Russian Drifting Stations “North Pole” for Improved Description of Air–Sea-Ice-Ocean Interactions in the Arctic Ocean

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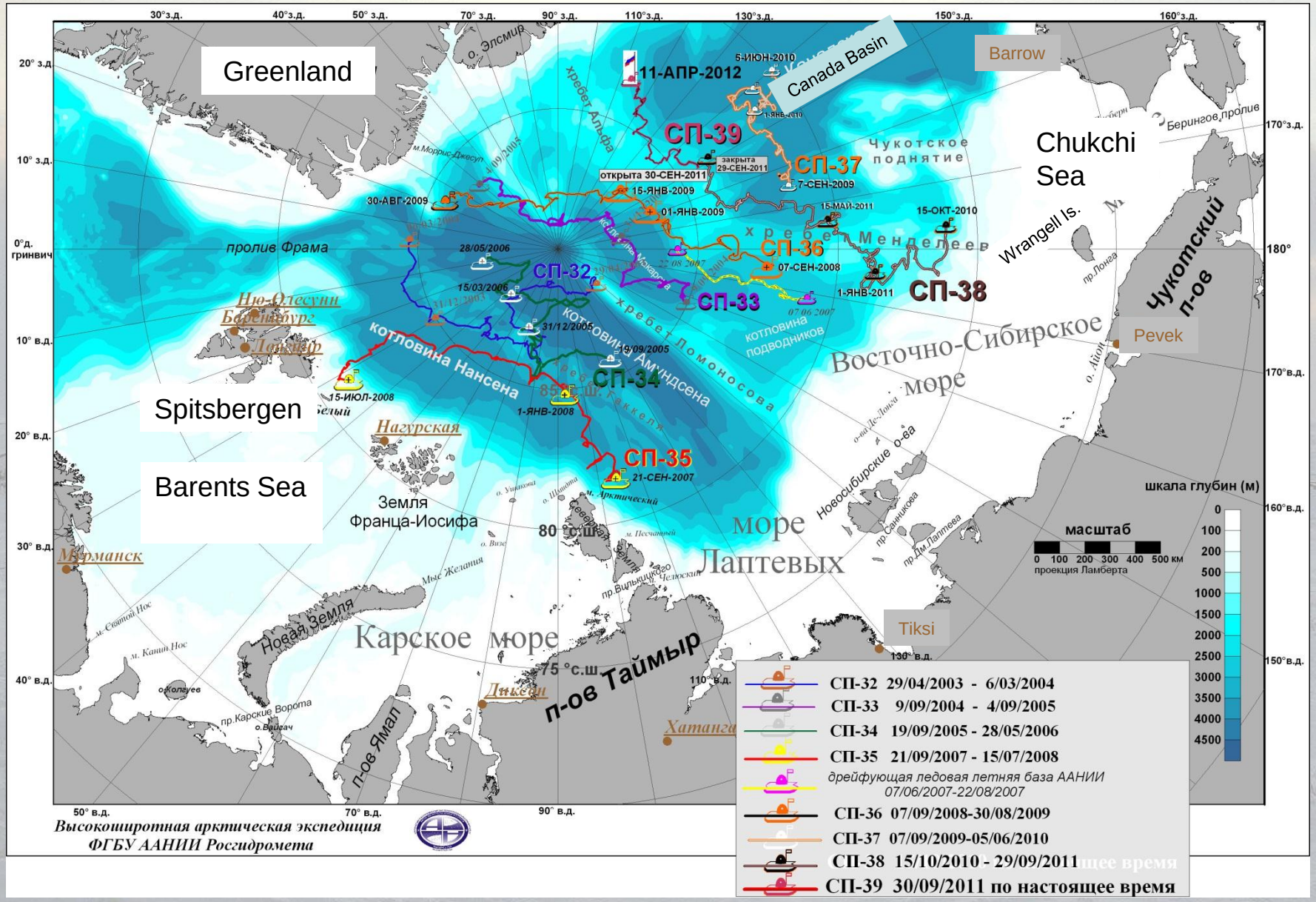
Russian drifting stations “North Pole” in 2003-2012

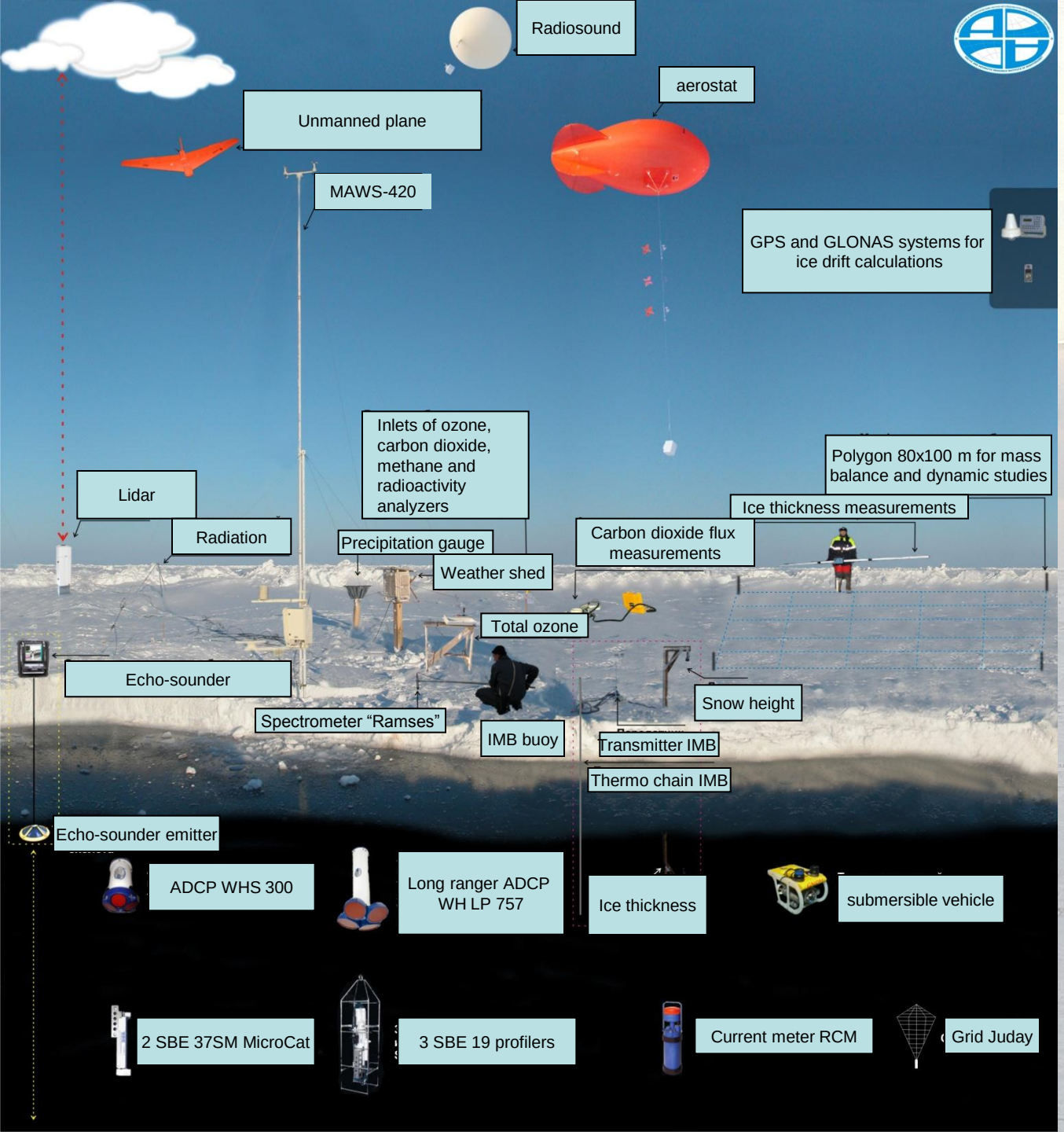


Высокоширотная арктическая экспедиция
ФГБУ ААНИИ Росгидромета

Science Issues Being Studied with “North Pole” station data

Atmospheric
Cryospheric
Oceanic
Greenhouse Gas

Overview of observations, organized at drifting station “North Pole – 39” and future “North Pole” stations



Atmospheric Science Issues

1) characterizing low-level inversions

2) cloud characteristics (cloud fraction, height; measurement technique variability)

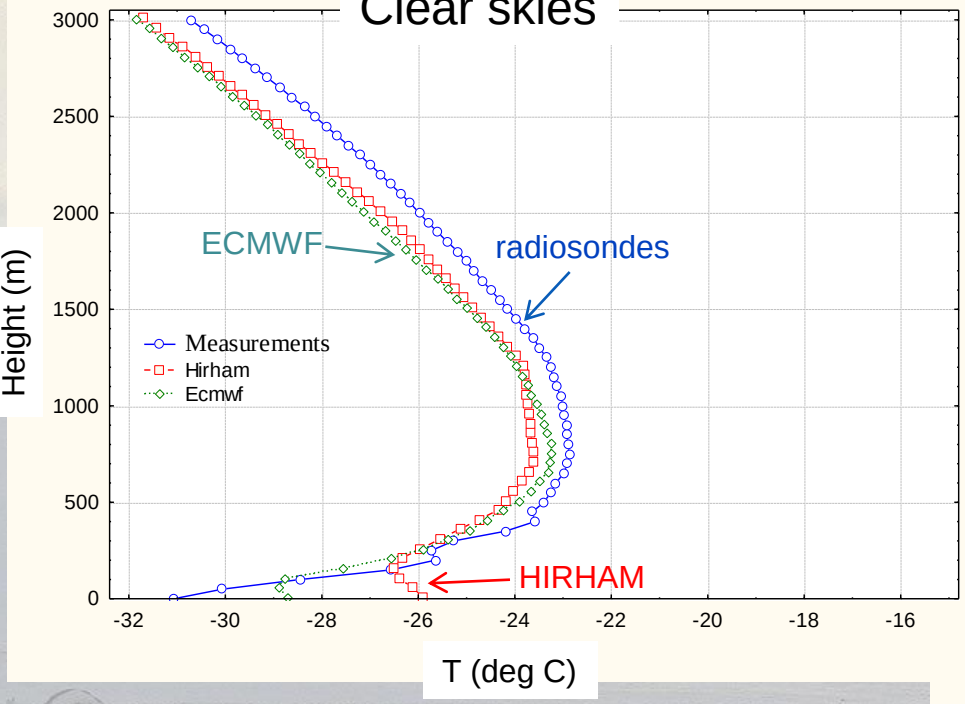
3) atmospheric boundary layer thermal structure – variability processes

4) atmospheric O_3
   - surface-layer/boundary layer
   - stratosphere – Arctic “ozone holes”

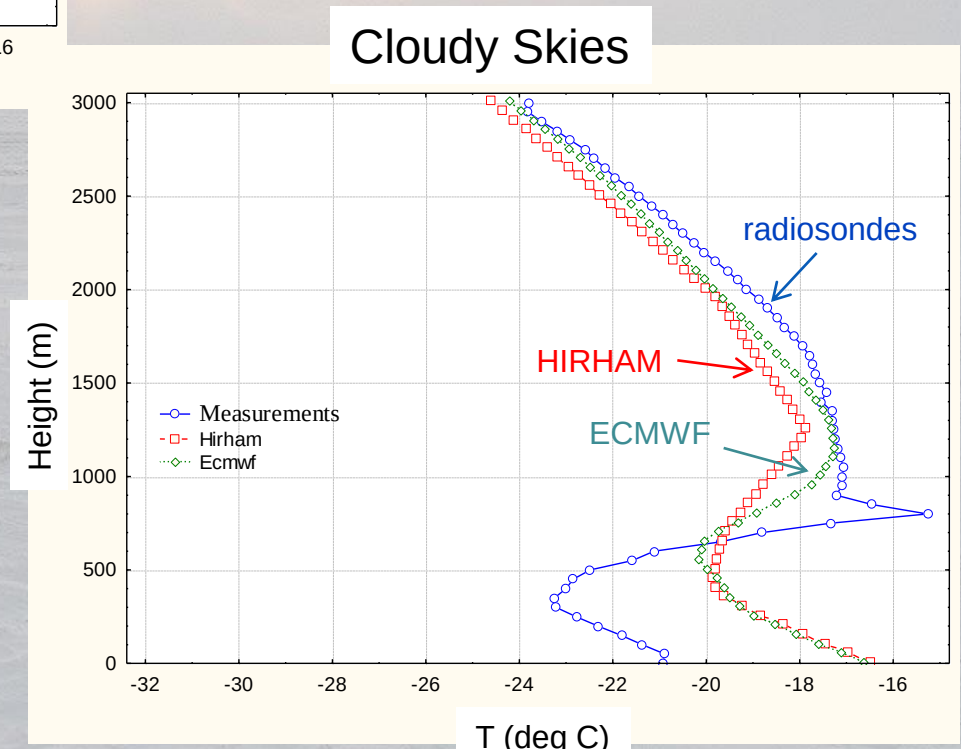
5) measurement techniques (e.g., clouds, skin temperature)

6) validation of models: mesoscale (WRF), RCMs and reanalyses
   - T, T_d, cloud fraction, BL thermal & kinematic structure
   - surface characteristics

7) parameterization validations
   - downwelling SW and LW radiation, incl. impact of clouds
   - turbulent fluxes in stable boundary layer
   - atmospheric boundary layer, for forcing sea-ice models



Monthly mean profiles of air temperature from radiosoundings and calculated by HIRHAM (Regional Climate Model) and ECMWF (ERA-Interim Reanalysis?)



<u>Clear Skies</u>

Observations: surface-based inversion

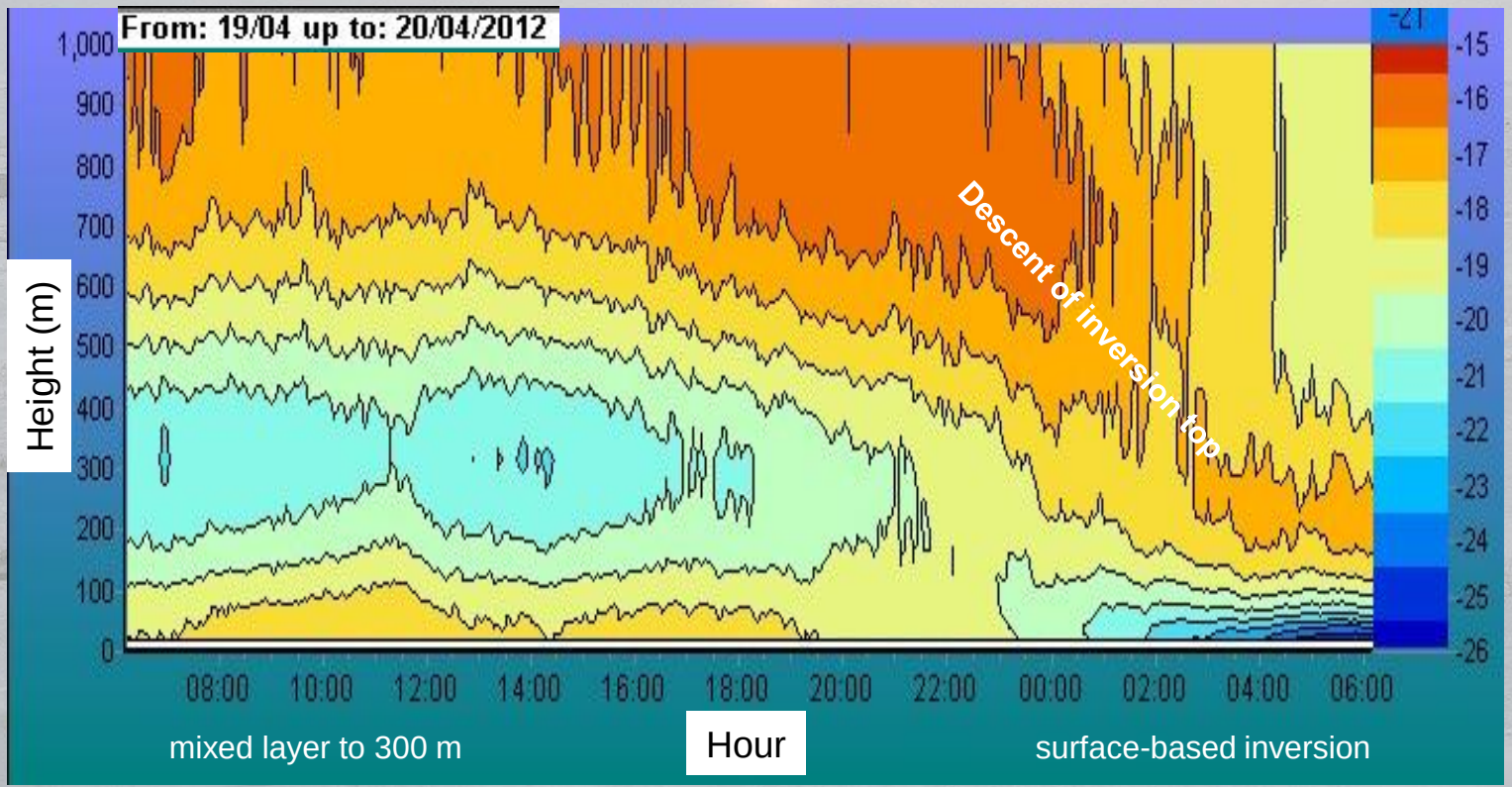
Models: shallow mixed layers, too warm T_s

<u>Cloudy Skies</u>

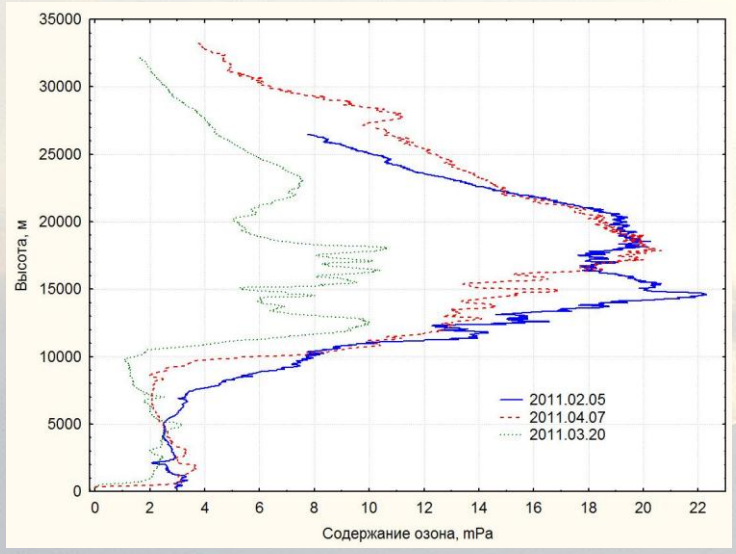
Observations: surface mixed layer

Models: surface mixed layers, too warm ML, inversions too weak & too deep

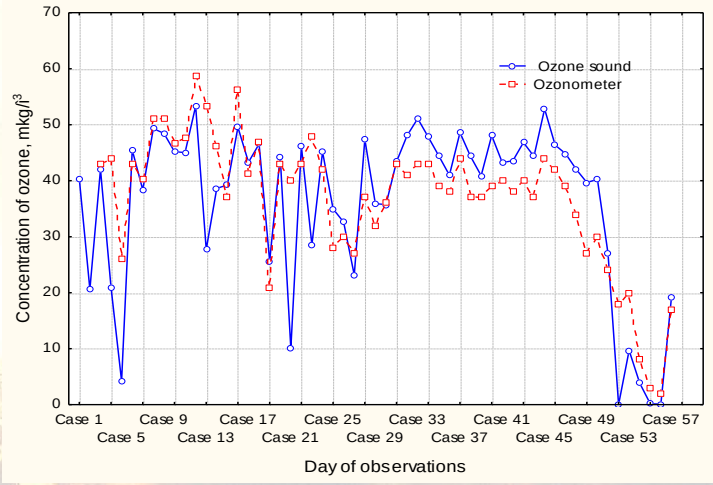
Detailed atmospheric boundary-layer processes: New approach with microwave temperature profiler at “North Pole 39” (April 2012)



Ozone studies at “North Pole” drifting stations (March 2011, NP-38)

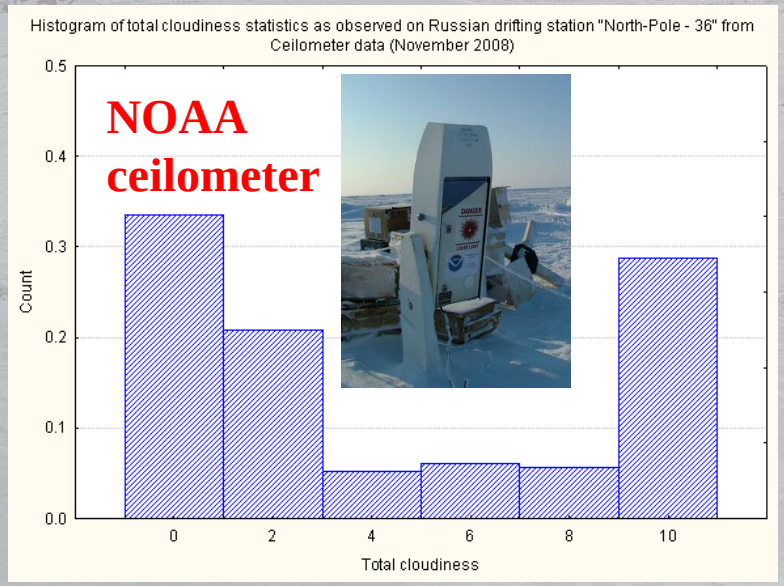


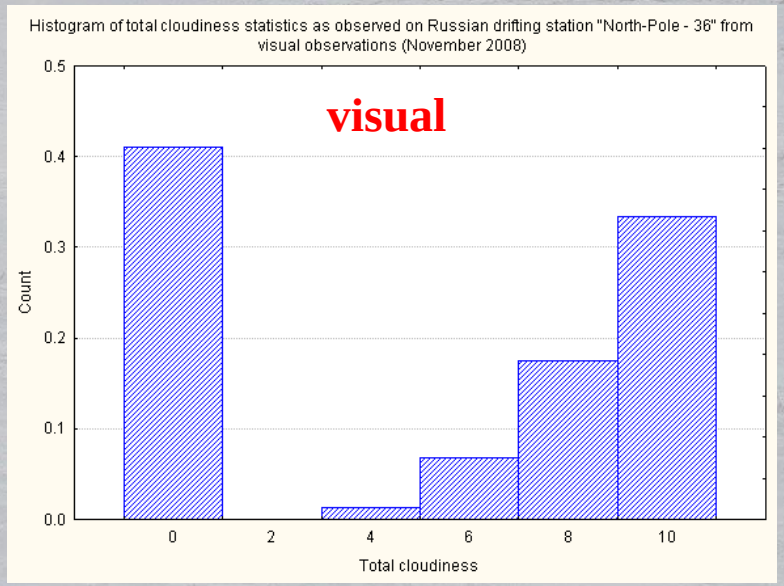
Evidence of “Ozone hole” in the Central Arctic (March 2011)



Ozone concentration in atmospheric surface layer in spring

Total cloudiness (in tenths), from ceilometer data and visual observations (Nov. 2008, NP-36)





Comparison air surface temperature (T) and total cloudiness (N) between NP and NCEP/NCAR Reanalysis data for 2007-2008

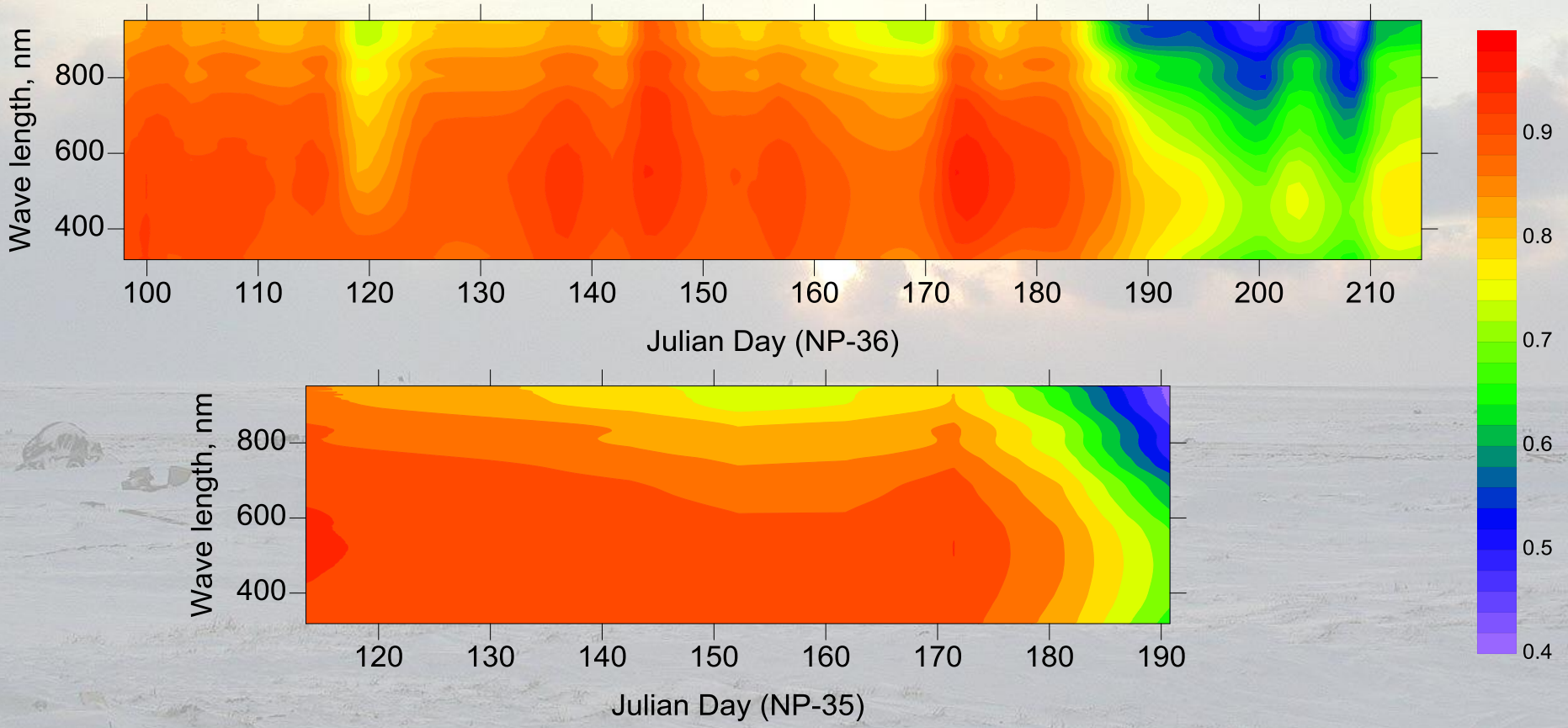
Season	T mean NP	T mean NCEP	Correlation	NCEP-NP
NP-35 (2007-2008)				
Winter	-29.4	-30.9	0.84	-1.5
Spring	-15.3	-13.2	0.97	2.1
Summer	-1.2	0.5	0.60	1.7
Autumn	-15.3	-18.1	0.89	-2.8
NP-36 (2008)				
Autumn	-17.7	-19.6	0.89	-1.9

Season	N mean NP	N mean NCEP	Correlation	NCEP-NP
NP-35 (2007-2008)				
Winter	4.2	4.0	0.48	-0.2
Spring	7.5	2.7	0.15	-4.8
Summer	9.4	4.2	0.30	-5.2
Autumn	7.9	5.0	0.34	-2.9
NP-36 (2008)				
Autumn	4.6	5.1	0.24	0.5

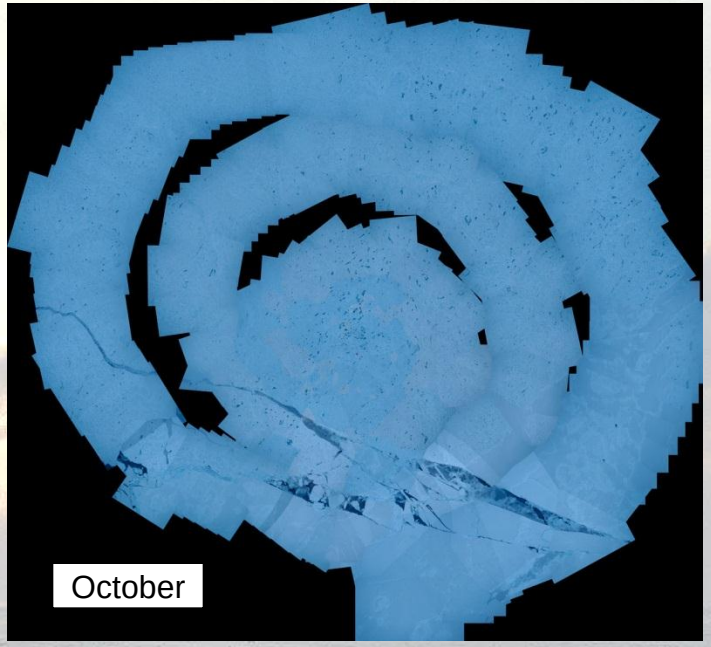
Cryospheric Science Issues

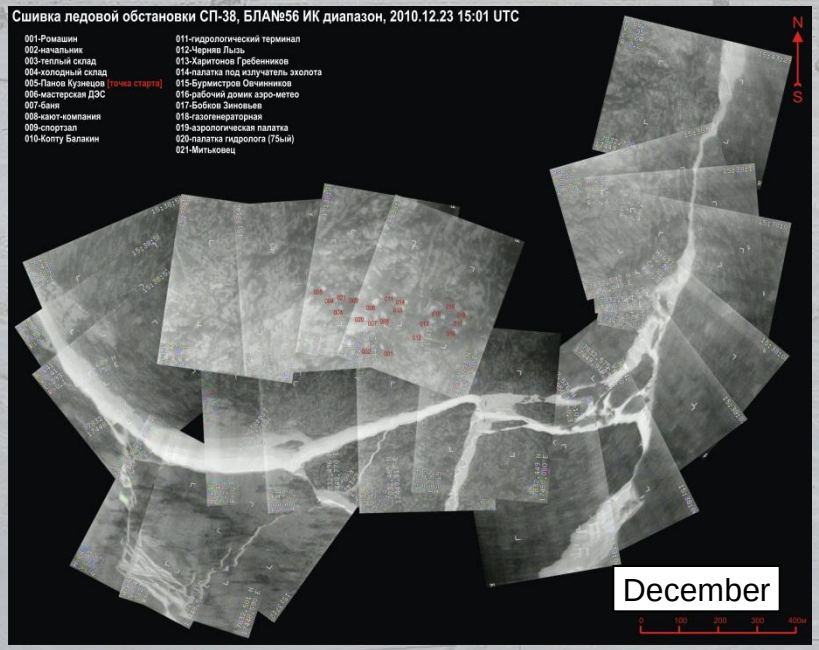
1) spatial and temporal variability of spectral albedo of snow/ice
   – transects of snow depth, density, morphology, spectral albedo (e.g., every 2nd day)
2) spatial and temporal variability of sea-ice surface characteristics (e.g., leads, meltponds, etc)
3) spatial and temporal variability of ice thickness
4) sub-surface ice structure
5) validation of modeled snow depth and ice thickness distributions

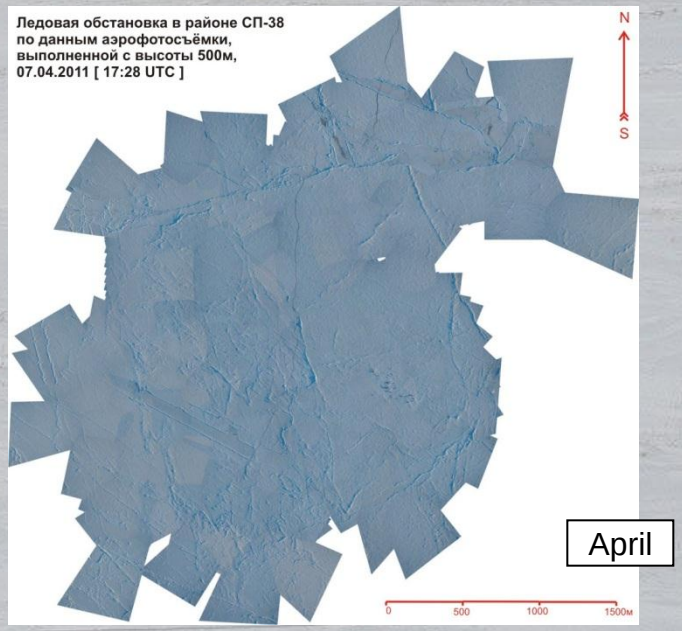
Transect average spectral albedo for day 98 to 215 (NP-36) and day 115 – 191 (NP 35)



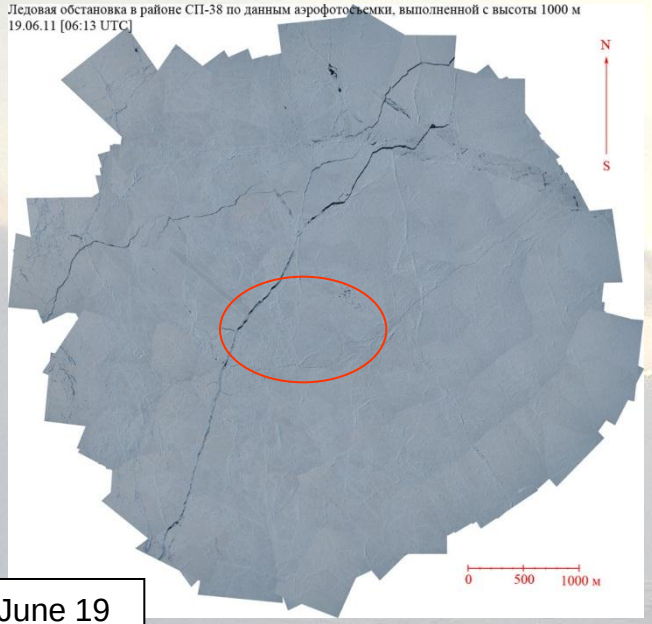
Ice floe characteristics near drifting station “North Pole 38” in winter



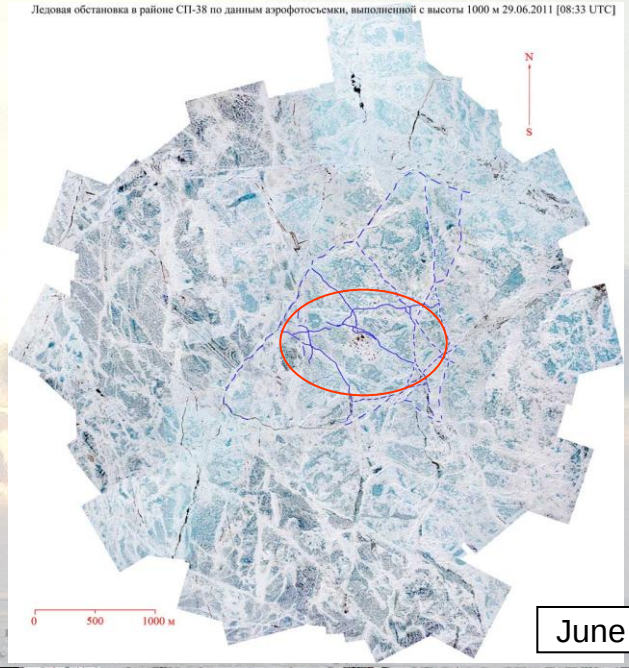




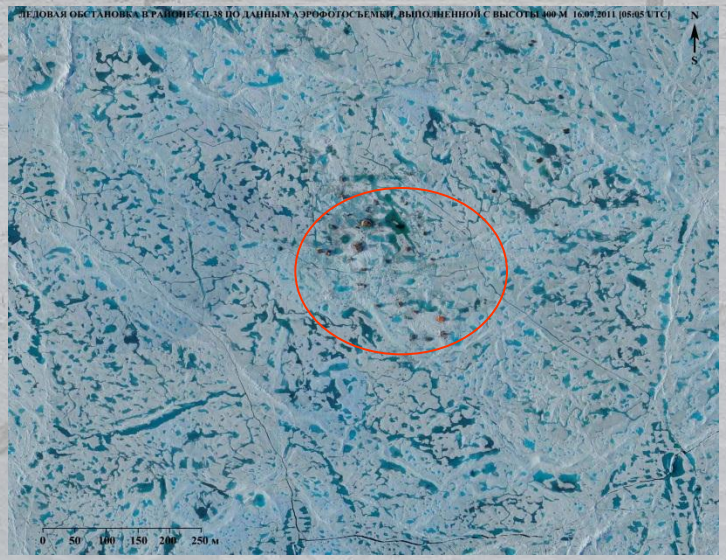
Ice floe characterization of summer melt - “North Pole 38”



June 19



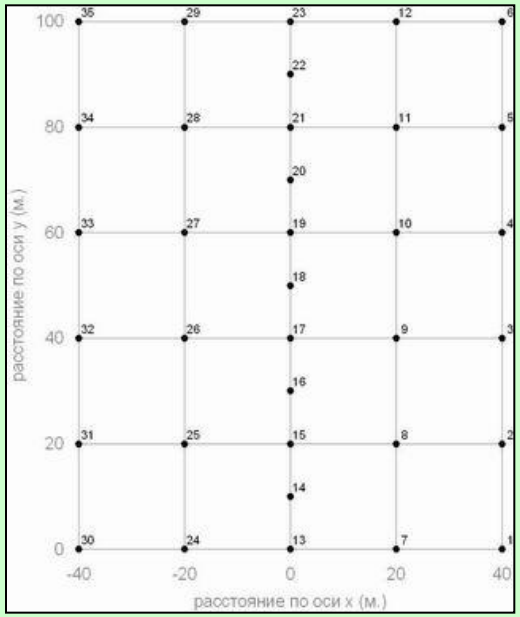
June 29



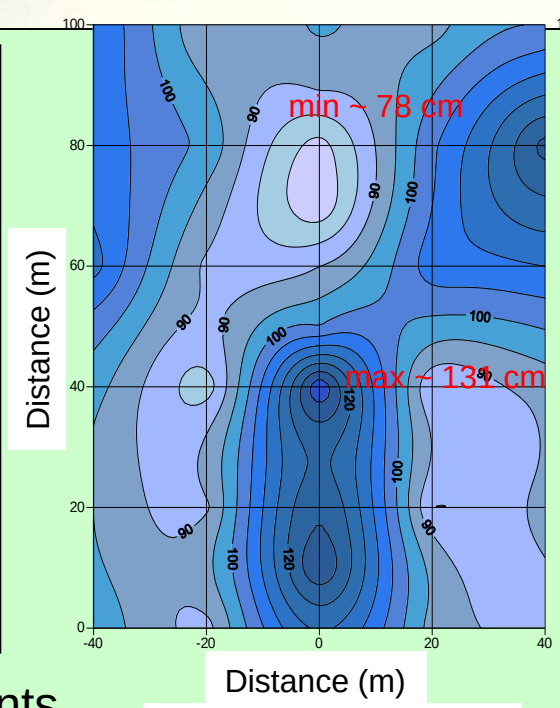
July 16

August 30

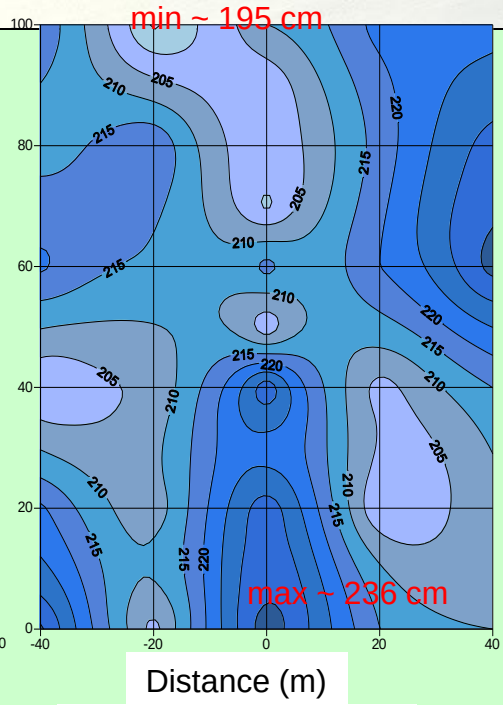
Ice thickness measurements (NP-36)



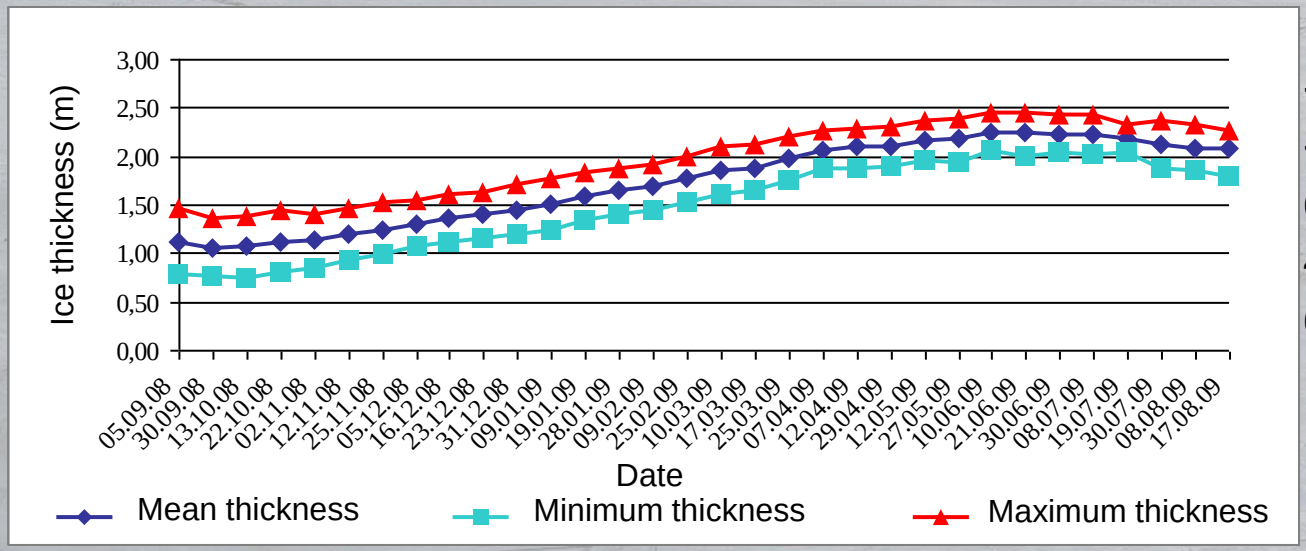
80 x 100 m grid of 35 points



September 30, 2008



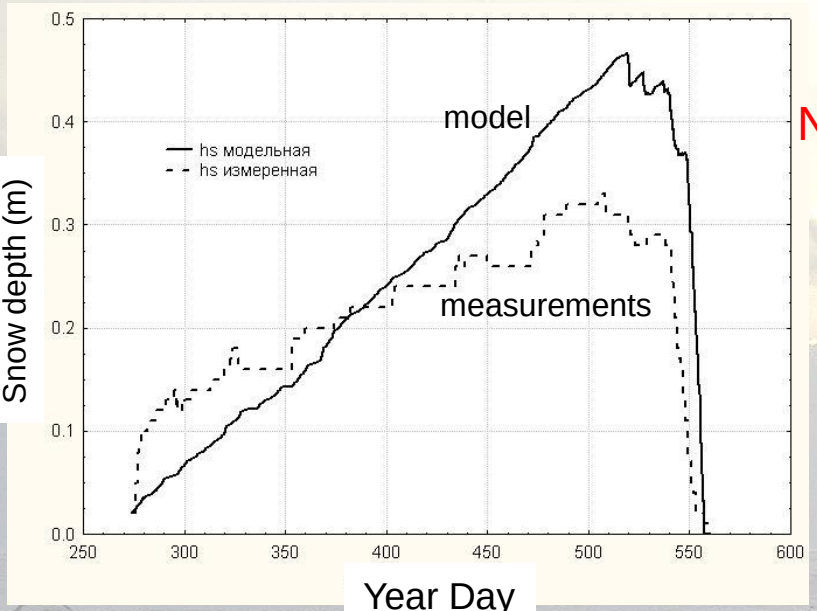
May 27, 2009



- mean growth of 1.3 m
- thickness range decreased during winter from 63 cm to 41 cm (thinner ice regions grew faster)

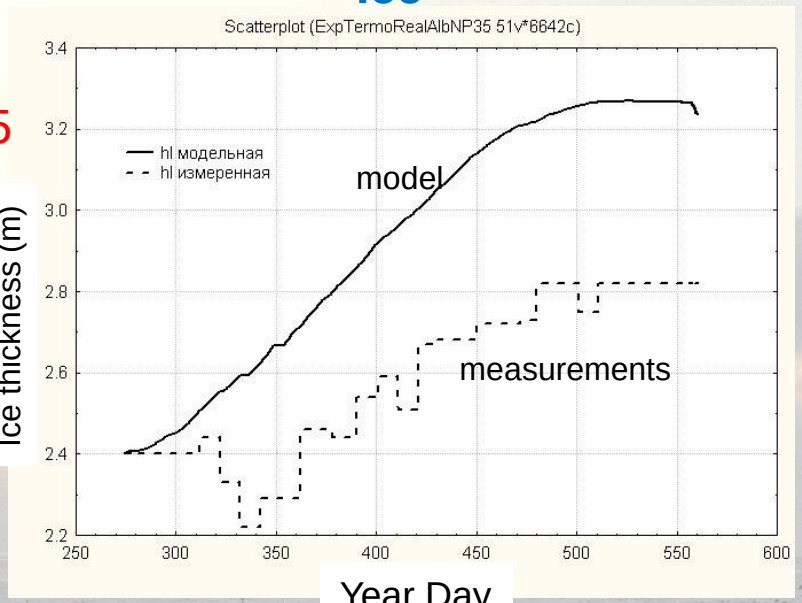
Comparison of modeled and measured snow and ice thickness evolutions

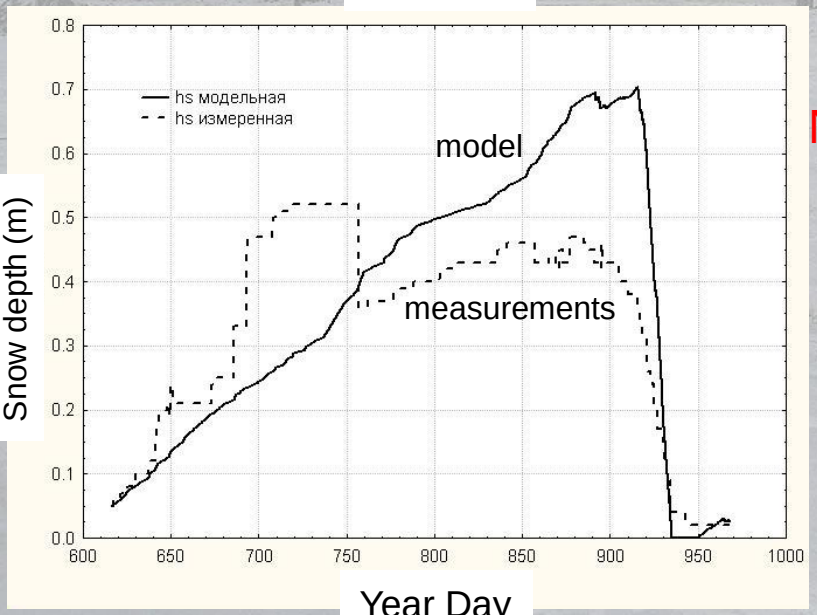
Snow



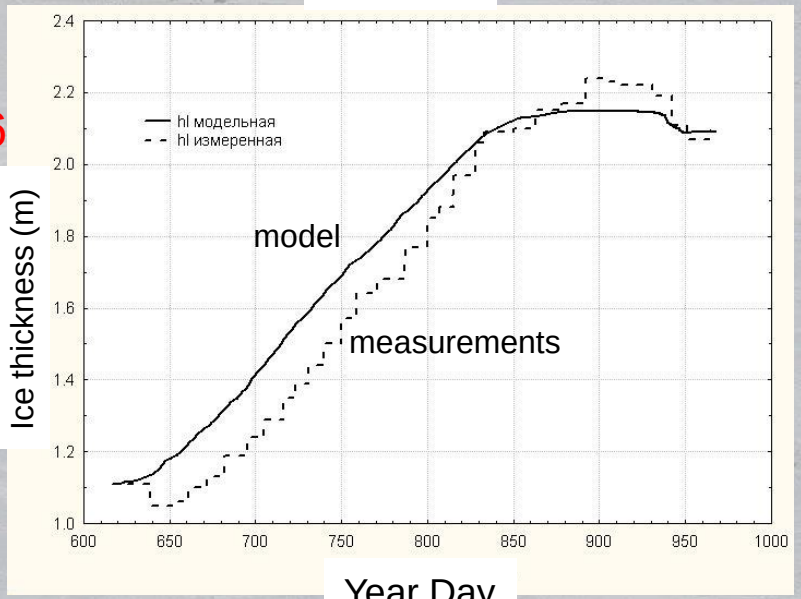
NP-35

Ice





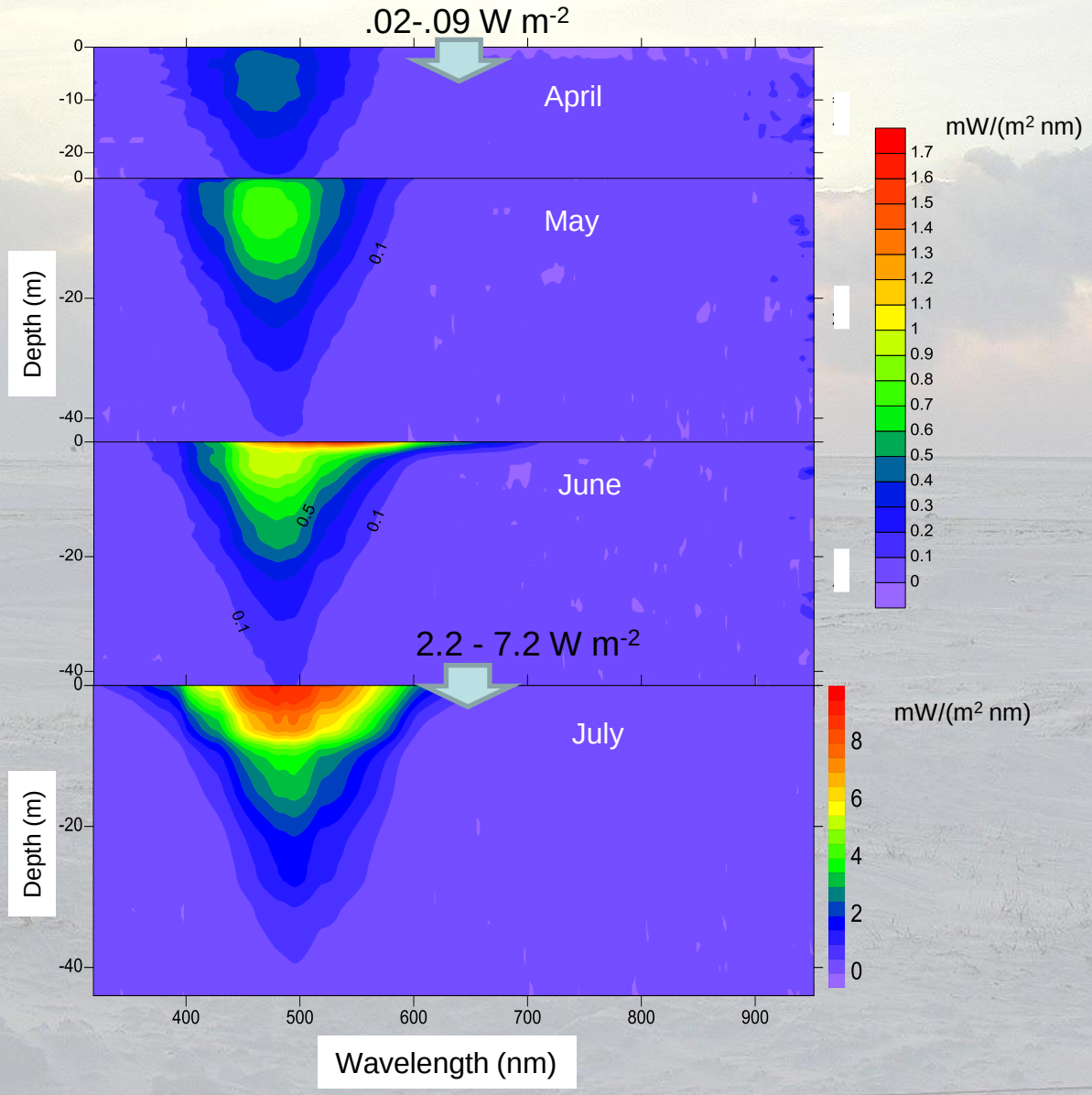
NP-36



Oceanic Science Issues

1) Temporal variability of solar radiation penetration of sea ice
2) Spectral and depth redistribution of solar radiation

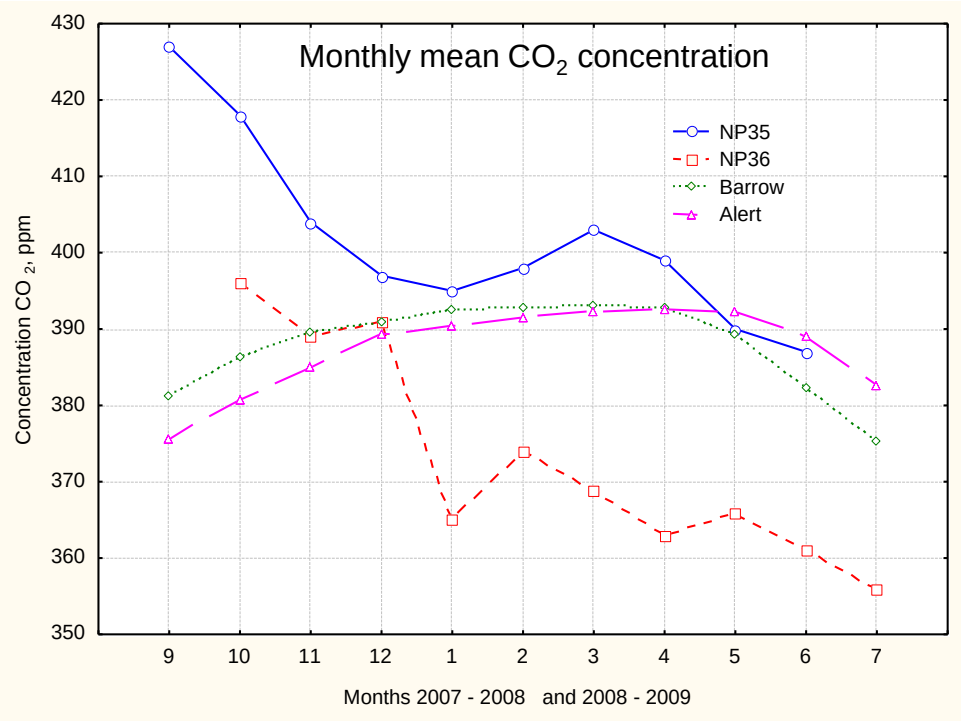
Redistribution of solar flux in upper ocean layer under sea-ice as function of wavelength and month

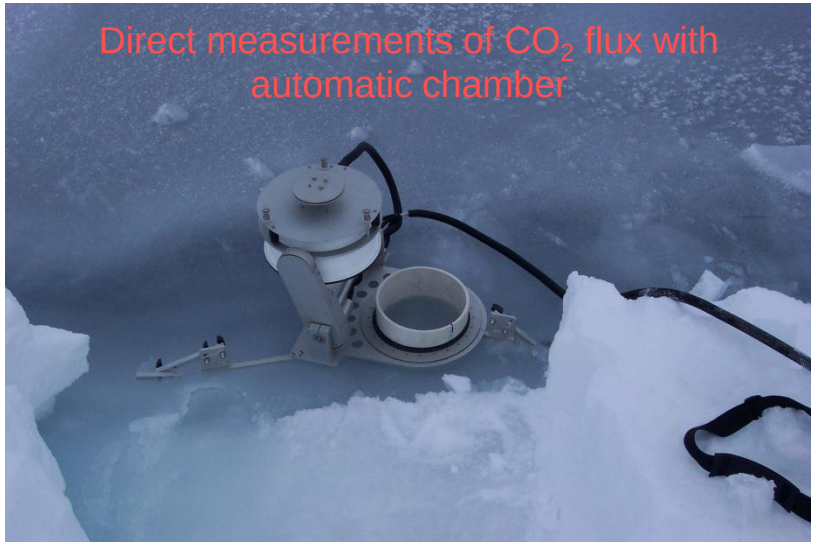


Greenhouse Gas Science Issues

1) Understanding greenhouse gas concentrations and fluxes – CO_2

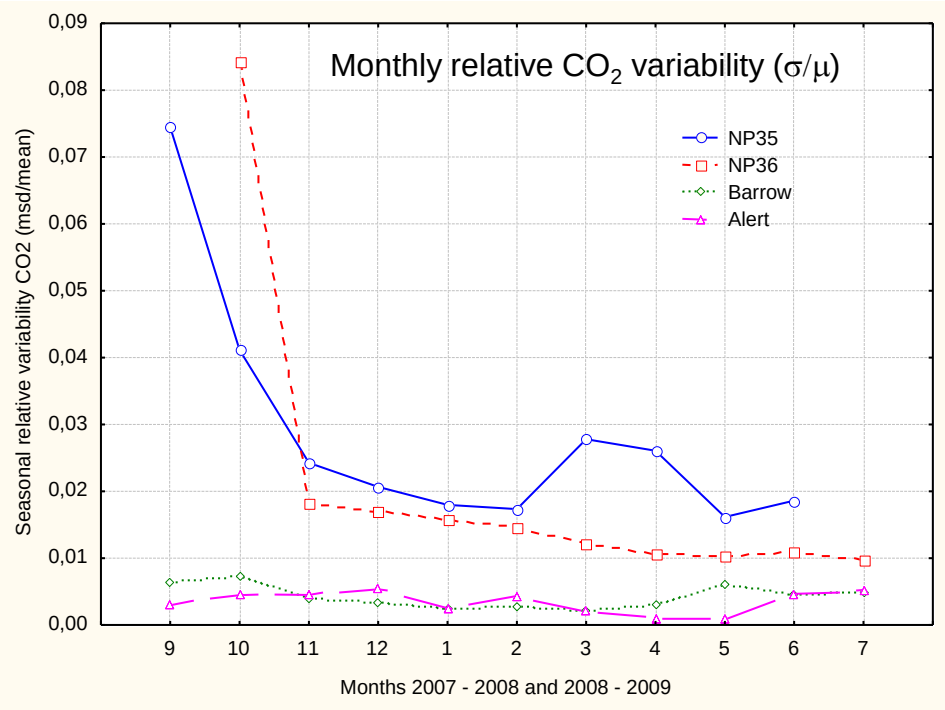
Comparison of seasonal variability of CO_2 concentration at drifting stations NP-35, NP-36 and Observatories in Barrow and Alert





a) during summer and early autumn, ice-free Arctic shelf seas serve as a sink for atmospheric CO_2.
b) in late autumn and winter, cooling seawater is CO_2 source to atmosphere.

Question: what is the role of sea ice in modulating or otherwise affecting this CO_2 exchange?



Scope of future work

1. Study of polar cloudiness

2. Investigate spatial characteristics and radiative properties of sea ice cover.

3. Detailed investigations of atmospheric surface and boundary layer
   - studies of stable boundary layers
   - improve/validate parameterizations of BL for forcing sea-ice models
   - improve/validate mesoscale models, esp. surface characteristics

4. Comprehensive study of atmospheric ozone (from surface to stratosphere).

5. Study of greenhouse gases concentrations and fluxes.