

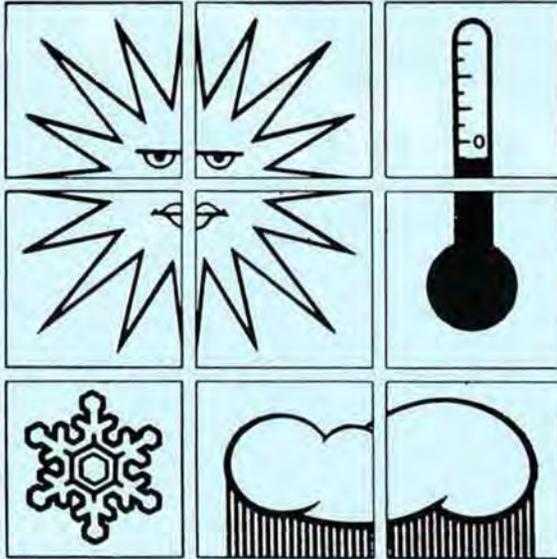
Chunook

THE CANADIAN MAGAZINE OF WEATHER AND OCEANS
LA REVUE CANADIENNE DE LA MÉTÉO ET DES OCÉANS

VOL. 9 NO. 2

SPRING / PRINTEMPS 1987





Learning Weather . . .

A resource study kit suitable for students grade seven and up, prepared by the Atmospheric Environment Service of Environment Canada

Includes new revised poster-size cloud chart

Découvrons la météo . . .

Pochettes destinées aux élèves du secondaire et du collégial, préparées par le service de l'environnement atmosphérique d'Environnement Canada

Incluant un tableau révisé descriptif des nuages

Learning Weather

A resource study kit, contains:

- 1. Mapping Weather**
A series of maps with exercises. Teaches how weather moves. Includes climatic data for 50 Canadian locations.
- 2. Knowing Weather**
Booklet discusses weather events, weather facts and folklore, measurement of weather and several student projects to study weather.
- 3. Knowing Clouds**
A cloud chart to help students identify various cloud formations.

Cat. No. EN56-53/1983-E

Each kit \$4.95

Order kits from:

CANADIAN GOVERNMENT PUBLISHING CENTRE
 OTTAWA,
 CANADA, K1A 0S9

Découvrons la météo

Pochette documentaire comprenant:

- 1. Cartographie de la météo**
Série de cartes accompagnées d'exercices. Décrit les fluctuations du temps et fournit des données climatologiques pour 50 localités canadiennes.
- 2. Apprenons à connaître la météo**
Brochure traitant d'événements, de faits et de légendes météorologiques. Techniques de l'observation et de la prévision de la météo. Projets scolaires sur la météorologie.
- 3. Apprenons à connaître les nuages**
Tableau descriptif des nuages aidant les élèves à identifier différentes formations.

Cat. N° EN56-53/1983F

Chaque pochette : 4,95 \$

Commandez les pochettes au :

CENTRE D'ÉDITION DU GOUVERNEMENT DU
 CANADA
 OTTAWA (CANADA) K1A 0S9

Order Form (please print)

Please send me _____ copy(ies) of Learning Weather at \$4.95 per copy. TOTAL \$_____. Cat. No.: EN56-53/1983E.

Name _____

School _____

Address _____ City _____

Province _____ Postal Code _____

Account No. _____ Enclosed \$ _____

Visa _____

Master Card _____

Expiry Date _____ Bank _____

Signature _____

Orders prepaid by postal money order or cheque must be made to the order of the Receiver General for Canada and addressed to the Canadian Government Publishing Centre, Ottawa (Canada) K1A 0S9. Also available through authorized bookstore agents or your local bookseller. Add 20% to prices for books to be shipped outside Canada. Payable in Canadian funds.

Également disponible en français: "Découvrons la météo"
 N° de cat.: EN56-53/1983F.

Bon de commande

Veuillez m'expédier _____ exemplaire(s) de la pochette "Découvrons la météo" à 4,95 \$ la copie. N° de cat. EN56-53/1983F.

Nom _____

Adresse _____

Ville _____

Province _____ Code postal _____

Ci-joint \$ _____ N° de compte _____

Visa _____

Master Card _____

Date d'expiration _____

Banque _____

Signature _____

Les commandes sont payables à l'avance par chèque ou mandat fait à l'ordre du Receveur général du Canada et doivent être adressées au Centre d'édition du gouvernement du Canada, Ottawa (Canada) K1A 0S9. En vente aussi chez les agents libraires agréés ou chez votre libraire.

Téléphone (819) 997-2560

Télex 053-4296

Also available in English: "Learning Weather"

Cat. No. EN56-53/1983E

The study on the Armada Storms of 1588 (see page 28) forms a new initiative on our part in our efforts to provide meaningful resource materials to secondary schools and undergraduate university programs. The weather discussion, supported by many relevant reports and inferred surface weather charts and authoritative meteorological interpretations, can form the basis for a combined series of classes and lectures between the history and geography teacher or lecturer. We propose that this particular topic could indeed be dealt with in this way. Teachers are often searching for a unique situation when team-teaching would be appropriate. We strongly suggest that the important historical event of the Spanish Armada is such an opportunity, particularly when supported by the study made by the Climatic Research Unit at the University of East Anglia. The team of researchers that lend their expertise to the topic consist of world-renowned authorities on historical climatology.

Besides being an occasion to teach basic weather theory, it is also an opportunity to teach a unique historical event. Similar studies can be undertaken when studying such happenings as the endeavours of William the Conqueror (1066), the Normandie landings (1944) and many others where weather formed a major factor in failure or success.

We further suggest, for the Armada storms, related studies about the vessels used at that time, the navigation theory used, the way decisions were made and the lines of communications that were available.

Since the beginning of human life, weather has played a significant part in the outcomes of our endeavours. Floods, famines, widespread epidemics, the development of nations, and the demise of others, all had a strong linkage with weather and climate factors.

It is strongly suggested that the teacher use an atlas or a suitable map (e.g. *National Geographic*) in locating the various places mentioned in the study.

We would appreciate very much any comments from schools on the usefulness of the study.

Hans VanLeeuwen

COVER

The Duke's Armada flagship, the *San Martin* (left), engages the *Ark Royal* off the Isle of Wight, as depicted by Hendrik Cornelisz Vroom. See the article on page 28.

COUVERTURE

Hendrik Cornelisz Vroom dépeint l'attaque du *Ark Royal* par le vaisseau amiral *San Martin* (à gauche) de l'armada du Duc au large de l'île de Wight. Voir l'article à la page 28.

Chinook

Spring / Printemps 1987 Vol. 9 No. 2

FROM THE EDITOR'S DESK	27
FLAVIT ET DISSIPATI SUNT – IT BLEW AND THEY WERE SCATTERED; THE SPANISH ARMADA STORMS. A Weather Perspective of July to October 1588	28
FALL OF '86 – A REVIEW By Peter Scholefield	44
EXTRAORDINARY CLIMATOLOGICAL EVENTS – 1986 By Peter Scholefield	45
FALL RAINS ON THE PRAIRIES By Hans Van Leeuwen	46
BOOK REVIEW	46
PRÉSENTATION D'ARTICLES POUR LE <i>Chinook</i> À L'INTENTION DES AUTEURS	47

EDITORIAL BOARD / CONSEIL DE RÉDACTION

- | | |
|--|---|
| Frank A. Boddy
Ontario Association for Geographic and Environmental Education Inc.
Barrie, Ontario | John W. Loder
Bedford Institute of Oceanography
Dartmouth, Nova Scotia |
| Howard Freeland
Institute of Ocean Sciences
Sidney, British Columbia | John Maybank
Saskatchewan Research Council
Saskatoon, Saskatchewan |
| Barry Grace
Agriculture Canada Research Branch
Lethbridge, Alberta | Jerry Salloun
Don Mills Collegiate
City of North York, Ontario |
| Yves Gratton
Université du Québec à Rimouski
Rimouski, Québec | Hans VanLeeuwen (Chairman)
Atmospheric Environment Service
Downsview, Ontario |
| Richard Leduc
Ministère de l'environnement
Québec, Québec | |

EDITOR: Hans VanLeeuwen RÉDACTEUR
 TECHNICAL EDITOR: Edward J. Truhlar RÉDACTION TECHNIQUE
 BUSINESS MANAGER: J. Carr McLeod GESTIONNAIRE
 ART WORK: Bill Kiely and Joan Gadger ILLUSTRATION
 TRANSLATION: Joanne Gagnon Pectini TRADUCTION
 FOUNDER AND EDITOR 1978-1984: Michael J. Newark FONDATEUR ÉDITEUR 1978-1984
 ISSN 0705-4572

Published by:
Canadian Meteorological and Oceanographic Society

Publié par:
La Société canadienne de météorologie et d'océanographie

Printed and produced in Canada and published quarterly by the Canadian Meteorological and Oceanographic Society, Suite 903, 151 Slater Street, Ottawa, Ont. K1P 5H3. Annual subscription rates are \$10.00 for CMOS members, \$12.00 for non-members and \$15.00 for institutions. Content copyright © the authors 1987. Copying done for other than personal or internal reference use without the expressed permission of the CMOS is prohibited. All correspondence including requests for special permission or bulk orders should be addressed to *Chinook* at the above address.

Second Class Mail Registration No. 4508
Spring 1987 Date of Issue – June 1987

Édité et imprimé au Canada, *Chinook* est publié tous les trois mois par la Société canadienne de météorologie et d'océanographie, Suite 903, 151, rue Slater, Ottawa (Ontario) K1P 5H3. Les frais d'abonnement annuel sont de 10,00 \$ pour les membres de la SCMO, de 12,00 \$ pour les non-membres et de 15,00 \$ pour les institutions. Les auteurs détiennent le droit exclusif d'exploiter leur œuvre littéraire (© 1987). Toute reproduction, sauf pour usage personnel ou consultation interne, est interdite sans la permission explicite de la SCMO. Toute correspondance doit être envoyée au *Chinook* à l'adresse ci-dessus, y compris les demandes de permission spéciale et les commandes en gros.

Courier de deuxième classe – enregistrement n° 4508
Printemps 1987 Date de parution – juin 1987

FLAVIT ET DISSIPATI SUNT IT BLEW AND THEY WERE SCATTERED* THE SPANISH ARMADA STORMS

A Weather Perspective of July to October, 1588

During the late 1500s and early 1600s the Spanish under the leadership of King Philip were deeply involved with rebellion and heresy in the Netherlands. As long as the English continued to provide help to the Dutch, it would be nearly impossible to defeat the rebels. Further factors that led to worsening of the relations between Spain and England were the competition for the riches of the Americas, and the religious differences between the two countries.

THE ARMADA

The invasion of England seemed to have been a desirable solution to the Spanish problems and planning for the formation of a fleet commenced in about 1580. In January 1586, King Philip had assembled a fleet of new and re-armed old ships; by May 1588 the Armada was ready – the Invincible Armada, since Spain believed it could not be beaten.

At that time about 130 ships were assembled in the port of Lisbon. On May 30, 1588, the Armada raised sail and left Lisbon. The Duke of Medina Sidonia was named by the King to lead the Armada. Unfortunately for the Spanish, the Duke lacked experience as a sailor. On July 30, 1588, the fleet entered the English Channel and encountered the English warships.

HISTORICAL SUMMARY

From the historical point of view certain events influenced, or directly affected, by the weather stand out as significant to the fate of the Armada, and a meteorological interpretation of them may be considered to make a new contribution to Armada history. The most important of them is probably the great gale that destroyed many of the Spanish ships on the Irish coast on September 21, 1588. This one incident caused the loss of more ships and men

*Inscription from the commemorative medal issued by Queen Elizabeth of England after the Armada events.



The commemorative Medal.

than any other during the whole voyage, including the English gunfire at Gravelines and in the Channel. But it might be well to take them in chronological order:

- The high winds of July 26–27 caused the four galleys to drop out of the voyage and run for the coast of France. The *Santa Ana*, flagship of Vice-Admiral Juan Martinez de Recalde, was so damaged that she put into Le Havre where she was later wrecked. Recalde himself transferred to the Portuguese galleon *San Juan* and continued the voyage.
- The first battle between the two fleets was fought off Plymouth on Sunday morning July 31 in apparently fairly brisk sea conditions followed by a rough night on July 31–August 1.
- From Monday August 1 till Saturday

August 6, in a period of much lighter winds, the Armada sailed along the English coast on its way to Calais. There were several battles, and obviously weather conditions during this whole week are important.

- The English fleet had the advantage of what wind there was for almost the whole time, in other words the wind was mostly Westerly. The one important exception was Tuesday morning August 2 when at dawn there was a land wind, apparently with an Easterly component, off the coast of England, giving the Armada the advantage. By 10 o'clock in the morning it was round to Westerly again. An understanding of the light winds of this period must be useful.
- On Sunday night, August 7, there was the fireship attack and on Mon-

day August 8 the biggest of the sea battles, at Gravelines.

- Tuesday, August 8, saw "the miraculous change of wind" on the banks of Zeeland. Accepted till now almost literally as a miracle, a proper meteorological explanation must be useful to historians.
- The constant Southerlies and Southwesterlies that prevailed for the rest of the week from August 8 to 10 prevented the Armada from returning to the Channel and the junction with Parma (Spanish governor of the Netherlands).
- Between August 21 and September 3 the Armada, having rounded Scotland between the Orkneys and Fair Isle, was held in high latitudes by South and Southwest winds at a time when given favourable conditions they might have made it home, before the violent weather that followed during September destroyed so many ships. During this period most of the Armada seem to have held on off the Hebrides, but a group of about 30 ships including Recalde's galleon *San Juan* and the galleass *Zuñiga* fell off to the northwest and, it is alleged, reached 63½°N.
- From September 12 onwards the buildup to the great gale on the 21st seems, despite rather sketchy data, to have been marked by a considerable sameness of the weather pattern, which can be explained by an anticyclonic regime gradually retreating farther east over Europe while a vigorous cyclonic Southwesterly sequence continued to develop over the Atlantic fringe. Essentially the same sequence seems to have continued till the 28th.
- The great gale of September 21 sank 2 ships off the Irish west coast at Blasket Island, one in the Shannon, 2 on the Co. Clare coast, one in Galway Bay, one at Clare Island, Co. Mayo, the *Rata* of Don Alonso at Blacksod Bay, Co. Mayo, a ship at Broad Haven, Co. Mayo, 3 ships (including Capt. Cuellar's) at Streedagh Strand, Co. Sligo, and 2 ships in company with the galleass *Girona* sheltering in Killybegs Harbour, Co. Donegal; 2 ships sank at sea off the north coast of Ireland – the *Bark of Hamburg* and *Juliana* – 17 in all and a number of other missing ships may have been its victims as well.
- From the point at which the Low w, which produced this gale, entered the mapped area it seems possible that it originated as a tropical storm, in much the same way as hurricane *Debbie*, which devastated woodlands



Museo Naval, Madrid



National Maritime Museum, Greenwich

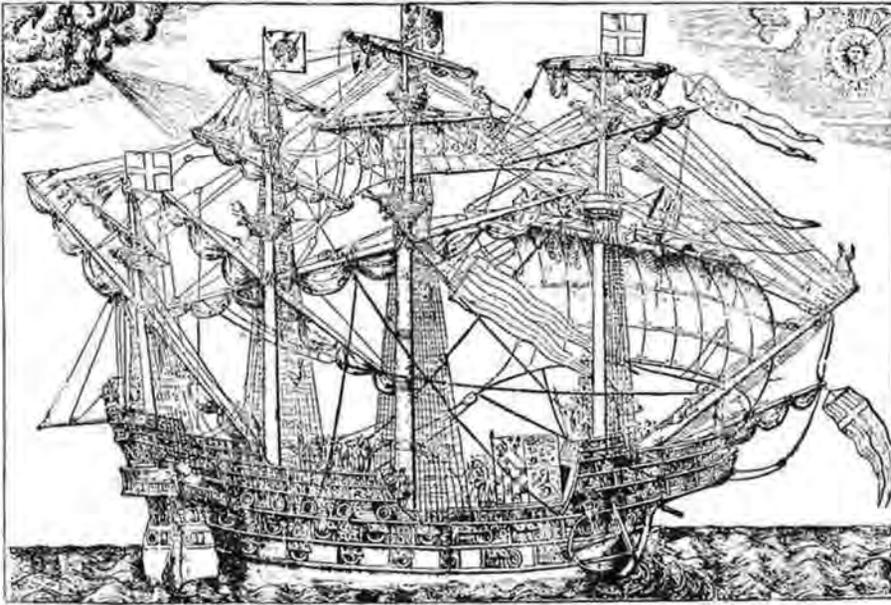
Principal contenders in the struggle between Spain and England. Left: Duke of Medina Sidonia. Right: Sir Francis Drake.



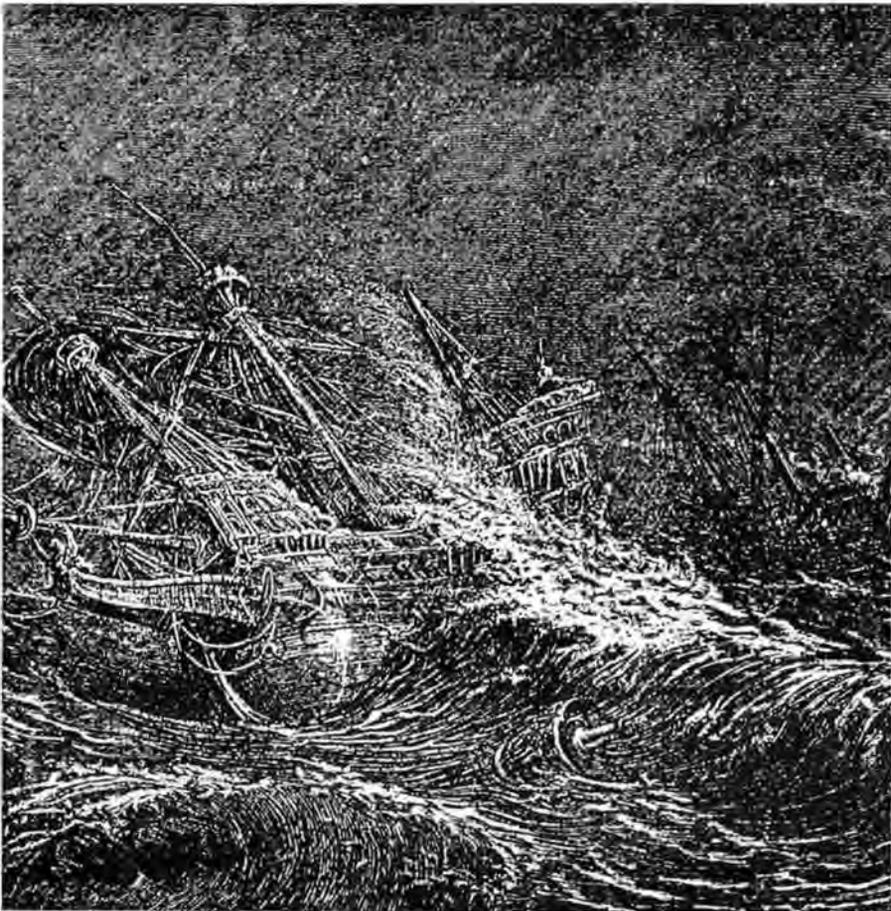
The Spanish Armada.

- in the west of Ireland on September 16, 1961.
- The days following the great gale are important as well, since during that time a number of ships previously trapped on the Irish coast got away and made it safely back to Spain, among them *Marcos de Aramburu* whose log is such a rich source of information.
- One ship that did not get away at the end of September was the *Girona*. She did not leave Killybegs until October 26, and the weather information tabulated for that day is deduced

from the circumstances rather than based on a contemporary report. The only specific contemporary weather reference says "she was hit by a squall". There is a conflict of information about the date she was wrecked on Giant's Causeway, some 200 km away to the northeast from Killybegs. One report says midnight on the 26th, another the following night, Friday the 27th. The latter, implying 40 hours of sailing time, seems the more likely in the difficult sailing weather around the exposed coast of Donegal and farther east.



The *Ark Royal*, The Lord High Admiral's Flagship.



Armada ships wrecked on the coast of Ireland.

REPORTS, MAPS AND INTERPRETATIONS

A wide range of sources was consulted by the authors of the original University of East Anglia study. Only a small but representative sample is reproduced here to assist in providing a logical and coherent flow to the weather events of that fateful summer of 1588. All dates refer to the modern Gregorian or New Style (N.S.) calendar rather than to the Julian or Old Style (O.S.) calendar. Positions are referenced either by latitude and longitude or by a specific geographic feature. The Authority makes reference to the source of the information and is identified through its author (e.g., The Duke of Medina Sidonia), letters and statements from those involved, and ship logs. Ships' names are indicated by italics.

The following reports thus provide on-the-spot descriptions of the actual weather elements and their impact on the Armada or specific vessels. The relevant meteorological interpretation ties together the inferred pressure and weather patterns and should be read in conjunction with the series of almost daily surface isobaric charts (see pages 35–38). Low- and high-pressure centres can be easily followed on the chart series since each is identified with a lower case letter (e.g., L_m and H_k). Several of the charts also indicate the estimated positions of several of the ships, whose reports are reproduced in-part in the report-interpretation tables. The Armada itself is shown with the black dot •, the Duke's ship with a \textcircled{D} , the *Aramburu* with an \textcircled{A} , the *Zuñiga* with a \textcircled{Z} , and the *Girona* with a \textcircled{G} .

ACKNOWLEDGEMENTS

This rather unique study is only a digest of the in-depth study that was carried out by Emeritus Professor H.H. Lamb and Dr. C. Loader of the Climatic Research Unit, School Of Environmental Sciences of the University of East Anglia in Norwich, United Kingdom, and Professor K.S. Douglas. The study was reported in detail in the Unit's Research Publications Nos. 6 (1978) (CRU RP6) and 6a (1979) (CRU RP6a). These publications can be purchased from the University (U.K. postal code: NR4 7TJ). It is gratefully recognized by *Chinook* that full permission was received from the Director of the Climatic Research Unit, Dr. T.M.L. Wigley, to reproduce material from the study. The maps were produced by Mr. David Mew and Mr. Peter Scott of the School of Environmental Sciences.

Date, Position and Authority	REPORTS	METEOROLOGICAL INTERPRETATION
Friday, July 22 CORUNNA The Duke of Medina Sidonia	Light SW wind in the morning following strong WNW winds the day before. The Armada left port but at 2 o'clock in the afternoon it fell dead calm.	The rear side of a low-pressure area had given the ships off northwest Spain strong WNW winds on July 20–21. This seems to have been followed by a sharp ridge of high pressure, giving calm conditions around the time of the map, followed in turn by winds from SE and S as the ridge passed on ahead of the ships.
Monday, July 25 BISCAY Calderon; The Duke	A strong wind sprang up and the Armada continued on its course. We proceeded on our voyage in excellent weather – no better weather could have been desired.	The ridge of high pressure continued to move east or northeast, followed by another Atlantic low. As the fronts of the low approached the ships, the wind strengthened probably at first from about S and later from SW.
Tuesday, July 26 NORTH BISCAY, 48°N The Duke	On Tuesday at dawn we had a dead calm with a very dense fog and the Armada made no way until midday when a wind from the North sprang up and we set an easterly course. ...I ordered the fleet to tack to the west...in the NNW winds and constant heavy squalls the whole day and following night we made but little way...after nightfall the weather became thick with very heavy rain.	The interval of dead calm and dense fog suggests the central region of a depression passing over, or close to, the ships: also rather cold sea – the unusual wind patterns, frequently blowing from the lands north and east of the ships' position may have produced some upwelling. The wind soon changed to Northerly as the centre moved away, probably northeastwards, and deepened. The thick weather and heavy rain at night are attributed to a trough – possibly the back-bent occlusion – moving South at the rear of the depression.
Wednesday, July 27 OFF BRITANNY The Duke	It blew a full gale with very heavy rain squalls and the sea was so heavy that all the sailors agreed that they had never seen its equal in July. Not only did the waves mount to the skies but some seas broke clean over the ships and the whole of the stern gallery of Diego Flores' flagship was carried away. We were on watch all night full of anxiety...it was the most cruel night ever seen.	The wind direction was not reported by the ships, but it seems reasonable to deduce that the depression of the day before was deepening as it moved on northeastwards, leaving the Armada in very strong winds from between NW and W.
Friday, July 29 OFF SCILLY ISLES The Duke	Friday dawned fine but hazy clearing as the day advanced. We continued to sail with a Westerly wind until midday when I ordered the sun to be taken. We found ourselves in 50°N. At 4 o'clock in the afternoon whilst still sailing with a Westerly wind the weather being clear we sighted land at the Lizard.	The low-pressure area experienced by the ships in the previous days seems to have moved away by the 28th far enough for some ridge development at the mouth of the Channel in the cold air. By the next day, the hazy conditions reported suggest the return of warmer air from the S or from France, the crest of the ridge of high pressure having passed east of the ships.
Sunday, July 31 OFF PLYMOUTH The Duke	The day broke with the wind changed to WNW in Plymouth Roads. By 4 o'clock in the afternoon the wind and the sea had risen to the extent that the Duke could not get a line on board the damaged <i>San Salvador</i> of Don Pedro de Valdez to put her in tow. During the night the wind and sea rose considerably.	The thick weather on the afternoon of the 30th is attributed to a warm front. By 2 a.m. on the 31st the moon was out, possibly thanks to a clearance in the warm sector. During the skirmish later that morning the wind came round WNW, presumably with the cold front of the depression, followed by increasing wind and rough seas.
Monday, August 1 OFF DEVON COAST <i>Zuñiga</i>	The main authorities, the Duke, Calderon and English sources, make no mention of weather on Monday, August 1. The Armada progressed eastwards followed by the English fleet so it can be assumed that the wind was generally Westerly and since there was a lot of communication with other vessels by way of pataches, etc., it was probably light to moderate in character. The <i>Zuñiga</i> report (a high unreliable document in several points) states that after nightfall on August 1 the wind fell calm and the Armada got separated in all directions.	On the 1st, the low-pressure system of the day before had moved away from the area. There followed a period of settled weather that lasted 4 to 5 days, a duration quite characteristic of the life of a slow-moving anticyclone cell.
Tuesday, August 2 OFF PORTLAND Calderon	The day dawned with an Easterly wind, the enemy's fleet being consequently to leeward of us, but the wind being light and the enemy's ships swifter than ours we were unable to give them chase. At 10 o'clock in the morning the wind shifted to the South which enabled the enemy to gain the wind.	

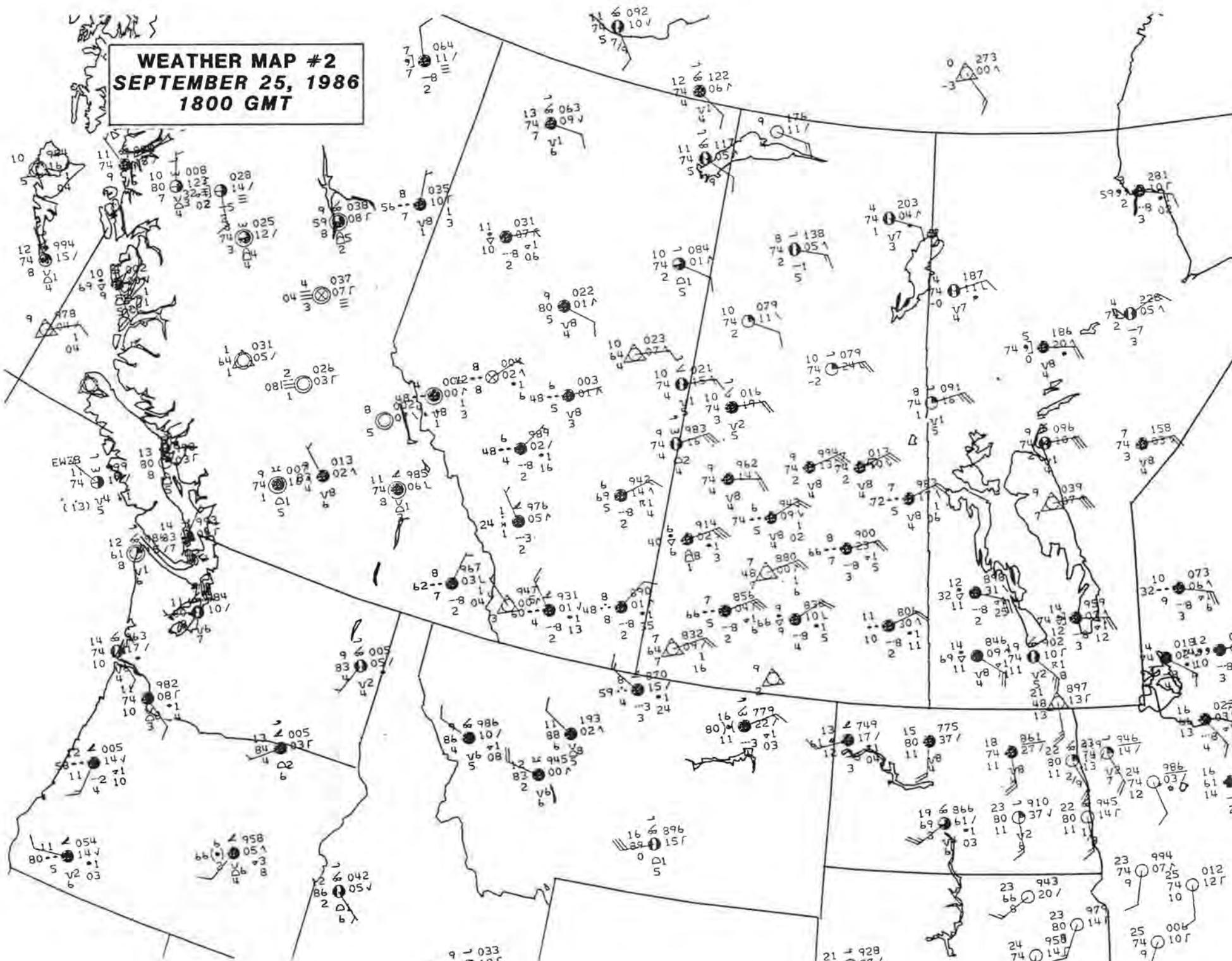
Date, POSITION and Authority	REPORTS	METEOROLOGICAL INTERPRETATION
<i>Wednesday, August 3</i> OFF ISLE OF WIGHT Calderon	...the wind then fell light and the enemy fearing the galleasses remained two leagues from our Armada....	An anticyclone seems to dominate the area of the Channel during these days, giving fair, settled weather and light winds. By the 5th, a light to moderate general breeze from the West may be deduced as the high-pressure centre began to drift away south of the area.
<i>Friday August 5</i> OFF SUSSEX COAST The Duke	On Friday the 5th the wind fell calm before dawn, the enemy always being on our rear and we remained motionless all day. At sunset a breeze sprang up and the Armada again got under way on the voyage towards Calais.	The anticyclone seems to have moved away southeastwards and winds over the Channel area were freshening from the SW, or SSW, except under the lee of the land at night. The showers on the 7th may have accompanied the passage of the fronts of the depression and the wind direction then veered to W and later NW.
<i>Saturday, August 6</i> OFF FRENCH COAST AT BOULOGNE Calderon	On Saturday the 6th the wind was blowing from the South-West, the weather being heavy with showers. The intention of the Duke was to anchor abreast of Calais with the wind astern. At night the weather fell light.	The frontal wave shown on the map is suggested by some report of an interval of light to moderate SW wind during the night of the 7th but it soon passed and the wind freshened from NW during the 8th. The heavy seas later suggest a long fetch of the windstream over the North Sea, the depression centre having presumably crossed Scotland and begun to move away northeastwards.
<i>Sunday, August 7</i> OFF CALAIS Calderon	On Sunday the 7th the weather was calm until 5 o'clock in the morning when it freshened with showers. At midnight the enemy set adrift eight fire ships with their sails set and the tide [?current?] in their favour.	"The miraculous change of wind" here reported marks the passage eastwards of the sharp ridge of high pressure indicated on the maps of the 8th and 9th ahead of the advancing Low f.
<i>Monday, August 8</i> OFF GRAVELINES The Duke	At dawn the Duke saw that his Armada was far ahead and went to collect them to bring them back to their previous position.* The wind freshened from NW, which is on shore, and the English fleet of 136 sail with the wind and tide in its favour was overhauling us with great speed....As the night was falling the sea was very heavy....the wind was blowing from NW towards the land and the pilots told him he would be forced either to run up into the North Sea or wreck all the Armada on the shoals. *These sentences are from the Duke's own report although he refers to himself in the third person.	The winds experienced by the ships of the Armada between the Strait of Dover-Flanders coast region and the northern North Sea blew continuously from about S or SW for four days, indicating that the anticyclone had become nearly stationary over the continent while the lows were being steered northeastwards over the Atlantic. The thick visibility reported indicates the passage of warm air over the cool sea.
<i>Tuesday, August 9</i> OFF ZEELAND The Duke	At 2 o'clock in the morning the wind blew so strongly that although our flagship was brought up as close to the wind as possible she began to fall off to leeward towards the Zeeland coast. At daybreak the NW wind fell somewhat and we discovered the English fleet of 109 ships rather over half a league astern....It was going to be impossible to save a single ship of the Armada as they must inevitably be driven by the NW wind on to the banks of Zeeland. From this desperate peril we were saved by the wind shifting by God's mercy to the SW and the Armada was then able to steer a northerly course. The wind from the SSW kept increasing in violence and we continued to get farther out to sea.	
<i>Wednesday, August 10</i> SOUTHERN NORTH SEA The Duke	The Armada was under way with a fresh SW wind and heavy sea. In the afternoon the violence of the wind abated.	
<i>Friday, August 12</i> OFF A SHOAL ON THE GERMAN COAST 55°N The Duke	We have continued sailing with the same wind.	
<i>Saturday, August 13</i> NORTH SEA Capt. Fenner in the <i>Nonpareil</i>	About 10 o'clock in the morning the wind came up at North-West. Stayed at NW till the 14th when it came up at SW and especially at night continued a very great gale at SW forcing him to ride out at sea.	

Date, POSITION and Authority	REPORTS	METEOROLOGICAL INTERPRETATION
<i>Sunday, August 14</i> NORTH SEA Seymour, Wynter and Palmer; Anon. Italian	A great storm at WSW. On the night of the 14th a great tempest arose, which lasted 40 hours.	
<i>Monday, August 15</i> NORTH SEA Sir Francis Drake	A great storm considering the time of year. ...from the 13th to the 18th we experienced squalls, rain and fogs with heavy sea and it was impossible to distinguish one ship from another.	The change of wind to NW about 10 o'clock on the 13th presumably marked the passage of a cold front and of the depression centre away to the east of the ships. The Southwesterly storm that followed was clearly produced by the approach of another depression from the Atlantic, evidently a very vigorous one for August and presumably with a very low central pressure since the anticyclone can no longer have been anywhere near.
Calderon		The great storm depression approaching on the 15th evidently made rather slow progress from the 16th to the 19th, during which time the variations of weather noted were such as might be produced by successive frontal wave depressions maintaining the activity of the cyclonic system and causing troughs of low pressure to extend south from the main Low centre and pass generally eastward. The continuance of high seas off northern Scotland to the 20th suggests a direct Northerly airstream from the Norwegian Sea followed the depression, and a meridional ridge of high pressure temporarily linking the subtropical and Arctic anticyclones came east from the Atlantic.
<i>Saturday, August 20</i> OFF NE SCOTLAND Calderon	The weather being very heavy we lost sight of Juan Martinez de Recalde and all the ships that followed him....we continued on our voyage alone through squalls and fogs.	
The Duke	We have now doubled the last of the Scottish Islands to the north and we have set our course with a NE wind for Spain.	The long sequence of unsettled weather and generally Southerly winds off northwest Scotland must indicate that the eastward passage of Lows from the Atlantic was blocked in the latitude of the British Isles and at times even farther north.
<i>Sunday, August 21</i> OFF NORTHERN SCOTLAND Zuñiga	On the 21st we saw the extreme point of Ireland [more probably the Hebrides]. The wind then freshened from the South and the Armada stood out to sea for the next 15 days reaching as high as 63½°N on September 8 [50 miles from Iceland].	No fronts seem to have produced any major change of wind direction at the ships, though the strength of the southerly windstream varied.
<i>Wednesday, August 24</i> 58½°N Calderon	From August 24 to September 4 we sailed without knowing whither through constant storms, fogs and squalls.	(From August 25 the log of Captain Marcos de Aramburu gives more detailed information.)
<i>Friday, August 26</i> OFF HEBRIDES Aramburu	The morning of the 26th it was still foggy, our main foresail was damaged and we were forced to repair it. Since it was raining and it took a lot of work we were delayed until about 1 o'clock after midday. In the afternoon we saw the Flagship with some other ships on our prow to the South-West and somewhat to windward [i.e., wind probably now SW or WSW].	The changes of wind direction and weather reported on the night of August 24–25 probably mark the passage of a warm front north over the ships and also indicate that the central regions of the cyclonic activity (tips of the warm sectors) were coming nearer than before. By the 27th the wind direction became more changeable and some cyclonic activity (warm front waves?) evidently began to break away to the east quite near the latitude where the ships were.
<i>Saturday August 27</i> OFF HEBRIDES Aramburu	During the night, about the fifth watch, the wind changed to South, the South-West and even as far as NNE. I gave orders to set course to the SSW. At dawn we saw some ships to the west to windward [i.e., wind W]. At nightfall the wind was Westerly as it had been all day. From dusk right through the night we pressed on with both mainsails changing course to SSE close to the wind which was the best we could do [i.e., wind changed to SW forcing them off their SSW course].	The erratic changes of the wind direction in the area where the ships were indicates the passage of a cyclonic centre (or centres) quite close. This is interpreted on the map as a warm front wave development. The sequence of weather observations from Denmark from this time onward indicates that the front in that sector was held farther south by prominence of a ridge from a polar anticyclone and wave activity passing east or east-southeast along the front, presumably steered by a West Northwesterly jet stream.
		Farther south over the British Isles and central Europe the situation was probably not much changed.

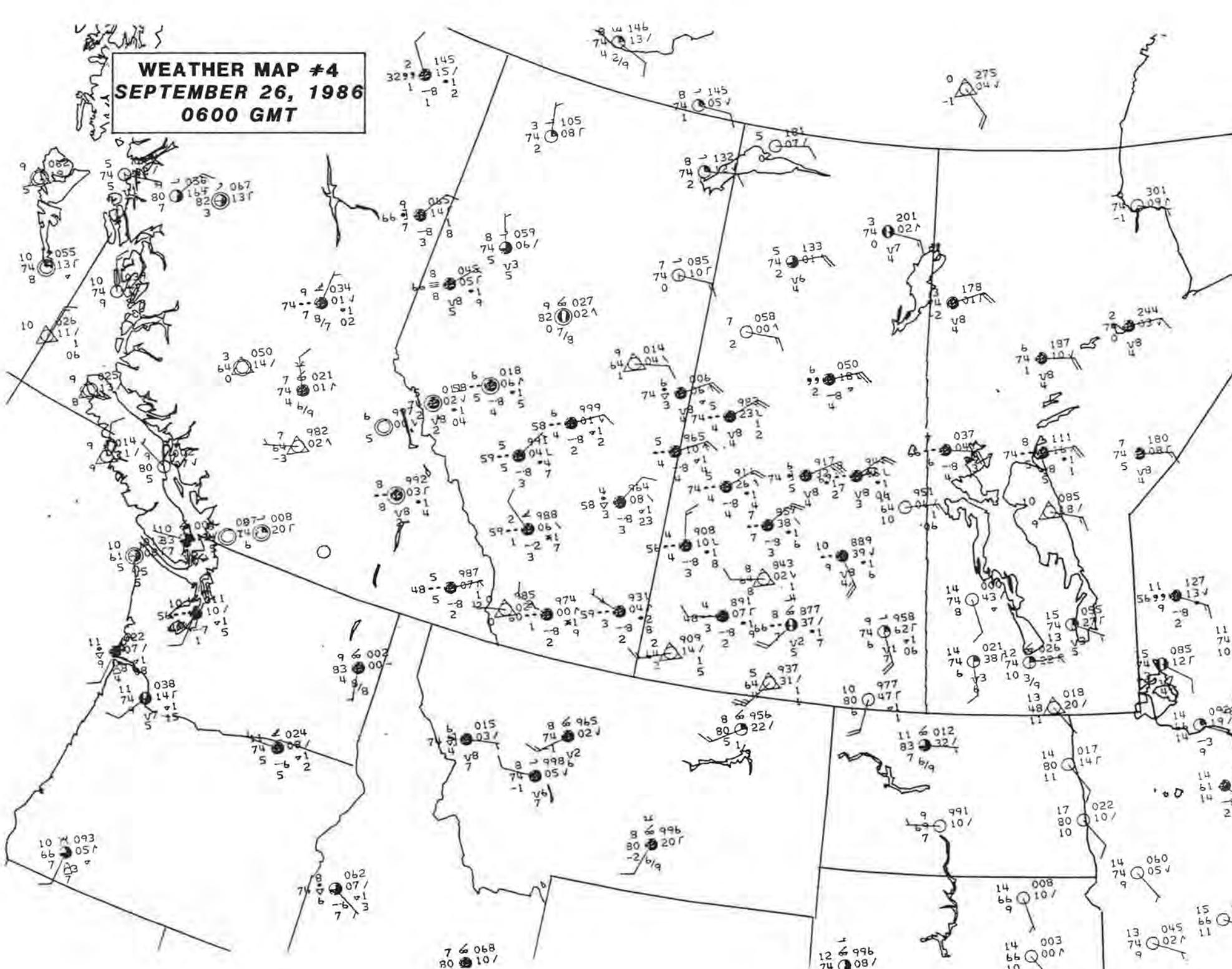
Date, POSITION and Authority	REPORTS	METEOROLOGICAL INTERPRETATION
Monday, August 29 WEST OF HEBRIDES, 58°N Aramburu	At dawn on the 29th the wind began to freshen from the South with heavy seas, mists and rain. We continued on the same course [W¼SW] with the mainsails lowered until night and all through the night until dawn on the 30th.	The ships off the Hebrides experienced a calm interval on the night of August 28–29. After that a front approached from the South, and renewed cyclonic activity made itself felt over the Atlantic. The wind variations between S and NE indicate a sequence of frontal waves probably travelling northwestwards over the Atlantic and intervening ridges of higher pressure affecting the area about the ships. The prominence of the polar anticyclone explains the wind directions in that area as well as over Denmark, a front, initially with some wave activity travelling southeastwards, being held effectively stationary from Scotland to the German Bight.
Tuesday, August 30 WEST OF HEBRIDES Aramburu	On the morning of the 30th the wind dropped but with a very heavy shower as the wind died and the sea moderated.	At first the general Southeasterly wind current continued over the region in which the ships were, the sea mist indicating that the air was warm before coming over the sea. During September 2nd a decisive change is registered by the wind shifting right round to NW and becoming strong: clearly a deepening depression broke through to the east on a new track.
Saturday, September 3 OFF HEBRIDES, 58°N The Duke (letter)	Since August 21 we have had on four separate nights heavy gales with strong head winds, thick fogs and rain. By God's mercy yesterday at noon the wind shifted to the West somewhat more in our favour. [This weather did not reach Aramburu until 2 hours after dark.] The wind has now veered to WNW with a more favourable appearance, but the winds on this coast are always more tempestuous than elsewhere and are so prevalent from the South that there is no certainty of a continuance of the present fair weather.	The change of weather on the evening of the 2nd had reached the Duke at 58°N at noon but did not reach Aramburu at 56½°N until 2 hours after dark. The cyclonic centre seems to have been well to the north of the ships, as the winds continued about NW and WNW through September 3rd.
Tuesday, September 6 WEST OF HEBRIDES, 56½°N Aramburu	We ran before the wind from WSW¼W [22¼ compass points] with heavy seas and strong wind until 2 o'clock in the afternoon when we had a heavy shower. At once the seas moderated and the wind moved round to WNW, the sea continued to moderate and we sailed SSE.	A mobile Westerly cyclonic sequence continued to affect the region of the northeast Atlantic where the ships were, with passing warm sectors and fronts and mostly strong winds and seas, while England enjoyed quiet, somewhat autumnal, anticyclonic weather.
Thursday, September 8 OFF NW IRELAND, 55°N Aramburu	The day dawned with the wind [WNW] and the sea the same as the previous afternoon. The latitude was taken at 55°N and we were sailing on a bearing SE¼S [12¼ compass points; 32 points = 360°].	Lighter winds in the region of the ships indicate that the area of influence of the anticyclone over the British Isles was spreading. The changes of wind direction mean, however, that the ships were still affected by the variations associated with the passage of cyclonic activity and intervening ridges of high pressure around the fringe of the anticyclone.
Monday, September 12 OFF SW IRELAND Aramburu	On the 12th we kept on heading out to sea with the same wind and sea conditions and at 5 o'clock in the afternoon it began to blow from the South with great strength, which by the night had become a very heavy storm with very rough seas and sea mist. The ship <i>Trinidad</i> had joined us, it had both sails furled; from midnight onwards we were unable to see it although we showed our lantern signal.	The anticyclone of the previous days over the British Isles clearly moves away eastwards, allowing strengthening Southerly winds to encroach ahead of the fronts of an Atlantic Low (t), probably coming from the southwest. This depression passed quickly. The wind at the ships veered NW and dropped as the cold front passed, a situation likely to be followed by at least some minor wave activity (Low u) on the front.
Tuesday, September 13 LE HAVRE Pedro de Igueldo (letter to Mendoza, September 17)	[His letter of September 17 describes events at Le Havre after the English attack on the <i>Santa Ana</i> on the 9th and 10th. Each event is not precisely dated but after the 12th he says]...after lightening the ship all we could with the intention of getting her into the harbour at the spring tides tomorrow a great gale arose and as these roads are unsheltered the cables broke at nightfall and the ship drifted ashore near the castle of the town. [No wind direction is given but Le Havre roads are south of the town so the ship drifting ashore is consistent with Aramburu's Southerly gale off SW Ireland on the night of 12th/13th.]	Igueldo's letter confirms that the Southerly gale encountered off Ireland on 12–13th continued to advance eastwards ahead of the fronts of the depression, until it affected the eastern part of the Channel and the French ports. In the rear of the depression the winds ultimately became Westerly and quite strong.

Continued on page 39

WEATHER MAP #2
SEPTEMBER 25, 1986
1800 GMT



WEATHER MAP #4
SEPTEMBER 26, 1986
0600 GMT



Friday, September 16
Co. CLARE
Zuñiga

[Farther north the *Zuñiga* was off the coast of Co. Clare, their report says] "on the morning of the 15th the wind changed to the west and we resumed our voyage. In the evening the wind blew heavily from the South again and we found ourselves between two points on the Irish coast neither of which we could get round on any tack for want of a rudder. We saw we were in great danger and in order not to be driven aground in the strong wind we followed the creek and, by God's grace, found shelter not far from a tower held for the enemy. Here we remained 8 days until the 23rd when we got out with the wind astern."

There was an interval of lighter winds on the west coast of Ireland on the 15–16th between Lows t + u and v, the next main centre in the sequence. The quiet interval seems to have been in a sharpening ridge of high pressure in which the anticyclone marked j formed and later passed over Denmark. The fact that the strongest winds over the next few days, as from the 13th onwards, continued to be from the South suggests that the Atlantic cyclonic centres continued tracking from about SW to NE and that the barometric pressure continued high over central Europe.

Sunday,
September 18
45°N, IN BISCAY
ABOUT 100 MILES
FROM NORTH COAST
OF SPAIN
The Duke (letter to
the King,
September 23)

I wrote to your Majesty from the Gulf sending an account of events up to that time. Subsequently the weather became so bad that the ships were all scattered only 60 standing by me. [Probably the Southerly gales of 12th/13th and 15th/16th]. They followed me until the 18th when a great storm overtook us in latitude 45°N, and we all expected to perish. I was left with only 11 ships and with them when the weather abated I continued on my course to Cape Finnesterre with a Westerly wind.

The ships' logs between September 16 and 20 give little specific information except that the winds in the west of Ireland continued generally strong and that on the 18th the Duke of Medina Sidonia experienced a further severe gale in the southern part of the Bay of Biscay: This is clear evidence of yet another storm cyclone (Low w) in the sequence and that the centres were approaching the British Isles from far to the southwest. This one may have originated as a tropical storm.

Wednesday,
September 21
WEST COAST OF
IRELAND
Aramburu

[At Blasket Sound] On the 21st in the morning it began to blow from the West with the most terrible fury. It was bright and with little rain. [Recalde's ship dragged anchor and struck Aramburu's.] At midday the *Santa Maria de la Rosa* came in by another entrance to the NW. Coming in he fired a piece as if asking for help. All her sails hung in pieces except for the foremast mainsail. She managed to come to a stop with one anchor which was all she had and with the tide entering from SE she was held steady for a while. At 2 o'clock in the afternoon the tide turned and she began to swing in her anchor and dragged down the Sound. We were also dragged not two cables length from her. She struck a submerged rock in the South entrance and went down right away with everyone on board, not a soul was saved.

The same afternoon at 4 o'clock the *San Juan* commanded by Fernando Horra came in, her mainmast gone, and as she came in her main foresail ripped to pieces. She dropped anchor and stopped. With the fierce weather we were not able to hail her nor give her any assistance.

STREEDAGH STRAND,
OFF SLIGO
Capt. Cuellar

On the fifth day there sprang up so great a storm on our beam with a sea up to the heavens so that the cables could not hold nor the sails serve us and we were driven ashore with all three ships upon a beach covered with fine sand, shut in on one side and the other by great rocks. Such a thing was never seen, for within the space of an hour all three ships were broken in pieces so that there did not escape three hundred men.....[later] and at that time which would be about nine o'clock in the evening the wind was calm and the sea subsiding.

The great Westerly storm winds on the west coast of Ireland on September 21 can confidently be attributed to the same cyclonic system that the Duke encountered as an already severe storm in southern Biscay on the 18th (see the progression of Low w in the chart series). There is some analogy with the progress of hurricane *Debbie* on a similar track on September 16, 1961, when there was

BLACKSOD BAY,
Co. MAYO
Irish State Papers

[The long account of events in Co. Mayo chronicled in two different reports by Edward Whyte, clerk to the

council of Connaught, gives the date of the great gale as Tuesday September 10 O.S. He is, however, shaky on dates in other passages and I am inclined to prefer Aramburu's date of Wednesday September 21 N.S.]

Upon Tuesday, September 10 [20 N.S.] there blew a most extreme and cruel storm the like whereof hath not been heard a long time which put us in very good hope that many of the ships should be beaten up and cast away upon the rocks as it happily came out afterwards according to our expectation.

[Indeed it did. Apart from the descriptions above at least seven other great Armada ships and probably more were destroyed by this great gale. As such it was the biggest single cause of losses in the whole course of the Armada voyage, bigger than that caused by the English gunfire at Gravelines, or the contrary weather off the northwest of Scotland.]

Friday, September 23
BLASKET SOUND
Aramburu

On the morning of the 23rd we sailed on a light Easterly wind but as we left harbour we had hardly gone two cables when the wind fell calm. The current began to drive us on to the island so that in a short time we would have been lost, when the wind picked up again and we were able to continue sailing as far as the rocky islets to the north of us. Again the wind dropped and the tide that was coming in kept moving us towards the land to the north. We cast anchor before nightfall with only one cable, which was all we had, and one hour after dark the wind began to blow from the SE and the ship began to drag towards the islands that are so rocky that no one sailing on them could be saved. We swung round on the cable and lifting the anchor we set sail commending ourselves to our Lord as we had no idea whether there was a way out, the night was so dark and cloudy, but we had to take the risk. First we tried to make our way out to windward of the rocky islets but were prevented by the currents which rather would have carried us to destruction. We turned and tried again for an opening between the islands. The wind was becoming fresh with rough sea, a lot of cloud and heavy rain. Thanks to our Lady in whom we put our trust we managed to get out this time and sailing all through the night to the west we found that by morning we were 8 leagues from land.

Wind NE, cloudy. Afternoon and all night through rain.

Saturday,
September 24
OFF SW IRELAND
Aramburu

On the 24th, three hours after daybreak a great storm sprang up from the SE with heavy rain and rough seas. Thank God it lasted only two hours. We feathered our sails and lay to. Almost at once the wind veered Westerly with big seas....It was not possible to set sails until the afternoon when with a moderate wind we did manage to do so. Next day at dawn we found ourselves off the entrance to the anchorage we had just left, 3 leagues out to sea and making no headway.

Monday,
September 26
OFF SW IRELAND
Aramburu

On the morning of the 26th the wind came round to WSW and SW strong with rough seas moving us along at good speed, the course was SSE and sometimes SE $\frac{1}{4}$ S [12 $\frac{1}{4}$ points] until we judged we had doubled the Cape of Drasey and were North-South from it 14 leagues.

much damage in the west of Ireland. Both storms may have originated as Atlantic tropical cyclones, this being near the peak date for such systems entering higher latitudes on recurving tracks that carry them far to the northeast. By September 21, 1588, Low w had probably been rejuvenated and deepened by drawing in Arctic cold air in its rear.

The mention of Aramburu's log of "little rain" probably means that the (occluded?) front of Low w passed quickly in the strong winds and perhaps during the night.

Winds became lighter and apparently Northerly after the great storm on the 21st, enabling the *Begoña* to set sail from Blacksod Bay and head south, while Aramburu prepared to depart from Blasket Sound. The ridge of high pressure over the British Isles between Low w and the approach of another depression from the southwest on September 24 produced a light Easterly breeze for a time on the 23rd – early 24th before the wind freshened from about SE and strengthened to gale. When the cold front of this new depression (Low a) passed the ships on the 24th, the wind veered sharply to W and blew Aramburu back to the entrance to Blasket Sound, while *Don Alonso* was driven northeast and shipwrecked again on the coast of Donegal.

The backing of the wind to SE and S on the morning of the 25th shows the approach of the warm front of another low-pressure system. Lack of mention of any rain probably means that it passed in the night of the 25–26th. By the morning of the 26th the wind had

Wednesday,
September 28
SOUTH OF IRELAND
Aramburu

On the morning of the 28th the wind came round Southerly and South-Southwesterly. We changed course to West and WNW. At midnight such a great gale blew up from the North-West and with such violent seas and rain, that our fore mainsail ripped to pieces, nothing was left of it. We lowered the mainsail but were not able to take it in....

veered Westerly and become stronger and with heavy seas, perhaps marking the rear side of the complex cyclonic system (Lows a, b, c) shown on the map for the 26th.

It is clear that yet another depression passed over the ships on the 28th, maintaining the sequence that had continued at approximately 2-day intervals since the 12th. This time, however, when the centre had passed, the wind direction stayed at NW to N for several days. The Northwesterly wind was at first very violent and the cold air outbreak seems to have been followed by the formation of an anticyclone and by some days of a fairer spell of weather.

Thursday,
September 29
SOUTH OF IRELAND
Aramburu

From the morning of the 29th the wind gradually dropped and because of the heavy seas we carried on sailing to the South until the afternoon when we were able to fix up an old main foresail that we had made ready. The night was quite calm with not much wind and until morning we steered SE¼E [11¼ points].

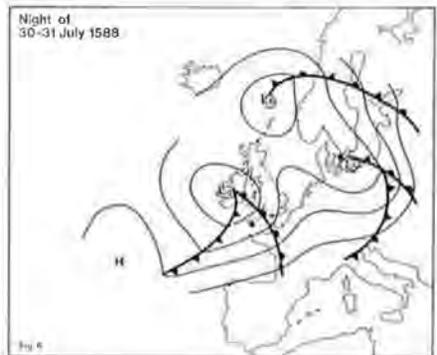
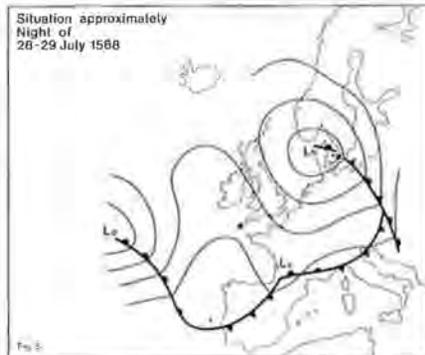
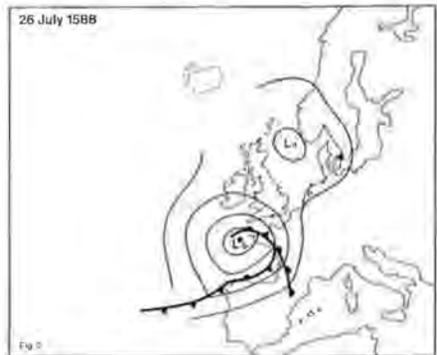
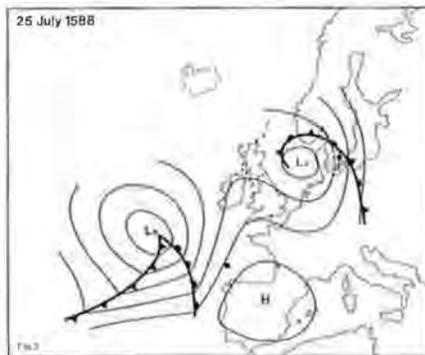
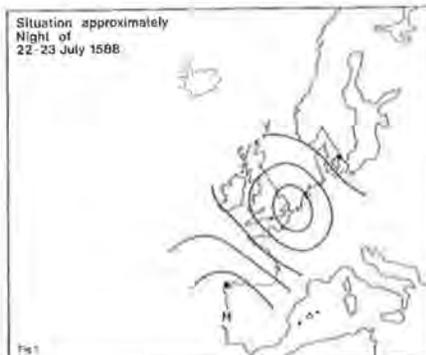
Sunday, October 2 to
Friday, October 7
BISCAY
Aramburu

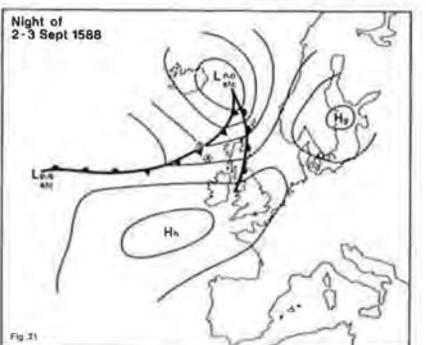
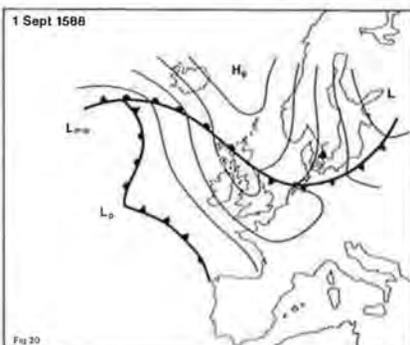
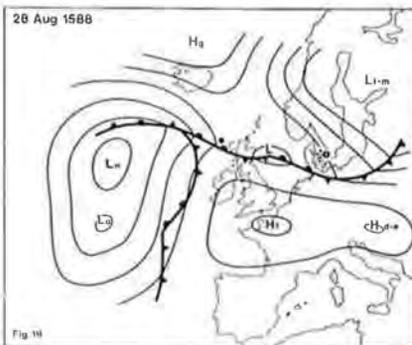
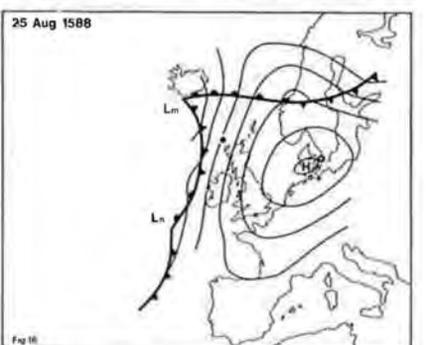
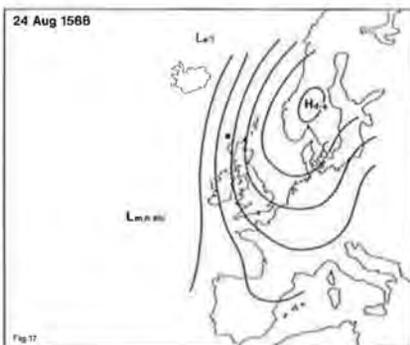
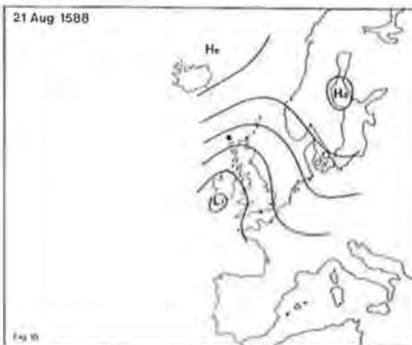
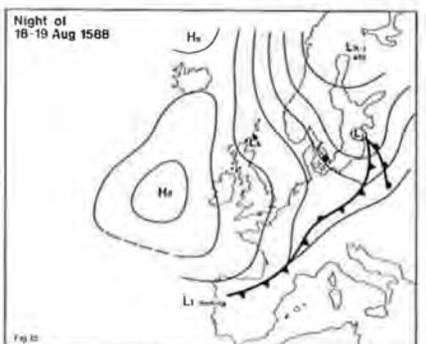
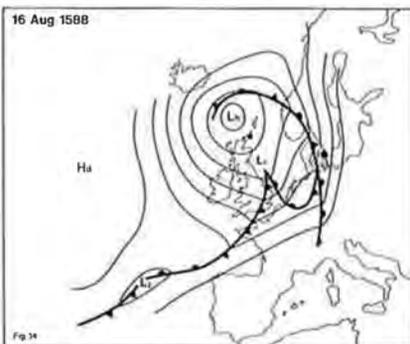
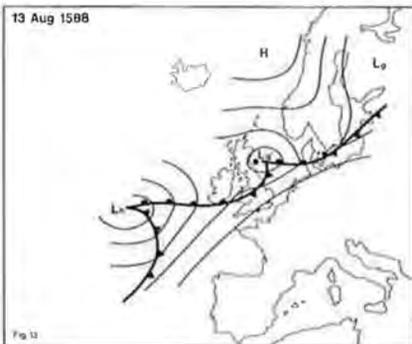
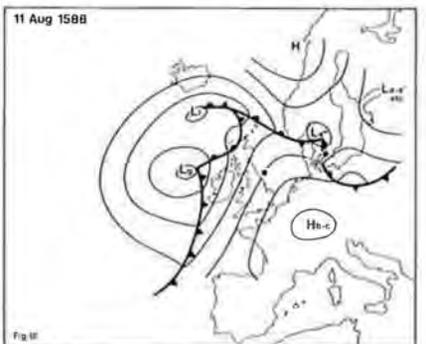
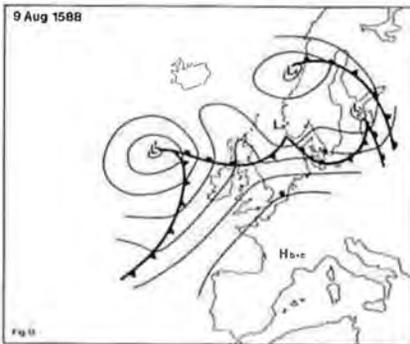
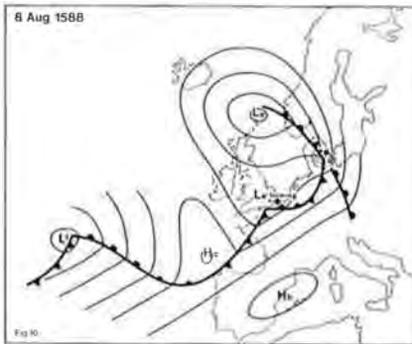
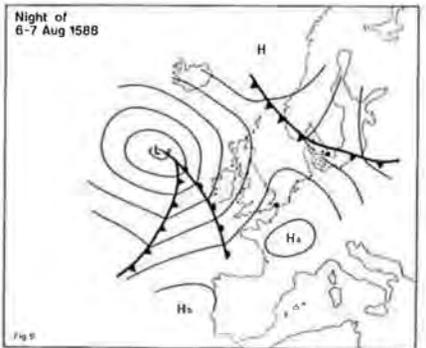
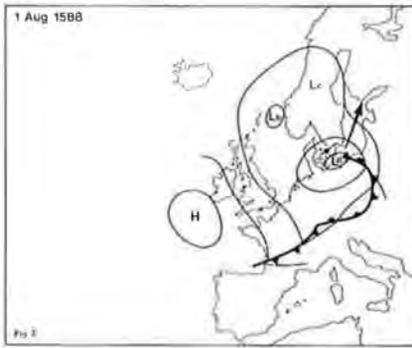
From October 2 to 7 we continued sailing in reasonable weather and on the 8th at dawn we sighted land – the Cap de Penas off Torres [43°34'N, 5°41'W].

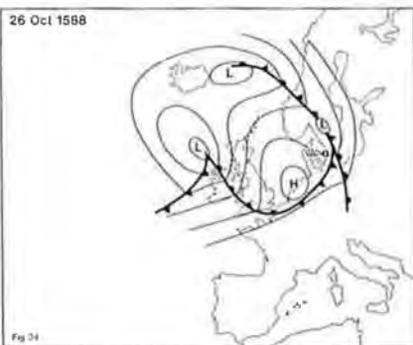
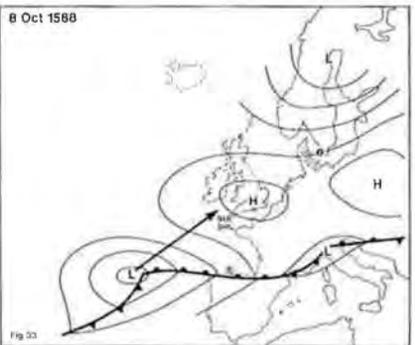
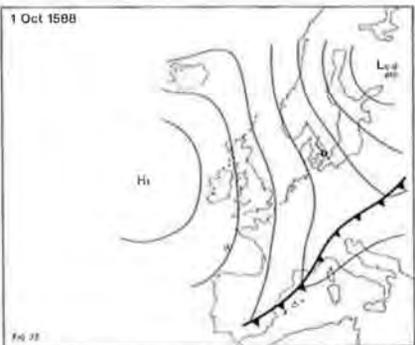
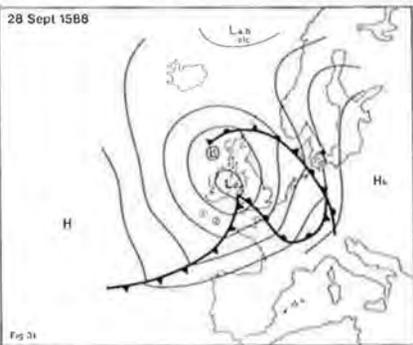
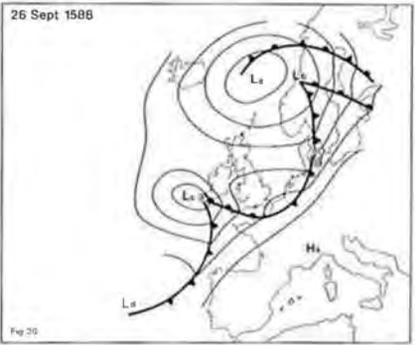
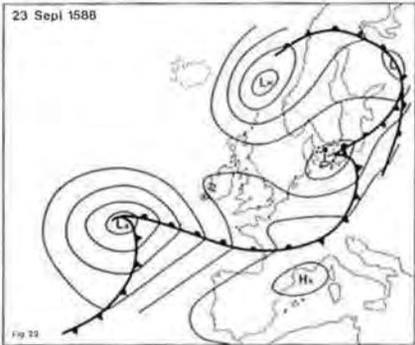
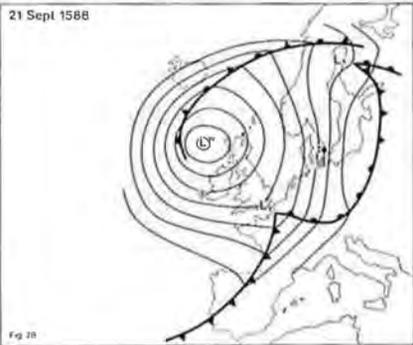
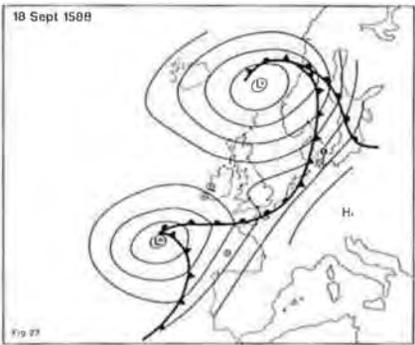
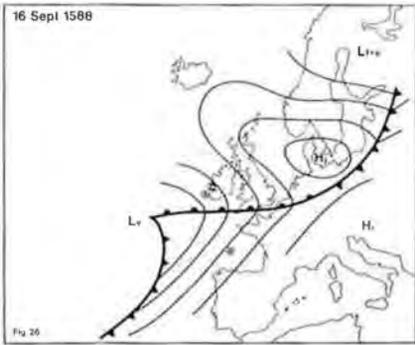
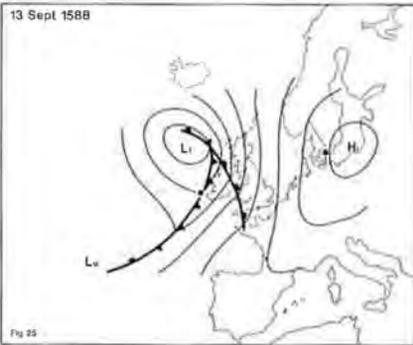
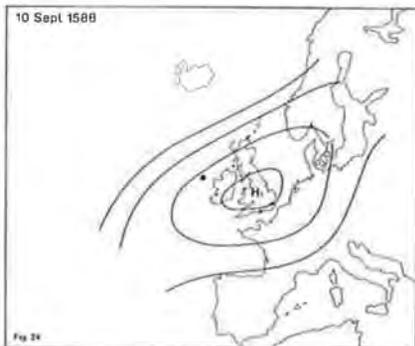
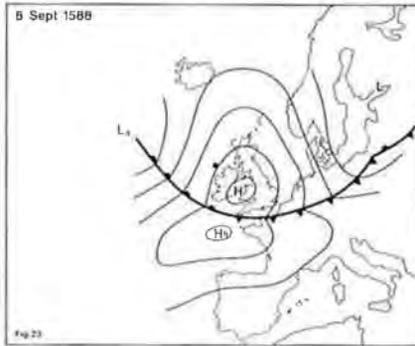
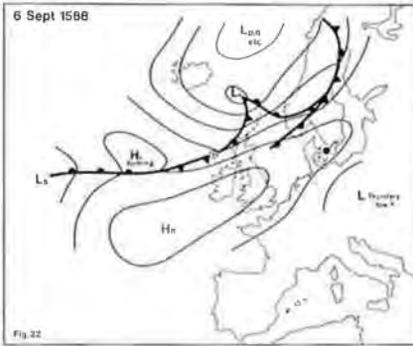
The anticyclone of September 29 to October 8 finally gave way to another sequence of unsettled weather ushered in by an Atlantic cyclone that approached the British Isles again from the southwest. After the initial E wind the direction became mostly Westerly in the Bay of Biscay and Spanish coast region.

Thursday, October 13
BISCAY, COAST OF
SPAIN
Aramburu

On the 13th we found ourselves off Santona but were unable to sail because of the bad state we were in. At 3 o'clock in the afternoon the wind came round fresh SE without rough seas, and two hours after nightfall we arrived and anchored at the entrance to Santander.







FALL OF '86 IN REVIEW

by Peter Scholefield

Fall was cool and wet across much of southern Canada with the notable exception of southwestern British Columbia and the glorious spell of Indian Summer in the western provinces during October

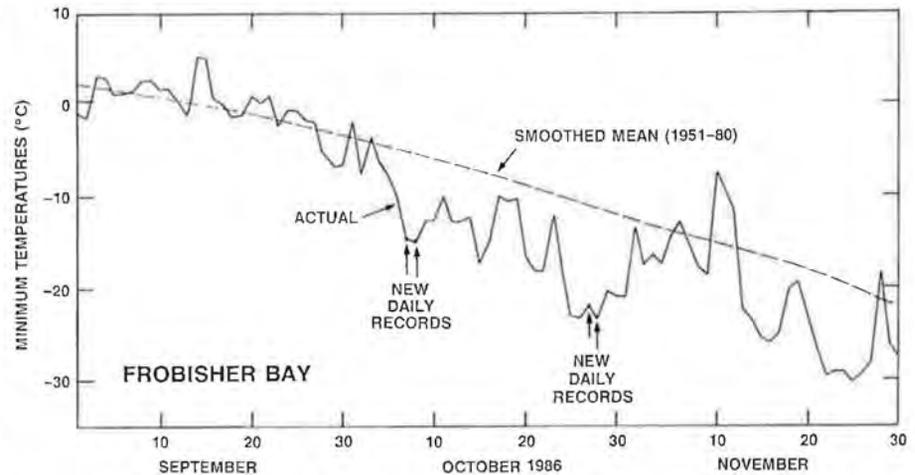
COLD CONTINUES OVER THE EASTERN HALF OF CANADA

The predominant climatic feature of the fall was the continuation and intensification of the cold spell that had produced a cooler than normal summer over most of Canada. As shown on the accompanying anomaly chart, the area with mean temperatures less than 2°C below normal covers most of the eastern half of Canada. Mean monthly temperatures have been below normal during the fall and the preceding three summer months throughout the Maritimes, central and southern Quebec, extreme northern Ontario and Manitoba and most of the High Arctic.

The unusual intensity and southward displacement of the polar vortex and its southward extending upper-level trough persisted through most of the fall over eastern Canada to cause this extended cold spell. The polar vortex itself moved steadily southward from the North Pole through September and October and finally settled over southern Baffin Island in November.

The accompanying graph of daily minimum temperatures illustrates the intensification of the cold spell near its core at Frobisher Bay. As in most of eastern Canada, September temperatures were only marginally below normal. The cold spell at Frobisher Bay intensified dramatically in October when minimum temperatures plunged below normal every day of the month and four daily minimum records were established.

In Canada, a colder than usual fall implies an early start to winter weather and this certainly happened this year. Across the southern Prairies the transition to winter was particularly dramatic: after nearly two weeks of abnormally warm Indian Summer weather during the last half of October, maximum temperatures plunged from the low twenties and high teens to below zero in a matter of days. Early outbreaks of Arctic air were experienced in the extreme southern portions of all provinces in early November. Some of the earliest and severest snowstorms on record struck Newfoundland, Nova Scotia



Record-breaking low temperatures at Frobisher Bay during October.

MAJOR EVENTS AND IMPACTS - FALL 1986

- | | |
|-----------|--|
| Sept. 2-8 | Heavy ice in Peel Sound prevents the cruise ship <i>World Discover</i> from sailing through the northwest passage. |
| 9 | A 54-day dry spell ends at Vancouver and Victoria. |
| 10 | A record 82-mm rainfall in Toronto floods some roads and railroad lines. Heavy rains cause an 11-m hydro dam to burst open near Lachute. |
| 23-24 | A monthly record 30 cm of snow falls at Whitehorse. |
| 25 | Calgary is paralysed by a 20-cm snowfall. |
| 25-26 | Consul, Saskatchewan, is swamped by 157 mm of rain in 48 hours. |
| 29 | London, Ontario, is deluged by 89 mm of rain. |
| Oct. 4 | A record 107.8 mm of rain falls in 24 hours at Prince Rupert, and a mud slide closes Bear Pass between Stewart and Terrace. |
| 5-6 | Flooding of shoreline properties on some southern Ontario Lakes results from high water levels; parts of the Trent-Severn waterway were closed. |
| 6 | Tornado-like storm damages Dublin Shore, Nova Scotia. |
| 12 | Thousands of dollars damage is inflicted on the town of Frobisher Bay by 110 km/h winds gusting to 137 km/h. |
| 15-27 | Record warm Indian Summer temperatures provide ideal harvesting conditions across the Prairies. |
| 18 | An October daily record snowfall of 14 cm at Gander disrupts traffic. |
| 25 | An October record dry spell of 24 days ends at Vancouver. |
| Nov. 6 | Early outbreak of Arctic air invades the southern B.C. coast. |
| 7 | The worst snowstorm since 1966 dumps 30-50 cm of snow on southern Manitoba paralysing transportation and imposing a snow removal cost of \$2.5 million on Winnipeg. |
| 14 | Winds gusting up to 140 km in a Newfoundland storm cause three tractor trailer units to overturn on a CN ferry. |
| 19 | Halifax receives a 24-hour November record snowfall of 28 cm closing most schools and businesses. |
| 20-22 | First major snowstorm hits southern Ontario and Quebec. Toronto traffic is snarled in 20 cm of snow, and Gaspé receives a record 70 cm of snow. The snow allows ski resorts to open early. |
| 24 | Several lobster boats are swamped by 100 km/h winds and one fisherman in Nova Scotia is drowned. |



and southern areas of Quebec, Ontario and Manitoba during November.

The cold fall weather hampered shipping in the north, delayed harvesting everywhere and led to reduced yields of warm weather crops in eastern Canada. On the positive side, winter sports activities got off to a much earlier start than usual.

RECORD WET AND DRY SPELLS

An extended wet spell in southern Ontario that began in early August

persisted through September into the first week of October, severely damaging crops and delaying the harvest. Record wet weather was also experienced in the drybelt agricultural areas of southern British Columbia, Alberta and Saskatchewan during September and early October. The buildup of soil moisture reserves in these usually moisture-deficient areas was a welcome benefit. Delays in harvesting across the Prairies were soon compensated by a prolonged three-week dry spell during

October. Unfortunately, the wet weather had deteriorated the quality of the record Prairie grain harvest.

On the west coast, Vancouver enjoyed a record 24-day dry spell in October. The upper-level atmospheric flow diverted incoming Pacific storms onto the northern B.C. coast where the fall was wetter than usual.

EXTRAORDINARY CLIMATOLOGICAL EVENTS – 1986

by Peter Scholefield

RECORD WINTER MILD SPELLS EXTEND INTO SPRING

The first five months of 1986 were characterized by extensive positive temperature anomalies which, in January, were centred out west then appeared to migrate eastward. Mean monthly temperatures were above normal for the first five months consecutively in parts of northern Alberta, central Saskatchewan, southern and central Manitoba, northwestern and southern Ontario, and southern Quebec. It was the warmest January on record at many places in British Columbia, Alberta and Saskatchewan. A few monthly record maximum temperatures established in subsequent months are:

Feb. 27: 18.4°C, Vancouver, B.C.
 Mar. 20: 20.3°C, Kelowna, B.C.
 Mar. 30: 26.6°C, Windsor, Ont.
 Mar. 31: 18.8°C, Shearwater, N.S.
 Apr. 24: 24.1°C, St. John's, Nfld.
 Apr. 25: 21.2°C, Goose Bay, Nfld.
 Apr. 28: 29.9°C, Timmins, Ont.

MILD DECEMBER ENDS THE PROLONGED COLD SPELL IN THE EAST

The abnormal cold over most of Canada in November extended the cold spell to six consecutive months over the Arctic Islands, northeastern Manitoba, far northern Ontario, central and southern Quebec and the three maritime provinces. After an extremely mild December across most of Canada, the only regions where the cold spell lasted for a seventh month were in the Arctic Islands, Prince Edward Island, Cape Breton, Nova Scotia and eastern New Brunswick.

RECORD DRY SPELLS ON THE B.C. SOUTH COAST

A period of 53 consecutive days without precipitation ended in Vancouver and Victoria on September 9. This was the longest dry spell on record at Victoria and the second longest at Vancouver. During October, no precipitation was

observed for 24 consecutive days at Vancouver, setting a record for the month.

RECORD SEPTEMBER RAINS

In the western drybelt area, Medicine Hat, Alberta, received an incredible September rainfall of 198 mm, which is more than six times the monthly normal. Penticton, B.C., received a record 62 mm for September. Many monthly record rainfalls were also set in southern Ontario. The 218 mm at Toronto is the most since September, 1843 and the second greatest monthly amount since observations began.

Peter Scholefield is the Head of the Monitoring and Prediction Section of the Canadian Climate Centre (Downsview, Ontario), and the Managing Editor of the weekly publication, *Climatic Perspectives*.

FALL RAINS ON THE PRAIRIES

Weather Map Series, September 25, 1986

by Hans VanLeeuwen

The weather map series presented in this issue on pages 35-38 describes the weather conditions on the Canadian and United States Pacific coast and the Prairies. Since the area is covered by three time zones, the local times will vary depending on the localities. In essence the maps cover an 18-hour period on September 25, 1986.

In order to carry out a meaningful analysis of the weather data plotted on each map, the coded information must be understood. A previous issue of *Chinook* (Volume 8, Number 2) contains a detailed explanation of the synoptic map plot and also a list of publications recommended for reading. If a copy of the above issue is not available one can be obtained by mailing a stamped, self-addressed envelope to the CMOS office in Ottawa, atten-

tion: Editor, *Chinook* (Weather Map Series; Vol. 9 No. 2).

The following suggested activities are particularly suitable for school audiences.

- 1) Remember the area shown covers three time zones: Pacific, Mountain and Central. For each map, what are the corresponding local times?
- 2) Draw isobars at intervals of 4 mb (or 0.4 kPa). In what direction is the low-pressure system moving during the period?
- 3) Draw the isotherms at intervals of 2°C.
- 4) Delineate the areas of precipitation. Were any thunderstorms reported?
- 5) During the 18-hour period did the low-pressure system deepen (i.e., decreasing pressure at the centre of the low) or did it fill (increasing central pressure)?
- 6) Describe in detail the weather and the changes in the various elements at Regina (Saskatchewan), Winnipeg (Manitoba) and Edmonton (Alberta).
- 7) If you had to prepare a TV-type briefing for your class, how would you describe the day's weather over the Canadian Prairies, along the B.C. coast and over the southern interior of British Columbia? In your discussion include all the relevant weather elements.
- 8) Compared with data in available climatological tables, would these weather conditions be normal, above normal or below normal for the time of year? In particular, focus on the temperatures.

LA MÉTÉO EN PHOTOS. Par Raymond Gervais et Richard Leduc. Presses de l'Université du Québec, Première édition, 1986, 96 pages, 9.95 \$.

Ce petit livre abondamment illustré se veut un résumé vulgarisé des principaux phénomènes météorologiques ainsi que des multiples techniques d'observation et de prévision de ces phénomènes.

Le livre comprend cinq chapitres complétés par un lexique de trois pages à la toute fin. Le chapitre 1 présente les différents types de nuages selon la classification habituellement utilisée en météorologie. Les chapitres 2 et 3 décrivent les instruments utilisés pour la mesure des variables météorologiques et climatologiques respectivement. Le chapitre 4 illustre divers phénomènes reliés au temps ou au climat. Le chapitre 5 suit avec un contenu varié d'éléments ayant trait à l'ensemble des chapitres précédents. Le lexique complète le tout en précisant certains des concepts traités dans les différents chapitres. Si l'ensemble couvre effectivement plusieurs notions météorologiques de base, il est dommage que le subtil lien unissant les nuages et le temps (chapitres 1 et 4) soit amenuisé par l'insertion des chapitres 2 et 3.

Néanmoins, cet ouvrage de format agréable intéressera sûrement ceux et



celles qui désirent s'initier au monde de la météorologie; à ce propos, l'attrait des 89 photographies qui servent de points de départ est indéniable. Celles des chapitres 1, 4 et 5 sont particulièrement intéressantes. Le texte, concis et construit en fonction des photographies, est agréable à lire et les concepts

traités y sont bien vulgarisés. Cependant, dans les chapitres 2 et 3, plus techniques, cette concision est à l'origine de quelques imprécisions; dans ces cas particuliers, le lecteur aura avantage à consulter le lexique ou des ouvrages plus avancés sur le sujet. Il faut enfin souligner l'agrément de lecture et l'intérêt que présentent les nombreuses notes historiques qui complètent plusieurs des descriptions et explications.

Bref, malgré de petites faiblesses, ce livre constitue une source d'information bien vulgarisée et surtout très bien illustrée. Nul doute que ceux et celles qui s'intéressent à la météorologie de tous les jours y trouveront ce qu'ils cherchent et un peu plus.

Denis Gosselin



Second Workshop on Operational Meteorology October 14–16, 1987, Halifax, Nova Scotia, Canada

The Second Workshop on Operational Meteorology, sponsored by the Atmospheric Environment Service of Environment Canada and the Canadian Meteorological and Oceanographic Society, will be held on October 14–16, 1987 at the Chateau Halifax Hotel in downtown Halifax, Nova Scotia. The theme for the workshop is *Marine Meteorology*, although a number of other topics in operational meteorology will be included.

Contributions have been solicited on the following topics:

- marine meteorology (e.g., near-shore forecasting, cyclogenesis, forecasting marine elements)
- mesoscale meteorology and local forecast problems
- data acquisition and remote sensing
- nowcasting and forecast tailoring

- data management, analysis and display systems
- using weather services and verification

The workshop will comprise the presentation of submitted and invited papers, laboratory sessions and a poster session. Theme speakers are scheduled to participate including Fred Sanders, Kenneth Lilly, Ron Stewart and Melvyn Shapiro. A preprint volume will be prepared and distributed to workshop participants.

The deadline for abstracts has passed. For further information and registration details, please contact the Chairman of the Local Arrangements Committee, Ken Macdonald, Maritimes Weather Centre, 6th Floor, 1496 Bedford Highway, Bedford, Nova Scotia, Canada B4A 1E5 (Telephone: 902-426-9182). Individuals are encouraged to register early, since registration may be limited.

PRÉSENTATION D'ARTICLES POUR LE CHINOOK À L'INTENTION DES AUTEURS

1. Contenu de l'article, langue et lecteurs

On vous invite à présenter des articles d'ordre général, rédigés soit en anglais, soit en français, dans le domaine de la météorologie et de l'océanographie, et qui conviennent à des lecteurs du niveau scolaire secondaire. Les opinions exprimées dans le texte reflètent celles de l'auteur.

2. Longueur et format

La longueur suggérée d'un article est de 1500 à 3000 mots, avec deux à quatre figures (et légendes). La présentation de photographies et d'illustrations nettes est particulièrement encouragée. Les auteurs sont priés de fournir un résumé de 100 à 200 mots, de préférence dans l'autre langue officielle. Au besoin, les résumés seront traduits et publiés dans l'autre langue.

3. Références

Les citations littéraires dans le texte même sont à éviter. On suggère plutôt d'y indiquer le nom des auteurs ou de l'organisme à qui le mérite est attribué et d'ajouter, à la fin de l'article, les références sous forme d'une liste brève de « lectures recommandées ». Toute référence à un article de revue doit comporter le nom et les initiales du ou des auteurs, l'année de publication, le titre de l'article en entier, le nom de la revue, le numéro du volume et le numéro des pages concernées. La mention d'un livre doit arborer le nom et les initiales du ou des auteurs, l'année de publication, le titre du livre, et le nom et l'adresse de la maison d'édition. Toutes les références doivent être présentées dans l'ordre alphabétique selon le nom de famille de l'auteur principal.

4. Mode de présentation des articles

Le manuscrit doit être dactylographié à double interligne et soumis en deux exemplaires au Rédacteur du *Chinook*, a/s de la Société canadienne de météorologie et d'océanographie, 151, rue Slater, suite 903, Ottawa (Ontario), Canada, K1P 5H3. Les épreuves finales des figures tracées et les photographies en noir et blanc de bonne qualité (l'original et deux photocopies de chacune) doivent accompagner le manuscrit. Nous faisons bon accueil aux illustrations ou photographies en couleurs qui pourraient paraître en page couverture du numéro. Les auteurs sont priés de fournir une brève description (50 mots environ) de leur affiliation professionnelle (le cas échéant) et de leur intérêt en météorologie et en océanographie; ils devraient de plus indiquer si leur article a déjà été publié ailleurs ou le sera plus tard.

5. Politique de la rédaction

Le rédacteur en chef décidera de la pertinence des articles à publier en consultation avec au moins un autre membre du conseil de rédaction. On prêtera une attention toute particulière à la lisibilité des articles par des profanes.

6. Tirés à part

On ne pourra pas faire réimprimer les articles. L'auteur principal recevra quatre tirés à part du numéro de parution de l'article. Des exemplaires additionnels seront fournis au frais de l'auteur pourvu que la demande soit faite avant l'impression.

Chinook

THE CANADIAN MAGAZINE OF WEATHER AND OCEANS

WHAT? *Chinook* is a popular magazine concerned with two major components of the Canadian environment – the atmosphere and the oceans. It is published quarterly by the Canadian Meteorological and Oceanographic Society (CMOS).

Features in *Chinook* include articles, weather summaries, interpretations of satellite and other photographs, and news and notes. These appear in the language submitted (English or French). In addition, summaries of all articles appear in the other language.

WHY? The aims of *Chinook* are

- to increase public awareness of meteorology and oceanography in Canada and of their modern scientific and technological aspects and achievements
- to stimulate public interest in and understanding of the impact of climate, weather and oceans on Canadian society and economics
- to inform Canadians about the education, information and interpretative services available to them on climate, weather and oceans

WHO? Features in *Chinook* are chosen to appeal particularly to

- secondary school and community college students
- farmers, fishermen and foresters

- marine-recreation, sports and tourism operators and enthusiasts
- aviators
- amateur observers of natural phenomena
- specialists in other sciences
- environmentalists

HOW? Subscriptions to *Chinook* may be ordered using the handy form above.

LA REVUE CANADIENNE DE LA MÉTÉO ET DES OCÉANS

QUOI? *Chinook* est une revue de vulgarisation qui traite de l'atmosphère et des océans – deux des importants éléments qui composent l'environnement canadien. *Chinook* est publié tous les trois mois par la Société canadienne de météorologie et d'océanographie (SCMO).

SUBSCRIPTION ORDER

Please enter my subscription to *Chinook* for one year (1987, 4 issues) at the following rate (please check one):

- | | |
|--|---------|
| <input type="checkbox"/> CMOS Member | \$10.00 |
| <input type="checkbox"/> Non-member Individual | \$12.00 |
| <input type="checkbox"/> Institution | \$15.00 |

Name _____ (PLEASE PRINT)

Address _____ (POSTAL CODE)

School or University (if student) _____

Mail with payment to CMOS, Suite 903, 151 Slater Street, Ottawa, Ontario K1P 5H3.

This is a NEW order; a subscription renewal. \$ _____ is enclosed.

Back issues: \$3.00 each; 10 or more: \$2.50

On retrouve dans *Chinook* des articles, des sommaires du temps, des interprétations de photos satellitaires et autres, des articles d'actualité et des notes. Ces articles paraissent dans la langue originale, le français ou l'anglais; tous les résumés sont rédigés dans l'autre langue.

POURQUOI? *Chinook* vise à :

- éveiller la curiosité du public en ce qui a trait aux aspects de la météorologie et de l'océanographie au Canada et à l'informer des réalisations scientifiques et technologiques d'aujourd'hui;
- stimuler l'intérêt du public et l'aider à mieux comprendre les effets du climat, du temps et des océans sur la société et sur l'économie du Canada;
- renseigner les canadiens sur les services d'éducation, d'information et d'interprétation qui leurs sont disponibles et qui traitent du climat, du temps et des océans.

QUI? Les articles choisis pour *Chinook* vise à intéresser notamment :

- les étudiants d'écoles secondaires et de collèges communautaires
- les agriculteurs, pêcheurs et agents forestiers
- les exploitants d'établissements de natisme, de sports et de tourisme, et les amateurs des ces activités
- les aviateurs
- les observateurs amateurs de phénomènes naturels
- les spécialistes d'autres sciences
- les environnementalistes

COMMENT? On peut s'abonner à *Chinook* en envoyant le formulaire ci-contre.

ABONNEMENT

Je désire m'abonner à *Chinook* pour une année (1987, 4 numéros) au tarif suivant (veuillez cocher):

- | | |
|--|----------|
| <input type="checkbox"/> Membre de la SCMO | 10,00 \$ |
| <input type="checkbox"/> Non-membre | 12,00 \$ |
| <input type="checkbox"/> Institution | 15,00 \$ |

Nom _____ (EN MAJUSCULES S.V.P.)

Adresse _____ (CODE POSTAL)

École ou université (pour étudiant) _____

Envoyez votre paiement à la SCMO, Suite 903, 151, rue Slater, Ottawa (Ontario), K1P 5H3.

Premier abonnement

Renouvellement d'abonnement

Numéros épuisés : 3,00 \$ chacun; pour 10 ou plus : 2,50 \$ chacun

J'inclus _____ \$