

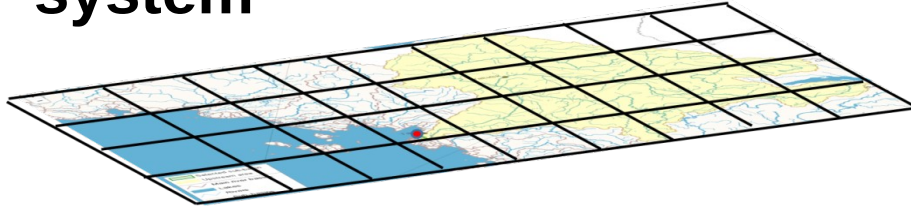
HIRLAM plans for surface physics and data assimilation development

Patrick Samuelsson
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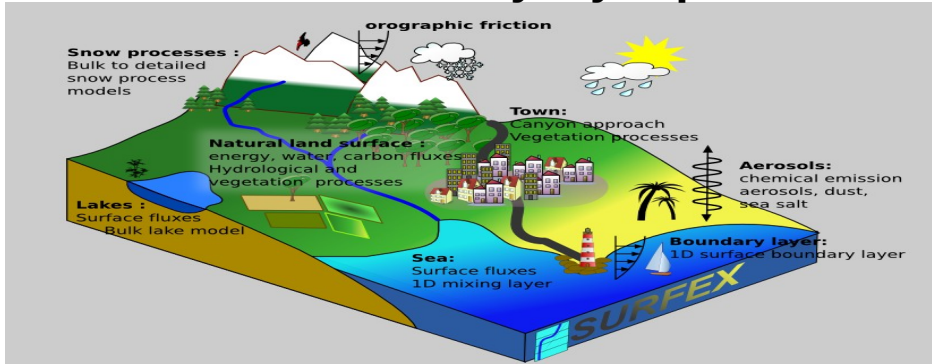
with contributions as acknowledged



Long term goal: An integrated hydrometeorological system

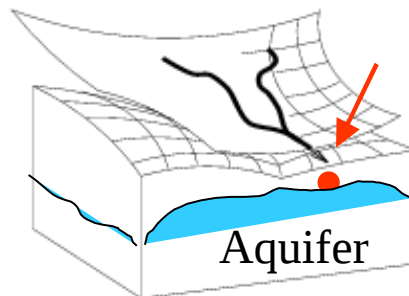


Coupled to NWP/climate model or
Offline with interpolation/downscaling to
higher resolution and/or spatial/time
correction or boundary layer processes...



OASIS coupler for deep and surface
runoff, ground water, flooding, irrigation,

...



ANALYSIS,
Operational deterministic, EPS
HARMONIE-Climate,

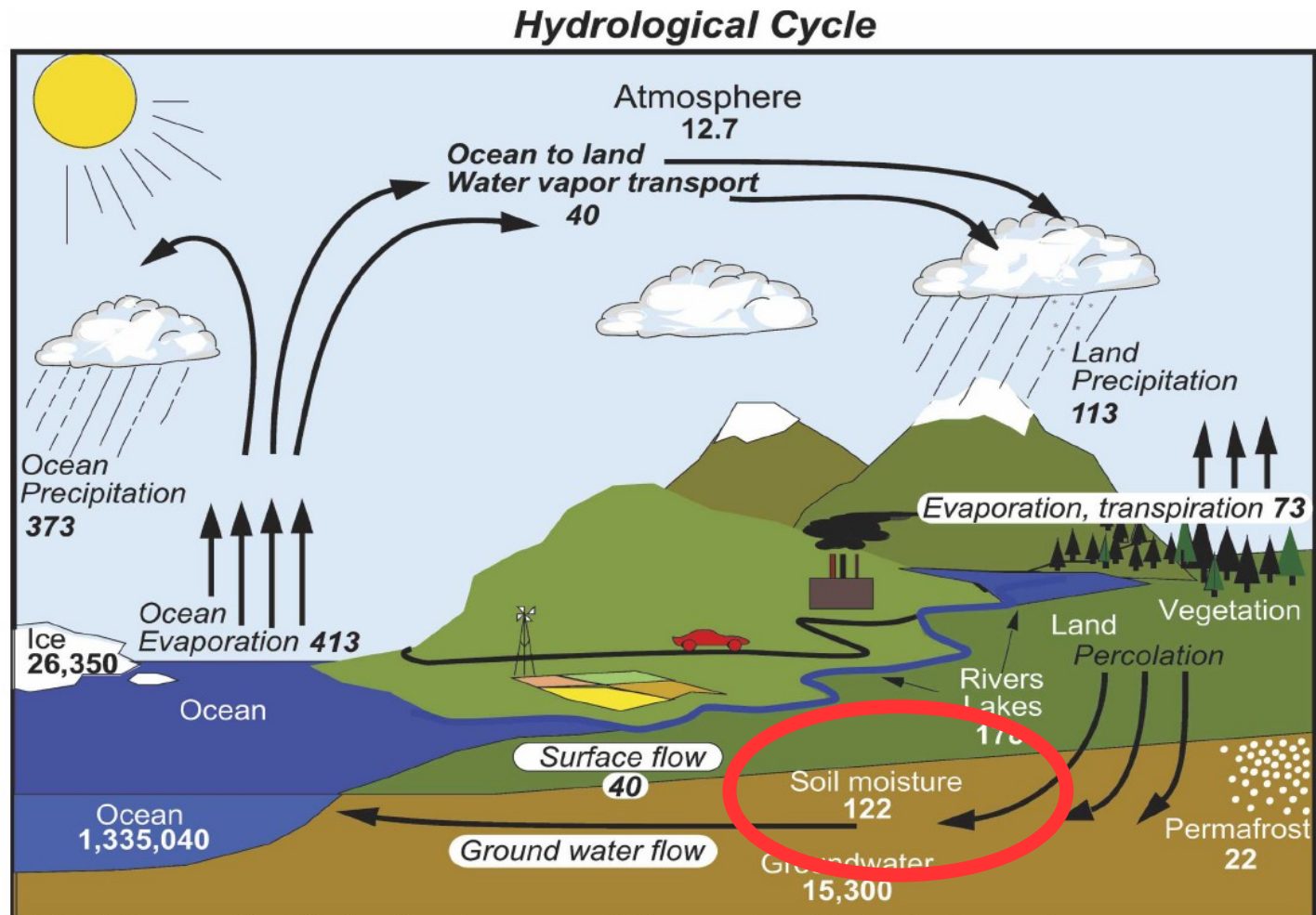
...

SURFEX
Nature-Town-Lake-Sea
Nature potential: 19 patches,
multi-layer snow and soil,
explicit veg/snow, veg
dynamics

Hydrological ground water and
routing model including water
mass balance (lake/river levels)

Hydrological and meteorological soil moisture should be the same!

Statement inspired by Martin Best (UK Metoffice) at a hydrometeorological meeting in Norway in December 2015.



Units: Thousand cubic km for storage, and *thousand cubic km/yr* for exchanges

FIG. 1. The hydrological cycle. Estimates of the main water reservoirs, given in plain font in 10^3 km^3 , and the flow of moisture through the system, given in slant font ($10^3 \text{ km}^3 \text{ yr}^{-1}$), equivalent to Eg (10^{18} g) yr^{-1} .

General surface thoughts and comments

Surface physics in SURFEX is in many aspects well beyond the needs in NWP applications but plenty of non-utilized potential exist! SURFEX includes more processes, implemented in a more consistent way, than HIRLAM surface ever did.

At the same time, our current operational cy38h1.2/40h1 HARMONIE (AROME-SURFEX) system is in some important aspects less “advanced” over land than latest HIRLAM (still running at some centres):

	cy38h1.2/40h1	HIRLAM
Land		
Patches	1	1-3 (incl. “MEB” patch)
Soil	Force-restore	Diffusion
Snow	Composite	Bulk-1L
Assimilation	OI	OI
Sea	SICE (MetCoOp)	2-layer ice scheme
Lake	Deep soil temp	Deep soil temp/Flake
Town	TEB	No (open land)
Physiog.	ECOCLIMAP	FAO

General surface thoughts and comments

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	cy38h1.2/40h1	HIRLAM	cyxxh
Land			
Patches	1	1-3 (incl. “MEB” patch)	2 patches
Soil	Force-restore	Diffusion	Diffusion (14 layers)
Snow	Composite	Bulk-1L	Explicit snow (12 layers)
Assimilation	OI	OI	EKF
Sea	SICE (MetCoOp)	2-layer ice scheme	Sea ice
Lake	Deep soil temp	Deep soil temp/Flake	FLake (later with EKF)
Town	TEB	No (open land)	TEB (more options)
Physiog.	ECOCLIMAP	FAO	Utilize high res. data.

How to reach progress

The potential we need regarding most relevant land processes (vegetation, snow, soil) is provided by SURFEXv8 (released autumn 2015) which will be part of cy43.

The surface assimilation needs to be based on EKF rather than OI. Both to utilize the physics and to utilize observations beyond SYNOP (satellite). Here we have need for substantial development. So, HIRLAM colleagues, please consider this need for development in your institute plans (applications, thesis projects, new positions,.....).

How to reach progress

- Please visit the "**Side meeting on surface data assimilation**" taking place on Wednesday 11:00-13:00. There will be four presentations from our main organizations: Rafiq Hamdi (ALADIN), Máté Mile (LACE), Eric Bazile (Météo-France) and Patrick Samuelsson (HIRLAM) + discussion.
- Next week (April 11-14 in Oslo) HIRLAM arranges a HARMONIE Surface Working Week on surface assimilation. See this wiki for more information: <https://hirlam.org/trac/wiki/HarmonieWorkingWeek/Surface201604>
The agenda includes an 1-hour Google Hangouts session for those who are interested to follow WW progress and have interest in surface assimilation:
Wednesday April 13, 10:00-11:00 (CET)
Please let Patrick know if you wish to attend!

HIRLAM surface activities that will be seen this week

This afternoon:

- Sander Tijm (KNMI): SURFEX fluxes in Spring and Summer
- Yurii Batrak (MetNorway): SICE: simple sea ice scheme
- Carl Fortelius (FMI): Urban heat fluxes from Arome-Harmonie compared to eddy-covariance data

Posters:

- Ekaterina Kurzeneva (FMI): Status of lake developments in HARMONIE
- MET Norway team: Surface modelling and assimilation at MET Norway
- Ruth Mottram et al. (DMI): Glaciers in HARMONIE

Other activities

Physiography

Bolli Palmason et al. (IMO) are correcting albedo (VIS,NIR) aspects related to the ECOCLIMAP database (black sand and permanent snow).

Please critically examine physiography fields and don't trust them to always be correct!

Global Lake Depth Data Base, GLDBv3, is released (Ekaterina Kourzeneva (FMI) and Margarita Choulga).

In PGD, inconsistencies for clay, sand and lakes existed for aggregation/interpolation when model grid is coarser/finer than physiography data – fixed for v7.3. (Ekaterina Kourzeneva (FMI))

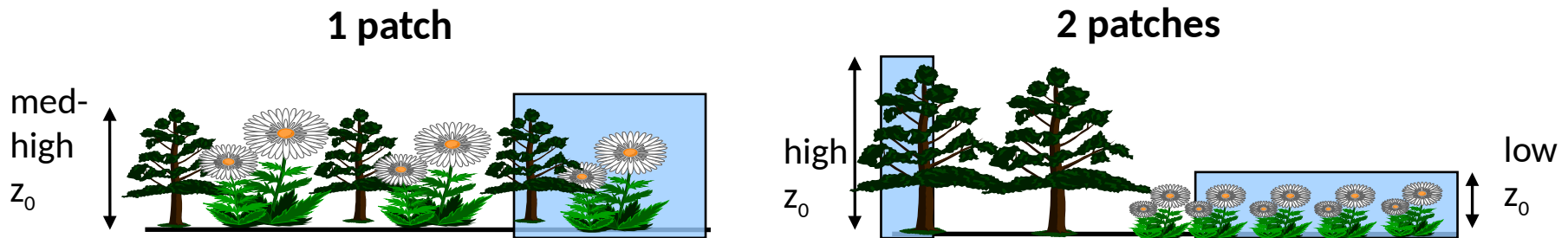
Plans exist to utilize high-resolution (order of 100 m) national data bases on land-use to complement current ECOCLIMAP on 1 km resolution. But these data bases need to be translated to SURFEX style physiography!

Future SURFEX versions will not be based on current ECOCLIMAP/cover representation of physiography but instead based on Plant Functional Types which will be given their characteristics from external data bases (albedo, LAI, roughness, ...). This representation will fit better with physiography satellite products.

Problem with too cold/moist spring conditions in cy38h1.2

Over Scandinavia HARMONIE (cy38h1.2) and HIRLAM (E05 at SMHI) differ in dividing available net radiation at surface into sensible and latent heat fluxes during spring situations leading to too cold/moist near-surface conditions in cy38h1.2. Similar problem is reported over the Netherlands...

One hypothesis is that using 2 patches in SURFEX instead of 1 can help this problem (similar to HIRLAM 7.4). A test branch of cy40h has been setup by MetCoOp with modified OI for 2 patches:



Note: The atmospheric surface-boundary layer (SBL) (also known as the Canopy model) needs to be switched off when 2 patches are used.

People involved: Trygve Aspeli (MetNo), Patrick Samuelsson (SMHI), Mariken Homleid (MetNo), Karl-Ivar Ivarsson (SMHI)

ISBA physics based on SURFEXv8 into cy40h

The explicit snow scheme and diffusion soil scheme in the land-surface (ISBA) part of SURFEX in cy40h (SURFEX7.3) are not well functioning. However, in SURFEXv8 they work fine.

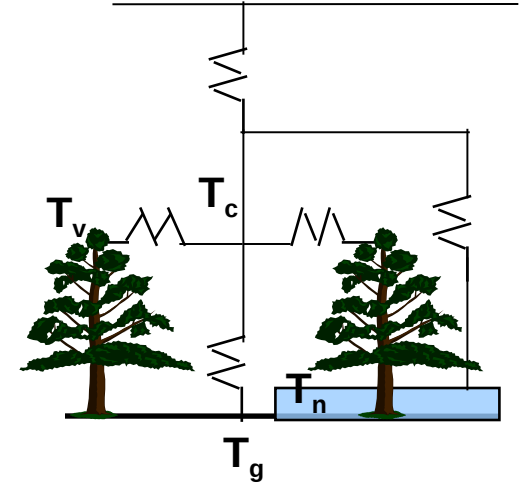
So, while waiting for cy43 (including SURFEXv8), and to allow tests and development connected to SURFEX Explicit snow scheme (12 layers) and soil diffusion scheme (14 layers) in combination with EKF assimilation method, a branch of cy40h has been set up where the default ISBA physics (7.3) has been replaced by corresponding subroutines from SURFEXv8.

People involved: Patrick Samuelsson (SMHI) inspired by needs raised by MetCoOp development.



Multi-Energy Balance (MEB) status and development

- MEB is part of SURFEXv8 as released autumn 2015. Thus, will become available as part of cy43.
- Is currently documented for peer-review journal papers and SURFEX scientific documentation.
- Is validated in French SIM (SAFRAN-ISBA-MODCOU) hydrometeorological system.



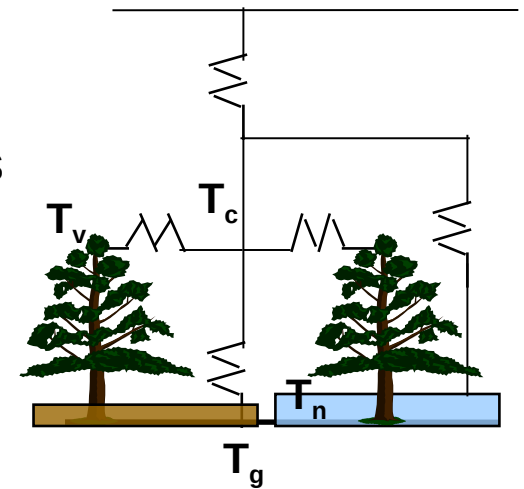
People involved: Aaron Boone (Météo-France), Adrien Napoly (Météo-France), Patrick Samuelsson (SMHI)

Multi-Energy Balance (MEB) status and development

Recent development by Napoly et al. concerns adding of a litter layer (dead vegetation material) at the surface under the canopy (its own energy balance, interception capacity).

Quotes from conclusions for four French forest sites:

- “the standard ISBA model is found to underestimate the amplitude of the sensible heat flux and overestimate that of the ground heat flux”. E.g., leads to too much ice in the soil during winter time.
- “The main difference occurs during spring for the deciduous forest site where the litter layer acts to significantly limit soil evaporation, whereas ISBA ... overestimates evapotranspiration due to strong ground evaporation.”



People involved: Aaron Boone (Météo-France), Adrien Napoly (Météo-France), Patrick Samuelsson (SMHI)

Sea and Sea ice

Yurii Batrak (MetNo) has developed the simple sea-ice scheme (SICE) which is now operational in MetCoOp (cy38h1.2) and will be part of SURFEX in cy40h. SICE has prescribed ice thickness and allows snow on ice.

Bin Cheng (FMI): Sea-ice model HIGHTSI with prognostic ice thickness, snow and slush layers.

Combine as a contribution to SURFEX?

How may this complement the sea-ice scheme GELATO in SURFEXv8?

Jan Barkmeijer (KNMI) showed good results with HARATU for 10-m-wind speed. However, a systematic overestimation for stormy conditions over sea is still there. This indicates the need for a wave model for the SURFEX sea tile...

ALARO1 and SURFEX in cy40...

We have problems to get ALARO1 running with SURFEX...

The main problem is to get TOUCANS working where PCD and PCDN need to be communicated between ALARO1 and SURFEX.

At the system working week in Bratislava last autumn an effort was made to solve this problem, based on solution made for Cy38T1OP3 by Rafiq, but it was not successful... At SMHI we have been working on this in a cy40h branch and Rafiq Hamdi has done comparable efforts in cy40t... Rafiq will now concentrate on PCD/PCDN/TOUCANS in SURFEXv8 development...

c40h does not run on the ECMWF machine with ALARO1-SURFEX, independent on TOUCANS... the “problem” is that ALARO-0 and SURFEX works...

Orographic effects on radiation, ororad

Laura Rontu (FMI) reports that a paper on ororad has been published:
<http://journal.frontiersin.org/article/10.3389/feart.2016.00013/full>

And ororad is on its way into SURFEX via cy43t phasing

SURFEX plans in general

SURFEXv8 was released autumn 2015. Check latest version in trunk of SURFEX repository. SURFEXv8 is part of cy43t

SURFEXv8.1 is planned for summer 2017 and will include technical developments only like

- Optimizations and parallelization of PGD and PREP
- Implementation of GMAP's solution to optimize PREP based on Full-POS (but will probably be removed later)
- Removing Open-MP from the off-line driver
- Use of XIOS I/O server
- Cleaning of obsolete options
- TYPE as argument of routines

SURFEXv9 is planned for end of 2018 and will include both both scientific and technical developments.