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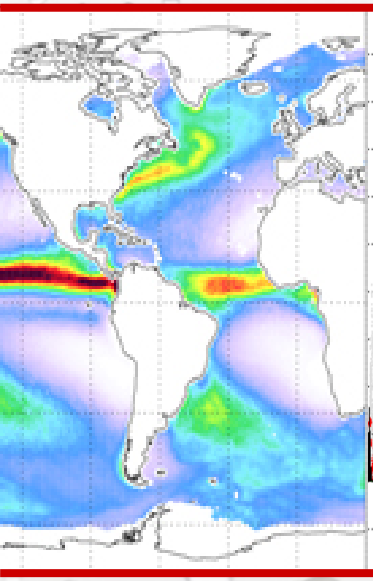
oceanRAIN

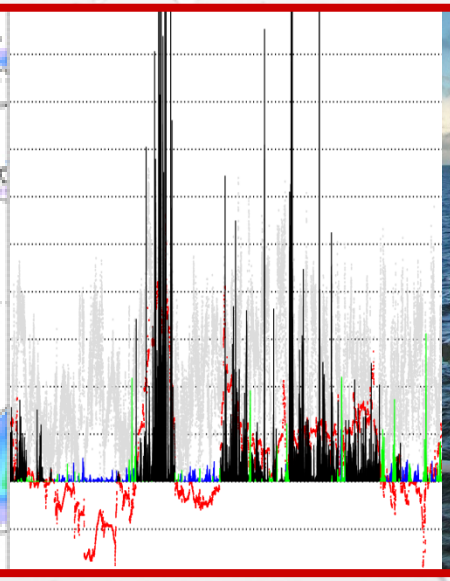
Ocean Rain And Ice-phase precipitation measurement Network

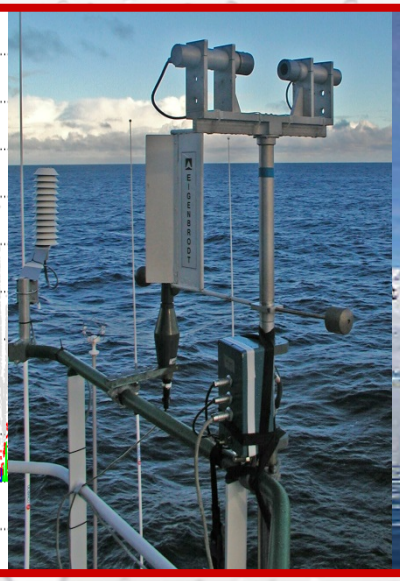
Christian Klepp [1,2], Andrea Dahl [3]

[1,2] University of Hamburg, Max Planck Institute for Meteorology, Germany
[3] Eigenbrodt GmbH & Co. KG, Königsmoor, Germany

christian.klepp@zmaw.de, andrea@eigenbrodt.de







Outline

- Why OceanRAIN
- Optical disdrometer system
- Calibration and Accuracy
- Data Ingest
- Data Set Construction
- Measurement Examples
- Summary

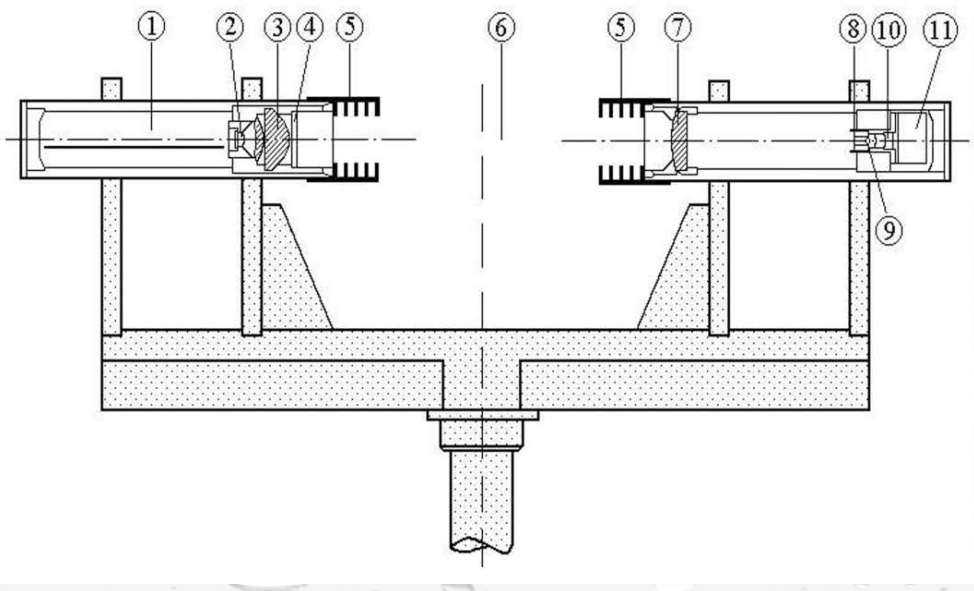
Why OceanRAIN ?

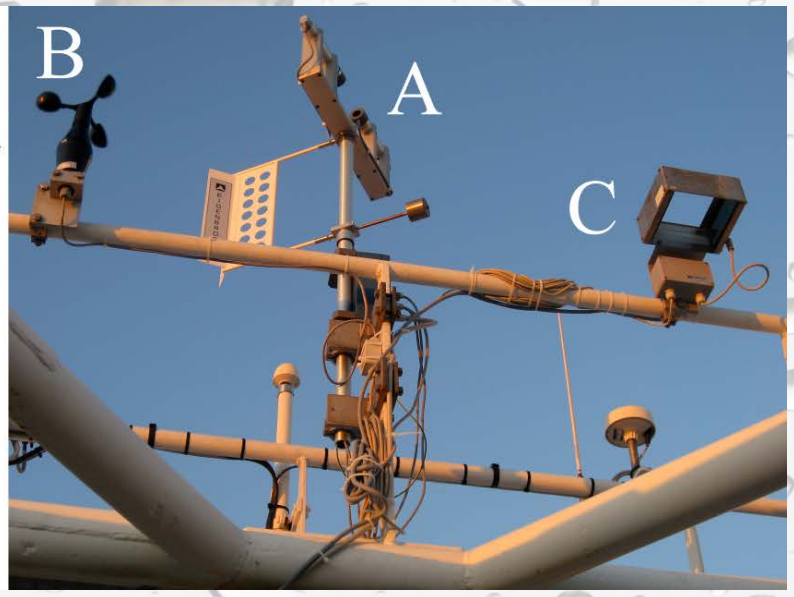
- Precipitation flux is ECV
- Energy and water cycle & freshwater flux
- Different phases (types)
- Intermittent parameter
- Measurement notoriously difficult
- Oceans void of in-situ data, lack of suitable in-situ instrumentation for shipboard usage
  VOS, ship gauge undercatch & snow issues
- Large uncertainties of in-situ, satellite, reanalysis and model data
  light rain and snow, no phase information.

→ High quality in-situ oceanic precipitation reference data is required and crucial for validation and calibration of GPM era satellites, algorithms and error characterization and to improve our knowledge about oceanic precipitation

Taylor (2000): "…no more than a few thousand [gauge] samples worldwide…"
Klepp (2014): "…more than 5 million samples of rain, snow and mixed-phase worldwide, steadily growing…"

Automatic Measurement System: Optical Disdrometer ODM470



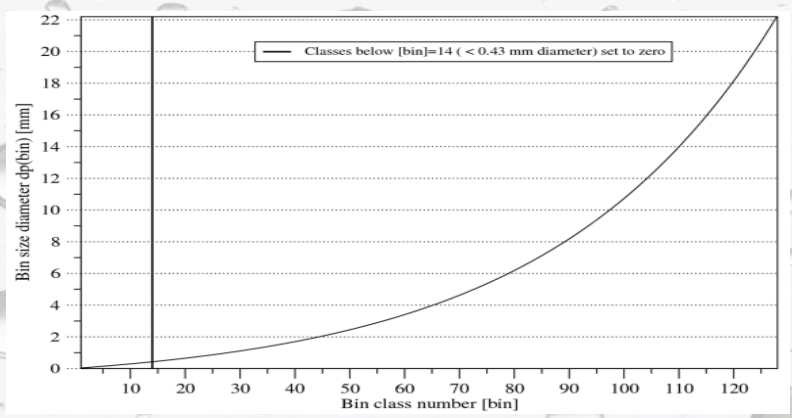


- sensitive volume volume 120 mm x 22 mm
- photoelectric barrier IR-LED
- reference voltage attenuates with occurrence of hydrometeors
- a size dependent light extinction measures cross-sectional area
- 128 size bins
- measurement interval 1 minute
- allocated bins
- number of particles per bin
- residence time of particles
- relative wind speed

ODM470
IRSS88
Cup anemometer
Embedded PC
UPS

Logarithmic size binning

$$D_p(bin) = \frac{e^{(\frac{bin}{94}\cdot \ln 10)} - 1 + e^{(\frac{bin+1}{94}\cdot \ln 10)} - 1}{2}$$



Particle size distributions

n(bin) = particle size distribution density (Clemens, 2002)
by particle counting N(bin)

$$n(bin) = \frac{N(bin)}{l \cdot d \cdot t \cdot \sqrt{U_{rel}^{\ 2} + (V_{fall}(bin))^2}}$$

after Großklaus (1996)

Rain and snowfall algorithm

$$P = 3600 \cdot \sum_{bin=0}^{128} n(bin) \cdot V_{fall}(bin) \cdot M_{particle}(bin)$$

Parameterizations for rain and snow

Rain:

$$M_{particle}(bin) = \frac{4}{3} \cdot \pi \cdot 1000 \cdot \left(\frac{D_p(bin)}{200}\right)^3$$

$$V_{fall}(bin) = 9.65 - 10.3 \cdot e^{(-1.2 \cdot \frac{D_p(bin)\cdot 10}{2})}$$

Atlas and Ulbrich, 1974

Snow (LWE):

$$M_{particle}(bin) = 0.0000107 \cdot (D_p(bin))^{3.1}$$

$$V_{fall}(bin) = 7.33 \cdot (D_p(bin))^{0.78}$$

Hogan, 1994 and Lempio, 2007

Automatic Measurement System: Optical Disdrometer ODM470

Publications : Großklaus, Ulbrich, Bumke, Clemens, Lempio, Klepp

Advantages over existing optical disdrometers

- developed for shipboard usage
- all-weather capability
- fully automatic system
- low maintenance requirements
- cylindrical volume
- pivoting
- high dynamic range
- rain and snowfall algorithm, PSD
- high accurracy

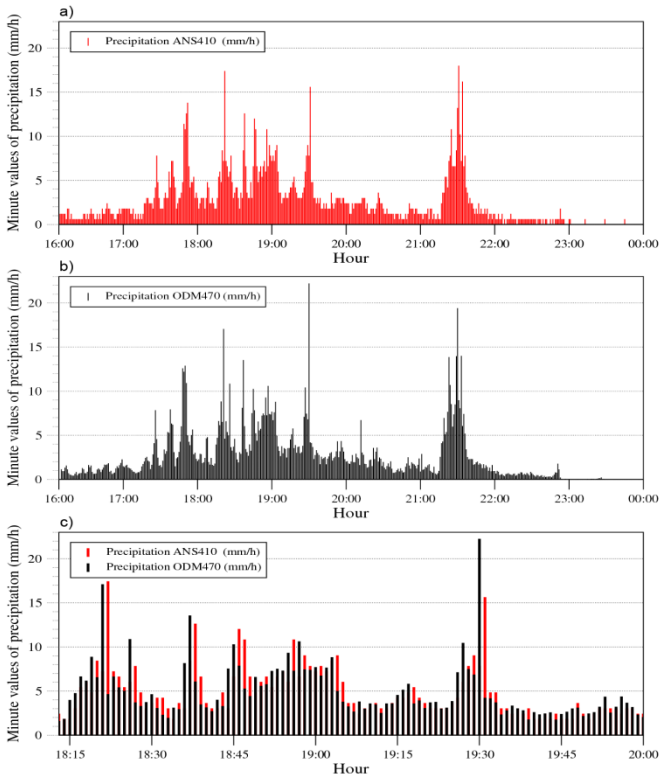
Developed by Univ. Kiel

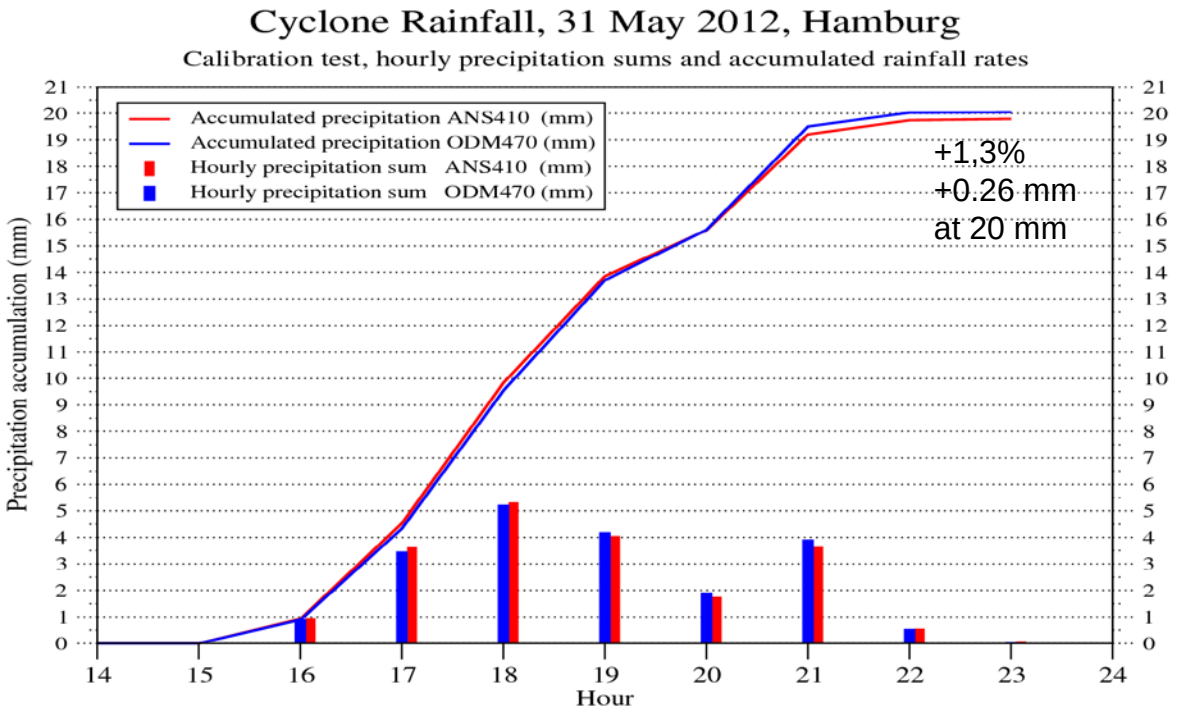
Meet us at the mini tradeshow
and our poster on Wednesday

Calibration

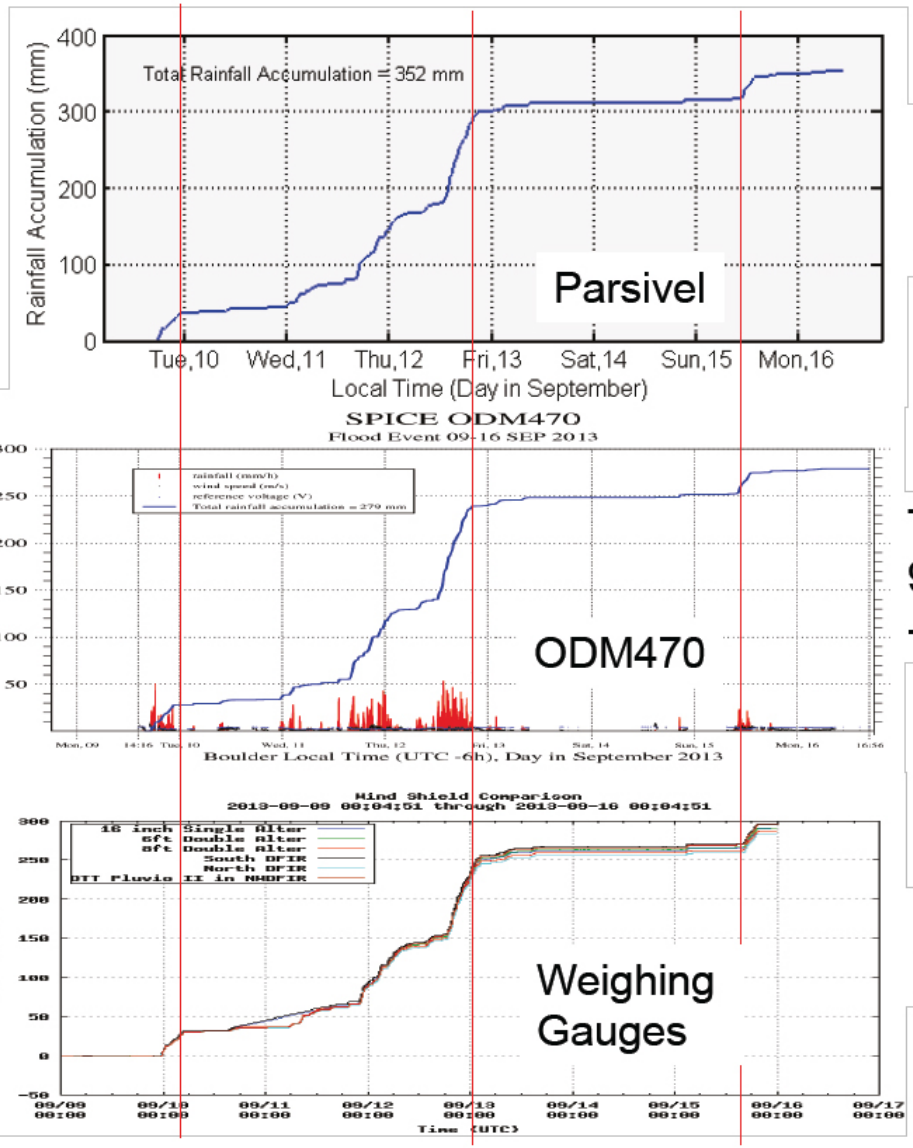
Optical axis adjustments
Spherical particles from 0.5 to 22 mm
Disdrometer-constant for precip volume scaling

ANS410 gauge vs ODM470 disdrometer
Windspeed < 1 m/s to avoid gauge undercatch

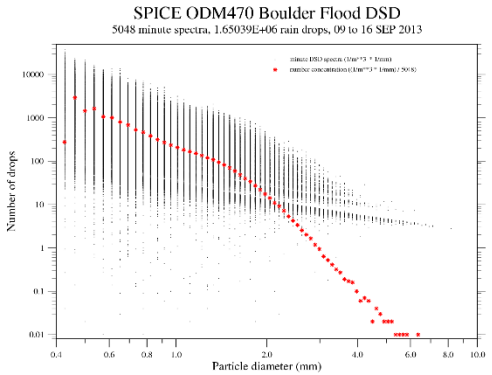




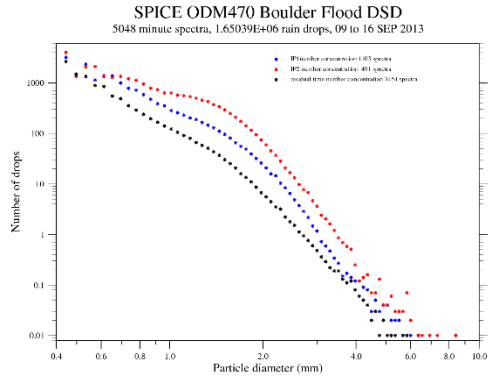
Accuracy: SPICE extreme event, Front Range flood 9-16 Sep 2013



Total 352 mm
123.5% of reference
+23.5% to reference



Total 279 mm
97.9% of reference
-2.1% to reference



Total ~285 mm
REFERENCE

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OceanRAIN

- founded 2009 at the Univ. Hamburg and MPI-M, Hamburg, Germany
- close cooperation with Eigenbrodt

- aims at a comprehensive statistical basis of long-term high-quality global oceanic precipitation data using ODM470 optical disdrometers

- provides occurrence, intensity, accumulation
- rain, snow, mixed-phase
- with minute resolution through particle size distributions
- for validation of satellite, re-analysis and model data
- statistical and process study analysis
- point to area analysis

- currently > 5 million minutes of measurements
- in all climatic regions and all seasons

Klepp C., Bumke, K., Bakan, S., Bauer, P., 2010. Ground validation of oceanic snowfall detection in satellite climatologies during LOFZY. Tellus A 62(4), 469-480. http://dx.doi.org/10.1111/j.1600-0870.2010.00459.x.
Klepp, C., 2014. The Oceanic Shipboard Precipitation Measurement Network for Surface Validation – OceanRAIN. J. Atmos. Res., Special Issue of the International Precipitation Working Group IPWG6, under review.

Long-term data ingest

Since 2010: Installations onboard 9 ships

R/V Celtic Explorer

K/V Senja

R/V Aranda

R/V Polarstern

R/V Akademik Ioffe

R/V Maria S. Merian

R/V Sonne

R/V Meteor

R/V S.A. Alguhas II

R/V Investigator

R/V Sonne II

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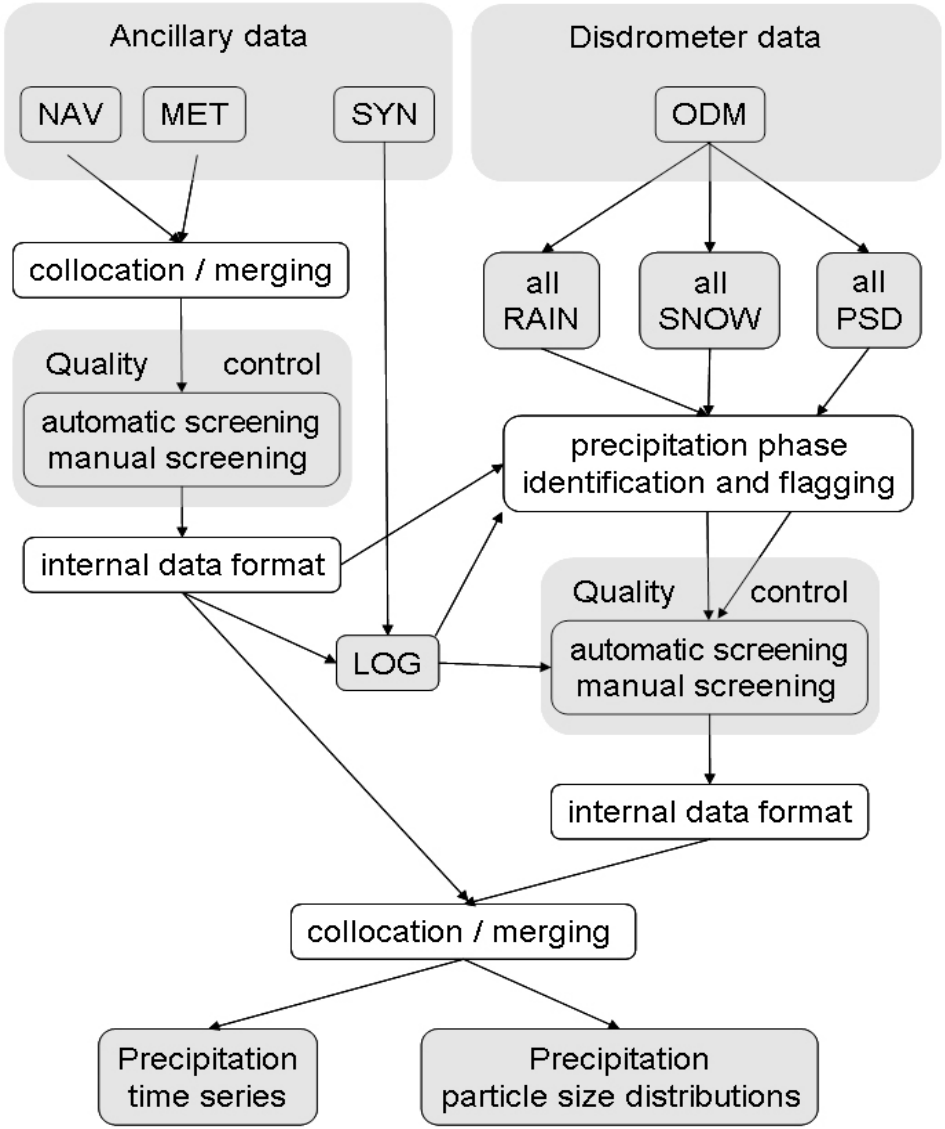
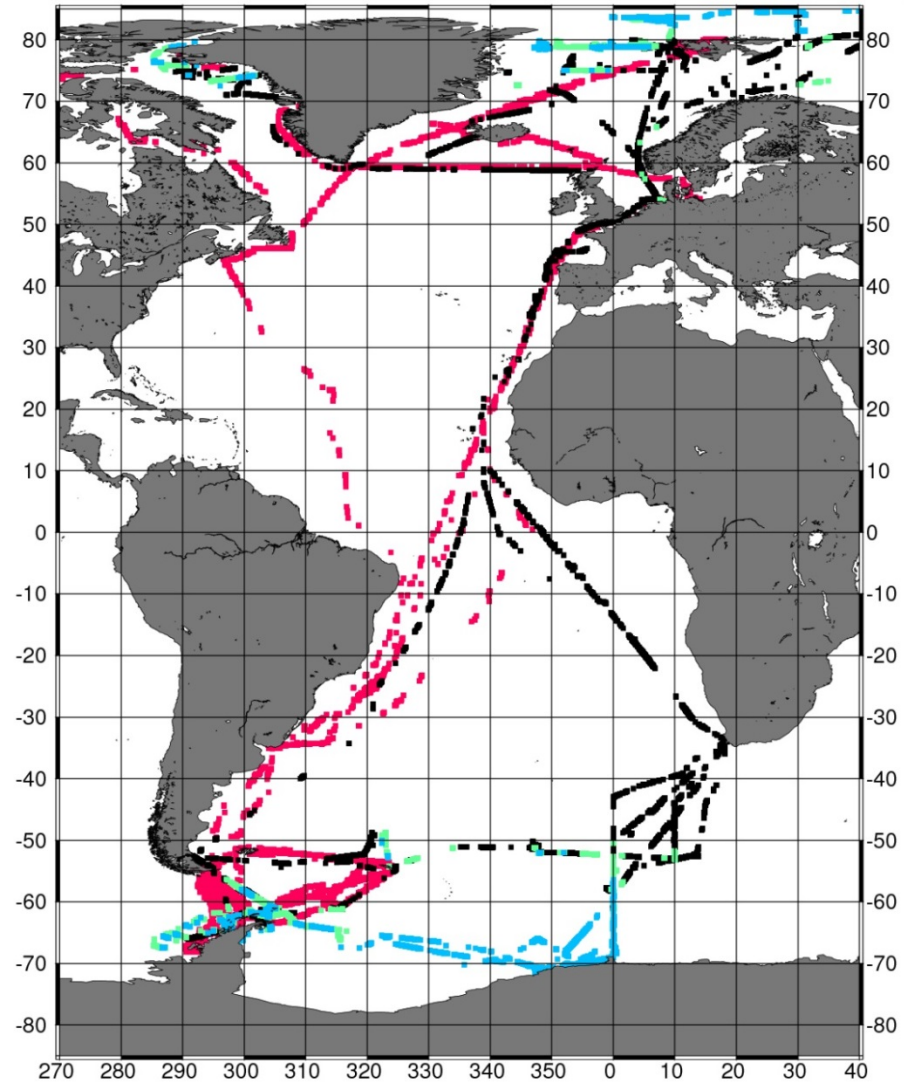
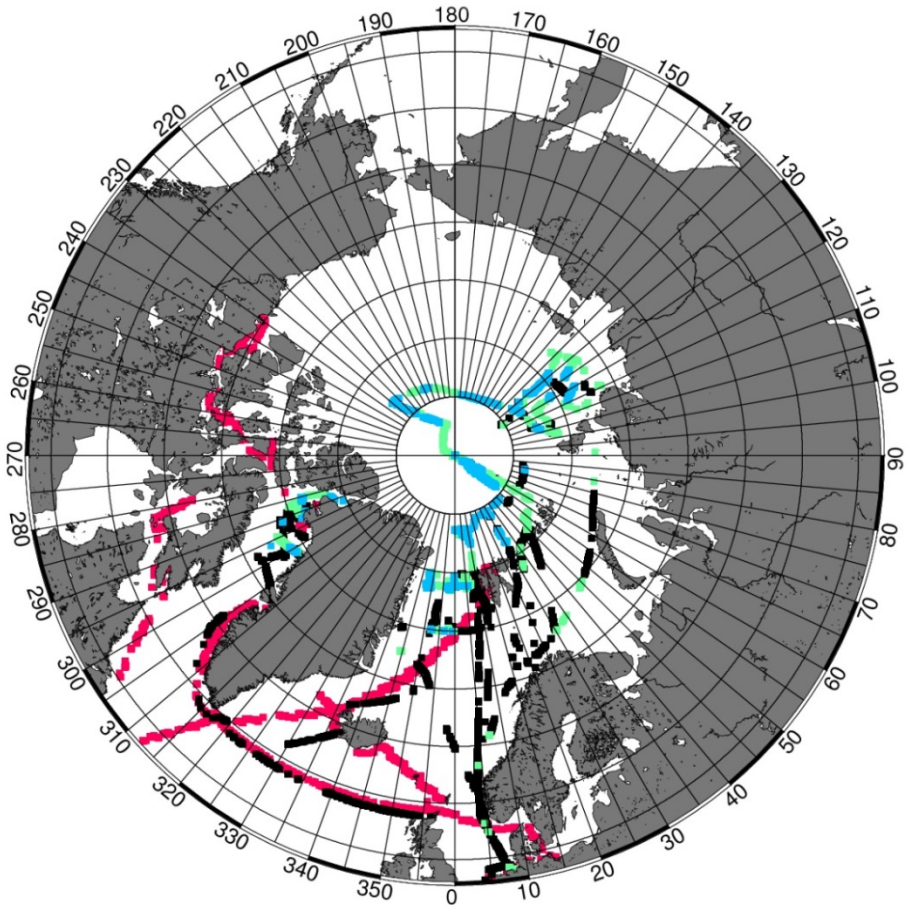
Data set construction



parameter	unit or value range	source
line count	[ ]	calculated
date	DDMMYYYY	common to all
time	HHMM [UT]	common to all
minute of the day	1-1400	calculated
continuous count	seconds since 01.06.10	calculated
latitude	-90° to 90°	NAV
longitude	-180° to 180°	NAV
air temperature	°C	MET
dew point	°C	MET
water temperature	°C	MET
relative humidity	%	MET
sea level pressure	hPa	MET
relative wind speed	m/s	MET
relative wind direction	deg	MET
absolute wind speed	m/s	MET
absolute wind direction	deg	MET
global radiation	W/m^2	MET
direct radiation	W/m^2	MET
horizontal visibility	m	MET
cloudbase height	m	MET
max wind speed	m/s	MET
ship rain gauge	mm/h	MET
precipitation rate	mm/h	ODM
relative wind speed	m/s	ODM
reference voltage	V	ODM
precipitation flag	0=rain, 1=snow, 2=mixed, 3=true zero, 4=inoperative, 5 = harbor times	calculated

Measurement examples: Precipitation track occurrence

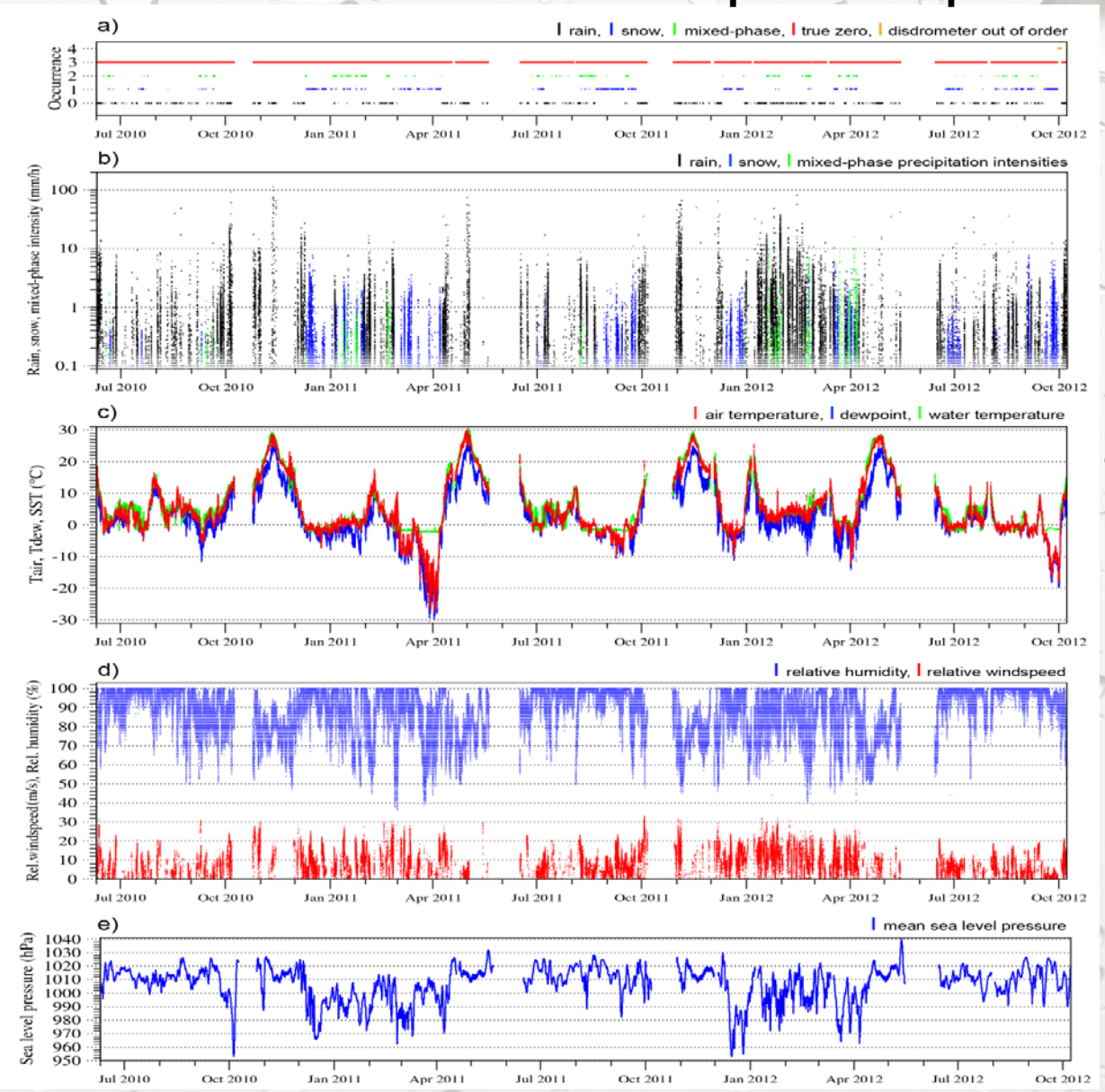




R/V 'Polarstern' and R/V 'Akademik Ioffe' precipitation tracks

For the first time cold season Southern Ocean data with > 40.000 minutes of snow

Measurement examples: Precipitation time series



> 4 years of data from R/V Polarstern Jun 2010 to Oct 2014 ongoing

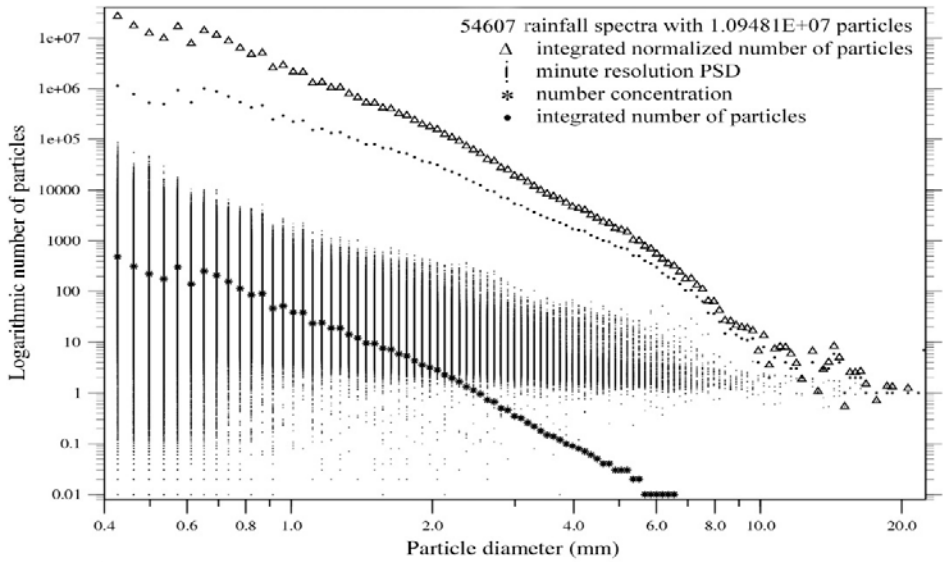
78023 minutes of rainfall (black)
83839 minutes of snowfall (blue)
23858 minutes of mix-phase (green)

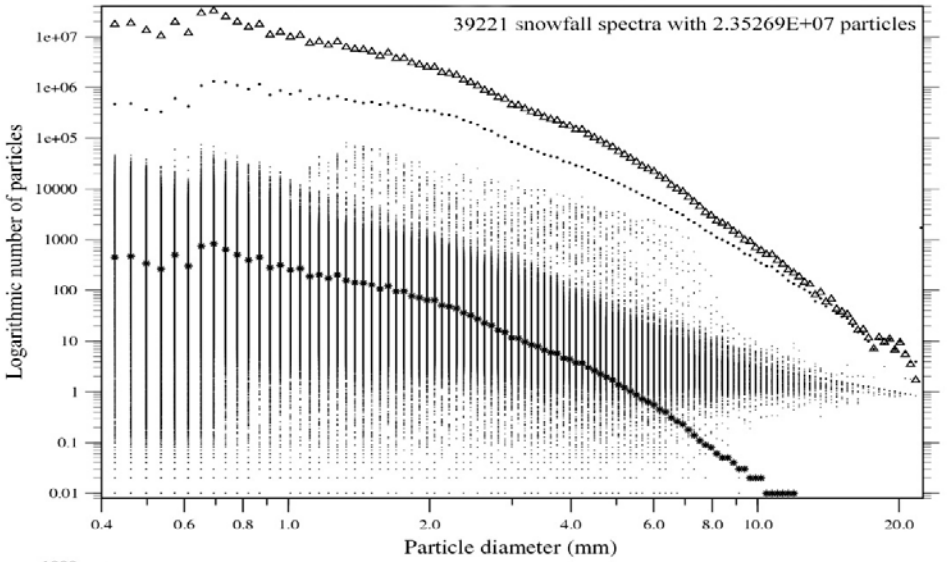
185720 minutes of precipitation equiv. 14.4% of the time

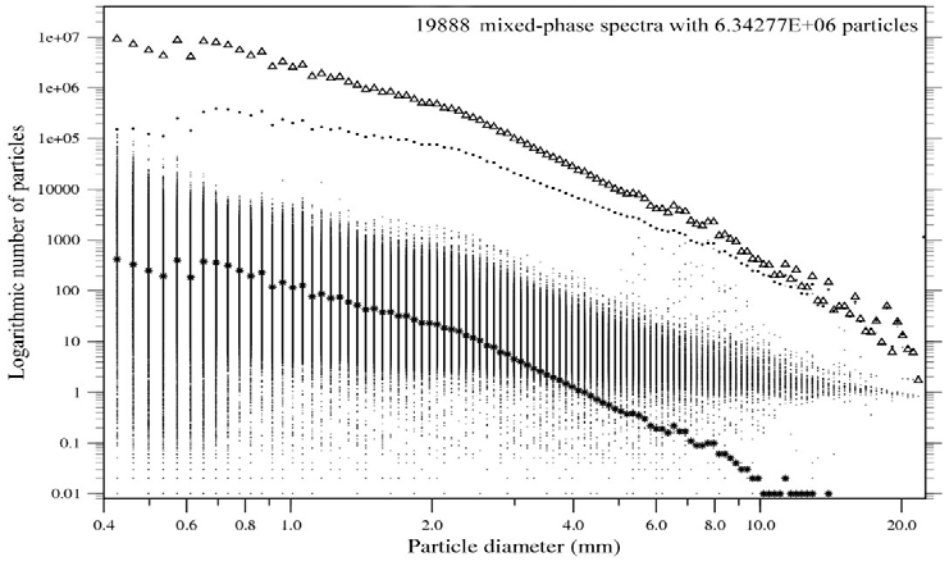
By Nov 2014:
> 5 Million minutes avail
> 500.000 non-zero values from 9 ships worldwide

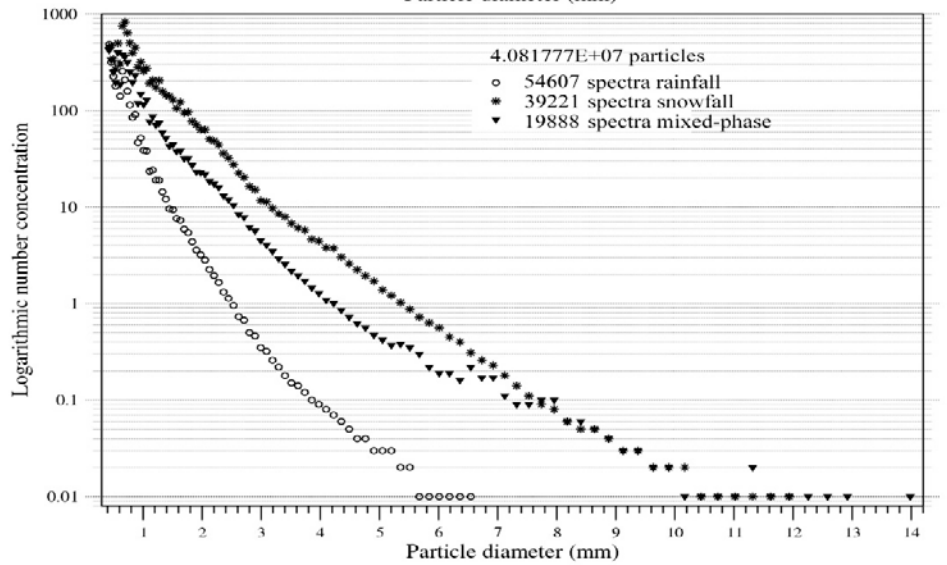
Measurement examples: Precipitation particle size distributions

27 months ODM470 precipitation R/V "Polarstern" from 10 June 2010 to 07 October 2012









Summary

- OceanRAIN is to date the only systematic long-term global ocean precipitation measurement effort for surface validation.
- High precision all-weather disdrometer systems.
- Low maintenance requirements.
- Automatic optical disdrometer system installed onboard 9 research vessels since 2010.
- Rain, snow and mixed-phase occurrence, intensity and accumulation through particle size distributions
- Rain and snowfall algorithms, automatic phase detection
- About 5 million minutes of data, steadily growing

www.oceanrain.org

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Thank You!

R/V Polarstern mast in 45 m height on 2 October 2012 in the Arctic