GABLS4 Results from NCEP Single Column Model

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NCEP GFS: Global Forecast System

Resolution: T-574 (1760x880) / T190 (576x288)

Vertical levels: 64 (~22m for the lowest model level)

Time step: 7.5 min

PBL scheme: Non-local mixing scheme with stratocumulus-top-driven turbulence mixing (Hong & Pan, 2011)

Land surface processes: Noah V2.7 (Michael Ek et al., 2003)

Snow scheme: one-layer scheme (Michael Ek et al. 2003)

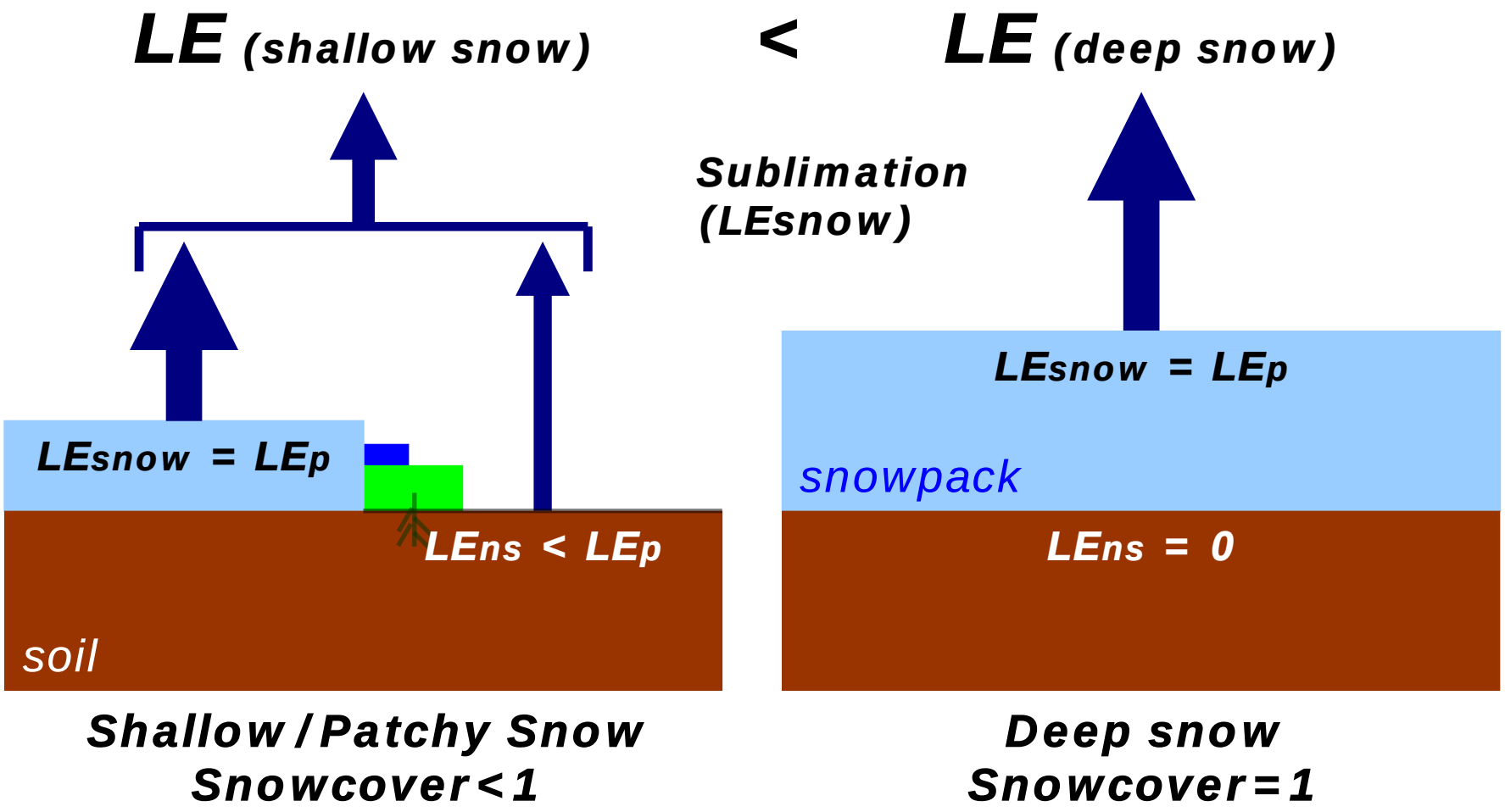
Radiation scheme:

LW—Rapid Radiative Transfer Model (AER, Mlawer et al. 1997)

SW-- Rapid Radiative Transfer Model version 2 (AER).

Convection scheme: Deep convection and shallow convection (Hong & Pan, 2011)

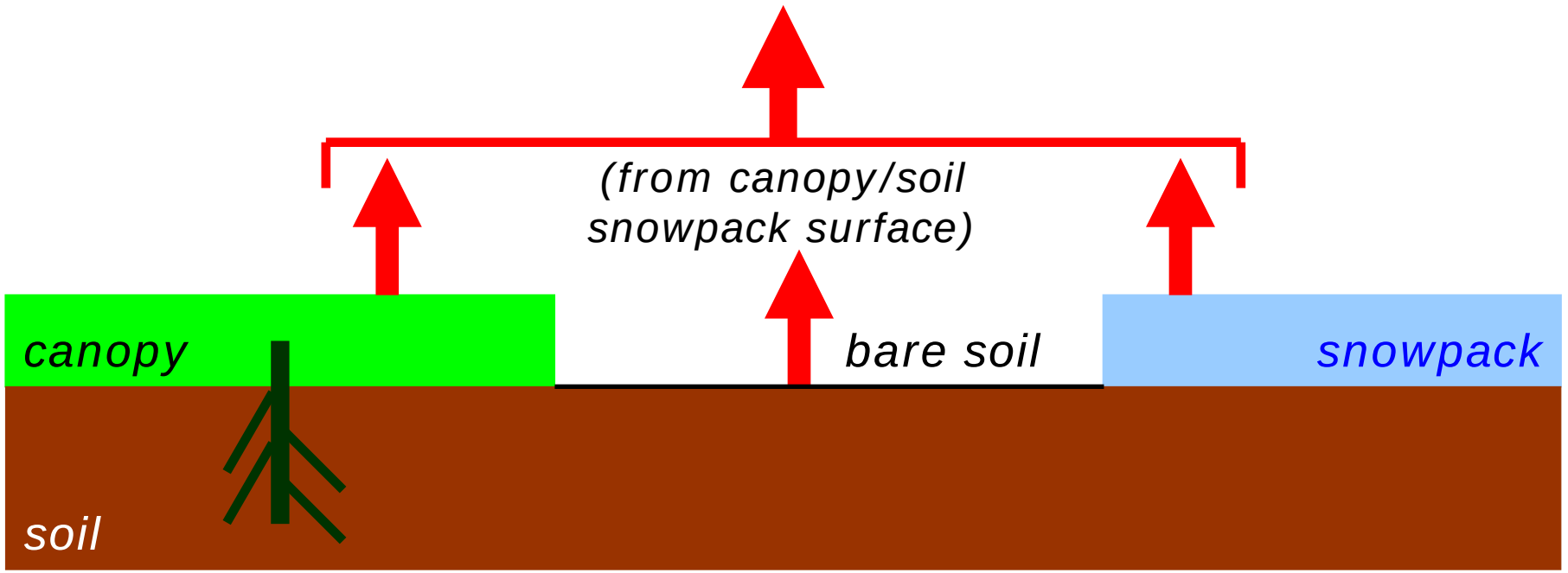
Land Physics: Latent Heat Flux over Snow



- **LEns** = "non-snow" evaporation (evapotranspiration terms).
- 100% snowcover a function of vegetation type, i.e. shallower for grass & crops, deeper for forests.

Land Physics: Surface Sensible Heat Flux

$$H = \rho c_p C_h U (T_{sfc} - T_{air})$$

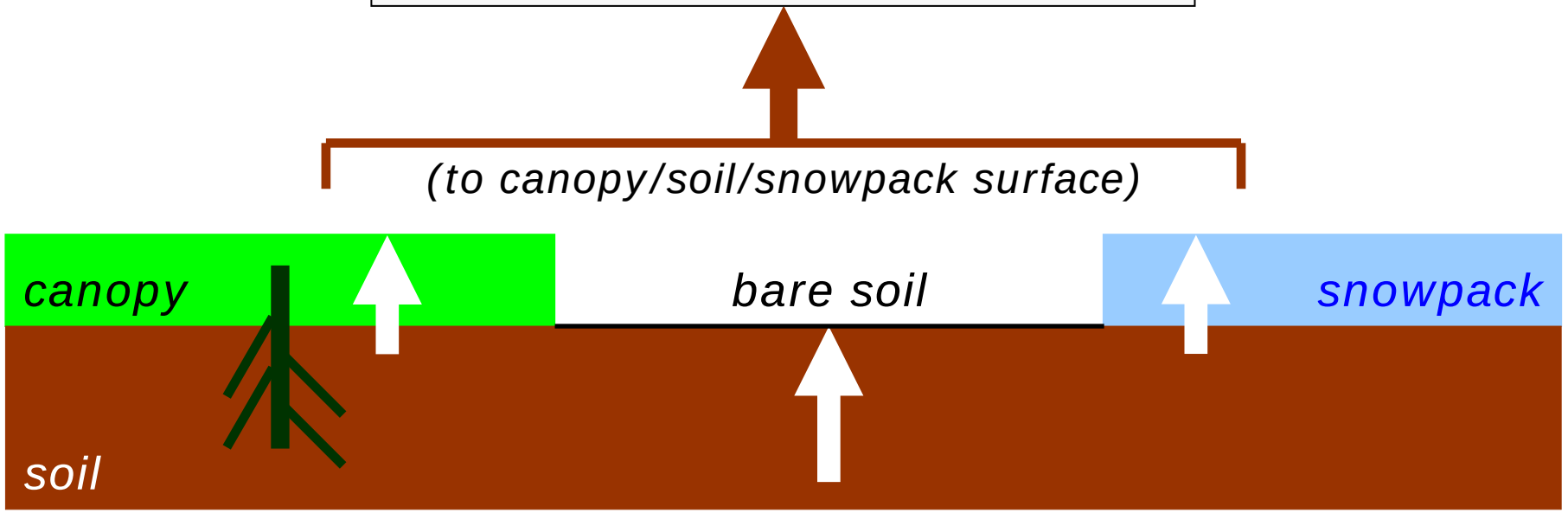


ρ, **cp** = air density, specific heat
Ch = surface-layer turbulent exchange coeff.
U = wind speed
Tsfc-Tair = surface-air temperature difference

- "effective" **Tsfc** for canopy, bare soil, snowpack.

Land Physics: Ground Heat Flux

$$G = \left(\frac{K_T}{\Delta z}\right)(T_{sfc} - T_{soil})$$



K_T = soil thermal conductivity (function of soil type: larger for moister soil, larger for clay soil; reduced through canopy, reduced through snowpack)

Δz = upper soil layer thickness

Tsfc-Tsoil = surface-upper soil layer temp. difference

- "effective" **Tsfc** for canopy, bare soil, snowpack.

One layer snow scheme (bulk)

Some related parameters setup in the Noah

Veg type: **13 (Glacial, SiB-1 veg. class categories)**

Soil type: **9 (Glacial land ice, Zobler soil class categoreis)**

Albedo: **0.81**

GVF: **0.01**

Emissivity: **1.0**

Z0m: **0.001 (m)**

Z0h: **0.0001 (m)**

Snow height: **0.05 (m)**

GABLS4: Three Stages

Case: Dome C (Antarctic Plateau), with snow/ice; Alt=3233m.

1.5 days: 00UTC Dec. 11 – 12 UTC Dec.12, 2009

Stage 0: LSM forced by observation, from 12/01 to 12/15, 2009.

Stage 1a: Use the surface and soil initial conditions from stage0.

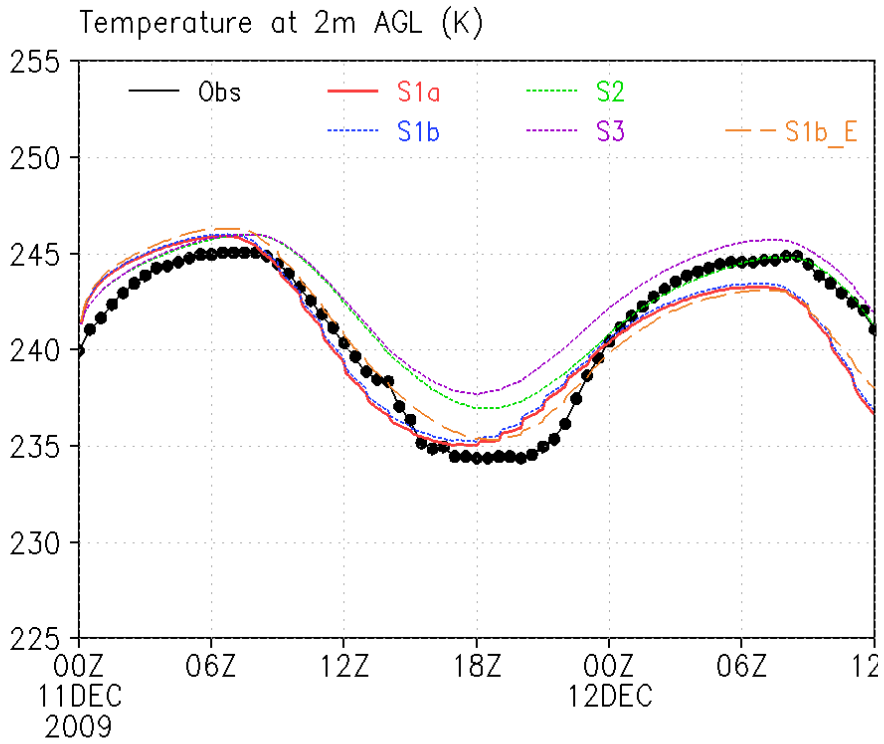
Stage 1b: Use the prescribed surface and soil initial conditions.

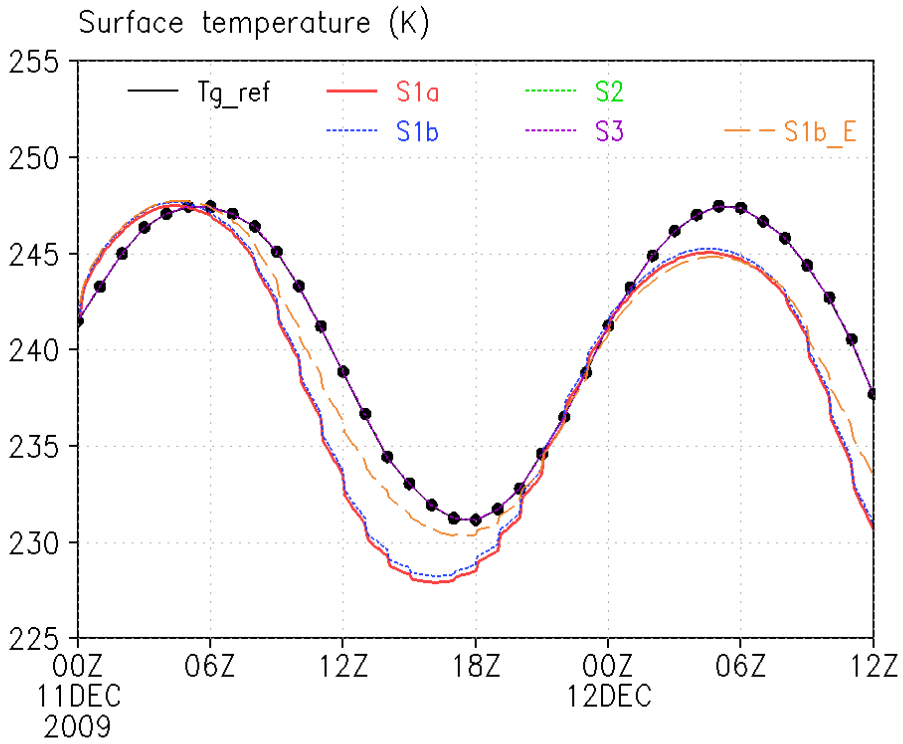
Stage1b_exp: test using the limitation of MO stability function (Talk#: 5B.5).

Stage 2 : Same atmospheric forcing used in stage1 but surface temperature is prescribed (given);

Stage 3: No radiation, no humidity, prescribed surface temperature (same as stage2) and constant geostrophic wind in time. So only the turbulence is active with the mass flux for the dry thermals.

Comparison of T2m and Tskin temperatures



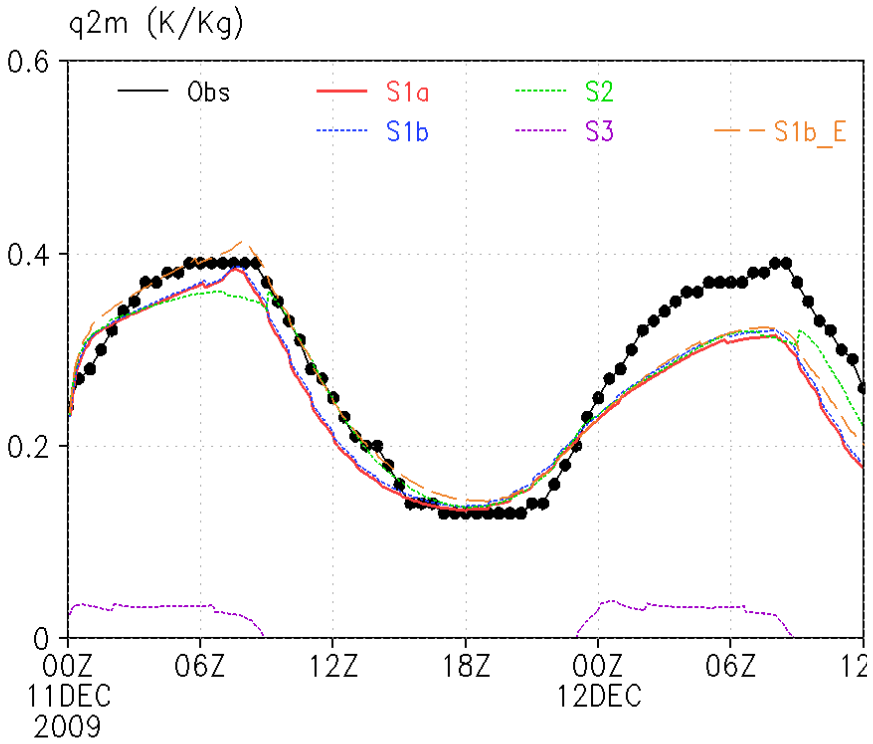


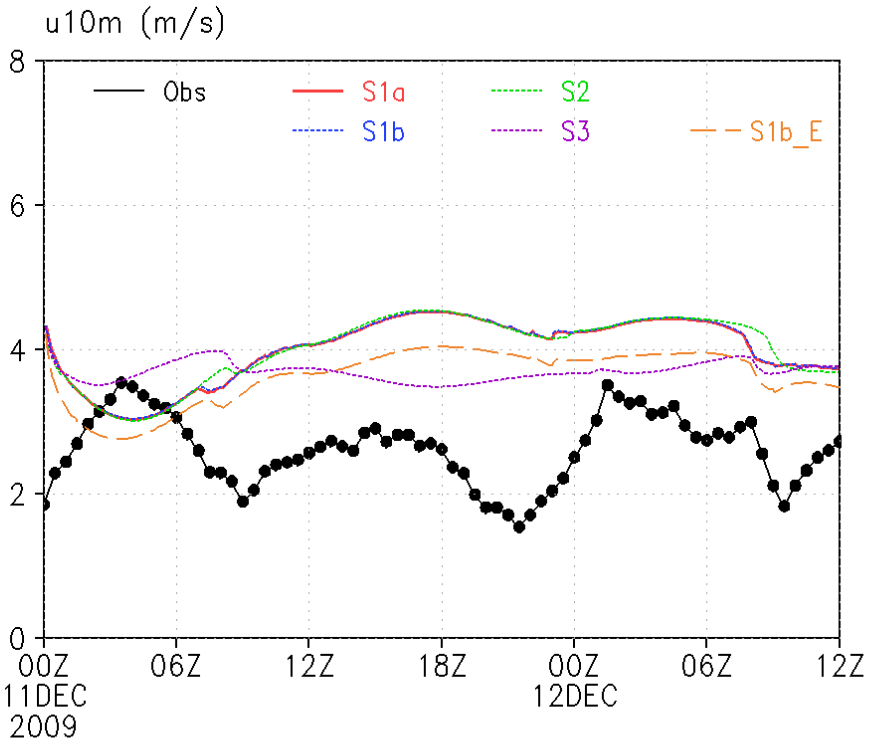
T2m: **Stages 1a and 1b (S1a and S1b) are quite similar and close to the Obs, except for a cold bias during the second daytime. S1b_E is a little better than S1b.**

S2 and S3 exhibit less bias during daytime but warm bias during nighttime.

Tskin: S1a and S1b show cold bias in the afternoon and S1b_E reduces this bias.

Comparison of q2m and wind speed at 10m

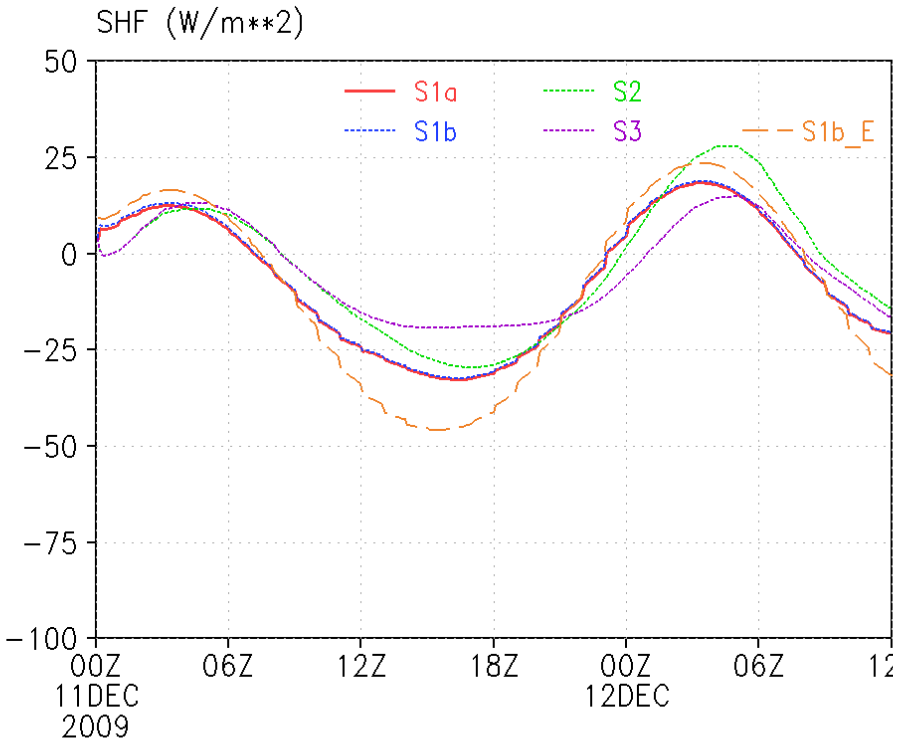


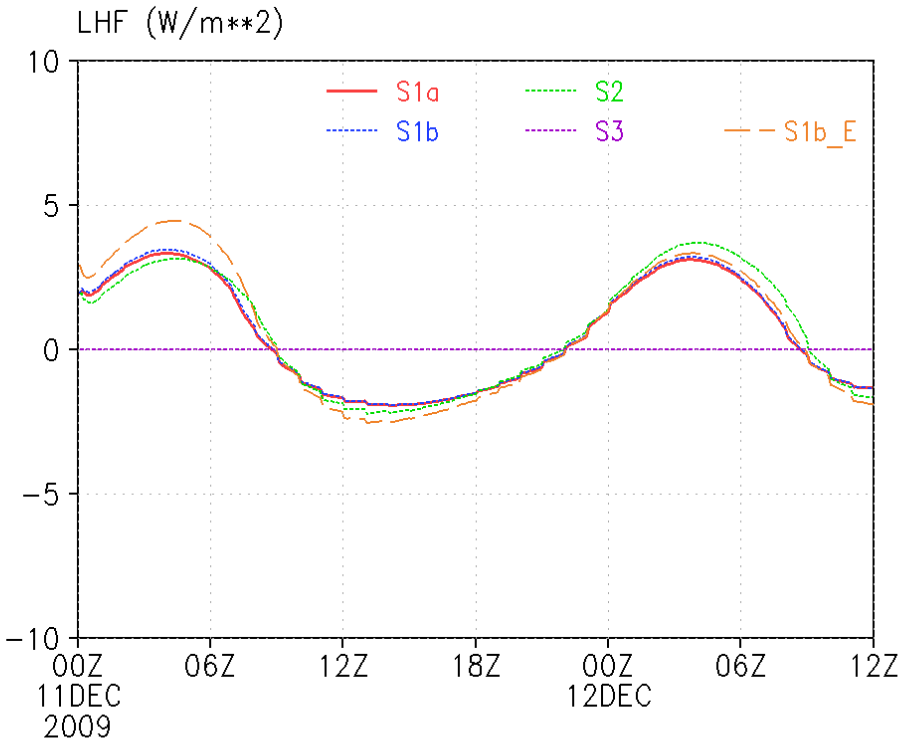


q2m: **S1a and S1b are quite similar and close to the Obs. during the first day. S2 reduces the late afternoon dry bias. S1b_E shows more close to the Obs.**

wspd@10m: All stages show somewhat stronger wind speed.

Comparison of Sensible and Latent Heat Fluxes

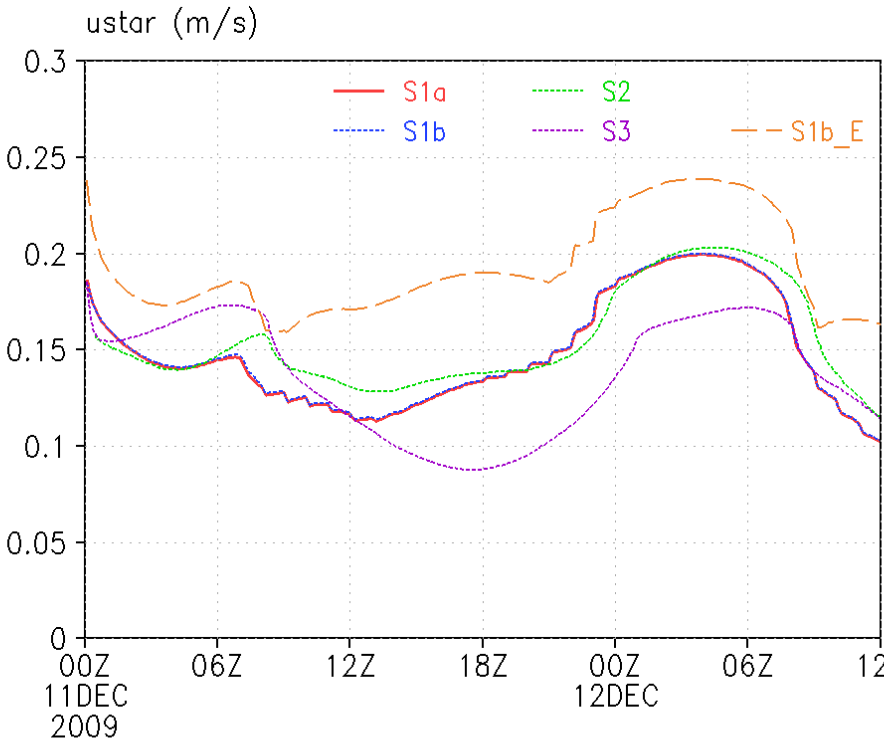


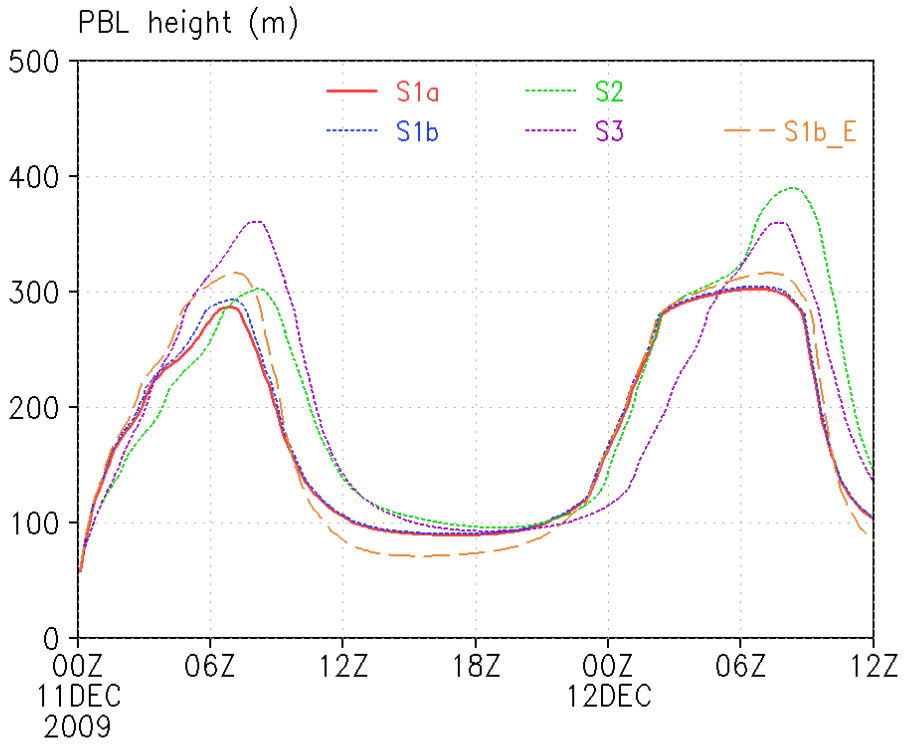


SHF: **S2 and S3 show less downward sensible heat flux than S1a and S1b during nighttime, and S1b_E produces more than S1a or S1b. {Nighttime SHF is overestimated for all stages, compared to the Obs. (Eric Bazile). Strong winds?}**

LHF: Except for S3, all other stages show similar.

Comparison of Ustar and PBL Height

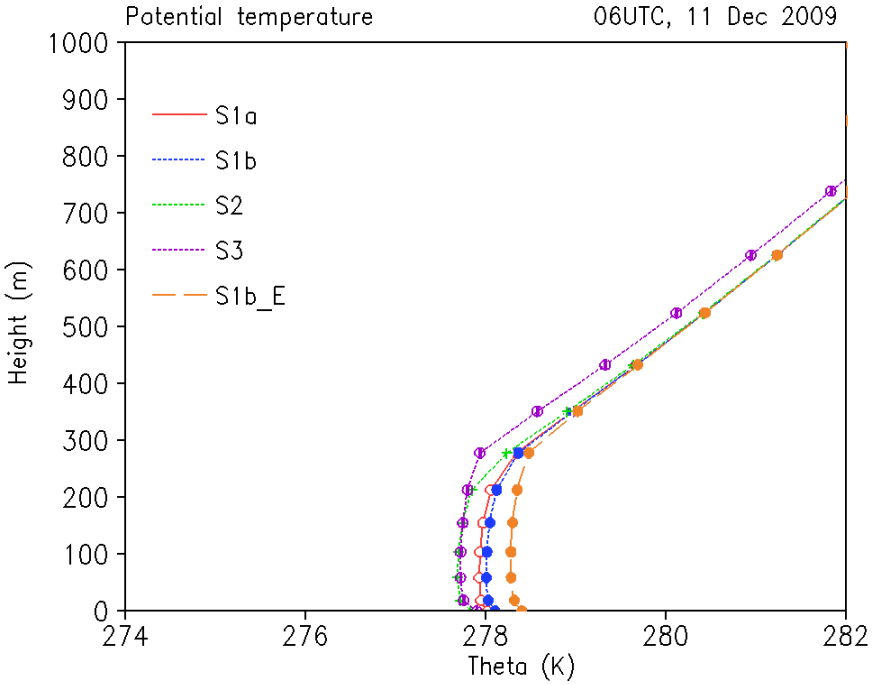


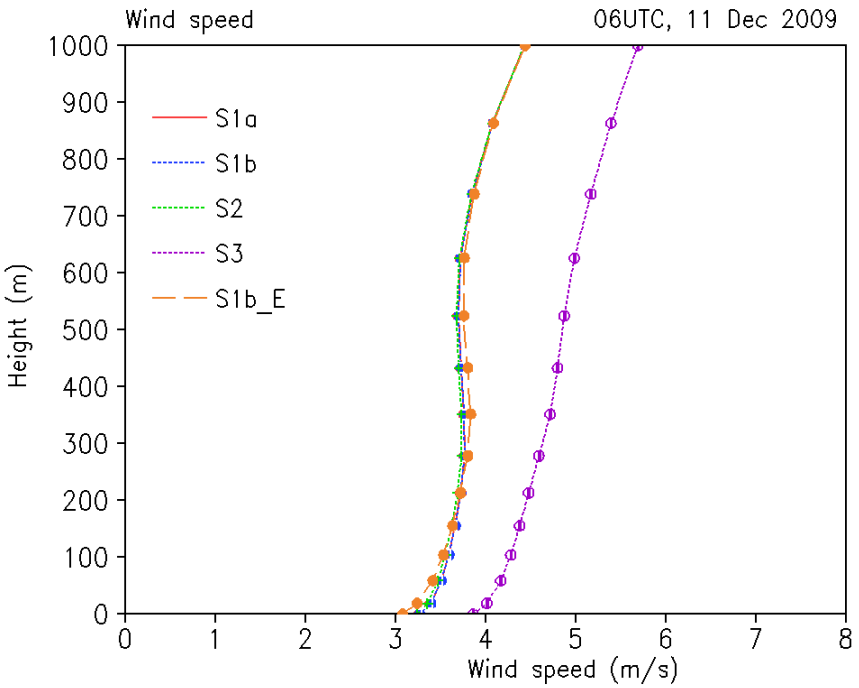


ustar: **Ustar is overestimated during nighttime, compared to the Obs. (~0.1 m/s) (Eric Bazile).**

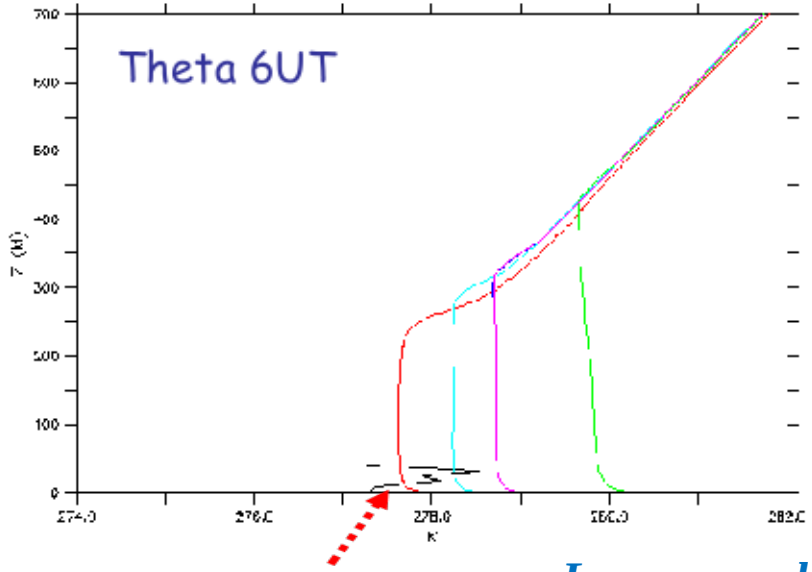
PBL: **All stages show similar, except for S3.**

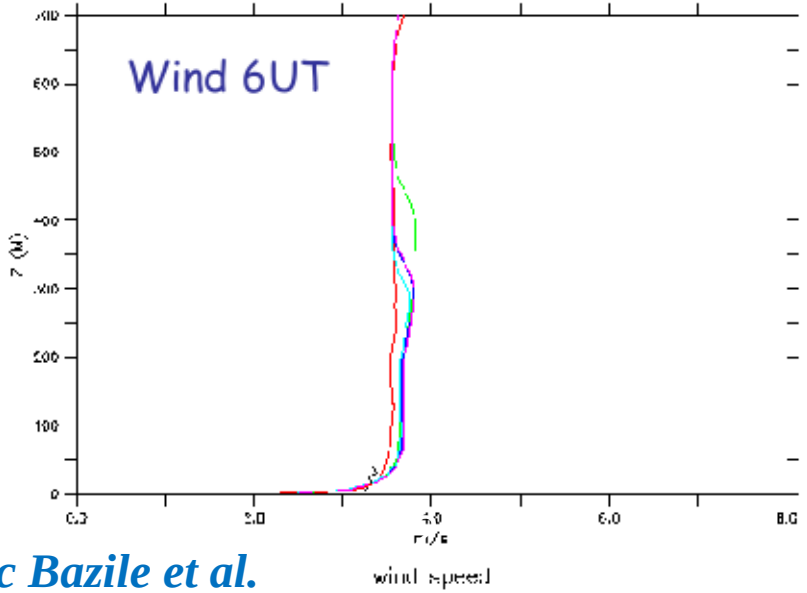
Potential temperature / wind profile at 06h





Reasonably reproduced temp/wind speed during daytime

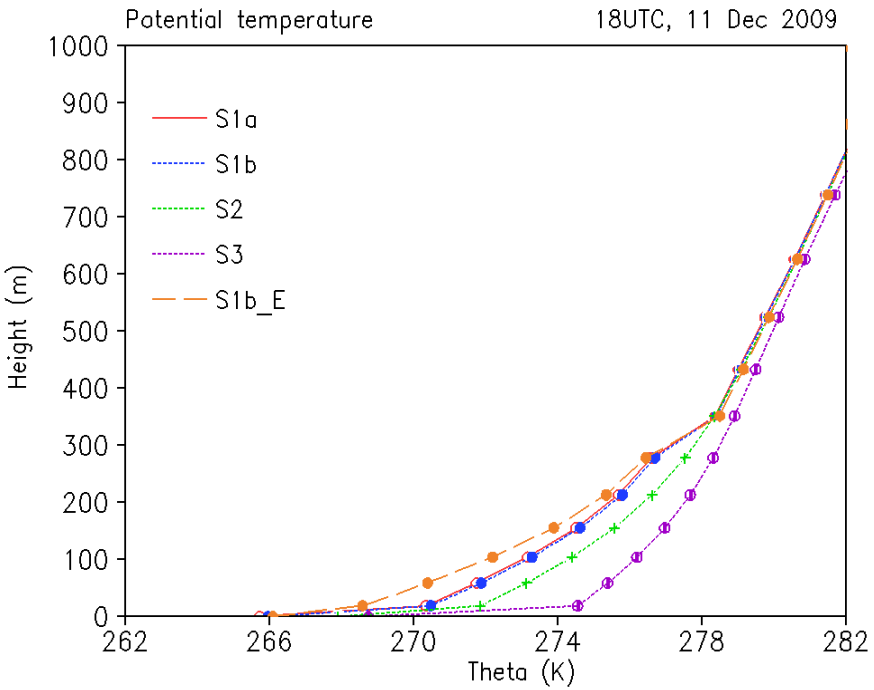


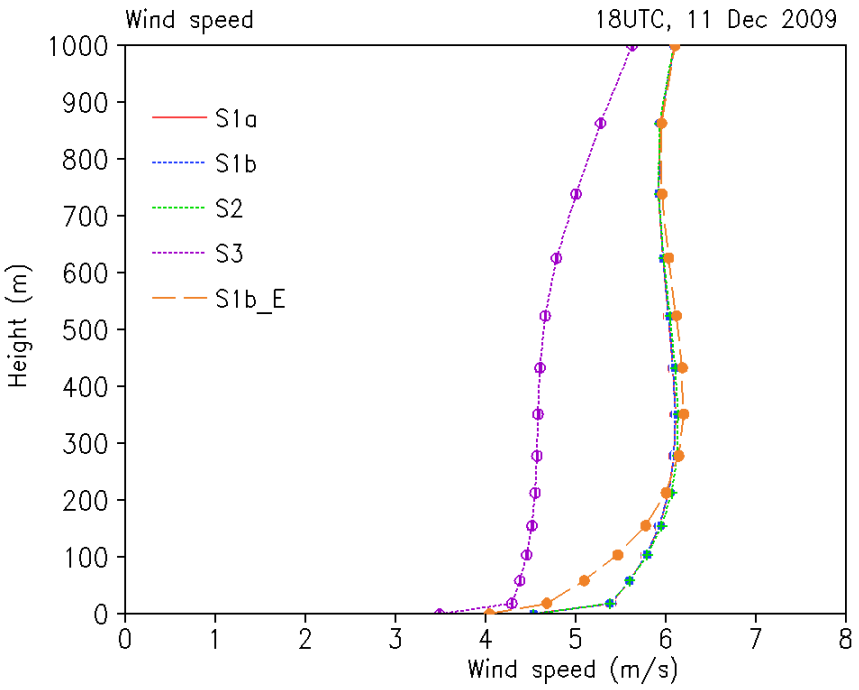


Black: Obs

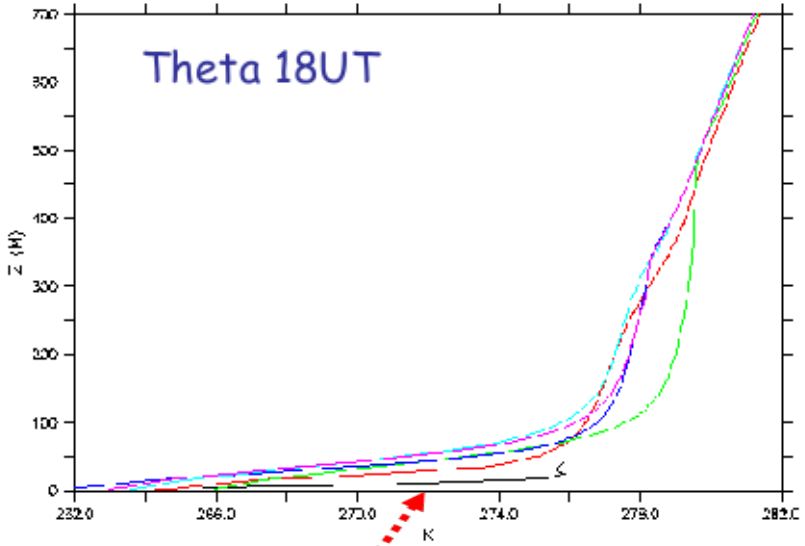
Lower panels from Eric Bazile et al.

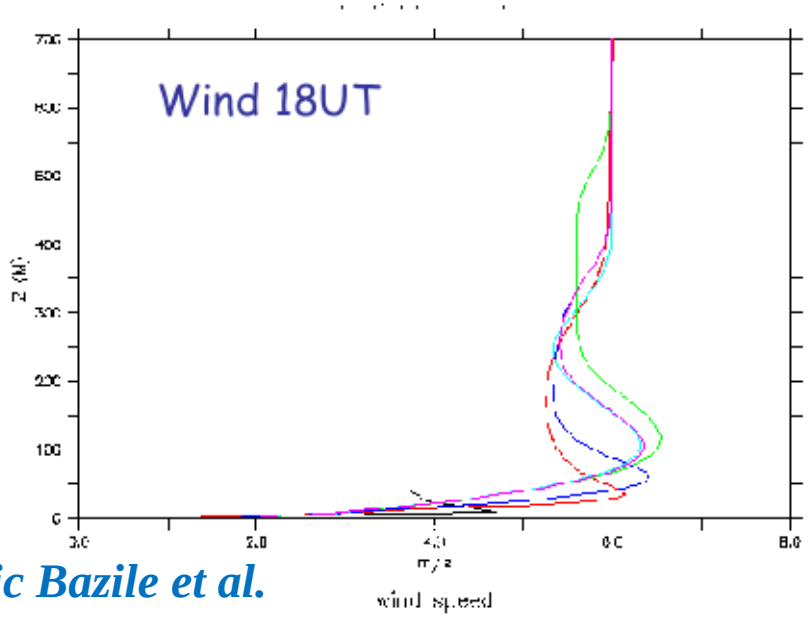
Potential temperature / wind profile at 18h





Poorly reproduced very stable temp layer & LLJ (nighttime).





Black: Obs

Lower panels from Eric Bazile et al.

Summary / Discussion

- **The NCEP SCM (GFS) coupled with Noah land surface model was performed for the GABLS4 case.**

- **The verification with the observations shows that the NCEP SCM (GFS) can reasonably reproduce the surface temperatures and humidity, but create too strong surface winds.**

- **The model exhibits a problem to reproduce the low-level jet near the surface and very stable layer.**

- **In the future, more validation using the GABLS4 observation data, more investigation for the Noah LSM/PBL schemes in the GFS model, etc.**

Thank You !

Any questions/comments?

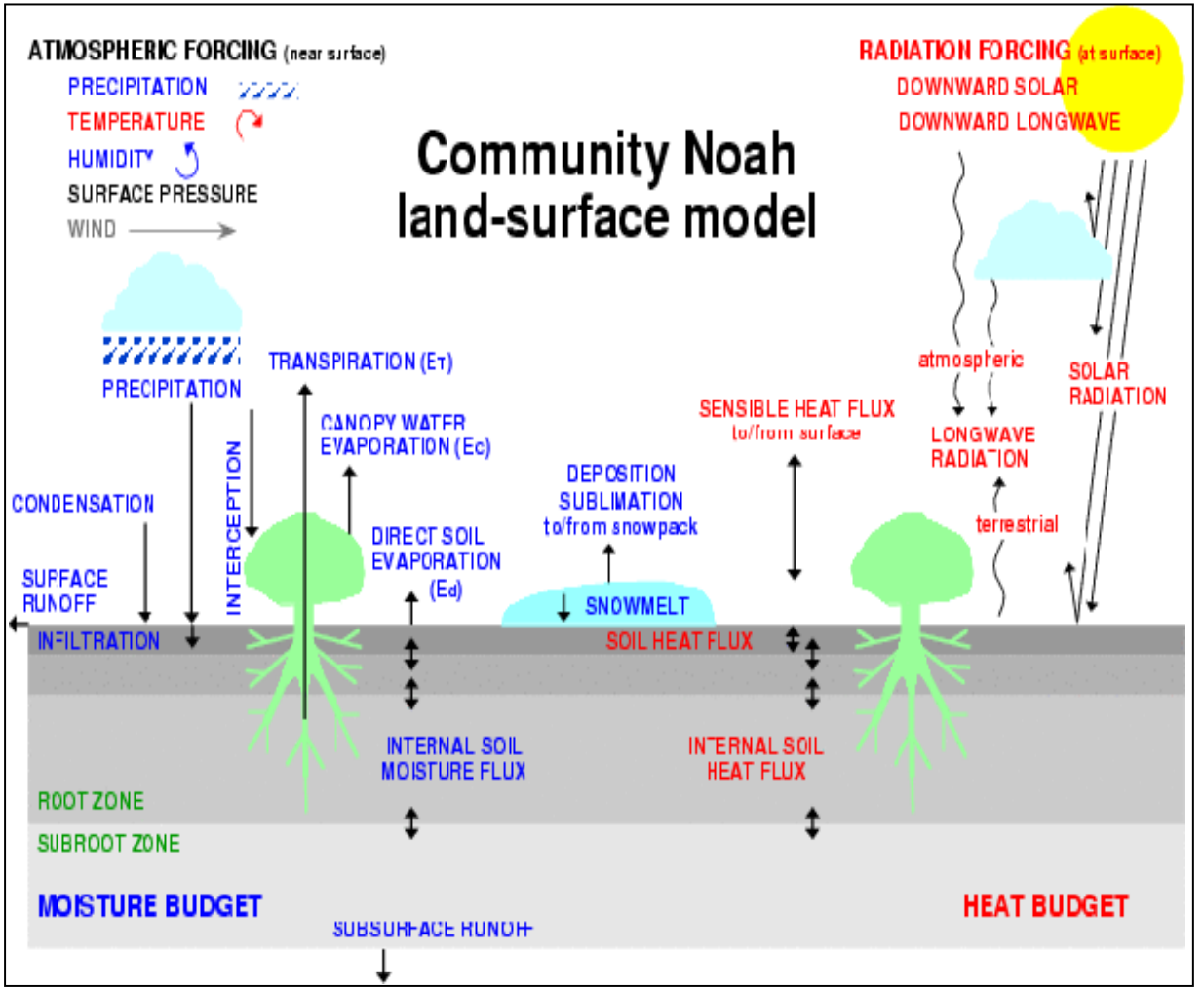
NCEP-NCAR unified Noah land model

- Surface **energy** (linearized) & **water** budgets; 4 soil layers.

- Forcing: downward radiation, precip., temp., humidity, pressure, wind.

- Land states: Tsfc, Tsoil*, soil water* and soil ice, canopy water*, snow depth and snow density.
**prognostic*

- Land data sets: veg. type, green vegetation fraction, soil type, snow-free albedo & maximum snow albedo.



- Noah coupled with NCEP models: North American Mesoscale model (NAM; short-range), Global Forecast System (GFS; medium-range), Climate Forecast System (CFS; seasonal), & other NCEP modeling systems (i.e. NLDAS & GLDAS).

From Mike Ek