Working Group 3

Snow data assimilation and validation methods for NWP and hydrological models

in

COST ES1404

Action Objectives & Benefits

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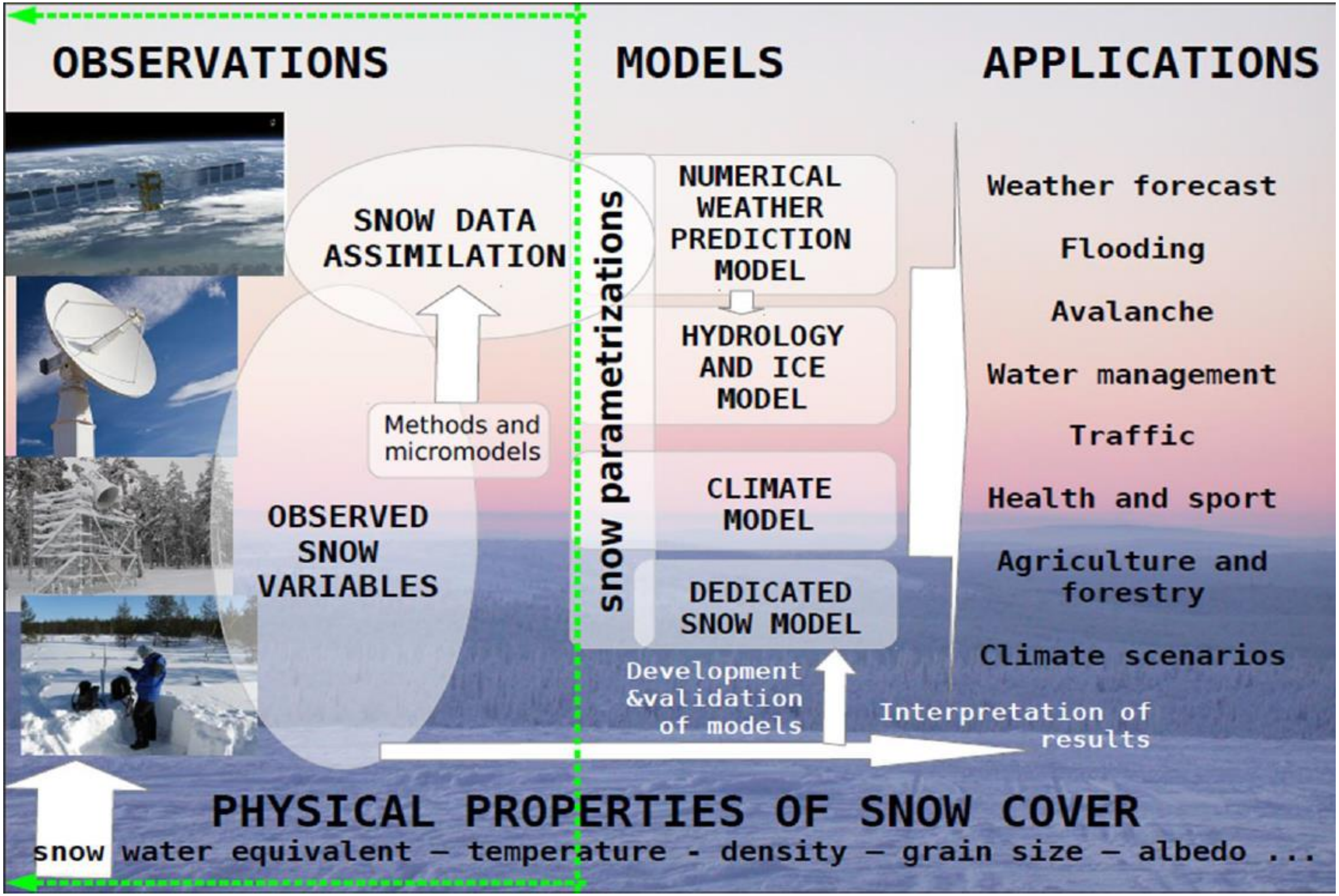
Wetter und Klima aus einer Hand

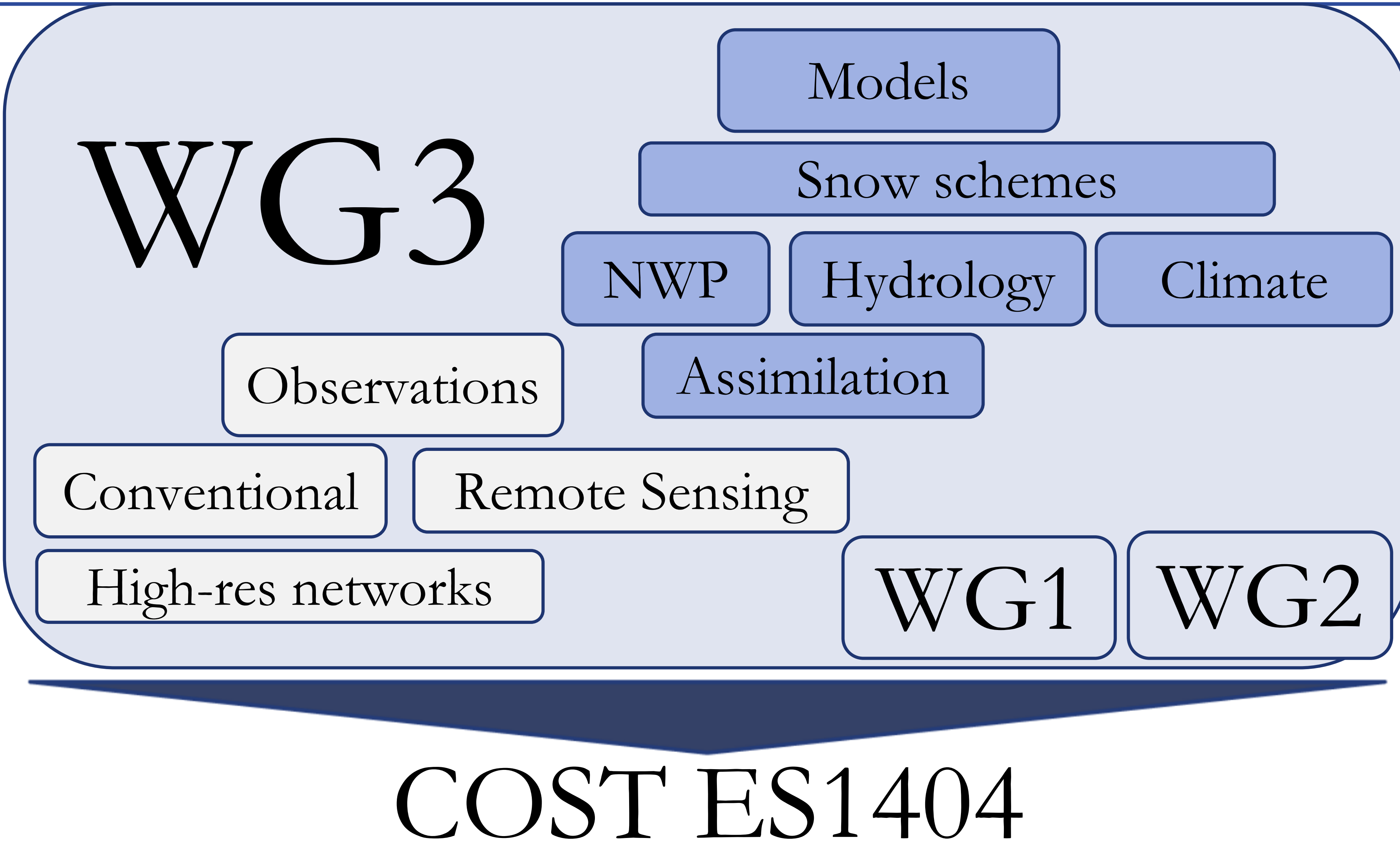
With relationship to WG3:

- Advance snow data assimilation in European NWP and hydrological models and show its benefit for relevant applications.

- Establish a validation strategy for climate, NWP and hydrological models against snow observations and foster its implementation within the European modelling communities.


OBSERVATIONS
MODELS
APPLICATIONS
SNOW DATA ASSIMILATION
Methods and micromodels
OBSERVED SNOW VARIABLES
snow parametrizations
NUMERICAL WEATHER PREDICTION MODEL
HYDROLOGY AND ICE MODEL
CLIMATE MODEL
DEDICATED SNOW MODEL
Development &validation of models
Weather forecast
Flooding
Avalanche
Water management
Traffic
Health and sport
Agriculture and forestry
Climate scenarios
Interpretation of results
PHYSICAL PROPERTIES OF SNOW COVER
snow water equivalent – temperature - density – grain size – albedo ...

Structure


Models
Snow schemes
WG3
NWP
Hydrology
Climate
Observations
Assimilation
Conventional
Remote Sensing
High-res networks
WG1
WG2
COST ES1404

Tasks

Key questions for 2015:

- How many and which kind of snow observations are assimilated in numerical weather prediction and hydrological models?

- What are the data assimilation methods used in meteorology and hydrology for snow observations?

- First meeting of the WG3 in Grenoble, 18-20 March, 2015
- Second meeting of the WG3 with Special Cold Lake Session during the workshop on Lakes in NWP and Climate modelling in Evora, May 8, 2015
- Third meeting of the WG3 in Erzurum, March 1st, 2016

Tasks

- *Overview* of the various *snow observations* used in NWP, hydrology and climate studies for *different purposes* including validation and data assimilation (e.g. different snow observations are used in different environmental applications).

Decision: Preparing a questionnaire for snow observations in meteorology and hydrology communities (categories of data types, parameters, frequency, scales, format, demands).

- For *data assimilation*, different methods are used in NWP and hydrology. The overview will allow to *assess* the current situation and to understand future *perspectives*.

Decision: Preparing a questionnaire for data assimilation in meteorology and hydrology, Short description of methodology, example of application will provided.

Working group topics for 2016

Next Tasks

• A critical review of *snow models* utilizing physical snow *parameters* as input and used as parametrization schemes or for downstream applications (CROCUS, Snowpack, SNTHERM) will be included.

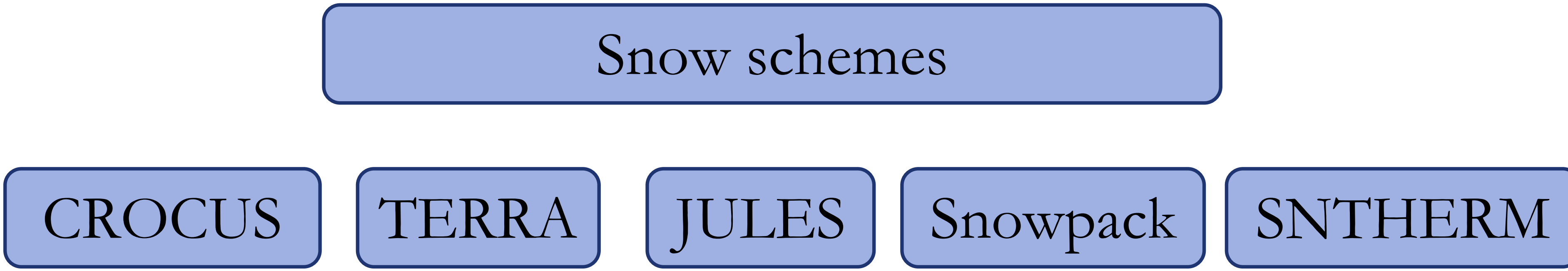
Preparing a questionnaire, using existing model intercomparison experience (e.g. SNOWMIP2), investigating interoperability of snow models with data assimilation, consider model sophistication.

•Establish *links* between different *communities* of users of snow observation.

Two-way feedback between working groups, preparing a guide for end users.

- 4th WG3 meeting during the workshop on in Vienna, April 19, 2016

Models



- Treatment of snow processes (metamorphism, liquid water)
- Considered complexity (one-layer, multi-layer schemes)
- Grid-scale and subgrid-scale features (snow tiles)
- Interaction with other land-surface properties (e.g. vegetation)

Models

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Agora wiki   Bereiche   Anmelden

HarmoSnow - COST ESSEM1404

BEREICHSVERKNÜPFUNGEN
- HarmoSnow.eu
- COST
- FMI
- Tasks
- File lists

SEITENHIERARCHIE
- File lists
- How to Use Agora Wiki
- Hydrological model comparison
- Meetings
- Questionnaires
- Snow DA-system comparison
- **Snow model comparison**
- Webpage - HarmoSnow.eu

Bereich konfigurieren

Seiten / HarmoSnow - COST Action ES1404 Home   Extras

Snow model comparison

Angelegt von Jürgen Helmert, zuletzt geändert am 07.10.2016

Parameter	Value	Value
Institution	DWD, Germany	
Application	NWP, Climate	
Reference	http://www2.cosmo-model.org/content/model/documentation/core/cosmoPhysParamtr.pdf	
Considered processes	Prognostic snow temperature, time dependent snow albedo, prognostic snow density, implicit solution of the heat conduction in the snow pack, melting of snow	
Model horizontal resolution	13 km (global), 6.5 km to 2.8 km in limited area mode	
Single/Multi-Layer scheme	Single	
Min. solar albedo of snow for forest free surfaces	0.50	
Max. solar albedo of snow for forest free surfaces	0.85	
Solar albedo of snow for surfaces with evergreen forest	0.27	
Solar albedo of snow for surfaces with deciduous forest	0.32	
Minimum snow depth (m)	0.01	
Maximum considered snow depth for heat transfer (m)	1.5	
Minimum density of snow (kg/m**3)	50	
Maximum density of snow (kg/m**3)	400	
Minimum density of *fresh* snow (kg/m**3)	50	
Maximum density of *fresh* snow (kg/m**3)	150	
Lower threshold temperature of snow for ageing and fresh snow density computation (K)	258.15	
Maximum density of snow at lower threshold temperature (kg/m**3)	200	
Time constant for ageing of snow at lower threshold temperature (days)	8	
Maximum value of time constant for ageing of snow (days)	2.5	
Minimum heat conductivity of snow (W/m K)	0.2	
Maximum heat conductivity of snow (W/m K)	1.5	

Working group topics for 2016

- Review of snow models, connecting to WG1/2 and user communities
- First steps for next phase of the project (Improving data assimilation)
- Others

Next Tasks

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- Finding a *new* method for combining *satellite* observations with *conventional* in-situ snow measurements and *modelling* results: Microwave satellite observations are combined with conventional in-situ observations in some products (Hydro-SAF), while optical satellite observations together with conventional in-situ observations are assimilated into NWP models.
  Will be considered in a later stage of the project.

- *Sustainable* principles to *combine* all types of information should be found. This will allow *advanced assimilation* of new and forthcoming satellite observations of different snow properties (snow-melt, snow extent and SWE).
  Will be considered in a later stage of the project.

- This approach will also need *new methods* to update *non-observed* simulated physical snow variables (such as snow wetness, density profiles and mechanical properties) based on the observed ones (such as snow depth and extent).
  Will be considered in a later stage of the project.

Next Tasks

- Looking for *strategies* towards a more *extended usage* of *conventional* snow observations to include observations from high-resolution *national networks* into NWP, hydrological and climate models, as the use of data from national networks is currently very limited.

  Considering a Web-Portal solution for data exchange (e.g. similar to OPERA for radar data); taking into account zero snow height information;

Inform national and international institutions about COST action needs.

- Their *impact* will be assessed and *recommendations* how to increase their availability will be given.

  Will be considered in a later stage of the project.

- *Acquiring* more information about *observational errors* relevant for DA by establishing *links* between the *modelling* and *measurement* communities via *WG1* and *WG2*. These links will also provide the *users' feedback* to the measurement community by reporting about the *quality of data* and potential problems.

  Exchange of information about representativeness of data, making realistic estimation of observation errors, managing deficiencies of observations.

Next Tasks

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Action items from Helsinki:

- Inform Snow Watch Team: Snow Watch Team contacted (S. Pullen)
- Inform NWP consortia contact persons: EWGLAM/SRNWP contacted
- Use mailing list for users of hydrologic models
- First draft of questionnaire for offline snow models
- COST statement on snow observation situation in GTS
- Ask for COST contribution at ISDA2016: Now own Snow DA workshop

Next Tasks

Action items from Vienna

- Questionnaires: Stay along with the questionnaires from WG1 and WG2. Need contact point and more feedback from Asia. More comprehensive evaluation in Q4 2016.
- Exchange of national snow observation data: Prepare statement paper from COST. Link with GCW Snow watch. Asia should be included. Sensitivity study from P. de Rosnay on the impact of additional snow obs.
- Contact EUMETNET for forcing zero snow depth reports (EUMETNET representative at DWD was informed)
- Review of snow models: Consider IAHS Working Group on Education in the Hydrological Sciences and Task 3.1 (http://www.harmosnow.eu/index.php?page=Working%20Group%203). Classes of snow models used in WG3 as starting point.
- Model intercomparison: verify participation in Earth System Model-Snow Model Intercomparison Project (ESM-SnowMIP).
- Snow in hydrological models: Provide a model overview in WG3. Common terminology according to Beven and Young (2013).
- Consider the impact of snow in long-term simulations: Link to EuroCORDEX comparisons. Uncertainties in alpine region could be related at least in parts to snow.

Assimilation and analysis (under development)

Article published on 11 July 2009

by JFM

http://www.cnrm-game-meteo.fr/aladin/spip.php?article179&lang=en

Model parameters	ALADIN	COSMO	HIRLAM	UM/JULES	ECMWF
Soil temperature and water content	Extended Kalman Filter (EKF) for conventional and satellite observations. Offline mode		First guess T2m and Q2m from open land/snow only (excluding forest)	Addition of ASCAT data. Longer term plan is to develop an EKF scheme that uses screen observations and satellite data	Extended Kalman Filter (EKF) for use of conventional (soil moisture and brightness temperatures). Offline mode
Sea surface temperature	Optimal interpolation using surface observations and satellite SST products (OSTIA)			None	
Sea-ice extent	None			None	
Sea-ice temperature	None	Implementation of bulk thermodynamic sea ice model presently applied operationally in GME		None	
Sea-ice concentration	None			None	
Snow depth	Optimal interpolation using surface observations + satellite MSG swno cover mask	Major revision of snow within COSMO project COLOBOC at Meteo-Swiss. Modifications in calculation of rho_snow, T_snow, additional use of snow observations in the Alpine region		Longer term plans to include SYNOPs and satellite SWE in snow depth analysis	
Lake	None			None	
Vegetation	Kalman filter for surface albedo analysis from LandSAF products			More frequent updates, possibly using LandSAF data. Longer term plan to assimilate LAI within EKF scheme	MODIS assimilation in a simplified 2D-Var

SRNWP/EWGLAM ETSFC

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Modelling components (under development)

Article published on 14 July 2009
dernière modification le 21 September 2012

by JFM

http://www.cnrm-game-meteo.fr/aladin/spip.php?article181&lang=en

Component	ALADIN	COSMO	HIRLAM	UM/JULES	ECMWF
Surface energy balance	Patch approach over the nature tile : (up to) 12 different energy and water budgets	Flexible tile approach with separate energy budgets	Multi Energy Balance in SURFEX/HARMONIE	Flexible tile scheme with user defined tiles and elevation bands	None
Coupling with the atmosphere	None	None	None	None	None
Soil transfers	Multi-layer soil scheme (ISBA-DIF)	Account for heterogeneous soil properties and organic soils	Multi-layer soil scheme in SURFEX/HARMONIE	Increased number of soil layers linked to code enhancement	None
Frozen soils	Multi-layer diffusion scheme	None	Multi-layer diffusion scheme	None	None
Vegetation	Two layers - separate energy balance for high and low vegetation canopies : MEB scheme	Water interception reservoir; improved root profiles	MEB scheme : improved vegetation-snow interactions in SURFEX/HARMONIE	None	None
Snow model	Three-layer scheme (variable depths) – liquid water in snow pack as an additional prognostic variable	Multi-layer – liquid water in snow pack as additional prognostic variable	Three-layer snow scheme	Multi-layer scheme – snow mass, snow density; liquid water in snow pack, dynamic snow layer depths	Snow/forest albedo revision and rainfall interception in the snow pack
Lake model	bulk fresh water lake model (Flake)	None	FLake in SURFEX/HARMONIE	FLake coupled via surface fluxes	bulk fresh water lake model (FLake)
Sea-ice	Sea-ice model	None	Sea-ice model with snow on top	Multi-layer thermodynamics with sea-ice categories	None
Ocean model	1-D mixed layer ocean (based on TKE concept)	None	1D-mixed model in SURFEX/HARMONIE	None	1-D mixed layer ocean (based on TKE concept)
Urban areas	Town Energy Budget (TEB) model with CANOPY	Multi-layer urban canopy parameterization	None	2 tile urban scheme with varying parameters	None
Chemistry module	Aerosols and dust emission	COSMO-ART : aerosols and dust emission	None	None	None
Surface boundary layer	5-layer scheme solving turbulent prognostic equations without advection	None	Monin-Obukhov similarity theory. T2m and q2m defined as canopy air values in the forest (not used in data assimilation)	None	None

EWGLAM/SRNWP Surface Expert Team Meeting, Rome, Italy, Oct. 3,2016

Chair: Patrick Samuelsson (SMHI)

Surface data assimilation of remote sensing information

Some observational operators can be shared and developed together cross our consortia. For example, in HIRLAM (Finland) there is currently development ongoing with respect to an observational operator for Snow-Water Equivalent originally deveoped by ECMWF. There should probably be similar situation for e.g. top soil moisture. Thuls, we would like to encourage that development of some observational operators are done in some version control environment so we can all benefit from development cross consortia.

A visiting student at FMI, Maxime Quenon, has published a report on “Visual and Statistical Analysis of Snow Cover” where snow extent (SE) and Snow-Water Equivalent (SWE) simulated by cy38h1.2 HARMONIE-AROME-SURFEX has been compared with SYNOP snow depth, MetOp and MSG SE and Globsnow SWE. Report available via hirlam.org. Ekaterina Kourzeneva plans a summary presentation of this work.

Besides this we did not identify clear cross-consortia surface data assimilation connections.

Update of common tables of model configurations

The participants have found the “Documentation of SRNWP surface modelling and assimilation systems” under the ALADIN web site here: http://www.cnrm-game-meteo.fr/aladin/spip.php?rubrique42 useful and would like to keep these documentation up to date.
Action: Patrick S. takes the responsibility to request information for updating of the tables.