

Dynamics of Venus Atmosphere

A. Sánchez-Lavega (1, 2), S. Lebonnois (3), T. Imamura (4), P. L. Read (5) and D. Luz (6)

(1) Universidad del País Vasco UPV-EHU, ETS Ingeniería, Bilbao (Spain)

(2) Unidad Asociada Grupo Ciencias Planetarias UPV/EHU- IAA(CSIC)

(3) LMD – CNRS/UPMC, Paris (France)

(4) Institute of Space and Astronautical Science, JAXA, 3-1-1, Yoshinodai, Chuo-ku, Sagamihara, Kanagawa 252-5210, Japan

(5) Department of Physics, University of Oxford, UK.

(6) Centro de Astronomia e Astrofísica da Universidade de Lisboa CAAUL, Observatório Astronómico de Lisboa Ed. Leste, Tapada da Ajuda, 1349-018 Lisboa, Portugal, and Faculdade de Ciências, Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

(agustin.sanchez@ehu.es / Fax: +34-946014178)

Abstract

We present the outline and the main contents of each section of the chapter dedicated to Venus atmospheric dynamics for the Venus III book (Space Science Reviews).

1. Introduction

In this section we present a summary of the ground-based and spacecraft-based instruments and methods used to study the atmospheric dynamics. See references [1] – [8] for previous reviews on Venus atmospheric dynamics.

2. Wind structure

We present in this section a review of the measurements of horizontal winds with different techniques: in-situ wind measurements; the cloud structure and morphology, that allows deduction of winds from cloud-tracking techniques; ground-based Doppler-shift measurements. Then we discuss the three dimensional structure of the mean horizontal wind field (zonal and meridional) and its temporal variability. We concentrate on the altitude range from the surface to about 70 km altitude. The topics include:

- 2.1. Cloud morphology at different altitude levels.
- 2.2. Wind measurement methods
- 2.3. Zonal winds: The Superrotation
 - (a) zonal wind meridional profiles
 - (b) zonal wind vertical profiles
- 2.4. The meridional component of the wind
- 2.5. Wind temporal variability

3. Cyclostrophic balance

We present the mean temperature structure and the winds derived from basic balances:

3.1. Cyclostrophy and thermal winds

3.2. Angular momentum conservation and transport.

4. Wave phenomena and tides

Waves are ubiquitous in the Venus atmosphere. We present:

4.1. Wave observations and their classification

4.2. Wave models

4.3. Thermal tides, observations and models

5. Convective motions

Here we show where convective motions have been observed and their main properties:

5.1. Static stability profiles and the Richardson number

5.2. Vertical and turbulent motions.

6. Polar vortices and the cold collars

Polar vortices are present in both hemispheres and are one of the signatures of Venus atmospheric circulation at cloud level. They are characterized by a steep vorticity profile, associated with a bright infrared feature of varying shape and rotation. We review wind measurements in the polar region and present:

- 6.1. Detailed structure of the wind and temperature fields and of the bright infrared feature in the polar region.
- 6.2. Vorticity and divergence maps.
- 6.3. Interpretation

7. Dynamics of the upper atmosphere

This section presents our knowledge of the dynamics of the atmosphere above the clouds (mesosphere). The topics are:

- 7.1. Atmospheric properties in the altitude range from 70 to 120 km.
- 7.2. Subsolar-to-antisolar circulations

8. Global atmospheric models

We review here the main mechanisms so far presented to explain Venus atmospheric dynamics, in particular those subjacent to the super-rotation, and the numerical GCM models so far presented:

- 8.1. The Gierach-Rossow-Williams mechanism, Hadley cells and influence of thermal tides
- 8.2. General Circulation Models
 - (a) Simplified radiative forcing and complete radiative transfer
 - (b) Open difficulties faced by GCMs: angular momentum conservation, gravity waves representation.

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