Strategies that Engage Undergraduate Students to Learn about Space Weather

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Outline

1. The case for undergraduate research- Why is it important?
2. Why Space Weather (Swx)?
3. Four strategies that engage students successfully in research
   -Case study: Queensborough Community College (QCC) of the City University of New York (CUNY)
4. Challenges
5. Outcomes
6. Summary--Broader Impact

Case for Undergraduate Research

Undergraduate research experiences in science, technology, engineering and mathematics (STEM) fields provide a variety of benefits to students including:

- ✓ Sophisticated understandings of science and its nature
- ✓ Improved attitudes toward STEM
- ✓ Career awareness in STEM fields
- ✓ Enhanced critical thinking, and
- ✓ Improved self-efficacy, persistence and confidence

Case for Undergraduate Research (cont.)

- ✓ Motivated students that are ready for graduate programs
- ✓ Preparing the next generation of researchers
- ✓ Passing the research baton to the next generation

Why Space Weather (Swx)?

-Space Weather? Never heard of it.
-Relevant to students because of technology
-Considered a natural hazard (www.Ready.gov)
-Learn about NASA– 60 years on,NASA still got it! (still a big draw!)
-Learn about National Oceanic & Atmospheric Administration (NOAA)
-Tons of freely available data online (both archival & real-time)—computational thinking &data analytic skills
-Lots of models that help with visualization
-Great way to teach physics without scaring students too much!
-Sounds interesting
-Pretty cool stuff!

Four strategies that engage students successfully in research

1. Adopt & Adapt (A&A)
2. Find partners (universities, research labs, private industries, etc.)
3. Develop a Community of scholars (COS)—Learning Community
4. Program Assessment

Four strategies that engage students successfully in research

1. **Adopt & Adapt (A&A)**

   -No need to reinvent the wheel!
   -Plenty of materials freely available online (public domain)

Four strategies that engage students successfully in research

2. **Find partners (other universities, research labs, private industry, etc.)**

-Don't have do it alone!

-Seek partners that can:

- Share resources (research facilities, library, etc.)
- Host students during the summer
- Mentor students
- Support/Write proposals

Four strategies that engage students successfully in research

3. **Develop a Community of scholars (COS)—Learning Community**

-Faculty & Peer mentoring
-Continuity– More advanced students train new students
-Academic & Social support--Students offer support to each other both academically & socially
-Integrate student into the academy—Students feel part of a greater community and have a sense of belonging.

Four strategies that engage students successfully in research

4. Program Assessment

What is working and what is not working

Methods: Surveys & focus groups (many available online– adopt & adapt)

1) What gains do students make from their year-long research?

2) Are students satisfied with their year-long research experience, and with the training and support provided by project?

Know what's available on campus

- QCC is a 2-Yr College – mission is primarily teaching, not research (QCC requiring research more and more)
- Very heavy teaching load
- Library resources (scientific journals, books, etc.) very limited
- Very little time to attend meetings/conferences
- **Only person in department doing research (lone wolf)**

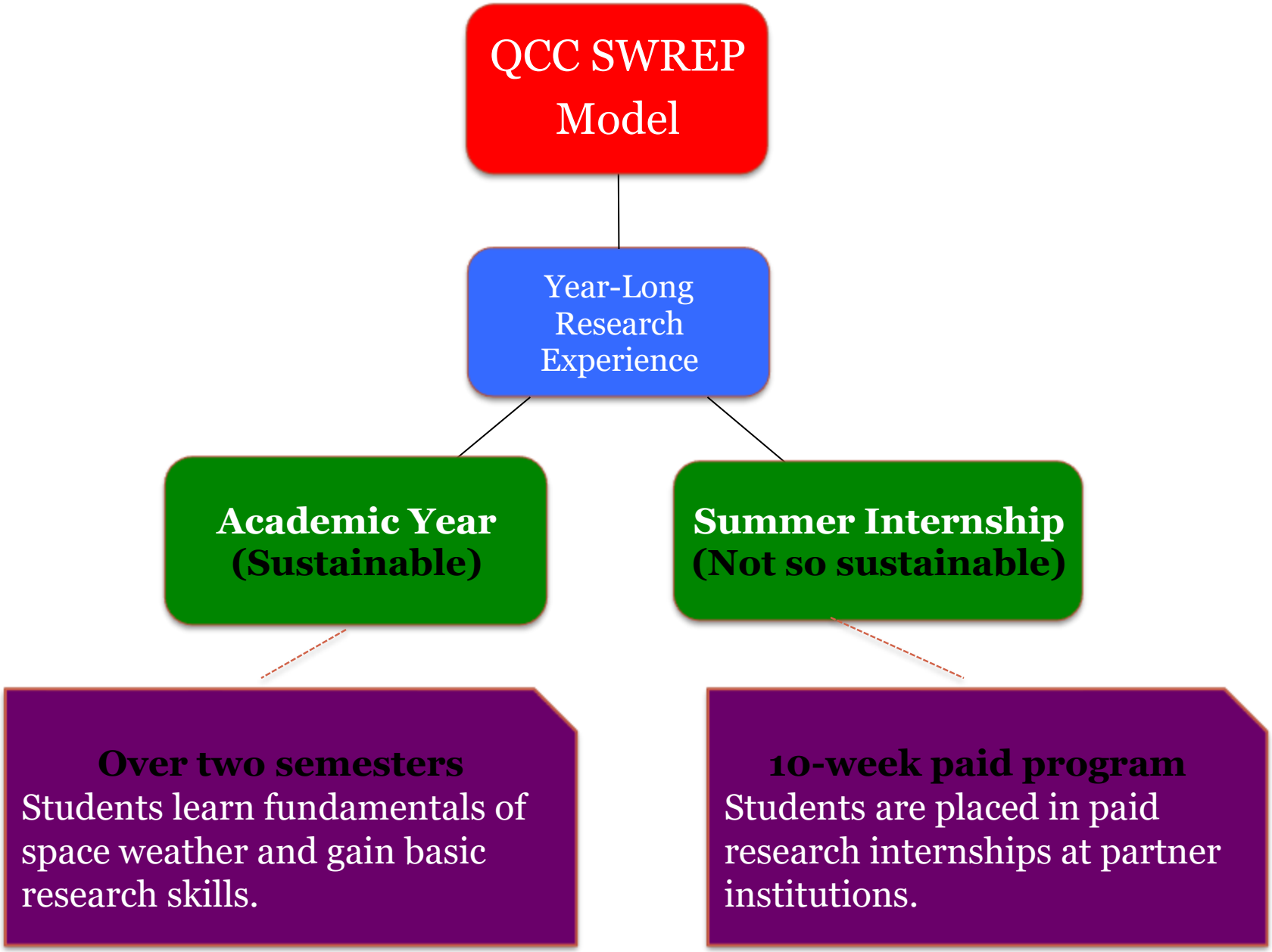
Know Students

- 2-Yr community college students (US)
- 1st year at university
- Little to no background in physics (~ 1-2 semesters of introductory physics)
- Diverse academic background, i.e., math skills
- Diverse population (minorities & women)
- Many work full-time/part-time + heavy course load + family obligations + commute = no time for research
- First generation college students

QCC Space Weather Research & Education Program Model

Program: Queensborough Community College (QCC) Space Weather Research & Education Program (SWREP)

Main Goal: Engage undergraduate students as early as their first year in research and education activities in solar, geospace and atmospheric physics under the **umbrella discipline of space weather**


QCC SWREP Model
Year-Long Research Experience
Academic Year (Sustainable)
Summer Internship (Not so sustainable)
Over two semesters
Students learn fundamentals of space weather and gain basic research skills.
10-week paid program
Students are placed in paid research internships at partner institutions.

QCC SWREP Model Year-long Format

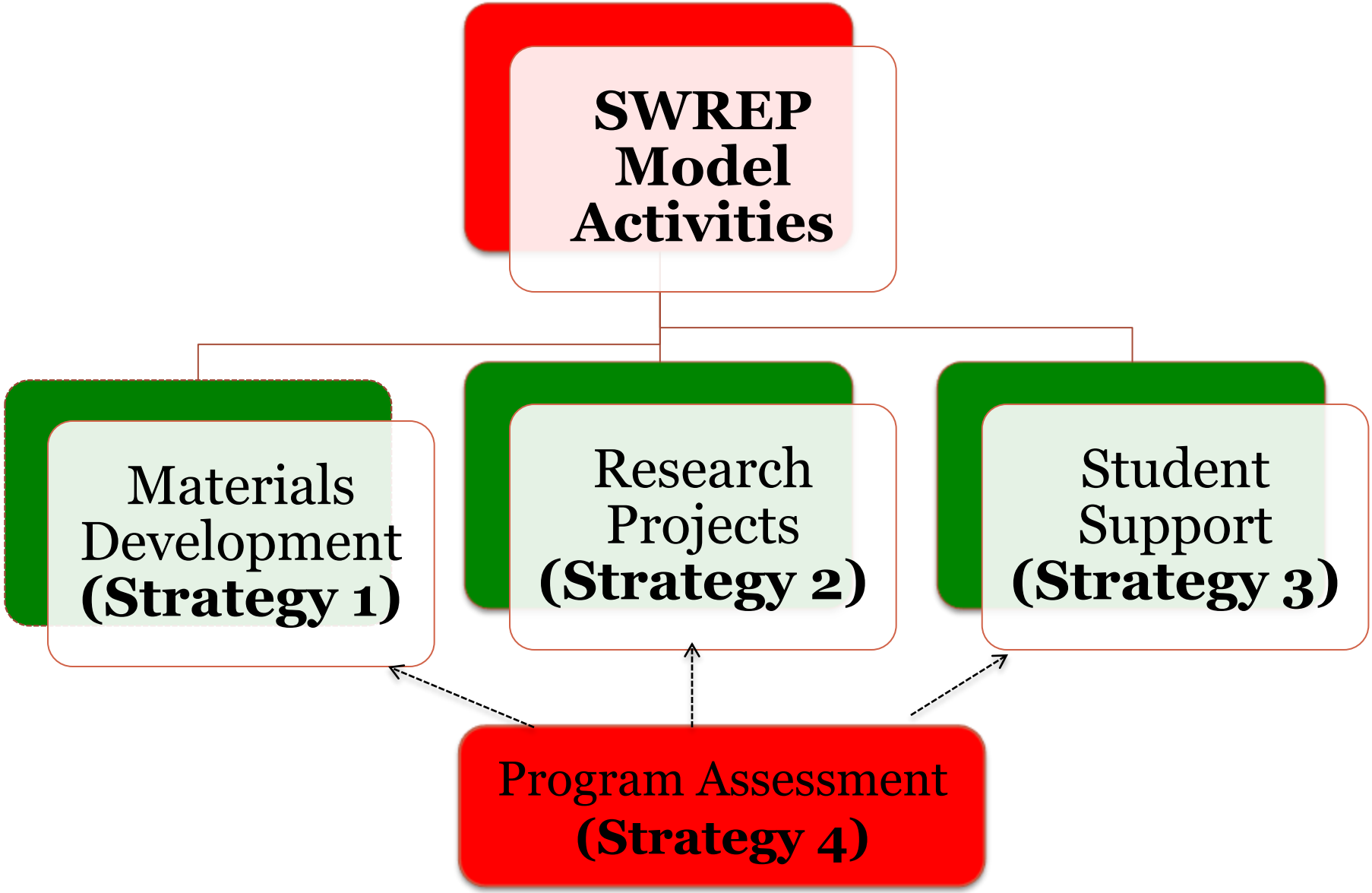
Table 2. Space Weather Research and Education Curriculum

Item	Contribution
Course: Research Projects in Space Weather (Swx)	Semester 1: Fundamentals of Swx and Impact technological systems. Semester 2: Research project through case studies of storm events.
Summer research internship program	-10-week research internship at GSFC or CUNY to expand academic year experience -Includes a one week Space weather bootcamp at NASA/CCMC
Synergistic Activities	Workshops & training, i.e., data analysis techniques, virtual community, research integrity, etc.

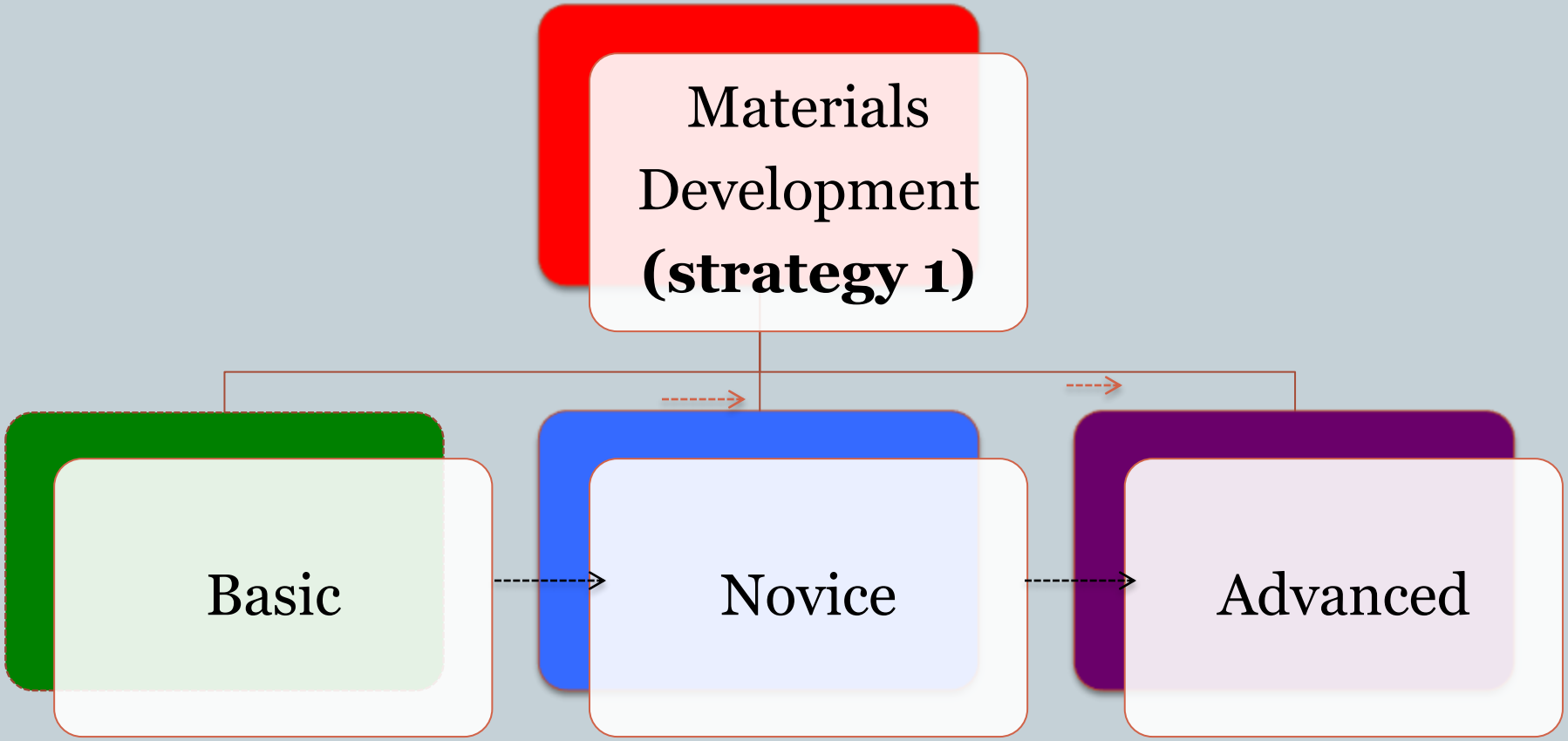
From Damas et.al., 2019 in preparation

QCC SWREP Model Year-long Format (cont.)

- Students receive course credit
- Students meet ~ 4-hours/week as a class
- Students work independently and in groups
- Students meet individually with faculty mentors


SWREP Model Activities
Materials Development (Strategy 1)
Research Projects (Strategy 2)
Student Support (Strategy 3)
Program Assessment (Strategy 4)

SWREP Activities



SWREP Activities: Materials—Basic

Fundamentals of Swx

A. Materials available freely on line that introduce students to space weather:

1. Jack Eddy's Book-The Sun, the Earth, and Near-Earth Space: A Guide to the Sun-Earth System published by NASA and the International Living with a Star (ILWS)
2. NASA@science videos—short videos on YouTube on the Sun, CMEs, solar flares, etc.
3. Community Coordinated Modeling Center (CCMC) materials & support

B. Websites:

1. Spaceweatherlive.com
2. Spaceweather.com
3. NASA, NOAA, etc.

C. Books:

1. Marc Moldwin's Introduction to Space Weather (basic & novice)
2. Delores Knipp's Understanding Space weather and the Physics behind it (for more advanced students because of E&M)

SWREP Activities: Research Projects **(strategy 2)**

Work with partners to develop student projects that:

- ✓ Are well-defined and have an end (not too open ended). There are some results even if more questions are raised.
- ✓ Take into account student level when developing projects
- ✓ Take into account home university's resources (library, computer lab space, software, etc.)
- ✓ With little or no background in physics (electricity & magnetism (E&M), plasma, etc.) use large data sets freely available on the internet from both space and ground-based instruments
- ✓ Require team work
- ✓ Are Interdisciplinary
- ✓ Take into account **System Science**, which views the Sun–heliosphere–magnetosphere–ionosphere–atmosphere complex as an integrated system.

Students, Meet Data!

Students:

- ✓ Get to know (intimately) large data sets
- ✓ Analyze both historical (archival) & real-time data
- ✓ Learn that data can be very messy!! with lots of gaps, etc.
- ✓ Perform data/statistical analysis using mainly **MS EXCEL** or MATLAB, etc.
- ✓ Gain both data analysis and computational thinking skills
- ✓ Write and present their results to scientists and peers

Where to get data

1. **NOAA Space weather Prediction Center (SWPC)**
2. **SPDF - Coordinated Data Analysis Web (CDAWeb)**
   (https://cdaweb.sci.gsfc.nasa.gov/index.html/)
3. **Individual spacecrafts (SDO, STEREO,SOHO, etc.)**

SWREP Activities: Student Support **(Strategy 3)**

"A good mentor is hard to find."

Need to establish a strong mentoring program consisting of a diverse team. Mentoring can be done face-to-face or online. Students are mentored by:

- ✓ Faculty
- ✓ Research scientists from science labs, industry, etc.
- ✓ Graduate students
- ✓ Peer tutoring—very powerful--establish a community of scholars where students feel part of a community where they help and mentor each other.

Challenges

- Preparedness of students (math skills)
- Have students for only one or two years
- Resources: access to journals, software, etc.
- Time: heavy teaching load (4-5 courses/semester) plus research and committee work
- Funds to travel and pay students (always writing proposals!!)
- Look for and foster research collaboration
- Own research suffers

Challenges

- Research projects that are manageable & at proper level, yet challenging for students
- Competition for students' time (courses, work, clubs, etc.)
- **Sustainability (Can we continue without funds? YES and NO)**
  - **Yes—Academic Year**
  - **No- Summer**

Program Outcomes
(strategy 4)

1. Well-trained students with research/interdisciplinary skills
2. Communication skills (oral, written)
    1. Abstract, scientific paper, ppt presentation (oral), poster
3. Computer skills (programming-Python, C++, Matlab, etc.)
4. Publish in peer-reviewed proceedings/journals
5. Attend and present at a scientific meeting
6. Desire to continue in STEM, including transferring to 4-Yr university STEM (BS) and doctoral programs

Sample Projects & Abstract Titles Submitted to AGU

- Analysis of Positive Ionospheric Storm Disturbances
- Characterizing Interplanetary Structures of Long- Lasting Ionospheric Storm Events
- Dst Profile Investigation with Gamma Distribution and Diffusion-Like Distribution
- Modeling the Impacts of Geomagnetic Disturbances on the New York State Power Transmission System
- Is the Solar Magnetic Field Getting Weaker?
- An Investigation of Interplanetary Structures for Solar Cycles 23 and 24 and their Space Weather Consequences.
- Quantifying Temporal and Spatial Characteristics of Pulsating Aurora.
- Study of Geomagnetic Field Response to Solar Wind Forcing.
- Validation of the Kp Geomagnetic Index Forecast at CCMC
- The Magnetic Evolution of Coronal Hole Bright Points
- Inverse Flux versus Pressure of Muons from Cosmic Rays.
- Using Flow Charts to Visualize the Decision Process in Space Weather Forecasting
- Comparing the Characteristics of Ionosphere for Different Solar Minimum Periods

People

Students have access to a diverse group of mentors

- CUNY/QCC- Physics Department– M. Chantale Damas, Paul Marchese, Tak Cheung
- Community Coordinated Modeling Center (CCMC) based at NASA Goddard Space Fight Center—- Maria “Masha’ Kuznetsova, Yihua Zheng, Chigomezyo Ngwira, Leila M. Mays, Karin Muglach, Yareiska Collado-Vega, Anna Chulaki
- CUNY/City College of New York– Electrical Engineering Department (Ahmed Mohamed, Roger Dorsinville)
- NASA Goddard Heliophysics—Robert Michell, Marilia Samara, Neeharika Thakur (also of Prince George’s Community College) & Nat Gopalswamy
- CUNY/York- Physics Department: Kevin Lynch & James Popp
- University of Colorado at Boulder: Delores Knipp

Funding

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Other sources of Funding:

- CUNY/QCC NSF Research Experience for Undergraduates (REU) Program
- CUNY/Medgar Evers College NSF REU Program
- NASA New York Space Grant for Community College Partnership program
- The City of New York Mayor's Office--CUNY Research Scholars Program for Community College Students (CRSP)
- Department of Education MSEIP

*Early Concept Grants for Exploratory Research

Summary

1) Undergraduate students contribute to the fundamental understanding of space weather, a natural hazard, and it's impact on Earth's space environment, life and society;
2) Long-term integration of space weather into the undergraduate curricula, thus exposing students to research early in their academic careers;
3) Increasing students' interest in and motivation to study science, technology, engineering and mathematics (STEM), as well as preparing them for choosing a career path in space science or STEM related fields; and
4) Increase student persistence, transfer & graduation rates.

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- Spaceweather.com & Spaceweatherlive.com

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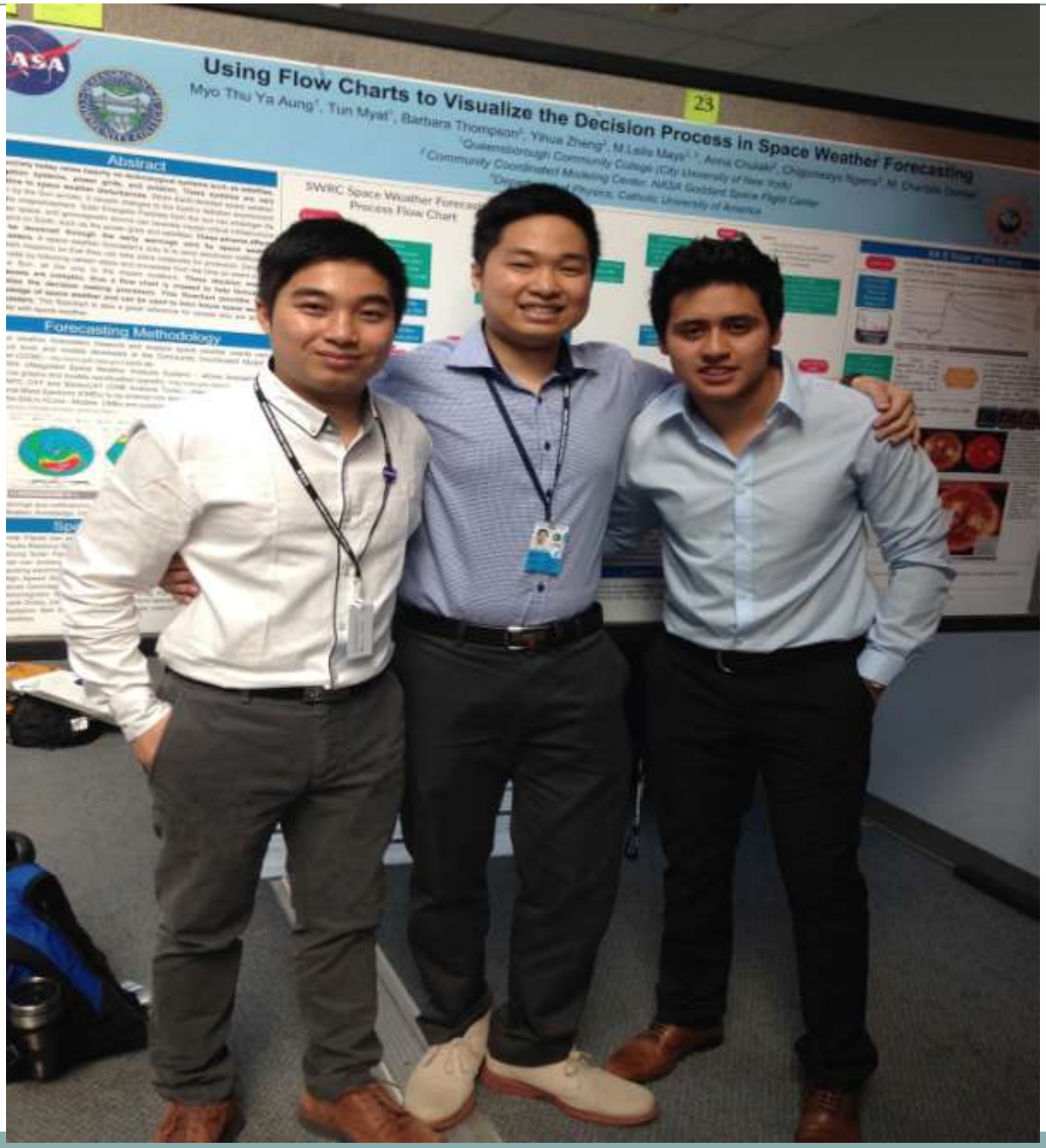
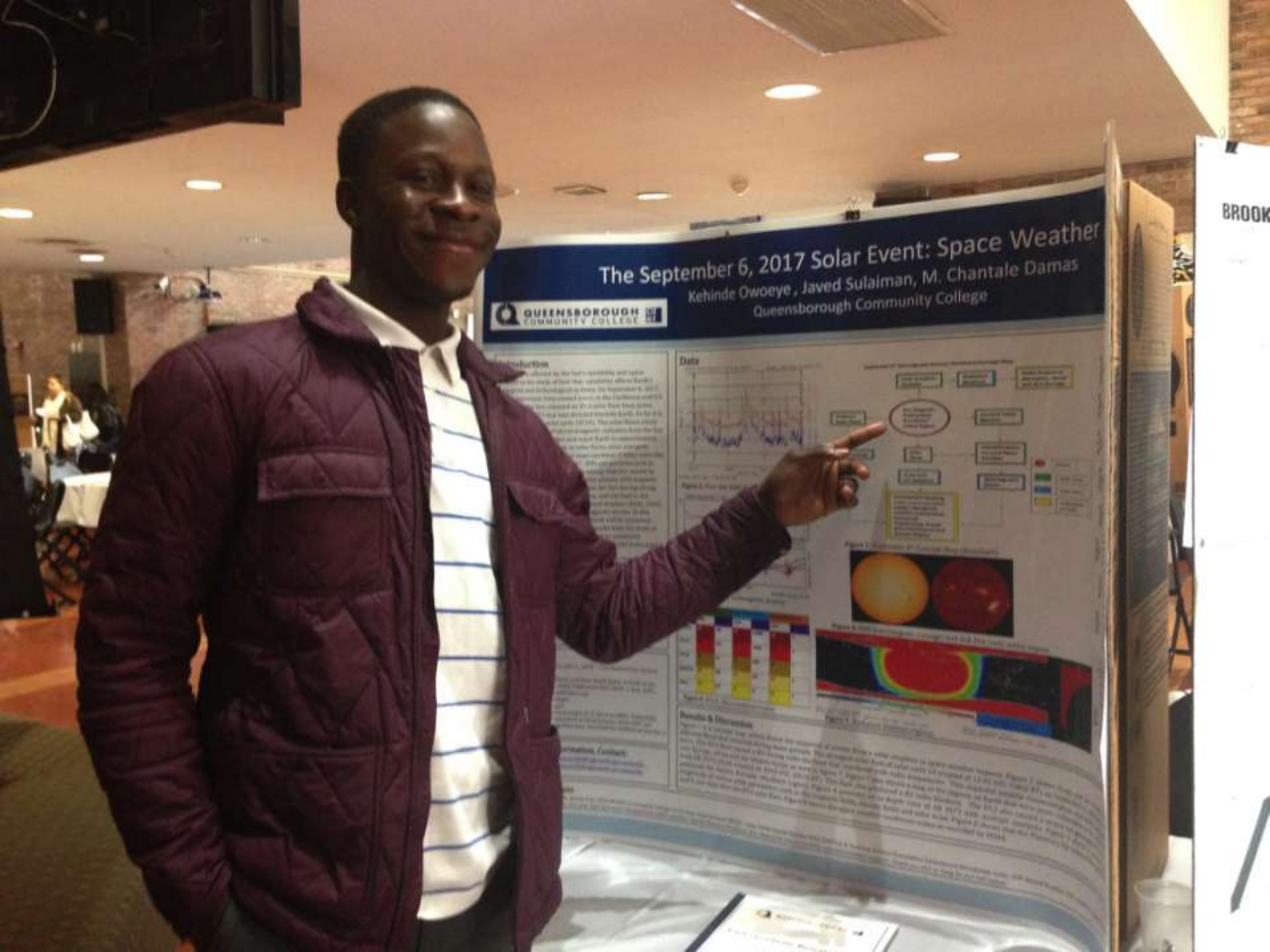
I will be at my poster
from ____ to ____ hrs


Using Flow Charts to Visualize the Decision Process in Space Weather Forecasting
23
Abstract
Forecasting Methodology


The September 6, 2017 Solar Event: Space Weather
Kehinde Owoeye , Javed Sulaiman, M. Chantale Damas
Queensborough Community College
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Data

Grazie!!

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