Feedbacks between Low Clouds and Radiation for the Climate Process Team Cases

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Thank Professor Minghua Zhang for providing the initial condition and forcing data and case setups

Introduction

- There are large uncertainties in the simulation of climate response to global warming by GCMs, due primarily to the parameterizations of low-level clouds
- The magnitude of the feedback of low-level clouds to global warming is unknown
- Large-eddy simulation (LES) is a promising tool to study such feedbacks, since low-level clouds are explicitly resolved

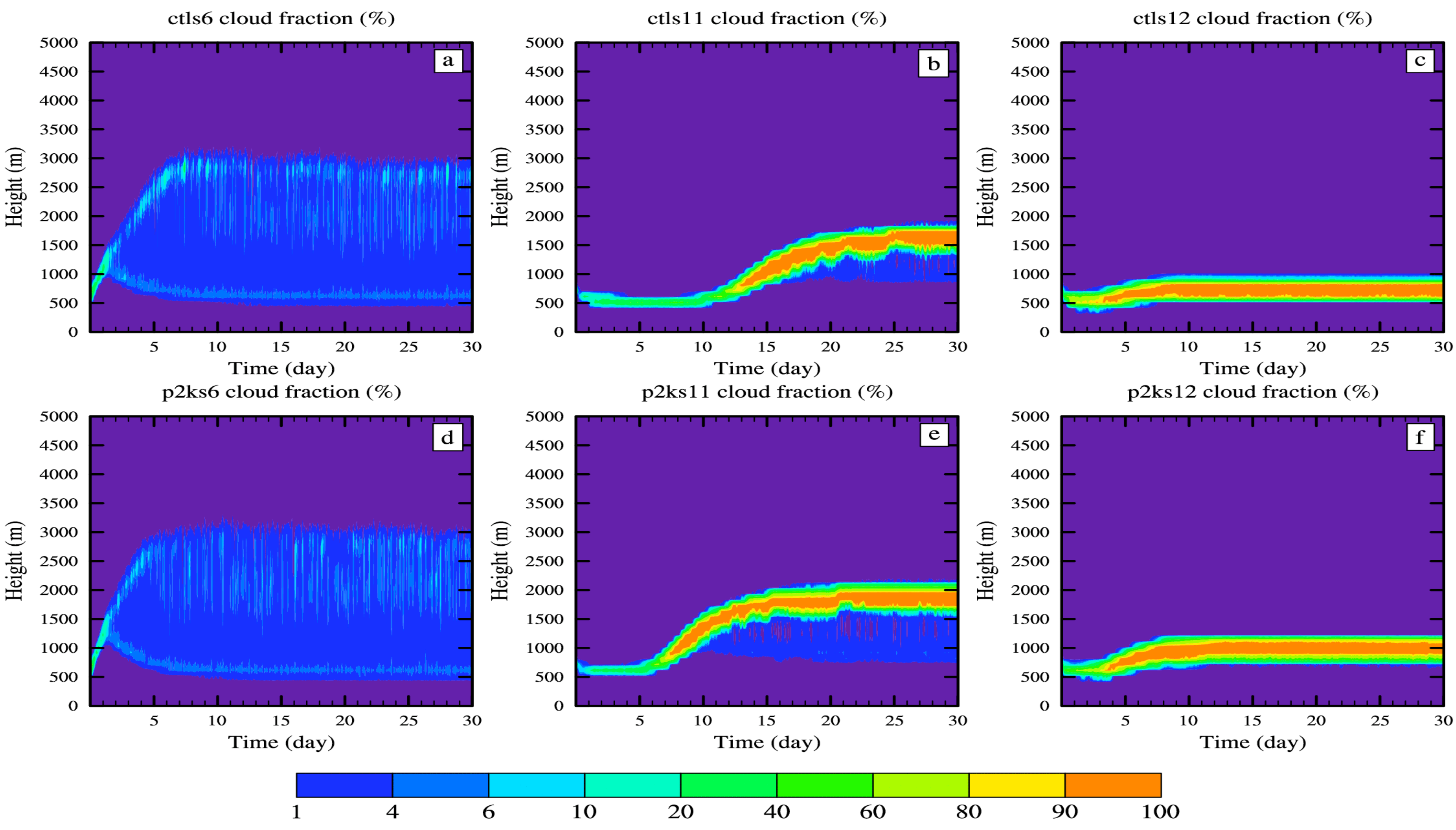
Model Description

- A directional-split monotone upwinding method for scalar advection and a fourth-order centered differences for momentum advection
- TKE-based subrange (small turbulence) closure
- Two-moment microphysics, with predicted rainwater and specified cloud droplet concentrations
- CAM3 radiation scheme

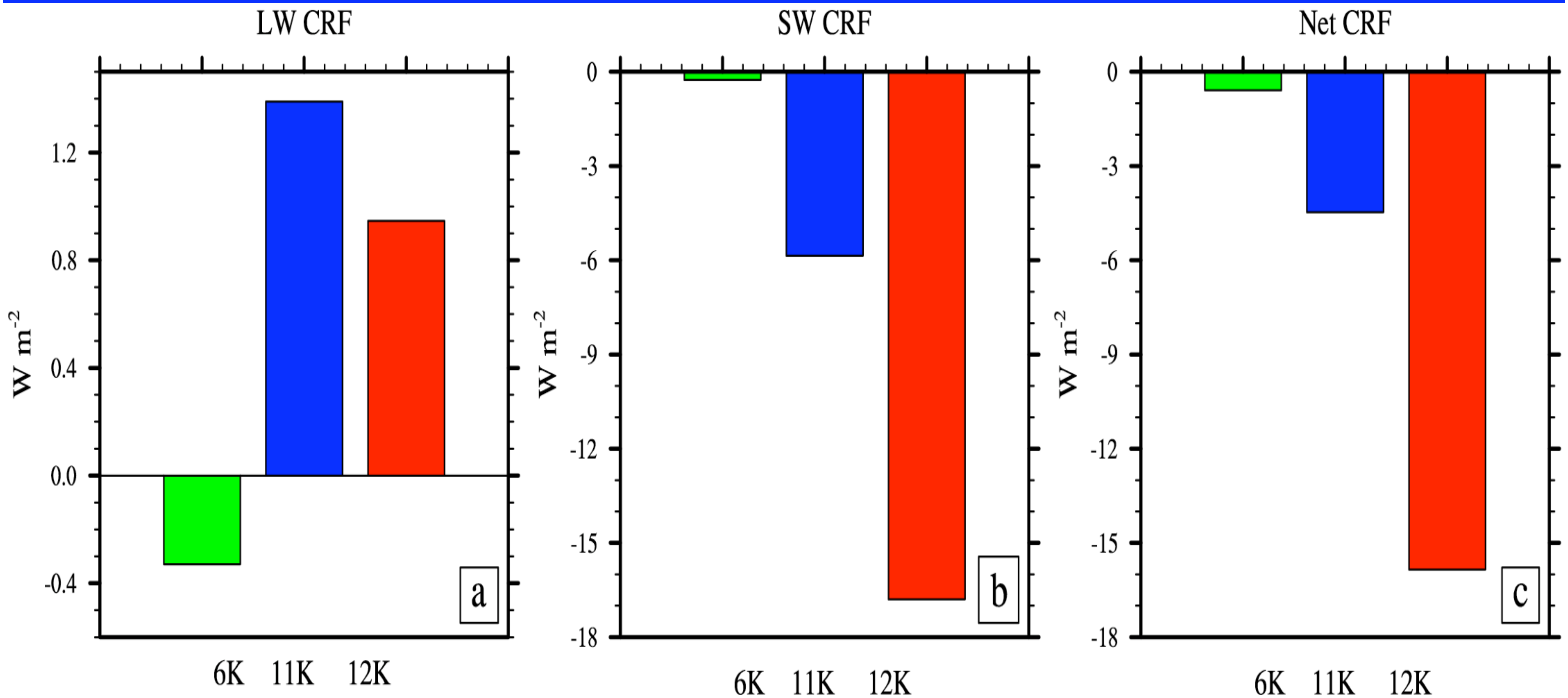
CPT Experiment Design

- Control experiments: specify the SST difference between two reference points in the warm and cold pools; ctls6K, ctls11K, ctls12K
- Sensitivity tests: increase SST by 2K from the control experiment: p2ks6K, p2ks11K, p2ks12K
- Domain: 6 km X 6 km X 20 km
- Grid-spacing: 200 m X 200 m X (stretched from 30 m to 360 m)
- Prescribed SST and large-scale forcing

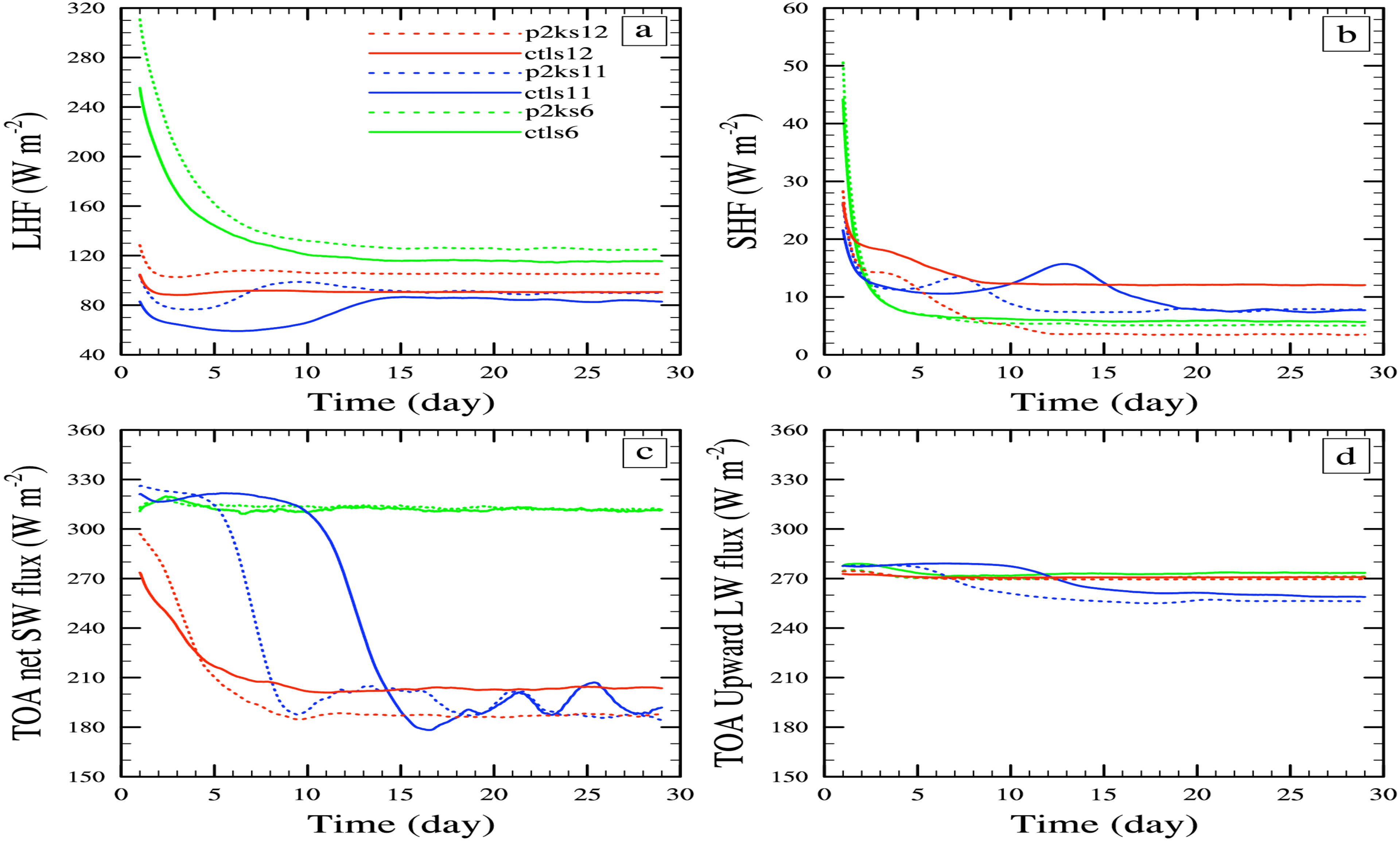
Cloud Evolution



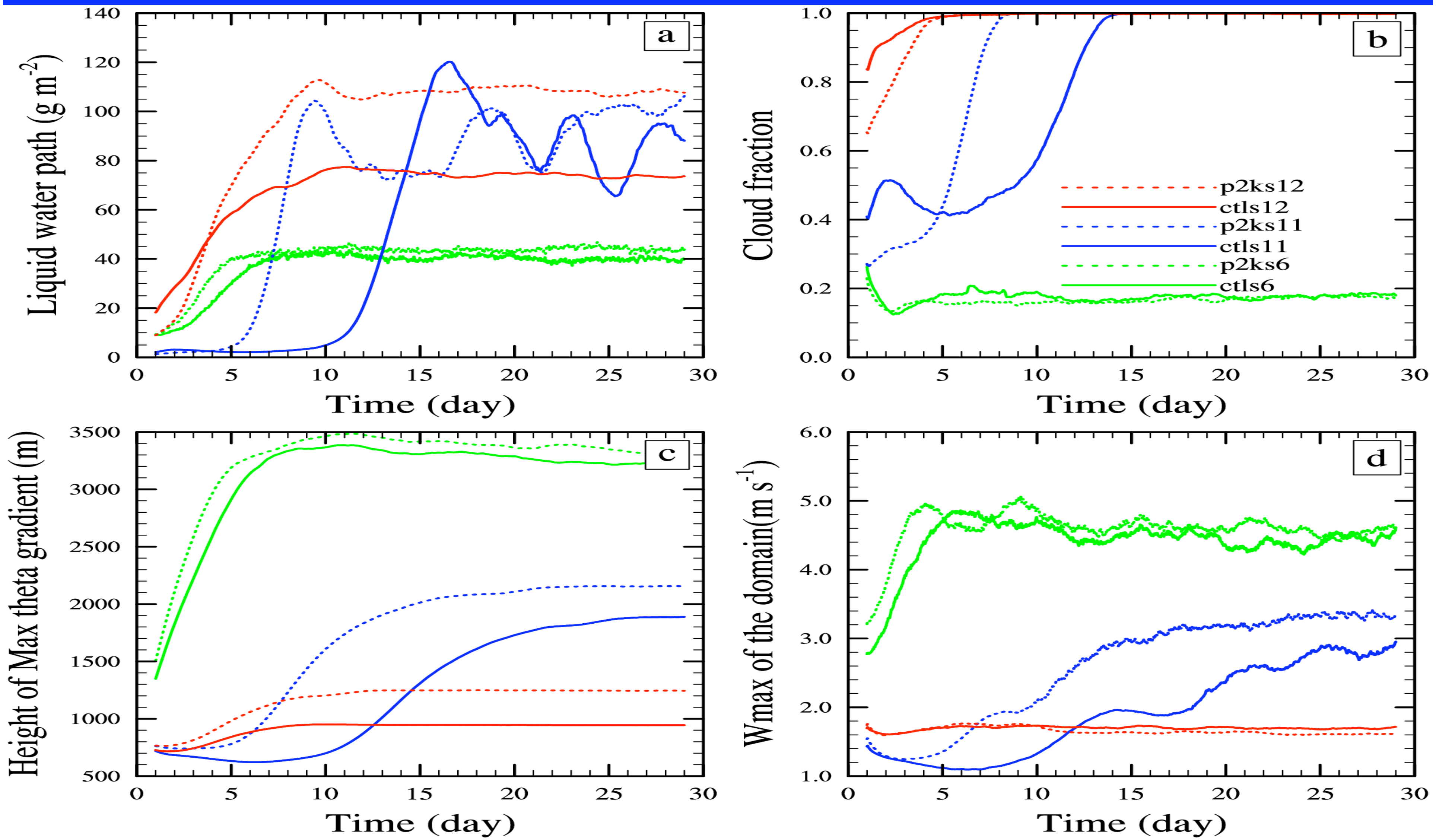
CRF at the Steady State



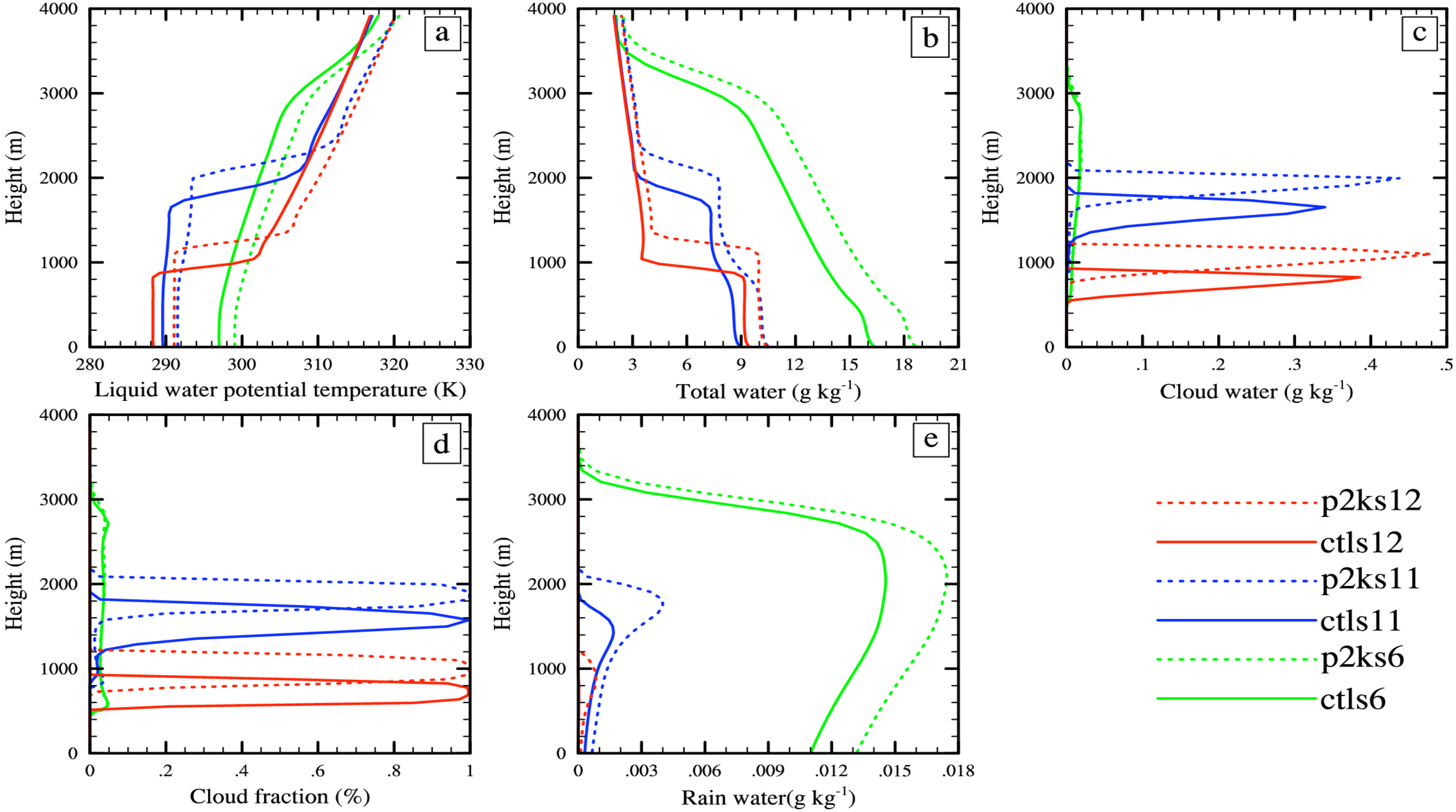
Time series of surface LH, SH and TOA radiative fluxes



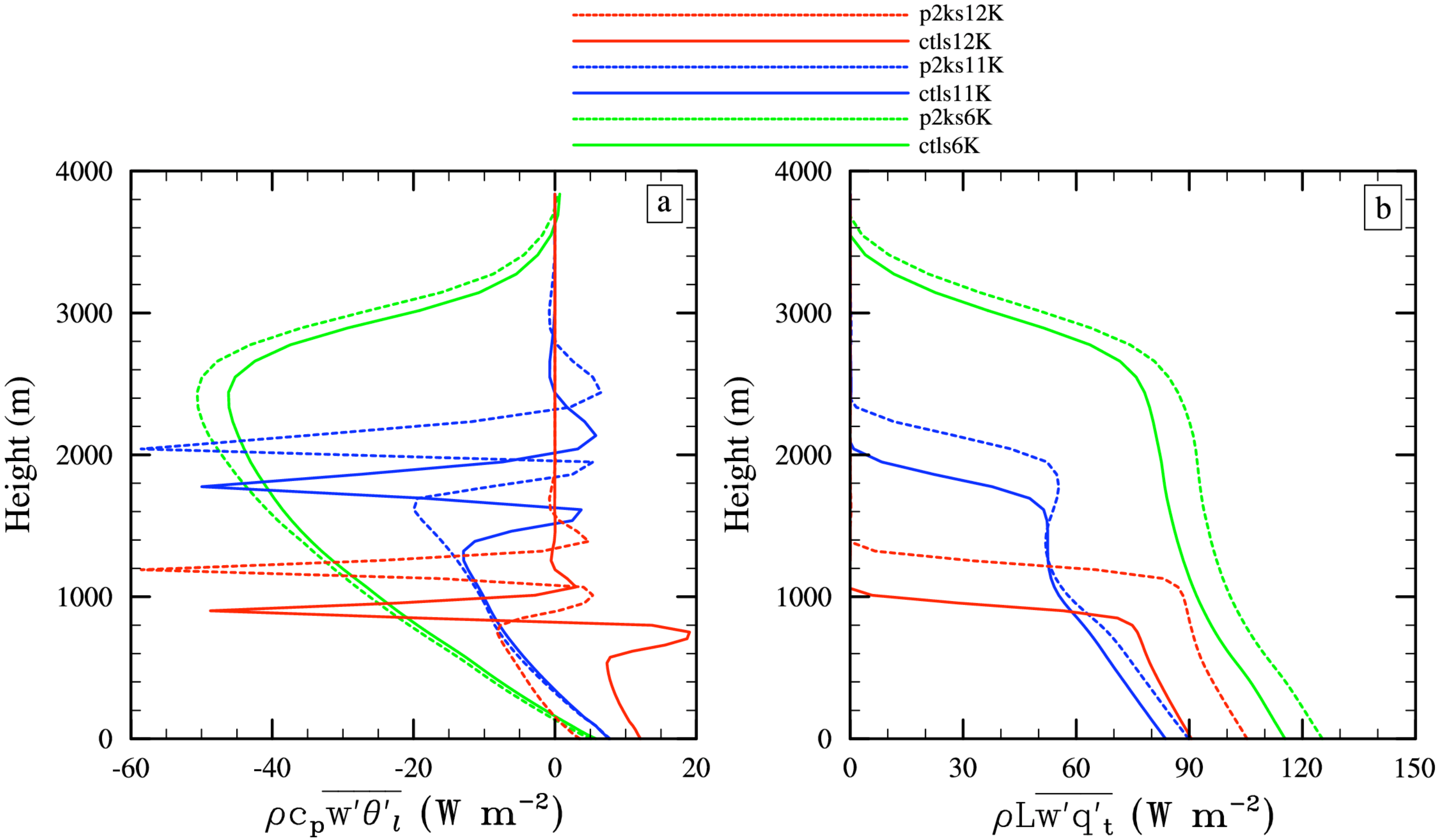
Times series of selected cloud-related fields



Mean Profiles of thermodynamic and cloud variables



Mean profiles of eddy transports



Summary and Discussions

- How low cloud amount and LWP change with the increased SST is the key result
- Negative feedback cycle:

Increased SST ->Increased moisture transport -> Increased low cloud amount and LWP -> more SW cooling >>> decreased SST

- The effects of the change of cloud height and LW CRF on the feedback are relatively weak
- The magnitude of CRF from Stratocumuli is larger than that from shallow cumuli

Thank You!

Large-scale forcing