Impact of wind speed variability on the surface energy balance and boundary-layer stability in central Alaska

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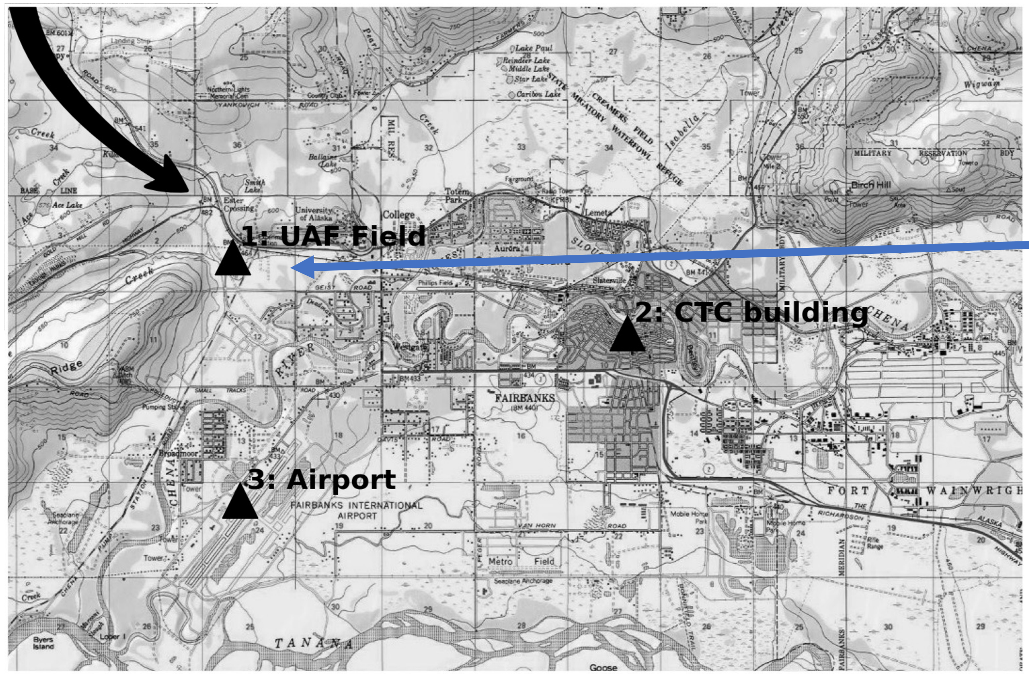
The pre-ALPACA campaign (Nov—Dec 2019)

In Fairbanks, Alaska



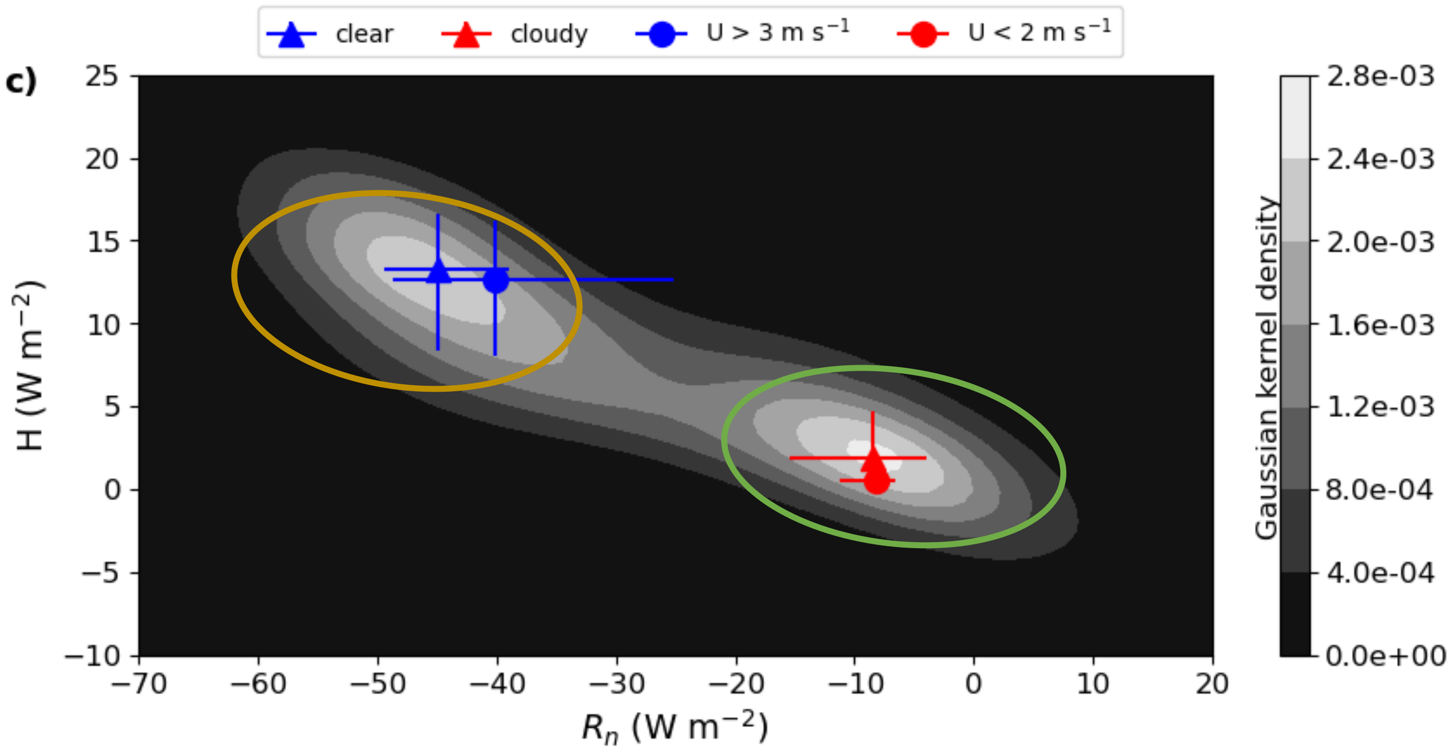
- sonic anemometer
- temperature and pressure sensors
- 4 component radiometer

Impact of a local flow on the SEB

At the field measurement site, the surface layer operated in two distinct states during the campaign :

1) **Cloudy + low wind** → H ~ 0 W/m² & R_n ~ - 5 W/m²
2) **Clear + high wind** → H > 10 W/m² & R_n < - 30 W/m²

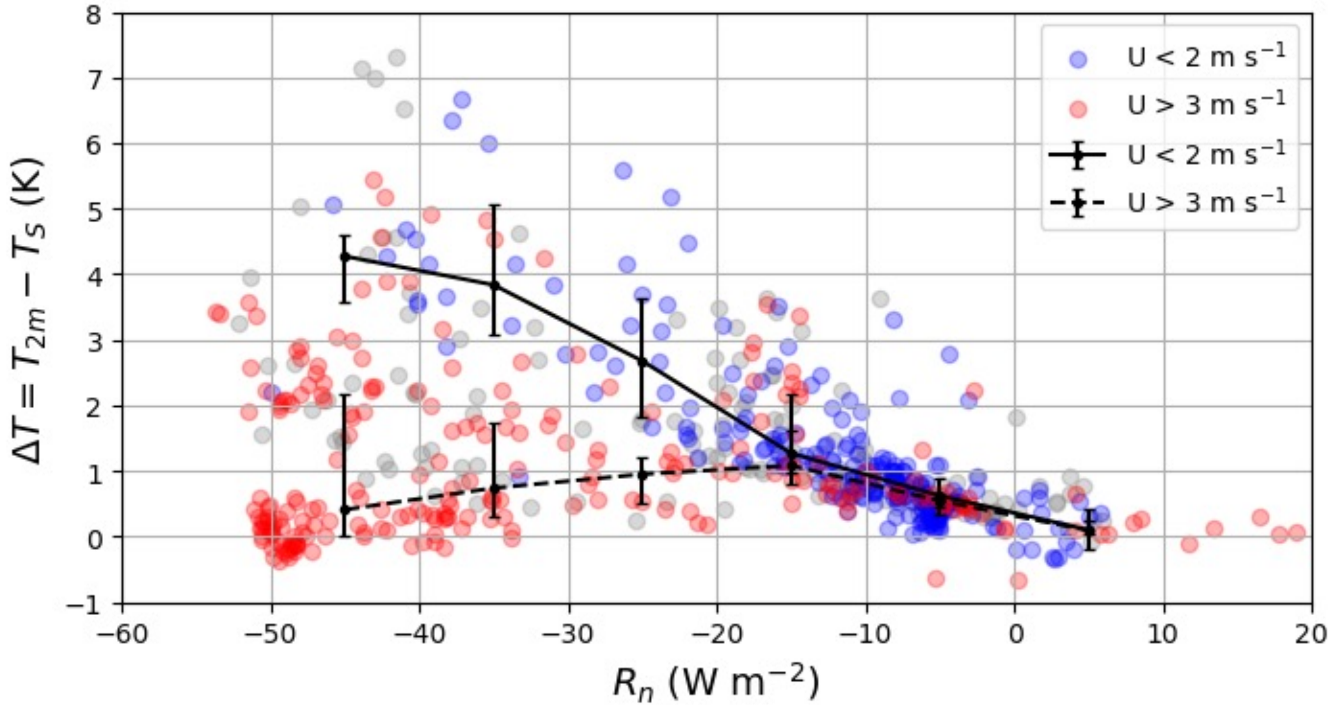
The association of heightened wind speeds with clear skies is likely due to a local, topographically driven flow



Impact of a local flow on surface stability

The response of ΔT to the net radiative flux depends on the wind speed. Two cases for R_n < - 20 W/m^2 :

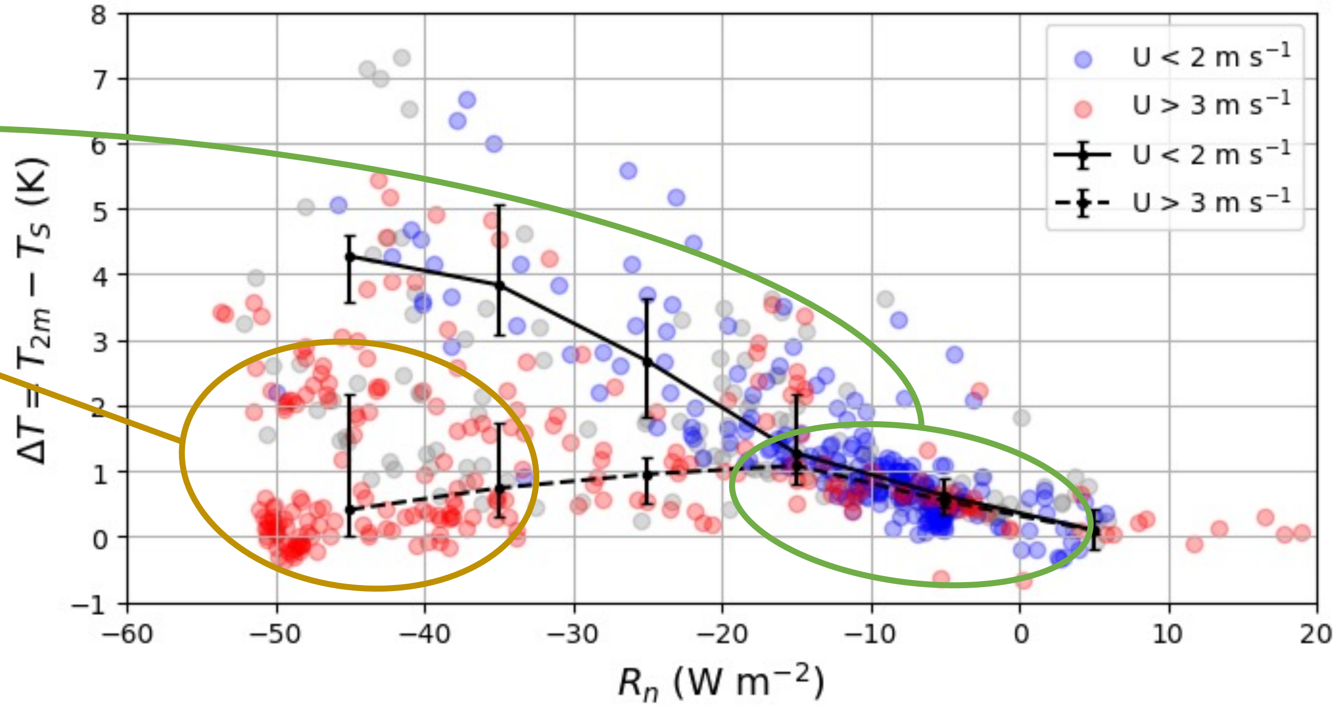
- **U < 2 m/s**: ΔT increases with decreasing R_n
  → « strongly stable »
- **U > 3 m/s**: ΔT only weakly sensitive to R_n
  → Wind shear maintains turbulence,
  « weakly stable »



Impact of a local flow on surface stability

<u>Result</u>: two « preferred states » at the field site both correspond to low ΔT:

1) **Cloudy + low wind** → no strong surface cooling
2) **Clear + high wind** → strong surface cooling, but wind maintains turbulence

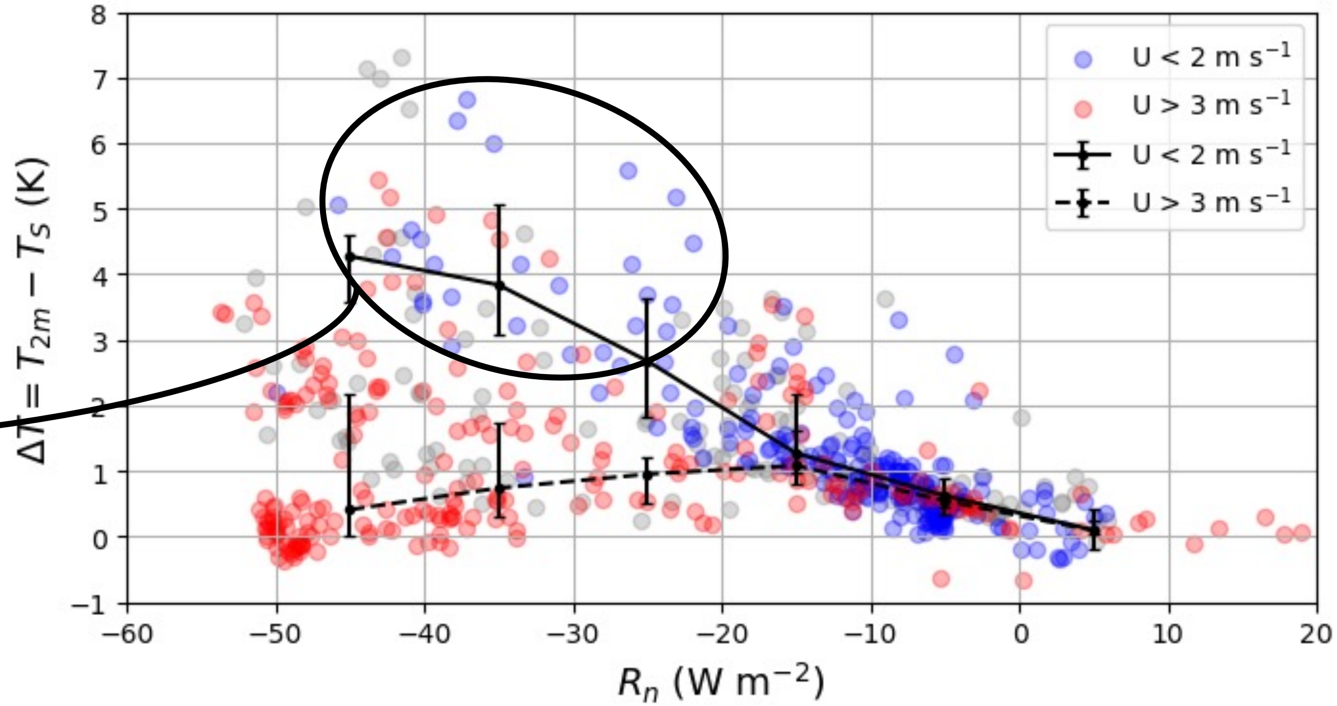


Impact of a local flow on surface stability

<u>Result</u>: two « preferred states » at the field site both correspond to low ΔT:

1) **Cloudy + low wind** → no strong surface cooling
2) **Clear + high wind** → strong surface cooling, but wind maintains turbulences

… **"Clear + low wind"** occurred only sporadically: long-lasting stable conditions did not occur at the Field site during the measurement campaign

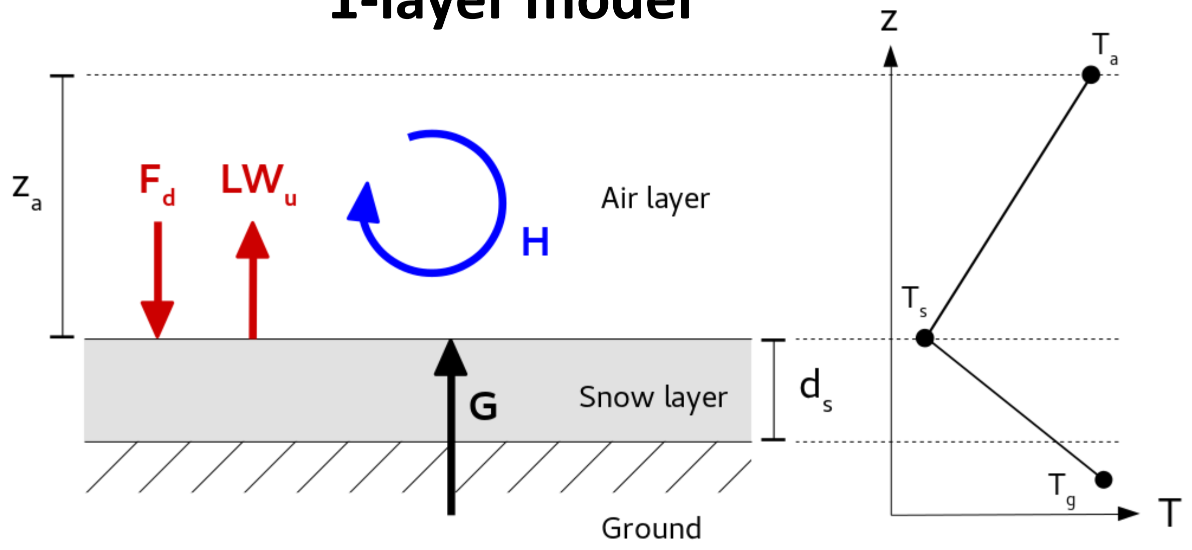


Modelling perspectives?

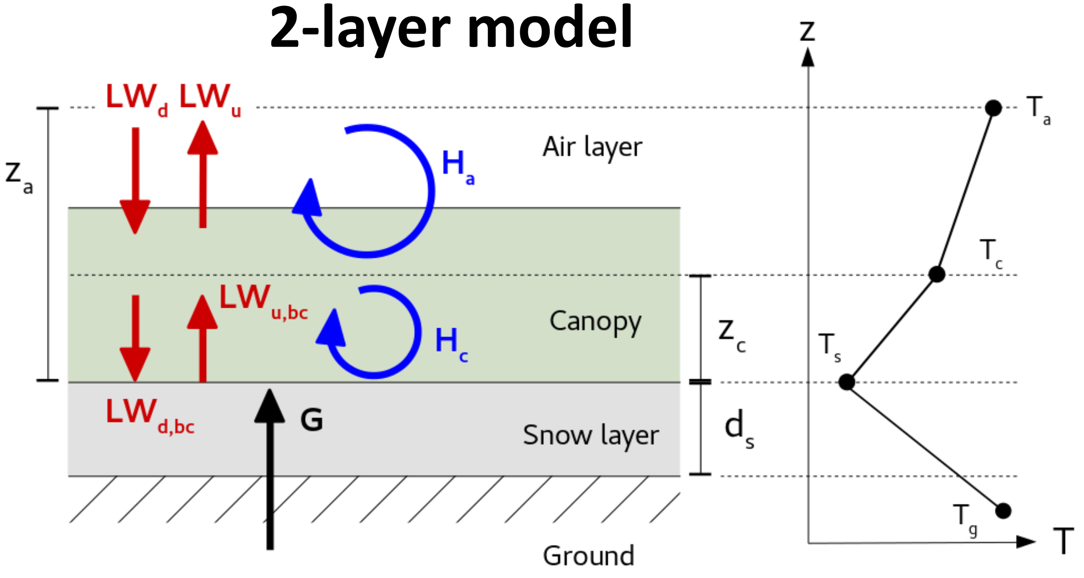
Surface layer/ land surface model schemes:

Inputs: Ta, Ua, za, LWd, Tg, surface characteristics (emissivity, roughness length …)
Output: Ts

1-layer model



2-layer model



Ex:
- In WRF: MYJ surface-layer + Noah land surface model
- Van de Wiel 2017

Ex:
- In WRF: Noah-MP