The impact of snow microphysics on the simulation of the ABL and snowdrift over polar ice sheets

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The IGLOS campaign 2002 at Summit (Greenland)

Investigation of the Greenland boundary Layer Over Summit
Experiment, 29 June - 25 July 2002
Research aircraft "Polar2" based in Kangerlussuaq (West Greenland)

SUMMIT station (3250m)

Surface conditions at SUMMIT are very homogenous, similar to the Antarctic plateau

ETH 50m tower
- Temperature, humidity, wind at 8 levels
- Turbulence at 4 levels
- Incoming and outgoing radiation fluxes at 4 levels

Simulations: non-hydrostatic mesoscale model LM

Improvement of the representation of snow properties in the LM of the German Meteorological Service
**Important physical processes in snowpack modelling**

Barthel and Lehning (2002)

**Snow microphysics model SNOWPACK** (SLF, Lehning et al. 2002)

Snow is treated as a three component system (ice, air, water), finite element, Lagrangian model

Simulation of snow microphysics:
- Intergranular bonding, grain size, dendricity, sphericity
- Computation of heat conductivity, albedo, snow drift, ...
- as a function of the snow microphysics

**Input:**
- meteorological data (T, RH, ff, radiation, clouds)
- initial snow profile

**SNOWPACK simulations driven with PARCA**

Swiss camp May- Sept. 2002

Lagrangian snow model: every snowfall or hoar frost event creates a new model layer

IGLOS: initial snow profile from Summit, 14 layers

**Comparison LM with radiosondes at Summit 3-12 July 2002**

48h forecast runs, day 2 used for comparison

28 soundings

**Comparison (LM-OBS) with 50m tower at Summit 3-12 July 2002**

1h data

**Case study 10 July 2002**

Kopp = coupled
**Snowdrift**

Lagrangian saltation model: solves the momentum equations for particles

Snow drift $S$: mass of snow in the air (suspension and saltation)

Comparison of snow drift parameterizations with LMS/SNOWPACK: SWISS Camp

Snow drift $S$: mass of snow in the air (suspension and saltation)

Comparison of snow drift parameterizations with LMS/SNOWPACK: Humboldt

Snow drift $S$

\[ \text{Acc} = - \nabla \cdot (\vec{v}_H S) \]

10d accumulation by snow drift (kg/m²)

LM14+SNOWPACK 3-12 July 2002

Hebbinghaus and Heinemann (2006)

Ratio snow drift/sublimation

LM14+SNOWPACK 3-12 July 2002
Conclusions

LM/SNOWPACK

Largest effect for new snow and melting
Snow drift is overestimated by snow drift parameterizations

Full coupling:
better representation of the SBL
decrease in snow drift (data for verification needed)

Computing time (32 node LINUX cluster, 16 CPUs used):
Uncoupled: 2h CPU for 48h forecast
Coupled: 100h CPU for 48h forecast

Publications

Peer reviewed

Non-reviewed