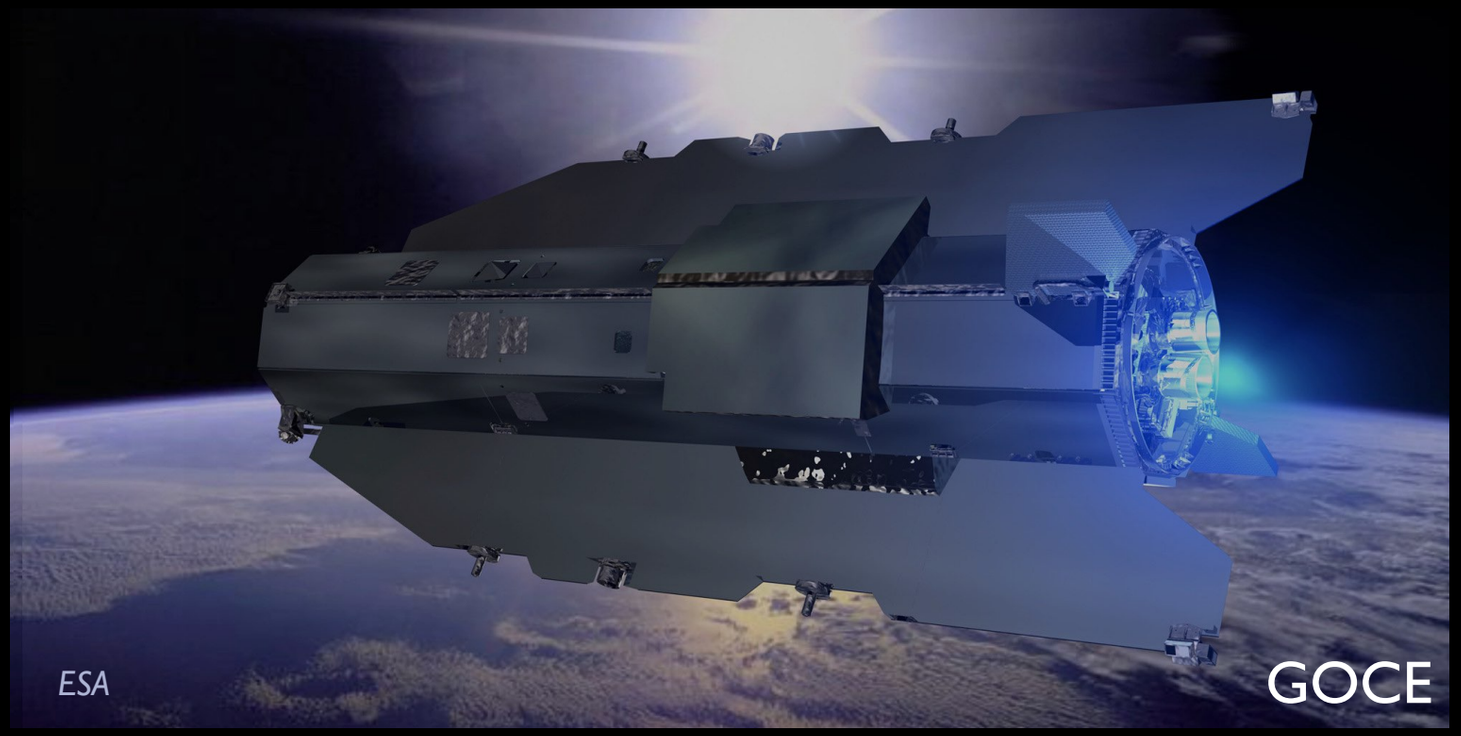
Evidence of tropospheric 90-day oscillations in the thermosphere

Federico Gasperini and Maura E. Hagan

gasperini@usu.edu

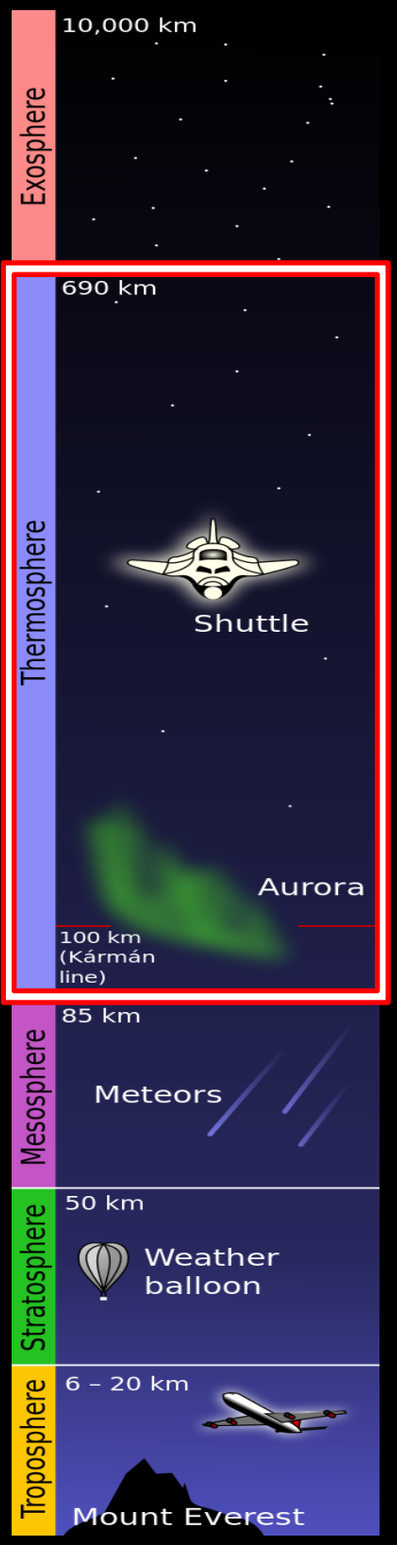
UtahStateUniversity



*Gasperini et al. [2017], Evidence of tropospheric 90-day oscillations in the thermosphere, Geophys. Res. Lett., 2017GL074461 (submitted)

CONTENTS

How does terrestrial weather influence space weather?



How does terrestrial weather influence space weather?

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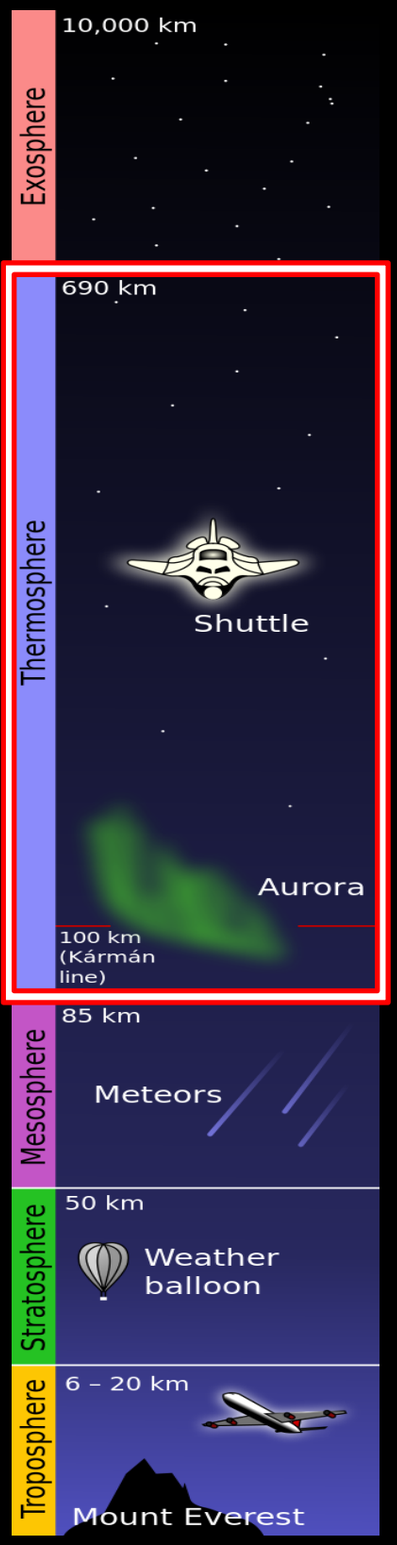

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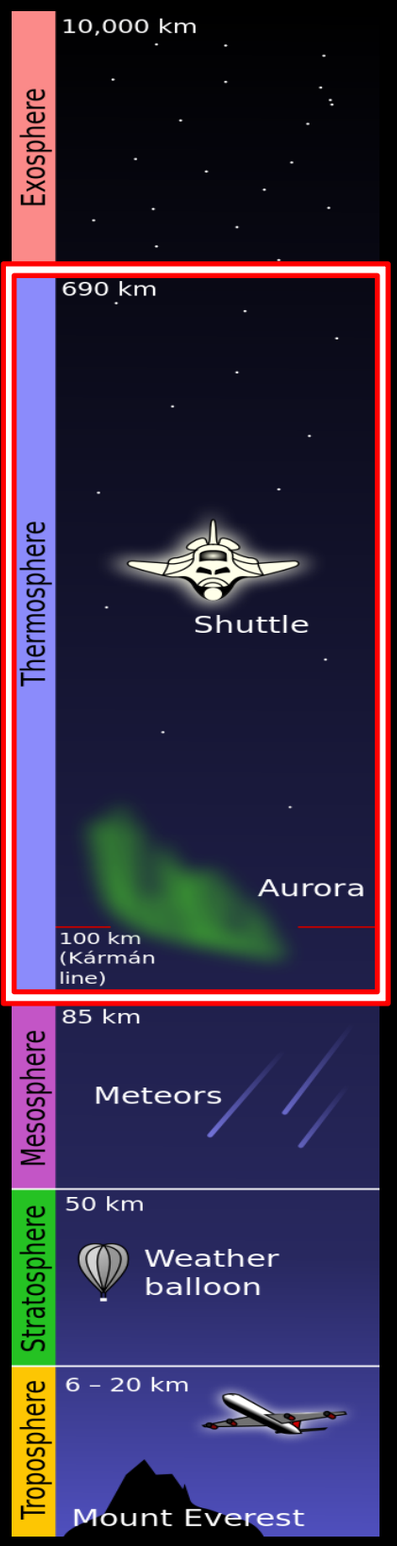

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Dissipation of Upward Propagating Waves

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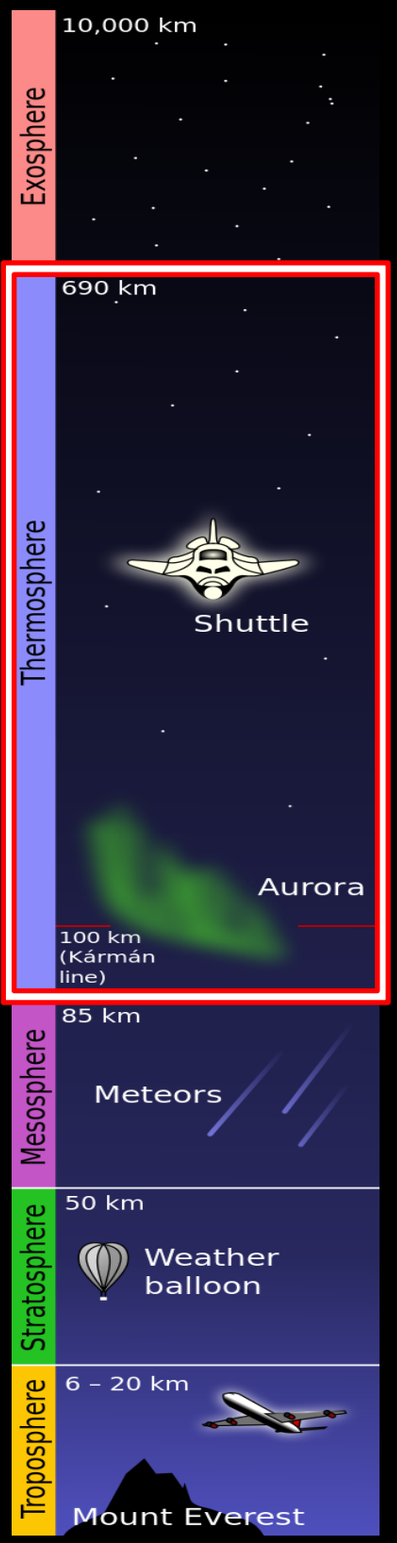
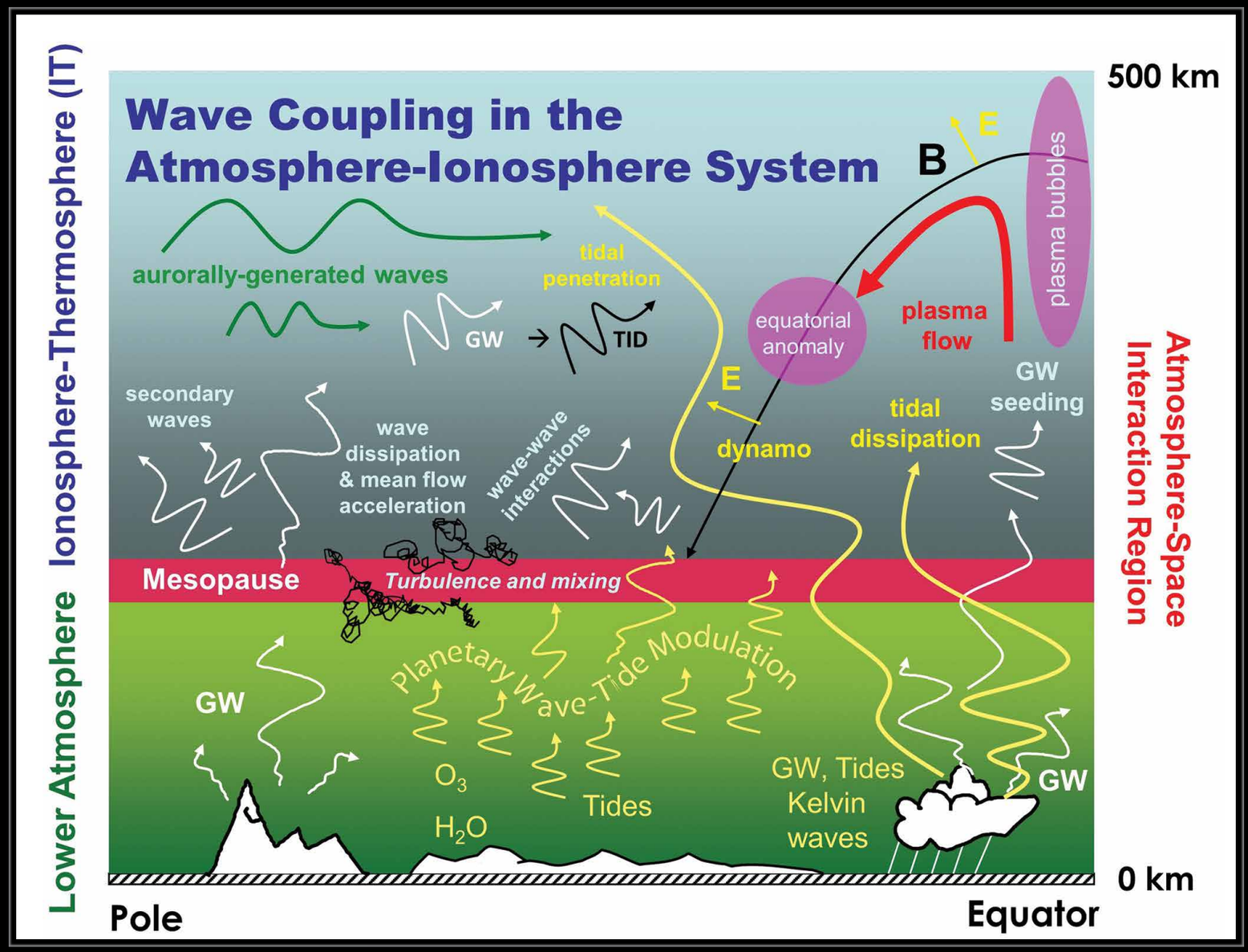




Solar and Space Physics Decadal Survey, National Academy of Sciences, 2012.

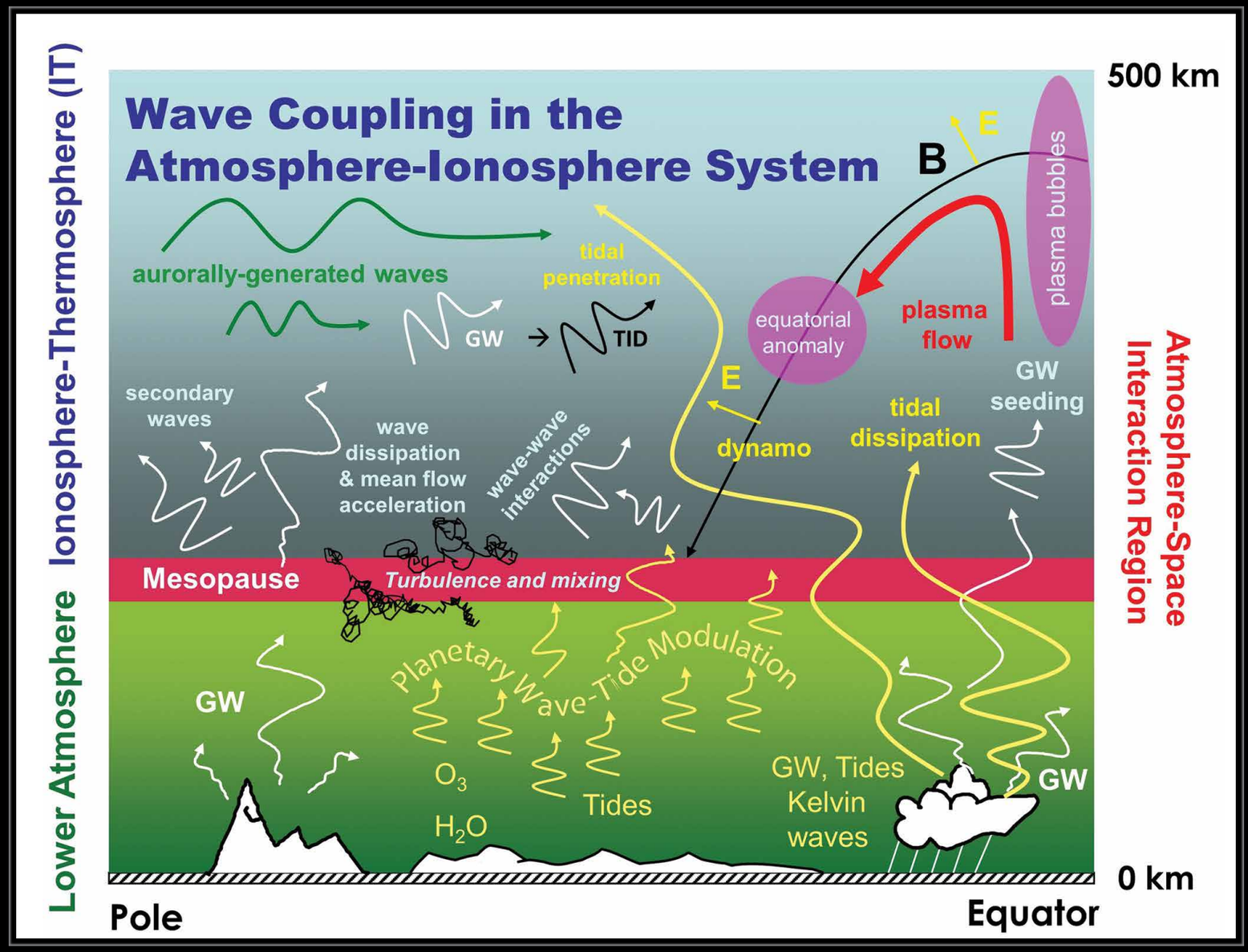
Dissipation of Upward Propagating Waves

Sources from BELOW

How does terrestrial weather influence space weather?

Lower Atmosphere Effects on Space Weather

- **Electron density variability —** affects HF radio communications, satellite navigation and communications.
- **Neutral density variability —** affects satellite drag, causing uncertainties in orbital and reentry predictions.



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Dissipation of Upward Propagating Waves

Sources from BELOW

DE3

i.e. Diurnal Eastward propagating wavenumber 3 tide

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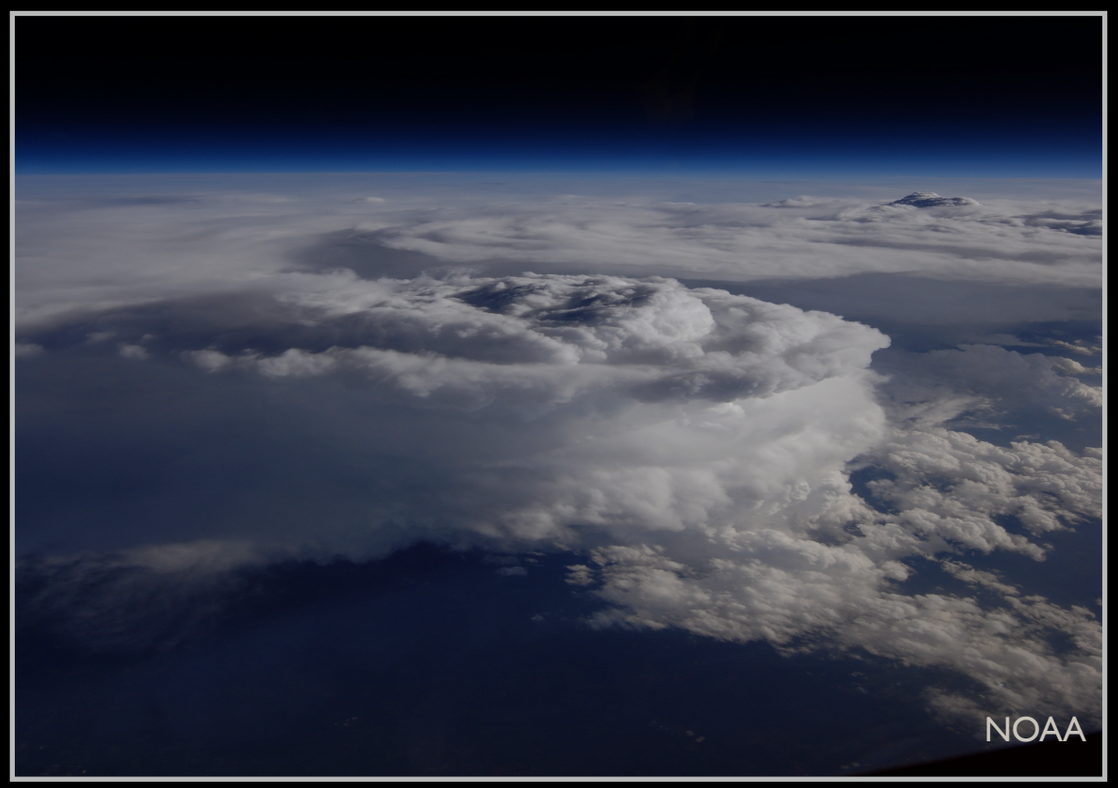
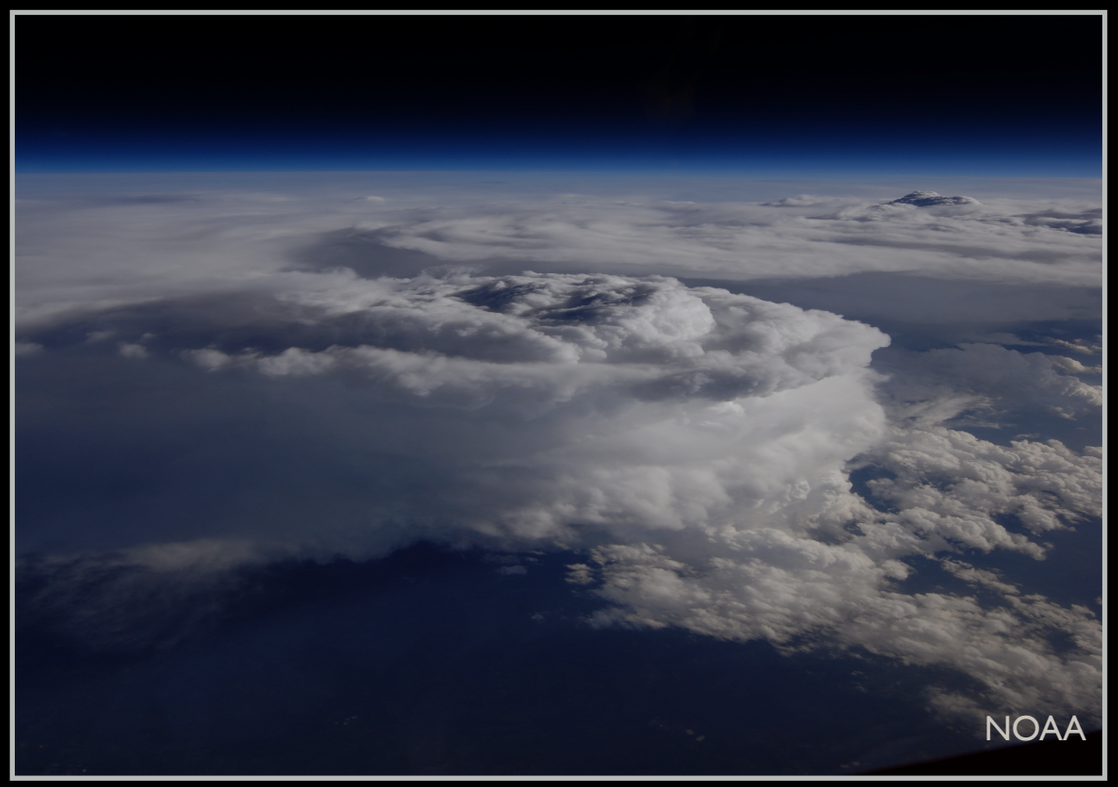
- Excited in the tropical troposphere by latent heat release in deep convective clouds.



DE3

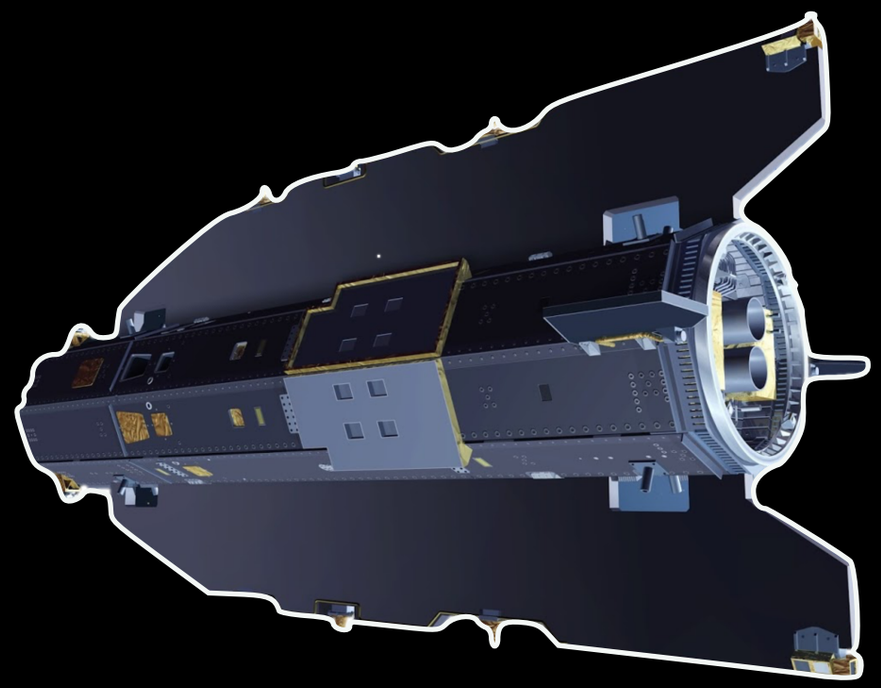
i.e. Diurnal Eastward propagating wavenumber 3 tide

- Excited in the tropical troposphere by latent heat release in deep convective clouds.
- Large source of variability in the thermosphere and ionosphere.



GOCE

Gravity Field and Steady-State Ocean Circulation Explorer



LIFETIME	Mar 09 – Nov 13
ORBIT	near-circular 260 km dawn-dusk with *i*=96.7° (sun-synchronous)
COVERAGE	Global
DATA	**C**ross-track (east-west) winds from accelerometer, ion thruster, and star camera data

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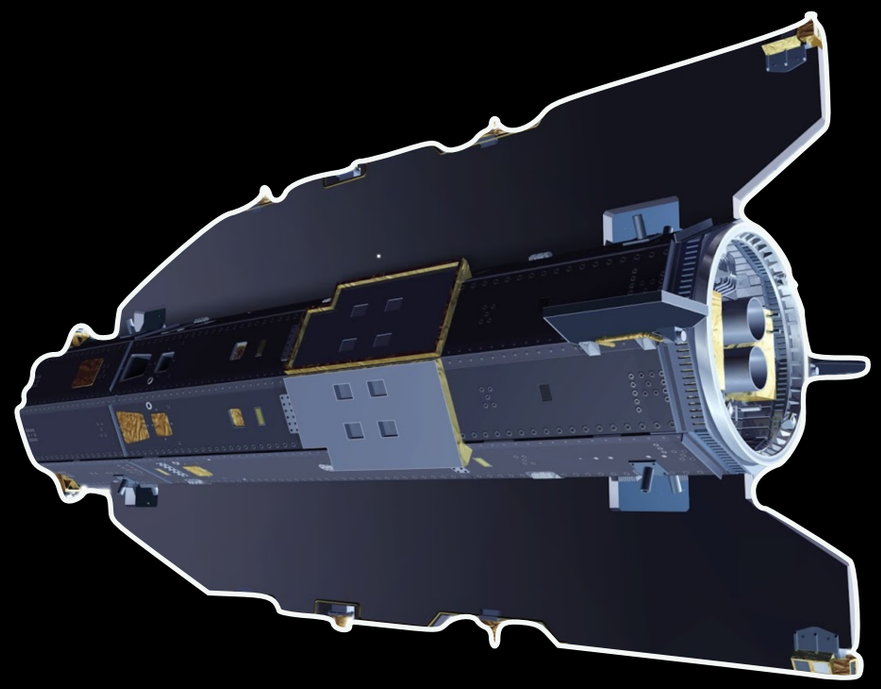
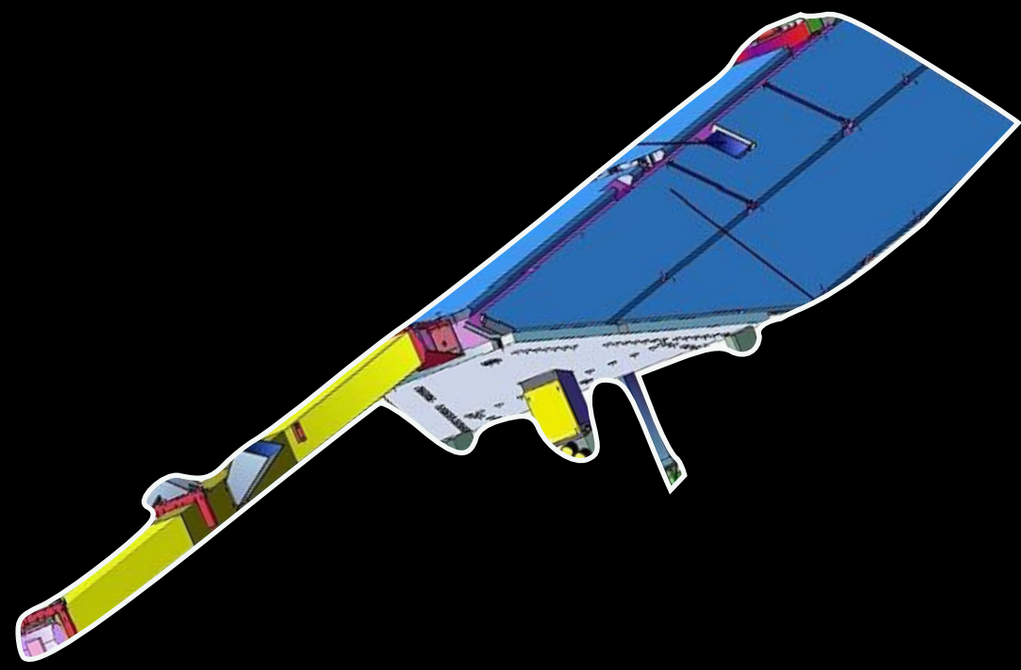


CHAMP

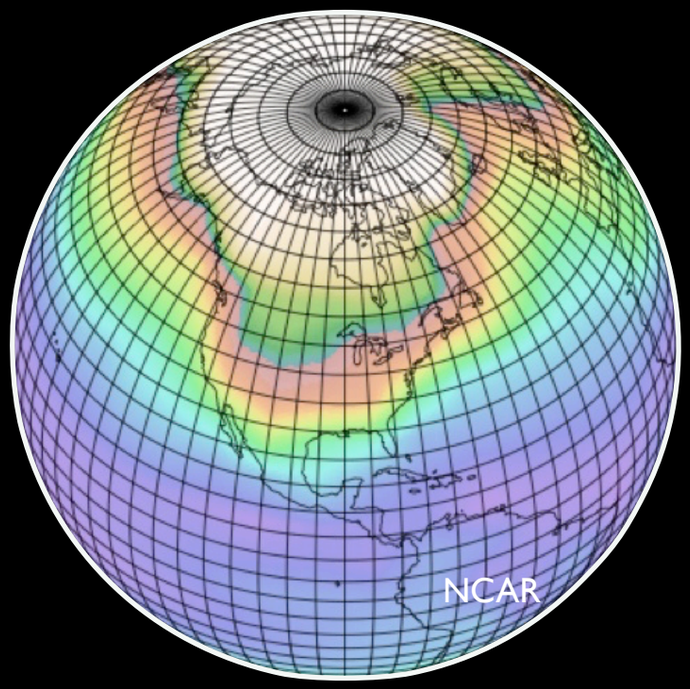
CHAllenging Minisatellite Payload



LIFETIME	Mar 09 – Nov 13	Jul 00 – Sept 10
ORBIT	near-circular 260 km dawn-dusk with *i*=96.7° (sun-synchronous)	near-circular 450-300 km with *i*=87° (slowly precessing)
COVERAGE	Global	±87° latitude
DATA	**C**ross-track (east-west) winds from accelerometer, ion thruster, and star camera data	**C**ross-track (east-west) winds from accelerometer data

TIME-GCM

Thermosphere Ionosphere Mesosphere Electrodynamics
General Circulation Model



- Global time-dependent model developed by NCAR.
- F10.7 and Kp indices are used to represent solar radiative and high-latitude forcing.
- Grid: 2.5°x2.5°, 4 points vertical (~30-500 km), 1-min time step.
- Lower boundary set with MERRA reanalysis data that provides realistic wave forcing.
- Field: zonal wind for 2009-2010.

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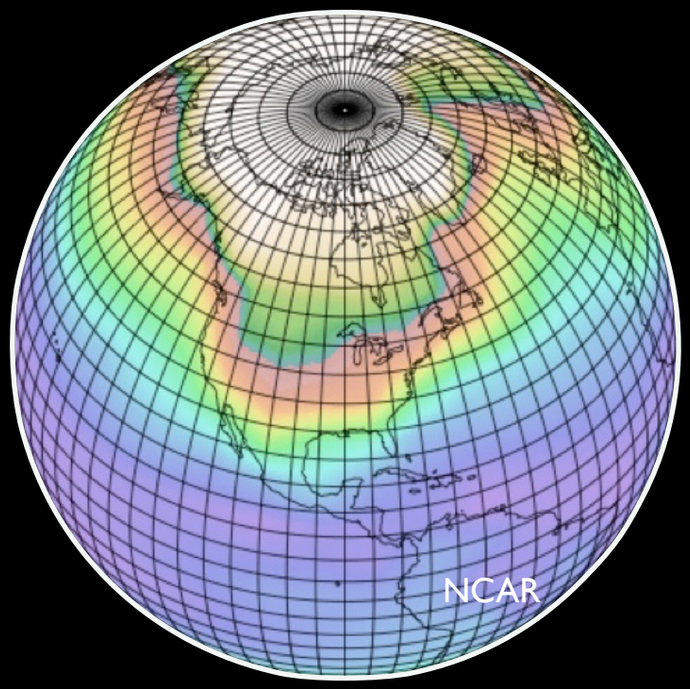

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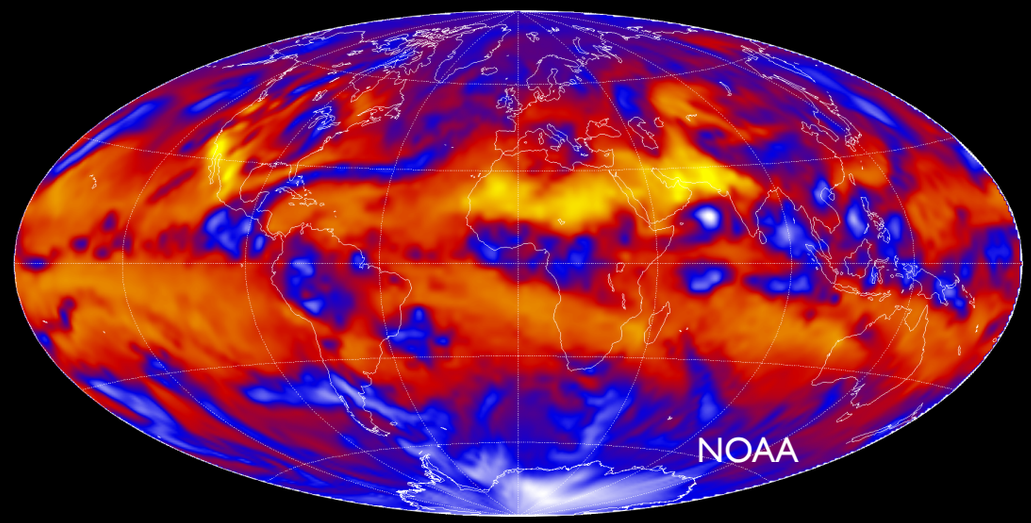
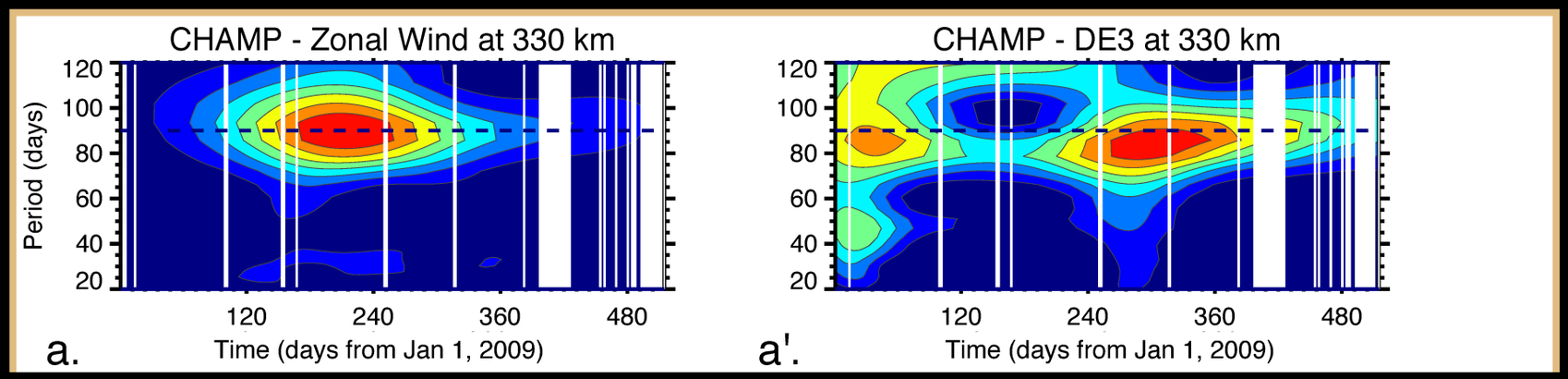
OLR

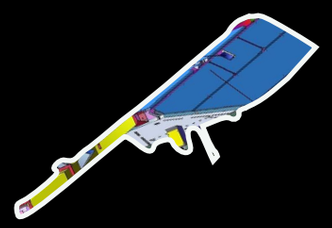
Outgoing Longwave Radiation



- Infrared radiation emitted from Earth and its atmosphere to space.
- Measured by radiometers onboard NOAA's polar orbiting satellites.
- Serves as proxy for tropospheric convection, because convective cloud tops are cold and thus emit little long-wave radiation.

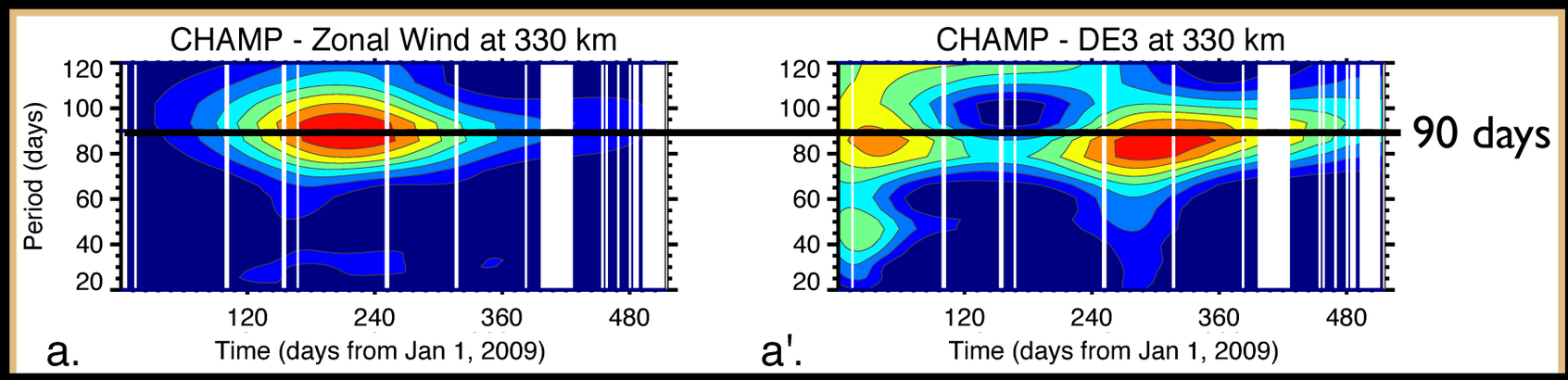
90-day oscillations in the thermosphere

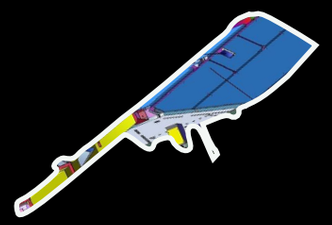




330 km

90-day oscillations in the thermosphere





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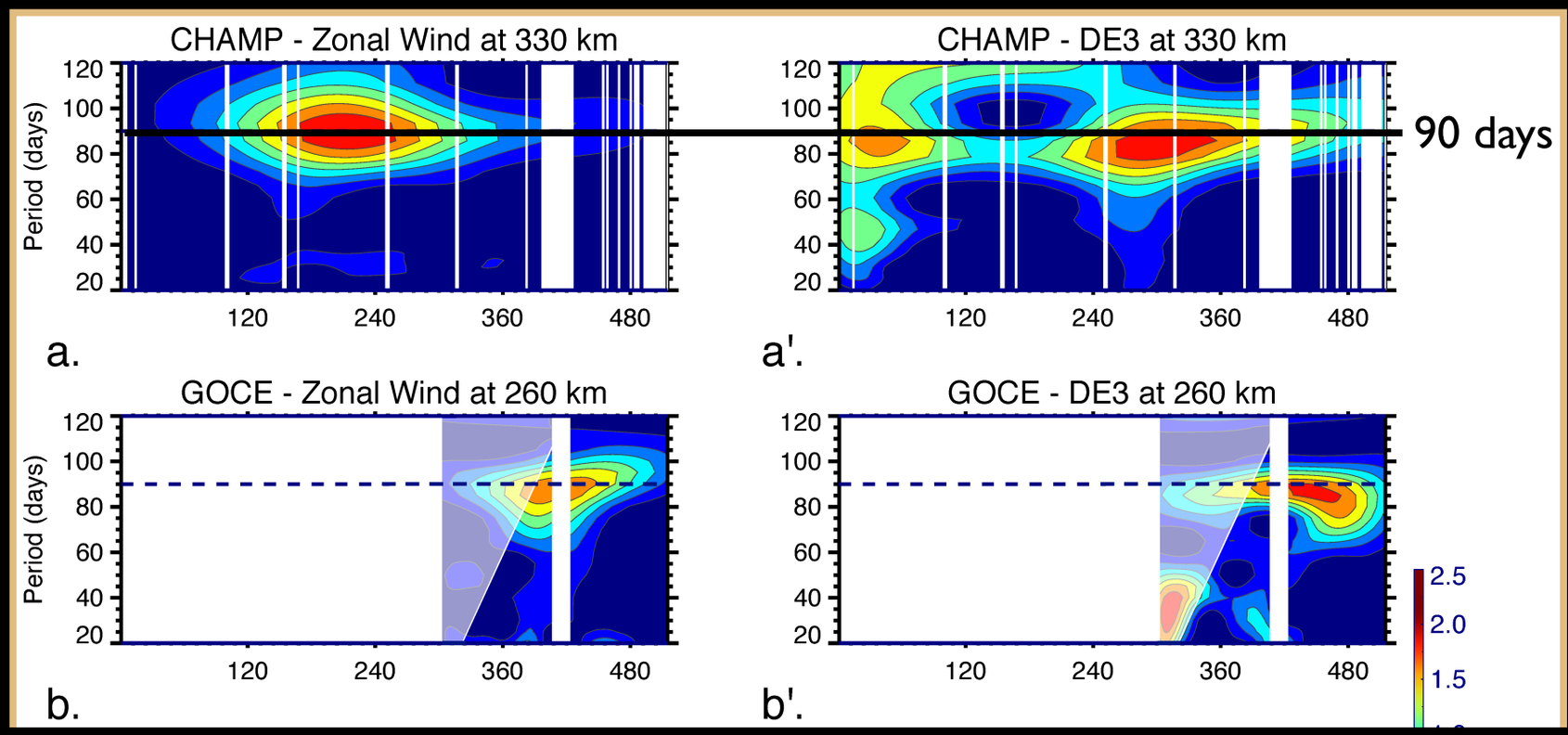

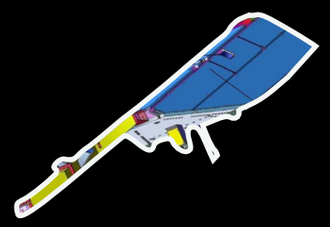

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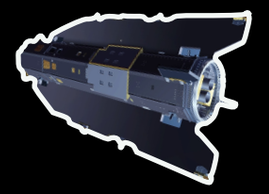
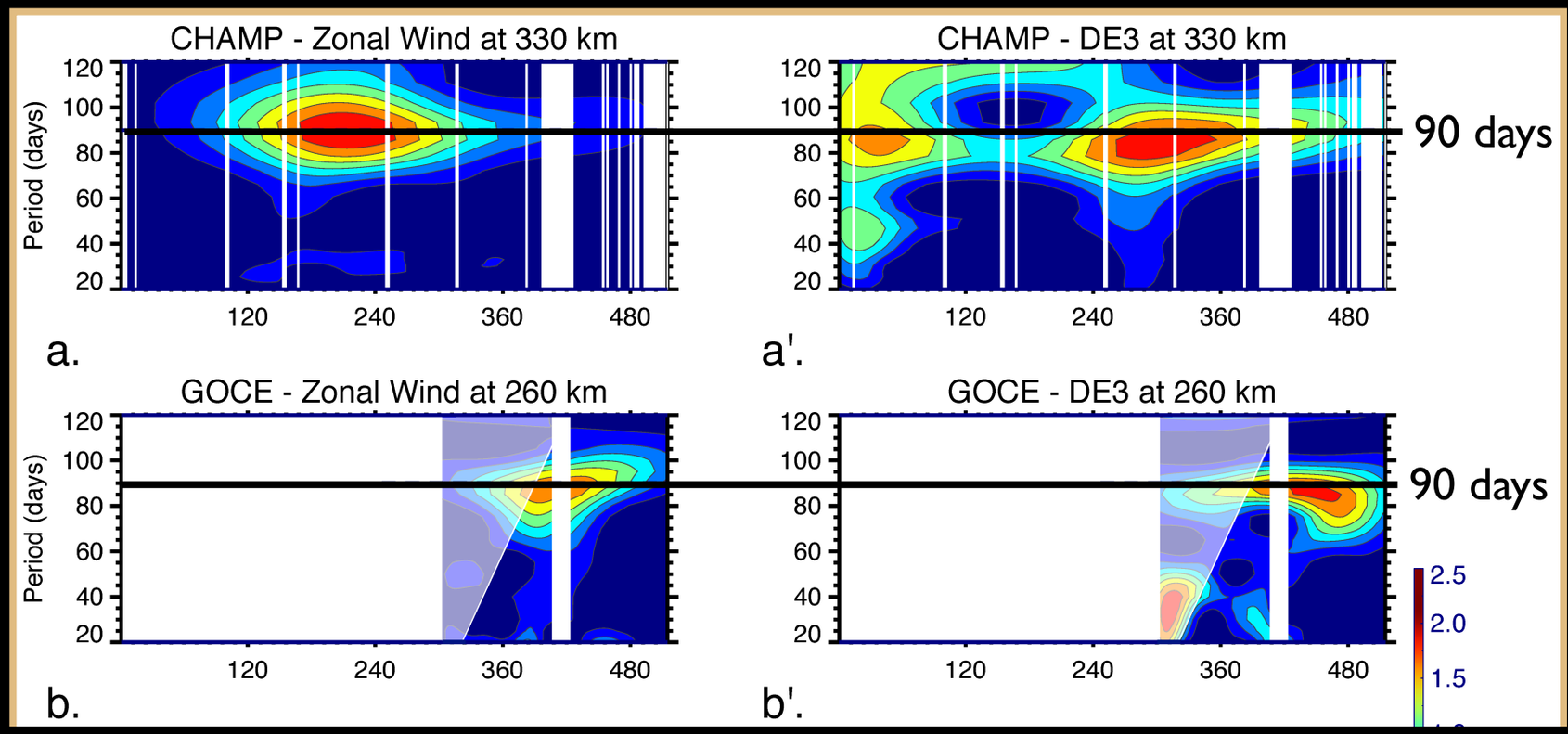
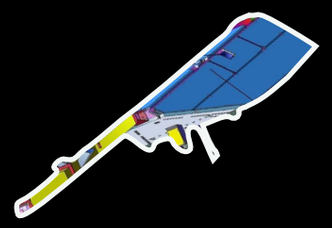


260 km

90-day oscillations in the thermosphere





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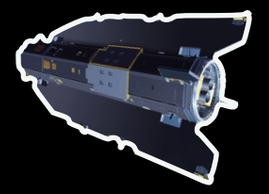

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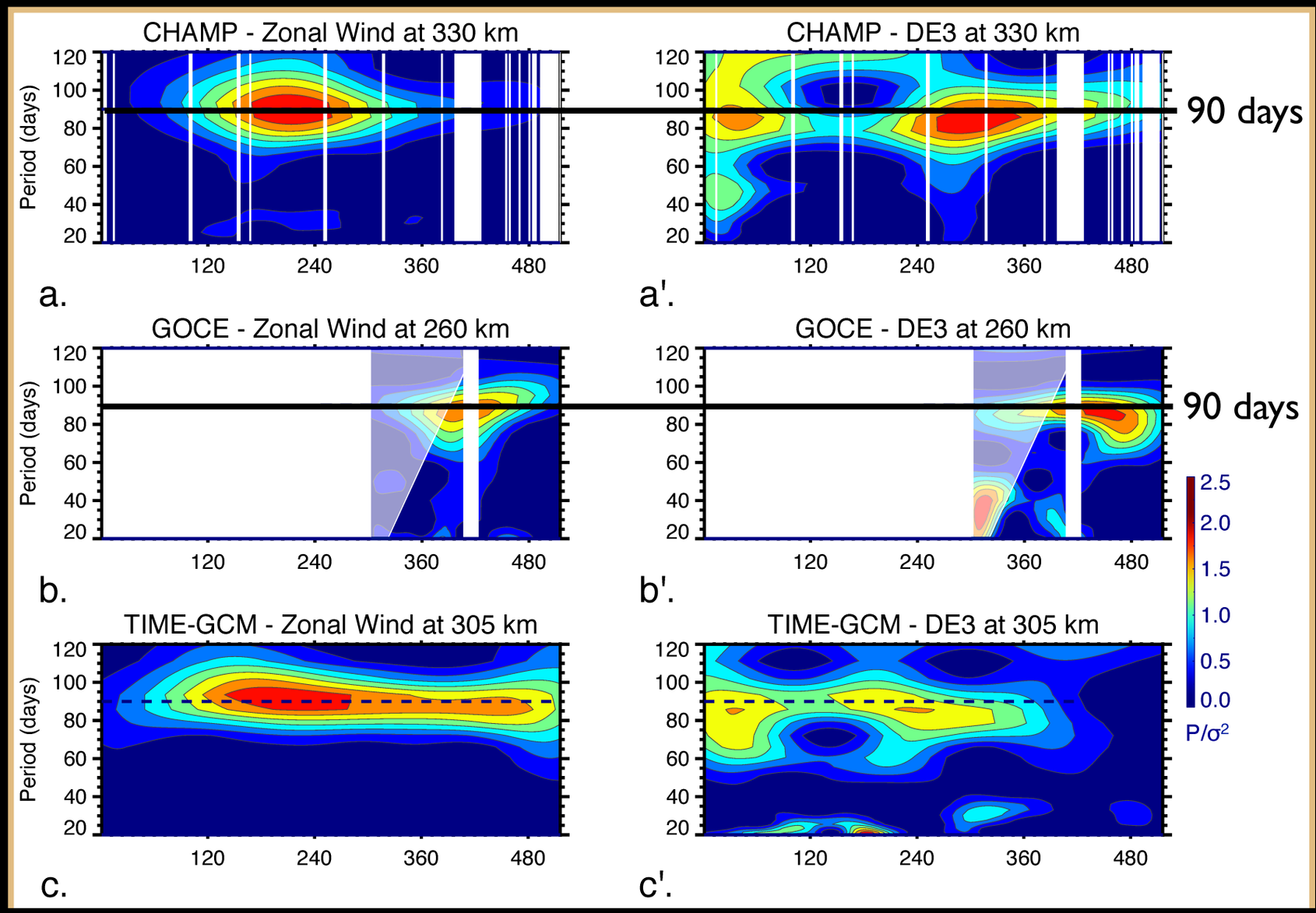

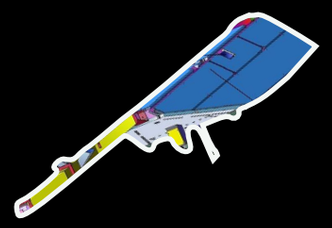

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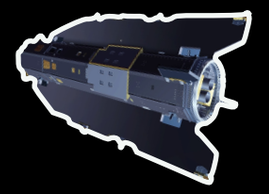

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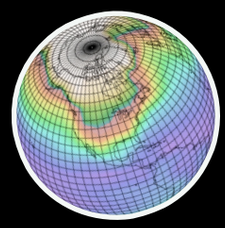

305 km

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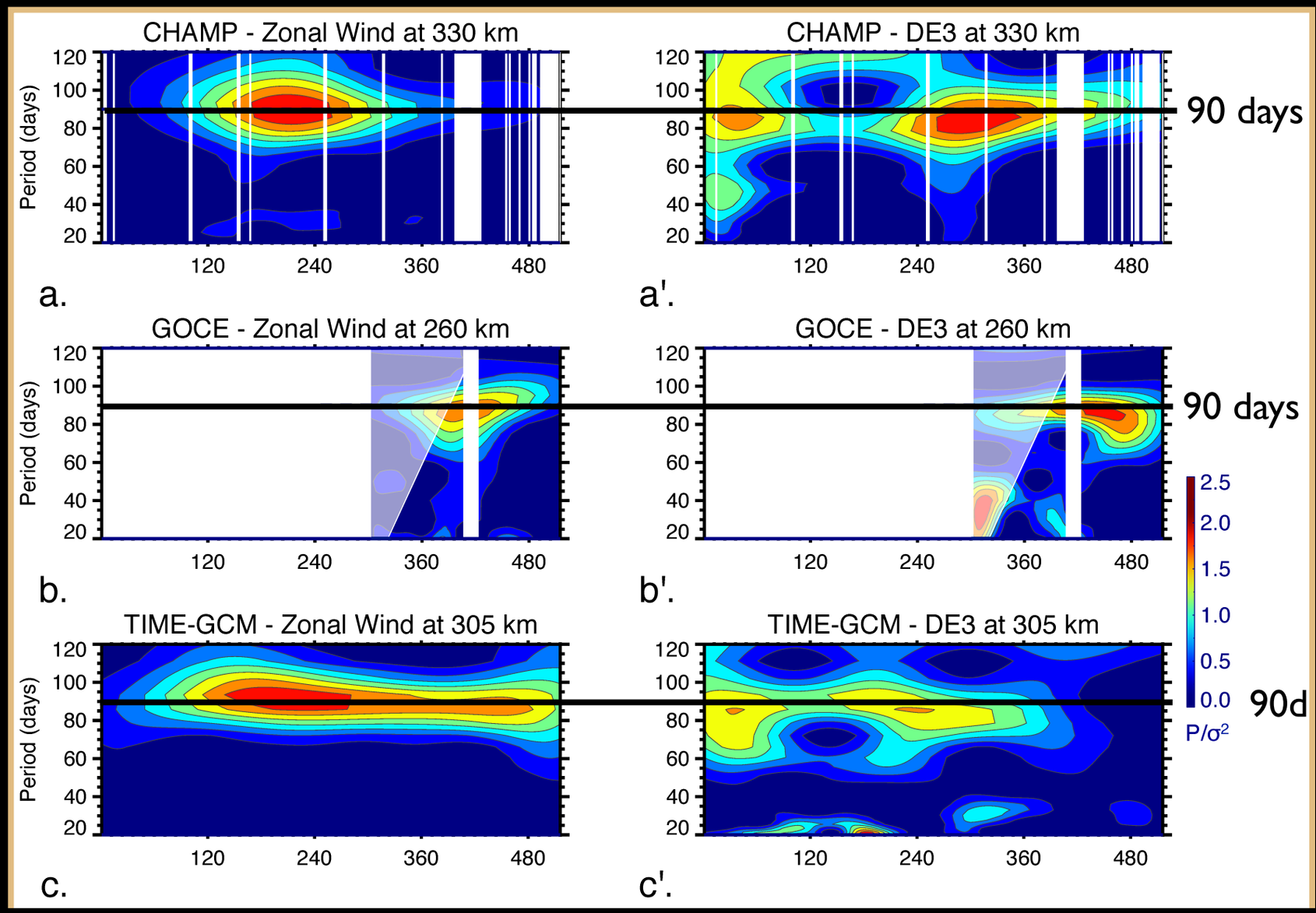

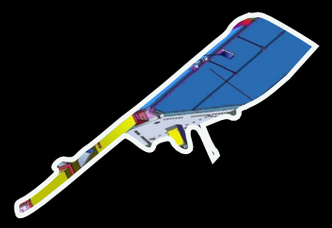

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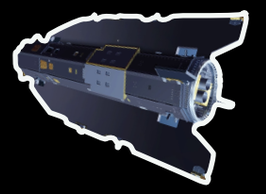

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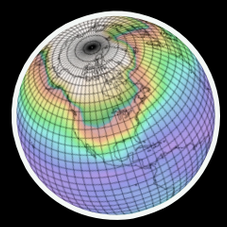

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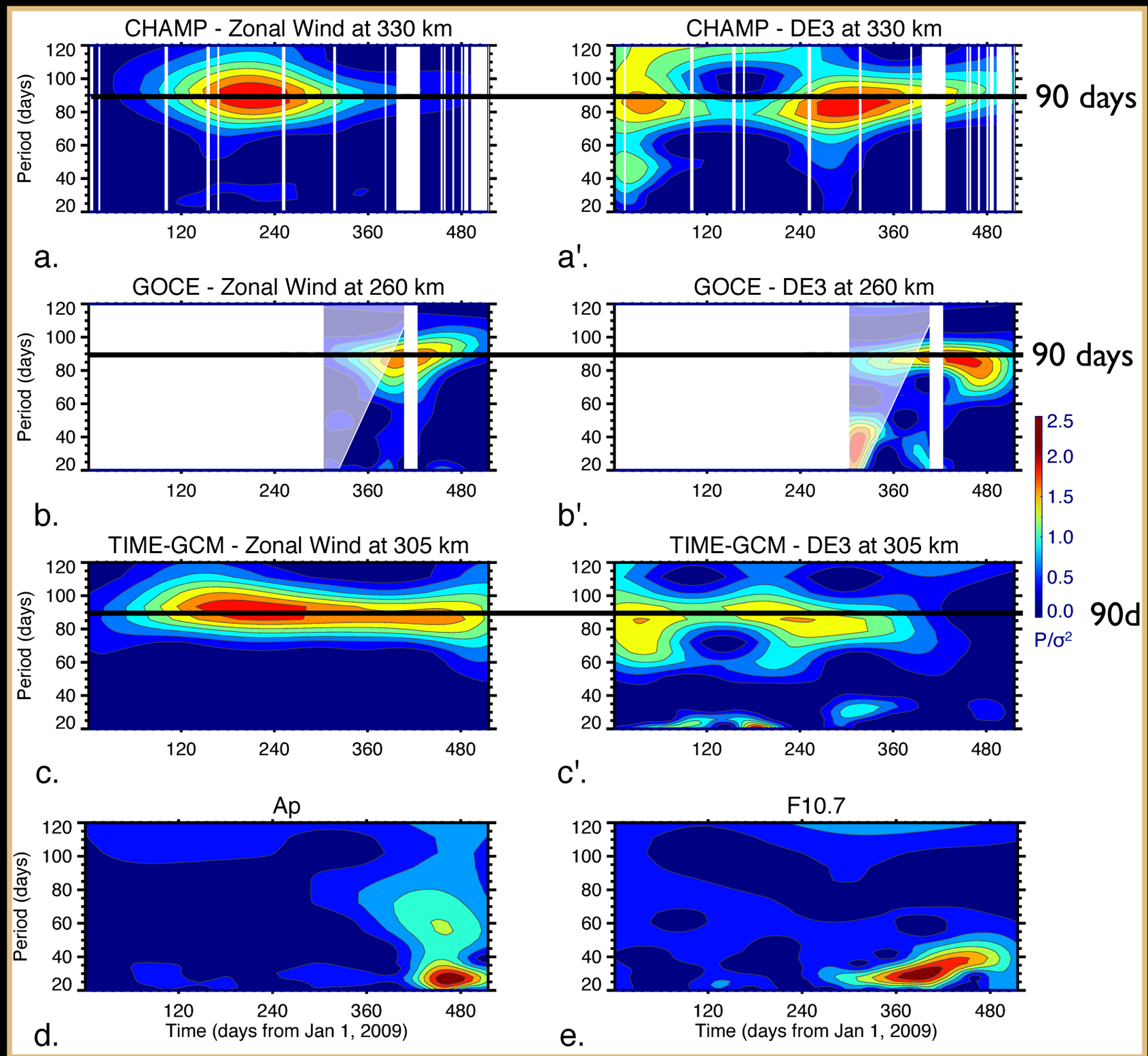

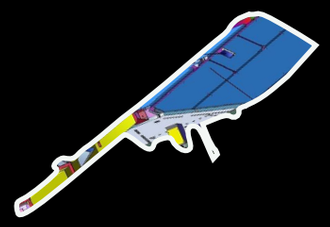

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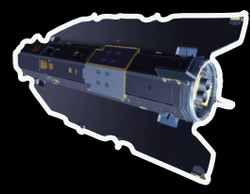

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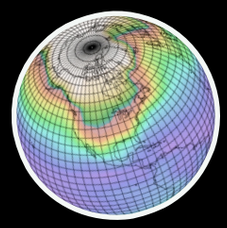

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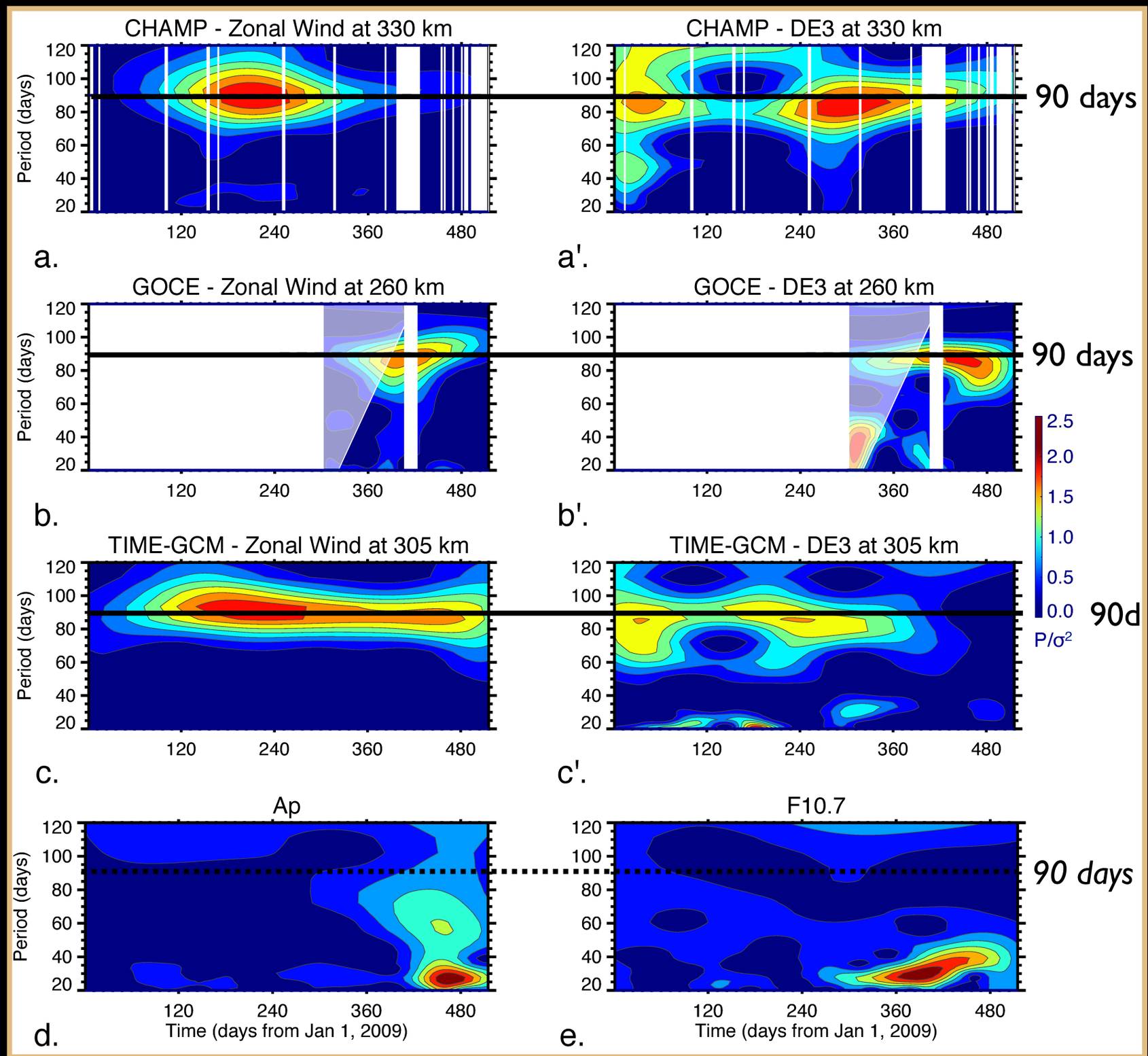

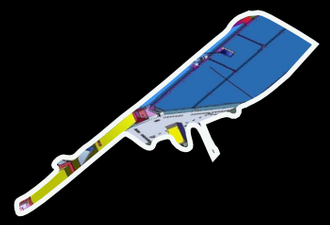

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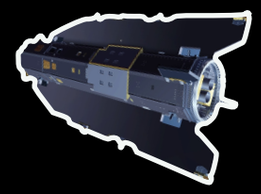

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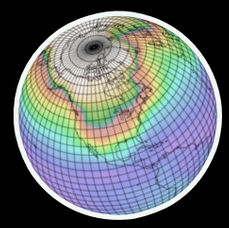

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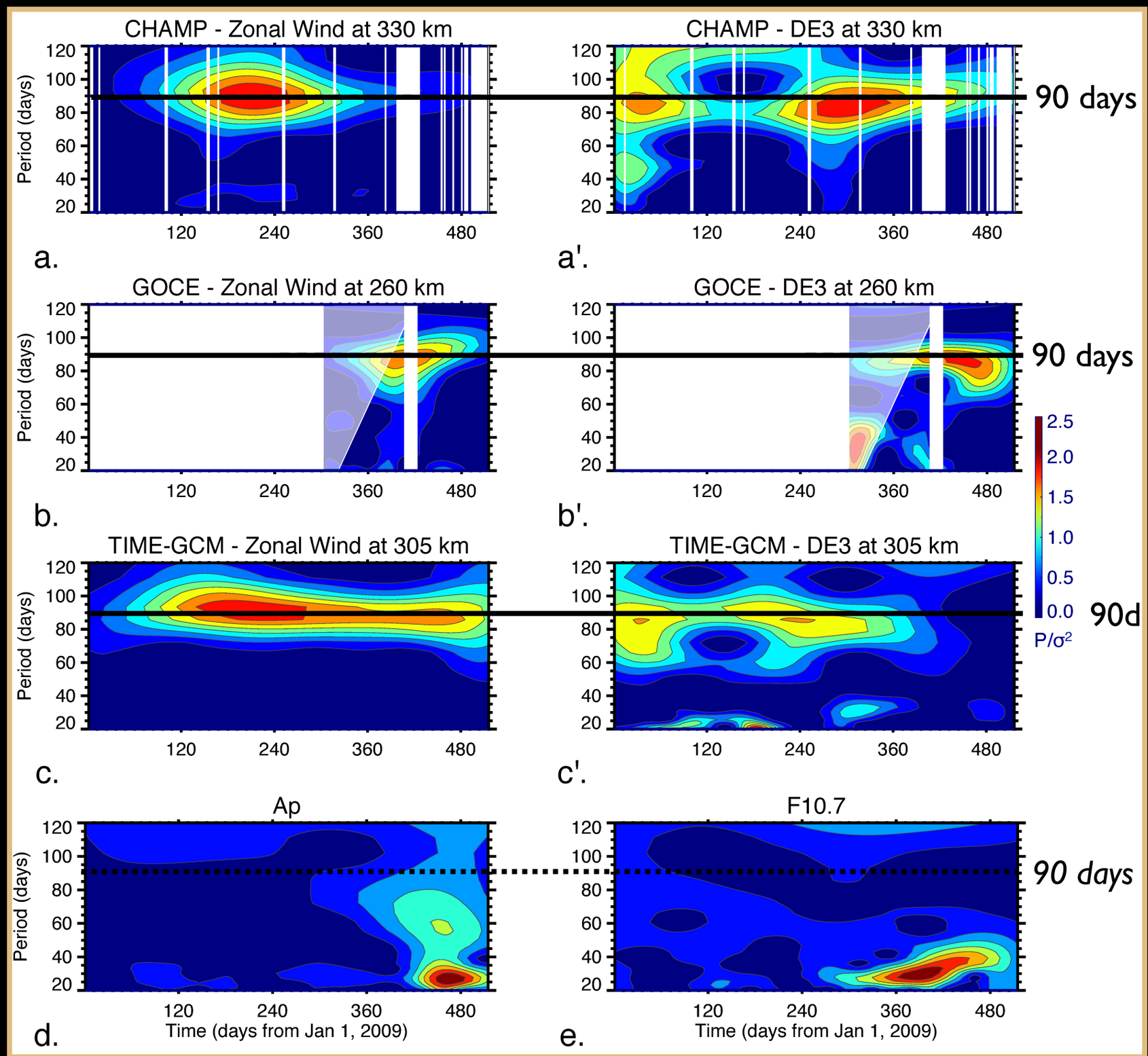

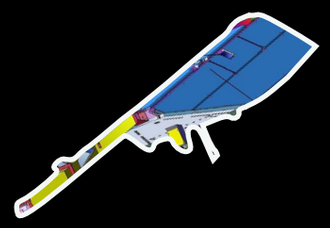

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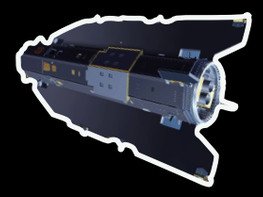

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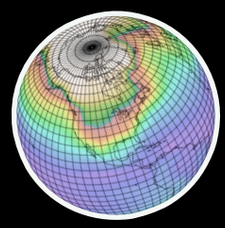
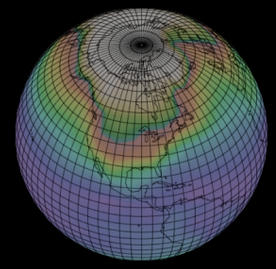
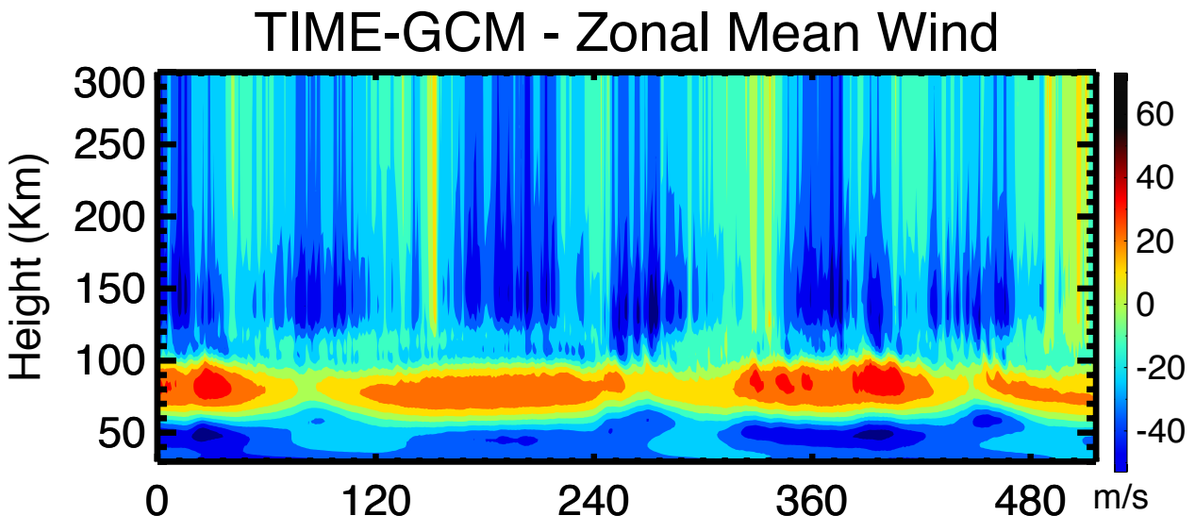


305 km

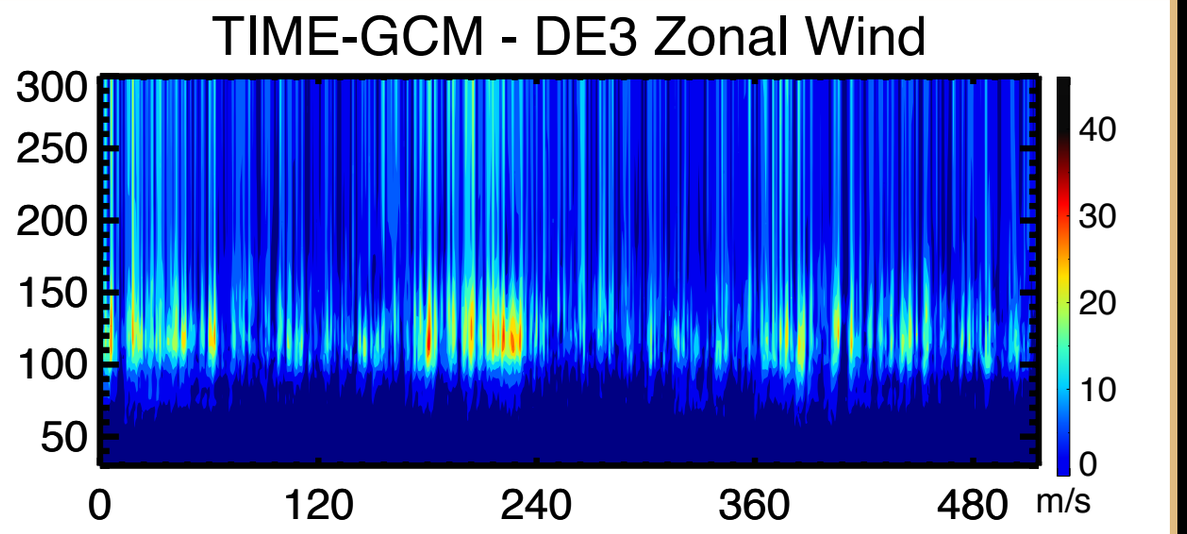
Not connected to solar or geomagnetic activity

Vertical structure



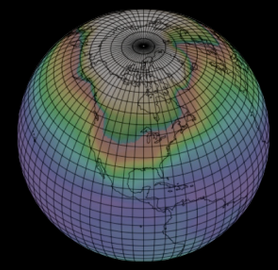


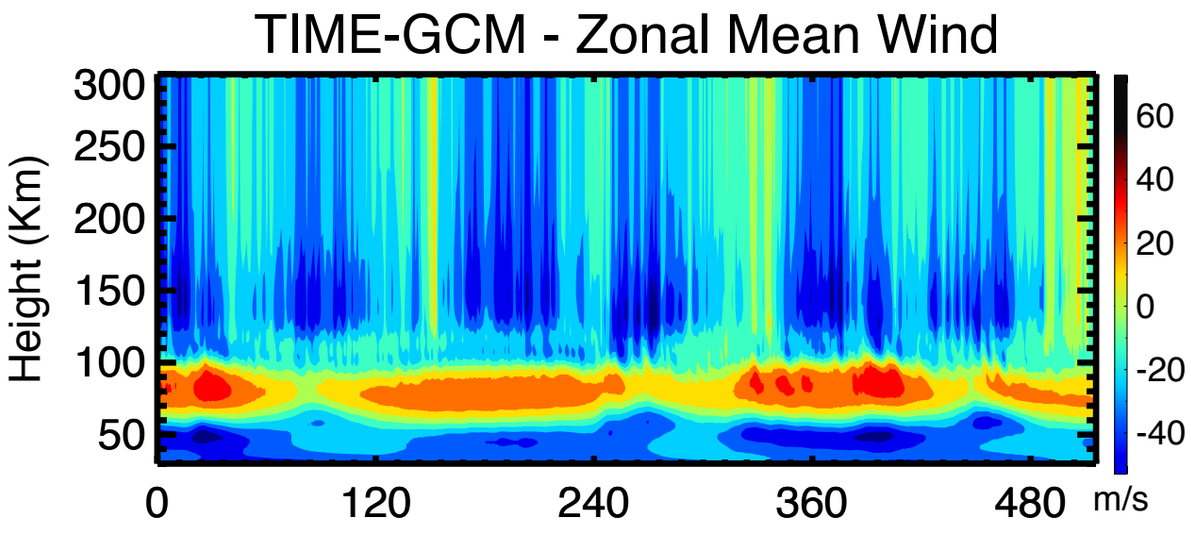
a.



b.

Vertical structure





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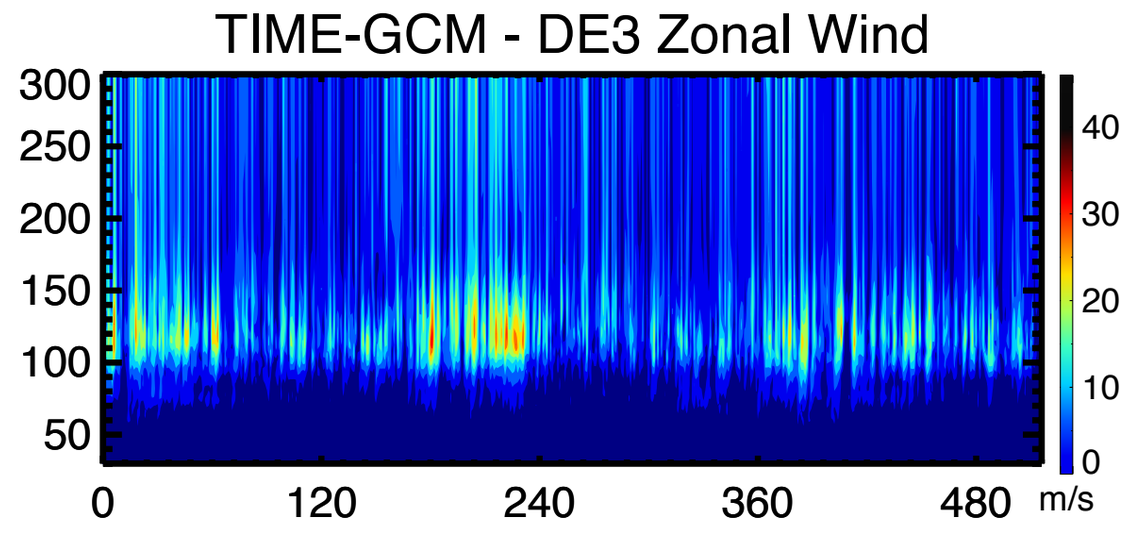

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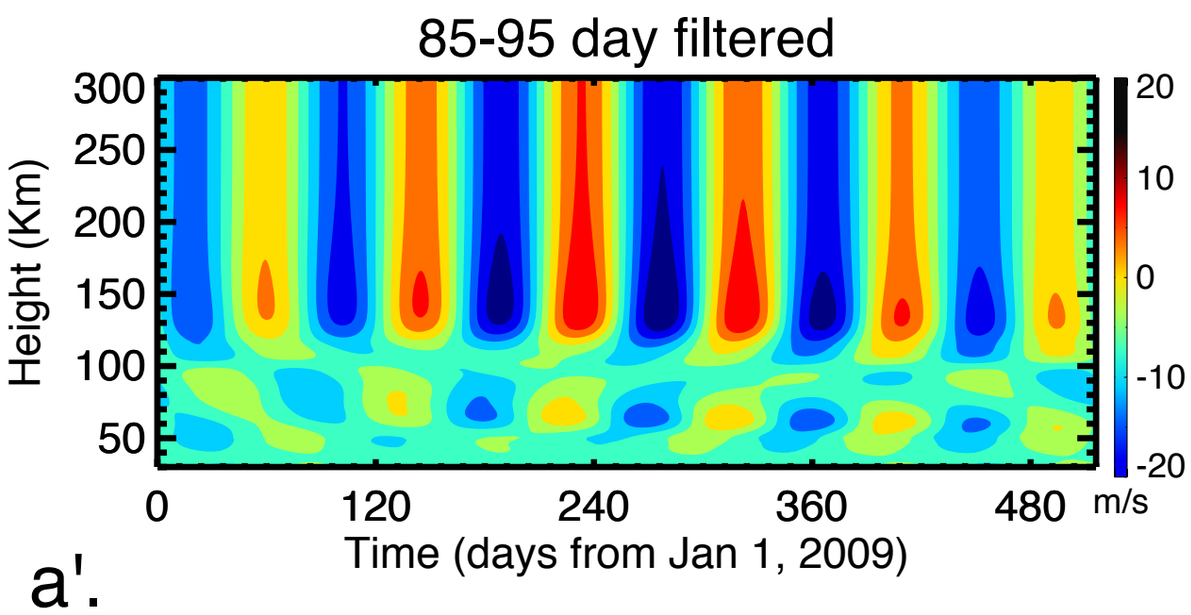
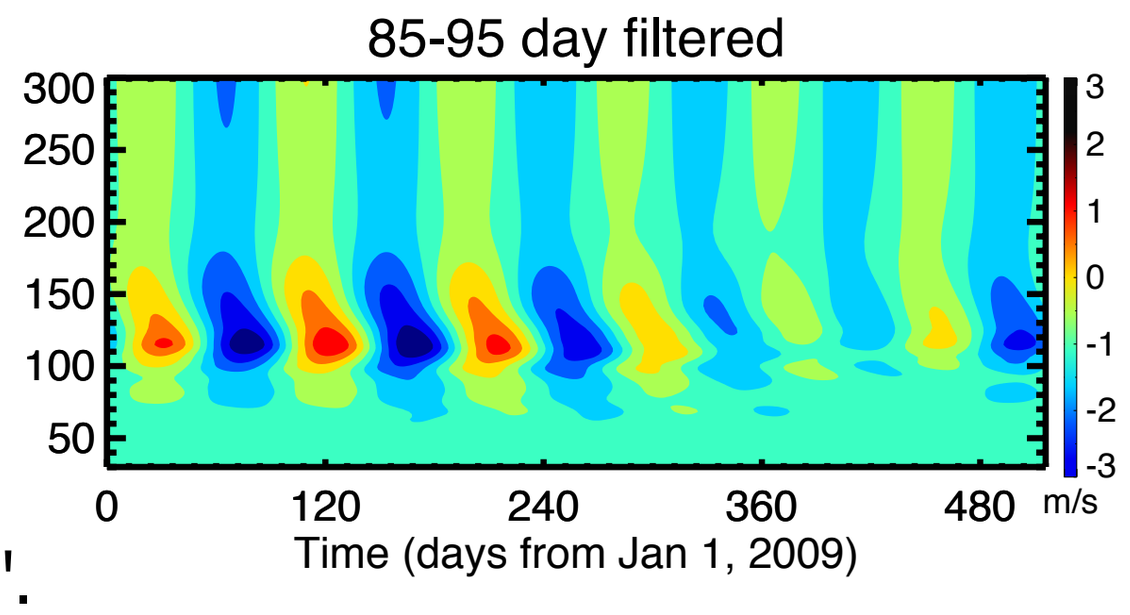
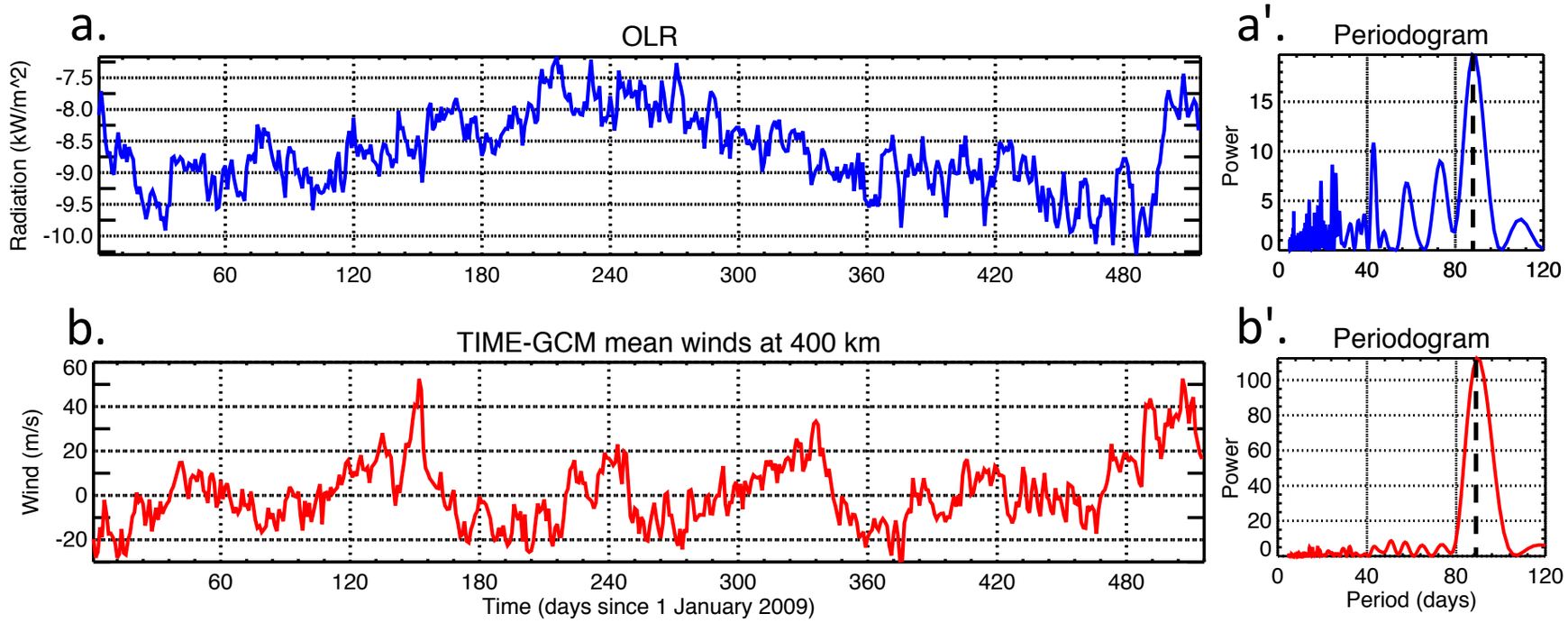


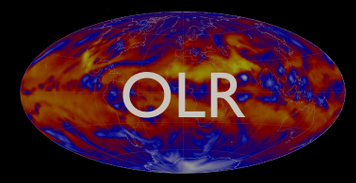
a'.

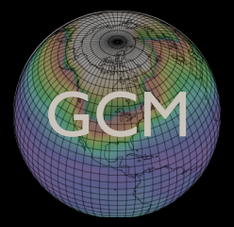


b'.

Link to Tropospheric Convection







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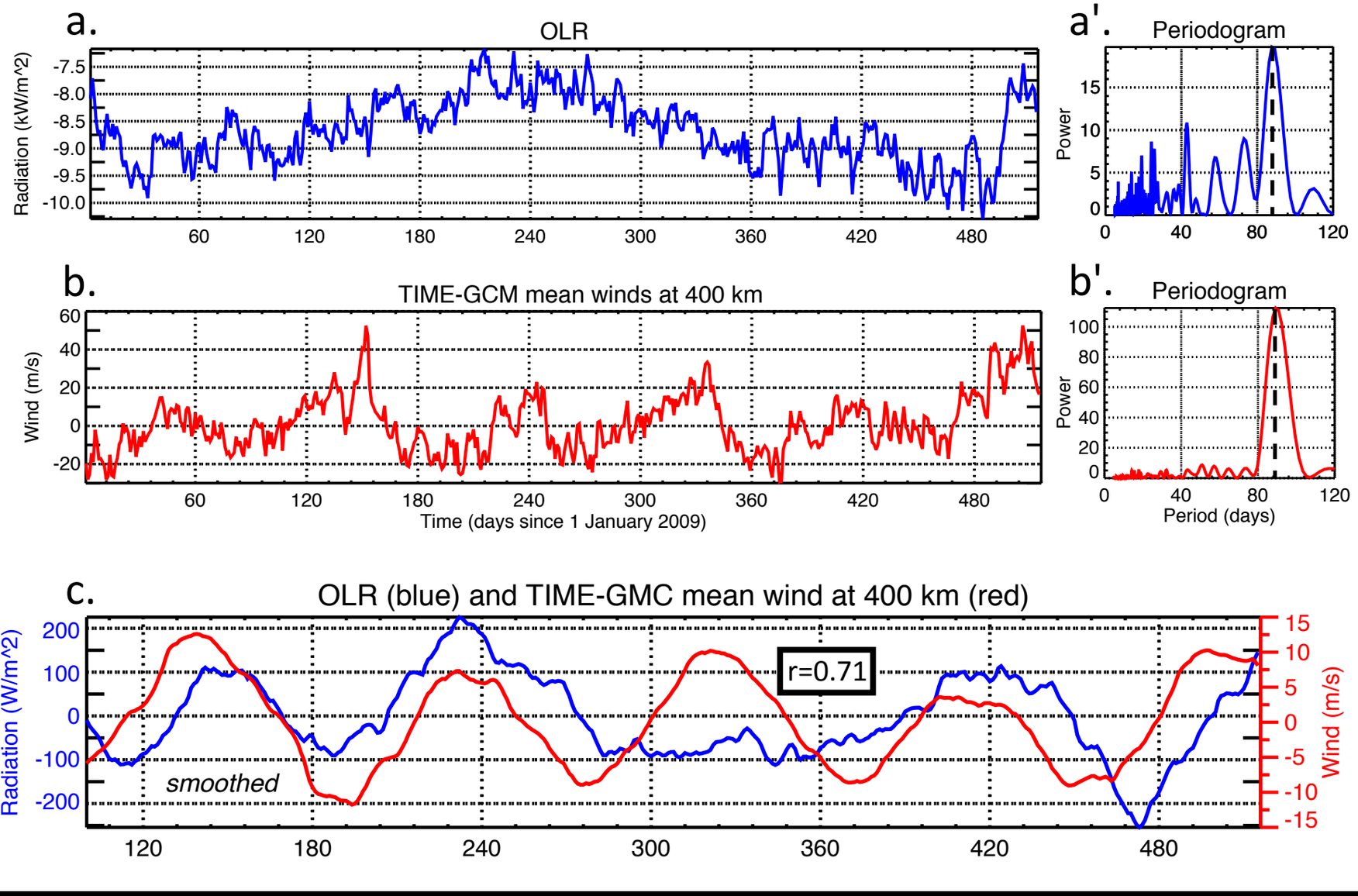

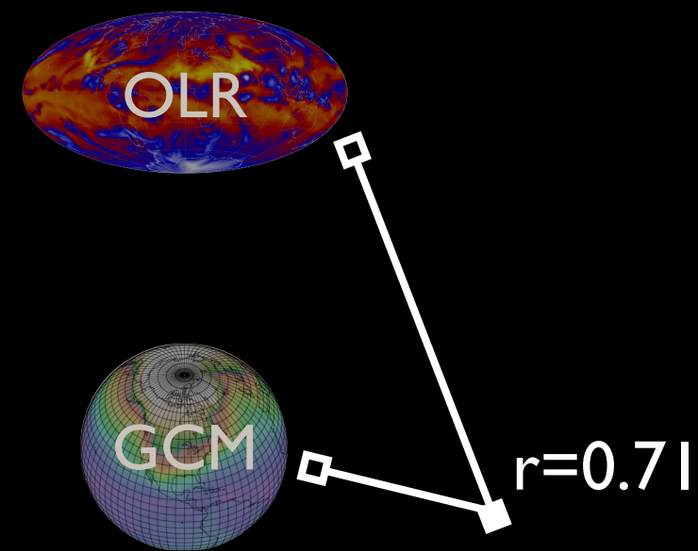

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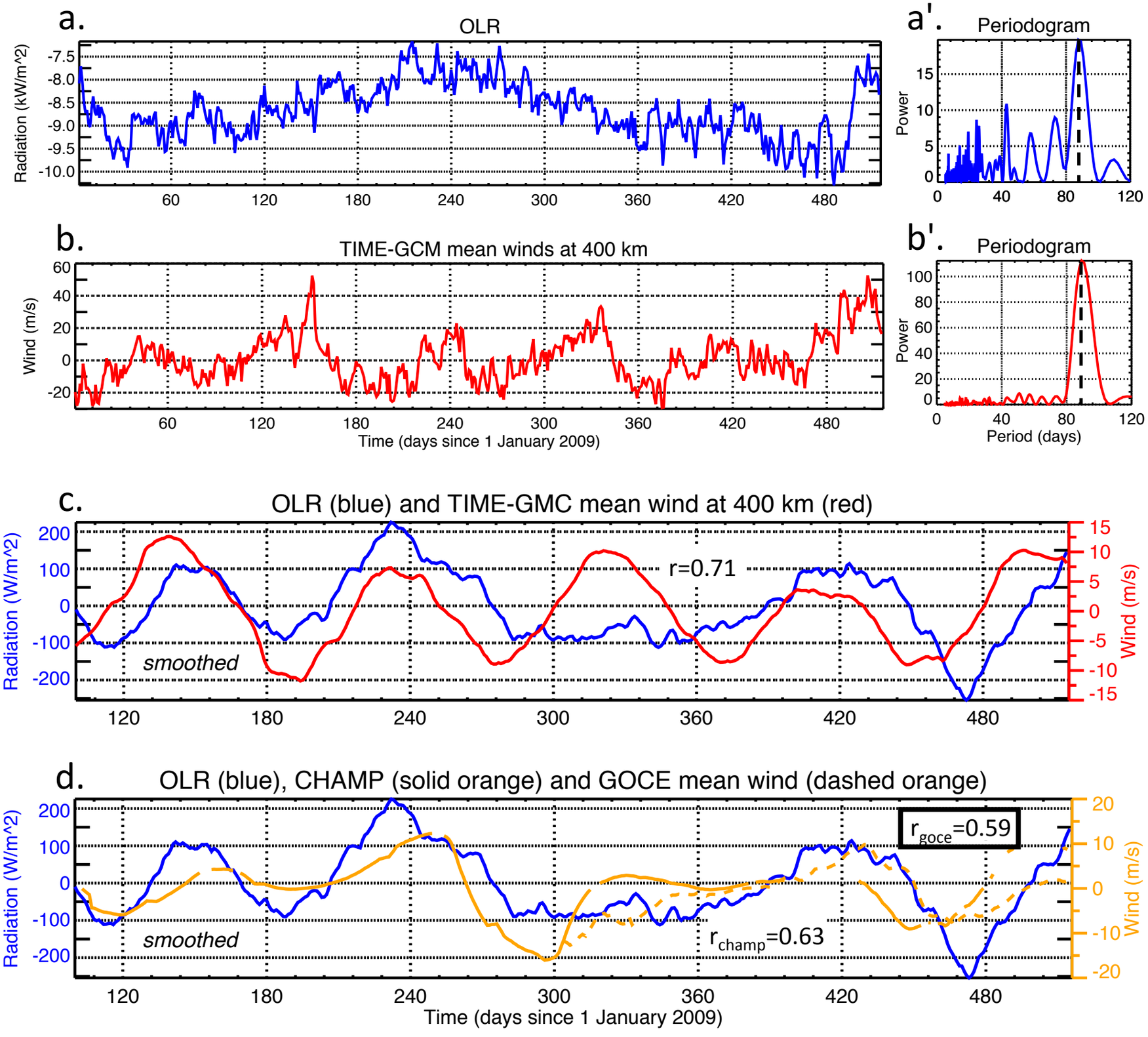

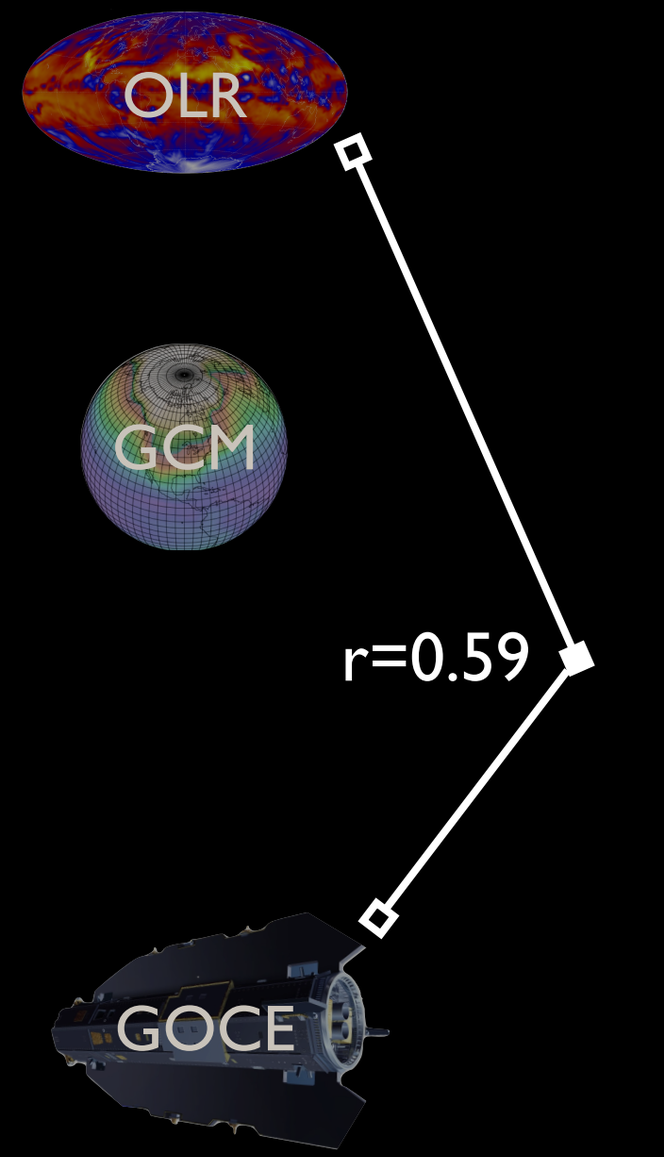

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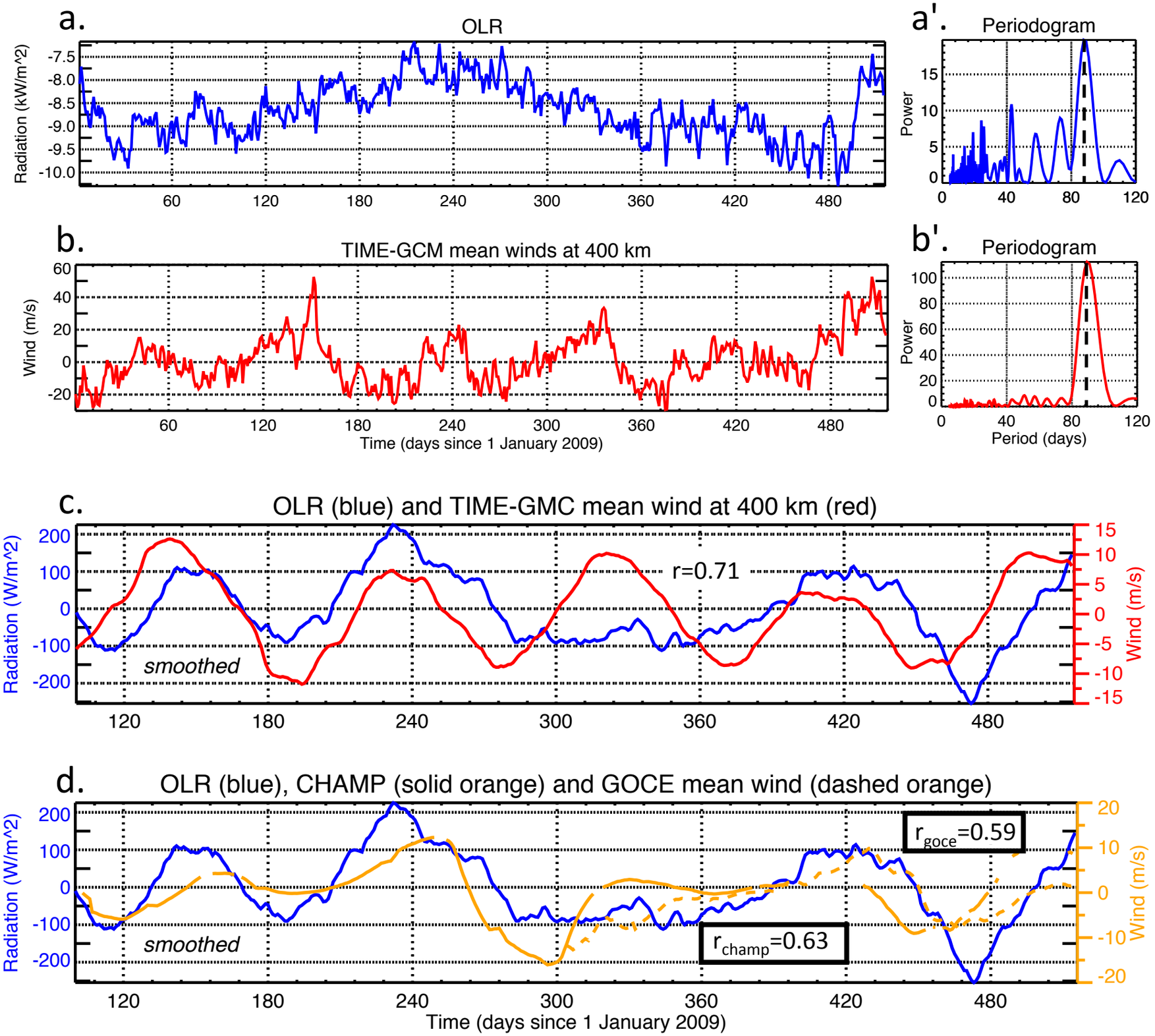
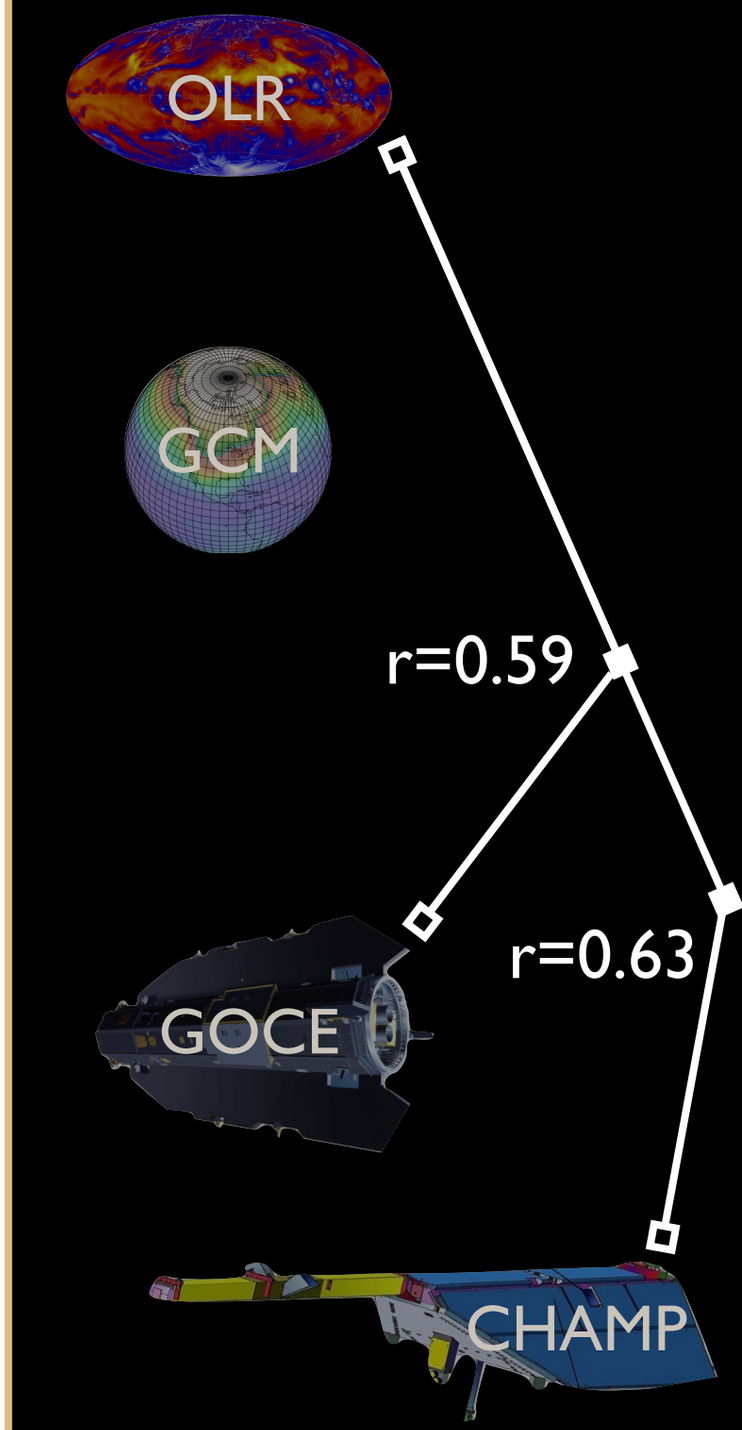
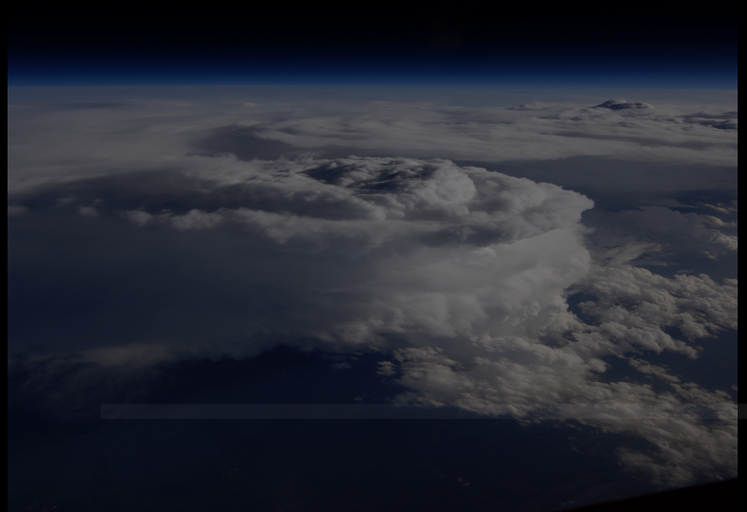




Summary



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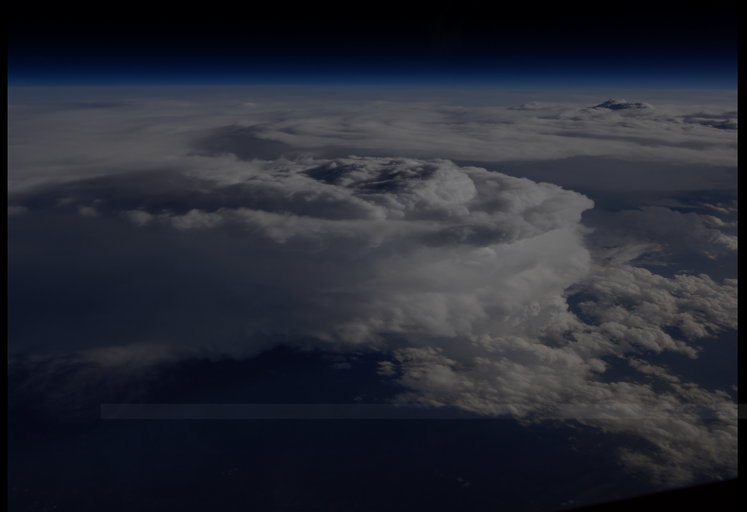

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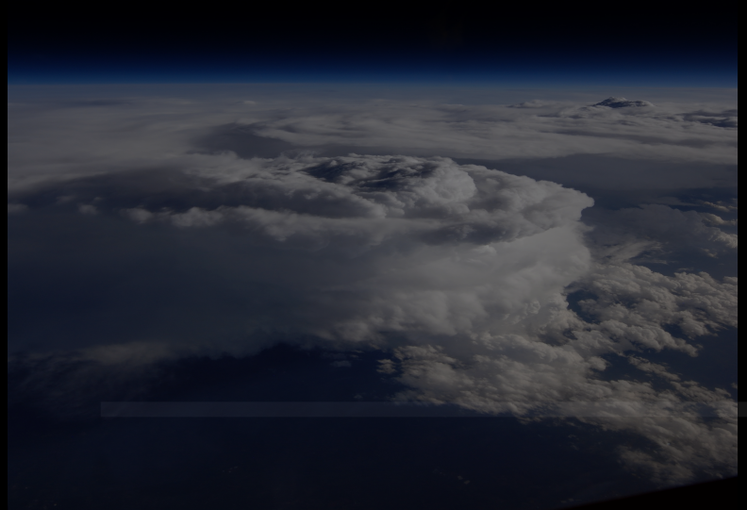

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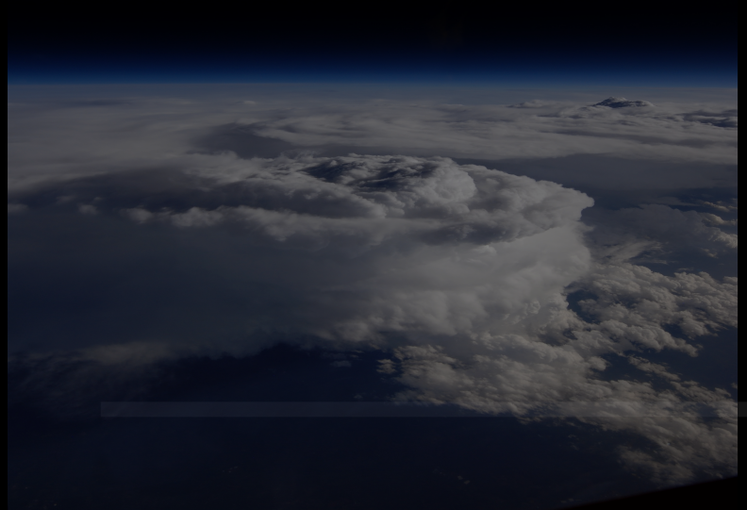

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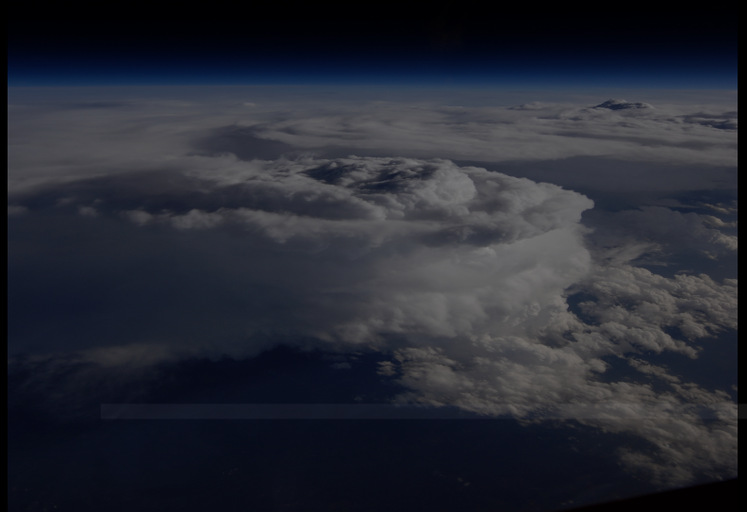

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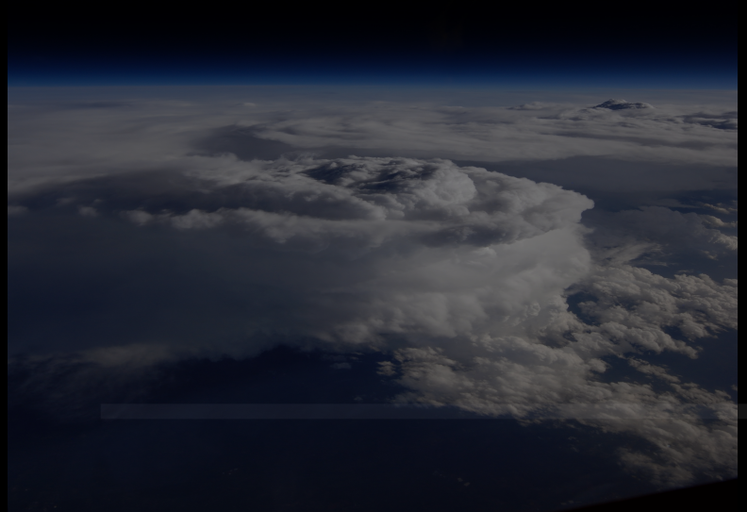

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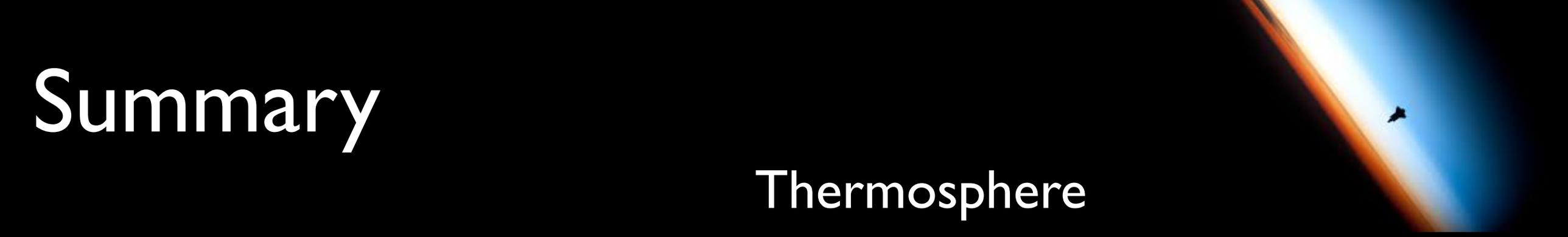

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Troposphere

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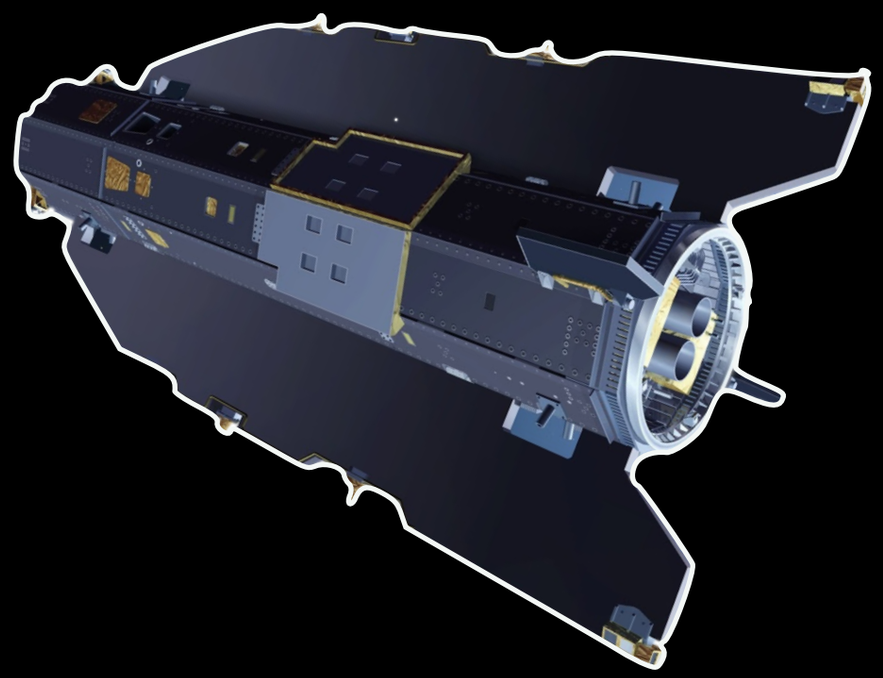

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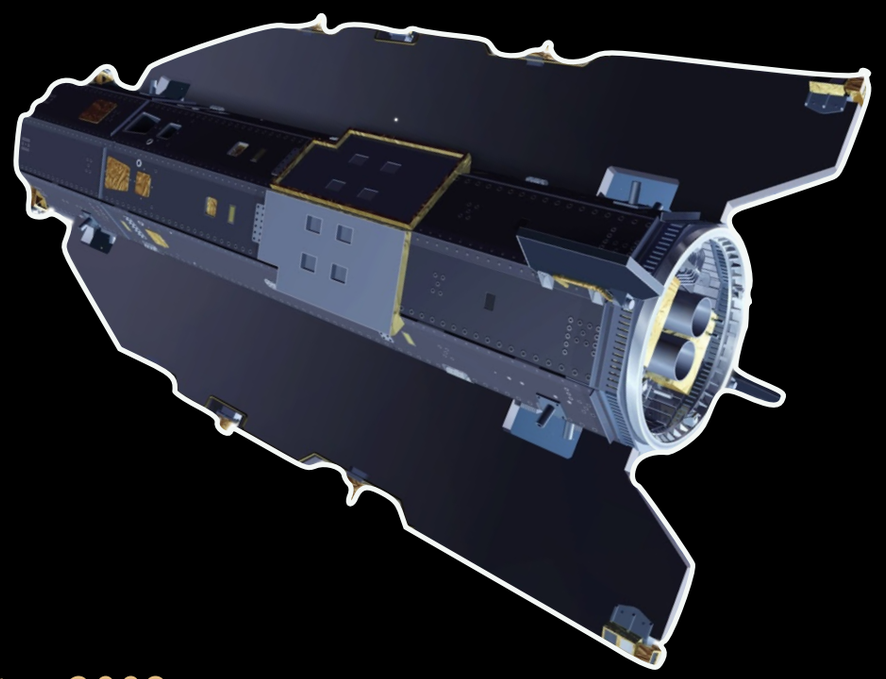

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Questions?

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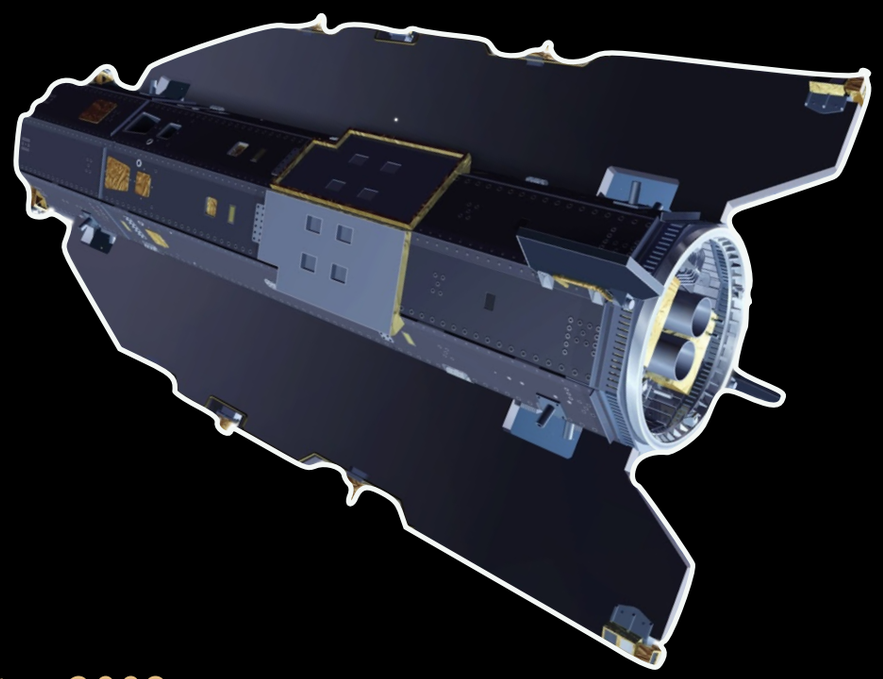

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