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Agroscope

ANA Autoridad Nacional del Agua

ÖAW ÖSTERREICHISCHE AKADEMIE DER WISSENSCHAFTEN

Agro-climatic observations in Huaraz, Peru – first insights from water, energy and carbon dioxide flux measurements

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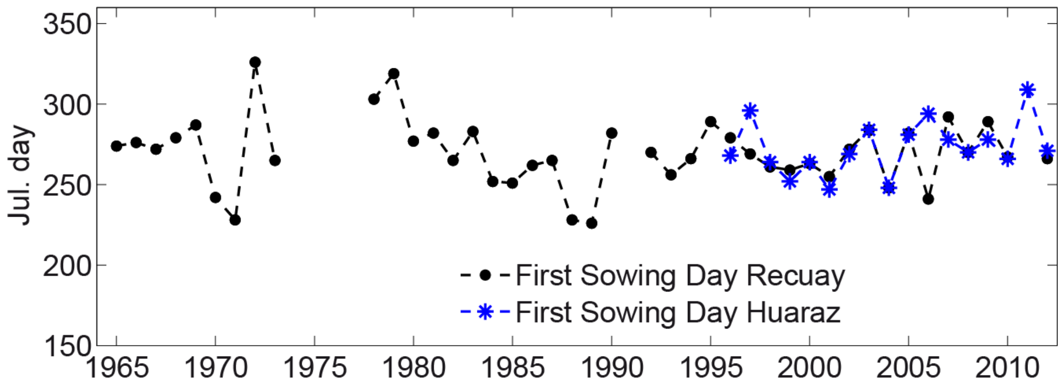
Introduction: Motivation & Context

- Project AgroClim Huaraz (www.agroclim-huaraz.info) financed by the Austrian Academy of Sciences (ÖAW) in the frame of an Earth System Sciences call (“Water in Mountain Regions”, 2018).

- Traditional (mostly rain-fed) farming increasingly threatened by climate and economic changes
- Disagreement between farmer‘s perception and (spatially and temporal limited) meteorological measurements
- Knowledge gap regarding both water demand and water availability to develop effective adaption strategies

Introduction: Motivation & Context



Reports by the peasants in relation to changes in precipitation and agriculture:

① In former times rainy season started in August.

② Waiting for the rain - if sowed earlier than the first rainfall, the crops might be hit by the frost or the drought.

③ In former times the rainy season stopped in April. Nowadays it occasionally continues until June or July.

④ The period for sowing and harvesting depends on altitude, soil moisture and climate.

⑤ Today, there is less rain than before. However, if it is raining it is a brief and heavy rain which destroys plants and the water disappears quickly. Consequently the people feel that there is less rain // they have to wait for the rain to return.

⑥ Ground frost, hail and heavy rains causing damages to the plants

- No trend in available precipitation records (here: theoretical Sowing Day due to first water availability after dry season)
- Perception of local farmers indicate climate-change induced threats to successful agriculture

Figure by: Gurgiser et al. (2016)

Introduction: Project goals

- **Water availability**: Better quantify the recent variability and change of climate variables relevant for rainfed farming practices.
  - See EGU2020-19981 in the same session by Cornelia Klein et al. for more details on this!
- **Water demand**: Quantify crop water demand for a range of crops and agricultural management practices using in-situ observations and a comprehensive crop model.

- By merging this data and implementing it into a model framework we aim to adress agroclimatic research questions in the region. Finally, we aim to find a set of recommendations for the most resilient crops and farming practices for present and near-future climate conditions.

Methods: Region of Interest

- Complex topography west-east transect
- Semi-arid climate
- Strong east-west precipitation gradient and temperature gradient with altitude
- City of Huaraz in between Cordillera Blanca and Coordillera Negra mountain range
- Traditional farming practices based on experiences of generations of farmers

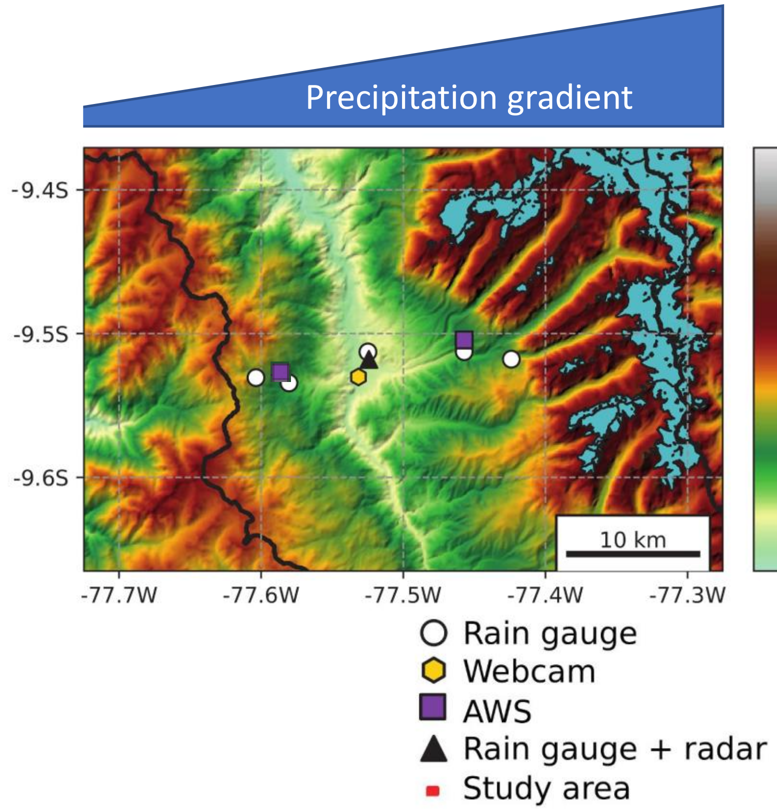


Figure by: Fabien Maussion
Photos on next slide by: Wolfgang Gurgiser

Methods

- Eddy Covariance to monitor evapotranspiration and net carbon dioxide exchange of a potato field
    - Measurements of exchange of energy and water between the biosphere and the atmosphere

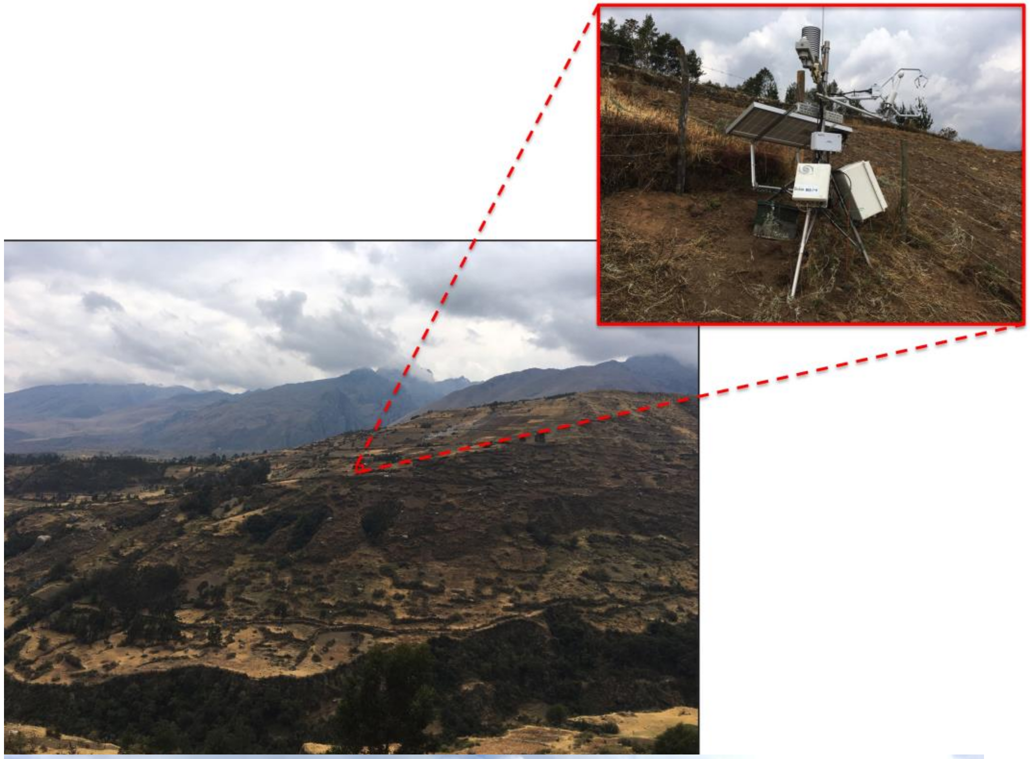


Photo (lower left): Lorenz Hänchen,
Photo (upper right): Georg Wohlfahrt,
Photo (lower right): Fiorella Collas

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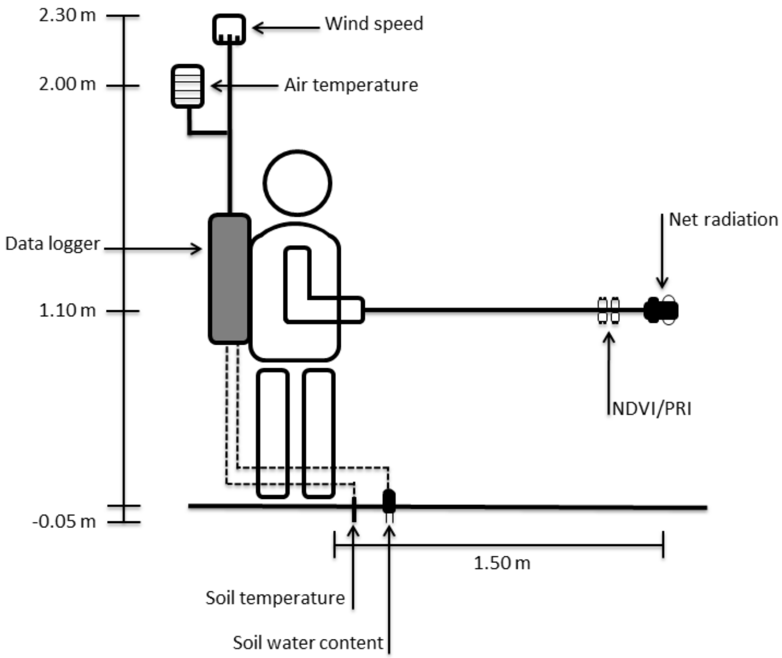
Methods: EcoBot



Methods: EcoBot

- Latent heat as a residual: $\lambda E = Rn - H - G$
- Calculation of sensible heat flux with measured and estimated parameters

$$H = \frac{\rho Cp(T_{aero} - T_{air})}{r_a} \qquad r_a = \frac{U}{u_*^2} + \frac{2}{ku_*} \qquad u_* = \frac{kU}{\ln(\frac{z-d}{z_0})}$$

- Assumptions/Limitations:
    - Near-neutral conditions required
    - Involved assumptions can potentially cause problems in certain conditions
        - e.g. partial canopy cover
        - Potential errors in estimation of ground heat flux

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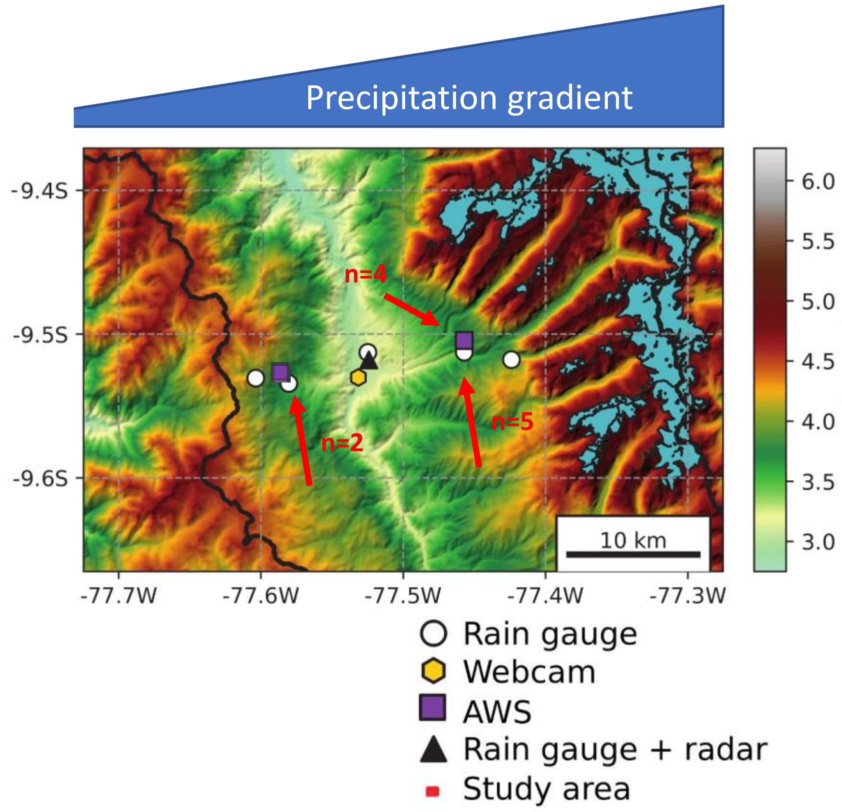
Concept by: Wohlfahrt & Tasser (2015)

Methods: EcoBot

- Three test sites with several crops
- Monthly diurnal measurements
- Above-ground biomass sampling



Llupa (+EddyCovariance & AWS)	Paquishca (rain gauge)	Chincay (AWS)
Potato, Quinua, Oca, Olluco, Oat	Potato, Maize, Alfalfa, Barley	Potato, Alfalfa, Oca, Barley, Pea
Coordillera Blanca	Coordillera Blanca	Coordillera Negra

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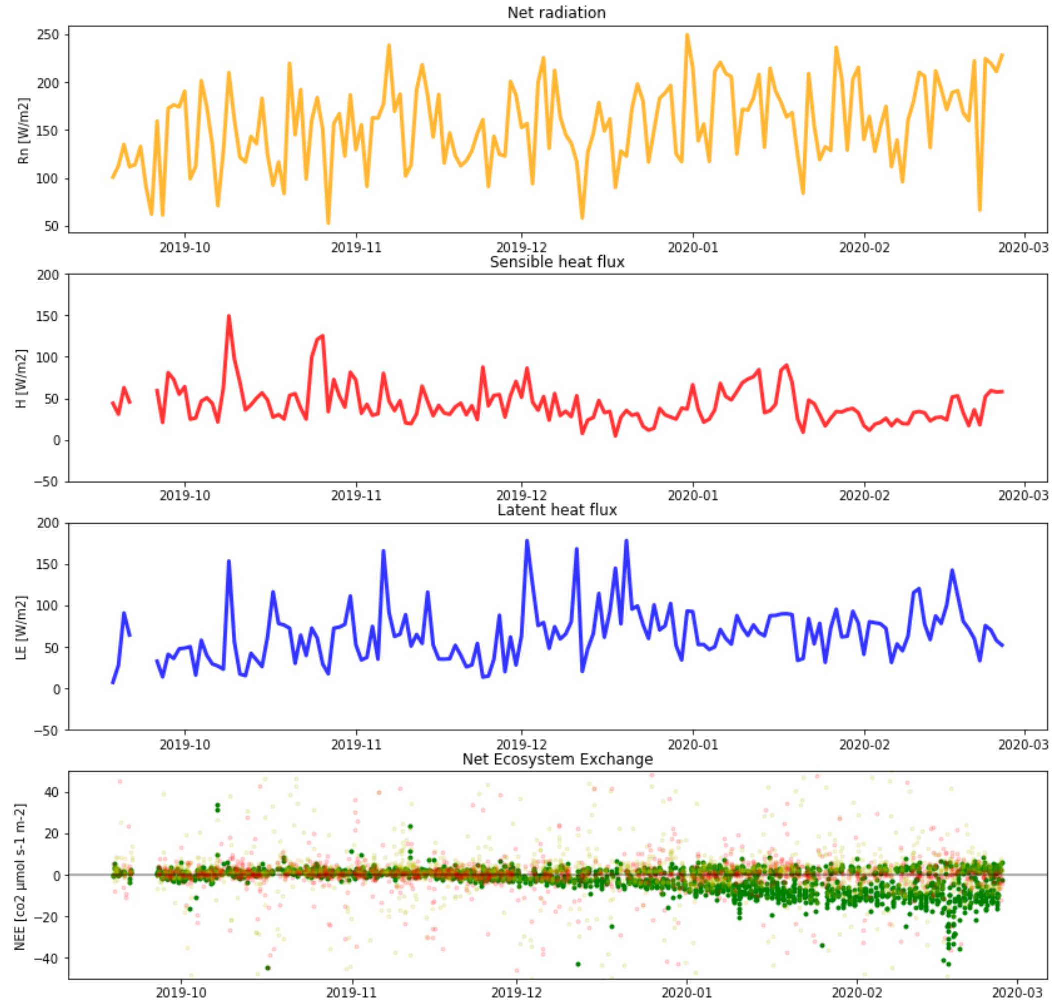
Preliminary results: Eddy Covariance

- Ongoing work: CO_2 uptake by potato plants is visible
- Currently data loss due to inaccessability of the station caused by quarantine measures



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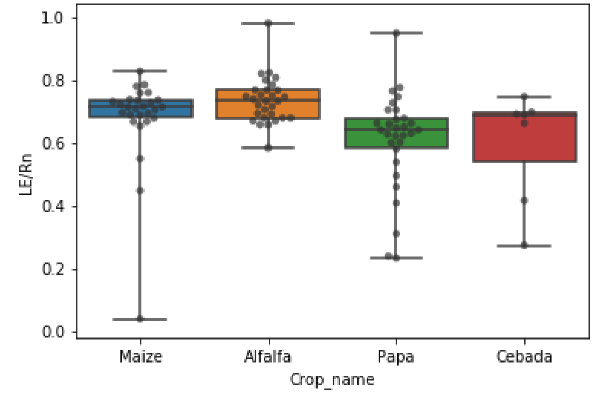
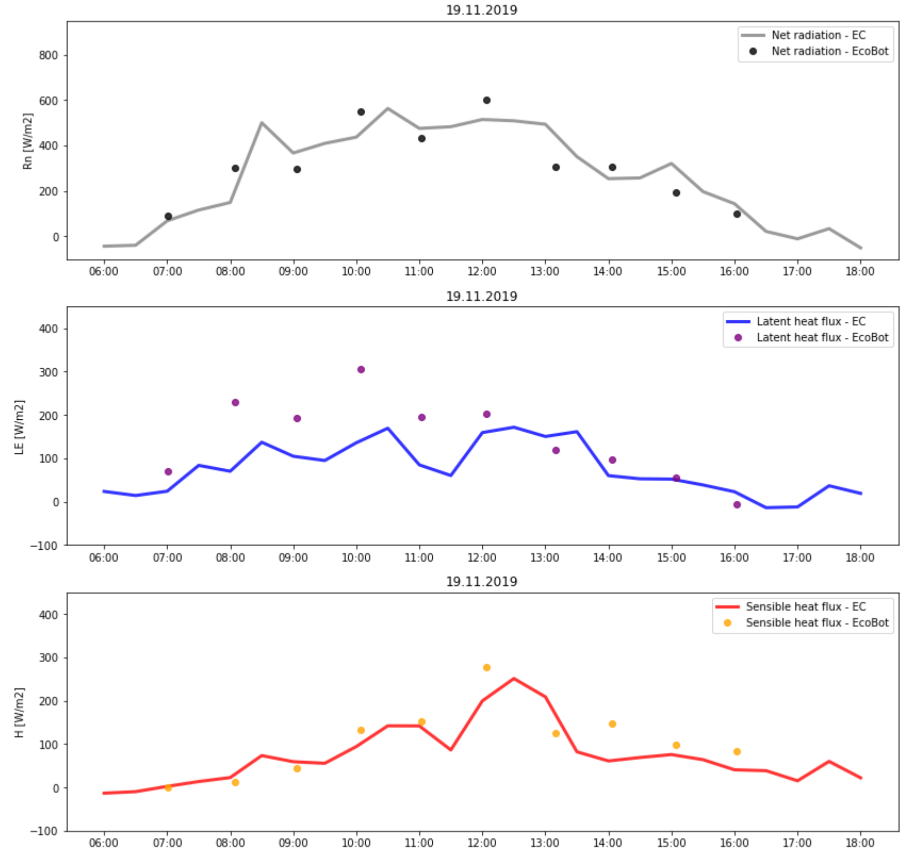
Preliminary results: EcoBot

- Ongoing work, currently outcomes limited by:
    - Small dataset (and currently no data of April and May)
    - Phenological effects
    - Currently working on improvement of estimated parameters involved in calculations





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Outlook: Crop modelling with AquaCrop OS

- Implement our novel empirical data to calibrate, validate and run the process-based crop model AquaCrop OS
- Adapt and extend the model to allow validation with optical satellite remote sensing to compensate for the poor availability of ground observation data in the region
- Model water demand and productivity of the most important crops for a range of rain-fed management scenarios for present-day and extrapolated near-future conditions.