COURSE DESIGN ELEMENTS

- **Active Learning** - Peer Learning in class builds on traditional astronomy course materials
- **Authentic Learning** - Classroom Environment creates Authentic Research-like environment, using actual peer-reviewed astrophysics literature
- **Inquiry Based** - Students assigned actual research questions posed by others, and design observing projects
- **Project Based** - Students implement observing projects and publish results in
- **Designed to develop "expert thinking"** among undergraduate students
- **Globalized** - Provides global cohort of undergraduates collaborating on shared datasets and develops international undergraduate astronomy community

BASIC FEATURES

- Multi-Campus parallel units to enable collaboration
- Shared Tutorials on advanced topics to accelerate learning
- Student Collaborative site for sharing data and tips for analysis
- Online blog/journal to share new student results
- Shared remote telescope access enabling student research with time-domain astronomy

GROWTH
Global Relay of Observatories Watching Transients Happen

Parallel Global Observational Astronomy Course - Possible Weekly Schedule

Week 1	Week 2	Week 3	Week 4	Weeks 5+6	Week 7
Telescope Design, CCD detectors, Astronomical Coordinates	Astrometry Exercise (parallax or orbit determination)	Basic Photometry (measurement of HR diagram)	Time-Domain Photometry - light curve + periodogram	Submit Proposals for student projects + conduct observing	Presentations and writeups of student work
Begin Project - within semester or quarter	Students at multiple campuses can provide parallax data, share orbit data	Professors can share tutorials, and students can pool data for photometry	Multiple student groups can provide 24-hour coverage of time-variable sources	Global student research community can share data analysis tips and telescope time	

Timeline of GROWTH Global Astronomy Course Implementation

Year 1	Year 2	Year 3	Year 4	Year 5
pilots at 4 institutions	2 institutions/ semester	4 institutions/semester, with mix of US and international	6 institutions/ semester with mix of US and international	6 institutions/semester with mix of US and international Presentation at Educational Conference
First year for linked astronomy classes				Assessment, and publication of curriculum
			fully scaled	

NSF PIRE

GRO
Global Relay of Observat

omona Brackett Observatory

TMO Wrightwood

Palomar Observatory

Telescopes for GROWTH Undergraduate Research Projects

BASIC FEATURES

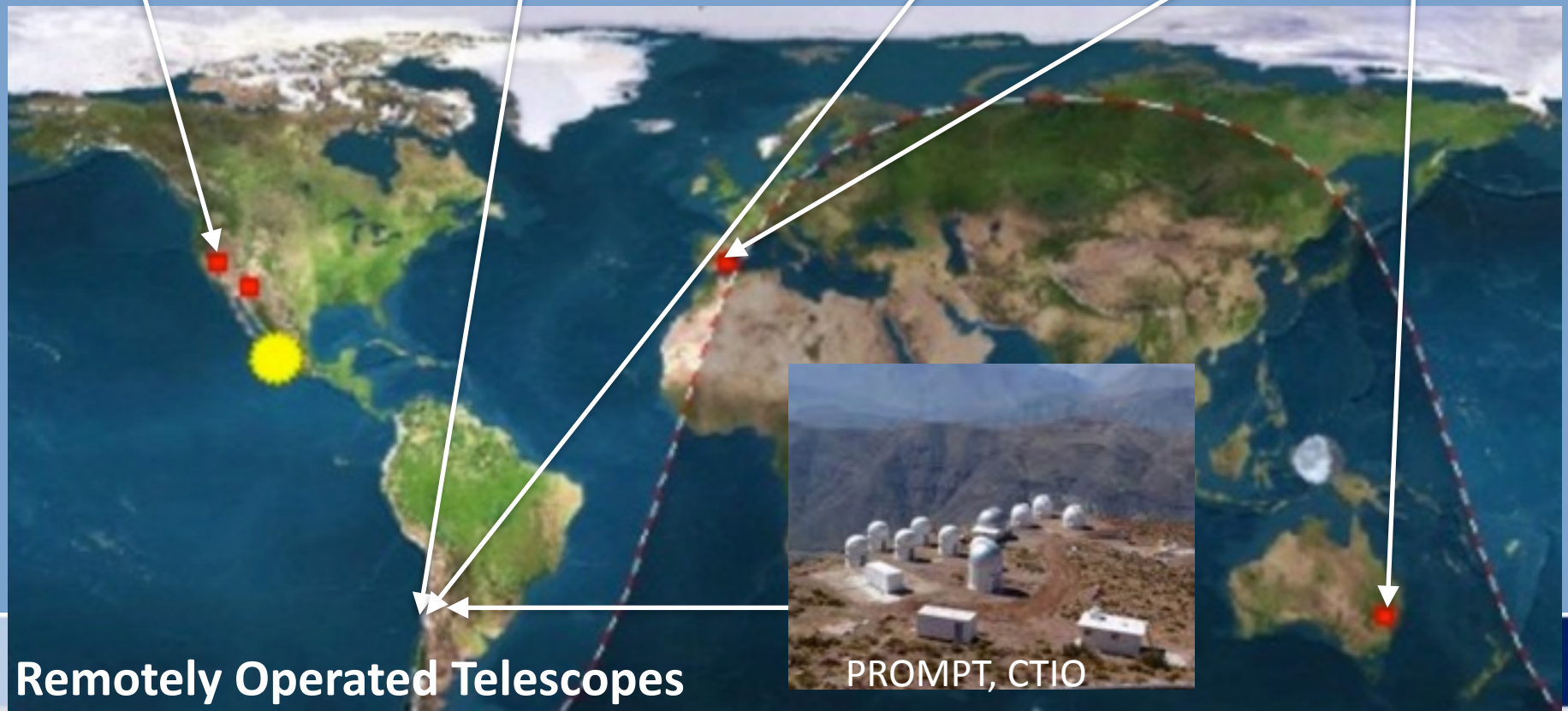
- Instructor Teams sharing exercises and in-class exercises
- Developing a global community of astronomy educators
- Students using remote observing and global telescope network for introductory classes
- Guest lectures from GROWTH team scientists conveys excitement about research and diversity of science community
- Access to new discoveries adds cutting-edge research possibilities for intro students


TMO Wrightwood


Las Campanas, Chile


LCRO, Las Campanas

Subscription Telescopes: ITelescope.net, PROMPT



PROMPT, CTIO

Remotely Operated Telescopes

GROWTH
Global Relay of Observatories Watching Transients Happen

Overview of GROWTH General Education Astronomy Courses

Instructor Workshops

GROWTH GE Astronomy Courses

Offered at U Maryland, U Wisconsin Milwaukee, SDSU, and other GROWTH PARTNERS

Impacts several 1000 students, including large numbers of URM and First-generation students

Instructor Community

Develop Common Resources

Expand Use of Research-Based Projects

Plan for Instructor Workshop

Instructor Workshops

Shared Resources - by Pedagogy

ACTIVE LEARNING

In Class Activities and Peer Learning Exercises
Conceptual Questions
Projects Using GROWTH data

FLIPPED

Online Tutorials for Common Topics

LABORATORY

Observational Astronomy Exercises

Laboratory Experiments

PROJECT-based and RESEARCH

Shared Journal Article "case studies"
Student Developed Reports and Research

NSF PIRE

OUTCOMES

- Large cohort of diverse students with research-based GE course experience - encouraged to pursue STEM fields
- Shared Tutorials and Course Materials to advance astronomy education
- Research-capable students prepared for graduate programs in new time-domain astronomy and astrophysics
- Curriculum developed that can make full use of remotely operated global telescope network
- Global community of astronomy educators and published time-domain astronomy curriculum