Testing target cy43h surface options in climate mode: First results

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Outline

New Surface options in cy43 (wishlist)

Why climate mode?

Setup of first experiments using the wishlist

Surface bias assessment: First results

Conclusions
New surface options in cy43h

**Force-restore in cy40/v7.3 with OI**

**Multi level/energy in cy43/v8.1 with EKF**

- Most of the development in the HIRLAM’s surface group is done now in cy43h since SURFEX8.1 code was introduced there last summer.
- We work in the introduction of a more advanced set of SURFEX land-surface physics: (diffusion soil, explicit snow, Multi-Energy Balance) in combination with SEKF assimilation.
- The first meteorological release of cy43h (harmonie43h2.1) can maybe be expected in autumn 2019. **It will still keep Force-restore and D95 snow** but will include some updates already tested in cy43h or previous releases.
Wishlist of SURFEX 8 namelist options

- New surface physics options: DIF, 3-L Snow scheme, MEB
- Sub-options defined according to past experience in the HCLIM community & with the help of SURFEX staff (Patrick, Aaron)
- New physiography: ECOCLIMAP-SG
Why running “climate mode” for nwp development?

- All NWP forecasting systems have biases.
- In principle, the role of data assimilation should not be to compensate for biases in the system.
- We expect changes in sfc-atm interactions introduced by the new surface components in cy43h.
- So we study the system in climate mode to identify and reduce biases before data assimilation is activated.
Climate mode status in cy43h

• SURFEX version updated to 8.1 last summer
• Update of SST during the Forecast (LMCC01_MSE=.TRUE.). A solution for updating Sea Ice not yet available (but RC working on it)
• The common CY43 git repository can be used for “climate mode” experiments. Good since we can keep our tests as close as possible to the development branch.
• Progress is slow since we’re early testers of cy43h and we’re trying many new options simultaneously. Also some issues we find are specific to the climate runs.
• We plan to run climate experiments over 2-4 domains to observe the impact of the new surface over different regions. People involved: Samuel Viana, Emily Gleeson, Patrick Samuelsson, RC colleagues.
Evaluation of cy43h model bias in climate mode.

- Methodology inspired by Lindtstedt et al. (2015): Seasonal & yearly PDFs, Annual cycles, maps, etc.

- Need to find a proper reference data for every variable:
  - Atmospheric fields (pcp, T+, T-...) can be compared against HR databases available from the different NWS.
  - Surface fields: ESA CCI Soil moisture, ERA5, etc.
  - Direct validation of surface fluxes when available
First cy43h long runs in climate mode

- Common setup for tests already done (not target sfc configs in red):
  - Full wishlist (except MEB)
  - ERA5 BCs.
  - ECOCLIMAP II
  - LUNBC=OFF (upper level boundary relaxation scheme)
  - LESPCPL=ON: Upper level spectral nudging to constrain the large scales (shorter simulations)
  - NPATCH=2 (Separate energy budgets for open-land & forest)

- So far only tested over domains without sea-ice (IBERIA & IRELAND)
DOMAIN: IBERIAxxm_2.5

- Medium-sized domain as a compromise
- Assuming ~400km as spin-up distance for precipitation
- Integration time: ~1 week / year when everything works fine.

2 experiments:
1. From 10/2013 to 01/2018. ECOCLIMAPII (4 years).
2. From 10/2014 to 10/2015. ECOCLIMAPII. Purpose: to study surface spin up time.
Checking the soil spin-up time

- Upper soil layers up to around 20-cm reach equilibrium in around 3 months (similar to F-R).
- Deep layers: For soil moisture 6-8 months is enough; for soil temperature a difference of 0.5-1 K remains after 1 year.
First results for PCP, TMAX, TMIN

- Analysis for years 2015-2017 (1st year left out for spin up)
- Reference: AEMET SPAN objective analysis (5km) for PCP, T2M_max, T2M_min

- Average pcp/year during the period 2015-2017 doesn’t look bad, but...
● The model tends to underestimate pcp (seasonally).
● Over complex orography (where model appears to “overestimate” pcp), the reference data (coarser) is probably too dry.
● Worst results during the convective season. Very little precipitation over the east coast & Balearic islands.
● Daily & seasonal PDFs reproduce correctly the reference data in winter & spring.
● Daily & seasonal PDFs show opposite biases during the convective season: better to compare station vs gridpoint data there.
● T2M_max: Good results in general, cold bias in winter
● T2M_min: Warm bias, larger in summer
● T2M_min: Problems to reproduce frost conditions in wintertime linked to open-land patch (P1) physics
Direct soil moisture validation: Is it possible?

- Soil moistures in LSMs are highly model-dependent quantities and therefore they’re difficult to validate i.e. against in-situ or satellite derived data. In addition, satellite products usually have their own LSMs.


- Example: ESA CCI Soil moisture (0.25°) product doesn’t look comparable to any of the first soil layers from DIF scheme.
CY43h soil moistures & temperatures against first soil layers in ERA5
Validation of surface fluxes

● In principle, direct validation through surface fluxes would be the “ideal” way to evaluate a LSM for NWP purposes.

● We expect impacts in the surface energy balance (SEB) caused by the new surface components/settings in the system (DIF, ES, MEB, ECOCLIMAP-SG, OROTUR, increase of Ri_max...).

● Problems:
  ○ Direct observations are scarce (eddy covariance sites)
  ○ Observations through long periods are not frequent
  ○ There’s usually question marks over the representativity of point data

● Ok, but at least we should make sure that the SEB is modified in the right direction.
Flux sites / domains under consideration

- **CESAR site** (Cabauw, Netherlands). All SEB components, 2000-2019 coverage, public data
- **ICOS Sweden stations**. All SEB components
  - Forest: Hyltemossa, Norunda, Svartberget
  - Open land (crop): Lanna
  - 2014-2017 public data, more recent data on request.
- La Herreria site from **GUMNET** (Spain).
  - All SEB components, data from 06/2016, public data available on request.
SEB example for a single day

- Solid lines: SEB data from a experimental site in northern Spain
- Dotted lines: CY43wishlist experiment (acting as a downscaling tool)
- Points: AEMET’s Operational run
Conclusions

● We try to reduce the biases by new surface physics before DA is applied
● A first multi-year simulation over IBERIA is studied for:
  ○ A general overview of the model performance with new surface
  ○ Testing methods for surface analysis
● Better results for temperature than for precipitation. Need to further investigate possible surface connections.
● More tests will follow after all the target surface components become available in cy43h (sea-ice update, MEB...)

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Thank you!