



Magnetic Field Investigation of the Venus Plasma Environment: Expected New Results

Tielong Zhang and Chris Russell



Venus Express



MAG



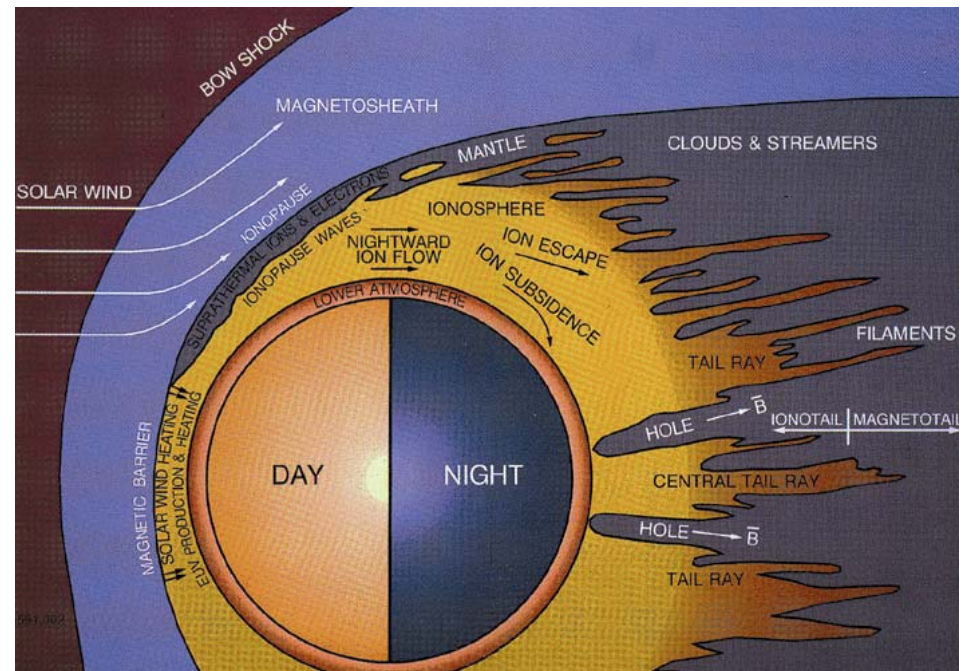
- New ESA mission to Venus
- Launched 2005
- Seven Instruments
- Magnetometer and plasma instrument



MAG Scientific Objectives



- Improve our understanding of the solar wind interaction with the Venus atmosphere/ionosphere
- Determine the nature of and the processes acting at the boundaries between the various plasma regions
- Provide magnetic field data for any combined field and particle studies, e.g., planetary ion pickup processes

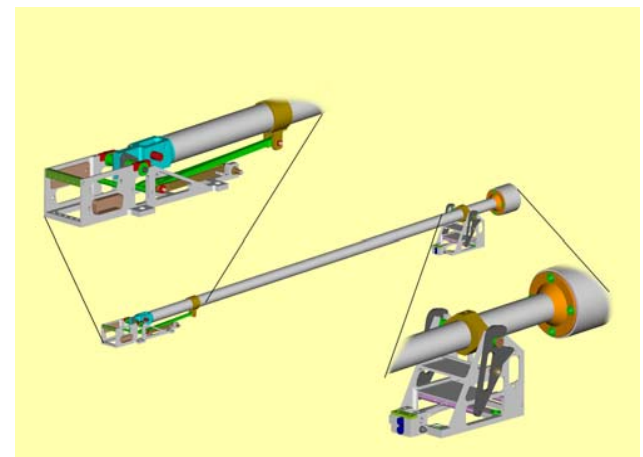
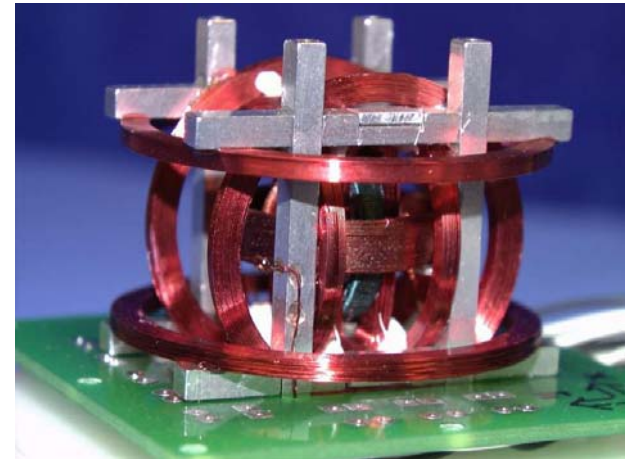




Magnetic Field Measurements



- Two triaxial fluxgate sensors
- Heritage of the Rosetta Lander
- One sensor on an 1-m deployable boom
- One sensor on the surface of the s/c
- Range: ± 256 nT (default); ± 32 nT .. ± 8192 nT
- Resolution: 8 pT (default); 1 pT .. 256 pT
- DC compensation $\pm 10,000$ nT
- Burst mode 128 Hz: 2 minutes around the periapsis
- Periapsis mode 32 Hz: about 2 hours around the periapsis
- Solar wind mode 1 Hz: 22 hours





Magnetic Cleanliness



For Venus Express mission, there is no magnetic cleanliness program:

- Mapping sources of spacecraft magnetic field before launch
- Large dynamic range and high resolution of the magnetometer
- In flight calibration
- VEX in solar wind
- 14 years of PVO magnetometer measurements
- Two sensor concept: monitoring the stray magnetic fields
- The s/c noise and the external field are uncorrelated
- Different time scale of the magnetic variations
- Comparing with ASPERA plasma measurements
- Properties of IMF such as lack of correlation between magnitude and components.



VEX MAG Data Cleaning



- Dual magnetometry
- Observed field
$$\text{Bobs1} = \text{Bam} + \text{Bsc1}$$
$$\text{Bobs2} = \text{Bam} + \text{Bsc2}$$
where
 - Bam: independent from sensor position
 - Bsc: SC field at sensor position
- Use $\text{Bobs2} - \text{Bobs1}$ to determine and eliminate SC field



Different Approaches to Magnetic Measurements



- NEAR mission
 - No gradiometer; no boom
 - Sensor mounted on the feed structure of the high-gain antenna approximately 1 meter from the main body of the s/c
 - Achieved a 1–5 nT accuracy

- PVO
 - Minimal magnetic test
 - Long boom
 - Data resolution
 - 1/2 nT for fields of 64 nT or greater
 - 1/16 nT for fields less than 16 nT

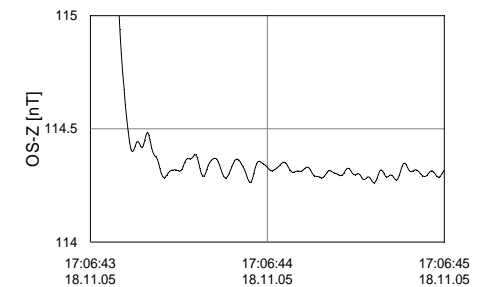
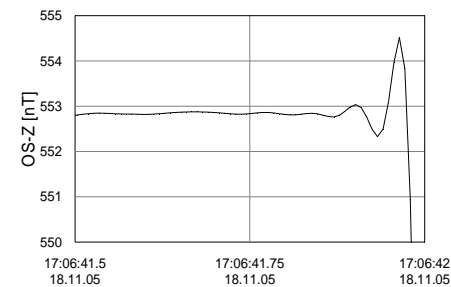
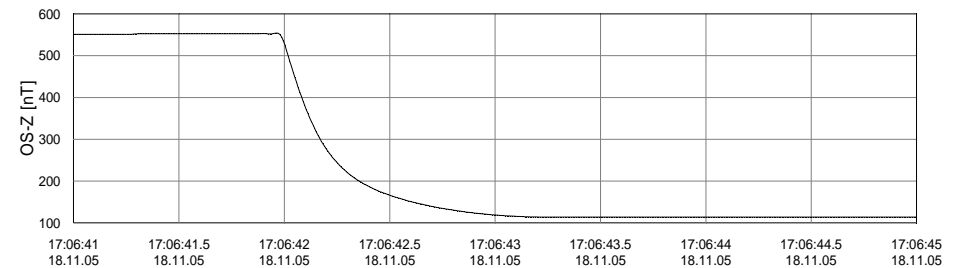
- Venus Express
 - High resolution, high accuracy data for wave study is possible, eg., 80 pT oscillations observed during boom deployment
 - Cleaned data set with 1–2 nT accuracy for quick look and event selection – direction determination better than 10 deg – to be achieved



Data



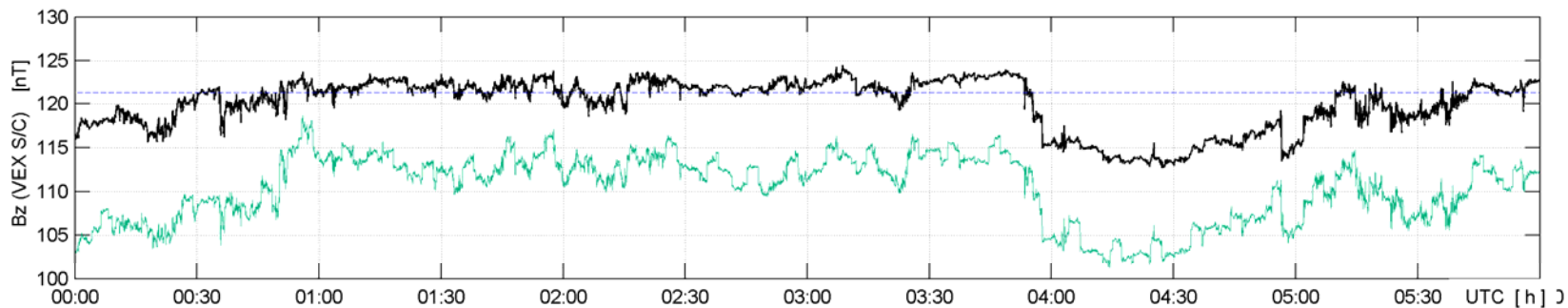
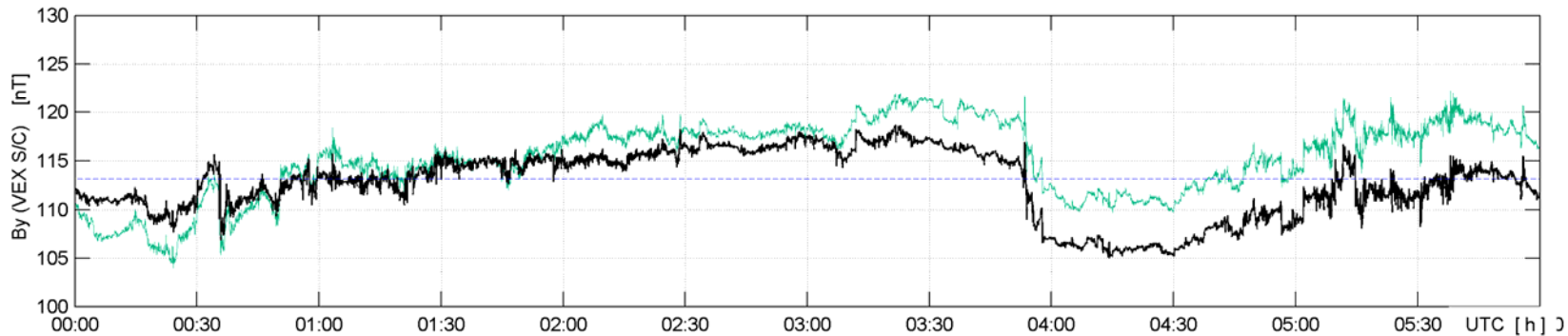
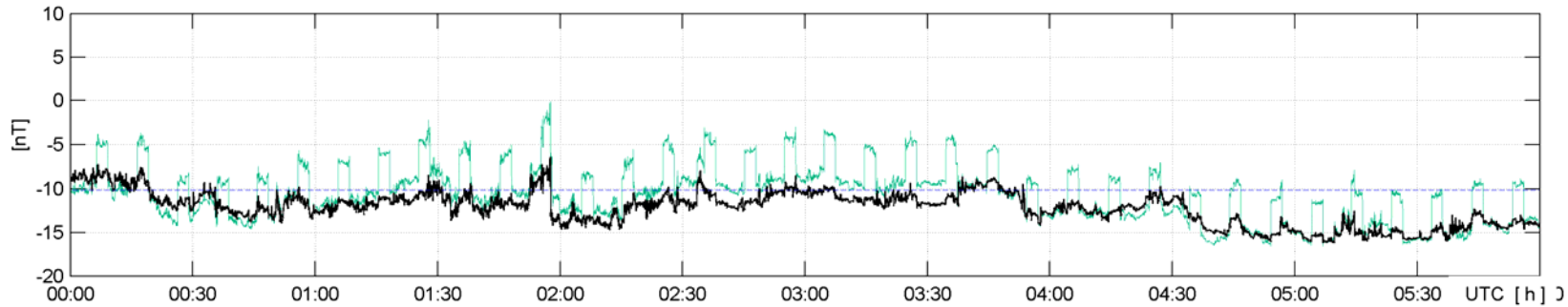
- MAG boom deployment at approx. 17:06:42 measured by MAG itself (OS-Z). The field drops from 553.8 nT to 114.3 nT. The deployment length is 1.3 sec
- The shock of the boom lock is visible followed by an 8 Hz oscillation (80 pT peak to peak)
- Excellent performance



VEXMAG BOS, BIS compared to BOSmean - Cruise 1Hz (2005-11-19)

25-Jan-2006 13:14:56

BOS, BIS - (BISmean-BOSmean); calibrated, inVEX S/C coord.



BOS(black); BIS-(BISmean-BOSmean) (green); BOSmean(blue, dashed);

VEXMAG IWF-Graz

DataRate = 1Hz

Interval in SCET UTC:

Start: 2005-11-19

00:00:00

End: 2005-11-19

05:59:59

2005 DOY 323

Data processing

DataLevel = ANALYSIS

- calibrated data [nT]

- times in UTC

- average in interval:

- 2005-11-19 00:00:01

- 2005-11-19 23:59:56

- (BOSmean)x= -10.1

- (BOSmean)y= 113.2

- (BOSmean)z= 121.3

- (BISmean)x= -653.8

- (BISmean)y= -638.0

- (BISmean)z= 1649.4

Calc.Date = 2006-01-25

Field values in [nT]

Coord. system:

VEX S/C

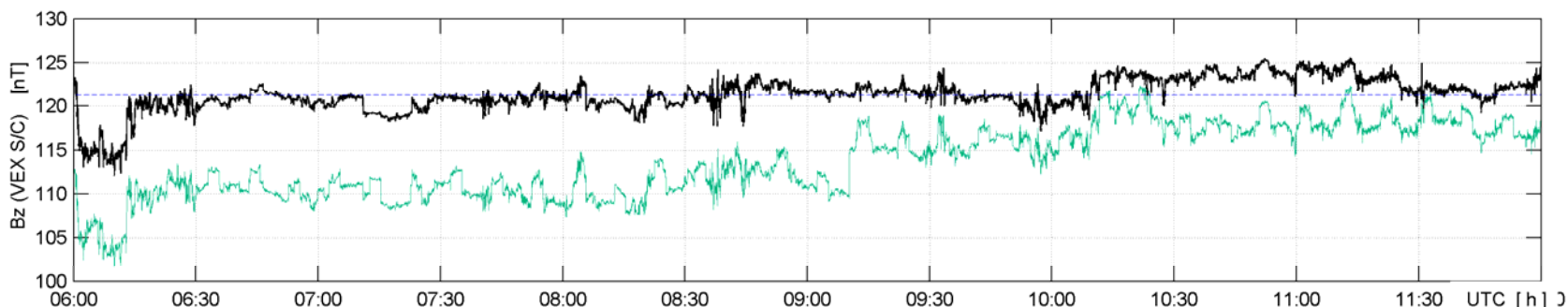
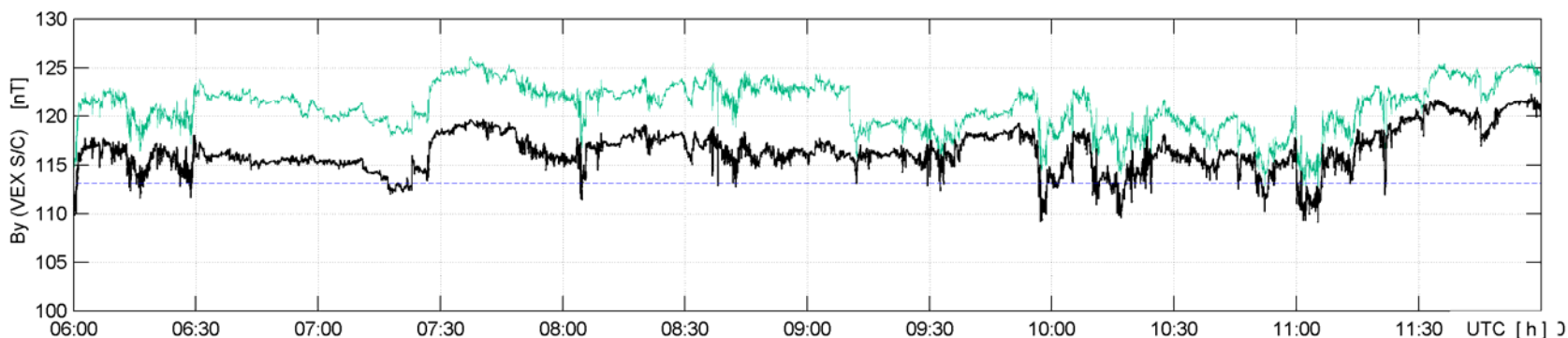
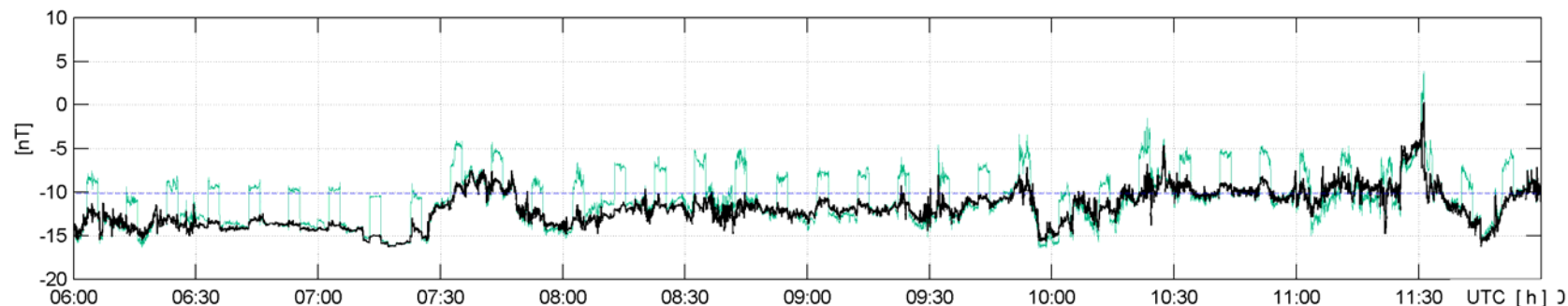
Venus Express
Magnetometer

Source data file [nT]: BIO_2005-11-19T00-00-01_DOY_323_D001_0_DIF.dat

VEXMAG BOS, BIS compared to BOSmean - Cruise 1Hz (2005-11-19)

25-Jan-2006 13:15

BOS, BIS - (BISmean-BOSmean); calibrated, inVEX S/C coord.



BOS(black); BIS-(BISmean-BOSmean) (green); BOSmean(blue, dashed);

VEXMAG IWF-Graz

DataRate = 1Hz

Interval in SCET UTC:

Start: 2005-11-19

06:00:00

End: 2005-11-19

11:59:59

2005 DOY 323

Data processing

DataLevel = ANALYSI

- calibrated data [nT]

- times in UTC

- average in interval:

- 2005-11-19 00:00:0

- 2005-11-19 23:59:5

- (BOSmean)x= -10

- (BOSmean)y= 113

- (BOSmean)z= 121

- (BISmean)x= -653.

- (BISmean)y= -638.

- (BISmean)z= 1649

Calc.Date = 2006-01-

Field values in [nT]

Coord. system:

VEX S/C

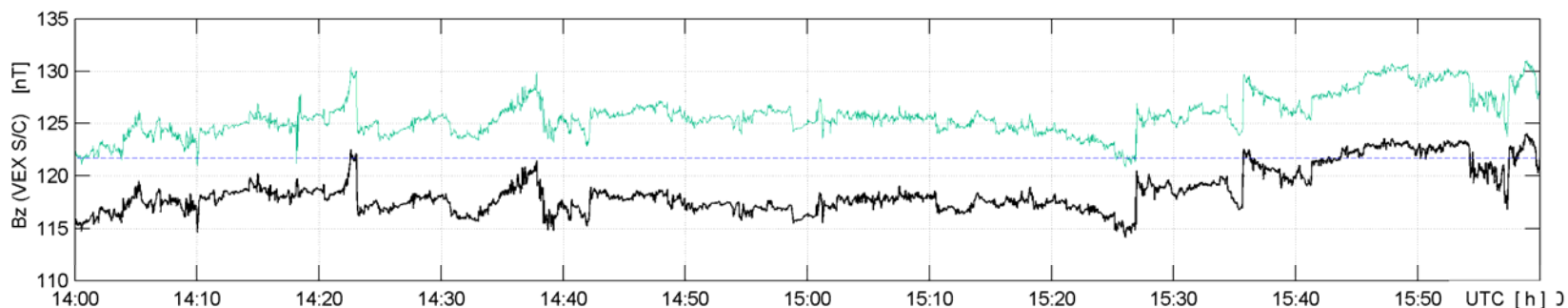
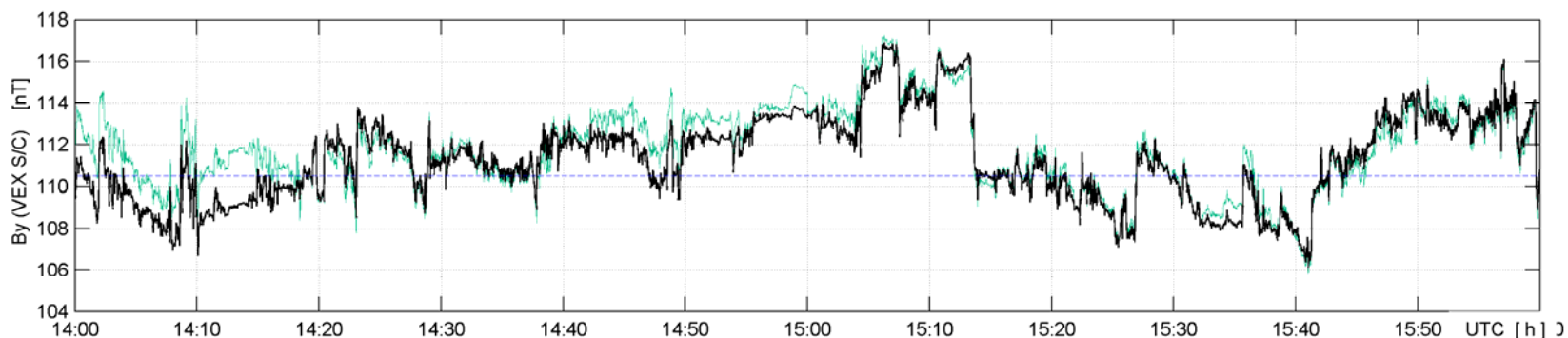
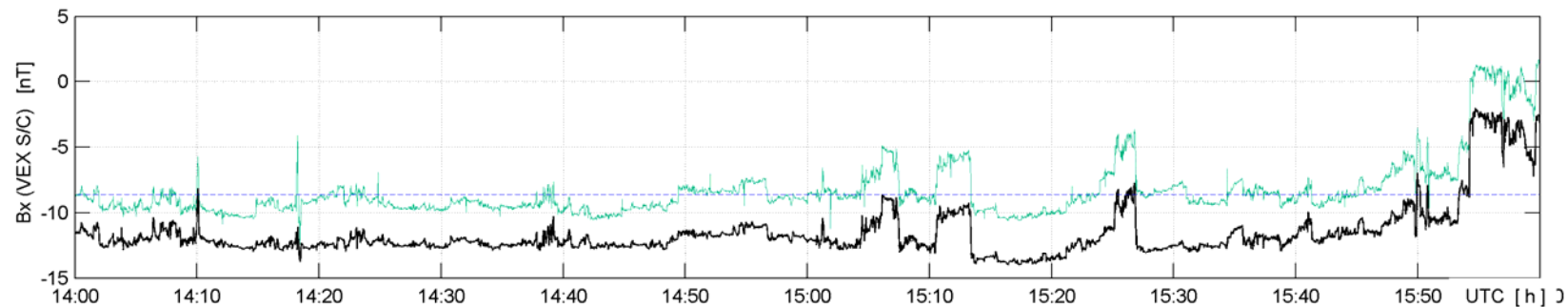
Venus Express
Magnetometer

Source data file [nT]: BIO_2005-11-19T00-00-01_DOY_323_D001_0_DIF.dat

VEXMAG BOS, BIS compared to BOSmean - CLEARED ALL 1Hz (2005-11-20)

02-Feb-2006 16:55:09

BOS, BIS - (BISmean-BOSmean); calibrated, in VEX S/C coord.



BOS(black); BIS-(BISmean-BOSmean) (green); BOSmean(blue, dashed);

VEXMAG IWF-Graz

DataRate = 1Hz

Interval in SCET UTC:
Start: 2005-11-20 14:00:00
End: 2005-11-20 15:59:59

2005 DOY 324

Data processing

DataLevel = CLEARED_A

Calibrated data [nT]
 Times in UTC
 Average in interval:
 2005-11-20 00:00:00
 2005-11-20 23:59:59
 (BOSmean)x= -8.6
 (BOSmean)y= 110.5
 (BOSmean)z= 121.7
 (BISmean)x= -647.6
 (BISmean)y= -643.9
 (BISmean)z= 1681.7

Calc.Date = 2006-01-18

Field values in [nT]

Coord. system:
VEX S/C

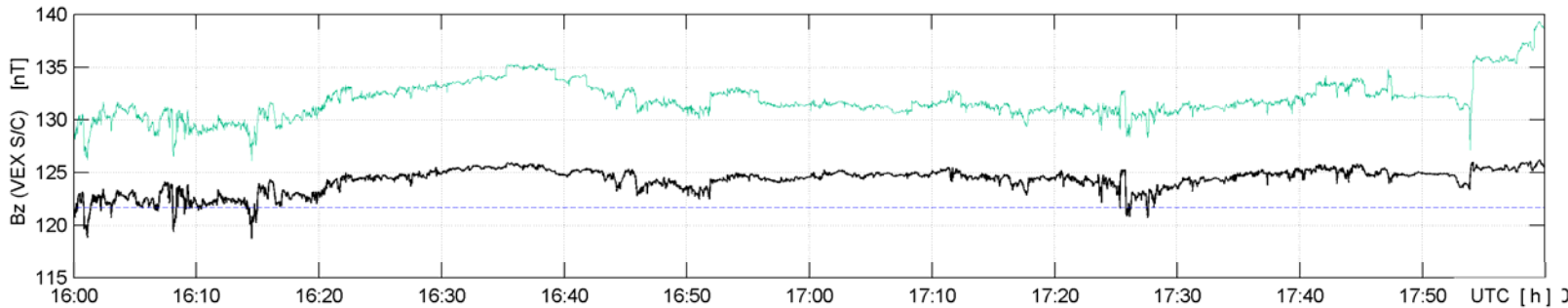
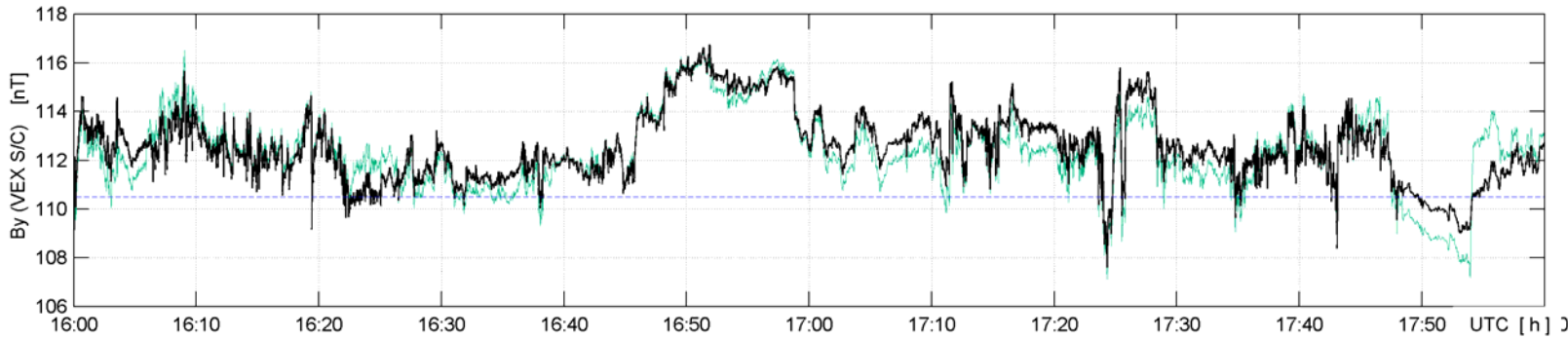
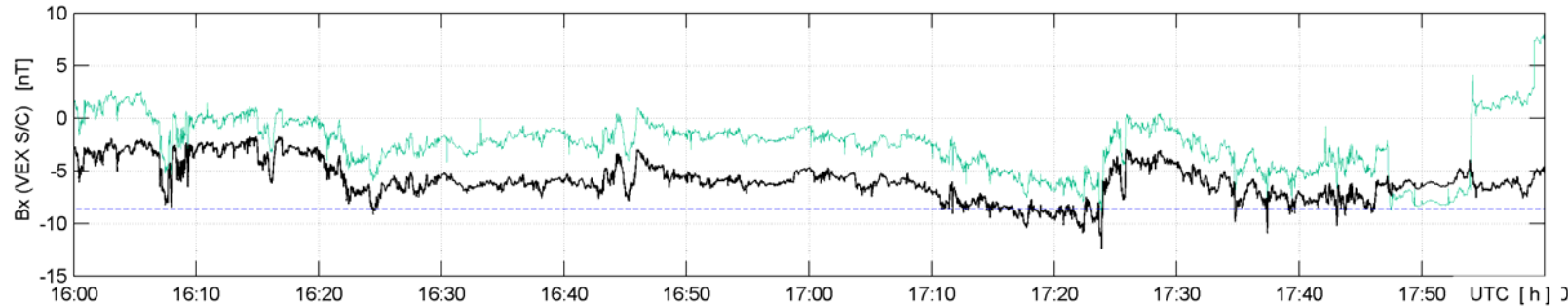
Venus Express
 Magnetometer

Source data file [nT]: BIO_2005-11-20T00-00-00_DOY_324_D001_0_clearedFeb1all

VEXMAG BOS, BIS compared to BOSmean - CLEARED ALL 1Hz (2005-11-20)

02-Feb-2006 16:55:21

BOS, BIS - (BISmean-BOSmean); calibrated, in VEX S/C coord.



BOS(black); BIS-(BISmean-BOSmean) (green); BOSmean(blue, dashed);

VEXMAG IWF-Graz

DataRate = 1Hz

Interval in SCET UTC:

Start: 2005-11-20

16:00:00

End: 2005-11-20

17:59:59

2005 DOY 324

Data processing

DataLevel = CLEARED_AL

Calibrated data [nT]

Times in UTC

Average in interval:

2005-11-20 00:00:00

2005-11-20 23:59:59

(BOSmean)x= -8.6

(BOSmean)y= 110.5

(BOSmean)z= 121.7

(BISmean)x= -647.6

(BISmean)y= -643.9

(BISmean)z= 1681.7

Calc.Date = 2006-01-18

Field values in [nT]

Coord. system:

VEX S/C

Venus Express
Magnetometer

Source data file [nT]: BIO_2005-11-20T00-00-00_DOY_324_D001_0_clearedFeb1all

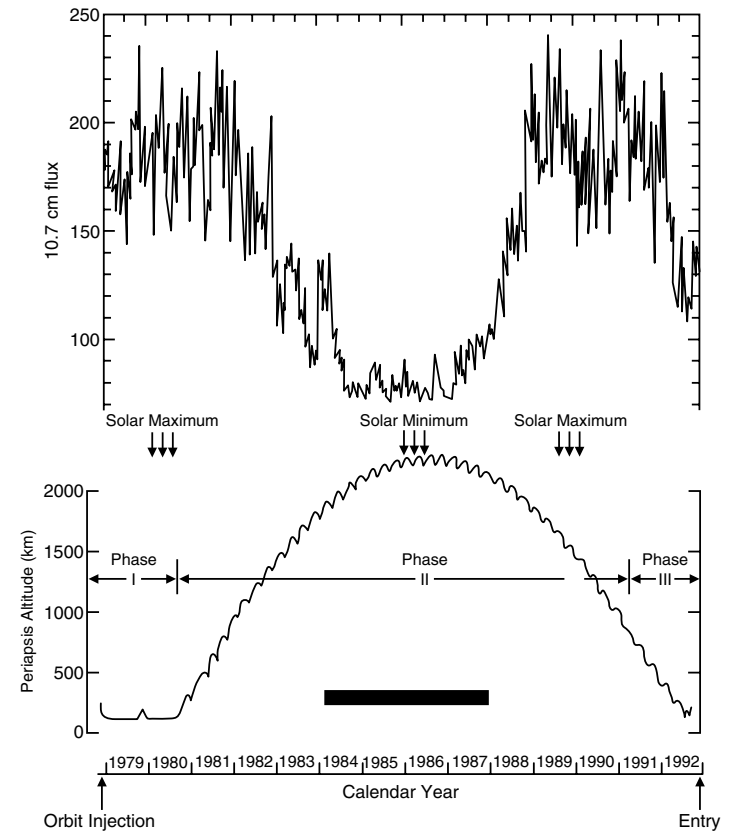
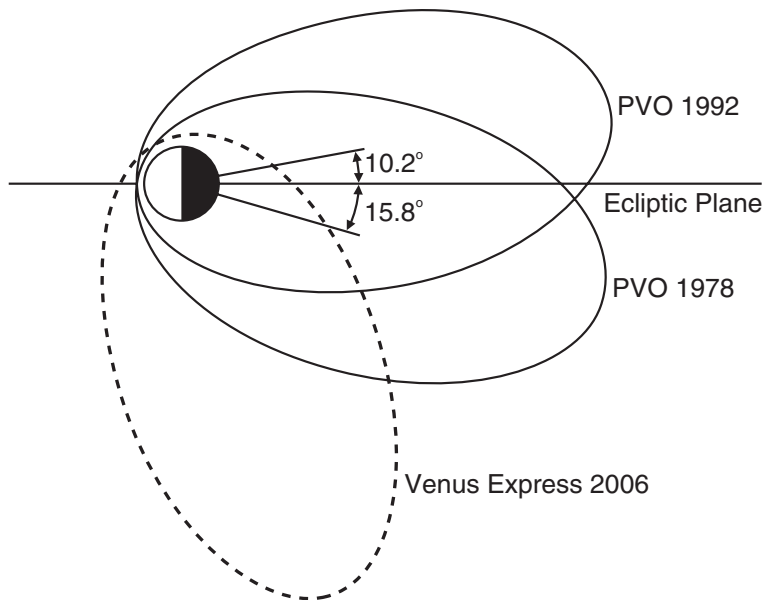


VEX vs PVO



PVO: OMAG+OPA

VEX: MAG+ASPERA





Venus Express vs. PVO



Orbit: Both Venus Express (Periapsis 250 km, Apoapsis 66000 km) and PVO have similar 24 hour elliptical polar orbits. However the PVO periapsis was near equator and the VEX periapsis will be situated more than 70 deg north. VEX samples both the subsolar shock and near-tail wake region. PVO did not.

Solar Activity: PVO measures at low (150 km) periapsis only at solar maximum. During solar minimum, the periapsis of PVO was more than 2000 km. In contrast, the Venus Express will be inserted into the Venus orbit during solar minimum.

Instrumentation: For PVO, the plasma analyzer was designed to monitor the solar wind with a resolution of about 10 minutes. Aboard VEX, the ASPERA will measure the plasma at 192 s resolution.



Expected new results



- Foreshock and upstream waves: high resolution MAG and plasma data
- Bow shock: improved orbital geometry to study subsolar shock and variation with solar activity
- Ionopause and magnetic barrier: effect of solar activity, better plasma data
- Near-Venus Wake: region never measured before
- Lightning: high resolution MAG data
- Ion Pickup: better plasma data
- Contribution to space weather study: large IMF data set for STEREO conjunction study