Snow Analysis & Snow Model - Agenda

Part I: Snow Analysis

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Schweizerische Eidgenossenschaft
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Swiss Confederation

Federal Department of Home Affairs FDHA
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Snow Analysis - MeteoSwiss

ICCARUS – 2021

Contact: Sascha.Bellaire@meteoswiss.ch

Sascha Bellaire[1] ,Varun Sharma[2,3], Louise Braud[1], Michael Lehning[2,3], Jean-Marie Bettems[1]

[1]MeteoSwiss, Zurich, Switzerland

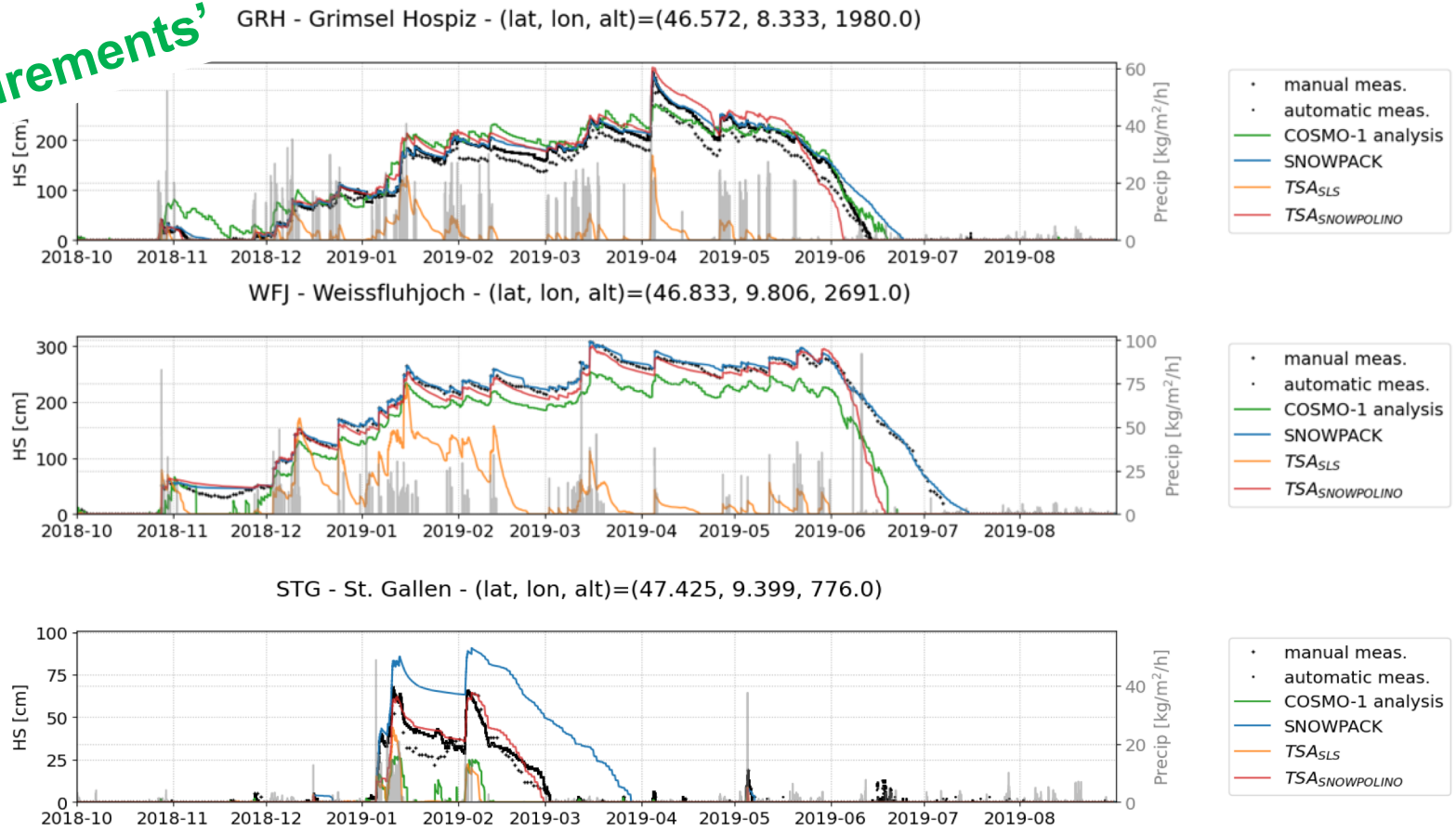
[2]WSL Institute for Snow and Avalanche Research SLF, Davos, Switzerland

[3]CRYOS, School of Architecture, Civil and Environmental Engineering, EPFL, Lausanne, Switzerland

Snow cover Simulations - TERRA-STANDALONE (TSA)

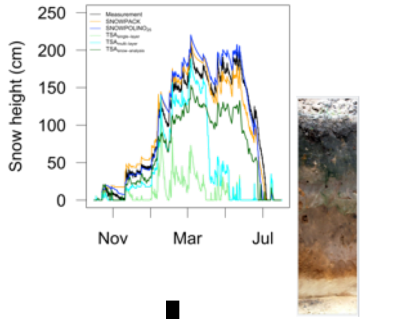
‘Measurements’

Snow height (cm)



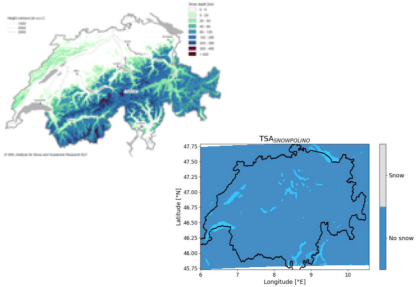
‘Snow’ Analysis – MeteoSwiss

$TSA_{SNOWPOLINO}$



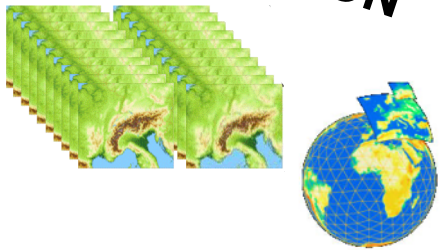
+

$SNOWPOLINO_{Output}$



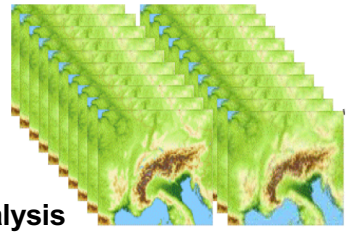
+

COSMO/ICON



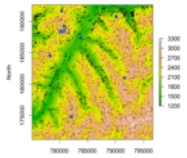
+

T_{AIR}, RH, FF, SW_D, LW_D, PP



$COSMO\text{-}1_{Analysis}$

Statistics

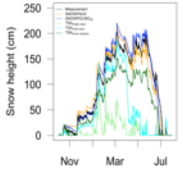


Alpine3d

AWS Data

Satellite Imagery

$TSA_{SNOWPOLINO}$



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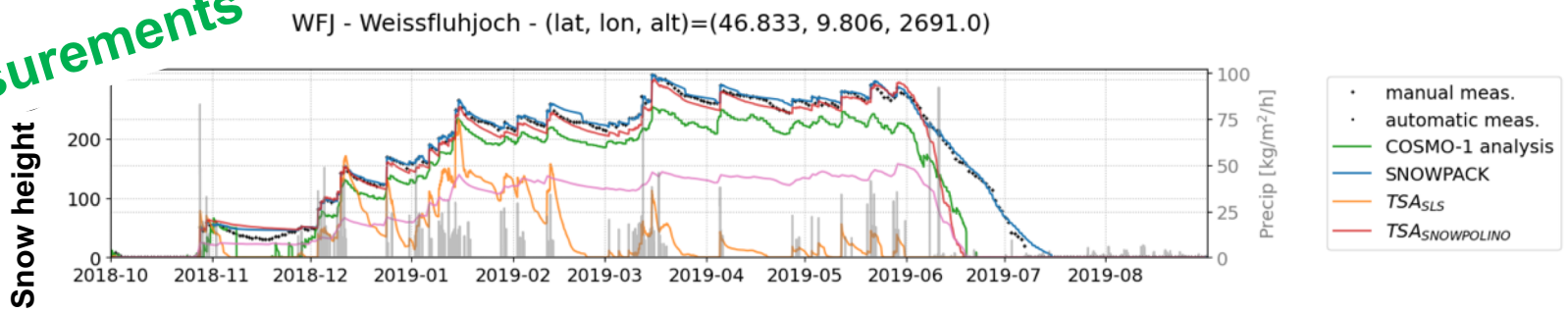
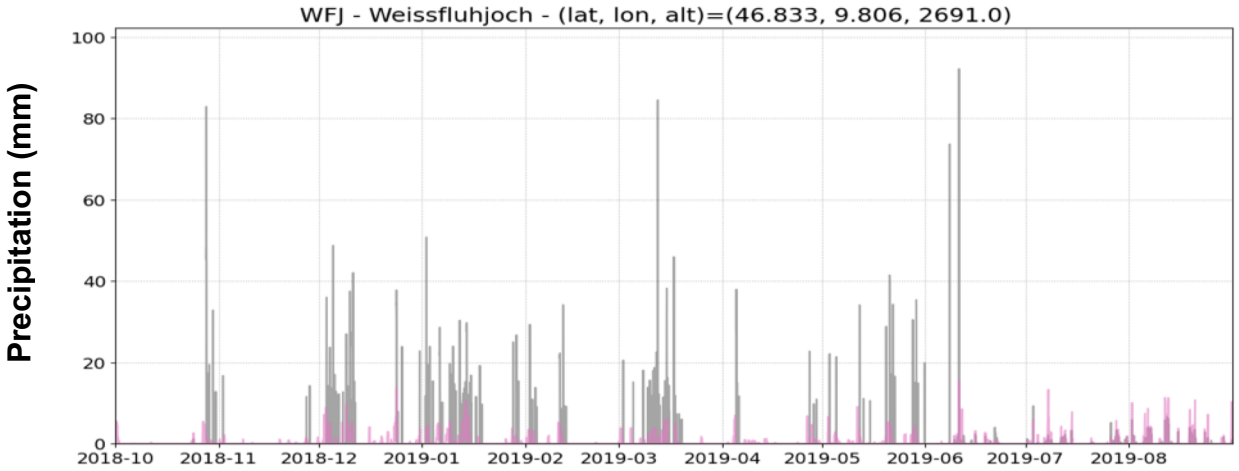
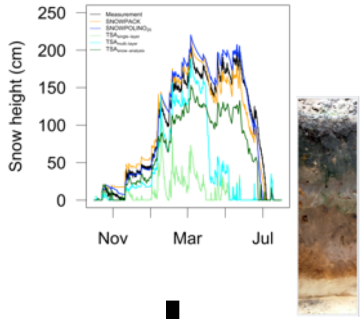


$TSA_{SNOWPOLINO}$ – $COSMO\text{-}1_{Analysis}$



‘Snow’ Analysis – MeteoSwiss

$TSA_{SNOWPOLINO}$



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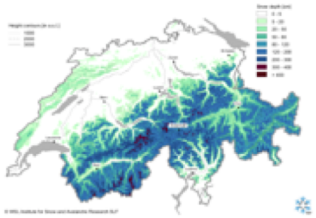
$SNOWPOLINO_{Output}$



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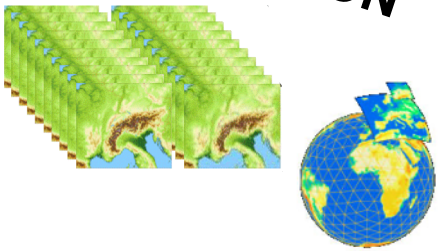
COSMO/ICON



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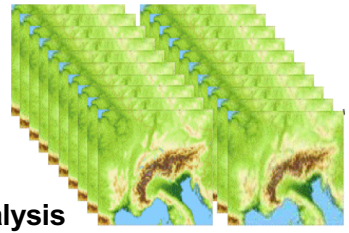

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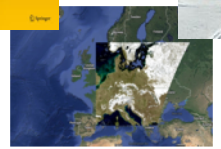

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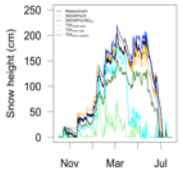

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Snow Model (SNOWPOLINO) - MeteoSwiss

ICCARUS – 2021

Contact: Sascha.Bellaire@meteoswiss.ch

Sascha Bellaire[1] ,Varun Sharma[2,3], Louise Braud[1], Michael Lehning[2,3], Jean-Marie Bettems[1]

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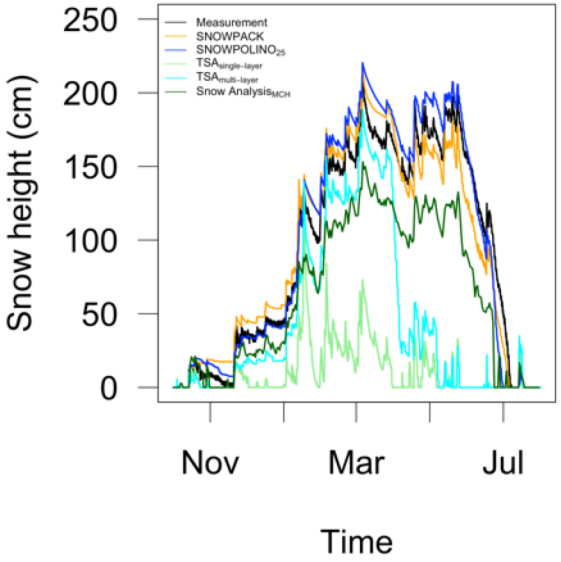
SNOWPOLINO – a little ‘history’

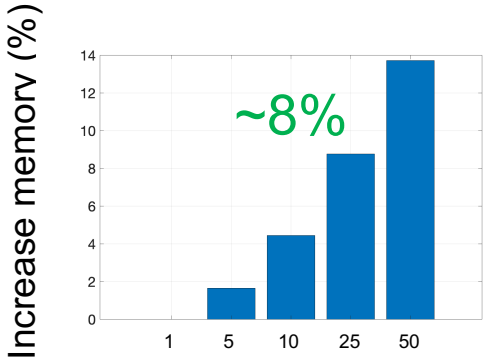
2013 **March**	Start of the Austrian Science Fund Project SAINT (**S**now cover **A**tmosphere **INT**eraction) at the University of Innsbruck; **Project Goal:** coupling/forcing of SNOWPACK with COSMO
2017 **July**	Revival of the ‘SAINT’ project co-funded by MeteoSwiss and WSL Institute for Snow and Avalanche Research SLF; **Project Goal:** development of a new multi-layer scheme for COSMO/ICON
2017 **September**	SAINT became an **priority task project** of the COSMO consortium (**PT-SAINT**)
2020 **December**	‘Official’ end of PT-SAINT (formal extension required)
2021 **September**	End of PT-SAINT and potential start of follow up project.

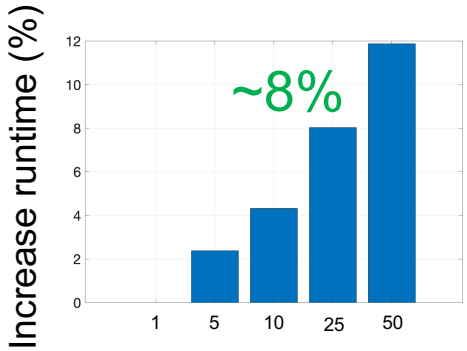
Multi-layer snow cover scheme - SNOWPOLINO

Weissfluhjoch – Winter 2015-16



- Physical based multi-layer snow cover scheme (SNOWPOLINO)
- Comparable to current sophisticated state of the art snow cover schemes (e.g. SNOWPACK)
- Solves for heat equation; calculates phase changes, water transport and settling/densification.
- Arbitrary number of layers (default 25); reasonable performance/runtime ratio.





COSMO-1 (500x500) on GPUs (SP)

What models currently contain SNOWPOLINO?

$SNOWPOLINO_{stand\text{-}alone}$

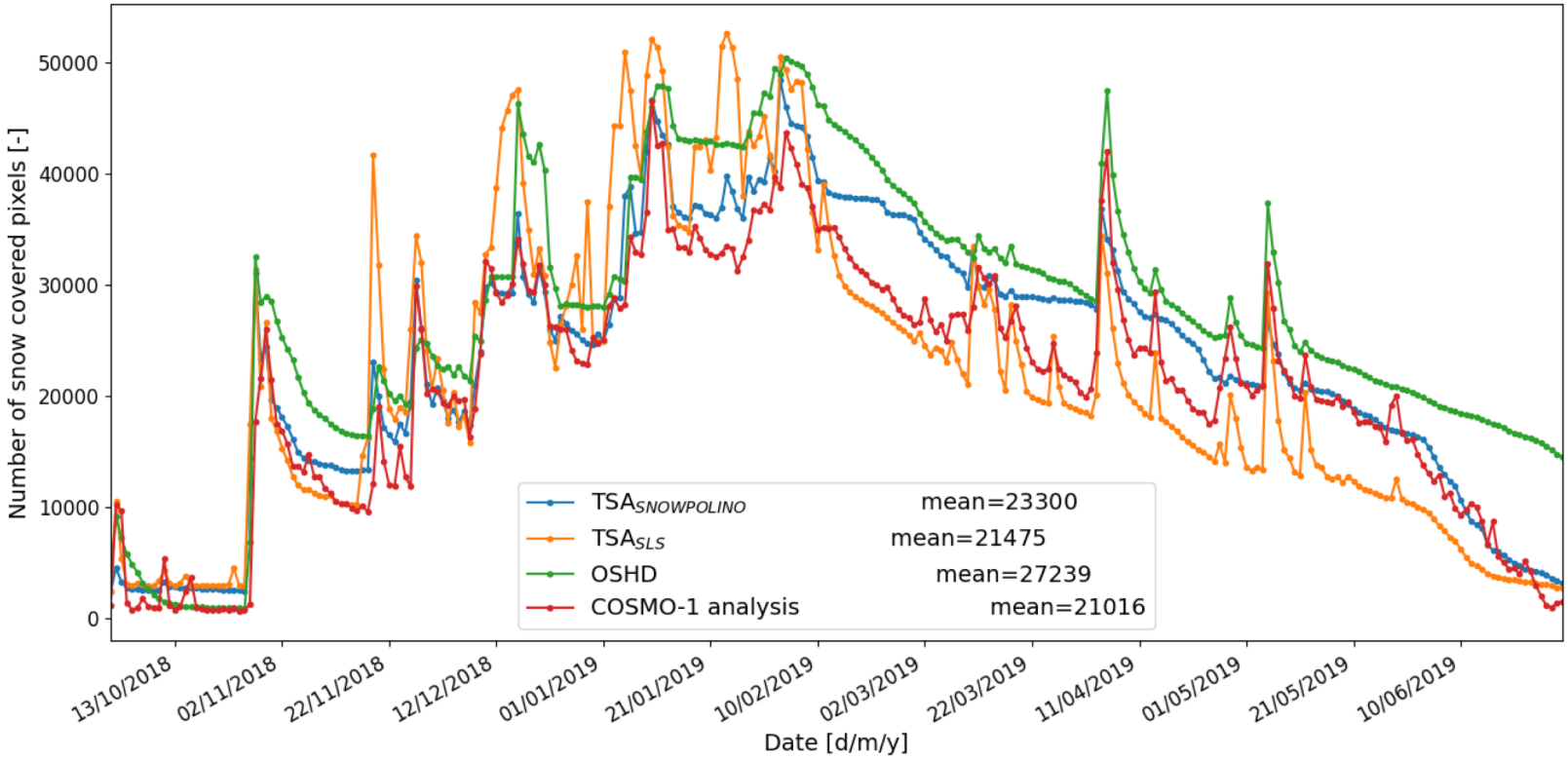
$TERRA_{stand\text{-}alone}$ (TSA)

- decoupled version of COSMO/ICON of the surface scheme TERRA
- TSA can be forced with gridded and non-gridded data
- unified code (with COSMO v6.0)

COSMO

- part of official COSMO (v6.0) code
- code is GPU capable
- currently implemented outside of TERRA …
- hence, transition to ICON and usage for other scheme, i.e. vegetation, urban model, sea/lake ice possible.

Results: TSA & COSMO-1 Analysis



Open issues & Discussion points

How should/can a follow up COSMO consortium project look like?

Currently, with secured resources at MeteoSwiss proposal is a 'one-liner'!

Task	Lead
Implementation of SNOWPOLINO into ICON	MeteoSwiss
Aerosols on snow; snow/albedo feedback	*KIT*
Snow/Vegetation interaction – snow in/on canopy	
Sea/Lake ice interaction	
Snow in urban areas	
Technical Support	DWD
Global/Local validation	DWD, RHM

SNOWPOLINO - Nice to have's & Must does

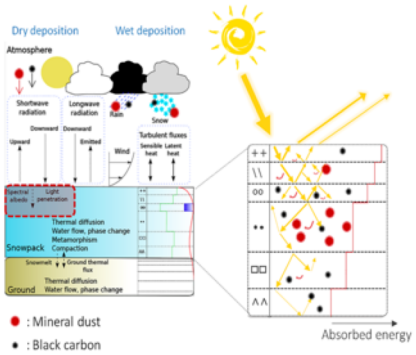
Impact of aerosols

The Cryosphere, 11, 2633–2653, 2017
https://doi.org/10.5194/tc-11-2633-2017

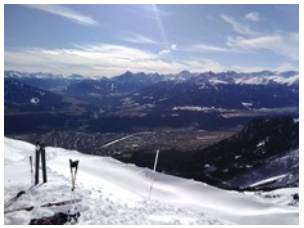
The Cryosphere EGU

A multilayer physically based snowpack model simulating direct and indirect radiative impacts of light-absorbing impurities in snow

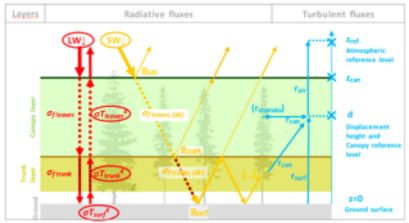
Francois Tuzet[1,2], Marie Dumont[1], Matthieu Lafaysse[1], Ghislain Picard[2], Laurent Arnaud[2], Didier Voisin[2], Yves Lejeune[1], Luc Charrois[1], Pierre Nabat[1], and Samuel Morin[1]



Urban snow cover



Snow/Canopy Interactions

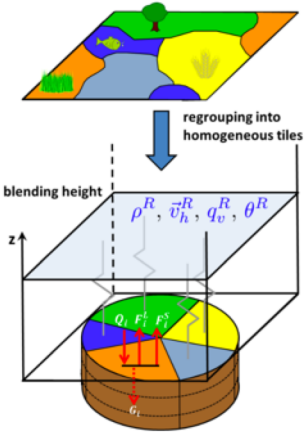


Geosci. Model Dev., 8, 2379–2388, 2015
www.geosci-model-dev.net/8/2379/2015/
doi:10.5194/gmd-8-2379-2015

Geoscientific Model Development

A two-layer canopy model with thermal inertia for an improved snowpack energy balance below needleleaf forest (model SNOWPACK, version 3.2.1, revision 741)

Tile approach



- Land
- Sea/lake ice
- Urban
- Canopy
- …

Open issues & Discussion points (not in ranking order)

- JSBACH vs. TERRA: Where should we implement SNOWPOLINO?
- Which code version of ICON?
    - ICON-NWP, ICON-A, ICON-DEV, latest/special release …
- TSA (Terra stand-alone) vs. ICON-LAND ‘stand-alone’? Should we switch to ICON-LAND?
- …