HERRAMIENTAS PARA LA GESTIÓN FUTURA DEL AGUA

IV CONGRESO INTERNACIONAL AGUA PARA EL FUTURO

High-resolution Remote Sensing for Sustainable Agricultural Water Management

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IRRIGACIÓN Agua que da vida

MENDOZA GOBIERNO

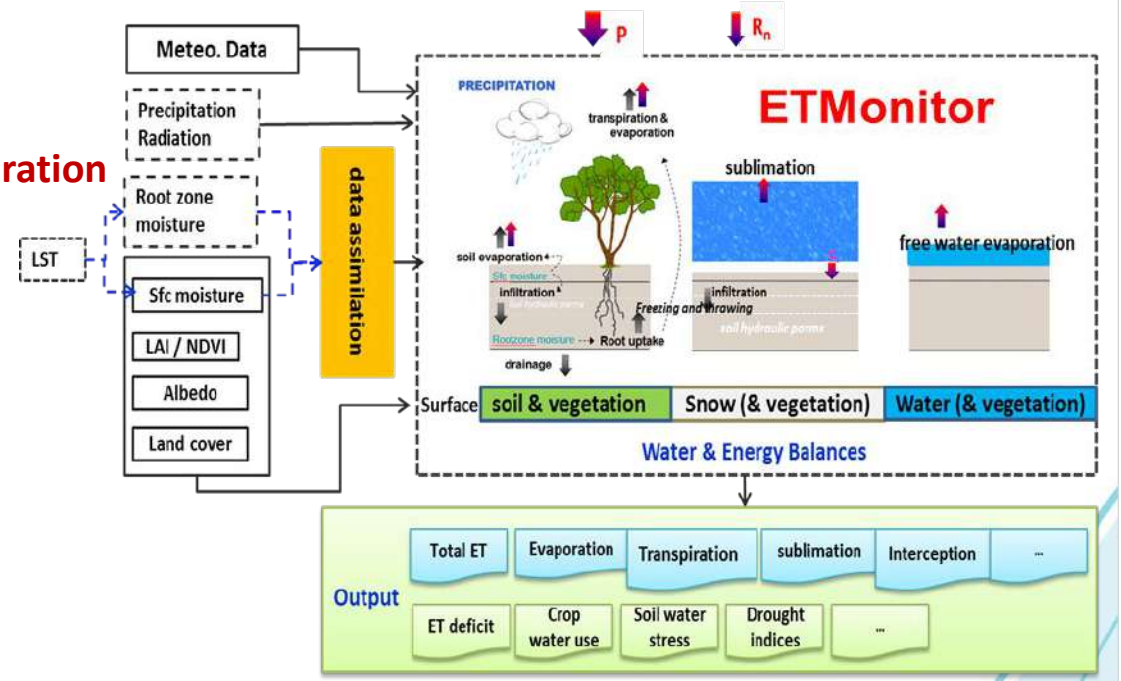
Outline

- Evapotranspiration
- Precipitation Deficit (Water Availability)
- Irrigation Efficiency
- Snow Water Equivalent

Evapotranspiration

ETMonitor: a model driven by multi-source satellite remote sensing data

- a model built upon energy balance, water balance and plant physiology processes
- estimate land surface **actual evapotranspiration (ETa)** and its **components**:
  - **soil evaporation**: Es;
  - **water evaporation**: Ew;
  - **plant transpiration**: Tr;
  - **canopy interception loss**: Ei;
  - **snow sublimation**: Ss;
  - total water flux.
- in a spatial distributed way:
  - **grid sizes: 10m – 30m – 1km**
  - **at daily step**

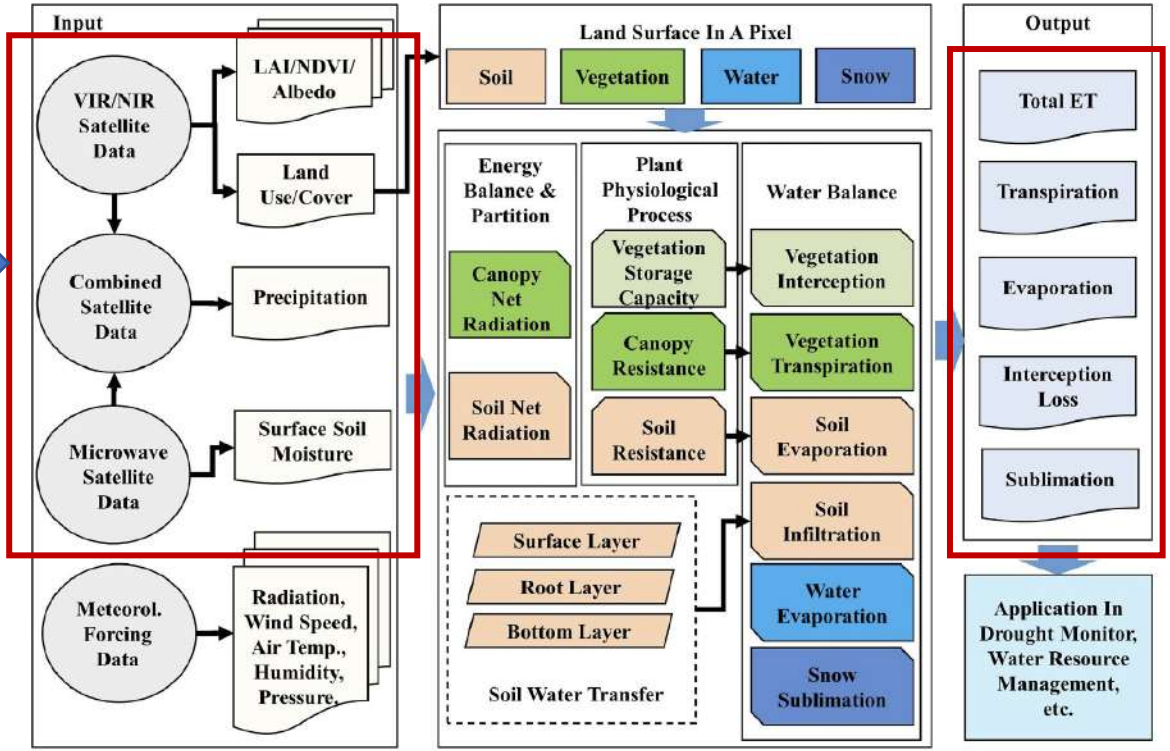


Hu, Jia, et al., 2014, GEWEX conference; Hu & Jia, RS, 2015; Cui & Jia, 2014, Water; Cui, Jia, et al., 2015, IEEE GRSL; Cui, 2016, PhD dissertation; Wang et al., 2017, IEEE JSTARS,; Wang, 2017, PhD dissertation; Zheng & Jia, 2017, IGARSS; Jia et al., 2018, book Chapter; Zheng, Jia, et al., RS, 2019; Chen, Jia, et al., AFM, 2019; Zheng & Jia, 2020, Ecohydrology, J. Hydrology; Cui & Jia, 2021, JoH; Zheng, Jia, et al, 2022, J. Hydrology; Hu, Jia et al, 2023, manuscript.

Evapotranspiration

Input: multi-source satellite observations

ETMonitor



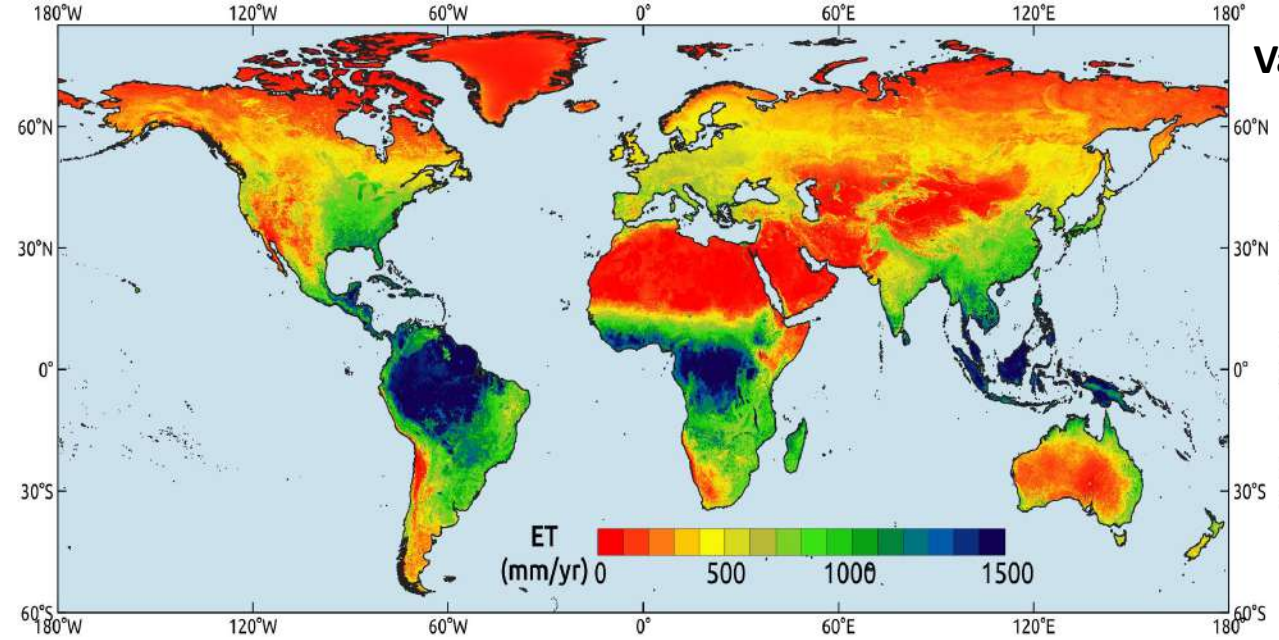
Output:

- Total actual ET (ETa)
- soil evaporation
- water evaporation
- plant transpiration
- canopy interception loss
- snow sublimation

@ 10m - 30m -1km resolution & daily

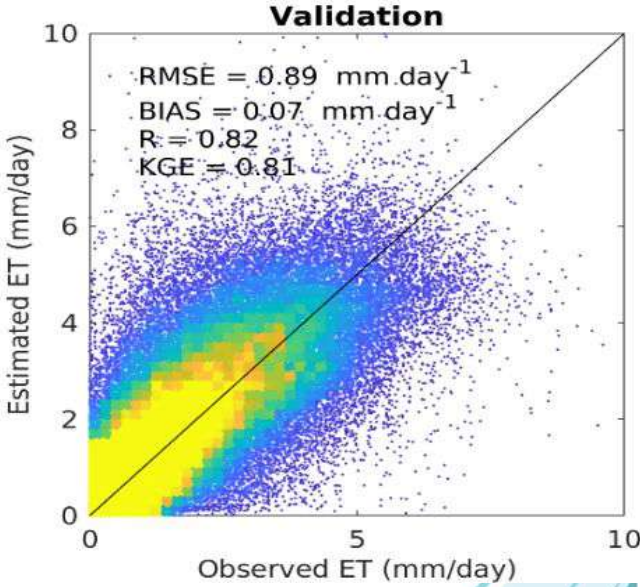
Evapotranspiration

ETMonitor global ET dataset: 21 years (2000-2021) at 1km spatial resolution and daily step



Zheng, Jia, Hu, 2022, Journal of Hydrology

Validation @ 252 flux towers globally



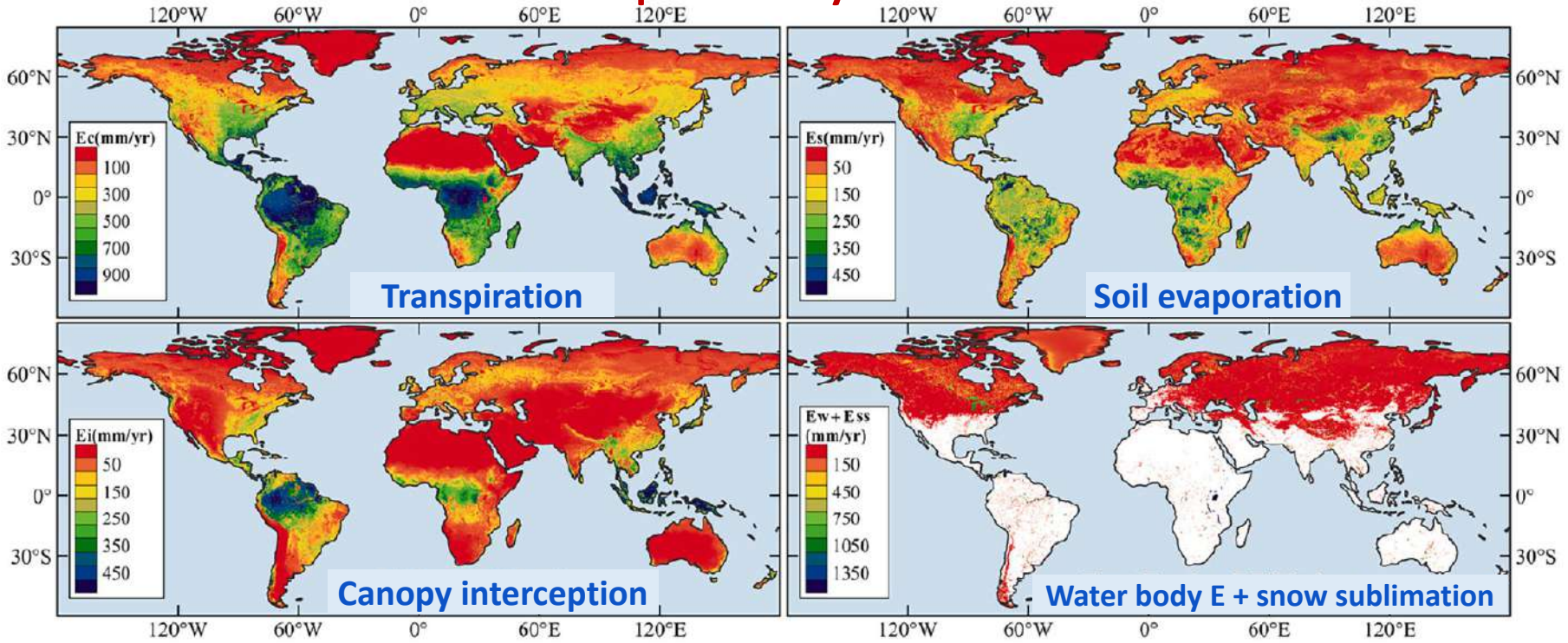
overall RMSE=0.93 mm/d

Data download: https://doi.org/10.12237/casearth.6253cddc819aec49731a4bc2

Evapotranspiration

ETMonitor global ET dataset: 21 years (2000-2021) at 1km spatial resolution and daily step

ET components by ETMonitor

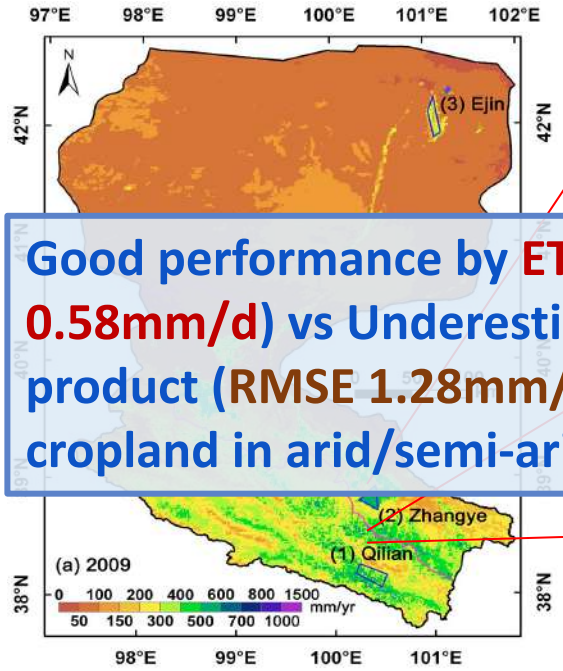


Zheng, Jia, Hu, 2022, Journal of Hydrology

Evapotranspiration

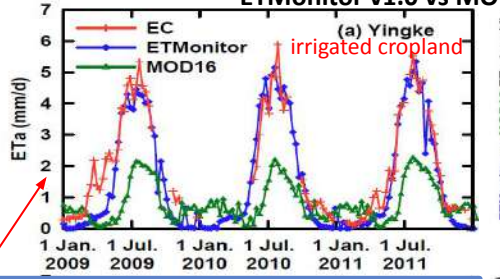
ETMonitor global ET dataset: 21 years (2000-2021) at 1km spatial resolution and daily step

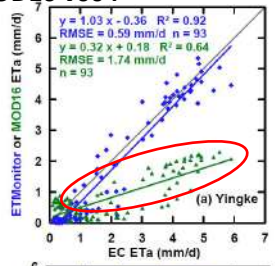
Heihe River Basin, arid/semi-arid climate

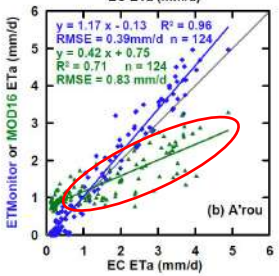


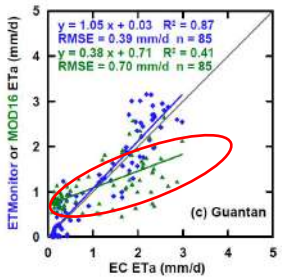
Hu and Jia, Remote Sensing, 2015

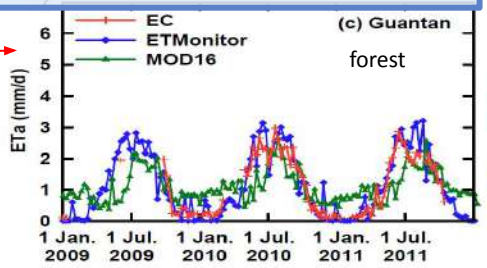
ETMonitor v1.0 vs MOD16 v004



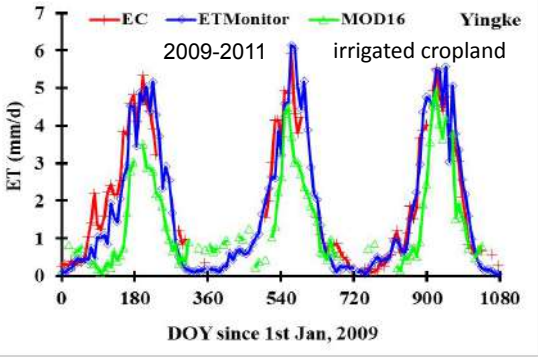


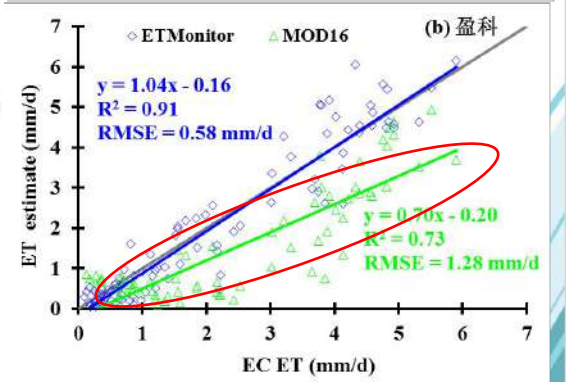






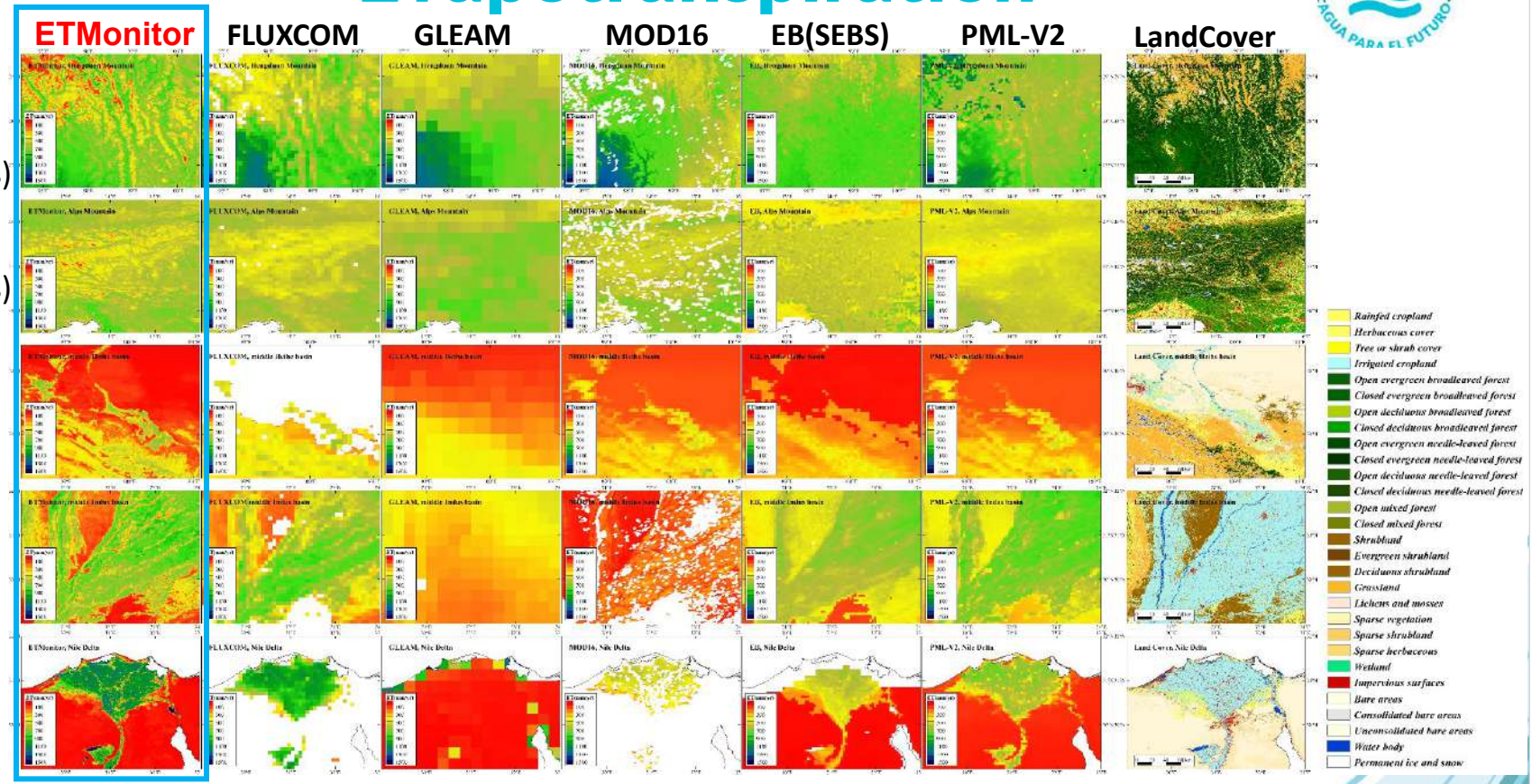
ETMonitor v1.0+assim vs MOD16 v005





Good performance by ETMonitor (RMSE 0.58mm/d) vs Underestimates by MODIS ET product (RMSE 1.28mm/d) for irrigated cropland in arid/semi-arid area

Evapotranspiration



Zheng, Jia, Hu, 2022, Journal of Hydrology

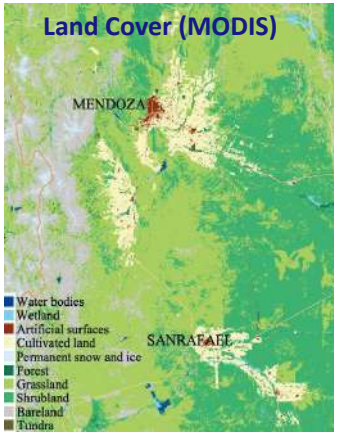
ETMonitor performs better in mountain area and irrigation cropland area

Evapotranspiration

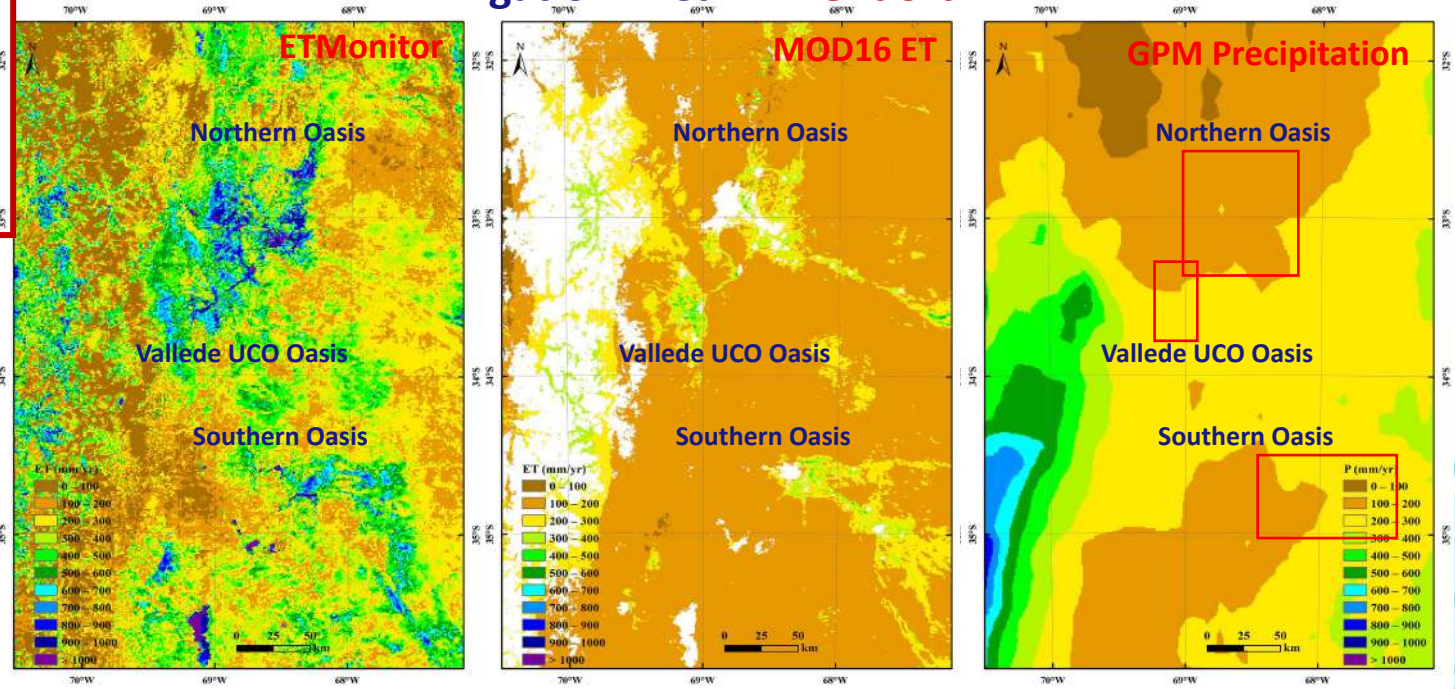
ETMonitor global ET dataset: 21 years (2000-2021) at 1km spatial resolution and daily step

For Mendosa Oasis (mm/yr)
(2019 July – 2020 June)

- **ETMonitor: 543.5**
- **MOD16: 270.0**
- **Precipitation: 198.2**



ET in Irrigation Area in Mendoza



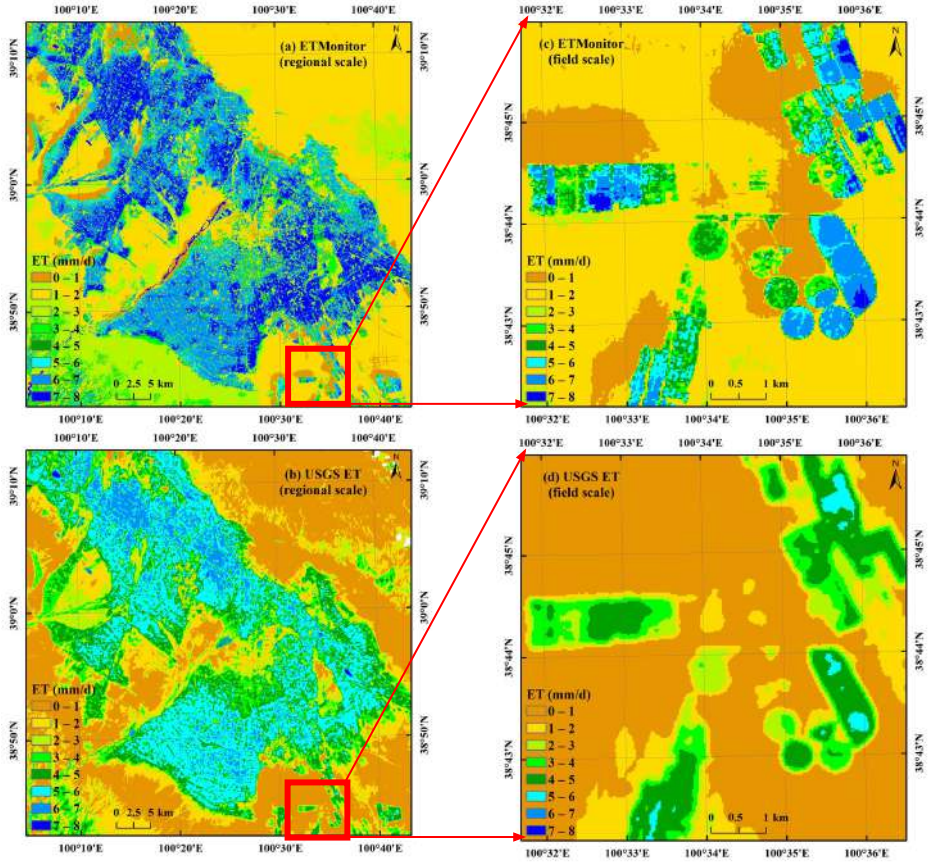
- ETMonitor shows reasonable spatial patterns with respect to the diverse landscapes in Mendoza
- MOD16 ET is underestimated especially for the irrigated oasis located in a semi-arid climate

High resolution farmland ET

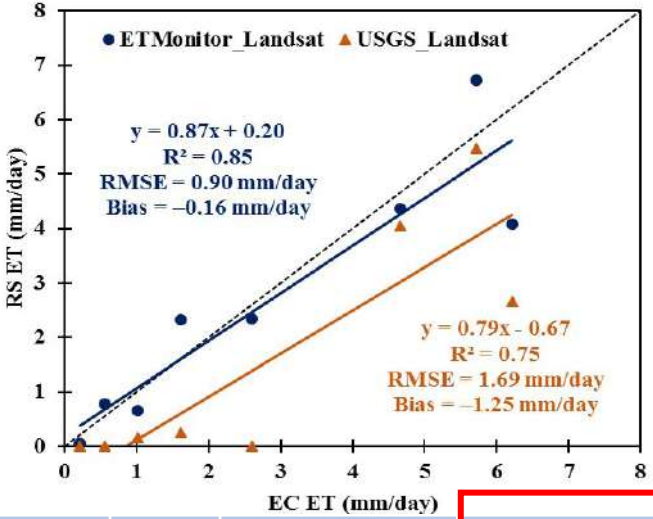
ETMonitor @30m resolution farmland ET mapping based on Landsat (Heihe River Basin, China)

ETMonitor

USGS ET



Validation using field EC measurements



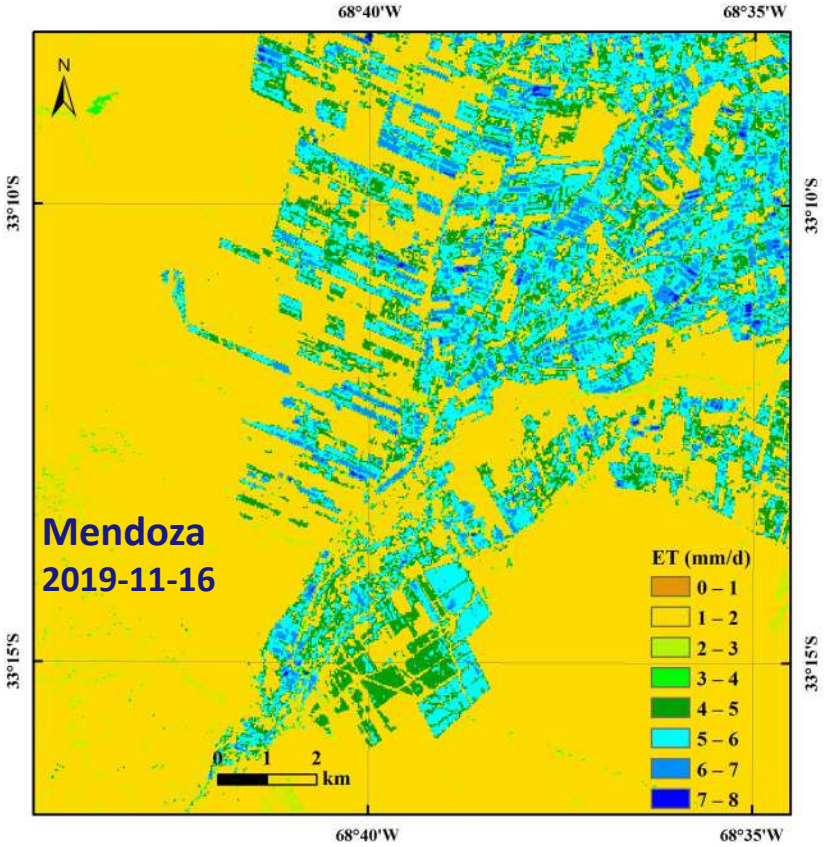
	R2	RMSE (mm/d)	BIAS (mm/d)
ETMonitor	0.85	0.9	-0.16
MOD16 ET	0.75	1.69	-1.25

Hu, Jia et al., 2023, manuscript

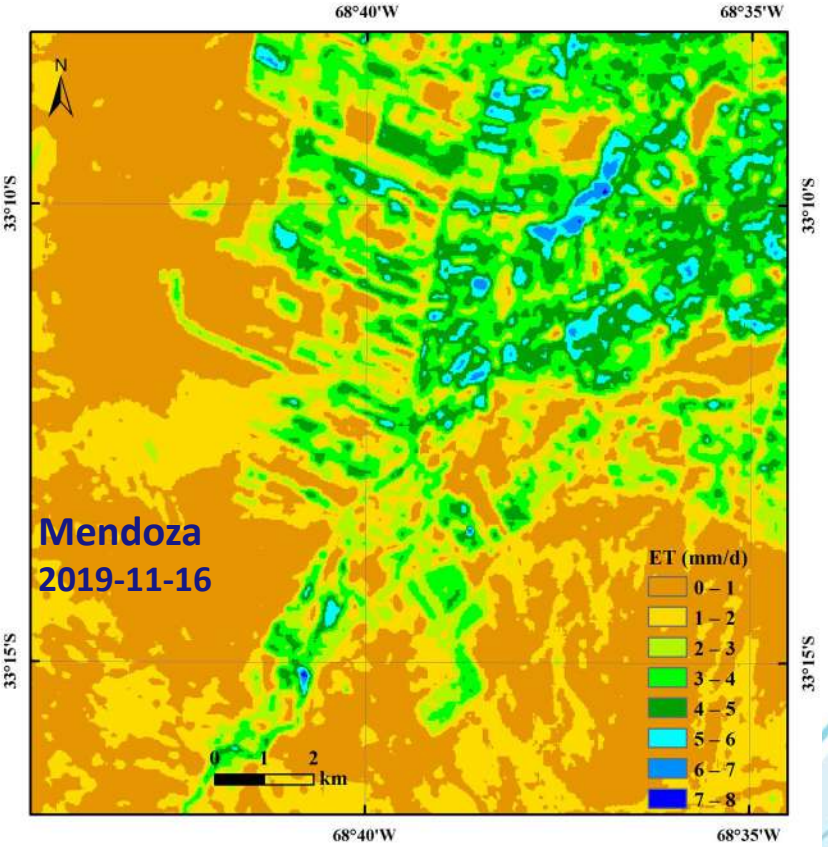
High resolution farmland ET

Mendoza

ETMonitor 30m ET



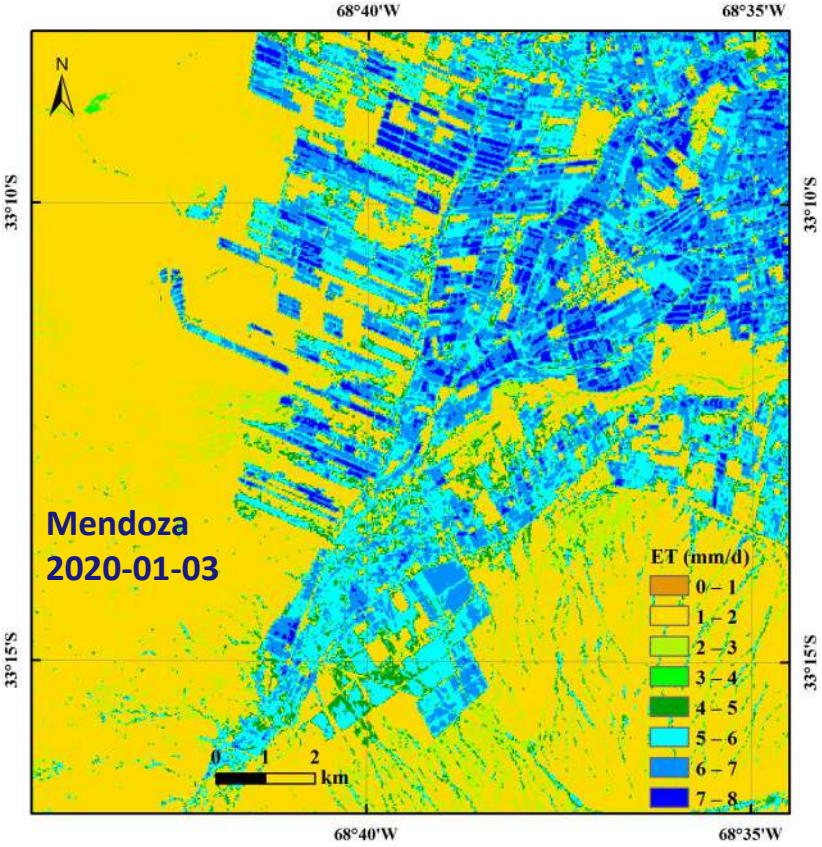
USGS 30m ET



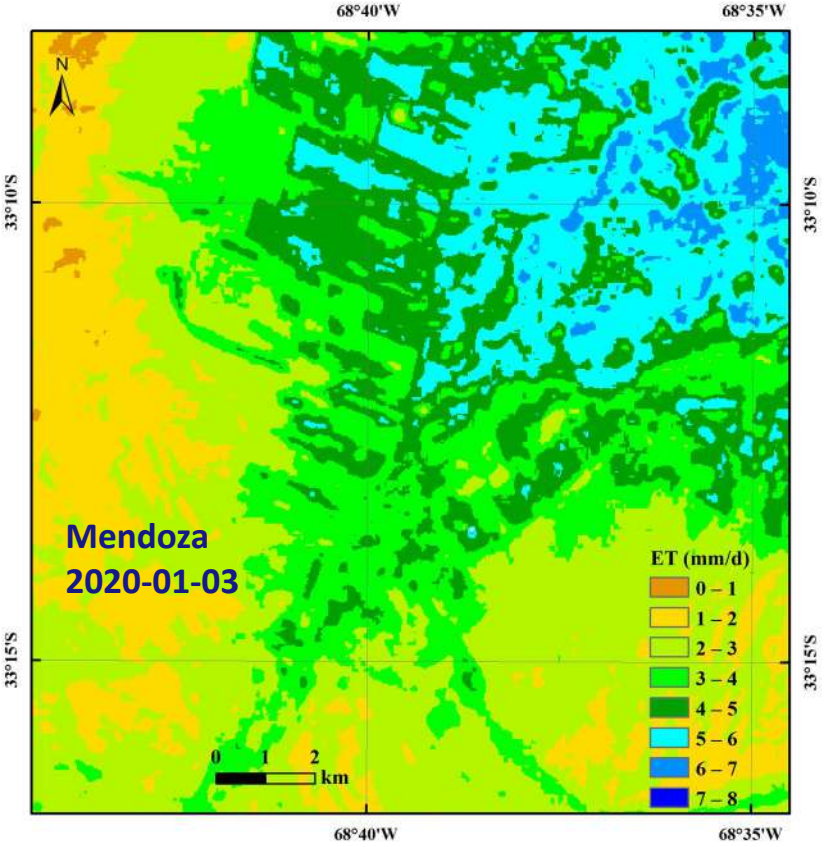
High resolution farmland ET

Mendoza

ETMonitor 30m ET



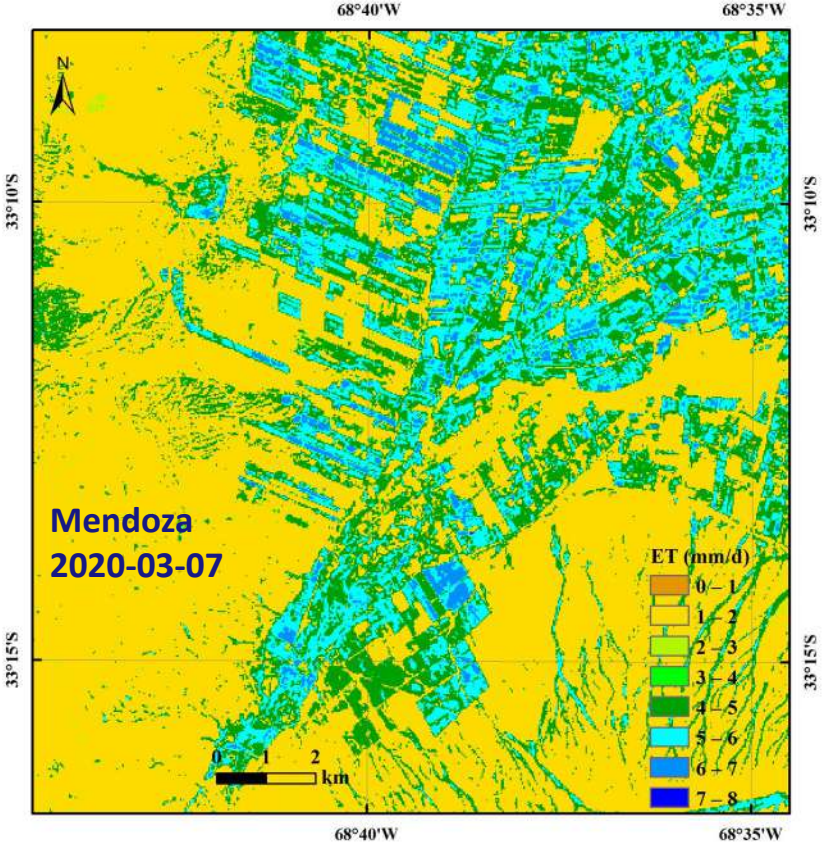
USGS 30m ET



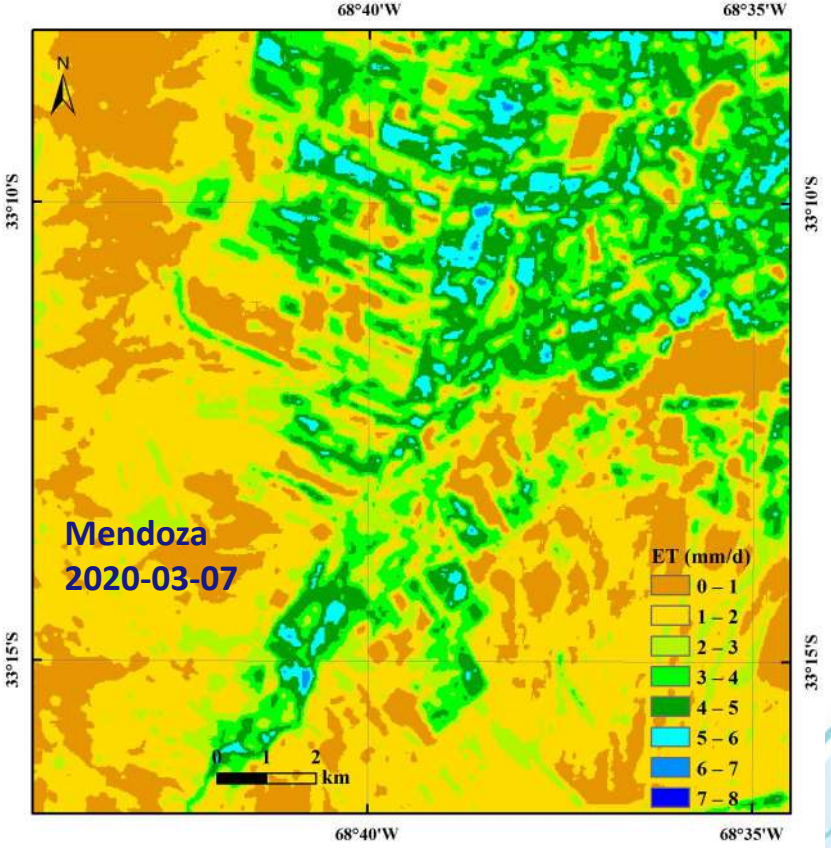
High resolution farmland ET

Mendoza

ETMonitor 30m ET



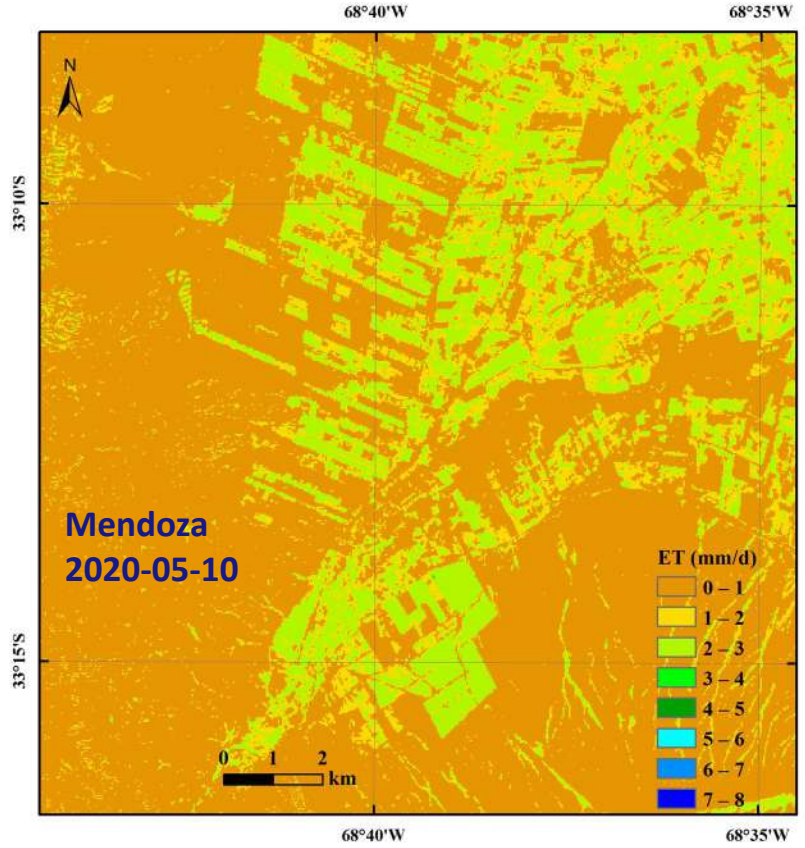
USGS 30m ET



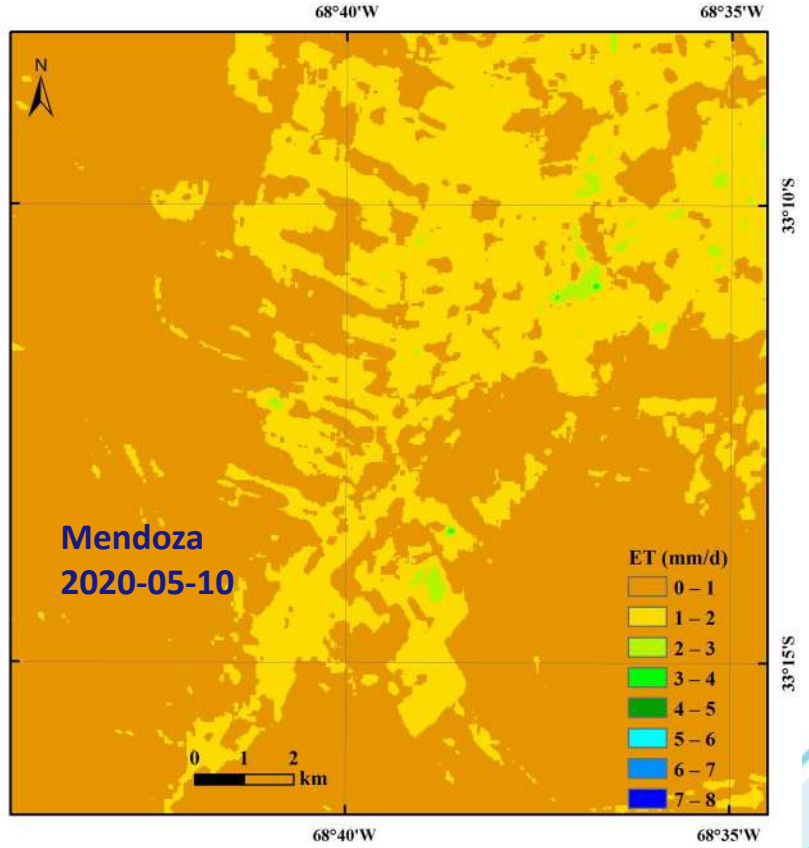
High resolution farmland ET

Mendoza

ETMonitor 30m ET

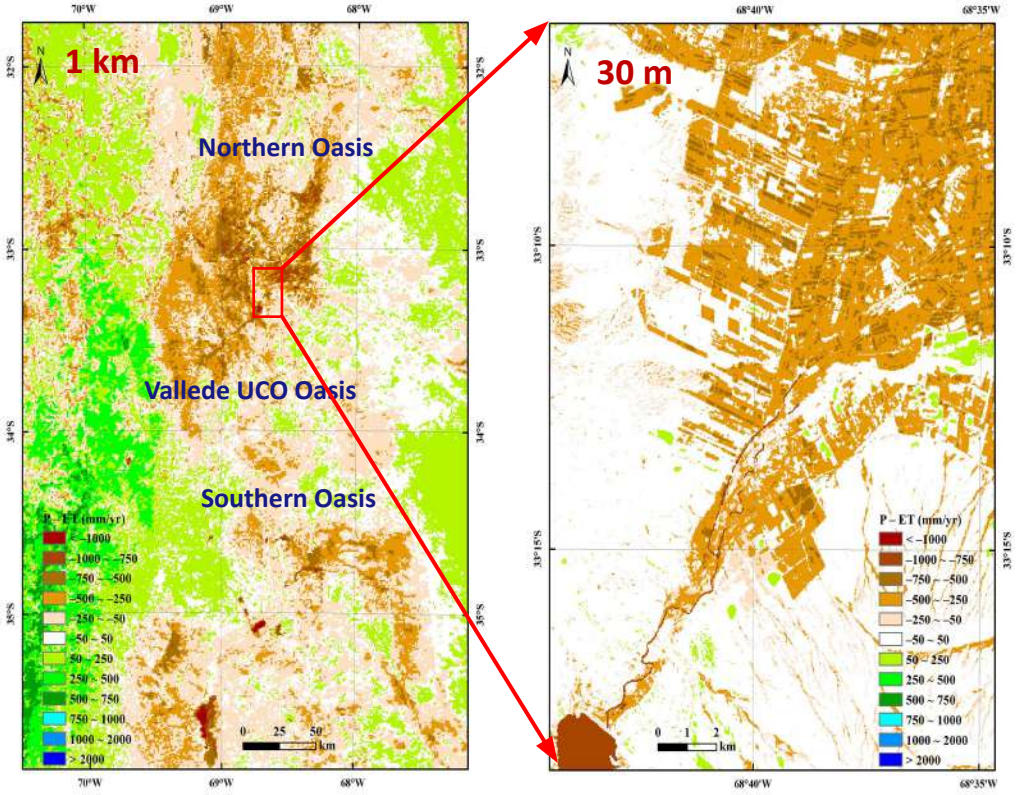


USGS 30m ET



Water Deficit (P–ET) in Mendoza

P – ET (2019 July – 2020 June, mm/yr)

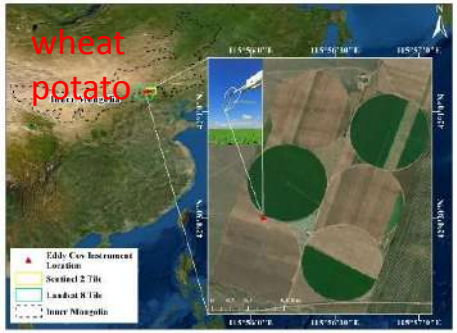


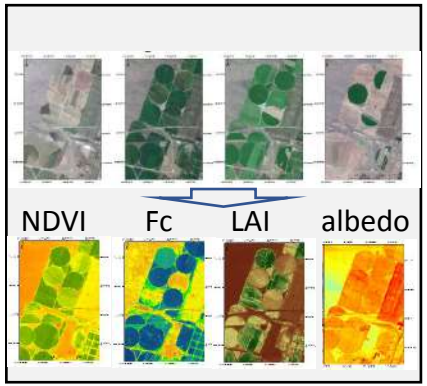
- The difference between GPM precipitation and ETMonitor ET indicates that precipitation is higher than ET in the up reaches of the river basin due to the high precipitation and low-to-moderate temperatures.
- For the oases in the lower reaches, especially for the agriculturally dominated regions whose natural climate alone cannot sustain the current level of agriculture, ET exceeds precipitation due to diverting surface water from the reservoirs.

Irrigation efficiency

Satellite based irrigation efficiency assessment at farmland scale

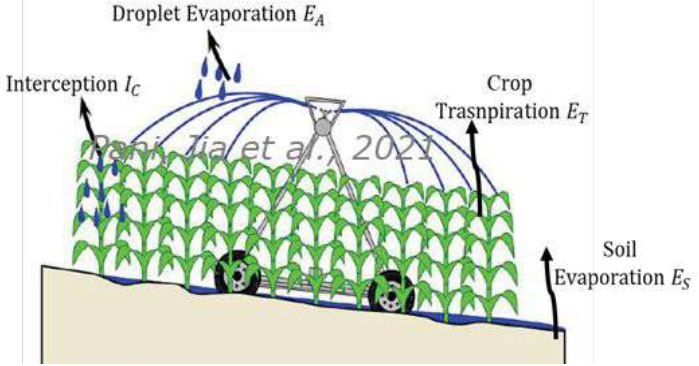
Inner Mongolia, China

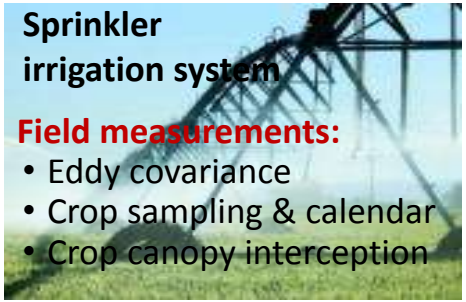




Consumptive irrigation water use (CWU):

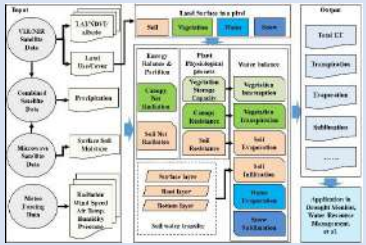
$$CWU_{Is} = E_A + I_C + E_S + E_T$$



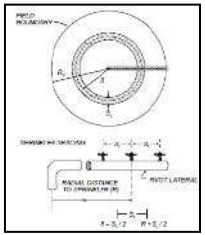


ETMonitor Model

Crop water use, interception loss: Multi-process parameterization model using multi-source satellite Earth observations



Irrigation water supply



Function of jet pressure and distance

Gross IWU = CWU - P_{eff}

Irrigation performance index:

IP1 = Net IWR / V

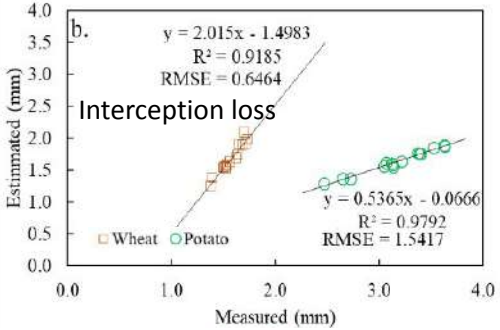
IP2 = Gross IWU / V

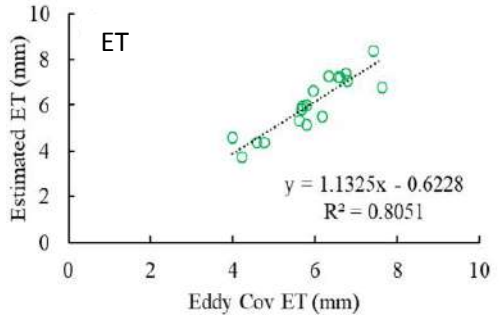
IP3 = Gross IWR / Gross IWU

Irrigation efficiency

Satellite based irrigation efficiency assessment at farmland scale

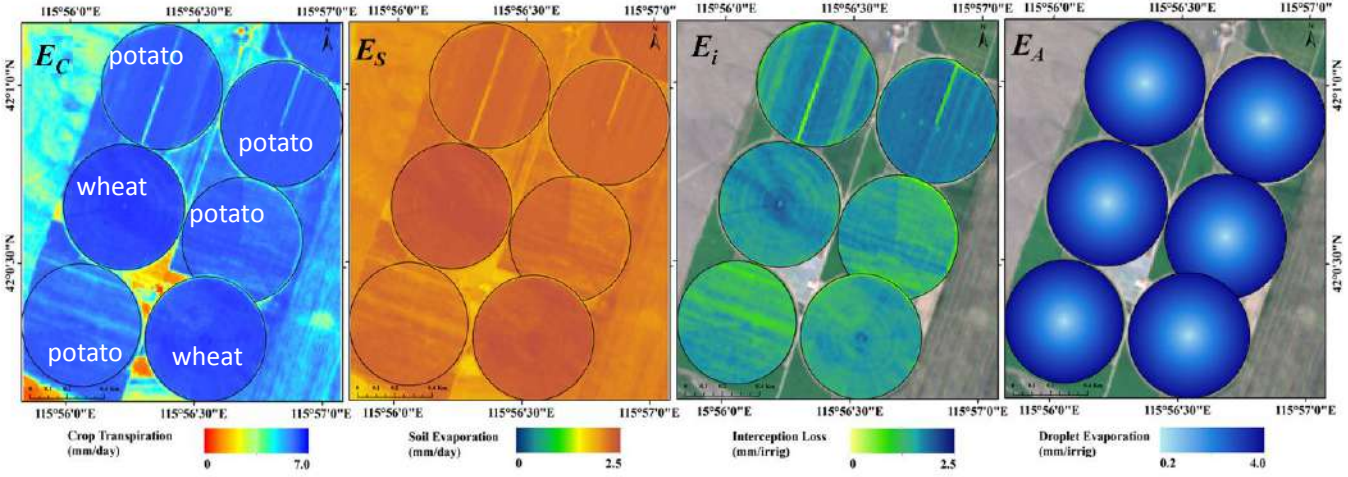
Validation

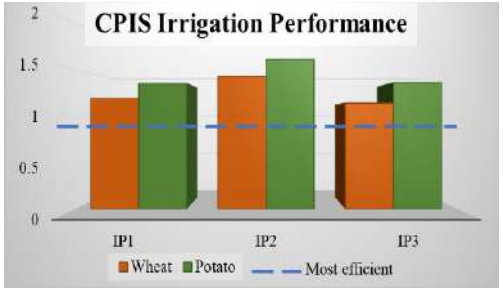




Zheng, Jia, et al., 2023, GSIS, 2nd review

Spatial variation of ET components





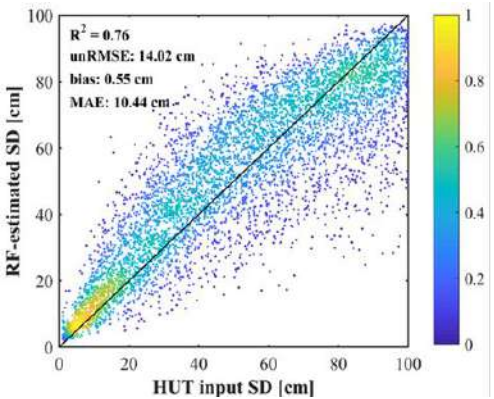
- **Overall performance of the irrigation system was highly insufficient.**
- **IP for wheat is better than that of potato.**

Snow Water Equivalent

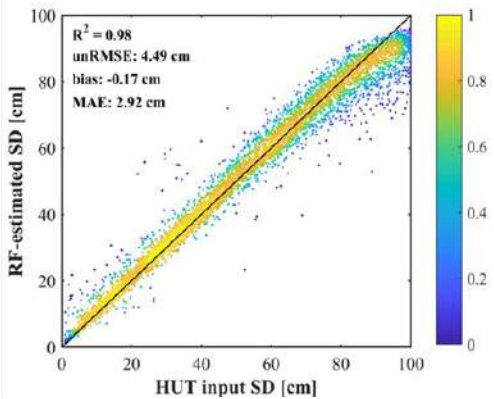
❑Improve Accuracy of SWE Inversion by Combining Physical Model and Machine Learning

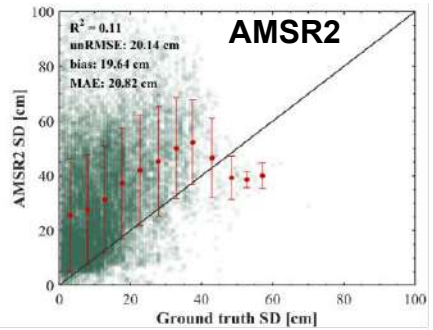
Microwave Forward Models + **Machine Learning Methods** → **Snow Water Equivalent**

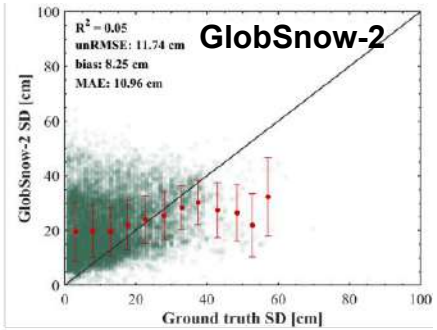
RF1: Input Variables:
TB (10-89GHz, FY3)

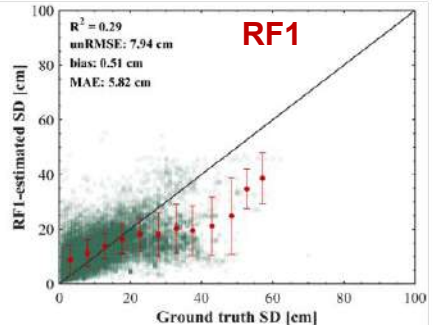


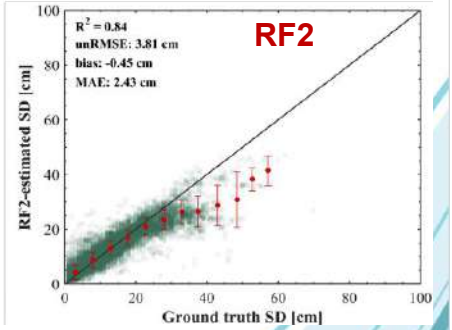
RF2: Input Variables:
TB (10-89GHz, FY3) and Snow Grain Size









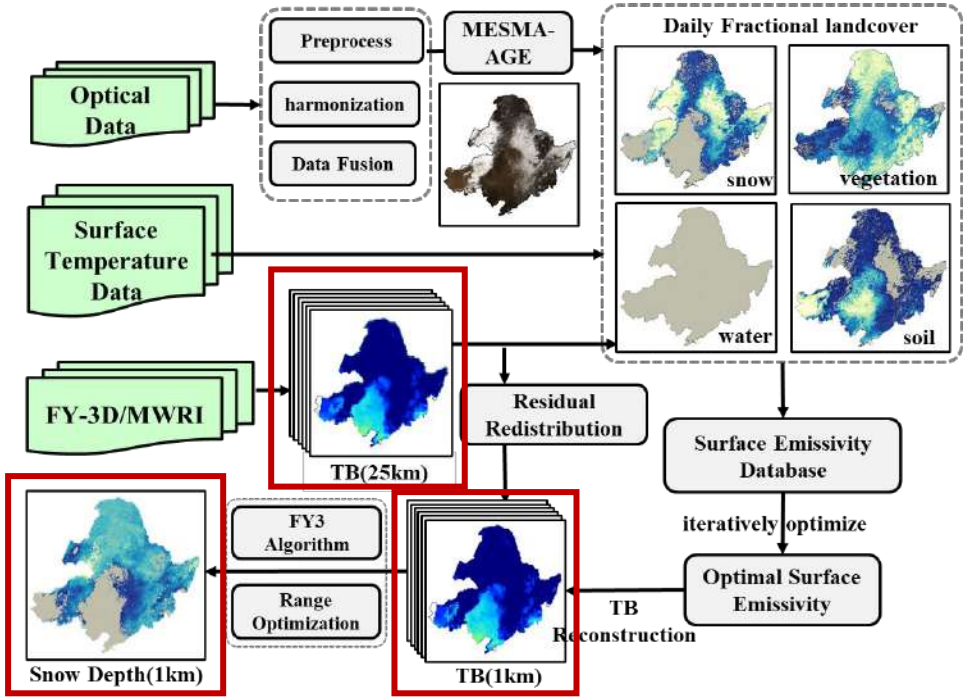


Yang et al. (RSE, 2021)

Snow Water Equivalent

❑Improve Spatial Resolution of SWE Product by Combining Microwave and Optical Data

Snow Depth Downscaling for FY-3/MWRI Using Mixed Pixel Decomposition



$$TB(m)_{\lambda}^{F} = \sum_{class} f(m)_{class}^{F} \times e(m)_{class,\lambda}^{F'} \times T(m)_{\lambda}^{F} + R(m)_{\lambda}^{F}$$

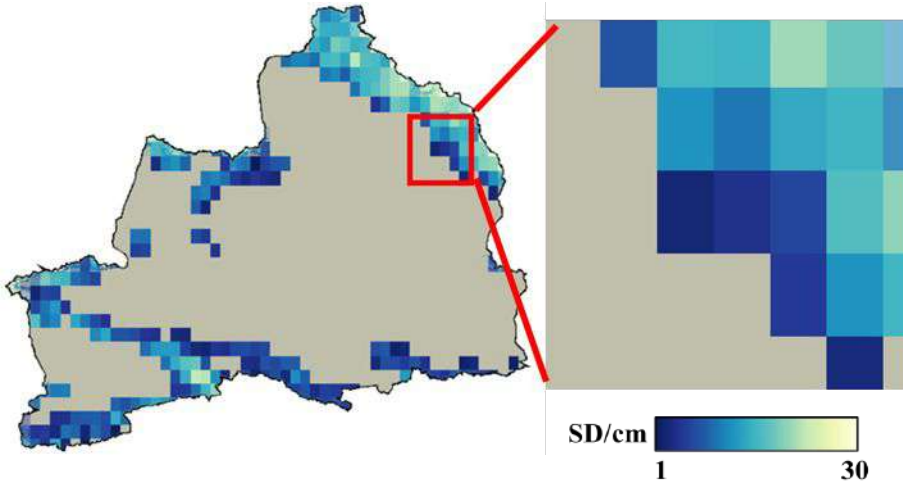
❑ **Validation at 40 in-situ stations in Altay, China**

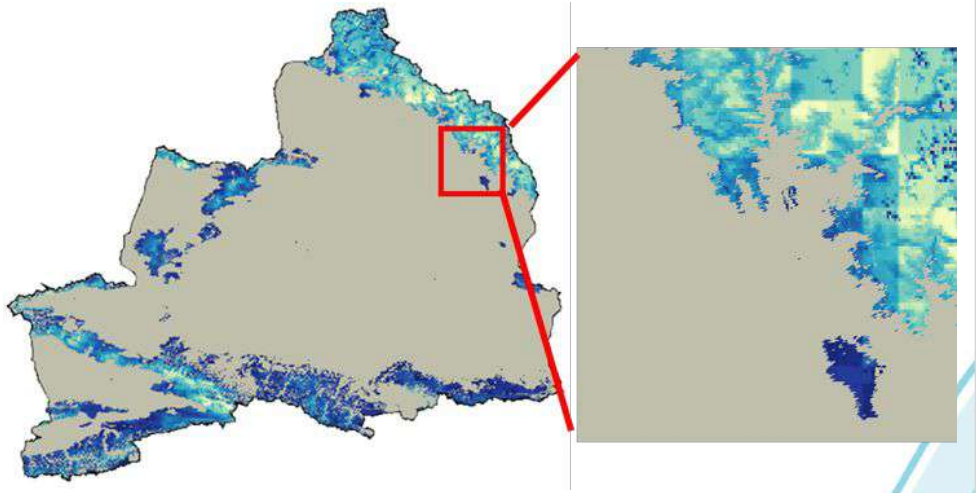
Evaluation Metrics	Original (cm)	Downscaled (cm)
accuracy	0.83	0.88
R2	0.33	0.41
MAE	5.40	4.95
RMSE	8.06	7.70
Bias	-2.65	-3.13

Snow Water Equivalent

❑Improve Spatial Resolution of SWE Product by Combining Microwave and Optical

- ❑ SD @ Original Resolution (25km)
- ❑ SD @ Downscaled Resolution (1km)





Thank you for your attention

Prof. Dr. Li Jia
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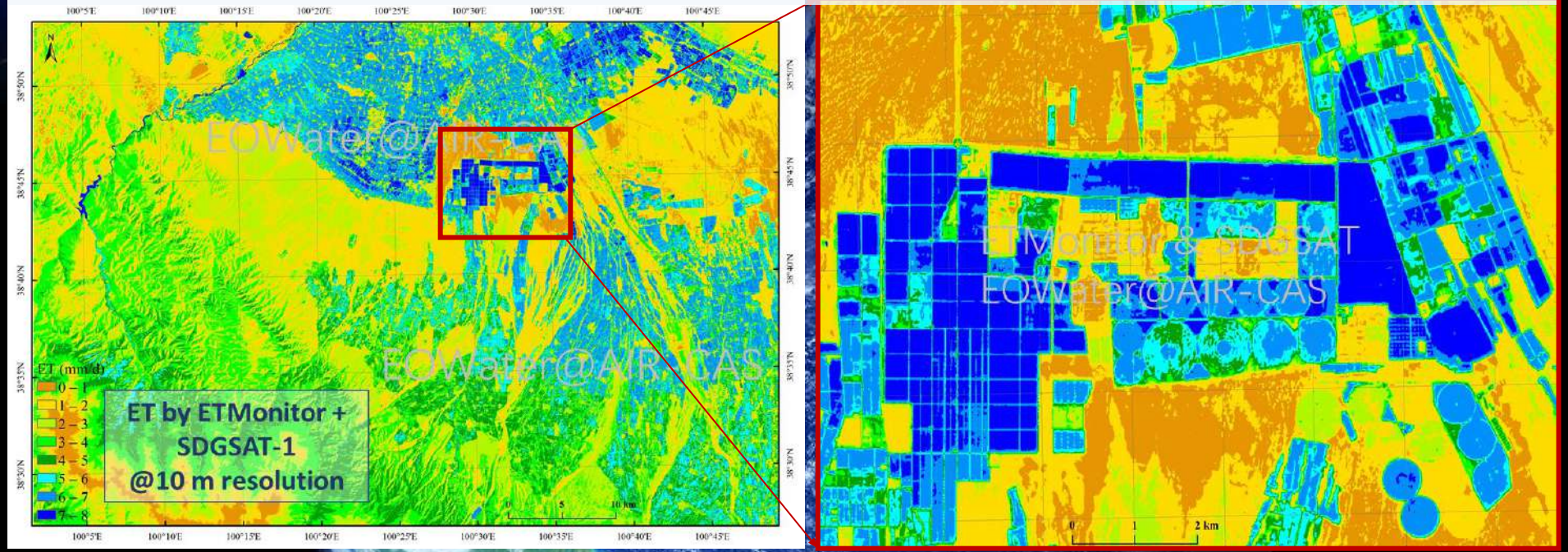
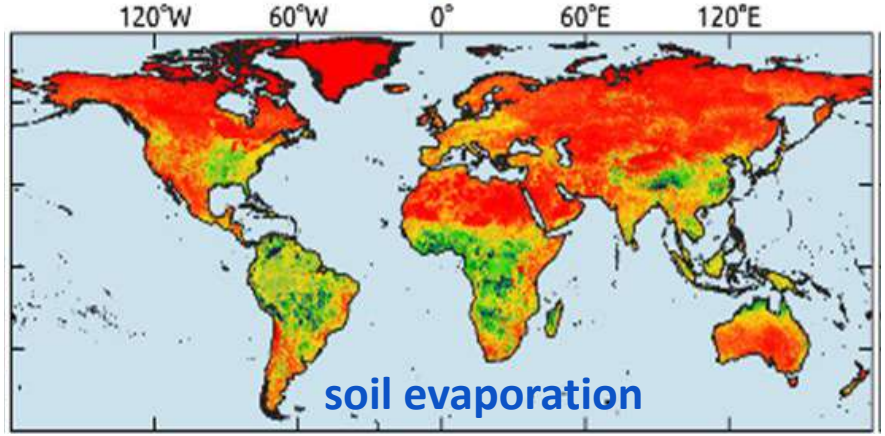
Chinese Academy of Sciences (CAS)

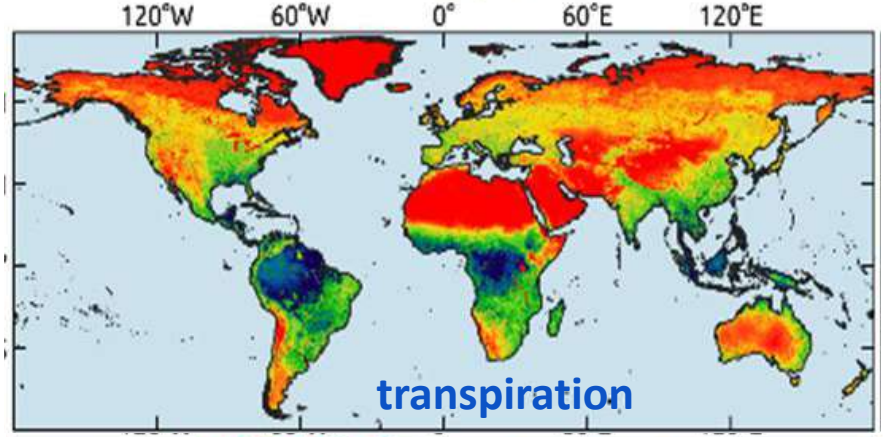
First 10m resolution farmland ET mapping based on SDGSAT-1 (Heihe River Basin, China)

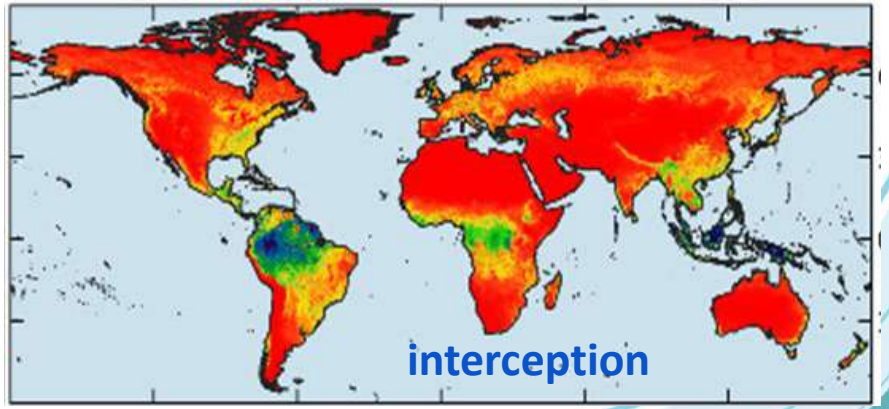


Evapotranspiration

ETMonitor global ET dataset: 21 years (2000-2021) at 1km spatial resolution and daily step







ET components

Zheng, Jia, Hu, 2022, Journal of Hydrology