AUTOMATIC MESUREMENTS OF JAPANESE CEDAR / CYPRESS POLLEN CONCENTRATION AND THE NUMERICAL FORECASTING AT TOKYO METROPOLITAN AREA

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1. Introduction

In Japan, daily pollen information is reported based on Durham method observations at each site (researchers count the number of pollen on a glass slide), and forecasts are made from Durham observation data, pollen volume at source forests and meteorological factors. Daily pollen forecast is calculated statistically by multiple regression equations which are fixed by relationship between numbers of pollens observed by Durham method and meteorological factors (temperature, precipitation, wind and pollen provision ration at date).

Recently, the Environment Agency and local governments installed pollen counters (particle counters focused for pollens) instead of Durham stands. The Duhram method provides the daily number of pollen on a glass as a number in 1 cm^2, however, pollen counters vacuum air and count the number of pollen by using optical analysis methods as a number in 1 cm^3.

We have developed the NPFM (Numerical Pollen Forecast Model) using automated pollen counters' data and numerical weather prediction data. And the system started to provide experimental forecasts around Tokyo from 2008 spring season actually (Fig.1). The system includes several processes, i.e. pollen flowering, pollen supply at forests, pollen dispersion and pollen dry/wet deposit process. And each process reflects meteorological and geographical situation at a grid. A numerical forecast has various advantages over a statistical

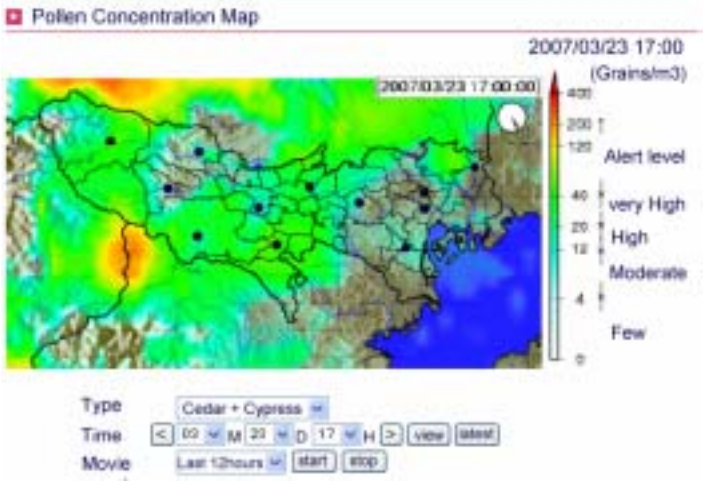

Fig.1 A sample of NPFM output

forecast, i.e. it can provide hourly forecast for people, and such precise information helps patients to avoid their exposure for pollens and eases their symptoms as a result. Additionally even for an abnormal meteorological situation (unusual warm/cold winter never experienced), it can provide a reasonable forecast.

2. Outline of NPFM

NPFM is composed of multi processes shown in Fig.1, local meteorological simulation model, pollen supply model, dispersion model from forests and so on. The dispersion model adopts Lagrange type dispersion scheme which includes effects of updraft and downdraft in boundary layers. The model provides pollen particles emitted from the pollen supply model, into the air synchronize with a time step of the meteorological model. It disperses pollens with wind and turbulence energy and deposes pollens with precipitation and sedimentation. Cedar and Cypress forests older than 26 years old, which provide pollens effectively, is shown in Fig.2.

Table-1 Processes of Numerical Pollen Forecast Model

Analysis date	**Feb. - Apr. 2005**
Analysis Area	**East Japan (Kanto district)**
Meteorological field estimation	**From MM5 meso-scale model calculation Lambert Connic Projection, Grid size: 6 X 6km (600 X 600km), Boundary Layer : Mellor-Yamada TCM**
Flowering status estimation	**Based on temprature (Kanazashi and Yokoyama, 2003) by objective analysis between MM5-Mesoscale model output and observation data**
Total account of pollen production	**Calculated by the cedar forest area dimensions(m^2) over 26 years old cedar tree and amount of male flowers per m^2**
Pollen quantity supplied from cedar forest	**Calculated by pollen emission and deposition rate balance in Cedar forest**
Dispersion model	**Lagrangian dispersion model including up-down drought process in Convective Boundary Layer**

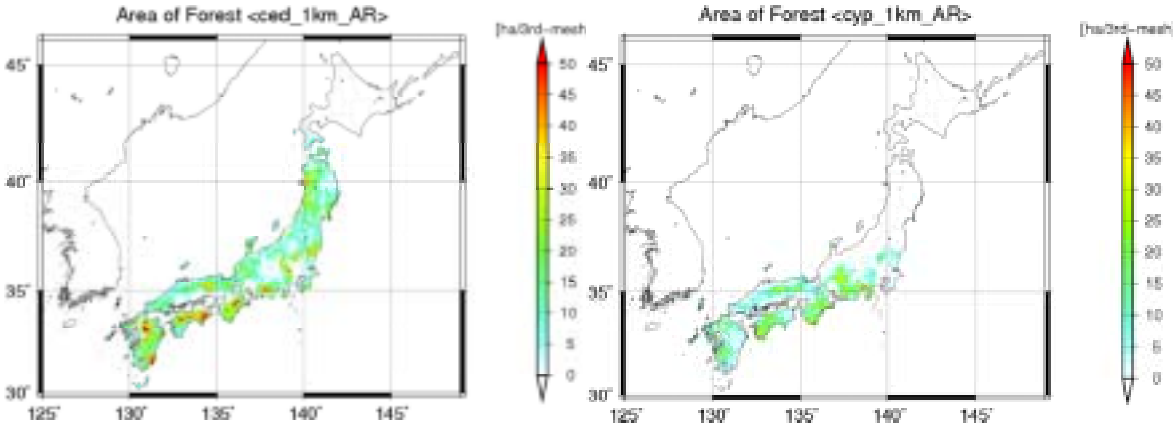

Fig.-2 A distribution of Cedar and Cypress forests older than 26 years old at 1995 (Left: Cedar, Right: Cypress)

3. Evaluation of NPFM

We show the relationship between daily average pollen concentration at 12 stations in central Tokyo and average number of pollen observed by traditional Durham method at 12 stations in Fig. 3. It reveals that the model can predict the situation exactly and the correlation factor is 0.92.

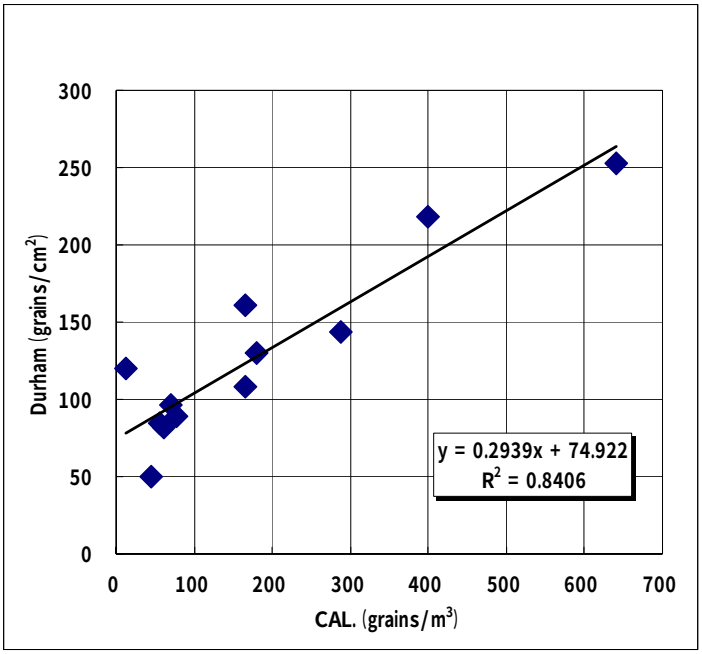

Fig.3 Comparison of Pollen Forecast Model results and actual pollen number observed by traditional Durham method

The drier the air is, the greater forests provide pollen from forests, so the peak of pollen concentration is observed around noon generally. However, in 2005 the greatest

pollen season in these years, a sub peak in the early morning was observed. We thought the sub peak was brought by long distance pollen transportation from Shizuoka, and to evaluate the assumption we run NPFM for the episode.

And to evaluate the high concentration pattern which brings severe symptom for patients, we evaluate the episode occurred in the early morning of 18th. and 20th. March 2005. We estimate hourly pollen concentration during 4 days at Chiyoda Tokyo by running Numerical Pollen Forecast Model beyond 24 hours based on 12 UTC initial data (at 16th., 17th, 18th. and 19th.) 4 times, and evaluate it with actual pollen concentration observed by an automatic pollen counters (KH-3000) at the same site.

The result is shown in Fig. 4. Actual pollen concentration at the site increased from early morning rapidly. It marked 400 to 600 grains/m^3 from 8 to 9 a.m. and it kept high concentration level greater than 200 grains/m^3 until 9 a.m. The model tended to estimate the concentration greater than actual concentration during peak hours, however, it could estimate daily trend precisely for warning the risk level of pollen to patients.

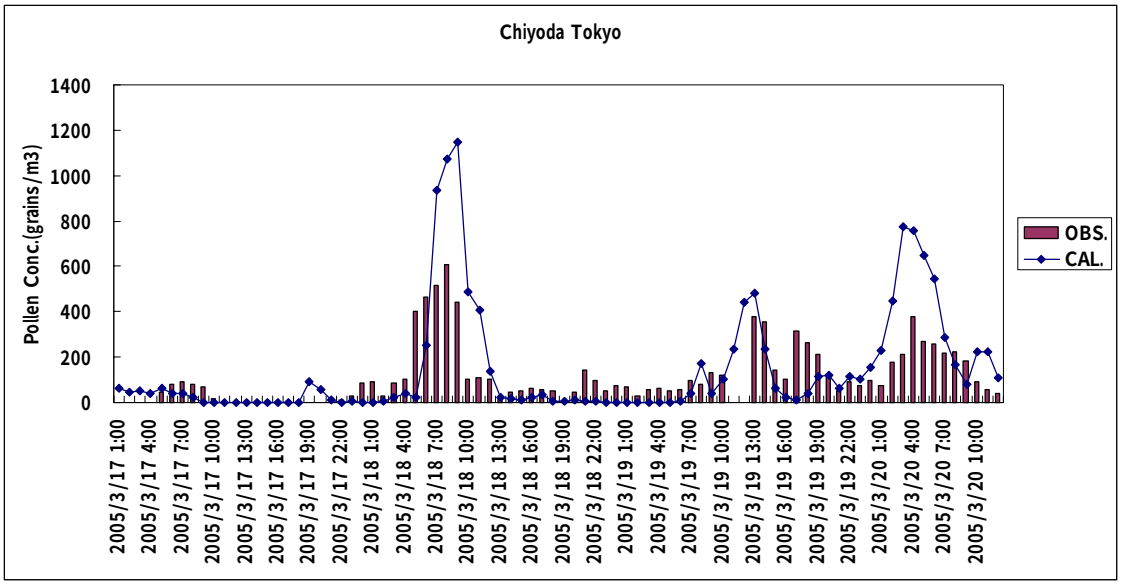

Fig.4 The result of NPFM and actual pollen concentration at 18th. and 20th. March 2005

NPFM adopts Lagrange type dispersion model, and if we add markers for each pollen., NPFM can analyze the source forests of pollens detected in Tokyo Metropolitan area (Suzuki et al, 2007). NPFM can provide not only hourly local pollen forecasts also a determination tool of pollens affect pollen allergy patients.

4. References

Kawaguchi, T. : A study for elucidation of symptoms and exacerbating mechanism of Japanese cedar pollinosis - Medical economics research, Integrated Research for Overcoming Japanese Cedar Pollinosis. Phase I, 143-157, (2000) (in Japanese)

Kanda, M., Zhang, X.Y., Uno, I., Kawashima, S., Takahashi, Y. and Hirano, M. : Numerical Study on Dispersion of Cedar Pollens Using Meso-scale Meteorological Model. Tenki, 49, 267-277, (2002). (in Japanese)

Suzuki, M. : A study for improvement of cedar pollen dispersion model and development of integrated Japanese cedar pollen forecasting - Japanese cedar pollen exposure avoidance research, Integrated Research for Overcoming Japanese Cedar Pollinosis. Phase II, 184-196, (2003) (in Japanese)

Kanazashi, T. : A study for identification of source cedar forests of pollen transported to great city - Japanese cedar pollen exposure avoidance research, Integrated Research for Overcoming Japanese Cedar Pollinosis. Phase II, 197-206, (2003) (in Japanese)

Davis, J.M. and Main, C.E. : A regional analysis of the meteorological aspects of the spread and development of blue mold on tobacco. Boundary-Layer Meteorology 28, 271-304, (1984).

Levetin, E., Rogers, C. and Main, C.E. : Forecasting long distance transport of mountain cedar pollen, 13th Conference on biometeorology and aerobiology, 339-340, (1998).

Rogers, C.A. and Levetin, E. : Evidence of long-distance transport of mountain cedar pollen into Tulsa, Oklahoma. Int. J. Biometeorol. 42, 65-72, (1998)

Chengwei, Y., Arya, S.P., Davis, J. and Main, C.E. : A numerical model of the transport and diffusion of Peronospora tabacina spores in the evolving atmospheric boundary layer, Atmos. Env. 31, 1709-1714, (1998)

Ley, A.J. and Thomson, D.J. : A random walk model of dispersion in the adiabatic surface layer, Quart.J.R.Met.Soc., 109,847-880, (1983)

Misaki, M. : About aerosol behavior, Meteorological research note, Meteorological Society of Japan, 142, (1981). (in Japanese)

Iehara, T., Miyamoto, A., Takahashi, M. : A development of pollen source distribution dataset for advanced prediction of Japanese cedar and cypress pollen dispersion in Kanto district, Nihon Ringakukai Kanto branch paper collection,51,63-66, (2000) (in Japanese)

Kanazashi,T.,Yokoyama,T. : Requirements of air temperature for rest break and anthesis of male flowers in Cryptomeria Japonica D. Don, Jpn. J. Palynol., 48, 95-102, (2002) (in Japanese)