High Spatiotemporal ET Mapping Using Multi-Sensor Data Fusion

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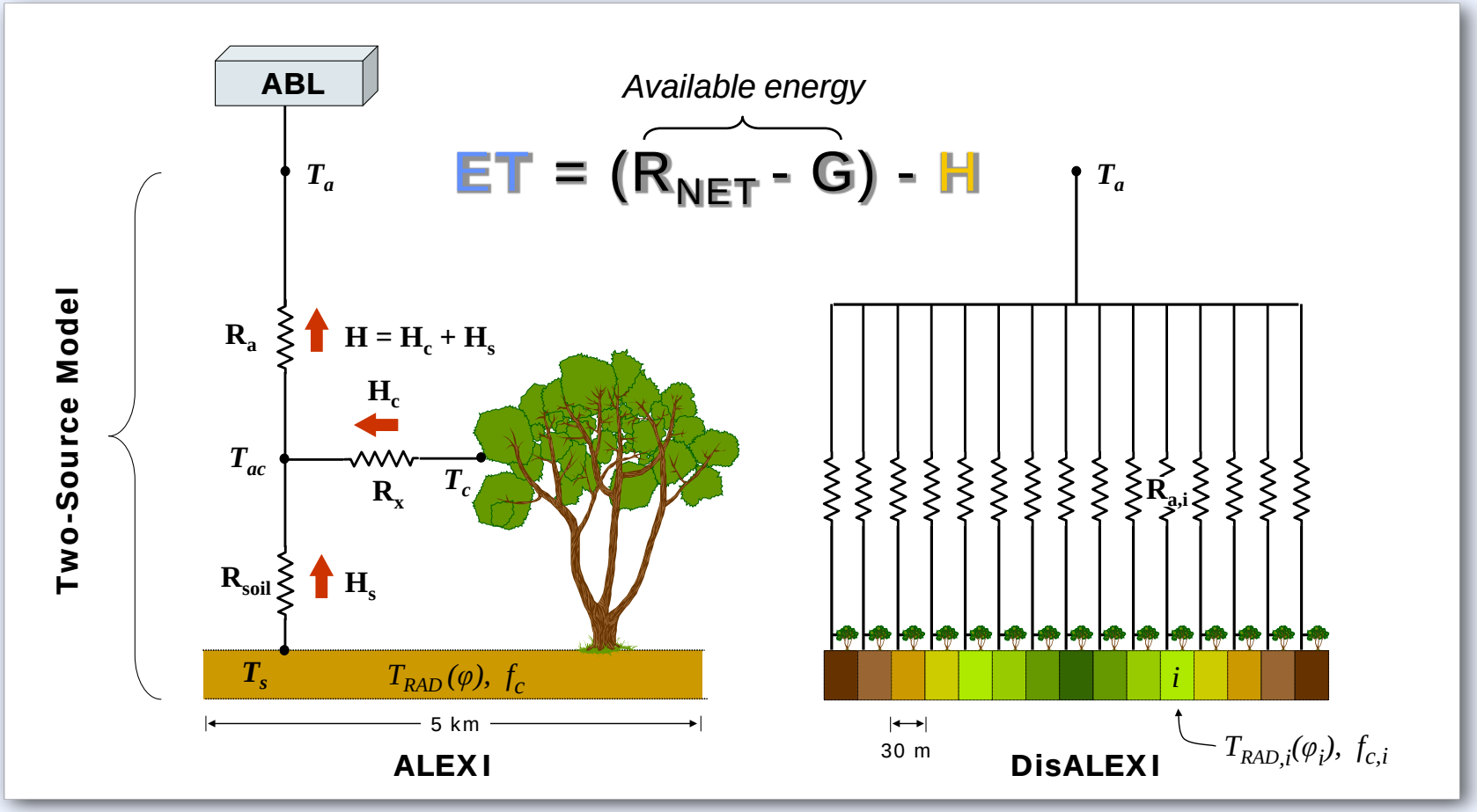
Satellite Thermal Imaging Systems

Pixel Scale	Spatial Resolution	Temporal Resolution	Current Sources	Future Sources
Coarse	5-20 km	15 min	AIRS GOES MSG	CrIS GOES MSG
Moderate	1 km	2-4 times daily	MODIS AVHRR ATSR	VIIRS AVHRR ATSR
Fine	90–120 m	Once every 8-16 days	ASTER Landsat	LDCM HysplRI?

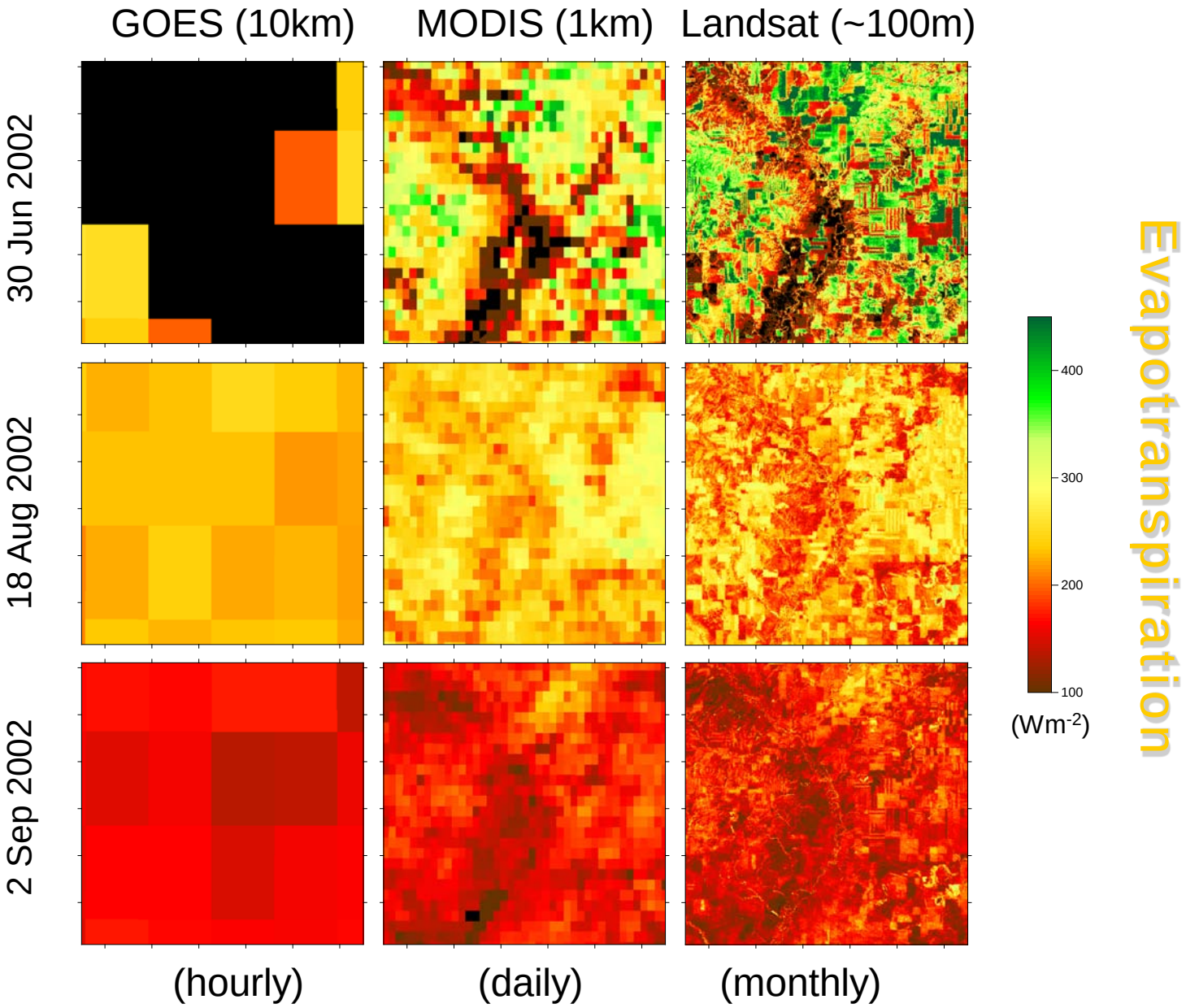
Table from S. Hook

Atmosphere-Land Exchange Inverse (ALEXI)

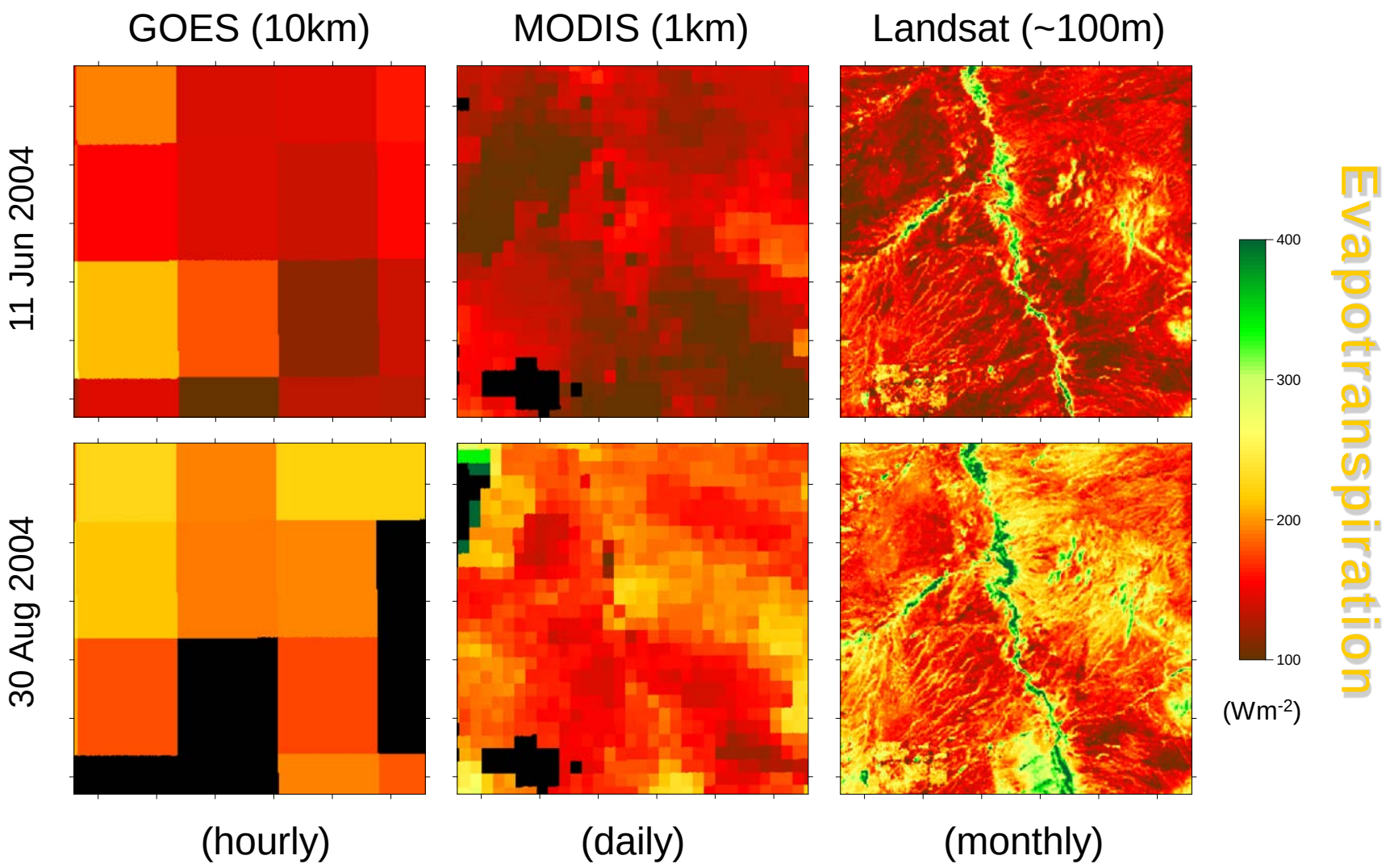


	Regional scale	Landscape scale
Surface temp:	ΔT_{RAD} - GOES	T_{RAD} - TM, MODIS, HyspIRI
Vegetation:	LAI from MODIS	LAI = f(NDVI)

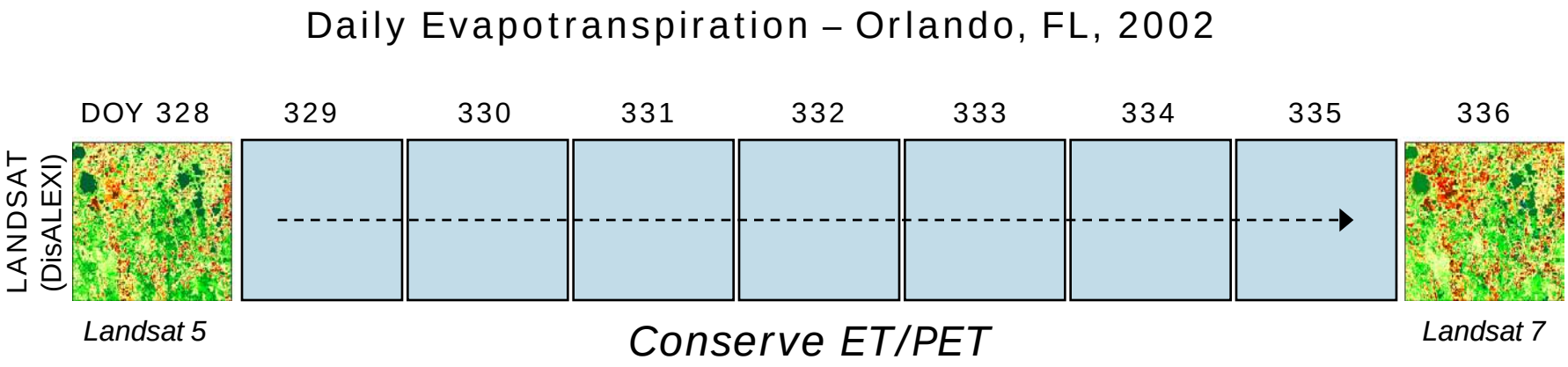
FORT PECK, MONTANA



SAN PEDRO RIVER, ARIZONA

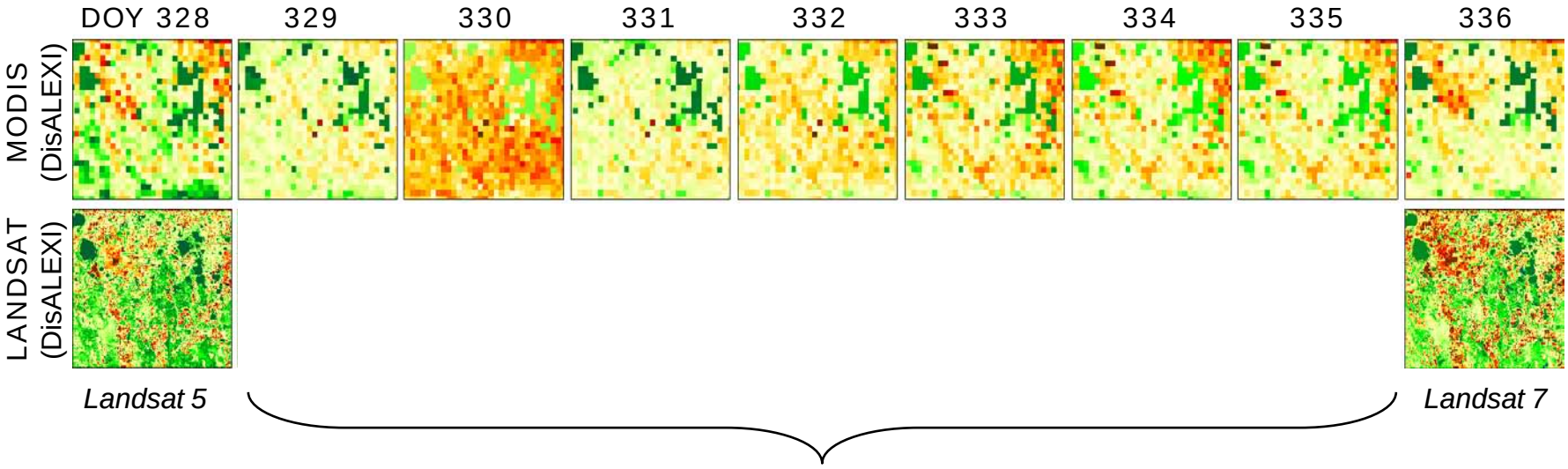


HIGH-RESOLUTION INTERPOLATION



MODIS-LANDSAT DATA FUSION

Daily Evapotranspiration – Orlando, FL, 2002

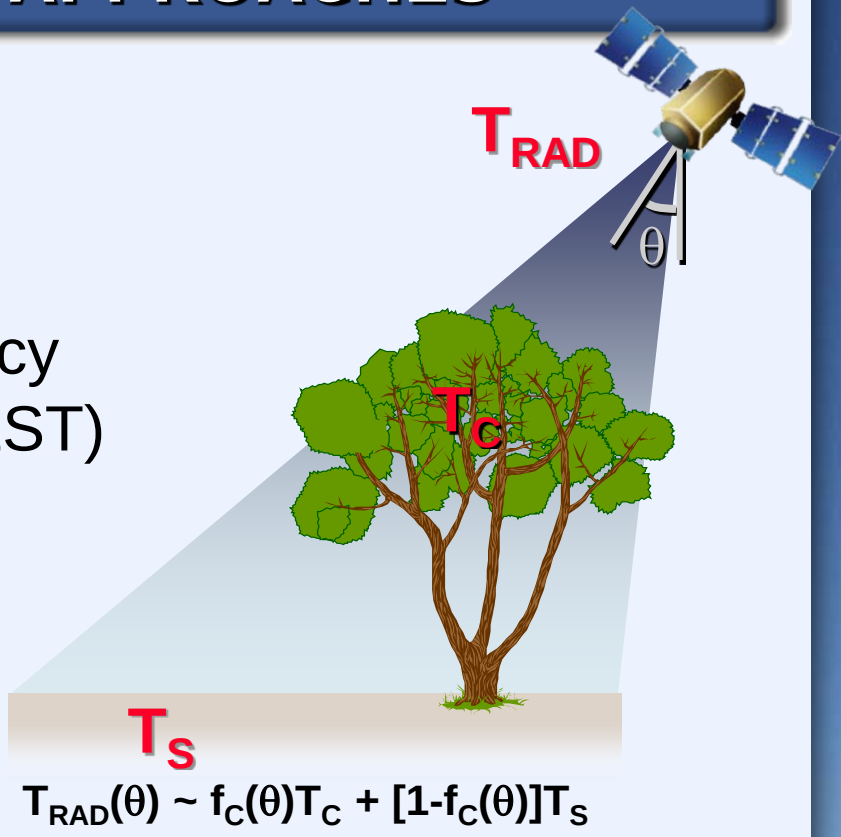


Spatial Temporal Adaptive Reflectance Fusion Model (STARFM)

POSSIBLE STARFM APPROACHES

Apply STARFM to TRAD?

- Acquisition time discrepancy (strong diurnal cycle to LST)
- View angle discrepancy



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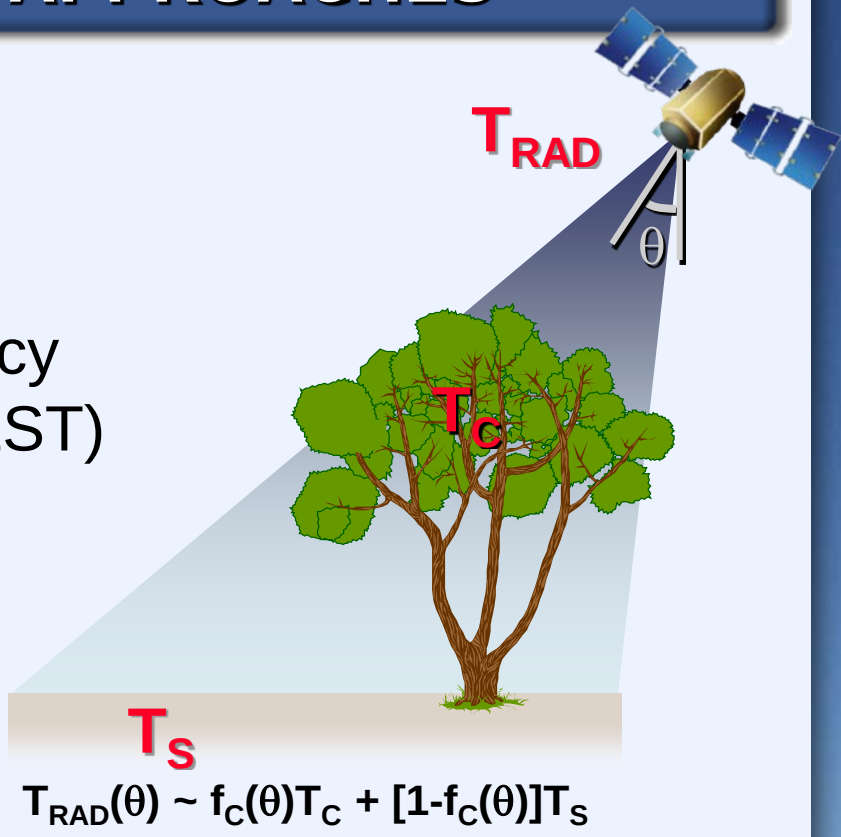


Apply STARFM to ET_{day}

- Minimizes dependence on acquisition time

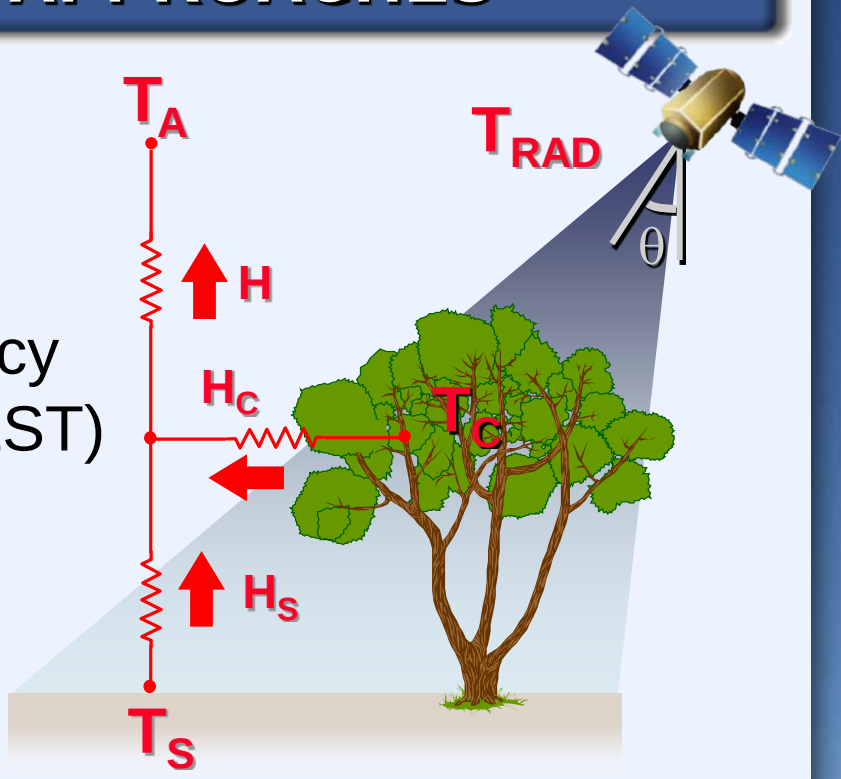
$$EF = \frac{LE_i}{RN_i - G_i}$$

$$LE_{day} = EF * (RN_{day} - G_{day})$$

POSSIBLE STARFM APPROACHES

Apply STARFM to TRAD?

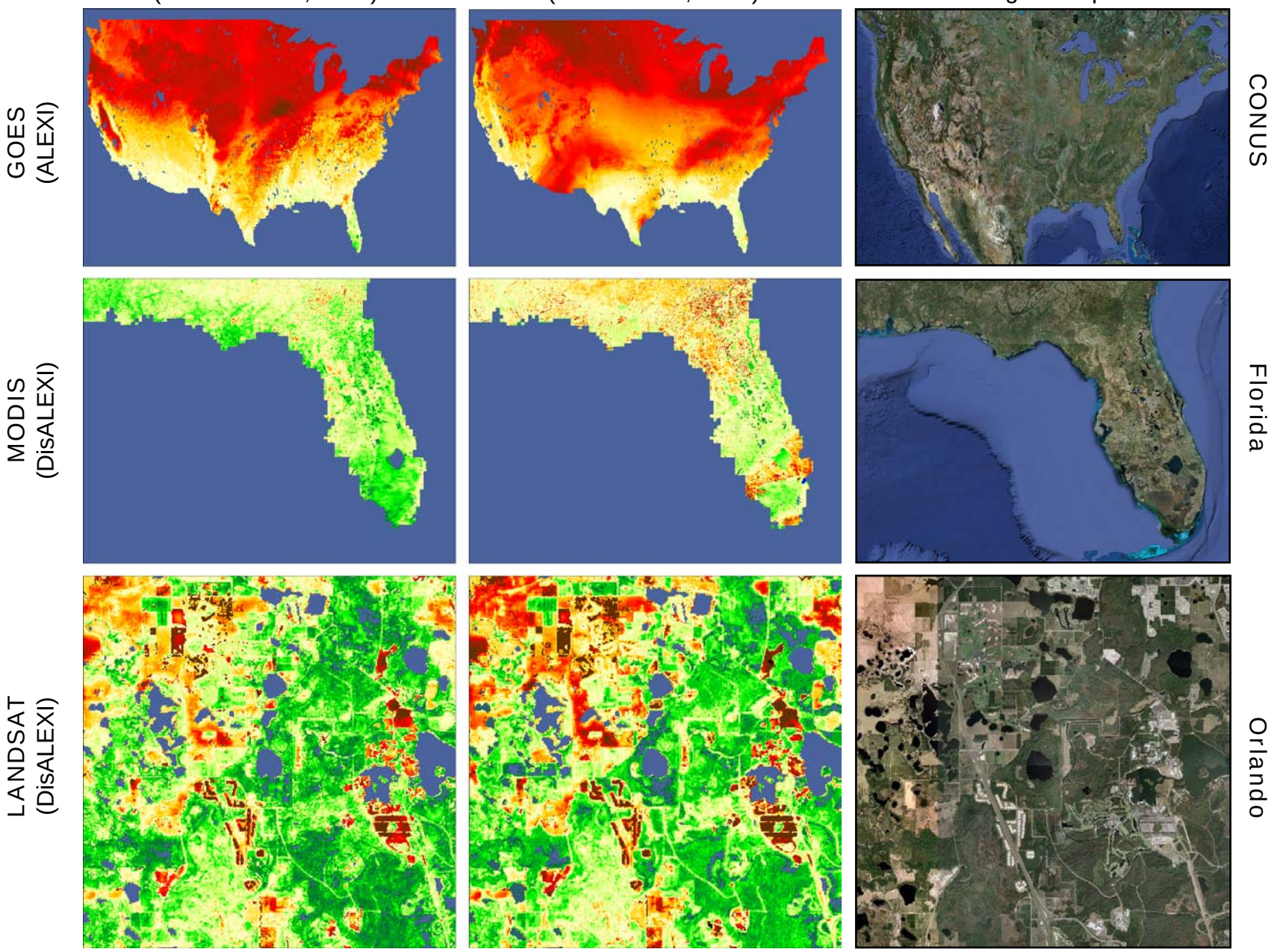
- Acquisition time discrepancy (strong diurnal cycle to LST)
- View angle discrepancy



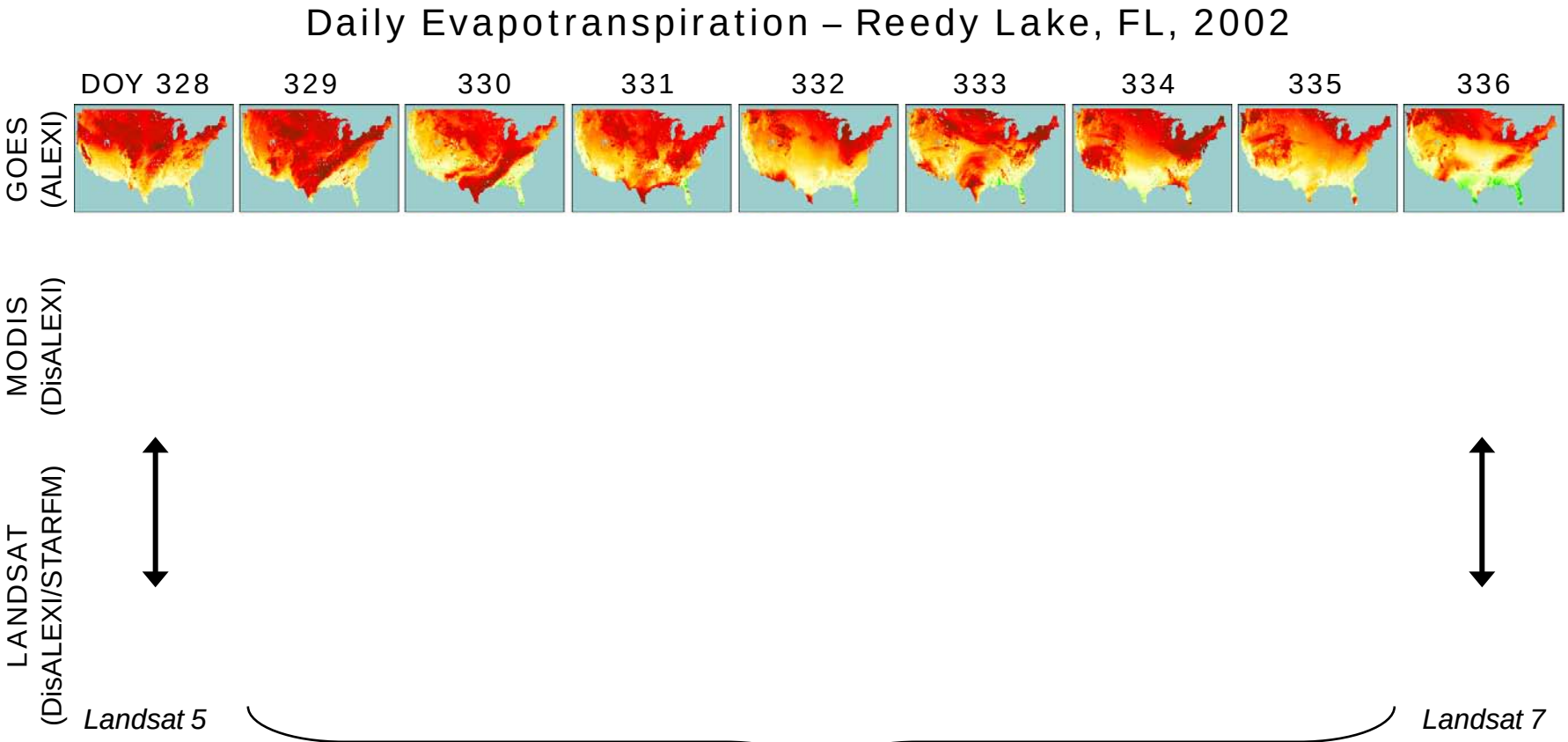
$T_{RAD}(\theta) \sim f_C(\theta)T_C + [1-f_C(\theta)]T_S$

Apply STARFM to ET_{day}

- Minimizes dependence on acquisition time
- ALEXI/DisALEXI account for view angle

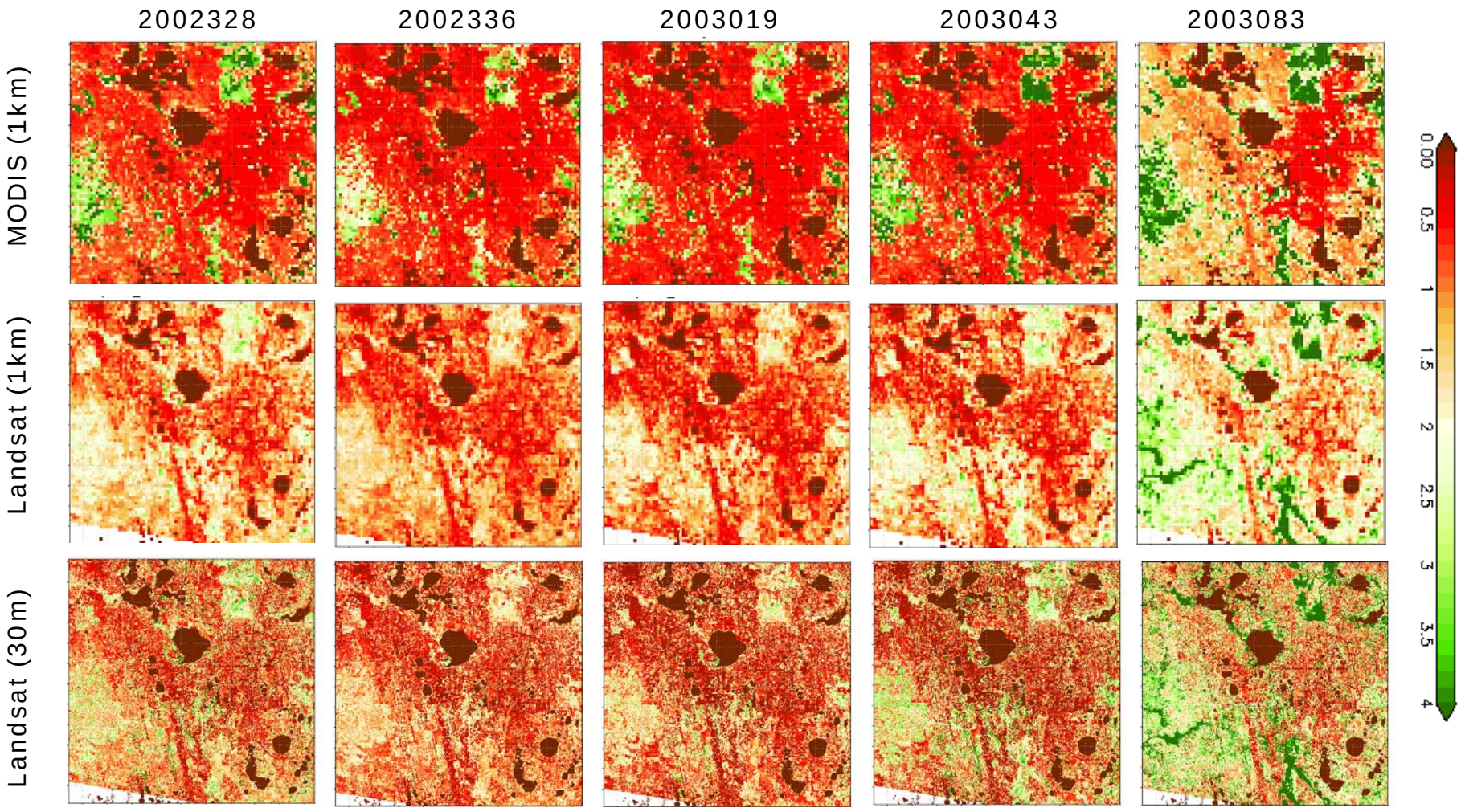

Daily ET
(November 28, 2002)
Daily ET
(December 2, 2002)
Google Maps
GOES
(ALEXI)
MODIS
(DisALEXI)
LANDSAT
(DisALEXI)
CONUS
Florida
Orlando

GOES/MODIS/Landsat FUSION



Spatial Temporal Adaptive Reflectance Fusion Model (STARFM) *(Gao et al, 2006)*

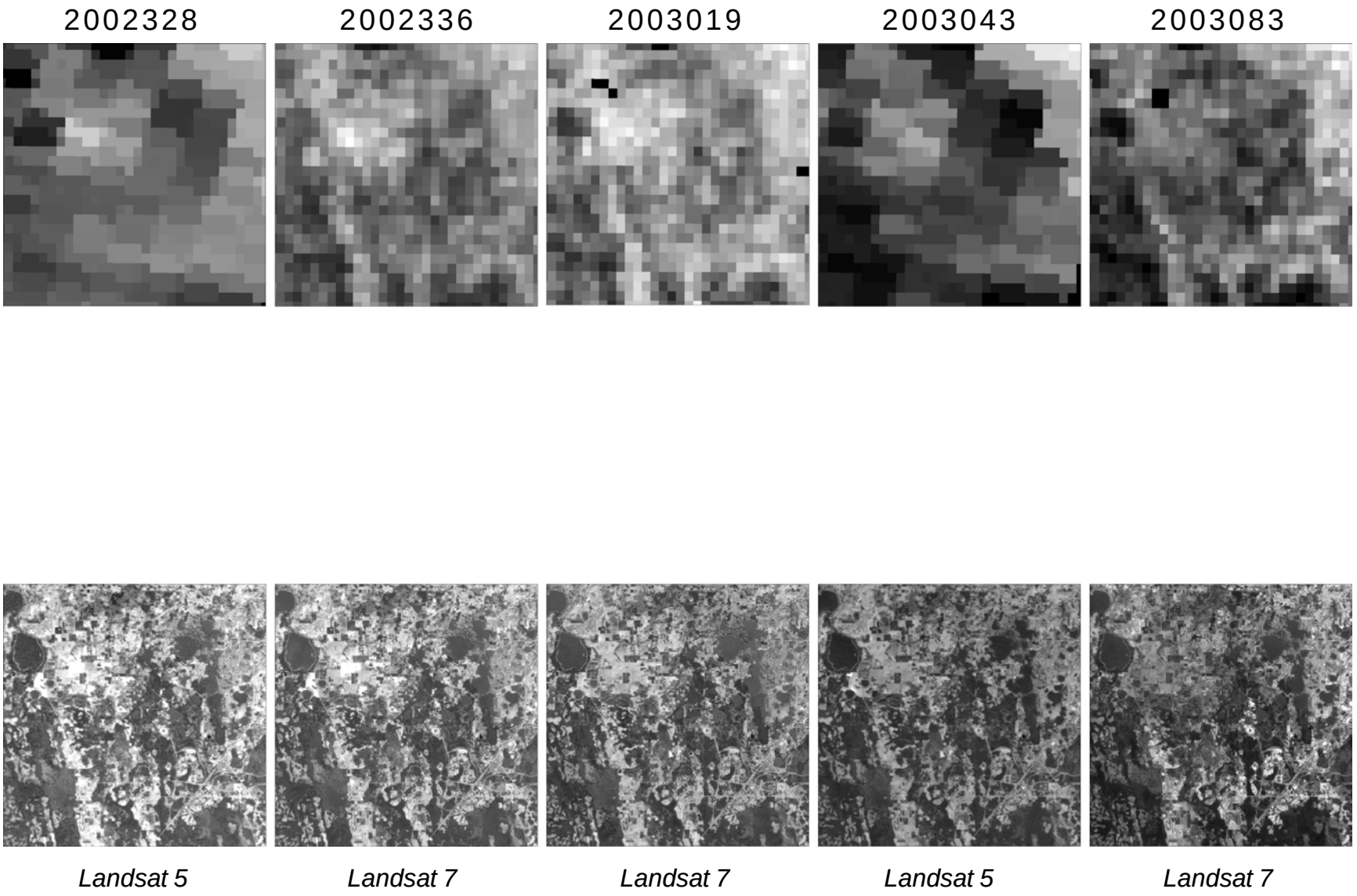
LEAF AREA INDEX



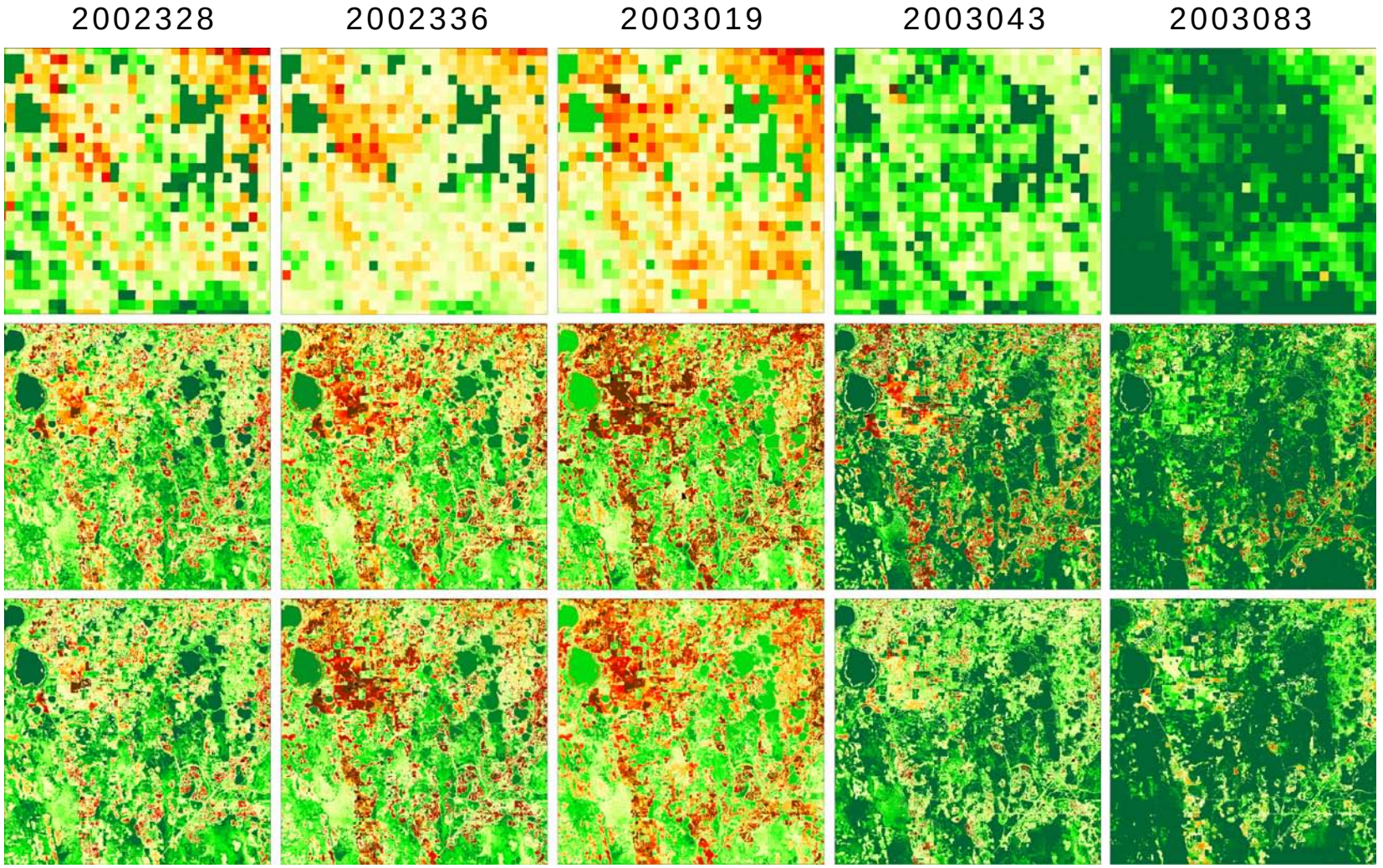
$$LAI_{TM} = -k_1 * \ln \frac{k_2 - NDVI_{TM}}{k_2 - k_3}$$

k_1, k_2, k_3 fit to MODIS LAI

LANDSURFACE TEMPERATURE



EVALUATION OF PREDICTED FIELDS



	Landsat 5	Landsat 7	Landsat 7	Landsat 5	Landsat 7
R^2:	0.77	0.83	0.81	0.67	0.63
% Err:	10%	9%	11%	12%	12%

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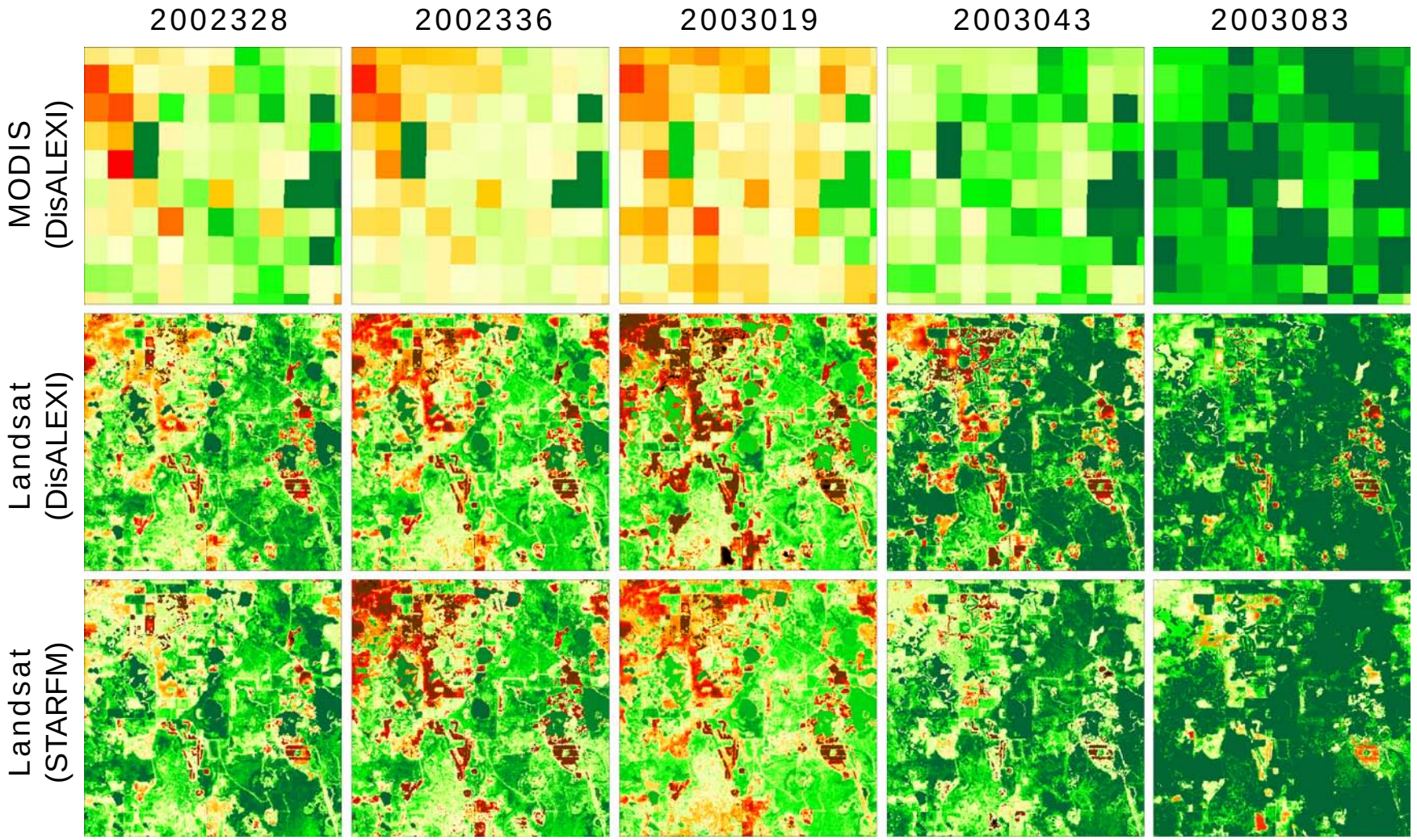

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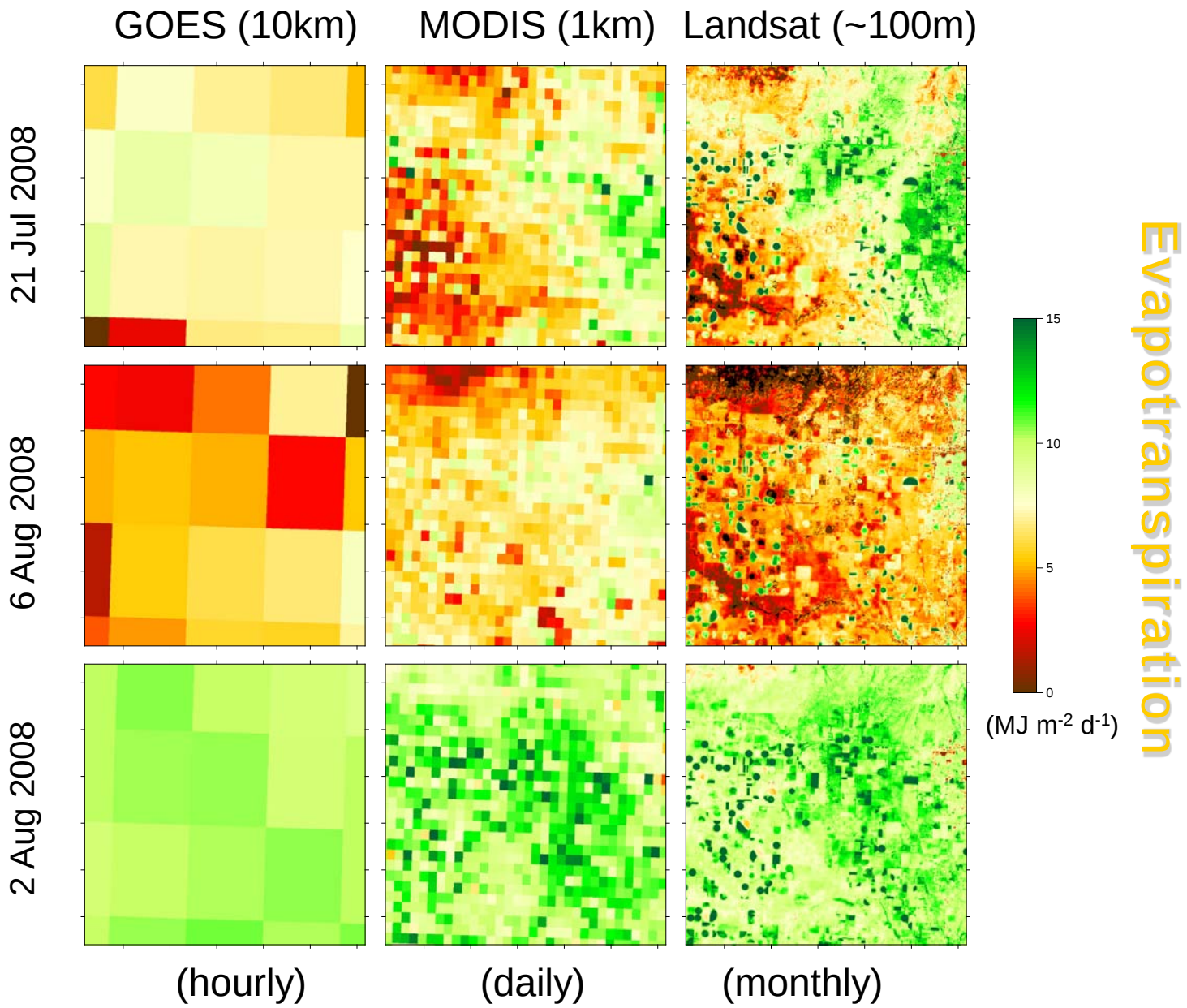
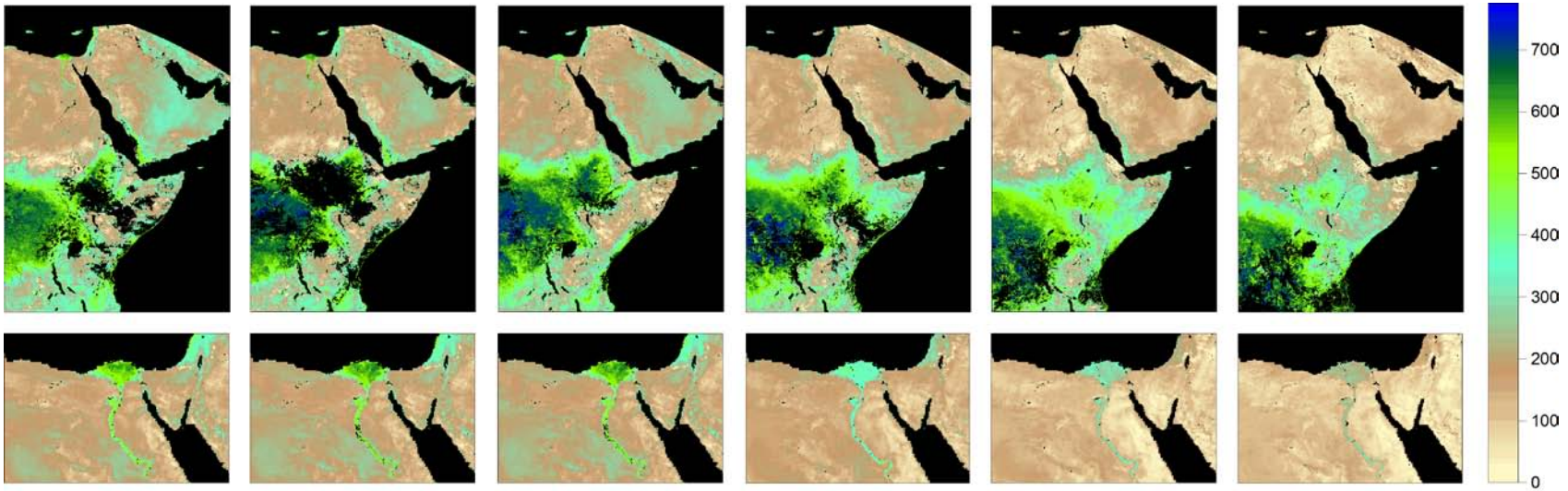
BUSHLAND, TEXAS



Midday Latent Heat Flux

2008

Meteosat (ALEXI)



CONCLUSIONS

- MODIS-Landsat daily ET fusion appears feasible
- Fusion results are optimized for MODIS-Landsat in formation
- Consistent MODIS-Landsat LAI products will be valuable

STILL NEED ≥ TWO LANDSATS!

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