

20 Years of IMAU observations on Antarctica using Automatic Weather Stations

Paul Smeets, Carleen Reijmer, Michiel van den Broeke, Wim Boot.....and many, many others



Information on:
<http://www.projects.science.uu.nl/iceclimate/aws/>

AWS 5 close to Aboa

Outline

- History/Projects
- Technical development
- Problems
- Time series
- To conclude



History of IMAU AWS in starts in Austria

- Hintereisferner (Austria) 1986
- In ablation zone drilling mast in ice problematic or using wooden plate
- Preferably measurements over longer period than a few weeks in one summer
- **Four leg free standing structure**
- **Power supply based on batteries**
- **Automatic Weather Stations**



Summer experiments core business in the nineties

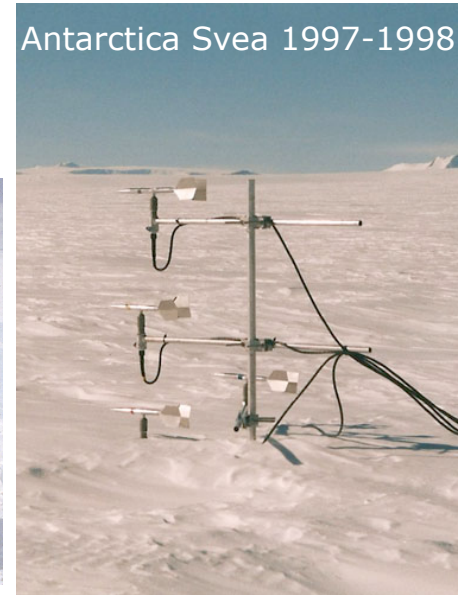
- Snow temperature/density
- Snow drift
- Snow/ice albedo (directional, wavelength dependent)
- Ice ripples/blue ice
- Shallow ice coring



Antarctica Svea 1992-1993



Antarctica Svea 1997-1998



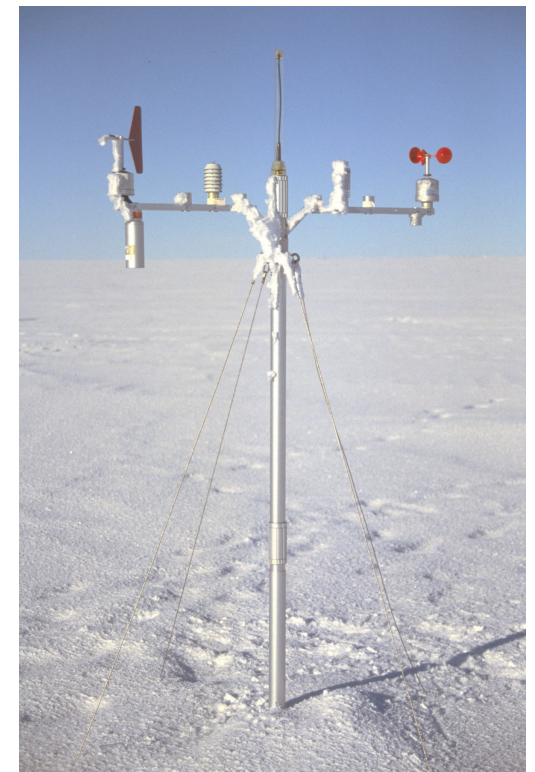
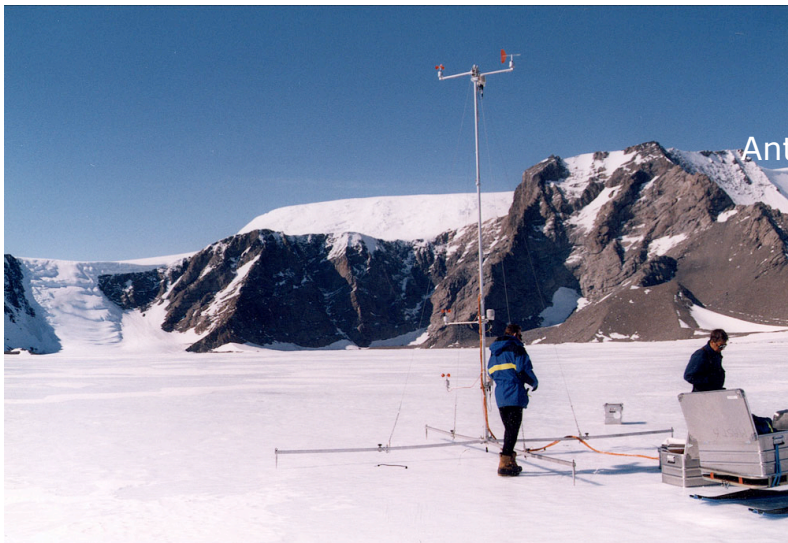
Summer experiments core business in the nineties

- Profile masts
 - Temperature/Humidity
 - Wind speed/direction
 - Radiation
- Turbulence
- Mass balance (stakes, sonic rangers)
- Balloon observations



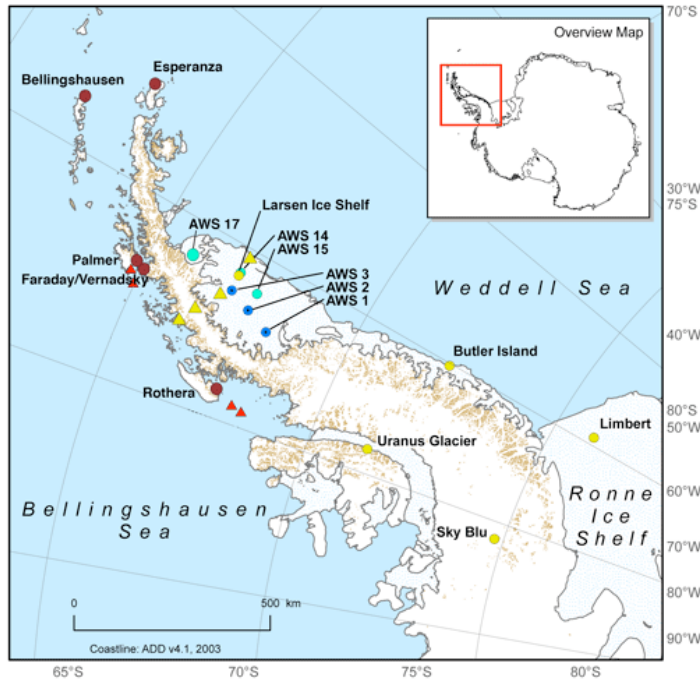
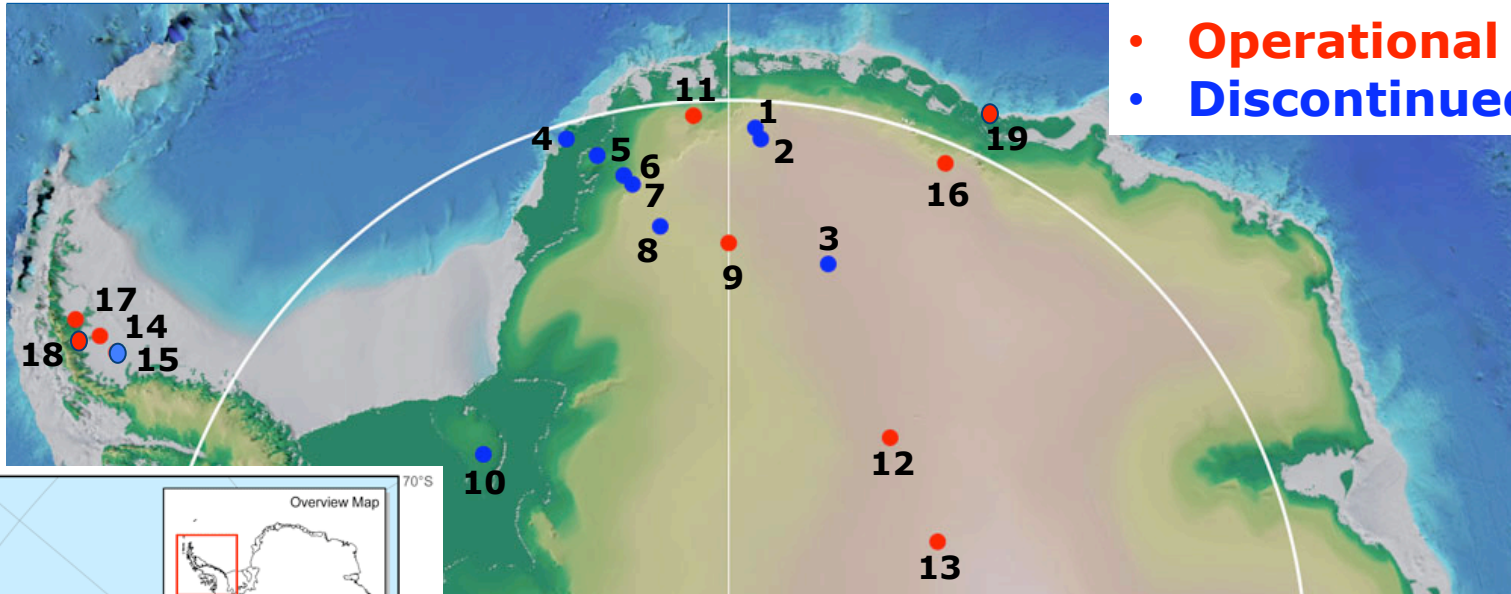
History of IMAU AWS in Antarctica

- King George Island, 1990-1991 one of the first Dutch Antarctic expeditions
- DML, Svea/Bluelce, 1992-1993 summer exp
- Berkner Island 1995 first AWS
- NARE96/97 traverse 1996, 3 AWS
- DML, Svea/Bluelce, and EPICA traverse 1997-1998, 6 AWS
- Halvfarryggen (near Neumayer), 2006 1 AWS
- Norwegian-US traverse plateau, and Larsen C, 2007 4 AWS
- Belgian Princess Elisabeth station 2009, 1 AWS
- Larsen B, 2011, 1 AWS
- King Baudoin Ice Shelf and Larsen C, 2014 2 AWS

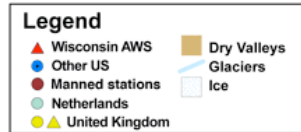


Locations stations: Antarctica

- **Operational**
- **Discontinued**

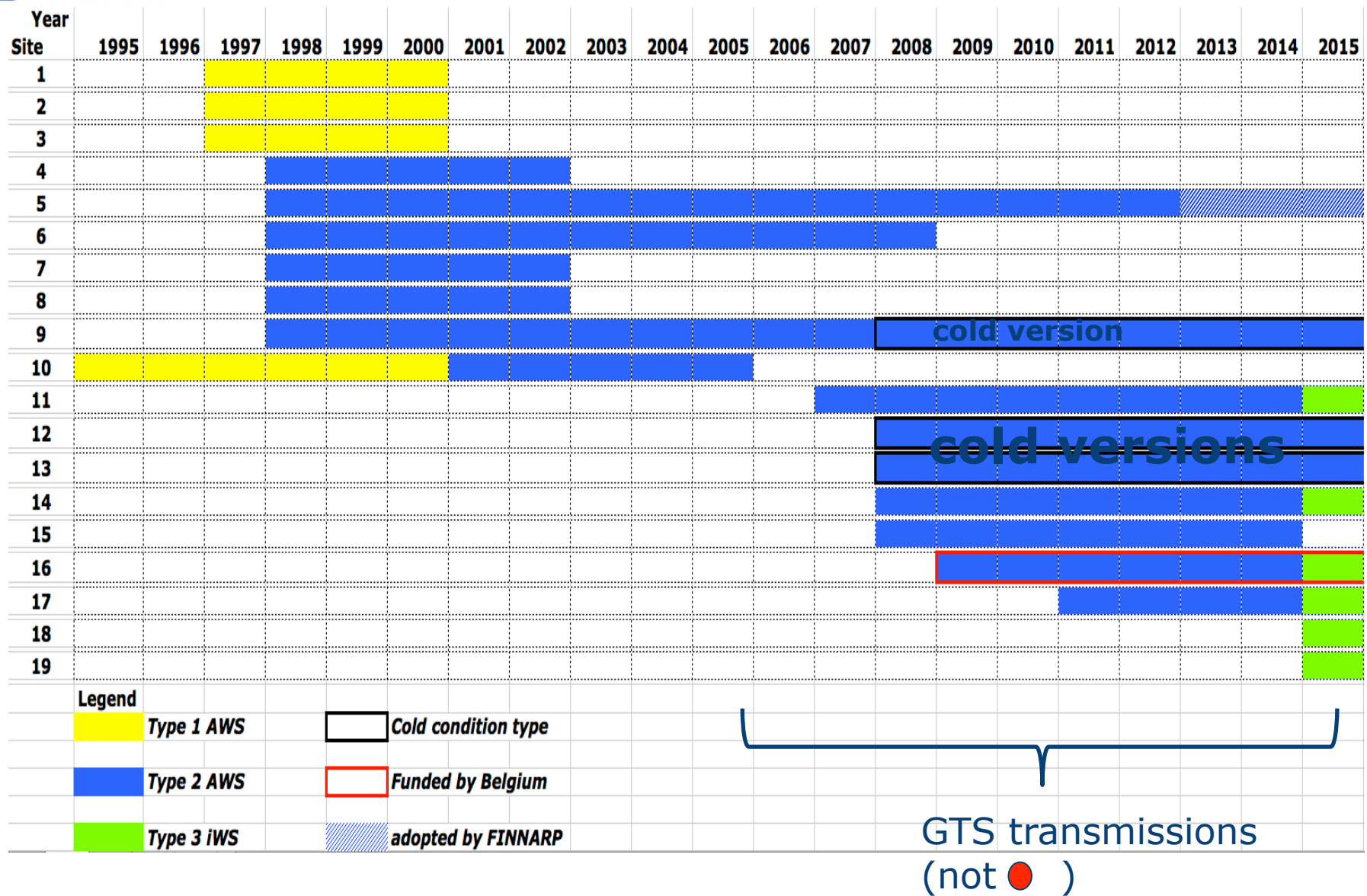


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Antarctic Peninsula

Available records Antarctica



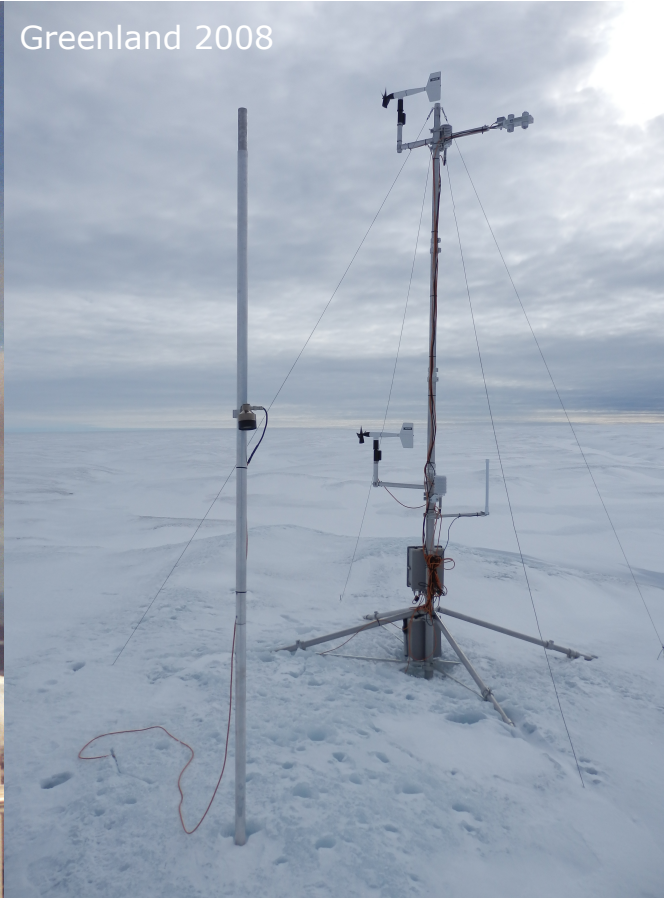
live data for most of these stations at <http://www.projects.science.uu.nl/iceclimate/aws/>

Iceland 1999



1993 – 1999
AWS Type I

Greenland 2008



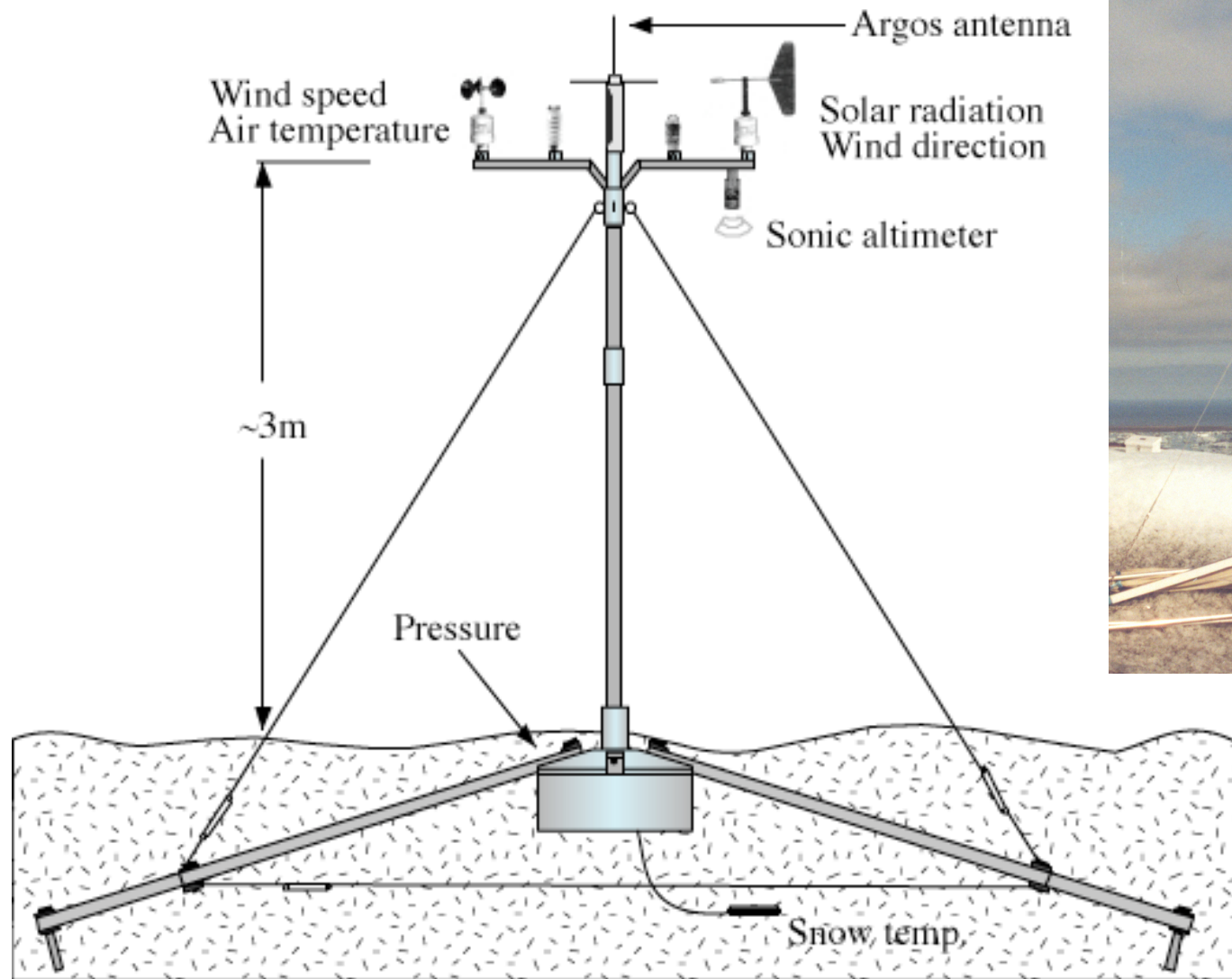
1997-2014
AWS Type II

Greenland 2014



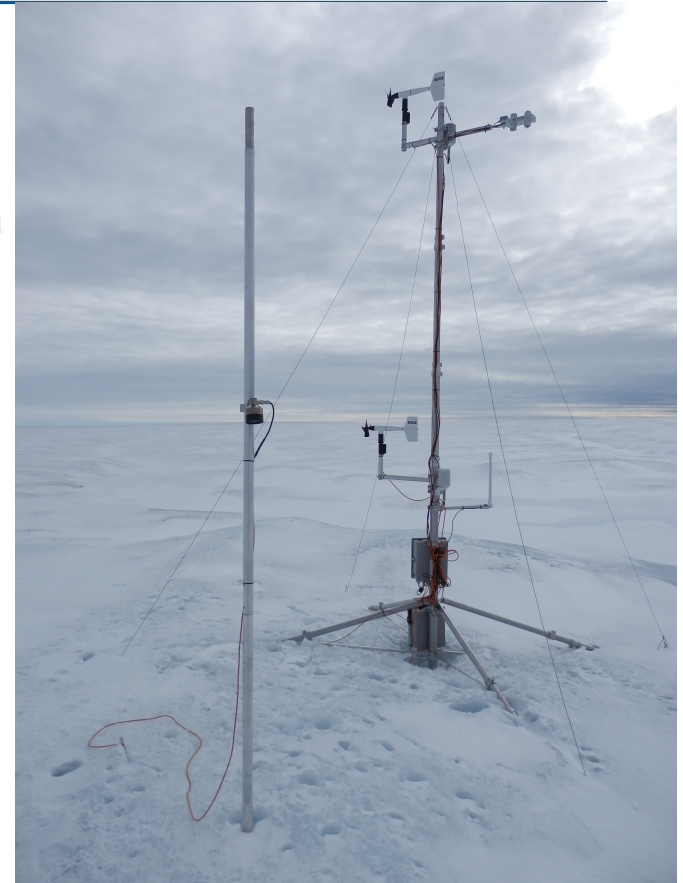
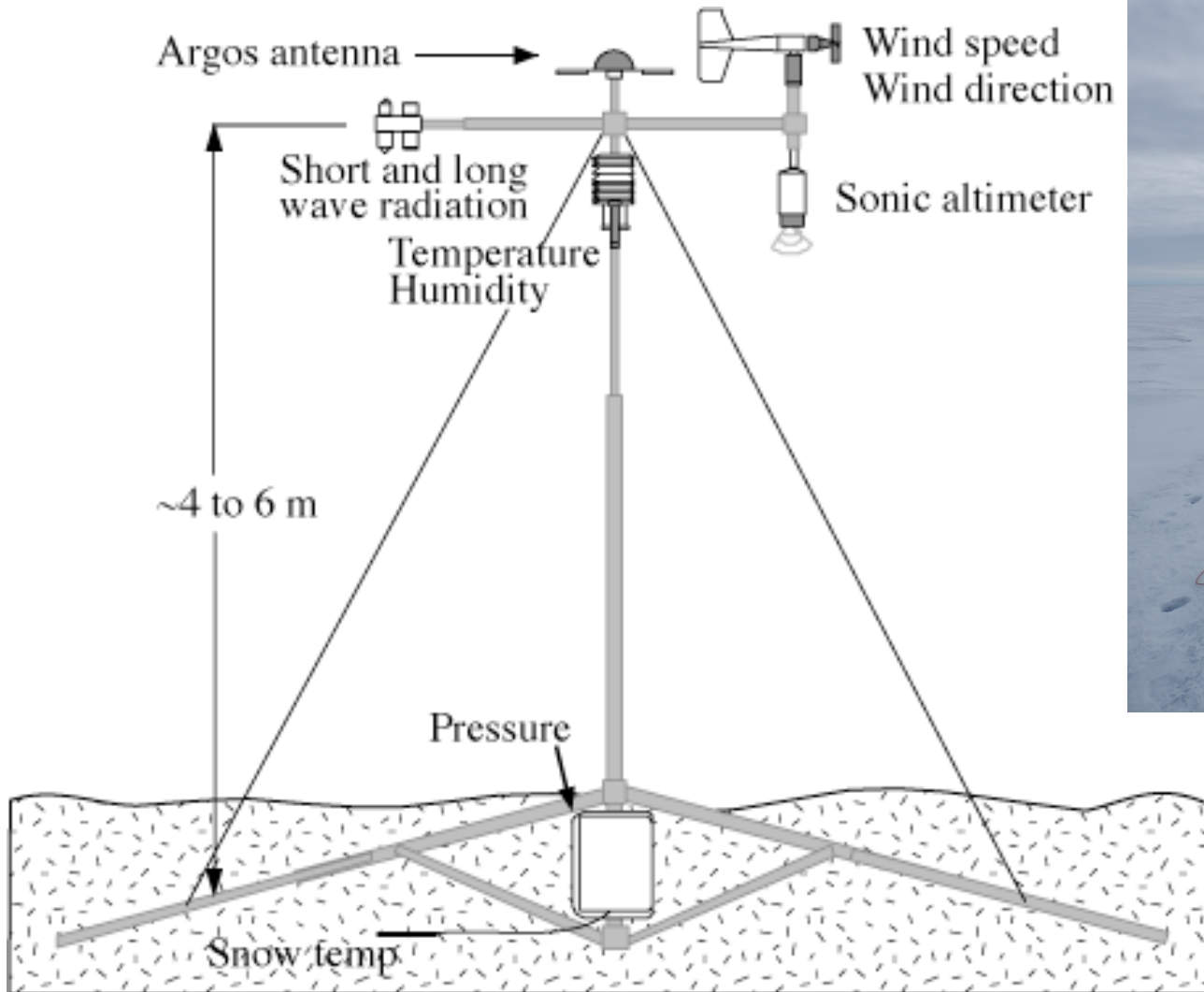
2014-
Type III, iWS

Technical development: Type 1



1994 – 1998
Campbell logger
Aanderaa sensors

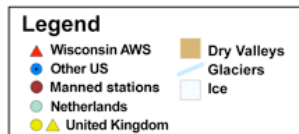
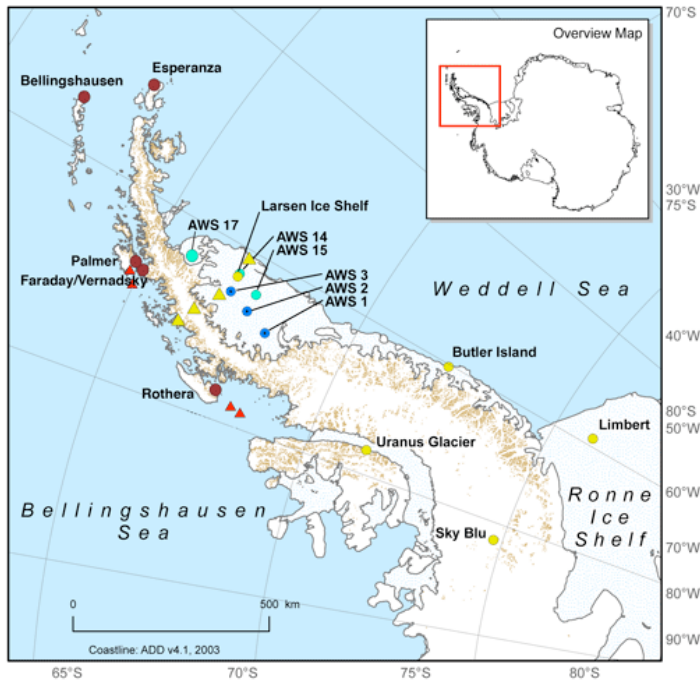
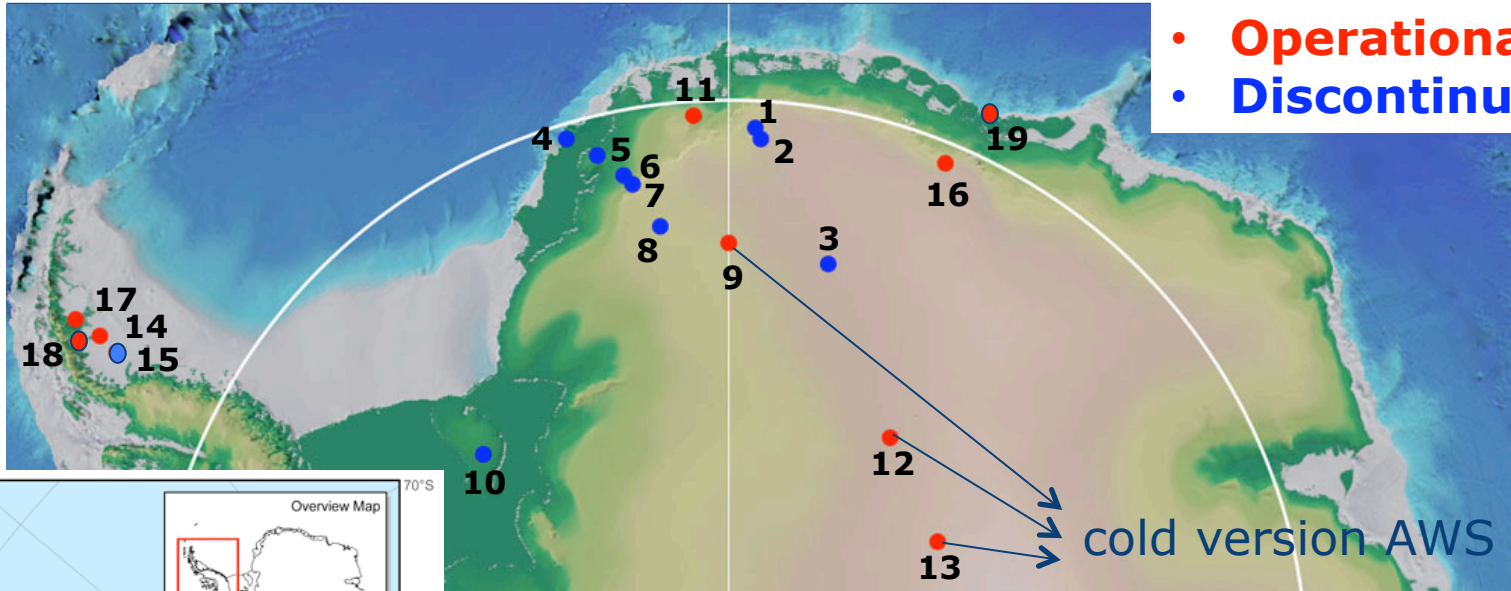
Technical development: Type 2



1997-present
Campbell logger
divers sensors

Locations stations: Antarctica

- **Operational**
- **Discontinued**

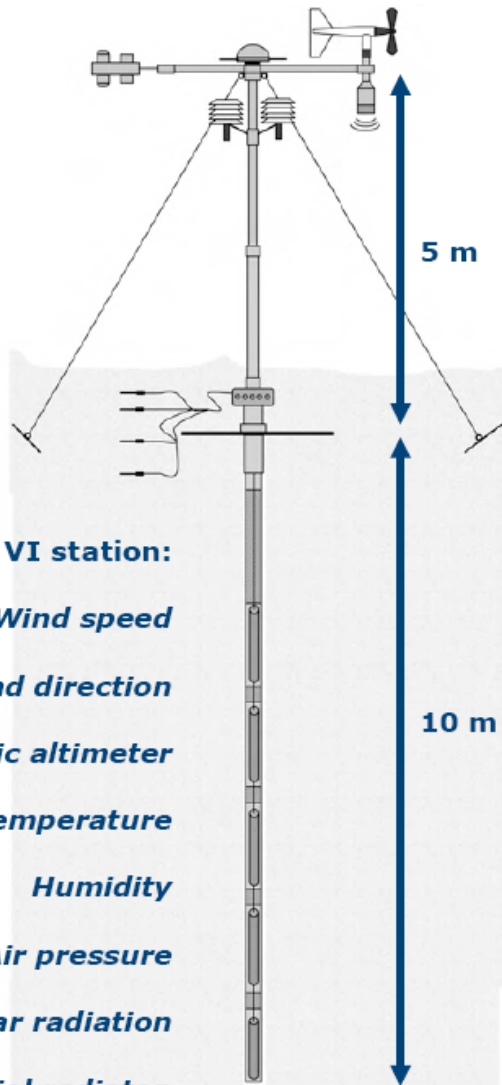


Antarctic Peninsula

2009_AWS_Sites_ALL_Peninsula / Dec 2008 Sam Batzli - SSEC

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Technical development: cold AWS version



Type VI station:

Wind speed

Wind direction

Sonic altimeter

Temperature

Humidity

Air pressure

Solar radiation

Terrestrial radiaton

Snow temperatures

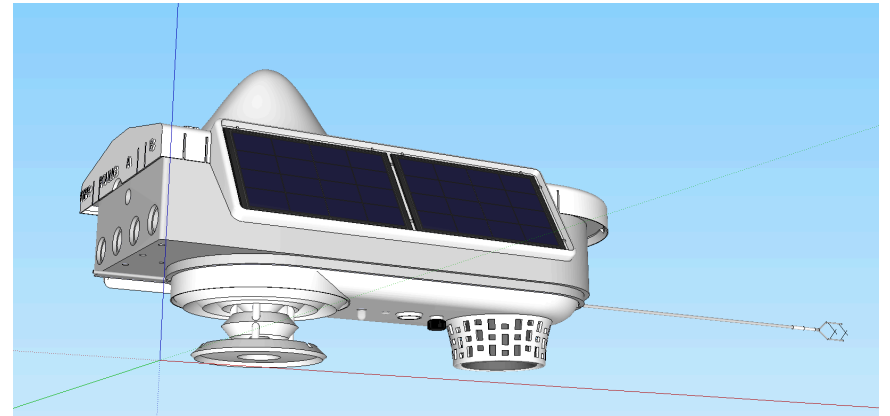
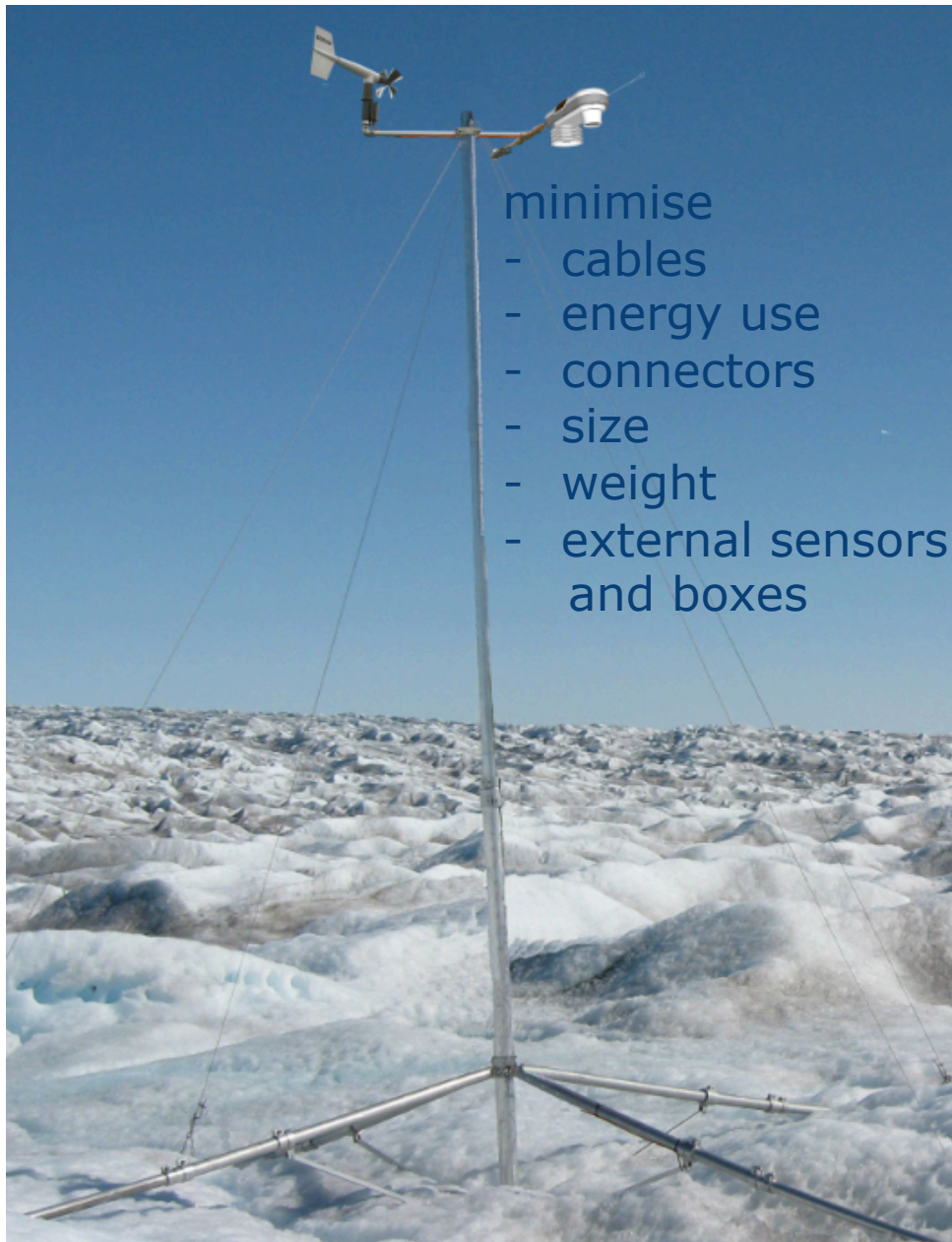
AWS12 2007



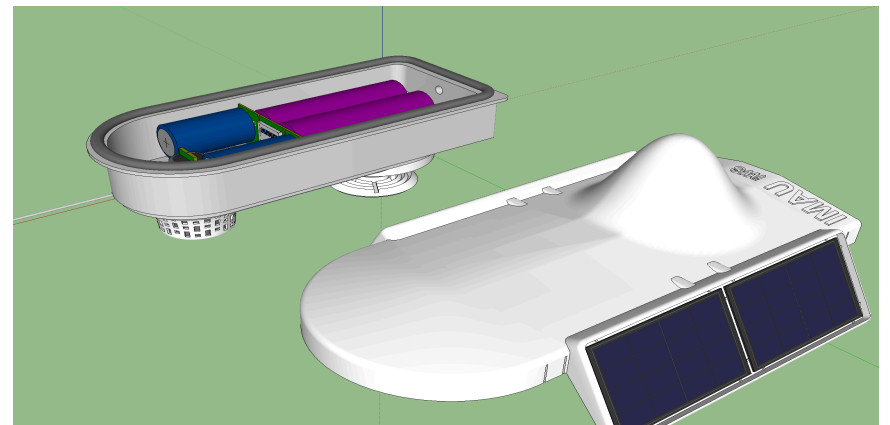
Cold condition type station

200 lithium type batteries at about
-50C inside the snow

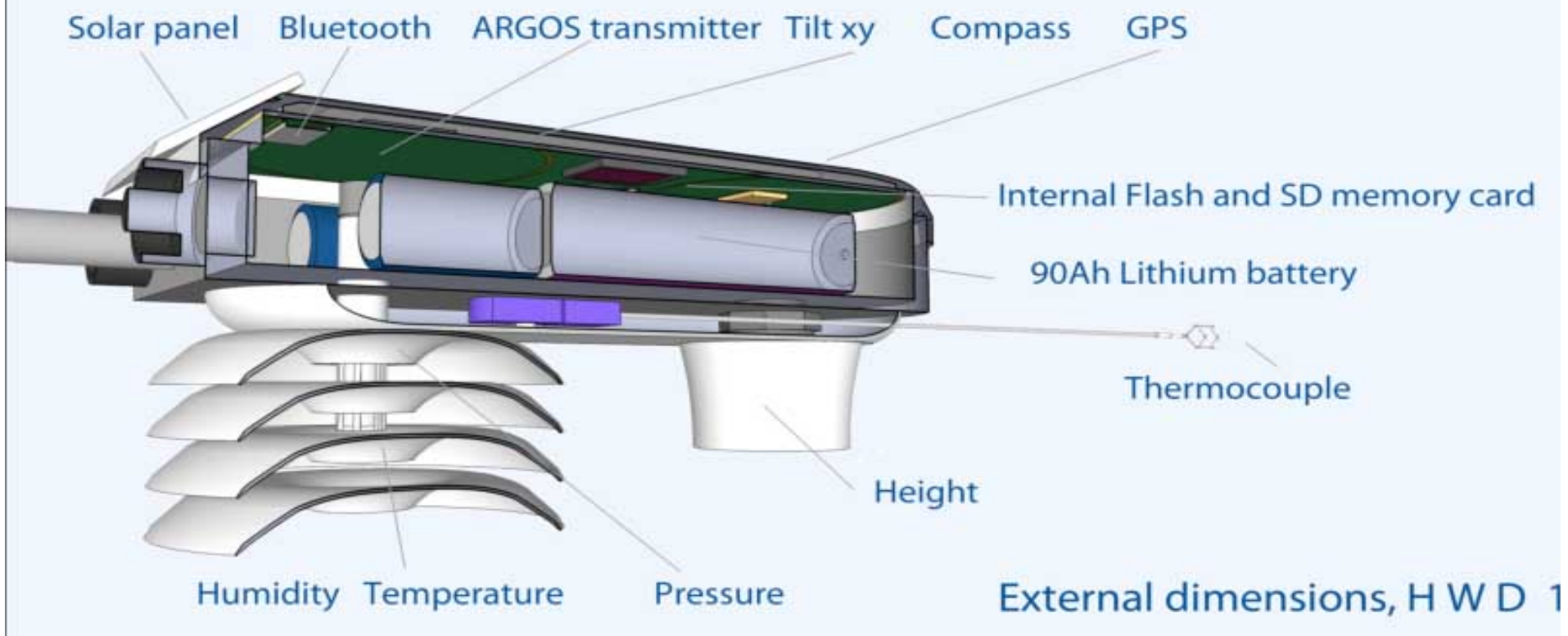
Technical development: Type 3, iWS



3 lithium batteries
4 small solar panels
2 capacitors



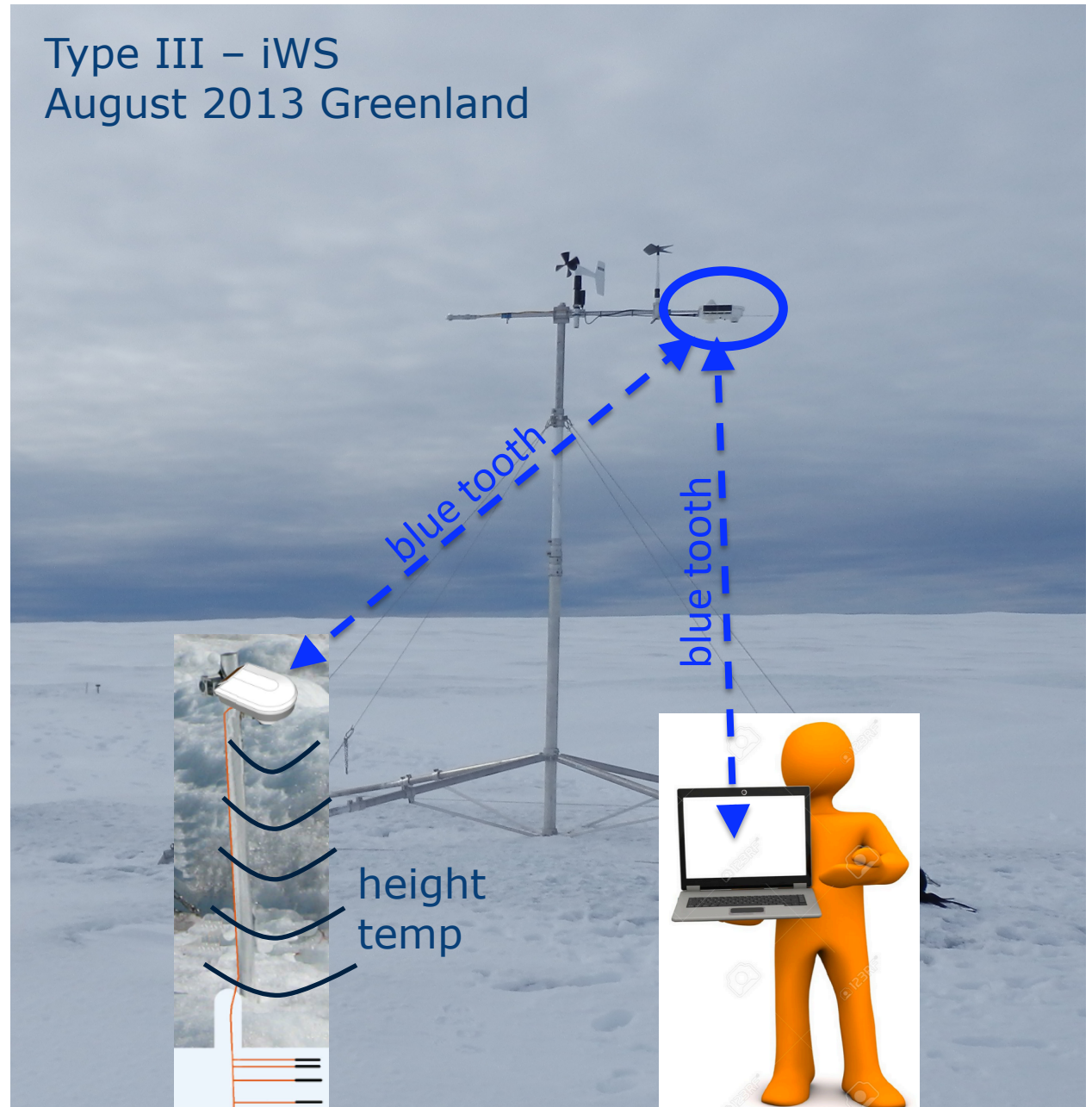
Technical development: type III iWS



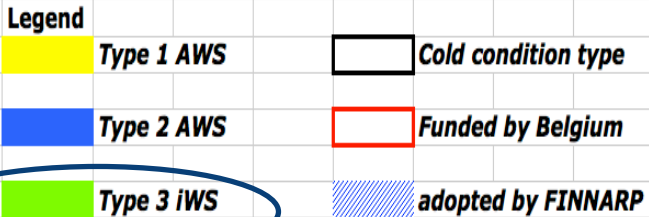
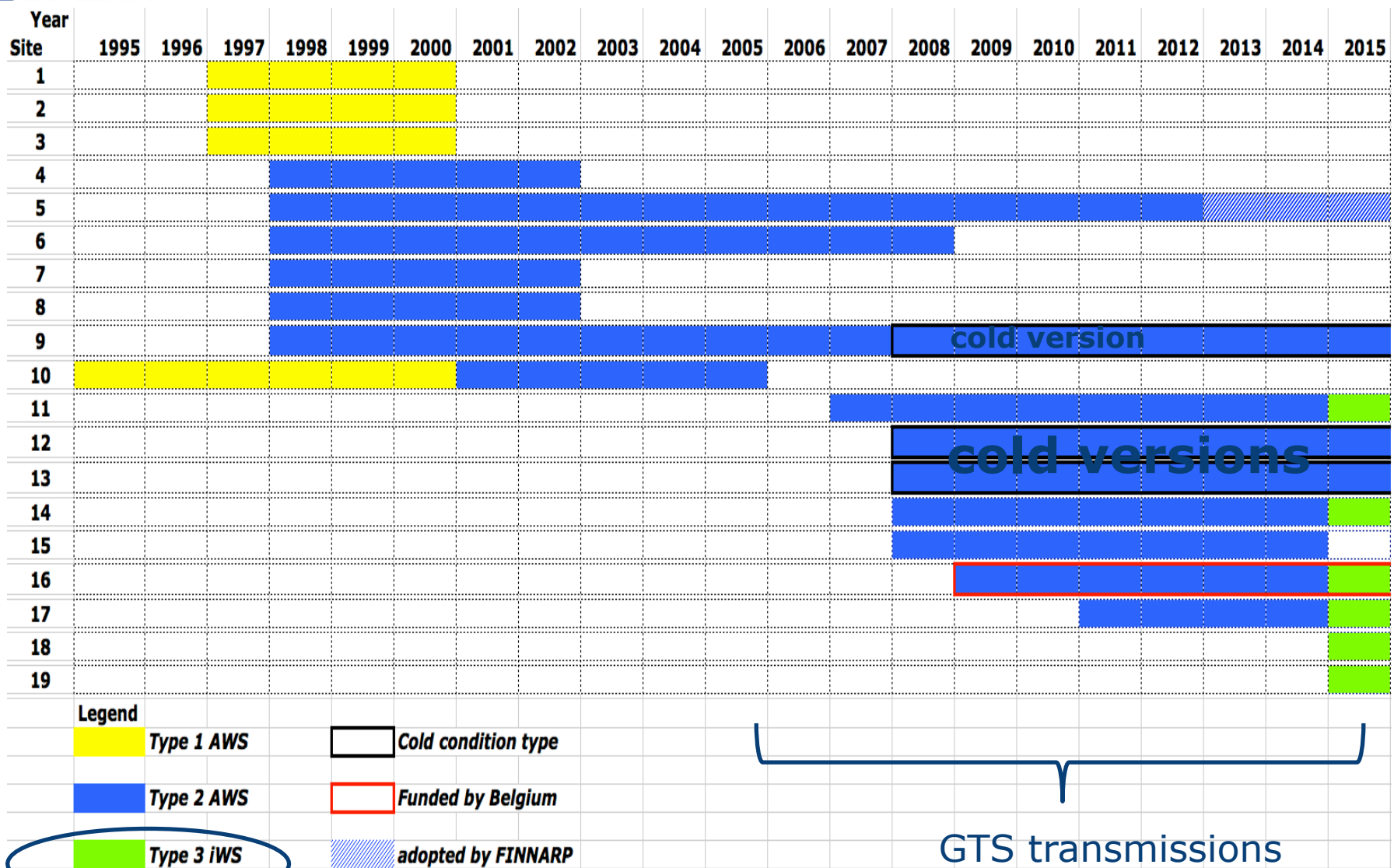
Technical development: type II versus III iWS

Type III – iWS
August 2013 Greenland

external slave unit
for subsurface T and/or
surface height



Available records Antarctica



cold version

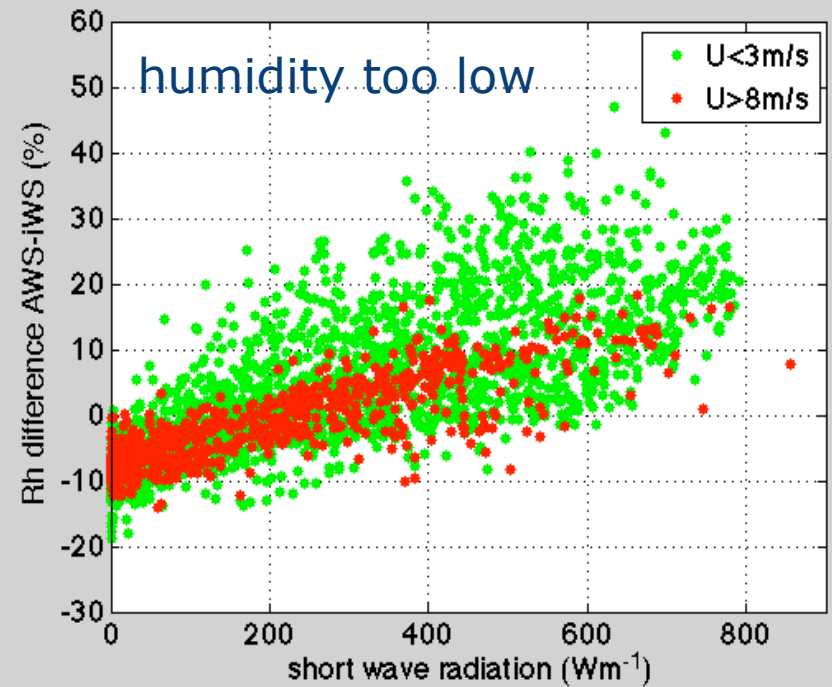
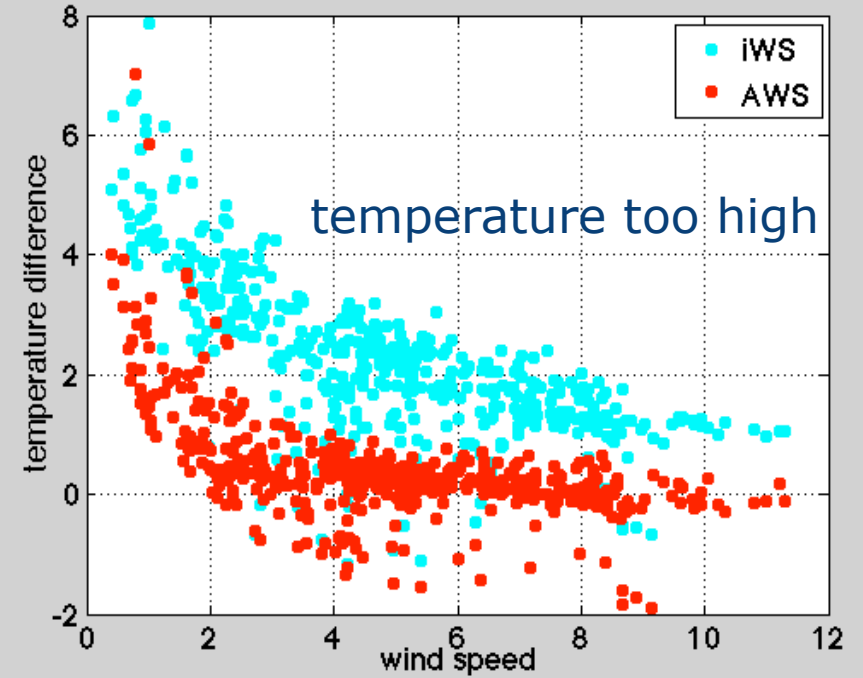
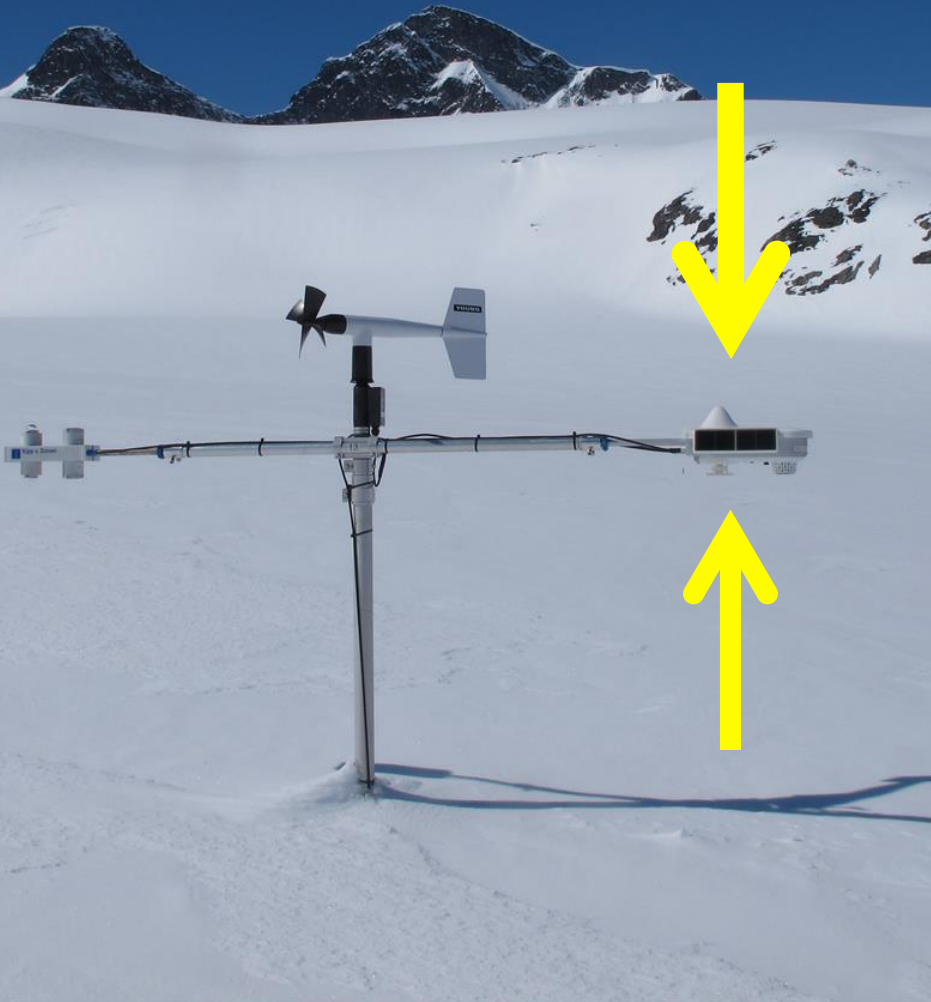
cold versions

GTS transmissions
(not ●)

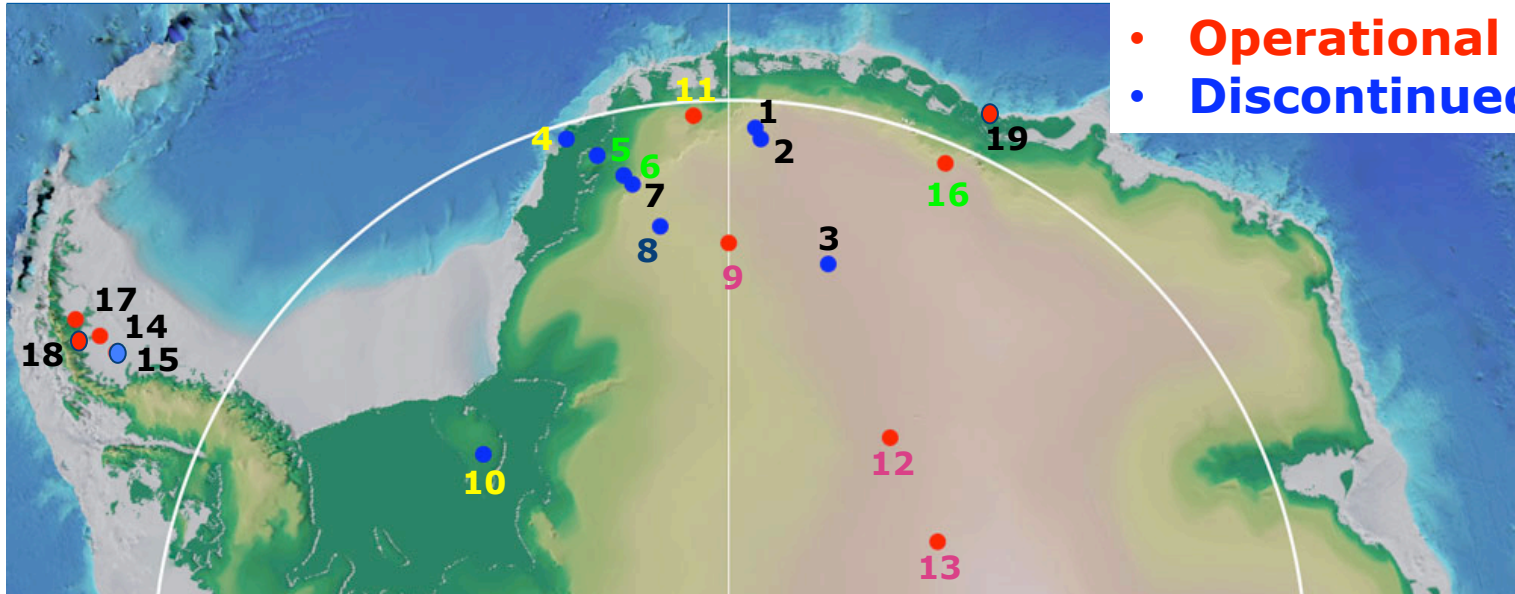
GTS transmissions are temporarily stopped since May 2015

Current problem iWS

short wave radiation



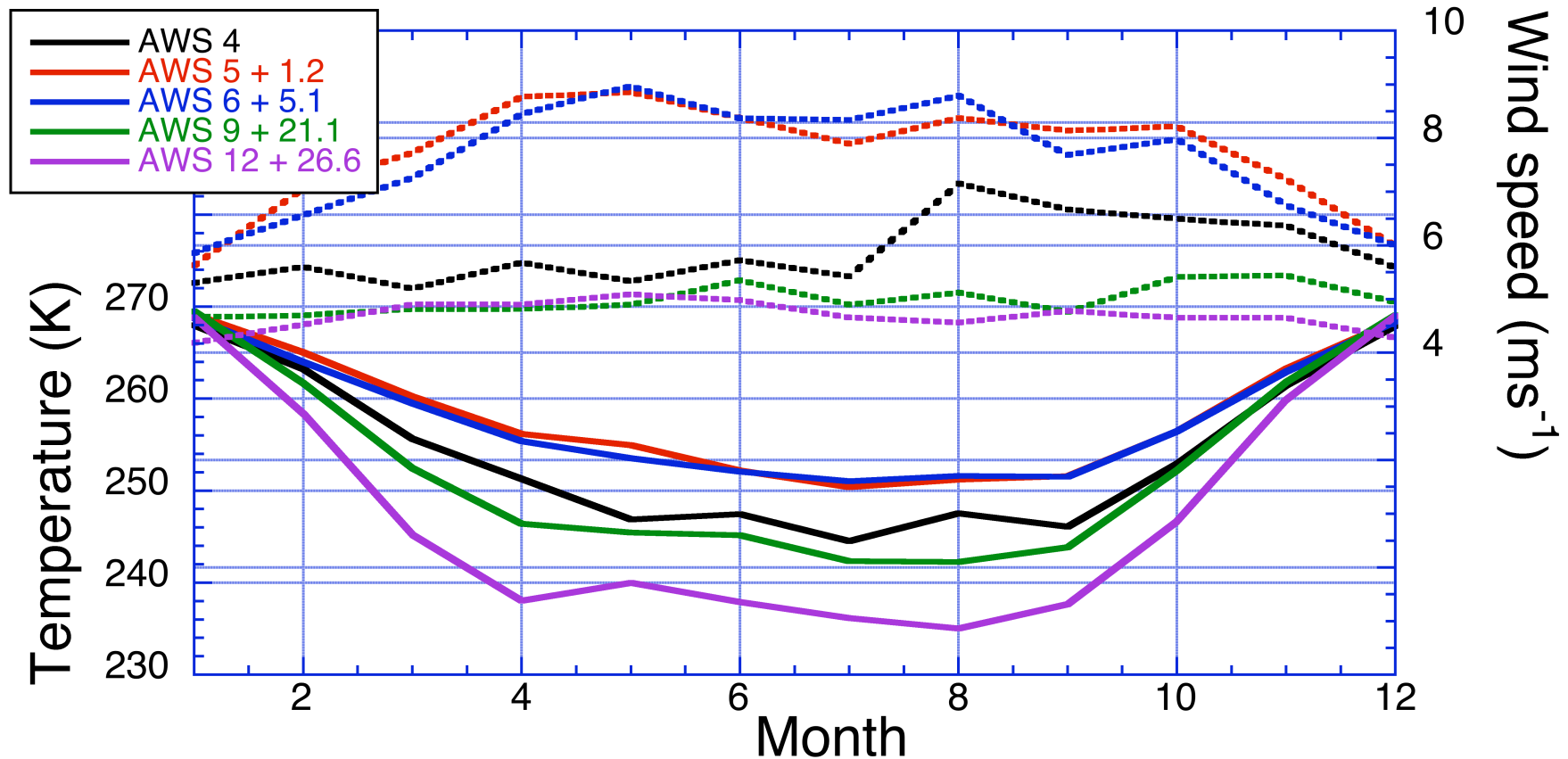
Locations stations: Antarctica



- **Operational**
- **Discontinued**

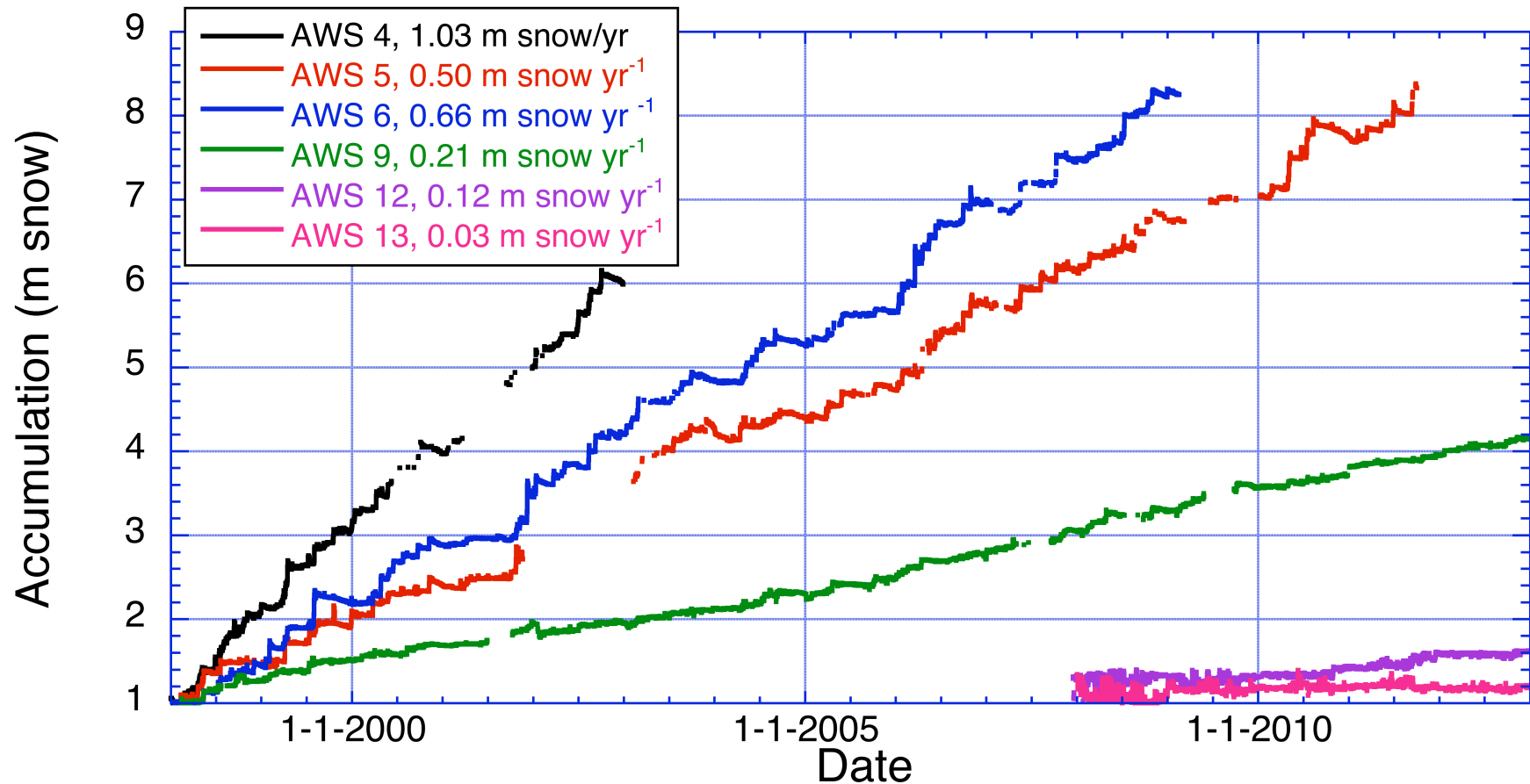
coast 4, 10, 11
escarpment 5, 6, 16
plateau 9, 12, 13

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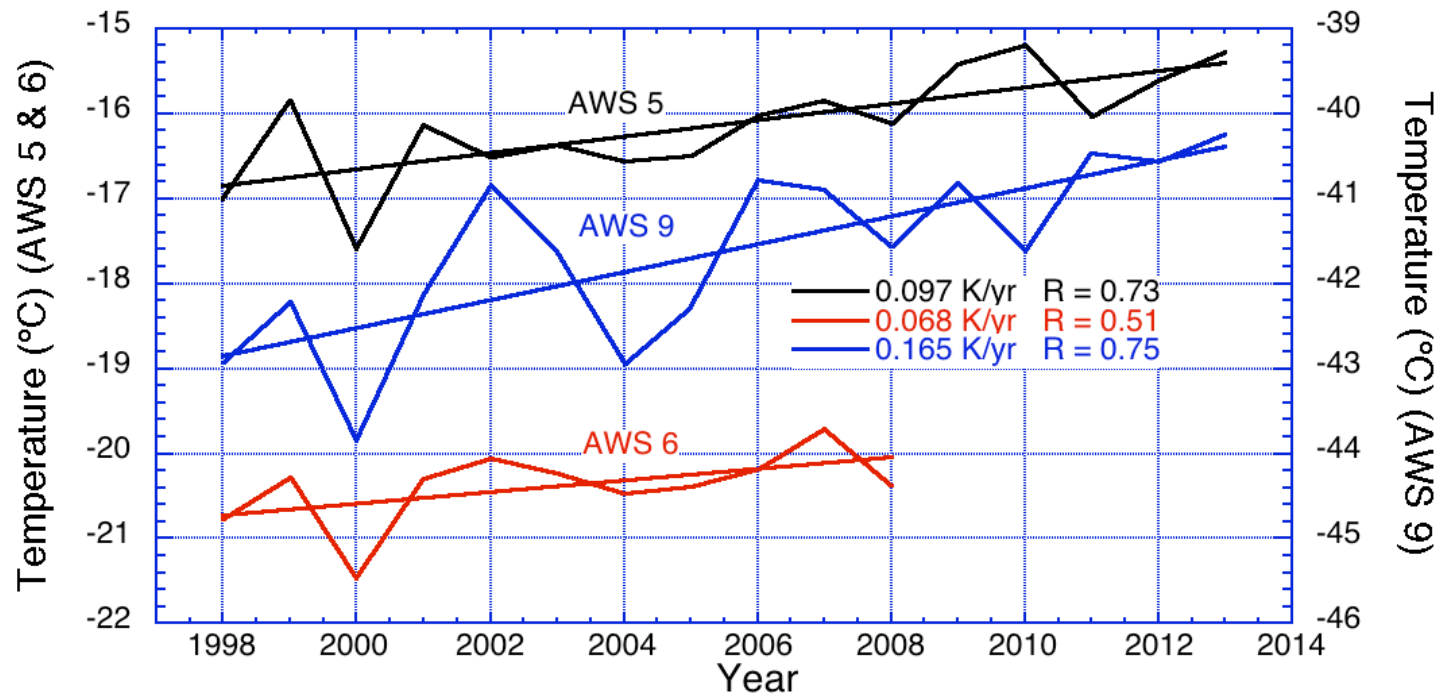
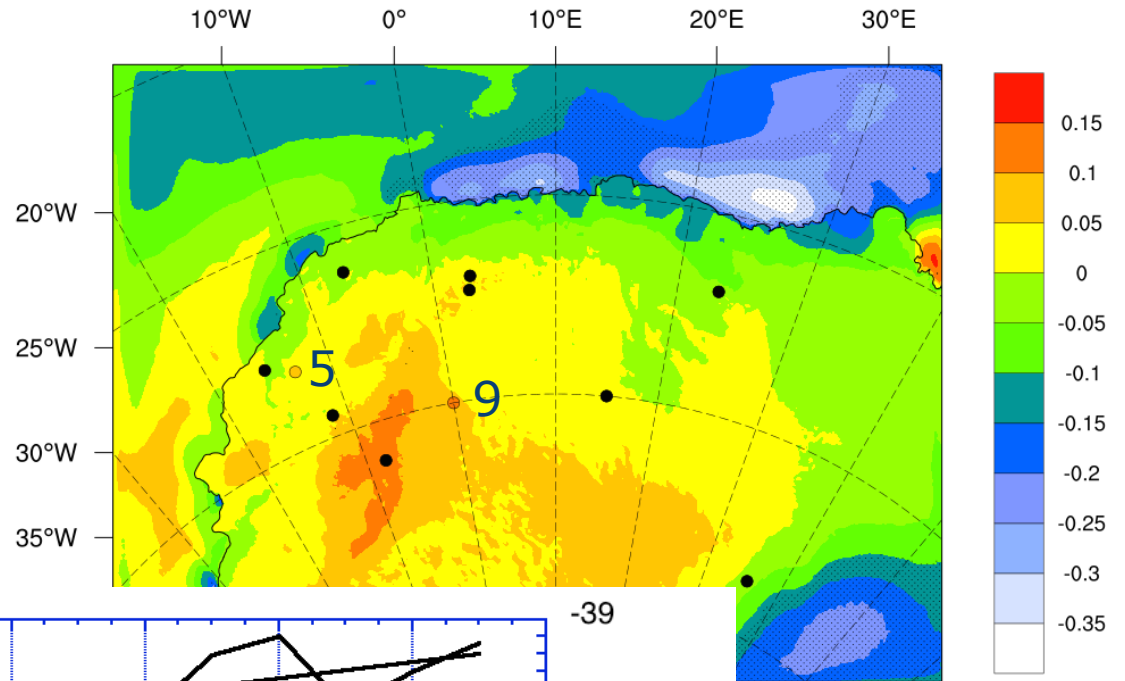
Katabatic winds dominate the wind regime resulting in enhanced mixing of warm air towards the surface and a reduced seasonal temperature amplitude in the escarpment regions.

Time series of accumulation

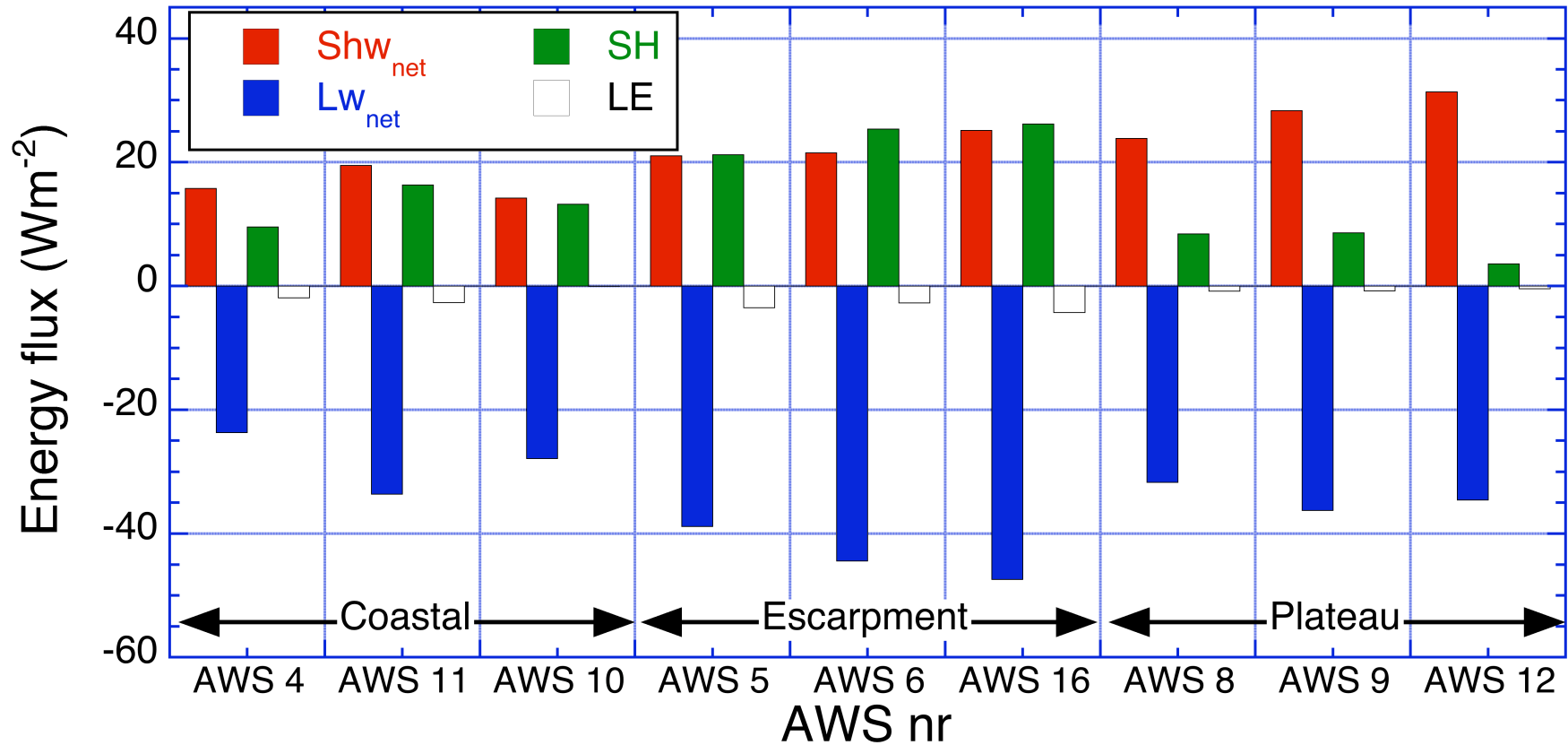


Accumulation is episodic and decreases with distance to the coast to almost zero on the East Antarctic Plateau. Assuming a density of 400 kgm^{-3} , accumulation at AWS 13 is $\sim 12 \text{ mm w.e. yr}^{-1}$.

Trends in long time series

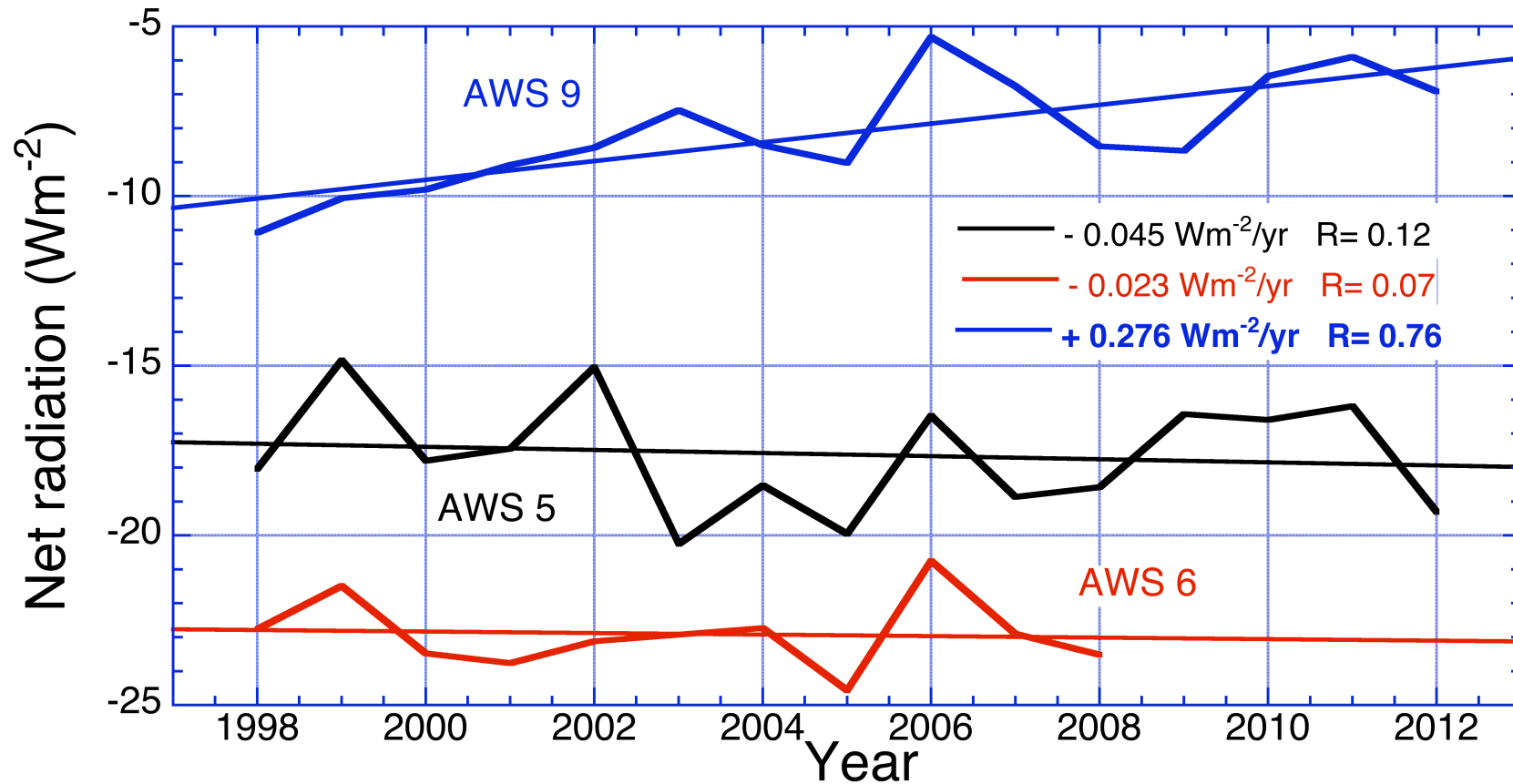


Annual mean energy balance components

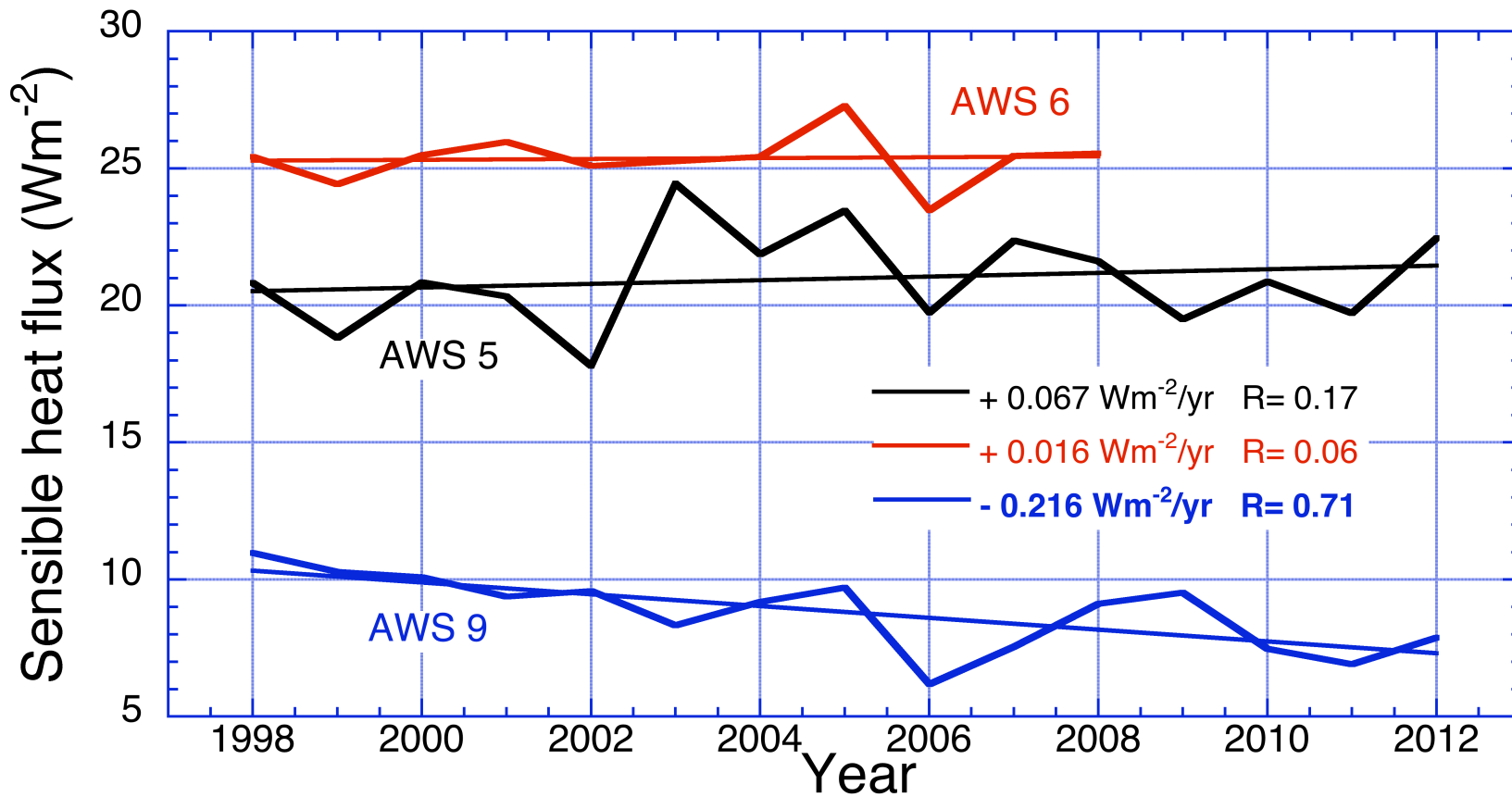


katabatic winds

Annual mean net radiation fluxes



Annual mean sensible heat fluxes



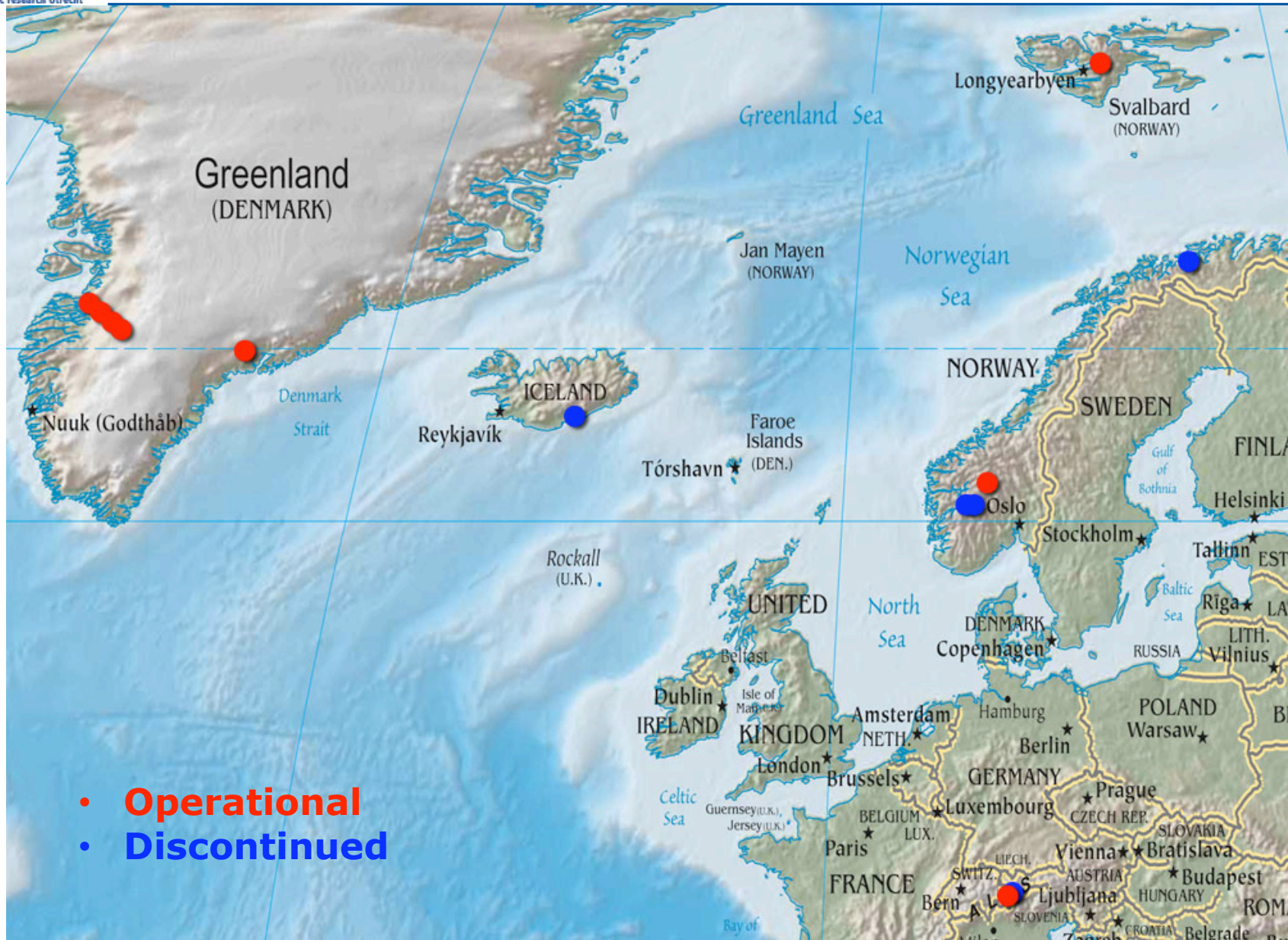
To conclude

- A lot of data available
 - Summer experiments
 - AWS
 - Other experiments
- Can be used for a range of applications
 - Local study climate and mass balance
 - Energy balance/melt calculations
 - Forcing distributed energy balance models
 - Validation models and satellite observations
- Data published in lots of publications, but a lot of available data is not published (yet)
- Website: <http://www.projects.science.uu.nl/iceclimate/>

THANK YOU



Location stations Northern Hemisphere



- **Operational**
- **Discontinued**

Problems, extreme riming

Hardangerjokelen 2006



Hardangerjokelen 2007

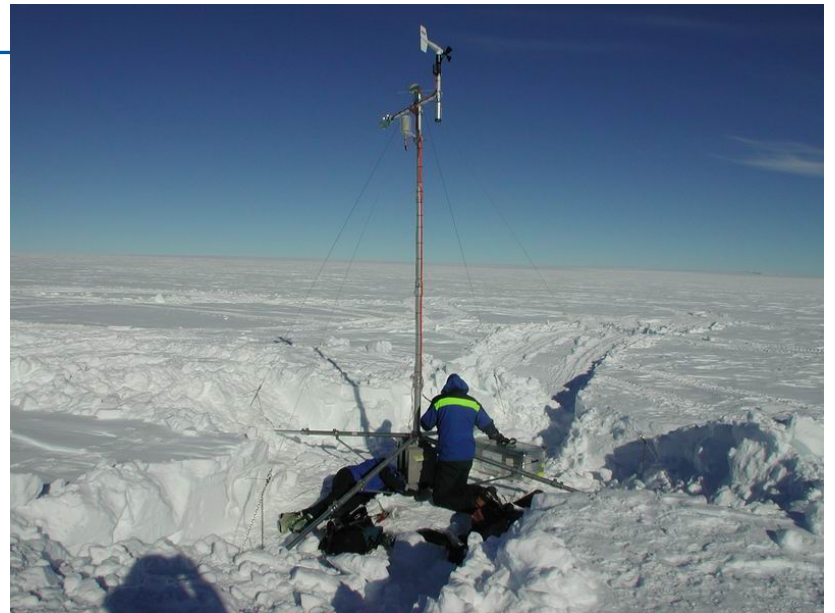


**Problem
riming**



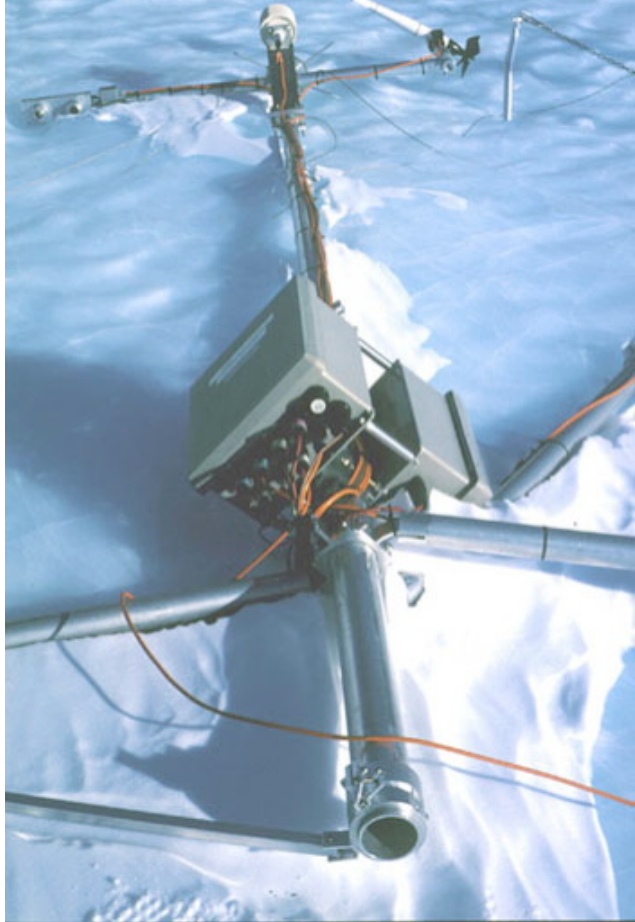
Berkner Island 2006

Problem accumulation

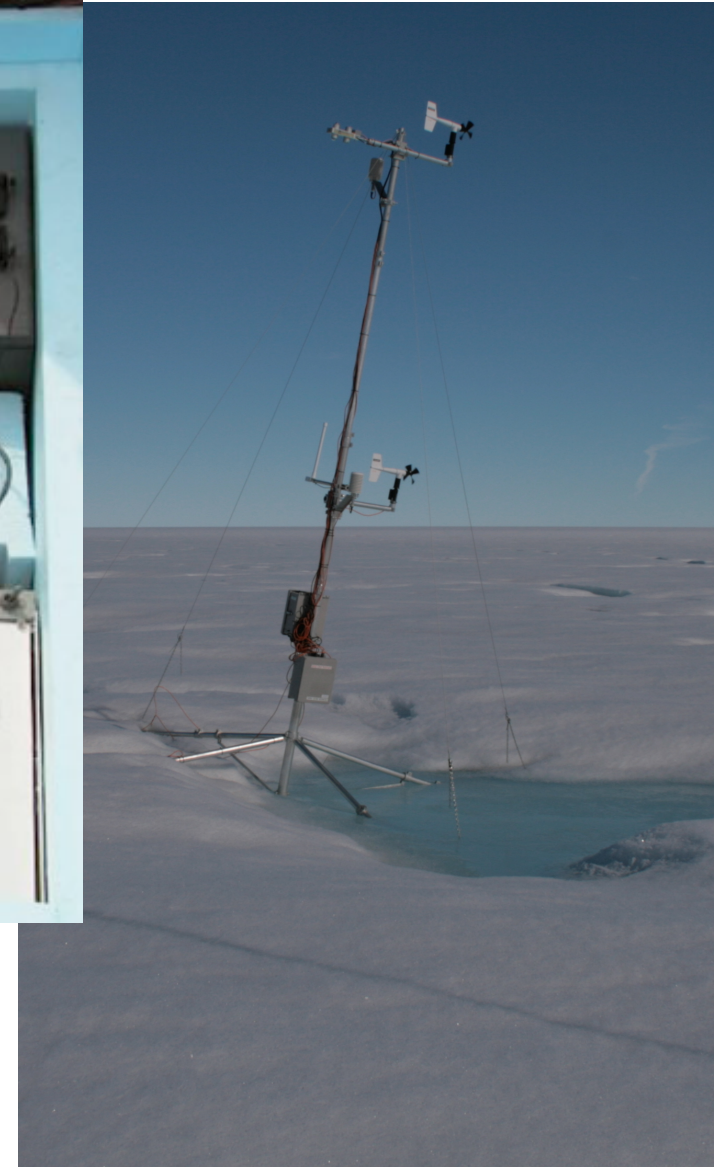
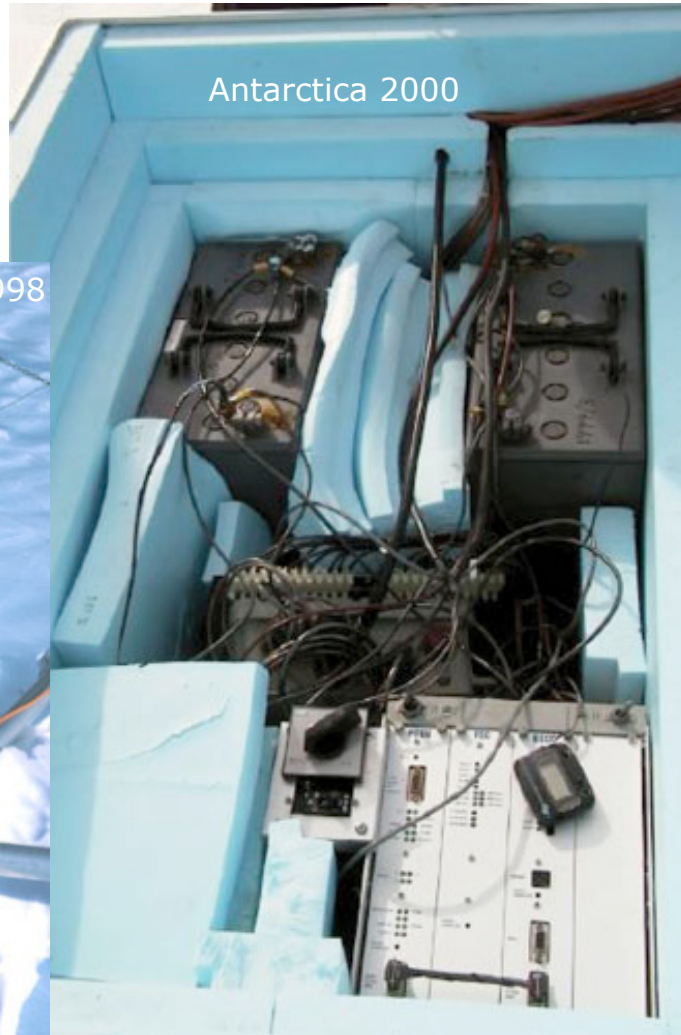


Problem too much wind or energy or melt or

Antarctica BLUE ICE SVEA 1997/1998



Antarctica 2000



Technical development: type III iWS



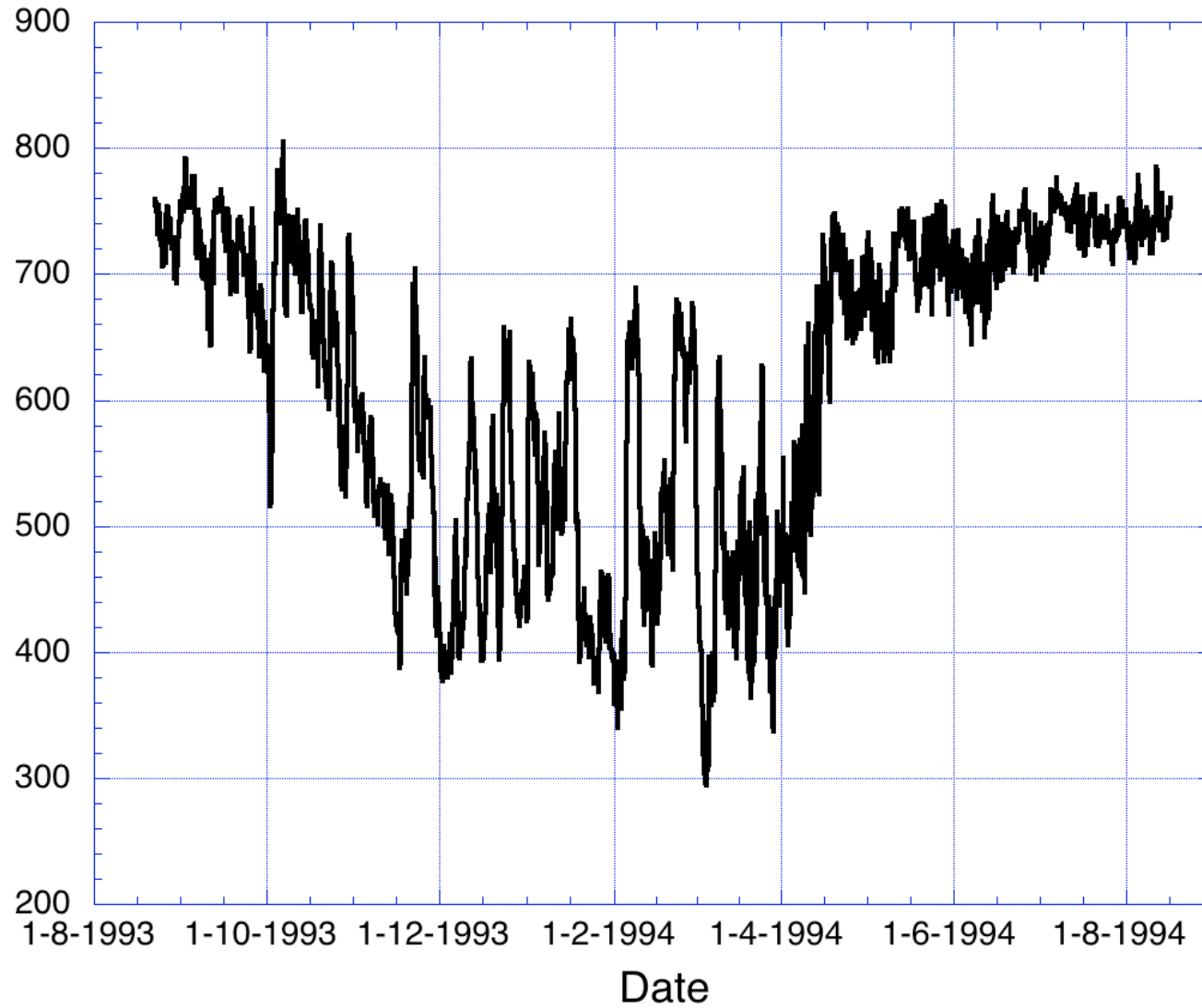
minimal in size and
energy consumption

only mast extensions
no need for digging !

(Besides scientific insights)

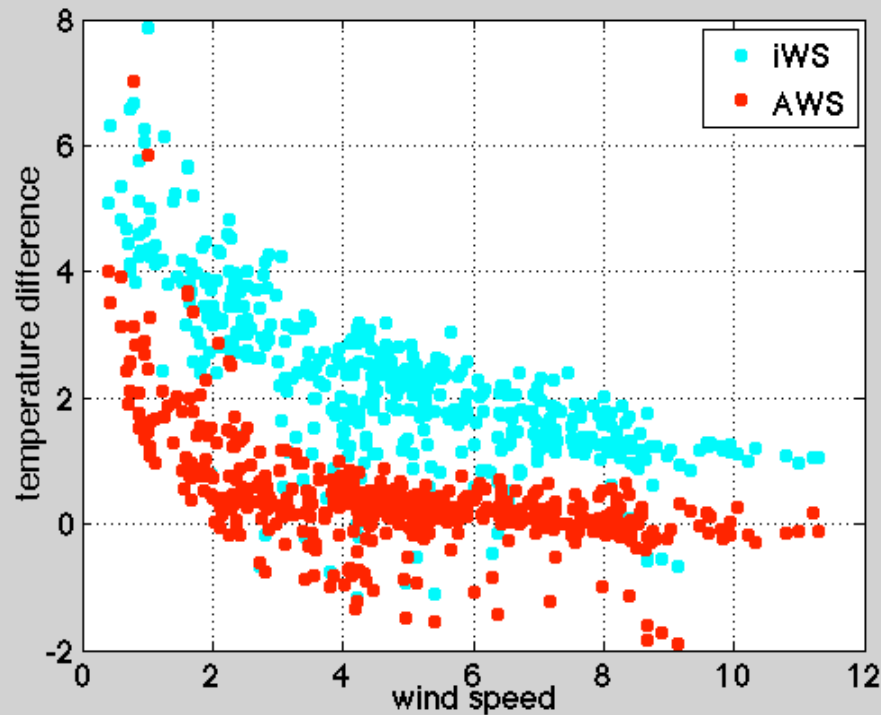
- In ablation zone drilling mast in ice problematic
- Preferably measurements over longer period than a few weeks in one summer
- **Four leg structure**
- **Automatic Weather Stations!!**





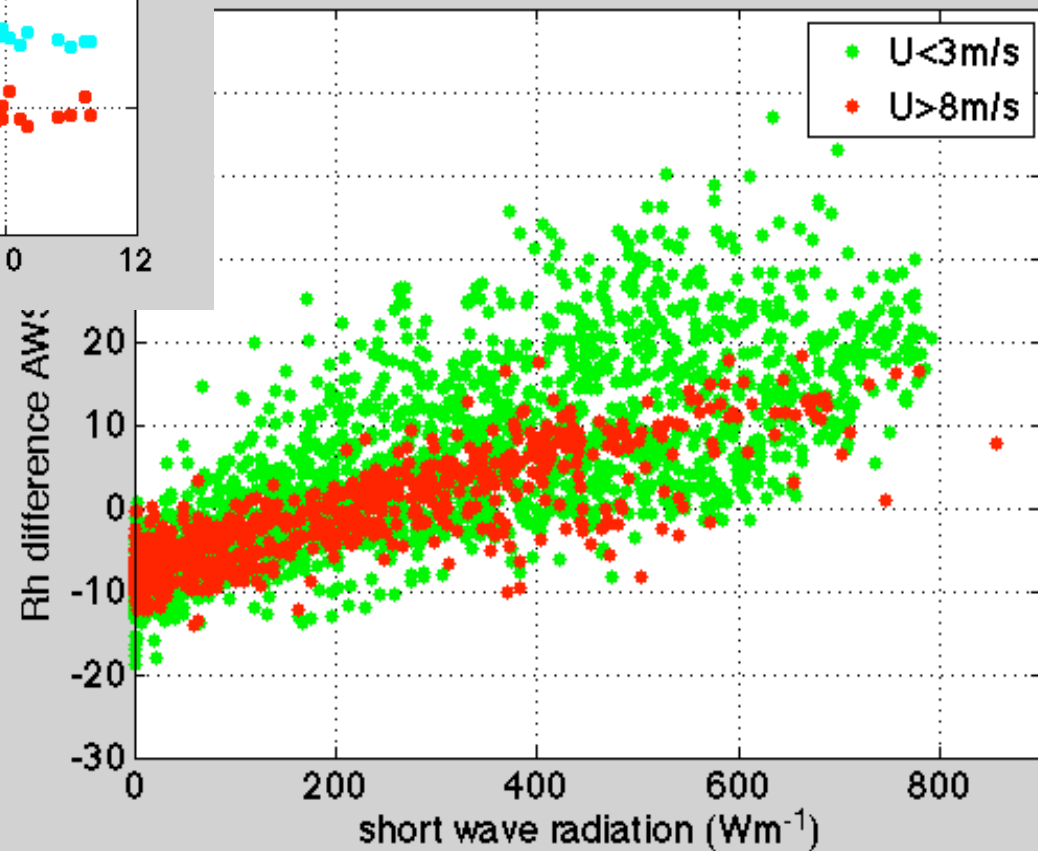
Greenland K-transect (exact location unknown, likely S5 or S6)

Current problem iWS

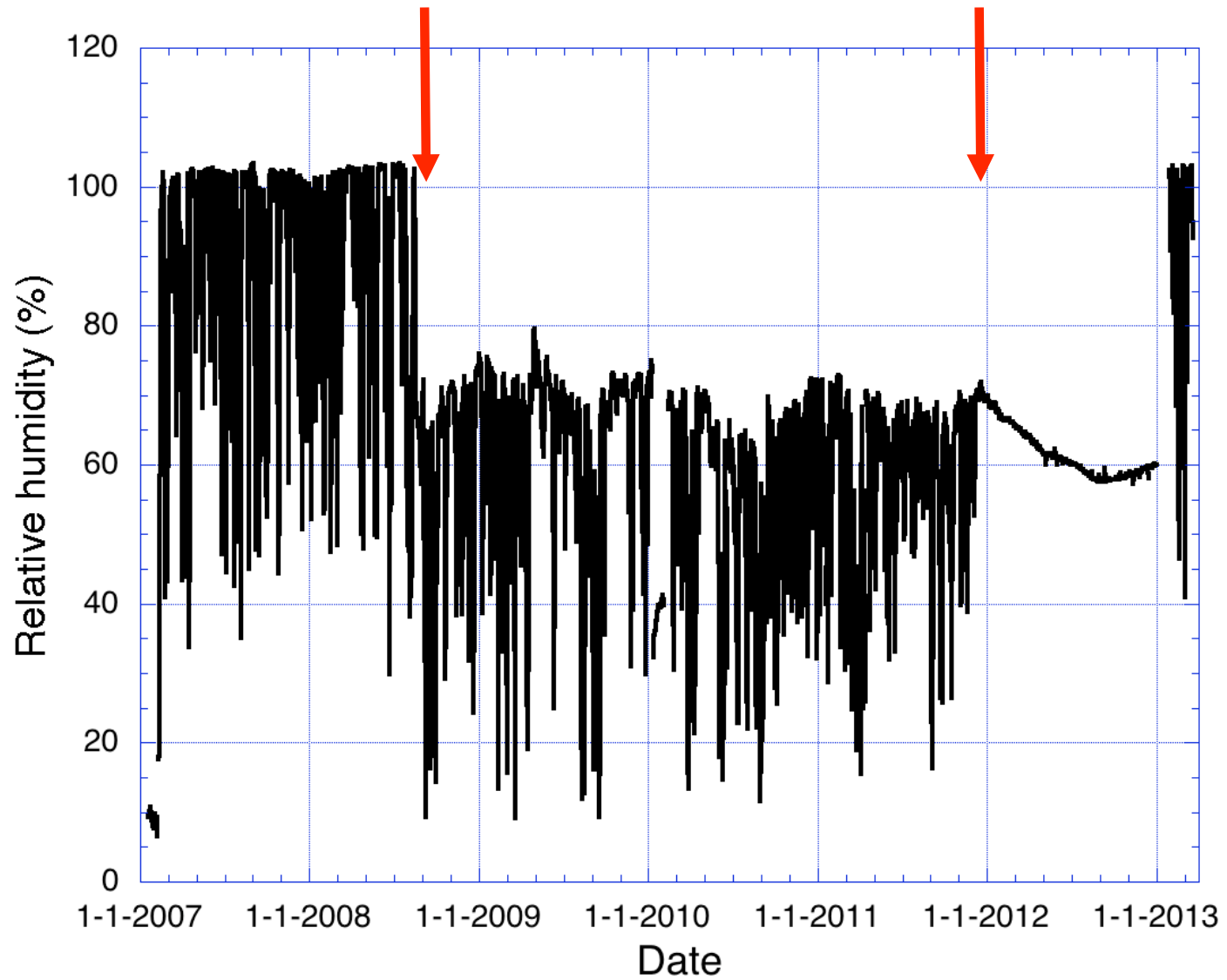


temperature too high

humidity too low



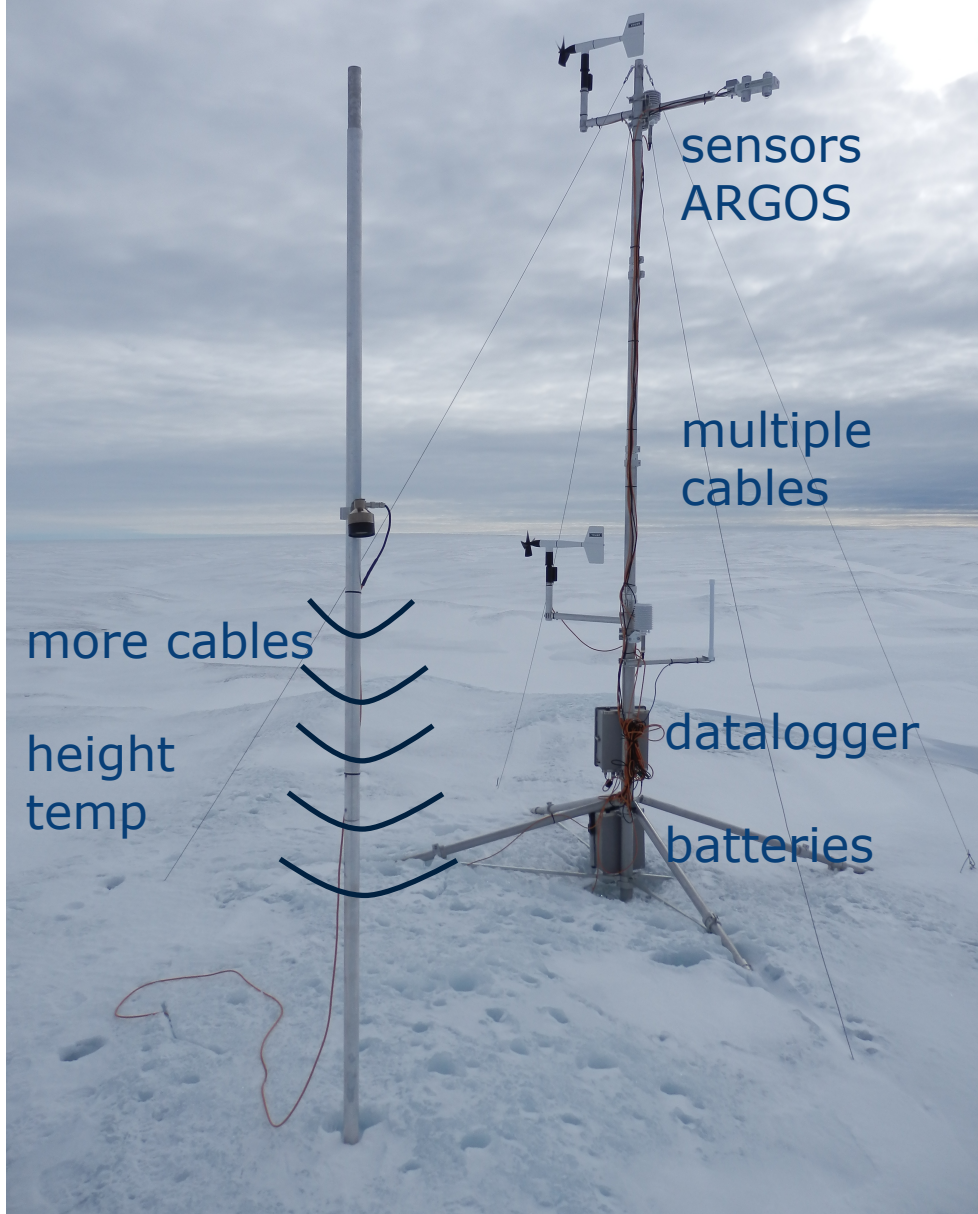
Problems



AWS 11, Halvfarrygen, Antarctica

Technical development: type II versus III iWS

Type II – two level version Greenland



Type III – iWS
first test August 2013-2014
Greenland



Data treatment

- Calibration coefficients applied (radiation)
- WD corrected for yard direction and declination
- H corrected for T deviation of 0°C
- RH calculated with respect to ice if applicable and Anderson (1994) correction
- Rime detection Lw according to Van den Broeke et al. (2004)

- Spike removal by setting reasonable min and max
- When applicable recalculated to hourly values

Problems in data set

- Metadata documentation (sensor numbers, yard directions)
 - Lack of ventilation T sensor
 - Rime formation on sensors
 - Breaking down of sensors
 - Change of sensors
-
- Importance of all radiation components for energy balance calculations
 - Importance of humidity

