D15.2
Materials from the second time series conference including tutorial and hand-book on the second time series conference

WORK PACKAGE 15–Training, e-Learning and courses

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Author(s):	Beneficiary/Institution
Sonja Grossberndt	NILU
Cathrine Lund Myhre	NILU
Benedicte Ferré	UiT
Paolo Laj	UHEL/CNRS

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ABSTRACT

This report is based on the 2nd training school and conference on "Time series analysis", held in Tromsø, Norway, from 28-31 January 2019. These events addressed time series in the atmospheric and marine domains, where accurate understanding of trends is key to predict future changes and assess effectiveness of emission reduction policies. Scientists from both domains gathered to show methods mostly focussing on *in-situ* measurements, in order to provide a discussion forum in the field of time series analysis and forecasting.

The presentations showed how observations can help detecting climate change and its impacts focusing on training in both mathematical modelling, statistics, signal processing (non-stationarity, gaps in series, extremes, etc.), and the environmental scientific results. The training schools and following conferences were part of a series of conferences gathering a wide community to be integrated in the ESONET-Vi (-the vision) consortium that builds upon ESONET, EuroSITES, EMSO, FixO3 and now ENVRI partners, extending worldwide.

Targeting audiences in *in-situ* and remote data analysis and modelling, this event has gathered senior and young researchers (post-doctoral, doctoral and master students) to share their experience in time series interpretation across several scientific fields. Starting by a 2 1/2-day training session and followed by a conference part during the two following days, these events promoted the transfer of knowledge to younger or less experienced scientists and between researchers from several research fields. Both training courses and scientific talks were mainly based on application examples and case studies.

The courses, focusing on time series related to climate change, covered the following themes:

- Trends in essential Atmospheric and Marine climate variables

- Methodologies for deriving trends

- Trends and emission inventories

- Atmospheric and marine biogeochemical cycles

- Mathematical tools to understand trends

More information and the programs of the training school and conference can be found here: https://www.actris.eu/Events/Eventsdescriptions/TS3_2019.aspx

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Project internal reviewer(s):	**Beneficiary/Institution**
Benedicte Ferré	UiT
Paolo Laj	UHEL/CNRS

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Amendments, comments and suggestions should be sent to the authors:

Sonja Grossberndt (sonja.grossberndt@nilu.no)

Cathrine Lund Myhre (Cathrine.lund.myhre@nilu.no)

TERMINOLOGY

No particular terminology used.

PROJECT SUMMARY

ENVRIplus is a Horizon 2020 project bringing together Environmental and Earth System Research Infrastructures, projects and networks together with technical specialist partners to create a more coherent, interdisciplinary and interoperable cluster of Environmental Research Infrastructures across Europe. It is driven by three overarching goals: 1) promoting cross-fertilization between infrastructures, 2) implementing innovative concepts and devices across RIs, and 3) facilitating research and innovation in the field of environment for an increasing number of users outside the RIs.

ENVRIplus aligns its activities to a core strategic plan where sharing multi-disciplinary expertise will be most effective. The project aims to improve Earth observation monitoring systems and strategies, including actions to improve harmonization and innovation, and generate common solutions to many shared information technology and data related challenges. It also seeks to harmonize policies for access and provide strategies for knowledge transfer amongst RIs. ENVRIplus develops guidelines to enhance transdisciplinary use of data and data-products supported by applied use-cases involving RIs from different domains. The project coordinates actions to improve communication and cooperation, addressing Environmental RIs at all levels, from management to end-users, implementing RI-staff exchange programs, generating material for RI personnel, and proposing common strategic developments and actions for enhancing services to users and evaluating the socio-economic impacts.

ENVRIplus is expected to facilitate structuration and improve quality of services offered both within single RIs and at the pan-RI level. It promotes efficient and multi-disciplinary research offering new opportunities to users, new tools to RI managers and new communication strategies for environmental RI communities. The resulting solutions, services and other project outcomes are made available to all environmental RI initiatives, thus contributing to the development of a coherent European RI ecosystem.

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Materials from the third time-series conference including tutorial and hand-book on the second time- series conference

INTRODUCTION

The 2nd training school and conference for "Time series analysis" has been held in Tromsø, Norway, from 28-31 January 2019. During these events, we addressed time series in the atmospheric and marine domains, where accurate understanding of trends is key to predict future changes and assess effectiveness of emission reduction policies.

The purpose of these events was to gather scientists from both domains mostly focussing on *in-situ* measurements, and to provide a discussion forum in the field of time series analysis and forecasting.

Targeted audience: Based on *in-situ* and remote data analysis and modelling, this conference has gathered senior and young researchers (post-doctoral, doctoral and master students) to share their experience in time series interpretation across several scientific fields. Starting by a 2 1/2-day training session and followed by a conference part during the two following days, this event promoted the transfer of knowledge to younger or less experienced scientists and between researchers from several research fields. Both training courses and scientific talks were mainly based on application examples and case studies.

The training was held from 28-30 January 2019 at the University of Tromsø and the conference took place from 30-31 January 2019 at the Clarion Hotel The Edge in Tromsø.

Conference themes:

- Trends in essential Atmospheric and Marine climate variables
- Methodologies for deriving trends
- Trends and emission inventories
- Atmospheric and marine biogeochemical cycles
- Mathematical tools to understand trends

The presentations showed how observations can help detecting climate change and its impacts focusing on both the mathematical modelling, statistics, signal processing (non-stationarity, gaps in series, extremes, etc.), and the environmental scientific results. This conference was part of a series of conferences gathering a wide community to be integrated in the ESONET-Vi (-the vision) consortium that builds upon ESONET, EuroSITES, EMSO, FixO3 and now ENVRI partners, extending worldwide. The course included different lecturers from other RIs, in particular ACTRIS, and international networks (EMEP, NOAA).

This report gathers abstracts from oral and poster presentations at the 2nd Time series training school and conference. The hand-book is based on the training material from the teachers who accepted to publicly share their course material. Due to their large volume, the appendices are online accessible at https://sky.nilu.no/index.php/s/5Zg5R3xRiLQgcPp.

TRAINING SCHOOL

Course content

The main topic and focus have been on atmospheric time series analysis in particular, but it was also open for others. The training course consisted of a plenary session limited to about 30 students in order to guarantee a good and effective teaching quality and enable interaction between students and teachers. The theoretical lectures have been complemented by practical sessions on real environmental data analysis, and there was ample opportunity to exchange ideas and questions among the students and the lecturers. The students split in groups to attend practical exercises related to the plenary courses to answer technical and programming questions. One common topic for all disciplines was to cover the requirements to the use of observational data to be included in the next IPCC report, AR6. The processes and requirements that apply to observational data to be used in assessment reports as IPCC have been explained, including requirements to data quality, access, and version control.

Practical work

Students were asked to prepare and bring data sets for analysis and cooperate in groups with an assistant on individual subjects of interest in the realm of climate model evaluation and analysis. The course started with a brief introduction by each student about their data set and expectations.

Learning outcomes

- Various statistical methods have been explained for time series analyses, outliers, gap filling etc.;
- Requirement for time series analysis in research;
- Knowledge about existing on-line databases containing atmospheric and oceanic data;
- The ability to evaluate model output by using observational data.

The event gathered 60 PhD students, post doc and researchers from 14 different countries. Based on the evaluation form provided to the attendants, the majority was satisfied with the events.

Training program

Monday 28.01.2019

08:45–09:00	Welcoming, registration, introduction and logistics – Benedicte Ferré (UiT)
09:00–10:15	Benjamin Planque (IMR) *Statistical inference on time series*
10:15–10:30	Break
10:30–11:45	Martine Collaud Cohen (Metoswiss) *From data distribution and characterization to trend analysis: examples from aerosol time series analysis*
11:45–12:30	Lunch
12:30–13:15	Students presentations – 1 min each, no slides or technical support

13:15–15:00	Exercises I	Exercises II
15:00–15:15	Break	
15:15–17:00	Exercises II	Exercises I
Evening program Informal gathering at the cabins for the students		

Tuesday 29.01.2019

09:00-10:15	Wenche Aas (NILU) *Trends in inorganic components, in air, aerosols and precipitation – The use of Mann Kendall for long time series*	
10:15-10:30	Break	
10:30-11:45	Vincenzo Artale (ENEA) *Training in deep ocean data alanysis*	
11:45-12:30	Lunch	
12:30-13:45	Exercises I	Exercises II
13:45-14:00	Break	
14:00-15:15	Exercises II	Exercises I
15:15-16:45	Betsy Andrews (NOAA) *Using autocorrelation analysis to evaluate long-term datasets*	
Free time		

Wednesday 30.01.2019

09:00-10:15	Exercise I	Discussions about reports
10:15-10:30	Break	
10:30-11:30	Discussions about reports	Exercise II
11:30-12:30	Lunch at UiT and bus to the hotel	

Training content

This section provides abstracts of the training sessions. The presentations indicated by an asterisk next to the abstract can be found in the Annex as part of the hand-book.

Statistical Inference on Time-Series*

Benjamin Planque

Institute of Marine Research, UiT The Arctic University of Norway benjamin.planque@hi.no

In this lecture, I will introduce how conventional statistical inference – classically bivariate correlations and regression analyses – can be biased when applied to time-series. Often, this results in statistical test being 'significant' (the null hypothesis is rejected) more often than expected.

I will show methods that have been proposed to correct for inferential biases, by either transforming original time-series or correcting the inference statistics.

I will then introduce inference by simulation, where null hypotheses are simulated using 'null models'. I will show how these can be developed on the specific case of time-series, using a method known as 'surrogate time-series'. Finally, I will expand these considerations to the case of explorative analyses on multivariate time series with an example based on Principal Component Analysis.

During the exercise session, I will go through the examples presented in the lecture using R/R-Studio. The students will be required to have R installed on their computer to be able to perform inference and simulations.

Keywords: autocorrelation, biased inference, null models, simulation, surrogate time-series

From Data Distribution and Characterization to Trend Analysis: Examples from Aerosol Time Series Analysis*

Martine Collaud Coen

Federal Office of Meteorology and Climatology, MeteoSwiss
Martine.collaudcoen@meteoswiss.ch

Different aspect of time series analysis will be presented, from the first characterisation of the data to the long-term trend analysis. Most examples will be taken from in-situ aerosol measurements and non- parametric statistical methods. The following topics will be covered during the course:

- Data distribution, confidence limits
- Break points and homogeneisation
- Diurnal and seasonal cycles, autocorrelation
- Least Mean Square trend analysis, with/without bootstrapping
- Non-parametric Mann-Kendall trend analysis
- Effect of length and granularity of the time series

- Focus on aerosol time series and some other atmospheric compound

Trends in Inorganic Components in Air/Aerosols and Precipitation*

Wenche Aas

NILU, Kjeller, Norway waa@nilu.no

Atmospheric concentrations and wet deposition of sulfur and nitrogen components have been measured by regional monitoring networks for several decades and are well suited for studying long-term trends. Trend assessments are needed for compliance monitoring of agreed emission reduction targets, and are important for evaluating the changes in impacts of air pollution on health, terrestrial environment and on climate.

Different global and regional trend studies will be presented and discussed. I.e. comparability between models and observations, use of different statistical approaches, and how to deal with spatial- and temporal gap filling, representativity and differences in data quality.

The commonly used technique for calculating linear trend (Mann Kendall test and Theil-Sen slope estimator) will be presented, and some examples and tools will be distributed for doing a set of exercises.

Keywords: Long-term observations, regional networks, representativity, Theil-Sen slope

Training in Deep Ocean Data Analysis

Vincenzo Artale[1], Nadia Lo Bue[2]

[1]ENEA [2]INGV vincenzo.artale@enea.it

The training in deep ocean data analysis, aims to explain the role of the deep ocean dynamics in climate variability and change. Real long-term observations are indispensable to an understanding of physical, chemical and biological processes in the ocean. The analysis of oceanographic long time series allows to separate real long-term trends in environmental drivers (such as temperature rising or acidification of water masses) and to value their longterm impacts (e.g CO_2 uptake reduction and variability and its biogeochemical cycle) from the random (natural) variation that is a key feature of complex dynamical systems like it is the earth's climate.

During the training will be presented an overview of different case studies focusing on classical and more sophisticated methodologies developed both to overcome issues related to high frequency sampling and to discriminate among different type of signals contained in all long-term ocean dataset.

Keywords: Deep ocean dynamics, long-term ocean dataset, deep ocean data analysis, trends and variability, high frequency sampling, long term impacts

Using Autocorrelation Analysis to Evaluate Long-Term Datasets*

Elisabeth (Betsy) Andrews

NOAA (National Oceanic and Atmospheric Administration) *betsy.andrews@noaa.gov*

Autocorrelation analysis is a technique for assessing the tendency of a system to remain in the same state from one observation to the next, e.g., persistence. Autocorrelation analysis can be used to identify the presence of temporal (or spatial) cycles, determine the expected 'best case' agreement between measurement platforms obtaining data at different temporal or spatial scales and provide some indication of the independence (or lack thereof) of the data points in a time series. Autocorrelation analysis can be used for predictions/forecasting because, in an autocorrelated dataset, the future values depend on current and past values.

- What is autocorrelation?
- Examples of autocorrelation analysis and applications from the literature
- Constraints and limitations of autocorrelation analysis (gaps, outliers, etc.)
- Tools and resources for performing autocorrelation analysis

Keywords: Long-term observations, autocorrelation, persistence, temporal cycles

Conference program

Wednesday 30.01.2019

12:00-13:30	Registration
13:30-13:50	**Welcome at Hotel the Edge** Cathrine Lund Myhre, NILU and Paolo Laj, UHEL, Finland/Univ-Grenoble, France
Session 1: *Atmosphere,* Chair: Paolo Laj, UHEL, Finland/Univ-Grenoble, France	
13:50-14:20	Betsy Andrews (NOAA)*: Temporal variability of aerosol properties – a lag-autocorrelation analysis*
14:20-14:50	Martine Collaud Coen (Meteoswiss): *Aerosol time series to evaluate the atmospheric boundary influence at high altitude stations*
14:50-15:20	Break
15:20-15:50	Cathrine Lund Myhre (NILU): *Methane at Svalbard and over the European Arctic Ocean*
15:50-16:20	Wenche Aas (NILU): *Global and regional trends of atmospheric sulfur*
16:45-17:45	Poster exhibition – all present
Evening program: Joint reception at The Edge	

Thursday 31.01.2019

09:00-09:30	Michael Schulz (MetNo): *Aerosol optical property trend evaluation of AeroCom models*
09:30-10:00	Alfred Wiedensohler (TROPOS): *Trends of black Carbon and ultrafine particles in Germany - long term observations of the German Ultrafine Aerosol Network (GUAN)*
10:00-10:30	Break
10:30-11:00	Nicholas Warner (NILU): *Climate driven factors in dietary feeding and physiological status on temporal exposure to the King penguin population in Antarctica: a 20 year perspective*
Session 2: *Ocean,* Chair: Benedicte Ferré (UiT)	
11:00-11:30	Pierre-Antoine Dessandier (CAGE/UiT): *Variations of river discharges controlled by the evolution of North Atlantic Oscillation, a multiproxy approach*
11:30-12:45	Lunch

12:45-13:15	Pierre Galand (Observatoire Océanologique de Banyuls): *Long term marine series: from observation to ecology*
13:15-13:45	Nadia Lo Bue (EMSO): *The role of fixed observations in the study of climate variability*
13:45-14:15	Benjamin Planque (IMR): *Apophenia and the search for summaries of multiple marine ecological time series*
14:15-14:45	Break
14:45-15:15	Chiara Borelli (Univ. of Rochester): *Variations in the carbonate compensation depth from the middle Eocene to the early Oligocene (43-32 Ma): implications for the marine carbon cycle*
15:15-15:45	Xavier Durrieu de Madron (CEFREM): *Propagation of uncertainty on parameters derived from time series*
15:45-16:15	Séverine Martini (Sorbonne Université): *Bioluminescence and environmental time series in the deep ocean. From imaging to cabled observatories*
16:30-18:00	Poster exhibition – all present
Evening program: Social dinner at The Edge	

Session 1: Atmosphere

Temporal Variability of Aerosol Properties – a Lag- Autocorrelation Analysis

Elisabeth Andrews et al.

National Oceanic and Atmospheric Administration/Global Monitoring Division (NOAA/GMD) and University of Colorado, Boulder, betsy.andrews@noaa.gov

Aerosol measurement platforms range from surface sites making long-term, high-frequency in-situ measurements at a single point to satellite remote sensing with global coverage but lowered spatial and/or temporal resolution. Aerosol output from 'operational' global chemical transport models tends to be on the order of 100s km2 with minimum time scales typically on the order of hours. Understanding the scales (temporal and/or spatial) of variability for different data sources can help to, (a) coordinate measurement strategies (e.g., during a campaign); (b) constrain comparisons by identification of expected 'best case' agreement between different data sources (c) determine whether data from different measurement platforms and models are internally consistent such that satellites/models can be used to fill the spatial gaps in in-situ measurements. Here we investigate the scales of temporal variability of various aerosol optical parameters at a number of long-term surface sites using lag-autocorrelation analysis. The autocorrelation statistic can be thought of as an indicator of air mass persistence – i.e., it provides some indication of how long the characteristics of an air mass are maintained either at a single location over time or across a distance at (virtually) the same time.

Keywords: Aerosol optical properties, in-situ measurements, autocorrelation analysis, persistence, spatial and temporal variability

Aerosol Time Series to Evaluate the Atmospheric Boundary Influence at High Altitude

Martine Collaud Coen, Elisabeth Andrews

Federal Office of Meteorology and Climatology, MeteoSwiss
martine.collaudcoen@meteoswiss.ch

High altitude stations are often emphasized as free tropospheric measuring sites but they remain influenced by the atmospheric boundary layer (ABL) due to convective transport processes. A topography analysis allows calculation of a newly defined index called ABL-TopoIndex. It relies on the criteria that the ABL influence will be low if 1) the station is one of the highest points in the mountainous massif, 2) there is a large altitude difference between the station and the average domain elevation, 3) the slopes around the station are steep, and 4) the inverse drainage basin is small. It allows ranking of the stations as a function of the ABL influence and is validated by long-term aerosol time series from 28 high altitude sites.

The aerosol diurnal and seasonal cycles were evaluated by s.s. auto-correlations calculated on pre-whitened time series. Considering the distributions of the parameters, rank correlation were used. The greatest correlations are found with the minima of the aerosol parameters that represent the most likely FT air masses. The maxima are more representative of the intensity of aerosol sources and of advection of polluted air masses. The strength of the diurnal cycles are mostly explained by the latitude, leading to the conclusion that the insolation drives the aerosol diurnal cycle.

Keywords: ABL, high altitude stations, aerosol time series, topography, diurnal and seasonal cycles.

Methane at Svalbard and Over the European Arctic Ocean

Cathrine Lund Myhre

NILU – Norwegian Institute for Air Research clm@nilu.no

Methane (CH_4) is a powerful greenhouse gas and its atmospheric mixing ratios have been increasing since 2005. Therefore, quantification of CH_4sources is essential for effective climate change mitigation. Here we report observations of the CH_4 mixing ratios measured at the Zeppelin Observatory (Svalbard) in the Arctic and aboard the research vessel (RV) Helmer Hanssen over the Arctic Ocean from June 2014 to December 2016, as well as the long-term CH_4 trend measured at the Zeppelin Observatory from 2001 to 2017. We investigated areas over the European Arctic Ocean to identify possible hotspot regions emitting CH_4 from the ocean to the atmosphere, and used state- of-the-art modelling (FLEXPART) combined with updated emission

inventories to identify CH_4 sources. Meanwhile, we show that the mean atmospheric CH_4 mixing ratio in the Arctic increased by 5.9±0.38 parts per billion by volume (ppb) per year (yr−1) from 2001 to 2017 and ∼8 ppbyr−1 since 2008, similar to the global trend of ∼7–8 ppbyr−1. Most large excursions from the baseline CH_4 mixing ratio over the European Arctic Ocean are due to long-range transport from land-based sources, lending confidence to the present inventories for high-latitude CH_4 emissions. However, we also identify a potential hotspot region with ocean–atmosphere CH_4 flux north of Svalbard (80.4°N, 12.8°E) of up to 26 nmol m−2 s−1 from a large mixing ratio increase at the location of 30 ppb.

Global and Regional Trends of Atmospheric Sulfur

Wenche Aas, Augustin Mortier et al.

NILU – Norwegian Institute for Air Research and Norwegian Meteorological Institute
waa@nilu.no

This is a presentation of a recently published paper in Scientific Report (DOI: 10.1038/s41598-018-37304-0)

The profound changes in global SO_2 emissions over the last decades have affected atmospheric composition on a regional and global scale with large impact on air quality, atmospheric deposition and the radiative forcing of sulfate aerosols. Reproduction of historical atmospheric pollution levels based on global aerosol models and emission changes is crucial to prove that such models are able to predict future scenarios.

Trends in observations of sulfur components in air and precipitation from major regional networks are compared to estimates from six different global aerosol models from 1990 until 2015. There are large interregional differences in the sulfur trends consistently captured by the models and observations, especially for North America and Europe. Europe had the largest reductions in sulfur emissions in the first part of the period while the highest reduction came later in North America and East Asia. The uncertainties in both the emissions and the representativity of the observations are larger in Asia. Discussions of the site representativeness will be discussed using a bootstrap approach from the model results.

Keywords: Sulfur, long-term observations, global model, representativity

Trends for Aerosol Optical Properties in the Database at Ebas and Aeronet

Michael Schulz, Augustin Mortier, Jonas Gliss

Norwegian Meteorological Institute michaels@met.no

Data for aerosol optical properties of aerosol scattering, absorption and optical depth are worked up in the framework of ACTRIS-2 to derive regional trends in aerosol loadings. Data

inhomogeneities from surface sites pose specific problems for combining these to robust long term trends. These consist of gaps, varying data documentation, time varying changes in aerosol sampling and measurement techniques. Stations may also not be representative for the larger regional trends. Since the number of useful sites is limited visual inspection of the time series becomes an important tool to help statistical analysis and eg comparison to modelling results. We have developed a web-supported work-up of different databases (EBAS, AERONET, aerosol-cci) to inspect trends of aerosol properties at global scale. Features, results and possible applications will be presented and discussed.

Keywords: Trend, aerosol optical properties, global, visualisation

Trends of Black Carbon and Ultrafine Particles in Germany – Long Term Observations of the German Ultrafine Aerosol Network (GUAN)

Jia Sun, Wolfram Birmili, Markus Hermann, Thomas Tuch, Kay Weinhold, Maik Merkel, Fabian Rasch, Andre Sonntag, Thomas Müller, Alexander Schladitz, Susanne Bastian, Gunter Löschau, Josef Cyrys, Jianwei Gu, Harald Flentje, Björn Briel, Christoph Asbach, Heinz Kaminski, Ludwig Ries, Ralf Sohmer, Holger Gerwig, Klaus Wirtz, Frank Meinhard, Andreas Schwerin, Olaf Bath, Nan Ma, Alfred Wiedensohler

Leibniz Institute for Tropospheric Research ali@tropos.de

The German Ultrafine Network (GUAN) was established in 2009, consisting of 14 observatories. The scientific goal of GUAN was to performed long-term studies of particulate matter, focusing on black carbon and ultrafine particle. The different measurement station are belonging either to research institutions or to federal & state authorities. The idea was to cover different environments, ranging from street, over urban background and rural and to mountain areas. Due to the mitigation of emissions from combustion, it was expected to observe a reduction, especially in the mass concentration of black carbon in general, but also in cities with a low emission zones due to the ban of older Diesel vehicles. The expectation for the concentrations of ultrafine particles have not been clear in the beginning, since they could be also formed via photo-oxidation of precursor gases. However, the observation showed for all environments significant reductions in the mass concentration of black carbon and ultrafine particles. The presentation thus provides general trends of the GUAN observatories as well as from the Low Emission Zone in Leipzig.

Keywords: Ultrafine particles, black carbon, low emission zone, German Ultrafine Aerosol Network

Climate Driven Factors in Dietary Feeding Behaviour and Physiological Status on Temporal Exposure to the King Penguin Population in Antarctica: A 20 Year Perspective

Nicholas A. Warner, Norith Eckbo, Céline Le Bohec, Katrine Borgå

NILU-Norwegian Institute for Air Research nicholas.warner@nilu.no

Despite Antarctica being a pristine environment, exposure to pollution still occurs with various persistent organic pollutants (POPs) detected in environmental matrices from this region. Atmospheric concentrations of POPs from the Antarctica continent show a declining trend due to the implementation of international regulations/restrictions placed since the beginning of this century. However, emissions may not be the only factor controlling exposure as climate alterations will introduce stressors to the system in which biota will need to response, particularly in regards to feeding behaviour and prey quality/ sources. The purpose of this work is to investigate a 20-year temporal trend of various persistent organic pollutants within blood from the King Penguin chick population from the Crozet islands to assess impacts of climate-induced changes on feeding behaviour and physiological condition. Preliminary results indicate that foraging proximity to the Antarctic Polar Front, may influence exposure to POPs. Dynamics surrounding POP exposure to the King penguin population movement of the Antarctic Polar Front will be discussed.

Keywords: Antarctica, persistent organic pollutants (POPs), penguins, feeding behaviour, climate change, Polar Front

Session 2: Ocean

Variations of River Discharges Controlled by the Evolution of North Atlantic Oscillation, Multiproxy Approach

Pierre-Antoine Dessandier, Jérôme Bonnin, Bruno Malaizé, Clément Lambert, Rik Tjallingii, Lisa Warden, Jaap S. Sinninghe Damsté, Jung-Hyun Kim

Centre for Arctic Gas Hydrate, Environment and Climate, UiT – The Arctic University of Norway pierre-antoine.dessandier@uit.no

We analyzed a 10-m sediment core retrieved at 82 m water depth off the coast of the Tagus River (Portugal Margin) to investigate the Tagus River discharge over the last 5700 years. Benthic foraminiferal assemblages were studied at high resolution in combination with benthic foraminiferal stable isotopes, bulk and molecular organic matter properties, magnetic susceptibility, and XRF analyses. Three periods of environmental changes were identified: 1) high Tagus River discharge in 5750–2200 BP, 2) lower discharge characterized by intense upwelling conditions (2250–1250 BP), and 3) both intense upwelling and Tagus River discharge (1250 BP-present). The data reveal alternating intense upwelling and increased river discharge periods. Our results showed that variations in benthic foraminiferal assemblages and environmental conditions corresponded to the well- known climatic periods in the study area, such as the Roman Period, the Dark Ages, the Medieval Warm Period, and the Little Ice Age. All these periods as well as upwelling intensity and river discharges seemed to be controlled by the North Atlantic Oscillation (NAO), with NAO negative phases correlated with increased precipitations and NAO positive phases correlated with intense upwelling system on the margin.

Keywords: Holocene, Portuguese Margin, paleo-reconstruction, North Atlantic Oscillation

Long Term Marine Time Series: From Observation to Ecology

Pierre Galand

Observatoire Océanologique de Banyuls pierre.galand@obs-banyuls.fr

In marine ecosystems, observing the environment through long term time series gives a precious understanding of how the sea and its biological compartments respond to environmental and human forcing. A network of 11 different time series observatories has been set up along all of France's coasts (Mediterranean Sea, Atlantic Ocean and the English Channel) to monitor a set of 16 distinct physical, chemical and biological parameters. The network has now accumulated over 20 years of data on these coastal areas that show strong patterns of seasonality and that are particularly sensitive to human activities. Within that frame, the SOLA station in the bay of Banyuls sur Mer, SE Mediterranean Sea, has a special focus on marine microorganisms, as marine microbes play key roles in major biogeochemical processes at a global scale. The composition of microbial communities has been described in details with "omic" tools to answer key questions in ecology, test if specific marine phytoplankton and bacteria taxa display yearly rhythms, and verify if there is a link between the tremendous diversity of microbial communities and environmental conditions. The presentation will introduce the long term marine time series set along the French coast with a special emphasis on the Banyuls Observatory and recent results from this Mediterranean site.

Keywords: Marine observatory, bacteria, microbial ecology, Mediterranean Sea, coastal ecosystem, metagenomics

The Role of Fixed Observatories in the Study of Climate Variability

Nadia Lo Bue[1] and Vincenzo Artale[2]

[1]INGV, [2]ENEA, nadialob@gmail.com

Despite the Stommel's theory of '50, the general idea that the ocean-deep circulation is in quasistationary motion has persisted for many decade, so that the observations excluded deep-layers from the majority of the ocean world surveys. An underestimation of deep ocean processes has continued to persist for decades. The real awareness about the unsteady state of the abyssal layers has only risen recently thanks to the continuously evolving of technology that enhanced long-term monitoring of deep layers through fixed observatories.

The new amount of data encourages studies on deep mechanisms, trying to understand how the internal instability can affect the ocean circulation. To know mechanism and rates that control the bottom flows is essential to quantify the re-transfer towards the upper layers of the energy

stored at the seafloor (de Lavergne et al., 2017) which could contribute to accelerate the rising trends affecting climate variability.

The purpose of this talk is to show the role of fixed bottom observatories in the monitoring and study of deep ocean, and how these data can contribute in filling the knowledge gap of deep processes (such as mixing, turbulence, bottom-up diffusion), providing essential outcomes for the implementation of climate models towards more reliable projections.

Keywords**:** Long-term monitoring, deep bottom observatories, deep ocean circulation and processes, ocean diffusion, subinertial motion and internal waves, baroclinic instability

Apophenia and the Search for Summaries of Multiple Marine Ecological Time Series

Benjamin Planque and Per Arneberg

Institute of Marine Research benjamin.planque@hi.no

Principal component analysis (PCA) is one of the most commonly used techniques to summarize multivariate datasets in marine ecology. There seems to be little recognition of the potential pitfalls associated with performing PCA on time-series that are autocorrelated and/or non-stationary. We investigate how the descriptive performance of PCAs may be affected by the structure of the underlying time-series and question whether such analyses can provide useful summaries of ecosystem trajectories. For this purpose, we reanalyse four datasets from the Barents, Norwegian, Baltic, and North Seas. We show that most of the patterns revealed by the PCA can emerge from random time-series. The Norwegian Sea dataset is a pathological case in which the variance explained by the first two components only exceeds what would be expected from randomly simulated time-series by 2%. We conclude that outputs from explorative multivariate analyses provide very little insight into ecosystem status, trajectories and functioning and may be no more than 'apophenia': the universal human tendency to seek patterns in random information. Alternative methods that account for the temporal structure in the data and the mechanistic relationships between variables can provide better insight into how marine ecosystems function, the drivers of their changes and their possible future trajectories.

Keywords: Autocorrelation, data mining, marine ecosystem assessment, principal component analysis, spurious correlations, time-series

Variations in the Carbonate Compensation Depth from the Middle Eocene to the Early Oligocene (43-32 Ma): Implications for the Marine Carbon Cycle

C. Borrelli[1], M. E. Katz[2], J. R. Toggweiler[3]

[1]*Department of Earth and Environmental Sciences, University of Rochester, Rochester, NY*

[2]*Department of Earth and Environmental Sciences, Rensselaer Polytechnic Institute, Troy, NY,*
[3]*National Oceanic and Atmospheric Administration, Washington, D.C.* *cborrelli@ur.rochester.edu*

The middle Eocene-early Oligocene (43-32 Ma) was a time of profound reorganization of the climate system. At this time, a global cooling was accompanied by build-up of permanent ice sheets in Antarctica and possibly even in the Northern Hemisphere, faunal turnovers, and changes in ocean circulation. In addition, a change in the ocean chemistry was recorded in sediments, with increased preservation of calcium carbonate ($CaCO_3$) at deeper depths (deepening of the carbonate compensation depth – CCD). Because the CCD is strictly connected to the marine carbon cycle, reconstructing the CCD variations from the middle Eocene to the early Oligocene can help us understand the evolution of the marine carbon cycle at this time.

In this study, we reconstruct changes in the $CaCO_3$ accumulation rates at several sites located at different paleodepths in the northwestern and equatorial Pacific, northwestern and south Atlantic, sub-Antarctic, equatorial Indian, and Southern Oceans. Our data reveal variable $CaCO_3$ accumulation rates in different basins and at different paleodepths. We hypothesize that this is a consequence of changes in regional (e.g., surface productivity) and global (e.g., weathering, changes in ocean circulation) processes on the $CaCO_3$ and marine carbon cycle dynamics during the middle Eocene-early Oligocene.

Keywords: carbonate accumulation events, carbonate compensation depth (CCD), eocene, oligocene, carbon cycle

Propagation of Uncertainty on Parameters Derived From Time Series

Xavier Durrieu de Madron

CNRS – UPVD *demadron@univ-perp.fr*

Acoustic current meters with their different measured parameters (horizontal and vertical components of the current, pressure, temperature, backscattered acoustic intensity) can be used to study and quantify the flows of water, heat and particulate matter in the ocean.

The estimation of the uncertainties of the derived parameters (particulate concentration, flux), based on the uncertainties specific to the raw parameters, and the propagation of these uncertainties for time series will be presented and illustrated from real observations illustrated from real observations obtained in a submarine canyon, and including an intense event of dense shelf water cascading.

Keywords: Error propagation, currents, particulate matter concentration, fluxes

Bioluminescence and Environmental Time Series in the Deep Ocean from Imaging to Cabled Observatories

Séverine Martini

Sorbonne Université (ex-UPMC), Laboratoire d'Océanographie de Villefranche-sur-Mer (LOV - UMR 7093) severine.martini@obs-vlfr.fr

Bioluminescence is the emission of light by living organisms and can be used as a proxy of biological activity. Current surveys of this capability in the oceans include traditional video observations of organisms from Remotely Operated Vehicles. More surprising ones are the use of astrophysics telescopes as deep sea observatories for oceanography. Such cabled observatories allow high-frequency sampling over long term deployments to investigate relationships between biological and environmental variables. The search for characteristic scales in time and frequency in this sampled dataset is achieved by using statistical methods from signal processing. Whereas most environmental data are non-stationary, most methods used in time- series analyses are based on stationarity assumptions, such as those used in the Fourier decomposition. I will describe methods well-adapted to deal with non- stationarity and to decompose each time series within time and frequency space. Finally, these methods applied to oceanographic time series from ANTARES (Mediterranean sea-France) and MARS (Pacific-USA) observatories highlighted a biological response to oceanographic events in the deep sea

Poster abstracts

Modeling of the Influence of Methane Emissions in the North Sea Region With Icon-Art

Christian Scharun

Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research
christian.scharun@kit.edu

Methane (CH_4) is the second most important greenhouse gas after CO_2 affecting global warming. Its global budget is balanced by various sources (e.g. fossil fuel production, agriculture and waste, biomass burning and natural wetlands) and the reaction with the OH-radical as its main sink. Through a long lifetime in the atmosphere methane can be transported over long distances.

In this study, ICON-ART will be used. ART (Aerosols and Reactive Trace Gases) is an online-coupled model extension for ICON that includes chemical gases and aerosols. This model aims at simulating interactions between the trace substances and the state of the atmosphere by coupling the spatiotemporal evolution of tracers with atmospheric processes (Schroeter et al., GMD, 2018).

Former and active offshore platforms are emitter of methane being difficult to quantify. Explorations at the sea floor of the North Sea showed an release of CH_4 near the boreholes of the oil and gas carrying platforms. The modeling of methane emission in the North Sea region and the evaluation of the differences compared to established emission data bases like EDGAR (Janssens-Maenhout et al., NAS, 2010) were goals of this work.

Keywords: Methane, emissions, north sea, modeling, atmosphere, icon-art

Trend Analysis on Atmospheric Measurements

Minqiang Zhou

Royal Belgian Institute for Space Aeronomy (BIRA-IASB), Belgium *minqiang.zhou@aeronomie.be*

Ground-based Fourier-transform infrared spectroscopy (FTIR) remote sensing measurements, including CO_2, CH_4, CO, N_2O, C_2H_6, HNO_3, NO_2, are operated at two sites on Reunion Island (21S, 55E) by BIRA-IASB since 2002. FTIR observes the direct solar radiation, and it only works during daytime in cloud-free cases. Therefore, it is necessary to take gaps and outlies into consideration when using the FTIR measurements to anaylaze the trends/changes/ variations in the atmospheric components. In this training school, I intent to grasp some tools to handle with the gaps and outlies, and the uncertainties from these gaps and outlies. FTIR can provide several vertical information for some species, for example it can provide two N_2O partial columns in the troposphere and in the stratosphere. It is well written in the literature that we need to be careful about the change of the age of air in the stratosphere. In this school, I am also interested in learning the trend analyses to identify the air circulation in the stratosphere.

Keywords: Atmosphere, FTIR remote sensing, ACTRIS, ICOS, stratosphere, trend

Aerosol Particle Formation Measurement Within Project Actris-CZ

Adéla Holubová Šmejkalová, Nadeˇžda Zíková, Vladimír Ždímal, Milan Váneˇa

Czech Hydrometeorological Institute *adela.holubova@chmi.cz*

Global change research involves among others also research of aerosol particles, their effect and behaviour in the atmosphere. Aerosols influence radiation balance, visibility and clouds formation (IPCC 2013). Direct and indirect effect of atmospheric aerosol on climate besides other things depends on particles size and concentration (Kulmala 2001, Weber 1997). Key process of atmospheric aerosols dynamic (changes in particle concentration and particle size distribution) is New particle formation (NPF) (Kulmala 2013, Spracklen 2006). NPF events can be observed in many different enviroments and cover diversity of nucleation mechanisms. Better understanding of processes including NPF and their transformation are valuable for climate studies (Birmili and Wiedensholer 2000, Kulmala 2001, Kulmala 2004).

Research of aerosol formation is carried out under project ACTRIS-CZ at National Atmospheric Observatory Košetice (NAOK) in Czech Republic. Current research at NAOK is focused on aerosol formation and conditions of the atmosphere (values of meteorological elements, atmospheric boundary layer thickness, and pollutants concentration) which favour or supress this process.

Keywords: Atmospheric aerosols, new particle formation, Atmospheric boundary layer, ACTRIS-CZ, National Atmospheric Observatory Košetice, meteorological parameters

25-Years Svalbard Data Record Reveals Change in Long-Range Transport of Sulphur Agents to the Warming Arctic

Alena Dekhtyareva

UiT The Arctic University of Norway alena.dekhtyareva@uit.no

Sulphur dioxide (SO_2) is a strong acidifying agent emitted via combustion of fossil fuel and various industrial processes. Atmospheric aerosols containing sulphate (SO42-), an oxidation product of SO_2, scatter sunlight and have negative radiative forcing. The highest concentration of sulphur agents are measured in Svalbard in winter and spring when the long-range transport of pollution from mid-latitudes to the High Arctic is the most pronounced. Since SO_2 is moderately soluble gas and SO42--particles are hydrophilic, efficiency of their removal through wet deposition depends on temperature and water content in the air masses. Indeed, concentration of sulphur compounds measured in winter and spring at the Zeppelin station, located in northwestern part of Spitzbergen island, shows significant negative correlation with daily air temperature and specific humidity. Current study investigates the 25-years seasonal trend in the concentration of SO_2 and non- sea salt SO42- and compares observed changes with the evolution in emission of sulphur agents in primary source regions of anthropogenic aerosols and alteration in characteristics of air masses transporting pollutants to Svalbard. HYSPLIT backward trajectory modelling results have been used to assess origin and properties of air masses arriving to the Zeppelin station.

Keywords: Aerosol, trajectory, air pollution, meteorology, climate change, emissions

Trends in PM_{10}, $PM_{2.5}$ and $PM_{10\text{-}2.5}$ in the Po Valley, Italy

Alessandro Bigi, Grazia Ghermandi

Department of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia, Italy
alessandro.bigi@unimore.it

Po valley is one of the few European regions with recurrent high concentration levels both for particulate and gaseous compounds. We assessed pattern and variability in PM_{10}, $PM_{2.5}$ and $PM_{10\text{-}2.5}$ across the Po valley over 1998 – 2015 from 41, 44 and 15 sites respectively. $PM_{2.5}$ and $PM_{10\text{-}2.5}$ (PM_{10}) series with a 7 (10) year or longer record were analysed for "long" term trend in deseasonalized monthly means, annual quantiles and in monthly frequency distribution. A significant decreasing trend was observed for all size fractions. We estimated the impact of primary anthropogenic emissions by 3 different statistical methods, testing for a significant weekly periodicity. Hierarchical cluster analysis showed larger variability for PM_{10} than for $PM_{2.5}$, with the former split in five clusters over the valley, while the finer fraction only in 3. Trends in primary and precursors emissions, in vehicular fleet details and in fuel sales were compared to the trends observed in atmospheric PM concentration. A significant basin-wide drop occurred for gaseous emissions, contrarily to primary PM emissions, whose drop was lower and spatially restricted. Overall the decrease in PM seems to originate from a drop in both primary emissions and in PM precursors, largely ascribed to traffic.

Keywords: PM, deseasonalisation, non-parametric statistics, weekly periodicity, emission, cluster analysis

Effects of Climate Change on the Hydroclimatic Conditions in the Languedoc-Roussillon Region (South of France); Analysis and Mitigation Strategies of the Agricultural Sector in the Tet River Basin

Camille Labrousse, Dr. Wolfgang Ludwig, Dr. Guillaume Lacquement

UMR CEFREM & UMR Art-Dev, France camille.labrousse66@gmail.com camille.labrousse@univperp.fr

Mediterranean area is particularly sensitive to climate change and has been identified as one of the most noticeable ''Hot-Spot'' for future projections. Investigating the effects of climatic condition changes on the Mediterranean basin water resources is a key challenge to manage future socio-economic pressure.

In our study we assess the hydroclimatic condition trends in the 6 major coastal river basins of the Languedoc-Roussillon (South of France) on the 1965- 2017 time period. We collect water discharge data from 6 gauging stations located as far downstream on each coastal river and we obtain climatic parameters as temperature, precipitation, ETP, runoff and snow from a spatialized model with a resolution about 8 km provided by Meteo-France. Time series analysis of those parameters are investigated with statistical software.

In a second part, we focus on the Tet river basin that presents the specificity of being a water-rich area with a historical highly sophisticated irrigation network. As a consequence, irrigation is the major user of water supplies in the basin and the management of the resource to sustain present socio-economic activities linked represents a real challenge. Our goals are to examine the consequences of changes in the crop type on the quantitative evolution of water resources and then, to investigate the ability of the agricultural sector to accept and assume those changes.

Keywords: Climate change, Coastal Mediterranean rivers, water resources, agricultural sector, irrigation, water management

Dataset of Observed Daily Snow Depth in Europe

Adrià Fontrodona Bach

Wageningen University, Netherlands ross.whiteford@soton.ac.uk

On timescales approaching that of the Cenozoic, it is typically necessary to deal with sparsely populated time series data, which generally requires interpolation to a full record to be of use. Interpolation is often linear, however other interpolation methods may prove more accurate and

realistic, especially where oscillations are present. Using a dataset of palaeo surface ocean pH and atmospheric CO_2, I show how such a sparse dataset may lead to large uncertainties. This propagates into model calculations, possibly leading to identification of spurious trends. Sophisticated time series data analysis methods are not often used on data produced by models, as this might be expected to only reveal periodicities originally imposed on the model, however nonlinearity and lags in model equations may lead to novel time series data analysis results.

Keywords: Snow depth, observations, quality control, trends, exponential, decreasing

Recent Changes in The Ocean Carbon Pump in the South China Sea and Implications for Regional Atmospheric CO_2 Accumulation

Anthony Banyouko Ndah

NF-POGO Centre of Excellence (CofE) in Observational Oceanography, Alfred Wegener Institute for Polar and Marine Research (AWI), Germany anthony.ndah@awi.de

The major biochemical and geophysical mechanisms that constitute potential drives of air-sea CO_2 flux in the South China Sea (SCS), and important modulators of regional atmospheric CO_2 concentration have been investigated. The objectives are two-fold: to ascertain the the drivers of the biological carbon pump and its effeciency ; secondly, to uncover the factors that drive the physical carbon pump ; and thirdly, to compare the effects of both pumps in order to understand the dominant driver of the current patterns of air-sea CO_2 flux and its effect on regional atmospheric CO_2 accumulation. Multiple time- series data-sets were analyzed (corresponding to the period 1998-2014) using mixed statistical methods. Primary production (using Chl-a and CDOM as a proxies) and phytoplankton were found to contribute approximately 50% of the variability of air-sea CO_2 uptake into the SCS. However, the magnitude of CO_2 fixed seasonally and yearly, by biological processes explain only approximately 15% of the variability of regional atmospheric CO_2 concentration. In contrast, CO_2 uptake declined by approximately 0.50 mol-1m-2s-1 and 0.53 mol-1m-2s-1 in response to a unit increase in SST and PAR respectively (99% confidence level), inducing an increase in atmospheric CO_2 concentration by approximately 0.03% (p=0.04). Changes in de-stratification/stratification mechanisms (MLD and freshwater input), wind-speed induced a weak decline of atmospheric CO_2 concentration (-0.02% and -0.001%, and -0.002% respectively) and a weak increase in air-sea CO_2 uptake, but the strength of the physical pump induced by strong warming experienced in the SCS since the 1970s is indisputably the major factor responsible for transforming the SCS into a net source of CO_2. These results serve as a useful reference for future deterministic modeling of marine ecosystem responses to regional carbon system dynamics.

Keywords: Physical carbon pump, biological carbon pump, regional atmospheric CO_2 concentration, South China Sea, Southeast Asia

Mainstreaming Climate Change into Eia Process in Nigeria: Perspectives from Projects in the Niger Delta Region

Saheed Matemilola

Brandenburg University of Technology, Cottbus, Germany matem7_saheed@yahoo.com

Climate change incorporation in environmental assessment is a growing research area, particularly following Paris agreement. Environmental Impact Assessment (EIA) is considered in many quarters as an important tool for factoring climate related components in the planning and design of a project. However, many recent research have shown that EIA has so far struggled in the attempt to incorporate climate change into its procedures. This study is another attempt to evaluate the level of consideration of climate change in the EIA process in Nigeria in the period 2011 to 2016 with a particular focus on the Niger Delta region. The result of this quantitative research shows that there is poor political will to address climate change as reflected in the absence of climate change requirements in the EIA guidelines. Although, there is a growing trend in the pattern of consideration of climate change in the EIA procedures, the overall level of consideration is still a far cry from the requirements if EIA is to be considered as an important tool to address challenges of climate change.

Keywords: Climate change; global warming; EIA; Paris agreement; Niger Delta; greenhouse gases

Time Series of Aerosol Absorption Optical Properties in the Arctic and Mediterranean Regions and Investigation of Measurement Artefacts

A-C. Kalogridis[1], M. Fiebig[2], G. Močnik[3], T. Muller[4], R. Krejci[5], M. Gini[1], K. Eleftheriadis[1]

[1] *Institute of Nuclear & Radiological Sciences & Technology, Energy & Safety*

[2] *NILU-Norwegian Institute for Air research*

[3] *Condensed Matter Physics, Jozef Stefan Institute*

[4] *Leibniz Institute for Tropospheric Research, TROPOS*

[5] *Inst. Applied Environm. Research, Stockholm University* akalogridi@ipta.demokritos.gr

The impacts of light-absorbing aerosols, such as black carbon (BC), present the highest uncertainty amongst climate active species with respect to radiative forcing. Even though the concentrations of BC in the Arctic are low, their effects may be substantial because of the impact of its deposition on snow. In contrast, the Mediterranean region experiences significant BC concentrations that result in a large positive atmospheric forcing.

The rigorous quantification of atmospheric BC load remains a challenging task. A widely used technique to measure light absorption is the use of filter-based absorption instruments such as the Aethalometer. However, these techniques have substantial uncertainties due to multiple scattering of light in the filter fibers and aerosol loading effects. Additionally, a conversion

constant referred to as mass absorption coefficient (MAC) is also required to infer mass concentrations from absorption measurements.

The scope of this study is to investigate differences in those artefacts on the filter-based measurements of aerosol absorption for different types of aerosols. Two sites with different characteristics have been selected:

(a) The Zeppelin Observatory at Svalbard (Arctic), and (b) the suburban DEM station near Athens. Differences in the artefacts are discussed in relation with the aerosol properties, the instrumental and operational parameters.

Keywords: Absorption, black carbon, aethalometer

Climate Response to Volcanic Forcing

Audun Theodorsen, Martin Rypdal

UiT – The Arctic University of Norway audun.theodorsen@uit.no

In determining the global temperature response to radiative forcing, volcanic activity is an important testbed since volcanic eruptions lead to negative pulse- like forcing. Moreover, since the forcing associated with a volcanic eruption is not long-lived, the climate system is not perturbed far enough from equilibrium to invoke non-linearfeedback effects. In this contribution, we will use millennium-long experiments of the Norwegian Earth System Model (NorESM) to study temperature anomalies due to volcanic forcing, and to estimate a linear response function.

We will assume linearity and use a method based on Richardson-Lucy deconvolution to estimate the response signal with the (known) volcanic forcing. Unlike simulations of single volcano events, where the response is lost in the noise after a few years, the proposed method will determine the response function most suited to all events in the entire time series, possibly giving new insight into the long-range nature of the response.

From a control run of the NorESM model, the inherent fluctuations in the system can be characterised as a long-range dependent stochastic process, and a Hurst parameter can be estimated. This allows for the synthetic generation of unforced climate noise, which in turn allows significance levels and method sensitivity to long-time correlations to be assessed.

Keywords: Climate modelling, NorESM, global temperature response, volcanic forcing, deconvolution, filtered Poisson process

Influence of Local Climate and Synoptic Scale Atmospheric Circulation on Long-Term Trends of Air Pollutants

Antoine Waked, Aude Bourin and Esperanza Perdrix

IMT Lille Douai, Département Science de l'Atmosphère et Génie de l'Environnement
aude.bourin@imt-lille-douai.fr

Statistical analysis is apowerfulmethodtostudyclimate and its impacts. In Europe, global warming nowadays affects significantly the society and the environment. The mean temperature increase by +1.3°C for the last 10 years and several proxies recorded dramatic changes in Europe. Earlier works show that atmospheric circulation will change before the end of the 21th century in the northern part of France. The aim of this study is to better understand links between global warming and air pollution. We have characterized spatio-temporal variability of local climate and determined long-term trends of air pollutants recorded at 12 monitoring stations located in Northern France for the period 2005-2015. Significant decreases were recorded for annual mean of PM_{10} and NO_2 (-2 to -4% year-1) and significant increases for annual mean of O_3 were highlighted (+1to +2 % year-1). According to the low spatial variability of the air pollutants trends, we conclude that local climate showed a non-significant influence on air pollutant trends. To better understand the link with synoptic scale atmospheric circulation, we explored the weather type influence on air pollution trends. Results indicated an intensification of seasonal air pollutant trends according to specific classes of circulation weather type.

Keywords: Air pollution - global warming - climate - long term trends - Sen Mann-Kendall test - weather types

Mid-Term Climatology of Aerosol and Saharan Dust Advections in Central Italy

Chiara Petroselli

University of Perugia (Italy) chiara.petroselli@unipg.i

Saharan dust advections occur very frequently in the Mediterranean Basin and reach the Italian peninsula several times per year. The EMEP regional background site of Monte Martano (MM), is particularly suited for the study of long-range transport events, thanks to the surrounding orography and to the naturally low background PM values. The MM site is equipped with aerosol instrumentation (sampling, size distribution), gaseous pollutants monitors and standard meteorological sensors. Moreover, chemical analyses (metals, major ions, EC/OC) are performed on daily filter samples, especially during intensive campaigns. The site is operational since 2009 but substantial improvements have been achieved in 2013 and 2017. PM values show a distinct seasonality with maxima in summer and minima in winter, while a decreasing inter-annual trend was detected for PM_{10} (MAKESENS test). In the considered period, an average value of about 17 advections per year was recorded, with an average dust load of 9.5 µg m-3 for PM_{10}. A very distinct seasonality is observed also for Saharan dust advections with maximum frequency and duration in spring and autumn. This pattern is reflected also in the size distribution data, where it shapes the coarse particles concentration trend, while fine particles follow the general PM seasonal trend.

Keywords: Atmospheric aerosol, Saharan dust, inter-annual trends, seasonality, Central Mediterranean

Automatic Procedures for Submitting Essential Climate Variables to Wmo/Gaw Data Centers, and the Application to Mt. Cimone Long-Term Ozone Time Series

Davide Putero, Angela Marinoni, Luca Naitza, Francescopiero Calzolari, Paolo Bonasoni, and Paolo Cristofanelli

CNR–ISAC, Italy, d.putero@isac.cnr.it

In this work, we describe a set of specific routines for the automatic filtering, flagging, format harmonization, and creation of ECVs (Essential Climate Variables) data products (i.e., plots of raw and valid-corrected- averaged data and internal instrumental parameters). The aim of these procedures is to facilitate data providers towards a more efficient and objective data production and submission to WMO/GAW world data centers, making data evaluation and revision more efficient. As an example, we show the application of these routines to the near-surface ozone (O_3) ECV, considering the time series at the Mt. Cimone WMO/ GAW global station in the Mediterranean basin. O_3 time series is the longest dataset recorded at Mt. Cimone, being measured since 1996; in this work, by applying the automatic procedures, we evaluated the long-term (1996–2017) trend of O_3, observing a significant ($p<0.01$) decreasing trend of −0.20 ppb yr−1. To assess the possible contribution of a natural phenomenon like stratospheric intrusions (SI) on this trend, we re-calculated it by neglecting days influenced by SI (as detected by the STEFLUX tool), obtaining a trend of −0.21 ppb yr−1. This result suggests that the near-surface O_3 negative trend at Mt. Cimone is influenced by SI variability for about less than 5%.

Keywords: Automatic procedures, validation, ECVs, remote site, ozone, stratospheric intrusions

Representativeness of Tall Tower Measured Greenhouse Gases Background Concentrations

Kateřina Komínková

Global Change Research Institute CAS, Czech Republic kominkova.k@czechglobe.cz

Continuous and high precision measurement of Greenhouse gases (GHGs) is one of crucial aspects in the process of Global Change (GC) understanding. At tall tower Kresin at National Atmospheric Observatory Košetice in the Czech Republic the GHGs has been measured since October 2016. This measurement is harmonized according to the specifications of ICOS (Integrated Carbon Observation System) Atmospheric Measurement Network (the station is classified as class one in this network). The GHGs concentrations are monitored at ground level and also at heights of 50, 125 and 250 m above ground. That allows to distinguish which values are affected by local influences (e.g. combustion of fossil fuels in heating systems or traffic) and which are representative as a background on the scale of Central Europe. Even if the time series from Křešín tall tower is not from long period it can be considered as general information about GHGs concentration evaluation according to the reality which was confirmed by comparison with data from other tall towers in the ICOS ATM network.

Keywords: Tall tower measurement, greenhouse gases concentrations gradients, local sources influences identification, data time series comparison

Radiative Forcing Effect on the Generation of Horizontal Meandering in a Low-Wind Boundary Layer

Michel Stefanello[1,2], Luca Mortarini[1,2], Daniela Cava[1], Umberto Giostra[3], Otavio Acevedo[2], Debora Roberti[2], Gervasio Degrazia[2], Angelo Viola[1], Mauro Mazzola[1], and Domenico Anfossi[1]

[1] Institute of Atmospheric Sciences and Climate - National Research Council, Italy, [2] Federal University of Santa Maria,Department of Physics, Brazil, [3] Department of Pure and Applied Sciences (DiSPeA), Università degli Studi di Urbino "Carlo Bo", Scientific Campus "E. Mattei", Urbino 61029, Italy michelstefanello@gmail.com

This work investigates the characteristics of submeso motions (on scales from meters to a few kilometers) and their influence on the dynamics of the atmospheric boundary layer in different stability conditions. During low-speed conditions, submeso activities often manifest themselves as meandering, i.e. large non- turbulent oscillations of the horizontal wind velocity components, wind direction, and temperature. Although horizontal meandering is typically associated with very stable stratifications of the boundary layer, wavelike oscillations associated with low turbulent activity have also been observed in diurnal conditions.

In this work, we study the role of radiative forcing on the generation of horizontal meandering in different stability conditions and its influence on the scalar transport. Measurements of wind velocity components, temperature, radiation, CO_2 and water vapour concentrations carried out at two distinct sites (Santa Maria, Brazil; Ny-Ålesund, Svalbard, Arctic) were analyzed. To detect meandering occurrences and their characteristic time-scales Eulerian autocorrelation functions and spectral analysis are employed. The study confirmed that meandering is always associated to strong radiative cooling. Further, we showed how during daytime low positive radiative forcing due to cloudy conditions triggers horizontal oscillations of the wind vector.

Keywords: boundary layer, submeso motions, horizontal meandering, weak turbulence, radiation, CO_2 and water vapour concentrations

Seasonal Basal Melting at Nivlisen Ice Shelf, East Antarctica, Inferred from Autonomous Phase-Sensitive Radars

Katrin Lindbäck[1], Geir Moholdt[1], Tore Hattermann[1], Keith Nicholls[2], Bhanu Pratap[3], Thamban Meloth[3], Kenichi Matsuoka[1]

[1] Norwegian Polar Institute, Norway, [2] British Antarctic Survey, UK, [3] National Centre for Polar and Ocean Research, India katrin.lindback@npolar.no

Thinning rates of ice shelves vary widely around Antarctica and basal melting is a major component in the mass loss of ice shelves. In this study, we present observational data of the spatial and temporal varying basal melting of Nivlisen Ice Shelf, central Dronning Maud Land, in 2017–2018, using autonomous phase-sensitive radars. These unique records for East Antarctica show in general moderate yearly melt rates of ~1 m/yr. High melt rates (4 m/yr) were observed close to a grounded feature near the ice shelf front. Daily time-varying measurements of basal melt rates show a strong seasonal signal 3 km from the ice shelf front, with the highest melt

rates (5 m/yr) occurring in summer. Comparing with atmospheric reanalysis data, we hypothesize that the seasonality was caused by summer-warmed surface water pushed by wind into the ice shelf cavity. 35 km into the ice-shelf cavity, we observe a clear tidal signal and no melt seasonality. We conclude that warm deep ocean waters have a limited effect on the basal melting of this relatively thin ice shelf, in contrast to thicker (>400 m) ice shelves elsewhere in Antarctica. On the other hand, warmer surface water, have the potential to increase basal melting.

Keywords: Ice shelf, basal melting, glaciology, oceanography, geophysics, Antarctica

Study of Atmospheric Desert Dust and Dust Model Evaluation Through Synergy and Integration of Different Measurement Techniques

Michail Mytilinaios

National Research Council of Italy – Institute of Methodologies for Environmental Analysis (CNR-IMAA), Italy michalis.mytilinaios@imaa.cnr.it

The impact of atmospheric desert dust upon climate, ecosystems, air quality and solar energy represents a major scientific and societal issue. In recent years there has been an increasing need for dust transport accurate information and predictions, leading to the development of dust forecast models. This thesis will be pursued in the framework of DustClim project, which main objective is the reanalysis of model forecast, based on the assimilation of aerosol observations. For this reanalysis will be used long-term data series of aerosol satellite observations over the last decade. Aim of this thesis is the evaluation of model reanalysis through the synergy and integration of various measurements techniques, combining remote sensing and in situ dust observations, taken by ACTRIS/EARLINET research infrastructure networks which provide high quality data series. For this purpose a statistical analysis of dust observations will be performed, in order to retrieve statistical indicators on various spatial and temporal ranges (annual, seasonal etc), which will be used to evaluate the model reanalysis output. Moreover the final results will provide reliable information on dust transport trends and current conditions, and could be used to assess dust impacts upon climate, solar energy and air quality.

Keywords: Desert dust, model reanalysis, observational data series, statistical analysis, model evaluation, dust impacts

Carbonaceous Particles in Developing Regions

Leizel Madueño[1], Simonas Kecorius[1], Marcos Andrade[2], Valeria Mordoñez[2], Alfred Wiedensohler[1]

[1] Leibniz-Institute for Tropospheric Research, Permoserstr. 15, Leipzig,Germany [2] Laboratory for Atmospheric Physics, IIF-UMSA, Cota Cota calle 27, La Paz, Bolivia madueno@tropos.de

To date, air pollution is one of the biggest environmental risks to health. Exposure to polluted outdoor air alone accounts for estimated 4.2 million premature deaths each year, most of which occurs in developing regions. Here, unsustainable massive urbanization resulted in explosion of combustion-related particles i.e. black carbon (BC). These particles were found to be particularly carcinogenic and have been associated with greater negative effects on cardiorespiratory morbidity and mortality than any other particulate matter.

Yet, only few studies focus on bridging the gap between air pollution and health-related effects in developing regions. For example, not only information on BC exposure levels in different micro-environments, but also personal-physical parameters are missing -making the estimation of respiratory tract deposition of inhaled ambient BC rather difficult.

In our work, we aim to assess the variability of BC in different microenvironments and its respiratory tract deposition dose (DD) in polluted metropolitan urban areas of La Paz (Bolivia) and Manila (Philippines). By applying the mobile measurements of BC, we are able to identify the impact of transportation modes on the spatial and micro-environmental distribution, and its DD. The expected results will be a valuable information to improve understanding the link between air pollution and health-related outcomes.

Keywords: Air pollution, black carbon, traffic, micro-environment, exposure, deposition dose

Complementary Tool for Aquaculture Management: Remote Sensing Time Series Analysis for Sines Region (Portugal)

Mara Ramos Gomes

Faculty of Sciences of University of Lisbon *mararamosgomes@gmail.com*

Phytoplankton are highly sensitive indicators of ecosystem condition, and changes in their dynamics are felt throughout the food web. Sines (Portugal), is an industrial centre reflecting great anthropogenic pressure, including offshore fish aquaculture. To support monitoring of the area and management of this activity, biomass variability was characterized through preliminary analysis of satellite-retrieved monthly chlorophyll-a concentration (Chl-a) (20 years, 4km resolution), from the Ocean Colour Climate Change Initiative (OC-CCI). The regional distribution of Chl-a revealed a highly temporal and spatial variability presumably under strong influence of upwelling. Spatially (44x44km box centered in Cape Sines), ranges of Chl-a were higher in summer (0.40 -2.62 mg/m3), followed by winter (0.40 - 1.12 mg/m3), spring (0.50 - 1.22 mg/m3) and autumn (0.36 - 0.94 mg/m3). Phytoplankton biomass averages for the box present two maxima, one in spring (March, μ=0.79 mg/m3) and other during summer (August, μ=0.62 mg/m3). Maximum differences between percentiles 90 and 10 were found in spring while minimum differences were in December, July and October. To better understand phytoplankton dynamics in Sines, improved spatio-temporal resolution such as daily Chl-a data from OC-CCI (18 years, 1km resolution) and from MERIS sensor (10 years, 300m resolution) will be used for further analysis.

Keywords: Phytoplankton variability, ocean colour, remote sensing, MERIS sensor, climate change initiative, aquaculture management

Return to Isotropy in Atmospheric Turbulence

Ganapati Sahoo[1,2], Gaby Katul[3], Ivan Mamarella[2], Üllar Rannik[2], Timo Vesala[2,4]

[1] *Department of Mathematics and Statistics, University of Helsinki, Finland*

[2] *Institute for Atmospheric and Earth System Research (INAR)/Physics, Faculty of Science, University of Helsinki, Finland*

[3] *Nicholas School of the Environment, Duke University, Durham, USA*

[4] *INAR/Forest Sciences, Faculty of Agriculture and Forestry, University of Helsinki, Finland*
ganapati.sahoo@helsinki.fi

An initially anisotropic but homogeneous turbulent flow created by the mean flow gradients relaxes to an isotropic flow upon removal of the mean velocity gradients. In second-order linear closure models of turbulence, third-order moment terms appearing in the transport equations for second-order moments such as momentum fluxes are modelled based on this return-to-isotropy behaviour of turbulence. Such linear models however fail when the initial flow that goes through relaxation is strongly anisotropic. The need for a nonlinear representation of slow pressure- strain correlation arises for such flows. In our work presented here we analyse the return-to-isotropy behaviour of flows above the canopy in forests of Hyytiälä. We observe that as the surface conditions and atmospheric stratification changes due to seasonal and diurnal cycle the relaxation process towards the isotropic state varies across large to small scales.

Equivalent Black Carbon (EBC) Measurement at a Regional Background Site in Central Europe Using a Multiple Wavelength Aethalometer: Variability and Source Identification (2012–2017)

Norbert Serfozo & Saliou Mbengue

Global Change Research Institute, Czechia serfozo.n@czechglobe.cz

Although measurements of Equivalent Black Carbon (EBC) with multiple wavelength aethalometer have been used to provide insights regarding the influence of fossil fuel (traffic emissions) and wood smoke in ambient air, scarce studies have been reported in Eastern and Central Europe using real-time EBC measurements. This study focuses on the seasonal, diurnal and weekly trends of EBC at a regional background site in Central Europe during a 5-year measurement. Our aim is to identify the potential sources of EBC, especially the influence from fossil fuel and biomass burning. The EBC in PM_{10} is monitored from September 2012 to December 2017 at the rural background NAOK (National Atmospheric Observatory Košetice,

49°35' N, 15°05' E), central Czech Republic. Ground based measurements were performed with at 5 min time resolution using a 7-wavelength aethalometer (AE31, Magee Scientific).

The wavelength dependence of light absorption by collected aerosols has been investigated to identify the potential sources of EBC at the rural site. Clear seasonal trend of EBC concentrations was found with higher values during the colder months (winter: EBC_{370nm} = 1.53 ± 1.25 µg/m3, EBC_{880nm} = 1.00 ± µg/m3) and lower values during warmer months (summer: EBC_{370nm} = 0.45 ± 0.26 µg/m3, EBC_{880nm} = 0.44 ± 0.29 µg/m3). In winter wood burning is the important sources of BC consitent with the higher Delta-C and α-value measured during this season compare to summer when fossil fuel combustion is the main source of EBC. This result is also in agreement with preliminary comparison with Levoglucosan (tracer of wood smoke), which show that there is higher correlation between Levoglucosan and Delta-C (r = 0.86) and α-value (r = 0.69) observed in winter. The measured α-value (1.1 ± 0.2) in summer is consistent with reported value for traffic emissions. In winter, increased emissions from wood burning lead to a higher α-value (1.5 ± 0.2).

Keywords: Equivalent Black Carbon, 7-wavelength aethalometer, 5-yr observation, Ångström absorption exponent, Delta-C, BC variability and sources

Levantine Intermediate Water Formation – an Argo Float Study from 2000–2017

Elisabeth Kubin, Pierre-Marie Poulain, Elena Mauri

Institute of Oceanography and Experimental Geophysics, OGS, Italy ekubin@inogs.it

Levantine Intermediate Water (LIW) is the saltiest intermediate Mediterranean water mass and spreads throughout the Mediterranean, following the general circulation.

Argo float data from 2000-2017 are analysed to investigate the formation of LIW in the area of the Levantine Sea, with a special focus on the winter periods in the area of Rhodes Gyre.

The data from 50 free-drifting Argo floats was used in the analysis. The study shows where, when and to which intensity LIW formation occurs. The results are then compared to satellite data from Sea Surface Height (SSH), Sea Surface Temperature (SST) and calculated heat fluxes.

Additionally, to give a description of the general Levantine water mass structures, mixed layer depths, the depth of the salinity maxima and T/S plots are illustrated.

Keywords: Levantine Intermediate Water formation, mixed layer depth, Argo floats, thermohaline circulation, water masses, winter convection

Methane Driven Dissolved Organic Matter Dynamics in the Arctic Ocean

Muhammed Fatih Sert

UiT The Arctic University of Norway, Centre for Arctic Gas Hydrate, Environment and Climate (CAGE) *muhammed.f.sert@uit.no*

Dissociated hydrates and gas bearing sediment release methane into the water column through a large number of shallow water seeps in the Arctic Ocean. The liberated methane dissolves and can lead to areas with high bottom concentrations, which fosters growth of aerobic methane oxidizing bacteria (MOB) that metabolize methane as a source of carbon and energy. Because of their metabolic activity, MOB release organic intermediates and cell lysis products, contributing to the dissolved organic matter (DOM) pool in the water column. Considering the massive flux of methane and elevated rates of microbial oxidation, methane driven DOM contribution may constitute an important control on the water column biochemistry and food web structure at the active seep sites.

We have collected seawater samples from well- characterized seep areas during two research expeditions at the western shelf of Svalbard and in the Barents Sea in summer 2017. We performed analyses of dissolved nutrients, methane, organic carbon, chlorophyll-a, and particulate organic matter in order to investigate the influence of methane seepage onwater column biogeochemistry. DOM will be characterized by fluorescence (excitation-emission matrices) of colored-DOM and its chemical composition at the molecular level using Ultrahigh resolution mass spectrometry (FT-ICR-MS).

We hypothesize that MOB processes may alter the composition of DOM towards more labile and heterogeneous formulae, which in turn could promote microbial activity and stimulate primary production by providing energetic carbon substrates to the water column.

Keywords: Dissolved organic matter, methane hydrate, methane seepage, Arctic Ocean, FT-ICR-MS, nutrients

Diel And Seasonal Trends Of Biogenic Volatile Organic Compounds From The Amazonian Tropical Rainforest

Nora Zannoni, Chiara Seghetti, Jonathan Williams

Max Planck Institute for Chemistry, Germany *Nora.Zannoni@mpic.de*

Biogenic Volatile Organic Compounds (BVOCs), emitted from the Earth's surface, play a key role in global atmospheric chemistry. Over 1000 megatons of carbon are emitted in this form to the atmosphere each year, primarily from terrestrial vegetation in the tropics. BVOCs react rapidly with the atmosphere's primary oxidizing agent the OH radical, producing a multitude of gas phase and particulate products, which have adverse effects on human health and air quality. There is still considerable uncertainty associated with BVOC emissions, their atmospheric chemistry, and their effect on climate drivers.

We collected ambient air samples during November 2017 (dry season) and March 2018 (wet season) at the remote field site ATTO (Amazonian Tall Tower Observatory) in the pristine Brazilian Amazonian rainforest. Samples were collected on sampling tubes equipped with ozone scrubbers every three hour for 2 weeks at different heights above the forest canopy and analysed in the laboratory through a TD-GC-TOF-MS (Thermodesorption-Gas Chromatographer-Time Of Flight-Mass Spectrometer, Markes International). The main chemical species were identified by comparison with literature mass spectra and injection of standard molecules and quantified through a targeted analysis on the relevant mass fragments. Preliminary results show isoprene and alpha pinene as the main VOCs emitted by the forest, with stronger emissions reported during the dry season.

Keywords: Volatile organic compounds, isoprene, monoterpenes, GC-MS, Tropical forest, ATTO site

Measurements From the Swedish Forest-Atmosphere Ecosystem Research Infrastructure Station Hyltemossa

Stina Ausmeel, John Falk, Erik Ahlberg, Axel Eriksson, Patrik Nilsson, Marcin Jackowicz-Korczynski, Michal Heliasz, Tobias Biermann, Thomas Holst, Adam Kristensson, Erik Swietlicki

Lund University, Sweden *stina.ausmeel@nuclear.lu.se*

Aerosol particles from natural or anthropogenic sources have negative health effects and affect the climate system, mainly by acting as seeds for cloud droplets as well as reflecting or absorbing solar radiation. Increasing air pollution is therefore an issue, and monitoring of aerosol properties and concentration over time is important for research and legislation. The Hyltemossa research station comprises infrastructure for monitoring of aerosols, and other variables related to the land ecosystem- atmosphere-climate system. It is part of both the ACTRIS (European Research Infrastructure for the observation of Aerosol, Clouds, and Trace gases) and an ICOS (Integrated Carbon Observation System) network. Hyltemossa is located in southern Sweden in a rural area surrounded by a managed spruce forest, typical for this region. Local emission as well as in-transport with winds from other areas in Europe are measured. Continuous measurements of aerosols include number size distribution, absorption (seven wavelengths, 370-950 nm), scattering, chemical speciation (organics, sulphate, nitrate, ammonia, and chloride), and OC/EC (organic carbon/elemental carbon). Aerosol measurements have been going on since 2017 (including the previous site Vavihill, 2001- 2017) and greenhouse gas measurements since 2014, and for the training school for time series analysis, the chemical speciation and size distributions during 2018 will be in focus.

Keywords: atmosphere, aerosol particles, chemistry, size distribution, rural, spruce forest

HO_X In The Upper Troposphere During The West African Monsoon

Roland Rohloff

Max Planck Institute for Chemistry, Germany r.rohloff@mpic.de

Emissions originated from Biomass-burning in southern Africa are transported to the ITC in the lower troposphere. The convective systems mix this air with local airmasses and transport them into the upper troposphere. During transport over polluted areas, these airmasses are enriched with ozone precursors.

Reactive radicals, formed by photolysis, oxidize trace gases in the troposphere. The most important reactive radical during daytime is the hydroxyl radical (OH), which is in fast equilibrium with hydroperoxy radicals (HO_2).

HO_x-radicals ($OH+HO_2$) are responsible for the oxidative decay of chemically and photolytically stable trace gases. Hence, the oxidation capacity can be understood as the tropospheric selfcleaning capacity. OH radicals are mainly generated by photolysis of ozone. Another important production is the reaction of HO_2 with NO, forming a 'recycled' OH-radical. Therefore lightning NOx, produced by thunderstorm cells over West Africa, affect for the oxidation in the transported airmasses.

The oxidation of VOCs and OH initiates the formation of secondary organic particles, that play an important factor in the production of aerosols.

The CAFE-Africa-Campaign (Chemistry of the Atmosphere field experiment) took place during the West African Monsoon in 2018. Measurements were carried out with the HALO-aircraft to study the air masses in the troposphere.

Keywords: Hydroxyl, self-cleaning, airborne, LIF-FAGE, CAFÉ- Africa, upper troposphere

HO_X During Aqaba Campaign

Sebastian Tauer

Max Planck Institute for chemistry, Germany s.tauer@mpic.de

The Middle East is endowed with about half the proven oil and gas reserves on the planet and has rich solar resources. In addition, exceptional environmental qualities, with extensive deserts and a high water scarcity promote dust mobilisation. Furthermore, it is subject to high air pollution due to high ship traffic and petrochemical industry. The AQABA (Air Quality and climate in the Arabian BAsin) field campaign took place in summer 2017 covering a track from Toulon to Kuwait through the Mediterranean and around the Arabian peninsula and back.

As one of the most reactive oxidants in the atmosphere, the hydroxyl radical (OH) is a driving force in air chemistry. Its close chemical relative, the hydroperoxyl radical (HO_2) is a major source of tropospheric ozone. Additionally HO_x (OH and HO_2) play a role in the production of aerosols via the formation of low volatility compounds like organic acids.

During the AQABA campaign, HO_x was measured using laser-induced fluorescence (LIF) to investigate the influence of the region on HO_x concentrations and budget. Particularly, the effect of dust on HO_2 was matter of this study.

Keywords: Hydroxyl, Hydroperoxyl, AQABA, Boundary layer, LIF, Arabian Peninsula

Challenges in Assessing the Spatial and Temporal Trends of Oil Spills in the Mediterranean Sea

Semion Polinov, Revital Bookman, Noam Levin

University of Haifa, and Hebrew University of Jerusalem Semion.polinov@gmail.con

Petroleum pollution spills from ships are severe environmental disasters often leading to significant and long-term impacts on marine ecosystems. On the one hand, in last 50 years there has been a significant decrease in accidental oil spills events and spilled volume. On the other hand, the number of ships and illegal discharges is also growing. An understanding of spatial and temporal patterns of petroleum pollution and generally of shipping is essential for better management of human impacts in the Mediterranean Sea, which is a major global corridor for oil (22%) and commercial shipping (30%). This study provides an overview of oil spill data collecting methods and available information sources for accidental spills and illegal discharges within the Mediterranean Sea for the periods 1970–2017 and 2015-2017 respectively, followed by a detailed examination of advantages and disadvantages of each approach and methodology. The analysis demonstrates that illegal discharges from ships have become a major problem and represent the main source of marine pollution from ships, while accidental pollution rarely occurs in the Mediterranean Sea region, despite low attention of scientific world.

Keywords: Mediterranean Sea, oil pollution, accidental oil spills, illegal discharges, temporal analysis, spatial analysis

Long-Term Observations of Aerosol Precursor Vapours in Boreal Forest

Nina Sarnela, Lisa Beck, Tuija Jokinen, Heikki Junninen, Mikko Sipilä, Tuukka Petäjä and Markku Kulmala

INAR, University of Helsinki, Finland nina.sarnela@helsinki.fi

The presence of suitable low-volatility vapours is crucial for new particle formation in which molecular clusters form from atmospheric vapours by condensation and/ or chemical reactions. In favourable conditions the clusters can grow into larger particle sizes and act as cloud condensation nuclei. In order to understand atmospheric emissions and concentration levels and their trends, long term observations are needed. New measurement techniques have enabled the in- situ measurements for low-volatility compounds. We have used Chemical Ionization Atmospheric Pressure interface Time of Flight Mass Spectrometer to measure low-volatility

vapours and molecular clusters in boreal forest site (at SMEAR II station in Hyytiälä, Finland) continuously starting from 2014. Starting from the year 2016 there has been two instruments measuring: one from ground level and one from a tower (36m altitude). In particular sulfuric acid and highly oxygenated organic compounds have been identified being responsible of new particle formation. In addition of those we have studied the appearance of iodic acid and methyl sulfonic acid. Also ambient ions and ion-clusters have been measured during some parts of this time period by using a switcher inlet. The measured vapour and ion concentrations have been studied together with meteorological parameters and particle concentrations measured on the site.

Keywords: mass spectrometry, low-volatility vapours, in-situ measurements, sulfuric acid, highly oxygenated organics, chemical ionization

Analysis Of Long-Term Measurements Of 1–3 Nm Particle Size Distributions And Aerosol Precursor Gases From The SmearIi Station

J. Sulo, P. Paasonen, J. Kontkanen, J. Kangasluoma, N. Sarnela, T. Jokinen, K. Lehtipalo, M. Kulmala

Institute for atmospheric and Earth system research (INAR), University of Helsinki, Finland
juha.sulo@helsinki.fi

Analysis of the time series of particle size distributions and aerosol precursor molecule data can provide new insights into initial steps of atmospheric new particle formation. In particular, continuous measurements provide information on trends and variation that aren't visible from short term observations. For this reason 18 months of data from Hyytiälä SMEARII- station, Finland, was analyzed. A time series analysis was performed to sub-3 nm particle size distributions measured by the Particle Size Magnifier and aerosol precursor molecule measurements by the CI-APi-ToF to study seasonal variability, diurnal patterns, data quality and relevant correlations between condensing gases and nanoparticles. The initial results show a clear correlation between daytime particle concentrations and sulfuric acid concentrations in the atmosphere, particularly for the smallest measured particles.

Further comparisons between these observations and meteorological quantities show that concentrations of 1-3 nm aerosol particles correlate with temperature and the absolute concentration of water in the atmosphere. These correlations may also be tied to an observed correlation between particle concentrations and highly oxidized molecules (HOM) that originate from e.g. monoterpene oxidation. More sophisticated analysis, such as principal component analysis is required to determine whether the observed sub-3 nm particles primarily correlate with the meteorological quantities or HOM concentrations.

Keywords: New particle formation, aerosol measurements, PSM, CI-APi-ToF, atmospheric aerosols, data inversion

CM SAF CLARA-A2 Global Cloud Cover Climate Data Record

Vasileios Tzallas

University of Ioannina, Greece vasileios.tzallas@gmail.com

CLARA-A2 is an updated data set produced by EUMETSAT CM SAF using measurements of the AVHRR instrument onboard the polar orbiting NOAA and EUMETSAT MetOp satellites, and extending from 1982 to 2015. The Total Cloud Cover (TCC) product of CLARA-A2 is derived with a multi-spectral thresholding method implemented in the Satellite Application Facility on Nowcasting (NWC SAF) polar platform system (PPS) cloud processing software. TCC is defined as the fraction of cloudy pixels per grid square compared to the total number of analyzed pixels in the grid square and it is expressed in percentage. In this study, the monthly mean CLARA-A2 total high-, middle- and low-level cloud cover data, have been averaged to a 2.5°×2.5° latitude-longitude grid. In addition, the CLARA-A2 product that combines day and night measurements from all available satellites was selected in order to represent as well as possible the diurnally averaged monthly CC. The number of satellites varies from one in the early part of the record to at least four in the last decade. With each satellite having two (daytime plus nighttime) or – towards higher latitudes – more overpasses over a specific location per day, CLARA-A2 reaches a variable coverage of the full diurnal cycle.

Keywords: cloudiness; CLARA-A2; remote sensing; climatology; AVHRR; climatology

Time Series in the Digital Earth Project

Viktoria Wichert

Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Germany, viktoria.wichert@t-online.de

The Digital Earth project is a collaboration of different earth and environmental science disciplines. It relies on data science methods to answer field-spanning questions, monitor environmental developments and explore existing data for new insights, as well as optimize future measurement campaigns.

One challenge that arises in this context is the integration of data from varying sources with different spatial and temporal resolutions. This includes, among others, time series from measurement campaigns, such as the water quality of the river Elbe or the methane concentration in the atmosphere. To analyse these time series correctly and understand their limitations is essential before combining findings from different sources to gain a throughout understanding of complex questions in the earth sciences.

Keywords: Earth Sciences, Data Science, Data Exploration, Machine Learning, Digital Earth, Software Development

ODYSSEA: A Novel, Interoperable Platform for Products and Services in the Mediterranean Sea

Maria Zoidou, Konstantinos Zachopoulos, Georgios Sylaios

Democritus University of Thrace, Department of Environmental Engineering, Greece
mzoidou@windowslive.com

ODYSSEA (http://odysseaplatform.eu/) is an EU H2020-funded project aiming to develop, operate and demonstrate an interoperable and cost-effective platform that fully integrates networks of observing and forecasting systems across the Mediterranean basin, addressing both the open sea and the coastal zone.

The project works systematically towards the development of the ODYSSEA platform to:

- Integrate marine data from existing databases maintained by Earth Observing facilities, scientific networks, agencies, public authorities, and institutions of Mediterranean countries (CMEMS, GEOSS, GOOS, EMODNet, and others with marine and maritime links);
- Receive and process novel newly produced datasets (through models, remote sensing and on-line sensors) from nine prototype Observatories, established along the continental shelf of the Mediterranean Sea, especially at areas with intense human activity but also at marine protected zones;
- Transform marine data into meaningful information, ultimately developing, testing, validating and disseminating marine data products and services to end-users and stakeholders from a diverse spectrum of marine and maritime sectors (mariculture, shipping, oil and gas exploitation, port management, civil protection, etc).
- Stimulate Blue Growth throughout the Mediterranean basin, creating businesses, advancing science and supporting the societal use of digital information.

The final platform will provide easy access to marine data and derived products to a variety of users to improve knowledge and decision-making in the Mediterranean.

Keywords: Mediterranean Sea, ODYSSEA platform, marine data, marine databases, Blue Growth, forecasting system

Simulation of Salt Wedge Intrusion Along Strymon River Mouth and Assessment for Potential Energy Production Using Salinity Gradient Energy Technology

K. Zachopoulos, N. Kokkos, G. Sylaios

Democritus University of Thrace, Department of Environmental, Greece
zachopoulosk@gmail.com

The intrusion of salt wedge in rivers is a natural phenomenon occurring in many Mediterranean estuaries, especially during the summer months. Strymon River mouth is an estuary with seabed below mean sea-level for the first 9km upstream. River dischargeatlowerStrymonisman-

controlledbyKerkini artificial lake; a reservoir located 77 km upstream. The extensive use of Kerkini water for summer irrigation reduces Strymon discharge and allows the salt water intrusion upstream the river mouth, forming a salt wedge. Salt wedge characteristics are important in the study and forecast of water, heat, salt, nutrients, pollutants, planktonicorganisms, suspendedsediments and dissolved oxygen horizontal and vertical fluxes. The present work simulates the dynamics of salt wedge intrusion along the Strymon River Estuary by applying a three-dimensional hydrodynamic numerical model. The simulation aims to describe the processes of salt wedge formation and is further used to estimate the potential osmotic energy that could be harvested in the Strymon river estuary when applying the Salinity Gradient Energy technology. More specifically, as the technology of Reverse Electrodialysis (RED) will be assessed. The outcomes of the hydrodynamic model (salinity, temperature and density) are used as input to the energy model, estimating the annual electricity produced from a pilot plant of 1MW.

Keywords: Salt Wedge, Strymon river, ELCOM, Salt Intrusion, Hydrodynamic model, Salinity Gradient Energy (SGE)

QA/QC of Particle Size Distribution Data by Cross-Section Filtration

Zdeněk Wagner, Pavel Kovanic*, Naděžda Zíková, Jakub Ondráček, Jaroslav Schwarz, Vladimír Ždímal

Department of Aerosol Chemistry and Physics, Institute of Chemical Process Fundamentals of the CAS, v. v. i., Prague, Czech Republic

**Retired from Institute of Information Theory and Automation of the CAS, v. v. i., Prague, Czech Republic*

wagner@icpf.cas.cz, zdenek.wagner@gmail.com

Particle size distribution is measured by the scanning mobility particle sizer (SMPS) in two steps, upscan (with increasing voltage and hence particle size) and downscan, and an arithmetic mean of counts of the two scans is used. If the measurement of particle counts is disturbed, particle concentrations at several size bins can be negative after inversion. Time series filtration may not cope with all such events, especially if several consecutive distributions are damaged. However, usually only one of the scans is affected. An algorithm based on mathematical gnostics was deployed to estimate the kernel of typical differences between scans for each distribution by analysis of residual entropy. Correction by omitting the erroneous value is then triggered. The algorithm is capable to restore even strongly damaged distributions, typical computation time is 6 seconds. The format of the diagnostic file can be extended to support information about this type of corrections and afterwards converted to a proper flag in the SMPS/DMPS files. It can thus increase the quality of data in the EBAS database while reducing the demand for human work for manual QA/QC. The work was supported by the Grant Agency of the Czech Republic under grant No. 17-19798S.

Keywords: scanning mobility particle sizer; particle size distribution; cross-section filtration; mathematical gnostics; residual entropy; QA/QC

Extreme Event Characterisation Based on Long-Term in Situ High- and Low-Frequency Observations of Coastal Waters Western Europe

Maximilian Unterberger[1], Guillaume Charria[1], Peggy Rimmelin-Maury[2], Eric Goberville[3], Paul Tréguer[4], Nicolas Barrier[5], Emilie Grossteffan[2], Michel Repecaud[6], Loïc Quemener[6], Sébastien Theetten[1]

[1] Ifremer, UBO, CNRS, IRD, UMR6523 Laboratoire d'Océanographie Physique et Spatiale (LOPS), IUEM, F-29280, Plouzané, France.

[2] OSU-Institut Universitaire Européen de la Mer (IUEM), UMS3113, F-29280, Plouzané, France.

[3] Muséum National d'Histoire Naturelle, UMR 7208 BOREA, Sorbonne Université, CNRS, UCN, UA, IRD, Paris, France.

[4] IUEM, UMR-CNRS 6539 Laboratoire de l'Environnement Marin (LEMAR), OSU IUEM, F-29280, Plouzané, France.

[5] MARBEC, Université de Montpellier, Centre National de la Recherche Scientifique (CNRS), Ifremer, Institut de Recherche pour le Développement (IRD), F-34203 Sète, France.

[6] Ifremer, Centre de Brest, REM/RDT/DCM, F-29280, Plouzané, France.
maximilian.unterberger@ifremer.fr

Coastal waters of western Europe and their associated marine ecosystems are under the influence of contrasted hydro-meteorological dynamics, that are highly sensitive to natural and anthropogenic climate variations at a global scale. These dynamic oceanic regions experience a variety of extreme events (e.g. freshening events due to river discharge) which remains challenging to assess and furthermore to predict in terms of temporal and spatial scales.

In this study, the physical and chemical dynamics in the Bay of Brest were investigated to obtain a better understanding and predictability of local extreme events. We analysed long-term high- and low- frequency in situ observations recorded from the year of 2000 onwards focusing on the winter period (December to March). Applying methods for seasonal and tidal variations as well as statistical procedures on in situ time series for extreme event characterisation. We ran numerical simulations over the same period of the observations to investigate and understand the dynamics in the Bay of Brest and their temporal occurrence. Furthermore, we directly compared these numerical simulations with our observations to analyse the involved ocean processes in the considered region.

Observations suggest that the temporal distribution of local extreme precipitation patterns linked with terrestrial watershed saturation capacities during the pre-event period appears to be the main driver for triggering freshening events. Within this study, the interannual occurrence of

extreme events and the role of the different oceanic and atmospheric processes (e.g. tides) are explored in detail.

Keywords: Extreme events, time series, high frequency in situ sampling, coastal environment, climate variability, model emulation