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CONSORTIUM FOR SMALL SCALE MODELING
COSMO

COSMO :
Soil and Surface Activities

Jean-Marie Bettems / MeteoSwiss

EWGLAM / SRNWP Meeting
Antalya, Octobre 1st, 2013

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COSMO SVAT scheme

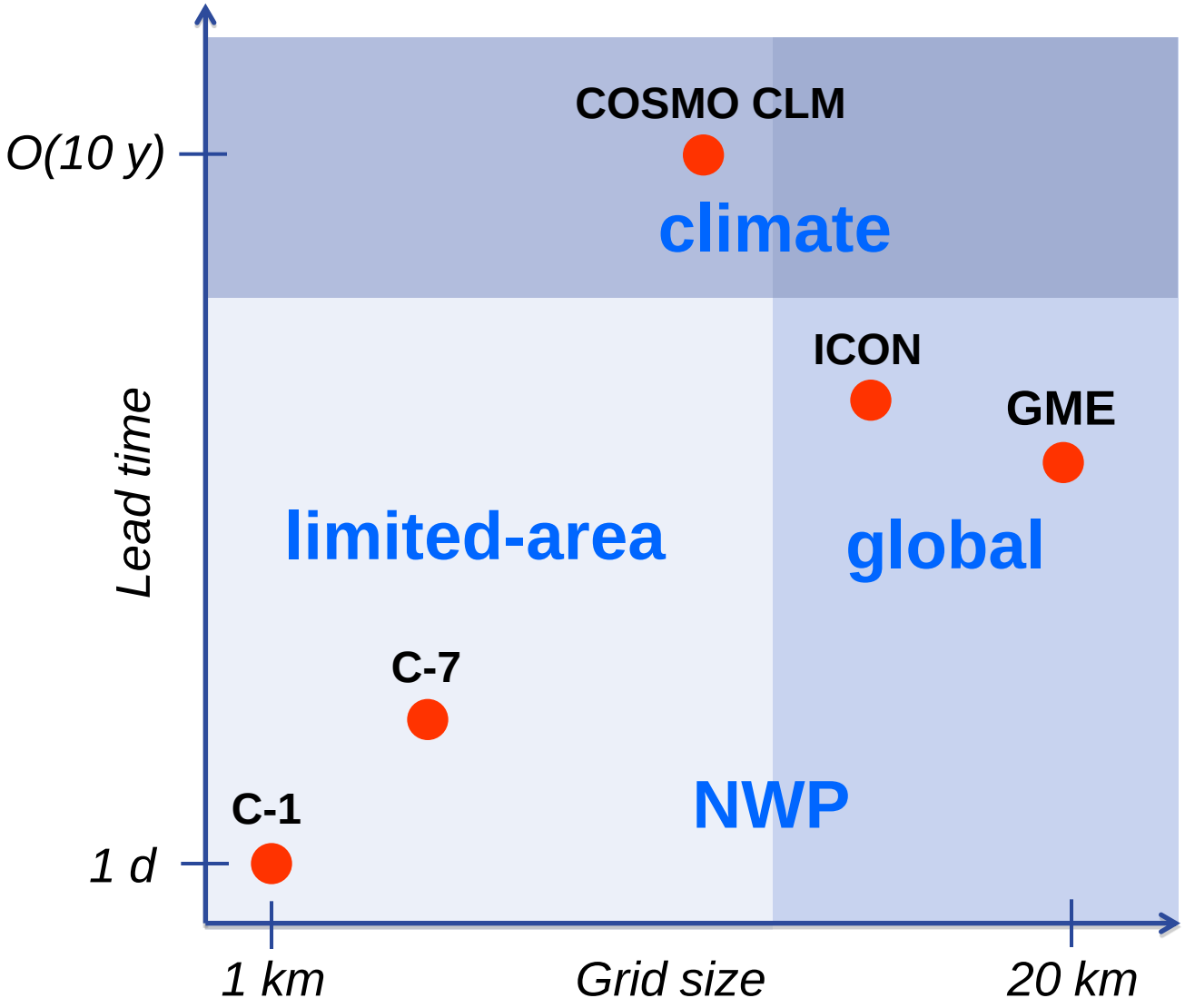
J.Helmert, E.Machulskaya, G.Vogel, D.Mironov

COSMO SVAT Scheme
Current status

- Multiple SVAT schemes are coupled with the COSMO model
  - **TERRA** (Climate and NWP applications)
  - **Community Land Model** 3.5 and 4.0 (Climate applications)
  - **VEG3D** (Climate applications)

- The **reference scheme** is **TERRA**, both for NWP and for climate applications
  - fast multilayer model, direct solution of the heat conduction equation, moisture transport due to hydraulic processes in the soil and effects of transpiration by plants, change of phase of water in the soil
  - no subgrid scale heterogeneities, single layer snow model, no vegetation shading, no dynamic vegetation, no biogeochemistry

COSMO SVAT Scheme
TERRA use



COSMO SVAT Scheme
TERRA or ... ?

- Due to the numerous dependencies between the NWP system and the SVAT model, a **deep understanding** of the capabilities and limitations of the SVAT model is required in the *operational services*.
- TERRA, which was developed at DWD, is running **safely** and **efficiently** since many years **at all scales**.

TERRA is further chosen as basis for COSMO NWP.

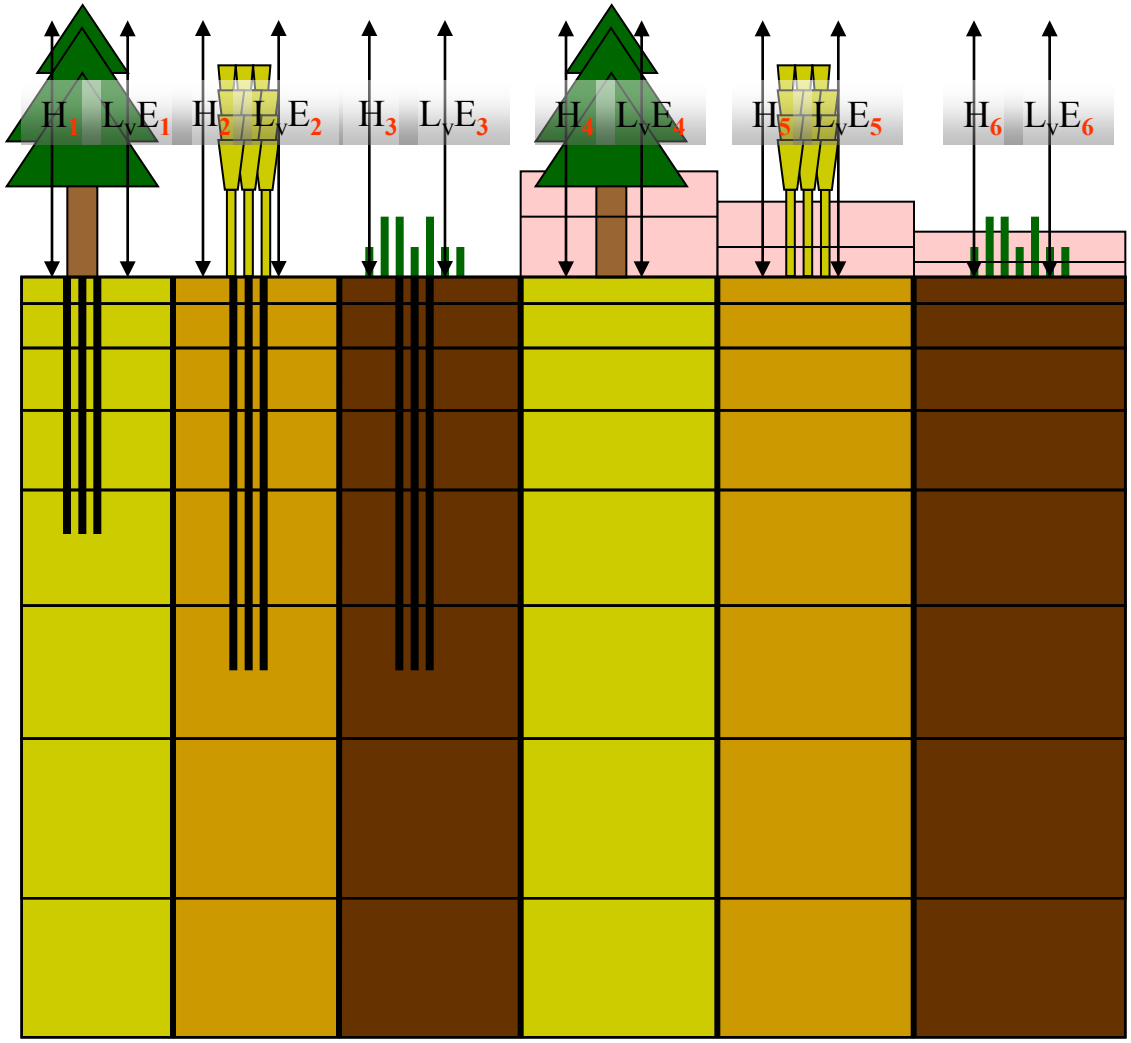
Coupling with other SVAT models supports the further development of TERRA, through intercomparison studies.

COSMO SVAT Scheme
Next steps

- Available soon (already tested)
  - **Multi-layers snow model** (incl. water phase changes in snow pack)
  - Parameterization of **sub-grid scale heterogeneities** (tiles approach)
  - **Mire** parameterization
  - **Urban** parameterization

- Developments priorities for 2014
  - **Vegetation shading** (and revision of ground heat flux)
  - New HWSD based **soil texture** (heterogeneities, pedotransfer functions)
  - Other **external parameters** (topography, land use …)

COSMO SVAT Scheme
Tiles

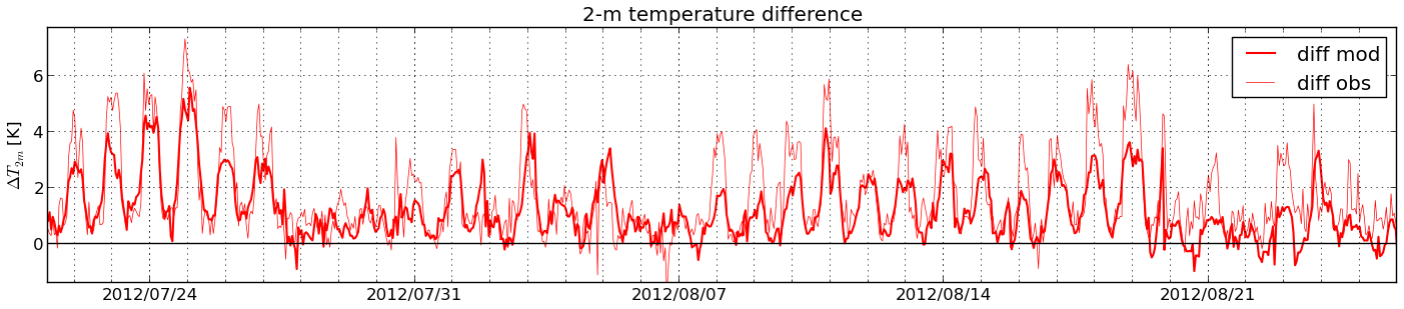


- **Computational efficiency** : variable number of tiles in each grid element
- Support **snow cover** in each type of tile
- Support different **soil textures** in each tile

COSMO SVAT Scheme
Urban *(H.Wouters)*

- **Direct representation of urban land use in TERRA**
  - **Urban land use class** with specific parameters for: albedo, emmisivity, conductivity, heat capacity
  - New **surface-layer transfer coefficients** and **thermal roughness** parameterization
  - **Impervious water storage**
  - **Anthropogenic heat** (climatology)

- Additional **CPU cost** is small
- Temporal and spatial variability of **Urban Heat Island** well reproduced



Soil and surface activities
Long term plan (1/2)

- Improve the treatment of **infiltration**, **interception**, and **run-off** from surface and ground, incl. consideration of ground water table. Possible extension to **stream flow routing.**
- New formulation of the **surface-layer transfer scheme** (in particular vegetation canopy).

- Assimilation of remote sensing soil moisture observations for **SVAT model initialisation.**

- Address the **uncertainties** associated with the **look-up tables.**

Soil and surface activities
Long term plan (2/2)

- Explicit treatment of **snow over sea ice**

- Explicit treatment of **snow over lake ice**
- Include the **abyssal layer** in FLake
- Include effect of **salinity** in FLake
- Collect data on the **optical properties** of lake

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External parameters

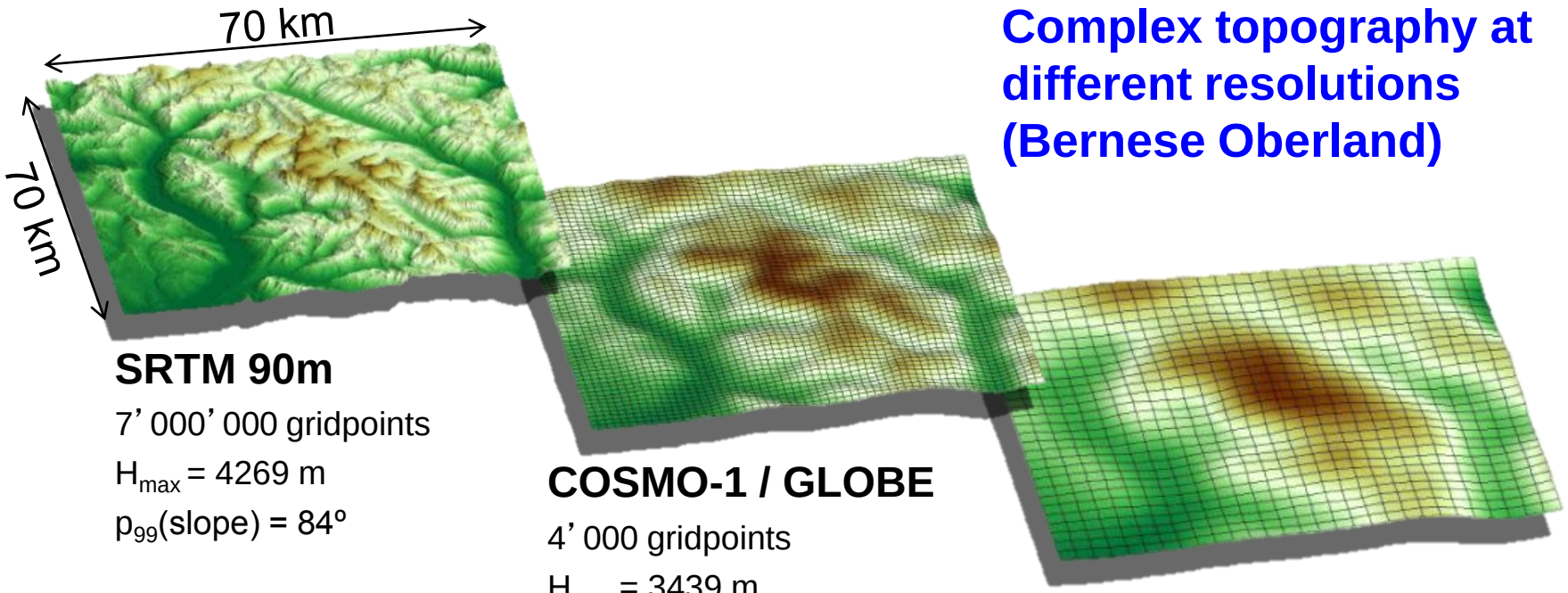
M.Messmer

(see also MeteoSwiss poster)

External parameters
Current developments

- ASTER **topography**
  - in the subdomain [60S, 60N]
  - used to derive sub-grid scale topography effects (z0, SSO, topo corrected radiation at the surface)
- HWSD for **soil texture**
  - and consider also vertically dependent soil texture
- GLOBCOVER for **land use**
- MODIS based background **surface albedo**

External parameters
Topography



Complex topography at different resolutions (Bernese Oberland)

SRTM 90m

7’000’000 gridpoints

H_{max} = 4269 m

p_{99}(slope) = 84°

COSMO-1 / GLOBE

4’000 gridpoints

H_{max} = 3439 m

p_{99}(slope) = 22°

COSMO-2

1’000 gridpoints

H_{max} = 3224 m

p_{99}(slope) = 13°

External parameters
Topography

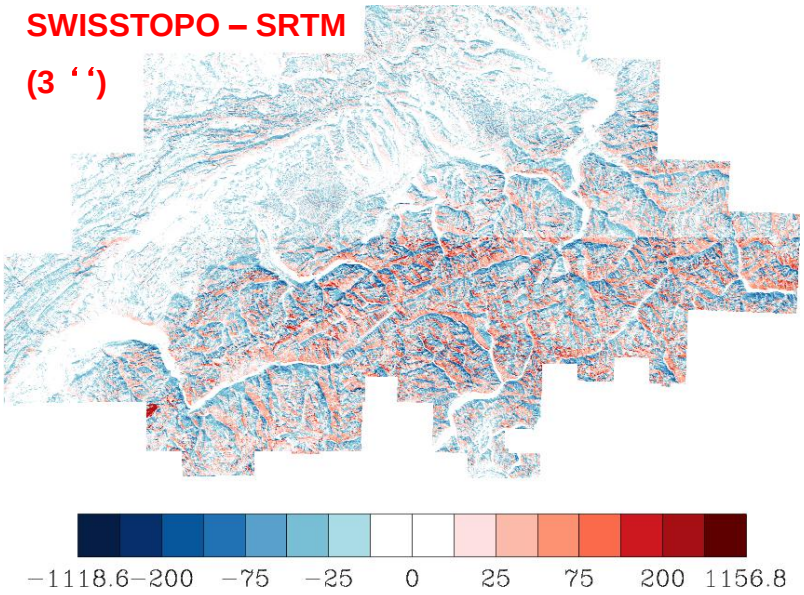
- Data set currently used is **GLOBE**
- Higher resolution digital elevation model (DEM) is needed to derive topography related external parameters for new models.
- Both **SRTM** and **ASTER** are considered. Federal Office of Topography **SWISSTOPO** data are used as reference.

	GLOBE	ASTER	SRTM V4	SWISSTOPO
Resolution	30 arc-sec (~1km)	1 arc-sec (~30m)	3 arc-sec (~90m)	25 meters
Lat range	90° N – 90° S	83° N – 83° S	60° N – 58° S	whole CH
Projection	WGS84	WGS84	WGS84	CH-1903
Method	Patchwork of multiple data	Satellite / stereoscopic IR	Space Shuttle / radar	

External parameters
Topography

SWISSTOPO – SRTM

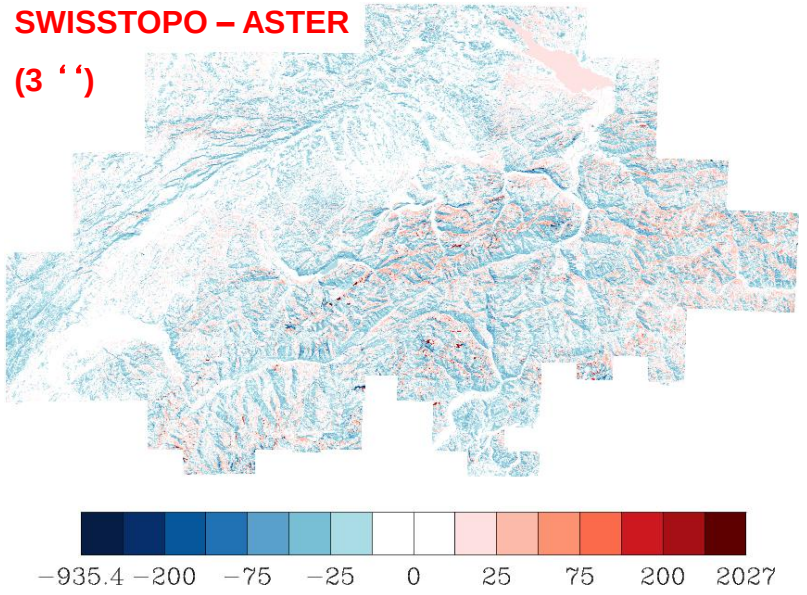
(3 ‘ ‘)



- Good match over flatlands
- Alps exhibit shift, visible as shading

SWISSTOPO – ASTER

(3 ‘ ‘)



- Overall good match
- Isolated spikes over Alps

⟹ **ASTER is more accurate than SRTM over CH Alps**

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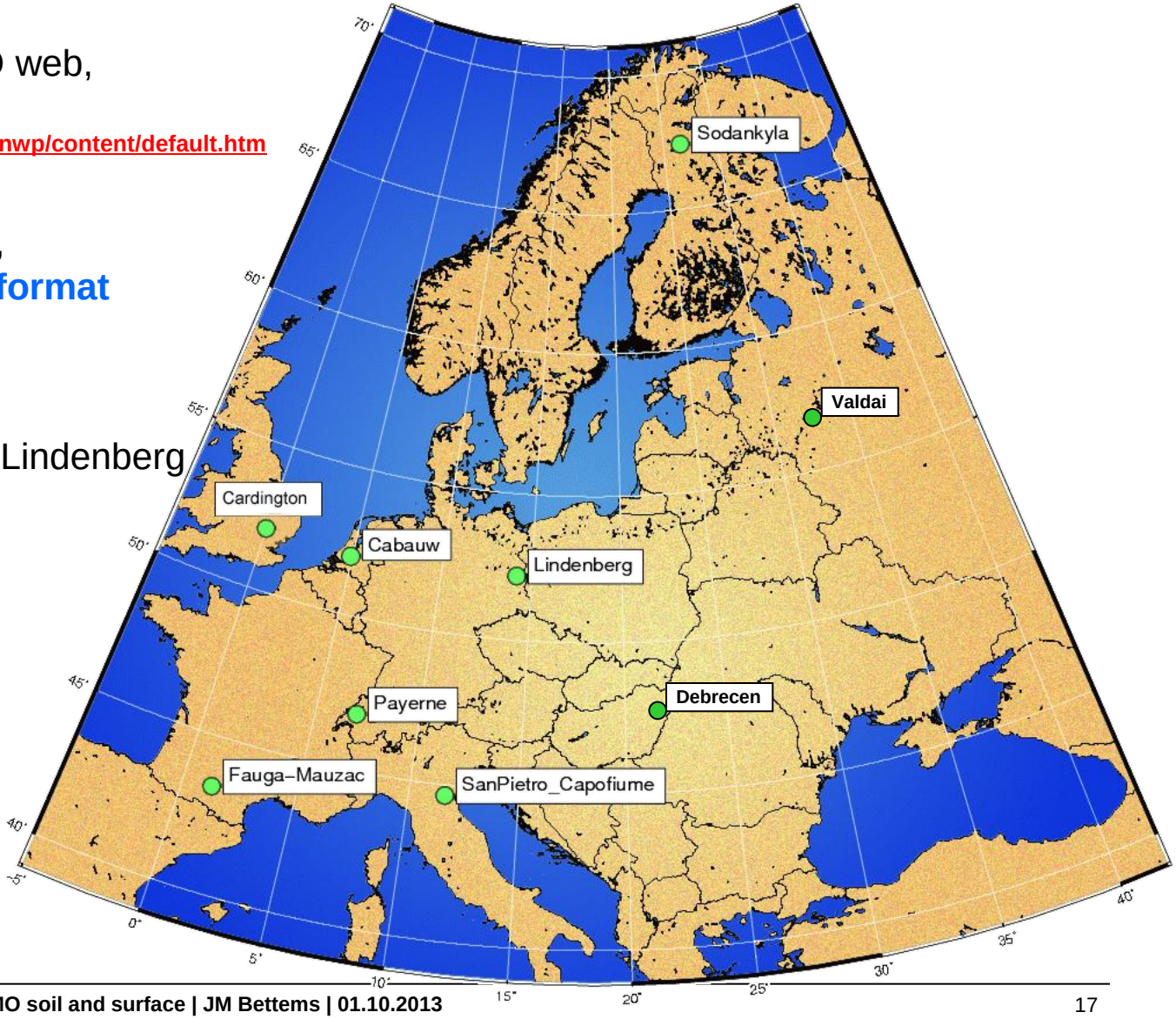
SRNWP data pool

C.Heret

Data pool action

- Access from COSMO web, password protected
  http://www.cosmo-model.org/srnwp/content/default.htm
- Currently **9 sites**, data from **2006-2012**, in a **common ASCII format**
- **Soil**, **surface** and **BL** observations
- Work done at DWD / Lindenberg



Data pool action
Status

- Data availability

Cabauw (NL) :	2006 - 2012
Capofiume (IT) :	2006 - 2012
Lindenberg (DE) :	2006 - 2012
Payerne (CH) :	2006 - 2012
Sodankyla (FI) :	2008 - 2012
Cardington (GB) :	2006 - 11.2011
Fauga-Mauzac (FR) :	2006 - 06.2012
Debrecen (HU) :	2011 only
Valdai (RU) :	work in progress (new station)

- Not all sites have a full set of soil and surface observations!

Data pool action
Outlook

- Work on data availability of **Debrecen** and **Valdai**
- Open data set to the **academic community**
  - SRNWP coordinator will write to the NWS directors

- Motivate observatories to **extend data set** by installing new devices
  - SRNWP data pool can be a good motivation – it occured at MeteoSwiss!

Use these data

Send feedback to srnwp_data_pool@cosmo-model.org
(usage, quality, wishes …)

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Model calibration

O.Bellprat, A.Voudouri

Model calibration
CALMO – A COSMO project (1/2)

Motivation

- NWP/Climate models are subject to **large parameter uncertainty**
- Estimation of parameters presently performed subjectively based on **expert tuning** during model development
- Difficult to **replicate**, **expensive** in terms of human resources
- Hinders implementation of new model developments, and *fair inter-comparison of alternate model components*, due to **error compensation**

Model calibration
CALMO – A COSMO project (2/2)

Main Goals

- **Transparent** parameter estimation which takes parameter interactions into account and follows a pre-defined strategy
- Mainly **automatized** framework for re-calibration after new model developments, resolution changes, or new model domains
- Determine observationally constrained parameter ranges for **perturbed physics** ensembles in EPS systems

Methodology

- Based on a PhD thesis, performed in group of C. Schaer / ETHZ
  „Objective calibration of regional climate models“, Bellprat et al., JGR (2012)

Model calibration
The method (1/3)

Measure of model performance (scalar)

- Choice of observations and model variables
- Choice of a verification score
- Choice of temporal sampling

Model parameters sub-space

- Exact value is not physically known
- Sensitivity of model performance

The **core of the method** is the assumption that the variability of the model performance in the parameter space can be modeled with a quadratic function of the parameters perturbations (**meta-model** , Neelin, 2011)

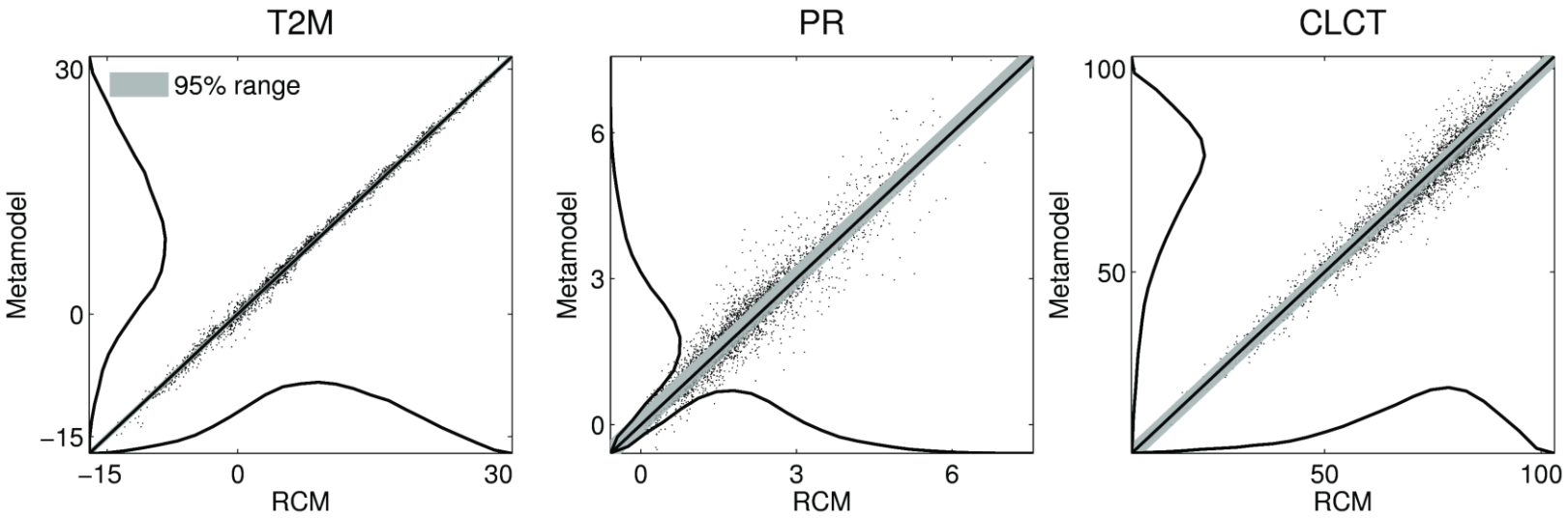
- Fit the meta model in parameter space
- Requires $N^2 + N*(N-1) / 2$ model simulations (e.g. 20 sim. for 5 param.)

Use the meta model to find the **optimum** choice of parameters (cheap!)

Model calibration
The method (2/3)

Meta-model validation (RCM calibration, O.Bellprat)

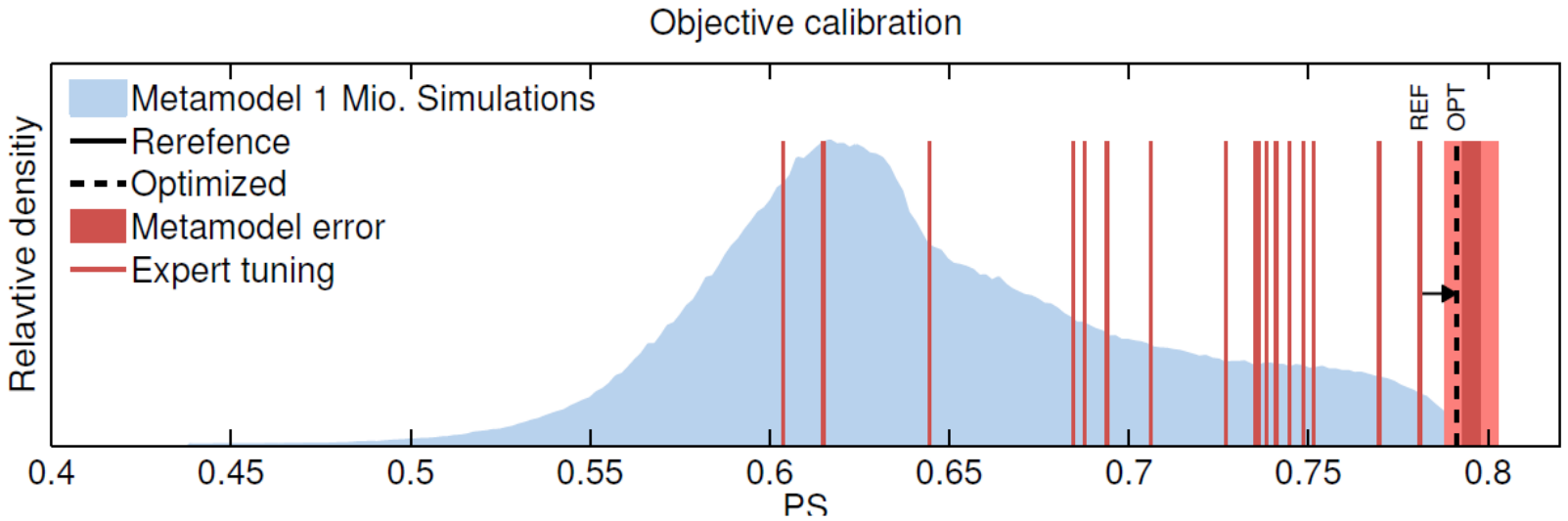
- The **meta-model** predicts the performance of **independent** model simulations with random parameter settings with high accuracy



Model calibration
The method (3/3)

Method validation (RCM calibration, O.Bellprat)

- Objective calibration (OPT black dotted line) **beats** expert tuning (REF red line) by almost 10%



Thank you for your attention!