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Venus Express

Science Activity Plan for
Extended Mission
SAP-E-3, Part 3
MTPs 76-87

VEX-SCIOPS-PL-032

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CHANGE RECORD SHEET

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Revisions are indicated by a vertical bar at the outside border.

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1. INTRODUCTION

1.1 Introduction

Venus Express (VEX) is ESA's first mission to Venus. It has a payload consisting of seven scientific instruments, ASPERA, PFS, SPICAV/SOIR, VeRa and VIRTIS, with heritage from Mars Express (MEX) and Rosetta, and MAG and VMC, which are new instruments. The spacecraft was inserted in orbit on April 11, 2006 and since June 2006 performs routine science observations. The Nominal Mission ended on October 2, 2007. However the mission extension till the end of 2012 was approved (third extension). The VEX Science Operations Centre (VSOC) has the task to coordinate the scientific operations of the VEX mission.

1.2 Scope of the document

The Science Activity Plan for Venus Express Third Extended Mission (SAP-E-3) describes in a structured way the scientific activities to be carried out throughout the third extended mission (September 2010 – January 2013). To create more manageable SAP documents, the SAP is subdivided in 3 parts, as follow

SAP number	PART	MTP	Period	SAP document
SAP#3	Part 1	57-65	Sep'10-Apr'11	VEX-SCIOPS-PL-030
	Part 2	66-75	May'11-Feb'12	VEX-SCIOPS-PL-031
	Part 3	76-87	Feb'12-Jan'13	VEX-SCIOPS-PL-032

This document describes the SAP-E-3 Part 3 (MTP#76-87 February 2012 – Jan 2013). It follows the objectives set out in the Science Requirements Document (AD6), and is enhanced with specific information applicable to each phase of the mission, as provided by VSOC and the Science Working Team during meetings and in written correspondence. It also includes the requests, per MTPs (Medium Term Planning cycle of 28 days), from each individual instrument team for the observations required to fulfil the different objectives for the respective phases. SAP-E-3 Part 3 contains preliminary MTP timelines (sequences of science cases) agreed by the VEX Science Team. The timelines will be later used as starting point for detailed discussion of each MTP planning. This document will for quite a period be a living document due to its iterative nature. In this respect the document can be considered as a combination of the long term plan and the medium term plan as outlined in the VSOC development plan. Once this document has been established and agreed, it will be used as an input for the detailed short-term plan.

At the time of writing (March 2011), a study is evaluating whether the VEx orbit can be changed to a lower orbital period through huse of aerobraking. Because the results of this study are not yet known, this SAP document has been formulated based on the assumption that the orbit remains a 24-hour period.

1.3 General observation strategy for Extended Mission

The Venus Express Extended Mission has the following strategic objectives:

- Improve and complete spatial and temporal observational coverage;
- Study in detail the phenomena discovered in the Nominal Mission;
- Take advantage of the new operation modes (case#2 “pendulum”, spot pointing, limb track etc)
- Perform pericentre lowering down to the altitude that allows measurement of atmospheric density using torque and drag measurements, without appreciably changing the orbital period of the spacecraft. (~160 km);
- Perform necessary studies and tests preparing the spacecraft for future aerobraking campaign.

1.4 Applicable Documents

1.4.1 Higher-level documents

AD2: Venus Express Mission Definition Report, ESA-SCI(2001)6, SCI(2001) October 2001

AD3: VEX-RSSD-PL-005_D_2_SAP_implementation_plan

AD4: VEX-RSSD-TN-001_1_b_VEX_Science_Cases

AD5: VEX-RSSD-SP-001_2_0_VSOC_Design_Specification_and_Requirements

AD6: VEX-RSSD-SP-002_1_1_VEX_Science_Requirements_Document

AD7: VEX-RSSD-LI-004_2_0_VEX_science_themes

AD8: VEX-T.ASTR.-TCN-00665_3/0_Science_Cases_Definition_and_Study_Assumptions

AD9: VEX-T.ASTR-TCN-00932_3/0_Synthesis_of_Science_Cases_Analysis, May 29, 2006.

AD10: VEX-T.ASTR-UM-01098_1/1_ Flight User Manual

AD11: VEX-RSSD-TN-0003_1/0_Thermal constraints and science planning

AD12:VEX-RSSD-TN-0006_1/1_Proposal for the post-FAR thermal analysis of the science cases

AD13: Venus Express science cases thermal analyses report, Draft, December 2005.

1.4.2 Documents on the same level

TBD

1.4.3 Lower-level documents

TBD

1.5 Reference Documents

TBD

1.6 Abbreviations

Note: A complete list of all experiment abbreviations and mission phases is given in RD1.

S/C	Spacecraft
CVP	Commissioning and Verification Phase

FoV	Field of View

1.7 Definitions

TBW

2. SCIENCE OPERATIONS PLANNING

2.1 Overview

Ten types of orbital science operations (called "science cases") were designed and studied early in the mission planning. They are now used as building blocks to design the Science Activity Plan. In order to check the experiment inputs and to merge them into a consolidated timeline, the VSOC uses a planning concept and two computer based planning tools: MAPPS and EPS. The concept and the tools are described below.

2.2 Science Cases

Science Cases are typical scientific orbital operations to be used as building blocks in the SAP development. The following ten science cases were designed in the early phase of mission planning (AD4, AD8).

Case #1: Pericentre observations (spacecraft sizing case)
Case #2: Off-pericentre observations
Case #3: Apocentre VIRTIS mosaic
Case #4: VeRa bistatic sounding
Case #5: SPICAV stellar occultation
Case #6: SPICAV solar occultation
Case #7: Limb observations
Case #8: VeRa radio occultation
Case #9: VeRa solar corona studies
Case #10: VeRa gravity anomaly studies

The Astrium study of the science cases (AD9) proved their feasibility with some constraints related to the thermal aspects and having seasonal implications.

2.3 SAP planning concept

In order to develop the Science Activity Plan a step-wise approach will be used. A detailed description of the steps are given in the SAP implementation plan (AD3). Current SAP (section 2.3.4) does not impose any limitations on number of cases as soon as the operational constraints (thermal, power, pointing etc) are not violated.

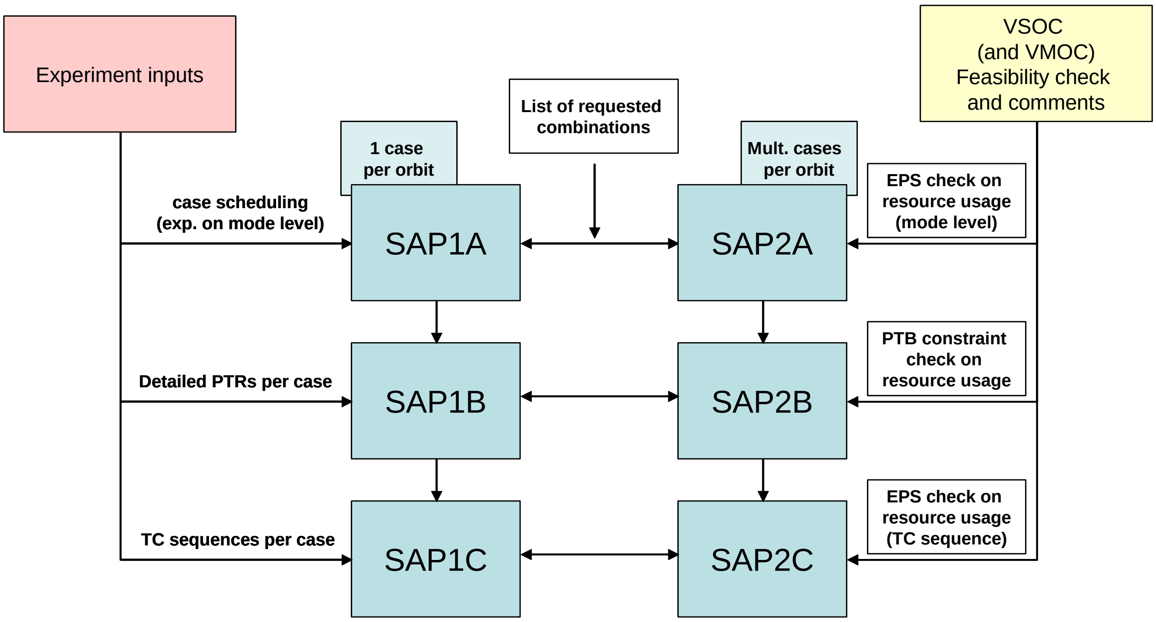


Figure 2.1 *SAP overview diagram*

2.4 MAPPS

MAPPS is a software package that will be used to analyze and plan the mapping of Venus. For Venus Express the EPS (see below) will be integrated within MAPPS. As a result MAPPS will also be able to make the necessary resource validation and conflict checking.

2.5 EPS

The Experiment Planning Software (EPS) is being used in the production of the Science Activity Plan. The particular functions of EPS used for this task are:

- Model and operate experiments on mode level (Experiment Description File, EDF)
- Consistency checks between the instrument timelines (ITL) on mode level
- Consistency check between the sequences and commands contained within the VMIB.
- Consistency checks between the instrument timelines (ITL) and the VMIB.
- ITL verification on mode level, EPS execution is prevented if ITL actions/transitions not consistent with mode.

- Modelling the resource allocation over the operational timeline.
- Output POR files for ingestion into VMOC MCS.

The use of EPS in planning is discussed in more detail in throughout this document. For more information on the capabilities of EPS refer to the user manual [AD xx].

2.6 Venus Express orbit and visibility of the ground stations

The Venus Express was inserted in a polar orbit with a period of 24 hours. The pericentre altitude was maintained between 250 km and 350 km during the first 8 months of the Extended Mission. In July-August, 2008 the pericenter was lowered to the corridor 170-270 km to allow plasma observations in this altitude range. This pericentre lowering does not require any changes in observations strategy or special spacecraft operations. The apocenter altitude is kept at about 66,000 km. In September 2009 the pericentre latitude reached the Northern pole.

The Venus Express orbit is divided in three parts (figure 2.2): two of them allocated for observations and the third one for telecommunications with the ground station.

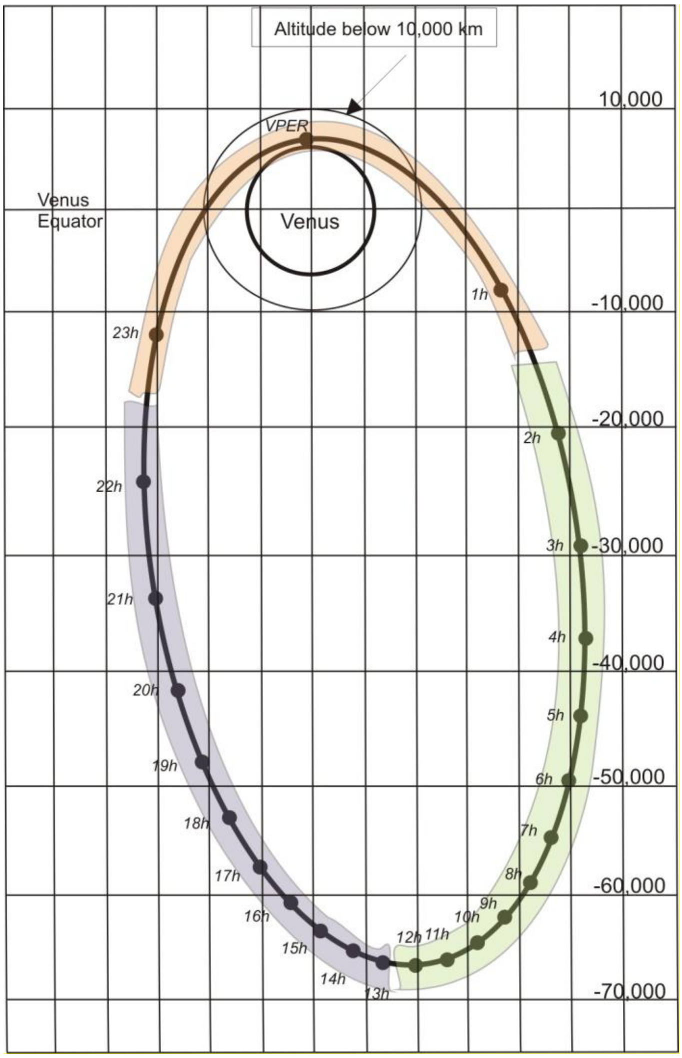


Figure 2.2 *The Venus Express orbit and orbital phases: orange: pericentre observations; blue: off-pericentre observations in ascending branch; green – telecommunications with Cebreros.*

Communication with Earth takes place in each orbit after the pericentre passage, i.e. in the descending part of the orbit, marked in green in Figure 2.2. The orbit period is tuned such that the communication window always falls in daytime at the primary ground station at Cebreros. Figure 2.3 shows visibility of the Cebreros station from the spacecraft. The lower of the upper two lines shows the end of telecommunication slot. Its duration does not exceed 10 hours even in case visibility of the planet is longer. The periods when the telecommunication phase ends early provide favorable conditions for the Case 3 apocentric mosaic.

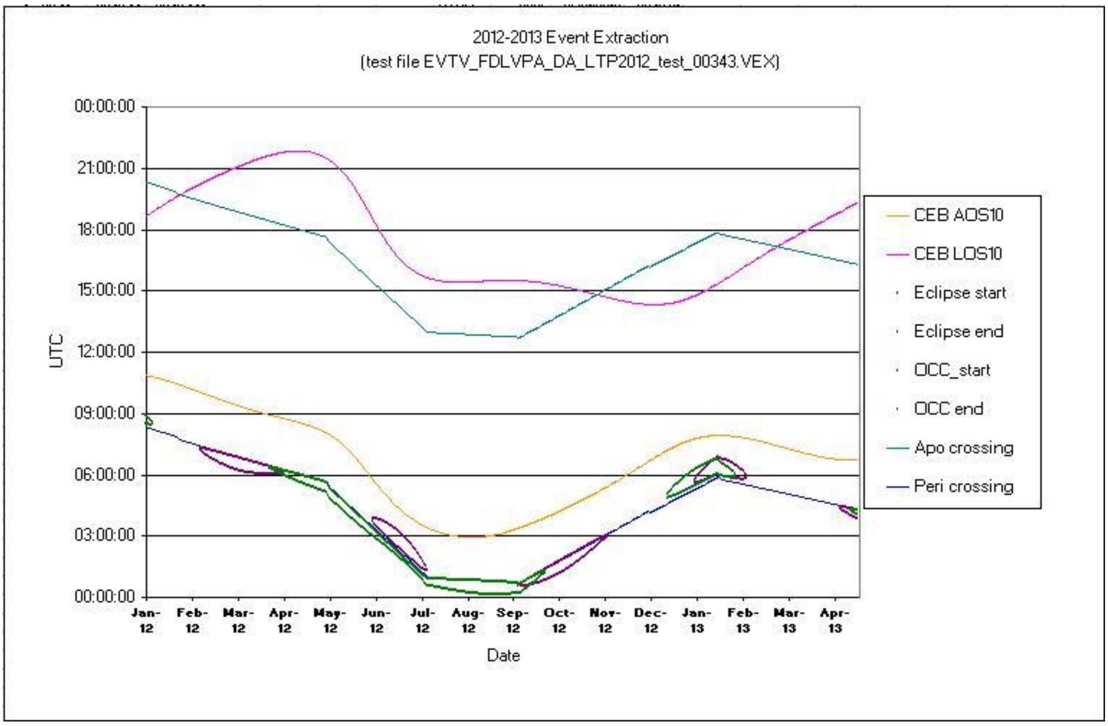


Figure 2.3 *Visibility of the Cebreros ground station from the satellite.*

The ground station at New Norcia, Australia, will be visible around pericentre and will be used for the radio science experiments. The DSN support to the VeRa radio occultations as well as the support for the data downlink in the periods of low data rate is agreed between ESA and NASA.

3. THE SAP-E-3 PART-3 PROPER

This section gives an overview of the Science Activity Plan for Extended Mission as a whole (chapter 3.1). It is followed by descriptions of payload activity during the period covering MTP#76-87 (February 2012 – January 2013). Depending on environmental conditions (occultation, illumination conditions etc.), the science will focus on different mission objectives.

3.1 Science Activity Plan overview

3.1.1 Coverage

The SAP-E-3 Part 3 (SAP for 3rd extension) will cover in detail the period from February 2012 until Jan 2013, or MTP range from #76 to #87.

3.1.2 Mission Objectives

The Venus Express mission aim is a global investigation of the Venus atmosphere, plasma environment and some important aspects of the surface. The detailed Science Objectives of the Venus Express mission are described in AD6.

3.1.3 Main principles of the SAP development

The SAP development was based on the following principles:

1. Complete and uniform coverage of the science themes;
2. Balance between distant and close-up views of the planet;
3. Balance between the observations of the Northern and Southern hemisphere;
4. Synergy between experiments in covering science objectives;
5. Use of multiple science cases in each orbit taking into account mission constraints (thermal, pointing, data volume etc);
6. Even distribution of pericentic science cases with priority given to the solar and Earth radio occultation experiments in specific seasons of the mission;
7. Maximum compliance with the current flight rules.

3.1.4 Extended Mission overview

A poster summarising this mission extension period is given in Annex 1.

3.1.5 Instruments objectives and Request Summary

3.1.5.1 Introduction

In this section the individual objectives for each instrument are summarised and their overall operational requests are listed.

3.1.5.2 ASPERA

ASPERA is typically operated twice per orbit, once near apocenter and once in the ascending branch as the spacecraft crosses the space/atmosphere boundry. Strategically the ASPERA activity will consist of two parts: survey observations in the beginning of the mission and more specific, more detailed observations performed on selected parts of orbit later in the mission. Data is collected at different rates depending on the selected mode.

3.1.5.3 MAG

MAG shall be ON during the entire mission and will permanently collect data. Data is collected at different rates depending on the selected mode.

3.1.5.4 PFS

PFS experiment was not operational during the nominal mission despite several attempts to unblock the scanning mechanism.

3.1.5.5 SPICAV

The main goal of the SPICAV experiment is to sound the Venus atmosphere in solar and stellar occultation geometry with sufficient latitude and local time coverage; further modes include nadir and limb pointing. The use of the near IR channel (0.7-1.7µm) compensates partially for the loss of VIRTIS-M, with a better spectral resolution but a lower sensitivity and spatial resolution (2°).

SPICAV observing modes include:

- Stellar occultation

  - This is performed only on the nightside (with few exceptions). Bright stars are chosen to maximize coverage in latitude and local solar time.
  - Orbits where the orbital plane is near the terminator are slightly less favourable for stellar occultation.
- Solar occultation (SOIR)
  - Occurs in eclipse seasons.
  - Allocation of orbits to SOIR is generally chosen to maximise latitude coverage. This requirement leads to use of consecutive orbits at the beginning and end of a solar occultation season, with typically one solar occultation every 2-3 orbits in the middle of eclipse season, alternating ingress and egress to observe both North and South hemispheres.
  - In addition to the above requirement, the SOIR team request repeated ingress or repeated egress observations on 4-5 consecutive orbits in order to study day-to-day variability at the same location, to be carried out occasionally (not necessarily in every eclipse season).
- Solar occultation (SPICAV UV)
  - Due to the imperfect co-alignment of SOIR and SPICAV UV in the solar occultation mode, SPICAV UV is looking at the sun at a place of the focal plane for which the spectral resolution is degraded. Spicav wishes to perform some solar occultations optimized for UV spectral resolution, in particular to confirm the absorption by SO.
  - Once per MTP in occultation.
- Nadir observation on dayside using SOIR boresight
  - This is a new request for SAP Ext 3 part 3. SOIR intends to observe light reflected from the dayside cloud-top. Observation should be chosen to maximize the signal, without illuminating the –X face.
  - In order to probe the atmosphere to the lowest possible altitude, it is desired that this observation be carried out in near-nadir geometry.
- Nadir observation dayside using SPICAV boresight.

  - The goals of this observation include mapping of unknown UV absorbers, mesospheric SO_2 and H_2O abundance, and cloud top altitude retrieval with CO2 band at 1.43 µm.
- Nadir observation nightside using SPICAV boresight
  - The main goal of this observation is mapping of the lower atmosphere and surface, in the 0.7 – 1.7 µm range. This includes H2O in the lower atmosphere.
  - This is usually carried out in eclipse.
- NO observation campaign
  - For the SAP Ext 3 Pt 3 SPICAV has added a new request for observations in eclipse of the NO airglow using inertial mode. In this mode, the spacecraft is held in an inertial pointing mode such that the observed point sweeps a wide range of latitudes while the spacecraft is in eclipse.
  - This will be carried out in campaigns lasting up to ~60 days. In this time the NO observation will be carried out on alternate orbits, in order to build up and map of NO emission evenly spaced in local solar time. See technical note VEX-SPICAV-TN-120.
- MEx-VEx joint observations
  - In this observation, SPICAV is pointed in the direction of Mars for one acquisition, and in the opposite direction for another acquisition. SPICAM/MEx performs the same observation. These are combined to make a study of dust interstellar/interplanetary Hydrogen atoms in the inner solar system by looking at the Lyman alpha emission of these atoms illuminated by the sun, and to intercalibrate SPICAV, SPICAM and SWAN on SOHO at the Lyman alpha frequency.
  - This observation is performed near apocentre, with a duration of ~ 1 hr, to avoid Lyman alpha contamination by the hydrogen corona of Venus.
  - Since it requires VEX to look into two strictly opposite directions, it can be done only when the elongation of Mars as seen from Venus is at 90°, plus or minus a few degrees, requiring the illumination of the – Z

face by a few degrees. This is to be performed ~ 3 times at each opportunity, which dates for 2011-2012 are: 2012/06/17, and 2011/08/06.

- VEx-SOHO joint observations
  - Same as above, but using SWAN/SOHO, near the Earth. Therefore, there is one opportunity at each quadrature, when the solar elongation of the Earth as seen from Venus is near 90°. This occurs over the 2011-2012 period around 2011/01/10, 2012/03/28 and 2012/08/16.
- Zodiacal light observation
  - It is important to look at small solar elongations (less than 30°), not well explored up to now. In order to avoid solar stray light contamination, it is performed in eclipse during a few minutes before exit of shadow, inertial viewing. A slew maneuver to increase the solar elongation is started one minute before exit of eclipse.
  - This is to be performed once per favourable MTP. The favourable MTPs are those when VEX is in eclipse before pericenter.
- Dayside airglow limb observation
  - The science goal is to look for dayside non-LTE emissions (‘airglow’). Their decreased brightness with altitude yields the thermospheric / exospheric temperature. Target species including H, O, CO, CO_2^+ ion and O at 297.2 nm in the UV, and O_2 in the IR. This is performed with the SPICAV-UV slit arranged perpendicular to the limb, to minimise stray light from the bright limb. The current procedure is to align the spacecraft with the large part of the slit towards the limb, resulting in some +X illumination. The SPICAV team has requested that the spacecraft be ‘flipped’ such that the narrow portion of the slit is towards the bright limb, to reduce stray light and increase the spectral resolution. This is not allowed under current flight rules (as of May 2011), but a revision of this rule is under study. If allowed, this observation should be performed at regular intervals e.g. 5-10 times per MTP, OR in campaigns of alternate orbits during half of a Venus day (120 days). See technical note VEX-SPICAV-TN-121.

- Dayside hydrogen corona observation
  - One preferred mode is to observe the H Lyman alpha emission in an inertial direction, letting Vex orbital motion perform the scan in altitude. In the same orbit (±1), the same pointing is required near the apocenter, in order to measure the interplanetary background in the same celestial direction, for a good subtraction from the data obtained at lower latitudes. In some instances, several ON-OFF observations by SPICAV may be done in the same direction, to scan a larger altitude range (the instrument cannot work more than 35 minutes in continuous duration because of potential over-heating.
- Observations of Mercury/comets/other targets
  - Occasional.
- Galactic scan
  - The science goal is to study diffuse UV radiation in some planetary nebulae (scattering of stellar light by interstellar dust) and to attempt to detect galactic Lyman alpha radiation (at 121.6 nm), which is suggested by Recent Voyager observations at 100 AU. Observation requires periods of ~2 hours near apocentre. A number of interesting sky areas have been identified. They can be observed when their solar elongation is between 60 and 90° (to minimize solar stray light). This usually requires a series of apocenters to be dedicated to a particular region in the sky, with about 3 to 6 apocentres per MTP.
- Solar UV imaging
  - The goal is to obtain a map of the sun in UV wavelengths (190-310 nm). This will be done by letting the FOV of SPICAV-UV (solar port) drift across the Sun, therefore building up a hyperspectral image of the sun. Spatial reolution will be 1.5 arcmin.
  - Observation duration is <30 minutes, and can be performed when VEx is away from Venus (e.g. near apocentre).
  - The long-term intention is to perform regular monitoring of the sun twice per MTP. However, as of late 2011 this observation type is not yet fully validated so it has not yet been included in the SAP.

In addition to the above scientific observations, there are occasional calibration observations, which include:

- SPICAV-SOIR ‘mini-scans’
    - Performed near apocentre, approximately twice per MTP. The purpose of the mini-scan calibrations is to get precise relationships between the applied RF frequency and the wave number and also to obtain the bandpass curve of the electrically tuneable order sorting filter (AOTF).
- SPICAV-SOIR alignment calibration
    - Performed near apocentre, approximately once per MTP. The main goal of the alignment scans is to define the exact alignment of the instrument boresight with respect to the spacecraft axes.
- SPICAV ‘polarisation’ calibration
    - Sunlight reflected at 0° phase angle should exhibit no net polarisation. Therefore it requires that boresight +Z be pointed exactly opposite to the sun (inertial pointing), and the –Z face be illuminated at 90° angle. The observed point is preferably at a low SZA angle (<30°). This point is observed with SPICAV in order to intercalibrate the photometry of the two channels sensitive to the two polarization components of back-scattered light. Duration is 5 to 10 minutes, to be made twice per year..
- Measurement of Dark Charge of the SPICAV UV CCD. This is to monitor the DCNU (Dark Charge Non-Uniformity) of the CCD detector, which is changing with time because of high energy particles. Those coming from the Sun are increasing in flux with the climb of the solar cycle. They may be performed anywhere in the orbit. Approximately 4 times per MTP (this is because of the many ways the CCD may be read, each mode requiring a dedicated measurement). At least one in Z mode (internal parameter of SPICAV) may be done.

3.1.5.6 VeRA

The VeRa experiment will perform four kinds of *"environment dependent"* observations.

(1) Earth occultation with *as good as possible* latitude and local time coverage of Venus. The attitude profile in this experiment is the most demanding for the spacecraft AOCS system. It will be provided by the VeRa PI for each radio-occultation individually and will define the pointing for the other experiments. It would be highly desirable to select the orientation of the spacecraft +Z axis during radio occultation so that the +Z-looking instruments could simultaneously see the planet.

(2) Bi-static sounding of surface targets. These observations are abandoned since autumn 2007 due to power loss in the S-band.

(3) Solar Corona observations. These observations are abandoned since autumn 2007 due to power loss in the S-band.

(4). Gravity anomaly. This investigation consists of precise tracking of the spacecraft while it passes over global geological formations on the Venus solid body. These observations are abandoned since the end of the nominal mission due to a judgment that the added scientific value with respect to previous observations was very small.

The VeRa experiment is mainly performed using the ESA New Norcia station. Support from the DSN antennae for the VeRa experiments as well as for the data downlink is agreed between ESA and NASA. A list of requested New Norcia and DSN passes for VeRa experiments is included as Annex 4, and the latitude and solar zenith angle coverage are shown in Annex 5.

3.1.5.7 VIRTIS

The VIRTIS goal is to provide spectral mapping of Venus with moderate spectral resolution and high spectral resolution observations preferably imbedded in the spectral maps. The VIRTIS-M-IR channel is no longer operational after a failure of the cooler in late 2007. The VIRTIS-H-cooler failed in June 2011 and will no longer be scheduled for future operations.

Specific observation types are:

- Case 1 VIRTIS-M-VIS N hemisphere nightside – 18 sec exposure time
  - Goal is to map thermal emission from surface at ~1.0 µm.
  - To be performed when data volume allows; VEx does not need to be in eclipse.
- Case 1 dayside phase function coverage.
  - The goal is to achieve coverage of the dayside at a range of latitudes, local solar times, incident and emergent angles, and phase angles. In particular, few observations at low phase angles (<45°) have been obtained to date.
  - Could be performed using spot pointing or inertial modes (TBD).
- Case 2 – hi-res images of cloud morphology
  - The goal is to obtain images at the highest possible spatial resolution. VMC has found many instances of gravity waves at high latitudes; VIRTIS could complement this by high resolution at low latitudes.
  - Will be performed at 1-2 hr from pericentre. Although push-broom imaging is possible, acquiring images using the scan mirror while VEx is in spot-tracking mode enables high-resolution images with consistent pixel aspect ratio. Spatial resolution will be < 5 km.
  - focus at first on low latitudes (e.g. 0, ±10°, ±20°, ±30°), during one dayside 'season' (four MTPs), at Local Solar Time = 7h, 9h, 11h, 13h, 15h, 17h (TBC).
- Case 2 – cloud tracking
  - The science goal is to enable cloud tracking of the upper clouds. This requires repeated images on the dayside using spot-tracking to target a specific latitude.
  - Carried out in campaigns of 3-5 consecutive orbits at each latitude
  - Double offset day + night
    - Depending on data volume
- Case 2 Nightside observations : surface thermal emission mapping
  - As for Case 1 surface observation above.
  - consecutive orbits not required
  - Typically, spot tracking is used to ensure latitude coverage.
- Case 3
  - Formally, this is a full or half mosaic acquired from near apocentre.
  - VIRTIS team suggest using this mode in 3 consecutive orbits, twice per MTP.
- Case 7- limb observation of O_2 visible airglow (nightside) with VIRTIS-M-VIS
  - Coverage in the past has been sporadic.
  - VIRTIS team now suggests campaign of every 3rd orbit during 120 days to ensure even coverage of nightside hemisphere.

  - Use limb track. Along-track or tangential limb. Slit almost perpendicular to limb.
- Case 7 Dayside limb imaging
  - The science goal is the study of vertical cloud structure, e.g. search for detached layers.
  - Observation is difficult due to stray light.
  - Strategy is yet TBD.

3.1.5.8 VMC

The default operation mode for VMC is to acquire images any time that Venus is in the field of view.

- Case 3 / 2 Dayside imaging
  - Repetition rate is set to optimise cloud tracking. This ranges from 30 minutes near apocentre to 1 minute when near pericentre.
  - If VMC has control over pointing in the period 1-2 hours before or after pericentre – when the disc of Venus is still larger than the FOV – VMC may command re-pointings to build a mosaic to cover the whole disc of Venus. (observation type 'C2VM')
- Case 1 dayside cloud morphology imaging
  - The time interval between successive images is chosen to ensure overlap between images. The degree of overlap may be 20% to 90%, depending on available data rate.
- Case 1 phase function observations
  - 'Phase function' observations in past SAPs were conducted using a spot tracking mode. This allowed a phase function to be built up for a particular cloud. In SAP Ext 3 part 3 different versions of off-nadir pointings may be used in order to permit observations at a range of phase angles, latitudes, emergence and incidence angles, in order to permit characterisation of upper cloud and haze properties.
- Case 1 nightside surface observation using near IR channels
  - Performed only in eclipse, using nadir geometry
- Terminator imaging campaigns

- Within ± 2 orbits of the terminator orbit, VMC can point towards the dayside in both the ascending and descending branches of the orbit as a cold observation (no illumination on –Z). Goals include: measurement of scattered light vs. solar zenith angle at the terminator; search for waves near terminator; "astronaut's view" P.R. movies.

For calibration, VMC requests 'flat field' observations on every orbit. These are nadir observations of the dayside, conducted near pericentre. Some geometrical calibrations are also periodically requested.

3.1.6 VEx Atmospheric Drag Experiment (VExADE)

Atmospheric drag experiments are conducted when the pericentre is lowered to its minimum levels, typically down to 160 km altitude. This observation precludes other observations for typically ±2 hours around pericentre. Campaigns are typically 10-20 orbits long, with additional 'pre-ADE' passes. See mission overview poster for details.

Atmospheric density may be measured both using 'classic' spacecraft radio science to determine the mean drag for each pass but also using torque experiments. In these the solar panels are set in asymmetric positions to induce a torque on the spacecraft, which is measured using the reaction wheels.

3.1.7 Summary of requested campaigns

Several of the requested observations described above require observation campaigns in which a complete map of the dayside (or nightside) is requested. These include:

DAYSIDE

- SPICAV dayside airglow limb (SPICAV). A dedicated campaign to map the spatial distribution across the entire dayside is called for. This observation requires the illumination of the –X panel of the spacecraft, and so is still under investigation, so has not been scheduled into this SAP document. If the –X illumination rules are resolved, though, we ***suggest campaign of every other orbit in MTP 76-77*** (note this only allows partial coverage, from LTAN 18:00 to LTAN 01:00, before quadrature period starts).

- VIRTIS campaign of high-resolution cloud imaging (performed at VPER ±2 to VPER ±1). ***Suggest campaign in MTP 79-82,*** using every third orbit (Note that this is during radio occultation season, which will take priority).
- Near-zero phase angle campaign (led by VMC). This is carried out in eclipse season, in the dayside period of the orbit, within 1 hour of pericentre. This is a very hot observation, with very high illumination on –Z axis, with a 19-hour recovery time. ***Suggest every other orbit in MTP 84-85*** (after pericentre)**.**

This is in addition to normal dayside near-pericentre observations (SPICAV nadir and VMC cloud morphology and occultations), which should be carried out every other orbit.

NIGHTSIDE

- NO observation campaign (SPICAV).
  This has already been carried out starting in MTPs 70-72. ***Suggest another dedicated campaign of every 2-3 orbits during MTP 84-85****.*

Oxygen Visible airglow campaign (VIRTIS-M-VIS)

- In addition to regular monitoring before and after each eclipse season (as described above), the VIRTIS team will attempt to map the spatial distribution during one nightside season. ***Suggest campaign in MTP 76-77.***

The above specific campaigns are in addition to the normal nightside near-pericentre observations (surface nadir observation when in eclipse, and occultation observations), which should continue to be carried out in at least every other orbit in eclipse season.

3.2 MTP #76

3.2.1 MTP in brief

MTP #76 covers the period from 4 Feb through 3 March, 2012 and orbits #2116 – 2143. This MTP includes the start of an eclipse season in orbit 2119. The solar occultation occurs before pericentre. Illumination conditions are similar to those in MTP #68 and #60. The MTP is cold. The data rate is moderate. Local time at ascending node changes from 21h to 24h. Pericentre altitude is shown in Annex #2. Quadrature illumination commences on orbit 2142 , which means that in the last two orbits of this MTP thermal requirements prevent hot observations unless communications passes are skipped to provide sufficient thermal cooling periods. Figures 3.7 and 3.8 show observations timeline and planet coverage by orbital tracks.

As per Section 3.1.7 above, MTP 76-77 is an opportune time for two campaigns. Before pericentre (nightside), every other orbit is allocated to VIRTIS-M-VIS night limb search for airglow. After pericentre (dayside), this MTP could be used for SPICAV dayside limb observations of airglow, if the –X illumination required by this observation is allowed.

Surface targets include: Ishtar Terra in the Northern Hemisphere; Central Eistla Regio, which has been identified as a ‘hotspot’, i.e. a surface manifestation of a mantle upwelling (Smrekar et al. chapter in ‘Venus II’, 1997). The Southern hemisphere hosts the usual targets identified by VIRTIS, e.g. Lada Terra.

Around orbit 2129, VEx will, in eclipse. fly over Bereghinia Planitia (28°E, 39°N), which was the area identified as a possible cooling lava flow by Bondarenko et al (GRL, 2009) – this should be observe using SPICAV-IR nadir and VMC.

3.2.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 20:40 - 23:40 h (similar to MTP#68)
- Eclipse season #20 starts in orbit 2118
- Surface targets: Ishtar Terra (N hemisphere); C. Eistla Regio; Lada Terra (S hemisphere)

- Cold period
- Downlink is moderate
- Quadrature commences orbit 2142 (10° illumination on +Y panel during communications pass). No hot observations allowed during quadrature, unless CEB passes are skipped for cooling.

3.2.3 *Proposed Observations*

The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-7-P-1 (VIRTIS limb track visible airglow observation)
- Type #2: cases 2-6-6-P-1 (first 6 orbits of eclipse season when eclipses occur in low latitudes and eclipse is short)
- Type #3: cases 2-6I-1-P-1 or 2-1-6E-P-1 (when eclipse moves to high latitudes and its duration is >15 min)

Note: 'P' in the orbit types above refers to the pericentre rather than to an observation.

Notes to the proposed timeline.

1. VIRTIS Case #3 (Mosaic from apocentre) observations are requested in two blocks of 3 orbits per MTP.
2. The baseline includes the VIRTIS limb track airglow observation assigned to every other orbit during MTP 76-77.
3. Opportunities for sub-solar point observation, for Cross Polarization calibration for SPICAV and/or SOIR nadir observation, at the end of MTP.
4. Dayside observations after pericentre at VPER to VPER+1: either nadir observations (optimised for nadir absorption spectroscopy (SPICAV, VIRTIS-M-VIS) or 'phase function observations' led by VMC, on alternate orbits.
5. VMC mosaics of dayside to be performed at VPER+1 to VPER+2 where possible.
6. Opportunity for Zodiacal Light Observation during Eclipse at the end of MTP when the eclipse duration is long.

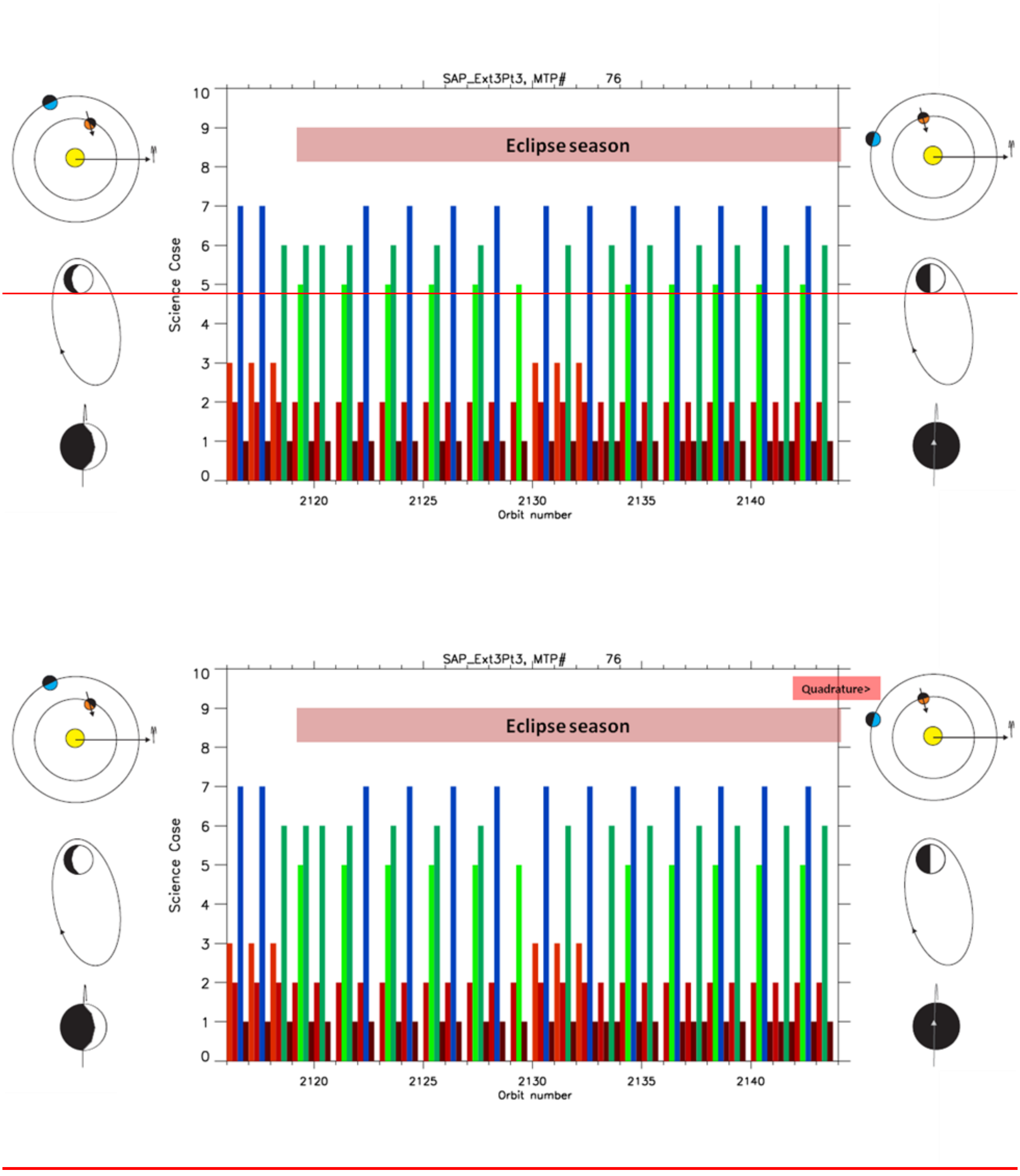


Figure 3.7 *MTP#76 timeline.*

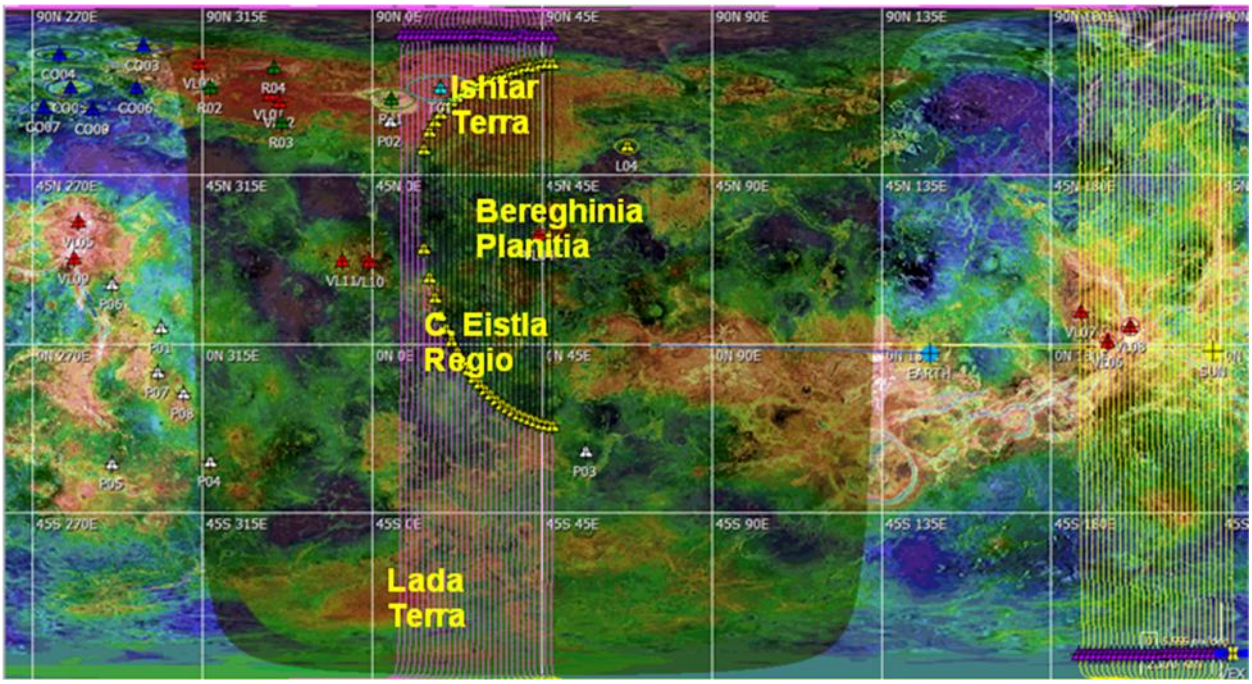


Figure 3.8 *Planet coverage by orbital tracks in MTP#76. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.3 MTP #77

3.3.1 MTP in brief

MTP #77 covers the period from 3 March through 31 March, 2012, and includes orbits #2144-2171. The entire MTP is in eclipse season #20. The long Earth occultation season starts at the end of this MTP (in orbit 2167), and will last until MTP#84. Quadrature illumination continues through the whole of this ~~commences on orbit 2156 and continues for the rest of the~~ MTP, where thermal requirements prevent hot observations unless communications passes are skipped to provide sufficient thermal cooling periods. The MTP is cold and has very high data rate (swap to HGA2 occurs just after this MTP). Local time at ascending node changes from 0h to 3h, thus illumination conditions are similar to those in MTP#69 and on the descending arc will be ideal to study the day side. It is preferred to extend observations till about VPER+02:00 by delaying the start of the CEB pass. Night surface observations in eclipse at ascending branch cover Ovda Regio and Tellus Tessera. Note that this may be a period of interest for co-ordinated observations with ground-based observers, because Venus is at maximum elongation from the Sun.

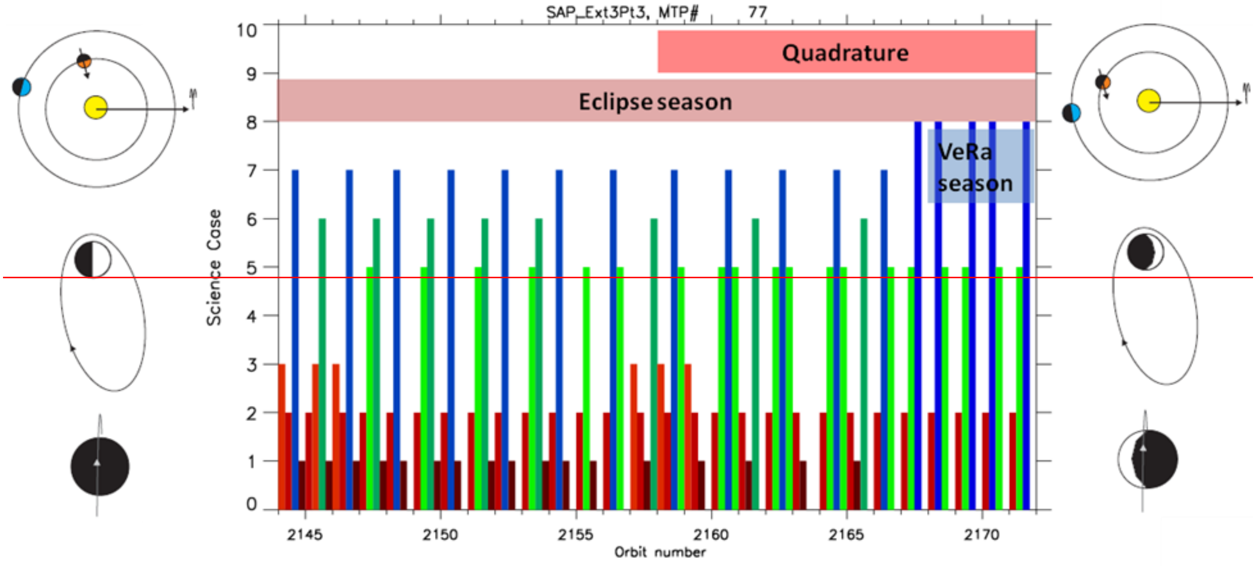
As outlined in Section 3.1.7 above, a VIRTIS-M-VIS limb-track observation has been scheduled in every second orbit in this MTP with the goal of mapping atomic oxygen airglow.

Surface targets include Ishtar Terra in the Northern Hemisphere; also, Bell Regio and Eastern Eistla Regio, which have been identified as ‘hotspots’, i.e. a surface manifestation of a mantle upwelling (Smrekar et al. chapter in ‘Venus II’, 1997).

Figures 3.9 and 3.10 show observations timeline and surface coverage in MTP#77.

3.3.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 23:40 - 02:40 h (similar to MTP#61)
- Cold season
- Eclipse season during whole MTP
- Earth occultation season #13 from orbit 2167.
- Quadrature ~~from orbit 2156~~throughout entire MTP (10° illumination on +Y panel during communications pass). No hot observations allowed during quadrature, unless CEB passes are skipped for cooling.
- Surface targets: Ishtar Terra, Bell Regio (e.g. Tepev Mons), E. Eistla Regio
- Very high data rate



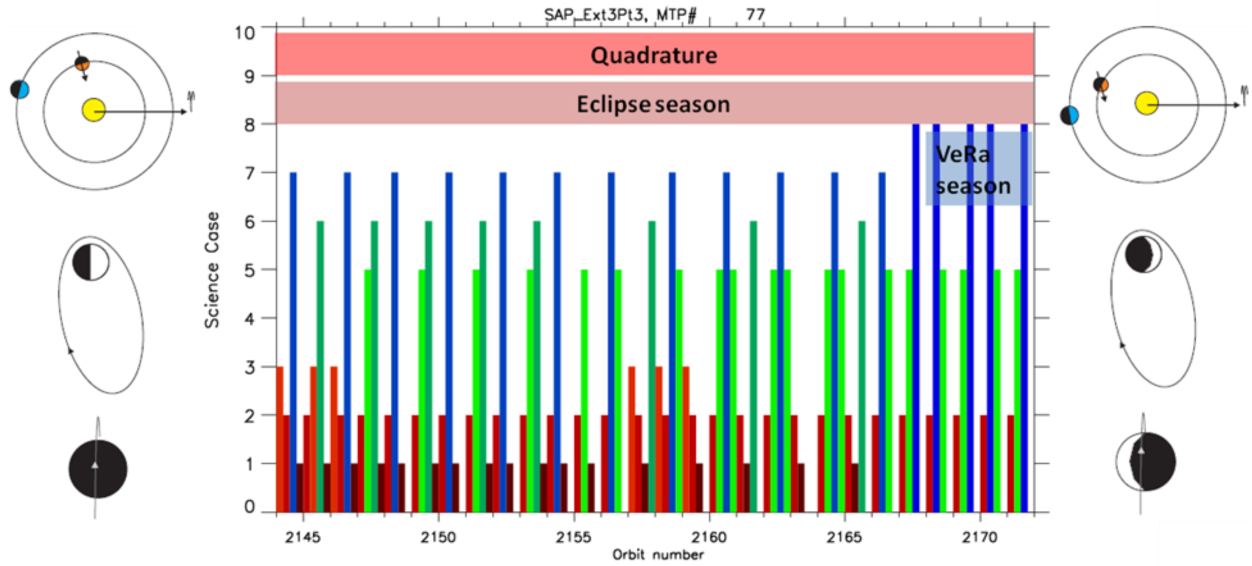


Figure 3.09 *MTP#77 timeline*

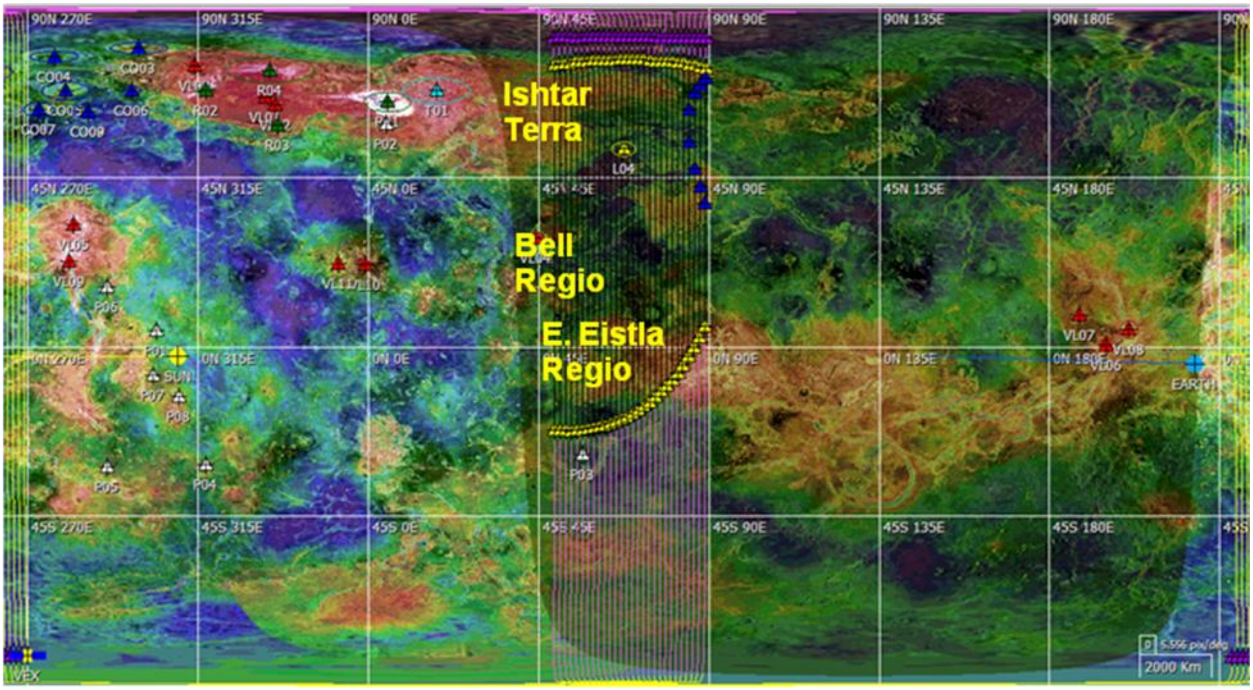


Figure 3.10 *Planet coverage by orbital tracks in MTP#77. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.3.3 Proposed Observations

The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-[5]-7LT-P-1
    - VIRTIS limb observation campaign (nightside, in eclipse) in alternate orbits throughout the MTP
    - Case 5 to be inserted before pericentre if appropriately located stars are available.
- Type #2: cases 2-[5]-1-6E-P-1 or 2-[5]-6I-1-P-1
    - SOIR observations to be combined, where possible, with nadir observations of the surface in eclipse.
- Type #3: cases 2-7LT-P-5 or 2-5-1-P (in quadrature when hot observations are not allowed)
- Type #4: cases 2-8-P (radio occultation passes, orbits 2167-2171).

- Further cold observations (eg. Cold case 5) may be added where possible.

Notes to the proposed timeline.

1. SOHO observations in orbits 2167-2169 near apocentre (if can be done cold).
2. It is suggested that at least two communications passes are skipped, in order to allow SOIR observations during quadrature (e.g. orbits 2157. 2161 and 2165).
3. SOIR observations after the start of Radio occultation season would require skipping both VeRa observation (NNO pass) *and* a downlink (CEB pass) so are not recommended. A maximum of one SOIR operation should be scheduled in orbits 2167-2171.
4. Two campaigns of 3x orbits each of Case 3 observations are performed, at beginning and middle of this MTP.
5. Case 3 and 2 observations must be cold if performed in quadrature without skipped pass.

3.4 MTP #78

3.4.1 MTP in brief

MTP #78 covers the period from 31 March through 28 April, 2012, and includes orbits #2172-2199. Eclipse season ends in orbit 2178. The long Earth occultation season continues throughout the whole of this MTP, with the VeRa ingress passes probing low latitudes (see Annex 6 for VeRa coverage). Quadrature illumination continues until orbit 2177~~during most of this MTP, until orbit 2191~~, disallowing hot observations unless communications passes are skipped. The MTP is cold and has very low data rate (swap to HGA2 occurs in the second orbit of this MTP).

Local time at ascending node changes from 3h to 6h, thus illumination conditions are similar to those in MTP#62. Night surface observations in eclipse at ascending branch cover Ovda Regio and Tellus Tessera, although it is noted that the eclipse season is only in the first week of this MTP and is very short. Atmospheric drag experiment campaign #8 starts towards the end of this MTP in orbit 2196; VeRa radio occultation passes using HGA2 in pure Earth-pointing mode will be combined with the drag passes (TRQ only). Pericentre altitude will descend to 165 km altitude in these TRQ experiments.

Note that this may be a period of interest for co-ordinated observations with ground-based observers, because Venus is at maximum elongation from the Sun.

Figures 3.11 and 3.12 show observations timeline and surface coverage for this MTP.

3.4.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 02:40 - 05:40 h (similar to MTP#62)
- Cold season
- Eclipse season until orbit 2178.
- Earth occultation season during whole MTP.
- Quadrature until orbit ~~2191~~ 2177 (10° illumination on +Y panel during communications pass). No hot observations allowed during quadrature, unless CEB passes are skipped for cooling.
- Surface targets: Ovda Regio, Tellus Tessera.
- Very low data rate

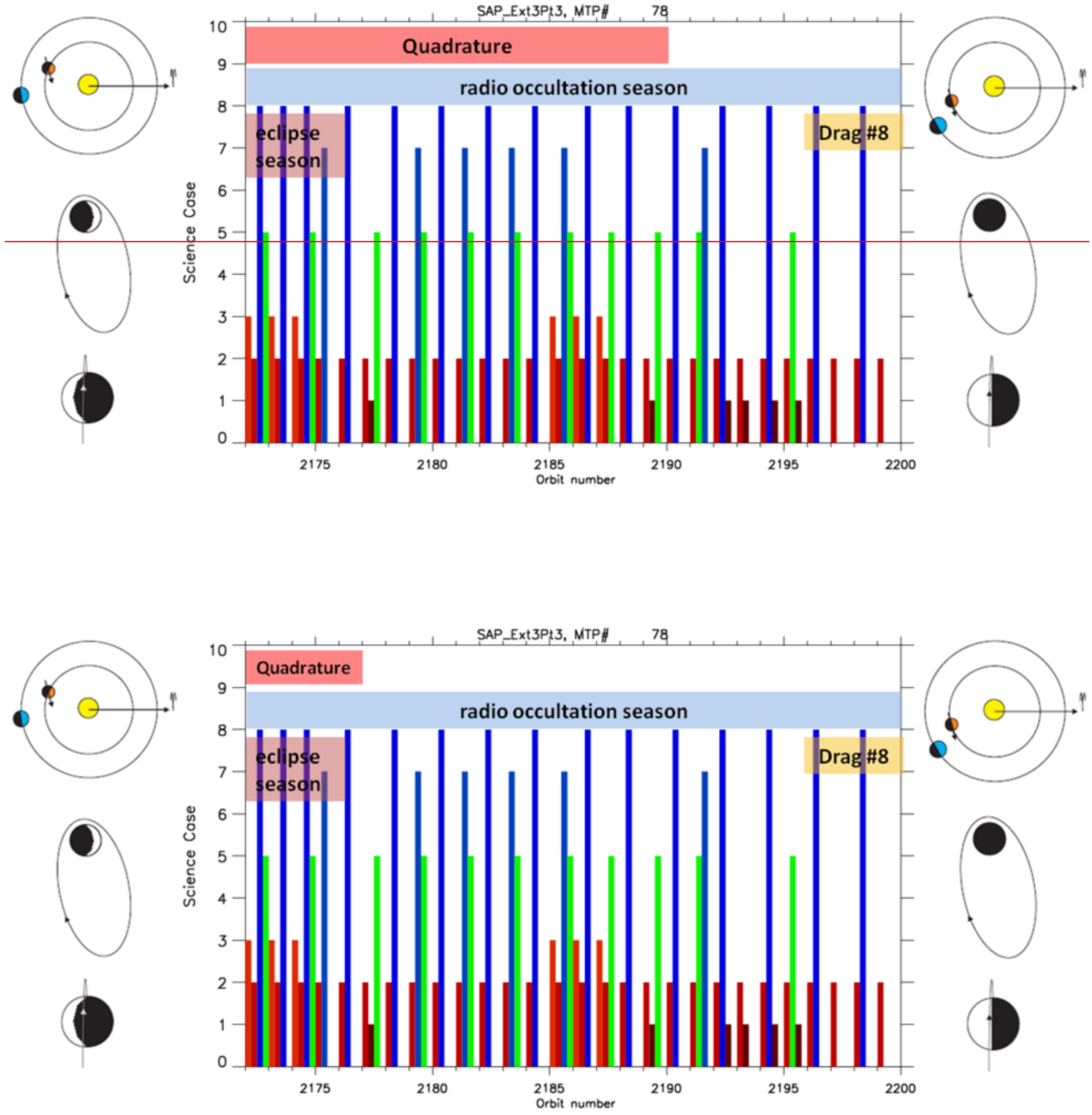


Figure 3.11 *MTP#78 timeline*

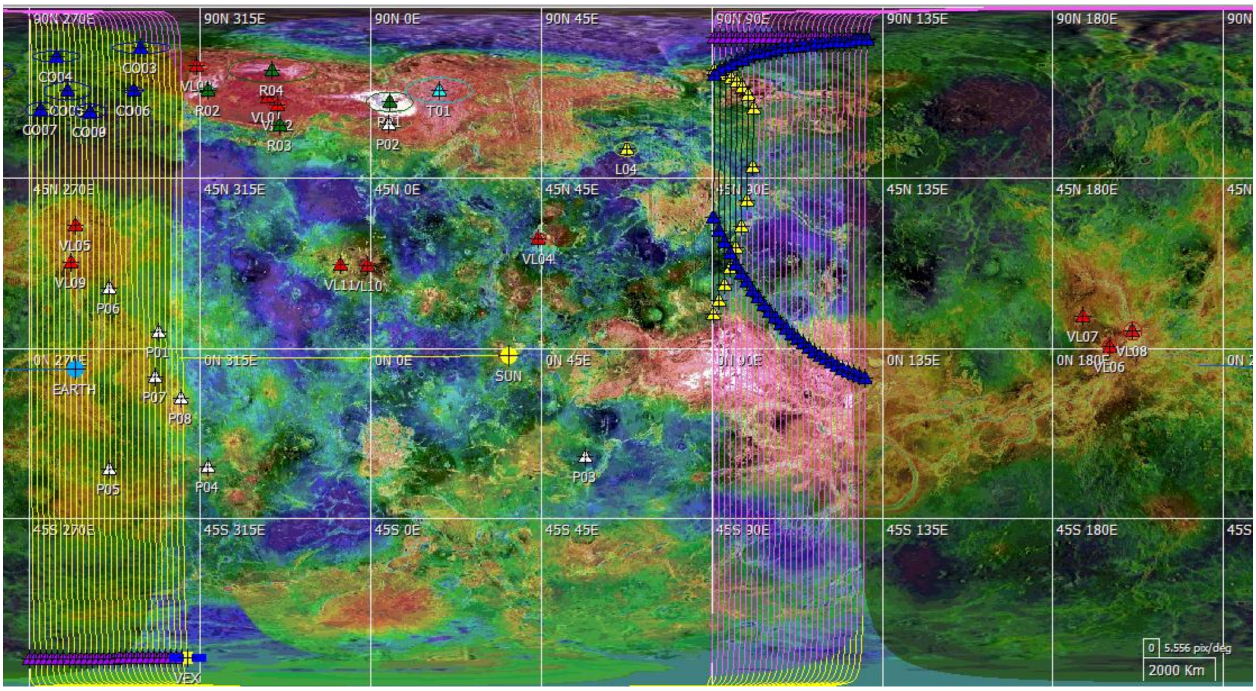


Figure 3.12 *Planet coverage by orbital tracks in MTP#78. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.4.3 Proposed Observations

The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-8-P and 2-7-5-P (used alternately when in quadrature)
  - The cold cases 7 are intended for VIRTIS-M-VIS to search for airglow.
  - Case 5 may also be inserted after pericentre if it can be performed as a cold observation.
- Type #2: cases 2-ADE
  - Atmospheric drag experiment passes will take up the entire pericentre pass. To be combined with VeRa occultations when ground stations have been booked (e.g. orbits 2196, 2198)

Notes to the proposed timeline.

1. No SOIR observations have been proposed in this MTP due to quadrature period. Skipped passes are not recommended since this is a period of extremely low data rate.

2. Two campaigns of 3x orbits each of Case 3 observations are performed, at beginning and middle of this MTP.
3. Case 3 and 2 observations must be cold if performed in quadrature without skipped pass.

3.5 MTP #79

3.5.1 MTP in brief

MTP #79 covers the period from 28 April 2012 through 26 May 2012, and includes orbits #2200-2227. The long Earth occultation season continues throughout the whole of this MTP. The beginning of the MTP (orbits 2196-2207) sees continuation of Atmospheric Drag experiment #8, in which VeRa occultations are performed during drag passes using HGA2 in pure Earth-pointing mode. From orbits 2204-2224 a campaign of consecutive VeRa ingress occultations on every orbit will repeatedly probe the same latitude (~30-35°S - see Annex 6 for VeRa coverage). There is no eclipse season in this MTP.

The MTP starts with a terminator orbit and is hot. Local time at ascending node changes from 6h to 9h, thus illumination conditions are similar to those in MTP#63 and #71. Data rate starts out low but rises rapidly through the MTP (HGA2 is used). Note though that this MTP is not well-suited for surface observation because (1) VEx is never in eclipse during this MTP and (2) almost every pericentre pass is reserved for radio science.

Another event of note is that VEx will cross the orbital plane of asteroid Oljato. There may be meteor showers and/or magnetic field anomalies associated with the passage of VEx through Oljato's orbital plane (expected 14 May 2012 / Orbit#2215). [C.T. Russell, GRL, 1987]. No special planning is needed for MAG observations; VMC may want to image at a higher rate around this date to look for meteor showers.

In MTPs 80-81 we suggest a campaign of hi-resolution cloud morphology imaging by VIRTIS-M-VIS in spot-tracking mode on the dayside at VPER-02:00 to VPER-01:00 on as many orbits as is practical.

Figures 3.13 and 3.14 show observations timeline and surface coverage for this MTP.

3.5.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 05:40 - 08:40 h (similar to MTP#63)
- Hot season
- Earth occultation season during whole MTP.
- Surface targets: Lada Terra (in the S hemisphere, for VIRTIS-M-VIS)
- Medium data rate

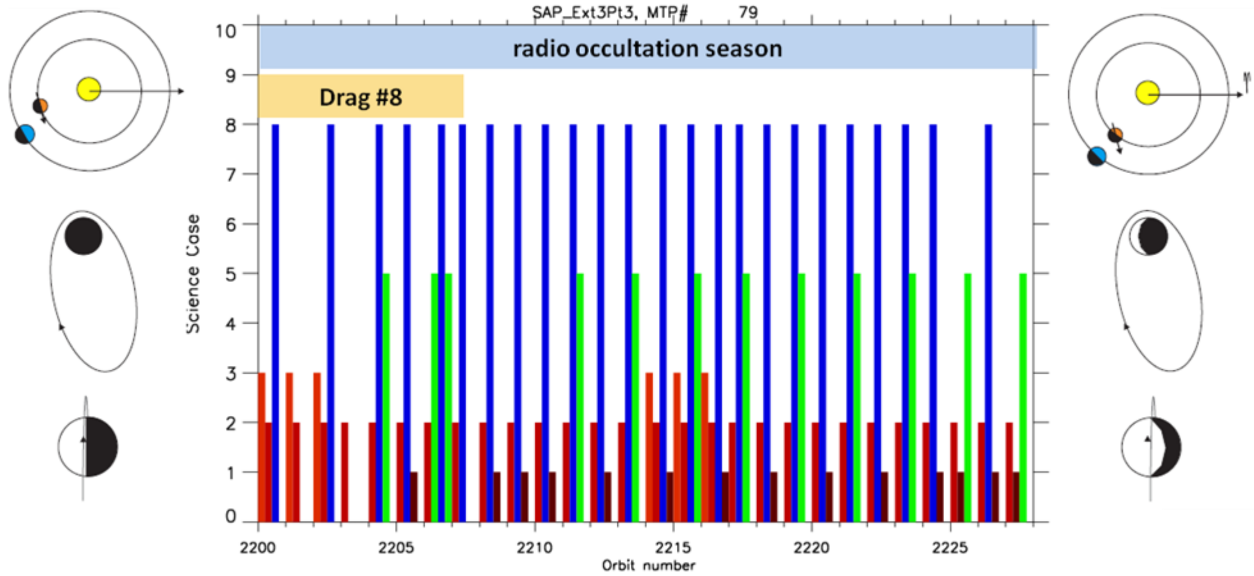


Figure 3.13 *MTP#79 timeline*

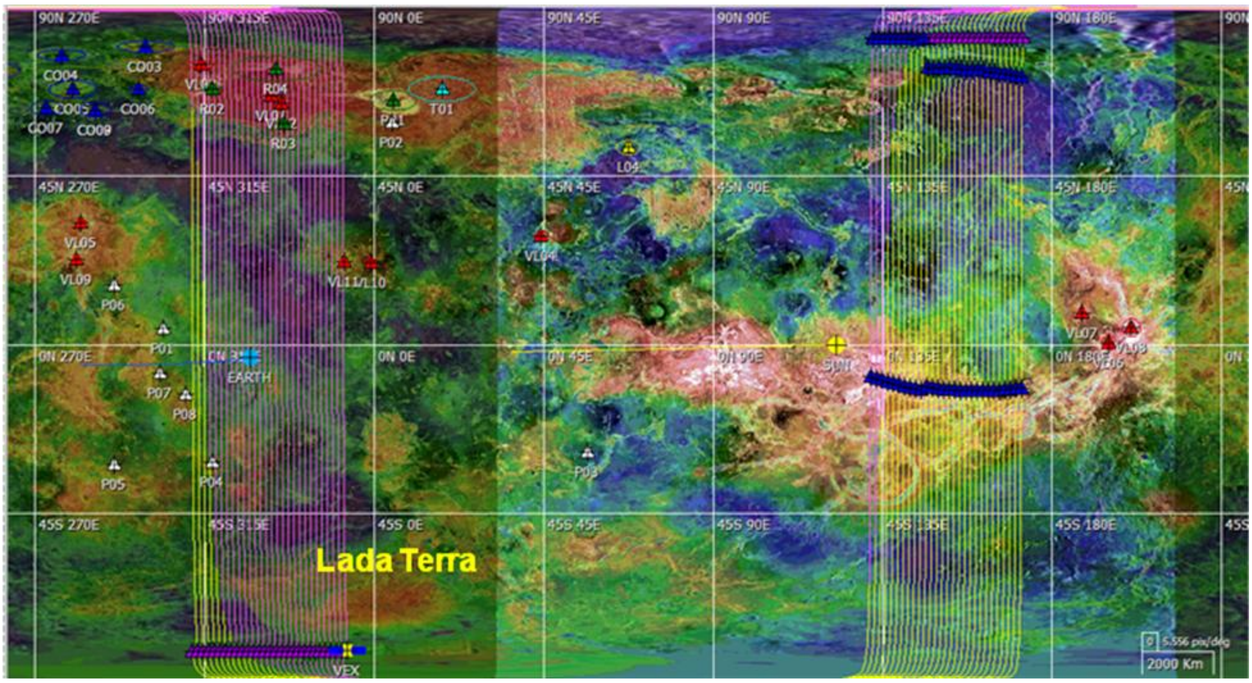


Figure 3.14 *Planet coverage by orbital tracks in MTP#79. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.5.3 Proposed Observations

The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-*SPOT*-8-P-1 and 2-*SPOT*-8-P-5 (used alternately during the VeRa campaign)
    - The case "*SPOT*" in this case represents the high-resolution VIRTIS morphology observation (VPER-02:00 to VPER-01:00).

Notes to the proposed timeline.

1. Location sounded by VeRa is on the nightside, so targeted imaging of this location is not possible.

2. Two campaigns of 3x orbits each of Case 3 observations are performed, at beginning and middle of this MTP.

3.6 MTP #80

3.6.1 MTP in brief

MTP #80 covers the period from 26 May 2012 until 23 June 2012, and includes orbits #2228-2255. This MTP includes the inferior conjunction, at which a transit of Venus occurs (6 June 2012, 01:29:35 UT, Orbit 2238). The long Earth occultation season continues throughout the whole of this MTP. Eclipse season starts on 06 June, orbit 2238.

The MTP is hot. Local time at ascending node changes from 9h to 12h, thus illumination conditions are similar to those in MTP#64 and #72. Data rate is high (HGA2 is used). Some co-ordinated observations with ground-based observers may occur near the time of the transit, because Venus is at its closest to the Earth. On June 6 (orbit 2238) this will include VeRa occultation, possible SOIR grazing occultation, possible limb imaging from VMC & VIRTIS. SPICAV-UV imaging of the sun is requested within a few days of the transit (orbit 2238) in order to allow cross-calibration between VEx/SPICAV and ISS/SOLSPEC instruments (TBC).

Surface targets are the same as were targeted in MTP76: Ishtar Terra, C. Eistla Regio, Bereghinia Planitia (anomalous thermal emissions reported by Bondarenko et al), also Lada Terra in the S hemisphere.

Figures 3.15 and 3.16 show observations timeline and surface coverage for this MTP.

3.6.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 08:40 - 11:40 h (similar to MTP#72)
- Hot season
- Earth occultation season during whole MTP.
- Eclipse season from orbit 2238.
- Surface targets: Ishtar Terra, C. Eistla Regio, Bereghinia Planitia, Lada Terra
- High data rate

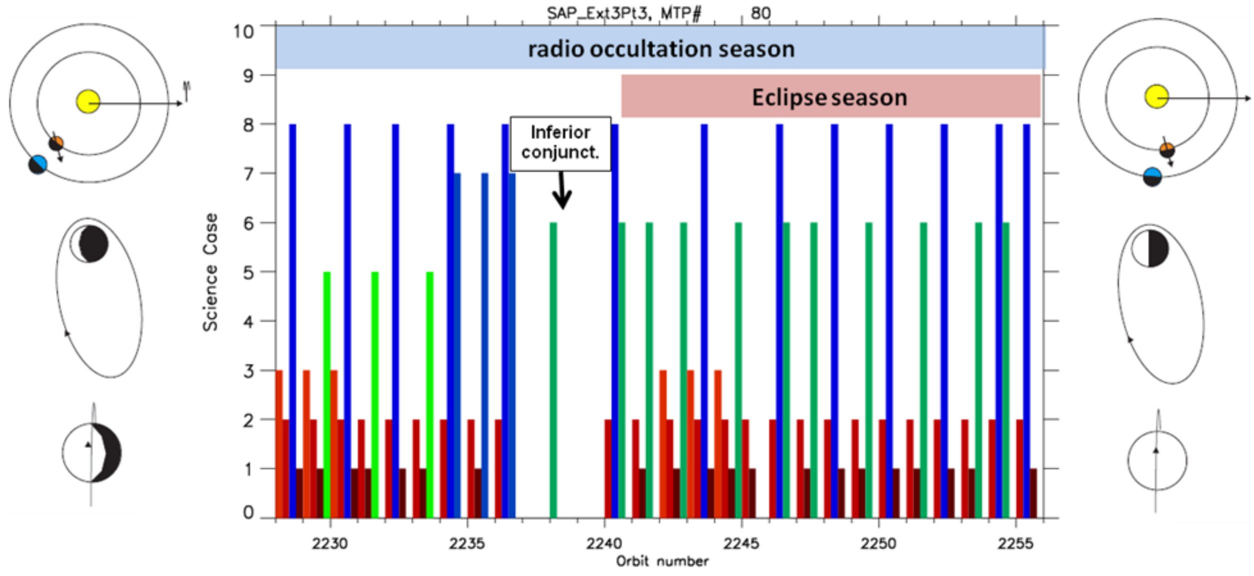


Figure 3.15 *MTP#80 timeline*

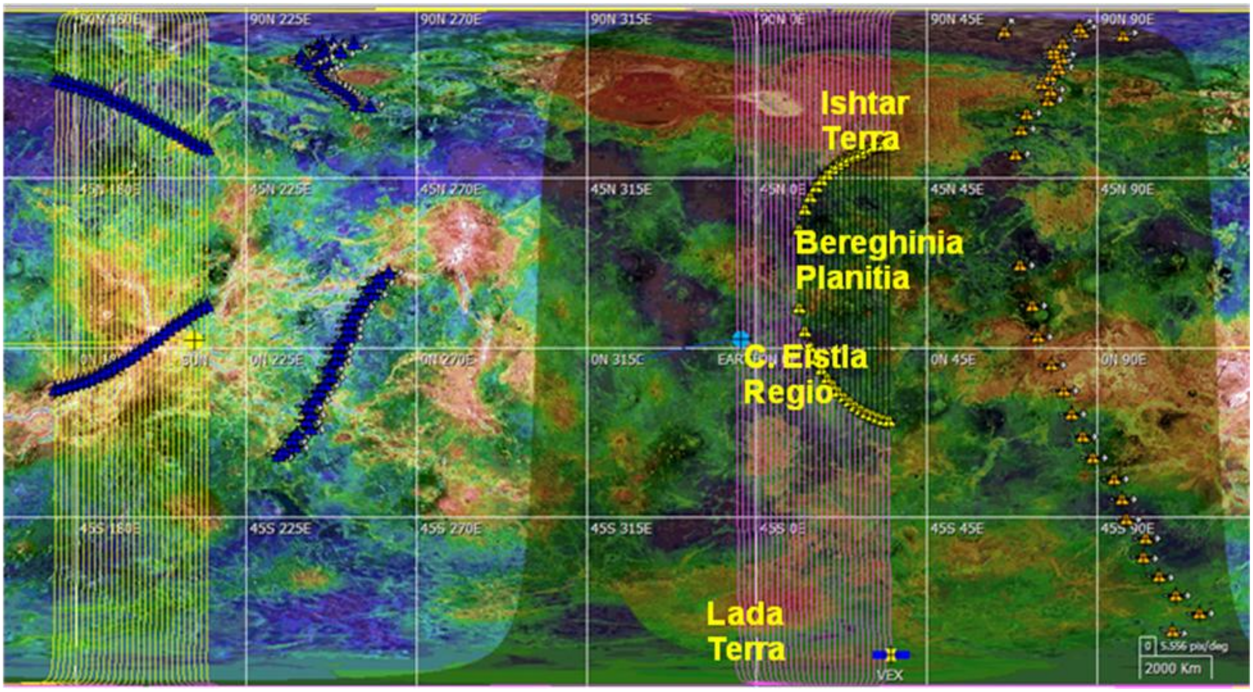


Figure 3.16 *Planet coverage by orbital tracks in MTP#80. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.6.3 Proposed Observations

The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-SPOT-8-P-1 and 2-SPOT-1-P-5 (used alternately, before eclipse season)
    - The case "*SPOT*" in this case represents the high-resolution Case 2 VIRTIS morphology observation (VPER-02:00 to VPER-01:00).
- Type #2: cases 2-*SPOT*-7LT-*P*-1
    - In orbits 2234-2236 is the VIRTIS atomic oxygen visible airglow monitoring, carried out before and after each eclipse season.
- Type #3: cases 2-*SPOT*-8-*P*-1
- Type #4: cases 2-*SPOT*-1-*P*-6
    - Solar and radio occultations are alternated in this MTP, after the eclipse season starts in orbit 2238.

Notes to the proposed timeline.

1. Location sounded by VeRa after orbit ~2236 is on the dayside, so VIRTIS spot-tracking can target VeRa ingress locations. VeRa ingress sounded location remains on the dayside until orbit 2318.
2. SPICAM-SPICAV observations near apocentre orbits 2248-2250.
3. Operations cease for a three-day outage around inferior conjunction at 5-7 June. A SOIR occultation during the Venus transit on 06 June will be requested for co-mparison with ground-based measurements (if permissible under flight rules).
4. Starting in orbit 2254 at the end of the MTP, there is a campaign of 13 (TBC) VeRa ingress occultations probing a nearly constant latitude of 20°N.
5. Two campaigns of 3x orbits each of Case 3 observations are performed, at beginning and middle of this MTP.

3.7 MTP #81

3.7.1 MTP in brief

MTP #81 covers the period from 23 June 2012 through 21 July 2012, and includes orbits #2256-2283. The long Earth occultation season continues throughout the whole of this MTP. From orbits 2254-2266 a campaign of consecutive VeRa ingress occultations on every orbit will repeatedly probe the same latitude (~20°N - see Annex 6 for VeRa coverage). Eclipse season ends on 15 July (orbit 2277).

The MTP is hot. Local time at ascending node changes from 12h to 15h, thus illumination conditions are similar to those in MTP#65 and #73. Data rate is medium to low (HGA2 is used).

Surface targets are as proposed for MTP#77: Ishtar Terra, Bell Regio (e.g. Tepev Mons), E. Eistla Regio.

Figures 3.17 and 3.18 show observations timeline and surface coverage for this MTP.

3.7.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 011:40 - 14:40 h (similar to MTP#73)
- Hot season
- Earth occultation season during whole MTP.
- Eclipse season ends orbit 2277.
- Surface targets: Ishtar Terra, Bell Regio (e.g. Tepev Mons), E. Eistla Regio
- Medium-low data rate

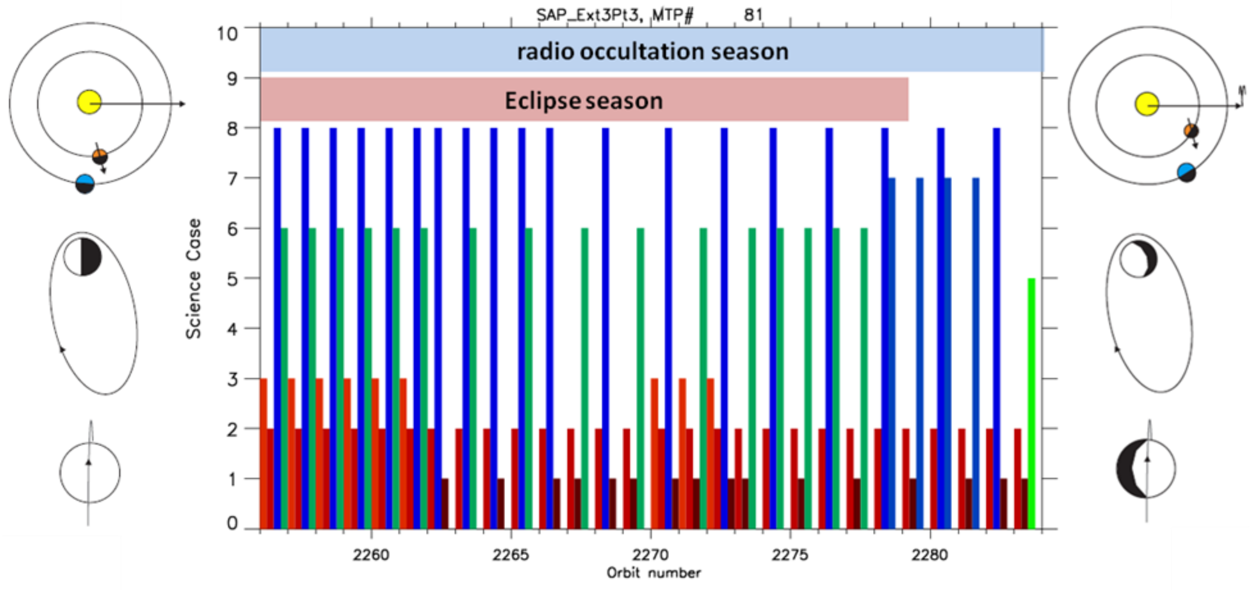


Figure 3.17 *MTP#81 timeline*

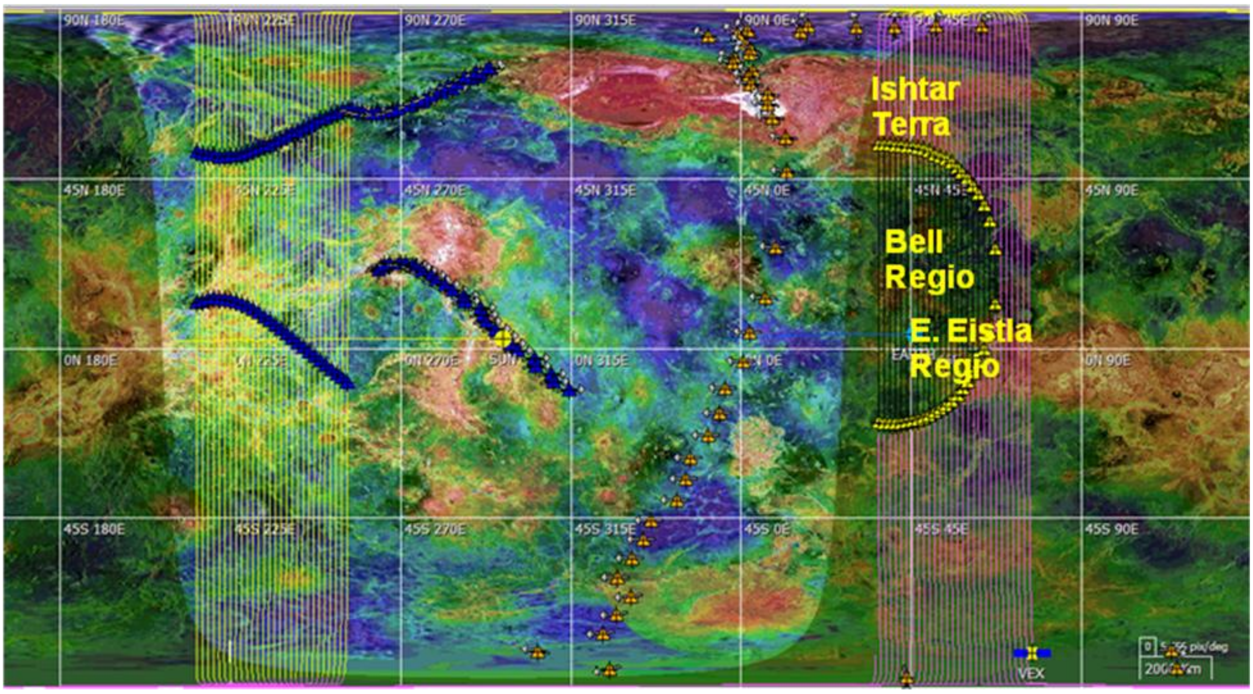


Figure 3.18 *Planet coverage by orbital tracks in MTP#81. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.7.3 Proposed Observations

The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-8-P-1 and 2-8-P-6
    - This is used during the VeRa constant-latitude campaign (orbits 2254-2266)
- Type #2: cases 2-*SPOT*-8-*P*-1
- Type #3: cases 2-*SPOT*-1-*P*-6
    - Solar and radio occultations are alternated in this MTP, after the VeRa campaign in orbits 2254-2266
- Type #4: cases 2-*SPOT*-7LT-P-1
    - In orbits 2278-2281 is the VIRTIS atomic oxygen visible airglow monitoring, carried out before and after each eclipse season.

Notes to the proposed timeline.

1. Location sounded by VeRa after orbit ~2236 is on the dayside, so VIRTIS spot-tracking can target VeRa ingress locations. VeRa ingress sounded location remains on the dayside until orbit 2318.

2. At the beginning of this MTP is a good opportunity to satisfy the SOIR team's request for ~5 consecutive orbits in order to search for day-to-day variability at high latitudes. We suggest that a campaign of consecutive SOIR observations could take place in orbits 2256-2261, which will probe latitudes > 70 ° S. This would occur approximately 50 minutes after pericentre, in orbits which have VeRa observations before pericentre.

3. VIRTIS and VMC should try to acquire imagery of the locations sounded by SOIR and VeRa soundings.

4. Two campaigns of 3x orbits each of Case 3 observations are performed, at beginning and middle of this MTP.

3.8 MTP #82

3.8.1 MTP in brief

MTP #82 covers the period from 21 July 2012 until 18 August 2012, and includes orbits #~~2283-2310~~2284-2311. The long Earth occultation season continues throughout the whole of this MTP.

The MTP is hot. Quadrature illumination conditions start in orbit ~~2290~~ 2300 (~~28 July~~7 August), ruling out hot observations unless a communications pass is skipped. Local time at ascending node changes from 15h to 18h, thus illumination conditions are similar to those in MTP#66 and #74. Data rate is low, sinking to very low at the end of the MTP, because HGA2 is in use.~~very low until orbit 2307 (14 August 2012) when the HGA2 → HGA1 swap is made~~.

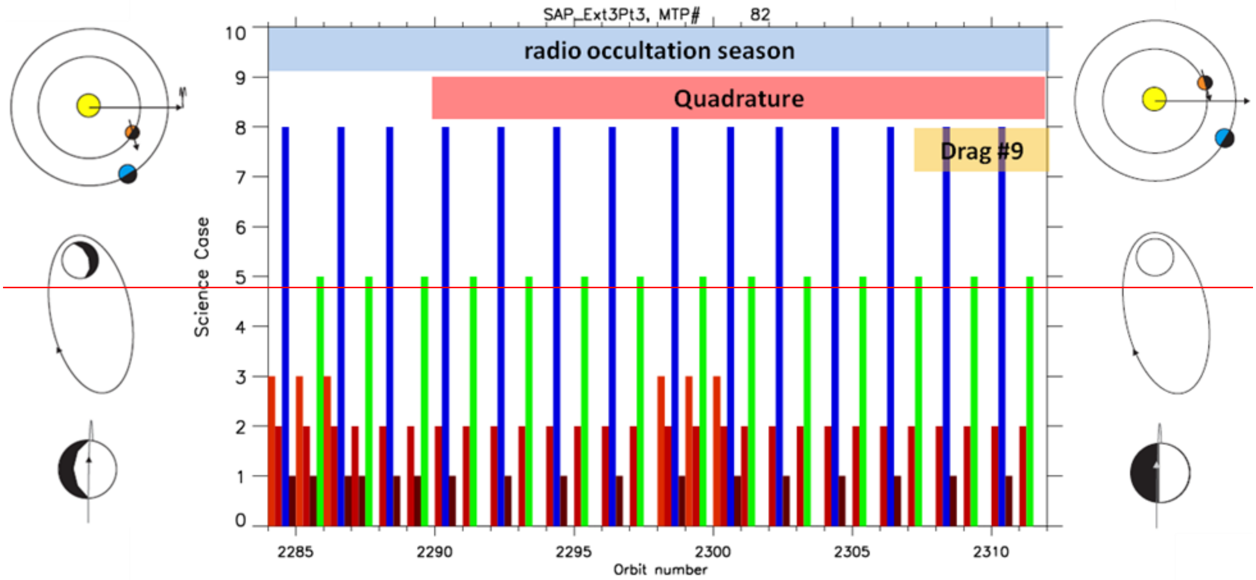
Atmospheric Drag Experiment campaign #9 starts in this MTP, on 14 August 2012 (orbits 2307-2325). This is a TRQ-only drag season, passes will alternate between TRQ and VeRa pointings.

Note that there may be interest in coordinated ground-based telescope observations during this period, because Venus is near maximum elongation from the Sun (this occurs on 15 August 2012).

Figures 3.19 and 3.20 show observation timelines and surface coverage for this MTP.

3.8.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 014:40 - 17:40 h (similar to MTP#73)
- Hot season
- Quadrature period from ~ ~~28 July~~7 August (orbit ~~2290~~2300)
- Earth occultation season during whole MTP.
- Surface targets: No particular targets (TBC)
- Very low data rate



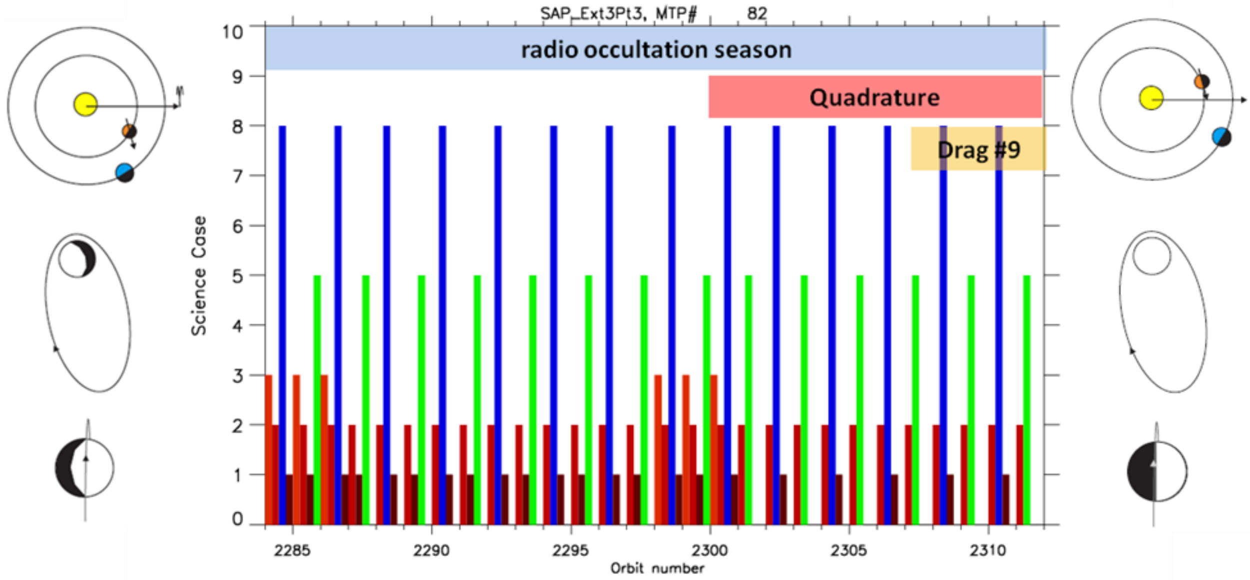


Figure 3.19 *MTP#82 timeline*

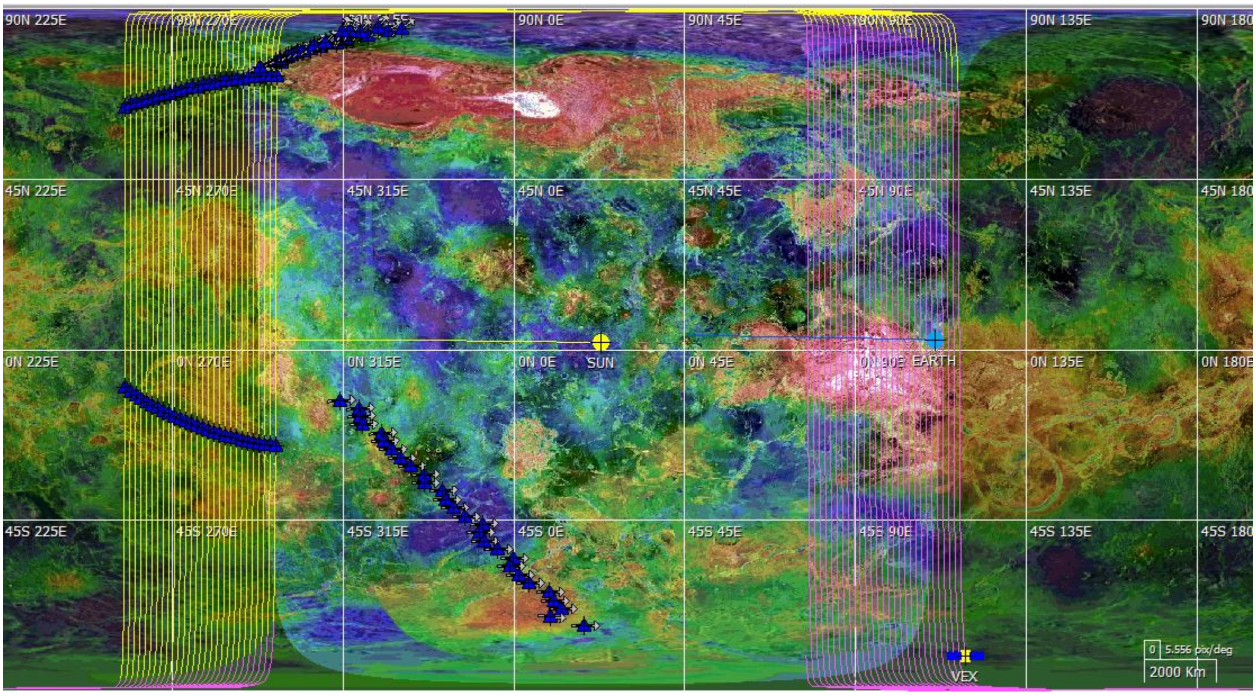


Figure 3.20 *Planet coverage by orbital tracks in MTP#82. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.8.3 Proposed Observations

The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-8-*P*-1
- Type #2: cases 2-1-*P*-5
    - These two observation types are alternated throughout the MTP.
    - Hot Case 1 before pericentre is not permitted during quadrature (unless skipping passes) so cold case 5 (or other cold observation) could be substituted.

Notes to the proposed timeline.

1. VEx-SOHO observation to be carried out in orbits 2308-2310.

3.9 MTP #83

3.9.1 MTP in brief

MTP #83 covers the period from 18 August 2012 until ~~14~~ 15 September 2012, and includes orbits #~~2311-2338~~2312-2339. The long Earth occultation season continues throughout the whole of this MTP.

The MTP starts off in quadrature illumination conditions, which last until ~~2326~~ 2335 (~~2~~ 11 September), ruling out hot observations unless a communications pass is skipped. Local time at ascending node changes from 17:40 to 20:40, thus the season is hot for the first few orbits until the terminator orbit (orbit 2315), after which it is cold season. Illumination conditions are similar to those in MTP#75. Data rate is very low for the first two orbits of the MTP, but become extremely high after orbit 2315 (22 August 2012) when the HGA2 → HGA1 swap is made~~very high~~.

Atmospheric Drag Experiment campaign #9 (TRQ only) continues in this MTP, until 1 September (orbits 2307-2325). This will be followed by a pericentre-raising OCM in orbit 2334. Note this is during a Earth occultation season; passes will alternate between VeRa (custom pointing) and TRQ-optimised pointings.

Figures 3.21 and 3.22 show observation timelines and surface coverage for this MTP.

3.9.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 17:40 - 20:40 h (similar to MTP#75)
- Starts as Hot season, but mostly Cold.
- Quadrature period until ~~2~~ 11 Sep (orbit ~~2326~~2335)
- Earth occultation season during whole MTP.
- VExADE campaign #9, orbits 2301-2340
- Surface targets: No particular targets identified (TBC)
- High data rate

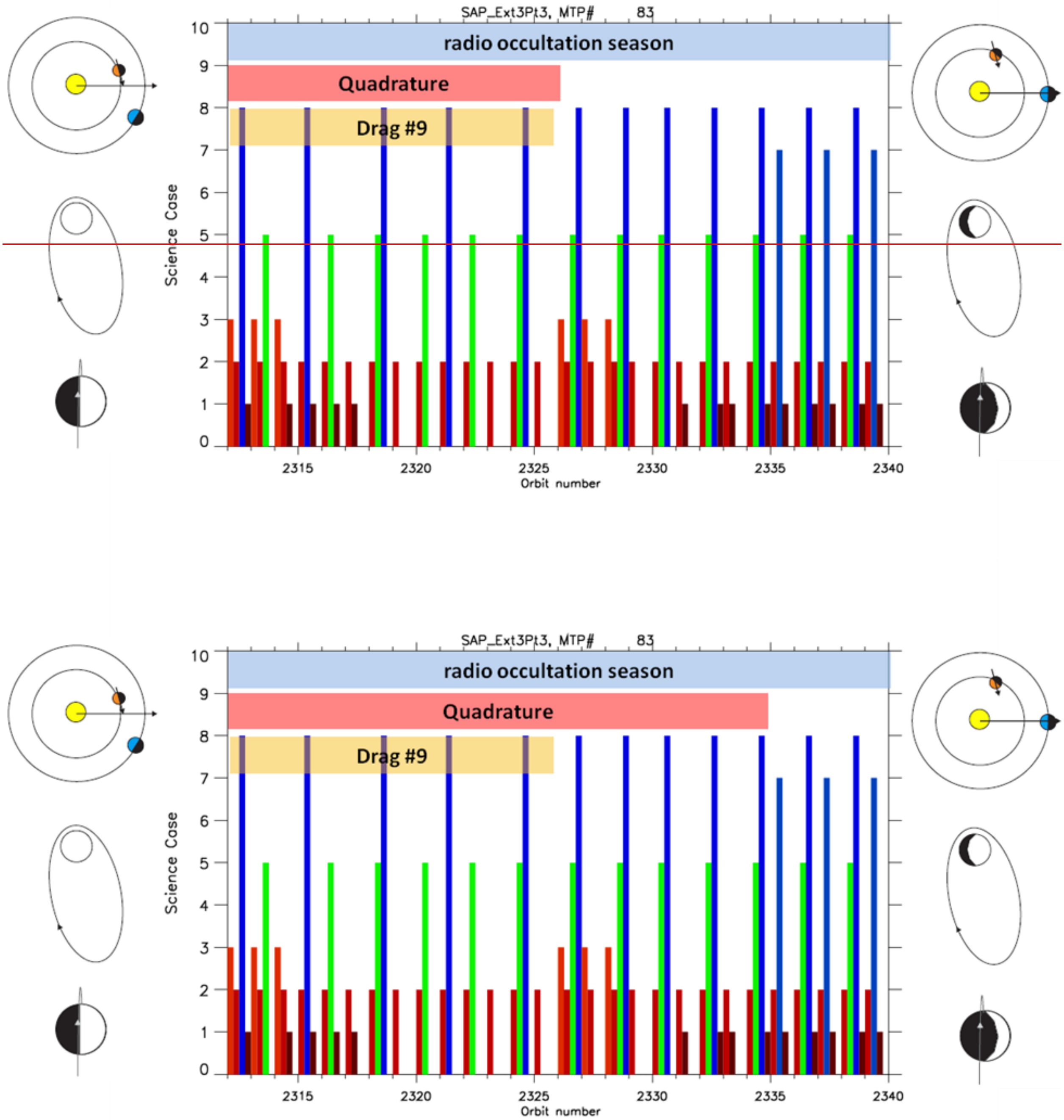


Figure 3.21 *MTP#83 timeline*

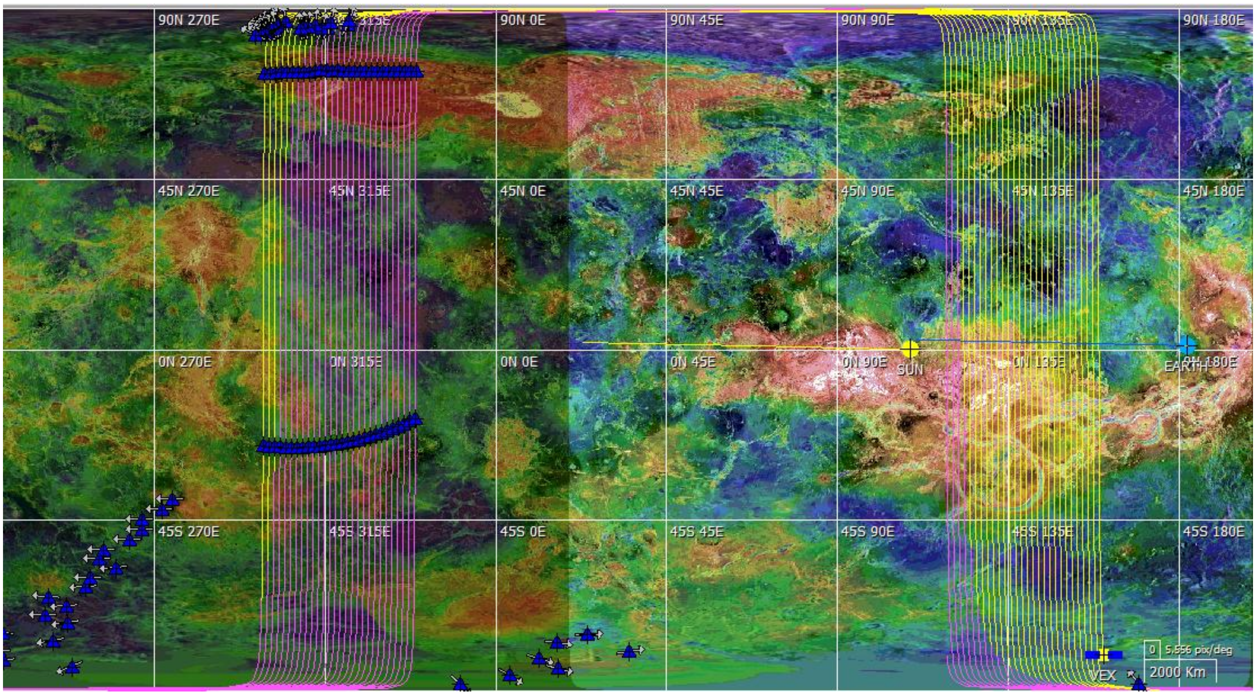


Figure 3.22 *Planet coverage by orbital tracks in MTP#83. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.9.3 Proposed Observations

The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-[5]-8-*P* or 2-[5]-ADE
  - This is carried out during ADE period (orbits 2301-2340)
  - Cold case 5 inserted where possible
- Type #2: cases 2-[5]-8-*P*-1 or 2-[5]-1-*P*-1
  - This is carried out after ADE, when VEx is no longer in quadrature.
- Type #3: cases 2-7LT-*P*-1
  - In orbits 2335, 2237, 2239 is the VIRTIS atomic oxygen visible airglow monitoring, carried out before and after each eclipse season.

Notes to the proposed timeline.

1. Cases 3 during the quadrature period must be performed cold.

3.10 MTP #84

3.10.1 MTP in brief

MTP #84 covers the period from 15 September 2012 through ~~12~~ 13 October 2012, and includes orbits #~~2339-2366~~2340-2367. The long Earth occultation season finally finishes at the end of this MTP (Orbit 2360, 06 Oct 2012).

Local time at ascending node changes from 20:40 to 23:40, thus the season is cold. Eclipse season starts on the second orbit of this MTP, so priority is given to solar occultations and surface observation in eclipse. Illumination conditions are similar to those in MTP#76. Data rate is high.

There will be an overflight of Maxwell Montes in orbit 2350-2360 – a high priority is given to nadir observations from SPICAV-IR and VMC during these orbits and consideration should be given to skipping VeRa passes in order to enable more of these observations. Further surface targets include Sif Mons (-8°E, 21°N) and Gula Mons (-1°E, -22°N) in Western Eistla Regio, which has been suggested to overly an active mantle plume (Smrekar et al., Venus II, 1997). In the Southern hemisphere, an important target is Innini Mons (-31.7°E, -34.7°N) in Dione Regio, which was identified by Smrekar & Mueller 2010 as a recently active volcano – this can be targeted by VIRTIS-M-VIS early in the MTP.

Figures 3.23 and 3.24 show observation timelines and surface coverage for this MTP.

3.10.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 20:40 - 23:40 h (similar to MTP#76)
- Cold season
- Eclipse season during entire MTP.
- Earth occultation season ends orbit 2360.
- Surface targets: Maxwell Montes, W. Eistla Regio (Sif Mons, Gula Mons), Dione Regio (Innini Mons).

- High data rate

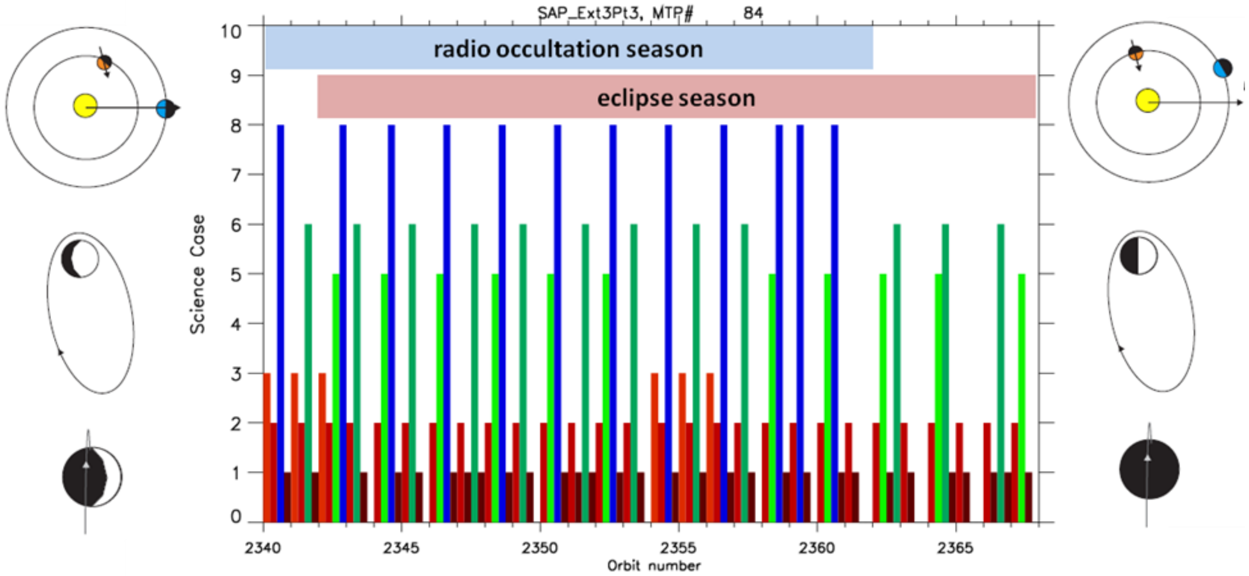


Figure 3.23 *MTP#84 timeline*

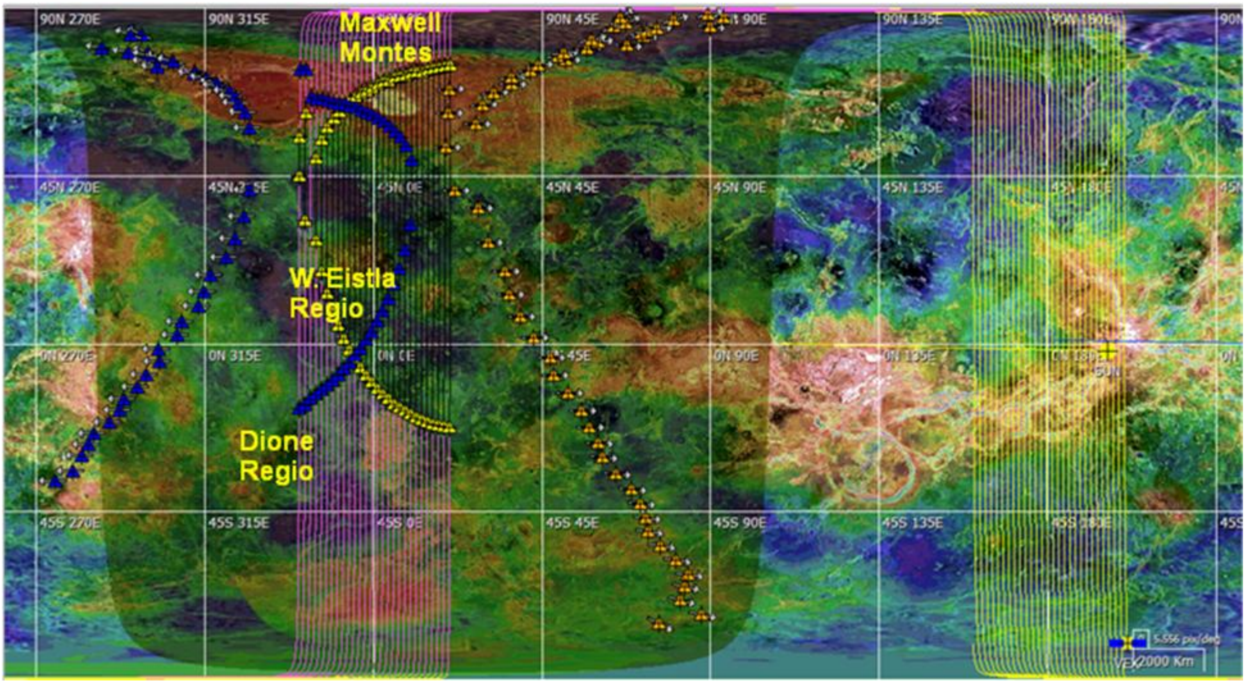


Figure 3.24 *Planet coverage by orbital tracks in MTP#84. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.10.3 Proposed Observations

The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-[5]-6I-C1E-*P*-1
- Type #2: cases 2-[5]-C1E-6E-*P*-1
    - Try to combine cases 6 ingress observations with Case 1 eclipse observations. In particular, in orbits 2350-2360 when flying over Maxwell Montes, case 6 ingress (probing S hemisphere) to be combined with C1E probing N hemisphere).
- Type #3: cases 2-[5]-8-*P*-1
    - In general, alternate between cases 8 and 6 until end of VeRa Earth occultation season (orbit 2360).
- Type #4: cases 2-SINO-*P*-1
- Type #5 cases 2-6I-C1E-*P*-1 or 2-C1E-6E-*P*-1
    - Alternate between these SINO and SOIR after orbit 2360.
    - SINO is the SPICAV NO observation campaign; goal is to map NO airglow across nightside, using an inertial pointing.

Notes to the proposed timeline.

1. Cases 1 after pericentre (dayside): These should alternate between pure nadir observations, designed for regular coverage for mapping of species including SO2 and H2O, and observations designed to maximize coverage of phase angles.

3.11 MTP #85

3.11.1 MTP in brief

MTP #85 covers the period from 13 October 2012 until ~~09~~ 10 November 2012, and includes orbits #~~2367-2394~~2368-2395.

Local time at ascending node changes from 23:40 to 02:40, thus the season is cold. Eclipse season continues throughout this whole MTP, so priority is given to solar occultations and surface observation in eclipse. Alternate orbits are also devoted to mapping NO on the nightside using SPICAV, and maximising phase function coverage on the dayside. Illumination conditions are similar to those in MTP#77. Data rate is medium.

Surface targets include Bell Regio and Central Eistla Regio, which are possible volcanic hotspot regions.

Figures 3.25 and 3.26 show observation timelines and surface coverage for this MTP.

3.11.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 23:40 – 02:40 h (similar to MTP#76)
- Cold season
- Eclipse season during entire MTP.
- Surface targets: Bell Regio, C. Eistla Regio
- Medium data rate

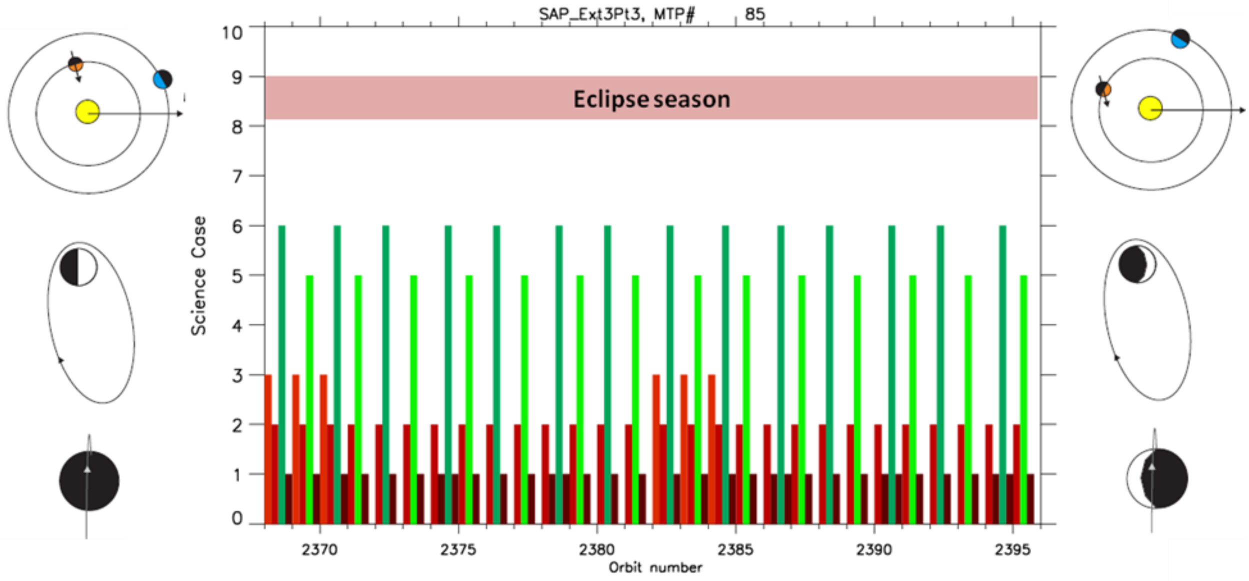
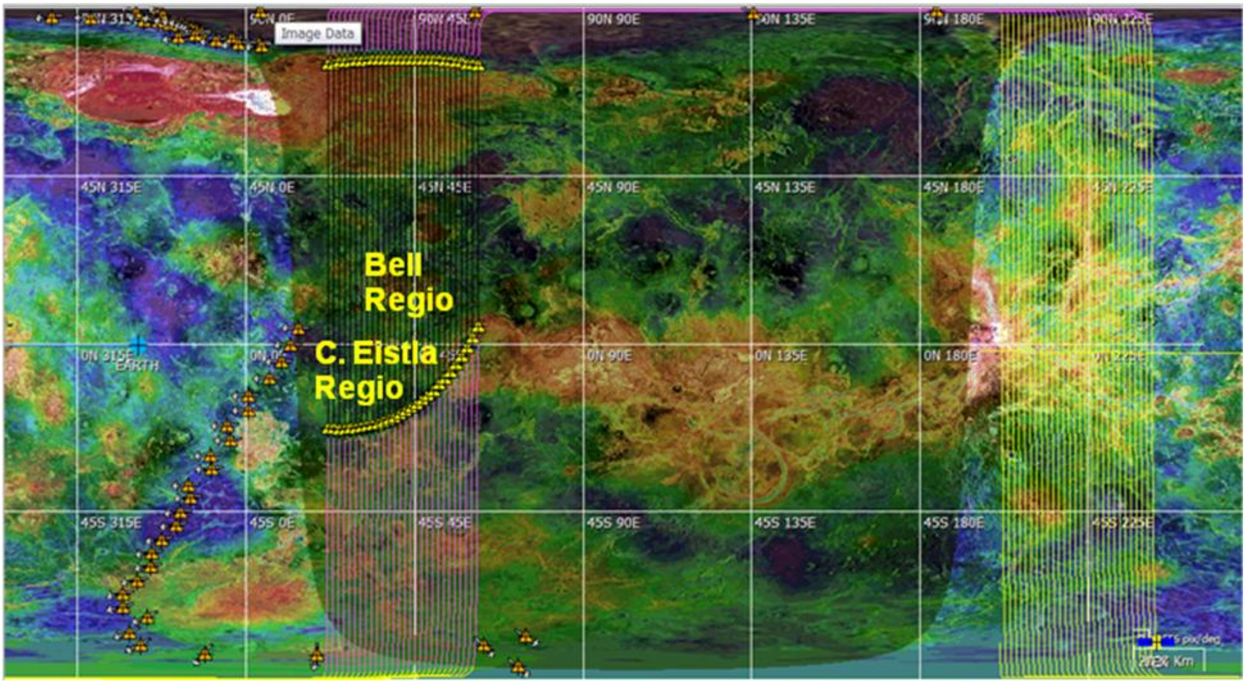


Figure 3.25 *MTP#85 timeline*



- **Figure 3.26** *Planet coverage by orbital tracks in MTP#85. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.11.3 Proposed Observations

The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-SINO-*P*-1
- Type #2 cases 2-6I-C1E-*P*-1 or 2-C1E-6E-*P*-1
  - Alternate between these SINO and SOIR after orbit 2360.
  - SINO is the SPICAV NO observation campaign; goal is to map NO airglow across nightside, using an inertial pointing.

Notes to the proposed timeline.

1. Cases 1 after pericentre (dayside): These should alternate between pure nadir observations, designed for regular coverage for mapping of species including SO2, H2O, and observations designed to maximize coverage of phase angles.

3.12 MTP #86

3.12.1 MTP in brief

MTP #86 covers the period from 10 November 2012 until ~~6~~ 8 December 2012, and includes orbits #~~2395-2421~~2396-2423.

Local time at ascending node changes from 02:40 to 05:40, thus the season is cold. Eclipse season finishes early in the MTP, in orbit 2404 (19 Nov 2012). Illumination conditions are similar to those in MTP#78. Data rate is medium.

The end of this MTP will see some pre-ADE passes, followed by the beginning of ADE campaign #10 on the 4 December 2012 (orbit 2419). Dual S- and X- band tracking is planned for each orbit in the range 2419-2430 for 4 hours around pericentre.

Figures 3.27 and 3.28 show observation timelines and surface coverage for this MTP.

3.12.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 02:40 – 05:40 h (similar to MTP#76)
- Cold season
- Eclipse season until orbit 2404 (19 Nov 2012).
- Surface targets: No particular targets specified (TBC).
- Medium data rate

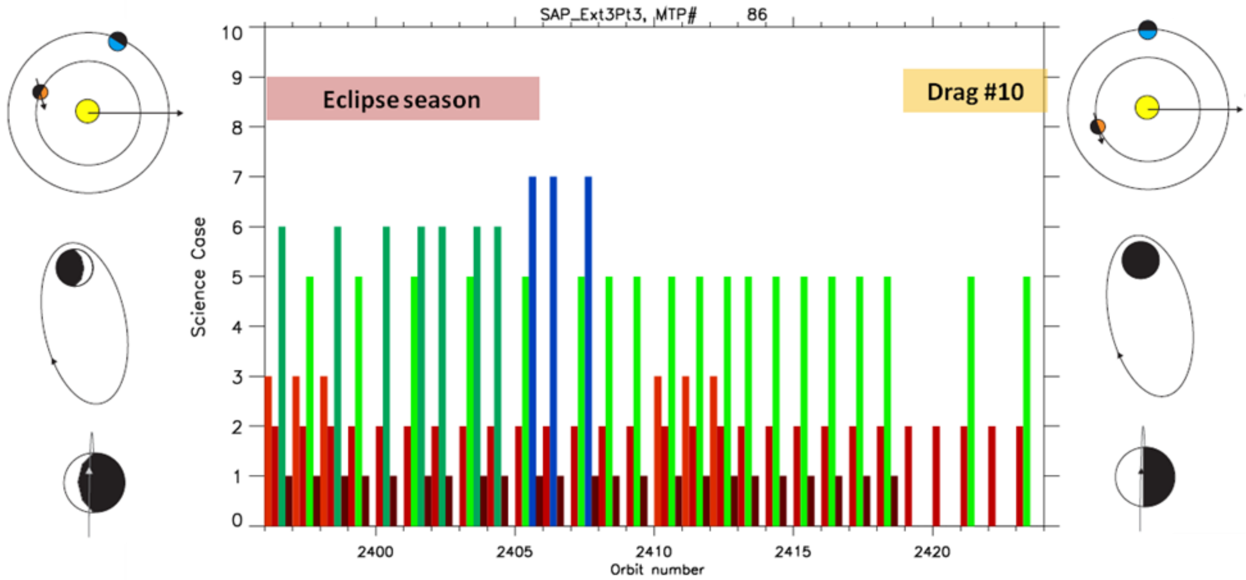


Figure 3.27 *MTP#86 timeline*

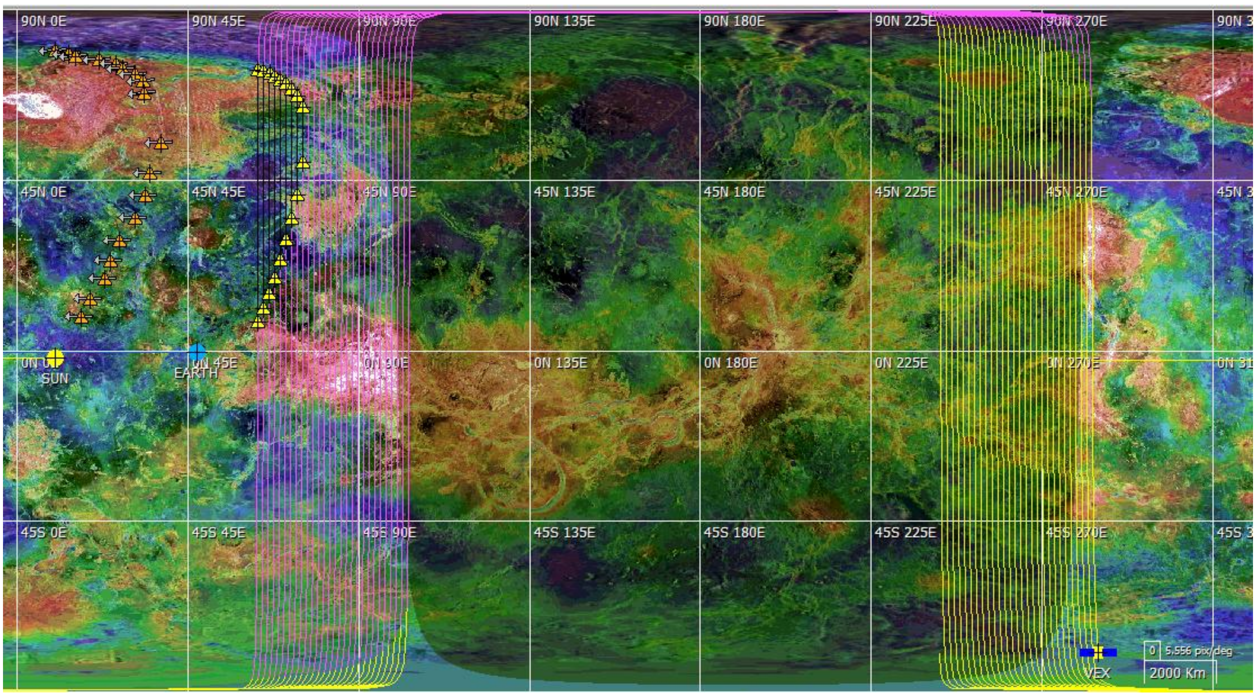


Figure 3.28 *Planet coverage by orbital tracks in MTP#86. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.12.3 *Proposed Observations*

The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-SINO-*P*-1
- Type #2 cases 2-6I-C1E-*P*-1 or 2-C1E-6E-*P*-1
    - Alternate between these SINO and SOIR after orbit 2360.
    - SINO is the SPICAV NO observation campaign; goal is to map NO airglow across nightside, using an inertial pointing.
- Type #3: cases 2-7LT-*P*-1
    - In orbits 2405-2407 is the VIRTIS atomic oxygen visible airglow monitoring, carried out before and after each eclipse season.
- Type #4: cases 2-ADE
    - In orbits 2419-2430 the pericentre passage is devoted to ADE passes.

Notes to the proposed timeline.

1. Cases 1 after pericentre (dayside): These should alternate between pure nadir observations, designed for regular coverage for mapping of species including SO2, H2O, and observations designed to maximize coverage of phase angles.

3.13 MTP #87

3.13.1 *MTP in brief*

MTP #87 covers the period from 8 December 2012 until 5 January 2013, and includes orbits #2424-2451.

Local time at ascending node changes from 05:40 to 08:40, thus the season is cold. Illumination conditions are similar to those in MTP#79. Data rate is moderately low. Earth occultation season #14 starts in orbit 2445 (30 Dec 2012).

The beginning of this MTP sees the continuation of VExADE campaign #10 until the 15 Dec (orbit 2430).

Observation geometry allows VIRTIS to target again two volcanoes identified by Smrekar et al. (2010) as possibly recently active: Mielikki Mons (-80°E, -28°N) and Ininni Mons (-31.7°E, -34.7°N).

Figures 3.29 and 3.30 show observation timelines and surface coverage for this MTP.

3.13.2 Environmental conditions

- Local Time at Ascending Node (LTAN): 05:40 – 08:40 h (similar to MTP#76)
- Cold season
- Earth occultation season #14 starts in orbit 2445 (30 Dec 2012).
- Surface targets: Mielikki Mons, Ininni Mons.
- Medium-low data rate

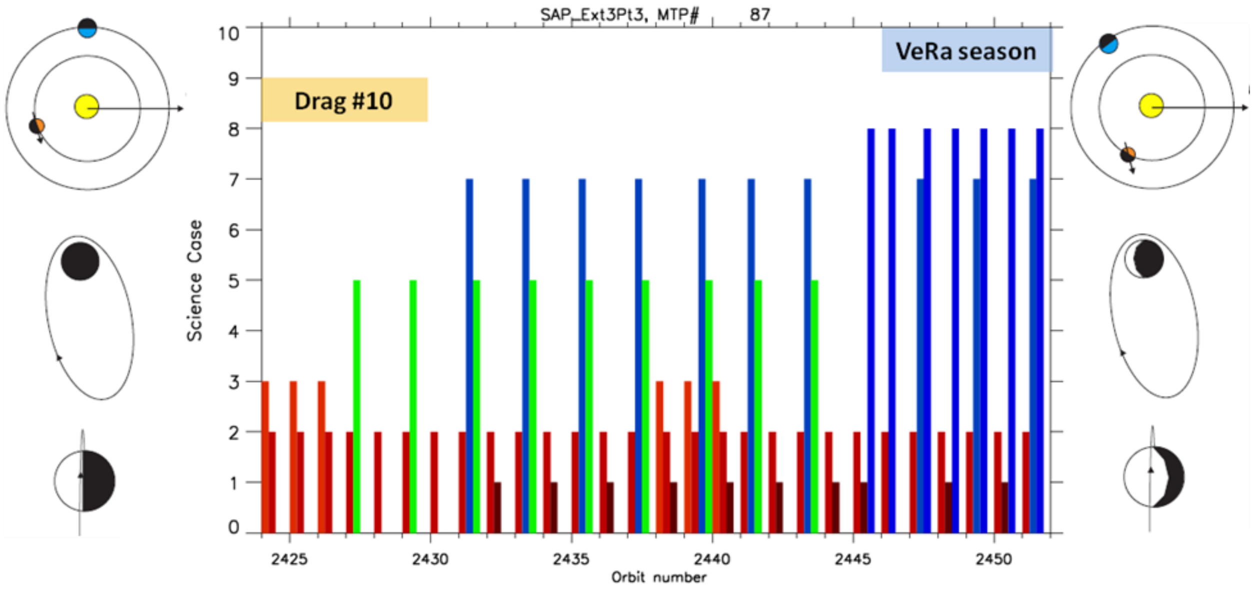


Figure 3.29 *MTP#87 timeline*

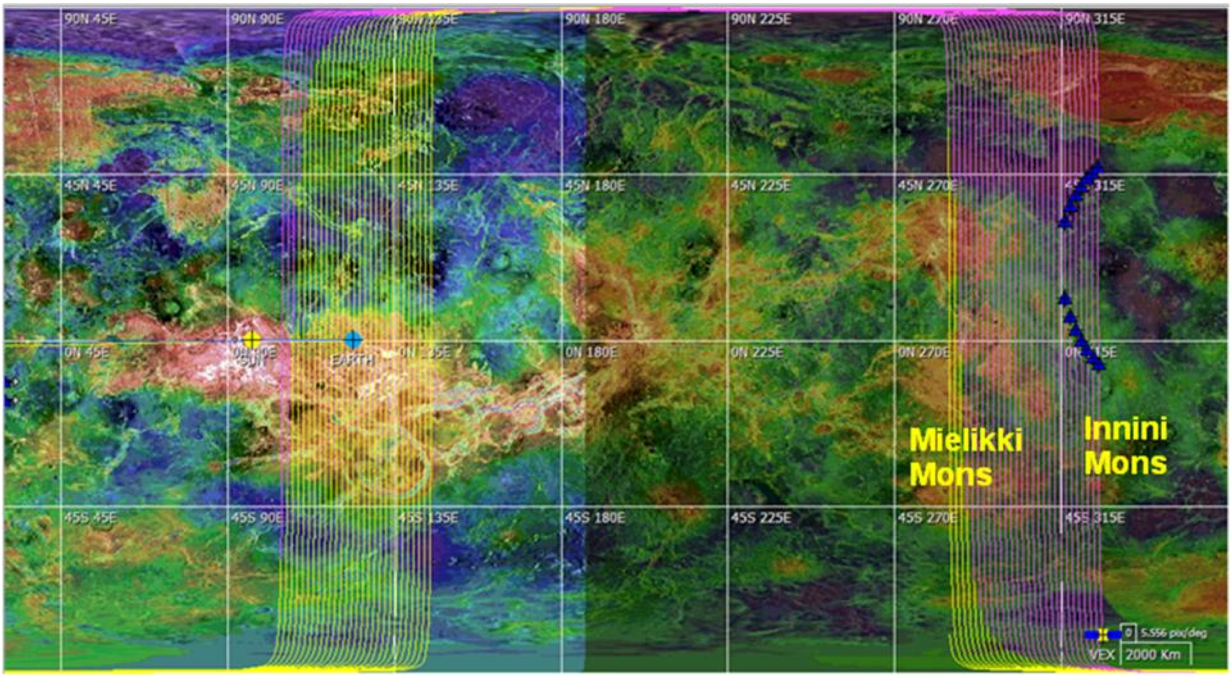


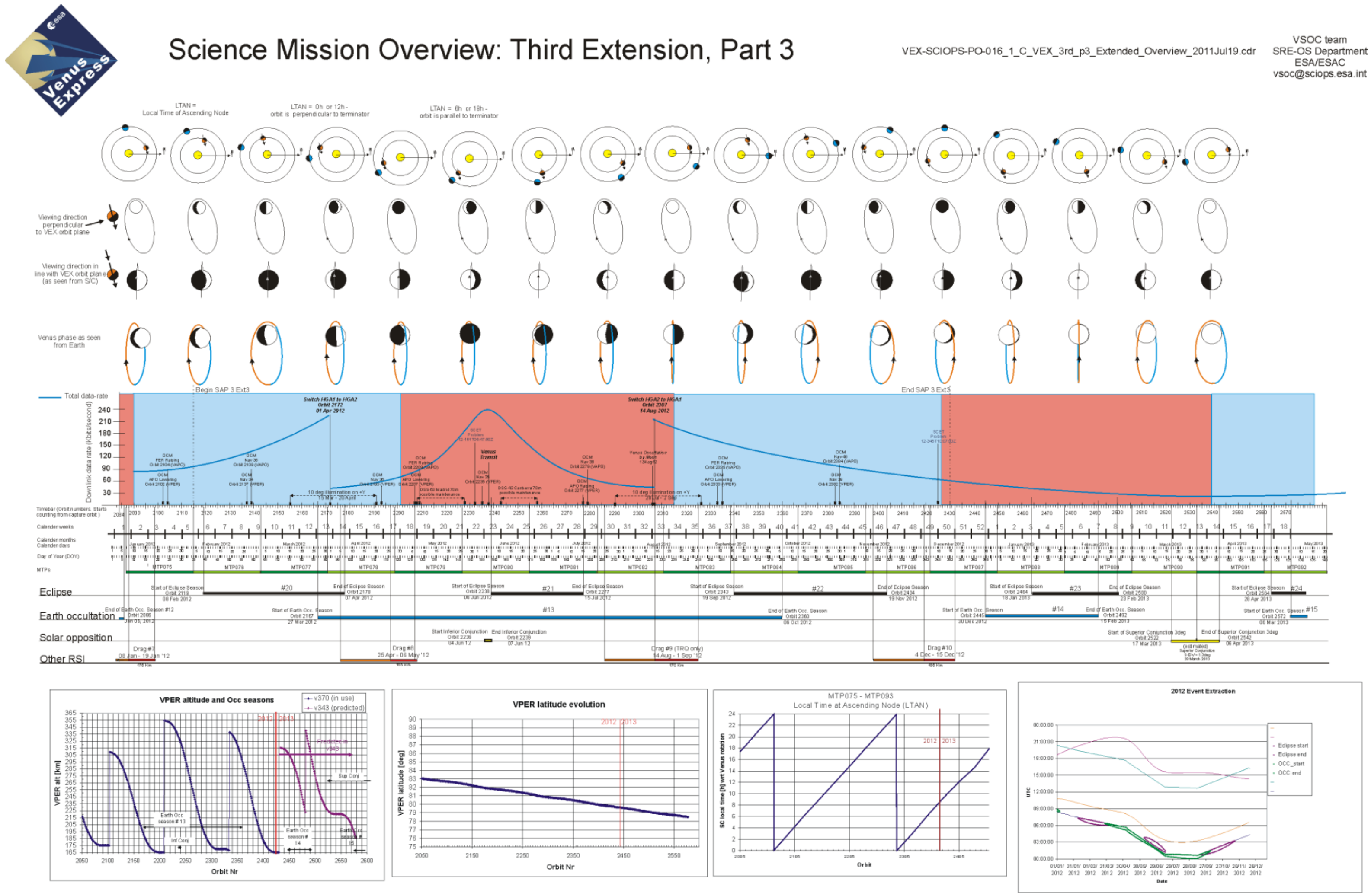
Figure 3.30 *Planet coverage by orbital tracks in MTP#87. Position of terminator, Earth and Sun correspond to the last orbit of MTP.*

3.13.3 Proposed Observations

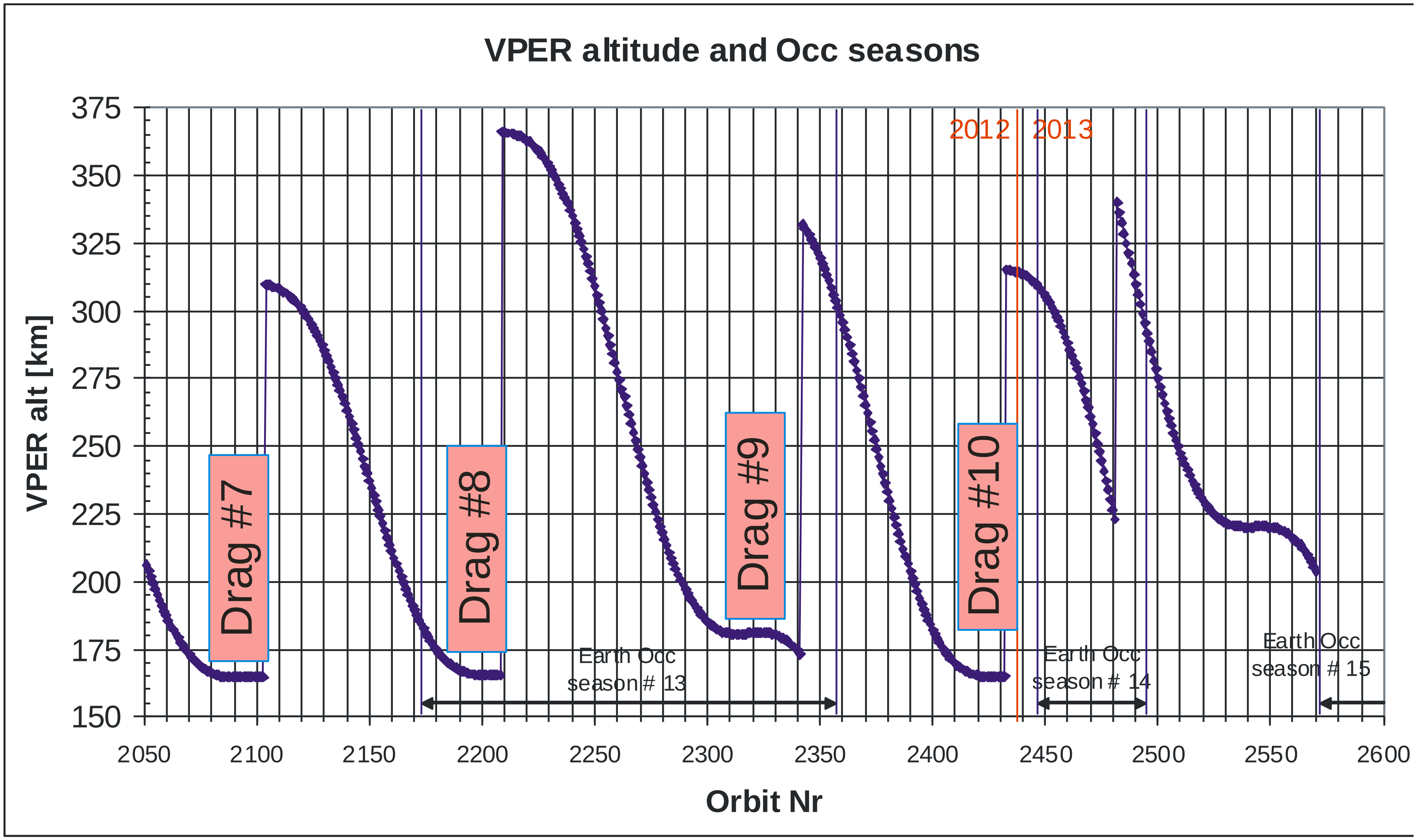
The proposed timeline consists of alternation of several types of orbits:

- Type #1: cases 2-ADE
  - In orbits 2424-2431 the pericentre passage is devoted to ADE passes. (Orbit range has changed)
- Type #2 cases 2-1-*P*-1
- Type #3 cases 2-7-*P*-5
  - Alternate between these orbit types after the drag campaign (orbit 2431).
  - The case 7 in this case is dayside limb imaging, intended as a campaign to study vertical profiles of clouds & hazes.
- Type #3: cases 2-1-*P*-8 or 2-7-*P*-8
  - To be carried out after start of radio occultation season (orbit 2445)

4. ANNEX 1. EXTENDED-3 PART 3 MISSION OVERVIEW



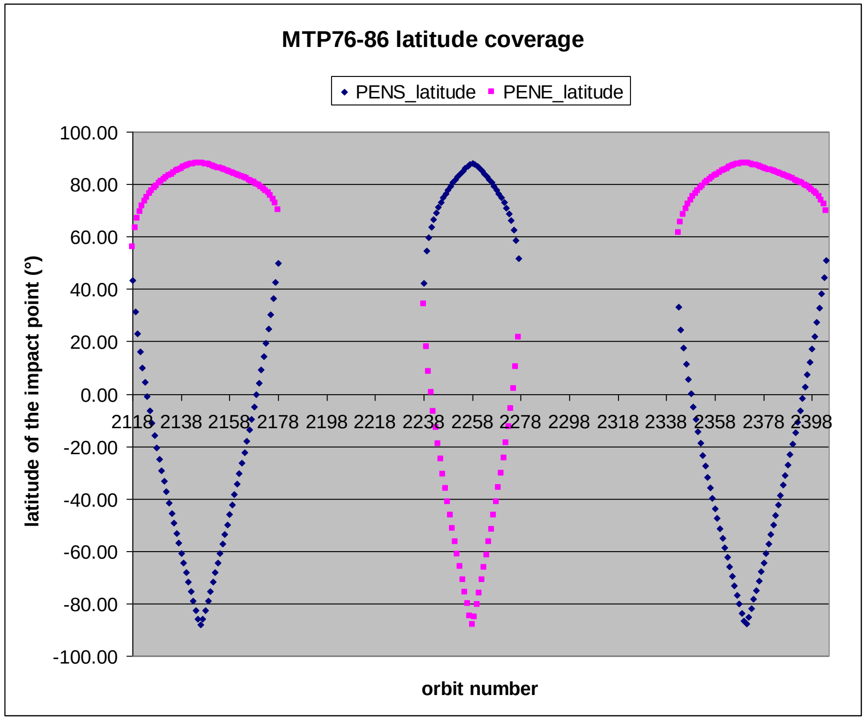
5. ANNEX 2. PERICENTRE ALTITUDE IN EXTENDED MISSION

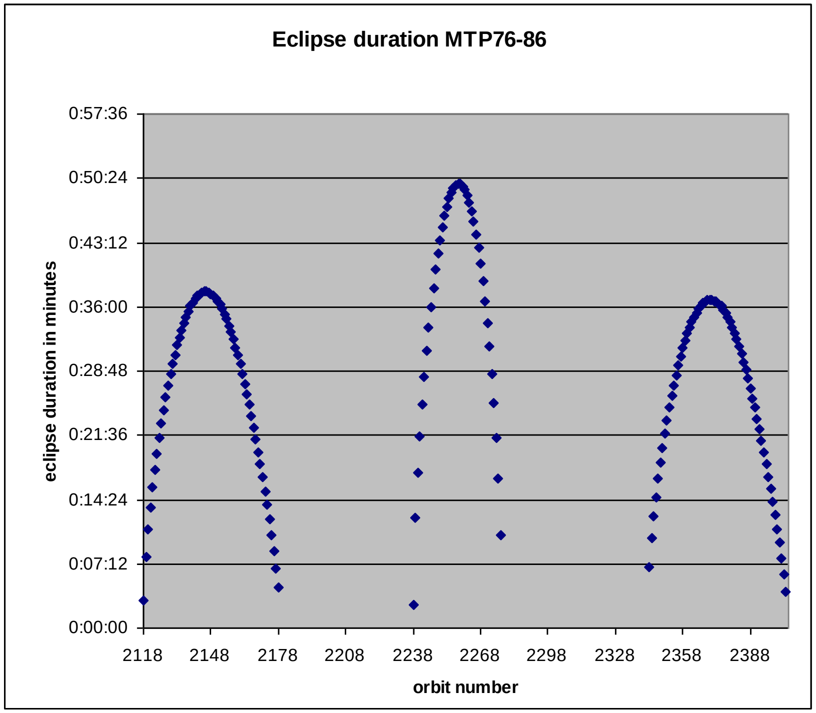


ANNEX 3. LIST OF STARS FOR STELLAR OCCULTATION OBSERVATIONS

PTB	Star	RA	DEC	RelTimeSt	RelTimeEı	Lat.in	Long.in	LSunIn	day/night	Lat.out	Long.out	LSunOut	day/night	OccDurIn	Dist.In	OTAngle	OccDurOı	Dist.Out	OTAngle	TotOccDuı
0	Star02	14,18	60,72																	
1	Star05	24,43	-57,24	-00:15:24	0:06:39	-1,52615	76,51323	2,626595	day	22,72781	-62,6585	134,4168	night	20	6031,593	137,4298	20	2926,255	25,39706	1330
2	Star08	58,53	31,88																	
3	Star09	59,46	40,01																	
4	Star12	78,63	-8,2	-00:04:14	0:19:49	59,20332	84,87461	58,52108	day	-32,9264	-38,4585	112,0243	night	20	2281,488	14,9577	20	7500,586	50,42033	1450
5	Star14	81,28	6,35	-00:02:14	0:24:39	73,92013	79,05021	72,94643	day	-38,9943	-25,3373	100,4806	night	30	1671,059	4,914946	20	9115,084	55,89387	1620
6	Star16	83	-0,3	-00:03:14	0:22:59	67,03779	85,61797	66,31215	day	-41,4765	-32,4052	105,3624	night	30	1905,423	9,954681	10	8578,777	54,2923	1580
7	Star17	83,78	9,93	-00:01:44	0:26:49	77,29326	77,23876	76,31203	day	-44,0114	-21,5792	97,12293	night	40	1559,126	12,96677	20	9793,102	57,68868	1720
8	Star18	83,86	-5,91	-00:04:04	0:21:29	61,22688	88,54272	60,85109	day	-41,3905	-38,6019	109,8713	night	30	2113,063	14,1317	10	8095,281	52,76362	1540
9	Star19	84,05	-1,2	-00:03:24	0:22:59	66,05069	87,02989	65,4361	day	-43,0943	-33,8472	106,0254	night	30	1924,192	10,79526	10	8573,839	54,2463	1590
10	Star20	85,19	-1,94	-00:03:24	0:22:59	65,26197	87,71637	64,71658	day	-44,7144	-35,236	106,5763	night	20	2005,366	10,79526	10	8583,436	54,33569	1590
11	Star21	86,94	-9,67	-00:04:34	0:21:09	57,29751	91,5157	57,44477	day	-44,3804	-45,1392	113,335	night	20	2277,305	16,59827	20	7937,852	51,94641	1550
12	Star25	95,68	-17,96	-00:05:34	0:19:49	49,09939	98,23362	51,35743	day	-46,941	-63,5439	122,8486	night	20	2651,067	21,41675	10	7512,451	50,53084	1530
13	Star28	101,29	-16,72	-00:05:24	0:20:29	50,69713	101,6513	53,8204	day	-50,5652	-72,5089	124,2366	night	20	2547,36	20,62522	10	7748,924	51,4704	1560
14	Star29	104,66	-28,97	-00:07:04	0:17:19	38,80049	104,4555	45,23914	day	-38,7178	-79,7036	136,8199	night	20	3095,736	143,3061	10	6649,52	47,01372	1470
15	Star36	120,9	-40	-00:08:24	0:14:19	29,63647	113,6572	44,89034	day	-22,8603	-92,125	155,8545	night	10	3655,507	143,7496	10	5613,058	42,21509	1370
16	Star41	140,53	-55,01	-00:11:04	0:10:29	15,64025	121,4636	45,94201	day	-0,98847	-93,032	170,3865	night	10	4572,081	142,5674	20	4226,653	34,27959	1300
17	Star44	160,74	-64,39	-00:13:34	0:08:09	4,658614	125,9419	48,70821	day	13,13918	-91,2806	161,9285	night	10	5424,197	139,87	20	3401,374	28,78338	1310
18	Star46	182,09	-50,72	-00:11:54	0:06:29	20,99942	138,0424	62,45686	day	27,94993	-98,2228	150,7571	night	20	4807,523	141,7882	20	2865,369	24,92755	1110
19	Star48	186,65	-63,1	-00:14:54	0:06:19	2,881351	133,6256	56,32148	day	25,90673	-92,5787	151,4038	night	10	5897,068	138,1165	20	2814,149	24,54457	1280
20	Star49	186,65	-63,1	-00:14:54	0:06:19	2,881351	133,6256	56,32148	day	25,90673	-92,5787	151,4038	night	10	5897,068	138,1165	20	2814,149	24,54457	1280
21	Star53	191,93	-59,69	-00:14:44	0:05:49	6,217824	136,7763	59,55759	day	29,98369	-93,8861	147,9248	night	20	5827,177	138,3426	20	2654,043	23,31475	1240
22	Star55	201,3	-11,16																	
23	Star56	204,97	-53,47	-00:14:54	0:04:29	11,59861	143,4431	66,4495	day	40,67981	-94,6861	137,7106	night	20	5903,796	138,1165	30	2147,901	19,15139	1170
24	Star57	206,88	49,31																	
25	Star59	208,88	-47,29	-00:13:54	0:03:29	20,78805	147,4832	71,15649	day	48,10999	-96,6269	130,6286	night	20	5544,446	139,4451	30	1891,641	17,05003	1050
26	Star60	210,96	-60,37	-00:17:14	0:04:29	-1,55653	140,1299	62,88125	day	38,58507	-92,0297	139,2418	night	20	6686,812	134,8496	20	2237,505	19,98597	1310
27	Star62	218,88	-42,16	-00:14:14	0:01:49	25,96898	153,5111	74,414	day	58,79292	-96,78	120,1165	night	30	5651,26	138,9936	40	1543,116	14,07431	970
28	Star65	220,48	-47,39	-00:16:24	0:02:29	13,74902	151,1879	71,13378	day	54,01476	-93,7994	124,7265	night	20	6406,017	136,0191	40	1652,793	15,01162	1140
29	Star70	239,71	-26,11																	
30	Star71	240,08	-22,62																	
31	Star73	241,36	-19,81																	
32	Star74	245,3	-25,59																	
33	Star76	248,97	-28,22	-00:23:54	-00:06:44	17,83872	162,7077	82,40637	day	73,85444	-174,197	93,22955	term	60	8889,839	125,8604	110	2971,777	25,76973	1030
34	Star77	249,29	-10,57																	
35	Star84	263,4	-37,1	-00:36:04	-00:02:04	-33,6313	163,8089	85,16366	day	75,47152	-97,1408	103,4659	night	20	12628,92	113,5194	60	1601,644	14,59286	2040
36	Star86	265,62	-39,03	-00:36:24	-00:01:24	-39,3528	161,7472	84,04897	day	73,61713	-90,8344	105,1381	night	20	12718,15	113,2478	60	1434,464	13,10046	2100
37	Star89	283,82	-26,3	-00:53:44	-00:06:14	-79,3618	170,6336	91,09294	term	85,94663	-96,5174	92,99871	term	20	17419,86	102,3025	50	2807,568	24,52729	2850
38	Star91	306,41	-56,74	-00:29:14	0:02:09	-50,076	83,67022	51,35008	day	53,44445	-73,3506	120,3645	night	20	10586,77	119,8081	30	1562,408	14,22119	1890
	LSun	=	Local	(Zenith)																
		angle	>	90	->	dark	conditions													
		angle	=	90	->	terminator	conditions													
		angle	<	90	->	light	conditions													
		RA	of	Express	orbit	is	102	degrees												
		Stars	in	102	and	282	(102	+		180)	will	get		occulted	easily					
		Stars	in	192	(102	+	90)	and		12	(102	-		90)	will	not	get	occulted	easily	

6. ANNEX 4. SOIR LATITUDE COVERAGE & ECLIPSE DURATION





7. ANNEX 5. TABLE OF THE VERA EXPERIMENTS

Scheduling of the VeRa experiments in the Extended-3 Mission Part 3(Feb 2012 – Jan 2013).

The VeRa Synoptic Table is taken from the document: VEX-SCIOPS-LI-500_41_VeRa_Synoptic_Table_2011Sep14.xls.

Key to last column (Observation type):

DRG: Drag

OCCF: Full Occultation

OCCI: Ingress Occultation

OCCE: Egress Occultation

Time Period Nominal Mission	Orbit No.	DoY	VeRa Experiment	Distance Earth-Venus [AU]	Surface Target	Station	Number of requested Passes	Status (executed, requested, confirmed, cancelled)	Orbits coordinated not yet finally granted or cancelled	
27 Mar. 2012- 6. Oct 2012	**2167-2360**	**87-280**	**Earth Occultation #13**			**Ingress**	**Egress**		**Planning Strategy Adapted to Lower Latitude Coverage**	
27/03/2012	**2167**	**87**	**Sun OCC -2178**			**NNO**	**NNO**	confirmed		OCCF
28/03/2012	**2168**	**88**				**NNO**	**NNO**	confirmed		OCCF
29/03/2012	**2169**	**89**				**NNO**	**NNO**	confirmed		OCCF
30/03/2012	**2170**	**90**				**NNO**		confirmed		OCCI
31/03/2012	**2171**	**91**				**NNO**	**NNO**	confirmed		OCCF
01/04/2012	**2172**	**92**				**NNO**		confirmed	**Switch HGA1->HGA2**	OCCI
02/04/2012	**2173**	**93**				**NNO**	**NNO**	confirmed		OCCF
03/04/2012	**2174**	**94**				**NNO**		confirmed		OCCI
05/04/2012	**2176**	**96**				**NNO**	**NNO**	confirmed		OCCF
07/04/2012	**2178**	**98**				**NNO**		confirmed		OCCI
09/04/2012	**2180**	**100**				**NNO**	**NNO**	confirmed		OCCF
11/04/2012	**2182**	**102**				**NNO**		confirmed		OCCI
13/04/2012	**2184**	**104**				**NNO**	**NNO**	confirmed		OCCF
15/04/2012	**2186**	**106**				**NNO**		confirmed	**HGA2**	OCCI

17/04/2012	2188	108				NNO	NNO	confirmed		OCCF
19/04/2012	2190	110				NNO		confirmed		OCCI
21/04/2012	2192	112				NNO	NNO	confirmed		OCCF
23/04/2012	2194	114				NNO		confirmed		OCCI
25. April-06. May 2012	2196-2207		ADE #8						**Only TRQ (torque). The altitude will be around 165 km VEX is in earth pointing (HGA2) for +/- 2h around pericenter. Combined observation OCC and TRQ are possible. OCC is X-Band only.**	
25/04/2012	2196	116	TRQ, OCC			NNO	NNO	confirmed		OCCF
26/04/2012	2197	117	TRQ						**no station request**	
27/04/2012	2198	118	TRQ, OCC			NNO		confirmed		OCCI
28/04/2012	2199	119	TRQ						**no station request**	
29/04/2012	2200	120	TRQ, OCC			NNO	NNO	confirmed		OCCF
30/04/2012	2201	121	TRQ						**no station request**	
01/05/2012	2202	122	TRQ, OCC			NNO		confirmed		OCCI
02/05/2012	2203	123	TRQ						**no station request**	
03/05/2012	2204	124	TRQ, OCC			NNO	NNO	confirmed		OCCF
04/05/2012	2205	125	TRQ, OCC			NNO		confirmed	**1st campaign**	OCCI
05/05/2012	2206	126	TRQ, OCC Lat -34			NNO		confirmed		OCCI
06/05/2012	2207	127	TRQ, OCC Lat -34			NNO	NNO	confirmed		OCCF
07/05/2012	2208	128				NNO		confirmed	Pericenter altitude correction (170-370 km)	OCCI
08/05/2012	2209	129				NNO		confirmed	from orbit 2208 - 2209	OCCI
09/05/2012	2210	130				NNO	NNO	confirmed		OCCF
10/05/2012	2211	131	Lat -35			NNO		confirmed		OCCI
11/05/2012	2212	132				NNO		confirmed		OCCI
12/05/2012	2213	133				NNO	NNO	confirmed		OCCF
13/05/2012	2214	134	Lat -35			NNO		confirmed		OCCI
14/05/2012	2215	135				NNO		confirmed		OCCI
15/05/2012	2216	136				NNO	NNO	confirmed		OCCF
16/05/2012	2217	137				NNO		confirmed		OCCI
17/05/2012	2218	138	Lat -35			NNO		confirmed		OCCI
18/05/2012	2219	139	Lat -35			NNO	NNO	confirmed		OCCF
19/05/2012	2220	140				NNO		confirmed		OCCI
20/05/2012	2221	141	Lat -34			NNO		confirmed		OCCI
21/05/2012	2222	142				NNO	NNO	confirmed		OCCF
22/05/2012	2223	143	Lat -33			NNO		confirmed		OCCI
23/05/2012	2224	144	Lat -32			NNO		confirmed		OCCI

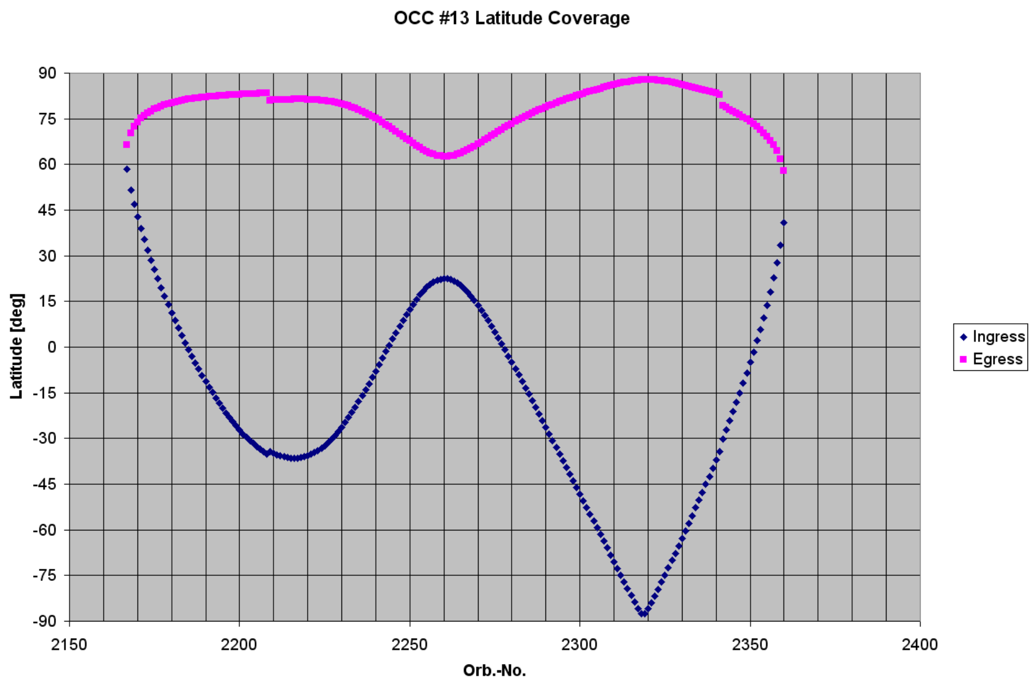
25/05/2012	2226	146				NNO	NNO	confirmed		OCCF
27/05/2012	2228	148				NNO		confirmed		OCCI
29/05/2012	2230	150				NNO	NNO	confirmed		OCCF
31/05/2012	2232	152				NNO		confirmed		OCCI
02/06/2012	2234	154				NNO	NNO	confirmed		OCCF
04/06/2012	2236	156				NNO		confirmed	Orbit 2238 (6.June 2011) Inferior Conjunction	OCCI
06/06/2012	2238	158				NNO	NNO	cancelled	Venus Transit	OCCF
08/06/2012	2240	160	Sun OCC 2239-2277			NNO		confirmed	No OCC observations possible in 2237, 2238 & 2239 ?	OCCI
11/06/2012	2243	163				NNO	NNO	confirmed		OCCF
14/06/2012	2246	166				NNO		confirmed		OCCI
16/06/2012	2248	168				NNO	NNO	confirmed		OCCF
18/06/2012	2250	170				NNO		confirmed		OCCI
20/06/2012	2252	172				NNO	NNO	confirmed		OCCF
22/06/2012	2254	174	ingress Lat 19 egress Lat 64			NNO		confirmed	**2nd campaign (in- and egress const. lat)**	OCCI
23/06/2012	2255	175				NNO	NNO	confirmed	**(2254-2266)**	OCCF
24/06/2012	2256	176				NNO	NNO	confirmed		OCCF
25/06/2012	2257	177				NNO	NNO	confirmed		OCCF
26/06/2012	2258	178				NNO	NNO	confirmed		OCCF
27/06/2012	2259	179				NNO	NNO	confirmed		OCCF
28/06/2012	2260	180	Lat 62			NNO	NNO	confirmed		OCCF
29/06/2012	2261	181	Lat 23, Lat 62			NNO	NNO	confirmed		OCCF
30/06/2012	2262	182				NNO	NNO	confirmed		OCCF
01/07/2012	2263	183				NNO	NNO	requested		OCCF
02/07/2012	2264	184				NNO	NNO	requested		OCCF
03/07/2012	2265	185				NNO	NNO	requested		OCCF
04/07/2012	2266	186	Lat 19, Lat 64			NNO	NNO	requested		OCCF
06/07/2012	2268	188				NNO		requested	**Replacement for 2238**	OCCI
08/07/2012	2270	190				NNO	NNO	requested		OCCF
10/07/2012	2272	192				NNO		requested		OCCI
12/07/2012	2274	194				NNO	NNO	requested		OCCF
14/07/2012	2276	196				NNO		requested		OCCI
16/07/2012	2278	198				NNO	NNO	requested		OCCF
18/07/2012	2280	200				NNO		requested		OCCI
20/07/2012	2282	202				NNO	NNO	requested		OCCF
22/07/2012	2284	204				NNO		requested		OCCI
24/07/2012	2286	206				NNO	NNO	requested		OCCF
26/07/2012	2288	208				NNO		requested		OCCI
28/07/2012	2290	210				NNO	NNO	requested		OCCF
30/07/2012	2292	212				NNO		requested	**HGA2**	OCCI

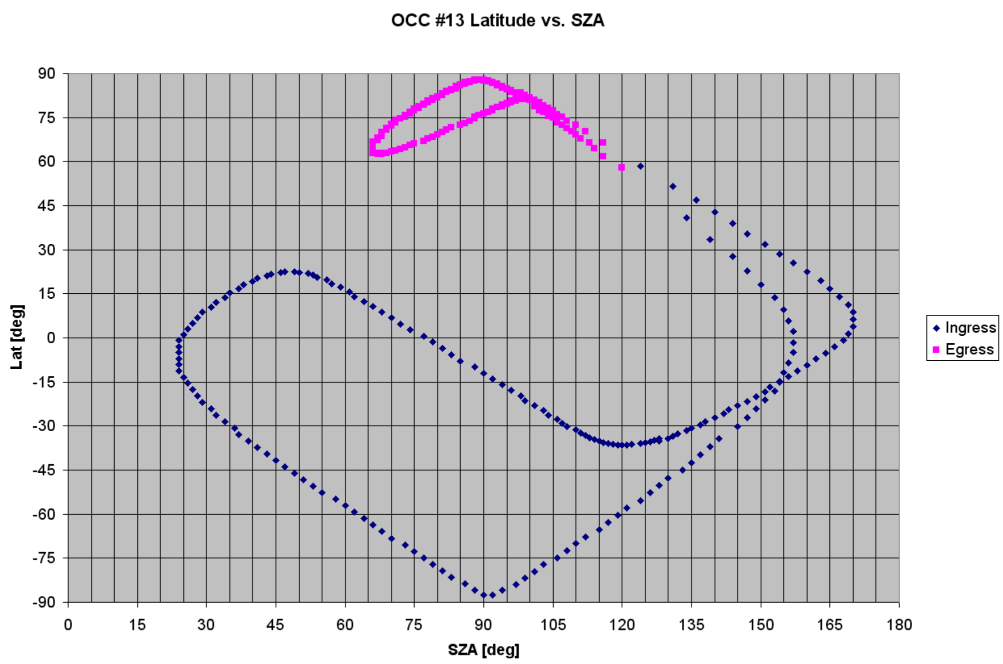
01/08/2012	2294	214				NNO	NNO	requested		OCCF
03/08/2012	2296	216				NNO		requested		OCCI
05/08/2012	2298	218				NNO	NNO	requested		OCCF
07/08/2012	2300	220				NNO		requested		OCCI
09/08/2012	2302	222				NNO	NNO	requested		OCCF
11/08/2012	2304	224				NNO		requested		OCCI
13/08/2012	2306	226				NNO	NNO	requested		OCCF
14. Aug. - 01. Sep. 2012	2307-2325		ADE #9						Only TRQ. The altitude will be around 170 km. Close to Quadrature. HGA1 10 deg off. Occs are hot	
14/08/2012	2307	227	TRQ						no station request approx. Quadrature. switch to HGA1 in orbit 2307 ?	
15/08/2012	2308	228				NNO		requested		OCCI
16/08/2012	1309	229	TRQ						no station request	
17/08/2012	2310	230				NNO	NNO	requested		OCCF
18/08/2012	2311	231	TRQ						no station request	
19/08/2012	2312	232				NNO		requested		OCCI
20/08/2012	2313	233	TRQ						no station request	
21/08/2012	2314	234	TRQ						no station request	
22/08/2012	2315	235				NNO	NNO	requested		OCCF
23/08/2012	2316	236	TRQ						no station request	
24/08/2012	2317	237	TRQ						no station request	
25/08/2012	2318	238				NNO	NNO	requested		OCCF
26/08/2012	2319	239	TRQ						no station request	
27/08/2012	2320	240	TRQ						no station request	
28/08/2012	2321	241				NNO	NNO	requested		OCCF
29/08/2012	2322	242	TRQ						no station request	
30/08/2012	2323	243	TRQ						no station request	
31/08/2012	2324	244				NNO	NNO	requested		OCCF
01/09/2012	2325	245	TRQ						no station request	
02/09/2012	2326	246				NNO		requested		OCCI
04/09/2012	2328	248				NNO	NNO	requested		OCCF
06/09/2012	2330	250				NNO		requested		OCCI
08/09/2012	2332	252				NNO	NNO	requested		OCCF
10/09/2012	2334	254				NNO		requested	Pericenter altitude correction (170-325 km) from Orbit 2334-2335	OCCI
12/09/2012	2336	256				NNO	NNO	requested		OCCF
14/09/2012	2338	258				NNO		requested		OCCI
16/09/2012	2340	260	Sun OCC 2340-			NNO	NNO	requested		OCCF
18/09/2012	2342	262				NNO		requested		OCCI

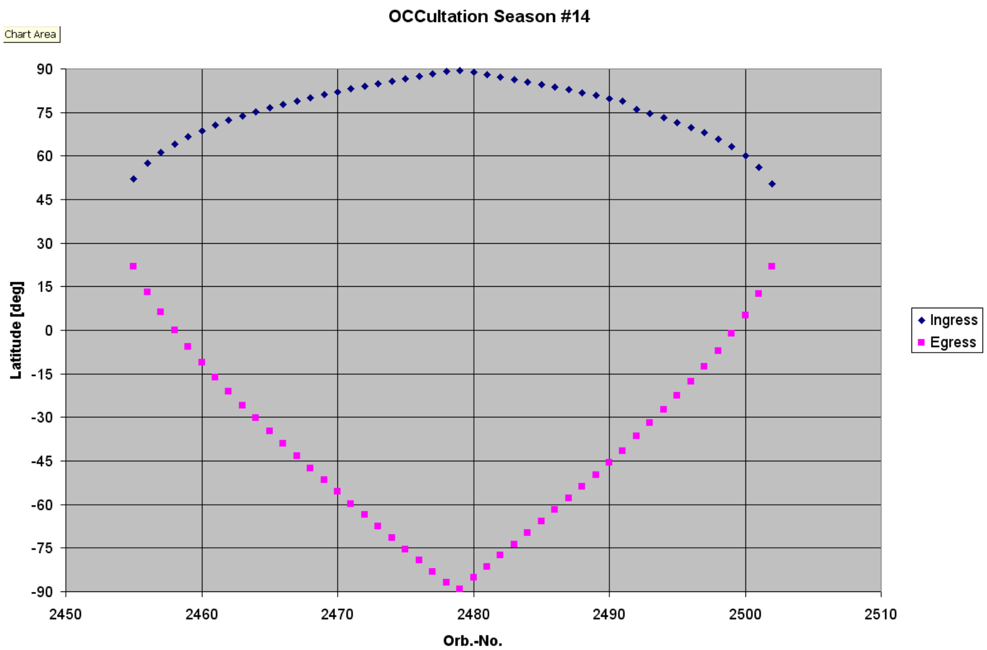
20/09/2012	**2344**	**264**				**NNO**	**NNO**	requested		OCCF
22/09/2012	**2346**	**266**				**NNO**		requested		OCCI
24/09/2012	**2348**	**268**				**NNO**	**NNO**	requested		OCCF
26/09/2012	**2350**	**270**				**NNO**		requested		OCCI
28/09/2012	**2352**	**272**				**NNO**	**NNO**	requested		OCCF
30/09/2012	**2354**	**274**				**NNO**		requested		OCCI
02/10/2012	**2356**	**276**				**NNO**	**NNO**	requested		OCCF
03/10/2012	**2357**	**277**				**NNO**		requested		OCCI
04/10/2012	**2358**	**278**				**NNO**	**NNO**	requested		OCCF
05/10/2012	**2359**	**279**				**NNO**	**NNO**	requested		OCCF
06/10/2012	**2360**	**280**				**NNO**	**NNO**	requested		OCCF
04.Dec.-15.Dec. 2012	**2419-2430**		**ADE #10**	**AU**	**Altitude (EVTF___370) 166 km**	**NNO/DSN**			**S-and X-Band**	
Part 1										
04/12/2012	2419	339	MTP086	1.43	166	**DSN**	1	requested	4hours around pericenter, DSN 70 m, HGA1	DRG
05/12/2012	2420	340	MTP086			NNO	1	requested	4hours around pericenter, HGA1	DRG
06/12/2012	2421	341	MTP086			**DSN**	1	requested	4hours around pericenter, DSN 70 m, HGA1	DRG
07/12/2012	2422	342	MTP087			NNO	1	requested	4hours around pericenter, HGA1	DRG
08/12/2012	2423	343	MTP087			**DSN**	1	requested	4hours around pericenter, DSN 70 m, HGA1	DRG
09/12/2012	2424	344	MTP087		166	NNO	1	requested	4hours around pericenter, HGA1	DRG
Part 2										
10/12/2012	2425	345	MTP087			**DSN**	1	requested	4hours around pericenter, DSN 70 m, HGA1	DRG
11/12/2012	2426	346	MTP087			NNO	1	requested	4hours around pericenter, HGA1	DRG
12/12/2012	2427	347	MTP087			**DSN**	1	requested	4hours around pericenter, DSN 70 m, HGA1	DRG
13/12/2012	2428	348	MTP087			NNO	1	requested	4hours around pericenter, HGA1	DRG
14/12/2012	2429	349	MTP087			**DSN**	1	requested	4hours around pericenter, DSN 70 m, HGA1	DRG
15/12/2012	2430	350	MTP087	1.48	166	NNO	1	requested	4hours around pericenter, HGA1	DRG
30 Dec. 2012- 15. Feb. 2013	**2445-2492**	**365-**	**Earth Occultation #14**			**Ingress**	**Egress**		**Planning Strategy Adapted to Lower Latitude Coverage**	
30/12/2012	**2445**	**365**				**NNO**	**NNO**	requested		OCCF
31/12/2012	**2446**	**366**				**NNO**	**NNO**	requested		OCCF
01/01/2013	**2447**	**1**				**NNO**	**NNO**	requested	**HGA1 or HGA2 ?**	OCCF
02/01/2013	**2448**	**2**					**NNO**	requested		OCCE
03/01/2013	**2449**	**3**				**NNO**	**NNO**	requested		OCCF
04/01/2013	**2450**	**4**					**NNO**	requested		OCCE

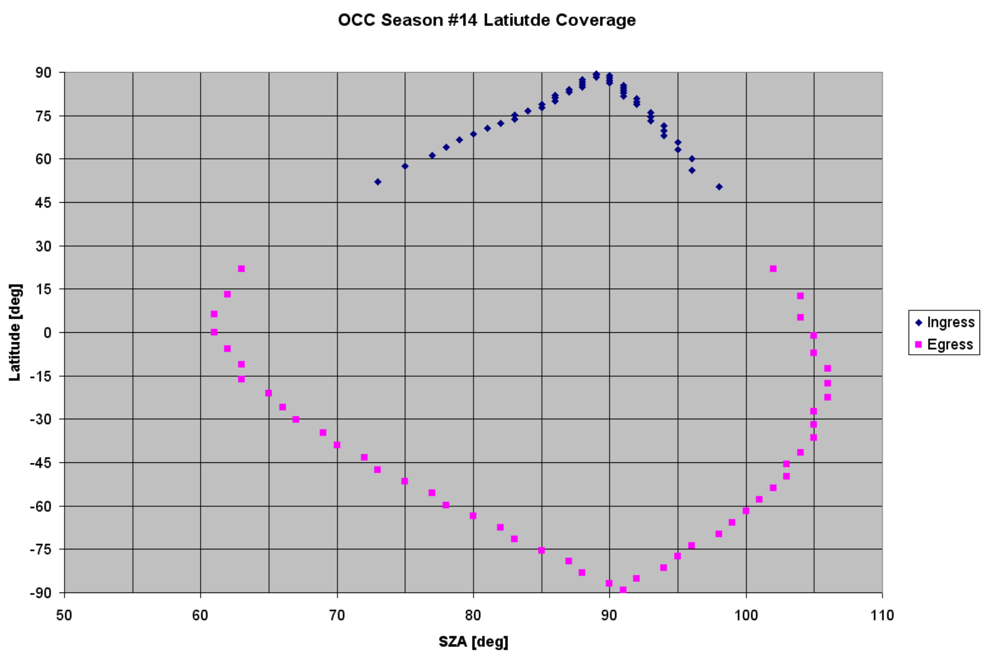
05/01/2013	2451	5				NNO	NNO	requested		OCCF
06/01/2013	2452	6					NNO	requested		OCCE
07/01/2013	2453	7				NNO	NNO	requested		OCCF
08/01/2013	2454	8					NNO	requested		OCCE
09/01/2013	2455	9				NNO	NNO	requested		OCCF
10/01/2013	2456	10					NNO	requested		OCCE
12/01/2013	2458	12				NNO	NNO	requested		OCCF
14/01/2013	2460	14					NNO	requested		OCCE
16/01/2013	2462	16				NNO	NNO	requested		OCCF
17/01/2013	2463	17				NNO	NNO	requested		OCCF
21/01/2013	2467	21	Sun OCC 2464 -			NNO	NNO	requested		OCCF
25/01/2013	2470	25				NNO	NNO	requested		OCCF
28/01/2013	2473	28				NNO	NNO	requested		OCCF
30/01/2013	2475	30				NNO	NNO	requested		OCCF
01/02/2013	2477	32					NNO	requested		OCCE
03/02/2013	2479	34				NNO	NNO	requested		OCCF
05/02/2013	2481	36					NNO	requested		OCCE
07/02/2013	2483	38				NNO	NNO	requested		OCCF
09/02/2013	2485	40				NNO	NNO	requested		OCCF
11/02/2013	2487	42					NNO	requested		OCCE
12/02/2013	2488	43				NNO	NNO	requested		OCCF
13/02/2013	2489	44					NNO	requested		OCCE
14/02/2013	2490	45				NNO	NNO	requested		OCCF
15/02/2013	2491	46				NNO	NNO	requested		OCCF
16/02/2013	2492	47				NNO	NNO	requested		OCCF

8. ANNEX 6. COVERAGE IN THE VERA OCCULTATION EXPERIMENT






OCCultation Season #14
Chart Area
Latitude [deg]
Orb.-No.
Ingress
Egress
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
2450
2460
2470
2480
2490
2500
2510


OCC Season #14 Latiutde Coverage
Latitude [deg]
SZA [deg]
Ingress
Egress
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
50
60
70
80
90
100
110