NOAA ESRL Physical Science Division Arctic Cruises and Science

Presented by Taneil Uttal

On Behalf of Matthew Shupe, Ola Persson, Byron Blomquist, Chris Fairall and Janet Intrieri

Cloud and Radiation Feedbacks

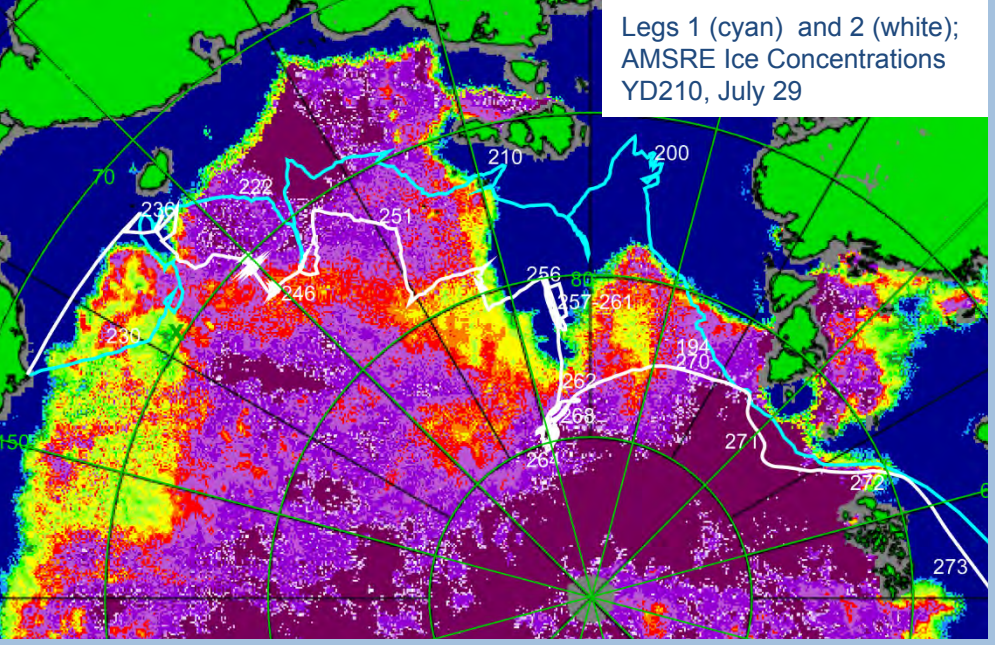
Sea Surface State

Arctic (Ocean) System Science

Arctic Clouds in Summer Experiment (ACSE)/SWERUS

(slides prepared by O. Persson, Oct 23, 2014)

- Atmospheric component of Swedish-Russian-U.S. Arctic Ocean Investigation of Climate-Cryosphere Carbon Interactions (SWERUS-C3)
- Swedish icebreaker R/V Oden (length 108 m)
- July 5 - Oct 4, 2014 (Year Day 187-277)
  Leg 1: Tromsø, NO – Barrow, AK (YD187-232)
  Leg 2: Barrow – Tromsø (YD232-277)
- Barents/Kara, Laptev, E. Siberian, Chukchi Seas (latitude 71°- 85° N)
- conditions: in open water (36%); marginal ice zone (MIZ, 22%); sea ice (42%); melting MYI; MIZ freeze-up
- collaboration with Japanese R/V Mirai (location Sep 5-25 green x)



Legs 1 (cyan) and 2 (white); AMSRE Ice Concentrations YD210, July 29

Objective: Improve understanding of clouds, boundary-layer structure, and air-ice/air-ocean interactions in the marginal ice zone.

Responsible ACSE Scientists:

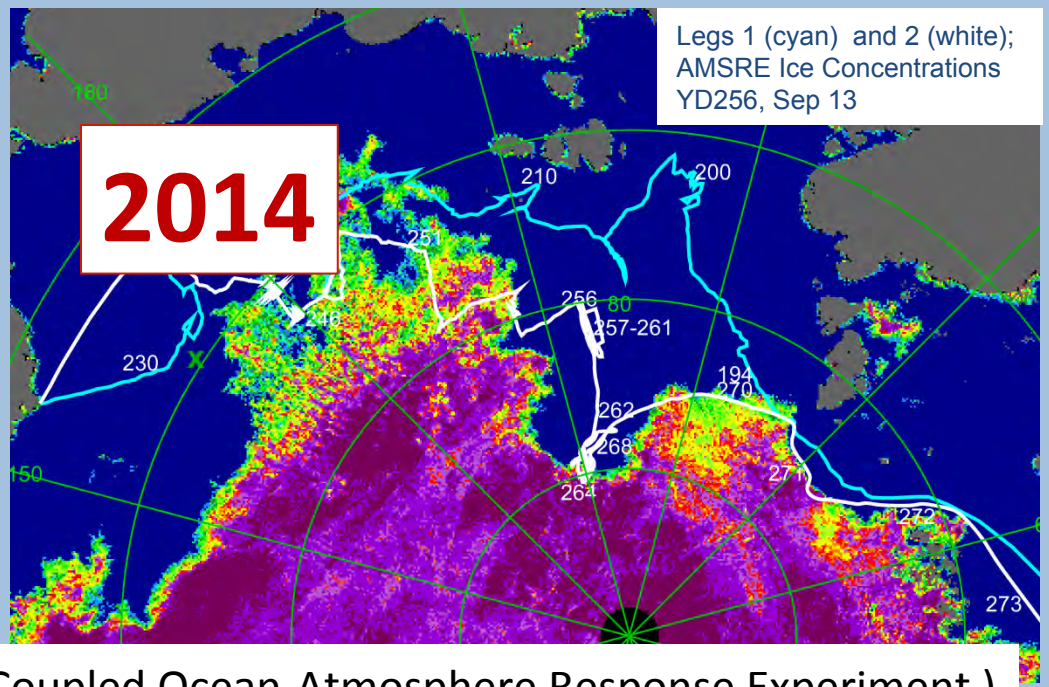
- Prof. Michael Tjernström, Univ. of Stockholm, Sweden (lead atmospheric scientist)
- Prof. Ian Brooks, Univ. of Leeds, UK
- Dr. Barbara Brooks, National Centre for Atmos. Sci., UK
- Dr. Ola Persson, Univ. of Colorado/NOAA, USA
- Dr. Matthew Shupe, Univ. of Colorado/NOAA, USA

Onboard ACSE support staff :

Dr. John Prytherch (ULeeds); Dr. Dominic Salisbury (ULeeds); Paul Johnston (UColorado/NOAA); Daniel Wolfe (UColorado/NOAA); Georgia Sotiropoulou (UStockholm)

SWERUS Chief Scientists:

Örjan Gustafsson (UStockholm); Martin Jakobsson (UStockholm); Igor Semiletov (Pacific Ocean Inst., Russia);



Legs 1 (cyan) and 2 (white); AMSRE Ice Concentrations YD256, Sep 13

Also R/V Mirai testing COARE algorimns (Coupled Ocean-Atmosphere Response Experiment)

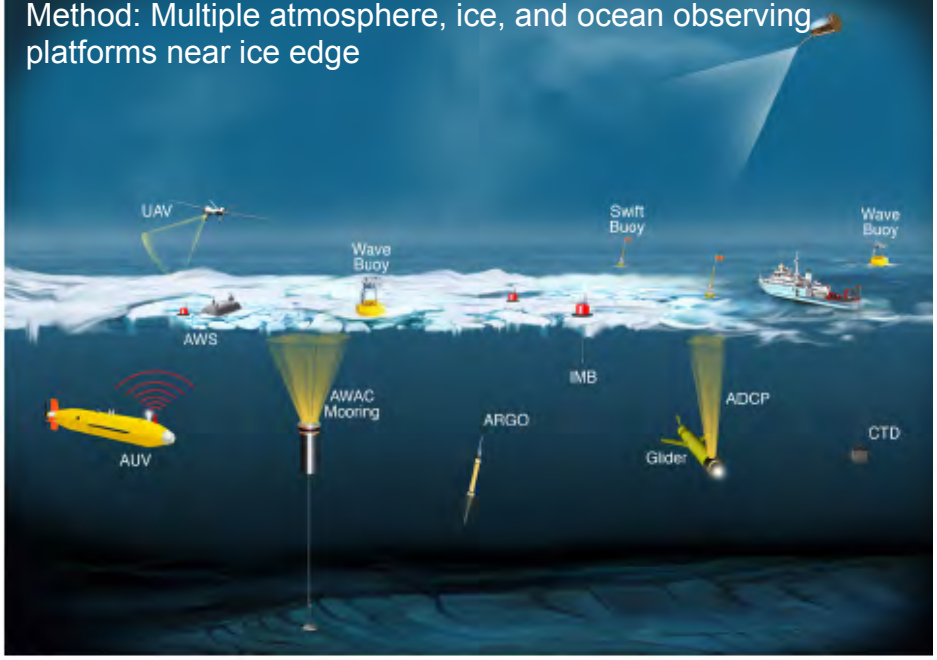
Sea State Field Program

Office of Naval Research
Sep. 29 - Nov. 10, 2015
Beaufort/Chukchi Sea ice edge

R/V Sikuliaq
New National Science Foundation icebreaker

2015

Objective: Improve understanding of wave impact on sea ice
Method: Multiple atmosphere, ice, and ocean observing platforms near ice edge

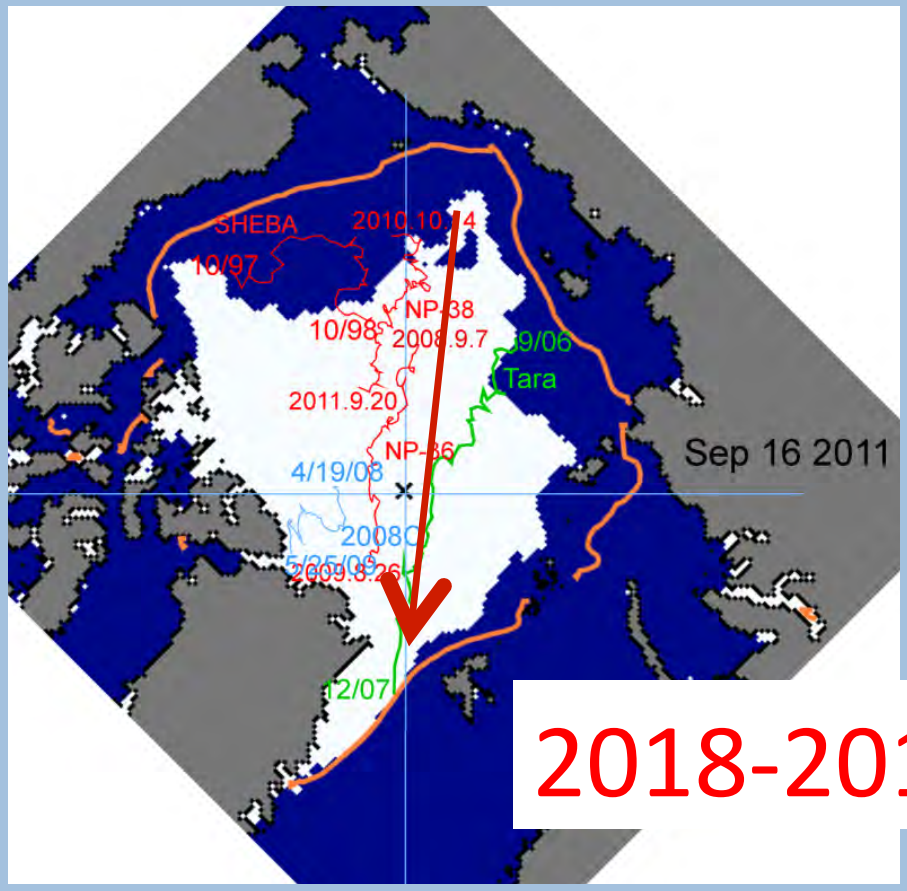


Platform	Topic	Investigator(s)	Measurements
R/V Sikuliaq	Atmosphere	Guest, Fairall	Ship basic met stations; weather obs; upper-air (Rawinsondes, balllons and tethered kit); turb. fluxes; radiation; surface temperature, clouds
R/V Sikuliaq	Sea Ice; Waves in Ice	Ackley, Weissling, Maksym, Doble, Wadhams	Ice coring; Shipboard digital photography; UAV photography; Underway Ice Thickness (EMI); Ice Surface Elevation (Ship-based and Terrestrial Lidars); AUV Underice Swath for ITD and FSD, AUV ADCP for Waves; Pancake Sampler; Waves-in-Ice buoys
	per-ocean rsics	Stammerjohn, Maksym, *Winsor	Towed CTD and EcoPuck(chl a;turbidity;CDOM) (Acrobat); Ship CTD Casts, two Ship ADCPs, (High Res and Hull-mounted), AUV CTD and ADCP, 3 Gliders w/ CTD and EcoPuck
R/V Sikuliaq	Large-scale ocean circ.	Stammerjohn, *Winsor	CTD profiling; underway CO_2 and TSG
R/V Sikuliaq	Sea State	Graber;Thomson; Guest;Fairall	Marine Radar; 2 Shipboard Video Systems for wave breaking area estimates; Downlooking Lidar
Remote sensing	Sea Ice; Waves; Waves in Ice	Gemmerich, Lehner, Holt, *IceBridge Science Team (Sea Ice)	TerraSAR-X Satellite; Satellite Active and Passive Microwave, Airborne Lidar Elevation and digital photography (NASA IceBridge Aircraft)
Autonomous Buoys	Sea Ice	Maksym, Stammerjohn, Ackley, Doble, Wadhams,^Perovich, ^Rigor,	Ice growth, drift and deformation; Ice Temperature Profiles (Ice Mass Balance Buoys and GPS Position Buoys); Surface TP (SVP); Waves-in-Ice Buoys
Autonomous Buoys	Sea State, Waves, Atmosphere, Upper Ocean	Thomson, Doble, Wadhams, Maksym, ^Steele,^ Rigor	Sea State and Turb. Flux (SWIFT) Buoys, Wave Buoys; Surface TP (SVP), Upper Ocean (UpTempO Buoys)
Moorings	Sea State, Ice	Thomson	2 Acoustic Wave and Current Profilers(AWACs) (continuation of MIZ DRI deployments)

MOSAiC

Multidisciplinary drifting Observatory for the Study of Arctic Climate

M. Shupe, K. Dethloff, M. Tjernstrom et al.



2018-2019

2018-2019, annual cycle
Central Arctic Basin ice pack

Interdisciplinary process study in central Arctic 1st-year sea ice:

1) **Central observatory: atmosphere-ice-ocean-BGC**
2) **Distributed observation network; Grid-box scale**
3) **Coordination, multi-scale modeling activities; YOPP**

Coupled, Sea Ice System

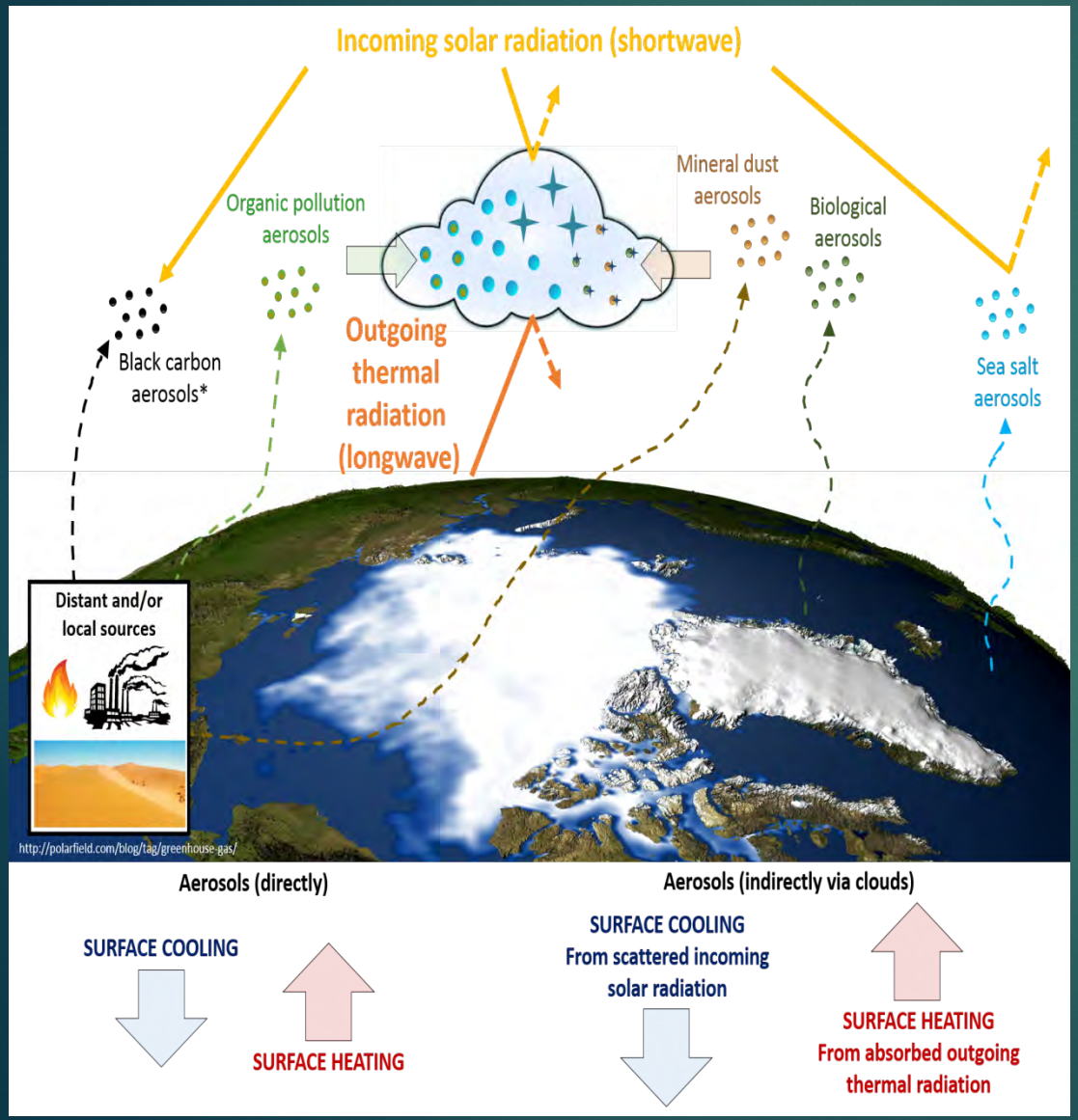
Science Themes

Sea-ice Energy Budget
Ice Motion / Deformation
Clouds / Precip / Aerosols
BioGeoChem Processes
Large-scale implications

Extra Slides

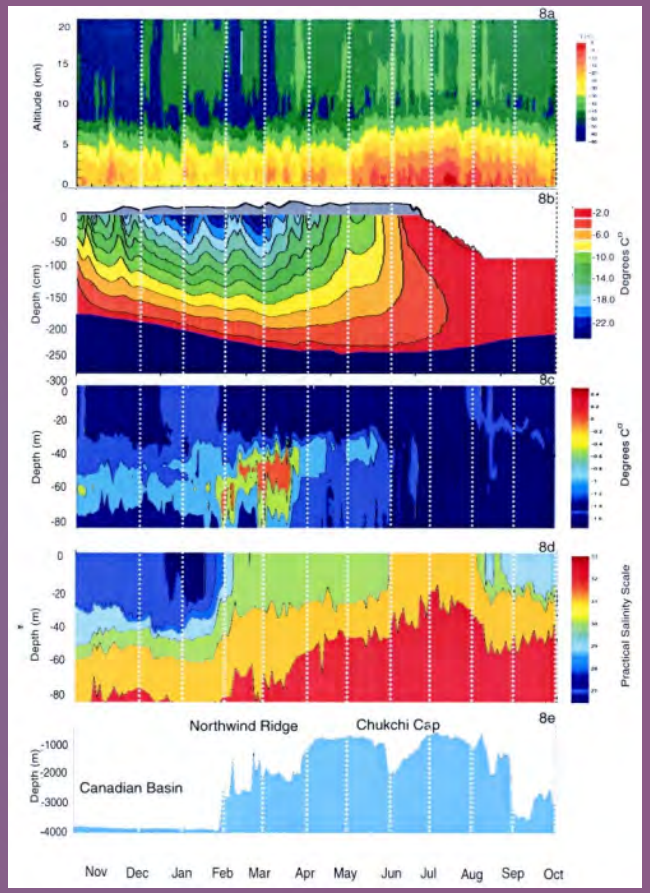
www.iasoa.org

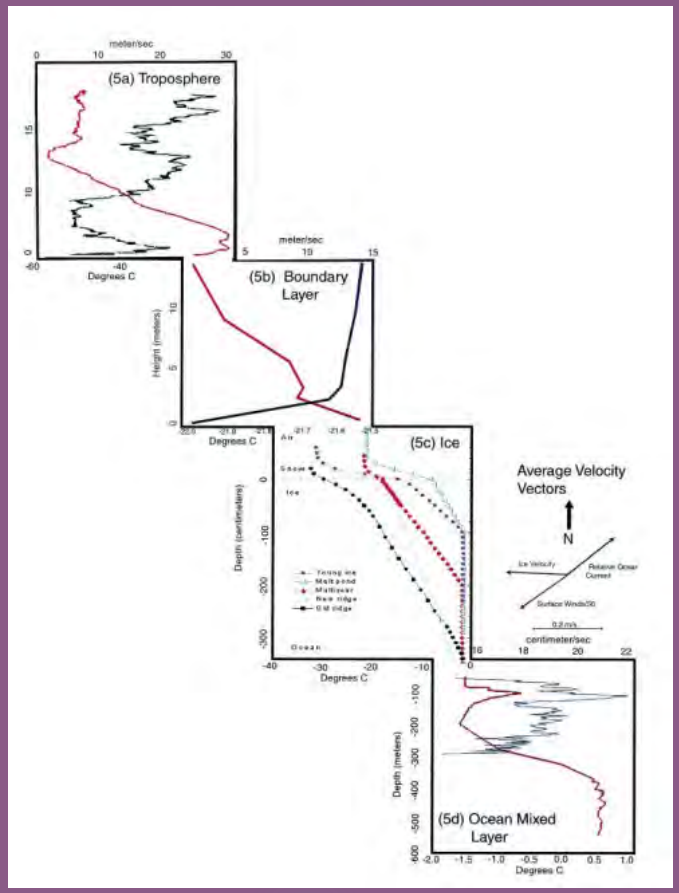
Understanding the sources and impacts of Arctic aerosols



- Potential aerosol sources and impacts on surface radiation budget
  - Black carbon aerosols absorb shortwave radiation, leading to atmospheric heating
  - Organic aerosols, such as those from local and transported pollution, can form small and numerous liquid cloud drops, increasing cloud lifetime and thickness
  - Mineral dust from distant sources can form cloud ice crystals, altering the cloud radiative properties
  - Biological aerosols from terrestrial and marine sources also form cloud ice crystals
  - Sea salt emitting from the Arctic Ocean scatter shortwave radiation
- These aerosol types can directly or indirectly lead to surface heating and/or cooling, and consequently impact sea ice extent
- Thus, a better understanding of Arctic aerosols is needed

The Ocean-Ice-Atmosphere as a System





Atmosphere-Sea Ice Ocean System:

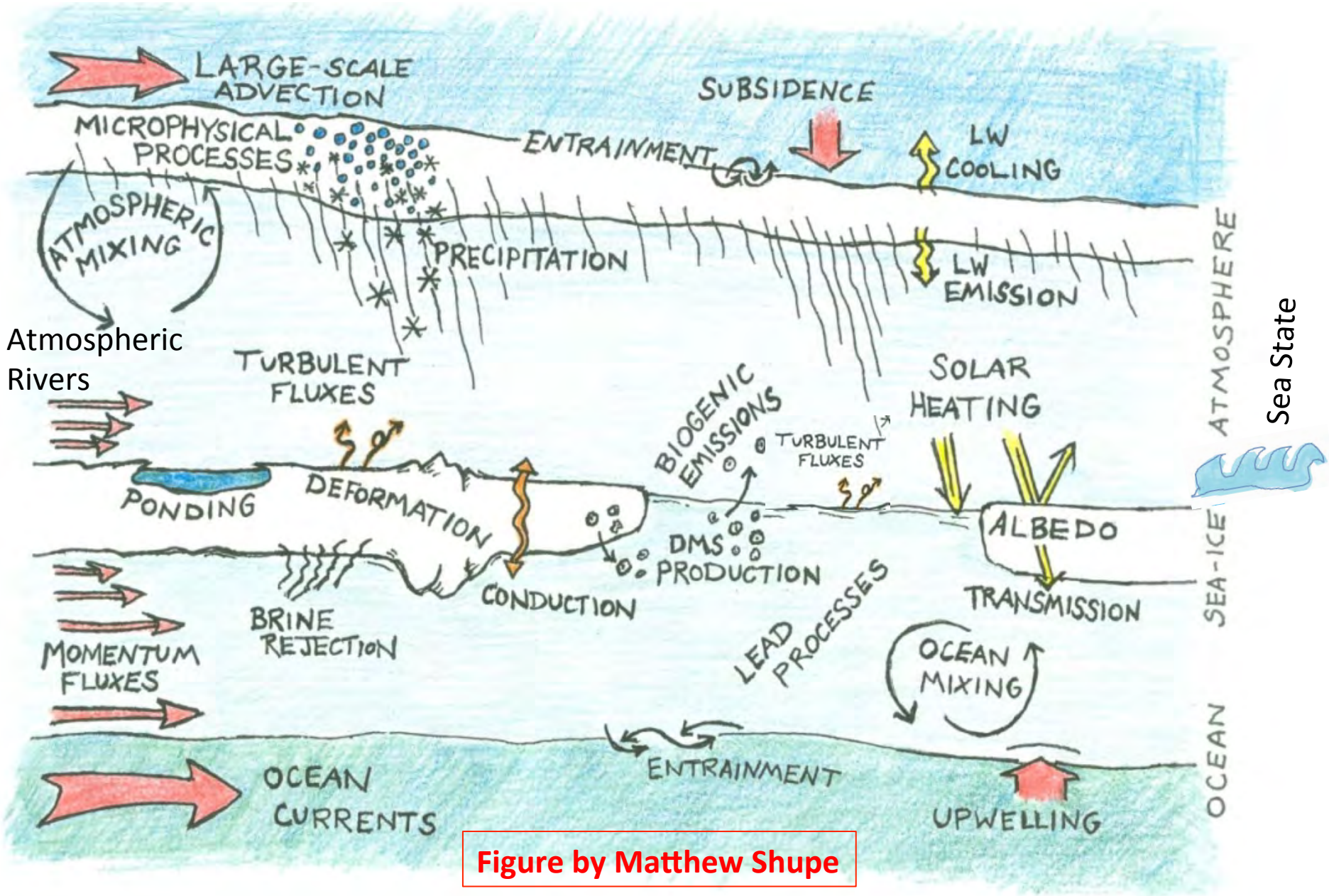
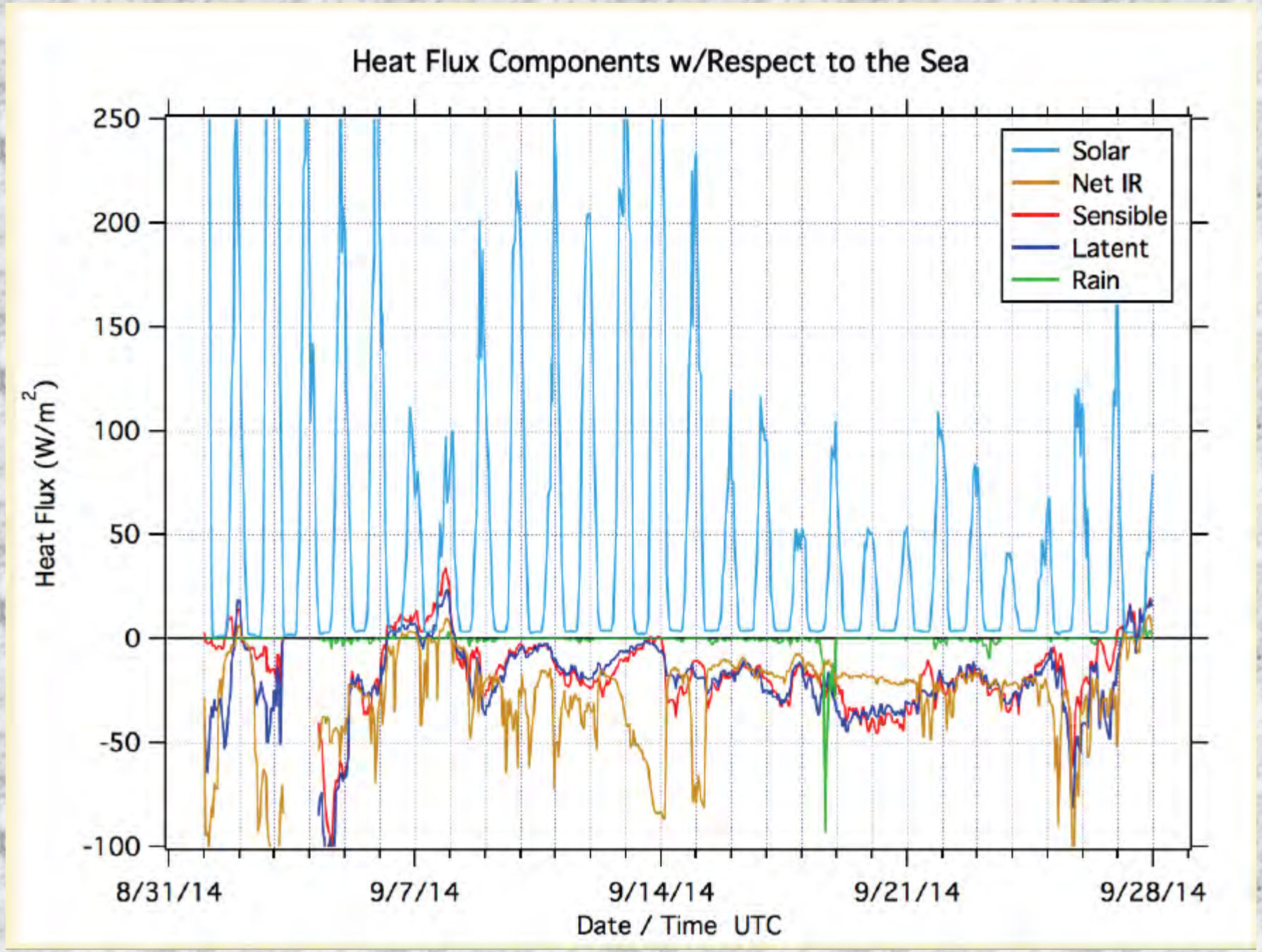


Figure by Matthew Shupe


Heat Flux Components w/Respect to the Sea
Solar
Net IR
Sensible
Latent
Rain
250
200
150
100
50
0
-50
-100
Heat Flux (W/m2)
8/31/14
9/7/14
9/14/14
9/21/14
9/28/14
Date / Time UTC

Instrumentation for ACSE/SWERUS

Instrument	Organization	Measurement
W-band radar	CIRES/NOAA	Cloud properties
449 MHz wind profiler	CIRES/NOAA	hourly profiles of wind speed,/direction
Sea snake	CIRES/NOAA	sea-surface temperature
35-channel Radiometrics radiometer	CIRES/NOAA	PWV, LWP, profiles of T, q
Ceilometer	CIRES/NOAA, MISU, Ship	cloud base
Reigl laser wave-height recorder	NOAA/Leeds	wave-height
Flux tower with trims, motion sensor	Leeds, MISU	turbulent fluxes (H_s, H_l, τ, CO_2)
CLASP	Leeds	aerosol size distribution
Stabilized, scanning Doppler Lidar	Leeds	winds (spatial, profiles), cloud phase, turbulence
HATPRO, scanning,12 ch radiometer	Leeds	PWV, LWP, profiles of T, q
Rawinsondes - 4x daily	MISU, Leeds	profiles of T, RH, p & winds
IRT, up & down	MISU	surface and sky temperature
Broadband radiation	MISU	radiative fluxes
Weather station	MISU	basic weather parameters, visibility
Webcams (3)	Leeds	local ice fraction, sea state
Waverider wave buoy	Leeds	directional wave-height spectra
Satellite (MODIS, SAR)	NOAA, NASA, U Victoria, Bedford Inst. Ocean.	large-scale weather, ice concentrations
(Ship data	Polar	basic met, near-surface water T, and salinity)
(CTD/XBT casts	GU, SU/ Phys. Ocean.	ocean temperature/salinity profiles)