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Topic: Introduction to agricultural meteorology with a special focus on energy balance near the land and water surfaces.

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- 0. What is agricultural meteorology? A discipline focusing on biophysical and agronomic processes taking place at the boundary between atmosphere and land (and water) surface.
- 1. Basic principle of energy balance at the atmosphere-land surface boundary

Three major components of the energy balance (Fig. 1):

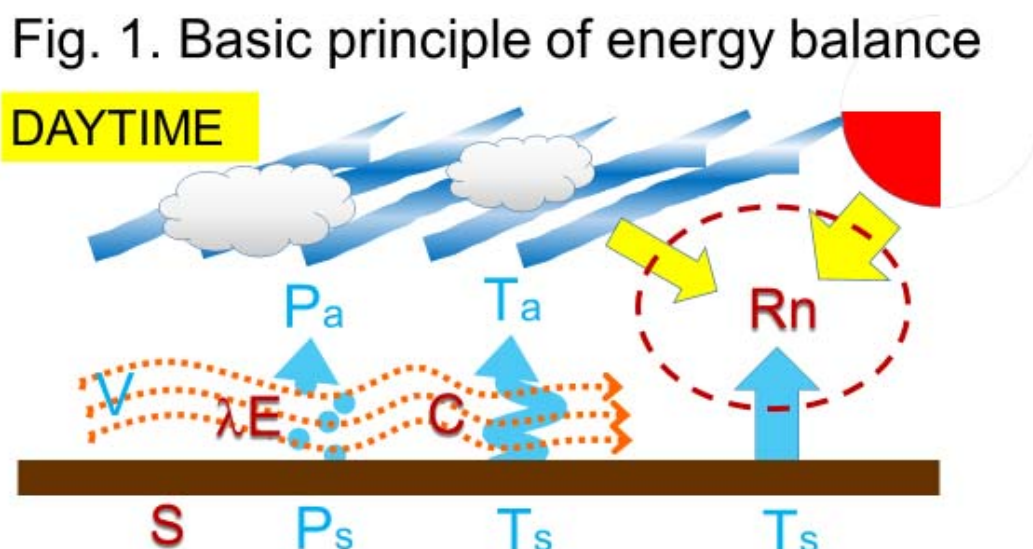
$$R_n - C - \lambda E = S$$

$R_n$ : Net radiation = incoming short and long wave radiations - reflected short wave radiation - outgoing long wave radiation. See the slides for some details of the radiations.

$C$ : Sensible heat loss = heat loss to the atmosphere in proportion to wind speed  $V$  and temperature difference:  $T_a - T_s$ , where  $T_a$  is air temperature and  $T_s$  is surface temperature.

$\lambda E$ : Latent heat loss = energy loss due to evaporation ( $E$ ,  $\text{kg m}^{-2} \text{s}^{-1}$ ) at plant, soil and water surfaces.  $E$  is proportional to wind speed  $V$  and humidity difference:  $P_a - P_s$ , where  $P_a$  is atmospheric humidity and  $P_s$  is surface humidity.  $\lambda$  is a constant called latent heat of vaporization of water (= 2.454 MJ  $\text{kg}^{-1}$  at 20 deg. C).

$S$ : Difference of incoming and outgoing energy used to raise or cool the surface temperature.



## 2. Examples of the contribution of agricultural meteorology research to agriculture

### 2.1. Snow plowing to accelerate soil freezing.

2.1.1. **My question for you: Why the snow plowing helps the soil freezing/ the snow pile prevents the soil freezing?**

#### 2.1.2. Your homework:

- **Why does the snow pressing help the soil freezing? Explain in plain words in English.**

### 2.2. Protecting rice from cooling damage by deep-water treatment (Figs. 2 -4).

2.2.1. Rice production in Hokkaido has often been reduced by cooling damages in the middle of summer (Fig. 2).

2.2.2. Water layer is in general warmer than air (Fig. 3).

2.2.3. The deep-water treatment (Fig. 4) to protect the developing young flowers.

- Developing rice flowers become highly sensitive to low temperature for the period from 15 to 10 days BEFORE flowering (the period when the pollens are developed).
- The developing flowers are initially located near the ground but pushed up by elongating stem as they experience the highly-sensitive period.

2.2.4. **My question for you: why water layer is warmer than air?**

- Note that water transmits the solar radiation but absorbs the infrared radiation from the soil surface.
- Note, however, that the temperature of irrigation water is often so low that the rice plants are damaged by the low temperature.

3. A funny fact about the greenhouse effect, which may have to be renamed... (Figs. 5 & 6).

## References

- 1) Hokkaido Branch of the Society of Agricultural Meteorology of Japan (2012) Climate and Agriculture in Hokkaido. Hokkaido Shinbun-sha (in Japanese).
- 2) Jones, H.G. (2014) Plants and Microclimate. Third edition. Cambridge University Press.