NILU Norsk institutt for luftforskning
Norwegian Institute for Air Research

Fingerprint of Volatile Organic Compounds in the Quintero-Puchuncaví area

Results from Screening Campaign

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ABSTRACT

This report presents the results from a screening study of volatile organic compounds (VOCs) in the Quintero-Puchuncaví region (Chile). Two different methods were selected, one quantitative (canisters samplers / analysis by Medusa/GC-MS) and a second semi-quantitative (Tenax TA/analysis by GC-MS). NILU evaluated the results of 4 compounds (methyl chloroform, nitrobenzene, iso-butane and toluene), which were previously reported at very high concentrations and intensively discussed in the media. NILU's measurement results show much lower concentrations and it was concluded that the former measurements were done with a significant error in the calibration. The average concentration of ambient benzene was 1.0 µg/m³ at industrial areas and 0.3 µg/m³ at the residential/background areas, both lower than international limit values. The main compounds emitted from the industrial areas are light hydrocarbons, which were detected at low concentration levels.

NORWEGIAN TITLE

Fingeravtrykk av flyktige organiske forbindelser i Quintero-Puchuncaví. Resultater fra kartlegging målkampanje

KEYWORDS

Industrial pollution	VOC - volatile organic compounds	Air Quality

ABSTRACT (in Norwegian)

Rapporten presenterer resultatene fra målinger foretatt i Quintero-Puchuncaví regionen (Chile) for å kartlegge flyktige organiske forbindelser (VOC). To ulike metoder ble benyttet, en kvantitativ (kanister prøvetaker / analyse med Medusa/GC-MS) og en semi-kvantitativ (Tenax TA / analyse med GC-MS). NILU evaluerte resultatene av 4 forbindelser (metylkloroform, nitrobenzen, isobutan og toluen), som tidligere rapporter viste meget høye konsentrasjoner av og som har vært mye omtalt i media. NILUs måleresultater viser mye lavere konsentrasjoner, og konkluderer med at målingene som ble foretatt tidligere ikke ble riktig kalibrert. Den gjennomsnittlige konsentrasjonen av benzen var 1,0 µg/m³ i industriområder og 0,3 µg/m³ i bolig- / bakgrunnsområder, begge lavere enn internasjonale grenseverdier. Hovedforbindelsene i utslippene fra industriområdene er lette hydrokarboner, som ble påvist ved lave konsentrasjonsnivåer.

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Preface

This scientific report is the final report of the project “VOC - Screening field sampling campaign in the Quintero-Puchuncaví area (Chile)”. The project is funded by the Ministry of Environment of the Government of Chile. In August and September 2018, in the region of Quintero-Puchuncaví (Chile), a series of episodes were reported when the population in the vicinity of the industrial sector showed severe health effects. Around 700 people were reported with headaches, vomiting, diarrhea and neurological symptoms. These episodes were presumably associated with emissions of Volatile Organic Compounds (VOCs) from the industrial area around the Quintero-Puchuncaví Bay.

The project aimed at carrying out a screening study of volatile organic compounds in the area of Quintero-Puchuncaví (Chile) and establish, based on the screening results, a preliminary fingerprint of organic gaseous pollutants in the region. The screening study focuses mainly on VOCs including halocarbons, hydrocarbons, alcohols, organic acids, ketones/aldehydes, aromatic compounds, compounds with chlorine or nitro-groups, and the very light polycyclic aromatic hydrocarbons (PAH), among other unknown organic compounds. This project will not be able to explain the reasons behind the events that previously occurred.

The focus of this study is on the **source strength** from fugitive VOC near to ground emissions and their **impact** on the nearby residential areas. The focus is also to establish **fingerprints** of the industrial VOC emissions and the detection of those fingerprints in air masses in the nearby areas. There is **no health competence** within the project group, thus the results are evaluated according to existing and established international limit values on VOCs. It is important to highlight that there are no measurements of SO_2 or particles carried out within this study.

The outcome of this study will be used to recommend future sampling programs in the area as well as recommendations for establishing a Chilean laboratory for analysis of VOCs in industrialized and urban areas.

The work has been carried out by Dr. Norbert Schmidbauer and led by Dr. Susana López-Aparicio from NILU – Norwegian Institute for Air Research (Norway). The sampling team in Chile was Rodrigo A. Romero Maldonado, Rodrigo Carrasco and Ronald Opazo. In addition, sampling was also carried out in schools with the support of Mr. Tomas Opazo Cespedes (Director of Sargento Aldea School in Ventanas), Mrs. Fanny Contreras (Director of La Greda School in Quintero) and Mrs. Catalina Orlandini (Director of Santa Filomena School in Puchuncaví).

Thanks to Dr. Rodrigo A. Romero, Technical Adviser to the Ministry of Environment (Chile), for his support and cooperation during the measurement campaign and the entire project duration. The quality control at NILU has been carried out by Dr. Tore Flatlandsmo Berglen.

Description of NILU – Norwegian Institute for Air Research

NILU - Norwegian Institute for Air Research (NILU, est. 1969) is an independent non-profit private research foundation with approximately 180 employees. The institute has since its foundation conducted environmental research with emphasis on the sources of airborne pollution, atmospheric transport, transformation and deposition, as well as on assessment of pollution effects on ecosystems, human health and materials. NILUs research in recent years has focussed on better understanding the interactions between climate change and atmospheric composition change, as well as the quantification of environmental effects and the analysis of the benefits of co-control measures for air pollution and climate change. A main priority for NILU's research is to improve the quality, scope and relevance of air and climate change data and assessments, in order to support national and international authorities developing environmental policies. NILU-scientists publish approximately 150 peer reviewed articles annually, and several of its research activities has been periodically reviewed on behalf of the Research Council of Norway and ranked highest nationally.

Core research activities at NILU are primarily funded by national and international research projects. In particular, NILU has a major project portfolio for the EU Research related Framework programs, with more than 120 projects since the start of the 2nd Framework Programme. NILU has coordinated or participated in many international environmental research projects. NILU has led and/or participated in some of the key European citizen science and citizen observatory projects in the field of monitoring and improving air quality, for example, hackAIR, CITI-SENSE, Citi-Sense-MOB and ENVIROFI.

In addition, NILU works for international programmes and projects under IGBP, UNECE, the World Bank, WMO, WHO and EC. Many of these projects involve an important capacity building component in different parts of the globe comprising planning, installation and operation of air quality monitoring and management programmes. NILU functions as a Chemical Coordinating Centre of the UNECE, CLRTAP and EMEP programs, it is the lead partner of the European Environment Agency Topic Centre on Air pollution, Transport, Noise and Industry, and it operates a national reference laboratory for Air Quality. NILU holds several accreditations including ISO 9001, and operates several International databases and hundreds of project portals.

NILUs Environmental Chemistry laboratory has staff of 50 persons and conducts research and provides a wide range of services in organic and inorganic chemistry, including country support to monitoring in Europe and Norway, employing a number of accredited methods. NILU has also significant infrastructure in support of national and international air quality monitoring and monitoring instrumentation development, including several calibration laboratories and a climate box for air quality micro-sensor systems testing. In addition, NILU operates large systems for information and communication technologies, both for own use and for external clients (projects, international conventions, national databases).

NILU scientists are currently active members of thirteen CEN committees (European Committee from Standardization), and contribute to work in Scientific Committees on European level such as the Scientific Committee for Consumer Products.

Abbreviations

BTEX	Benzene-Toluene-Ethylbenzene-Xylenes
GC-MS	Gas chromatography–mass spectrometry
NILU	Norwegian Institute for Air Research
ppm	Parts per million, 10^{-6} mixing ratio, i.e. 1 molecule out of 1 000 000 molecules
ppb	Parts per billion, 10^{-9} mixing ratio, i.e. 1 molecule out of 1 000’000 000 molecules
ppt	Parts per trillion, 10^{-12} mixing ratio, 1 molecule out of 1 000 000 000 000 molecules
TWA	Time Weighted Average
VOC	Volatile Organic Compounds

Units

Mixing ratio	Parts per Million (ppm)	Parts per billion (ppb)	Parts per trillion (ppt)
Mixing ratios describes how many molecules are of a certain component. E.g. % (per cent) means parts per hundred, ppm: parts per million, how many molecules out of 1’000’000 molecules, ppb: parts per billion, how many molecules out of 1’000’000’000 molecules, ppt: parts per trillion, how many molecules out of 1’000’000’000’000 molecules.			
Concentration	**Milligrams per cubic meter (mg/m^3)**	**Microgram per cubic meter ($\mu g/m^3$)**	**Nanogram per cubic meter (ng/m^3)**
Concentration describes the mass of a component per unit volume. It is possible to calculate from mixing ratio to concentration, and vice versa. The conversion depends on the molecular weight of the compound. Milli: 10^{-3}, 1/1000, micro: 10^{-6}, 1/1000’000, nano: 10^{-9}, 1/1000’000’000			
Examples:			
Ethyne (Acetylene)	1 ppm ≈ 1 mg/m^3	1 ppb ≈ 1 $\mu g/m^3$	1 ppt ≈ 1 ng/m^3
Benzene	1 ppm ≈ 3 mg/m^3	1 ppb ≈ 3 $\mu g/m^3$	1 ppt ≈ 3 ng/m^3
Xylene	1 ppm ≈ 4 mg/m^3	1 ppb ≈ 4 $\mu g/m^3$	1 ppt ≈ 4 ng/m^3

Contents

Contents

Summary

In this report, NILU presents the results obtained in three measurement campaigns, which were performed as a first screening study of volatile organic compounds (VOCs) in the Quintero-Puchuncaví region. The aim of the study was to characterize the fingerprint of near ground VOC-emissions from the industrial areas in the region, and its potential impact on nearby residential areas and nearby schools. The screening study will focus on halocarbons, hydrocarbons, alcohols, organic acids, ketones/aldehydes, aromatic compounds, compounds with chlorine or nitro-groups, and the very light polycyclic aromatic hydrocarbons (PAH), among other unknown organic compounds. Two different methods were selected, one quantitative that provide high precision and accuracy on the concentration of targeted compounds (canisters samplers and chemical analysis by Medusa cryo-trapping followed by GC-MS) and a second semi-quantitative method to identify unknown organic compounds (sampling on Tenax TA adsorption tubes and chemical analysis by automated thermo desorption followed by GC-MS).

Samples in the areas around the Quintero – Puchuncaví industrial complex and Concón were taken by a team of three persons from the Ministry of Environment supported by a scientist from NILU during some of the days. Air samples were taken at 17 different locations in the Quintero – Puchuncaví area and at 11 locations in the Concón area.

Samples were taken following four different strategies:

1) Identifying plumes by odor sensing of the sampling team - as close as possible to the industrial areas and under low wind conditions in order to capture the plumes as undiluted as possible;
2) Whenever plumes out of the industrial areas pointed towards residential areas or schools, samples were also taken at those areas;
3) Leaving equipment at schools and residential homes for sampling during periods of odors;
4) Diffusive (passive) sampling for average measurements over longer time periods.

Two different sampling and analytical methods were used. The first method looked for 20 halogenated compounds (including methylchloroform), 4 sulfur containing compounds (including hydrogen sulfide) and 14 light hydrocarbons including ethane, propane, butanes and pentanes, as well as acetylene, ethene and propene and the aromatic compounds benzene, toluene, ethylbenzene and xylenes (BTEX). This method targets only those compounds, thus other compounds are not identified. Samples were taken in evacuated Summa polished stainless steel canisters and thereafter analyzed, after a pre-concentration step, in a Medusa cryo-focusing unit with GC-MS in SIM mode. The method is quantitative (determines concentration of the compounds) and provide data with high precision and accuracy. Each sample is calibrated with standards from international global networks (i.e., AGAGE and NOOA or NPL) before and after each sample run. The second method aims at identifying unknown VOCs after sampling on an adsorption[1] tube. The method is semi-

[1] **Adsorption** is the process in which the gas molecules sticks to a surface of the adsorbent (no chemical reactions). **Absorption** is the process in which the gas is dissolved by a liquid or a solid (absorbent), including chemical reactions.

quantitative, but calibrated with toluene in order to have a common reference point. Tenax TA as a universal adsorbent was chosen in order to have a wide spectrum of compounds, which can be captured and released with thermos-desorption. The VOC-identification is done with GC-MS in scan mode using Mass Spectra Library together with a Retention Time Index database.

Summary results regarding the four compounds discussed in the media
Measurements of very high ppm (part per million) levels of methyl chloroform, nitrobenzene, isobutane and toluene done with a MIRAN instrument, were extensively discussed in Chilean media. Hydrogen sulfide (H_2S) was also discussed as a possible pollutant in the media. The measurements of methyl chloroform during the campaigns carried out in this study show less than 2 ppt (parts per trillion), which is several million times lower than the concentrations discussed in the media. Methyl chloroform measured in all samples show global atmospheric background concentration of less than 2 ppt. This compound has been measured at 10 different background sites around the globe with high precision and accuracy every second hour since it was forbidden to produce and use within the Montreal Protocol (1989). The measurements of AGAGE and the National Oceanic and Atmospheric Administration (NOAA) show no production or use in the last decades. It is very unlikely that methyl chloroform could have shown such high concentrations in Chile.

NILU did not find nitrobenzene in any sample with a measurement method with a detection limit of 100 ppt (detection limit means the method cannot detect mixing ratios below 100 parts per trillion).

In the project:
The isobutene-levels were between 0.1 and 15 ppb and never in the ppm ranges.
Toluene-levels were between 0.2 and 5 ppb and never in ppm ranges.
H_2S-levels were between 0.1 and 0.4 ppb.

Summary VOC results for the Quintero – Puchuncaví industrial area
The main compounds emitted from the industrial areas are light hydrocarbons, which were detected at low concentration levels. The sum of the 14 measured hydrocarbons was below 25 µg/m^3 in background areas and the levels rose to about 200 µg/m^3 during episodes where the sampling team could perceive hydrocarbon odor. Given normal dispersion conditions, industrial plumes are diluted close to background levels within a distance of some hundred meters from the source. The fingerprints from the industrial sites could not be found in any of the samples taken in the residential areas or at the three schools in Quintero and Puchuncaví.

NILU could not identify any plumes coming out of the area of the most northern parts of the industrial area, meaning that AES GENER, Cementos Melon and Codelco Ventanas are not contributing considerably to near ground fugitive VOC emissions.

The sum of other VOCs taken by Tenax adsorption tubes ranged from 50 µg/m^3 in the background/residential sites to 100 -- 180 µg/m^3 close to the industrial site but with a majority of samples between 30 and 80 µg/m^3. These levels are comparable to VOC levels both indoors and outdoors in cities.

Summary VOC results for Concón industry al area
The situation in Concón is different from that in Quintero-Puchuncaví. The source strength of the refinery has a larger impact on the nearby residential area even in summer time. The sum of the 14 hydrocarbons was as high as 325 µg/m^3 during nighttime and low wind speed conditions. Those situations were quite local (changing from street to street) and changed fast during the night, but the plume could be sensed due to a strong hydrocarbon odor. Peak concentrations of VOCs were up to 2000 µg/m^3 (2 mg/m^3) at a residential house.

Summary VOC fingerprints
The VOC-emissions from the industrial areas are mainly due to evaporation processes from oil and gas related products. Acetylene (ethyne) is a compound which has no natural sources – there is no acetylene in the gas or oil products evaporating at the industrial sites. The main source for acetylene are combustion processes like those from car engines. **Therefore the hydrocarbon to acetylene ratios are very different for plumes coming out of the industrial areas than for air masses at background sites or residential areas.** The hydrocarbon to acetylene ratios are a very useful tool to evaluate whether and to what extent the emissions from the industrial areas are directly influencing the air at the residential areas. The three measurement campaigns were done during spring and summer time. Meteorological conditions during summer time are usually better than in winter in order to disperse pollutants, therefore emission plumes from the industrial areas will be more diluted towards the residential areas in the summer. On the other side, the evaporations during the hottest time of the year should give the highest concentrations from the industrial sources. Giving normal dispersion conditions and the distance to the nearby residential areas, the VOC-concentrations of the plumes out of the industrial areas need to be in the very high µg/m^3 or lower mg/m^3 range in order to enable detection of the influence the VOC-plumes at the residential sites. During the three campaigns, the source strength of the emissions were never high enough to influence the air of nearby surroundings in a measurable way. The ratios of hydrocarbon to acetylene in air masses out of an industrial area are different from those in background or urban air masses – that, in case of high VOC-emissions from the industrial sites, it should be possible to measure and quantify the influence on the nearby domestic areas in Quintero and Puchuncaví.

Fingerprint of Volatile Organic Compounds in the Quintero-Puchuncaví area

Results from Screening Campaign

1 Introduction

1.1 Volatile Organic Compounds

Volatile organic compounds (VOCs) include a wide variety of organic chemical that have a high vapor pressure and subsequently high volatility. VOCs are in liquid phase under normal atmospheric conditions. However, as they have a high vapor pressure, they will also be present in the air above the liquid phase. Examples of VOCs are hydrocarbons (e.g., propane, butane, benzene, toluene, xylene), alcohols (e.g., methanol, ethanol, propanol), aldehydes and ketones (e.g., formaldehyde, acetaldehyde, acetone), and organic acids (e.g., formic acids, acetic acids, fatty acids).

VOCs may have a natural or anthropogenic origin. The most important anthropogenic sources are from fossil fuels, through combustion or evaporation, biofuels (e.g., heating and cooking), consumer products (e.g., solvents, refrigerants, paints, building materials) or biomass burning. The global VOC emissions of anthropogenic origin are estimated to be around 200 million tons C/y. The main sources of biogenic VOCs are vegetation, soil and the ocean. The global VOC emissions of natural origin are estimated to be between 400 and 1200 million tons C/y.

1.2 Limit values for VOCs

There are no limit values for VOCs in outdoor air, with the exception of benzene which is a potential carcinogenic compound (Table 1). Previously, limit value for total sum of VOC in outdoor air existed at 400 µg/m^3. However, this limit was removed due to fact that no health issues were documented for the total sum of VOC. The European AQ Directive (EU Directive 2008/50/EU; Table 1) established limit value for benzene to be met by the 1st of January 2010.

Table 1: Benzene limit value establish by the European Air Quality Directive (EU Directive 2008/50/EU).

Pollutant	Concentration	Averaging period
Benzene	5 µg/m^3	1 calendar year

Limit values are established for occupational exposure (indoor environment) and for the protection of human health. Examples of regulatory limits for benzene, xylene and propane are shown in Table 2 as values in ppm and mg/m^3. These values are established for 8 hours average time (TWA). Comparing the limit value for benzene in outdoor air (yearly average 0.005 mg/m^3) and the occupational exposure limit (8 hour average 3 mg/m^3) – there is a factor of 600 between those limit values.

Table 2: Regulatory limit values for occupational exposure to benzene, xylene and propane (8 hours TWA). The values for other organic compounds can be obtained in OSHA (2019).

Compound	Regulatory limit (OSHA PEL) - 8-hours TWA	
	ppm	mg/m^3
Benzene	1	3
Xylene (o-, m-, p-isomeres)	100	435
Propane	1000	1800

1.3 Purpose of the study

This study focus on an industrial area in Chile, in the region of Quintero-Puchuncaví, characterized by industrial activities (i.e., power generation, metal industry, petrochemical industry). To our knowledge, there is no study that provides information about ambient VOCs and potential contribution from the industrial areas in Quintero-Puchuncaví, using the stainless steel Canister-Tenax tubes approach. This approach (canister and adsorption tubes) has never been used in the region. However, there are some reports which include few VOC measurements using adsorption tubes.

In August and September 2018, in the region of Quintero-Puchuncaví (Chile), a series of episodes were reported when the population in the vicinity of the industrial sector showed severe health effects. Around 700 people were reported with headaches, vomiting, diarrhea and neurological symptoms. This episodes were presumably associated with the emissions from the industrial area around the Quintero-Puchuncaví Bay. A preliminary investigation in the area was carried out with an IR-spectroscope based portable equipment (MIRAN SapphIRE, Thermo Fisher Scientific). The results from these measurements indicated very high concentrations (ppm levels) of methyl chloroform, nitrobenzene, isobutane and toluene. Methyl chloroform has been reported to have short and long term effects in human health. Methyl chloroform is one of the compounds included in the Montreal Protocol on Substances that deplete the ozone layer, agreed in 1987. The Montreal Protocol stipulates that the production and use of chloroflourocarbons (CFCs), halons, carbon tetrachloride and methyl chloroform are to be phase out by 2000 or 2005 in the case of methyl chloroform. Nitrobenzene has not been detected in ambient air and exposure may occur within industries that produce or use nitrobenzene (occupational exposure), in the vicinity of industries that produce nitrobenzene or where this VOC is disposed. Toluene is commonly used as a solvent or additive in gasoline, and the largest sources of toluene to the atmosphere are industrial emissions, traffic and biomass burning including cigarette smoke.

This report summarizes the results obtained in three measurement campaigns, which were performed as a first screening study of volatile organic compounds (VOCs) in the region. The aim of the study was to characterize the fingerprint of organic gaseous pollutants in the region, and its potential association with fugitive emissions from the industrial area. The screening study will focus on halocarbons, hydrocarbons, alcohols, organic acids, ketones/aldehydes, aromatic compounds, compounds with chlorine or nitro-groups, and the very light polycyclic aromatic hydrocarbons (PAH), among other unknown organic compounds. Two different methods were selected, one quantitative that provide high precision and accuracy on the concentration of targeted compounds (i.e., canisters samplers and chemical analysis by Medusa – GC-MS) and a second method semi quantitative to identify unknown organic compounds (i.e., Tenax TA adsorption samplers and chemical analysis by GC-MS).

2 Area of study

The municipalities of Quintero and Puchuncaví are located in the central part of Chile in the Valparaiso Region (Figure 1), which has the second highest population and the fourth smallest area. Thus, Valparaiso is the most densely populated region in Chile after Santiago Metropolitan Region. The area of interest is centered around the Quintero bay (Figure 1), where the industrial complex is located in the border between both municipalities Quintero and Puchuncaví. In the northern side of the complex (Ventanas), the industrial activities consist mainly of coal power plant generation, metallurgic (copper smelter) and the production of cement and asphalt. On the central part of the bay, the main industrial activities are the handling, storage and distribution of petrochemical products (More detailed information in Table 3). The Concón industrial complex is located south Quintero and the industrial activity is mainly oil refinery including over 20 stacks of about 30 and 55 meters.

From a meteorological point of view, the central part of Chile is located in a transition zone with marked daily and seasonal variations in temperature, precipitations, winds and cloud cover. The prevailing winds are southwest throughout the year, and northwest winds occur frequently in winter (for more details see Gallardo et al., 2000). In the area of Quintero-Puchuncaví, the prevailing winds are from the west with certain occurrences from east and northeast characterized by low wind speeds. The area of Concón is situated south of Quintero (Figure 1 left). The prevailing local wind direction in the Concón area is evenly distributed between westerly and easterly winds.

Figure 1: Location of the area of study. The Valparaiso region (left; Modified from d-maps.com) and the location of the industrial activities in the Quintero-Puchuncaví (right; source: mongabay.com). The red square on the left figure represents the area zoom-in on the right figure.

Table 3: List of the most important industrial facilities in the Quintero – Puchuncaví area and short description of the type of industrial operations and emission control technologies. Source: information reported by the industrial facilities to the Ministry of Environment.

Name	Description
AES GENER (“Electrica Ventanas”)	Coal thermo power plant (4 units) located in Puchuncaví municipality. The emission control technologies include desulfurization, particle filter systems and tangentially fired combustion techniques to reduce NO_x emissions.
CEMENTOS MELON	Cement factory
CODELCO VENTANAS S.A.	Copper smelter refinery that produces cathode copper, and gold, silver and selenium from the anode left over from the refining process. The gases produced during the production are captured and processed in a sulphuric acid plant to produce commercial sulphuric acid.
OXIQUIM S.A.	Petrochemical facility. The main operations are loading/uploading of bulk liquid tankers from its marine terminal in the bay of Quintero, transfer to the storage facilities and distribution for the industry and mining sector. A list of the products in storage and potential sources of VOCs is presented in Appendix A.
GASMAR	Liquefied petroleum gas (LPG) storage facility. Commonly, LPG is mainly propane, butane or a mix of both. The main operation is the uploading of LPG from tankers at the OXIQUIM marine terminal, the storage in refrigerated tanks (total capacity 145 000 m^3) and distribution through pipeline to the Metropolitan region or by trucks to different costumers.
ENAP	Diesel and Liquefied Natural Gas (LNG) storage facility. LNG is mainly methane. The main operation is the uploading of LNG at the marine terminal, the storage and regasification.
GNL	Storage and regasification of LNG
COPEC	Storage of gas and fuels
SHELL	Storage of gas and fuels
ENDESA	LNG/Diesel Thermo power plant

3 Methodology

3.1 Sampling sites and strategy

The sampling site and the design of the measurement campaign was decided in close cooperation between NILU and the Ministry of Environment. Over 10 meetings (videoconference) took place to get a full understanding of the area subject to study and plan the field campaign. A visit from Rodrigo A. Romero Maldonado the week 29th – 31st October (2018) to NILU was supported by meetings with NILU experts in meteorology and air pollution monitoring in industrial areas to design the field campaign.

Based on the problems detected among the population in Quintero-Puchuncaví regarding odor and the type of materials stored in the industrial area, it was decided to focus on volatile organic compounds (VOCs) and a screening sampling campaign that can provide information about the fingerprint of organic pollutants in the region. The study includes halocarbons, hydrocarbons, alcohols, organic acids, ketones/aldehydes, aromatic compounds, compounds with chlorine or nitro-groups, and the very light polycyclic aromatic hydrocarbons (PAH), among other unknown organic compounds.

Figure 2 shows the location of the sampling points in the areas of Quintero-Puchuncaví and Concón. The area of Concón was included in a later stage of the project. Both Quintero-Puchuncaví and Concón are characterized by intense industrial activity but they encompass different industrial processes. In Quintero-Puchuncaví, apart from the thermal power plan and the copper smelter, the industrial processes are dominated by loading/uploading, storage and distribution of petrochemical products, whilst Concón industrial area is characterized by production processes (i.e. refinery). Based on the location of the industrial facilities and the prevalence meteorological conditions in the area (i.e., wind direction and speed), it was decided to carried out the sampling along transverses that allow the potential identification of main contributing sources among the industrial facilities (e.g., points 14A, 10A, 11A, 12A in Figure 2). In addition, sampling points at certain distance from the industrial facilities (e.g., 16A and 7A in Figure 2) were selected to capture the potential contribution downwind, and sampling points at the residential areas and schools (e.g., 1A and 9A in Figure 2).

A first sampling campaign was carried out in the week 5th to 9th November 2018, the second between 13th and 15th November and a third campaign was performed between 16th and 18th January 2019. The samples were taken by a team of three persons from the Ministry of Environment supported by a scientist of NILU during some of the days. Air samples were taken at 17 different locations in the Quintero – Puchuncaví region and at 11 locations in the Concón area. Samples were taken within very few meters from the fences of the industrial sites in order to capture the plumes as undiluted as possible. In addition, the samples were taken at different scenarios in low wind situations (1 to 5 m/s) covering different sectors of the industrial area. Whenever the wind direction pointed to some of the residential areas or the three different schools in the area, samples were also taken at those sites.

Figure 2: Sampling points in the area of Quintero – Puchuncaví (top) and Concón (bottom, where North is to the right of the picture).

- **SUMMARY: 4 SAMPLING STRATEGIES**
- Sampling as close as possible to the industrial areas at low wind conditions. This was preferably performed when the sampling team could identify odors, but also under normal activity conditions inside the industrial areas.
- Sampling when the wind direction pointed towards some of the residential areas or the schools in the area, where also samples were taken.
- Sampling supported by citizen participation. Equipment was provided to schools and residents for sampling during periods where citizens could perceived odors or strange smells.
- Passive sampling over longer time periods for average measurements.

3.2 Samplers and analytical methods

Two different sampling methods were used in the campaigns employing two different types of samplers (Figure 3).

Figure 3: Samplers employed in the measurement campaigns. Canisters (left) and Tenax TA adsorption tube (right).

3.2.1 Sampling and analytical method I

The first method targeted 20 halogenated compounds (including methyl chloroform), 4 sulfur containing compounds (including hydrogen sulfide) and 14 light hydrocarbons including ethane, propane, butanes and pentanes, as well as acetylene, ethene and propene and the aromatic compounds benzene, toluene, ethylbenzene and xylenes (BTEX). This method targets only those compounds, and therefore other compounds are not identified. Samples were taken in clean steel canisters (Figure 3 left) and thereafter analyzed, after a pre-concentration step, in a Medusa cryo focusing unit with GC-MS in SIM mode. The method is quantitative and provide data with high precision and accuracy. Each sample is calibrated with standards from international global networks (AGAGE and NOOA) before and after each sample run. Before and after each sample run on the Medusa, there is a standard run from a working standard. A working standard is an ambient air standard, which again is carefully calibrated against a station standard. A station standard is also ambient air filled at AGAGE's calibration facility at Scripps Institution of Oceanography UC La Jolla. Station standards are calibrated before shipment to the stations against a second generation of standards, again are calibrated against the "Gold Standard" which is a gravimetrically prepared standard. Station standards are returned to Scripps for recalibration before they are empty. All Medusas receive their calibration values directly from Scripps via the common data handling software and cannot be altered by the individual Medusa users. For some of the compounds there are common gravimetrically standards from National Oceanographic and Atmospheric Administration (NOAA, Boulder Colorado) or from National Physics Laboratory (London).The precision and accuracy of the results are usually within less than one percent when running in online mode. The use of evacuated electropolished stainless steel canister as sampling medium is a well proven method and will not alter the precision or accuracy in a significant way. The entire method is described in Miller et al., (2008).

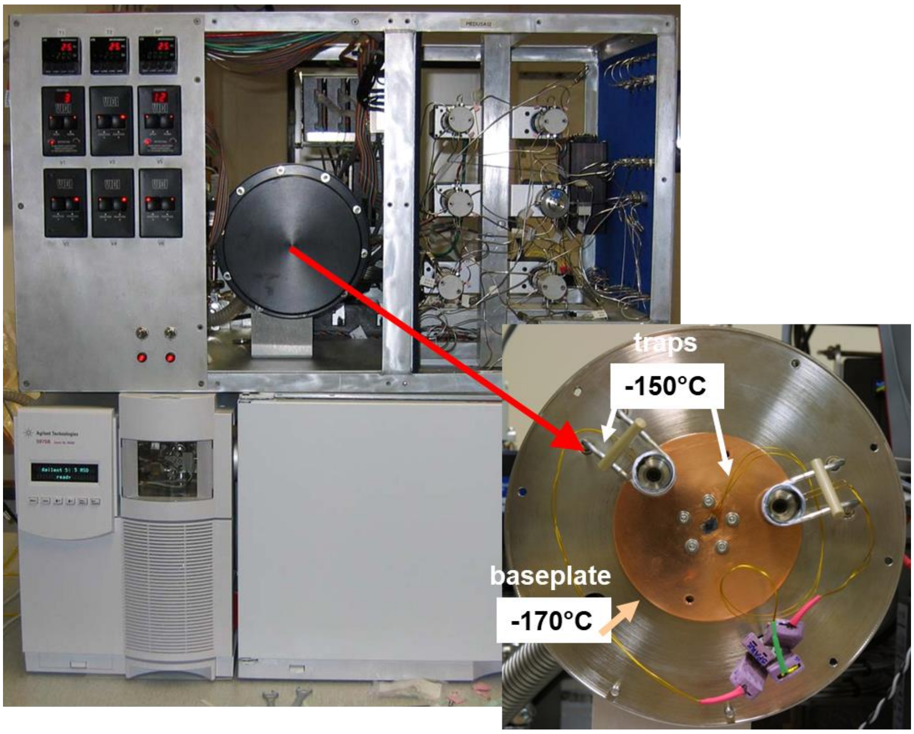

Figure 4: *Medusa (Source: http://agage.eas.gatech.edu/instruments-gcms-medusa.htm. Miller et al., 2008.)*

3.2.2 Sampling and analytical method II

The second method aims at identifying unknown VOCs after sampling on an adsorption tube. The method is semi quantitative, although it is calibrated with toluene in order to have a common reference point. Since Tenax sampling and analysis is aiming at on beforehand not known compounds or concentration ranges – the calibration routines are different. Using toluene as a standard compound has several reasons. It is measurable in nearly every sample taken around the globe both indoors or outdoors. It is a medium volatile compound in the VOC range – not very influenced by sampling breakthrough effects, and not too heavy boiling to stick to surfaces within the analytical instruments. It is also easy to make standard calibration solutions in suitable solvents like methanol. Tenax TA as a universal adsorbent was chosen (Figure 3 right) in order to have a wide spectrum of compounds, which can be captured and released with thermo desorption. Using an automated thermal desorber (Markes UNITY) – cold-trapping at -30°C - gas chromatographic separation on DB 1701 – 1 µm – 50 m and an Agilent mass spectrometer with EI detection in scan mode.

The VOC identification is done with automated pre search in two large Mass Spectra Libraries (Wiley and NIST). The pre search suggestions are then cross checked manually towards NILUs own Retention Time Index database. NILU's RT index database contains about 1000 of the most common VOCs – built up during the last 35 years – verified compound injection with standards made of pure chemicals. The use of retention time in addition to automatic library search is a necessity to avoid misidentification of compounds with very similar mass spectra. Compounds with a confidence values of less than 85 % are also checked for possible overlapping peaks with peak purity tools.

4 Results and Interpretation

4.1 Sulphur containing compounds

Sulphur compounds can be sensed by humans down to very low concentrations. All results are shown in Appendix B. Table 4 and Figure 5 shows the average values of the sulphur containing compounds in addition to the maximum and minimum values.

The mixing ratios found in this project are very low, the highest measured value of H_2S was below 1 ppb. This is clearly below the odor threshold of those compounds, which in the case of H_2S is between 10 ppb and 1500 ppb. There are no indications for large emissions of those compounds during the three measurement campaigns. Occupational limit values are in the range of 10 ppm (10 000 ppb) or above.

Table 4: Average mixing ratio of sulphur containing organic compounds in the samples collected in the area of Quintero Puchuncaví. StaDev: standard deviation. Max: Maximum value. Min: Minimum value. N: number of samples Unit: ppt (parts per trillion).

Unit: ppt	COS	H_2S	CH_3SH	CS_2
Average	726.8	181.3	8.8	90.6
StaDev	121.6	124.6	9.0	54.1
Max	1252.5	853.6	60.1	231.1
Min	599.6	83.7	3.7	25.2
N	47	47	47	47

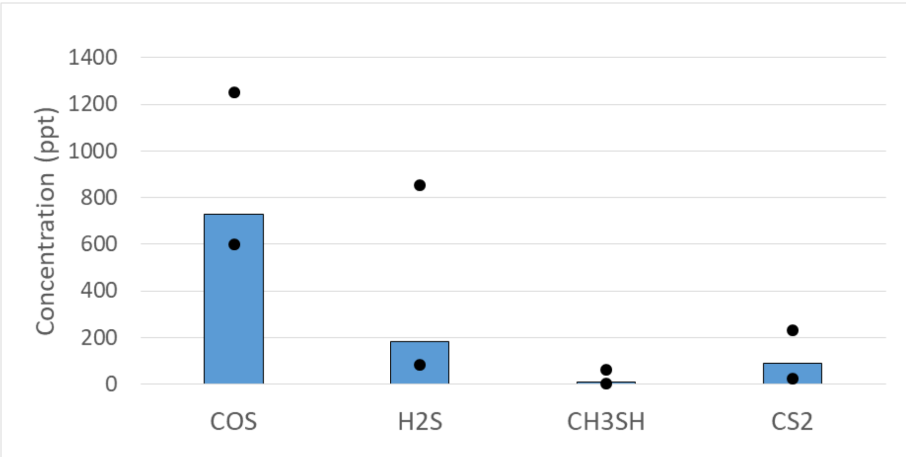

Figure 5: Average mixing ratio of sulphur containing organic compounds in the Quintero – Puchuncaví area. The black circles represent the maximum and minimum values obtained.

4.2 Chlorinated solvents

All results are shown in Appendix B, and Figure 6 and Table 5 show a summary of the results represented by the average and median values, along with maximum and minimum. The results show that there are no indications of emissions of chlorinated compounds out the industrial area.

Table 5: Average mixing ratios of chlorinated organic compounds in the samples collected in the area of Quintero Puchuncaví. StaDev: standard deviation. Max: Maximum value. Min: Minimum value. N: number of samples. Unit: ppt.

Units: ppt	CH_2Cl_2	$CHCl_3$	CH_3CCl_3	TCE	PCE
Average	23.1	9.0	1.7	0.2	3.7
StaDev	7.6	1.8	0.1	0.1	3.1
Max	51.3	14.6	1.9	0.6	15.3
Min	18.1	6.0	1.5	0.0	0.5
N	38	38	38	38	38

The measurements of methyl chloroform (CH_3CCl_3) during the campaigns carried out in this study show less than 2 ppt (part per trillion), which is several million times lower than the concentrations discussed in the media. Methyl chloroform shows in all samples taken in Quintero-Puchuncaví-Concón global atmospheric background of less than 2 ppt. This compound has been measured at 10 different background sites around the globe (Figure 7) with high precision and accuracy every second hour since it was forbidden to produce and use within the Montreal Protocol (1987). The measurements of AGAGE and the National Oceanic and Atmospheric Administration (NOAA) show no production or use since decades. It is very unlikely that methyl chloroform could have shown ppm concentrations within the Quintero – Ventanas – Puchuncaví area - over a period of several weeks - without being detected by the global network. The measurements using the MIRAN instrument are clearly wrong due to severe lack of calibration. The other chlorinated solvents are also within the range of normal background concentrations.

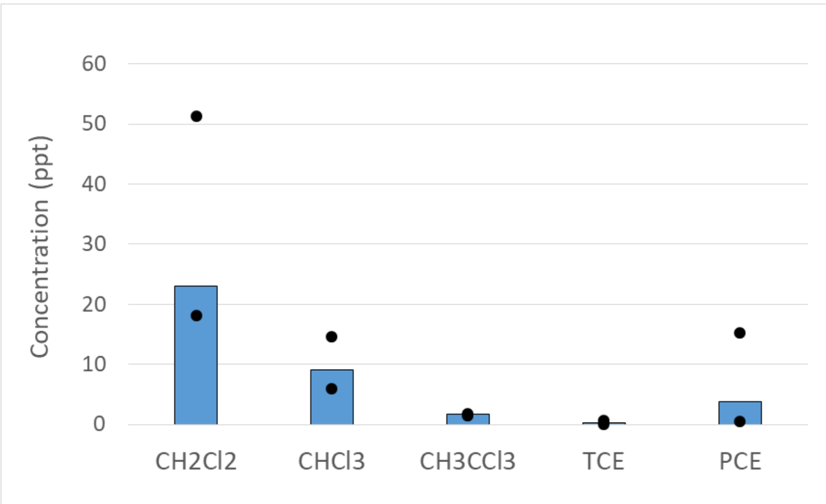

Figure 6: Average mixing ratios of chlorinated organic compounds in the Quintero – Puchuncaví area. The black circles represent the maximum and minimum values obtained.

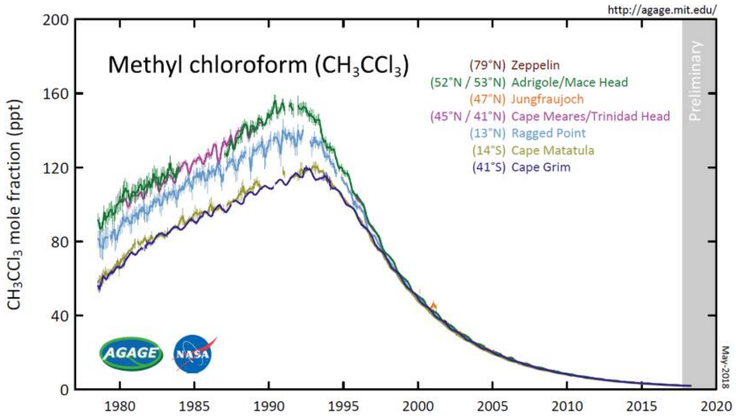

Figure 7: Methyl chloroform measured by AGAGE during the last 4 decades

4.3 Cooling agents

All results are shown in Appendix B and a summary is shown in Table 6 as average, median, maximum and minimum values.

Those hydrochlorofluorocarbon, hydrofluorocarbon and halon compounds were included into the measurement campaigns because of their widespread use as cooling agents. There are several gas and liquid storage tanks in the industrial area which are cooled in order to minimize evaporation. Cooling devices do often show some leaks – leading to very high concentrations of those compounds in the air in the vicinity of those devices. In case of leaks or malfunction of those cooling devices, plumes out of the industrial area would have shown high elevated levels of those gases and could have been traced for many kilometers along their travelled trajectory. None of the samples of air coming out of the industrial areas had elevated concentrations of those compounds. There were some elevated concentrations measured in Quintero – which is probably due to leaks from domestic air conditioner or leaks from air conditioning systems in cars.

The measurements of those gases are also used as an additional quality assurance measure for the Medusa measurements – as long as the measurements show global background concentrations – there are no sampling problems or calibration issues or calculation errors.

Table 6: Average mixing ratios of cooling agent compounds in the samples collected in the area of Quintero Puchuncaví. StaDev: standard deviation. Max: Maximum value. Min: Minimum value. N: number of samples. Unit: ppt.

(ppt)	HCFC-22	HCFC-141b	HCFC-142b	HFC-125	HFC-134a	HFC-152a	H-1211	H-1301
Average	239.0	24.5	21.9	57.6	134.7	5.0	3.6	3.4
StaDev	8.2	1.3	0.1	161.7	166.9	0.3	1.8	0.0
Max	285.7	30.1	22.3	1037.4	1148.1	6.2	14.4	3.4
Min	235.1	22.7	21.6	25.9	98.7	4.7	3.1	3.3
N	38	38	38	38	38	38	38	38

4.4 BTEX (Benzene, toluene, ethylbenzene, xylenes)

The BTEX results are sorted by sampling locations and classified as either regional / residential or as industrial. Appendix B shows the complete results and Table 7 and Table 8, and Figure 8 and Figure 9, show the summary for regional/residential and industrial locations, respectively.

4.4.1 BTEX in regional/residential locations

Table 7 and Figure 10 show the average, maximum and minimum concentrations of benzene, toluene, ethylbenzene and xylenes measured at the regional/residential areas. Benzene concentration ranges between 0.1 and 2.2 µg/m^3 (average 0.3 µg/m^3) below limit value established by EU Air Quality Directive at 5 µg/m^3 for a calendar year. Toluene is measured at 1 µg/m^3 as average, whereas xylene shows the highest values at 5.2 and 1.9 µg/m^3 of m+p xylene and o-xylene, respectively.

Table 7: BTEX concentrations in the regional/residential locations. StaDev: standard deviation. Max: Maximum value. Min: Minimum value. N: number of samples. Unit: µg/m^3.

Unit: µg/m^3	benzene	toluene	ethylbenzene	m + p xylene	o-xylene
Average	0.3	1.0	1.2	5.2	1.9
StdDev	0.4	0.6	0.7	3.1	1.1
Max	2.2	2.4	3.2	13.3	4.8
Min	0.1	0.2	0.3	0.8	0.3
N	32	32	32	32	32

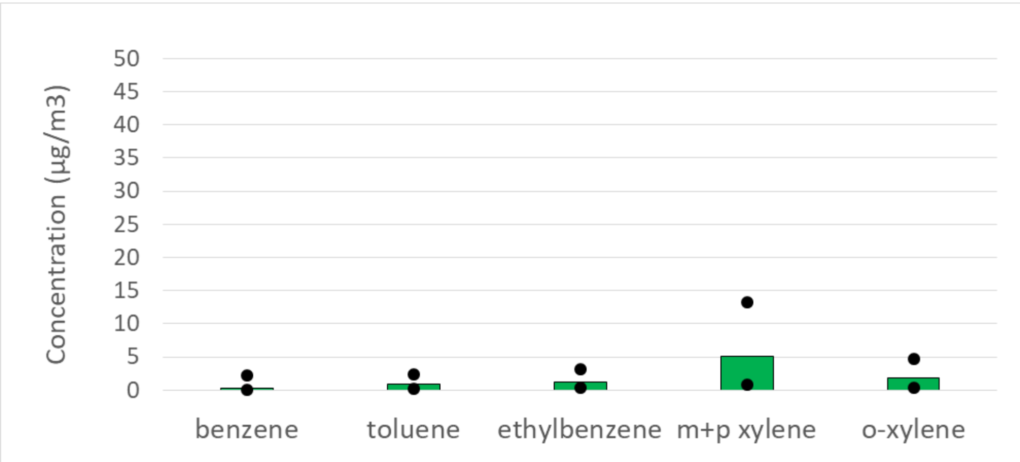

Figure 8: BTEX average concentration in the regional/residential locations. The black circles represent the maximum and minimum concentration.

4.4.2 BTEX in industrial locations

Table 8 and Figure 9 shows the average, maximum and minimum concentrations of benzene, toluene, ethylbenzene and xylenes measured at the industrial sampling locations. The values are higher than those measured at residential locations and reported in the previous chapter. Benzene concentration ranges between 0.1 and 2.5 µg/m^3 (average 1 µg/m^3) and below limit values established by EU Air Quality Directive at 5 µg/m^3 for a calendar year. Toluene is measured at 4.9 µg/m^3 as average, whereas xylene shows the highest values at 20.9 and 7.4

µg/m³ of m+p xylene and o-xylene, respectively. Taking in to account this low concentration and given normal dispersion conditions, relatively short pollution plumes will not have a significant effects on the concentration levels in nearby schools or residential areas.

Table 8: BTEX concentrations in the industrial locations. StaDev: standard deviation. Max: Maximum value. Min: Minimum value. N: number of samples. Unit: µg/m³.

µg/m3	benzene	toluene	ethylbenzene	m+p-xylene	o-xylene
Average	1.0	4.9	4.6	20.9	7.4
StaDev	0.6	3.7	2.1	10.1	3.8
Max	2.5	14.1	9.1	44.8	15.5
Min	0.1	0.3	2.1	6.5	2.0
N	15	15	15	15	15

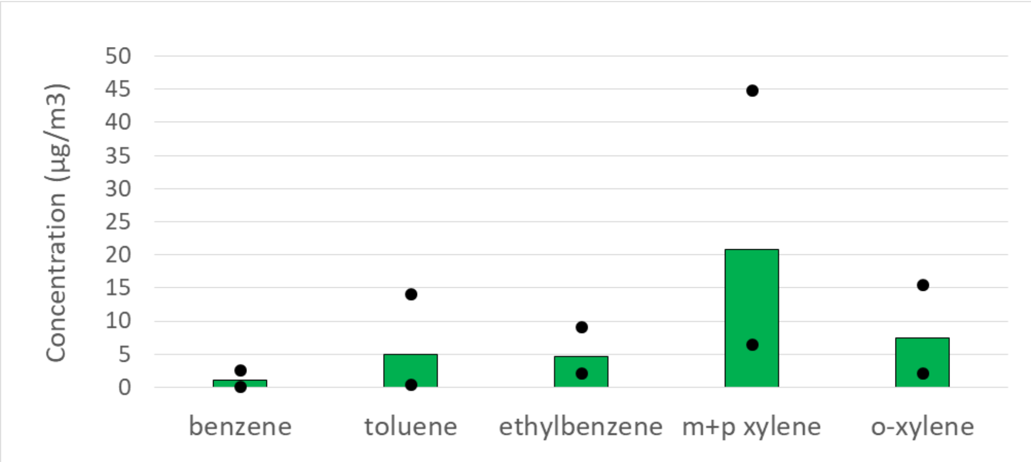

Figure 9: BTEX average concentration in the industrial locations. The black circles represent the maximum and minimum concentrations.

4.4.3 BTEX normalization to benzene

The ratio of toluene and ethylbenzene and the xylenes to benzene is often used as fingerprint for vehicle emissions in urban areas.

In this study NILU have evaluated the ratios in the locations classified as industrial sides and those classified as regional / residential. The results are shown in Figure 10 as average and median values (of course the benzene to benzene ratio equals 1).

As it is observed, the ratios are similar in residential / regional locations and in industrial locations. The normalization of the aromatic compounds toluene, ethylbenzene and the xylenes by benzene **does not show a fingerprint** to distinguish between air masses out of the industrial areas and regional / residential air masses. The main sources of BTEX are exhaust from vehicles and evaporation from fossils fuels. BTEX emissions in vehicle exhaust are more or less caused by incomplete combustion and therefore very similar to evaporation from fossil fuels. Neither average nor median values allow to distinguish between industrial or regional/residential air masses.

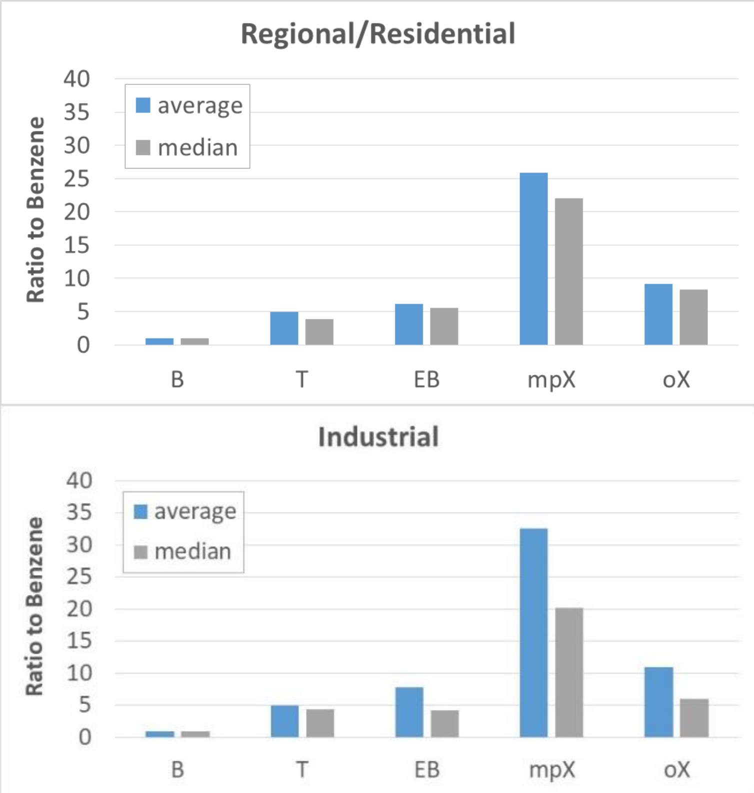

Figure 10: Ratio BTEX compounds to benzene at regional / residential areas (top) and industrial sampling locations (bottom). Unit: unit less.

4.4.4 BTEX normalization to acetylene

The VOC emissions from the industrial areas are mainly due to evaporation processes from oil and gas related products and fossil fuels. Acetylene (ethyne, C_2H_2) is a compound which has no natural sources – there is no acetylene source in the gas or oil products evaporating at the industrial sites. The main source for acetylene are combustion processes like those from car engines.

The BTEX to acetylene ratios are a very useful tool to evaluate whether and to what extent the emissions from the industrial areas are directly influencing the air at the residential areas. The ratios of BTEX to acetylene are shown in Figure 11. The ratios of BTEX to acetylene in air masses out of the industrial area are between 5 and 10 times higher than those from regional or residential areas. In case of high VOC-emissions from the industrial sites, it will be possible to measure and quantify the influence on the nearby domestic areas in Quintero and Puchuncaví. **Therefore the BTEX to Acetylene ratios are significant different for plumes coming out of the industrial areas than for air masses at background sites or residential areas.**

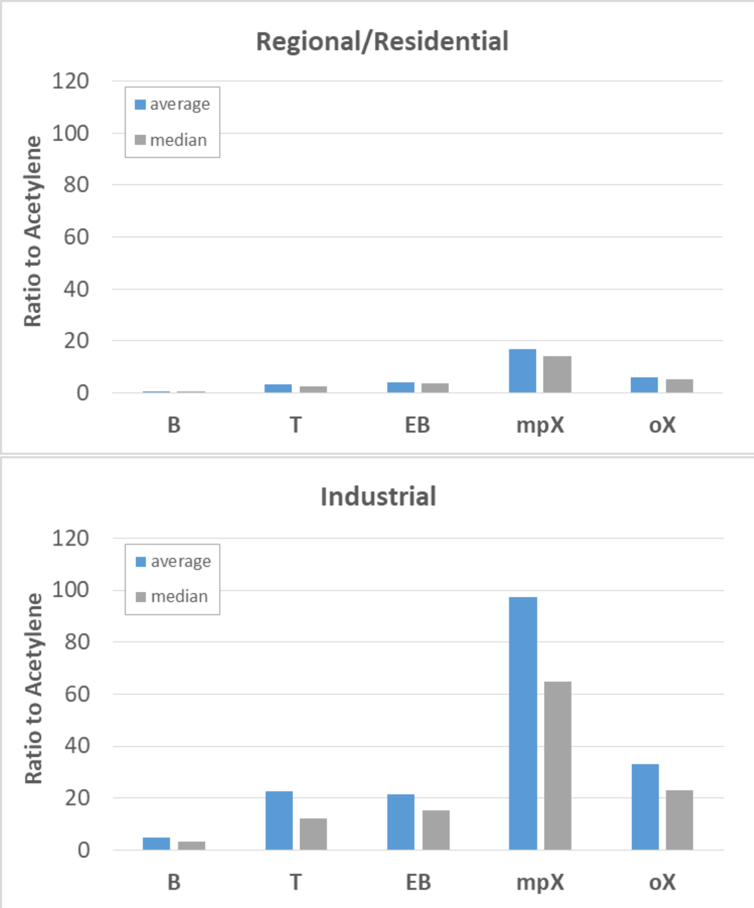

Figure 11: Ratio BTEX compounds to acetylene at regional or residential areas (top) and industrial sampling locations (bottom)

4.5 Light hydrocarbons

All light hydrocarbons results are shown in Appendix B and summarized in Table 9 and Figure 12 (light hydrocarbons means hydrocarbons with low molecular weight such as methane, ethane, propane and butane, and ethane, propene etc.).

Emissions of light hydrocarbons from the industrial area are mainly butanes and pentanes with the exception of one sample where the ethane concentration was elevated. Ethene and propene did not show elevated concentration in any of the samples.

Propane concentrations are very random high or low also in domestic areas which is due to the use of propane as fuel for domestic kitchen stoves. Therefore it is not useful to include propane in any fingerprint discussion.

The ratios of butane, isobutene, pentane and isobutene to acetylene are however showing even bigger differences between air masses from the industrial sites and at regional/domestic sites (Figure 13). The ratios are between 30 to 40 times higher in air coming out of the industrial areas. Making the ratios of those 4 compounds towards acetylene an even better fingerprint than BTEX/Acetylene ratios.

Table 9: Light hydrocarbon average concentrations in the industrial locations. StaDev: standard deviation. Max: Maximum value. Min: Minimum value. N: number of samples. Unit: µg/m^3.

µg/m^3	ethyne	ethene	ethane	propene	propane	i-butane	n-butane	i-pentane	n-pentane
Average	0.3	0.6	1.6	0.5	7.4	5.2	5.2	11.0	8.0
StaDev	0.2	0.3	4.2	0.5	11.3	9.1	9.0	19.3	12.9
Max	1.0	1.5	28.9	3.7	67.6	37.6	42.3	96.4	53.3
Min	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1
N	47	47	47	47	47	47	47	47	47

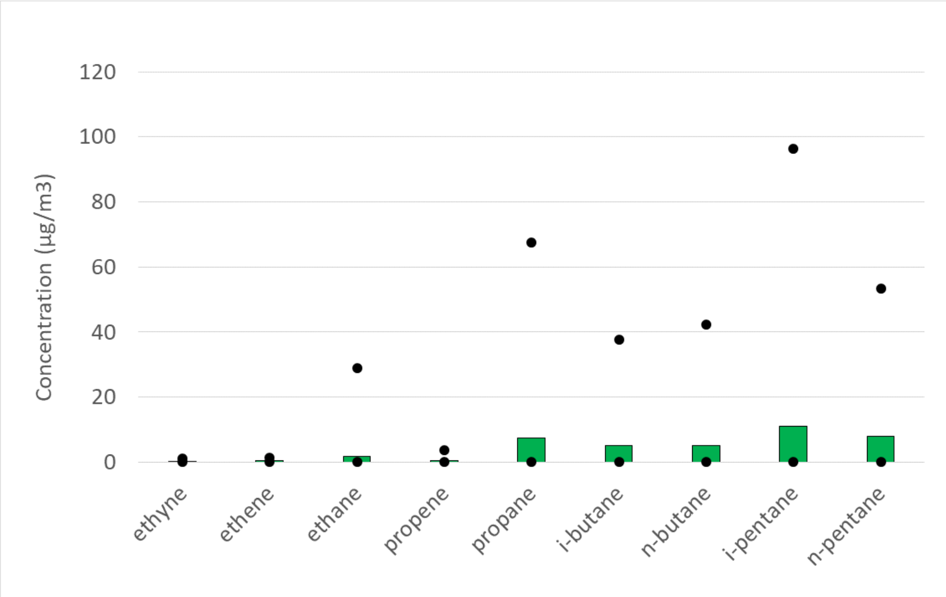

Figure 12: Light hydrocarbons average concentrations in the industrial sites. Unit: µg/m^3.

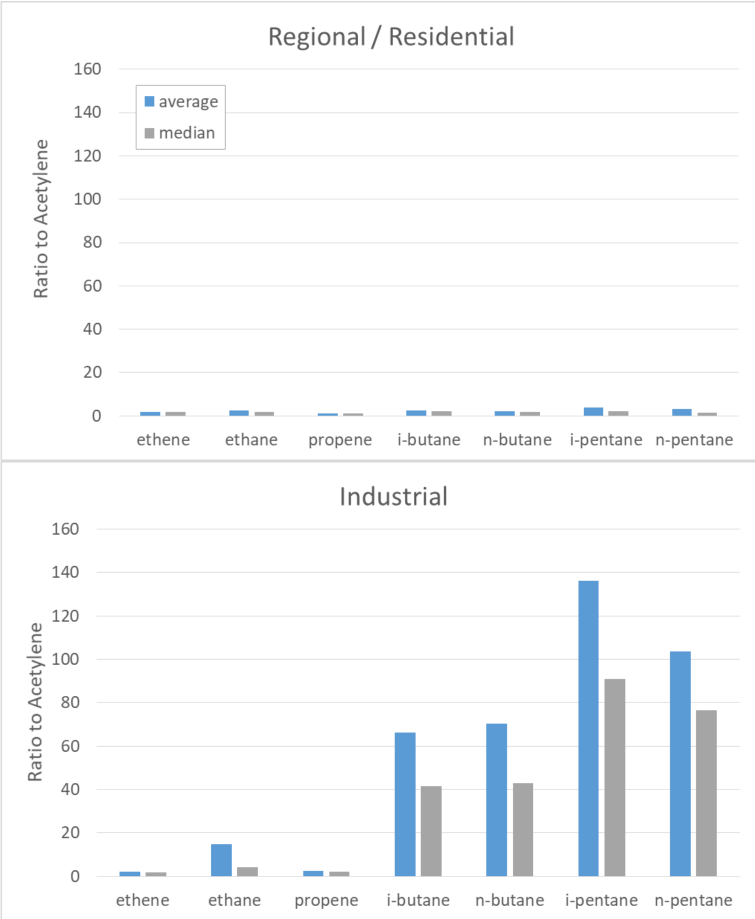

Figure 13: Light hydrocarbons to acetylene ratios (unit less).

4.6 Results from Tenax TA samples

All the results from Tenax TA are in presented in Appendix C. In general, the concentration of VOCs measured with Tenax TA that represent average concentration of VOC over long exposure time (e.g. one week), are low as the sum of VOC compounds ranged between 25 and 180 µg/m^3.

The main purpose of using a second method was to scan for VOCs which have not been in discussion or consideration before the campaign start and VOCs which cannot be analyzed with the Medusa method.

All in all there were no "surprising" compounds emitted from the industrial areas.

Samples taken in residential areas and background areas are also influenced by other sources – both natural and anthropogenic sources.
The level of organic acids at all sampling sites was higher than expected. Sources are most probably natural – with degradation processes of organic matter or waste during the hot summer season both in the residential areas as well as the shore line.

Natural VOC emission in summer time are on most places of the globe the dominant VOC sources. Examples are alfa pinene, beta pinene and limonene as well as other terpenes or terpenoic compounds.

But there are also compounds seen in some of the samples which point to local activities like biomass or waste burning, vulcanization processes (benzothiazole is a VOC which is mainly emitted during vulcanization or from vulcanized items like car tires), small scale industry and building or restauration activities.

The concentration levels were far below what could be considered as "polluted" – concentrations are well within the range which are normal concentration levels for both indoor and outdoor air worldwide.

NILU could not find the fingerprints of the industrial air plumes in any of the samples taken in the residential areas of Puchuncaví or Quintero. This is not surprising – since the plumes of the industrial area were in the range of 100 to 300 $\mu g/m^3$ and usually very short in time. Using normal dispersion schemes - concentrations of that size - will be diluted down to background levels within few hundred meters and will surely not be detectable at places some kilometer further downwind.

5 Main Findings and Conclusions

Below is a summary of the main findings and conclusions obtained for the area of Quintero-Puchuncaví (Finding I to VII) and in Concón (Finding C). The results were also presented at a workshop on 15 March 2019 and included in this report in Appendix D.

Finding I: From this study, NILU concludes that the ratio obtained from the hydrocarbon concentrations divided by the acetylene concentration constitute an useful tool to evaluate whether and to what extent the emissions from the industrial areas are directly influencing the air at the residential areas.
Conclusion I: The results from the measurements carried out in this study indicate that there was no measurable influence from the industrial emissions of VOCs towards the residential areas.

Finding II: The VOC-compounds showing the highest concentrations in the emissions from the industrial area are ethane, propane, butane and pentanes, as well as BTEX (benzene, toluene, ethylbenzene, xylenes).
Conclusion II: This is expected since the main activity in the area is the storage and/or the distribution of petrochemical materials.

Finding III: NILU evaluated the measurement results of the 4 compounds (i.e., methyl chloroform, nitrobenzene, iso-butane and toluene) which were reported at very high concentrations and intensively discussed in the media. The measurement results in the present project showed much lower concentrations.
Conclusion III: NILU concludes that the former measurements were done with a significant error in the calibration. Methyl chloroform levels from NILU's measurements were a million times lower and nitrobenzene was not detected. Toluene and iso butane were in the low ppb (parts per billion) levels and not in ppm (parts per million) levels.

Finding IV: The highest concentration levels of light hydrocarbons in air masses leaving the industrial area were in the range up to 100 µg/m^3. The sum of all light hydrocarbons was up to 300 µg/m^3. The highest concentration levels for the BTEX-compounds were up to 50 µg/m^3. The highest sum of all BTEX was 85 µg/m^3.
Conclusion IV: Given normal dispersion conditions, relatively short pollution plumes will not have a significant effects on the concentration levels in nearby schools or residential areas.

Finding V: The sum of compounds sampled with Tenax tubes ranged between 25 and 180 µg/m^3.
Conclusion V: No light hydrocarbon levels or BTEX levels at the residential areas had hydrocarbon or BTEX signatures (fingerprints) in any of the episodes measured close to the sources. The levels of VOCs were a blend of local natural and anthropogenic sources (e.g., vehicle emissions, domestic sources and decomposition of waste and biological processes).

Finding VI: In nearly all situations where the sampling team defined sampling time and location by using their sense of smell, the VOC-concentrations were elevated. This shows that our nose is a good detector for sensing unusually high concentration of hydrocarbons.

Conclusion VI: Close to the sources, the human nose is able to detect fresh plumes of hydrocarbons and BTEX compounds. Smelling episodes in Quintero or nearby schools had different signatures, being affected by mostly local sources (e.g., vehicle emissions, domestic sources and decomposition of waste and biological processes).

Finding VII: The average concentration of ambient benzene was 1.0 µg/m^3 in emissions from the industrial areas and 0.3 µg/m^3 at the residential and background areas.
Conclusion VII: The benzene levels are lower than international limit values (5 µg/m^3 as yearly averaged value).

Finding C: The situation in Concón is different than in Quintero – Puchuncaví. The sum of hydrocarbons was as high as 325 µg/m^3 during night time and low wind speed. The peak concentration of VOCs were up to 2000 µg/m^3 at a residential house.
Conclusion C: The source strength of the refinery has a larger impact on the nearby residential area. Concentration levels were quite local (changing from street to street) and changed fast during the night.

6 References

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Appendix A

List of products Oxiquim A.S.

Chemical product
Propane
Gasoline
Tertiary Butyl Mercaptan (30%) + Dimethyl Sulfide (70%)
Hydrocarbon mix (C10 to C14) (Turpentine)
Methanol
Vinyl acetate
Isopropyl alcohol
n-propanol
x-xylene
styrene
Butyl acrylate
Phenol
Diesel
Aliphatic Hydrocarbons (EXXSOL D-40)
Aliphatic Hydrocarbons (Escaid 110)
Ethyl acrylate

Appendix B

Results obtained with medusa sampling and analysis

									mixing ratio in ppt (vol)			
						Direction (from)	Velocity (m/s)		COS	H2S	CH3SH	CS2
1	A10584	06.11.2018	11:25	11:40	3A (AES GENER)	W	1	chisa01	631	233	28	72
2	A10528	06.11.2018	12:45	13:00	4A (CODELCO VENTANAS)	W	1	chisa02	730	215	20	110
3	A10523	06.11.2018	21:16	21:31	10A (Cross-section, near to the beach)	N	4	chisa03	680	421	20	55
4	A10526	06.11.2018	22:00	22:15	11A (half of the croos-section)	N	3	chisa04	600	186	17	84
5	A10552	06.11.2018	22:55	23:10	9A (by-side road, Sta Filomena School)	N	2	chisa05	842	218	15	140
6	A10550	07.11.2018	09:50	10:05	9A (by side road, Sta Filomena School)	N	2	chisa06	636	403	13	64
7	A10541	07.11.2018	11:40	11:55	5A (highway, ENAP west area)	W	3	chisa07	783	194	11	148
8	A10582	07.11.2018	12:43	13:00	7A (road to MAITENES)	W	3	chisa08	685	172	11	52
9	A10587	07.11.2018	17:11	17:28	13A (in front of ENAP)	W	3	chisa09	639	186	10	47
10	A10492	07.11.2018	22:45	23:03	10A (cross-section, near to the beach)	W	1	chisa10	697	161	10	43
11	A10586	07.11.2018	23:30	23:30	15A (Exit to Quintero)	W	1	chisa11	957	854	60	72
12	A10540	08.11.2018	10:13	10:28	6A (near, exit El Bato)	W	1	chisa12	680	194	9	47
13	A10591	08.11.2018	11:00	11:15	5A (Highway, ENAP west area)	W	3	chisa13	688	163	9	71
14	A10480	08.11.2018	11:48	12:05	4A (CODELCO VENTANAS)	W	3	chisa14	736	187	8	48
15	A10495	08.11.2018	12:38	12:55	3A (AES GENER)	W	3	chisa15	706	160	7	48
16	A10522	08.11.2018	13:48	14:05	7A (road to MAITENES)	W	4	chisa16	723	339	6	83
17	A10578	08.11.2018	22:26	22:42	10A (Cross-section, near to the beach)	S	0	chisa17	686	122	6	88
18	A10595	08.11.2018	23:08	23:25	11A (half of the cross-section)	S	1	chisa18	1252	138	6	225
19	A10513	09.11.2018	00:08	00:12	14A (cross-section, near to the beach)	NE	1	chisa19	736	131	7	117
20	A10530	09.11.2018	11:15	11:45	5A (highway, ENAP west area)	W	3	chisa20	831	129	6	210
21	A10488	09.11.2018	12:46	13:03	7A (road to MAITENES)	W	4	chisa21	636	115	5	25
22	A10594	09.11.2018	13:42	14:00	3A (AES GENER)	W	4	chisa22	653	151	5	53
23	A10475	09.11.2018	16:41	16:56	4A (CODELCO VENTANAS)	W	4	chisa23	825	110	5	77
1	A10535	13.11.2018	12:33	12:40	13A (in front to ENAP)	SW	5	chisa201	747	108	6	146
2	A10555	13.11.2018	12:43	12:58	13A (in front of ENAP)	SW	5	chisa202	703	106	5	130
3	A10575	13.11.2018	22:38	22:54	10A (cross-section near to the beach)	S	4	chisa203	686	106	5	48
4	A10491	13.11.2018	22:57	23:12	11A (half of cross-section)	S	4	chisa204	638	103	5	48
5	A10486	13.11.2018	23:58	00:13	17A (near to the beach, in front of OXIQUIM)	E	3	chisa205	652	97	5	39
6	A10512	14.11.2018	00:28	00:43	1A (Sargent ALDEA School)	SE	1	chisa206	718	89	5	64
7	A10536	14.11.2018	09:04	09:19	11A (half of the cross-section)	SSW	2	chisa207	736	84	4	108
8	A10538	14.11.2018	09:21	09:36	10A (cross-section, near to the beach)	SSW	2	chisa208	618	89	4	34
9	A10531	14.11.2018	10:00	10:16	2A (La GREDA School)	SSW	3	chisa209	616	286	5	50
10	A10516	14.11.2018	10:55	11:10	7A (road to MAITENES)	SSW	4	chisa210	630	101	4	52
11	A10596	14.11.2018	22:20	22:35	10A (cross-section, near to the beach)	SSE	2	chisa211	638	92	5	71
12	A10549	14.11.2018	22:38	22:53	11A (half of the cross-section)	SSE	2	chisa212	640	88	4	85
13	A10543	14.11.2018	23:06	23:21	1A (Sargent ALDEA School)	SSE	2	chisa213	651	94	4	46
17	A10545	15.11.2018	08:05	08:20	1A (Sargent ALDEA School)	SSE	1	chisa217	617	145	5	54
18	A10521	15.11.2018	10:27	10:42	7A (road to MAITENES)	E	2	chisa218b	640	306	4	54
1	A10548	16.01.2019	10:05	10:21	7A (Road to Maitenes)	SW	3 m/s	301	986	160	6	231
2	A10579	16.01.2019	12:10	12:25	4A (CODELCO VENTANAS)	SW	4 m/s	302	988	158	5	113
4	A10585	17.01.2019	08:30	08:32	17A (beach, strand in front of Oxiquim)	NEE	1 m/s	304	764	162	6	146
5	A10551	17.01.2019	08:38	08:40	10A (Transient near to the beach)	NEE	1 m/s	305	718	157	5	127
6	A10537	17.01.2019	08:42	08:44	11A (half of transient)	NEE	1 m/s	306	863	160	6	213
7	A10547	17.01.2019	08:50	08:52	14A (Transient, bord of the beach)	NEE	1 m/s	307	772	163	6	209
8	A10554	17.01.2019	09:19	09:21	9A (Passage, by Santa Filomena School , Quintero)	NEE	1 m/s	308	615	152	6	68
9	A10476	17.01.2019	10:50	11:05	13A (in front ENAP)	SW	4 m/s	309	721	169	4	73
10	A10553	17.01.2029	11:40	11:55	5A (highway, Zone west ENAP)	SW	5 m/s	310	773	165	4	69
CONCON												
14	A10497	15.11.2018	06:34	06:50	Con-con No 1	SSE	1	chisa214	630	282	7	77
15	A10487	15.11.2018	06:59	07:14	Con-con No 2	SSE	1	chisa215	711	138	6	49
16	A10487	15.11.2018	07:19	07:34	Con-con No 3	SSE	1	chisa216	565	91	5	37
3	A10496	16.01.2019	14:54	15:09	CONCON4	SW	6 m/s	303	714	190	8	158
11	A10511	18.01.2019	02:44	02:55	CONCON 5	SE	2 m/s	311	802	165	8	143
12	A10559	18.01.2019	03:17	03:25	CONCON 6	SE	2 m/s	312	725	146	5	153
13	A10583	18.01.2019	03:34	03:38	CONCON 7	SE	2 m/s	313	764	143	6	118
14	A10514	18.01.2019	03:57	04:07	CONCON 2	E	1 m/s	314	681	139	5	105

							mixing ratios in ppt (vol)				
						sample	CH_2Cl_2	$CHCl_3$	CH_3CCl_3	TCE	PCE
1	A10584	06.11.2018	11:25	11:40	3A (AES GENER)	chisa01	20.23	10.08	1.70	0.21	1.81
2	A10528	06.11.2018	12:45	13:00	4A (CODELCO VENTANAS)	chisa02	21.32	8.43	1.78	0.31	2.26
3	A10523	06.11.2018	21:16	21:31	10A (Cross-section, near to the beach)	chisa03	19.02	7.68	1.58	0.13	4.39
4	A10526	06.11.2018	22:00	22:15	11A (half of the croos-section)	chisa04	19.51	7.75	1.78	0.05	0.83
5	A10552	06.11.2018	22:55	23:10	9A (by-side road, Sta Filomena School)	chisa05	21.29	11.21	1.74	0.14	2.96
6	A10550	07.11.2018	09:50	10:05	9A (by side road, Sta Filomena School)	chisa06	19.41	9.78	1.78	0.46	5.97
7	A10541	07.11.2018	11:40	11:55	5A (highway, ENAP west area)	chisa07	19.13	8.34	1.63	0.07	1.03
8	A10582	07.11.2018	12:43	13:00	7A (road to MAITENES)	chisa08	19.17	8.35	1.82	0.11	8.37
9	A10587	07.11.2018	17:11	17:28	13A (in front of ENAP)	chisa09	18.96	8.94	1.63	0.12	8.16
10	A10492	07.11.2018	22:45	23:03	10A (cross-section, near to the beach)	chisa10	19.48	9.51	1.79	0.08	0.51
11	A10586	07.11.2018	23:30	23:30	15A (Exit to Quintero)	chisa11	30.19	12.36	1.65	0.21	5.90
12	A10540	08.11.2018	10:13	10:28	6A (near, exit El Bato)	chisa12	19.40	9.53	1.65	0.31	2.01
13	A10591	08.11.2018	11:00	11:15	5A (Highway, ENAP west area)	chisa13	22.09	9.95	1.79	0.29	2.18
14	A10480	08.11.2018	11:48	12:05	4A (CODELCO VENTANAS)	chisa14	19.55	9.27	1.86	0.29	3.08
15	A10495	08.11.2018	12:38	12:55	3A (AES GENER)	chisa15	19.14	9.46	1.76	0.16	8.39
16	A10522	08.11.2018	13:48	14:05	7A (road to MAITENES)	chisa16	22.90	8.87	1.76	0.11	1.62
17	A10578	08.11.2018	22:26	22:42	10A (Cross-section, near to the beach)	chisa17	22.26	7.89	1.69	0.12	4.28
18	A10595	08.11.2018	23:08	23:25	11A (half of the cross-section)	chisa18	20.06	8.39	1.75	0.16	1.09
19	A10513	09.11.2018	00:08	00:12	14A (cross-section, near to the beach)	chisa19	19.17	8.34	1.48	0.08	15.25
20	A10530	09.11.2018	11:15	11:45	5A (highway, ENAP west area)	chisa20	21.55	7.60	1.54	0.39	3.45
21	A10488	09.11.2018	12:46	13:03	7A (road to MAITENES)	chisa21	20.00	6.99	1.79	0.36	1.74
22	A10594	09.11.2018	13:42	14:00	3A (AES GENER)	chisa22	18.27	6.87	1.71	0.18	1.22
23	A10475	09.11.2018	16:41	16:56	4A (CODELCO VENTANAS)	chisa23	23.12	6.01	1.71	0.11	1.25
1	A10535	13.11.2018	12:33	12:40	13A (in front to ENAP)	chisa201	18.77	6.74	1.55	0.12	1.69
2	A10555	13.11.2018	12:43	12:58	13A (in front of ENAP)	chisa202	18.15	6.50	1.63	0.08	2.92
3	A10575	13.11.2018	22:38	22:54	10A (cross-section near to the beach)	chisa203	18.56	8.02	1.74	0.13	1.03
4	A10491	13.11.2018	22:57	23:12	11A (half of cross-section)	chisa204	18.08	7.52	1.72	0.06	0.72
5	A10486	13.11.2018	23:58	00:13	17A (near to the beach, in front of OXIQUIM)	chisa205	22.46	8.02	1.65	0.15	5.87
6	A10512	14.11.2018	00:28	00:43	1A (Sargent ALDEA School)	chisa206	51.27	13.52	1.74	0.25	2.91
7	A10536	14.11.2018	09:04	09:19	11A (half of the cross-section)	chisa207	31.08	9.50	1.65	0.33	3.66
8	A10538	14.11.2018	09:21	09:36	10A (cross-section, near to the beach)	chisa208	33.53	9.10	1.79	0.38	3.75
9	A10531	14.11.2018	10:00	10:16	2A (La GREDA School)	chisa209	45.53	14.58	1.77	0.64	8.41
10	A10516	14.11.2018	10:55	11:10	7A (road to MAITENES)	chisa210	40.67	8.89	1.61	0.47	6.59
11	A10596	14.11.2018	22:20	22:35	10A (cross-section, near to the beach)	chisa211	18.51	8.86	1.69	0.19	1.08
12	A10549	14.11.2018	22:38	22:53	11A (half of the cross-section)	chisa212	20.63	8.61	1.75	0.22	9.09
13	A10543	14.11.2018	23:06	23:21	1A (Sargent ALDEA School)	chisa213	19.64	8.76	1.76	0.13	0.76
17	A10545	15.11.2018	08:05	08:20	1A (Sargent ALDEA School)	chisa217	24.35	12.81	1.86	0.29	2.43
18	A10521	15.11.2018	10:27	10:42	7A (road to MAITENES)	chisa218b	20.19	9.26	1.64	0.47	3.66
CONCON											
14	A10497	15.11.2018	06:34	06:50	Con-con No 1	chisa214	41.46	19.80	1.84	3.73	32.23
15	A10487	15.11.2018	06:59	07:14	Con-con No 2	chisa215	57.04	15.60	2.07	2.38	38.47
16	A10487	15.11.2018	07:19	07:34	Con-con No 3	chisa216	21.73	12.25	1.73	0.48	3.15

							mixing ratios in ppt (vol)							
						sample	HCFC-22	HCFC-141b	HCFC-142b	HFC-125	HFC-134a	HFC-152a	H-1211	H-1301
1	A10584	06.11.2018	11:25	11:40	3A (AES GENER)	chisa01	238.01	25.55	22.13	31.49	107.44	4.91	3.34	3.36
2	A10528	06.11.2018	12:45	13:00	4A (CODELCO VENTANAS)	chisa02	240.66	24.21	21.91	28.23	103.84	4.95	3.30	3.35
3	A10523	06.11.2018	21:16	21:31	10A (Cross-section, near to the beach)	chisa03	235.98	26.67	21.85	26.91	98.79	4.80	3.15	3.35
4	A10526	06.11.2018	22:00	22:15	11A (half of the croos-section)	chisa04	237.02	25.09	21.97	25.98	98.70	4.85	3.31	3.36
5	A10552	06.11.2018	22:55	23:10	9A (by-side road, Sta Filomena School)	chisa05	285.72	24.27	21.73	1037.39	1148.14	5.39	3.27	3.30
6	A10550	07.11.2018	09:50	10:05	9A (by side road, Sta Filomena School)	chisa06	236.63	24.16	21.94	33.76	108.46	6.22	3.28	3.34
7	A10541	07.11.2018	11:40	11:55	5A (highway, ENAP west area)	chisa07	236.46	22.95	21.80	34.38	107.53	5.05	3.11	3.39
8	A10582	07.11.2018	12:43	13:00	7A (road to MAITENES)	chisa08	236.29	23.44	21.94	26.87	99.72	4.81	3.35	3.40
9	A10587	07.11.2018	17:11	17:28	13A (in front of ENAP)	chisa09	235.97	22.70	21.86	28.15	99.92	4.77	3.17	3.39
10	A10492	07.11.2018	22:45	23:03	10A (cross-section, near to the beach)	chisa10	236.01	23.33	21.80	115.40	100.76	4.81	3.31	3.33
11	A10586	07.11.2018	23:30	23:30	15A (Exit to Quintero)	chisa11	235.52	24.16	21.65	28.85	104.75	4.70	3.46	3.38
12	A10540	08.11.2018	10:13	10:28	6A (near, exit El Bato)	chisa12	237.02	24.17	21.73	29.28	107.97	4.99	3.76	3.31
13	A10591	08.11.2018	11:00	11:15	5A (Highway, ENAP west area)	chisa13	238.25	23.87	22.01	27.54	104.65	4.99	3.33	3.36
14	A10480	08.11.2018	11:48	12:05	4A (CODELCO VENTANAS)	chisa14	235.99	23.72	21.87	28.40	101.51	4.86	3.32	3.34
15	A10495	08.11.2018	12:38	12:55	3A (AES GENER)	chisa15	236.58	25.59	21.96	27.02	111.39	4.86	3.34	3.36
16	A10522	08.11.2018	13:48	14:05	7A (road to MAITENES)	chisa16	235.75	23.26	21.75	26.19	98.81	4.75	3.32	3.34
17	A10578	08.11.2018	22:26	22:42	10A (Cross-section, near to the beach)	chisa17	235.54	25.65	21.70	26.42	101.15	4.77	3.15	3.32
18	A10595	08.11.2018	23:08	23:25	11A (half of the cross-section)	chisa18	235.19	24.63	21.84	26.29	101.84	4.79	3.31	3.37
19	A10513	09.11.2018	00:08	00:12	14A (cross-section, near to the beach)	chisa19	235.10	30.06	21.65	26.39	100.66	4.81	3.14	3.34
20	A10530	09.11.2018	11:15	11:45	5A (highway, ENAP west area)	chisa20	240.71	23.66	21.95	28.78	109.05	5.07	3.24	3.39
21	A10488	09.11.2018	12:46	13:03	7A (road to MAITENES)	chisa21	239.91	23.91	22.32	28.00	104.57	5.00	3.36	3.42
22	A10594	09.11.2018	13:42	14:00	3A (AES GENER)	chisa22	237.03	24.25	21.84	26.94	103.42	4.85	3.34	3.34
23	A10475	09.11.2018	16:41	16:56	4A (CODELCO VENTANAS)	chisa23	235.72	24.93	21.76	26.40	98.97	4.68	3.31	3.34
1	A10535	13.11.2018	12:33	12:40	13A (in front to ENAP)	chisa201	236.83	22.78	21.83	31.76	101.36	4.89	14.40	3.36
2	A10555	13.11.2018	12:43	12:58	13A (in front of ENAP)	chisa202	236.84	23.36	22.06	28.49	101.04	4.82	3.20	3.35
3	A10575	13.11.2018	22:38	22:54	10A (cross-section near to the beach)	chisa203	237.20	23.50	21.70	27.08	105.97	4.94	3.36	3.35
4	A10491	13.11.2018	22:57	23:12	11A (half of cross-section)	chisa204	235.68	23.48	21.79	25.95	103.56	4.91	3.34	3.37
5	A10486	13.11.2018	23:58	00:13	17A (near to the beach, in front of OXIQUIM)	chisa205	237.01	24.91	21.76	28.27	104.25	4.79	3.41	3.36
6	A10512	14.11.2018	00:28	00:43	1A (Sargent ALDEA School)	chisa206	236.57	24.79	21.80	26.86	141.87	6.08	3.26	3.35
7	A10536	14.11.2018	09:04	09:19	11A (half of the cross-section)	chisa207	240.12	24.95	21.93	30.26	111.37	5.21	3.28	3.32
8	A10538	14.11.2018	09:21	09:36	10A (cross-section, near to the beach)	chisa208	241.41	25.44	21.95	30.03	110.50	5.22	3.31	3.33
9	A10531	14.11.2018	10:00	10:16	2A (La GREDA School)	chisa209	248.55	25.60	22.06	36.91	130.81	5.38	3.31	3.35
10	A10516	14.11.2018	10:55	11:10	7A (road to MAITENES)	chisa210	247.90	25.12	22.11	33.66	114.77	5.30	3.34	3.38
11	A10596	14.11.2018	22:20	22:35	10A (cross-section, near to the beach)	chisa211	236.76	24.11	21.89	27.29	101.19	4.85	4.48	3.36
12	A10549	14.11.2018	22:38	22:53	11A (half of the cross-section)	chisa212	235.12	25.47	21.81	27.62	125.64	4.83	3.71	3.36
13	A10543	14.11.2018	23:06	23:21	1A (Sargent ALDEA School)	chisa213	236.33	24.02	21.81	26.57	114.54	4.84	3.32	3.38
17	A10545	15.11.2018	08:05	08:20	1A (Sargent ALDEA School)	chisa217	237.34	25.84	22.09	27.38	120.98	5.11	3.30	3.33
18	A10521	15.11.2018	10:27	10:42	7A (road to MAITENES)	chisa218b	240.41	24.69	21.88	34.70	107.97	5.03	3.32	3.39
CONCON														
14	A10497	15.11.2018	06:34	06:50	Con-con No 1	chisa214	1112.37	30.14	21.90	32.37	110.60	5.07	3.19	3.39
15	A10487	15.11.2018	06:59	07:14	Con-con No 2	chisa215	626.23	25.64	22.13	29.28	114.42	5.14	3.26	3.36
16	A10487	15.11.2018	07:19	07:34	Con-con No 3	chisa216	239.50	25.10	21.93	29.71	115.34	5.14	3.18	3.35

										concentrations in µg/m3				
						wind	m/s	TVOC	sum all 14	benzene	toluene	ethylbenz	mxylene	o-xylene
chisa206	A10512	14.11.2018	00:28	00:43	1A (Sargent ALDEA School)	SE	1		**47**	0.5	2.4	2.6	11.7	4.3
chisa213	A10543	14.11.2018	23:06	23:21	1A (Sargent ALDEA School)	SSE	2		**22**	0.1	0.6	1.0	5.9	2.7
chisa217	A10545	15.11.2018	08:05	08:20	1A (Sargent ALDEA School)	SSE	1		**47**	0.6	2.2	2.3	10.2	3.5
chisa209	A10531	14.11.2018	10:00	10:16	2A (La GREDA School)	SSW	3		**38**	0.3	1.9	3.2	13.3	4.8
chisa05	A10552	06.11.2018	22:55	23:10	9A (by-side road, Sta Filomena School)	N	2	**173**	**38**	0.3	2.2	1.3	6.2	2.2
chisa06	A10550	07.11.2018	09:50	10:05	9A (by side road, Sta Filomena School)	N	2	**32**	**24**	0.2	0.7	2.1	9.5	3.0
308	A10554	17.01.2019	09:19	09:21	9A (Passage, by Santa Filomena School , Quintero)	NEE	1 m/s		**28**	0.3	1.3	1.6	7.9	2.9
chisa01	A10584	06.11.2018	11:25	11:40	3A (AES GENER)	W	1	**50**	**12**	0.3	0.7	0.9	3.2	1.4
chisa15	A10495	08.11.2018	12:38	12:55	3A (AES GENER)	W	3	**55**	**7**	0.1	0.3	0.8	2.4	0.8
chisa22	A10594	09.11.2018	13:42	14:00	3A (AES GENER)	W	4		**10**	0.1	0.6	1.3	3.9	1.3
chisa02	A10528	06.11.2018	12:45	13:00	4A (CODELCO VENTANAS)	W	1	**33**	**9**	0.2	0.4	0.7	2.2	0.9
chisa14	A10480	08.11.2018	11:48	12:05	4A (CODELCO VENTANAS)	W	3	**50**	**15**	2.2	0.6	0.7	2.9	1.1
chisa23	A10475	09.11.2018	16:41	16:56	4A (CODELCO VENTANAS)	W	4		**10**	0.2	0.6	0.6	2.6	0.9
302	A10579	16.01.2019	12:10	12:25	4A (CODELCO VENTANAS)	SW	4 m/s	**27**	**10**	0.2	0.5	0.9	3.7	1.3
chisa07	A10541	07.11.2018	11:40	11:55	5A (highway, ENAP west area)	W	3	**87**	**141**	0.8	3.7	4.1	19.9	6.5
chisa13	A10591	08.11.2018	11:00	11:15	5A (Highway, ENAP west area)	W	3	**100**	**28**	0.3	1.0	1.2	5.0	2.2
chisa20	A10530	09.11.2018	11:15	11:45	5A (highway, ENAP west area)	W	3		**83**	0.6	2.6	2.6	9.4	3.5
310	A10553	17.01.2029	11:40	11:55	5A (highway, Zone west ENAP)	SW	5 m/s	**74**	**154**	1.2	7.4	5.8	28.4	9.8
chisa12	A10540	08.11.2018	10:13	10:28	6A (near, exit El Bato)	W	1	**81**	**146**	1.5	2.7	2.3	12.2	5.3
chisa08	A10582	07.11.2018	12:43	13:00	7A (road to MAITENES)	W	3	**51**	**3**	0.1	0.3	0.3	0.8	0.3
chisa16	A10522	08.11.2018	13:48	14:05	7A (road to MAITENES)	W	4	**48**	**5**	0.1	0.2	0.4	1.4	0.5
chisa21	A10488	09.11.2018	12:46	13:03	7A (road to MAITENES)	W	4		**7**	0.1	0.6	0.5	1.2	0.5
chisa210	A10516	14.11.2018	10:55	11:10	7A (road to MAITENES)	SSW	4		**17**	0.2	1.0	1.3	4.3	1.6
chisa218b	A10521	15.11.2018	10:27	10:42	7A (road to MAITENES)	E	2		**23**	0.3	0.9	1.3	5.2	2.4
301	A10548	16.01.2019	10:05	10:21	7A (Road to Maitenes)	SW	3 m/s	**75**	**12**	0.1	0.4	0.8	3.0	1.1
chisa03	A10523	06.11.2018	21:16	21:31	10A (Cross-section, near to the beach)	N	4	**137**	**199**	0.7	2.5	2.4	11.8	4.4
chisa10	A10492	07.11.2018	22:45	23:03	10A (cross-section, near to the beach)	W	1	**67**	**10**	0.1	0.8	0.9	4.9	2.0
chisa17	A10578	08.11.2018	22:26	22:42	10A (Cross-section, near to the beach)	S	0	**63**	**125**	0.8	3.1	2.9	13.6	5.0
chisa203	A10575	13.11.2018	22:38	22:54	10A (cross-section near to the beach)	S	4		**19**	0.1	1.8	2.0	9.1	2.4
chisa208	A10538	14.11.2018	09:21	09:36	10A (cross-section, near to the beach)	SSW	2		**24**	0.3	1.1	1.7	7.1	2.3
chisa211	A10596	14.11.2018	22:20	22:35	10A (cross-section, near to the beach)	SSE	2		**30**	0.4	1.2	1.7	5.9	2.1
305	A10551	17.01.2019	08:38	08:40	10A (Transient near to the beach)	NEE	1 m/s		**16**	0.2	0.6	0.8	3.2	1.2
chisa04	A10526	06.11.2018	22:00	22:15	11A (half of the cross-section)	N	3	**49**	**52**	0.1	0.3	6.8	27.3	7.2
chisa18	A10595	08.11.2018	23:08	23:25	11A (half of the cross-section)	S	1	**35**	**16**	0.2	0.8	1.2	4.7	1.6
chisa204	A10491	13.11.2018	22:57	23:12	11A (half of cross-section)	S	4		**11**	0.1	1.5	0.6	3.4	0.9
chisa207	A10536	14.11.2018	09:04	09:19	11A (half of the cross-section)	SSW	2		**32**	0.4	1.6	2.0	9.0	3.6
chisa212	A10549	14.11.2018	22:38	22:53	11A (half of the cross-section)	SSE	2		**51**	0.2	1.8	2.1	6.5	2.0
306	A10537	17.01.2019	08:42	08:44	11A (half of transient)	NEE	1 m/s		**16**	0.2	0.6	0.7	3.3	1.2
chisa09	A10587	07.11.2018	17:11	17:28	13A (in front of ENAP)	W	3	**86**	**129**	0.9	4.3	4.7	21.3	5.5
chisa201	A10535	13.11.2018	12:33	12:40	13A (in front to ENAP)	SW	5		**259**	2.5	12.3	7.2	35.3	11.0
chisa202	A10555	13.11.2018	12:43	12:58	13A (in front of ENAP)	SW	5		**109**	1.0	5.0	3.0	13.9	4.4
309	A10476	17.01.2019	10:50	11:05	13A (in front ENAP)	SW	4 m/s	**132**	**287**	2.2	14.1	9.1	44.8	14.6
chisa19	A10513	09.11.2018	00:08	00:12	14A (cross-section, near to the beach)	NE	1	**180**	**171**	1.4	5.4	4.4	19.7	7.9
307	A10547	17.01.2019	08:50	08:52	14A (Transient, bord of the beach)	NEE	1 m/s		**17**	0.2	1.1	1.3	5.3	1.9
chisa11	A10586	07.11.2018	23:30	23:30	15A (Exit to Quintero)	W	1		**9**	0.1	0.5	0.5	2.3	0.9
chisa205	A10486	13.11.2018	23:58	00:13	17A (near to the beach, in front of OXIQUIM)	E	3		**101**	0.6	2.6	4.6	26.8	15.5
304	A10585	17.01.2019	08:30	08:32	17A (beach, strand in front of Oxiquim)	NEE	1 m/s		**136**	0.6	5.7	7.2	22.4	9.1
CONCON														
chisa214	A10497	15.11.2018	06:34	06:50	Con-con No 1	SSE	1		**324**	3.3	13.7	17.8	81.9	27.7
chisa215	A10487	15.11.2018	06:59	07:14	Con-con No 2	SSE	1		**147**	1.5	5.0	3.0	14.6	4.3
chisa216	A10487	15.11.2018	07:19	07:34	Con-con No 3	SSE	1		**185**	1.5	7.4	6.0	25.1	8.8
303	A10496	16.01.2019	14:54	15:09	CONCON4	SW	6 m/s	**362**	**408**	1.4	21.6	40.8	233.4	94.8
311	A10511	18.01.2019	02:44	02:55	CONCON 5 (street 14/Street Saint Agustin)	SE	2 m/s	**254**	**434**	3.8	24.2	25.3	150.7	54.4
312	A10559	18.01.2019	03:17	03:25	CONCON 6 highest street level (street 12/street Vergara)	SE	2 m/s	**187**	**236**	2.5	15.6	15.2	96.3	35.7
313	A10583	18.01.2019	03:34	03:38	CONCON 7 - Level low (Reference: street 14 /Street Cortes)	SE	2 m/s		**110**	0.8	4.7	4.8	24.2	9.5
314	A10514	18.01.2019	03:57	04:07	CONCON 2 - Middle Level (Reference: Street 13 /Street Cortes)	E	1 m/s	**125**	**58**	0.4	2.5	2.2	11.6	4.7

										concentrations in µg/m3								
						wind	m/s	TVOC	sum all 14	ethyne	ethene	ethane	propene	propane	i-butane	n-butane	i-pentane	n-pentane
chisa206	A10512	14.11.2018	00:28	00:43	1A (Sargent ALDEA School)	SE	1		47	0.6	1.3	0.6	0.6	14.6	2.1	1.6	2.1	1.4
chisa213	A10543	14.11.2018	23:06	23:21	1A (Sargent ALDEA School)	SSE	2		22	0.2	0.4	0.4	0.2	8.9	0.6	0.4	0.4	0.3
chisa217	A10545	15.11.2018	08:05	08:20	1A (Sargent ALDEA School)	SSE	1		47	0.9	1.5	1.0	0.7	16.4	2.3	1.6	2.5	1.3
chisa209	A10531	14.11.2018	10:00	10:16	2A (La GREDA School)	SSW	3		38	0.4	0.7	0.8	0.3	5.7	1.0	0.9	2.6	1.9
chisa05	A10552	06.11.2018	22:55	23:10	9A (by-side road, Sta Filomena School)	N	2	173	38	0.7	1.1	0.7	0.6	19.0	1.6	1.2	0.7	0.4
chisa06	A10550	07.11.2018	09:50	10:05	9A (by side road, Sta Filomena School)	N	2	32	24	0.3	0.5	0.5	0.2	4.9	0.6	0.5	0.8	0.5
308	A10554	17.01.2019	09:19	09:21	9A (Passage, by Santa Filomena School , Quintero)	NEE	1 m/s		28	0.5	0.9	0.5	0.6	5.8	1.6	1.1	2.2	1.2
chisa01	A10584	06.11.2018	11:25	11:40	3A (AES GENER)	W	1	50	12	0.3	0.6	0.5	0.3	2.2	0.4	0.3	0.6	0.4
chisa15	A10495	08.11.2018	12:38	12:55	3A (AES GENER)	W	3	55	7	0.2	0.4	0.6	0.2	0.4	0.1	0.1	0.1	0.1
chisa22	A10594	09.11.2018	13:42	14:00	3A (AES GENER)	W	4		10	0.2	0.5	0.3	0.3	0.7	0.2	0.2	0.5	0.3
chisa02	A10528	06.11.2018	12:45	13:00	4A (CODELCO VENTANAS)	W	1	33	9	0.3	0.5	0.5	0.2	1.7	0.3	0.2	0.6	0.4
chisa14	A10480	08.11.2018	11:48	12:05	4A (CODELCO VENTANAS)	W	3	50	15	1.0	1.3	1.0	0.3	1.1	0.4	0.4	1.0	0.6
chisa23	A10475	09.11.2018	16:41	16:56	4A (CODELCO VENTANAS)	W	4		10	0.4	0.7	2.2	0.3	0.8	0.1	0.1	0.2	0.1
302	A10579	16.01.2019	12:10	12:25	4A (CODELCO VENTANAS)	SW	4 m/s	27	10	0.4	0.9	0.3	0.4	0.7	0.2	0.1	0.4	0.2
chisa07	A10541	07.11.2018	11:40	11:55	5A (highway, ENAP west area)	W	3	87	141	0.3	0.7	1.6	0.7	6.4	9.5	13.2	39.9	33.4
chisa13	A10591	08.11.2018	11:00	11:15	5A (Highway, ENAP west area)	W	3	100	28	0.2	0.4	0.7	0.3	2.9	1.8	2.2	5.7	4.2
chisa20	A10530	09.11.2018	11:15	11:45	5A (highway, ENAP west area)	W	3		83	0.3	0.6	1.0	0.5	4.2	4.2	7.6	25.2	21.2
310	A10553	17.01.2029	11:40	11:55	5A (highway, Zone west ENAP)	SW	5 m/s	74	154	0.3	0.6	0.4	0.6	3.6	18.3	11.9	47.7	18.1
chisa12	A10540	08.11.2018	10:13	10:28	6A (near, exit El Bato)	W	1	81	146	0.4	0.8	1.3	0.3	18.1	25.6	21.8	29.1	24.2
chisa08	A10582	07.11.2018	12:43	13:00	7A (road to MAITENES)	W	3	51	3	0.1	0.3	0.4	0.2	0.3	0.1	0.1	0.1	0.1
chisa16	A10522	08.11.2018	13:48	14:05	7A (road to MAITENES)	W	4	48	5	0.1	0.3	0.3	0.2	0.5	0.1	0.1	0.3	0.1
chisa21	A10488	09.11.2018	12:46	13:03	7A (road to MAITENES)	W	4		7	0.1	0.2	0.6	0.1	1.8	0.2	0.2	0.2	0.1
chisa210	A10516	14.11.2018	10:55	11:10	7A (road to MAITENES)	SSW	4		17	0.3	0.5	0.5	0.2	4.2	0.7	0.6	1.1	0.6
chisa218b	A10521	15.11.2018	10:27	10:42	7A (road to MAITENES)	E	2		23	0.4	0.6	0.9	0.3	5.2	1.1	1.2	2.1	1.6
301	A10548	16.01.2019	10:05	10:21	7A (Road to Maitenes)	SW	3 m/s	75	12	0.3	0.7	0.4	0.5	3.1	0.5	0.4	0.6	0.4
chisa03	A10523	06.11.2018	21:16	21:31	10A (Cross-section, near to the beach)	N	4	137	199	0.2	0.4	3.2	1.3	67.6	9.2	13.7	45.3	36.1
chisa10	A10492	07.11.2018	22:45	23:03	10A (cross-section, near to the beach)	W	1	67	10	0.1	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1
chisa17	A10578	08.11.2018	22:26	22:42	10A (Cross-section, near to the beach)	S	0	63	125	0.5	0.9	1.6	3.7	18.1	21.4	16.8	18.6	17.6
chisa203	A10575	13.11.2018	22:38	22:54	10A (cross-section near to the beach)	S	4		19	0.2	0.3	0.4	0.2	0.9	0.2	0.2	0.3	0.3
chisa208	A10538	14.11.2018	09:21	09:36	10A (cross-section, near to the beach)	SSW	2		24	0.4	0.6	0.7	0.3	5.4	1.0	0.9	1.5	1.2
chisa211	A10596	14.11.2018	22:20	22:35	10A (cross-section, near to the beach)	SSE	2		30	0.2	0.4	2.9	0.2	3.8	1.9	2.2	3.1	4.3
305	A10551	17.01.2019	08:38	08:40	10A (Transient near to the beach)	NEE	1 m/s		16	0.4	0.8	1.4	0.5	3.8	0.6	0.5	1.3	0.8
chisa04	A10526	06.11.2018	22:00	22:15	11A (half of the cross-section)	N	3	49	52	0.1	0.2	0.8	0.2	4.7	0.9	0.9	1.4	1.2
chisa18	A10595	08.11.2018	23:08	23:25	11A (half of the cross-section)	S	1	35	16	0.3	0.7	0.4	0.4	1.2	0.8	0.7	1.8	0.9
chisa204	A10491	13.11.2018	22:57	23:12	11A (half of cross-section)	S	4		11	0.1	0.3	0.3	0.2	0.7	0.5	0.6	1.2	0.9
chisa207	A10536	14.11.2018	09:04	09:19	11A (half of the cross-section)	SSW	2		32	0.5	0.7	0.8	0.4	6.2	1.8	1.5	2.2	1.7
chisa212	A10549	14.11.2018	22:38	22:53	11A (half of the cross-section)	SSE	2		51	0.2	0.5	28.9	0.3	5.2	1.1	0.7	0.9	1.0
306	A10537	17.01.2019	08:42	08:44	11A (half of transient)	NEE	1 m/s		16	0.3	0.7	2.1	0.5	2.9	0.8	0.6	1.2	0.8
chisa09	A10587	07.11.2018	17:11	17:28	13A (in front of ENAP)	W	3	86	129	0.2	0.3	0.6	0.3	3.0	12.2	13.6	33.5	28.6
chisa201	A10535	13.11.2018	12:33	12:40	13A (in front to ENAP)	SW	5		259	0.2	0.3	0.7	0.3	5.1	37.1	42.3	51.8	53.3
chisa202	A10555	13.11.2018	12:43	12:58	13A (in front of ENAP)	SW	5		109	0.1	0.2	0.4	0.2	2.0	18.3	21.9	19.3	19.4
309	A10476	17.01.2019	10:50	11:05	13A (in front ENAP)	SW	4 m/s	132	287	0.2	0.5	0.4	0.6	4.6	37.6	23.5	96.4	38.4
chisa19	A10513	09.11.2018	00:08	00:12	14A (cross-section, near to the beach)	NE	1	180	171	0.3	0.7	3.7	1.4	29.5	12.7	26.0	30.2	27.2
307	A10547	17.01.2019	08:50	08:52	14A (Transient, bord of the beach)	NEE	1 m/s		17	0.4	0.8	0.5	0.8	2.4	0.7	0.5	0.8	0.5
chisa11	A10586	07.11.2018	23:30	23:30	15A (Exit to Quintero)	W	1		9	0.1	0.3	0.2	0.2	0.8	0.6	0.6	1.0	0.6
chisa205	A10486	13.11.2018	23:58	00:13	17A (near to the beach, in front of OXIQUIM)	E	3		101	0.2	0.4	4.5	0.3	14.8	5.9	6.1	8.9	9.3
304	A10585	17.01.2019	08:30	08:32	17A (beach, strand in front of Oxiquim)	NEE	1 m/s		136	0.5	1.2	4.7	0.8	29.5	3.5	3.9	28.7	17.8
CONCON																		
chisa214	A10497	15.11.2018	06:34	06:50	Con-con No 1	SSE	1		324	1.5	2.4	3.1	1.8	29.7	18.8	25.4	47.1	50.1
chisa215	A10487	15.11.2018	06:59	07:14	Con-con No 2	SSE	1		147	0.5	1.0	4.2	2.3	23.3	14.0	17.4	26.5	29.8
chisa216	A10487	15.11.2018	07:19	07:34	Con-con No 3	SSE	1		185	1.4	1.6	1.7	53.0	29.9	24.5	7.6	8.4	8.2
303	A10496	16.01.2019	14:54	15:09	CONCON4	SW	6 m/s	362	408	0.3	0.6	0.3	0.3	1.1	0.7	0.7	7.4	4.7
311	A10511	18.01.2019	02:44	02:55	CONCON 5 (street 14/Street Saint Agustin)	SE	2 m/s	254	434	1.0	1.6	5.7	8.8	57.6	21.7	12.9	45.2	21.2
312	A10559	18.01.2019	03:17	03:25	CONCON 6 highest street level (street 12/street Vergara)	SE	2 m/s	187	236	0.7	1.1	1.9	1.7	20.4	7.5	4.8	21.5	11.6
313	A10583	18.01.2019	03:34	03:38	CONCON 7 - Level low (Reference: street 14 /Street Cortes)	SE	2 m/s		110	0.7	1.2	7.2	1.6	27.6	6.5	4.2	11.2	6.3
314	A10514	18.01.2019	03:57	04:07	CONCON 2 - Middle Level (Reference: Street 13 /Street Cortes)	E	1 m/s	125	58	0.5	0.8	2.2	0.8	19.2	2.4	1.7	5.4	3.8

										concentrations in µg/m3								
						wind	m/s	TVOC	sum all 14	ethyne	ethene	ethane	propene	propane	i-butane	n-butane	i-pentane	n-pentane
chisa206	A10512	14.11.2018	00:28	00:43	1A (Sargent ALDEA School)	SE	1		**47**	0.6	1.3	0.6	0.6	14.6	2.1	1.6	2.1	1.4
chisa213	A10543	14.11.2018	23:06	23:21	1A (Sargent ALDEA School)	SSE	2		**22**	0.2	0.4	0.4	0.2	8.9	0.6	0.4	0.4	0.3
chisa217	A10545	15.11.2018	08:05	08:20	1A (Sargent ALDEA School)	SSE	1		**47**	0.9	1.5	1.0	0.7	16.4	2.3	1.6	2.5	1.3
chisa209	A10531	14.11.2018	10:00	10:16	2A (La GREDA School)	SSW	3		**38**	0.4	0.7	0.8	0.3	5.7	1.0	0.9	2.6	1.9
chisa05	A10552	06.11.2018	22:55	23:10	9A (by-side road, Sta Filomena School)	N	2	**173**	**38**	0.7	1.1	0.7	0.6	19.0	1.6	1.2	0.7	0.4
chisa06	A10550	07.11.2018	09:50	10:05	9A (by side road, Sta Filomena School)	N	2	**32**	**24**	0.3	0.5	0.5	0.2	4.9	0.6	0.5	0.8	0.5
308	A10554	17.01.2019	09:19	09:21	9A (Passage, by Santa Filomena School , Quintero)	NEE	1 m/s		**28**	0.5	0.9	0.5	0.6	5.8	1.6	1.1	2.2	1.2
chisa01	A10584	06.11.2018	11:25	11:40	3A (AES GENER)	W	1	**50**	**12**	0.3	0.6	0.5	0.3	2.2	0.4	0.3	0.6	0.4
chisa15	A10495	08.11.2018	12:38	12:55	3A (AES GENER)	W	3	**55**	**7**	0.2	0.4	0.6	0.2	0.4	0.1	0.1	0.1	0.1
chisa22	A10594	09.11.2018	13:42	14:00	3A (AES GENER)	W	4		**10**	0.2	0.5	0.3	0.3	0.7	0.2	0.2	0.5	0.3
chisa02	A10528	06.11.2018	12:45	13:00	4A (CODELCO VENTANAS)	W	1	**33**	**9**	0.3	0.5	0.5	0.2	1.7	0.3	0.2	0.6	0.4
chisa14	A10480	08.11.2018	11:48	12:05	4A (CODELCO VENTANAS)	W	3	**50**	**15**	1.0	1.3	1.0	0.3	1.1	0.4	0.4	1.0	0.6
chisa23	A10475	09.11.2018	16:41	16:56	4A (CODELCO VENTANAS)	W	4		**10**	0.4	0.7	2.2	0.3	0.8	0.1	0.1	0.2	0.1
302	A10579	16.01.2019	12:10	12:25	4A (CODELCO VENTANAS)	SW	4 m/s	**27**	**10**	0.4	0.9	0.3	0.4	0.7	0.2	0.1	0.4	0.2
chisa07	A10541	07.11.2018	11:40	11:55	5A (highway, ENAP west area)	W	3	**87**	**141**	0.3	0.7	1.6	0.7	6.4	9.5	13.2	39.9	33.4
chisa13	A10591	08.11.2018	11:00	11:15	5A (Highway, ENAP west area)	W	3	**100**	**28**	0.2	0.4	0.7	0.3	2.9	1.8	2.2	5.7	4.2
chisa20	A10530	09.11.2018	11:15	11:45	5A (highway, ENAP west area)	W	3		**83**	0.3	0.6	1.0	0.5	4.2	4.2	7.6	25.2	21.2
310	A10553	17.01.2029	11:40	11:55	5A (highway, Zone west ENAP)	SW	5 m/s	**74**	**154**	0.3	0.6	0.4	0.6	3.6	18.3	11.9	47.7	18.1
chisa12	A10540	08.11.2018	10:13	10:28	6A (near, exit El Bato)	W	1	**81**	**146**	0.4	0.8	1.3	0.3	18.1	25.6	21.8	29.1	24.2
chisa08	A10582	07.11.2018	12:43	13:00	7A (road to MAITENES)	W	3	**51**	**3**	0.1	0.3	0.4	0.2	0.3	0.1	0.1	0.1	0.1
chisa16	A10522	08.11.2018	13:48	14:05	7A (road to MAITENES)	W	4	**48**	**5**	0.1	0.3	0.3	0.2	0.5	0.1	0.1	0.3	0.1
chisa21	A10488	09.11.2018	12:46	13:03	7A (road to MAITENES)	W	4		**7**	0.1	0.2	0.6	0.1	1.8	0.2	0.2	0.2	0.1
chisa210	A10516	14.11.2018	10:55	11:10	7A (road to MAITENES)	SSW	4		**17**	0.3	0.5	0.5	0.2	4.2	0.7	0.6	1.1	0.6
chisa218b	A10521	15.11.2018	10:27	10:42	7A (road to MAITENES)	E	2		**23**	0.4	0.6	0.9	0.3	5.2	1.1	1.2	2.1	1.6
301	A10548	16.01.2019	10:05	10:21	7A (Road to Maitenes)	SW	3 m/s	**75**	**12**	0.3	0.7	0.4	0.5	3.1	0.5	0.4	0.6	0.4
chisa03	A10523	06.11.2018	21:16	21:31	10A (Cross-section, near to the beach)	N	4	**137**	**199**	0.2	0.4	3.2	1.3	67.6	9.2	13.7	45.3	36.1
chisa10	A10492	07.11.2018	22:45	23:03	10A (cross-section, near to the beach)	W	1	**67**	**10**	0.1	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1
chisa17	A10578	08.11.2018	22:26	22:42	10A (Cross-section, near to the beach)	S	0	**63**	**125**	0.5	0.9	1.6	3.7	18.1	21.4	16.8	18.6	17.6
chisa203	A10575	13.11.2018	22:38	22:54	10A (cross-section near to the beach)	S	4		**19**	0.2	0.3	0.4	0.2	0.9	0.2	0.2	0.3	0.3
chisa208	A10538	14.11.2018	09:21	09:36	10A (cross-section, near to the beach)	SSW	2		**24**	0.4	0.6	0.7	0.3	5.4	1.0	0.9	1.5	1.2
chisa211	A10596	14.11.2018	22:20	22:35	10A (cross-section, near to the beach)	SSE	2		**30**	0.2	0.4	2.9	0.2	3.8	1.9	2.2	3.1	4.3
305	A10551	17.01.2019	08:38	08:40	10A (Transient near to the beach)	NEE	1 m/s		**16**	0.4	0.8	1.4	0.5	3.8	0.6	0.5	1.3	0.8
chisa04	A10526	06.11.2018	22:00	22:15	11A (half of the cross-section)	N	3	**49**	**52**	0.1	0.2	0.8	0.2	4.7	0.9	0.9	1.4	1.2
chisa18	A10595	08.11.2018	23:08	23:25	11A (half of the cross-section)	S	1	**35**	**16**	0.3	0.7	0.4	0.4	1.2	0.8	0.7	1.8	0.9
chisa204	A10491	13.11.2018	22:57	23:12	11A (half of cross-section)	S	4		**11**	0.1	0.3	0.3	0.2	0.7	0.5	0.6	1.2	0.9
chisa207	A10536	14.11.2018	09:04	09:19	11A (half of the cross-section)	SSW	2		**32**	0.5	0.7	0.8	0.4	6.2	1.8	1.5	2.2	1.7
chisa212	A10549	14.11.2018	22:38	22:53	11A (half of the cross-section)	SSE	2		**51**	0.2	0.5	28.9	0.3	5.2	1.1	0.7	0.9	1.0
306	A10537	17.01.2019	08:42	08:44	11A (half of transient)	NEE	1 m/s		**16**	0.3	0.7	2.1	0.5	2.9	0.8	0.6	1.2	0.8
chisa09	A10587	07.11.2018	17:11	17:28	13A (in front of ENAP)	W	3	**86**	**129**	0.2	0.3	0.6	0.3	3.0	12.2	13.6	33.5	28.6
chisa201	A10535	13.11.2018	12:33	12:40	13A (in front to ENAP)	SW	5		**259**	0.2	0.3	0.7	0.3	5.1	37.1	42.3	51.8	53.3
chisa202	A10555	13.11.2018	12:43	12:58	13A (in front of ENAP)	SW	5		**109**	0.1	0.2	0.4	0.2	2.0	18.3	21.9	19.3	19.4
309	A10476	17.01.2019	10:50	11:05	13A (in front ENAP)	SW	4 m/s	**132**	**287**	0.2	0.5	0.4	0.6	4.6	37.6	23.5	96.4	38.4
chisa19	A10513	09.11.2018	00:08	00:12	14A (cross-section, near to the beach)	NE	1	**180**	**171**	0.3	0.7	3.7	1.4	29.5	12.7	26.0	30.2	27.2
307	A10547	17.01.2019	08:50	08:52	14A (Transient, bord of the beach)	NEE	1 m/s		**17**	0.4	0.8	0.5	0.8	2.4	0.7	0.5	0.8	0.5
chisa11	A10586	07.11.2018	23:30	23:30	15A (Exit to Quintero)	W	1		**9**	0.1	0.3	0.2	0.2	0.8	0.6	0.6	1.0	0.6
chisa205	A10486	13.11.2018	23:58	00:13	17A (near to the beach, in front of OXIQUIM)	E	3		**101**	0.2	0.4	4.5	0.3	14.8	5.9	6.1	8.9	9.3
304	A10585	17.01.2019	08:30	08:32	17A (beach, strand in front of Oxiquim)	NEE	1 m/s		**136**	0.5	1.2	4.7	0.8	29.5	3.5	3.9	28.7	17.8
CONCON																		
chisa214	A10497	15.11.2018	06:34	06:50	Con-con No 1	SSE	1		**324**	1.5	2.4	3.1	1.8	29.7	18.8	25.4	47.1	50.1
chisa215	A10487	15.11.2018	06:59	07:14	Con-con No 2	SSE	1		**147**	0.5	1.0	4.2	2.3	23.3	14.0	17.4	26.5	29.8
chisa216	A10487	15.11.2018	07:19	07:34	Con-con No 3	SSE	1		**185**	1.4	1.6	1.7	53.0	29.9	24.5	7.6	8.4	8.2
303	A10496	16.01.2019	14:54	15:09	CONCON4	SW	6 m/s	**362**	**408**	0.3	0.6	0.3	0.3	1.1	0.7	0.7	7.4	4.7
311	A10511	18.01.2019	02:44	02:55	CONCON 5 (street 14/Street Saint Agustin)	SE	2 m/s	**254**	**434**	1.0	1.6	5.7	8.8	57.6	21.7	12.9	45.2	21.2
312	A10559	18.01.2019	03:17	03:25	CONCON 6 highest street level (street 12/street Vergara)	SE	2 m/s	**187**	**236**	0.7	1.1	1.9	1.7	20.4	7.5	4.8	21.5	11.6
313	A10583	18.01.2019	03:34	03:38	CONCON 7 - Level low (Reference: street 14 /Street Cortes)	SE	2 m/s		**110**	0.7	1.2	7.2	1.6	27.6	6.5	4.2	11.2	6.3
314	A10514	18.01.2019	03:57	04:07	CONCON 2 - Middle Level (Reference: Street 13 /Street Cortes)	E	1 m/s	**125**	**58**	0.5	0.8	2.2	0.8	19.2	2.4	1.7	5.4	3.8

Appendix C

VOC Concentration measured with Tenax

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	3A / 352	
pumped sampling on Tenax TA	6.november 2018, 10:45 -11:20	
wind from W 1 m/s - temperature 19 °C	no odor	
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	1.2	67-64-1
acetic acid	13.3	64-19-7
toluene	0.6	108-88-3
propanoic acid	0.5	79-09-4
nonane	0.7	111-84-2
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	0.5	106-42-3
o-xylene (1,2-dimethylbenzene)	0.6	95-47-6
1,2,4-trimethylbenzene	0.6	95-63-6
benzaldehyde	3.6	100-52-7
2-ethyl-1-hexanol	0.3	104-76-7
hexanoic acid	4.4	142-62-1
nonanal	3.1	124-19-6
acetophenone	2.2	98-86-2
decanal	4.0	112-31-2
octanoic acid	2.6	124-07-2
tetradecane	0.8	629-59-4
nonanoic acid	8.2	112-05-0
hexadecane	3.4	544-76-3

total concentration of compounds with concentration above 1µg/m3	**50.5**
number of identified compounds	18

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	**4A / 409**	
pumped sampling on Tenax TA	6.november 2018, 12:08 -12:43	
wind from W 1 m/s - temperature 22 °C	no odor	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	0.9	67-64-1
acetic acid	9.3	64-19-7
toluene	0.6	108-88-3
benzaldehyde	3.5	100-52-7
octanal	0.7	124-13-0
hexanoic acid	1.8	142-62-1
nonanal	1.5	124-19-6
acetophenone	2.6	98-86-2
decanal	2.5	112-31-2
octanoic acid	0.7	124-07-2
tetradecane	0.5	629-59-4
nonanoic acid	3.3	112-05-0
pentadecane	1.8	629-62-9
hexadecane	2.9	544-76-3

total concentration of compounds with concentration above 1µg/m3	**32.8**
number of identified compounds	14

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	10A / 910	
pumped sampling on Tenax TA	6.november 2018, 21:16 - 21:51	
wind from N 4 m/s - temperature 18 °C	no odor	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
pentane	7.3	109-66-0
hexane	4.6	110-54-3
2,3-dimethylpentane	3.4	565-59-3
heptane	5.5	142-82-5
benzene	1.7	71-43-2
2-methylheptane	2.1	592-27-8
acetic acid	16.8	64-19-7
toluene	3.4	108-88-3
nonane	1.8	111-84-2
ethylbenzene	1.5	100-41-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	2.9	106-42-3
o-xylene (1,2-dimethylbenzene)	3.5	95-47-6
styrene (ethenylbenzene)	1.9	100-42-5
2-furancarboxaldehyde	1.2	98-01-1
decane	1.4	124-18-5
1-ethyl-3-methylbenzene	1.5	620-14-4
1,2,4-trimethylbenzene	4.8	95-63-6
benzaldehyde	15.0	100-52-7
benzonitrile	1.1	100-47-0
hexanoic acid	16.8	142-62-1
benzeneacetaldehyde	1.3	122-78-1
nonanal	5.3	124-19-6
acetophenone	8.4	98-86-2
heptanoic acid	3.3	111-14-8
decanal	8.8	112-31-2
octanoic acid	3.7	124-07-2
tetradecane	1.2	629-59-4
nonanoic acid	6.8	112-05-0

total concentration of compounds with concentration above 1µg/m3	**137.0**
number of identified compounds	28

Customer	**Ministerio del Medio Ambiente**	
Sample id / tube id	**11A / 62**	
pumped sampling on Tenax TA	6.november 2018, 22:00 -22:35	
wind from N 3 m/s - temperature 18 °C	no odor	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	1.9	67-64-1
benzene	0.5	71-43-2
octane	8.2	111-65-9
ethylbenzene	1.3	100-41-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	4.7	106-42-3
o-xylene (1,2-dimethylbenzene)	1.5	95-47-6
benzaldehyde	4.2	100-52-7
hexanoic acid	0.8	142-62-1
nonanal	3.6	124-19-6
acetophenone	2.4	98-86-2
decanal	4.8	112-31-2
octanoic acid	1.2	124-07-2
tetradecane	0.6	629-59-4
2-phenoxyethanol	1.6	122-99-6
nonanoic acid	8.9	112-05-0
5,9-Undecadien-2-one, 6,10-dimethyl-, (E)-	2.5	003796-70-1

total concentration of compounds with concentration above 1µg/m3	**48.7**
number of identified compounds	16

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	**9A / 420**	
pumped sampling on Tenax TA	6.november 2018, 22:55 -23:30	
wind from N 2 m/s - temperature 15 °C	no odor	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	3.5	67-64-1
Butane, 1-chloro-	3.4	000109-69-3
formic acid	16.6	64-18-6
acetic acid	26.5	64-19-7
2-methyl-2-propenoic acid methylester (methyl methacrylate)	24.3	80-62-6
toluene	4.0	108-88-3
o-xylene (1,2-dimethylbenzene)	3.3	95-47-6
Benzothiazole, 2-phenyl-	6.6	000883-93-2
benzaldehyde	19.0	100-52-7
2-ethyl-1-hexanol	5.0	104-76-7
hexanoic acid	4.8	142-62-1
nonanal	3.7	124-19-6
acetophenone	15.6	98-86-2
decanal	3.3	112-31-2
octanoic acid	4.4	124-07-2
benzoic acid	14.5	65-85-0
nonanoic acid	14.5	112-05-0

total concentration of compounds with concentration above 1µg/m3	**172.8**
number of identified compounds	17

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	9A / 39	
pumped sampling on Tenax TA	7.november 2018, 09:49 - 10:24	
wind from N 2 m/s - temperature 20 °C	during sampling 2 school children to hospital	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	0.8	67-64-1
acetic acid	5.2	64-19-7
toluene	0.7	108-88-3
nonane	1.0	111-84-2
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	1.2	106-42-3
o-xylene (1,2-dimethylbenzene)	0.6	95-47-6
decane	1.1	124-18-5
1,2,4-trimethylbenzene	0.8	95-63-6
benzaldehyde	3.7	100-52-7
nonanal	2.1	124-19-6
acetophenone	3.8	98-86-2
decanal	3.1	112-31-2
tetradecane	0.5	629-59-4
2-phenoxyethanol	1.6	122-99-6
nonanoic acid	3.8	112-05-0
5,9-Undecadien-2-one, 6,10-dimethyl-, (E)-	2.6	003796-70-1

total concentration of compounds with concentration above 1µg/m3	**32.5**
number of identified compounds	16

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	9 A - id 4 Saint Filomena School	
passive sampling on Tenax TA	kinder area	
7.-22. november 2018		
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
benzene	0.5	71-43-2
acetic acid	2.7	64-19-7
toluene	1.4	108-88-3
nonane	0.7	111-84-2
ethylbenzene	0.5	100-41-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	1.7	106-42-3
alfa pinene	5.1	80-56-8
decane	1.2	124-18-5
beta pinene	5.0	127-91-3
1,2,4-trimethylbenzene	1.1	95-63-6
benzaldehyde	2.5	100-52-7
undecane	0.8	1120-21-4
2-methyl-2,4-pentanediol (hexylene glycol)	0.5	107-41-5
hexanoic acid	0.5	142-62-1
nonanal	1.1	124-19-6
acetophenone	2.7	98-86-2
Pinocarvone	0.9	030460-92-5
decanal	0.8	112-31-2
2-(2-butoxyethoxy)ethanol	0.5	112-34-5
6,6-dimethyl-bicyclo[3.1.1]hept-2-ene-2-carboxaldehyde (myrtenal)	0.8	564-94-3
benzothiazole	0.7	95-16-9
benzoic acid	1.7	65-85-0
2-Methylpropanoic acid,3-hydroxy-2,4,4-trimethylpentyl ester	2.2	77-68-9

total concentration of compounds with concentration above 1µg/m3	**35.3**
number of identified compounds	23

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	9A - Saint Filomena School	
passive sampling on Tenax TA	Kinder area	
7.-22. november 2018	id tube nr 214	
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	0.6	67-64-1
acetic acid	3.0	64-19-7
toluene	1.7	108-88-3
nonane	0.8	111-84-2
ethylbenzene	0.6	100-41-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	1.9	106-42-3
alfa pinene	8.9	80-56-8
styrene (ethenylbenzene)	1.0	100-42-5
decane	1.0	124-18-5
beta pinene	9.2	127-91-3
1,2,4-trimethylbenzene	1.2	95-63-6
limonene	0.7	138-86-3
benzaldehyde	2.8	100-52-7
undecane	0.7	1120-21-4
hexanoic acid	0.7	142-62-1
nonanal	1.9	124-19-6
acetophenone	2.9	98-86-2
Pinocarvone	2.8	030460-92-5
tridecane	1.7	629-50-5
2-(2-butoxyethoxy)ethanol	0.8	112-34-5
6,6-dimethyl-bicyclo[3.1.1]hept-2-ene-2-carboxaldehyde (myrtenal)	1.5	564-94-3
nonanoic acid	1.9	112-05-0
2-Methylpropanoic acid,3-hydroxy-2,4,4-trimethylpentyl ester	4.7	77-68-9

total concentration of compounds with concentration above 1µg/m3	**53.1**
number of identified compounds	23

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	5A / 452	
pumped sampling on Tenax TA	7.november 2018, 11:35 - 12:10	
wind from W 2 m/s - temperature 22 °C	hydrocarbon odor	
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
methylcyclopentane	10.3	96-37-7
3-methylhexane	4.1	589-34-4
heptane	3.5	142-82-5
benzene	0.7	71-43-2
acetic acid	18.5	64-19-7
octane	2.0	111-65-9
toluene	6.4	108-88-3
nonane	1.7	111-84-2
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	2.8	106-42-3
o-xylene (1,2-dimethylbenzene)	1.9	95-47-6
decane	1.0	124-18-5
1,2,4-trimethylbenzene	1.0	95-63-6
benzaldehyde	6.4	100-52-7
hexanoic acid	1.8	142-62-1
nonanal	5.9	124-19-6
acetophenone	4.2	98-86-2
decanal	8.6	112-31-2
nonanoic acid	3.6	112-05-0
5,9-Undecadien-2-one, 6,10-dimethyl-, (E)-	3.0	003796-70-1

total concentration of compounds with concentration above 1µg/m3	**87.5**
number of identified compounds	19

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	7A / 428	
pumped sampling on Tenax TA	7.november 2018, 12:33 - 13:08	
wind from W 3 m/s - temperature 22 °C		
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	1.4	67-64-1
butanal	0.3	123-72-8
benzene	0.9	71-43-2
acetic acid	10.1	64-19-7
benzaldehyde	5.6	100-52-7
2-Methyl-2,4-pentanediol	0.3	1000429-36-9
2-ethyl-1-hexanol	1.0	104-76-7
hexanoic acid	1.5	142-62-1
benzeneacetaldehyde	0.4	122-78-1
nonanal	2.2	124-19-6
acetophenone	4.9	98-86-2
1-methyl-2-pyrrolidinone	0.4	872-50-4
decanal	3.2	112-31-2
Levoglucosenone	2.2	037112-31-5
2-phenoxyethanol	5.5	122-99-6
nonanoic acid	11.3	112-05-0

total concentration of compounds with concentration above 1µg/m3	**51.2**
number of identified compounds	16

Customer	**Ministerio del Medio Ambiente**	
Sample id / tube id	**13A / 501**	
pumped sampling on Tenax TA	7.november 2018, 17:13 - 17:48	
wind from W 3 m/s - temperature 21 °C	hydrocarbon odor	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
pentane	11.2	109-66-0
2-methylpentane	2.4	107-83-5
2-propanol (isopropylalkohol)	10.2	67-63-0
methylcyclopentane	1.2	96-37-7
2-methylhexane	1.5	591-76-4
heptane	5.1	142-82-5
benzene	0.8	71-43-2
methylcyclohexane	1.2	108-87-2
acetic acid	8.4	64-19-7
octane	2.0	111-65-9
toluene	4.3	108-88-3
nonane	1.2	111-84-2
ethylbenzene	1.1	100-41-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	4.2	106-42-3
o-xylene (1,2-dimethylbenzene)	1.7	95-47-6
1,2,4-trimethylbenzene	2.1	95-63-6
benzaldehyde	3.7	100-52-7
nonanal	4.1	124-19-6
acetophenone	2.6	98-86-2
decanal	5.6	112-31-2
tetradecane	1.4	629-59-4
nonanoic acid	3.1	112-05-0
pentadecane	1.9	629-62-9
hexadecane	4.7	544-76-3

total concentration of compounds with concentration above 1µg/m3	**85.5**
number of identified compounds	24

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	10A / 722	
pumped sampling on Tenax TA	7.november 2018, 22:23 - 22:58	
wind from W 1 m/s - temperature15 °C	odor	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
formic acid	5.3	64-18-6
Acetic acid	4.4	000064-19-7
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	0.3	106-42-3
heptanal	0.3	111-71-7
6-methyl-5-heptene-2-one	0.4	110-93-0
benzaldehyde	16.1	100-52-7
benzonitrile	1.8	100-47-0
hexanoic acid	2.8	142-62-1
2-hydroxy benzaldehyde (salicylaldehyde)	0.7	90-02-8
benzeneacetaldehyde	0.6	122-78-1
nonanal	7.2	124-19-6
acetophenone	14.3	98-86-2
decanal	13.5	112-31-2

total concentration of compounds with concentration above 1µg/m3	**67.4**
number of identified compounds	13

Customer	**Ministerio del Medio Ambiente**	
Sample id / tube id	**1A Sargent Aldea school**	
passive sampling on Tenax TA	under the roof	
7.-22. november 2018	id tube nr 63	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	0.6	67-64-1
benzene	0.6	71-43-2
acetic acid	2.3	64-19-7
octane	0.2	111-65-9
toluene	0.7	108-88-3
nonane	0.3	111-84-2
ethylbenzene	0.2	100-41-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	1.0	106-42-3
alfa pinene	0.9	80-56-8
decane	0.3	124-18-5
beta pinene	0.3	127-91-3
1,2,4-trimethylbenzene	0.5	95-63-6
Eucalyptol	0.2	000470-82-6
benzaldehyde	2.3	100-52-7
undecane	0.3	1120-21-4
nonanal	0.8	124-19-6
dodecane	0.2	112-40-3
acetophenone	1.6	98-86-2
nonanal	0.3	124-19-6
Pinocarvone	0.4	030460-92-5
decanal	1.1	112-31-2
benzothiazole	0.7	95-16-9
pentadecane	2.1	629-62-9

total concentration of compounds with concentration above 1µg/m3	**18.0**
number of identified compounds	26

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	1A Sargent Aldea school	
passive sampling on Tenax TA	above a tree	
7.-22. november 2018	id tube nr 711	
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	0.8	67-64-1
2-methylhexane	0.9	591-76-4
3-methylhexane	1.6	589-34-4
heptane	1.1	142-82-5
benzene	0.6	71-43-2
1-methoxy-2-propanol	10.5	107-98-2
toluene	11.7	108-88-3
1-ethoxy-2-propanol	2.5	1569-02-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	1.2	106-42-3
o-xylene (1,2-dimethylbenzene)	1.3	95-47-6
decane	0.9	124-18-5
beta pinene	0.7	127-91-3
1,2,4-trimethylbenzene	1.0	95-63-6
benzaldehyde	2.5	100-52-7
nonanal	1.1	124-19-6
acetophenone	2.6	98-86-2
Pinocarvone	1.5	030460-92-5
tridecane	0.6	629-50-5
benzothiazole	0.7	95-16-9
tetradecane	0.8	629-59-4
pentadecane	1.7	629-62-9

total concentration of compounds with concentration above 1µg/m3	**46.1**
number of identified compounds	21

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	8A Quintero Municipality	
passive sampling on Tenax TA		
8.-22. november 2018	id tube nr 350	
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
octane	4.8	111-65-9
toluene	1.5	108-88-3
nonane	0.6	111-84-2
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	1.8	106-42-3
o-xylene (1,2-dimethylbenzene)	2.2	95-47-6
decane	0.7	124-18-5
beta pinene	0.8	127-91-3
pentanoic acid	0.6	109-52-4
1,2,4-trimethylbenzene	1.5	95-63-6
benzaldehyde	4.6	100-52-7
undecane	0.6	1120-21-4
hexanoic acid	2.3	142-62-1
benzeneacetaldehyde	0.5	122-78-1
nonanal	1.2	124-19-6
acetophenone	4.1	98-86-2
phenol	1.7	108-95-2
tridecane	0.9	629-50-5
octanoic acid	0.7	124-07-2
benzothiazole	1.2	95-16-9
benzoic acid	3.9	65-85-0
2,4,7,9-Tetramethyl-5-decyn-4,7-diol (TMDD)	1.6	126-86-3
2,4-Di-tert-butylphenol	1.1	000096-76-4

total concentration of compounds with concentration above 1µg/m3	**38.9**
number of identified compounds	22

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	6A / 722	
pumped sampling on Tenax TA	8.november 2018, 10:05 - 10:40	
wind from W 1 m/s - temperature 13 °C		
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
pentane	6.0	109-66-0
hexane	4.9	110-54-3
methylcyclopentane	1.6	96-37-7
3-methylhexane	2.5	589-34-4
heptane	3.6	142-82-5
benzene	2.5	71-43-2
methylcyclohexane	1.8	108-87-2
2-methylheptane	2.7	592-27-8
octane	1.7	111-65-9
toluene	4.0	108-88-3
nonane	5.1	111-84-2
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	4.4	106-42-3
o-xylene (1,2-dimethylbenzene)	2.4	95-47-6
decane	2.5	124-18-5
1,2,4-trimethylbenzene	2.6	95-63-6
benzaldehyde	8.2	100-52-7
nonanal	2.3	124-19-6
acetophenone	6.1	98-86-2
decanal	4.3	112-31-2
nonanoic acid	2.4	112-05-0
pentadecane	3.5	629-62-9
5,9-Undecadien-2-one, 6,10-dimethyl-, (E)-	2.3	003796-70-1
hexadecane	3.9	544-76-3

total concentration of compounds with concentration above 1µg/m3	**81.2**
number of identified compounds	23

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	**5A / 724**	
pumped sampling on Tenax TA	8.november 2018, 10:51 - 11:26	
wind from W 3 m/s - temperature 15 °C	hydrocarbon odor	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	3.2	67-64-1
formic acid	14.1	64-18-6
acetic acid	26.3	64-19-7
propanoic acid	1.1	79-09-4
nonane	1.1	111-84-2
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	1.0	106-42-3
o-xylene (1,2-dimethylbenzene)	1.2	95-47-6
Benzothiazole, 2-phenyl-	2.1	000883-93-2
benzaldehyde	7.0	100-52-7
Oxime-, methoxy-phenyl-_	3.2	1000222-86-6
hexanoic acid	5.8	142-62-1
nonanal	4.1	124-19-6
acetophenone	4.8	98-86-2
phenol	3.3	108-95-2
decanal	3.6	112-31-2
octanoic acid	1.9	124-07-2
tetradecane	1.5	629-59-4
2-phenoxyethanol	3.6	122-99-6
nonanoic acid	10.8	112-05-0

total concentration of compounds with concentration above 1µg/m3	**99.7**
number of identified compounds	19

Customer	**Ministerio del Medio Ambiente**	
Sample id / tube id	**4A / 961**	
pumped sampling on Tenax TA	8.november 2018, 11:41 - 12:16	
wind from W 3 m/s - temperature 17°C		
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	1.0	67-64-1
methylcyclohexane	1.8	108-87-2
acetic acid	15.2	64-19-7
toluene	0.6	108-88-3
propanoic acid	0.3	79-09-4
benzaldehyde	6.8	100-52-7
benzonitrile	0.4	100-47-0
hexanoic acid	1.8	142-62-1
benzeneacetaldehyde	0.3	122-78-1
nonanal	2.7	124-19-6
acetophenone	5.3	98-86-2
decanal	4.5	112-31-2
octanoic acid	1.2	124-07-2
tetradecane	1.4	629-59-4
nonanoic acid	9.2	112-05-0

total concentration of compounds with concentration above 1µg/m3	**52.4**
number of identified compounds	15

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	3A / 423	
pumped sampling on Tenax TA	8.november 2018, 12:32 - 13:07	
wind from W 3 m/s - temperature 18°C		
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	1.0	67-64-1
hexane	2.1	110-54-3
acetic acid	21.6	64-19-7
toluene	0.5	108-88-3
benzaldehyde	4.9	100-52-7
hexanoic acid	1.2	142-62-1
nonanal	3.6	124-19-6
acetophenone	2.6	98-86-2
phenol	1.1	108-95-2
citronella	0.6	106-23-0
decanal	7.0	112-31-2
octanoic acid	0.9	124-07-2
tetradecane	1.9	629-59-4
nonanoic acid	4.7	112-05-0
pentadecane	1.7	629-62-9

total concentration of compounds with concentration above 1µg/m3	**55.4**
number of identified compounds	15

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	7A / 962	
pumped sampling on Tenax TA	8.november 2018, 13:40 - 14:15	
wind from W 4 m/s - temperature 19°C		
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	0.7	67-64-1
heptane	2.5	142-82-5
acetic acid	10.5	64-19-7
toluene	0.3	108-88-3
benzaldehyde	5.1	100-52-7
2-methyl-2,4-pentanediol (hexylene glycol)	0.5	107-41-5
hexanoic acid	1.2	142-62-1
2-methyl-1-propenyl benzene	0.4	768-49-0
nonanal	2.1	124-19-6
acetophenone	5.3	98-86-2
1-methyl-2-pyrrolidinone	0.4	872-50-4
decanal	3.5	112-31-2
octanoic acid	1.3	124-07-2
tetradecane	0.7	629-59-4
2-phenoxyethanol	5.7	122-99-6
nonanoic acid	8.3	112-05-0

total concentration of compounds with concentration above 1µg/m3	**48.2**
number of identified compounds	16

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	**10A / 903**	
pumped sampling on Tenax TA	8.november 2018, 22:15- 22:50	
wind from S 0 m/s - temperature 15°C		
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
pentane	3.5	109-66-0
2-methylpentane	1.1	107-83-5
methylcyclopentane	0.7	96-37-7
3-methylhexane	1.1	589-34-4
heptane	1.2	142-82-5
2,4-dimethylhexane	4.2	589-43-5
methylcyclohexane	0.5	108-87-2
acetic acid	10.2	64-19-7
toluene	1.6	108-88-3
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	1.5	106-42-3
o-xylene (1,2-dimethylbenzene)	0.8	95-47-6
1,2,4-trimethylbenzene	0.7	95-63-6
benzaldehyde	5.0	100-52-7
hexanoic acid	0.7	142-62-1
nonanal	2.1	124-19-6
acetophenone	3.7	98-86-2
decanal	2.3	112-31-2
octanoic acid	1.4	124-07-2
tetradecane	0.8	629-59-4
2-phenoxyethanol	3.8	122-99-6
nonanoic acid	13.7	112-05-0
pentadecane	2.4	629-62-9

total concentration of compounds with concentration above 1µg/m3	**62.9**
number of identified compounds	22

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	**11A / 211**	
pumped sampling on Tenax TA	8.november 2018, 23:02- 23:37	
wind from S 1 m/s - temperature 13°C		
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	2.0	67-64-1
methylcyclopentane	0.5	96-37-7
2,4-dimethylhexane	0.8	589-43-5
acetic acid	7.8	64-19-7
toluene	0.7	108-88-3
nonane	0.3	111-84-2
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	0.4	106-42-3
o-xylene (1,2-dimethylbenzene)	0.3	95-47-6
decane	0.3	124-18-5
1,2,4-trimethylbenzene	0.3	95-63-6
benzaldehyde	4.8	100-52-7
hexanoic acid	0.5	142-62-1
nonanal	1.6	124-19-6
acetophenone	2.8	98-86-2
phenol	2.3	108-95-2
decanal	2.9	112-31-2
octanoic acid	0.8	124-07-2
tetradecane	0.7	629-59-4
2-phenoxyethanol	2.2	122-99-6
nonanoic acid	3.5	112-05-0

total concentration of compounds with concentration above 1µg/m3	**35.4**
number of identified compounds	20

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	**14A / 90**	
pumped sampling on Tenax TA	9.november 2018, 00:28 - 01:03	
wind from NEast 1 m/s - temperature 13°C	hydrocarbon odor	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
pentane	3.4	109-66-0
hexane	4.7	110-54-3
methylcyclopentane	1.5	96-37-7
3-methylhexane	1.1	589-34-4
heptane	2.0	142-82-5
2,4-dimethylhexane	2.3	589-43-5
acetic acid	50.6	64-19-7
octane	1.2	111-65-9
toluene	2.9	108-88-3
propanoic acid	3.8	79-09-4
nonane	1.7	111-84-2
ethylbenzene	1.2	100-41-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	2.3	106-42-3
o-xylene (1,2-dimethylbenzene)	3.3	95-47-6
hexanoic acid ethylester	2.5	123-66-0
benzaldehyde	7.6	100-52-7
hexanoic acid	19.9	142-62-1
nonanal	3.3	124-19-6
acetophenone	4.6	98-86-2
phenol	1.7	108-95-2
heptanoic acid	4.0	111-14-8
decanal	4.0	112-31-2
octanoic acid	6.9	124-07-2
benzoic acid	18.6	65-85-0
nonanoic acid	19.5	112-05-0
pentadecane	5.1	629-62-9

total concentration of compounds with concentration above 1µg/m3	**179.4**
number of identified compounds	26

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	1A - Sargent Aldea / 75	
sampling on Tenax TA with syringe by school principal	22.november time 16:35	
wind from SW - temperature 22 °C	feels gas odor	
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	11.6	67-64-1
Cyclohexane	4.4	000110-82-7
methylcyclohexane	3.5	108-87-2
acetic acid	18.4	64-19-7
butanoic acid	3.1	107-92-6
2-Propenoic acid, 2-methyl-	7.3	000079-41-4
decane	2.5	124-18-5
benzaldehyde	11.9	100-52-7
2-ethyl-1-hexanol	5.4	104-76-7
hexanoic acid	4.5	142-62-1
2-hydroxy benzaldehyde (salicylaldehyde)	9.4	90-02-8
nonanal	8.3	124-19-6
dodecane	2.8	112-40-3
acetophenone	8.8	98-86-2
phenol	5.4	108-95-2
decanal	4.9	112-31-2
benzothiazole	10.8	95-16-9
tetradecane	4.7	629-59-4
2-phenoxyethanol	4.0	122-99-6
nonanoic acid	10.3	112-05-0
pentadecane	4.3	629-62-9
decanoic acid	3.9	334-48-5
hexadecane	10.0	544-76-3
2,4-Di-tert-butylphenol	4.8	000096-76-4

total concentration of compounds with concentration above 1µg/m3	**165.1**
number of identified compounds	24

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	**7A / 63**	
pumped sampling on Tenax TA	16.january 2019 time 9.55-10:30	
wind from SW 3 m/s - temperature 16 °C		
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	2.2	67-64-1
3-buten-2-one (methyl-vinyl-ketone)	2.1	78-94-4
Butane, 1-chloro-	2.7	000109-69-3
formic acid	3.2	64-18-6
acetic acid	14.5	64-19-7
nonane	3.2	111-84-2
benzaldehyde	8.8	100-52-7
Oxime-, methoxy-phenyl-_	1.9	1000222-86-6
2-ethyl-1-hexanol	2.7	104-76-7
hexanoic acid	1.4	142-62-1
nonanal	3.3	124-19-6
acetophenone	6.7	98-86-2
decanal	5.7	112-31-2
octanoic acid	1.7	124-07-2
nonanoic acid	9.0	112-05-0
decanoic acid	2.5	334-48-5
hexadecane	3.8	544-76-3

total concentration of compounds with concentration above 1µg/m3	**75.4**
number of identified compounds	17

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	7A / 711 Road to Maitenes	
passive sampling on Tenax TA		
16.january 10:45 to 18.january 15:30		
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	0.9	67-64-1
acetic acid	3.2	64-19-7
benzaldehyde	3.5	100-52-7
hexanoic acid	0.2	142-62-1
nonanal	2.5	124-19-6
acetophenone	3.0	98-86-2
heptanoic acid	0.2	111-14-8
decanal	4.8	112-31-2
tridecane	0.3	629-50-5
octanoic acid	0.5	124-07-2
benzoic acid	1.3	65-85-0
2-phenoxyethanol	2.3	122-99-6
nonanoic acid	3.3	112-05-0

total concentration of compounds with concentration above 1µg/m3	**26.0**
number of identified compounds	13

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	4A /213	
pumped sampling on Tenax TA	16.january 2019 time12:05-12:40	
wind from SW 4 m/s - temperature 17 °C		
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	1.0	67-64-1
acetic acid	6.1	64-19-7
toluene	0.4	108-88-3
benzaldehyde	4.0	100-52-7
nonanal	2.7	124-19-6
acetophenone	2.2	98-86-2
phenol	2.6	108-95-2
decanal	3.9	112-31-2
octanoic acid	0.4	124-07-2
tetradecane	1.6	629-59-4
2-phenoxyethanol	2.4	122-99-6

total concentration of compounds with concentration above 1µg/m3	**27.2**
number of identified compounds	11

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	Concon 4 / 213	
pumped sampling on Tenax TA	16.january 2019 time12:05-12:40	
wind from SW 4 m/s - temperature 17 °C	intense odor of heavy hydrocarbons	
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
toluene	15.0	108-88-3
ethylbenzene	6.7	100-41-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	30.1	106-42-3
o-xylene (1,2-dimethylbenzene)	14.0	95-47-6
decane	9.5	124-18-5
1-ethyl-3-methylbenzene	9.7	620-14-4
1-ethyl-2-methylbenzene	5.7	611-14-3
1,2,4-trimethylbenzene	21.3	95-63-6
1,2,3-trimethylbenzene	6.7	526-73-8
undecane	9.7	1120-21-4
1-methyl-3-propylbenzene	6.8	1074-43-7
o-Cymene	8.7	000527-84-4
Benzene, 1-ethyl-2,4-dimethyl-	7.0	000874-41-9
1-methyl-2-(2-propenyl) benzene	8.6	1587-04-8
Benzene, 1,2,3,4-tetramethyl-	5.9	000488-23-3
dodecane	10.3	112-40-3
2,3-dihydro-4-methyl-1H-inden	16.6	824-22-6
2,3-dihydro-2-methyl-1H-inden	15.2	824-63-5
2,2-Dimethylindene, 2,3-dihydro-	15.7	020836-11-7
tridecane	15.7	629-50-5
naphthalene	21.9	91-20-3
1H-Indene, 2,3-dihydro-4,7-dimethyl-	7.2	006682-71-9
tetradecane	12.0	629-59-4
2-methylnaphthalene	35.6	91-57-6
1-methylnaphthalene	17.7	90-12-0
pentadecane	6.6	629-62-9
Naphthalene, 1,4-dimethyl-	11.8	000571-58-4
Naphthalene, 2,7-dimethyl-	10.8	000582-16-1

total concentration of compounds with concentration above 1µg/m3	**362.4**
number of identified compounds	28

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	**13A /903**	
pumped sampling on Tenax TA	17.january 2019 time10:42-11:17	
wind from SW 4 m/s - temperature 16 °C	light hydrocarbon odor	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
pentane	24.7	109-66-0
2-methylpentane	6.5	107-83-5
3-methylpentane	14.1	94-14-0
methylcyclopentane	2.9	96-37-7
2-methylhexane	2.0	591-76-4
2,2,4-trimethylpentane (iso octane)	2.0	540-84-1
heptane	2.9	142-82-5
1,2-dimethyl cyclopentane	1.4	2452-99-5
benzene	4.5	71-43-2
2,3,4-trimethylpentane	1.0	565-75-3
acetic acid	1.0	64-19-7
toluene	6.6	108-88-3
ethylbenzene	15.8	100-41-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	2.0	106-42-3
o-xylene (1,2-dimethylbenzene)	7.9	95-47-6
Benzene, 1-ethyl-2-methyl-	2.9	000611-14-3
1,2,4-trimethylbenzene	1.2	95-63-6
benzaldehyde	2.3	100-52-7
nonanal	6.8	124-19-6
acetophenone	3.7	98-86-2
decanal	4.8	112-31-2
tetradecane	7.2	629-59-4
nonanoic acid	1.0	112-05-0
pentadecane	5.1	629-62-9

total concentration of compounds with concentration above 1µg/m3	**132.4**
number of identified compounds	25

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	5A /62	
pumped sampling on Tenax TA	17.january 2019 time 11:37 -12:12	
wind from SW 5 m/s - temperature 17 °C	light hydrocarbon odor	
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
pentane	4.1	109-66-0
2-methylpentane	1.4	107-83-5
methylcyclopentane	0.9	96-37-7
3-methylhexane	1.3	589-34-4
heptane	1.5	142-82-5
1,2-dimethyl cyclopentane	1.9	2452-99-5
acetic acid	14.3	64-19-7
octane	0.8	111-65-9
toluene	4.1	108-88-3
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	2.4	106-42-3
o-xylene (1,2-dimethylbenzene)	0.9	95-47-6
1,2,4-trimethylbenzene	0.8	95-63-6
benzaldehyde	4.5	100-52-7
hexanoic acid	0.8	142-62-1
nonanal	3.2	124-19-6
dodecane	3.3	112-40-3
decanal	5.8	112-31-2
octanoic acid	1.4	124-07-2
tetradecane	1.2	629-59-4
2-phenoxyethanol	2.8	122-99-6
nonanoic acid	6.2	112-05-0
pentadecane	1.5	629-62-9
decanoic acid	3.0	334-48-5
hexadecane	5.5	544-76-3

total concentration of compounds with concentration above 1µg/m3	**73.7**
number of identified compounds	24

Customer	**Ministerio del Medio Ambiente**	
Sample id / tube id	**Concon 5 / 39**	
pumped sampling on Tenax TA	18.january 2019 time 02:38-02:56	
wind from SEast 2 m/s - temperature 13 °C	heavy hydrocarbon odor	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
pentane	11.8	109-66-0
heptane	8.4	142-82-5
2-methylheptane	14.0	592-27-8
octane	7.3	111-65-9
toluene	19.6	108-88-3
ethylcyclohexane	5.1	1678-91-7
nonane	6.5	111-84-2
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	21.7	106-42-3
o-xylene (1,2-dimethylbenzene)	10.3	95-47-6
decane	5.4	124-18-5
Benzene, 1-ethyl-2-methyl-	5.3	000611-14-3
1,2,4-trimethylbenzene	11.7	95-63-6
benzaldehyde	5.8	100-52-7
undecane	7.7	1120-21-4
1-methyl-4-(1-methylethyl)-benzene	5.1	99-87-6
nonanal	8.7	124-19-6
dodecane	8.1	112-40-3
2,6-dimethylundecane	12.6	17301-23-4
diethenylbenzene isomere	9.5	0.0
1H-Indene, 2,3-dihydro-4,7-dimethyl-	6.9	006682-71-9
tridecane	20.3	629-50-5
tetradecane	6.6	629-59-4
2-methylnaphthalene	9.8	91-57-6
1-methylnaphthalene	7.4	90-12-0

total concentration of compounds with concentration above 1µg/m3	**254.1**
number of identified compounds	24

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	concon 6 / 722	
pumped sampling on Tenax TA	18.january 2019 time 03:14-03:29	
wind from SEast 2 m/s - temperature 13 °C	heavy hydrocarbon odor slightly different	
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
pentane	7.2	109-66-0
hexane	13.5	110-54-3
3-methylhexane	4.3	589-34-4
heptane	5.9	142-82-5
benzene	5.2	71-43-2
methylcyclohexane	3.9	108-87-2
2,2,5-trimethylhexane	12.4	3522-94-9
octane	4.3	111-65-9
toluene	13.1	108-88-3
nonane	4.5	111-84-2
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	12.0	106-42-3
o-xylene (1,2-dimethylbenzene)	5.8	95-47-6
1,2,4-trimethylbenzene	6.2	95-63-6
benzaldehyde	4.7	100-52-7
undecane	5.3	1120-21-4
nonanal	5.8	124-19-6
dodecane	6.8	112-40-3
2,6-dimethylundecane	9.4	17301-23-4
Benzene, (1-methyl-1-propenyl)-, (Z)-	6.7	000767-99-7
1H-Indene, 2,3-dihydro-1,2-dimethyl-	5.2	017057-82-8
tridecane	16.5	629-50-5
tetradecane	5.2	629-59-4
2-methylnaphthalene	6.7	91-57-6
1-methylnaphthalene	4.6	90-12-0

total concentration of compounds with concentration above 1µg/m3	**186.7**
number of identified compounds	26

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	Concon 2 / 955	
pumped sampling on Tenax TA	18.january 2019 time 03:51-04:06	
wind from East 2 m/s - temperature 13 °C	sporadic light odor	
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	3.9	67-64-1
acetic acid ethylester (ethylacetate)	1.0	141-78-6
2-butanol	5.5	78-92-2
acetic acid	22.9	64-19-7
octane	1.0	111-65-9
toluene	1.9	108-88-3
hexanal	1.4	66-25-1
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	1.0	106-42-3
benzaldehyde	15.2	100-52-7
nonanal	9.2	124-19-6
acetophenone	8.1	98-86-2
phenol	1.0	108-95-2
decanal	18.4	112-31-2
octanoic acid	1.0	124-07-2
tetradecane	1.9	629-59-4
2-phenoxyethanol	5.8	122-99-6
nonanoic acid	6.3	112-05-0
pentadecane	3.0	629-62-9
decanoic acid	3.4	334-48-5
hexadecane	13.5	544-76-3

total concentration of compounds with concentration above 1µg/m3	**125.5**
number of identified compounds	20

Customer	**Ministerio del Medio Ambiente**	
Sample id / tube id	**Concon domestic house / 10592**	
canister sampling and transfer to Tenax TA at NILU		
17.january at 04:30	heavy disgusting odor	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
hexane	13.0	110-54-3
butanal	25.7	123-72-8
heptane	13.7	142-82-5
2-methylheptane	44.4	592-27-8
octane	20.2	111-65-9
toluene	46.0	108-88-3
ethylcyclohexane	10.4	1678-91-7
hexanal	9.2	66-25-1
nonane	13.0	111-84-2
ethylbenzene	13.3	100-41-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	49.2	106-42-3
o-xylene (1,2-dimethylbenzene)	25.3	95-47-6
3-heptanone	14.6	106-35-4
decane	15.5	124-18-5
1-ethyl-3-methylbenzene	14.8	620-14-4
2-ethylhexanal	8.9	123-05-7
1,2,4-trimethylbenzene	8.6	95-63-6
p- og m- methyl isopropyl benzene (cymene)	24.0	25155-15-1
octanal	11.6	124-13-0
undecane	10.4	1120-21-4
1-methyl-2-(2-propenyl) benzene	9.4	1587-04-8
1,2,3,5-tetramethylbenzene	13.8	527-53-7
nonanal	8.8	124-19-6
1-Phenyl-1-butene	10.2	000824-90-8
1H-Indene, 2,3-dihydro-1,6-dimethyl-	8.8	017059-48-2
decanal	23.8	112-31-2

total concentration of compounds with concentration above 1µg/m3	**466.6**
number of identified compounds	26

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	Concon highway / a10519	
canister sampling and transfer to Tenax TA at NILU	level 1	
18.january at 04:30 NEast 1 m/s temperature 13 ° C		
compound chemical name	concentration	CAS NR
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	6.1	67-64-1
acetic acid ethylester (ethylacetate)	11.6	141-78-6
Butane, 1-chloro-	2.7	000109-69-3
benzene	3.3	71-43-2
2-Ethylacrolein	1.7	000922-63-4
acetic acid	58.6	64-19-7
toluene	2.4	108-88-3
propanoic acid	2.6	79-09-4
hexanal	2.8	66-25-1
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	1.5	106-42-3
3-heptanone	5.2	106-35-4
heptanal	1.9	111-71-7
benzaldehyde	5.3	100-52-7
2-ethyl-1-hexanol	4.0	104-76-7
nonanal	4.0	124-19-6
acetophenone	2.1	98-86-2
decanal	7.6	112-31-2

total concentration of compounds with concentration above 1µg/m3	**123.4**
number of identified compounds	17

Customer	**Ministerio del Medio Ambiente**	
Sample id / tube id	**Concon highway / a10481**	
canister sampling and transfer to Tenax TA at NILU	level 3	
18.january at 04:32 NEast 1 m/s temperature 13 ° C		
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	3.2	67-64-1
butanal	1.1	123-72-8
benzene	1.6	71-43-2
acetic acid	4.7	64-19-7
toluene	1.0	108-88-3
hexanal	1.0	66-25-1
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	0.7	106-42-3
alfa pinene	2.4	80-56-8
3-heptanone	6.3	106-35-4
benzaldehyde	3.8	100-52-7
2-ethyl-1-hexanol	20.7	104-76-7
1,2,3,5-tetramethylbenzene	0.6	527-53-7
nonanal	2.7	124-19-6
acetophenone	1.1	98-86-2
phenol	2.3	108-95-2
decanal	2.7	112-31-2
tetradecane	0.7	629-59-4

total concentration of compounds with concentration above 1µg/m3	**56.6**
number of identified compounds	17

Customer	**Ministerio del Medio Ambiente**	
Sample id / tube id	**Concon highway / a10498**	
canister sampling and transfer to Tenax TA at NILU	level 2	
18.january at 04:34 NEast 1 m/s temperature 13 ° C		
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	5.1	67-64-1
butanal	3.3	123-72-8
benzene	0.7	71-43-2
2-Ethylacrolein	1.5	000922-63-4
acetic acid	33.3	64-19-7
toluene	1.5	108-88-3
hexanal	1.9	66-25-1
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	1.1	106-42-3
alfa pinene	1.0	80-56-8
heptanal	0.7	111-71-7
cyclohexanone	1.4	108-94-1
benzaldehyde	2.2	100-52-7
2-ethyl-1-hexanol	3.5	104-76-7
2-Piperidinone	1.4	000675-20-7
nonanal	1.0	124-19-6
acetophenone	1.3	98-86-2
Atrolactic acid	1.8	000515-30-0
decanal	1.3	112-31-2
tetradecane	0.7	629-59-4
hexadecane	0.8	544-76-3

total concentration of compounds with concentration above 1µg/m3	**65.4**
number of identified compounds	20

Customer	Ministerio del Medio Ambiente	
Sample id / tube id	Concon domestic house / 223	
sampling on Tenax TA with syringe by resident	18.january 2019 time 03:51-04:06	
between 01:00 and 06:00 on november 16,22 25 and december 5,8,9,28	odor episodes	
compound chemical name	**concentration**	**CAS NR**
	'Toluene-equivalents' (µg/m3)	
2-propanone (acetone)	120.3	67-64-1
acetic acid ethylester (ethylacetate)	29.4	141-78-6
1-butanol	29.9	71-36-3
toluene	720.1	108-88-3
ethylcyclohexane	124.0	1678-91-7
hexanal	55.6	66-25-1
ethylbenzene	47.1	100-41-4
p-and m- Xylene (1,4 og 1,3 dimethylbenzene)	235.9	106-42-3
o-xylene (1,2-dimethylbenzene)	121.2	95-47-6
decane	18.2	124-18-5
beta pinene	47.5	127-91-3
pentanoic acid	14.4	109-52-4
1,2,4-trimethylbenzene	33.6	95-63-6
limonene	29.3	138-86-3
6-methyl-5-heptene-2-one	27.7	110-93-0
benzaldehyde	41.6	100-52-7
undecane	56.1	1120-21-4
4-ethyl-1,2-dimethylbenzene	15.2	934-80-5
hexanoic acid	39.5	142-62-1
2-hydroxy benzaldehyde (salicylaldehyde)	26.7	90-02-8
nonanal	73.2	124-19-6
dodecane	14.3	112-40-3
tridecane	17.6	629-50-5
2,2,4,4,6,8,8-heptamethylnonane	17.5	4390-04-9
benzothiazole	30.4	95-16-9

total concentration of compounds with concentration above 1µg/m3	**1986.3**
number of identified compounds	25

Appendix D

Presentation at the open Workshop (15th March 2019)

Fingerprint of Volatile Organic Compounds in Quintero-Puchuncaví area

Norbert Schmidbauer and Susana Lopez-Aparicio
NILU – Norwegian Institute for Air Research (Norway)

Understanding units for concentration

Mixing ratio	Parts per Million (ppm)	Parts per billion (ppb)	Parts per trillion (ppt)
Actually a kind of %: % means parts per hundred			
Concentration	**Miligrams per cubic metre (mg/m3)**	**Microgram per cubic metre (µg/m3)**	**Nanogram per cubic metre (ng/m3)**
It is possible to calculate from mixing ratio to concentration, and vice verse. It depends on how heavy the compound is.			
Examples:			
Ethyne (Acetylene)	1 ppm ≈ 1 mg/m3	1 ppb ≈ 1 µg/m3	1 ppt ≈ 1 ng/m3
Benzene	1 ppm ≈ 3 mg/m3	1 ppb ≈ 3 µg/m3	1 ppt ≈ 3 ng/m3
Xylene	1 ppm ≈ 4 mg/m3	1 ppb ≈ 4 µg/m3	1 ppt ≈ 4 ng/m3
Pollution Plume: size 100 m x 10 m x 4 km.	100 mg/m3 ≈ 500 litre ≈ gasoline in 10 cars	100 µg/m3 ≈ 0.5 litre ≈ small bottle of water	100 ng/m3 ≈ 0.5 milli litre ≈ tea spoon

Main Findings and Conclusions (I)

The VOC compounds showing the highest concentrations out of the industrial area are ethane, propane, butane and pentanes, as well as BTEX.

Conclusion: this is expected as the main activity in the area is the storage and/or the distribution of petrochemical material.

Main Findings and Conclusions (II)

We evaluated the measurements results of the 4 compounds (methyl chloroform, nitrobenzene, iso-butane and toluene), which were reported at very high concentration and intensively discussed in the media.

Conclusion: the results from our measurements show very much lower concentration and we conclude that the measurements were done with a significant error in their calibration.

Methyl chloroform levels from our measurements were million times lower and nitrobenzene was not detected.

Toluene and iso butane were in the low ppb levels and not in ppm levels.

Main Findings and Conclusions (III)

The highest concentration levels of air masses leaving the industrial area were for light hydrocarbons in the range of up to 100 µg/m3. The sum of all light hydrocarbons was up to 300 µg/m3. The highest concentration levels for the BTEX compounds were up to 50 µg/m3. The highest sum of all BTEX was 85 µg/m3.

Conclusion: given normal dispersion ("dilution") conditions, relatively short pollution plumes will not have a significant effects on the concentration levels in nearby schools or residential areas.

Main Findings and Conclusions (IV)

The sum of compounds sampled in Tenax tubes ranged between 25 and 180 µg/m3.

Conclusion: No light hydrocarbon levels or BTEX levels at the residential areas had hydrocarbon or BTEX signatures (fingerprints) of any of the episodes measured closed to the sources. The levels of VOCs were a blend of local natural and anthropogenic sources (e.g., vehicle emissions, domestic sources and decomposition of waste and biological processes).

Main Findings and Conclusions (V)

In nearly all situations were the sampling team defined sampling time and location by using their sense of smell, the VOC concentrations were elevated. This shows that our nose is a good detector for sensing unusually high concentration of hydrocarbons.

Conclusion: closed to the sources, the nose is able to detect fresh plumes of hydrocarbons and BTEX compounds. Smelling episodes in Quintero or nearby schools had different signatures – being affected by mostly local sources (e.g., vehicle emissions, domestic sources and decomposition of waste and biological processes).

Main Findings and Conclusions (VI)

The average concentration of ambient benzene was 1.0 µg/m^3 out of the industrial areas and 0.3 µg/m^3 at the residential and background areas.

Conclusion: the benzene levels are lower than international limit values (5 µg/m^3 as yearly averaged value).

Main Findings and Conclusions (Concón)

The situation in Concón is different than in Quintero – Puchuncaví. The sum of hydrocarbons was as high as 325 µg/m³ during night time and low wind speed. The peak concentration of VOCs were up to 2000 µg/m3 at a residential house.

Conclusion: The source strength of the refinery has a larger impact on the nearby residential area. Those situations were quite local (changing from street to street) and changed fast during the night.

VOC measurements in the Concón – Quintero – Puchuncaví –Ventanas industrial zone

Aim of the project

- Overview of the presence of **VOCs in the area**.
- Identification of **fingerprints of fugitive VOC** emissions at ground level close to the industrial areas and nearby residential areas
- Important Note: our study only focus on VOCs and measurement campaigns in November, December and January.

Choice of analytical methods (I)

Using a **very precise and accurate and well calibrated** method for light hydrocarbons, BTEX, chlorinated solvents and some sulphur containing gases.

This method is only measuring a certain number of **target compounds** – no other «unknown compounds» will be measured

Medusa a very **precise and accurate** instrument for target VOCs

http://agage.eas.gatech.edu/instruments-gcms-medusa.htm
Miller et al., Anal. Chem., 2008.

Active Stations

Cape Grim
Cape Matatula
Cape Ochiishi
Gosan, Jeju Island
Hateruma
Jungfraujoch
Mace Head
Monte Cimone
Mt. Mugogo
Ragged Point
Shangdianzi
Trinidad Head
Zeppelin, Ny-Ålesund

Global Network

The ALE/GAGE/AGAGE stations are coastal or mountain sites around the world chosen primarily to provide accurate measurements of trace gases with lifetimes that are long compared to global atmospheric circulation times. The AGAGE and affiliated stations are shown in the map below. For more information on each station please select a station from the map or the list.

AGAGE Advanced Global Atmospheric Gases Experiment

Sponsored by NASA's Atmospheric Composition Focus Area in Earth Science

History of Chemically and Radiatively Important Atmospheric Gases from the Advanced Global Atmospheric Gases Experiment (AGAGE)

for submission to *Earth System Science Data* (http://www.earth-system-science-data.net/)

PRECISION

Compound	Global mean 2016 conc. (ppt)[a]	Typical Precision (%)	Compound	Global mean 2016 conc. (ppt)[a]	Typical[3] Precision (%)
PFC-14	82.7	0.15	CFC-114	16.28	0.3
PFC-116	4.58	1	CFC-115	8.48	0.7
PFC-218	0.63	3	Halon-1211	3.59	0.4
PFC-c318	1.56	1.5	Halon-1301	3.37	1.7
PFC-5-1-14	0.31	3	Halon-2402	0.41	2
SF_6	8.88	0.6	CH_3Cl	552	0.2
SF_5CF_3	0.17	7	CH_3Br	6.96	0.6
SO_2F_2	2.26	2	[5]CH_3I	0.58	2
NF_3	1.44	1	CH_2Cl_2	31.06	0.5
HFC-23	28.90	0.7	[5]CH_2Br_2	1.08	1.5
HFC-32	12.63	3	$CHCl_3$	8.78	0.4
HFC-134a	89.31	0.5	[5]$CHBr_3$	1.84	0.6
HFC-152a	6.71	1.4	CCl_4	79.92	1
HFC-125	20.63	0.7	CH_3CCl_3	2.61	0.7
HFC-143a	19.31	1	$CHCl=CCl_2$	0.11	3
HFC-227ea	1.24	2.2	[2]$CCl_2=CCl_2$	1.07	0.5
HFC-236fa	0.15	10	[2]COS	543	0.5
HFC-245fa	2.42	3	[1]C_2H_6	596	0.3
HFC-365mfc	1.00	6	C_2H_2	9.04	0.6
HFC-43-10mee	0.27	3	[1]C_6H_6	17.91	0.3
HCFC-22	237.28	0.3	[1]C_7H_8	4.19	0.6
HCFC-141b	24.49	0.5			
HCFC-142b	22.57	0.4			

Choice of analytical methods (II)

Use of a «broad-band» method for VOCs which can deal with **identification of «unknown compounds»**.

The method should cover a wide range of different compound classes like hydrocarbons, aldehydes and ketones, organic acids, solvents and widely used industrial chemicals as well as natural VOCs.

This method is «semi-quantitative» and should therefore **overlap with the first method** on a range of hydrocarbons like BTEX.

Method for screening and identification of non-target VOC

- Sampling on adsorption tubes filled with Tenax TA
- **Most common adsorbent** for wide range VOC analysis
- Sample amount 2 liter of air
  - avoiding breakthrough
  - enough sample for good identification of VOC with µg/m³ concentrations
  - not looking for trace concentrations
- Not suitable for very reactive gases – may react with the adsorbent or with compounds already captured on the adsorbent
- «**Semi quantitative**»
- Blank issues - but in the low µg/m^3 concentration range
- Both passive (diffusive) sampling – as well as pumped sampling

Analytical method for Tenax TA sample tubes

- Using a automatic thermal desorber – cold-trapping at -30°C
- Gas chromatografic separation on DB 1701 – 1 µm – 50 m
- Mass spectrometer with EI detection
- Using first automatic search on three different mass spec libraries
- Automated cross check of retention time index during the **manual identification routine** - mass spectra for higher alkanes look very similar – as well as aromatic compound or terpenes have very similar signature
- **NILU's RT index database** contains about 1000 of the most common VOCs – **built up during the last 35 years** – verified compound injection with standards made of pure chemicals

4 different sampling strategies

Sampling and sampling strategy (I)

Sampling as **close as possible to the industrial areas** at low wind conditions.

Preferable when the sampling team could **identify odors** - but also when **normal activity conditions** inside the industrial areas were seen

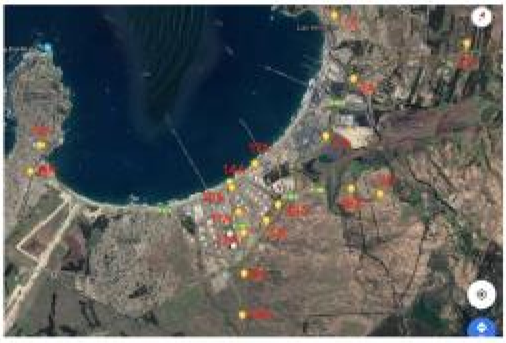
Sampling and sampling strategy (II)

Whenever the wind direction **pointed to some of the residential areas** or towards the different schools in the area – samples were taken at those respective sites as well.

Sampling and sampling strategy (III)

Supported by citizen participation.

Leaving equipment at **schools and residential homes** for sampling during periods of odors or strange smells.



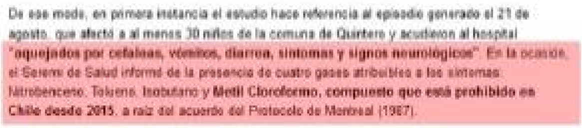
Sampling and sampling strategy (IV)

Taking passive samples for average measurements **over longer time periods**

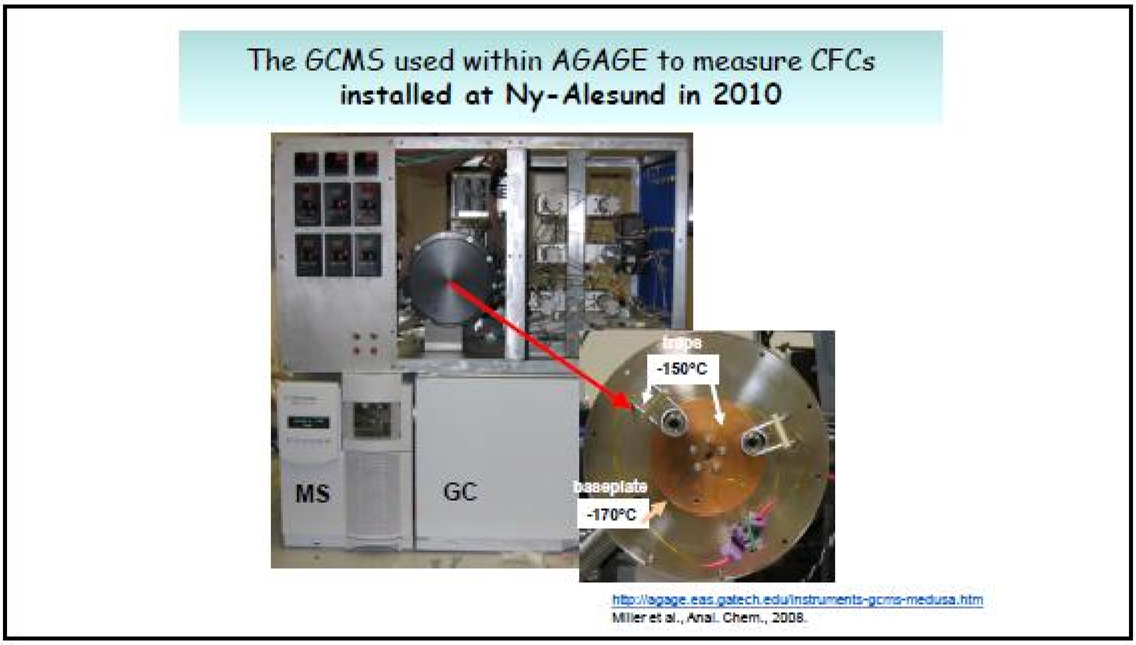
Sampling locations - Concón

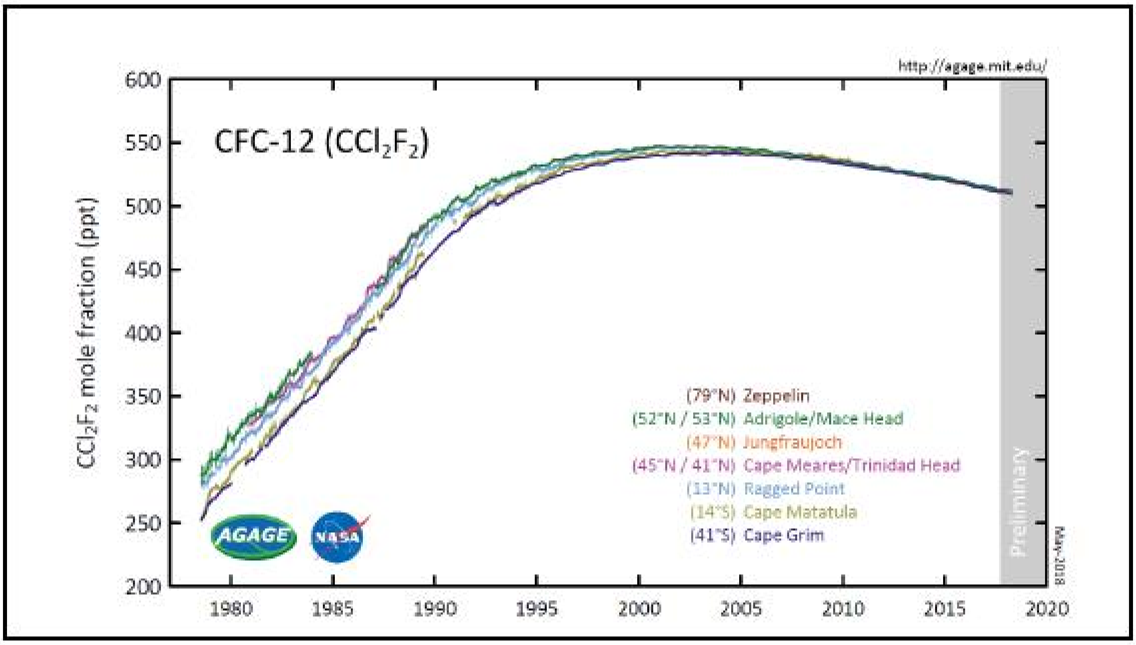
The 4 compounds in the newspapers

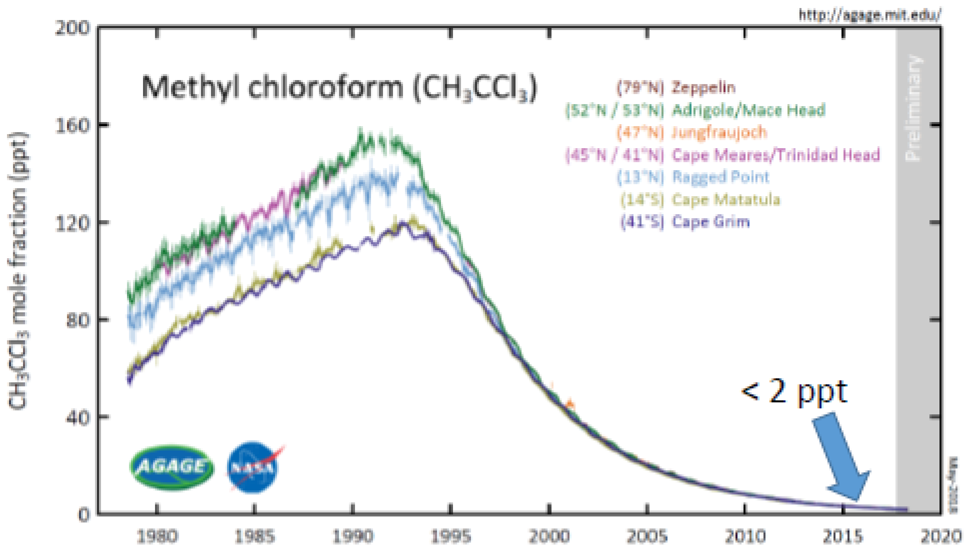
Quintero y Puchuncaví: Informe del Colegio Médico advierte de nocivos efectos en la salud por contaminantes



De ese modo, en primera instancia el estudio hace referencia al episodio generado el 21 de agosto, que afectó a al menos 30 niños de la comuna de Quintero y acudieron al hospital **"aquejados por cefaleas, vómitos, diarrea, síntomas y signos neurológicos"**. En la ocasión, el Seremi de Salud informó de la presencia de cuatro gases atribuibles a los síntomas: Nitrobenceno, Tolueno, Isobutano y **Metil Cloroformo, compuesto que está prohibido en Chile desde 2015**, a raíz del acuerdo del Protocolo de Montreal (1987).


The GCMS used within AGAGE to measure CFCs
installed at Ny-Alesund in 2010
traps
-150°C
baseplate
-170°C
MS
GC
http://agage.eas.gatech.edu/instruments-gcms-medusa.htm
Miller et al., Anal. Chem., 2008.


http://agage.mit.edu/
CFC-12 (CCl_2F_2)
CCl_2F_2 mole fraction (ppt)
600
550
500
450
400
350
300
250
200
1980
1985
1990
1995
2000
2005
2010
2015
2020
(79°N) Zeppelin
(52°N / 53°N) Adrigole/Mace Head
(47°N) Jungfraujoch
(45°N / 41°N) Cape Meares/Trinidad Head
(13°N) Ragged Point
(14°S) Cape Matatula
(41°S) Cape Grim
AGAGE
NASA
Preliminary
May-2018



What are VOCs?

VOCs (**V**olatile **O**rganic **C**ompounds) includes a wide variety of organic chemicals that are at normal atmospheric conditions liquids.

However, they have a high vapor pressure and will also be present in the air above the liquid phase.

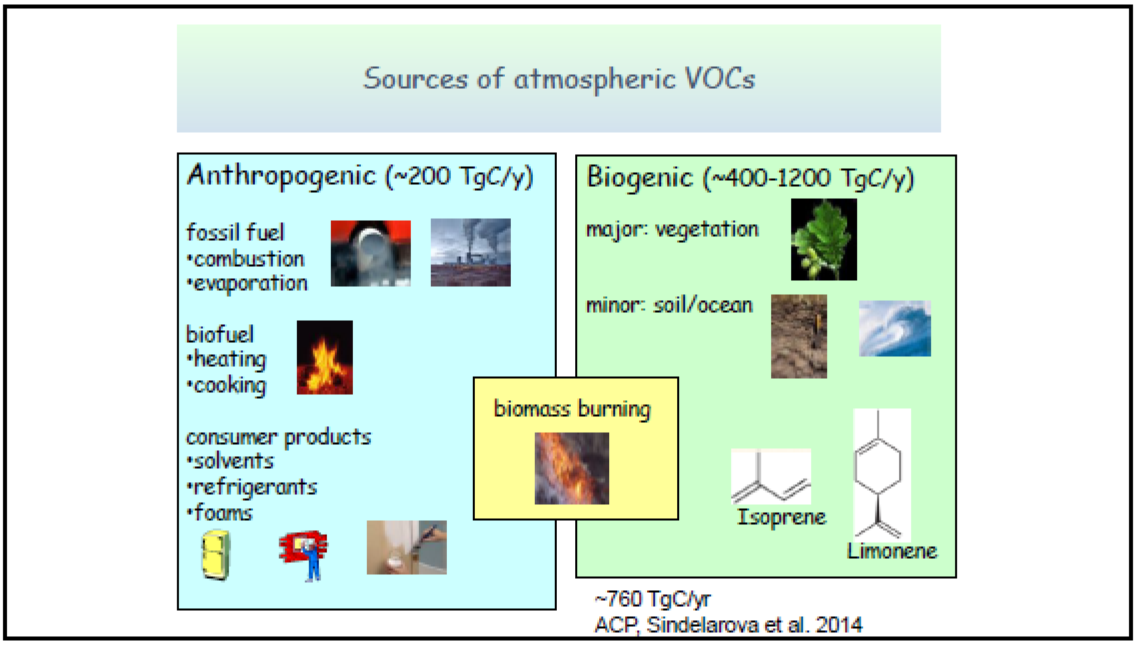
Some examples :

Hydrocarbons: Propane, Butane… Benzene, Toluene, Xylene…

Alcohol: Methanol, Ethanol, Propanol …

Aldehydes and Ketones: Formaldehyde, Acetaldehyde… Acetone

Organic Acids: Formic Acid, Acetic Acid …Fatty Acids



VOC – volatile organic compounds

- **Oil and gas and coal** are natural products
- Widely used in the **energy-sector**, as fuel for **transportation** and as chemical feedstock. Most of our **modern materials** have their origin in fossil fuels.
- Our **tolerance** for those compounds is **usually very high** – but there are EXCEPTIONS – like **Benzene** which is carcinogenic. Therefore the compound is regulated and concentration limits are quite low – less than 5 µg/m^3 as a yearly average (EU limit value).
- This is a very low limit compared to all the other VOCs. **There are no limit values for VOCs in outdoor air.**
- Previously, limit value for total sum of VOC in outdoor air existed at 400 µg/m3. This limit was removed due to fact that no health issues were documented for the total sum of VOC.

VOC – Limit Values (Outdoor)

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European Commission

ENVIRONMENT

European Commission › Environment › Air

Home | About us | Policies | Funding | Legal compliance | News & outreach

Clean Air
Clean Air Programme
Air quality
Introduction
AQD Fitness Check
Assessment

Air Quality Standards

Humans can be adversely affected by exposure to air pollutants in ambient air. In response, the European Union has developed an extensive body of legislation which establishes health based standards and objectives for a number of pollutants present in the air. These standards and objectives are summarised in the table below. These apply over differing periods of time because the observed health impacts associated with the various pollutants occur over different exposure times.

Pollutant	*Concentration*	*Averaging period*	*Legal nature*	*Permitted exceedences each year*
Benzene	5 µg/m3	1 year	Limit value to be met as of 1.1.2010**	n/a

VOC – Limit Values (Occupational Exposure)

UNITED STATES DEPARTMENT OF LABOR

Find it in OSHA

A TO Z INDEX

Occupational Safety and Health Administration

English | Spanish

Substance	CAS No.	Regulatory Limits			Recommended Limits	
		OSHA PEL		Cal/OSHA PEL (as of 4/4/2018)	NIOSH REL (as of 2/2/16)	ACGIH® 2018 TLV®
		ppm	mg/m³	8-hour TWA (ST) STEL (C) Ceiling	Up to 10-hour TWA (ST) STEL (C) Ceiling	8-hour TWA (ST) STEL (C) Ceiling
Benzene; See 1910.1028; See Table Z-2 for the limits applicable in the operations or sectors excluded in 1910.1028	71-43-2			1 ppm (ST) 5 ppm See Section 5218	Ca 0.1 ppm (ST) 1 ppm See Appendix A	0.5 ppm (ST) 2.5 ppm
Xylenes (o-, m-, p-isomers)	1330-20-7	100	435	100 ppm (ST) 150 ppm (C) 300 ppm	100 ppm (ST) 150 ppm	100 ppm (ST) 150 ppm
Propane	74-98-6	1000	1800	1000 ppm	1000 ppm	See *TLV® book* Appendix F (D, EX)

VOC – Limit Values (Occupational Exposure)

UNITED STATES
DEPARTMENT OF LABOR

Find it in OSHA

A TO Z INDEX

Occupational Safety and Health Administration

English | Spanish

Regulatory Limits						Recommended Limits	
OSHA PELs[a]					Cal/OSHA PEL[c] (as of 4/4/18)	NIOSH REL[d] (as of 7/7/16)	ACGIH® 2018 TLV®[e]
Substance	8-hour Time Weighted Average (TWA)	Acceptable Ceiling Concentration	Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift: Concentration	Maximum Duration	8-hour TWA (ST) STEL (C) Ceiling	Up to 10-hour TWA (ST) STEL (C) Ceiling	8-hour TWA (ST) STEL (C) Ceiling
Toluene (Z37.12-1967)	200 ppm	300 ppm	500 ppm	10 min	10 ppm (ST) 150 ppm (C) 500 ppm	100 ppm (ST) 150 ppm	20 ppm

Comments on concentration levels of certain compounds widely discussed in Chilean media

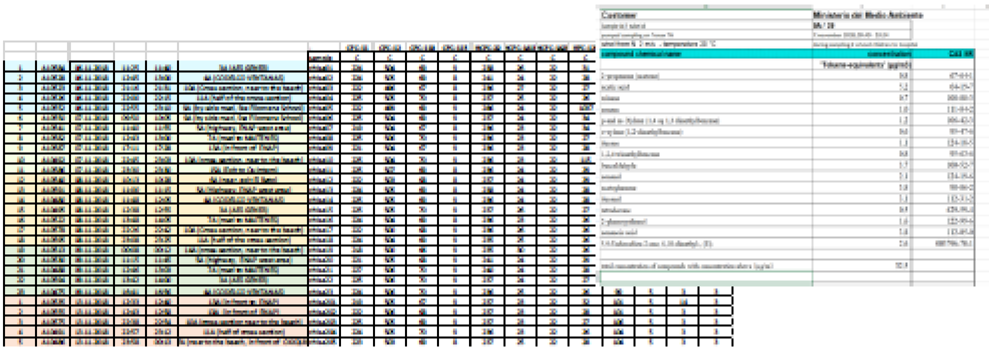
- high ppm values of the 4 compounds measured with MIRAN

Based on our measurements:

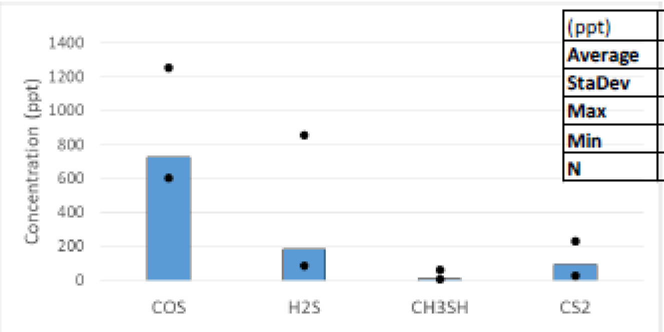
- *Methyl chloroform* levels were million times lower.
- *Nitrobenzene* was not detected, detection level 1 µg/m3.
- *Toluene* and *iso-butane* were in the low ppb levels and not in ppm levels.

Results from the measurements

- We analyzed over 50 canister samples and over 25 Tenax samples.
- This involved large tables of analytical results.



Sulphur Compounds (ppt levels)

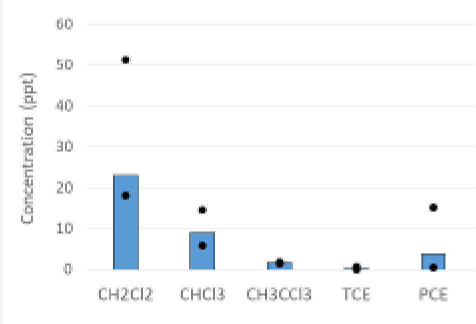


(ppt)	COS	H2S	CH3SH	CS2
Average	726,8	181,3	8,8	90,6
StaDev	121,6	124,6	9,0	54,1
Max	1252,5	853,6	60,1	231,1
Min	599,6	83,7	3,7	25,2
N	47	47	47	47

- **Sulphur components**, very smelly, associated with coal combustion or oil/gas.
- These values are low and cannot be smelled.

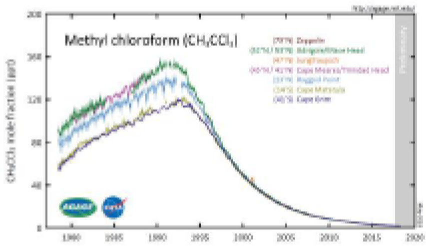
Chlorinated solvents (ppt levels)

ppt	CH2Cl2	CHCl3	CH3CCl3	TCE	PCE
Average	23,1	9,0	1,7	0,2	3,7
StaDev	7,6	1,8	0,1	0,1	3,1
Max	51,3	14,6	1,9	0,6	15,3
Min	18,1	6,0	1,5	0,0	0,5
N	38	38	38	38	38



Methyl chloroform was measured at all the sampling points between **1.5 and 1.9 ppt.** This is global atmospheric background.

The other chlorinated solvents are at also very low levels



Cooling Agents (ppt levels)

	-	HCFC-22	HCFC-141	HCFC-142	HFC-125	HFC-134a	HFC-152a	H-1211	H-1301
	sample	c	c	c	c	c	c	c	c
3A (AES GENER)	chisa01	238	26	22	31	107	5	3	3
4A (CODELCO VENTANAS)	chisa02	241	24	22	28	104	5	3	3
10A (Cross-section, near to the beach)	chisa03	236	27	22	27	99	5	3	3
11A (half of the cross-section)	chisa04	237	25	22	26	99	5	3	3
9A (by-side road, Sta Filomena School)	chisa05	286	24	22	1037	1148	5	3	3
9A (by side road, Sta Filomena School)	chisa06	237	24	22	34	108	6	3	3
5A (highway, ENAP west area)	chisa07	236	23	22	34	108	5	3	3
7A (road to MAITENES)	chisa08	236	23	22	27	100	5	3	3
13A (in front of ENAP)	chisa09	236	23	22	28	100	5	3	3
10A (cross-section, near to the beach)	chisa10	236	23	22	115	101	5	3	3

mixing ratio in ppt (vol)

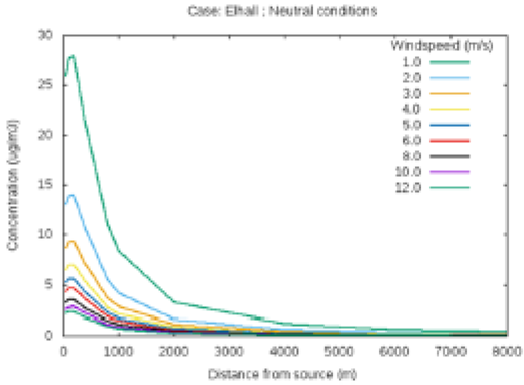
These compounds are associated with **cooling processes or fire extinguishers** ongoing in Ventanas Industrial area.

These values indicate that there are **no leaking processes.**

Dispersion

How do concentration change with distance from the source at different wind speed

Industrial area

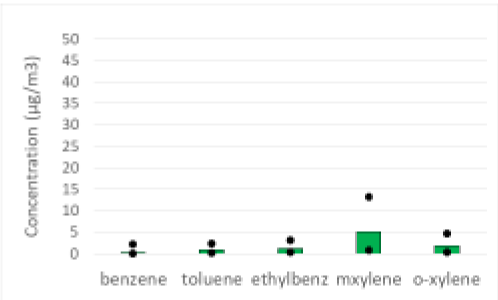


Residential area

BTEX (µg/m3)

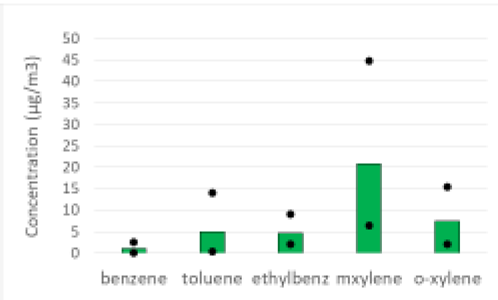
Residential – Regional

µg/m3	benzene	toluene	ethylbenz	mxylene	o-xylene
Average	0,3	1,0	1,2	5,2	1,9
StaDev	0,4	0,6	0,7	3,1	1,1
Max	2,2	2,4	3,2	13,3	4,8
Min	0,1	0,2	0,3	0,8	0,3
N	32	32	32	32	32



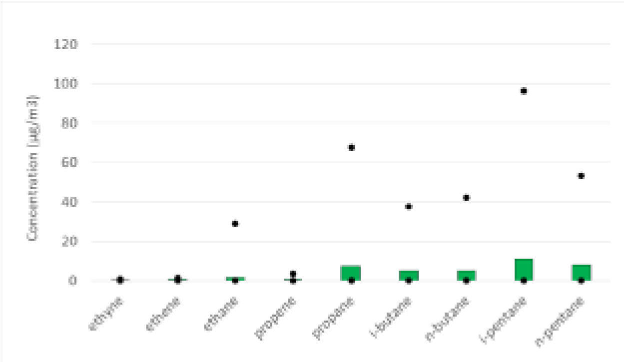
Industrial

µg/m3	benzene	toluene	ethylbenz	mxylene	o-xylene
Average	1,0	4,9	4,6	20,9	7,4
StaDev	0,6	3,7	2,1	10,1	3,8
Max	2,5	14,1	9,1	44,8	15,5
Min	0,1	0,3	2,1	6,5	2,0
N	15	15	15	15	15



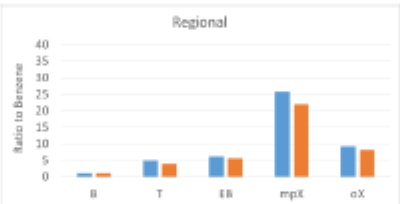
Light Hydrocarbons (µg/m3)

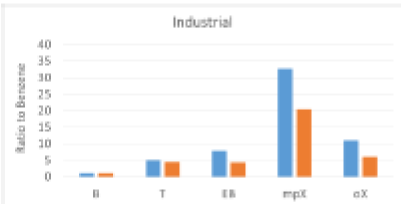
µg/m3	ethyne	ethene	ethane	propene	propane	i-butane	n-butane	i-pentane	n-pentane
Average	0,3	0,6	1,6	0,5	7,4	5,2	5,2	11,0	8,0
StaDev	0,2	0,3	4,2	0,5	11,3	9,1	9,0	19,3	12,9
Max	1,0	1,5	28,9	3,7	67,6	37,6	42,3	96,4	53,3
Min	0,1	0,2	0,2	0,1	0,2	0,1	0,1	0,1	0,1
N	47	47	47	47	47	47	47	47	47



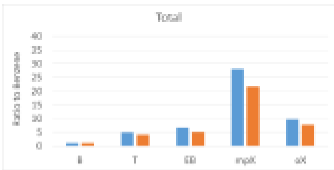
Evaluating the ratios of certain VOCs

We look at the ratio between compounds to identify fingerprints of different emission sources

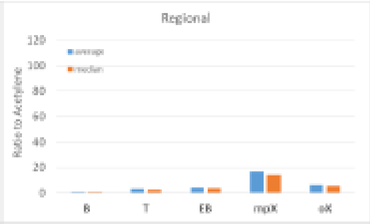


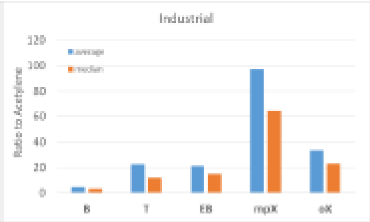


The result of **normalizing by benzene** does not allow to distinguish between evaporation or combustion processes (e.g. traffic).



Normalization of BTEX by acetylene





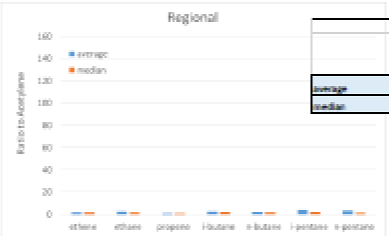
	Residential					Industrial				
	B	T	EB	mpX	oX	B	T	EB	mpX	oX
average	1	3	4	17	6	5	22	21	97	33
median	1	3	4	14	5	3	12	15	65	23

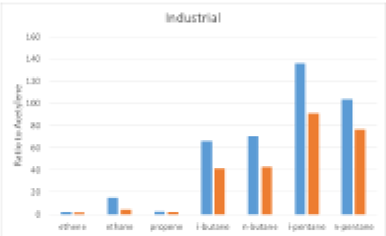
The **normalization to acetylene** however shows very different fingerprints.

Acetylene is only produced by combustion processes, there is no natural source.

The fingerprint from evaporation processes in the industrial area is very different (high ratio) than the fingerprint in residential areas (low ratio).

Normalization of light hydrocarbons by acetylene





	Residential (ratio to acetylene)							Industrial (ratio to acetylene)						
	ethene	ethane	propene	i-butane	n-butane	i-pentane	n-pentane	ethene	ethane	propene	i-butane	n-butane	i-pentane	n-pentane
average	1.9	2.6	1.1	2.4	2.2	4.0	3.1	2.0	15	3	66	70	136	104
median	1.9	1.7	1.1	2.0	1.7	2.3	1.6	1.9	4	2	42	43	91	77

The **normalization of light hydrocarbons by acetylene** shows also very different fingerprints.

Acetylene is only produced by combustion processes, there is no natural source.

The fingerprint from evaporation processes in the industrial area is very different (high ratio) than the fingerprint in residential areas (low ratio).

Results at Concón (µg/m3)

			TVOC	sum all 14	sum C2-C5	sum BTEX
Con-con No 1	SSE	1		324	180	144
Con-con No 2	SSE	1		147	119	28
Con-con No 3	SSE	1		185	136	49
CONCON4	SW	6 m/s	362	408	16	392
CONCON 5 (street 14/Street Saint Agustin)	SE	2 m/s	254	434	176	258
CONCON 6 highest street level (street 12/street Vergara)	SE	2 m/s	187	236	71	165
CONCON 7 - Level low (Reference: street 14 /Street Cortes)	SE	2 m/s		110	66	44
CONCON 2 - Middle Level (Reference: Street 13 /Street Cortes)	E	1 m/s	125	58	37	21

µg/m3	ethyne	ethene	ethane	propene	propane	i-butane	n-butane	i-pentane	n-pentane	benzene	toluene	ethylbenz	mxylene	o-xylene
Average	0,8	1,3	3,3	8,8	26,1	12,0	9,3	21,6	17,0	1,9	11,8	14,4	79,7	30,0
StaDev	0,4	0,5	2,1	16,9	14,7	8,5	8,0	15,7	15,1	1,1	7,7	12,6	74,1	29,6
Max	1,5	2,4	7,2	53,0	57,6	24,5	25,4	47,1	50,1	3,8	24,2	40,8	233,4	94,8
Min	0,3	0,6	0,3	0,3	1,1	0,7	0,7	5,4	3,8	0,4	2,5	2,2	11,6	4,3
N	8	8	8	8	8	8	8	8	8	8	8	8	8	8

Summary : Concón

- The nearby domestic areas are clearly influenced from the nearby industry
- Especially during night time and under low windspeed conditions – the concentrations are high
- The episodes are very variable in time and very different from street to street in the nearby areas
- The concentrations are in a range where most people can sense the pollution episodes
- The situation during winter time should be monitored as well
- There should also be included different measurements – like heavy hydrocarbons and PAH

Appendix E

Communication and NILU mission to Chile

Over 10 meetings (videoconference) between NILU and the Ministry of the Environment took place to plan the field campaign and following up the activities in the project. In addition, a visit from Rodrigo A. Romero between 29th and 31st October (2018) to NILU was supported by meetings with NILU experts in meteorology and air pollution monitoring in industrial areas to design the field campaign. The communication with the Ministry of Environment was the basis to decide the focus on organic compounds and a sampling campaign that can provide information about the fingerprint of organic pollutants in the region.

Three missions to Chile were carried out within the project. The first missions was the week from 5th to 9th November (2018), when the Senior Researcher Norbert Schmidbauer travelled to Santiago de Chile to carry out the placement of the samplers and provide instructions for further sampling and the needed specification for sending the material back to NILU for analysis. This missions also involved communication with the authorities and the press to explain the objectives of the project. At the first mission, the main sampling locations and the sampling campaign were decided. A second mission took place in January 2019, when Dr. Norbert Schmidbauer travelled to Chile to carry out additional sampling, including the additional sampling in Concón. The last mission took place in March 2019. At this missing, Dr. Norbert Schmidbauer and Dr. Susana Lopez-Aparicio travelled to Chile when the final results and their interpretation were presented at a workshop (see Appendix D). During the last mission, several meetings took place including meetings with local, regional and national authorities, and a visit to one of the schools.

NILU – Norwegian Institute for Air Research

NILU – Norwegian Institute for Air Research is an independent, nonprofit institution established in 1969. Through its research NILU increases the understanding of climate change, of the composition of the atmosphere, of air quality and of hazardous substances. Based on its research, NILU markets integrated services and products within analyzing, monitoring and consulting. NILU is concerned with increasing public awareness about climate change and environmental pollution.

NILU's values: *Integrity - Competence - Benefit to society*
NILU's vision: *Research for a clean atmosphere*

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