A CASE STUDY OF THE NOCTURNAL BOUNDARY LAYER ON A SLOPE AT THE FOOT OF A DESERT MOUNTAIN

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Case study: Spring IOP 4

- Spring IOP 4: 11–12 May 2013
- Quiescent, clear-sky conditions
- Tethered-balloon soundings on the east slope
**Case study: Spring IOP 4**

- East slope of Granite Mountain
Phase 1
Evening flow transition
Evening flow transition

Tethered-balloon soundings

UV \ldots up-valley
DV \ldots down-valley
DS \ldots downslope
Evening flow transition

(a) local sunset

(b) cooling onset

(c) flow transition
Evening flow transition

- The shadow propagated down the sidewall from northwest to southeast.
- The strongest temperature decrease occurred shortly after the shadow passed each site.
- The transition from upslope/up-valley winds to downslope winds followed the propagation of the shadow down the slope.
- Differences between the upper and lower parts of the slope:
  - Upper part: weakening and stagnating upslope winds before the onset and increase of downslope winds.
  - Lower part: gradual counter-clockwise turning of the weakening up-valley winds to a downslope direction.
Phase 2
Undisturbed nocturnal slope-boundary layer
Near-surface heat budget

$\frac{\partial \theta}{\partial t}$

advection
(along-slope, cross-slope)

heat flux

residual
Undisturbed nocturnal slope-boundary layer

Downslope-flow characteristics

(a) Inversion strength
(b) Inversion depth
(c) Jet maximum speed
(d) Jet maximum height
**Phase 3**

Sloshing valley inversion
Sloshing valley inversion

Slope immersed in cold air as the valley inversion pushed up the slope.
Sloshing valley inversion

Tethered-balloon soundings

(a) T (°C)

Time (MST)

h (m AGL)
Three distinct periods:

1. Evening flow transition
2. Undisturbed nocturnal slope-boundary layer
3. Sloshing valley inversion
Three distinct periods:

1. **Evening flow transition**
2. **Undisturbed nocturnal slope-boundary layer**
3. **Sloshing valley inversion**

**Phase 1**
- Shadow propagates down the east-facing sidewall.
- Transition from upslope to downslope winds follows the shadow propagation down the slope.
Three distinct periods:

1. Evening flow transition
2. Undisturbed nocturnal slope-boundary layer
3. Sloshing valley inversion

**Phase 1**
- Shadow propagates down the east-facing sidewall.
- Transition from upslope to downslope winds follows the shadow propagation down the slope.

**Phase 2**
- Near-surface temperatures remained almost constant (balance between along-slope advection and heat-flux divergence).
- Three small disturbances affected temperature and wind fields.
Three distinct periods:

1. **Evening flow transition**
   - Shadow propagates down the east-facing sidewall.
   - Transition from upslope to downslope winds follows the shadow propagation down the slope.

2. **Undisturbed nocturnal slope-boundary layer**
   - Near-surface temperatures remained almost constant (balance between along-slope advection and heat-flux divergence).
   - Three small disturbances affected temperature and wind fields.

3. **Sloshing valley inversion**
   - Valley inversion repeatedly pushes up the slope and retreats again producing large temperature oscillations over the slope.