AIR SEA FLUXES OF CO_2 OVER A HIGH LATITUDE FJORD IN GREENLAND

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OUTLINE

Introduction: Importance of the large fjordsystems in Greenland for CO_2 air – sea exchange

Measurements: Fluxes of CO_2 measured over a high Arctic fjord using Eddy Covariance and spectral techniques

Data analysis and conclusions: Is Sea spray an important ”player” here?

THE GREENLANDIC DEEP FJORD SYSTEMS

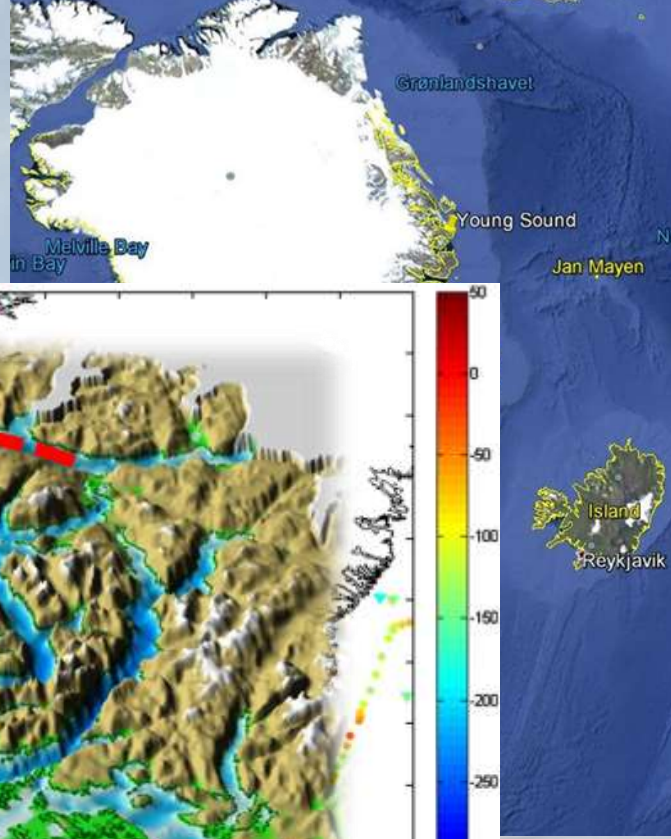
Size of the coastal area:

Greenland: 920 x 10^3 km^2

Global: 26000 x 10^3 km^2

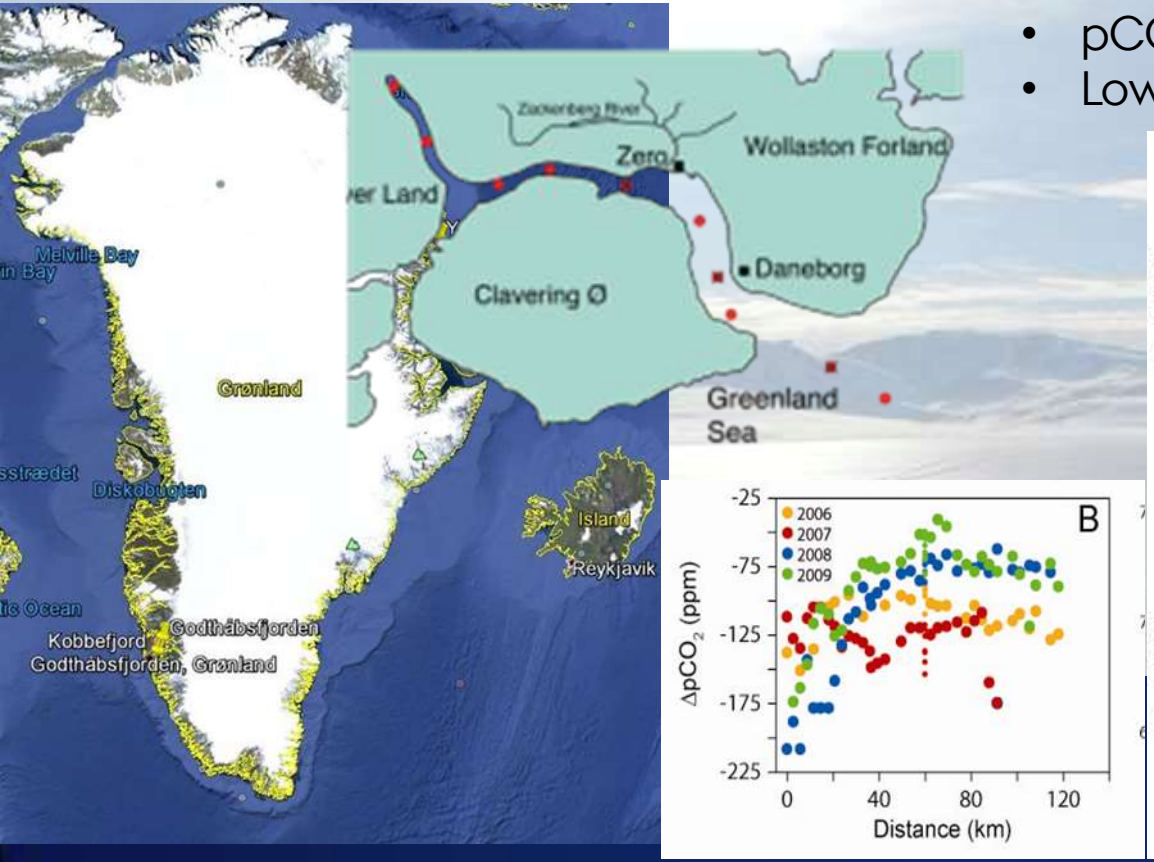
CO_2 flux estimated from this coastal area:

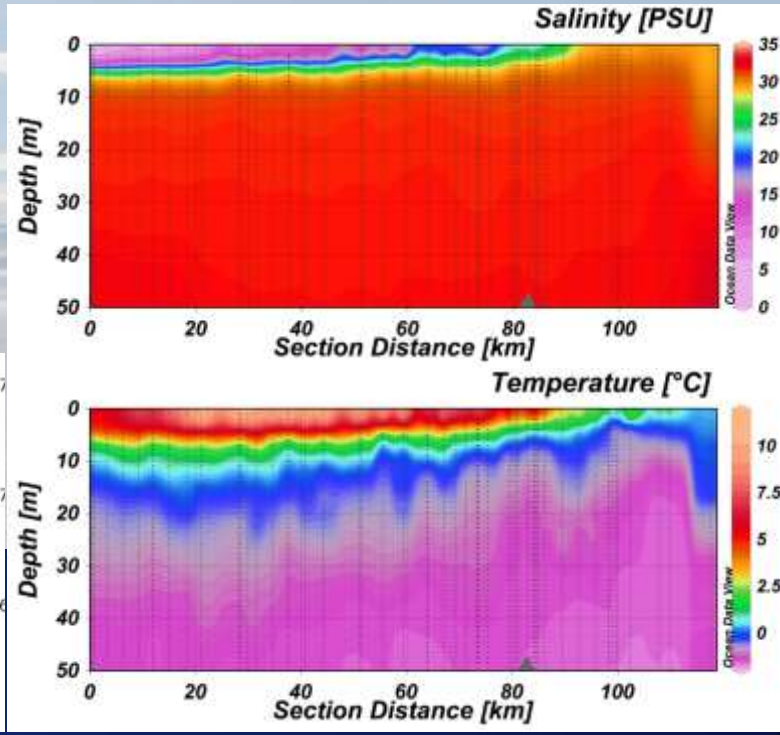
- Nordic Sea ~ 2.5 mol m^{-2} $year^{-1}$ (Takahashi et al., 2009)
- Greenland shelf ~ 6 mol m^{-2} $year^{-1}$ (Chen et al., 2013).



MANY FJORDS ARE CONNECTED TO GLACIERS

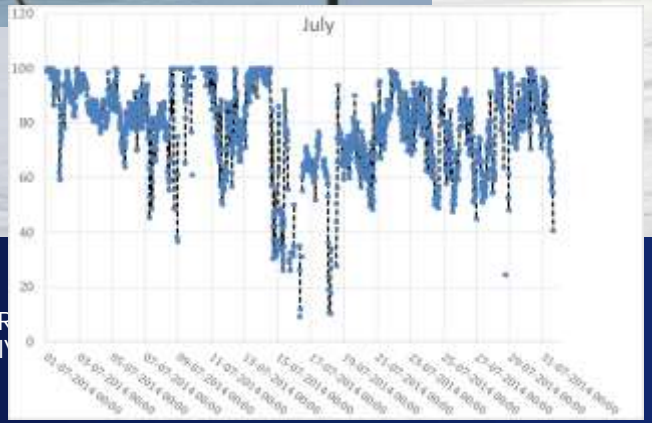
- Stratified
- pCO2 subsaturated
- Low salinity in surface

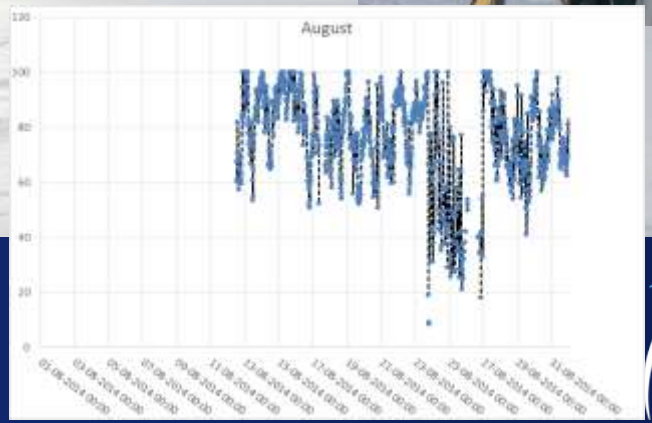




ARCTIC AREAS HAS FREQUENTLY LOW RELATIVE HUMIDITY

- RH change fast from day to day
- In spring (june) at snow melt we find 100% for days
- In july and august we find often RH < 75%



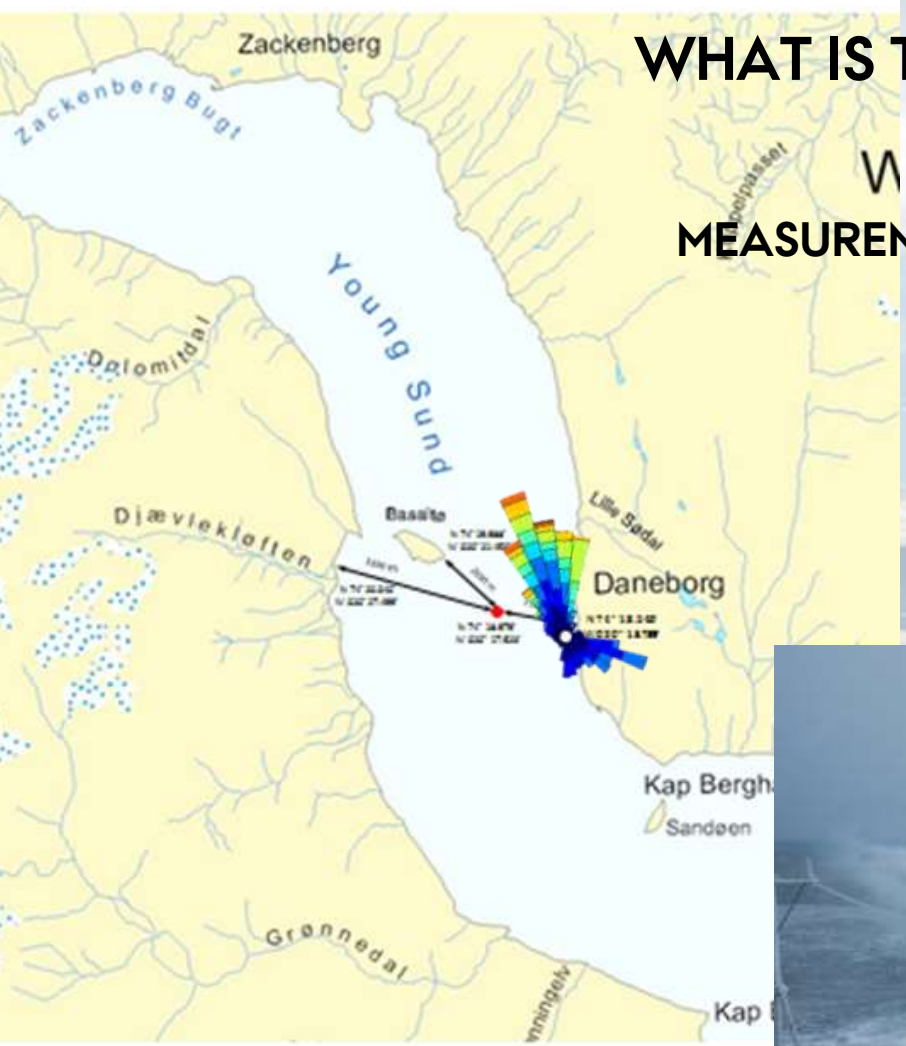


WHAT IS THE UPTAKE OF CO_2 IN A HIGH ARCTIC FJORD?

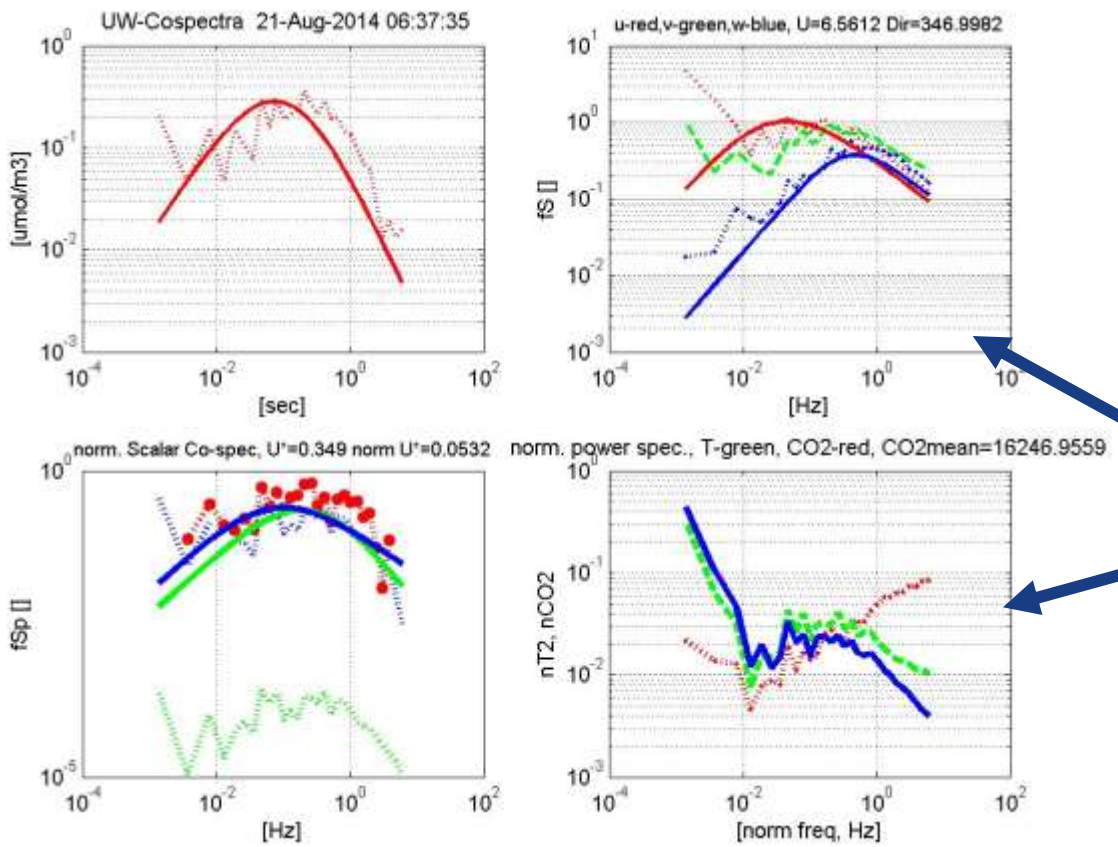
MEASUREMENTS IN/AT YOUNG SOUND IN 2014

CO_2 and wind velocities were sampled at 10 Hz, from June 2014 to September 2014

- Metek sonic
- Licor 7500A



DATA ANALYSIS USING SEVERAL MICRO METEORO-LOGICAL METHODS



Analysis of spectra to ensure well developed turbulence and well defined co-spectra

Follow Kaimal calculated spectra forms for momentum and scalars

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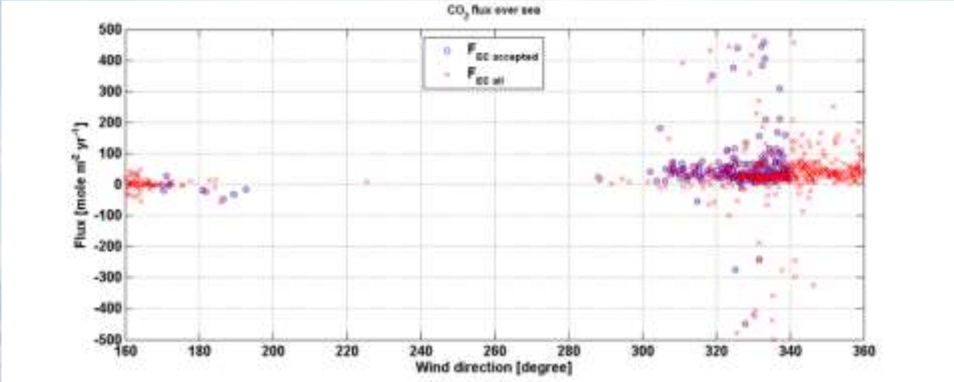
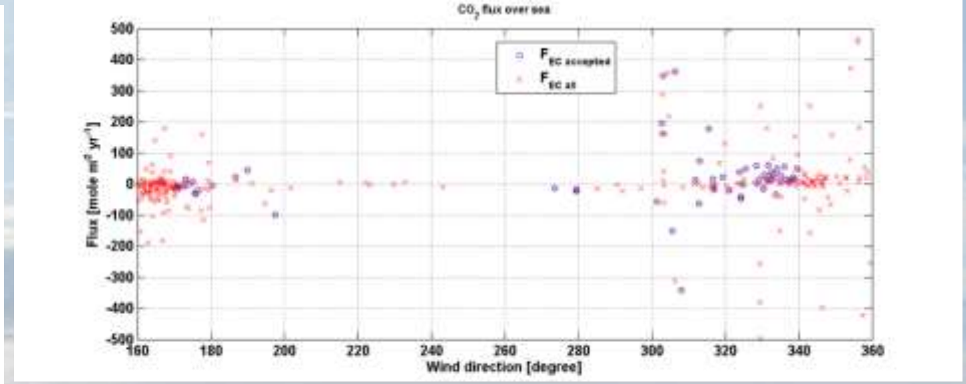
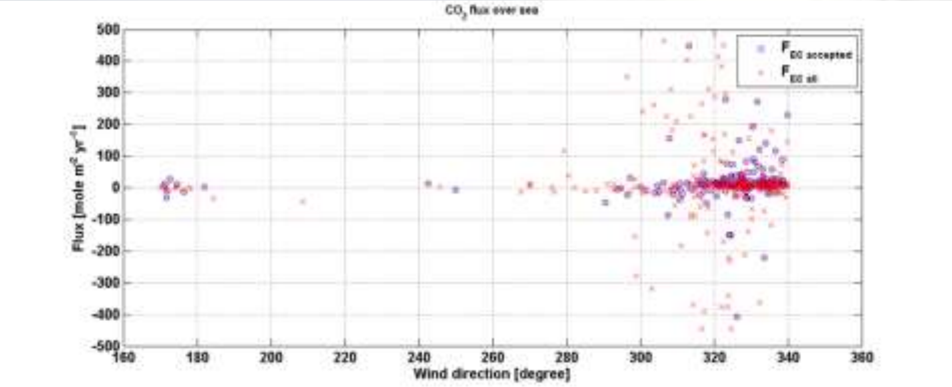
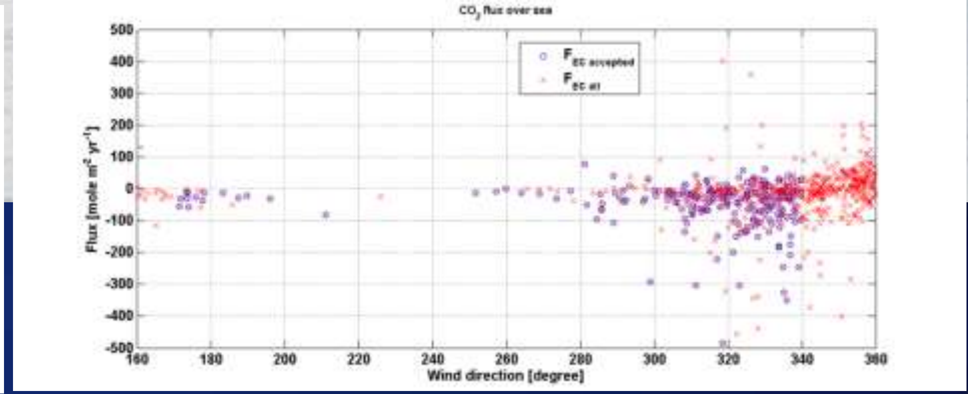
CO_2 FLUXES MEASURED/ESIMATED OVER WATER IN JULI, AUGUST, SEPTEMBER

Raw data and filtered based on turbulence development (co-spectra)



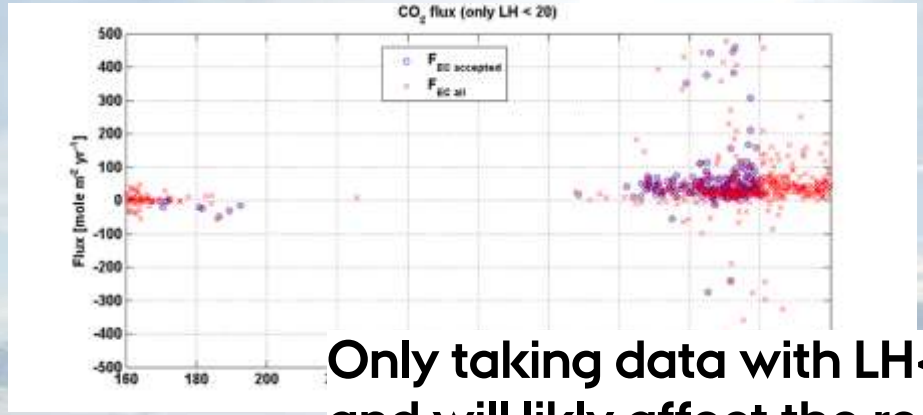


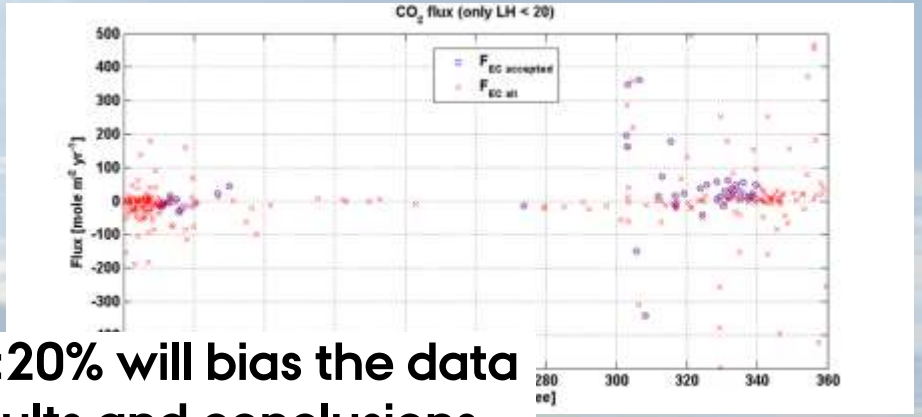




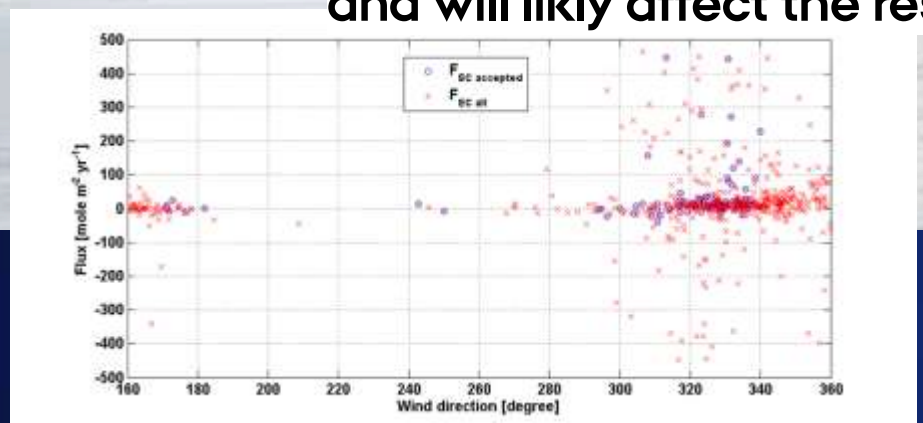
CO_2 FLUXES MEASURED/ESIMATED OVER WATER IN JULI, AUGUST, SEPTEMBER

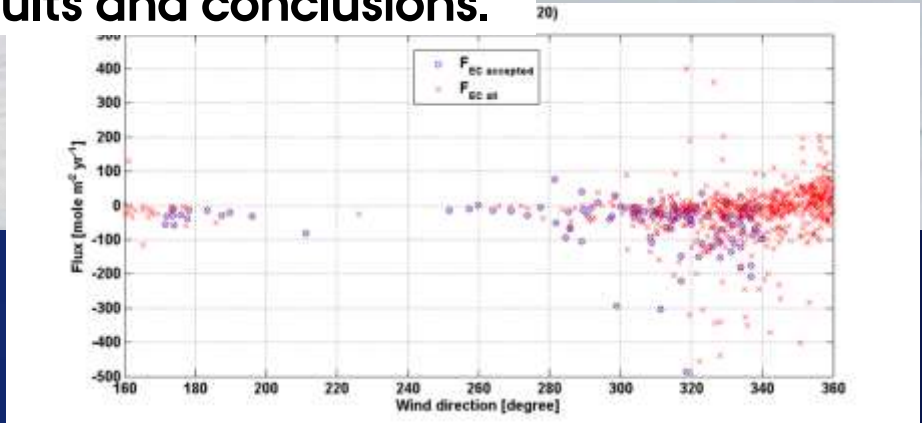
Raw data and filtered based on turbulence development (co-spectra), LH<20%





Only taking data with LH<20% will bias the data and will likly affect the results and conclusions.



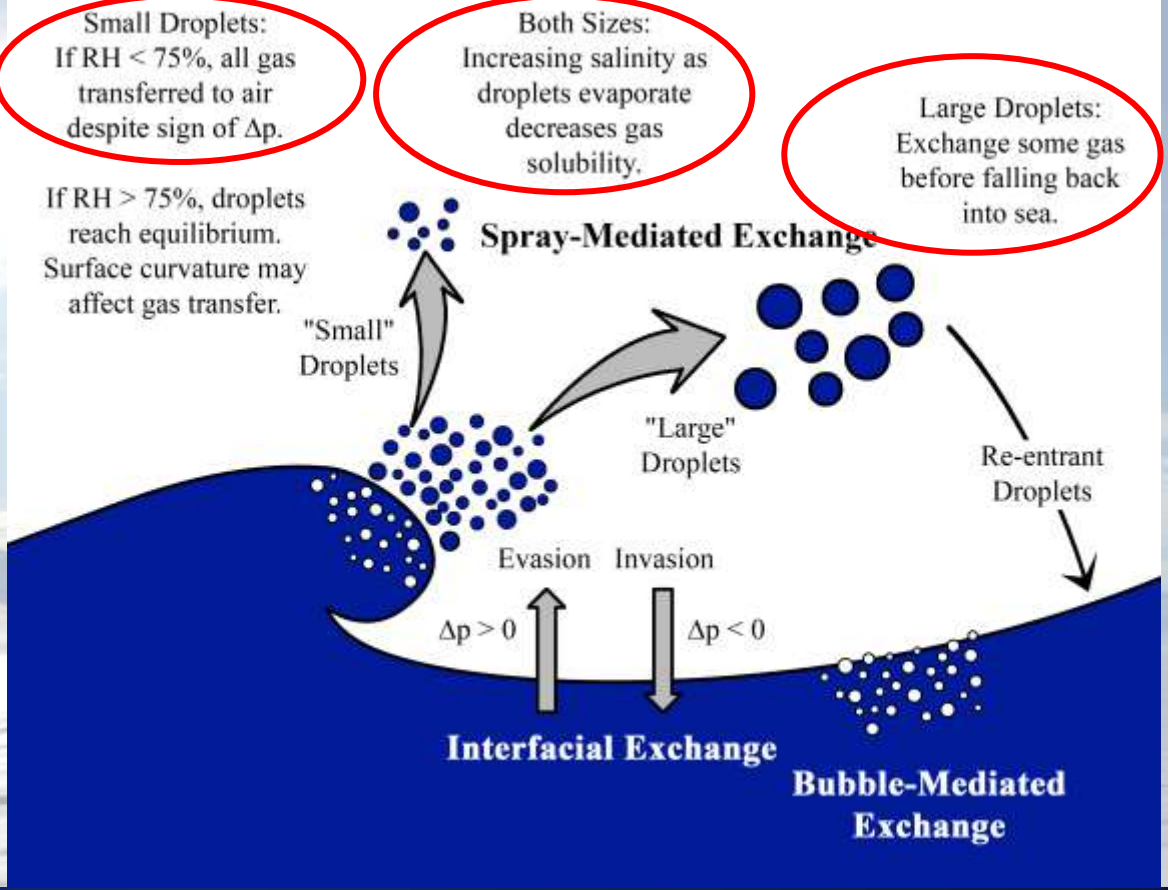


DATA ANALYSIS & SEA SPRAY EFFECTS

E L Andreas, P Vlahos and E C Monahan, 7th International Symposium on Gas Transfer at Water Surfaces IOP, Earth and Environmental Science **35** (2016) 012003 doi:10.1088/1755-1315/35/1/012003

We have to look at:

- Sea spray production and evolution
- Energy exchange between droplet and atmosphere
- Solubilty changes in the droplet



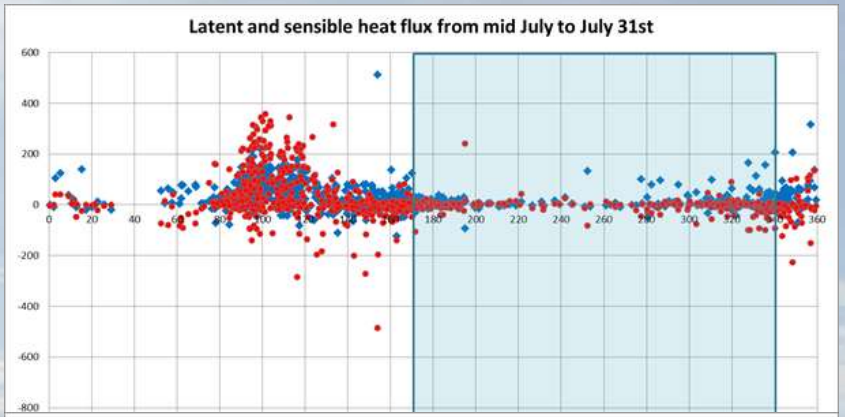
DATA ANALYSIS AND SEA SPRAY EFFECT HYPOTHESIS

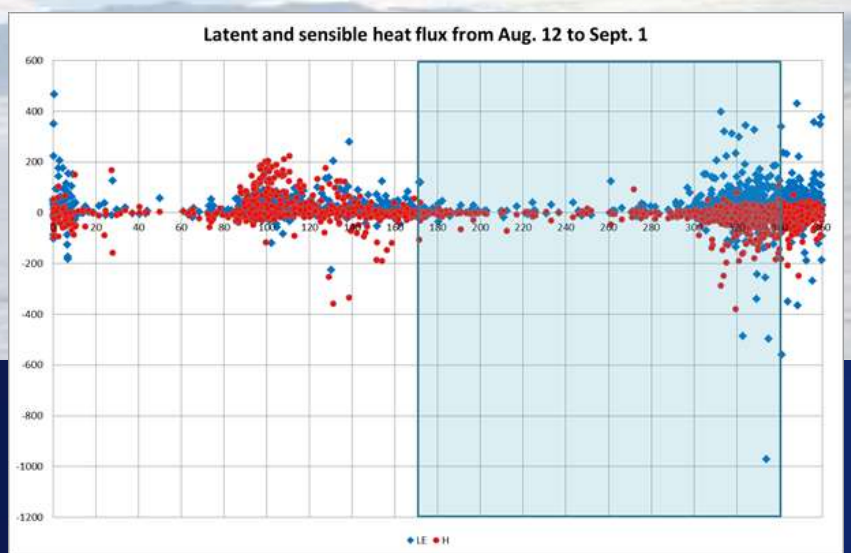
- At RH<75% the small particles will emitt all H_2O and other gases, and this will lead to upward latent heat flux (+LE flux)

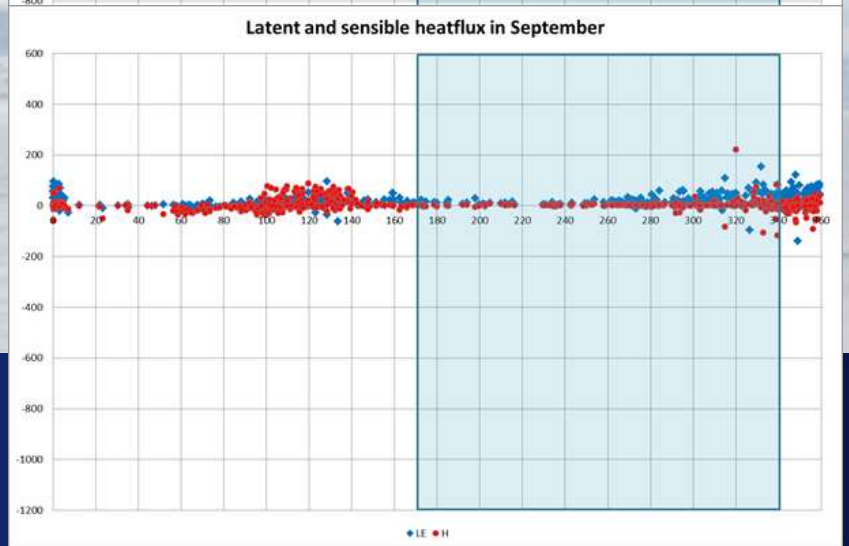
- Heat exchange between the seaspray droplets and the atmosphere (very fast: Andreas et al., 2016) causes heating of the droplets in the arctic atmosphere and affect solubility in the droplet

HOW DOES THE LE AND H BEHAVE OVER THE OPEN WATER SEASON?

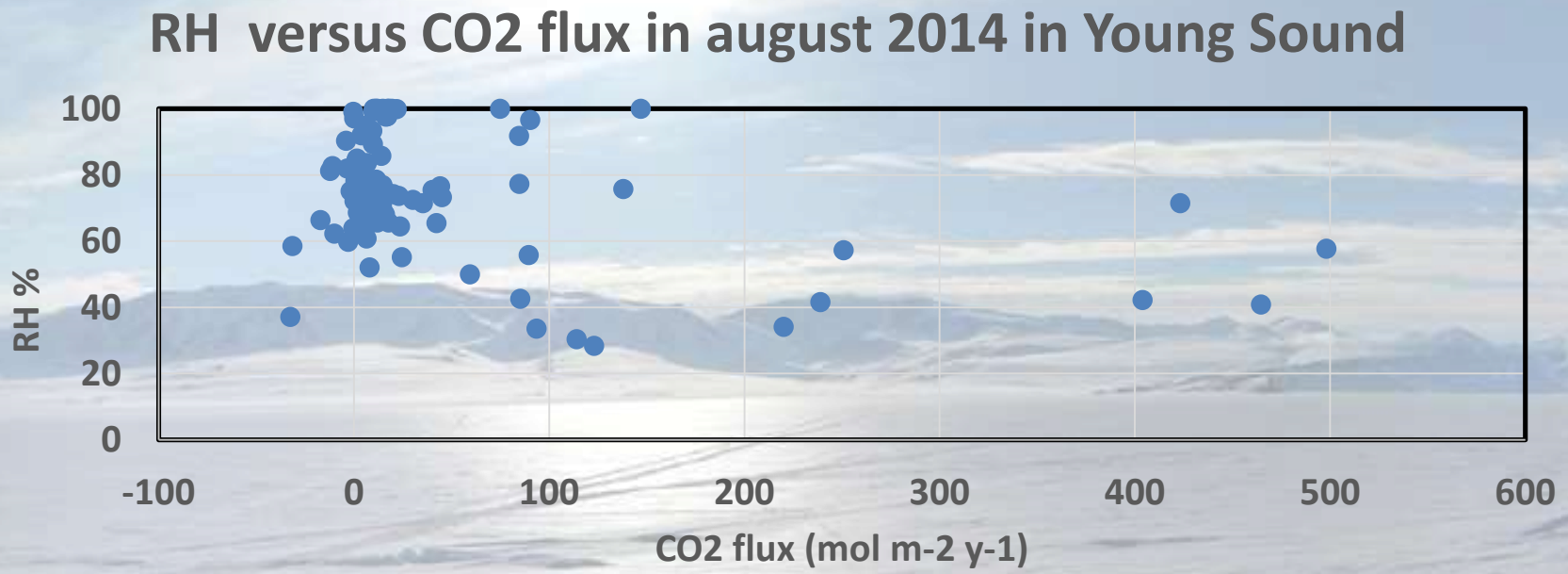
- Data show expected pattern over the sea surface
- Does **not** prove that sea spray has an effect, but needs to be tested by calculation of LE from energy surface parameters.







ANALYSIS (RELATION TO RH)



CONCLUSION

- We do see increased upward LE flux, downward H and low RH in periods with large upward CO_2 fluxes
- Our data support the theory of Andreas et al. AND Andreas et al.,s theory support our measurement result, however it is still not a prove
- In order to test the theory proper we need measurements of **sea spray fluxes** for different size range and minimum water surface temperatures. So next step is to install fluxes of sea spray measurements at our site in YS
- However, if what we find is true, this will be very important for the estimation of the Arctic marine CO_2 flux

ACKNOWLEDGEMENT

- Thanks to the technical and logistic support by Kunuk Lennert and Ivali Lennert.
- We gratefully acknowledge the contributions of Arctic Research Centre (ARC), Aarhus University.
- This work is a contribution to the Arctic Science Partnership (ASP) asp-net.org. Support was also provided by the Canada Excellence Research Chair (CERC)

Thank You