

Research on Domestic Remote-sensing Equipments for Participating Yangjiang-2010 International Upper Air System Comparison

According to the plan of Joint Meeting of the Expert Team on Upper-Air Systems Intercomparisons and International Organizing Committee on Upper-Air Systems Intercomparisons was held in Yangjiang, Guangdong Province from August 30 to September 5, 2009. It is decided after discussion that the comparison work will be held in Yangjiang from July 12 to 31, 2010.

Besides the high performance upper air sounding systems from many other countries, the remote-sensing equipments play a very important role for analyzing the capability of the sounding equipments. They can provide important assistance for the analyzing data, especially the vapor observation by remote-sensing which acts as a reference for analyzing the performance of the relative humidity sensor between day and night; meanwhile, it is essential for determining the cloud condition during flight comparison.

Following the requirement of WMO, China Meteorological Administration conducted research on the remote-sensing equipments that China can offer to participate in the 8th International Upper-air Sounding Equipments Comparison. The equipments and their Function, technical specifications are as following.

Part One Cloud-detection Radar

It is used for detecting the delicate structure of the cloud, and analyzing the effects of the sounding equipments when going through the cloud.

The below radars possess RHI scanning. They can obtain the vertical structure property of the clouds above the observing region.

I. SCRMP-01 Regular Millimeter-wave Cloud-detection Radar

1. Function

It works at Ka frequency, and can detect the non-precipitating clouds and weak precipitating clouds within the range of 30 km. It obtains data on the

reflectivity of the target and its lineal depolarization ratio, etc.

2. Technical Specifications of the Observed Elements

Detection range	Range	0.15km~40km
	Azimuth	0~360°
	Elevation	-2~+90°
	Reflectivity	-50~+30dBz
	Depolarization ratio	-30~-5dB

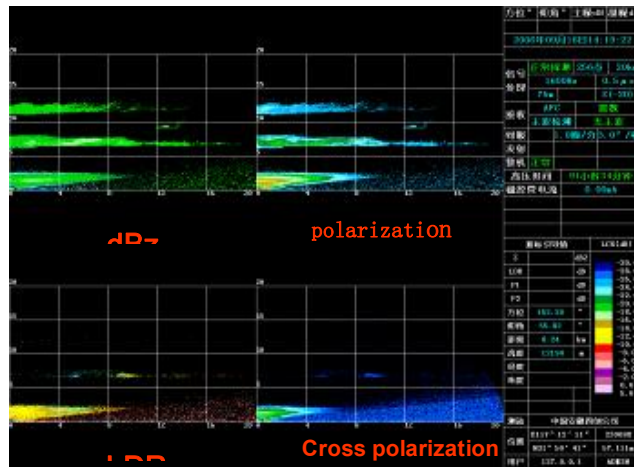
3. Frequency Range

34.90GHz±50MHz

4. Technical Specifications of the Hardware

Antenna Form	Parabolic Antenna
Diameter	1.5m
Wave Width	0.4° ±0.05°
Antenna Gain	≥50 dB
First Side Lobe	≤-25dB
Cross-polarization Isolation	≤-30dB
Transmitting Tube	Coaxial Pulse Magnetron
Transmitting Pulse Power	≥20kw
Pulse Width	0.5us±0.05us
Repetition Frequency	1600Hz
Noise Figure	≤4.5dB
Intermediate frequency	400MHz
Range Bin	75m
Processing	DVIP
Accumulation	16/32/64/128/256/512/1024/2048
Terminal Processing	High-performance computer (including a 19 inch flat screen monitor), radar control, echo display and save, the basic parameter of the terminal display is Z, LDR.
Power Consumption	≤3kw

5. Domestic Application and Equipments Photo



Echo from SCRMP-01 Radar

II. SCRMP-02 whole coherent Millimeter-wave Cloud-detection Radar

1. Function

It works at Ka frequency, and can detect the non-precipitating clouds and weak precipitating clouds within the range of 30 km. It obtains data on the reflectivity, velocity, spectrum width and lineal depolarization ratio of the target. Also, it provides the secondary products such as the cloud distribution, size as well as the phase of the particles in the cloud.

2. Technical Specifications of the Observed Elements

Detection range	Range	0.15km~30km
	Position	0~360°
	Elevation	0~+90°
	Reflectivity	-50~+30dBz

	Velocity	-8.5~+8.5m/s
	Spectrum width	0~4m/s
	Depolarization ratio	-30~-5dB

3. Frequency Range

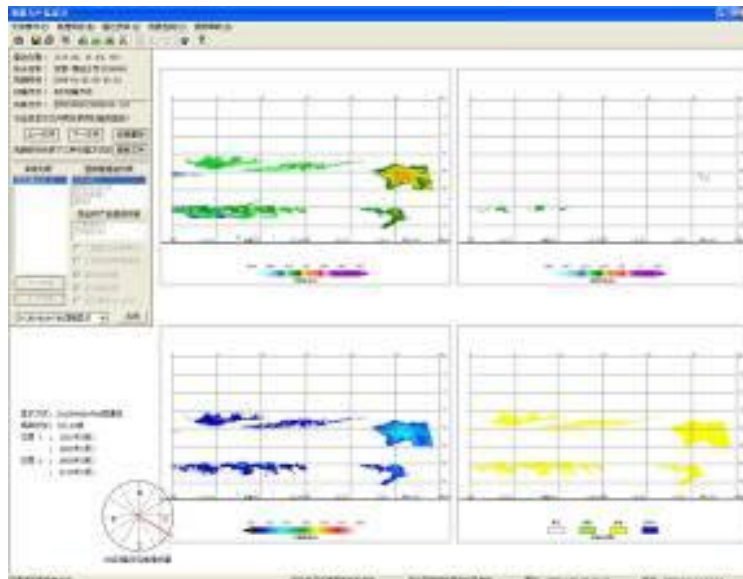
35GHz±10MHz

4. Technical Specifications of the Hardware

Antenna Form	Cassegrain Antenna
Diameter	1.5m
Wave Width	≤0.4°
Antenna Gain	≥51 dB
First Side Lobe	≤-23dB
Cross-polarization Isolation	≤-30dB
Transmitting Tube	TWT
Transmitting Pulse Power	0.6kw
Pulse Width	0.5 μ s、20 μ s、40 μ s
Repetition Frequency	1000、2000、4000Hz
Noise Figure	≤4.5dB
Intermediate Frequency	50MHz
Range Bin	75m
Reflectivity Processing	Linear Average
Velocity Processing	FFT、PPP
Accumulation	32/64/128/256/512/1024/
Reflectivity Z	-50~+30dBz (Accuracy: ≤0.5dB)
lineal Depolarization Ratio (LDR)	-10~-30dB (Accuracy: ≤0.5dB)

Terminal Processing	High-performance computer (including a 17 inch flat screen monitor), radar control, echo display and save. Not only can the terminal display the basic parameters such as reflectivity, radial velocity, spectrum width and lineal depolarization ratio, but also the cloud ceiling, height of the cloud base, cloud thickness as well as the size and phase distribution of the particles in the cloud.
Power Consumption	$\leq 3\text{kw}$

5. Domestic Application and Instrument Photo



Evolved Products of Cloud Phase and Cloud Particles

III. Cloud Radar

1. Function

It is an 8mm mobile weather radar system. Its main detecting parameters are the echo reflectivity, radial velocity, velocity spectrum width and depolarization factors of the cloud, fog and dust storm, etc.

2. Technical Specifications of the Observed Elements

Item	Technical Requirements
Radar System	Coherent pulse Doppler, Horizontal polarization emission and simultaneous horizontal&vertical polarization signal receiving
Frequency	33.44GHz
Signal	Single-carrier frequency rectangular pulse (τ : $0.3 \mu s$) LFM rectangular pulse (τ : $20 \mu s$, $40 \mu s$)
Detection Range	Vertical: 10km, Horizontal: 30km
Min. Detection Range	$\leq 360m$
Detection Volume	Echo reflectivity: dBZ, Radial velocity: V_r , Velocity width W, depolarization factor LDR
Range resolution	$\leq 50m$
Accuracy	Echo reflectivity $\leq 1dB$ (RMS) Radial velocity $\leq 1m/s$ (RMS)
Scan Range	Position: $-185^\circ \sim +185^\circ$ Elevation: $-1^\circ \sim +95^\circ$
Power	Single phase, 220V、50Hz, AC

3. Frequency Range

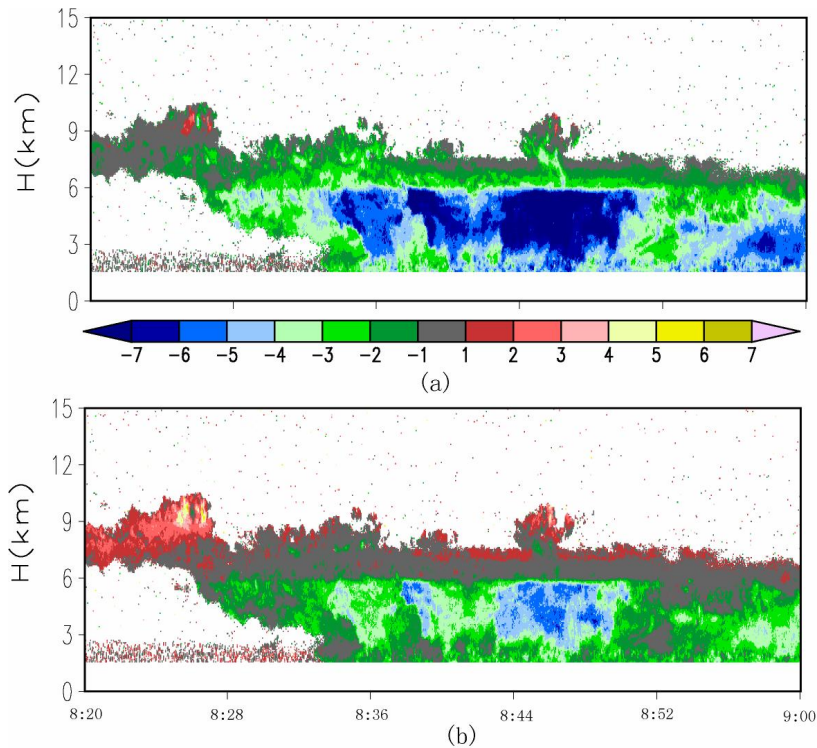
33.44GHz

4. Technical Specifications of the Hardware

See the above table.

5. Domestic Application and Equipments Photo





Vertical velocity (a), updraft velocity of the air (b) observed by radar

Part Two Ceilometer

It is for measuring the height and amount of the clouds, analyzing the influence of clouds for sounding.

It is strongly suggested to use the Ceilometer produced by VAISALA. The current products in China are not mature which can only be used as supplementary.

1. Function

YGJG-A1 Laser Ceilometer, for measuring cloud height, cloud thickness as well as layers.

2. Technical Specifications of the Observed Elements

Measurement range	0—25 Km
Multi-Cloud	3 layers structure
Spatial Resolution	12m, 15m or selected by program for higher resolution
Time Resolution	10s—600s or selected by program

3. Frequency Range

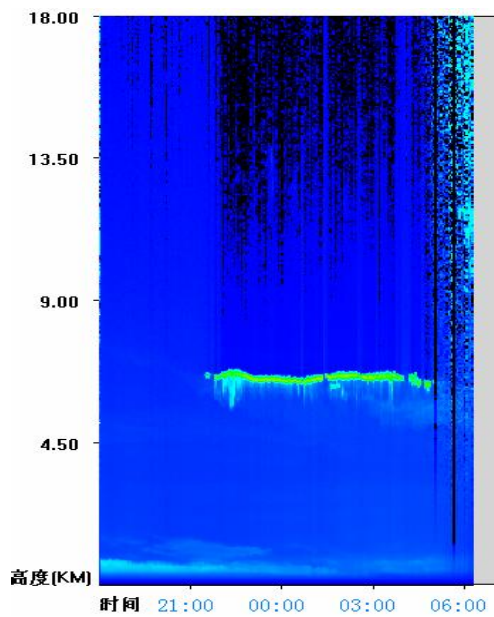
Visible light of 532 nanometers.

4. Technical Specifications of the Hardware

Operation Temperature	-10—40℃
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Relative Humidity	0—100%
Communication	Internet
length-width-height	320mmx220mmx650mm
Weight	<30KG
Power	AC220V 50Hz 300W

5. Domestic Application and Instrument Photo



Cloud Observation

Part Three Lidar

I. Micro-pulse Lidar

It is used to detect the spatial distribution of aerosol, and analyze the influence of aerosol on sounding.

It possesses the vertical scanning mode, and can obtain the vertical structure property of the upper air above the observed region.

1. Function

EV-LIDAR can be used to detect the spatial distribution of aerosol, atmospheric boundary layer characteristics of the structure and time evolution, atmospheric aerosols (airborne dust) extinction coefficient of the vertical profile and time evolution characteristics, cloud height and multi-layer cloud structure, atmospheric visibility and other information. It can be used as either stationary or mobile.

2. Technical Specifications of the Observed Elements

Detection range	Up to 25 km (Related to the weather conditions)
Polarization detection	Parallel channel and vertical channel Distinguish of spherical particles and non-spherical particles
Direct detection	Spatial distribution of aerosol particle echo photon, Spatial and temporal distribution
Data inversion	Extinction coefficient Aerosol concentration

3. Frequency range

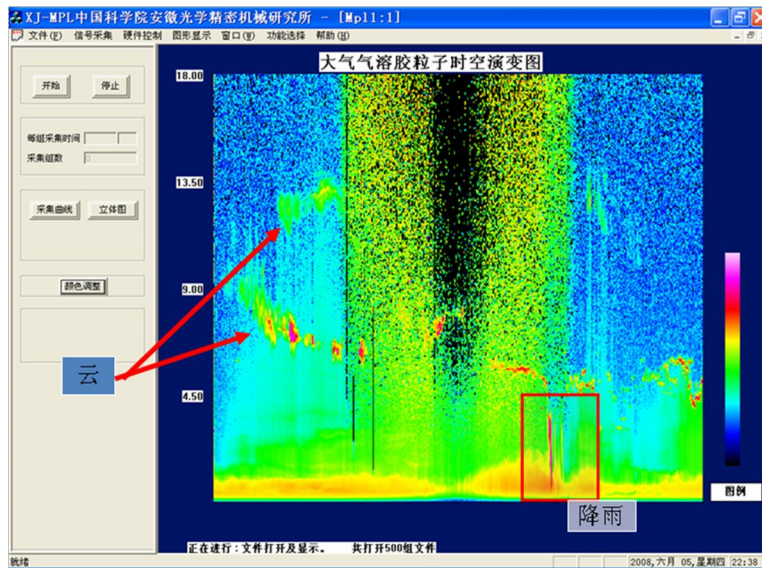
Laser modulation frequency 2.5KHz

4. Technical specifications of the hardware

Laser	Diode pumped solid Nd:YAG
Wave Length	532 nm
Output laser energy	~10 μ J (2500Hz)
Pulse width	15 ns
Divergence angle	~25 μ rad (semiangle)
Receiving aperture	160 mm (caliber)
Receiving angle	~50 μ rad (semiangle)
Filter bandwidth	0.5 nm
Detector	CPM
Data Collector	Multi-channel photon counter
Working	PC control, automatic operation (intermittent or continuous)

Communication	Internet (according to the user's
Temperature	0°C~40°C
Humidity	0~100%
Power supply	220VAC
Power consumption	<300W
Size	242mm×200mm×743mm
Weight	< 50 kg (including all equipment)

5. Equipment photo and domestic application



II. Wind Lidar

It is used to detect the delicate structure of the wind field, and compare its data with that from sounding.

It possesses the vertical scanning mode, and can obtain the vertical structure property of the upper air above the observing region.

1. Function

Small mobile (truck-carried) Doppler wind lidar is used to monitor and conduct forecasting research of the boundary layer, the mid-, low-level wind field at the troposphere, turbulence, and the aerosol. It realized high spatial & time resolution measurement for dimensional wind field in clear weather.

2. Technical Specifications of the Observed Elements

Velocity detection range	500 m-10000 m
Velocity range resolution	50 m
Velocity Tangential resolution	less than 2°
Velocity Range	±50m/s
Velocity Accuracy	1 m/s
Visibility Measurement Range	50 m -10000 m
Visibility Measurement Accuracy	<500 m: ± 50 m 500 m - 2000 m with ±10% 2000 m - 10000 m with ±20%

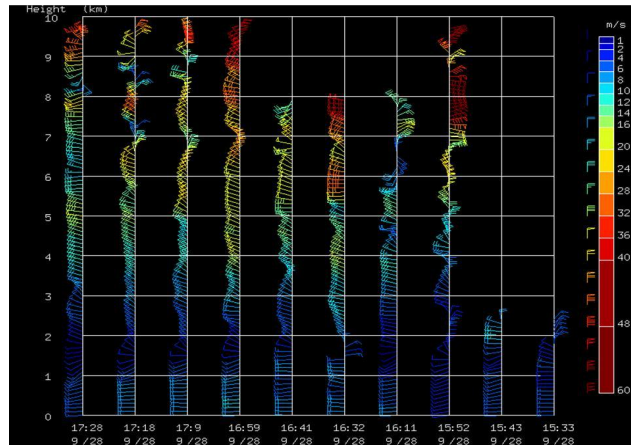
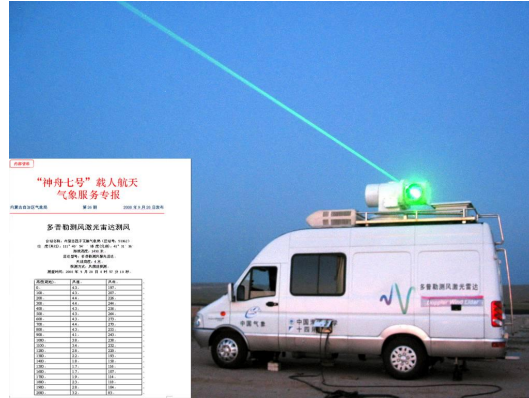
3. Frequency range

Laser Length: 532nm

4. Technical specifications of the hardware

Scanning	PPI, RHI scanning and volumn scanning
Scanning Velocity	horizontal 3° /s(180° in a minute)
Pulse Repetition Frequency	vertical 3° /s(180° in a minute)
Integral Number of Times	500-1000Hz
	≥200次

5. Equipment photo and domestic application



Wind plume map at 15:30-17:30 on Sept. 28, 2008

Part Four Doppler Weather Radar

It is deployed in stations, when necessary, C-band mobile weather radar and X-band weather radar can also be provided.

It possesses the vertical scanning mode, and can obtain vertical structure property of the upper air above the observed region.

I. C-band Mobile Doppler Radar

1. Function

Truck-carried C-band dual polarization radar possesses the capability of retrieving raindrop size distribution and a strong ability to detect clear sky.

2. Technical Specifications of the Observed Elements

Parameter	Reflectivity	-15~+70dBz
	Velocity	±36m/s
	Spectrum width	0~16m/s
Accuracy	Reflectivity factor	1dB

	Radial velocity	1m/s
	Velocity width	1m/s
	Differential reflectivity ZDR	0.1~0.2dB
	Differential transmission phase shift ϕ_{DP}	$1^{\circ} \sim 2^{\circ}$
	Zero-delay correlation coefficient of horizontal and vertical polarized waves ρ_{HV}	0.01

3. Frequency Range

5300~5500MHz (operational frequency can be selected)

4. Technical Specifications of the Hardware

Operational Frequency	5300~5500MHz		
Operating Range	Doppler Mode	Monitor range	450km
		Quantitative measurement	150km
	Dual-polarization mode	Measurement range	150km
Azimuth Range	0~360°		
Tilt Range	-2° ~+90°		
Height	20km		
Adaptation to the Environment	Temp.	Inside shelter	-40°C ~+50°C
		Outside shelter	0°C ~+40°C
	Max. humidity	Outside	95%~98% (30°C时)
Wind Resistance	Wind Velocity $\leq 25\text{m/s}$ (normal operation)		
	Wind Velocity $\leq 35\text{m/s}$ (no damage)		
Others	Waterproof, mould-proof, anti-salt spray, anti-wind and dust, operatable below 3000m		

Power	Three-phase four-wire 380V±10% 50Hz±2%
Power Consumption	≤20kW
Reliability	MTBF≥400h
	MTTR≤0.5h
Mobile	Install or demolition time≤4h/4person

5. Equipment photo and domestic application

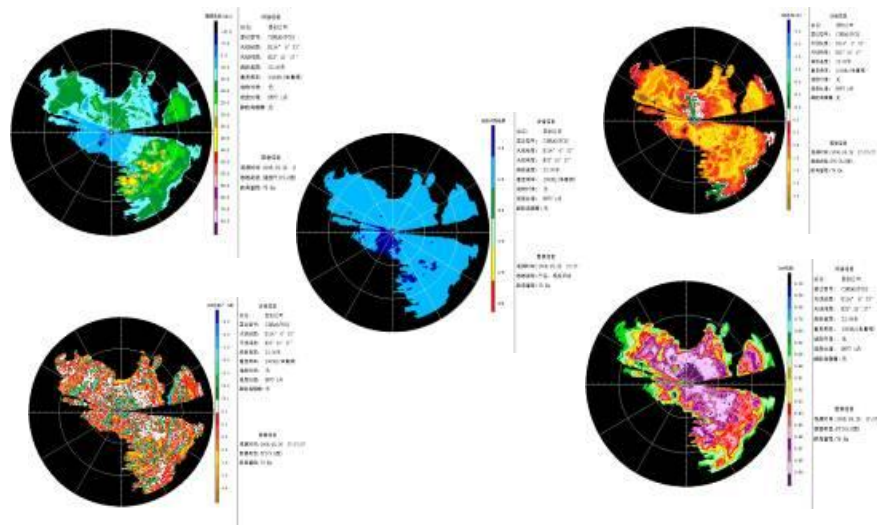


Image of the polarization parameters and the precipitation particles during a mixed precipitating process on May 26, 2008 in Boluo, Guangdong

II. X-band Mobile Doppler Radar

1. Truck-carried X-band IF Coherent Radar

(1) Function

It is used to detect the height, thickness and base of precipitating clouds. It possesses the capability of real-time monitoring and warning for disasters such as medium & small scale storm, hail, intensive wind profiling, cyclone, hurricane and high wind.

(2) Technical Specifications of the Observed Elements

Item	Technical Specification
Reflectivity	Warning: $\geq 300\text{km}$ Quantity: $\geq 150\text{km}$
Velocity, Spectrum Width	$\geq 100\text{km}$
Azimuth scanning	$0\sim 360^\circ$
Elevation Scanning	$-2\sim +62^\circ$ (can be adjusted to $-2\sim +90^\circ$ according to users' need)
Accuracy	Range: 50m, Azimuth: 0.2° , Elevation angle: 0.2° , Height: 200m ($R\leq 100\text{km}$) /300m ($R>100\text{km}$)
Parameters	Reflectivity: $-15 \sim +70\text{dBZ}$, Velocity: $\geq \pm 32\text{m/s}$ Spectrum width: 0-16m/s
Parameter Accuracy	Reflectivity: 1dB, Velocity: 1m/s, Spectrum width: 1m/s
Resolution	Azimuth: $\leq 1.5^\circ$; Range: $\leq 150\text{m}$; Reflectivity: $\leq 1\text{dBZ}$; Velocity, Spectrum width: $\leq 0.5\text{m/s}$

(3) Frequency Range

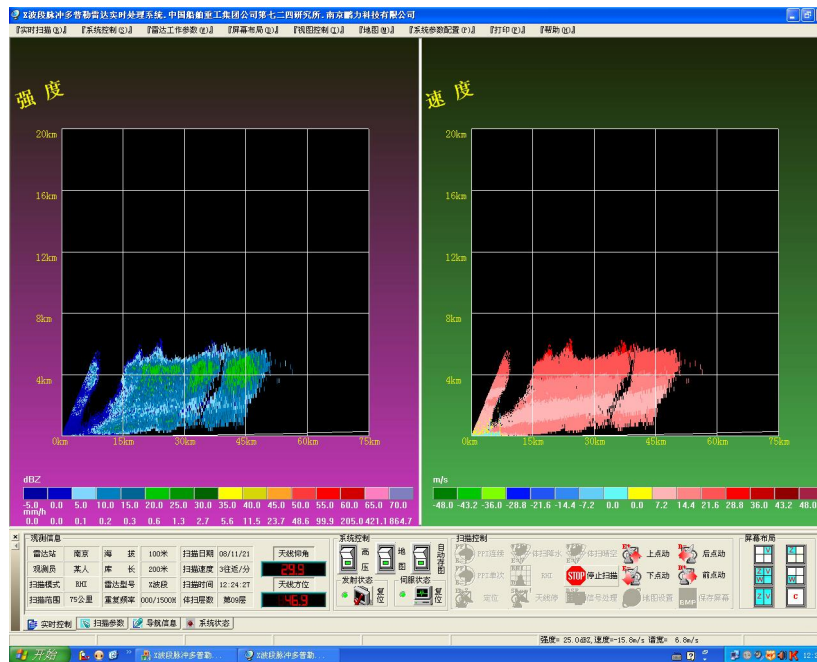
$9360\pm 30\text{MHz}$

(4) Technical Specifications of the Hardware

Item	Technical Specification
Antenna	Operation frequency: X wave; Caliber: $\geq 1.5\text{m}$; Gain: $\geq 40\text{dB}$; Wave width: 1.5° ; Polarization: horizontal/vertical, selectable
Servo	360° , 0~6rpm adjustable; Elevation: $-2^\circ \sim +62^\circ$, 0~4times/min, adjustable; Angle accuracy: $\leq 0.2^\circ$;
Transmitter	Peak power: $\geq 50\text{Kw}$; Maximum operating ratio: 0.1%; Pulse width: $0.5\mu\text{s} / 1\mu\text{s}$; Control: control/remote control
Receiver	Noise figure: $\leq 3.5\text{dB}$; Dynamic range: 86dB; Frequency control: AFC.
Signal Processor	Digital IF technique; PPP processing;

	<p>With the ambiguity capacity to eliminate range / velocity;</p> <p>Synchronous display reflectivity / radial velocity;</p> <p>Real-time display control communicate data through high-Velocity terminal</p> <p>Ground clutter suppression capability: not less than 25Db;</p> <p>A/D 14 bits;</p> <p>Sampling: 100MHZ;</p> <p>Range bin: 512;</p> <p>Data transmission: high Velocity data network</p>
Display and Control / Data Terminal	<p>PC terminal;</p> <p>Convenient and flexible program control;</p> <p>Best dynamic display of results;</p> <p>Network-based communication and management; Superior weather software</p>
Phase Correction Accuracy	Better than 2°
Clutter Suppression	≥25dB
Radar System	Medium frequency coherent Doppler system
Working Environment	<p>Temp: Inside 0°C~40°C</p> <p>Outside -40°C~50°C</p> <p>Humidity: Inside: 95%~98% (30°C)</p> <p>Outside: 90%~96% (30°C)</p> <p>Others: Waterproof, mould-proof, anti-salt spray, anti-wind and dust, operatable when shocking and vibrating during field transportation</p>
MTBF	MTBF >600h
MTRR	MTRR <0.5h
Power Consumption	<1kw
Continuous working time	>24h
Power	220V±10%, 50Hz±5%.
Interference	Power supply interference, electromagnetic interference, radio frequency interference

(5)Equipment photo and domestic application



2. Truck-carried X-band Doppler Radar

(1) Function

It is to monitor the position, reflectivity, average Doppler velocity and its spectrum width of the weather target at the range of 300km, below 24km in height, .

(2) Technical Specifications of the Observed Elements

Range	Range	500m~300km (reflectivity)
	Quantitative detection	150km (reflectivity, velocity, spectrum width)
	Azimuth	0~360°
	Elevation	-2~+90°
	Height	0~24km
	Reflectivity	-10dBZ~+70dBZ
	Velocity	±24m/s (150km)

		$\pm 48\text{m/s}$ (75km)
	Spectrum width	0~16m/s
Accuracy (RMS)	Range (Point target)	$\leq 150\text{m}$
	Azimuth (Point target)	$\leq 0.15^\circ$
	Elevation (Point target)	$\leq 0.15^\circ$
	Height (Point target)	300m (100km 内)
		400m (100~200km)
	Reflectivity	$\leq 1.0\text{dBZ}$
	Velocity	$\leq 1.0\text{m/s}$
Spectrum width	$\leq 1.0\text{m/s}$	
Resolution	Range	150m
	Azimuth	1.5° (Beamwidth)
	Elevation	1.5° (Beamwidth)
	Reflectivity	0.2dBZ
	Velocity	0.5m/s
	Spectrum width	0.5m/s

(3) Frequency Range

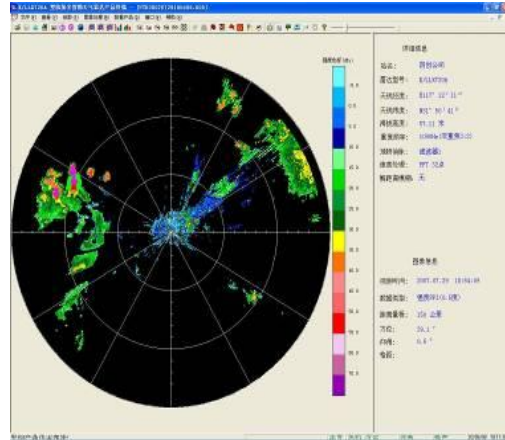
$9370 \pm 20\text{MHz}$

(4) Technical Specifications of the Hardware

Clutter Rejection		30~50dB
Uptime		$\leq 10\text{min}$
Environment	Equipment outside	Temp: $-40^\circ\text{C} \sim +50^\circ\text{C}$; Relative Humidity: 95%~98% (+30 $^\circ\text{C}$).
	Equipment inside	Temp: $0^\circ\text{C} \sim +40^\circ\text{C}$; Relative Humidity: 90%~96% (+30 $^\circ\text{C}$)
	Storing condition	Temp: $-40^\circ\text{C} \sim +60^\circ\text{C}$; Relative Humidity: 90%~96% (+30 $^\circ\text{C}$)
	Altitude	$\leq 3000\text{m}$
	Wind resistance (Steady wind)	$\leq 20\text{m/s}$ (no ice) or 14m/s (with ice, ice thickness 1cm) operatable
		$\leq 35\text{m/s}$ (no ice) or 20m/s (ith ice, ice thickness 2cm) no damage
	Others	With anti-moisture, anti-mold, anti-salt spray performance
Reliability and maintainability	Reliability	MTBF $\geq 600\text{h}$
	Maintainability	MTTR $\leq 0.5\text{h}$
	Fault detection rate	$\geq 98\%$
	Fault isolation Rate	$\geq 90\%$
	Failure false alarm rate	$\leq 2\%$
Power Supply and	Power Supply	Mains supply or power station

Consumption	Voltage	AC 220V ±10%
	Frequency	50 Hz ±2Hz
	Consumption	≤4kW

(5) Equipment photo and domestic application



3. Truck-carried X-band Dual Polarization Radar

(1) Function

It is for observing the shape, size, point, phase, and the distribution of droplet spectra. It is for the research of atmospheric structure and the characteristics of particles.

(2) Technical Specifications of the Observed Elements

Range	Range	250km (reflectivity) 150 km (velocity, spectrum width, depolarization)
	Azimuth	0~360°
	Elevation	-2~+90°
	Height	0~24km
	Reflectivity	-10dBZ~+70dBZ
	Velocity	±24m/s (150km) ±48m/s (75km)
	Spectrum width	0~16m/s
Accuracy (RMS)	Range (Point target)	≤150m
	Azimuth (Point target)	≤0.15°
	Elevation (Point target)	≤0.15°
	Height (Point target)	200m (within 100km) 300m (100~200km)
	Reflectivity	≤1.0dBZ

	Velocity	$\leq 1.0\text{m/s}$
	Spectrum width	$\leq 1.0\text{m/s}$
Resolution	Range (Point target)	150m
	Azimuth (Point target)	1° (Beamwidth)
	Elevation (Point target)	1° (Beamwidth)
	Reflectivity	0.2dBZ
	Velocity	0.5m/s
	Spectrum width	0.5m/s

(3) Frequency Range

9370±20MHz

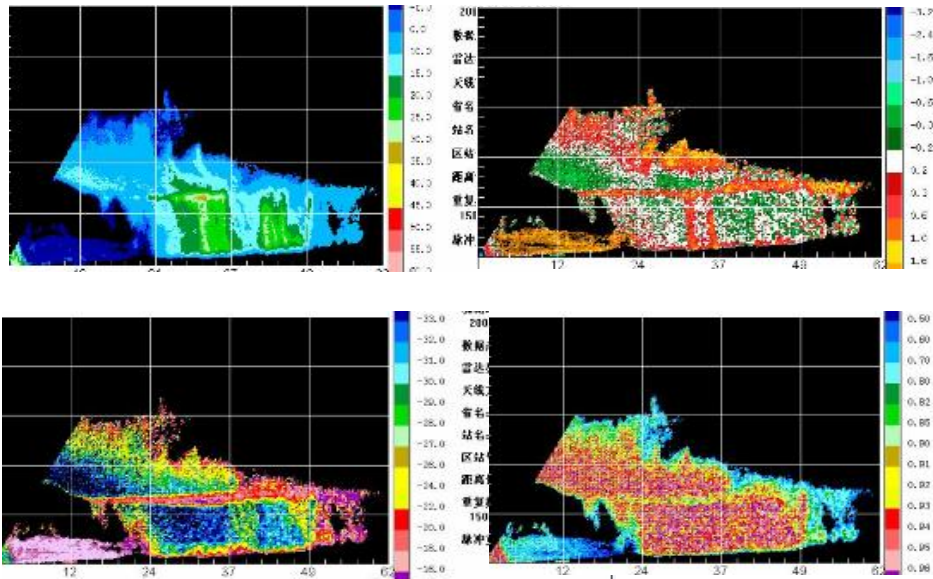
(4) Technical Specifications of the Hardware

Clutter Rejection		30~50dB
Uptime		$\leq 10\text{min}$
Environment	Equipment outside	Temp: $-40^{\circ}\text{C} \sim +50^{\circ}\text{C}$; Relative humidity: 95%~98% (+30°C)。
	Equipment inside	Temp: $0^{\circ}\text{C} \sim +40^{\circ}\text{C}$; Relative humidity: 90%~96% (+30°C)
	Storing condition	Temp: $-40^{\circ}\text{C} \sim +60^{\circ}\text{C}$; Relative humidity: 90%~96% (+30°C)
	Altitude	$\leq 3000\text{m}$
	Wind resistance (Steady wind)	$\leq 20\text{m/s}$ (no ice) or 14m/s (with ice, ice thickness 1cm) operatable
		$\leq 35\text{m/s}$ (no ice) or 20m/s (with ice, ice thickness 2cm) no damage
	Others	With anti-moisture, anti-mold, anti-salt spray performance
Reliability and maintainability	Reliability	MTBF $\geq 400\text{h}$
	Maintainability	MTTR $\leq 0.5\text{h}$
	Fault detection rate	$\geq 98\%$
	Fault isolation Rate	$\geq 90\%$
	Failure false alarm rate	$\leq 2\%$
Power Supply and Consumption	Power Supply	Mains supply or power station
	Voltage	AC 220V±10%

	Frequency	50 Hz \pm 2Hz
	Consumption	\leq 4kW
Continuous Performance Time		24h continuously
Truck		
Size	Meet the needs for road transportation Length \leq 10m, width \leq 2.5m, height \leq 2.7m	
Equipment weight	\leq 7500 Kg	
Max. Height during Transportation	\leq 3.9m	
Max. Velocity	20~40km/hr	
Carriage Size	Length 3000 \pm 100mm width 2000 \pm 100mm height 2000 \pm 100mm	
Carriage Property	Rainproof, dustproof, decay proof, insulation performance is good; take shielding measures; isolation buffer, dust proof, grounding, power distribution, alignment, lighting and other requirements should be considered when integration	
Carriage Air Conditioner	One 1.5 split warm and cold air-conditioning	

(5) Equipment photo and domestic application





Echo of Typhoon "Sepat" on August 21,2007 in Hengyang, Hunan

Part Five Mobile Boundary Layer Wind Profiler Radar

1. Function

It is used for all-weather detection of air wind field, and can provide boundary layer wind field information with high spatial and time resolution.

2. Technical Specifications of the Observed Elements

Item	Technical Specification
Max. Height	$\geq 2\text{km}$
Min. Height	$\leq 100\text{m}$
Range	Wind Velocity: $0\sim 60\text{m/s}$; Wind direction: $0\sim 360^\circ$; Virtual temperature: $223\sim 323\text{K}$.
Error (Root mean square error)	Wind Velocity: $\leq 1.5\text{m/s}$; Wind direction: $\leq 10^\circ$; Virtual temperature: $\leq 1\text{K}$.
Resolution	Wind Velocity: 0.2 m/s Wind direction: 0.5° Altitude: $60\text{m}, 120\text{m}$ Time: 3-beam work, less than or equal to 3 min ;5-beam work, less than or equal to 5 min

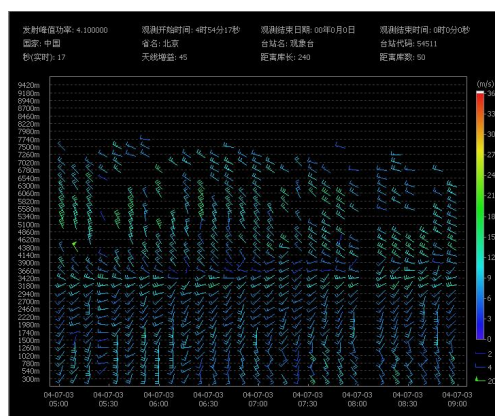
3. Frequency Range

Point-frequency work between $1270\sim 1375\text{MHz}$

4. Technical Specifications of the Hardware

Item	Technical Specification
Beam pointing	5-beam, a vertical beam and four mutually orthogonal direction beams, the elevation beams with the same tilt angle
Beam width	$\leq 9^\circ$
Antenna gain	$\geq 24\text{dB}$
Maximum sidelobe level	$\leq -20\text{dB}$ (Scanning and non-scanning surfaces)
Far-zone sidelobe	$\leq -25\text{dB}$
VSWR	≤ 1.3
Polarization	Linear polarization
Lobe forms	Pen-shaped beam
Output peak power	$\geq 1\text{kW}$
Pulse width	$0.4\mu\text{s}$ and $0.4\mu\text{s}$ multiples
Pulse repetition cycle	$40\sim 80\mu\text{s}$
Maximum duty cycle	$\geq 8\%$

5. Equipment photo and domestic application



Part Six All-sky imager

It is used to detect the height, amount and thickness of the clouds for analyzing the influence of clouds on sounding.

1. Function

Infrared cloud imager is for the all-sky scanning which passively receives the

data. It is used to observe all-sky cloud cover, cloud height, partial cloud shape and all-sky imaging.

2. Technical Specifications of the Observed Elements

Output Requirement	Unit	Accuracy	Resolution
All-sky cloud (sky above 15 degrees elevation)	percentage cloud cover	$\pm 1\%$	1%
	1/10	$\pm 0.1, 1/10$	0.1, 1/10
cloud height	Meter	$\pm 500\text{m}$, cloud height $< 2500\text{m}$; $\pm 1000\text{m}$, $2500\text{m} \leq \text{cloud height} < 6000\text{m}$; $\pm 20\%$, $6000\text{m} \leq \text{cloud height} \leq 10000\text{m}$;	1m
Cloud shape		$\leq 25\%$ (Cirrus, layered clouds, Cumulus, wave clouds, mixed clouds);	/
Cloud image	Image	/	1image/5min

3. Frequency Range

8-14 μm

4. Technical Specifications of the Hardware

Operation Temp.	-20°C—40°C
Air humidity	<100%
Operation voltage	220V A/C
Vacancy rate	<2%
MTBF	>3000h

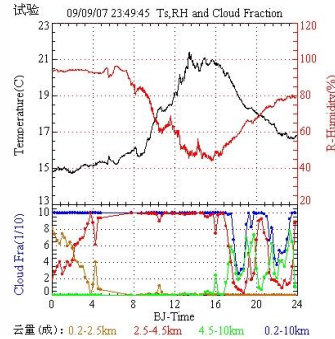
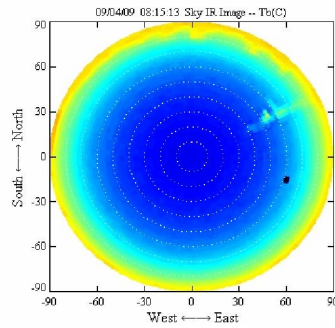
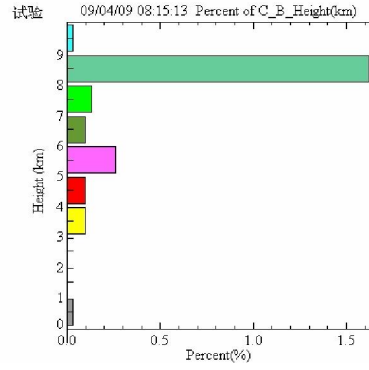
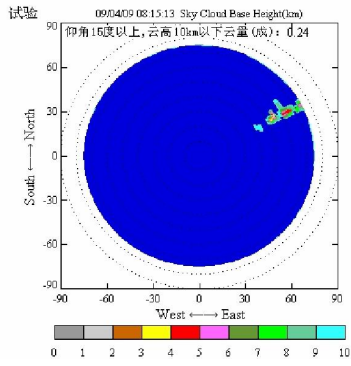
5. Equipment photo and domestic application



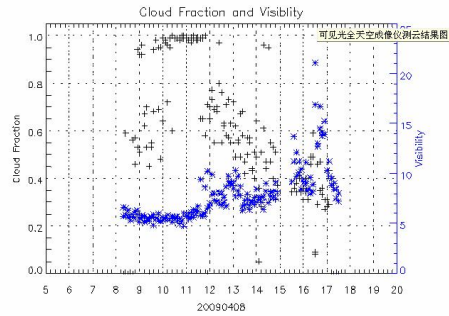
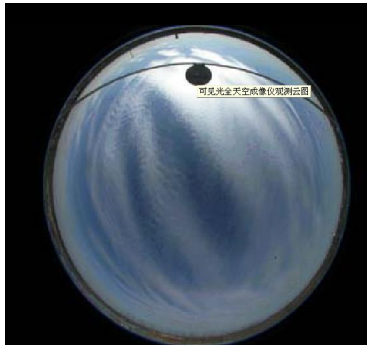
All Sky Imager I



All Sky Imager II



(a) Scanning Infrared Imager



(b) Visible light all-sky imager

