Laseyer Rotor - Dynamics and Climatology follow-up studies

Laseyer Rotor - Dynamics and Climatology follow-up studies

Lukas Egloff

January 2010

Contents

1 Wind, temperature and precipitation for Wasserauen and Ebenalp

The following plots show wind direction, wind velocity, temperature and precipitation in Wasserauen as well as wind direction, wind velocity and potential temperature on Ebenalp for selected Laseyer Events between 1998 and 2009.

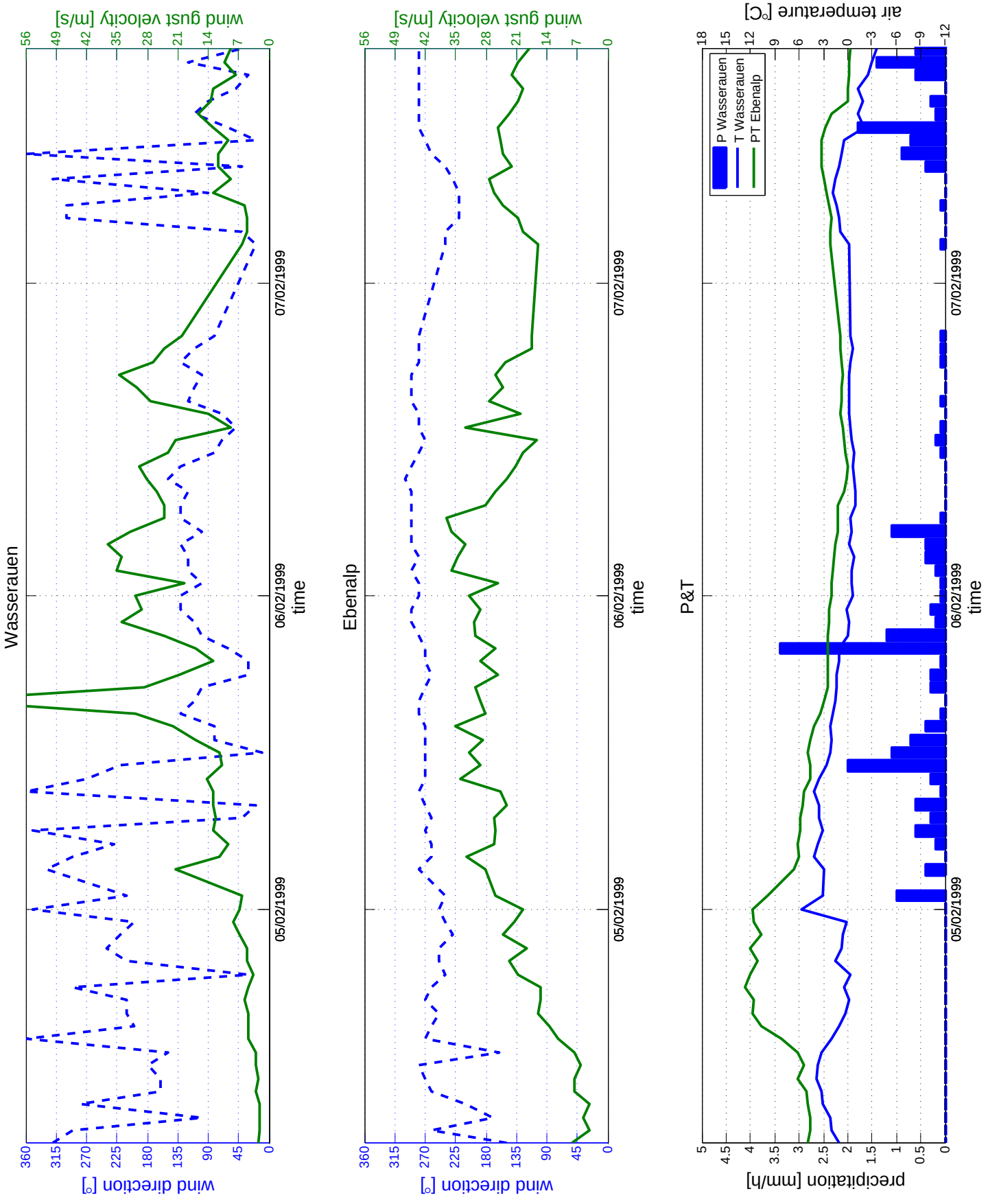

Wasserauen
wind direction [°]
wind gust velocity [m/s]
05/02/1999
06/02/1999
07/02/1999
time
Ebenalp
wind direction [°]
wind gust velocity [m/s]
05/02/1999
06/02/1999
07/02/1999
time
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp
05/02/1999
06/02/1999
07/02/1999
time

Figure 1.1

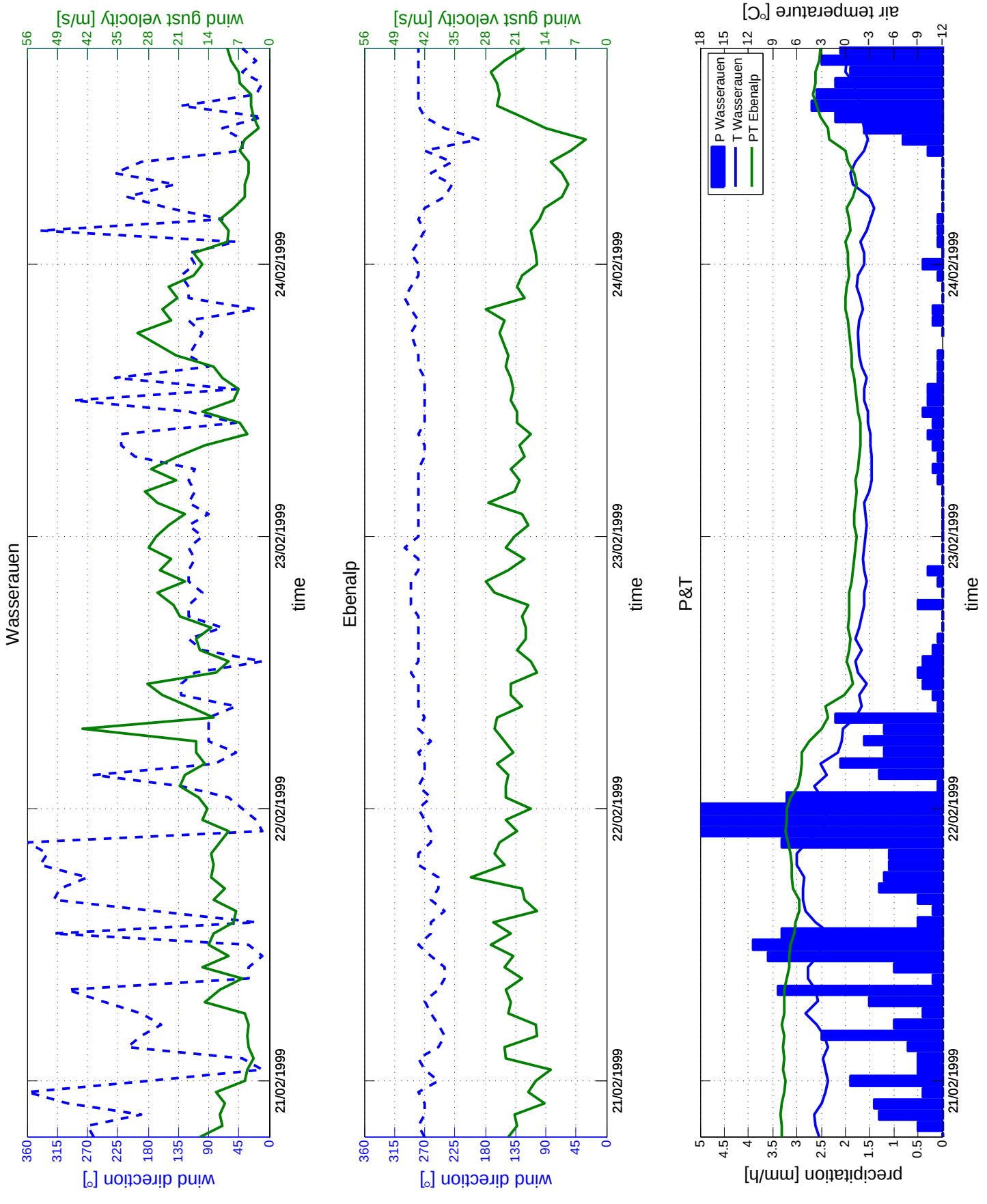

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
21/02/1999
22/02/1999
23/02/1999
24/02/1999
Ebenalp
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 1.2

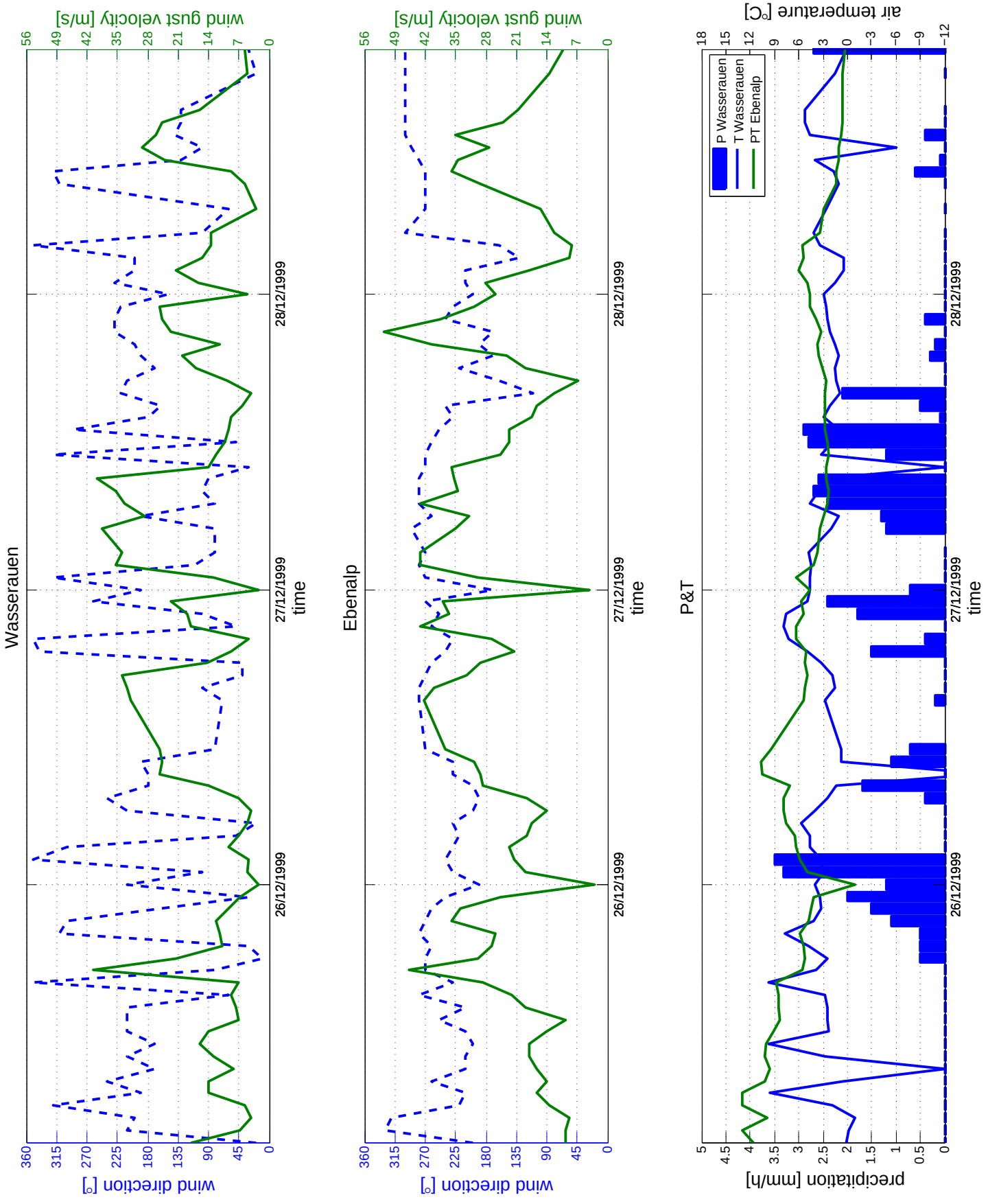

Wasserauen
wind direction [°]
wind gust velocity [m/s]
26/12/1999
27/12/1999
28/12/1999
time
Ebenalp
wind direction [°]
wind gust velocity [m/s]
26/12/1999
27/12/1999
28/12/1999
time
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp
26/12/1999
27/12/1999
28/12/1999
time

Figure 1.3

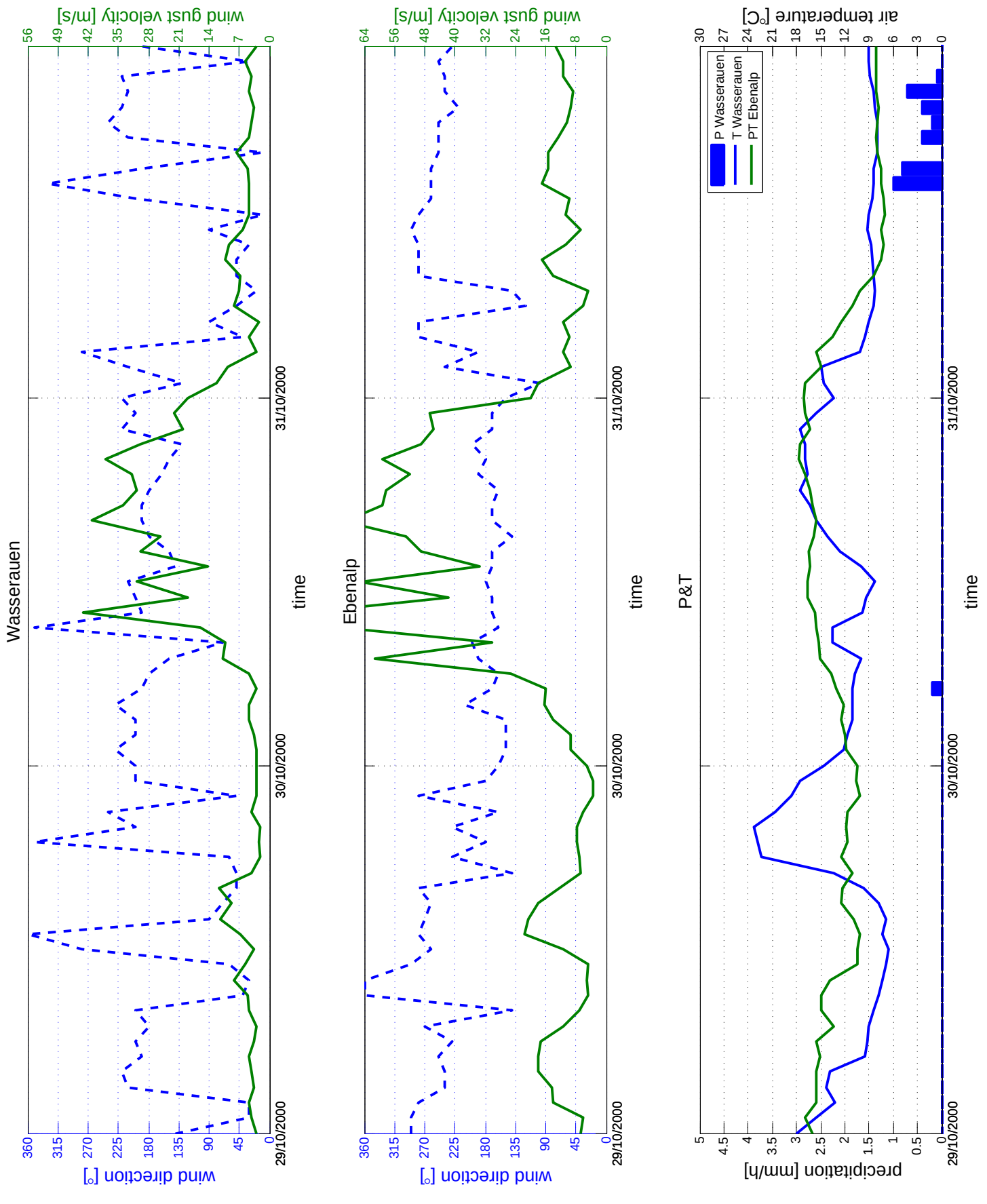

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
29/10/2000
30/10/2000
31/10/2000
Ebenalp
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 1.4

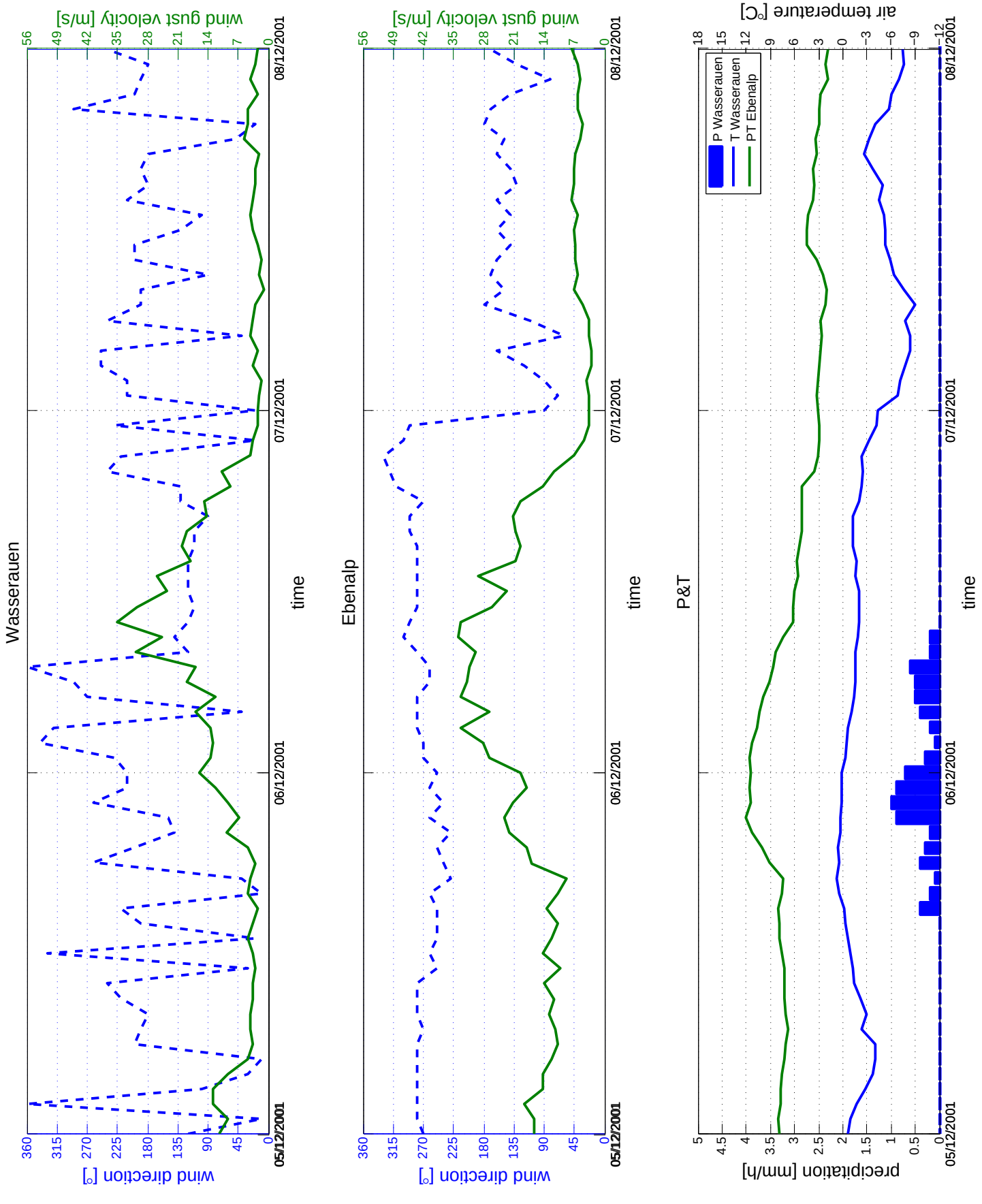

Wasserauen
wind gust velocity [m/s]
wind direction [°]
time
05/12/2001
06/12/2001
07/12/2001
08/12/2001
Ebenalp
P&T
air temperature [°C]
precipitation [mm/h]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 1.5

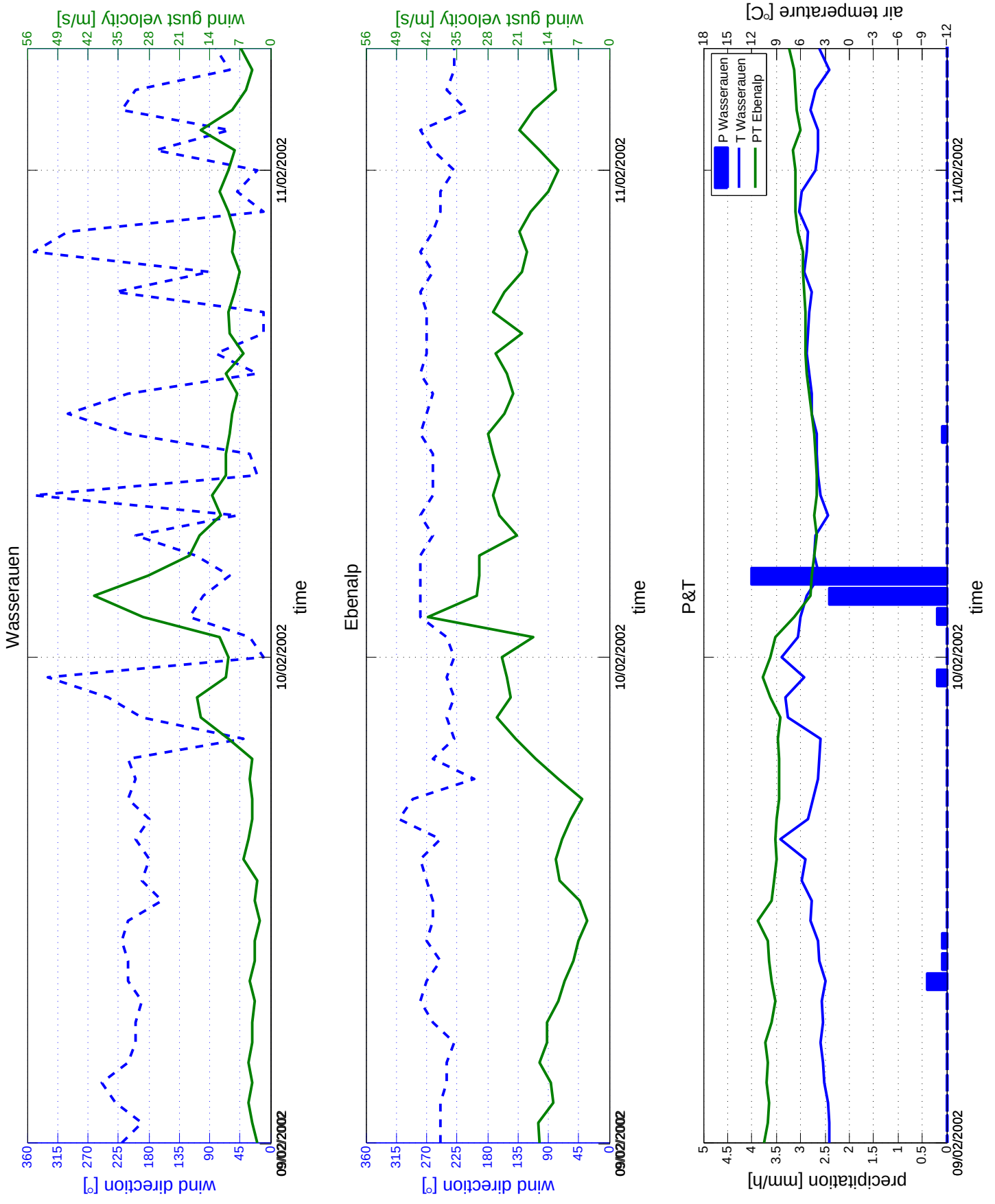

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
09/02/2002
10/02/2002
11/02/2002
Ebenalp
wind direction [°]
wind gust velocity [m/s]
time
09/02/2002
10/02/2002
11/02/2002
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp
time
09/02/2002
10/02/2002
11/02/2002

Figure 1.6

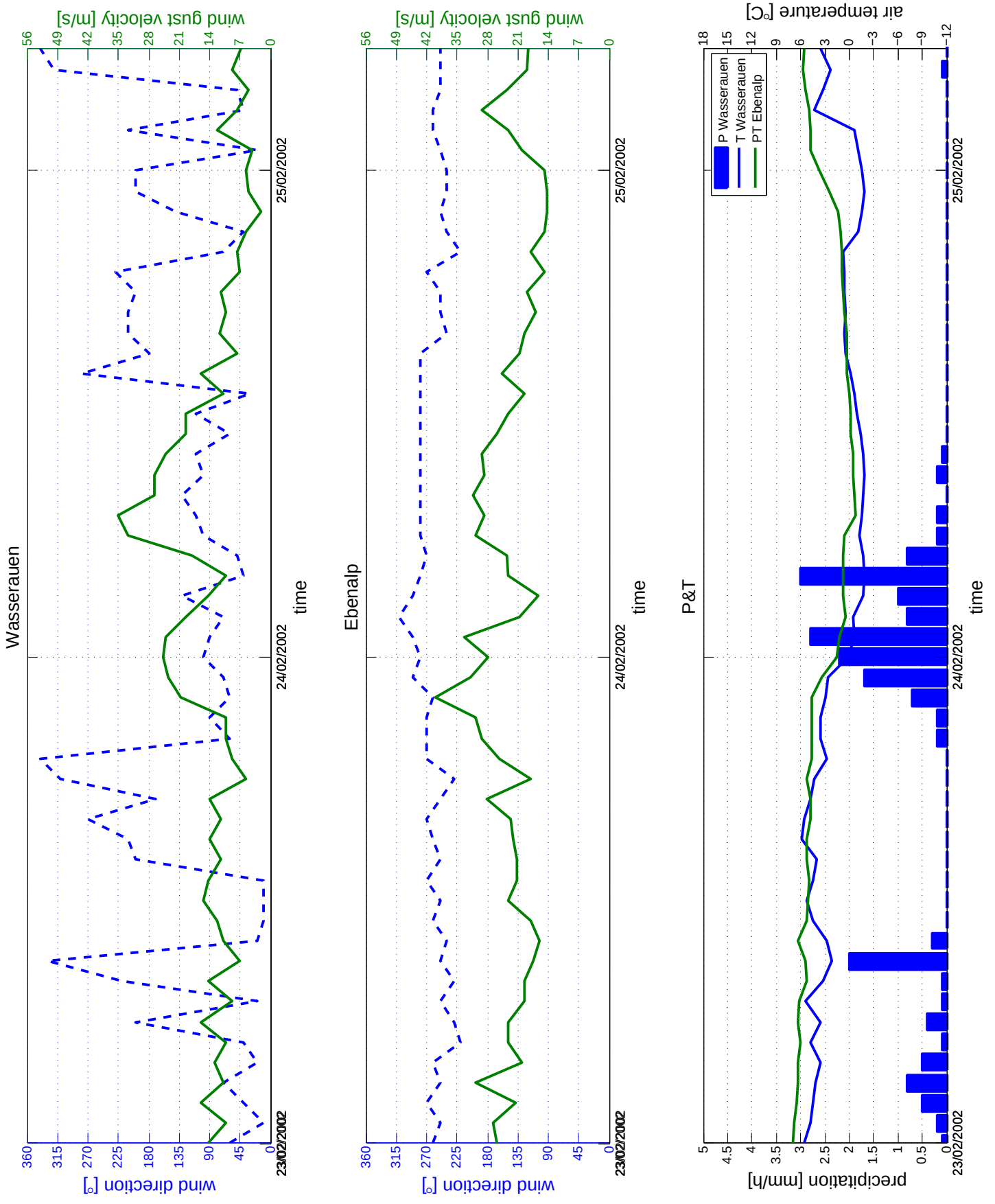

Wasserauen
wind gust velocity [m/s]
wind direction [°]
time
23/02/2002
24/02/2002
25/02/2002
Ebenalp
wind gust velocity [m/s]
wind direction [°]
time
23/02/2002
24/02/2002
25/02/2002
P&T
air temperature [°C]
precipitation [mm/h]
P Wasserauen
T Wasserauen
PT Ebenalp
time
23/02/2002
24/02/2002
25/02/2002

Figure 1.7

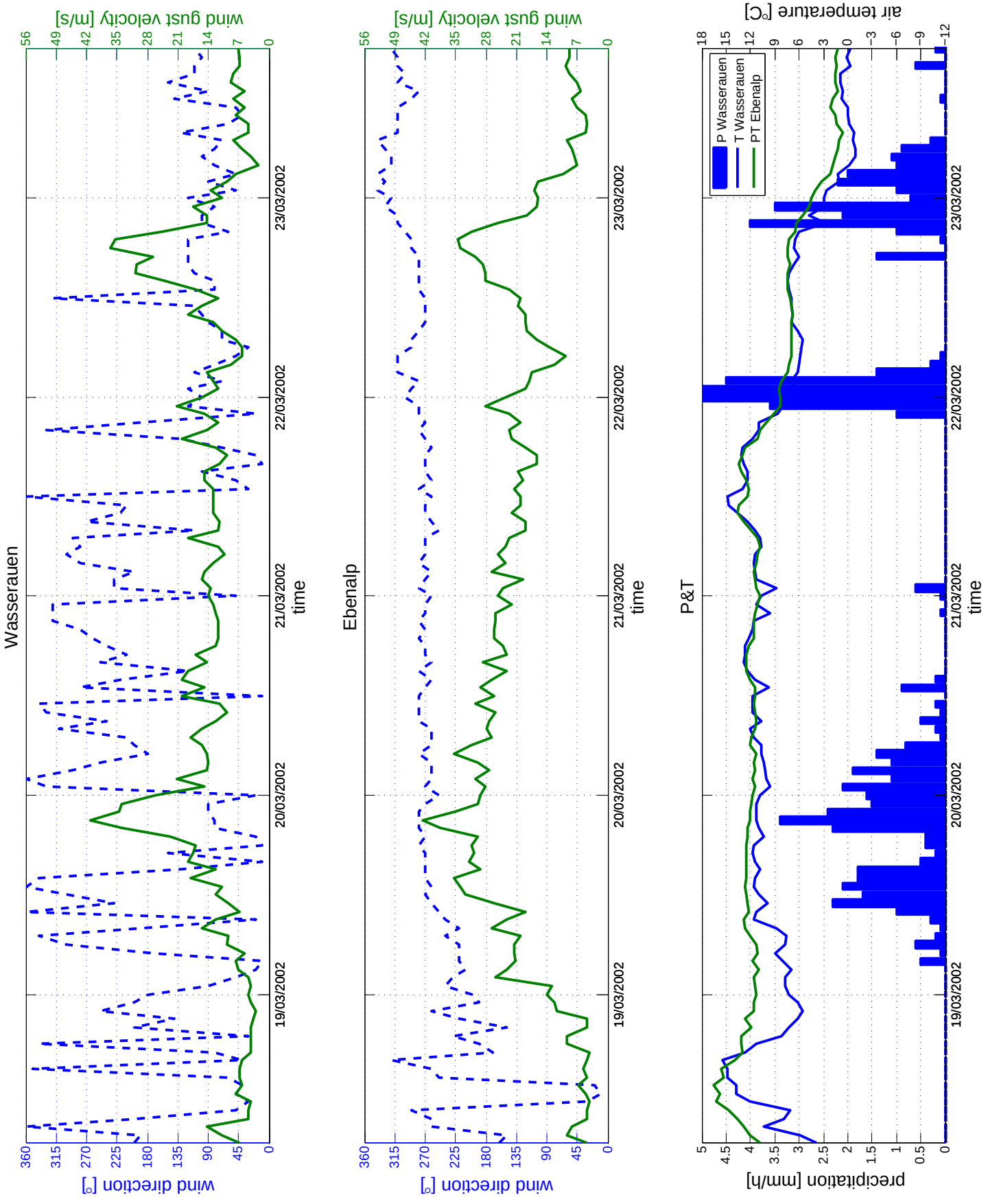

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
19/03/2002
20/03/2002
21/03/2002
22/03/2002
23/03/2002
Ebenalp
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 1.8

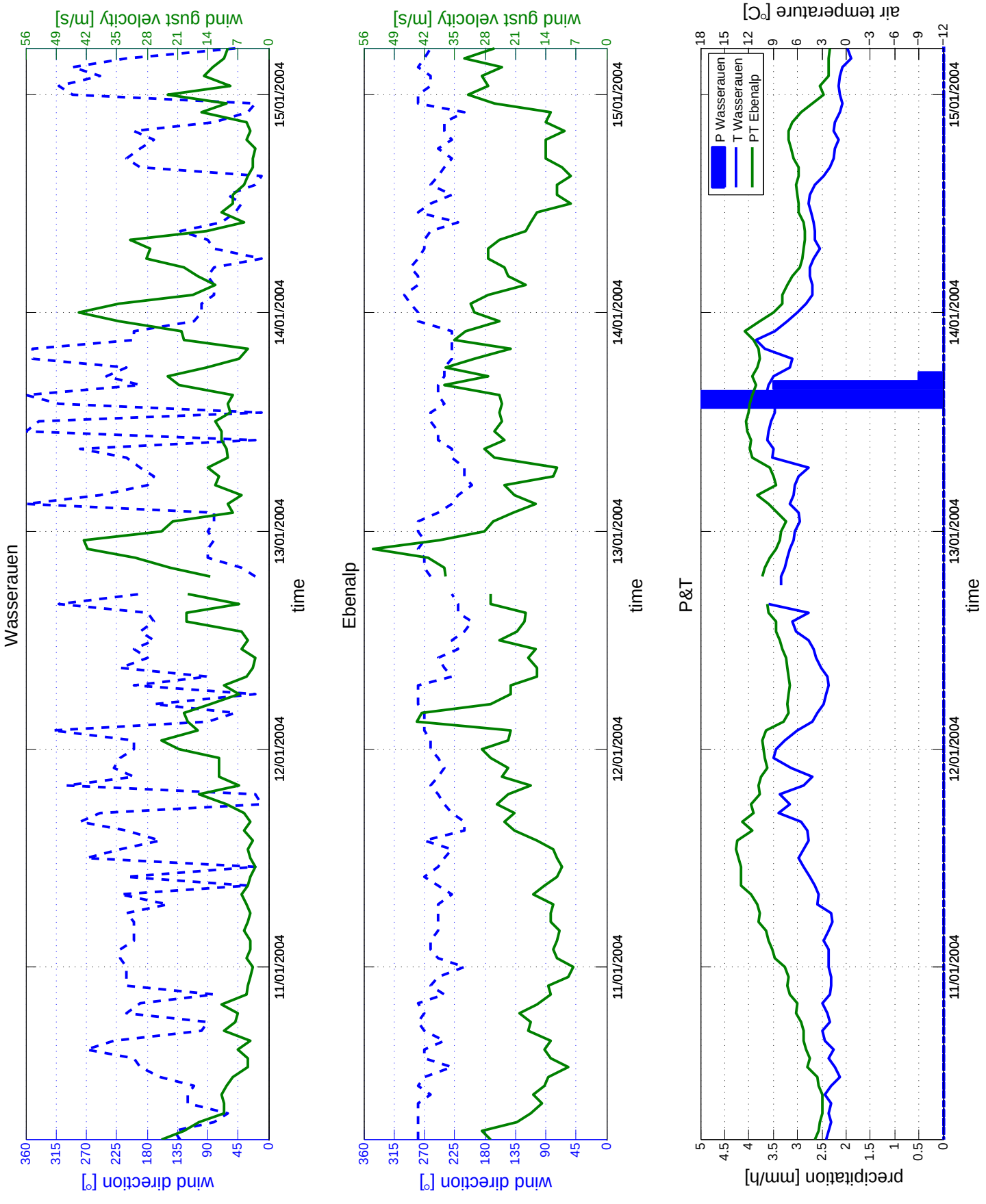

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
11/01/2004
12/01/2004
13/01/2004
14/01/2004
15/01/2004
Ebenalp
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 1.9

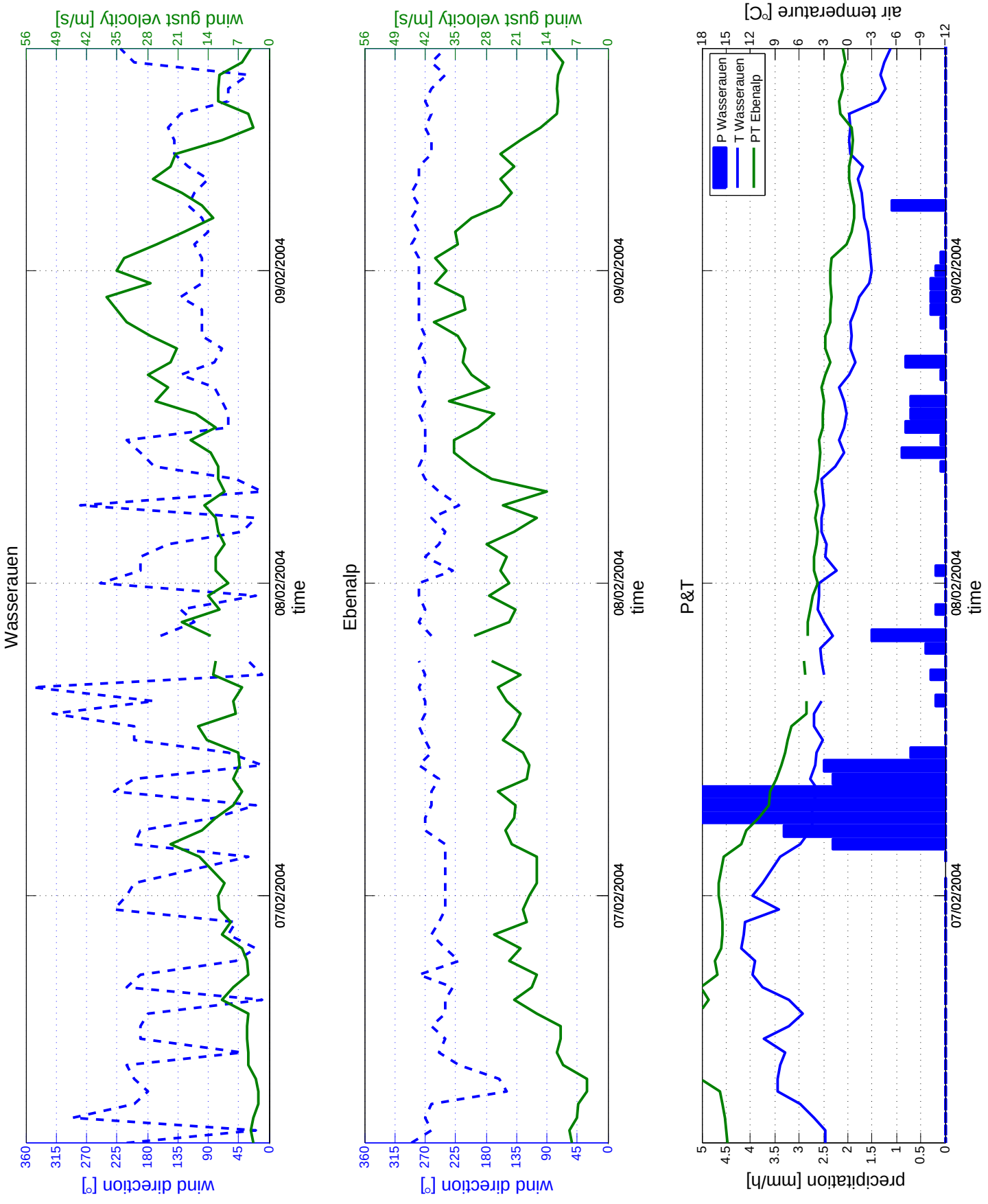

Wasserauen
wind direction [°]
wind gust velocity [m/s]
07/02/2004
08/02/2004
09/02/2004
time
Ebenalp
wind direction [°]
wind gust velocity [m/s]
07/02/2004
08/02/2004
09/02/2004
time
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp
07/02/2004
08/02/2004
09/02/2004
time

Figure 1.10

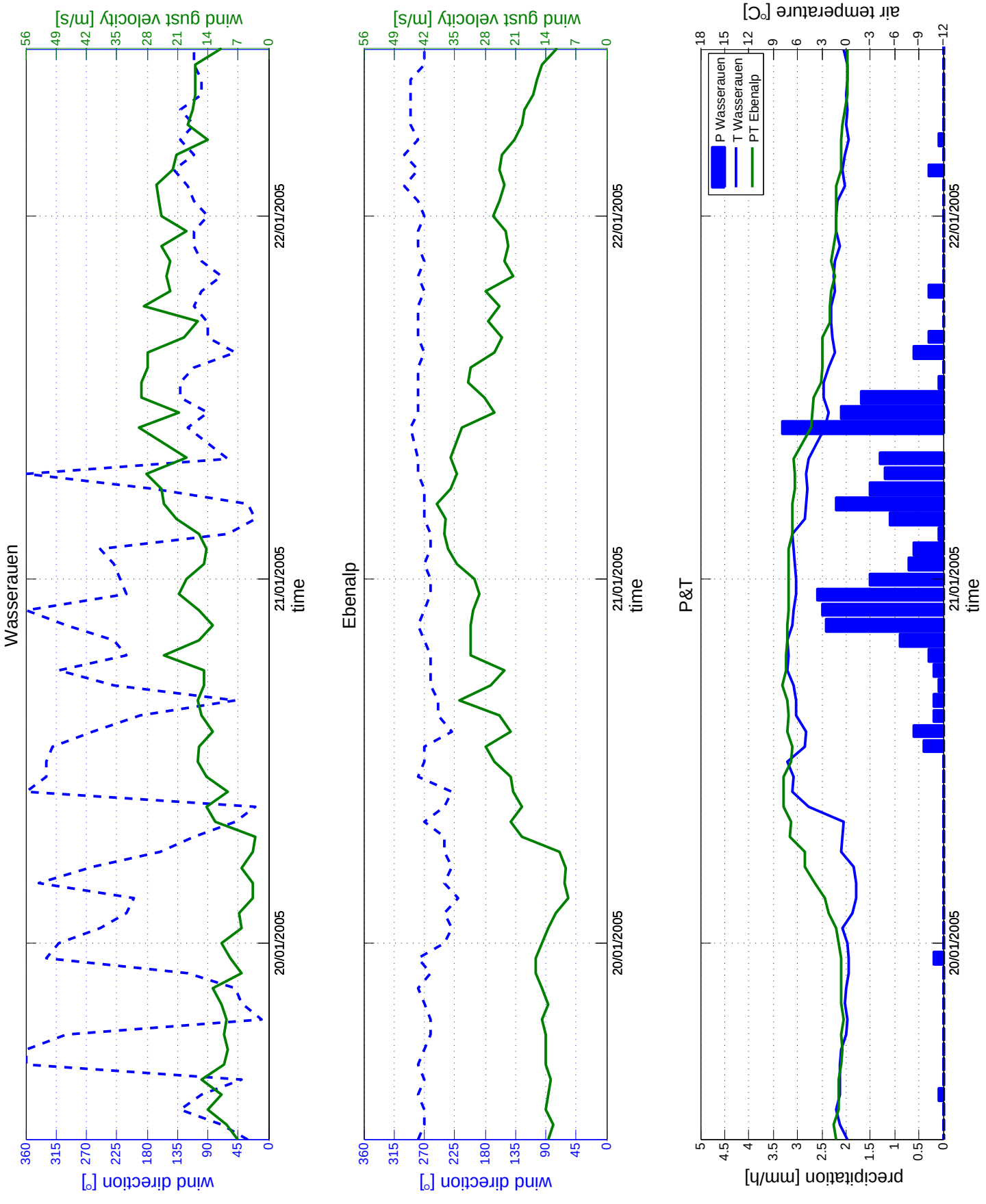

Wasserauen
wind direction [°]
wind gust velocity [m/s]
20/01/2005
21/01/2005
22/01/2005
time
Ebenalp
wind direction [°]
wind gust velocity [m/s]
20/01/2005
21/01/2005
22/01/2005
time
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp
20/01/2005
21/01/2005
22/01/2005
time

Figure 1.11

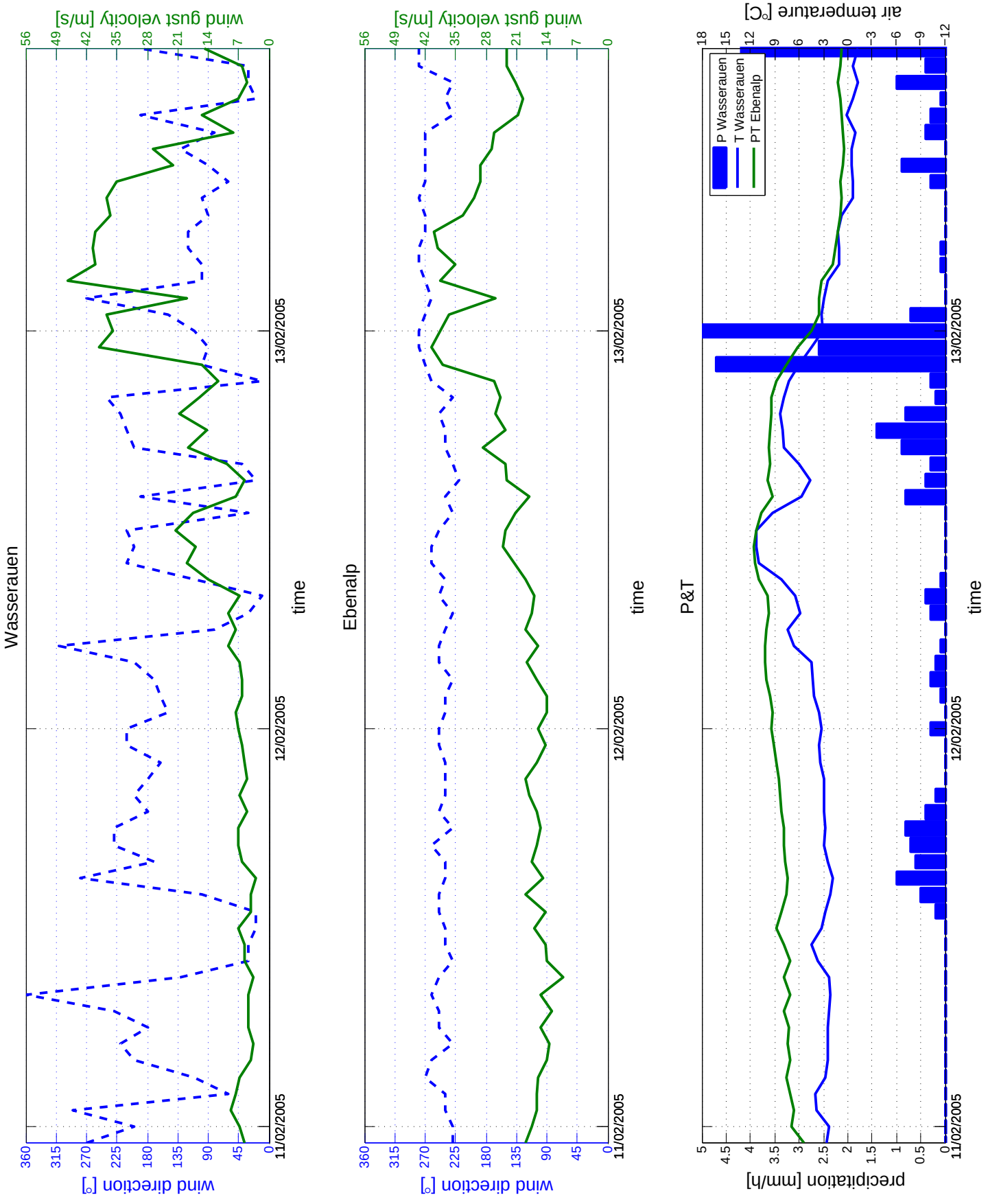

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
11/02/2005
12/02/2005
13/02/2005
Ebenalp
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 1.12

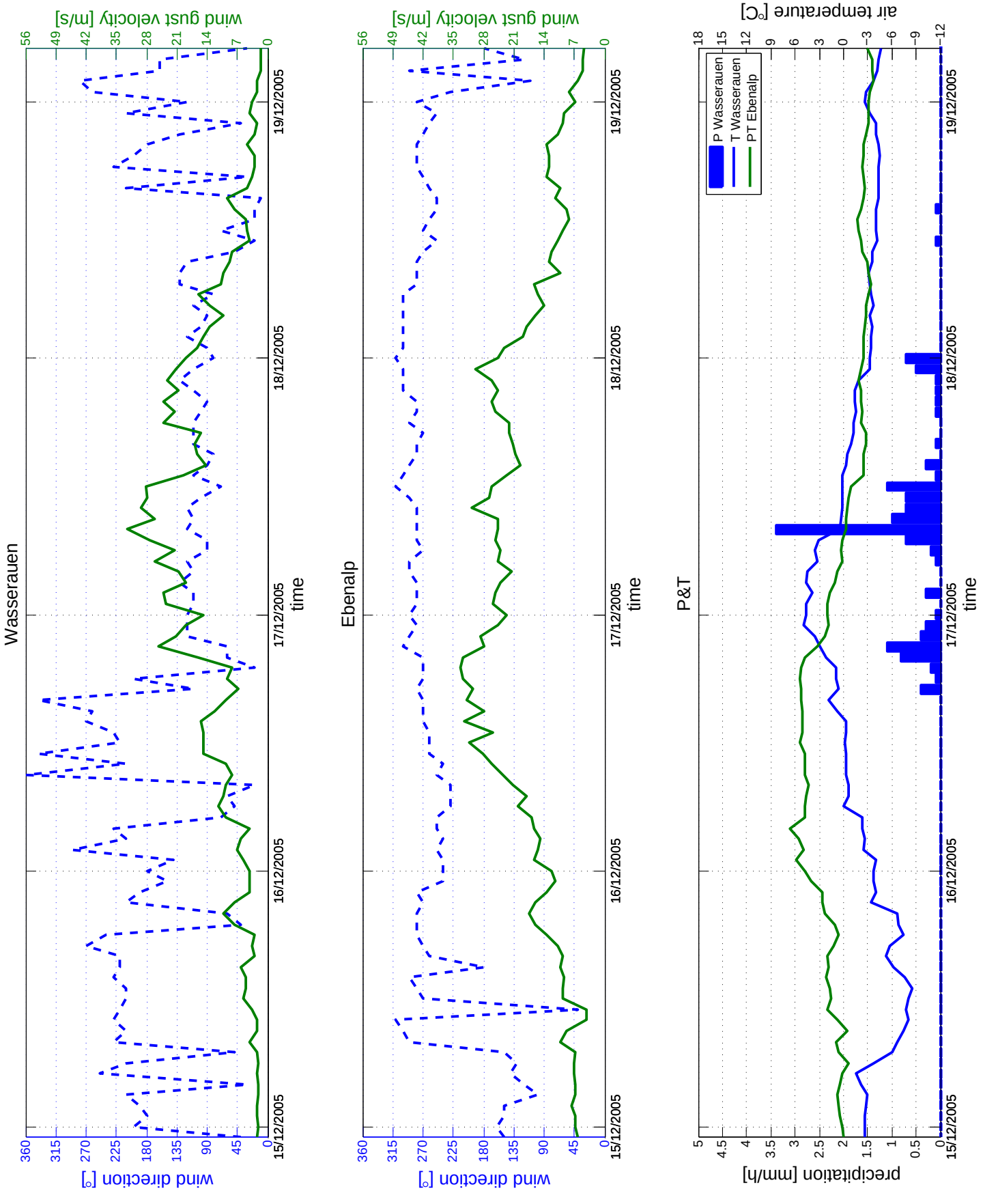

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
15/12/2005
16/12/2005
17/12/2005
18/12/2005
19/12/2005
Ebenalp
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 1.13

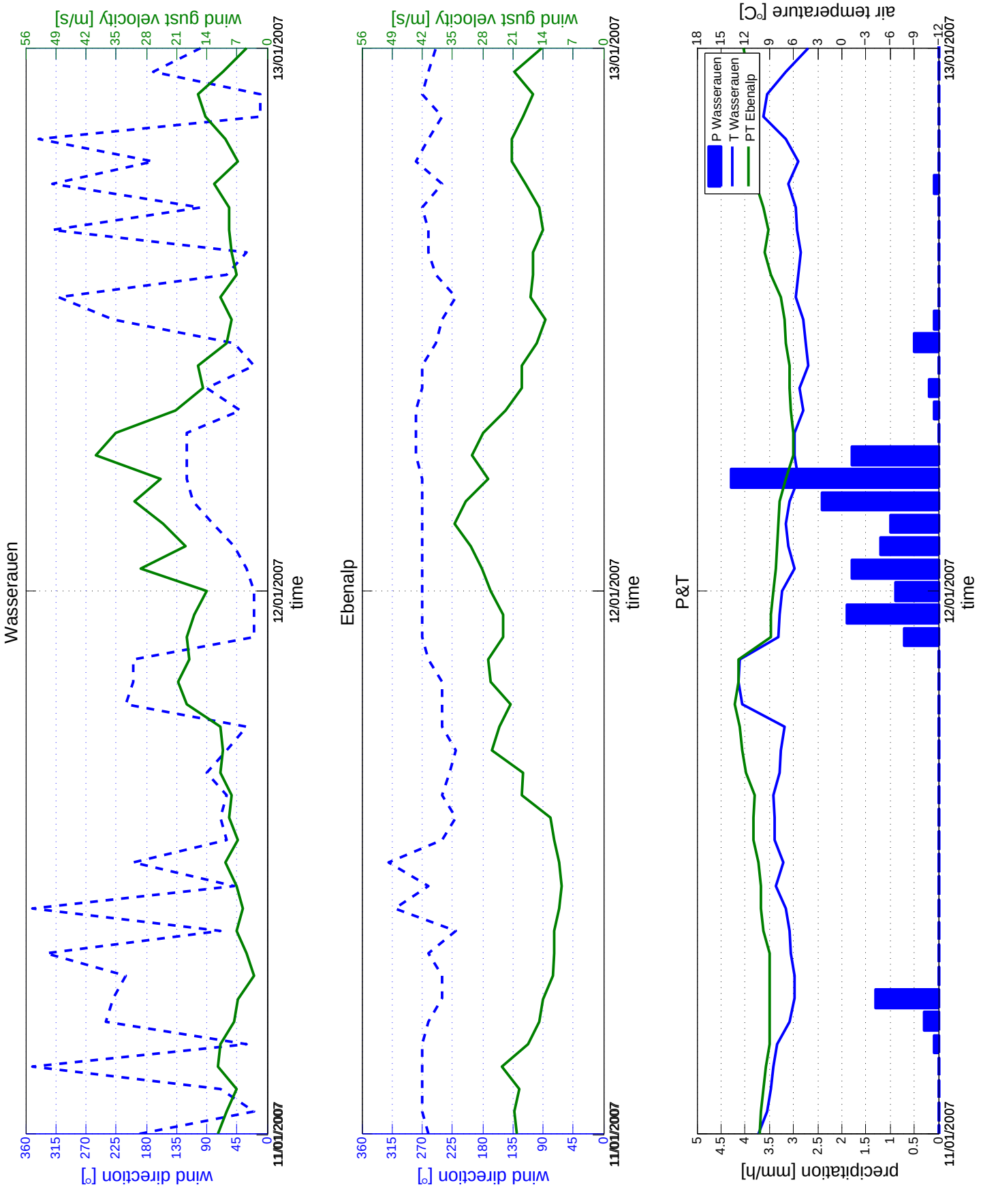

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
11/01/2007
12/01/2007
13/01/2007
Ebenalp
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 1.14

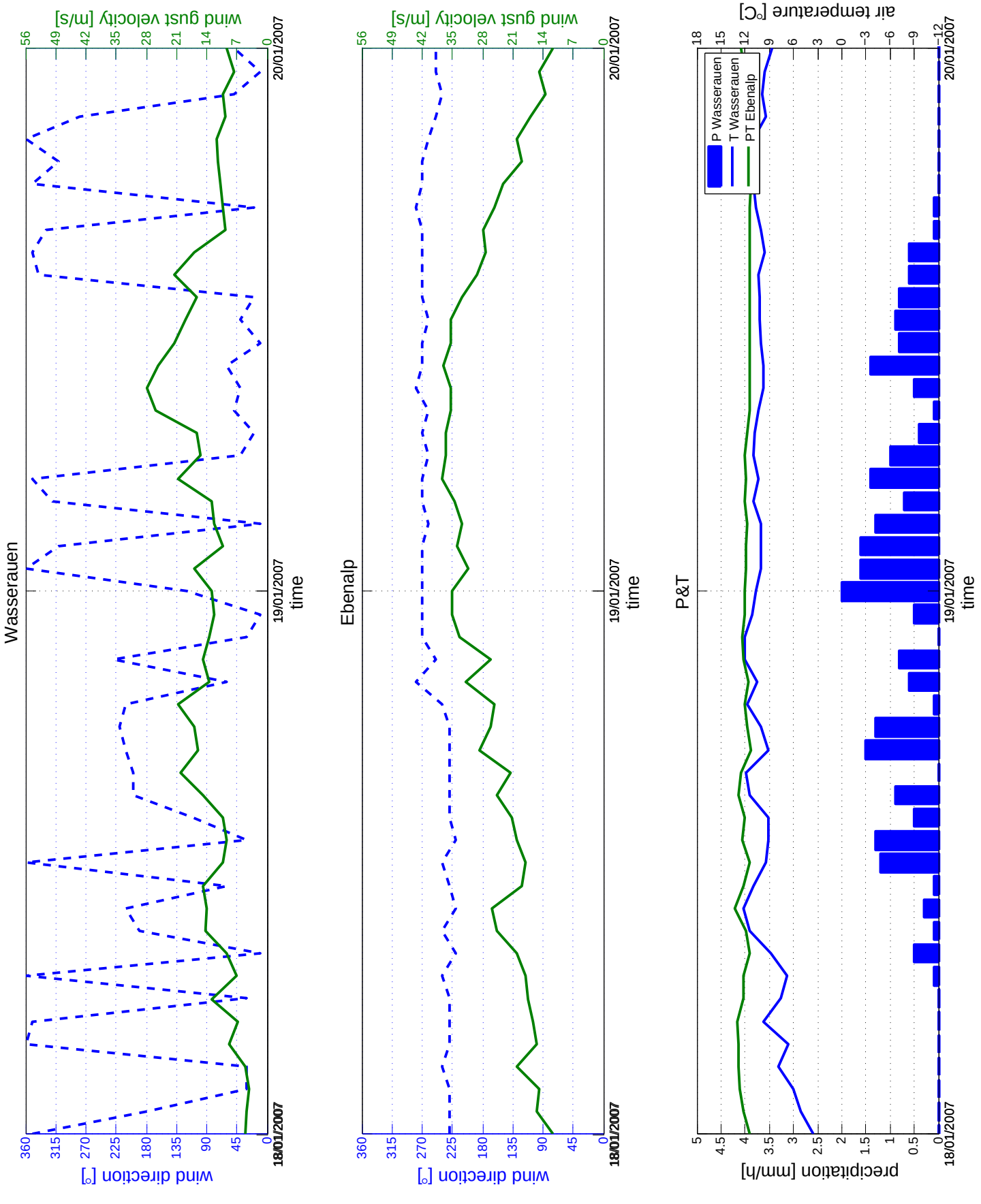

Wasserauen
wind gust velocity [m/s]
wind direction [°]
time
18/01/2007
19/01/2007
20/01/2007
Ebenalp
P&T
air temperature [°C]
precipitation [mm/h]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 1.15

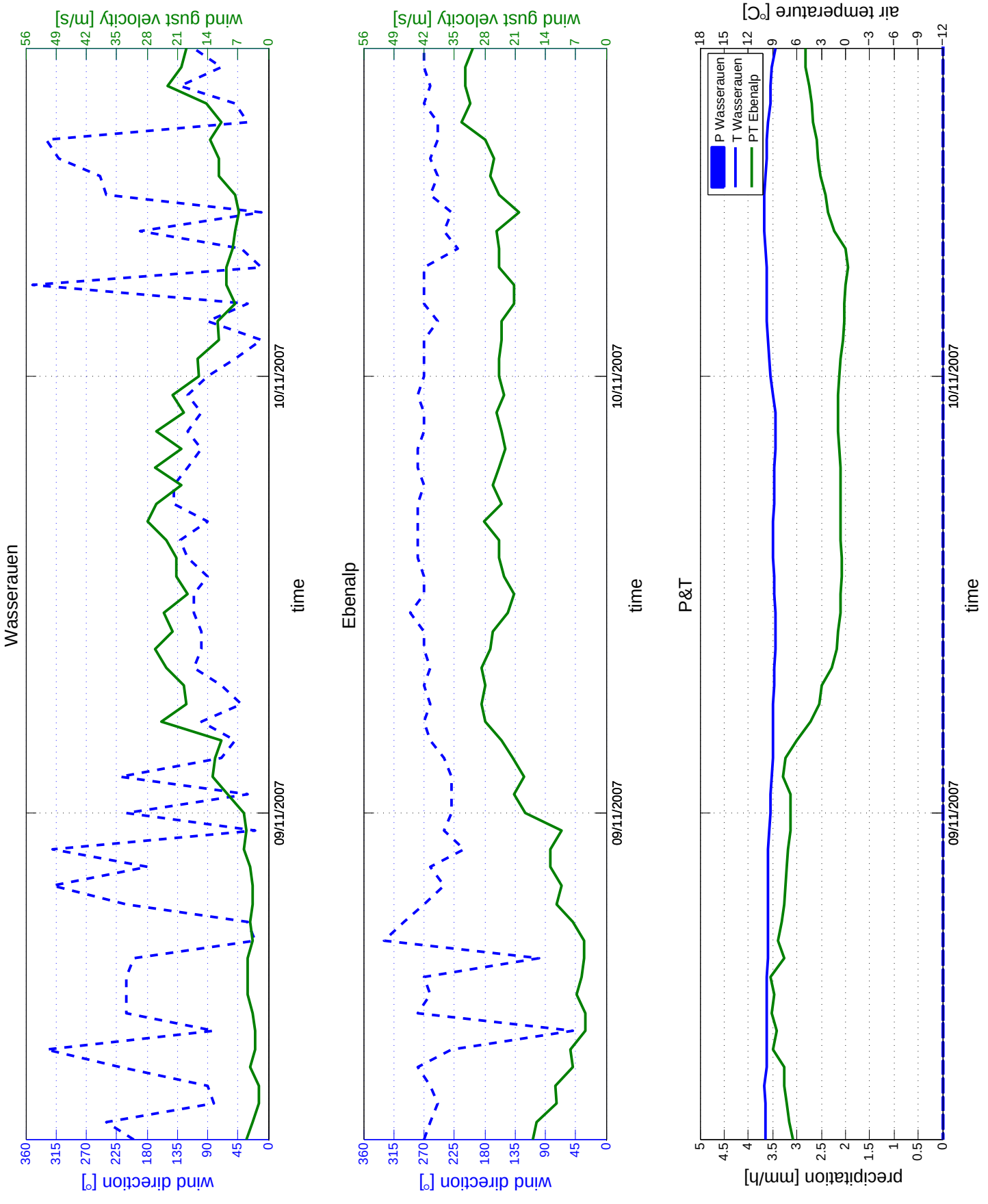

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
09/11/2007
10/11/2007
Ebenalp
wind direction [°]
wind gust velocity [m/s]
time
09/11/2007
10/11/2007
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp
time
09/11/2007
10/11/2007

Figure 1.16

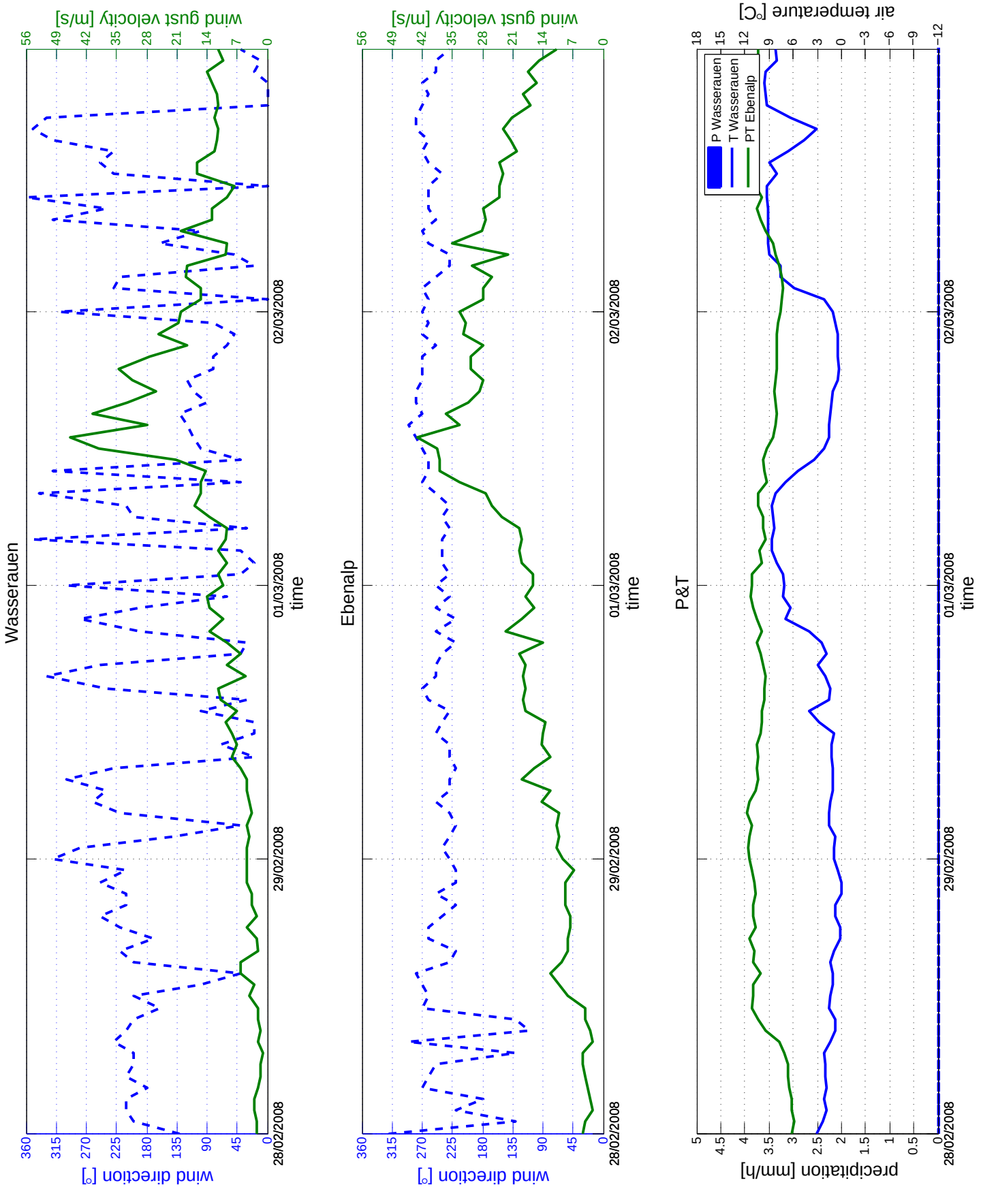

Wasserauen
wind direction [°]
wind gust velocity [m/s]
28/02/2008
29/02/2008
01/03/2008
02/03/2008
time
Ebenalp
wind direction [°]
wind gust velocity [m/s]
28/02/2008
29/02/2008
01/03/2008
02/03/2008
time
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp
28/02/2008
29/02/2008
01/03/2008
02/03/2008
time

Figure 1.17

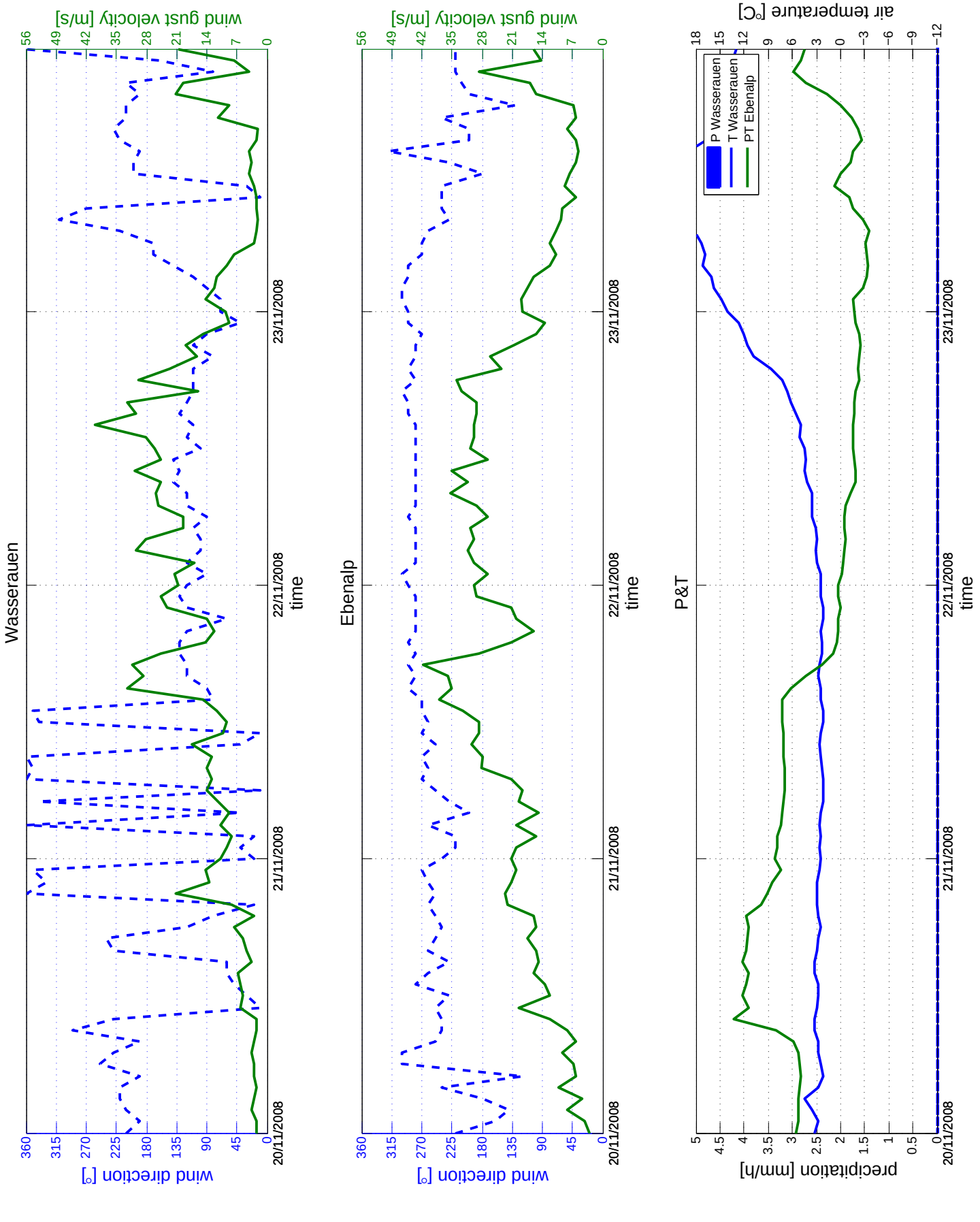

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
20/11/2008
21/11/2008
22/11/2008
23/11/2008
Ebenalp
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 1.18

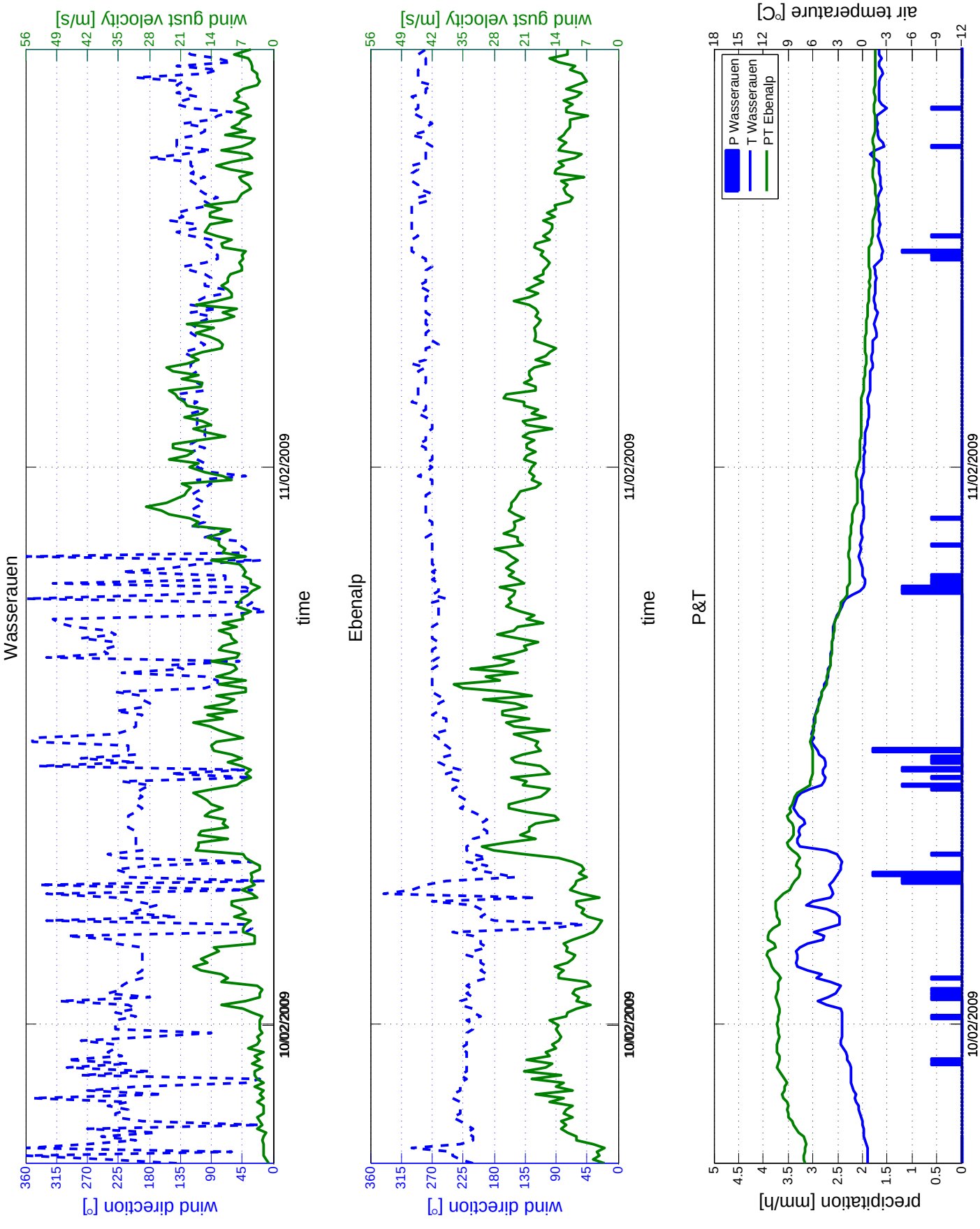

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
10/02/2009
11/02/2009
Ebenalp
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 1.19

2 Weather charts for selected events

2.1 Laseyer Event 07/02/2004

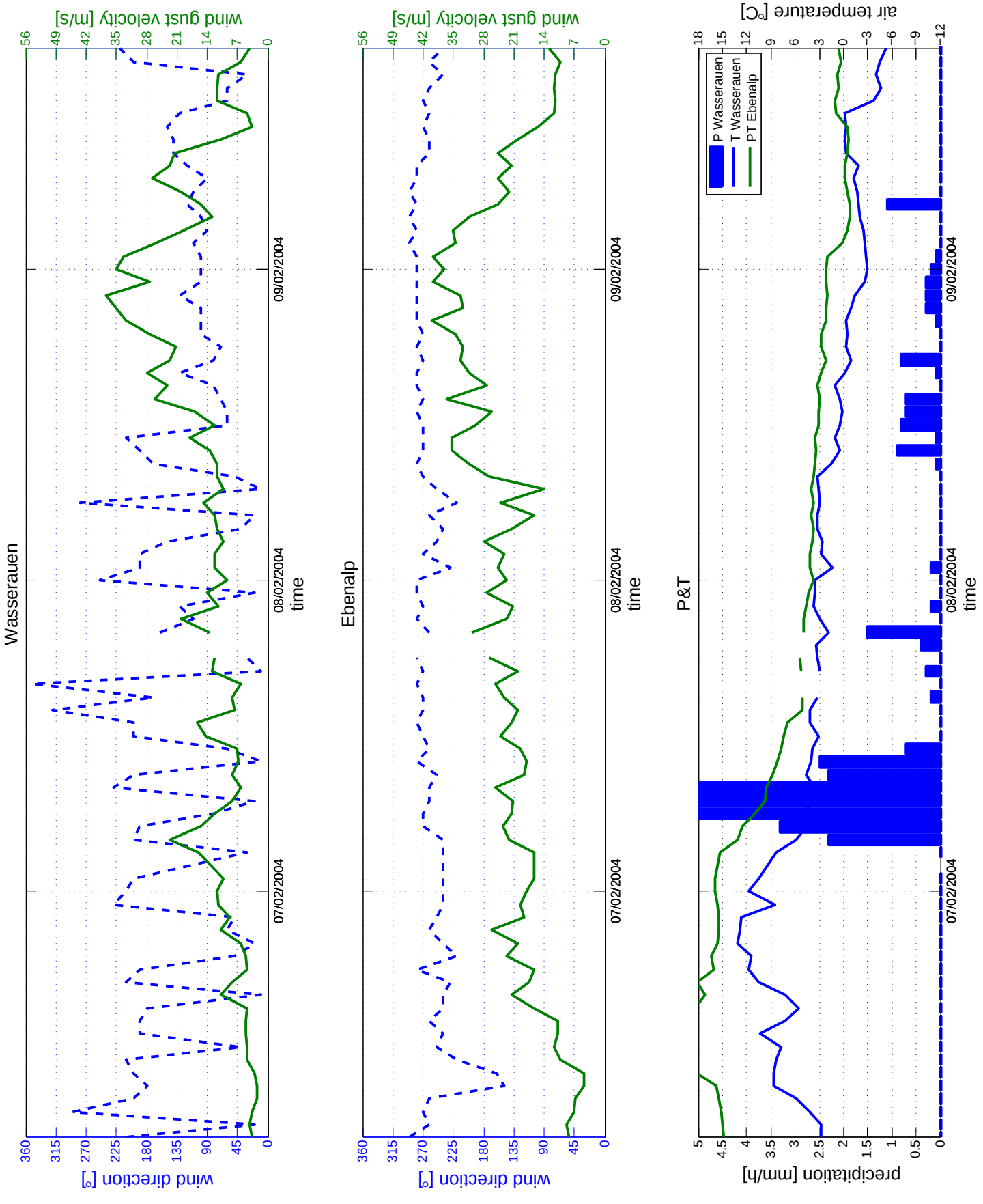
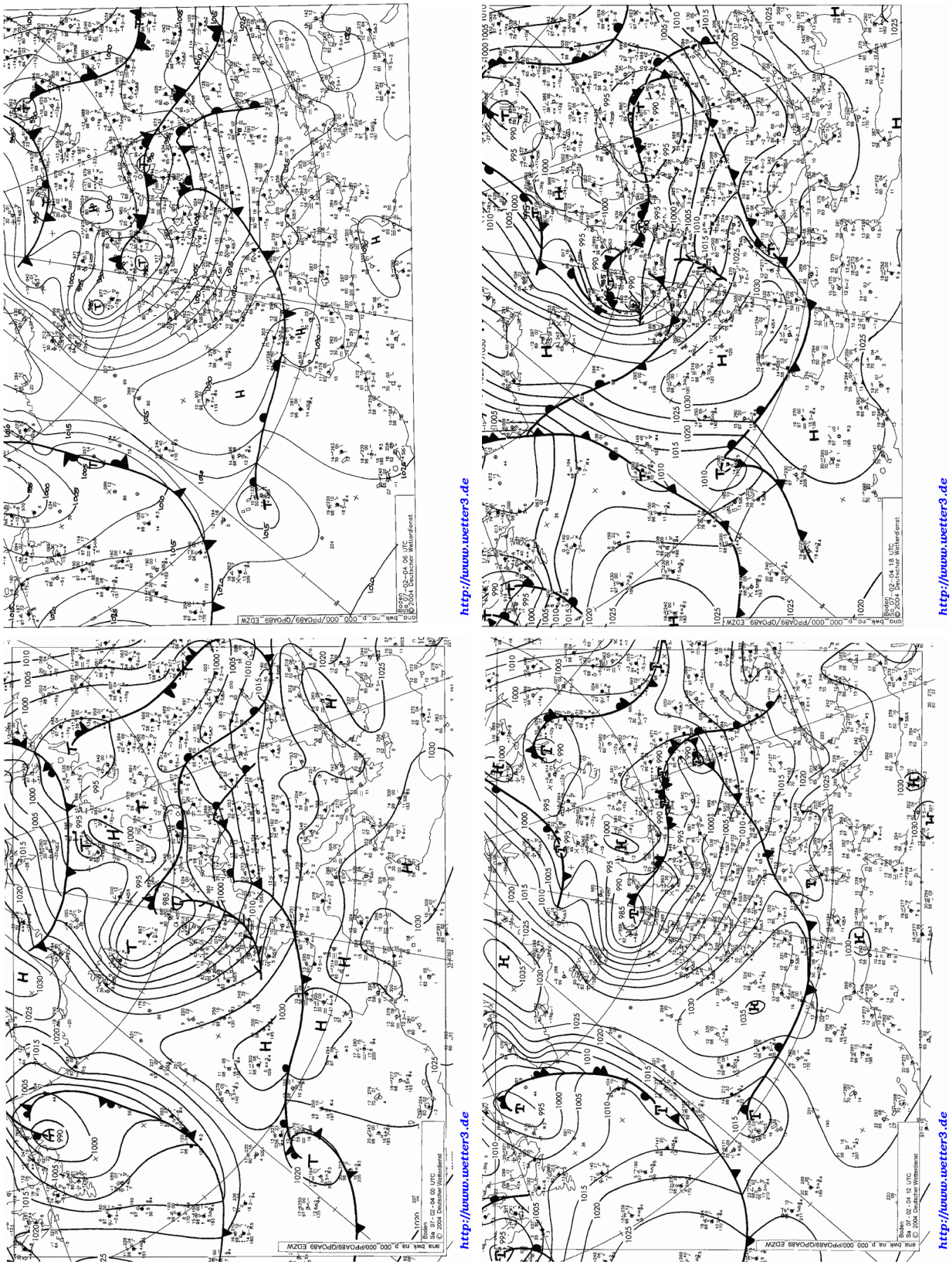

Wasserauen
Ebenalp
P&T
wind direction [°]
wind gust velocity [m/s]
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp
07/02/2004
08/02/2004
09/02/2004
time

Figure 2.1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http://www.wetter3.de
http://www.wetter3.de
http://www.wetter3.de

Figure 2.2

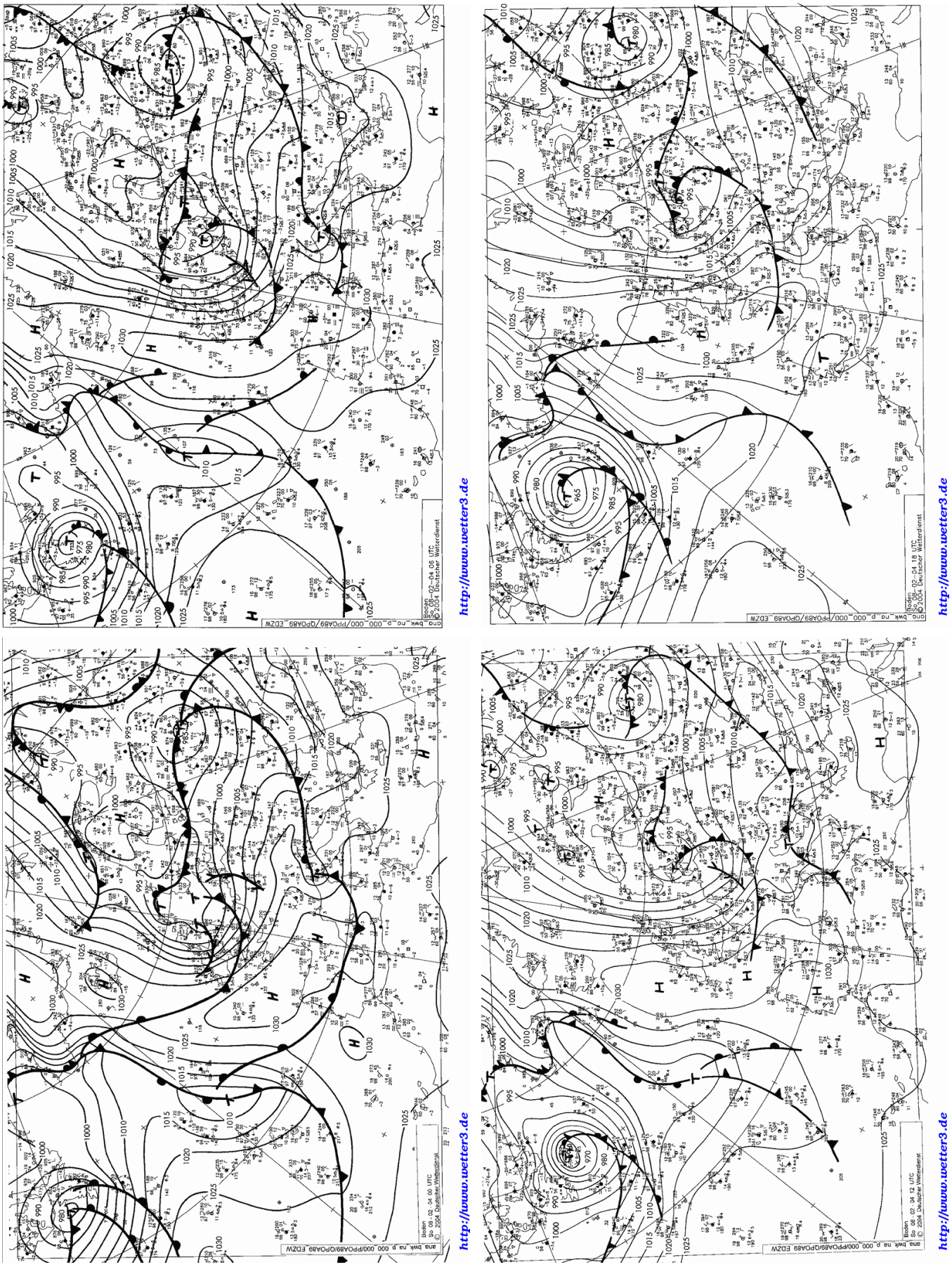
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Figure 2.3

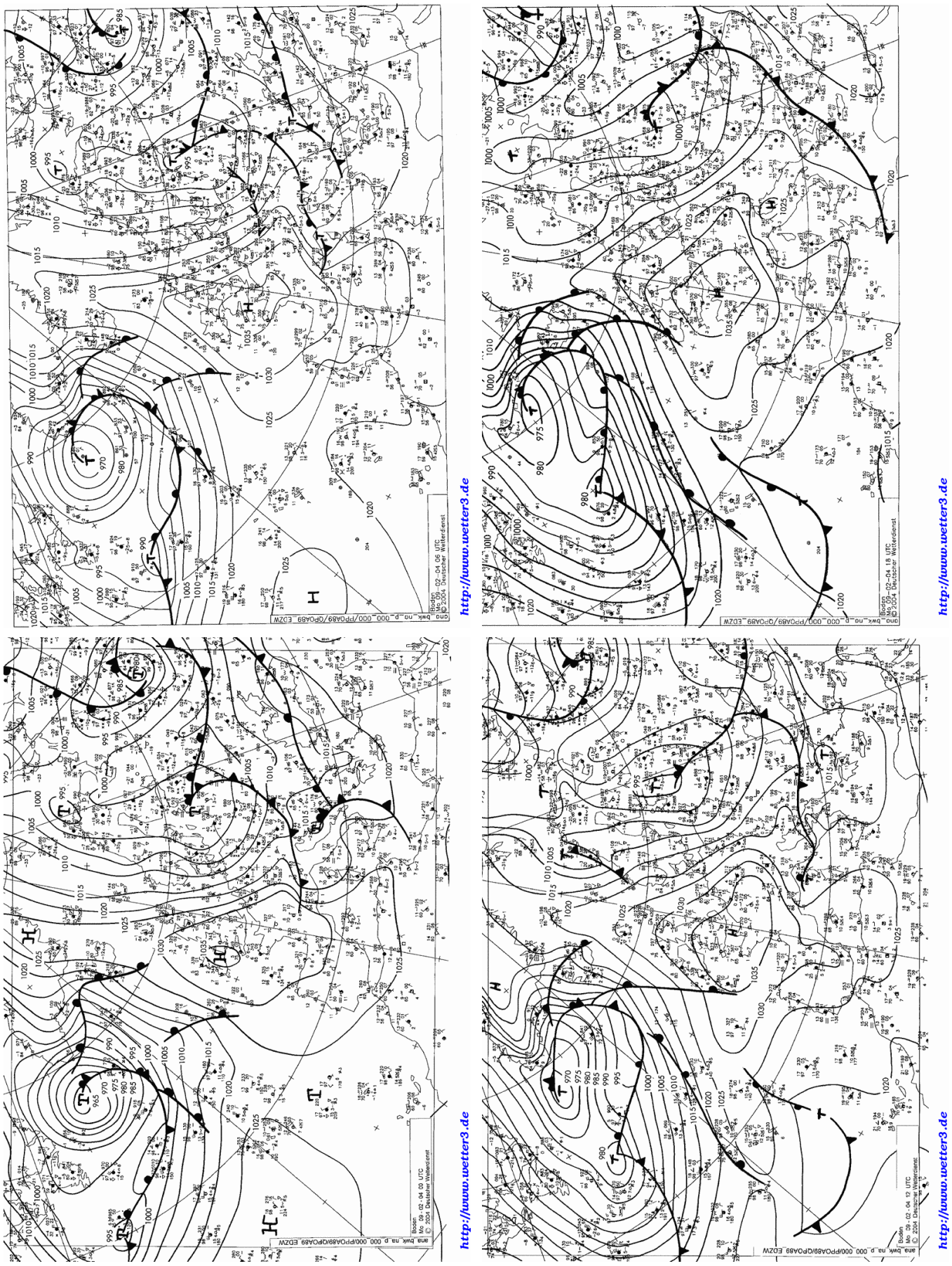
http://www.wetter3.de
http://www.wetter3.de
http://www.wetter3.de
http://www.wetter3.de

Figure 2.4

2.2 Laseyer Event 12/02/2005

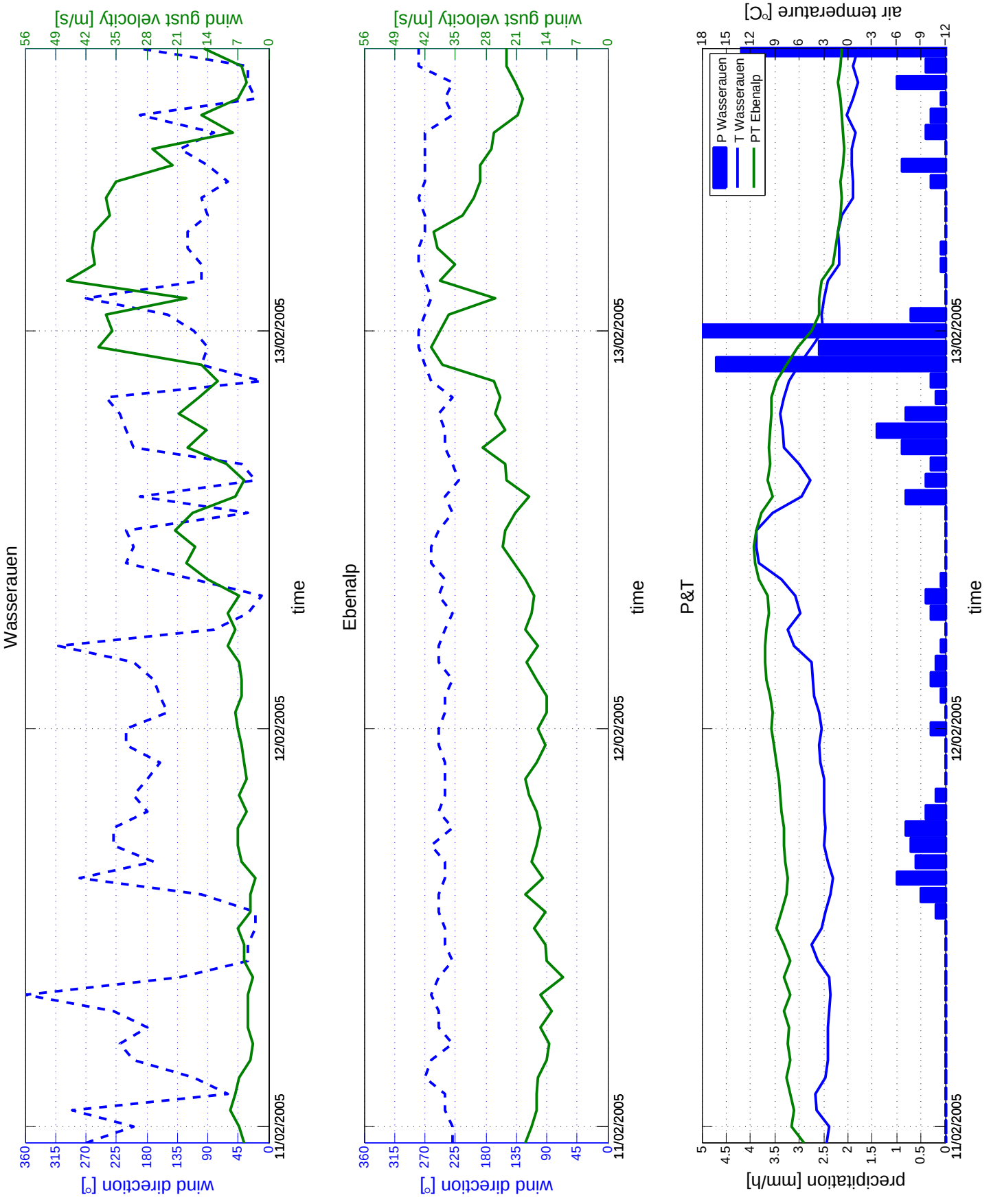
Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
11/02/2005
12/02/2005
13/02/2005
Ebenalp
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 2.5

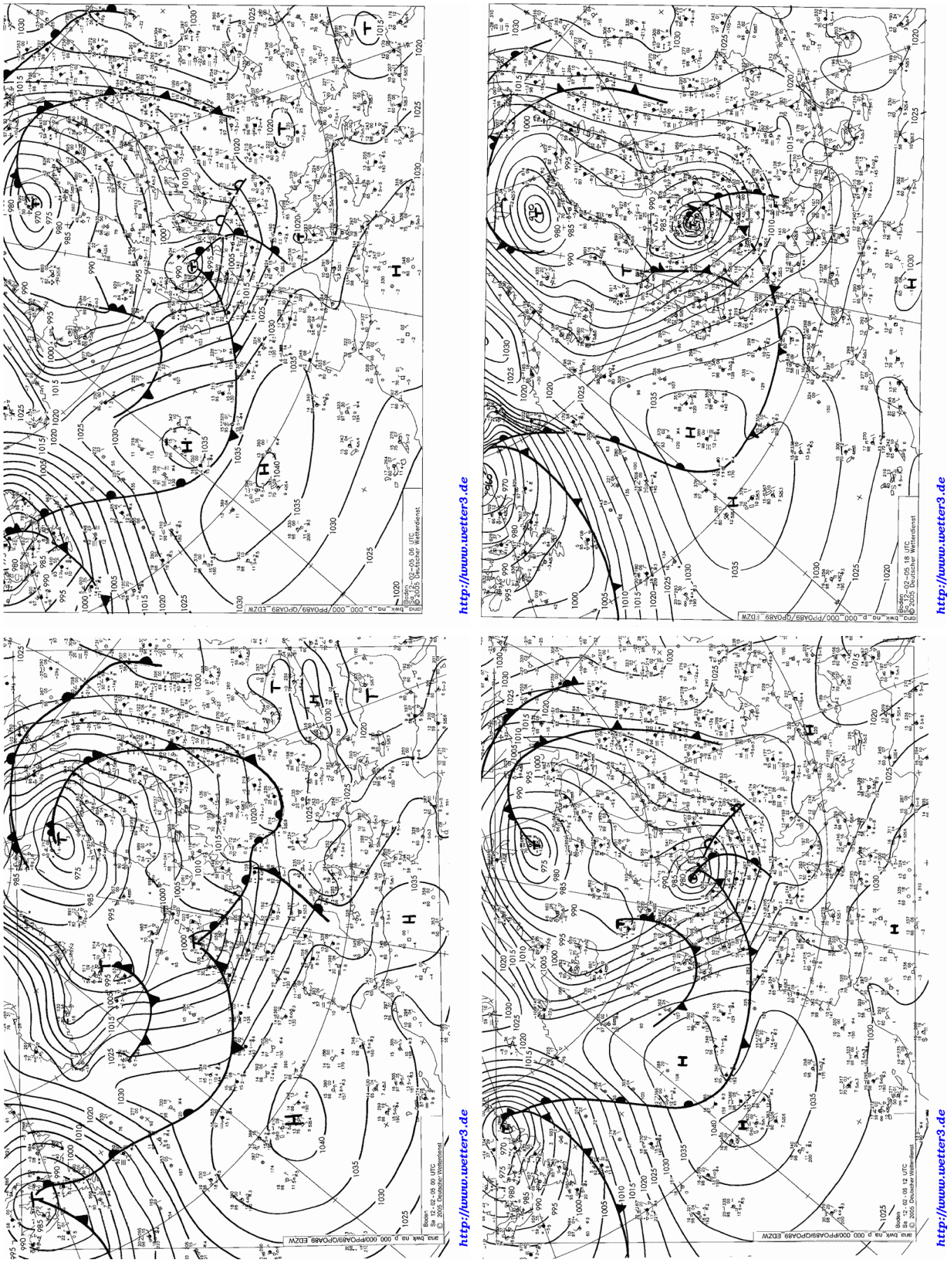
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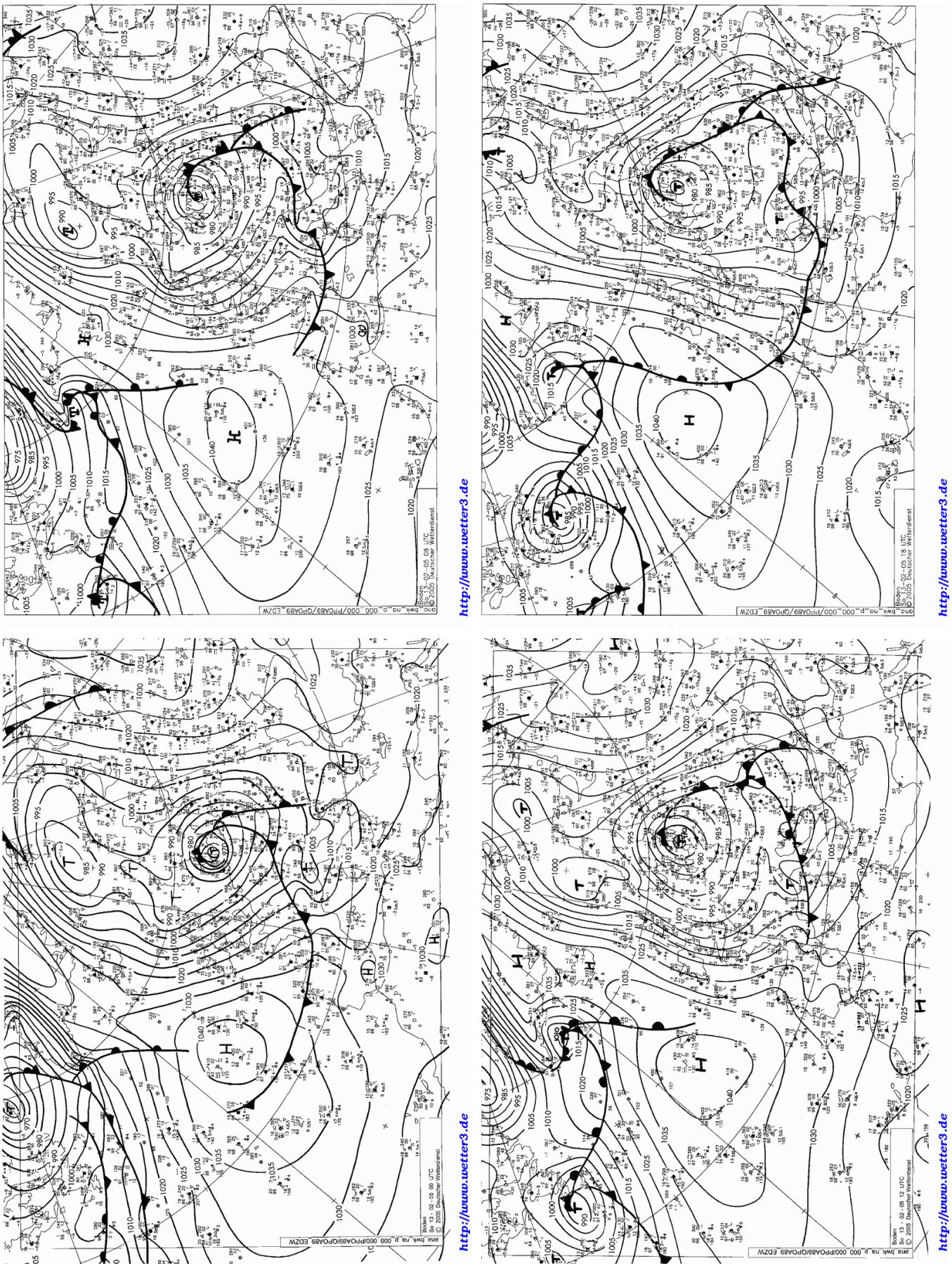
Figure 2.6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http://www.wetter3.de

Figure 2.7

2.3 Laseyer Event 11/01/2007

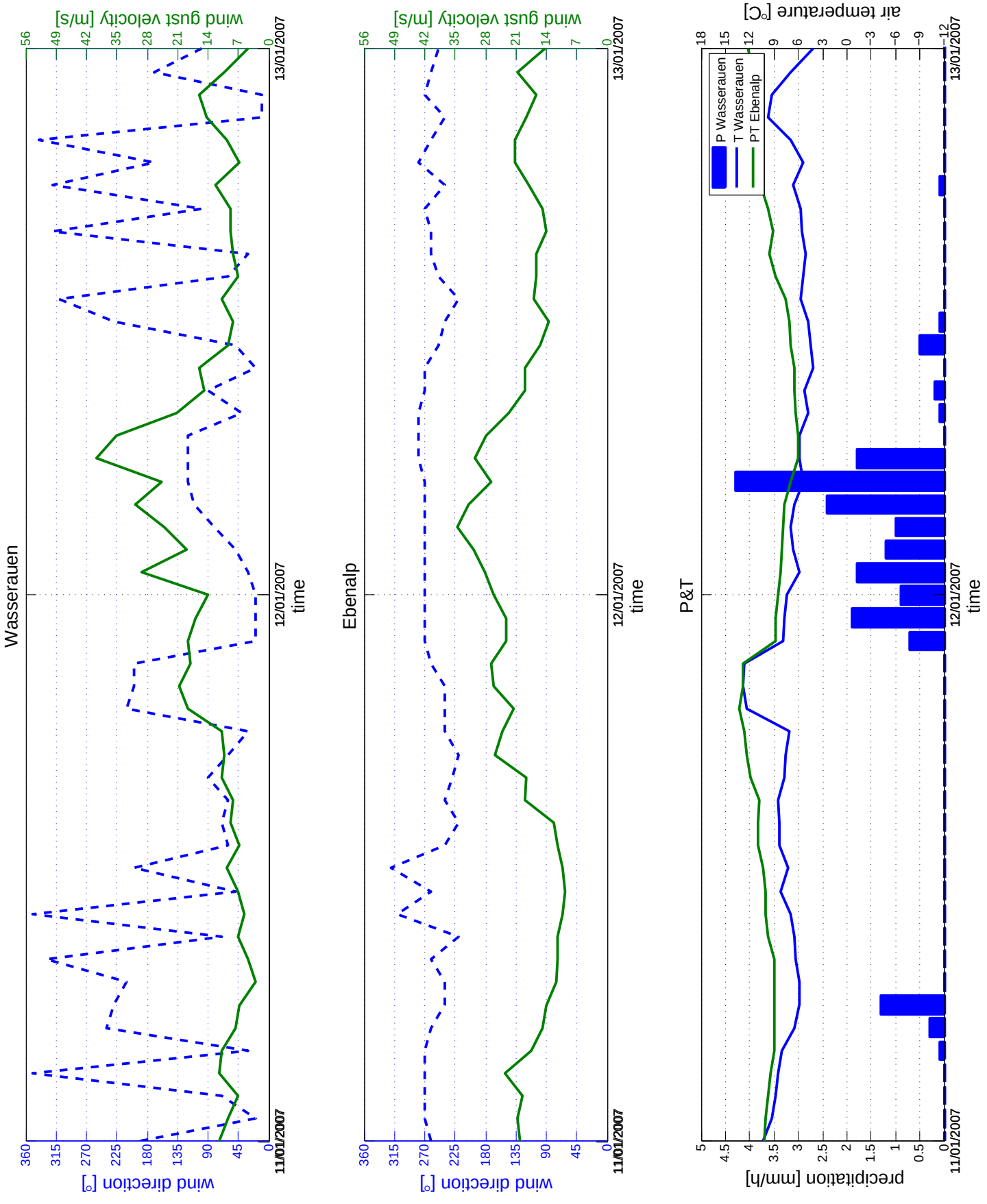
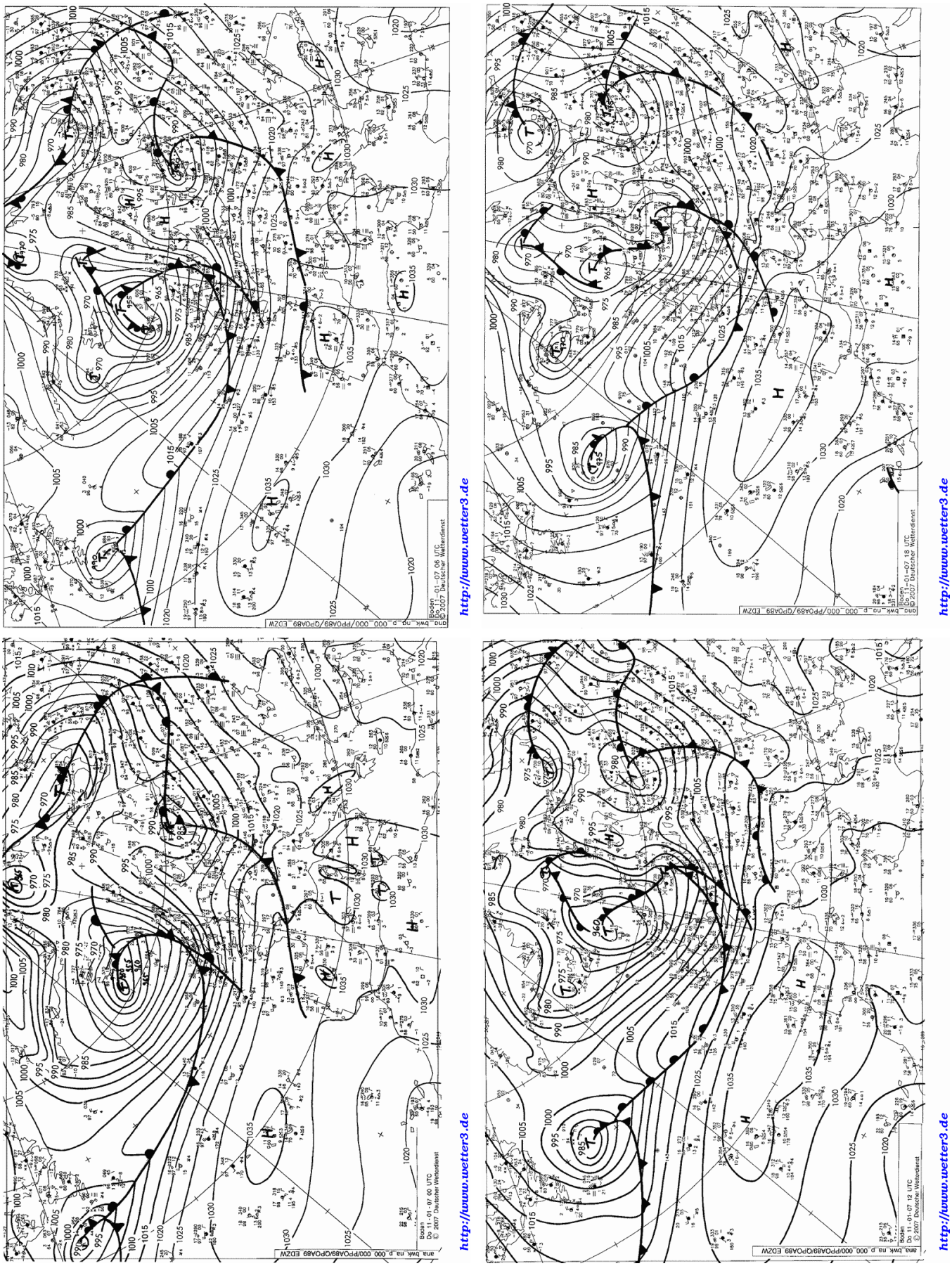

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
11/01/2007
12/01/2007
13/01/2007
Ebenalp
wind direction [°]
wind gust velocity [m/s]
time
11/01/2007
12/01/2007
13/01/2007
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp
time
11/01/2007
12/01/2007
13/01/2007

Figure 2.8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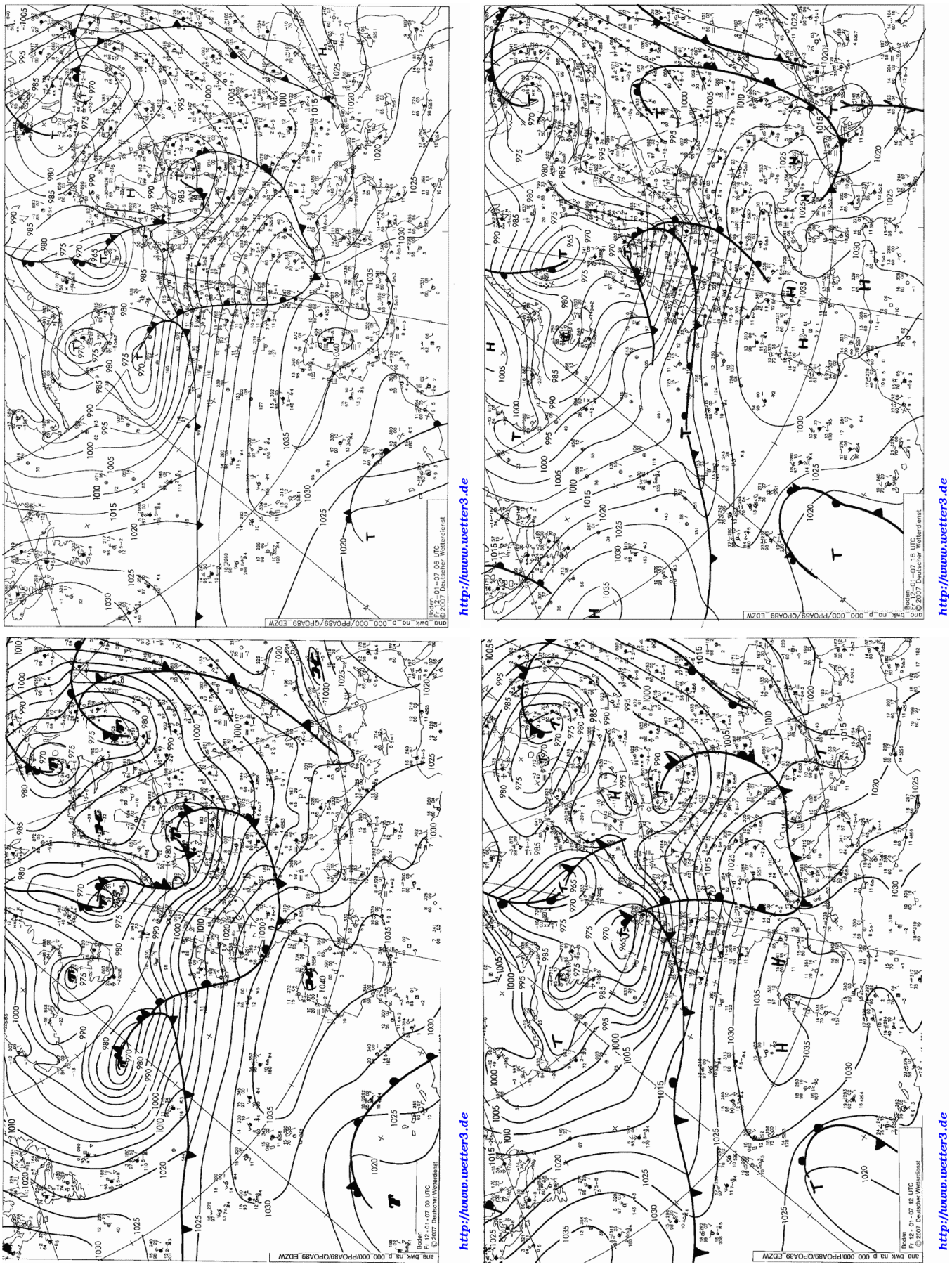
http://www.wetter3.de
http://www.wetter3.de
http://www.wetter3.de

Figure 2.9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http://www.wetter3.de
http://www.wetter3.de

Figure 2.10

2.4 Laseyer Event 01/03/2008

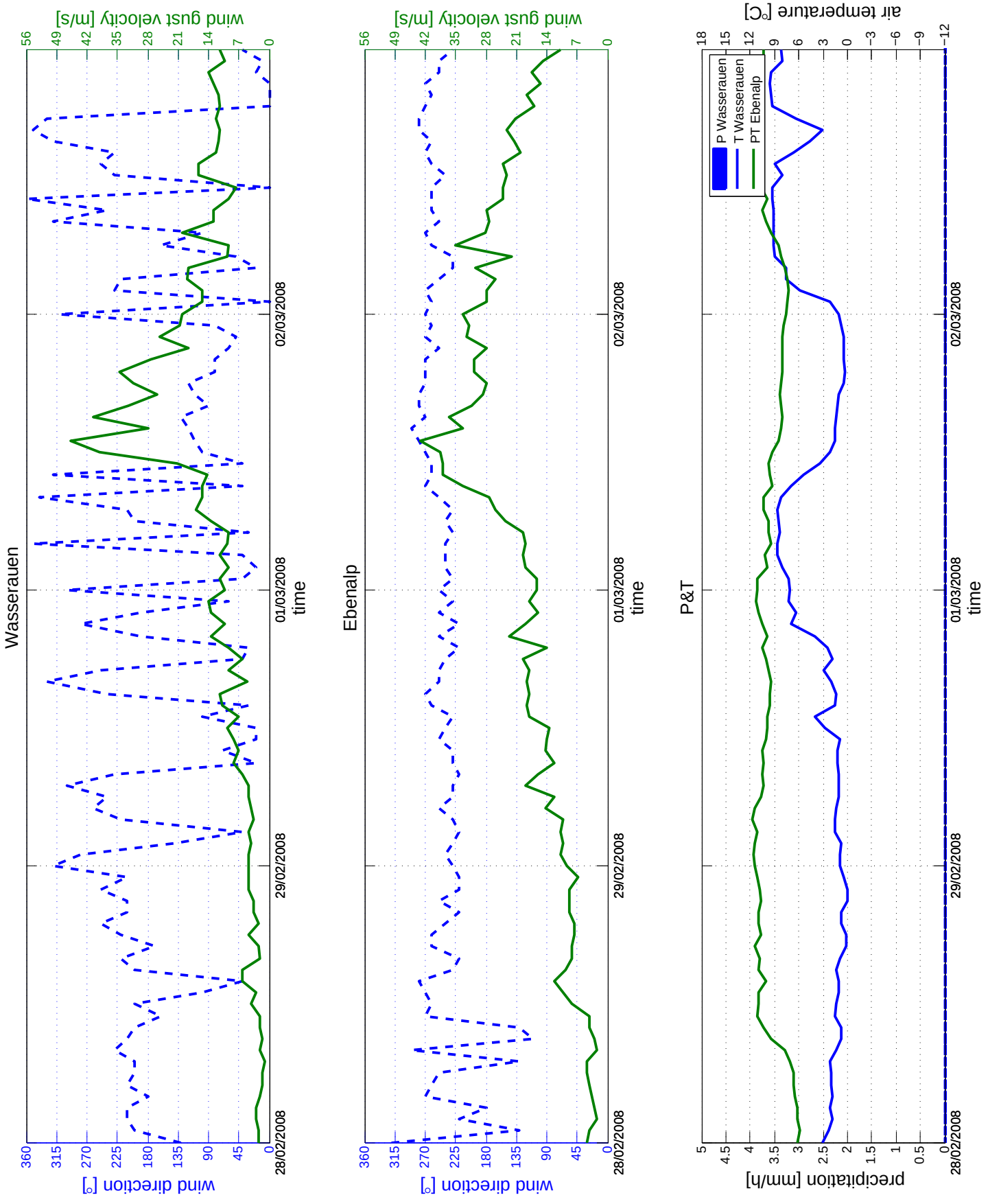

Wasserauen
wind direction [°]
wind gust velocity [m/s]
time
28/02/2008
29/02/2008
01/03/2008
02/03/2008
Ebenalp
P&T
precipitation [mm/h]
air temperature [°C]
P Wasserauen
T Wasserauen
PT Ebenalp

Figure 2.11

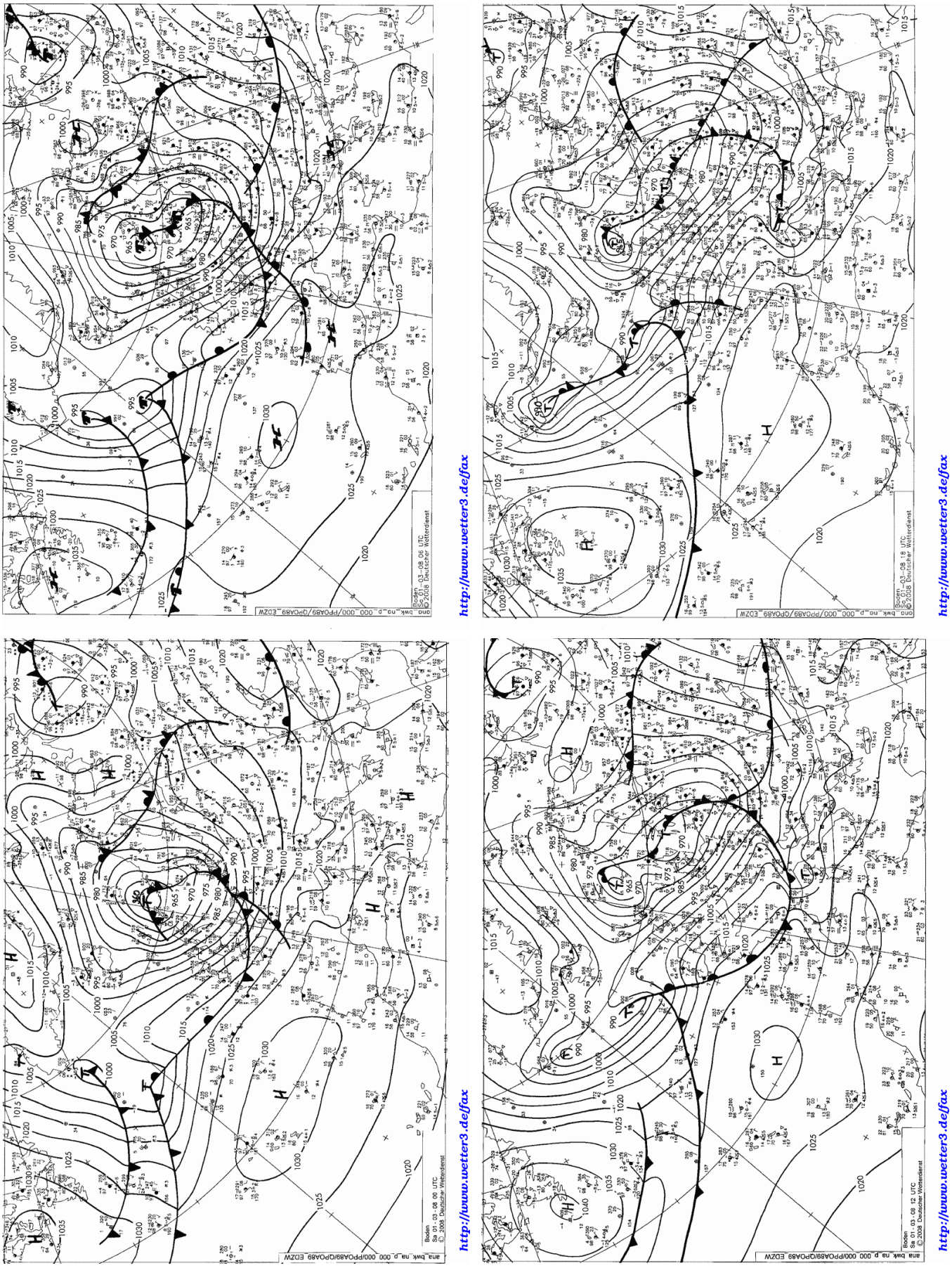

http://www.wetter3.de/fax
http://www.wetter3.de/fax
http://www.wetter3.de/fax
http://www.wetter3.de/fax

Figure 2.12

2.5 Laseyer Event 19/01/2007

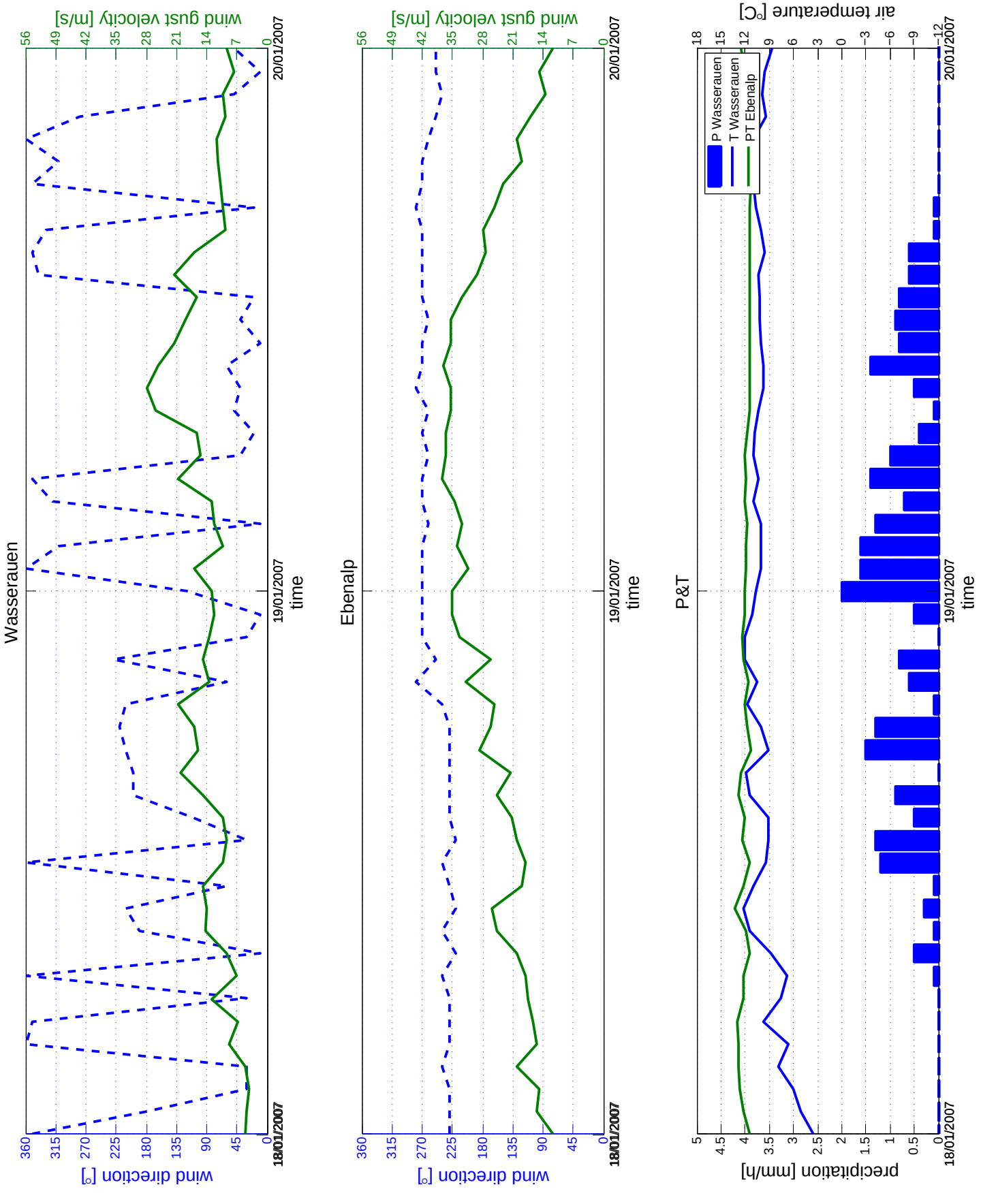

Wasserauen
wind gust velocity [m/s]
wind direction [°]
time
18/01/2007
19/01/2007
20/01/2007
Ebenalp
P&T
P Wasserauen
T Wasserauen
PT Ebenalp
air temperature [°C]
precipitation [mm/h]

Figure 2.13

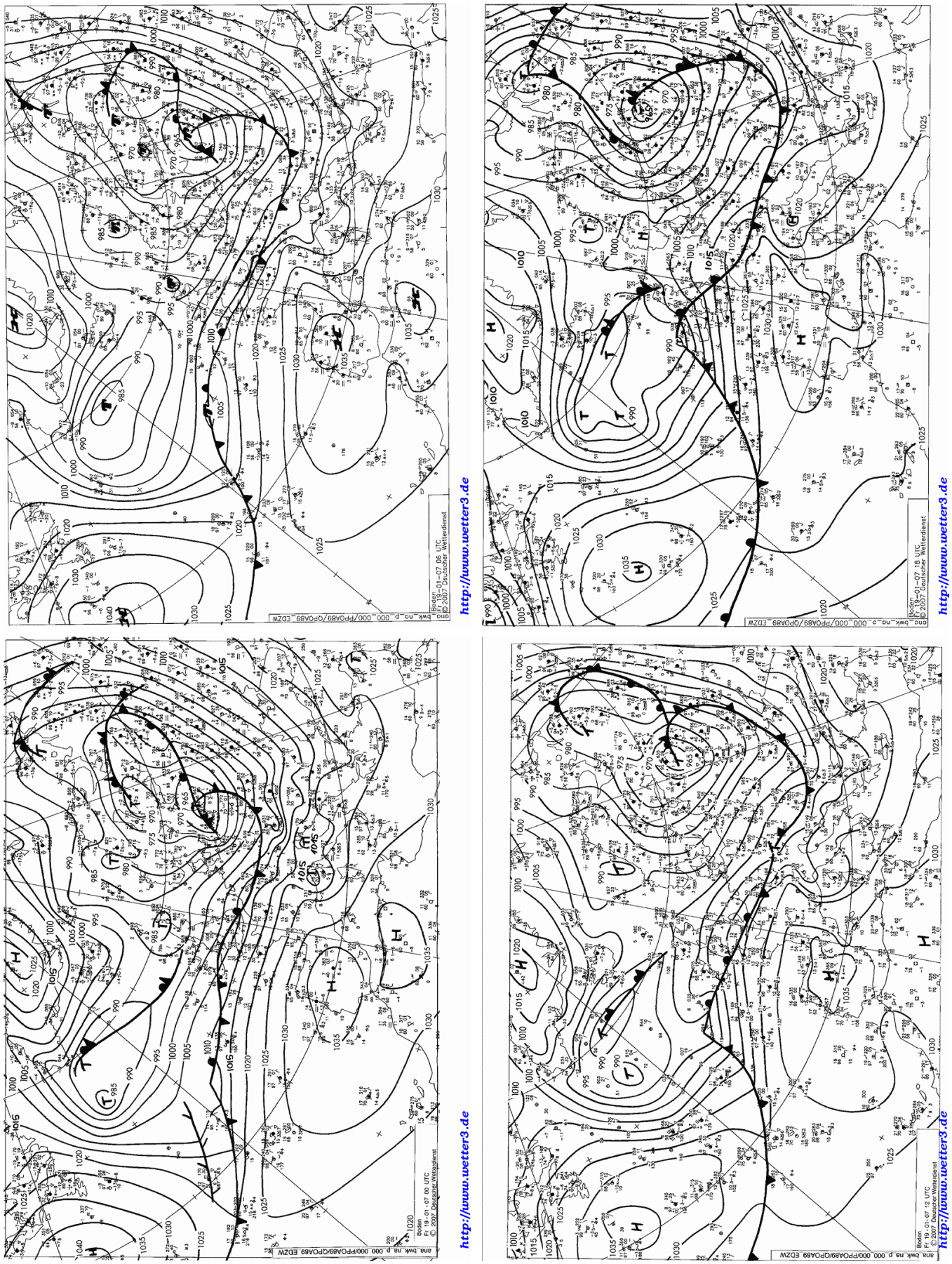

http://www.wetter3.de
http://www.wetter3.de
http://www.wetter3.de
http://www.wetter3.de

Figure 2.14

3 Wind observations at the location of the train accident

The following plots show two recent laseyer events and compare the wind velocity and wind direction at the location of the train accident in January 2007 (next to the rail tracks of the Appenzellerbahn) and at the weather station of Meteomedia (valley station of the Ebenalpbahn).

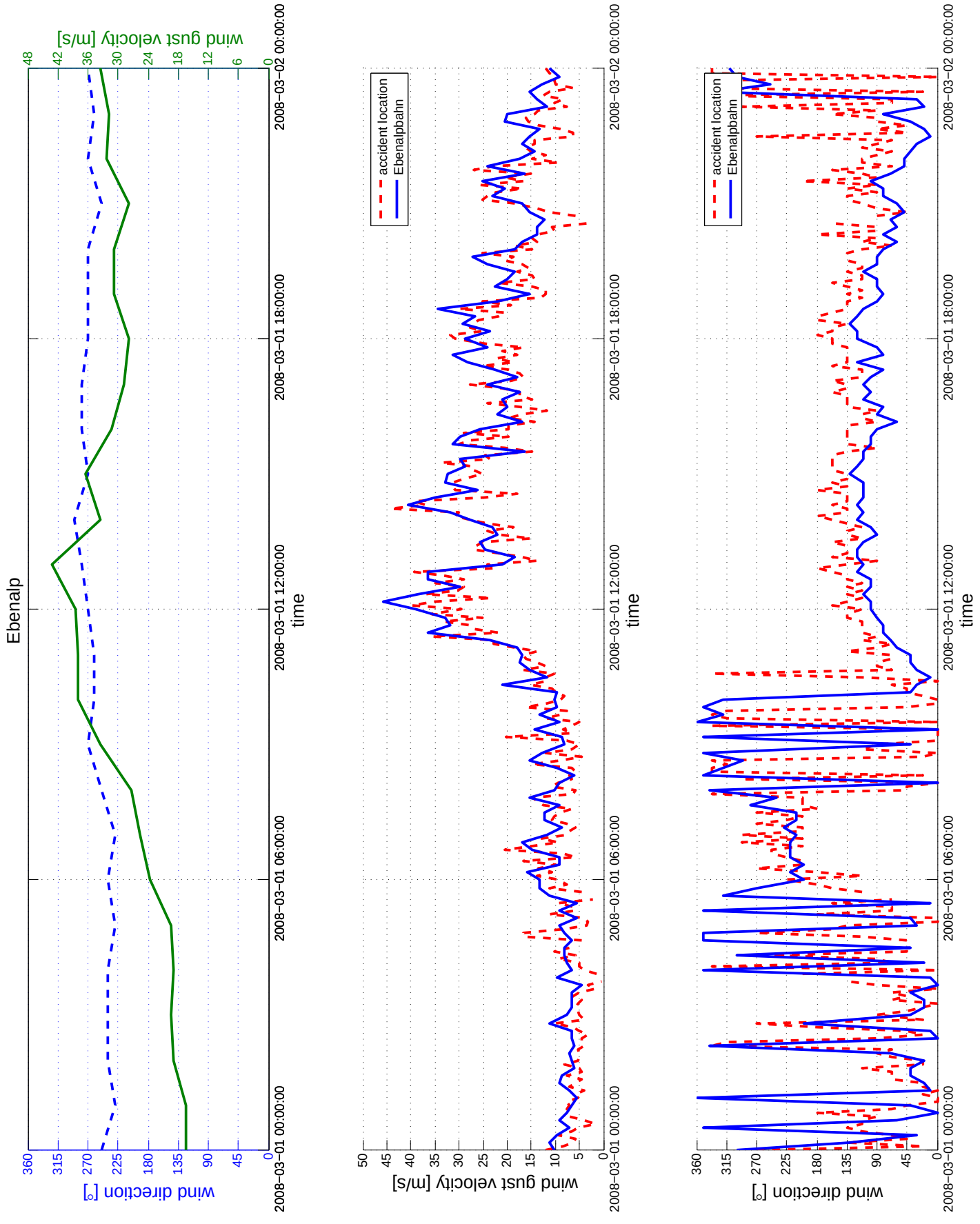

Ebenalp
wind direction [°]
wind gust velocity [m/s]
time
2008−03−01 00:00:00
2008−03−01 06:00:00
2008−03−01 12:00:00
2008−03−01 18:00:00
2008−03−02 00:00:00
accident location
Ebenalpbahn

Figure 3.1

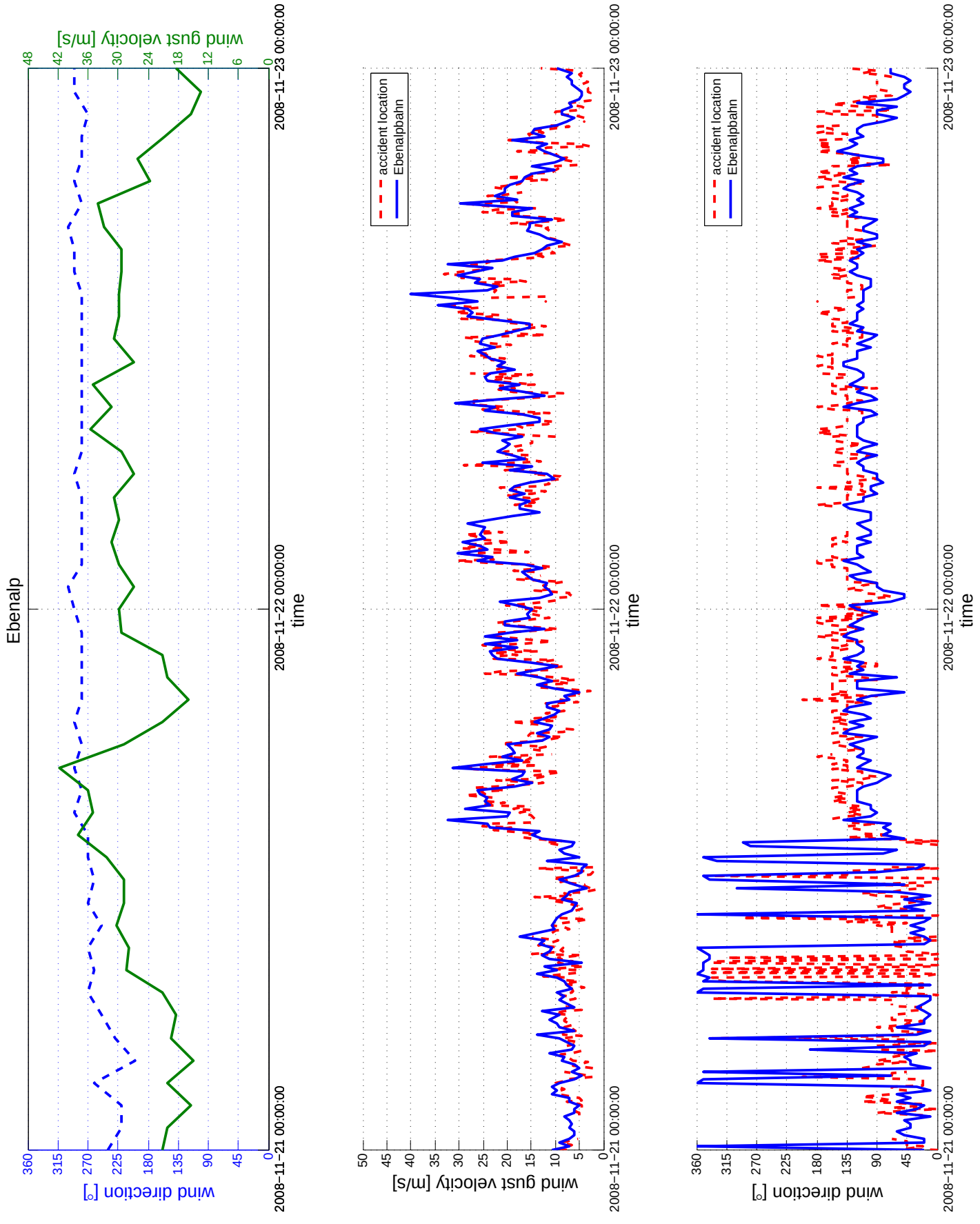
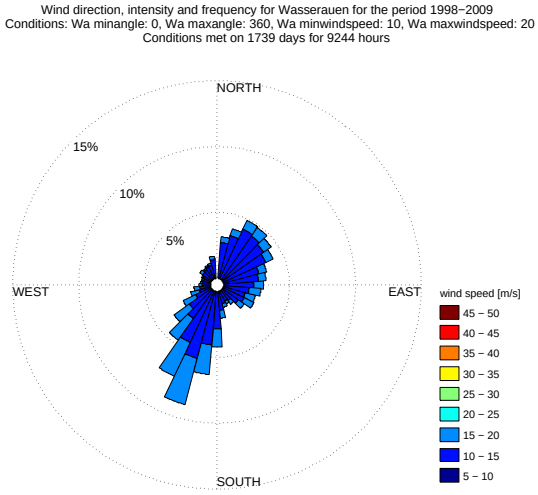
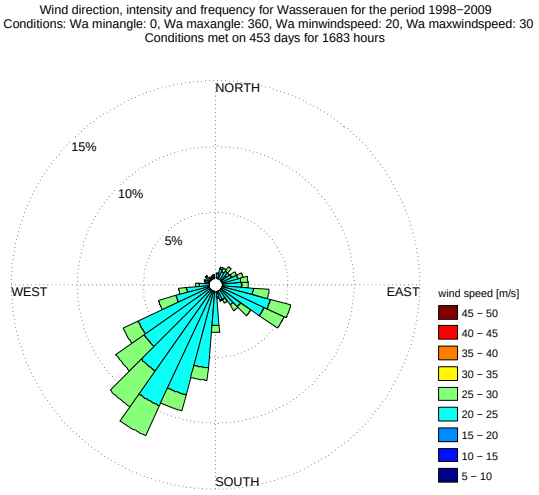

Ebenalp
wind direction [°]
wind gust velocity [m/s]
time
2008-11-21 00:00:00
2008-11-22 00:00:00
2008-11-23 00:00:00
accident location
Ebenalpbahn

Figure 3.2

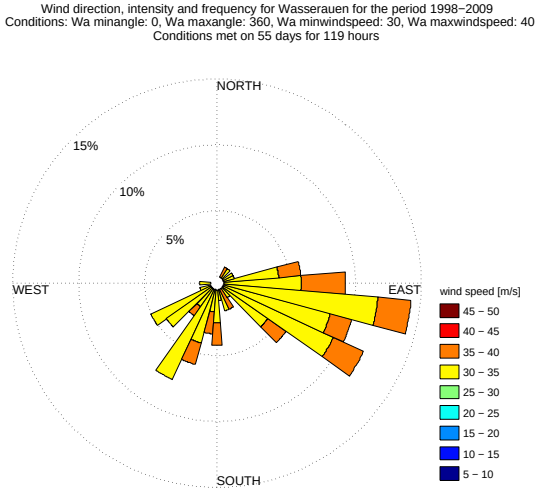
4 Windrose plots 1998-2009



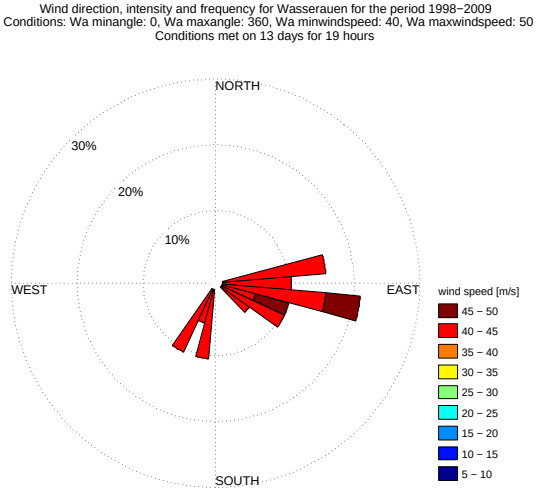
(a) wind gust range: 10-20 m/s



(b) wind gust range: 20-30 m/s

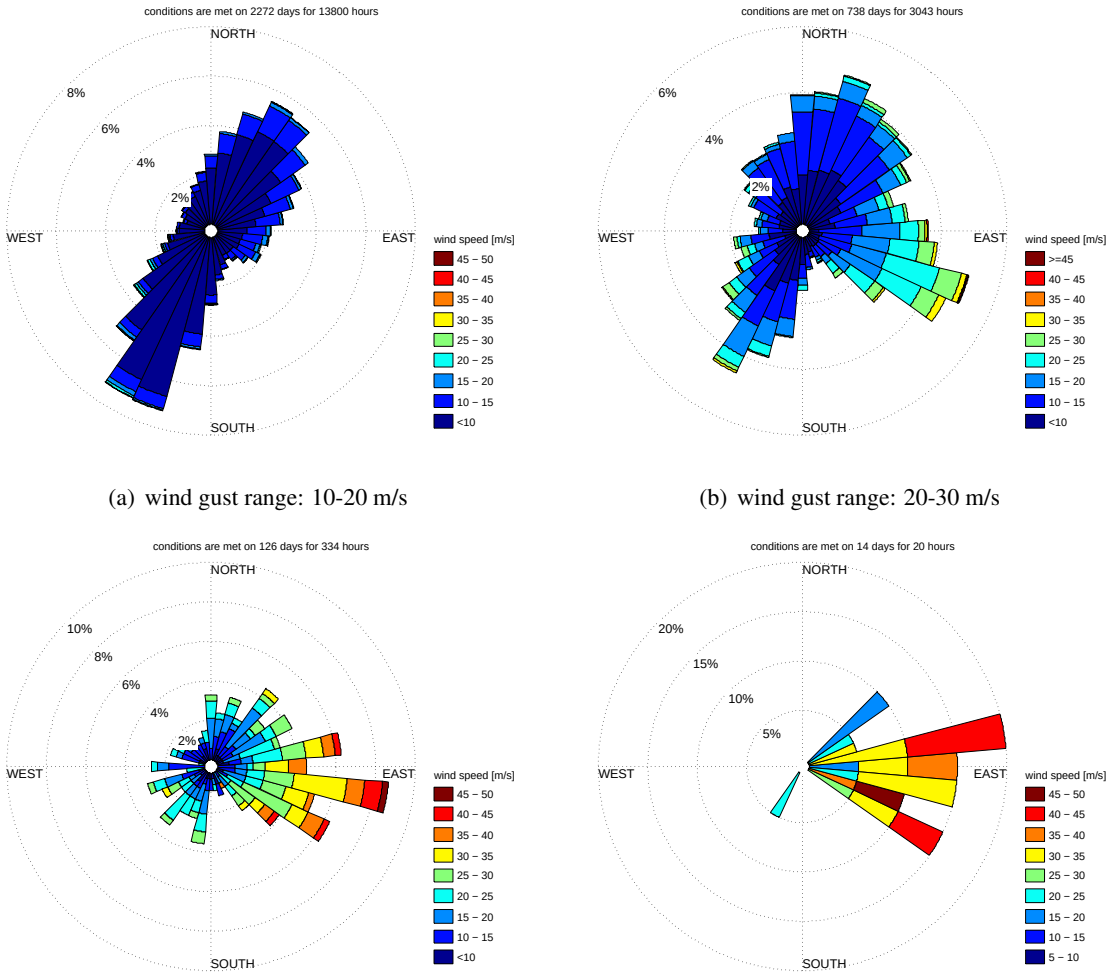


(c) wind gust range: 30-40 m/s



(d) wind gust range: 40-50 m/s

Figure 4.1: Recorded wind direction, intensity (colours) and frequency (percentage circles) of wind gusts at Wasserauen for different gust velocity ranges for the period 1998-2009. No wind direction requirements were imposed.



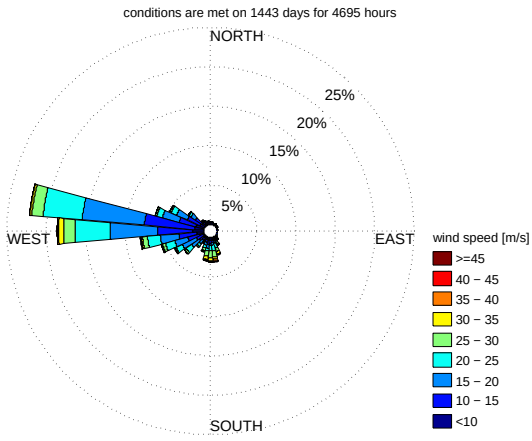
(a) wind gust range: 10-20 m/s

(b) wind gust range: 20-30 m/s

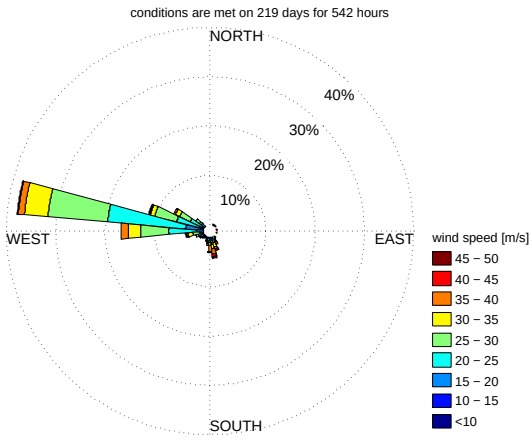
(c) wind gust range: 30-40 m/s

(d) wind gust range: 40-50 m/s

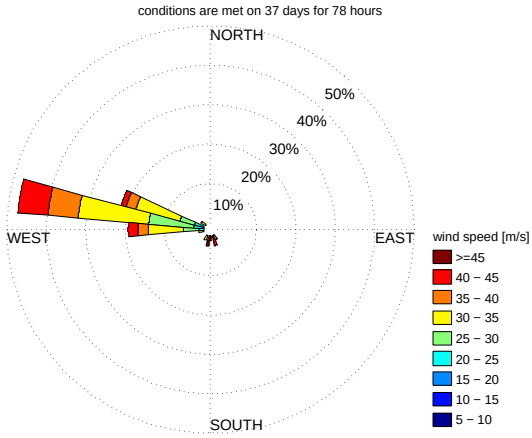
Figure 4.2: Recorded wind direction, intensity (colours) and frequency (percentage circles) of wind gusts at Wasserauen for wind directions between 240 and 360 degree azimuth and different gust velocity ranges on Ebenalp. Analysed for the period 1998-2009.



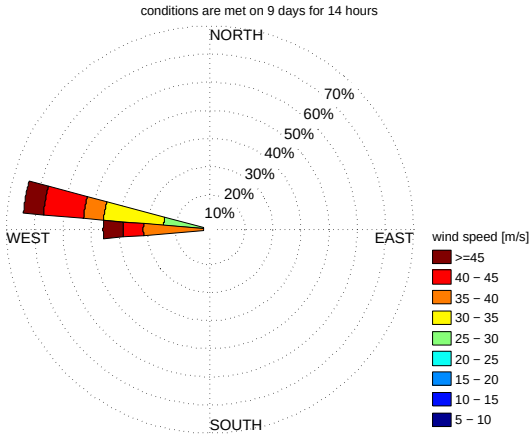
(a) wind gust range: 10-20 m/s



(b) wind gust range: 20-30 m/s



(c) wind gust range: 30-40 m/s

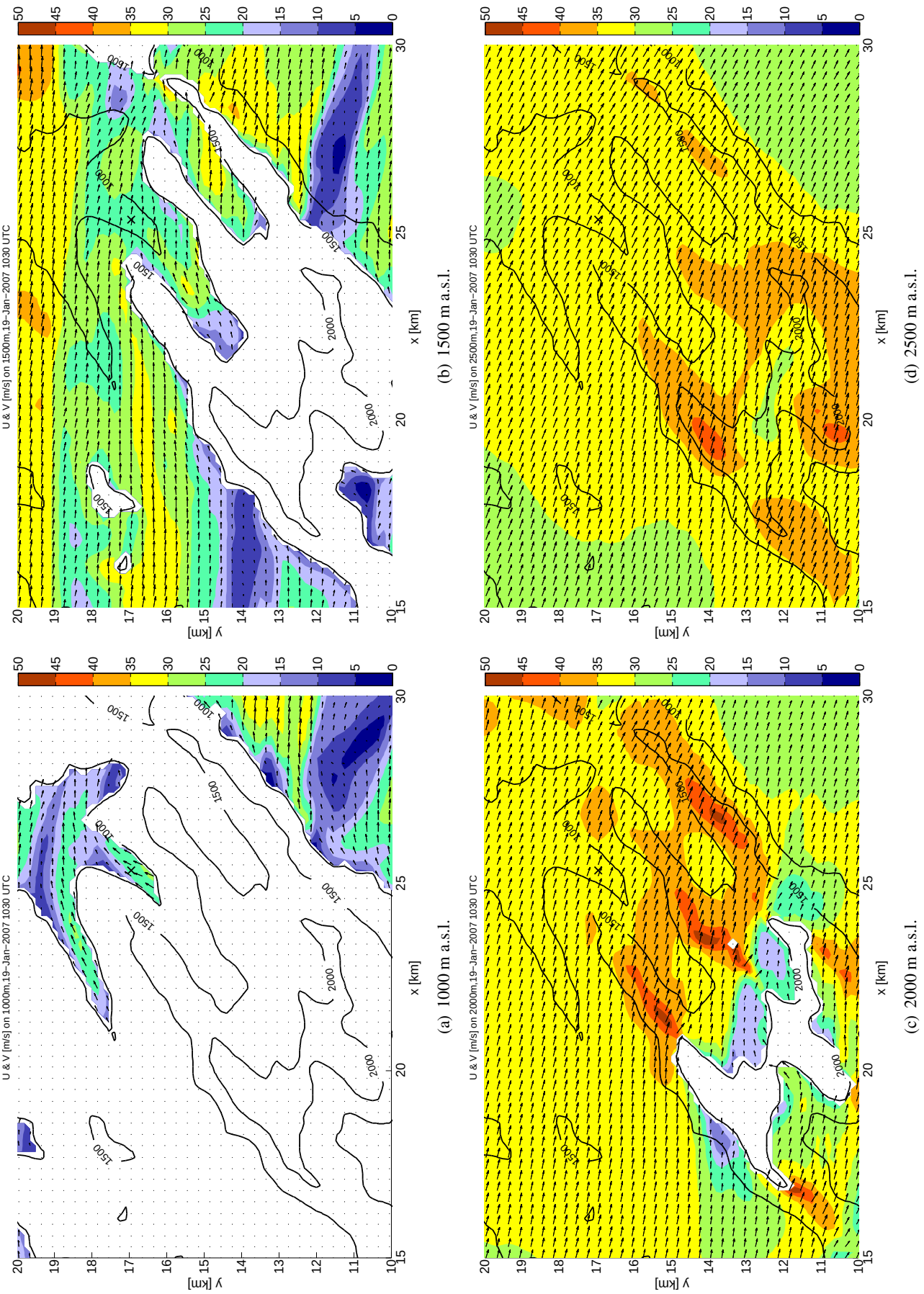


(d) wind gust range: 40-50 m/s

Figure 4.3: Recorded wind direction, intensity (colours) and frequency (percentage circles) of wind gusts on Ebenalp for wind directions between 0 and 180 degree azimuth and different gust velocity ranges at Wasserauen. Analysed for the period 1998-2009.

5 ARPS runs with heterogenous surface fields

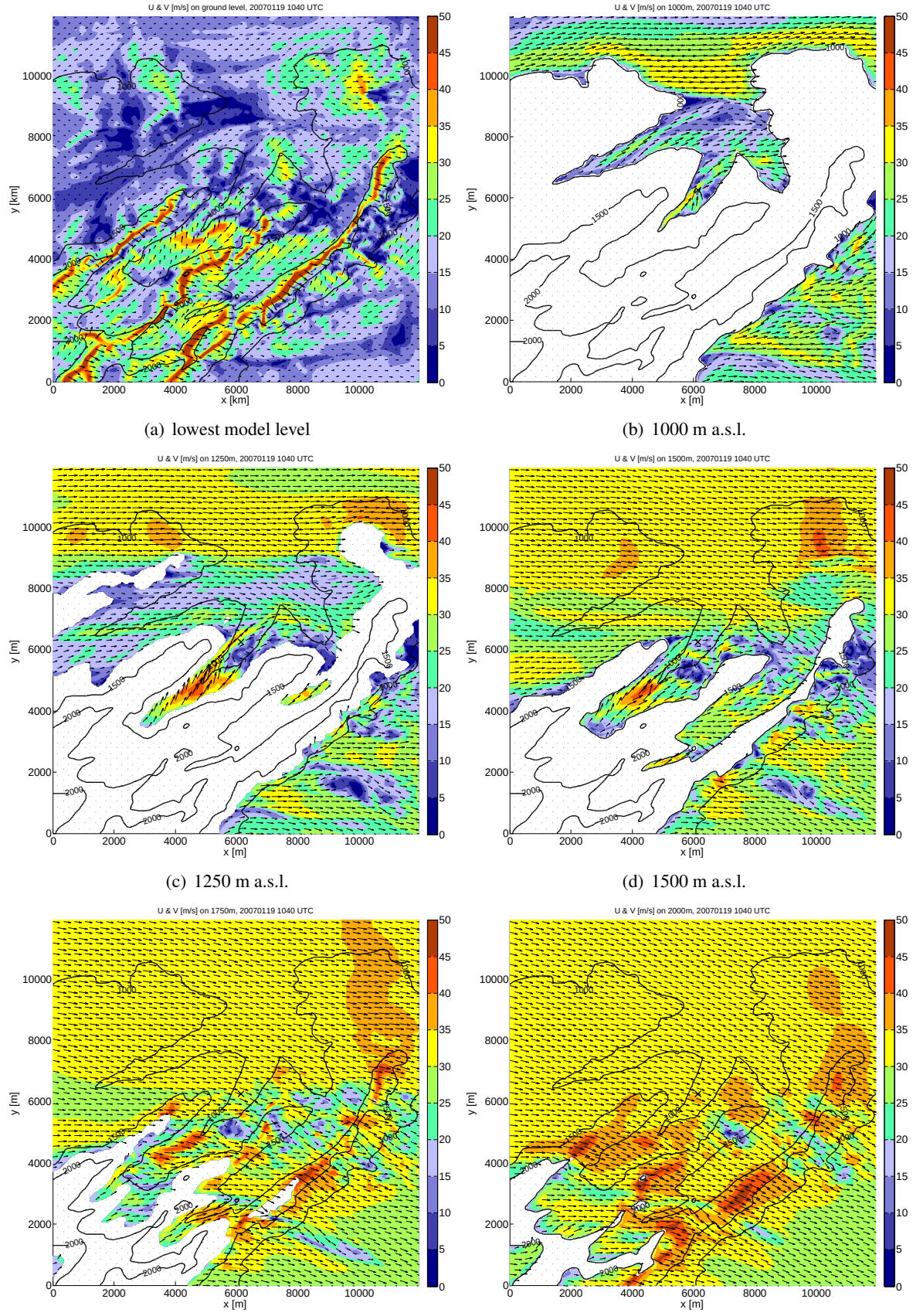
5.1 150m run



(a) 1000 m a.s.l. (b) 1500 m a.s.l. (c) 2000 m a.s.l. (d) 2500 m a.s.l.

Figure 5.1: Horizontal wind direction (arrows) and velocity (colors, in m/s) of the ARPS-150m simulation (with heterogenous surface roughness) on different elevations on January 19^{th} at 10.30 UTC. The approximate location of the train accident is marked with a cross.

5.2 50m run



(a) lowest model level

(b) 1000 m a.s.l.

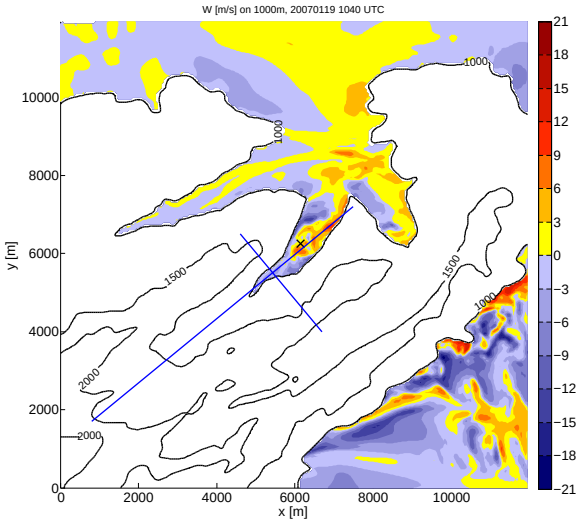
(c) 1250 m a.s.l.

(d) 1500 m a.s.l.

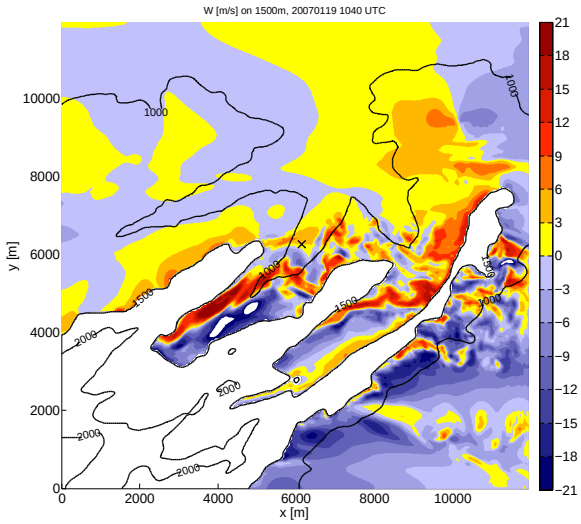
(e) 1750 m a.s.l.

(f) 2000 m a.s.l.

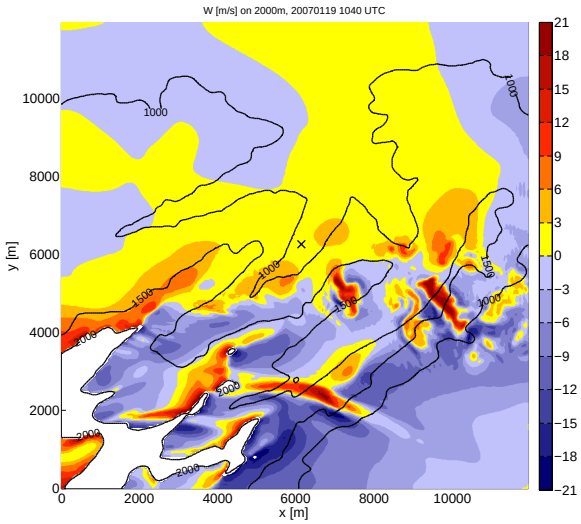
Figure 5.2: Horizontal wind direction (arrows) and velocity (colors, in m/s) of the ARPS-50m simulation (with heterogenous surface roughness) on different elevations on January 19^{th} at 10.40 UTC. The approximate location of the train accident is marked with a cross.



(a) 1000 m a.s.l.

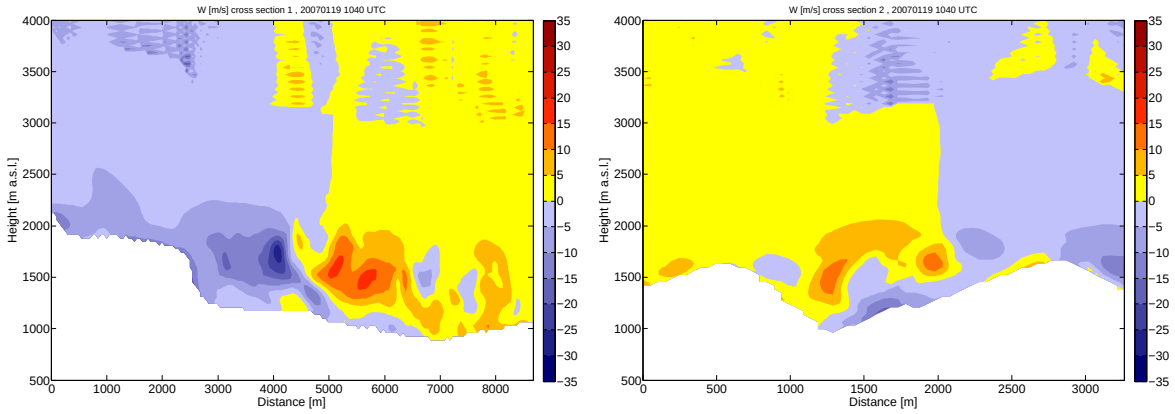


(b) 1500 m a.s.l.



(c) 2000 m a.s.l.

Figure 5.3: Vertical wind velocity (colours, in m/s) of the ARPS-50m simulation for January 19^{th} at 10.40 UTC on different elevations. The approximate location of the train accident is marked with a cross. The two blue lines in (a) indicate the course of the vertical cross sections in Figure 5.4.



(a) along valley: SW-NE

(b) cross valley: NW-SE

Figure 5.4: Vertical cross sections of vertical velocity (colours, in m/s) of the ARPS-50m simulation for January 19^{th} at 10.40 UTC. The course of the cross sections is depicted in Figure 5.3(a).