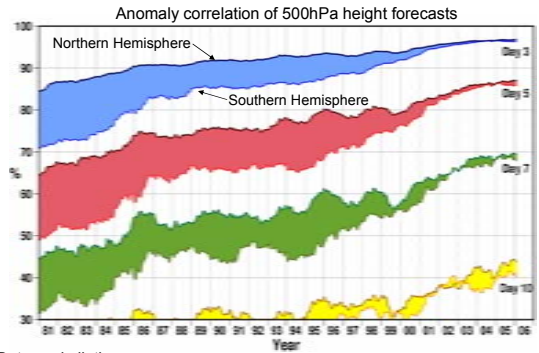


Ground, Airborne and Satellite Study of Snow on the North Slope of Alaska

Richard Essery
School of GeoSciences, University of Edinburgh

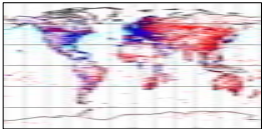
Contributions from: Chawn Harlow (Met Office)
Nick Rutter (University of Sheffield)
H-P Marshall (Boise State University)

ECMWF Forecast Performance

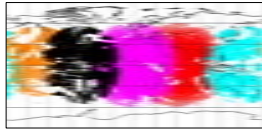


Data assimilation:
2001 – 1.4 million data items / day
2006 – 7 million data items / day → ~10⁸ state variables in model atmosphere

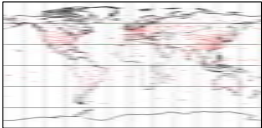
Surface stations



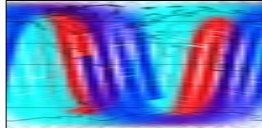
Geostationary satellites



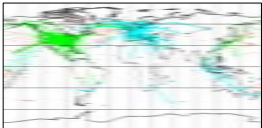
Radiosondes



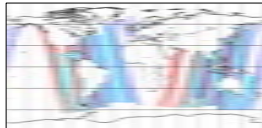
Polar orbiters, infrared



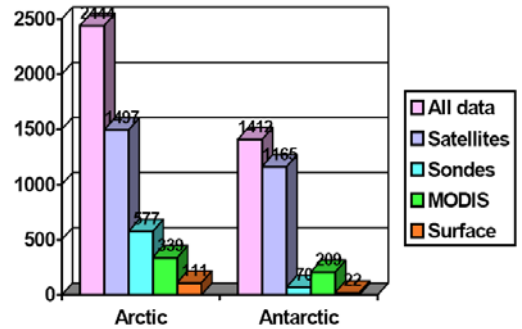
Aircraft



Polar orbiters, microwave



Information Content of Polar Observing Systems



Atmospheric Sounding

Monochromatic radiance at the top of the atmosphere without scattering:

$$L(\nu) = \int_0^\infty B(\nu, T(z)) \frac{d\tau_\nu}{dz} dz + L_{\nu 0} \tau_\nu(0)$$

Planck function Weighting function Surface contribution

$\tau_\nu(z)$ – fractional transmission of radiation with frequency ν from height z to the top of the atmosphere

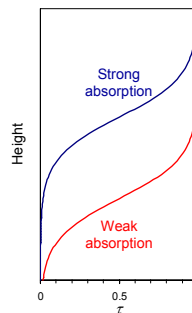
Brightness temperatures:

$$T_b = T_a + \tau(1 - \epsilon)T_a + \tau \epsilon T_s$$

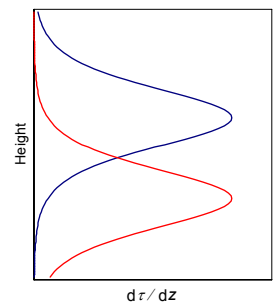
Surface emissivity Surface temperature

Atmospheric Sounding

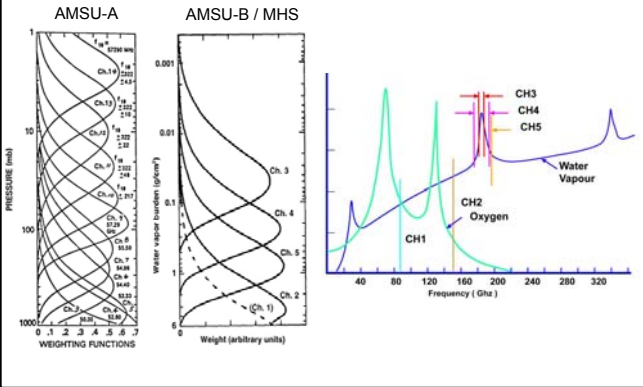
Transmission



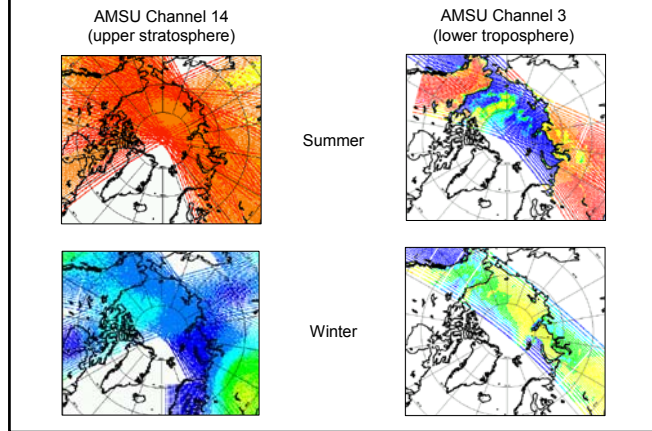
Weighting function



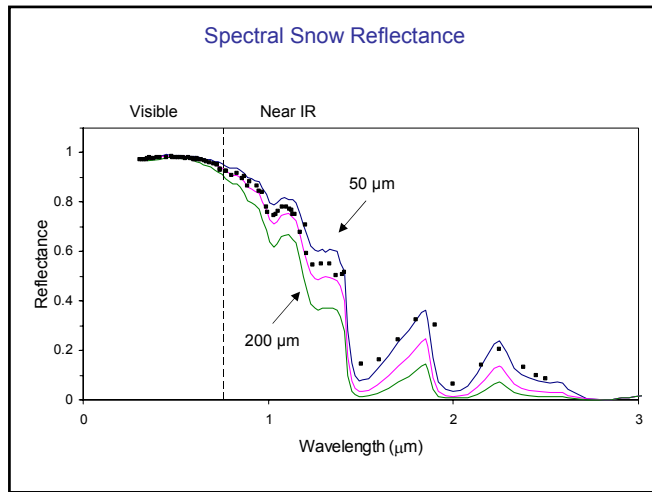
Atmospheric Sounding



Microwave Brightness Temperatures



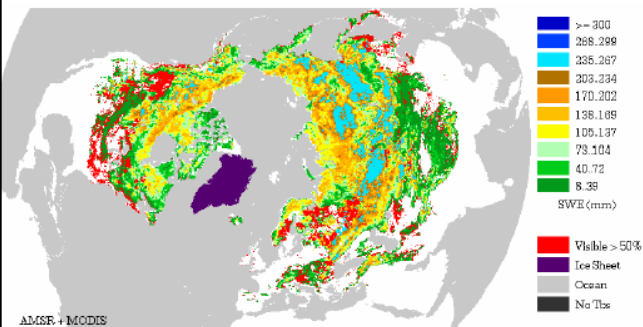
Spectral Snow Reflectance



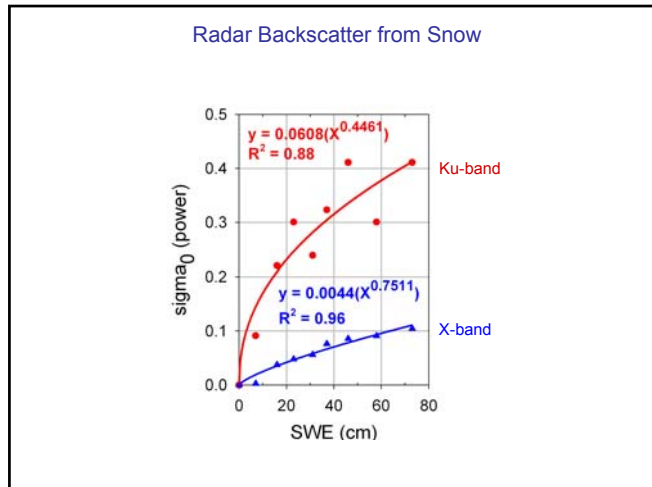
Passive Microwave Remote Sensing of Snow

Empirical relationship:

$$SWE = 4.8 [T_b(18GHz) - T_b(37GHz)]$$



Radar Backscatter from Snow



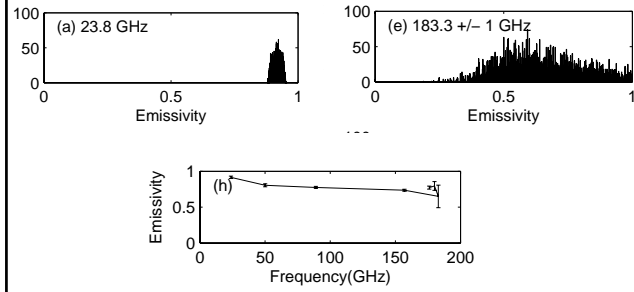
NASA Cold Land Process Experiment

Aims:

- Advance airborne and spaceborne snow-measurement capabilities
- Test and develop high-frequency radar (Ku-, X-band) remote sensing techniques for measuring snow water equivalent (SWE)
- Collect repeat coincident high-frequency radar and in situ snow observations of a wide range of snow-covered terrain
- Study campaigns in Colorado and Alaska

Airborne Retrieval of Snow Microwave Emissivities

Harlow (2007). *J. App. Meteorol.*, **46**(1)



Facility for Atmospheric Airborne Measurements (FAAM) BAe-146
(<http://www.faam.ac.uk>)

Passive microwave radiometers, 23.8, 50.1, 89, 157 and 183.3 GHz
Visible and infrared spectrometers
Dropsondes



