Status and plans for cooperation with SURFEX between NILU and Met.No

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Thanks to Sam-Erik Walker, Nicolay Korslund, Joan Galve, Met.No & Météo-France

HIRLAM Management Group Meeting, Met.No, 3rd November 2008

Contents

Motivation

Build Land DA capability at NILU:

•Match expertise in Met.No & NILU

•Collaboration with world leaders: Met.No & Meteo-France (SURFEX); Paul Houser, USA (Land DA & modelling); U. Ghent, Belgium (Possibility theory); U. Valencia, Spain (Satellite observations)

•Visits to NILU: Paul Houser (Mar 2008); Pavel Sakov (Jan 2009); Olivier Talagrand (Feb 2009) & more

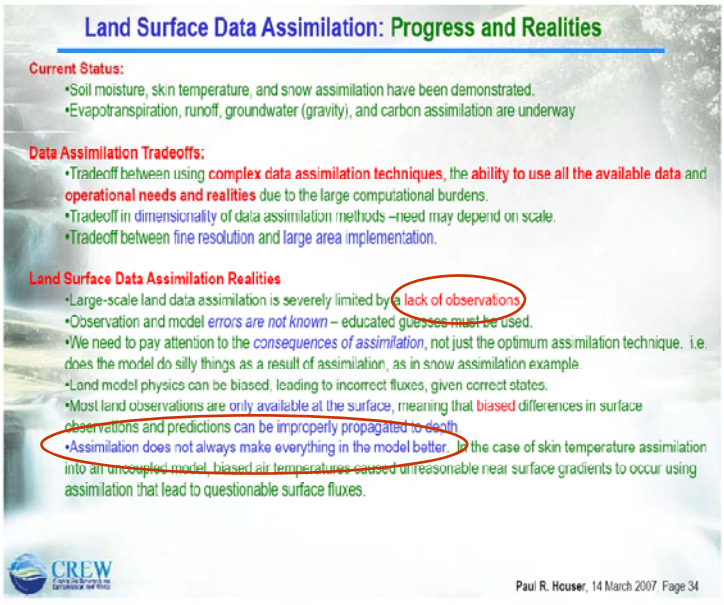
•Build critical mass & capacity

•Have fun and do science!

NILU

www.nilu.no

From Paul Houser:



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Land DA goals

(1) Assimilate variables: land soil temperature (LST), soil moisture, snow
(2) Use DA to produce analyses, evaluate observations & models (e.g. SURFEX land surface parameters if appropriate)

(1) Approach:
   i. Work with NILU DA system (EnKF) + land model (SURFEX/CANARI) from HARMONIE/Met No + satellite observations + novel developments (errors, biases)
   ii. Compare with EKF from Meteo-France (to be received from JFM)
   iii. Consultation with Met.No in future developments in HARMONIE
   iv. CANARI not addressed at NILU now

(2) Outcomes:
   i. Experience at NILU in: using SURFEX (e.g. with HIRLAM forcing data); understanding land/atmos interactions; in land DA with SURFEX -> feeds into
   ii. Improved use of EO
   iii. Improved forecast & modelling capability
   iv. Studies of land/atmosphere system

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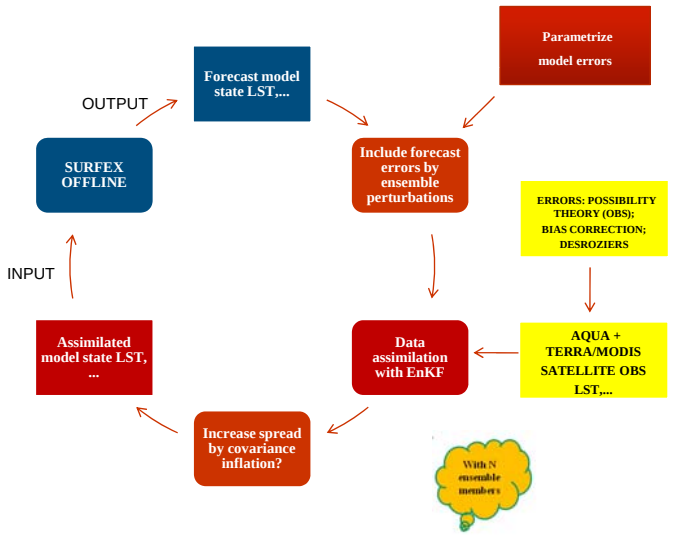
DA scheme

SURFEX ensemble based DA using satellite obs



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DA algorithm:Two recent EnKF versions

- Sakov and Oke: MWR, 2008.
  - An Ensemble Square Root filter (ESRF) using a symmetric Ensemble Transform Matrix (ETM): classical KF - ensemble mean
- Sakov and Oke: Tellus, 2008
  - A Deterministic Ensemble Kalman Filter (DEnKF) using a linear approximation to the Ensemble Square Root Filter (ESRF) update matrix. Better for avoiding ensemble collapse

- These versions of the EnKF have been implemented at NILU using Fortran 90 and BLAS (Basic Linear Algebra Subprograms), Sparse BLAS and LAPACK libraries
- DA code is general & includes matrix-free versions of observation operators
- DA code tested on Lorenz63 model
- To be tested with SURFEX and satellite data

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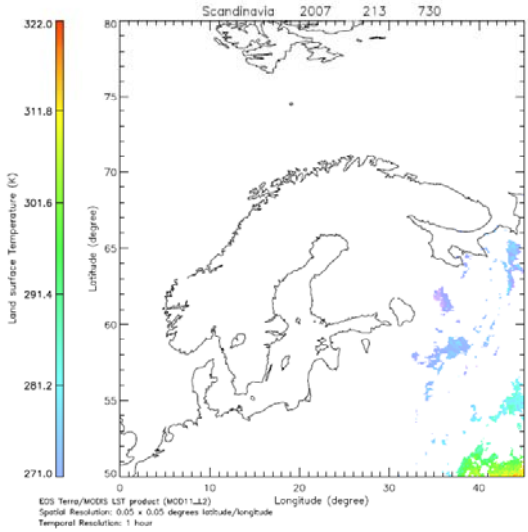
Observations

TERRA-MODIS LST: 1 August 2007, 7.30 am UTC



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Satellite observations

- Using satellite observations of Land surface temperature (LST), snow cover and soil moisture (+errors) over Scandinavia
  - LST from EOS TERRA/MODIS and AQUA/MODIS satellites with 1 km spatial resolution
  - Snow cover from same satellites with 500 m resolution
  - Soil moisture from EOS AQUA/AMSR-E with 25 km resolution
- Currently a DA system is being set up to use these observations together with SURFEX model applying two state-of-the-art EnKFs
  - Ensemble Square Root filter & Deterministic EnKF
  - 1-D assimilation initially (mainly 1-D processes in land)
  - 3-D assimilation later
- Later stage: will compare EKF & EnKF

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SURFEX model

Implementation of the SURFEX model at NILU
Collaboration with Met.No

- Using latest version (v3.0) of off-line SURFEX model from Météo-France
- NILU hardware and software environment: "Ulven" machine
  - HP ProLiant DL360 G5 PC-server with 4 Intel Xeon 3 GHz CPUs with 4 GB RAM and > 1 TB disk space
  - Linux Redhat Enterprise Server 5 Operating System
  - GNU Fortran G95 compiler
- Currently the SURFEX model is set up for part of Scandinavia for the period 31 July – 3 August 2007

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- Atmospheric forcing data from met.no (next slide): files from Met.No (Mariken Holmleid)
  - HIRLAM4 model output in rotated lat-lon grid over part of Scandinavia with 4km resolution in GRIB format
  - Two files h4km_YYYYMMDDHH.grb for each day (with HH = 00 and 12) with analysis data (+0) and forecast data (+6, +12 and +18)
  - Currently only using analysis data
  - As SURFEX model does not support GRIB format we convert files to NetCDF format: gives file FORCING.nc, used by SURFEX
  - HIRLAM4 grid (rotated lat-lon) is currently not supported by SURFEX, so we use a regular lat-lon grid (NILU grid) instead and interpolate the forcing data to this grid

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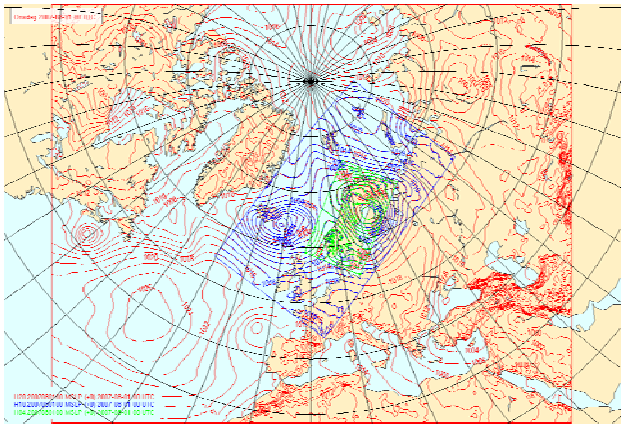

Currently set up to use HIRLAM4 forcing data for innermost (green) HIRLAM grid (4km resolution)

NILU grid is inside green area and has a 4km resolution

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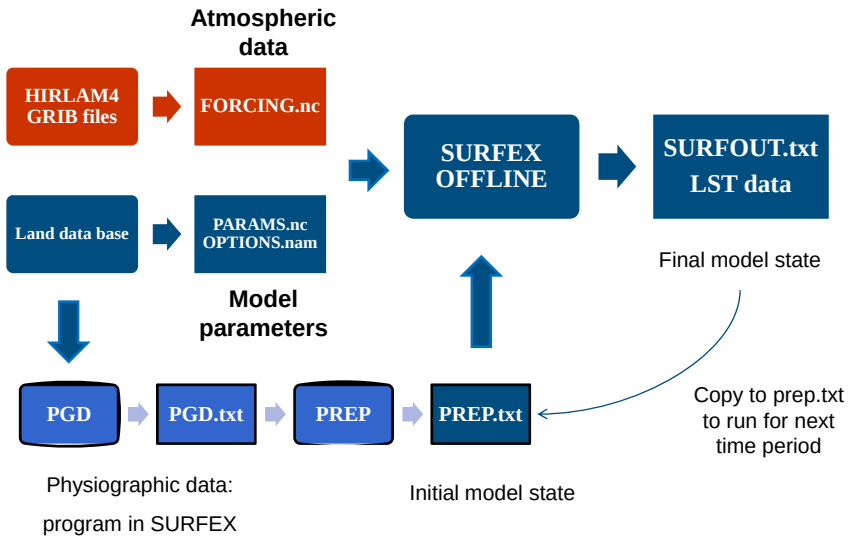
- When running the SURFEX model several files are read and written (See next slide)
  - Initial model state (land surface temperature, soil moisture, snow cover, etc.) is read from an ASCII file PREP.txt
  - Final model state is written to an ASCII file with the same format SURFOUT.txt
  - The model also produces a set of NetCDF files (*.OUT.nc) containing various fields (e.g. LST,...) which can be plotted
  - Model successfully run on a linux platform: email to Met.No Aug 2008
  - Now implementing and testing SURFEX model on "Ulven" machine at NILU

SURFEX model data flow (no DA)



Actions

•Couple SURFEX to DA scheme and satellite observations

•NILU hope to use HIRLAM tools & benefit from developments (e.g. plotting software, rotated grid, formats,...) – to discuss 5 November

•Building resources at NILU: several proposals submitted & planned; involvement of Met.No

•Proposal to ISSI for a workshop in Land DA (2009 timeframe), led by NILU/Met.No – outcome to include a book (standard for workshops at ISSI)

•Visits: P. Sakov, O. Talagrand,...

Outlook

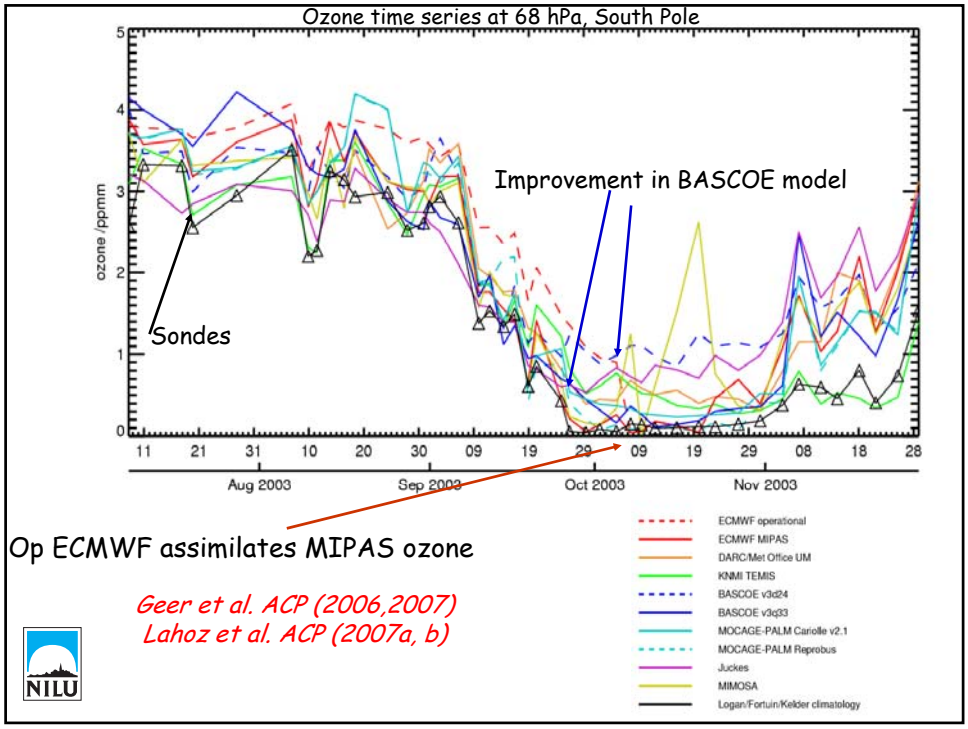
•Confront models with observations (extend ideas from NWP)
•Exciting & important problem scientifically with lots of benefits

•Interest to NWP
- •Better use of observations affected by the land
- •Better initial conditions for 2-week to seasonal forecasts

•Interest to climate modellers
- •Better land surface schemes
- •Better climate models
- •Better set up/design of experiments
- •Better understanding of performance of climate models

•General interest to land/atmosphere scientists

Build on general ideas beyond NWP, e.g. chemical DA (see next slide):
Geer et al. ACP (2006,2007); Lahoz et al. ACP (2007a,b)



Geer et al. ACP (2006,2007)
Lahoz et al. ACP (2007a, b)