3 OTHER CENTRES

3.1 Japan

> "I think we all feel that this symposium represents a milestone in the development [of NWP] and that we can look towards the future development with a great deal of optimism", Bert Bolin at the farewell reception at the 1960 NWP Symposium in Tokyo

The history of Japanese NWP is not only about difficulties in a war torn country, but also a constant "brain-drain" to foreign institutions, most notably in the USA. The contributions the Japanese have made to NWP are as much part of the American development as the one in Japan. In this outlay I will concentrate on the development in Japan. The text is based on correspondence with professor Kanzaburo Gambo, Hassam Taba's interview with Kiyoo Wadati and notes by George Platzman from 1955, Yoshio Kurihara from this year and, not least, John Lewis' article in Bull Am Met Soc in July 1993.

The story seems to start in 1949 and the (late) arrival of Jule Charney's 1947 paper on baroclinic disturbances in the westerlies. Akira Kasahara told Lewis in 1992 that one day in 1949 Professor Syono, rushed into their classroom in the Geophysical Institute with a copy of Charney's paper in his hand and excitedly proclaimed:

> "Look! This paper has modernised the science of meteorology!

Shigekata Syono had been appointed professor at the meteorological department of the Tokyo University in 1945 (a post he would held to 1969). The students, obviously, had to read the paper very carefully from beginning to end. Kasahara had the feeling that Syono himself had been thinking of developing a similar theory and now was excited that his long-term wish had been accomplished. Syono had always emphasised to his students that the research atmosphere in dynamical meteorology in Japan was inferior compared to other countries. So, he strongly encouraged the young students to make contact with the international colleagues. A NWP group was formed around Syono whichj included young staff and scientists, and researchers from the Japanese Meteorological Agency. The times were hard; they were poorly paid and had to find part-time work as teachers in high schools to make ends meet.

The group studied other papers from abroad, among them Charney and Eliassens 1949 paper about one-dimensional barotropic forecasting. In 1950 Syono and some members in his group published in the Journal of the Meteorological Society of Japan, the first in a series of three papers on "numerical weather prediction". The first was a comparison between Syono's ideas and Charney-Eliassen, which were rather similar.

In the meantime one of Syono's students, Kanzaburo Gambo had entered into a correspondence with Charney. Gambo had graduated from the university in Tokyo in 1945 and was employed as a research associate in 1947. One of his first papers was a study of energy dispersion, much inspired by Yeh's paper 1949. In 1952 Syono and Gambo published two more papers on NWP in J Met Soc Jap. Now they were much more

following in the steps of Charney and Rossby.

The contact with Charney was mutually fruitful and Gambo was invited to spend two years at the Institute for Advanced Science in Princeton with Charney's group. He also had contacts with George Platzman at the Chicago University. During the stay he sent frequent letters home to report on the progress in the US.

When Gambo came back to Japan in 1954 he established a NWP research group in Tokyo. Together with Syono he coordina-ted a monthly set of lectures that included about 25 researchers who were either gra-duates or JMA employees. They occasio-nally held retreats in the outskirts of Tokyo. They covered a broad spectrum of subjects including dynamical meteorolo-gy and numerical weather prediction. From the mid-1950's there were a number of seminal contributions from the members of the NWP group, for example the first paper on barotropic track forecasting by Sasaki and Miyakoda in 1954.

The ability of Japanese meteorologists to make important contributions to NWP already at this stage is the more remarkable since they had limited financial support from the federal government (except for the stipend to Gambo). As a matter of fact, their greatest sponsor was one of the largest newspaper companies in Japan, the Asahi Press. They provided a lump sum gift of $ 2 800, which significantly enhanced the group's activities**. [We all are eager to know why they did this!]**

Between 1954 and 1960 the Japanese meteorologists performed their numerical calculations using graphical methods designed by Ragnar Fjörtoft, desk calcula-tors and the FACOM 100, an electro-mechanical relay switching computer that was built by the Fuji Tsu Shin Ki Compa-ny **[surely it must be what we today know as Fujitsu].** They carried out prediction experiments to a wide range of problems, including predictions of pre-cipitation, motion of tropical cyclones as well as extended forecast.

So far JMA had not been actively invol-ved. But that was not because of any non-interest by its Director General Kiyoo Wadati. Already in 1950 he had visited the US and met Rossby and his group. He had been much impressed by what he saw: weather radar, automated observations and numerical weather prediction. In the mid-1950's the time had come for Wadati to start to put in requests for money to install their own electronic computer.

But it was not until 1959 that JMA succeeded in obtaining an IBM704 (memory 8KW). Now it was meaningful to create a NWP section at JMA, under the formal name of Section of Electronic Com-putation Centre (E.C.C). Gambo and others **[who??]** joined from University of Tokyo. The plan was to make NWP operational. Already in April 1960 they had a hemispheric barotropic model up and running forecast to +48 hours. The model was very similar to the one used by NMC at the same time with a grid length of 381 km. The reception by the forecasters was mixed. Gambo: "At that time, some fore-casters understood our efforts well, while other ones did not accept our efforts."

As with the NMC model they experienced serious problems how to prevent the rapid retrogressive motion of the ultra-long waves. It was, as many of us know, by introducing the so-called "Cressman term". [This term is sometimes called "artificial", but I understand that it has a solid physical-hydrodynamical meaning: by allowing the upper surface to become an internal surface it could increase its motion so that some of the

energy that previously went into moving the ultra-long waves westward was now deflected upwards.]

In my correspondence with professor Gambo I asked specifically about problems with constant boundary conditions. To me the computational area appeared quite small compared to Charney's theories and what had been used in my country. Profes-sor Gambo assured me emphatically that there had been no or few problems:

> "In case of NWP over Japan, the westerlies are not maximum over Japan due to the Himalayas. As is well known, the maximum speed of the jet stream is found over the middle of the Pacific Ocean, not over Japan, which is situated on the western side of the Paci-fic Ocean. In this sense, the problem of western boundary in relation to the energy dispersion was not serious for the short range forecasts (2-3 days)."

Again, professor Gambo made me aware of that experience from the European area, on the eastern side of an ocean, is not necessarily applicable to regions on the western side. This might explain why Charney and his co-workers simulating the Thanksgivingday storm from 1950 (and other east-coast storms) also seem to have managed with relative small computational areas.

More serious was the problem of non-adiabatic effects due to sensible heat fluxes from the warm water in the Pacific Ocean, this in contrast to Europe and western North America.

At the end of the 1950s, professor Syono, in order to show the world what was being accomplished in Japan and to benefit from work in other countries, worked passiona-tely to organise the largest international NWP symposium so far, to be held in Tokyo 7-11 November 1960. The sympo-sium was a great success and became a milestone for the advancement of numeri-cal weather prediction. It was here the development of primitive equation models definitely was put on the agenda, but is was also here that Edward Lorenz presen-ted to the world his first experiences of how non-linear computations could diverge from one coffee break to the other…

"Looking back, it is fair to say that the meeting was one of the epoch-making events in the history of NWP" (A. Kasahara to John Lewis in 1992.

.