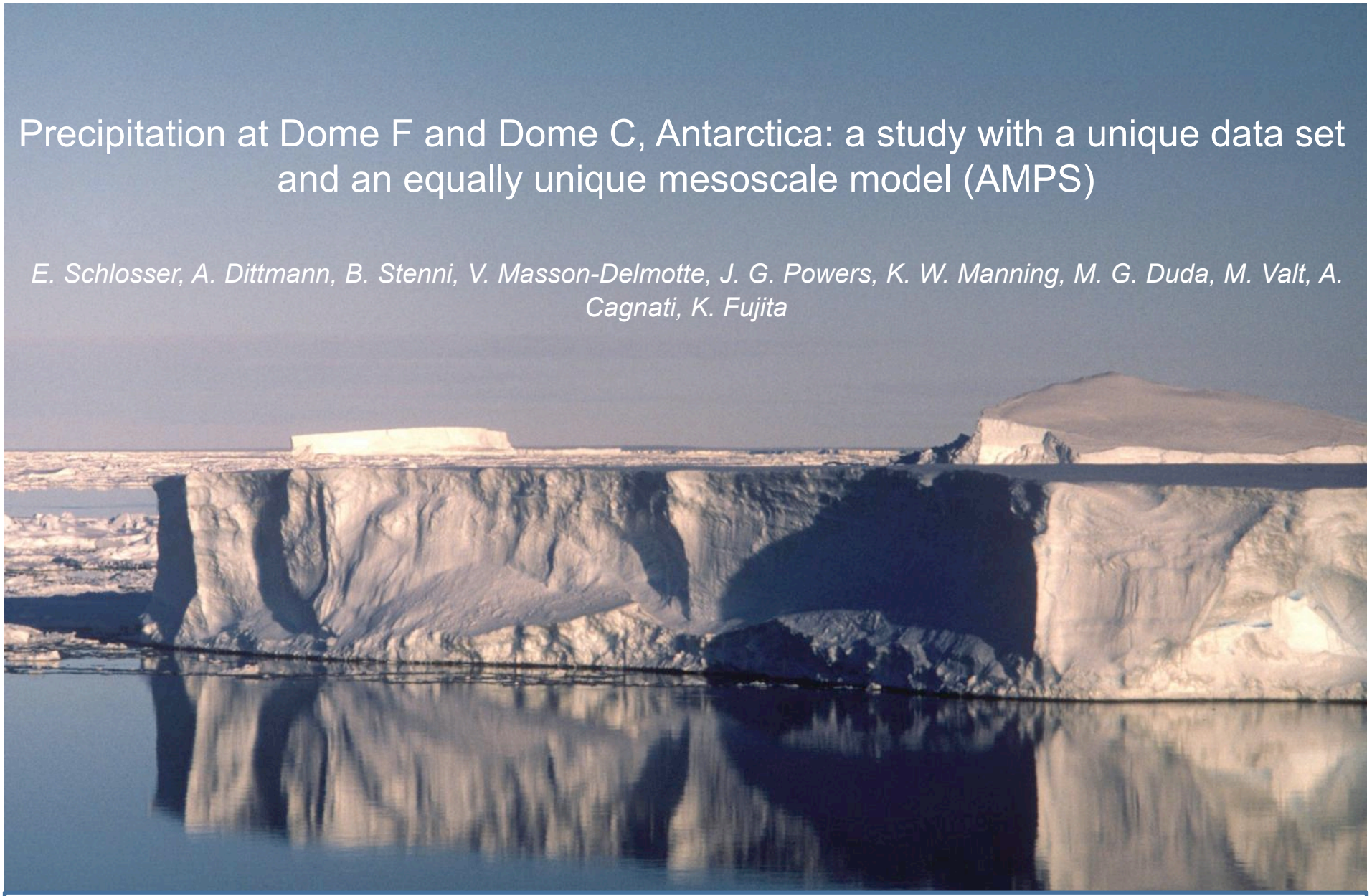
Precipitation at Dome F and Dome C, Antarctica: a study with a unique data set and an equally unique mesoscale model (AMPS)

E. Schlosser, A. Dittmann, B. Stenni, V. Masson-Delmotte, J. G. Powers, K. W. Manning, M. G. Duda, M. Valt, A. Cagnati, K. Fujita



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Motivation

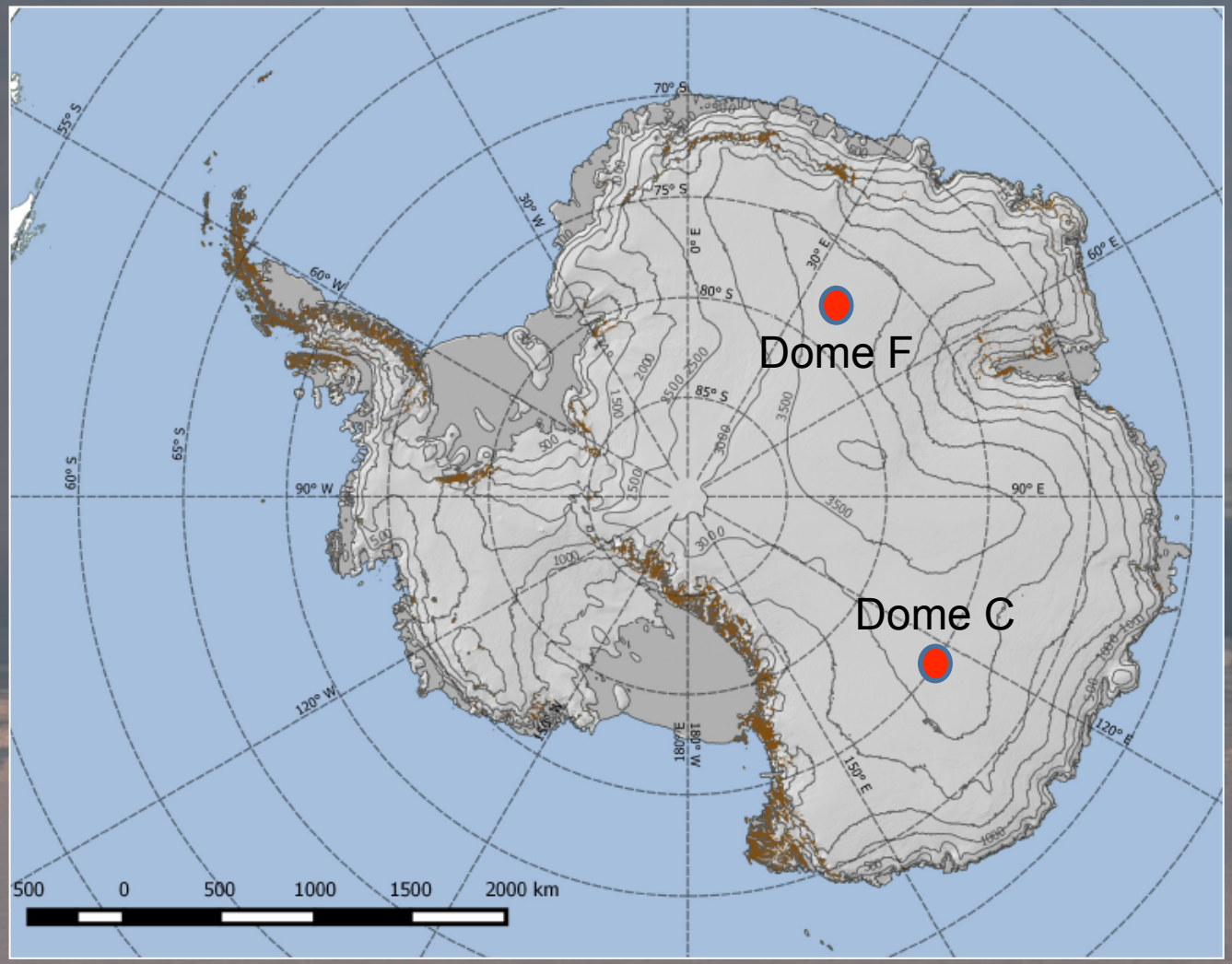
- Correct interpretation of stable water isotopes in ice cores
- Understanding of synoptic processes that lead to precipitation
- Determination of oceanic moisture sources and transport ways

Precipitation data: Dome C: 2006 – ongoing

Dome Fuji: 2003 only

(Stable isotope ratios for all samples)

Study sites: Dome Fuji, Dome Concordia



Dome F:

Japanese deep drilling site

Dome C:

European deep drilling site
French-Italian wintering base

Precipitation at deep drilling site: Dome C (3233m / T_{ann}= -55°C)

Data

Since 2006: precipitation measurements (!), only multi-year time series at a deep drilling site

- precipitation amounts
- crystal analysis (diamont dust, drift snow, synoptic precipitation)
- stable isotope ratios, incl. $\delta^{17}O$ excess

  (O16: O17: O18 = 99.76% : 0.04% : 0.20%)
- meteorological data (incl. radiosondes)

(courtesy: B. Stenni)

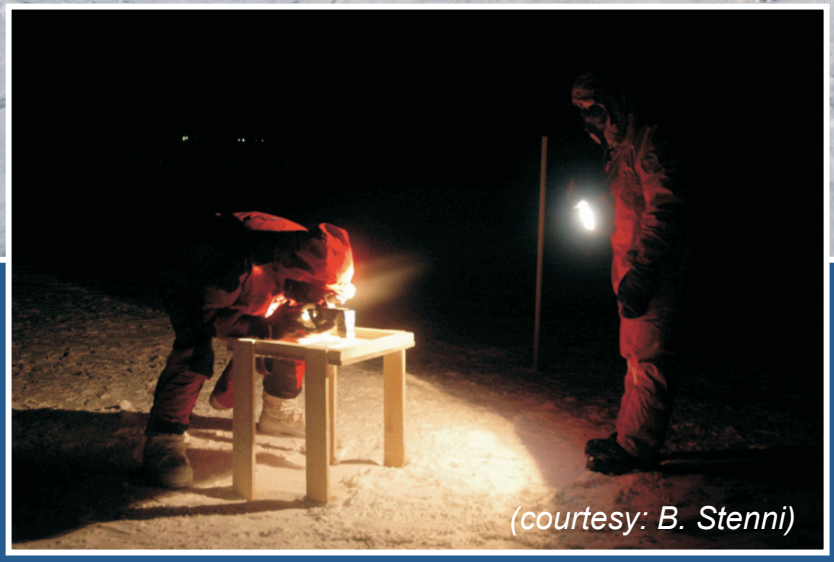
Precipitation at deep drilling site: Dome C / Dome F

Methods:

- Investigation of moisture sources + transport and precipitation mechanisms
- Analysis of synoptic situation
- Back-trajectory calculation
- Modeling of stable isotopes with MCIM (Mixed Cloud
- Combination of MCIM with trajectory study

(courtesy: B. Stenni)

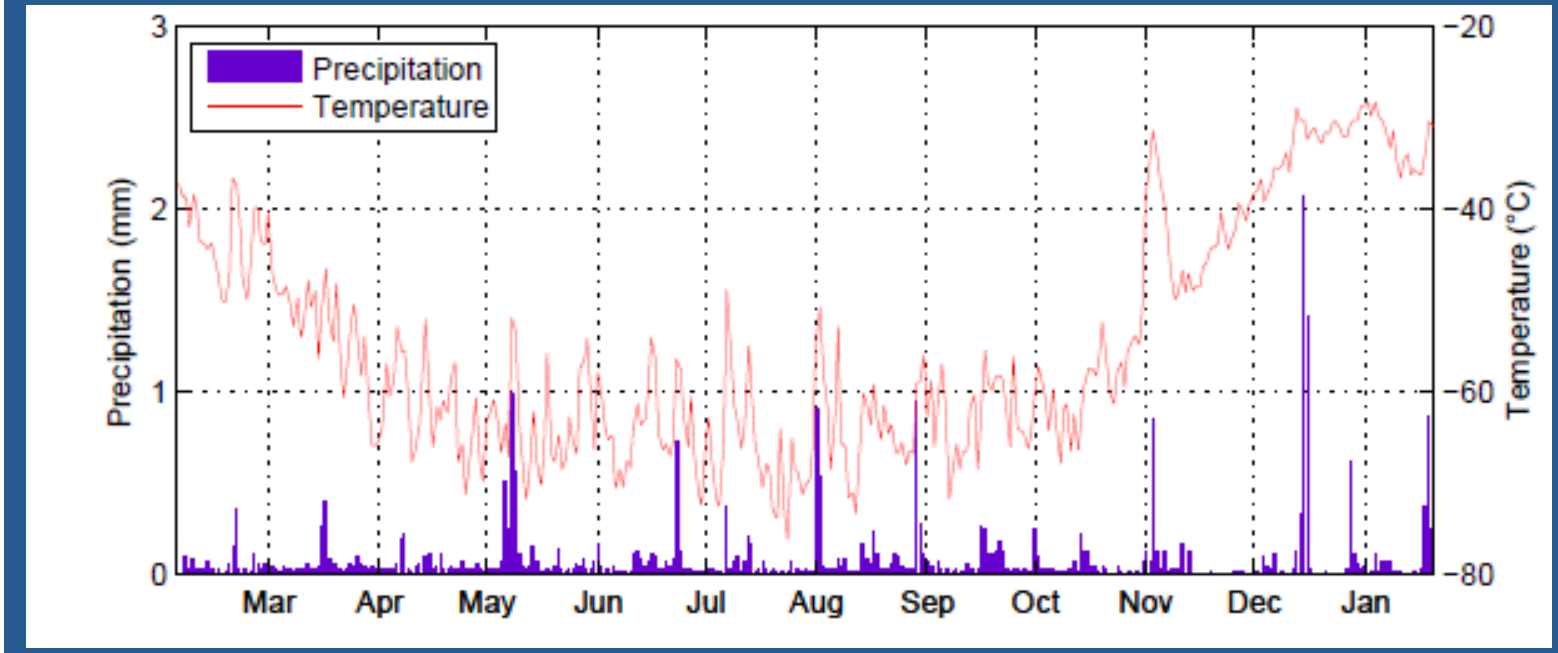
Precipitation measurements



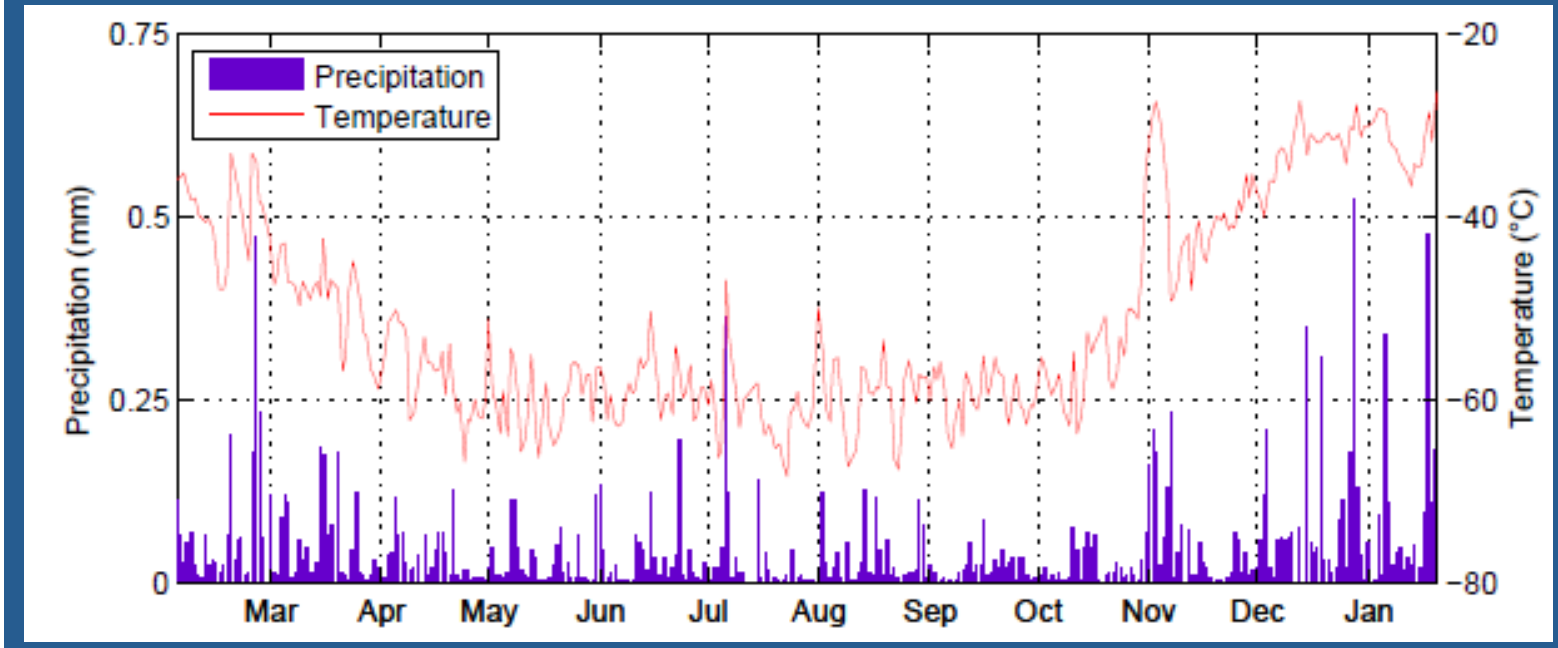
Daily snow deposition samples collected at 1 m height

- avoid drifting surface snow
- photos of crystals for analysis at Avalanche Institute in Arabba, Italy

Dome Fuji



observations

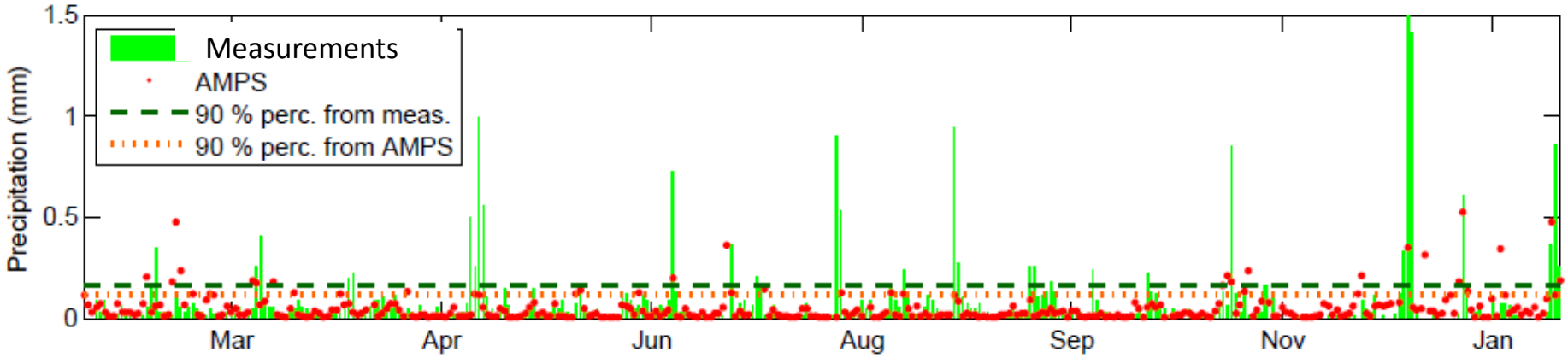


Note different precip scale!

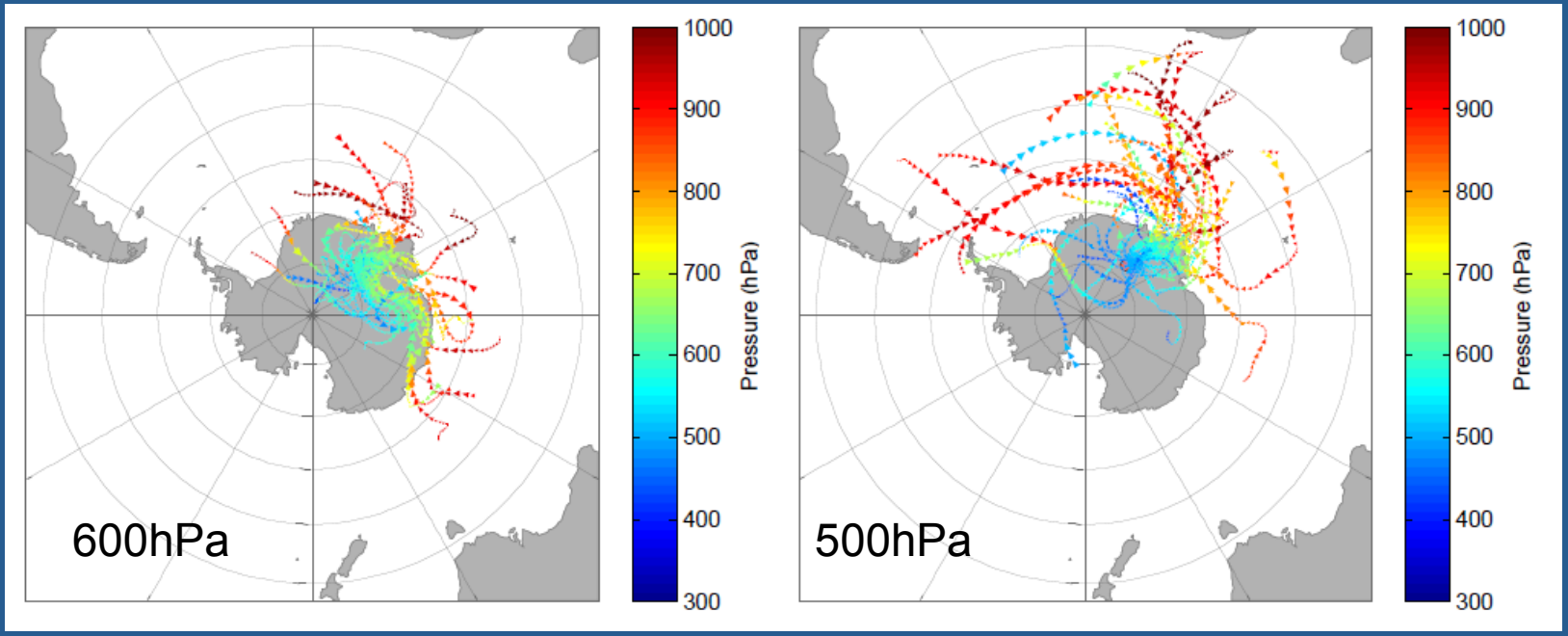
AMPS

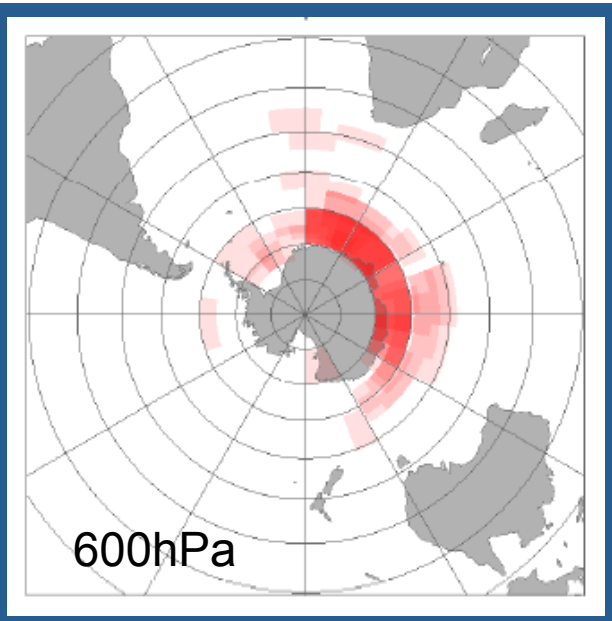
Comparison precipitation “events“ AMPS - measurements

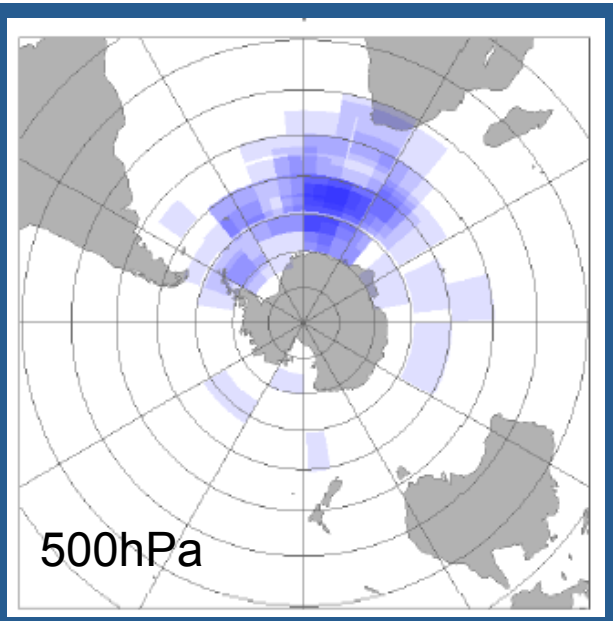
Measured and modeled 24h-precipitation in mm w.e. for the entire measurement Period at Dome F:



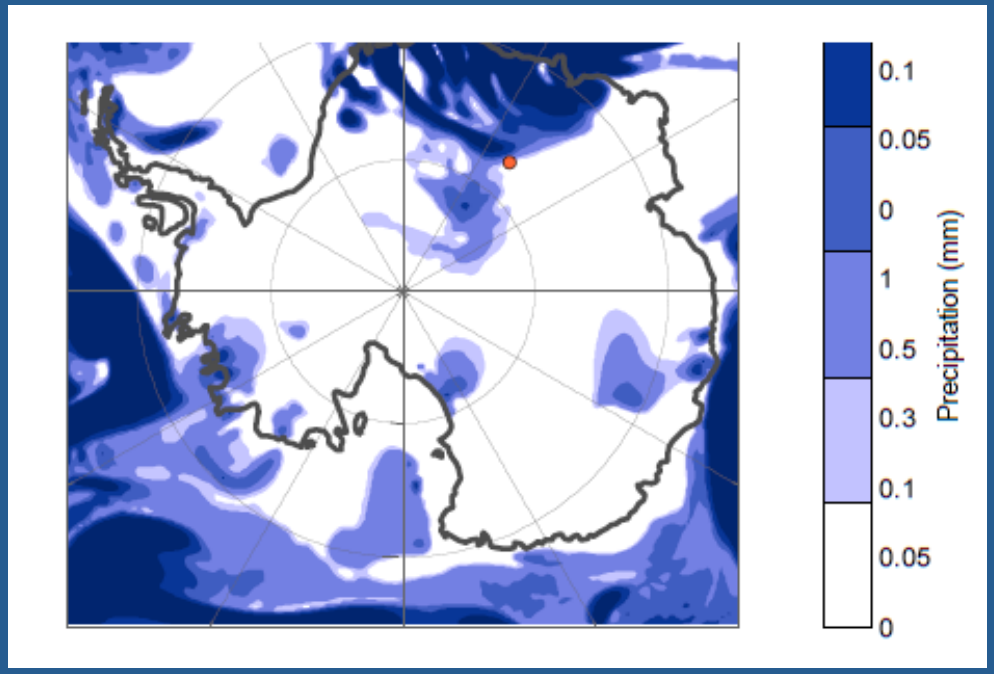
Back-trajectories (RIP4) and estimated moisture source areas



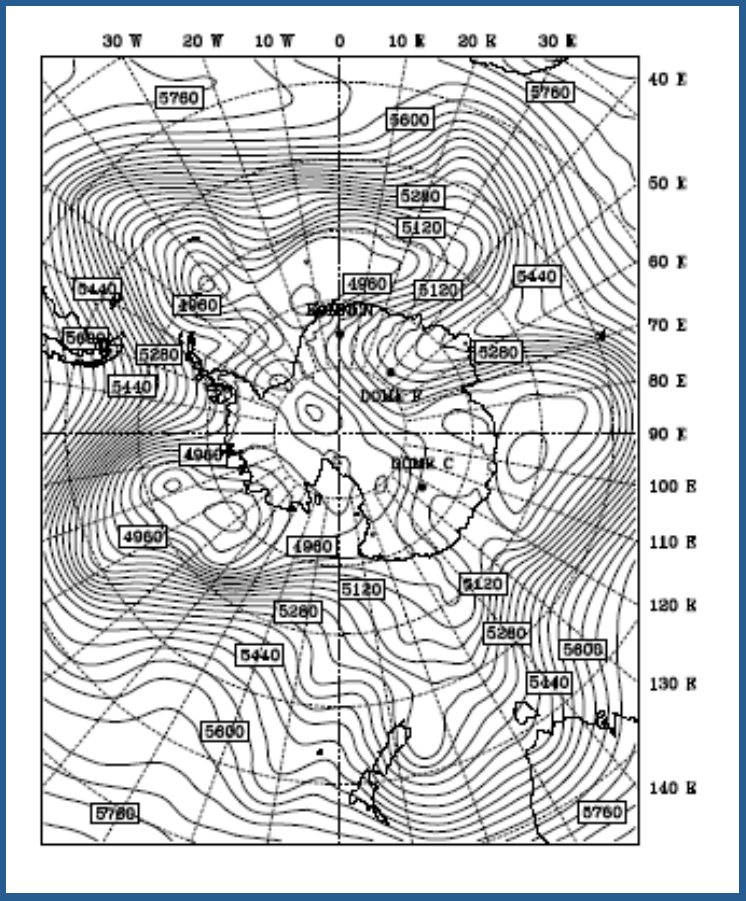




Example: Dome Fuji 1.Nov 2003

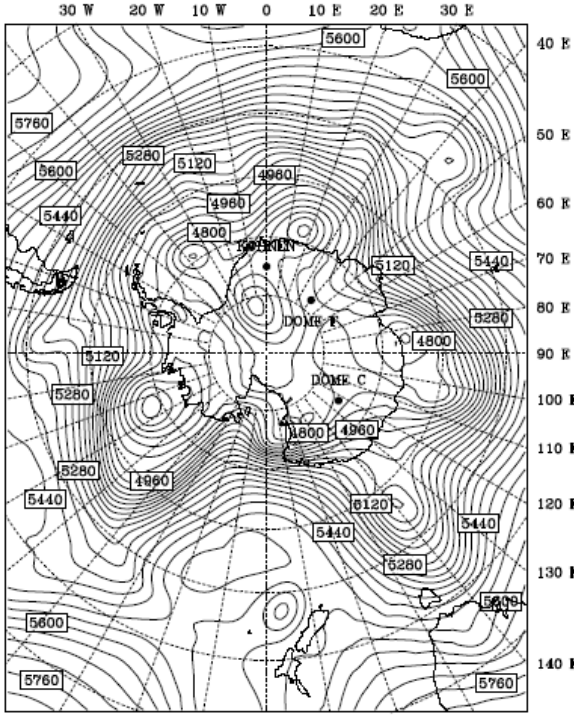


6h-precipitation 1.11.2003 12 UTC

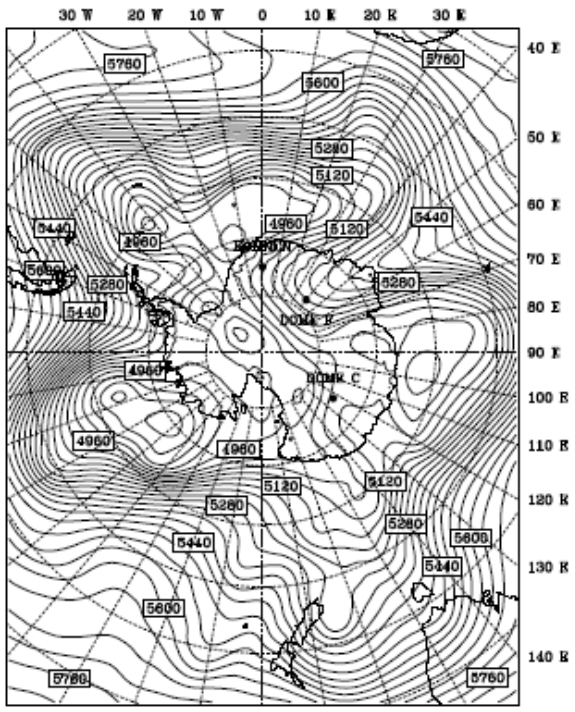


500hPa geopotential height
1.11.2003 12UTC

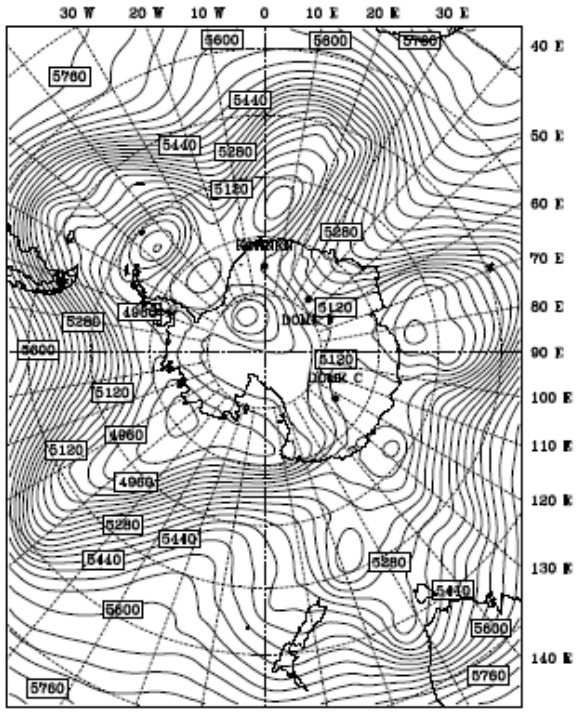
Weather situations for „high“-precipitation events:



1. Shallow ridge

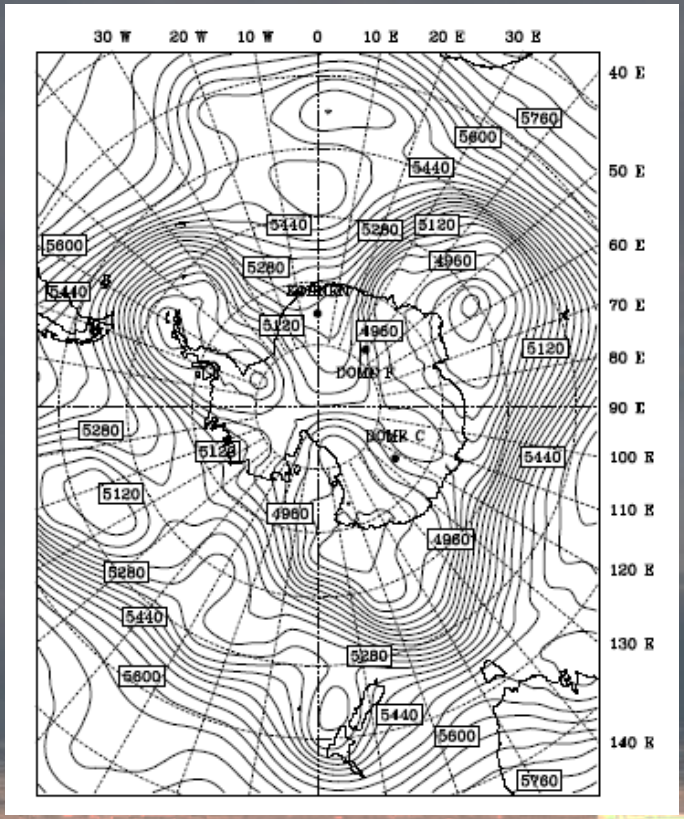


2. Amplified ridge



3. Blocking

Weather situations for „high“-precipitation events:

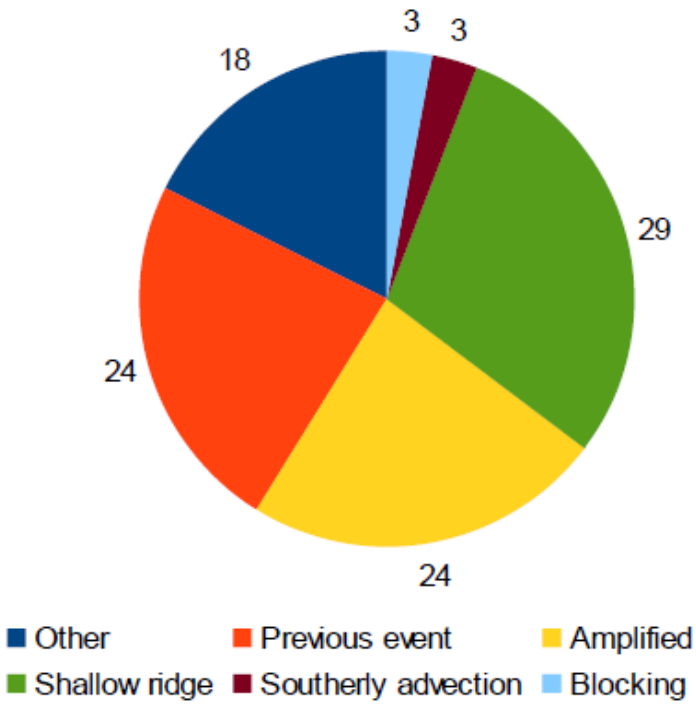


4. Southerly flow

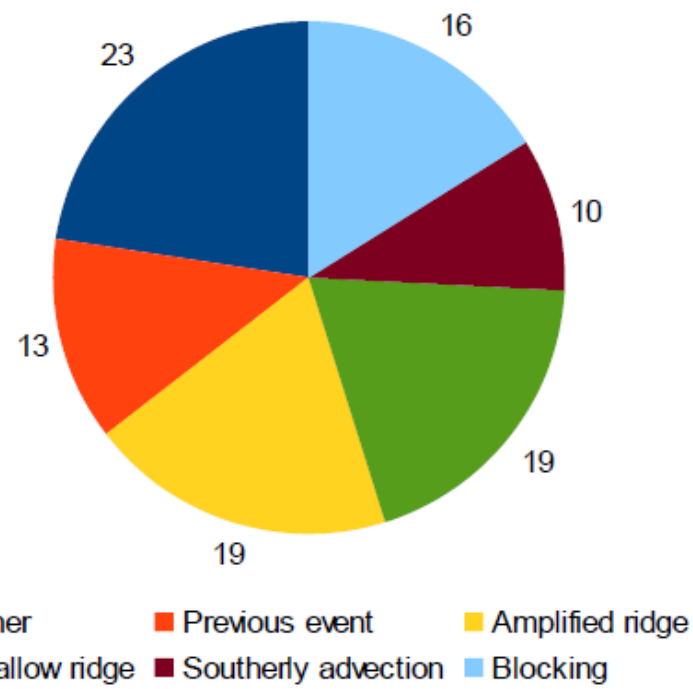
5. Previous event

e.g. cutoff high,
main flow westerly again
Remaining moisture produces precipitation
(hoar frost/diamond dust?)

Synoptic situations for precipitation at Dome F



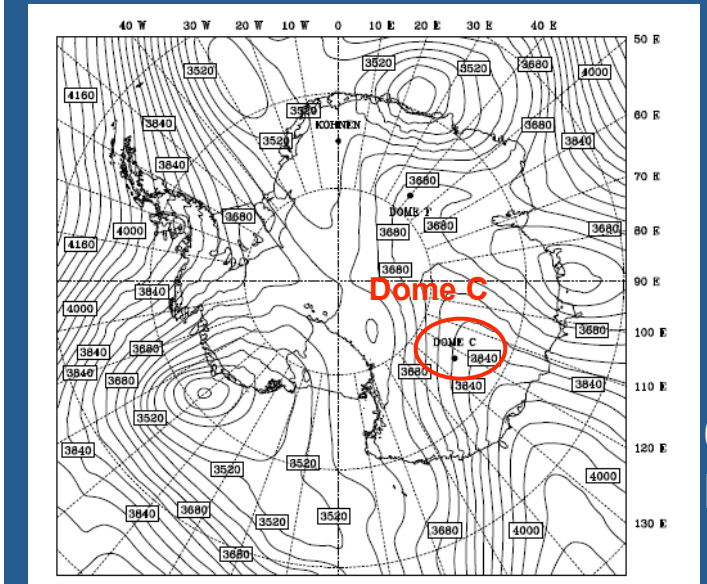
Measurements

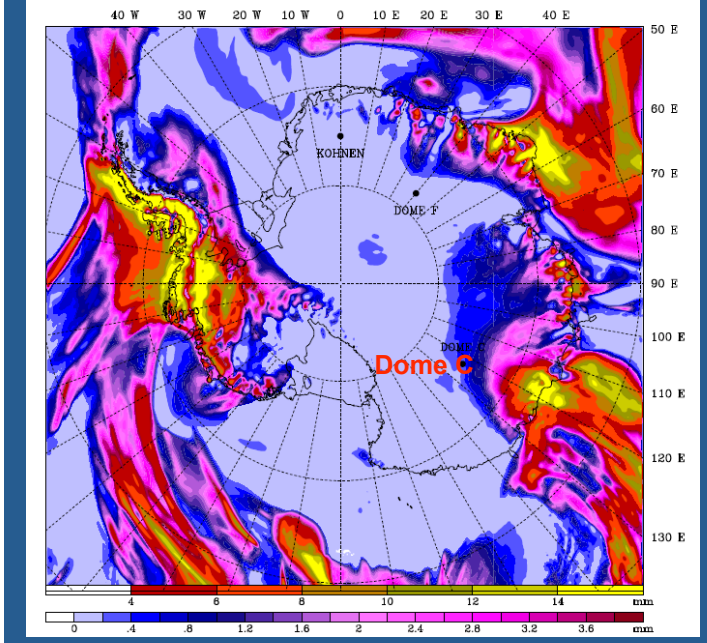


AMPS

56% (AMPS 54%) related to anticyclones

Example Dome C 18 July 2009

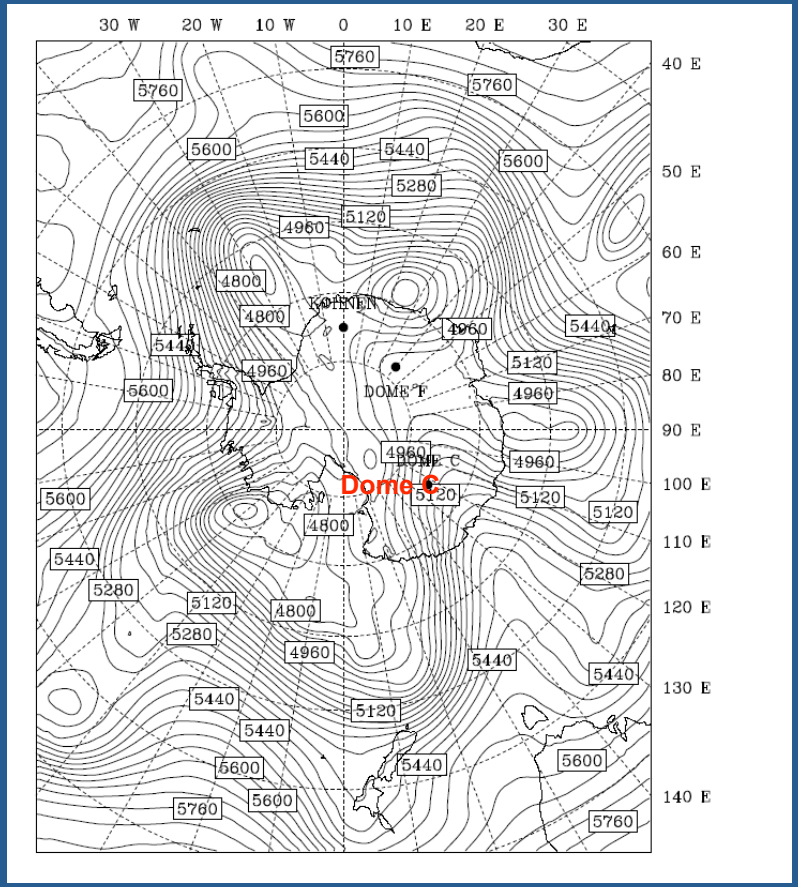




Example: 18.7.2009

600hPa geopot. height 00Z

AMPS 24h-precipitation (0-24Z) (forecast 12-36)



500hPa geopotential height 00Z

Measured precipitation: 0.44mm

Comparison AMPS- observations:

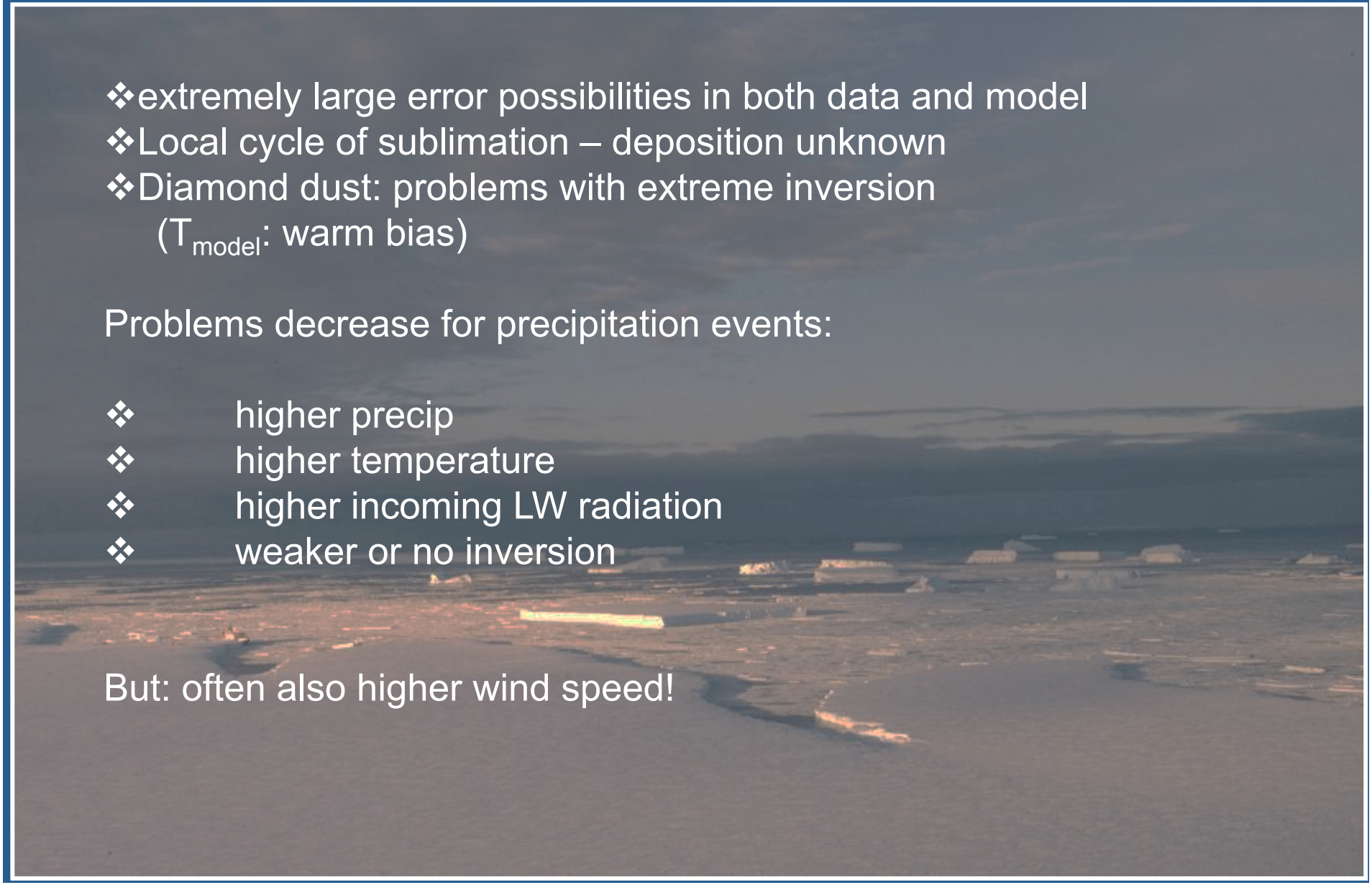
Occurrence of synoptic „events“ / comparison with model

(day-by-day comparison pointless (error >100%))

	all	2009	2010	2003
Number of observed „events“:	29	20	9	19
Model shows precip:	48%	44%	50%	12
Model shows precip in vicinity:	28%	33%	25%	
Model shows no precip:	24%	22%	25%	

2003 most likely comparable to 2009 („warm and humid“)

Reasons for differences between model and data:



- extremely large error possibilities in both data and model
- Local cycle of sublimation – deposition unknown
- Diamond dust: problems with extreme inversion
  (T_{model}: warm bias)

Problems decrease for precipitation events:

- higher precip
- higher temperature
- higher incoming LW radiation
- weaker or no inversion

But: often also higher wind speed!

Conclusion and outlook

- AMPS represents event-type precipitation at Dome F and C reasonably well
- Amounts too low in the model
- More than 50% of the precipitation events related to anticyclones: Amplified Rossby waves, advection of „warm, moist“ air from lower latitudes
- Dome C similar to Dome F
- Isotope modeling for Dome C and Dome F (Dome F already done)

Future:

- ^{17}O excess
- Continous measurements of stable isotope ratios of water vapor with CRDS (next project, Neumayer, with NCAR, AWI, LSCE)

THANKS FOR YOUR ATTENTION!

ACKNOWLEDGEMENTS

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Thanks to all Dome C winterers who participated in the measurements!

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