New simplified ISBA scheme

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1 Introduction

Across the ACCORD community, there are different options available for the surface scheme. AROME and HARMONIE-AROME are using SURFEX scheme, while ALARO is still using the old ISBA scheme. SURFEX is a model which is constantly being developed and there are more versions available. Since surface schemes inevitably affect the atmosphere, using different surface options makes comparisons between different physical parameterizations or model versions unfair. Having one simplified surface scheme would ensure running different model configurations with the same surface scheme. This simplified surface scheme is also useful for running a single column model MUSC where surface input fields do not need to be very detailed.

2 General design of the subroutine

The new subroutine was named GROUND_SPISBA. All work was done on cy46t1. The subroutine is called from APLPAR with a plan to implement it also in APL_AROME.
Depending on whether we use SURFEX or not, input files contain different surface fields. To make it more simple in cases where they do not need to be detailed, 20 surface fields were extracted and can be initialized through the namelist. First, those fields will be listed. After that, the proper setting of the logical switches will be presented. Finally, the subroutines which will be replaced by the new subroutine and their simplifications will be described.

2.1 Surface fields to be in the namelist

The first task was extraction of the fields which can be passed through the namelist. Originally, the new surface scheme should replace the three old ISBA subroutines called in APLPAR:

- ACSOL - determination of surface characteristics
- ACVEG - determination of vegetation characteristics
- ACDROV - computation of water fluxes in the soil

Surface characteristics which can be defined through the namelist were extracted in the way to be the input to one of those three subroutines and not changed in APLPAR. They are added in the module YOMPHY1, having default values set in SUPHY1. That value can be modified in the namelist NAMPHY1. To be able (just for the GROUND_SPISBA scheme) to change their values, their INTENT in APLPAR was changed from IN to INOUT. Their list with descriptions is shown in Table 1.

Table 1: List of the surface characteristics which do not need to be in the input file

variable	**field name (input file)**	**name in NAMPHY1**	**description**	**default value in SUPHY1**
PD2	SURFEPAIS.SOL	RD2_SP	deep-layer of the profound water-tank	1 m
PIVEG	SURFIND.VEG.DOMI	RIVEG_SP	type of vegetation	3
PLAI	SURFIND.FOLIAIRE	RLAI_SP	leaf area index	1
PRSMIN	SURFRESI.STO.MIN	RRSMIN_SP	stomatal minimal resistance	40 s/m
PWL	SURFRESERV.INTER	RWL_SP	skin reservoir water content	0 kg/m^2
PWP	PROFRESERV.EAU	RWP_SP	deep-layer water content	10 kg/m^2
PARG	SURFPROP.ARGILE	RARG_SP	silt percentage within the soil	30 %
PGZ0F	SURFZ0.FOIS.G	RGZ0F_SP	gravity x roughness length	0.1 m^2/s^2
PGZ0HF	SURFGZ0.THERM	RGZ0HF_SP	g x thermal roughness length	0.01 m^2/s^2
PGZ0RLF	SURFZ0REL.FOIS.G	RGZ0RLF_SP	gravity x relief roughness length	0 m^2/s^2
PALBNS	SURFALBEDO.NEIGE	RALBNS_SP	snow albedo	0.7
PRHONS	SURFDENSIT.NEIGE	RRHONS_SP	snow density	0.2 kg/m^3
PSAB	SURFPROP.SABLE	RSAB_SP	percentage of sand within the soil	30 %
PSNS	SURFRESERV.NEIGE	RSNS_SP	mass of snow per unit surface	0 kg/m^2
PTS	SURFTEMPERATURE	RTS_SP	surface layer temperature	293 K
PVEG0	SURFPROP.VEGETAT	RVEG0_SP	fractional cover by vegetation	0.5
PWPI	PROFRESERV.GLACE	RWPI_SP	deep-layer ice content	0 kg/m^2
PWS	SURFRESERV.EAU	RWS_SP	surface layer water content	1 kg/m^2
PWSI	SURFRESERV.GLACE	RWSI_SP	surface layer ice content	0 kg/m^2
PTP	PROFTEMPERATURE	RTP_SP	deep-layer temperature	293 K

2.2 Logical switches when calling it

Logical switch to call the simplified surface scheme, LSPISBA has been added to YOMPHY. By default it is set to FALSE in SU0PHY, while it can be changed in the namelist NAMPHY.
When having LSPISBA set to TRUE, some other switches have also to be modified:

- LMSE - switch for the externalized surface scheme (SURFEX) - FALSE
- LSOLV - key for Noilhan-Planton soil and vegetation scheme (ACSOL,ACVEG and ACDROV) - FALSE
- LFGEL - key for soil freezing with ISBA - FALSE
- LVGSN - key for combining vegetation and snow - FALSE

By setting LMSE and LSOLV to FALSE, we ensure that no other surface scheme (SURFEX or ISBA) will be used. The rest are just switching off schemes which we do not need for such simplified scheme.

2.3 Creating the GROUND_SPISBA routine

As already mentioned, the main idea behind the SPISBA scheme was to replace the three subroutines which are necessary for the old ISBA scheme (ACSOL, ACVEG and ACDROV). When we were looking for the optimal location for the SPISBA routine, we realized the following:

- routine has to be called after radiation scheme ACRANEB2 because it needs radiation as an input
- routine has to be placed after the old ISBA routine ARP_GROUND_PARAM because its output is needed for ACDROV

- if SPISBA is called, ACSOL is not; its output variables ZNEIJG and ZNEIJV are needed for ACHMT subroutine, which is called before radiation scheme
- variables ZCHROV and ZGWDCS, which are input for SPISBA, are calculated in ACHMT
- because of the previously mentioned issues, our SPISBA subroutine should contain also simplified ACHMT routine
- regarding the positions, all individual subroutines which are forming SPISBA can be placed behind the old ISBA routine ARP_GROUND_PARAM, except the ACHMT

The solution for all the above mentioned problems is to make a subroutine containing simplified five (and not three) subroutines.
The new subroutine GROUND_SPISBA contains the following simplified routines, in that order:

1. ACSOL
2. ACHMT
3. ACVEG
4. ARP_GROUND_PARAM
5. ACDROV

Routines were simplified in the following way:

- condition loops were excluded and only taken calculations for the cases of LFGEL=T, LVGSN=T, LIMW=T, LIMC=T, LSNV=F, LSOLV=T
- antifibrilation amplification parts were taken out
- ice cap part is neglected
- only one soil layer is considered (KCSS=1)

The only (so far) remaining problem was variable PRS (surface air gas constant). It is output from ACHMT, but is used in APLPAR before SPISBA. Therefore, it is hardcoded for the case of SPISBA to the value 287,56.

3 Results

In Figure 1, 2 and 3 are shown surface temperature, shortwave and longwave radiation at the surface. Results are shown for the forecast range of 14 hours with the initial time being 00 UTC. To obtain smoother plots for radiation, frequency of calling radiation scheme (ACRANEB2) has been set to every time step, instead of once per hour.
From the plots, it can be seen that simplified surface routine (red line), does not change surface temperature much from the reference experiment using the old ISBA scheme (blue line). As for the radiation, there is more shortwave radiation at 11 UTC. Accordingly, there is also more radiative cooling in the afternoon.

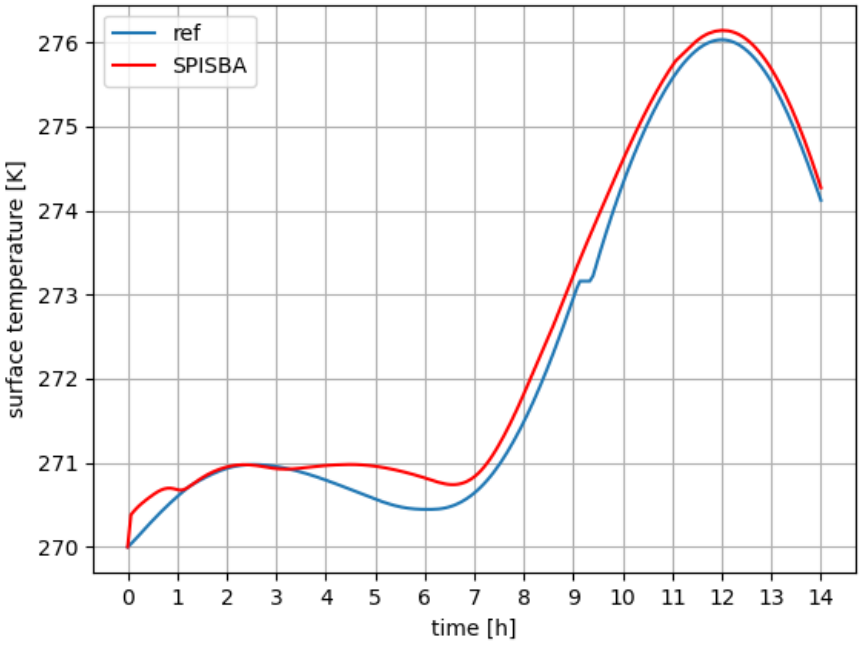

Figure 1: surface temperature

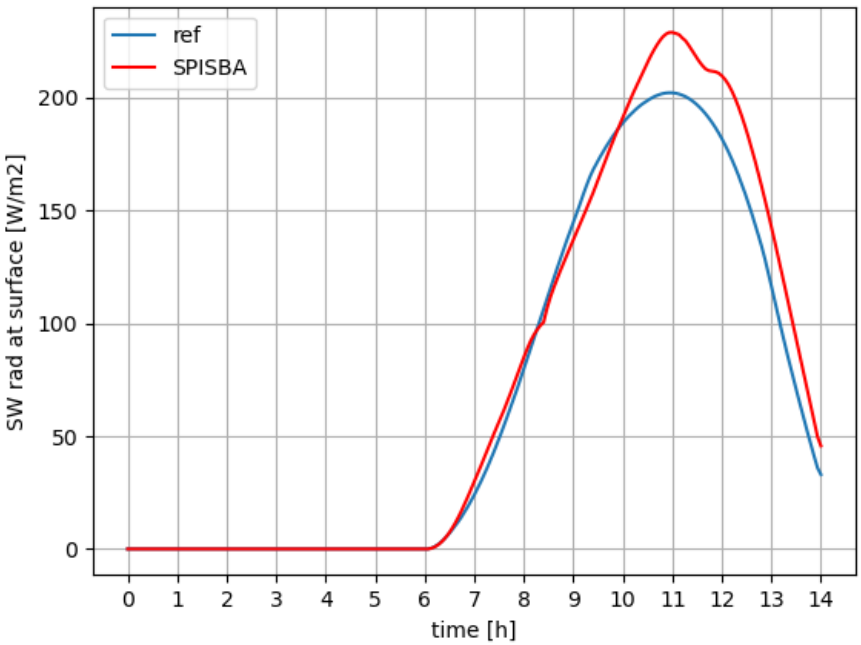

Figure 2: shortwave radiation at the surface

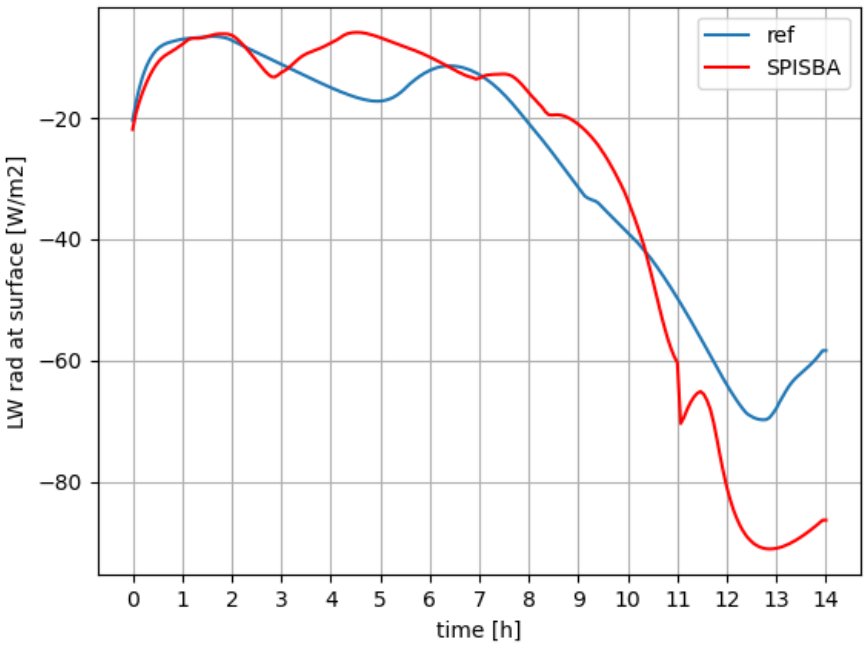

Figure 3: longwave radiation at the surface

4 Further work and conclusion

From five subroutines, one simplified surface scheme GROUND_SPISBA has been made. It can be useful for various tests including single column model.
After having a stable simulation with the new scheme and (at first validation) meaningful results, the next step would be implementation to APL_AROME and making more thorough validation.