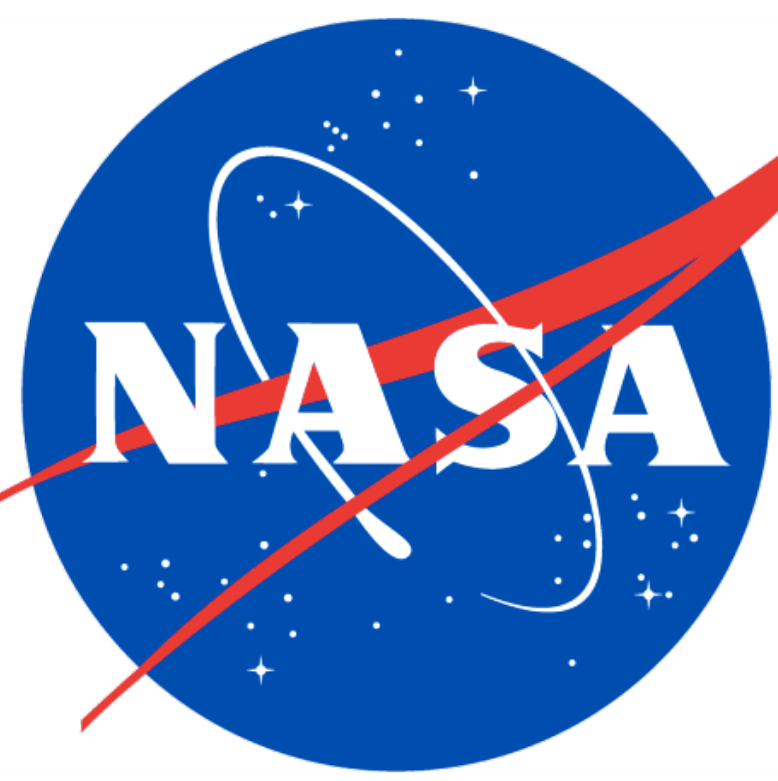




Long-term Engagement in Authentic Research with NASA (LEARN): Innovative Practices Suggested by a New Model for Teacher Research Experiences

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The NASA LEARN Project is an innovative program that **provides long-term, year-round immersion in the practice of atmospheric science for middle and high school in-service teachers**. Working alongside NASA scientists and using authentic NASA Science Mission Directorate (SMD) Research and Analysis (R&A) related and mission-based research data, teachers **develop individual research topics** of interest during two weeks in the summer while on-site at NASA Langley. With continued, intensive mentoring and guidance of NASA scientists, the teachers further develop their research throughout the academic year through virtual group meetings and data team meetings mirroring scientific collaborations. Working with their mentors, teachers learn how scientists approach problems and gain a level of comfort with the research. Teachers act in the role of a scientist and experience how scientists interact at science team meetings and when presenting results at a conference. At the end of the first year, the LEARN teachers present scientific posters. The LEARN model incorporates **intensive support and mentoring, ongoing virtual and face-to-face check-ins, and flexibility to meet teachers' needs** on their research projects and in their classrooms.



The LEARN evaluation has focused on how an extended research experience for teachers spanning a full year influences teacher views of science and classroom integration of scientific principles. Early findings indicate that **teachers' perceptions of the scientific enterprise have changed, and that LEARN provided substantial resources to help them take real-world research to their students**. Teachers also valued the teamwork and cohort approach.

To see the teacher participants' final posters and to learn more about LEARN, please visit <http://science-edu.larc.nasa.gov/LEARN/>



THE LEARN PD MODEL

2 Week Onsite Workshop

- GLOBE training in atmosphere protocols
- Scientist guest lectures to introduce NASA missions, projects, and critical research questions
- Large blocks of time to develop research topics with intensive guidance from scientist mentors, and to begin the process of accessing and working with data

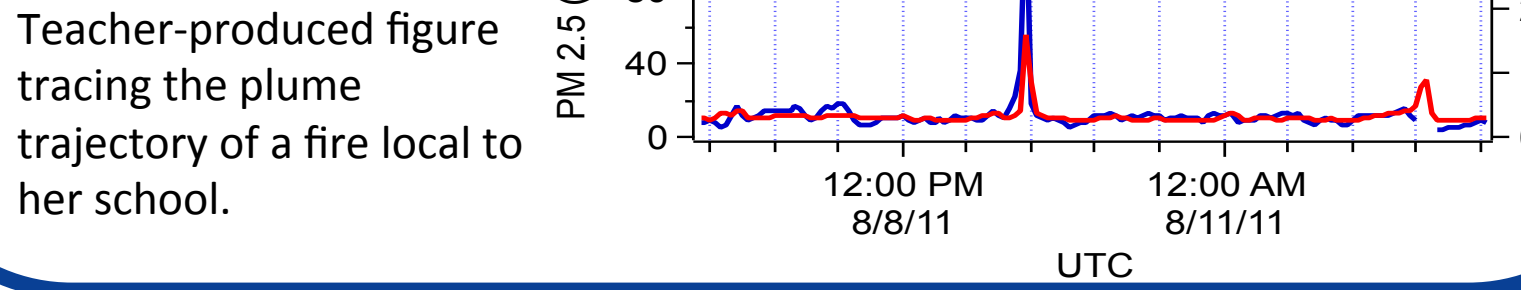


Virtual Meetings

- Mirrors science research group meetings, while teachers independently pursue their research topics
- Weekly small group WebEx (webinar) discussions with scientist mentors, phasing to biweekly and then monthly during the school year
- Undergraduate research assistants provide real-time, one-on-one support to teachers, focusing particularly on data access, processing, and analysis tasks
- Virtual support persists throughout every stage of the LEARN model

Science Data Meeting

- Mirrors the NASA mission science team process
- In the winter, teachers convene to formally present their progress and to gather feedback from their peers & mentors
- Focuses on developing the science "story," and narrowing projects to appropriate scope, with the goal of producing a final poster



Poster Presentation

- Mirrors the scientific conference format for presenting final results
- In the 2nd summer, teachers present their findings among each other, to the scientist mentors and project team, and to the public at NASA Langley
- Feedback and discussions prompt teachers to consider next steps for furthering their research and uncovering new, interesting questions

Teachers have the option to return for a 2nd (or 3rd!) annual cycle, and meet up with the new cohort at the 2 week summer workshop.

Team and one-on-one virtual meetings take place throughout the year.

An Innovative Model for Teacher PD: How LEARN is Different

- The LEARN model differs from many other teacher research experiences in that:
- LEARN is led by a scientist, and the LEARN model depends on facilitation by a scientist who has the time and resources to be a constant leader, mentor, and project manager (see Challenges!).
 - LEARN focuses its learning objectives on the science process skills related to framing and approaching scientific research questions, and the evaluation of study feasibility based on scope, scale, and availability of data.
 - LEARN breaks the workshop mold, creating long-term, ongoing, collaborative relationships where teachers and scientists work together as colleagues. This results in an intensive, year-round experience in which teachers truly develop and carry out their own investigations.
 - Teacher participants have free choice of science topics within the general domain of atmospheric science. Their choices are often driven by relevance (either personal interest or a local/regional focus).



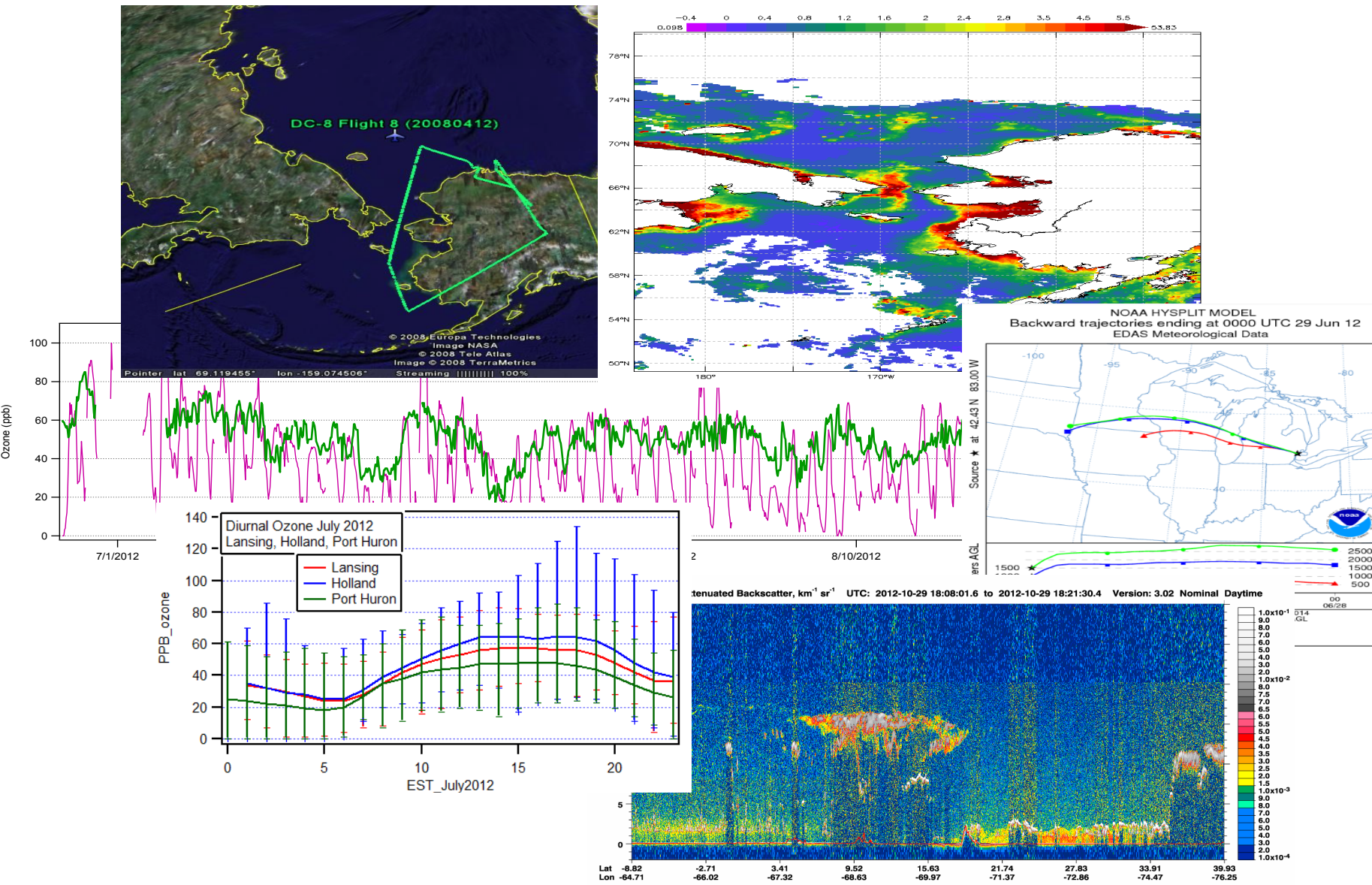
What Works: Key Implementation Factors

- During onsite workshops, blend mini-lessons on science content with hands-on activities and engagement with data – help teachers avoid feeling overwhelmed!
- In particular, teachers struggle with narrowing and focusing their ideas into specific research topics. Good topics will be supported by accessible data and straightforward analyses (the universe of data is larger than they anticipate!).
- Provide teachers with ongoing support throughout the year. Virtual meetings kept teachers engaged and connected to their scientist mentors. The knowledge that another conversation was always around the corner created a safe space for confusion and mistakes. One-on-one meetings are most helpful early in the model, but further down the road, groups can meet together.
- Be flexible and patient. Life intervenes! The LEARN model is based on building relationships over time. The model also emphasizes that teachers' success is more important than deadlines or rigid protocols.



LEARN Pays Dividends in Teacher Practices

- It took several years to build relationships and confidence, but now LEARN is seeing outcomes in several areas of teachers' research and professional practice:
- LEARN teachers are presenting their work at conferences and writing journal articles.
 - LEARN teachers working on related projects have started to collaborate with each other, independent of their scientist mentors.
 - LEARN teachers are bringing their experiences back to the classroom, involving their students in research, and implementing changes in their pedagogical practices.



Challenges in Implementing an Innovative, Intensive Model

The key challenge of LEARN is the **significant amount of time and effort required on the part of the scientist leader** in guiding, mentoring, and encouraging the teacher participants.

The scientist leader plays a large number of roles in the success of the LEARN model:

- Providing a single point of contact and support for teachers
- Providing guidance and assisting with data collection and analysis for a wide variety and large number of atmospheric science investigations (see inset).
- Seeking out sources of data and expertise that will help teachers carry out their investigations.
- Differentiating learning experiences based on the specific needs of individual participants (schedules, confidence, quantitative and science process skills).

Some examples of the varied research topics selected and investigated by teachers:
"Asthma and PM 2.5 in New York City";
"CO2 Spatial and Temporal Variability: Local to Global";
"Correlation of Autism Birth Rates and Surface Ozone in the United States";
"Correlation of Chlorophyll and Sea Surface Temperature in Sub Arctic Regions";
"Long-Range Transport of Smoke Plumes from 2011 Lateral West Fire";
"Ozone Production and Transport over the Great Lakes."

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