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

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Introduction: Motivation & Context


- 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

- 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
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:

Region of Interest

Concept by: Wohlfahrt & Tasser (2015)

- Complex topography
- Semi-arid climate
- Strong east-west precipitation and temperature gradient with altitude

Precipitation gradient
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
Methods: EcoBot

Concept by: Wohlfahrt & Tasser (2015)
Methods: EcoBot

- Latent heat as a residual: \( \lambda E = Rn - H - G \)

- Calculation of sensible heat flux with measured and estimated parameters

\[
H = \frac{\rho C_p (T_{aero} - T_{air})}{r_a} \quad r_a = \frac{U}{\frac{u_*^2 + 2}{k u_*}} \quad u_* = \frac{k U}{\ln\left(\frac{z}{z_0}\right)}
\]

- 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
Methods: EcoBot

- Three test sites with several crops
- Monthly diurnal measurements
- Above-ground biomass sampling
Preliminary results: Eddy Covariance

- Ongoing work: CO₂ uptake by potato plants is visible
- Currently data loss due to inaccessability of the station caused by quarantine measures
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
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.