Strong Wind and Heavy Precipitation Events on the Antarctic Plateau: Observations from Kohnen Station, Dronning Maud Land

G. Birnbaum, J. Freitag, G. König-Langlo
Alfred Wegener Institute for Polar and Marine Research, Bremerhaven

R. Brauner
Deutscher Wetterdienst, Hamburg

C. Tijm-Reijmer
Institute for Marine and Atmospheric Research, Utrecht University

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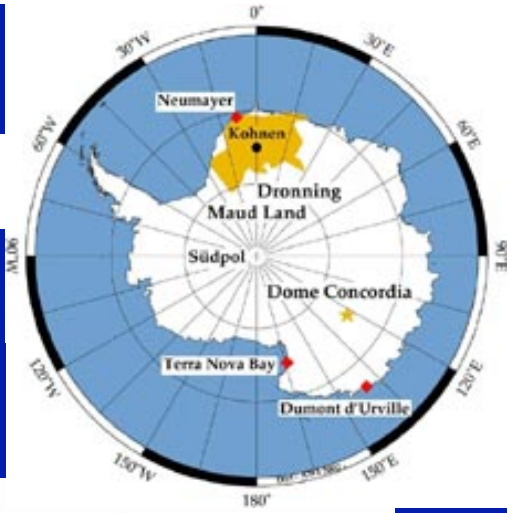
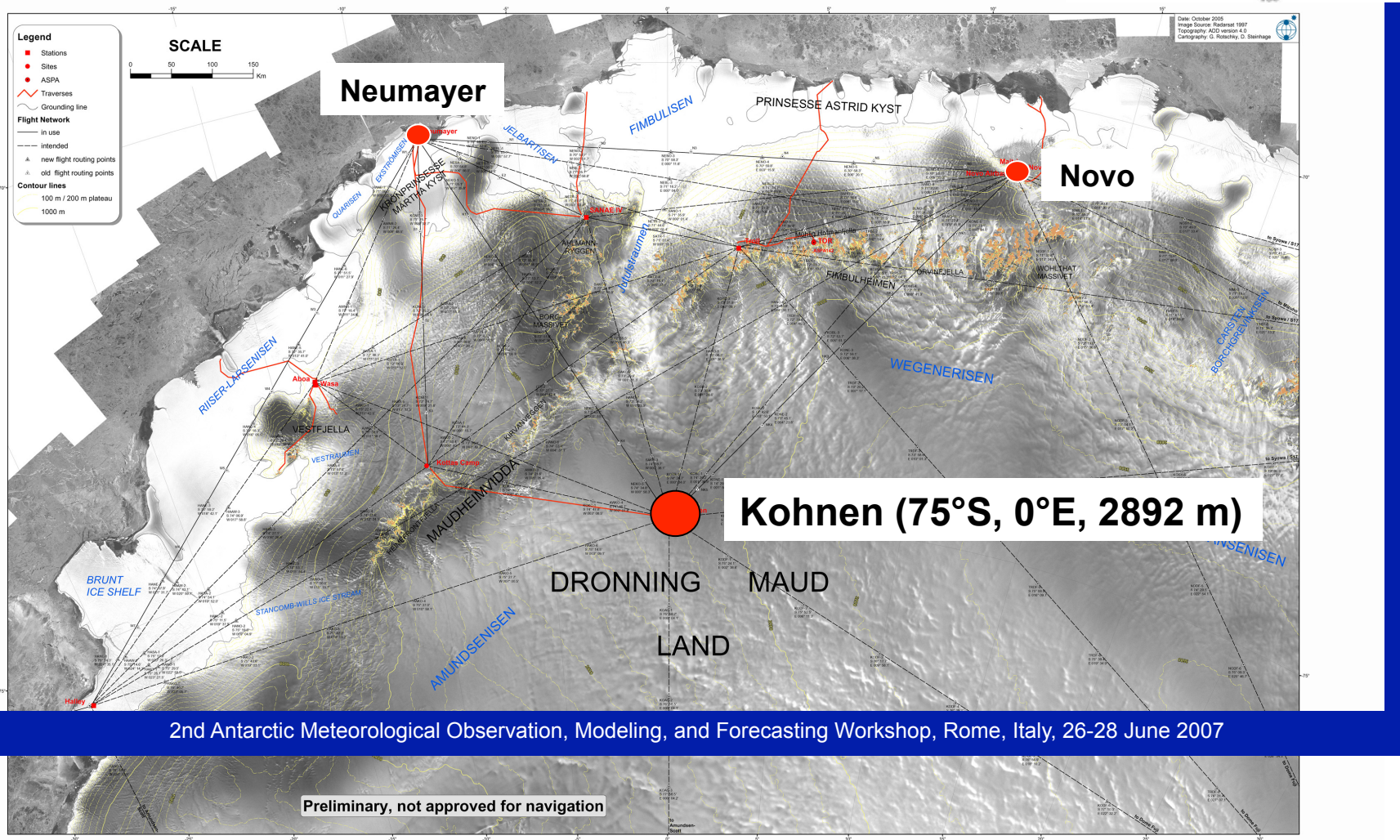
Motivation

European Project for Ice Coring in Antarctica (EPICA)





Synoptic classification of visually observed high precipitation events at Kohnen Station during summer campaigns since 2001/02

Synoptic Classification	*Frequency*
Category I: Occluding fronts of eastward moving lows reach the plateau.	61% of events
Category II: Lows or secondary lows which form east of the Greenwich Meridian move to the west (retrograde movement) and frontal clouds influence the plateau.	30% of events
Category III: Large-scale lifting processes due to an upper air low west of Kohnen Station cause snowfall on the plateau.	9% of events

Birnbaum et al. (2006)

Strong Wind Events

Impact on snow surface structure

Barchan Dune

Glaciological field program at Kohr summer season 2005/2006:

- Continuous surface inspection
- Profiling of surface density
- Drilling of 9 short firn cores of 4-5 m depth along a 600 m profile line

- Redistribution of unbounded surface snow into hard and dense fine grained layers
- Dunes influence the air transport along the connected pore space in polar firn.

Three snow dune formation events observed in period 2005-11-15 to 2006-01-31:

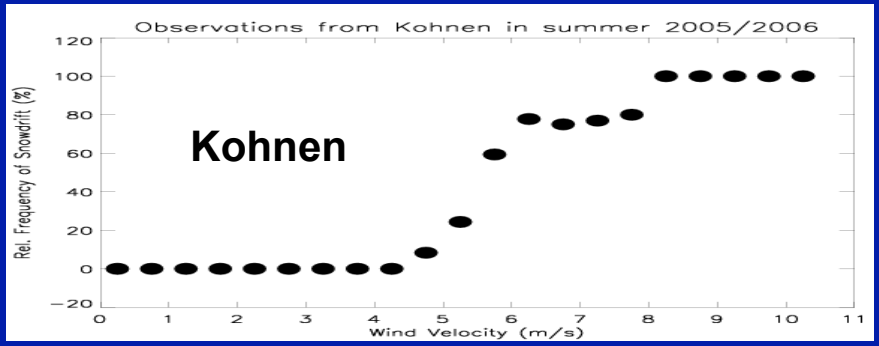
- Dune surface coverage after an event: 5 to 15 %
- Mean density within a dune: 380 to 500 kg m^{-3}
  (Mean surface density: 330 +/- 5 kg m^{-3})
- Dune size: 8 +/- 3 m x 4 +/- 2 m
- Maximum height: 0.2 +/- 0.1 m
- Periodicity length: 30 m

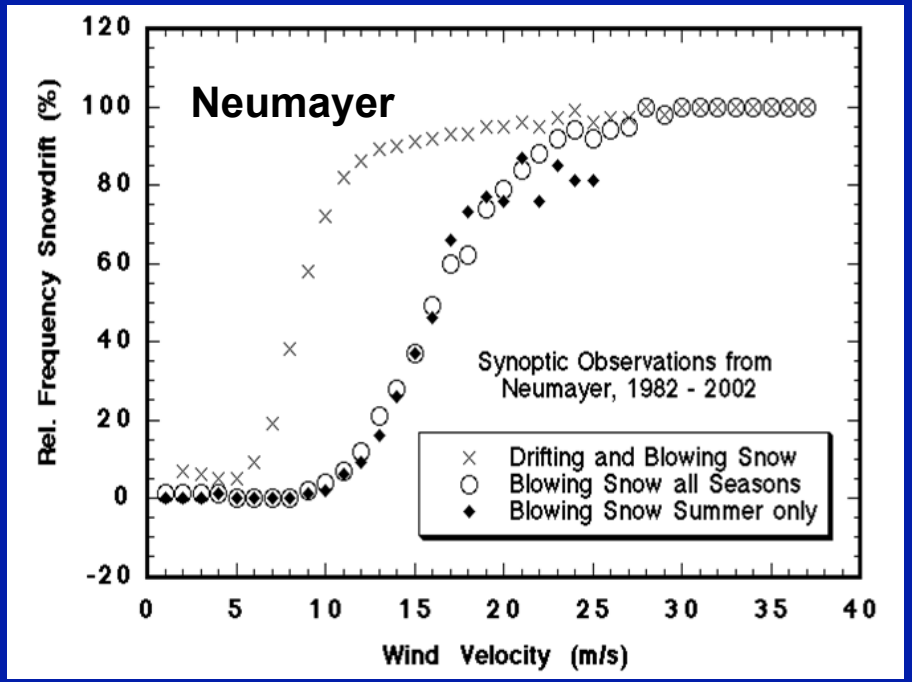
Firn core analysis:
3 to 8 events per year of formation of snow dunes that are conserved in the firn

Identification of events

Visual Observations:

- Drifting snow
- Mean wind speed > 10 m s^{-1} (for 4 and 6 hours, respectively)
- General structure of dunes was formed within 2 hours
- No or very weak precipitation during and 24 hours prior to the event
- Very different accumulation histories during the week prior to the events





Definition of a strong wind event

(1) An event starts when the 2-h mean AWS wind speed exceeds 10 m s^{-1} for the first time.

(2) An event ends when the 2-h mean AWS wind speed drops below 10 m s^{-1}.

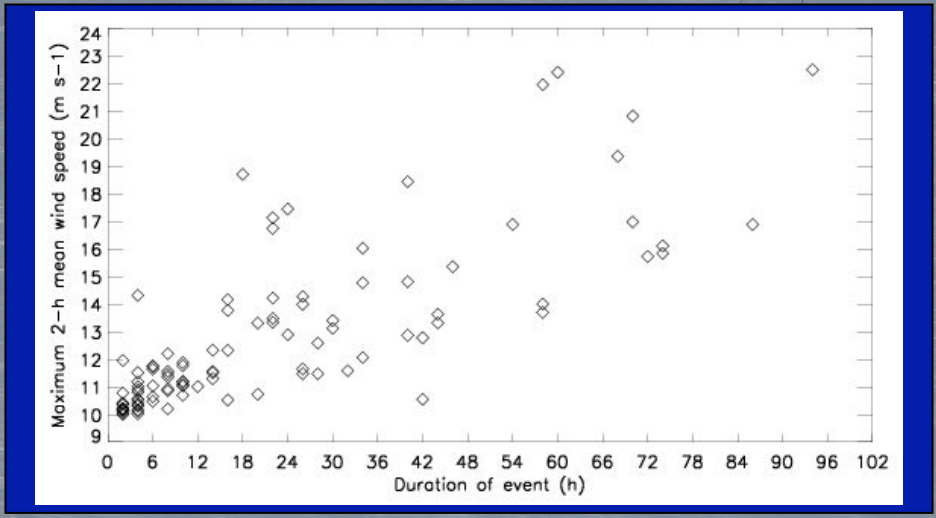
(3) Two periods meeting conditions (1) and (2) are considered as one event in case the 2-h mean AWS wind speed does not drop below 5 m s^{-1} during a time of less than 24 hours between two periods with wind speeds exceeding 10 m s^{-1}.

Main characteristics of events

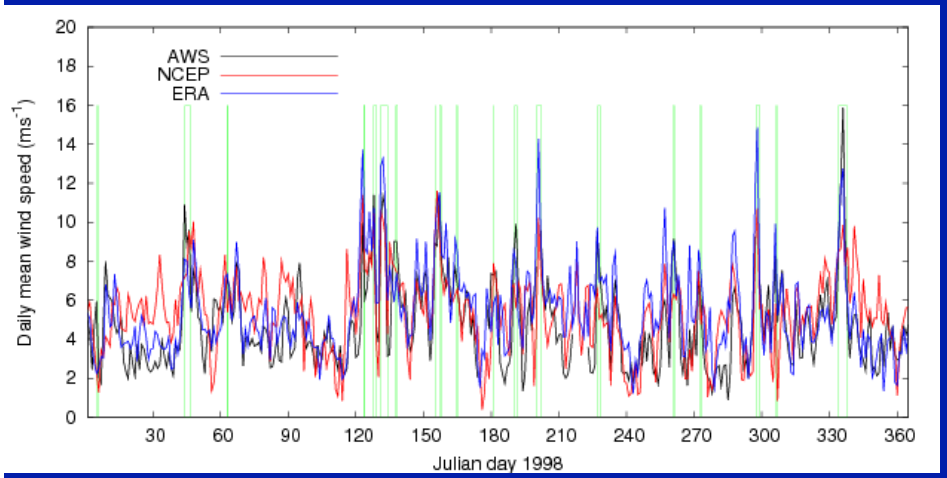
100 strong wind events in the 7-year period 1998-2000/2002-2005:

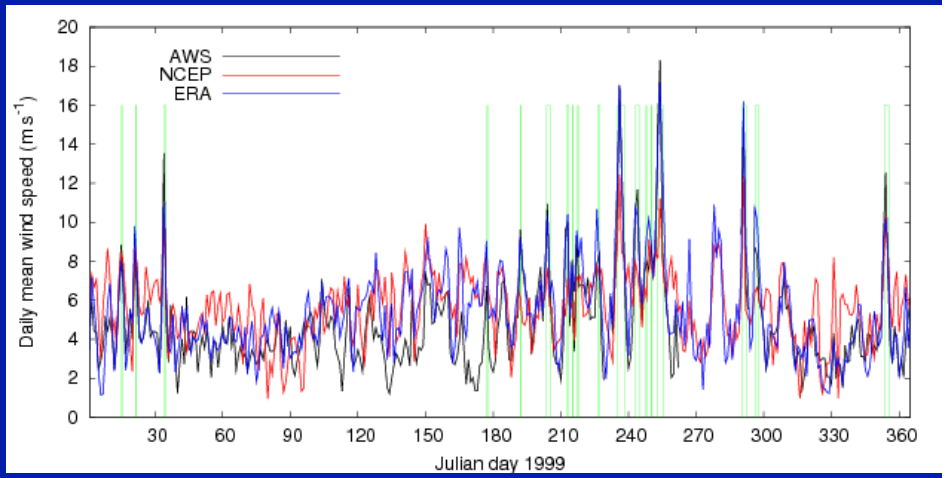
- number per year: 11 to 19
- 18 in summer (DJF)
- 19 in autumn (MAM)
- 38 in winter (JJA)
- 25 in spring (SON)

Duration (h)	02-12	14-24	26-36	38-48	50-60	62-72	74-84	86-96
Events (%)	50	18	12	7	5	4	2	2



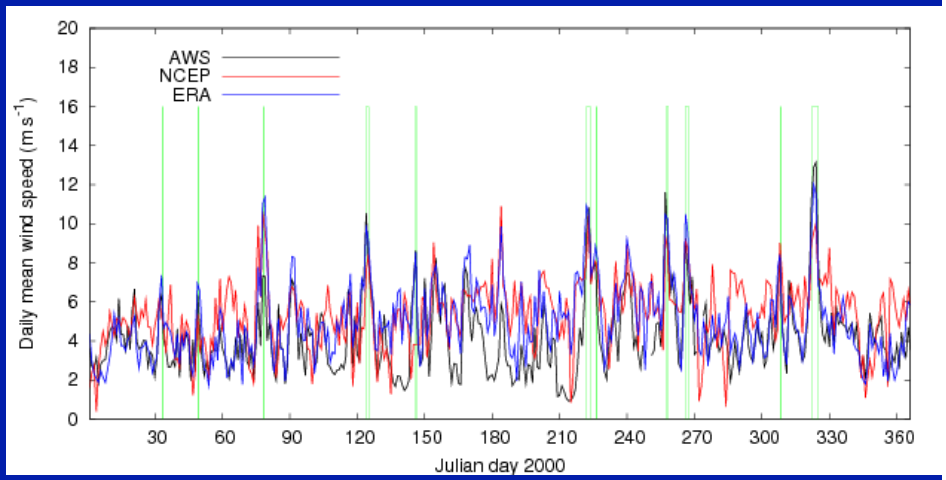
Comparison to NCEP/NCAR and ERA40 Reanalysis Data





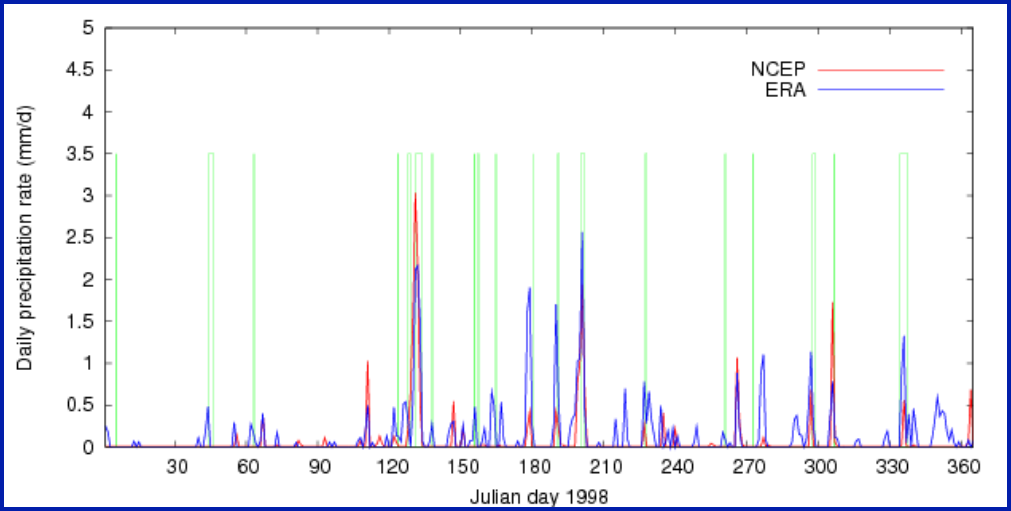
NCEP/NCAR grid point (75,2351°S; 0°E)

ERA40 grid point (75°S; 0°E)



How many strong wind events are not directly influenced by moderate or heavy precipitation?

Criterion: On the day prior to the event and on all days of the event the precipitation rate is less than 0.2 mm w.e. per day.



	NCEP/NCAR (1998-2000/2002-2005)	NCEP/NCAR (1998-2000)	ERA40 (1998-2000)
Events influenced	43	24	38
Events not influenced (Cases of dune formation)	57 (8.1 events/year)	24 (8.0 events/year)	10 (3.3 events/year)

Firn core analysis: 3 to 8 events per year of formation of snow dunes

Synoptic classification of strong wind events

Pattern

Frequency

10 typical synoptic situations identified

Conclusions

- Number of snow dunes formed per year and conserved in the firn could be explained by a combined analysis of atmospheric observations and model data.
- Typical synoptic mechanisms for the occurrence of strong wind and high precipitation events could be identified.
- Unexpected high number of events due to retrograde moving lows
- The influence of snow age and microstructure on the redistribution of surface snow has to be investigated further.