

Multi-scale monitoring of plant phenology - from environmental triggers to satellite signals



Dawn M. Browning

Physical Research Scientist
USDA-ARS Range Management Research Unit,
Jornada Experimental Range



Big picture: Phenology research on Jornada Experimental Range and Jornada Basin LTER

MECHANISM – environmental triggers and phenophase transitions – **Field perspective using NPN protocols and legacy LTER data**

SCALING – data collected using different platforms (pheno-cams, UAV, Landsat, MODIS) – **Remote sensing**

DATA INTEGRATION – cross-walk between historic LTER and contemporary datasets - **Integration**

PHENO-MET study has two goals:

1) Integrate field phenology with meteorological and soil moisture observations

What environmental cues are associated with phenological events (e.g., leaf out, first flower, fruit..)?

Can we predict plant responses to climate change (amount, distribution of rainfall, higher temps)?

2) Devise quantitative links between field and satellite perspectives for plant phenology

Are phenophases (i.e., dormancy, leaf emergence, flowering, etc.) for a given species spectrally distinct?

How do field observations of phenology translate to remotely sensed aerial depictions of land surface phenology?

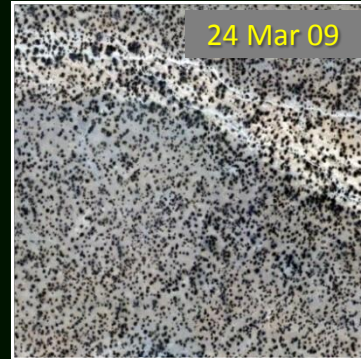
Approaches to measuring/monitoring

Field observations

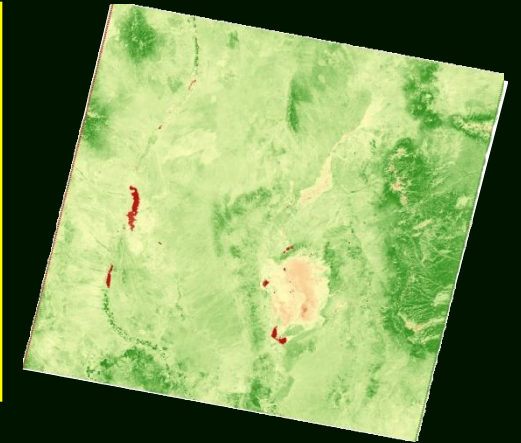


155 m

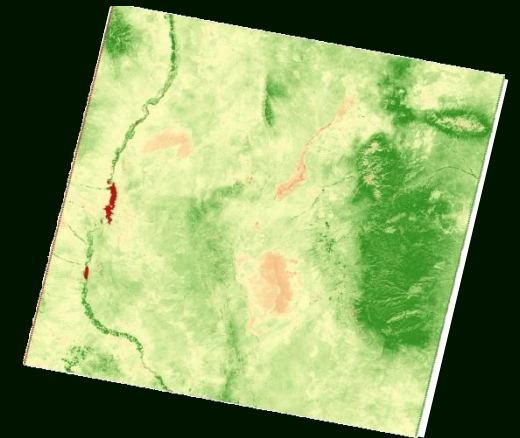
UAV imagery



Satellite imagery



200 km



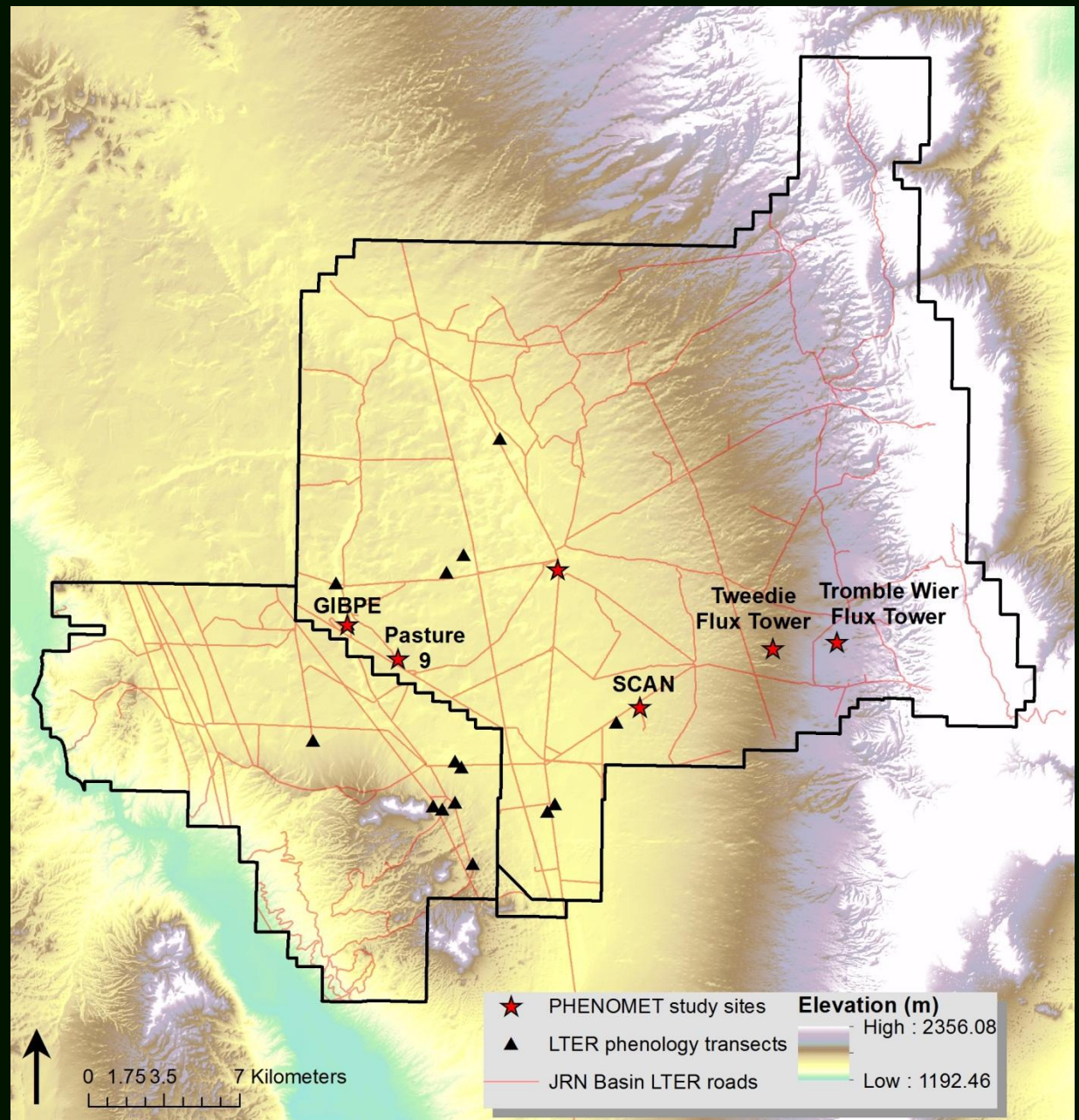
Pheno-cam observations



1MINUTE GRAV -1 AUG.24,12 01:11PM

PHENO-MET

- 5 sites (★)
- 14 species
- 137 individuals
- As of 10 Oct 12, 130 observations
- Existing infrastructure (temp., rainfall, relative humidity, soil moisture...)



PHENO-MET: Field observations

Set of **149 weekly observations** on **130 individuals**

Spp by growth form:

1 Succulent

4 Decid. Shrubs

1 Broadleaf evergreen

7 Per. Grasses



Species code	Common name	Pheno. Group	Site 1 (SCAN)	Site 2 (Tweedie)	Site 3 (CRN)	Site 4 (GIBPE)	Site 5 (Tromble)
YUEL	Yucca	Succulent				4	
ATCA	4-wing salt bush	Deciduous Shrub			5		
FLCE	Tarbush	Deciduous Shrub	4	5			4
PAIN	Mariola	Deciduous Shrub					4
PRGL	Mesquite	Deciduous Shrub	4	5	5	5	4
GUSA	Snakeweed	Deciduous Shrub			1	3	3
LATR	Creosote	Broadleaf Evergreen	4	5		1	4
MUPO	Bush muhly	Grass		5			4
ARPU	Purple 3 awn	Grass	4		5	5	
DAPU	Fluff grass	Grass					
SPOR spp.	Dropseed spp.	Grass	4 (SPCO SPFL)		4 (SPFL)	5 (SPFL)	
PLMU	Tobosa grass	Grass	4				
BOER	Black grama	Grass				5	
Total			24	20	21	28	23

PHENO-MET

Hydro-meteorological infrastructure



NRCS Soil Climate Analysis
Network Site



For the sake of soil
moisture...

Mechanism

- (1) Devise monitoring protocol for plants representing the veg. community that coincide with hydro-meteorological measurements
- (2) Explore relationships between plant phenophases and environmental variables (temp., soil moisture)

Scaling

- (1) Characterize spectral profiles of phenophases
- (2) Integrate fine-scale imagery (UAV) with satellite time series
- (3) Daily greenness from Pheno-cam photos

Data integration

- (1) Compare patterns in phenology between monthly LTER and weekly PHENOMET observations to determine what (if anything) we miss with monthly time-steps.
- (2) With mechanistic understanding of phenophase transitions (from PHENOMET) hind cast patterns to determine if they match historic data.

Overall patterns (across sites)

- At a given site, functional group differences in synchrony

Shrub spp (consistent) > Grass spp (variable)

Within a species, indiv. grasses more variable than shrubs

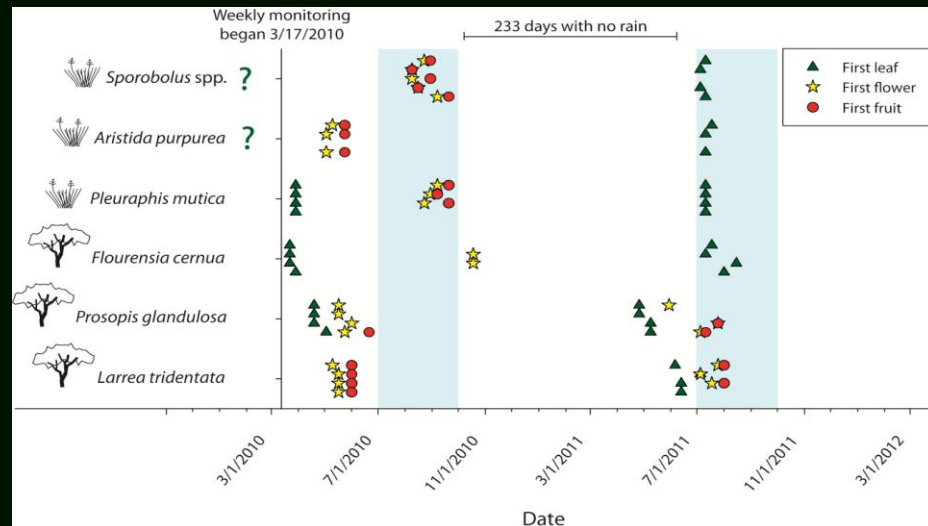
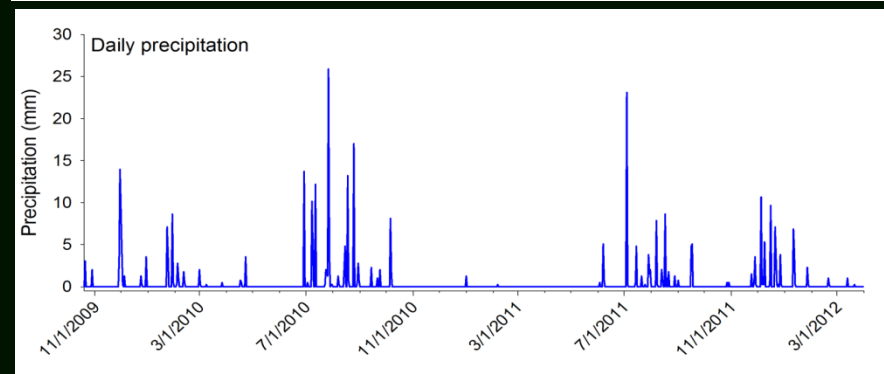
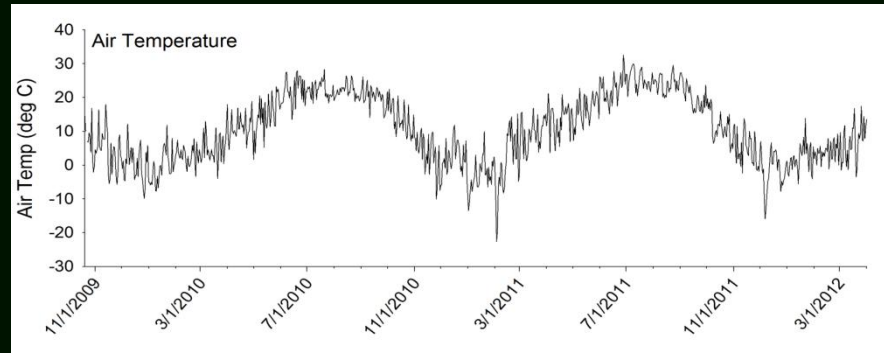
- Across sites, species demonstrate differences in timing

Mechanism (SCAN site)

Timing

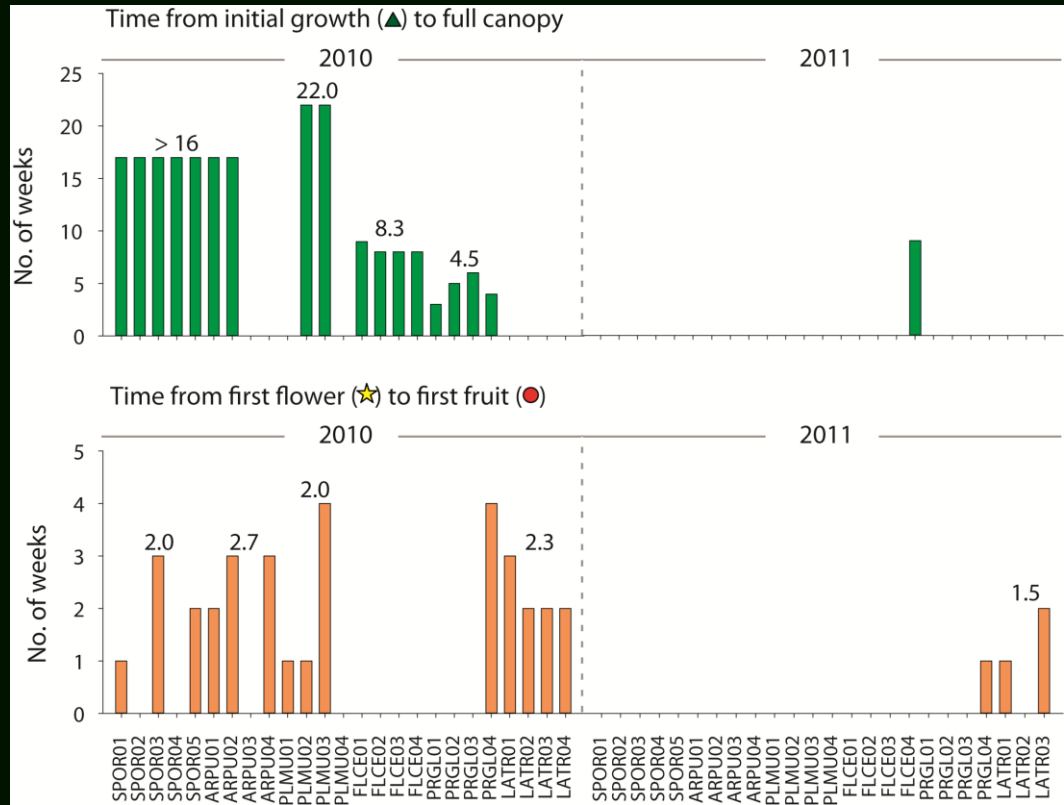
Extreme events

2011: 242 days without rain



Mechanism

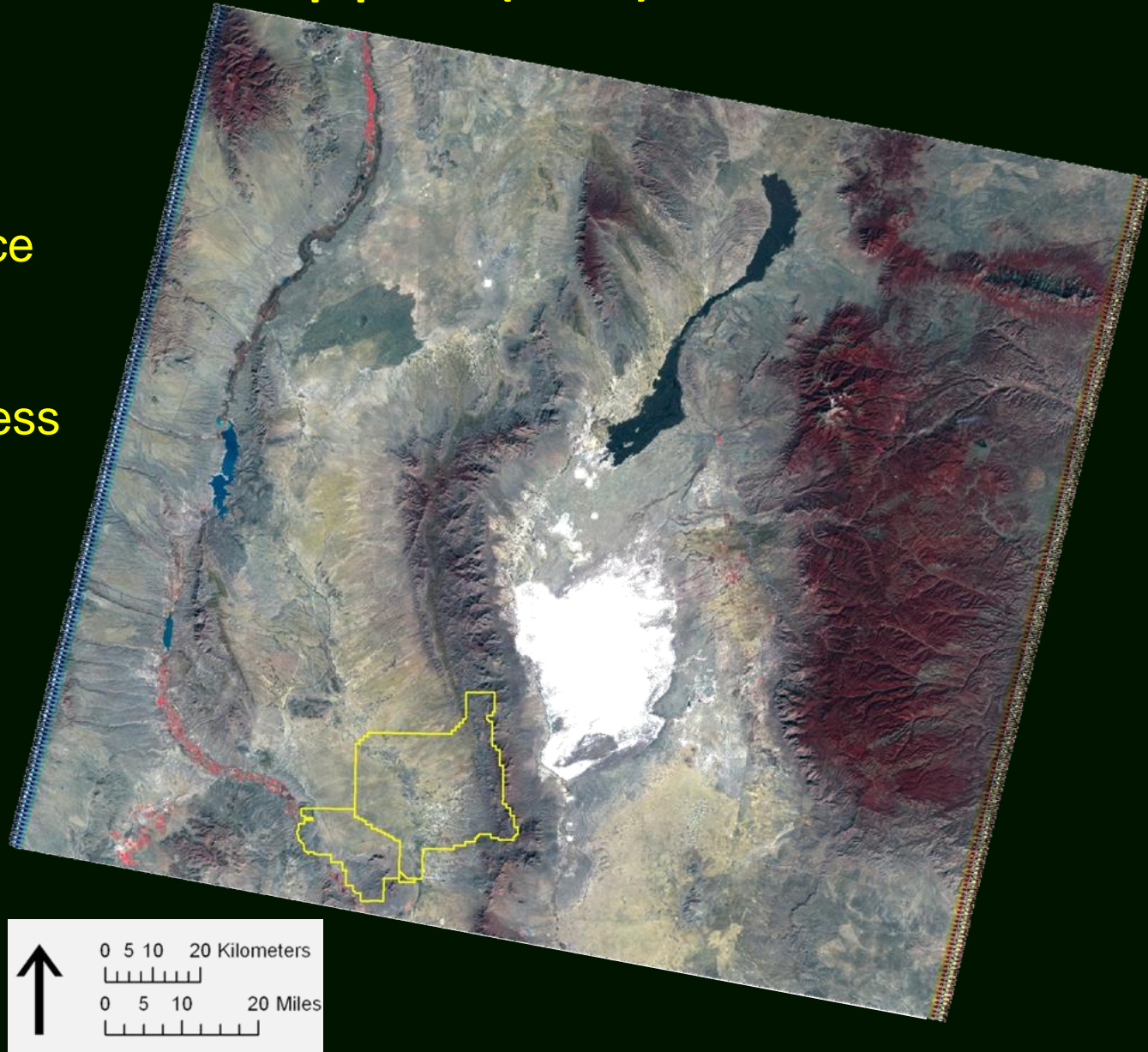
Duration



Landsat Thematic Mapper (TM)

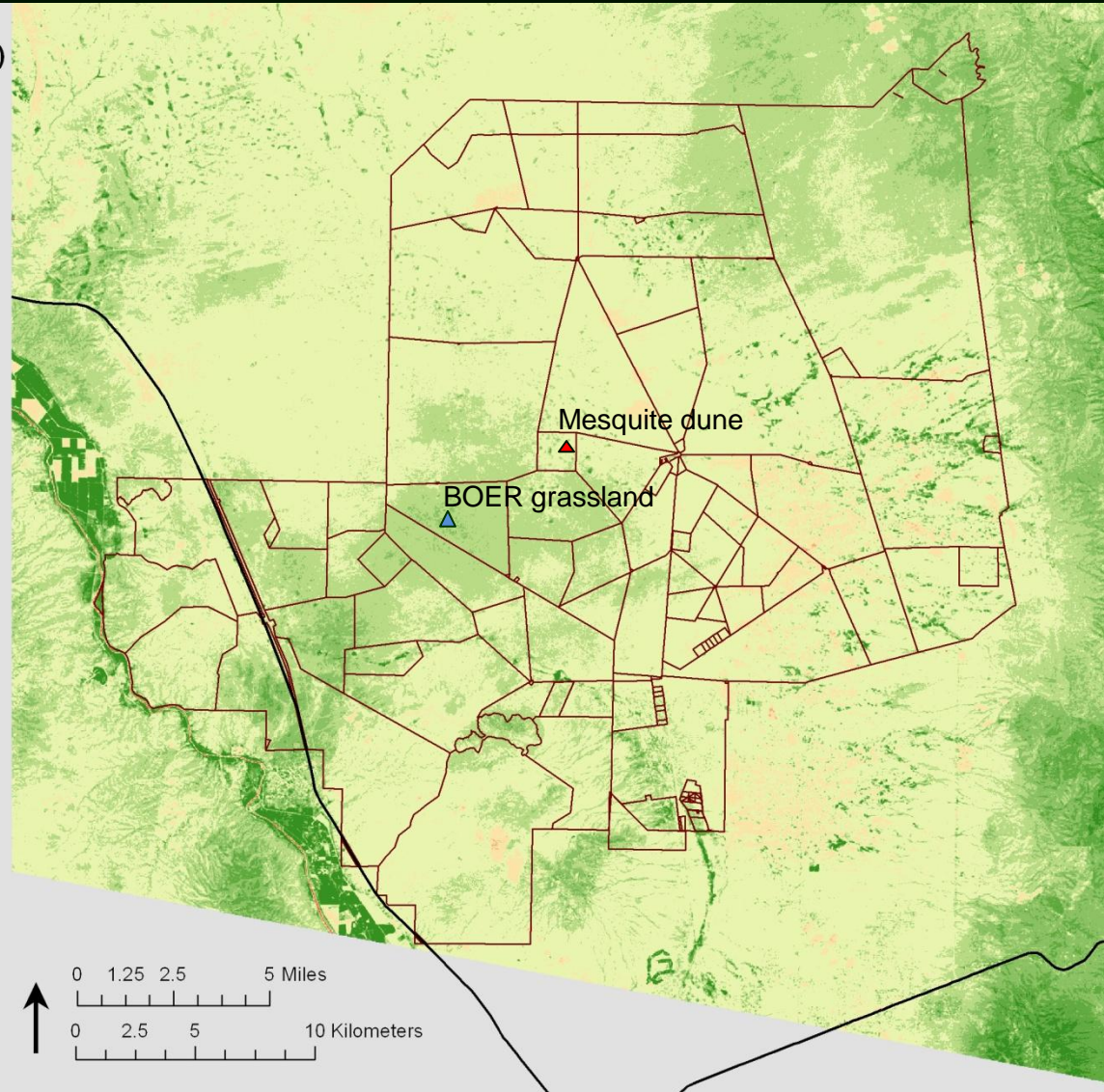
7 bands, 30 m
16-day repeat cycle

Normalized Difference
Vegetation Index
(NDVI)
~ vegetation greenness



18 Sep 2010

Normalized Difference
Vegetation Index (NDVI)
from Landsat 5 TM



Phenology profiles

Black grama grassland



Sep 09 mean biomass = 137 g/m²

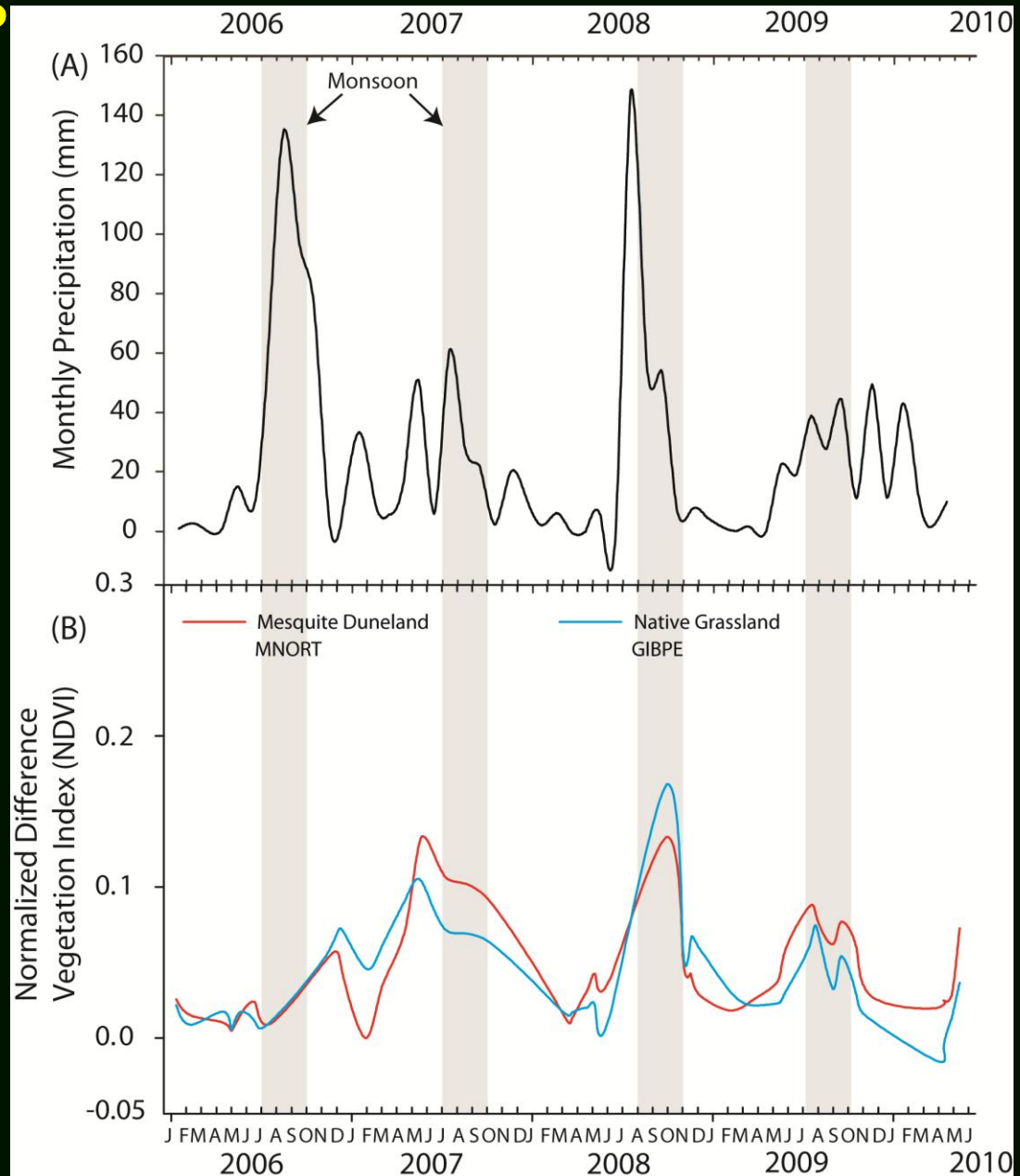
Mesquite duneland



Sep 09 mean biomass = 181 g/m²

Phenology profiles

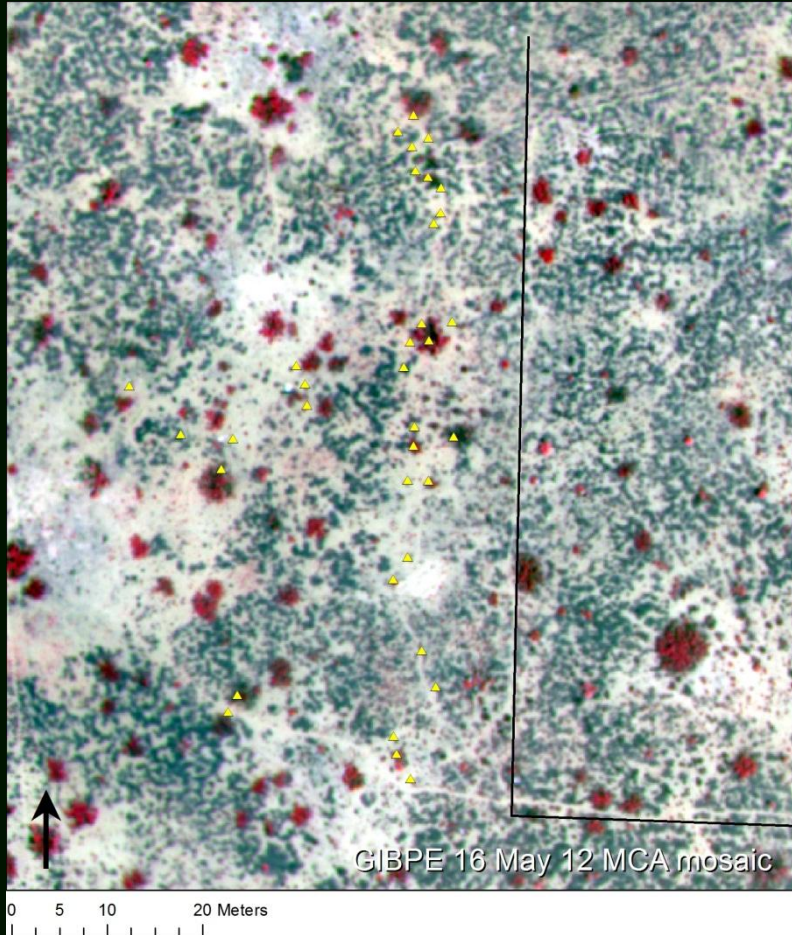
Repeat snapshots reveal differences in timing and rates of change.



UAV imagery

23 Mar 12

16 May 12



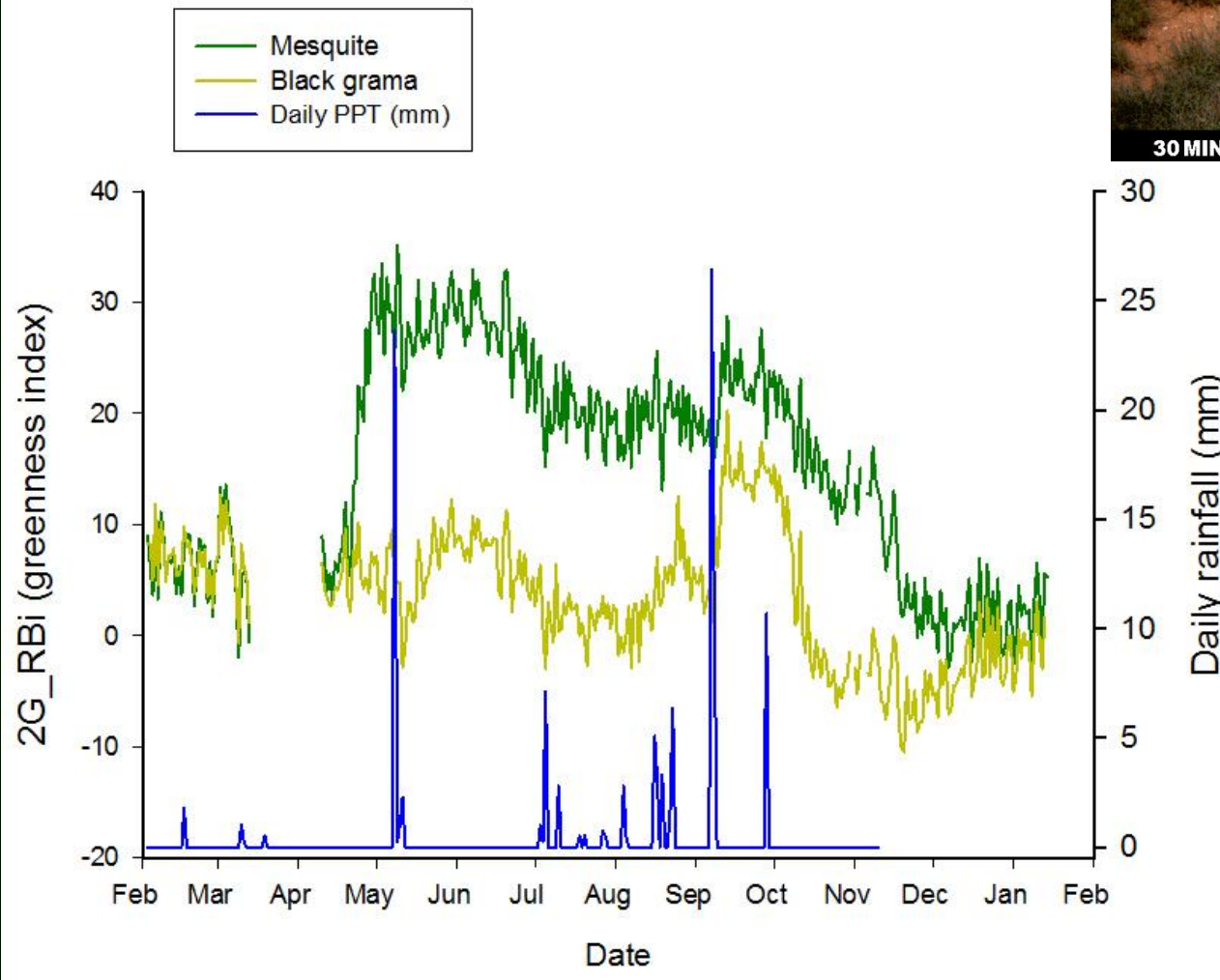
Pheno-cams



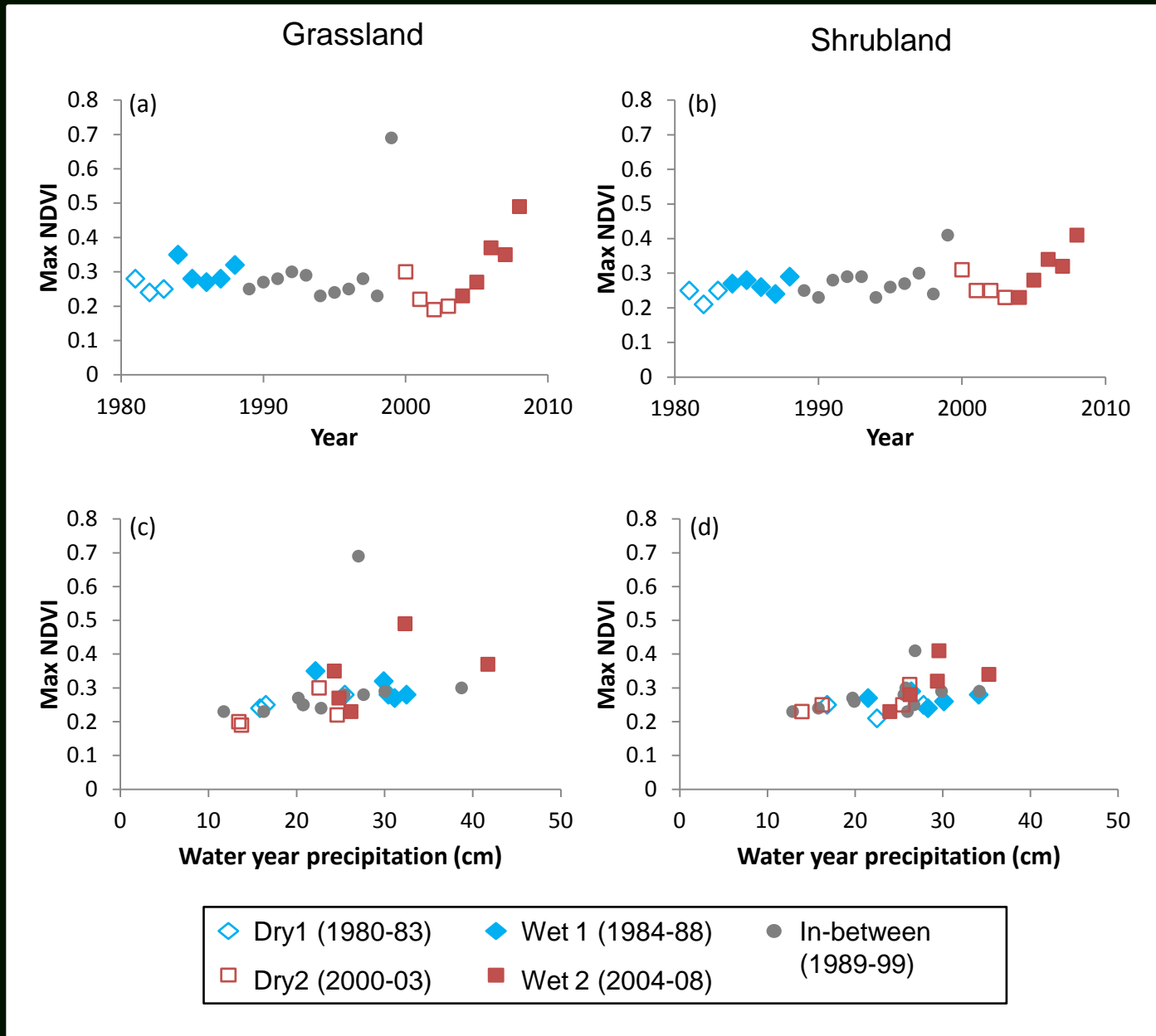
30 MINUTES IBPE -1

APR.10,12 01:00 PM

Pheno-cams



VIP data product integration



Data integration

- Monthly observations correspond to weekly obs.
- Flowering is missed.
- Emphasis on reproductive phenology (LTER) prohibits capturing senescence.

For discussion

- MANY disparate datasets...
- Collaborative opportunities...
- What is of greatest importance?



Questions?

