TECHNICAL MEMORANDUM

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Collecting surface ship observations via maritime satellite telex service: a pilot study

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1. Introduction

In an experiment ECMWF tried to establish the possible advantages of acquiring ship generated automatic surface weather observations directly from the vessel via the telex network operated through satellite links by INMARSAT (International Maritime Satellite Organisation). The experiment was undertaken with only one ship, the WORLD PROGRESS owned by the Sanko Steamship Company of Japan, equipped with instrumentation by Japan Radio Co.

The purpose of INMARSAT is to provide the satellite and ground support facilities necessary for improving maritime communications. The coast earth stations, funded by the signatory countries, provide the link between the satellites and the national and international conventional communication networks, while small satellite communication terminals installed onboard ship provide the ship earth stations. Telex channels are directly assigned to the ships by individual coast earth stations.

Apart from its commercial use, the INMARSAT satellite ship to coast link is of great potential for the collection of meteorological data. Ship earth stations have already been installed on a large number of tankers, container ships and other vessels regularly sailing across the oceans. Meteorological services have started to make use of the INMARSAT system for collecting manually generated weather observations from ships which have agreed to send the reports in that way rather than to the nearest coastal radio station. The coast earth stations will relay the data to the national weather services for further distribution via the Global Telecommunication System (GTS) of the WMO. Either onboard ship or at a later stage the data needs to be converted into the WMO code for surface observations.

For collection of automatically recorded atmospheric data from the vessel the satellite communication computer onboard ship is connected to a meteorological instrumentation package. The data can be requested at time intervals left to the discretion of the user at the receiving end.

The following paper will summarise the experience with the direct data collection and some comments will be made on the quality and usefulness of the data.

2. Description of the Experiment

During the pilot study, 13-27 July 1984, the telex link was established directly between ECMWF and the ship. The raw data was collected without using any WMO code. The instrumentation onboard ship was polled every six hours at approximately 05.50, 11.50, 17.50 and 23.50 GMT by the ECMWF VAX computer. The timing of the data collection was chosen in order to simulate as closely as possible the collection of conventional surface observations through the usual channels. The connection was achieved using the AUTOTELEX software on the VAX, the public international telex network and the INMARSAT maritime satellite system.

The WORLD PROGRESS is equipped with a number of sensors which can be polled from the telex network. The data collected included information on the ship position, speed and direction and the time of observation. The meteorological parameters given were the air temperature, atmospheric pressure reduced to mean sea level and pressure tendency, wind direction and speed. A complete list of the parameters and an example of a telex message is given in Annex 1. The data was evaluated manually by comparison with the final analyses and with surrounding observations.

3. Detailed Results of Data Gathering

During the period 13-27 July it was possible to receive a total of 58 observations. Details of the data gathering are given in table 1.

The first 3 categories in table 1 can be considered successful from the communications viewpoint which gives a success rate of 87.9%. 36 of these 51 connections were made without a retry being necessary.

Categories 4 and 5 contain problems of the initial phase of the experiment which were eliminated by tuning the AUTOTELEX parameters governing the number and delay between retries. No errors in these categories occurred during the final 8 days at the trial, following parameter adjustment.

Categories 7 and 8 can also be considered as problems which are typical of a pilot study and which would not be expected to occur so frequently if a production service were to be in operation.

Category	No.	Comment
1.	41	Completed automatically successfully within 5 minutes of nominal time.
2.	5	Completed automatically successfully within 25 minutes of nominal time.
3.	4	Completed automatically successfully after being delayed an average of 27.75 minutes by VAX systems time.
4.	2	Failed to connect due to telex network congestion or errors and were manually rescheduled with a delay averaging 49.5 minutes.
5.	1	Failed to connect due to telex network congestion or errors and was not rescheduled.
6.	1	Completed successfully but had missing data (ship position).
7.	2	Failed due to VAX or AUTOTELEX problems and were manually rescheduled with a delay averaging 73.5 minutes.
8.	1	Failed due to VAX or AUTOTELEX problems and was not rescheduled.

Table 1: Details of the telex communications between ECMWF and the WORLD PROGRESS, 13-27 July 1984.

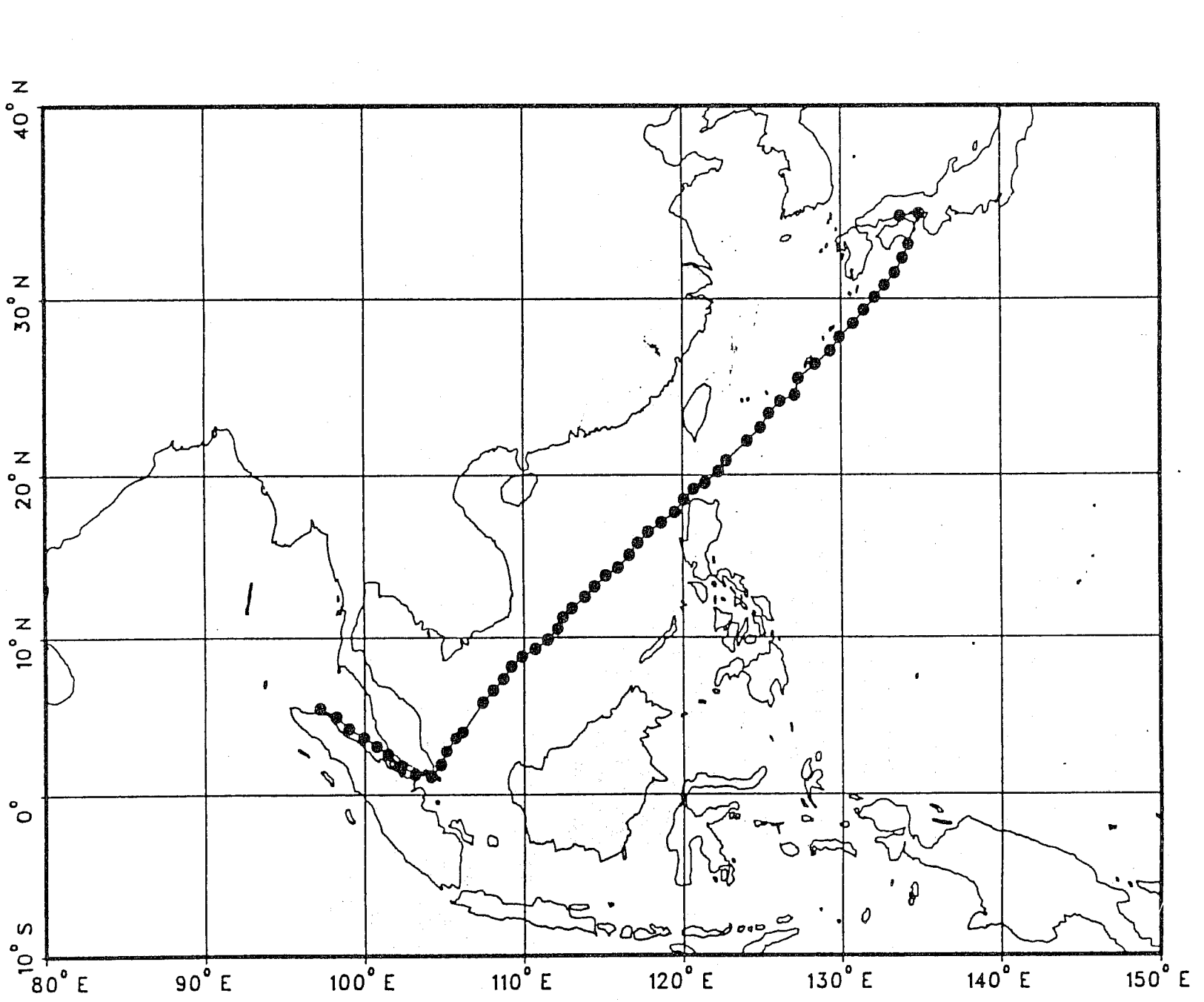

Fig. 1: Course of the WORLD PROGRESS during the experiment 13-27 July 1984. Each dot corresponds to the location from which atmospheric observations were collected from the ship.

4. Comments on Aspects of the Data Gathering

4.1. Format Standardisation

Unfortunately the experiment had to be limited to one ship as it was not possible to find ships with suitable ship earth stations able to have weather instrumentation installed.

If this method of data collection were to become widely used in the meteorological community, standards would be required in the following areas:

(i) A standard interface between an instrumentation package and a ship earth station would need to be specified.

(ii) A standard format for the coded data would need to be specified to aid decoding. Note, however, that other ship data is often transmitted in the data package and that provision would need to be made for this to continue.

(iii) A standard method for acquiring the data would need to be specified. In the experiment, a particular polling sequence of characters was sent to the ship, but the option would be open for the ship to automatically connect to a meteorological centre and to transmit data without polling.

4.2. Limitation of the Equipment

The location of the instrumentation package on the ship must always be a compromise dictated by the design of the ship superstructure. In the case of the WORLD PROGRESS, the wind speed and direction data may on occasions be inaccurate at certain wind directions with respect to the ship's course due to blocking from the ship radar scanner. Presumably the instrumentation package, or the collecting centre, could be aware of such limitations on specific ships and flag suspect data. In the evaluation of the usefulness of the data this problem did not arise.

WORLD PROGRESS was not equipped with a satellite navigation system, and under some circumstances the radio navigation system can give an error of up to 10 miles.

4.3. The Telex Network

Use of the telex network to gather the data proved to be very reliable, and was 100% reliable during the last 8 days of the trial, following tuning of the retry parameters.

Including the time required for retries it can be estimated that each telex line can accommodate 350-400 connections per 24 hours.

4.4. Connection to Telex Network

During the experiment, a commercially available VAX telex package, AUTOTELEX was used to connect to the ship. Whilst this performed satisfactorily, it is clear that a more sophisticated mechanism for specifying the INMARSAT satellite to be used would be necessary if the system were to be more widely used. This is due to the fact that the satellite is specified as part of the ship's telex number. A mechanism for remembering the last satellite used, and trying other satellites in the case of failure would be more appropriate for this application.

5. Quality and Usefulness of the Data

The course of the WORLD PROGRESS during the period of the experiment is given in fig. 1. Each dot corresponds to the location from which an observation was received. Gaps are related to the data collection problems discussed above.

A comprehensive manual checking of meteorological observations received from WORLD PROGRESS was carried out by comparison against independent information in the vicinity of the ship, e.g. other surface reports received via the GTS, and by comparison against ECMWF analyses.

5.1. Other Observations in the Area

Observations received from the ship WORLD PROGRESS have been plotted on analysed mean sea level pressure and 2-metre temperature charts every 6 hours, together with other surface ship observations available in the area.

The analysed surface pressure was usually well supported by several reliable ship observations in the area. The positions of these ships often coincided approximately with those of the WORLD PROGRESS, but none of them was identified as the WORLD PROGRESS. The latter obviously did not provide any conventional surface observations (SYNOP) via the GTS, which would have been used for comparing the data received via the telex network.

5.2. Quality

5.2.1 Pressure

The reported pressure values agreed very well with the analysed values and those from the surrounding ships. Deviations were always less than one millibar, often even smaller than half a millibar.

5.2.2 Temperature

The surface temperature observations from ships are not used by the ECMWF analysis system, but this parameter was also checked by comparing it to the analysed temperature field. Deviations in the order of 1^0 to 2^0 C (with a maximum of 3^0 C in two cases) were found; the observed temperature exceeded the value given by the analyses in the majority of the cases (63%).

5.2.3 Wind

This parameter was compared to the wind observations from surrounding ships only. Both direction and speed measured on the WORLD PROGRESS agreed very well with the data received from other ships.

5.3. Usefulness of the Observation

During the voyage the WORLD PROGRESS was surrounded by several other vessels reporting regularly through the normal GTS channels. Observations from the WORLD PROGRESS complemented the coverage of surface data in regions of the western North Pacific. As the automatically recorded pressure, wind and temperature values were found to be of good quality, the observations from the WORLD PROGRESS must be considered as a useful data set.

Similar reports from vessels en route through data sparse areas would be a welcome and valuable contribution towards the enhancement of the global data coverage.

6. The Potential Use of the INMARSAT Communication Links

A growing number of vessels will in future be fitted with satellite communication terminals. The meteorological community will benefit from these efficient data links providing a more stable ship to coast connection than the conventional radio stations. This will result in a more reliable collection of meteorological observations, a reduction in the loss of data and therefore an increasing data coverage.

The use of the INMARSAT system should not be limited to the application of collecting meteorological observations in the conventional WMO codes. Similar to the fully automatic gathering of atmospheric measurement taken onboard aircrafts (Aircraft to Satellite Data Relay, ASDAR), an automatic system can be envisaged for the collection of surface observations from ships by means of INMARSAT. The basic telecommunication facilities will be installed on the ships for commercial purposes. They need to be connected to sensors providing the atmospheric and possibly oceanic measurements. The data could be sent in connection with other information in a compressed form instead of using any WMO code. The meteorological information could easily be compressed into a few bytes. This would reduce the communications costs considerably.

The data collection could be operated by a few centres with responsibility for certain oceanic regions. These centres would have the obligation of making the data available globally by inserting them into the GTS after encoding into WMO code. The data could be accessed onboard ship with a recommended frequency, e.g. the synoptic hours, but high frequency polling of data from regions of special interest, e.g. during periods of rapid weather developments, is possible.

7. Summary and Conclusions

In a pilot study undertaken by ECMWF in cooperation with the owners and the master of the WORLD PROGRESS the feasibility of collecting ship generated automatic weather observations using a direct satellite telex link between the ship and the collecting centre was demonstrated. The data underwent a manual quality control by comparing it to other observations and to the ECMWF analyses. Surface pressure, temperature and wind observations were found to be useful and of good quality.

The data collection process was almost entirely automated requiring manual intervention only during the initial period while the system needed further tuning. It is anticipated that the automated data collection could be extended to cover more ships, but further investigations will be needed to determine the feasibility of such a system.

In order to set up an effective data collection from a large number of ships it would be necessary to use a few designated centres for the data collection and redistribution on the GTS in the conventional way. The data could be sent from the ship in a compressed form, with encoding into WMO code taking place at the receiving centre.

Sending the data from the ship in a compressed form of a few bytes per message should reduce the communications costs significantly.

It is estimated that, using a medium sized minicomputer and 5 telex lines, a system could be produced which would permit some 2,000 observations per day to be automatically collected and disseminated to the GTS.

Annex 1

Data available and Formats

WORLD PROGRESS is equipped with a number of sensors which can be polled from the telex network. The information available, and its format, is as follows:

A. Ship's callsign (6ZUY)

B. Date and time (GMT) in format MMDDHHMM (month, day, hour, minute - days are biassed by 40 - e.g. 07490927 = July 9 0927)

C. Latitude, preceeded by N or S in format degrees, minutes and decimal minutes - e.g. N34553 = north 34deg 55.3mins)

D. Longitude preceeded by E or W, as above

E. Omega navigation information

F. Surface temperature in tenths of a degree Celsius

G. Surface pressure in tenths of a millibar

H. Change in surface pressure over last 3 hours in tenths of a millibar

I. P(ave) - P(max) in tenths of a millibar, where P(ave) is average pressure detected by 3 sensors and P(max) is maximum pressure detected by 3 sensors

J. Wind direction (degrees)

K. Wind velocity (units unknown at present)

L. Ship's course (degrees)

M. Ship's speed (units unknown at present)

N. Shaft revolutions per minute

O. Total shaft revolutions in last 24 hours

P. Fuel oil consumption in past 24 hours

Q. Distance travelled in past 24 hours (units unknown at present)

The complete format of the message is as follows:

=AAAA =BBBBBBBB=CCCCCC=DDDDDD=EEEE EE
FFF=GGGGG HHH II
JJJ=KK=LLL=MMM=NNNN=OOOOOO=PPPP=QQQQ=