T}(Z) + T'(Z) * \cos(\phi)$$

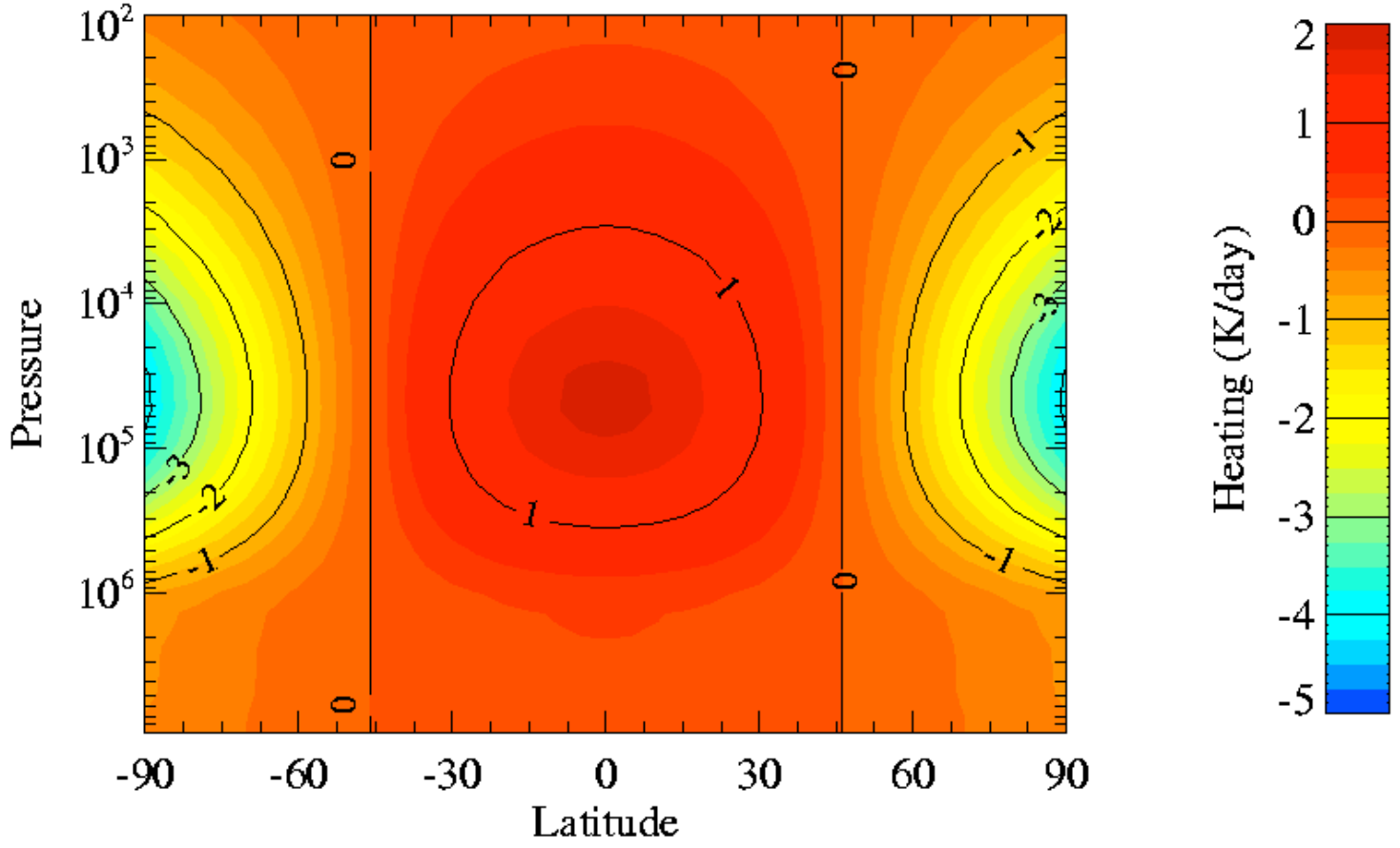
Global Mean



Linearized cooling

$$T_0 = \overline{T}(Z) + T'(Z) * \cos(\phi)$$

Latitudinal dependence



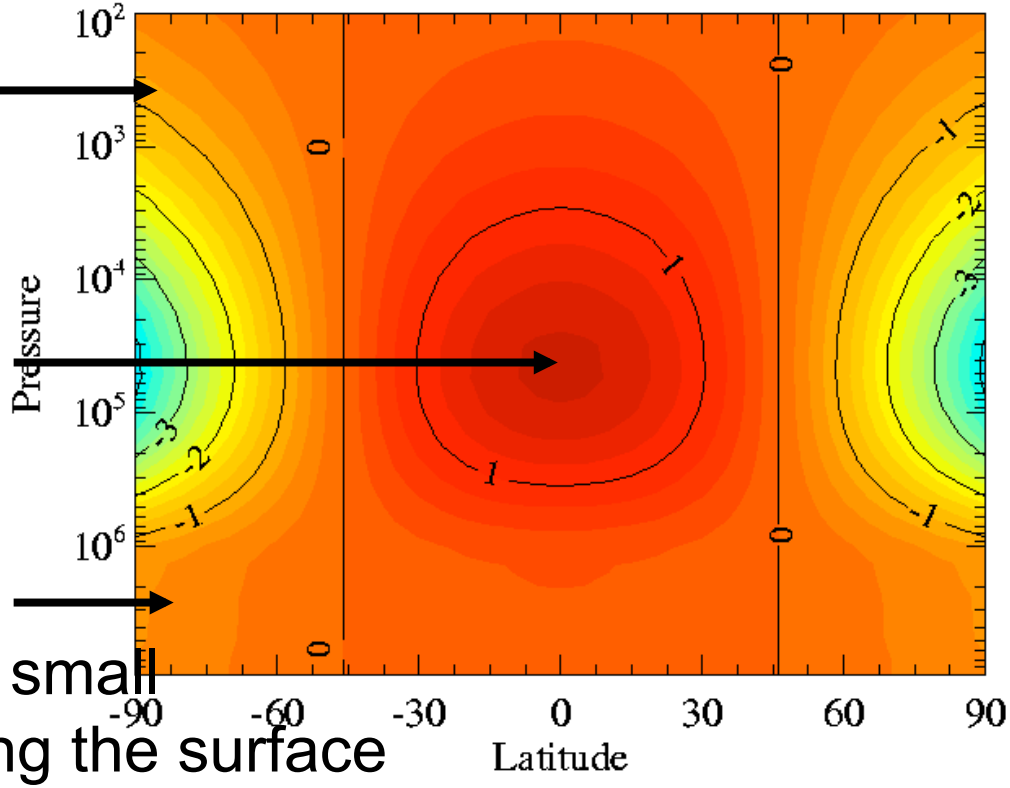
Linearized cooling

$$T_0 = \overline{T}(Z) + T'(Z) * \cos(\phi)$$

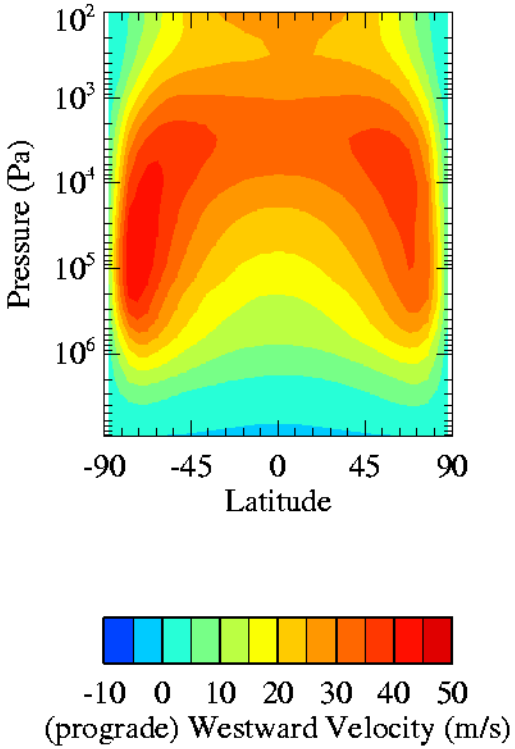
Small gradient in the upper atmosphere because of the thinning atmosphere

Peak heating in the cloud deck

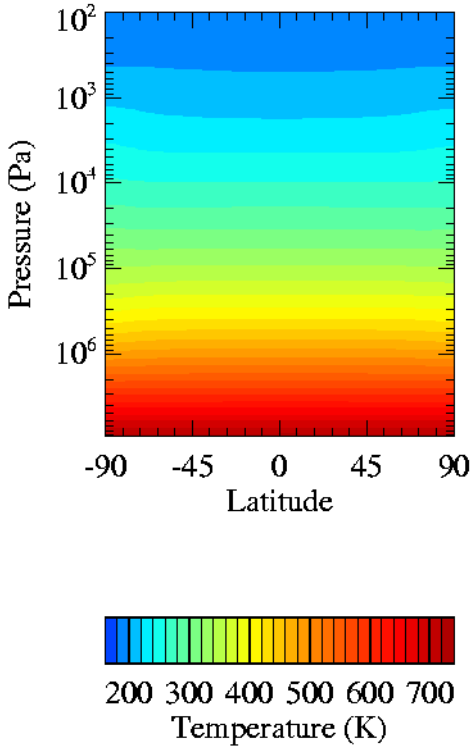
Small gradient in the lower atmosphere because of the small amount of insolation reaching the surface



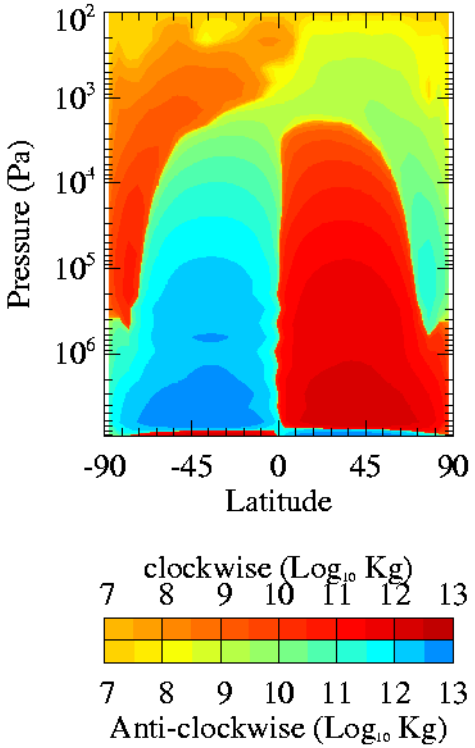
Zonal mean atmospheric state



U (m/s)

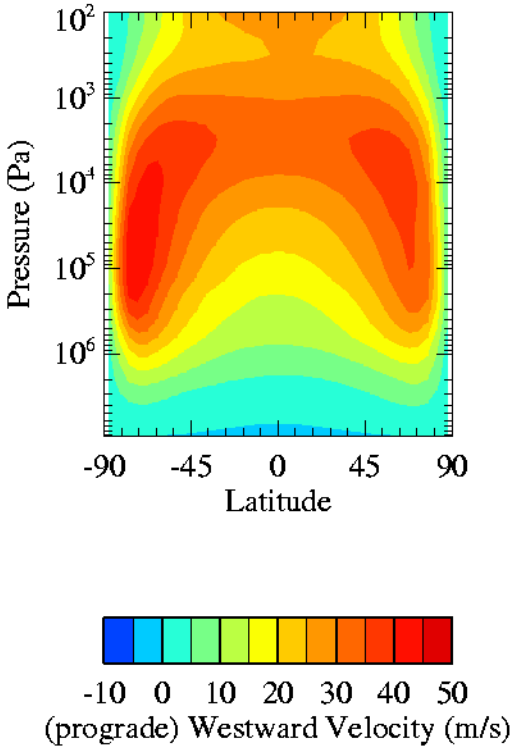


T (K)

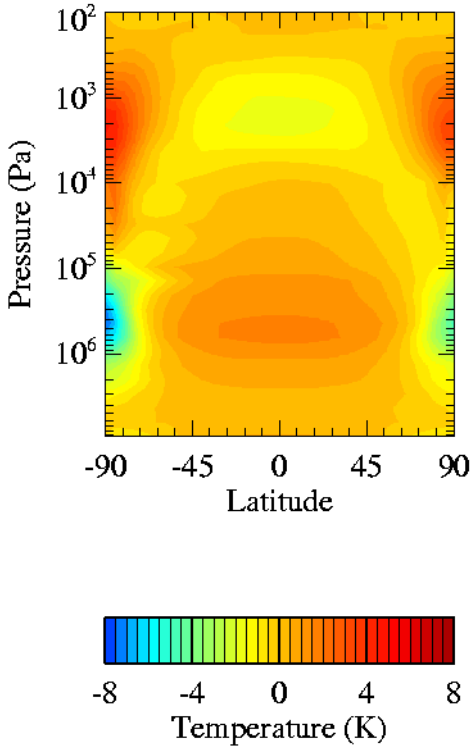


Mass circulation

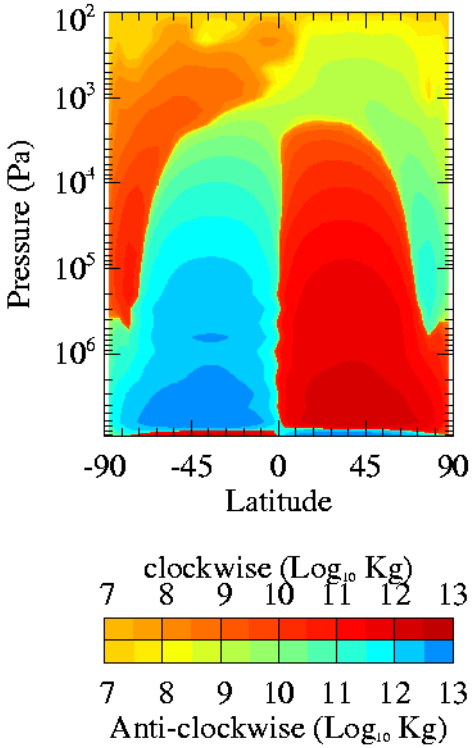
Zonal mean atmospheric state



U (m/s)

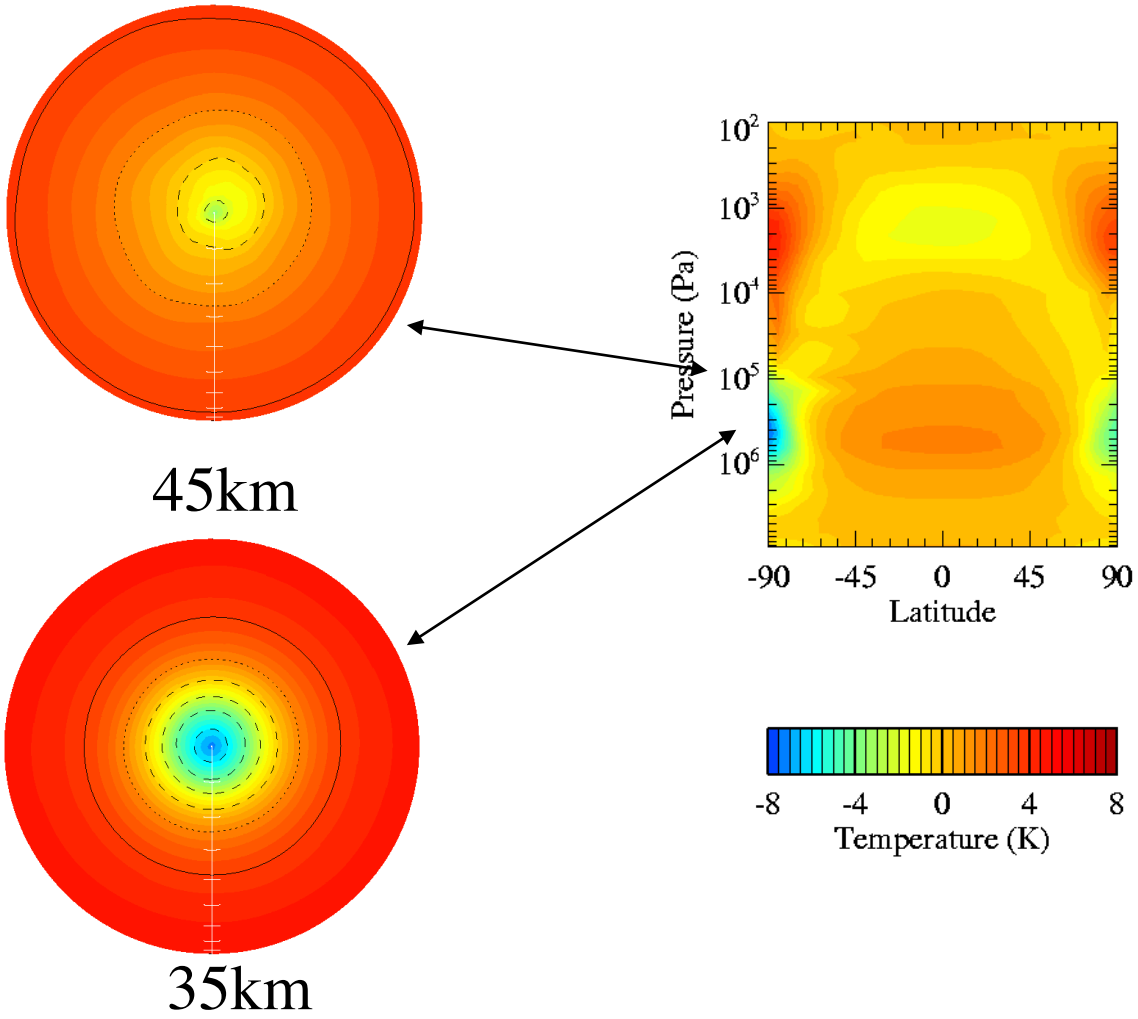


T'' (K)

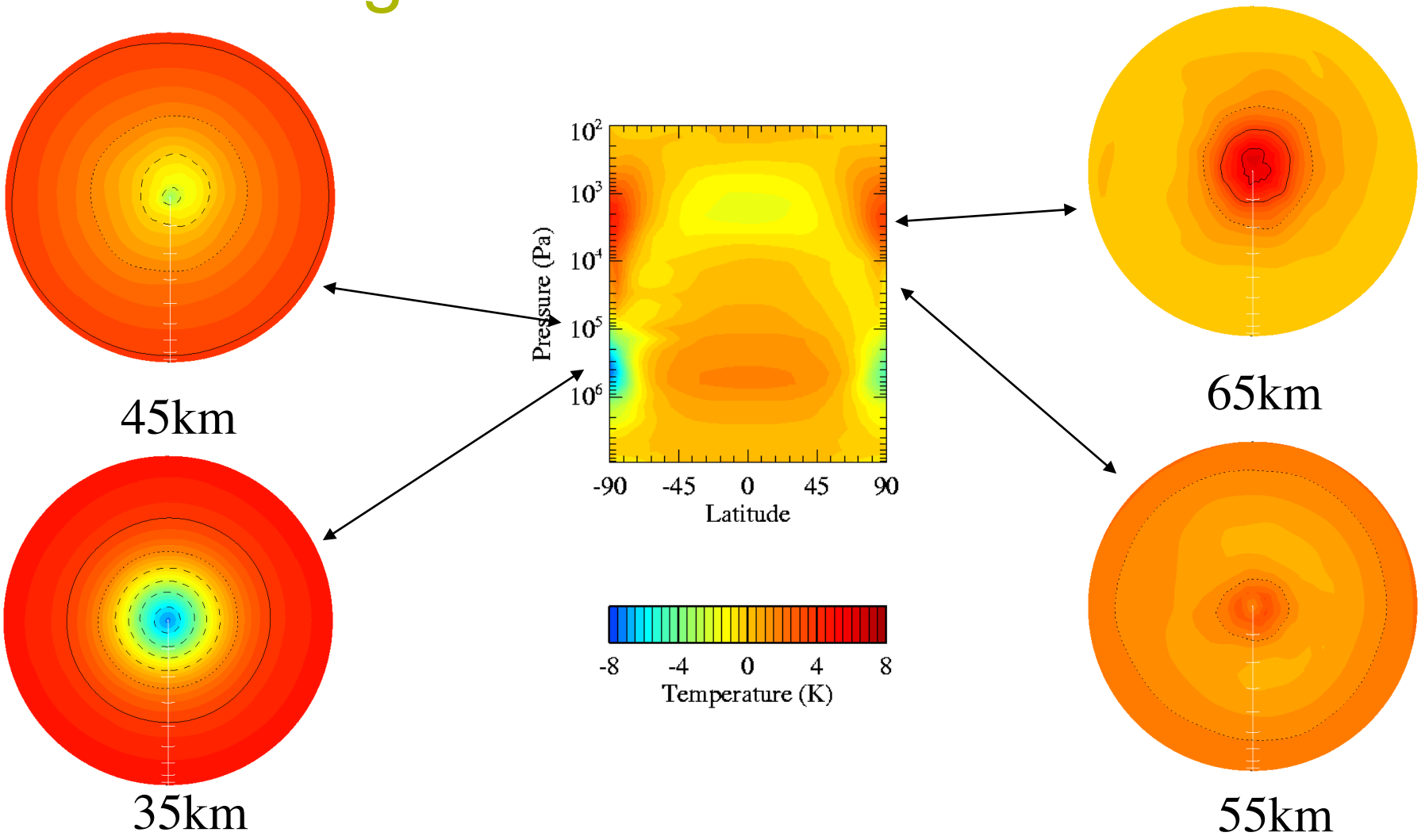


Mass circulation

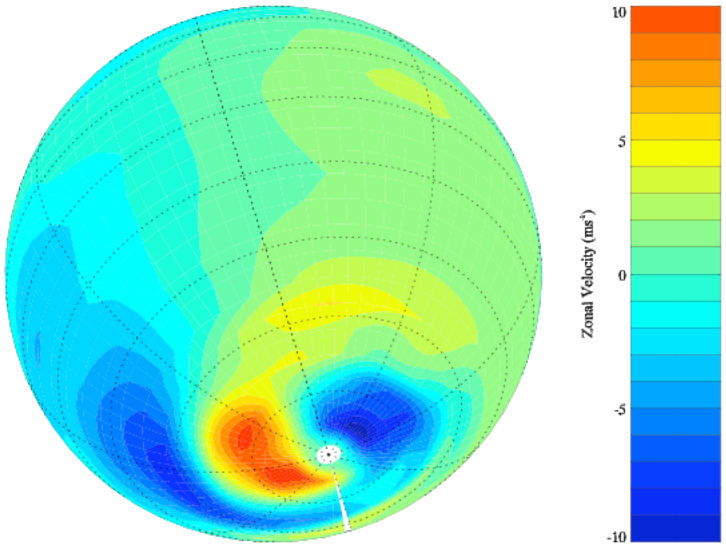
Polar regions



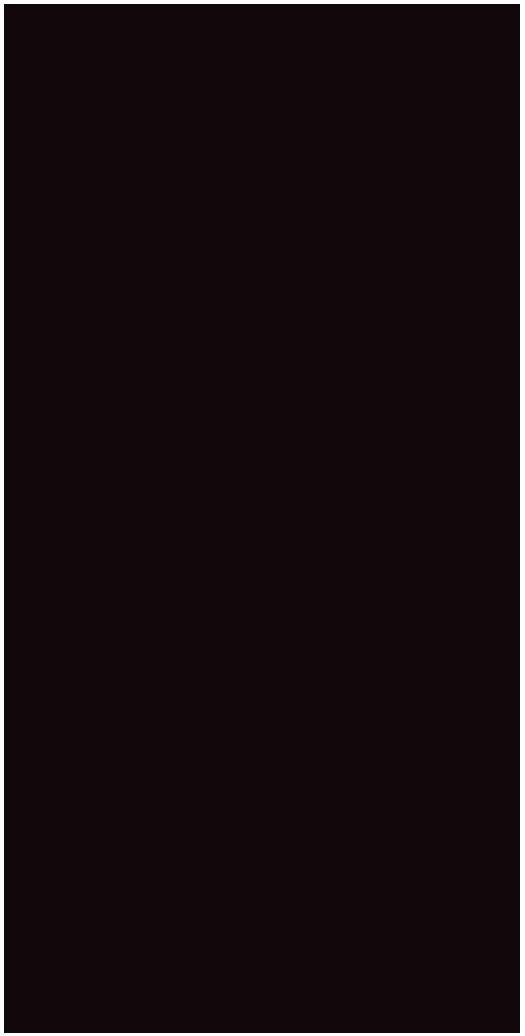
Polar regions



Polar vortices



GCM polar dipole?

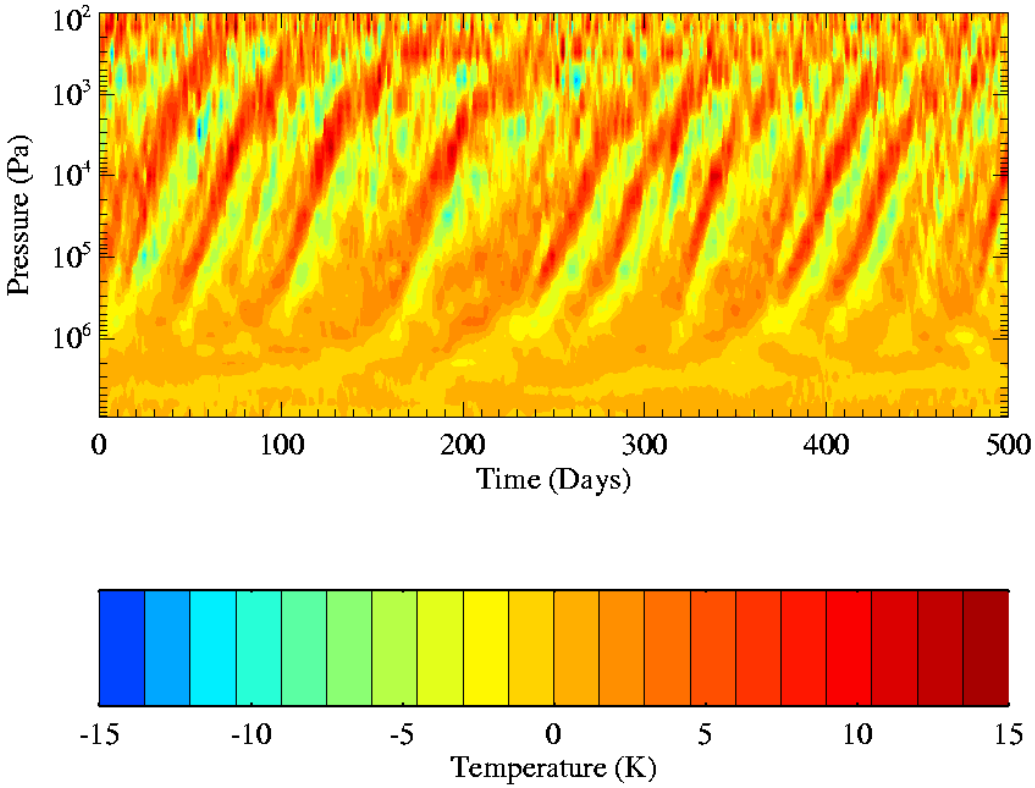


GCM cloud scheme

(condensates at 55km altitude)

Mixed Rossby-gravity wave

(in temperature)

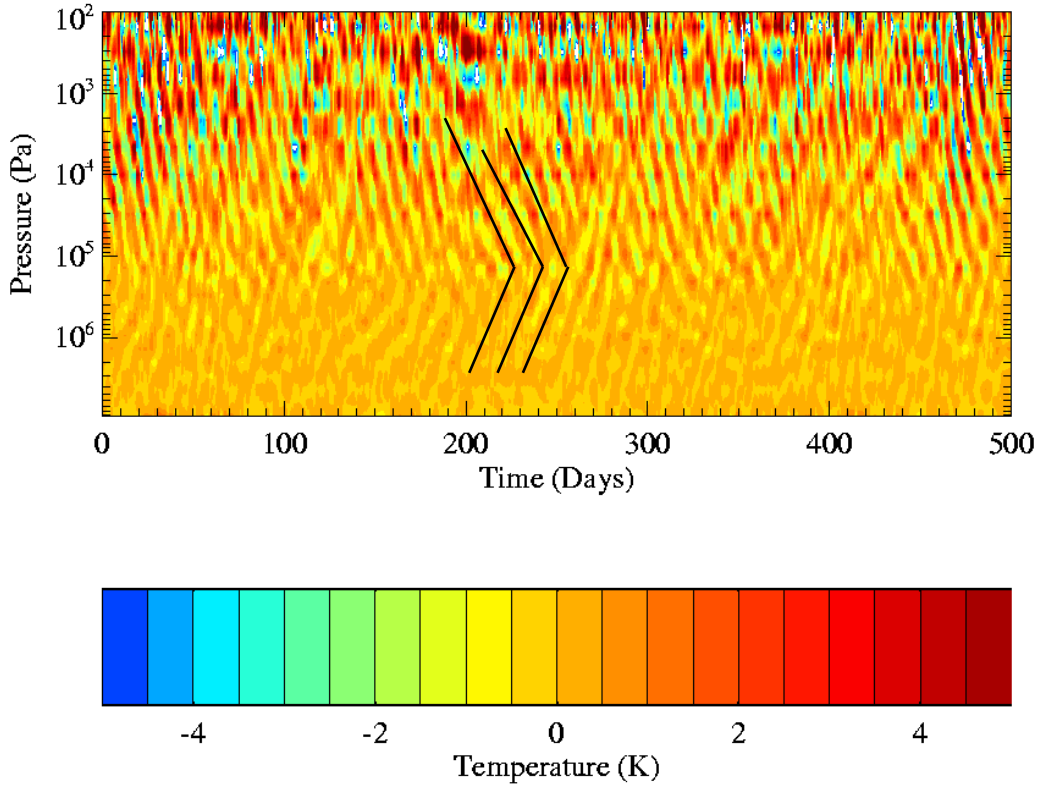


Period: 30 ± 2 days
Amp: 7K
(at 50kPa)

(Observed period of 5-6 days at the cloud decks)

Kelvin wave

(in temperature)

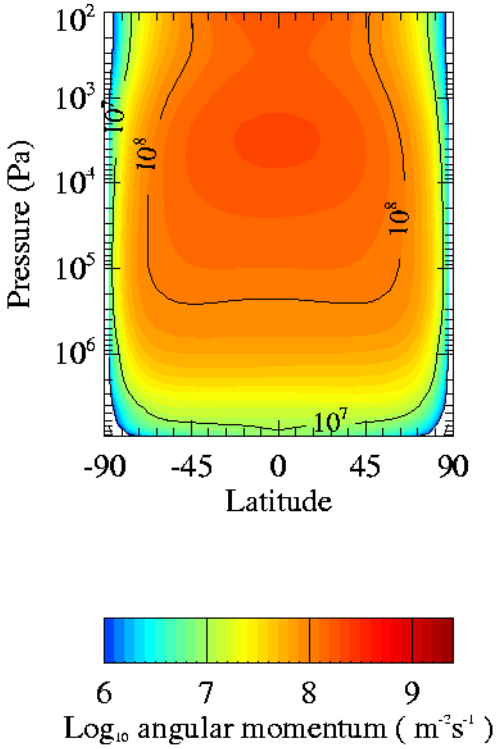


Period: 9.5 ± 0.5 days
Amp: 2K
(at 50kPa)

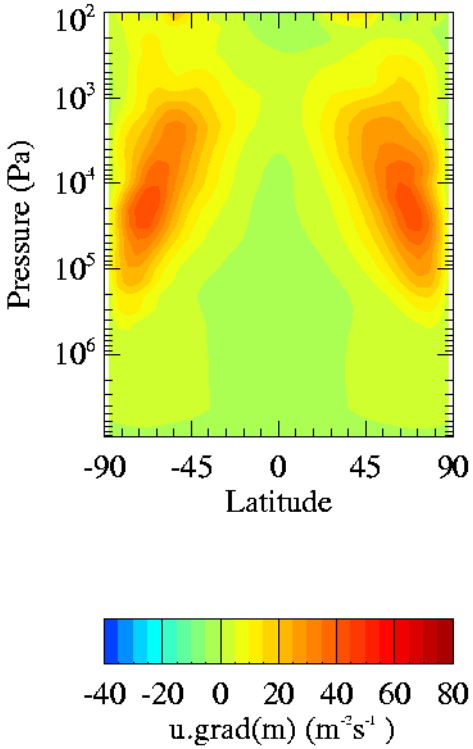
Propagating away from peak forcing at 100kPa

(Observed period of 4-5 days at the cloud decks)

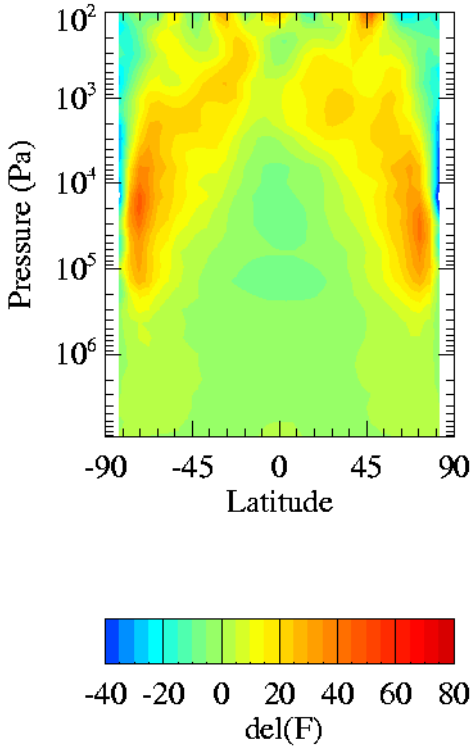
Eliassen-Palm fluxes



Angular Momentum

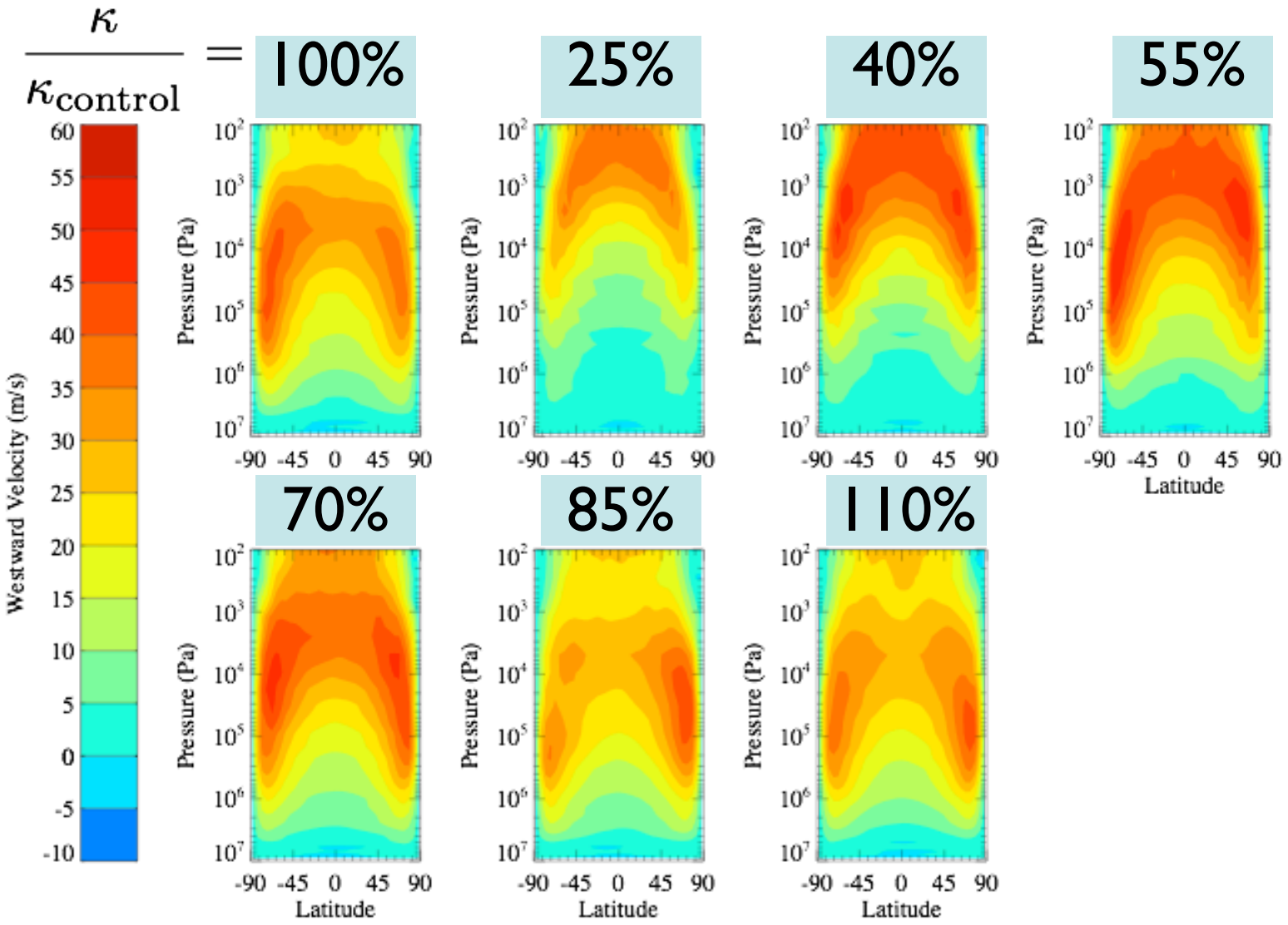


Mean circulation (acceleration)



EP flux divergence (deceleration)

Model sensitivity - diffusivity parameter



New Venus GCM plans

- Update dynamical core of model to new UKMO code
  - allows for options of deep, nonhydrostatic atmosphere
- New Ph.D. students starting at both Oxford and OU from October 2008, joint model development
  - João Manuel do Carmo Fialho Mendonça at Oxford with Peter Read will implement new radiation code and cloud schemes
  - Jonathan Dawson at OU with Stephen Lewis will implement interchangeable dynamical cores (spectral model option) and study surface-atmosphere interactions, improve PBL parameterization and GWD scheme

A new radiation scheme

- Base code on Eymet et al. (2008) net exchange scheme
- Possible systematic errors (surface too cold by 10s K)
- Extend and recalibrate to allow for varying cloud cover
- Coupled simulations with model cloud scheme
- Predict spatially-varying IR brightness for comparison with VEx