Draft version December 12, 2018
Typeset using LATEX default style in AASTeX62

Supporting information for "First observations of rippled interplanetary shocks at ion scales by Cluster"

Primož Kajdič,[1] Luis Preisser,[1] Xóchitl Blanco-Cano,[1] David Burgess,[2] and Domenico Trotta[2]

[1]Instituto de Geofísica, Universidad Nacional Autónoma de México, Circuito de la investigación Científica s/n, Ciudad Universitaria, Delegación Coyoacán, C.P. 04510, Mexico City, Mexico
[2]School of Physics and Astronomy, Queen Mary University of London, London E1 4NS, UK

(Received January 1, 2018; Revised January 7, 2018; Accepted December 12, 2018)

Submitted to ApJL

1. CONTENTS

This file contains information on our novel one-spacecraft method for determining shock normals. We first provide the description, then we discuss the sources of errors and in the end we provide figures of B-field profiles of the shocks in the shock-normal soordinate system.

2. METHOD

Determining the geometry (θ_{BN}) of observed collisionless shocks is fundamental for understanding the physical processes that govern particle acceleration at these shocks as well as their evolution in time. In order to determine θ_{BN}, one needs to find the shock normal and the upstream B-field direction. Obtaining the latter is straightforward, while determining precise shock normal vectors not so much. Common methods used for calculating the normal vectors can be divided into multi-spacecraft and one-spacecraft methods. The first relay on determining accurate shock crossing times for at least four spacecraft. This can be hard if the shock transition is highly structured and if time differences between pairs of spacecraft are of the order of time periods during which the shocks are observed.

The most common one-spacecraft method involves the magnetic coplanarity theorem. This requires averaging of upstream and downstream fields during chosen time intervals (but exclude the shock transition) which are then used to calculate the shock normal and θ_{BN}. Thus one obtains some time-averaged values. When multiple inter-spacecraft separations are small ($\lesssim$100 d_i), one would expect the shock normals calculated this way to coincide within the margin of error. This is because self-reformation is a cyclic process so local shock normals and θ_{BN} vary in time around some average value which should be similar at small spacecraft separations.

In order to study shock rippling, we need local shock normals at the times when the shocks were observed by each spacecraft and see how they vary as a function of inter-spacecraft separation. Here we use a one-spacecraft method based on shock normal coordinate system (SNCS). The latter contains three perpendicular axes, n, l and m. The n-axis is parallel to the shock normal, the l-axis contains a projection of the upstream B-field on the shock plane, while the m-axis completes the right-hand coordinate system. When crossing a shock, the B_n component is constant at some finite value, the B_m-component is zero, while the B_l component changes from upstream to downstream.

This is of course strictly true only for MHD shocks. In the case of collisionless shocks there exist out-of-plane component of the magnetic field produced in the shocks's foot and overshoot. Still we expect to find a unique direction of the maximum variance of the B-field (l-axis) and another direction in which the B-field oscillates around zero (m-axis). The third direction that completes the right-hand coordinate system is thus the n-axis along which the B_n component varies around some average value.

In order to find the SNCS using given interval, we first smooth the B-field data by using a 4-second sliding window in order to remove the upstream whistlers. We then perform minimum variance analysis (MVA, Sonnerup & Scheible 1998) of the B-field across the shock and postulate that the direction of maximum variance gives us the l-direction. We also obtain two more vectors, perpendicular to l. We then rotate one of them around the l-axis and calculate the

Corresponding author: Primož Kajdič
primoz@igeofisica.unam.mx

absolute value of the mean of the B-field projection along it. Once this value reaches its minimum close to 0, we take the corresponding vector to point along the m-axis and the remaining vector has to point along n.

3. SOURCES OF ERROR

This method is not without errors. There are two main sources that distort our calculations. The first is the error of the MVA method itself which depends on the number of measurement points and the calculated eigenvalues (Sonnerup & Scheible 1998):

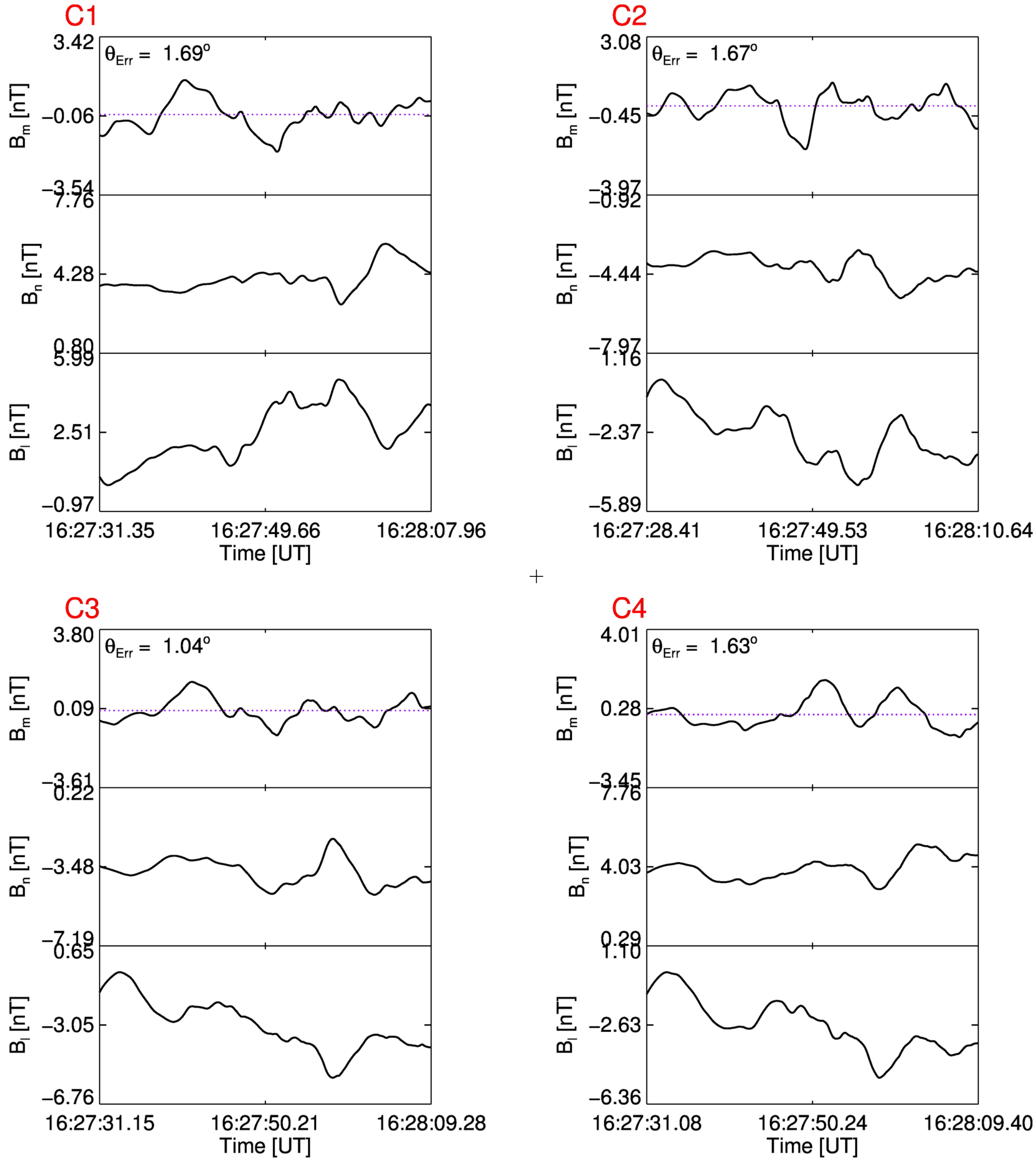
$$\theta_{Err} = \sqrt{\frac{\lambda_3}{M-1}\frac{\lambda_2}{\lambda_2 - \lambda_3}}. \quad (1)$$

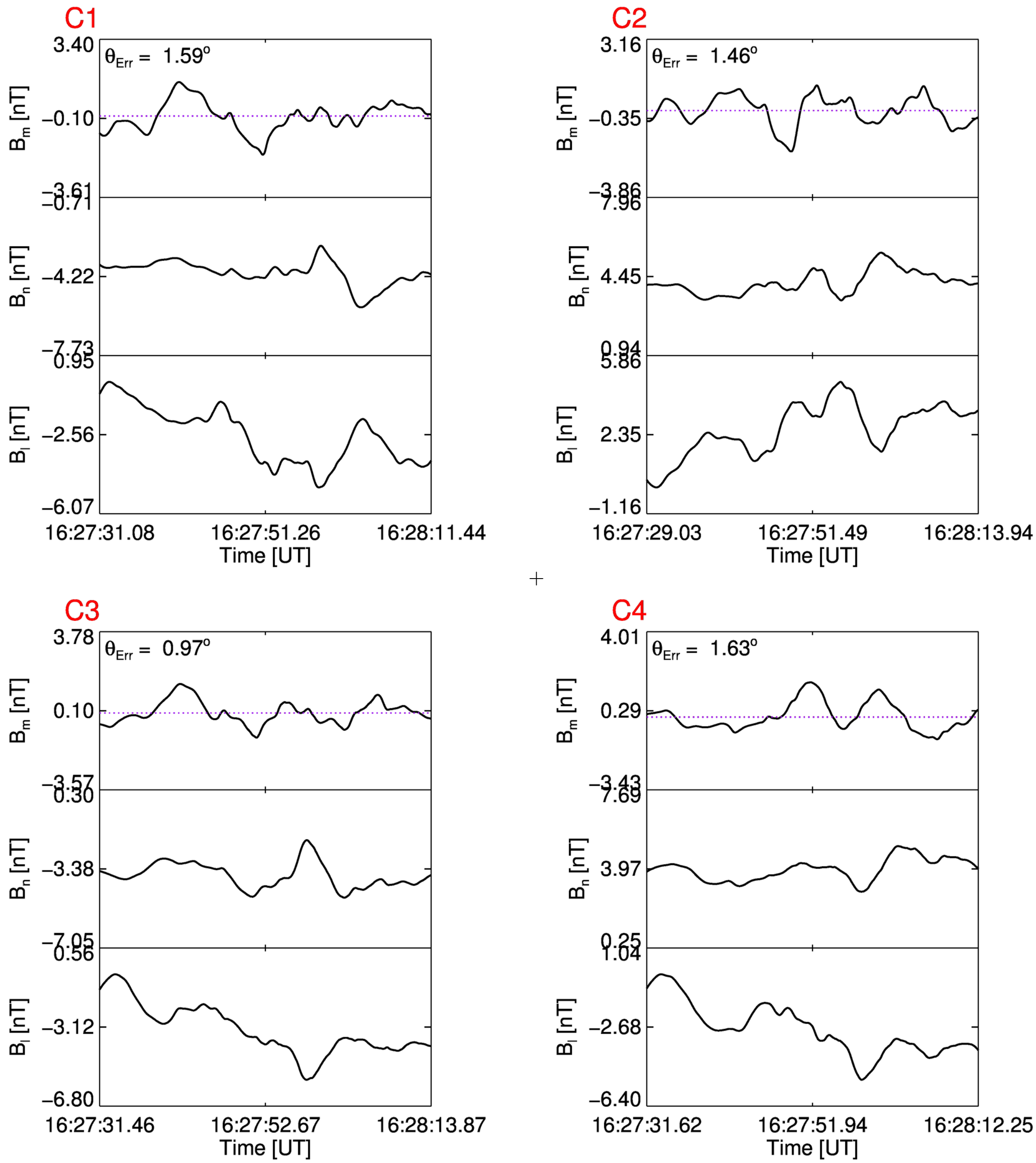
Here λ_2, λ_3 and M are the intermediate and minimum eigenvalues and the number of measurement points, respectively. In the figures below we show this error for each case.

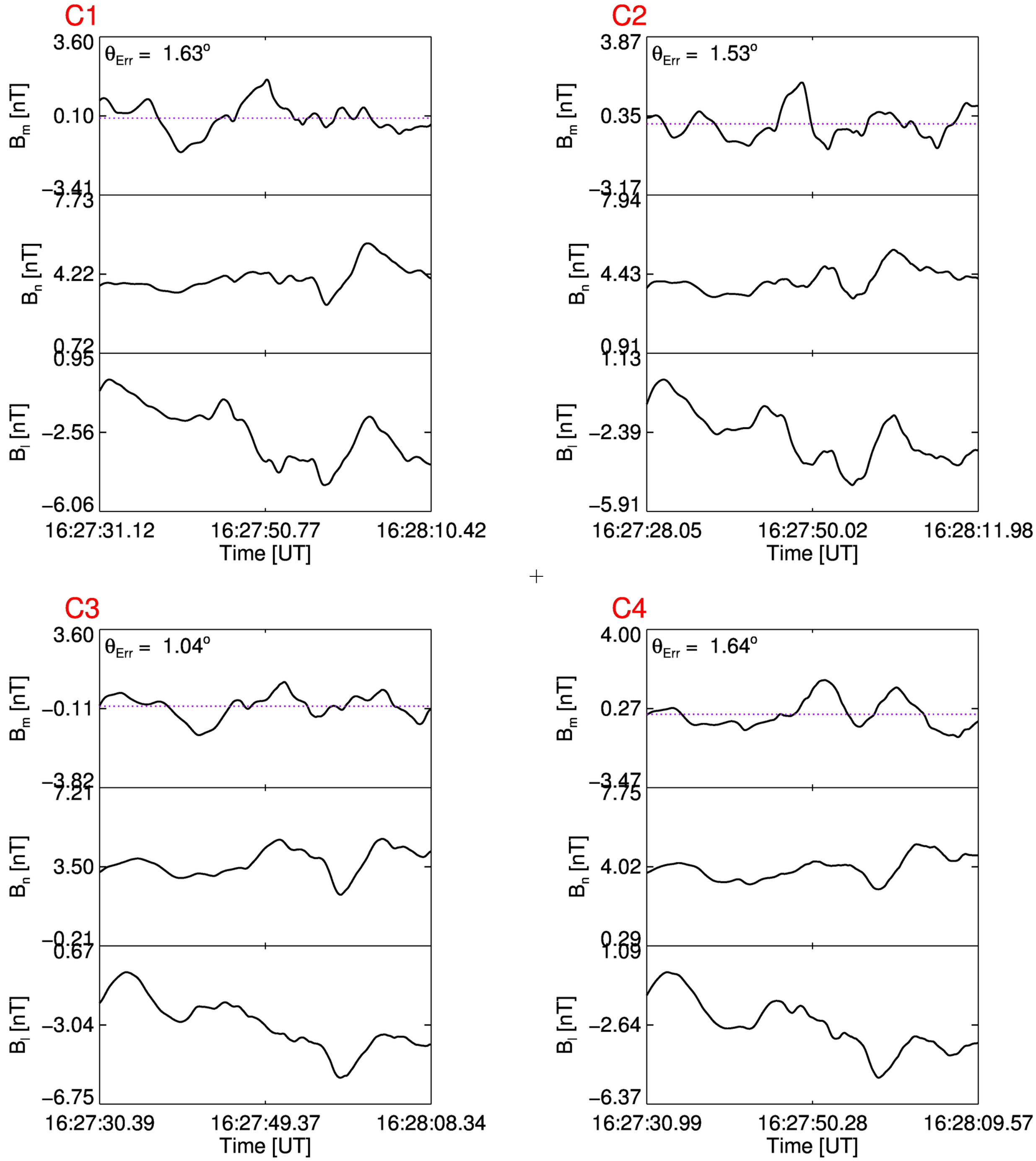
The second source of errors comes from determining time intervals which are used for the MVA. These intervals need to include the shock transition but also some upstream and downstream regions. One needs to select the intervals carefully so not to include large B-field rotations that are not associated with shocks and could affect the the determination of the direction of maximum variance. We select the time intervals by hand. We repeat the process for each shock and spacecraft ten times. We then proceed to calculate angles between pairs of normals from different spacecraft (θ_{NN}) and calculate the the average angles and the error of the mean. We then sum this error with θ_{Err} in order to estimate the total error of our method. The latter is shown in Table 1 and in Figure 2 in form of error bars.

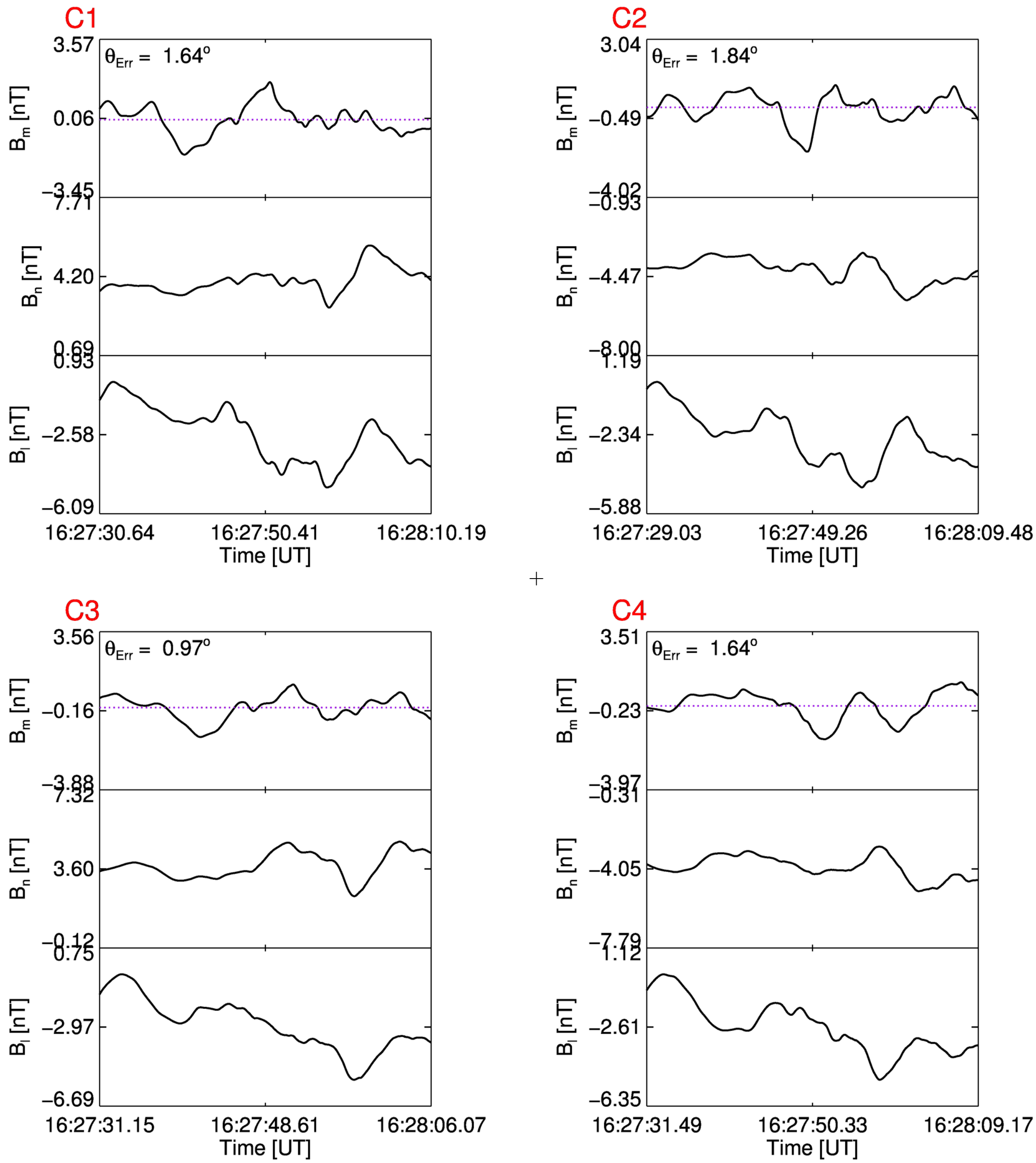
4. PLOTS

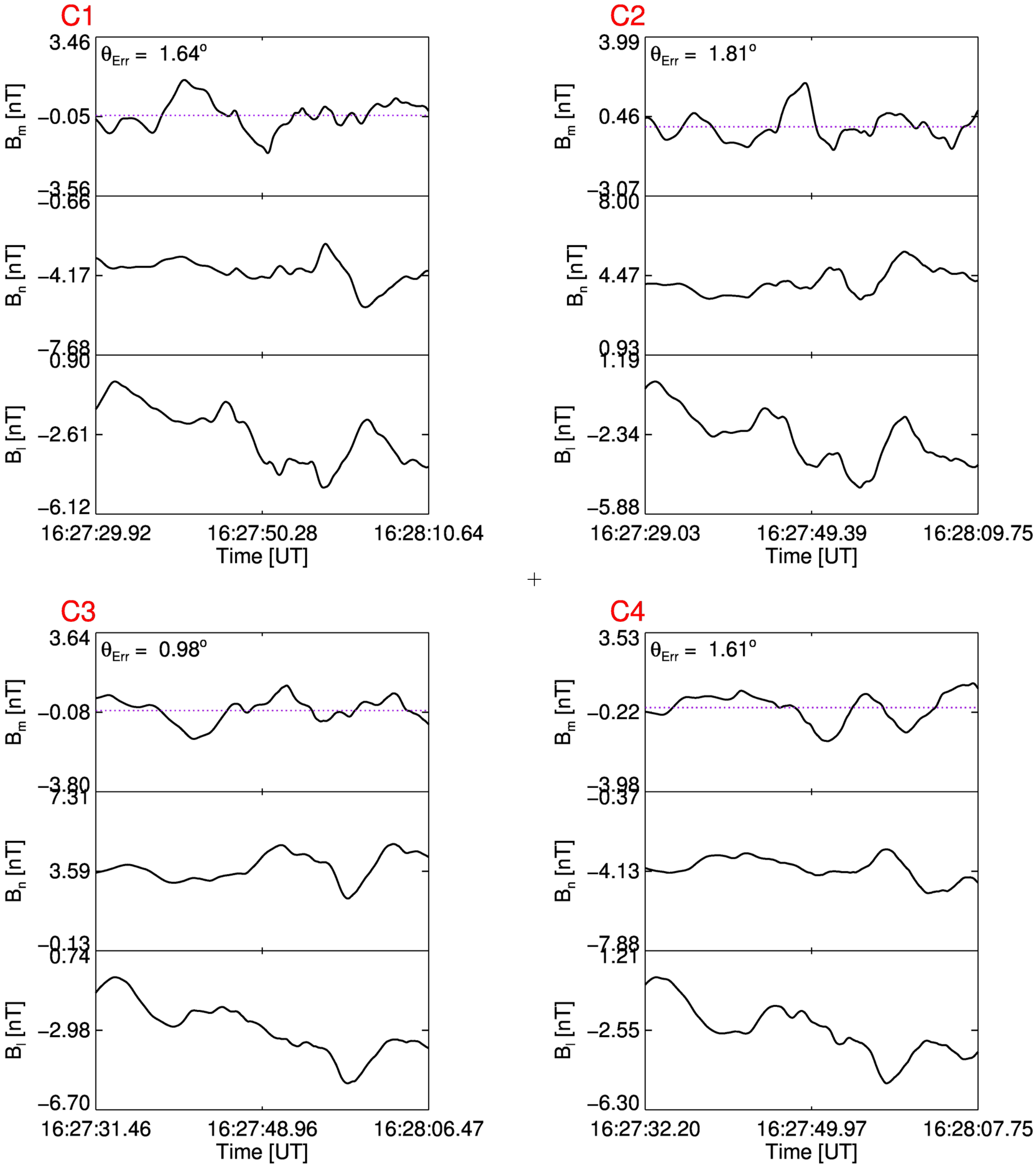
4.1. **17 January 2001**

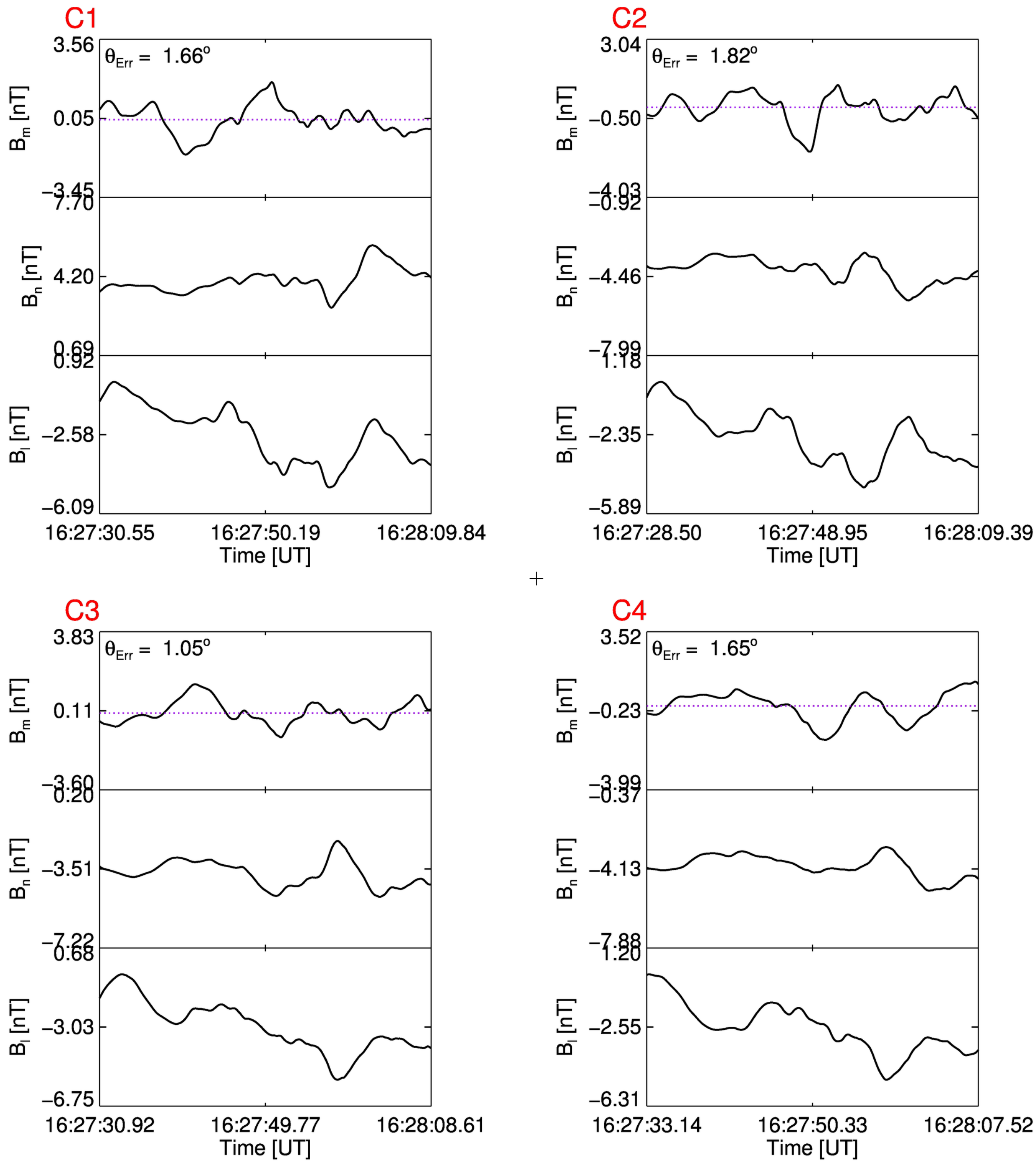

C1
θErr = 1.69°
3.42
−0.06
−3.54
7.76
4.28
0.80
5.99
2.51
−0.97
Bm [nT]
Bn [nT]
Bl [nT]
16:27:31.35
16:27:49.66
16:28:07.96
Time [UT]
C2
θErr = 1.67°
3.08
−0.45
−3.97
−0.92
−4.44
−7.97
1.16
−2.37
−5.89
Bm [nT]
Bn [nT]
Bl [nT]
16:27:28.41
16:27:49.53
16:28:10.64
Time [UT]
C3
θErr = 1.04°
3.80
0.09
−3.61
0.22
−3.48
−7.19
0.65
−3.05
−6.76
Bm [nT]
Bn [nT]
Bl [nT]
16:27:31.15
16:27:50.21
16:28:09.28
Time [UT]
C4
θErr = 1.63°
4.01
0.28
−3.45
7.76
4.03
0.29
1.10
−2.63
−6.36
Bm [nT]
Bn [nT]
Bl [nT]
16:27:31.08
16:27:50.24
16:28:09.40
Time [UT]

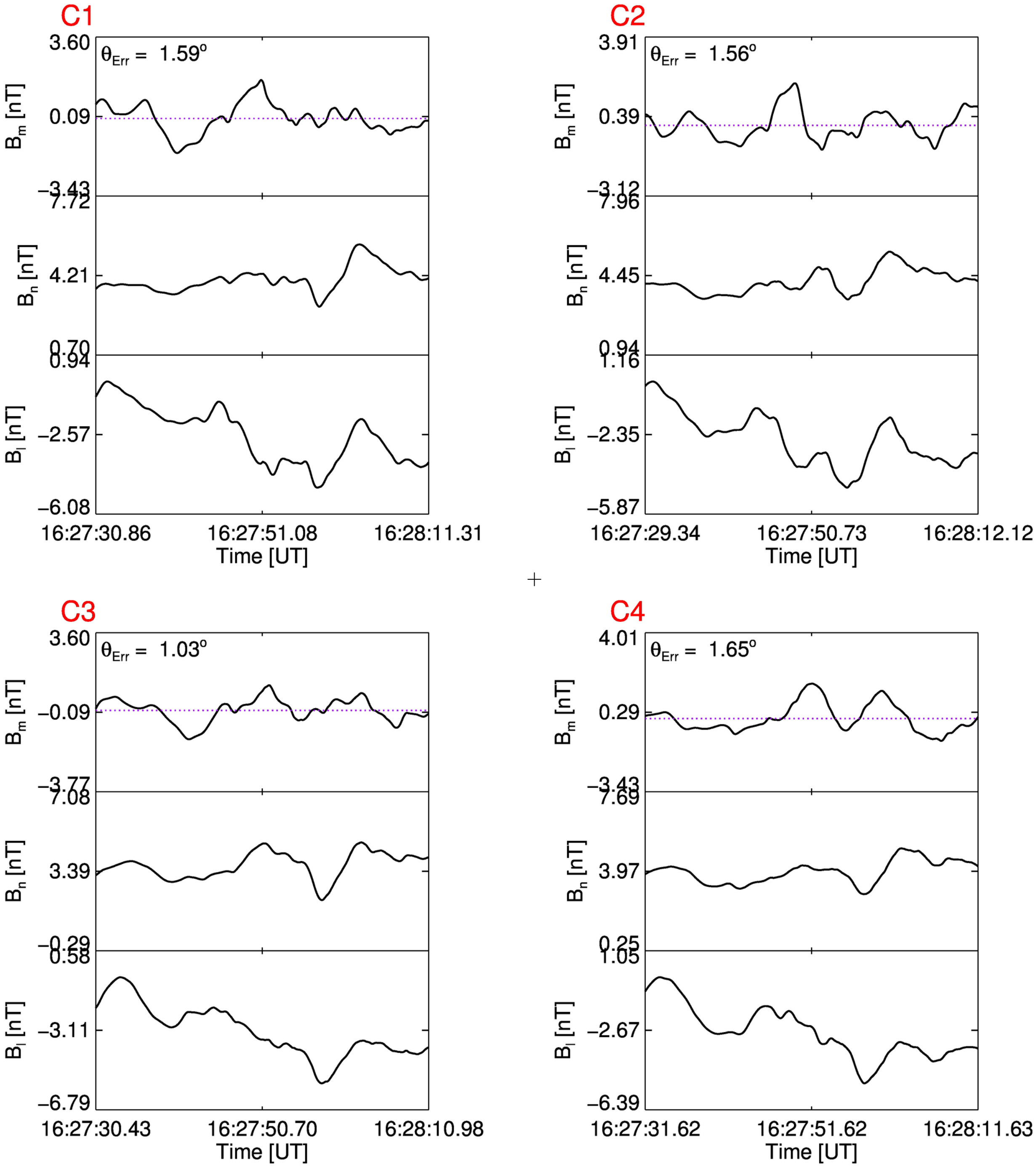

C1
θ_{Err} = 1.59°
3.40
−0.10
−3.61
B_m [nT]
−0.71
−4.22
−7.73
B_n [nT]
0.95
−2.56
−6.07
B_l [nT]
16:27:31.08
16:27:51.26
16:28:11.44
Time [UT]
C2
θ_{Err} = 1.46°
3.16
−0.35
−3.86
B_m [nT]
7.96
4.45
0.94
B_n [nT]
5.86
2.35
−1.16
B_l [nT]
16:27:29.03
16:27:51.49
16:28:13.94
Time [UT]
C3
θ_{Err} = 0.97°
3.78
0.10
−3.57
B_m [nT]
0.30
−3.38
−7.05
B_n [nT]
0.56
−3.12
−6.80
B_l [nT]
16:27:31.46
16:27:52.67
16:28:13.87
Time [UT]
C4
θ_{Err} = 1.63°
4.01
0.29
−3.43
B_m [nT]
7.69
3.97
0.25
B_n [nT]
1.04
−2.68
−6.40
B_l [nT]
16:27:31.62
16:27:51.94
16:28:12.25
Time [UT]

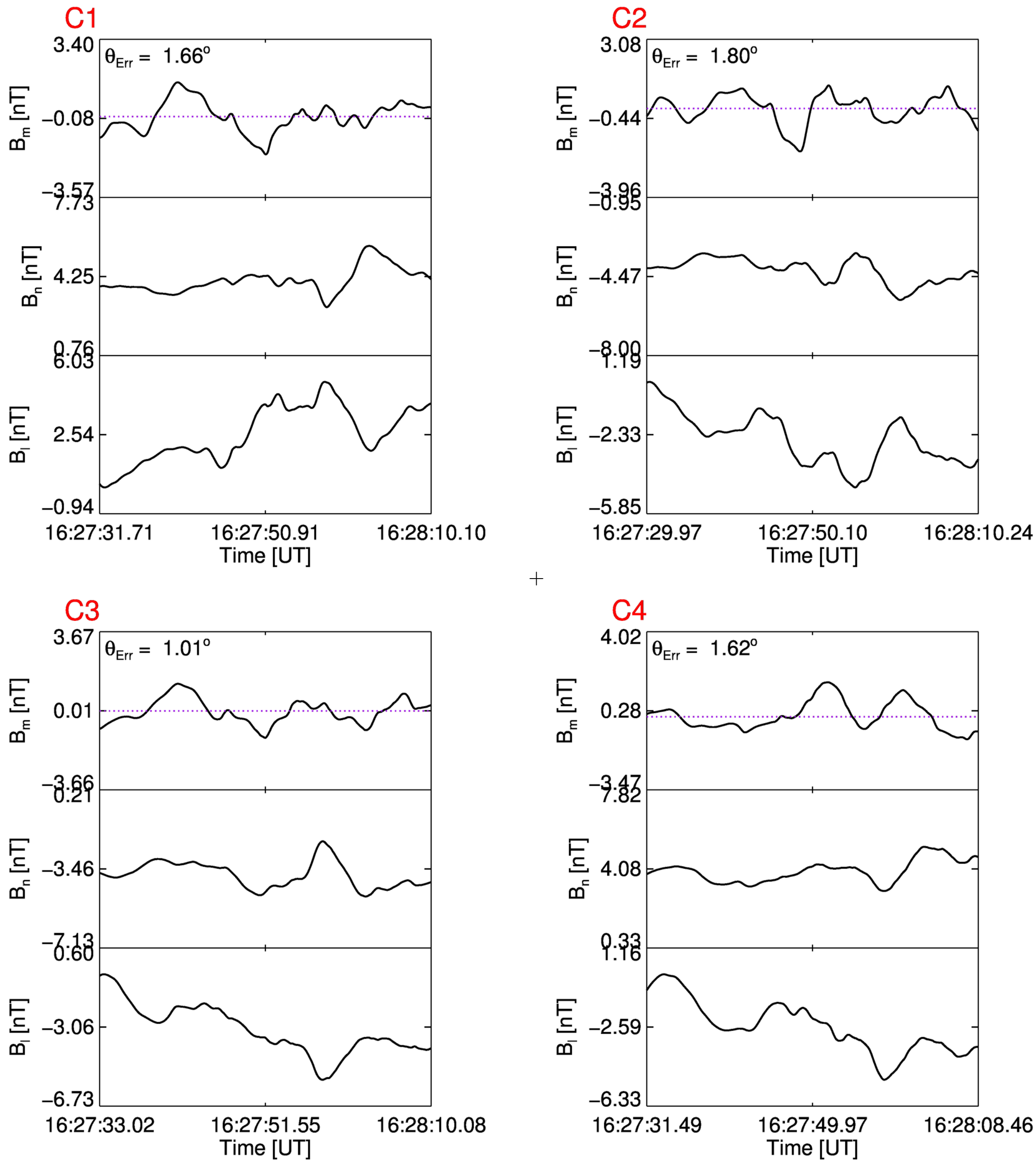

C1
θ_{Err} = 1.63°
3.60
0.10
−3.41
B_m [nT]
7.73
4.22
0.72
B_n [nT]
0.95
−2.56
−6.06
B_l [nT]
16:27:31.12
16:27:50.77
16:28:10.42
Time [UT]
C2
θ_{Err} = 1.53°
3.87
0.35
−3.17
B_m [nT]
7.94
4.43
0.91
B_n [nT]
1.13
−2.39
−5.91
B_l [nT]
16:27:28.05
16:27:50.02
16:28:11.98
Time [UT]
C3
θ_{Err} = 1.04°
3.60
−0.11
−3.82
B_m [nT]
7.21
3.50
−0.21
B_n [nT]
0.67
−3.04
−6.75
B_l [nT]
16:27:30.39
16:27:49.37
16:28:08.34
Time [UT]
C4
θ_{Err} = 1.64°
4.00
0.27
−3.47
B_m [nT]
7.75
4.02
0.29
B_n [nT]
1.09
−2.64
−6.37
B_l [nT]
16:27:30.99
16:27:50.28
16:28:09.57
Time [UT]

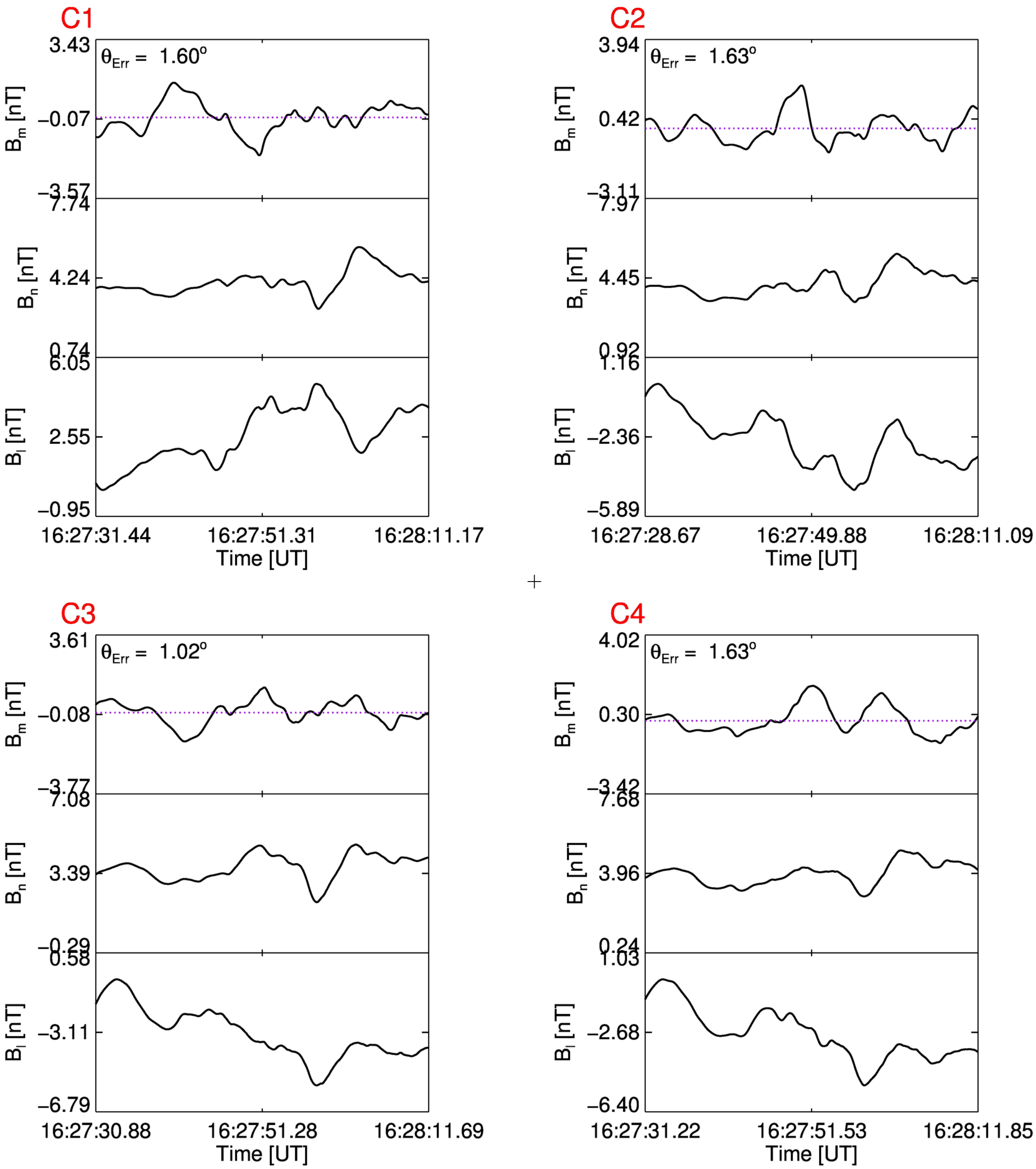

C1
θ_{Err} = 1.64°
B_m [nT]
3.57
0.06
−3.45
B_n [nT]
7.71
4.20
0.69
B_l [nT]
0.93
−2.58
−6.09
16:27:30.64
16:27:50.41
16:28:10.19
Time [UT]
C2
θ_{Err} = 1.84°
B_m [nT]
3.04
−0.49
−4.02
B_n [nT]
−0.93
−4.47
−8.00
B_l [nT]
1.19
−2.34
−5.88
16:27:29.03
16:27:49.26
16:28:09.48
Time [UT]
C3
θ_{Err} = 0.97°
B_m [nT]
3.56
−0.16
−3.88
B_n [nT]
7.32
3.60
−0.12
B_l [nT]
0.75
−2.97
−6.69
16:27:31.15
16:27:48.61
16:28:06.07
Time [UT]
C4
θ_{Err} = 1.64°
B_m [nT]
3.51
−0.23
−3.97
B_n [nT]
−0.31
−4.05
−7.79
B_l [nT]
1.12
−2.61
−6.35
16:27:31.49
16:27:50.33
16:28:09.17
Time [UT]

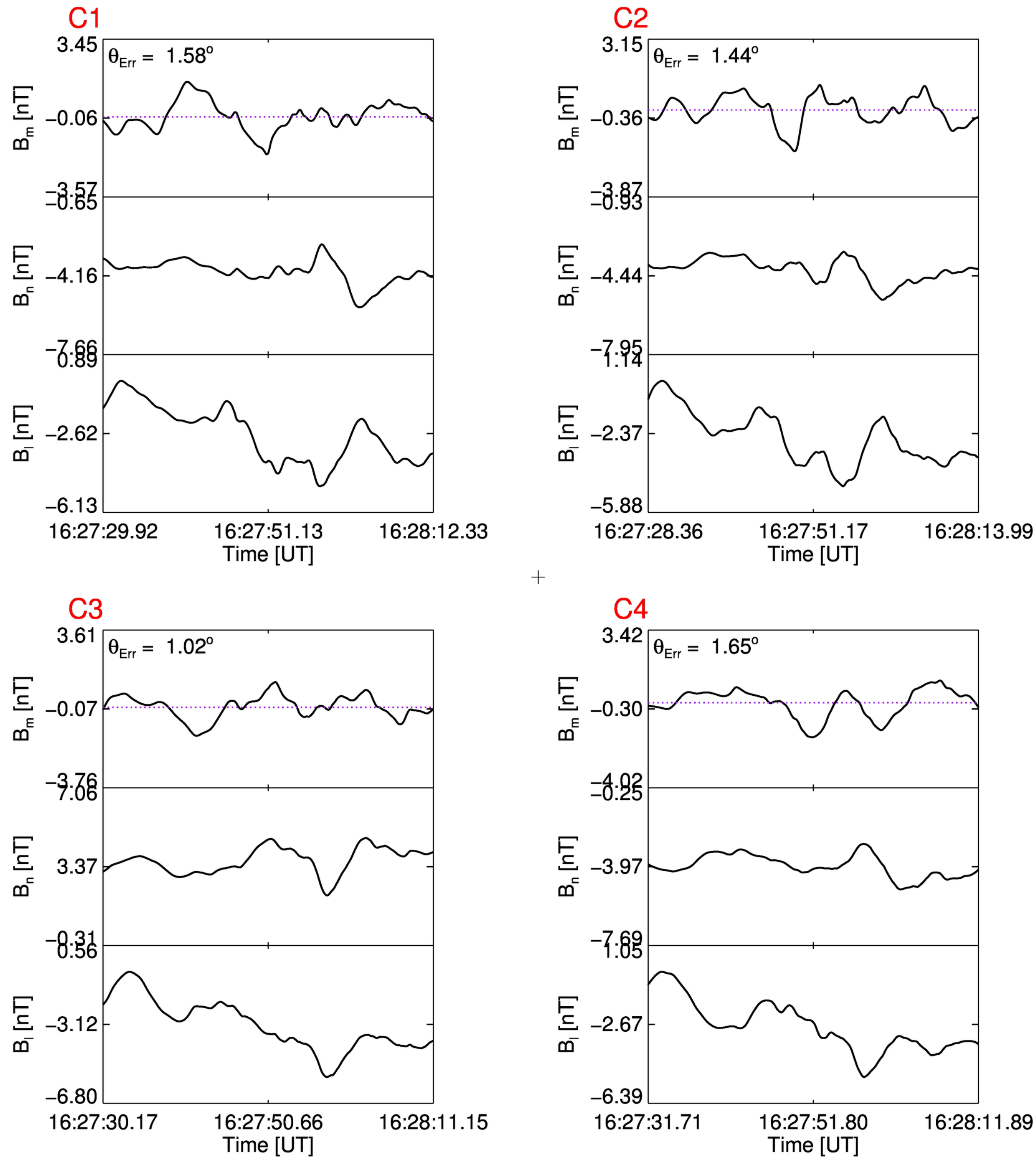

C1
θErr = 1.64°
3.46
−0.05
−3.56
−0.66
−4.17
−7.68
0.90
−2.61
−6.12
Bm [nT]
Bn [nT]
Bl [nT]
16:27:29.92
16:27:50.28
16:28:10.64
Time [UT]
C2
θErr = 1.81°
3.99
0.46
−3.07
8.00
4.47
0.93
1.19
−2.34
−5.88
Bm [nT]
Bn [nT]
Bl [nT]
16:27:29.03
16:27:49.39
16:28:09.75
Time [UT]
C3
θErr = 0.98°
3.64
−0.08
−3.80
7.31
3.59
−0.13
0.74
−2.98
−6.70
Bm [nT]
Bn [nT]
Bl [nT]
16:27:31.46
16:27:48.96
16:28:06.47
Time [UT]
C4
θErr = 1.61°
3.53
−0.22
−3.98
−0.37
−4.13
−7.88
1.21
−2.55
−6.30
Bm [nT]
Bn [nT]
Bl [nT]
16:27:32.20
16:27:49.97
16:28:07.75
Time [UT]


C1
θ_Err = 1.66°
3.56
0.05
−3.45
7.70
4.20
0.69
0.92
−2.58
−6.09
B_m [nT]
B_n [nT]
B_l [nT]
16:27:30.55
16:27:50.19
16:28:09.84
Time [UT]
C2
θ_Err = 1.82°
3.04
−0.50
−4.03
−0.92
−4.46
−7.99
1.18
−2.35
−5.89
B_m [nT]
B_n [nT]
B_l [nT]
16:27:28.50
16:27:48.95
16:28:09.39
Time [UT]
C3
θ_Err = 1.05°
3.83
0.11
−3.60
0.20
−3.51
−7.22
0.68
−3.03
−6.75
B_m [nT]
B_n [nT]
B_l [nT]
16:27:30.92
16:27:49.77
16:28:08.61
Time [UT]
C4
θ_Err = 1.65°
3.52
−0.23
−3.99
−0.37
−4.13
−7.88
1.20
−2.55
−6.31
B_m [nT]
B_n [nT]
B_l [nT]
16:27:33.14
16:27:50.33
16:28:07.52
Time [UT]

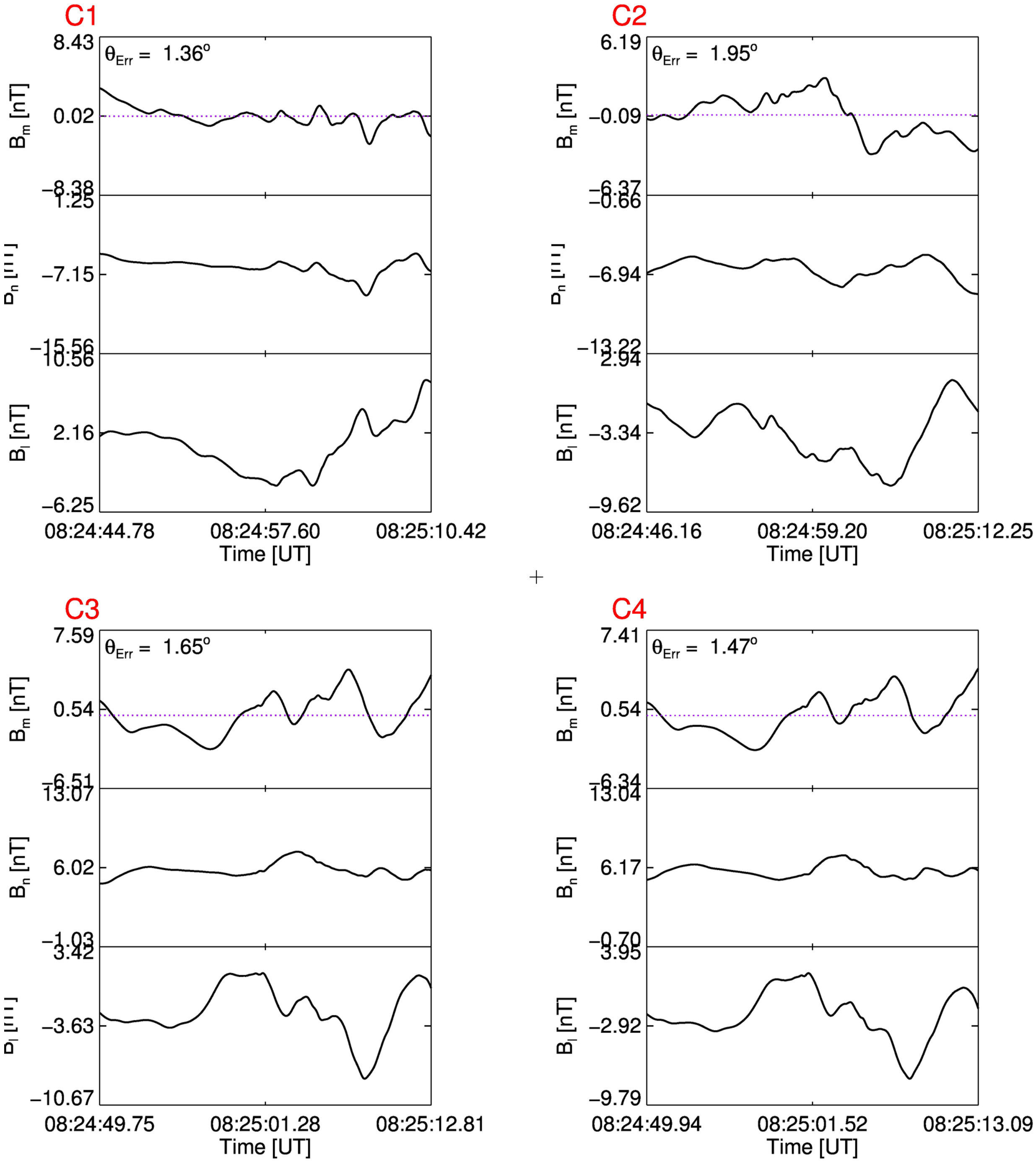

C1
θErr = 1.59°
3.60
0.09
−3.43
7.72
4.21
0.70
0.94
−2.57
−6.08
Bm [nT]
Bn [nT]
Bl [nT]
16:27:30.86
16:27:51.08
16:28:11.31
Time [UT]
C2
θErr = 1.56°
3.91
0.39
−3.12
7.96
4.45
0.94
1.16
−2.35
−5.87
16:27:29.34
16:27:50.73
16:28:12.12
C3
θErr = 1.03°
3.60
−0.09
−3.77
7.08
3.39
−0.29
0.58
−3.11
−6.79
16:27:30.43
16:27:50.70
16:28:10.98
C4
θErr = 1.65°
4.01
0.29
−3.43
7.69
3.97
0.25
1.05
−2.67
−6.39
16:27:31.62
16:27:51.62
16:28:11.63

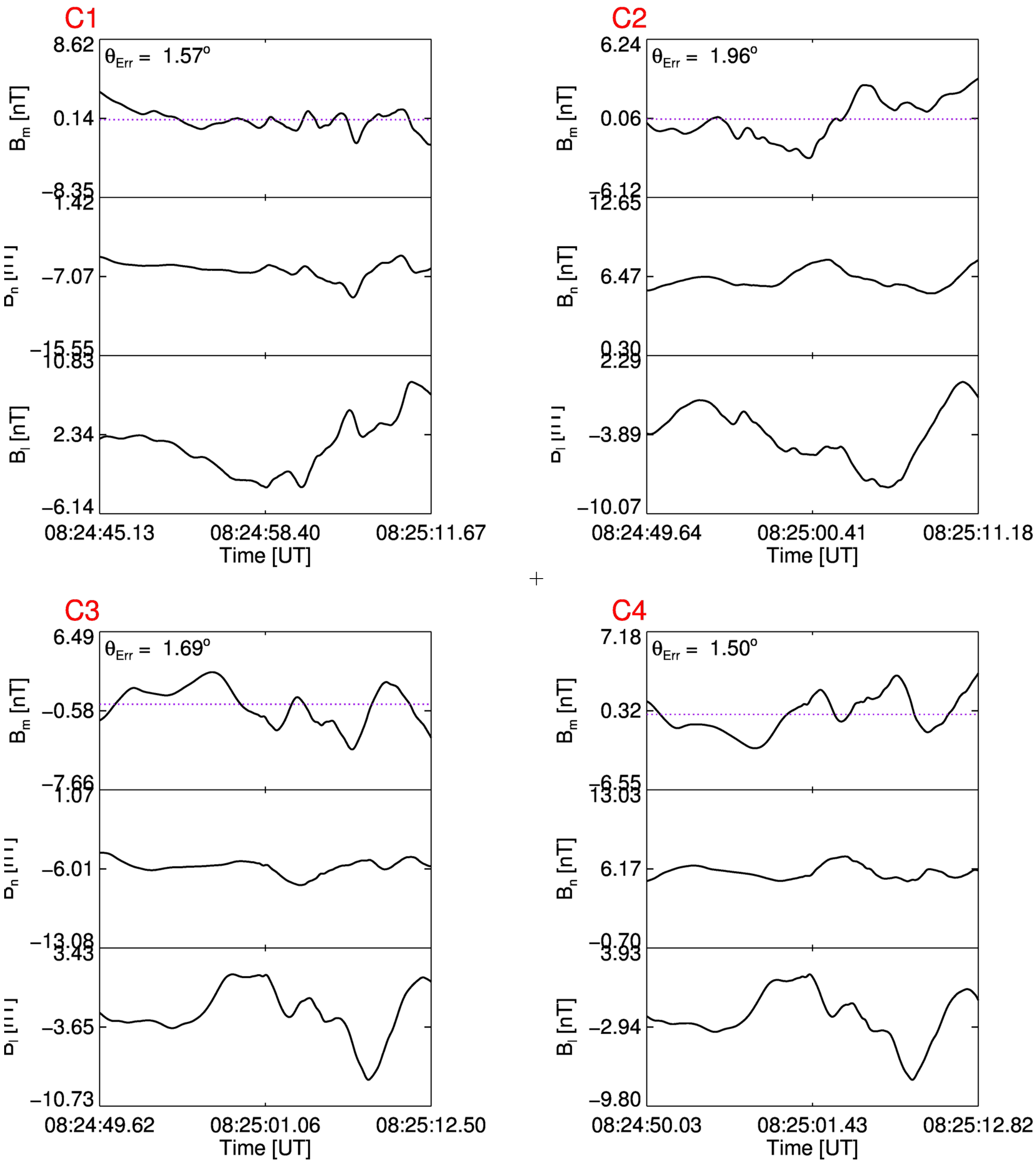

C1
θErr = 1.66°
3.40
−0.08
−3.57
7.73
4.25
0.76
6.03
2.54
−0.94
Bm [nT]
Bn [nT]
Bl [nT]
16:27:31.71
16:27:50.91
16:28:10.10
Time [UT]
C2
θErr = 1.80°
3.08
−0.44
−3.96
−0.95
−4.47
−8.00
1.19
−2.33
−5.85
Bm [nT]
Bn [nT]
Bl [nT]
16:27:29.97
16:27:50.10
16:28:10.24
Time [UT]
C3
θErr = 1.01°
3.67
0.01
−3.66
0.21
−3.46
−7.13
0.60
−3.06
−6.73
Bm [nT]
Bn [nT]
Bl [nT]
16:27:33.02
16:27:51.55
16:28:10.08
Time [UT]
C4
θErr = 1.62°
4.02
0.28
−3.47
7.82
4.08
0.33
1.16
−2.59
−6.33
Bm [nT]
Bn [nT]
Bl [nT]
16:27:31.49
16:27:49.97
16:28:08.46
Time [UT]

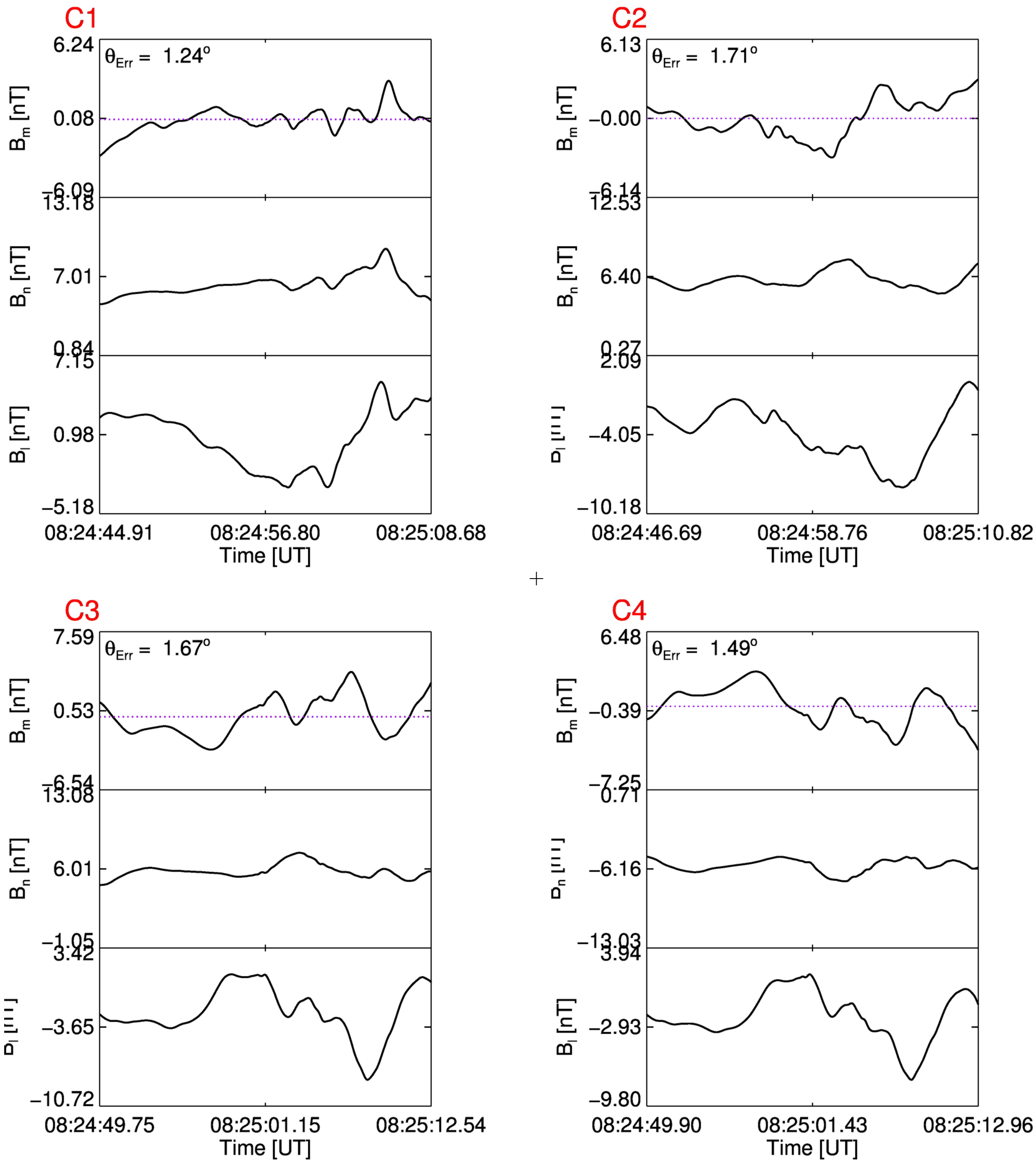

C1
θErr = 1.60°
3.43
−0.07
−3.57
7.74
4.24
0.74
6.05
2.55
−0.95
Bm [nT]
Bn [nT]
Bl [nT]
16:27:31.44
16:27:51.31
16:28:11.17
Time [UT]
C2
θErr = 1.63°
3.94
0.42
−3.11
7.97
4.45
0.92
1.16
−2.36
−5.89
Bm [nT]
Bn [nT]
Bl [nT]
16:27:28.67
16:27:49.88
16:28:11.09
Time [UT]
C3
θErr = 1.02°
3.61
−0.08
−3.77
7.08
3.39
−0.29
0.58
−3.11
−6.79
Bm [nT]
Bn [nT]
Bl [nT]
16:27:30.88
16:27:51.28
16:28:11.69
Time [UT]
C4
θErr = 1.63°
4.02
0.30
−3.42
7.68
3.96
0.24
1.03
−2.68
−6.40
Bm [nT]
Bn [nT]
Bl [nT]
16:27:31.22
16:27:51.53
16:28:11.85
Time [UT]

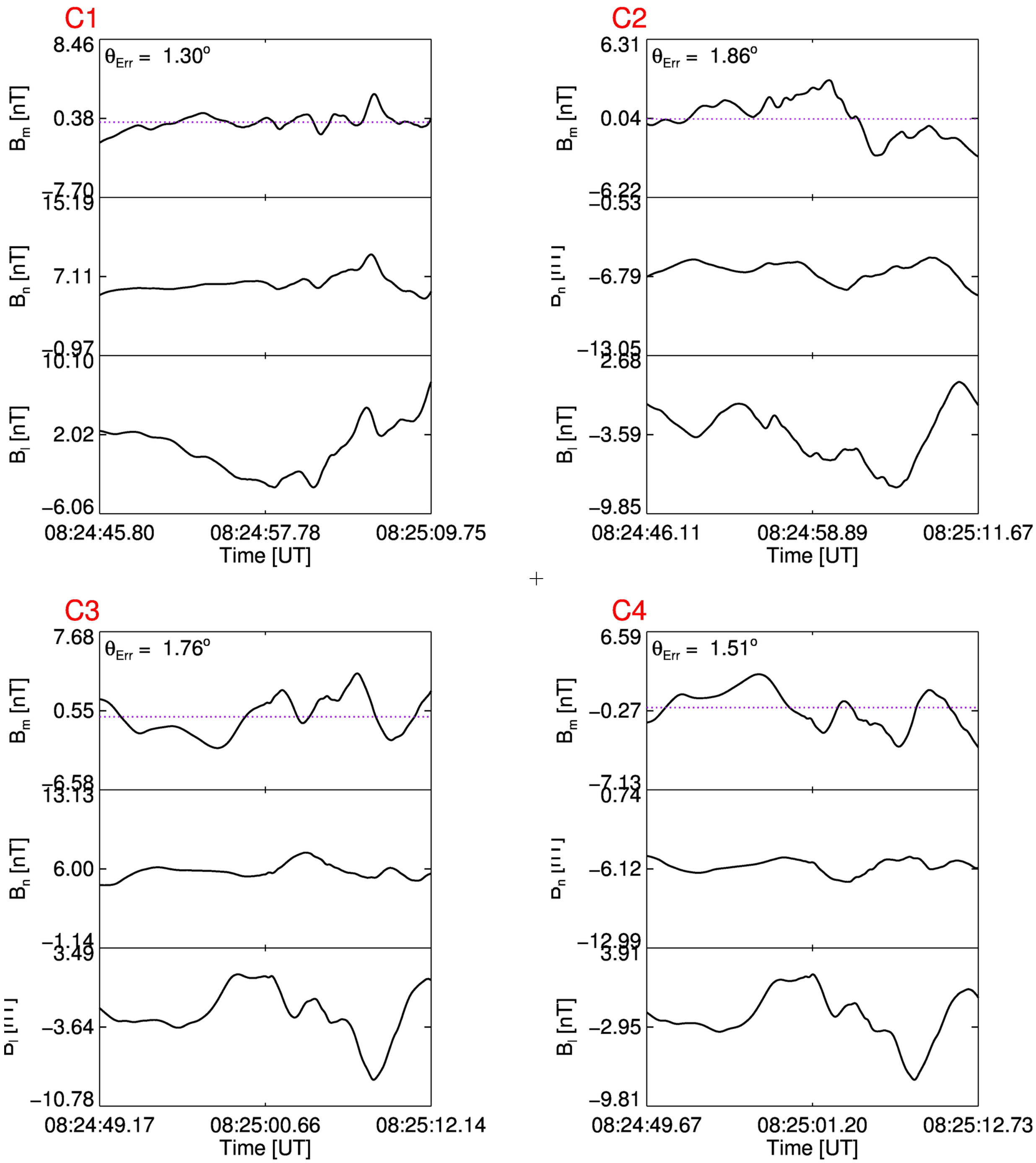

C1
θErr = 1.58°
3.45
−0.06
−3.57
−0.65
−4.16
−7.66
0.89
−2.62
−6.13
Bm [nT]
Bn [nT]
Bl [nT]
16:27:29.92
16:27:51.13
16:28:12.33
Time [UT]
C2
θErr = 1.44°
3.15
−0.36
−3.87
−0.93
−4.44
−7.95
1.14
−2.37
−5.88
Bm [nT]
Bn [nT]
Bl [nT]
16:27:28.36
16:27:51.17
16:28:13.99
Time [UT]
C3
θErr = 1.02°
3.61
−0.07
−3.76
7.06
3.37
−0.31
0.56
−3.12
−6.80
Bm [nT]
Bn [nT]
Bl [nT]
16:27:30.17
16:27:50.66
16:28:11.15
Time [UT]
C4
θErr = 1.65°
3.42
−0.30
−4.02
−0.25
−3.97
−7.69
1.05
−2.67
−6.39
Bm [nT]
Bn [nT]
Bl [nT]
16:27:31.71
16:27:51.80
16:28:11.89
Time [UT]

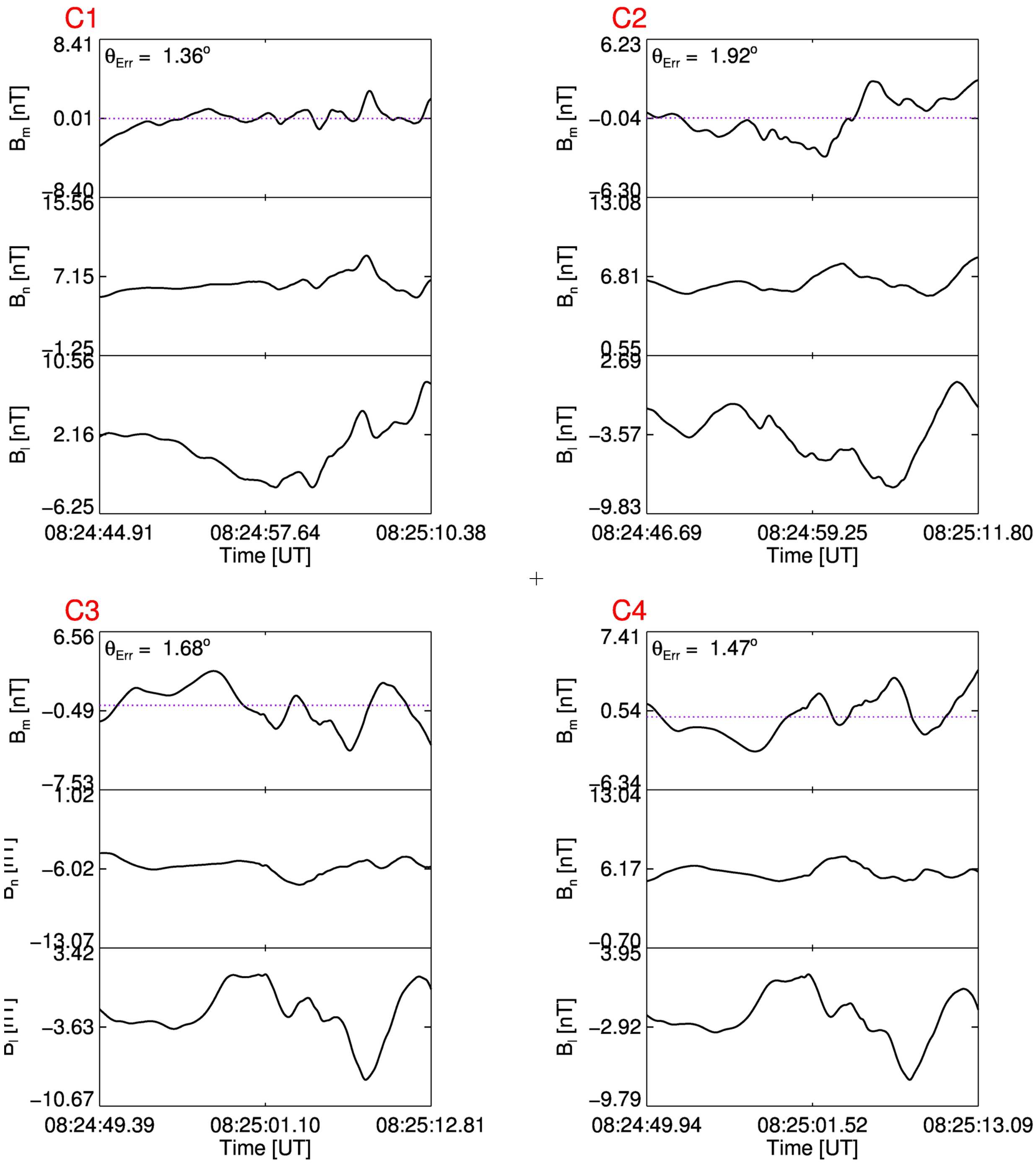
4.2. **5 April 2010**

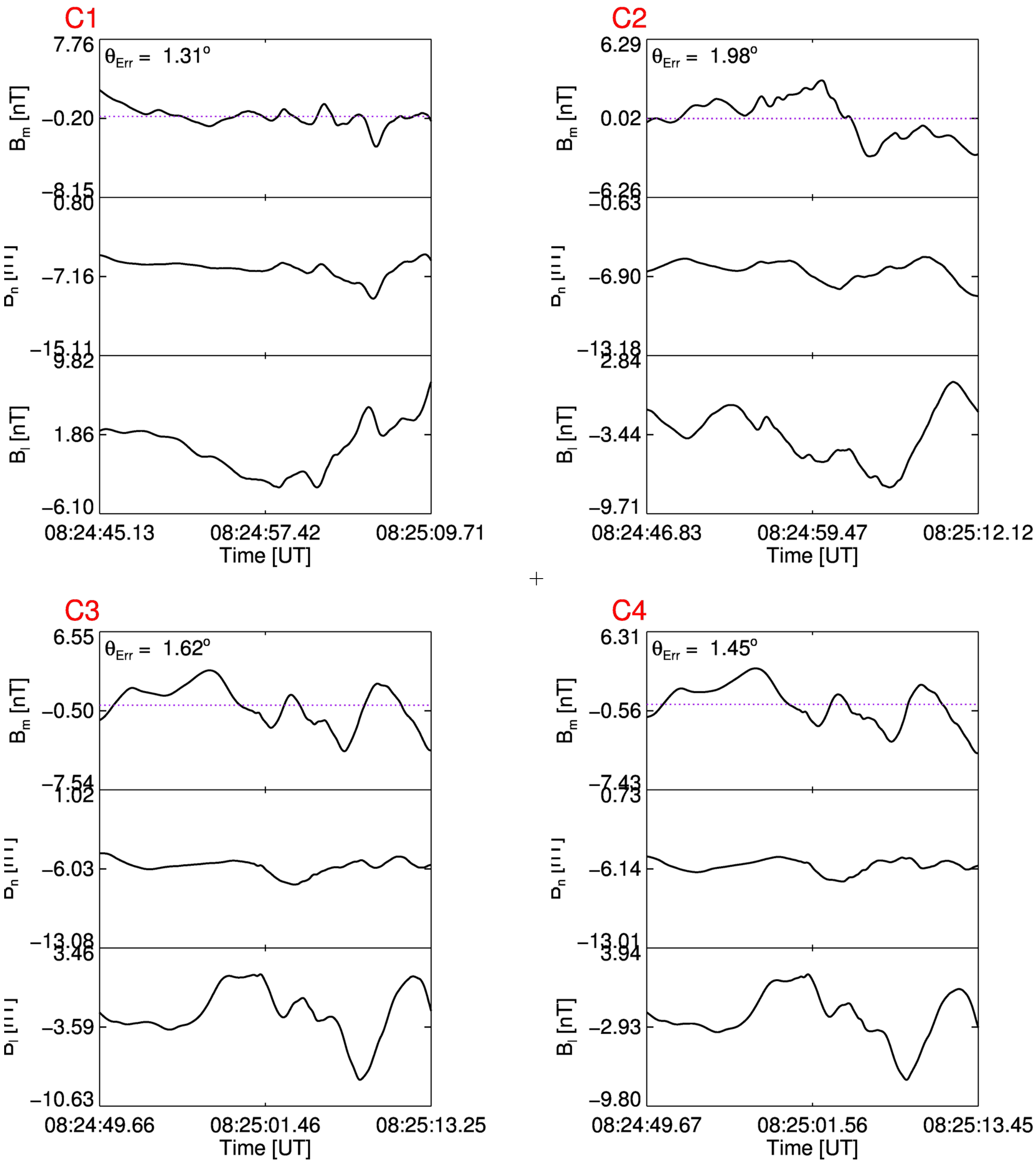


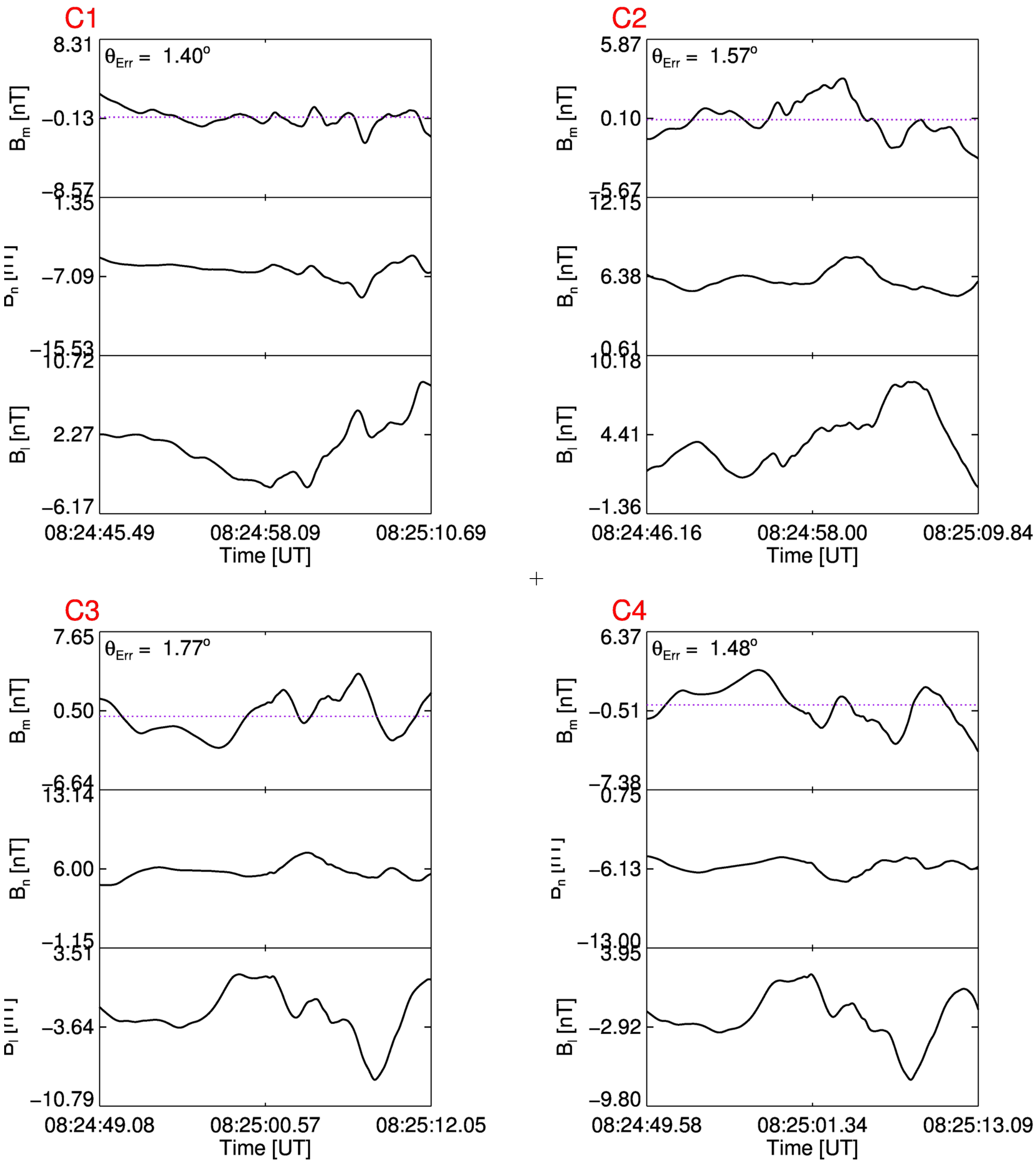

C1
θ_{Err} = 1.57°
8.62
0.14
−8.35
B_m [nT]
1.42
−7.07
−15.55
10.83
2.34
−6.14
B_l [nT]
08:24:45.13
08:24:58.40
08:25:11.67
Time [UT]
C2
θ_{Err} = 1.96°
6.24
0.06
−6.12
B_m [nT]
12.65
6.47
0.30
B_n [nT]
2.29
−3.89
−10.07
08:24:49.64
08:25:00.41
08:25:11.18
Time [UT]
C3
θ_{Err} = 1.69°
6.49
−0.58
−7.66
B_m [nT]
1.07
−6.01
−13.08
3.43
−3.65
−10.73
08:24:49.62
08:25:01.06
08:25:12.50
Time [UT]
C4
θ_{Err} = 1.50°
7.18
0.32
−6.55
B_m [nT]
13.03
6.17
−0.70
B_n [nT]
3.93
−2.94
−9.80
B_l [nT]
08:24:50.03
08:25:01.43
08:25:12.82
Time [UT]

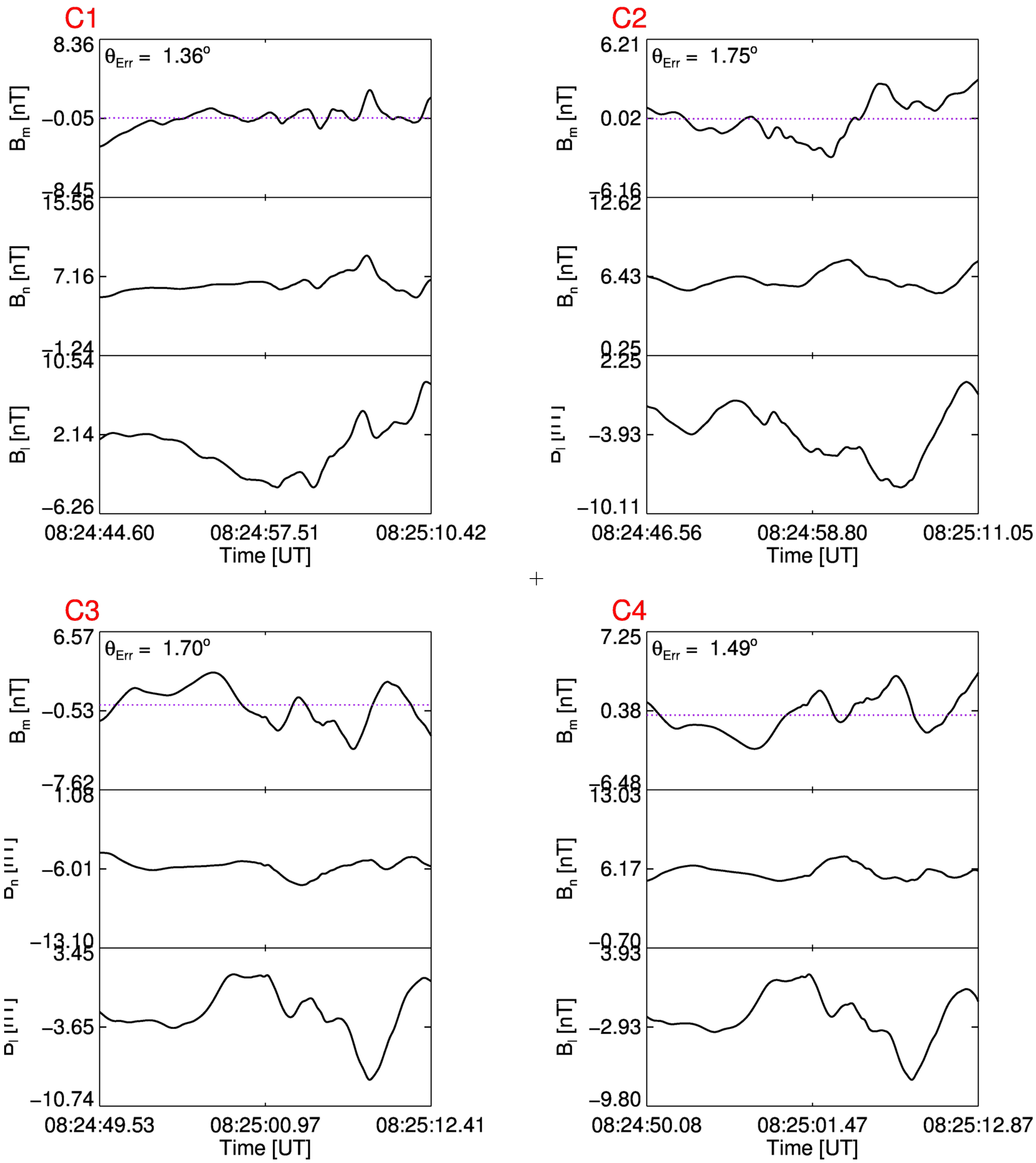

C1
θErr = 1.24°
6.24
0.08
−6.09
13.18
7.01
0.84
7.15
0.98
−5.18
Bm [nT]
Bn [nT]
Bl [nT]
08:24:44.91
08:24:56.80
08:25:08.68
Time [UT]
C2
θErr = 1.71°
6.13
−0.00
−6.14
12.53
6.40
0.27
2.09
−4.05
−10.18
Bm [nT]
Bn [nT]
08:24:46.69
08:24:58.76
08:25:10.82
Time [UT]
C3
θErr = 1.67°
7.59
0.53
−6.54
13.08
6.01
−1.05
3.42
−3.65
−10.72
Bm [nT]
Bn [nT]
08:24:49.75
08:25:01.15
08:25:12.54
Time [UT]
C4
θErr = 1.49°
6.48
−0.39
−7.25
0.71
−6.16
−13.03
3.94
−2.93
−9.80
Bm [nT]
Bl [nT]
08:24:49.90
08:25:01.43
08:25:12.96
Time [UT]

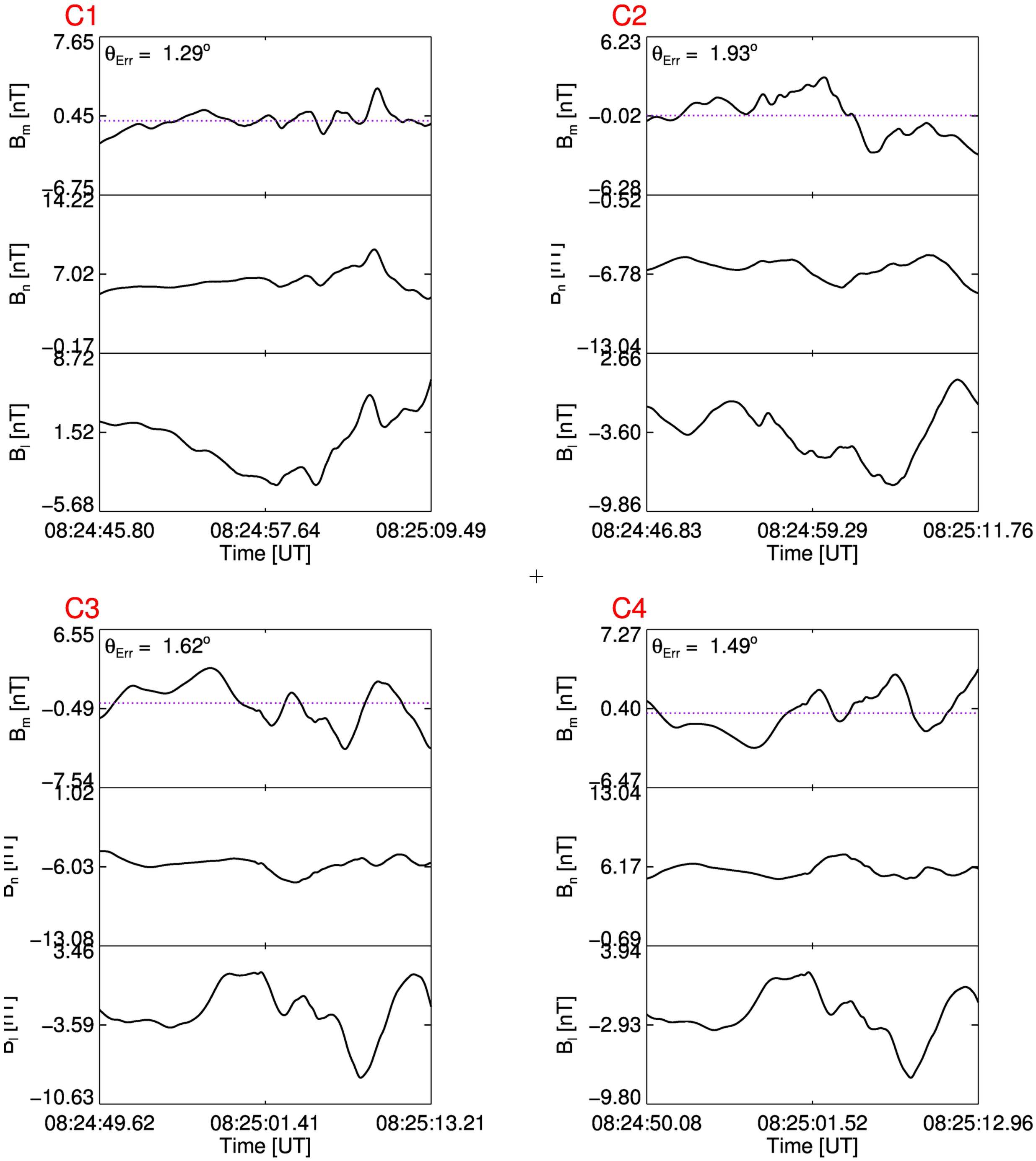

C1
θ_{Err} = 1.30°
8.46
0.38
−7.70
15.19
7.11
−0.97
10.10
2.02
−6.06
B_m [nT]
B_n [nT]
B_l [nT]
08:24:45.80
08:24:57.78
08:25:09.75
Time [UT]
C2
θ_{Err} = 1.86°
6.31
0.04
−6.22
−0.53
−6.79
−13.05
2.68
−3.59
−9.85
08:24:46.11
08:24:58.89
08:25:11.67
Time [UT]
C3
θ_{Err} = 1.76°
7.68
0.55
−6.58
13.13
6.00
−1.14
3.49
−3.64
−10.78
08:24:49.17
08:25:00.66
08:25:12.14
Time [UT]
C4
θ_{Err} = 1.51°
6.59
−0.27
−7.13
0.74
−6.12
−12.99
3.91
−2.95
−9.81
08:24:49.67
08:25:01.20
08:25:12.73
Time [UT]

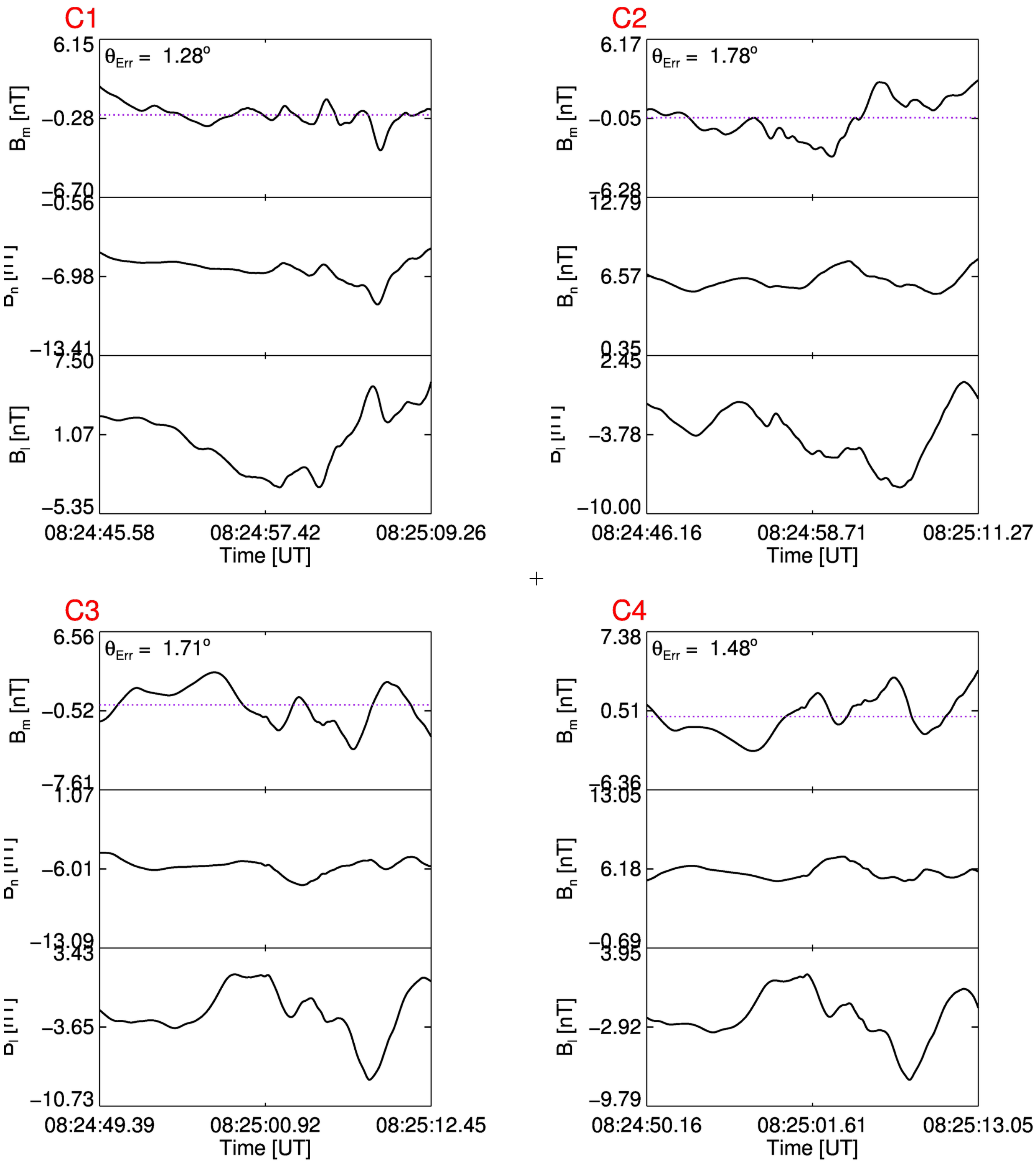

C1
θErr = 1.36°
Bm [nT]
Bn [nT]
Bl [nT]
8.41
0.01
−8.40
15.56
7.15
−1.25
10.56
2.16
−6.25
08:24:44.91
08:24:57.64
08:25:10.38
Time [UT]
C2
θErr = 1.92°
6.23
−0.04
−6.30
13.08
6.81
0.55
2.69
−3.57
−9.83
08:24:46.69
08:24:59.25
08:25:11.80
Time [UT]
C3
θErr = 1.68°
6.56
−0.49
−7.53
1.02
−6.02
−13.07
3.42
−3.63
−10.67
08:24:49.39
08:25:01.10
08:25:12.81
Time [UT]
C4
θErr = 1.47°
7.41
0.54
−6.34
13.04
6.17
−0.70
3.95
−2.92
−9.79
08:24:49.94
08:25:01.52
08:25:13.09
Time [UT]


C1
θErr = 1.31°
7.76
-0.20
-8.15
Bm [nT]
0.80
-7.16
-15.11
9.82
1.86
-6.10
Bl [nT]
08:24:45.13
08:24:57.42
08:25:09.71
Time [UT]
C2
θErr = 1.98°
6.29
0.02
-6.26
Bm [nT]
-0.63
-6.90
-13.18
2.84
-3.44
-9.71
Bl [nT]
08:24:46.83
08:24:59.47
08:25:12.12
Time [UT]
C3
θErr = 1.62°
6.55
-0.50
-7.54
Bm [nT]
1.02
-6.03
-13.08
3.46
-3.59
-10.63
08:24:49.66
08:25:01.46
08:25:13.25
Time [UT]
C4
θErr = 1.45°
6.31
-0.56
-7.43
Bm [nT]
0.73
-6.14
-13.01
3.94
-2.93
-9.80
Bl [nT]
08:24:49.67
08:25:01.56
08:25:13.45
Time [UT]

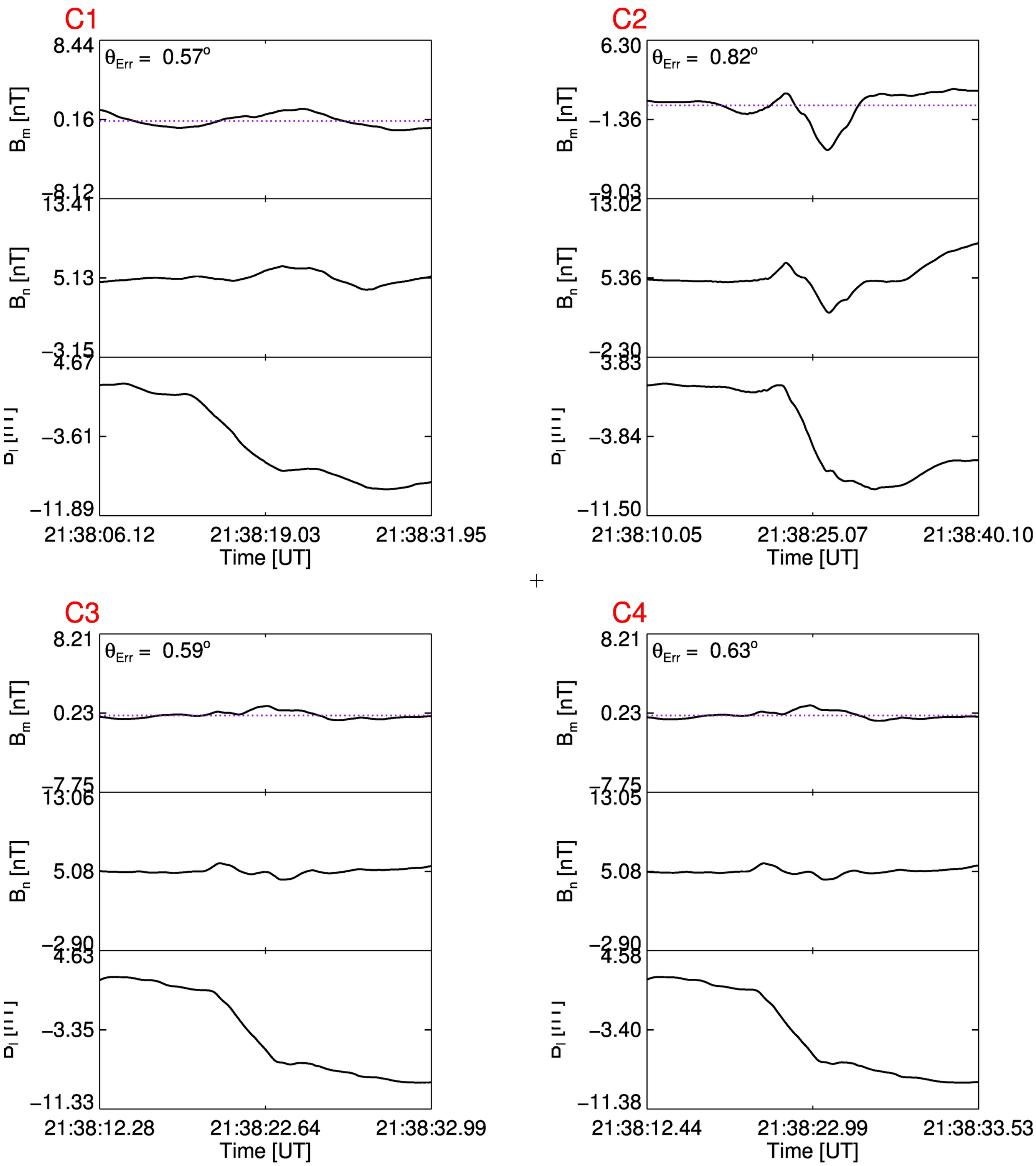

C1
θErr = 1.40°
Bm [nT]
Bn [nT]
Bl [nT]
08:24:45.49
08:24:58.09
08:25:10.69
Time [UT]
C2
θErr = 1.57°
08:24:46.16
08:24:58.00
08:25:09.84
Time [UT]
C3
θErr = 1.77°
08:24:49.08
08:25:00.57
08:25:12.05
Time [UT]
C4
θErr = 1.48°
08:24:49.58
08:25:01.34
08:25:13.09
Time [UT]

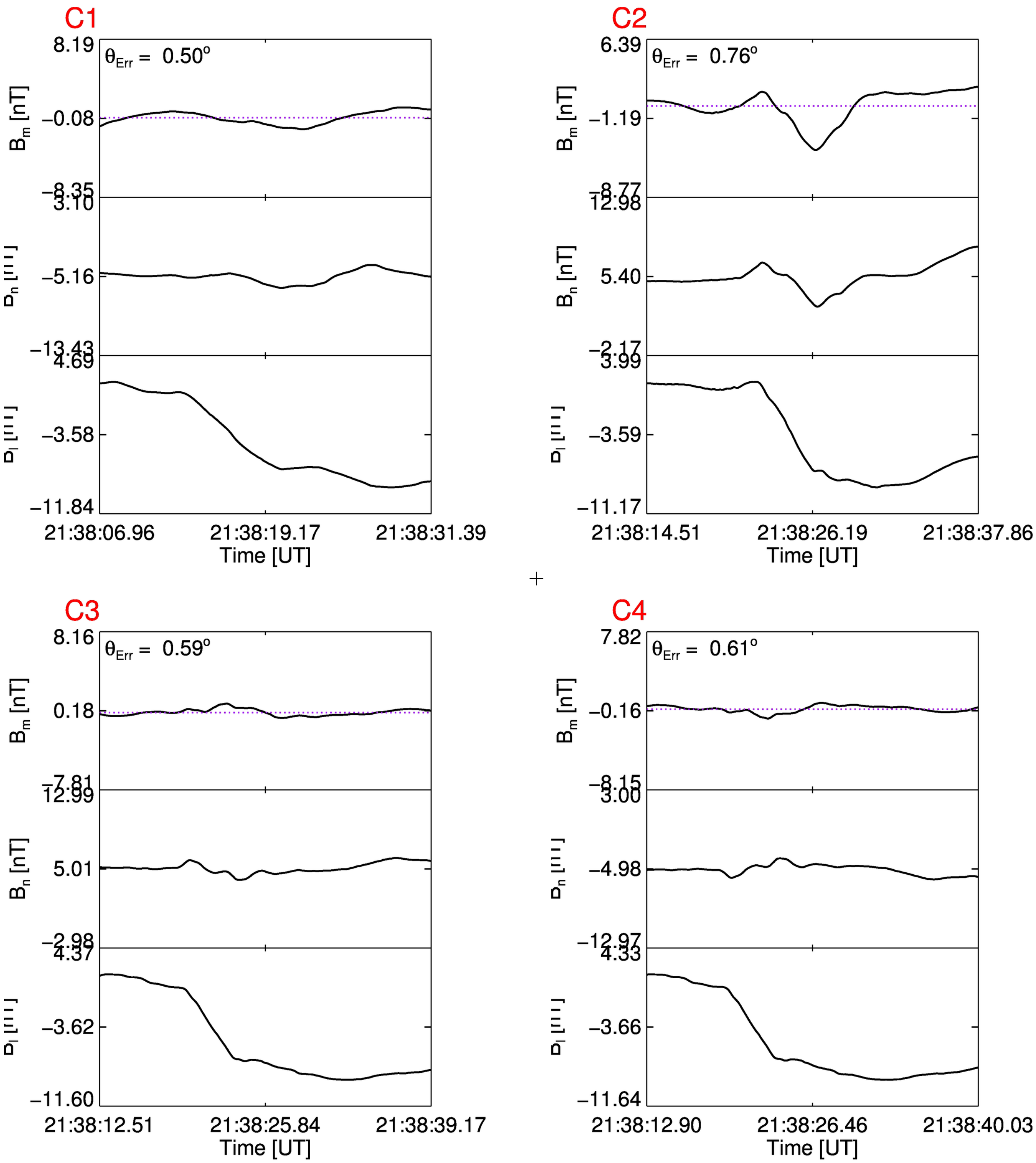

C1
θErr = 1.36°
8.36
−0.05
−8.45
15.56
7.16
−1.24
10.54
2.14
−6.26
Bm [nT]
Bn [nT]
Bl [nT]
08:24:44.60
08:24:57.51
08:25:10.42
Time [UT]
C2
θErr = 1.75°
6.21
0.02
−6.16
12.62
6.43
0.25
2.25
−3.93
−10.11
Bm [nT]
Bn [nT]
08:24:46.56
08:24:58.80
08:25:11.05
Time [UT]
C3
θErr = 1.70°
6.57
−0.53
−7.62
1.08
−6.01
−13.10
3.45
−3.65
−10.74
Bm [nT]
08:24:49.53
08:25:00.97
08:25:12.41
Time [UT]
C4
θErr = 1.49°
7.25
0.38
−6.48
13.03
6.17
−0.70
3.93
−2.93
−9.80
Bm [nT]
Bn [nT]
Bl [nT]
08:24:50.08
08:25:01.47
08:25:12.87
Time [UT]

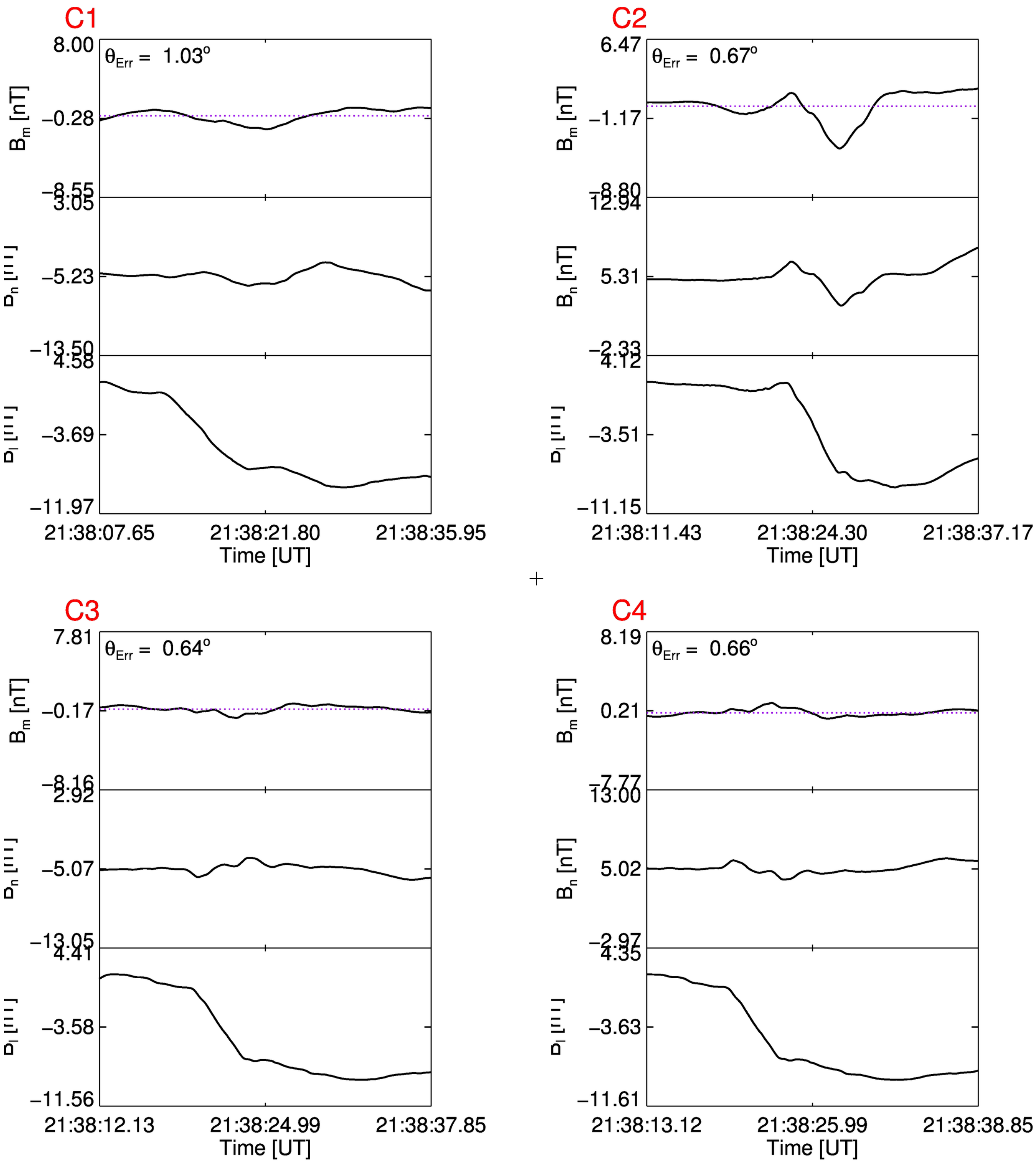

C1
C2
C3
C4
θErr = 1.29°
θErr = 1.93°
θErr = 1.62°
θErr = 1.49°
Bm [nT]
Bn [nT]
Bl [nT]
Time [UT]
08:24:45.80
08:24:57.64
08:25:09.49
08:24:46.83
08:24:59.29
08:25:11.76
08:24:49.62
08:25:01.41
08:25:13.21
08:24:50.08
08:25:01.52
08:25:12.96

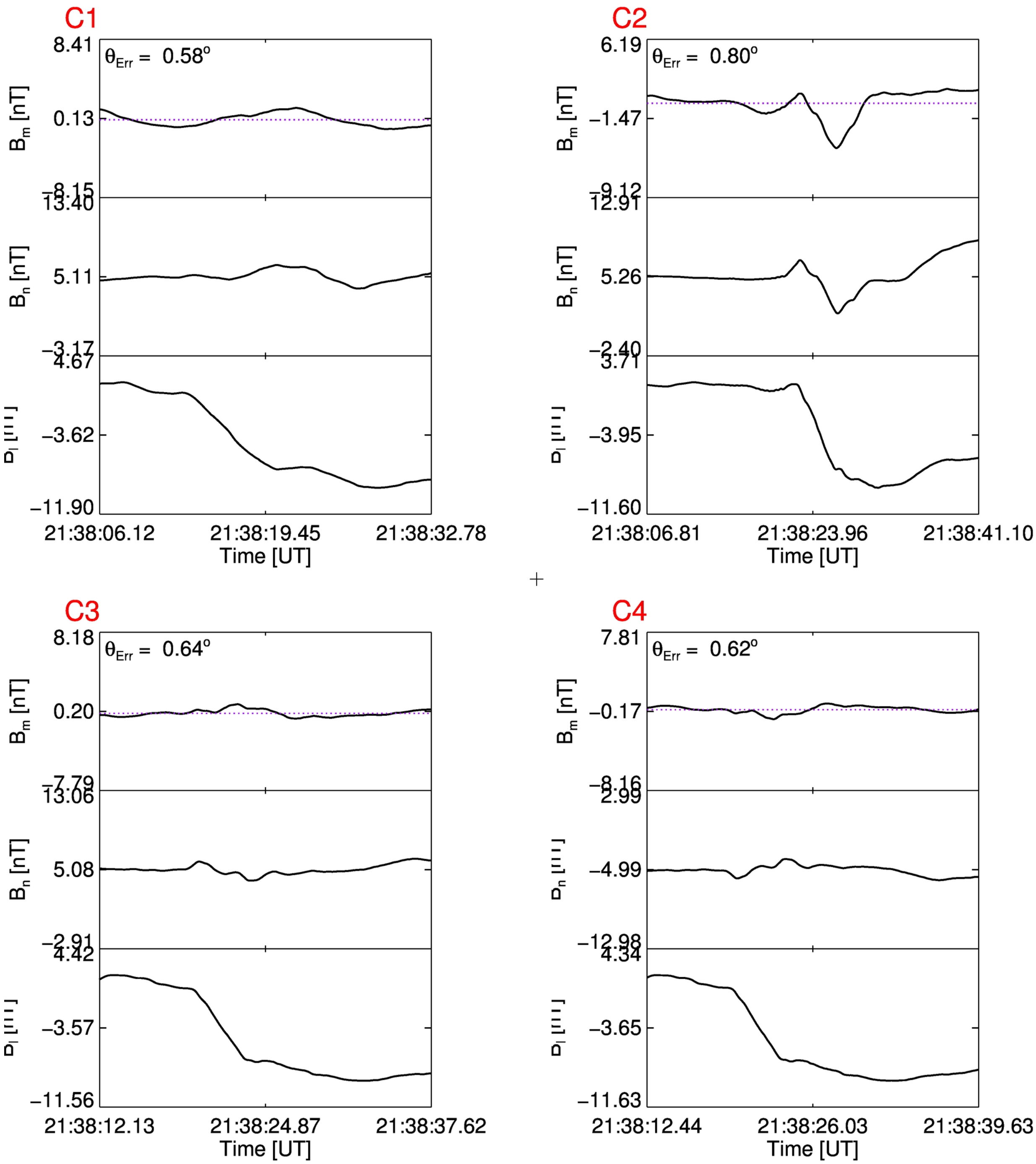

C1
θErr = 1.28°
6.15
−0.28
−6.70
B_m [nT]
−0.56
−6.98
−13.41
7.50
1.07
−5.35
B_l [nT]
08:24:45.58
08:24:57.42
08:25:09.26
Time [UT]
C2
θErr = 1.78°
6.17
−0.05
−6.28
B_m [nT]
12.79
6.57
0.35
B_n [nT]
2.45
−3.78
−10.00
08:24:46.16
08:24:58.71
08:25:11.27
Time [UT]
C3
θErr = 1.71°
6.56
−0.52
−7.61
B_m [nT]
1.07
−6.01
−13.09
3.43
−3.65
−10.73
08:24:49.39
08:25:00.92
08:25:12.45
Time [UT]
C4
θErr = 1.48°
7.38
0.51
−6.36
B_m [nT]
13.05
6.18
−0.69
B_n [nT]
3.95
−2.92
−9.79
B_l [nT]
08:24:50.16
08:25:01.61
08:25:13.05
Time [UT]

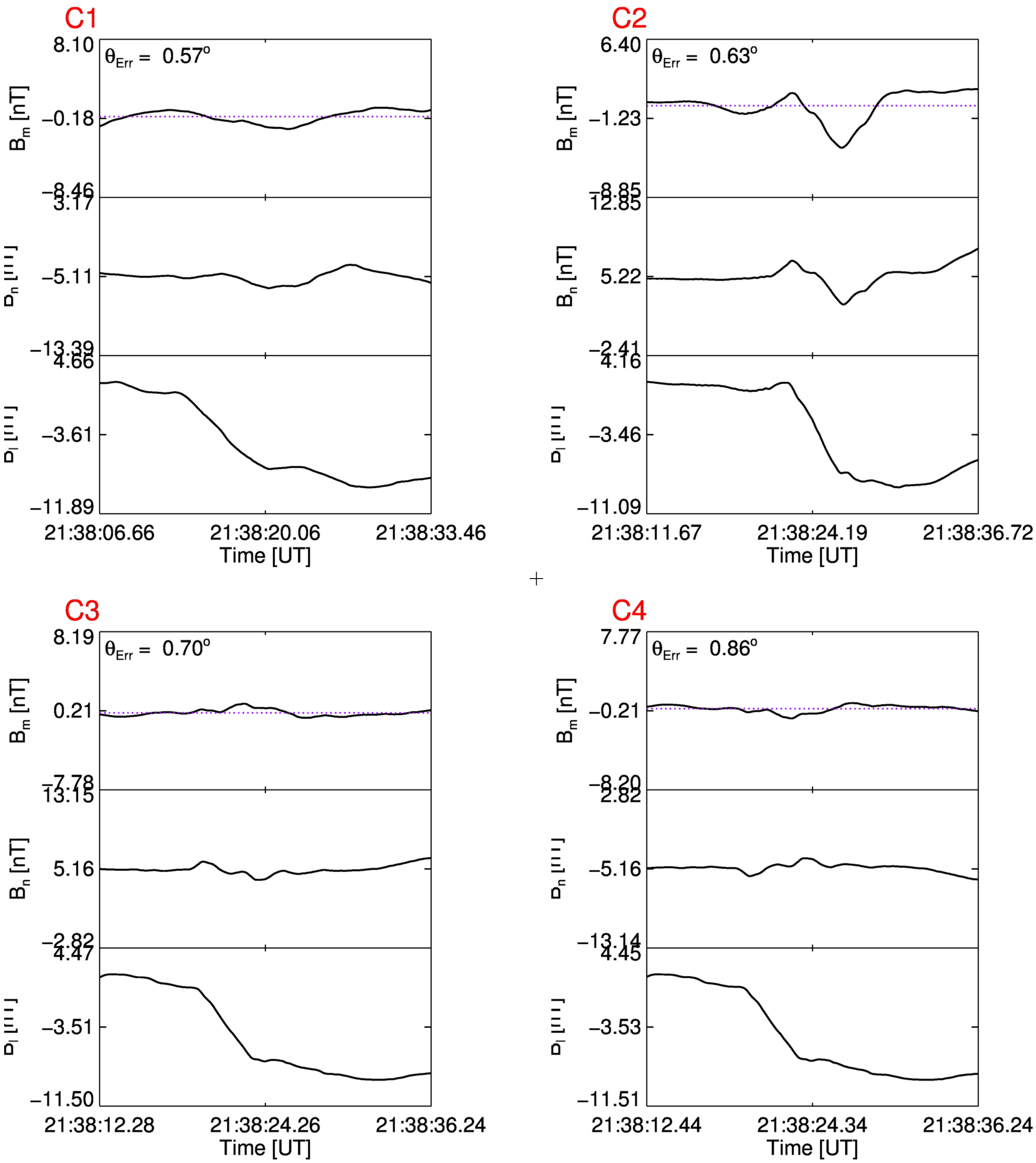
4.3. **26 February 2012**

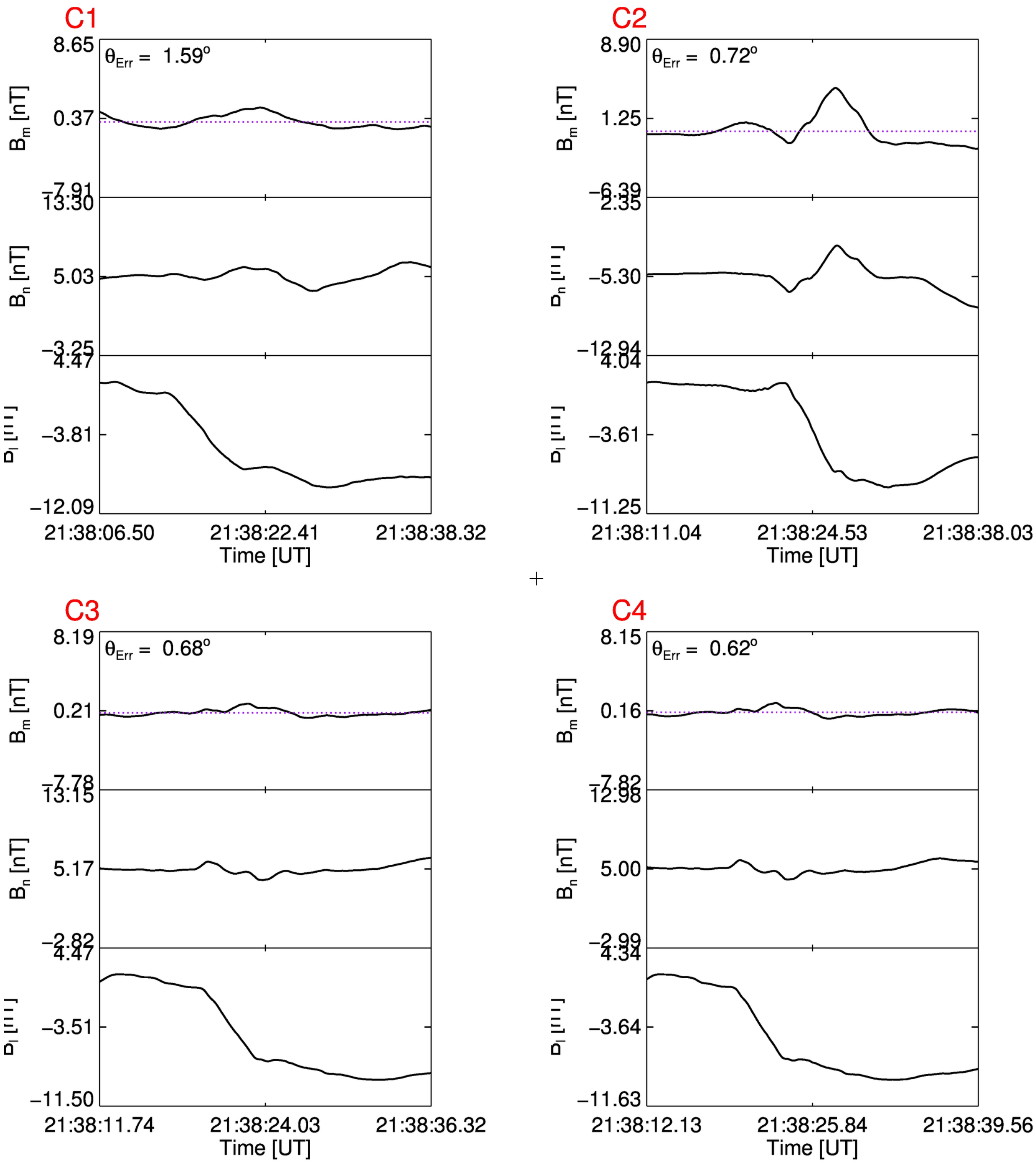


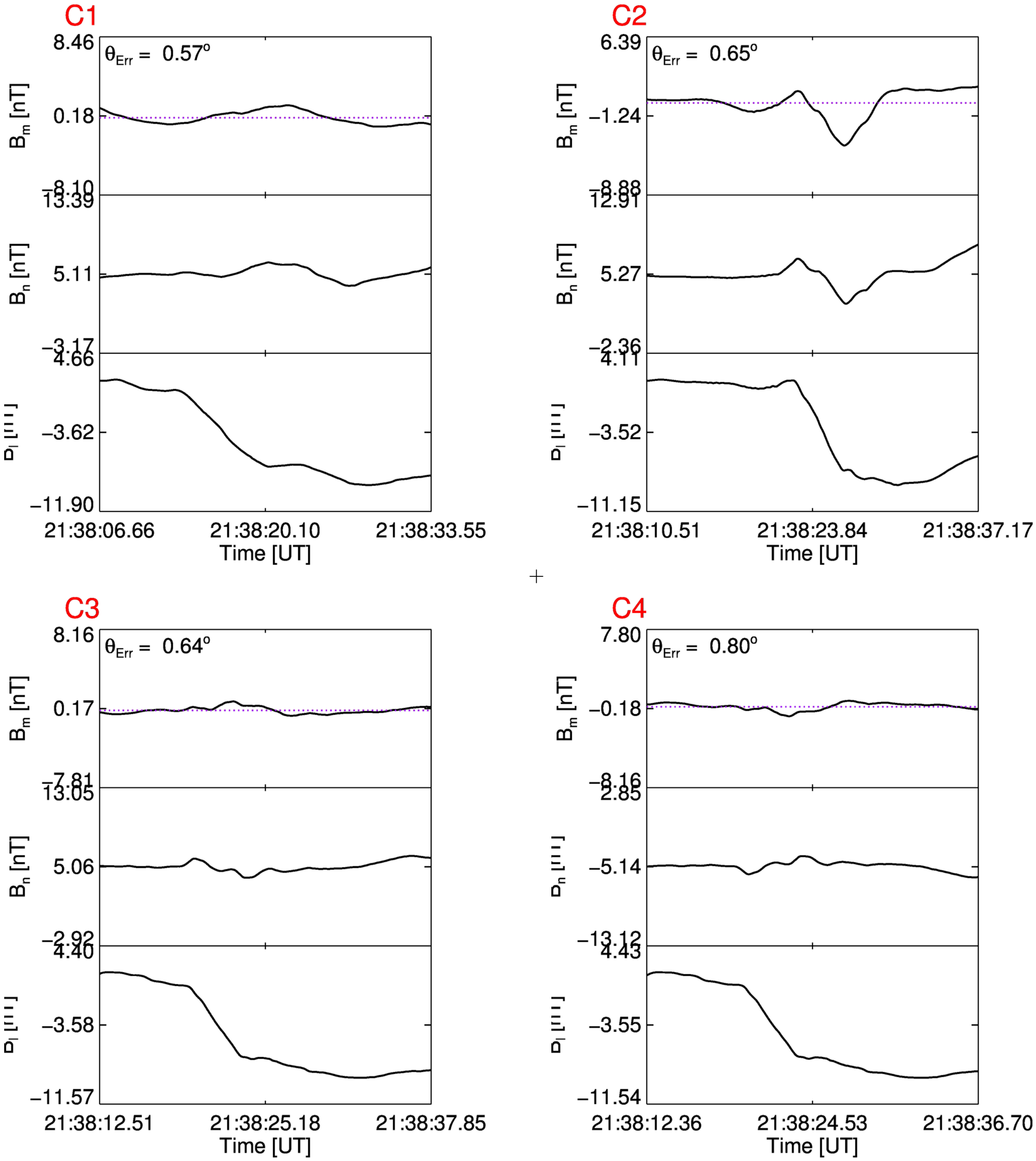

C1
θErr = 0.50°
8.19
−0.08
−8.35
3.10
−5.16
−13.43
4.69
−3.58
−11.84
Bm [nT]
21:38:06.96
21:38:19.17
21:38:31.39
Time [UT]
C2
θErr = 0.76°
6.39
−1.19
−8.77
12.98
5.40
−2.17
3.99
−3.59
−11.17
Bm [nT]
Bn [nT]
21:38:14.51
21:38:26.19
21:38:37.86
Time [UT]
C3
θErr = 0.59°
8.16
0.18
−7.81
12.99
5.01
−2.98
4.37
−3.62
−11.60
Bm [nT]
Bn [nT]
21:38:12.51
21:38:25.84
21:38:39.17
Time [UT]
C4
θErr = 0.61°
7.82
−0.16
−8.15
3.00
−4.98
−12.97
4.33
−3.66
−11.64
Bm [nT]
21:38:12.90
21:38:26.46
21:38:40.03
Time [UT]

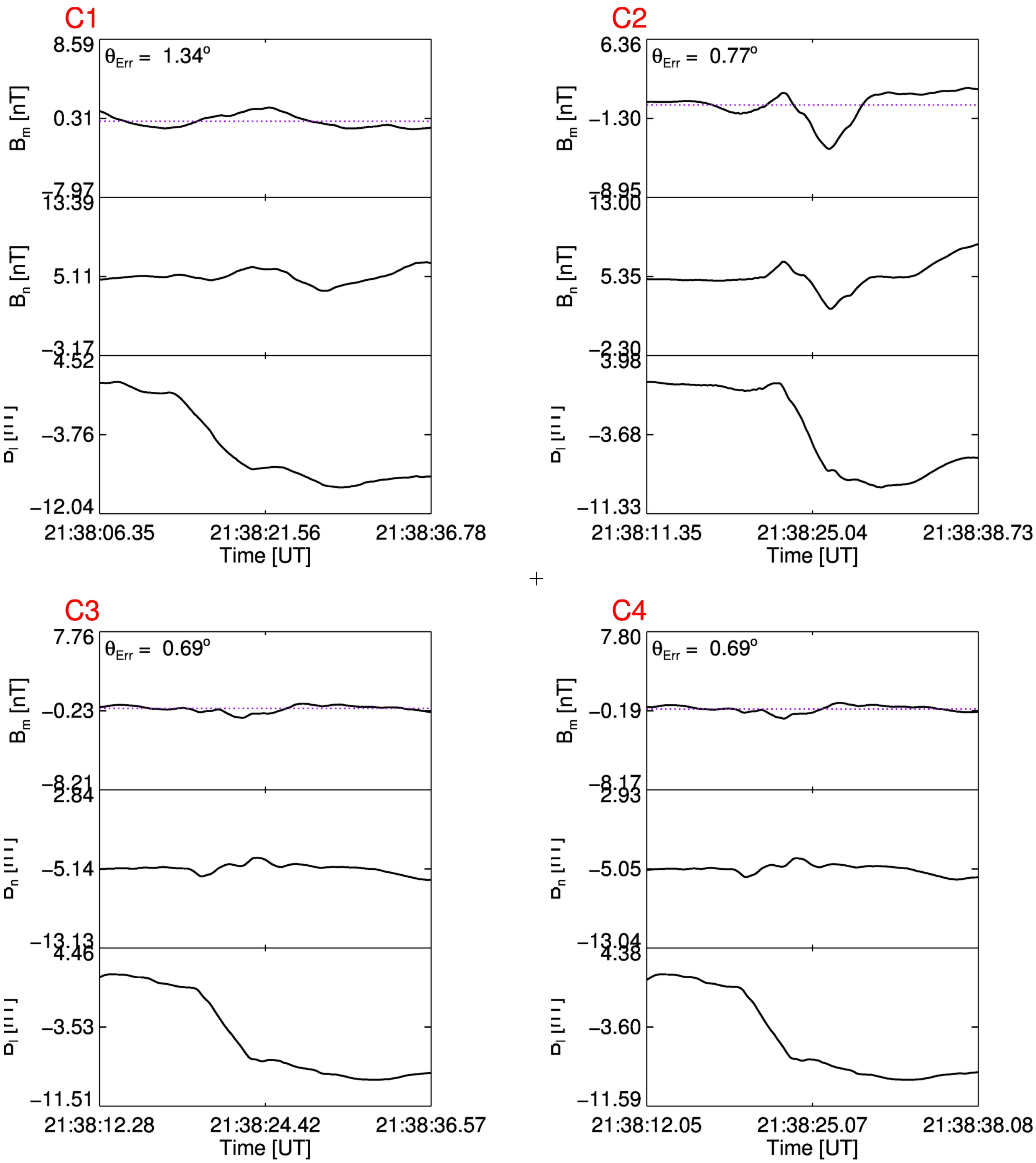

C1
θErr = 1.03°
8.00
Bm [nT]
−0.28
−8.55
3.05
−5.23
−13.50
4.58
−3.69
−11.97
21:38:07.65
21:38:21.80
21:38:35.95
Time [UT]
C2
θErr = 0.67°
6.47
Bm [nT]
−1.17
−8.80
12.94
Bn [nT]
5.31
−2.33
4.12
−3.51
−11.15
21:38:11.43
21:38:24.30
21:38:37.17
Time [UT]
C3
θErr = 0.64°
7.81
Bm [nT]
−0.17
−8.16
2.92
−5.07
−13.05
4.41
−3.58
−11.56
21:38:12.13
21:38:24.99
21:38:37.85
Time [UT]
C4
θErr = 0.66°
8.19
Bm [nT]
0.21
−7.77
13.00
Bn [nT]
5.02
−2.97
4.35
−3.63
−11.61
21:38:13.12
21:38:25.99
21:38:38.85
Time [UT]

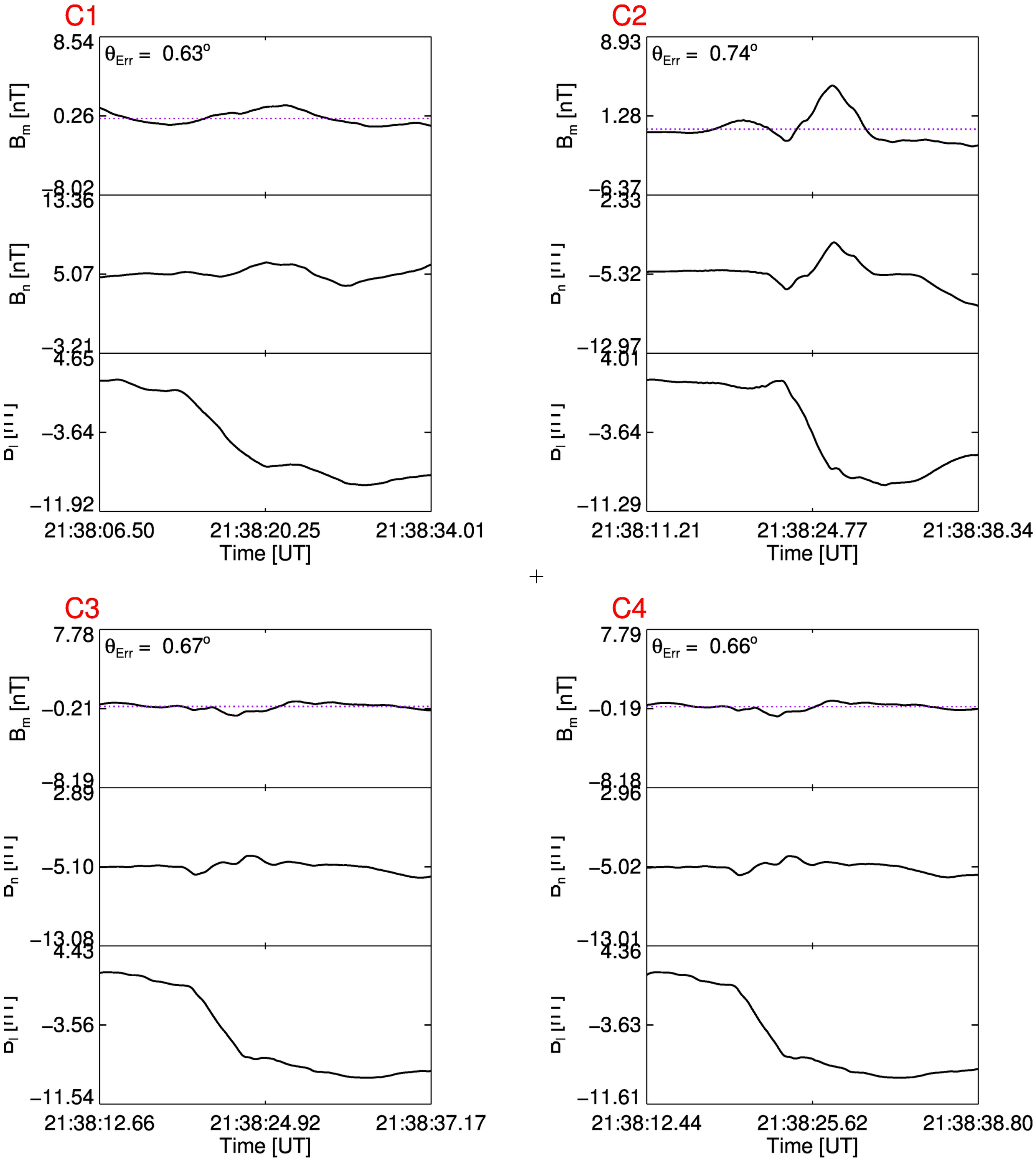

C1
θErr = 0.58°
Bm [nT]
8.41
0.13
−8.15
Bn [nT]
13.40
5.11
−3.17
4.67
−3.62
−11.90
21:38:06.12
21:38:19.45
21:38:32.78
Time [UT]
C2
θErr = 0.80°
Bm [nT]
6.19
−1.47
−9.12
Bn [nT]
12.91
5.26
−2.40
3.71
−3.95
−11.60
21:38:06.81
21:38:23.96
21:38:41.10
Time [UT]
C3
θErr = 0.64°
Bm [nT]
8.18
0.20
−7.79
Bn [nT]
13.06
5.08
−2.91
4.42
−3.57
−11.56
21:38:12.13
21:38:24.87
21:38:37.62
Time [UT]
C4
θErr = 0.62°
Bm [nT]
7.81
−0.17
−8.16
2.99
−4.99
−12.98
4.34
−3.65
−11.63
21:38:12.44
21:38:26.03
21:38:39.63
Time [UT]

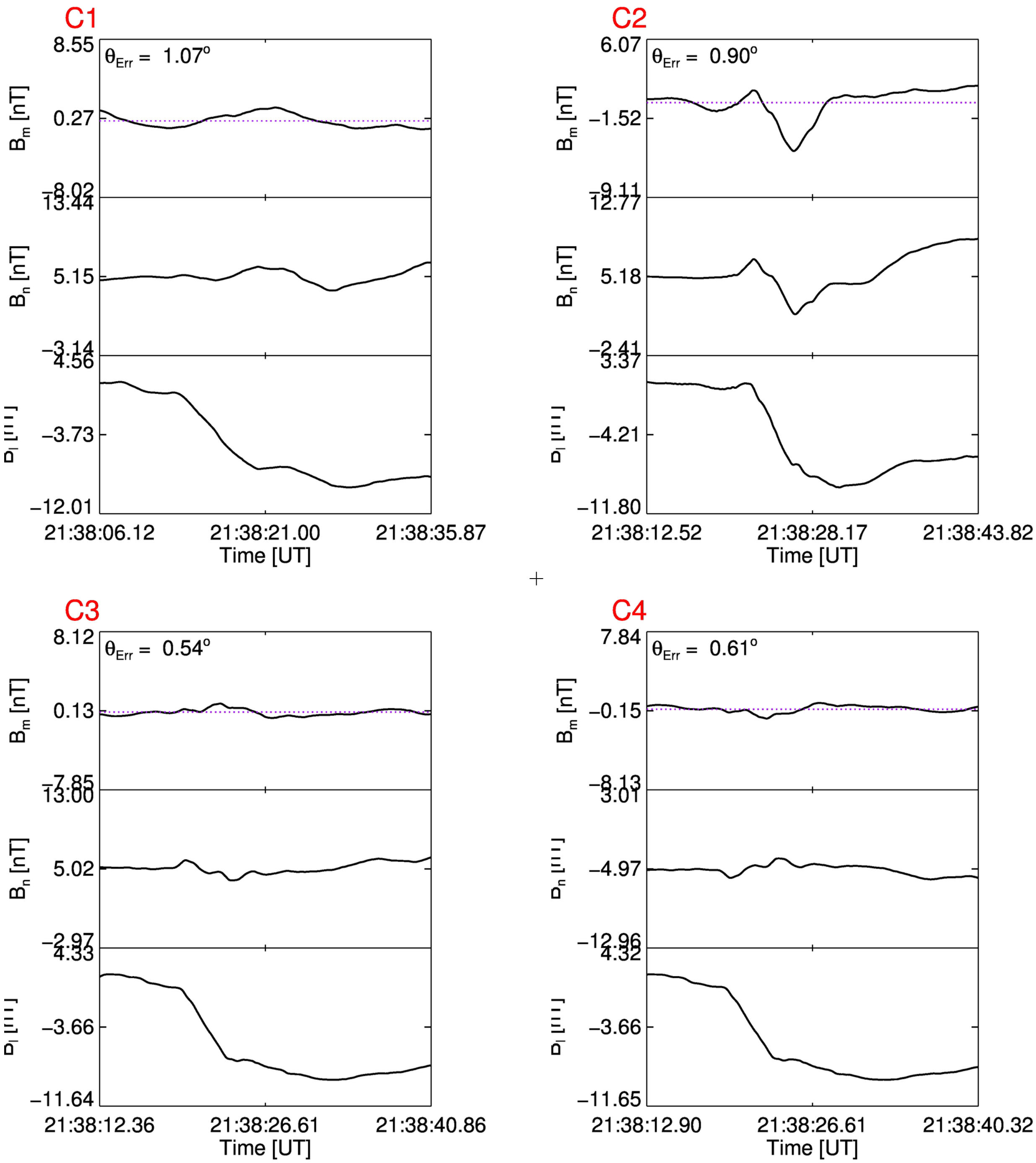

C1
θErr = 0.57°
Bm [nT]
8.10
−0.18
−8.46
3.17
−5.11
−13.39
4.66
−3.61
−11.89
21:38:06.66
21:38:20.06
21:38:33.46
Time [UT]
C2
θErr = 0.63°
Bm [nT]
6.40
−1.23
−8.85
12.85
Bn [nT]
5.22
−2.41
4.16
−3.46
−11.09
21:38:11.67
21:38:24.19
21:38:36.72
Time [UT]
C3
θErr = 0.70°
Bm [nT]
8.19
0.21
−7.78
13.15
Bn [nT]
5.16
−2.82
4.47
−3.51
−11.50
21:38:12.28
21:38:24.26
21:38:36.24
Time [UT]
C4
θErr = 0.86°
Bm [nT]
7.77
−0.21
−8.20
2.82
−5.16
−13.14
4.45
−3.53
−11.51
21:38:12.44
21:38:24.34
21:38:36.24
Time [UT]


C1
θ_{Err} = 1.59°
8.65
0.37
−7.91
B_m [nT]
13.30
5.03
−3.25
B_n [nT]
4.47
−3.81
−12.09
21:38:06.50
21:38:22.41
21:38:38.32
Time [UT]
C2
θ_{Err} = 0.72°
8.90
1.25
−6.39
B_m [nT]
2.35
−5.30
−12.94
4.04
−3.61
−11.25
21:38:11.04
21:38:24.53
21:38:38.03
Time [UT]
C3
θ_{Err} = 0.68°
8.19
0.21
−7.78
B_m [nT]
13.15
5.17
−2.82
B_n [nT]
4.47
−3.51
−11.50
21:38:11.74
21:38:24.03
21:38:36.32
Time [UT]
C4
θ_{Err} = 0.62°
8.15
0.16
−7.82
B_m [nT]
12.98
5.00
−2.99
B_n [nT]
4.34
−3.64
−11.63
21:38:12.13
21:38:25.84
21:38:39.56
Time [UT]

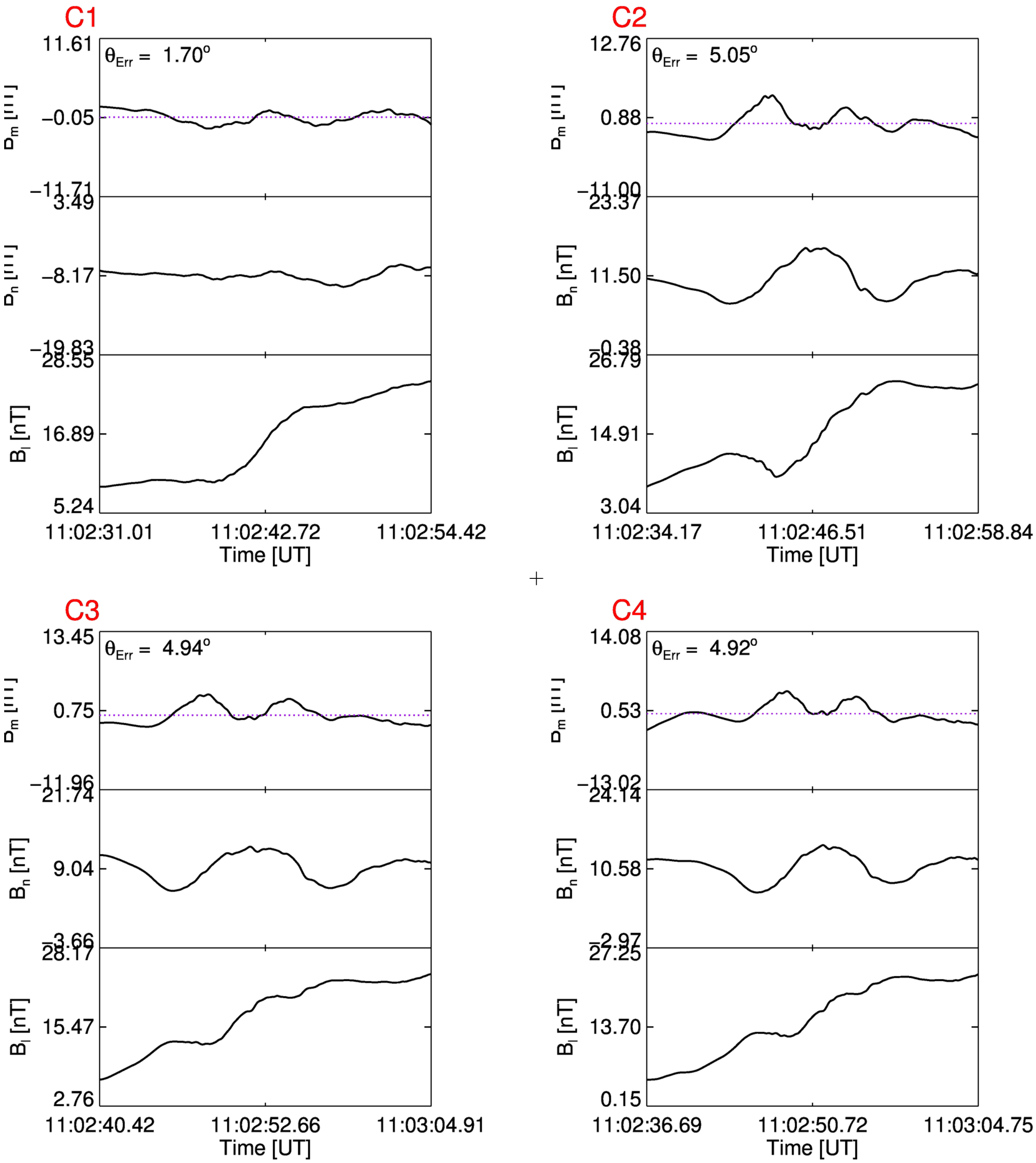

C1
θ_Err = 0.57°
8.46
0.18
−8.10
13.39
5.11
−3.17
4.66
−3.62
−11.90
B_m [nT]
B_n [nT]
21:38:06.66
21:38:20.10
21:38:33.55
Time [UT]
C2
θ_Err = 0.65°
6.39
−1.24
−8.88
12.91
5.27
−2.36
4.11
−3.52
−11.15
B_m [nT]
B_n [nT]
21:38:10.51
21:38:23.84
21:38:37.17
Time [UT]
C3
θ_Err = 0.64°
8.16
0.17
−7.81
13.05
5.06
−2.92
4.40
−3.58
−11.57
B_m [nT]
B_n [nT]
21:38:12.51
21:38:25.18
21:38:37.85
Time [UT]
C4
θ_Err = 0.80°
7.80
−0.18
−8.16
2.85
−5.14
−13.12
4.43
−3.55
−11.54
B_m [nT]
21:38:12.36
21:38:24.53
21:38:36.70
Time [UT]

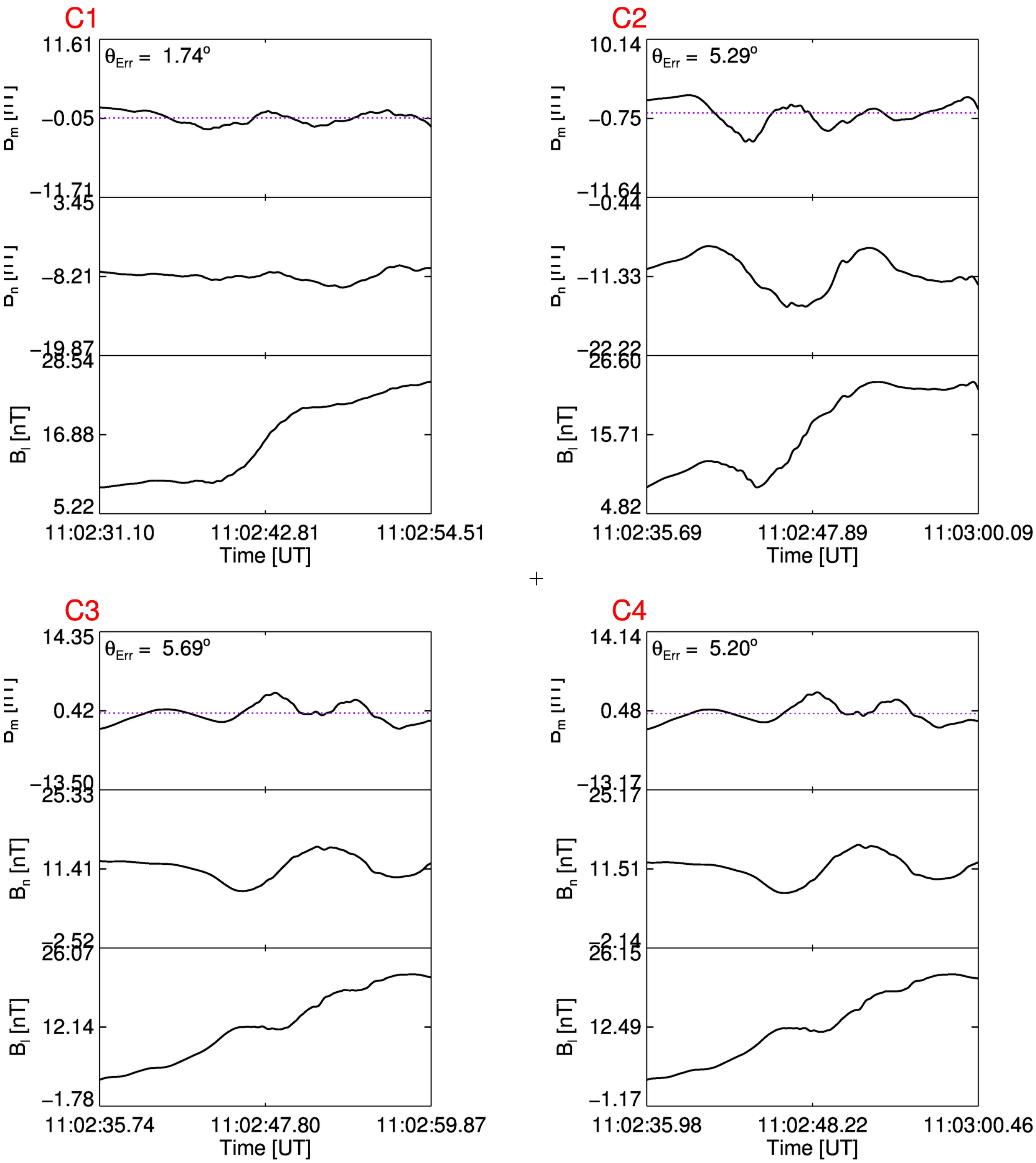

C1
θErr = 1.34°
8.59
0.31
−7.97
13.39
5.11
−3.17
4.52
−3.76
−12.04
21:38:06.35
21:38:21.56
21:38:36.78
Time [UT]
C2
θErr = 0.77°
6.36
−1.30
−8.95
13.00
5.35
−2.30
3.98
−3.68
−11.33
21:38:11.35
21:38:25.04
21:38:38.73
Time [UT]
C3
θErr = 0.69°
7.76
−0.23
−8.21
2.84
−5.14
−13.13
4.46
−3.53
−11.51
21:38:12.28
21:38:24.42
21:38:36.57
Time [UT]
C4
θErr = 0.69°
7.80
−0.19
−8.17
2.93
−5.05
−13.04
4.38
−3.60
−11.59
21:38:12.05
21:38:25.07
21:38:38.08
Time [UT]
Bm [nT]
Bn [nT]

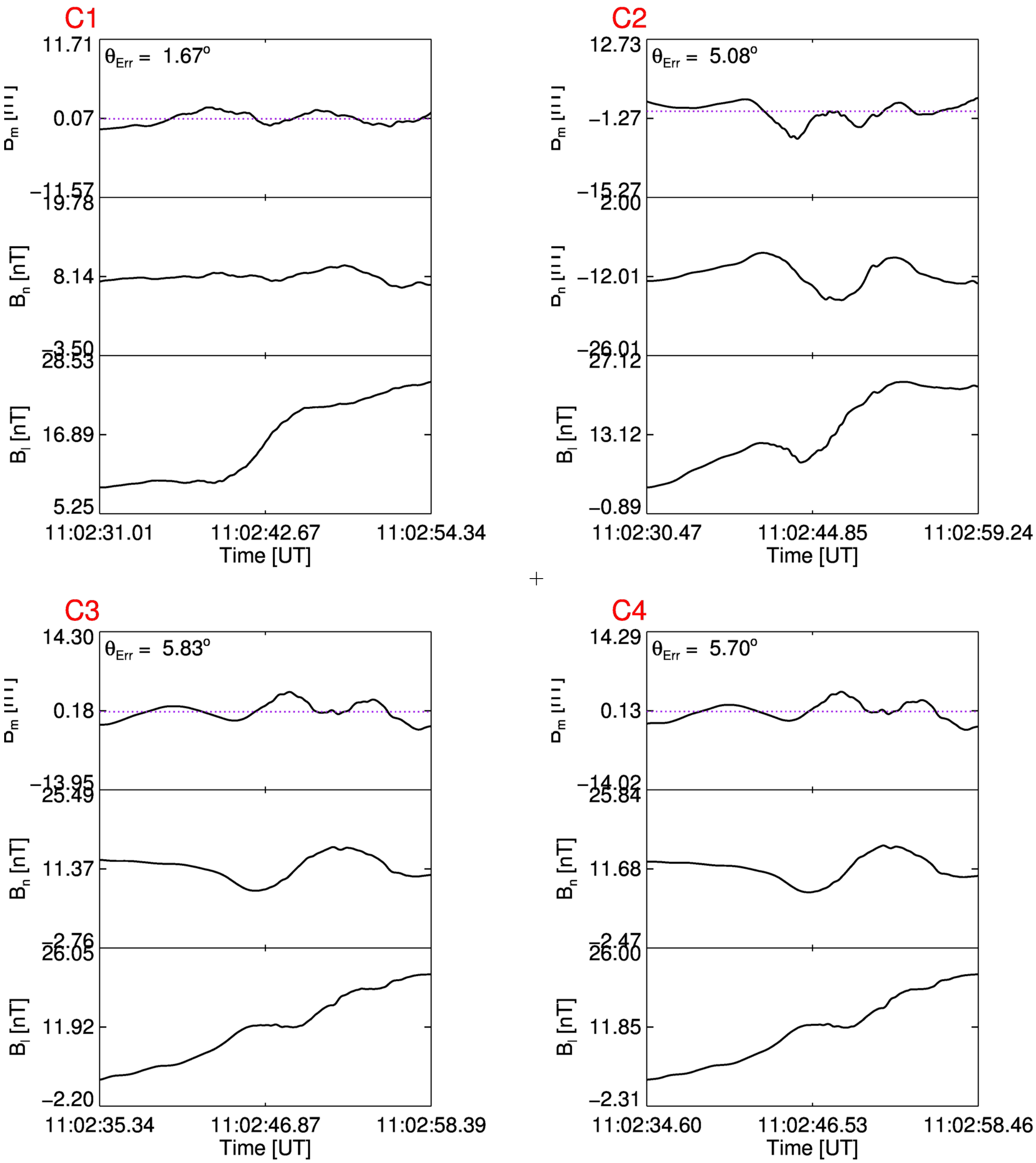

C1
θErr = 0.63°
Bm [nT]
Bn [nT]
Time [UT]
21:38:06.50
21:38:20.25
21:38:34.01
C2
θErr = 0.74°
Bm [nT]
Time [UT]
21:38:11.21
21:38:24.77
21:38:38.34
C3
θErr = 0.67°
Bm [nT]
Time [UT]
21:38:12.66
21:38:24.92
21:38:37.17
C4
θErr = 0.66°
Bm [nT]
Time [UT]
21:38:12.44
21:38:25.62
21:38:38.80

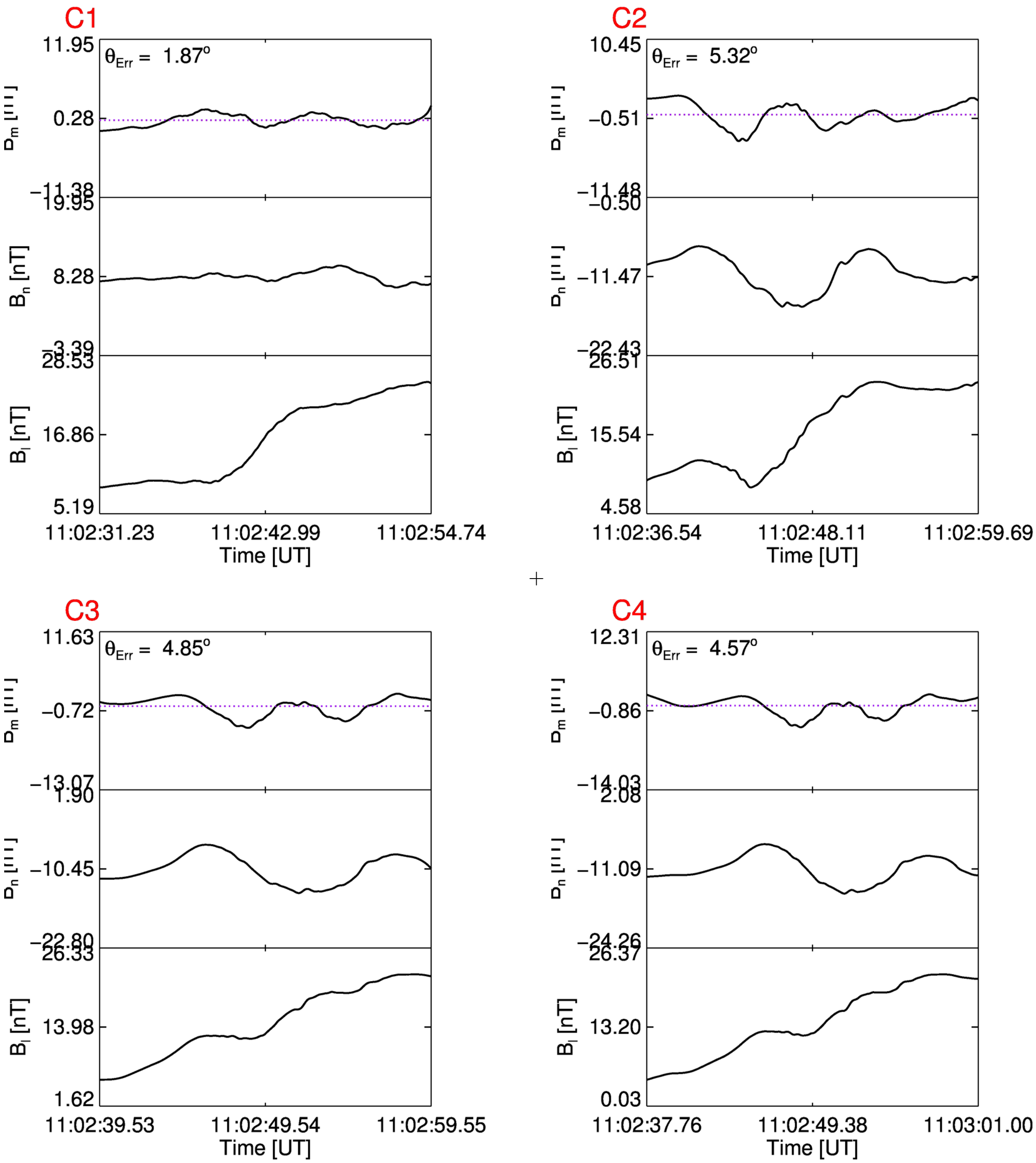

C1
θ_{Err} = 1.07°
8.55
0.27
−8.02
B_m [nT]
13.44
5.15
−3.14
B_n [nT]
4.56
−3.73
−12.01
21:38:06.12
21:38:21.00
21:38:35.87
Time [UT]
C2
θ_{Err} = 0.90°
6.07
−1.52
−9.11
B_m [nT]
12.77
5.18
−2.41
B_n [nT]
3.37
−4.21
−11.80
21:38:12.52
21:38:28.17
21:38:43.82
Time [UT]
C3
θ_{Err} = 0.54°
8.12
0.13
−7.85
B_m [nT]
13.00
5.02
−2.97
B_n [nT]
4.33
−3.66
−11.64
21:38:12.36
21:38:26.61
21:38:40.86
Time [UT]
C4
θ_{Err} = 0.61°
7.84
−0.15
−8.13
B_m [nT]
3.01
−4.97
−12.96
4.32
−3.66
−11.65
21:38:12.90
21:38:26.61
21:38:40.32
Time [UT]

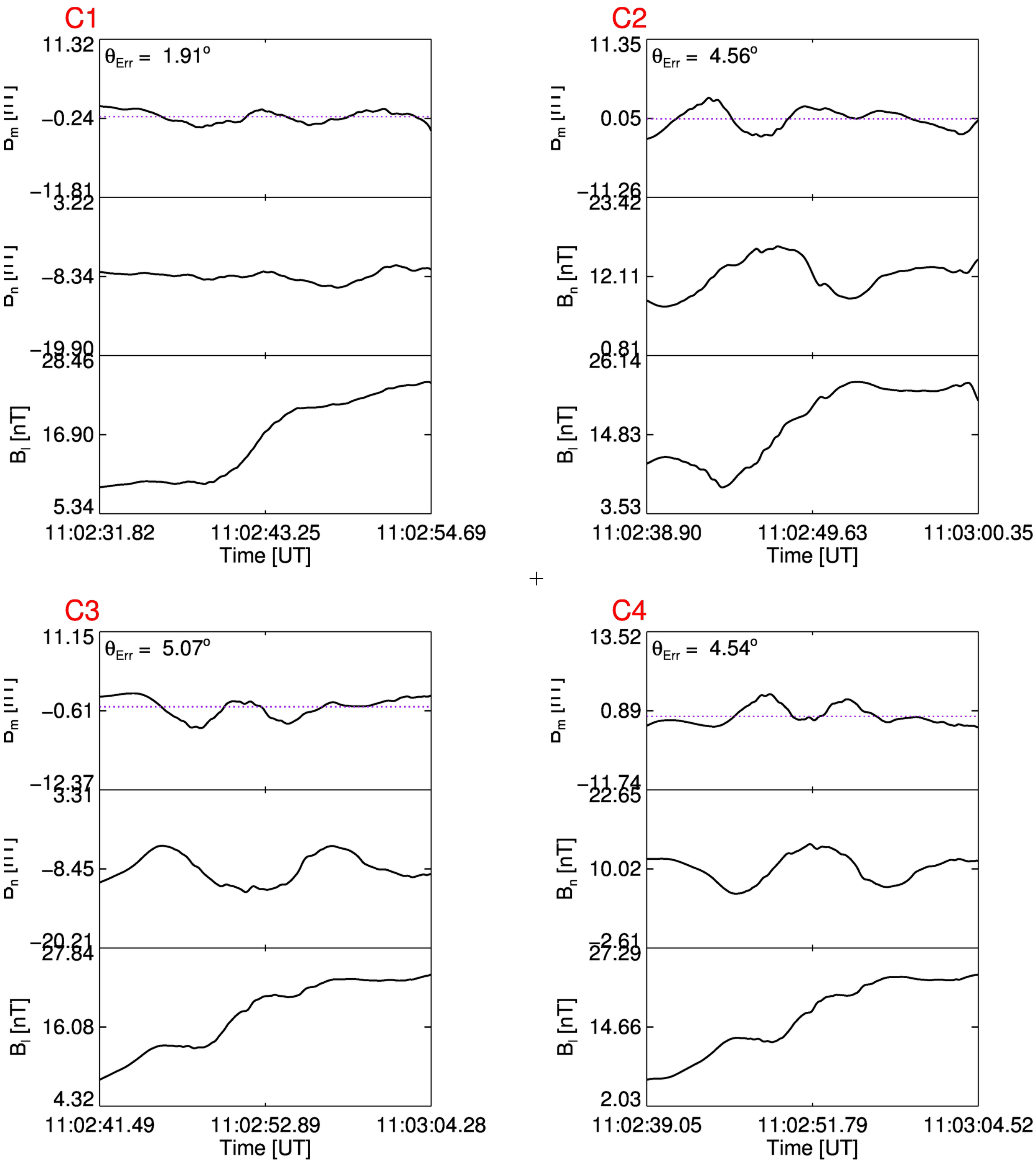
4.4. **8 March 2012**

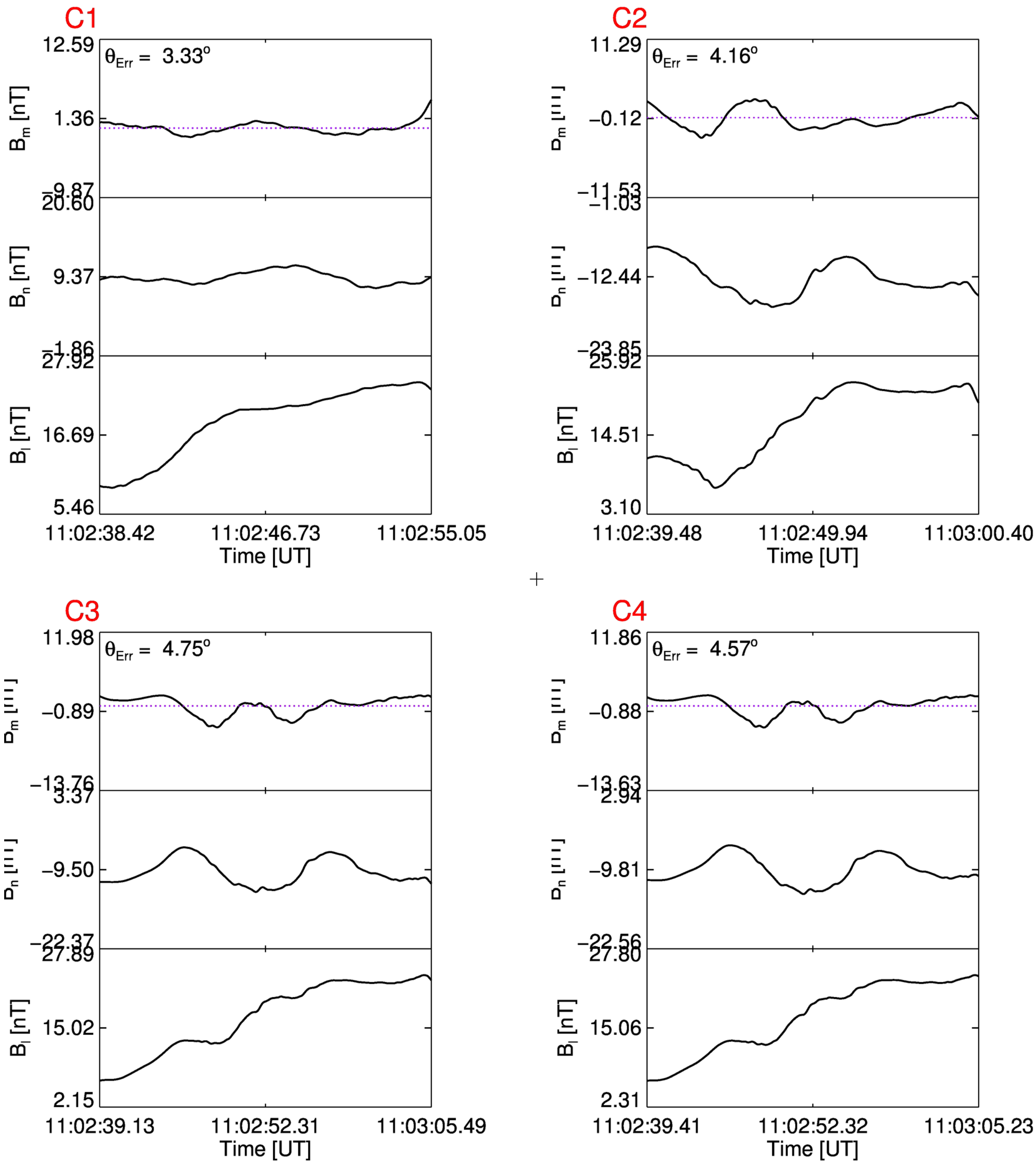


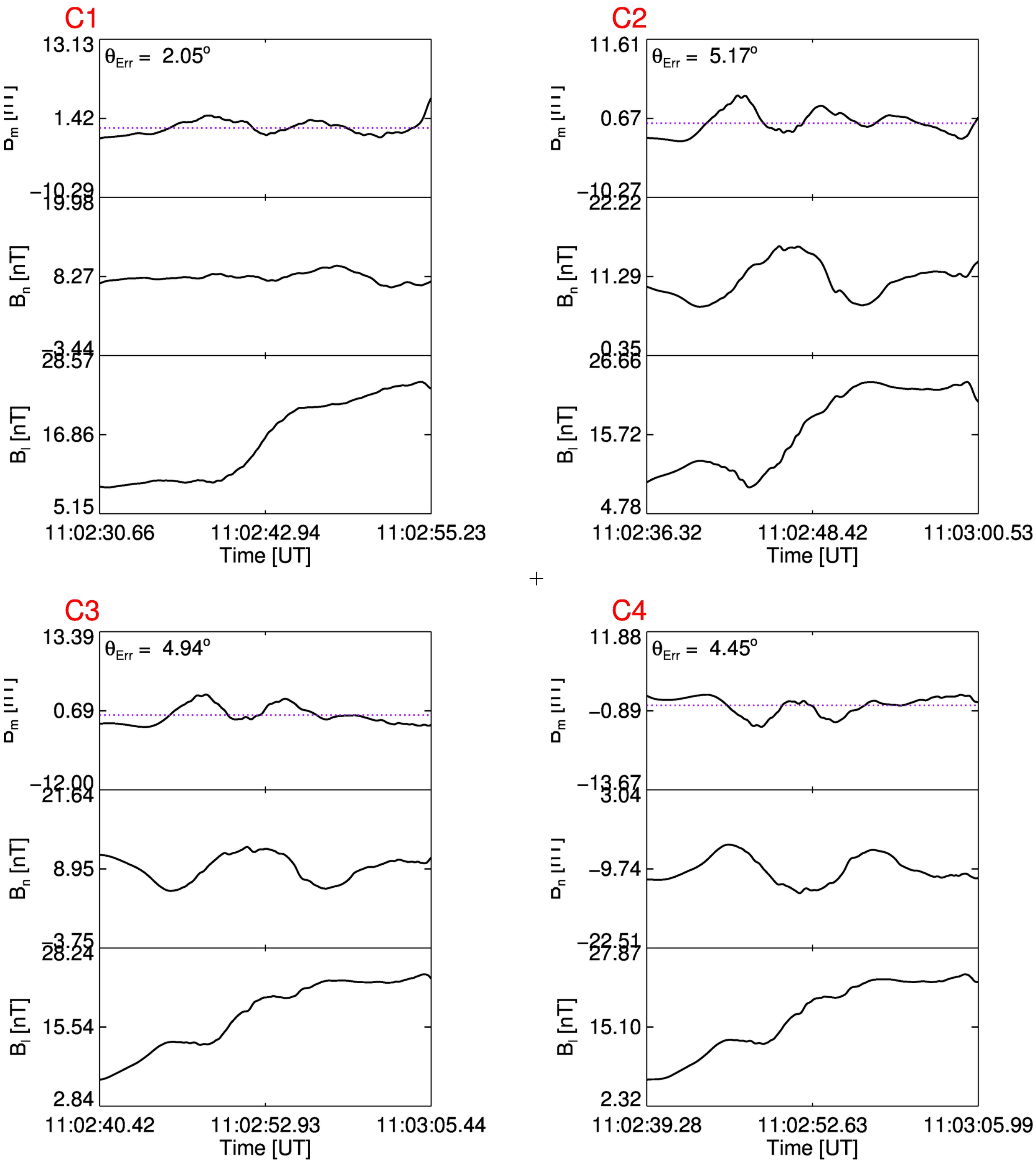

C1
θErr = 1.74°
11.61
−0.05
−11.71
3.45
−8.21
−19.87
28.54
Bl [nT]
16.88
5.22
11:02:31.10
11:02:42.81
11:02:54.51
Time [UT]
C2
θErr = 5.29°
10.14
−0.75
−11.64
−0.44
−11.33
−22.22
26.60
Bl [nT]
15.71
4.82
11:02:35.69
11:02:47.89
11:03:00.09
Time [UT]
C3
θErr = 5.69°
14.35
0.42
−13.50
25.33
Bn [nT]
11.41
−2.52
26.07
Bl [nT]
12.14
−1.78
11:02:35.74
11:02:47.80
11:02:59.87
Time [UT]
C4
θErr = 5.20°
14.14
0.48
−13.17
25.17
Bn [nT]
11.51
−2.14
26.15
Bl [nT]
12.49
−1.17
11:02:35.98
11:02:48.22
11:03:00.46
Time [UT]

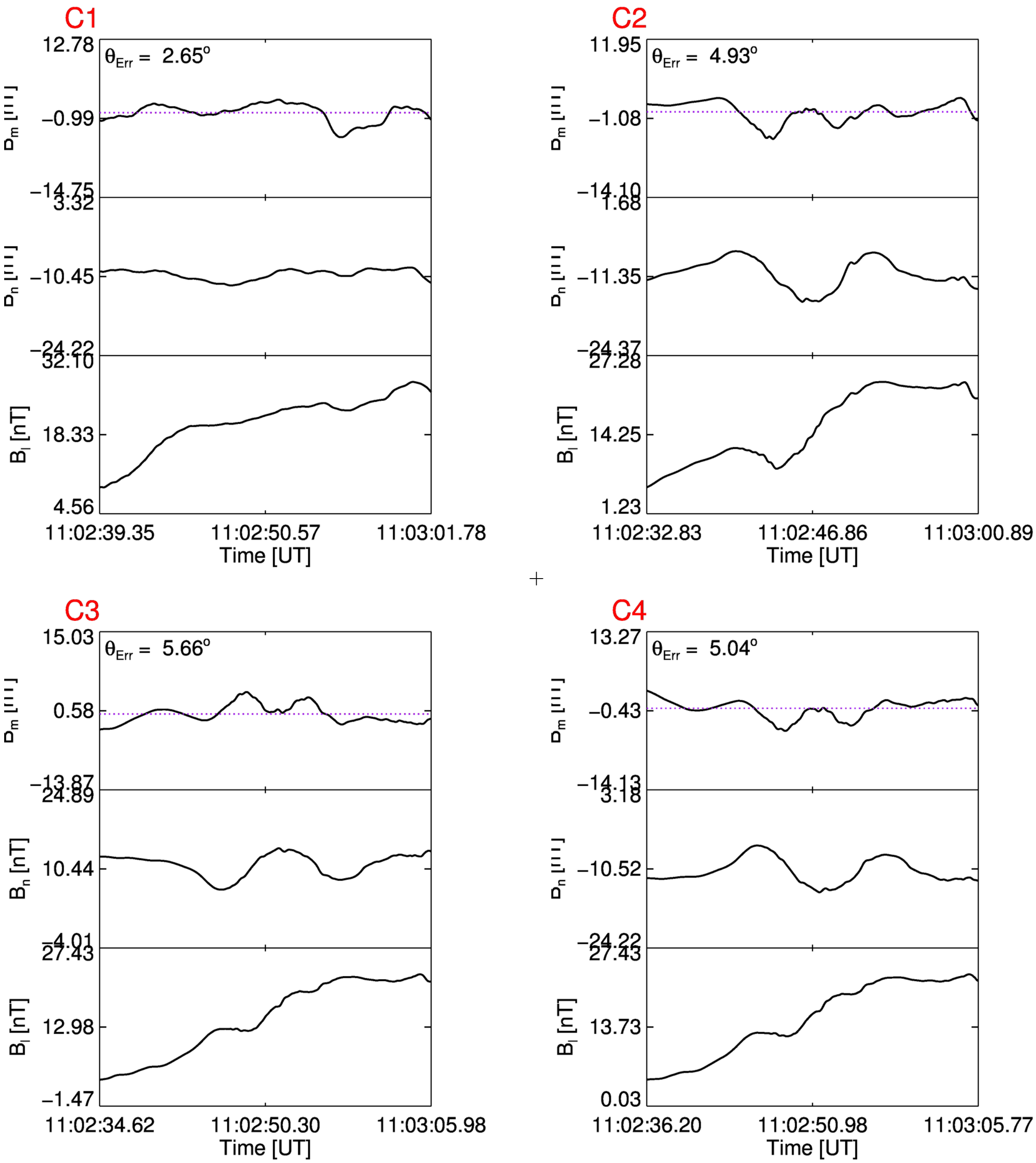

C1
θ_Err = 1.67°
11.71
0.07
−11.57
19.78
B_n [nT]
8.14
−3.50
28.53
B_l [nT]
16.89
5.25
11:02:31.01
11:02:42.67
11:02:54.34
Time [UT]
C2
θ_Err = 5.08°
12.73
−1.27
−15.27
2.00
−12.01
−26.01
27.12
B_l [nT]
13.12
−0.89
11:02:30.47
11:02:44.85
11:02:59.24
Time [UT]
C3
θ_Err = 5.83°
14.30
0.18
−13.95
25.49
B_n [nT]
11.37
−2.76
26.05
B_l [nT]
11.92
−2.20
11:02:35.34
11:02:46.87
11:02:58.39
Time [UT]
C4
θ_Err = 5.70°
14.29
0.13
−14.02
25.84
B_n [nT]
11.68
−2.47
26.00
B_l [nT]
11.85
−2.31
11:02:34.60
11:02:46.53
11:02:58.46
Time [UT]

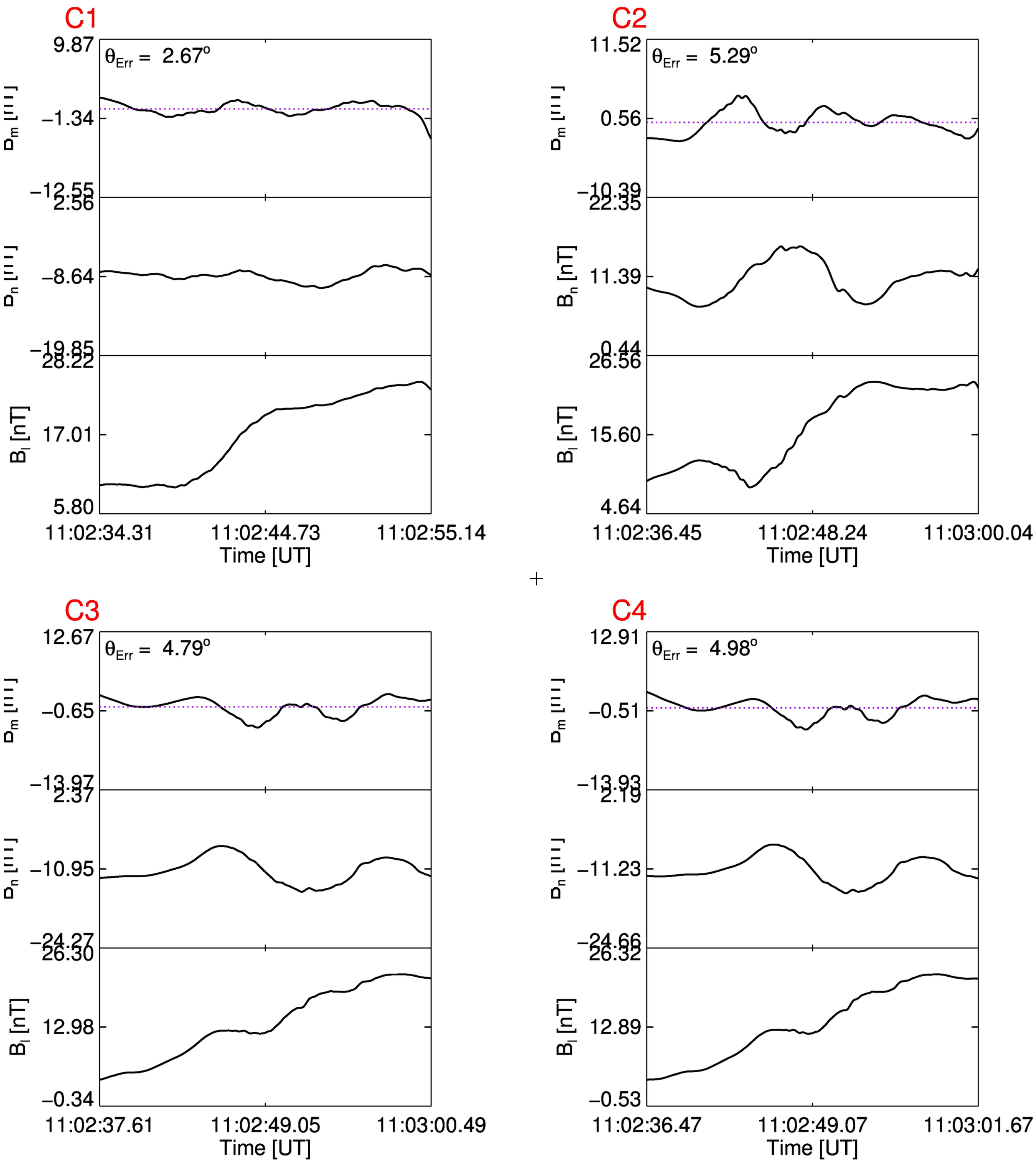

C1
θErr = 1.87°
11.95
0.28
−11.38
19.95
8.28
−3.39
28.53
16.86
5.19
Bn [nT]
Bl [nT]
11:02:31.23
11:02:42.99
11:02:54.74
Time [UT]
C2
θErr = 5.32°
10.45
−0.51
−11.48
−0.50
−11.47
−22.43
26.51
15.54
4.58
Bl [nT]
11:02:36.54
11:02:48.11
11:02:59.69
Time [UT]
C3
θErr = 4.85°
11.63
−0.72
−13.07
1.90
−10.45
−22.80
26.33
13.98
1.62
Bl [nT]
11:02:39.53
11:02:49.54
11:02:59.55
Time [UT]
C4
θErr = 4.57°
12.31
−0.86
−14.03
2.08
−11.09
−24.26
26.37
13.20
0.03
Bl [nT]
11:02:37.76
11:02:49.38
11:03:01.00
Time [UT]

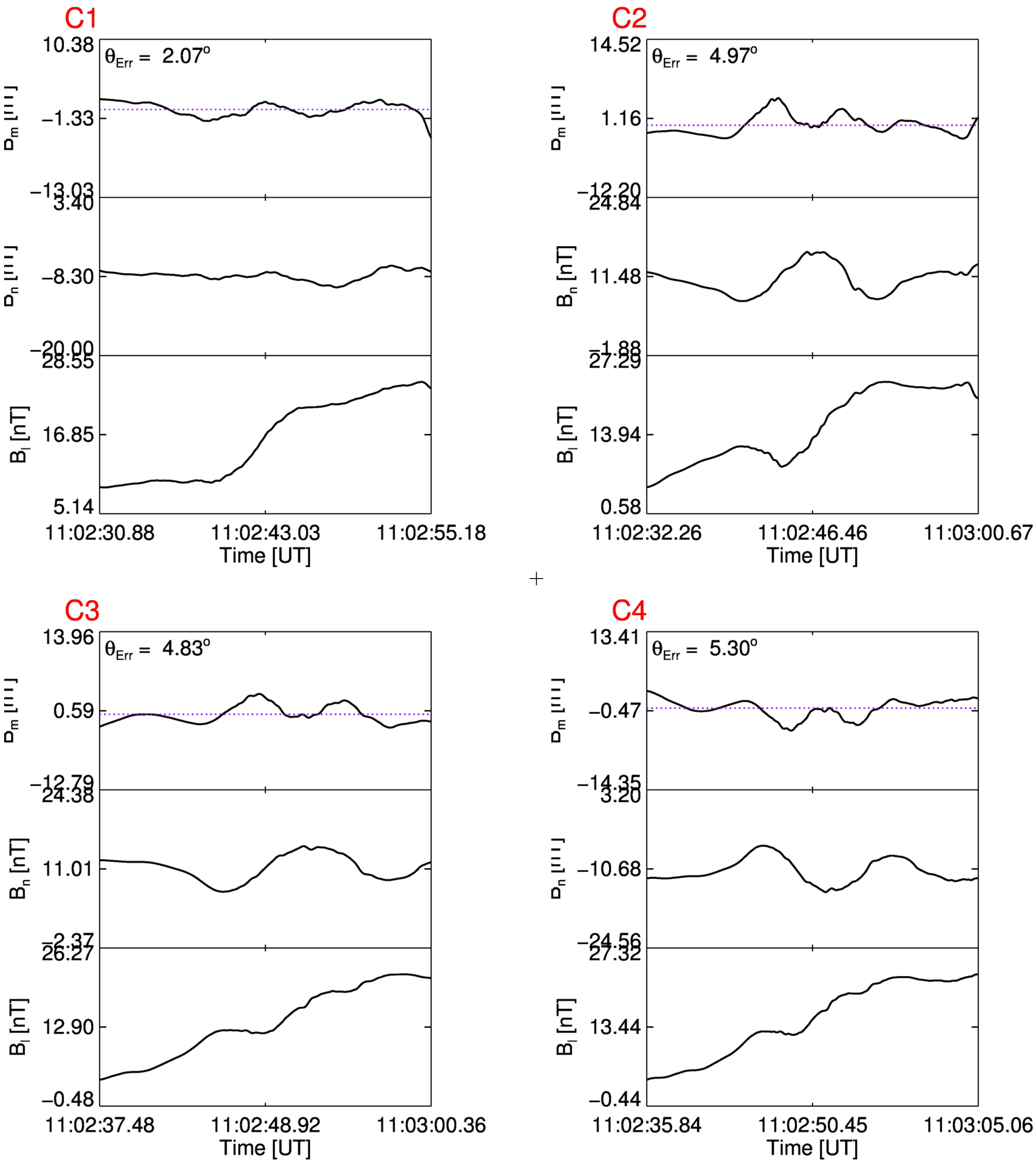

C1
θErr = 1.91°
11.32
−0.24
−11.81
3.22
−8.34
−19.90
28.46
16.90
5.34
B_l [nT]
11:02:31.82
11:02:43.25
11:02:54.69
Time [UT]
C2
θErr = 4.56°
11.35
0.05
−11.26
23.42
12.11
0.81
B_n [nT]
26.14
14.83
3.53
B_l [nT]
11:02:38.90
11:02:49.63
11:03:00.35
Time [UT]
C3
θErr = 5.07°
11.15
−0.61
−12.37
3.31
−8.45
−20.21
27.84
16.08
4.32
B_l [nT]
11:02:41.49
11:02:52.89
11:03:04.28
Time [UT]
C4
θErr = 4.54°
13.52
0.89
−11.74
22.65
10.02
−2.61
B_n [nT]
27.29
14.66
2.03
B_l [nT]
11:02:39.05
11:02:51.79
11:03:04.52
Time [UT]


C1
θErr = 3.33°
B_m [nT]
B_n [nT]
B_l [nT]
12.59
1.36
−9.87
20.60
9.37
−1.86
27.92
16.69
5.46
11:02:38.42
11:02:46.73
11:02:55.05
Time [UT]
C2
θErr = 4.16°
B_l [nT]
11.29
−0.12
−11.53
−1.03
−12.44
−23.85
25.92
14.51
3.10
11:02:39.48
11:02:49.94
11:03:00.40
Time [UT]
C3
θErr = 4.75°
B_l [nT]
11.98
−0.89
−13.76
3.37
−9.50
−22.37
27.89
15.02
2.15
11:02:39.13
11:02:52.31
11:03:05.49
Time [UT]
C4
θErr = 4.57°
B_l [nT]
11.86
−0.88
−13.63
2.94
−9.81
−22.56
27.80
15.06
2.31
11:02:39.41
11:02:52.32
11:03:05.23
Time [UT]


C1
13.13
θErr = 2.05°
1.42
−10.29
19.98
Bn [nT]
8.27
−3.44
28.57
Bl [nT]
16.86
5.15
11:02:30.66
11:02:42.94
11:02:55.23
Time [UT]
C2
11.61
θErr = 5.17°
0.67
−10.27
22.22
Bn [nT]
11.29
0.35
26.66
Bl [nT]
15.72
4.78
11:02:36.32
11:02:48.42
11:03:00.53
Time [UT]
C3
13.39
θErr = 4.94°
0.69
−12.00
21.64
Bn [nT]
8.95
−3.75
28.24
Bl [nT]
15.54
2.84
11:02:40.42
11:02:52.93
11:03:05.44
Time [UT]
C4
11.88
θErr = 4.45°
−0.89
−13.67
3.04
−9.74
−22.51
27.87
Bl [nT]
15.10
2.32
11:02:39.28
11:02:52.63
11:03:05.99
Time [UT]


C1
θErr = 2.65°
12.78
−0.99
−14.75
3.32
−10.45
−24.22
32.10
B_l [nT]
18.33
4.56
11:02:39.35
11:02:50.57
11:03:01.78
Time [UT]
C2
θErr = 4.93°
11.95
−1.08
−14.10
1.68
−11.35
−24.37
27.28
B_l [nT]
14.25
1.23
11:02:32.83
11:02:46.86
11:03:00.89
Time [UT]
C3
θErr = 5.66°
15.03
0.58
−13.87
24.89
B_n [nT]
10.44
−4.01
27.43
B_l [nT]
12.98
−1.47
11:02:34.62
11:02:50.30
11:03:05.98
Time [UT]
C4
θErr = 5.04°
13.27
−0.43
−14.13
3.18
−10.52
−24.22
27.43
B_l [nT]
13.73
0.03
11:02:36.20
11:02:50.98
11:03:05.77
Time [UT]


C1
θErr = 2.67°
Bm [nT]
Bn [nT]
Bl [nT]
9.87
−1.34
−12.55
2.56
−8.64
−19.85
28.22
17.01
5.80
11:02:34.31
11:02:44.73
11:02:55.14
Time [UT]
C2
θErr = 5.29°
Bm [nT]
Bn [nT]
Bl [nT]
11.52
0.56
−10.39
22.35
11.39
0.44
26.56
15.60
4.64
11:02:36.45
11:02:48.24
11:03:00.04
Time [UT]
C3
θErr = 4.79°
Bm [nT]
Bn [nT]
Bl [nT]
12.67
−0.65
−13.97
2.37
−10.95
−24.27
26.30
12.98
−0.34
11:02:37.61
11:02:49.05
11:03:00.49
Time [UT]
C4
θErr = 4.98°
Bm [nT]
Bn [nT]
Bl [nT]
12.91
−0.51
−13.93
2.19
−11.23
−24.66
26.32
12.89
−0.53
11:02:36.47
11:02:49.07
11:03:01.67
Time [UT]


C1
θErr = 2.07°
10.38
−1.33
−13.03
3.40
−8.30
−20.00
28.55
B_l [nT]
16.85
5.14
11:02:30.88
11:02:43.03
11:02:55.18
Time [UT]
C2
θErr = 4.97°
14.52
1.16
−12.20
24.84
B_n [nT]
11.48
−1.88
27.29
B_l [nT]
13.94
0.58
11:02:32.26
11:02:46.46
11:03:00.67
Time [UT]
C3
θErr = 4.83°
13.96
0.59
−12.79
24.38
B_n [nT]
11.01
−2.37
26.27
B_l [nT]
12.90
−0.48
11:02:37.48
11:02:48.92
11:03:00.36
Time [UT]
C4
θErr = 5.30°
13.41
−0.47
−14.35
3.20
−10.68
−24.56
27.32
B_l [nT]
13.44
−0.44
11:02:35.84
11:02:50.45
11:03:05.06
Time [UT]

REFERENCES

Sonnerup, B. U. Ö., & Scheible, M. 1998, in Analysis Methods for Multi-Spacecraft Data, ed. G. Paschmann & P. Daly (Noordwijk: ESA), 185–220