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A C-BAND BISTATIC DOPPLER RADAR SYSTEM AT DLR OBERPFAFFENHOFEN

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1. INTRODUCTION

Bistatic Doppler radar systems are less-expensive but reliable alternatives for multiple Doppler wind field retrieval (Wurman et al., 1993). They allow for a real-time and gate-by-gate multiple Doppler wind analysis. Only one active radar with a transmitter is needed. The remote bistatic stations consists of a non-scanning antenna and a PC-based receiver, as well as a communication link between the radar, the remote receiver and the central vector processing unit.

In summer 1998 a bistatic Doppler system with one remote receiver was installed supplementing the polarimetric Doppler radar POLDIRAD at DLR Oberpfaffenhofen, Germany. This system is the first bistatic installation for a C-band weather radar system using a magnetron transmitter.

First measurements were performed during a three week period in August 1998. Wind vectors were retrieved successfully in both clear-air and precipitation. Additionally some studies using different transmit polarizations have been performed.

In future the vector winds will be used for a 4D-data assimilation of a mesoscale numerical model.

2. SYSTEM DESIGN

POLDIRAD is a C-band polarimetric Doppler radar installed at DLR Oberpfaffenhofen, Germany (Schroth et al., 1988). The transmitted pulse is generated by a magnetron. This is in contrast to the other already operating bistatic Doppler networks and required a modification of the existing concept. In addition, communications have been modified and are now implemented via TCP/IP, and connection to the remote site is through an ISDN router.

Figure 1 shows the design of the bistatic network at DLR. The bistatic network is a system almost independent of the radar data processing system. It consists of a receiver connected to the radar antenna, a remote receiver and a bistatic hub which computes the wind vectors in realtime.

The receiver at the radar consists of a PC-based PIRAQ receiver which receives the IF (I and Q samples in the case of POLDIRAD) from the radar and some housekeeping data like the antenna pointing angles and the radar trigger. The radar transmit pulse is sampled to detect the phase of the transmitted pulse. The housekeeping data and the phase angle of the transmit pulse are distributed through the network to the remote receiver and the bistatic hub. Doppler velocities and reflectivities are sent to the bistatic hub.

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The remote receiver is located at Lichtenau, a DLR site 27 km from the radar (at azimuth 213°). During the test phase, an antenna with a horizontal beam width of about 70° and a vertical beam width of 8° was used (antenna gain ~8 dB). The antenna consists of a slotted wave-guide of about 1.80 m length and was mounted about 3 m above ground. The receiver is almost identical to the one at the radar site. The receiver can store up to 1 second of received data (at 1000 Hz PRF) until the phase information of the transmitted pulse is required from the radar site. The retrieved Doppler velocity and the reflectivities are then sent to the bistatic hub. The ISDN line (64 kbits/s) is loaded by about 50%.

The bistatic hub receives the Doppler velocity and reflectivity from both receivers. The data from each ray are merged into a common data file and the horizontal wind vectors are estimated in real time. They can be displayed through a simple X11 display anywhere in the net.

3. MEASUREMENTS

Figures 2 and 3 show results from measurements in August 1998. During the second installation week, strong clear- air echoes were observed by the radar. They were also observed by the low-gain bistatic antenna. Figure 2 shows a measurement with slight north-easterly winds. Figure 3 shows measurements in precipitation with strong south-westerly winds. The wind vectors north and west of

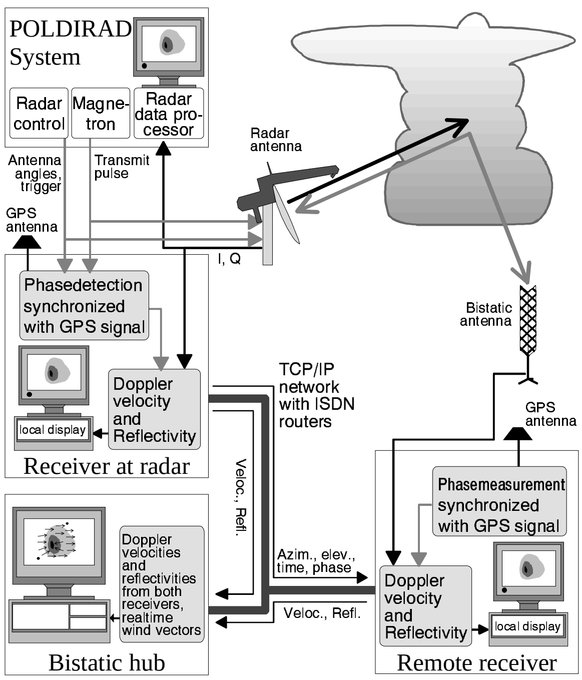

Figure 1. Simplified block diagram of the bistatic network at DLR Oberpaffenhofen with one remote receiver.

the receiver at Lichtenau are wrong due to folding of the Doppler velocity of either the radar or the bistatic receiver. In the present state the system does not allow for any signal quality control of the Doppler velocity. However, spurious wind vectors have been removed by a simple editing routine, which can not handle all “wrong” wind vectors. Due to the antenna geometry, reliable wind vectors can be only obtained in a sector east of the remote receiver.

4. OUTLOOK

For the year 1999 the installation of two further receivers is planned. The aim is to use the system either for studies of deep convection as well as for wind retrieval in the vicinity of an airport. For the first application antennas with a wide beam (~ 20° elevation, low-gain) are needed. For the wind retrieval within clear-air in the boundary layer high-gain antennas have to be used. This implies a narrow beam width (~4° elevation). A remote switch at the receivers can choose between different antennas during the measurement. The development of sophisticated routines for the retrieval of real-time vector winds is planned for the future. This will include a real-time unfolding algorithm. The vector winds will be used further for a 4D-data assimilation of a mesoscale numerical model.

5. REFERENCES

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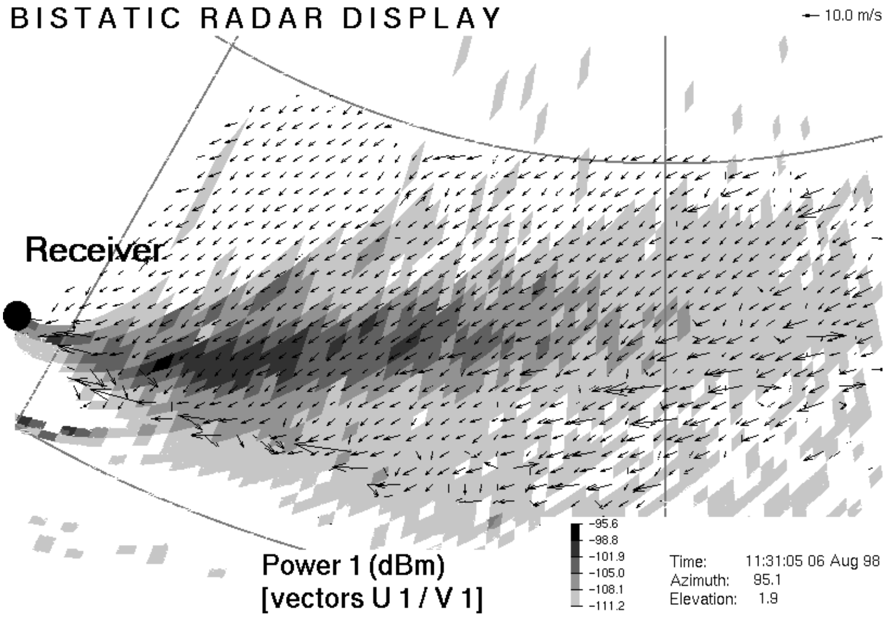

Figure 2. Measurements in clear air on 6 August 1998, 13:31 local time. Power in dBm measured by the bistatic receiver in Lichtenau and retreived wind vectors. Range rings every 10 km. Wind vectors are available every range bin. They are shown on a regular grid every 450 m.

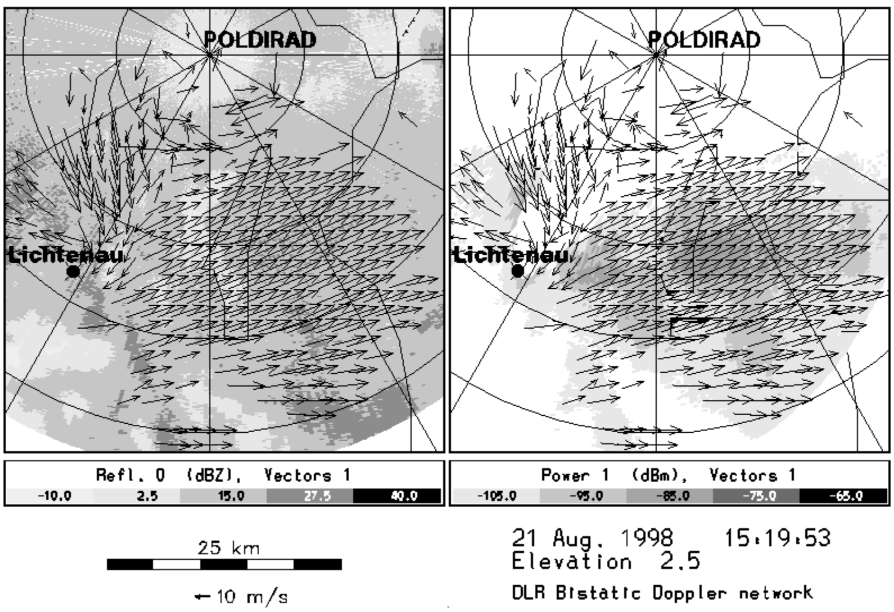

Figure 3. Measurements in precipitaion on 21 August 1998, 17:19 local time. Reflectivity measured by the radar and power measured by the bistatic receiver. Doppler velocities to the west and north of the bistatic receiver are folded. Range rings every 10 km. Wind vectors are available every range bin. They are shown every 2.2 km.