A new narrow beam MF radar at 3 MHz: System description and first results

W. Singer[(1)], R. Latteck[(1)], D. A. Holdsworth[(2)], T. Kristiansen[(3)],

(1) Leibniz-Institut für Atmosphärenphysik, Schloss-Str. 6, D-18225 Kühlungsborn, Germany
(2) Atmospheric Radar Systems, 1/26 Stirling St., Thebarton, SA, 5031, Australia
(3) Andoya Rocket Range, Andenes, Norway

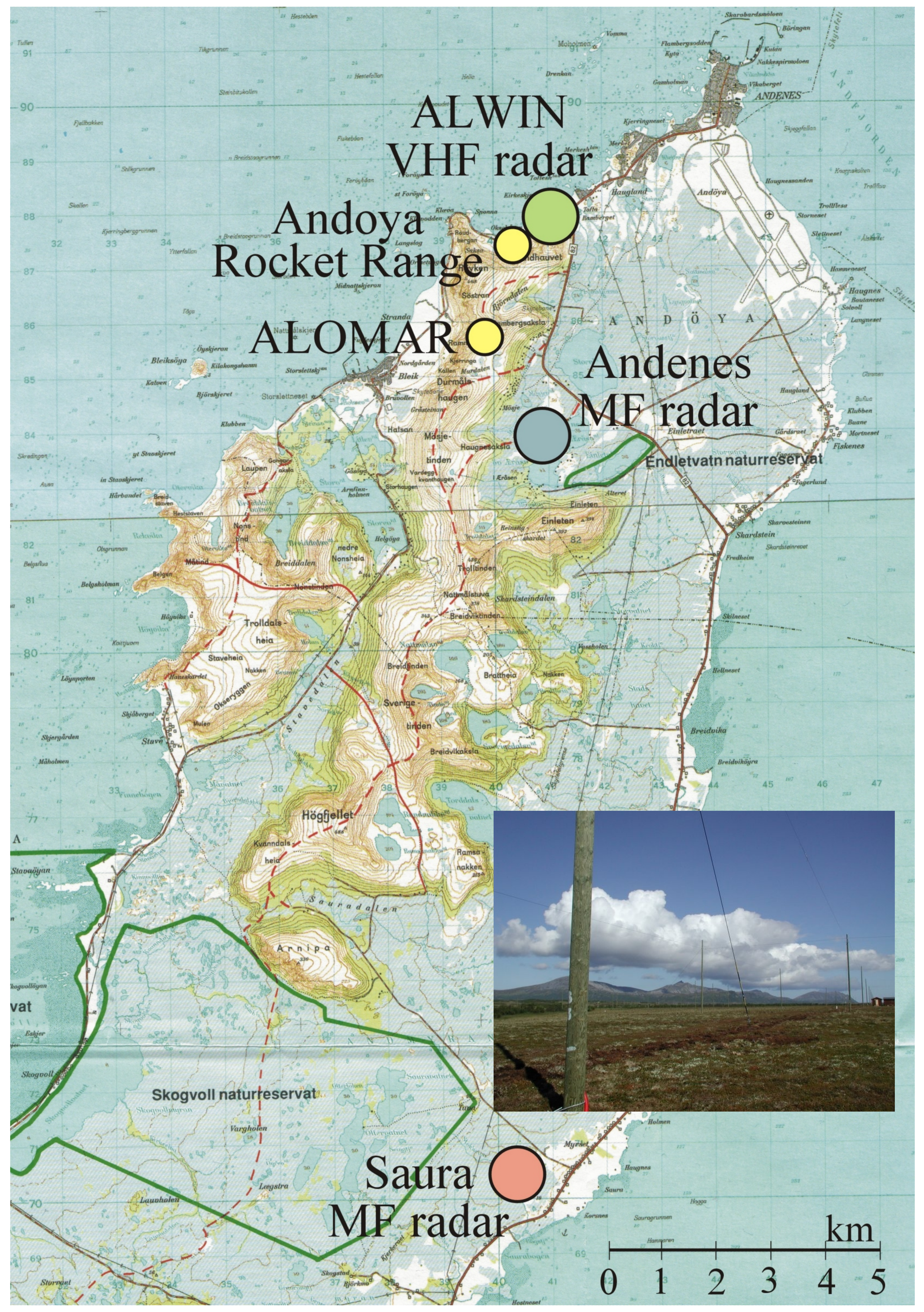
16th ESA Symposium on European Rocket and Balloon Programmes and related Research,
St. Gallen, Switzerland, June 2 - 5, 2003.

Introduction

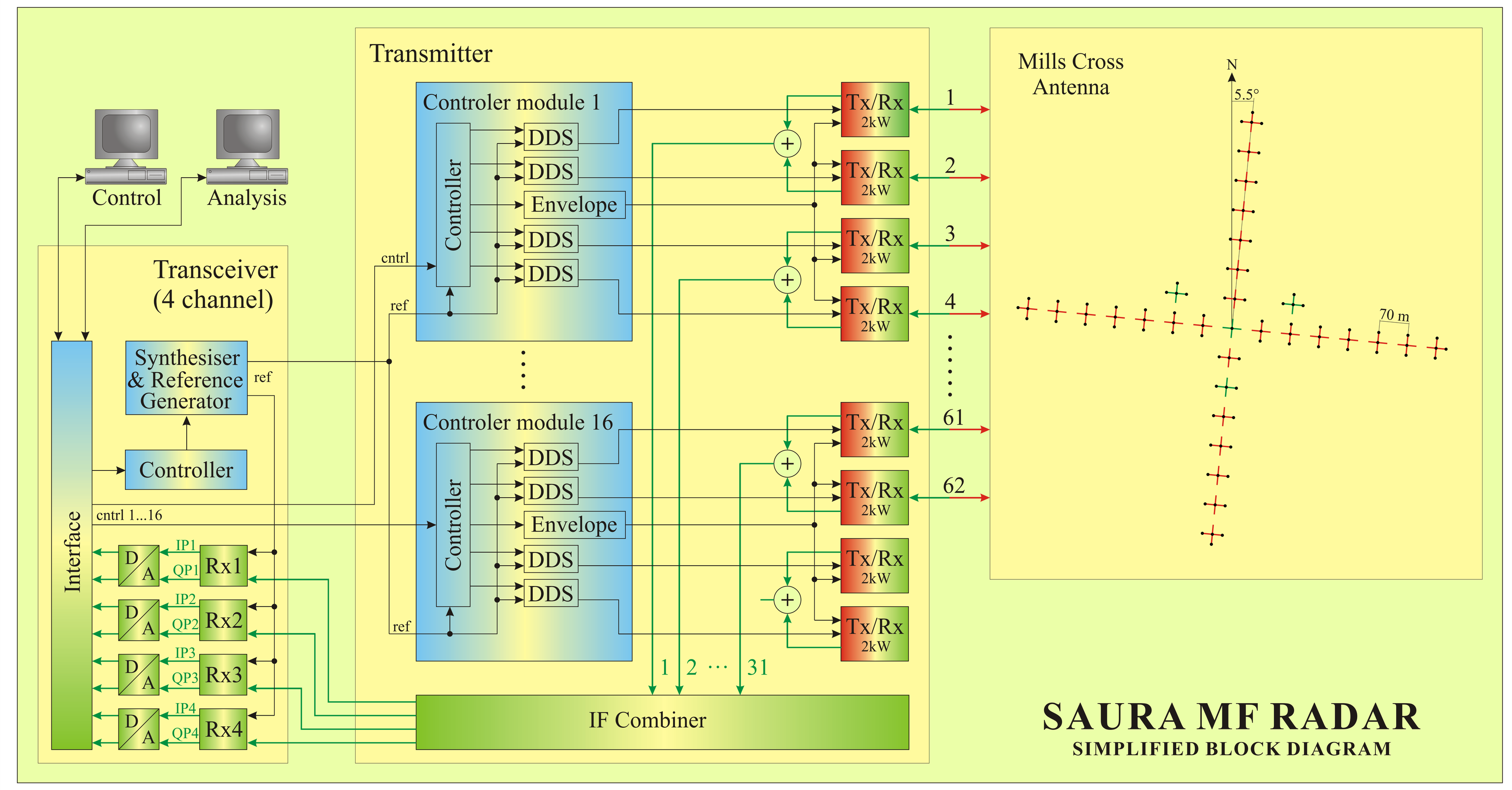
A new narrow beam MF radar has been installed close to the Andoya Rocket Range as part of the ALOMAR observatory to improve the ground based capabilities for studies of the dynamical status (small scale features, turbulence) of the upper mesosphere. The characteristics of radio wave scatterers can be studied now in a wider frequency range by common volume observations with the ALWIN MST radar at 53.5 MHz. The Saura MF radar is a joint experiment of the Andoya Rocket Range, the Communication Research Laboratory, Tokyo and the IAP. The radar has been developed by Atmospheric Radar Systems (ATRAD).

The system operated at 3.17 MHz was put into operation in July 2002 applying spaced antenna observations and reached its full Doppler capabilities in April 2003. Doppler beam steering technique as well as spaced antenna applications can be applied. The main feature of the new radar is the transmitting/receiving antenna which is formed by 29 crossed half-wave dipoles arranged as a Mills-cross. The spacing of the crossed dipoles is 0.7 wave lengths resulting in a minimum beam width of 6.4° (FWHP, one way). Each dipole is fed by its own transceiver unit with a peak power of 2 kW (phase controlled on transmission and reception) providing high flexibility in beam forming and pointing as well as O - and E - mode operation for differential absorption measurements. Off-zenith beams towards N, S, E, W and NW, NE, SE, SW at 7.3°/17.2° can be formed. In addition, beams with different widths at the same pointing angle can be formed. For multiple receiver applications four independent receiving channels and two additional crossed dipole arrangements are available.

Observations of PMSE signatures at 3 MHz and interleaved Doppler winds and spaced antenna winds using Full Correlation Analysis are presented. First results of electron density observations, of momentum flux measurements using coplanar beams and of turbulent parameters (mean turbulent velocities, energy dissipation rates) are presented.



System description



Saura MF Radar narrow beam Doppler (DBS) & spaced antenna (SA) system	
Frequency	3.17 MHz
Peak power transmitter	116 kW
Peak power incl. cable loss	40 kW
Transmitt/receive modules	62 (2 kW, individual phase control)
Receivers	4
Pulse width	7 s, 10 s, 13.3 s
Range resolution	1.0, 1.5 km, 2.0 km
Sample step	1.0, 1.5 km, 2.0 km
Pulse rep. frequency	max. 200 Hz
Length of time series	minimum 60 s

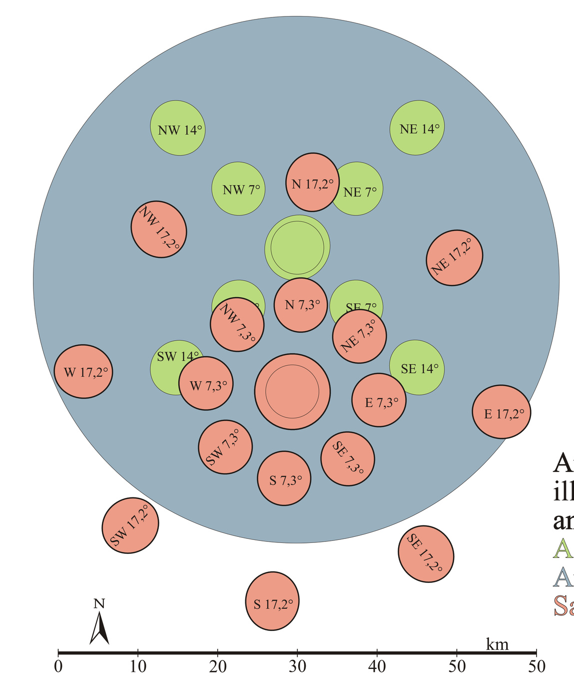
Antenna system Crossed half-wave dipoles arranged as Mills-cross (spacing 70 m) Circular polarization (o, x)	
Transmission	DBS, SA, user: 29 crossed dipoles or less
Reception	DBS: 29 crossed dipoles or less
	SA: 4 crossed dipoles
	User mode: 4 crossed dipoles
Gain	19 dB
Beam width	6.6°/13.8° (one way, FPHW)
Beam directions	vertical; 7.2° and 17.2° off-zenith
	preferred towards NW, SE, NE, SW (N, S, E, W)
Interleaving mode	polarisation {o, x}
(from data point to data point)	co-planar beams of same width

Outlook

The Saura MF radar is full operational since April 2003 allowing Doppler experiments with various beam configurations to measure wind, electron density, momentum flux and turbulent spectral width. In addition, the system can be operated in spaced antenna mode for wind and meteor observations.

New correlative experiments with co-located radars and lidars can be performed

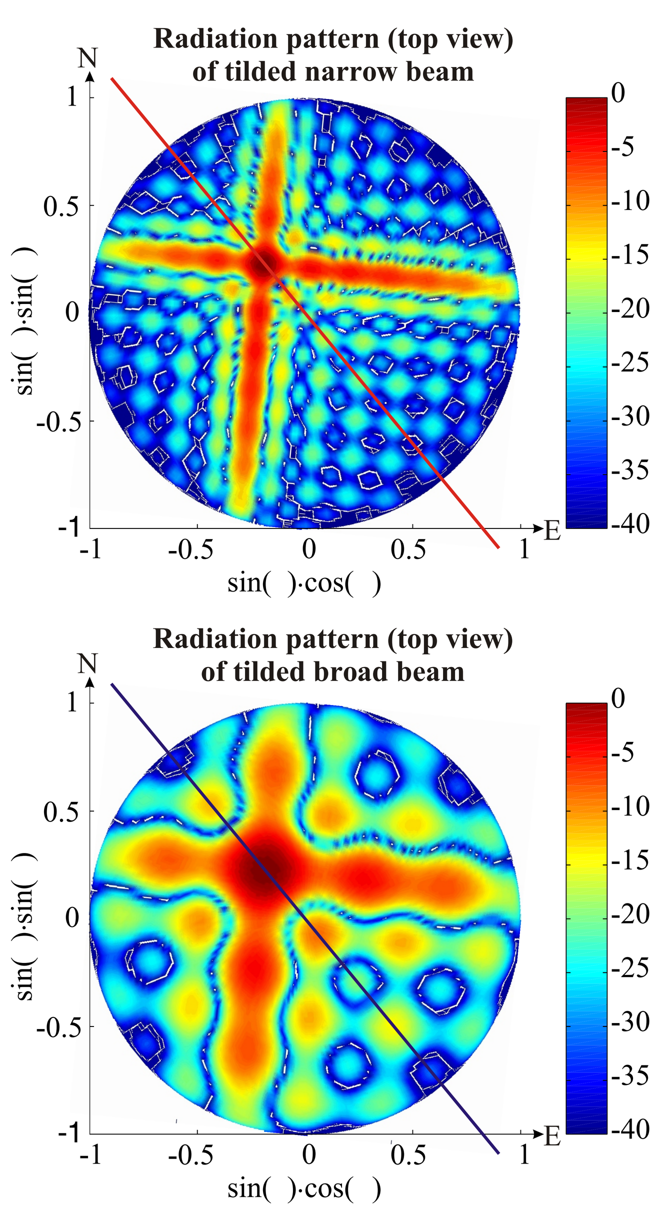
- ALWIN VHF radar (wind, spectral width)
- ALOMAR MF radar, Meteor radar (wind)
- ALOMAR RMR lidar
- ALOMAR Weber lidar (wind, momentum flux)
- Sounding and meteorological rockets

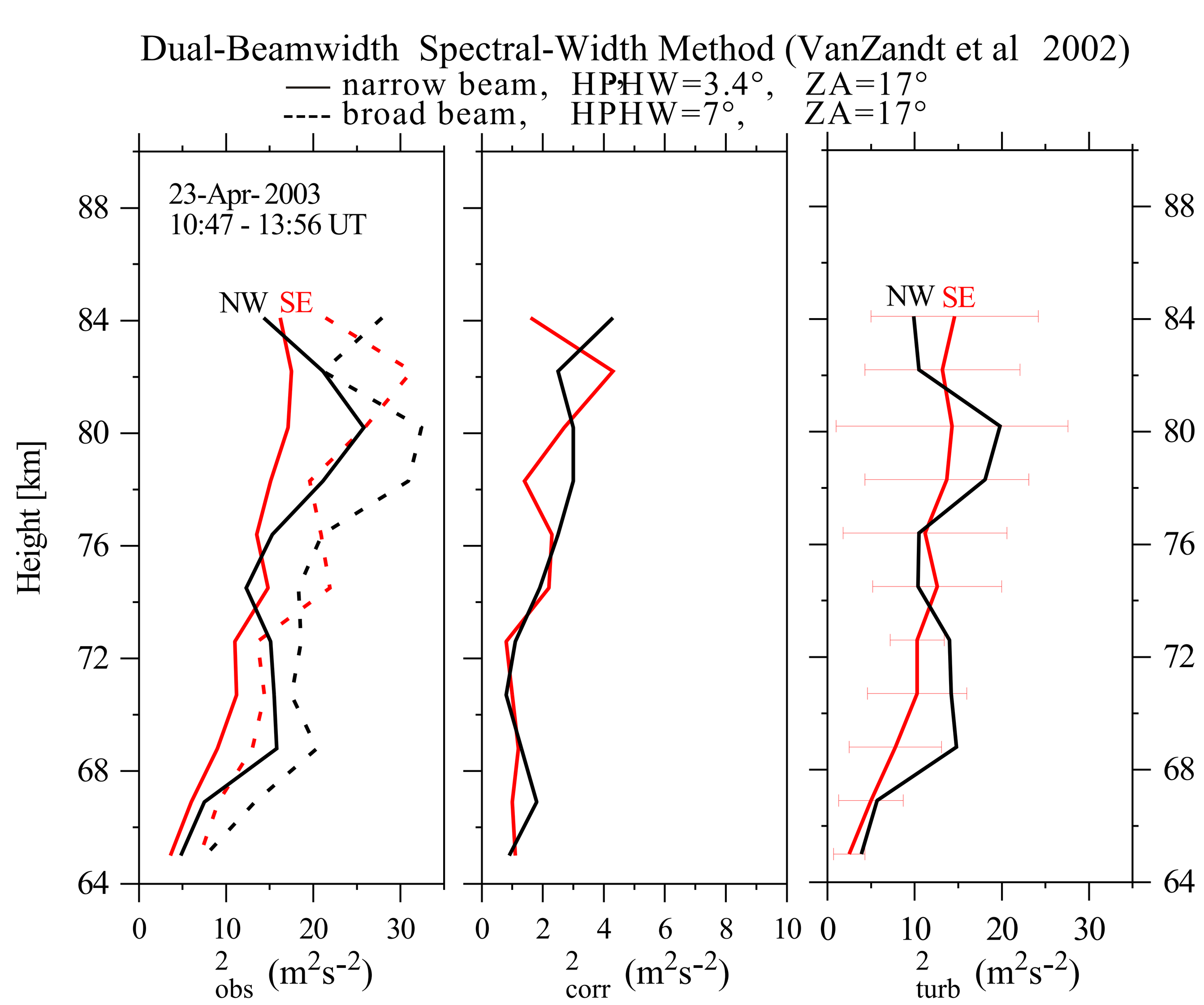


Areas at 85km altitude illuminated by oblique and vertical beams of ALWIN VHF radar, Andenes MF radar, and Saura MF radar.

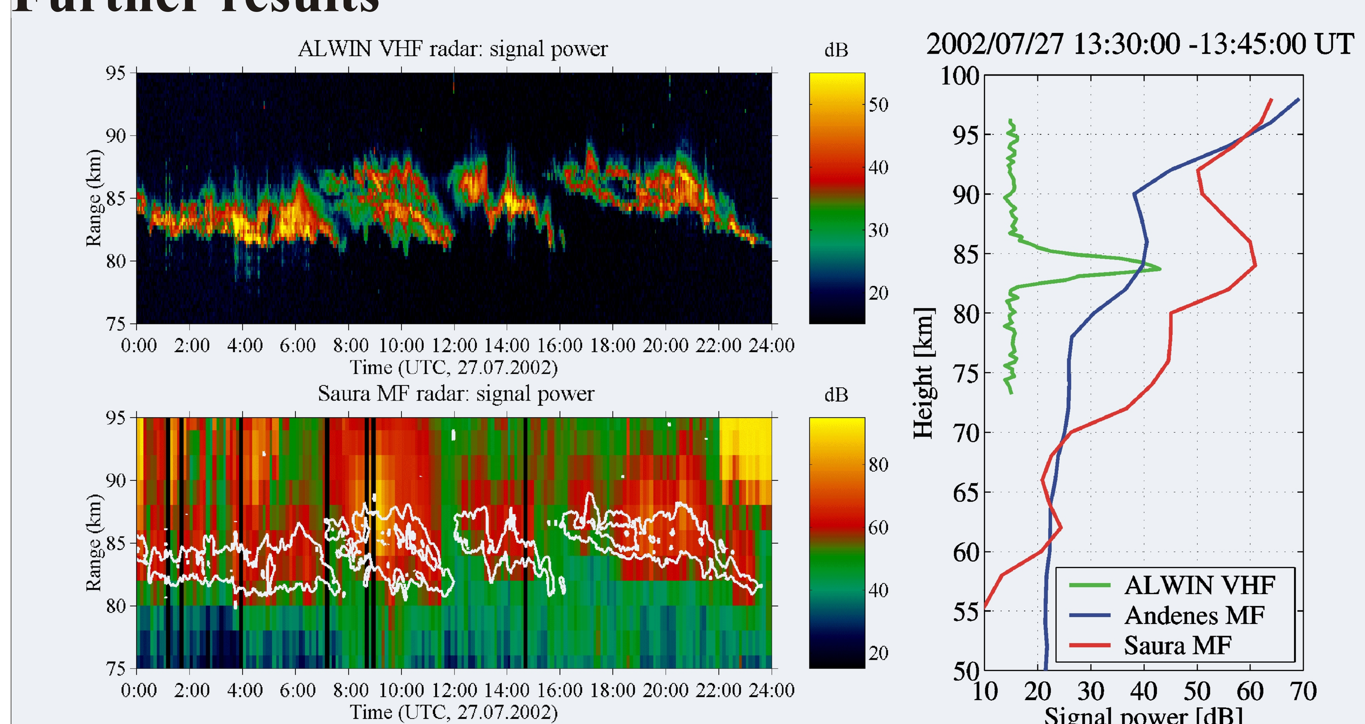
Estimation of turbulent spectral widths using the dual-beam width method

The dual-beam width method allows the estimation of the turbulent spectral width without knowledge of the wind profile using spectral width observations at the same beam pointing angle with different beam widths. Beams with 6.6° and 13.8° FWHP at 17.2° zenith angle are applied to avoid contamination due to Fresnel scatter. The observed turbulent spectral widths correspond to energy dissipation rates of 20 to about 60 mW/kg.

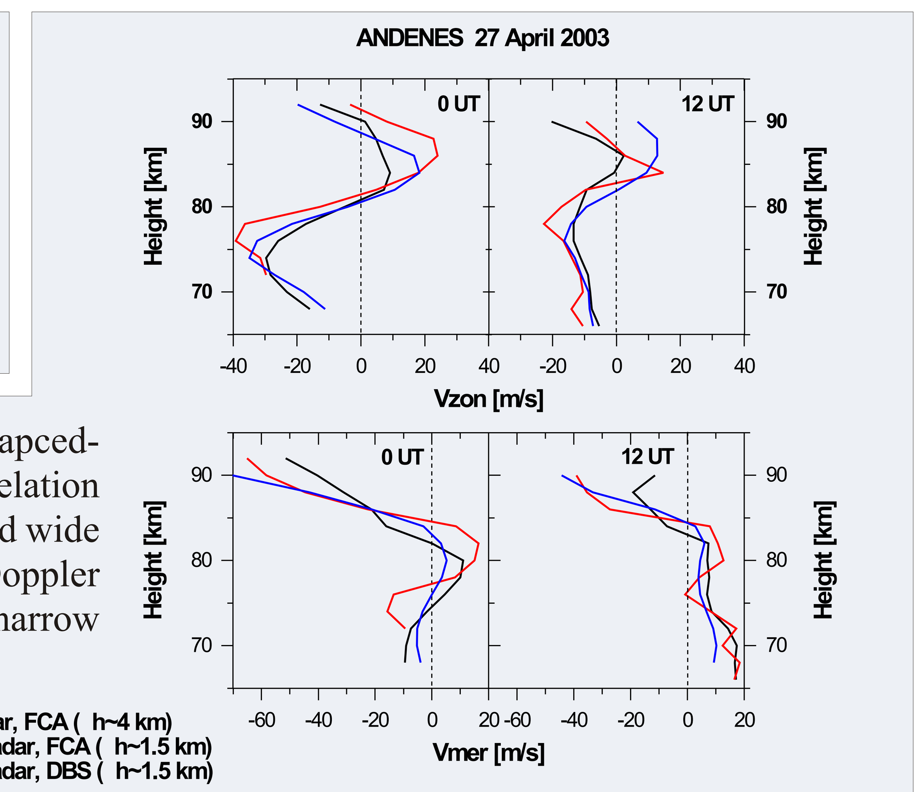




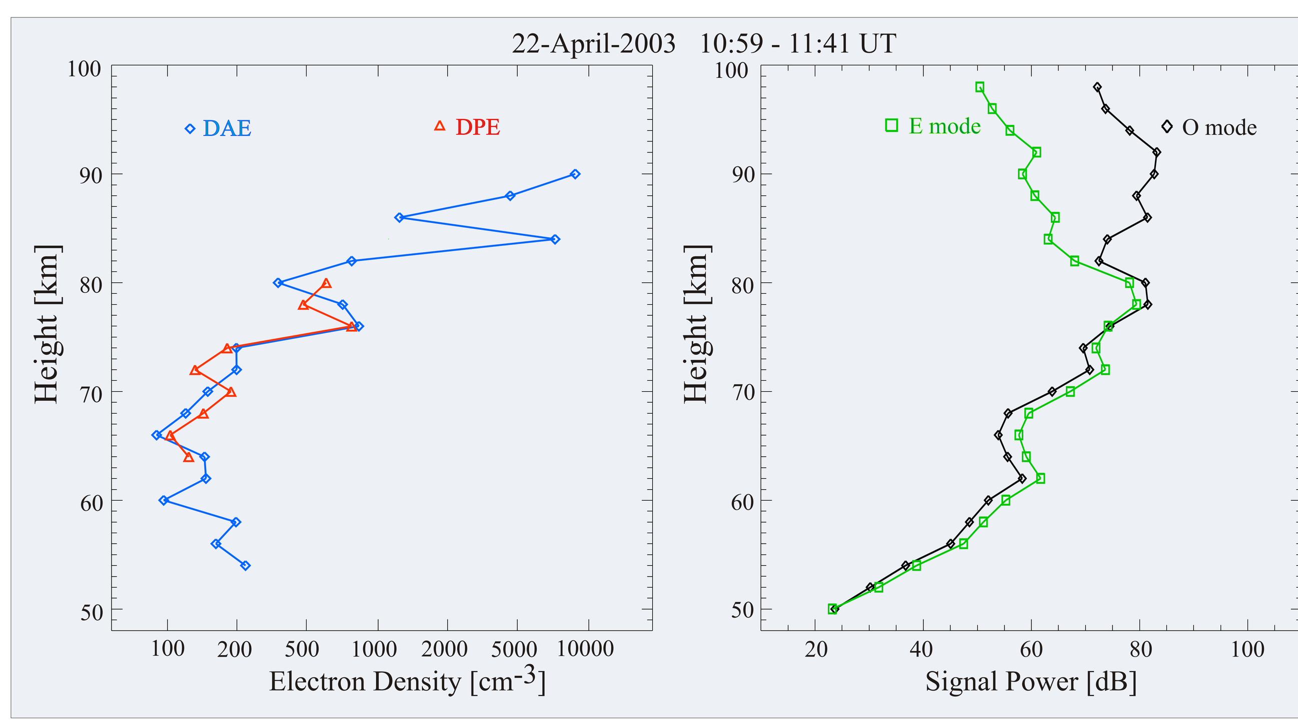
Further results



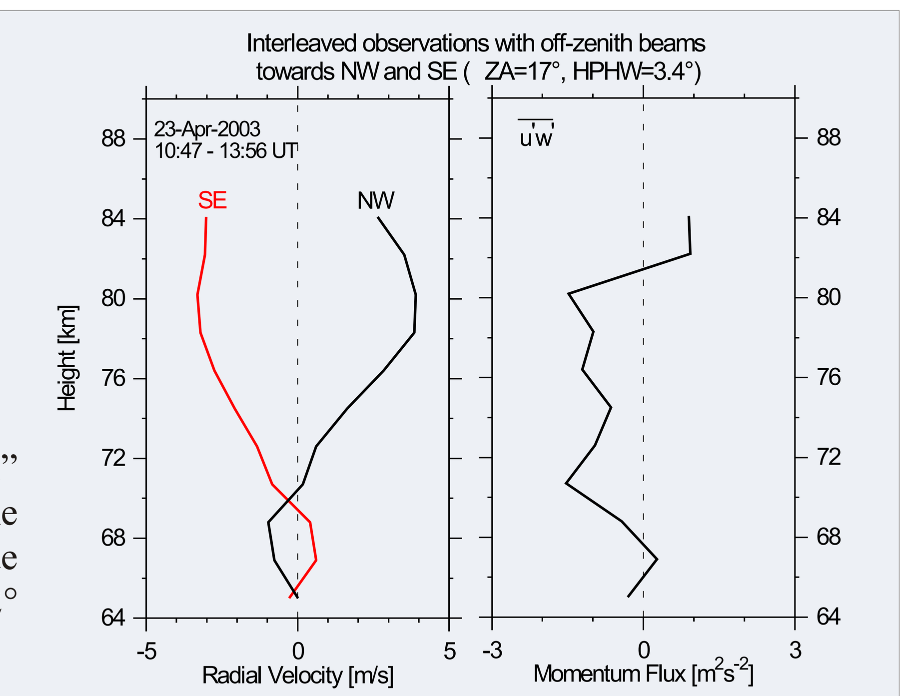
PMSE signatures observed with ALWIN VHF radar (53.5 MHz) and Saura MF radar (3.17 MHz). Height Profiles and height-time plots of signal power with overlayerd contours of VHF signals.



Horizontal winds obtained by sapced-antenna observations (Full Correlation Analysis) with the narrow beam and wide beam MF radar as well as by Doppler beam swinging technique with the narrow beam MF radar.



Electron densities derived from the Differential Absorption Experiment and the Differential Phase Experiment. Interleaved observations with ordinary (O mode) and extra-ordinary (E mode) polarisation.



Mean radial velocities and "zonal" momentum flux in the NW-SE plane obtained with interleaved oblique beams toward NW and SE at 17.2° zenith angle (HPHW=3.4°).