4 Weather Radar Operations

as of 20 May 1999

4.1 Scientific objectives

According to the MAP U.S. Overview Document, the purpose of Wet MAP is to investigate the mechanism of orographically generated heavy precipitation events with special emphasis on their dynamics, microphysics, and hydrological consequences (especially flooding). These specific objectives are described in Section 1.1.

4.2 Intensive Observing Periods (IOPs) for Wet MAP

Radar data collection in Wet MAP will be maximized during times designated as *MAP Intensive Observing Periods* (IOPs). Any day on which the research radars are operated based on significant precipitation is forecast for one or more of the target regions (Lago Maggiore (including the Liguria upwind study area) and the north-east Italian / Slovenian area) will be an IOP. During an IOP, all ground-based radars will be operated, and the Italian operational radars will transmit full three-dimensional volume-scan data. Whenever possible during an IOP, Wet MAP aircraft flights will be carried out over the ground-based radar network.

4.3 Summary of Weather Radar Installations in the Alpine Region

Figure 4-1 gives an overview of the operational radars in the Alpine region. Also indicated are the research radars available for MAP. A summary of the operational and research radars is given in Table 4-1.

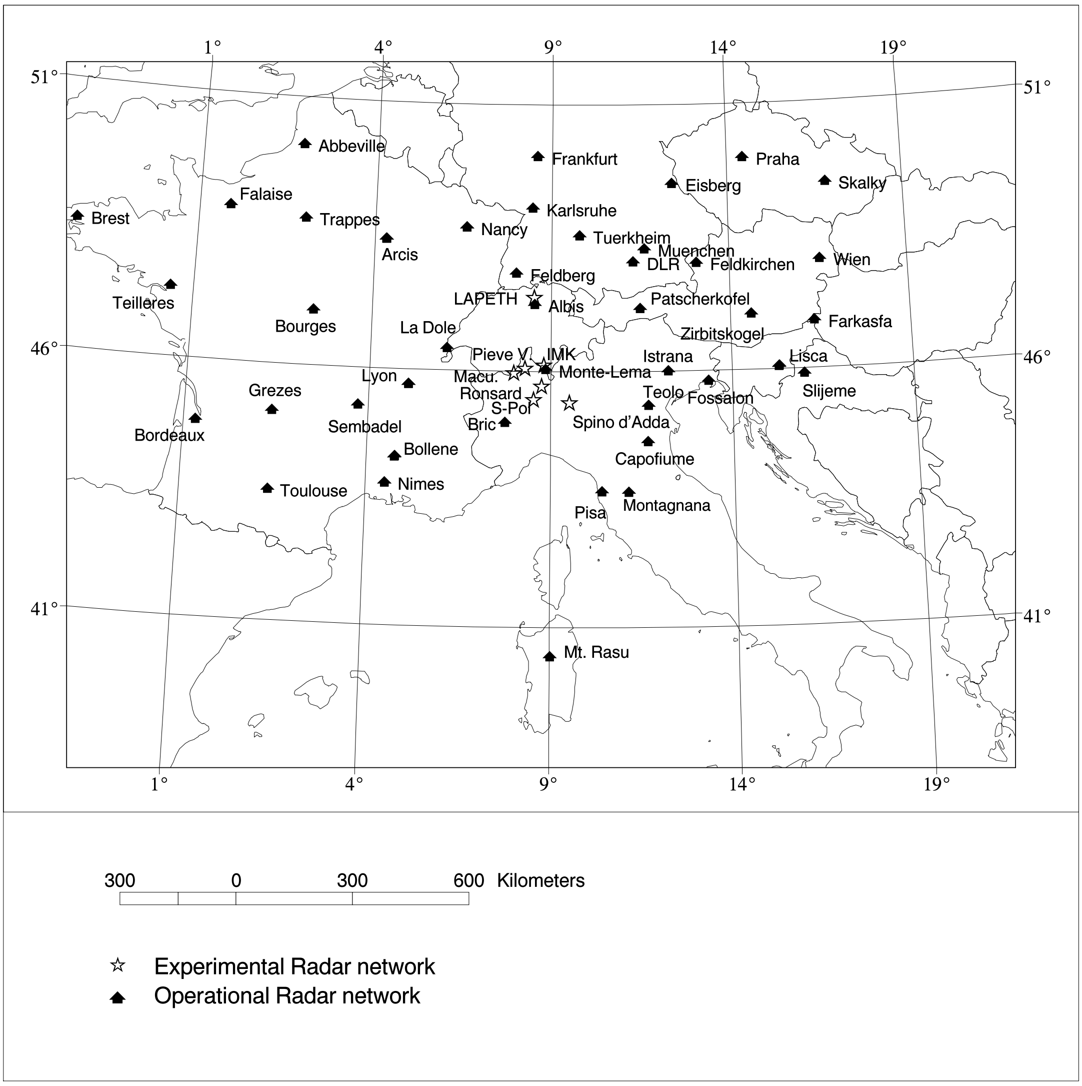

FIGURE 4-1. Ground-based network.of operational and research weather radars in the Alpine area.

TABLE 4-1. Operational (o) and research (r) radars in the region [44-50˚ N, 4-18˚ E] (as from January 1999). For the Italian radars see separate list in Table 4-10.

Name of Radar Station	Indicator	Country	Latitude (deg)	Longitude (deg)	Altitude (m MSL)	Band	Doppler / Polarimetric
Wien Schwechat (o)	AT-41	Austria	48.074 N	16.536 E	205 m	C	yes/no
Feldkirchen (o)	AT-43	Austria	48.065 N	13.062 E	555 m	C	yes/no
Patscherkofel (o)	AT-44	Austria	47.209 N	11.461 E	2254 m	C	yes/no
Zirbitskogel (o)	AT-46	Austria	47.072 N	14.56 E	2372 m	C	yes/no
Albis (o)	CH-41	Switzerland	47.283 N	8.517 E	921 m	C	yes/no
La Dole (o)	CH-42	Switzerland	46.433 N	6.100 E	1685 m	C	yes/no
Monte-Lema (o)	CH-43	Switzerland	46.042 N	8.833 E	1626 m	C	yes/no
ETH-Zuerich Doppler radar (r)	CH-90	Switzerland	47.409 N	8.512 E	600 m	C	yes/no
Praha-Libus (o)	CZ-40	Czech Republic	50.008 N	14.447 E	356 m	X	no/no
Skalky (o)	CZ-41	Czech Republic	49.501 N	16.79 E	765 m	C	yes/no
Frankfurt Rhein-Main (o)	DE-61	Germany	50.052 N	8.568 E	146 m	C	no/no
Tuerkheim (o)	DE-72	Germany	48.583 N	9.768 E	731 m	C	yes/no
Eisberg (o)	DE-73	Germany	49.547 N	12.408 E	798 m	C	yes/no
Feldberg - Schwarzwald (o)	DE-81	Germany	47.868 N	8.000 E	1506 m	C	yes/no
Muenchen - Frueholzen (o)	DE-82	Germany	48.334 N	11.601 E	515 m	C	no/no
Karlsruhe (o)	DE-92	Germany	49.093 N	8.437 E	148 m	C	yes/no
DLR (Oberpfaffenhofen) POLDIRAD (r)	DE-91	Germany	48.088 N	11.280 E	603 m	C	yes/yes
Lyon (o)	FR-46	France	45.726 N	5.075 E	250 m	C	no/no
Nancy (o)	FR-47	France	48.717 N	6.583 E	297 m	C	no/no
Nimes (o)	FR-49	France	43.807 N	4.504 E	77 m	S	no/no
Arcis (o)	FR-52	France	48.462 N	4.311 E	166 m	?	no/no
Trappes (o)	FR-	France	48.774 N	2.008 E	190 m	C	no/no
Sembadel (o)	FR-	France	45.291 N	3.710 E	1143 m	?	no/no
Bollene (o)	FR-	France	44.324	4.763 E	327 m	S	no/no
Slijeme (o)	HR-41	Croatia	45.908 N	15.973 E	1024 m	S	no/no
Bilogora (o)	HR-42	Croatia	45.883 N	17.206 E	262 m	S	no/no
Farkasfa (o)	HU-41	Hungary	46.914 N	16.317 E	327 m	S/X	no/no
Lisca (o)	SL-41	Slovenia	46.068 N	15.290 E	941 m	C	no/no

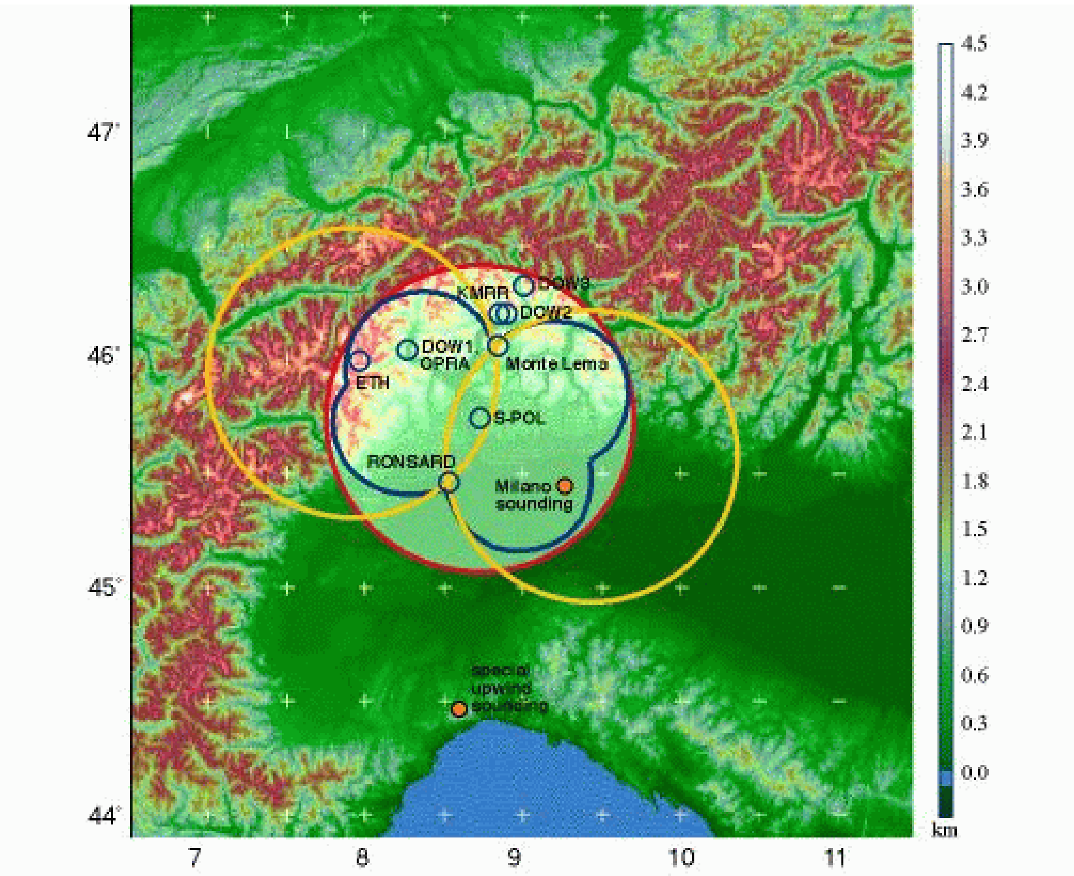

FIGURE 4-2. Proposed array for ground-based dual-Doppler and polarimetric radar observations in MAP. Radars are indicated by small blue circles (S-POL: NCAR S-band polarimetric Doppler radar; RONSARD: French C-band Doppler radar; Monte Lema: Swiss Agency C-band Doppler radar; ETH: Swiss Federal Institute of Technology X-band vertically pointing Doppler radar; OPRA: University of Washington S-band vertically pointing Doppler Orographic Precipitation Radar; DOW1/DOW2/DOW3 [the three possible DOW locations]: the US X-band scanning Doppler Radar on Wheels; KMRR: University of Karlsruhe Ka-band vertically pointing radar. The large red circle encloses the region of high-resolution polarimetric radar data collected by the NCAR S-Pol radar. The yellow outlines indicate regions of low-resolution dual-Doppler coverage between the Swiss SMA radar at Monte Lema and the French RONSARD at Casaleggio. The blue outlines indicate regions of high-resolution dual-Doppler coverage obtained between the S-Pol at Vergiate and the other two radars. The small orange circles are sounding sites in the upstream flow (Milano and a special station to be installed by Italy for MAP).

4.4 Ground-based research radar operations

The research radars in Wet MAP (Fig. 4-2 and Table 4-2) follow different operating procedures as shown in Table 4-3 and Table 4-4, which summarize the scan strategies of the research radars and Table 4-5, which lists the fields recorded by all the Wet MAP research and operational radars and displayed at the POC. The operating procedures summarized in these tables are discussed in more detail below.

TABLE 4-2. Research and operational radars in the Lago Maggiore target area (as of January 1999).

Name of radar station	Institution	Location	Latitude (deg)	Longitude (deg)	Altitude (m MSL)	Status	Frequency (GHz)	Mode	Range	Contact person
Lema	SMI (Switzerland)	Monte Lema (CH)	46.042 N	8.833 E	1625 m	[permanent]	5.44 GHz	Volumic Ref. + Doppler OPERATIONAL	25-230 km	J. Joss (SMI, CH)
Ronsard	CETP (France)	San Pietro - Mosezzo (IT)	45.460 N	8.517 E	155 m	[confirmed]	5.6	Volumic Ref. + Doppler	50-200 km	G. Scialom (CETP, FR)
S-Pol	NCAR (USA)	Vergiate (IT)	45.720 N	8.730 E	280 m	[confirmed]	2.7 - 2.9	Volumic Differential Ref. + Doppler	100-400 km	J. Wilson (NCAR, USA)
Vertically Pointing Radar (VPR)	ETH-Z (Switzerland)	Macugnaga (IT)	45.967 N	7.967 E	1308 m	[confirmed]	9.34	Vertically pointing Ref. + Doppler	13 km	E. Barthazy (ETH-Z, CH)
MicroRain Radar-1 (MRR-1)	IMK (Germany)	Locarno (CH)	46.174 N	8.788 E	379 m	[confirmed]	24	Vertically pointing Ref.	1.2 km	M. Löffler-Mang (IMK, DE)
Orographic Precipitation Radar (OPRA)	University of Washington (USA)	Pieve Vergonte (IT)	46.017 N	8.273 E	230 m	[confirmed]	3.05	Vertically pointing Ref. + Doppler	10 km	K. Pearl (University of Washington, USA)
Doppler on Wheels (DOW)	OU, NSSL, NCAR, CAPS (USA)	Toce and Ticino River Valley (IT)	2 predermined sites			[confirmed]	9.375	PPI, RHI Ref. + Doppler	20 km	M. Steiner (Princeton University, USA)

4.4.1 *Mt. Lema operations*

The Monte Lema radar operations are described in *Operational Use of Radar for Precipitation Measurements in Switzerland*, by J. Joss et al. (1998, VDF Hochschulverlag AG, an der ETH Zurich, 108 pp). The radar operations and products transmitted are fixed to serve Swiss Meteorological Institute requirements. These operations will not be altered for MAP. The Monte Lema radar obtains a volume scan consisting of ten 360 degree azimuth sweeps every 2.5 min. The set of elevation angles alternates from one scan time to the next. A scan made up of elevation angles -0.3, 1.5, 3.5, 5.5, 7.5, 9.5, 13, 18.3, 25.3, 34.5 is performed in 2.5 min. and is followed by the set 0.5, 2.5, 4.5, 6.5, 8.5, 11.0, 15.5, 21.6, 29.6, 40.0, which also takes 2.5 min. Thus it takes 5 min. to complete a single high-resolution volume scan, composed of these two interleaved low-resolution volume scans.

For MAP, the Monte Lema radar data will be transmitted via an internet connection to the POC, in the form of standard SMI products:

- POLARU (Doppler radial velocity, 20 elevations), POLARZ (reflectivity, 20 elevations),
- TODAY (horizontal map of peak value of reflectivity in the vertical column overlying each horizontal grid element),
- RAIN (best estimate of radar-derived precipitation rate), and
- WIND (vertical profile of horizontal wind derived by VAD methodology).

TABLE 4-3. Scan strategies of the research radars

Radar	Type Scan	# Sweeps	Elevation Angles (deg.)	Az Covered	Sampling Interval	# Gates	Gate Size	Gate Spacing	Range
Mt Lema	PPI	20	-0.3,1.5, 3.5, 5.5, 7.5, 9.5, 13.0, 18.3, 25.3, 34.5, 0.5, 2.5, 4.5, 6.5, 8.5, 11.0, 15.5, 21.6, 29.6, 40.0	0-360°	5 min	230 (130)	1000m	1000 m	230 (130) km
RON-SARD	A	20	0.62, 1.23, 1.85, 2.46, 3.08, 3.69, 4.31, 4.92, 5.54, 6.15, 6.77, 7.38, 8.35, 9.67, 11.43, 13.89, 17.75, 24.35, 37.71, 69.43	0-360°	9 min	512	100 m	100 m	51.2 km
	B	20	Same as A	21.5°-201.5° (clockwise)	5 min	512	100 m	100 m	51.2 km
	C	20	Same as A	201.5-21.5° (clockwise)	5 min	512	100 m	100 m	51.2 km
*highest priority	D	20	Same as A	0-360°	9 min	512	100 m	200 m	102.4 km
	E	20	Same as A	21.5°-201.5° (clockwise)	5 min	512	100 m	200 m	102.4 km
	F	20	Same as A	201.5°-21.5° (clockwise)	5 min	512	100 m	200 m	102.4 km
	G	20	Same as A	0-360°	9 min	512	200 m	200 m	102.4 km
	H	20	Same as A	21.5°-201.5° (clockwise)	5 min	512	200 m	200 m	102.4 km
	I	20	Same as A	201.5°-21.5° (clockwise)	5 min	512	200 m	200 m	102.4 km
	J	4	0.62, 1.23, 1.85, 2.46	0-360°	2 min	512	200 m	400 m	204.8 km
	K	4	Same as J	21.5°-201.5° (clockwise)	1 min	512	200 m	400 m	204.8 km
	L	4	Same as J	201.5°-21.5° (clockwise)	1 min	512	200 m	400 m	204.8 km

During IOPs Monte Lema velocity data will be unfolded at the SMI before transmission by means of an algorithm supplied by the University of Washington. At the POC a reflectivity volume will be interpolated to a 3 km x 3km x 1 km grid every 20 min., the simultaneously observed radial velocities will be interpolated to the same grid at the same times (every 20 min), and the radial velocity volume will be combined by dual-Doppler synthesis with a RONSARD volume at least once every 60 min.

4.4.2 *RONSARD operations*

The RONSARD will be operated to obtain dual Doppler data in coordination with the Monte Lema radar on a 10-min. cycle continuously throughout all IOPs in which rain occurs in the Ticino region. The RONSARD will conduct a sequence of scans at 20 elevation angles once every 10 min. The RONSARD will obtain only "VAD" scans (i.e. a series of PPI at increasing elevation, see below) for either 180 or 360 (preferred) degrees azimuth and will be conducted according to one of the following sequences (labelled A-L):

- A: 512 100-m wide range gates every 100 m (i.e. range 0.1->51.2 km), 360 degrees azimuth. (Note however that the first 3 gates are for technological purposes only.)

TABLE 4-4. Scan strategies of the research radars.(continued)

Radar	Scan Type	# Sweeps	Elevation Angles (deg.)	Az Covered	Sampling Interval	# Gates	Gate Size	Gate Spac-ing	Range
SPOL	Surv (noth-ing of inter-est in W lobe)	12 (PPI)	0.6, 1.4, 2.2, 3.0, 3.8, 4.6, 5.4, 6.2, 7.0, 7.8, 8.6, 9.4	0-360˚	10 min	1000	150 m		0-150 km
	Interesting activity in W. lobe; echo tops < 8 km	15 (PPI)	0.6, 1.4, 2.2, 3.0, 3.8, 4.6, 5.4, 6.2, 7.1, 8.1, 9.3, 10.6, 12.1, 13.9, 15.8	120˚ (western lobe)	5 min	1000	150 m		0-150 km
		50 (RHI)	RHI's spaced ~ 2.5˚ apart	Same as above	5 min	1000	150 m		0-150 km
	Interesting activity in W. lobe; echo tops 8-10 km	17 (PPI)	0.6, 1.5, 2.4, 3.2, 4.1, 5.0, 5.8, 6.7, 7.6, 8.5, 9.6, 10.8, 12.1, 13.6, 15.3, 17.1, 19.3	120˚ (western lobe)	5 min	1000	150 m		0-150 km
		50 (RHI)	RHI's spaced ~ 2.5˚ apart	Same as above	5 min	1000	150 m		0-150 km
	Interesting activity in W. lobe; echo tops 10-12 km	19 (PPI)	0.6, 1.6, 2.6, 3.5, 4.5, 5.5, 6.5, 7.5, 8.4, 9.4, 10.5, 11.7, 13.0, 14.5, 16.2, 18.1, 20.1, 22.4, 24.0	120˚ (western lobe)	5 min	1000	150 m		0-150 km
		50 (RHI)	RHI's spaced ~ 2.5˚ apart	Same as above	5 min	1000	150 m		0-150 km
DOW		22 (PPI)	0.5, 1.5, 2.5, 4.0, 5.5, 7.0, 9.0, 11.0, 13.0, 15.5, 18.0, 21.0, 24.0, 28.0, 32.0, 37.0, 42.0, 48.0, 55.0, 63.0, 72.0, 82.0	0-360˚	9 min.	250	30-150 m		7.5-37.5 km
		≤20 (RHI)		0-360˚	6 min.	250	30-150 m		7.5-37.5 km
ETH	Vert. Pt.	N/A	90˚	N/A	30-60 s	150-300	50 m		7.5-15 km
KMRR	Vert. Pt.	N/A	90˚	N/A					
OPRA	Vert. Pt.	N/A	90˚	N/A					

- B: As A, except for azimuths between 21.5 and 201.5 deg from North (clockwise).
- C. As A, except for azimuths between 201.5 and 21.5 deg from North (clockwise).
- D: 512 100-m wide range gates every 200 m (i.e. range 0.2 ->102.4 km), 360 degrees azimuth.
- E: As D, except for azimuths between 21.5 and 201.5 deg from North (clockwise).
- F. As D, except for azimuths between 201.5 and 21.5 deg from North (clockwise).
- G: 512 200-m wide range gates every 200 m (i.e. range 0.2 ->102.4 km), 360 degrees azimuth.
- H: As G, except for azimuths between 21.5 and 201.5 deg from North (clockwise).
- I. As G, except for azimuths between 201.5 and 21.5 deg from North (clockwise).
- J: 512 200-m wide range gates every 400 m (i.e. range 0.4 -> 204.8 km), 360 degrees azimuth.
- K: As J, except for azimuths between 21.5 and 201.5 deg from North (clockwise).
- L. As J, except for azimuths between 201.5 and 21.5 deg from North (clockwise).

Sequences D, E, and F will be preferred to G, H, and I. For sequences A-I, there will be 20 elevations at: 0.62, 1.23, 1.85, 2.46, 3.08, 3.69, 4.31, 4.92, 5.54, 6.15, 6.77, 7.38, 8.35, 9.67, 11.43, 13.89, 17.75, 24.35, 37.71 and 69.43 degrees from horizontal. For sequences J,K, and L (200-km range), we will probably use only the 4 first (0.62, 1.23, 1.85, 2.46) elevations. The highest priority will be on the 360-deg azimuth, 100-km range scans (i.e., sequence D). Sequence G gives less precise measurements; it is only for insurance, as it gives the best coordination with S-Pol and Monte Lema. Changes will be made according to the presence of precipitation in a limited part of the scanning domain [shorter range (50 km)- Sequence A, narrower azimuthal range- Sequence B, C, E, F], or to the position of the NOAA P-3 and/or NCAR Electra. Any decision to change the azimuth or range will be based on consultation with the POC and will be coordinated with S-Pol (if necessary). It may turn out that it is better to continue the 360-deg and 100-km scans (Seq. D) whatever happens within the scanning region, so as to have a homogeneous data set (as Monte Lema will). These are open questions that will be considered in the field and in consulation with the POC. The 200-km range scans (360-deg J and 180-deg K and L) have only four elevations and will be used only qualitatively.

The RONSARD's typical scanning rate is 15 deg/sec. It takes about 3 sec to change elevation (and direction of the azimuth speed from clockwise to counterclockwise and vice-versa). So a 20-elevation sequence takes about: 20x(360/15+3)=540 sec = 9 min. A 20-elevation sequence over a 180 degree sector would take about half this time. Since Monte-Lema obtains a full-resolution, three-dimensional scan every 5 min., the proposed schedule will thus allow dual-Doppler data to be produced every 10 min. if the RONSARD scans 360 degrees and every 5 min. if RONSARD scans 180 degrees.

Figure 8-2 summarizes the data flow from the RONSARD and Monte Lema radars. The RONSARD data will be transmitted to the POC via an ISDN line. 20 min. (This frequency is subject to testing by French scientists and engineers in spring 1999.) At the POC the three-dimensional fields of reflectivity and radial velocity in this volume will be interpolated to a 3 km x 3 km x 1 km grid and ingested into MountainZebra. The velocity data from RONSARD will be combined at the POC with the corresponding Monte Lema and/or S-Pol data into a multiple-Doppler wind field at least every 60 min. This will be done on a PC-LINUX machine using programs (dealiasing, VAD, multi-VAD analyses, horizontal wind field, variational integration of the continuity equation over complex terrain) from Laboratoire d'Aerologie (F. Roux and J. F. Georgis) and CNRM (M. Chong). Displays of the resulting 3-D wind fields (to be written as netcdf files) will be done in MountainZebra. The Ronsard data (copies of the radar tapes) will be available upon request after the SOP.

Key personnel supporting the Ronsard radar operations include a Chief Scientist, Technician or Engineer, and a Student Operator. Their responsibilities are outlined as follows:

i) ***Chief Scientist:*** provides oversight in planning and execution of radar operations, in relation with POC and radar scientists at other sites; monitors progress toward meeting scientific objectives and serves as a key point of contact at the POC for debrief and mission planning purposes; coordinates with Technician/Engineer/Operators to generate quick-look data sets.

ii) ***Technician/Engineer:*** knowledgable in details of Ronsard operations; assists with set-up, operations, and data management; trains operator personnel; calibrates radar and performs any required repairs/maintenance to Ronsard radar.

iii) ***Student Operators:*** responsible for operating Ronsard during declared IOPs; assist in data management and generation of quick-look data sets.

TABLE 4-5. Fields recorded by all the wet MAP research and operational models displayed by the POC.

Radar	Fields Recorded	Fields Displayed in POC
S-POL (S-BAND)	*	Z, VR, Particle type, Multiple Doppler horiz. wind
RONSARD (C-BAND)	Z, VR	Z, VR, Mult. Doppler horiz. wind
MT LEMA (C-BAND)	Z, VR	Z, VR, Mult. Doppler horiz. wind
DOW (X-BAND)	Z, VR	No real-time display; Quicklook data avail. after WetMAP active periods
OPRA (S-BAND)	Z, VR, SW	Z
ETH (X-BAND)	Z, VR, SW	No real-time display
U of KARLSRUHE (Ka-BAND)	?	"
BRIC DELLA CROCE		
FOSSALON DI GRADO		
PISA		
TEOLO	Z, VR	Z
SPINO D'ADDA		
S. PIETRO CAPAFIUME		

*Z, ZDR, LDR, VR, KDP, DBM, phiDP, rhohv, SD, NCP, DX, CH, AH, CV, AV

4.4.3 *S-Pol operations*

The S-Pol radar has two objectives, which are illustrated in Fig. 4-2. The primary objective of S-Pol is to provide microphysical coverage within the broad dual-Doppler coverage of RONSARD and Monte Lema (yellow lobes in) by performing precipitation particle-type mapping by dual-polarization measurements within a 75-km radius region centred between RONSARD and Monte Lema (red circle in). The secondary objective of S-Pol is to provide higher resolution dual- Doppler velocity data in the central portion of the coarser resolution RONSARD/Monte Lema dual-Doppler area. These two objectives will be accomplished by the following scan sequences which will be conducted throughout the duration of any IOP in which precipitation occurs in the Ticino region.

The following basic considerations will guide the S-Pol scanning:

1. Since microphysical particle typing is a primary goal of S-Pol, it will always scan in dual-polarization mode.
2. Since orographic lifting is of primary interest, S-Pol will preferentially but not exclusively collect polarimetric data in the western dual-Doppler lobes.
3. A secondary objective of S-Pol is to provide high resolution multiple-Doppler data with RONSARD and/or Monte Lema.
4. To be temporally commensurate with the 5 min. (interleaved) volume scans at Monte Lema and the 5 or 10 min. volume scans of RONSARD, S-Pol will operate on a 10-min. cycle with 5 min. dedicated to RHIs and 5 min. to PPIs.
5. The maximum data collection rate of S-Pol is PRF = 1000, 100 samples (50H and 50V), all variables, and 1000 gates.

Four basic scan sequences will be used:

1. When little interesting activity is in the western lobe, full 360 degree scans, each taking 10 min., will be obtained for surveillance. Scan rate = 8 deg/sec, beam spacing in horizontal = 0.8 deg, and 12 scans elev. angles = 0.6, 1.4, 2.2, 3.0, 3.8, 4.6, 5.4, 6.2, 7.0, 7.8, 8.6, 9.4.
2. Interesting activity in the western lobe and echo tops < 8 km. Scan to at least 8 km between 30 and 100 km of radar. Sixteen 120 deg PPI sectors over western lobe plus about 50 RHIs spaced ~2.5 deg apart over the same sector. Scan rate = 8 deg/sec and PPI horizontal beam spacing = 0.8 deg. RHI vertical beam spacing = ~0.5 deg. Elevation angles = 0.6, 1.4, 2.2, 3.0, 3.8, 4.6, 5.4, 6.2, 7.1, 8.1, 9.3, 10.6, 12.1, 13.9, and 15.8.
3. Interesting activity in the western lobe and echo tops 8-10 km. Scan to at least 10 km between 30 and 100 km of radar. Seventeen 120 deg PPI sectors over western lobe plus ~50 RHIs spaced ~2.5 deg apart over the same sector. Scan rate = 9 deg/sec, PPI horizontal beam spacing = 0.9 deg. RHI vertical spacing = ~0.5 deg. Elevation angles are 0.6, 1.5, 2.4, 3.2, 4.1, 5.0, 5.8, 6.7, 7.6, 8.5, 9.6, 10.8, 12.1, 13.6, 15.3, 17.1, and 19.3.
4. Interesting activity in the western lobe and echo tops 10-12 km. Scan to at least 12 km between 30 and 100 km of radar. Nineteen 120 deg PPI sectors over western lobe plus ~50 RHIs spaced ~2.5 deg apart over the same sector. Scan rate = 10 deg/sec, PPI horizontal beam spacing = 1.0 deg. RHI vertical spacing is ~0.5 deg. Elevation angles = 0.6, 1.6, 2.6, 3.5, 4.5, 5.5, 6.5, 7.5, 8.4, 9.4, 10.5, 11.7, 13.0, 14.5, 16.2, 18.1, 20.1, 22.4, and 24.0.

The S-Pol data will be sent to the POC in real time via an ISDN line. At the POC the transmitted PPI volume scans of reflectivity and radial velocity will be interpolated to a 3 km x 3 km x 1 km grid and ingested into MountainZebra. Two particle-type algorithms (NCAR and University of Washington) will be run on RHI volumes at the S-Pol site and the outputs will be sent as sweepfiles to the POC, where they will be displayed in MountainZebra.

4.4.4 *DOW operations*

The key objective for the Doppler-on-Wheels (DOW), a mobile X-band Doppler-radar platform, will be to capture the detailed precipitation and airflow structure deep within the major Toce and Ticino river valleys that cannot be observed by the larger, fix-installed research radars scanning above the ridges or airborne radars passing overhead. A secondary objective is to provide radar coverage for the boundary-layer group at their site close to the Lodrino Airport in the Ticino River valley.

Because of its mobility, the DOW may be deployed flexibly at a variety of predetermined sites. There are two primary sites considered in the Toce River valley (near Pieve Vergonte on the shoulder and the valley floor) and the Ticino River valley (Lodrino and Magadino airports), pending written approval from the local authorities and/or land owners. Additional secondary sites (with limited view) may be possible.

The site selection for a particular IOP will be done at the POC, depending on the weather situation and the status of accomplishment of DOW objectives. It is not anticipated that synoptic/mesoscale forecasts will be sufficiently accurate to identify a clear preference between the Toce and Ticino valleys in advance of heavy precipitation events. Typical synoptic evolution of archived flood events suggests that baroclinic forcing (evidenced by banded precipitation features) advances eastward with time. The Toce and Ticino river valleys are thus expected to be impacted in sequence, though details related to the local flow dynamics in these two regions might certainly differ. An effort will be made to obtain a representative set of observations from various sites throughout the duration of the entire SOP, in order to avoid a situation in which conclusions are overlayed site specific.

It would be feasible to move the DOW from one site to another during an IOP (e.g., from the Toce Valley over to the Ticino) to follow precipitation; however, limitations arise due to time spent in traffic, while moving from one location to the next, and a maximum sustainable operation of 12-15 hours for currently identified personnel. Thus, initially, operations based on one specified site per IOP will be the preferred mode. If it turns out that the airflow may be well captured within shorter time periods (a few hours) then multiple site IOPs may become an option.

Tables DOW-1 and DOW-2 highlight some of the basic characteristics and trade-off for the DOW. Given the short distances of observations possible within the valleys and the anticipated, possibly significant wind speeds (likely in excess of 30 m/s, with maxima of 80 m/s), the pulse repetition frequency (PRF) used will be in the range of 3,000 to 5,000 Hz. Using a pulse integration as given in Table DOW-1, which produces radial Doppler velocity estimates accurate to within 0.25 m/s, one may scan the antenna at roughly 15 degrees per second (Table DOW-2) without losing full area coverage. Site-dependent properties (e.g., degree of second-trip or ground clutter contamination, sidelobes) may further influence these choices in ways that will not be obvious until actual deployment of the DOW in the field, necessitating careful attention to the quality of observations by well-trained field staff.

TABLE 4-6. **Table DOW-1:** Radar operation trade-off while maintaining a 0.25 m/s resolution for the Doppler-velocity measurements. Shown are the pulse repetition frequency (PRF), the maximum unambiguous range and Nyquist velocity, and the number of pulses to be integrated per gate to achieve that.

PRF	**Max. Range**	**Nyquist Velocity**	**Pulse/Gate**
2,000 Hz	75.0 km	16 m/s (57.6 km/h)	128
3,000 Hz	50.0 km	24 m/s (86.4 km/h)	192
4,000 Hz	37.5 km	32 m/s (115.2 km/h)	256
5,000 Hz	30.0 km	40 m/s (144.0 km/h)	320

TABLE 4-7. **Table DOW-2:** Average beam spacing and time to complete one sweep for a given antenna rotation speed (deg/sec), independent of the PRF. The beamwidth of the DOW is roughly 1 degree (0.9 degree).

Rotation	**Beam Spacing**	**Time/PPI**
10 deg/sec	0.64 deg	36 sec
15 deg/sec	0.96 deg	24 sec
20 deg/sec	1.28 deg	18 sec

The basic scanning strategy is to operate the DOW in multi-elevation 360-degrees PPI volume scan mode, interspersed with vertical cross section RHI scans up, down, and across the valley. This basic scanning sequence will be repeated every 15 minutes. The volume scan consists of 22 elevation PPI sweeps, based on the following tilt sequence: 0.5, 1.5, 2.5, 4.0, 5.5, 7.0, 9.0, 11.0, 13.0, 15.5, 18.0, 21.0, 24.0, 28.0, 32.0, 37.0, 42.0, 48.0, 55.0, 63.0, 72.0, and 82.0 degrees.(For elevated sites above the valley floor, the sequence may start at 0 degrees, or at negative angles if the hardware allows for that and the tilt angle sequence is shifted accordingly.) This 360-degree PPI volume scan takes approximately 9 minutes to be completed (Table DOW-3), and will be followed by a series of at most 20 vertical cross section RHI scans (Table DOW-4): minimally up, down, and on both sides across the valley. However, the operator may choose to spread some RHIs over the angle of view and add sector scans as time permits. It is important though to comply with the 15-minute repetition of the basic module (22-elevation, 360-degrees PPI volume scan followed by several vertical cross section RHI scans).

TABLE 4-8. **Table DOW-3:** 360-degrees volume scan modes and their execution time. Radar is operated with PRF=3,000 Hz and an antenna rotation of 15 degrees per second.

Mode	Pulse Width	250 Gates	Tilts	Time
P1	1.0 us (150 m)	37.5 km	22	9 min.
P2	0.6 us (90 m)	22.5 km	22	9 min.
P3	0.4 us (60 m)	15.0 km	22	9 min.
P4	0.2 us (30 m)	7.5 km	22	9 min.

TABLE 4-9. **Table DOW-4:** 0-90 degrees vertical cross section RHI scan modes and their execution time. The radar is operated with PRF=3,000 Hz and a vertical antenna movement of 10 degrees per second.

Mode	Pulse Width	250 Gates	Time
R1	1.0 us (150 m)	37.5 km	10 sec
R2	0.6 us (90 m)	22.5 km	10 sec
R3	0.4 us (60 m)	15.0 km	10 sec
R4	0.2 us (30 m)	7.5 km	10 sec

The standard operation mode is either P2 or P3 for the volume scans and R2 or R3 for the vertical cross sections. For the Magadino Airport site in the Ticino Valley, the P1 and R1 modes may be applied because of the larger range to possibly be covered. On the other hand, for the observations at the Lodrino Airport (Ticino Valley), particularly those in coordination with the boundary-layer group (located roughly 5 km south of Lodrino), the operation modes P4 and R4 will be used to provide highest spatial resolution. For these clear air observations, a higher PRF of 4,000 Hz and/or a slower antenna rotation of 10 degrees per second may be needed to increase the sensitivity. These clear air boundary-layer observations are most likely to take place in the time frame of 20 September through 9 October, where DLR Falcon overflights (with the downward-looking LIDAR) are anticipated in close coordination with other enhanced boundary-layer observations.

While DOW radar data will not be transmitted to the POC in real time, quick-look products (e.g., in the form of representative GIF image sequences of reflectivity and raw radial velocity) will ideally be made available for post- IOP debriefings at the POC and transmission to the MOC within 24-48 hours following each IOP.

Key personnel supporting the DOW operations include a Chief Scientist, Technician or Engineer, and 1-2 Student Operators. Their responsibilities are outlined as follows:

- *Chief Scientist (Steiner, Smull):* provides oversight in planning and execution of DOW deployments (incl. site selection and periods of operation); monitors progress toward meeting DOW-related scientific objectives and serves as a key point of contact at the POC for debrief and mission planning purposes; coordinates with Technician/Engineer/

Operators to generate quick-look data sets.

- *Engineer (Univ. of Oklahoma: McDonald, NCAR: Lutz, Randall):* knowledgable in details of DOW operations; assists with set-up, operations, and data management; trains operator personnel; calibrates radar and performs any required repairs/maintenance to DOW electric system.
- *Student Operators (from Univ. of Oklahoma):* responsible for transporting and operating the DOW at predetermined sites during declared IOPs; assist in data management and generation of quick-look data sets.

4.4.5 *OPRA S-band vertically pointing radar operations*

The University of Washington Orographic Precipitation Radar (OPRA) will be located at Pieve Vergonte, Italy within a fenced enclosure of a power station (). The OPRA scientist in the field will be R. Houze. The OPRA engineer will be K. Pearl. The radar antenna and shelter for the electronics will sit near the fence on a concrete-surfaced area. A Joss-Waldvogel disdrometer will be located near the radar. Power for the radar and disdrometer will be provided via two extension cords from the power station building. The radar will arrive in Pieve Vergonte on 6 September 1999 and be setup on 7 September 1999.

OPRA will run continuously and unattended for the duration of the SOP period except for when it is down for maintenance. OPRA data will be monitored remotely via phone line. Brief checks on OPRA status will be made via a PC equipped with a modem at the POC. The modem connection will be used to ftp over recent hourly data files. Except for these status checks, real-time OPRA data will not be routinely accessible from the POC. OPRA recording media (CDs) will be changed approximately weekly. At least once a month, the engineer will perform a thorough system check which will include a receiver calibration using a signal generator and a noise-level measurement.

OPRA data recorded on the CDs will be reviewed and quality controlled using a PC in the POC by the OPRA engineer. Quicklook gif or jpeg images of OPRA data produced on the PC in the POC will be selected by the OPRA scientist for inclusion in mission summaries posted on the MAP Field Catalogue (###XREF see Section 9).

4.4.6 *ETH X-band vertically pointing radar (VPR) operations*

The ETH-VPR will be set up, together with various microphysical instruments in Macugnaga, Italy (7.965°E, 45.970°N), at the end of a tributary valley to the Toce River. The objective of this setup is to provide detailed microphysical data of solid and liquid precipitation particles at one point within the dual-Doppler lobes of the Monte Lema, S-Pol, and RONSARD radars. Macugnaga is also within the region where the S-Pol radar provides information about particle types performing dual-polarization measurements.

The ETH-VPR will operate during long-lasting precipitation events (at least 3 hours of continuous precipitation) and/or when airborne microphysical measurements are performed above the Ticino-Toce watershed or any other time that the POC recommends that the radar be in operation.

The time resolution of the measurements is 30-60 s, range resolution is 50 m, and vertical velocity resolution is 0.125-0.25m/s. Together with the radar, a disdrometer and meteorological instruments will be operated. In cases of long-lasting precipitation, optical particle measuring instruments will be operated on a mountain 1500 m above the radar.

Hourly gif images of radar reflectivity and Doppler velocity of the ETH-VPR will be sent to the POC via Internet either after every IOP or every hour during an IOP. Raw data will be available after the SOP or upon request.

4.4.7 University of Karlsruhe vertically pointing K-band radar operations

The Karlsruhe Micro Rain Radar (KMRR) will be operated at Locarno Monti (Osservatorio Ticinese, SMI; 46.174°N, 8.788°E, 379 m.s.l.) during the MAP field phase. The instrument will provide vertical profiles of reflectivity, rain rate, and spectral number density in six steps up to the height of 1200 m above ground level. This will be done as one-minute mean values during the whole field phase. The KMRR will be accompanied by two optical disdrometers to give ground values of the measured parameters and to have the possibility to measure snow spectra on Cimetta (approx. 1100 m above Locarno Monti). Data will be transmitted to MDC and POC once a day during SOPs, otherwise once a week.

4.4.8 Intercomparison and Calibration of Radar and Disdrometer Instruments prior to the MAP SOP (pre-SOP exercise)

During the SOP of MAP seven radars (three vertically pointing and four scanning ones) will be operated at different locations in the Ticino-Toce watershed partly in combination with spectrometer or disdrometer measurements. In order to profit as much as possible from this set-up, an intercomparison of radar data and ground data of precipitation is planed. During the SOP of MAP seven radars (three vertically pointing and four scanning ones) will be operated at different locations in the Ticino-Toce watershed partly in combination with spectrometer or disdrometer measurements. In order to profit as much as possible from this set-up, an intercomparison of radar data and ground data of precipitation is planed during the pre-SOP. This measuring period will take place during three weeks preceding the SOP (16 August - 3 September 1999). A report on this intercomparison will be published at the beginning of SOP. The radars considered in the pre-SOP are:

i) Three vertically pointing radars:

- the MRR1 vertically-pointing Doppler radar of the University of Karlsruhe (K-band)
- the ETH vertically pointing Doppler radar (X-band)
- the vertically-pointing OPRA of the University of Washington (S-band)

ii) Two of the scanning radars:

- the scanning DOW of the University of Oklahoma (C-band)
- the Monte Lema radar of the SMI (C-band)

All vertically pointing radars will be operated close together at the SMI (Swiss Meteorological Institute) in Locarno, Switzerland with a horizontal distance of 15 km to the Monte Lema radar and a distance of around 8 km to the DOW.

In addition, the ground based disdrometers and spectrometers involved in the pre-SOP are:

- Joss Waldvogel disdrometer of the ETH
- Joss Waldvogel disdrometer of the DLR
- two optical array spectrometers of the ETH
- two optical disdrometers of the University of Karlsruhe
- Acoustic Sphere of Prof. Hertig EPFL
- optical spectrometer from France (Frank Roux)

All these instruments are operated close together with the vertically pointing radars at the SMI in Locarno, Switzerland.

This pre-SOP is a unique opportunity to investigate the following points of interest:

1. Profiles of radar reflectivity of rain obtained by different radars will be compared with each other. As a result the radars can be calibrated using the spectrometers and disdrometers. This allows to obtain correction factors for the following ten weeks of SOP.
2. Also reflectivity profiles of snow and melting snow recorded by radars operating at different wavelength (K- to S-band) will be compared with each other. This yields information about how electromagnetic radiation of different wavelengths is scattered by snow and melting snow. Since solid precipitation particles may be, for some of the wavelengths, large enough to show significant deviations from the Rayleigh-approximation, this aspect might be of special interest.
3. The Doppler spectrum of rain and snow obtained by the different radars can be compared to spectra calculated from the fall velocity measurements performed by the different spectrometers and disdrometers.
4. The representativeness of estimates reflected by the intercomparison will be investigated. This includes ground-based disdrometers as well as the radars involved.
5. Analysing the disdrometer data, special attention will be given to the small drops (how many are "real", how many created/eliminated by the instrument).

4.4.9 Doppler radar observations in clear air

If time and weather permit, clear air (no precipitation) measurements will be attempted with Ronsard and S-Pol. Under favourable circumstances, both radars have the capability to obtain reliable measurements in the boundary layer (below 1-2 km altitude) and at relatively close distance (< 30-50 km) from the radar. Although the exact origin of the clear air return is not completely known, insects are the most probable source of radar echoes in the hydrometeor-free environment. The most favourable conditions for such observations are generally associated with warm, moist and buoyant boundary layer, although reliable signals can be obtained in other weather conditions.

As it is done for rainy situations, different analyses depending on the available radar data can be conducted. Single-Doppler data provide mean wind profiles through the VAD technique, while simultaneous dual-Doppler data allow the three-dimensional wind field to be retrieved. Turbulent mass and momentum fluxes can also be derived from the residual with respect to the mean wind.

During the MAP SOP, two different weather situations will be considered for clear air measurements. Firstly, pre-convective situations during which warm and moist mediterranean air is flowing from the south over the Po valley should be particularly favourable. Such data could help to identify and, possibly, quantify the turbulent fluxes in the boundary layer before precipitating systems develop. Secondly, north Foehn cases could also be associated with detectable signal in clear air in the Lago Maggiore region, but this is less certain owing to the much drier air as compared to the previous case. If possible, the goal would be to determine kinematic and turbulent characteristics of the boundary layer circulation associated with PV banners.

Although these clear-air observations have the potential to reveal interesting new phenomena, it is to be outlined that priority will be given to ground-based Doppler radar observations of precipitating systems. Due to the limited number of scientists and engineers available to operate the radars, it may not be possible to have enough manpower to conduct frequent observations in clear-air situations. However, the radar groups have agreed to attempt such observations when possible. Of course, complementary measurements conducted in the boundary layer with ground-based instruments by the different Italian groups in the Po valley, and with the French Merlin IV aircraft (one dedicated flight is planned for "PV banner survey on southern Alps with emphasis on turbulent fluxes", see flight P7A in Section 5.7.7) will be of great interest for comparisons.

4.5 Operational Radars Supporting MAP

4.5.1 Operational and research radars over the Alps

Observations with the operational and research radars in the Alpine region outside the "Lago Maggiore target area" (Fig. 4-1 and Table 4-1) during the SOP are important for two reasons. Firstly, mesoscale precipitating systems are not isolated entities. As they are generally associated with synoptic-scale disturbances, it is highly probable that during "MAP episodes" heavy precipitation events will not be restricted to the north Italian southern flank of the Alps. The presence of airborne Doppler radars during the SOP insures that such an event will not be missed. Hence, complementary observations with the operational radar networks covering the whole Alpine range (i.e. from France, Switzerland, Germany, Austria, Slovenia, Croatia) will certainly be helpful to understand the large-scale structure of the meteorological perturbations causing the "MAP episodes", and the conditions under which heavy precipitation can occur locally.

Secondly, although less frequent than the typical "southerly-flow archetype", some meteorological situations associated with prevailing westerly or north-westerly winds may also lead to heavy precipitation events west or north of the Alps. In such a case, a northerly Foehn event would occur over northwestern Italy. Although no special equipment (except, maybe, instrumented aircraft) will be deployed north of the Alps during the SOP, the dense network of operational radars in France, Switzerland and Germany, and the two research radars near Munich (DLR / POLDIRAD) and in Zurich (ETH / Doppler radar) could provide useful information.

4.5.2 *Italian operational radars*

Reflectivity fields observed by the six C-band Italian operational Doppler radars (Bric della Croce, Fossalon di Grado, Pisa, Teolo, Spino d'Adda, S. Pietro Capofiume, see Fig. 4-3) will be transmitted to the POC every 30 min. according to the data flow shown in Fig. 8-2. During

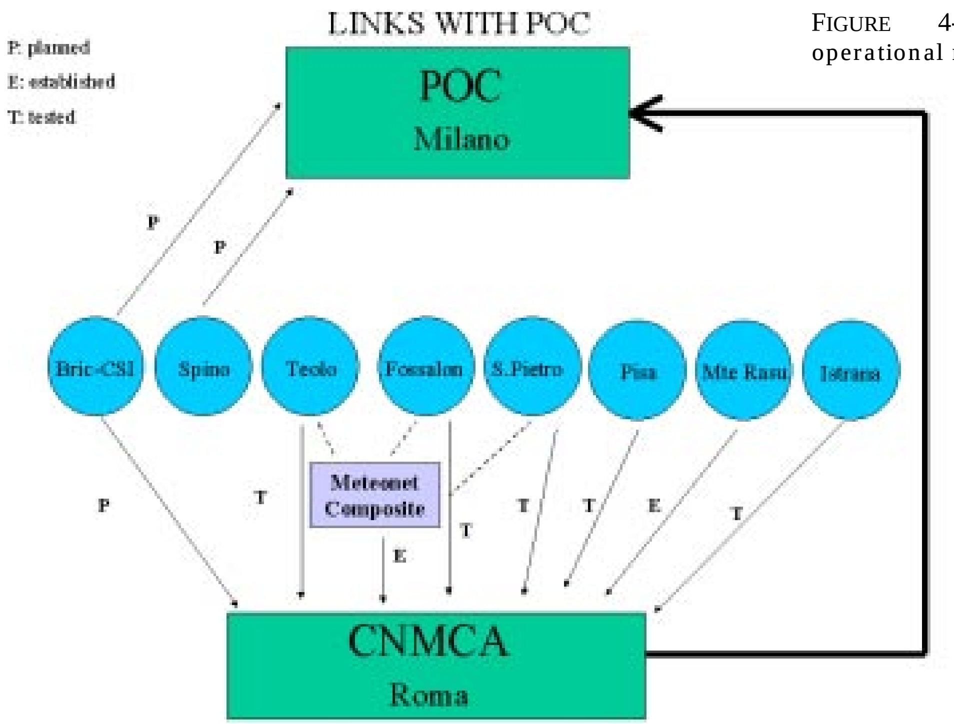

FIGURE 4-3. North Italian operational radars.

TABLE 4-10. Italian radars (as of January 1999).

Name of radar station	Institution	Latitude (deg)	Longitude (deg)	Altitude (m MSL)	Frequency (GHz)	Doppler capability	Range	Contact person
Istrana (IT-43)	Italian Air Force Meteorlogical Service	45.694 N	12.107 E	70 m	5.45 - 5.825	no	200 km	Maj. S. Cau (+39 6 599 6333)
Teolo - Mt. Grande (IT-44)	Meteorological Centre-ARPAV in Teolo	45.350 N	11.667 E	472 m	5.625	yes	max: 240 km Doppler: 120 km	M. Monai CSIM
Fossalon di Grado (IT-45)	ERSA Friuli Venezia-Giulia	45.817 N	13.333 E	25 m	5.42 - 5.63	yes	max: 480 km Doppler: 125 km	Dr. E. Dietrich (ERSA) (+39 431 35177)
Capofiume (IT-46)	Servizio Meteorologico Emilia-Romagna	44.650 N	11.653 E	40 m	5.43	yes	max: 400 km Doppler: 125 km	Dr. S. Nanni (Serv. Met. Em. Rom.) (+39 512 84559)
Pisa (IT-48)	Italian Air Force Meteorlogical Service	43.683 N	10.383 E	80 m	5.45 - 5.65	yes	max: 500 km Doppler: 125 km	Maj. S. Cau (+39 6 599 6333)
Bric della Croce (IT-65) (> 1 Oct 99)	CNR Politecnico Milano	45.034 N	7.331 E	727 m	5.44	yes	max: 230 km Doppler: 120km	M. Gabella (+39 11 564 4067)
Spinod'Adda (IT-66)	CNR Politecnico di Milano	45.400 N	9.500 E	80 m	2.8	yes	150 km	M. D'Amico Politecnico di Milano
Mt. Rasu (IT-71)	Servizio Agrometeor. Regionale della Sardegna	40.421 N	9.005 E	1258 m	5.60 - 5.65	yes	max: 500 km Doppler: 125 km	G. Bardinelli (+39 79 158601)
Montagnana (IT-64)	Istituto di Fisica dell'Atmosfera (CNR)	43.674 N	11.116 E	655 m	5.395-5.955	yes	max: 400 km Doppler: 100 km	B. Luca (+39 574 602535)

non-IOP times, gif images of low-level reflectivity from all six Italian radars will be sent to the POC.During IOPs, some data referred to a set of levels (lowest CAPPI and some higher level), in BUFR format, will be transmitted to the POC, mainly via CNMCA-Roma, every 30 minutes. At the POC these data will be converted to netcdf format and ingested into MountainZebra where they will be overlaid on the radar data fields from the Monte Lema, RONSARD, and S-Pol radars. Hopefully more radars (Istrana, Mt. Rasu and Montagnana) should give some support to the campaign.

4.5.3 Operational Alpine radar composite

During the SOP, a special effort will be conducted by M. Hagen (DLR, Germany) so as to generate 30-min. updated Alpine reflectivity composites from the French, German, central European (CERAD) and, hopefully, Italian radar composites or individual images. This information will be available at POC through MDC, and it will complement the composite from the Italian operational radars and the data from the research radars concerning the southern flank of the Alps.

4.6 Ground Radar Support Activities in the Project Operations Centre (POC)

To coordinate the aircraft and ground-based observations in Wet MAP, a Project Operation Centre (POC) will be operated in northern Italy, at the Linate military air base outside Milano. The Regional Meteorological Centre located on this base will host the POC. The POC will coordinate both the ground and air operations of Wet MAP.

4.6.1 *POC coordination of ground-based radar operations*

During all IOPs the POC will coordinate the data collection by Wet MAP meteorological radars. In addition to the radars in the Ticino region (Fig. 4-2), the Wet MAP meteorological radars include six C-band Italian operational Doppler radars (Table 4-10). Since the DOW is a roving radar, it will have to be deployed each day to a location recommended by the POC. Since the S-Pol, RONSARD, and ETH VPR radars will not be operated continuously, the POC will determine when those radars should be activated. (The Karlsruhe and OPRA radars will run continuously from early September to mid-November.) The POC further must decide the specific scan strategies to be carried out at the S-Pol and RONSARD radars. The scan strategy options are discussed above in Section 4.4.2 and Section 4.4.3.

During a non IOP operation, the engineering staff will monitor data flow from the radars to POC. Radar scientists will monitor all participating Italian and Swiss operational scanning radar. Radar scientists will notify the POC Operations Coordinator if significant precipitation appears to be developing.

During a non-IOP, the engineering staff will monitor data flow to the POC from the S-Pol, RONSARD, Monte Lema, Bric della Croce, Fossalon di Grado, Pisa, and Teolo radars. Radar scientists will produce hourly composite radar images on the and provide them around the clock to MOC via the MAP Field Catalogue, within ~15 min. of data collection from RONSARD, Mt. Lema, and S-Pol radars, during all operational periods. On the day following a IOP, radar scientists will generate mission summaries and post them on the MAP Field Catalogue.

4.6.2 Technical Support in the POC

- Engineering Staff: Stacy Brodzik, Chris Burghart. Maintain computer hardware and communications hardware and software, in collaboration with Italian Air Force personnel. Administer local computer network in POC and its connections to external network. Manage data flow into POC from seven radars (S-Pol, RONSARD, Monte Lema, Bric della Croce, Fossalon di Grado, Pisa, and Teolo). The received data, whether polar or Cartesian, should be converted to Cartesian netcdf files appropriate for ingesting into MountainZebra. These data must be displayed on MountainZebra. They must be near real time and updated every 20 min. The displayed fields should be 3-D and should allow for the data from the seven radars to be portrayed on the screen as a composite horizontal echo pattern and for arbitrary vertical cross sections of the data to be displayed on demand. The raw data received and the netcdf files will be archived. The continually updated Mountain Zebra display will include current aircraft position and tracks for the last hour. These tracks will be provided to the engineering staff from Italian civilian and military air traffic control by a method which is still being determined. As a backup, the aircraft position will be provided at intervals of ~5 min. by voice communication from each aircraft to the POC.
- Radar scientists: C. James, Z. Zeng, S. Medina, G. Jaubert, plus one person from Laboratoire d'Aerologie, K. Pearl (part-time), and R. Meitin (part-time). Monitor radars during both non-operational and operational periods. Advise POC Operations Coordinator

of any significant changes in radar echo pattern. During periods of precipitation over any of the focus regions (Lago Maggiore, north-east Italian/Slovenian), produce hourly radar images and provide them around the clock to MOC, within ~15 min. of data collection from RONSARD, Mt. Lema, and S-Pol radars, during all operational periods. Provide post-mortem summary charts of each aircraft mission on which are overlaid the aircraft tracks, aircraft radar, and ground-based radar. Provide a complete set of these summary charts to MOC within 24 hours of mission.

4.6.3 *Location for Italian forecasting support to MAP*

The Italian CMR will be contributing forecast staff to MAP to assist with forecasting and nowcast requirements especially in the Italian region of MAP and for Wet-MAP operations in particular. This is detailed further in Chapter 7.

4.6.4 *Operational support capabilities at the POC*

The POC will be provided with a local area network to support MAP scientists housed at the POC and several important operational tools (cf. ###chapter9). The operations staff will utilize the MountainZebra and LAPS systems to coordinate aircraft flight operations and the determination of ground-based radar scan strategies to best sample weather systems of interest. The MAP Field Catalogue will provide operations information, weather products, facility status, flight mission summaries, and preliminary field data as input from both the POC and MOC.

4.7 Ground-based Radar Documentation

It will be very important for MAP participants located at the POC to provide documentation on all aspects of the radar data collection. The information required includes:

- Facility status for all ground-based radar systems. This should be received daily, in the early morning prior to the 0830 LST morning briefing and immediately if an IOP is underway. This information should be delivered to the POC Operations Coordinator.

Mission summaries. The POC Science Coordinator will prepare an IOP summary discussion from the POC perspective. This may be done daily or at the conclusion of the IOP, whichever makes the most sense. Radar scientists must contribute to this discussion or provide separate summaries to help all MAP participants understand the evolution of precipitation systems in the region. This information will be accessible by all MAP participants via the MAP Field Catalogue.

All documentation discussed above will be made available to all MAP participants at the POC and MOC via the MAP Field Catalogue. Input to the catalogue may be made via ftp, email, or by using available html forms. Pictures in common formats (gif, jpeg, ps, etc.) will be accessible via the catalogue at all sites. Further details on the catalogue are given in Section 9.4.