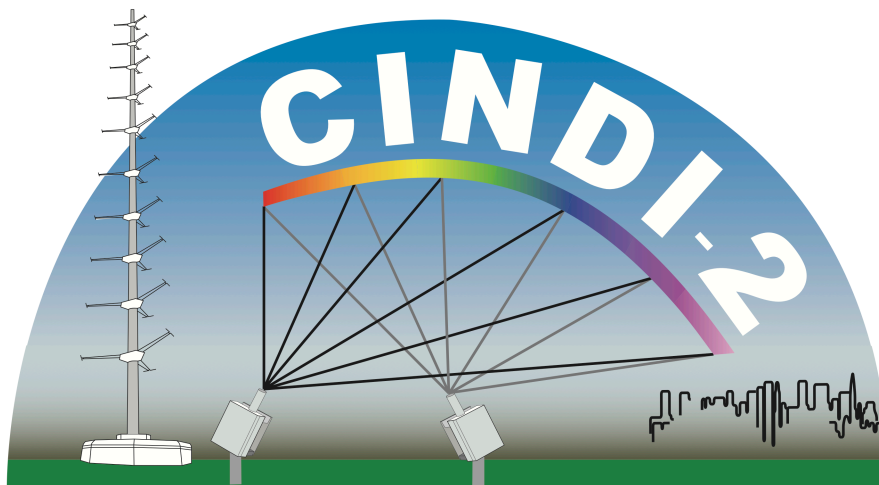


CINDI-2

Second Cabauw Intercomparison of Nitrogen Dioxide measuring Instruments



**Cabauw, The Netherlands
25 August – 7 October 2016**

Campaign Planning Document

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1 Introduction

In 2009, about thirty in-situ and remote sensing instruments were intercompared as part of the Cabauw Intercomparison campaign for Nitrogen Dioxide measuring Instruments (CINDI) which took place at KNMI's Cabauw Experimental Site for Atmospheric Research (CESAR) in the Netherlands. The main objectives of this field experiment were to determine the accuracy of ground-based remote sensing measurement techniques for the detection of atmospheric nitrogen dioxide, and to investigate their usability in satellite data validation. As a result, a large dataset of NO₂, aerosols and other air pollution components were observed and documented in a number of peer-reviewed articles (Peters et al, 2012; Roscoe et al., 2010; Friess et al., 2016; Pinardi et al., 2013; Zieger et al., 2011; Irie et al., 2011), providing an assessment of the performance of ground-based remote sensing instruments for the measurement of NO₂ and aerosol vertical profiles and tropospheric/total columns. Recommendations were issued regarding the operation and calibration of such instruments, retrieval settings, and observation strategies for the use in ground-based networks for air quality monitoring and satellite data validation.

In the preparation of the Sentinel-5 Precursor validation, and seven years after the first CINDI campaign, a CINDI-2 campaign will be organized at the CESAR site between 25 August and 7 October 2016, with the target to intercompare an expanded new generation of ground-based remote-sensing and in-situ air quality instruments. The activity aims at characterising the differences between the measurement approaches and systems used within the overall DOAS community and to progress towards harmonisation of settings and methods for data acquisition and retrieval from similar but not identical systems of MAXDOAS type. Such an activity is essential to enable harmonised global validation of satellite missions focusing on air quality, such as the ESA Sentinel 4, 5 and 5P, and the future TEMPO and GEMS missions planned in the US and Korea respectively.

CINDI-2 is a broad international activity supported by ESA and by the Dutch National Agency. It builds on the experience gained during and after the first CINDI campaign as well as on several ongoing projects aiming to improve the exploitation of MAXDOAS network data for satellite validation. CINDI-2 is also organised under the auspices of the Network for the Detection of Atmospheric Composition Change (NDACC). A successful participation in such formal instrument intercomparison campaign ensures the NDACC certification of new instruments and associated teams.

The major science objectives of CINDI-2 can be summarised as follows:

Objective 1:

To assess the consistency of slant column measurements of several key target species (NO₂, O₃, O₄ and HCHO) of relevance for the validation of SSP and the future ESA atmospheric Sentinels, through coordinated operation of a large number of DOAS and MAXDOAS instruments from all over the world.

This objective will be met by organizing a two-week semi-blind intercomparison exercises involving 34 MAXDOAS and 2 zenith-sky DOAS instruments. All participating groups will apply common data acquisition schemes (e.g. common pointing direction, same number and values of elevation angles, synchronised data acquisition) and spectral analysis settings. Both will be based on the experience gained during the previous CINDI-1 and MADCAT campaigns and on MAXDOAS harmonisation efforts carried out within the framework of the EC FP7 projects NORS and QA4ECV. Trace gas slant column densities will be collected and intercompared on a daily basis under the coordination of an independent campaign referee. The interpretation of the comparison results will benefit from additional observations and ancillary data collected during the campaign, in particular aerosol lidar, ceilometer, O₃ and NO₂ sondes, in-situ monitors, long-path DOAS as well as co-located satellite and air quality model data.

Objective 2

to study the relationship between remote-sensing column and profile measurements of NO₂, HCHO and O₃ and reference in-situ concentration measurements of the same species.

This objective will be addressed by comparing trace gas profiles derived from MAXDOAS slant column observations using various approaches (see e.g. Cl  mer et al., 2010; Friess et al., 2006; Ortega et al. (2015);

Peters et al., 2012; Vlemmix et al., 2011; Wagner et al., 2011) to correlative profile measurements from sonde, lidar and LP-DOAS systems as well as to near-surface concentrations from in-situ monitors operated in parallel at the CESAR site. The agreement between the different techniques will be assessed considering the known horizontal extent of the MAXDOAS observations, the characteristics of the emission sources around Cabauw and relevant meteorological parameters such as wind speed and direction. The established relationship between retrieved vertical profiles and surface concentration measurements will also be investigated in the context of the needs for satellite validation in support of air quality studies.

For tropospheric O₃, exploratory work on retrieval methodologies will be performed in order to better evaluate the information content of MAXDOAS as a new technique for routinely monitoring this species.

Objective 3

to investigate the horizontal representativeness of MAXDOAS measuring systems in view of their use for the validation of satellite tropospheric measurements featuring ground pixel sizes in the range of 25-50 km².

In order to meet this objective, 17 2D-MAXDOAS instruments with azimuthal scan capability will be operated during the campaign. O₄ measurements will be used to determine the azimuth-dependent horizontal extent of the MAXDOAS observations. In addition, the horizontal distribution of the trace gas column and concentrations will be assessed through comparison with mobile-DOAS and bicycle-based NO₂-sonde measurements regularly performed around Cabauw during the most intensive parts of the campaign. High resolution air quality model data will also be used in support of this study.

2 Description of the CESAR site

The Cabauw Experimental Site for Atmospheric Research (CESAR; 51.971°N, 4.927° E; 0.7m below sea level) is located in an extended and flat polder landscape in the direct proximity (<40 km) from the 4 largest cities of the Netherlands (see Figure 1).



Figure 1: Location of the Cabauw/CESAR site on a map of The Netherlands. Cabauw is a background site surrounded by 4 main Dutch cities: Utrecht, Amsterdam, The Hague and Rotterdam.

This site, which has been used for the CINDI-I campaign (see Piters et al., 2012), is chosen because of its unobstructed view close to the horizon, its large day-to-day variability in tropospheric nitrogen dioxide and aerosols enabling the sampling of a wide range of pollution conditions, the absence of local pollution sources, the 213 m research tower as depicted in Figure 4, from which the planetary boundary layer can be sampled at various altitudes, and the excellent local support. Although being a rural site, with only a few pollution sources nearby, the wider vicinity of Cabauw is densely populated, with the city of Utrecht and a dense highway grid within 25 km, so that the site experiences recurring pollution events such as from the daily morning and afternoon rush hours.

In addition, Cabauw is influenced by the transport of air pollution from emission sources further away. The mean NO_2 surface concentration in the Netherlands, as estimated from land use models, are represented in Figure 2. Northerly winds generally carry relatively clean air from the sea, but winds from any other direction are likely to result in the sampling of polluted air. For winds from the west to south-west, Cabauw is downwind of Rotterdam (40 km), Europe's largest harbour and location of petrochemical plants, and of the UK. Inflow from the south to south-east carries pollution from the southern parts of the Netherlands, Belgium, and the industrialized and densely populated German Ruhr area (140 to 190 km).

For more information, visit the CESAR Observatory website: www.cesar-observatory.nl. The website includes an overview of active instrumentation:

<http://www.cesar-observatory.nl/index.php?pageID=2000>

and access to (near real time) quicklooks of data:

<http://www.cesar-observatory.nl/index.php?pageID=9000>.

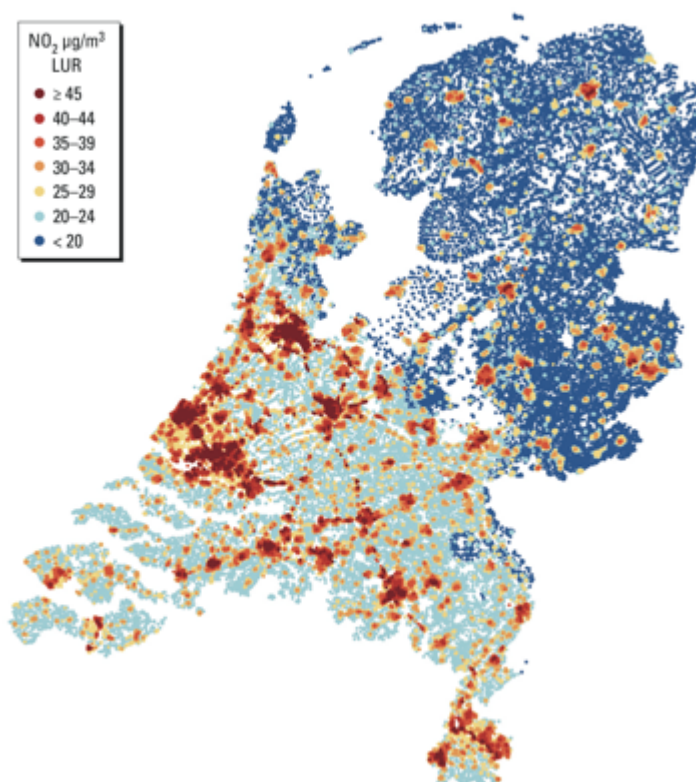


Figure 2: Distribution of the estimated mean NO_2 concentrations in the Netherlands for the year 2001, based on land use regression models (Fisher et al., 2015).

3 Participating Instruments

3.1 Static MAXDOAS and zenith-sky DOAS

Static MAXDOAS and zenith-sky DOAS (ZS-DOAS) systems will be intercompared as part of the semi-blind intercomparison exercise (see section 5.2.3). Table 1 presents an overview of the different systems which will all be installed on the Remote Sensing Site (RSS). The complete technical specifications of each instrument can be found in Appendix A of the present document.

Table 1: List of MAXDOAS (1D and 2D) and ZS-DOAS spectrometers participating in the semi-blind intercomparison exercise. Columns denote: Institute, instrument type, instrument number, azimuthal scan/direct-sun capability, field of view, spectral range and resolution, coupling between telescope and spectrometer (F: multimode fibre, D: direct coupling), type of detector, detector temperature, power consumption. Instruments have been assigned a number for the campaign (third column).

Institute	Instrument	Nr	Az./DS Cap.	FOV (°)	Spectral Range (nm)	Resol. (nm)	Light Coupl.	Det. type	T (°C)	Power (W)
AIOFM	2D-MAXDOAS	CINDI-2.01	y/n	0.2	290-380	0.35	F (10 m)	CCD	-30	300 (220 V)
AMOIAP/IAPh	2-port DOAS	CINDI-2.02	n/n	0.3	420-490	0.5	F	CCD	-40	1000
AUTH	PHAETHON	CINDI-2.03	y/y	1	297-452	0.34-0.42	F (10 m)	CCD	5	50 (100-240V)
BIRA-IASB	2D-MAXDOAS	CINDI-2.04	y/y	<1	300-400	0.6	F (10m)	CCD	-50	<1000 (220 V)
					400-560	1.0		CCD	-50	
BLS	Catadioptric telescope-MARSB	CINDI-2.05	n/n	0.2-1	300-500 (80 nm width)	0.4	D	CCD	-40	300 (220 V)
BOKU	2D-MAXDOAS	CINDI-2.06	y/n	1	Approx. 406-579	0.85	F (25 m)	CCD	-30	500-1000 (220 V)
CAMS	Mini-DOAS Hoffmann UV+Vis	CINDI-2.07	n/n	0.8	292-447	0.6-0.8	D	LinArr		200 (220 V)
		CINDI-2.08	n/n	0.8	399-712	0.6-0.8	D	LinArr		200 (220 V)
CHIBA-U	CHIBA-U/MAX-DOAS	CINDI-2.09	n/n	<1	310-515	0.4	F (10 m)	CCD	40	<500 (220 V)
CSIC	MAXDOAS	CINDI-2.10	n/n	1	300-500	0.5	F (10 m)	CCD	20-25	550 (220 V)
CU-Boulder	2D-MAXDOAS	CINDI-2.11	y/y	0.7	327-470	0.7	F (25 m)	CCD	-30	380-785 (220 V)
					432-678	1.2		CCD	-30	
	1D-MAXDOAS	CINDI-2.12	n/n	0.7	300-466	0.77	F (25 m)	CCD	-30	400-800 (220 V)
					379-493	0.5		CCD	0	



										V)
DLR+USTC	2D-EnviMeS (X2)	CINDI-2.13	y/n	0.4	300-460	0.6	F (10 m)	CCD	20	<120 (220 V)
		CINDI-2.14			450-600	0.6		CCD	20	
DWD	MAXDOAS	CINDI-2.15	y/n	<1	307-436	0.6/0.7	F	CCD	-7	450 (220 V)
IISER	Mini-DOAS Hoffmann UV	CINDI-2.16	n/n	0.7	317-466	1.0	D	CCD	<0 (if room t is ~20)	<100 (220V)
INTA	RASAS-III MAXDOAS	CINDI-2.17	y/n	1	325-445 or 400-550	0.55	F (8 m)	CCD	~17 if room t° is 22-23	2350-3450 (220 V)
IUP-Bremen	2D-MAXDOAS	CINDI-2.18	y/n	1	305-390	0.5	F (22m)	CCD	-35	500-1000 (220 V)
					406-579	0.85		CCD	-30	
IUP-Heidelberg	2D-EnviMeS	CINDI-2.19	y/y	<0.5	296-459	0.6	F (10 m)	CCD	0-40	20-120 (220 V)
					439-583	0.5		CCD	0-40	
	1D compact MAXDOAS*	CINDI-2.20	n/n	0.3	295-450	0.53	D	CCD	10-20	30 (12 V)
					430-565	0.74		CCD	10-20	
KNMI	Mini-DOAS Hoffmann UV**+Vis	CINDI-2.21	n/n	0.45	290-433	0.6	n/a	LinArr		5 (220 V)
		CESAR-2.22	n/n	0.4	400-600	0.5	n/a	LinArr		5 (220 V)
	PANDORA***	CINDI-2.23	y/y	1.5-2	290-530	0.6	F (10 m)	CCD	+20	220 (220 V)
LATMOS	SAOZ	CINDI-2.24	n/n	10	270-640	1.3	D	LinArr	n/a	500 (220 V)
	Mini-SAOZ	CINDI-2.25	n/n	8	270-820	0.7	F (10m)	CCD	18-20 AirCo room	300 (220 V)
LuftBlick	PANDORA-2S (x2)	CINDI-2.26	y/y	1.5 (sky) 2.8 (sun)	280-540	0.6	F (10m)	CCD	15	220 (220 V)
		CINDI-2.27			400-900	1.1		CCD		
MPIC	TubeMAXDOAS	CINDI-2.28	n/n	1	316-474	0.6	F (5m)	CCD	10	100 (220 V)
NIWA	EnviMeS	CINDI-2.29	n/n	<0.5	305-457	0.7	F (10m)	CCD	20	120 (220 V)
					410-550	0.7		CCD	20	
	ACTON275 MAXDOAS	CINDI-2.30	n/n	0.5	290-363	0.6	F (12m)	CCD	-20	100 (220 V)
					400-460	0.6		CCD	-20	
NASA	PANDORA	CINDI-	y/y	1.5	285-530	0.6	F	CCD	+20	220

	(x2)	2.31 CINDI- 2.32					(10 m)			(220 V)
NUST	Mini-DOAS	CINDI- 2.33	n/n	1.2	320-465	0.7	D	CCD		400 (220V)
TU-Delft	Mini-DOAS Hoffmann	CINDI- 2.34	n/n	0.4	300-515	0.67	n/a	LinArr		5 (220 V)
U. Munich	EnviMeS	CINDI- 2.35	y/n	0.4	300-460	0.6	F (10m)	CCD	20	<120 (220 V)
					450-600	0.6		CCD	20	
U. Toronto	PEARL-GBS	CINDI- 2.36	y/y	0.62	300-500	0.4-0.5	F (6 m)	CCD	-70	2200 (120V)

* Will not participate to the semi-blind intercomparison and will be installed at the tower.

** Permanently operated by KNMI at the tower.

*** Permanently operated by KNMI at the wind profiler cabin.

3.2 Static Imaging-DOAS

Table 2 presents an overview of the Imaging-DOAS systems which will be installed on the Remote Sensing Site (RSS). The complete technical specifications of each instrument can be found in Appendix B of the present document.

Table 2: List of participating Imaging-DOAS spectrometers. Columns denote: Institute, instrument name, azimuthal scan/direct-sun capability, field of view, spectral range and resolution, coupling between telescope and spectrometer (F: multimode fibre, D: direct coupling), type of detector, detector temperature, power consumption.

Institute	Instrument	Nr	Az./DS Cap.	FOV (°)	Spectral Range (nm)	Resol. (nm)	Light Coupl.	Det. type	T (°C)	Power (W)
IUP- Bremen	Imaging-DOAS	CINDI- 2.37	y/n	50 (vert.) 1.2 (hori.)	To be decided	~0.5	F (15 m)	CCD	-30	350-700 (220 V)
VTT-FMI	Imaging spectrometer	CINDI- 2.38	y/y	7	UV, Vis, Nir	TBD	D	CCD, CMOS, InGaAs	n/a	100 W 230 V

3.3 Long-Path DOAS (LP-DOAS)

[Instrument number CINDI-2.39]

A LP-DOAS instrument will be operated by the University of Heidelberg during the campaign. The main purpose of these measurements is to provide 'true' surface concentrations of the CINDI-2 target trace gases averaged over a representative light path. The instrument will be located at ~3.8 km South-East of the tower and will point towards four retro-reflectors installed at different altitude levels on the CESAR tower (see **Figure 3** and Figure 4). This configuration will allow to derive average concentrations at several altitudes between the surface and the top of the tower (213 m).



Figure 3: Location of the LP-DOAS system (Cabauwsekade 95, 3411EG Lopik) and view from LP-DOAS position to the tower.

The wavelength ranges used by the LP-DOAS system is: 290-370 nm, 390-470 nm, and 600-680 nm. In these spectral windows, the following trace gases can in principle be monitored: NO₂, HCHO, HONO, SO₂, O₃, NO₃, H₂O, BrO, IO, CHOCHO and O₄.

The technical requirements for installing the instrument are the following:

- 200 m of power cable (220 V);
- Power should be stable, UPS is optional
- Power meter for electricity bill
- Mobile internet
- Air-conditioned container for instrument housing

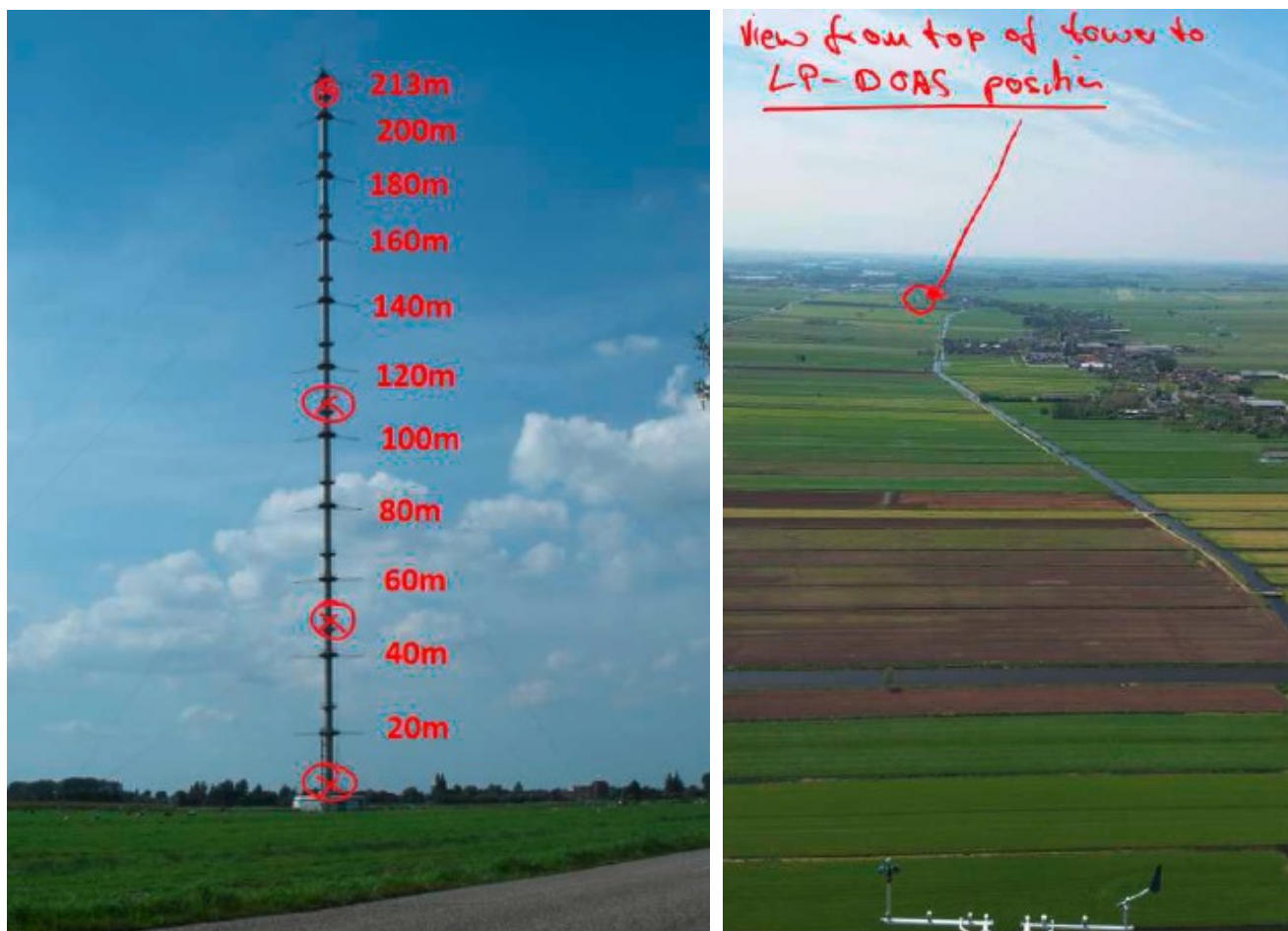


Figure 4: Position of the retro-reflectors on the tower (left) and view from top of the tower to LP-DOAS position (right).

3.4 Cavity-Enhanced DOAS (CE-DOAS)

[Instrument number CINDI-2.40]

Participation not yet confirmed. Description will be included when confirmed.

3.5 In-situ analysers

3.5.1 Cavity Attenuated Phase Shift NO₂ monitor (CAPS)

[Instrument number CINDI-2.41]

The AS32M analyzer that will be operated by BIRA-IASB at the tower, is a commercial instrument from Environnement SA. It measures the volume mixing ratio of NO₂ based on its absorption properties at 450 nm, following the Cavity Attenuated Phase Shift Spectroscopy (CAPS) technique (Kebabian et al., 2005). The measurement range is 0-1 ppm with a detection limit (2s) of 0.1 ppb. The system fits in a 3 unit 19 inch rack (591 mm x 483 mm x 133 mm) and weights 12.5 kg. The power consumption reaches 225 W at boot-up.

3.5.2 NO₂ analysers

[Instrument number CINDI-2.42]

NO₂ is sampled three times per hour during 5 minutes from the sample line with inlets at 20, 60, 120 and 200 m altitude at the tower (also measuring CO₂, CH₄, N₂O, CO). Ozone is also measured using this

configuration. NO, NO₂ are measured with a Teledyne API, model M200E with Photolytic converter and simultaneously with a molybdenum system. Ozone is measured with a Thermo 49i. The NO₂ observations are a collaboration between ECN (Energy research Centre of the Netherlands) and RIVM (Dutch National Institute for Public Health and the Environment).

3.5.3 NO₂ sonde

[Instrument number CINDI-2.43]

NO₂ sondes are experimental devices developed at KNMI. The measurement is based on the chemiluminescent reaction of NO₂ in an aqueous luminol solution, which is optimised to be specific to NO₂ (Sluis et al., 2010). The sonde is attached to a small meteorological balloon. It has a vertical resolution of 5m and a measurement range between 1 and 100 ppbv. The instrument weighs 0.7 kg.

During the CINDI-2 campaign, one launch per day during the semi-blind intercomparison period is planned. Launch times are to be decided.

3.5.4 O₃ sonde

[Instrument number N/A]

ECC ozone sondes are routinely launched from De Bilt (about 20 km distance from Cabauw) once per week. Additional soundings are possible on request. The ECC ozone sensor (Komhyr, 1969; Komhyr and Harris, 1971) is an electrochemical cell consisting of two half cells, made of Teflon, which serve as cathode and anode chamber, respectively. Both half cells contain a platinum mesh serving as electrodes. They are immersed in KI solution of different concentrations. The two chambers are linked together by an ion bridge in order to provide an ion pathway and to prevent mixing of the cathode and anode electrolytes. The ECC does not require an external electrical potential. The ECC gets its driving electromotive force from the difference in the concentration of the KI solution in the cathode and anode chamber. The electrical current is directly related to the uptake rate of ozone. The sonde is flown in a polystyrene protective box (source: Harris et al., 1998).

3.5.5 In-situ O₃ monitor

[Instrument number N/A]

An in-situ ozone analyser is sampling from multiple altitudes in the tower (see Sec. 3.5.3). In addition, an ozone analyser from the Dutch air quality monitoring network is operational (<http://www.lml.rivm.nl/histo/index.php?stat=NL10644>). The instrument is a Thermo 49i.

3.5.6 HCHO analyser (Hantzsch)

[Instrument number CINDI-2.44]

In-situ HCHO observations could not be confirmed. Instrument number and description were already included and kept for now.

{HCHO in-situ measurements will be performed at the tower. They are based on the continuous Hantzsch technique, a sensitive wet chemical fluorimetric detection of CH₂O, which requires the transfer of formaldehyde from the gas phase into the liquid phase. This is accomplished quantitatively by stripping the CH₂O from the air in a stripping coil with a well defined exchange time between gas and liquid phase. The technique is based on the “Hantzsch” reaction (Nash, 1953) and employs the fluorescence of 3,5-diacetyl-1,4-dihydrolutidine (DDL) at 510 nm, which is produced from the reaction of aqueous CH₂O with a solution containing acetylacetone and ammonia. Detection limits are about 50 ppt and time resolution is 90 sec. More details can be found in Junkermann and Burger (2006).}

3.5.7 Nephelometer

[Instrument number CESAR.xx]



TNO continuously performs aerosol observations in the basement of the tower where air is sampled via a common inlet at 60 m.

The inlet system consists of four parts: (a) PM10 size selective inlets (4 PM10 heads), (b) a Nafion drying system that dries aerosol to or below 40% RH, (c) a 60-m stainless steel pipe, and (d) a manifold that splits the flow to the suite of instruments. The manifold and the in-situ instruments are all located at the basement of the tower. The instruments sample their flow from the manifold using separate pumps to adjust the required flow for proper operation of the instruments.

The total flow sustained in the 60-m inlet pipe is 60 lpm, for optimal operation of the PM10 inlets. Whenever an instrument is added or removed, the flows to the other instruments need to be checked and adjusted when needed. See also (Zieger, ACP, 2011).

An integrating nephelometer (DryNeph, TSI Inc., Model 3563) is used for the (back-) scattering coefficient.

To increase comparability between observations in (global) aerosol networks (WMO/GAW guidelines, 2003) prescribe that sampled aerosol is dried to relative humidities below 40%.

Note that aerosol optical properties, most notably the scattering coefficient, strongly increase with increasing relative humidity; thus drying frustrates comparison to aerosol optical properties measured at ambient conditions, e.g. remotely sensed aerosol properties.

3.5.8 MAAP

[Instrument number CESAR.xx]

TNO continuously performs aerosol observations in the basement of the tower where air is sampled via a common inlet at 60 m. A multi-angle absorption photometer (MAAP, Thermo Scientific Inc., Model 5012) is used to quantify the aerosol absorption coefficient. See also remarks under Sec.3.5.7

3.5.9 SMPS

[Instrument number CESAR.xx]

TNO continuously performs aerosol observations in the basement of the tower where air is sampled via a common inlet at 60 m. See also remarks under Sec.3.5.7

The SMPS (a modified TSI Inc., Model 3034) consists of a bipolar particle charger, a differential mobility analyzer (DMA) and a condensation particle counter (CPC). Particles are charged before they are classified in the DMA according to their electrical mobility diameter and are counted by the CPC. A correction for multiple charged particles is applied. Number size distributions in the diameter range between approximately 10 and 520 nm are recorded with a time resolution of 5 min.

3.6 Mobile measurement systems

Mobile measurements will be used to characterise the spatial variability of the measured trace gases around the CESAR site. These measurements will be performed using compact DOAS

systems operated in cars, as well as using NO₂ sondes installed on board of bicycles operated by KNMI. Figure 5 shows the routes that can be accessed in the neighbourhood of the site. A full circle around Cabauw starting from Vianen and going through Gouda, Rotterdam, Dordrecht and back to Vianen corresponds to approximately 120 km in length.

Table 3 presents an overview of the mobile-DOAS systems which will be deployed during CINDI-2. The complete technical specifications of these instruments can be found in Appendix C of the present document.



Figure 5: Map of highways and local roads surrounding Cabauw.

Table 3: List of participating Mobile-DOAS spectrometers. Columns denote: Institute, instrument name, field of view, spectral range and resolution, coupling between telescope and spectrometer (F: multimode fibre, D: direct coupling), type of detector, detector temperature, power consumption.

Institute	instrument	Nr	FOV (°)	Spectral range (nm)	Resol. (nm)	Light coupl.	Det. type	T (°C)	Power
BIRA-IASB	Aeromobil	CINDI-2.45	2.5	270-500	1.15	F	LinArr	Ambient	
MPIC	Car-DOAS	CINDI-2.46	1.2	299-454	0.6 - 0.9	F	CCD	+5	200 W
Uni. Galati	Car-DOAS	CINDI-2.47	1.2	280-550	0.7	F	CCD	Ambient	
IUP-Bremen*	IUP-Truck DOAS*	CINDI-2.48	1	286-419	0.55	F	CCD	-35	10kVA, 32 A (truck)
				413-524	0.65		CCD	-35	

*Will be used as a moveable static instrument

3.7 Sun-photometer, all-sky imager and aerosol Lidar systems

3.7.1 Sun photometer

[Instrument number CESAR.xx]

At Cabauw a Cimel sunphotometer is installed that is part of AERONET:

http://aeronet.gsfc.nasa.gov/new_web/photo_db/Cabauw.html

and following the AERONET protocols the data is automatically uploaded to the data center:

[http://aeronet.gsfc.nasa.gov/cgi-](http://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_opera_v2_new?site=Cabauw&nachal=0&year=24&aero_water=0&level=1)

[bin/type_one_station_opera_v2_new?site=Cabauw&nachal=0&year=24&aero_water=0&level=1.](http://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_opera_v2_new?site=Cabauw&nachal=0&year=24&aero_water=0&level=1)

3.7.2 All-sky imager

[Instrument number CESAR.xx]

The Total Sky Imager (TSI) operated by KNMI takes an image every minute of the sky in daytime projected on a hemispherical shaped mirror. The fractions of 'thin' and 'opaque' clouds are calculated by the TSI-processing based on the red-blue ratio of the pixels. TSI images are available at http://projects.knmi.nl/cloudnet/realtime/rt_img_tsi.html.

Additional cloud cover information is obtained from a Nubiscope. Near real time information is available from http://projects.knmi.nl/cloudnet/realtime/rt_img_nubi.html.

3.7.3 Raman LIDAR CAELI

[Instrument number CESAR.xx]

The CESAR Water Vapor, Aerosol and Cloud Lidar (CAELI, Apituley et al., 2009) is a high-performance, multi-wavelength Raman lidar, capable of providing round-the-clock measurements. The instrument is part of the European Aerosol Research Lidar Network (EARLINET), and provides 24 profiles of volume backscatter and extinction coefficients of aerosol particles, the depolarization ratio, and water-vapour-to-dry-air mixing ratio. A high-power Nd:YAG laser transmits pulses at 355, 532, and 1064 nm. Because a large telescope is essentially blind for lidar signals from close to the instrument, a second, small telescope is needed to cover the near range, in particular for measurements in the planetary boundary layer.

Quicklooks of the observations are made available in near-real time:

<http://projects.knmi.nl/earlinet/quicklookpages/lidar/Cabauw/images/?year=2016>

3.7.4 Ceilometer

[Instrument number CESAR.xx]

Diurnal profiling of aerosol layers and cloud layers is obtained from a Lufft CHM15k Nimbus ceilometer. Data is not yet provided on-line, but is planned to have that established before CINDI-2. An automated detection algorithm is implemented for boundary layer height detection.

3.7.5 RIVM mobile NO₂ LIDAR

[Instrument number CINDI-2.49]

The RIVM mobile lidar will take part in CINDI-2 configured to measure nitrogen dioxide with elevation scanning and operating from a mobile truck provided vertical profiles of nitrogen dioxide at moderate resolution (Volten et al., 2009) The lidar will not be located at the remote sensing site, but at the parking lot at the main entrance to the Cabauw site, or close to the tower. The lidar will be deployed at Cabauw during a selected number of days during the semi-blind intercomparison period.

4 Meteorological data

A complete set of meteorological parameters are routinely measured at the Cabauw site. This includes:

- Surface temperature and pressure,
- wind speed and direction,
- relative humidity,
- cloud cover.

Real time quicklooks of meteorological parameters obtained at various levels in the tower are available: <http://www.cesar-observatory.nl/index.php?pageID=9000>.

In addition weather forecast information will be available on a daily basis or at higher frequency. Tailored meteorological model output will be provided through a password protected website, e.g. <http://projects.knmi.nl/imau/ISPEX/>, login: HIRLAM, pwd: H@rmoni3. This website will be updated.

5 CAMS chemical forecast

Low resolution global analysis and forecast of the atmospheric chemical composition are available from the Copernicus Atmospheric Monitoring Service (CAMS). CAMS output will be provided for CINDI-2 by H. Eskes (KNMI). Dedicated scripts will be written to make the data for Cabauw (and surroundings) available. The delivered CAMS data fields also include LOTOS-EUROS simulations.

6 Regional air quality modelling

Output fields from regional and/or local air quality models might be available from Dutch colleagues. Further information still need to be collected.

In addition, IUP-Bremen (LAMOS group) is evaluating the possibility to perform spatially high resolved air quality simulations, using the WRF-Chem model together with TNO-MACC3 (7 km resolution) and RIVM ("emissieregistratie.nl", 1km resolution) emissions.

7 Satellite data

Daily overpass NO₂ and HCHO measurements from the OMI and GOME-2 B instruments will be made available for comparison and further analysis of the campaign results. **Tables of the forecasted overpass coordinates are to be provided by KNMI. Details to be completed.**

8 Logistics

8.1 Site Layout

Several areas can be distinguished on the Cabauw site:

- The main facility is the tower with the main building.
- The Remote sensing site
- The Wind profiler site
- The energy balance field
- The North side of the station with air quality observations
- Parking lot near the main gate

Many instruments are installed permanently. The CINDI-2 instruments will be distributed over the site.

Almost all MAXDOAS systems will be placed on the remote sensing site. To accommodate this, temporary containers or units will be rented. The layout of the remote sensing site is shown in Fig.6a and 6b.

No parking is allowed at the Remote Sensing Site, other than for delivery and pick up of equipment and supplies. Parking will be provided near the main gate, either on the permanent parking lot, and/or a temporary parking.

More information about local logistics can be found on the cindi-2 website : <http://projects.knmi.nl/cindi-2>

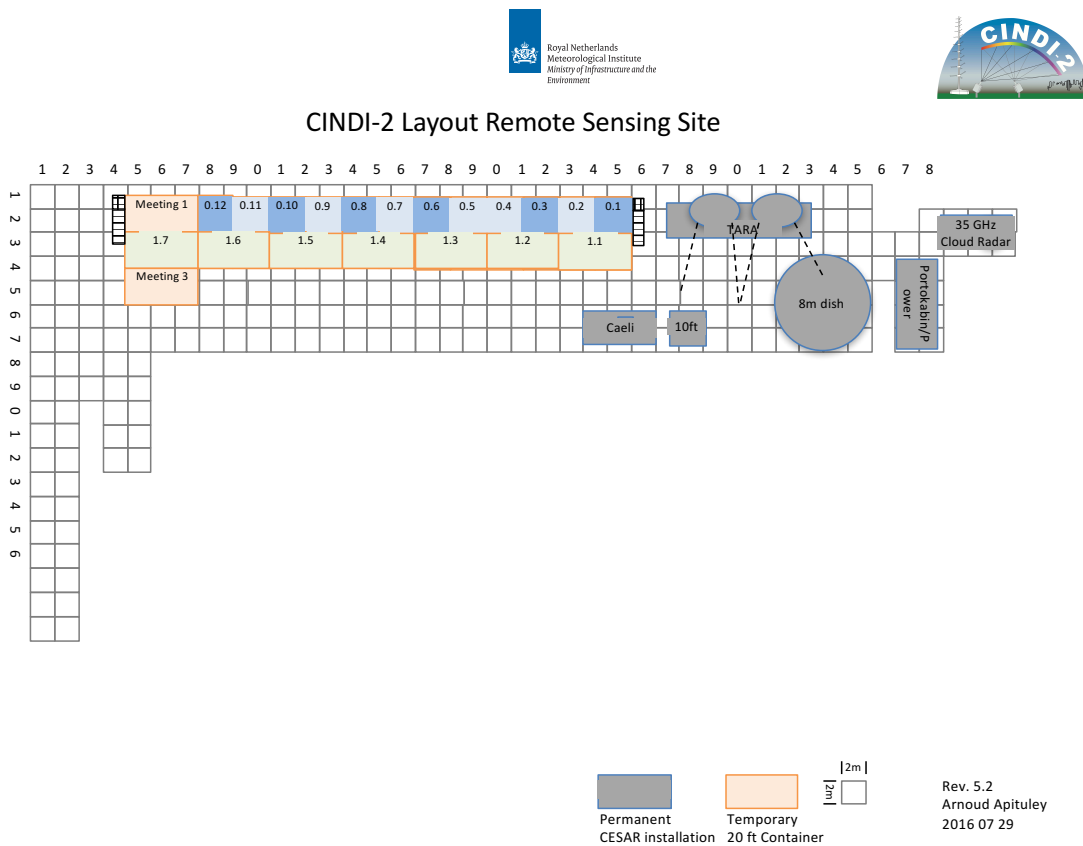


Figure 6a: Site layout of the Remote Sensing Site. Squares are $2 \times 2 \text{ m}^2$. The general viewing direction of the non-scanning instruments will be to the top of the figure.

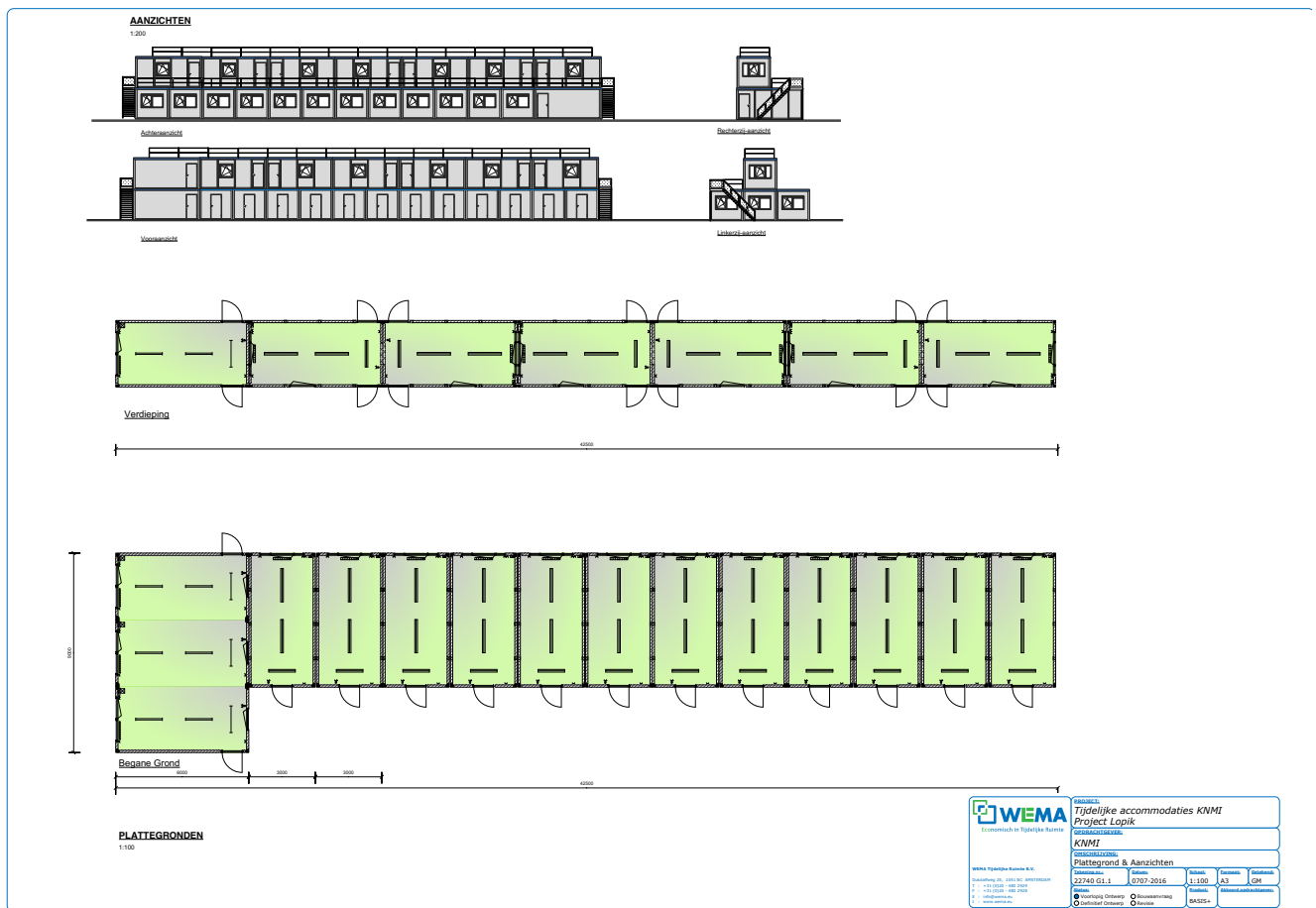


Figure 6b: Container layout on the Remote Sensing Site.

Ground floor

For CINDI-2 a series of 12 containers (3m x 6m each) will be placed side by side on the remote sensing site as indicated in Fig.6a. Adjacent to those, three more units (3m x 6m each) will be linked together to form a meeting room.

Access to the roof of the ground level units is via fixed staircases on either side of the row. A railing will be put around the roof for safety (required). The railing is about 1 m high and consists of 6 cm diameter aluminium tubes. The railing will be kept in place by concrete slabs.

The roof will be partially covered by plate material to walk on. Instruments will be placed directly on the roof.

All units housing instruments will be air-conditioned. And two tables and four chairs are provided for each unit (also if no instruments are placed).

For each unit used for instruments, instrument cables and fibers will be fed through the window facing the observation direction. A wooden panel will replace the window. For most units, a second window will provide daylight.

Units on the ground floor that are not used for instruments will not be air-conditioned and can be used for storage and/or office space.

Wired network with fixed ip-addresses will be provided for computers controlling instruments. Wifi (dynamic addresses) will be made available for general use, e.g. email, browsing etc.

Top level



On top of the units on the ground floor, 7 units (3m x 6m each) will be placed over the length of the bottom layer.

Access to the roof of the top level units is first via a fixed staircase on either side of the row on the ground floor and next via a ladder to the top level (one ladder for each unit). A railing will be put around the roof for safety (required). The railing is about 1 m high and consists of aluminium tubes of about 5 cm diameter. The railing will be kept in place by concrete slabs.

The roof will be partially covered by plate material to walk on. Instruments will be placed directly on the roof.

All units housing instruments will be air-conditioned. And two tables and four chairs are provided for each unit.

For each unit on the top level, instrument cables and fibers will be fed through the window facing the observation direction. A wooden panel will replace the window. For most units, a second window will provide daylight.

Instrument placement

The instruments with fixed azimuth will be placed on the roof and (if needed) in front of the units on the ground floor. The azimuthal scanning instruments and imaging instruments will be placed on the roof of the top level units.

During installation and break-up, lifting material will be made available if needed.

Instruments can be placed directly on either on the ground, on the roof, or attached to the railing, depending on the assigned location and placement needs of the instrument.

8.2 Instrument location assignment

The instrument location assignment is given in the tables below. Note that the units are numbered right to left, according to the drawings in Fig.6.

RS-site ground level	Unit#	Institute	Instr.Number	Instrument
	0.1			Office/storage use
1	0.2	AMOIAP/IA Ph	CINDI-2.02	2-port DOAS
2		BLS	CINDI-2.05	Catadioptric telescope-MARSB Airco
	0.3			Office/storage use
3	0.4	CAMS	CINDI-2.07	Mini-DOAS Hoffmann UV+Vis (#1)
4		CAMS	CINDI-2.08	Mini-DOAS Hoffmann UV+Vis (#1)
5		CHIBA-U	CINDI-2.09	CHIBA-U/MAX-DOAS Airco
6	0.5	IISER	CINDI-2.16	Mini-DOAS Hoffmann UV (#2)
7		KNMI	CINDI-2.21	Mini-DOAS n/n Hoffmann-UV+Vis (#3)
8		NUST	CINDI-2.33	Mini-DOAS
9		TU-Delft	CINDI-2.34	Mini-DOAS n/n Hoffmann-UV+Vis (#4) Airco
	0.6			Office/storage use
10	0.7	CSIC	CINDI-2.10	MAXDOAS
11		CU-Boulder	CINDI-2.12	1D-MAXDOAS Airco
	0.8			Office/storage use
12	0.9	LATMOS	CINDI-2.24	SAOZ
13		LATMOS	CINDI-2.25	Mini-SAOZ
14		MPIC	CINDI-2.28	TubeMAXDOAS Airco
	0.10			Office/storage use
15	0.11	NIWA	CINDI-2.29	EnviMeS (#3)
16		NIWA	CINDI-2.30	ACTON275 MAXDOAS



	Airco
0.12	Office/storage use

RS-site top level	Unit#	Institute	Instr.Number	Instrument
	1	1.1 AIOFM	CINDI-2.01	2D-MAXDOAS
	2	AUTH	CINDI-2.03	PHAETHON
	3	INTA	CINDI-2.17	RASAS-III MAXDOAS Airco
	4	1.2 BIRA-IASB	CINDI-2.04	2D-MAXDOAS
	5	IUP-Heidelberg	CINDI-2.19	2D-EnviMeS (#2) Airco
	6	1.3 DLR+USTC	CINDI-2.13	2D-EnviMeS (#1)
	7	DLR+USTC	CINDI-2.14	2D-EnviMeS (#2) Airco
	8	1.4 CU-Boulder	CINDI-2.11	2D-MAXDOAS
	9	DWD	CINDI-2.15	MAXDOAS Airco
	10	1.5 IUP-Bremen	CINDI-2.18	2D-MAXDOAS
	11	IUP-Bremen	CINDI-2.37	Imaging DOAS
	12	BOKU	CINDI-2.06	2D-MAXDOAS Airco
	13	1.6 Luftblick	CINDI-2.26	PANDORA-2S (#2)
	14	Luftblick	CINDI-2.27	PANDORA-2S (#2)
	15	NASA	CINDI-2.31	PANDORA (#3)
	16	NASA	CINDI-2.32	PANDORA (#3) Airco
	17	1.7 U. Munich	CINDI-2.35	2D-EnviMeS (#4)
	18	U. Toronto	CINDI-2.36	PEARL-GBS
	19	VTT-FMI	CINDI-2.38	Imaging Spectrometer Airco

Tower	Unit#	Institute	Instr.Number	Instrument	
	1	20 m level	KNMI	CESAR.22	Mini-DOAS n/n Hoffmann-UV+Vis (#3)
	2	200 m level	CINDI-2.20	1D compact MAXDOAS	
	3	ground floor	IUP-Bremen	CINDI-2.48	IUP-Truck DOAS
	4	~10 m	IUP-Heidelberg	CINDI-2.39.1	retroreflector
	5	~50 m	IUP-Heidelberg	CINDI-2.39.2	retroreflector
	6	~110 m	IUP-Heidelberg	CINDI-2.39.3	retroreflector
	7	~213 m	IUP-Heidelberg	CINDI-2.39.4	retroreflector
	8	workshop/lab	KNMI	CINDI-2.43	NO2 sonde preparation and ground station
	9	unk	KIT	CINDI-2.44	Hantzsch HCHO analyser
	10	unk	IUP-Heidelberg	CINDI-2.40	CE-DOAS
	11	unk	BIRA-IASB	CINDI-2.41	CAPS
	12	basement	RIVM/ECN	CINDI-2.42	NO2 blue light
	13	workshop/lab	TNO	ACTRIS-JRA1.1	CAPS
	14	workshop/lab	TNO	ACTRIS-JRA1.2	SP2
	15	workshop/lab	TNO	ACTRIS-JRA1.3	MAAP
	16	workshop/lab	TNO	ACTRIS-JRA1.4	MAAP
	17	workshop/lab	TNO	ACTRIS-JRA1.5	Aethalometer Dual Spot
	18	workshop/lab	TNO	ACTRIS-JRA1.6	Aethalometer AE31
	19	basement	TNO	ACTRIS-JRA1.7	EC/OC samplers

Wind Profiler Site	Institute	Instr.Number	Instrument
1	KNMI	CESAR.23	PANDORA (#1)

Main parking lot	Institute	PI name	Instr.Number	
1	RIVM		CINDI-2.49	Mobile DIAL
2	BIRA-IASB		CINDI-2.45	Aeromobil

3	MPIC	CINDI-2.46	Car-DOAS
4	Uni. Galati	CINDI-2.47	Car-DOAS

Cabauwsekade 95, Lopik	Institute	PI name	Instr.Number
1	IUP-Heidelberg		CINDI-2.39 LP-DOAS

8.3 FTP Server

An FTP server will be available for upload and exchange of campaign data.

A directory will be assigned to each participant (group), with read and write access for that participant only. Participants will not have read or write access to directories from other groups.

A cindi-2 directory will be assigned to the referee, with write access for all participants, but without read access for the participants. In this way the (daily) campaign results can be submitted to the referee, while only the referee is able to see all the results.

Furthermore, a cindi-2-share directory will be available for exchange of commonly accessible material. Ahead of the campaign, access to this common directory is possible using the following:

```
sftp cindi@bbc.knmi.nl
```

```
pwd: C1n81q
```

```
directory: /bbcddata/FTP/PROJECT/CINDI/cindi-2-share
```

Note that the login credentials and directories will change prior to the campaign. You will be notified when that happens.

9 Additional ACTRIS-2 activities

During the CINDI-2 campaign two additional activities from ACTRIS-2 (www.actris.eu) will take place. These are experiments for aerosol absorption measurements (ACTRIS-2 JRA1) and aerosol flux measurements (ACTRIS-2 JRA2). Additional instruments will be installed, mainly in the tower and will therefore not interfere with activities at the remote sensing site. The benefit from the additional aerosol measurements for CINDI-2 is that more background information is collected about aerosol optical properties, in particular aerosol optical absorption in the boundary layer (in-situ). For the aerosol flux measurements, detailed observations will be made for the vertical distribution and the dynamics of the aerosol (vertical) distribution.

10 Campaign planning

10.1 Schedule

The overall schedule of the main campaign activities is represented in Figure 7. The site will be open for installation of the instruments on 25 August 2016, i.e. one week before the formal start of the campaign which is planned for 1st September 2016. From this time on, instruments should be ready for data acquisition. We plan for one full week of warm-up during which hardware and software adjustments as well as various calibrations will be performed.

At the occasion of a Press Event planned to take place on 12 September, the semi-blind intercomparison exercise will be kicked off for 2 weeks of intensive coordinated measurements (see details in section 11). Upon necessity (e.g. due to persisting bad weather conditions during weeks 37 and 38) an optional 1-week extension of the semi-blind exercise is planned in week 39 (26 Sep – 2 Oct). After that period the Cabauw site will remain open for one additional week

during which interested groups might conduct specific experiments not performed during the semi-blind exercise.

August 2016

Mo	Tu	We	Th	Fr	Sa	Su	Wk
15	16	17	18	19	20	21	33
22	23	24	25 Site opening	26	27	28	34
				Installation Phase			

September 2016

Mo	Tu	We	Th	Fr	Sa	Su	Wk
29	30	31	1	2	3	4	35
Installation Phase			Start	Warm-up Phase			
5	6	7	8	9	10	11	36
Warm-up Phase							
12	13	14	15	16	17	18	37
Semi-blind intercomparison (Intensive phase)							
19	20	21	22	23	24	25	38
Semi-blind intercomparison (Intensive phase)							
26	27	28	29	30	1	2	39
Backup semi-blind/ extra measurements							

Opening event →

October 2016

Mo	Tu	We	Th	Fr	Sa	Su	Wk
3	4	5	6	7	8	9	40
Extra measurements							
10	11	12	13	14	15	16	41

Figure 7: Schedule of the CINDI-2 campaign.

10.2 Main campaign phases

As already indicated, the campaign will include 4 main successive phases: installation, warm-up, semi-blind intercomparison and extra measurements.

10.2.1 Installation

The installation of the instruments is planned to take place between 25 August and 1st September 2016. During this period, no coordinated activity will take place. Each measurement team will bring and install their instrumentation on-site, perform all necessary adjustments and tests and interact with the local organisation team to fix possible issues and be ready to start the campaign in optimal conditions. Upon feasibility, some of the on-site calibration activities requested from the teams participating in the semi-blind intercomparison might already be started (see details in section **Error! Reference source not found.**).

10.2.2 Warm-up phase

In the first 11 days of the formal campaign, starting on 1st September 2016, it is anticipated that most measurement systems will be operational. This period will be used for intercomparison protocol rehearsal (including adjustments if necessary) and continued calibration activities.

Additional activities will also take place such as intercomparison of the various in-situ NO₂ and HCHO analysers, test flights of the NO₂ sonde, set-up of mobile systems and test of most adequate roads circuits, set-up of long-path and cavity-enhanced systems, preparation of all ancillary data, etc.

10.2.3 Semi-blind intercomparison

The semi-blind intercomparison of the MAXDOAS instruments will take place during two weeks from 12 to 25 September 2016. Details on the organisation of this exercise are given in the next section and in a separate Semi-blind Intercomparison Protocol document.

10.2.4 Backup week/ extra measurements

An additional (backup) week is reserved for a possible extension of the semi-blind intercomparison in case of major instrumental issues or persisting bad weather conditions during the formal 2-weeks period. If the original schedule is maintained, this extra-week and the following one (first week of October) will be used to explore more specifically additional science topics such as, e.g.

- Focused measurements of other gases (CHOCHO, HONO)
- Setup of specific experiments that could contribute to better interpretation of the remote-sensing measurements in combination with other measurement system available on site, etc.

11 The semi-blind intercomparison exercise

The aim of the CINDI-2 semi-blind intercomparison will be to characterise the differences between a large number of DOAS measurement systems and to contribute to the harmonisation of the measurement settings and retrieval methods for similar systems. As for precedent UV-Vis Intercalibration exercises (Roscoe et al. (1999), Vandaele et al. (2005) and Roscoe et al. (2010)) the adopted intercomparison protocol is semi-blind, meaning that exchange of information and discussions are promoted during the campaign, but without explicit identification of the participating data sets.

The groups and instruments registered for participation in the semi-blind intercomparison exercise are listed in Table 1. In total 39 instruments from 26 different organisations will be accommodated on the CESAR Remote Sensing Site. Among them, 19 will be two-dimensional MAXDOAS systems

allowing for scans in both elevation and azimuth. The comparison will also include 15 one-dimensional MAXDOAS systems and two zenith-sky DOAS systems of the SAOZ type.

Particular efforts will be devoted to optimise the co-location of the measurements (in terms of sampled air-masses) as well as their synchronisation in time. This should allow to reduce the influence of the natural variability on the comparison results, which was identified as a major limitation during the CINDI-1 campaign.

The formal intercomparison exercise will be coordinated by Karin Kreher (BK Scientific) assisted by Ermioni Dimitropoulou (BIRA-IASB/AUTH).

A complete description of the semi-blind intercomparison protocol is given in a separate document.

12 Campaign Data Protocol

All participants are requested to read and sign the CINDI-2 Data Protocol (See Annex E) as well as the EVDC Data Protocol (See Annex F). Note that for groups involved in the semi-blind intercomparison exercise, an additional data protocol has to be filled (see Semi-blind Intercomparison Protocol document).

Once ready, please send an electronic version of each signed protocol to Francois Hendrick (BIRA-IASB) at the address mentioned on the form.

13 List of participants

Table 4: List of participants.

	Name + First name	Affiliation	E-mail address	Mobile phone number	Period(s) of on-site presence + arrival of the instruments
1	Ang, Li	AIOFM	angli@aiofm.ac.cn	+ 86-13855196384	
2	Anguas, Mónica	CSIC	manguas@iqfr.csic.es		
3	Apituley, Arnoud	KNMI	apituley@knmi.nl	+31655457540	26 Aug. – 10. Sept.
4	Bais, Alkis	AUTH	abais@auth.gr	+30 6977558850	8-14 Sep
5	Benavent, Nuria	CSIC	nbenavent@iqfr.csic.es	+34 633473877	3-28 Sep
6	Bognar, Kristof	U. Toronto	kbognar@physics.utoronto.ca	+ 06-30-494-8464 (or + 1-416-566-6763)	31 Aug-30 Sep
7	Alexander Borovski	A.M. Obukhov Institute of Atmospheric Physics	alexander.n.borovski@gmail.com	+7 915 390 56 45	(01-05) – (25-30) Sep 2016
8	Bruchkovsky2010@yandex.by	BSU	bruchkovsky2010@yandex.by	+375293279807	
9	Cede, Alexander	LuftBlick	alexander.cede@luftblick.at	+43 681 84448717	
10	Chan, Ka Lok	LMU	lok.chan@physik.uni-muenchen.de	+49 089 2180 4386	
11	Chengxin, Zhang	USTC	zcx2011@mail.ustc.edu.cn		25 Aug-17Sep
12	Constantin, Daniel-Eduard	U. Galati	Daniel.Constantin@ugal.ro	+40726320942	~2weeks in Sept
13	Dix, Barbara	CU-Boulder	Barbara.Dix@colorado.edu		
14	Donner, Sebastian	MPIC	sebastian.donner@mpic.de		



15	Drosoglou, Theano	AUTH	tdroso@auth.gr	+30 6977483092	8-25 Sep
16	Fayt, Caroline	BIRA-IASB	Caroline.Fayt@aeronomie.be		
17	Finkenzeller, Henning	CU-Boulder	Henning.Finkenzeller@colorado.edu		
18	Friess, Udo	IUP-Heidelberg	udo.friess@iup.uni-heidelberg.de	+49-151-22278453	
19	García, David	BIRA-IASB	dgarcia@iqfr.csic.es	+34 666467907	3-28 Sep
20	Gielen, Cio	BIRA-IASB	Clio.Gielen@aeronomie.be		
21	Hao, Nan	DLR	nan.hao@dlr.de	+49-1745396998	5-8 Sep
22	Hendrick, François	BIRA-IASB	Francois.Hendrick@aeronomie.be	+32496500311	
23	Hermans, Christian	BIRA-IASB	Christian.Hermans@aeronomie.be		
24	Holla, Robert	DWD	Robert.Holla@dwd.de	+4917656219264	
25	Hoque, Syedul	CEReS/Chiba U.	shoque@chiba-u.jp	+81-80-1308-9083	TBD
26	Irie, Hitoshi	CEReS/Chiba U.	hitoshi.irie@chiba-u.jp	+81-90-1549-2635	TBD
27	Jin, Junli	CAMS/CMA	jinjunli@cams.cma.gov.cn	+86 13426397058	9~27 Sep (may change according to visa permission)
28	Johnston, Paul	NIWA	Paul.Johnston@niwa.co.nz	+64 27 608 6003	31 Aug-27 Sep (tentative)
29	Khayyam Butt, Junaid	NUST	jkb2ravian@gmail.com	+92-310-4320293	
30	Khokhar, Fahim	NUST	fahim.khokhar@iese.nust.edu.pk	+92-341-8422377	
31	Koenig, Theodore	CU-Boulder	Theodore.Koenig@colorado.edu		
32	Kreher, Karin	BKS	Karin.kreher@bkscientific.eu	+64210503363	~11-29 Sep
33	Lampel, Johannes	IUP-Heidelberg	Johannes.lampel@iup.uni-heidelberg.de		
34	Ma, Jianzhong	CAMS/CMA	mjz@camscma.cn	+86 13911511326	9~27 Sep (may change according to visa permission)
35	Meier, Andreas	IUP-Bremen	ameier@iup.physik.uni-bremen.de	+49 151 28207282	
36	Merlaud, Alexis	BIRA-IASB	Alexis.Merlaud@aeronomie.be	+32 486 963 937	
37	Mishra Abhishek Kumar	IISER Mohali	Abhishekkumar.mishra21@gmail.com	+91-7508082367	06-26 Sep
38	Mueller, Moritz	LuftBlick	moritz.mueller@luftblick.at	+43 677 61445168	
39	Navarro-Comas, Mónica	INTA	navarrocm@inta.es		TBD
40	Ostendorf, Mareike	IUP-Bremen	mareike.ostendorf@uni-bremen.de	+49 176 31642689	
41	Pazmino, Andrea	LATMOS	andrea.pazmino@latmos.ipsl.fr	+33 (0)664138643	12-26 Sep
42	Peters, Enno	IUP-Bremen	enno@iup.physik.uni-bremen.de	+49 171 6761981	
43	Pinardi, Gaia	BIRA-IASB	Gaia.Pinardi@aeronomie.be		
44	Pinharanda, Manuel	LATMOS	Manuel.Pinharanda@latmos.ipsl.fr	+33 (0)6 64 13 86 43	12-26 Sep
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					Sep-7 Oct
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50	Querel, Richard	NIWA	Richard.Querel@niwa.co.nz	+64 21 072 2540	31 Aug-1 Sep, 9-27 Sep (tentative)
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Appendix A: Technical characteristics of the static MAXDOAS systems


Colour code: 1D-MAXDOAS; 2D-MAXDOAS; ZS-DOAS


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Instrument type: 2D-MAXDOAS		
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type: Princeton Instrument 150i Detector type: Princeton Instrument PIXIS-2K BUW Optical fibers: quartz optical fiber, length: 10 m Filters: ZWB3(=UG5) Mirrors: no Temperature control of spectrometer/detector: 35°C /-30°C	
Instrument performance	Spectral range/resolution: 290-380 (adjustable)/0.35 nm Azimuthal scan/direct-sun capabilities: yes/no Elevation angle capability: fully configurable Field of view: 0.2° Typical integration time: 10-60s Typical scan duration: 15 minutes	
Calibration/characterization procedures	Elevation angles: inclinometer Field of view: scanning over a light source in the laboratory Straylight: Dark signal: by using the shutter Line shape: Hg lamp in the laboratory Polarization: - Detector nonlinearity: halogen lamp/dark background Pixel-to-pixel variability: halogen lamp/dark background	
Spectral analysis software	QDOAS / WinDOAS	
Supporting measurements	Video camera, inclinometer, GPS, electronic compass	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 300 W Internet: data volume: 200 MB, 2 IP addresses, ftp Outdoor space requirements: 1 m(H) x 0.5 m x 0.5 m; 20 kg Indoor space requirements: 0.3 (H) m x 0.5 m x 0.5 m; 50 kg Maximum distance between telescope and spectrometer: <10 m Indoor facility: air conditioning Local support: mobile elevator	


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Instrument type: 2-port DOAS		Nr: CINDI-2.02
Overall design of the instrument	Optical head including telescope: separated; 2 telescope units (one for zenith + one for off-axis) Spectrometer type: Shamrock303i spectrograph with filter wheel Detector type: Newton CCD (DU940N-BU2, 2048×512 pxls) Optical fibers: standard fiber cable with two inputs and one output, length: 15 m Filters: unknown yet Mirrors: no Temperature control of spectrometer/detector: 35°C/-40°C	
Instrument performance	Spectral range/resolution: 420-490 / 0.5 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: two fixed elevation angles (one zenith and one off-axis) Field of view: 0.3° Typical integration time: 1 – 10 s Typical scan duration: 1 – 10 s	
Calibration/characterization procedures	Elevation angles: adjusted manually using bubble level Field of view: measured in the lab Straylight: unknown Dark signal: unknown Line shape: Gaussian Polarization: unknown Detector nonlinearity: unknown Pixel-to-pixel variability: unknown	
Spectral analysis software	Andor Solis/own-developed software	
Supporting measurements	Cloud stereo photo-cameras. We will be in need in place of 2 ethernet cables to connect notebook with cameras.	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 1.2kW (max) Internet: 3 IP addresses, no big data volume to be transferred, remote desktop (TeamViewer) Outdoor space requirements: flat surface (about 1 m ²) to mount telescope holder (tripod; height:0.5m). Weight of outside part: 14kg. Indoor space requirements: 1.6 m (width) × 0.5 m (depth) × 0.8 m (height) for instrument and notebook(s). Weight indoor part: ~80kg Maximum distance between telescope and spectrometer: up to 12 m Indoor facility: air-conditioned room (18-25°C), 9 sockets 220VAC Local support: one extra people needed for installation, mobile elevator	


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Instrument type: Phaethon mini MAXDOAS		Nr: CINDI-2.03
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type: AvaSpec-ULS2048LTEC (Avantes) Detector type: SONY2048L (CCD linear array) Optical fibers: standard fiber cable with metal silicone jacketing, 800 μm fiber core diameter and overall length of 8 meters Filters: filter wheel: neutral density filter + ground quartz diffuser plate for direct-sun, clear aperture for sky-radiance, opaque for dark signal Mirrors: no mirrors, plano-convex lens Temperature control of spectrometer/detector: 5°C/5°C	
Instrument performance	Spectral range/resolution: 297-452/0.3-0.4 nm Azimuthal scan/direct-sun capabilities: yes/yes Elevation angle capability: fully configurable, 0.125° resolution Field of view: 1° Typical integration time: 200-3000 ms (scattered light) Typical scan duration: 10-20 minutes for a sequence of elevation angles	
Calibration/characterization procedures	Elevation angles: Sighting using the solar disk Field of view: white reflecting stripe measurements in laboratory Straylight: tunable-laser measurements Dark signal: after each scan sequence for all integration times used Line shape: laser lines and spectral discharge lamp measurements Polarization: zenith radiance measurements at different azimuth angles Detector nonlinearity: tunable-laser measurements with varying output Pixel-to-pixel variability: tungsten halogen lamp measurements	
Spectral analysis software	QDOAS (currently version 2.109.3)	
Supporting measurements	None during the campaign	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 200 W Internet: data volume: 300MB, 2 IP addresses, remote desktop (TeamViewer) + ftp Outdoor space requirements: 1.5 x 1.5 m ² (tripod), height: 1-1.6m, 30kg Indoor space requirements: 1m ² on a bench or desk Maximum distance between telescope and spectrometer: 6 m Indoor facility: air conditioning (ambient temperature <30°C) Local support: no extra people needed	


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Instrument type: 2D MAXDOAS		Nr: CINDI-2.04
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable; active sun tracking system Spectrometer type UV: Newport, model: 74086 Spectrometer type vis: Horiba, model: Micro HR Detector type UV: CCD Back-illuminated Princeton Instrument Pixis 2K Detector type vis: CCD Back-illuminated Princeton Instrument Pixis 100 Optical fibers: quartz UV channel: monofiber (l:6m,diam:1000µm)+ bundle(length:2m, 51 fibers 100µm) Vis channel: monofiber (l:6m,diam:800µm)+ bundle(length:2m, 37 fibers 100µm) Filters: UV channel : Filter band U-340 Hoya Mirrors: no (for telescope we use lens in quartz) Temperature control of spectrometer and detector UV: 30°C/-50°C Temperature control of spectrometer and detector vis: 30°C/-50°C	
Instrument performance	Spectral range/resolution UV: 300–390/0.4 nm Spectral range/resolution vis: 405–540/0.7 nm Azimuthal scan/direct-sun capabilities: yes/yes Elevation angle capability: fully configurable; resolution: <0.1° Field of view: <1° Typical integration time: total measurement t:60 sec (t min: vis 0.03s, UV 0.1s) Typical scan duration: 20 minutes	
Calibration/characterization procedures	Elevation angles: digital inclinometer in telescope Field of view: white light source in lab Straylight: double monochromator fed by white light source Dark signal: measured as night every day Line shape: HgCd lamp in the lab, further adjusted using QDOAS Polarization: n/a (use of long depolarising fiber bundle) Detector nonlinearity: white light source in the lab Pixel-to-pixel variability: white light source in the lab	
Spectral analysis software	QDOAS	
Supporting measurements	Video camera	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ <1000 W on average Internet: data volume: 600MB, 4 IP addresses, VNC, Logmein, ftp Outdoor space requirements: 1 m ² ; height: 1.6m, weight: 30kg Indoor space requirements: 2.5x1.5m Maximum distance between telescope and spectrometers: 6 m Indoor facility: air conditioning temperature between 20 and 25 ° Local support: no extra people needed; a mobile elevator could be useful	


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Instrument type: MAXDOAS one azimuth, catadioptric telescope / MARS-B		Nr: CINDI-2.05
Overall design of the instrument	Optical head including telescope: integrated Spectrometer type: Oriel MS257 imaging spectrograph (1:4) Detector type: Andor DV420-OE 256*1024 pixels CCD Optical fibers: n/a Filters: red Mirrors: yes Temperature control of detector: -40°C	
Instrument performance	Spectral range/resolution: 409-492/0.4 nm + possibly also UV Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable Field of view: 0.2° (azimuth); 1° (elevation) Typical integration time: 1-3s Typical scan duration: 1.5 minutes (12 elevation angles)	
Calibration/characterization procedures	Elevation angles: Udo Friess method (laser level, narrow mercury lamp) Field of view: measured in the lab Straylight: N/A Dark signal: 485 ±6 counts Line shape: Gaussian Polarization: N/A Detector nonlinearity: above 25000 counts Pixel-to-pixel variability: ±6 counts	
Spectral analysis software	Self-made + Windoas	
Supporting measurements	Video camera (possibly)	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 300 W Internet: Only WIFI for e-mails Outdoor space requirements: distance between telescope and basement is about 1 m, therefore there should be no obscurances along line of sight and above 1 m; two boxes: 1x0.7x0.3 m ³ (60kg); 1x0.8x0.7 m ³ (81kg) Indoor space requirements: need space for computer, LCD monitor, keyboard Maximum distance between instrument and computer: 3 m Indoor facility: I have no special requirements	


Institute: Institut für Meteorologie (BOKU-Met), Universität für Bodenkultur Wien, Wien, Austria		
Responsible person(s): Stefan Schreier		
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Instrument type: 1 channel scientific grade elevation and azimuth scanning MAXDOAS		Nr: CINDI-2.06
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type: Acton Standard Series SP-2356 Imaging Spectrograph Detector type: PIX100B-SF-Q-F-A Optical fibers: Y-type quartz bundle, diameter: 150µm, length: 25m Filters: no Mirrors: no Temperature control of spectrometer and detector: 35°C/-30°C	
Instrument performance	Spectral range/resolution: 406–579/0.85 nm Azimuthal scan/direct-sun capabilities: yes/no Elevation angle capability: fully configurable Field of view: 1° Typical integration time: 60s; 120s for zenith Typical scan duration: 15 minutes for 11 elevation angles	
Calibration/characterization procedures	Elevation angles: geometric alignment of telescope, horizon scan Field of view: white light source in lab Straylight: not yet characterized Dark signal: nightly measurements Line shape: HgCd lamp in telescope Polarization: - Detector nonlinearity: white light source in lab, characterization only Pixel-to-pixel variability: white light source in lab, characterization only	
Spectral analysis software	NLIN	
Supporting measurements	Video camera, HgCd lamp	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 500 W on average; 1000 W peak Internet: data volume: 200MB, 2 IP addresses, remote desktop + ftp Outdoor space requirements: 1.5 x 1.5 m ² for telescope tripod Indoor space requirements: 2.5 x 1 m ² rack, 150 kg, no more than 25°C Maximum distance between telescope and spectrometer: 20 m Indoor facility: air conditioning (<25°C) Local support: mobile elevator	


<u>Institute:</u> Chinese Academy of Meteorology Science, China Meteorological Administration, Beijing, China <u>Responsible person(s):</u> Junli Jin, Jianzhong Ma <u>Contact details:</u> jinjunli@camsma.cn, mobile phone: +86 13426397058			
<u>Instrument type:</u> mini-DOAS Hoffmann UV (#1)			Nr: CINDI-2.07
Overall design of the instrument	Optical head including telescope: integrated Spectrometer type: Ocean Optics usb 2000 Detector type: Sony ILX511 CCD (2048 pixels) Optical fibers: n/a Temperature control of spectrometer/detector: n/a		
Instrument performance	Spectral range/resolution: 292-447/0.6-0.8 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable Field of view: 0.8° Typical integration time: 1-2 minutes Typical scan duration: 15-30 minutes		
Calibration/characterization procedures	Elevation angles: horizontal scan calibration Field of view: not yet characterized Straylight: not characterized Dark signal: measurement in night or measured with telescope covered, then subtracted before spectra analysis Line shape: not yet characterized Polarization: not yet characterized Detector nonlinearity: not yet characterized Pixel-to-pixel variability: not yet characterized		
Spectral analysis software	WinDOAS		
Supporting measurements	none		
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 200 W Internet: data volume: 300 MB, 2 IP addresses, remote desktop, VNC, and ftp Outdoor space requirements: 0.5*0.5*0.5 m ³ , height: 1m; weight not a problem Indoor space requirements: 1*1m ² desk(for laptop and electric power converter) Maximum distance between telescope and instruments: n/a Indoor facility: air conditioning Local support: metal framework or stand to support the instrument ; sticky tape to fix the accessories/wires; extended power cord (electricity line) if the instrument is far away from power supply; one external people		


<u>Institute:</u> Chinese Academy of Meteorology Science, China Meteorological Administration, Beijing, China		
<u>Responsible person(s):</u> Junli Jin, Jianzhong Ma		
<u>Contact details:</u> jinjunli@camsma.cn, mobile phone: +86 13426397058		
<u>Instrument type:</u> mini-DOAS Hoffmann VIS (#1)		<u>Nr:</u> CINDI-2.08
Overall design of the instrument	Optical head including telescope: integrated Spectrometer type: Ocean Optics usb 2000 Detector type: DET2B-vis (2048 pixels) Optical fibers: n/a Filters: n/a Mirrors: n/a Temperature control of spectrometer/detector: n/a	
Instrument performance	Spectral range/resolution: 399-712/0.6-0.8 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable Field of view: 0.8° Typical integration time: 1-2 minutes Typical scan duration: 15-30 minutes	
Calibration/characterization procedures	Elevation angles: horizontal scan calibration Field of view: not characterized Dark signal: measurement in night or measured with telescope covered, then subtracted before spectra analysis Line shape: not yet characterized Polarization: not yet characterized Detector nonlinearity: not yet characterized Pixel-to-pixel variability: not yet characterized	
Spectral analysis software	WinDOAS	
Supporting measurements	none	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 200 W Internet: data volume: 300 MB, 2 IP addresses, remote desktop, VNC, and ftp Outdoor space requirements: 0.5x0.5x0.5 m ³ , height: 1m; weight not a problem Indoor space requirements: 1x1m ² desk(for laptop and electric power converter) Maximum distance between telescope and instruments: n/a Indoor facility: air conditioning Local support: metal framework or stand to support the instrument ; sticky tape to fix the accessories/wires; extended power cord (electricity line) if the instrument is far away from power supply; one external people	

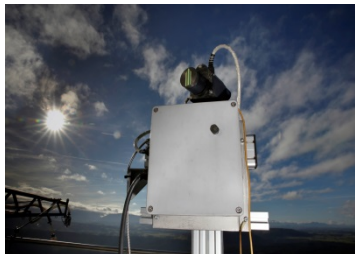
Institute: Center for Environmental Remote Sensing (CEReS), Chiba University, Chiba, Japan Responsible person(s): Hitoshi Irie Contact details: hitoshi.irie@chiba-u.jp, mobile phone:+81 9015492635		
Instrument type: 1 channel scientific grade elevation and azimuth scanning MAXDOAS		
Overall design of the instrument	Optical head including telescope: separated Spectrometer type: Ocean Optics Maya2000Pro Detector type: Back-thinned, 2D FFT-CCD Optical fibers: premium-grade UV/VIS Optical fibre, length - 10 m Filters: no Mirrors: quartz mirror Temperature control of spectrometer and detector: 40°C/40°C	
Instrument performance	Spectral range/resolution: 310–515/0.4 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: set of 6 elevation angles, values can be adjusted but not the number of angles Field of view: <1° Typical integration time: 4 minutes Typical scan duration: 30 minutes	
Calibration/characterization procedures	Elevation angles: Two horizontal levels embedded in the base plate and in a plate holding the reflecting mirror are used to adjust the zero angle of the reflecting mirror. A stepping motor with an angle step of 0.038) is used for controlling the mirror angle. Field of view: Characterized by Prede Stray light: Subtracted as an offset component in DOAS analysis Dark signal: nightly measurements Line shape: An asymmetry Gaussian shape is determined during the wavelength calibration. Polarization: - Detector nonlinearity: characterized by Ocean Optics Pixel-to-pixel variability: nightly measurements	
Spectral analysis software	JM2 (Japanese MAXDOAS profile retrieval algorithm, version 2)	
Supporting measurements	none	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ <500 W Internet: data volume: 15 MB, 2 IP addresses, SSH+ftp Outdoor space requirements: 0.6m x 0.2m x 1.5m (H); weight: 10 kg; space for 1-m high rack on which the outside unit is placed may be required too. Indoor space requirements: 0.5m x 0.5 m Maximum distance between telescope and spectrometer: 10 m Local support: no	


Institute: Department of Atmospheric Chemistry and Climate (AC2), Spanish National Research Council (CSIC), Madrid, Spain Responsible person(s): David García, Nuria Benavent, Shanshan Wang Contact details: dgarcia@iqfr.csic.es, mobile phone: +34 666467907		
Instrument type: MAXDOAS		
Overall design of the instrument	Optical head including telescope: separated; elevation angles fully configurable Spectrometer type: Princeton Acton SP2500 Detector type: Pixis 2D CCD Camera, 1340x400 pixels Optical fibers: Multifiber UV-VIS, 10 m length Temperature control of spectrometer and detector: 20-25°C/20-25°C	
Instrument performance	Spectral range/resolution: 300–500/0.5 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable Field of view: 1° Typical integration time: 0.01-1s Typical scan duration: 5 minutes	
Calibration/characterization procedures	Elevation angles: 45 ° Field of view: lamp in telescope Straylight: - Dark signal: by using the shutter Line shape: Hg/Ne Polarization: - Detector nonlinearity: laboratory Pixel-to-pixel variability: laboratory	
Spectral analysis software	QDOAS	
Supporting measurements	Video camera	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 550 W Internet: data volume: 500MB; 1 IP address; VNC + SFTP Outdoor space requirements: Telescope and tracker are inside a box of about 60*60*40 cm ³ ; <20-30kg Indoor space requirements: Working space of about 1.5 m (for the spectrometer, computer, filter wheel, temperature control...) Maximum distance between telescope and spectrometer: 10 m Indoor facility: air conditioning (steady temperature for the spectrometer) Local support: no extra people needed ?	

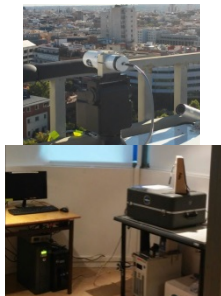
Institute: University of Colorado, Boulder, Colorado Responsible person(s): Rainer Volkamer, Henning Finkenzeller Contact details: Rainer.Volkamer@colorado.edu, Henning.Finkenzeller@colorado.edu		
Instrument type: 3D-MAXDOAS	Nr: CINDI-2.11	
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable; integrating sphere for direct sun measurements Spectrometer type: 2 x Acton SP2150 Detector type: 2 x PIXIS 400 back-illuminated CCD Optical fibers: Monofiber, diameter: 1.25mm, length: 25m connects to Y-type bundle, diameter: 0.145mm, length: 1m Filters: BG3/BG38, GG395 Mirrors: quartz prisms Temperature control of spectrometer and detector: 34°C/-30°C	
Instrument performance	Spectral range/resolution: 327-470/0.7 & 432–678/1.2 nm Azimuthal scan/direct-sun capabilities: yes/yes Elevation angle capability: fully configurable Field of view: 0.7 degrees (full angle) Typical integration time: ~20s Typical scan duration: ~8min (12 EA & 12 Az)	
Calibration/characterization procedures	Elevation angles: geometric alignment, solar aureole/horizon scan Field of view: laser pointer backwards Straylight: dark areas on CCD Dark signal: characterized at night, and by dark areas on CCD Line shape: Hg/Kr lamps (external) & QDOAS for wavelength dependency Polarization: - Detector nonlinearity: Fraunhofer OD at different saturation levels of CCD Pixel-to-pixel variability: monitored	
Spectral analysis software	QDOAS	
Supporting measurements	Webcam, Hg & Kr lamp	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 380 W average / 785 W peak Internet: data volume: 1 GB, 2 IP addresses, remote desktop + SSH Outdoor space requirements: railing mount, 1.5 x 1.5 m ² (access & rotat.); 15kg Indoor space requirements: 1 standard rack: 1.1 x 0.9 x 1.2 m ³ (L x W x H) Maximum distance between telescope and spectrometer: 12 m Indoor facility: air conditioned, ethernet plug accessible	


<u>Institute:</u> University of Colorado, Boulder, Colorado <u>Responsible person(s):</u> Rainer Volkamer <u>Contact details:</u> Rainer.Volkamer@colorado.edu		
<u>Instrument type:</u> ZS & MAXDOAS (1D)	<u>Nr:</u> CINDI-2.12	
Overall design of the instrument	Optical head including telescope: rotating prism, elevation angles fully configurable horizon-to-horizon across zenith Spectrometer type: Acton SP2356i & QE65000 Detector type: PIXIS 400 back-illuminated CCD & Sony CCD Optical fibers: Monofiber, diameter: 1.5mm, length: 10m connects to Y-type bundle, diameter: 0.145mm, length: 1m Filters: BG3/BG38 Mirrors: quartz prism Temperature control of spectrometer/detector: 34°C/-30°C	
Instrument performance	Spectral range/resolution: 300-466/0.8 & 379–493/0.5 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable Field of view: 0.4 degrees (full angle) Typical integration time: ~30s Typical scan duration: ~8min	
Calibration/characterization procedures	Elevation angles: geometric alignment, horizon scan Field of view: laser pointer backwards Straylight: dark areas on CCD Dark signal: characterized at night, and by dark areas on CCD Line shape: Hg/Kr lamps (external) & QDOAS for wavelength dependency Polarization: - Detector nonlinearity: Fraunhofer line distortion at different sat levels Pixel-to-pixel variability: monitored	
Spectral analysis software	QDOAS	
Supporting measurements	Webcam, Hg & Kr lamp	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 400 W average / 800 W peak Internet: data volume: 1 GB, 2 IP addresses, remote desktop + SSH Outdoor space requirements: railing mount, 1.5 x 1.5 m ² ; 15kg Indoor space requirements: shares indoor rack (with #13 2D-MAXDOAS); 120kg Maximum distance between telescope and spectrometer: 10m Indoor facility: air conditioned, ethernet plug accessible	


<p>Institute 1: Institut fuer Methodik der Fernerkundung (IMF), Deutsches Zentrum fuer Luft- und Raumfahrt e.V. (DLR), Wessling, Germany</p> <p>Institute 2: School of Earth and Space Sciences, University of Science and Technology of China (USTC), Hefei, Anhui, China</p> <p>Responsible person(s): Nan Hao (DLR) and Cheng Liu (USTC)</p> <p>Contact details: nan.hao@dlr.de, Chliu81@ustc.edu.cn + mobile phone</p>		
<p>Instrument type: 1D MAXDOAS EnviMeS (#1)</p>	<p>Nr: CINDI-2.13 CINDI-2.14</p>	
<p>Overall design of the instrument</p>	<p>Optical head including telescope: separated; elevation and azimuth angles fully configurable</p> <p>Spectrometer type UV and Vis: Avantes AvaBench-75</p> <p>Detector type UV: Backthinned Hamamatsu CCD (2048 pixel)</p> <p>Detector type vis: Backthinned Hamamatsu CCD (2048 pixel)</p> <p>Optical fibers: Multifibre (UV), single fibre (VIS), length: 10m</p> <p>Filters: UV bandpass filters (BG3)</p> <p>Mirrors: none (rotatable prism for elevation angle selection)</p> <p>Temperature control of spectrometer and detector UV: 20°C/20°C</p> <p>Temperature control of spectrometer and detector vis: 20°C/20°C</p>	
<p>Instrument performance</p>	<p>Spectral range/resolution UV: 296–460/0.56 nm</p> <p>Spectral range/resolution vis: 440–583/0.54 nm</p> <p>Azimuthal scan/direct-sun capabilities: yes/no</p> <p>Elevation angle capability: fully configurable; step: 0.1° or less</p> <p>Field of view: <0.5°</p> <p>Typical integration time: 2.5ms -60s</p> <p>Typical scan duration: 5 minutes</p>	
<p>Calibration/characterization procedures</p>	<p>Elevation angles: Point-like light source and laser level</p> <p>Field of view: Point-like light source and laser level</p> <p>Straylight: Optical filters</p> <p>Dark signal: Measurement during the night</p> <p>Line shape: Atomic emission lines (Hg/Ne)</p> <p>Polarization: n/a (depolarizing fibre)</p> <p>Detector nonlinearity: Measurement of artificial light source with varying integration times</p> <p>Pixel-to-pixel variability: Halogen lamp</p>	
<p>Spectral analysis software</p>	<p>DOASIS</p>	
<p>Supporting measurements</p>	<p>Webcam, tilt sensor, GPS</p>	
<p>Special needs/requests regarding logistics</p>	<p>Power supply/consumption: 220 V/20-120 W on average</p> <p>Internet: data volume: 10 GB, VNC, 2 IP addresses</p> <p>Outdoor space requirements: about 50 cm x 50 space, preferably mounted on a metal frame</p> <p>Indoor space requirements: 1 m² tablespace</p> <p>Maximum distance between telescope and instruments: 10 m</p> <p>Indoor facility: PC and spectrometer</p>	


Institute: Meteorological Observatory, Hohenpeissenberg, Germany		
Responsible person(s): Robert Holla		
Contact details: robert.holla@dwd.de, mobile phone: +4917656219264		
Instrument type: MAXDOAS EUSAAR-Type		Nr: CINDI-2.15
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type UV: OMT ctf-60 Spec-1275 Spectrometer type vis: OMT ctf-60 Spec-1310 Detector type UV: Backthinned Hamamatsu CCD (1024 pixel) Detector type vis: Backthinned Hamamatsu CCD (2048 pixel) Optical fibers: Multifibre (UV),Multifibre (VIS), length: 10 m Filters: UV bandpass filters (BG3+BG40), UV-Spec only Mirrors: spherical object mirror Temperature control of spectrometer and detector UV: 20°C/-7°C Temperature control of spectrometer and detector vis: 20°C/-7°C	
Instrument performance	Spectral range/resolution UV: 307–436/0.6 nm Spectral range/resolution vis: 415–637/0.7 nm Azimuthal scan/direct-sun capabilities: yes/no Elevation angle capability: fully configurable; step: 0.1° or less Field of view: <1° Typical integration time: 3 min per elevation Typical scan duration: 20 min	
Calibration/characterization procedures	Elevation angles: Udo Friess method (laser level, narrow mercury lamp)+ scanning horizon Field of view: Udo Friess method (laser level, narrow mercury lamp) Straylight: not yet characterized Dark signal: determined during night, telescope facing down Line shape: N/A Polarization: N/A Detector nonlinearity: Laboratory measurement using halogen lamp Pixel-to-pixel variability: N/A	
Spectral analysis software	Windoas, DOASIS	
Supporting measurements	Webcam	
Special needs/requests regarding logistics	Power supply/consumption: 150 W Instrument, ~300 W measurement PC Internet: data volume: 50 MB, 1 IP address, remote desktop Outdoor space requirements: 0.5x0.5x1.2 m ³ (length x width x height) Indoor space requirements: 0.6x0.6x0.5 m ³ (length x width x height) Maximum distance between telescope and instruments: 10 m Indoor facility: air conditioning	


Institute: Indian Institute of Science Education and Research Mohali Department of Earth and Environmental Sciences, Indian Institute of Science Education and Research Mohali, Punjab, India Responsible person(s): Abhishek Kumar Mishra and Vinod Kumar Contact details: abhishekkumar.mishra21@gmail.com , vinodmagic@hotmail.com		
Instrument type: mini-MAX DOAS Hoffmann UV (#2)		
Overall design of the instrument	Optical head including telescope: integrated Spectrometer type UV: Ocean Optics usb 2000+ Spectrometer type : CCD (2048 pixels) Filters: no Mirrors: - Temperature control of spectrometer and detector : n/a	
Instrument performance	Spectral range/resolution : 316–466/1 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable; step: 0.1° or less Field of view: 0.7° Typical integration time: 60ms Typical scan duration: ~5 minutes for one full elevation sequence	
Calibration/characterization procedures	Elevation angles: - Field of view: - Straylight: - Dark signal: - Line shape: - Polarization: - Detector nonlinearity: - Pixel-to-pixel variability: -	
Spectral analysis software	WinDOAS and DOASIS	
Supporting measurements	None	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/<100 W on average Internet: 2 IP addresses (500 MB/IP), remote desktop and ftp, Outdoor space requirements: 30cm(L)*20cm(W)*20cm(H); 3 kg Indoor space requirements: - Maximum distance between telescope and instruments: 10 m Indoor facility: Three power sockets, bench for placing laptops, battery and battery charger Local support: no extra people needed	


<u>Institute:</u> National Institute of Aerospace Technology (INTA), Madrid, Spain		
<u>Responsible person(s):</u> Olga Puentedura Rodriguez		
<u>Contact details:</u> puentero@inta.es + mobile phone		
<u>Instrument type:</u> 2D-MAXDOAS RASAS III		<u>Nr:</u> CINDI-2.17
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type: Andor Shamrock SR-163i Detector type: IDUS Andor Optical fibers: Bundle 100 μm, length: 8 m Filters: No Mirrors: No Temperature control of spectrometer/detector: 17°C/-30°C	
Instrument performance	Spectral range/resolution: 325-445 or 400-550/0.55 nm Azimuthal scan/direct-sun capabilities: yes/no Elevation angle capability: fully configurable Field of view: 1° Typical integration time: ~1 minute/pointing direction Typical scan duration: ~1 minute x number of pointing directions	
Calibration/characterization procedures	Elevation angles: inclinometer during operation Field of view: Geometrical Straylight: HgCd lamp Dark signal: measured at constant temperature and subtracted during analysis Line shape: HgCd lamp Polarization: Optical fiber depolarizes the signal Detector nonlinearity: HgCd lamp Pixel-to-pixel variability: HgCd lamp	
Spectral analysis software	LANA software	
Supporting measurements	Video camera, inclinometer, and GPS	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 2350 W; peak at 3450 W Internet: data volume: 20MB, VNC, SSH, and FTP, 4 IP addresses Outdoor space requirements: 1.5x1.5x1.2 m ³ , 20kg Indoor space requirements: 2x1m. 80kg. Room temperature lower than 25°C. Maximum distance between telescope and spectrometer: <8 m Indoor facility: air conditioning + a room for the air zero generator which uses a compressor that makes some noise. Local support: one people for installing the instrument	


Institute: Institute for Environmental Physics (IUP), University of Bremen, Bremen, Germany Responsible person(s): Andreas Richter Contact details: richter@iup.physik.uni-bremen.de, mobile phone: +49 160 911 345 33		
Instrument type: 2 channel scientific grade elevation and azimuth scanning MAXDOAS	Nr: CINDI-2.18	
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type UV: Acton ARC500 Spectrometer type vis: Acton ARC500 Detector type UV: Princeton NTE/CCD-1340/400-EMB Detector type vis: Princeton NTE/CCD-1340/400-EMB Optical fibers: Y-type quartz bundle, diameter: 150µm, length: 22m Filters: UG5 (UV only) Mirrors: no Temperature control of spectrometer and detector UV: 35°C/-35°C Temperature control of spectrometer and detector vis: 35°C/-30°C	
Instrument performance	Spectral range/resolution UV: 305–390/0.5 nm Spectral range/resolution vis: 406–579/0.85 nm Azimuthal scan/direct-sun capabilities: yes/no Elevation angle capability: fully configurable Field of view: 1° Typical integration time: 60s; 120s for zenith Typical scan duration: 15 minutes for 11 elevation angles	
Calibration/characterization procedures	Elevation angles: geometric alignment of telescope, horizon scan Field of view: white light source in lab Straylight: not yet characterized Dark signal: nightly measurements Line shape: HgCd lamp in telescope Polarization: - Detector nonlinearity: white light source in lab, characterization only Pixel-to-pixel variability: white light source in lab, characterization only	
Spectral analysis software	NLIN	
Supporting measurements	Video camera, HgCd lamp	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 500 W on average; 1000 W peak Internet*: data volume: 200 MB, 10 IP addresses, remote desktop + ftp, Outdoor space requirements: 1.5 x 1.5 m ² for telescope tripod Indoor space requirements: 2.5 x 1 m ² desk, 150kg, no more than 25°C Maximum distance between telescope and instruments: 10 m	

Institute: Institute of Environmental Physics, University of Heidelberg, Heidelberg, Germany		
Responsible person(s): Udo Friess		
Contact details: udo.friess@iup.uni-heidelberg.de, Mobile phone: +49-151-22278453		
Instrument type: 2D MAXDOAS EnviMeS (#3)		Nr: CINDI-2.19
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type UV and Vis: Avantes AvaBench-75 Detector type UV: Backthinned Hamamatsu CCD (2048 pixel) Detector type vis: Backthinned Hamamatsu CCD (2048 pixel) Optical fibers: Multifibre (UV), single fibre (VIS), length: 10m Filters: UV bandpass filters (BG3) Mirrors: none (rotatable prism for elevation angle selection) Temperature control of spectrometer and detector UV: 20°C/20°C Temperature control of spectrometer and detector vis: 20°C/20°C	
Instrument performance	Spectral range/resolution UV: 296–460/0.56 nm Spectral range/resolution vis: 440–583/0.54 nm Azimuthal scan/direct-sun capabilities: yes/no Elevation angle capability: fully configurable; step: 0.1° or less Field of view: <0.5° Typical integration time: 2.5ms -60s Typical scan duration: 5 minutes	
Calibration/characterization procedures	Elevation angles: Point-like light source and laser level Field of view: Point-like light source and laser level Straylight: Optical filters Dark signal: Measurement during the night Line shape: Atomic emission lines (Hg/Ne) Polarization: n/a (depolarizing fibre) Detector nonlinearity: Measurement of artificial light source with varying integration times Pixel-to-pixel variability: Halogen lamp	
Spectral analysis software	DOASIS	
Supporting measurements	Webcam, tilt sensor, GPS	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/20-120 W on average Internet: yes Outdoor space requirements: about 50 cm x 50 space, preferably mounted on a metal frame Indoor space requirements: 1 m ² tablespace Maximum distance between telescope and instruments: 10 m Indoor facility: PC and spectrometer	


Institute: Institute of Environmental Physics, University of Heidelberg, Heidelberg, Germany		
Responsible person(s): Udo Friess		
Contact details: udo.friess@iup.uni-heidelberg.de, Mobile phone: +49-151-22278453		
Instrument type: Compact MAXDOAS		Nr: CINDI-2.20
Overall design of the instrument	Optical head including telescope: integrated; elevation fully configurable Spectrometer/detector type UV: Hamamatsu TM (2048 pixels) Spectrometer/detector type vis: Sony TM 2048L Optical fibers: n/a (compact system) Filters: Schott TM BG3 (UV) Mirrors: none (rotatable prism for elevation angle selection) Temperature control of spectrometer and detector UV: 10-20°C Temperature control of spectrometer and detector vis: 10-20°C	
Instrument performance	Spectral range/resolution UV: 295–430/0.53 nm Spectral range/resolution vis: 430–565/0.74 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable Field of view: 0.27° (UV) and 0.32° (vis) Typical integration time: 1 minute Typical scan duration: 5 minutes	
Calibration/characterization procedures	Elevation angles: Point-like light source and laser level Field of view: Point-like light source and laser level Straylight: Optical filters Dark signal: Measurement during the night Line shape: Atomic emission lines (Hg/Ne) Polarization: n/a (depolarizing fibre) Detector nonlinearity: Measurement of artificial light source with varying integration times Pixel-to-pixel variability: Halogen lamp	
Spectral analysis software	Windoas	
Supporting measurements	Inclinometer	
Special needs/requests regarding logistics	Power supply/consumption: 12 V/30 W Internet: data volume: 50 MB, 10 IP addresses for all Heidelberg instruments, VNC and remote desktop Outdoor space requirements: will be mounted on the railing of the tower Indoor space requirements: none (only small power supply) Maximum distance between telescope and spectrometers: n/a Indoor facility: power supply	


Institute: Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands		
Responsible person(s): Ankie Piters		
Contact details: ankie.piters@knmi.nl, mobile phone: +31-30-2206433		
Instrument type: mini-DOAS Hoffmann UV (#3)		Nr: CINDI-2.21
Overall design of the instrument	Optical head including telescope: integrated Spectrometer type: Ocean Optics usb 2000 Detector type: Sony ILX511 CCD (2048 pixels) Optical fibers: n/a	
Instrument performance	Spectral range/resolution: 290-443/0.6 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable Field of view: 0.45° Typical integration time: 1-2 minutes Typical scan duration: 15-30 minutes	
Calibration/characterization procedures	Elevation angles: calibration of horizon (+/-0.5 degree) via quick horizon-scan (-3 to +3, very short integration time) Field of view: scanning over a light source in the laboratory Straylight: not yet characterized Dark signal: characterized in the dark room as a function of detector temperature Line shape: determined from lamp lines (function of temperature and wavelength) Polarization: not yet characterized Detector nonlinearity: not yet characterized Pixel-to-pixel variability: characterized in the dark room as a function of detector temperature	
Spectral analysis software	Own software (Python-based)	
Supporting measurements	none	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 5-50 W Internet: yes Outdoor space requirements: already mounted at 20m platform of Cabauw tower Indoor space requirements: no Maximum distance between telescope and instruments: n/a Indoor facility: table to put laptop on (or, when on tower: n/a)	


<u>Institute:</u> Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands		
<u>Responsible person(s):</u> Ankie Piters		
<u>Contact details:</u> ankie.piters@knmi.nl, mobile phone: +31-30-2206433		
<u>Instrument type:</u> mini-DOAS Hoffmann VIS (#3)		<u>Nr:</u> CINDI-2.22
Overall design of the instrument	Optical head including telescope: integrated Spectrometer type: Ocean Optics usb 2000+ Detector type: Sony ILX511 CCD (2048 pixels)	
Instrument performance	Spectral range/resolution: 400-600/0.5 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable Field of view: 0.4° Typical integration time: 1-2 minutes Typical scan duration: 15-30 minutes	
Calibration/characterization procedures	Elevation angles: calibration of horizon (+/-0.5 degree) via quick horizon-scan (-3 to +3, very short integration time) Field of view: scanning over a light source in the laboratory Straylight: not yet characterized Dark signal: characterized in the dark room as a function of detector temperature Line shape: determined from lamp lines (function of temperature and wavelength) Polarization: not yet characterized Detector nonlinearity: not yet characterized Pixel-to-pixel variability: characterized in the dark room as a function of detector temperature	
Spectral analysis software	Own software (Python-based)	
Supporting measurements	none	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 5 W Internet: yes Outdoor space requirements: 30x30x30cm (can be mounted on tripod or a horizontal bar, e.g. next to other KNMI MAXDOAS on tower); 10kg Indoor space requirements: 50x50x50cm (laptop) Maximum distance between telescope and instruments: n/a Indoor facility: table to put laptop on (or, when on tower: n/a)	


<u>Institute:</u> Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands		
<u>Responsible person(s):</u> Ankie Piters		
<u>Contact details:</u> ankie.piters@knmi.nl, mobile phone: +31-302206433		
<u>Instrument type:</u> PANDORA (#1)		<u>Nr:</u> CINDI- 2.23
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type: AvaSpec-ULS2048x64 Detector type : 2046 x 64 pixel backthinned non-cooled Hamamatsu CCD Optical fibers: single strand 400um core diameter high OH fused silica fiber, 10m long Filters: spectral filters (U340 and BP300 to remove visible light) Mirrors: no Temperature control of spectrometer and detector: 20°C/20°C	
Instrument performance	Spectral range/resolution UV: 290-530/0.6 nm Azimuthal scan/direct-sun capabilities: yes/yes Elevation angle capability: fully configurable Field of view: circular, 1.5° (sky mode); 2.0° (sun mode) Typical integration time: 2.4ms-300ms (sun), 20ms to 1000ms (sky) Typical scan duration: 20-40s per pointing position	
Calibration/characterization procedures	Elevation angles: based on astronomical calculations and 'sun searches' Field of view: determined in the laboratory Stray light: not determined Dark signal: determined in laboratory Line shape: determined in the laboratory with a mercury lamp Polarization: no residual polarization measured after 10m fiber Detector nonlinearity: determined in laboratory Pixel-to-pixel variability: determined in laboratory	
Spectral analysis software	Own software (Python-based) and participating in PANDONIA	
Supporting measurements	none	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 125 W Internet*: data volume: 40 MB, 3 IP addresses, rdp and ftp Outdoor space requirements: 1x1x1.5m ³ Indoor space requirements: 100x100x100cm (box) Maximum distance between telescope and instruments: 10 m	

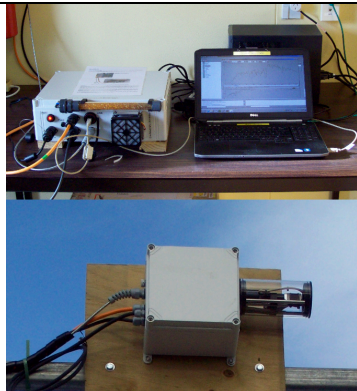
*In total for KNMI MAXDOAS instruments



Institute: Laboratoire Atmosphère, Milieux, Observations Spatiales (LATMOS), Guyancourt, France		
Responsible person(s): Andrea Pazmino		
Contact details: andrea.pazmino@latmos.ipsl.fr, Manuel.pinharanda@latmos.ipsl.fr, +33 (0)6 64 13 86 43		
Instrument type: Système d'Analyse par Observations Zénithales (SAOZ)	Nr: CINDI-2.24	
Overall design of the instrument	Optical head including telescope: n/a Spectrometer type: Jobin-Yvon CP200 flat field Detector type: 1024 NMOS diode array from Hamamatsu Optical fibers: n/a Filters: no Mirrors: Yes Temperature control of spectrometer and detector: n/a	
Instrument performance	Spectral range/resolution: 270–640/1.3 nm Azimuthal scan/direct-sun capabilities: n/a Elevation angle capability: n/a Field of view: 10° Exposure time: 0.19 s - 5 x measurement cycle (adjusted automatically) Measurement cycle: 60 s (programmable)	
Calibration/characterization procedures	Elevation angles: n/a Field of view: n/a Straylight: n/a Dark signal: shutter Line shape: wavelength calibration based on reference spectrum Polarization: Est-West fixed direction of the entrance slit Detector nonlinearity: exposure time calibrated to 12000 counts in elementary spectrum Pixel-to-pixel variability: dark background	
Spectral analysis software	SAM version 5.9	
Supporting measurements	GPS	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 500 W Internet: data volume: 5 MB, 2 IP addresses, ftp + remote desktop (TeamViewer10) Outdoor space requirements: 0.7 x 0.4 m ² ; 30 kg Indoor space requirements: interface box + computer; cable length between interface box and computer < 2 m Maximum distance between SAOZ and interface box: 20 m Indoor facility: - Local support: one extra people	


Institute: Laboratoire Atmosphère, Milieux, Observations Spatiales (LATMOS), Guyancourt, France		
Responsible person(s): Andrea Pazmino		
Contact details: andrea.pazmino@latmos.ipsl.fr, Manuel.pinharanda@latmos.ipsl.fr, +33 (0)6 64 13 86 43		
Instrument type: Mini Système d'Analyse par Observations Zénithales (mini-SAOZ)		Nr: CINDI-2.25
Overall design of the instrument	Optical head: separated Spectrometer type: Cerny-Turner, grating 600 grooves/mm Detector type: 2048x16 CCD back-thinned from Hamamatsu Optical fibers: HGC950; diameter: 950 μm; length:10 m Temperature control of spectrometer and detector: n/a	
Instrument performance	Spectral range/resolution: 270–820/0.7 nm Azimuthal scan/direct-sun capabilities: n/a Elevation angle capability: n/a Field of view: 8° Exposure time: 0.037 s - 5 x measurement cycle (adjusted automatically) Measurement cycle: 60 s (programmable)	
Calibration/characterization procedures	Elevation angles: n/a Field of view: n/a Straylight: n/a Dark signal: shutter Line shape: wavelength calibration based on reference spectrum Polarization: n/a Detector nonlinearity: exposure time calibrated to 12000 counts in elementary spectrum Pixel-to-pixel variability: dark background	
Spectral analysis software	SAOZ.gui Version 1.25-50f870	
Supporting measurements	GPS	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 300 W Internet: data volume: 5 MB, 2 IP addresses, ftp + remote desktop (TeamViewer10) Outdoor space requirements: 0.4 m x 0.25 m x 0.15 m; 5kg; support for optical header; optical header placed horizontally Indoor space requirements: interface box + computer; cable length between interface box and computer < 2 m Maximum distance between mini-SAOZ and optical header: <10 m; GPS antenna cable <5 m Indoor facility: Air conditioned room (18°- 20° C) Local support: one extra people	


<u>Institute:</u> LuftBlick, Mutters, Austria		
<u>Responsible person(s):</u> Alexander Cede		
<u>Contact details:</u> alexander.cede@luftblick.at, mobile phone: +43 681 84448717		
<u>Instrument type:</u> PANDORA-2S (#2)		<u>Nr:</u> CINDI-2.26 CINDI-2.27
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type: AvaSpec-ULS2048x64 (one for UV and one for vis) Detector type : 2046 x 64 pixel backthinned non-cooled Hamamatsu CCD (one for UV and one for vis) Optical fibers: single strand 400um core diameter high OH fused silica fiber, 10m long Filters: spectral filters (U340 and BP300 to remove visible light) Mirrors: no Temperature control of spectrometer and detector UV: 20°C/20°C Temperature control of spectrometer and detector vis: 20°C/20°C	
Instrument performance	Spectral range/resolution UV: 280-540/0.6 nm Spectral range/resolution vis: 400–900/1.1 nm Azimuthal scan/direct-sun capabilities: yes/yes Elevation angle capability: fully configurable Field of view: circular, 1.5° (sky mode); 2.8° (sun mode) Typical integration time: 2.4ms-300ms (sun), 20ms to 1000ms (sky) Typical scan duration: 20-40s per pointing position	
Calibration/characterization procedures	Elevation angles: based on astronomical calculations and 'sun searches' Field of view: 1.5deg FWHM (sky view), 2.8deg FWHM (sun view) Stray light: Correction Dark signal: Correction Line shape: Modified Guassian Polarization: no residual polarization measured after 10m fiber Detector nonlinearity: Correction Pixel-to-pixel variability: Corrected	
Spectral analysis software	Blick Software Suite (Python-based)	
Supporting measurements	None	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 220 W Internet: data volume: 2x70 MB, 2 IP addresses, SSH (putty SCP) Outdoor space requirements: 1mx1mx1.5m; 9kg Indoor space requirements: Box L 70cm, W 55cm, H 40cm; 30 kg Maximum distance between telescope and instruments: 8m Local support: to check on the instrument or clean the entrance window from time to time (PI not present during the whole campaign)	


Institute: Max-Planck Institute for Chemistry (MPIC), Mainz, Germany		
Responsible person(s): Thomas Wagner		
Contact details: thomas.wagner@mpic.de (mobile phone: +491629228450)		
Instrument type: TubeMAXDOAS		Nr: CINDI-2.28
Overall design of the instrument	Optical head including telescope: separated; elevation angles fully configurable Spectrometer type: Avantes Detector type: CCD Optical fibers: quartz fibre bundle, length: 5 m Filters: BG3 (UV) Mirrors: no Temperature control of spectrometer and detector: 10°C/10°C	
Instrument performance	Spectral range/resolution: 316–474/0.6 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable Field of view: 1° Typical integration time: 30s Typical scan duration: 30 minutes	
Calibration/characterization procedures	Elevation angles: performed at the campaign using laser device or water level Field of view: performed at the campaign using laser device or water level Straylight: has to be quantified Dark signal: will be measured on site Line shape: almost symmetric Gaussian-like, almost not dependent on wavelength Polarization: - Detector nonlinearity: characterised in the laboratory Pixel-to-pixel variability: -	
Spectral analysis software	Windoas	
Supporting measurements	Video camera	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 100 W Internet: Data volume: 150 MB, 1 IP address, remote desktop via VPN Outdoor space requirements: 25x25x35 cm ³ , weight: 3kg Indoor space requirements: 2.5 x 1 m ² desk Maximum distance between telescope and spectrometer: 4 m Indoor facility: air conditioning (<25°C) Local support: not needed	


Institute: National Institute of Water and Atmospheric Research (NIWA), Lauder, New Zealand			
Responsible person(s): Richard Querel, Paul Johnston			
Contact details: richard.querel@niwa.co.nz ; +64 21 0722540			
Instrument type: EnviMeS 1D MAXDOAS (#3)			Nr: CINDI-2.29
Overall design of the instrument	Optical head including telescope: elevation angle configurable Spectrometer type UV: Avantes AvaBench-75 Spectrometer type vis: Avantes AvaBench-75 Detector type UV: Backthinned Hamamatsu CCD (2048 x 64 pixels) Detector type vis: Backthinned Hamamatsu CCD (2048 x 64 pixels) Optical fibers: Multifibre (6 x UV), single fibre (1 x VIS), length: 10m Filters: UV bandpass filter (BG3), VIS bandpass filter (BG40) Mirrors: Rotating glass quartz prism as entrance optic Temperature control of spectrometer and detector UV: 20 °C / 20 °C Temperature control of spectrometer and detector vis: 20 °C / 20 °C		
Instrument performance	Spectral range/resolution UV: 305–457 nm / 0.7 nm Spectral range/resolution vis: 410–550 nm / 0.7 nm Azimuthal scan/direct-sun capabilities: no Elevation angle capability: fully configurable; step: 0.1° or less Field of view: <0.5° Typical integration time: 2.5ms -60s Typical scan duration: 60 s		
Calibration/characterization procedures	Elevation angles: Calibrated tilt meter and level Field of view: ? Straylight: <1e-3 ? Dark signal: shutter blocks light path in scanning head Line shape: taken from Hg lamp spectra Polarization: 10 m fibre effectively depolarizes incoming light Detector nonlinearity: observations of a temperature stabilized LED with several different exposure times, assuming LED to be constant intensity. Pixel-to-pixel variability: Not tested		
Spectral analysis software	DOASIS, STRATO		
Supporting measurements	Tilt sensor (for elevation angle), PTU		
Special needs/requests regarding logistics	Power supply/consumption: 220 V/120 W on average Internet: 1 IP address, VNC and remote desktop, data volume: 25 MB Outdoor space requirements: 36 x 13 x 20 cm ³ (width x depth x height); weight: 2 kg Indoor space requirements: 40 x 30 x 13 cm ³ (width x depth x height) Maximum distance between telescope and instruments: 10 m Indoor facility: air conditioning (< 28 C)		


Institute: National Institute of Water and Atmospheric Research (NIWA), Lauder, New Zealand		 
Responsible person(s): Richard Querel, Paul Johnston Contact details: richard.querel@niwa.co.nz ; +64 21 0722540		
Instrument type: Lauder Acton275 MAXDOAS		Nr: CINDI-2.30
Overall design of the instrument	Optical head including telescope: elevation angle configurable Spectrometer type UV/Vis: Acton 275 with grating control Detector type UV/Vis: Backthinned Hamamatsu CCD (1044 x 128pixels x 24um) Optical fibers: Multifibre with 100um fibres, input end circular 1mm diam, length: 12m Filters: Mirrors: Front silvered rotating mirror and quartz lens optic. Temperature control of detector: -20 °C	
Instrument performance	Spectral range/resolution: multi band configurable; typical two bands are: alternating 290–363 nm and 400-460; 0.6 nm Azimuthal scan/direct-sun capabilities: no Elevation angle capability: fully configurable; step: < 0.1° Field of view: about 0.5° Typical integration time: 16ms -20s Typical scan duration: 60 s (but flexible)	
Calibration/characterization procedures	Elevation angles: Bubble level on mirror and external laser level Field of view: ? Straylight: <1e-2 ? Dark signal: night spectra or manual scan Line shape: taken from Hg and other line lamp spectra Polarization: 12 m fibre effectively depolarizes incoming light Detector nonlinearity: quantified by comparing observations of a clear sky with and without neutral density filter. Pixel-to-pixel variability: Measured with white lamp.	
Spectral analysis software	STRATO (Lauder, NIWA)	
Supporting measurements	GPS time, Camera possible.	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/100 W on average Internet: 1 IP address, VNC and remote desktop, data volume: 25 MB Outdoor space requirements: 60x40cm flat surface; 35 cm high; weight: 15kg Indoor space requirements: 80 x 130 cm table (1m ²) Maximum distance between telescope and instruments: 10 m Indoor facility: air conditioning (< 28 C)	

Institute: NASA-Goddard (Greenbelt, Maryland) Responsible person(s): Jay Herman Contact details: jay.r.herman@nasa.gov, mobile phone: 443-994-3560 On-Site Person: Elena Spinei (elena.spinei@nasa.gov) Mobile phone: +509-432-4674		
Instrument type: PANDORA-1S (#3)		
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type: AvaSpec-ULS2048x64 (one for 285 – 530 nm) Detector type : 2046 x 64 pixel backthinned non-cooled Hamamatsu CCD Optical fibers: single strand 400um core diameter high OH fused silica fiber, 10m long Filters: spectral filters (U340 and BP300 to remove visible light) Mirrors: no Temperature control of spectrometer and detector UV: 20°C/20°C Temperature control of spectrometer and detector vis: 20°C/20°C	
Instrument performance	Spectral range/resolution UV: 280-540/0.6 nm Azimuthal scan/direct-sun capabilities: yes/yes Elevation angle capability: fully configurable Field of view: circular, 1.6° (sky mode); 2.8° (sun mode) Typical integration time: 2.4ms-300ms (sun), 20ms to 1000ms (sky) Typical scan duration: 20-40s per pointing position	
Calibration/characterization procedures	Elevation angles: based on astronomical calculations and 'sun searches' Field of view: 1.5° FWHM (sky view), 2.8° FWHM (sun view) Stray light: Correction Dark signal: Correction Line shape: Modified Guassian Polarization: no residual polarization measured after 10m fiber Detector nonlinearity: Correction Pixel-to-pixel variability: Corrected	
Spectral analysis software	Blick Software Suite (Python-based)	
Supporting measurements	Laboratory Calibration and Field Calibration	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 220 W Internet: data volume: 100 MB/instrument (200 MB in total), 4 IP addresses, Logmein remote desktop + SSH Outdoor space requirements: circle of 70cm radius space; weight: 20 kg Indoor space requirements: 2 m ² Maximum distance between telescope and instruments: 8m Local support: 2 people for 3 hours + one ladder; people to check on the instrument or clean the entrance window from time to time (PI not present during the whole campaign)	

Institute: National University of Sciences and Technology (NUST), Islamabad, Pakistan		
Responsible person(s): Muhammad Fahim Khokhar and Junaid Khayyam Butt		
Contact details: fahim.khokhar@iese.nust.edu.pk (mobile phone: +92-341-8422377), jkb2ravian@gmail.com (mobile phone: +92-310-4320293)		
Instrument type: Mini MAXDOAS		Nr: CINDI-2.33
Overall design of the instrument	Optical head including telescope: integrated Spectrometer type: Czerny-Turner spectrometer Detector type: 1 dimensional CCD (Sony ILX511, 2048 individual pixels) Optical fibers: n/a Filters: n/a Mirrors: n/a Temperature control of spectrometer and detector: n/a	
Instrument performance	Spectral range/resolution: 320–465/0.7 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable; 1 degree resolution Field of view: ~1.2° Typical integration time: 10-60s Typical scan duration: 20 minutes	
Calibration/characterization procedures	Elevation angles: water/sprit level Field of view: n/a Straylight: n/a Dark signal: manual procedure Line shape: n/a Polarization: n/a Detector nonlinearity: n/a Pixel-to-pixel variability: n/a	
Spectral analysis software	QDOAS (version:2.111) / WinDOAS	
Supporting measurements	GPS but not integrated	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 200 W (4 sockets needed) Internet: 2 IP addresses, Outdoor space requirements: 1.5 x 1.5 m ² ; 5kg Indoor space requirements: 2.5 x 1 m ² desk Maximum distance between telescope and instruments: n/a Laboratory facility: no Local support: mounting Pipes/stands and accessories to fix the instrument	


Institute: Delft University of Technology (TU-Delft), Delft, The Netherlands		
Responsible person(s): Tim Vlemmix		
Contact details: t.vlemmix@tudelft.nl, mobile phone: +31 6 167 900 98		
Instrument type: mini-DOAS Hoffmann uv/vis (#4)		
		Nr: CINDI- 2.34
Overall design of the instrument	Optical head including telescope: integrated Spectrometer type: Ocean Optics usb 2000+ Detector type: Sony ILX511 CCD (2048 pixels) Optical fibers: n/a Filters: n/a Mirrors: n/a Temperature control of spectrometer/detector: n/a	
Instrument performance	Spectral range/resolution: 300-515 / 0.67nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: fully configurable Field of view: 0.4° Typical integration time: 1-2 minutes Typical scan duration: 15-30 minutes	
Calibration/characterization procedures	Elevation angles: calibration of horizon (+/-0.5 degree) via quick horizon-scan (-3 to +3, very short integration time) Field of view: values taken from similar KNIM instrument: scanning over a light source in the laboratory Straylight: not yet characterized Dark signal: characterized in the dark room as a function of detector temperature Line shape: TBD Polarization: not yet characterized Detector nonlinearity: characterized in the dark room as a function of detector temperature Pixel-to-pixel variability: characterized in the dark room as a function of detector temperature	
Spectral analysis software	Own software (Matlab-based)	
Supporting measurements	none	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 5 W Internet: data volume: <50 MB, 1 IP addresses + 2 more if WIFI not available, remote desktop Outdoor space requirements: 75x75x50cm (can be mounted on tripod or a horizontal bar, e.g. next to other KNMI MAXDOAS on tower); weight: 5kg Indoor space requirements: 50x50x50cm (laptop) Maximum distance between telescope and instruments: n/a Indoor facility: table to put laptop on (or, when on tower: n/a) Local support: no	

Institute: Meteorologisches Institut, Ludwig-Maximilians-Universität München, Munich, Germany		
Responsible person(s): Mark Wenig		
Contact details: mark.wenig@physik.uni-muenchen.de, lok.chan@physik.uni-muenchen.de, mobile phone: +49 089 2180 4386		
Instrument type: 2D MAXDOAS EnviMeS (#4)		Nr: CINDI-2.35
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type UV: Avantes AvaBench-75 Spectrometer type vis: Avantes AvaBench-75 Detector type UV: Backthinned Hamamatsu CCD (2048 pixel) Detector type vis: Backthinned Hamamatsu CCD (2048 pixel) Optical fibers: Multifibre (UV), single fibre (VIS), length: 10m Filters: UV bandpass filters (BG3) Mirrors: N/A Temperature control of spectrometer and detector UV: 20°C/20°C Temperature control of spectrometer and detector vis: 20°C/20°C	
Instrument performance	Spectral range/resolution UV: 305–460/0.56 nm Spectral range/resolution vis: 430–650/0.54 nm Azimuthal scan/direct-sun capabilities: yes/yes Elevation angle capability: fully configurable Field of view: <0.5° Typical integration time: 2.5ms -60s Typical scan duration: 15 min	
Calibration/characterization procedures	Elevation angles: tilt sensor Field of view: not yet characterized Straylight: not yet characterized Dark signal: not yet characterized Line shape: not yet characterized Polarization: not yet characterized Detector nonlinearity: not yet characterized Pixel-to-pixel variability: not yet characterized	
Spectral analysis software	DOASIS	
Supporting measurements	Two video cameras, inclinometer	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/20-120 W on average Internet: data volume: 10 GB, 2 IP addresses, remote desktop, VNC, and SSH Outdoor space requirements: telescope 80cm(W)x80cm(L)x50cm(H) Indoor space requirements: spectrometer and controller 80cm(W)x50cm(L)x30cm(H) ~1mx2m desk space for the PC and work Maximum distance between telescope and instruments: 10 m Indoor facility: electricity, internet, air conditioning (<25°C) Local support: one extra people, ladder	

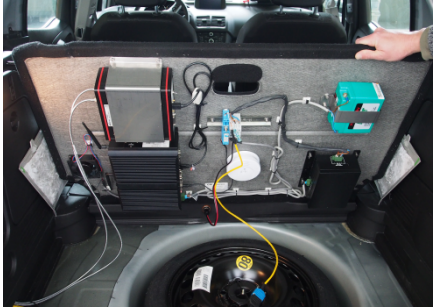
Institute: Department of Physics, University of Toronto, Toronto, Canada Responsible person(s): Xiaoyi Zhao, Kristof Bogнар, Kimberly Strong Contact details: xizhao@atmosp.physics.utoronto.ca, kbognar@physics.utoronto.ca, strong@atmosp.physics.utoronto.ca Kristof Bogнар: 1-416-566-6763 (Toronto) or 06-30-494-8464 (preferred) Xiaoyi Zhao: 1-647-283-9629		 Note: This is a photo of the spectrometer and CCD detector. At Cabauw, it will be deployed outdoors in a box (details below).
Instrument type: PEARL-GBS instrument (MAXDOAS, ZSL-DOAS, and DS)	Nr: CINDI- 2.36	
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type: Jobin Yvon Triax-180 grating spectrometern Detector type: back-illuminated cooled CCD with 2048 x 512 pixels Optical fibers: fibre bundle (37 HOH mapped fibres, spot-to-slit), spot end diameter: ~0.8 mm, length: 6 m Filters: Filter wheel containing one empty spot, 4 metallic neutral density filters (31.6%, 1%, 0.1%, 0.01% transmittance) and a UV diffuser Mirrors: UV-enhanced aluminum (suntracker) Temperature control of spectrometer and detector: 25°C/-70°C	
Instrument performance	Spectral range/resolution: 300–550/0.4 nm Azimuthal scan/direct-sun capabilities: yes/yes Elevation angle capability: fully configurable Field of view: 0.6° Typical integration time: 50-140s Typical scan duration: 12-23 minutes for 9 elevation angles	
Calibration/characterization procedures	Elevation angles: calibrated by levelling the suntracker Field of view: calculated analytically Straylight: determined using a red filter and a halogen lamp Dark signal: determined from a series of closed shutter measurements Line shape: assumed to be Gaussian Polarization: determined using a polarizer and a halogen lamp; fiber bundle mostly depolarizes incoming light Detector nonlinearity: <0.4% as given by the CCD manufacturer Pixel-to-pixel variability: not characterized	
Spectral analysis software	Raw data is processed using in-house MATLAB code and analysis is performed using the QDOAS software	
Supporting measurements	Webcam	
Special needs/requests regarding logistics	Power supply/consumption: 120 V/ 2200 W (10 sockets needed) Internet: no daily data transfer, 6 IP addresses, VNC and SSH Outdoor space requirements: spectrometer will be installed outdoors, inside a box of dimensions 1.1 x 0.9 x 1.2 m ³ (length x width x height), which should be located close (<10 m) to indoor space for laptop computers, weight: 120 kg Indoor space requirements: table space for 3 laptop computers Maximum distance between telescope and spectrometer: 0 m (suntracker is mounted on top of the box containing the spectrometer) Local support: no extra people needed, heavy duty cart would be useful	


Appendix B: Technical characteristics of the static Imaging-DOAS systems

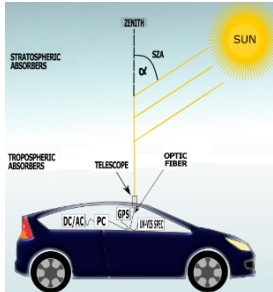
Institute: Institute for Environmental Physics (IUP), University of Bremen, Bremen, Germany Responsible person(s): Enno Peters Contact details: Enno.Peters@iup.physik.uni-bremen.de, mobile phone: +49 171 6761981		Instrument picture
Instrument type: single channel scientific grade imaging-DOAS, telescope mounted on pan-tilt-head for azimuthal scans and zenith (reference) pointing, indoor parts equipped in a 19" rack		
		Nr: CINDI-2.37
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type: Andor Shamrock 303i Detector type: Andor Newton DU940P-BU, 2048x512 pixel (only inner pixels for imaging) Optical fibers: Fibre bundle with 69 sorted single fibres, diameter: 100µm, length: 15m Filters: BG39 Mirrors: no Temperature control of spectrometer and detector: 35°C/-30°C	
Instrument performance	Spectral range/resolution: To be decided/~0.50 nm Azimuthal scan/direct-sun capabilities: yes/n/a Elevation angle capability: fully configurable Field of view: to be decided, vertically approx. 50°, horizontally 1.2° Typical integration time: 10s Typical scan duration: 10 min for complete horizon scan (10° azimuthal steps 0-360° followed by zenith reference)	
Calibration/characterization procedures	Elevation angles: to be decided; probably between -5 and +30 + regular zenith-sky Field of view: white light source in lab Straylight: not yet characterized Dark signal: manually Line shape: HgCd lamp (manually) Polarization: - Detector nonlinearity: white light source in lab, characterization only Pixel-to-pixel variability: white light source in lab, characterization only	
Spectral analysis software	NLIN	
Supporting measurements	Video camera	
Special needs/requests regarding logistics	Power supply/consumption: 220 V/ 350 W on average; 700 W peak Internet: remote desktop + ftp Outdoor space requirements: 1.5 x 1.5 m ² space for telescope tripod outdoors, free view of horizon Indoor space requirements: 1 x 1 m ² space indoors for rack, 80kg, no more than 25°C Maximum distance between telescope and spectrometer: 8 m	


Institute: Technical Research Centre of Finland VTT and Finnish Meteorological Institute (FMI)		
Responsible person(s): Heikki Saari (VTT), Harri Ojanen (VTT) and Johanna Tamminen (FMI), Jukka Kujanpää (FMI)		
Contact details: Heikki.saari@vtt.fi, harri.ojanen@vtt.fi, Johanna.tamminen@fmi.fi, jukka.kujanpaa@fmi.fi		
Instrument type: Imaging spectrometers		Nr: CINDI-2.38
Overall design of the instrument	Optical head including telescope: elevation and azimuth angles fully configurable Spectrometer type: Fabry-Pérot interferometer based hyperspectral imagers for different wavelength ranges in a single telescope mount Detector type: UV enhanced CCD, CMOS (Vis), InGaAs (Nir) Optical fibers: n/a Filters: Interchangeable band pass filters for wavelength range selection and ND filters Mirrors: n/a Temperature control of spectrometer and detector: uncooled	
Instrument performance	Spectral range/resolution: UV instrument uses a tunable transmission comb for matching with trace gas absorbance Azimuthal scan/direct-sun capabilities: yes/yes Elevation angle capability: fully configurable Field of view: 7° full frame Typical integration time: 0.1ms – 100ms Total time for a measurement cycle: 1s - 10s	
Calibration/characterization procedures	Elevation angles: TBD Field of view: TBD Straylight: TBD Dark signal: TBD Line shape: TBD Polarization: TBD Detector nonlinearity: TBD Pixel-to-pixel variability: TBD	
Spectral analysis software	In house software	
Supporting measurements	Ocean Optics HR4000 and NirQuest in the same mount	
Special needs/requests regarding logistics	Power supply/consumption: 230V /100 W Internet: yes (preferably wired) Outdoor space requirements: 1m x 1m for instrument + working area for scientists Indoor space requirements: 1m x 1m x 1m (for overnight storage), desk area for scientists Maximum distance between telescope and spectrometer: n/a Indoor facility: -	

Appendix C: Technical characteristics of the mobile-DOAS systems

<u>Institute:</u> Royal Belgian Institute for space Aeronomy (BIRA-IASB), Brussels, Belgium		
<u>Responsible person(s):</u> Alexis Merlaud, Frederik Tack		
<u>Contact details:</u> alexis.merlaud@aeronomie.be, mobile phone: +32 486 963 937		
<u>Instrument type:</u> Car-DOAS		<u>Nr:</u> CINDI-2.45
Overall design of the instrument	Optical head including telescope: separated; Two telescopes (one for zenith and one for 30° elevation) Spectrometer type zenith: Avantes-2048, Grating UB, 50 um slit, 75 mm bench, coating DUV-800 and OSC-UB Spectrometer type 30° elevation: Avantes-2048, same characteristics Detector type: Sony CCD 2048 linear array Optical fibers: 2 chrome plated brass mono fibers, diameter: 400 μm, length: 2.5 m Temperature control of UV and vis spectrometers and detector: no	
Instrument performance	Spectral range/resolution: 270–500/1.15 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: zenith and 30° elevation Field of view: 2.5° Typical integration time: 30s Typical scan duration: n/a	
Calibration/characterization procedures	Elevation angles: with a light source before the campaign Field of view: with a lamp in the lab before the campaign Straylight: estimated from UV signal during measurements Dark signal: nightly measurements Line shape: Hg-Cd lamp before the campaign Polarization: With a polarizer in the lab before the campaign Detector nonlinearity: with a lamp before the campaign Pixel-to-pixel variability: Avantes spec	
Spectral analysis software	QDOAS	
Supporting measurements	GPS antenna	
Special needs/requests regarding logistics	Power supply/consumption: car battery Internet: n/a Outdoor space requirements: n/a Indoor space requirements: n/a Maximum distance between telescope and instruments: n/a Indoor facility: n/a	

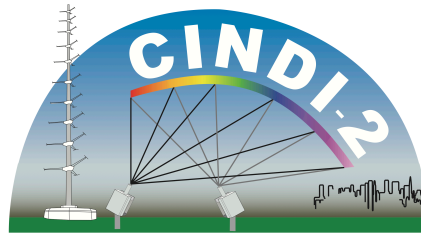
Institute: MPI for Chemistry, Mainz, Germany Responsible person(s): Thomas wagner Contact details: thomas.wagner@mpic.de ; +49 6131 3054700; mobile +49 162 9228450		
Instrument type: Car-MAX-DOAS	Nr: CINDI-2.46	
Overall design of the instrument	Optical head including telescope: integrated in instrument Spectrometer type: Ocean optics USB2000, integrated in instrument Detector type: 1D- CCD, integrated in instrument Optical fibers: monofibre, ca. 1.5m, diameter: 400 μm Filters: yes Mirrors: only inside spectrometer Temperature control of spectrometer and detector: yes	
Instrument performance	Spectral range/resolution: 299 – 451 nm/0.6 – 0.9 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: yes Field of view: 1.2° Typical integration time: 30 or 60 sec Total time for a measurement cycle: 30 to 60 sec	
Calibration/characterization procedures	Elevation angles: water level Field of view: elevation scan Straylight: n/a Dark signal: measurements with telescope covered Line shape: mercury lamp Polarization: n/a Detector nonlinearity: n/a Pixel-to-pixel variability: n/a	
Spectral analysis software	WINDOAS, MDOAS	
Supporting measurements	Video camera, GPS	
Special needs/requests regarding logistics	Power supply/consumption: car battery, external battery Internet: n/a Outdoor space requirements: n/a Indoor space requirements: n/a Maximum distance between telescope and instruments: n/a Indoor facility: n/a	

Institute: University of Galati, Galati, Roumania Responsible person(s): Daniel Constantin Contact details: Daniel.Constantin@ugal.ro, mobile phone: +40726320942		
Instrument type: Car-DOAS		
Overall design of the instrument	Optical head including telescope: separated; zenith geometry only Spectrometer type: UV-Vis Avantes-AvaSpec-ULS2048XL Detector type: Back-thinned CCD image sensor 2048 pixels Optical fibers: one chrome plated brass mono fibers, diameter: 400 μm, length: 3 m Filters: n/a Mirrors: n/a Temperature control of spectrometer and detector: n/a	
Instrument performance	Spectral range/resolution: 280–550/0.7 nm Azimuthal scan/direct-sun capabilities: no/no Elevation angle capability: zenith only Field of view: 1.2° Typical integration time: 30-200ms Total time for a measurement cycle: 10s	
Calibration/characterization procedures	Elevation angles: n/a Field of view: 1.2° Straylight: < 0.3% Dark signal: nightly measurements Line shape: n/a Polarization: by optical fiber Detector nonlinearity: n/a Pixel-to-pixel variability: n/a	
Spectral analysis software	QDOAS	
Supporting measurements	Video camera, GPS and G-Sensor with 3 axes	
Special needs/requests regarding logistics	Power supply/consumption: car battery Internet: WLAN, ftp Outdoor space requirements: n/a Indoor space requirements: n/a Maximum distance between telescope and instruments: n/a Indoor facility: n/a	

<u>Institute:</u> Institute for Environmental Physics (IUP), University of Bremen, Bremen, Germany <u>Responsible person(s):</u> Folkard Wittrock <u>Contact details:</u> folkard@iup.physik.uni-bremen.de, mobile phone: +49 175244350		
<u>Instrument type:</u> mobile 2 channel scientific grade elevation and azimuth scanning MAXDOAS	<u>Nr:</u> CINDI-2.48	
Overall design of the instrument	Optical head including telescope: separated; elevation and azimuth angles fully configurable Spectrometer type UV: Isoplane SCT-320 Imaging Spectrograph Spectrometer type vis: Acton SP2156 Detector type UV: Princeton PIXIS:2KBUV Detector type vis: Princeton PIXIS:100B Optical fibers: Y-type quartz bundle, diameter: 150µm, length: 20m Filters: UG5 (UV only) Mirrors: no Temperature control of spectrometer and detector UV: 35°C/-35°C Temperature control of spectrometer and detector vis: 35°C/-35°C	
Instrument performance	Spectral range/resolution UV: 286–419/0.55 nm Spectral range/resolution vis: 413–524/0.65 nm Azimuthal scan/direct-sun capabilities: yes/no Elevation angle capability: fully configurable Field of view: 1° Typical integration time: 5s; 15s for zenith Typical scan duration: 3 minutes	
Calibration/characterization procedures	Elevation angles: geometric alignment of telescope, horizon scan Field of view: white light source in lab Straylight: not yet characterized Dark signal: nightly measurements Line shape: HgCd lamp in telescope Polarization: - Detector nonlinearity: white light source in lab, characterization only Pixel-to-pixel variability: white light source in lab, characterization only	
Spectral analysis software	NLIN	
Supporting measurements	Video camera, HgCd lamp	
Special needs/requests regarding logistics	Power supply/consumption: 10 kVA, 32 A for whole truck Internet: yes, remote desktop Outdoor space requirements: 8x3 m for whole truck, height of telescope 3.8 m agl Indoor space requirements: n/a Maximum distance between telescope and instruments: n/a	

Appendix D: CINDI-2 General Data Protocol

Second Cabauw Intercomparison of Nitrogen Dioxide measuring Instruments



**Cabauw, The Netherlands
25 August – 7 October 2016**

DATA PROTOCOL

The aims of this protocol are: a) to encourage rapid dissemination of the data and scientific results from the CINDI-2 campaign; b) to uphold the rights of the individual scientists; and c) to have all involved researchers/groups treated equitably. The rules and guidelines with respect to the use of CINDI-2 data are the following:

1. Each PI of participating instrument(s) and/or ancillary data products listed in the Campaign Planning Document (see last version of the document at <http://www.tropomi.eu/science/cindi-2>) should make his/her data available to the whole CINDI-2 consortium, either through the campaign ftp server, or by giving free access to his/her own database. The CINDI-2 consortium is defined as being all scientists/groups participating to the campaign.
2. The CINDI-2 ftp data server will be hosted by KNMI, which will take the responsibility of the server management.
3. All campaign data are and remain the exclusive property of the respective group.
4. All scientists involved in CINDI-2 are to have equal and complete access to all campaign data, including ancillary data products.
5. Data should not be distributed outside the CINDI-2 consortium without prior permission of the corresponding PI(s). This statement is valid during and after the campaign.
6. In order to foster discussions on scientific results during the campaign, participants should make their data available as soon as possible after acquisition, preferably on a daily-basis.
7. Each participating group is invited to attend the workshops and briefings which will be regularly organized during the campaign. During the intensive semi-blind intercomparison part (12-25 September), these meetings will be organized each day at 1pm. Participation is mandatory for the groups involved in the semi-blind intercomparison (see dedicated data protocol).

8. The persons willing to use measurement data from others in scientific papers or presentations should offer the data owner(s) participation and co-authorship. If the data owner(s) refrain(s) from co-authorship, a second option is to mention the data owner(s) in the acknowledgements.
9. The ESA Validation Data Center (EVDC) will provide the ECMWF meteorological fields (analysis and forecast) for the campaign area and period. Participants to the campaign are asked to not distribute these data outside the CINDI-2 consortium, neither to make commercial use of them.

The undersigned agrees to the conditions of this data protocol.

Signature :

Date :

Name :

Position (PI, Post-doc, student...) :

Address :

.....

.....

E-mail :

Please return to:

BIRA-IASB

3, Avenue Circulaire

B-1180 Brussels

Belgium

Attn: Dr François Hendrick francois.hendrick@aeronomie.be

Appendix E: EVDC Data Protocol

Protocol for exchange of data for the ESA Validation Data Centre – EVDC for the Sentinel-5P mission

The aims of this protocol are to encourage rapid dissemination of results for scientists involved in ESA funded measurement campaigns and to respect the rights of the individual scientists:

- i) Preliminary data should be made available to the EVDC data centre at NILU as soon as possible.
- ii) Old data should be replaced as soon as possible by corrected data in the EVDC database. The descriptive information in the data file shall also reflect such an update.
- iii) All EVDC data are to be submitted in the HDF version 4, 5 or nc formats. All files should be in conformity with the GEOMS metadata guidelines.
- iv) The ownership of data remains with the data originator.
- v) Each Principal Investigator has access to the database, but any publication resulting from its use requires prior written permission from the owner.
- vi) Access to the EVDC data hosted at NILU is granted only after having signed this protocol. Re-distribution of data is nominally not allowed and requires written permission from ESA.

The undersigned agrees to the conditions of this data protocol (PLEASE PRINT CLEARLY)

Name :

Position (PI, Student, etc) :

Project or AO (Name, Number) :

E-mail :

Address :

:

:

Date :

Signature :

Please return to:

NILU

P.O. Box 100

N-2027 Kjeller

NORWAY

Attention: NADIR team

Tel:

(+47) 63 89 80 00

E-mail:

nadirteam@nilu.no