atmosphere

Supplementary Materials:

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Introduction

This is Supplementary Materials with two tables and two figures. Tables contain the timeslots and orbit numbers of the VMC/Venus Express (Table S1) and UVI/Akatsuki (Table S2) used in the main article. Table S3 contains early measurements of the mean zonal wind speed from the previous missions. The figures provide additional visual information that makes it easier to understand the text in the Discussion and Conclusions section.

Table S1.

Data set Number (VMC).	Date of observations Begin - End	Orbits
1	2006-06-19	0060
2	2006-12-18 - 2007-02-09	0241, 0246, 0253, 0254, 0258, 0263, 0265, 0266, 0267, 0280, 0281, 0283, 0284, 0289, 0290, 0291, 0295
3	2007-06-30 - 2007-09-10	0436, 0437, 0441, 0443, 0445, 0446, 0452, 0457, 0458, 0461, 0462, 0465, 0469, 0470, 0471, 0472, 0474, 0475, 0484, 0485, 0497, 0508
4	2008-01-21 - 2008-04-23	0641, 0649, 0653, 0655, 0656, 0662, 0664, 0669, 0672, 0674, 0678, 0679, 0682, 0686, 0688, 0689, 0690, 0692, 0694, 0696, 0697, 0699, 0702, 0704, 0708, 0717, 0718, 0722, 0723, 0727, 0728, 0731, 0734
5	2008-09-04 - 2008-12-09	0868, 0871, 0875, 0876, 0880, 0884, 0887, 0889, 0892, 0893, 0894, 0895, 0898, 0900, 0901, 0902, 0906, 0910, 0911, 0913, 0914, 0916, 0919, 0920, 0922, 0924, 0926, 0931, 0932, 0936, 0937, 0938, 0940, 0942, 0964
6	2009-04-14 - 2009-07-26	1090, 1093, 1094, 1102, 1103, 1104, 1105, 1107, 1108, 1109, 1113, 1114, 1117, 1118, 1120, 1121, 1122, 1123, 1126, 1127, 1131, 1171, 1177, 1179, 1184, 1185
7	2009-11-21 - 2010-02-19	1310, 1312, 1313, 1315, 1317, 1318, 1319, 1320, 1321, 1322, 1324, 1325, 1326, 1328, 1329, 1330, 1331, 1332, 1333, 1334, 1335, 1337, 1339, 1340, 1341, 1342, 1343, 1344, 1345, 1346, 1347, 1374, 1375, 1376, 1377, 1378, 1380, 1381, 1382, 1383, 1384, 1385, 1386, 1387, 1388, 1389, 1390, 1391, 1392, 1394, 1395, 1397, 1398, 1399, 1400, 1401
8	2010-06-28 - 2010-10-12	1530, 1532, 1544, 1545, 1546, 1548, 1550, 1551, 1552, 1591, 1592, 1593, 1594, 1595, 1596, 1597, 1598, 1599, 1600, 1601, 1602, 1604, 1605, 1606, 1608, 1610, 1611, 1612, 1613, 1614, 1617, 1622, 1623, 1628, 1630, 1631, 1632, 1634, 1635, 1636

9	2011-02-13 - 2011-05-06	1760, 1763, 1770, 1774, 1775, 1780, 1782, 1783, 1787, 1793, 1796, 1797, 1800, 1802, 1803, 1804, 1806, 1808, 1813, 1814, 1820, 1821, 1822, 1823, 1827, 1828, 1829, 1830, 1831, 1834, 1840, 1841, 1842
10	2011-10-02 - 2011-12-18	1991, 1994, 1998, 1999, 2010, 2012, 2013, 2014, 2016, 2017, 2018, 2020, 2031, 2032, 2034, 2035, 2037, 2039, 2040, 2042, 2043, 2044, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068
11	2012-05-18 - 2012-08-01	2220, 2223, 2224, 2225, 2226, 2227, 2228, 2231, 2233, 2245, 2247, 2250, 2254, 2258, 2262, 2264, 2268, 2273, 2274, 2275, 2276, 2280, 2281, 2283, 2287, 2295
12	2012-12-28- 2013-02-20	2444, 2450, 2452, 2453, 2454, 2457, 2459, 2460, 2463, 2464, 2465, 2466, 2468, 2469, 2470, 2472, 2473, 2475, 2482, 2484, 2486, 2491, 2494, 2495, 2497, 2498
13	2013-07-30 - 2013-09-26	2658, 2659, 2662, 2667, 2680, 2684, 2687, 2690, 2691, 2693, 2695, 2697, 2699, 2713, 2714, 2715

Table S2.

Data set Number (UVI)	Date of observations Begin - End	Orbits
1	2016-04-25 - 2016-07-23	013, 014, 015, 016, 018, 019, 020, 021, 022
2	2016-11-09 - 2017-03-10	031, 032, 033, 035, 036, 037, 038, 039, 040, 043
3	2017-06-26 - 2017-10-27	052, 053, 054, 055, 056, 057, 058, 059, 060, 061, 062, 063, 064
4	2018-02-01 - 2018-05-24	072, 073, 074, 075, 076, 077, 078, 079, 080, 081, 082, 083
5	2018-08-30 - 2018-12-29	091, 092, 093, 094, 095, 096, 097, 098, 099, 100, 101, 102, 103
6	2019-04-07 - 2019-07-27	111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122
7	2019-11-22 - 2020-06-08	132, 133, 134, 135, 136, 137, 139, 140, 141, 142, 143
8	2020-06-19 - 2020-10-29	150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 163, 164
9	2021-02-14 - 2021-05-28	173, 174, 175, 176, 178, 179, 180, 181, 182, 183

Table S3.

Number	Experiment/Mission	Date of observation	Zonal speed (m/s)
1	TPE/Mariner-10	1974.10	-92.0
2	OCPP/Pioneer Venus	1979.20	-93.8
3	OCPP/Pioneer Venus	1980.40	-92.8
4	OCPP/Pioneer Venus	1982.30	-87.6
5	OCPP/Pioneer Venus	1983.50	-90.7
6	OCPP/Pioneer Venus	1985.40	-94.2
7	SSI/Galileo	1990.23	-103.2

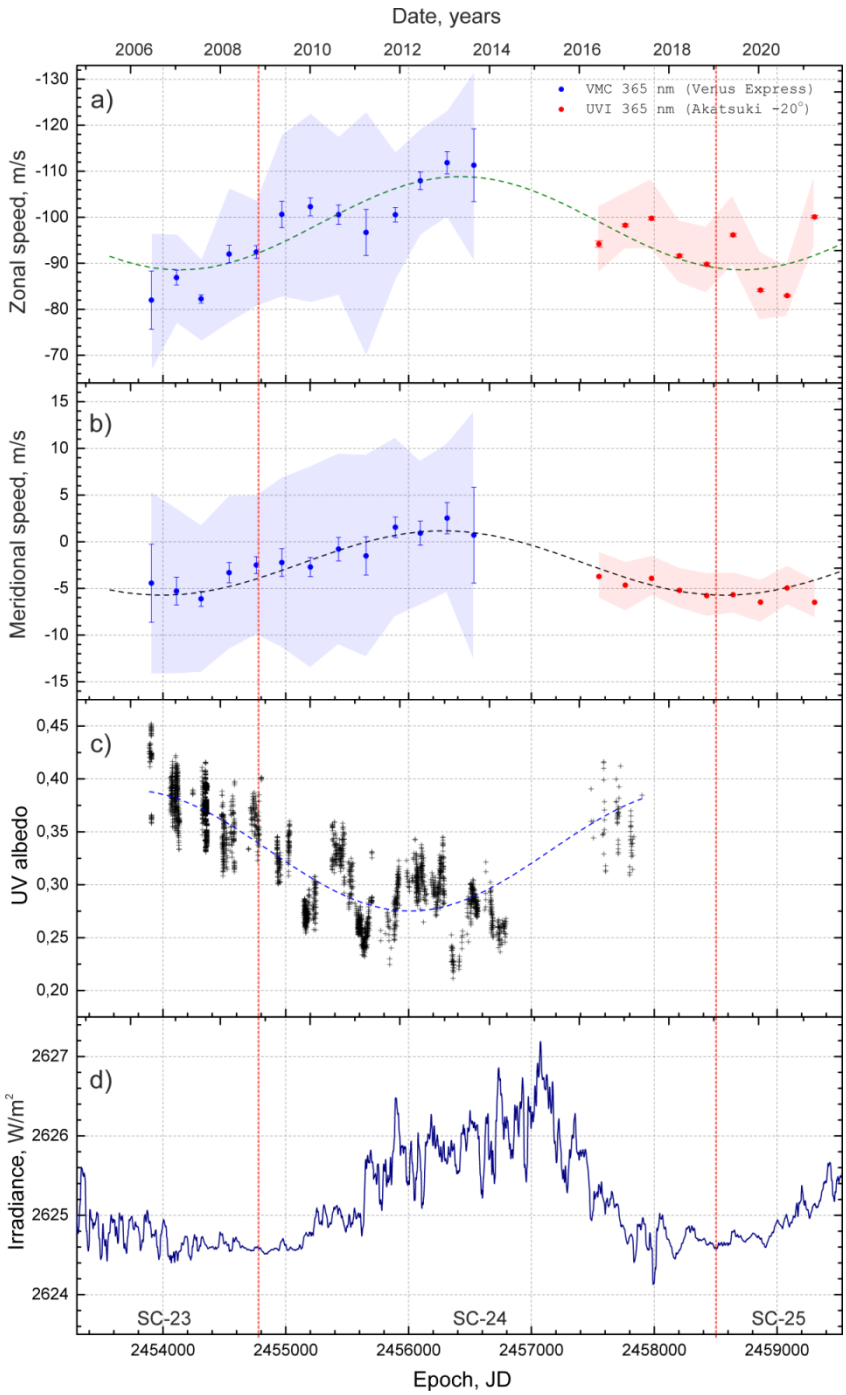

Figure S1. Long-term variations of the mean zonal (a) and meridional (b) wind speed at 20±2.5ºS over the mission time from 11 to 13 LT. Each point is the result of averaging over the Venusian year (224.7 days) in the latitude band 20±2.5°S around noon (12±1h). Blue circles show zonal wind averaged through the Venusian year derived from VMC images, red circles are the same for UVI. The vertical red dotted lines mark the boundaries between Solar cycles. The green dashed lines denote the approximating sinusoids. The error bars correspond to the 99.6% confidence interval ($3\cdot\sigma_{\overline{x}}$). Colored shaded areas correspond to the standard deviations σ. UV albedo at 0-30°S (Figure 5 in [13]) for 85-90° phase angle (c). Total Solar Irradiance on Venus over mission time (d).

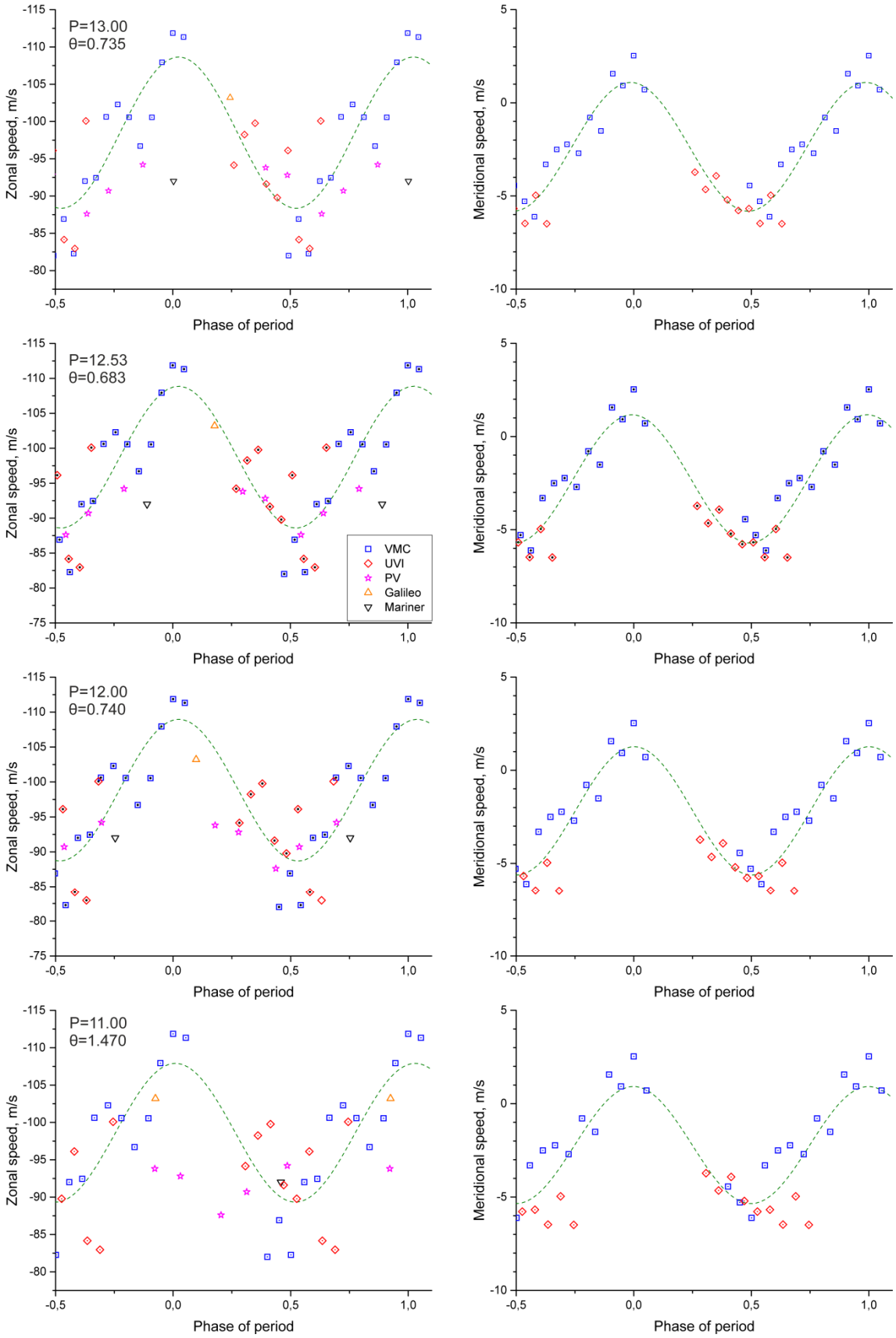

Figure S2. Phase curves of the zonal (left column) and meridional (right column) components of the wind speed for the periods of 13.0 (top), 12.5, 12.0 and 11.0 (bottom) years. The period and corresponded parameter θ are indicated in the upper left corner of each zonal wind plot.

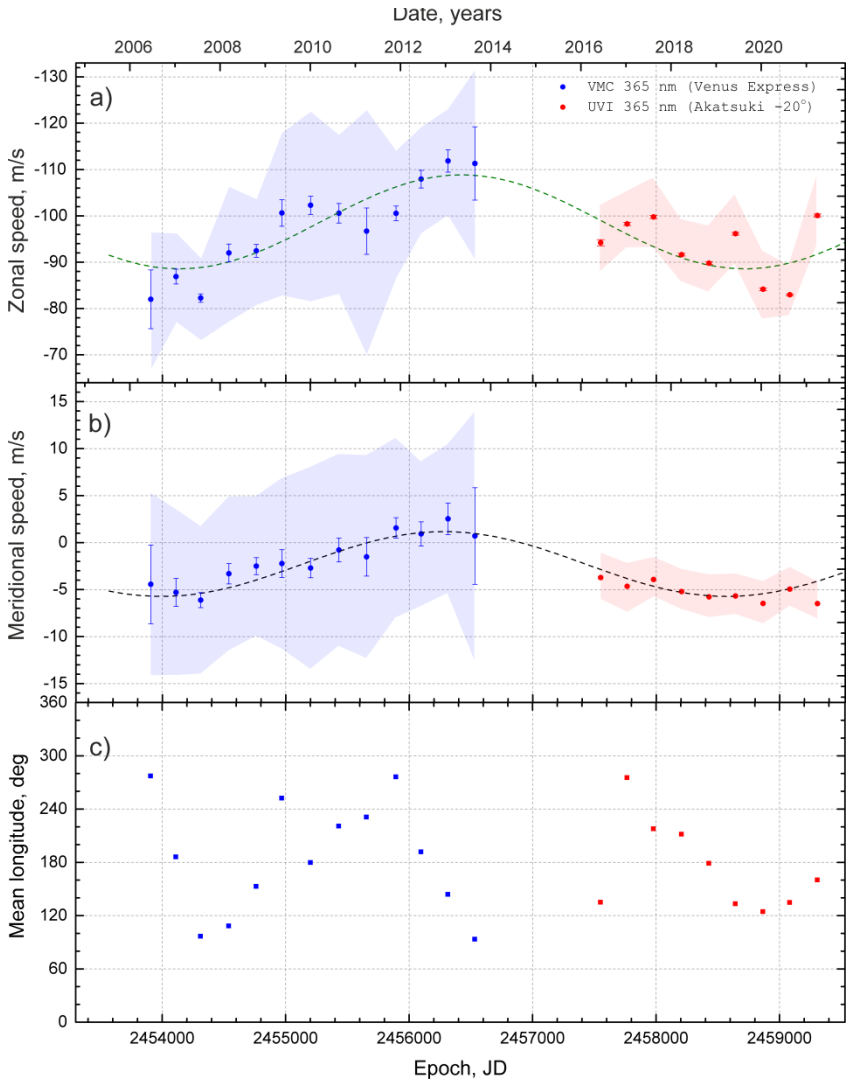

Figure S3. Long-term variations of the mean zonal (a) and meridional (b) wind speed at 20±2.5°S at around noon (12±1^{h} LT) derived from the VMC/ Venus Express (blue) and UVI/ Akatsuki (red) imaging, and mean longitude averaged over Venusian year corresponding to the wind measurements (c).