Collaborative Research: Framework: Improving the Understanding and Representation of Atmospheric Gravity Waves using High-Resolution Observations and Machine Learning

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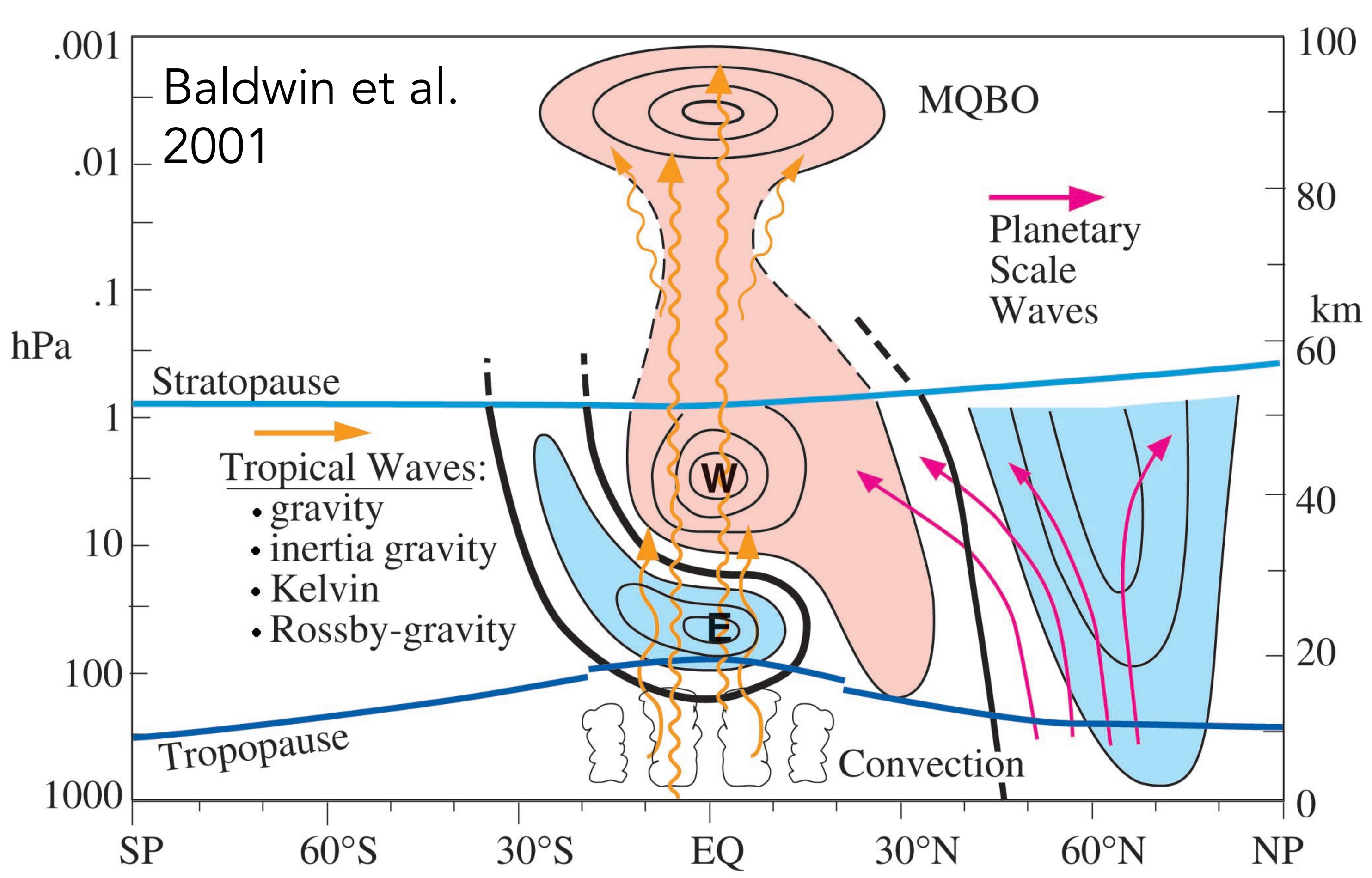
NSF Programs: OAC/CSE, Climate & Large-Scale Dynamics, Software Institutes, EarthCube

Atmospheric gravity waves (GWs)

- GWs are excited by convection, orography, and fronts
- Move momentum and energy from the surface to 20-100km altitudes
- Drive variability of stratosphere and mesosphere; e.g., Quasi-biennial oscillation (QBO) and polar vortex
- Length scales: O(1)km to O(100)km



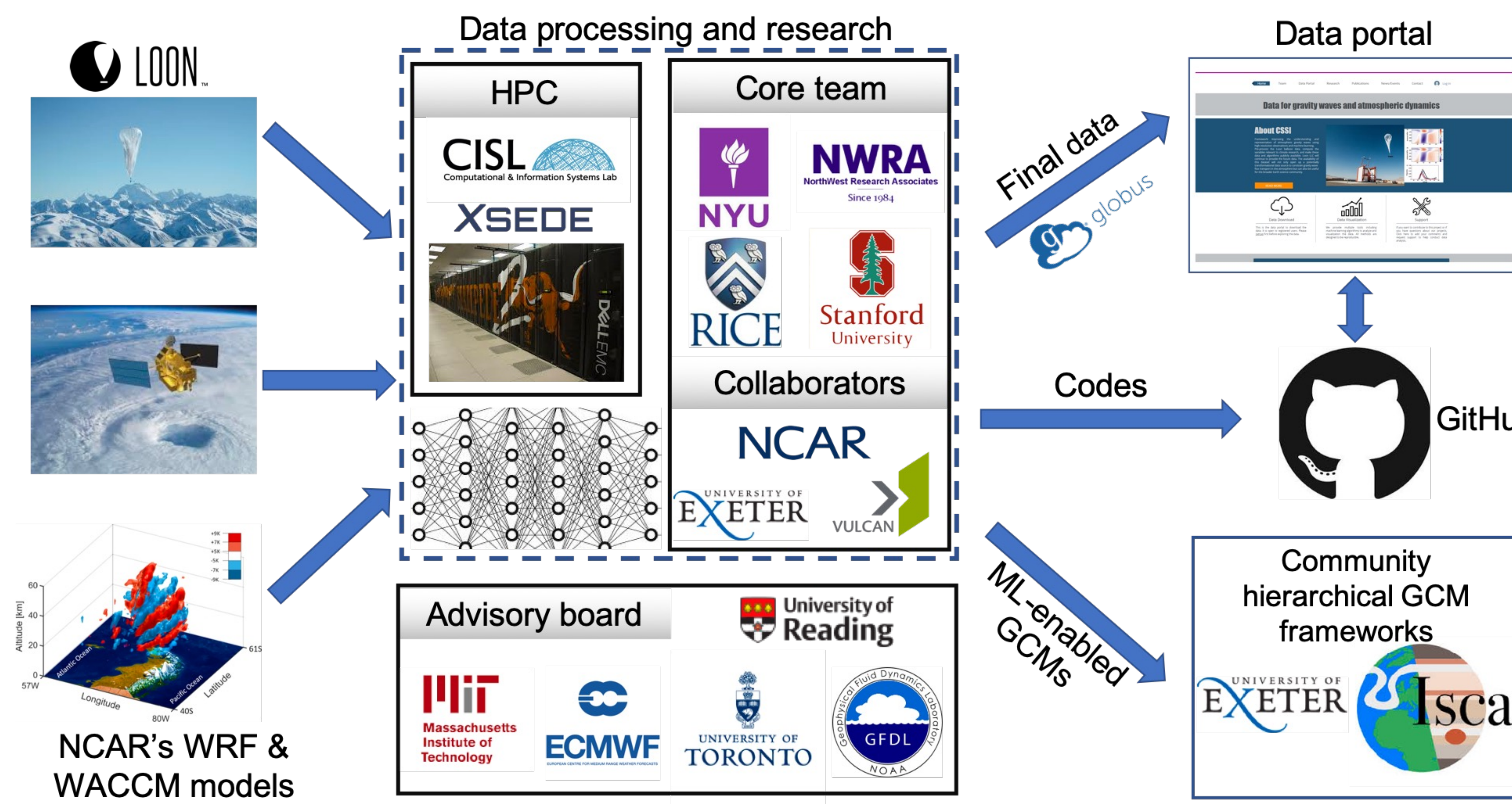
GW parameterization in weather/climate models

- Current state-of-the-art models, with typical resolutions of **10-100km** cannot resolve all GWs
- Part of the GW spectrum has to be **parameterized**
- Current parameterizations are
  - Poorly constrained by observations
  - Only account for vertical propagation
  - Have structural and parametric uncertainties
- Climate change projections are sensitive to the choice of parameterization

Objective: Develop new observationally constrained GW parameterizations for better weather forecasts and more reliable climate change projections

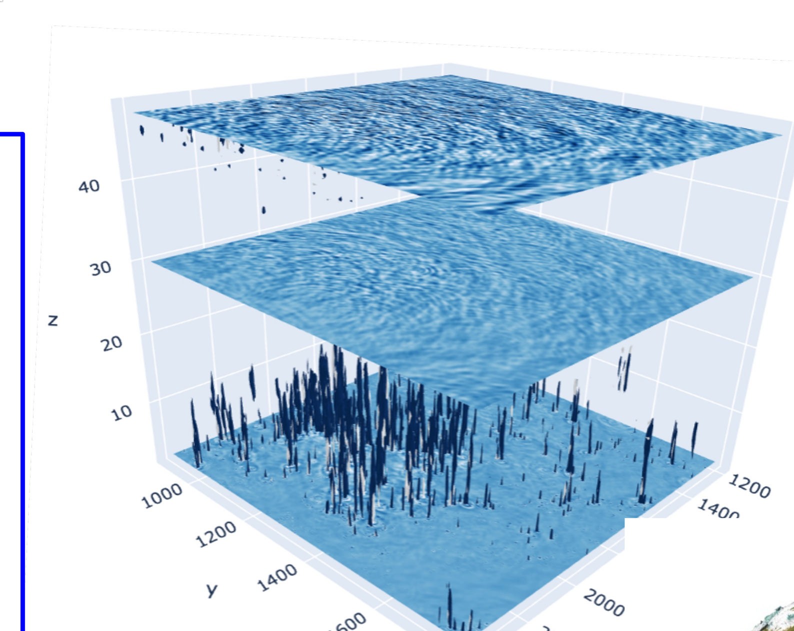
Project combines:

- Observations from Google Loon balloons
- High-resolution regional and global simulations (1-3km resolution)
- Physics-informed machine learning
- Theory: Subgrid-scale modeling + atmospheric dynamics + machine learning

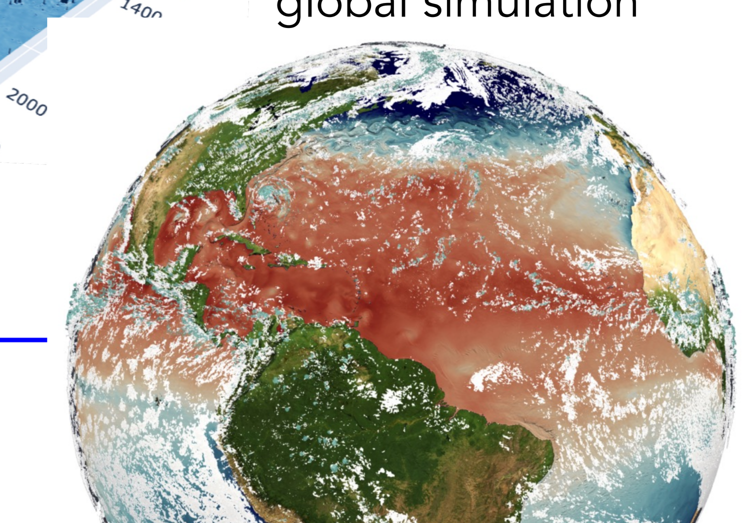


Cyberinfrastructures:

- Data from balloons and simulations are shared via a data portal (Redivis Inc.)
- Community-driven GitHub for codes for novel data processing and machine learning algorithms



NCAR's WRF 1km regional simulation



ICON (German weather model) 3km global simulation

International partner (DataWave)

- Supported by Schmidt Futures
- Involve European modeling centers: UK Met Office, MPI (Germany), IPSL (France)