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The effect of SSTs and roughness on the meridional moisture transport and precipitation of extratropical cyclones

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NMM31
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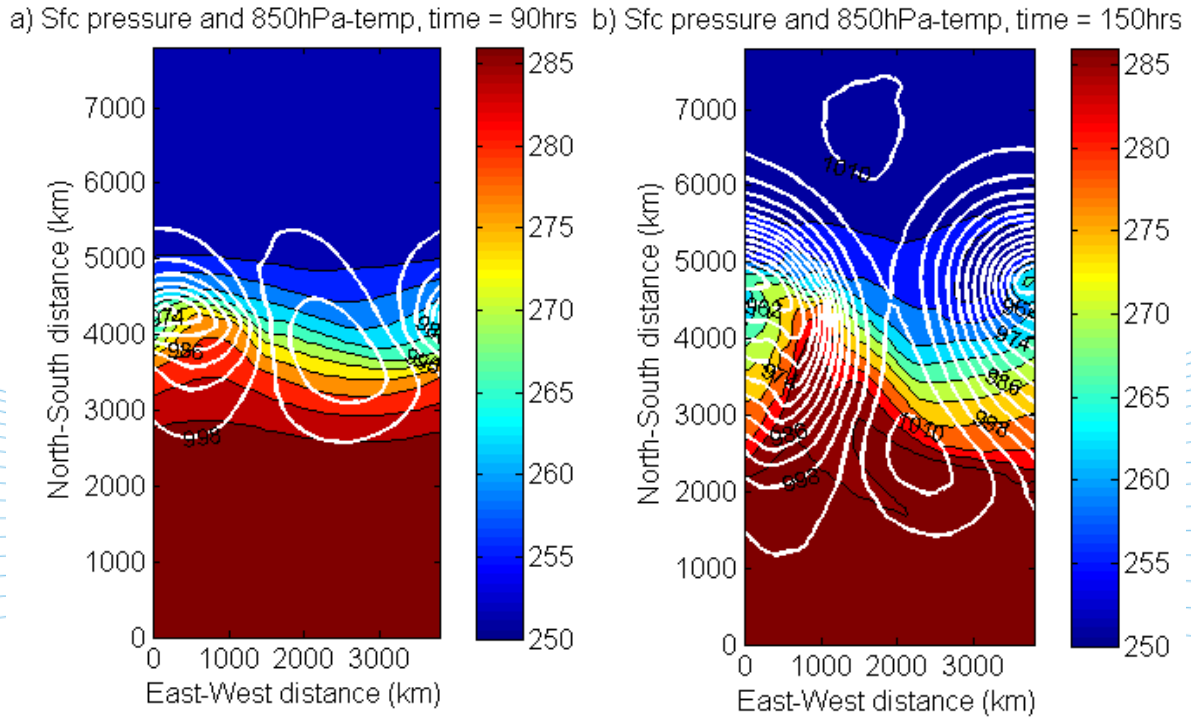
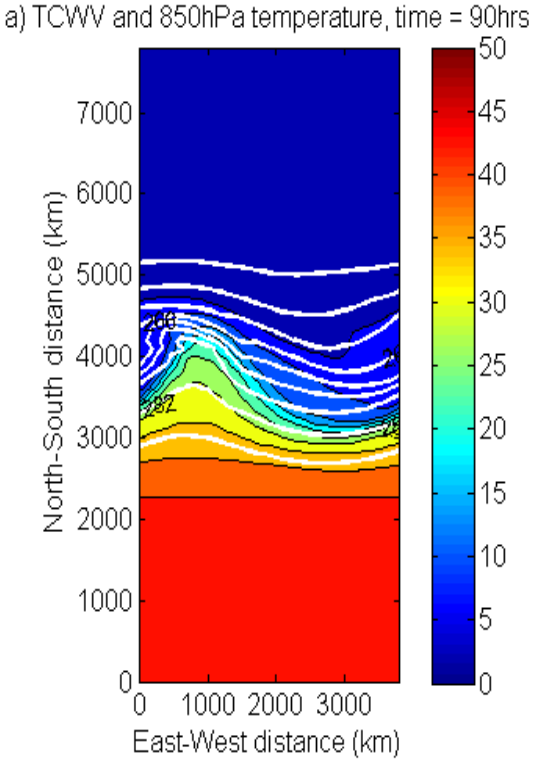
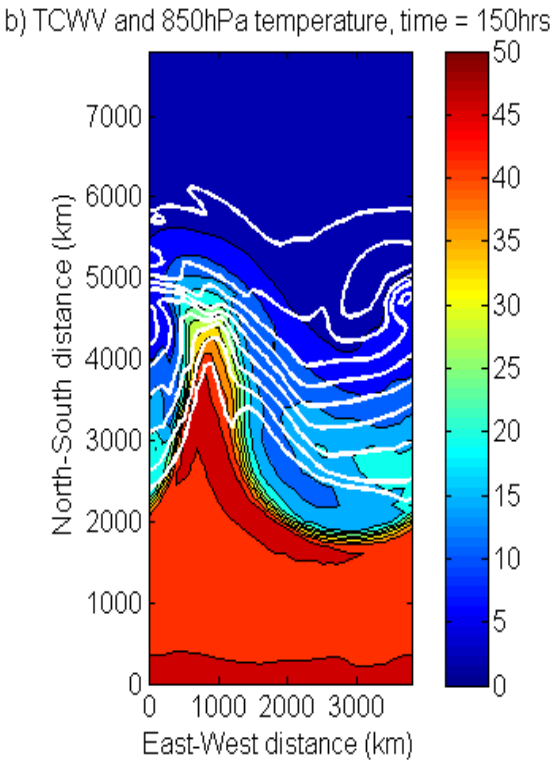


Why the effect of SSTs on the extratropical cyclones needs to be studied



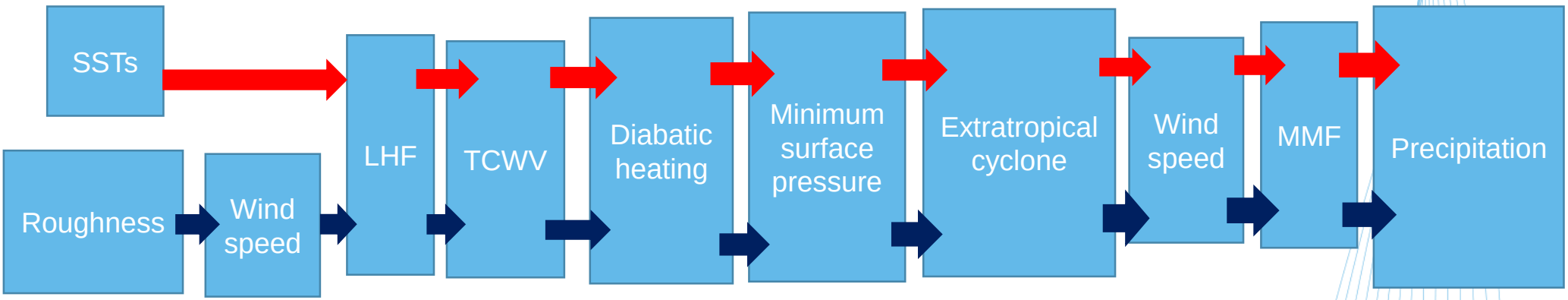


1. Sea surface temperature (SST) is increasing due to global warming
2. Moisture is transported from tropics towards poles by extratropical cyclones
3. Roughness is less studied but important factor because the surface varies around the globe

The research setup

1. The Weather Research and Forecasting model (WRF, 3.4.1)
   a) Idealized simulations with baroclinic wave test case
   b) 10 day cycles, in that time the baroclinic wave developed and decayed
   c) Full physics, except radiation
2. Sensitivity experiments
   a) Changing the surface temperature homogeneously
   b) Two different roughness lengths
   c) In total 10 runs
      - Control run (CNT), CNT -1 degree, CNT +1 degree, CNT +2 degree and CNT +3 degree
      - Same set for rougher surface

Hypothesis of the effect of SSTs and roughness on the meridional moisture flux (MMF) and precipitation



Increments in SSTs amplify effects

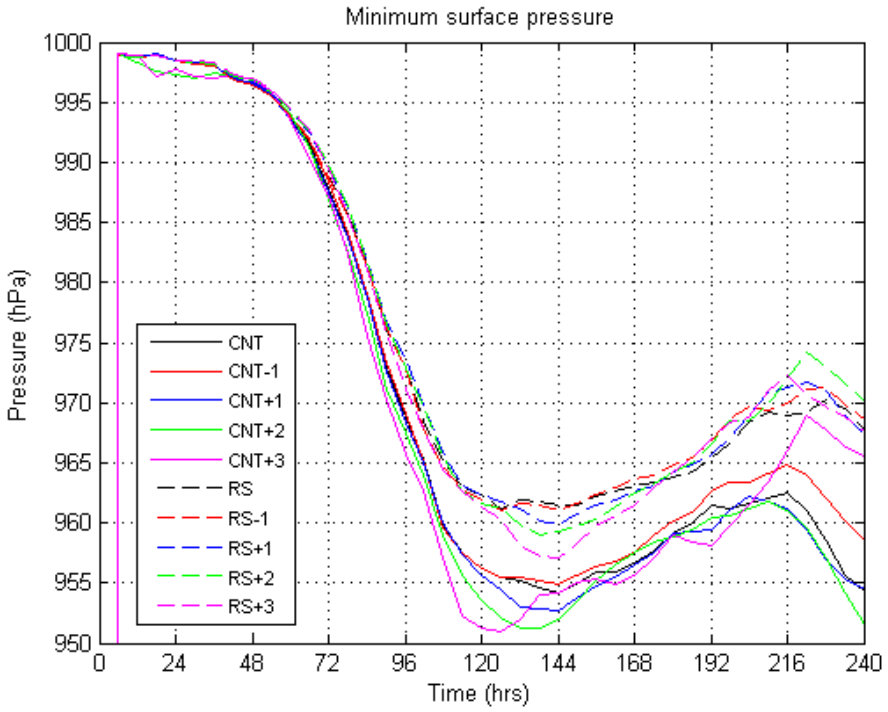
Increments in roughness lengths diminish effects

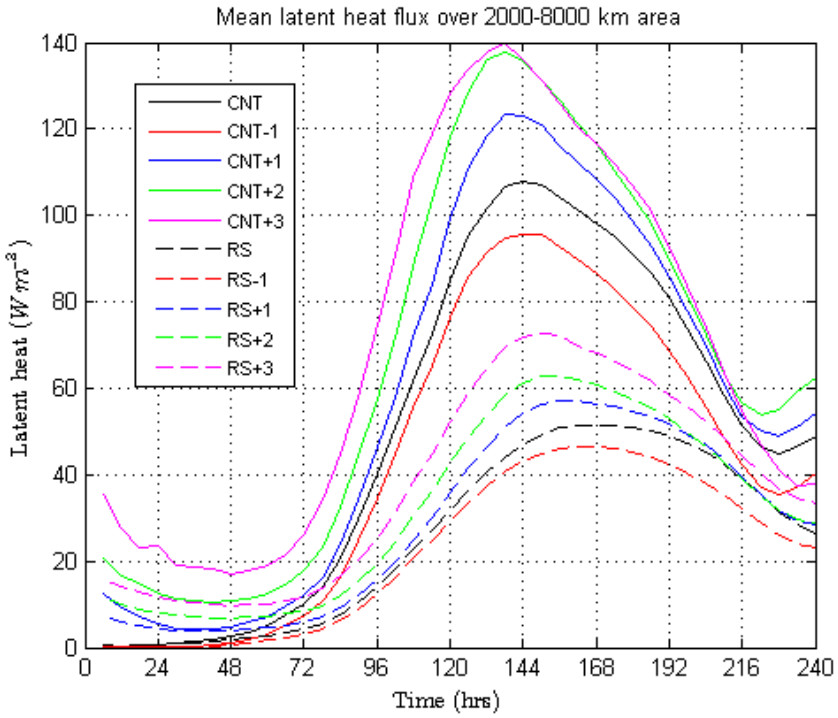
LHF, Latent heat flux
TCWV, Total column water vapor
MMF, Meridional moisture flux

Baroclinic wave as the SSTs increase

Minimum surface pressure decreases slightly as SSTs increase

Mean latent heat flux (LHF) increases as the SSTs increase

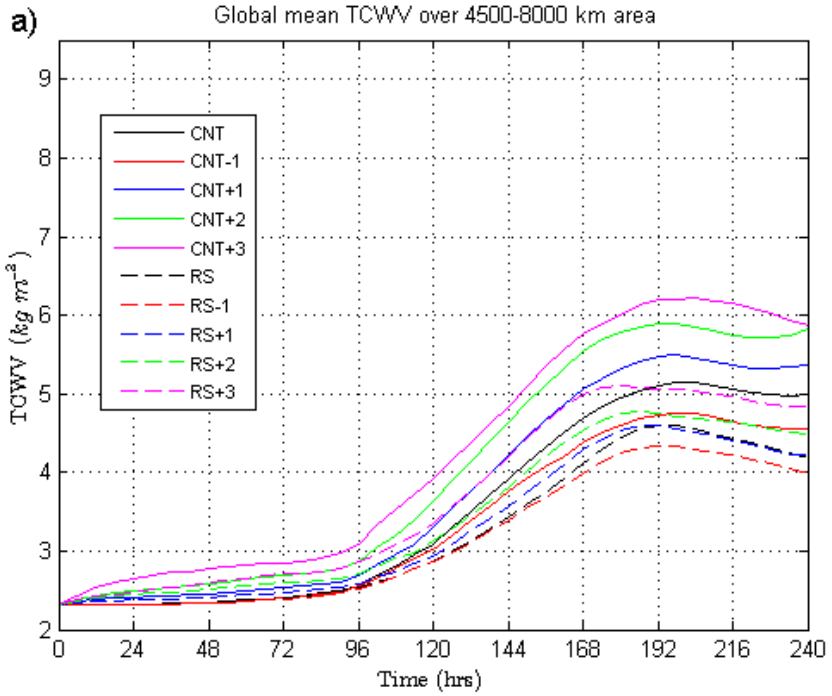


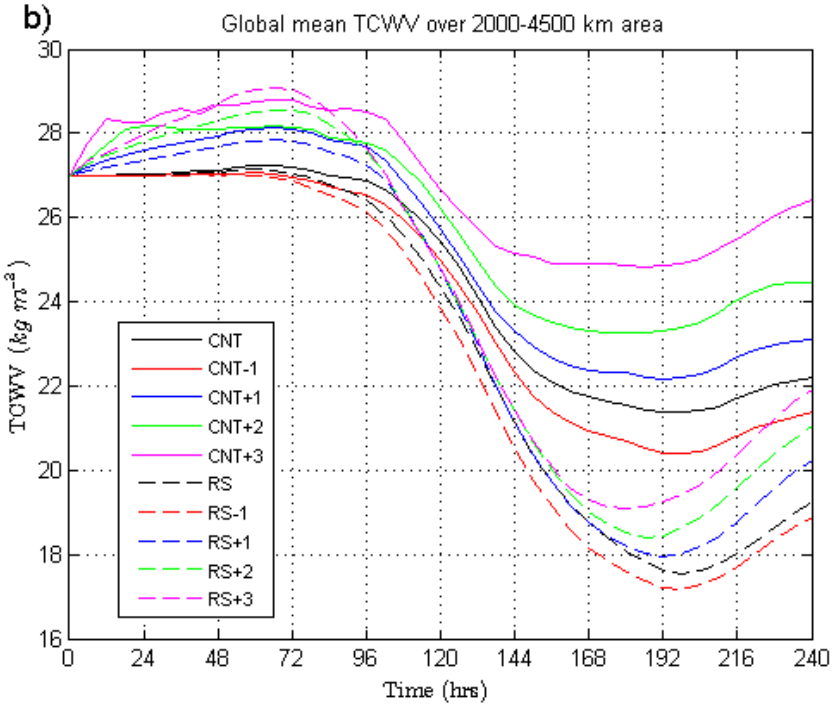


Total column water vapor (TCWV)

The total column water vapor (TCWV) increases in the northern parts of baroclinic wave.

The TCWV decreases in the southern parts of baroclinic wave, but as the SST increases there is more left.

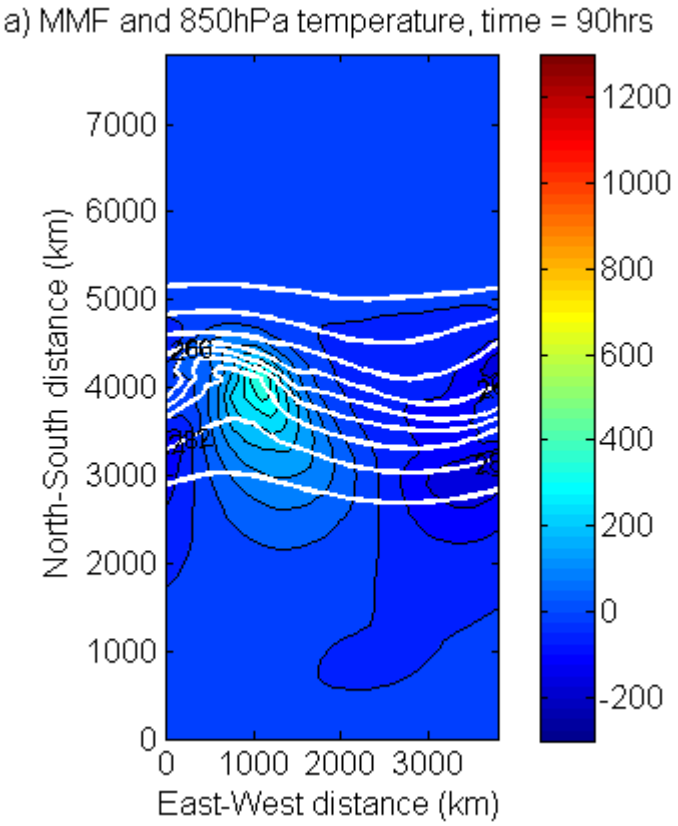


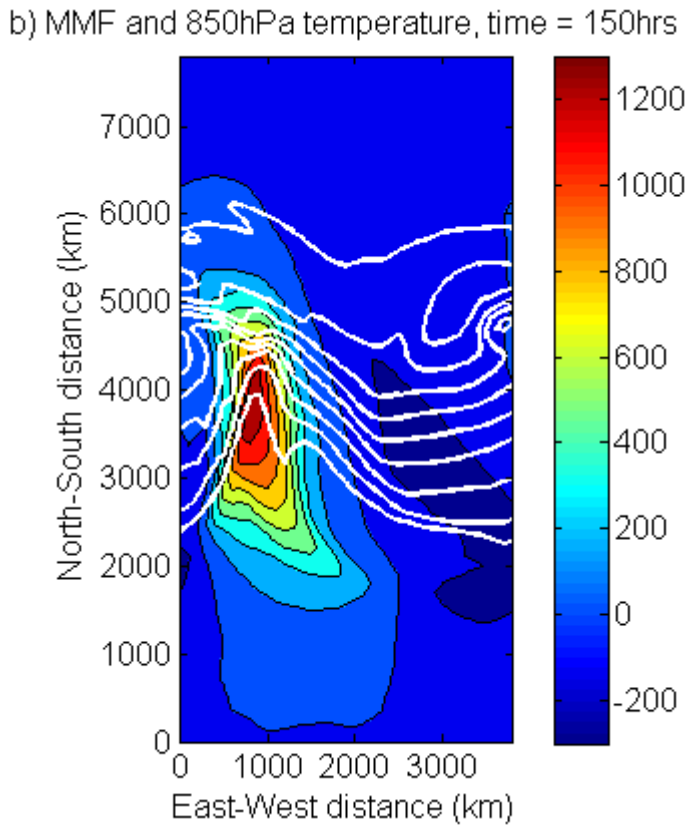


Meridional moisture flux (MMF)

MMF is strongest in the mature phase of baroclinic wave.

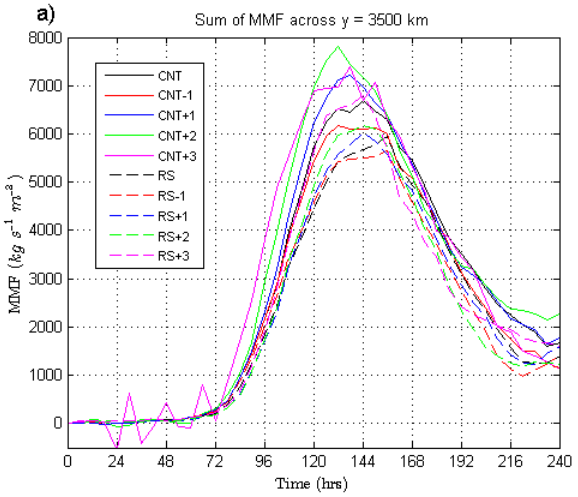
MMF is towards the north where the cyclone center is located.



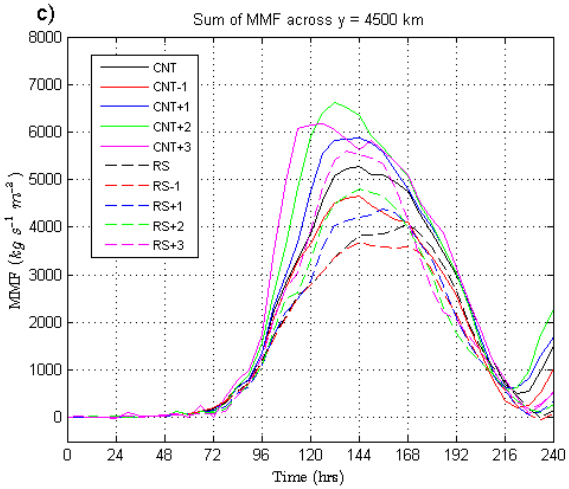


Meridional moisture flux (MMF)

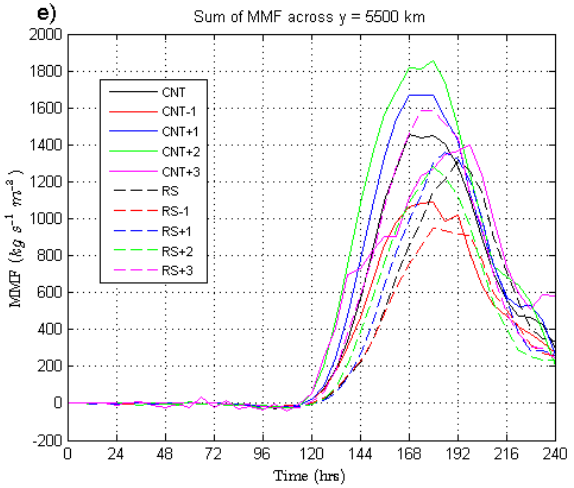
MMF at south latitude



MMF at midlatitude



MMF at north latitude



1. MMF is smaller at northern latitude than in south
2. Maximum of MMF occurs later in north than in south
3. MMF increases generally with increasing SSTs

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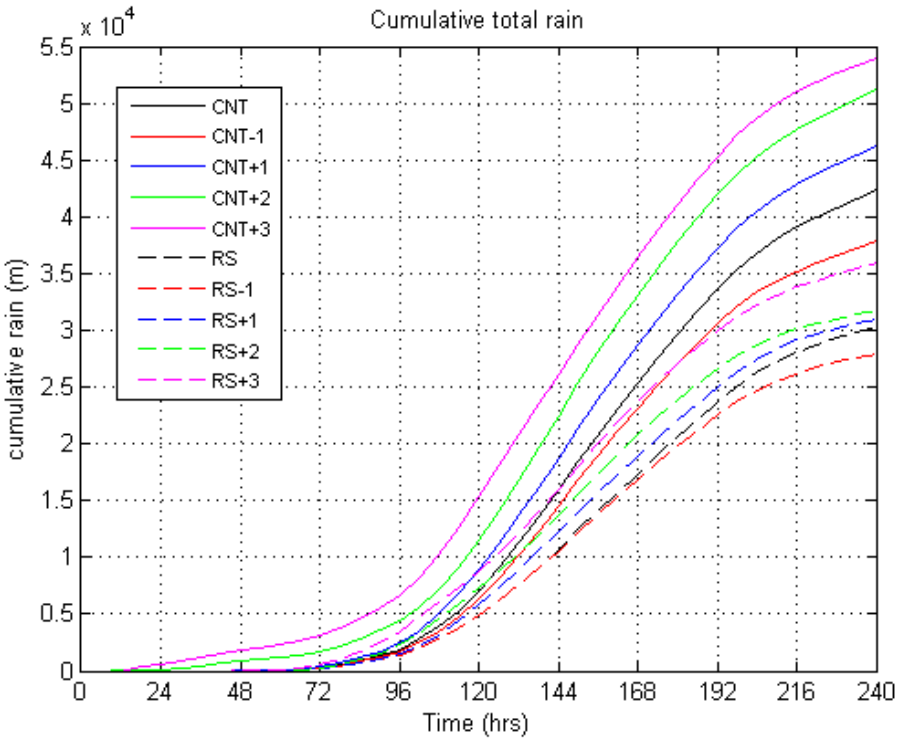
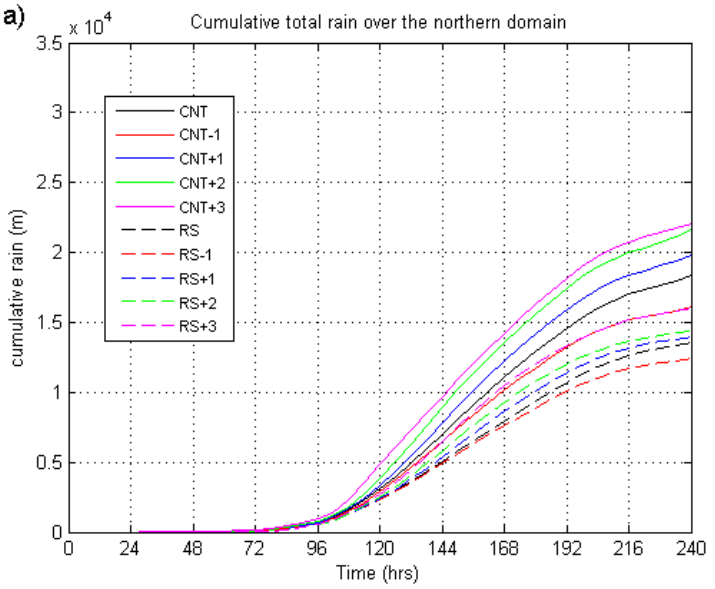
Precipitation

Cumulative total precipitation

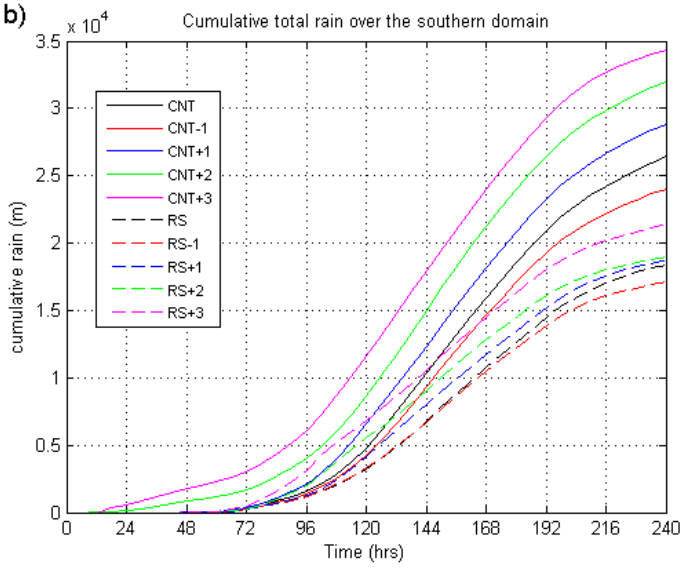


1. Precipitation increased with increasing SSTs
2. The change was larger in south

Cumulative rain in north



Cumulative rain in south



Conclusions

- increase in SSTs caused:
  - lower minimum pressure
  - stronger latent heat flux
  - more total column water vapor
  - stronger meridional moisture flux
  - more precipitation

- Increase in roughness length caused the opposite