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Chemical characteristics of the three-stage fog water in the winter of Nanjing

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In order to understand the chemical characteristics of fog water in Nanjing, three-stage Caltech Active Strand Cloud Collector (CASCC) was used to collect fog droplets in three separate droplet size ranges (from December 7th to December 9th, 2013). Fifty percent droplet size cuts of 22, 16, and 4 μm diameter are featured in stages one, two and three, respectively. Twenty-three fog samples were collected in two fog events and divided into eight periods. Concentrations of cations and anions in each sample were detected by ion chromatography. Composition of the fog water, chemical composition distribution characteristics of fog water in each stage, the correlation of ions in each stages and the relationship between ion concentrations and gaseous pollutants or microphysics were considered together during the analysis. The results showed the pH mostly resided in acidic range. The electrical conductivity and the changing trends of total ion concentration (TIC) of the fog water on the outskirts of Nanjing are consistency. The conductivity of the first stage fog water is markedly lower than the third stage, but during the second, forth and the fifth sample period, we found that the conductivity with the distribution of particle diameter, present a "U" type distribution. The three-stage CASCC data showed significant size-dependence for all reported species. The small drop fraction had significantly high concentrations of the major ions (NH_4^+ , NO_3^- , SO_4^{2-}), lower pH values and higher EC values than the large drop fraction. Also the data showed concentrations of the species was higher at night. Due to the differences in contribution from regional pollutant sources, soluble components varied greatly in different fog events. Also the ionic composition had a significant relationship with microphysical properties and pollutant gases.

High Anthropogenic Contribution in Fog Water at a Coastal Island Bhola, Bangladesh

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A comprehensive study on the chemical composition and source characterization of fog water (18 samples) was carried out at an outflow location of the Indo-gangetic plain to the Bay of Bengal (Coastal Bhola Island, Bangladesh) during the winter season (December 2017 to February 2018). Different physical properties of fog water including color, odor, pH, electrical conductivity (EC), total dissolved solids (TDS), total organic carbon (TOC) were measured. Concentrations of different water-soluble ions (F^- , Cl^- , SO_4^{2-} , NO_3^- , HCO_3^- , Na^+ , K^+ , NH_4^+ , Ca^{2+} , and Mg^{2+}) and trace metals (Zn, Fe, Mn, Cu, Cr, Pb, and Ni) were determined in fog water. Source characterization was conducted with a combination of correlation analysis, enrichment factor analysis, % source contribution calculation, and air mass trajectory analysis. The average pH, EC, TDS, TOC of the collected fog water were 7.03 ± 0.2 , $371.2 \pm 63 \mu S\ cm^{-1}$, $235.8 \pm 128\ ppm$, and $15.8 \pm 5.8\ ppm$, respectively. The average concentration of (F^- , Cl^- , SO_4^{2-} , NO_3^- , HCO_3^- , Na^+ , K^+ , NH_4^+ , Ca^{2+} , and Mg^{2+}) were 77.7 ± 38.5 , 937 ± 416.5 , 725.24 ± 383.9 , 1002.4 ± 562.2 , 70 ± 48.2 , 733.8 ± 205.3 , 338.6 ± 188.7 , 562.5 ± 402.9 , 1147.4 ± 616.2 , $350 \pm 125.5\ \mu eq\ L^{-1}$, respectively. The concentration of the determined ions followed the sequence: $Ca^{2+} > NO_3^- > Cl^- > Na^+ > SO_4^{2-} > NH_4^+ > Mg^{2+} > K^+ > F^- > HCO_3^-$. The average concentration of Zn, Mn, Fe, Cu were 336 ± 150 , 272 ± 123 , 50 ± 30 , $23 \pm 15\ \mu g\ L^{-1}$ while the concentrations of Cr, Pb and Ni were very low. The order of concentration of trace metals was $Zn > Mn > Fe > Cu > Ni > Cr > Pb$. The ratio of $\Sigma cation$ to $\Sigma anion$ was 1.07, indicating that alkaline constituents neutralize acidity. The recorded pH (on average $pH = 7.03 \pm 0.2$) also confirm the ratio of $\Sigma cation$ to $\Sigma anion$ was neutral. The concentration of K^+ and NO_3^- were higher than many countries of the world but lower than China. Neutralization factor analysis showed that Ca and NH_4^+ were the major neutralization constituents of the fog water. Correlation analysis between different chemical species showed a significant correlation among sea, soil and anthropogenic species. High enrichment factors of SO_4^{2-} , NO_3^- , Zn, Mn, and Cu were a good indication of anthropogenic sources. % source contribution of different species showed a significant anthropogenic contribution of Cl^- (8.30%), SO_4^{2-} (84.02%) and NO_3^- (99.74%). The results suggested that fog water chemistry is strongly influenced by anthropogenic sources rather than natural and marine sources.

Keywords: Fog water; chemical composition, enrichment Factors; % Source Contribution

A persistent fog event involving heavy pollutants in Yancheng area of Jiangsu province

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In the early December 2013, dense fog involving heavy pollutants lasted for 9 days in Yancheng area. The characteristics, formation and lasting mechanisms of this persistent fog were analyzed based on observational data at Sheyang site, reanalysis data and final analysis data from NCEP/NCAR, combining with the weather background, meteorological and physical variable fields. Results include that: (1) The fog process was characterized by long duration, low visibility and high pollutants concentration. (2) Atmospheric circulation contributed to the development and maintenance of heavily polluted fog. The existing southerly anomaly in the lower troposphere brought more moisture to the Jiangsu area, which provided moisture condition for fog formation. Meanwhile, the weakening of South Asian winter monsoon led to the weakening of surface wind, which favored fog formation and pollutants' accumulation, but not for transporting fog and pollutants outward via advection, resulting in the maintenance of polluted fog process. The higher pressure in the middle troposphere controlled the development of convection, and helped the polluted fog aggregated in the lower layer of the atmosphere. The decreasing vertical gradient of horizontal wind in the middle and lower troposphere not only suppressed the development of synoptic-scale disturbances by weakening the atmospheric baroclinic instability, but also made the atmospheric stratification more stable by weakening vertical mixing. (3) Deep inversion was the key thermal factor causing the heavily polluted fog. (4) The fog exhibited obvious outbreaks with good visibility weather turned to severe fog several times; and the weak cold air invasion and radiative cooling were the triggering factors to the sudden enhancement of the fog.

Evidences for regional radioactive contamination in mountain forests of East Japan due to fogwater deposition during the Fukushima Daiichi Nuclear Power Station accident

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Although the importance of fogwater deposition onto mountain forests during the Fukushima Daiichi Nuclear Power Station (FDNPS) accident has been suggested, its impact on regional-scale radiological contamination is still unclear due to very limited environmental monitoring data. Here we show the first observational result of radiocesium of fogwater and its deposition at a Japanese mixed forest (1264 m asl.) during the early stage of FDNPS in March 2011. Monthly fogwater sampled by a passive sampler in March 2011 was analyzed above the canopies, whereas monthly throughfall and stemflow of radiocesium were also measured under the canopies of *Fagus crenata*, *F. japonica*, *Tsuga sieboldii*, and *Cryptomeria japonica* during the same period. In addition, the available data of the ratio of ^{137}Cs concentration of throughfall to that of bulk precipitation obtained at various mountains was analyzed with use of the deposition map of fogwater calculated by an atmospheric dispersion model and the available data of cloud base height. Observed ^{137}Cs concentration in fogwater was 45.8 Bq L^{-1} , two times higher than that in bulk precipitation. The ratio of ^{137}Cs concentration in bulk precipitation to that in throughfall was ranged from 1.0 to 2.5. Both results indicated that the high ratio value of ^{137}Cs concentration could be caused by the high concentration of fogwater deposition. The available data and model results also revealed the evidence of fogwater deposition as a large area of mountain forests located over approximately 300 m in altitude in East Japan were contaminated. Since the impact of fogwater deposition is apparent during the accident, a role of fogwater deposition process should be carefully considered for understanding the radiocesium cycling in forest ecosystems in East Japan.

Mercury speciation and adsorption in cloud water over the North China Plain

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Cloud effects on heterogeneous reactions of atmospheric mercury (Hg) and thus on Hg geochemical cycling are poorly understood due to our knowledge gap in cloudwater Hg chemistry. To investigate Hg species in cloud water and their behaviors in cloud processes, we collected cloud water samples using CASC sampler in summer 2015 at the summit of Mt. Tai (1545 m) over the North China Plain, where air pollution is severe. Total mercury (THg), dissolved Hg (DHg) and methylmercury (MeHg) were analyzed. Ancillary water-soluble ions, dissolved organic matter (DOM), small carboxylic acids and cloud physical parameters were also determined. The results showed that cloudwater THg concentrations ranged from 10.2 to 773.3 ng L⁻¹ with an average of 70.5 ng L⁻¹, which was the highest in clouds/fogs worldwide until now. Two-thirds of THg was comprised of particulate Hg (PHg), probably contributed by abundant aerosol particles. MeHg, which was almost all dissolved, had moderate concentration level of 0.15 ng L⁻¹ on average. Chemical equilibrium simulations using Visual MINTEQ v3.1 indicated that Hg complexes by DOM dominated the DHg speciation, which was highly pH dependent and competed with chloride. Concentrations and speciation of Hg were irreversibly altered by cloud processes, during which significant positive correlations of PHg and MeHg with cloud droplet number concentration (Nd) were observed. However, unlike direct contribution to PHg from cloud scavenging of aerosol particles, abiotic DHg methylation was likely the source of MeHg. The measured Hg adsorption coefficient K_{ad} (mean of 70 L g⁻¹) was much higher than that employed in transport model (45 L g⁻¹), and exhibited an inverse-power relationship with cloud residues content. SEM-EDS analyses of cloud residue particles indicated that fly ash particles, compared to mineral particles, could enhance physical and chemical adsorption of Hg due to larger specific surface area and more abundant carbon binding sites. Our findings imply that aerosol-cloud interactions over the air polluted northern China may bring substantial Hg into cloud droplets, impacting atmospheric heterogeneous reactions and cycling of Hg.

Organic aerosol composition and chemistry during foggy and non-foggy episodes over Indo-Gangetic Plain

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Foggy episode is a conspicuous feature under predominant north-westerly wind-system during wintertime over the Indo-Gangetic Plain (IGP). Multiple factors including emissions from ground level and secondary transformations in the atmosphere, shallower planetary boundary layer height and low temperature result into haze and fog formation, and thus, degrade the air quality during winter over IGP. In this study, our major focus is to assess the role of fog in influencing the organic aerosols chemistry and composition. Measurements of various other chemical species like EC, water-soluble inorganics and mineral dust have been utilized to augment the observations on fog-processing. Briefly, we have collected 50 PM₁ (particulate matter of aerodynamic diameter $\leq 1.0 \mu\text{m}$) samples of which 17 were collected during foggy episodes. PM₁ mass concentrations during non-foggy episodes (NF, Avg.: $247 \mu\text{g m}^{-3}$) were relatively high as compared to that during foggy condition (F, Avg.: $107 \mu\text{g m}^{-3}$). Lower fractional contribution of SO₄²⁻ (NF: 15.9%, F: 8.3%), NO₃⁻ (NF: 9.1%, F: 3.3%) and NH₄⁺ (NF: 8%, F: 3.2%) during foggy episode results into lower abundance of PM₁ mass highlighting their scavenging into fog droplets. Interestingly, in a sharp contrast the co-enhancement in OC/PM₁ (NF: 0.25, F: 0.39), OC/EC (NF: 8.3, F: 13.4), WSOC/OC (NF: 0.44, F: 0.83) and SOC/OC (NF: 0.73, F: 0.84) ratios indicates role of fog-processing in SOAs (secondary organic aerosols) formation leading to change in atmospheric sub-micron aerosol composition and its properties. Mass absorption efficiency (MAE at 660 nm) of EC was higher by 30% ($9.0 \text{ m}^2 \text{ g}^{-1}$) during foggy episode whereas the mass fraction of EC remained quite similar ($\approx 3\%$ of PM₁). Thus, it is evident from our study that fog-processing could lead to quite significant enhancement in organic matter contribution and in MAE of EC with a parallel decrease in SO₄²⁻, NO₃⁻ and NH₄⁺ mass fractions. Mass fraction of mineral dust also exhibits a remarkable decrease from 14.1% to 9.2% during non-foggy and foggy conditions, respectively whereas the characteristic ratios of Fe/Al, Ca/Al and Mg/Al remained similar.

Influence of fog events on air quality at the background scale of the Czech Republic.

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The aim of presented study is to evaluate the influence of dense fogs on air quality at the background scale of the Czech Republic. The study is based on the data from the National Atmospheric Observatory Košetice (NAOK) operated by the Czech Hydrometeorological Institute (CHMI). The Observatory, established in 1988, is specialized in long-term air quality monitoring at the background scale. NAOK is located in free area outside of settlement (49°35' N, 15°05' E, 534 m above sea level) and represents the Czech Republic in several international long-term monitoring networks (ACTRIS EMEP, GAW, ICOS, ICP-IM). The professional meteorological station (WMO indicative 11 286) is an integral part of NAOK. Air quality measurements are implemented within accredited National Air Quality Monitoring network since 1992. In the Czech Republic, fog is a year-round phenomenon but is most frequently observed during autumn and winter months. The average annual number of days with fog at NAOK is 47. The study covers the period with fully automated meteorological measurements (2002-2018). Special attention was devoted to the episodes of very dense (visibility less than 50m) and dense (50-200m) fogs. PM concentrations during the fog episodes were significantly higher than usual level. The average concentration of PM₁₀ during the episodes with visibility less than 200 m was 43 $\mu\text{g.m}^{-3}$ and the 27 $\mu\text{g.m}^{-3}$ with visibility 50-200 m. The adequate values for PM_{2,5} were 27 $\mu\text{g.m}^{-3}$ and 21 $\mu\text{g.m}^{-3}$. The average concentrations for the whole period are 22 $\mu\text{g.m}^{-3}$ for PM₁₀ and 15 $\mu\text{g.m}^{-3}$ for PM_{2,5}. In the cold period, when the fog events occur most frequently, the concentrations are higher (25 $\mu\text{g.m}^{-3}$ for PM₁₀ and 17,7 $\mu\text{g.m}^{-3}$ for PM_{2,5}). The PM_{2,5}/PM₁₀ ratio was significantly lower during fog events (0,62%). The average ratio at NAOK is 0,76%. The regular monitoring of elemental/organic compounds started only in 2014, so that only limited number of events was taken into account, but the concentrations during dense fog events are significantly higher than the annual means. On contrary, the generation of tropospheric ozone was limited during the fog episodes. Mean concentration by the visibility below 200 m was 28 $\mu\text{g.m}^{-3}$ and 50-200 m 32 $\mu\text{g.m}^{-3}$. The mean annual concentration in 64 $\mu\text{g.m}^{-3}$ and during the cold period 52 $\mu\text{g.m}^{-3}$. Evaluating the SO₂ and NO_x data we found only slightly higher concentrations during fog episodes.

Dew occurrence and hydroxymethanesulfonate chemistry of dewwater in Yokohama, Japan

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Dewwater is an important source of water for animals and plants in arid regions though the amount of dewwater is lower compared to rainfall. On the other hand, it is also pointed out that the deposition velocity of air pollutants is increased on the surface of dew. In this study, we collected dewwater in Yokohama, Japan and analyzed for various chemical components so as to clarify the dew formation frequency and hydroxymethanesulfonate (HMSA) chemistry of dewwater in urban environments.

Dewwater was collected on the roofs of the five-story buildings on the campus of Kanagawa University in Yokohama, Japan. Dew-collector consisted of a 0.05 mm thick Teflon sheet (90 cm x 90 cm) mounted on a 10 cm thick slab of a styrofoam. The collector was set up after sunset and dewwater formed on the collector was collected with Teflon scraper in the following morning. The samples were weighted and filtrated with a 0.45 μm pore-size membrane filter. The electric conductivity, pH and ion components were measured using an electric conductivity meter, pH meter and ion chromatographs. The aldehydes in the samples were measured by means of a DNPH-HPLC method.

The average annual frequency of dew occurrence from 1997 to 2001 was about 24%, and was the highest during the winter. Although the relative humidity during the summer was the highest of all the seasons, the frequency of dew occurrence was the lowest during the summer because the summer included the rainy season. Precipitation resulting from dew was 7.7 mm/year in 1998 and corresponded to about 0.4% of annual rainfall (1901 mm in 1998). Considering both the events of dew and rain, the ground surface was wet state for approximately 60% of the night (days).

The reaction of formaldehyde (HCHO) with S(IV) forms the HMSA, which is one of the significant characteristics of dewwater. The volume-weighted mean concentrations of HCHO and HMSA from 1993 to 2001 were 109 μM and 18 μM , respectively. The formaldehyde concentration was high in summer and low in winter, whereas the HMSA concentration was high in winter, reflecting the difference in the concentration of atmospheric SO_2 , i.e. high in winter and low in summer.

Organic chemical components of fog water and aerosol particles in a subtropical forest in Taiwan

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This study was conducted at Xitou, a forest site in central Taiwan, in order to investigate the composition of organic chemical components in fog water and aerosol particles. Different types of air samplers were used, including an active fog collector, Mini-Vol-, Met One Speciation Air Sampling System SuperSASS- and ChemComb Cartridge Model 3500 -aerosol-samplers, and impingers to collect fog water and air samples within and above the canopy on different media, such as fog water, Quartz, Teflon and Nylon filters. Samples were analyzed by various techniques, such as high-performance anion exchange chromatography (HPAEC).

Particulate matter (PM) concentrations within and above the canopy were similar, while higher during day time.

Ammonium, nitrate and sulfate were the major species in samples in both, fog water and aerosol samples, derived from compounds emitted from regional agriculture, industry and traffic.

Total organic carbon (TOC) and carbonaceous species (organic and elemental carbon) were measured, showing that on average more than 80% of organic carbon in fog water was water-soluble and the concentration of organic carbon in aerosol particles was rather high. Low-molecular-weight organic acids (LMWOA), including acetic, formic and oxalic acids, gave information about the emission type, and accounted for the great majority of identified organic species. Acetate (A) to formate (F) ratios well above unity indicate the contribution of anthropogenic emissions from biomass burning and automobile exhaust at the site.

Selected carbohydrate species, including arabinol, mannitol and 2-methyl-tetrols, were quantified and used as molecular source tracers for bioaerosol (fungal spores) and secondary organic aerosols (SOA). The total amount of fungal spores was estimated by the molecular tracer method. Ambient concentrations of the fungi and SOA tracers in the subtropical forest were high, with average concentrations of $73.4 \pm 34.5 \text{ ng m}^{-3}$ (SD) for 2-methyltetrols, indicating important influence of microbial activities and secondary aerosol formation on the activity of cloud condensation nuclei (CCN) and resulting fog water chemistry. Furthermore, the biomass burning tracers levoglucosan and mannosan were detected.

As few studies have investigated the role which organic compounds play in cloud-aerosol interactions, especially in form of ambient measurements, and specifically in subtropical forests in East and Southeast Asia, the results from this study reveal new insights into the composition and sources of aerosol particles and fog/cloud water in mountain forest environments.

Fog Chemistry at the subtropical cloud forest of Xitou in Central Taiwan

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Fog water was collected at the subtropical mountain site of Xitou in the center of Taiwan. Investigations took place in different years, covering all four seasons, with the aim to identify and compare the chemical composition of fog water at the site. Fog was sampled with identical active fog collectors (modified Caltech design) using the same sampling strategies. The fog collector was triggered with a Vaisala Present Weather Detector PWD11/12 and automatically started sampling whenever the visibility was below 1000 m. Samples were removed manually as soon as there was sufficient collected fog water for chemical analysis by ion chromatography (approx. 50 ml).

In total, 237 fog samples were taken, 69 samples during autumn 2013, 106 samples during spring 2017, and 62 samples during winter 2017. While no fog water could be collected during summer, the amounts of fog water collected during spring, autumn and winter varied largely in terms of liquid water content (LWC), ion concentrations and potential sources of constituents in fog water.

The chemical composition of fog water was in all cases clearly dominated by H^+ , NH_4^+ , NO_3^- and SO_4^{2-} , making up more than 84 % of the total ion concentrations. The median pH ranged from 4.10 in autumn to 5.62 in winter, median total ion concentration (TIC) ranged from $275 \mu\text{eq L}^{-1}$ in winter to $3210 \mu\text{eq L}^{-1}$ in autumn. Ion concentrations in autumn were up to ten times higher than in winter. Different chemical composition of fog samples during the seasons were caused by the different origin of the air masses and different meteorological conditions. A relatively high median pH was caused by acid neutralization through ammonium, which originated from local NH_3 emissions from agriculture and other sources such as vehicular traffic.

Median $\text{NO}_3^-/\text{nss-SO}_4^{2-}$ ratios during all seasons were larger than unity, indicating a particularly large influence of NO_x emissions from local road traffic and nearby urbanized central-west Taiwan. Nitrogen oxides emissions as well as sulfur dioxide emissions from coal combustion in Taiwan and long range transport from mainland China were the main precursors of fog acidity.

As no fog water could be sampled during south-westerly monsoon season during summer, further research is advisable to fully cover the two main monsoon seasons and also investigate changes in LWC due to regional effects of global climate change.

Aqueous-phase reactivity of polyfunctional organic nitrates under atmospheric conditions

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Organic nitrates (RONO_2) are relevant compounds in the atmosphere as they are involved in the NO_x spread, and thus they are related to the O_3 and SOA production. For this reason, the study of the reactivity of RONO_2 has a huge importance for achieving proper atmospheric pollutants predictions. So far, the studies of these compounds have only been focused on their fates in the gas phase, however, most of the RONO_2 are highly functionalized, with a relevant presence in the condensed phases.

The present work deals with the atmospheric reactivity of several RONO_2 within the aqueous phase. We will present our methodology, including direct photolysis and OH-oxidation, validated with two commercial alkyl nitrates in the aqueous phase. A complete study has been performed by following the reaction with a wide variety of analytical techniques (LC-UV, LC-MS, GC-MS, IC, PTR-MS, NO_x and EPR) covering the evolution of the compounds and intermediate reactants in the aqueous-phase and its exchange with the gas-phase.

For OH-oxidation, we have determined precise kinetic rate constants by a new competitive kinetics method that can be used for other relevant molecules that partition between the gas and the aqueous phase. We have elucidated the mechanisms which take place in the reactions and have identified the main reaction products. The results show the extent to which the aqueous processing differs from the gas-phase reactivity. The formation of highly oxidised compounds have been found, thus implicating the connexion between SOA formation and aqueous phase reactivity. After validation, this procedure is applied to more functionalized and atmospherically relevant RONO_2 such as those derived from biogenic compounds.

The results show the relevance of multi-phase studies of polyfunctional RONO_2 in the atmosphere.

Characteristics of urban thin fog or mist in Yokohama, Japan

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Context/Purpose: Fog was formed frequently over 50 years ago, but is rarely formed recently for the warming temperature and the improving air pollution in Yokohama. Thin fog or mist, whose visibility is larger than that of fog, over 1 km but less than 10 km, occurs frequently recent years, and it is difficult to characterize urban thin fog because of its very low liquid water content. The characteristics of the droplets in urban areas, in Yokohama, are investigated, and will be reported.

Methods: The concentrations of the droplets were estimated via the determination of water-soluble components of the aerosol and the observation of the imprints of the droplets on a MgO-coated glass slide. The pH of the mist droplets, whose diameter was larger than 10 μm , was estimated from the equilibrium calculation with the data of the Gran plot of the solution of the dissolved coarse particles, the inorganic ion concentrations of aerosol larger than 10 μm , and the estimated volume of mist water.

Results: Thin fog or mist is easily formed during early morning and the diameter of most of droplets is 10 to 50 μm . When the humidity increased over 75%, the deliquescence proceeded, and the diameter of the nucleation aerosol of NaCl grows to be over 10 μm . The droplets contain highly concentrated air pollutants as about 1 eq/L total concentration for typical inorganic ions, although pH is not so low, ca. pH5, because of acid consumption materials in the droplets in Yokohama.

Interpretation: Mist events occur frequently in many urban areas. Highly contaminated mist droplets may severely affect respiratory systems, plants, and materials in urban areas because of their aqueous properties. Accurate observation of small droplets and the characteristics of acid consumption materials are the agendas for further studies.

Conclusion: Such highly concentrated droplets may have intense environmental effects.

Chemical reactions of nitrite in dew accelerated during freezing and in ice.

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Generally chemical reaction rates are suppressed at lower temperature and more inhibited in ice. However, we found that nitrite is immediately oxidized during freezing, and the reaction rate becomes much faster than that in solution under acidic condition. In dew, nitrite and ammonium ions are included at very high concentrations in Sakai, Japan. In the last meeting, we reported that ammonium nitrite is decomposed to produce nitrogen by drying due to concentration by water evaporation. Further, we evaluate the effect of drying dew on ozone concentration. The formation and disappearance of dew can depress ozone buildup. Usually evaporation of dew is observed in summer, spring, autumn and also winter in Japan. However, in winter, sometimes dew freezes or frost forms on the ground. We found that ammonium nitrite in ice is also decomposed to produce nitrogen for 24 hours under weak acidic and neutral conditions.

When ice forms from aqueous solution, solutes are rejected from ice lattice and concentrated around each ice crystals. When growing ice crystals, unfrozen solution is confined in some ice crystals, it is called “micro-pockets”. Here, solutes cannot escape from the micro-pockets, and concentrated very much, and as a result, the reaction is accelerated. In the presentation, we will explain the acceleration mechanisms of nitrite oxidation and decomposition of ammonium nitrite in detail. Also, general chemistry of freezing or in ice will be presented.

The reactions during evaporation of dew water and also freezing dew can effect on the atmospheric chemistry since nitrogen species has important role in the atmospheric chemistry.

Three decades trend of fog in Mt. Oyama, Japan

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Context/Purpose: We have observed fog characteristics and deposition of air pollutants in Mt. Oyama situated at the southwest of Tokyo for over 30 years. Such a long observation is limited in the world, and the air pollution has been improved in the duration. Three decades trend will be summarized, and the properties of the trend will be reported in this report.

Method: We have collected gas, fog, rain, throughfall, and stream water at the mountain (summit: 1252m) and analyzed them since 1988. Weather phenomena were also observed for wind direction and velocity, temperature, humidity, visibility, and rainfall intensity.

Results/Interpretation: The air pollution has been improved in Japan, and its largest effect on fog is the decreasing frequency of the severe acid fog event. The fog water pH is increasing gradually, and pH is relatively low in spring when the air mass is transported from the continent. Because of the improved air pollution in Japan, the effect of the transboundary pollution may become significant. Formation of fog is facilitated by the increasing concentration of condensation nuclei, particulate matter, which is also decreasing, but the fog frequency has been almost constant, about 30%, at the summit for recent 10 years. However, the precipitation of throughfall has been decreased gradually, although the precipitation of rain is almost constant for years. The difference of the precipitation between throughfall and rain is caused by fog deposition, and the fog sample amount collected in the passive fog collector in the mountain is also decreasing. The nitrate and sulfate concentrations are decreasing in the fog water, although sodium and chloride concentrations are constant. Therefore, the effect of air pollutants on the trees in the mountain has been decreasing, although the ozone concentration has been increasing gradually in this region.

Conclusion: Environmental effect of the acid fog has been decreasing in the mountainous site near the metropolitan city, Tokyo, because of the improving air pollution in Japan.

The acidity of clouds and fogs around the world

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The initial acidity of a fog or cloud drop is determined by the balance between inputs of acids and bases that enter the drop through particle scavenging and uptake of soluble gases, with subsequent changes from aqueous chemical reactions that release or consume H^+ ions. While inputs of sulfuric and nitric acids and ammonia are often the principal determinants of fog or cloud pH, other compounds can also be important contributors to droplet acidity or alkalinity. Among important pH-altering constituents are carbon dioxide, carboxylic and dicarboxylic acids, and soil dust. Because individual droplets in a fog or cloud form on different cloud condensation nuclei and because gas uptake efficiency can vary with drop size, one expects some degree of variability among droplet pH within a single cloud or fog.

This presentation will review measurements of cloud and fog pH over the past several decades. Observations will be included from North and South America, Europe, Asia, Africa, and Australia, as well as from maritime clouds. We will examine regional patterns in observed acidity and highlight temporal changes in fog pH driven by changing air pollution emissions over recent decades. The presentation will further review variations in pH as a function of drop size in a single cloud/fog and consider reactions, such as aqueous phase sulfuric acid production, that can strongly affect droplet pH. We will examine the importance of internal and external buffering agents, including organic acids, phenols, ammonia, and carbonates, that help limit pH changes otherwise expected as a result of strong acid addition.

Thermo-dynamical, Microphysical and Chemical, Properties of Fog in Megacity Delhi: Results from WIFEX 2015-18

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Context-By considering the national interests and key research issues it is important to consider how future research on fog modeling and forecasting will be organized so that it will most effectively address the issues that are important for public services in India. Therefore, Ministry of Earth Sciences (MoES), Government of India (GoI) has taken a multi-institutional lead in understanding broad aspects of winter-time haze and fog formation over northern regions of India, and for developing a suitable fog forecasting system that has relevance to all sectors and policy issues.

Methods-The main aim of WIFEX was to characterize the fog events occurring in Delhi and monitor simultaneously associated dynamics, thermodynamics, microphysics and chemical composition of the gases, aerosols and fog water phases to understand factors responsible for their genesis, intensity and duration.

Results-This study provides results on fog thermo dynamical, microphysical and chemical analysis. We found that the fog particles grew larger and number concentration increased uniformly with time along entire diameter ranges (not shown here) when condition changes from the non-foggy to the foggy condition. Hence it is most likely that the particles grew larger by vapor deposition/collection processes.

Interpretation- Data from the aerosol and fog water chemistry collected so far from MARGA and PM analyzer indicate a highly polluted environment in which fog developed and dominance of combustion and vehicular exhaust sources have been noted in the aerosol samples. Secondary inorganic aerosols (NH_4 , Cl, SO_4 and NO_3) were the dominant ions (60%) in the chemical constituents of the fine particles and were higher during the fog events. The chemical partitioning of fog water samples suggest that Cl (29%), NH_4^+ (28%), NO_3^- (24%) and SO_4^{2-} (17%) dominates the chemical composition. The pH of fog water indicates the alkaline (6.91).

Conclusion-These results are important for considering role of chemistry and Microphysics in Fog life cycle and very much important for forecasting purpose, to tune the model simulation schemes accordingly to get accurate forecast.

Fog and Rain Water Chemistry at Mt. Tateyama, Near the Coast of the Japan Sea in Central Japan

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To investigate the atmospheric environment at mountainous sites near the coast of the Japan Sea which is highly affected by air pollution from Asian continent, measurements of the chemical compositions of fog and rain water at Mt. Tateyama, central Japan, were performed especially during autumn. Fog water was collected using a passive string sampler and rain water was sampled by a bulk sampler at Murododaira (altitude, 2,450 m) and Midagahara (altitude, 1,930 m), on the western slope of Mt. Tateyama. The samples were usually recovered every 7-10 days. Strong acidic fogs ($\text{pH} < 4$) were frequently observed until 2010 when air masses were transported from the industrial regions in Asian continent. High concentrations of nssSO_4^{2-} were detected in the acidic fogs. The nssSO_4^{2-} concentration was usually higher than the NO_3^- concentration in the fog and rain water. Unfortunately, from 2011 to 2016, the fog water sampling was not made, and the sampling of fog water was restarted in 2017. Highly acid fogs were not detected in 2017 and 2018 and pH was relatively high ($\text{pH} > 4.5$). The concentration of nssSO_4^{2-} in fog and rain water in 2017 and 2018 was much lower than that before 2010, and the ratio of $\text{nssSO}_4^{2-}/\text{NO}_3^-$ dramatically decreased in 2017 and 2018. The H^+ and nssSO_4^{2-} deposition at Murododaira and Midagahara was also much lower in the recent two years. The SO_2 emission has been greatly reduced in China after 2010. There is a possibility that the natural environment of Mt. Tateyama at the high altitude has been improved.

Observation of Cloud Water Chemistry in the Free Troposphere and the Atmospheric Boundary Layer on Mt. Fuji (6)

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Context/Purpose: Mt. Fuji is an isolated peak and its top is located in the free troposphere, so we could observe the background concentration of various chemicals in the ambient air over Japan, background pollution due to the long-range transportation from Asian Continent, and aerosol-gas-cloud interaction. To clarify cloud water chemistry in the atmospheric boundary layer, long-term observation through the whole year has been performed at the southeastern foot of Mt. Fuji from 2006.

Method: Cloud water samples were automatically collected by an active string-type cloud water sampler (Hokuto Electronics. Co., DFC-2200) at the southeastern foot of Mt. Fuji (1284 m a.s.l.). Concentrations of major inorganic ions in cloud water were measured by ion chromatography. The pH and electric conductivity were measured after the filtration by 0.45 μm membrane filter. Major inorganic ions were measured by ion chromatography. Twelve trace metals were measured by ICP-MS, while Hg was measured by a reducing-vaporization mercury analyzer. The origin of air mass was determined by the backward trajectory.

Results/Interpretation: The annual average of LWC has been on the order of 0.10 g/m³ from 2009 to 2018, while the annual occurrence of cloud has remained below 10 % from 2009 to 2015, but it increased after 2016 and was 16 % in 2018. Volume weighted mean annual pH was less than 4.0 from 2009 to 2014, but it increased along with the decrease of nitrate/nss sulfate ratio after 2015. The total concentration of major inorganic ions has reached the highest concentration (2.7 meq/L) in 2015 during the nine years from 2009 to 2018, but it decreased to about 1.0 meq/L. Atmospheric loadings of As, Se and Cd varied similarly and reached the maximum concentration (As: 0.21 ng/m³, Se: 0.15 ng/m³, Cd: 0.05 $\mu\text{g/L}$) in 2014, but it decreased from 2015. While the atmospheric loadings of Hg did not show a clear trend because of the discharge of volcanic gaseous mercury from Mt. Fuji.

Conclusion: The decreasing trend of the atmospheric loadings of acidic substances and some harmful trace elements in cloud water at the foot of Mt. Fuji after 2015 suggested that the air quality is improving due to the reduction of both domestic emissions and transboundary pollution in recent years.

Observation of Cloud Water Chemistry in the Free Troposphere and the Atmospheric Boundary Layer on Mt. Fuji (5)

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Context/Purpose: Mt. Fuji is an isolated peak and its top is located at the free troposphere, so we could observe background concentration of various chemicals in the ambient air over Japan, background pollution due to the long-range transportation from Asian Continent to Japan, and aerosol-gas-cloud interaction. To make clear cloud water chemistry in the free troposphere, we studied acidic substances and trace metals at the top of Mt. Fuji.

Method: Observations of cloud water were conducted in July and August from 2007 to 2018 at the Mt. Fuji Research Station located at the summit (3776 m a.s.l.). Cloud water samples were manually collected by a passive string-type cloud water collector (Usui Co. Inc., FWP-500) at the top of Mt. Fuji (3776 m a.s.l.). Concentrations of major inorganic ions in cloud water were measured by ion chromatography. The pH and electric conductivity were measured after the filtration by 0.45 μm membrane filter. Major inorganic ions were measured by ion chromatography. Fifty-six trace metals were measured by ICP-MS, while Hg was measured by a reducing-vaporization mercury analyzer. The origin of air mass was determined by the backward trajectory. As rare earth metal production in China accounts for 80% of world production, they may be an indicator of the emissions from China.

Results/Interpretation: Volume weighted mean (VWM) pH of cloud water slightly increased from 3.75 in 2007 (n=1) to 4.73 in 2018 (n=27), although total major ion concentration was relatively low around 0.10 meq/L during the studied periods. The average of nitrate/nss sulfate equivalent ratio (N/S ratio) of cloud water increased from 0.67 in 2007 (n=1) to 1.14 in 2018 (n=27). The increase of pH and N/S ratio indicates that the acidification of cloud water at the top of Mt. Fuji is recovering. Backward trajectory analysis showed that cloud water at the top of Mt. Fuji was acidified with the decrease of N/S ratio, the increase of soluble As, Se, and Cd, and rare earth metals such as cerium and yttrium when air mass comes from the Continent.

Conclusion: The recovery of the acidification of cloud water collected at the top of Mt. Fuji was probably due to the reduction of transboundary air pollution from China.

Cloud Chemistry with High Temporal Resolution

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Context/Purpose. The scope of this project is to develop the understanding of the temporal dynamics of cloud chemistry in various cloud types at a subtropical mountain site. Up to now, cloud water samples were collected with an active collector and with sample integration times of 30 minutes or more. We now improved the temporal resolution of the cloud water sampling intervals by reducing the minimum required water volume and by using an autosampler. The minimum sampling period is significantly reduced, in some cases as low as 15 seconds. The central research question of this investigation is to study the variability of cloud chemistry on short time scales during the wet season. How fast are pH and electric conductivity (EC) changing? How is the temporal variability of ion concentrations and of ion loads? What are the main drivers for heterogeneity of cloud chemistry?

Method. We employed an active fog collector (modified Caltech design) at the Lulin Atmospheric Background Station (LABS, 2862 m asl) in mountainous southern-central Taiwan. The measuring period was in August and September 2018. Fog water samples were collected automatically whenever sample volumes of 10 ml were reached. EC and pH were measured immediately after the collection. Aliquots of the samples were kept deep-frozen until chemical analysis with anion and cation chromatography. A total of 623 samples was collected, of which 189 were fully analyzed for their anions' and cations' concentrations.

Results and Interpretation. The median sampling time for one sample was about 3 minutes and depended on the liquid water content. All water samples show low EC and low ion concentrations. Some events exhibit a high variability of EC and ion concentrations on a short time scale. The fog water was rather acidic (pH's as low as 3.8) for most samples, although high pH's (up to over 5.5) also occurred. Further analysis of the composition of the fog will be conducted together with an analysis of air mass back trajectories. Data analysis is underway.

Conclusion. This is one of the first applications of active fog collectors with a high temporal sample frequency. It is suggested that a perennial fog collection project should be initiated that covers all seasons and includes systematic rain collection for chemical analysis as well. The role of in-cloud turbulence as a driver for heterogeneity of chemical conditions should be studied in more detail.

Application of New Data in the Pollution Event During the Spring Festival of 2014

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This article analyzed the pollution event background during the Spring Festival of 2014 using reanalysis data of NCEP/NCAR $1^\circ \times 1^\circ$ and monitoring data obtained by environmental protection agency(EPA) in Nanjing. Meanwhile, by analyzing the sounding data, observation data, wind profile radar data and the microwave radiometer data, the mixed layer height, ventilation coefficient and inversion layer during the Spring Festival of 2014 were discussed. According to the pollution, the process could be divided into two periods: the first period was from January 30th to February 2nd and the second was from February 3rd to 6th. During the first period, Nanjing lied in uniform pressure field, and the meteorological conditions for pollutant dispersion was poor. All these lead to the formation of inversion layer and pollutant accumulation, the pollution was serious. On the contrary, during the second period, the movement of atmospheric turbulence was more active, the thickness of mixing layer and ventilation coefficient were great risen, then the inversion layer was destroyed. Air quality improved significantly. In the first period. The results showed that, the lower mixing layer height, less ventilation coefficient, thicker and stronger inversion layer, then the pollution would be more serious. According to different pollution levels, the quantitative indexes for the four elements was established. When the mixed layer height less than 1 km, ventilation coefficient less than 2500 m²/s-1, inversion layer thickness greater than 500 m and inversion intensity more than $2[U+2103]/100\text{m}$, it is prone to moderate pollution. Accordingly, pollution weather will difficult to appear when mixing layer height higher than 2 km, ventilation coefficient greater than 7000 m²/s-1, inversion layer thickness less than 200 m and inversion intensity less than $0.5[U+2103]/100\text{m}$. The findings could provide the references for the future forecast.

Effect of endogenous microbiota on the molecular composition of cloud water: a study by Fourier-transform ion cyclotron resonance mass spectrometry (FT-ICR MS)

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Cloud droplets contain dynamic and complex pools of highly heterogeneous organic matter, resulting from the dissolution of both water soluble organic carbon in atmospheric aerosol particles and gas-phase soluble species, and are constantly impacted by chemical, photochemical and biological transformations. Recently, the presence of microorganisms, as bacteria, fungi and yeasts, was highlighted in clouds: they are alive and metabolically active [1]. In this work, we report the results of molecular characterisation of a cloud water sample collected at the puy de Dôme observatory, incubated with endogenous microbiota at two different temperatures (5 and 15°C). Microbial metabolism is able to transform the dissolved organic matter and it changes the molecular composition of cloud water, as evidenced by Fourier-transform ion cyclotron resonance mass spectrometry (FT-ICR MS). Microorganisms were metabolically active and strongly modified the dissolved organic matter since they were able to form and consume many compounds. At 15°C, microorganisms were able to consume 58% of the compounds initially present and produce 266 new compounds. For this cloud sample, the impact of dark chemistry was negligible. Decreasing the temperature to 5°C led to the more efficient degradation of organic compounds (1716 compounds vs 1094 at 15°C) but with the less important production of new ones (173). The influence of endogenous microbiota was evaluated on oxygen to carbon and hydrogen to carbon ratios and other parameters. Using Venn diagrams, four fractions of compounds were identified: (1) compounds consumed by microbial activity; (2) compounds not transformed during incubation; (3) compounds resulting from dark chemistry (i.e. hydrolysis and Fenton reactions) and, finally, (4) compounds resulting from microbial metabolic activity. These transformations were analysed using a division into classes based on the O/C and H/C ratios: lipid-like compounds, aliphatic/peptide-like compounds, carboxylic-rich alicyclic molecule (CRAM)-like structures, carbohydrate-like compounds, unsaturated hydrocarbons, aromatic structures and highly oxygenated compounds (HOCs) [2]. Lipid-like and aliphatic/peptide-like compounds were the most impacted since they were consumed to maintain the microbial metabolism. On the contrary, the relative percentages of CRAMs and carbohydrates increased after incubation.

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Comparative study on chemistry of dew water collected from New Delhi and adjoining townships in north India

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In north India, dew formation is a frequent phenomenon during intense winters and has implications on crop productivity. Dew water is used to understand the pollution sources, and multi phase chemical reactions. Dew water samples were collected during winter of 2015-16 and 2016-17 over New Delhi and Sonipat and Rohtak in the National Capital Region of New Delhi after the Sun set and before the Sun rise. All samples were alkaline in nature (average pH= 6.7) as opposed to the natural rain water pH of 5.6. There has been increase in the ionic equivalents of all ions with few exceptions of Ca^{2+} and SO_4^{2-} in successive years from 2014 to 2016 indicating the rise in level of anthropogenic pollutant sources such as vehicular emission, biomass burning, industrial activities. Higher values of $\text{SO}_4^{2-} / \text{NO}_3^-$ ratio in dew water suggested that stationary sources of SO_4^{2-} dominates over NO_3^- and the role of SO_4^{2-} in determining the acidity of the dew water samples was more compared to nitrate ions. Acidity was neutralized by the cations in the order of $\text{NH}_4^+ > \text{Ca}^{2+}$ and Mg^{2+} except that the order for New Delhi samples was $\text{Ca}^{2+} > \text{NH}_4^+$ and Mg^{2+} in 2015-16 due to increased construction activities and re-suspension of crustal mass. All studied ions except Cl^- and Mg^{2+} have non marine origin. Cl^- has very outsized sea salt fraction at both the NCR sites but it partly showed anthropogenic influence over New Delhi. The less than one ratio of formate and acetate were indicative of anthropogenic activity like fossil fuel and biomass burning around the sampling sites. Biomass burning, vehicular emissions and plant emissions as well as oxidation pathways of volatile organic compounds in ambient atmosphere are possible sources of organic acids. Total Carbon in dew water composed of 57 % organic carbon (OC) and 43% Inorganic Carbon (IC). Average TOC (8.15 ppm) was found to be higher than the average carbon equivalents of organic acids (2.75 ppm). This could be due to unaccounted organic compounds present which were not analysed in this study. Zinc, lead and iron concentrations in dew water samples of New Delhi showed increasing trend in the year 2016-17 compared to previous year but Cu and V showed lower concentrations. In general, the metal concentrations in all samples were higher compared to similar previous studies. Higher amounts of soluble metals in dew water could harm the soil and water quality and corrode the surfaces. All sampling sites had similar meteorological conditions but different levels of pollution resulted in variable chemical nature of dew water. Dew water could be used as potable water at Sonipat but at other place would require treatment before being used for drinking and other domestic purposes.

Ionic characteristics and buffering capacity of Fog water collected over New Delhi and adjoining satellite township in North India

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North India encounters frequent foggy events during winter season which lead to significant economic losses through disruption of rail, road and air traffic. In this study, fog samples were collected from New Delhi and adjoining township of Sonipat in north India during the year 2015-16 and 2016-17. Fog water pH was found to be close to natural rainwater of 5.6 due to limited contribution of Ca^{2+} , Mg^{2+} ions by virtue of low wind speed during winters, not sufficient enough to re-suspend surface dust. Despite the sources of ammonia such as livestock and agricultural emissions, NH_4^+ could not completely neutralize the acidity caused by sulfates and nitrates. NH_4^+ and Ca^{2+} were dominant cations present in fog samples at both sites during both sampling years. NH_4^+ and Ca^{2+} contribution were similar at New Delhi during 2015-16 but calcium on account of construction activities increased during 2016-17. NH_4^+ was significantly higher in comparison to calcium at Sonipat for both years. Wheat fields around Sonipat could have contributed high NH_3 through fertilizer applications and animal breeding and excretion. Sulfate concentrations were amount equals to that of chlorine followed by nitrate ions. High chlorine in fog water is probably due to plastic burning in this region. The strength of neutralization decreases in the order $\text{NH}_4^+ > \text{Ca}^{2+}$ and Mg^{2+} for all studied fog samples at Sonipat while the trend for New Delhi samples was $\text{Ca}^{2+} > \text{NH}_4^+$ and Mg^{2+} due to more contributions of calcium carbonates on account of ongoing construction activities and limited sources of ammonia in and around the sampling site at New Delhi. Higher nitrate at New Delhi indicates high anthropogenic emissions of NO_x which eventually formed nitrate. Vehicular emission at New Delhi and agriculture fields and plants at Sonipat appeared to be dominant sources of organic acids. The difference between the observed and theoretical acid buffering capacities was large and occurred over a broad pH range from 4 to 7 at New Delhi whereas the theoretical and measured buffering capacities were close to each other in Sonipat samples. Additional species such as organic species such as acetate, formate and formaldehyde and humic material and dicarboxylic acids (not identified here) could contributed to the unexplained buffering in urban fog at New Delhi. Fog water at both sites had higher level of lead than prescribed safe limits for drinking water and therefore, cannot be used for drinking purposes. Zinc was dominant metal present in fog water. Higher concentrations of metals, organic acids and soluble inorganic ions at New Delhi in comparison to Sonipat were indicators of worse state of air pollution.

A study on chemistry of fog water over Indo-Gangetic basin

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Air pollutants get released in the atmosphere from the different sources and reaches to earth system via: dry, wet and occult deposition. Fog is an important mechanism of removal of pollutants from the atmosphere to earth surface as it scavenge the pollutants and transfer many chemical components and affects underlying surfaces like vegetation, buildings and other underlying surfaces. Indo-Gangetic basin is known for high pollution load and occurrence of fog particularly in winter seasons but less attention has been paid on chemistry of fog over this region. In this investigation measurements of chemical constituents of fog water at Agra over Indo-Gangetic basin was carried out from 2016-2018. Fog water was sampled using indigenous fog sampler. pH, electrical conductivity, Na⁺, K⁺, Ca²⁺, Mg²⁺, NH₄⁺, F⁻, Cl⁻, NO₃⁻, SO₄²⁻, water soluble organic carbon, and water soluble total nitrogen have been determined. The pH of fog water was in alkaline range. The basic fog may be due to contribution of local soil which constitutes mainly alkaline components. The concentration of NH₄⁺ was highest followed by NO₃⁻, Cl⁻, Ca²⁺, Mg²⁺, K⁺, Na⁺, F⁻. The high concentration of ammonium may be due to high concentration in soil and nearby dairy. The other dominant sources of pollutants were cow dung cake burning, increase in combustion of coal for cooking and heating purposes over this region. Ammonium was found to be major neutralizing agents, The air mass trajectory study reveals the role of long range transport to fog water. The annual input of sulphur and nitrogen components by fog water have been determined and found to be relatively higher than rainwater over this region.

Fog water chemical composition in Namibia during the AEROCLO-SA 2017 campaign

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Namibia is an arid country where many rural and urban centers depend on ephemeral rivers for their water supply. These water sources are, however, limited and display seasonal salinisation. Fog occurs along the coast and extends for up to 100 km inland, and has been considered for a long time as a source of drinking water. Fog is also a vital source of moisture for the endemic flora and fauna of the Namib Desert. However, due to the current change in climate and air quality, fog occurrence and composition, of crucial importance for the local ecosystems and populations, may be impacted. In the frame of the campaign of the AEROCLO-SA (AErosol, RadiatiOn and CLOUDs in southern Africa) project, fog collection experiments were performed at Henties Bay, along the Namibian coast, and at the desert site of the Gobabeb Research and Training Centre, in August and September 2017. Fog collection experiments were done using two pre-cleaned Caltech Active Strand Cloud Water Collectors (CASCC), run in parallel. A stainless steel CASCC was deployed and samples were analyzed for organics (TOC, DOC, organic acids, and specific organic markers), while a plastic collector was used for sampling and further analysis of pH, inorganic ions, metals and water isotopes. Complementary measurements were performed on some of these samples, such as UV-visible and 3D-fluorimetric analysis, and nebulization into an AMS-c-ToF. In addition to chemical analysis, we monitored the droplet and the aerosol size distributions.

During the field campaign, we observed several fog events (mostly at Henties Bay and two at the Gobabeb Research Station), including major occurrences of a reduction of visibility to less than 1 km for several hours. The chemical composition of fog water on the coast (at Henties Bay) revealed a high marine influence, and also some influence of crustal sources, but no impact of biomass burning. The organic content was high compared to sea water, and compared to other coastal fogs, suggesting a probable influence of marine microorganisms. These results will be presented and discussed relative to the local aerosol composition, and they will also be contrasted with observations from two fog events at the inland desert site. Overall, the results indicate that the Namibian fogs are unique in terms of both microphysics and chemical content, and further studies are needed to deepen our knowledge of these clouds, and their inter-relations to air quality and climate change.

Characterization of cloud water impacted by wildfire emissions in the western United States

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Clouds play an important role in processing trace gases and atmospheric aerosols by providing an abundant water medium for atmospheric aqueous-phase chemical reactions and through the potential to incorporate and deposit scavenged material directly or via precipitation. Relevant reactions include oxidation of volatile organic compounds to lower volatility products, thus contributing to secondary organic aerosol (SOA) formation and changing properties of aerosol released by evaporating clouds. One important source of gas and particulate emissions to the atmosphere is wildfires; however, direct sampling and measurements of the chemical composition of fog and cloud water impacted by wildfire plumes has been scarce. In order to improve understanding of the interaction between biomass burning smoke and clouds, cloud water was collected aboard the NSF/NCAR C-130 research aircraft during the WE-CAN (Western wildfire Experiment for Cloud chemistry, Aerosol absorption and Nitrogen) study in July and August 2018. 5 cloud water samples were collected from 4 research flights using the CSU/NCAR airborne cloud water collector and analyzed for major inorganic ions, total organic carbon (TOC), carboxylic and dicarboxylic acids, levoglucosan and other anhydrosugars, S(IV), formaldehyde and hydrogen peroxide.

The average pH value of collected cloud water was 3.85. The aqueous-phase concentrations of S(IV) and HCHO were higher than predicted from equilibrium partitioning of observed gas phase concentrations using Henry's Law. Due to abundant H₂O₂ (average concentration of 167.8 μ M) and moderate pH, H₂O₂ was the dominant S(IV) oxidant in sampled clouds. Cloud composition was dominated by organic matter (OM) (TOC range = 15.9 – 131.7 mg C L⁻¹), contributing approximately 85% of the measured solute load, inorganic species contribute the remaining 15%. The most abundant individual organic compounds measured were maleate, acetate, methylsulfonate, oxalate and formate. Measured organic acids and anhydrosugars contributed only 2-4% and <0.01-1%, respectively, of cloud water TOC. The composition of inorganic ions in collected cloud water varied considerably, with major species including ammonium, nitrate, sodium and chloride.

Molecular Insights on the Aqueous Phase Processing of Ambient Biomass Burning Emissions Influenced Fog and Aerosol using Ultrahigh Resolution Orbitrap Elite Mass Spectrometry

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Ambient samples of fog water and PM₁ aerosol were collected in the Italian Po Valley over 5 consecutive days in the winter of 2015. The Po Valley has an established history of regional biomass burning emissions influence and aqueous aging processes resulting in significant concentrations of brown carbon. Five samples of fog water and ten samples of extracted PM₁ aerosol filters (day and night samples) were analyzed by ultrahigh resolution Orbitrap mass spectrometry using both electrospray ionization and atmospheric pressure photoionization methods. The water-soluble organic matter of the samples was fractionated prior to analysis using a 2-step solid phase extraction procedure for HULIS. This fractionation method facilitated the observation of additional less easily ionized condensed aromatic species. Thousands of distinct molecular formulas were assigned to the monoisotopic masses of each sample and were categorized into elemental groups and sub-classes based on the observed number of oxygen, nitrogen and/or sulfur atoms in the formulas. An atypically large frequency of molecular formulas containing nitrogen and sulfur were observed. Many of which could be attributed to multifunctional organonitrates and organosulfates, however a wide array of aromatic species with lower numbers of oxygen observed using atmospheric pressure photoionization were not. In general, higher numbers of CHNO species were observed in aerosol samples and higher numbers of CHOS species were found in fog water. The observed molecular trends were related to the atmospheric conditions to determine their likely origins. The overlapping collection time periods between the two sample types, and the progressive chronological sampling allowed for a unique perspective on chemical transformations within this humid atmosphere.

Air pollution and its impact of tropical heavy rainwater and dew water chemistry in Siem Reap-Angkor region of Cambodia

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Context/Purpose: Angkor monument is a common property of mankind, so restoration and conservation activities are carried out. In recent years, the impact of air pollution is of great concern, but the situation of air pollution in the Angkor region is unknown. In Cambodia, tropical heavy rainfall frequently occurs during the rainy season, while dew is formed early in the morning during the dry season. During the rainy season, air pollutants are scavenged by heavy rainfall, while dry deposition velocities of air pollutants could be accelerated by the presence of dew during the dry seasons. As a result, degradation of Angkor monument may be promoted. This study aims to clarify the actual state of air pollution in Siem Reap-Angkor region of Cambodia and to clarify the impact of air pollutants on heavy rainwater chemistry in the rainy season and dew water chemistry in the dry season.

Methods: Observations of gases (NO_x , O_3 , acidic gases, ammonia, gaseous elemental mercury (GEM) and VOCs) and particulate matters ($\text{PM}_{2.5}$, black carbon (BC), water-soluble components, and trace metal elements) were conducted along with collection of tropical heavy rainwater in the rainy season and dew in the dry season.

Results/Interpretation: Preliminary observation of $\text{PM}_{2.5}$ by AM 520 (TSI) was performed in the dry season from February 27 to March 3, 2018. We observed $\text{PM}_{2.5}$ more than $200 \mu\text{g}/\text{m}^3$ in Siem Reap. We conducted a comprehensive sampling campaign on air pollution during the rainy season from 3 to 8 September 2018. The average concentration of $\text{PM}_{2.5}$ and BC were $10 \mu\text{g}/\text{m}^3$ and $1.34 \mu\text{g}/\text{m}^3$, respectively, and there was no correlation between them. The average concentration of acidic gases such as HNO_3 , HCl, and SO_2 , in the ambient air in Siem Reap were 1.93 ppbv, 1.43 ppbv, and 0.80 ppbv, respectively, while the average NH_3 concentration was 86.2 ppbv during the studied period. In the rainy season, air pollution by $\text{PM}_{2.5}$ and BC was not severe, but the aerosol particles were not neutralized despite the high concentration of NH_3 . There is a possibility that SOA oxidized from VOCs in the daytime could interfere with the neutralization of sulfuric acid aerosols because of the lower concentration of VOCs in the daytime than in the nighttime. Total VOCs concentrations including BVOCs were 3.12 ppbv on average in the daytime and 6.55 ppbv on average in the nighttime.

Conclusion: High acidity of the particulate matters could cause acidification of tropical heavy rainwater in the rainy season and dew water in the dry season. We will discuss the controlling factors of tropical heavy rainwater and dew water chemistry in the presentation.

Long-term cloud water chemistry observed at Mt. Bamboo, West Pacific Ocean during northeast monsoon seasons in 1996-2016

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This study investigates the long-term chemistry of cloud water at Mt. Bamboo (25.18°N, 121.53°E; 1,100 m MSL) in northern Taiwan under the primary influence of Asian continental outflows during the northeast monsoon seasons in 1996-2016. Cloud water was collected on an hourly basis and measured for pH and inorganic soluble ions. In total, around 180 cloud events were observed and 6433 samples were collected. HYSPLIT backward trajectory analysis was conducted, illustrating the majority of air masses originated from northern and eastern China. To our knowledge, this is the first study in the region that verified the long-term relationship between Asian continental outflow and cloud water in the West Pacific Ocean. The long-term volumetric weighted mean (VWM) pH was 3.97 for cloud samples and 4.21 for mixed samples (cloud and rain together), respectively. Major contributors in cloud water were sea-salt components (Na^+ , Cl^-) and nss (non sea-salt)- SO_4^{2-} which might be associated with Asian continental outflow. During the whole sampling period, the nss- SO_4^{2-} ion concentrations VWM was $131.0 \mu\text{eq l}^{-1}$ (cloud type) and $75.4 \mu\text{eq l}^{-1}$ (mixed type), while for NO_3^- was $63.4 \mu\text{eq l}^{-1}$ (cloud type), and $27.3 \mu\text{eq l}^{-1}$ (mixed type). Average cloud loading during the entire sampling period (averaging cloud and mixed type samples) of nss- SO_4^{2-} was $1.95 \mu\text{g m}^{-3}$ and that of NO_3^- was $1.02 \mu\text{g m}^{-3}$. Mann-Kendall test and Sen's slope were applied to statistically assess the temporal trends of the measured variables. The nss- SO_4^{2-} cloud loading showed a significant decreasing trend over time, which can likely be attributed to SO_2 emission reduction in China, while pH, NO_3^- and NH_4^+ revealed no significant temporal trends. A source (Asian continental outflow) and receptor (West Pacific Ocean cloud water) relationship was verified by using the nss- $\text{SO}_4^{2-}/\text{NO}_3^-$ cloud loading ratios and China annual emission SO_2/NO_x (CNBS data) ratios from 1996-2014. A significant correlation coefficient was established ($R=0.66$, $p<0.05$), confirming the strong relationship over a long-term period.

Fog Chemistry and Sources at an Urban and a Rural Sites in Indo-Gangetic Plains

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Indo-Gangetic Plain (IGP) is among the most densely populated regions of the world, where 70% of the population still reside in the villages. Growing energy demands of such a large population have led to the increased emission of pollutants from residential, industrial and transport sectors. Due to higher biomass burning incidents, lower mixing height, temperature inversion and calm winds during winters the IGP experience severe problems associated with fog such as poor air quality, respiratory problems, visibility reduction, haze, etc. The present study aimed to quantify the bulk chemical composition of ambient air during fog forming hours through dissolution method using the re-fluxing mist chamber over the Prayag region of IGP. A total of 41 and 23 samples were collected at an urban and a rural sites, respectively from November 2016 to February 2017. Chemical composition of ambient air samples was characterized with respect to the major water soluble Inorganic ions (Na^+ , NH_4^+ , K^+ , Ca^{2+} , Mg^{2+} , Cl^- , NO_2^- , NO_3^- and SO_4^{2-}). Significant variation of inorganic ions was observed between urban and rural sites with NH_4^+ and Ca^{2+} as major cations and SO_4^{2-} and NO_3^- as major anions at both the sites. Monthly variation of the ions has shown high concentrations in November as compared to other months due to the added emissions from crop residue burning and festival pollution. Further, the relationship of cations with anions and their aqueous chemistry is also studied to analyze the major chemical interactions and scavenging patterns in winters. Neutralization of fog acidity ($\text{NO}_3^- + \text{NO}_2^- + \text{SO}_4^{2-}$) by cations occurs in the order of $\text{NH}_4^+ > \text{Ca}^{2+} > \text{K}^+ > \text{Mg}^{2+}$. Subsequently, Principle Component Analysis (PCA) was used to investigate the site specific dominating sources. Apart from natural sources like soil dust, sea salts and biogenic emissions, local anthropogenic sources and meteorological conditions play an important role in the fog formation in winters. While fossil fuel, solid waste and biofuel burning were the major contributor at the urban site, biomass burning and agricultural activities were predominant sources at the rural site.

The relationships between human visual range, PM_{2.5} and meteorological factors in urban Taichung from 2013-2017

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Visibility has attracted significant attention in central and southern Taiwan, where the public perceive that the visibility has been declining over recent years. Human visual range (HVR) is determined by human eye observations and thus known to be more related to human's perception, unlike meteorological optical range (MOR) which is determined by optical-based instrument. Daily-average HVR, air pollutants and meteorological parameters in urban Taichung were acquired from the Taiwan Central Weather Bureau and Environmental Protection Administration, respectively, from 2013-2017. Descriptive statistics and regression analysis were carried out on the data to explore their relationships. The results show that both the HVR and PM_{2.5} have been improving over the study period, from 10 km to 12 km and from 30.2 $\mu\text{g m}^{-3}$ to 21.9 $\mu\text{g m}^{-3}$, respectively. The relative humidity (RH) has increased from 70% to 75%, whereas the wind speed (WS) has maintained relatively stable at an average of 1.4 m s⁻¹. Using 10 km and 35 $\mu\text{g m}^{-3}$ as cutoffs for high/low visibility (HV/LV) and high/low PM (HPM/LPM), the percentages of LV days have decreased substantially from 36% to 14%, and that they are more prominent during spring and winter. It is noteworthy that LV days are near-equally associated with LPM and HPM. Given that there is a moderate negative relationship between HVR and PM_{2.5}, this highlights that LV does not necessarily indicate high PM_{2.5} pollution, and other factors come into play as well. In particular, RH is a strong modifier of the HVR and PM_{2.5} relationship; poor visibility could occur under LPM but high RH, whereas good visibility could occur under HPM but low RH. The roles of WS and wind direction are less obvious, though stagnant condition ($< 1 \text{ m s}^{-1}$) and northwesterly winds are conducive to poor visibility in urban Taichung. In conclusion, we find that HVR and PM_{2.5} have concurrently improved over recent years, contrary to public perception. In addition, there is a negative correlation between HVR and PM_{2.5}; however, PM_{2.5} alone cannot explain the variability of HVR and, in particular, the RH is an important modifying factor.

Chemistry of fine particulates during winter fog of 2017-18 at IGIA, Delhi

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PURPOSE:

Delhi region frequently receives fog of different intensity during winter (Dec-Feb) season. The peak months of dense and persistent fog occurrence over the Delhi region are December and January when temperature reaches to very low level and the frequency of Western Disturbance (WD), the only weather phenomenon causing rainfall over that region during the colder months, is increased. A polluted atmosphere with high aerosol concentration may be linked to the formation of fog in urban areas like Delhi.

METHODS:

Concentration of trace gases (NH_3 , HNO_3 , HNO_2 , HCl and SO_2) and inorganic chemical constituents (NO_3^- , Cl^- , SO_4^{2-} , Na^+ , NH_4^+ , K^+ , Mg^{2+} and Ca^{2+}) of fine particulates (PM_{10} and $\text{PM}_{2.5}$) was monitored simultaneously on hourly resolution using Monitor for Aerosols and Gases in ambient Air (MARGA) at Indira Gandhi International Airport (IGIA) Delhi, during a period from 01 December 2017 to 10 February 2018. The present work aims at investigating chemical composition of fine particles and their variability on different time scales during fog and non-fog episodes.

RESULTS:

Major ions constituting PM_{10} mass were chloride, nitrate, sulfate and ammonium. Their concentration during clear sky condition was 17.30 ± 16.84 , 16.39 ± 8.04 , 9.61 ± 5.24 and $17.03 \pm 8.77 \mu\text{g m}^{-3}$ respectively which constituted 26.25%, 26.73%, 16.17% and 27.34% of the total PM_{10} mass concentrations respectively. It was 25.81 ± 23.36 , 18.88 ± 9.48 , 12.58 ± 6.43 and $22.89 \pm 11.99 \mu\text{g m}^{-3}$ respectively during moderate fog condition. During dense fog condition, concentration of all the above chemical species drastically decreased.

Chloride, nitrate, sulfate and ammonium dominated in $\text{PM}_{2.5}$ mass also. Their mass concentration during clear sky condition was 29.81 ± 28.96 , 25.57 ± 12.66 , 15.48 ± 9.97 and $27.42 \pm 14.54 \mu\text{g m}^{-3}$ respectively. It increased to 50.20 ± 38.84 , 34.66 ± 12.91 , 27.72 ± 15.66 and $43.84 \pm 16.15 \mu\text{g m}^{-3}$ respectively during moderate fog episodes due to secondary aerosol formation.

On average, Sulphur Oxidation Ratio (SOR) during clear, moderate fog and dense fog days were 0.30 ± 0.20 , 0.41 ± 0.24 , 0.45 ± 0.26 respectively in case of PM_{10} and 0.35 ± 0.22 , 0.54 ± 0.29 , 0.67 ± 0.31 respectively in case of $\text{PM}_{2.5}$. The increase in SOR values during fog episodes suggests higher oxidation of SO_2 during fog events.

NH_4^+ appeared to be the main neutralizer during the whole observational period and mostly occurred as NH_4Cl and NH_4NO_3 and poorly as $(\text{NH}_4)_2\text{SO}_4$ or NH_4HSO_4 .

CONCLUSIONS:

The chemical composition of fine particulates during fog was dominated by nitrogen species (ammonium and nitrate), with important contributions from chloride and sulfate. This study shows how fog drastically modifies the atmospheric chemical properties of the polluted urban aerosol. It appears that secondary fine mode inorganic aerosol formation can occur rather rapidly under such conditions.

Modeling the non-ideal chemical processing in aqueous aerosol particles with SPACCIM-SpactMod

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Highly-polluted urban regions are often characterized by high aerosol particle loadings impacting atmospheric chemistry and, hence, air quality. Tropospheric deliquesced particles including haze particles are a complex multiphase and multi-component environment with simultaneously occurring multiphase chemical transformations. Such chemical processes are able to alter the chemical composition and the deduced physical aerosol properties. Deliquesced particles are characterized by concentrated non-ideal solutions that can affect the occurring multiphase chemical processing. The effects of such non-ideal solutions have generally not been adequately investigated by present complex multiphase chemistry models. Thus, the present study is aimed at accessing the impact of non-ideality on multiphase chemical processing. Therefore, simulations with a multiphase chemistry model (SPACCIM-SpactMod) including the CAPRAM chemical mechanism are performed for polluted and less polluted environmental conditions. The present study shows that activity coefficients of inorganic ions are often below unity under deliquesced aerosol conditions, and that most uncharged organic compounds exhibit activity coefficient values around or even above unity. The model studies demonstrated that the inclusion of non-ideality considerably affects the multiphase chemical processing of transition metal ions (TMIs), key oxidants, and related chemical subsystems, e.g. organic chemistry.

In detail, both the chemical formation and oxidation fluxes of Fe(II) are substantially lowered by a factor of 2.8 under polluted haze conditions compared to a case study without non-ideality treatment. The reduced Fe(II) processing in the polluted base case, including lowered chemical fluxes of the Fenton reaction (-70 %), results in a reduced processing of HO_x/HO_y under deliquesced aerosol conditions. Therefore, higher multiphase H_2O_2 concentrations (by a factor of 3.1 larger) and lower aqueous-phase OH concentrations (by a factor of ≈ 4 lower) were modeled during aerosol conditions. For H_2O_2 , the consideration of non-ideality increases S(VI) oxidation fluxes under aqueous aerosol conditions by 40 %. Moreover, the chemical fluxes of the OH radical are about 50 % lower in the non-ideal haze case. Accordingly, the consideration of non-ideality affects the chemical processing and the concentrations of organic compounds under deliquesced particle conditions in a compound-specific manner. For important organic carboxylic acids, e.g. glyoxylic acid and oxalic acid, the reduced radical oxidation budget under aqueous particle conditions leads to increased concentration levels. For oxalic acid, the present study demonstrates that the non-ideality treatment enables more realistic predictions of high oxalate concentrations observed under ambient highly polluted conditions. Furthermore, the simulations show that lower humidity conditions, i.e. more concentrated solutions, might promote higher oxalic acid concentration levels in aqueous aerosols due to differently affected formation and degradation processes. Overall, the performed studies demonstrate the important role of a detailed non-ideality treatment in multiphase models dealing with aqueous aerosol chemistry and the needs to further improve current model implementations.

Modelling the multiphase formation of high H_2O_2 concentrations observed during winter haze periods in the NCP

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During winter, the North China Plain (NCP) is frequently characterized by severe haze conditions connected with extremely high $\text{PM}_{2.5}$ and NO_x concentrations, i.e. strong air pollution. The NCP is one of the most populated regions worldwide where haze periods have direct health effects. Tropospheric haze particles are a complex multiphase and multi-component environment, in which multiphase chemical processes are able to alter the chemical aerosol composition and deduced physical aerosol properties and can strongly contribute to air pollution. Despite many past investigations, the chemical haze processing is still uncertain and represents a challenge to atmospheric chemistry research. Recent NCP studies during autumn/winter 2017 haze periods have revealed unexpected high H_2O_2 concentrations of about 1 ppb suggesting H_2O_2 as a potential contributor to secondary $\text{PM}_{2.5}$ mass, e.g., due to sulfur(IV) oxidation in haze particles. However, the multiphase H_2O_2 formation under such NO_x concentrations is still unclear. Therefore, the present study aimed at the examination of potential multiphase H_2O_2 formation pathways, and the feedback on sulfur(IV) oxidation.

Multiphase chemistry simulations of a NCP measurement campaign are performed with the box model framework SPACCIM. The multiphase chemistry model within SPACCIM contains the gas-phase mechanism MCMv3.2 and the aqueous-phase mechanism CAPRAM4.0 together with both its aromatics module CAPRAM-AM1.0 and its halogen module CAPRAM-HM2.1. Furthermore, based on available literature data, the multiphase chemistry mechanism is extended considering further multiphase formation pathways of HONO and an advanced HO_x mechanism scheme enabling higher in-situ H_2O_2 formations in haze particles. The simulations have been performed for three periods characterized by high H_2O_2 concentrations, high RH and $\text{PM}_{2.5}$ conditions and high measurement data availability. Several sensitivity runs have been performed examining the impact of the soluble transition metal ion (TMI) content on the predicted H_2O_2 formation.

Simulations with the improved multiphase chemistry mechanism shows a good agreement of the modelled H_2O_2 concentrations with field data. The modelled H_2O_2 concentration shows a substantial dependency on the soluble TMI content. Higher soluble TMI contents result in higher H_2O_2 concentrations demonstrating the strong influence of TMI chemistry in haze particles on H_2O_2 formation. The analysis of the chemical production and sink fluxes reveals that a huge fraction of the multiphase HO_2 radicals and nearly all of the subsequently formed reaction product H_2O_2 is produced in-situ within the haze particles and does not origin from the gas phase. Further chemical analyses show that, during the morning hours, the aqueous-phase reaction of H_2O_2 with S(IV) contributes considerably to S(VI) formation beside the HONO related formation of sulfuric acid by OH in the gas-phase. Therewith, the simulations demonstrate that an improved knowledge of chemical haze interactions is crucial to interpret the chemical gas and aqueous composition observed during highly polluted haze conditions.

Characterizing the variability of cloud water acidity at Mt. Bamboo in the West Pacific Ocean across two decades of northeast monsoon seasons

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This study builds on the work of Thu et al., (IFDA2019-161), which analyzes the influence of Asian continental outflows on cloud water chemistry observed at Mt. Bamboo in northern Taiwan, and specifically focuses on the variability of the cloud water acidity. In addition to fog reducing visibility and impacting climate variability, acidic fog at mountain sites has a unique relationship with ecosystem health, contributing both nutrients and harmful inputs, and at this location may influence the air quality of a large metropolitan area downwind. In this work, the measured cloud water values of pH, LWC and the inorganic ion concentrations are used and several metrics of acid/base relationships, including the pAi, fractional acidity (FA), and neutralization factors (NF) are derived to characterize the cloud water acidity and assess the overall variability at the site. Results from this study reveal that although the long-term trend of pH at the mountain site has not significantly changed over two decades, there is significant variability year-to-year and is driven by the acidifying and neutralizing potentials of the cloud water. In addition, our analysis suggests a complex and changing relationship between pH and FA over the two decades of data and is likely connected to changing source patterns, many of which are borne from Asian continental outflows and are highlighted by correlation analyses in this work. The variability analysis in this study provides important details to more comprehensively characterize the northeast monsoon season contributions to cloud water acidity, and indicates possible routes for further study moving forward.

Chemical composition of fogwater collected in three contrasted sites in northeastern France between 2015 and 2018

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The Alsace region of France experiences autumnal radiation fog that can play an important role in local atmospheric chemistry. For this purpose, radiation fogs were collected using stainless steel Caltech Active Strand Cloud Collectors (CASCC2) between 2015 and 2018 in three contrasted areas; one in rural (Erstein), one in peri-urban (Geispolsheim) and one in urban (Strasbourg) dealing to a total of 11, 25 and 16 samples respectively.

Fogwater samplers were operated manually during the totality of the fog event. Each samples were filtered through glass fiber filters and pH, conductivity, ionic composition (F^- , Cl^- , Br^- , NO_2^- , NO_3^- , PO_4^{3-} , SO_4^{2-} , Li^+ , Na^+ , K^+ , NH_4^+ , Mg^{2+} and Ca^{2+}) DOC and organic molecular speciation (pesticides, phenols, PAHs, organic acids,...) were done on the filtrate. Organic composition was done by SPME-GC/MSMS and LC/MSMS depending of the compound under study. Filters were analysed for their organic molecular composition.

pH varied between 5.6 and 6.7 and their whatever the considered site. PH value are higher than those previously measured in Strasbourg between 1991 and 1993 where pH values were strongly acidic (between 2.0 and 4.0). This observation can be explained by the strong decrease of acidic species in fogwater samples.

The ionic composition presents in general the same tendency with ammonium and nitrates as the predominant cations and anions. Ammonia and nitrates remains in the same order of magnitude between the three sites (rural, peri-urban and rural).

DOC varied between 0.68 and 37.68 ppm and were generally more concentrated in the peri-urban areas than in the urban.

Chemical organic speciation presents also some variabilities depending on the site and on the period of sampling of the fog event.

All data obtained will be discussed and presented in details during the conference.

Photochemical transformations of fatty acids in atmospheric waters

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Secondary organic aerosols (SOA), which account for a substantial and often a dominant fraction of total OA mass, are formed by photooxidation of various precursors emitted from anthropogenic and biogenic sources in the atmosphere. They have serious impacts on the Earth's climate system by absorbing solar radiation and acting as cloud condensation nuclei and adverse effects on human health. In recent times, a considerable attention has been paid on laboratory studies, preferably in gas-phase, in order to understand the SOA formation chemistry. However, the laboratory studies, particularly on fatty acids, in aqueous phase are very limited. Fatty acids are believed to be photochemically inert in the actinic region but in fact, they can produce SOA during illumination of an air-water interface coated solely with a monolayer of carboxylic acid and such processes have not been fully understood yet. To better understand the air-water interface photochemistry of fatty acids and their transformations to lower homologues and/or more oxygenated species in atmospheric waters (fog, cloud and aqueous aerosol), we conducted batch UV irradiation experiments on fatty acids ($C_{18}H_{36}O_2$ and $C_{18}H_{32}O_2$) in aqueous-phase for different time periods (age) up to 120 h. All the irradiated samples were analyzed for the measurements of mono- and di-acids, oxoacids and α -dicarbonyls. We found high abundances of C_{11} diacid followed by pyruvic acid and α -dicarbonyls in less aged (irradiated up to 24 h) samples whereas C_3 and C_4 diacids in the more aged (irradiated for 48-120 h) samples. Our results revealed that the photochemical transformations of fatty acids in the aqueous phase are significant and result in more oxygenated SOA with aging in the atmosphere.

Chemical composition of fog water and computation of air masses within the southern Atlantic fog zone

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With population growth and climate change increasing the exposure of communities and assets to extreme climatic conditions such as drought, it is crucial to assess possible alternative sources of good quality water such as fog, for climate adaptation of communities in arid regions. The Gobabeb and Walvisbay Town (herein referred to as the "Southern Atlantic Fog Zone") in the coastal desert of Namibia (the Namib Desert) experience fog events, which are beneficial to specific local ecosystems and human activities. Several studies have been conducted on the types and composition of fog in Gobabeb. However, knowledge on the possible sources of chemical contaminants of fog (including air pollution) using computations of air masses need to be improved.

Moreover, air pollutants can travel over great distance and remain suspended in the atmosphere before they are washed out by fog. Therefore, this study determined the chemical composition of fog based on the origin of its air masses; and investigated the possible addition of pollutants along the transport pathway. Backward trajectories for each fog water sample were computed to identify the origin of the respective air masses using wind speed, air temperature, soil temperature (at 10 cm and 20 cm depth), rainfall, relative humidity, leaf wetness and ion loadings. The backward trajectories were analysed using the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model. The ion loadings of the four dominating ions; H^+ , NH_4^+ , NO_3^- and SO_4^{2-} were enhanced in the air masses possibly advected from inland and dominated by anthropogenic influence. High concentrations of Na^+ and Cl^- as well as a high fraction of sea-salt- Mg^{2+} indicate high possibility of a maritime influence. The metals in fog water served as good indicators for local anthropogenic pollution of fog water.

Mercury in fog water collected on Mt. Front Lulin in central Taiwan

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Atmospheric mercury (Hg) can get incorporated into fog water via scavenging of gaseous oxidized Hg and particulate Hg. Besides, fog droplet may act as a reaction vessel for aqueous chemistry by providing the medium for the conversion of various Hg species. Accordingly, fog water deposition through impaction with vegetation and the Earth's surface can be an important source of Hg deposition to these ecosystems. In spite of the potential importance of fog to atmospheric Hg transport and cycling, however, very limited fog water Hg measurements have been reported. Fog water was sampled on Mt. Front Lulin in central Taiwan between March 7 and April 1, 2017 for total mercury (Hg) analysis. A total of 10 fog events were encountered, and 78 and 63 fog water samples were collected for Hg and major ion analyses, respectively. The mean cloud water pH was 4.17. NH_4^+ and SO_4^{2-} were the major cation and anion in fog water. About 99% of the measured SO_4^{2-} was non-sea-salt- SO_4^{2-} (nss- SO_4^{2-}), indicating the influence of human activities. Concentrations of Hg ranged between 0.1 and 32.8 ng L^{-1} , with a mean of 7.2 ng L^{-1} , which is lower than the mean Hg level of 9.6 ng L^{-1} for the cloud water samples collected on Mt. Bamboo in northern Taiwan in January-March 2009. Elevated Hg concentrations were usually associated with highly acidic samples. Hg concentrations were well correlated with major ion concentrations, especially SO_4^{2-} , NO_3^- , K^+ , and NH_4^+ . Results of this research indicated that human activities, such as coal combustion, industrial activities, and biomass/biofuel burning could have contributed to the measured Hg in fog water.