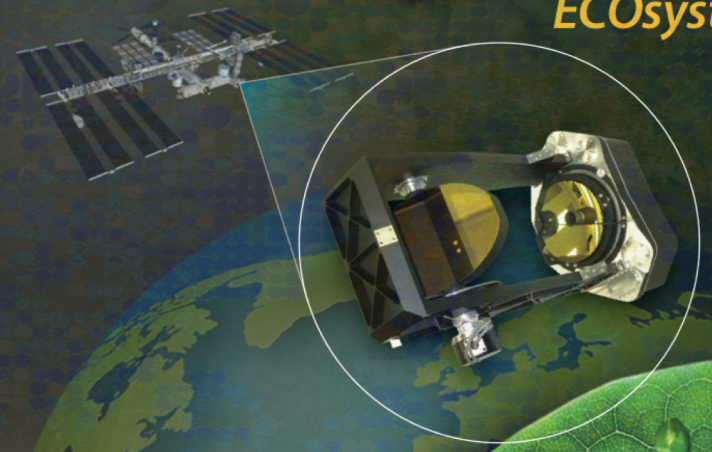
National Aeronautics and Space Administration

ECOSTRESS

ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station



An Earth Venture Instrument-2 Proposal

Submitted in response to

AO NNH12ZDA006O EVI2

Prepared for

National Aeronautics and Space Administration
Science Mission Directorate

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National Aeronautics and Space Administration

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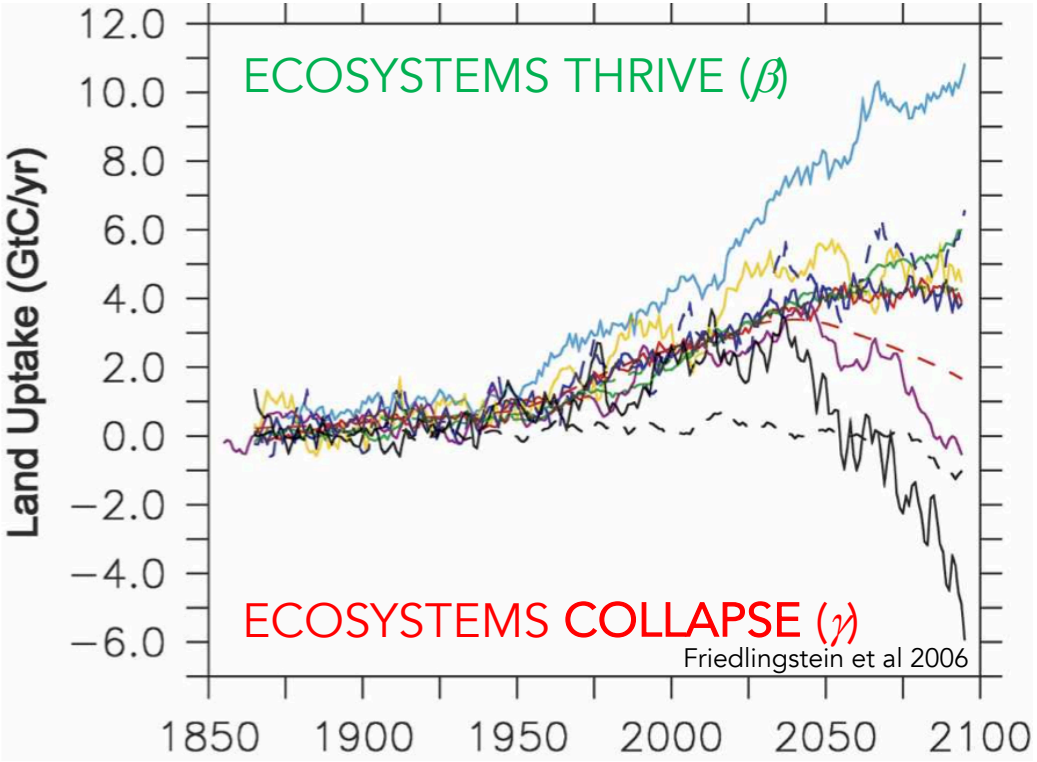
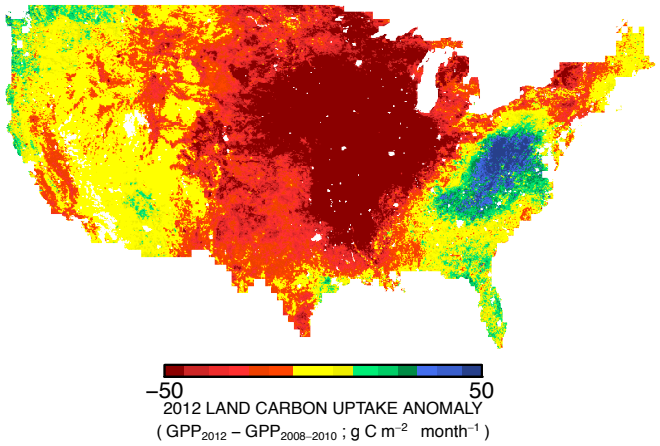
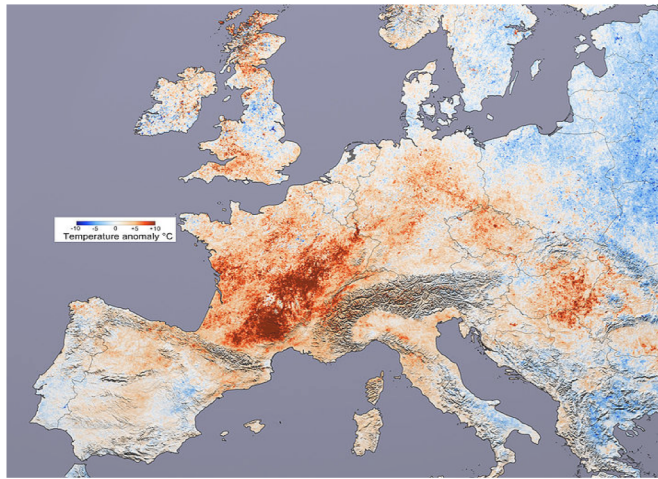
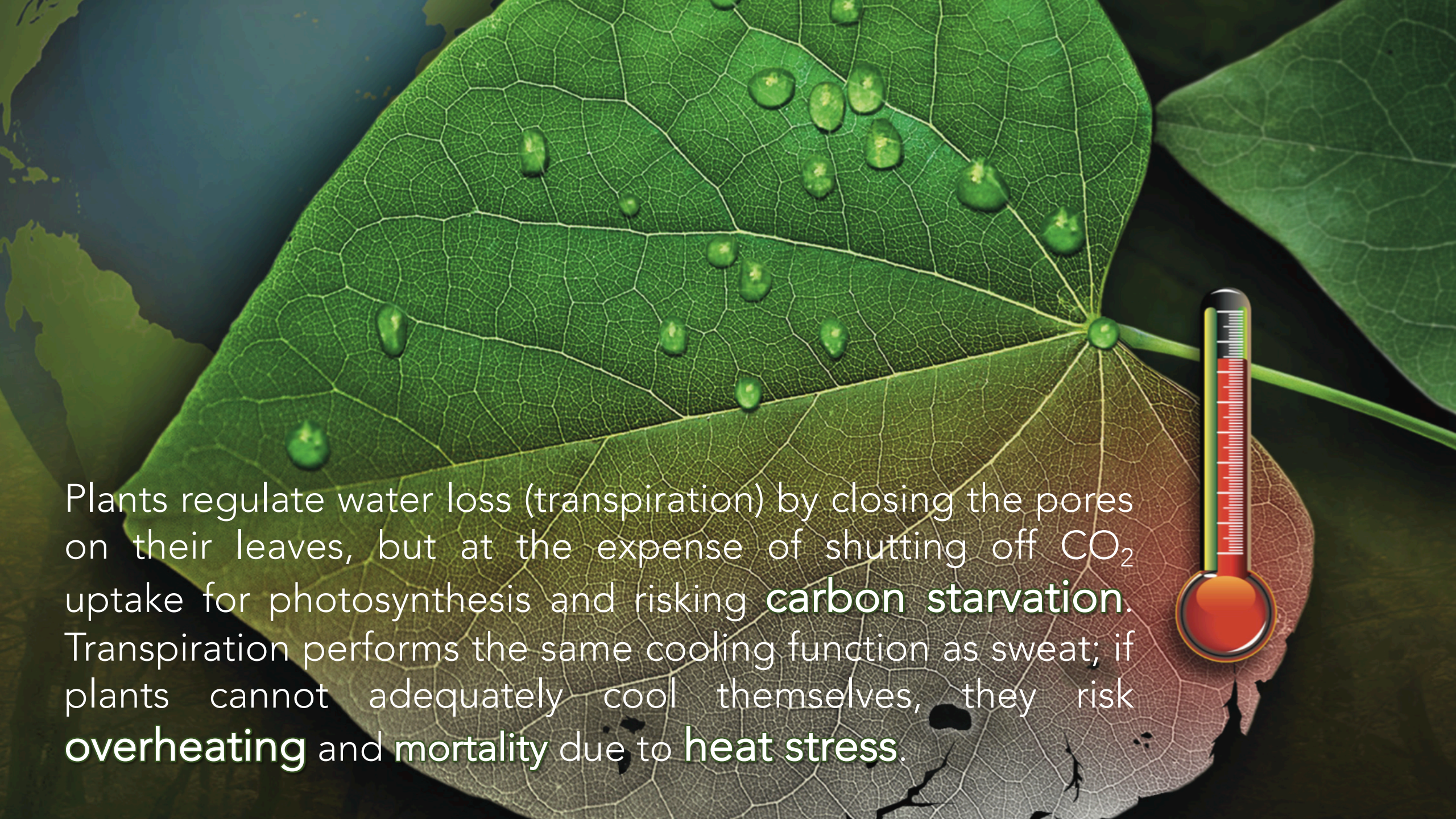


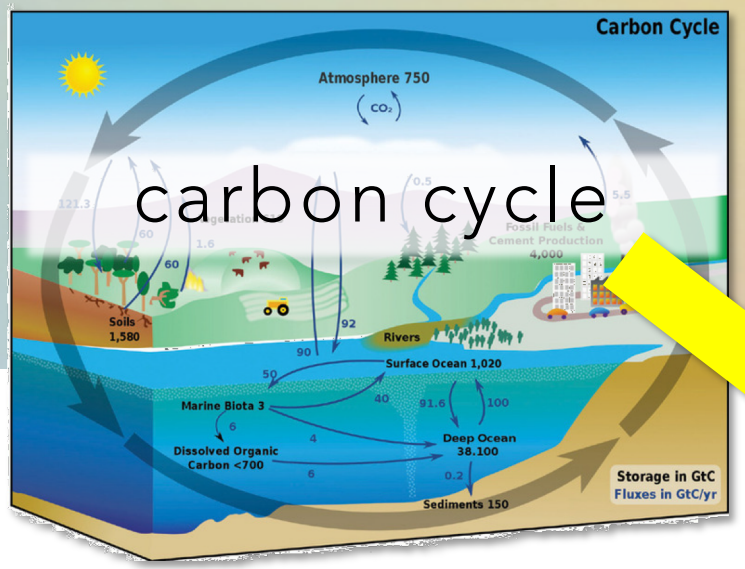
The response of the terrestrial biosphere to changing climate is one of the largest uncertainties in future climate projections.

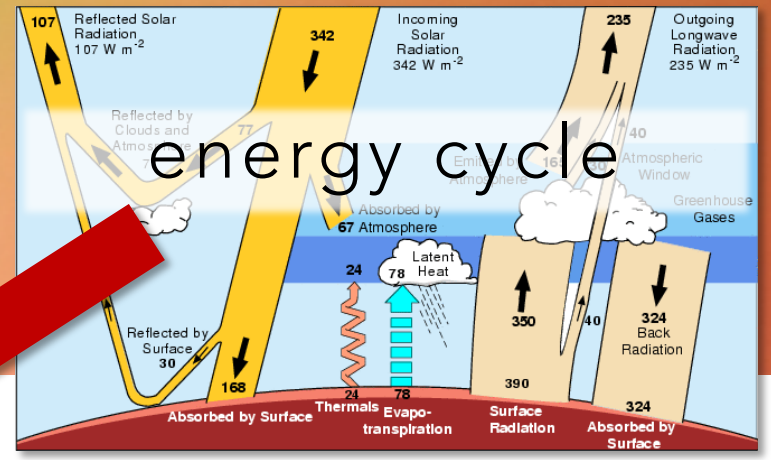
Current US drought prediction capabilities failed to predict the intensity and magnitude of the 2012 US Midwest drought

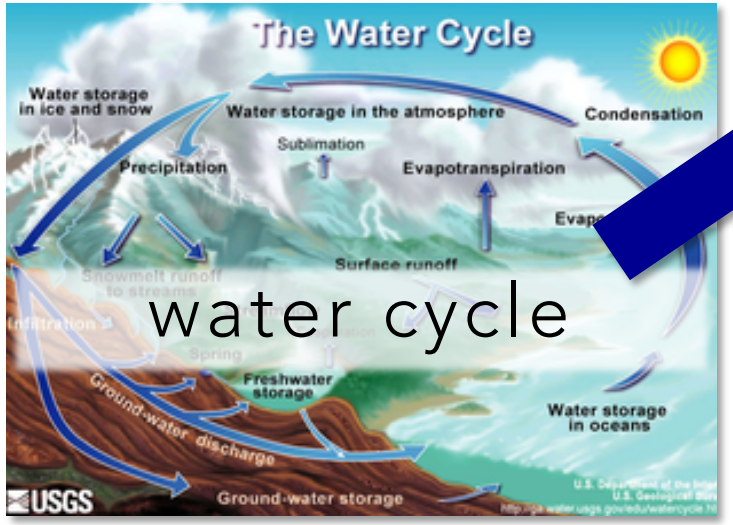





Plants regulate water loss (transpiration) by closing the pores on their leaves, but at the expense of shutting off CO_2 uptake for photosynthesis and risking **carbon starvation**. Transpiration performs the same cooling function as sweat; if plants cannot adequately cool themselves, they risk **overheating** and **mortality** due to **heat stress**.







ET describes the net exchange of water vapor between the land surface and the atmosphere, and is comprised of water evaporated directly from the soil or other surfaces and water transpired (i.e., used; consumptive use) by plants.

what is evapotranspiration (ET)?

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what is evapotranspiration (ET)?

HOW DO DIFFERENT PLANTS RESPOND TO CHANGES IN WATER AVAILABILITY?

WHICH PLANTS DIE FIRST?

How plants respond to changes in water availability can be expressed in terms of Water Use Efficiency (WUE), defined as the amount of carbon fixed per unit water used (gross primary production, GPP, divided by ET). Some plants have high WUE and can fix a large amount of carbon using a small amount of water; other plants are less efficient. Low WUE plants risk replacement with increasing droughts.

ECOSTRESS KEY SCIENCE QUESTIONS

1. How is the terrestrial biosphere responding to changes in water availability?

2. How do changes in diurnal vegetation water stress impact the global carbon cycle?

3. Can agricultural vulnerability be reduced through advanced monitoring of agricultural consumptive use and improved drought detection?

ECOSTRESS SCIENCE OBJECTIVES

1. IDENTIFY **CRITICAL THRESHOLDS** OF WATER USE AND WATER STRESS IN KEY CLIMATE SENSITIVE BIOMES (E.G., TROPICAL/DRY TRANSITION FORESTS, BOREAL FORESTS);

2. DETECT THE TIMING, LOCATION, AND PREDICTIVE FACTORS LEADING TO PLANT WATER UPTAKE DECLINE AND/OR CESSATION OVER THE **DIURNAL CYCLE**;

3. MEASURE AGRICULTURAL WATER **CONSUMPTIVE USE** GLOBALLY AT SPATIOTEMPORAL SCALES APPLICABLE TO IMPROVING DROUGHT ESTIMATION ACCURACY.

ECOSTRESS CORE SCIENCE HYPOTHESES

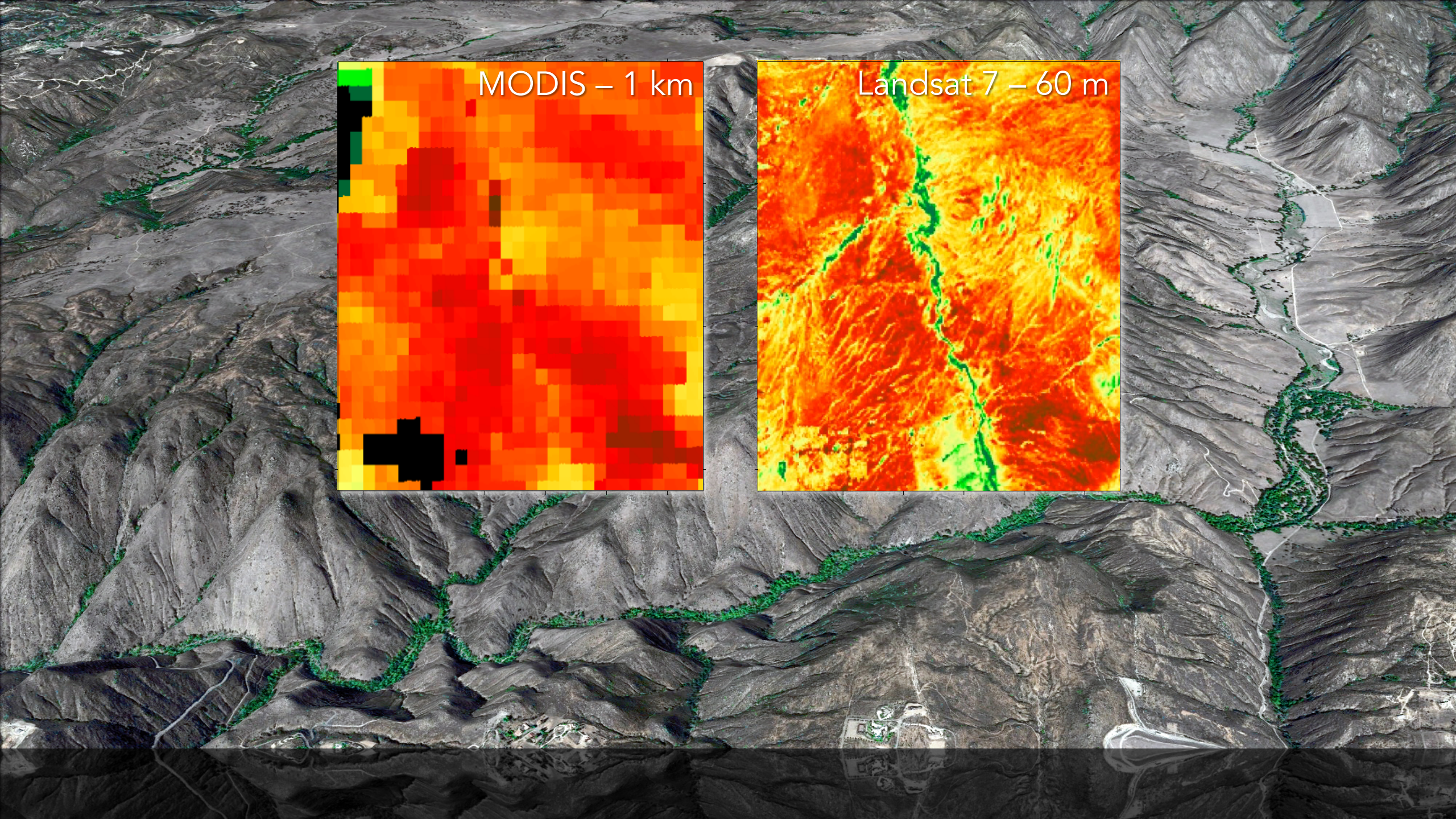
H_1: The WUE of a climate sensitive hotspot is significantly lower than non-hotspots of the same biome type;

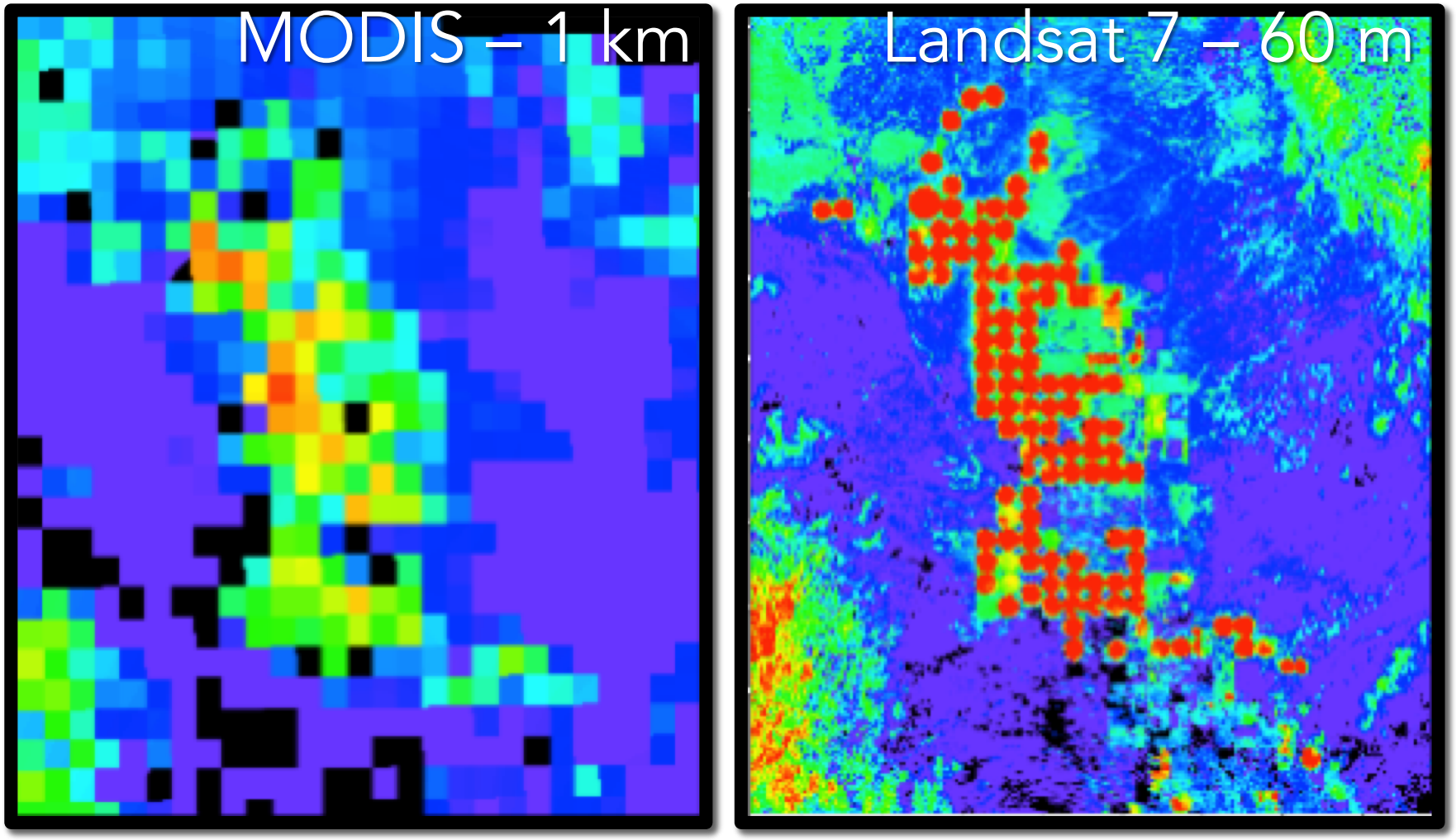
H_2: Daily ET is overestimated when extrapolating from morning-only observations;

H_3: Remotely sensed ET measured at the field scale will improve drought prediction over managed ecosystems.

A P P R O A C H

What we need: accurate, high spatial, high temporal, diurnal cycle, global, ET.


MODIS – 1 km
Landsat 7 – 60 m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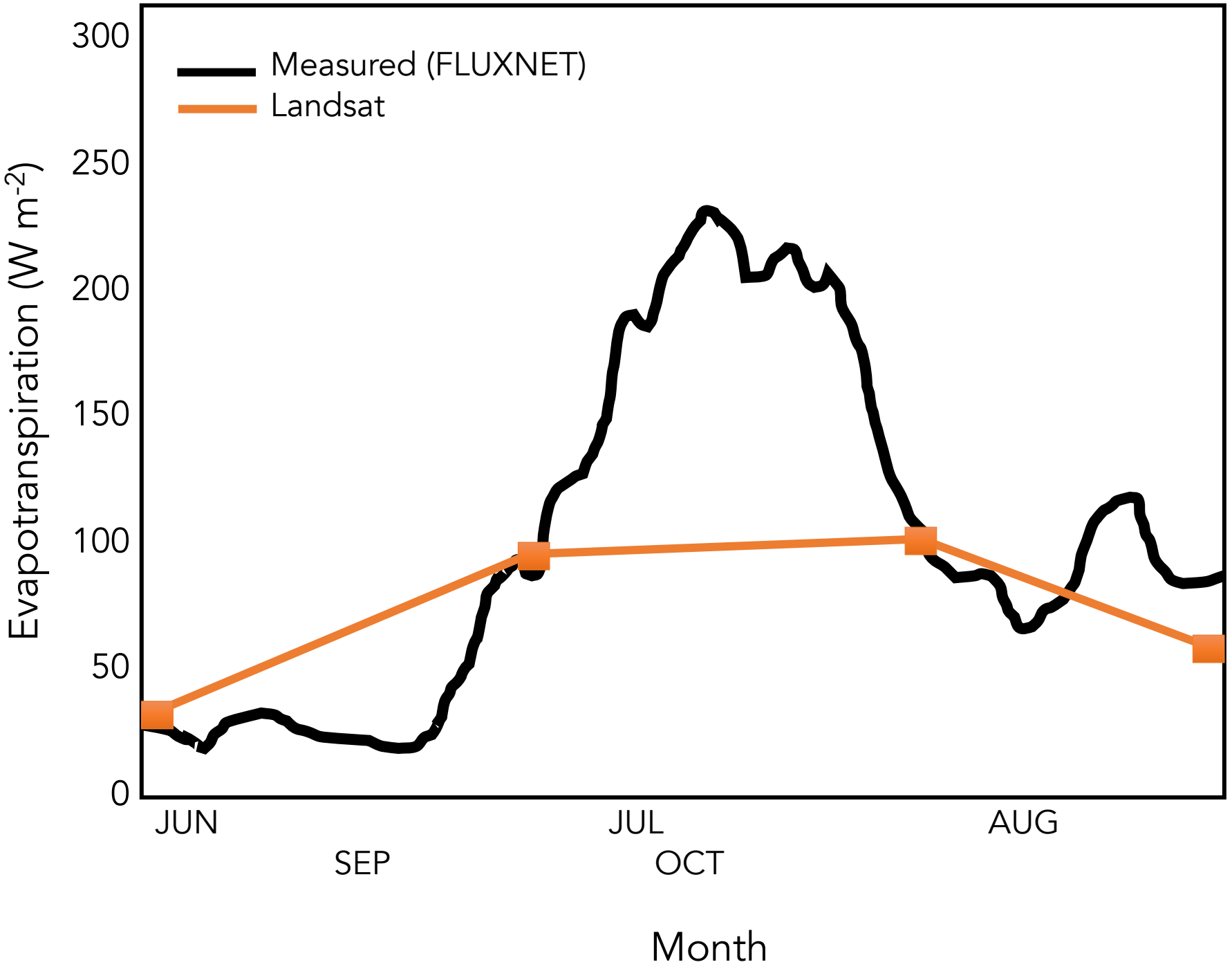
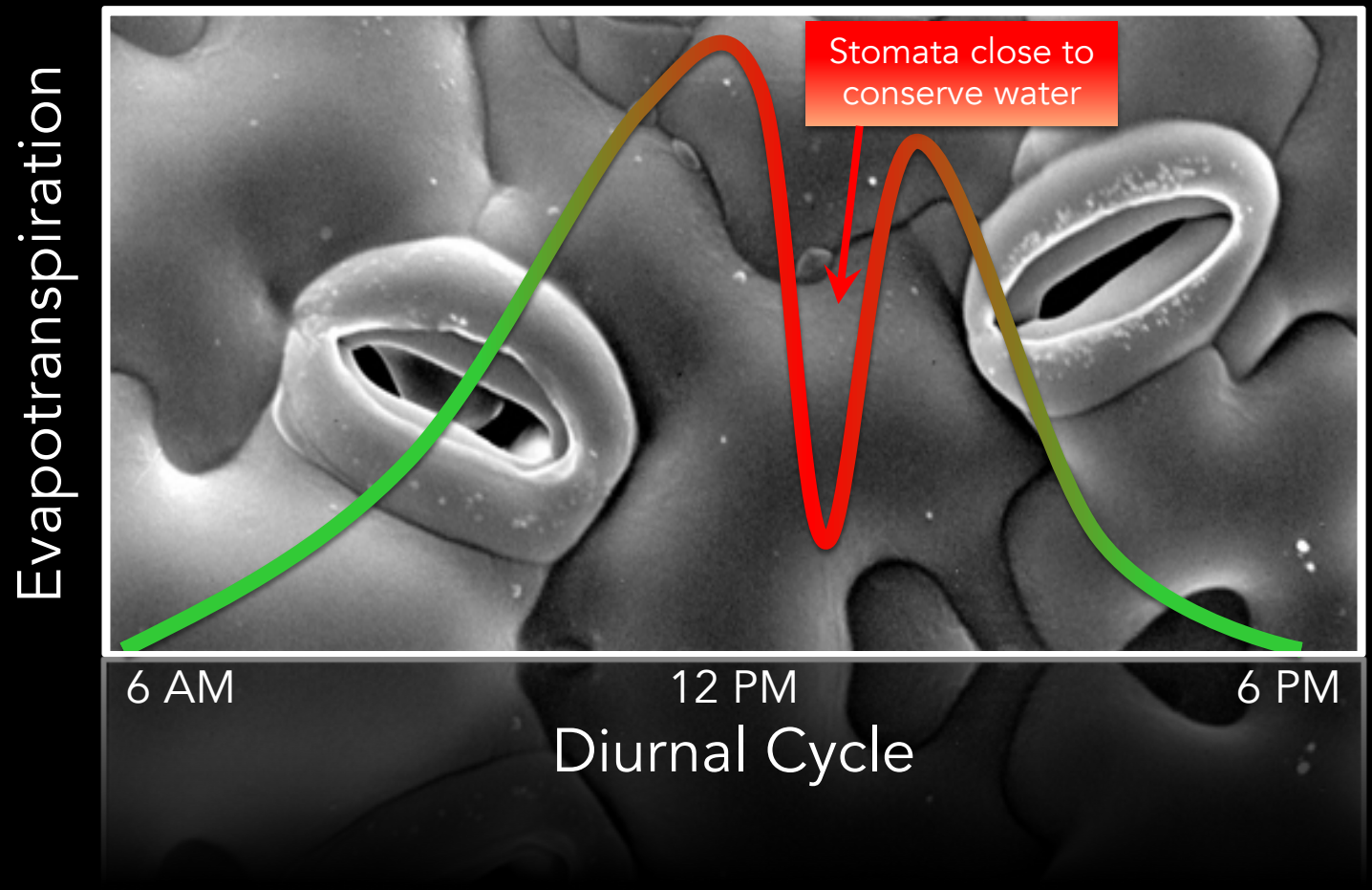
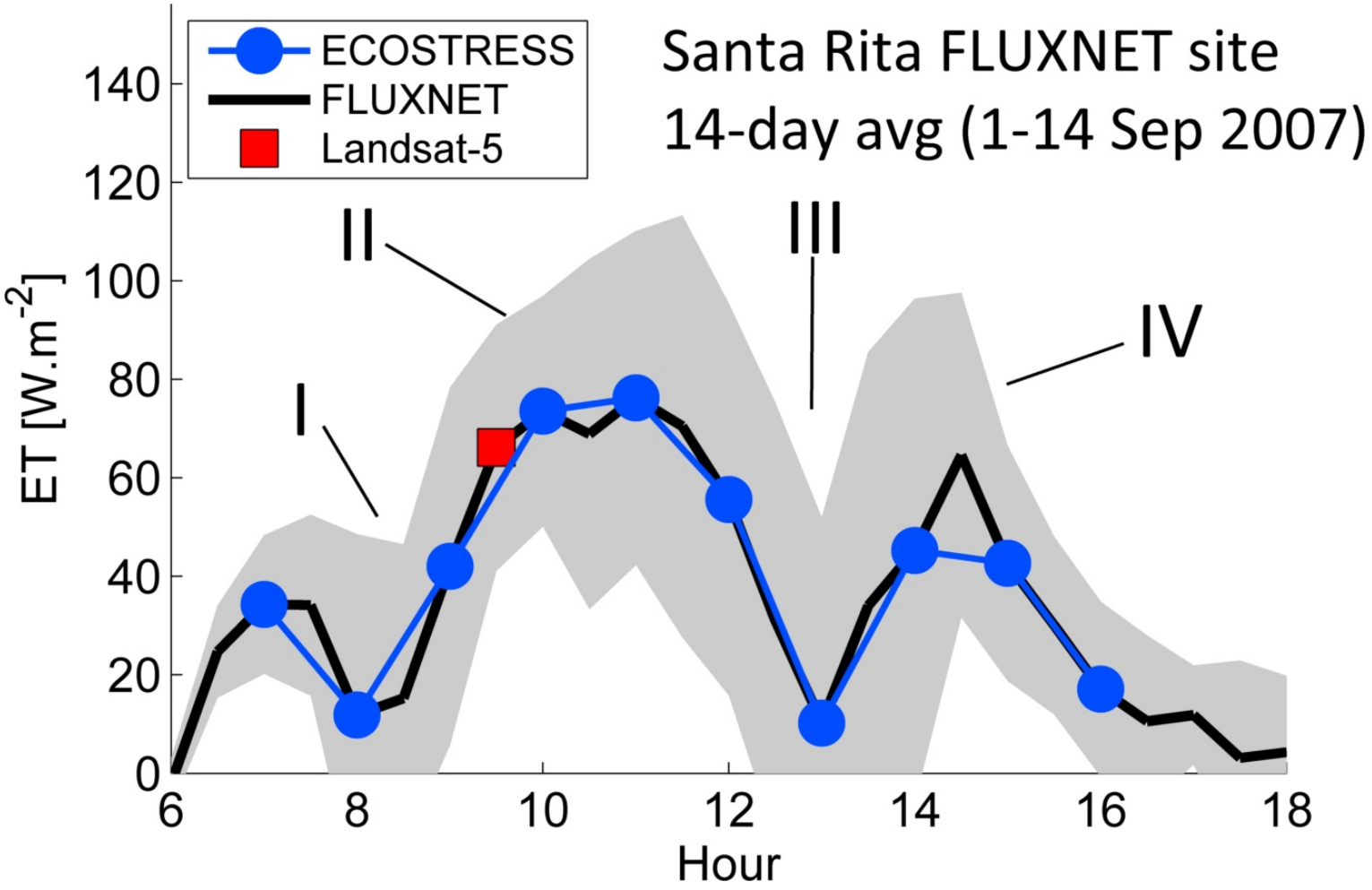

Measured (FLUXNET)
Landsat
Evapotranspiration (W m-2)
300
250
200
150
100
50
0
JUN
JUL
AUG
SEP
OCT
Month

Water Stress Drives Plant Behavior





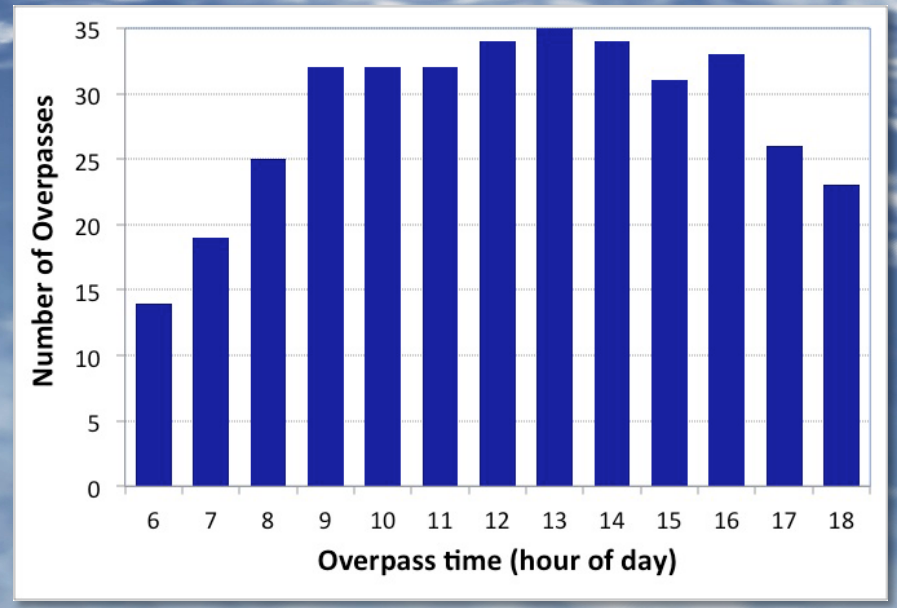
Gray shading represents mean **diurnal variation** in ET over 14-days. The afternoon decline in ET is related to water stress (clear day).

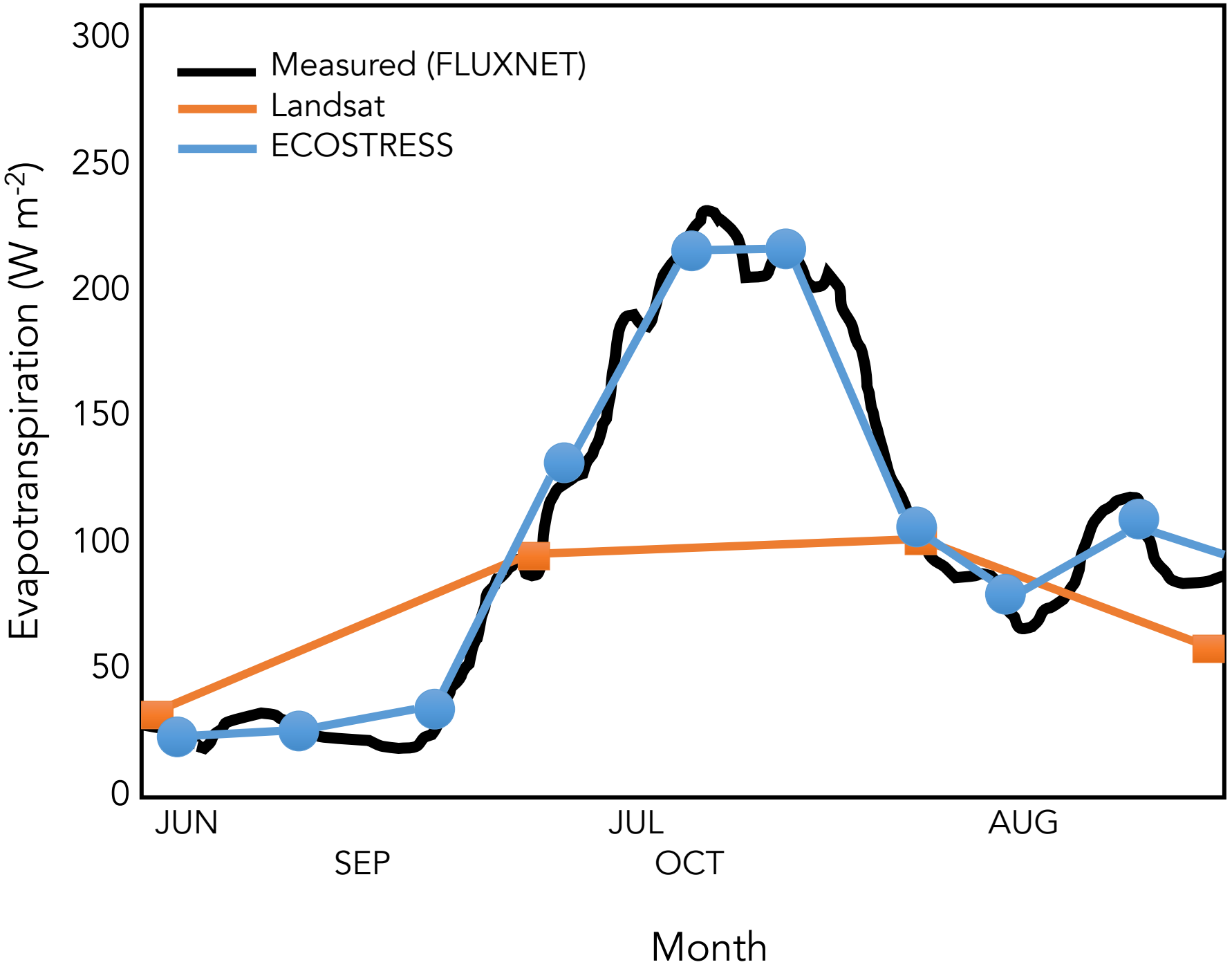
I	Xylem refilling after initial water release.
II	ET at maximum/potential rate in the morning.
III	Stomata shut down water flux in the afternoon.
IV	ET resumes at maximum/potential in early evening when demand is reduced.

GOES-R

AMERICA'S
NEXT GENERATION
WEATHER SATELLITE

The International Space Station (ISS)

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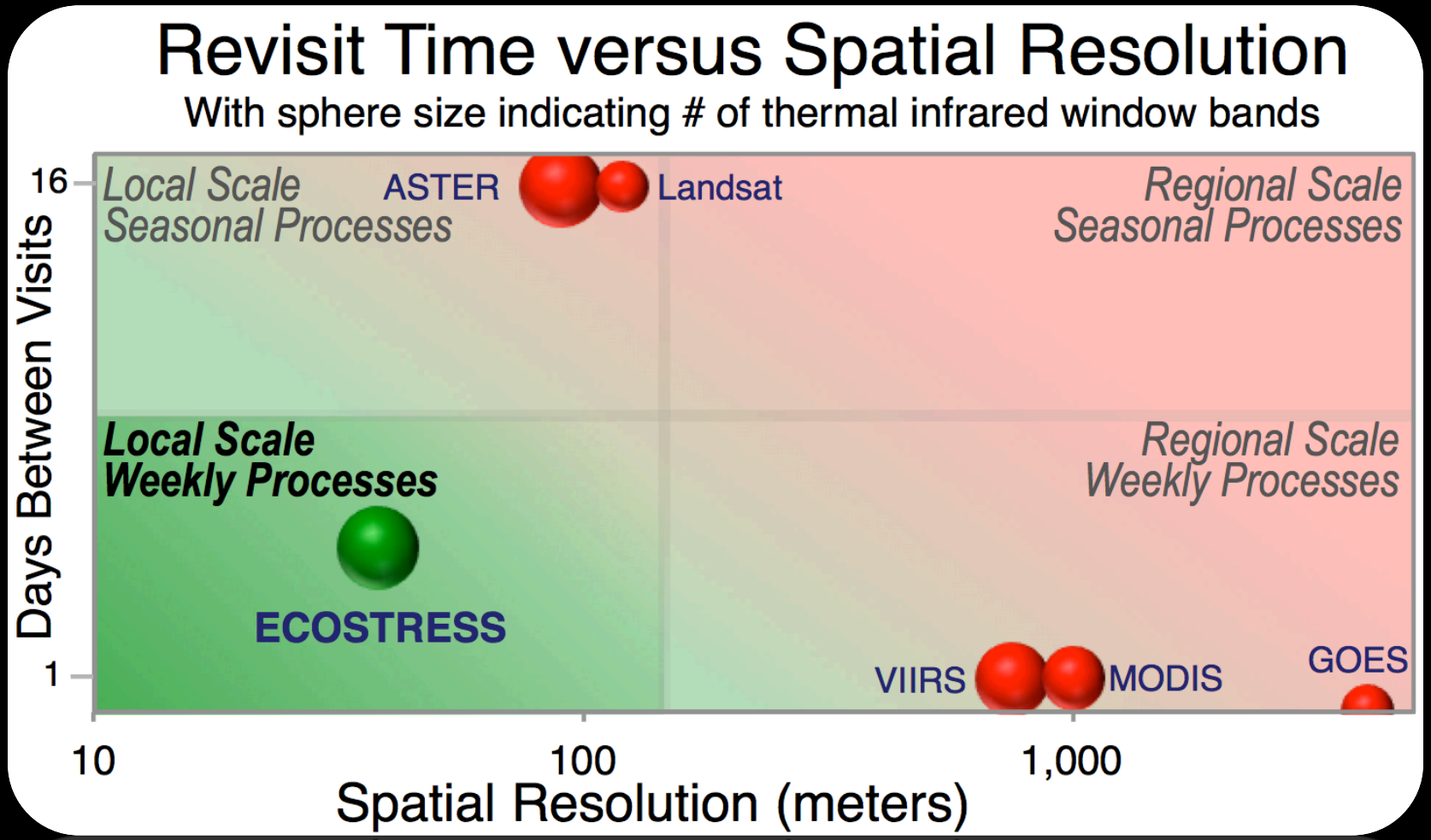
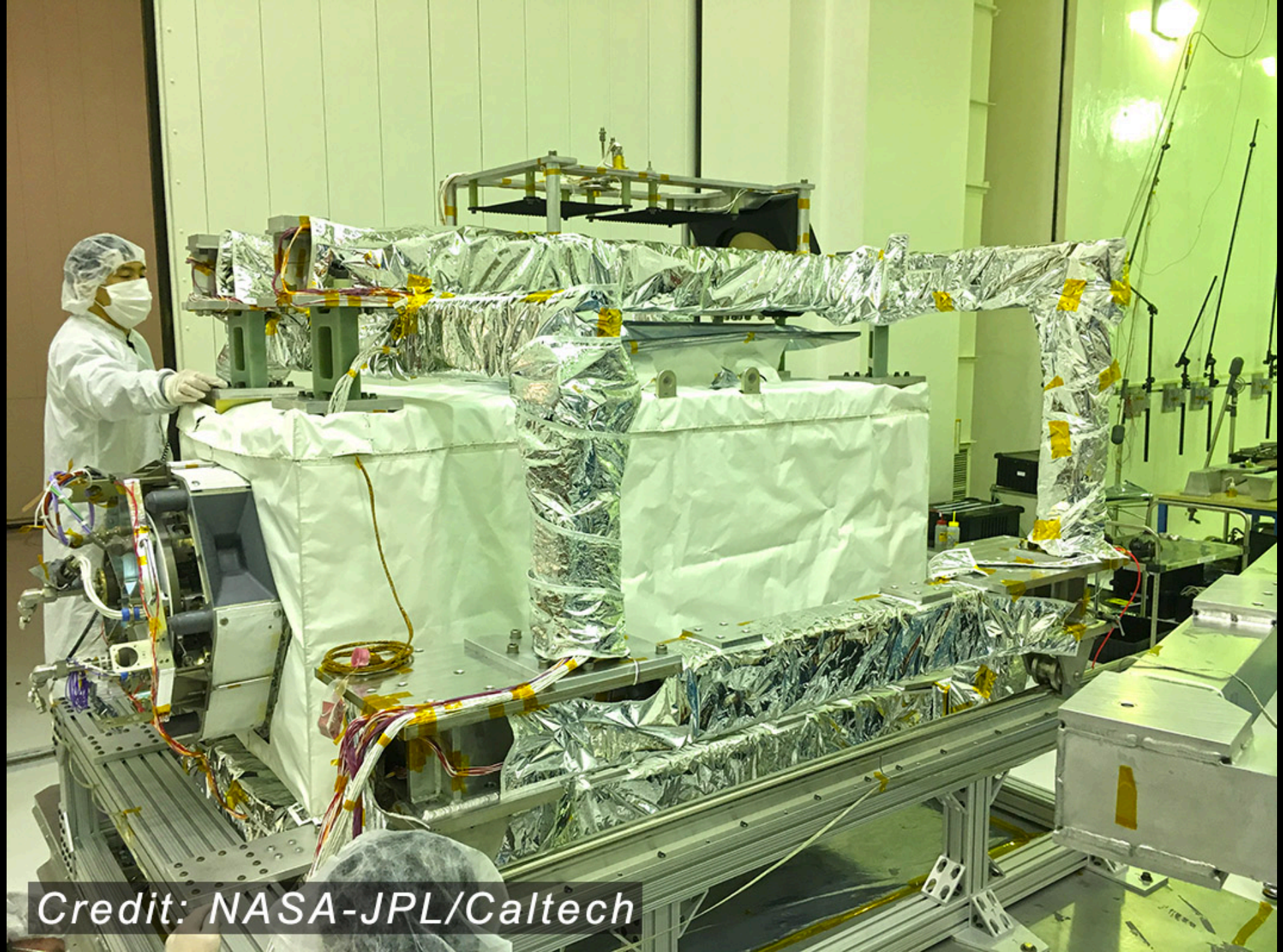
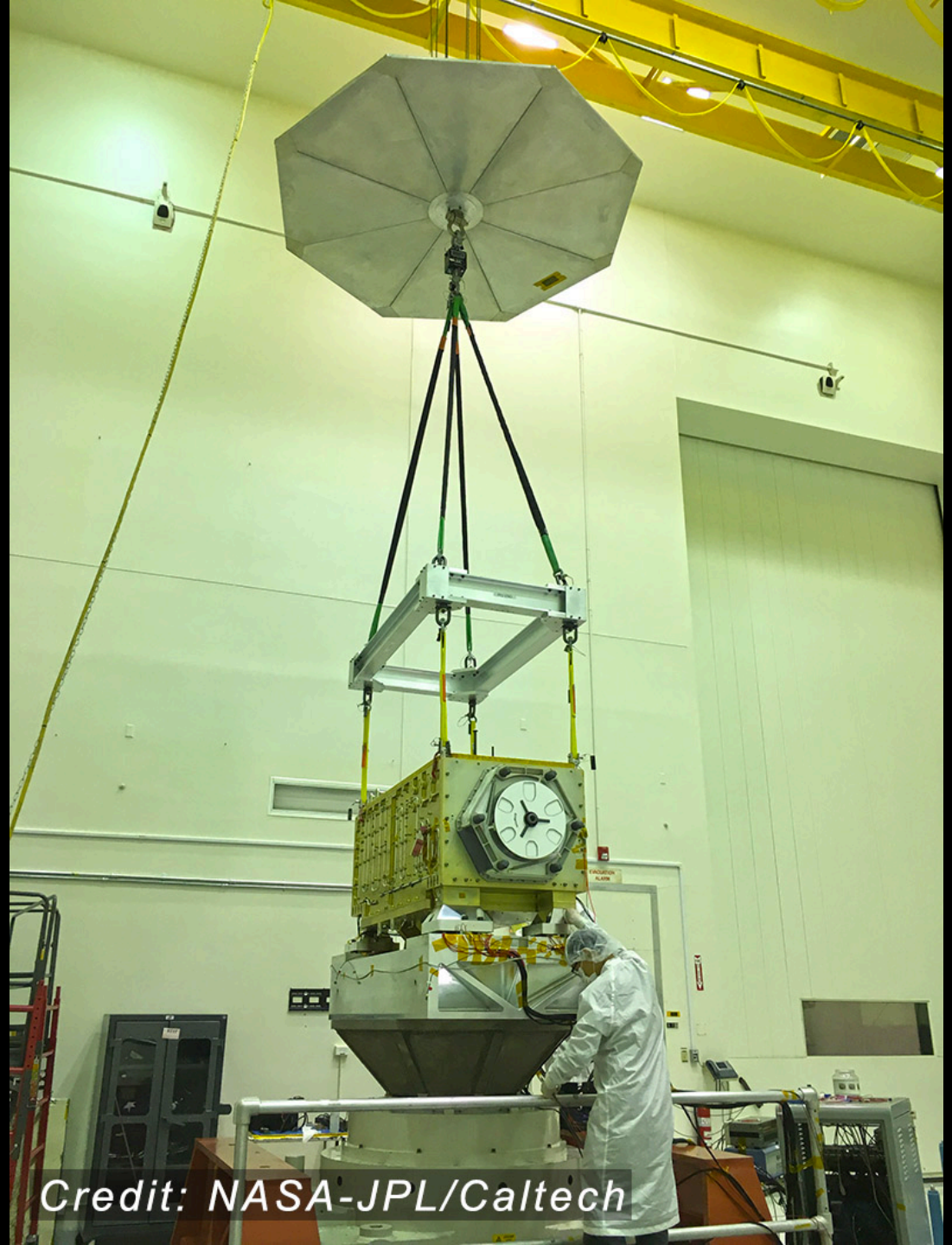

Revisit Time versus Spatial Resolution
With sphere size indicating # of thermal infrared window bands
Days Between Visits
16
1
Local Scale
Seasonal Processes
ASTER
Landsat
Regional Scale
Seasonal Processes
Local Scale
Weekly Processes
ECOSTRESS
Regional Scale
Weekly Processes
VIIRS
MODIS
GOES
10
100
1,000
Spatial Resolution (meters)


Credit: NASA-JPL/Caltech


Credit: NASA-JPL/Caltech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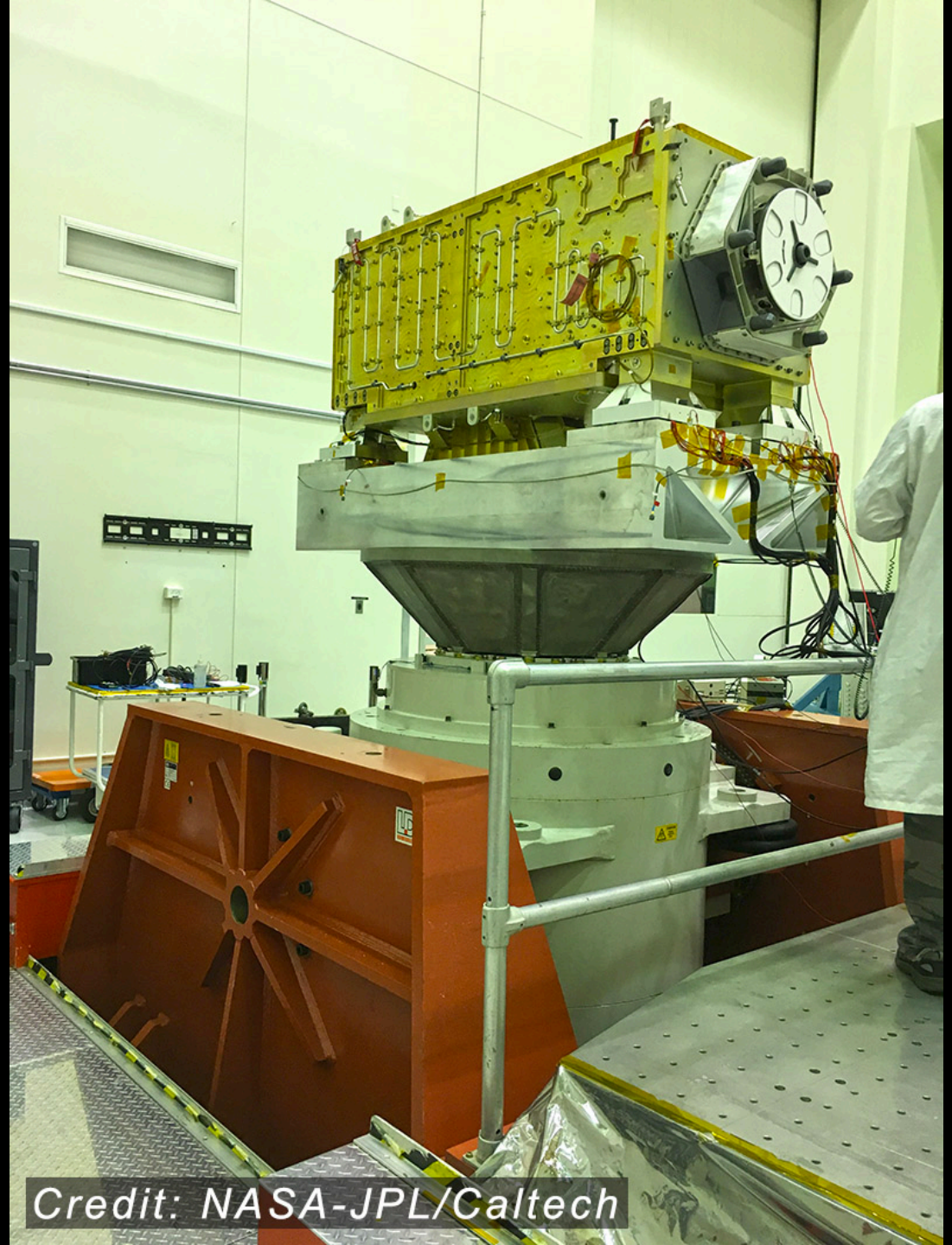
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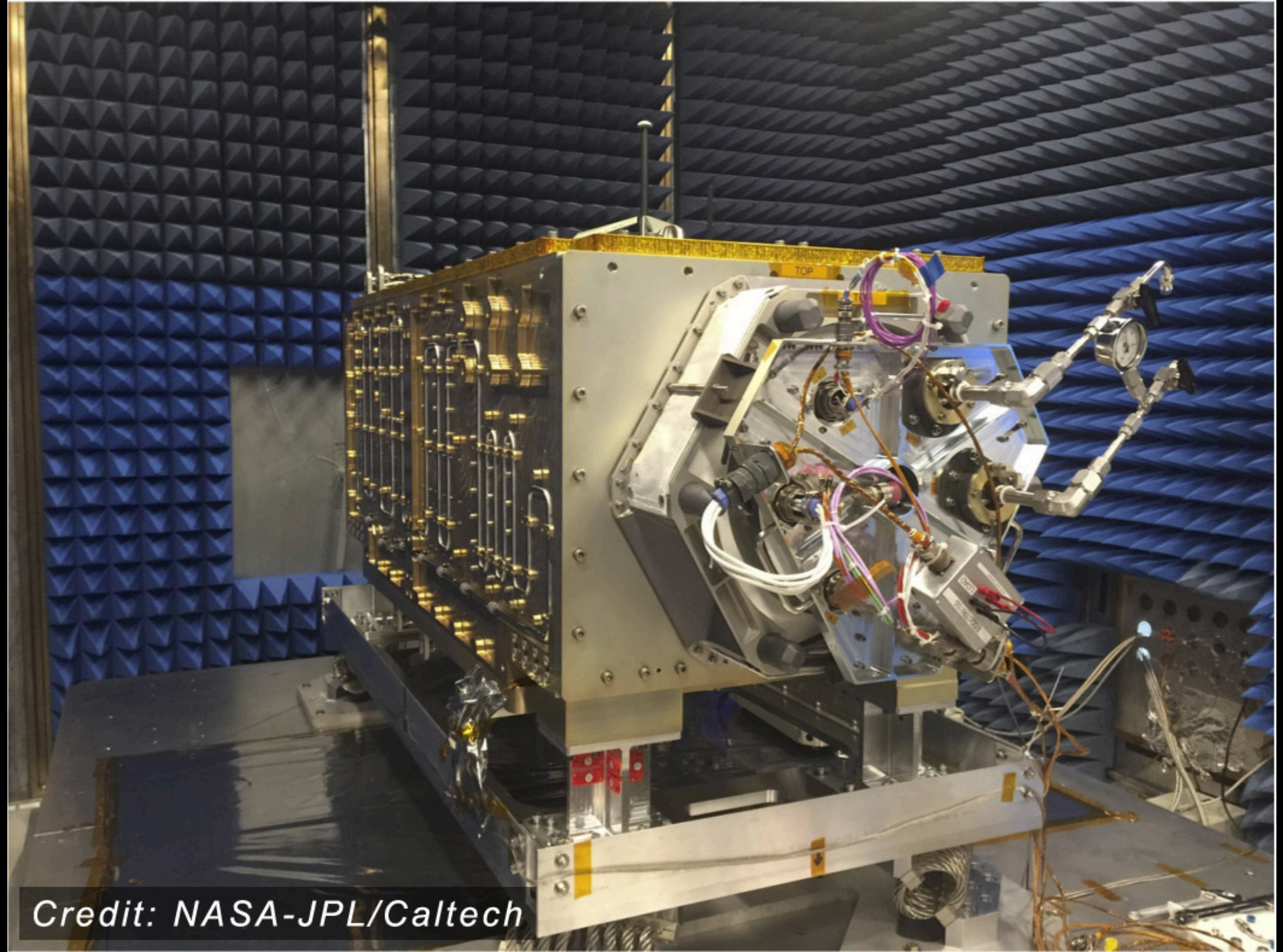

Credit: NASA-JPL/Caltech

NASA astronaut Drew Feustel seemingly hangs off the International Space Station while conducting a spacewalk with fellow NASA astronaut Ricky Arnold on March 29, 2018. ***Credits: NASA***

Jim Bridenstine @JimBridenstine · Aug 27

The #ECOSTRESS team is doing critical work to better understand how plants react to heat and water stress by measuring the temperature of Earth's vegetation. Great job!

NASA Earth and NASA JPL

29 JUN 2018: 5.30am


CRS-15 Mission
T- 00:00:10
UPCOMING
LIFTOFF
STARTUP
THE FALCON 9 FLIGHT COMPUTERS HAVE TAKEN CONTROL OF THE COUNTDOWN
LAUNCH: CRS-15
STARTUP
MAX-Q
SECOND ENGINE STARTUP
DRAGON DEPLOY
SPACEX


TESLARATI
@_tom.cross_

2 JUL 2018

Earth Orbiting Mission Operations Control (EOMOC)