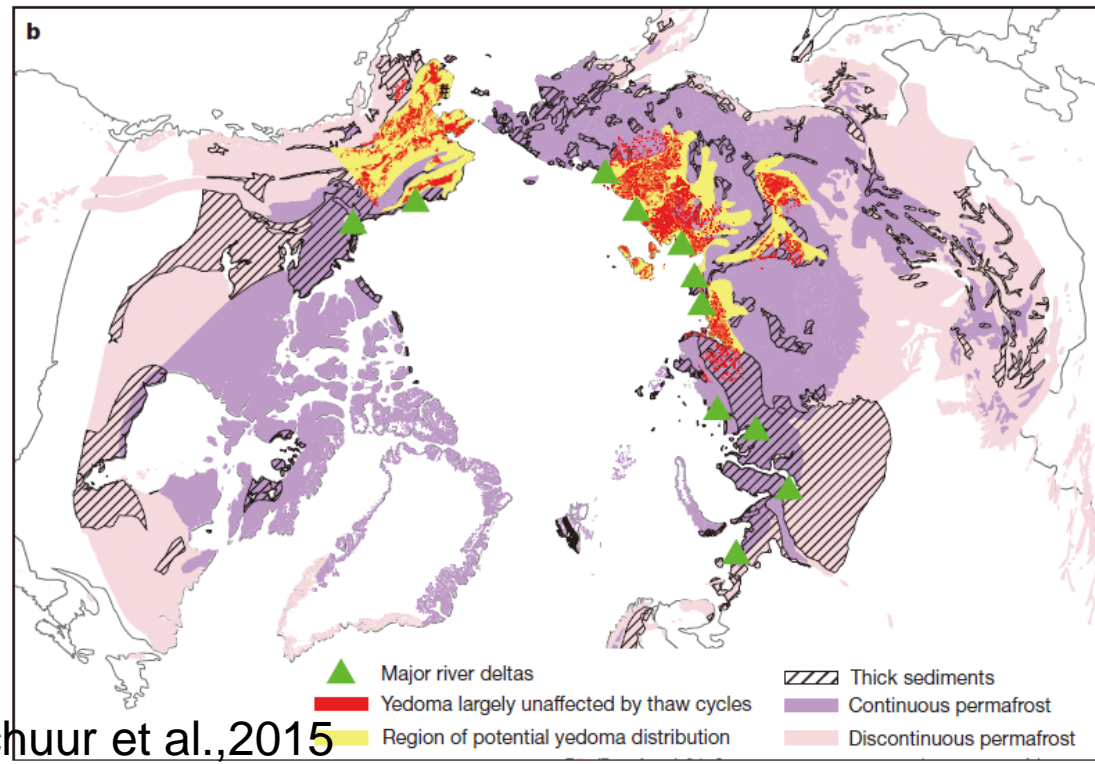


Motivation: to simulate deep carbon in yedoma deposits

Soil organic carbon stocks	Tarnocai et al. (2009) Pg (% of region total)	Hugelius, 2014 Pg (% of region total)	Difference Pg
Total for 0–3 m soils	1024 (61 %)	1035 (79%)	+11
Deposits below 3 m depth			
Deltaic alluvium	241 (14 %)	91 (7%)	-150
Yedoma region	407 (24 %)	181 (14%)	-226



Today's yedoma area:
 Intact: 0.42 Mkm²
 Degraded: 0.78 Mkm²

Yedoma: frozen deposits of Pleistocene carbon

- Average depth of ~20m, various sedimentation processes
- Carbon contents from 1% to 5%
- Large ice content ~80 vol%
- Fossils from the Mammoth Steppe (plants + mega fauna)



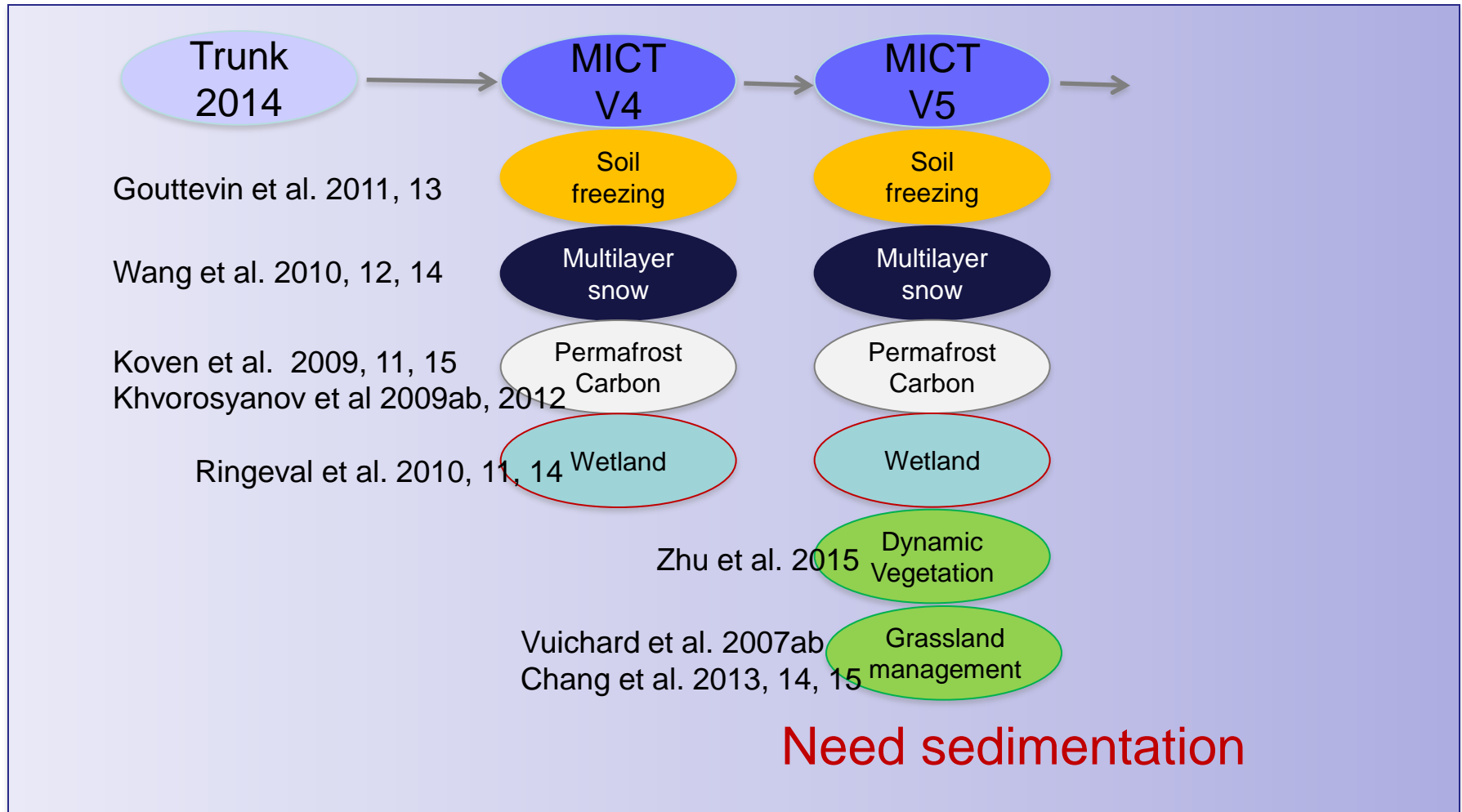
Schirrneister et al., 2011

people



Zimov et al, 2008

The ORCHIDEE-MICT land model version used for spatially explicit simulations



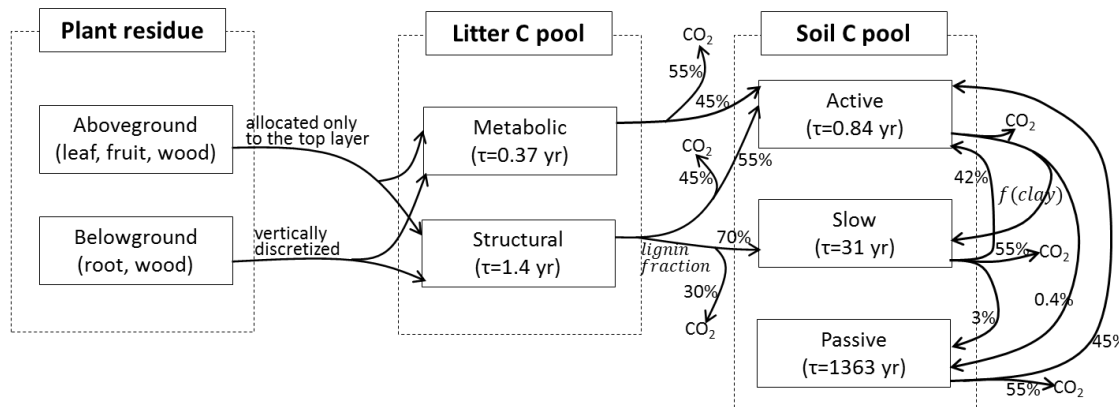
Modifications in MICTv5

- A vertical advection equation to simulate the equivalent downward transport due to sediments aggrading on ground surface

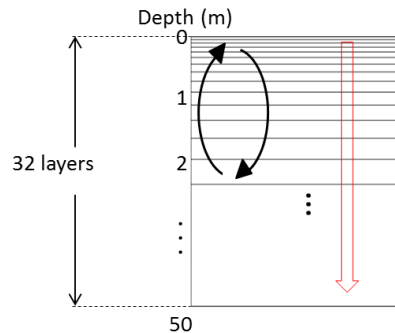
$$\frac{\partial C_i(z,t)}{\partial t} + u(t) \frac{\partial C_i(z,t)}{\partial z} = f_i(z,t) - g_i(z,t) \times C_i(z,t)$$

- Litter pools are vertically discretized and go through cryoturbation and downward advection, the same as soil carbon pools

(a) carbon flow from plant residue to litter and soil C pools



(b) vertical movement among layers within each litter and soil C pool



Modifications in MICTv5 (committed as perso version rev3032)

Two flags to switch on sedimentation or litter discretization:

ok_deposit = y (need to prescribe sedimentation rate “sedr”)

ok_deeplitter =y

```
IF (ok_cryoturb) THEN
  IF (ok_deeplitter) THEN
    CALL cryoturbate_litter(kjpinde, dtradia, dayno, altmax_ind_lastyear, dl_met, dl_str, litter, &
      'diffuse', cryoturbation_diff_k_in/(one_day*one_year), altmax_lastyear, fixed_cryoturbation_depth)
    ENDIF
    CALL cryoturbate(kjpinde, dtradia, dayno, altmax_ind_lastyear, deepC_a, deepC_s, deepC_p, &
      'diffuse', cryoturbation_diff_k_in/(one_day*one_year), altmax_lastyear, fixed_cryoturbation_depth)
  ENDIF
ENDIF

IF (ok_deeplitter) CALL deeplitter(kjpinde, dtradia, turn_l, turn_sa, turn_sb, turn_ha, turn_hb, turn_r, turn_f, turn_c, &
  btl_l, btl_sa, btl_sb, btl_ha, btl_hb, btl_r, btl_f, btl_c, veget_max, z_root, altmax_lastyear, &
  fbact, rprof, deposit_level, dl_met, dl_str, litter, &
  dead_leaves, lignin_struc, sla_calc, &
  deadleaf_cover, resp_hetero_litter, soilcarbon_input)

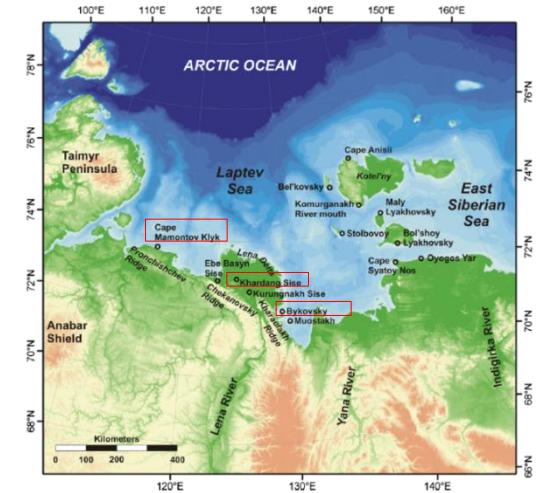
IF (ok_deposit) THEN

  CALL input_decomp_deposition(kjpinde, dtradia, itau*dtradia, no_p_frost_decomp, z_root, altmax_lastyear, &
    deepC_a, deepC_s, deepC_p, deposit_level, soilc_in, soilcarbon_input, dc_litter_z, rprof, clay, fbact, deltaC1_a, deltaC1_s, deltaC1_p)
ELSE

  CALL carbinput(kjpinde, dtradia, itau*dtradia, no_p_frost_decomp, tprof, tsurf, hslong, dayno, z_root, altmax_lastyear, &
    deepC_a, deepC_s, deepC_p, soilc_in, soilcarbon_input, dc_litter_z, z_organic, veget_max_bg, rprof)

  CALL permafrost_decomp(kjpinde, dtradia, tprof, frozen_respiration_func, airvol_soil, &
    oxlim, tau_CH4troph, ok_methane, fbactratio, O2m, &
    totporO2_soil, totporCH4_soil, hslong, clay, &
    no_p_frost_decomp, deepC_a, deepC_s, deepC_p, deltaCH4g, deltaCH4, deltaC1_a, deltaC1_s, deltaC1_p, deltaC2, &
    deltaC3, O2_soil, CH4_soil, fbact, MG_useallCpools)
ENDIF
```

Vertical profiles of yedoma deposits are reproduced after modifications



NPP under LGM climate: 21~38 gC/m²/yr

