

1-17-89

Bruce Mast
Contracts
105 Davenport House

The final report for account (1-5-37867)
with the Shell Development Company has been
sent in. The contract should be closed.
Thank you.

Karen Garrelts
Atmospheric Sciences
101 Atmos Sci Bldg
3-2046

University of Illinois
at Urbana-Champaign

Grants and Contracts Office

105 Davenport House
809 South Wright Street
Champaign
Illinois 61820

217 333-2186

Date: March 7, 1988

TO: Karen Garrelts
Atmospheric Sci.

FROM: Wm. D. Morgan
Associate Director
Grant & Contract Administration

SUBJECT: Shell Development Co. PO# RE39912LA

X

Please review the attached contractual document. If it meets with your approval, indicate your acceptance by signing below or having the Project Director sign below and return it, along with the document, to this office for further processing.

John E. Walsh
Project Director

X

All persons employed in the performance of this contract are subject to its terms regarding patents, copyrights, or other intellectual property rights. Please have all such persons read the intellectual property terms of the contract and signify their understanding and acceptance of the stated terms. For assistance in interpreting the significance of the contract terms, you may call this office. The department or unit head is requested to sign the following statement before returning the contract to this office.

I hereby certify that all persons engaged in the work of this contract, and before commencing such work, shall have (a) read its intellectual property provisions, (b) indicated their understanding thereof, and (c) agreed to accept those provisions as part of their terms of employment.

Am. Snak
DEPARTMENT/UNIT HEAD

3-8-88
DATE

Shell Development Company

A Division of Shell Oil Company



Bellaire Research Center
P. O. Box 481
Houston, Texas 77001

3737 Bellaire Boulevard
Houston, Texas 77025

February 26, 1988

The Board of Trustees of the
University of Illinois
c/o Mr. J. J. Kramerer, Director
Grants and Contracts Administration
807 South Wright Street
Champaign, IL 61820-6219

Dear Mr. Kramerer:

PROPOSAL TO DEVELOP AN ANALOG SYSTEM FOR PREDICTION OF SEA ICE SEVERITY

We have completed our review of the proposal submitted by Professor John Walsh, dated August 1987, to develop an analog ice forecasting system. We feel that the development of such a model will enhance our present capabilities and are interested in pursuing the system development as outlined in the proposal.

Attached is a Purchase Order for the amount of \$26,235. This Purchase Order includes a description of our standard terms and conditions under which this work is to be performed. Please note that we have specified a minimum confidentiality period of two years beginning upon completion of the work. We understand that this length has already been agreed upon from past discussions between Professor Walsh and Mr. Dave Agerton, formerly with Shell Western E&P Inc. Further, this confidentiality is limited to only the development of new technology. All data supplied by Shell, and results derived for the benefit of Shell, shall still remain confidential.

As discussed recently between Professor Walsh and Mr. Mitchell Winkler of our staff, completion of the work within the August-September 1988 time frame is acceptable. Presently, we are interested in the prediction of summer season lengths in both the Beaufort and Chukchi seas. As a minimum, we would like to have the model applied to two sites each in both these regions. Accordingly, we will make historical season length records available to the project.

In addition, we would like to have the performance of the new model compared to the older statistical model for the case of the SWEPI ice season index. Although we would like the analog model to share the same

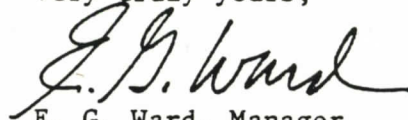
Mr. J. J. Kramerer

2

basic capabilities as the older statistical model, we do not feel that both models need be similar. For example, we are not completely satisfied with the use of quintiles to provide a measure of model skill and would encourage you, if possible, to suggest an alternative measure.

Please do not hesitate to contact Mitchell Winkler at (713) 663-2779 if you have any questions. We look forward to working with you on this project.

Very truly yours,

A handwritten signature in dark ink, appearing to read "E. G. Ward". The signature is fluid and cursive, with the first letters of each word being capitalized and prominent.

E. G. Ward, Manager
Offshore Engineering Research Department

Attachment

cc: Professor John E. Walsh
Department of Atmospheric Sciences
University of Illinois
Champaign, IL 61820-6219



PURCHASE ORDER

0-304-8G FRONT: REV. 6-85 BACK: REV. 6-85 PRTD. (10-85)

1

RE

DATE

2/19/88

SHIP TO

Illinois SHELL DEVELOPMENT COMPANY
PARCEL POST — P. O. BOX 481, HOUSTON, TX., 77001
TRUCK-UPS — 3737 BELLAIRE, BLVD., HOU. TX. 77025
ROOM NO. 2252

BILL TO

TELEPHONE
493-7171

NON-TAXABLE

1. If delivery is not or cannot be made promptly by _____ Contractor must so notify BUYER immediately, and BUYER reserves the right to cancel this order in whole or in part. To give such notice, or for any further information, contact _____

2. If routing is NOT specified, ship by cheapest route; but if that route will not meet required delivery date, contact BUYER for instructions. If products are subject to released value FREIGHT RATES and sold FOB origin with FREIGHT CHARGES for BUYER'S account, ship at the released value which will provide the lowest rate. DO NOT insure shipments unless specifically instructed. NO CHARGES will be allowed for packing or cartage unless specified in QUOTATION.

3. Show cash discount terms on invoice. All invoices for material on which no discount is allowed will be paid 30 days from date invoice is received.

AUTHORIZED BUYER'S REPRESENTATIVE



SHELL OIL COMPANY ☐
SHELL CHEMICAL COMPANY ☐
SHELL DEVELOPMENT COMPANY ☐

PURCHASE ORDER

0-304-9 (REV. 10-82)

PURCHASE ORDER NO. (Show this Number on Invoices, Tags, Boxes, etc.)

HEREIN CALLED "SHELL"

BLANKET ORDER NO. (if applicable)	ALTERATION NO.	RELEASE NO.	DATE 2/19/88
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CONTINUATION SHEET

PAGE 2 OF 4

CONTRACTOR

THIS CONTINUATION SHEET IS SUBJECT TO ALL TERMS, CONDITIONS AND INSTRUCTIONS CONTAINED ON FACE AND REVERSE SIDE OF FIRST PAGE HEREOF.

ARTICLE I

SECRECY AND INVENTIONS

I.1 As used herein, the term "Confidential Information" shall mean technical information relating to the work performed by Contractor and general knowledge of Shell's plans and activities, confirmed or disclosed to Contractor by Shell and/or affiliates of Shell (or on behalf of Shell or such affiliates) either directly or indirectly in writing or by drawings or by inspection of plants or in any other way, unless such information is in Contractor's possession at the time of disclosure without binder of secrecy, or is then or thereafter becomes part of the public knowledge or literature through no fault of Contractor's, or is thereafter received by Contractor from a third party without binder of secrecy. Confidential Information disclosed under this Agreement shall not be deemed to be within the foregoing exceptions merely because such information is embraced by more general information in the public domain or in Contractor's possession.

I.2 All Confidential Information supplied by Shell to Contractor, shall be and remains the property of Shell; and Contractor, its agents, servants, employees, and subcontractors shall not divulge any such Confidential Information to third parties, nor publish same, nor use same for any purpose other than in connection with the work done hereunder, without the advance written consent of Shell.

I.3 All work performed for Shell by Contractor hereunder (including but not limited to all information, data, reports, working notes, drawings, designs, and specifications developed or prepared by Contractor in connection with such work) shall become the property of Shell, unless specifically otherwise agreed upon in writing by Shell and Contractor, and no information concerning such work shall be divulged or disclosed by Contractor to third parties without the advance written consent of Shell.

I.4 ~~New technology developed from this project shall remain confidential for a minimum of two years beginning upon completion of the project. Notwithstanding any other provision of this Contract, paragraphs I.2 and I.3 hereof shall continue in force following termination or expiration of the other provisions of this Contract, to the end that Confidential Information, and information relating to the work performed hereunder, shall remain confidential indefinitely and never be revealed except as authorized in writing by Shell.~~



SHELL OIL COMPANY ☐
SHELL CHEMICAL COMPANY ☐
SHELL DEVELOPMENT COMPANY ☐

PURCHASE ORDER

0-304-9 (REV. 10-82)

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BLANKET ORDER NO. (if applicable)

ALTERATION NO.

RELEASE NO.

DATE 2/19/88

CONTINUATION SHEET

PAGE 3 OF 4

CONTRACTOR

THIS CONTINUATION SHEET IS SUBJECT TO ALL TERMS, CONDITIONS AND INSTRUCTIONS CONTAINED ON FACE AND REVERSE SIDE OF FIRST PAGE HEREOF.

I.5 If, as a result of or incidental to any work or services performed by Contractor or employees of Contractor hereunder, any inventions are conceived, made, or developed by Contractor or employees of Contractor which relate in any way to Shell's business or that of its subsidiaries or affiliates, all such inventions shall be the property of Shell, and Contractor shall: (a) give notice thereof to Shell; (b) formally assign to Shell all rights therein, or formally assign to Shell all rights therein and cause employees of Contractor to formally assign all rights therein to Shell; and (c) execute or cause employees of Contractor to execute any necessary documents and otherwise reasonably cooperate with Shell in the securing of patents for such inventions.

ARTICLE II

PATENTS AND ROYALTIES

II.1 Contractor shall report to Shell, promptly and in reasonably written detail, each notice or claim of patent or copyright infringement based on the performance of this contract of which Contractor has knowledge. In the event of any claim or suit against Shell on account of any alleged patent or copyright infringement arising out of the performance of this contract or out of the use of any supplies furnished or work or services performed hereunder, Contractor shall furnish to Shell, when requested by Shell, all evidence and information in possession of Contractor pertaining to such suit or claim.

ARTICLE III

SERVICES AND MANNER OF PERFORMANCE

III.1 In the performance of this contract, Contractor shall be and remain an independent contractor, and Contractor shall not be considered under the provisions of this contract or otherwise as having employee status within Shell nor shall Contractor be entitled to participate in any plans, arrangements, or distributions by Shell or its affiliates relating to any pensions, deferred compensation, bonus, stock bonus, hospitalization, insurance or other benefits extended to Shell employees.



SHELL OIL COMPANY ☐
 SHELL CHEMICAL COMPANY ☐
 SHELL DEVELOPMENT COMPANY ☐

HEREIN CALLED "SHELL"

PURCHASE ORDER

0-304-9 (REV. 10-82)

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CONTINUATION SHEET

PAGE 4 OF 4

CONTRACTOR

THIS CONTINUATION SHEET IS SUBJECT TO ALL TERMS, CONDITIONS AND INSTRUCTIONS CONTAINED ON FACE AND REVERSE SIDE OF FIRST PAGE HEREOF.

III.2 Shell shall have the right to determine scope and objective of the programs or projects under this contract. Shell also shall have the right to modify said programs or projects as the work progresses during the term of this contract. Contractor shall have the sole control over the manner and method of attaining the results to be achieved under this contract, and Shell shall have no direction or control of Contractor or Contractor's employees and agents, except in the results to be obtained.

III.3 Contractor shall be free to dispose of that portion of your entire time, energy, and skill as you are not obligated to devote hereunder to Shell and its subsidiaries, in any manner you see fit and to any persons, firms or corporations as you deem advisable so long as you do not create a conflict of interest between Shell and any other persons, firms or corporations.

ARTICLE IV

TERMINATION

IV.1 This Contract shall be in effect for a term commencing on the date set out first above and ending upon completion of the work, provided, however, that Shell may terminate this Contract at least 10 days prior to termination date. Upon the effective date of any such termination, Contractor shall cease all work being done hereunder. Contractor shall be reimbursed for Contractor's Recoverable Costs incurred prior to the time that the termination becomes effective, but Contractor shall not be entitled to any other compensations on account of such termination, whether by way of claims for damages, or for loss of anticipated profits, or otherwise.

Please indicate your concurrence with the foregoing terms and conditions by signing below and returning one copy to Shell.

 The Board of Trustees of
 the University of Illinois

 Date

University of Illinois
at Urbana-Champaign

REQUEST FOR ANTICIPATION ACCOUNT
REQUEST TO USE EXPIRED OR OVERDRAFTED ACCOUNT

RECEIVED

TO: Grants & Contracts Office

FROM: Mankin Mak 3-11-88
Name (Type or Print) Signature & Date

Dean's Approval (if required)

THE UNIT IS TO COMPLETE A THROUGH C, AS APPROPRIATE

A. REQUEST FOR ANTICIPATION ACCOUNT

Notice has been received from the sponsor that the pending proposal listed below will be funded. Permission is requested to incur costs in anticipation of an award. If the proposal is not funded or if the resulting award has a different effective date, all unallowable charges will be promptly transferred by the unit in accordance with Guideline 16-1D-200, Section E, of the General Policy & Guidelines.

PROPOSAL DATA (on file in the Grants & Contracts Office)

Principal Investigator John Walsh Unit Atmospheric Sciences

Title An Analog System for Prediction of Sea Ice Severity

Sponsor Shell Western E & P, Inc. Proposal Ref. No. 87-PRI-S/W-1718

EXISTING AWARD DATA (if applicable):

Award No. _____ Acct No. _____ Termination Date _____

ANTICIPATION REQUEST:

Amount 11,000.00 Period (Limited to 3 Months) 3-21-88 to 6-20-88

(Please check one of the following):

1) A NEW ACCOUNT NUMBER IS REQUESTED:

- ☒ a. This is a new project,
☐ b. It is not known how the Sponsor will fund the project (renewal or continuation),
☐ c. This is a continuation of an AFOSR or EPA grant/cooperative agreement, or
☐ d. This is a new project period for a PHS grant.

2) CONTINUED USE OF THE EXISTING ACCOUNT NUMBER LISTED ABOVE IS REQUESTED:

_____ The project will be continued with the same grant/contract number and is not a continuation of an EPA or AFOSR grant/cooperative agreement. In the event the Sponsor assigns a different grant/contract number, a new University account number will be assigned, and the Unit agrees to promptly transfer all allowable charges to the new account.

B. REQUEST TO USE EXPIRED OR OVERDRAFTED ACCOUNT

Permission is requested to use the existing account listed in A above:

- _____ 1. To incur costs in anticipation of a no-cost extension which has been requested from the sponsor through the Grants & Contracts Office, or
_____ 2. To incur costs in excess of the award for the purpose of accumulating total project costs.

C. DISTRIBUTION After this form has been processed by the Grants & Contracts Office, please distribute a copy to:

Name Karen Garrelts Address 101 Atmos Sci Bldg (MC 223)

D. GRANTS & CONTRACTS OFFICE ☒ Request approved as noted ☐ Request denied

New Account Number 1-5-37867 Title SHELL WESTERN E&P WAL

University of Illinois
at Urbana-Champaign

REQUEST FOR ANTICIPATION ACCOUNT
REQUEST TO USE EXPIRED OR OVERDRAFTED ACCOUNT

TO: Grants & Contracts Office

FROM: Mankin Mak [Signature] 3-11-88
Name (Type or Print) Signature & Date

Dean's Approval (if required)

THE UNIT IS TO COMPLETE A THROUGH C, AS APPROPRIATE

A. REQUEST FOR ANTICIPATION ACCOUNT

Notice has been received from the sponsor that the pending proposal listed below will be funded. Permission is requested to incur costs in anticipation of an award. If the proposal is not funded or if the resulting award has a different effective date, all unallowable charges will be promptly transferred by the unit in accordance with Guideline 16-1D-200, Section E, of the General Policy & Guidelines.

PROPOSAL DATA (on file in the Grants & Contracts Office).

Principal Investigator John Walsh Unit Atmospheric Sciences

Title An Analog System for Prediction of Sea Ice Severity

Sponsor Shell Western E & P, Inc. Proposal Ref. No. 87-PRI-S/W-1718

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Name Karen Garrelts Address 101 Atmos Sci Bldg (MC 223)

D. GRANTS & CONTRACTS OFFICE _____ Request approved as noted _____ Request denied

New Account Number _____ Title _____

University of Illinois
at Urbana-Champaign

Grants and Contracts Office

105 Davenport House
809 South Wright Street
Champaign, IL 61820-6219

217 333-2186

To: _____

John Walsh

Date: _____

7/1/88

From: Bill Morgan

Ref: _____

_____ Per our Telephone Conversation

☒ For Your Information

_____ Thank You

_____ Per Your Request

Comments: _____

University of Illinois
at Urbana-Champaign

Grants and Contracts Office

105 Davenport House
809 South Wright Street
Champaign, IL 61820-6219

217 333-2186

July 1, 1988

E. G. Ward, Manager
Offshore Engineering Research Department
Shell Development Company
Bellaire Research Center
P. O. Box 481
Houston, TX 77001-0481

Re: Purchase Order No. RE41855LA

Dear Mr. Ward,

Pursuant to your letter of 17 June 1988 to Dr. Mapother, please find enclosed one copy of the above referenced Purchase Order properly signed on behalf of The Board of Trustees of the University of Illinois. This P. O. now reflects terms negotiated between Dr. Mapother and Mr. Winkler.

Regarding General Conditions on the reverse side of Shell's Purchase Order, the following deletions/understandings are recognized. These have been previously discussed with Mr. Winkler:

- 1) The Board of Trustees of the University of Illinois is prohibited by State Statute from contracting to indemnify and/or hold harmless. Accordingly, the following deletions are recognized:
 - a) Article 3 - Taxes, the last part of the sentence beginning "...and the CONTRACTOR..." is deleted in its entirety.
 - b) Article 5 - Infringement, this article is deleted in its entirety.
 - c) Article 11 - Liability-Indemnity, this article is deleted in its entirety.
 - d) Article 14 - Bills and Liens, the wording "...and indemnify CONTRACTOR ..." from the last sentence is deleted in its entirety.
2. Article 7 - Default, the penalty provision included therein \ item 7 (c) / is deleted in its entirety. This is a best-efforts project, and no funds are available to cover re-procurement of similar services.
3. Article 12 - Insurance, Shell accepts that the University of Illinois is self-insured.

4. Article 13 - Use of Premises, this article is considered not applicable.

Per your request, I am also returning your original Purchase Order #RE39912LA.

Please contact me at (217) 333-5897 if any of the above creates difficulties for Shell.

Sincerely,

Wm. D. Morgan, Associate Director
Grant & Contract Administration

cc: B. Mast
D. Mapother
J. Walsh



INVOICE MUST BE FORWARDED TO THE ADDRESS
INDICATED ON THIS ORDER. FAILURE TO DO
SO WILL DELAY OR PREVENT PAYMENT.

VENDOR

1

SHELL DEVELOPMENT COMPANY

PURCHASE ORDER

PURCHASE ORDER NO. Show this
Number on Invoices, Tags, Boxes, etc.

RE 41855LA

DATE 6/14/88

0-304-8G FRONT: REV. 6-85 BACK: REV. 6-85 PRTD. (11-87)

HEREIN CALLED "BUYER"

BLANKET ORDER NO. (IF APPLICABLE) REB	ALTERATION NO.	RELEASE NO.	DATE 6/14/88
------------------------------------------	----------------	-------------	-----------------

VENDOR NAME AND ADDRESS The Board of Trustees of the University of Illinois c/o Mr. Dillon Mapother Associate Vice Chancellor for Research Swanlund Administration Building 601 East John Street Champaign, IL 61820 HEREIN CALLED "CONTRACTOR"	SHIP TO SHELL DEVELOPMENT COMPANY PARCEL POST — P. O. BOX 481, HOUSTON, TX. 77001 TRUCK-UPS 3737 BELLAIRE BLVD., HOU., TX. 77025 ROOM NO. 2252
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------

IMPORTANT: Mail invoice in QUADRUPLICATE with two copies of FREIGHT BILL (when PREPAID and ADDED to INVOICE), ACKNOWLEDGEMENT, SHIPPING NOTICES, and BILLS OF LADING to:	BILL TO SHELL DEVELOPMENT CO. TELEPHONE 493-7171 P. O. BOX 1382 HOUSTON, TEXAS 77251-1382
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------

SHIP VIA—FREIGHT: <input checked="" type="checkbox"/> PREPAID <input type="checkbox"/> PREPAID/ADD TO INVOICE <input type="checkbox"/> COLLECT	F.O.B. <i>Shell-Houston</i>	TERMS <i>Net 30</i>	TAXABLE	NON-TAXABLE <input checked="" type="checkbox"/>
---------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------	---------------------	---------	-------------------------------------------------

1. If delivery is not or cannot be made promptly by _____ Contractor must so notify BUYER immediately, and BUYER reserves the right to cancel this order in whole or in part. To give such notice, or for any further information, contact _____
2. If routing is NOT specified, ship by cheapest route; but if that route will not meet required delivery date, contact BUYER for instructions. If products are subject to released value FREIGHT RATES and sold FOB origin with FREIGHT CHARGES for BUYER'S account, ship at the released value which will provide the lowest rate. DO NOT insure shipments unless specifically instructed. NO CHARGES will be allowed for packing or cartage unless specified in QUOTATION.
3. Show cash discount terms on invoice. All invoices for material on which no discount is allowed will be paid 30 days from date invoice is received.

QUANTITY	MATERIAL OR SERVICE	PRICE
	This purchase order provides up to the amount shown for completion of the study entitled "An Analog System for Prediction of Sea Ice Severity" which is described in the University of Illinois proposal dated August 1987.	\$26,235.00
	Projects costs may be billed to Shell in installments corresponding to progress.	
	Ten percent of the total project cost will be retained until receipt and acceptance of the final report.	
	Please send all invoices and correspondence to M. M. Winkler, Shell Development Company, P. O. Box 481, Houston, Texas, 77001.	
	Additionally, the parties hereto agree as follows:	

IMPORTANT: All provisions on the face hereof, as well as all conditions on the back hereof, are part of this order. Read them carefully. No substitutions or changes will be effective without BUYER'S written approval.	AUTHORIZED BUYER'S REPRESENTATIVE GORDON LAN BRC-PURCHASING
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------

NOTICE: THIS FORM CONTAINS A LIABILITY-INDEMNITY CLAUSE ON THE REVERSE SIDE. PLEASE READ CAREFULLY

CONDITIONS. The following General Conditions are always applicable, and the following Work Order Conditions are also applicable when this Order provides for performance of any work.

GENERAL CAUTION. Flammable liquids and gases may be present in equipment and work areas involved in performance of this Order. CONTRACTOR must take extreme care in such performance, and accept the entire risk to CONTRACTOR and CONTRACTOR's employees and property in connection herewith.

GENERAL CONDITIONS

1. **Contract.** This Order, when accepted by CONTRACTOR either in writing or by shipment of any article or other commencement of performance hereunder, constitutes the entire contract between CONTRACTOR and BUYER concerning its subject matter; and neither any contrary or additional conditions then specified by CONTRACTOR nor any subsequent amendment or supplement shall have any effect without BUYER's written approval.

2. **Quality Assurance.** All articles, materials and work furnished shall be of good quality and free from any defects, and shall at all times be subject to BUYER's inspection; but neither BUYER's inspection nor failure to inspect shall relieve CONTRACTOR of any obligation hereunder. If, in BUYER's opinion, any article, material or work fails to conform to specifications or is otherwise defective, CONTRACTOR shall promptly replace same at CONTRACTOR's expense. No acceptance or payment by BUYER shall constitute a waiver of the foregoing; and nothing herein shall exclude or limit any warranties implied by law.

3. **Taxes.** Unless otherwise provided herein or by law, CONTRACTOR shall pay all sales, use, excise, and other taxes, charges, and contributions now or hereafter imposed on, or with respect to, or measured by the articles, materials or work furnished hereunder or the compensation paid to persons employed in connection with performance hereunder; and CONTRACTOR shall indemnify BUYER against any liability and expense by reason of CONTRACTOR's failure to pay the same.

4. **Compliance.** In performance hereunder and every activity connected therewith, CONTRACTOR shall comply fully with all applicable laws, ordinances, rules and regulations, and, when requested, shall furnish evidence satisfactory to BUYER of such compliance. Without limiting the foregoing CONTRACTOR warrants that all articles and materials furnished were and shall be produced in compliance with the Fair Labor Standards Act of 1938 as amended.

5. **Infringement.** CONTRACTOR shall indemnify and defend BUYER against all claims, suits, liability and expense on account of alleged infringement of any patent, copyright or trademark resulting from or arising in connection with the manufacture, sale, normal use or other normal disposition of any article or material furnished hereunder. BUYER may participate in the defense of any such claim or suit without relieving CONTRACTOR of any obligation hereunder.

10. **Performance.** CONTRACTOR shall perform all work diligently, carefully and in a good and workmanlike manner; shall furnish all labor, supervision, machinery, equipment, materials and supplies necessary therefor; shall obtain and maintain all building and other permits and licenses required by public authorities in connection with performance of the work; and, if permitted to subcontract, shall be fully responsible for all work performed by subcontractors. CONTRACTOR shall conduct all operations in CONTRACTOR's own name and as an independent contractor, and not in the name of, or as agent for BUYER.

11. **Liability-Indemnity.** CONTRACTOR shall be solely responsible for all materials, equipment and services until the work is completed to BUYER's satisfaction. CONTRACTOR's responsibility for loss of or damage to work in progress (including materials on the premises or in storage or in transit which are intended for incorporation in the work) shall, however, be limited to \$1,000 per occurrence. CONTRACTOR shall be solely responsible for tools, equipment and other property owned, rented or leased by CONTRACTOR or any subcontractor or employee of either which are not to be incorporated in the work.

Except as stipulated above in this Article 11, and to the maximum extent permitted by applicable law (but no further), CONTRACTOR shall defend, indemnify and hold harmless BUYER, its parent and subsidiary companies, coventurers, and directors, employees and agents of such companies against any loss, damage, claim, suit, liability, judgment and expense (including attorneys' fees and other costs of litigation), and any fines, penalties and assessments, arising out of injury, disease or death of persons or damage to or loss of any property (including but not limited to BUYER's existing facilities) or the environment resulting from or in connection with performance or nonperformance of work under this Order by CONTRACTOR, its agents or subcontractors, even though caused by the concurrent and/or contributory negligence (whether active or passive or of any kind or description) or fault of a party indemnified, subject to the next succeeding sentence herein. Without regard to the extent of negligence, if any, of an indemnified party, CONTRACTOR, at its expense, shall defend any such claim or suit against an indemnified party and shall pay any judgment resulting therefrom. If, after CONTRACTOR has both defended any such suit and paid any resulting judgment, it is judicially determined that the injury, disease, death or damage was caused by the sole negligence of a party indemnified, then BUYER shall reimburse CONTRACTOR for the judgment and for reasonable defense costs incurred. BUYER shall have the right but not the duty to participate in the defense of any such claim or suit with attorneys of its own selection without relieving CONTRACTOR of any obligations hereunder.

The obligations, indemnities, and liabilities assumed by the CONTRACTOR under this Article 11 shall not be limited by any provisions or limits of insurance required by Article 12 below.

6. **Assignment.** Neither this Order nor any claim against BUYER arising directly or indirectly out of or in connection with this Order shall be assignable by CONTRACTOR or by operation of law, nor shall CONTRACTOR subcontract any obligations hereunder, without BUYER's prior written consent.

7. **Default.** If CONTRACTOR or any subcontractor breaches any provision hereof, or becomes insolvent, enters bankruptcy, receivership or other like proceeding (voluntarily or involuntarily), or makes an assignment for the benefit of creditors, BUYER shall have the right, in addition to any other rights it may have hereunder or by law, to terminate this Order by giving CONTRACTOR written notice; whereupon (a) BUYER shall be relieved of all further obligation hereunder, except to pay the reasonable value of CONTRACTOR's prior performance, but not more than the contract price and (b) title to any product(s) of CONTRACTOR's work, whether completed or partially completed, as well as all materials prepared, procured or set aside by CONTRACTOR for use in the work, shall, at BUYER's option upon giving written notice to CONTRACTOR, vest in BUYER and BUYER may enter CONTRACTOR's premises and remove the same therefrom, and (c) BUYER may, at its option, complete performance of the work, in which event, CONTRACTOR shall be liable to BUYER for all cost incurred by BUYER completing such performance in excess of the contract price (whether or not BUYER exercises its option in clause (b)). Time is of the essence hereof, and BUYER's right to require strict performance by CONTRACTOR shall not be affected by any waiver, forbearance or course of dealing.

8. **Withholding.** BUYER shall have the right to withhold any money ever payable by it hereunder and apply the same to payment of any obligations of CONTRACTOR to BUYER or to any other parties arising in any way out of this Order or its performance.

9. **Excuses.** Either CONTRACTOR or BUYER shall be excused from performance of the obligations hereunder when and to the extent that such performance is delayed or prevented (and, in BUYER's case, its need for the articles, materials or work is reduced or eliminated) by any circumstances reasonably beyond control, or by fire, explosion, any strike or labor dispute or any act or omission of any Governmental authority.

WORK ORDER CONDITIONS

11. **Liability-Indemnity (Cont'd.)**
If it is judicially determined that any of the indemnity obligations (which CONTRACTOR agrees shall be supported by insurance) under Article 12 are invalid, illegal or unenforceable in any respect, said obligations shall automatically be amended to conform to the maximum monetary limits and other provisions in the applicable law for so long as that law is in effect.

12. **Insurance.** Without in any way limiting any of CONTRACTOR's obligations, indemnities or liabilities under Article 11, CONTRACTOR shall maintain at all times the following minimum insurance, at CONTRACTOR's expense, in compliance with all applicable laws and satisfactory to BUYER: (a) Workers' Compensation Insurance — statutory limits; and Employers' Liability Insurance — limit of \$100,000 each occurrence, both coverages to apply to liability as applicable under any state or federal statute or through any common law process; (b) Comprehensive Automobile Liability Insurance — combined bodily injury and property damage limit of \$300,000 each occurrence; (c) Comprehensive General Liability Insurance (including contractual coverage for Article 11 above) — combined bodily/personal injury and property damage limit of \$300,000 each occurrence; and (d) any other insurance BUYER may require.

Whenever requested, CONTRACTOR shall furnish evidence satisfactory to BUYER that such insurances are in effect.

13. **Use of Premises.** CONTRACTOR shall perform all work in such manner as to cause minimum interference with the operations of BUYER and of other contractors on the premises, and shall take, and cause CONTRACTOR's and every subcontractor's employees, agents, licensees, and permittees to take, all necessary precautions (including those required by BUYER's safety regulations) to protect the premises and all persons and property thereon from damage or injury. Upon completion of the work, CONTRACTOR shall leave the premises clean and free of all equipment, waste materials and rubbish.

14. **Bills and Liens.** CONTRACTOR shall pay promptly all indebtedness for labor, materials and equipment used in performance of the work. CONTRACTOR shall not be entitled to receive final payment from BUYER, until CONTRACTOR furnishes evidence satisfactory to BUYER of full payment of such indebtedness. CONTRACTOR shall not permit any lien or charge to attach to the work or the premises; but if any does so attach, CONTRACTOR shall promptly procure its release, and indemnify BUYER against all damage and expense incident thereto.

15. **Changes.** CONTRACTOR shall make no change in the work or perform any additional work without BUYER's specific written approval. BUYER may order changes in the work or require additional work at any time, and CONTRACTOR shall comply therewith; but the price hereunder shall be increased by an amount equal to the increase (if any) in CONTRACTOR's cost of labor and materials, plus 10% of such increase.

6/30/88
clb



SHELL OIL COMPANY ☐
SHELL CHEMICAL COMPANY ☐
SHELL DEVELOPMENT COMPANY ☐
HEREIN CALLED "SHELL"

PURCHASE ORDER

0-304-9 (REV. 10-82)

PURCHASE ORDER NO. (Show this
Number on Invoices, Tags, Boxes, etc.)

DATE

6/14/88

BLANKET ORDER NO. (if applicable)

ALTERATION NO.

RELEASE NO.

CONTINUATION SHEET

PAGE 2 OF 4

CONTRACTOR University of Illinois

THIS CONTINUATION SHEET IS SUBJECT TO ALL TERMS, CONDITIONS AND INSTRUCTIONS CONTAINED ON FACE
AND REVERSE SIDE OF FIRST PAGE HEREOF.

ARTICLE I

SECRECY AND INVENTIONS

I.1 As used herein, the term "Confidential Information" shall mean ~~technical information disclosed to Contractor by Shell which relates to the work performed by Contractor under this Purchase Order; such information shall be in writing or other tangible form and marked "Confidential", or, if disclosed by other means, shall be confirmed in writing within thirty (30) days. Confidential Information shall not include information which (a) was in the public knowledge at the time of disclosure by Shell hereunder, or (b) was already in Contractor's possession without binder to secrecy. The term "Confidential Information" shall cease to apply to information which (c) becomes part of the public knowledge without fault of Contractor, or (d) is disclosed to Contractor without binder of secrecy by a third party having the right to do so.~~

I.2 All Confidential Information supplied by Shell to Contractor, shall be and remains the property of Shell; and Contractor, its agents, servants, employees, and subcontractors shall not divulge any such Confidential Information to third parties, nor publish same, nor use same for any purpose other than in connection with the work done hereunder, without the advance written consent of Shell.

I.3 All work product developed for Shell by Contractor hereunder (including but not limited to reports, data, work notes, drawings, and computer output) which is based on Confidential Information provided by Shell shall become the property of Shell, and no information concerning such work shall be divulged or disclosed by Contractor to third parties without prior written consent of Shell.

I.4 Work product developed hereunder which is not based on Confidential Information provided by Shell shall remain confidential for two years after completion of the Project.



SHELL OIL COMPANY ☐
 SHELL CHEMICAL COMPANY ☐
 SHELL DEVELOPMENT COMPANY ☐

HEREIN CALLED "SHELL"

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ALTERATION NO.

RELEASE NO.

DATE

6/14/88

CONTINUATION SHEET

PAGE 3 OF 4

CONTRACTOR University of Illinois

THIS CONTINUATION SHEET IS SUBJECT TO ALL TERMS, CONDITIONS AND INSTRUCTIONS CONTAINED ON FACE AND REVERSE SIDE OF FIRST PAGE HEREOF.

I.5 Inventions made by employees of Contactor resulting from work done hereunder shall be and remain the property of Contractor. Shell shall have an exclusive, worldwide, irrevocable, paid-up license to use and practice such inventions, whether or not patented, in its businesses, which license may be extended by Shell to its affiliates and subsidiaries without accounting to Contractor therefor. Contractor may license third parties for applications which do not infringe the license rights granted Shell hereinabove.

I.6 Notwithstanding any other provision hereof, the rights and obligations provided herein shall survive completion or termination of this contract.

ARTICLE II

SERVICES AND MANNER OF PERFORMANCE

II.1 In the performance of this contract, Contractor shall be and remain an independent contractor, and Contractor shall not be considered under the provisions of this contract or otherwise as having employee status within Shell nor shall Contractor be entitled to participate in any plans, arrangements, or distributions by Shell or its affiliates relating to any pensions, deferred compensation, bonus, stock bonus, hospitalization, insurance or other benefits extended to Shell employees.

II.2 Shell shall have the right to determine scope and objective of the programs or projects under this contract. Shell also shall have the right to modify said programs or projects as the work progresses during the term of this contract subject to reimbursement of contractor for any additional costs incurred as a result of such modification. Contractor shall have the sole control over the manner and method of attaining the results to be achieved under this contract, and Shell shall have no direction or control of Contractor or Contractor's employees and agents, except in the results to be obtained.

II.3 Contractor shall be free to dispose of that portion of your entire time, energy, and skill as you are not obligated to devote hereunder to Shell and its subsidiaries, in any manner you see fit and to any persons, firms or corporations as you deem advisable so long as you do not create a conflict of interest between Shell and any other persons, firms or corporations.



SHELL OIL COMPANY ☐
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 HEREIN CALLED "SHELL"

PURCHASE ORDER

0-304-9 (REV. 10-82)

PURCHASE ORDER NO. (Show this Number on Invoices, Tags, Boxes, etc.)

BLANKET ORDER NO. (if applicable)	ALTERATION NO.	RELEASE NO.	DATE 6/14/88
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CONTINUATION SHEET

PAGE 4 OF 4

CONTRACTOR University of Illinois


THIS CONTINUATION SHEET IS SUBJECT TO ALL TERMS, CONDITIONS AND INSTRUCTIONS CONTAINED ON FACE AND REVERSE SIDE OF FIRST PAGE HEREOF.

ARTICLE III

TERMINATION

III.1 This Contract shall be in effect for a term commencing on the date set out first above and ending upon completion of the work, provided, however, that Shell may terminate this Contract upon 10 days written notice to contractor. Upon the effective date of any such termination, Contractor shall cease all work being done hereunder. Contractor shall be reimbursed for Contractor's Recoverable Costs incurred prior to the time that the termination becomes effective, but Contractor shall not be entitled to any other compensations on account of such termination, whether by way of claims for damages, or for loss of anticipated profits, or otherwise.

Please indicate your concurrence with the foregoing terms and conditions by signing below and returning one copy to Shell.


 Craig S. Bazzani, Comptroller
 for The Board of Trustees of
 The University of Illinois

6/30/88
 Date

University of Illinois
at Urbana-Champaign

Grants and Contracts Office

105 Davenport House
809 South Wright Street
Champaign, IL 61820-6219

217 333-2186

September 4, 1987

U of I Ref. No. 87-PRI-S/W-1718

MR. DAVID AGERTON
SHELL WESTERN E & P, INC.
200 NORTH DAIRY ASHFORD
HOUSTON, TX 77079

Title: AN ANALOG SYSTEM FOR PREDICTION OF
SEA ICE SEVERITY.

Amount: \$26,235.00

Period: OCT. 1, 1987 - SEPT. 30, 1988

Principal Investigator(s) JOHN E. WALSH

Department ATMOSPHERIC SCIENCE

Type of Request: XX New Request, Supplement,
Continuation, Renewal for Existing Award

Revision of Original Proposal Transmitted on

Proposal Number

Enclosed are copies of the referenced proposal. This proposal has been reviewed by the proper University administrative officials and has been approved for submission.

Your consideration will be appreciated. Any contract or grant supporting the above described project must be issued in the University's corporate name, The Board of Trustees of the University of Illinois, Urbana, Illinois 61801.

Any questions of a non-technical nature regarding this proposal should be addressed to Willie Dozier or Jay Menacher at the above telephone number.

Sincerely,

Wm. D. Morgan / E. J.
Wm. D. Morgan, Associate Director
Grant and Contract Administration

WDM:ef

Enclosure

cc: Judith Liebman, Vice-Chancellor
for Research

KAREN GARRELTS ✓

Estimated Budget

Salaries

J. Walsh, 1 month \$4700

B. Ross (programmer, 4 months 8739

Total salaries \$13,439

Fringe benefits (11.366%) 1,527

Computer (U. of Ill. Cray X-MP) 3,000

Telephone, postage, supplies 300

Total Direct Costs \$18,266

Indirect Costs

52.2% (18,266-3,000) = 7,969

Total Costs \$26,235

July 29, 1987

Mr. David Agerton
Shell Western E & P, Inc.
200 North Dairy Ashford
Houston, TX 77079

Dear Dave:

As a follow-up to our telephone conversation, I have enclosed a description of a project that would produce an analog system for long-range prediction of Alaskan ice severity. Also enclosed is an estimated budget totaling approximately \$26K. Because the project would draw upon previous analog model development by the National Weather Service and others, we should be able to complete the work within one year.

The project personnel at Illinois would be myself and a research programmer, B. Ross, who has been working on Arctic-related projects for the past five years. Resumes and publications lists for both of us are attached.

If there is interest at Shell in this type of project, we can submit a formal research proposal through the University. We can also modify the present outline to better suit your needs.

Thanks for your consideration. I look forward to hearing from you.

Sincerely,

John Walsh

JW:nm
Enclosure

Sponsor deadline
postmarked by _____
receipt by _____

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
PROPOSAL TRANSMITTAL FORM
(submit three copies of this form completed on both sides with proposal)

IDENTIFICATIONS:

Principal Investigator Name:

Last	First	Middle	SSN	Initiating Dept/Division
Walsh	John	E	183-40-9013	Atmospheric Sciences

Co-principal Investigator(s):

Last	First	Middle	SSN	Home Department(s)

Proposal Title:¹ An analog system for prediction of sea ice severity

Sponsor/Agency Name: Shell Western E & P, Inc.

Sponsor/Agency Address: 200 North Dairy Ashford, Houston, TX 77079

Agency RFP# _____ Begin date: 10-1-87 End date: 9-30-88

(Request For Proposal, if applicable)

Other agencies to which proposal was/will be submitted: None

Supports a program of: (check one)

<input type="checkbox"/> Basic Research ²	<input type="checkbox"/> Instruction	<input type="checkbox"/> Public Service
<input checked="" type="checkbox"/> Applied Research ²	<input type="checkbox"/> Commercial Testing	<input type="checkbox"/> Student Aid
<input type="checkbox"/> Product Development ²	<input type="checkbox"/> Other (specify) _____	

Proposal type: (check one)

<input checked="" type="checkbox"/> New	<input type="checkbox"/> Revised proposal or budget	<input type="checkbox"/> Supplementary request
<input type="checkbox"/> Renewal ³	<input type="checkbox"/> Continuation ³	

For renewal or continuation, please provide previous grant number (not acct. no.)# _____

APPROVAL REQUIREMENTS: It is understood that if a grant or contract results from this application, the principal investigator will perform the administrative duties normally associated with the project. The principal investigator assures that s/he makes this submission with the understanding that any resulting grant or contract will contain no provision restricting the University's right to publish research results, and that if any question of such restriction arises in subsequent negotiation s/he will assist in arranging the further review that will be required.

08-31-87	_____
Date	Principal Investigator(s) or Initiator(s) of Proposal
Approved by: 08-31-87	_____
Date	Executive Officer(s) of Department(s)
_____	_____
Date	Dean or Director
_____	_____
Date	Other Signatures if Required ⁴

Office of Grants & Contracts

Research Board Authorization

(1), (2), AND (3) See definitions on attached green sheet. (4) See approval requirements on attached green sheet.

For information on this proposal call _____ (phone)

SPECIAL MAILING INSTRUCTIONS: (Attach label & special instructions if needed)

over

BUDGET INFORMATION:

Direct Costs \$ 18,266 (If ICR is less than approved rate, a waiver must be approved by
Indirect Costs \$ 7,969 Dept. Exec. Officer and Dean and Vice Chancellor for Research)
Total \$ 26,235

Cost Sharing in the form of contributed effort: ☐ yes ☒ no

Allocation of University Funds:

In addition to the funds provided by the sponsor, other funds committed to this project are documented in the proposal and include:

\$ _____ From Campus/Central Administration
\$ _____ From College
\$ _____ From Department
\$ _____ From Other University Sources, (including Research Board)
Please specify: _____

COMPUTING SERVICES:

ORGANIZATION	\$ TOTAL REQUIRED	\$ REQUESTED FROM SPONSOR
<input type="checkbox"/> CSO	_____	_____
<input type="checkbox"/> PLATO	_____	_____
<input checked="" type="checkbox"/> NCSA	3,000	3,000

SPACE:

Acceptance of the proposal ☐ will ☒ will not require that additional space be made available to the department or that existing space be renovated. If renovation or additional space is needed, arrangements to meet this need have been made with the Office of Space Utilization and are described on the attachment.

COMPLIANCE: (check all that apply) Work performed under this proposal involves:

<input type="checkbox"/> use of human subjects, or Exemption # _____	<input type="checkbox"/> classified research	<input type="checkbox"/> purchase of computer equipment > \$10,000
<input type="checkbox"/> use of live vertebrate animals ⁵	<input type="checkbox"/> requirement for environmental statement	<input type="checkbox"/> consultant payment
<input type="checkbox"/> use of live organisms in a nonclinical safety study	<input type="checkbox"/> construction of building	<input type="checkbox"/> IPA
<input type="checkbox"/> chemical hazard	<input type="checkbox"/> patent or copyright considerations	<input type="checkbox"/> IRIS
<input type="checkbox"/> radiation hazard	<input type="checkbox"/> equipment acquisition only	<input type="checkbox"/> potential conflict of interest has been identified and addressed
<input type="checkbox"/> biological hazard	<input type="checkbox"/> recombinant DNA	<input type="checkbox"/> prior Research Board seed money
<input type="checkbox"/> hazardous or pressurized gases	<input type="checkbox"/> use of PLATO	<input checked="" type="checkbox"/> use of proprietary or confidential information
<input type="checkbox"/> other hazard	<input type="checkbox"/> international program ⁴	<input type="checkbox"/> NONE OF THE ABOVE

4) See approval requirements on attached green sheet. (5) Submit lab animals care form LACAL-1 and Protocol with proposal.

Proposal submitted to
Shell Western E & P, Inc.

from the
Board of Trustees, University of Illinois

AN ANALOG SYSTEM FOR PREDICTION OF SEA ICE SEVERITY

John E. Walsh

Department of Atmospheric Sciences

University of Illinois

Start Date: October 1, 1987

Duration: 1 year

Amount Requested: \$26,235

John E. Walsh
Principal Investigator
SS#: 183-40-9013
Phone: (217) 333-7521

H. J. Stapleton
Secretary
Campus Research Board

J. J. Kamerer
Director
Grants and Contracts
Office

August 1987

An Analog System for Prediction of Sea Ice Severity

A. Background

The two major approaches to sea ice forecasting are numerical models and statistical procedures. The range of forecasts derived from numerical models such as the U.S. Navy Polar Ice Prediction System (PIPS; see Preller, 1985) is limited to 5-7 days by the accuracy of the forcing data required to drive the model. Consequently, the so-called "long-range" forecasts for periods of a month to several seasons are based on statistical procedures. The U.S. Navy/NOAA seasonal ice forecasts for the Alaskan region rely heavily on a pair of April air pressure indicators selected nearly ten years ago (Barnett, 1980). A more sophisticated system, recently developed by Sea Ice Consultants (SIC) under contract with Shell Western, is based on systematic scans of correlations between an ice severity index and multi-month fields of atmospheric sea level pressure and geopotential height. The SIC procedure uses screened grid-point predictors in multilinear regression equations derived from the historical data base.

An alternative approach to long-range statistical forecasting is the analog method, whereby the past year(s) that most closely resemble the year being forecast are objectively determined. The essence of an analog forecast scheme is the postulate that the predictand will evolve as it did in the analog year(s). The identification of the analog years is made in terms of predictors or predictor fields that are known to be physically relevant to predictand evolution. Because the analog approach offers several significant advantages over the grid point correlation/screening approach (see pp. 2-3), it may be viewed as an extension of the ice forecasting system now in use at Shell Western.

Significant skill derived from analog techniques has recently been demonstrated in studies at the Canadian Climate Center (Shabbar and Knox, 1986) and the U.S. National Weather Service's Climate Analysis Center (Livezey and Barnston, 1987). In the latter case, sufficient skill was found in analog forecasts of United States temperatures that the analog system "has been adopted as a major input for operational use by official forecasters" at the NWS (Livezey and Barnston, 1987, p. 1).

The emergence of the analog technique as a major weather forecasting tool has positive implications for long-range forecasts of weather and sea ice, and has motivated this proposal. More specifically, the analog approach offers the potential to extend considerably the Alaskan ice forecasting capability developed for Shell Western by Sea Ice Consultants. The capabilities of the forecast system will be enhanced in the following ways by the analog input:

- (1) Whereas the user of approach based on screening of correlation grids was "locked into" forecasts of a particular ice index (used in computing the grid point correlations), the analog methodology permits the extrapolation of a forecast to other predictands--subject only to the requirement that the ice-index data base include the analog years. Figure 1 shows schematically how the ice index enters the forecast scheme before predictor selection in the correlation/screening approach, but after predictor selection in the analog case.

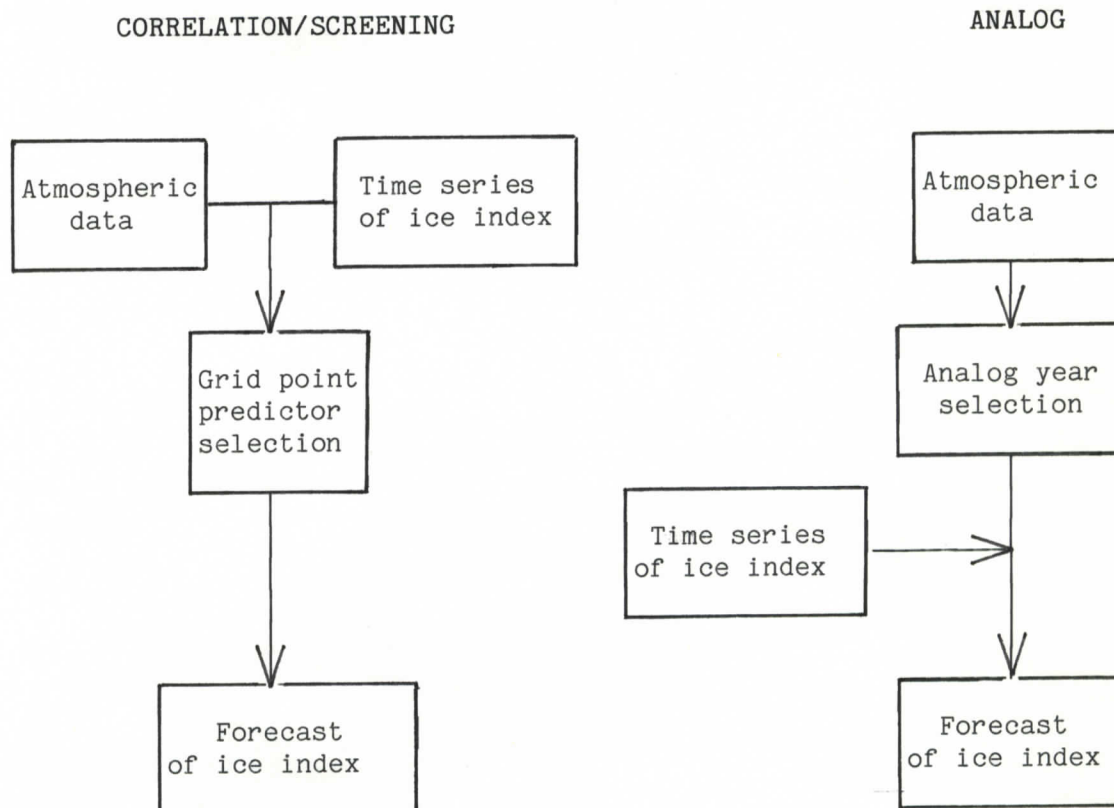


Fig. 1. Schematic comparison of correlation/screening and analog approaches to forecasts of ice severity index.

Should exploratory/drilling operations expand to other high-latitude regions, the analog approach can be applied to the new region immediately; by contrast, the re-implementation of the correlation/screening approach would require a return to the initial computational stages and the re-computation of all correlation grids.

- (2) As the severity ranks of the analog years cluster more closely together, the confidence level of an analog forecast increases. Each set of analog years can be assigned a measure of consistency based on the difference in the ice severity rank of those years. This "consistency statistic" will serve as a readily quantifiable indicator of the confidence to be placed in a particular analog forecast.
- (3) Extreme years can be identified and forecast through the routine implementation of an analog system, whereas a system based on correlations or correlation scans can be subject to statistical dilution of the associations that are most relevant to the evolution of an extreme ice year.
- (4) The evolutionary nature of the predictor fields can be incorporated directly into the analog determination, e.g., by defining metrics based on a series of sequential (monthly) predictor/predictand matches and their summation or integration over all the months. Temporally-dependent weighting of the more recent months can be objectively employed in order to avoid the temporal averaging inherent in the use of multi-month mean predictors.
- (5) The analog approach is conceptually simple and therefore more easily grasped by users than is the "black box" component of a system of correlation scans, predictor screening, and regression equation formulation.

B. Proposed work

The proposed work includes the design, formulation and testing of an analog system for forecasting seasonal ice severity. The procedure will draw heavily on the analog system recently implemented by the National Weather Service (NWS) for United States temperature forecasting. However, the application to forecasts of a sea ice severity index will require several modifications and corresponding experimentation.

On the basis of the NWS system development and our own sea ice forecasting experience, the following predictor inputs will be supplied to the analog selection procedure:

- (a) Sea level pressure, 45°-90°N, 5° x 10° lat x long grid,
- (b) 700 mb geopotential height, 45°-90°N, 5° x 10° lat x long grid,
- (c) Sea surface temperature, 50°-90°N, 4° x 4° lat x long grid, and
- (d) Southern Oscillation Index as computed by NWS.

In all cases, the data will be monthly and will cover the period 1950-1985. The period spanned by the developmental data base is essentially the same as the 1950-1984 period used by the NWS.

The statistic to be used as a measure of the analog "match" will be the root-mean-square (rms) difference between the grid or index of the forecast year and the corresponding grid or index of the possible analog year. The year(s) with the smallest rms differences will be selected as the analog year(s). Verification statistics will be based on the set of analog forecasts for all years for which the ice severity index is available. (The values of or computational procedures for this ice severity index will be provided by the sponsor.) An analog system will be constructed for operational usage in forecasts made at the end of January, February, ..., July of the year for which the forecast is valid, as well as November and December of the antecedent year.

B.1 Sensitivity experiments

At the core of an analog system development is a set of sensitivity tests pertaining to various aspects of the analog selection procedure. The following list of sensitivity tests is intended to indicate the types of parameters to be optimized in the models for each month:

- (a) Number of analogs. The analog forecast made during any month will be the ice severity index averaged over the n best analog years. In view of the sample size used here and previous experience with long-range weather forecasts, the optimum values of n will likely be in the range of 2-6. Experimentation will establish the optimum value for each month.
- (b) Length and weighting of antecedent period. The skill of forecasts made in a particular calendar month will likely depend on the length of the antecedent period used for determining the best analogs. A weighting of the more recent months relative to the less recent months is also likely to impact the forecast skill. Antecedent periods of 1-8 months will be examined systematically prior to the final selection of the analog model for a particular month, as will the effect of uniform vs. inverse-time weightings of the rms statistics of the antecedent months.
- (c) Evolutionary vs. stationary rms metric. The rms metric can be a mean of the rms differences for m antecedent months, or it can be a single value computed from the m -month mean of the predictor data. These two alternatives will be compared, and the superior alternative will be used consistently in all models.
- (d) Regional weighting of grid point differences. It is likely that predictor values near the predictand region will represent more meaningful input to an analog selection system. The sensitivity tests will include experiments in which the rms metric is computed using distance-weighted grid-point differences. The weights will decrease with increasing distance from the predictand region.

- (e) Predictor subsets. In view of NWS experience, analog models from which one or more of the four predictors are deleted will also be examined. Should skill be unchanged (or higher) without one or more of the predictors, the predictor(s) will not be included in the analog selection scheme for that month.

C. Products

A final report will contain the parameters and structural elements of the analog models to be used for forecasts issued at the end of November, December, ..., July. The model parameters and structural elements will be those addressed in the sensitivity tests described above.

Skill assessments will be presented in terms of the mean absolute error of the predicted severity index, the mean absolute rank error, the average error of the forecast quintile, and probability distributions showing the likelihood of occurrence of each quintile in the case of a forecast of quintile k ($k = 1, 2, 3, 4, 5$). It should be noted that the skill statistics will be valid for independent data because a year being forecast is not included in the pool of potential analogs (i.e., the forecast year is effectively independent of the predictor pool).

The error analysis will also include a quantitative evaluation of the relationships between forecast skill and the consistency (i.e., clustering) of the analog-year values of the ice index. This evaluation will form the basis of an algorithm for assigning confidence levels to specific forecasts on the basis of the similarity of the analogs.

Finally, all the predictor datasets will be provided so that the analog models can be implemented directly at the site most appropriate for real-time usage by the sponsor.

D. References

- Barnett, D. G., 1980: A practical method of long-range ice forecasting from the north coast of Alaska. Sea Ice Processes and Models (R. Pritchard, Ed.), Univ. of Washington Press, Seattle, 402-409.
- Livezey, R. E., and A. G. Barnston, 1987: An operational multifield analog prediction system for United States seasonal temperatures. Part I: System design and winter experiments. Mon. Weather Rev., 115, in press.
- Preller, R. H., 1985: The NORDA/FNOC Polar Ice Prediction System (PIPS)--Arctic: A Technical Description. NORDA Report 108, NSTL, MS, 61 pp.
- Shabbar, A., and J. L. Knox, 1985: Monthly prediction by the analogue method. Proceedings, Tenth NOAA Climate Diagnostics Workshop, College Park, MD, NMC/NWS/NOAA, Washington, DC, 672-681.

Estimated BudgetSalaries

J. Walsh, 1 month	\$4700	
B. Ross (programmer, 4 months)	<u>8739</u>	
Total salaries		\$13,439
Fringe benefits (11.366%)		1,527
Computer (U. of Ill. Cray X-MP)		3,000
Telephone, postage, supplies		<u>300</u>
Total Direct Costs		\$18,266
Indirect Costs		
52.2% (18,266-3,000) =		<u>7,969</u>
Total Costs		\$26,235

RESUME

John E. Walsh

ADDRESS

Office: Department of Atmospheric Sciences
University of Illinois
1101 W. Springfield Avenue
Urbana, IL 61801
Tel. (217) 333-7521

Home: 712 W. Delaware Ave.
Urbana, IL 61801
Tel. (217) 344-4939

PERSONAL DATA

Born 9 August 1948, Philadelphia, PA; U.S. Citizen

EDUCATION

1970 B.A. Dartmouth College, Hanover, NH (Mathematics and Computer Science)
1974 Ph.D. Massachusetts Institute of Technology, Cambridge, MA (Meteorology)

EMPLOYMENT

1986-87 Naval Postgraduate School, Department of Oceanography
ONR Chair in Arctic Marine Science, Visiting Professor

1974-pres. University of Illinois, Department of Atmospheric Sciences
Professor of Meteorology (1985-); Associate Professor (1979-85);
Assistant Professor (1974-79)
Research: polar meteorology, numerical and statistical forecasting
Course instruction: polar meteorology, physical meteorology,
numerical weather prediction, introductory meteorology

1977, 1983 National Center for Atmospheric Research, Boulder, CO
Visiting Scientist: polar meteorology and climatology

1976-1979 Arctic Institute of North America, Arlington, VA
Consultant: data analysis, sea ice forecasting

1969-1970 U.S. Naval Oceanographic Office, Polar Oceanogr. Div., Washington, D.C.
Science Aid (summers): sea ice forecasting

OTHER EXPERIENCE

Chairman, AMS Committee on Polar Meteorology (1983-1985)
Member, Committee on Geophysical Data, National Academy of Sciences (1984-1986)
Science Advisor, Arctic Five-Year Plan Consultative Workshop, Anchorage (1986)
Speaker, National Science Board hearing on NSF Role in Polar Regions (1986)
Participant & lecturer, Workshop on Long-Range Forecasting, World Meteor. Org. (1982)
Lecturer, NATO Advanced Study Institute on Air-Sea-Ice Interaction (1981)
Participant, AIDJEX Arctic research flights, Barrow, Alaska (1975)

PROFESSIONAL SOCIETIES

American Meteorological Society
American Association for the Advancement of Science
American Geophysical Union
Arctic Institute of North America

Journals and books:

- Sater, J. E., J. E. Walsh and W. I. Wittman, 1974: A study of the impingement of sea ice on the north coast of Alaska. The Coast and Shelf of the Beaufort Sea, The Arctic Institute of North America, pp. 85-105.
- Walsh, J. E., 1974: Sea breeze theory and applications. J. Atmos. Sci., 31, 2012-2026.
- Mak, M.-K., and J. E. Walsh, 1976: On the relative intensities of land and sea breezes. J. Atmos. Sci., 33, 242-251.
- Walsh, J. E., 1976: On the nesting of grids in nonhydrostatic computations. Mon. Wea. Rev., 104, 735-743.
- Walsh, J. E., 1977: Measurements of the temperature, wind and moisture distribution across the northern coast of Alaska. Arctic and Alpine Research, 9(2), 143-151.
- Walsh, J. E., 1977: The incorporation of ice station data into a study of recent Arctic temperature fluctuations. Mon. Wea. Rev., 105, 1527-1535.
- Walsh, J. E., 1978: Temporal and spatial scales of the Arctic circulation. Mon. Wea. Rev., 106, 1532-1544.
- Walsh, J. E., and C. M. Johnson, 1979: An analysis of Arctic sea ice fluctuations, 1953-77. J. Phys. Oceanogr., 9, 580-591.
- Walsh, J. E., and C. M. Johnson, 1979: Interannual atmospheric variability and associated fluctuations in Arctic sea ice extent. J. Geophys. Res., 84, 6915-6928.
- Walsh, J. E., 1980: Empirical orthogonal functions and the statistical predictability of sea ice extent. Sea Ice Processes and Models, University of Washington Press, pp. 373-384.
- Walsh, J. E., and A. Mostek, 1980: A quantitative analysis of meteorological anomaly patterns over the United States, 1900-1977. Mon. Wea. Rev., 108, 615-630.
- Walsh, J. E., and M. B. Richman, 1981: Seasonality in the associations between surface temperatures over the United States and the North Pacific Ocean. Mon. Wea. Rev., 108, 767-783.
- Walsh, J. E., and J. E. Sater, 1981: Sea surface temperature effects in northern high latitudes. J. Geophys. Res., 86, 7425-7445.
- Mostek, A., and J. E. Walsh, 1981: Relationships between large-scale patterns of corn yield and meteorological variability over the United States. Agricul. Meteor., 22, 111-124.
- Walsh, J. E., and D. Allen, 1981: The accuracy of the Farmer's Almanac predictions. Weatherwise, 34, 212-215.

John Walsh
Publications--journals and books

- Walsh, J. E., M. B. Richman and D. W. Allen, 1982: Spatial coherence of monthly precipitation in the United States. Mon. Wea. Rev., 110, 272-286.
- Hibler, W. D. III, and J. E. Walsh, 1982: On modeling the seasonal and interannual fluctuations of arctic sea ice. J. Phys. Oceanogr., 12, 1514-1523.
- Walsh, J. E., D. R. Tucek and M. R. Peterson, 1982: Seasonal snow cover and short-term climatic fluctuations over the United States. Mon. Wea. Rev., 110, 1474-1485.
- Klein, W. H., and J. E. Walsh, 1983: A comparison of pointwise screening and empirical orthogonal functions in specifying monthly surface temperatures from 700 mb data. Mon. Wea. Rev., 111, 669-673.
- Walsh, J. E., 1983: Diagnostic studies of large-scale air-sea-ice interactions. Chapter 12 in The Geophysics of Sea Ice (N. Untersteiner, Ed.), Reidel Publ. Co., New York.
- Walsh, J. E., 1983: The role of sea ice in climatic variability: a current assessment. Atmos.-Ocean, 21, 229-242.
- Walsh, J. E., W. D. Hibler III and B. Ross, 1984: A model simulation of twenty years of northern hemisphere sea ice fluctuations. Annals of Glaciology, 5, 170-176.
- Walsh, J. E., 1984: Snow cover and atmospheric variability. Amer. Sci., 72, 50-57.
- Walsh, J. E., and M. B. Richman, 1984: Reply to comment by R. L. Haney. Mon. Wea. Rev., 112, 871.
- Walsh, J. E., 1984: Forecasts of monthly 700 mb height: Verification and specification experiments. Mon. Wea. Rev., 112, 2135-2147.
- Walsh, J. E., W. D. Hibler III and B. Ross, 1985: Numerical simulation of Northern Hemisphere sea ice variability, 1951-1980. J. Geophys. Res. (Oceans), 90, 4847-4865.
- Walsh, J. E., W. H. Jasperson and B. Ross, 1985: Influences of snow cover and soil moisture on monthly air temperature. Mon. Wea. Rev., 113, 756-768.
- Walsh, J. E., 1985: Book Review of Dynamics of Ice Cover (L. A. Timokhov, Ed.) Bull. Amer. Meteor. Soc., 66, 1550-1551.
- Walsh, J. E., 1985: Sea ice - climatic changes. Encyclopedia of Climatology, Hutchinson-Ross Publ. Co., Stroudsburg, Pennsylvania.
- van den Dool, H. M., W. H. Klein and J. E. Walsh, 1986: The geographical distribution and seasonality of persistence in monthly mean air temperatures over the United States. Mon. Wea. Rev., 114, 546-560.

John Walsh

Publications--journals and books

Herman, G. F., J. E. Walsh, W. H. Raymond, R. E. Schlesinger and B. Ross, 1986: Observing system sensitivities in the North Atlantic during FGGE. Mon. Wea. Rev., 114, 2133-2153.

Ross, B., and J. E. Walsh, 1986: Synoptic-scale influences of snow cover and sea ice. Mon. Wea. Rev., 114, 1795-1810.

Walsh, J. E., W. I. Wittmann, L. H. Hester and W. S. Dehn, 1986: Seasonal prediction of iceberg severity in the Labrador Sea. J. Geophys. Res., 91, 9683-9692.

Walsh, J. E., D. W. Plummer, G. F. Herman, B. Ross and W. H. Raymond, 1986: Data sensitivities of sea ice drift and ocean stress in North Atlantic high latitudes. J. Geophys. Res., 91, 11,657-11,676.

Zwally, H. J., and J. E. Walsh, 1987: Comparison of observed and modeled ice motion in the Arctic Ocean. Ann. Glaciol., 9, in press.

Ross, B., and J. E. Walsh, 1987: A comparison of simulated and observed fluctuations in Arctic surface albedo. J. Geophys. Res., submitted.

Other articles:

- Walsh, J. E., 1977: Ice forecasting limitations imposed by the accuracy of atmospheric prediction models. AIDJEX Bulletin, No. 36, 1-13.
- Walsh, J. E., 1978: A data set on Northern Hemisphere sea ice extent, 1953-76. Glaciological Data, GD-2.
- Walsh, J. E., 1981: Sea ice data sets. Snow Watch 1980, Glaciological Data, GD-11, 139-144.
- Walsh, J. E., and D. R. Tucek, 1982: On the use of snow cover as a short-term climatic predictor. Proceedings of the Sixth Annual Climate Diagnostics Workshop, U. S. Department of Commerce/NOAA, 170-177.
- Walsh, J. E., 1982: Surface forcing by sea ice, snow cover and soil moisture. Long-range forecasting expert study meeting, World Meteorological Organization, Princeton, New Jersey (December 1982), 13 pp.
- Walsh, J. E., 1983: Continental snow cover and associations with 700 mb height: 1966-1980. Proceedings of the Seventh Annual Climate Diagnostics Workshop, U. S. Department of Commerce/NOAA, 189-195.
- Walsh, J. E., and W. D. Hibler III, 1984: East Greenland sea ice variability in large-scale model simulations. MIZEX Bulletin, III: Modeling the Marginal Ice Zone. U. S. Army CRREL Special Report 84-7, 1-8.
- Walsh, J. E., 1984: Numerical simulation of North Atlantic sea ice variability, 1951-1980. North Atlantic Deep Water Formation, NASA Goddard Institute for Space Studies, Workshop Report (in press), 36-38.
- Walsh, J. E., 1984: Snow cover, soil moisture and associated atmospheric variability. Studies in Climate (H. van Loon, Ed.), NCAR Technical Note NCAR/TN-227+STR, National Center for Atmospheric Research, 336-360.
- Walsh, J. E., G. F. Herman, W. Raymond, B. Ross and R. Schlesinger, 1985: Observing system sensitivities in the North Atlantic during FGGE. Preprints, Seventh Conference on Numerical Weather Prediction, American Meteorological Society, Boston, 129-136.
- Walsh, J. E., and W. H. Jasperson, 1985: Land surface fluctuations and associated climatic variability. Preprints, Third Conference on Climate Variations and Symposium on Contemporary Climate, American Meteorological Society, Boston, 85-86.
- Richman, M. R., and J. E. Walsh, 1985: Hemispheric pattern analysis of weekly 500 mb data. Preprints, Ninth Conference on Probability and Statistics, American Meteorological Society, Boston, 101-107.
- Walsh, J. E., 1986: Surface-atmosphere interactions over the continents: The Namias influence. Namias Symposium Volume, University of California Press, 161-171.

List of Publications

John Walsh

Other articles - 2:

Walsh, J. E., 1986: Northern Hemisphere sea ice variability: Observed and simulated. Canadian East Coast Workshop on Sea Ice, Bedford Institute of Oceanography, Bedford, NS, 1-21.

Wittmann, W. I., L. H. Hester, W. S. Dehn and J. E. Walsh, 1986: Long-range prediction of iceberg severity in the Labrador Sea. Canadian East Coast Workshop on Sea Ice, Bedford Institute of Oceanography, Bedford, NS, 341-360.

Walsh, J. E., 1986: High-latitude coverage and applications of COADS. Proceedings, COADS Workshop, NOAA Environmental Research Laboratories, Boulder, CO, 21-25.

RESUME

Becky J. Ross

ADDRESS

Office:	Department of Atmospheric Sciences	Home:	710 E. Pennsylvania
	University of Illinois		Urbana, IL 61801
	1101 W. Springfield Ave.		Tel. (217) 344-8046
	Urbana, IL 61801		
	Tel. (217) 333-2128		

EDUCATION

1980 B.A. Bryn Mawr College, Bryn Mawr, PA (Physics)
1982 M.S. Purdue University, West Lafayette, IN (Atmospheric Science)

EMPLOYMENT

1982-pres. University of Illinois, Department of Atmospheric Sciences
Scientific Programmer

1980-1982 Purdue University, Department of Geosciences
Research Assistant: mesoscale cellular convection

AWARDS

1981 June Bacon-Bercey award (AGU) for women in atmospheric science

PROFESSIONAL AND HONONARY SOCIETIES

American Meteorological Society
Sigma Xi

- Aronson, M., P. Beckmann, B. Ross and S. W. Tan, 1981: Intramolecular reorientations and the effects of thermal history and hydrogen bonding in four closely related organic molecular solids. Chemical Physics, 63, 349-358.
- Walsh, J. E., W. D. Hibler III and B. Ross, 1984: A model simulation of 20 years of Northern Hemisphere sea ice fluctuations. Ann. Glaciol., 5, 170-176.
- Ross, B., 1984: A model investigation of interannual sea ice variability in the Beaufort Sea. J. Glaciol., 23, 30, 223-226.
- Walsh, J. E., W. D. Hibler III and B. Ross, 1985: Numerical simulation of Northern Hemisphere sea ice variability, 1951-1980. J. Geophys. Res. (Oceans), 90, 4847-4865.
- Walsh, J. E., W. H. Jasperson and B. Ross, 1985: Influences of snow cover and soil moisture on monthly air temperatures. Mon. Wea. Rev., 113, 756-768.
- Ross, B. and E. Agee, 1985: Aircraft investigation of wintertime convective and non-convective boundary layers over the East China Sea. J. Meteor. Soc. Japan, 63, 405-417.
- Herman, G. F., J. E. Walsh, W. H. Raymond, R. E. Schlesinger and B. Ross, 1986: Observing systems sensitivities in the North Atlantic during FGGE. Mon. Wea. Rev., 114, 2133-2153.
- Ross, B. and J. E. Walsh, 1986: Synoptic-scale influences of snow cover and sea ice. Mon. Wea. Rev., 114, 1795-1810.
- Walsh, J. E., D. W. Plummer, G. F. Herman, B. Ross and W. H. Raymond, 1986: Data sensitivities of sea ice drift and ocean stress in North Atlantic high latitudes. J. Geophys. Res., 91, 11,657-11,676.
- Ross, B., and J. E. Walsh, 1987: A comparison of simulated and observed fluctuations in summertime Arctic surface albedo. Submitted to J. Geophys. Res.

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Bruce Mast
Contracts
105 Davenport House

The final report for account (1-5-37867)
with the Shell Development Company has been
sent in. The contract should be closed.
Thank you.

Karen Garrelts
Atmospheric Sciences
101 Atmos Sci Bldg
3-2046