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Supplement of

Modeling the evolution of the structural anisotropy of snow

Silvan Leinss et al.

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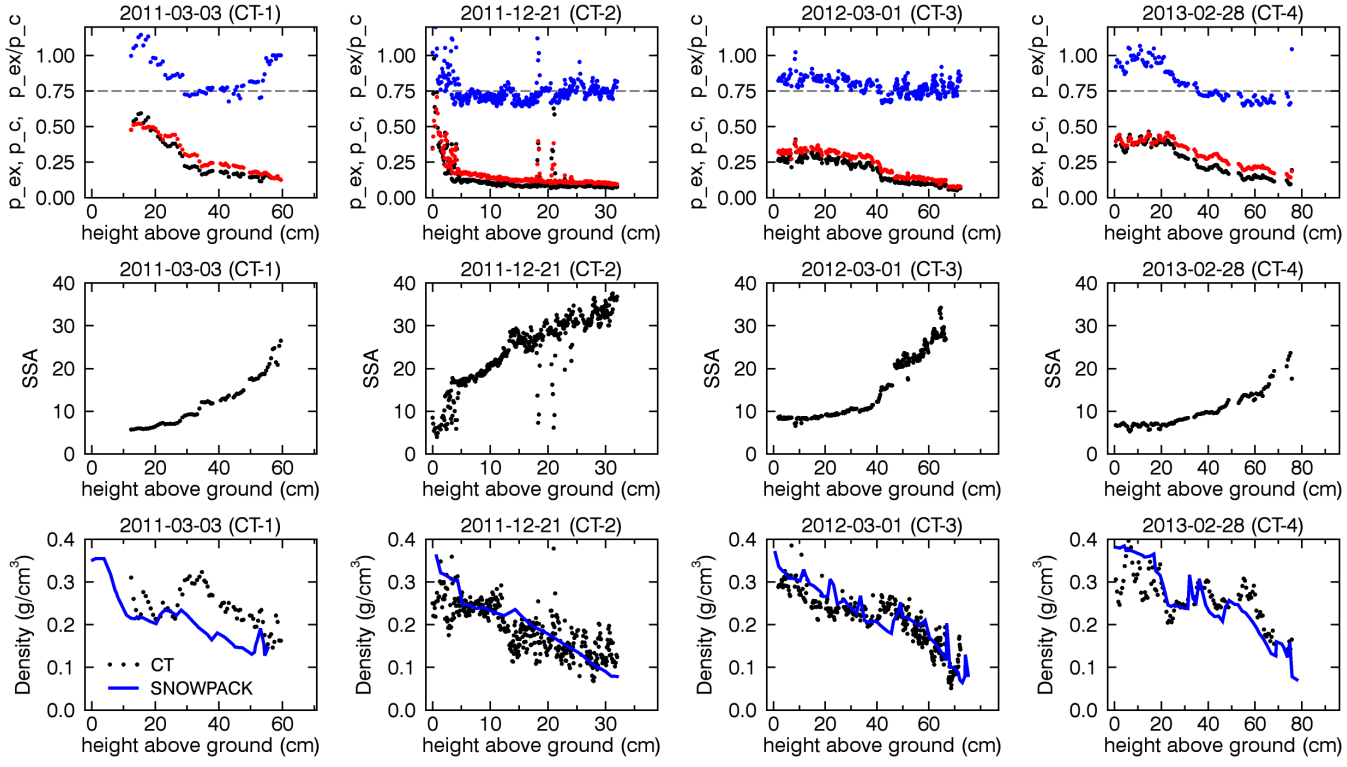

Figure S1. Further parameters derived from the CT data. Top row: exponential correlation length (p_{ex}, black), slope of the correlation function at the origin (p_{c}, red), and the ratio $p_{\mathrm{ex}}/p_{\mathrm{c}}$. The dashed lines indicates the commonly used ratio $p_{\mathrm{ex}}/p_{\mathrm{c}} \approx 0.75$ which is not valid for depth hoar (Mätzler, 2002). Middle row: SSA, bottom row: density from CT data compared with density of the SNOWPACK simulation with enforced snow height (ensemble ID: 22890+45W-HnEL=1cm).

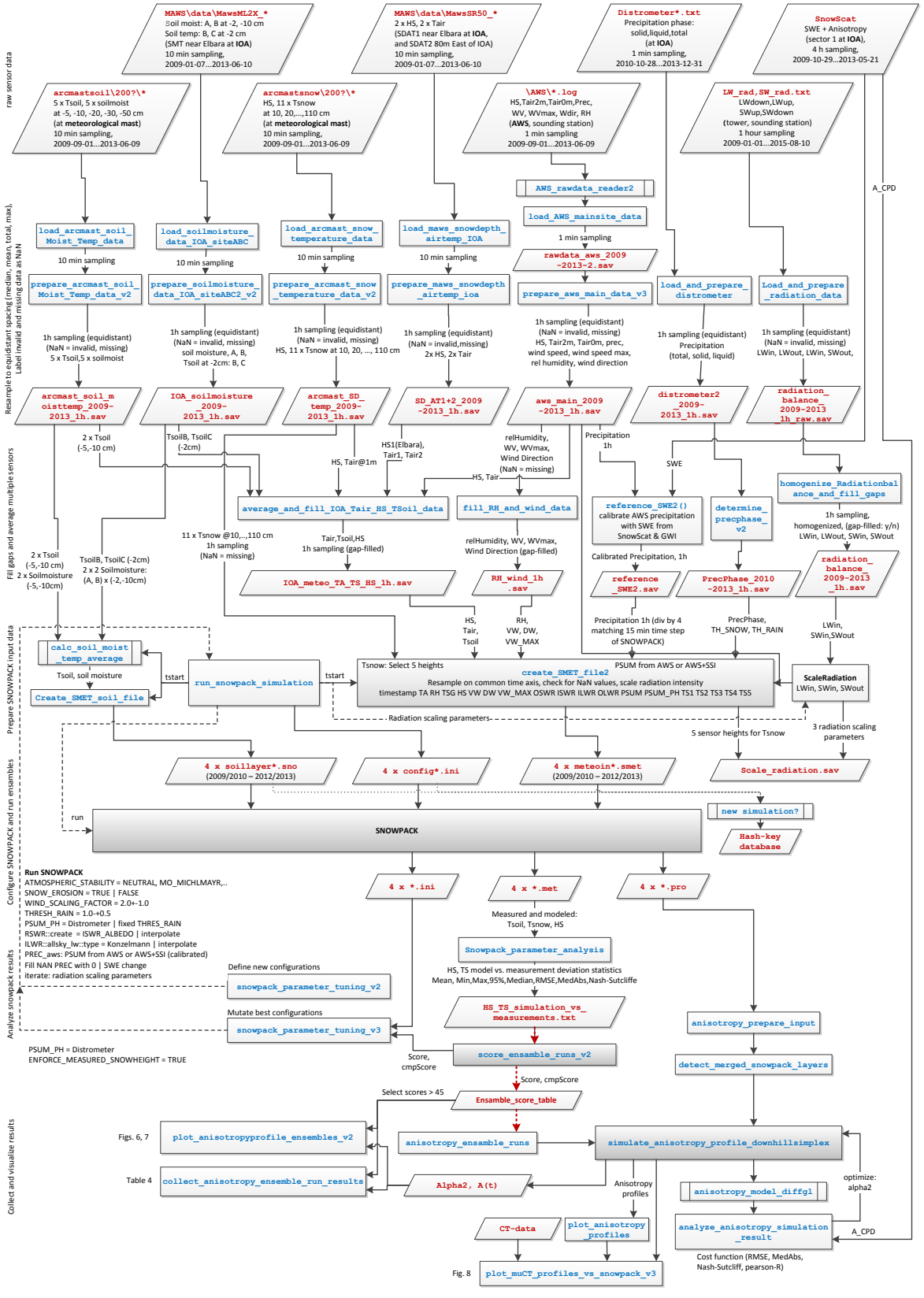

Figure S2. The flowchart presents the entire data flow for preprocessing of the meteorological data, configuration of snow pack, automated analysis and selection of SNOWPACK results, and finally the calibration and validation of our model.

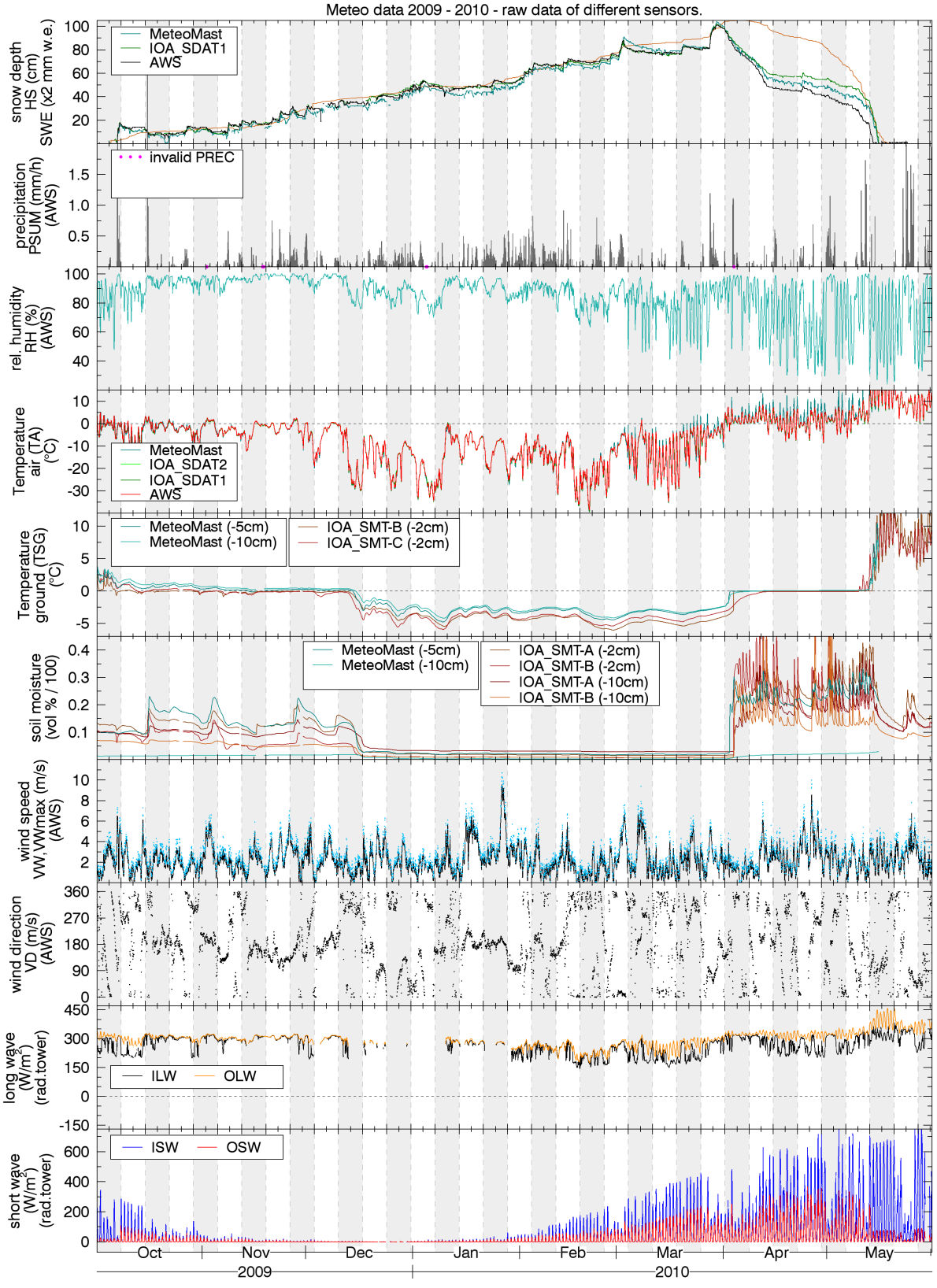

Figure S3. Raw meteodata 2009/2010 measured by different sensors.

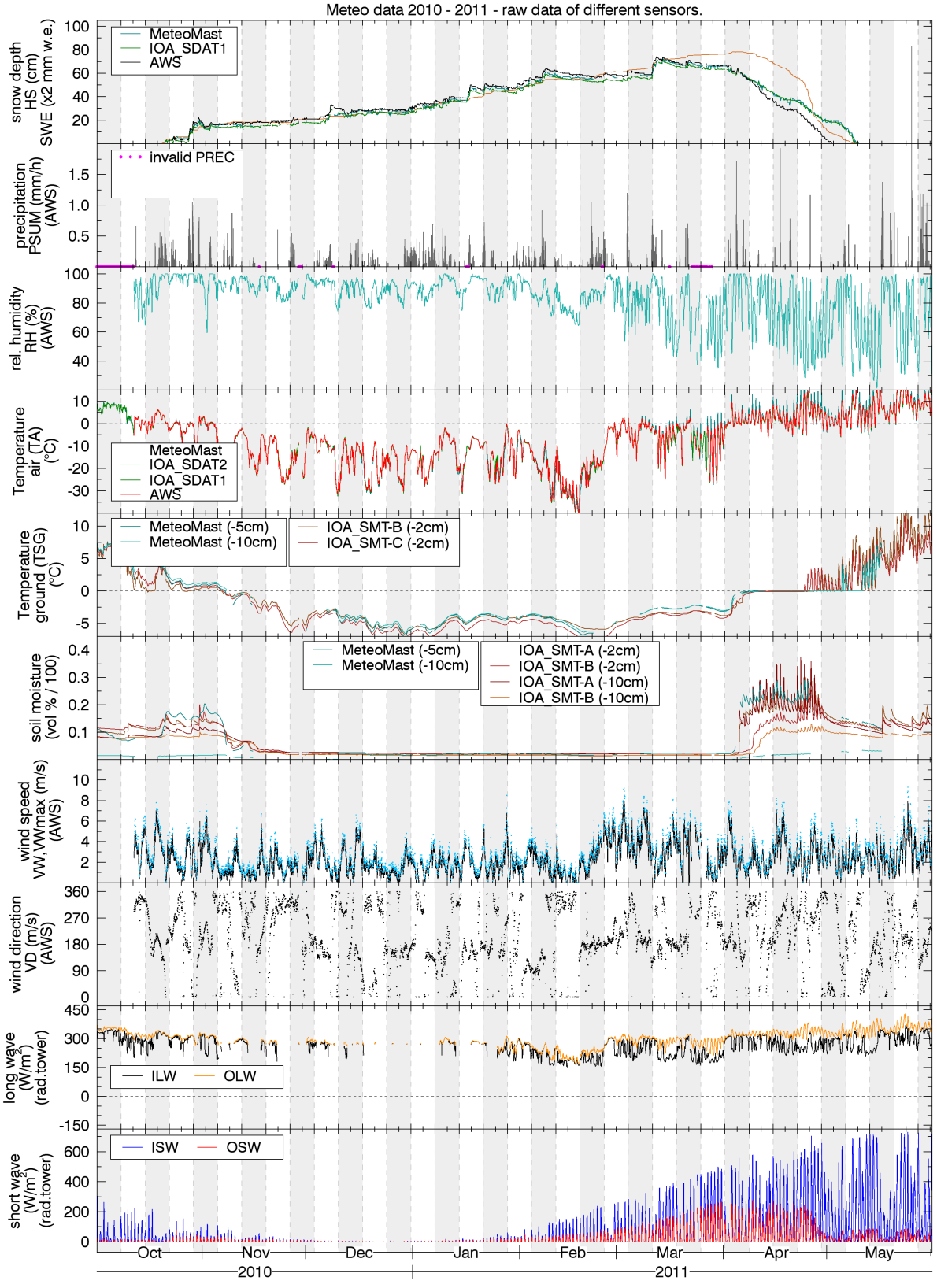

Figure S4. Raw meteodata 2010/2011 measured by different sensors.

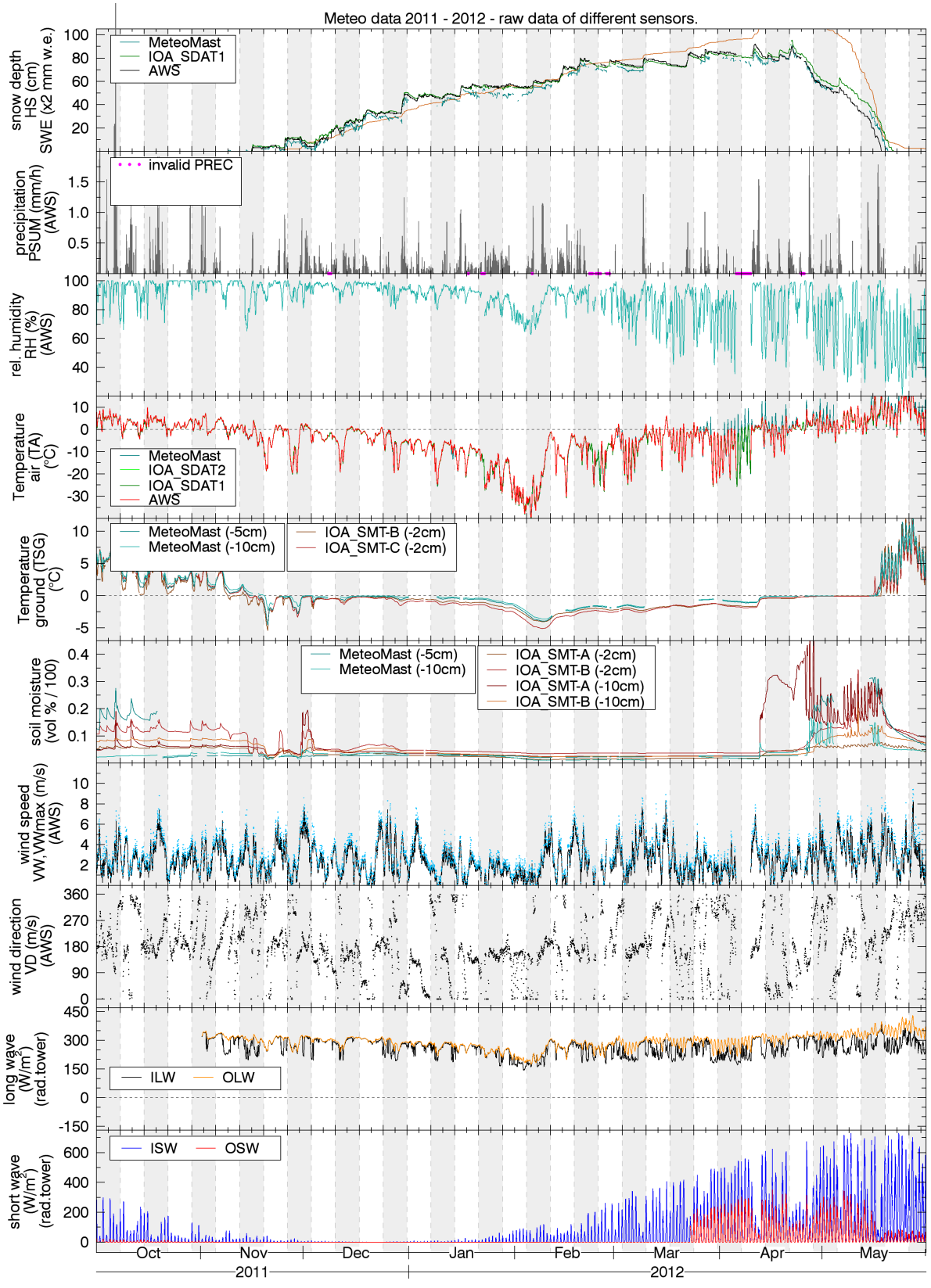

Figure S5. Raw meteodata 2011/2012 measured by different sensors.

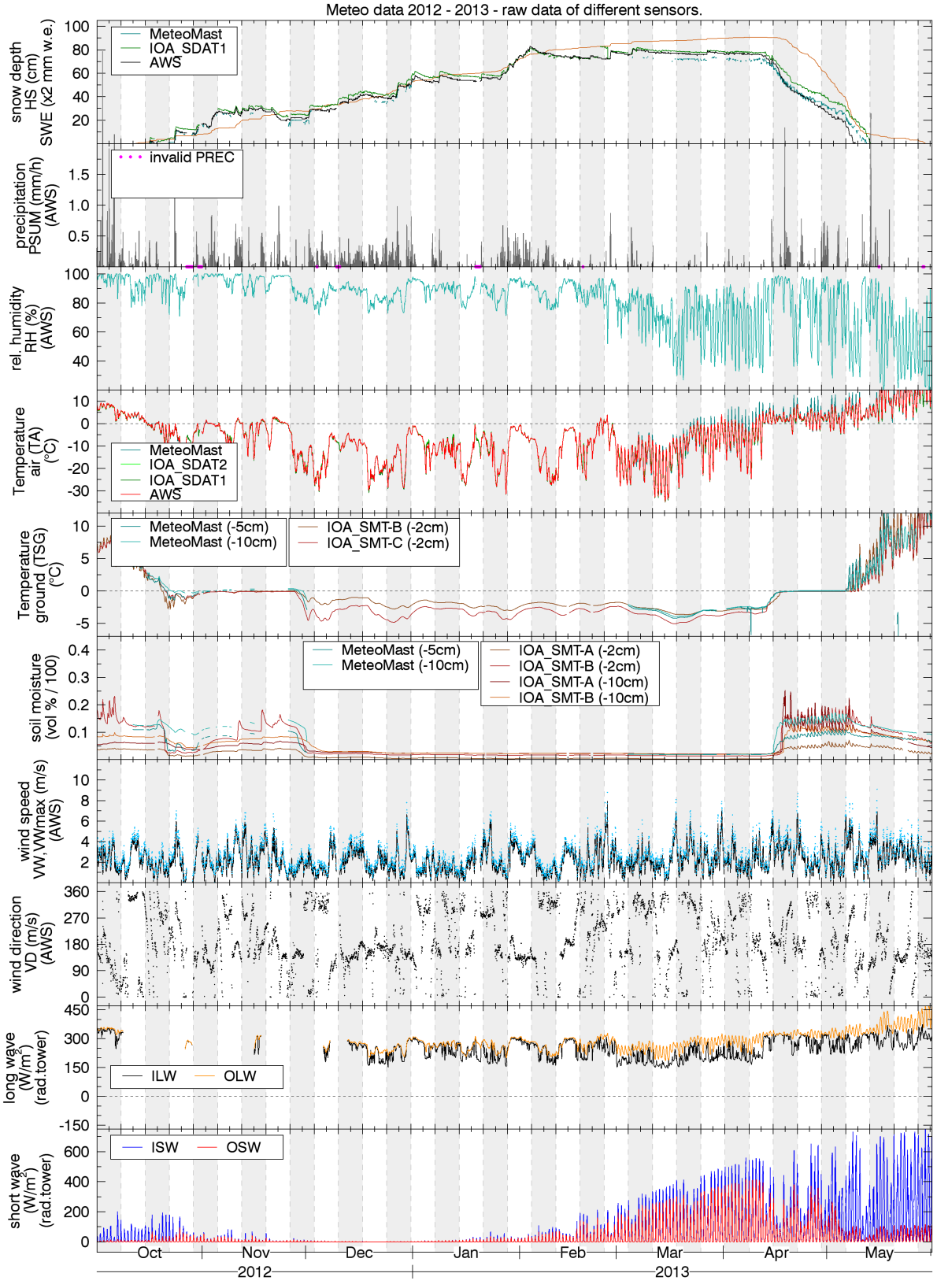

Figure S6. Raw meteodata 2012/2013 measured by different sensors.

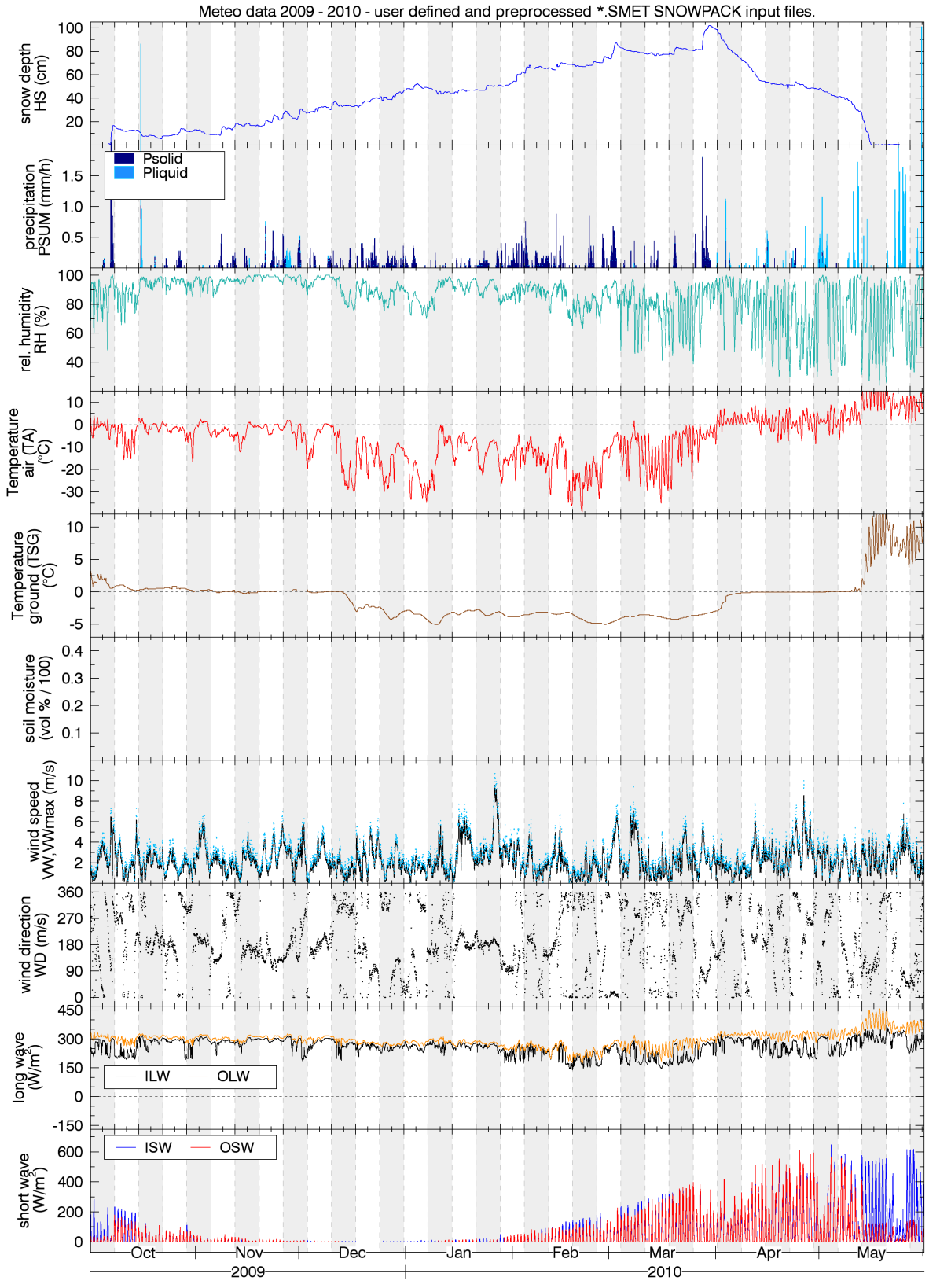

Figure S7. Meteodata 2009/2010 provided as SNOWPACK input (*.SMET files). (ensemble ID: 2458753-22890+45W-HnEL=1cm)

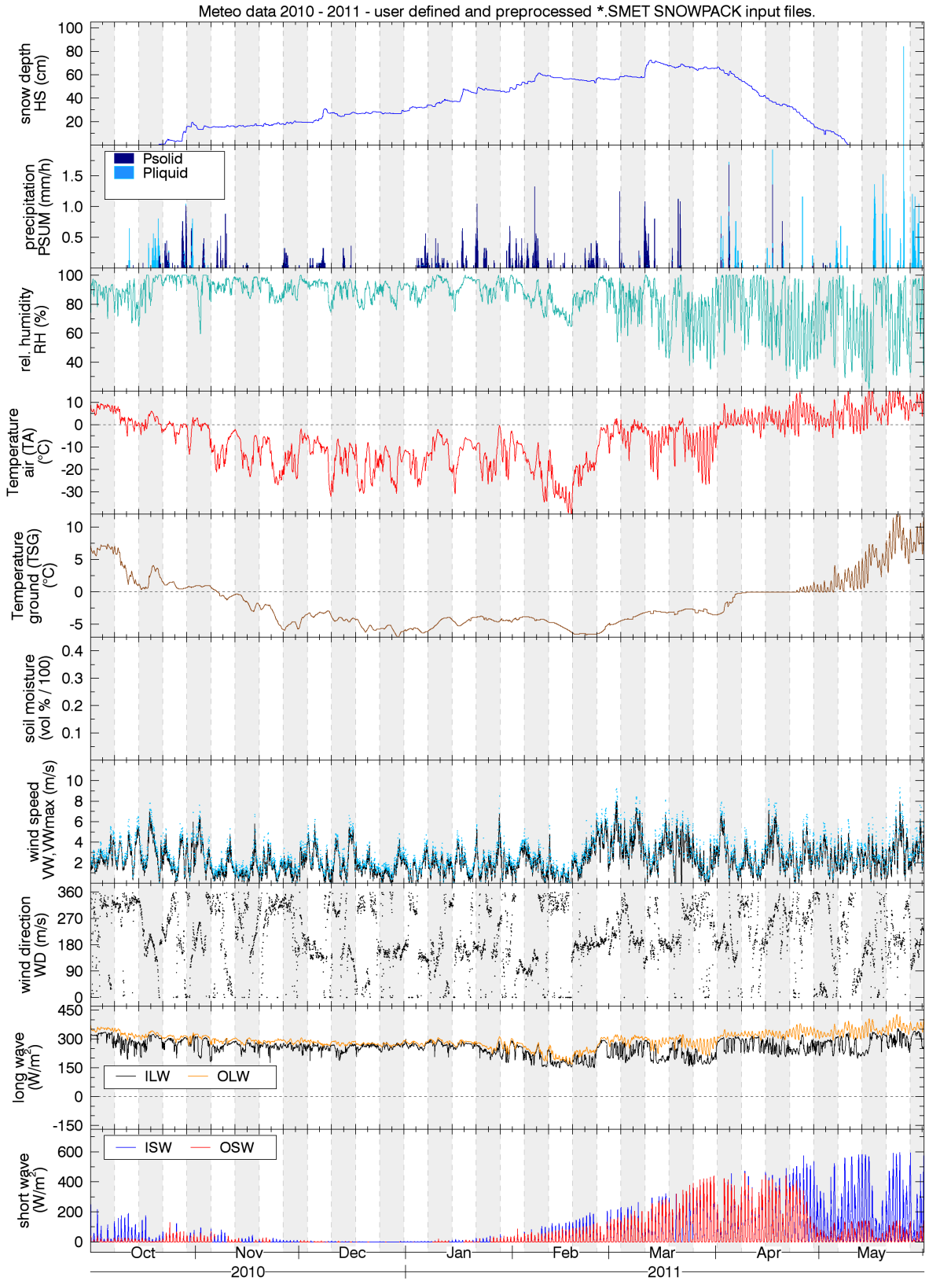

Figure S8. Meteodata 2010/2011 provided as SNOWPACK input (*.SMET files). (ensemble ID: 2458753-22890+45W-HnEL=1cm)

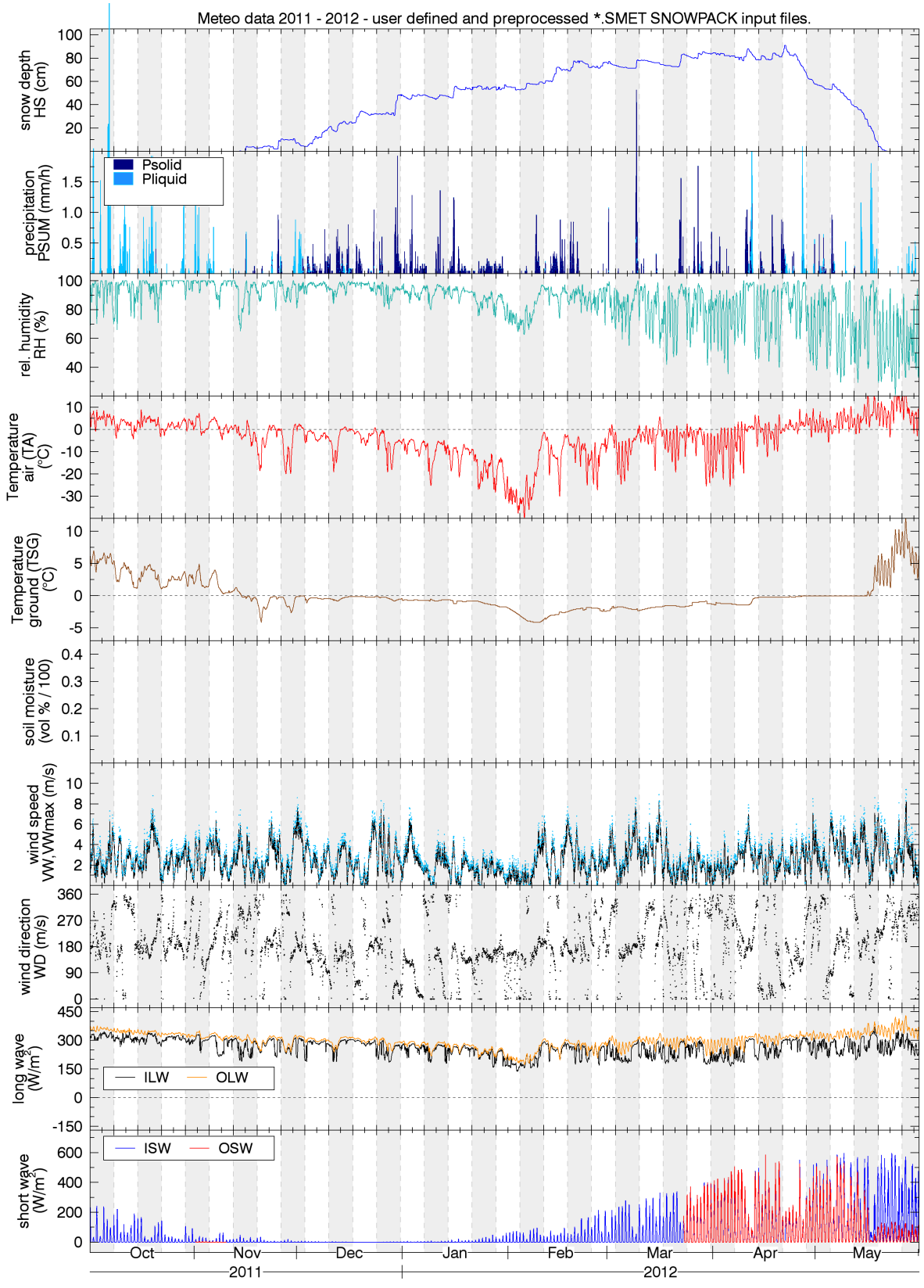

Figure S9. Meteodata 2011/2012 provided as SNOWPACK input (*.SMET files). (ensemble ID: 2458753-22890+45W-HnEL=1cm)

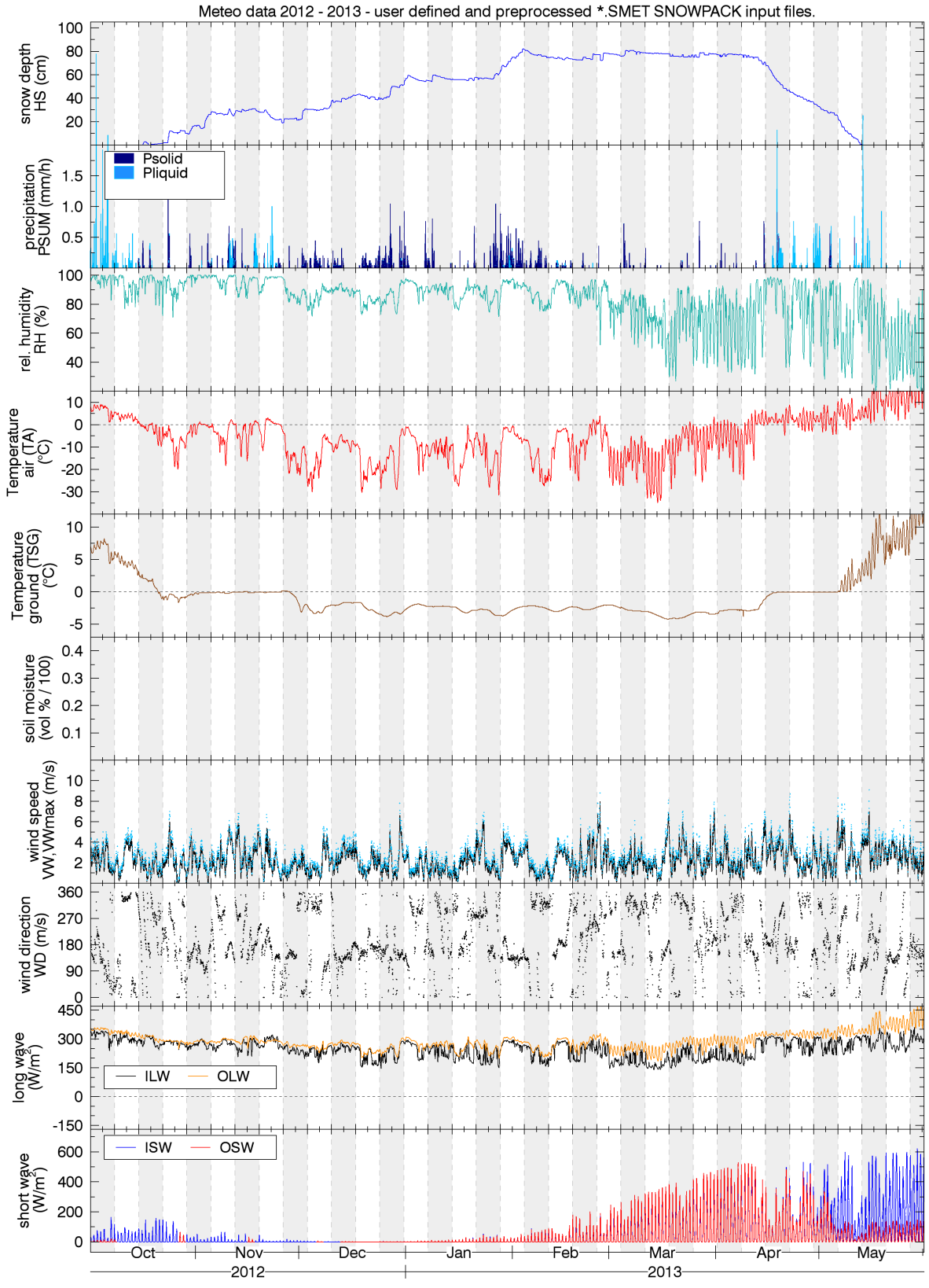

Figure S10. Meteodata 2012/2013 provided as SNOWPACK input (*.SMET files). (ensemble ID: 2458753-22890+45W-HnEL=1cm)

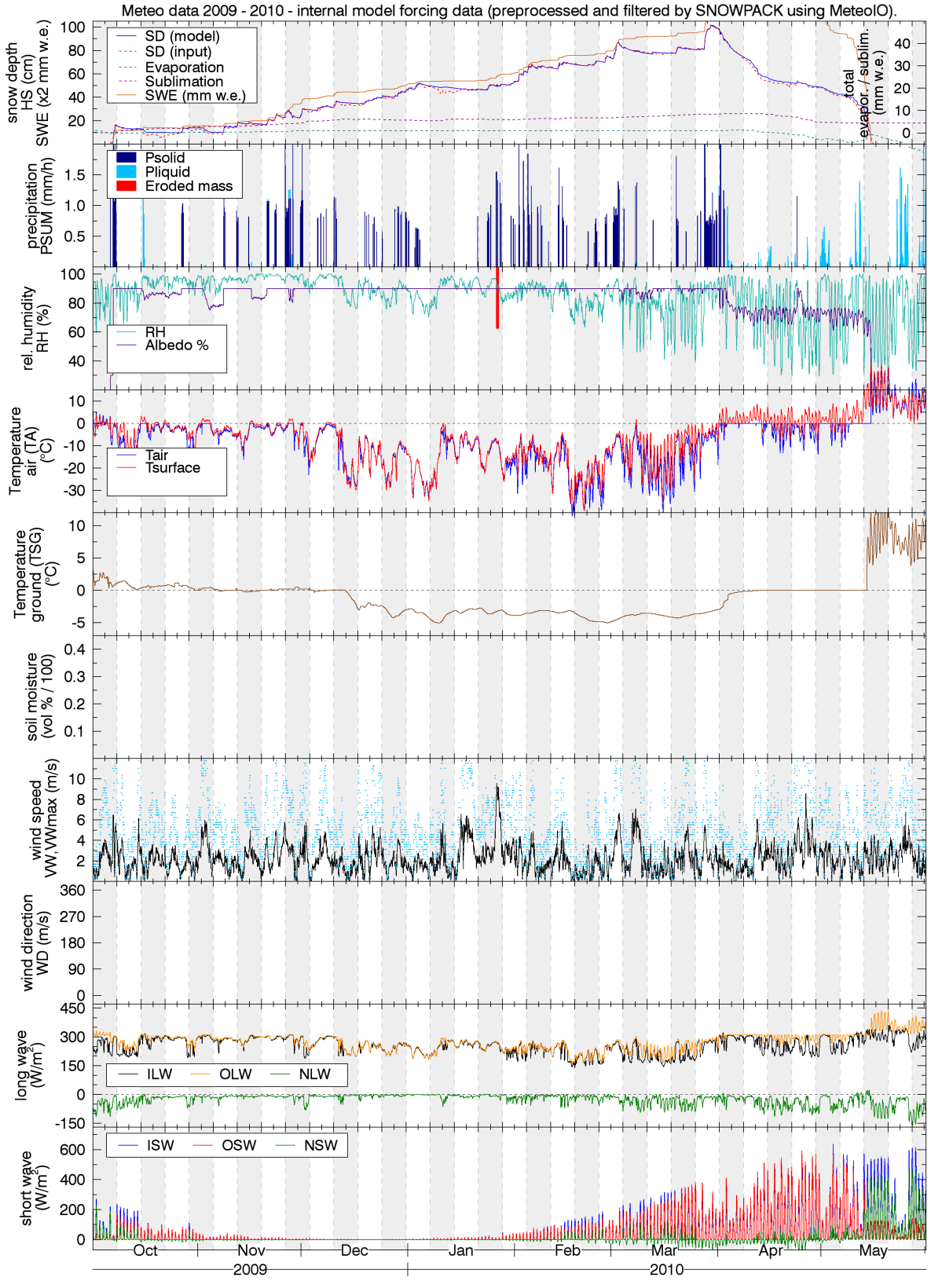

Figure S11. Meteodata 2009/2010, processed and filtered by SNOWPACK/MeteoIO. This data is the forcing data in the core of the model and is written out to *.met files (WRITE_PROCESSED_METEO = TRUE). HS was enforced (ensemble ID: 2458753-22890+45W-HnEL=1cm).

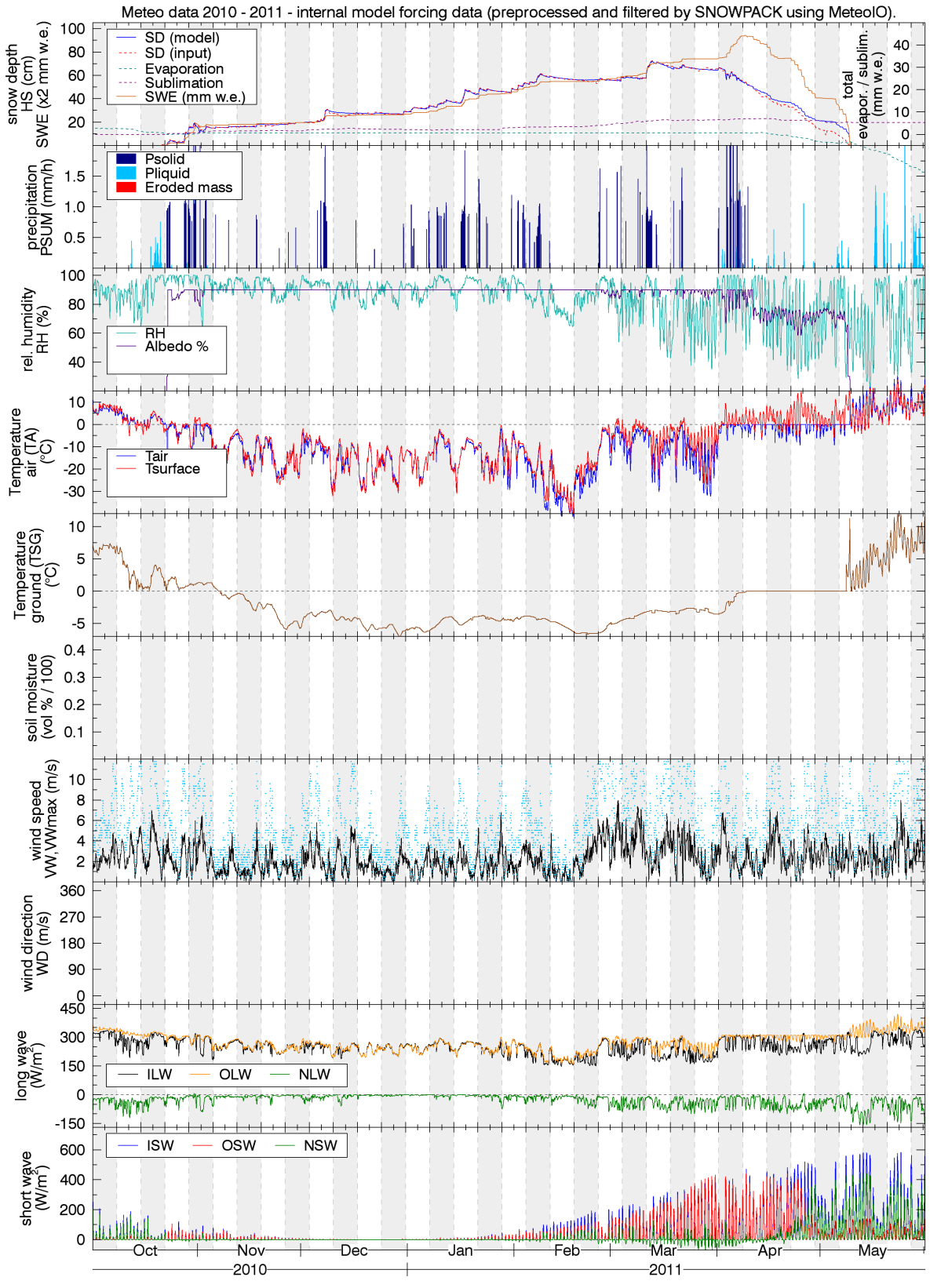

Figure S12. Meteodata 2010/2011, processed and filtered by SNOWPACK/MeteoIO. This data is the forcing data in the core of the model and is written out to *.met files (WRITE_PROCESSED_METEO = TRUE). HS was enforced (ensemble ID: 2458753-22890+45W-HnEL=1cm).

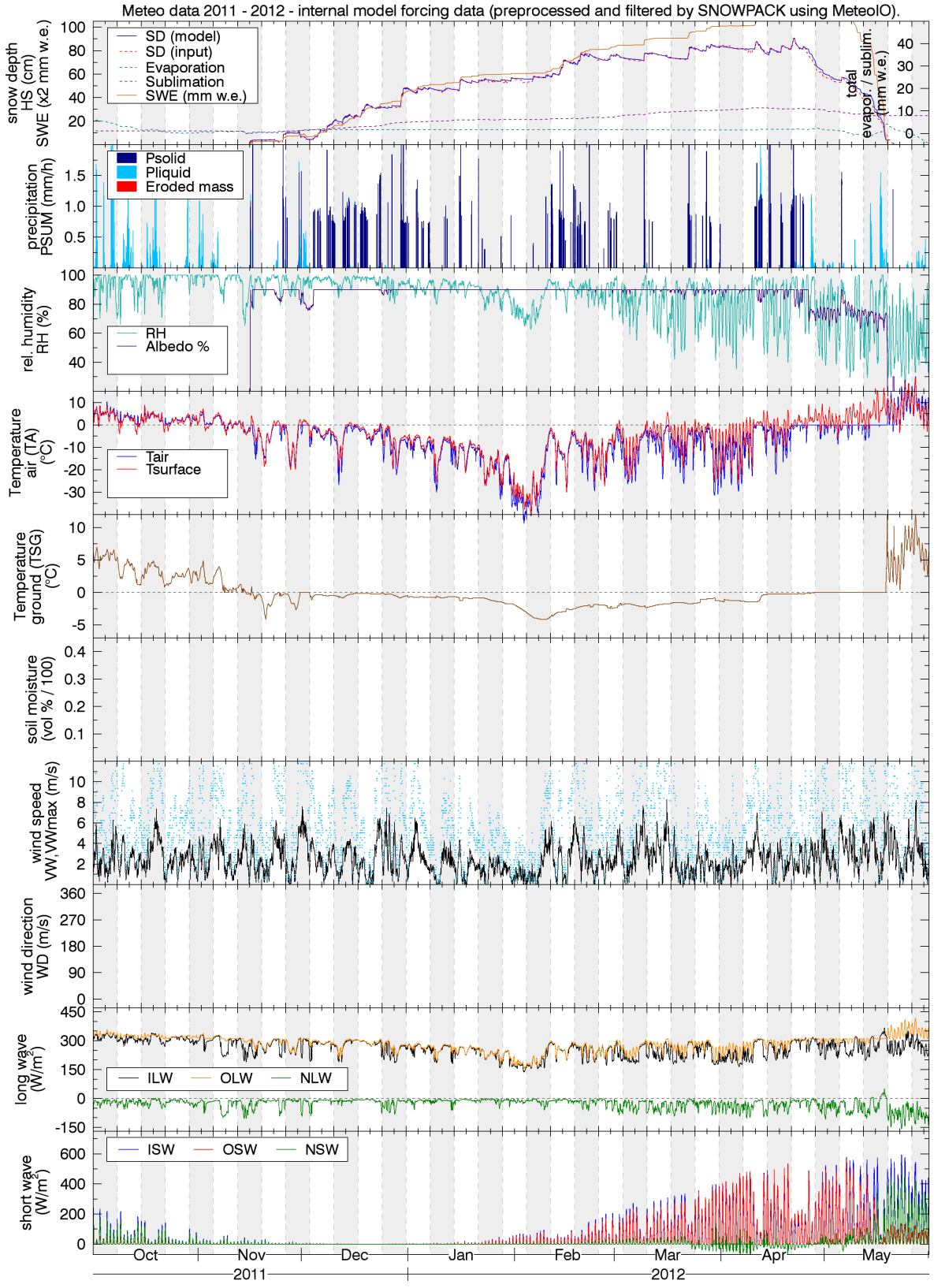

Figure S13. Meteodata 2011/2012, processed and filtered by SNOWPACK/MeteoIO. This data is the forcing data in the core of the model and is written out to *.met files (WRITE_PROCESSED_METEO = TRUE). HS was enforced (ensemble ID: 2458753-22890+45W-HnEL=1cm).

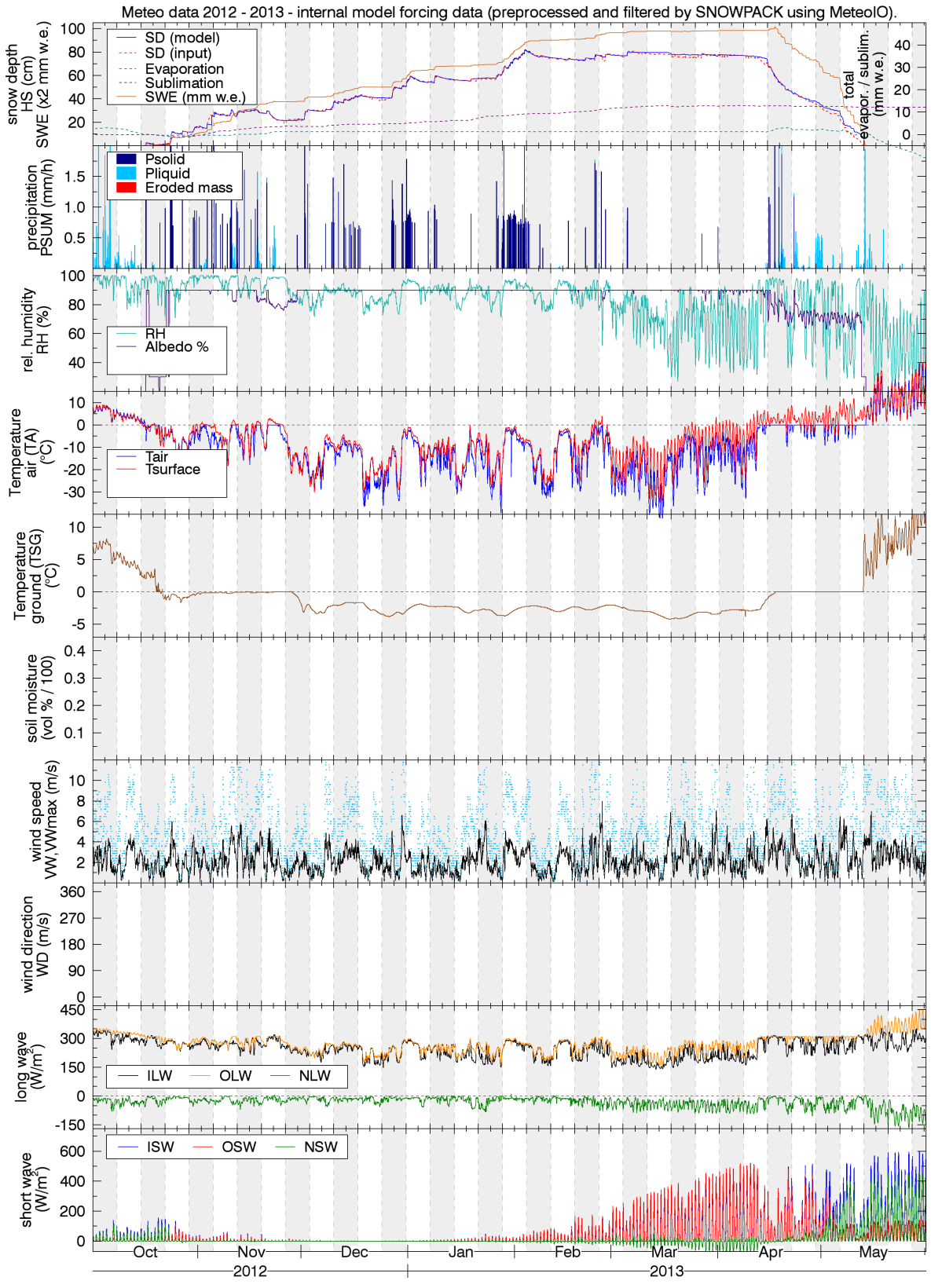

Figure S14. Meteodata 2012/2013, processed and filtered by SNOWPACK/MeteoIO. This data is the forcing data in the core of the model and is written out to *.met files (WRITE_PROCESSED_METEO = TRUE). HS was enforced (ensemble ID: 2458753-22890+45W-HnEL=1cm).

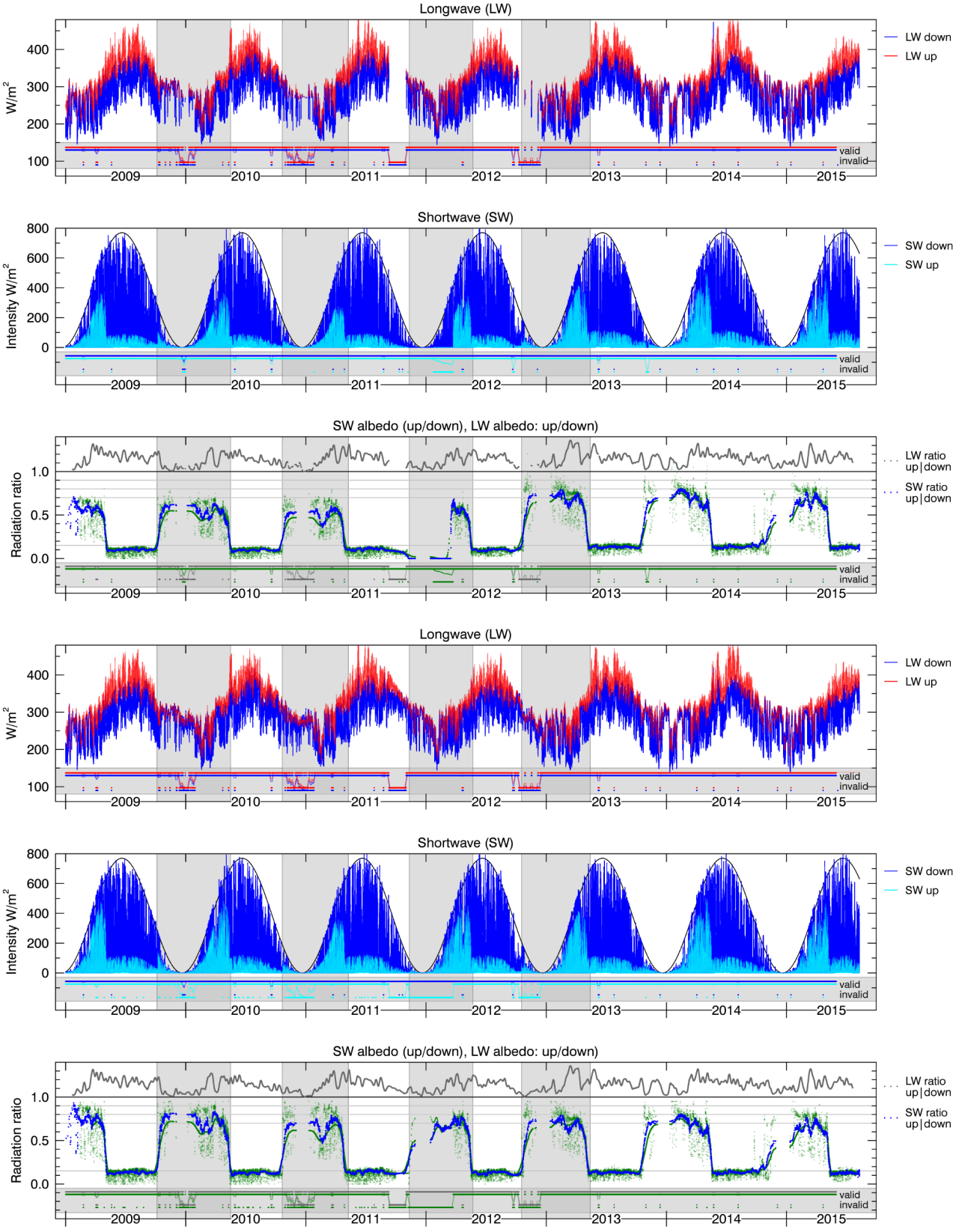

Figure S15. Top three graphs: raw radiation data, gaps show invalid or missing data. Bottom three graphs: filled and homogenized radiation data. The short wave sensor was replaced in August 2012.

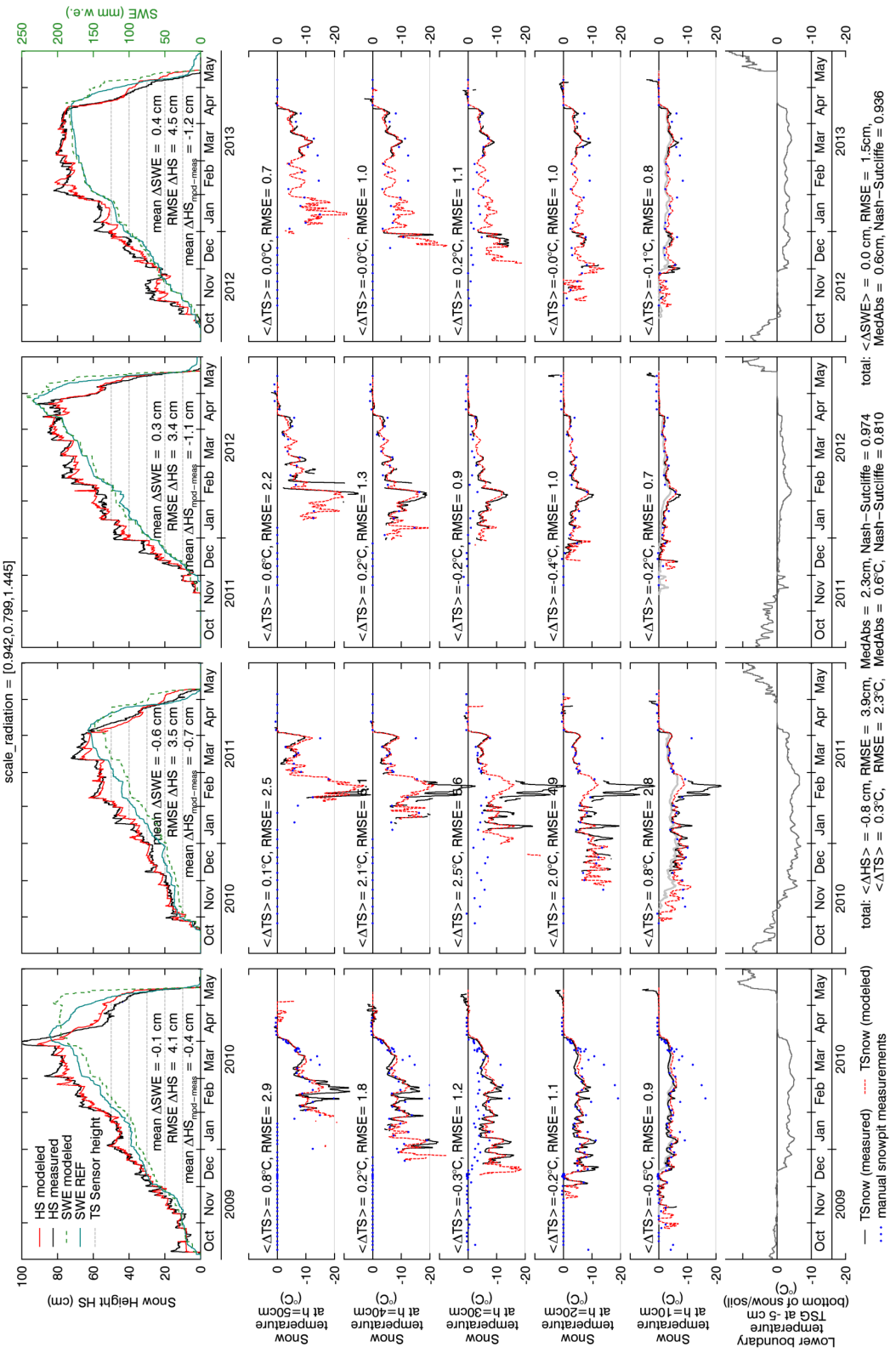

Figure S16. Measured and modeled snow height and SWE (top), and snow temperature at various depths (bottom) for the best SNOWPACK run where snow height was not enforced (ID: 2458414-31824). The gray line in the second-lowest row is equivalent to the -5 cm soil temperature (TSG, last row) and is helpful to identify unrealistically low measured snow temperatures (e.g. Feb 2011). For comparison, blue dots indicate manual snow temperature measurements in a snow pit.

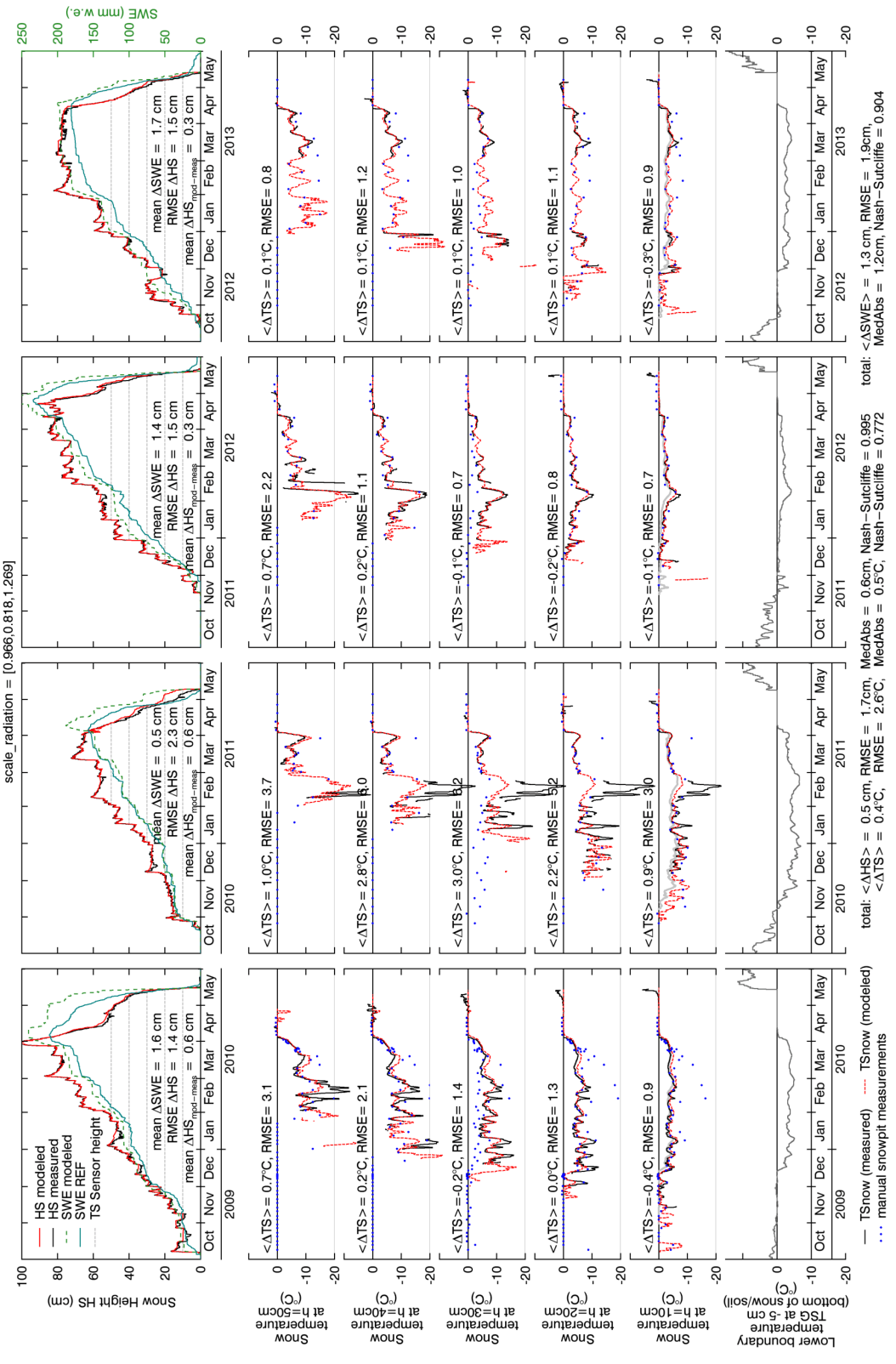

Figure S17. Measured and modeled snow height, SWE, and snow temperature at various depths for the best SNOWPACK run where snow height was enforced (ID: 2458753-22890+45W-HnEL=1cm). The gray line in the second-lowest row is equivalent to soil temperature (TSG, last row) and can be used to identify unrealistically low measured snow temperatures (e.g. Feb 2011). For comparison, blue dots indicate manual snow temperature measurements in a snow pit.

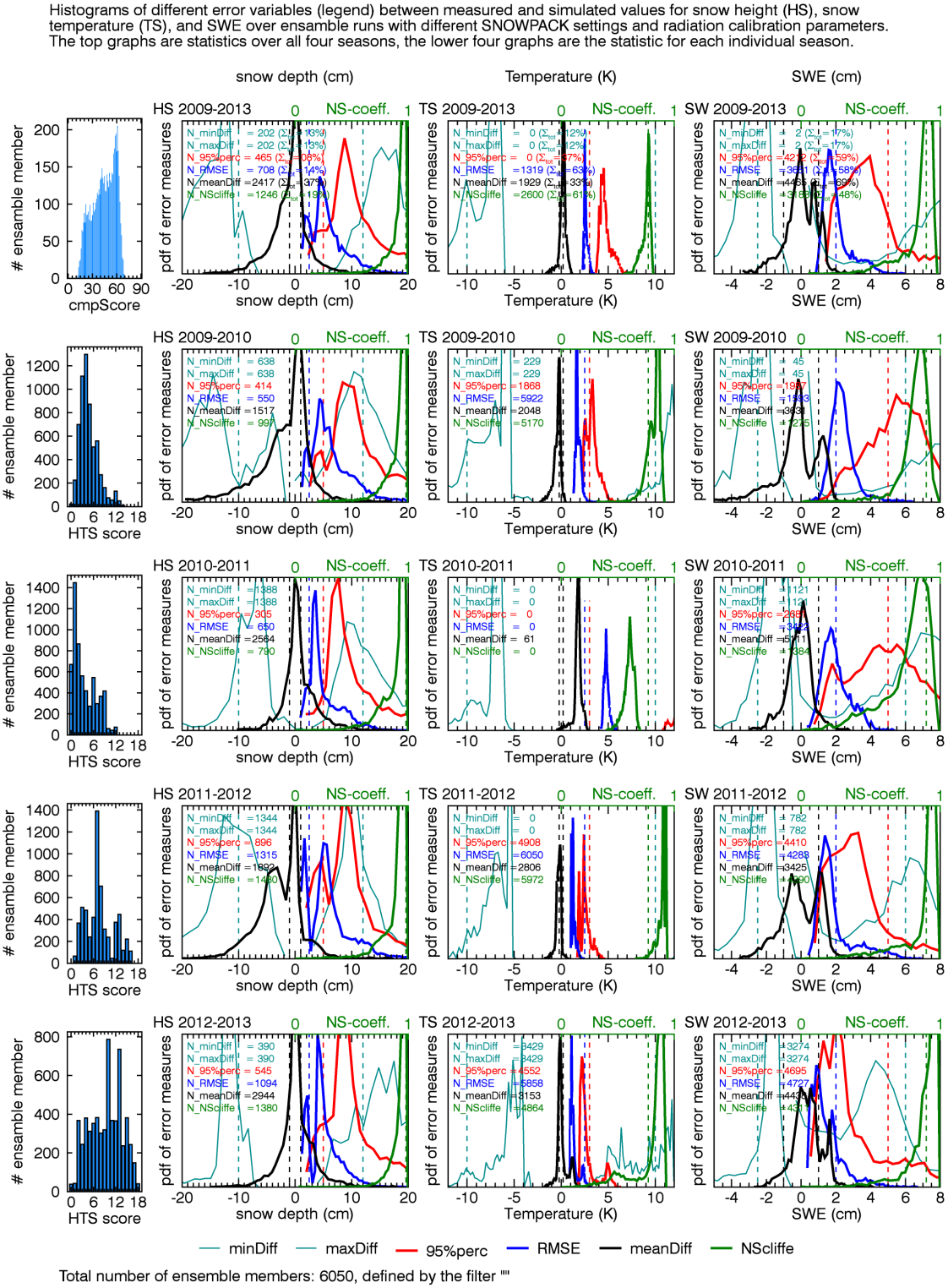

Figure S18. Histograms of the six statistical descriptors (see legend) used to measure the accuracy of different SNOWPACK runs. The descriptors rate the difference between measured and simulated values for snow height (HS) and snow temperature (TS). The shown histograms of the descriptors cover all SNOWPACK ensemble runs with different settings and radiation scaling parameters. The top row shows the statistics over all four seasons; the lower four rows are the statistic for each individual season. The left column shows the score of each season and the total score determined by thresholding. The thresholds are shown as vertical dashed lines. Numerical values of the thresholds are given in the main document.

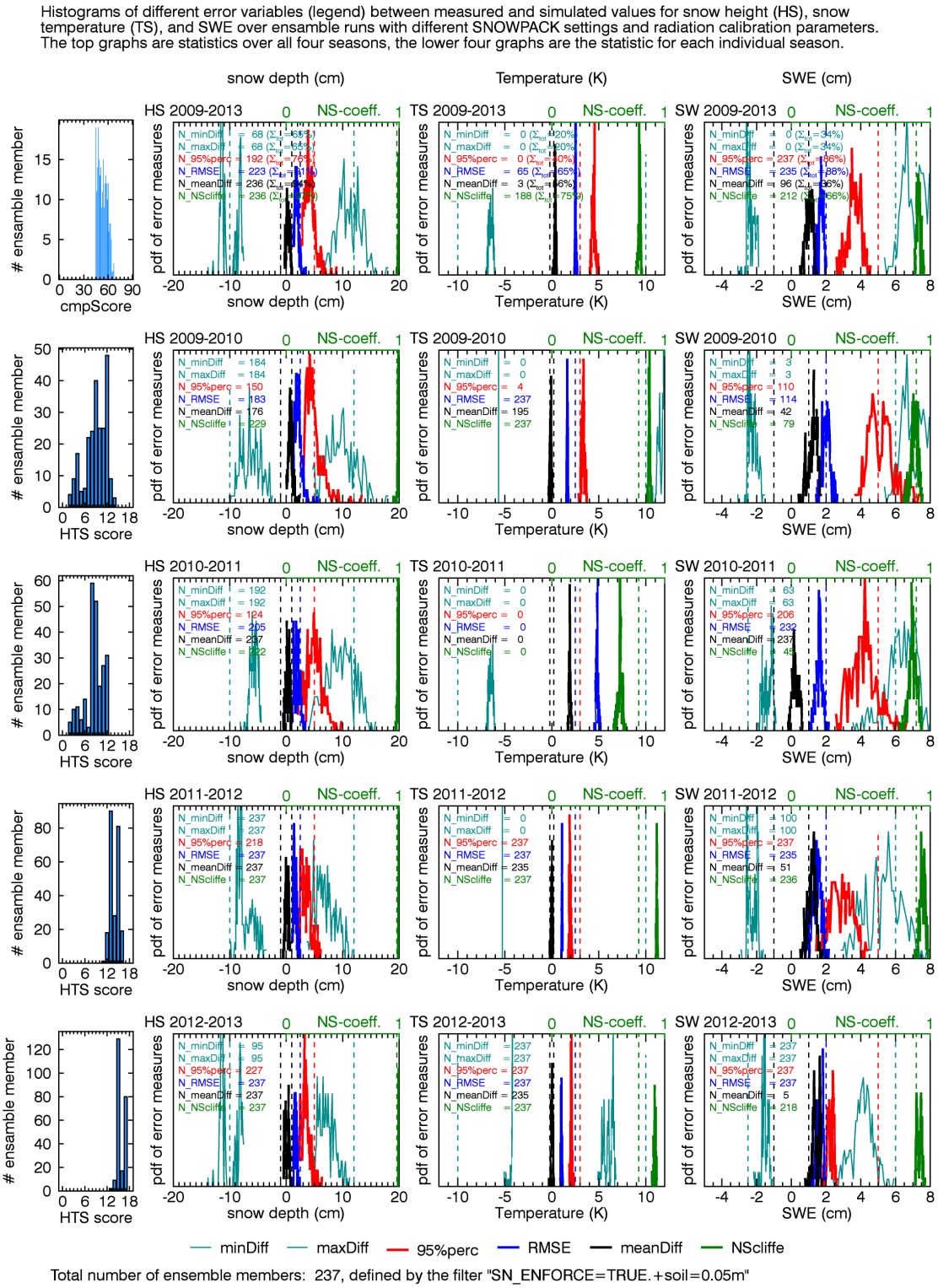

Figure S19. Histograms of the six statistical descriptors (see legend) for the best 237 snow pack runs. The descriptors rate the difference between measured and simulated values for snow height (HS) and snow temperature (TS). The shown histograms of the descriptors cover all SNOWPACK ensemble runs with different settings and radiation scaling parameters. The top row shows the statistics over all four seasons; the lower four rows are the statistic for each individual season. The left column shows the score of each season and the total score determined by thresholding. The thresholds are shown as vertical dashed lines. Numerical values of the thresholds are given in the main document.

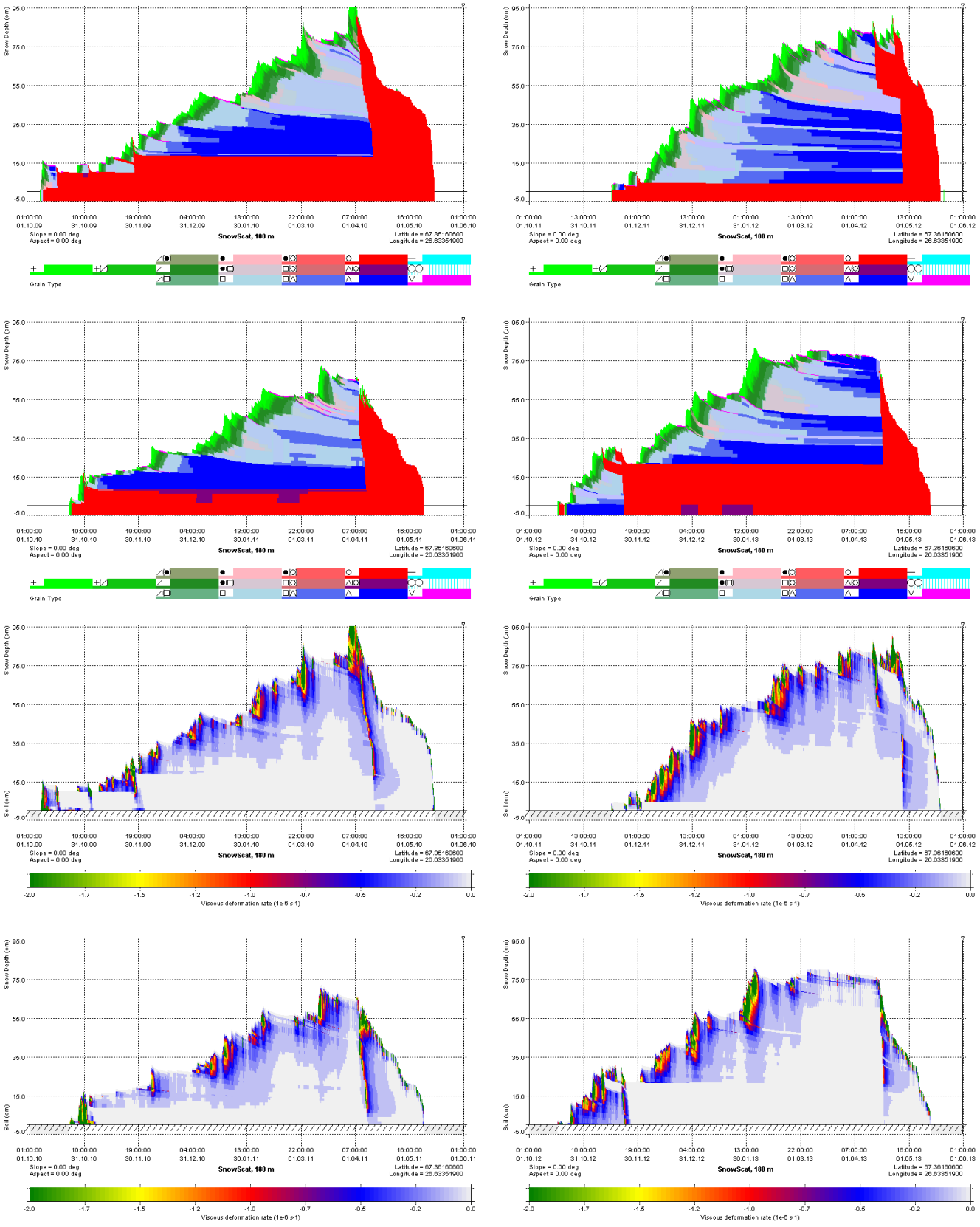

Figure S20. SNOWPACK visualizations for grain type classification and viscous deformation rate.

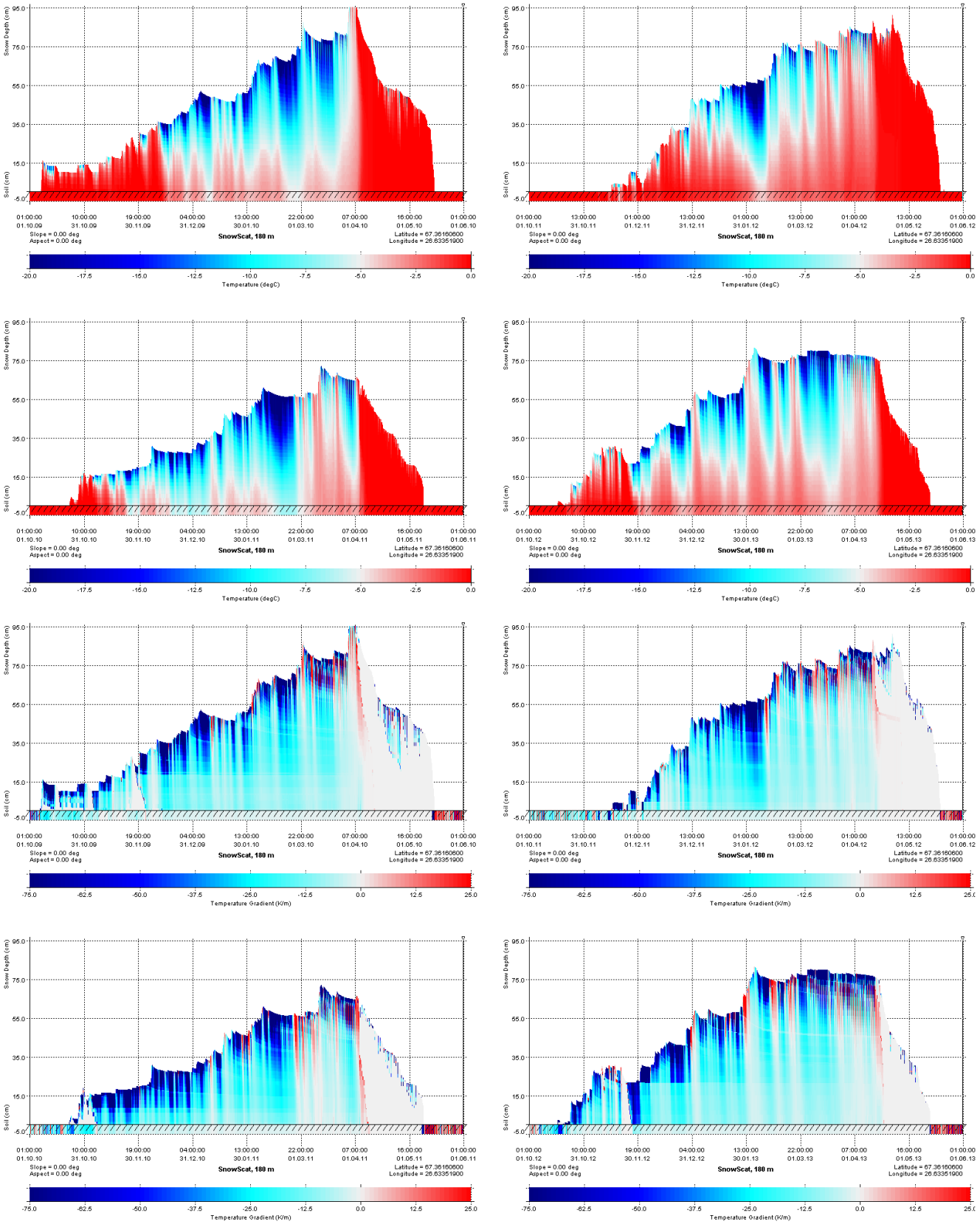

Figure S21. SNOWPACK visualizations for snow temperature and temperature gradient.

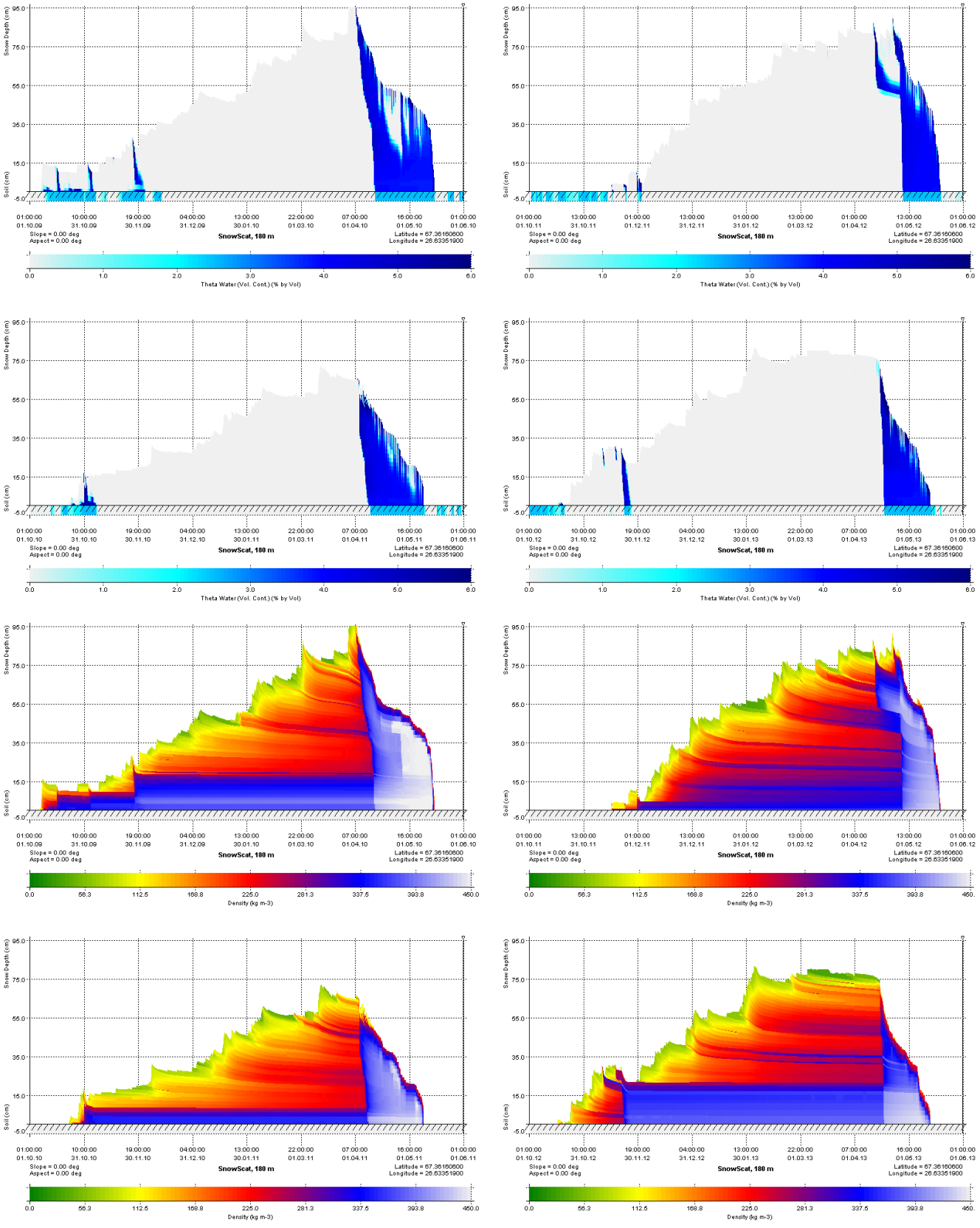

Figure S22. SNOWPACK visualizations for liquid water fraction and snow density.

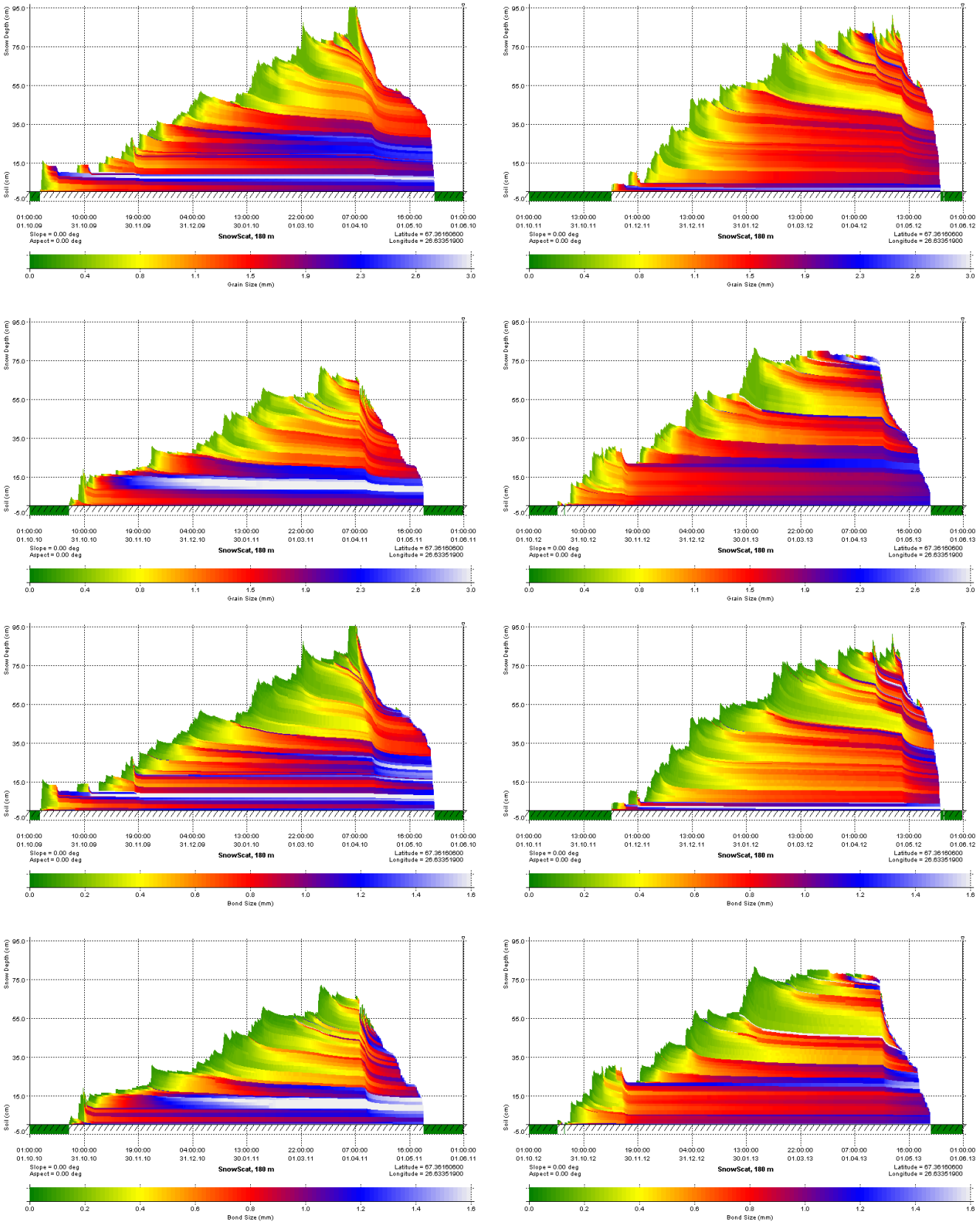

Figure S23. SNOWPACK visualizations for grain size and bond size.

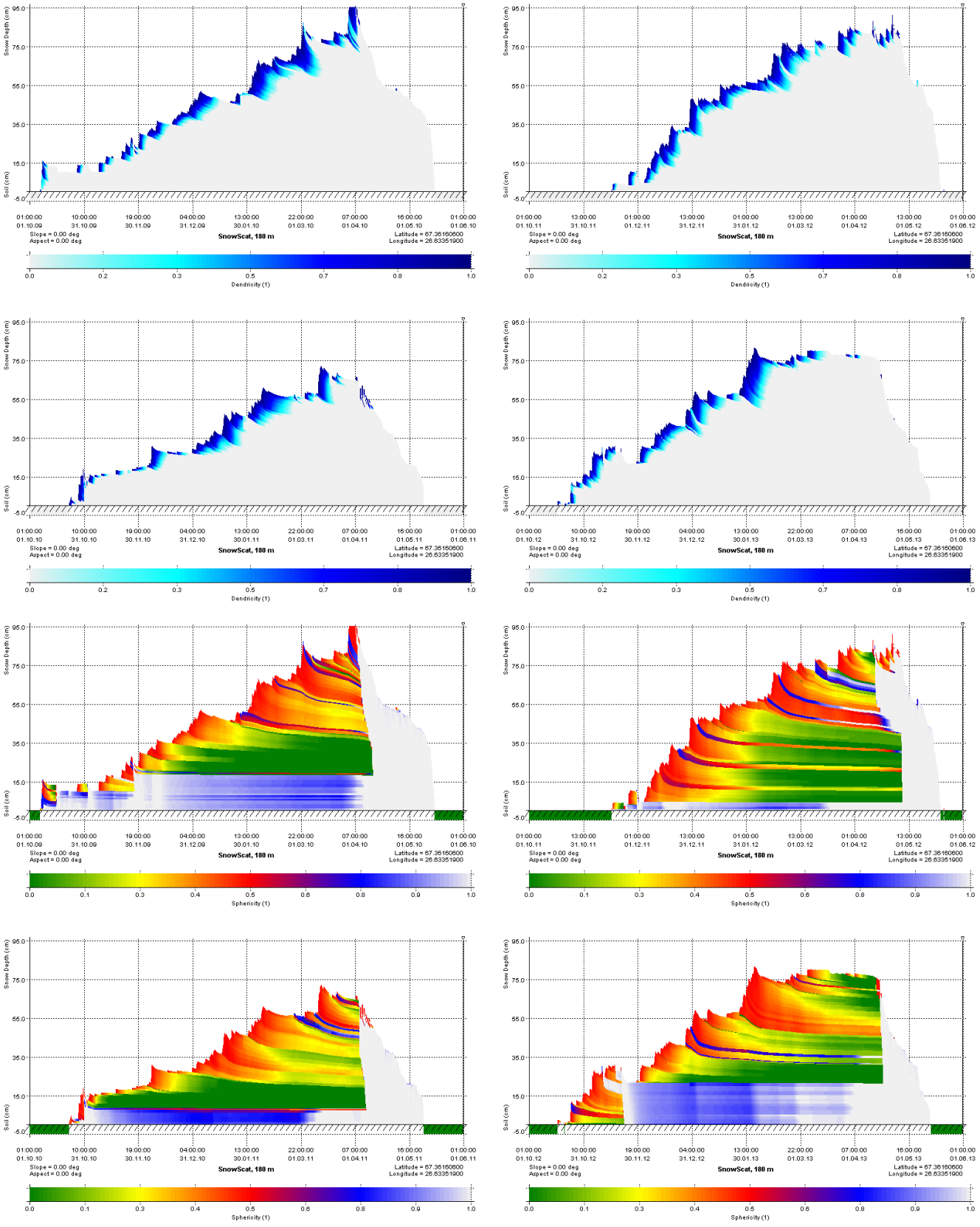

Figure S24. SNOWPACK visualizations for dentricity and sphericity.

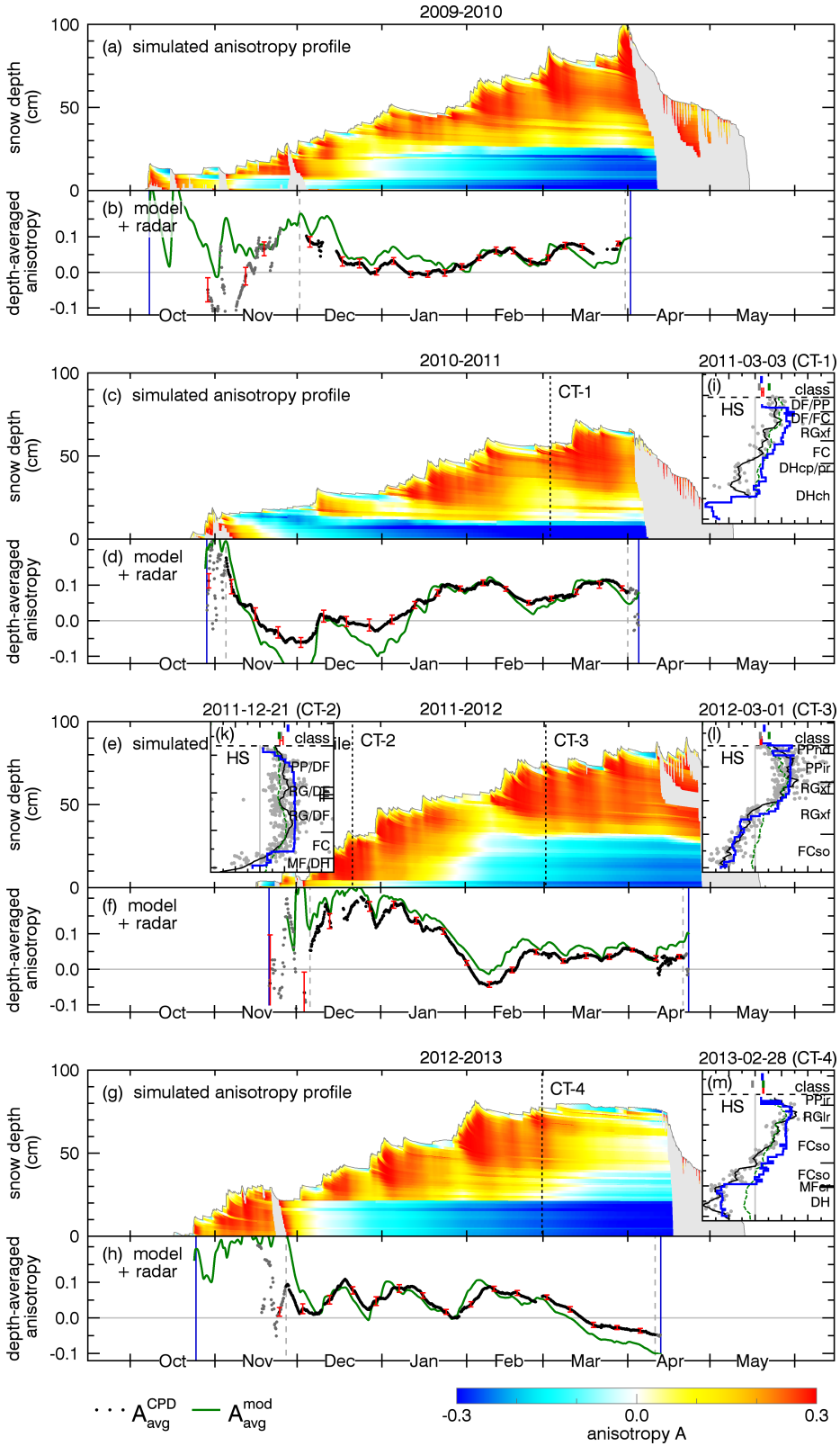

Figure S25. Modeled solution for $\alpha_2 = 1.68$. This figure is identical to the results shown in Figs. 6 and 7 in the main document of the paper.

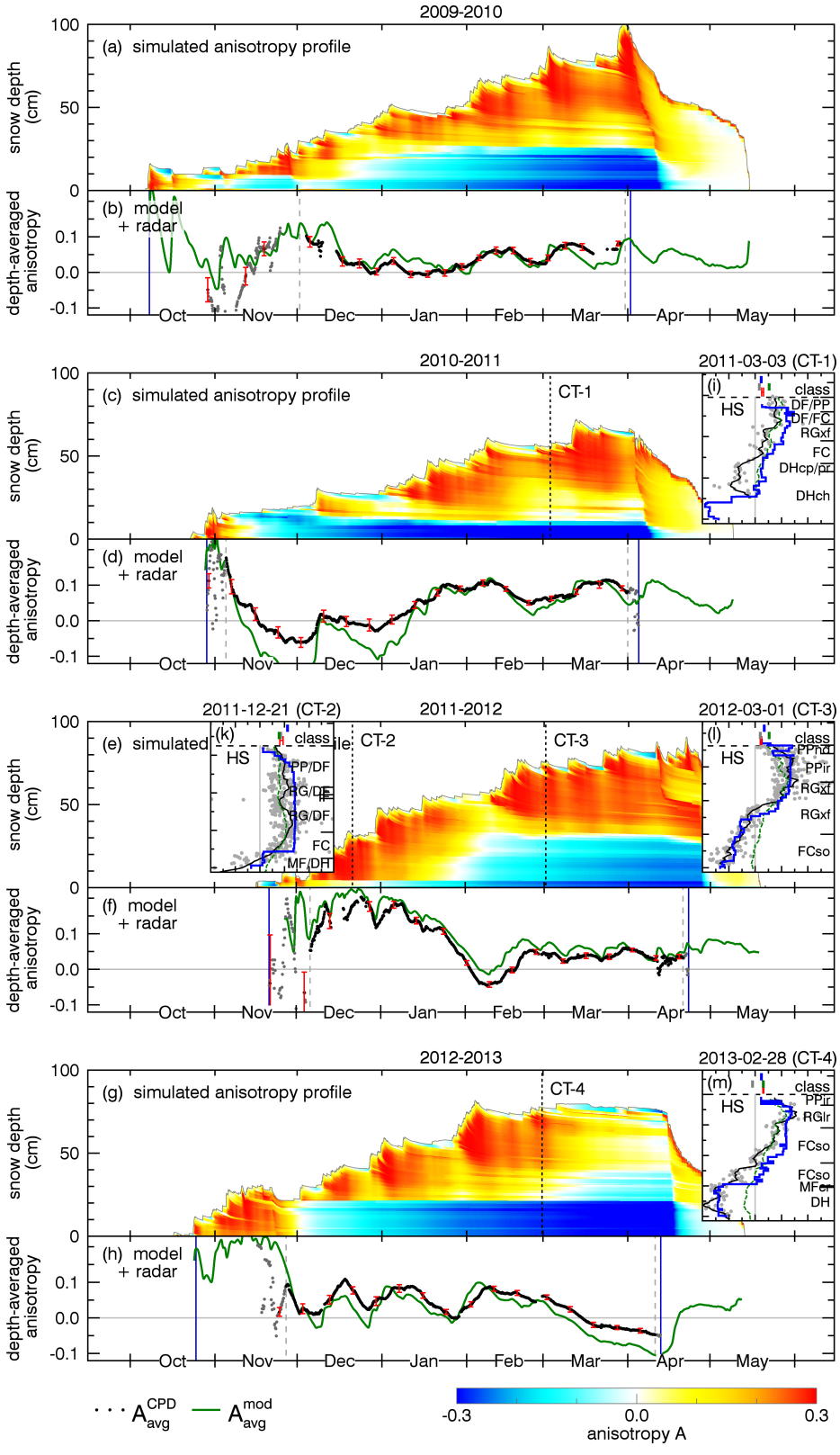

Figure S26. Same as Fig.S25 but with melt metamorphism switched on.