

A study on an atmospheric propagation delay estimation method using a fixed radio source

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This study aims to develop a new method to observe water vapor horizontal distribution using a side-lobe emission of the 1.3 GHz-band wind profiling radar (WPR). The phase delay of the received side-lobe emission is mainly due to the refractive index fluctuation along the propagation path. In the atmospheric boundary layer, the temporal and spatial non-uniformity of water vapor determines the refractive index fluctuation. Main scope of the study is to extract humidity information from the atmospheric phase delay of side-lobe emission from a WPR. Horizontal humidity distribution can be derived by the data assimilation into numerical prediction model.

The receiver system and data analysis algorithm were developed. A software radio, USRP N200 with an RX daughter board was employed to detect side-lobe emission received by an antenna. A Rubidium frequency standard and a 1 pps signal source of GPS receiver were used for accurate estimation of phase delay variation. The frequency stability of a crystal oscillator, which is generally employed for a reference frequency source of WPR, is insufficient for the accurate estimation. We proposed a new method to compensate the frequency uncertainty of WPR by using data of the additional receiver nearby the WPR site.

IQ data detected by USRP B210 which is controlled by GNURadio, an open source software. By using GNURadio the system will be low cost. The program written in IDL language extracts the temporal variation of the phase delay from the received IQ signal. In order to achieve good performance even in low SNR conditions, we developed an algorithm using STFT (Short-term Fourier transformation) aiming to remove noise in undesired frequency range.

The developed system is promising to derive humidity information from side-lobe emission from various WPRs such as the operational WPR network in Japan (WINDAS (WInd profiler Network and Data Acquisition System)).

Keywords: Wind Profiling Radar, estimation of horizontal humidity distribution, non-hydrostatic forecast model, software radio, side-lobe, propagation delay

Development of a 266 nm Raman lidar for profiling atmospheric water vapor

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It is projected that localized extreme weather events could increase due to the effects of global warming, resulting in severe weather disasters, such as a torrential rain, floods, and so on. Understanding water vapor's behavior in the atmosphere is essential to understand a fundamental mechanism of these weather events. Therefore, continuous monitoring system to measure the atmospheric water vapor with good spatio-temporal resolution is required. We have developed several water vapor Raman lidar systems employing the laser wavelengths of 355 and 532 nm. However, the signal-to-noise ratio of the Raman lidar strongly depends on the sky background because of the detection of the weak inelastic scattering of light by molecules. Therefore, these systems were mainly used during nighttime.

Hence, we have newly developed a water vapor Raman lidar using a quadrupled Nd:YAG laser at a wavelength of 266 nm. This wavelength is in the ultraviolet (UV) range below 300 nm known as the "solar-blind" region, because practically all radiation at these wavelengths is absorbed by the ozone layer in the stratosphere. It has the advantage of having no daytime solar background radiation in the system. The lidar is equipped with a 25 cm receiving telescope and is used for measuring the light separated into an elastic backscatter signal and vibrational Raman signals of nitrogen and water vapor at wavelengths of 266.1, 283.6, and 294.6 nm, respectively. This system can be used for continuous water vapor measurements in the lower troposphere. This study introduces the design of the UV lidar system and shows the preliminary results of water vapor profiles.

About the approach and the progress of the DoCoMo environmental sensor network

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Since 2008, the automated meteorological observation network has been developed by NTT DOCOMO corporation and a total of 4,000 stations are operating now.

The hyper-dense wind measurement network was constructed through the industrial-academical corporation between NTT DOCOMO and Kyoto University, which enables us to elucidate the detailed characteristics of strong downslope windstorm, Hira Oroshi, blowing down in the West coast of the Lake Biwa.

This paper discussed the outline of our activities and fruitful results will be discussed in detail.

Keywords: Environmental Sensor Network

Surface Pressure Distributions of Downburst and Tornado captured by High Dense Ground Observation Network "POTEKA"

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Meisei developed low-cost compact weather sensor (POTEKA Sta., hereinafter referred to as the POTEKA), which can measure temperature, relative humidity, pressure, sunlight, and rain detection per one minute and achieve higher density weather observation system economically. We installed economical and high dense ground observation network (total 55 stations, 1.5~4 km-mesh) in Gunma, Japan. This paper presents observation of wind gust phenomena around Takasaki city and Maebashi city on 11 August 2013 and tornado in Midori city on 16 September 2013.

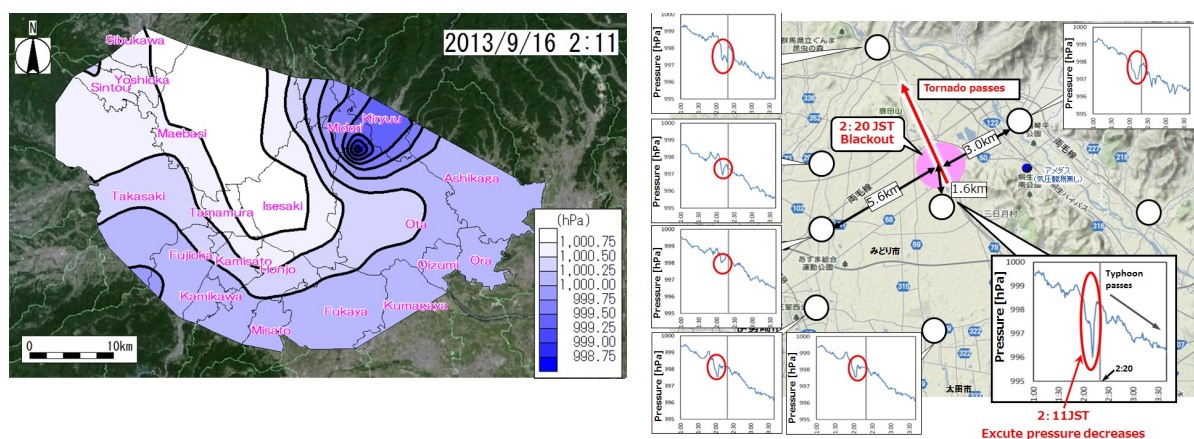
Pressure jumps of 1-2 hPa were recorded at POTEKA with one minute resolution, indicating that the temporal high pressure was caused by downburst downflow. Beside, two pressure jump can be found at some stations. The first and second jumps are coincided with gust fronts and down flow of downburst, respectively (Discrimination between downburst and gust-front by the surface dense observation network POTEKA).

In the September 16, tornado occurred in Typhoon passes, and blackout occurred at 2:20(JST). At the point from 1.2km away, surface pressure was decreasing 3hPa in 3 minutes at 1.6km blackout area away (Fig.)

Local weather observation network consisting of POTEKA succeeded in capturing the change of surface pressure caused by gust wind phenomena with unprecedented spatio-temporal resolution, which enables us not only to distinguish between gust fronts and downbursts but also to detect such wind phenomena earlier. The observation network is going to continue in the future to data accumulation.

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Keywords: High Dence observation network, Downburst, Tornado



A sensibility study on the role of the urban land surface scheme for a regional climate model, NHRCM

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The conditions of land surfaces give large impacts on surface air temperature, via the dynamical and thermal energy exchanging. In order to forecast the physical quantities, such as momentum, heat, and vapor fluxes from the land surface, we have selected a sophisticated vegetation scheme of the SiB (Simple Biosphere) as the land surface scheme of the MRI's NHRCM (Non-Hydrostatic Regional Climate Model). Recently, as model-resolution became higher up to several kilo-meter, non-vegetation but urbanized grids had appeared, and these grids were treated as dried bare ground on the SiB to express the so-called urban deserts. But, in these grids, reproducibility of the climatology seemed to be insufficient. Therefore, we need to apply the new scheme to improve the representation of radiation and heat budgets in such urban area. For that purpose, we developed a new scheme for urban land surface to applied to a regional climate model. This new scheme is called SPUC (Square Prism Urban Canopy, Aoyagi and Seino 2011).

In this study, we applied SiB and SPUC scheme to the 4km-resolution NHRCM, executed present climate simulations, and compared outputs with observational data of JMA(Japan Meteorological Agency). The target area was Kanto-Koshin region including Tokyo metropolitan area. As initial and boundary condition, we used the JMA's RANAL (Regional analysis) dataset (20km resolution), which was downscaled once by NHRCM10km with SiB scheme for all grid. The 10km resolution dataset was also downscaled by NHRCM4km. We executed the 4km experiments, using SiB scheme for all land grids (NHRCM-SiB), and using both SiB for natural surface grids and SPUC for urban surface grids (NHRCM-SPUC).Time integration was continuously executed for about 5 years from August 1st, 2001 to September 1st, 2006.

The result of the experiment using SiB scheme had negative bias(about -1.3 °C) in the surface temperature in the Tokyo metropolitan area. By using SPUC scheme, this negative bias changed to positive(+1.55 °C). Although the bias remains, the correlation factor between the simulation and observation was improved from 0.73 (NHRCM-SiB) to 0.86 (NHRCM-SPUC). This improvement implies that NHRCM-SPUC had the better reproducibility on horizontal distribution of air temperature. On the other hand, the difference was hardly seen in total amount of precipitation in five years.

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Keywords: regional climate, land surface, downscaling, urban canopy

Temporal and spatial characteristics of gust ratio in the

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Localized downslope wind often causes severe disasters, although the dynamics of these severe phenomena has not fully elucidated due to their small temporal and spatial scale. The damage by downslope wind is strongly determined by the instantaneous maximum wind speed. Since the numerical model can derive averaged wind speed along time and space determined by the model resolution. The classical analogous theory points out that the gust ratio, which is defined as the ratio of maximum wind velocity to the averaged wind velocity, becomes a constant value (1.5-2.0), depends only on the roughness length of surface condition.

In the actual atmosphere with the horizontal inhomogeneity, the gust ratio may varies with time even at the same location. The sophisticated modeling of gust ratio beyond the simple constant model is very important for the forecasting of gust damage. The detailed characteristics of gust ratio was investigated by the data of hyper-dense surface observation network in the Hira Oroshi region. The temporal and spatial characteristics of gust ratio and future prospective to install our algorithm into the numerical prediction models are discussed in the presentation.

An trial of direct monitoring of turbulence intensity by using the balloon-borne high-resolution temperature sensor

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The fine tungsten wire (10 μ m diameter) temperature sensor, whose response time is 5/1000sec on surface and 40/1000sec at around 30km altitude, were employed to detect turbulence intensities. For the temperature data at the sampling frequency of 16Hz were used for the turbulence detection. The contamination of the wake of the balloon should be carefully removed from the original data before the analysis of turbulence.

We are developing the new method to extract temperature perturbation by turbulence at the vertical wavelength shorter than the effects of pendular movement of radiosondes.

The preliminary results show very promising to detect turbulence intensities to compare with echo intensity of atmosphere radar.

The detailed scheme and first results are discussed in the presentation.

High resolution numerical study of migrating strong downslope wind "Hira-Oroshi" in Japan

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This paper studied the generation mechanism of a unique downslope wind in the west coast of Lake Biwa, Shiga, Japan. This strong downslope wind, feared as "Hira-Oroshi" for millennial years shows the narrow gust of a few kilometers in the various location within 10 km width area. This feature cannot be explained by the conventional mechanism of previous studies: the location of downslope wind is strongly restricted by the location of valley in mountain range. Due to such distinct characteristic, the numerical prediction of this gust wind is too inaccurate to use operationally.

Considering strong demands to the prediction of this gust wind, this study aims to elucidate the mechanism via very fine numerical forecast model with the horizontal resolution of 50 m. The results successfully represented the narrow gust wind structure in the edge of the mountain range. The spots of gust wind due to complicated topographical structure is also seen in the simulation results, although the gust wind speed changes with the larger scale wind direction and speed. Because the stagnant region due to the breaking of the mountain wave is widely extended in the leeward of the mountain range in the free atmosphere (~1 km), the location of the gust wind looks to be determined by the detailed topographic structure of the mountain range and the a kilometer-scale eddies over the Lake Biwa.

The simulation results suggested these synergy effects determined the gust generation and its location. The unveiled behavior of the gust wind is also beneficial to the improvement of the gust prediction.

Keywords: High resolution numerical simulation, Downslope wind, Local wind