# Adjoint CS510 high-resolution cubed sphere

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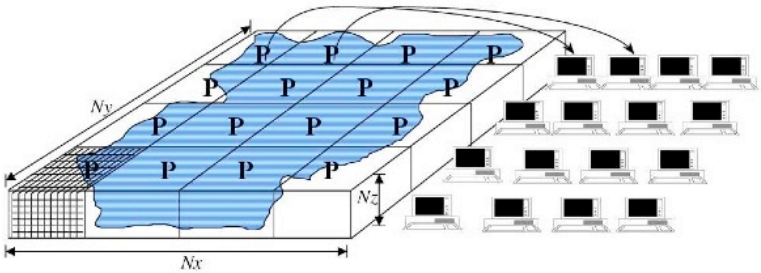
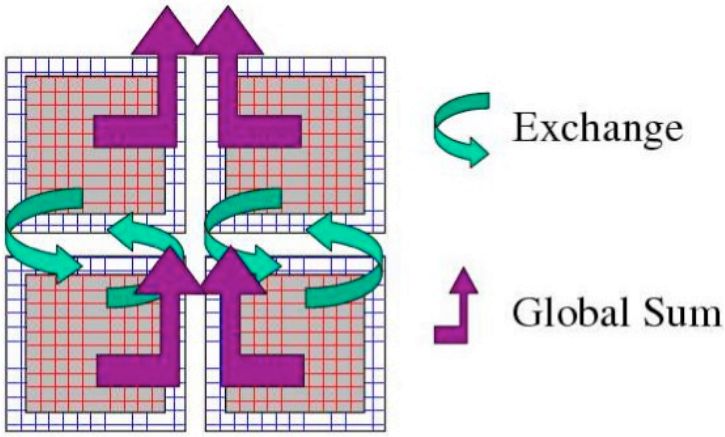
# ECCO-GODAE's contribution to ECCO2

- Proposal, section 4.2.2:
  - "*1. Cubed-sphere adjoint: Development of cubed-sphere adjoint will first take place on a global, coarse-resolution setup that includes Arctic Ocean and sea-ice. Each face of the cube comprises 32 by 32 grid cells, …* "
  - "*2. Exact high-resolution adjoint: The full high-resolution adjoint will be attempted for the global, 18-km cubed-sphere configuration and for two regional application, one in the North-Atlantic and one in the Southern Ocean.* "
  - "*3. …* "

# The issue:
# The parallel WRAPPER adjoint

- domain decomposition (tiles) & overlaps (halos)
- split into extensive on-processor and global phase

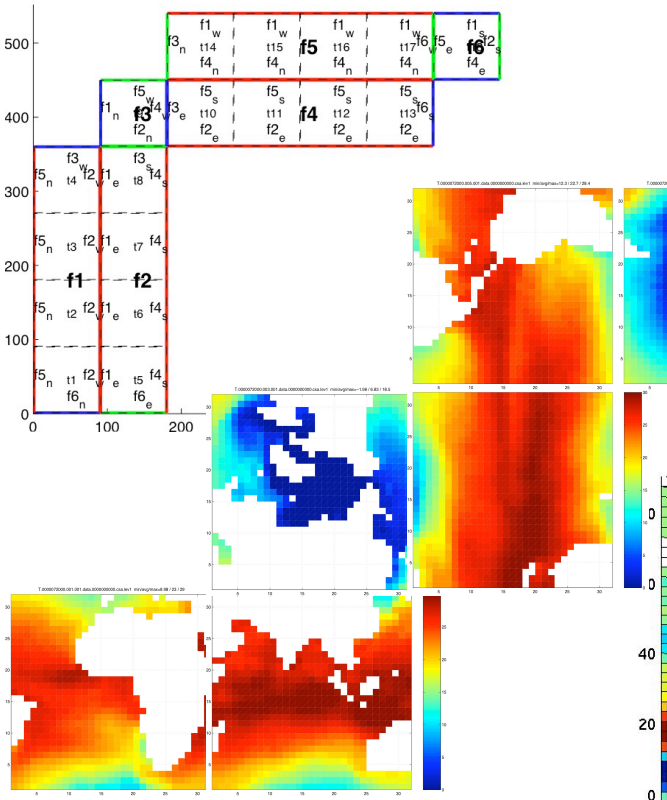


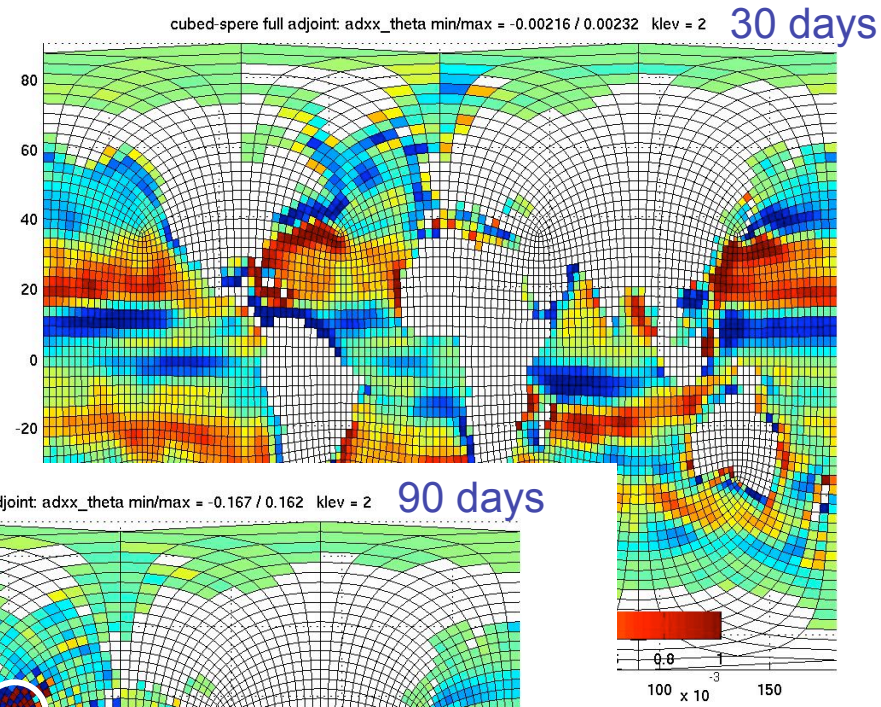



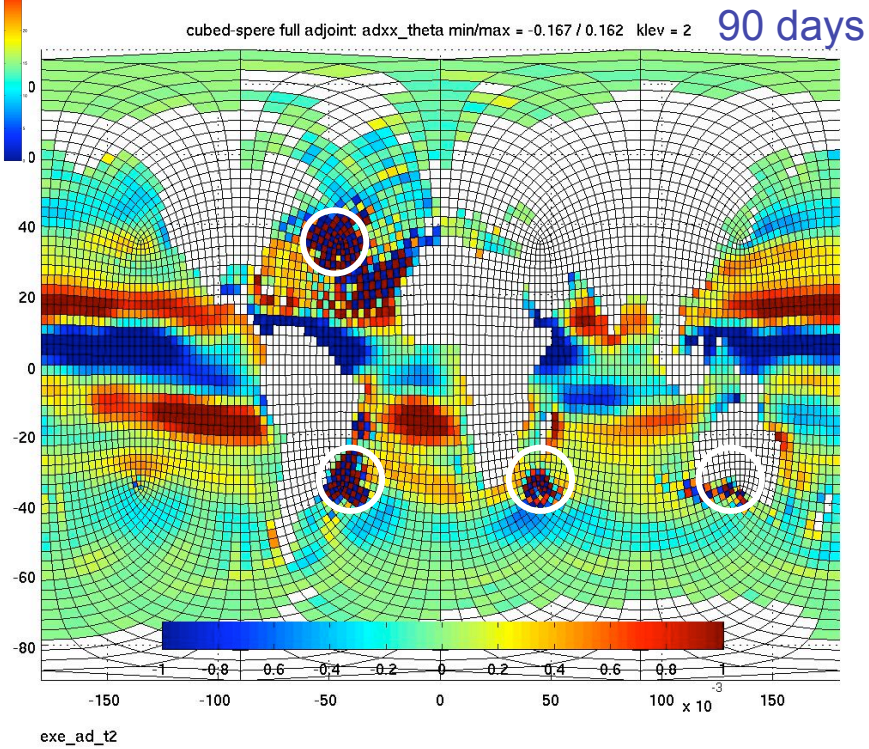

Global communication/arithmetic op.'s supported by MITgcm's intermediate layer (WRAPPER) which need hand-written adjoint forms

| | operation/primitive | forward | | reverse |
|---|---|---|---|---|
| • | communication (MPI,...): | send | $\longleftrightarrow$ | receive |
| • | arithmetic (global sum,...): | gather | $\longleftrightarrow$ | scatter |
| • | active parallel I/O: | read | $\longleftrightarrow$ | write |

# Adjoint of the EXCH2 cubed-sphere topology
# *Almost* there (I had thought)



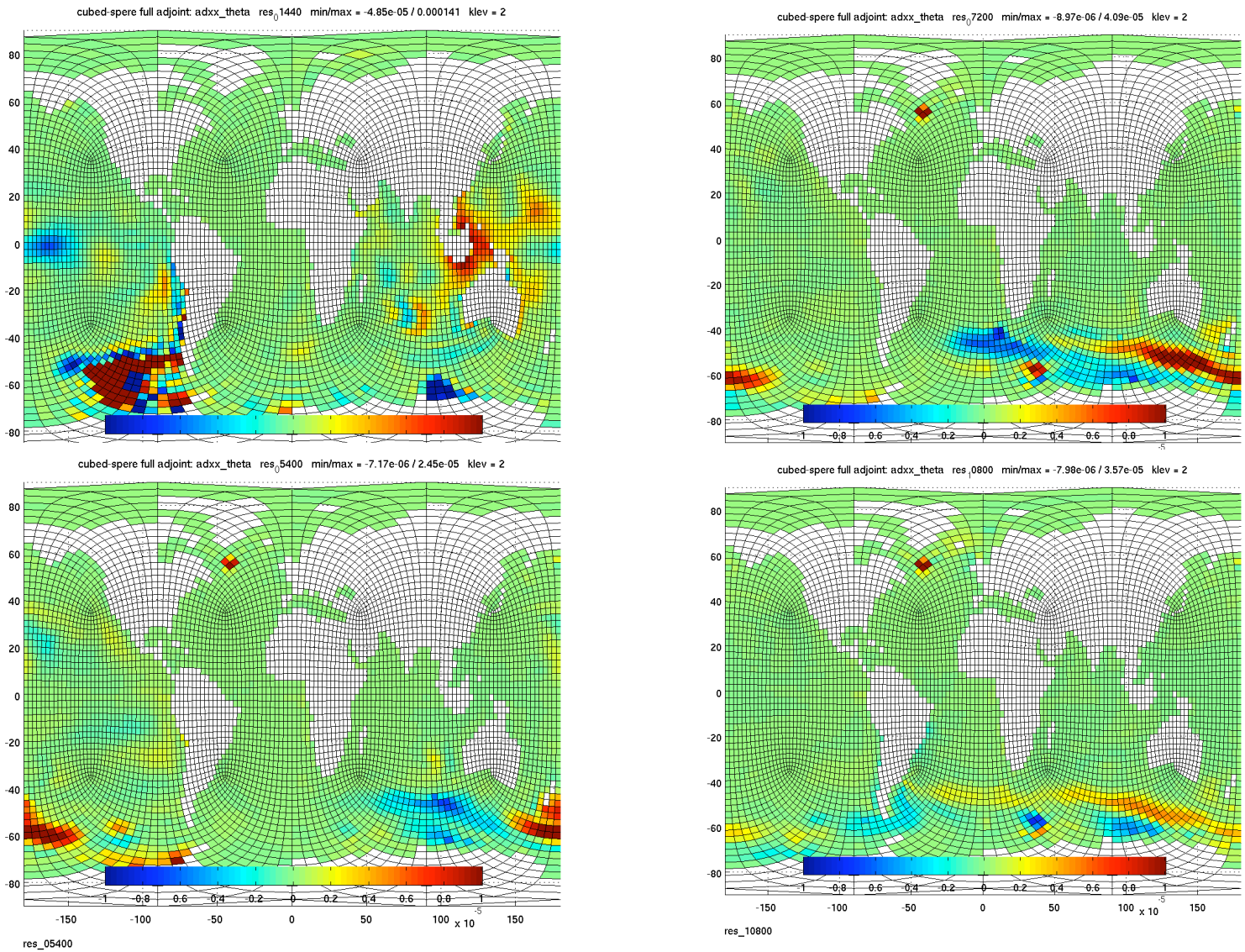




**4-processor MPI setup**

***Giering & Heimbach***

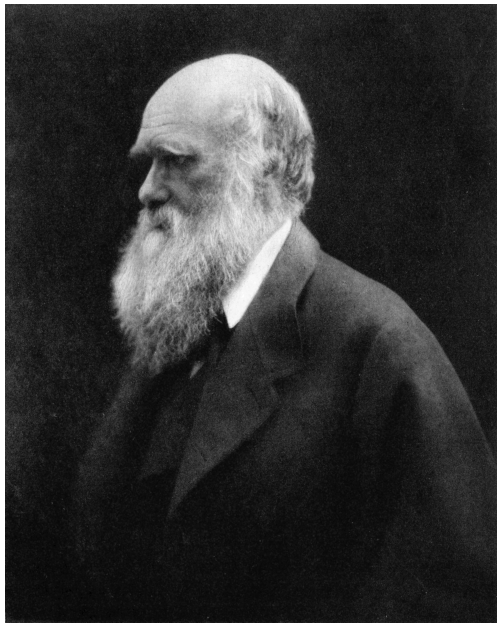
# BUT: Checkerboard instabilities were artifacts of horizontal tracer mixing bug

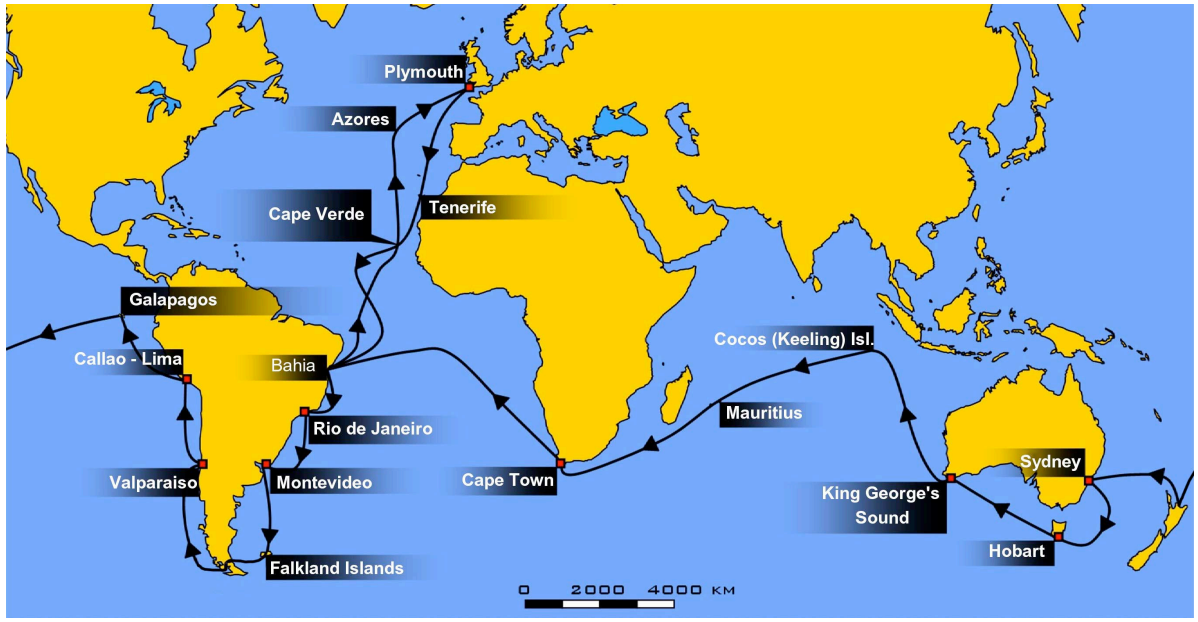
## E.g.: Drake Passage transport sensitivity on CS32



# The ECCO2 CS510 adjoint

- **Big** thanks for access to MIT-Darwinproject's ***Beagle*** for testing purposes

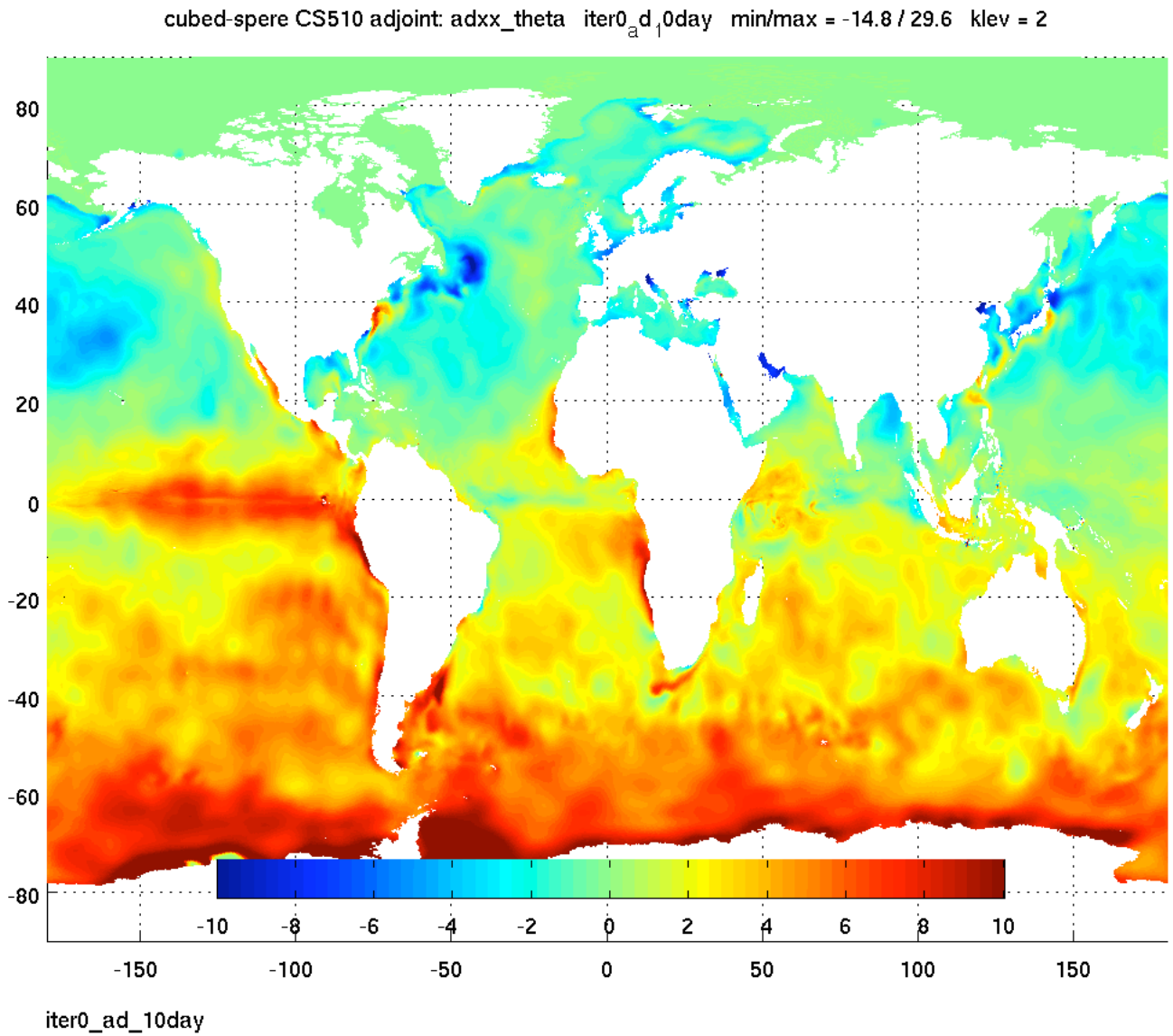





- ***Beagle*** is running very first CS510 adjoint state estimation config. on 360 processors

  (really at the lower config. limit)
- Cost is misfit to monthly climatology

# The ECCO2 CS510 adjoint: Initial temperature gradient at z = 15 m




- Cost function is misfit to monthly climatology
- 10-day run, with 1200 sec timestep
- On 360 procs (3.5 hours), nchklev_1 = 2