**Operational global actual evapotranspiration: development, evaluation and distribution**

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**Abstract**

-1 km, 10-day, Aqua since 2003

-calibration with MPI

-validation with MPI and others

-performance by world river basins

-application for drought monitoring

-data availability and access

**Introduction**

Statement on usefulness of ET for crop water monitoring, drought early warning, water budget studies

Review Existing global ET models:

MPI, MOD1S, Alexi etc

**Materials and Methods**

Study site: limits of the data (northern and southern latitude limits etc)

Data

--IWMI PET and blended global PET data: GRIDMET for North America and how we filled it up

-Aqua LST, MODIS albedo and emissivity

-worldclim Tmax

-SSEBop V5

            -dT using gray-sky approach

            -elevation correction

--model parameter table for Tc creation etc

Baba (BABAM) algorithm to fill missing (cloudy data)

Before, after, before, after, median (BABA or BABAM)

Bias correction with MPI:

            Table of 3-year period

Evaluation: comparison with MPI, flux tower and water balance

Analysis procedures

            -time series

-tables

            -flux tower, MPI etc summary

            -water balance summary

            -stat and other evaluation metrics

**Figures under methods:**

1)      Annual PET distribution (ETom: blended ETo)

2)      Gridded Tmax:  Jan 1-10, July 1-10

3)      Gridded c factor that will turn Tmax into Tc for Jan 1-10 and Jul 1-10

4)      Global dT for Jan 1 and Jul 1

Tables:

Table 1-SSEBop Model parameters

            -c factor, elevation, number of images e.t.c.

Table 2: BIAS correction parameters and their consistency over 3 3-year periods

**Results and Discussion**

**Global ET distribution: with country boundaries and lakes? Rivers?**

Figure xx: 10-day: January 1, July 1

Figure xx: monthly: January 1, July 1

Figure xx: year median of 16 years (2003-20018)

Figure xx:  year total 2018 (recent completed year)

Figure xx: anomaly 2018 / median as percent

**Evaluation:**

***Maps:***

Figure xxx: annual total MPI (10 km), SSEBop (1 km) and difference ( 1km)

--discuss on differences in irrigated areas etc and advantage of 1 km data

***Time series and scatter plots (Monthly)***

***MPI***

Figure xx: scatter plot + time series (2006-20011) between MPI and SSEBop, using basin scale averages

--use smaller basin boundaries in different parts of the world (Create figures for different parts of the world)

--e.g. HUC 8 averages in the US (Missouri) , Europe (Danube), Africa (Niger + Nile), India (Ganges) , China (Yangtze), Australia (Murray-Darling basin), S. America (Amzon)

For Niger + Nile: we will combine the two sub-basin averages

=show seasonality at monthly time scale may reveal why we underestimate in Europe (summer, spring??)

***Flux tower (maybe??)***

Figure xx: use selected flux tower data, at least one and up to 5 in each continent

**Basin water balance (maybe not): P-**

---table: Accuracy metrics summary, r, bias, RMSE etc

**Application for drought monitoring using anomalies**

Figure: ET anomalies for selected wet, drought and normal years (based on US knowledge or global?):

Figure xx: Drought year: 2012

 With zoom in over irrigated and non irrigated areas on selected spots

Nile delta, Central Valley, Indus irrigated area, Mekong delta, Obe delta (Russia),  location Spain or Italy?

Figure xx: Wet: 2016

 With zoom in over irrigated and non irrigated areas

Figure xx: Normal: 2018

 With zoom in over irrigated and non irrigated areas

**Application for ET by region and by cover types**

Table xxx: summary of annual ET by cover type for d/t climatic regions:

Tropics (+/- 20 deg)

Forest

Crops

Shrubs/savana

others

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Temperate (20 deg+)

Forest

Crops

Shrubs/savana

others

**Discussion points:**

-why K factor varies widely between high in Europe and low in irrigated areas

--could it be low IWMI PET?

-low winter ET estimation by SSEBop?

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**Conclusion**

--creation

-accuracy

-reliability for drought monitoring

-uncertainty for water budget studies

-more bias correction for local/regional use

-limitation

-data availability and access

Future work