LAYER GEOMETRY AS A CONSTRAINT ON THE PHYSICS OF SLIDING ONSET

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EGU GENERAL ASSEMBLY

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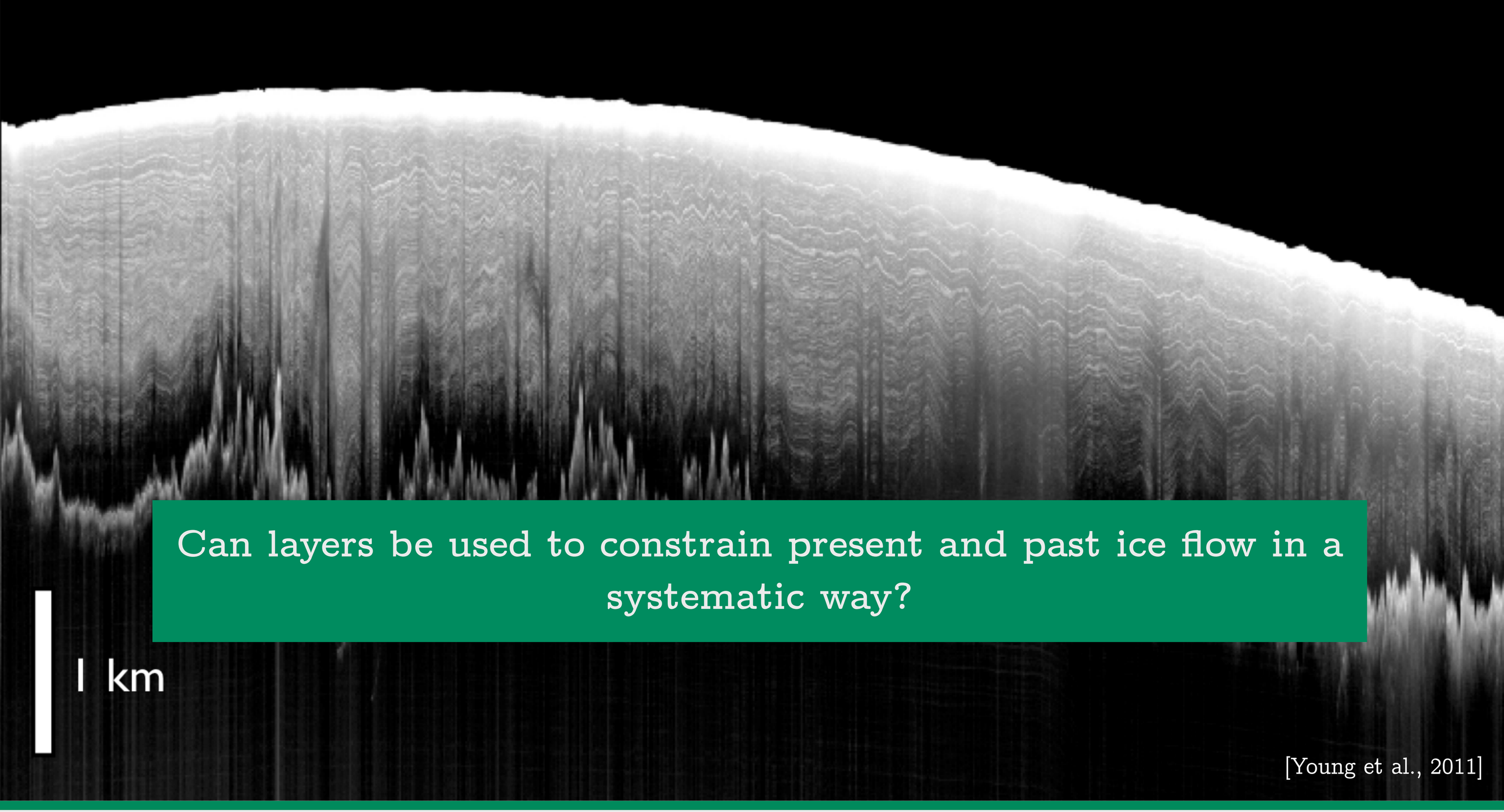
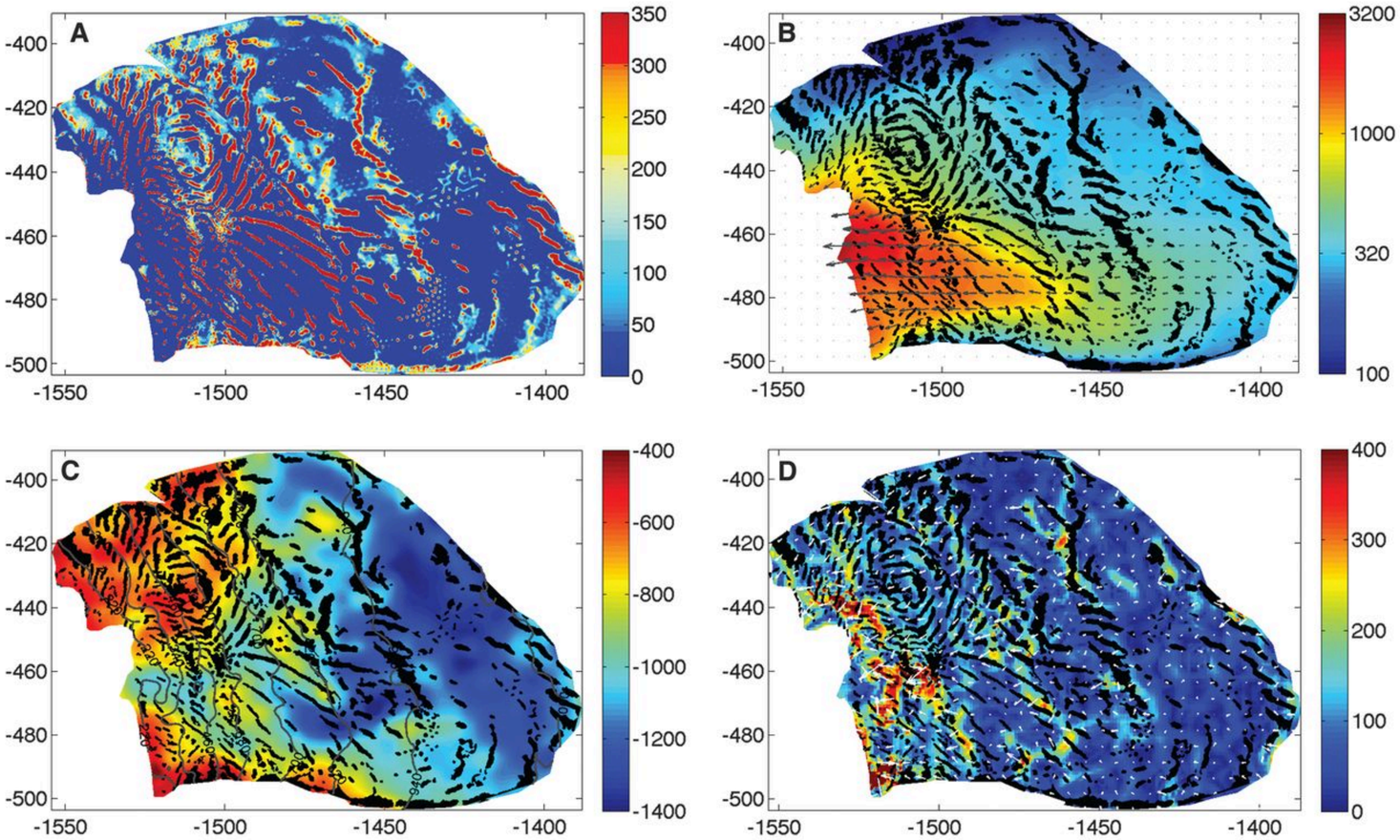


Can layers be used to constrain present and past ice flow in a systematic way?

[Young et al., 2011]

BASAL FRICTION IS KEY … CAN LAYERS HELP?



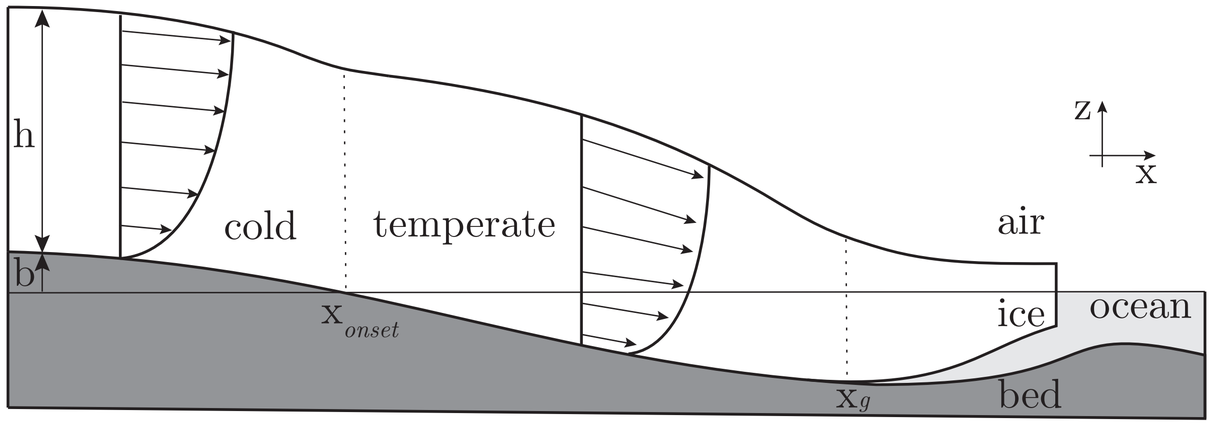
THE RATIONALE:

- bed friction usually inferred from surface speeds
- layers encode information on velocity/deformation at depth
- could layers provide direct constraints on basal friction?

[Left: Sergienko and Hindmarsh, 2014]

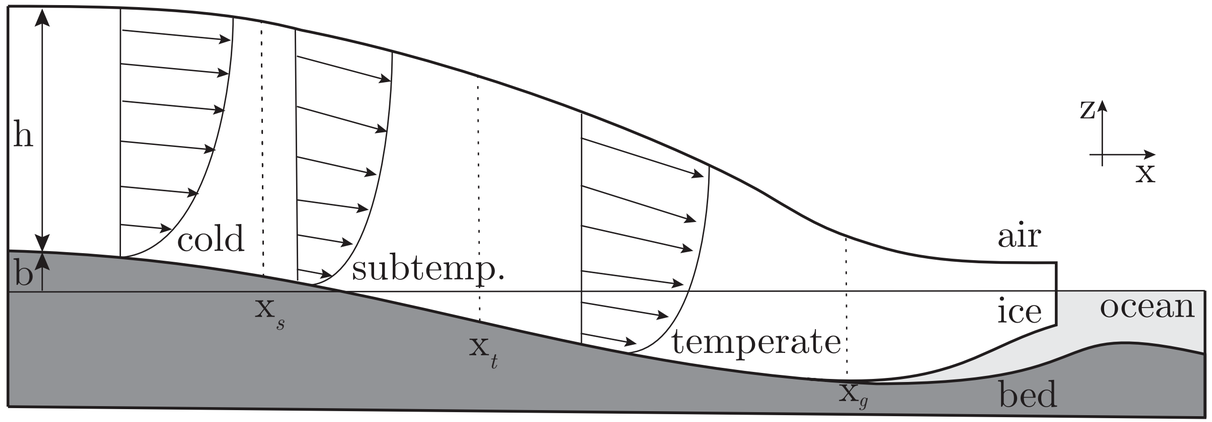
INSIGHTS ON SLIDING ONSET FROM LAYER GEOMETRY

ABRUPT ONSET



$x \sim h$

DISTRIBUTED ONSET



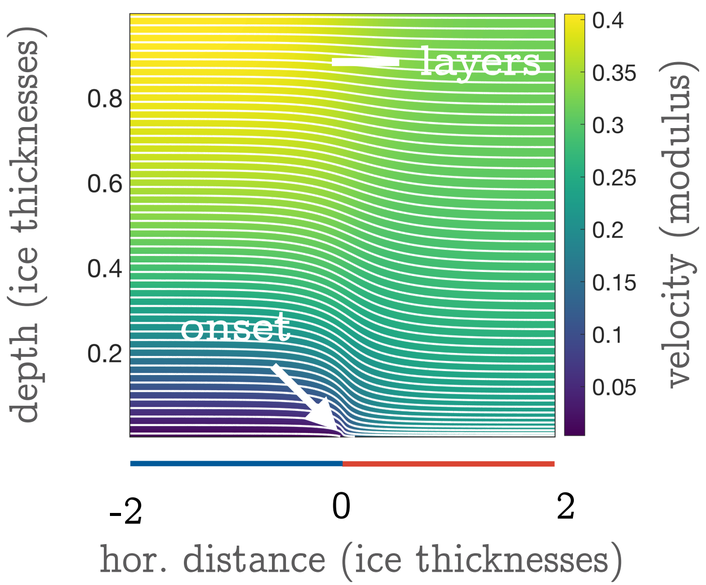
$x \sim L$

The theory says abrupt onset should be impossible. Can we leverage its signature in layers to rule it out in the real world?

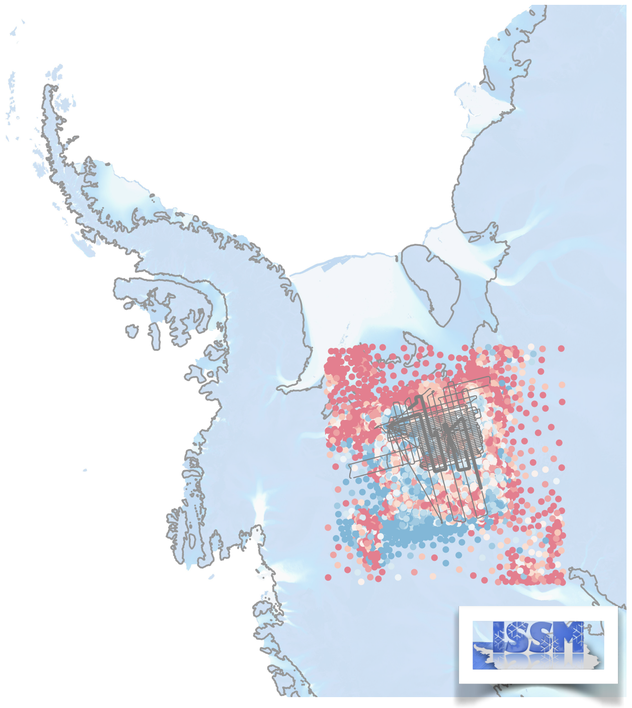
[e.g., Fowler & Larson 1978; Mantelli et al. 2019]

HOW - SLIDING ONSET AT INSTITUTE ICE STREAM

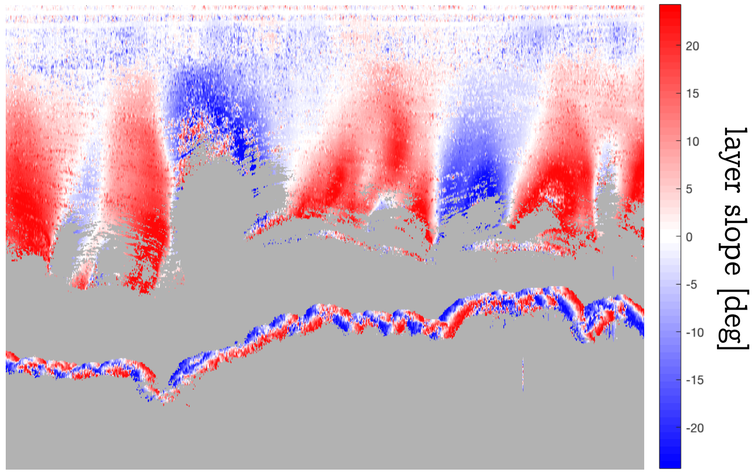
1. FULL STOKES MODEL (+ THEORY)



2. BED FRICTION INVERSION



3. LAYER-OPTIMIZED SAR PROCESSOR

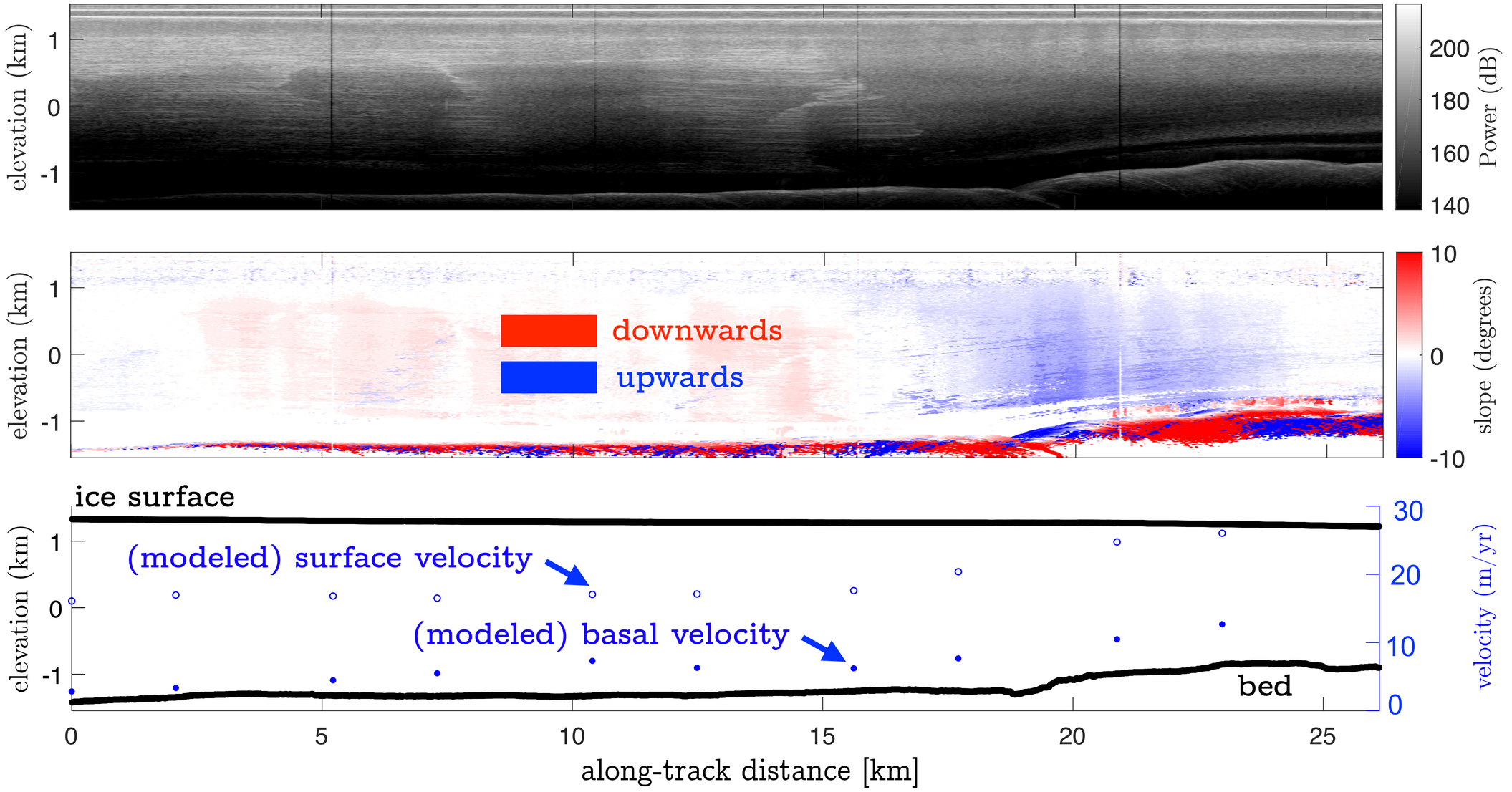


WHAT

- expected layer slopes if onset is abrupt
- location of sliding onset at IIS
- high res. layer slopes from airborne radar data

[Mantelli et al., 2019; Castelletti et al. 2019]

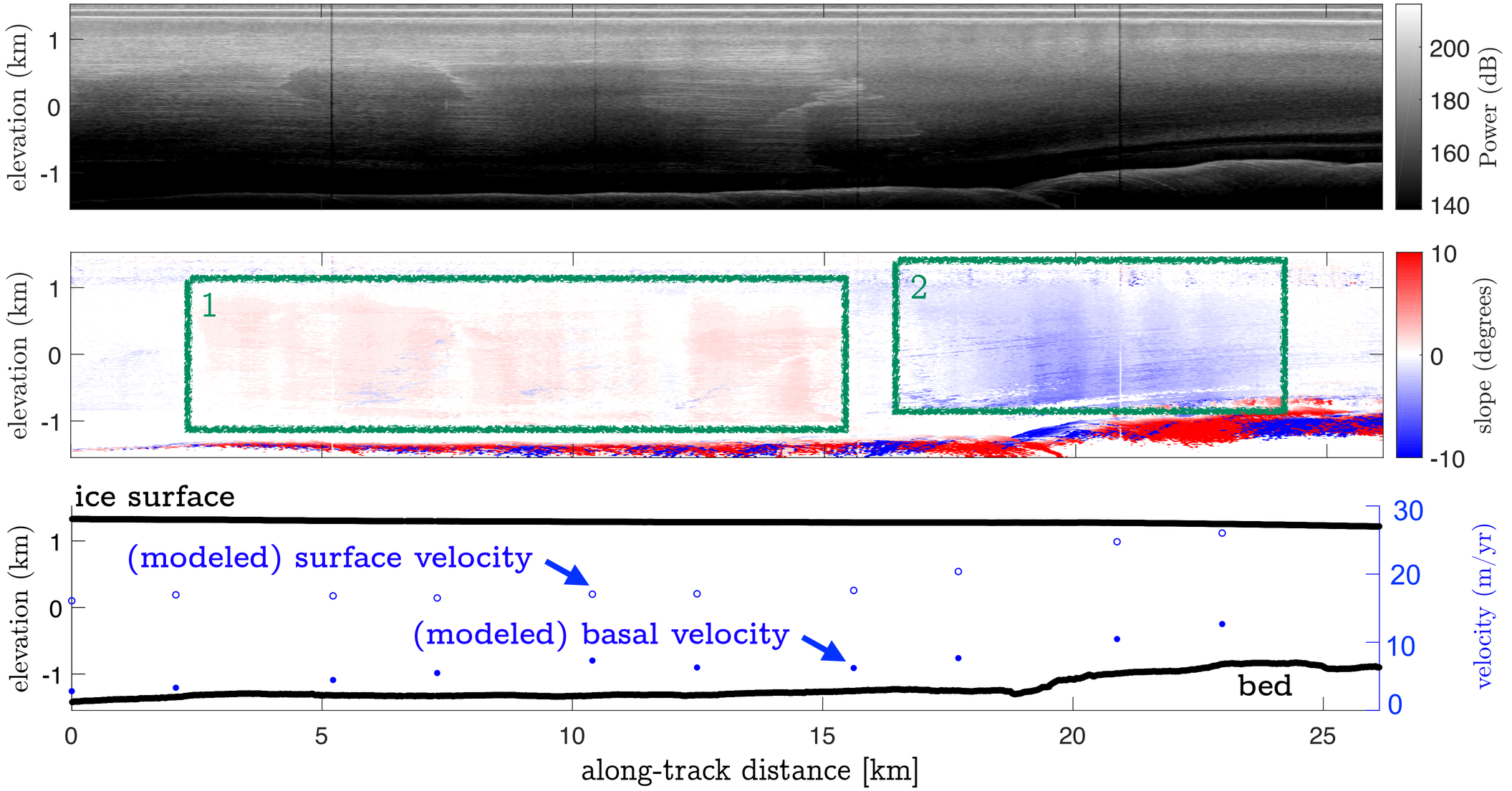
A TYPICAL TRANSECT



LAYER SLOPES

ICE SPEEDS

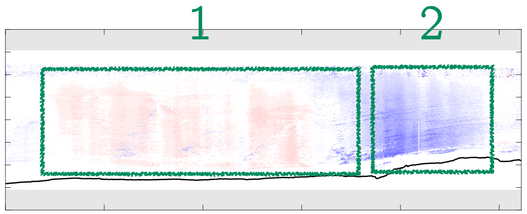
A TYPICAL TRANSECT



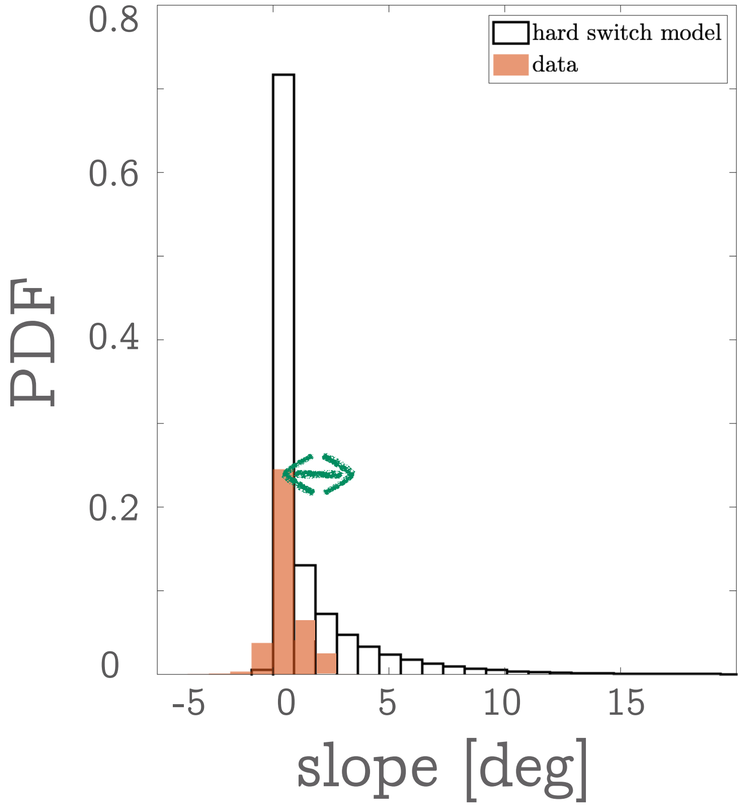
LAYER SLOPES

ICE SPEEDS

OBSERVATIONS DO NOT MATCH PREDICTIONS

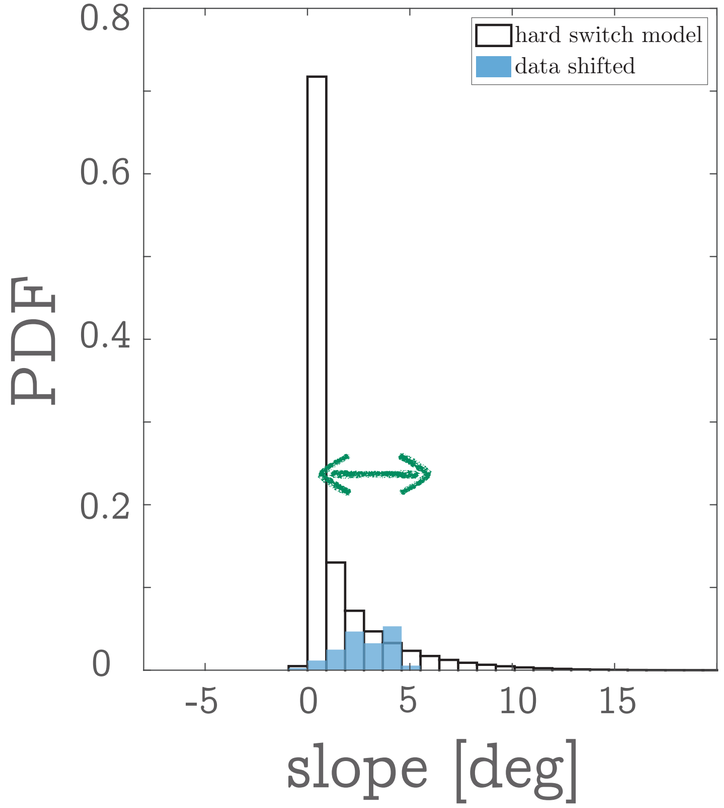


WINDOW 1



SLOPE MAX: 2.5°
Δu: 3.4 m/yr

WINDOW 2

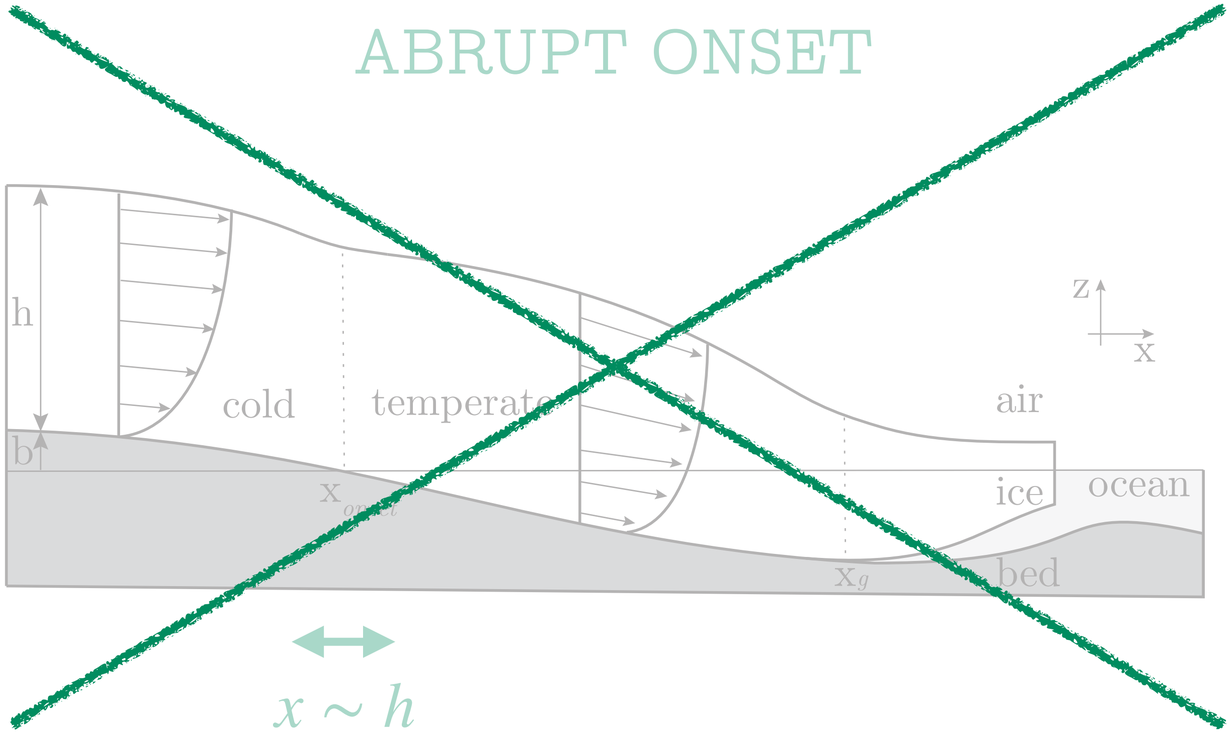


SLOPE MAX: 5.2°
Δu: 6.4 m/yr

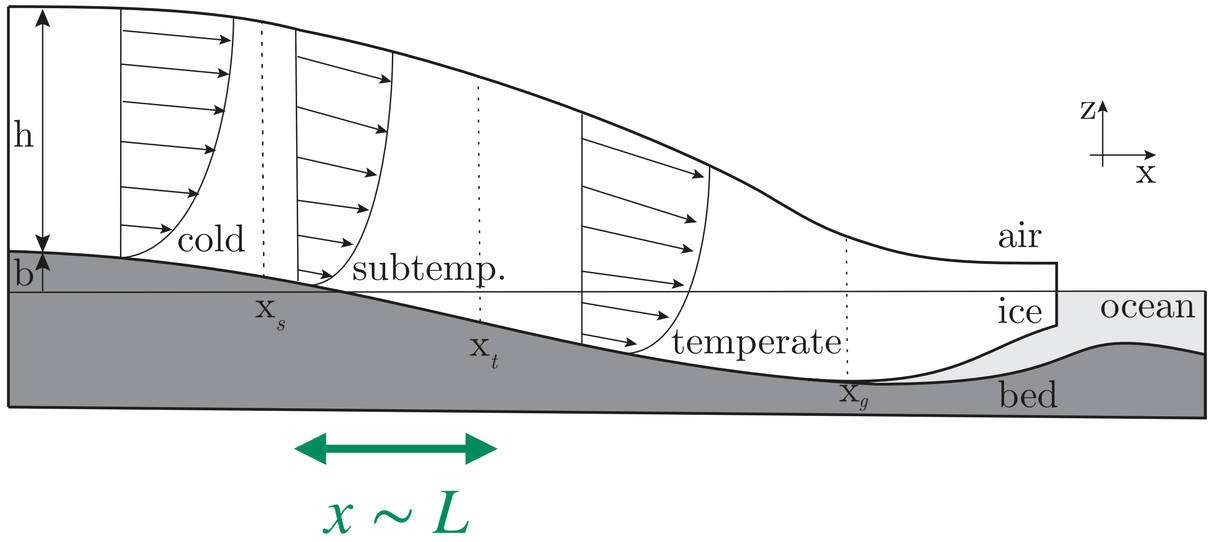
Observed layer slopes are never steep enough to be compatible with an abrupt onset.

AFTER ALL, SLIDING ONSET MAY NOT BE ABRUPT (@IIS)

ABRUPT ONSET



DISTRIBUTED ONSET (?)



The gentle pattern of englacial deformation at Institute Ice Stream is compatible with an instance of subtemperate sliding.

[as first proposed by Fowler & Larson, 1978]