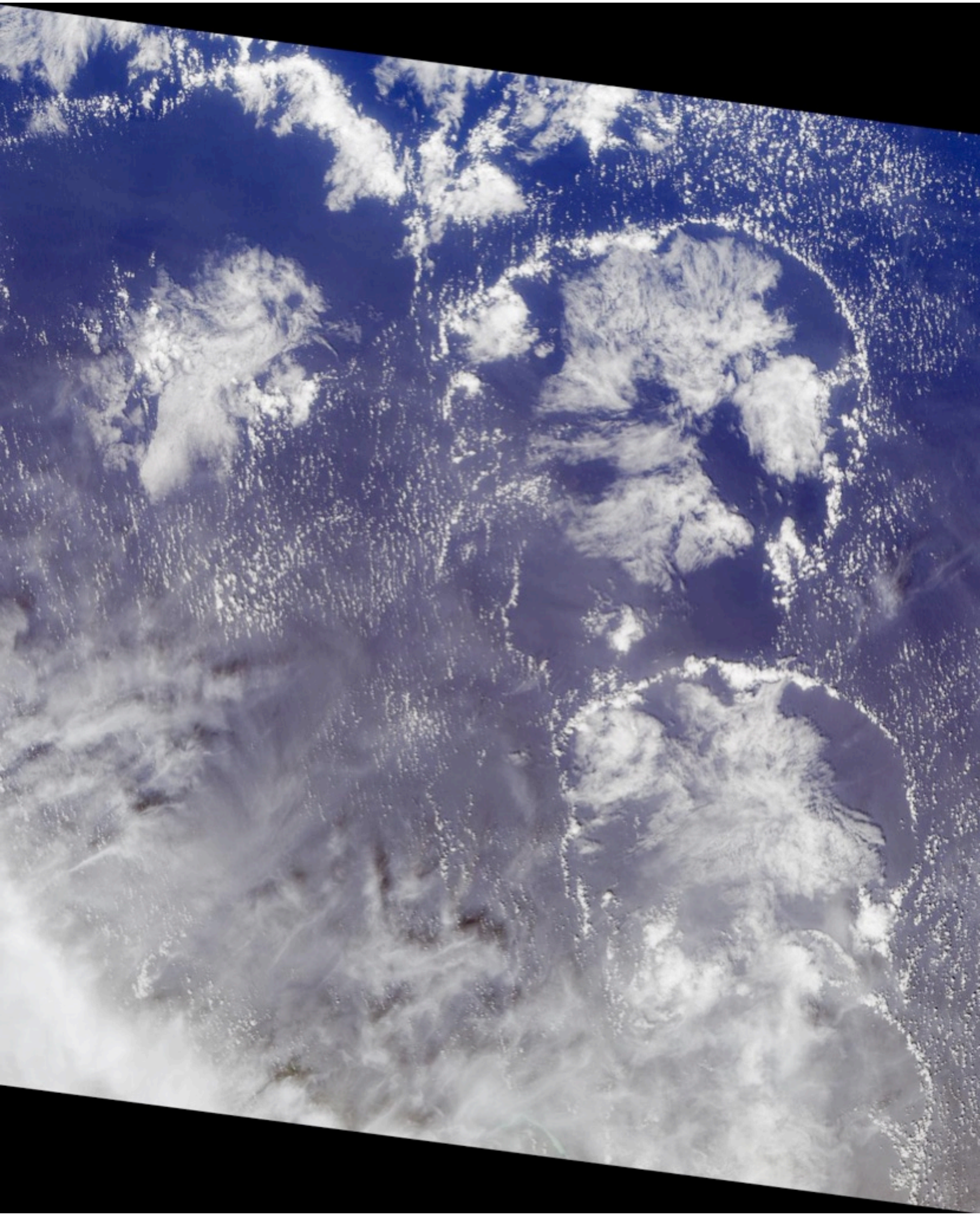
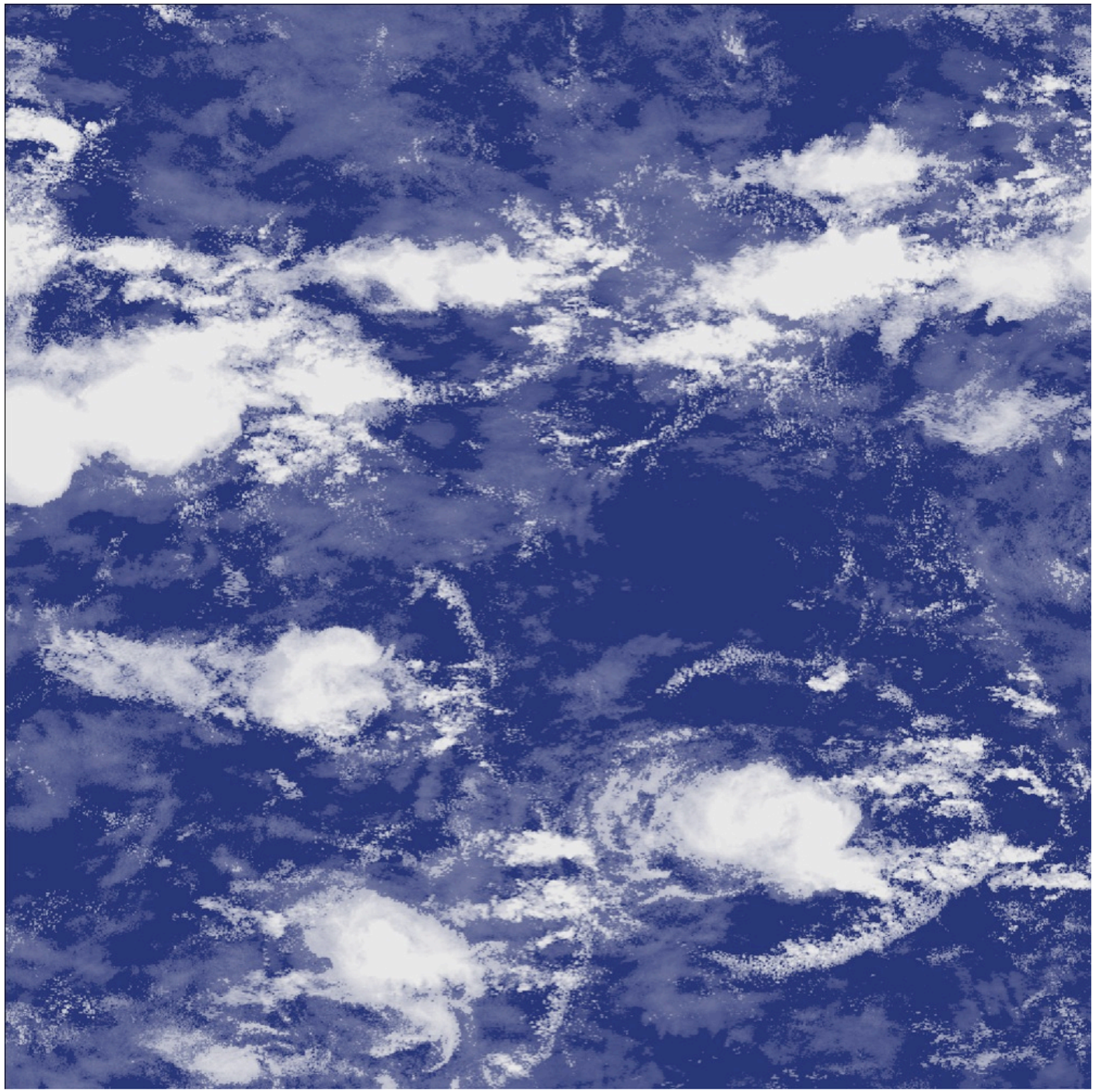
Boundary Layer Meteorology

LES of passive scalar in a convective boundary layer (grid size = 20 m)

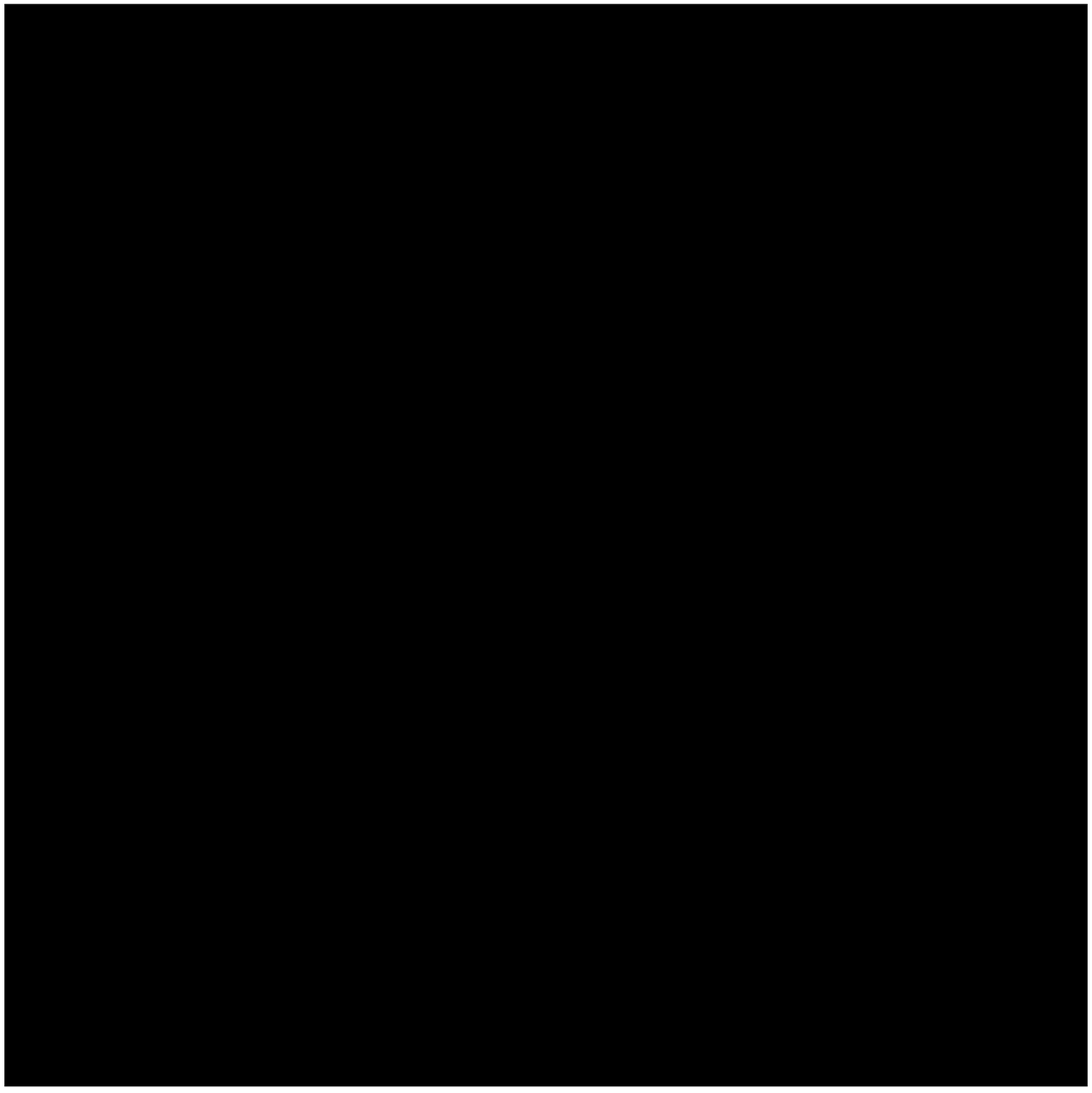
Convective Clouds and the Boundary Layer



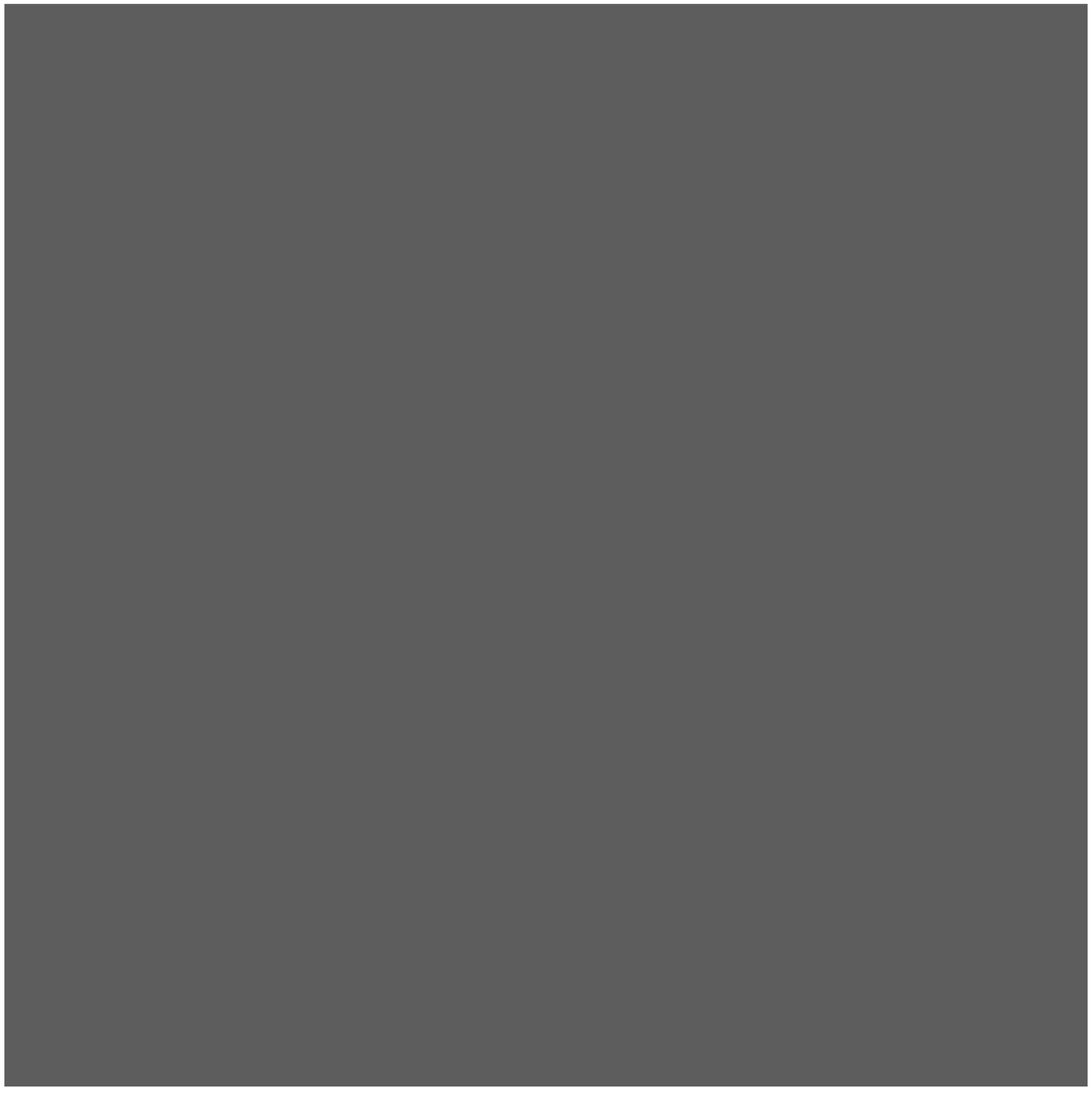
LES “visible image” 180 km x 180 km



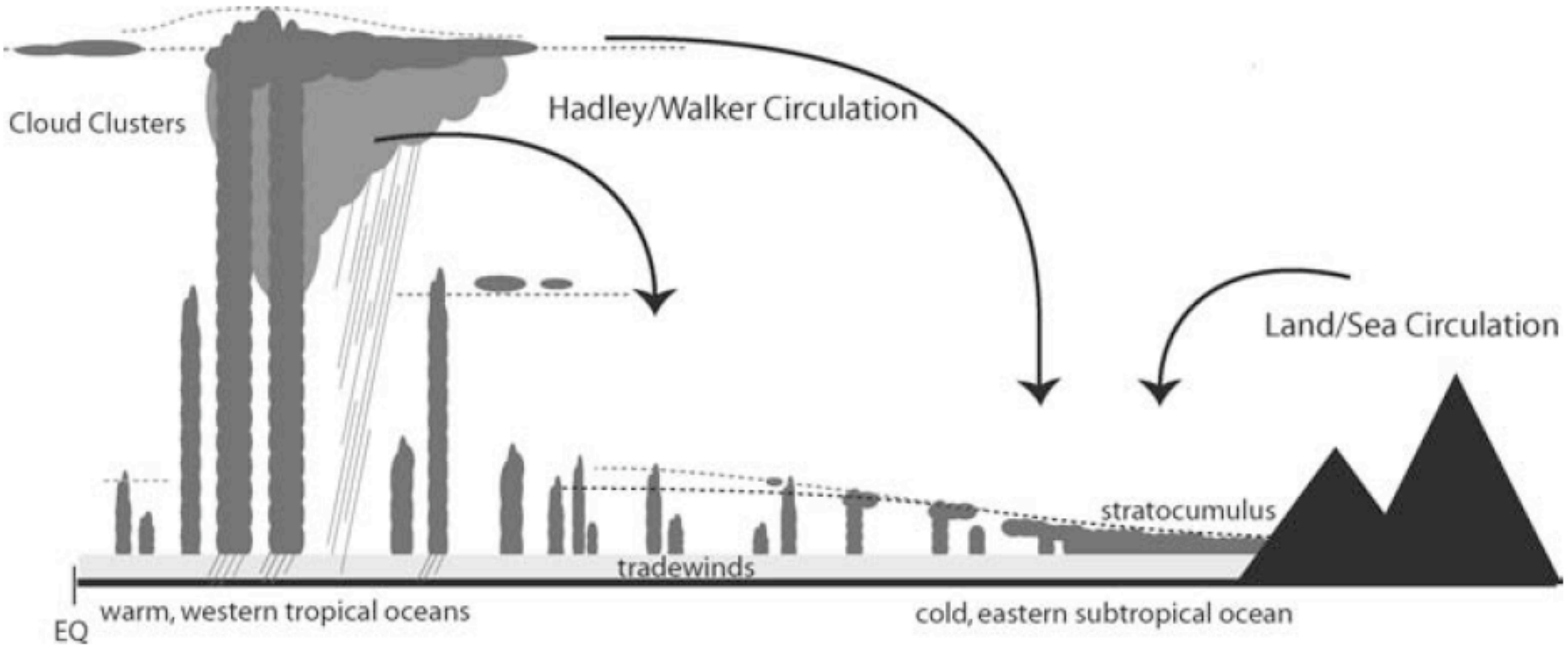
Cloud Water Path (vertical integral)



Water Vapor Mixing Ratio at surface



Boundary Layer Transition over Subtropical Oceans



(from Stevens 2005, after Arakawa 1975)

Simulation of a Boundary Layer Transition

- Lagrangian simulation: SST increases 1.5 K/day for 7 days while other forcings remain fixed.
- Interactive surface fluxes and radiative heating.
- OWN i.c., subsidence, and adective tendencies.

Cloud Fraction

3.2 km x 3.2 km

Height (m)

2000
1500
1000
500

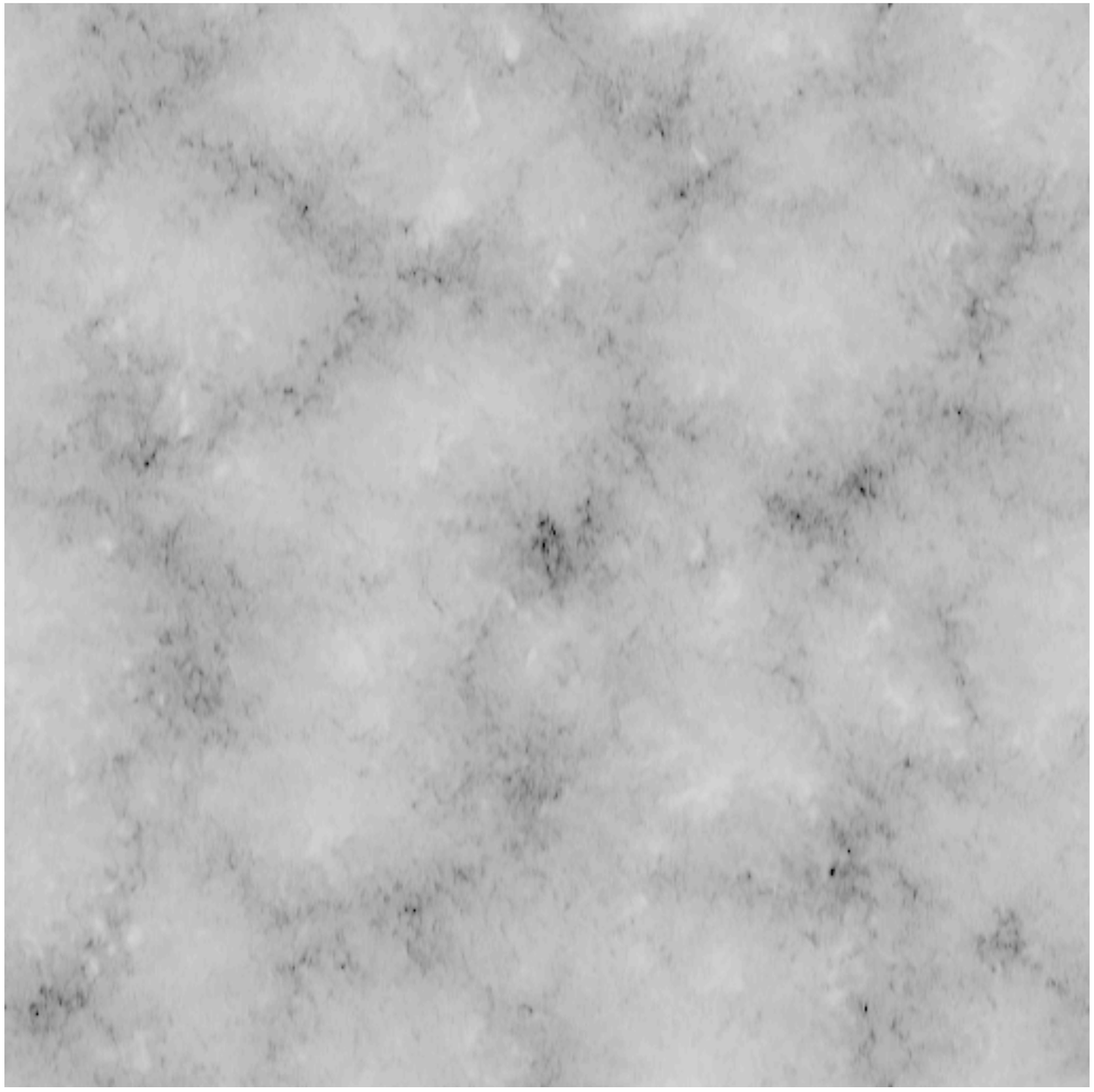
0.01
1

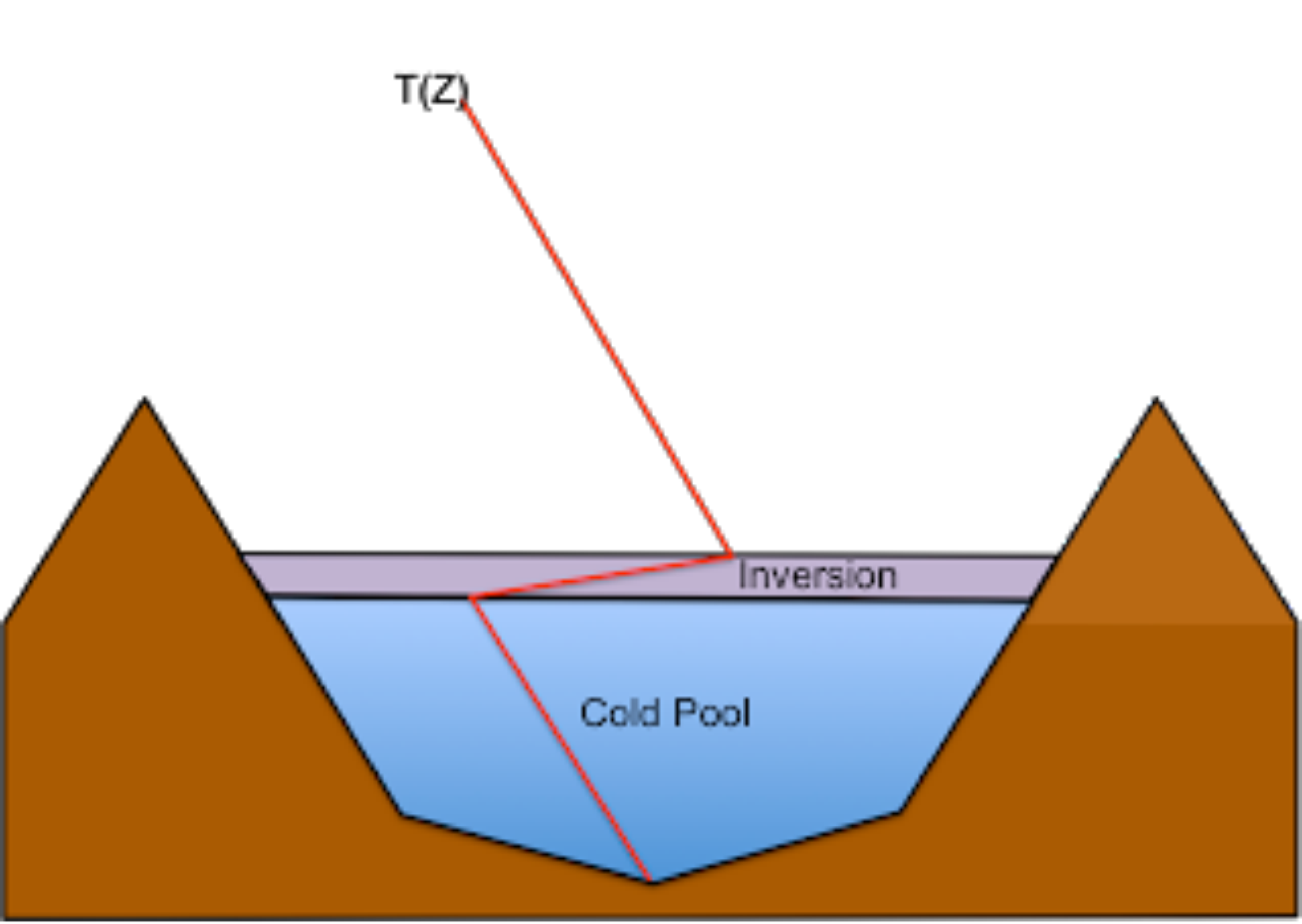
0 1 2 3 4 5 6

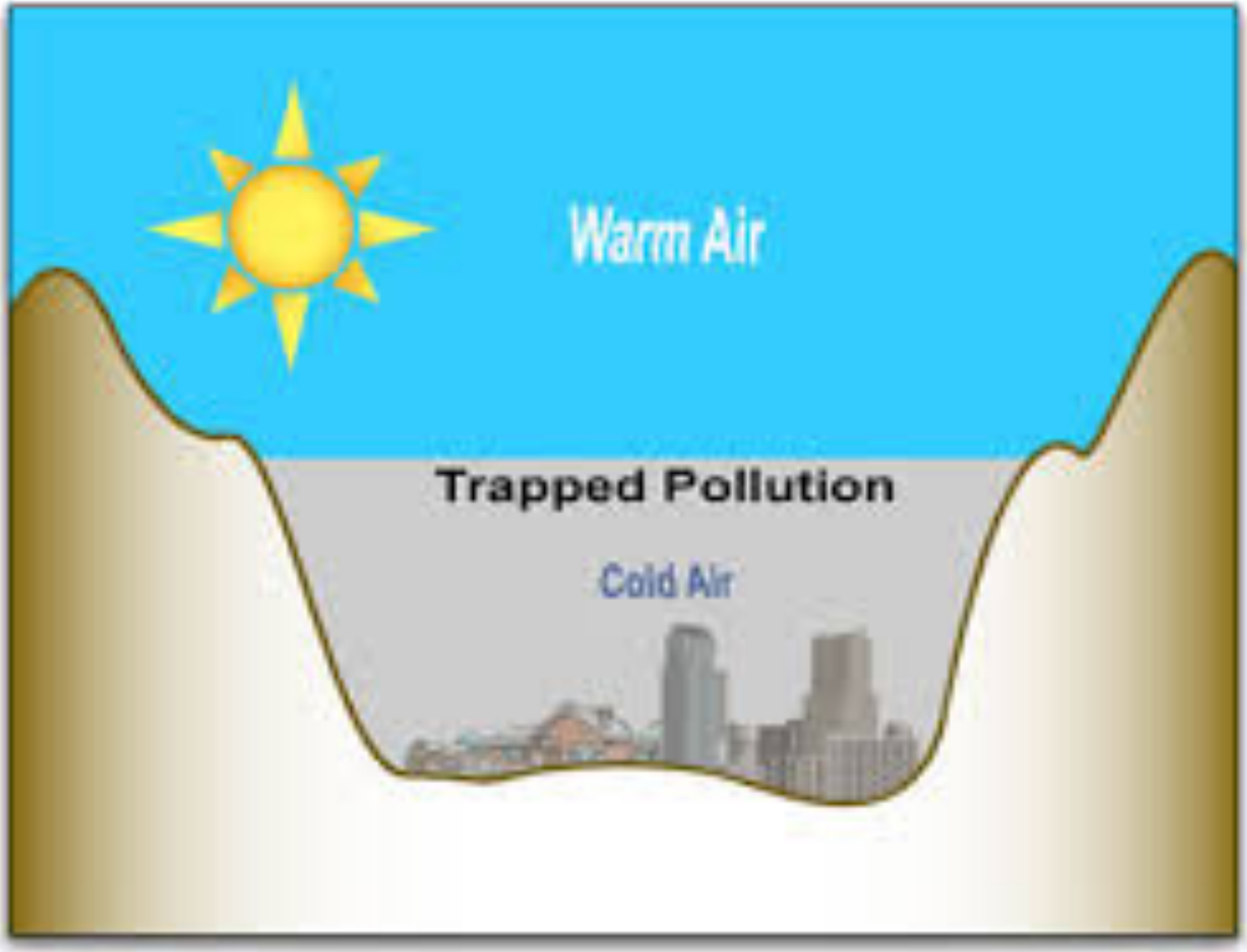
Time (days)

0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1

Cloud Water Path: 25.6 km x 25.6 km




T(Z)
Inversion
Cold Pool


Warm Air
Trapped Pollution
Cold Air

Time-lapse video of fog in Salt Lake Valley
Jan 26 and Feb 2, 2006

THE PERSISTENT COLD-AIR POOL STUDY

BY NEIL P. LAREAU, ERIK CROSMAN, C. DAVID WHITEMAN, JOHN D. HOREL,
SEBASTIAN W. HOCH, WILLIAM O. J. BROWN, AND THOMAS W. HORST

Utah's Salt Lake valley was the setting for a wintertime study of multiday cold-air pools that affect air quality in urban basins.

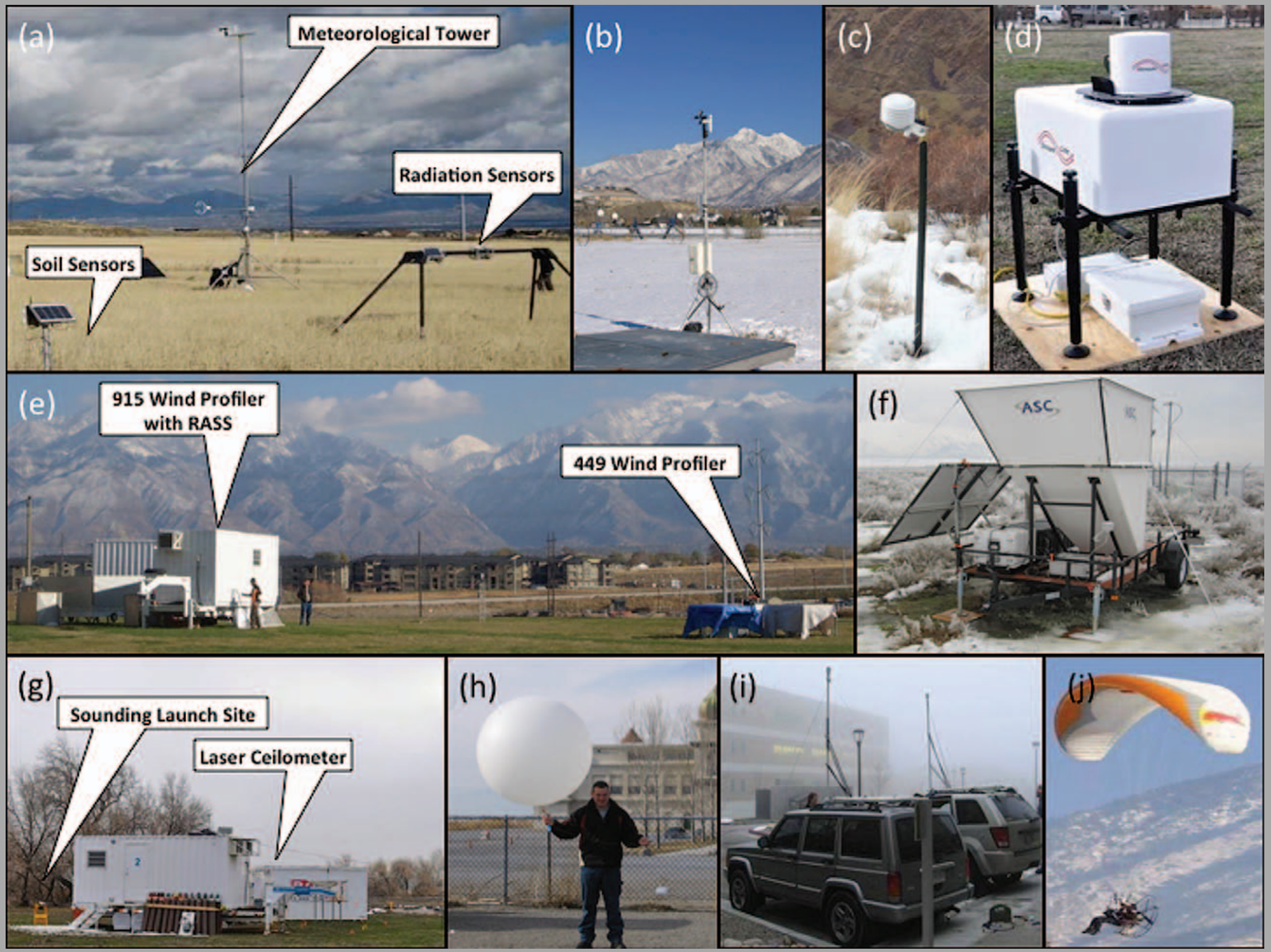
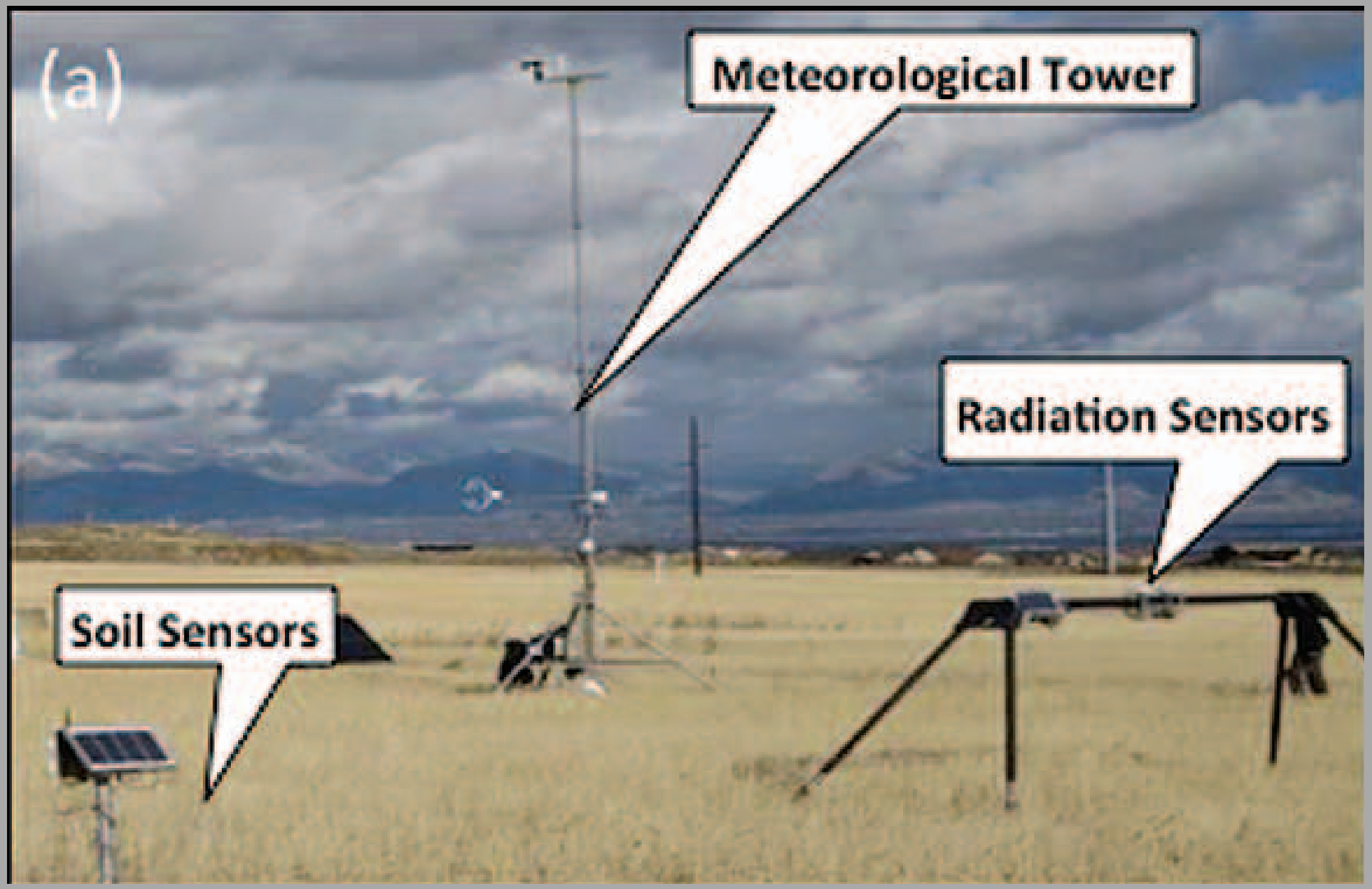
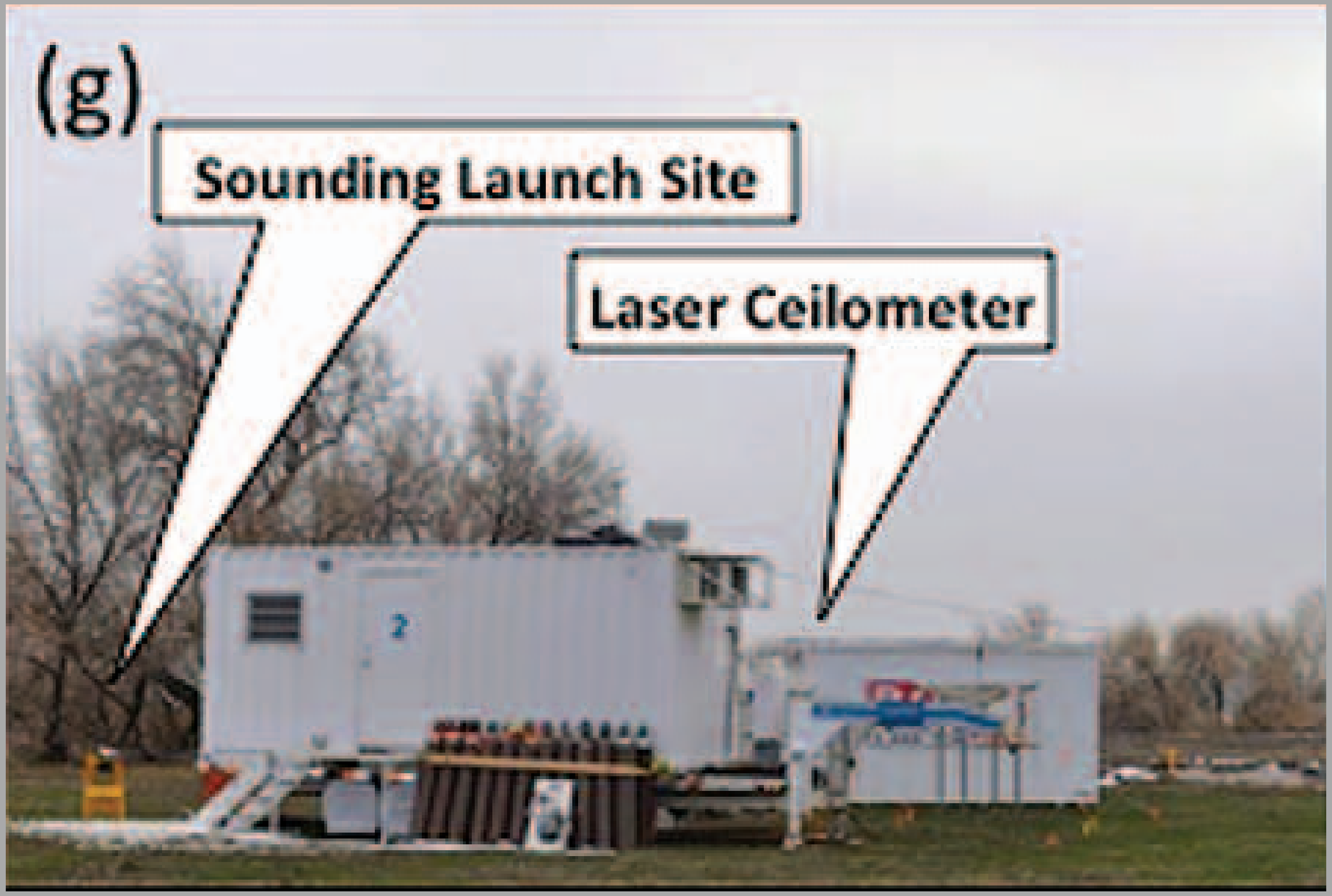


FIG. 2. Photos of key PCAPS instrumentation. See Fig. 1 for location of instruments. (a) NCAR ISFS, (b) University of Utah automatic weather station, (c) University of Utah Hobo temperature dataloggers, (d) University of Utah scanning Doppler lidar, (e) and (g) NCAR ISS sites, (f) University of Utah minisodar, (h) University of Utah mobile radiosonde launch, (i) University of Utah mobile weather stations, and (j) instrumented motorized paraglider.


(a)
Meteorological Tower
Radiation Sensors
Soil Sensors


(d)


(e)
915 Wind Profiler
with RASS
449 Wind Profiler


(g)
Sounding Launch Site
Laser Ceilometer


(h)


(j)

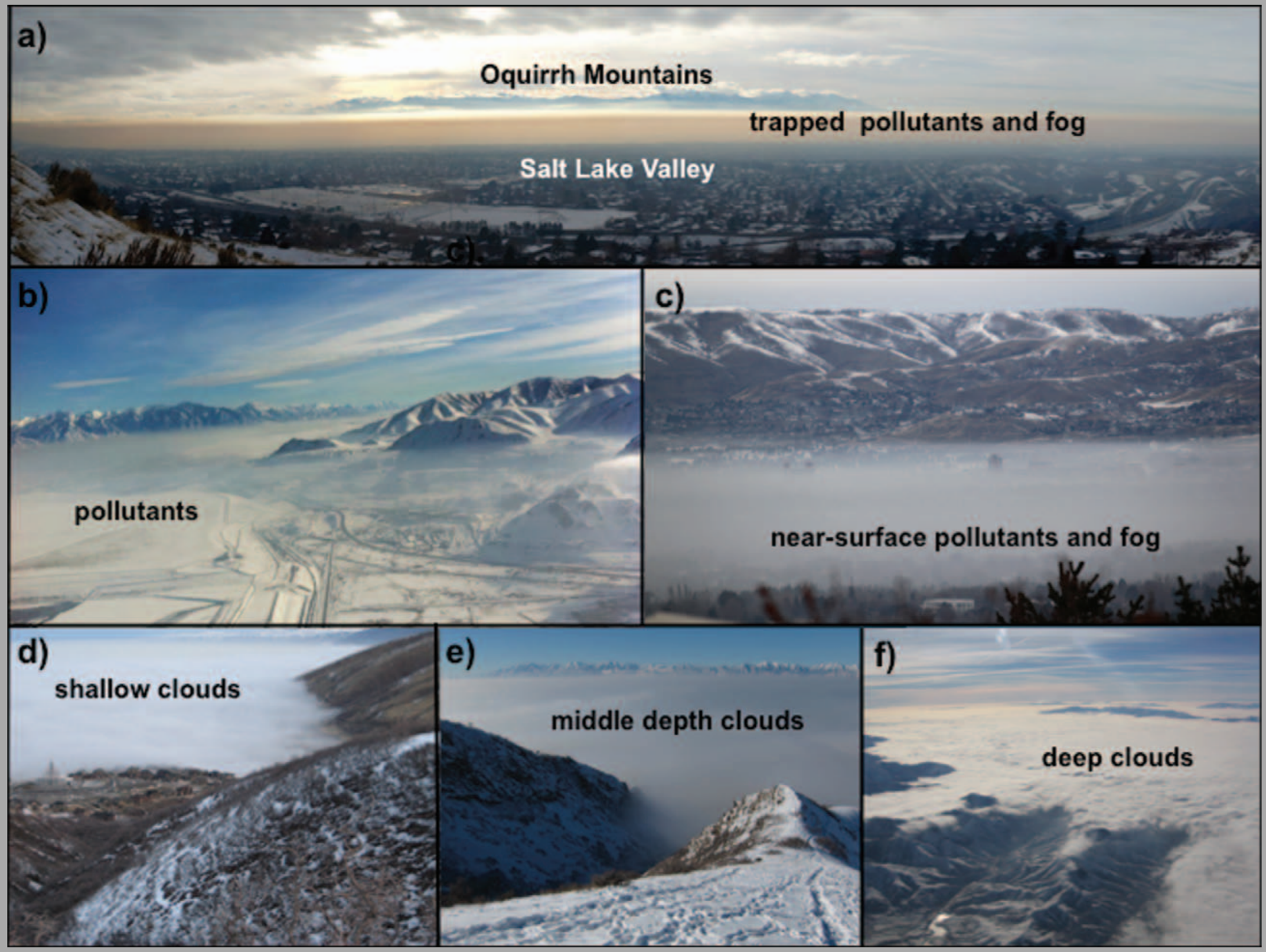


Fig. 4. Photos of SLV inversions during PCAPS (photo credits are in parentheses): (a) 14 Jan 2011: combined fog and pollutants (Sebastian Hoch); (b) 2 Dec 2010: cloud-free deep (~700 m) polluted layer (Chris Santacroce); (c) 16 Jan 2011: thin surface layer (<100 m) of fog and pollution (James Ehleringer); (d) 30 Jan 2011: cloudy inversion (John Horel); (e) 7 Jan 2011 (David Bowling): cloudy inversion; and (f) 24 Dec 2010: cloudy inversion, stratocumulus clouds extending to about the crest (Erik Crosman).

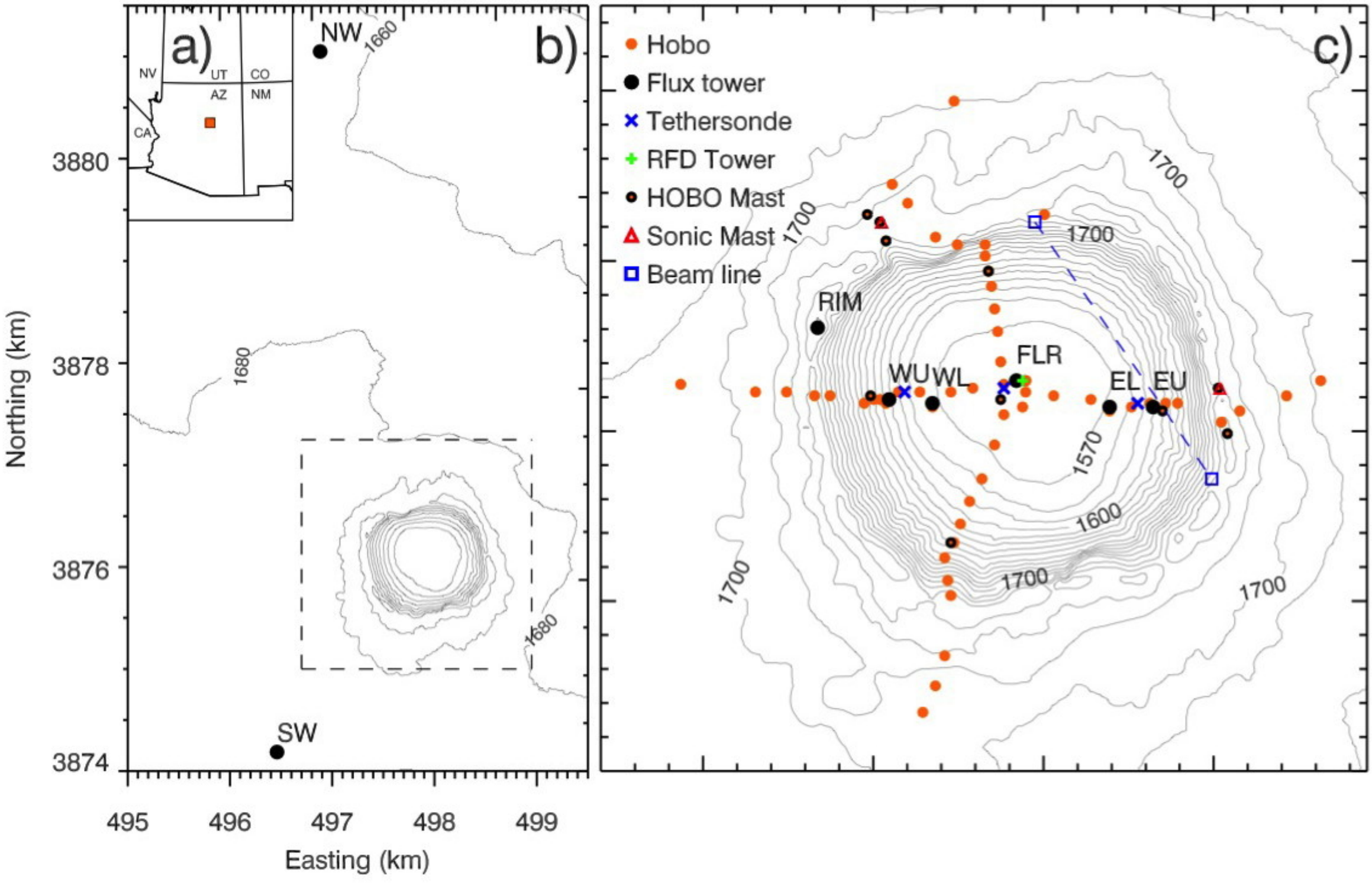

Oquirrh Mountains
trapped pollutants and fog
Salt Lake Valley


c)
near-surface pollutants and fog

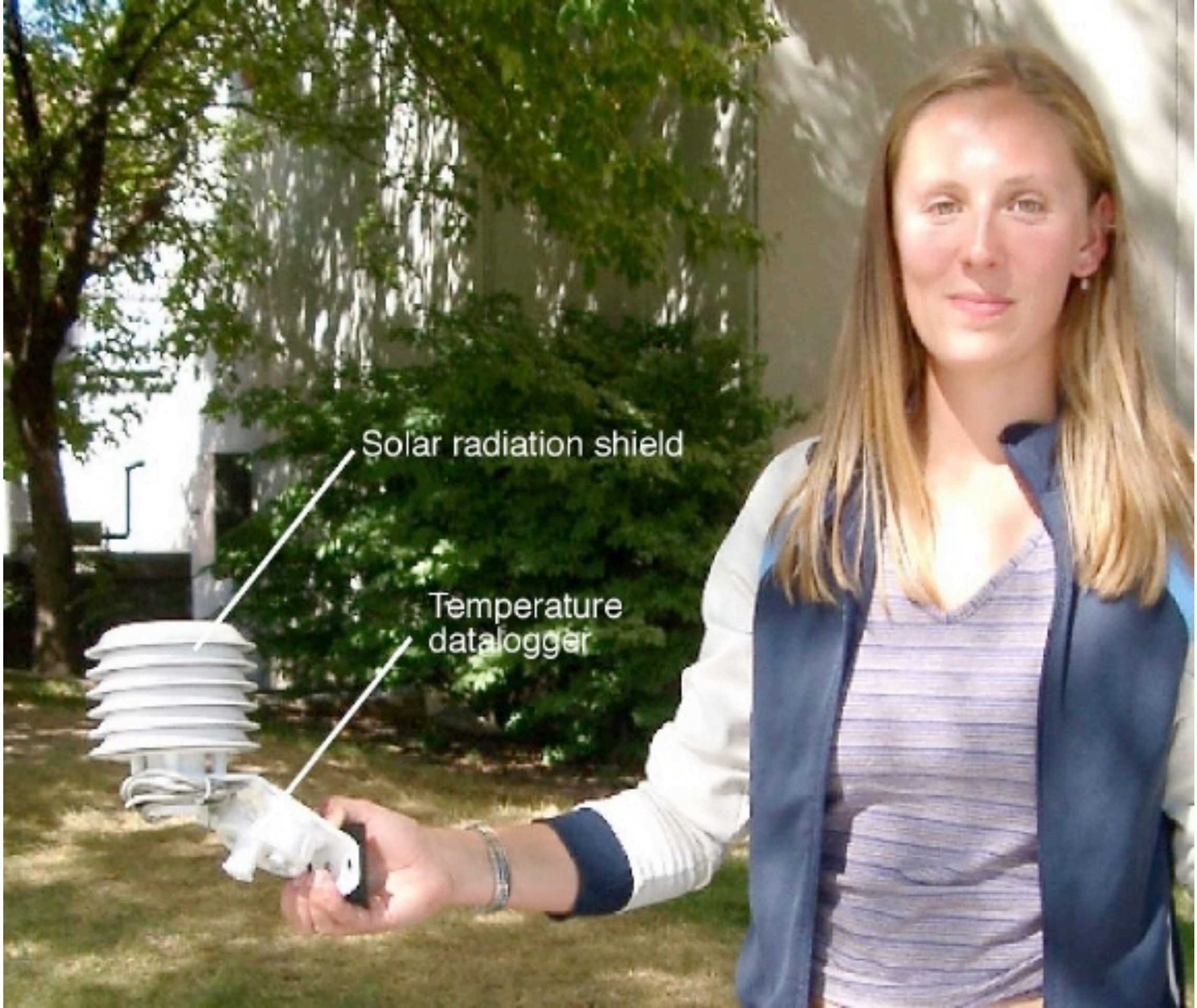
METCRAX

(Meteor Crater Experiment)

METCRAX II Field Equipment




Sebastian Hoch


Solar radiation shield
Temperature
datalogger


Sebastian Hoch

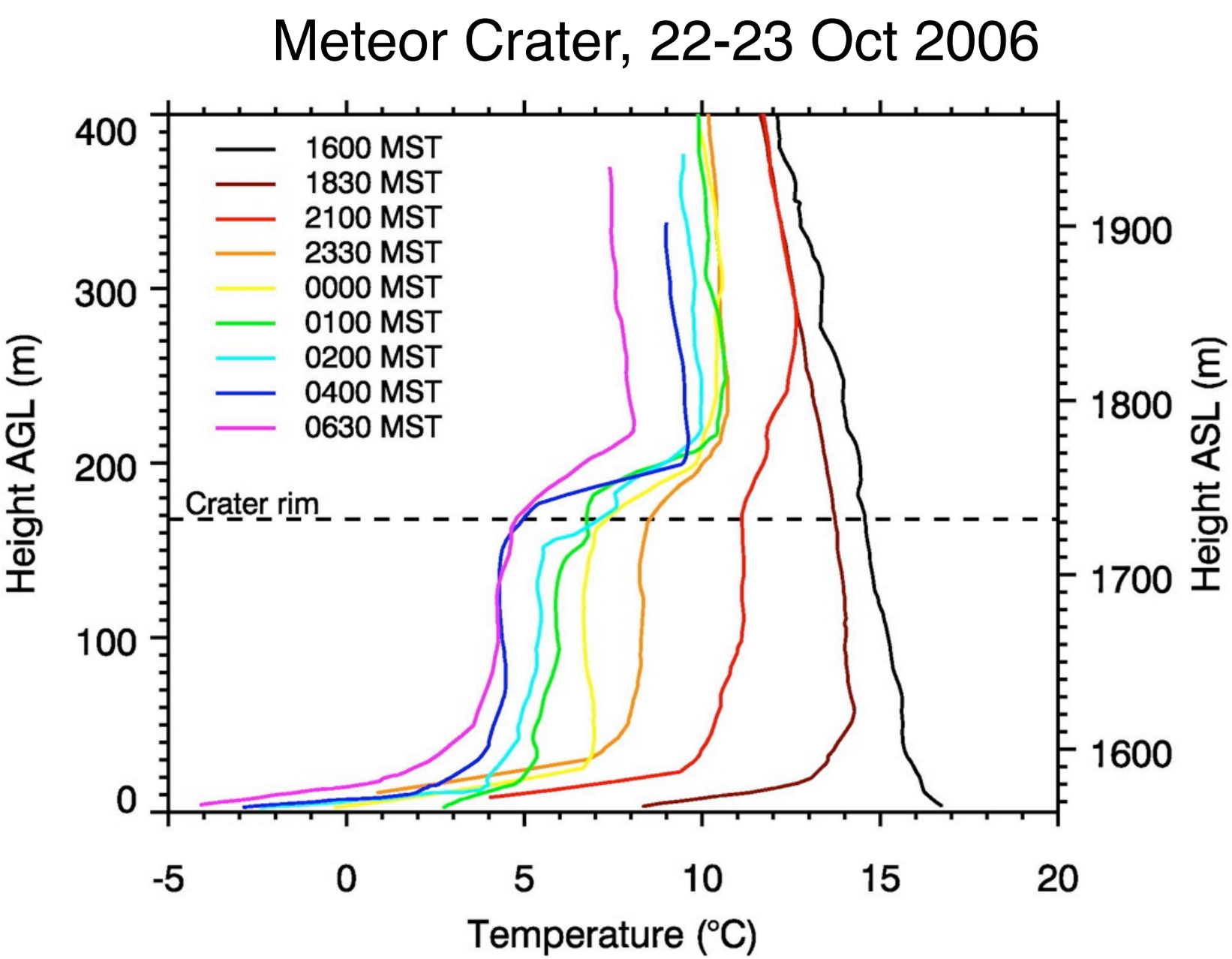

Sebastian Hoch

Sebastian Hoch


Sebastian Hoch

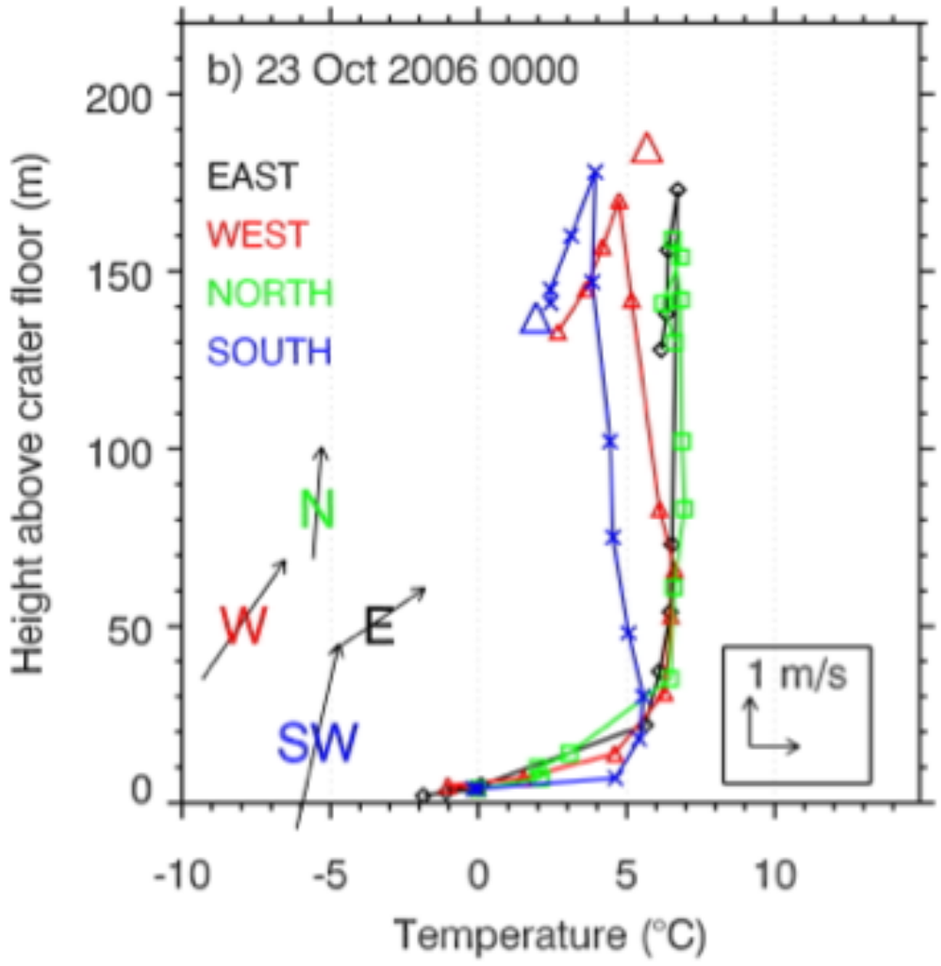

K&Z 940181
EP31977
Sebastian Hoch


Sebastian Hoch

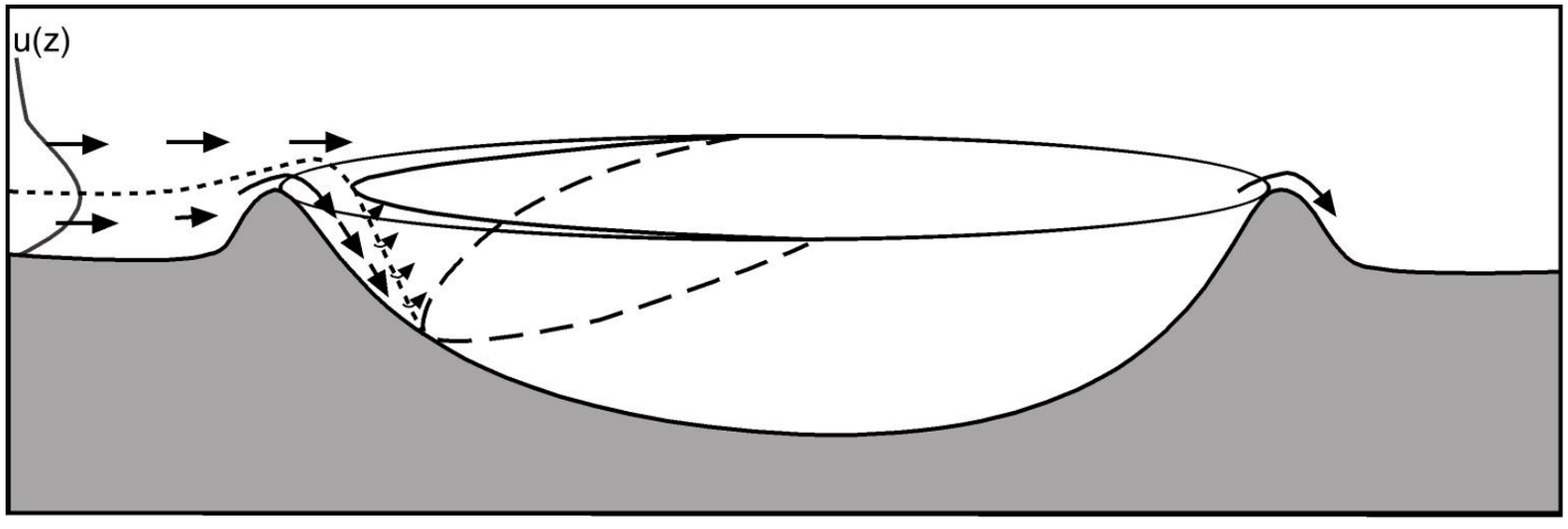


- Strong 30-m deep inversion on crater floor
- Isothermal atmosphere in remaining 75% of crater depth
- Temperature jump develops at rim level
- Crater cools while remaining isothermal

What physical process(es) produce the isothermalcy?



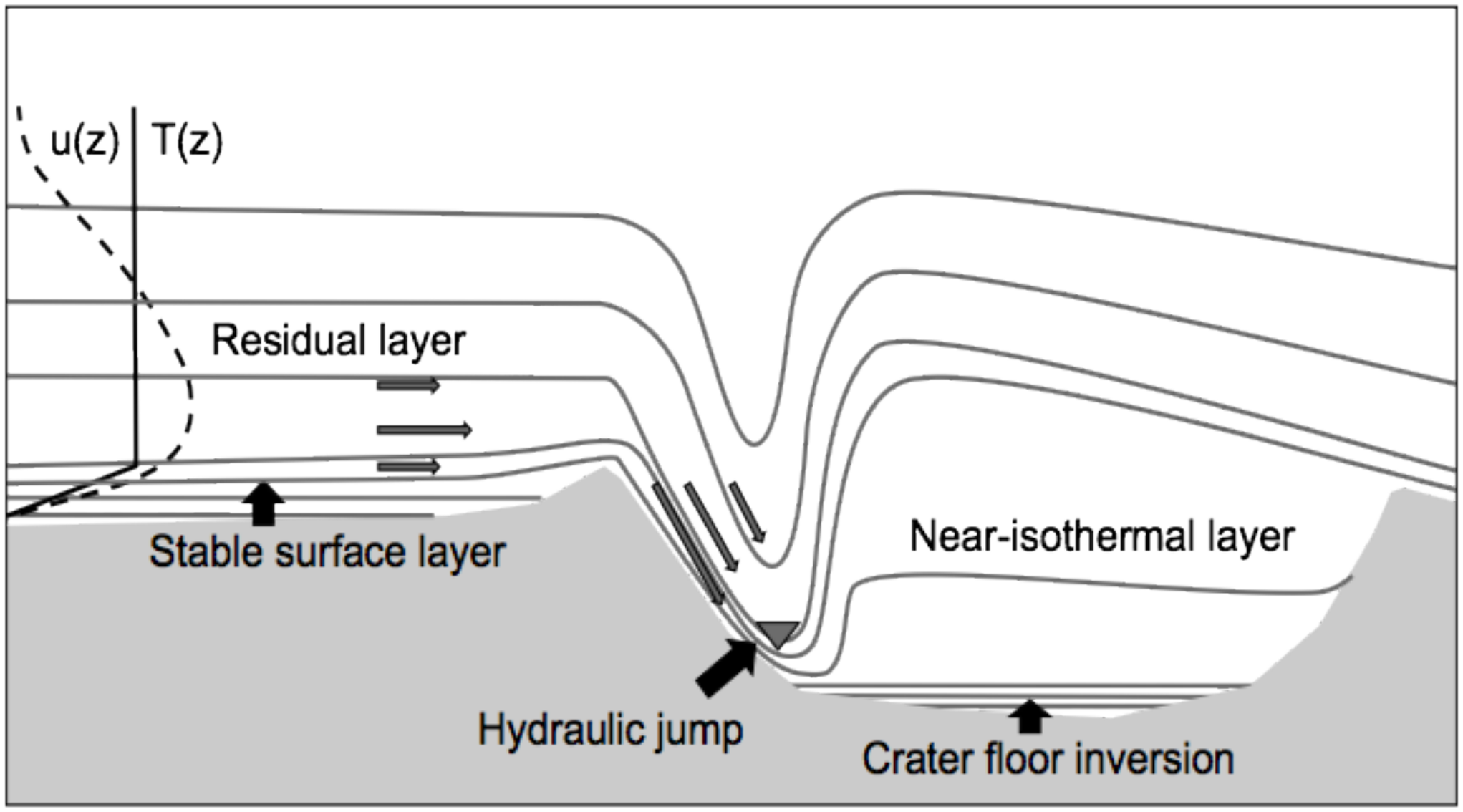
- The depth of the notch indicates the depth of the cold air intrusion on that sidewall of the crater
- The intrusion becomes deeper on the south sidewall when the regional scale drainage flow is from the south, and deeper on the west sidewall when the flow is from the west
- The intrusion is deepest on the upwind side of the crater

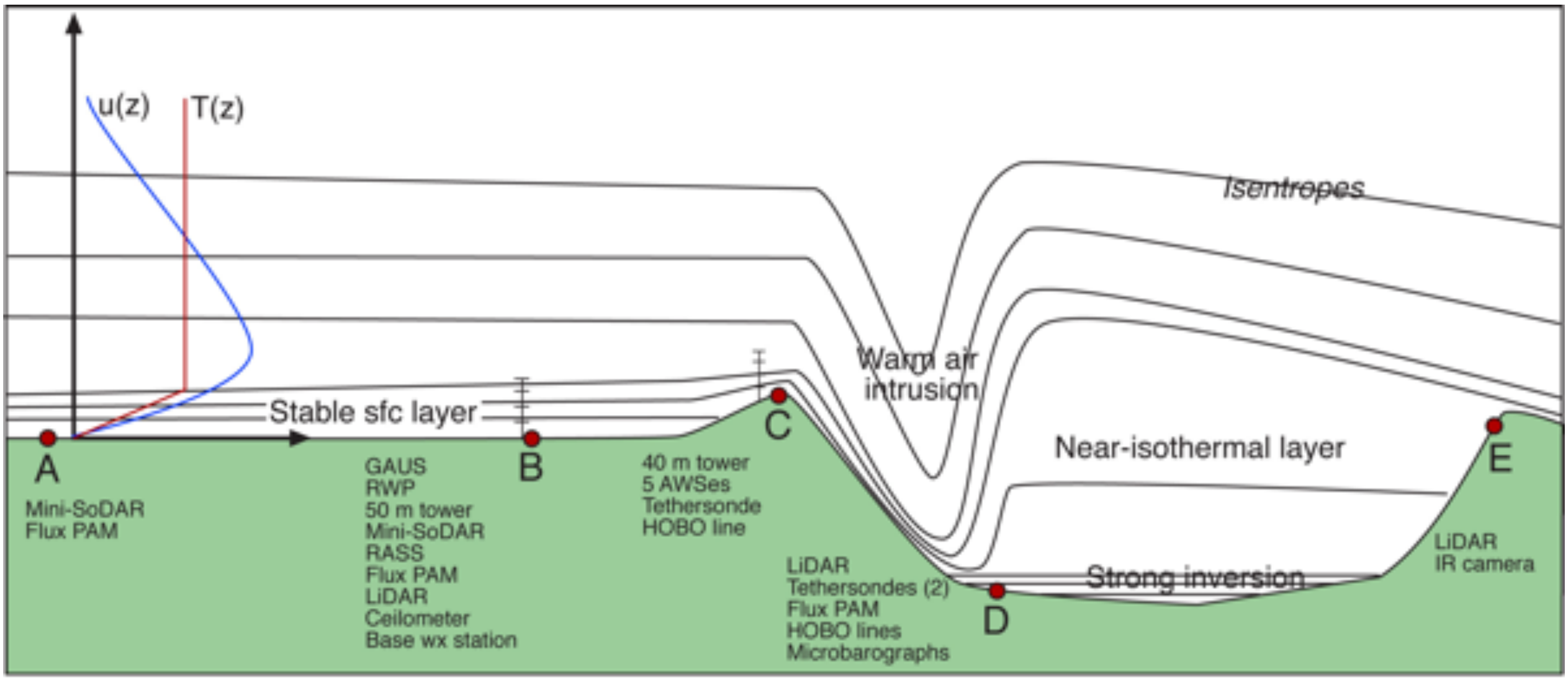


Cold air intrusions
Conceptual model

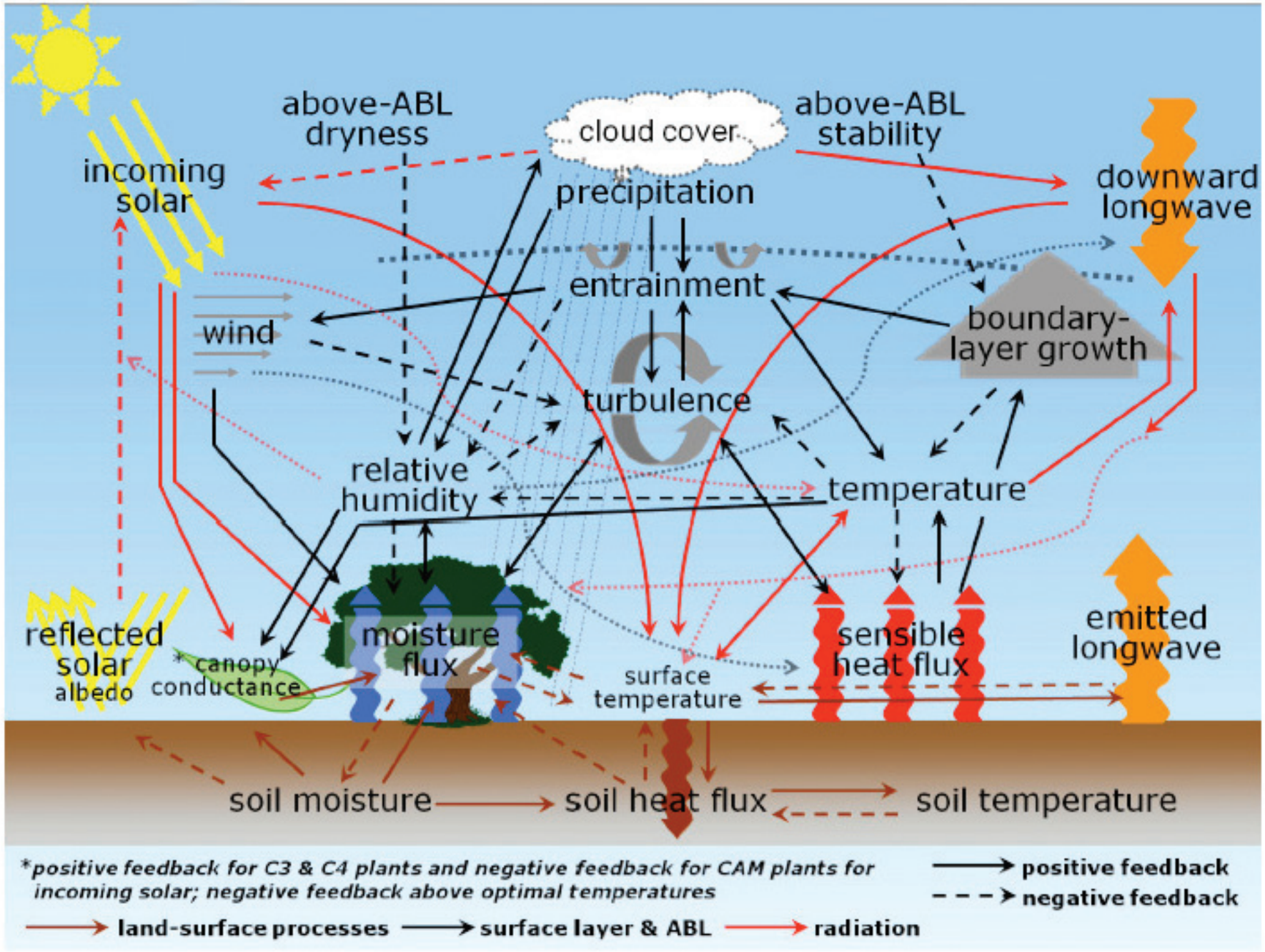
Downslope-Windstorm-type Flow

Conceptual model - DWF




u(z)
T(z)
Isentropes
Warm air intrusion
Stable sfc layer
Near-isothermal layer
Strong inversion
A
Mini-SoDAR
Flux PAM
B
GAUS
RWP
50 m tower
Mini-SoDAR
RASS
Flux PAM
LiDAR
Ceilometer
Base wx station
C
40 m tower
5 AWSes
Tethersonde
HOBO line
D
LiDAR
Tethersondes (2)
Flux PAM
HOBO lines
Microbarographs
E
LiDAR
IR camera

Diurnal Land-Atmosphere Coupling Experiment (DICE): A First Attempt to Identify These Complex Interactions *(see page 3)*



Schematic of the complex interactions between the land surface, atmospheric boundary layer, and radiation via many variables. These interactions are not well understood, in general, and are often poorly represented in numerical models. See article by Martin Best, et al. on page 3. Figure adapted from Ek and Holtslag (2004), courtesy of Mike Ek.