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Cyclic instabilities, turbulence and heat transfer in rotating channel flow simulations GEERT BRETHOUWER, PHILIPP SCHLATTER, ARNE JOHANSSON, DAN HENNINGSON, FLOW, KTH Mechanics, Sweden — Fully developed turbulent channel flow subject to spanwise rotation including a passive scalar is studied by direct numerical simulations. The Reynolds number based on the bulk velocity and channel half width is up to 30000 and the rotation rate covers a broad range. At moderate rotation rates the flow partly relaminarizes on the stable side of the channel and in some cases turbulent spots or oblique laminar and turbulent bands can be identified. The turbulent Prandtl number is close to one in non-rotating channel flow, but is it much smaller if the flow is rotating. At high rotation rates and sufficiently high Reynolds numbers cyclic instabilities are observed. The time scale of the instabilities is much longer than any turbulent time scale. Further analysis show that these instabilities are caused by exponentially growing Tollmien-Schlichting (TS) waves which can develop due to the weak turbulence in rapidly rotating channel flow. When the amplitude is large these TS waves become unstable and break down into intense turbulence which decays because of the rotation. After some time the TS waves start growing again when the turbulence is sufficiently weak and the whole process repeats itself. The cyclic instabilities lead to intense bursts of turbulence, strong wall shear stresses and high heat transfer rates.

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