R&D Spirits

Toward the Dissemination of Environmental Information Designed to Improve the Quality of Life

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NTT Energy and Environment Systems Laboratories is making good progress on an environmental information system that collects and stores environmental data on air, water, and soil using sensing networks. The system then publishes information derived from this environmental data. What significance could this environmental information hold for you and me? And what does the development of such a system require on the provisioning side? We put these questions to Research Engineer Jean-Jacques Delaunay, who is in charge of developing a cedar pollen forecasting system that will be used to offer a pollen forecasting service on a commercial basis starting in January 2004.

48-hour cedar pollen forecasts computed using a three-dimensional transport model

—Please describe your current research.

We are working on the development of a real-time cedar pollen forecasting system. The system comprises a pollen sensing network and an associated server to collect and store pollen data, a simulator that models the major processes involved in pollen transport such as flowering, emission, advection, and dispersion, and graphical tools that are used to publish the forecasts on a variety of different media such as the web, digital television, email, newspapers, and fax (**Figs. 1** and **2**). When we started this project, there was no system that could provide round-the-clock pollen information with a useful spatial and temporal resolution. Our group was the first to create such a system and circulate the information to the general public. This new type of information should help to improve the quality of life of pollen allergy sufferers by providing them with pollen forecasts, thus allowing them to take preventive measures.

Today, more than one in ten inhabitants of the Kanto region are reported to be suffering from pollen allergy, a proportion that will probably continue to increase in the near future. The main cause of pollen allergy in Japan is now recognized to be the potent allergen in cedar pollen. The medical community is clear in its advice that the most effective way to prevent the occurrence of pollen allergy is to avoid inhaling pollen. By knowing the current and projected pollen concentrations, a person is in a position to take preventative/precautionary measures such as wearing a mask or taking appropriate medication. Through interviews, we found tremendous enthusiasm among allergy sufferers for a service that would enable them obtain pollen information easily and conveniently by cell phone, the Internet, and other means. The medical community is also interested in pollen observation data in relation to epidemiology studies, which will contribute to improvements in prescription drugs.

—What are the technological aspects of this research?

To enable us to compute the time varying three-dimensional pollen concentration fields over an area as large as the Kanto plain, we had to develop and

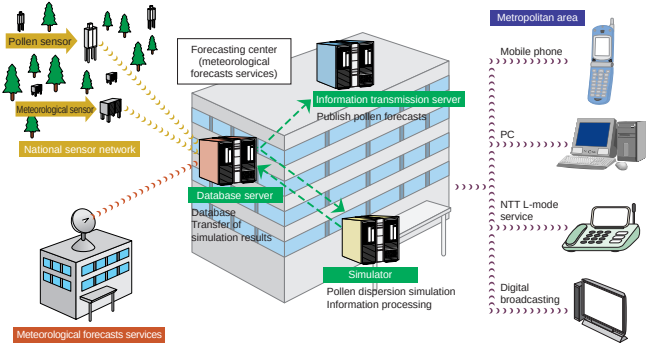

Fig. 1. Pollen forecasting system.

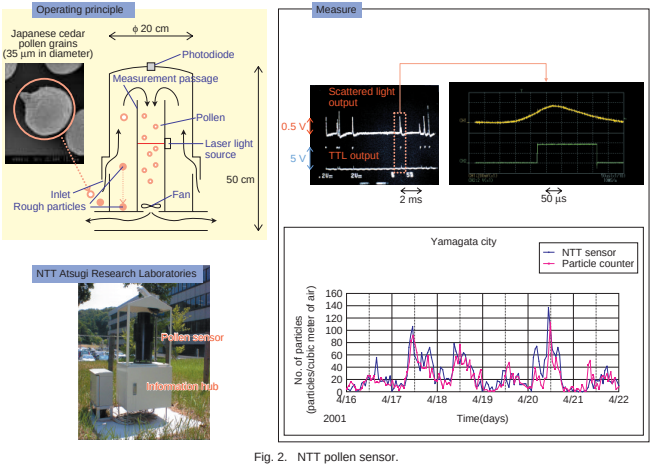

Fig. 2. NTT pollen sensor.

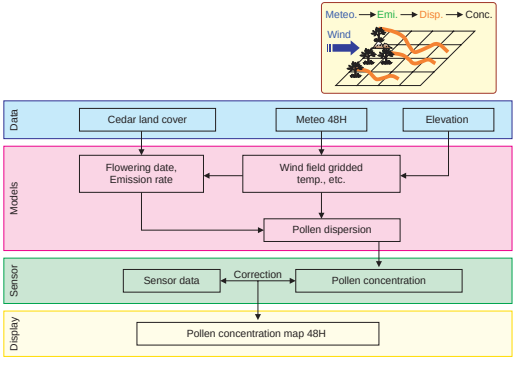

Fig. 3. Pollen simulation.

implement several models in our pollen forecasting system. These models compute the flowering dates, the pollen emission rates, and the pollen transport in three dimensions (**Fig. 3**). In particular, the development of a realistic emission model required us to adopt a completely new approach. The hourly pollen concentrations are computed at fixed points in space located on a three-dimensional grid with a grid size of 2 km on the horizontal plane, and a variable grid spacing with 20 layers. Pollen sensor data collected from our sensing network is used in real time to correct the pollen forecasts (post-processing) and thus improve the accuracy of short-range forecasts provided by our system. We also developed optimization code so that the parameters for the models could be adjusted over a longer period. It is difficult to operate the system in real time. Achieving real-time operation requires great care as regards the design and coding of the system, which controls many data flows (meteorological data, pollen data, and forecast results) and processes (flowering, emission, transport, post-processing, and optimization).

One of the unique aspects of this work is that it involves numerous disciplines including atmospheric science, computer science, data processing, and biology. Many of these disciplines were outside my own area of expertise, so I had to learn a lot, which turned out to be a very enjoyable process.

—Tell us how the research and development is progressing.

We field-tested the system last year in the Kanto region. The system generated pollen concentration maps that were published in real time on our web/WAP sites. Maps for ten cities were derived on a larger scale from a regional model covering the Kanto area. For dissemination and analysis purposes, we applied a four-level classification index to the computed pollen concentration: low, moderate, high, and very high. The forecast accuracy, given as the percentage of correct classification for all predicted events, reached an average value of 50%. The main pollen peaks were well reproduced.

As a trial service, we offered the information to the general public through our interactive web site and also on the i-mode service of NTT DoCoMo. The response from users was remarkable with both sites averaging 1000 hits per day (**Fig. 4**). The service was also featured on a popular TV weather forecast spot on TBS and was covered by other media as well. Finally, our pollen forecasts were displayed continuously on a TBS digital television channel.

Our ultimate target was to make a commercially viable service, and, based on how well the trial service was received, it is clear that we achieved our goal. Recently, we have been transferring technolo-

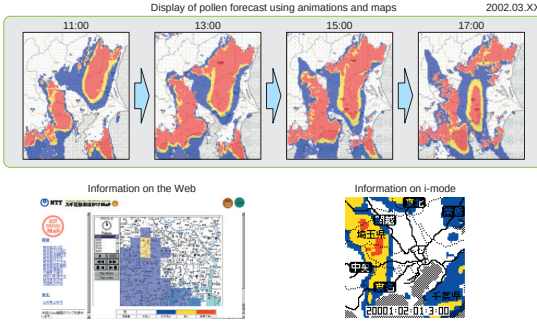

Fig. 4. New information contents.

gies and making various arrangements to provide a smooth start to the service. NTT-GP, a subsidiary of NTT, plans to launch the service commercially in alliance with a weather information company in January 2004.

Real pleasure in pursuing research through direct interaction with society

—What do you think this research will bring forth three and five years from now?

Our main role has been to develop the technology up to the point where it is ready for commercialization, and it is now someone else's job to turn this service into a successful business. I think that the service could develop in two directions: it could provide individual users with information related directly to them and provide professional users with high-quality information. On the personal user level, the pollen forecast service might develop in the form of an i-mode site, while on the professional user level (targeting hospitals, pharmaceutical companies, and local governments), services providing observed data together with data analysis expertise will probably be essential.

—What issues need to be addressed for that to happen?

One of the issues that must be addressed is the lack of standardization of the pollen information. Different measurement standards have been around for a long time now, and some effort at standardization is needed. Also, pollen reports do not necessarily use the same vocabulary and units to describe the same situation, thus contributing to confusion among the general public.

In terms of forecast quality, the models require a number of improvements. In particular, better modeling of the variations in the amount of pollen produced from year to year would certainly improve system performance. If we are to model these variations, we first need a better understanding of the ecology of cedar trees.

—Have you participated in any academic conferences related to this research?

I have written a number of papers and given presentations at conferences, but recent developments in my project have left me very little time to participate in conferences. Also the primary mission of our laboratory is more oriented toward applications and the practical implementation of services, so communicating our results to the academic community is only one of our many responsibilities. For me, it is the direct connection between my research and potential users that makes my life as a researcher rewarding.

—Tell us about international research trends regarding the dissemination of environmental information?

Until fairly recently Japan was criticized for being slow in addressing these needs, but this country has made up for lost time over these past five years with the passage of legislation in 1999 that regulates the reporting and management of the release of chemical substances into the environment (based on OECD recommendations), the creation of national and prefectural web sites that carry environmental information, and many other initiatives. With regard to technologies related to sensing networks and data collection, progress has been extraordinarily rapid and no one could claim that Japan lags behind in these areas today. It is the subsequent analysis and action once the data has been collected that still leaves something to be desired. In this regard, Japan is in a similar situation to the U.S.: research is very advanced, but the subsequent action is not what it might be. In contrast, I think Europe has achieved a better balance between research and action. And this applies not just to a segment of the research community but also to the general population, which has a keen appreciation of environmental issues. This is evident from the formation of many non-profit organizations (NPOs) at the local level and proactive citizen-led initiatives designed to investigate environmental problems and come up with solutions.

Resolving conflicts between society and the environment—a persistent research theme

—What kind of research did you do as a Ph.D. student?

I majored in physics and got my Ph.D. in France, based on experimental work undertaken at the Fraunhofer Institute for Solar Energy Systems in Freiburg, Germany. My research at that time focused on the modeling of natural light and its use in the interior lighting of buildings. The research dealt with the modeling of direct and diffuse solar light under different meteorological conditions (types of sky) and targeted better designs for building apertures with a view to avoiding glare and over-heating in summer. My work also made it possible to compute the energy balance of a building taking account of both the heating and cooling loads of the building and the contribution made by natural and artificial lighting.

Although Freiburg is a small city, it is home to one of the most traditional Universities in Germany, together with several prestigious research institutes. Today, it is well known for its environmental initiatives. More than ten years ago, the city took steps to preserve its environment by restricting vehicle access to the city center, thus becoming a model for neighboring cities such as Strasburg in France. Living in this town was very significant for me, and I still go back there about once every two years to look at the evolution of different projects and obtain new ideas.

—What first motivated the research you are doing now?

First of all, I wanted to do research in the field of atmospheric science. At the same time I was concerned by the impact of air pollution on health. Air pollution has long been a neglected field, which can probably be explained by the difficulties involved in studying air pollution and quantifying the impact of any regulation on air quality. As the atmosphere is a borderless medium, the air we breathe knows no geographical or political boundaries, which makes it extremely difficult to regulate/manage. This is generally not the case for other natural resources. For example fresh water (which people are used to paying for) is certainly a better-managed resource than the air. Unfortunately, atmospheric pollution is also a serious health problem contributing to respiratory disease and associated with high mortality rates during times of high pollution. So there is a need for people to be better informed and to understand the challenges to improving the air quality. As this is a difficult topic that is still widely debated in the scientific community, I thought that the cedar pollen problem in Japan could offer an opportunity to contribute to the debate and help to stimulate a community that is interested in air quality problems. While pollen allergy cannot be considered a man-made problem in quite the same way that car exhaust can, the incidence of pollen allergy has certainly been exacerbated by Japan's aggressive postwar afforestation policy and in today's Japan it can be considered a form of anthropogenic atmospheric pollution.

Commanding presence of NTT Energy and Environment Systems Laboratories

—How would you like to see this research develop in the coming years?

One area of interest relates to the dispersion of pollen from genetically modified crops and its inter-

action with other species. As pollen can travel over very large distances, there will inevitably be some interaction between transgenic plants and native species, a problem that has yet to receive the attention it deserves. A pollen dispersion simulation could help quantify the risk of cross-pollination and help us to regulate this phenomenon.

Another natural continuation of my work would be to simulate the dispersion of other bio-particles such as viruses and bacteria. This area has far-ranging applications that can probably be used to improve the wealth and prosperity of society.

—Please tell us your research aspirations.

Since the ultimate goal of our research and development effort is the commercialization of new services, I would certainly try to expand my project in the directions I mentioned previously. I am also highly motivated by the idea of providing extensive and good-quality environmental information to people in support of an improved decision-making process. Despite the recent efforts by many government bodies to inform people, information on our environment is at best sparse and often incomplete. Strangely enough, the data necessary to provide this information might be available, but in many cases steps to disseminate it in a relevant form have not been taken, thus leaving the public uniformed and unable to take part in the debate. Knowing our environment may not only change the way we think about where we live, but could also influence our lifestyle and the methods we use for producing goods and providing services. This is why environmental information is so crucial to society.

—How do you think NTT Laboratories appear to the world through their research activities to date?

NTT Laboratories have an indisputable international reputation in many key technologies that support today's telecommunication infrastructure. In particular, our basic laboratory is doing fascinating research at the forefront of science. There is no other telecommunication carrier anywhere in the world with such great potential as regards research and development.

The Energy and Environment Systems Laboratories has not been around long enough to establish such a reputation, but its mission lies elsewhere. The true substance of our laboratory is to be found at a domestic level where it has commenced several large environmental information projects hand in hand with its natural partners (NTT-East and NTT-West). We have forged new environmental communities by working closely with local groups as well as local authorities.

In recent years, I was saddened by the closure of many research laboratories in Japan and throughout the world. The global trend toward outsourcing activities and cost-reduction has taken a heavy toll on the research community. Although in many situations outsourcing may be the best economic strategy, when it comes to R&D and long-term strategy, outsourcing is likely to be detrimental. NTT, which has a strong culture of mastering the technology it uses, has a different approach, which should give the company a decisive advantage in the technological battles to come.

—What is it like working at NTT Laboratories?

This is a very appealing and rewarding place to work. What amazes me most is the incredible breadth of knowledge that is available here: you can find an expert on virtually any area of interest, and any information that you might need is available somewhere within NTT. No matter what question you might have, there is bound to be someone around who can help. The expertise and knowledge encompassed by these research teams and developed over many years are invaluable.

Interviewee profile

■ Career highlights

1991 M.E. from the "École Nationale Supérieure de Physique de Strasbourg".
1995 Ph.D. from the Louis Pasteur University.
1995 Post-doctoral position at the National Industrial Research Institute of Nagoya.
1996-1997 Post-doctoral position at NTT.
1998- Currently with NTT Energy and Environment Systems Laboratories and engaged in the development of information systems.

■ Major awards

1995 STA scholarship from the Japan Science and Technology Corporation.
2001 NTT Science and Core Technology Laboratory Group award for best press release.
2003 NTT Energy and Environment Systems Laboratories Director Award.