Soil CO_2 efflux and concentration under drip irrigation in dry-land agriculture, China

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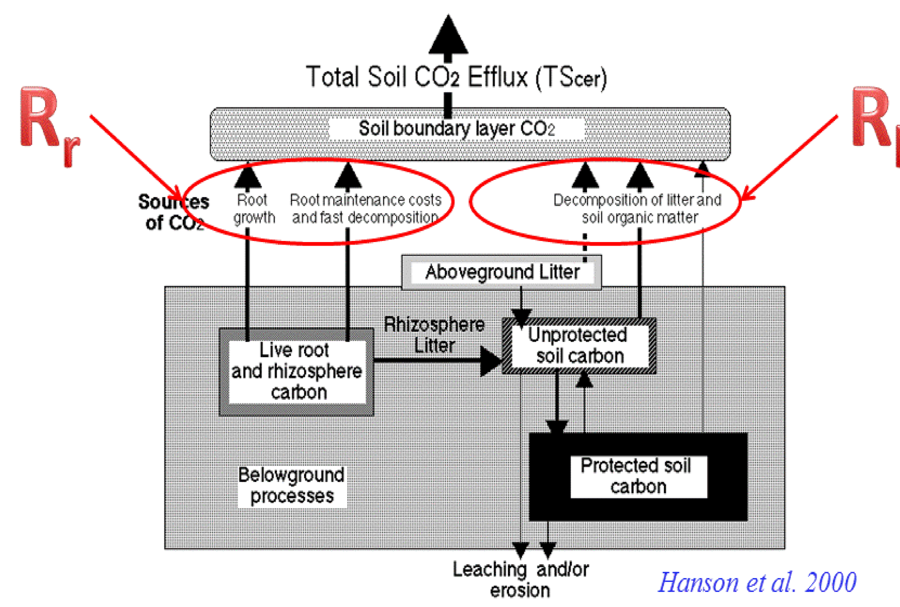
Introduction

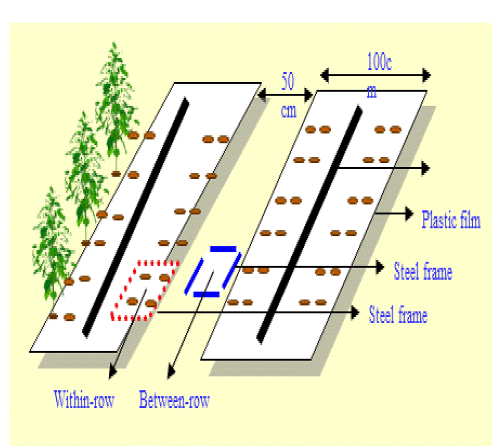
Dry-land agriculture in China comprise of more than 45% of the Earth land surface. Mean soil respiration rates of dry-land agriculture is from 1.96 to 4.86 higher than the natural ecosystems in arid area (Lai et al.,2012)。Drip irrigation farmland is approximately 5 million ha^{-1} in Xinjiang. Improve the utilize efficient of canal water from 0.48 to 0.65. Save water resource 1.0 billion cubic meter.

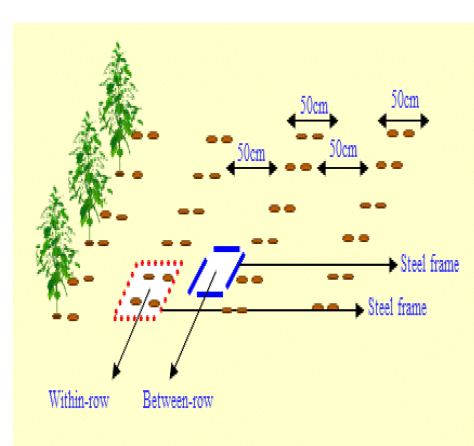


Unresolved questions:
?Soil CO_2 concentration is much larger than that reported in other studies. Plastic film will stop soil CO_2 emission from farmland?
?Alkali soil is an overstocked missing Carbon Pool?

Methods

1. Soil respiration under the crowns of plants (*Rt*), and between the gaps of plants (*Rh*). Root respiration (*Rr*) was calculated by: *Rr = Rt– Rd.*
2. Soil and root respiration were modelled by the DNDC model
3. Directly measured CO_2 efflux(chamber method) vs. estimated CO_2 efflux by gradient measurements and diffusivity models(Fick's first law of diffusion).
4. Measured soil CO_2 efflux and NPP from mulched and non-mulched fields

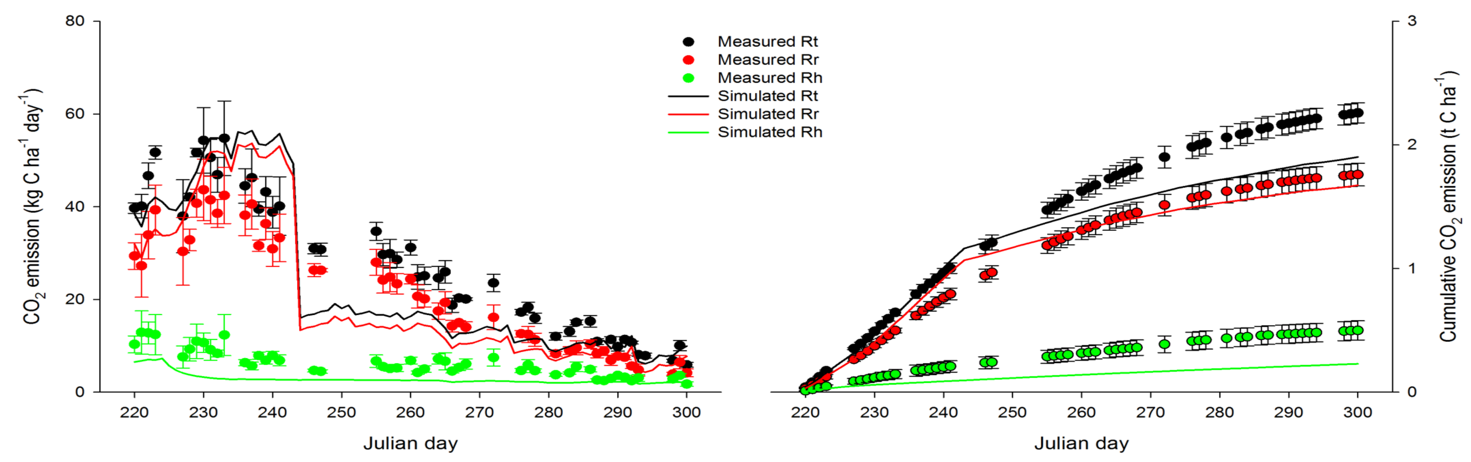




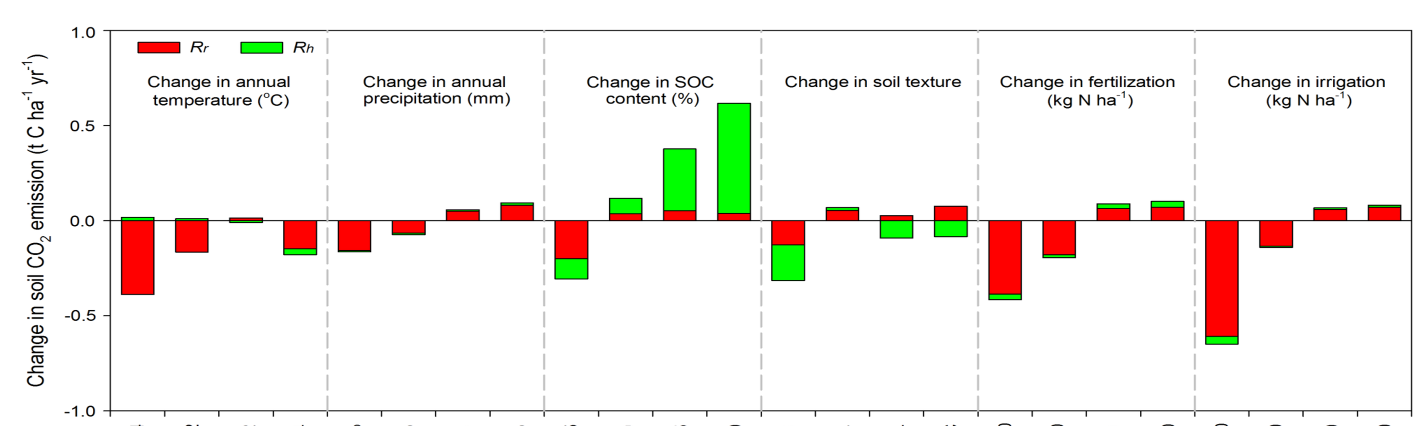
Conclusions

- Root respiration plays an important role in the cotton field, which was sensitivity to temperature, precipitation, fertilization and irrigation.
- The estimated CO_2 effluxes by gradient measurements and diffusivity correlated well with measured data.
- Daily q decreased gradually with the increasing of soil temperature, and Arrhenius model proved to be the optimum model for the simulating the variations of soil respiration.
- Plastic film mulching increased the production of CO_2 in the soil profile whereas the emissions were unaffected, indicating plastic film stop soil CO_2 emission from arable soil.
- With land areas of cotton under plastic film mulching reaching 750 000 ha in Xinjiang, this type of cultivation had a higher carbon sequestration in terms of NEP, with value of 1.9×10^9 kg C $season^{-1}$ comparing with non-mulching.

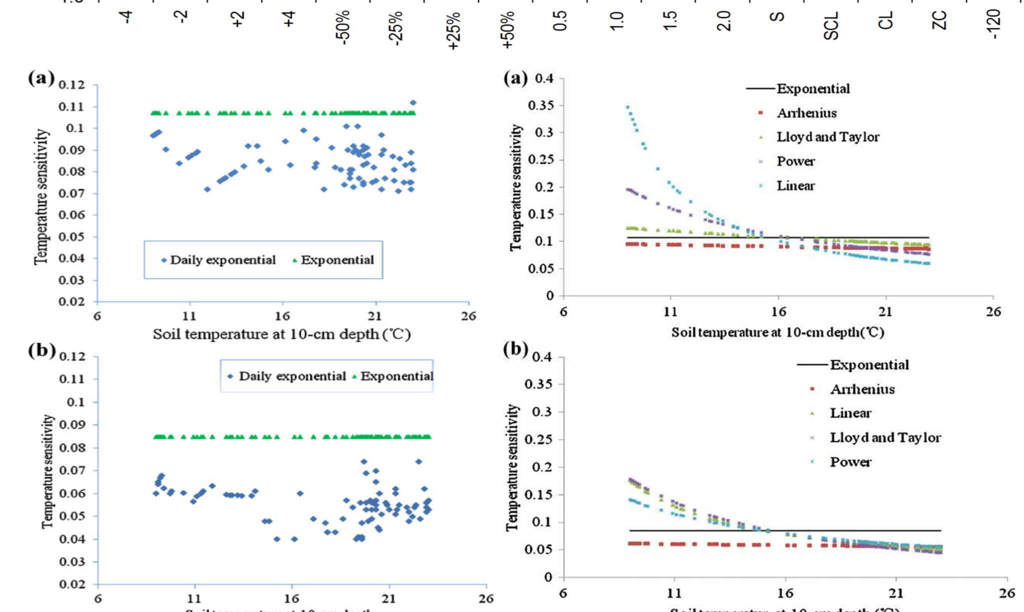
Results



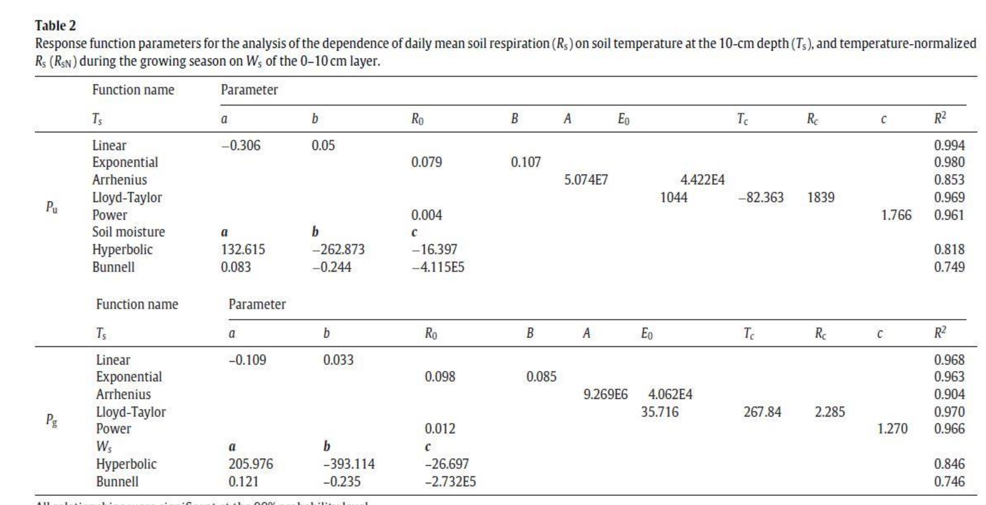
Average contribution of root respiration (*Rr*) to total soil respiration (*Rt*) in cotton field was about 72%. The DNDC model was able to simulate the temporal variation in soil and root respiration.



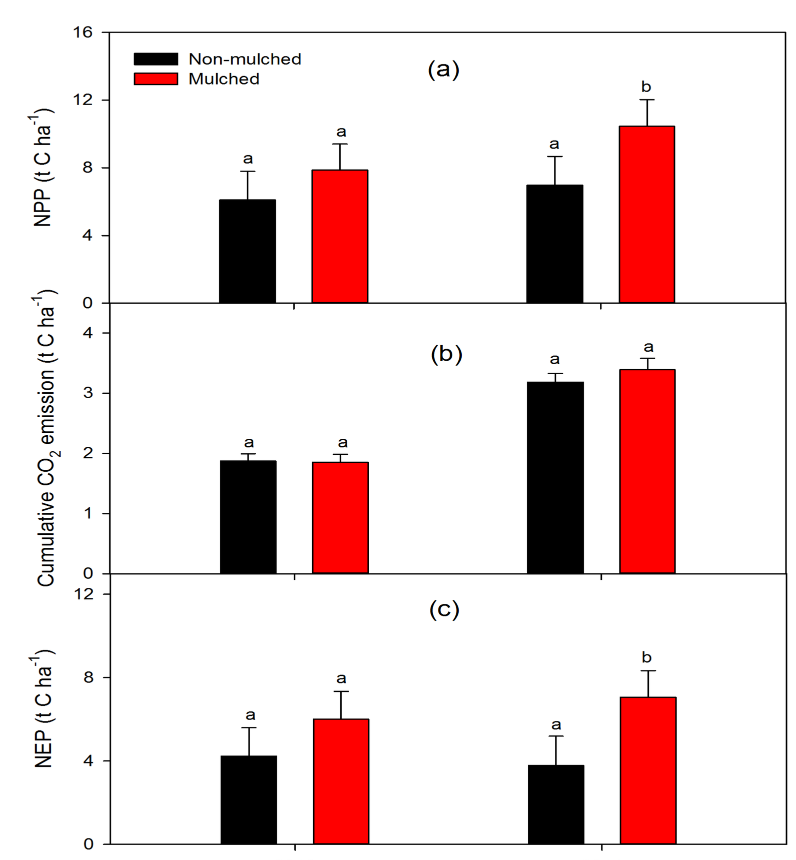
The sensitivity tests showed that temperature, precipitation, soil organic C content, fertilization, and irrigation had a positive effect on soil respiration. Root respiration was more sensitivity to temperature, precipitation, fertilization and irrigation.

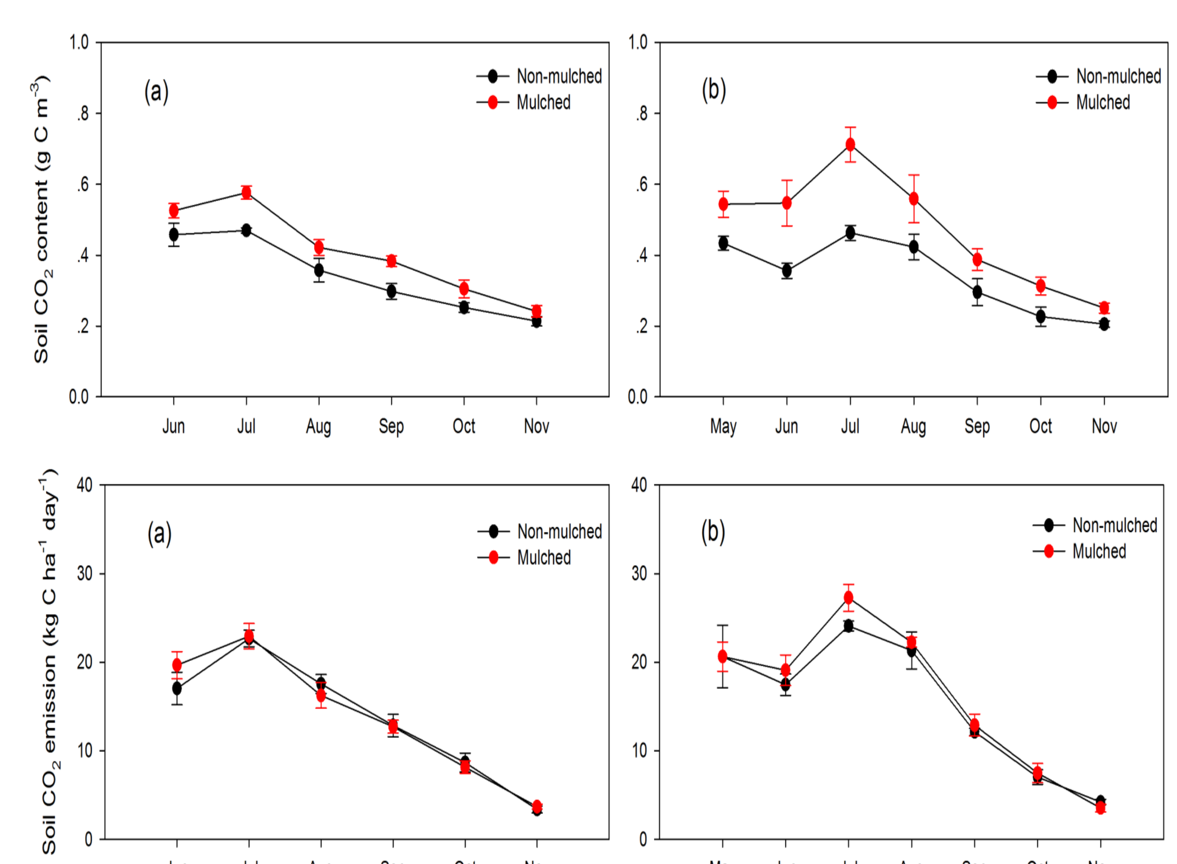


Most daily *q* values of were smaller than those during general growth period. Daily *q* decreased gradually with the increasing of soil temperature. Arrhenius function simulated the relationship between *Rs* and *Ts* more accurately than other four functions.

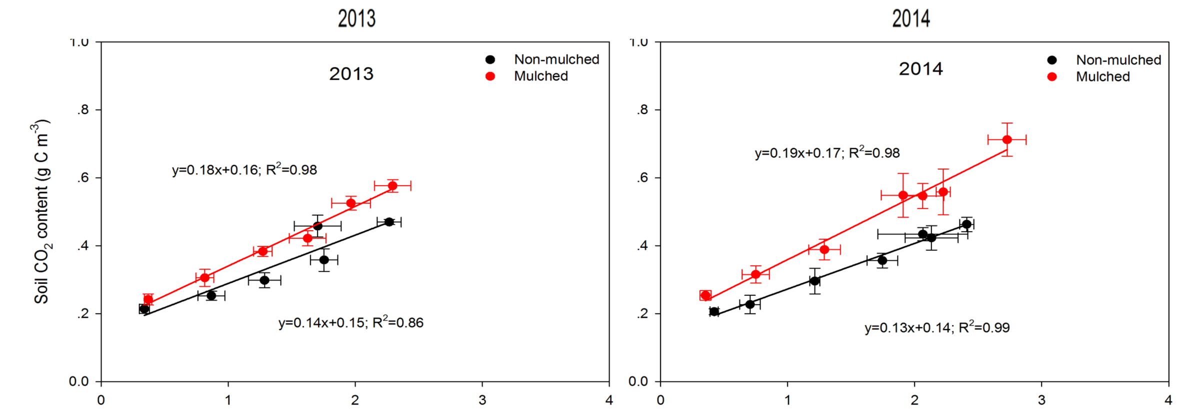


The five temperature-response functions performed well in describing the variations of *Rs* both for *Pu* and *Pg* during the study period. However, when the variations of temperature sensitivity of *Rs* are considered, the Arrhenius model proved to be the optimum model for the simulating the variations of *R*.





Our results demonstrate plastic film mulching is an effective way to increase carbon sequestration in the short term in cotton systems of arid areas through increasing NPP rather than decreasing soil CO_2 emission.



Although plastic film mulching enhanced CO_2 content in the soil profile by 29%, soil CO_2 emission was unaffected by plastic film, as the cumulative CO_2 emissions were 2.53 and 2.62 t C ha^{-1} for the non-mulched and mulched treatments, respectively. The relationships between soil CO_2 concentration and emission were affected by plastic film mulching.

References

Zhao, Z. et al. (2013). Interpreting the dependence of soil respiration on soil temperature and moisture in an oasis cotton field, central Asia. Agriculture, Ecosystems and Environment, 2013(168), 46-52.
Yu, Y., & Zhao, C. (2015). Modelling soil and root respiration in a cotton field using the DNDC model. Journal of Plant Nutrition and Soil Science, 178(5), 787-791.