Demonstration of the High-Resolution (375-m) ALEXI ET Product for the NENA Region

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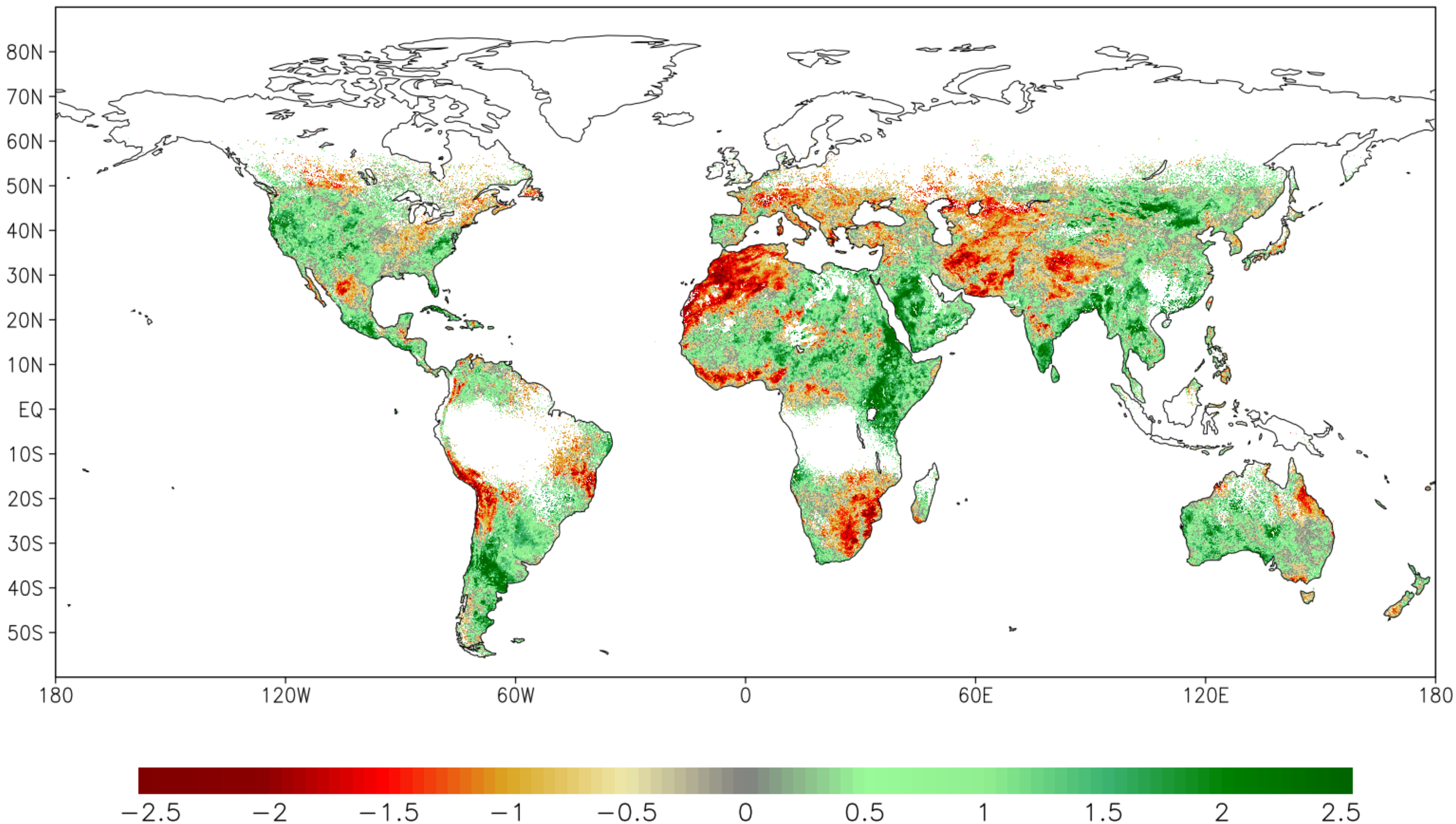
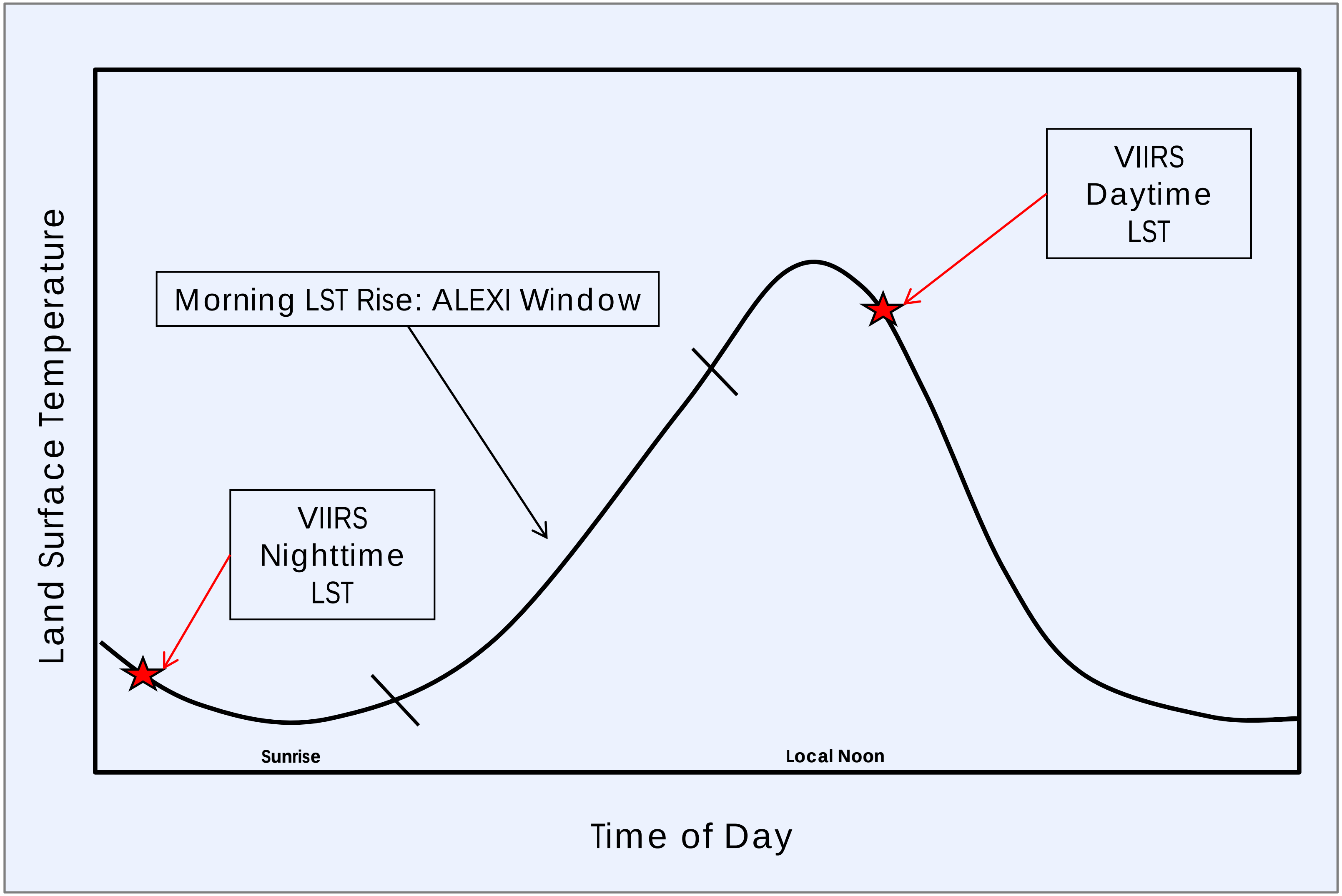
Evaporative Stress Index 12–wk: 1 March 2016



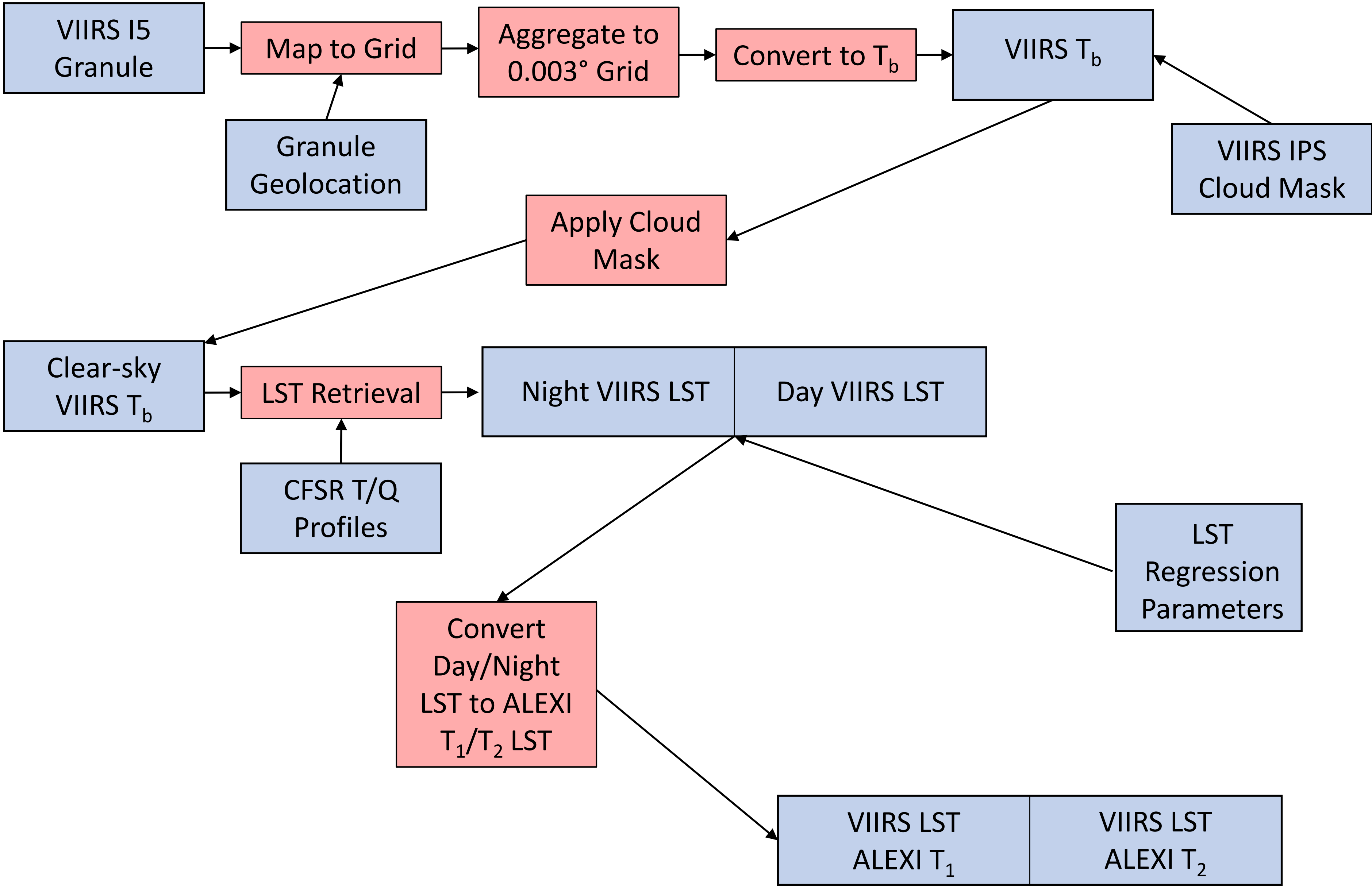
Supplementing ALEXI Capabilities with Polar Orbiting Sensors

A technique has been developed and evaluated using GOES data to train a regression model to use day-night LST differences from MODIS to predict the morning LST rise needed by ALEXI. The regression model can provide reasonable estimates of the mid-morning rise in LST (RMSE ~ 5 to 8%) from the twice daily VIIRS LST observations.



Development of a High-Resolution (375-m) VIIRS ET Product

1. Mid-morning change in Land Surface Temperature



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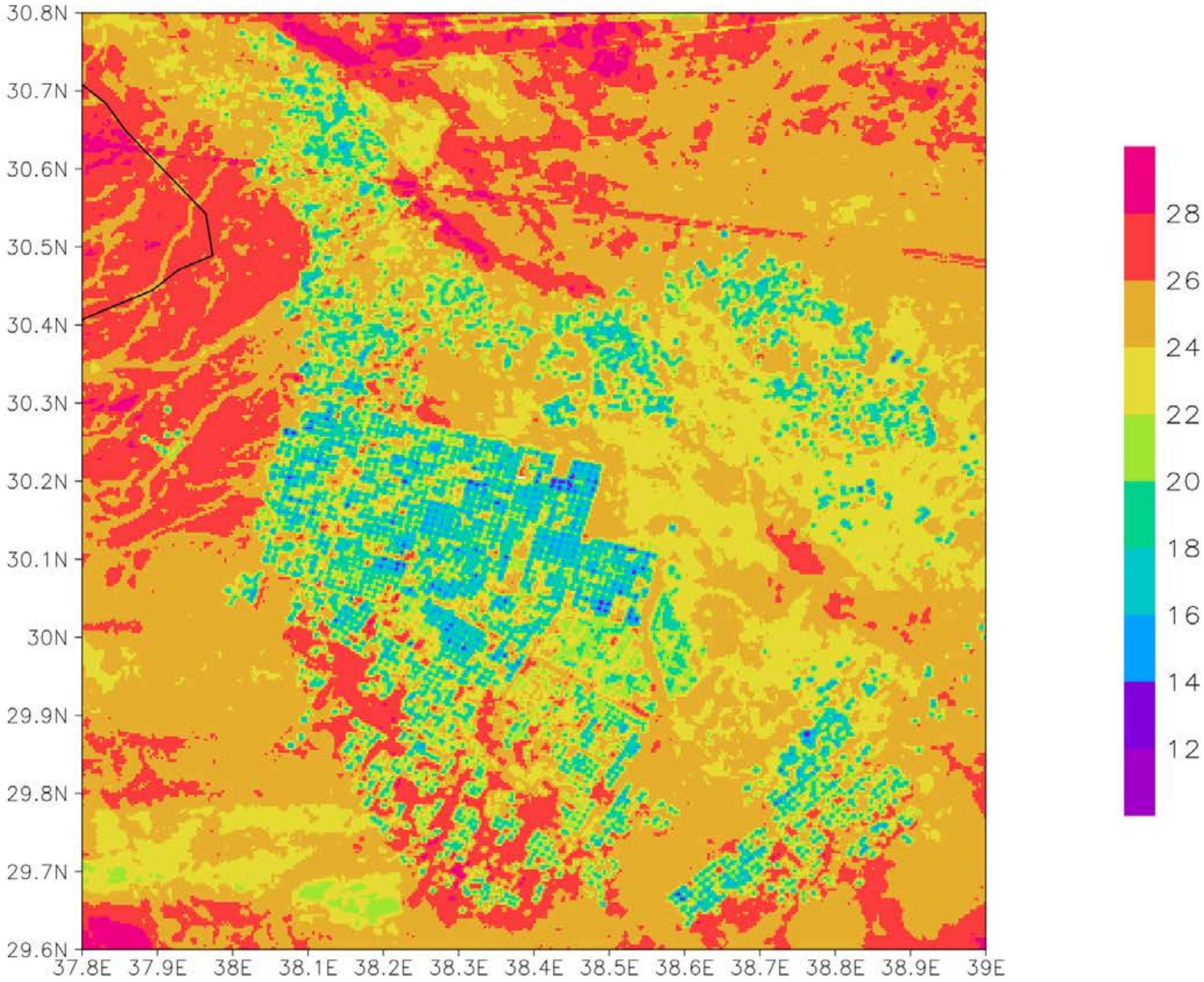

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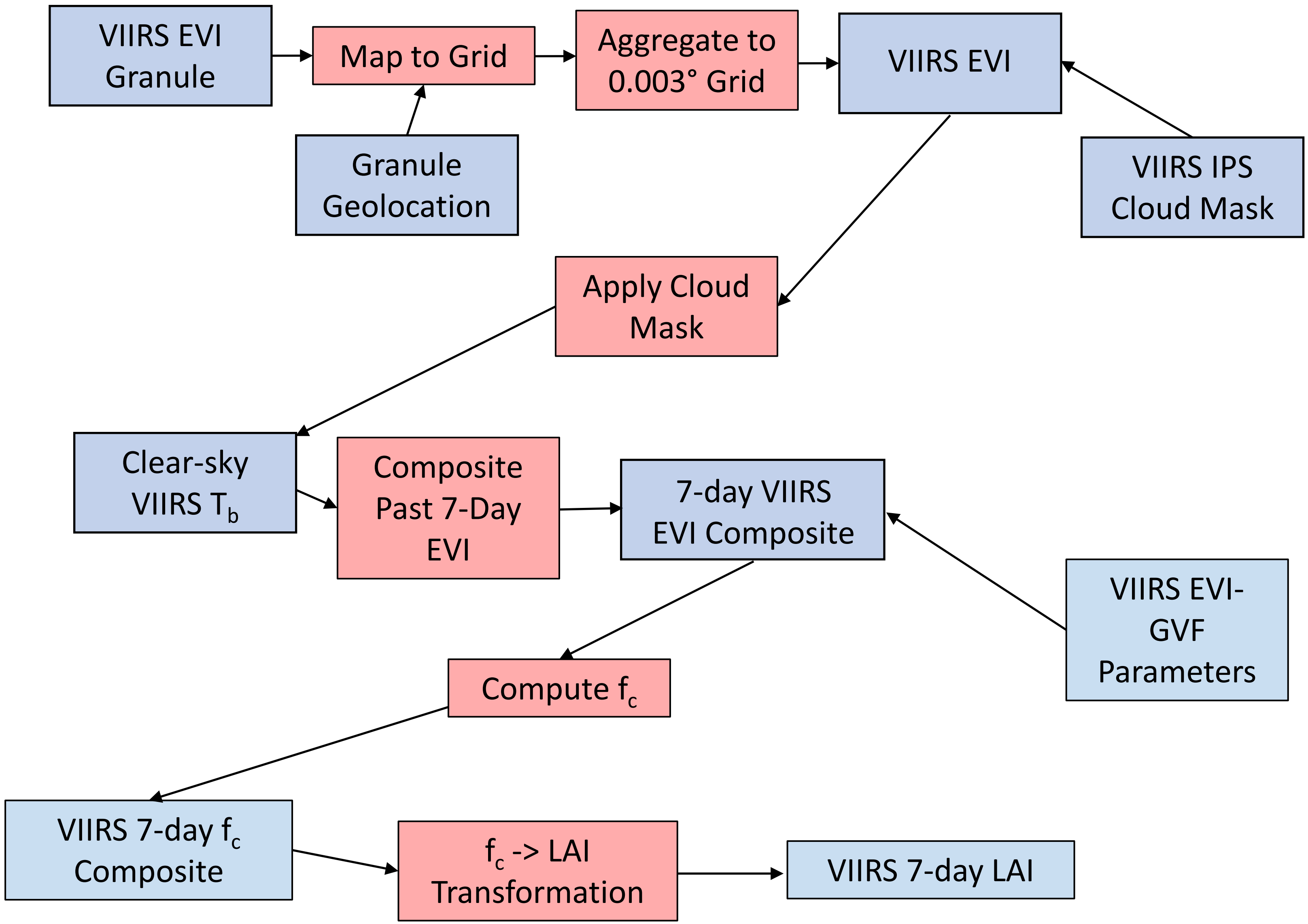
2. Leaf Area Index and Fraction of Green Vegetation Cover (f_c)



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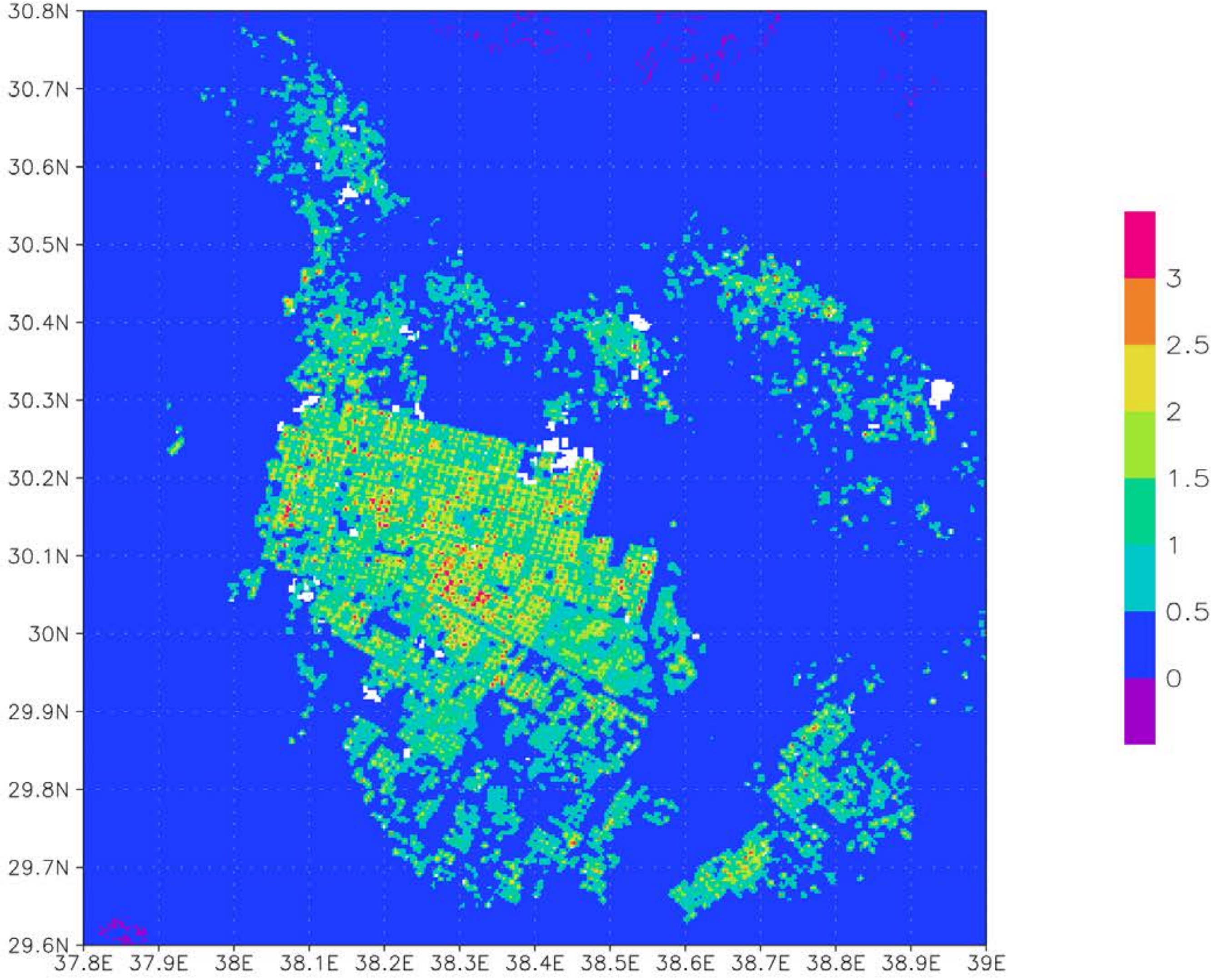

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3. Land Surface Albedo

- Only available VIIRS product is at 750-m – mapped to 375-m grid – used to calculate surface reflectivity in VIS/NIR spectrum as needed by ALEXI

4. Incoming Solar Radiation

- Only available from geostationary platforms – Meteosat (3-km) / will use CFS-4 daily insolation for scaling to daily fluxes as back-up data source [currently used for other ALEXI applications; not ideal due to model-based estimate but model/RS-based insolation tend to converge when considering monthly-annual time scales]

5. Meteorological Surface Fields (e.g., air temperature; wind speed; surface pressure; incoming LW)

- Climate Forecast System Reanalysis (hourly; 0.50º)

6. Morning Profile of Potential Temperature

- Climate Forecast System Reanalysis (hourly; 0.50º)

CFS-R fields are currently being used for all data fusion results (30-m ET) so we don't expect any issues with this dataset.

Development of a High-Resolution (375-m) VIIRS ET Product

7. Landcover / Vegetation Type

- Only available VIIRS product is at 1-km – insufficient for 375-m product;
- So we'll use 30-m Landsat-based classification (Chinese dataset) – we've downloaded all tiles over MENA region and have gridded to 375-m domain and calculated % of each land class in each VIIRS pixel.
- What happens when Landsat-based classification is not representative of VIIRS EVI/NDVI information?
  - We're developing a processing check to ensure changes to agricultural practices which can be determined by VIIRS vegetation time series to ensure we're processing pixels which may be classified as "barren" but now include agricultural pixels.

8. Cloud Mask

- Only available VIIRS product is at 750-m – mapped to 375-m grid.
- Once we acquire more years of VIIRS data we'll develop additional climatological-based QC metrics to remove cloud contamination that is "missed" in VIIRS cloud mask.

How are we getting retrospective/realtime VIIRS data

Current MENA Domain: -20W to 70E; 0N to 50N; 45 processing tiles (assuming no full desert tiles)

All data will be downloaded from NOAA CLASS system:

SVI05 – 11 micron 375-m TB

VIVIO – 375-m NDVI/EVI

IICMO – 750-m Cloud Mask

GITCO – 375-m terrain-corrected geolocation files (lat/lon)

GMTCO – 375-m terrain-corrected geolocation files (lat/lon)

Retrospective VIIRS data:

About 1250 data granules per product per month (300-400 GB / month)

We order all five products one month at a time – takes about 12 to 24 hours to receive "staged" data and about 3 to 6 hours to download data to local archive.

We expect to have all 2015/2016 data locally archived by mid-April.

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Realtime VIIRS data:

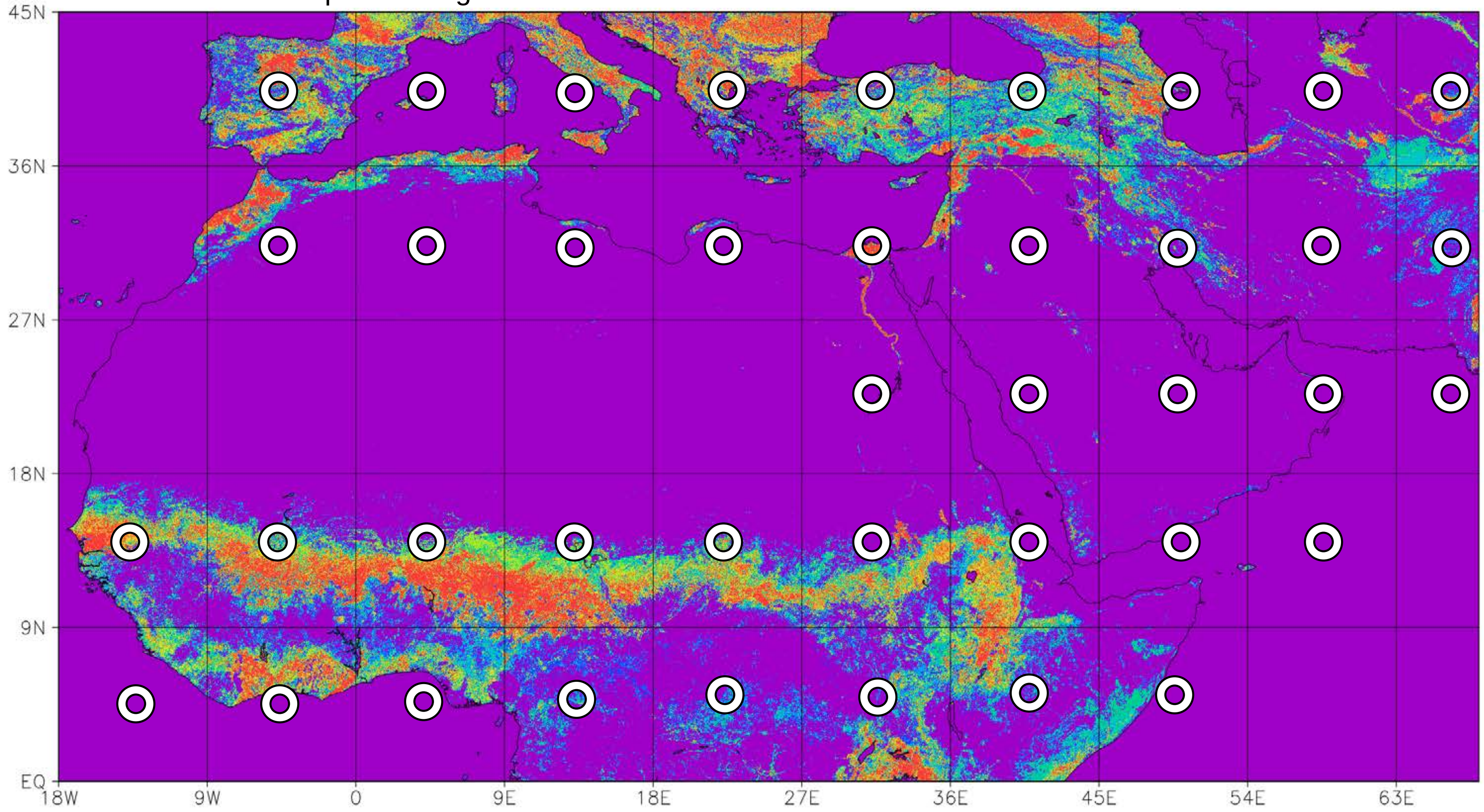
We have established a data subscription at NOAA CLASS which will push all data for the MENA domain to a specific FTP location so that we can download all the previous day's data each night.

This process will occur at HCC which will serve as the realtime processing platform for the VIIRS ET product.

Development of a High-Resolution (375-m) VIIRS ET Product

Initial NENA region processing nodes (9º x 9º) – we'll be moving to 10 x 10 deg boxes and expanding processing domain to -20W to 70E and 0N to 50N.

Circles denote active processing nodes.



*Shading indicates 1-km percentage of cropland from global synthesis of several RS-based land use maps

How are we going to validate this product?

TBD – we're open to all ideas at this point!

A general lack of validation data over the processing domain makes it difficult to validate the VIIRS ET product.

Idea:

Develop parallel processing systems over targeted Ameriflux sites that our teams are familiar with and/or currently working with:

- Mead
- Arizona sites
- NC sites
- Gallo CA
- Choptank (eastern shore of MD; USDA)
- PVID (irrigated agriculture)
- Salton Sea irrigated agriculture
- others?

HCC Processing?

1. Start downloading realtime VIIRS data from NOAA CLASS – archive data and begin processing when processing system is in place

2. Retrospective processing will begin at UMD – after initial testing; can be moved to HCC to increase processing efficiency

3. Develop realtime processing system – Questions?
    1. What latency are we comfortable with or what do we want to strive for?
    2. Are we processing on a daily time-step or a weekly time-step?
    3. Timeline?

Initial 375-m VIIRS ET Results

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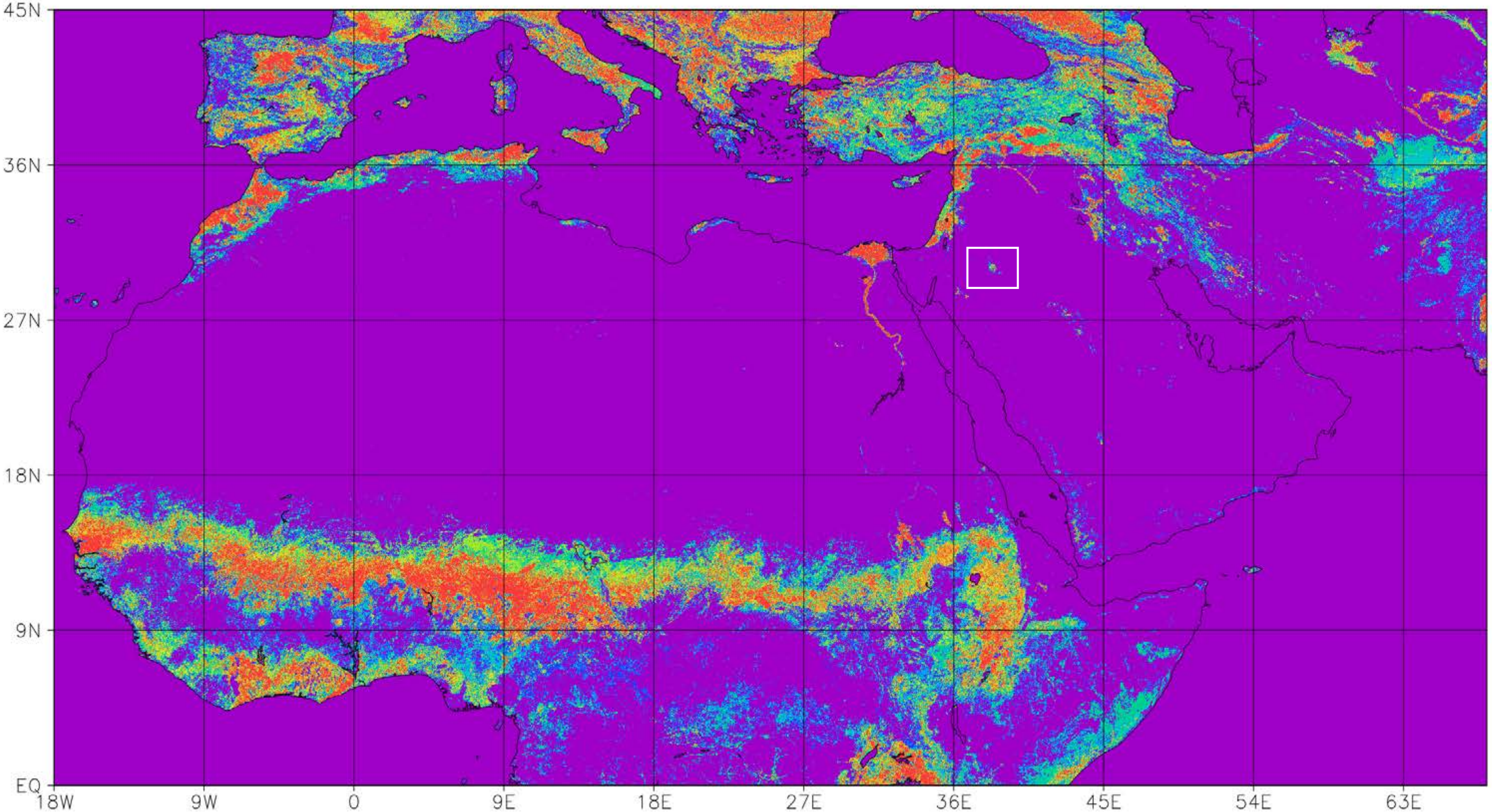

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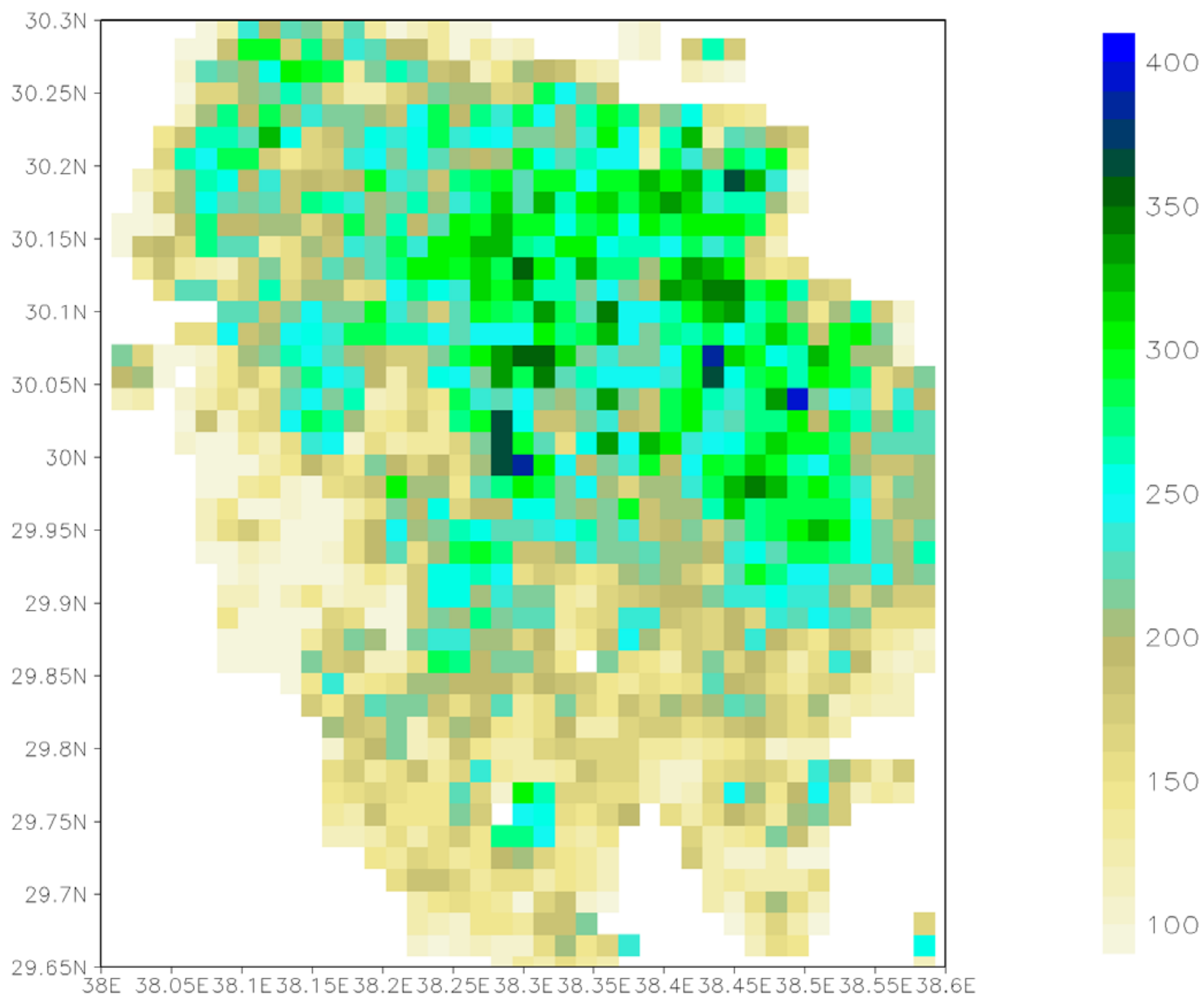
Current MODIS Latent Heat Flux (W m^{-2}) Capability (1-km)



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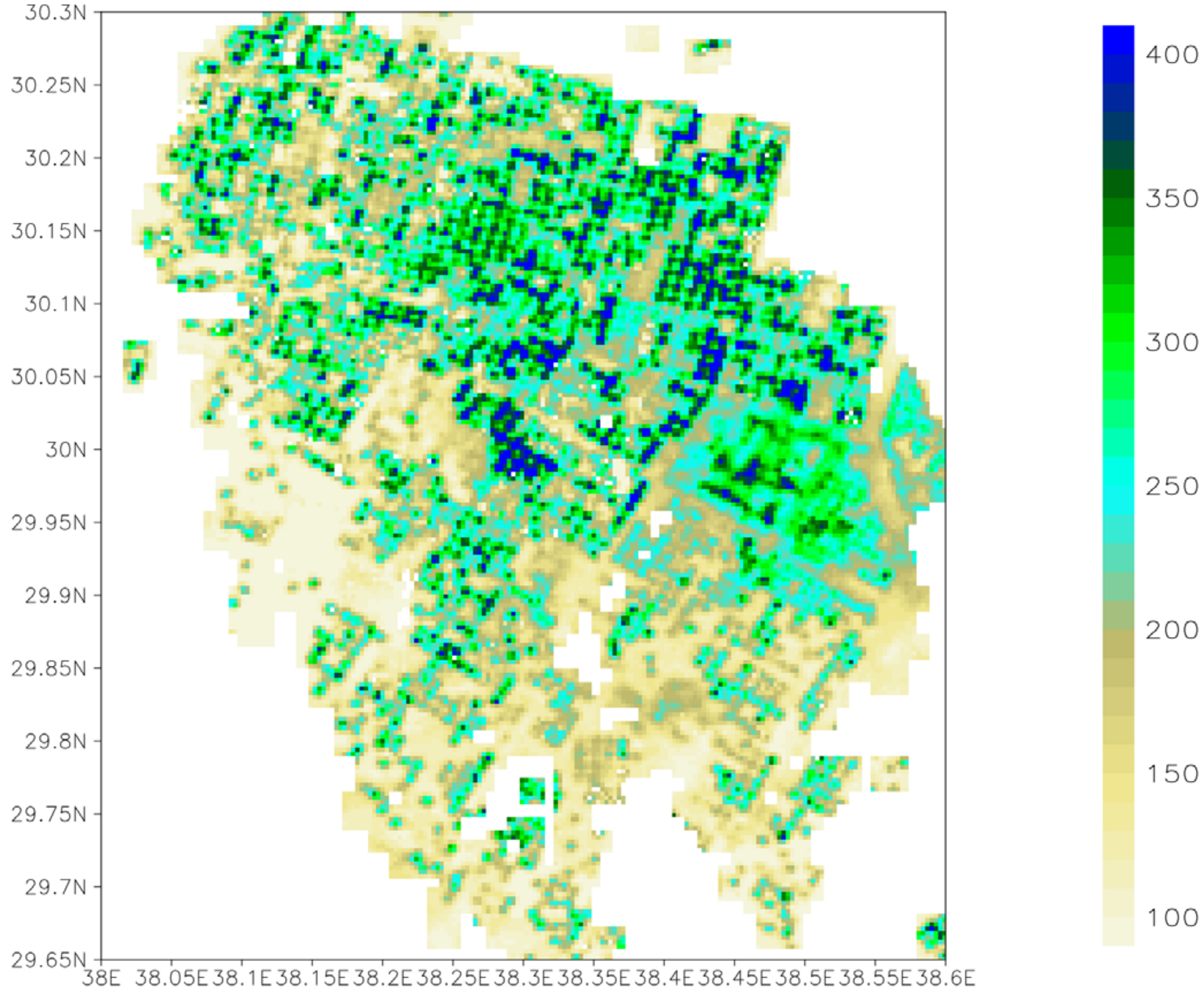

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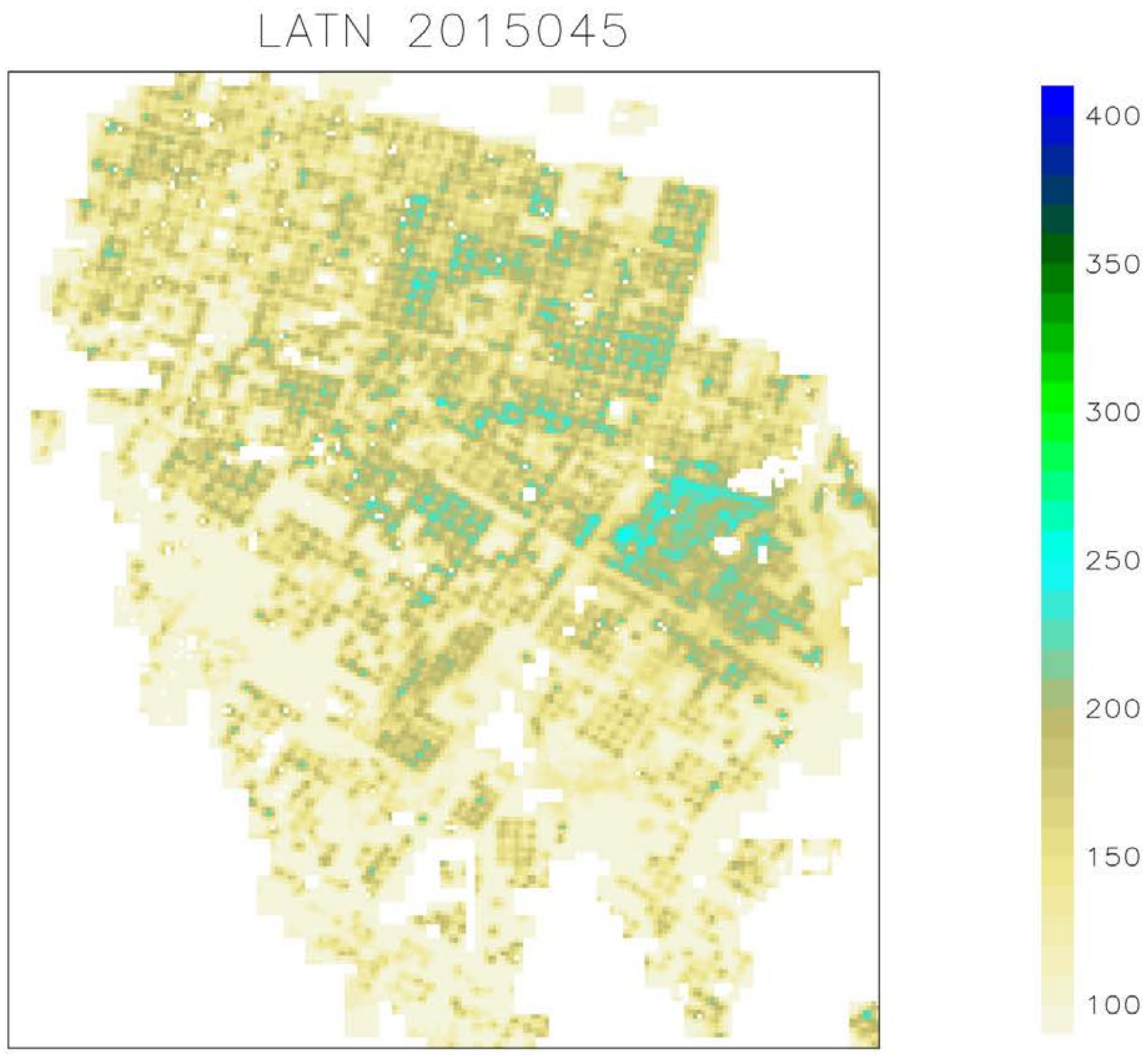

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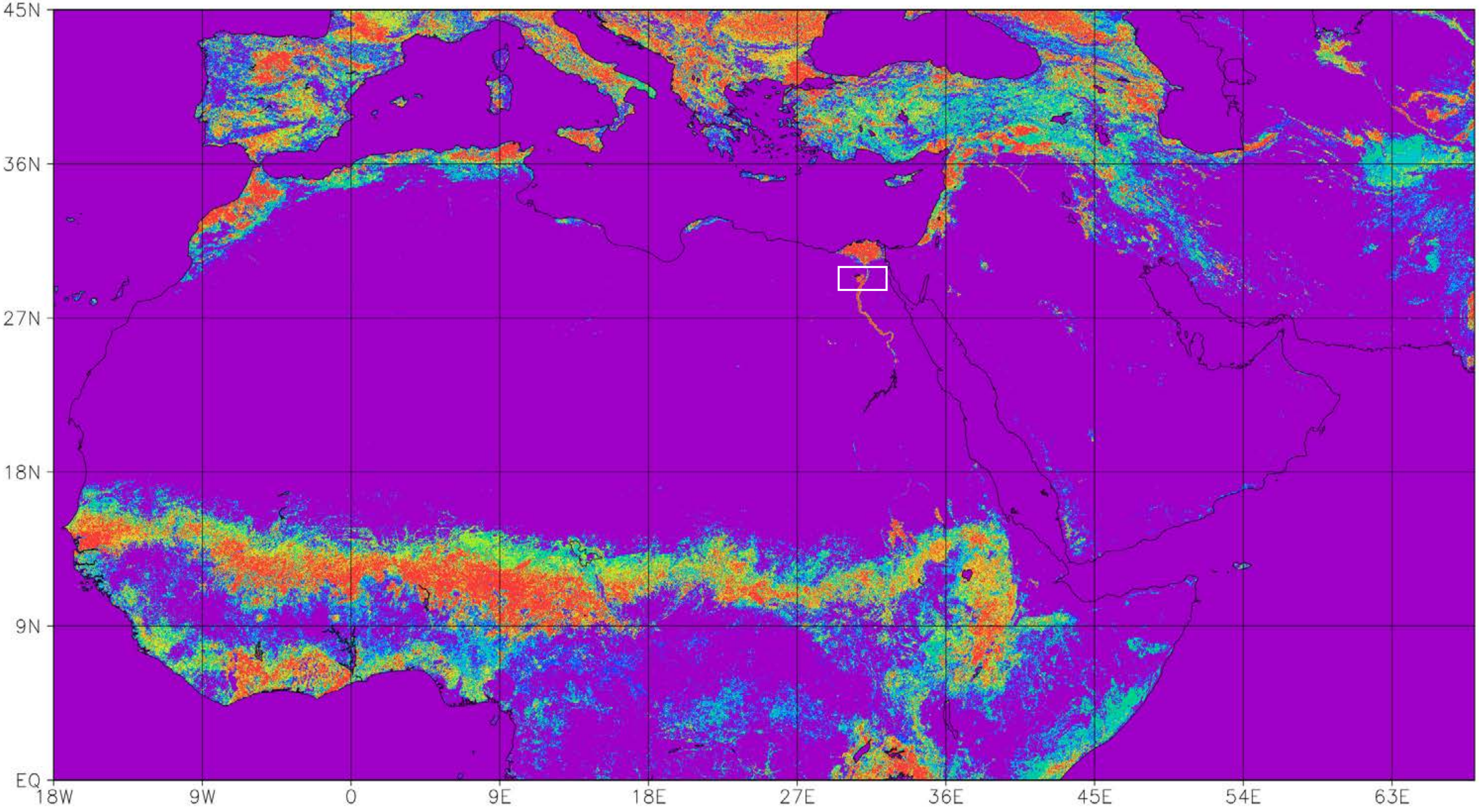

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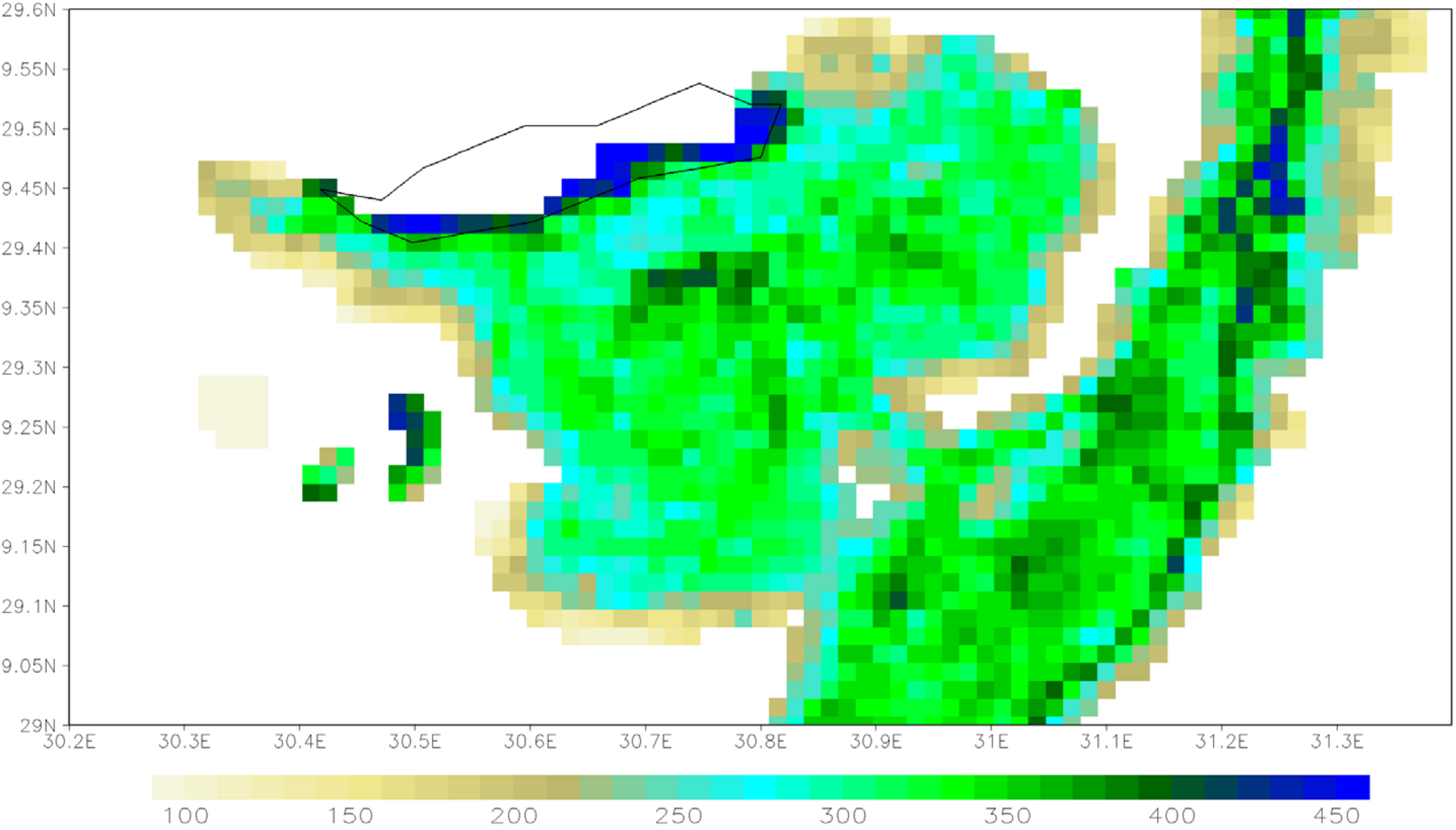

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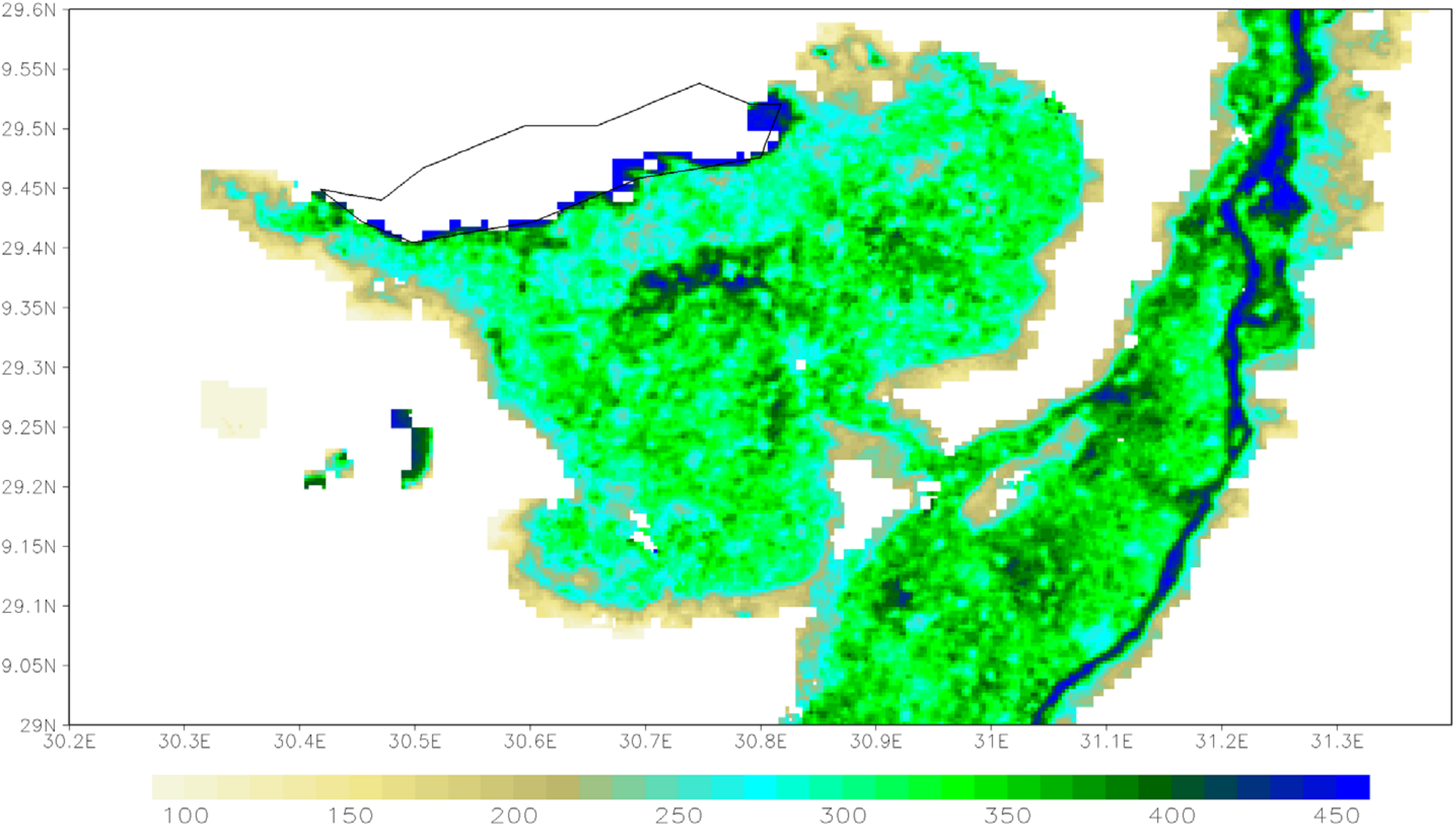

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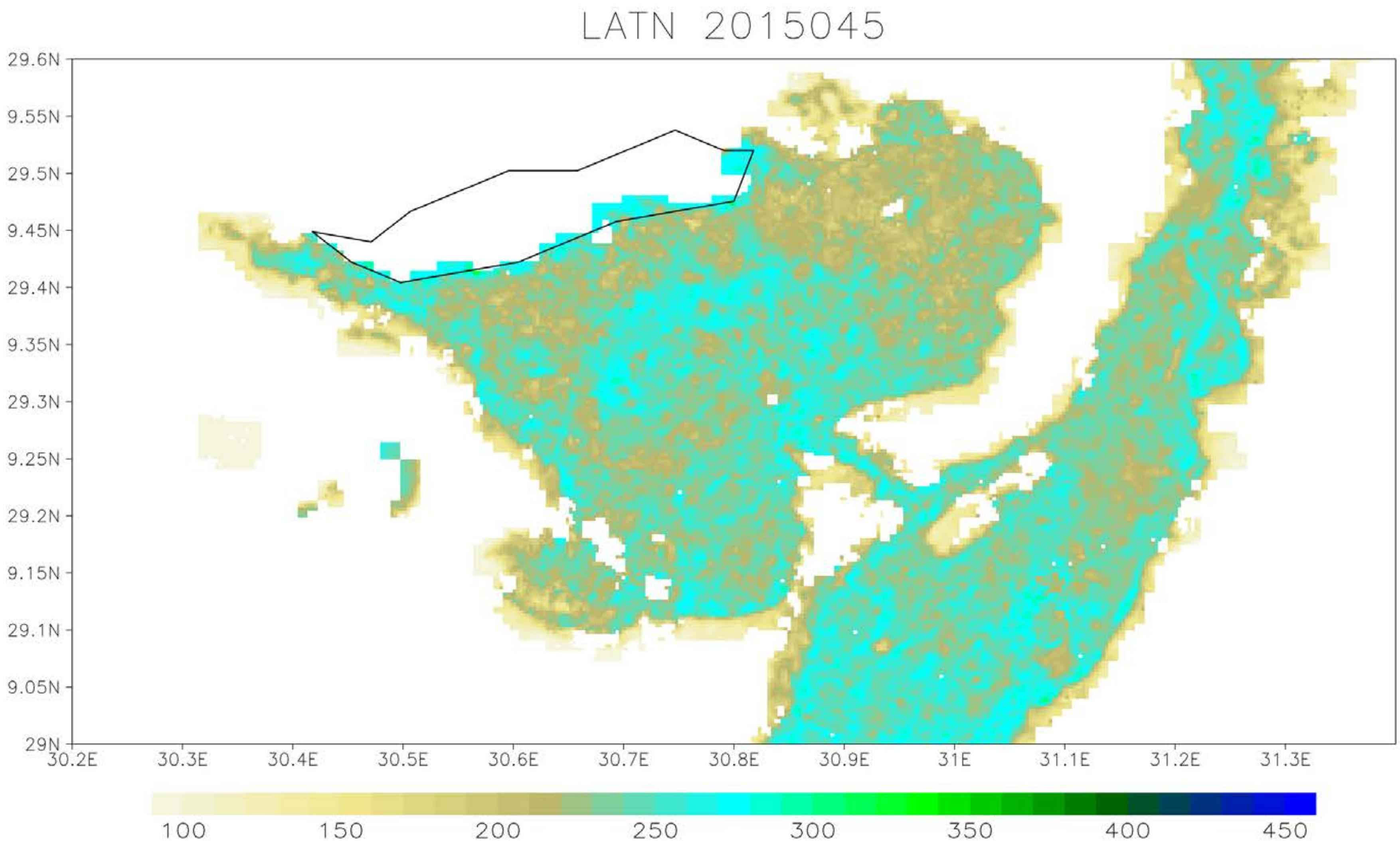

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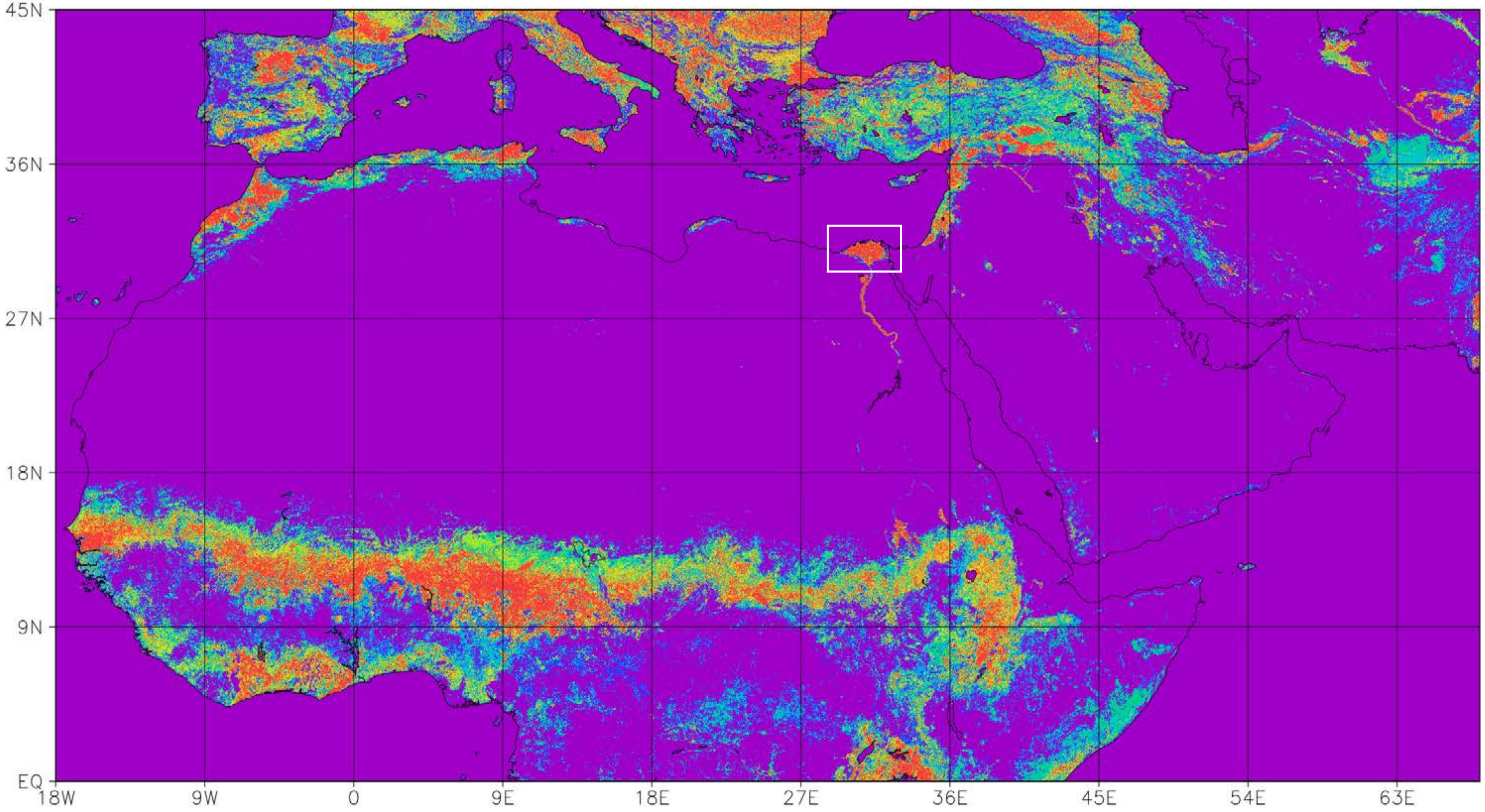

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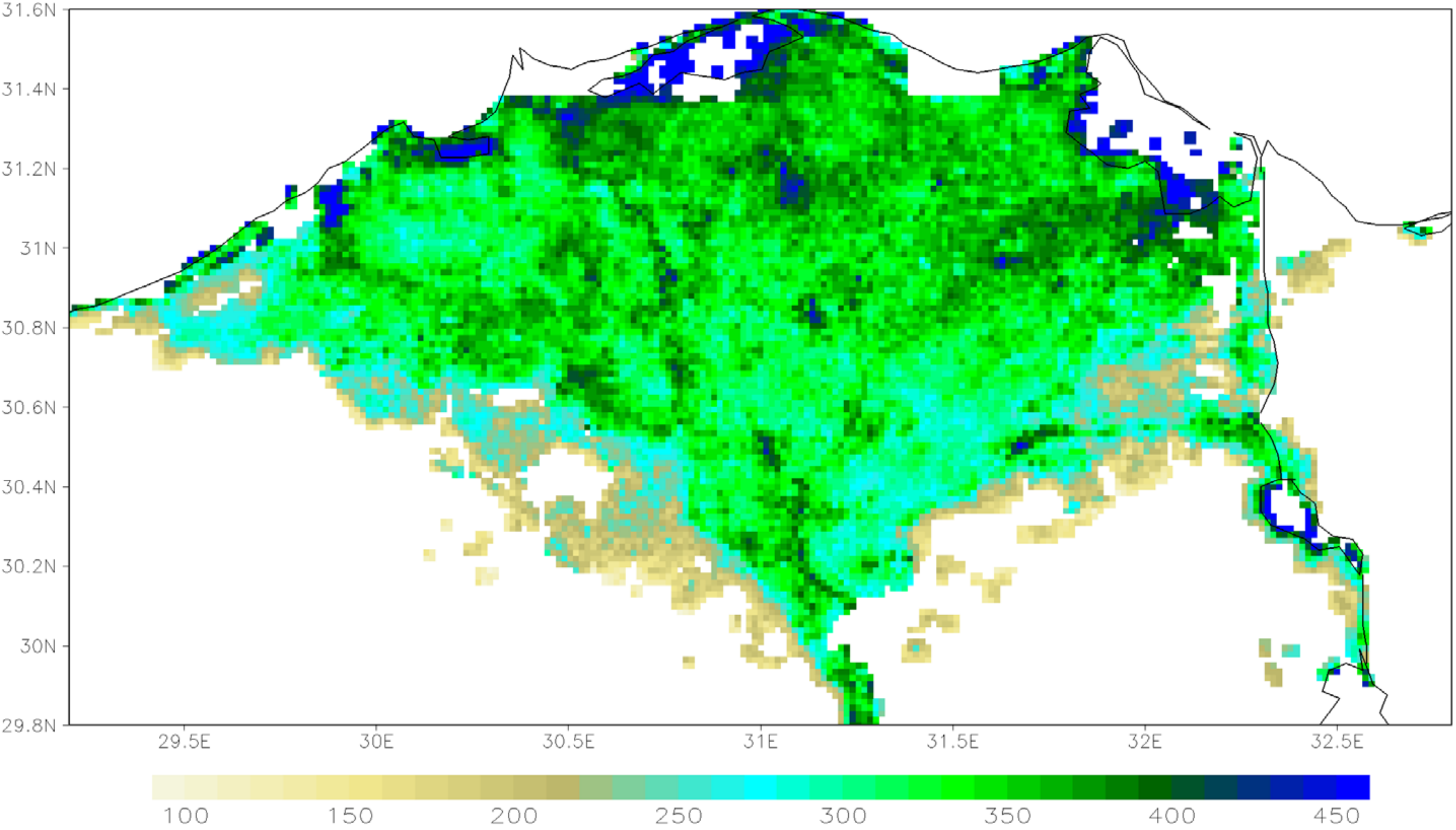

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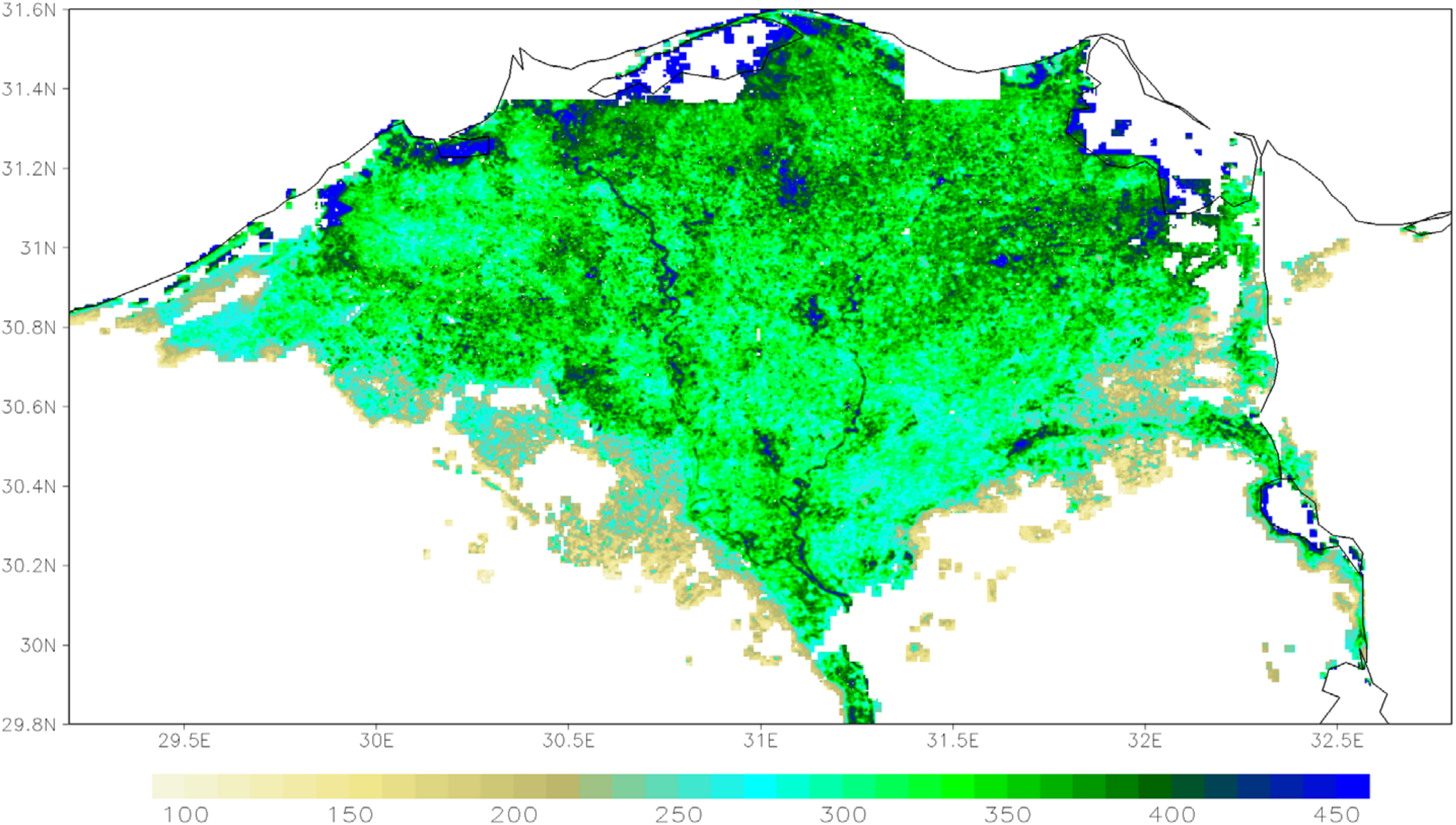

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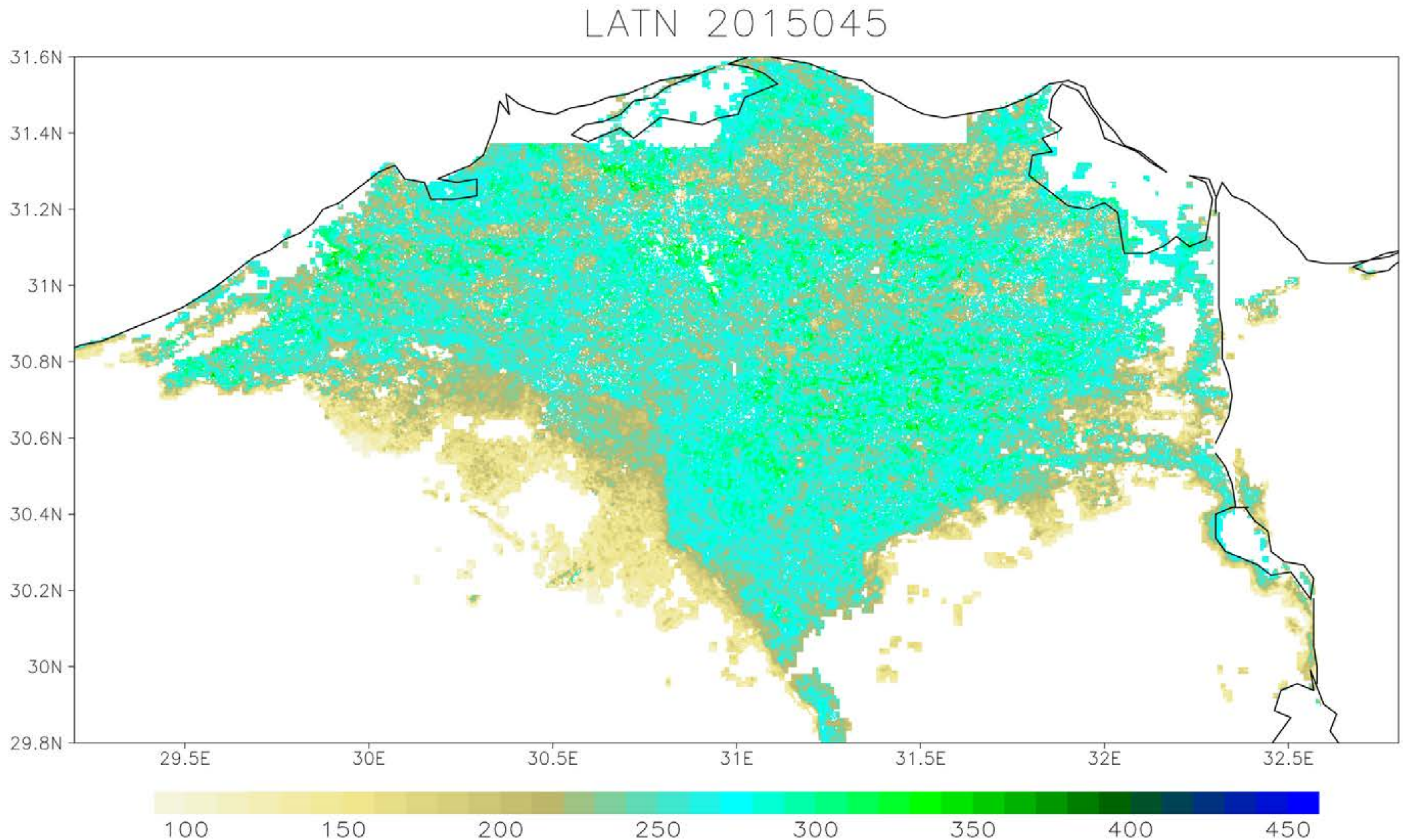


General Issues for Discussion:

1. Gap-filling – best methodology to use?

2. Timeline for online production of product (early 2017?)?

3. Best down-scaling methodology?

    1. We need to test "sharpening" 375-m ET vs. full-scale data fusion? – if we can get reasonable results using a "sharpening" technique, we could potentially produce "hi-res" ET much more efficiently than relying on full data fusion/disaggregation system?

Next steps:

Expansion?

MW-integration?

Applications for Drought Monitoring

ESI Methodology

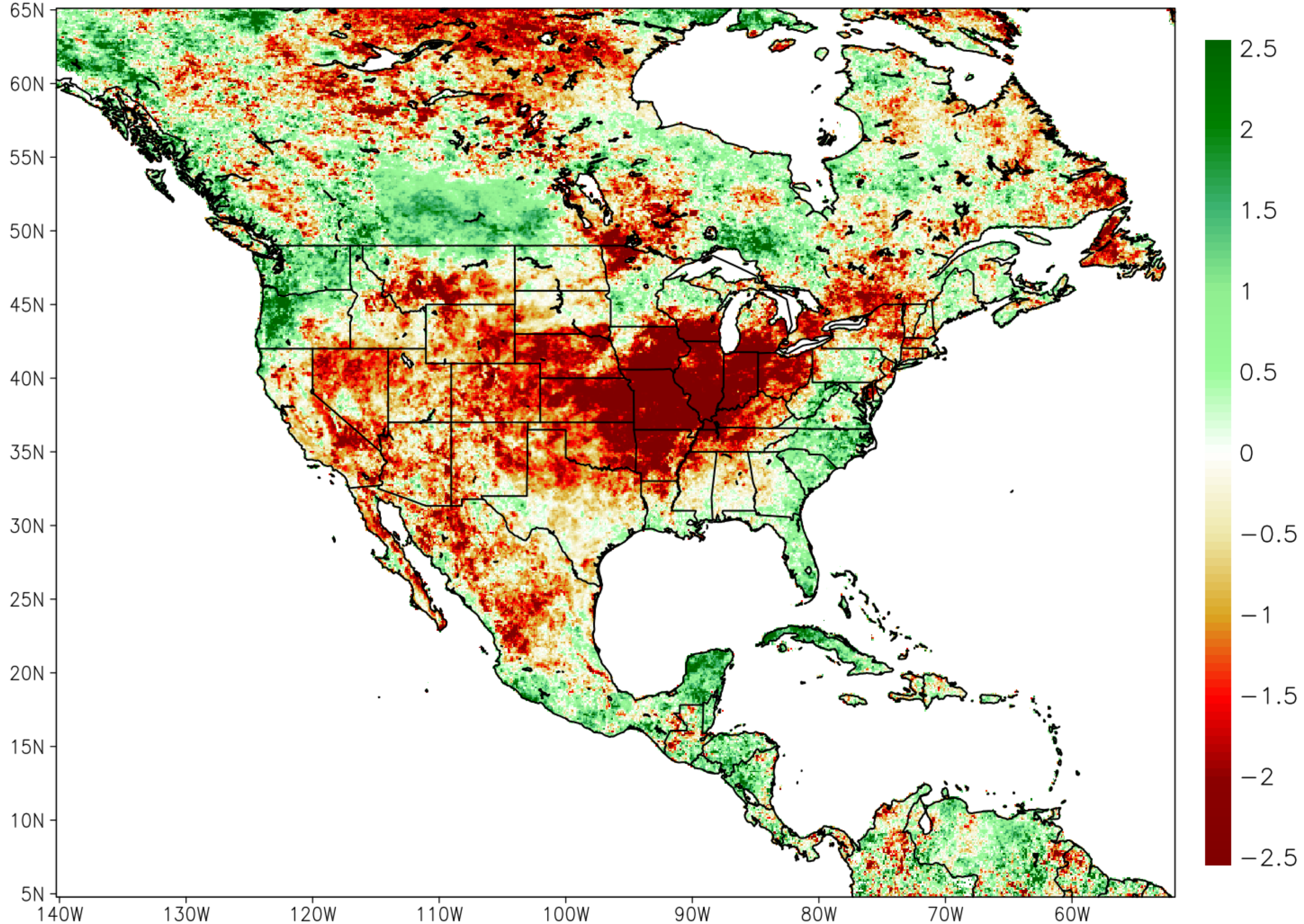
ALEXI ESI represents temporal anomalies in the ratio of actual ET to potential ET.

- ESI does not require precipitation data, ***the current surface moisture state is deduced directly from the remotely sensed LST*** , therefore it may be more robust in regions with minimal in-situ precipitation monitoring.
- Signatures of vegetation stress are manifested in the LST signal before any deterioration of vegetation cover occurs, for as example as indicated in NDVI, so TIR-based indices such as ESI can provide an effective early warning signal of impending agricultural drought.
- ALEXI ESI inherently includes non-precipitation related moisture signals (such as irrigation; vegetation rooted to groundwater; lateral flows) that need to be modeled a priori in prognostic LSM schemes.
- ALEXI ESI provides an independent assessment of current drought conditions, supplementing precipitation and modeling-based indices – an invaluable resource to decision-makers who usually depend on a convergence of information in the decision making process.

ESI Methodology

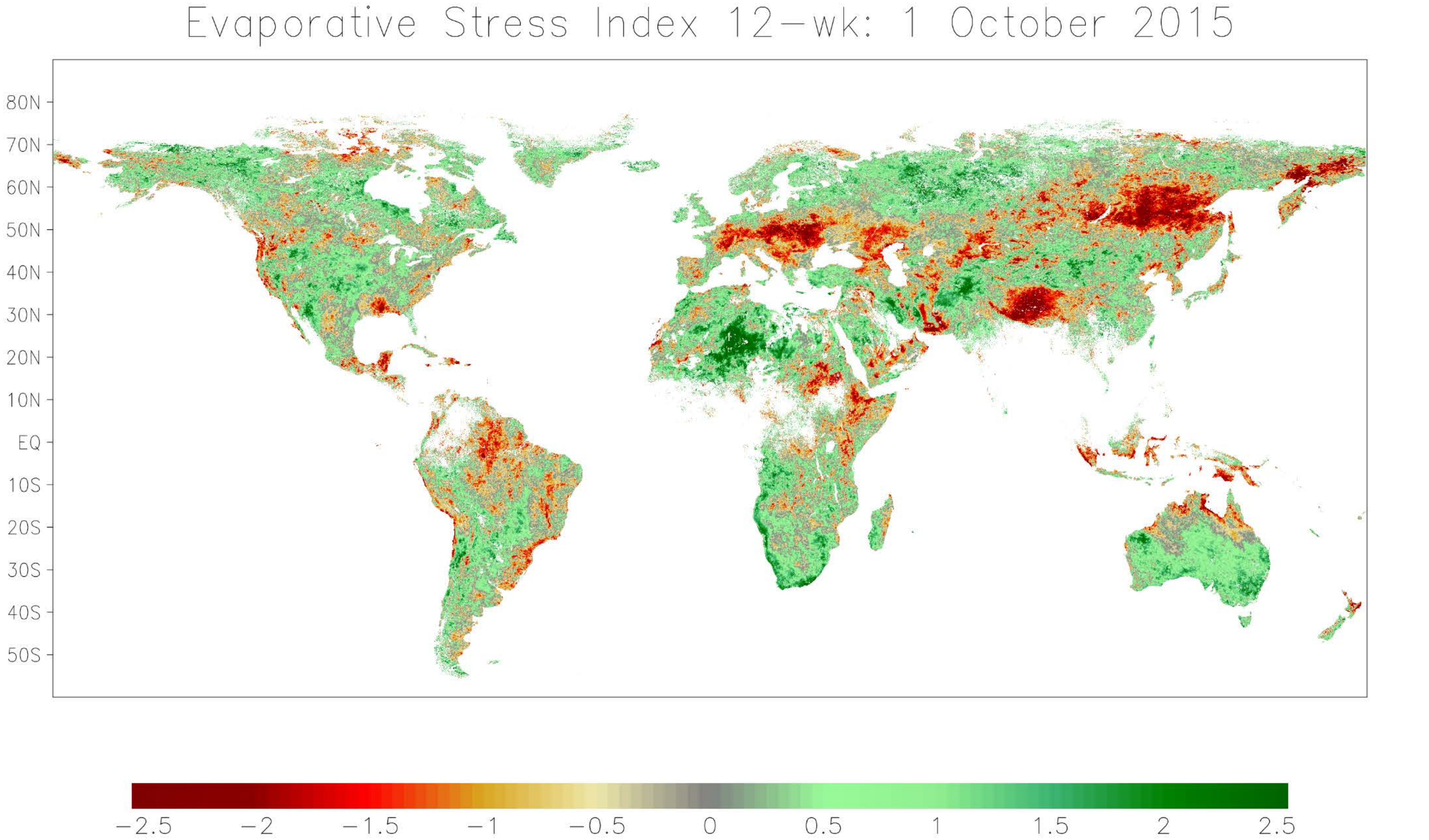
ALEXI Evaporative Stress Index: 12−week Composite

Initialized : 5 August 2012



ALEXI NAMR 10−km Grid (820x560) | ALEXI 2000−2011 Climatology

ESI Methodology



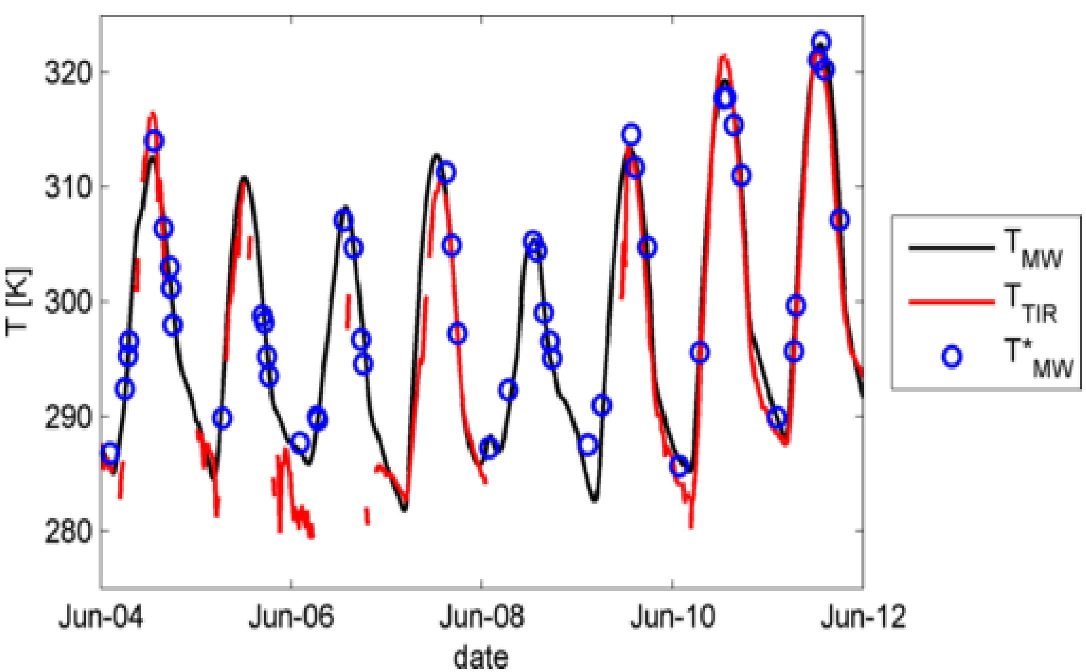
Backup Slides

Coupled Thermal / MW ALEXI System

The synergy between TIR and MW observations is further being exploited by the development of LST observations from MW observations(Ka-band).

The integration of MW LST into a coupled TIR/MW ALEXI system will allow for retrieval of surface fluxes under cloud cover (where TIR-only retrievals are not possible).

This capability fills in a significant gap in a TIR-only system over tropical equatorial regions where clear-sky retrievals may only be possible 1 to 3 times per month, particularly during the wet season .



Cumulative - Clear Sky - Evapotranspiration (mm)
Jul/Aug/Sep (2004)

TIR-ALEXI | MW-ALEXI