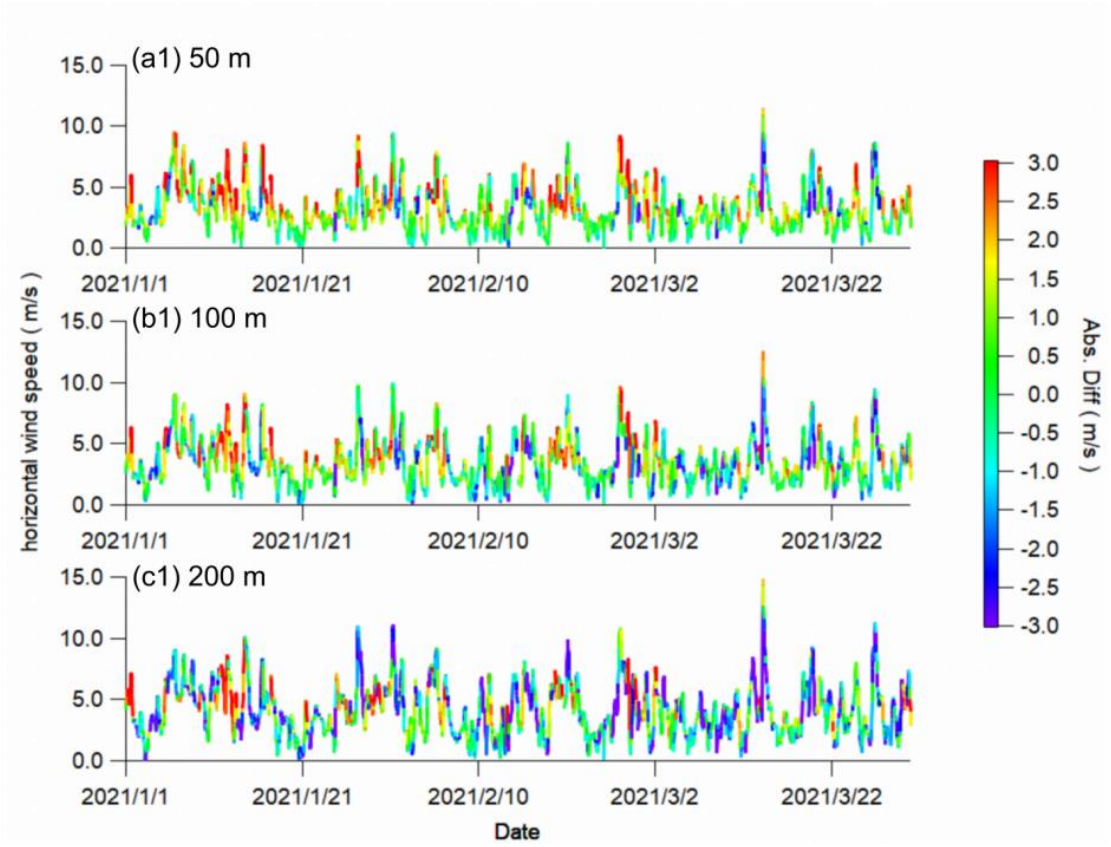
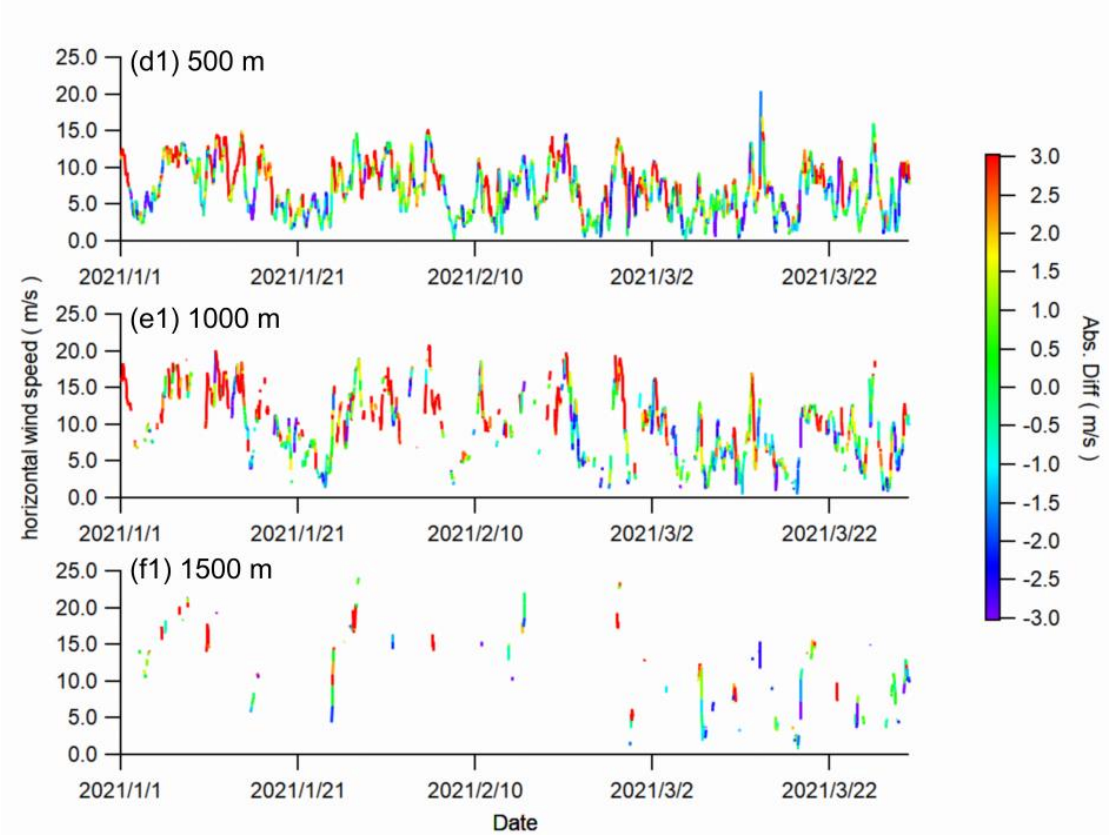

(a1) 50 m
(b1) 100 m
(c1) 200 m
horizontal wind speed (m/s)
15.0
10.0
5.0
0.0
2021/1/1
2021/1/21
2021/2/10
2021/3/2
2021/3/22
Date
Abs. Diff (m/s)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0


(d1) 500 m
(e1) 1000 m
(f1) 1500 m
horizontal wind speed (m/s)
25.0
20.0
15.0
10.0
5.0
0.0
2021/1/1
2021/1/21
2021/2/10
2021/3/2
2021/3/22
Date
Abs. Diff (m/s)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0

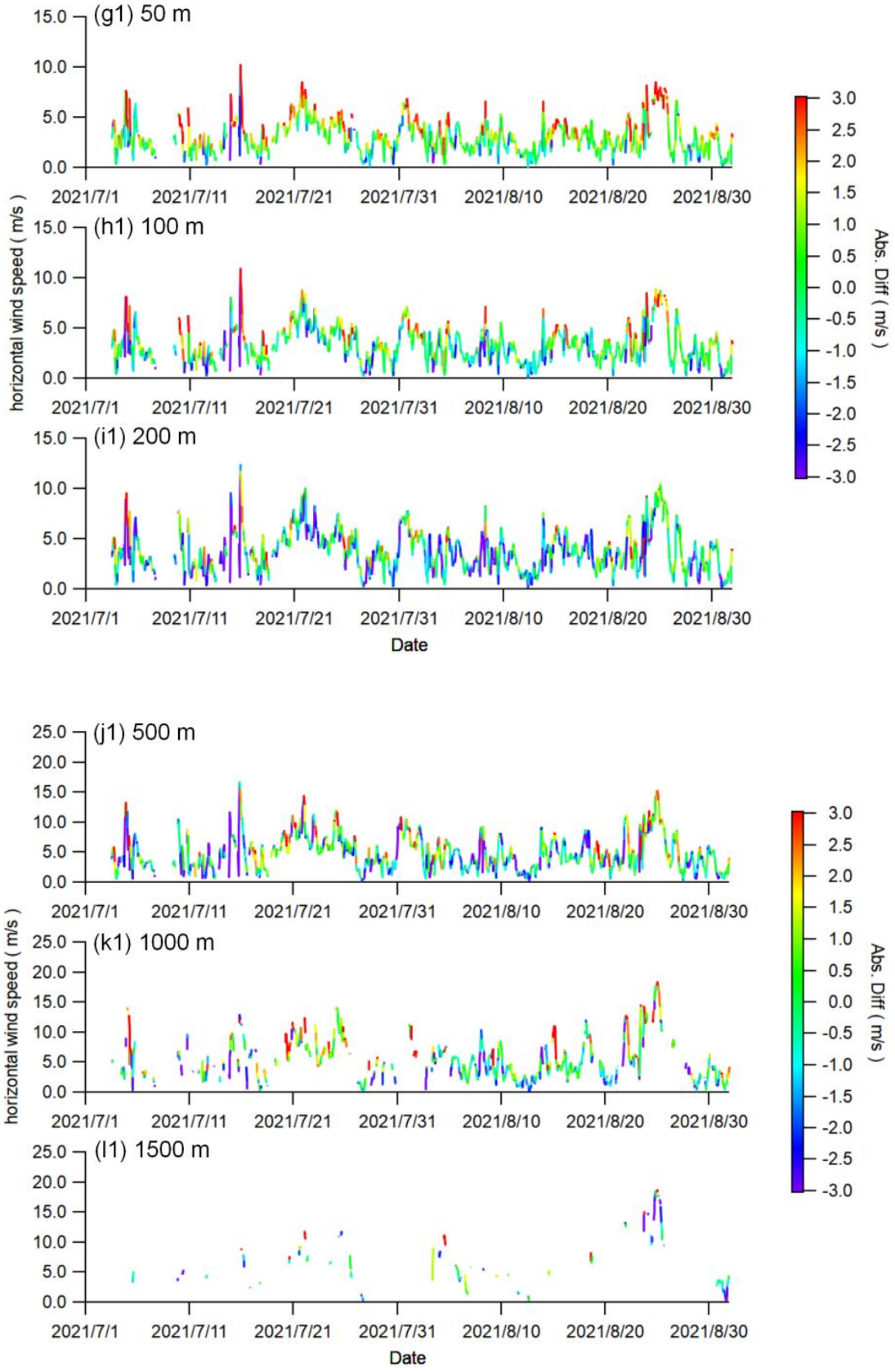
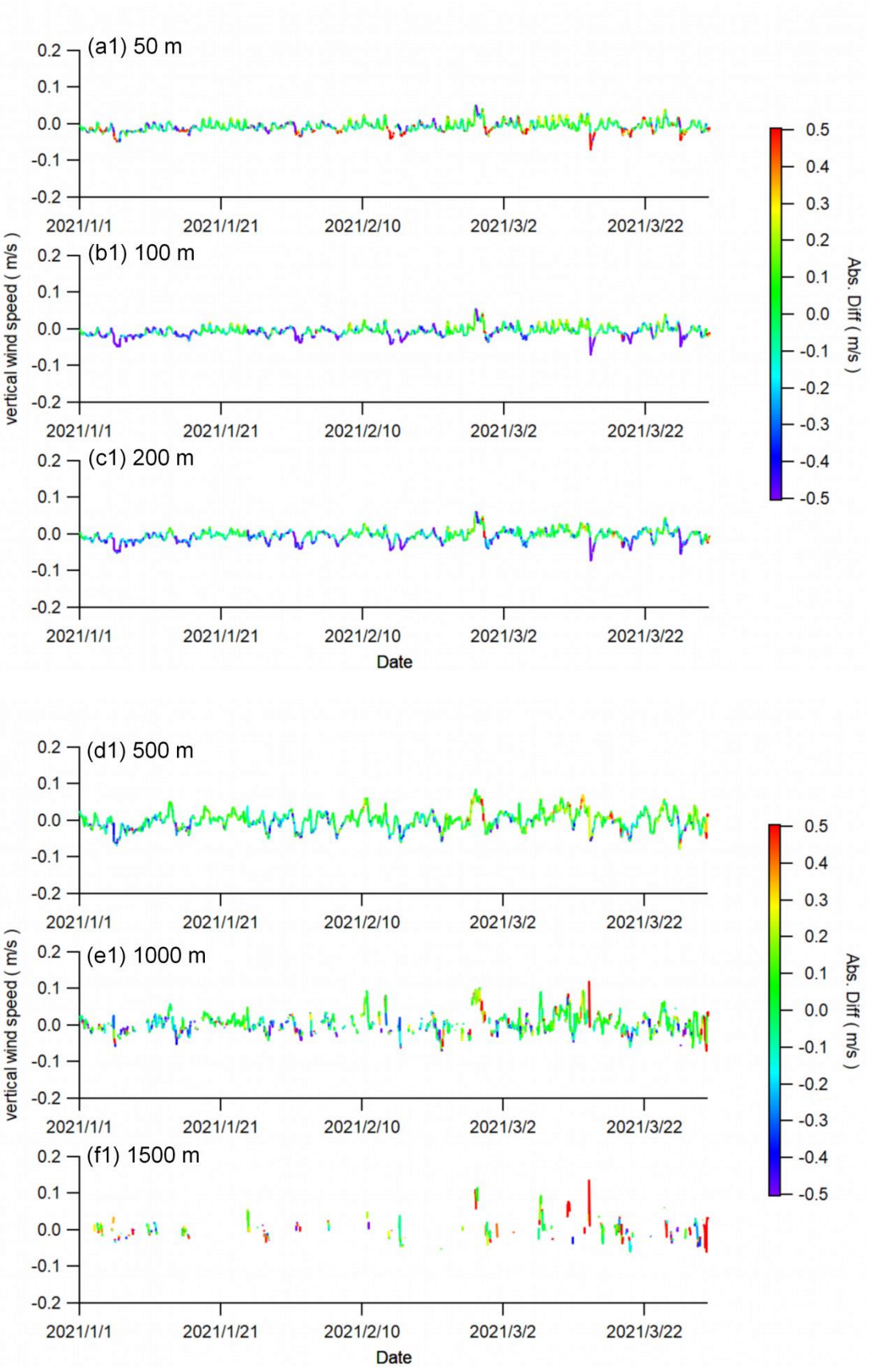


Figure S1. Time-series plot of horizontal wind speeds for ERA5 data at each altitude superimposed on the ERA5 absolute deviation plot (ERA5 reanalysis data values minus

observed data values).



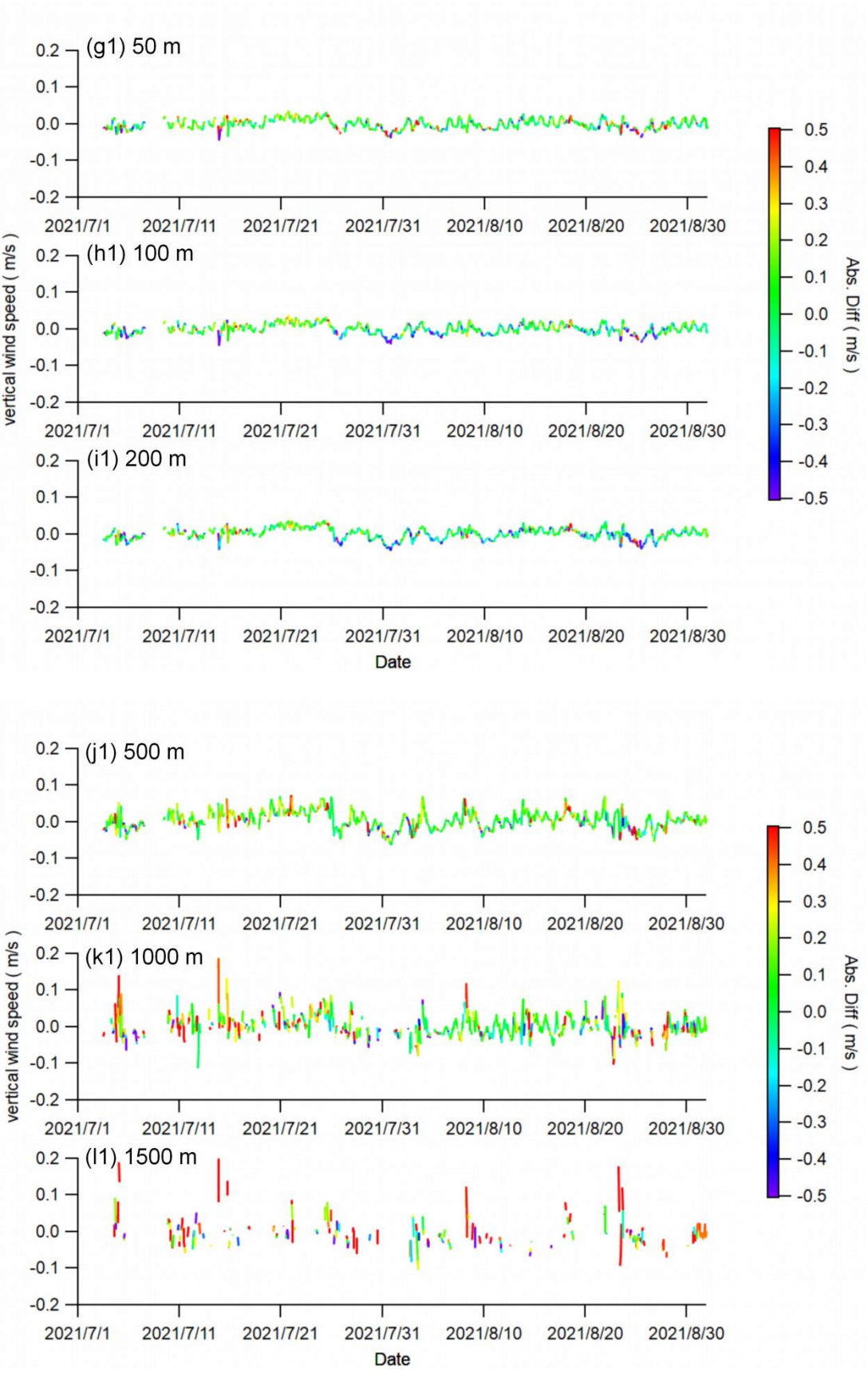
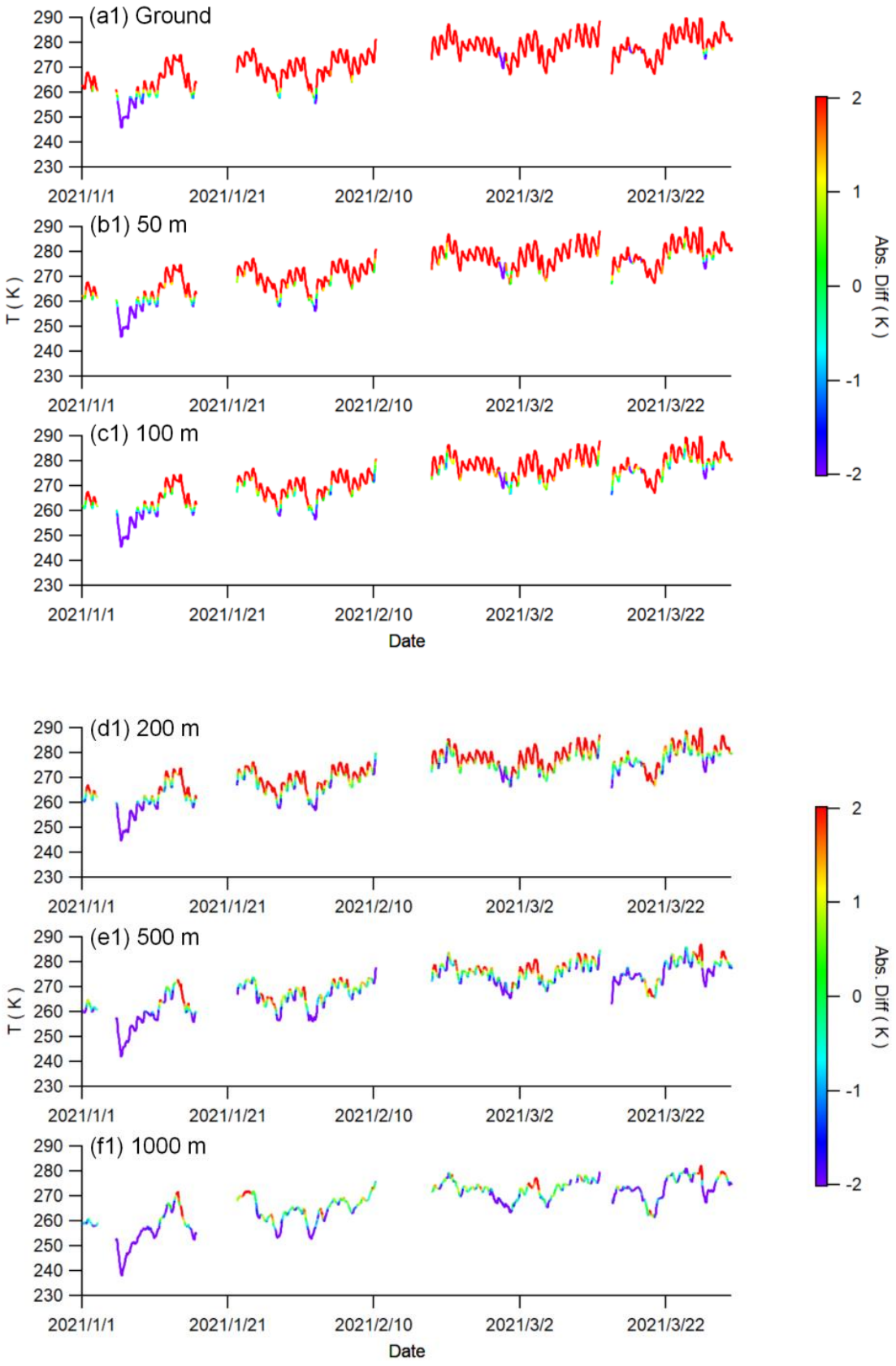
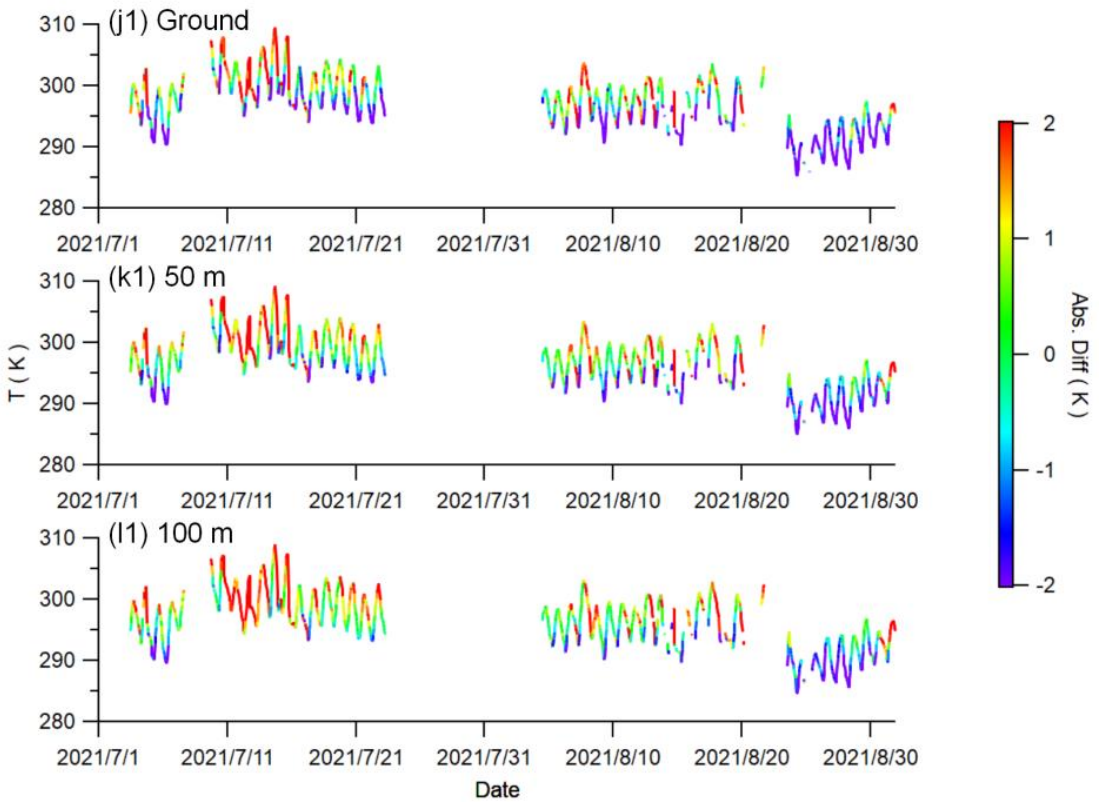


Figure S2. Time-series plot of vertical wind speeds for ERA5 data at each altitude superimposed on the ERA5 absolute deviation plot (ERA5 reanalysis data values minus

observed data values).




(g1) 1500 m
(h1) 2000 m
(i1) 3000 m
T (K)
290
280
270
260
250
240
230
2021/1/1
2021/1/21
2021/2/10
2021/3/2
2021/3/22
Date
Abs. Diff (K)
4
2
0
-2
-4


(j1) Ground
(k1) 50 m
(l1) 100 m
T (K)
310
300
290
280
2021/7/1
2021/7/11
2021/7/21
2021/7/31
2021/8/10
2021/8/20
2021/8/30
Date
Abs. Diff (K)
2
1
0
-1
-2

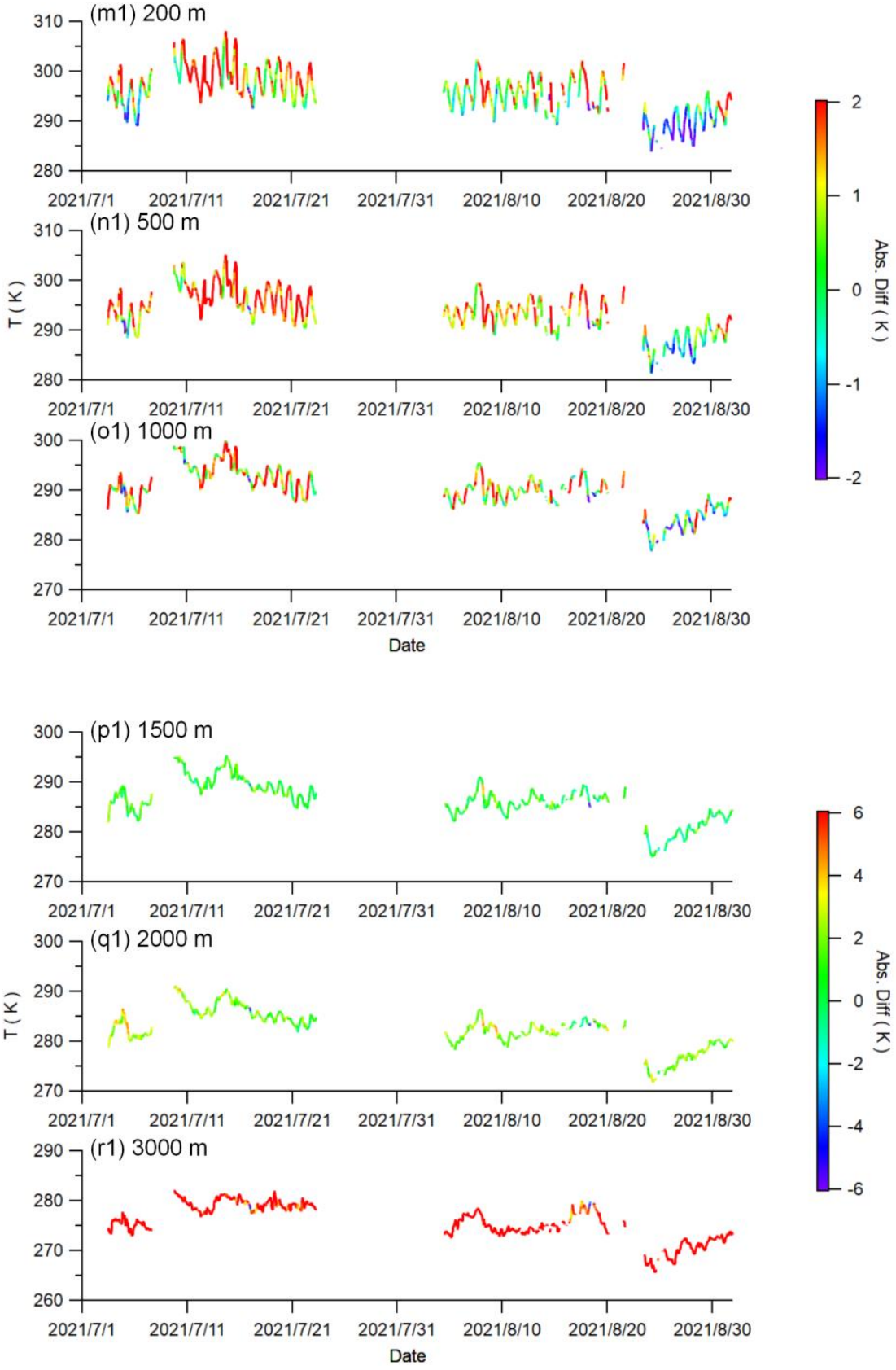
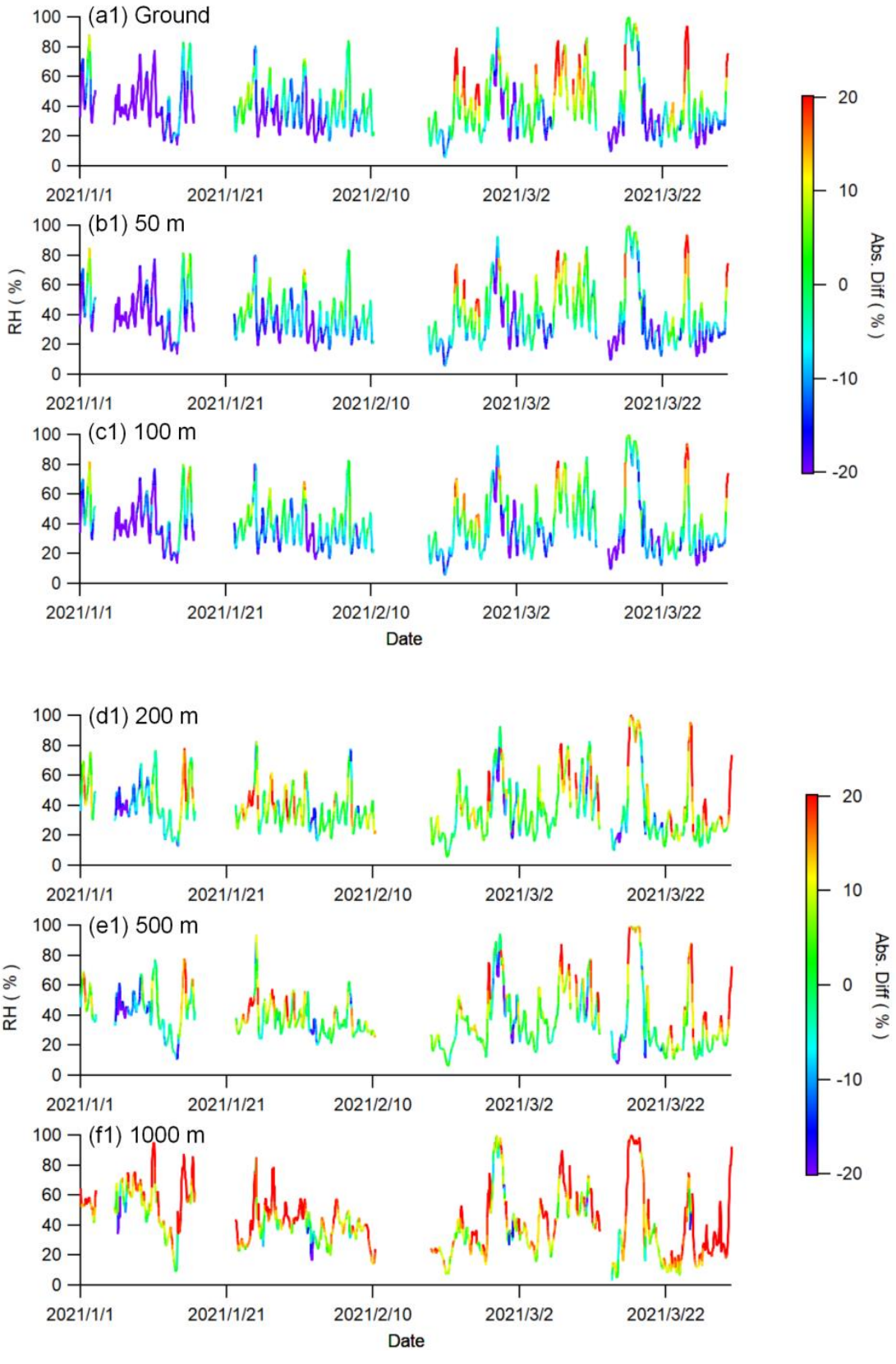
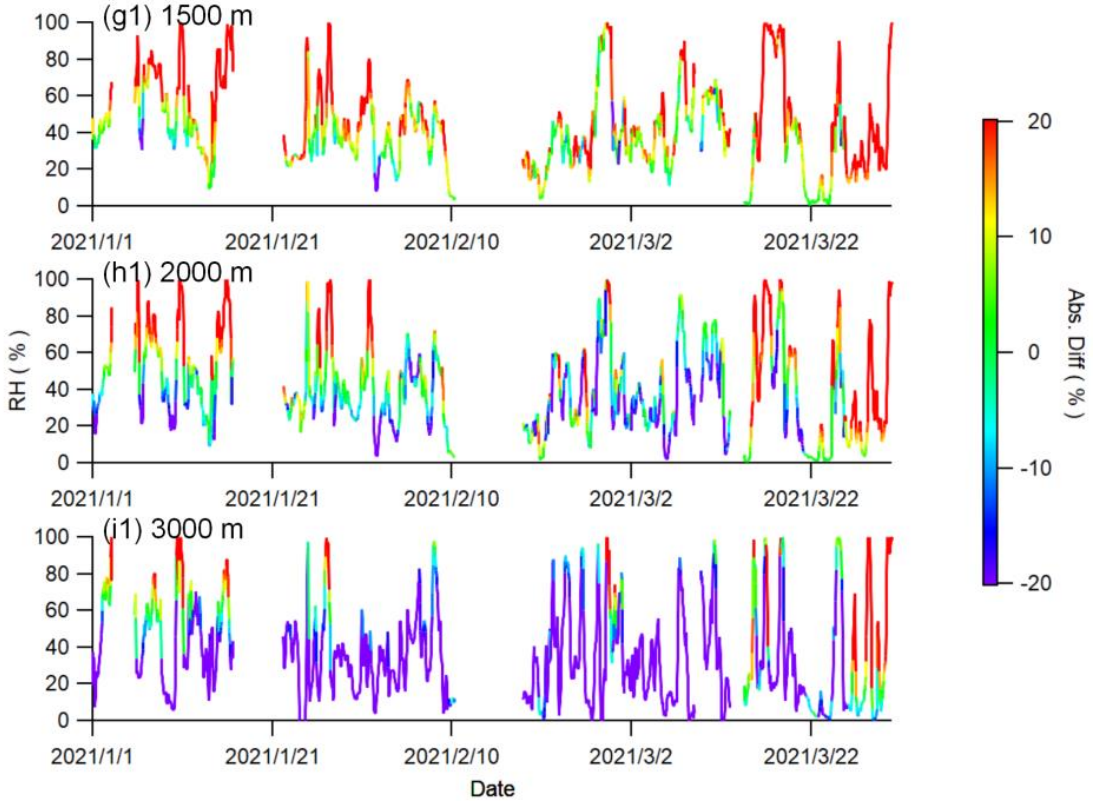
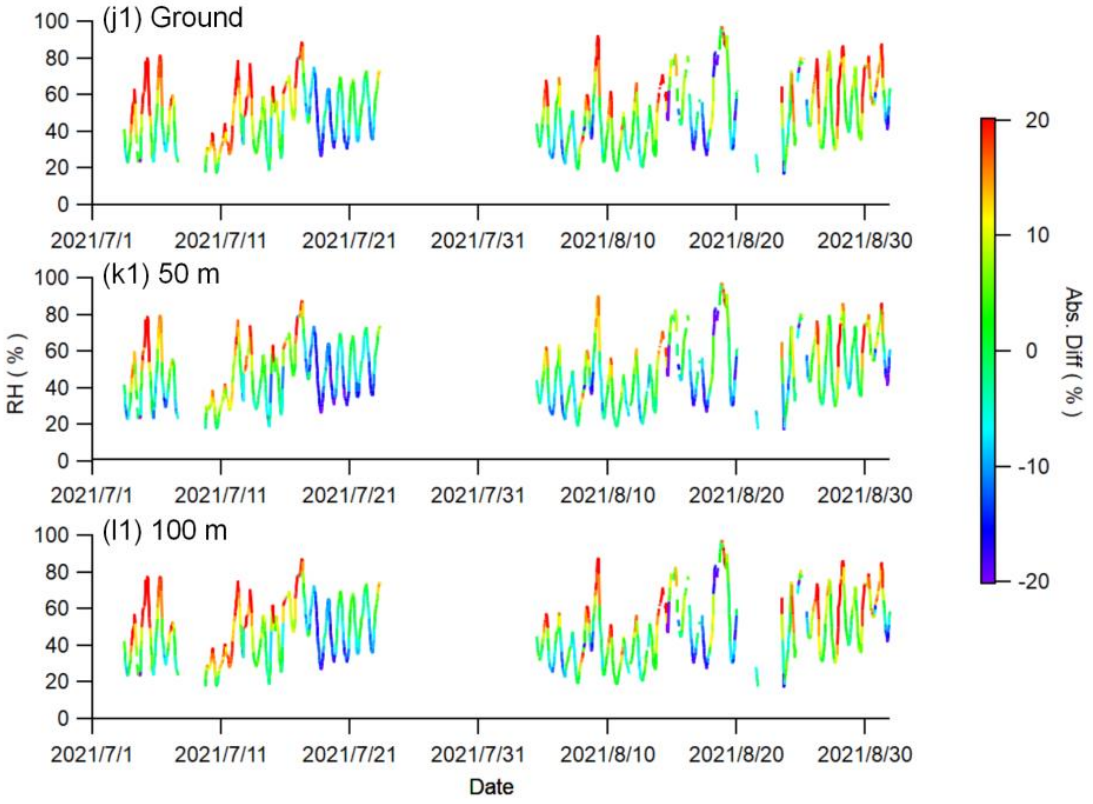


Figure S3. Time-series plot of temperature for ERA5 data at each altitude superimposed on the ERA5 absolute deviation plot (ERA5 reanalysis data values minus observed data

values).


(a1) Ground
(b1) 50 m
(c1) 100 m
(d1) 200 m
(e1) 500 m
(f1) 1000 m
RH (%)
Date
2021/1/1
2021/1/21
2021/2/10
2021/3/2
2021/3/22
Abs. Diff (%)
20
10
0
-10
-20


(g1) 1500 m
(h1) 2000 m
(i1) 3000 m
RH (%)
Date
2021/1/1
2021/1/21
2021/2/10
2021/3/2
2021/3/22
Abs. Diff (%)
20
10
0
-10
-20


(j1) Ground
(k1) 50 m
(l1) 100 m
RH (%)
Date
2021/7/1
2021/7/11
2021/7/21
2021/7/31
2021/8/10
2021/8/20
2021/8/30
Abs. Diff (%)
20
10
0
-10
-20

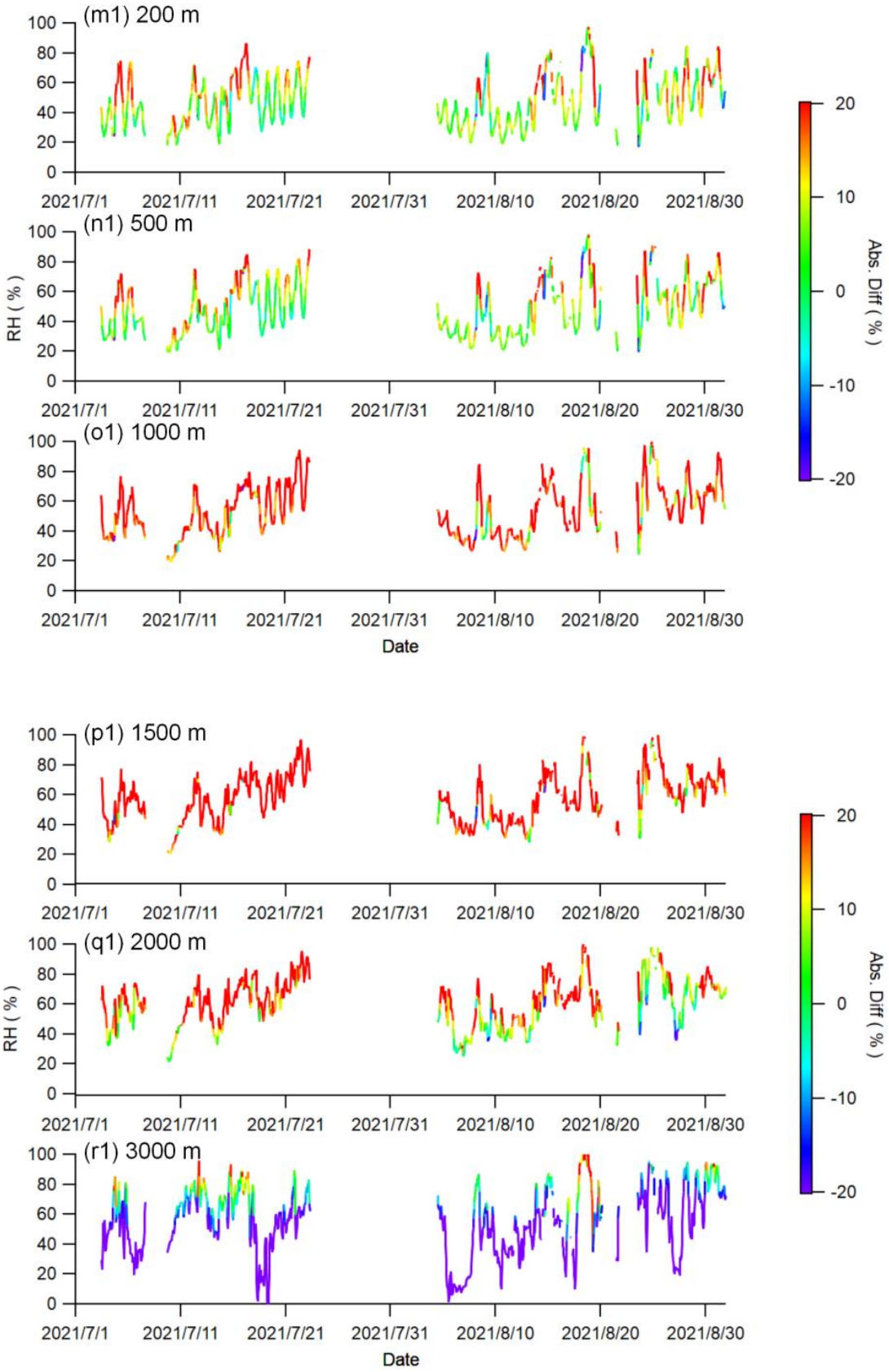


Figure S4. Time-series plot of relative humidity for ERA5 data at each altitude superimposed on the ERA5 absolute deviation plot (ERA5 reanalysis data values minus

observed data values).

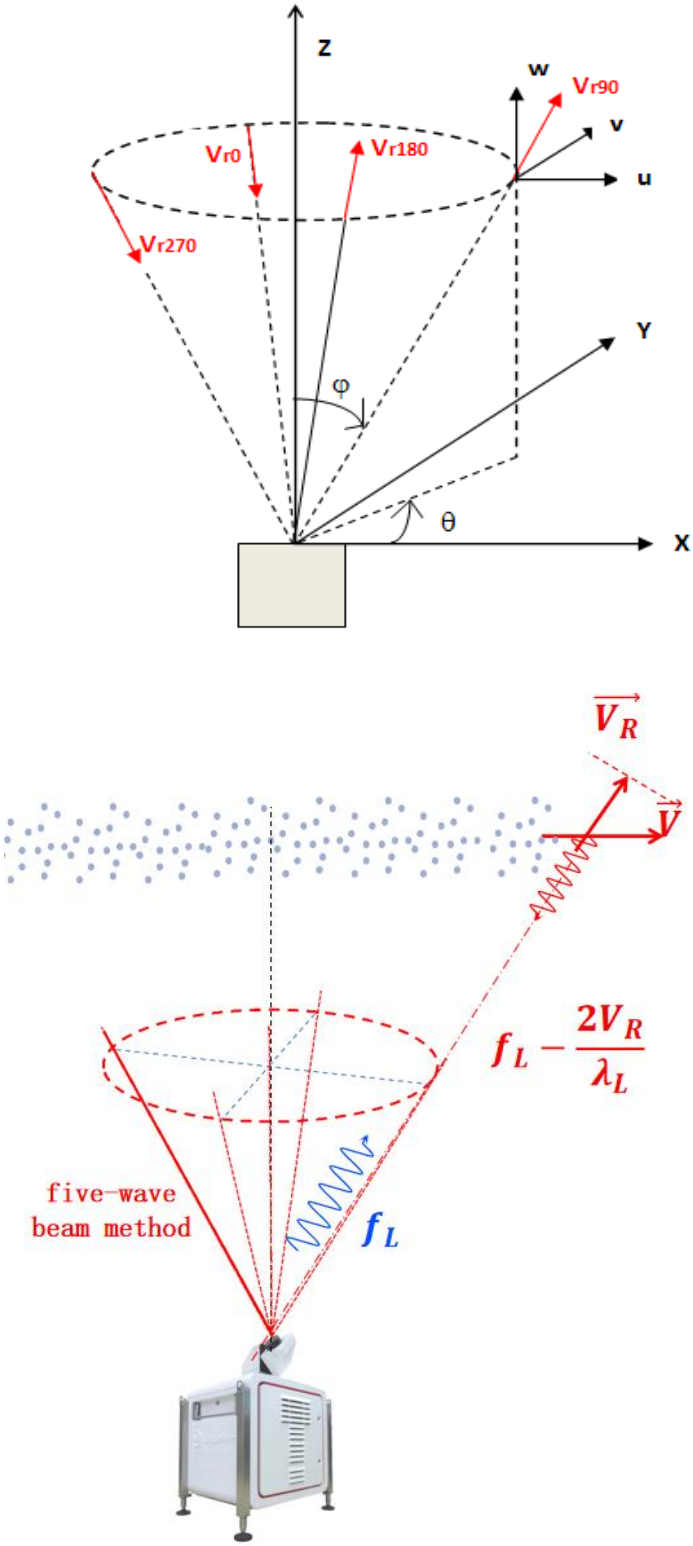


Figure S5. Detection Principle of WindCube 100S

Detection Principle of WindCube 100S:

The Doppler wind profiling lidar measures the wind speed in the direction of the emitted beam, which is the radial wind speed (Vr). The lidar performs conical scanning at a fixed angle of $\theta=75^{\circ}$, obtaining the radial wind speeds (Vr) on the surface of the conical scan. Specifically, it extracts the radial wind speeds at the four azimuthal directions: Vr270, Vr0, Vr90, and Vr180. Using the conical angle θ of the DBS (Doppler Beam Swinging) scanning mode, the radial wind speeds in these directions are decomposed and combined based on trigonometric relationships to calculate the horizontal wind speed components (u,v), the wind direction (β), and the vertical wind speed (w) at different heights along the vertical direction. The vertical wind speed w is directly measured as the radial wind speed by the lidar's vertical beam. The specific calculations are as follows:

$$u=(Vr90-Vr270)/2\sin\theta$$

$$v=(Vr0-Vr180)/2\sin\theta$$

$$w=Vr$$

$$Vh=(u^2+v^2)^{1/2}$$

$$\beta=\arctan(v/u)$$