Uncertainties in simulating tropical cyclones with dynamical downscaling

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Background

- Impact of global warming on TC activity is still not clear
- Consensus of future projections with dynamical downscaling:

	#TC	Mean intensity
Global	Reduce	Increase
Regional	???	Increase

EX: Downscaling experiments for North Atlantic #TC
23 studies projected increases
11 studies projected decreases

[Knutson et al. 2010]

Question:

What are the sources of uncertainty in simulating #TC?

✓ Inter-model differences

✓ Various configuration within a single model, and how you count simulated #TC

> vi namelist.input

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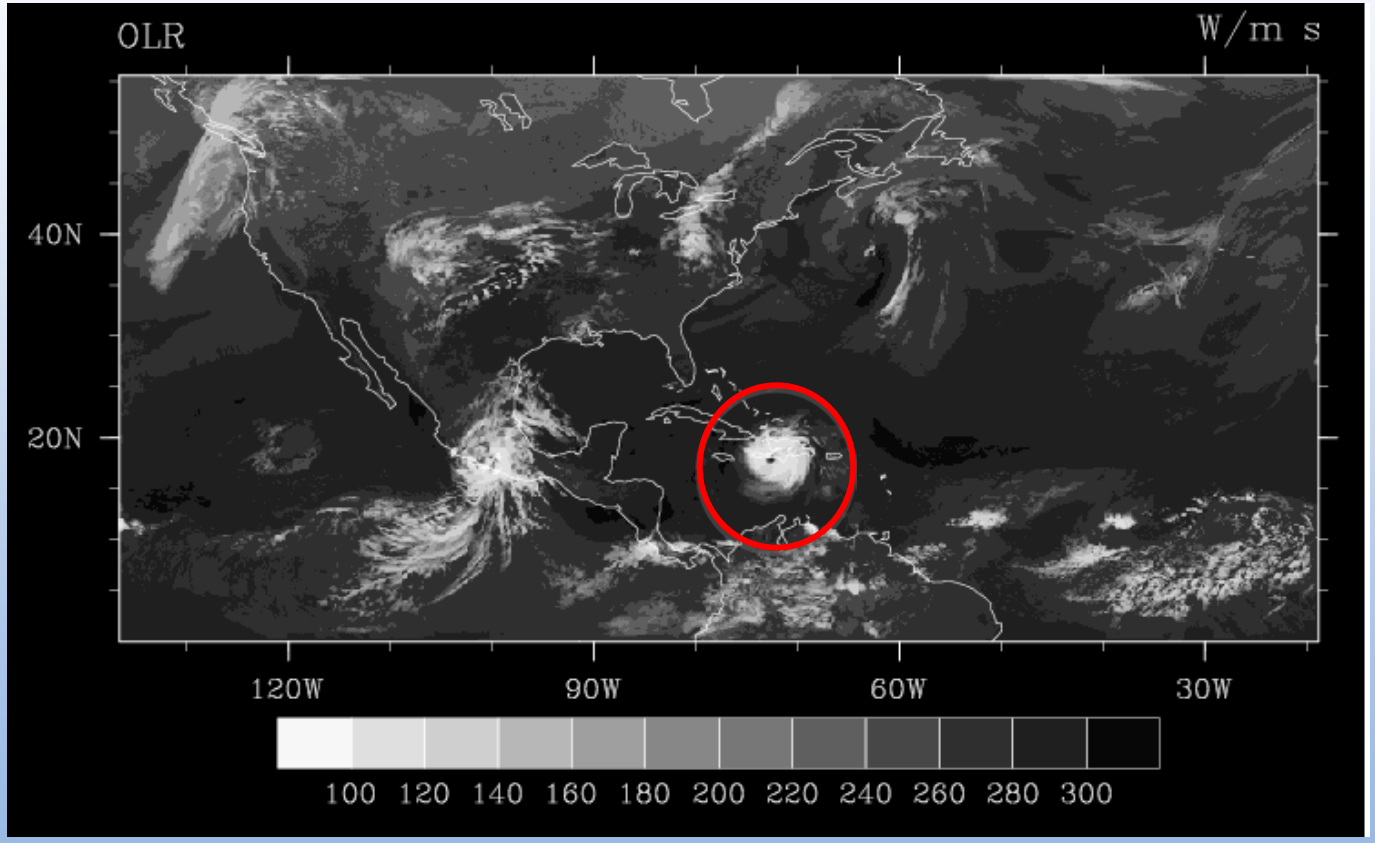
#TC is known to be sensitive to:

- Resolution
- Parameterization
- Boundary location

> ./configure

Please select from among the following supported platforms. 1. Linux i486 i586 i686, gfortran compiler with gcc (serial) 2. Linux i486 i586 i686, gfortran compiler with gcc (smpar) 3. Linux i486 i586 i686, gfortran compiler with gcc (dmpar) 4. Linux i486 i586 i686, gfortran compiler with gcc (dm+sm) 5. Linux i486 i586 i686, g95 compiler with gcc (serial) 6. Linux i486 i586 i686, g95 compiler with gcc (dmpar) 7. Linux i486 i586 i686, PGI compiler with gcc (serial) 8. Linux i486 i586 i686, PGI compiler with gcc (smpar) 9. Linux i486 i586 i686, PGI compiler with gcc (dmpar) 10. Linux i486 i586 i686, PGI compiler with gcc (dm+sm) 11. Linux x86_64 i486 i586 i686, ifort compiler with icc (non-SGI installations) (serial) 12. Linux x86_64 i486 i586 i686, ifort compiler with icc (non-SGI installations) (smpar) 13. Linux x86_64 i486 i586 i686, ifort compiler with icc (non-SGI installations) (dmpar) 14. Linux x86_64 i486 i586 i686, ifort compiler with icc (non-SGI installations) (dm+sm) 15. Linux i486 i586 i686 x86_64, PathScale compiler with pathcc (serial) 16. Linux i486 i586 i686 x86_64, PathScale compiler with pathcc (dmpar

TC detection and tracking



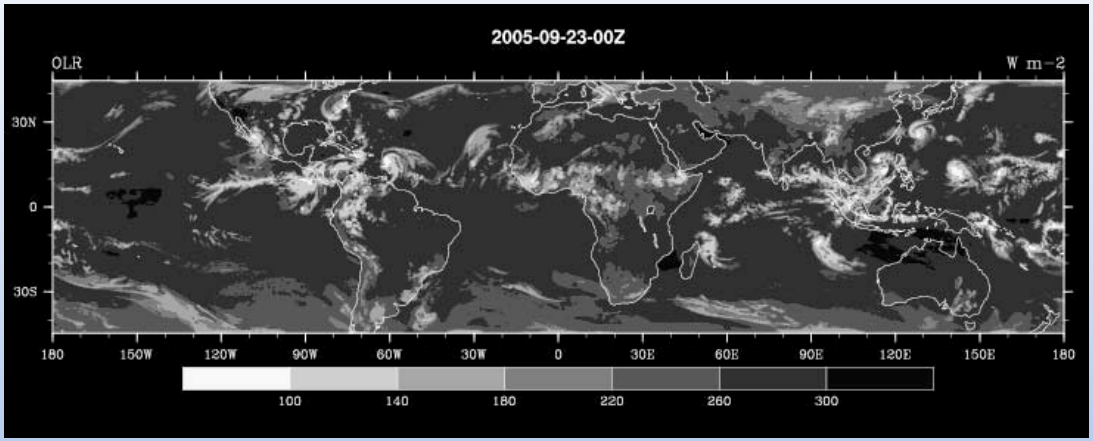
A snapshot of OLR from NRCM

Sensitivity experiment list

- TC tracking scheme
- Boundary location
- Initial condition (start date)
- Computer architecture

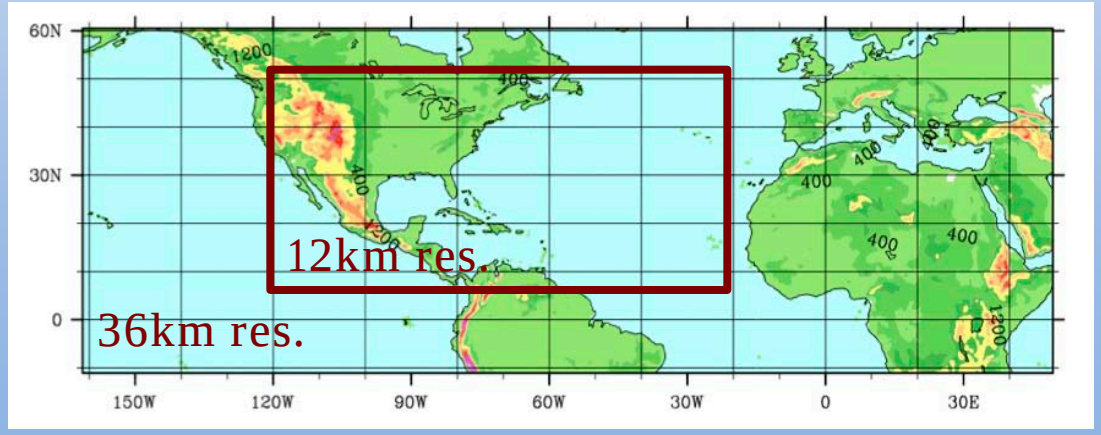
Model setup

Nested Regional Climate Model



TC tracking scheme and boundary location

- tropical channel
- 36km res.
- NCEP/NCAR forcing



Initial condition, and computer architecture

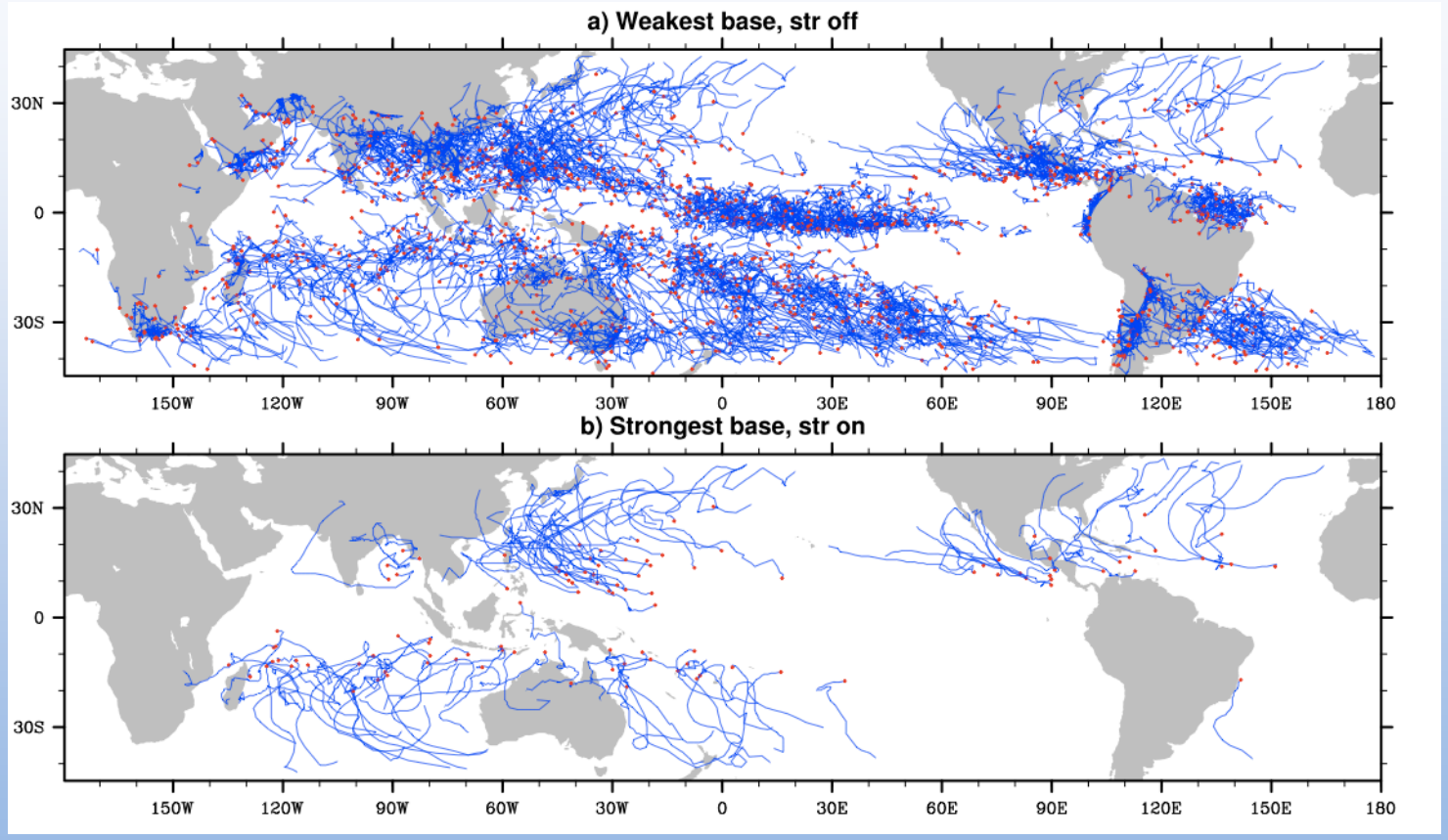
- 12- and 36km res.
- CCSM forcing

TC tracking parameters

- ✓ Pressure minimum or vorticity maximum
- ✓ Maximum wind speed (V)
- ✓ Vorticity
- ✓ Warm core
  - Usually vertical sum or mean of horizontal temperature anomaly (T')
- ✓ Vertical structure
  - V850>V300, T'300>T'850
- ✓ Duration

Vary parameters within the range of commonly used values in downscaling experiments

Sensitivity to TC tracking scheme

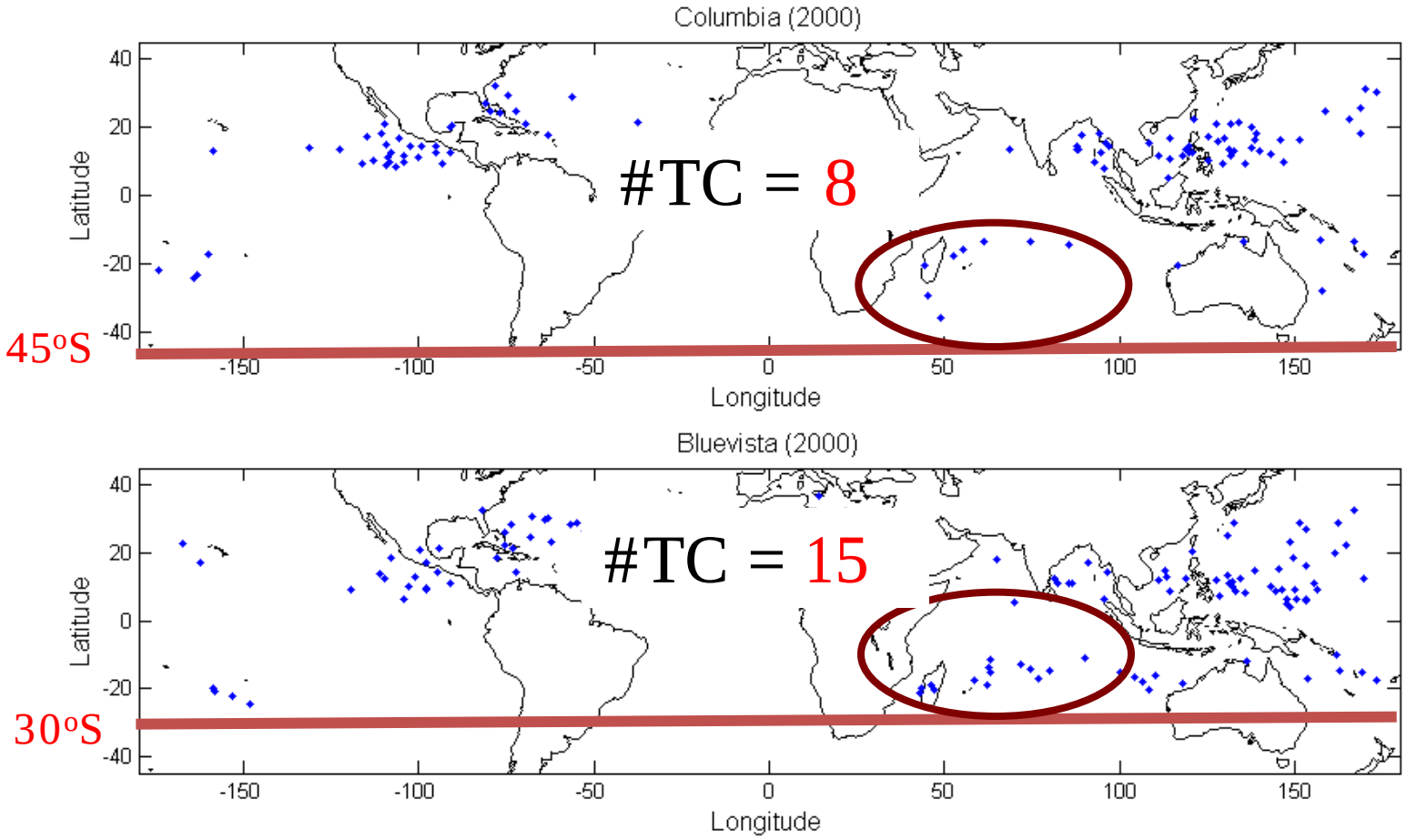


Least strict
1467 tracks
per year

Most strict
106 tracks
per year

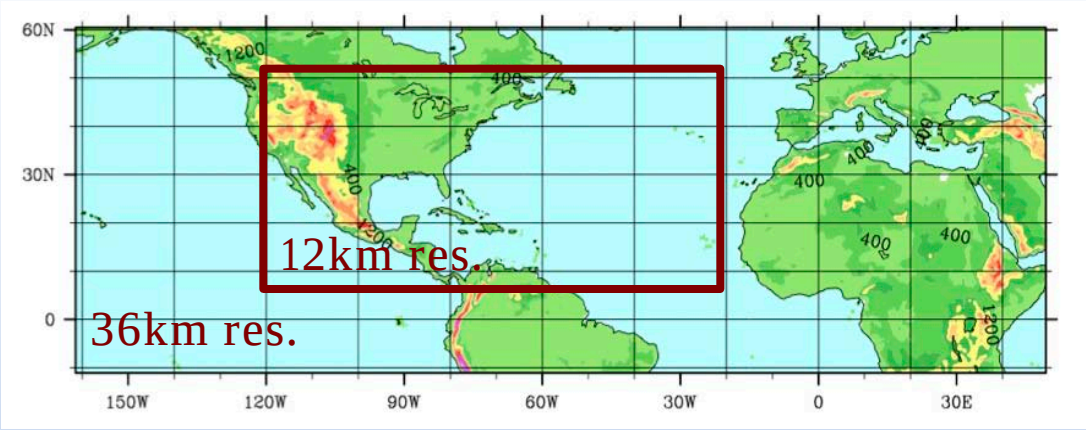
#TC is highly sensitive to TC tracking scheme, especially to wind speed and duration parameters

Sensitivity to boundary location

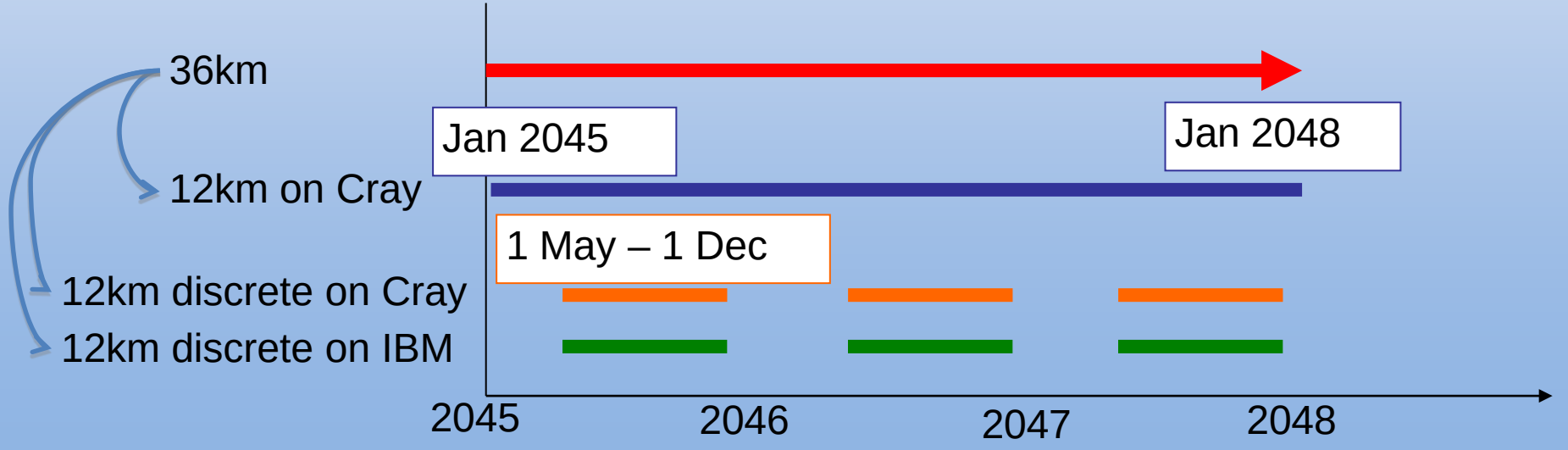


Simulated #TC is sensitive to boundary location*

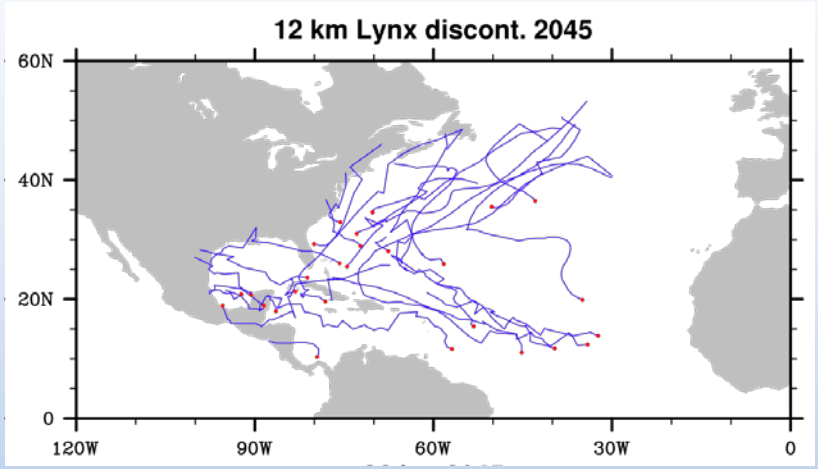
CCSM downscaling simulations



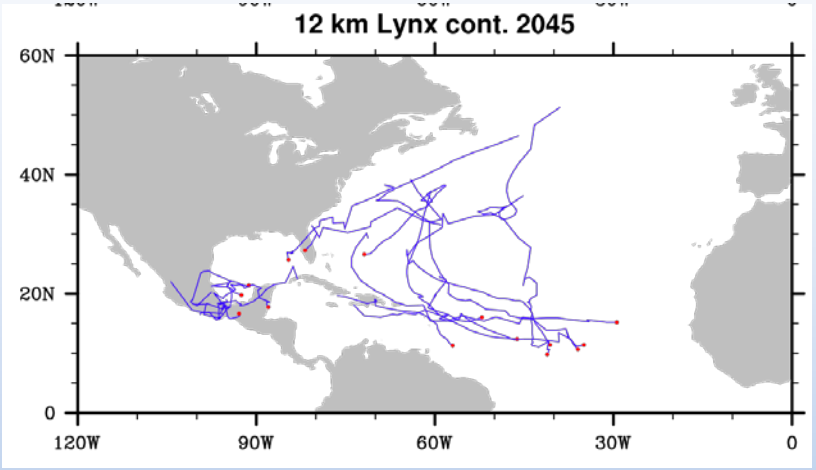
BC/IC from CCSM



Sensitivity to initial condition



Start date: 1-May-2045
#TC = 27

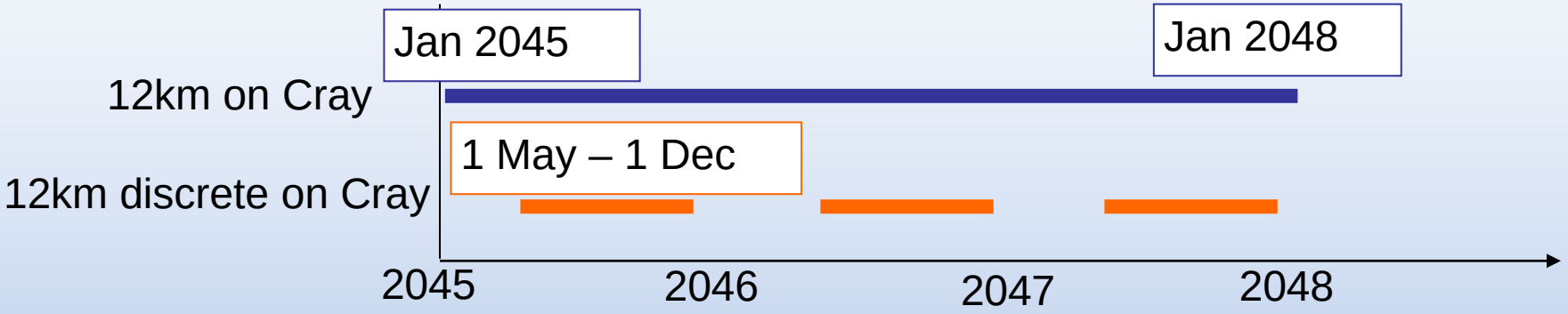


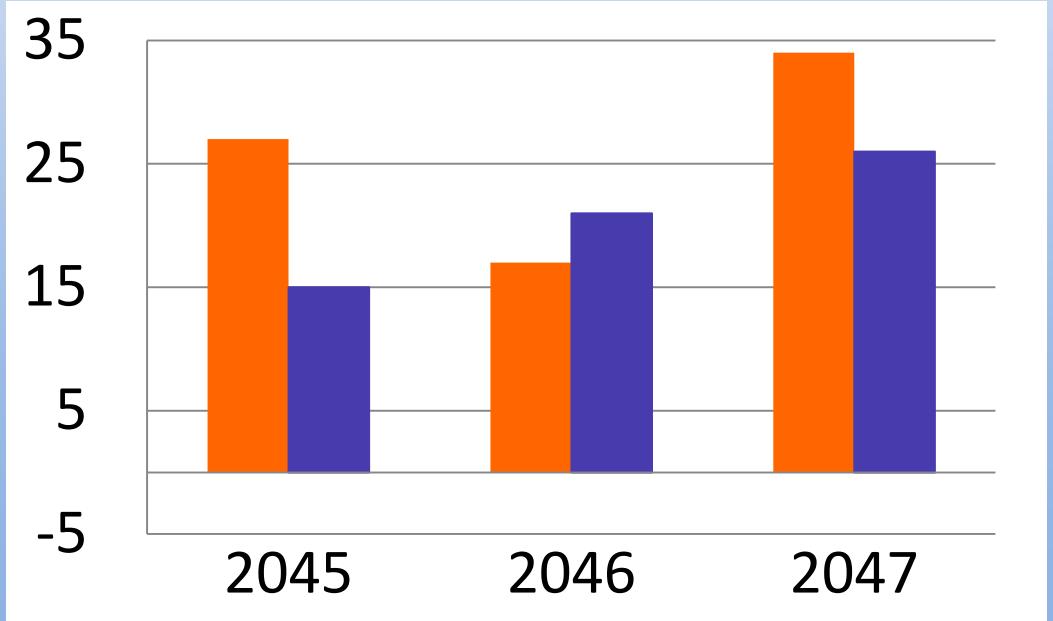
Start date: 1-Jan-2045
#TC = 15

<u>Additional ensemble experiments</u>
10 members, vary initial date by 10 days apart
→ 13 to 20 TCs per season

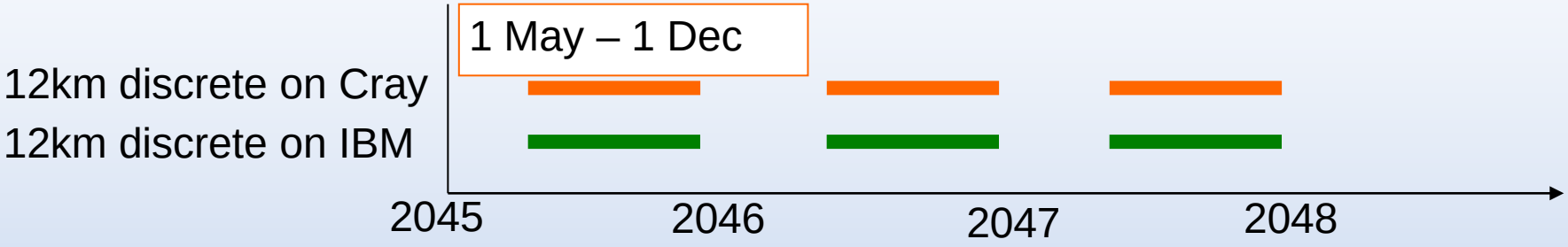
#TC and genesis locations can be altered by changing initial condition

Sensitivity to initial condition interannual variability

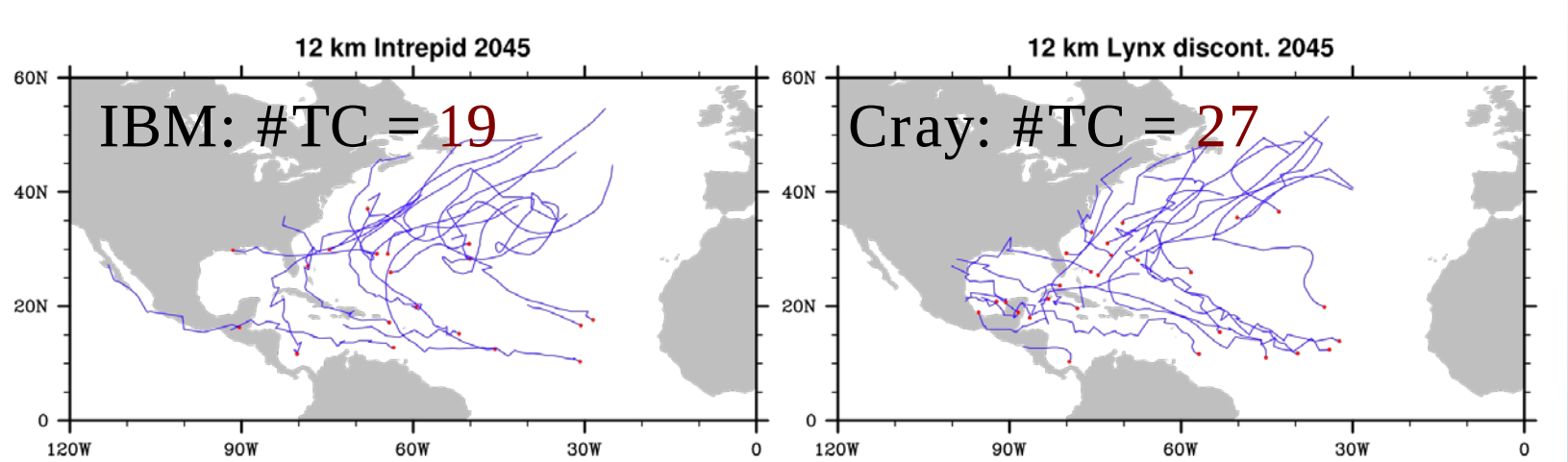


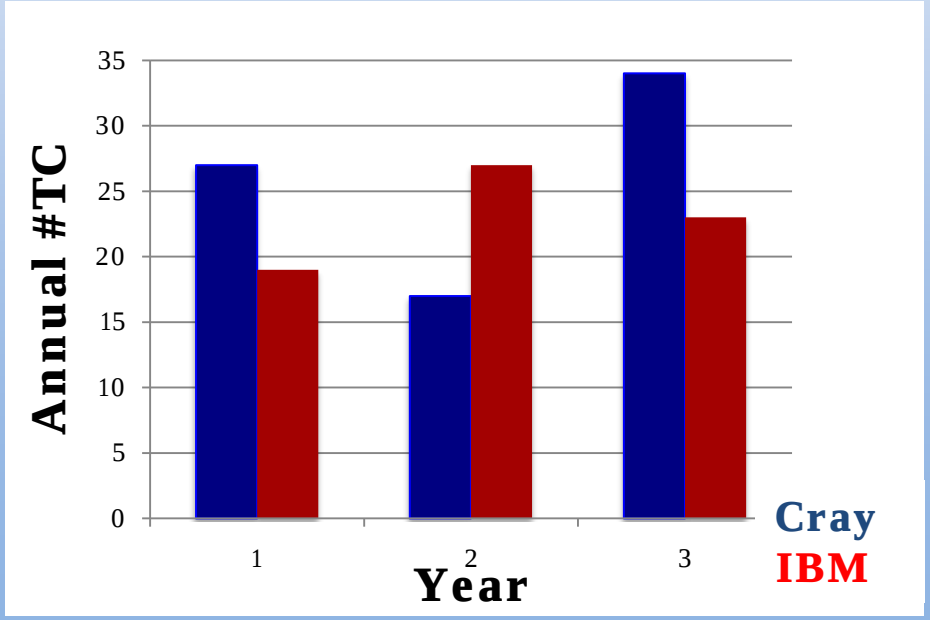


Computer architecture



Computer architecture





Simulated #TC and tracks are sensitive to computer architecture, interannual variability is not conserved

Summary

Simulated #TC is sensitive to:

- TC tracking scheme
- Boundary location
- Initial condition (start date)
- Computer architecture

How do these uncertainties affect future projection?