Chapter 1 - Introduction

Contents

Introduction to the Revised Edition

Some of the information in this document was originally published by the NIMS team in November 1990 as part of a NIMS guide to the E1 Earth-Moon Encounter (VE11) and Venus Data Playback (VE9). This guide was later revised and corrected for inclusion on the 2nd CD-ROM of NIMS Experimental Data Records (EDRs). The present guide only covers the Venus Encounter of February, 1990. It includes material from the previous guides which pertain to the Venus Encounter. Also, additional material was added to give a more thorough presentation of the NIMS Venus Encounter data, including a chapter describing the data that was returned.

The aim of the revised guide is to provide detailed information on the various NIMS Venus observations. Also included is background information on the encounter. An overview of the guide is given below. Please refer to the beginning of each chapter for a detailed list of contents.

Chapter 1 gives an introduction to the Venus Encounter as well as a brief discussion of various issues that went into the design of the NIMS observations in the Venus Encounter sequence. Chapter 2 gives an overview of the NIMS Venus observations and the entire Venus Encounter using a number of tables, maps and timelines. Chapter 3 contains diagrams of various aspects of geometry for the Venus Encounter. Chapter 4 summarizes the planned NIMS Venus observations by means of a comprehensize sequence summary, PA summary and Observation Table (OBSTAB). Chapter 5 is a collection of the Detailed Observation Designs made up of OAPEL forms and POINTER plots. Chapter 6 is a summary of the NIMS data return for the Venus Encounter.

For information on the NIMS instrument, please see the preprint of the NIMS instrument paper provided elsewhere on the CD-ROM, or refer to the published version: R.W. Carlson, P.R. Weissman, W.D. Smythe, J.C. Mahoney and the NIMS Science and Engineering Teams, "Near-infrared Mapping Spectrometer Experiment on Galileo", Space Science Reviews 60: 457-502, 1992.

ACKNOWLEDGEMENTS

The NIMS Venus observations in this guide were designed by Kevin Baines and the NIMS Team. Kevin Baines prepared the Venus portion of the original printed guide. Frank Leader subsequently retrieved and edited the original material for consistency and clarity, recovered missing material by scanning parts of the original printed document and prepared the last chapter describing the data return. Some figures from the Galileo Venus Encounter Notebook prepared by the Galileo Mission Design Team were incorporated into this guide. Al Stevenson generated the Venus sequence summary. Bob Mehlman oversaw production of this guide.

Introduction to the Venus Encounter

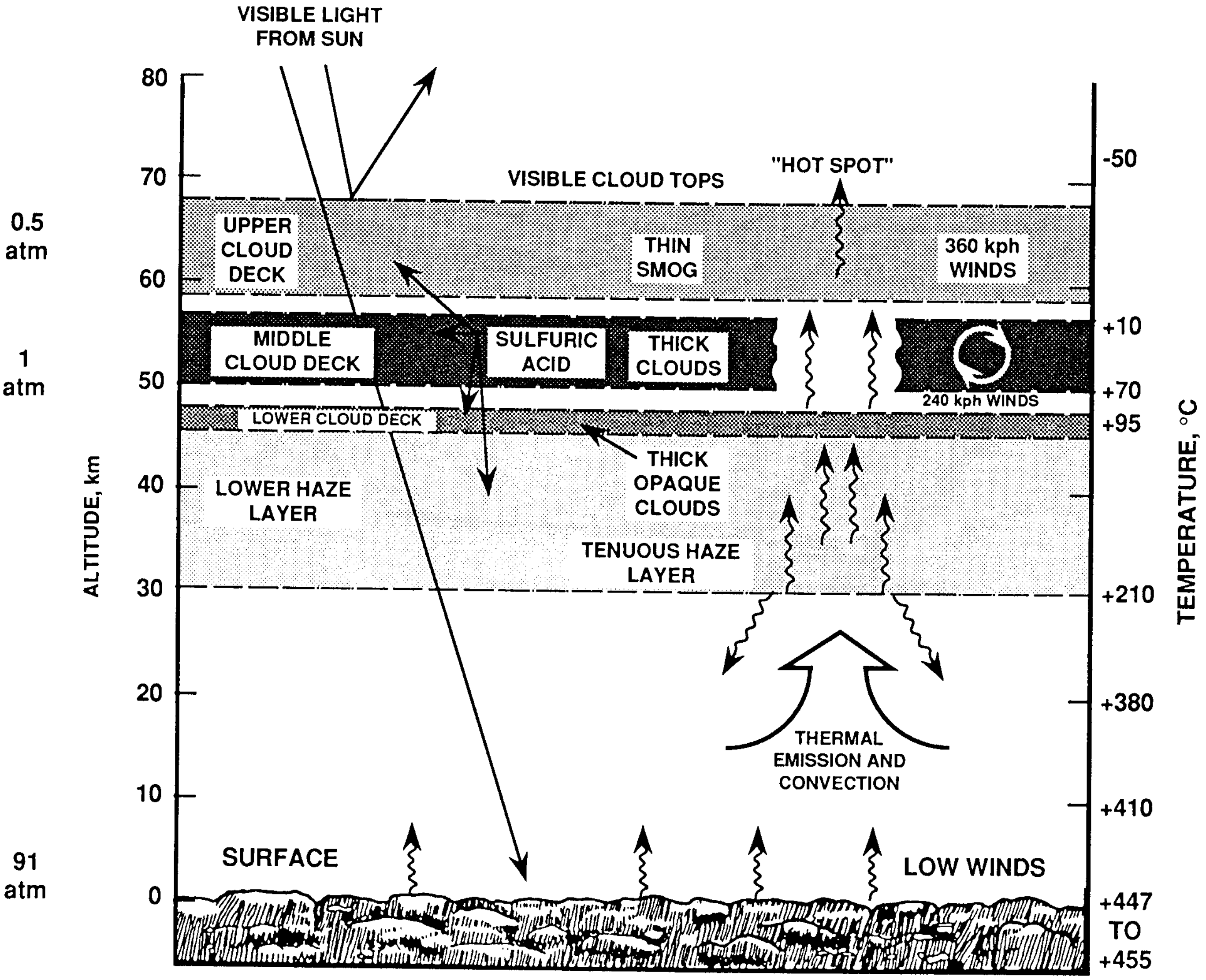
Galileo flew by Venus on February 10, 1990 as part of its VEEGA gravity-assist trajectory to Jupiter allowing observation of Venus by the remote sensing instruments on board. The Venus observations were recorded onto Galileo's tape recorder and played back just before the first Earth Encounter (E1).

Galileo approached Venus from its nightside at an asymptotic phase angle of 155 degrees from slightly north of Venus' equatorial plane. During the approach, the Sun was in the same direction as Venus so that the spacecraft's sun shade obscured the planet until about a day before closest approach. During the approach phase of the encounter, NIMS made three nightside observations. At closest approach NIMS made limb scans of both the nightside limb and the dayside limb. After closest approach, NIMS rode along behind SSI's dayside observations.

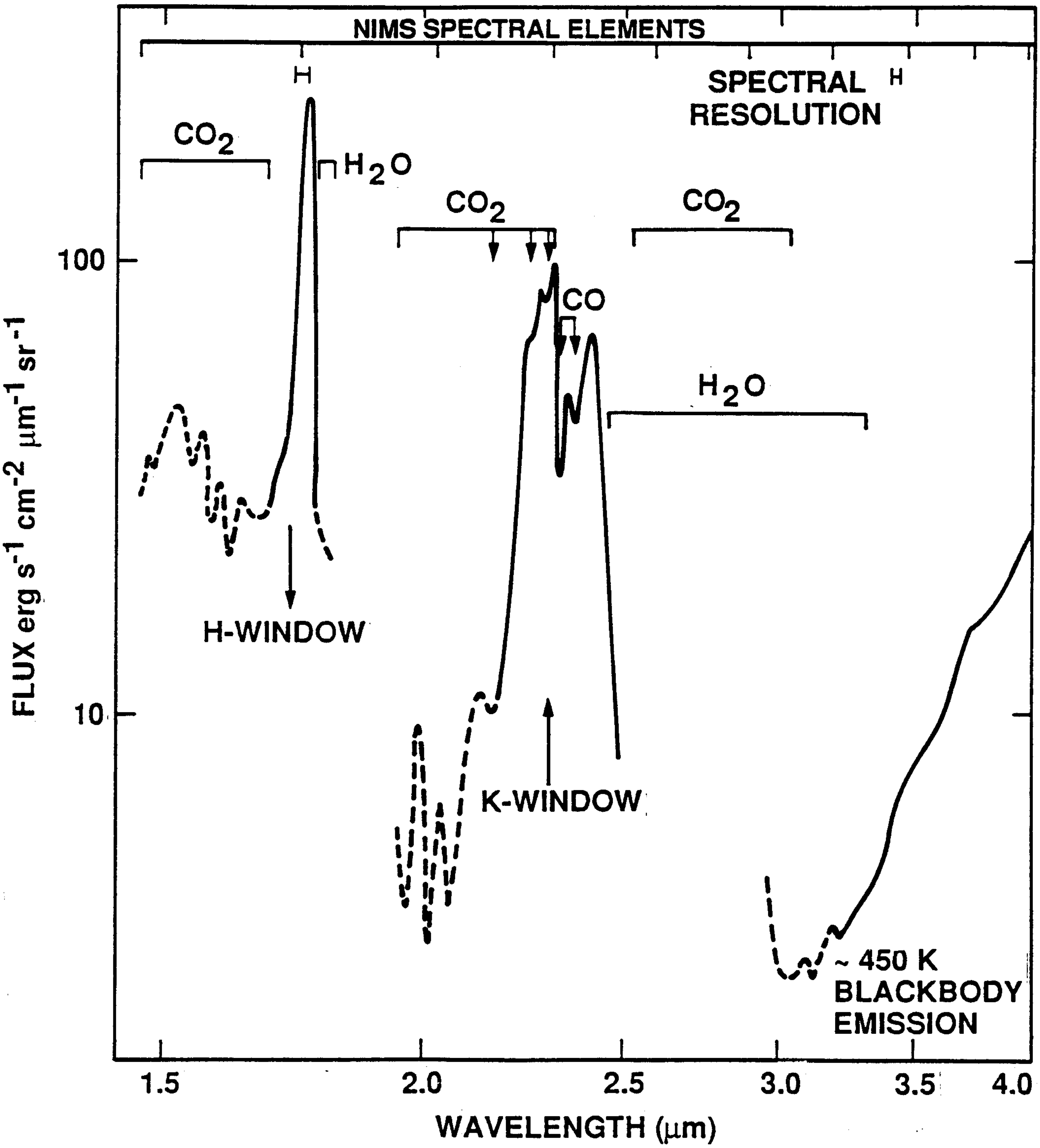
The nightside observations were the principal NIMS Venus science objectives. NIMS was built before it was known that Galileo would fly by Venus, but it turned out that it was ideal for investigating Venus' nightside emissions in the near-infrared part of the spectrum. These originate as thermal emissions from Venus' hot lower atmosphere, which then diffuse through the cloud layer into space. The observed near-infrared spectrum is mostly blacked out by strong absorption bands of carbon dioxide and water, but the spectral regions between the bands contain information about the composition of Venus' lower atmosphere and clouds. The figure on page 4 is a schematic of the cloud layers of Venus, as well as the variation of temperature with altitude. The wavelengths for the two NIMS Fixed Map (17 wavelengths) partial disk images were chosen to take advantage of these spectral windows to get maps of deep atmosphere cloud properties. The figure on page 5 shows the absorption bands of Venus' atmosphere with the Fixed Map wavelengths and spectral resolution indicated across the top. The third NIMS nightside observation was done in Long Map mode (408 wavelengths) in a jailbar pattern to obtain detailed spectroscopic information of the latitudinal and longitudinal variation of water and carbon dioxide in Venus' atmosphere. The Long Map spectrum fills the spectral region between the Fixed Map wavelengths (see figure on page 5).

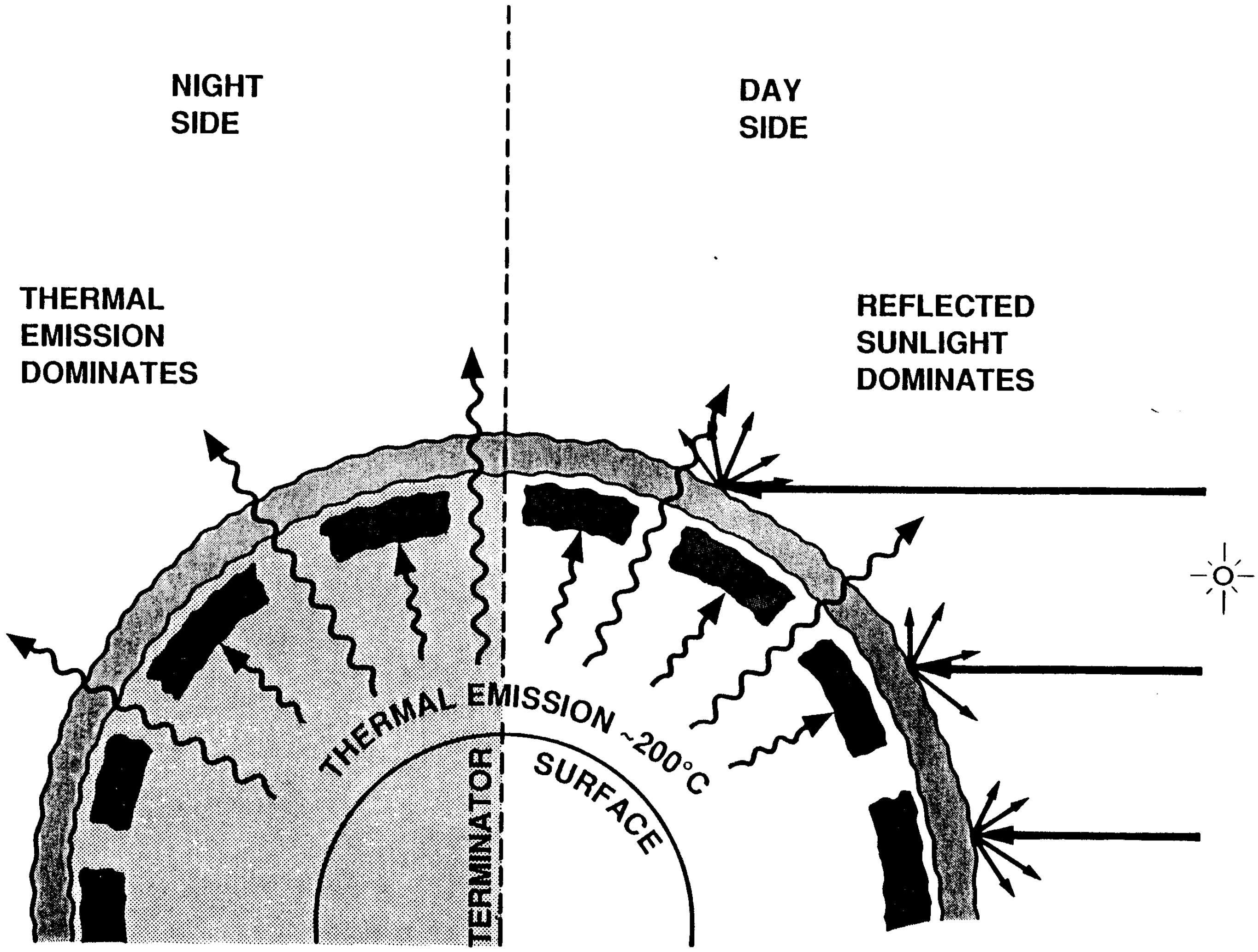
Two limb scans, one on the nightside limb and the other on the dayside limb, were performed in Long Spectrometer mode to study the vertical profile of oxygen and other trace species in Venus' atmosphere.

NIMS was in Long Map mode for the dayside ride-along observations. These observations are very different from the nightside observations in that the spectrum is dominated by reflected sunlight rather than deep thermal emission. The figure on page 6 is a cartoon showing the dramatic difference between the dayside and nightside of Venus in the near infrared.


VISIBLE LIGHT FROM SUN
80
70
60
50
40
30
20
10
0
0.5 atm
1 atm
91 atm
ALTITUDE, km
VISIBLE CLOUD TOPS
"HOT SPOT"
UPPER CLOUD DECK
THIN SMOG
360 kph WINDS
MIDDLE CLOUD DECK
SULFURIC ACID
THICK CLOUDS
240 kph WINDS
LOWER CLOUD DECK
THICK OPAQUE CLOUDS
LOWER HAZE LAYER
TENUOUS HAZE LAYER
THERMAL EMISSION AND CONVECTION
SURFACE
LOW WINDS
-50
+10
+70
+95
+210
+380
+410
+447 TO +455
TEMPERATURE, °C

GALILEO/NIMS VENUS MAPS
SPECTRAL COVERAGE




NIGHT
SIDE
DAY
SIDE
THERMAL
EMISSION
DOMINATES
REFLECTED
SUNLIGHT
DOMINATES
THERMAL EMISSION ~200°C
TERMINATOR
SURFACE