

Title of Grant / Cooperative Agreement:	SEACIONS during the 2012 Asian Monsoon: A Strategic Approach..
Type of Report:	Summary of Research
Name of Principal Investigator:	Anne M. Thompson/George S. Young
Period Covered by Report:	02/26/2013-02/25/2016
Name and Address of recipient's institution:	The Pennsylvania State University, University Park, PA 16802
NASA Grant / Cooperative Agreement Number:	NNX12AF05G

Reference 14 CFR § 1260.28 Patent Rights (abbreviated below)

The Recipient shall include a list of any Subject Inventions required to be disclosed during the preceding year in the performance report, technical report, or renewal proposal. A complete list (or a negative statement) for the entire award period shall be included in the summary of research.

Subject inventions include any new process, machine, manufacture, or composition of matter, including software, and improvements to, or new applications of, existing processes, machines, manufactures, and compositions of matter, including software.

Have any Subject Inventions / New Technology Items resulted from work performed under this Grant / Cooperative Agreement?	No <input checked="" type="radio"/>	Yes <input type="radio"/>
If yes a complete listing should be provided here: Details can be provided in the body of the Summary of Research report.		

Reference 14 CFR § 1260.27 Equipment and Other Property (abbreviated below)

A Final Inventory Report of Federally Owned Property, including equipment where title was taken by the Government, will be submitted by the Recipient no later than 60 days after the expiration date of the grant. Negative responses for Final Inventory Reports are required.

Is there any Federally Owned Property, either Government Furnished or Grantee Acquired, in the custody of the Recipient?	No <input checked="" type="radio"/>	Yes <input type="radio"/>
If yes please attach a complete listing including information as set forth at § 1260.134(f)(1).		

Attach the Summary of Research text behind this cover sheet.

Reference 14 CFR § 1260.22 Technical publications and reports (December 2003)

Reports shall be in the English language, informal in nature, and ordinarily not exceed three pages (not counting bibliographies, abstracts, and lists of other media).

A Summary of Research (or Educational Activity Report in the case of Education Grants) is due within 90 days after the expiration date of the grant, regardless of whether or not support is continued under another grant. This report shall be a comprehensive summary of significant accomplishments during the duration of the grant.

Closeout Report - NASA Grant NNX12AF05G: "SEACIONS during the 2012 Asian Monsoon: A Strategic Approach to Determining Convective Impacts on Tropospheric Ozone and TTL Gravity Waves"

Closeout: 26 Feb 2013- 25 Feb 2016

Principal Investigator: Prof. Anne M. Thompson (To 31 May 2013)
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Proposal Objectives & Final Overview of Accomplishments

Objectives: Purpose of making ozone and water vapor profiles measurements in SEAC4RS is to give consistent coverage of the vertical structure at fixed sites to (1) complement campaign aircraft sampling; (2) ground-truth satellite measurements of H₂O and ozone; (3) provide profiles for model evaluation; (4) study processes responsible for day-to-day variability at each site. Revised objective for 2013, due to cancellation of the 2012 and 2013 plans to operate in Southeast Asia: rapidly re-configure the original “SEACIONS,” Southeast Asian Consortium for Intensive Ozonesonde Network Study, to a SouthEast American plan (SEACIONS) for collecting daily ozonesonde data during DC-8 and ER-2 flights throughout the southeastern US. As in previous IONS (2004, 2006, 2008), students were trained at St Louis, Tallahassee, Houston, Penn State, Huntsville, Socorro. Images of the soundings and related flight-planning products were posted each day at NASA and Penn State (PSU) websites. With the aircraft based at Ellington Field (Houston), water CFH (cryogenic frost-point hygrometer) sondes in addition to ozonesondes, were to be taken launched at that site.

Revised SEACIONS Rationale, after Spring 2013: *New rationale and arrangement of US SEACIONS sites follows: (1) retain capability to sample in a region affected by “North American” (=NAM) monsoon operating in southwestern US, aimed at original SEAC4RS goals; (2) add stations in areas where ozone may respond to fires, especially in western US; (3) add stations in southeast US where there is a mixture of biogenic hydrocarbon and Nox sources that contribute to ozone formation, adding as opportunity allows, forays over cities and the Ohio River Valley power plants.*

Station	Affiliation/Network	Goals/Leveraging
Boulder, CO	NOAA/GMD; B. Johnson/S. Oltmans/P. Cullis	Western Fire impacts. Ozone/water vapor Group in place, launching weekly.
Socorro, NM	K. R. Minschwaner & New Mexico Tech students	Western fires possible. In NAM region. Use equipment, personnel from IONS-06.
Ellington Field, TX	PI Penn State/GSFC team. Thompson, Selkirk, Morris & four students	In NAM, validation for ER-2 and DC-8 water vapor instruments
St Louis, MO	Jack Fishman at Saint Louis Univ	In biogenic, maybe fire-affected region. Leverage with TEMPO, ACAST, Geo-CAPE partner

Huntsville, AL	M. Newchurch & UAH group	In biogenic region. Leverage on weekly sonde launches, ozone & aerosol lidars, as in IONS04, IONS06
Tallahassee, FL	H. Fuelberg (SEAC4RS PI) & student group	In NAM, hurricane potential region; some biogenics.

YEAR 3 & FINAL ACCOMPLISHMENTS: ANALYSIS & PUBLICATIONS

(1) Attendance at SEAC4RS Science Team Meeting, Pasadena, April 2015.

Collaborations on papers were established with

- ▶ Joseph Wilkins, St Louis Univ, with J Fishman: Poster shown, Manuscript still in preparation.
- ▶ Katie (Katherine Rose) Travis, Harvard Univ, with D Jacob: Issues of ozone gradients in lower troposphere observed in sondes and mismatches in measured Nox from DC-8 and models, implying over-estimates of surface NO.
- ▶ Mission Scientist O Brian Toon, Univ Colorado, Input for SEAC4RS Overview Paper
- ▶ Input given on sondes for Huntsville analysis and publication to Jeff Reid

(2) Training for Nepal Operations & Collection of Pokhara Ozonesonde Data.

The original SEACIONS had a site in Pokhara, Nepal, and the equipment had already been sent there when the Asian campaign was cancelled. In August 2015 we trained UVA Grad Student Shraddah Dhungel who took data in December 2015. Unfortunately there were many technical problems with the radiosondes. We await Ms Dhungel's PhD thesis using the boundary layer segments of the flights.

(3) Preparation of Publications. Analysis of Case Studies.

A SEACIONS overview paper is still in preparation by the PI with S Miller, UMD grad student Z Fasnacht and Dr R Stauffer. Laminar analysis has been employed along with comparison of tracer-correlations, stratospheric tracers in GEOS-5, in a collaborative effort supported by ACCDAM (L Ott, GSFC, PI). Some cases of upper trop enhanced ozone are from biomass burning (27 Aug 2013) and others are from STE, eg 21-23 Sept 2013.

Post-convective redistribution of ozone from a Pacific hurricane Henriette registered in ozone soundings from Socorro (Minschwaner et al., 2015). Ozone in the upper troposphere was low, water vapor elevated (both these phenomena also seen in MLS data). Trajectories also showed storm origins.

In Toon et al. (2016) the overall SEAC4RS project is described with lists of all instruments flown on the DC-8 and ER-2, SEACIONS (with a map). A summary of every flight day, with tracks superimposed on cloud maps, is provided.

The study referred to above by Travis, Jacob et al, was completed and submitted.

PERSONNEL SUPPORTED:

PI A. M. Thompson, Graduate Student N. V. Balashov, Graduate Student R. M. Stauffer

FINAL BIBLIOGRAPHY: PAPERS SUPPORTED BY SEAC4RS

R. M. Stauffer,* G. A. Morris, **A. M. Thompson**, E. Joseph, G. J. R. Coetzee, N. R. Nalli, Propagation of radiosonde pressure sensor errors to ozonesonde measurements, *Atmos. Meas. Tech.*, 7, 65-79. 2014. doi:10.5194/amt-7-65-2014.

K. R. Minschwaner, G. L. Manney, I. Petropavlovskikh, L. A. Torres, Z. D. Lawrence, B. Sutherland, **A. M. Thompson**, B. J. Johnson, Z. Butterfield, M. Dubey, L. Froidevaux, A. Lambert, W. G. Read, M. J. Schwartz, Signature of a Pacific cyclone in the composition of the upper troposphere over Socorro, NM, *Geophys. Res. Lett.*, 42, doi: 10.1002/2015GL065824, 2015.

O. B. Toon, H. Maring, J. Dibb, R. Ferrare, D. J. Jacob, E. J. Jensen, Z. J. Luo, G. G. Mace, L. L. Pan, L. Pfister, K. H. Rosenlof, J. Redemann, J. S. Reid, H. B. Singh, **A. M. Thompson**, R. Yokelson, P. Minnis, G. Chen, K. W. Jucks, A. Pszenny, Planning, implementation and scientific goals of the Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys (SEAC⁴RS) field mission, *J. Geophys. Res.*, **121**, doi: 10.1002/2015JD024297, in press, 2016.

K. R. Travis*, D. J. Jacob, J. A. Fisher, P. S. Kim, E. A. Marais, L. Zhu, K. Yu, C. C. Miller, R. M. Yantosca, M. P. Sulprizio, **A. M. Thompson**, P. O. Wennberg, J. D. Crouse, J. M. St. Clair, R. C. Cohen, J. L. Laughner, J. E. Dibb, S. R. Hall, K. Ullmann, G. M. Wolfe, J. A. Neuman, X. Zhou, NO_x emissions, isoprene oxidation pathways, vertical mixing, and implications for surface ozone in the Southeast United States, *Atmos. Chem. Phys. Disc.*, 2016-110, submitted, 2016.

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