National Aeronautics and Space Administration

Disclosure of Invention and New Technology (Including Software)

Form Approved
O.M.B. NO.
2700-0009

DATE
2014-09-11

CONTRACTOR CASE NO.

NASA CASE NO. (OFFICIAL USE ONLY)
LAR-18552-1

This is an important legal document. Carefully complete and forward to the Patent Representative (NASA in-house innovation) or New Technology Representative (contractor/grantee innovation) at NASA. Use of this report form by contractor/grantee is optional; however, an alternative format must at a minimum contain the information required herein. NASA in-house disclosures should be read, understood and signed by a technically competent witness in the witness signature block at the end of this form. In completing each section, use whatever detail deemed appropriate fora "full and complete disclosure." Contractors/Grantees please refer to the New Technology or Patent Rights – Retention by the Contractor clauses. When necessary, attach additional documentation to provide a full, detailed description.

1. DESCRIPTIVE TITLE
The Modified Snowmelt Runoff Model For Forecasting Water Availability in Chile

2. INNOVATOR(S) *(For each innovator provide: Name, Title, Work Address, Work Phone Number, and Work E-mail Address. If multiple innovators, number each to match Box 5.)*

Jeffry Ely 10210 Greenbelt Road, Lanham, MD 20706, US, 757-218-1673 Jeff.ely.08@gmail.com
Amberle Keith 10210 Greenbelt Road, Lanham, MD 20706, US, x keitambe1@gmail.com
Joshua Kelly 10210 Greenbelt Road, Lanham, MD 20706, US, 978-604-1679 jkelly17@gmail.com
Lydia Cuker 10210 Greenbelt Road, Lanham, MD 20706, US, 757-262-7085 lcuker@gmail.com
Joseph Novak 10210 Greenbelt Road, Lanham, MD 20706, US, 540-494-9624 josephjnovak@yahoo.com
Ajoke Williams 10210 Greenbelt Road, Lanham, MD 20706, US, 504-394-4740 ajwilliams012@gmail.com
Bethany Burress 10210 Greenbelt Road, Lanham, MD 20706, US, 540-222-9210 bethany.burress.12@cnu.edu
Laura Macaluso 10210 Greenbelt Road, Lanham, MD 20706, US, 757-999-6052 laura.macaluso.12@cnu.edu

3. INNOVATOR'S EMPLOYER WHEN INNOVATION WAS MADE *(For each innovator provide: Name, Division and Address of Employer, Organizational Code/Mail Code, and Contract/Grant Number if applicable. If multiple innovators, number each to match Box 5.)*
Science Systems And Applications, Inc., , 10210 Greenbelt Road, Lanham, MD 20706, US, , NNL11AA00B
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Science Systems And Applications, Inc., , 10210 Greenbelt Road, Lanham, MD 20706, US, , NNL11AA00B

4. PLACE OF PERFORMANCE *(Address(es) where innovation made)*
10210 Greenbelt Road, Lanham, MD 20706, US
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5. EMPLOYER STATUS *(choose one for each innovator)*

___ Innovator #1
___ Innovator #2
___ Innovator #3
___ Innovator #4

GE = Government
CU = College or University
NP = Non-Profit Organization
SB = Small Business Firm
LE = Large Entity

6. ORIGIN *(Check all that apply and provide all applicable numbers. If multiple Contracts/Grants, etc., list Contract/Grant Numbers in Box 3 with applicable employer information.)*

[ ] NASA In-house Org. Mail Code
[ ] Grant/Cooperative Agreement No.
[ ] Prime Contract No.
Task No.   Report No.
[ ] Subcontractor: Subcontract Tier
[ ] Joint Effort (contract, subcontractor and/or grantee contributions(s), and NASA in-house contribution)
[ ] Multiple Effort (multiple contractor, subcontractor and/or grantee contributions, no NASA in-house contribution)
[ ] Other (e.g., Space Act Agreement, MOA) No.

7. NASA CONTRACTORING OFFICER'S TECHNICAL REPRESENTATIVE (COTR)
Shannon Walker

8. CONTRACTOR/GRANTEE NEW TECHNOLOGY REPRESENTATIVE (POC)
Jeffry W Ely

9. BRIEF ABSTRACT *(A general description of the innovation which describes its capabilities, but does not reveal details that would enable duplication or imitation of the innovation.)*

This implementation of the Snowmelt Runoff Model, originally developed by the United States Department of Agriculture, was created specifically for studying snowmelt in Chile. Minor modifications were made to allow precipitation inputs from multiple sources, which accommodate the unique elevation characteristics and capabilities of the in situ data collection network in Chile. Additional modifications were included which use individual time lag parameters for water from rainfall, and water from snowmelt to better suit the observed hydrological characteristics of the region. Each of these considerations culminates into a customized set of data manipulation tools and accompanying graphical user interface in both spanish and english versions to assist in making 3 month water availability forecasts.

SECTION I – DESCRIPTION OF THE PROBLEM OR OBJECTIVE THAT MOTIVATED THE INNOVATION'S DEVELOPMENT (Enter as appropriate: A. – General description of problem/objective; B. – Key or unique problem characteristics; C. – Prior art, i.e., prior techniques, methods, materials, or devices performing function of the innovation, or previous means for performing function of software; and D. – Disadvantages or limitation of prior art.)

A. General description of problem/objective

Chiles central northern regions depend largely on seasonal Andean snowmelt and a system of dams to provide enough water to support their growing population and industry. Water allocation strategy for each agricultural growing season is influenced by reservoir levels at the time the decisions are made. This information alone however is no longer sufficient in water management planning as the region suffers from decreasing precipitation and increasingly severe drought conditions every year.

B. Key or unique problem characteristics

Though adequately robust methods for forecasting highly variable precipitation in the upper Andes do not yet exist, a snowmelt runoff modeling approach based on the Snowmelt Runoff Model created by the United States Department of Agriculture (USDA) and MODIS snowcover data may be employed to grant short range estimates of water availability from snowmelt during the most critical growing season. An exceptionally dry climate with slightly more complex physics, a sub-optimal number of monitoring stations and limited in-situ data required a customized approach to implementing the a snowmelt runoff model in this region of the world.

SECTION II – TECHNICALLY COMPLETE AND EASILY UNDERSTANDABLE DESCRIPTION OF INNOVATION DEVELOPED TO SOLVE THE PROBLEM OR MEET THE OBJECTIVE (Enter as appropriate; existing reports, if available, may form a part of the disclosure, and reference thereto can be made to complete this description: A. – Purpose and description of innovation/software; B. – Identification of component parts or steps, and explanation of mode of operation of innovation/software preferably referring to drawings, sketches, photographs, graphs, flow charts, and/or parts or ingredient lists illustrating the components; C. – Functional operation; D. – Alternate embodiments of the innovation/software; E. – Supportive theory; F. – Engineering specifications; G. – Peripheral equipment; and H. – Maintenance, reliability, safety factors.)

A. Purpose and Description of innovation/software

This implementation of the Snowmelt Runoff Model, originally developed by the United States Department of Agriculture, was created specifically for studying snowmelt in Chile, and for making three month estimates of consequent water availability. Mathematical and procedural modifications were made to allow precipitation inputs from multiple sources, which accommodate the unique elevation characteristics and limited capabilities of the in situ data collection network in Chile. Additional modifications were included which use individual time lag parameters for water from rainfall, and water from snowmelt to better suit the observed hydrological characteristics of the region. The Snowmelt Runoff Model (SRM) Users Manual by J. Martinec, A. Rango, and R. Roberts remains the definitive source of information on the mathematics used for modeling runoff and including snow melt. This document aims to explain deviations from this model, and to outline the methodology used specifically by the NASA DEVELOP team with some detailed step by step instructions and some general explanations. For user reference, the Snowmelt Runoff Model (SRM) Users Manual may be found at the link below:
[http://aces.nmsu.edu/pubs/research/weather_climate/SRMSpecRep100.pdf]

A program known as WinSRM was written to accompany the Snowmelt Runoff Model (SRM) Users Manual, but is not used in the present study. A custom implementation of the Snowmelt runoff Model equation, henceforth referred to as the Modified Snowmelt Runoff Model (M-SRM) was coded in Matlab to accommodate the variations on this model necessitated by Chiles unique climate. An additional document has been provided with the NASA_DEVELOP_SRM package specifically for help using the graphical user interface (GUI) which replaces the WinSRM software for this study.

SECTION III – UNIQUE OR NOVEL FEATURES OF THE INNOVATION AND THE RESULTS OR BENEFITS OF ITS APPLICATION (Enter as appropriate: A. – Novel or unique features; B. – Advantages of innovation/software; C. – Development or new conceptual problems; D. – Test data and source of error; E. – Analysis of capabilities; and F. – For software, any re-use or re-engineering of existing code, use of shareware, or use of code owned by a non-federal entity.)

Incorporation of TRMM precipitation data and MODIS snow covered area data at daily time steps. Software is ready for data from the Global Precipitation Measurement mission (GPM).

SECTION IV – SPECULATION REGARDING POTENTIAL COMMERCIAL APPLICATIONS AND POINTS OF CONTACT (Including names of companies producing or using similar products.)

Not applicable

10. ADDITIONAL DOCUMENTATION *(Include copies or list below any pertinent documentation which aids in the understanding or application of the innovation (e.g., articles, contractor reports, engineering specs, assembly/manufacturing drawings, parts or ingredients list, operating manuals, test data, assembly/manufacturing procedures, etc.).)*

TITLE	PAGE	DATE
Graphical_User_Interface_Help		2014-04-17
Modified snowmelt runoff model for forecasting water availability in Chile		2014-04-17

11. DEGREE OF TECHNOLOGY SIGNIFICANCE *(Which best expresses the degree of technological significance of this innovation?)*
[X] Modification to Existing Technology [ ] Substantial Advancement in the Art [ ] Major Breakthrough

12. STATE OF DEVELOPMENT
[ ] Concept Only [ ] Design [X] Prototype [X] Modification [ ] Production Model [ ] Used in Current Work

13. PATENT STATUS (Prior patent on/or related to this innovation)

14. INDICATE THE DATE OR THE APPROXIMATE TIME PERIOD WHICH THIS INNOVATION WAS DEVELOPED *(i.e., conceived, constructed, tested, etc.)*
The innovation was conceived in September of 2014 and concluded in October of 2013

15. PREVIOUS OR CONTEMPLATED PUBLICATION OR PUBLIC DISCLOSURE INCLUDING DATES *(Provide as applicable: A. - Type of publication or disclosure, e.g. report, conference or seminar, oral presentation; B. - Disclosure by NASA or Contractor/Grantee; and C. - Title, volume no., page no., and date of publication*

16. QUESTIONS FOR SOFTWARE ONLY

(a) Using non-NASA employees to beta-test the program? [X]YES [ ]NO If Yes, done under a beta-test agreement? [ ]YES [X]NO
(b) Modification of this program continued by civil servant and/or contractual agreement? [ ]YES [X]NO
(c) Copyrighted registered? [ ]YES [X]NO [ ]UNKNOWN If Yes, then by whom?
(d) Has the lastest version been distributed outside of NASA or contractor? [ ]YES [X]NO [ ]UNKNOWN
(e) Were prior version distributed outside of NASA or Contractor? [ ]YES [X]NO [ ]UNKNOWN If Yes, supply NASA or contractor contact
(f) Contains or based on code not owned by U.S. Government or its contractors? [ ]YES [ ]NO [X]UNKNOWN
If Yes, name of code and code's owner
Has a license for use been obtained? [ ]YES [ ]NO [X]UNKNOWN

17. DEVELOPMENT HISTORY

STAGE OF DEVELOPMENT	DATE (MM/YYYY)	LOCATION	IDENTIFY SUPPORTING WITNESSES NASA in-house only)
a. First disclosure to others	11/2013	NASA Langley Research Center	
b. First sketch, drawing, logic chart or code	11/2013	NASA Langley Research Center	
c. First written description	11/2013	NASA Langley Research Center	
d. Completion of first model of full size device *(invention)* or beta version *(Software)*	1/2014	NASA Langley Research Center	
e. First successful operational test *(invention)* or alpha version *(Software)*	2/2014	NASA Langley Research Center	

f. Contribution of innovators *(if jointly developed, provide the contribution of each innovator)*
Jeffry William Ely: Project Lead 1, Lead software design and integration
Joshua Kelly: Project Lead 2, software design
Laura Macaluso: Software design for graphical user interface
Joseph Novak: Software testing and validation
Amberle Keith: Model development for using remotely sensed data
Lydia Cuker: Model development for geological considerations
Bethany Burress: Characterization of basin parameters and model validation
Ajoke Williams: Characterization of basin parameters and model validation

g. Indicate any past, present, or contemplated government use of the innovation

18. SIGNATURES OF INNOVATOR(S), WITNESS(ES), AND NASA APPROVAL

TYPED NAME AND SIGNATURE *(Innovator #1)*	DATE	TYPED NAME AND SIGNATURE *(Innovator #2)*	DATE
TYPED NAME AND SIGNATURE *(Innovator #3)*	DATE	TYPED NAME AND SIGNATURE *(Innovator #4)*	DATE
TYPED NAME AND SIGNATURE *(Innovator #5)*	DATE	TYPED NAME AND SIGNATURE *(Innovator #6)*	DATE

NASA APPROVED	TYPED NAME	SIGNATURE	DATE