



WaPOR v3

ETLook evapotranspiration from field to global scale

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📅 10-12 MAY 2023 📍 ESA-ESRIN

Boulogne forest

INTERNATIONAL WORKSHOP ON HIGH-RESOLUTION THERMAL EO



Topic of this presentation



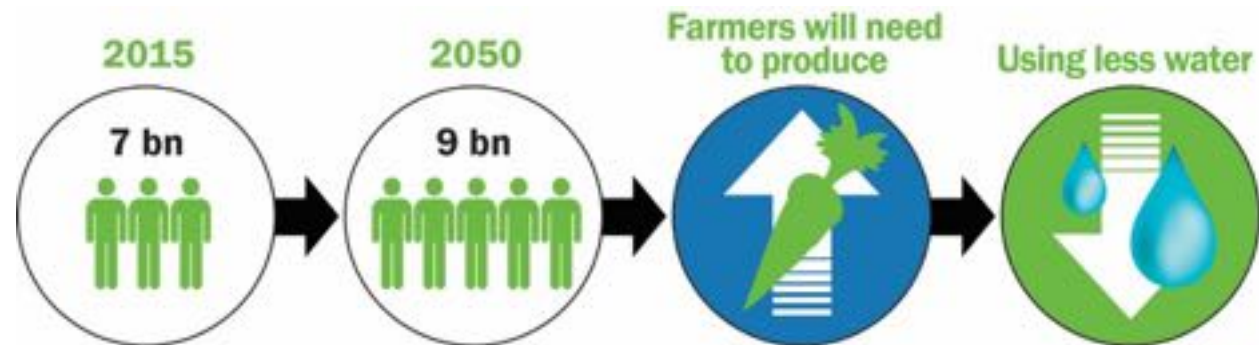
- Our experience developing and using the FAO WaPOR dataset from field to continental level.
- Three other presentations on WaPOR:
 - Livia Peiser (FAO): Keynote
 - Karlis Zalite (eLEAF): Simulating high spatial-temporal land surface temperature at scale
 - Bert Coerver (FAO): Poster presentation on PyWaPOR



Water is increasingly in short supply



- It is threatening food security and the livelihood of many people.
- Drought are occurring in higher frequency all over the world.
- Climate change will only make this problem worse.
- Agriculture is by far the biggest user of fresh water, consuming 70% of the total available water.
- It has not been high on the political agenda and most farmers do not see saving water as a high priority.
- Sentiment is changing, with more political attention and a growing focus in corporate sustainability.





Good intensions need actionable information



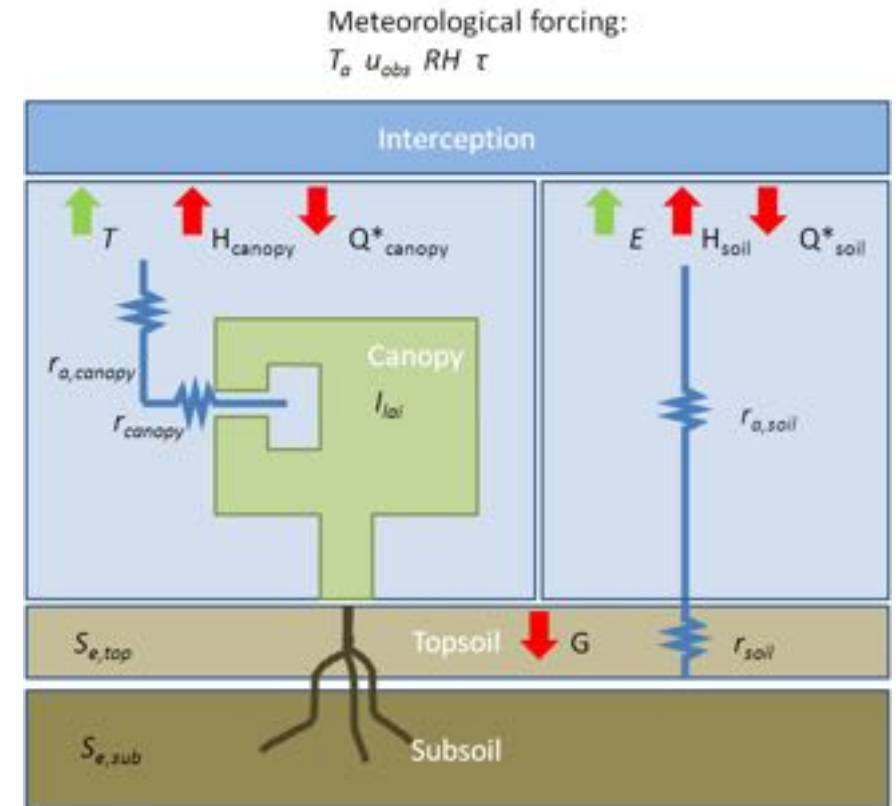
- Lack of knowledge and information is a major issue for taking action.
- It is an issue for all stakeholders, from (international) policy makers to smallholder farmers.
- Remote Sensing based solutions can play a big role in supplying this information.
- FAO's Water Productivity Portal was set up for this purpose, to map agricultural water productivity from field to the global level.
- Main data products are Actual Evapotranspiration and Net Primary Production.



ETLook Open Source



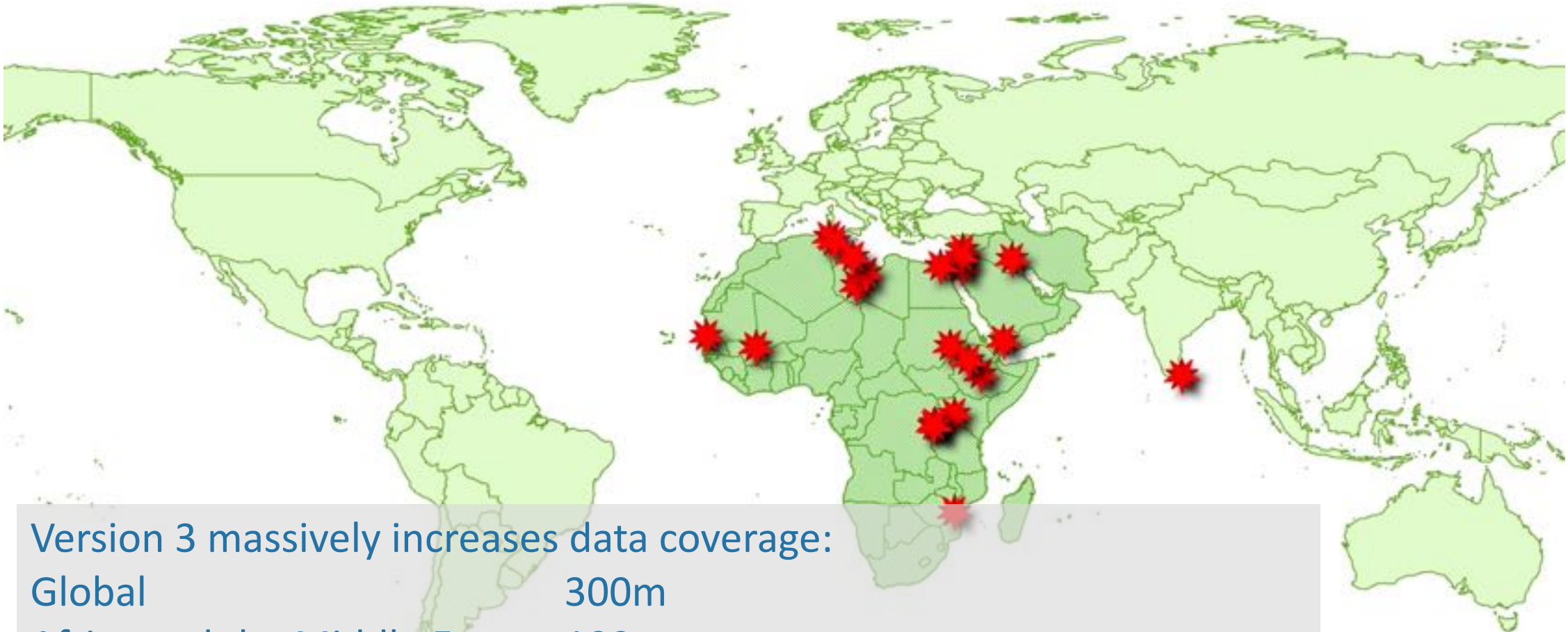
- eLEAF has developed the ETLook model.
- The Open Source version of the model was release under the name WaPOR-ETLook in 2016.
- Prior to its release, the soil moisture algorithm was substantially changed from passive radar to LST based.
- Uses the Penman monteith equation
- Daily temporal frequency.



<https://www.fao.org/in-action/remote-sensing-for-water-productivity/en>



WaPOR Versions



Version 3 massively increases data coverage:

Global	300m
Africa and the Middle East	100m
Over 20 irrigation areas	20m

Last week the continental dataset was delivered to the WaPOR portal.





Change made for Version 3



- Version 3 is a major improvement over the previous version.
Main changes:
 - Switch from MODIS to VIIRS, increasing the TIR resolution from 1000m to 375m.
 - Use of a thermal sharpening method, to enhance the resolution of the LST data.
 - Better algorithms for creating NDVI and Albedo timeseries.
- ETLook model changed only slightly



Thermal sharpening VIIRS LST

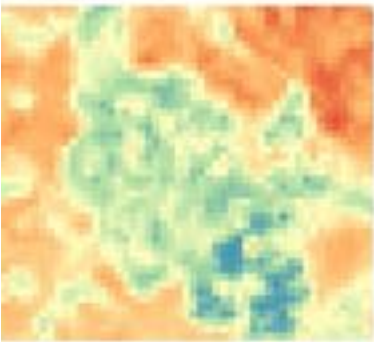


Data Mining Sharpener (DMS) methodology by Gao et al (2012) and open-access code PyDMS published by the European Space Agency (ET4FAO, Guzinski et al, 2019)

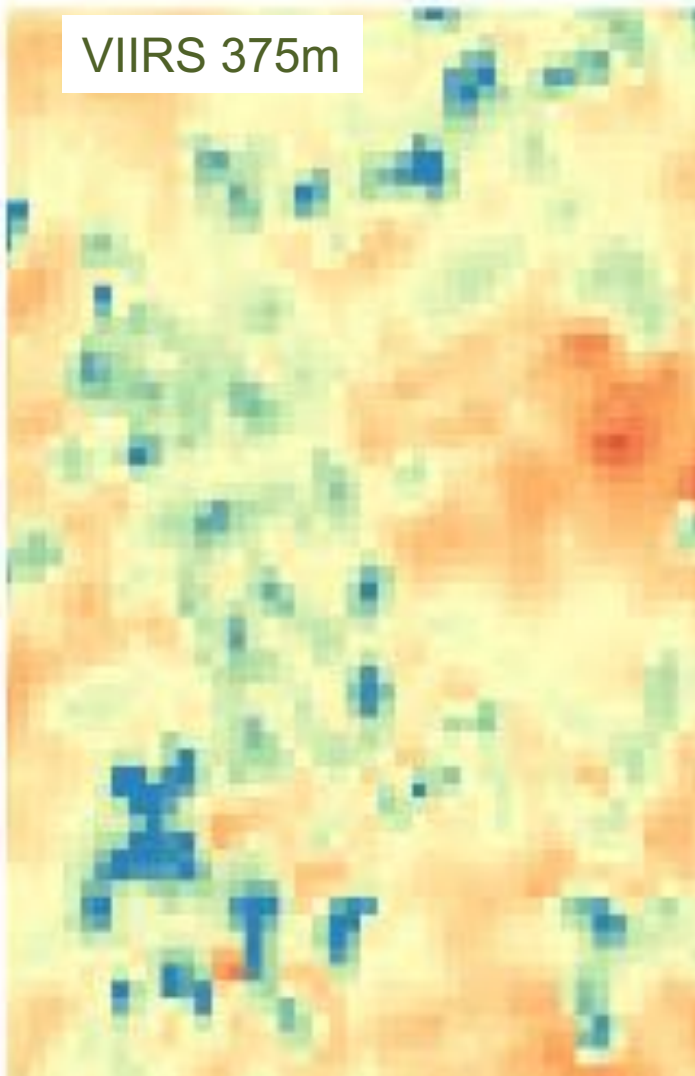
MODIS 1km



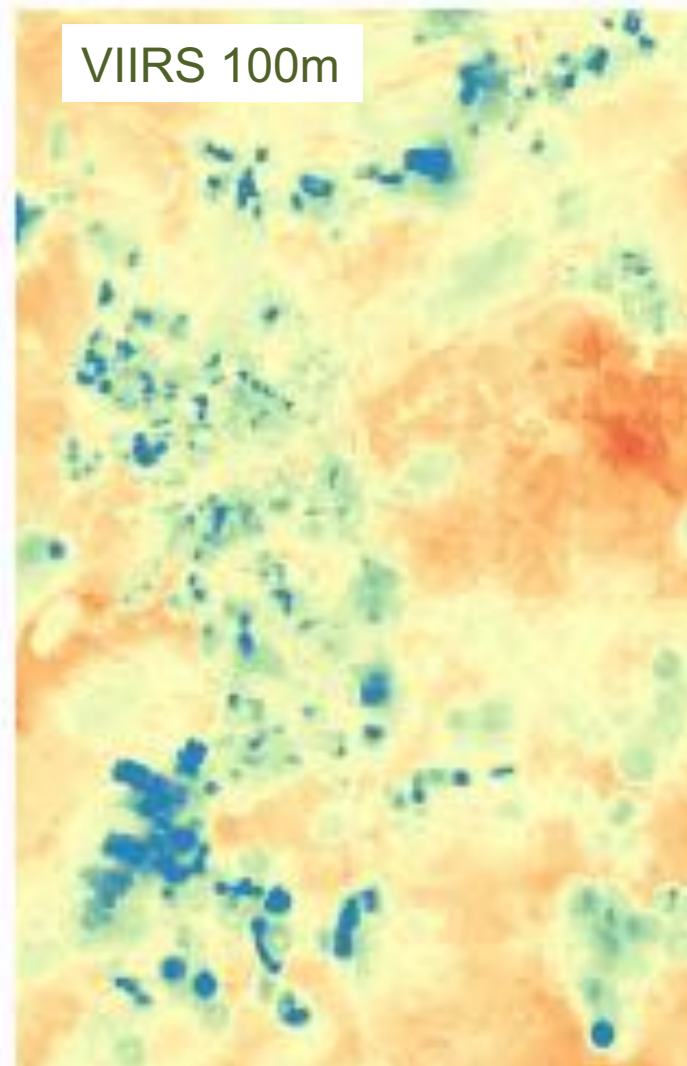
VIIRS 375m



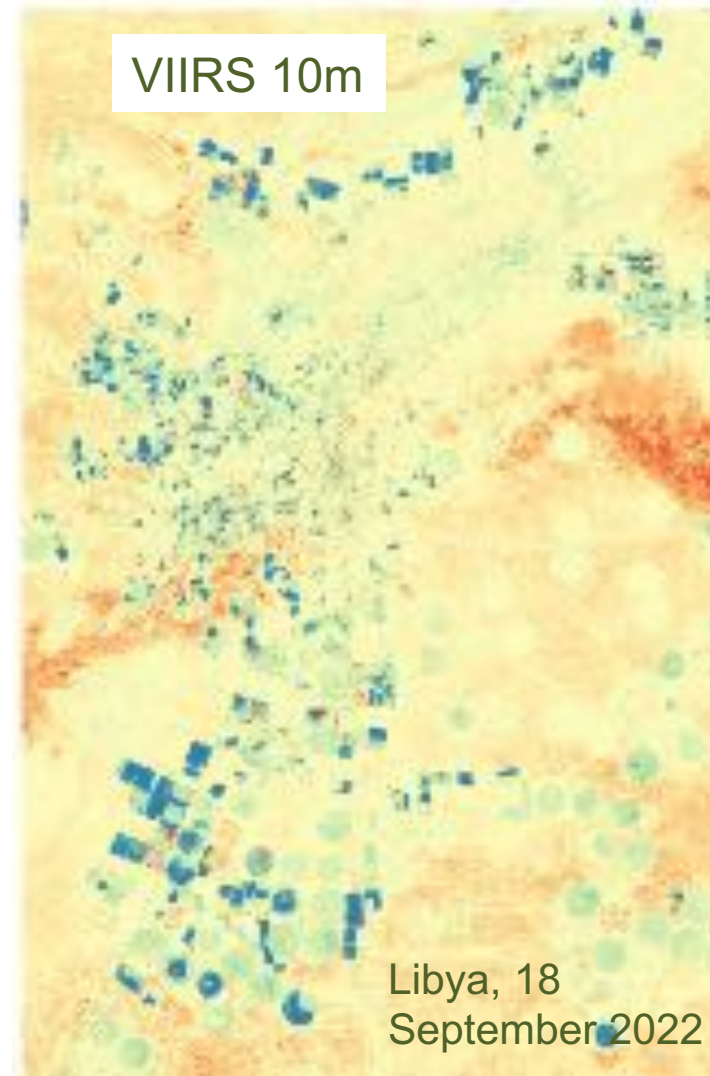
VIIRS 375m



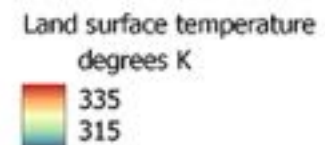
VIIRS 100m



VIIRS 10m



Libya, 18
September 2022

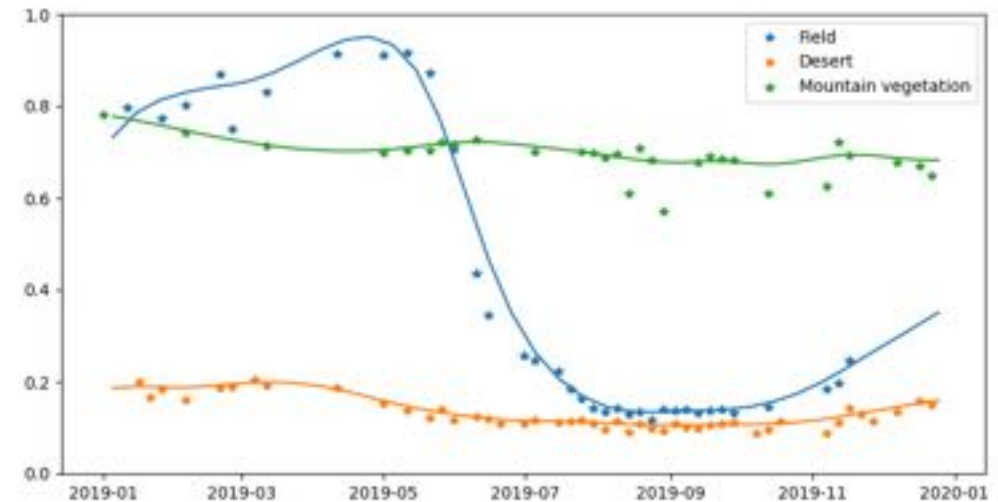
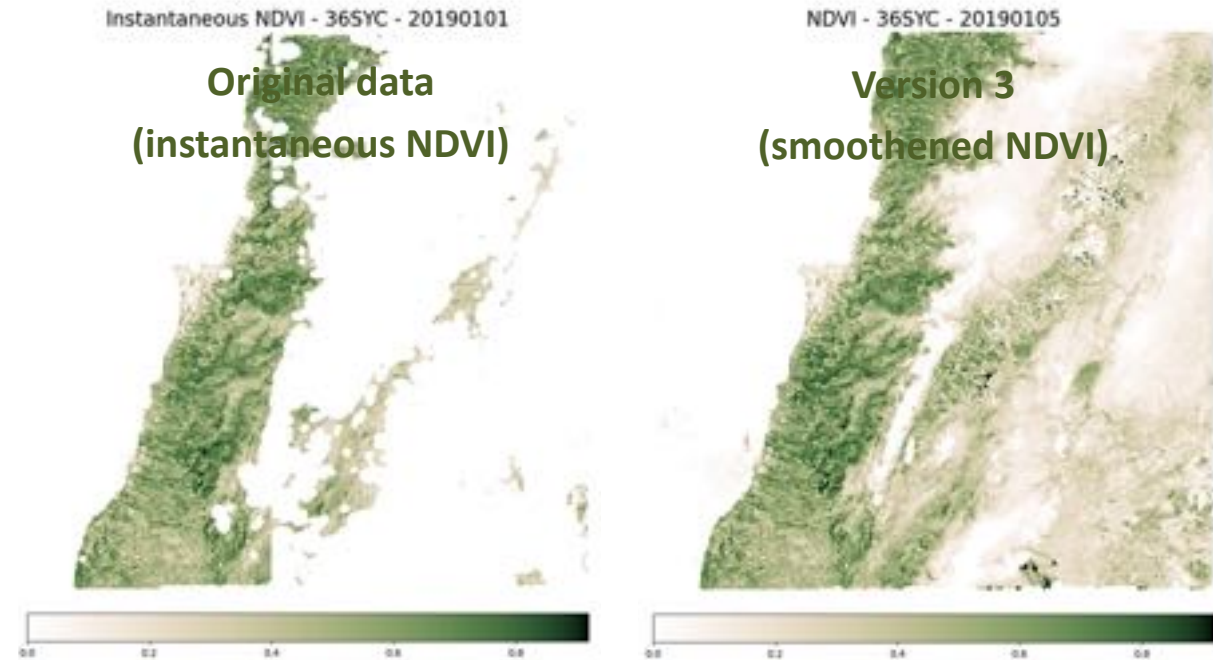




NDVI and Albedo

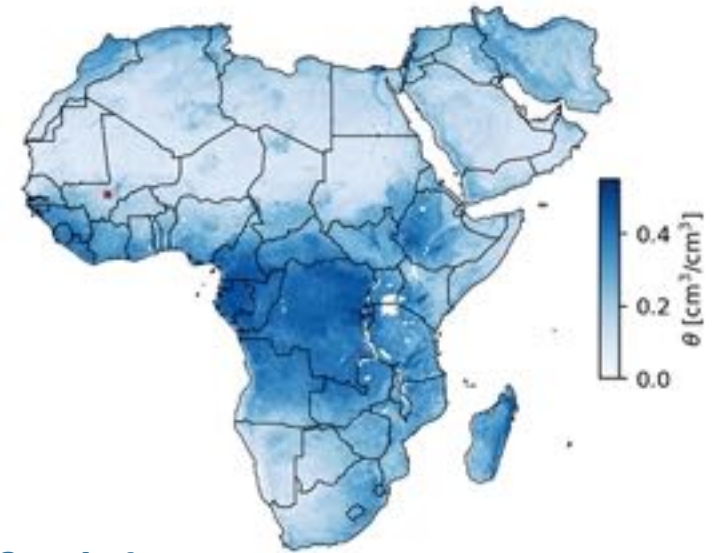


- Improved data quality with new Kappa cloud masking procedure
- Improved smoothing and interpolation (pixel based temporal fill algorithm: the Whittaker smoother (Eilers, 2003))
- Improved gap-filling approach (Weiss, Daniel J., et al., 2014) using both spatial and temporal information





New in version 3



- Relative Soil Moisture product.
- The available Soil Moisture is scaled between field capacity (value 1) and wilting point (value 0) and applied as a stress factor to reduce Evapotranspiration.
- From internal variable to Beta version released to the wider public.
- Currently assessing how to convert it into actual soil moisture content



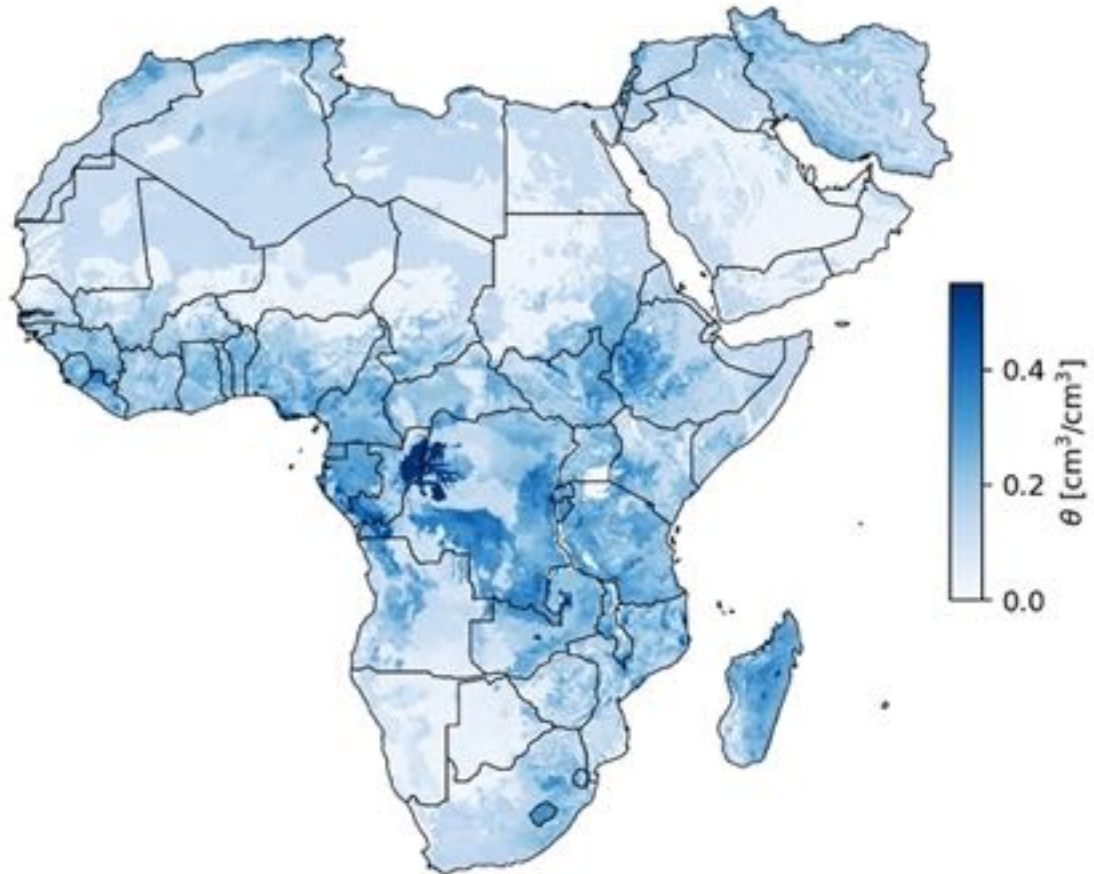
Soil Moisture: WaPOR vs SMAP



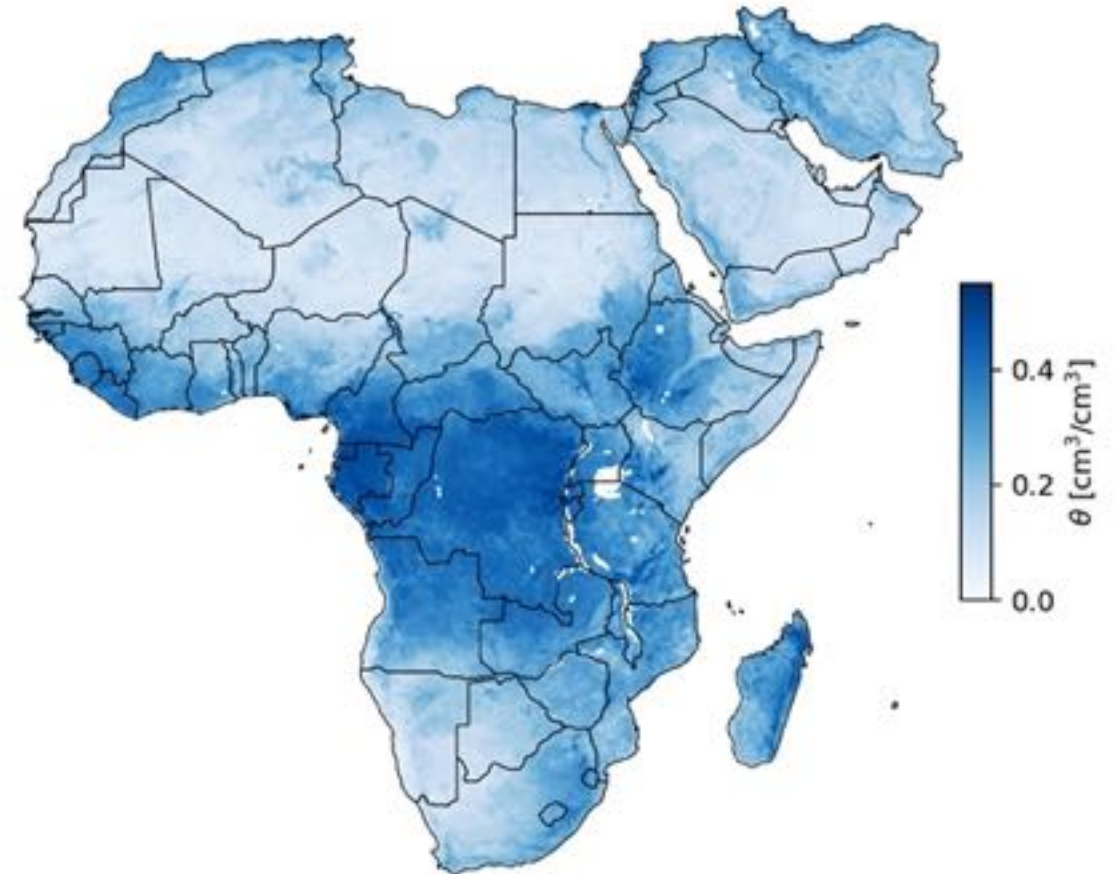
A first rudimentary comparison

20180101

SMAP L4 rootzone soil moisture



ETLook rootzone soil moisture





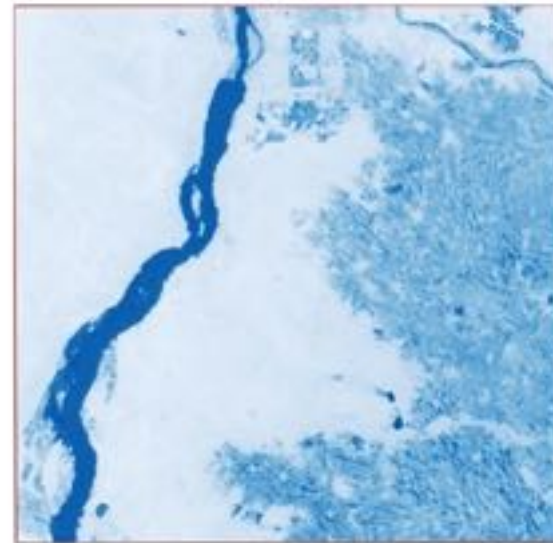
Relative soil moisture: WaPOR vs SMAP



SMAP L4
9km resolution
root zone soil moisture

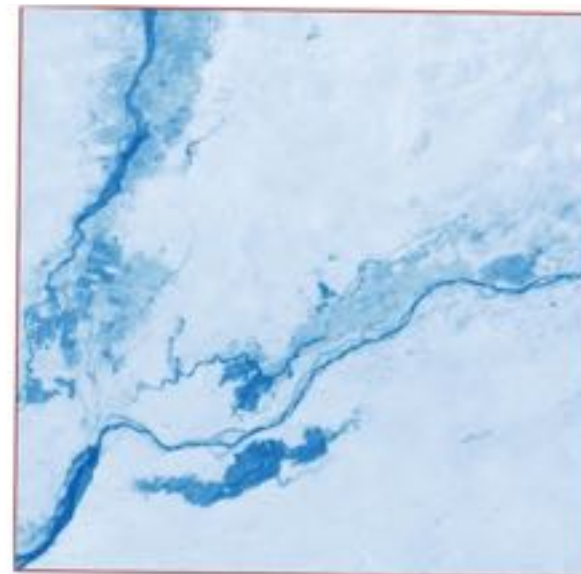


Gezira,
Sudan



WaPOR RSM
converted to absolute
values (cm³/cm³)

Office du Niger,
Mali

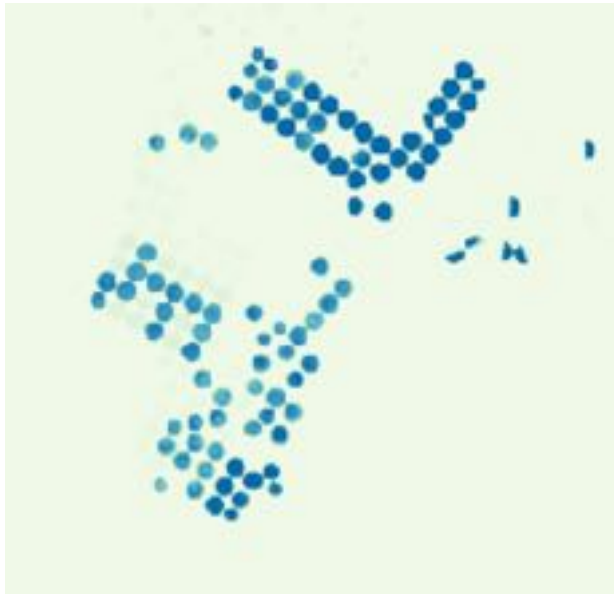




Evapotranspiration (100m)

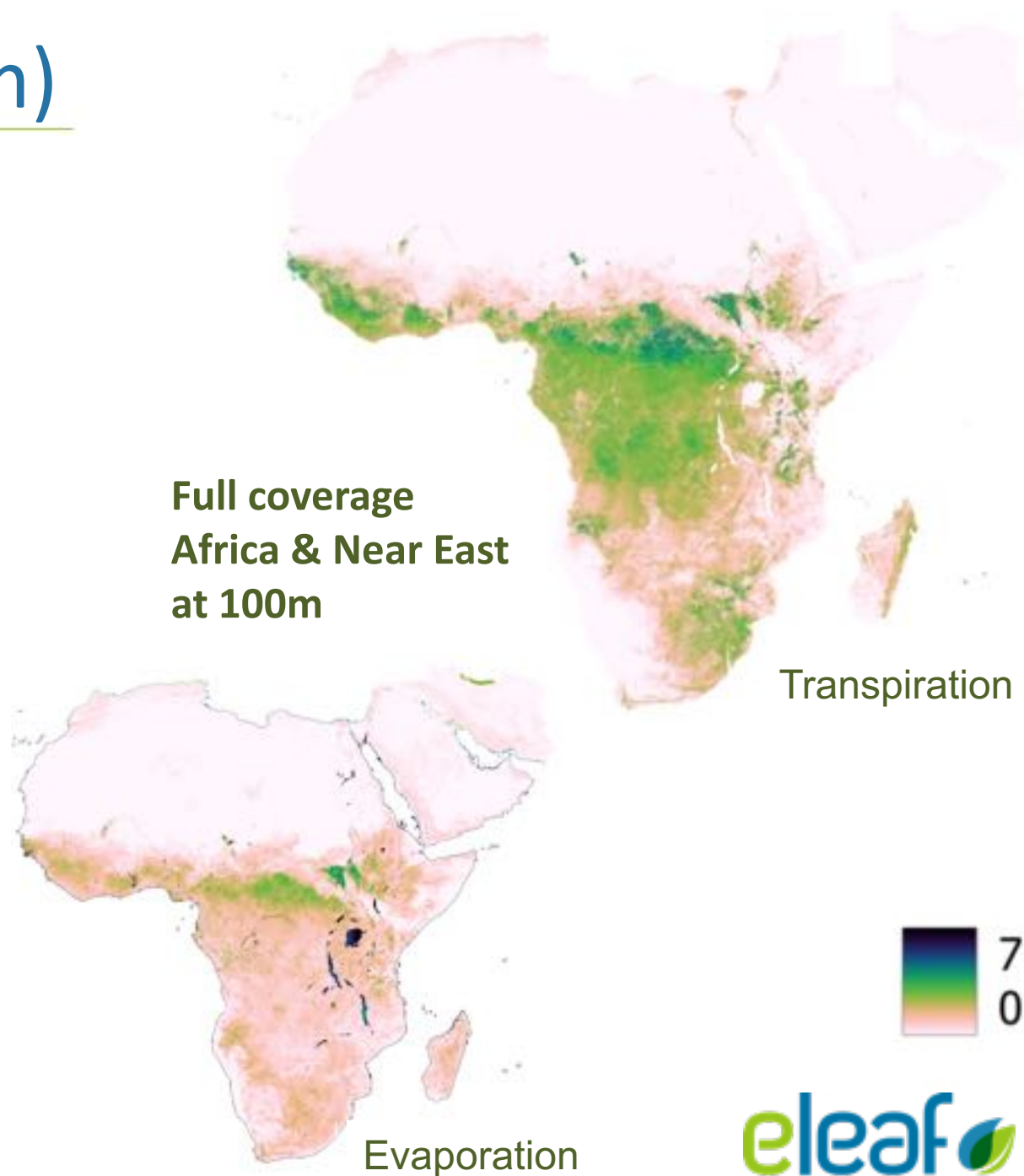


Version 2



Version 3

Transpiration 1st dekad of May 2022
Egypt pivots



Full coverage
Africa & Near East
at 100m

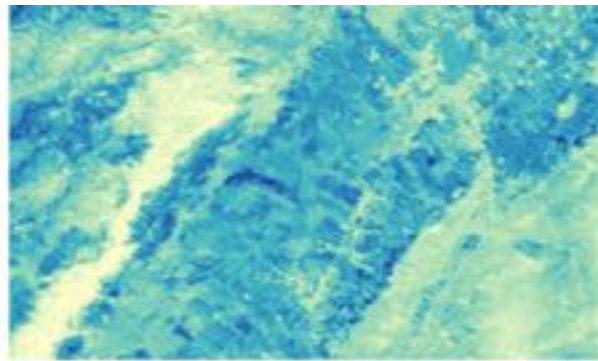
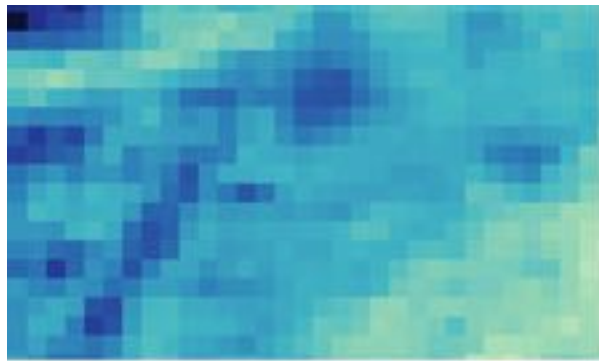
Transpiration

Evaporation



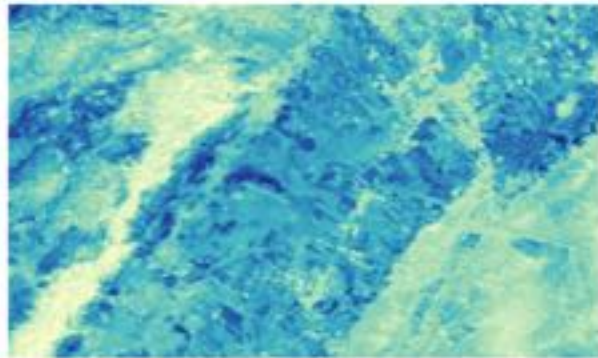
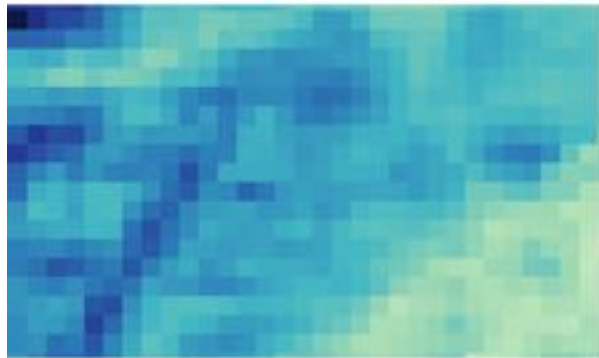


Evapotranspiration (100m)



2019

Evapotranspiration (mm/year)

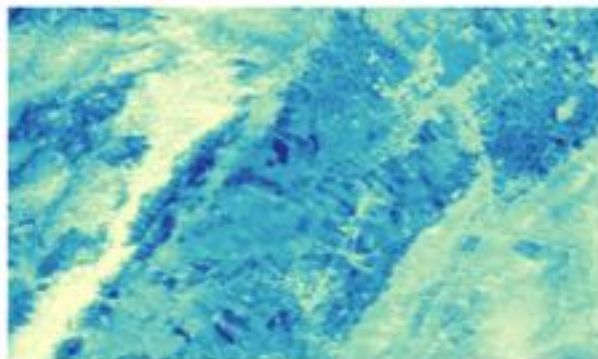
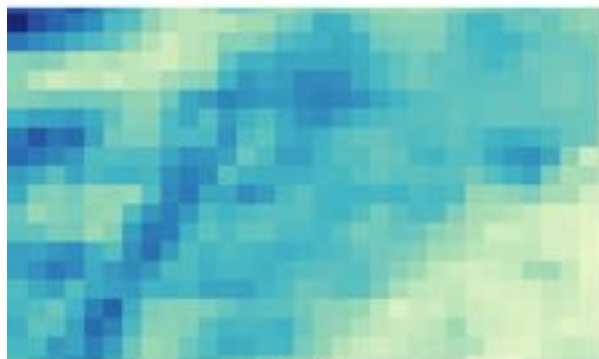


2020

Evapotranspiration (mm/year)



ist



2021

Evapotranspiration (mm/year)



FEWS SSEBop

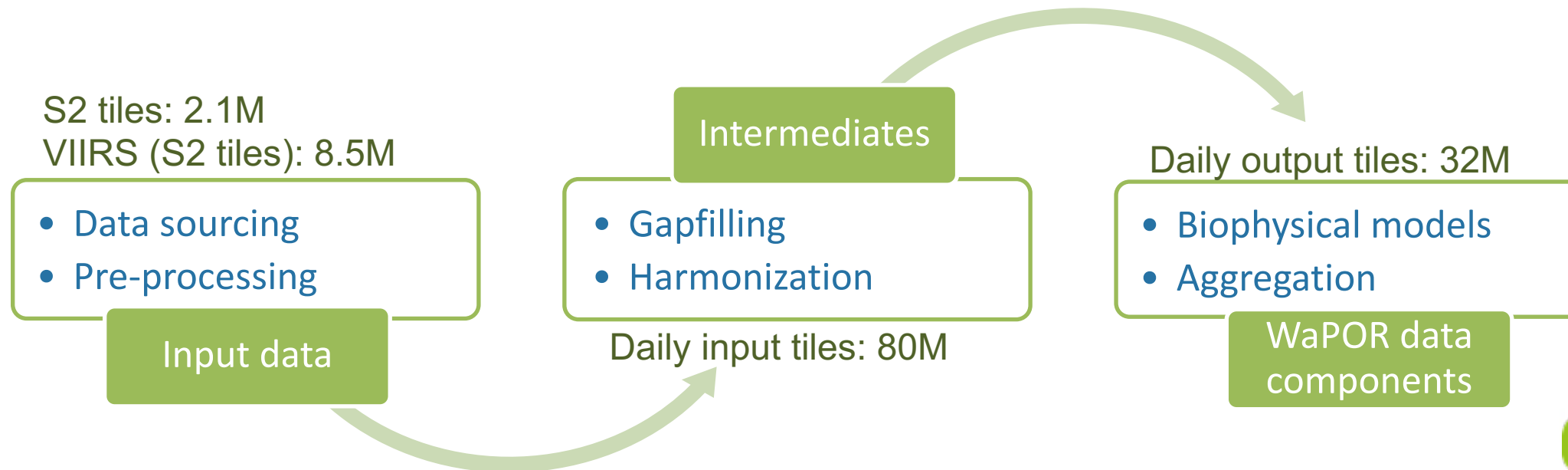
ETLook



Additional challenge to produce the data



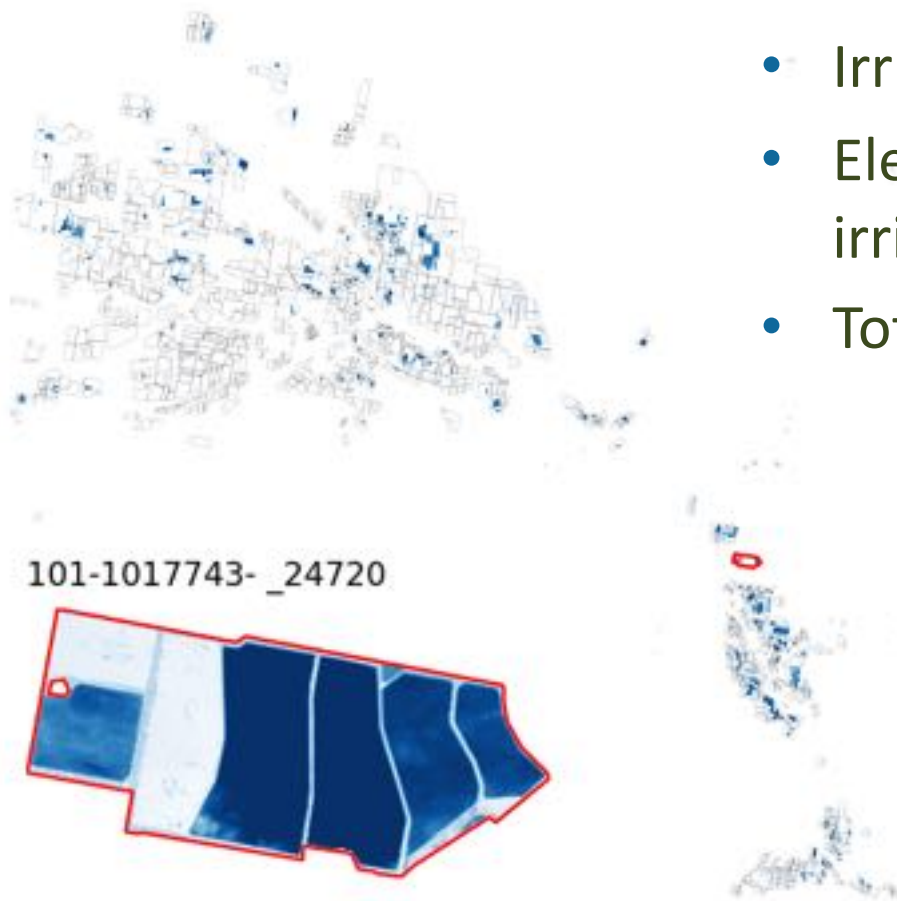
- The challenge of these new methods is that they are computationally heavy.
- The amount of data is a challenge on its own.
- Rebuild our processing infrastructure in the Cloud.
- Separated models from processing infrastructure in a modular design.



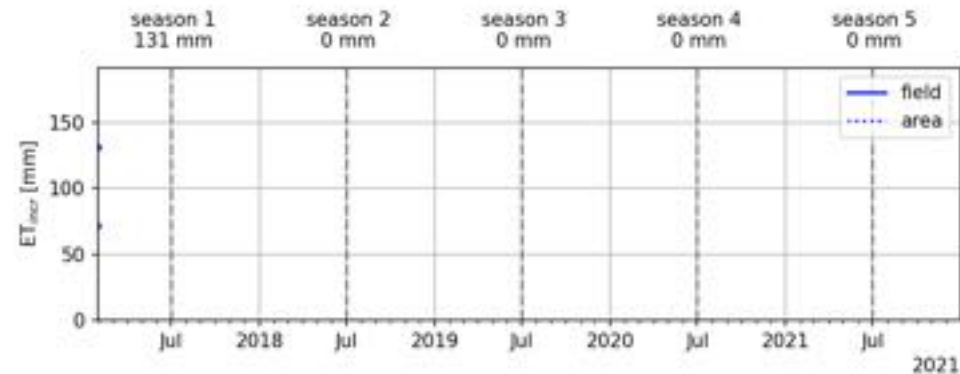


Applications based on WaPOR data

- Many possible applications to improve agricultural practices and water management with WaPOR data.



- Irrigated Water Use Monitoring in New South Wales
- Elevated level of evapotranspiration is attributed to irrigation
- Total water use calculated per cluster





Open Source preferred by Governments



- WaPOR is particularly suitable for water management because it is open source.
- Governments like to know on which basis they take decisions.
- Transparency is important particularly in the public domain, for example when enforcing water allocation rights.

The screenshot shows the Bitbucket interface for the repository 'wapor-et-look'. The left sidebar contains navigation links: Source, Commits, Branches, Pull requests, Pipelines, Deployments, Jira issues, and Security. The main content area displays the 'WIKI CONTENT' for the repository, which includes sections for 'Getting started', 'Understanding the WaPOR pipeline', 'Intermediate data components', 'Data Sources', 'WaPOR data components and methodology', and 'References'. Below the Wiki content, there is a 'Release Notes' section for version 3.0, dated 2022/07/20, with a bullet point indicating that 'Emissivity estimates' were added to VIIRS.

Bitbucket

wapor-et-look

- Source
- Commits
- Branches
- Pull requests
- Pipelines
- Deployments
- Jira issues
- Security

WIKI CONTENT

Getting started for Abbreviations and Definitions

Understanding the WaPOR pipeline for a general overview of the produced WaPOR database components, the Technical Approach to produce these components, the WaPOR intermediate Data Components and Related Inputs produced and pre-processing applied, and the Code Repository with links to all relevant documentation.

Intermediate data components for detailed documentation on Albedo, fAPAR, Land Surface Temperature, Light Use Efficiency (LUE), NDVI, Precipitation, Solar radiation, Statics and Weather data

Data Sources for an overview of all input data (both model and sensor data) used to produce the (intermediate) data components: CERES, CHIRPS, Copernicus DEM, (Ag)ERAS, FengYun, GEOS-5, MSG, Landsat, Sentinel-2, Sentinel-3 and VIIRS

WaPOR data components and methodology described in more detail and also includes the underlying methodology as well as the scripts used for Evapotranspiration (AET), Land Cover Classification (LCC), Net Primary Productivity (NPP), Precipitation (PCP), Phenology (PHE) Quality layers (QUAL), Reference Evapotranspiration (RET), Soil moisture (RSM), Total Biomass Production (TBP) and Water Productivity (WP)

References provides all literature references

Release Notes

3.0 2022/07/20

- Emissivity estimates added to VIIRS



More Thermal Infrared is better



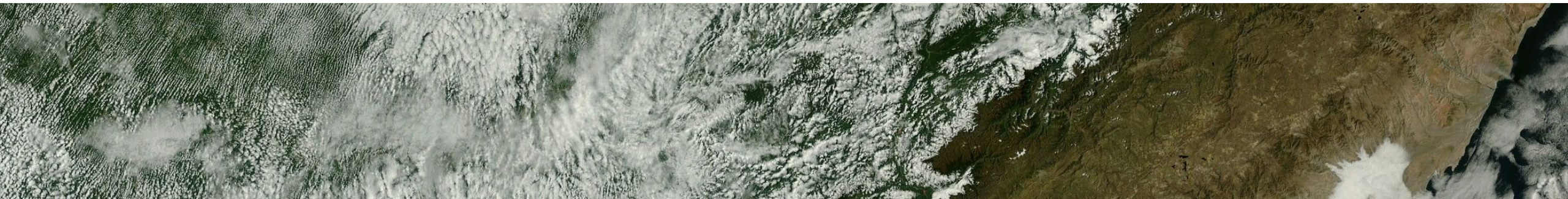
- eLEAF is a heavy user of Optical and TIR data to produce the WaPOR dataset and for its other data as well (MODIS, VIIRS, S2, S3, Landsat).
- WaPOR version 3 shows good results with the existing available data.
- Satellite missions carrying high spatial-temporal thermal infrared sensors such as LSTM, TRISHNA and SBG are expected to improve the results further.



Cloud cover



- Some areas suffer from very persistent cloud cover, making it challenging to create good quality data.
- Radar based products can play a role here, but our experience is that when optical is available it yields better results because it better represents the (bio)physical processes of the vegetation cover.
- More overpasses increase the change of collecting valid observations, increase the quality of the data.





Modelling vs Observing



- New methods become increasingly good at reconstruction images to fill the gaps or increase the resolution.
- These methods are based on generalized trends and correlations. Such as with Smoothing and Thermal Sharpening.
- We are interested in the situations where this trends or correlation does not hold up. Where a field is performing different than general trend.
- More high-resolution data can observe this better, improving the quality.





Assessing and Explaining Quality



- Assessing the quality is not always easy, particularly in Africa where it is difficult to find good reference data.
- A more concerted effort by the international community would be helpful, for developers and users.
- It will make explaining the quality to users easier, supporting a broader societal acceptance of the technology.





Conclusion



- WaPOR version 3 data is a major improvement over the previous versions, giving good results at medium (100m) and high (20m) resolution.
- Higher resolution TIR data and enhancement techniques are behind this improvement.
- New high resolution TIR data will further improve the quality.
- More effort to validate and explain the quality of remote sensing based products is needed.



Next Steps



- High resolution areas (20m) will be added to the WaPOR portal in the coming weeks.
- A global 300m product will be release during the summer.
- Start with Version 3 Assessment and Validation, expending collaboration with other organizations.
- Further development of ETLook and implementation of other models on our production system.
- Release long time series of low Resolution for climate risk assessment.
- **Adding the new TIR data to WaPOR and other products**



Thank you for listening

Contact:
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