

PROPOSAL TO
SOUTHERN COMPANY SERVICES

FOR

UNDERSTANDING SOLAR VARIABILITY AND CLIMATE CHANGE:
SIGNALS FROM TEMPERATURE RECORDS OF THE UNITED STATES

P6882-1-08

For the period 15 January 2008 through 31 December 2008

January 2008

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts 02138

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

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For the period 15 January 2008 through 31 December 2008

Funds Requested: \$60,000

Principal Investigator

Dr. Willie Soon

Associate Director,
Solar, Stellar, and Planetary Division

Dr. Nancy S. Brickhouse

January 2008

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts 02138

Director: Dr. Charles Alcock

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SI-000041



Smithsonian Astrophysical Observatory

Understanding Solar Variability and Climate Change: Signals from Temperature Records of the United States *A Proposal to The Southern Company*

Dr. Willie Soon, Principal Investigator
Smithsonian Astrophysical Observatory
Solar, Stellar and Planetary Sciences Division
(617-495-7488; wsoon@cfa.harvard.edu)
January, 2008

Research Target and Proposal:

This proposal seeks \$60,000 from The Southern Company for year one of this two-year project, "*Understanding Solar Variability and Climate Change: Signals from Temperature Records of the United States.*" I propose to conduct an intensive up-to-date science review of solar variability and climate change (see e.g., Soon 2007a), with emphasis on the signals from temperature records of the U.S., that will be a clear improvement of previous studies. The goals for the first year are to collect and assess the scientific quality of the available temperature records from the United States, aggregated into four inter-related spatial domains: 1) a rural city (i.e., a city that is minimally disturbed by urban development), 2) an individual state, 3) regional U.S. area, and 4) the whole conterminous U.S. The goals for the second year are to study any plausible connection of these U.S. temperature records with estimated solar irradiance history for the past 112 years from 1895 to 2006.

The previously published research paper by Soon (2005) identifies both the multidecadal variation in total solar irradiance and the 11-year solar UV irradiance forcings to be important in explaining the observed Arctic surface air temperature change over the past 130 years or so. The overall goal for this 2-year program is to extend our basic understanding on how the variable solar irradiance outputs could be physically connected to the Earth climate system. The ability to confirm or reject the statistical correlations shown in Figure 1 will be of enormous scientific importance. The ultimate physical understanding will arise from detailed assessments on how the solar irradiance is related to the cloud field as well as how the solar irradiance may systematically and persistently modulate the land surface heat fluxes (i.e., sensible and latent heats) on multidecadal to centennial time scales. A parallel hypothesis regarding the role of rising atmospheric carbon dioxide (see e.g., Soon 2007b) in warming the surface temperatures of the United States on these 4 spatial scales will also be evaluated.

A Sun-Climate Coincidence?

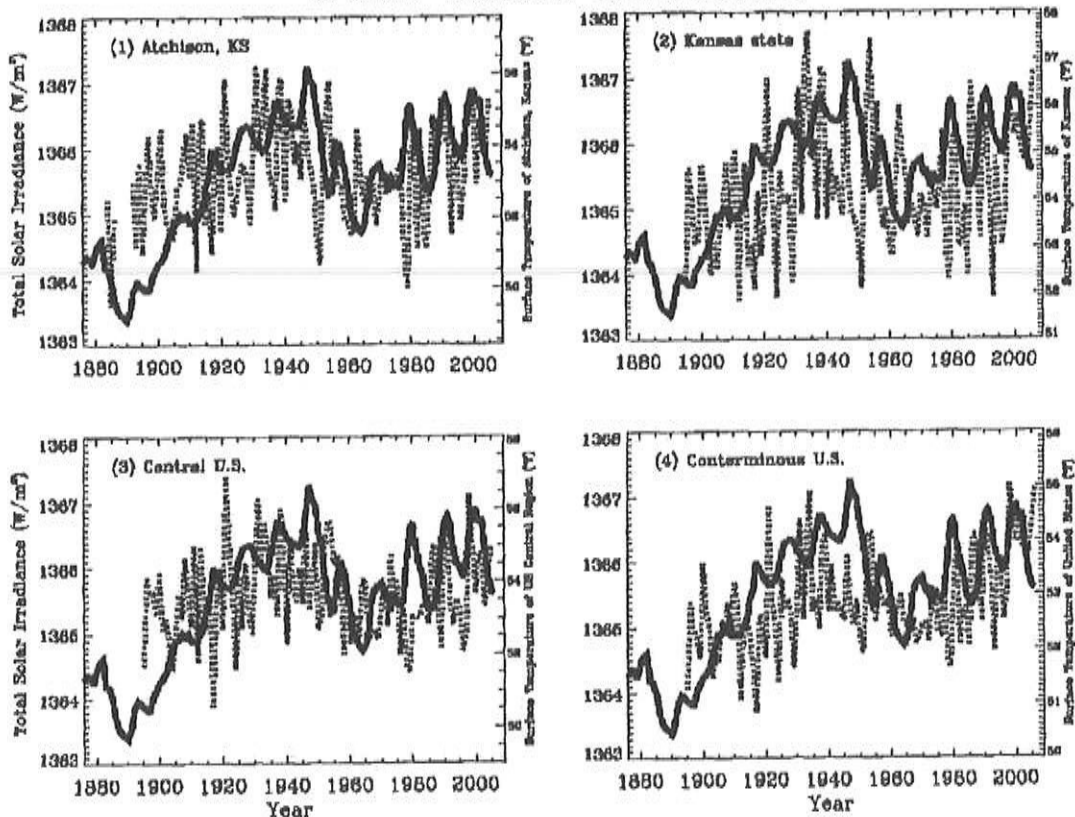


Figure 1: A plausible connection of the solar irradiance (red curves in all four plots; based on Hoyt and Schatten 1993-rescaled to the mean absolute value¹ measured by the ACRIM radiometers) compared with U.S. temperature records in 4 spatial domains (the blue dotted curves are for 1) Atchison, KS, 2) state of Kansas, 3) Central region of the U.S., and 4) conterminous U.S.). These results extend the previous relation found for the Arctic shown in Soon (2005). The scientific hypothesis for this sun-climate relation will be carefully formulated and examined in the proposed project.
 [Temperature Data Source: U.S. National Climatic Data Center, <http://lwf.ncdc.noaa.gov/oa/climate/research/cag3/cag3.html>].

¹ Soon (2007a) calls for the solar physics community to firmly establish this value emphasizing its great importance in establishing the mean climatology in climate models. The mean climatology in climate models can be subjected to a rather arbitrary tuning given that the absolute level of total solar irradiance is not determined to any level of confidence, with values ranging from 1372 to 1360 W/m².

Expected Outcomes:

- (1) Publication of both original and review papers on solar variability and climate change and various environmental impacts of that related change in leading scientific journals for the advancement of climate and meteorological sciences.
- (2) Development of tools, including power-point presentations and concise scientific essays, for unbiased and more accurate science accounting that will more powerfully serve informed public policy making.
- (3) Better public education with active participations by the PI of this research proposal in all national and international forums interested in promoting the basic understanding of solar variability and climate change.

Research Team:

Dr. Willie Soon at the Smithsonian Astrophysical Observatory, which is part of the Harvard-Smithsonian Center for Astrophysics, will lead and direct this scientific research program. In addition, the PI *may* solicit interests for collaborative effort from interested colleagues at no additional cost to the proposal.

Funding Request:

The funding is primarily to support approximately 3.5 months of the full-time research work of Dr. Willie Soon at the Smithsonian Astrophysical Observatory and a small amount of travel to a scientific meeting or publication costs. This research proposal requests \$60,000 from the Southern Company for work to start January, 2008, extending for a duration of about one year.

References

- Hoyt D. V. and Schatten K. H. (1993) A discussion of plausible solar irradiance variations, 1700-1992. *Journal of Geophysical Research* 98 (A11), 18895-18906 [with updates from Dr. Nicola Scafetta, Duke University, private communication May 31, 2007].
- Soon W. (2005) Variable solar irradiance as a plausible agent for multidecadal variations in the Arctic-wide surface air temperature records of the past 130 years. *Geophysical Research Letters* 32: L16712.
- Soon W. (2007a) Some Issues of Solar Irradiance Variability and Climatic Responses: A Brief Review. Invited Talk GC42A-05 at the American Geophysical Union Fall Meeting (December 10-14, 2007).
- Soon W. (2007b) Implications of the secondary role of carbon dioxide and methane forcing in climate change: Past, present, and future. *Physical Geography* 28, 97-125.

ESTIMATE OF COST

Period of Performance: January 15, 2008 through December 31, 2008

Productive Labor:	Hrs	Dollars
Dr. Willie Soon, PI	494	\$25,209
Program Administration	8	\$495
Secretary	20	\$607
Total Productive Labor	522	26,311
Leave @ 19.5%		5,131
Total Direct Labor		31,442
Fringe Benefits @ 26.5%		8,332
Direct Operating Overhead Base		39,774
Direct Operating Overhead @ 30%		11,932
Travel -see schedule		1,789
Printing and Reproduction - see schedule		1,050
G & A Base		54,545
G & A @ 10%		5,455
TOTAL ESTIMATED COST		\$60,000

TRAVEL SCHEDULE

DESTINATION	NO TRIPS	NO TRAVELERS	DAYS/ TRIP	RATE PER DIEM	TOT PER DIEM	AIR FARE	TOT AIR FARE	MISC*	TOTAL COST
Scientific Meeting-San Francisco	1	1	5	204	\$1,020	\$500	\$500	\$269	\$1,789
TOTAL TRAVEL					\$1,020		\$500	\$269	\$1,789

*Includes local transportation costs and meeting registration fees

PRINTING AND REPRODUCTION SCHEDULE

COST BASIS	OBJECT CLASS DESCRIPTION	VENDOR	TOTAL COST
Est	Page charges	Astrophysical Journal	\$1,050
	# Pages	10	
	Cost Per Page	105	
	TOTAL PRINTING AND REPRODUCTION		\$1,050

CONTRACTUAL AND COST INFORMATION INCLUDING CERTIFICATIONS

The Smithsonian Institution, an independent trust establishment was created by an act of the Congress of 1846 to carry out the terms of the will of James Smithson of England, who had bequeathed his entire estate to the United States of America "to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men." After accepting the trust property for the United States, Congress vested responsibility for administering the trust in a Smithsonian Board of Regents.

The Smithsonian performs research, educational and other special projects supported by grants and contracts awarded under the cost principles of the Federal Acquisition Regulation, Subpart 31.7 Contracts with Nonprofit Organizations. It is audited by the Defense Contract Audit Agency, Landover, Maryland.

The Charter of the Smithsonian Institution carries a mandate for the "increase and diffusion of knowledge among men." Therefore, any grant or contract that may be awarded as a result of this proposal must be unclassified, in order not to abridge the Institution's right to publish, without restriction, findings that result from this research project.

Considering the nature of the proposed effort, it is requested that a Research Grant with reimbursement via electronic funds transfer be awarded to cover the proposed project in accordance with Subpart C Section .22(e) of OMB Circular No. A-110 dated 30 September 1999.

Pursuant to Subpart C, Section .33 and .34 of OMB Circular No. A-110 dated 30 September 1999, it is requested that title to all exempt property and equipment purchased or fabricated under the proposed contract be vested irrevocably in the Institution upon acquisition.

In accordance with an agreement between the Office of Naval Research and the Smithsonian, the Institution operates with predetermined fixed overhead rates with carry-forward provisions. For Fiscal Year 1996 and beyond, the Indirect Cost and Fringe Benefits Rates are developed in accordance with the Office of Management and Budget Circular (OMB) A-122: Cost Principles for nonprofit organizations. The following approved rates, provided by ONR Negotiation Agreement dated 2 November 2007, shall be used for forward pricing and billing purposes for Fiscal Year 2008. The Fringe Benefits Rate will be applied to the Total Direct Labor Costs. The Material Overhead Rate will be applied to the cost of materials, equipment and subcontracts. The Direct Operating Overhead Rate will be applied to the Direct Labor and Benefits costs. The G&A Rate will be applied to the base consisting of total costs except the costs associated with the materials, equipment and subcontracts.

The following Approved Rates shall be used for forward pricing and billing purposes for Fiscal Year 2008:

Material Burden Rate (Cost of Materials, equipment and subcontracts)	5.4%
Personnel Leave Rate (Total Direct Labor Costs less paid leave and training (Productive Labor))	19.5%
Fringe Benefits Rate (Full/Part Time Employees) (Total Direct Labor Costs)	26.5%
Fringe Benefits Rate (Intermittent Employees) (Total Direct Labor Costs)	8.5%
Direct Operating Overhead Rate (Total Direct Labor and Fringe Benefits Costs)	30.0%
General and Administrative Rate (G&A) (Base consists of Direct Operating Activities less Net Costs Associated with materials, subcontracts and equipment)	10.0%
Central Engineering Overhead Rate (Central Engineering Direct Labor and Benefits Costs)	28.9%

Rate verification can be made by contacting Ms. Linda Shipp, Office of Naval Research, Indirect Costs/ONR 242, 800 N. Quincy Street, Room 704, Arlington, Virginia 22217, telephone (703) 696-8559, or e-mail linda_shipp@onr.navy.mil.

Engineering services are provided by the Central Engineering Department as a Cost Center. Charges by the department to research projects are inclusive of Direct Labor, Fringe Benefits, and Central Engineering Overhead.

CERTIFICATIONS

Pursuant to Executive Order 12549 and implementing rule (FAR 52.209-5), the Smithsonian Institution certifies that it presently is not debarred, suspended, proposed for debarment, declared ineligible or voluntarily excluded from covered transactions by any Federal department or agency.

Pursuant to Section 1352, Title 31, United States Code (USC) and implementing rule (FAR 52.203-12), the Smithsonian Institution certifies that no Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress on his or her behalf in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment or modification of any Federal contract, grant, loan or cooperative agreement.

**UNDERSTANDING SOLAR VARIABILITY AND CLIMATE
CHANGE: SIGNALS FROM TEMPERATURE RECORDS OF THE
UNITED STATES**

YEAR 1 REPORT

For the Period 15 January 2008 to 15 January 2009

Principal Investigator: Dr. Willie Soon

January 2009

Prepared for
Southern Company
Atlanta, GA 30308

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

The Southern Company contact for this grant is Robert Gehri,
Southern Company, 30 Ivan Allen Jr. Blvd. NW, Atlanta, GA 30308

Year 1 Report
**"Understanding Solar Variability and Climate Change:
Signals from Temperature Records of the United States"**
For the Southern Company
Period of performance: 1/15/08 to 1/15/09

by Willie Soon, Principal Investigator
Smithsonian Astrophysical Observatory
Solar, Stellar and Planetary Sciences Division
(617-495-7488; wsoon@cfa.harvard.edu)

The goals of this research proposal have been completely and successfully executed with the following list of deliverables:

- (1) **The publication of: "Polar bear population forecasts: A public-policy forecasting audit" *Interface*, vol. 38, 382-405 by Scott Armstrong, Kesten Green and Willie Soon (2008) [with comments and replies]**

Calls to list polar bears as a threatened species under the United States Endangered Species Act are based on forecasts of substantial long-term declines in their population. Nine government reports were written to help US Fish and Wildlife Service managers decide whether or not to list polar bears as a threatened species. We assessed these reports based on evidence-based (scientific) forecasting principles. None of the reports referred to sources of scientific forecasting methodology. Of the nine, Amstrup et al. [Amstrup, S. C., B. G. Marcot, D. C. Douglas. 2007. Forecasting the rangewide status of polar bears at selected times in the 21st century. Administrative Report, USGS Alaska Science Center, Anchorage, AK.] and Hunter et al. [Hunter, C. M., H. Caswell, M. C. Runge, S. C. Amstrup, E. V. Regehr, I. Stirling. 2007. Polar bears in the Southern Beaufort Sea II: Demography and population growth in relation to sea ice conditions. Administrative Report, USGS Alaska Science Center, Anchorage, AK.] were the most relevant to the listing decision, and we devoted our attention to them. Their forecasting procedures depended on a complex set of assumptions, including the erroneous assumption that general circulation models provide valid forecasts of summer sea ice in the regions that polar bears inhabit. Nevertheless, we audited their conditional forecasts of what would happen to the polar bear population assuming, as the authors did, that the extent of summer sea ice would decrease substantially during the coming decades. We found that Amstrup et al. properly applied 15 percent of relevant forecasting principles and Hunter et al. 10 percent. Averaging across the two papers, 46 percent of the principles were clearly contravened and 23 percent were apparently contravened. Consequently, their forecasts are unscientific and inconsequential to decision makers. We recommend that researchers apply all relevant principles properly when important public policy decisions depend on their forecasts.

(2) The publication of : "Reply to response to Dyck et al. (2007) on polar bears and climate change in western Hudson Bay by Stirling et al. (2008)" *Ecological Complexity*, vol. 5, 289-302 by Dyck, Soon et al. (2008)

We address the three main issues raised by Stirling et al. [Stirling, I., Derocher, A.E., Gough, W.A., Rode, K., in press. Response to Dyck et al. (2007) on polar bears and climate change in western Hudson Bay. *Ecol. Complexity*]: (1) evidence of the role of climate warming in affecting the western Hudson Bay polar bear population, (2) responses to suggested importance of human-polar bear interactions, and (3) limitations on polar bear adaptation to projected climate change. We assert that our original paper did not provide any "alternative explanations [that] are largely unsupported by the data" or misrepresent the original claims by Stirling et al. [Stirling, I., Lunn, N.J., Iacozza, I., 1999. Long-term trends in the population ecology of polar bears in western Hudson Bay in relation to climate change. *Arctic* 52, 294–306], Derocher et al. [Derocher, A.E., Lunn, N.J., Stirling, I., 2004. Polar bears in a warming climate. *Integr. Comp. Biol.* 44, 163–176], and other peer-approved papers authored by Stirling and colleagues. In sharp contrast, we show that the conclusion of Stirling et al. [Stirling, I., Derocher, A.E., Gough, W.A., Rode, K., in press. Response to Dyck et al. (2007) on polar bears and climate change in western Hudson Bay. *Ecol. Complexity*] – suggesting warming temperatures (and other related climatic changes) are the predominant determinant of polar bear population status, not only in western Hudson (WH) Bay but also for populations elsewhere in the Arctic – is unsupported by the current scientific evidence. The commentary by Stirling et al. [Stirling, I., Derocher, A.E., Gough, W.A., Rode, K., in press. Response to Dyck et al. (2007) on polar bears and climate change in western Hudson Bay. *Ecol. Complexity*] is an example of uni-dimensional, or reductionist thinking, which is not useful when assessing effects of climate change on complex ecosystems. Polar bears of WH are exposed to a multitude of environmental perturbations including human interference and factors (e.g., unknown seal population size, possible competition with polar bears from other populations) such that isolation of any single variable as the certain root cause (i.e., climate change in the form of warming spring air temperatures), without recognizing confounding interactions, is imprudent, unjustified and of questionable scientific utility. Dyck et al. [Dyck, M.G., Soon, W., Baydack, R.K., Legates, D.R., Baliunas, S., Ball, T.F., Hancock, L.O., 2007. Polar bears of western Hudson Bay and climate change: Are warming spring air temperatures the "ultimate" survival control factor? *Ecol. Complexity*, 4, 73–84. doi:10.1016/j.ecocom.2007.03.002] agree that some polar bear populations may be negatively impacted by future environmental changes; but an oversimplification of the complex ecosystem interactions (of which humans are a part) may not be beneficial in studying external effects on polar bears. Science evolves through questioning and proposing hypotheses that can be critically tested, in the absence of which, as Krebs and Borteaux [Krebs, C.J., Borteaux, D., 2006. Problems and pitfalls in relating climate variability to population dynamics. *Clim. Res.* 32, 143–149] observe, "we will be little more than storytellers."

(3) The publication of the scientific manuscript "Centennial variations of the global monsoon precipitation in the last millennium: Results from ECHO-G model" by Jian Liu, Bin Wang, Qinghua Ding, Xueyuan Kuang, Willie Soon and Eduaordo Zorita (2009) in press for the peer-reviewed journal *Journal of Climate*.

We investigate how the global monsoon (GM) precipitation responds to the external and anthropogenic forcing in the last millennium by analyzing a pair of control and forced millennium simulations with the ECHO-G coupled ocean-atmosphere model. The forced run, which includes the solar, volcanic and greenhouse gas forcing, captures the major

modes of precipitation climatology comparably well when contrasted with those captured by the NCEP reanalysis. The strength of the modeled GM precipitation in the forced run exhibits a significant quasi-bi-centennial oscillation. Over the past 1000 years, the simulated GM precipitation was weak during the Little Ice Age (1450-1850) with three weakest periods occurring around 1460, 1685, and 1800, which fell in, respectively, the Spörer Minimum, Maunder Minimum, and Dalton Minimum periods of solar activity. Conversely, strong GM was simulated during the model Medieval Warm Period (ca. 1030-1240). Before the industrial period, the natural variations in the total amount of effective solar radiative forcing reinforce the thermal contrasts both between the ocean and continent and between the northern and southern hemispheres resulting in the millennium-scale variation and the quasi-bi-centennial oscillation in the GM index. The prominent upward trend in the GM precipitation occurring in the last century and the notable strengthening of the global monsoon in the last 30 years (1961-1990) appear unprecedented and owed possibly in part to the increase of atmospheric carbon dioxide concentration though our simulations of the effects from recent warming may be overestimated without considering the negative feedbacks from aerosols. The simulated change of GM in the last 30 years has a spatial pattern that differs from that during the Medieval Warm Period, suggesting that global warming that arises from the increases of greenhouse gases and the input solar forcing may have different effects on the characteristics of GM precipitation. We further note that GM strength has good relational coherence with the temperature difference between the northern and southern hemispheres, and that on centennial timescale, the GM strength responds more directly to the effective solar forcing than the concurrent forced response in global mean surface temperature.

(4) The publication of the scientific manuscript "Validity of Climate Change Forecasting for Public Policy Decision Making" by Kesten Green, Scott Armstrong, and Willie Soon (2009) in the peer-reviewed journal *International Journal of Forecasting* [Status: accepted; subject to further revision]

Policymakers need to know whether prediction is possible and if so whether any proposed forecasting method will provide forecasts that are substantively more accurate than those from the relevant benchmark method. Inspection of global temperature data suggests that it is subject to irregular cycles on all relevant time scales and that variations during the late-20th Century were not unusual. In such a situation, a "no change" extrapolation is an appropriate benchmark forecasting method. We used the U.K. Met Office Hadley Centre's annual average thermometer data from 1850 through 2007 to examine the performance of the benchmark method. The accuracy of forecasts from the benchmark is such that even perfect forecasts would be unlikely to help policymakers. For example, mean absolute errors for 20- and 50-year horizons were 0.18°C and 0.24°C. We nevertheless evaluated the Intergovernmental Panel on Climate Change's 1992 projected long-term linear warming rate of 0.03°C-per-year. We used the IPCC projection for our demonstration of benchmarking because it has influenced important policy decisions. The small sample of errors from *ex ante* projections for 1992 through 2008 was practically indistinguishable from the benchmark errors. Validation for long-term forecasting, however, requires a much longer horizon. We illustrate proper

validation procedures by projecting the IPCC warming rate successively over a period analogous to that envisaged in their 0.03°C-per-year 21st Century warming scenario in which CO₂ levels are expected to grow exponentially. Namely 1851 to 1975. The errors from the projections were more than seven times greater than the errors from the benchmark method. Relative errors were larger for longer forecast horizons. Our validation exercise illustrates the importance for policymakers of determining predictability before making expensive decisions.

- (5) Preparation of the scientific manuscript “Multiple and changing cycles of active stars II. Results” by K. Olah, Z. Kollath¹, T. Granzer, K.G. Strassmeier, A.F. Lanza, S. Jarvinen, H. Korhonen, S.L. Baliunas, W. Soon, S. Messina, and G. Cutispoto (2009) for publication in the peer-reviewed journal *Astronomy & Astrophysics* (Status: submitted)

ABSTRACT

Aims. We study the time variations of the cycles of 20 active stars based on decades-long photometric or spectroscopic observations.

Methods. A method of time-frequency analysis, as discussed in a companion paper, is applied to the data.

Results. Fifteen stars definitely show multiple cycles; the records of the rest are too short to verify a timescale for a second cycle. The cycles typically show systematic changes. In three stars we found 2-2 cycles that are not harmonics, and which vary in parallel, indicating that a common physical mechanism arising from a dynamo construct. The positive relation between the rotational and cycle periods is confirmed for the inhomogeneous set of active stars.

Conclusions. Stellar activity cycles are generally multiple and variable.

- (6) Preparation of the scientific manuscript “Solar Arctic-Mediated Climate Variation on Multidecadal to Centennial Timescales: Empirical Evidence, Mechanistic Explanation, and Testable Consequences” (2009) by Willie Soon for publication in the peer-reviewed journal *Physical Geography* (Status: submitted)

The abstract of this new paper says: “Soon (2005) showed that the variable total solar irradiance (TSI) could explain, rather surprisingly, well over 75% of the variance for the decadal-smoothed Arctic-wide surface air temperature over the past 130 years or so. The present paper provides additional empirical evidence for this physical connection, both through several newly published high-resolution paleo-proxy records and through robust climate-process modeling outputs, and proposes a mechanistic explanation, involving 1) the variable strength of the Atlantic meridional overturning circulation (MOC) or thermohaline circulation (THC), 2) the shift and modulation of the Inter-Tropical Convergence Zone (ITCZ) rainbelt and tropical Atlantic ocean conditions, and 3) the intensity of the wind-driven subtropical and subpolar gyre circulation, across both the North Atlantic and North Pacific. A unique test of this proposed solar TSI-Arctic thermal-salinity-cryospheric coupling mechanism is the 5-to-20-year delayed effects on

(1) the peak Atlantic MOC flow rate centered near 30-35°N, and (2) sea surface temperature (SST) for the tropical Atlantic. The solar Arctic-mediated climate mechanism on multidecadal to centennial timescales presented here can be compared with and differentiated from both the related solar TSI and UV irradiance forcing on decadal timescale. The ultimate goal of this scientific research is to gain sufficient mechanistic details so that the proposed solar-Arctic climate connection on multidecadal to centennial timescales can be confirmed or falsified. A further incentive is to expand this physical connection to longer, millennial-scale variability as motivated by the multiscale climate interactions shown by Braun et al. (2005), Weng (2005) and Dima and Lohmann (2009).”

**(7) The prominent participation of PI in the following list of scientific talks and discussion at both national and international forums of professional scientists:
All power-point talks are available upon request**

- (a) January 4-6, 2008: Awakening 2008 Conference, Sea Island, Georgia
"The secondary role of CO2 radiative forcing in climate change:
Real facts you are not even supposed to find out!"
- (b) March 2-4, 2008: International Climate Conference, New York City, NY
"Global Warming 101: Al Gore's CO2 Theory"
- (c) March 15, 2008: Good Neighbor Forum, Cheyenne, WY
"Global Warming Explained!" (co-panelist Lyle Laverty, Assistant
Secretary of Fish, Wildlife and Park Services)
- (d) March 31, 2008: Deliberative Polling Event at California University
of Pennsylvania, California, PA
"Global Warming Explained: The importance of getting the science right!"
- (e) April 3, 2008: Department of Physics Colloquium, University of Buffalo, NY
"The secondary role of CO2 and CH4 forcing on climate change:
Past, present and future"
- (f) April 24, 2008: Sutherland Institute Global Warming Panel
(with Roy Spencer as co-panelist) "Future of Utah", Salt Lake City, Utah
- (g) June 19-22, 2008: 1st Annual "Winning Ideas Weekend" of
the Free to Choose Network, New York City, NY
"The Sun, CO2 and Global Warming" (with Dave Legates as co-panelist)
(among other speakers: John Fund of WSJ and John Stossel of ABC News)
- (h) June 23-28, 2008: Nice France Special session for the ISF.
Session Title: "Climate Forecasting and Public Policy."

"Do the Forecasts by the U.S. Government Provide Valid Evidence for the Decision to Classify Polar Bears as an Endangered Species?"
J. Scott Armstrong, The Wharton School, U. of Pennsylvania, Philadelphia, PA,
Kesten. C. Green, Business and Economic Forecasting,
Monash University, Vic 3800, Australia and
Willie Soon, Harvard-Smithsonian Center for Astrophysics, Cambridge MA

- (i) July 11-13, 2008: Annual Meeting of Doctors for Disaster Preparedness,
Phoenix, Arizona
"Endangering the Polar Bears: How environmentalists kill"
- (j) August 6-14, 2008: the 33rd International Geological Congress, Oslo, Norway
 - (i) co-chairing, with Professor Bob Carter of James Cook University,
the science session CGC-03:
"Solar drivers of climate change and the stratigraphic record"
 - (ii) selected by Professor David Gee of Uppsala University,
the IGC SciCom Chairman, to be one of the speakers
for the August 8's Theme of the Day of IGC on "Climate" and the title of my talk:
"Solar and Climate Variability: Past, present and future"
 - (iii) invited speaker for CGC-03 session:
"Solar irradiance variability and climatic responses: A brief review"
 - (iv) contributing author for CGC-03 session:
"Relationship between the global monsoon intensity and the effective solar radiation in the last millennium" by Jian Liu, Bin Wang and Willie Soon
- (k) September 15, 2008: Marshall Institute Climate Discussion Group,
"The Sun-Climate Connection"
- (l) September 23, 2008: University of Southern California, Ayn Rand Institute Global Warming and Policy Panel (with Keith Lockitch as co-panelist), "On the science of global climate change"
- (m) September 25, 2008: University of California Berkeley, Ayn Rand Institute Global Warming and Policy Panel (with Keith Lockitch as co-panelist), "On the science of global climate change"
- (n) September 29, 2008: Columbus, Ohio, Annual Meeting of the G&T Managers' Association, "On the science of global climate change"
- (o) November 24-26, 2008: Jakarta, Indonesia, **Invited speaker at the International Symposium on Climate and Weather of the Sun-Earth System** hosted by Indonesia's National Agency for Meteorology & Geophysics (as part of the scoping processes for the upcoming UN IPCC AR5 reports).

**AGREEMENT
FOR FUNDING A GRANT TO
SMITHSONIAN ASTROPHYSICAL OBSERVATORY**

THIS AGREEMENT is entered into by and between the **Smithsonian Astrophysical Observatory**, located at 60 Garden Street, Cambridge, MA 02138-1516, hereinafter referred to as "Smithsonian"), and **Southern Company Services, Inc.**, having its principal place of business at 600 North 18th Street, Birmingham, Alabama 35203, on behalf of itself, its parent and its affiliate companies, (collectively referred to as "SCS").

WITNESSETH

WHEREAS, the Smithsonian is interested in conducting an intensive science review of solar variability and climate change, as provided in the attached Proposal P6882-1-08 (referred to as the "Project"); and,

WHEREAS, SCS, on behalf of itself, its parent and its affiliate companies is interested in furthering the research on the Project and in obtaining advance information and is therefore willing to make a grant to fund this research.

NOW, THEREFORE, Smithsonian and SCS hereby agree as follows:

1. **Scope of Work.** The Scope of Work for this Project shall be conducted in accordance with the attached Proposal P6882-1-08 entitled "Understanding Solar Variability and Climate Change: Signals from Temperature Records of the United States", which is incorporated and made a part of this Agreement. In consideration of the Research to be provided by Smithsonian, SCS agrees to make an advance payment in the sum of Sixty Thousand Dollars (\$60,000.) and to reimburse Smithsonian for its costs in accordance with the Proposal in an amount not to exceed the advance sum.
2. **Limited Nature of Parties Obligations.**
The obligations of SCS and the Smithsonian hereunder shall be limited to payment of the amounts and the Project effort as specified in Article 1 above. SCS assumes no other obligation or responsibility of any kind to the Smithsonian or any other participants or sponsors, if any. SCS makes no warranties or Representations, Express or implied, of any kind.
3. **Termination.** Smithsonian understands and agrees that in the event the Project is terminated prior to completion or is not in accordance with the attached Proposal, SCS shall be entitled to a refund of the unexpended funds.
4. **No Joint Venture.** This Agreement is not intended to create nor shall it be construed to create any partnership, joint venture, employment or agency relationship between or among the parties, and no party shall be liable for the payment or performance of any debts, obligations, or liabilities of any other party, unless expressly assumed in writing.
5. **Deliverables.** In consideration to SCS for its one (1) year funding contribution to the Project, Smithsonian shall deliver to SCS a progress report of the findings including a detailed summary and analysis of the results and findings at the end of the one year period. SCS shall be entitled to a no-cost, non-exclusive irrevocable license to utilize the data and results of the Project for its internal purposes.
6. **Authority.** Each party represents and warrants to the other that as of the effective date of this Agreement: (a) it has all requisite power and authority to enter into and perform its obligations under this Agreement, and (b) there are no actions, suits, or proceedings pending, or to the best of its knowledge threatened, which may have a material adverse effect on its ability to fulfill its obligations under this Agreement or on its operations, business, properties, assets or condition.

7. **Assignment and Subcontracting Prohibited.** This Agreement shall not be assigned by Smithsonian nor its obligations subcontracted without the prior written consent of SCS, which shall not be unreasonably withheld. Any assignment or subcontracting in violation of this provision shall be deemed null and void and SCS shall be entitled to a refund of its contribution in full.
8. **Subsequent Changes in Agreement.** This Agreement may be modified only by an amendment executed in writing by a duly authorized representative for each party.
9. **Partial Invalidity.** If any provision of this Agreement is found to be unenforceable then, notwithstanding such unenforceability, this Agreement shall remain in effect and there shall be substituted for such unenforceable provision a like but enforceable provision which most nearly effects the intention of the parties. If a like but enforceable provision cannot be substituted, the unenforceable provision shall be deemed to be deleted and the remaining provisions shall continue in effect, provided that the performance, rights, and obligations of the parties hereunder are not materially adversely affected by such deletion.
10. **Successors and Assigns.** This Agreement shall inure to the benefit of and be binding upon the respective successors and permitted assigns, if any, of the parties, provided that this provision shall not be construed to permit any assignment which would be unauthorized or void pursuant to any other provision contained herein.
11. **Non-Waiver.** No provision of this Agreement shall be deemed waived and no breach shall be deemed excused unless such waiver or consent is in writing and signed by the party claimed to have waived or consented. No consent by either party to, or waiver of, a breach by the other, whether express or implied, shall constitute a consent to, waiver of, or excuse for any different or subsequent breach.
12. **Force Majeure.** Neither party shall be deemed to be in default of any provision of this Agreement or liable for failures in performance resulting from acts or events beyond the reasonable control of such party. Such acts shall include but not be limited to acts of God, civil or military authority, civil disturbance, war, strikes, fires, other catastrophes, or other 'force majeure' events beyond a party's reasonable control.
13. **Survival of Representations.** The provisions contained in this Agreement that by their sense and context are intended to survive the performance hereof by either or both parties shall so survive the completion of performance and termination of this Agreement, including the making of any and all payments due hereunder.
14. **Notices.** All notices permitted or required to be given under this Agreement shall be in writing and shall be deemed duly given upon personal delivery (against receipt) or on the fourth day following the date on which each such notice is deposited postage prepaid in the United States Mail, registered or certified, return receipt requested. All notices shall be delivered or sent to the other party at the address(es) shown below or to any other address(es) as the party may designate by ten (10) days prior written notice given in accordance with this provision.

If to Smithsonian:

Smithsonian Institution Astrophysical Observatory
60 Garden Street
Cambridge, MA 02138-1516
Attention: Dr. Willie Soon (for technical matters)
Attention: Mr. William J. Ford (for contractual matters)

If to SCS:

Southern Company Services, Inc.
600 North 18th Street
Bin 14N-8195
Birmingham, Alabama 35203
Attention: Robert P. Gehri (for technical matters)
Attention: Joseph L. Coker (for contractual matters)

15. **Publicity.** Smithsonian shall not publish and utilize the name or otherwise identify SCS or its affiliate companies in any publications or other advertisements without the express written consent of SCS. As further consideration to SCS, Smithsonian shall provide SCS an advance written copy of proposed publications regarding the deliverables for comment and input, if any, from SCS.
16. **Duplicate Originals.** Duplicate originals of this Agreement shall be executed, each of which shall be deemed an original but both of which together shall constitute one and the same instrument.
17. **Entire Agreement.** This Agreement contains the entire agreement of the parties and there are no oral or written representations, understandings or agreements between the parties respecting the subject matter of this Agreement which are not fully expressed herein.

IN WITNESS WHEREOF, each of the parties hereto acknowledge that they have caused this Agreement to be executed in duplicate originals by its duly authorized representative on the respective dates entered below.

SOUTHERN COMPANY SERVICES, INC.

THE SMITHSONIAN INSTITUTION
ASTRPPHYSICAL
OBSERVATORY
("Smithsonian")

By: Bryan Baldwin
("SCS")
(Signature)

By: William J. Ford
(Signature)

Name: Bryan Baldwin
(Typed or printed)

Name: William J. Ford
(Typed or printed)

Title: Manager, Environmental Assessment

Title: Contract and Grant Specialist

Date: 2/28/08

Date: 2/21/08

**AMENDMENT ONE
TO
AGREEMENT FOR FUNDING A GRANT TO
SMITHSONIAN ASTROPHYSICAL OBSERVATORY**

This **AMENDMENT ONE** ("Amendment") is made and entered into by and between The Smithsonian Astrophysical Observatory, (the "Smithsonian") and Southern Company Services, Inc., ("SCS") and is effective on the date it is executed by the later of the parties ("Effective Date").

WHEREAS, Smithsonian and SCS (the "Parties") entered into an Agreement for Funding a Grant to Smithsonian Astrophysical Observatory ("Agreement") dated February 28, 2008; and

WHEREAS, the parties now desire to amend such Agreement:

NOW, THEREFORE, for and in consideration of the mutual agreements, promises and covenants contained herein, the adequacy and sufficiency of which are hereby acknowledged, the parties hereby mutually agree as follows:

1. The following sentence is hereby added after the last sentence of Paragraph 1, Scope of Work:

"In consideration of further continued Research to be provided by Smithsonian to SCS, SCS agrees to make a second advance payment in the sum of Sixty Thousand Dollars (\$60,000.00) for its costs for additional research in an amount not to exceed the second advance sum.

2. The following sentence is hereby added after the first sentence of Paragraph 5, Deliverables:

"In consideration to SCS for its second one (1) year of funding contribution to the Project, Smithsonian shall deliver to SCS a progress report of the findings including a detailed summary and analysis of the results and findings at the end of the second one (1) year period."

3. The following new Paragraph is hereby added after Paragraph 17:

"18. **Invoicing and Payment.** Smithsonian shall invoice SCS in advance for the full amount of funding for each year that SCS may provide funding. All invoices shall be mailed to Robert P. Gehri at the address for notices provided in Paragraph 14, Notices. SCS shall pay Smithsonian for the full amount of each invoice within thirty (30) days after receipt of each such invoice. Payment shall be mailed to the address set forth in the invoice."

EXCEPT AS EXPRESSLY MODIFIED BY THIS AMENDMENT, ALL OTHER TERMS AND CONDITIONS OF THE AGREEMENT SHALL REMAIN IN FULL FORCE AND EFFECT.

IN WITNESS WHEREOF, each of the Parties hereto have caused this Amendment to be executed in duplicate originals by its duly authorized representative on the respective dates entered below.

Smithsonian Astrophysical Observatory
("Smithsonian")

By:  _____

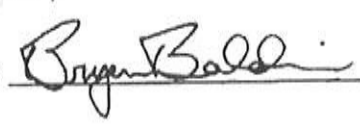
PETER W. SOZANSKI

(Name typed or printed) CONTRACTING OFFICER

Title: _____

Date: 5/1/09

Southern Company Services, Inc.
("SCS")

By:  _____

Bryan Baldwin

(Name typed or printed)

Title: Manager, Environmental Assessment

Date: April 6, 2009



**Understanding Solar Radiation and Climate Change:
A Research Program Into the Physical Links Between
Surface Sunshine History and Chinese Temperature Record**

Scientific Justification/Statement of Work
March, 2010

Research Motivation, Target and Proposal:

The primary motivation for such an in-depth scientific research proposal is to explore the mechanism on how the Earth's climate system actually varies naturally on multidecadal to multicentennial timescales. Establishing the reality of large natural climate change on the important timescales of decades to centuries is well supported by available climate proxy data but has been one of the most difficult hurdles in arguing for catastrophic man-made global warming or climate change. Thus, this scientific research proposal will be both timely and relevant for the current debate about man-made climate change.

In Soon (2009), a scientific hypothesis on how variable sunlight affects Earth's surface temperature and climate was outlined for the first time. The physical mechanism involves variable solar outputs, primarily in the visible light portion of the spectrum, modulating the equator-to-pole heat transport and affecting the heat and water budgets of the Arctic air-sea-ice system. Ultimately, the solar-Arctic changes modulate the Atlantic Ocean "conveyor-belt" circulation which has significant climatic teleconnections to different parts of the world.

Figure 1 shows such a predicted consequence – the connection between the variable solar irradiance with the Chinese temperature record from 1880-2002. The motivation in the search for a plausible solar explanation came from Zhou and Yu (2006):

"No model could successfully produce the reconstructed warming over China in the 1920s. ... Limitations of the current state-of-the-art coupled models in simulating spatial patterns of the 20th century [surface air temperature] over China cast a shadow upon their capability toward projecting credible geographical distributions of future climate change through IPCC scenario simulations." (p. 5843)

In the context of this research proposal, my goal is to uncover the physical mechanism of natural climate variation or other anthropogenic factors of climate change other than greenhouse gases; the conclusion of Zhou and Yu (2006; p. 5857) "further [computer climate model] runs without the GHG [greenhouse gases] are encouraged for the international modeling groups" is important.

Although impressive, my new result (Figure 1) is still unsatisfactory for a simple reason: What actually happens to the incoming solar radiation and does it actually reach the surface of the Earth? In other words, while the correlation is impressive, a physical explanation is required.

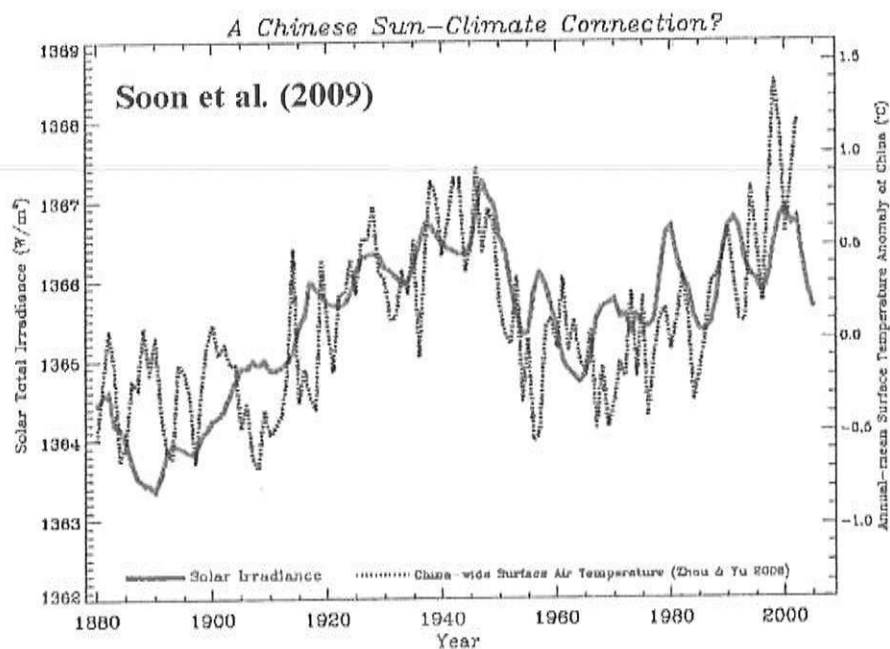


Figure 1

Figure 2 shows an exciting and promising hint that indeed one can demonstrate that a large part of the incoming solar radiation at the top of the atmosphere can, in fact, reach the surface of the Earth under favorable weather and climatic conditions with appropriate water vapor and cloud distributions. This result (Figure 2) suggests that the incoming solar radiation is strongly modulated by the transparency of the atmosphere. Once we replace the solar radiation recorded at the top of atmosphere by the available record of sunshine reaching the surface (*i.e.*, accounting for the atmospheric transmissivity), the connection between the Chinese temperature history and solar radiation becomes even stronger in explaining the rapid warming of the last 20 years of the Chinese air temperature record.

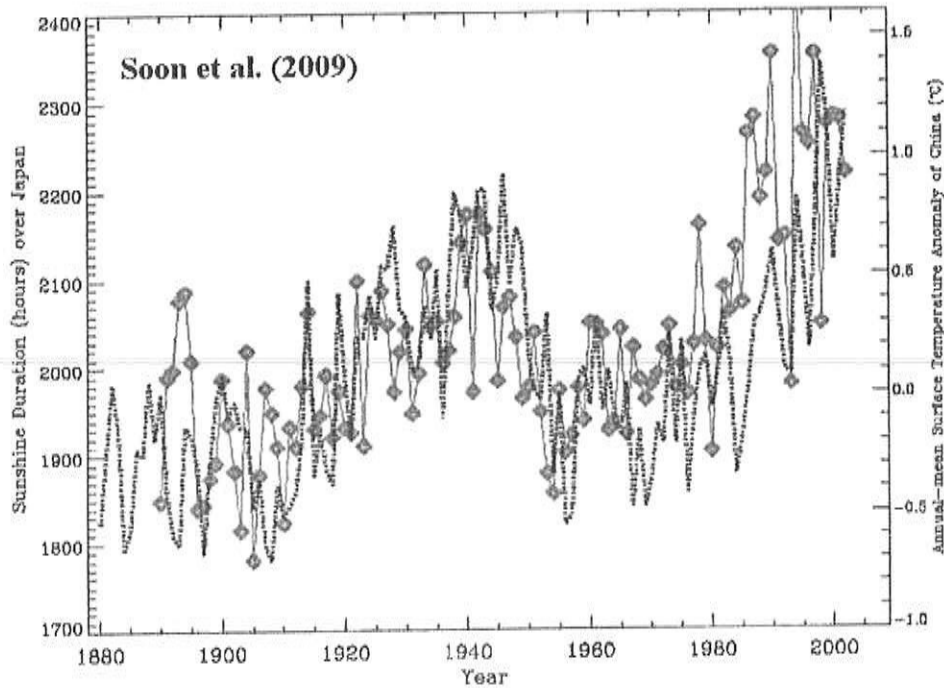


Figure 2

The main sources of data for this research (including those shown in Figures 1 and 2) will include:

- (a) Composite total solar irradiance data (Hoyt and Schatten 1993; and see updates and discussion in Scafetta and Willson 2009 and Soon 2009),
- (b) Surface sunshine duration measurements (*e.g.*, see the high-quality data from the Japanese Meteorological Agency; Stanhill and Cohen 2008, private communication with Professors Gerry Stanhill and Shep Cohen September 2008), and
- (c) Chinese and other high-quality temperature station records (Wang *et al.* 2001; 2004 and Zhou and Yu 2006, private communication with Professor Tian Jun Zhou May 2008).

The main hypothesis postulated by this research proposal is that if the empirical results from Figures 1 and 2 can be fully confirmed, then we are finally able to say for the first time that the Sun-climate connection through its impact on surface air temperature is a proven fact rather than mere speculation and spurious correlation.

The near-term and longer-range research strategy: In light of the current debate concerning the role of atmospheric carbon dioxide in causing global and regional warming – including the encouraging results of the Chinese temperature history shown here – I propose the following 2-prong research plan that involve both a quick turn-around research publication time for the most important results as shown in Figure 1 and Figure 2 as well as a longer 3-year research program that will uphold the scientific results to the climate science community for regions beyond China. The proposed research program will be especially invaluable in serving to inform the 5th UN IPCC reports which will be finalized in 2014.

Specific scientific research steps will include further research to:

- (1) Determine if a similar relationship can be shown for the temperature history in Japan and the direct surface sunshine records over Japan and its surrounding sea.
- (2) Evaluate if the enhanced surface sunshine for the most recent 20 years can be explained by cloud cover and/or simply changes in the transparency of the atmosphere above the East China region related to distribution of water vapor or by particulate matter (aerosols).
- (3) Find if a similar empirical relationship as in Figure 2 may exist elsewhere since similar results for Figure 1 can clearly be shown, for example, for temperature records of the United States (under current investigation by Willie Soon).
- (4) Quantify and explain the relationship shown in Figure 2 which will ultimately involve the study of the surface energy budget over the seas around Japan and China and how the modulation of the sea surface energy budget will lead to a land-sea contrast that will modify the East Asian monsoon weather-climate system.

Research Team:

Dr. Willie Soon at the Smithsonian Astrophysical Observatory, which is part of the Harvard-Smithsonian Center for Astrophysics, will lead and direct this scientific research program. This research program will also involve a distinguished list of atmospheric scientists, oceanographers, climate modelers and geologists.

Funding requirements: This research proposal requests \$60,000 from the Southern Company for work to start in May 2010 and extend for a duration of 12 months to support part-time research work of Dr. Willie Soon.

References:

- Hoyt, D.V., and Schatten, K.H. (1993) A discussion of plausible solar irradiance variations, 1700-1992. *Journal of Geophysical Research*, vol. 98, 18895-18906.
- Scafetta, N., and Willson R. (2009) ACRIM-gap and TSI trend issue resolved using a surface magnetic flux TSI proxy model. *Geophysical Research Letters*, vol. 36, doi:10.1029/2008GL036307.
- Soon, W. (2009) Solar Arctic-mediated climate variation on multidecadal to centennial timescales: Empirical evidence, mechanistic explanation, and testable consequences. *Physical Geography*, vol. 30, 144-184.
- Stanhill, G., and Cohen, S. (2008) Solar radiation changes in Japan during the 20th century: Evidence from sunshine duration measurements. *Journal of Meteorological Society of Japan*, vol. 86, 57-67.
- Wang, S., Gong, D., and Zhu, J. (2001) Twentieth-century climatic warming in China in the context of the Holocene. *The Holocene*, vol. 11, 313-321.
- Wang, S., Zhu, J., and Cai, J. (2004) Interdecadal variability of temperature and precipitation in China since 1880. *Advances in Atmospheric Sciences*, vol. 21, 307-313.
- Zhou, T., and Yu, R. (2006) Twentieth-century surface air temperature over China and the globe simulated by coupled climate models. *Journal of Climate*, vol. 19, 5843-5858.

BUDGET NARRATIVE

Understanding Solar Radiation and Climate Change: A Research Program into the Physical Links between Surface Sunshine History and Chinese Temperature Record

PI: Dr. Willie Soon

Period of Performance: 01 May 2010 – 30 April 2011

The budget includes 4 months of the PI's salary and benefits, as well as minor costs for salary and benefits for administrative and clerical work specific to this research effort. Indirect rates applied are listed on the Estimate of Cost page and the Contractual and Cost section.

ESTIMATE OF COST

Period of Performance: 05-01-10 THRU 04-30-11

Productive Labor:	Hrs	Dollars
PI Soon	440	\$24,693
Program Administrator	40	2,222
Staff Assistant	24	781
Total Productive Labor	<u>504</u>	<u>27,696</u>
Leave @ 18.5 %		5,124
Total Direct Labor		<u>32,820</u>
Fringe Benefits @ 27.6 %		9,058
Direct Operating Overhead Base		<u>41,878</u>
Direct Operating Overhead @ 27.7%		11,600
G & A Base		<u>53,478</u>
G & A @ 12.2%		6,524
TOTAL ESTIMATED COST		<u><u>\$60,003</u></u>

CONTRACTUAL AND COST INFORMATION INCLUDING CERTIFICATIONS

The Smithsonian Institution, an independent trust establishment was created by an act of the Congress of 1846 to carry out the terms of the will of James Smithson of England, who had bequeathed his entire estate to the United States of America "to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men." After accepting the trust property for the United States, Congress vested responsibility for administering the trust in a Smithsonian Board of Regents.

The Smithsonian performs research, educational and other special projects supported by grants and contracts awarded under the cost principles of the Federal Acquisition Regulation, Subpart 31.7 Contracts with Nonprofit Organizations. It is audited by the Defense Contract Audit Agency, Landover, Maryland.

The Charter of the Smithsonian Institution carries a mandate for the "increase and diffusion of knowledge among men." Therefore, any grant or contract that may be awarded as a result of this proposal must be unclassified, in order not to abridge the Institution's right to publish, without restriction, findings that result from this research project.

Considering the nature of the proposed effort, it is requested that a Cost-Reimbursement (No Fee) Research and Development Contract with reimbursement via electronic funds transfer be awarded to cover the proposed project in accordance with Subpart C, Section 215.22(e) of Title 2 of the Code of Federal Regulations (CFR) Part 215 [formerly the Office of Management and Budget (OMB) Circular A-110: *Uniform Administrative Requirements for Grants and Other Agreements with Institutions of Higher Education, Hospitals and Other Non-Profit Organizations*].

Pursuant to Subpart C, Section 215.33 and 215.34 of Title 2 CFR Part 215 [formerly OMB Circular No. A-110], it is requested that title to all exempt property and equipment purchased or fabricated under the proposed contract be vested irrevocably in the Institution upon acquisition.

In accordance with an agreement between the Office of Naval Research and the Smithsonian, the Institution operates with predetermined fixed overhead rates with carry-forward provisions. For Fiscal Year 1996 and beyond, the Indirect Cost and Fringe Benefits Rates are developed in accordance with Title 2 CFR Part 230 [formerly OMB Circular A-122: *Cost Principles for Non-Profit Organizations*]. The following approved rates, provided by ONR Negotiation Agreement dated 4 March 2010, shall be used for forward pricing and billing purposes for Fiscal Year 2010. The Fringe Benefits Rate will be applied to the Total Direct Labor Costs. The Material Overhead Rate will be applied to the cost of materials, equipment and subcontracts. The Direct Operating Overhead Rate will be applied to the Direct Labor and Benefits costs. The G&A Rate will be applied to the base consisting of total costs except the costs associated with the materials, equipment and subcontracts.

The following Approved Rates shall be used for forward pricing and billing purposes for Fiscal Year 2010:

Material Burden Rate (Cost of Materials, equipment and subcontracts)	5.3%
Personnel Leave Rate (Total Direct Labor Costs less paid leave and training {Productive Labor})	18.5%
Fringe Benefits Rate (Full/Part Time Employees) (Total Direct Labor Costs)	27.6%
Fringe Benefits Rate (Intermittent Employees) (Total Direct Labor Costs)	8.5%
Direct Operating Overhead Rate (Total Direct Labor and Fringe Benefits Costs)	27.7%
General and Administrative Rate (G&A) (Base consists of Direct Operating Activities less Net Costs Associated with materials, subcontracts and equipment)	12.2%
Central Engineering Overhead Rate (Central Engineering Direct Labor and Benefits Costs)	28.2%

Rate verification can be made by contacting Ms. Linda Shipp, Office of Naval Research, Indirect Costs/ONR 242, 800 N. Quincy Street, Room 704, Arlington, Virginia 22217, telephone (703) 696-8559, or e-mail linda_shipp@onr.navy.mil.

Engineering services are provided by the Central Engineering Department as a Cost Center. Charges by the department to research projects are inclusive of Direct Labor, Fringe Benefits, and Central Engineering Overhead.

CERTIFICATIONS

Pursuant to Executive Order 12549 and implementing rule (FAR 52.209-5), the Smithsonian Institution certifies that it presently is not debarred, suspended, proposed for debarment, declared ineligible or voluntarily excluded from covered transactions by any Federal department or agency.

Pursuant to Section 1352, Title 31, United States Code (USC) and implementing rule (FAR 52.203-12), the Smithsonian Institution certifies that no Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress on his or her behalf in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment or modification of any Federal contract, grant, loan or cooperative agreement.

**AGREEMENT
BETWEEN
SMITHSONIAN ASTROPHYSICAL OBSERVATORY
SOUTHERN COMPANY SERVICES, INC.**

THIS AGREEMENT is entered into by and between the **Smithsonian Astrophysical Observatory**, located at 60 Garden Street, Cambridge, MA 02138-1516, hereinafter referred to as "Smithsonian"), and **Southern Company Services, Inc.**, having a place of business at 600 North 18th Street, Birmingham, Alabama 35203, on behalf of itself, its parent and its affiliate companies, (collectively referred to as "SCS").

WITNESSETH

WHEREAS, the Smithsonian is interested in conducting an intensive science review of solar variability and climate change, as provided in the attached Proposal P7480-3-10 (referred to as the "Project"); and,

WHEREAS, SCS, on behalf of itself, its parent and its affiliate companies is interested in furthering the research on the Project and in obtaining advance information and is therefore willing to fund this research.

NOW, THEREFORE, Smithsonian and SCS hereby agree as follows:

1. **Scope of Work.** The Scope of Work for this Project shall be conducted in accordance with the attached Proposal P7480-3-10 entitled "Understanding Solar Radiation and Climate Change: A Research Program into the Physical Links between Surface Sunshine History and Chinese Temperature Record", which is incorporated and made a part of this Agreement. In consideration of the Research to be provided by Smithsonian, SCS agrees to make an advance payment in the sum of Sixty Thousand Three Dollars (\$60,003.) and to reimburse Smithsonian for its costs in accordance with the Proposal in an amount not to exceed the advance sum.
2. **Limited Nature of Parties Obligations.**

The obligations of SCS and the Smithsonian hereunder shall be limited to payment of the amounts and the Project effort as specified in Article 1 above. SCS assumes no other obligation or responsibility of any kind to the Smithsonian or any other participants or sponsors, if any. SCS makes no warranties or Representations, Express or implied, of any kind.
3. **Termination.** Smithsonian understands and agrees that in the event the Project is terminated prior to completion or is not in accordance with the attached Proposal, SCS shall be entitled to a refund of the unexpended funds.
4. **No Joint Venture.** This Agreement is not intended to create nor shall it be construed to create any partnership, joint venture, employment or agency relationship between or among the parties, and no party shall be liable for the payment or performance of any debts, obligations, or liabilities of any other party, unless expressly assumed in writing.
5. **Deliverables.** In consideration to SCS for its one (1) year funding contribution to the Project, Smithsonian shall deliver to SCS a progress report of the findings including a detailed summary and analysis of the results and findings at the end of the one year period. SCS shall be entitled to a no-cost, non-exclusive irrevocable license to utilize the data and results of the Project for its internal purposes.
6. **Authority.** Each party represents and warrants to the other that as of the effective date of this Agreement: (a) it has all requisite power and authority to enter into and perform its obligations under this Agreement, and (b) there are no actions, suits, or proceedings pending, or to the best of its knowledge threatened, which may have a material adverse effect on its ability to fulfill its obligations under this Agreement or on its operations, business, properties, assets or condition.

7. **Assignment and Subcontracting Prohibited.** This Agreement shall not be assigned by Smithsonian nor its obligations subcontracted without the prior written consent of SCS, which shall not be unreasonably withheld. Any assignment or subcontracting in violation of this provision shall be deemed null and void and SCS shall be entitled to a refund of its contribution in full.
8. **Subsequent Changes in Agreement.** This Agreement may be modified only by an amendment executed in writing by a duly authorized representative for each party.
9. **Partial Invalidity.** If any provision of this Agreement is found to be unenforceable then, notwithstanding such unenforceability, this Agreement shall remain in effect and there shall be substituted for such unenforceable provision a like but enforceable provision which most nearly effects the intention of the parties. If a like but enforceable provision cannot be substituted, the unenforceable provision shall be deemed to be deleted and the remaining provisions shall continue in effect, provided that the performance, rights, and obligations of the parties hereunder are not materially adversely affected by such deletion.
10. **Successors and Assigns.** This Agreement shall inure to the benefit of and be binding upon the respective successors and permitted assigns, if any, of the parties, provided that this provision shall not be construed to permit any assignment which would be unauthorized or void pursuant to any other provision contained herein.
11. **Non-Waiver.** No provision of this Agreement shall be deemed waived and no breach shall be deemed excused unless such waiver or consent is in writing and signed by the party claimed to have waived or consented. No consent by either party to, or waiver of, a breach by the other, whether express or implied, shall constitute a consent to, waiver of, or excuse for any different or subsequent breach.
12. **Force Majeure.** Neither party shall be deemed to be in default of any provision of this Agreement or liable for failures in performance resulting from acts or events beyond the reasonable control of such party. Such acts shall include but not be limited to acts of God, civil or military authority, civil disturbance, war, strikes, fires, other catastrophes, or other 'force majeure' events beyond a party's reasonable control.
13. **Survival of Representations.** The provisions contained in this Agreement that by their sense and context are intended to survive the performance hereof by either or both parties shall so survive the completion of performance and termination of this Agreement, including the making of any and all payments due hereunder.
14. **Notices.** All notices permitted or required to be given under this Agreement shall be in writing and shall be deemed duly given upon personal delivery (against receipt) or on the fourth day following the date on which each such notice is deposited postage prepaid in the United States Mail, registered or certified, return receipt requested. All notices shall be delivered or sent to the other party at the address(es) shown below or to any other address(es) as the party may designate by ten (10) days prior written notice given in accordance with this provision.

If to Smithsonian:

Smithsonian Institution Astrophysical Observatory
60 Garden Street
Cambridge, MA 02138-1516
Attention: Dr. Willie Soon, Mail Stop 28 (for technical matters)
Attention: Mr. Thomas G. Bonnenfant, Mail Stop 23 (for contractual matters)

If to SCS:


Southern Company Services, Inc.
600 North 18th Street
Bin 14N-8195
Birmingham, Alabama 35203
Attention: Justin T. Walters, Bin 14N-8195 (for technical matters)
Attention: Joseph L. Coker, Bin 7N-8374 (for contractual matters)

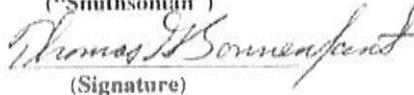
15. **Publicity.** Smithsonian shall not publish and utilize the name or otherwise identify SCS or its affiliate companies in any publications or other advertisements without the express written consent of SCS. As further consideration to SCS, Smithsonian shall provide SCS an advance written copy of proposed publications regarding the deliverables for comment and input, if any, from SCS.
16. **Duplicate Originals.** Duplicate originals of this Agreement shall be executed, each of which shall be deemed an original but both of which together shall constitute one and the same instrument.
17. **Entire Agreement.** This Agreement contains the entire agreement of the parties and there are no oral or written representations, understandings or agreements between the parties respecting the subject matter of this Agreement which are not fully expressed herein.

IN WITNESS WHEREOF, each of the parties hereto acknowledge that they have caused this Agreement to be executed in duplicate originals by its duly authorized representative on the respective dates entered below.

SOUTHERN COMPANY SERVICES, INC.

THE SMITHSONIAN INSTITUTION
ASTRPPHYSICAL
OBSERVATORY
("Smithsonian")

("SCS")
By: 
(Signature)

By: 
(Signature)

Name: John J. Jansen
(Typed or printed)

Name: Thomas G. Bonnenfant
(Typed or printed)

Title: Principal Scientist

Title: Contract and Grant Specialist

Date: 7/21/10

Date: 7/28/2010

**UNDERSTANDING SOLAR RADIATION AND CLIMATE
CHANGE: A RESEARCH PROGRAM INTO THE PHYSICAL
LINKS BETWEEN SURFACE SUNSHINE HISTORY AND CHINESE
TEMPERATURE RECORD**

Final Report

Agreement No. 15670

For the Period 1 May 2010 to 30 April 2011

Principal Investigator: Dr. Willie Soon

May 2011

Prepared for
Southern Company Services, Inc.
Birmingham, Alabama 35203

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

The goals of this research project have been completely and successfully executed with the following list of deliverables:

- (1) The publication of the invited paper "Avoiding Carbon Myopia: Three Considerations for policy makers concerning man made carbon dioxide" by Willie Soon and David R. Legates (2010) in *Ecology Law Currents*, vol. 37, 1-9.**

In December 2009, lawmakers and representatives from around the world, along with scientists, numerous journalists, and various celebrities flew to Copenhagen, Denmark. For the most part, their goal was to promote a regulatory scheme aimed at controlling human carbon emissions by declaring the element a tradable commodity and establishing laws and regulations to govern the trade.

The proposed regulations were premised on the flawed notion, articulated by the United Nations Intergovernmental Panel on Climate Change (IPCC), that increasing atmospheric carbon dioxide (CO₂) concentrations will change climate dramatically and thereby cause major ecological and economic damage.

While many scientists, including us, have observed some changes in climate, the hypothesized *dangerous* consequences of rising atmospheric CO₂ are too speculative for responsible regulatory policy. In analyzing climate policy, decision makers should be cognizant of three key considerations regarding the impact of projected rises in atmospheric CO₂: (1) policy choices likely will have no measurable effect on the occurrence of severe weather; (2) positive effects on ecosystems and biodiversity are likely and should be weighed against the negatives; and (3) carbon trading schemes (such as the one touted in Copenhagen) are unlikely to lead to a reduction in atmospheric CO₂.

Given these considerations, policy makers must carefully consider their objectives and the potential impacts, both positive and negative, of carbon emission control. If climate change regulation proceeds unchecked, it will likely produce policy that is out of touch with both the real world and objective science and will likely impose large costs on society that benefit only a small cadre of "climate entrepreneurs" and provide no meaningful effect on the Earth's climate.

- (2) The publication of the scientific manuscript "Sea Level Changes in Bangladesh: Observational Constraints on Human, Geologic and Weather-Climate Variability Related Factors" by David R. Legates and Willie Soon (2011) (as a book chapter) in *Understanding Climate Change Issues in Bangladesh*, Rafique Ahmed et al. (editors), in press.**

Bangladesh is a nation prone to flooding due to its geographical location. Situated on the Bay of Bengal, Bangladesh is the floodplain of the Ganges River which is fed by other major rivers including the Meghna and the Brahmaputra Rivers. Since much of Bangladesh lies in the flat, coastal delta of the *Mouths of the Ganges*, it is easily susceptible to flooding from both coastal storms as well as spring meltwater. As Bangladesh does not have flood control structures on the Ganges River, the increase in river flow resulting from rain and snowmelt from the Himalayas of both India and Nepal often floods the country. Indeed, the Indian highlands are among the regions of the world with the heaviest annual precipitation. Moreover, tropical storms which frequent Indian Ocean during the high sun season – when highland rains are greatest and the flow of the Ganges is highest – often drive storm surges into the low-lying country.

It is well noted that current conditions in and around Bangladesh are harsh and unforgiving. The adverse impact of natural hazards is commonplace and this only serves to exacerbate the economic and social difficulties that plague the country. It has to be recognized, however, that floods and droughts, storm surges and high winds associated with tropical storms, and other naturally-caused catastrophes have always

affected this region. Such variations have occurred despite any possible effects of anthropogenic CO₂ and indeed are likely to occur again in the future, regardless of any steps taken to mitigate the effects of anthropogenic CO₂ emissions.

Thus, the tendency by self-indulged politicians, rent-seeking advocates, and scare-mongers in the popular press to downplay the current difficulties present in the climate of Bangladesh and hype future disasters postulated from a rise in global sea levels is clearly counterproductive for the Bangladeshi citizens. It serves to divert efforts from proper planning, mitigation, and adaptation strategies that are vital to saving lives *now*. However, the future of Bangladesh is not bleak as attention is paid to helping the Bangladeshi people develop realistic controls on river flow and discharge and provide timely dissemination of warnings of environmental hazards (*e.g.*, cyclones and flooding) while simultaneously protecting the Ganges-Brahmaputra-Meghna Delta landscape and the continued destruction of the mangrove forest ecosystem. Only by properly addressing current problems can Bangladesh be prepared for future changes in the climate, regardless of the source – natural or anthropogenic.

Moreover, one has to recognize that in other tidal wetland systems such as the Kirkpatrick marsh land (Maryland, USA) around the Chesapeake Bay (off the USA Atlantic coast, bounded by Maryland and Virginia), evidence exists that enhanced levels of atmospheric CO₂ may actually stimulate marsh vegetation thereby providing an effective counter to sea level rise and ocean water encroachment. Langley *et al.* (2009:6182) notes:

“Here, we present experimental evidence that plant response to elevated atmospheric [CO₂] stimulates biogenic mechanisms of elevation gain in a brackish marsh. Elevated CO₂ (ambient + 340 ppm) accelerated soil elevation gain by 3.9 mm yr⁻¹ in this 2-year field study, an effect mediated by stimulation of below-ground plant productivity. Further, a companion greenhouse experiment revealed that the CO₂ effect was enhanced under salinity and flooding conditions likely to accompany future [sea level rise]. Our results indicate that by stimulating biogenic contribution to marsh elevation, increases in the greenhouse gas, CO₂, may paradoxically aid some coastal wetlands in counterbalancing rising seas.”

It also is likely that increased CO₂ will enhance vegetation growth in the Ganges-Brahmaputra-Meghna Delta region and help offset rises in sea level, regardless the cause.

(3) Submission of the scientific manuscript “Temporal derivative of total solar irradiance and anomalous Indian Summer Monsoon: An empirical evidence for a sun-climate connection” by Rajesh Agnihotri, Koushik Dutta and W. Soon (2011) in the peer-reviewed journal *Journal of Atmospheric and Solar-Terrestrial Physics*.

Abstract

Identifying the pattern of natural climate variability is of immense importance to delineate the effects of anthropogenic climate changes. Global and regional climates are suspected to vary, in unison or with delays, with the Total Solar Irradiance (TSI) at decadal to centennial timescales. Here we show that the Indian summer monsoon rainfall correlates well with the temporal derivative of TSI on multidecadal timescales. This linkage between the temporal derivative of TSI and the Indian summer monsoon is tested and corroborated both for the instrumental period (1871-2006) and for the last ~300 years using a speleothem δ¹⁸O record representing rainfall in southwestern India. Our analyses indicate that both anomalously drier and wetter periods of the Indian monsoon record fall near negative and positive excursions in the TSI derivative, respectively. Our study thus demonstrates the potential of ‘TSI derivative’ as an important indicator of natural monsoon variability on an interdecadal timescale.

- (4) Submission of the scientific manuscript “Variation in surface air temperature of China during the 20th century” by Willie Soon, Koushik Dutta, David Legates, Victor Velasco, WeiJia Zhang (2011) in the peer-reviewed journal *Journal of Atmospheric and Solar-Terrestrial Physics*.**

Abstract

The 20th Century surface air temperature (SAT) records of China from various sources are analyzed using data which include the recently-released Twentieth Century Reanalysis Project (20CRv2). Two key features of the Chinese records are confirmed: (1) significant 1920s and 1940s warming in the temperature records, and (2) evidence for a persistent multi-decadal modulation of the Chinese surface temperature records in covariation with solar radiation. New evidence is presented for this Sun-climate link for the instrumental record from 1880 to 2002. As well, two non-local, physical aspects of solar radiation-induced modulation of the Chinese SAT record are documented and discussed.

Teleconnections that provide a persistent and systematic modulation of the temperature response of the Tibetan Plateau and/or the tropospheric air column above the Eurasian continent (*e.g.*, 30-70°N; 0 to 120°E) are described. These teleconnections may originate from the solar irradiance-Arctic-North Atlantic Overturning Circulation mechanism proposed by Soon (2009). Also considered is the modulation of large-scale land-sea thermal contrasts, both in terms of meridional and zonal gradients, between the subtropical western Pacific and mid-latitude North Pacific and the continental landmass of China. The Circumglobal Teleconnection (CGT) pattern of summer circulation of Ding and Wang (2005) provides a physical framework for study of the Sun-climate connection over East Asia. Our results highlight the importance of solar radiation reaching the ground, and the concomitant importance of changes in atmospheric transparency or cloudiness or both, in motivating a true physical explanation of any Sun-climate connection. We conclude that solar radiation provides demonstrable forcing for Chinese SAT changes on multidecadal to centennial timescales. Therefore, a comprehensive view of local and remote factors of climate change in China must take account of this, as well as other natural and anthropogenic forcings.

- (5) Preparation of the scientific report “Research to date on forecasting for the manmade global warming alarm” by Scott Armstrong, Kesten Green and Willie Soon (as a supporting document for the Testimony of Professor Scott Armstrong to the Subcommittee on Energy and Environment on March 31, 2011).**

Abstract

The validity of the manmade global warming alarm requires the support of scientific forecasts of (1) a substantive long-term rise in global mean temperatures in the absence of regulations, (2) serious net harmful effects due to global warming, and (3) cost-effective regulations that would produce net beneficial effects versus alternatives such as doing nothing.

Without scientific forecasts for all three aspects of the alarm, there is no scientific basis to enact regulations. In effect, it is a three-legged stool. Despite repeated appeals to global warming alarmists, we have been unable to find scientific forecasts for any of the three legs.

We drew upon scientific (evidence-based) forecasting principles to audit the forecasting procedures used to forecast global mean temperatures by the Intergovernmental Panel on Climate Change (IPCC) –leg “1” of the stool. This audit found that the procedures violated 81% of the 89 relevant forecasting principles

We also did an audit of the forecasting procedures used for two papers that were designed to support proposed regulation related to protecting polar bears – leg “3” of the stool. On average, these procedures violated 85% of the 90 relevant principles.

The warming alarmists have not demonstrated the predictive validity of their procedures. Instead, their argument for predictive validity is based on their claim that nearly all scientists

agree with the forecasts. Such an appeal to “voting” is contrary to the scientific method. It is also incorrect.

We conducted a validation test of the IPCC forecasts based on the assumption that there would be no interventions. This test found that the errors for IPCC model long-term forecasts (91 to 100 years in the future) were 12.6 times larger than those from an evidence-based “no change” model.

Based on our analyses, we concluded that the global warming alarm is an anti-scientific political movement.

We then turned to the “structured analogies” method to forecast the likely outcomes of this movement. In this ongoing study, we have, to date, identified 26 historical alarmist movements. None of the forecasts for the analogous alarms proved correct. In the 25 alarms that called for government intervention, the government imposed regulations in 23. None of the 23 interventions was effective and harm was caused by 20 of them.

**(6) The prominent participation of PI in the following list of scientific talks and discussion at both national and international forums of professional scientists:
All power-point talks are available upon request.**

- (a) May 17, 2010, International Climate Conference 4, Chicago
- (b) May 18, 2010: University of Chicago
Ayn Rand Institute Global Warming and Public Policy Discussion Panel
- (c) May 20, 2010: Ohio State University, Department of Economics Seminar
- (d) June 11-13, 2010: Doctors for Disaster Preparedness Annual Meeting, Orlando, Florida
- (e) September 10, 2010: Hong Kong University, Department of Earth Sciences Seminar
- (f) September 14, 2010: PAGES 2nd Global Monsoon Symposium (Invited Talk), Tongji University Shanghai, China
- (g) September 16, 2010: 2000-year Climate Simulation Workshop (Invited Talk), HuangShan, China (organized by Nanjing Institute of Geography and Limnology)
- (h) March 2-4, 2011: WSJ ECO:NOMICS conference discussion leader
- (i) April 28-30, 2011: University of Delaware, Departments of Geography and Physics Joint Seminar

PROPOSAL TO
SOUTHERN COMPANY

FOR

*Understanding Solar Radiation and Climate Change: A Research Program into the
Physical Links between Surface Sunshine History and Chinese Temperature Record*

P7480-3-10

For the period 1 May 2010 through 30 April 2011

Funds Requested: \$60,003

Principal Investigator
Dr. Willie Soon

Associate Director of Solar,
Stellar & Planetary Sciences
Dr. Nancy S. Brickhouse

March 2010

Smithsonian Astrophysical Observatory
Cambridge, Massachusetts 02138

Director: Dr. Charles Alcock

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

**UNDERSTANDING SOLAR RADIATION AND CLIMATE CHANGE:
A RESEARCH PROGRAM INTO THE PHYSICAL LINKS BETWEEN
SURFACE SUNSHINE HISTORY AND CHINESE TEMPERATURE RECORD**

DONORS TRUST, INC.

Grant No. LTR 11/18/10

Final Report

for the period
1 January 2011 to 31 December 2011

Principal Investigator
Dr. Willie Soon

January 2012

Prepared for

Donors Trust, Inc.

Smithsonian Astrophysical Observatory
Cambridge, Massachusetts 02138

The Smithsonian Astrophysical Observatory is a member of
the Harvard-Smithsonian Center for Astrophysics

Final Report
Period of Performance: 1/01/2011-12/31/2011

**Understanding Solar Radiation and Climate Change:
A Research Program Into the Physical Links Between
Surface Sunshine History and Chinese Temperature Record**

Willie Soon

The goals of this research project have been completely and successfully executed with the following list of deliverables:

- (1) Publication of the scientific manuscript “Temporal derivative of total solar irradiance and anomalous Indian Summer Monsoon: An empirical evidence for a sun-climate connection” by Rajesh Agnihotri, Koushik Dutta and W. Soon (2011) in the peer-reviewed journal *Journal of Atmospheric and Solar-Terrestrial Physics*.**

Abstract

Identifying the pattern of natural climate variability is of immense importance to delineate the effects of anthropogenic climate changes. Global and regional climates are suspected to vary, in unison or with delays, with the Total Solar Irradiance (TSI) at decadal to centennial timescales. Here we show that the Indian summer monsoon rainfall correlates well with the temporal derivative of TSI on multidecadal timescales. This linkage between the temporal derivative of TSI and the Indian summer monsoon is tested and corroborated both for the instrumental period (1871-2006) and for the last ~300 years using a speleothem $\delta^{18}\text{O}$ record representing rainfall in southwestern India. Our analyses indicate that both anomalously drier and wetter periods of the Indian monsoon record fall near negative and positive excursions in the TSI derivative, respectively. Our study thus demonstrates the potential of ‘TSI derivative’ as an important indicator of natural monsoon variability on an interdecadal timescale.

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Teleconnections that provide a persistent and systematic modulation of the temperature response of the Tibetan Plateau and/or the tropospheric air column above the Eurasian continent (e.g., 30-70°N; 0 to 120°E) are described. These teleconnections may originate from the solar irradiance-Arctic-North Atlantic Overturning Circulation mechanism proposed by Soon (2009). Also considered is the modulation of large-scale land-sea thermal contrasts, both in terms of meridional and zonal gradients, between the subtropical western Pacific and mid-latitude North Pacific and the continental landmass of China. The Circumglobal Teleconnection (CGT) pattern of summer circulation of Ding and Wang (2005) provides a physical framework for study of the Sun-climate connection over East Asia. Our results highlight the importance of solar radiation reaching the ground, and the concomitant importance of changes in atmospheric transparency or cloudiness or both, in motivating a true physical explanation of any Sun-climate connection. We conclude that solar radiation provides demonstrable forcing for Chinese SAT changes on multidecadal to centennial timescales. Therefore, a comprehensive view of local and remote factors of climate change in China must take account of this, as well as other natural and anthropogenic forcings.

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under salinity and flooding conditions likely to accompany future [sea level rise]. Our results indicate that by stimulating biogenic contribution to marsh elevation, increases in the greenhouse gas, CO₂, may paradoxically aid some coastal wetlands in counterbalancing rising seas.”

It also is likely that increased CO₂ will enhance vegetation growth in the Ganges-Brahmaputra-Meghna Delta region and help offset rises in sea level, regardless the cause.

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All power-point talks are available upon request.**

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- (b) June 21, 2011: Invited talk at Climate Science session of the 104th International Air and Waste Management Conference Orlando, Florida
- (c) July 16, 2011: Invited talk on “Solar Radiation, Indian Summer Monsoon, and Dragonfly (TransOceanic) Migration” at the 29th Doctors for Disaster Preparedness’s Annual Meeting, Albuquerque, New Mexico
- (d) October 11, 2011: Invited speaker in the session on “The Illusive Sea Level Threat in the Indian Ocean” at the 7th International Conference on Asian Marine Geology (ICAMG7) held at the National Institute of Oceanography in Goa, India. (Co-authoring two other scientific talks given by my colleagues, Dr. Rajesh Agnihotri of the National Physical Laboratory of India and Dr. Selvaraj Kandasamy of Xiamen University in China)
- (e) October 14, 2011: Invited speaker at the Centre for Extra-Mural Studies at University of Mumbai entitled “Conference on Climate Change: Shifting Science and Changing Policy.”
- (f) November 11, 2011: University of Delaware, American Meteorological Society Student Chapter Seminar

PROPOSAL TO

SOUTHERN COMPANY

FOR

Solar Modulation of Equator-to-Pole Temperature Gradients

PS0182-9-11

For the period 01 December 2011 through 30 November 2012

September 2011

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts 02138

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

SI-000093

PROPOSAL TO
SOUTHERN COMPANY

FOR

Solar Modulation of Equator-to-Pole Temperature Gradients

PS0182-9-11

For the period 1 December 2011 to 30 November 2012

Funds Requested: \$59,942

Principal Investigator
Dr. Willie Soon

Associate Director of Solar,
Stellar & Planetary Sciences
Dr. Nancy S. Brickhouse

September 2011

Smithsonian Astrophysical Observatory
Cambridge, Massachusetts 02138

Director: Dr. Charles Alcock

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Smithsonian Astrophysical Observatory

Solar Modulation of Equator-to-Pole Temperature Gradients

Science Justification/Statement of Work

The primary motivation for this in-depth scientific research proposal is to explore the mechanism on how the Earth's climate system varies naturally on multi-decadal to multi-centennial timescales. Establishing the reality of large natural climate change on the important timescales of decades to centuries is well supported by available climate proxy data, but has been one of the most difficult hurdles in arguing for any "controllable" or catastrophic man-made global warming or climate change. Thus, this scientific research proposal will be both timely and relevant for the current debate about the quantitative role of natural climate change as related to solar variability.

In Soon (2005), Soon (2009), Agnihotri *et al.* (2011) and Soon *et al.* (2011), a range of sun-climate connections on local, regional, and hemispheric scales were first postulated. The main physical mechanism involves solar variability, primarily in the visible light portion of the spectrum, modulating the equator-to-pole heat transport and affecting the heat and water budgets of the Arctic air-sea-ice system. Ultimately, the solar-Arctic changes modulate the Atlantic Ocean "conveyor-belt" circulation, which has significant climatic teleconnections to different parts of the world.

Figure 1 provides not only direct evidence for the important role of ground surface solar radiation to the regional sun-climate connection but also hints at the important inter-connection among regions through the so-called circum-global teleconnection (CGT) pattern that was discovered by Branstator (2002) and Ding and Wang (2005) for both winter and summer weather-climate regimes, respectively.

The physical mechanism involved in the CGT pattern, involving the seasonal variations in the position and intensity of the North African-Asian Jet Streams, is certainly relevant for discussing the various local and regional sun-climate evidence that have been found for surface air temperatures around Arctic, the conterminous United States, and China, as well as Indian summer monsoon rainfalls. What is still missing, however, is the evidence of a cause for such a broad coherence and inter-correlation on the large spatial scales.

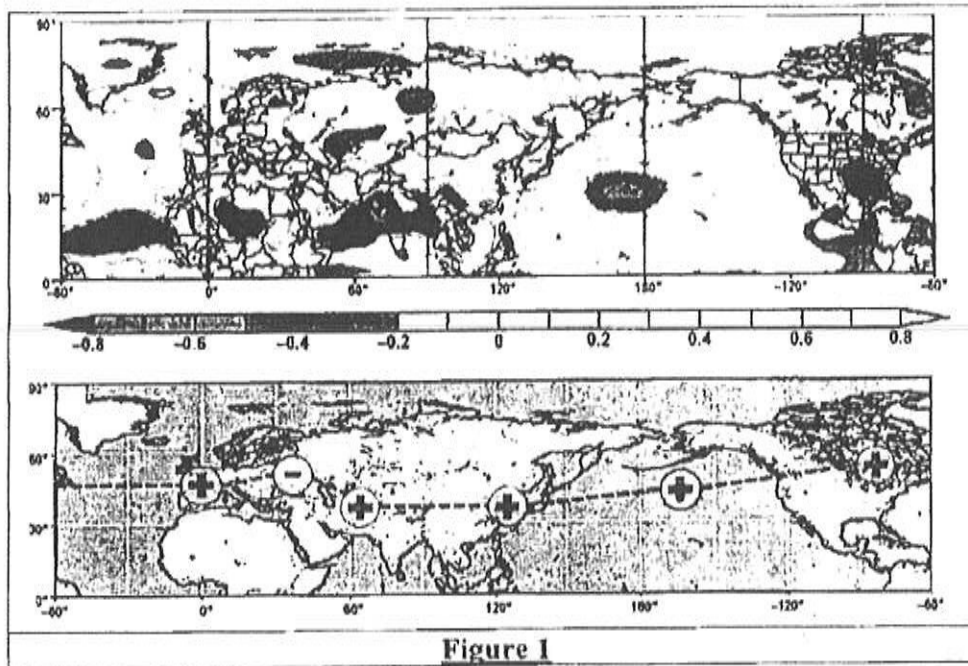


Figure 1

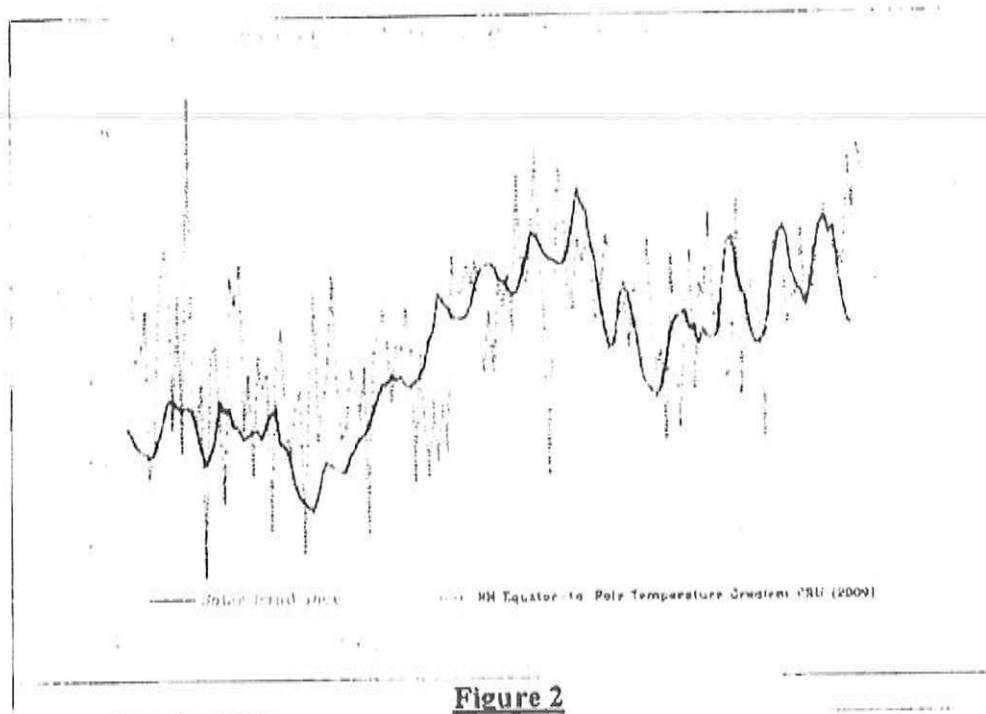
Figure 2 shows the exciting and promising indication that, on the largest spatial-scales, the total solar irradiance (TSI) time series is highly correlated with the so-called equator-to-pole (*i.e.*, Arctic) temperature gradient index as defined by Jain *et al.* (1999). My proposed research, therefore, would explore this empirical relationship and seek to find an appropriate underlying physical dynamic process that may best explain the observed empirical correlation. In this respect, it is interesting to note the identification of solar and lunar forcing responses in terms of the winter and summer latitudinal temperature gradients, respectively, by Davis and Brewer (2011).

The main sources of data for this proposed research (including those shown in Figures 1 and 2) will include:

- (a) Composite total solar irradiance data (Hoyt and Schatten 1993; with updates and discussion by Scafetta and Willson 2009, Soon 2009, Kopp and Lean 2011, Shapiro *et al.* 2011¹),
- (b) The 5°x5° gridded surface temperature product from the Climatic Research Unit (CRU) at the University of East Anglia for the whole interval of 1856-present, and

¹ It is especially important to note that in Shapiro *et al.* (2011), it was determined that the amplitude of total solar irradiance change between present and the Maunder Minimum interval could be $6 \pm 3 \text{ W/m}^2$; a value significantly larger than estimates by several authors but in good agreement with the estimate by Zhang *et al.* (1994). This latest result supports the amplitude of total solar irradiance series shown in Figure 2.

- (c) The 2.5°x2.5° gridded temperature product for lower troposphere derived from the University of Alabama Huntsville team (lead by Professor John Christy) for 1979-present interval [which can serve as a crucial test and verification of a robust equator-to-pole temperature gradient index that must be compared with the one derived from the CRU database].



If a solid physical explanation using the dynamics of the natural Earth system can be found for the results shown in Figures 1 and 2, the dream of a physical theory for a predictable sun-climate connection, especially on multi-decadal and multi-centennial timescales as focused in this comprehensive research program, may soon be realized. Plausible physical lead times available from this new sun-climate connection framework will be explored and that may soon permit a true prediction of local and regional climatic variables such as temperature, rainfall and snowfall under the real weather-dominated climate system in which we live.

Research Team:

Dr. Willie Soon at the Smithsonian Astrophysical Observatory, which is part of the Harvard-Smithsonian Center for Astrophysics, will lead and direct this scientific research program. This research program will also involve a distinguished list of atmospheric scientists, oceanographers, climate modelers and geologists.

References:

- Agnihotri, R., Dutta, K., and Soon, W. (2011) Temporal derivative of Total Solar Irradiance and anomalous Indian Summer Monsoon: An empirical evidence for a sun-climate connection. *Journal of Atmospheric and Solar-Terrestrial Physics*, accepted.
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- Davis, B.A.S., Brewer, S. (2011) A unified approach to orbital, solar, and lunar forcing based on the Earth's latitudinal insolation/temperature gradient. *Quaternary Science Reviews*, in press.
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- Soon, W., Dutta, K., Legates, D.R., Velasco, V., and Zhang, W. (2011) Variation in surface air temperature of China during the 20th Century. *Journal of Atmospheric and Solar-Terrestrial Physics*, submitted.
- Zhang, Q., Soon, W.H., Baliunas, S.L., Lockwood, G.W., Skiff, B.A., and Radick, R.R. (1994) A method of determining possible brightness variations of the Sun in past centuries from observations of solar-type stars. *The Astrophysical Journal Letters* 427, L111-L114.

BUDGET NARRATIVE

Solar Modulation of Equator-to-Pole Temperature Gradients

PI: Dr. Willie Soon

Period of Performance: 01 December 2011 30 November 2012

The budget includes 3.25 months of the PI's salary and benefits (work commitment given in units of percentage of a nominal full-time Work Year of 1,750 hours) and a minimal amount of grant specific administrative services.

Indirect rates applied are listed on the Estimate of Cost page and the contractual and cost section at the end of this document.

ESTIMATE OF COST

PI: SOON

Proposal ID: PS0192-9-11

Period of Performance: 01 December 2011 through 30 November 2012

	Hours	Dollars
SOON, WILLIE WEI HOCK	475.00	\$26,467
Division Administrator	20.00	\$1,210
Direct Labor	495	\$27,677
<i>Leave @ 19.3%</i>		\$5,342
<i>Gov Fringe Non-NCR @ 26.8%</i>		\$8,849
SAO Direct Operating Overhead Base		\$41,867
<i>SAO Direct Operating Overhead @Rate 26.7%</i>		\$11,179
SAO General & Administrative Base		\$53,046
<i>SAO General & Administrative @Rate 13%</i>		\$6,896
TOTAL ESTIMATED COST		\$69,942

CONTRACTUAL AND COST INFORMATION INCLUDING CERTIFICATIONS

The Smithsonian Institution, an independent trust establishment was created by an act of the Congress of 1846 to carry out the terms of the will of James Smithson of England, who had bequeathed his entire estate to the United States of America "to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men." After accepting the trust property for the United States, Congress vested responsibility for administering the trust in a Smithsonian Board of Regents.

The Smithsonian performs research, educational and other special projects supported by grants and contracts awarded under the cost principles of Title 2 of the Code of Federal Regulations (CFR) Part 230 [formerly the Office of Management and Budget (OMB) Circular A-122: *Cost Principles for Non-Profit Organizations*] and the Federal Acquisition Regulation, Subpart 31.7 *Contracts with Nonprofit Organizations*. It is audited by the Defense Contract Audit Agency, Landover, Maryland.

The Charter of the Smithsonian Institution carries a mandate for the "increase and diffusion of knowledge". Therefore, any grant or contract that may be awarded as a result of this proposal must be unclassified, in order not to abridge the Institution's right to publish, without restriction, findings that result from this research project.

Considering the nature of the proposed effort, it is requested that a Cost-Reimbursement (No Fee) Research and Development Contract with reimbursement via electronic funds transfer be awarded to cover the proposed project in accordance with Subpart C, Section 215.22(e) of Title 2 CFR Part 215 [formerly OMB Circular A-110: *Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education, Hospitals and Other Non-Profit Organizations*].

Pursuant to Subpart C, Section 215.33 and 215.34 of Title 2 CFR Part 215 [formerly OMB Circular A-110], it is requested that title to all exempt property and equipment purchased or fabricated under the proposed contract be vested irrevocably in the Institution upon acquisition.

In accordance with an agreement between the Office of Naval Research and the Smithsonian, the Institution operates with predetermined fixed overhead rates with carry-forward provisions. The Indirect Cost and Fringe Benefits Rates are developed in accordance with Title 2 CFR Part 230 [formerly OMB Circular A-122]. The following approved rates, provided by ONR Negotiation Agreement dated 17 August 2011, shall be used for forward pricing and billing purposes for Fiscal Year 2011. The Fringe Benefits Rate will be applied to the Total Direct Labor Costs. The Material Overhead Rate will be applied to the cost of materials, equipment and subcontracts. The Direct Operating Overhead Rate will be applied to the Direct Labor and Benefits costs. The G&A Rate will be applied to the base consisting of total costs except the costs associated with the materials, equipment and subcontracts.

The following Approved Rates shall be used for forward pricing and billing purposes for Fiscal Year 2011:

Material Burden Rate (Cost of Materials, equipment and subcontracts)	4.9%
Personnel Leave Rate	19.3%
Fringe Benefits Rate (Full/Part Time Employees) (Total Direct Labor Costs)	26.8%
Fringe Benefits Rate (Intermittent Employees) (Total Direct Labor Costs)	8.4%
Direct Operating Overhead Rate (Total Direct Labor and Fringe Benefits Costs)	26.7%
General and Administrative Rate (G&A) (Base consists of Direct Operating Activities less Net Costs Associated with materials, subcontracts and equipment)	13.0%
Central Engineering Overhead Rate (Central Engineering Direct Labor and Benefits Costs)	24.6%

Rate verification can be made by contacting Ms. Linda Shipp, Office of Naval Research, Indirect Costs/ONR 242, 800 N. Quincy Street, Room 704, Arlington, Virginia 22217, telephone (703) 696-8559, or e-mail linda_shipp@onr.navy.mil.

Engineering services are provided by the Central Engineering Department as a Cost Center. Charges by the department to research projects are inclusive of Direct Labor, Fringe Benefits, and Central Engineering Overhead.

CERTIFICATIONS

Pursuant to FAR 52.204-8, ANNUAL REPRESENTATIONS AND CERTIFICATIONS (MAY 2011), for federally funded awards, the Smithsonian Astrophysical Observatory (SAO) is registered with the Online Representations and Certifications Application (ORCA). ORCA can be viewed at <http://orca.bpn.gov>, using SAO DUNS # 003261823.

**AGREEMENT
BETWEEN
SMITHSONIAN ASTROPHYSICAL OBSERVATORY
SOUTHERN COMPANY SERVICES, INC.**

THIS AGREEMENT is entered into by and between the Smithsonian Astrophysical Observatory, located at 60 Garden Street, Cambridge, MA 02138-1516, hereinafter referred to as "Smithsonian"), and Southern Company Services, Inc., having a place of business at 600 North 18th Street, Birmingham, Alabama 35203, on behalf of itself, its parent and its affiliate companies, (collectively referred to as "SCS").

WITNESSETH

WHEREAS, the Smithsonian is interested in conducting in-depth scientific research to explore the mechanism on how the Earth's climate system varies naturally on multi-decadal to multi-centennial timescales, as provided in the attached Proposal PS0182-9-11 dated September, 2011, (referred to as the "Project"); and,

WHEREAS, SCS, on behalf of itself, its parent and its affiliate companies is interested in furthering the research on the Project and in obtaining advance information and is therefore willing to fund this research.

NOW, THEREFORE, Smithsonian and SCS hereby agree as follows:

1. **Scope of Work.** The Scope of Work for this Project shall be conducted in accordance with the attached Proposal PS0182-9-11 entitled "Modulation of Equator-to-Pole Temperature Gradients", which is incorporated and made a part of this Agreement. In consideration of the Research to be provided by Smithsonian, SCS agrees to make an advance payment in the sum of Fifty Nine Thousand Nine Hundred Forty Two (\$59,942.) and to reimburse Smithsonian for its costs in accordance with the Proposal in an amount not to exceed the advance sum.
2. **Limited Nature of Parties Obligations.**
The obligations of SCS and the Smithsonian hereunder shall be limited to payment of the amounts and the Project effort as specified in Article 1 above. SCS assumes no other obligation or responsibility of any kind to the Smithsonian or any other participants or sponsors, if any. SCS makes no warranties or Representations, Express or implied, of any kind.
3. **Termination.** Smithsonian understands and agrees that in the event the Project is terminated prior to completion or is not in accordance with the attached Proposal, SCS shall be entitled to a refund of the unexpended funds.
4. **No Joint Venture.** This Agreement is not intended to create nor shall it be construed to create any partnership, joint venture, employment or agency relationship between or among the parties, and no party shall be liable for the payment or performance of any debts, obligations, or liabilities of any other party, unless expressly assumed in writing.
5. **Deliverables.** In consideration to SCS for its one (1) year funding contribution to the Project, Smithsonian shall deliver to SCS a progress report of the findings including a detailed summary and analysis of the results and findings at the end of the one year period. SCS shall be entitled to a no-cost, non-exclusive irrevocable license to utilize the data and results of the Project for its internal purposes.
6. **Authority.** Each party represents and warrants to the other that as of the effective date of this Agreement: (a) it has all requisite power and authority to enter into and perform its obligations under this Agreement, and (b) there are no actions, suits, or proceedings pending, or to the best of its knowledge threatened, which may have a material adverse effect on its ability to fulfill its obligations under this Agreement or on its operations, business, properties, assets or condition.

7. **Assignment and Subcontracting Prohibited.** This Agreement shall not be assigned by Smithsonian nor its obligations subcontracted without the prior written consent of SCS, which shall not be unreasonably withheld. Any assignment or subcontracting in violation of this provision shall be deemed null and void and SCS shall be entitled to a refund of its contribution in full.
8. **Subsequent Changes in Agreement.** This Agreement may be modified only by an amendment executed in writing by a duly authorized representative for each party.
9. **Partial Invalidity.** If any provision of this Agreement is found to be unenforceable then, notwithstanding such unenforceability, this Agreement shall remain in effect and there shall be substituted for such unenforceable provision a like but enforceable provision which most nearly effects the intention of the parties. If a like but enforceable provision cannot be substituted, the unenforceable provision shall be deemed to be deleted and the remaining provisions shall continue in effect, provided that the performance, rights, and obligations of the parties hereunder are not materially adversely affected by such deletion.
10. **Successors and Assigns.** This Agreement shall inure to the benefit of and be binding upon the respective successors and permitted assigns, if any, of the parties, provided that this provision shall not be construed to permit any assignment which would be unauthorized or void pursuant to any other provision contained herein.
11. **Non-Waiver.** No provision of this Agreement shall be deemed waived and no breach shall be deemed excused unless such waiver or consent is in writing and signed by the party claimed to have waived or consented. No consent by either party to, or waiver of, a breach by the other, whether express or implied, shall constitute a consent to, waiver of, or excuse for any different or subsequent breach.
12. **Force Majeure.** Neither party shall be deemed to be in default of any provision of this Agreement or liable for failures in performance resulting from acts or events beyond the reasonable control of such party. Such acts shall include but not be limited to acts of God, civil or military authority, civil disturbance, war, strikes, fires, other catastrophes, or other 'force majeure' events beyond a party's reasonable control.
13. **Survival of Representations.** The provisions contained in this Agreement that by their sense and context are intended to survive the performance hereof by either or both parties shall so survive the completion of performance and termination of this Agreement, including the making of any and all payments due hereunder.
14. **Notices.** All notices permitted or required to be given under this Agreement shall be in writing and shall be deemed duly given (i) upon personal delivery (against receipt) or (ii) on the third day following the date on which each such notice is deposited postage prepaid in the United States Mail, registered or certified, return receipt requested or (iii) on the second business day after being sent by a nationally recognized overnight courier service which provides proof of receipt. All notices shall be delivered or sent to the other party at the address(es) shown below or to any other address(es) as the party may designate by ten (10) days prior written notice given in accordance with this provision.

If to Smithsonian:

Smithsonian Astrophysical Observatory
60 Garden Street
Cambridge, MA 02138-1516
Attention: Dr. Willie Soon, Mail Stop 63 (for technical matters)
Attention: Mr. Thomas G. Bonnecfant, Mail Stop 23 (for contractual matters)

If to SCS:

Southern Company Services, Inc.
600 North 18th Street
Bin 14N-8195

Birmingham, Alabama 35203
Attention: Justin T. Walters, Bin 14N-8195 (for technical matters)
Attention: Joseph L. Coker, Bin 7N-8374 (for contractual matters)

15. **Publicity.** Smithsonian shall not publish and utilize the name or otherwise identify SCS or its affiliate companies in any publications or other advertisements without the express written consent of SCS. As further consideration to SCS, Smithsonian shall provide SCS an advance written copy of proposed publications regarding the deliverables for comment and input, if any, from SCS.
16. **Duplicate Originals.** Duplicate originals of this Agreement shall be executed, each of which shall be deemed an original but both of which together shall constitute one and the same instrument.
17. **Entire Agreement.** This Agreement contains the entire agreement of the parties and there are no oral or written representations, understandings or agreements between the parties respecting the subject matter of this Agreement which are not fully expressed herein.

IN WITNESS WHEREOF, each of the parties hereto acknowledge that they have caused this Agreement to be executed in duplicate originals by its duly authorized representative on the respective dates entered below.

SOUTHERN COMPANY SERVICES, INC.

("SCS")

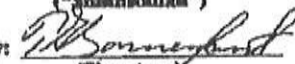
By: 
(Signature)

Name: John J. Jansen
(Typed or printed)

Title: Principal Scientist

Date: 10/30/2011

SMITHSONIAN ASTROPHYSICAL
OBSERVATORY
("Smithsonian")

By: 
(Signature)

Name: Thomas G. Bonnenfant
(Typed or printed)

Title: Contracting Officer

Date: 10/26/2011

**SOLAR IRRADIANCE MODULATION OF EQUATOR-TO-POLE
(ARCTIC) TEMPERATURE GRADIENTS**

CONTRACT 20175

FINAL REPORT

FOR THE PERIOD 01 DECEMBER 2011 – 30 NOVEMBER 2012

PRINCIPAL INVESTIGATOR
Dr. Willie Soon

NOVEMBER 2012

PREPARED FOR

SOUTHERN COMPANY SERVICES

Smithsonian Astrophysical Observatory
Cambridge, Massachusetts 02138

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

Final Report — Willie Soon

The goals of this research project have been successfully executed with the following list of deliverables:

- (1) The submission of the scientific manuscript "Solar Irradiance Modulation of Equator-to-Pole (Arctic) Temperature Gradients: Empirical Evidence for Climate Variation on Multi-decadal Timescales" by Willie Soon and David R. Legates (2012) to *Journal of Atmospheric and Solar-Terrestrial Physics*.**

Abstract

Using thermometer temperature records for the period 1850 to 2010, we present empirical evidence for a direct relationship between total solar irradiance (TSI) and the Equator-to-Pole (Arctic) surface temperature gradient (EPTG). Modulation of the EPTG by TSI is also shown to exist, in variable ways, for each of the four seasons. Interpretation of the positive relationship between the TSI and EPTG indices suggests that solar-forced changes in the EPTG may represent a hemispheric-scale relaxation response of the system to a reduced Equator-to-Pole temperature gradient, which occurs in response to an increasing gradient of incoming solar insolation. Physical bases for the TSI-EPTG relationship are discussed with respect to their connections with large-scale climate dynamics, especially a critical relationship with the total meridional poleward energy transport. Overall, evidence suggests that a net increase in the TSI, or in the projected solar insolation gradient which reflects any net increase in solar radiation, has caused an increase in both oceanic and atmospheric heat transport to the Arctic in the warm period since the 1970s, resulting in a reduced temperature gradient between the Equator and the Arctic. We suggest that this new interpretative framework, which involves the extrinsic modulation of the total meridional energy flux beyond the implicit assumptions of the Bjerknes Compensation rule, may lead to a better understanding of how global and regional climate has varied through the Holocene and even the Quaternary (the most recent 2.6 million years of Earth's history). Similarly, a reassessment is now required of the underlying mechanisms that may have governed the equable climate dynamics of the Eocene (35 to 55 million years ago) and late Cretaceous (65 to 100 million years ago), both of which were warm geological epochs. This newly discovered relationship between TSI and the EPTG represents the "missing link" that was implicit in the empirical relationship that Soon (2009) recently demonstrated to exist between multi-decadal TSI and Arctic and North Atlantic climatic change.

- (2) The submission of the scientific manuscript "Indian Summer Monsoon Rainfall: Dancing with the Tunes of the Sun" by K. M. Hiremath, H. Manjunath, and W. Soon (2012) to *Journal of Atmospheric and Solar-Terrestrial Physics*.**

Abstract

There is strong statistical evidence that solar activity influences the Indian summer Monsoon rainfall. To search for a physical link between the two, we consider the coupled cloud hydrodynamic equations, and derive an equation for the rate of precipitation that is similar to the equation of a forced harmonic oscillator, with cloud and rain water mixing ratios as forcing variables. Those internal forcing variables are parameterized in terms of the combined effect of external forcing as measured by sunspot and coronal hole activities with several well known solar periods (9, 13 and 27 days; 1.3, 5, 11 and 22 years). The equation is then numerically solved and the results show that the variability of the simulated rate of precipitation captures very well the actual variability of the Indian Monsoon rainfall, yielding vital clues for a physical understanding that has so far eluded analyses based on statistical correlations alone.

- (3) The publication of the scientific manuscript “Temporal derivative of total solar irradiance and anomalous Indian Summer Monsoon: An empirical evidence for a sun-climate connection” by Rajesh Agnihotri, Koushik Dutta and W. Soon (2011) in the journal *Journal of Atmospheric and Solar-Terrestrial Physics*, vol. 73, 1980-1987.

Abstract

Identifying the pattern of natural climate variability is of immense importance to delineate the effects of anthropogenic climate changes. Global and regional climates are suspected to vary, in unison or with delays, with the Total Solar Irradiance (TSI) at decadal to centennial timescales. Here we show that the Indian summer monsoon rainfall correlates well with the temporal derivative of TSI on multidecadal timescales. This linkage between the temporal derivative of TSI and the Indian summer monsoon is tested and corroborated both for the instrumental period (1871-2006) and for the last ~300 years using a speleothem $\delta^{18}\text{O}$ record representing rainfall in southwestern India. Our analyses indicate that both anomalously drier and wetter periods of the Indian monsoon record fall near negative and positive excursions in the TSI derivative, respectively. Our study thus demonstrates the potential of ‘TSI derivative’ as an important indicator of natural monsoon variability on an interdecadal timescale.

- (4) The publication of the scientific manuscript “Variation in surface air temperature of China during the 20th century” by Willie Soon, Koushik Dutta, David Legates, Victor Velasco, WeiJia Zhang (2011) in the journal *Journal of Atmospheric and Solar-Terrestrial Physics*, vol. 73, 2331-2344.

Abstract

The 20th Century surface air temperature (SAT) records of China from various sources are analyzed using data which include the recently-released Twentieth Century Reanalysis Project (20CRv2). Two key features of the Chinese records are confirmed: (1) significant 1920s and 1940s warming in the temperature records, and (2) evidence for a persistent multi-decadal modulation of the Chinese surface temperature records in covariation with solar radiation. New evidence is presented for this Sun-climate link for the instrumental record from 1880 to 2002. As well, two non-local, physical aspects of solar radiation-induced modulation of the Chinese SAT record are documented and discussed.

Teleconnections that provide a persistent and systematic modulation of the temperature response of the Tibetan Plateau and/or the tropospheric air column above the Eurasian continent (e.g., 30-70°N; 0 to 120°E) are described. These teleconnections may originate from the solar irradiance-Arctic-North Atlantic Overturning Circulation mechanism proposed by Soon (2009). Also considered is the modulation of large-scale land-sea thermal contrasts, both in terms of meridional and zonal gradients, between the subtropical western Pacific and mid-latitude North Pacific and the continental landmass of China. The Circumglobal Teleconnection (CGT) pattern of summer circulation of Ding and Wang (2005) provides a physical framework for study of the Sun-climate connection over East Asia. Our results highlight the importance of solar radiation reaching the ground, and the concomitant importance of changes in atmospheric transparency or cloudiness or both, in motivating a true physical explanation of any Sun-climate connection. We conclude that solar radiation provides demonstrable forcing for Chinese SAT changes on multidecadal to centennial timescales. Therefore, a comprehensive view of local and remote factors of climate change in China must take account of this, as well as other natural and anthropogenic forcings.