



# **Finnish Activities and Plans in the Antarctic sea ice zone**

Timo Vihma

with contributions from Petteri Uotila, Achim Stössel, Esa-Matti Tastula,  
Teresa Valkonen, Jouko Launiainen, Milla Johansson

## Objectives:

- to better understand the interactive physical processes in the Antarctic climate system
- to improve NWP and climate models

## Main international collaborators:

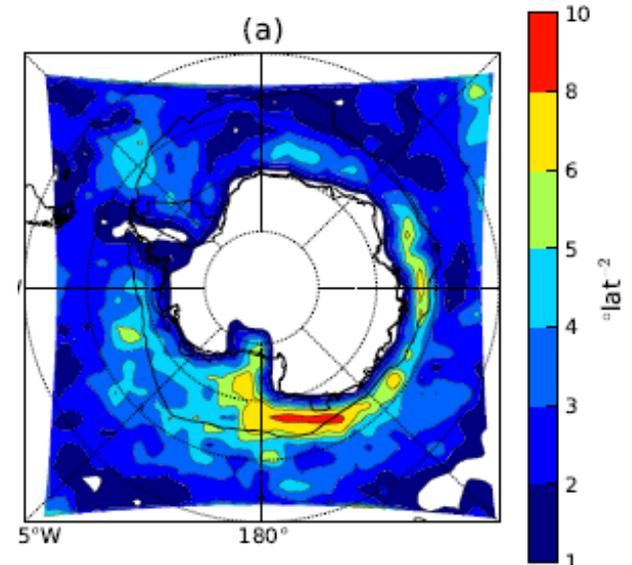
AWI, BAS, CSIRO, Texas A & M University, Brown University, Ohio State Univ.



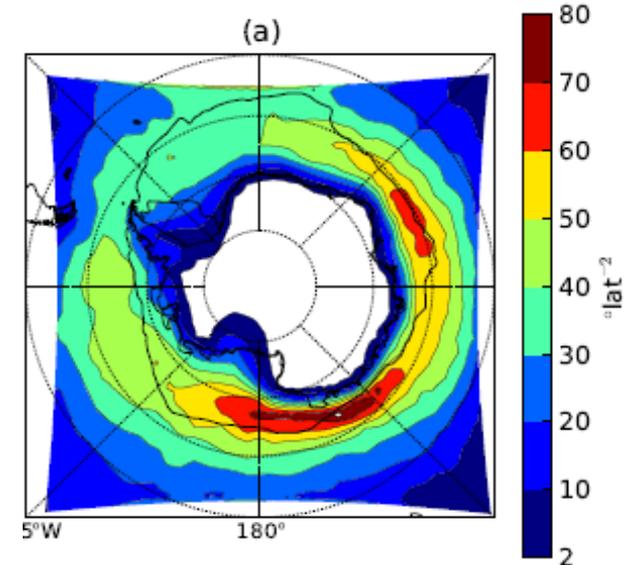
## Interaction of cyclones and sea ice (Uotila et al., 2011, JGR)

- 17 000 cyclones in 2001-2009 analysed on the basis of AMPS archive
- large cyclones control the atmosphere-ocean heat exchange, but the heat exchange and surface properties control the strength of small cyclones

Occurrence of  
small cyclones  
(diameter <  
1000 km)



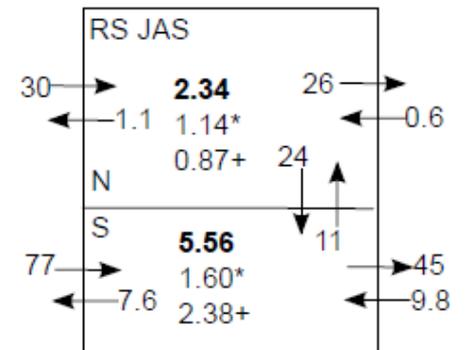
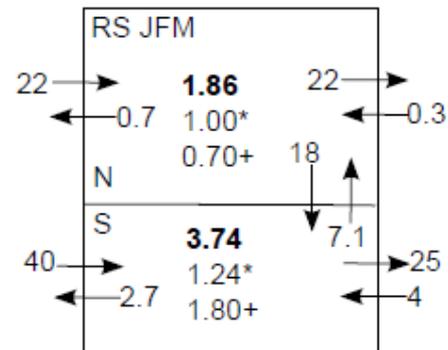
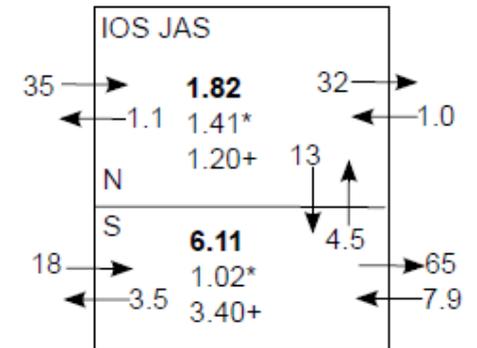
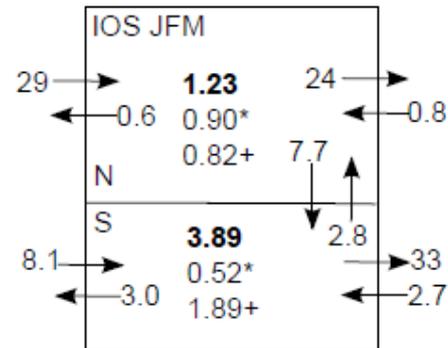
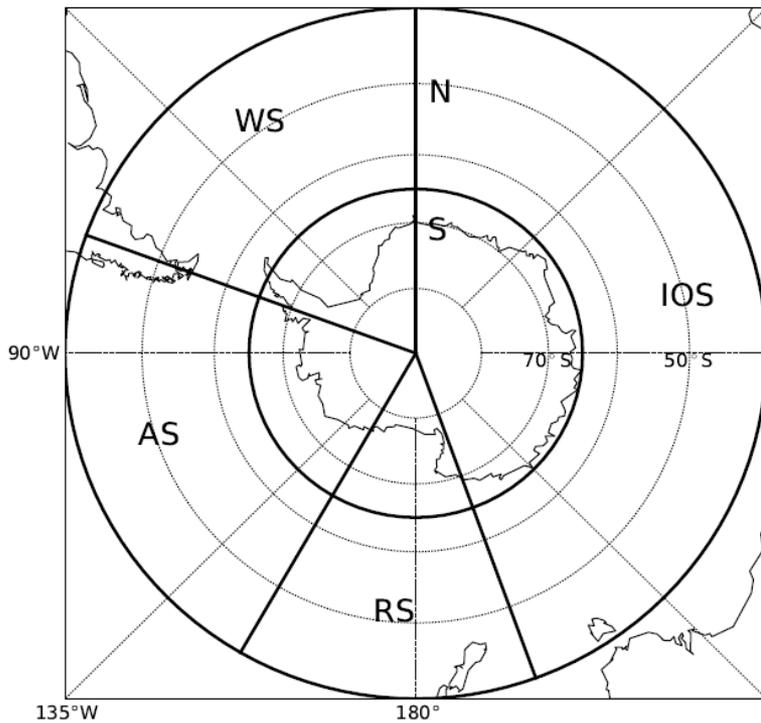
Occurrence of  
large cyclones  
(> 1000 km)





## The Antarctic cyclonicity budget and large scale atmospheric circulation

Uotila, Vihma, Tsukernik





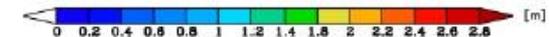
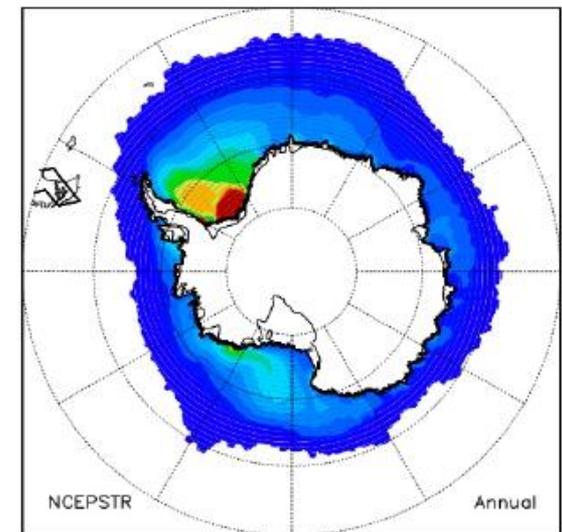
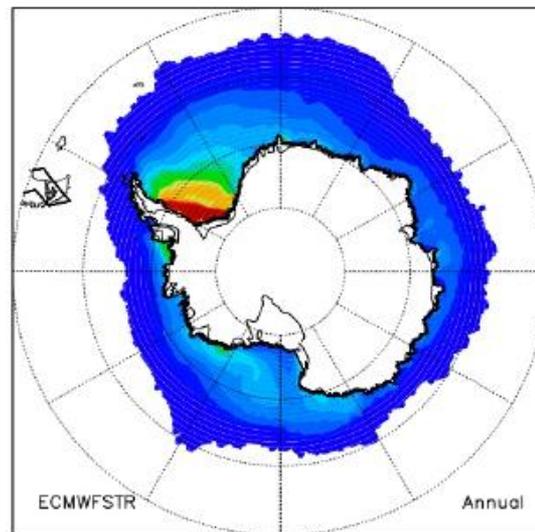
## Atmospheric forcing on large-scale ocean and sea ice models

Parameterization of wind stress over heterogeneous sea ice (Stössel et al., 2008, JGR)  
- In long integrations (1000 years), the parameterization method applied affects ocean salinity, temperature, deep convection, and formation of Antarctic Bottom Water.

Effects of presentation of continental orography on sea ice modelling

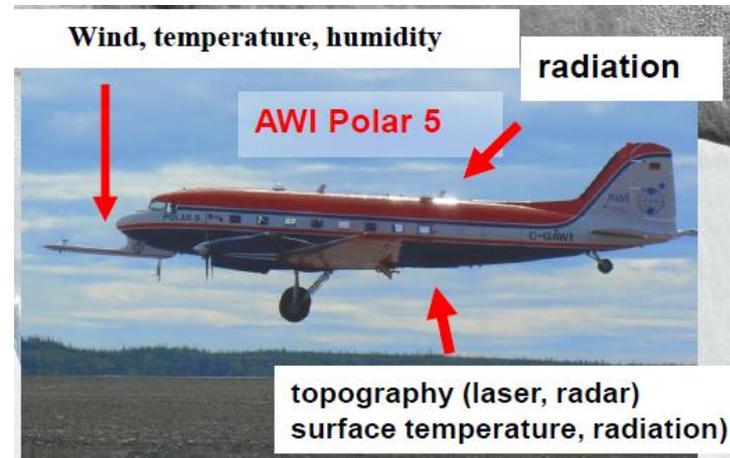
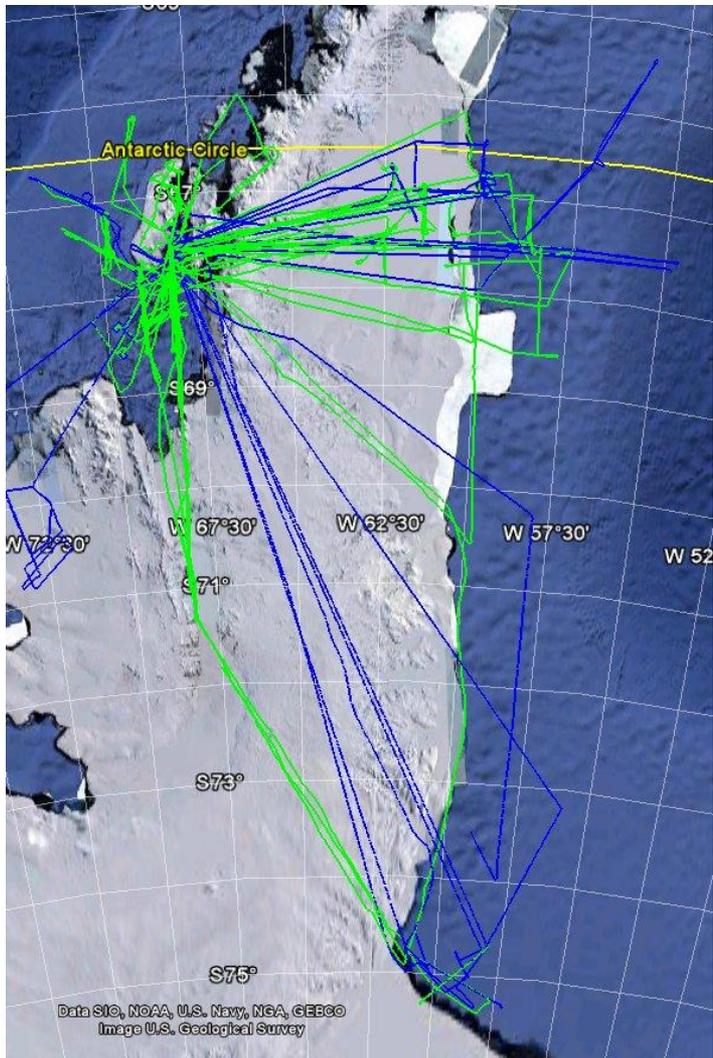
(Stössel et al., 2011, JGR)

Ongoing: AMPS –  
ECMWF comparisons:  
effects on sea ice  
concentration and  
thickness in the Weddell  
Sea



# Joint Airborne Study of the Peninsula Region: JASPER

In February – March 2010, aircraft measurements were carried out by BAS, AWI and FMI over the Weddell and Bellingshausen Seas. The focus was on meteorology, but the data also include sea ice concentration, surface temperature, as well radiative and turbulent fluxes at low altitude.



## Studies:

- boundary-layer processes over Ronne Polynya; observations and modelling: **talk on Monday**
- reanalysis validation: **talk on Tuesday**
- cloud-radiation-turbulence interaction
- clear-sky radiative fluxes over sea ice and ice shelves
- large-scale heterogeneity and effective albedo: observations and modelling



# Surface energy budget over sea ice in early summer (ISPOL)

(Vihma et al., 2009, JGR)

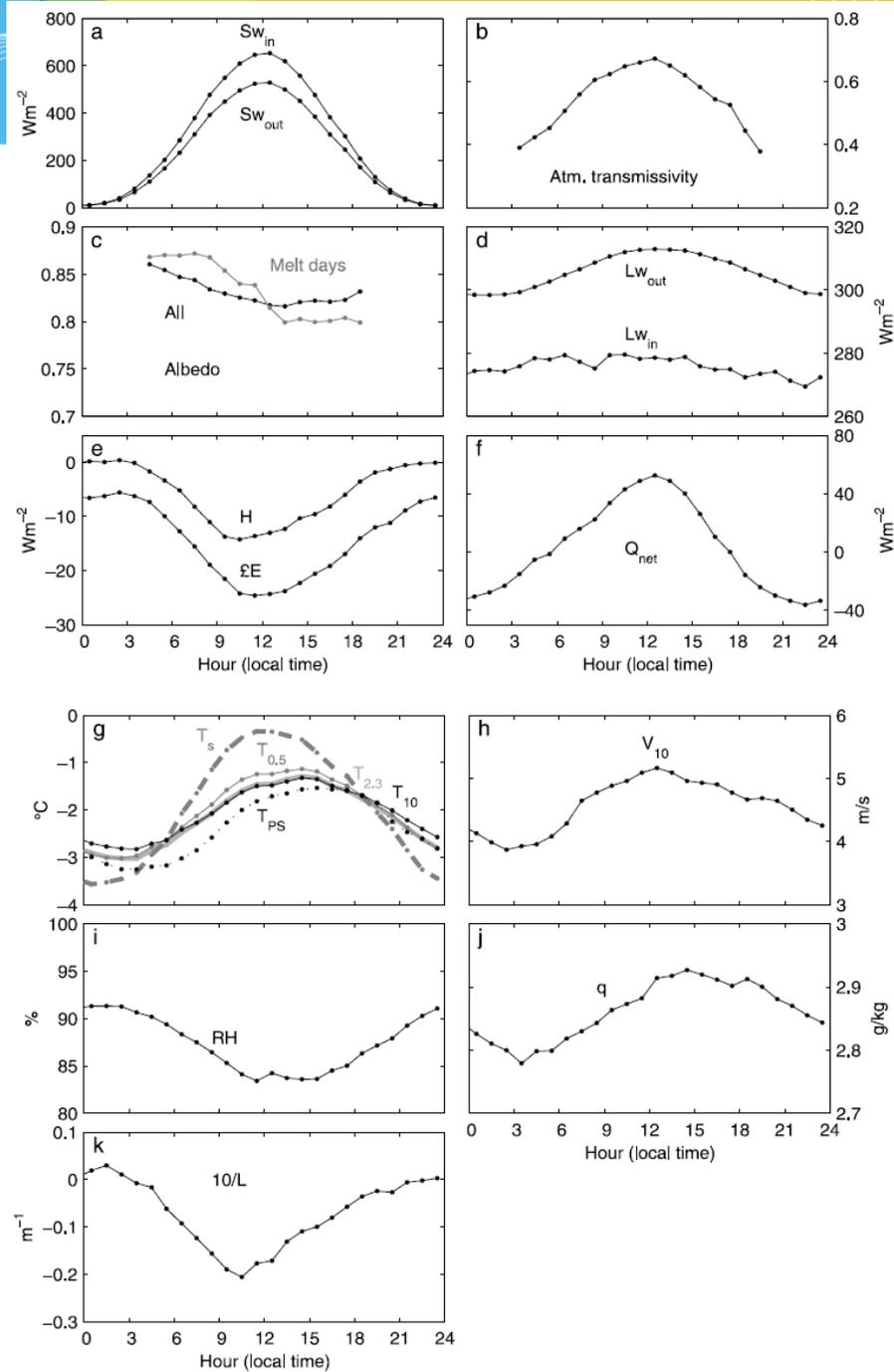
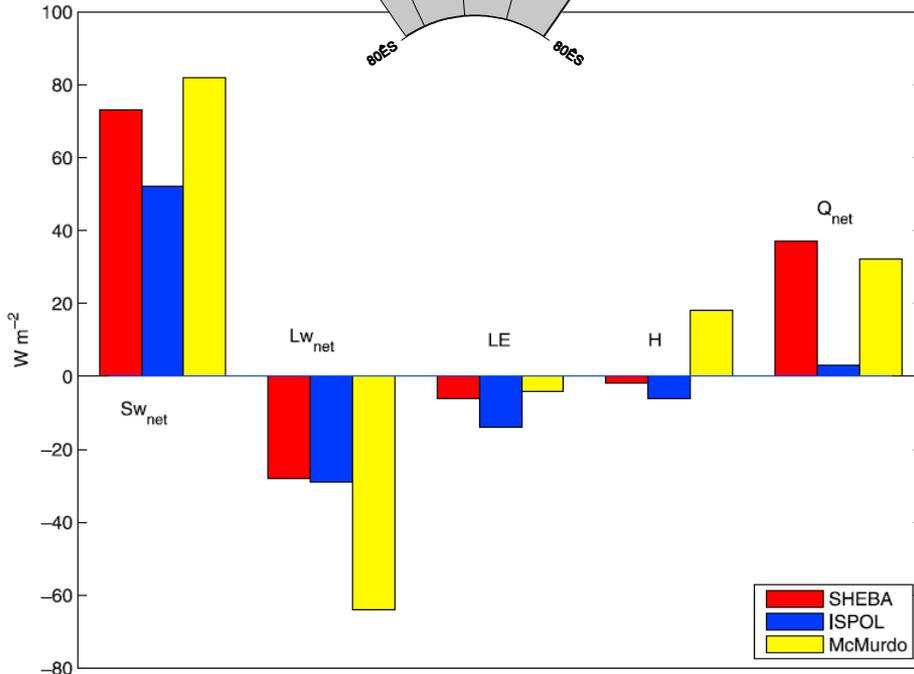
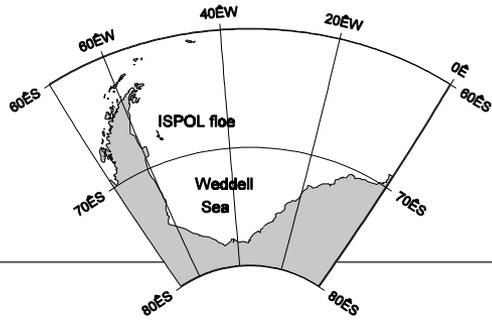


Figure 11. Mean surface fluxes at SHEBA in June 1998 (red), at ISPOL (blue), and at McMurdo Sound on 28–31 December 2000 (yellow [Wendler et al., 2005, Table 3]).



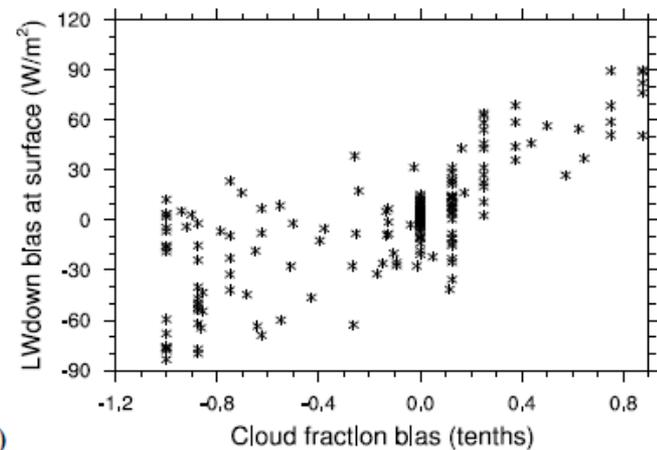
## Modelling of the ISPOL period

Valkonen, Vihma, Johansson, Launiainen:  
Atmosphere - sea ice interaction in early  
summer in the Antarctic: evaluation and  
challenges of the Polar WRF model, to be  
submitted in summer 2012

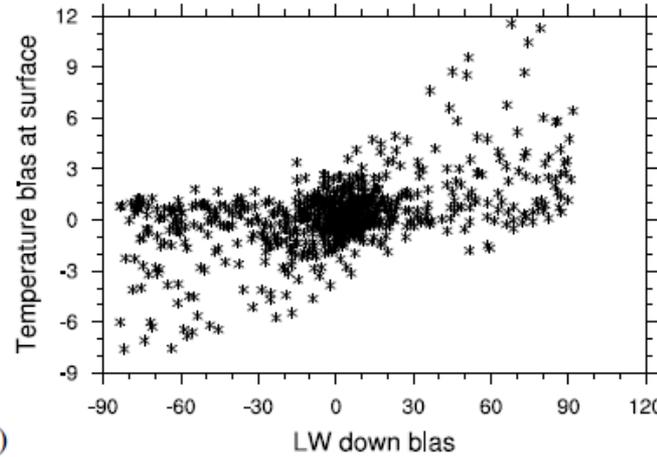
Major challenges:

Modelling of clouds: errors results in errors in  $T_s$

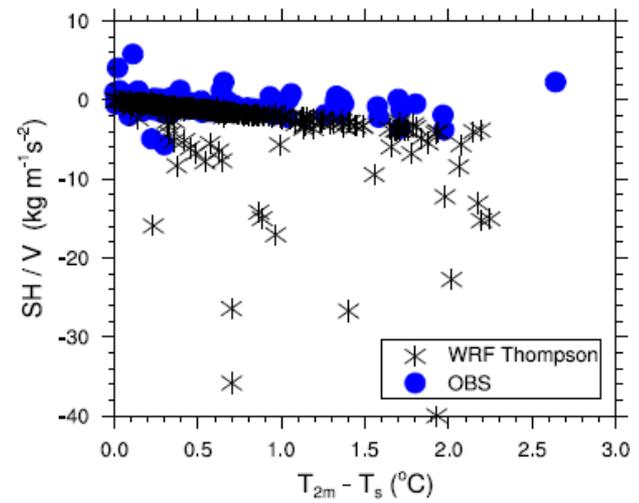
Too much turbulent mixing



(a)



(b)





## Modelling of the ISW 1992 period

Tastula, Vihma, Andreas: **Evaluation of Polar WRF from Modeling the Atmospheric Boundary Layer over Antarctic Sea Ice in Autumn and Winter**, Mon. Wea. Rev, in press

- Surprisingly good results for  $T_s$  (bias 0-2 K)
- Largest challenges with low-level jets → further affect surface turbulent fluxes

Tastula, Vihma, Andreas, Galperin: **Validation of the diurnal cycles in atmospheric reanalyses over Antarctic sea ice**, to be submitted in GRL in summer 2012.

- great variability in the diurnal cycles of surface fluxes given by different reanalyses
- for near-surface temperature, specific humidity and wind speed, the diurnal cycles are more alike
- failure to capture diurnal cycle in cloud cover fraction leads to errors in other cycles
- the diurnal cycles by NCEP-CFSR are found to have shapes and ranges closest to those observed



## Recently started studies

1. Cyclone effects on moisture transport
2. Links between Arctic and Antarctic sea ice conditions
3. Surface energy balance on Larsen and Wilkins Ice Shelves
4. GEWEX Atmospheric Boundary Layer Study, 4th Experiment (GABLS4)

# Participation in Polarstern Winter Weddell Sea Cruise, Jan – Aug 2013

## Small Unmanned Meteorological Observer (SUMO)



## Quadrocopter



Ice mass balance buoys?



## Publications in 2011-2012

Stössel, A., Z. Zhang, and T. Vihma (2011), The effect of alternative real-time wind forcing on Southern Ocean sea ice simulations, *J. Geophys. Res.*, 116, C11021, doi:10.1029/2011JC007328.

Tastula, E.-M., and T. Vihma (2011). WRF model experiments on the Antarctic atmosphere in winter. *Mon. Wea. Rev.*, 139, 1279-1291, doi:10.1175/2010MWR3478.1

Tastula, E.-M., T. Vihma, and E. L. Andreas (2012), Modeling of the Atmospheric Boundary Layer over Antarctic Sea Ice in Autumn and Winter, *Mon. Wea. Rev.*, in press.

Uotila, P., T. Vihma, A. B. Pezza, I. Simmonds, K. Keay, and A. H. Lynch (2011), Relationships between Antarctic cyclones and surface conditions as derived from high-resolution numerical weather prediction data, *J. Geophys. Res.*, 116, D07109, doi:10.1029/2010JD015358.

Vihma, T. (2011). Atmosphere-snow/ice interactions. In: V.P. Singh, P. Singh, U.K. Haritashya (Eds.): *Encyclopedia of snow, ice and glaciers*. Springer, Dordrecht, The Netherlands, p. 66-75.

Vihma, T., E. Tuovinen, and H. Savijärvi (2011), Interaction of katabatic winds and near-surface temperatures in the Antarctic, *J. Geophys. Res.*, 116, D21119, doi:10.1029/2010JD014917.

Vihma, T., O.-P. Mattila, R. Pirazzini, and M. M. Johansson. (2011). Spatial and temporal variability in summer snow pack in Dronning Maud Land, Antarctica. *The Cryosphere.*, 5, 187–201, doi:10.5194/tc-5-187-2011.