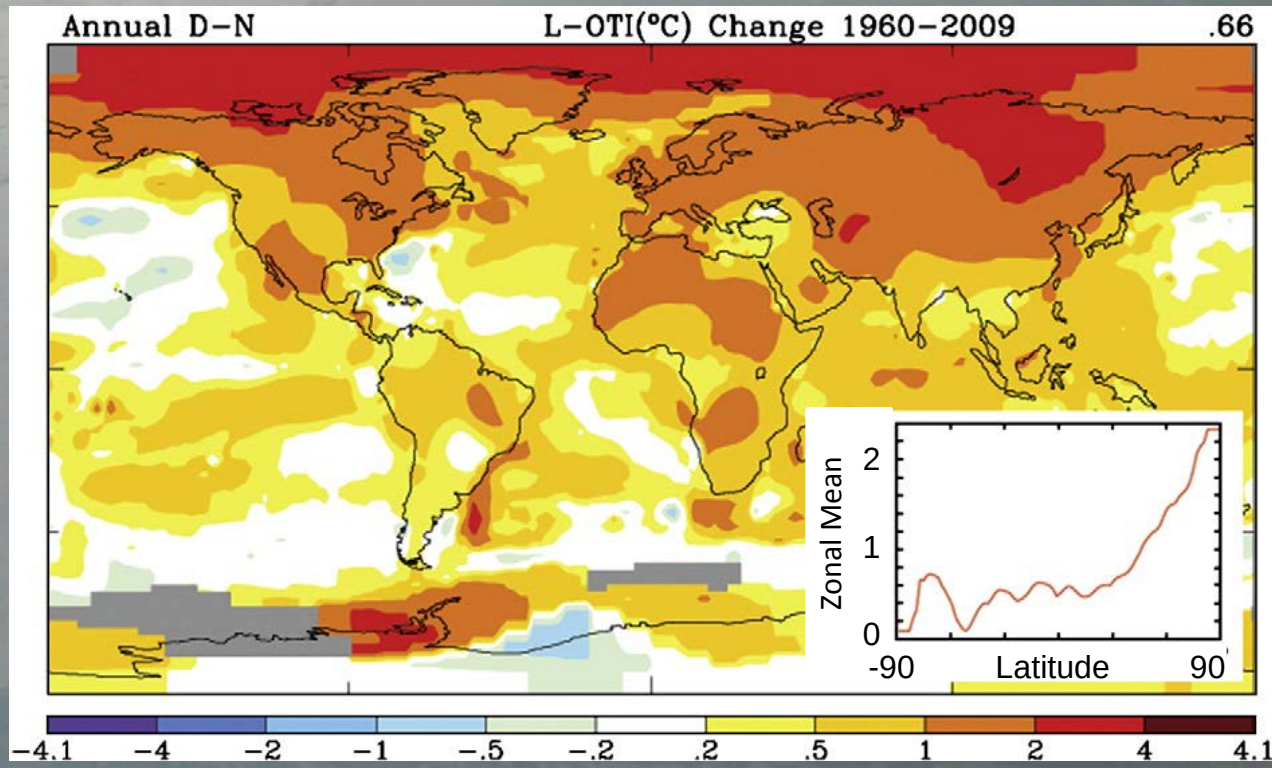
Oliktok Point

Hans Verlinde
Penn State University

Arctic Amplification

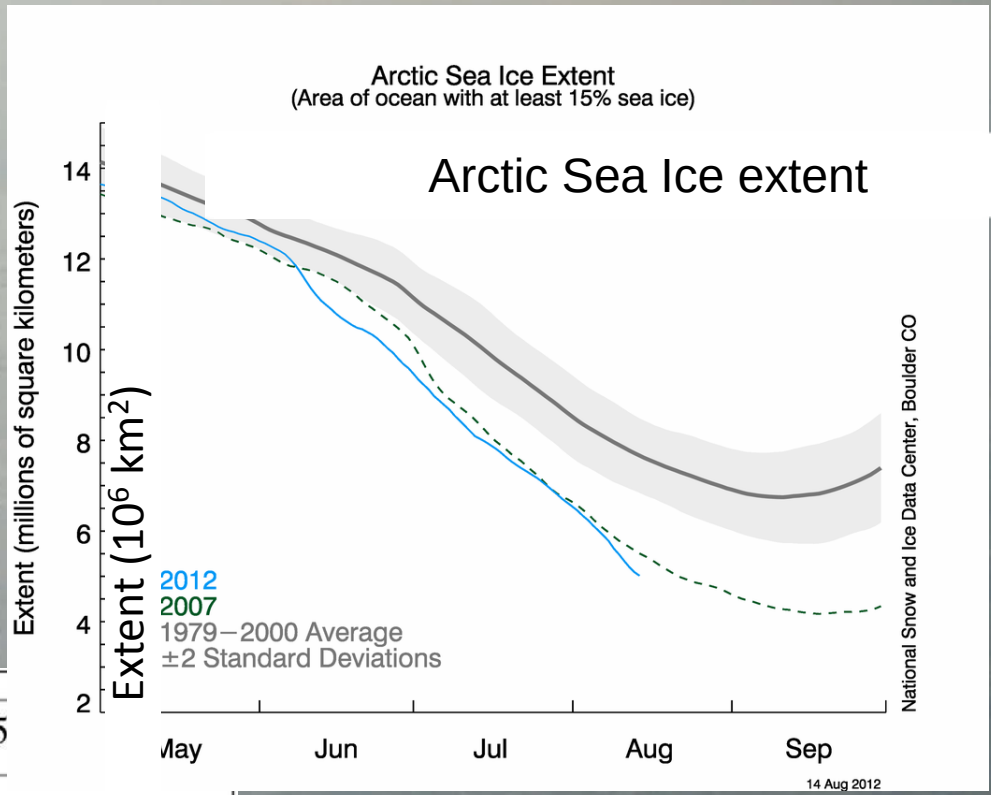
- Temperature trends/variability
  - Arctic > Globe
- Inherent characteristic of global climate system
- 2x globe
- Just in Arctic
- Strongest
  - Fall
  - Winter



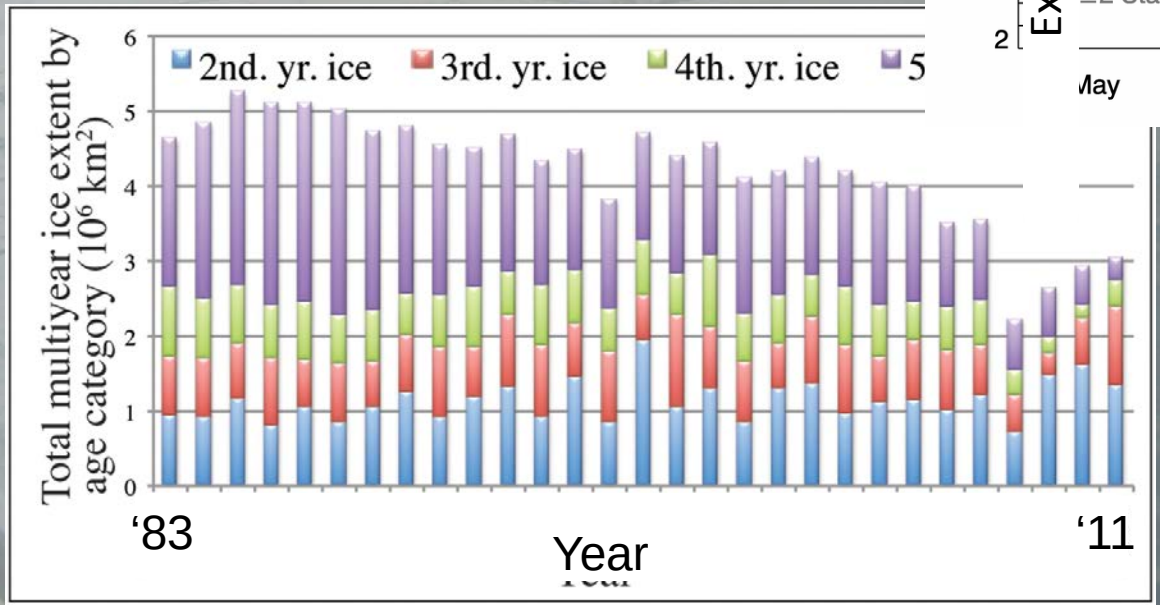
Serezze and Barry, 2011
NASA GISS

Most visible manifestation

- Sea ice
  - Summer extent
  - Volume

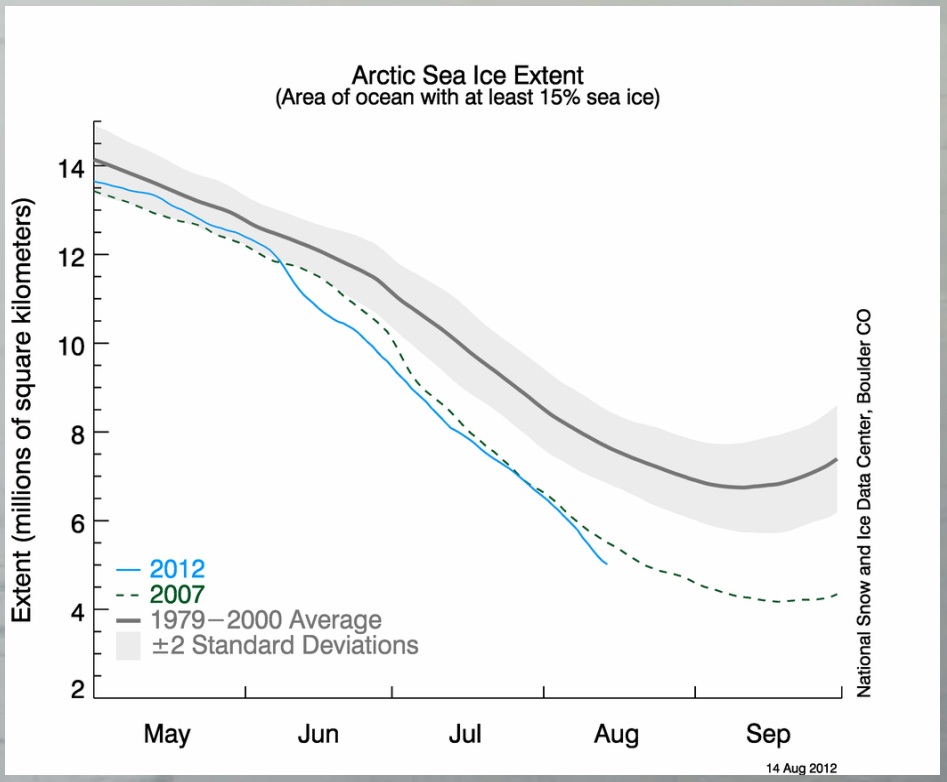


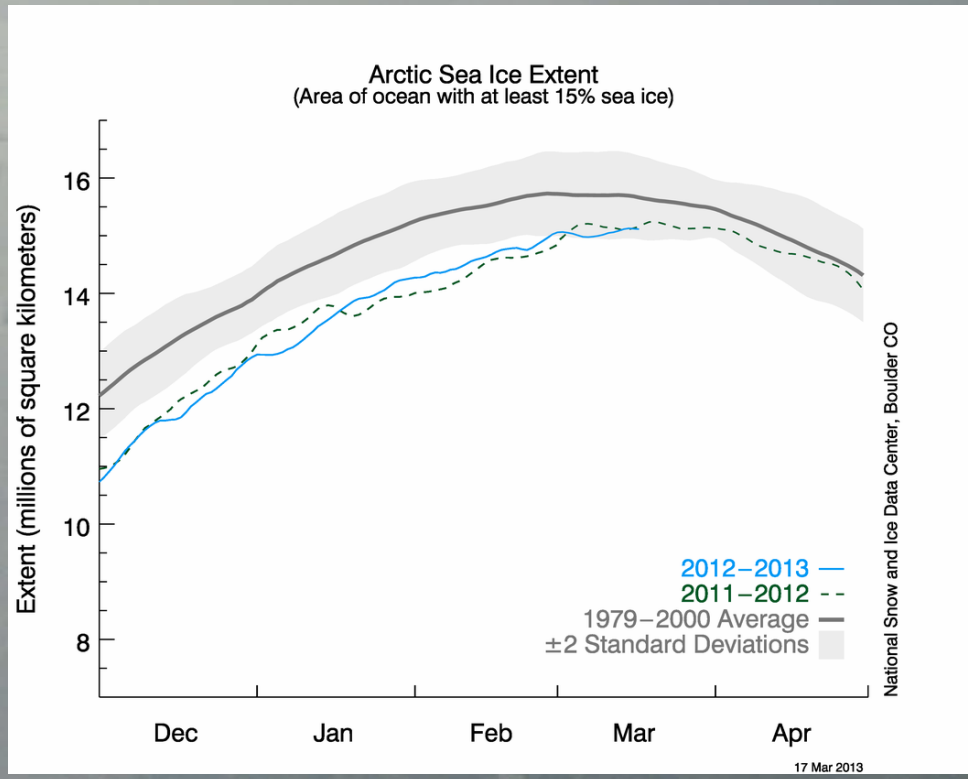
Maslanik et al. 2011



National Snow and Ice Data Center

Arctic Sea Ice Extent





National Snow and Ice Data Center

Why in the Arctic?

- Simplest explanation
  - Ice albedo feedback
- Unfortunately, not that simple
  - suite of causes
  - operating on different time/spatial scales
  - interacting

Serezze and Barry 2011

Contributing Processes

- Changes in sea ice
- Changes in albedo

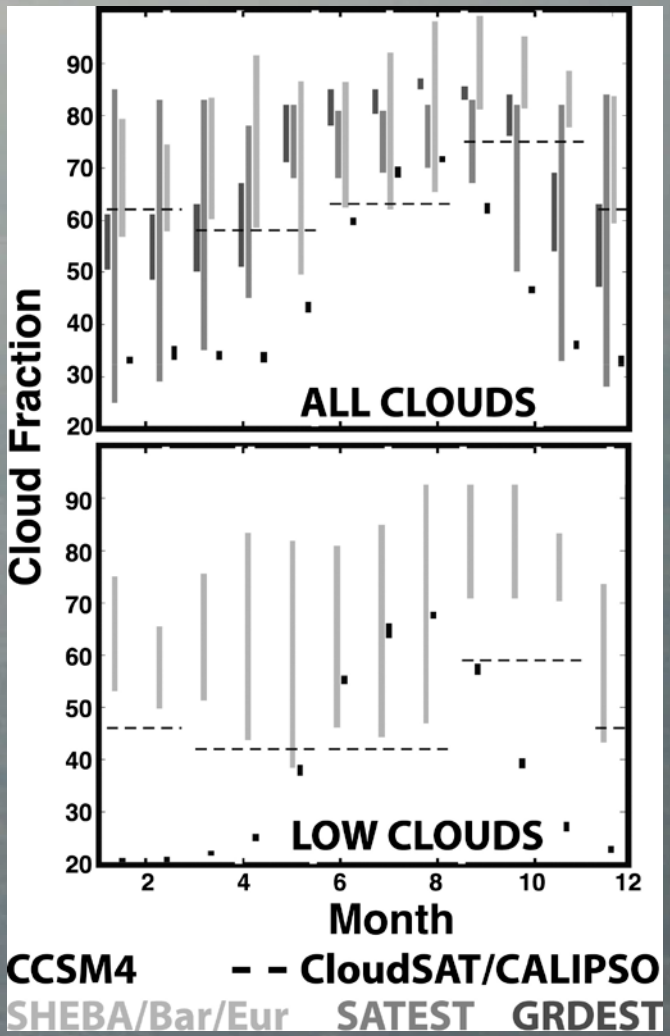
} delayed seasonal response

  - +4% yr^{-1} absorbed solar since ‘79 in Chukchi
- Horizontal heat flux convergence (atm & ocean)
  - changing water vapor & clouds
- Cloud cover & water vapor
  - augmented by weak vertical mixing
  - mostly cold surface
  - impact > albedo (?)
  - relationship to horizontal heat flux

Serezze and Barry 2011

Current Situation: CCSM4

- Observational “data” consist of reanalyses
  - input primarily surface, upper-air circumarctic
- Community Climate System Model 4 (input to AR5)
  - underpredicts Beaufort High (~14 mb)
  - underestimates cloud cover
  - too much (little) liquid (ice)
  - over (under) predicts surface fluxes in summer (winter)
  - lower troposphere too stable
- Factors strongly linked / poorly understood



De Boer et al. 2012

Summary: Current State

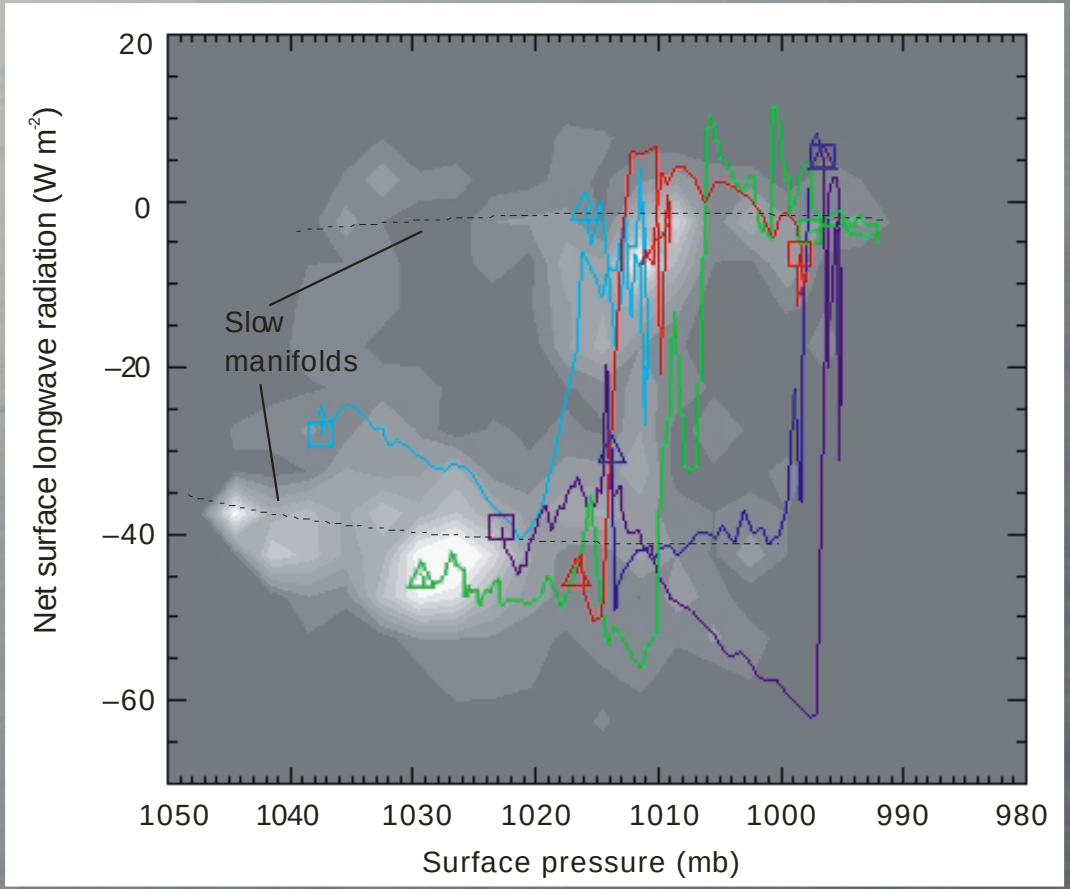
- Large changes observed in Arctic, not captured by models
- Clouds play dominant role in regional radiation budget, impacting ice-albedo feedback, important in own right
- Clouds, and (lower) atmospheric state, poorly represented in models
- Physics coupling atmosphere, clouds, and surface not well understood
- Yet, this coupling determines extent of cloud role in ice-albedo feedback

ASR Challenges

- Arctic vs mid-latitude low-level stratiform clouds
  - Single parameterization
  - Thermodynamic structure
  - Mixed-phase
    - Cloud Dynamics
    - Cloud microphysics (liquid/ice partitioning)
- Role of large-scale conditions (Morrison et al 2012)

Different Attractors
Two-fold observational strategy

- Fast-timescale
  - Clouds processes
- Slow-timescale
  - Longer periods
  - Detailed profiles
- Atmospheric state
  - Advection
  - Sea-ice/Ocean
- Transitions



Morrison et al., 2012

Needs

- Routine (sustained) measurements through cloudy layers
  - Thermodynamic profiles
  - Microphysical parameters (liquid)
  - Aerosol characteristics
- Larger scale environment
  - Surface conditions
  - Advection into limited domain
- Multi-scale modeling effort

Oliktok Point

- Tether Balloon System
  - only realistic option for routine measurements
  - Thermodynamics/microphysics/aerosol
- Spatial structure precipitation (scanning radar)
- Unmanned Aerial Systems
  - Forcing data sets for environment
  - Spatial measurements
  - Surface state
- Multi-scale modeling effort using this much expanded data set
- Platform in the Arctic Ocean basin (need ice breaker: collaboration with other programs)