

# Sea ice flux exchanges: A top down, bottom up approach.

David Bailey and Marika Holland  
NCAR

NCAR is sponsored by the National Science Foundation

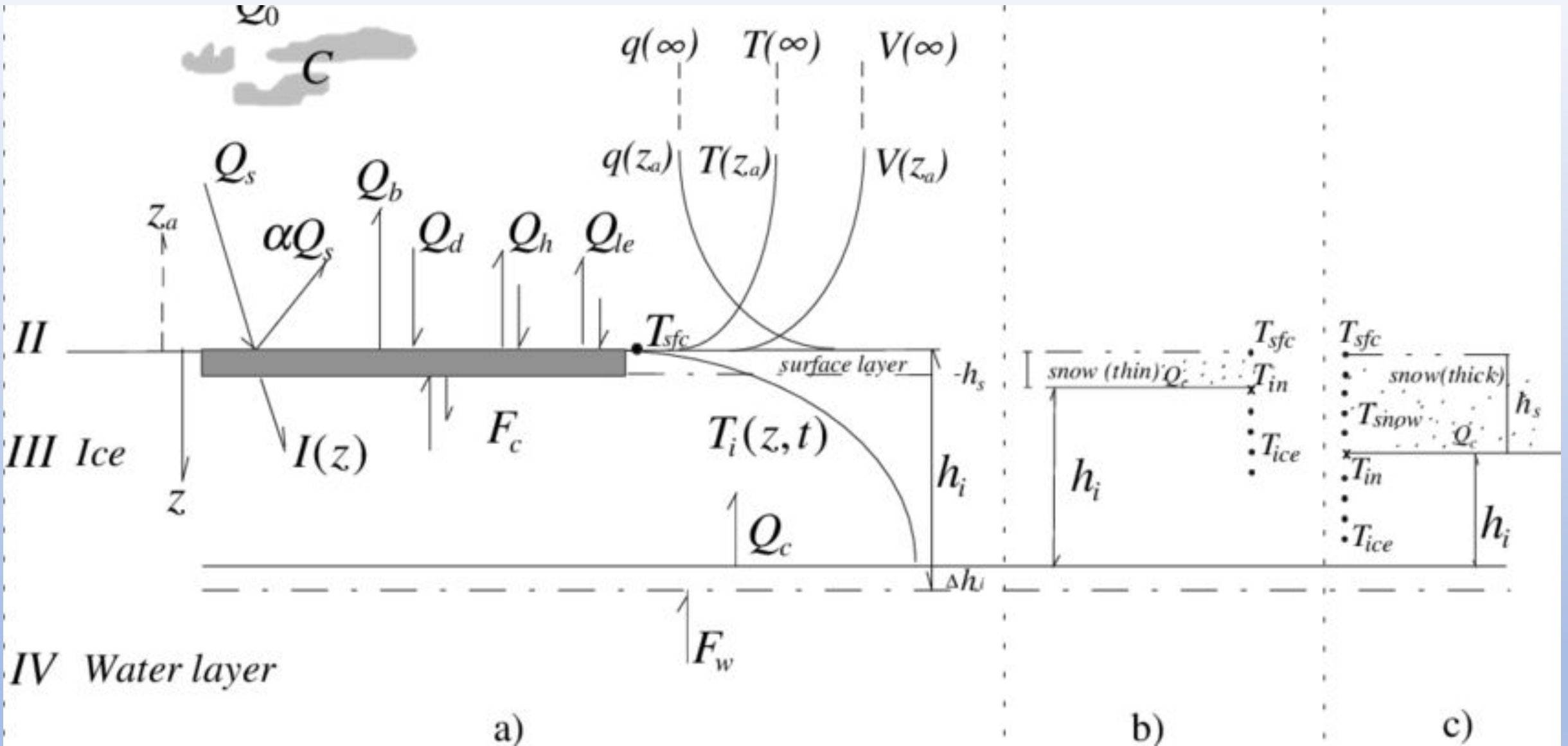
# Current State of Flux Exchange in CESM.

Atmosphere-Sea Ice: Radiation, Sensible and Latent Heat, Momentum, Fresh Water

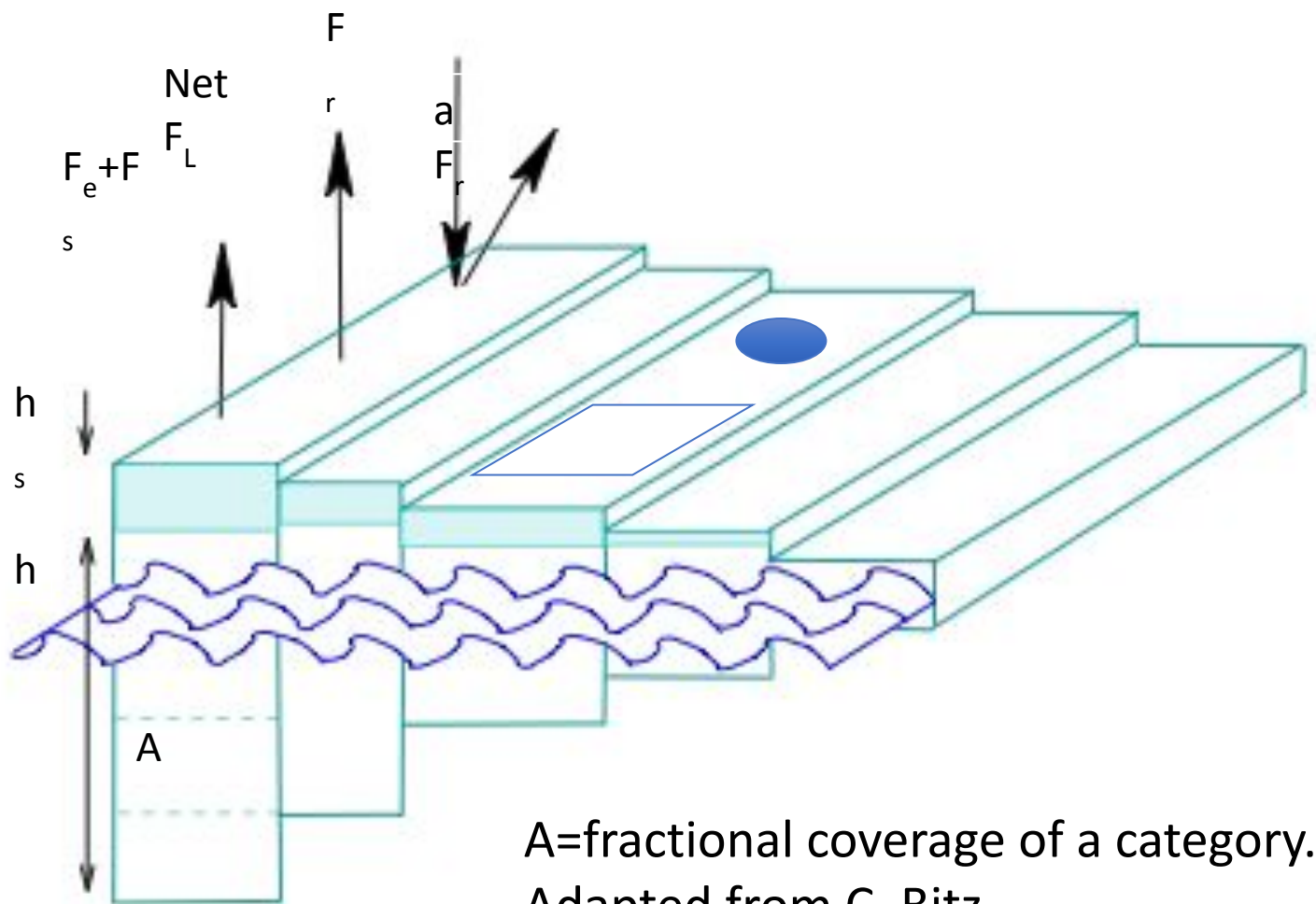
- Stability dependent formulation (Bryan, Kaufman, Large, and Gent 1996; Large and Yeager, 2004; 2009). Similar over the ocean.
- Drag and transfer coefficients a function of stability.  $U^*$  a function of wind / sea ice speed. Constant roughness length.

Ocean-Sea Ice: Fresh Water, Salt, Momentum, Sensible and Latent Heat, Radiation

- Constant drag and transfer coefficients.  $U^*$  a function of ocean and sea ice speed. (Maykut and McPhee 1995)



Cheng and Launiainen 1999



$A$ =fractional coverage of a category.  
Adapted from C. Bitz

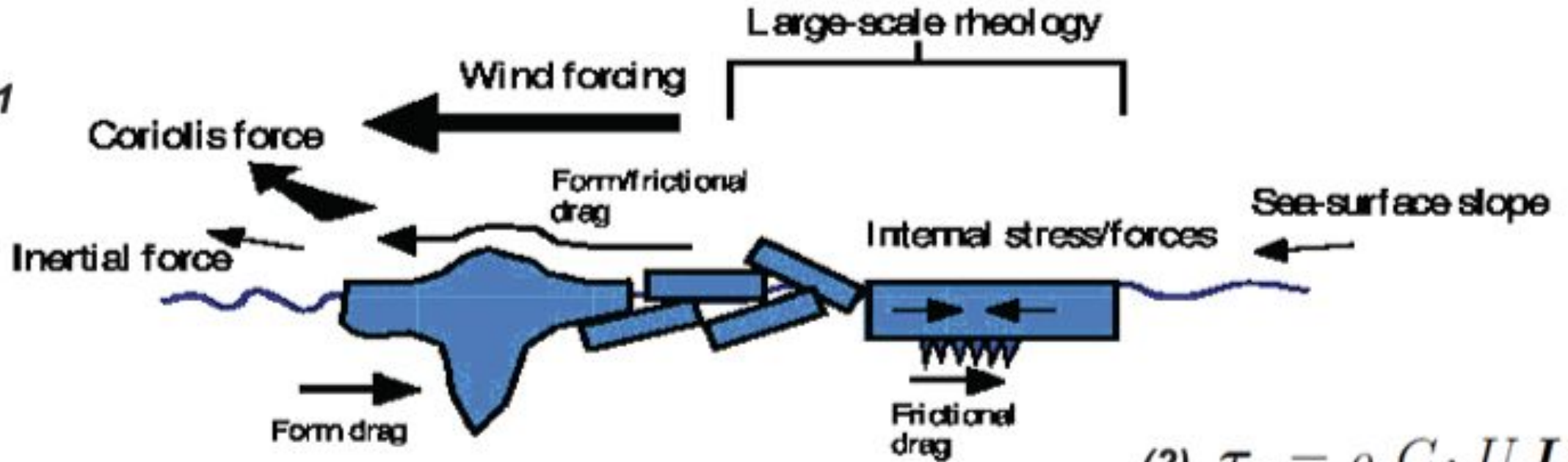
Subgrid-scale ice thickness distribution (ITD)

Typically five thickness categories.

All fluxes are merged by fraction before sending to coupler.

# Future: Form Drag (Tsamados et al. 2014)

Fig 1

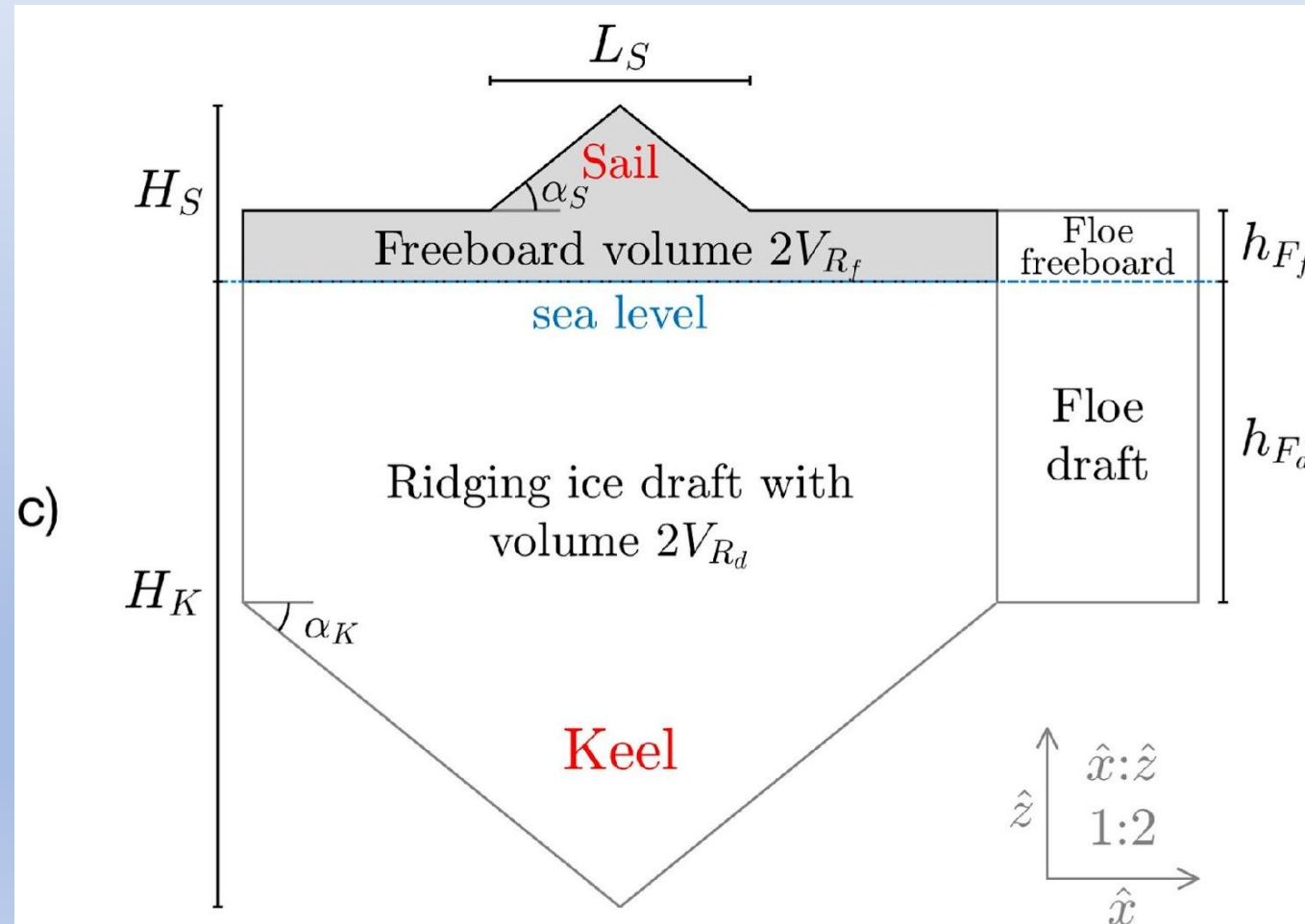


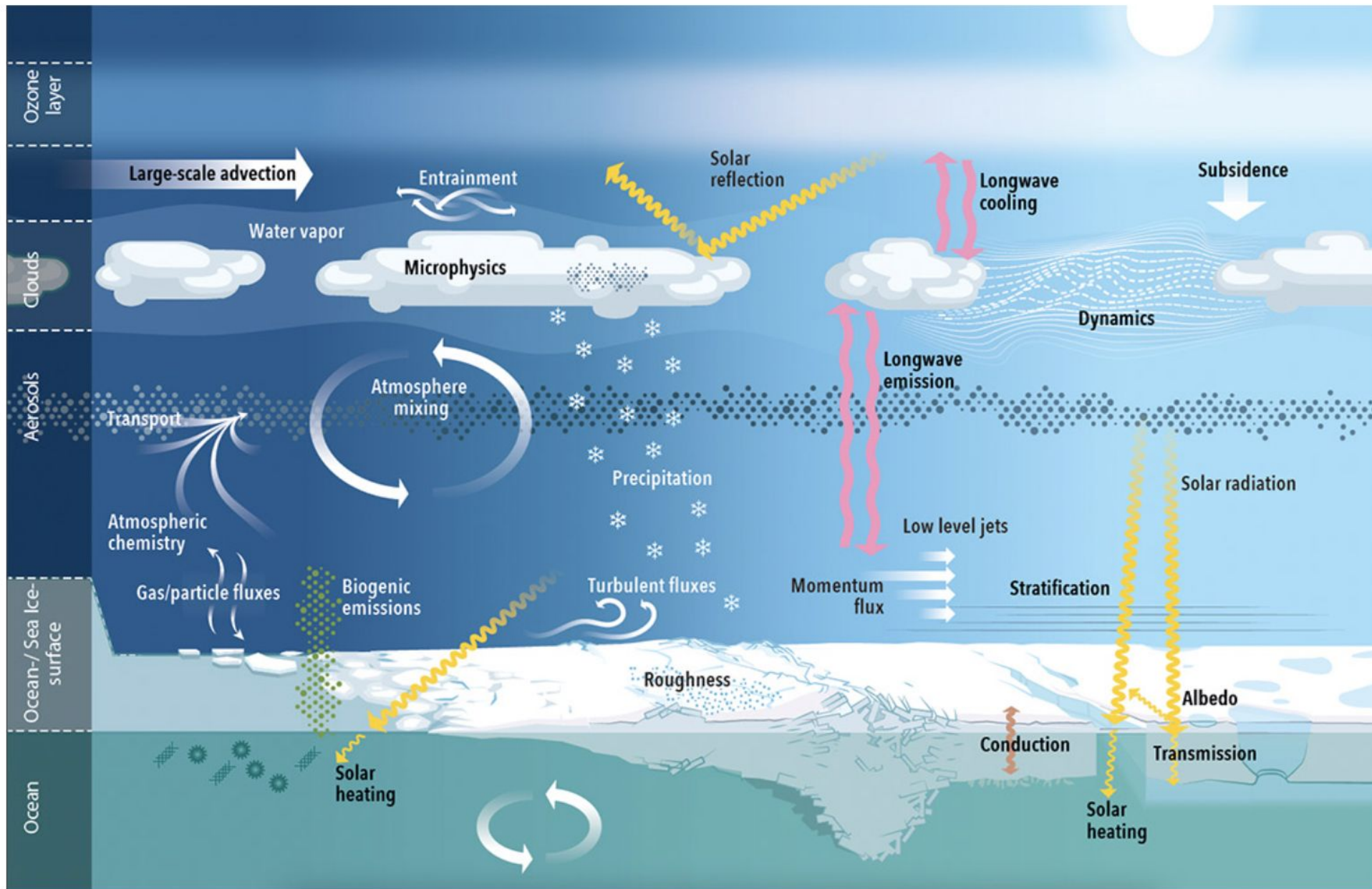
$$(1) m \frac{Du}{Dt} = \tau_a + \tau_w + \nabla \cdot \sigma - m f_c \mathbf{k} \times \mathbf{u} - mg \nabla H$$

$$(2) \tau_a = \rho_a C_{da} U_a U_a$$

$$(3) \tau_w = \rho_w C_{dw} U_w e^{i\theta_w} U_w$$

# Future: Variational Ridging Approach (Roberts et al. 2019)





# MOSAIC: Multidisciplinary drifting Observatory for the Study of Arctic Climate

The interactions between atmosphere, ice and snow, and ocean in the central Arctic Ocean. Graphics: MOSAiC Team

Atmosphere

# Summary

- Atmosphere-sea ice-ocean flux exchange has not been updated in many years.
- Subgridscale Ice Thickness Distribution: Fluxes merged by fraction and sent to coupler.
- Form drag and variational ridging approaches still to come.
- Eventually make use of MOSAiC and machine learning methods (Zampieri)