Sensitivity of Stratospheric Dynamics to Uncertainty of Ozone Production

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Introduction

- Research in stratospheric ozone chemistry is well established. So is research in stratospheric dynamics.
- What about the coupling/interaction between ozone and the stratospheric circulation?
  - eg.1: transport affects ozone chemistry and its distribution; an EC met field year 2005 example
  - eg.2, Antarctic ozone depletion-> Surface wind->Ocean Circulation (extreme case)

Introduction (continued)

- If ozone chemistry is perturbed within its uncertainty, what is its impact on the stratospheric dynamics?

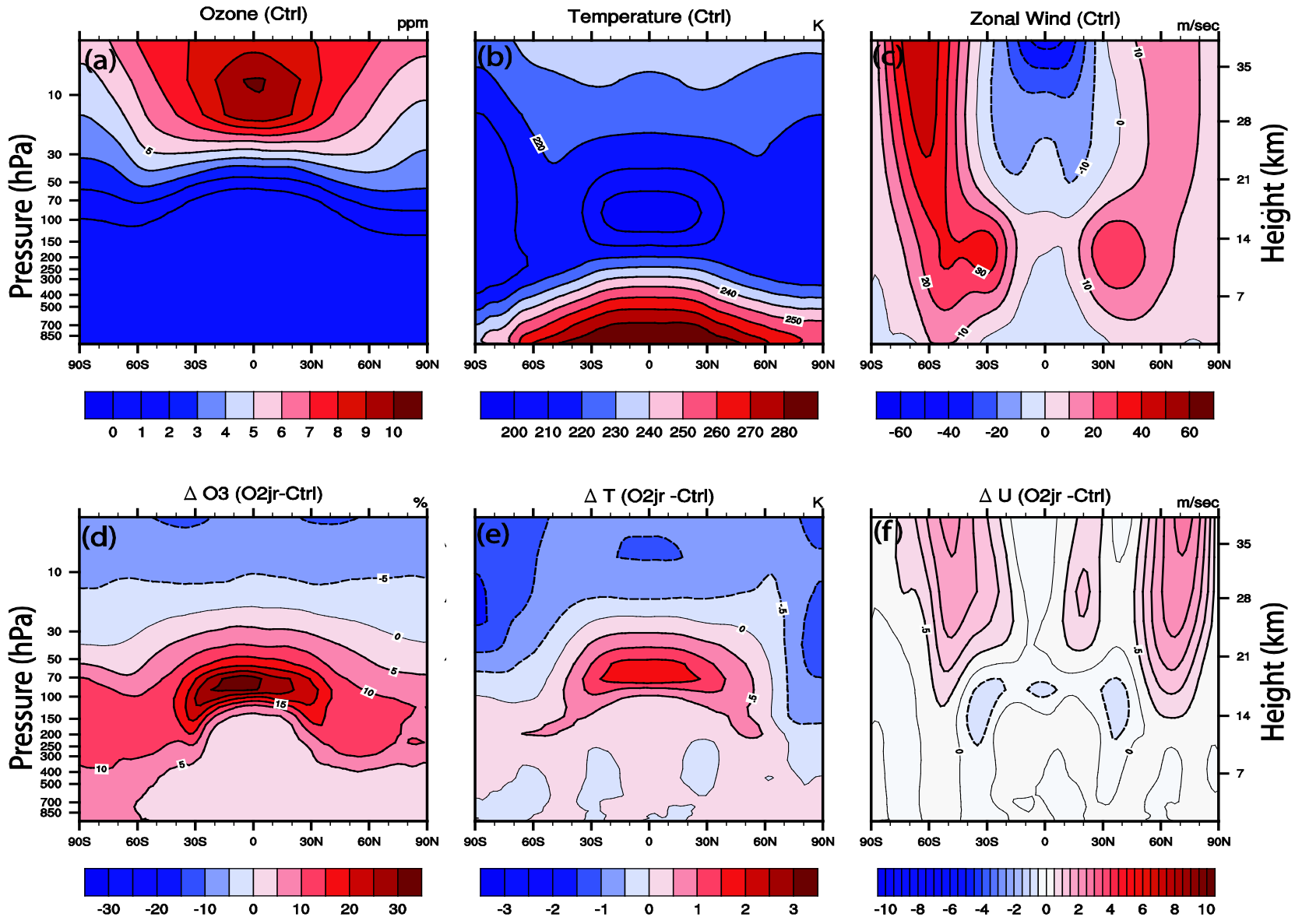
- Brewer-Dobson circulation (wave-driven)
- The annual cycle of the lower stratosphere (TTL)
- Winter polar vortex

- In this study, we elected the uncertainty in O2 cross sections to represent the uncertainty of ozone production.

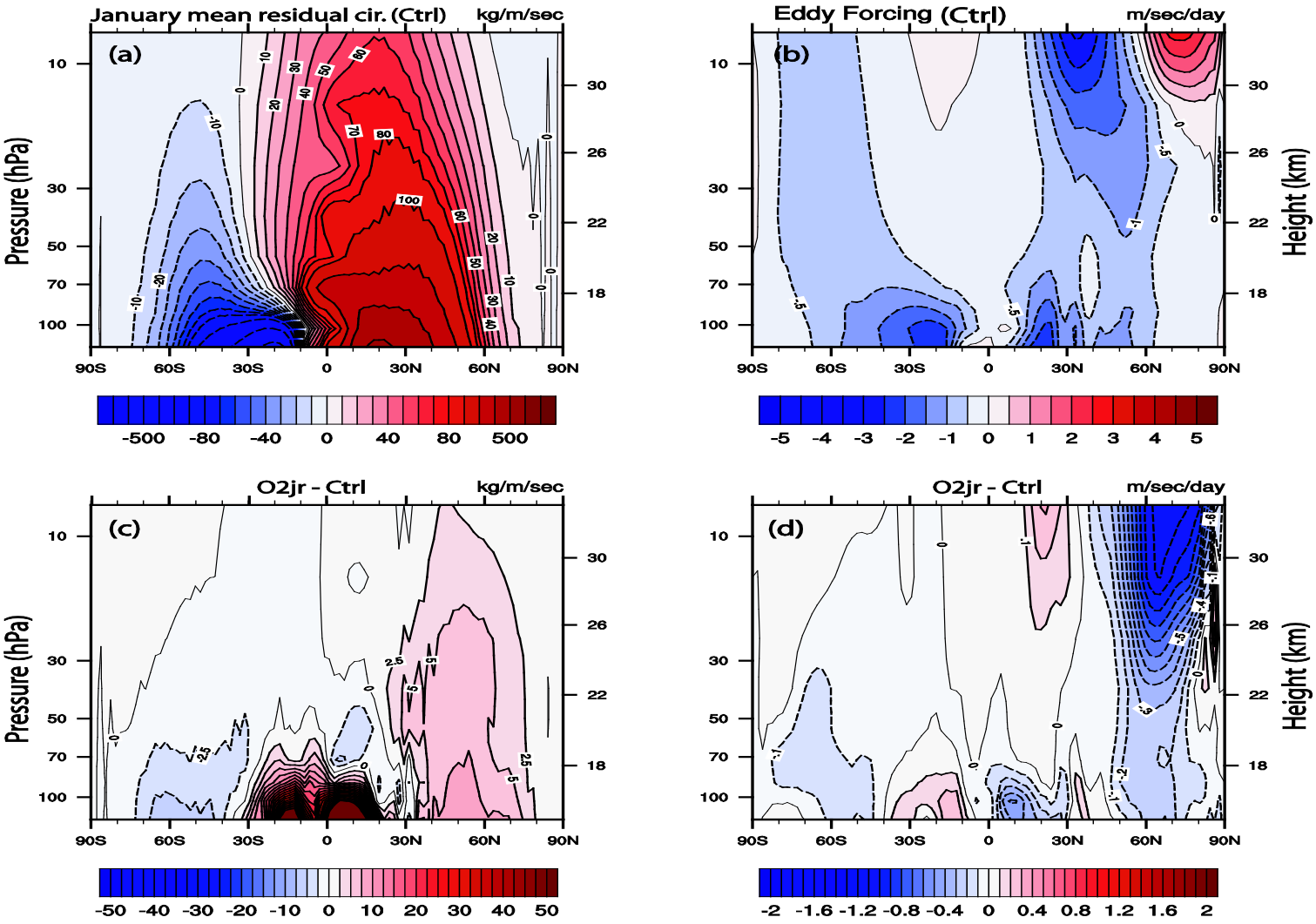
Model Setup and Simulations

- Cam 5.0 + Superfast version of LLNL-IMPACT+ Linoz v2
- Prescribed annually repeating SST; no obvious QBO
- Two 15-year runs; analyze the last 10-year output
- 1 Ctrl run &1 Perturbed run with O2 cross sections reduced by 30 % at Hertzberg Continuum (202-242 nm)
- Only monthly data were analyzed

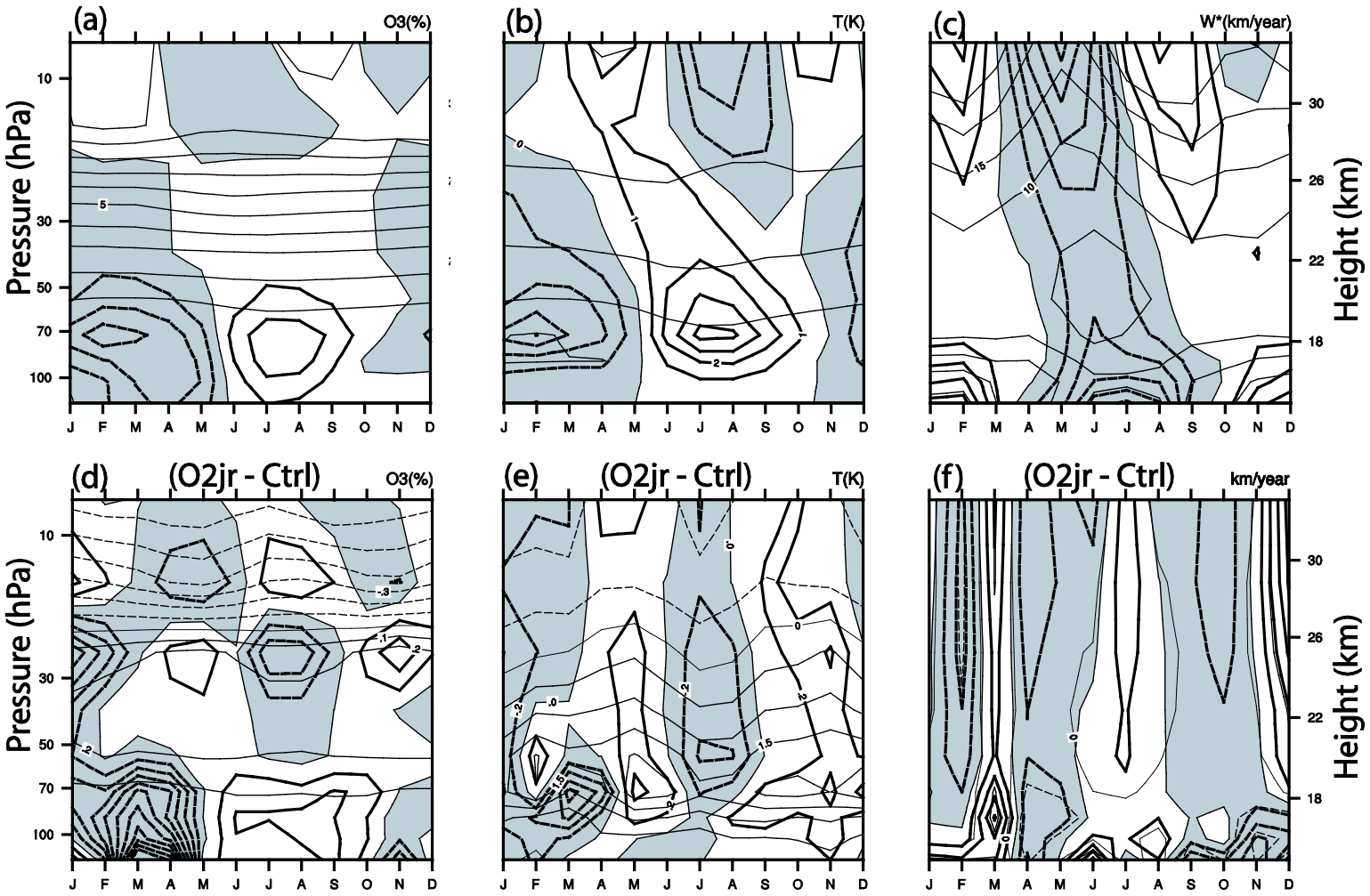
Time-mean basic-state (10-year annual-mean climatology)



January Mean Residual Circulation and Eddy forcing:

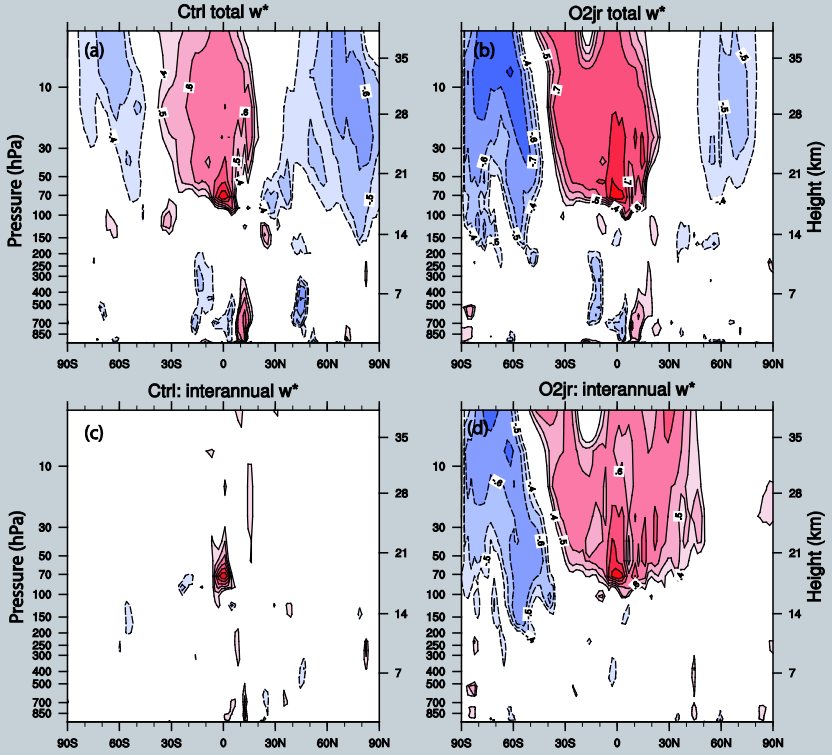


The Annual and Semi-Annual Cycles in deep tropics:

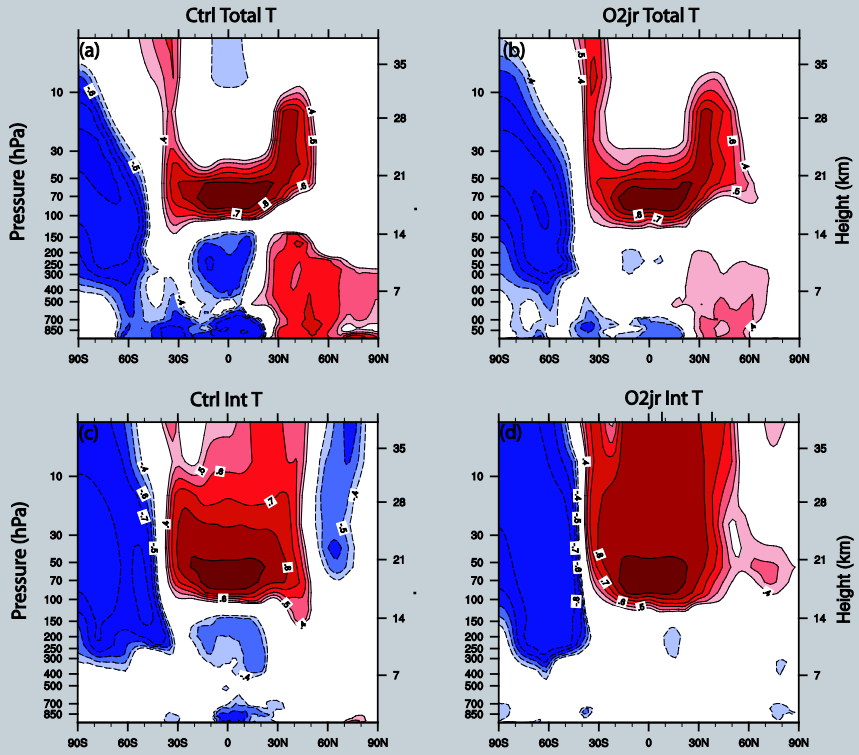


Ventilation starting at 70mb

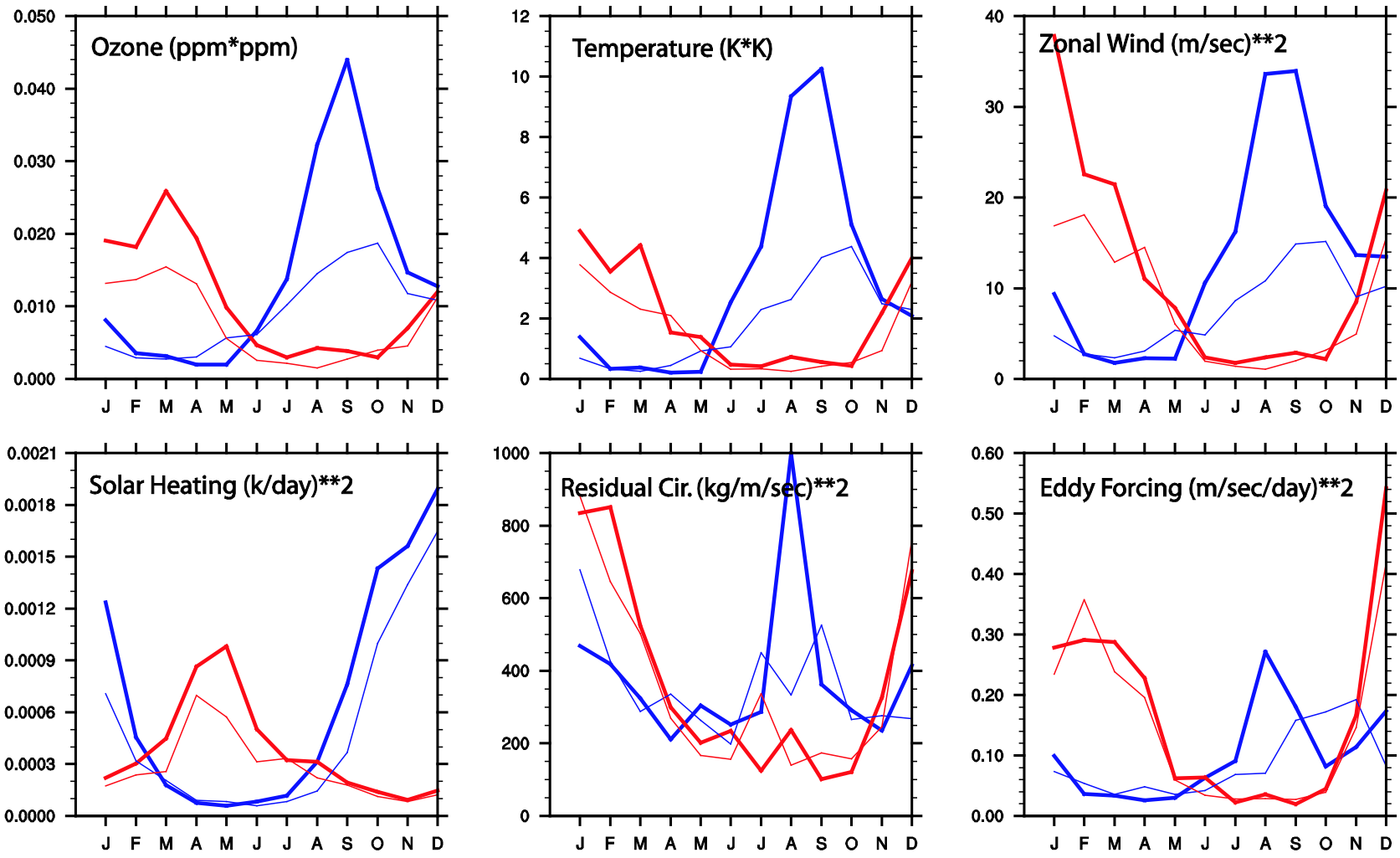
One point correlation map: residual vertical velocity w*



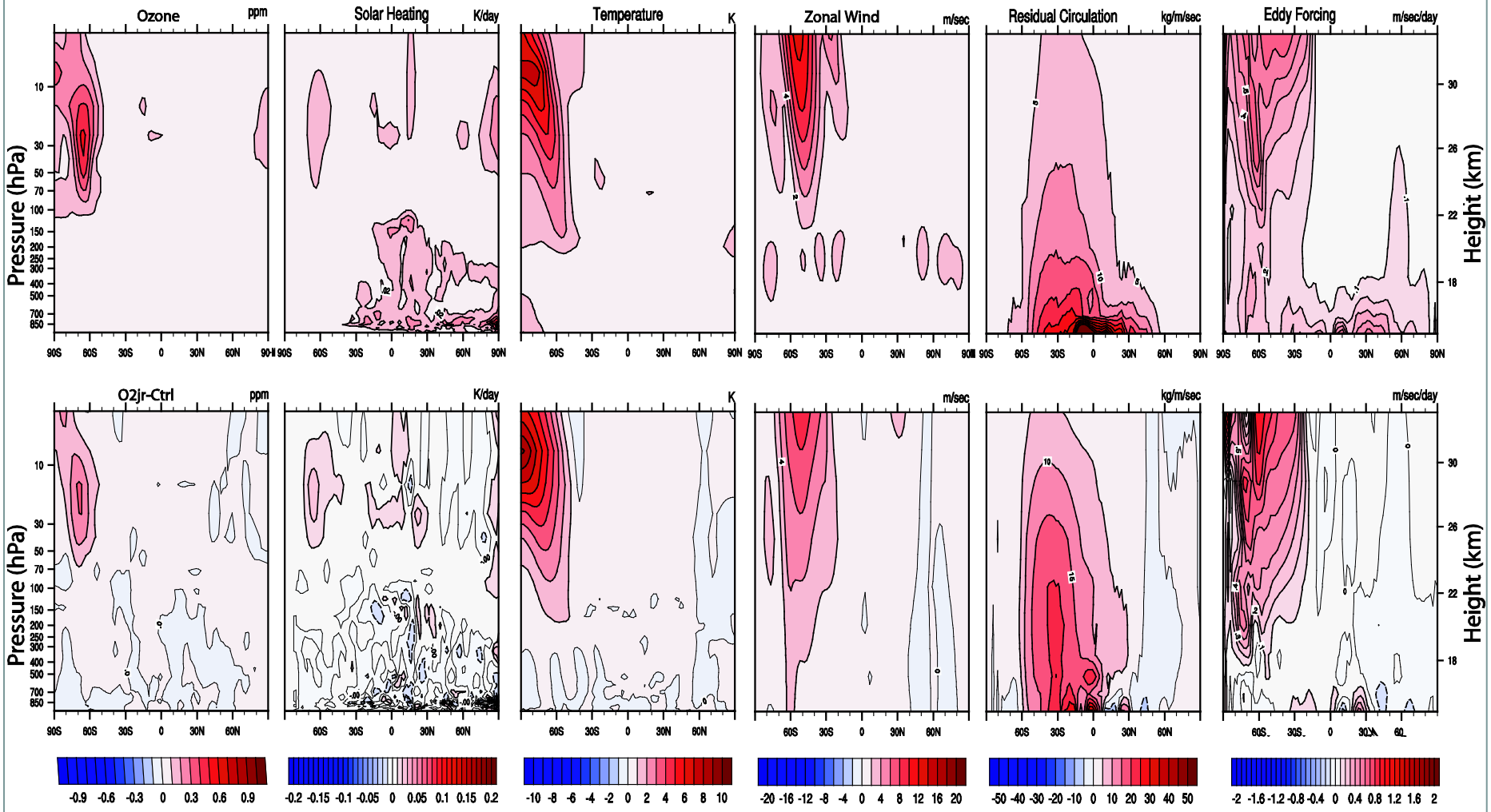
One point correlation map: temperature



Hemispheric Interannual Variability:



Interannual Variability for August:



Conclusion:

- Simulation with O2-cross sections reduced by 30 % at Hertzberg continuum leads to:

1. 15-30 % more ozone in the lower stratosphere; 5-10 % less ozone in the upper stratosphere.
2. 2-3 K increase for latitudinal temperature gradient with the maximum increase at the top of TTL.
3. The change in time mean basic state changes the wave-mean flow interaction.
4. The winter Polar vortex in the SH is largely perturbed. Its interannual variability is doubled for August.

What is the next thing we can do with CESM1?

We are implementing Linoz v3.0 into CESM1.

Linoz v3.0 is a linearized chemistry module for stratospheric O3, N2O, NOY and CH4.

What is the sensitivity of the circulation to the increased GHGs such as CH4 and N2O ?

Suggestions and collaboration are more than welcome!

Acknowledgements:

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