Global Yield Gap Atlas

GYGA Weather Data Sources

University of Nebraska Lincoln

Wageningen University
Wageningen UR

Weather data used for simulations

- First choice: Observed, high quality, 10+ years
  - Tmin, Tmax, solar radiation, relative humidity, precipitation
- Acceptable: Observed, 3+ years of Tmin, Tmax
  - Missing data estimated by “propagation” (see detailed explanation in the next slides) coupled with crude TRMM (1st option) or NASA POWER (2nd option) rainfall data.
- Last resort: gridded data (NASA data)

Global Yield Gap Atlas

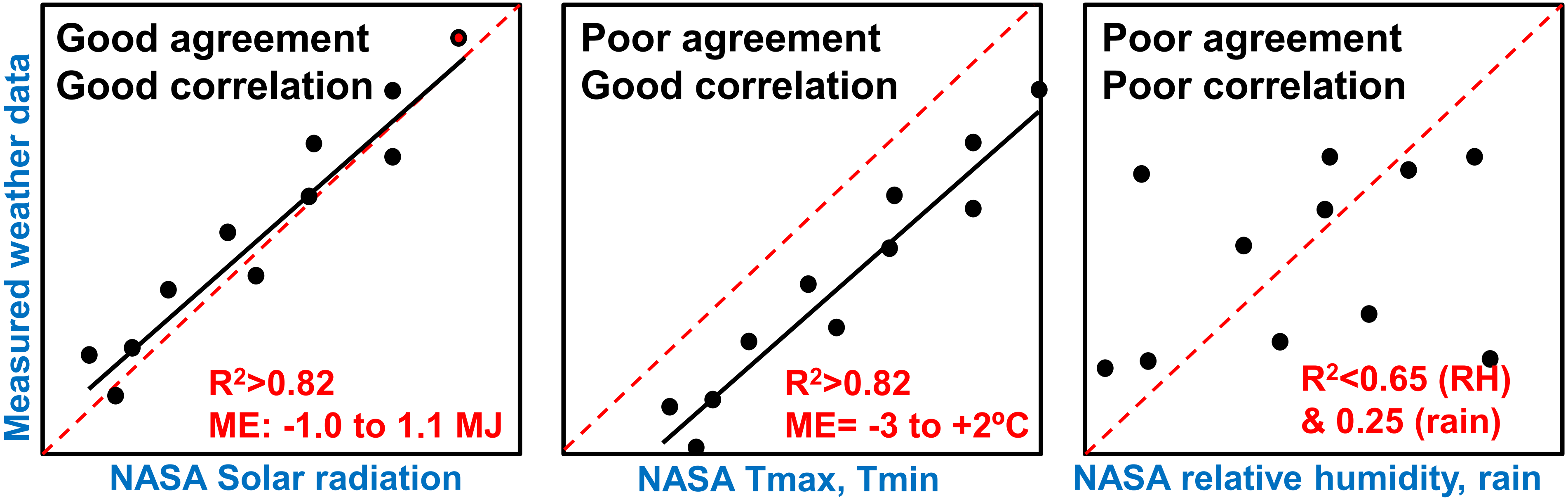
Justification for propagated weather data

- A robust estimation of average yield potential using crop simulation models requires long-term daily weather data (15+ yrs)
- However, in many regions of the world, only few years of measured weather data (and for a limited number of variables) are available
- Even if observed weather data are available (and can be used for simulations), the underpinning data can be rarely made publicly available
- How can we use a few years of weather data to 'generate' suitable long-term weather records for crop simulations and/or to generate weather files that can be made publicly available?

Global Yield Gap Atlas

Summary of a the comparison between NASA and observed daily weather data

Red dashed line: 1-to-1 line; solid black line: linear regression. Note that dots do not represent actual data!

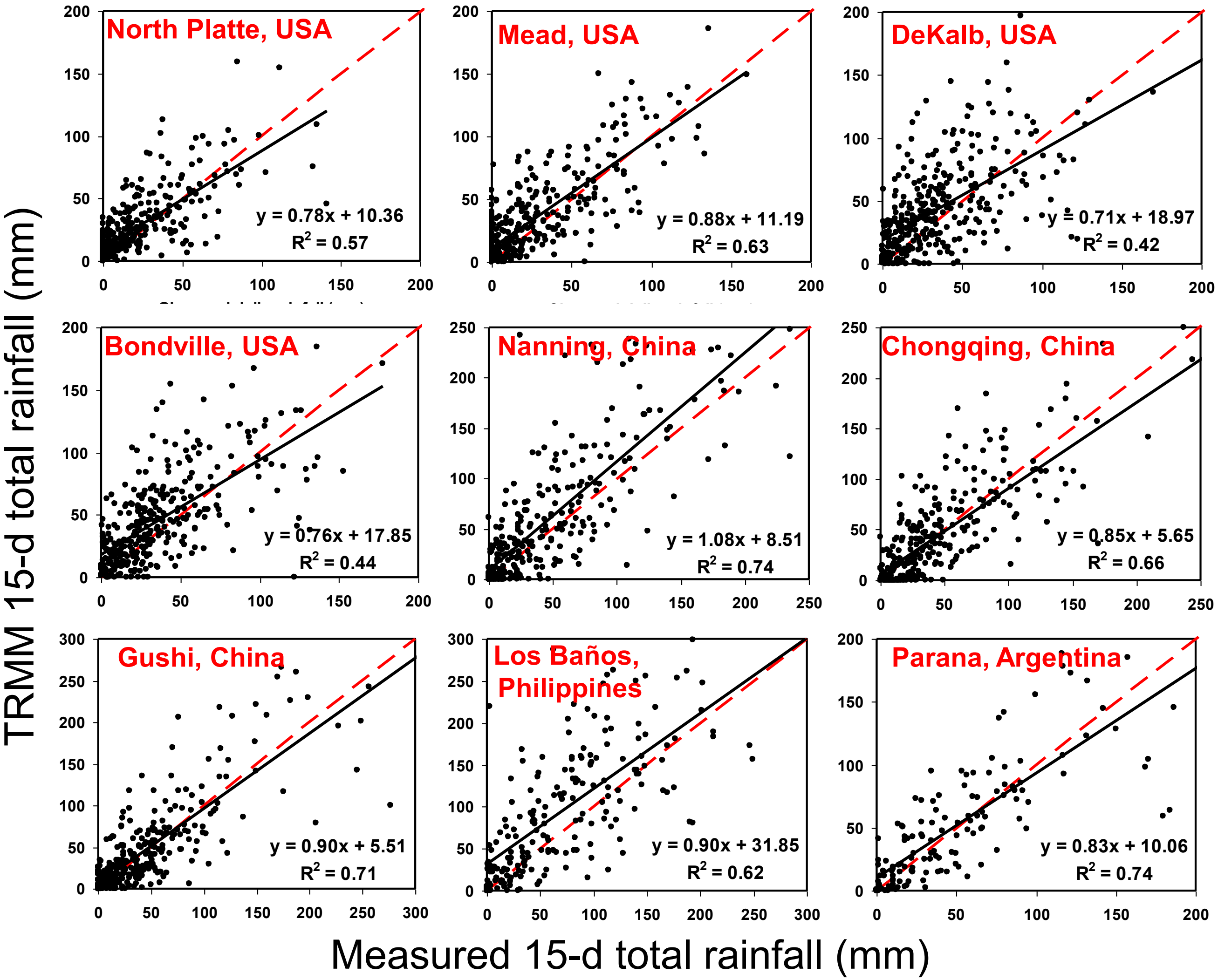


- **'Crude' NASA radiation can be used for simulations, except at sites with complex topography**
- **Good correlation between NASA vs. measured Tmax & Tmin but poor agreement. NASA temperature can be used for simulations <u>after calibration</u> against few years of measured data**
- **Very poor agreement and correlation between NASA vs. measured relative humidity and precipitation**

Global Yield Gap Atlas

TRMM *versus* observed 15-day total precipitation

Red dashed line: 1-to-1 line; solid black line: linear regression.



TRMM 15-d total precipitation and occurrence of wet/dry days are in reasonable agreement with observed precipitation data making TRMM a viable alternative for crop model simulations when observed precipitation data are not available. TRMM performs better than NASA POWER rainfall.

Global Yield Gap Atlas

Propagation of long-term daily weather data

- **Crude solar radiation** from NASA-POWER
- **Calibrated-NASA Tmax and Tmin** based on correlations between NASA and ground-measured Tmax and Tmin for a few number of years
- **Humidity is derived from crude NASA Tdew** (unless measured Tdew or RH are available)
- **Crude TRMM (1st option) or NASA (2nd option) rainfall data**

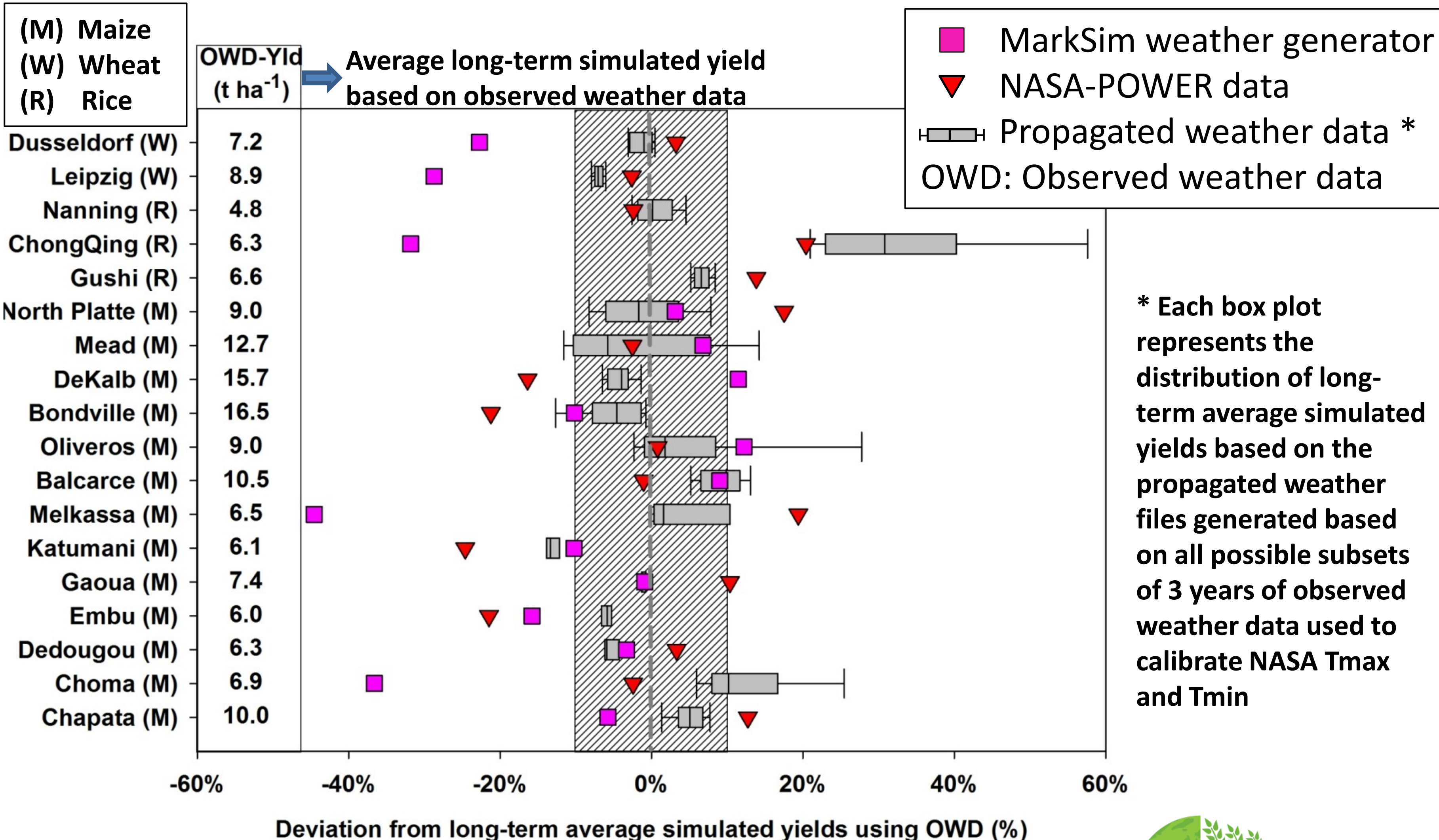
Global Yield Gap Atlas

Testing propagated weather data

- By the end of the day, we want to see how well simulated yields based on propagated weather compare against simulations based on measured weather data
- In practice, we won't know *a priori* which subset of years of measured weather data will be available for calibrating NASA Tmax and Tmin.
- To evaluate the sensitivity to 'year effect', we calibrated NASA Tmax and Tmin based on all possible subsets of 3 consecutive years of measured Tmax and Tmin. This yielded into multiple files of propagated weather data and multiple simulated average yields.
- The distribution of average simulated yields based on propagated weather data was compared against the (single) average simulated yield based on long-term measured weather data
- In the comparison, we also included the average yield simulated using crude NASA, crude NASA + TRMM rain, and generated weather data derived from monthly means using MarkSim
- The comparison was performed for 18 locations (including sites in South and North America, Europe, Africa, and Asia) using well-validated models based on site-specific management practices and soil type.

Global Yield Gap Atlas

Simulations of yield potential based on propagated *versus* observed and gridded weather data



* Each box plot represents the distribution of long-term average simulated yields based on the propagated weather files generated based on all possible subsets of 3 years of observed weather data used to calibrate NASA Tmax and Tmin

Global Yield Gap Atlas

Conclusions

- **Distribution of simulated yields based on propagated weather was within (or close to) ± 10% of simulated yield based on measured weather in 83% of the cases**
- **Simulations based on propagated weather had better agreement with simulations based on measured weather than other sources of weather data (such as crude NASA or weather generators)**
- **Wherever only few years of measured Tmax & Tmin data are available, the propagation technique is a viable and superior alternative to generate long-term weather for crop simulations.**

Global Yield Gap Atlas

Conclusions (cont.)

- GYGA has one of the most complete, site-specific, weather databases for the world
- Simulations were based on all available observed data (provided by country agronomists), and, if there was not enough data, propagated data to supplement the observed data and reach an acceptable number of years
- Because in some cases we are not allowed to post observed data provided by country agronomists, weather data posted in the GYGA website sometimes contains only propagated data (e.g. Sub-Saharan Africa) or crude NASA data for those locations for which weather data did not exist.
- Different types of weather data will be distinguished by colour coding – SEE NEXT SLIDE

Global Yield Gap Atlas

Weather data

station_id	country	DOY	date	year	month	day	srad	tmax	tmin	rain	rh	wind	vp	tdew	sunhrs	et
5000006	Ethiopia	212	07/30/2008	2008	7	30	14	22	15.7	9.4	100	2	NA	NA	NA	NA
5000006	Ethiopia	213	07/31/2008	2008	7	31	12.6	25.8251986	15.2414434	1.14	87	2	NA	NA	NA	NA
5000006	Ethiopia	214	08/01/2008	2008	8	1	17.3	24.5	16.5	0	93	2	NA	NA	NA	NA
5000006	Ethiopia	215	08/02/2008	2008	8	2	13.7	24	16	3.9	100	2	NA	NA	NA	NA
5000006	Ethiopia	216	08/03/2008	2008	8	3	16.3	23.6	15	24.5	100	2	NA	NA	NA	NA
5000006	Ethiopia	217	08/04/2008	2008	8	4	19	24	16.5	7.7	87	2	NA	NA	NA	NA
5000006	Ethiopia	218	08/05/2008	2008	8	5	7.6	21.9	17	3.5	95	2	NA	NA	NA	NA
5000006	Ethiopia	219	08/06/2008	2008	8	6	16	24.5	16.6	0	88	2	NA	NA	NA	NA
5000006	Ethiopia	220	08/07/2008	2008	8	7	17.2	25	16	0.4	84	2	NA	NA	NA	NA
5000006	Ethiopia	221	08/08/2008	2008	8	8	16.5	23	17.1	15.6	95	2	NA	NA	NA	NA
5000006	Ethiopia	222	08/09/2008	2008	8	9	13.7	21.6	16	2	99	2	NA	NA	NA	NA

Abbreviation	Full name	Unit
srad	solar radiation	MJ/m2/day
tmax	maximum daily temperature	oC
tmin	minimum daily temperature	oC
rain	precipitation	mm
rh	relative humidity	%
wind	wind speed	m/s
vp	vapour pressure	kPa
tdew	dew point temperature	oC
sunhrs	sunshine hours	hrs
et	evapotranspiration	mm
NA	data is not available	

Global Yield Gap Atlas

The source of the data

station_id	country	DOY	date	year	month	day	srad_inf	tmin_inf	tmax_inf	rain_inf	rh_inf	wind_inf	vp_inf	tdew_inf	sunhrs_inf	et_inf
5000006	Ethiopia	212	07/30/2008	2008	7	30	gridded	observed	observed	observed	gridded	propagated	NA	NA	NA	NA
5000006	Ethiopia	213	07/31/2008	2008	7	31	gridded	propagated	propagated	propagated	gridded	propagated	NA	NA	NA	NA
5000006	Ethiopia	214	08/01/2008	2008	8	1	gridded	observed	observed	observed	gridded	propagated	NA	NA	NA	NA
5000006	Ethiopia	215	08/02/2008	2008	8	2	gridded	observed	observed	observed	gridded	propagated	NA	NA	NA	NA
5000006	Ethiopia	216	08/03/2008	2008	8	3	gridded	observed	observed	observed	gridded	propagated	NA	NA	NA	NA
5000006	Ethiopia	217	08/04/2008	2008	8	4	gridded	observed	observed	observed	gridded	propagated	NA	NA	NA	NA
5000006	Ethiopia	218	08/05/2008	2008	8	5	gridded	observed	observed	observed	gridded	propagated	NA	NA	NA	NA
5000006	Ethiopia	219	08/06/2008	2008	8	6	gridded	observed	observed	observed	gridded	propagated	NA	NA	NA	NA
5000006	Ethiopia	220	08/07/2008	2008	8	7	gridded	observed	observed	observed	gridded	propagated	NA	NA	NA	NA
5000006	Ethiopia	221	08/08/2008	2008	8	8	gridded	observed	observed	observed	gridded	propagated	NA	NA	NA	NA
5000006	Ethiopia	222	08/09/2008	2008	8	9	gridded	observed	observed	observed	gridded	propagated	NA	NA	NA	NA

Abbreviation	Full name
_inf	information on data if it is observed, gridded, propagated, interpolated
NA	data is not available

Global Yield Gap Atlas

References

Van Wart J, Grassini P, Yang HS, Claessens L, Jarvis A, Cassman KG, 2015. Creating long-term weather data from thin air for crop simulation modelling. *Agricultural and Forest Meteorology* 208, 49-58.

Global Yield Gap Atlas