My academic journey and the challenge of interdisciplinarity: from mathematics to planetary science

Daphné Lemasquerier

Lecturer in Fluid Dynamics
School of Mathematics and Statistics
University of St Andrews

PiWORKS Seminar Series
Piscopia Initiative
St Andrews -- 24 September 2024

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https://sites.google.com/view/daphnelemasquerier/accueil

The plan for today

- My academic journey and career path
- A few words about my research and the challenge of interdisciplinarity – two examples
- Why academia + a few words about women in mathematics

FEEL FREE TO COMMENT AND ASK QUESTIONS!

Academic journey

Background

2005 2009 2012 2014 2016 2017 2018 2021 2022-now

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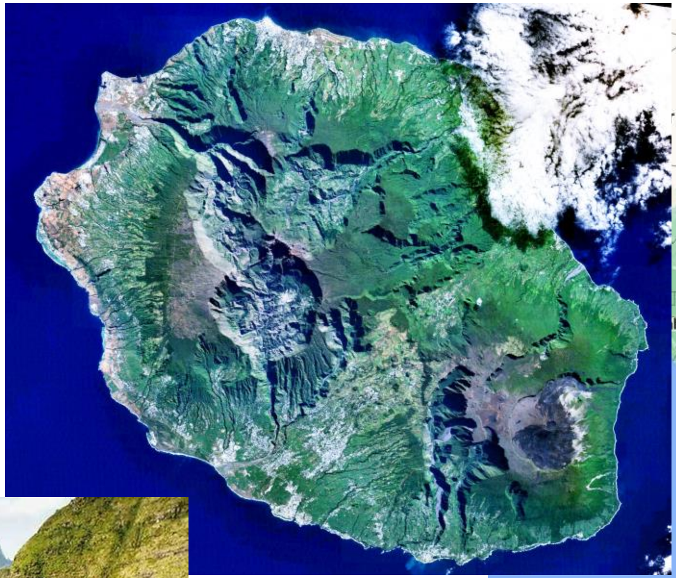
2005 2009 2012 2014 2016 2017 2018 2021 2022-now



Background

2005 2009 2012 2014 2016 2017 2018 2021 2022-now

Secondary School Terrain Fleury (Le Tampon)

académie La Réunion Région académique

Collège Terrain Fleury

Background

2005 | 2009 | 2012 | 2014 | 2016 | 2017 | 2018 | 2021 | 2022-now

Secondary School
Terrain Fleury
(Le Tampon, Reunion Island)

Scientific « baccalaureate »
Major: Physics and Chemistry
Lycée Roland Garros
(Le Tampon)

Lycée Roland Garros
Envolez-vous vers la réussite !

Background

2005 | 2009 | 2012 | 2014 | 2016 | 2017 | 2018 | 2021 | 2022-now

Secondary School
Terrain Fleury (Le Tampon, Reunion Island)

Scientific « baccalaureate »
Major: Physics and Chemistry
Lycée Roland Garros (Le Tampon)

2 years of « preparatory courses for entry in higher education schools »
Lycée Roland Garros (Le Tampon)

→ Studied: Biology, Chemistry, Physics, Earth Sciences, Mathematics…
National competitive exam at the end for entry to HE schools

Lycée Roland Garros

Background

2005 | 2009 | 2012 | 2014 | 2016 | 22-now

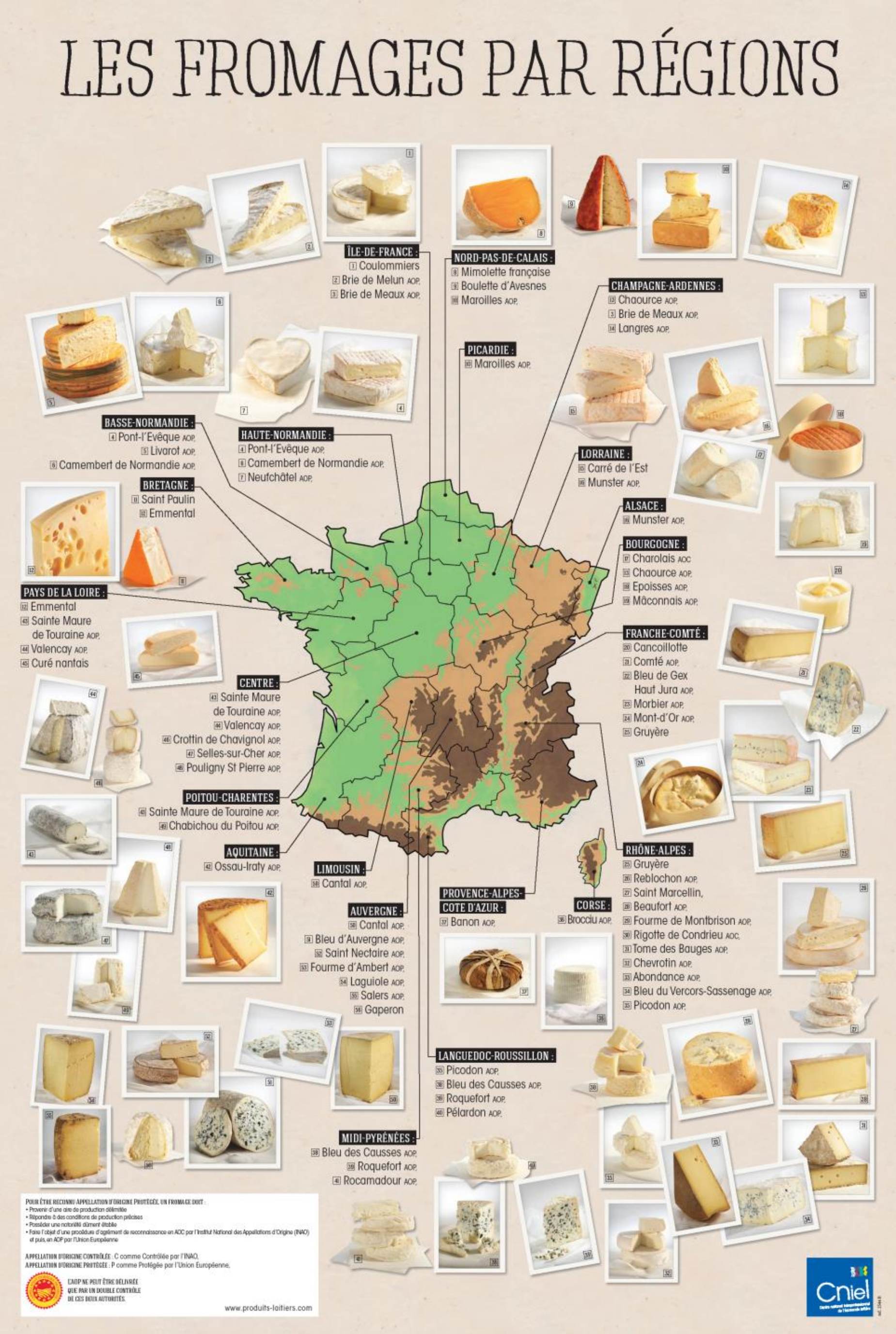
Secondary School Terrain Fleury (Le Tampon, Reunion Island)

High School Roland Garros + **2-yr prepa course** BCPST (Le Tampon)

3rd year Bachelor and 1st year Master
major Physics and Chemistry of the Earth and Other Planets

ENS Lyon (France)

UNIVERSITÉ DE LYON | ENS DE LYON



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UNIVERSITÉ DE LYON

ENS DE LYON

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IPAG

Institut de Planétologie et d'Astrophysique de Grenoble

Research internships:

- 4 weeks at ENS Lyon: experimental penetrative convection
- 8 weeks at a Planetology Institute in Grenoble: organic content in meteorites
- 14 weeks at SpinLab (Los Angeles): libration experiments
- 19 weeks at IRPHE (Marseille, France): Jupiter's dynamics

Background

2005 | 2009 | 2012 | 2014 | 2016 | 2017 | 2018 | 2021 | 2022-now

Secondary School Terrain Fleury (Le Tampon, Reunion Island)

High School Roland Garros + **2-yr prepa course** BCPST (Le Tampon)

Research internships:

- 4 weeks at ENS Lyon: experimental penetrative convection
- 8 weeks at a Planetology Institute in Grenoble: organic content in meteorites
- 14 weeks at SpinLab (Los Angeles): libration experiments
- 5 months at IRPHE (Marseille, France): Jupiter’s dynamics

UCLA Spinlab

https://youtu.be/WGe-vLsm9Ho?feature=shared

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2005 | 2009 | 2012 | 2014 | 2016 | 2017 | 2018 | 2021 | 2022-now

Secondary School Terrain Fleury (Le Tampon, Reunion Island)

High School Roland Garros + **2-yr prepa course** BCPST (Le Tampon)

Bachelor degree and first year of Master in planetary science ENS Lyon (France)

National Teaching Examination
To teach in higher education (Earth Science, Planetary Science and Biology)

ENS Lyon
(France)

UNIVERSITÉ DE LYON

ENS DE LYON

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Master 2
en Mécanique des Fluides
et Physique Non-Linéaire

Aix-Marseille Université
(France)

Aix*Marseille université
Socialement engagée

6 | 2017 | 2018 | 2021 | 2022-now

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Bachelor degree and first year of Master in planetary science ENS Lyon (France)

Teaching examination in Biology and Earth Sciences ENS Lyon (France)

Second year of Master in Fluid Mechanics and Nonlinear-Physics Aix-Marseille Université (France)

PhD
On the fluid dynamics of Jupiter

Aix-Marseille Université, laboratoire IRPHE (France)

Aix*Marseille université Socialement engagée
irphé Institut de Recherche sur les Phénomènes Hors Equilibre
cnrs
CENTRALE MARSEILLE

Background

2005	2009	2012	2014	2016	2017	2018	2021	2022-now
Secondary School Terrain Fleury (Le Tampon, Reunion Island)	**High School** Roland Garros + **2-yr prepa course** BCPST (Le Tampon)		**Bachelor degree and first year of Master** in planetary science ENS Lyon (France)	**Teaching examination in Biology and Earth Sciences** ENS Lyon (France)	**Second year of Master** in Fluid Mechanics and Nonlinear-Physics Aix-Marseille Université (France)	**PhD** Aix-Marseille Université (France)		

Post-doctoral Fellow
Ocean dynamics of icy moons of Jupiter and Saturn

University of Texas at Austin (USA)

TEXAS Geosciences
The University of Texas at Austin
Jackson School of Geosciences

UTIG INSTITUTE FOR GEOPHYSICS
JACKSON SCHOOL OF GEOSCIENCES

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2017

Second year of Master in Fluid Mechanics and Nonlinear-Physics
Aix-Marseille Université
(France)

2018

PhD
Aix-Marseille Université
(France)

2021

Post-doctoral researcher
University of Texas at Austin
(USA)

2022-now

Lecturer
School of Mathematics and Statistics
University of St Andrews

University of St Andrews | FOUNDED 1413

Background

2005	2009–2012	2014	2016	2017	2018	2021	2022-now
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University of St Andrews | FOUNDED 1413

Background

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- **Secondary School** Terrain Fleury (Le Tampon, Reunion Island)
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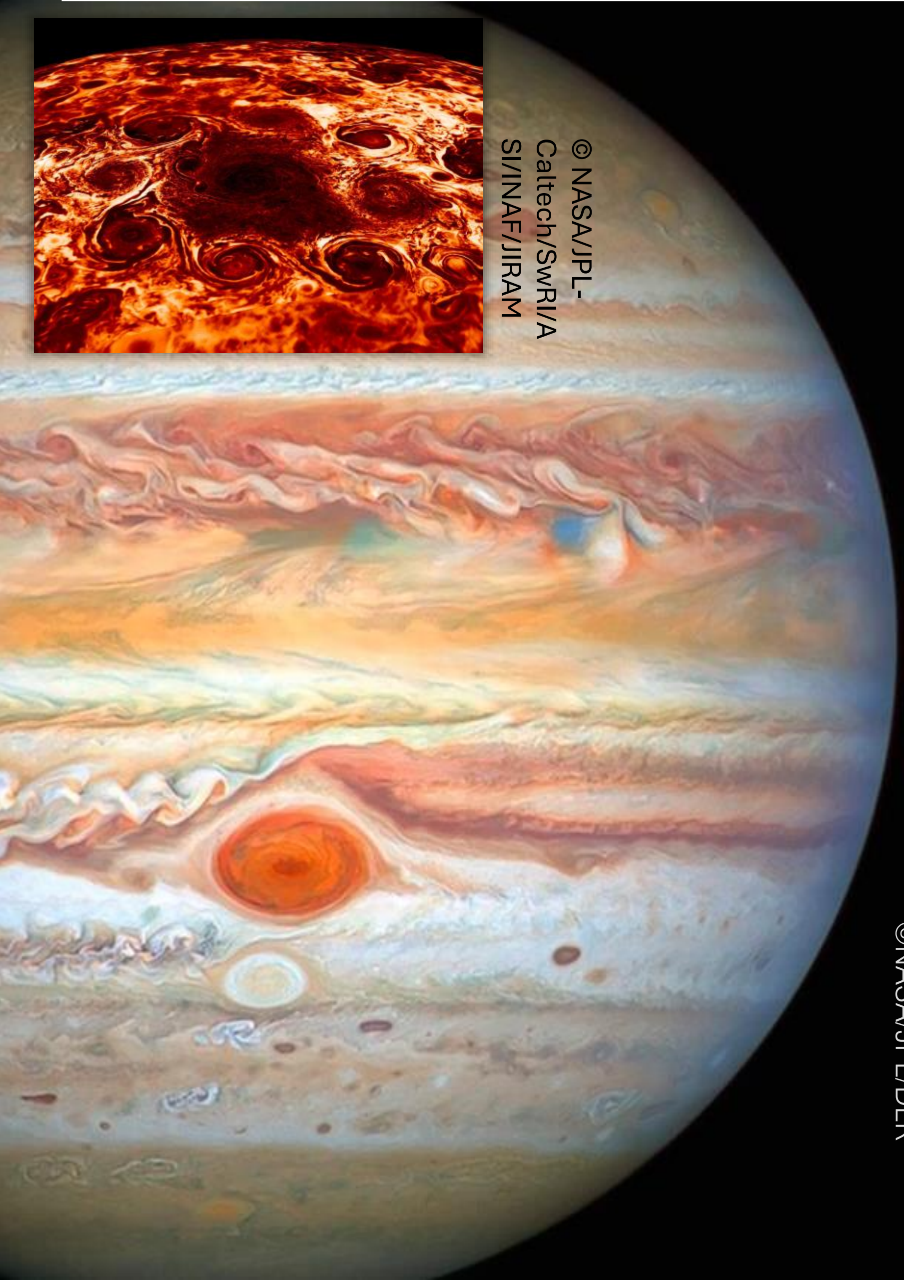
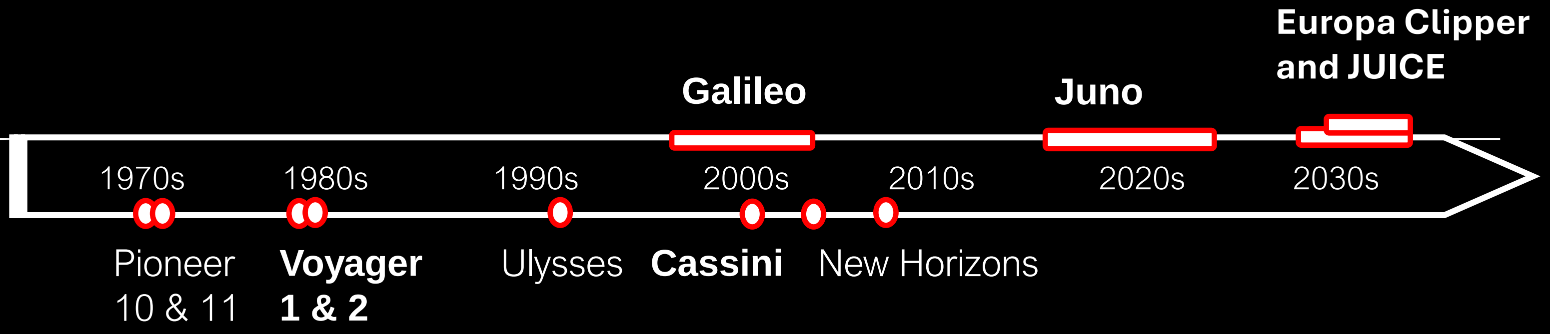
- **PhD** Aix-Marseille Université (France)
- **Post-doctoral researcher** University of Texas at Austin (USA)
- **Lecturer** University of St-Andrews

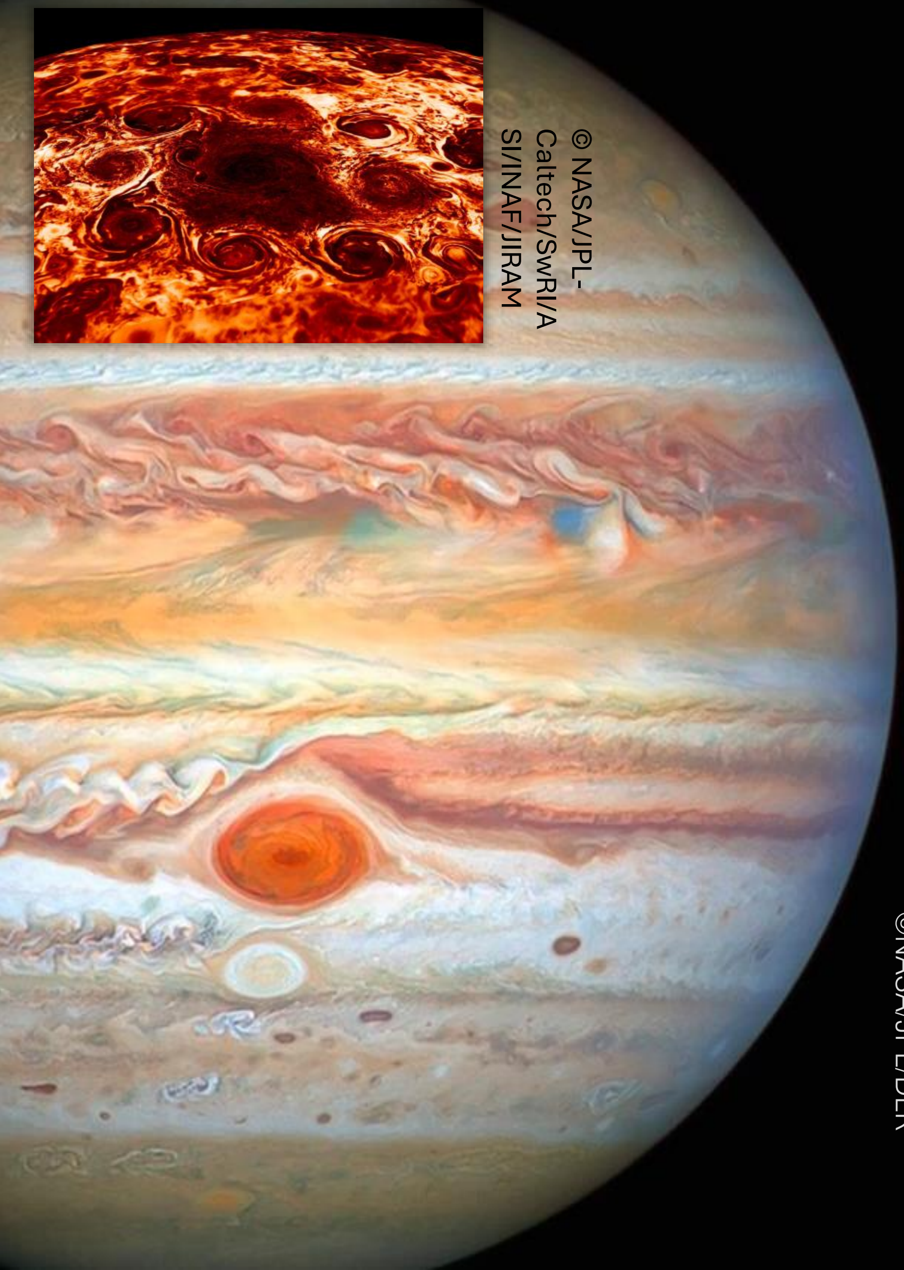
A few words about my research and the challenge of interdisciplinarity

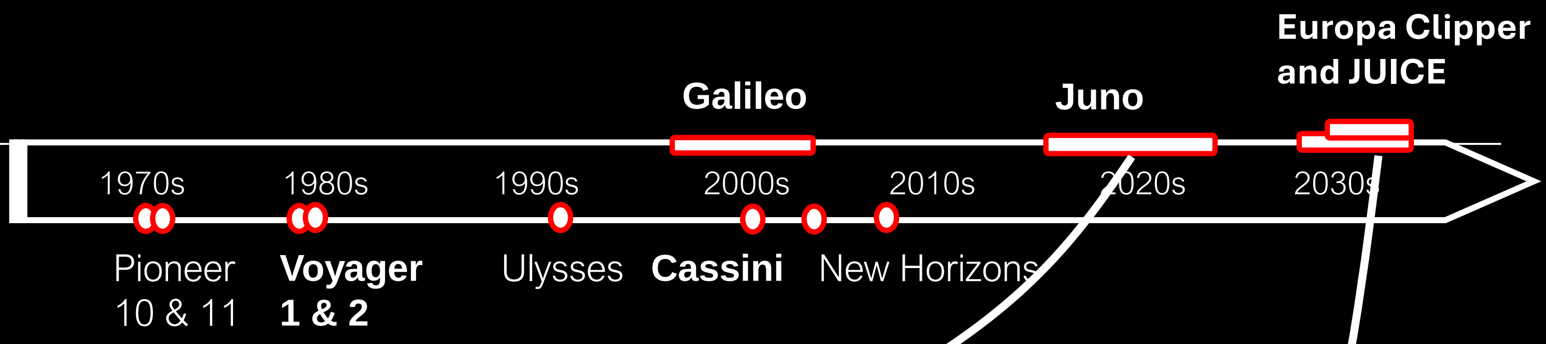
My research: challenge





My research: challenge

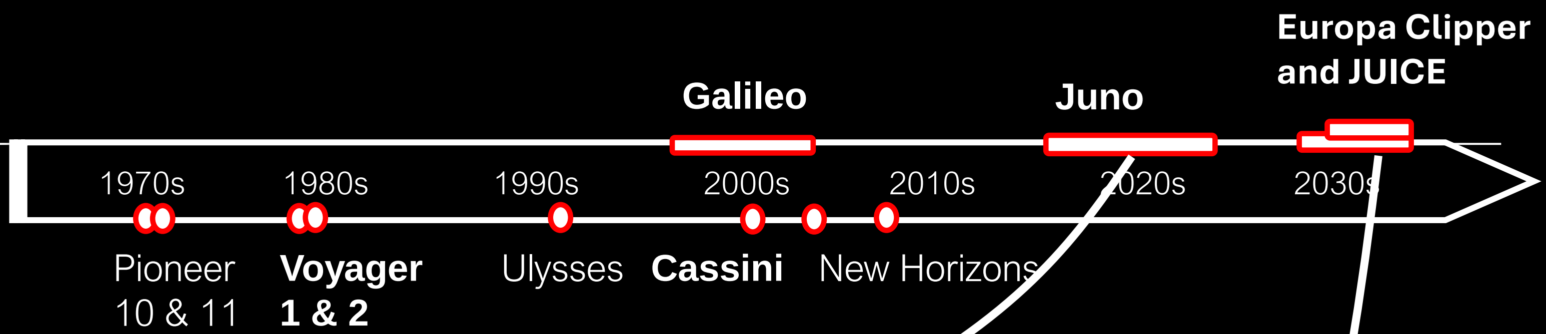


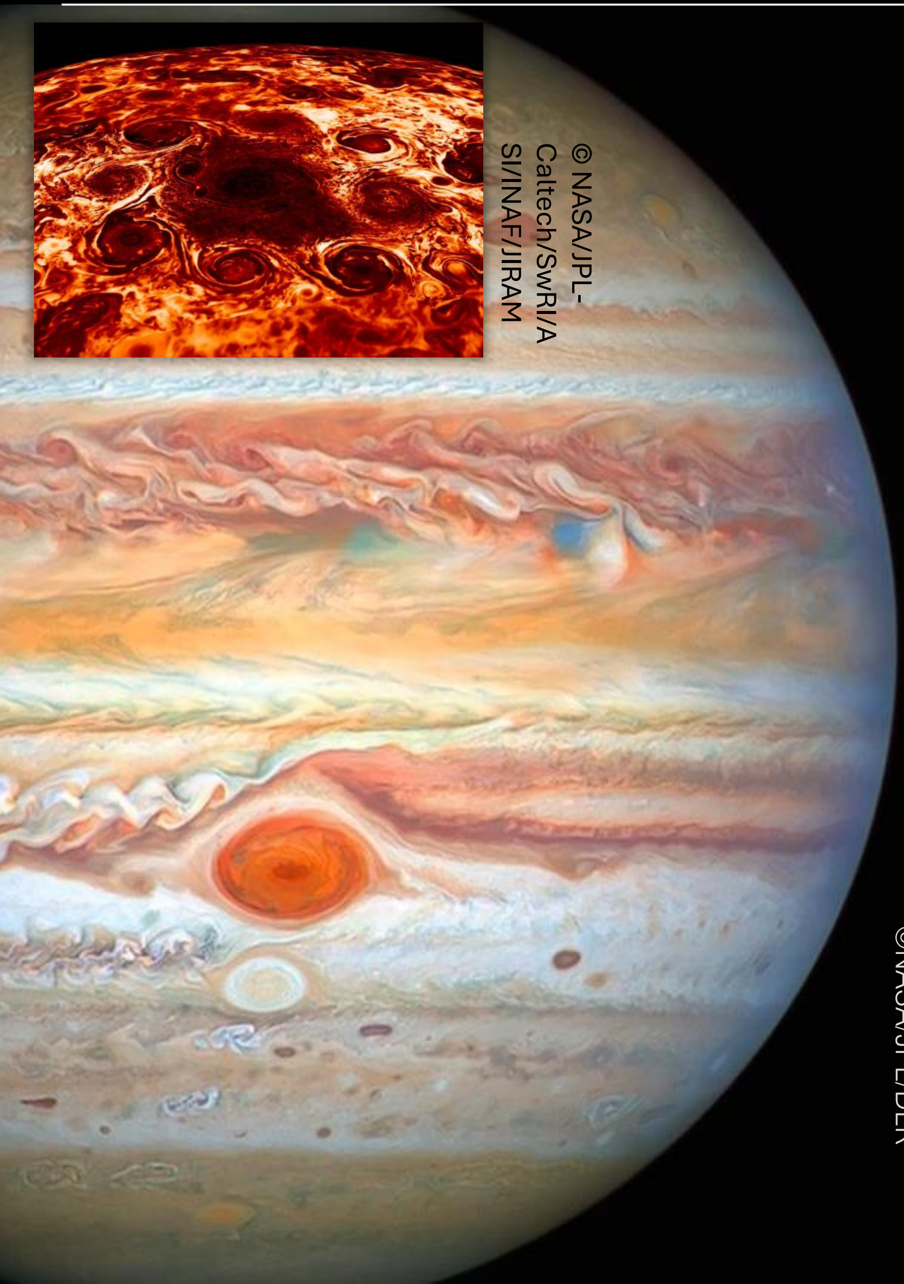


2016-now: JUNO

2030-2034+: JUICE and EUROPA CLIPPER

My research: challenge





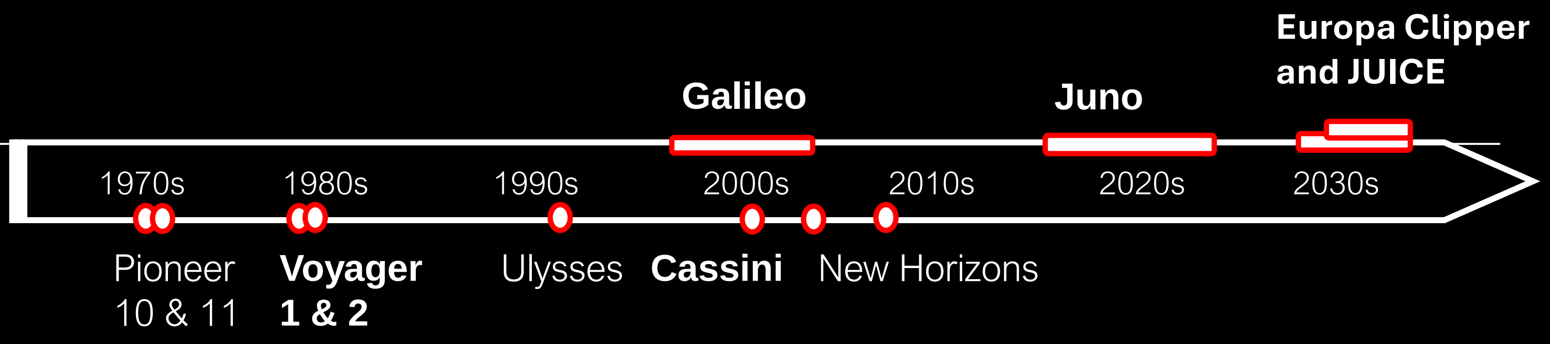
2016-now: JUNO

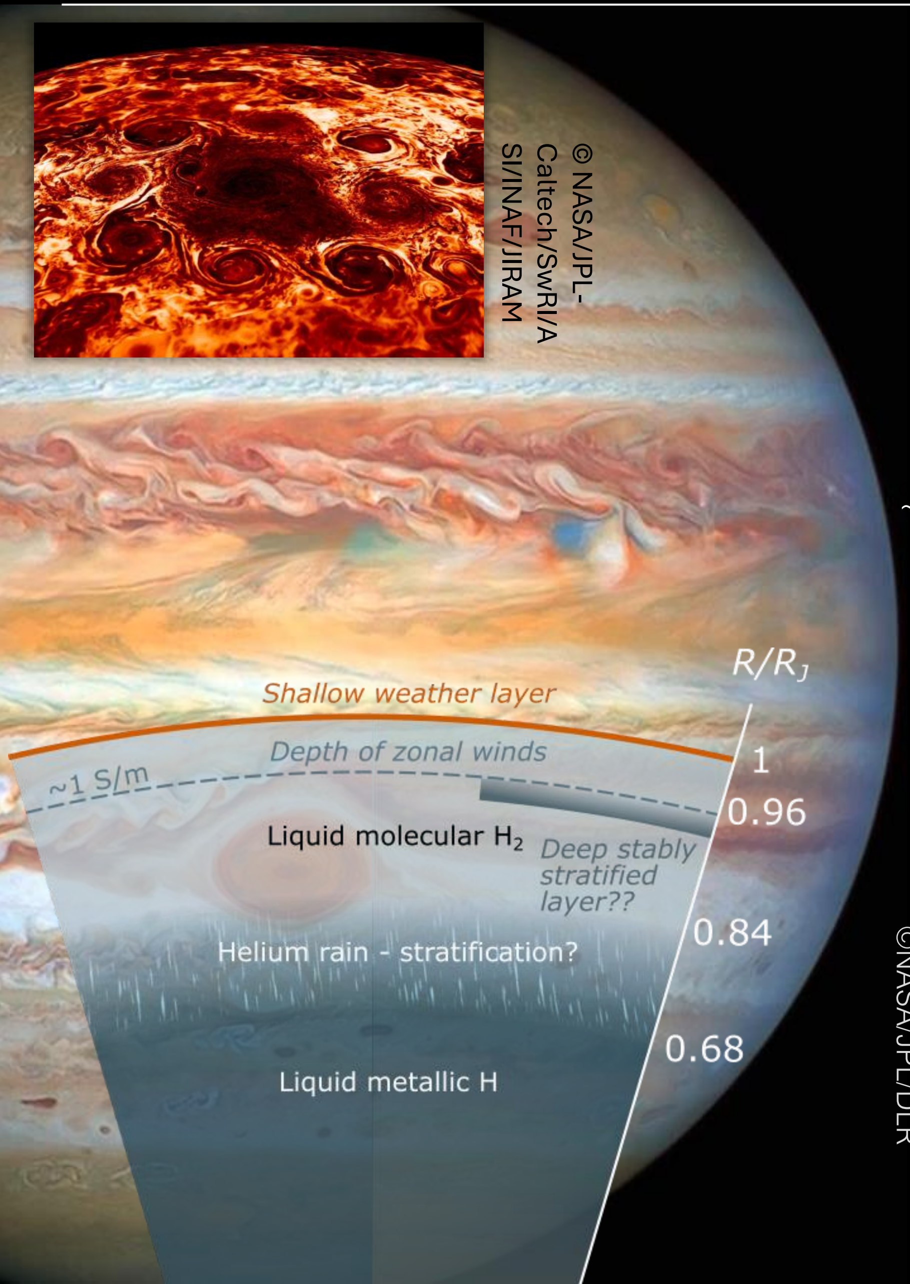
Wealth of space missions

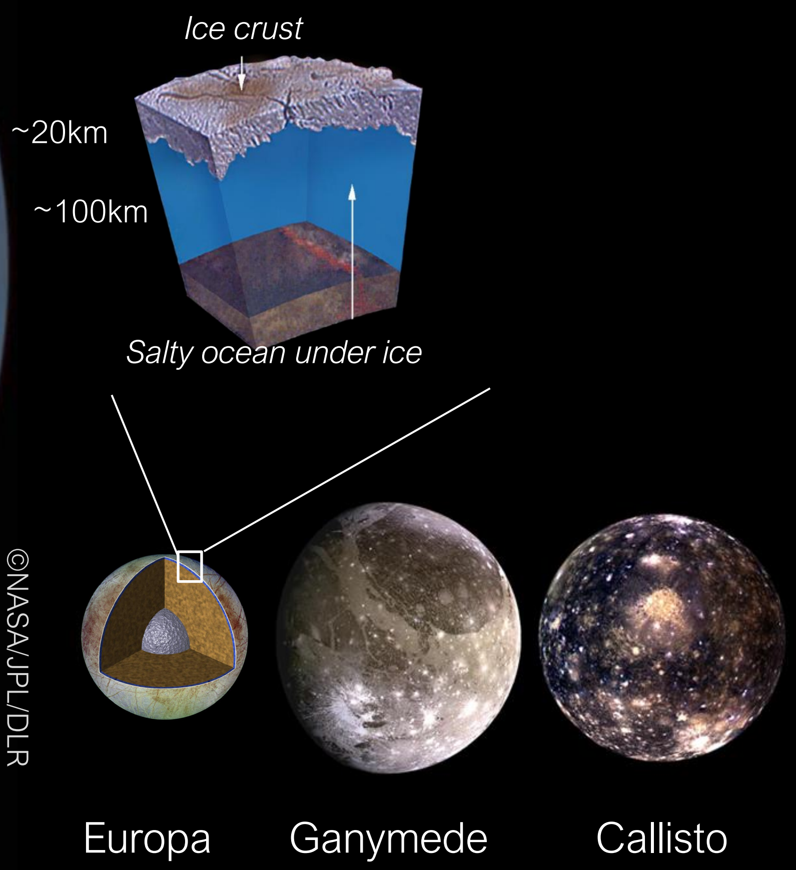
➔ Need for **physically-informed forward models**

2030-2034+: JUICE and EUROPA CLIPPER

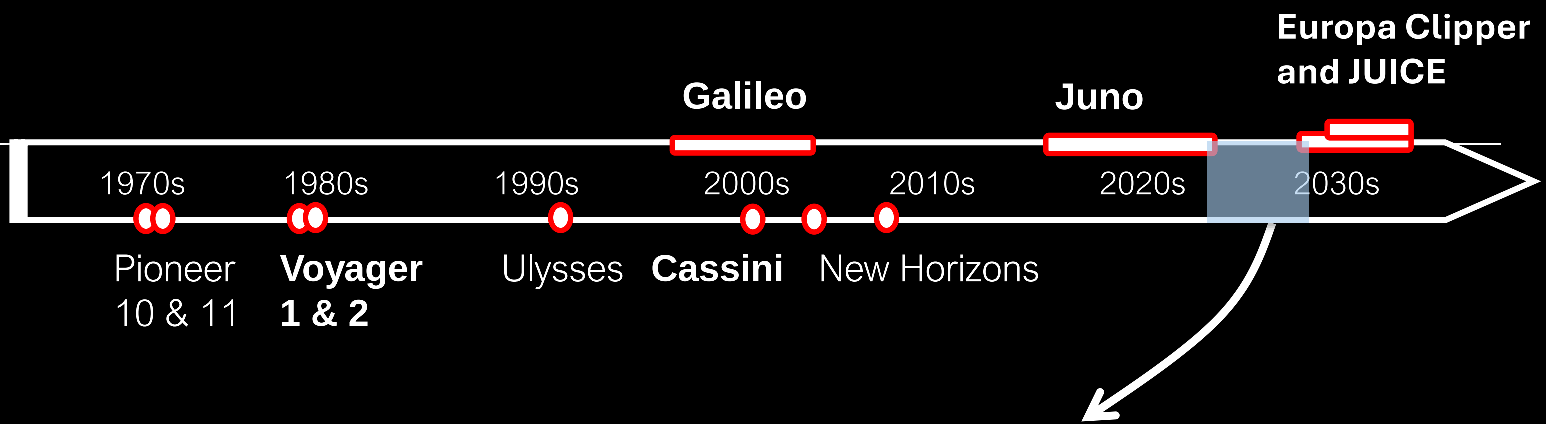
My research: challenge



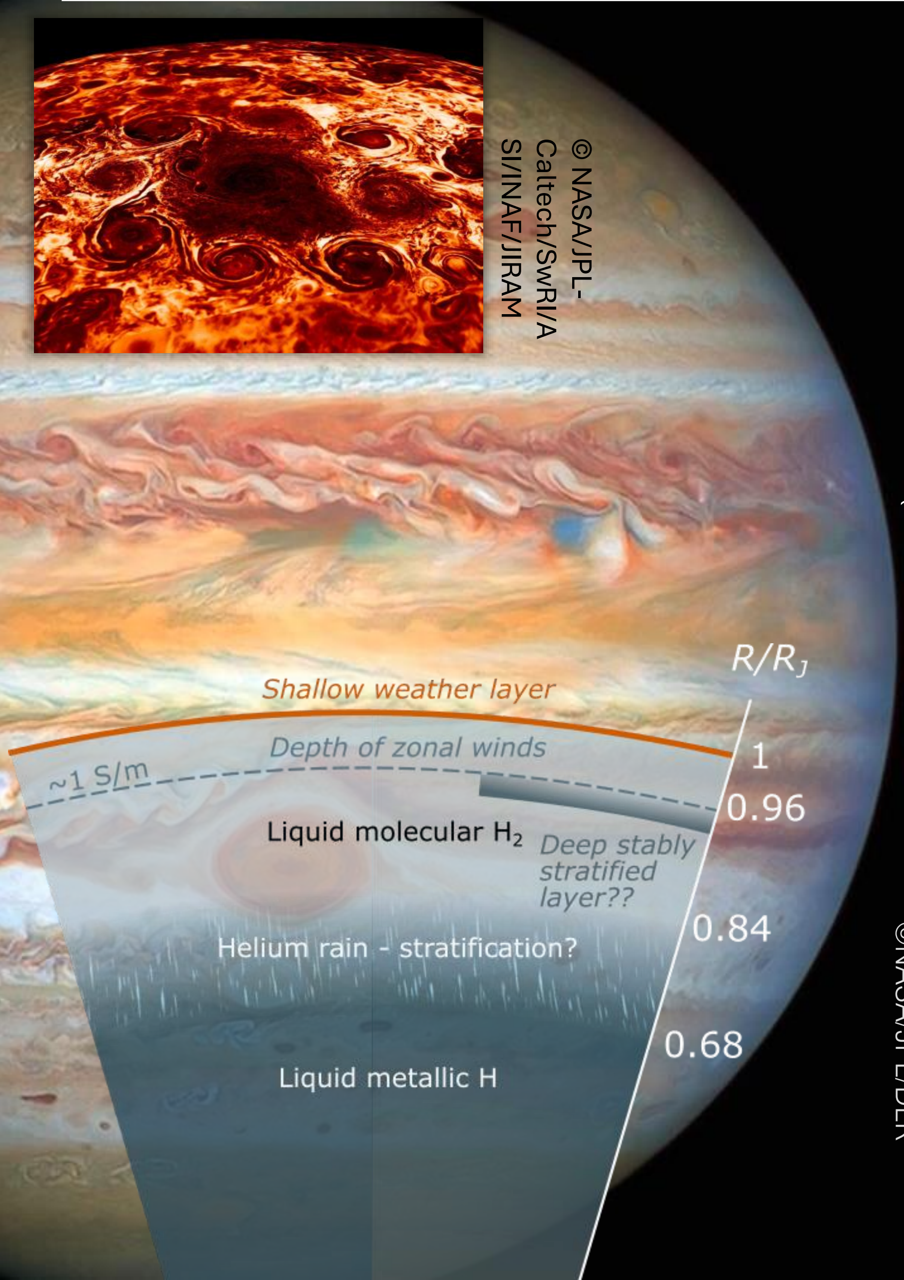


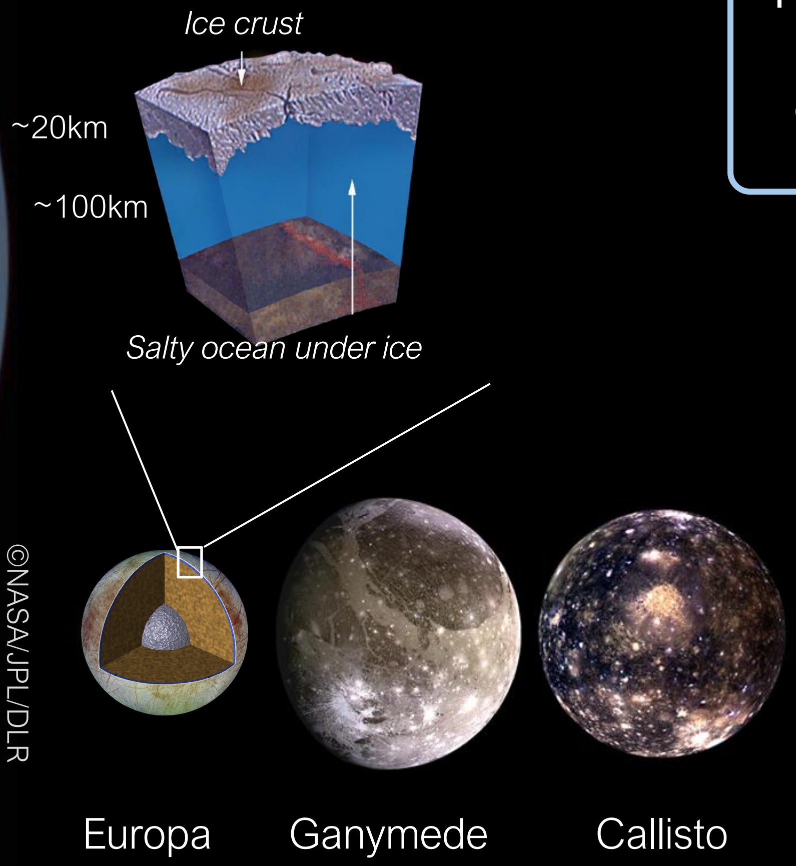


My research: challenge



My research: Build **self-consistent dynamical models** to match observations and interior models



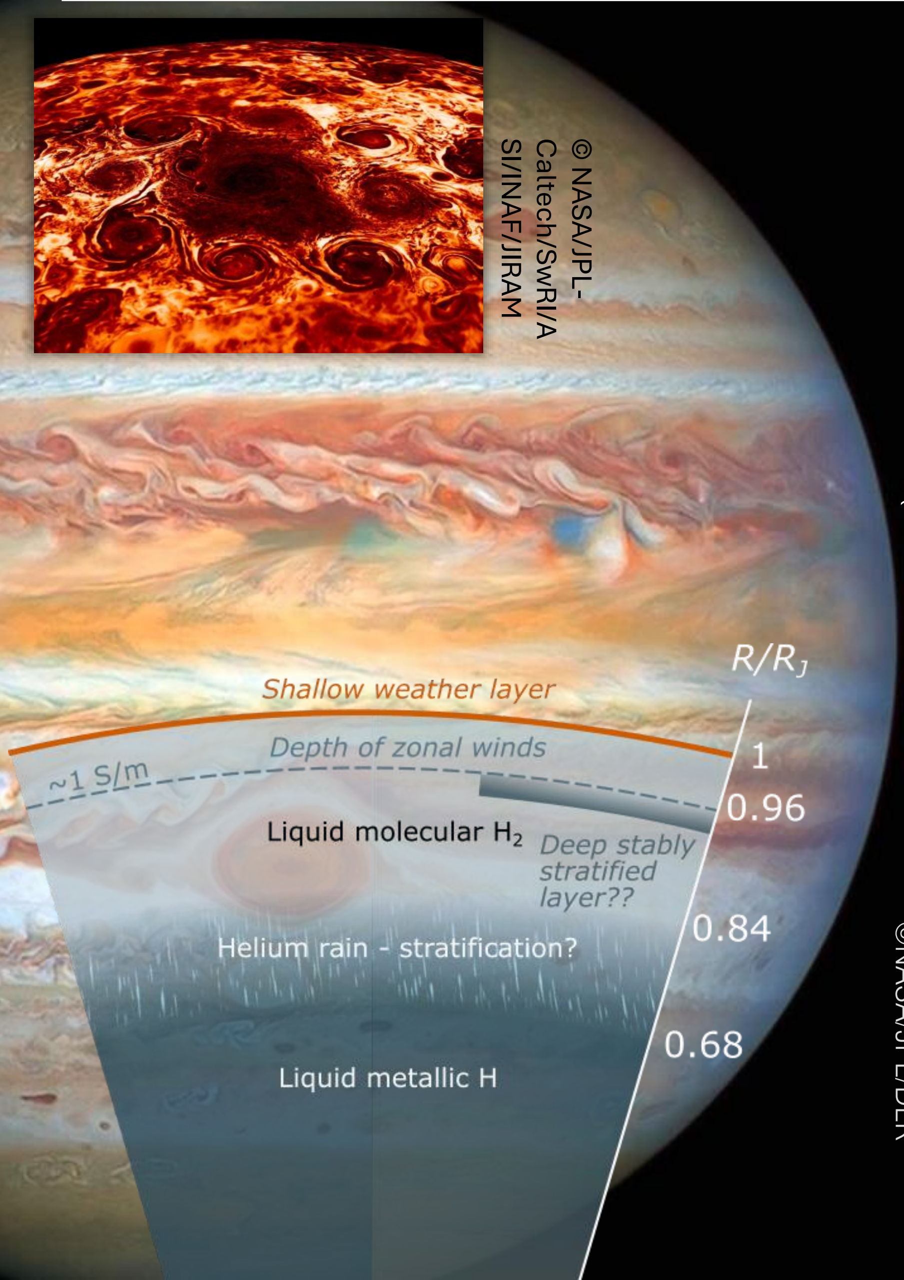


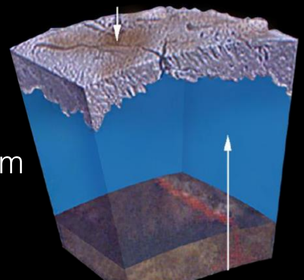
My research: challenge

- **Extreme dynamical regimes**
- Complex physical effects
- **Scales well** beyond our day-to-day experience

Fundamental fluid mechanics

My research: Build **self-consistent dynamical models** to match observations and interior models



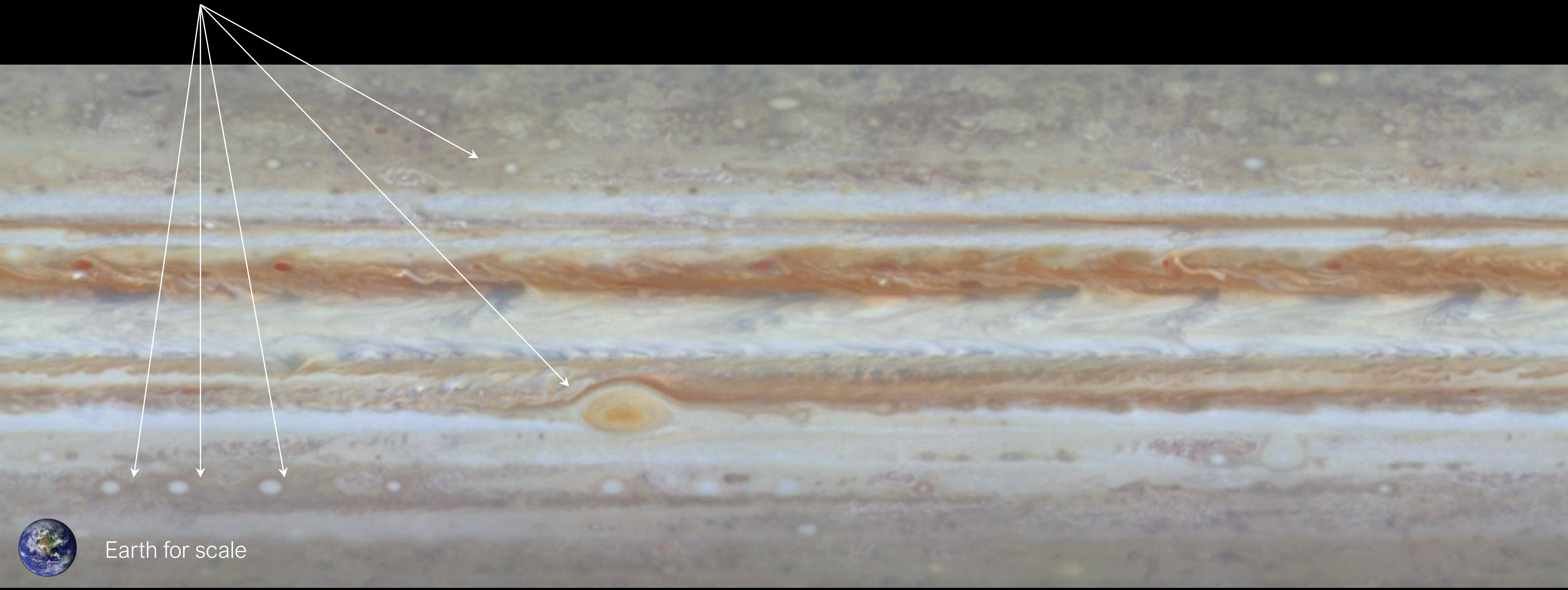


Europa Ganymede Callisto

My research: challenge

Midlatitudes dynamics

- Large scale vortices (Great Red Spot…)

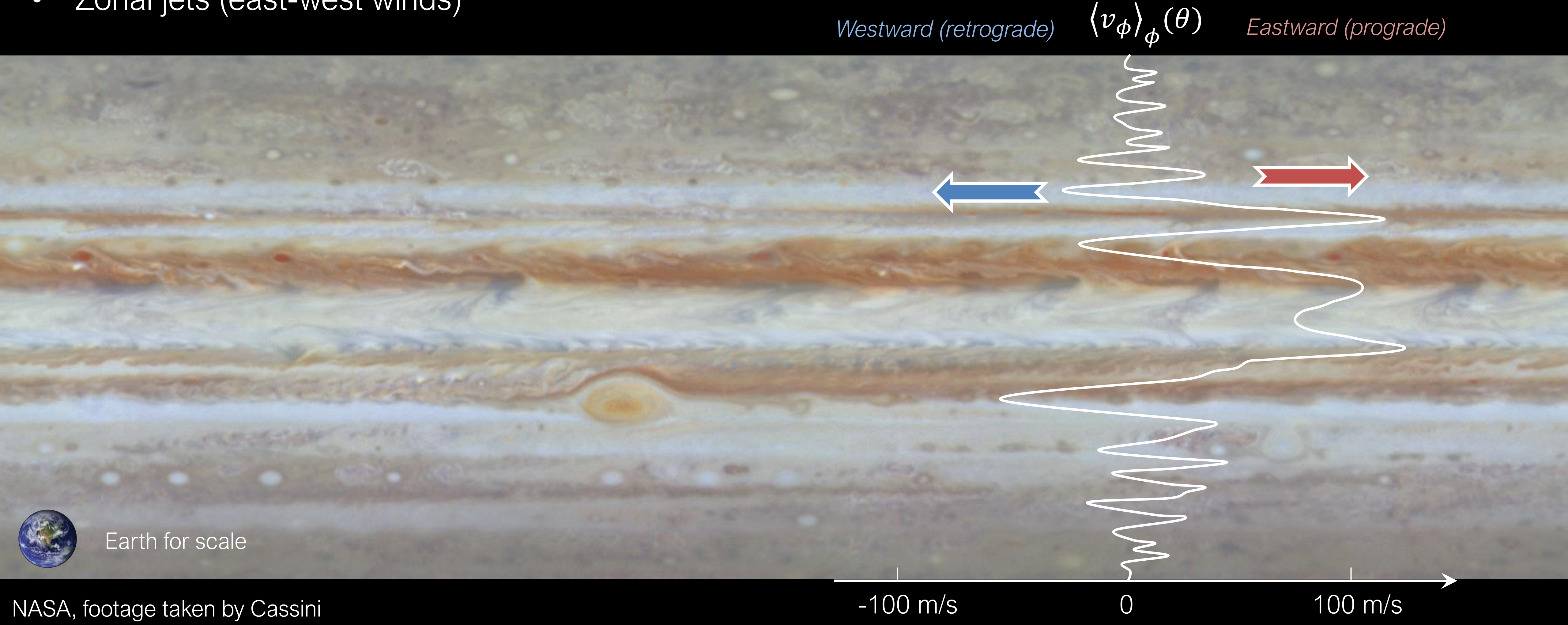


NASA, footage taken by Cassini
24 Jupiter rotations between Oct. 31 and Nov. 9, 2000

My research: challenge

Midlatitudes dynamics

- Large scale vortices (Great Red Spot…)
- Zonal jets (east-west winds)



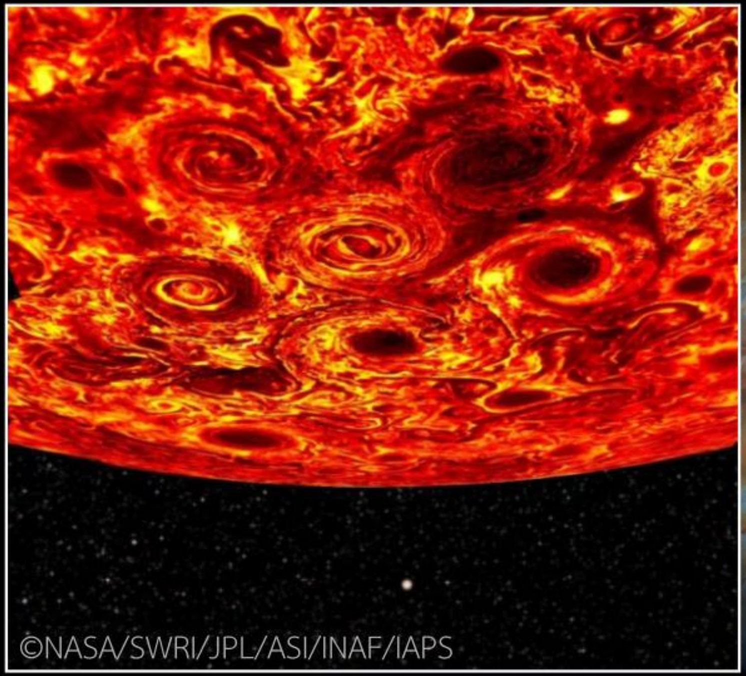
NASA, footage taken by Cassini
24 Jupiter rotations between Oct. 31 and Nov. 9, 2000

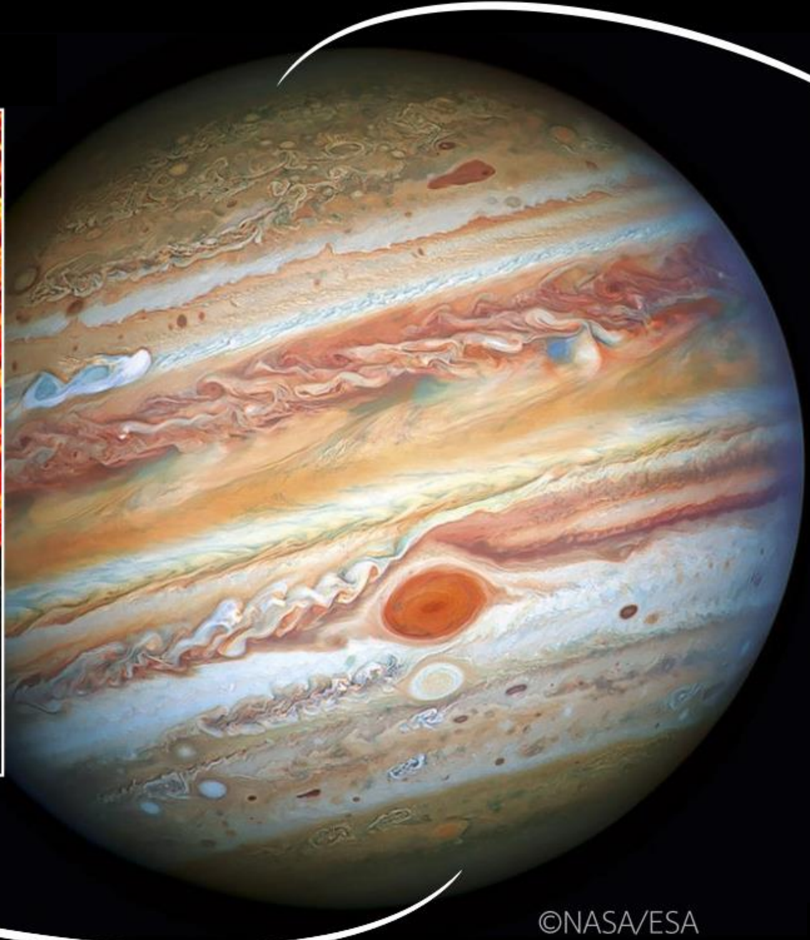
Jupiter's dynamic picture

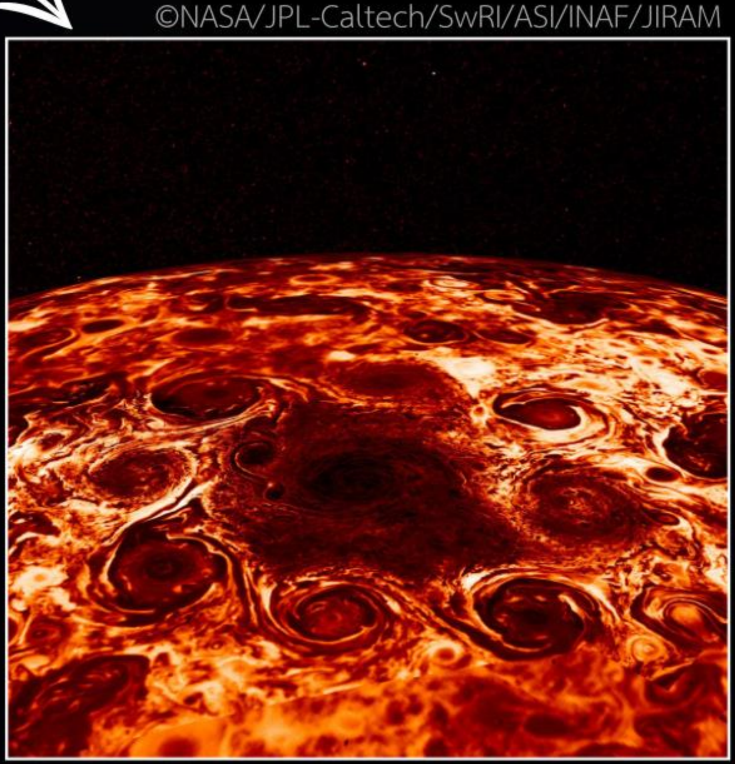
High-latitudes dynamics

- No more zonal jets
- Polygonal clusters of cyclones

Pentagon of cyclones (South Pole)







Octogon of cyclones (North Pole)

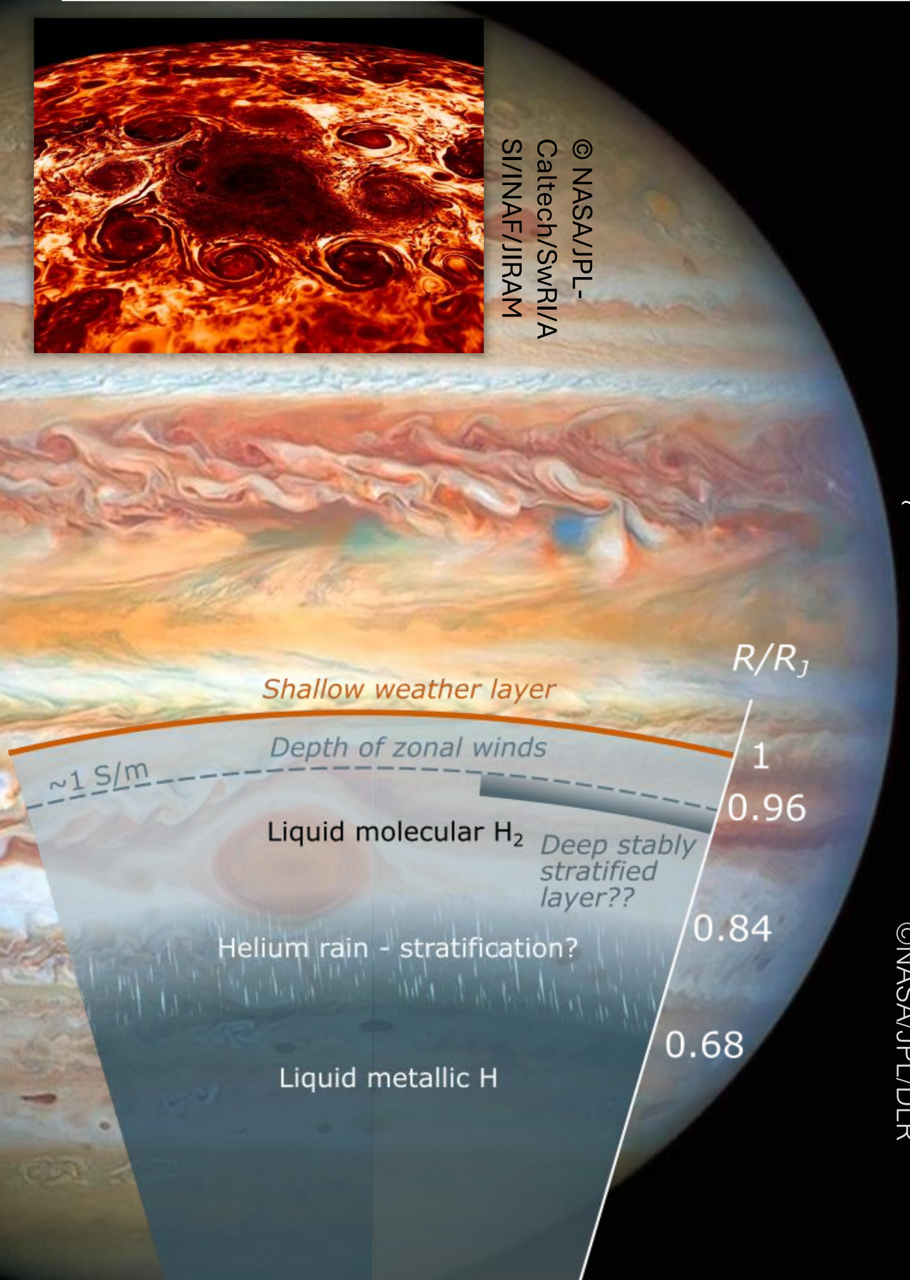
My research: challenge

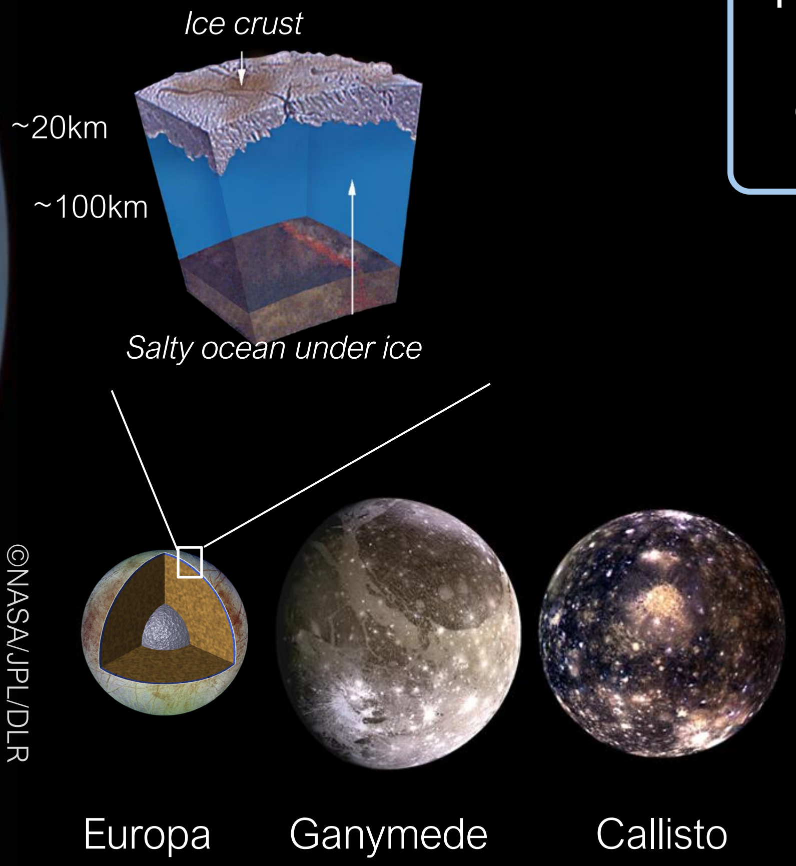
- **Extreme dynamical regimes**
- Complex physical effects
- **Scales** well beyond our day-to-day experience

Fundamental fluid mechanics

My research: Build **self-consistent dynamical models** to match observations and interior models

TREMENDOUS INTERDISCIPLINARY CHALLENGE DESPITE MORE THAN A CENTURY OF INTENSE RESEARCH!





My research: challenge

- **Extreme dynamical regimes**
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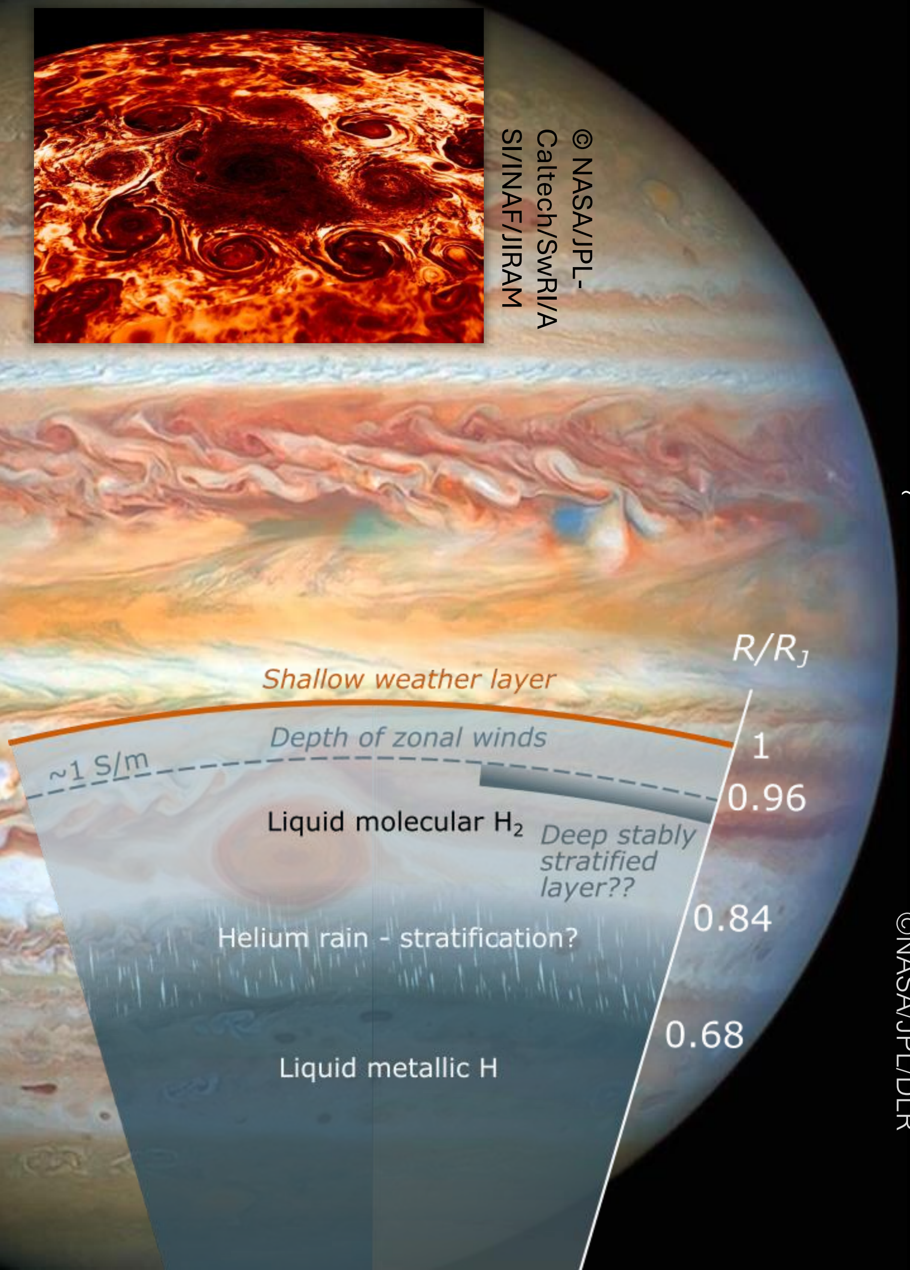
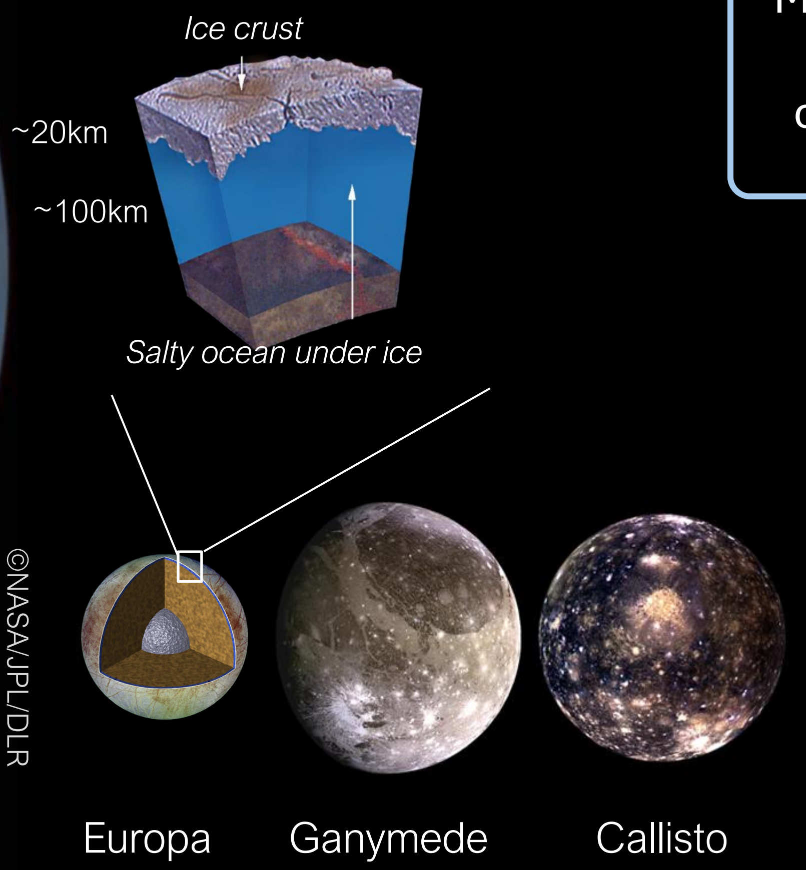
Fundamental fluid mechanics

My research: Build **self-consistent dynamical models** to match observations and interior models

My strategy:

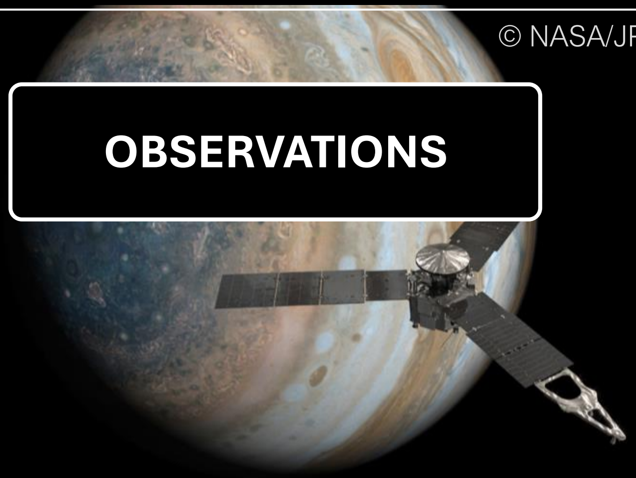
Process-oriented approach + Multi-method modelling





My research: approach/methods

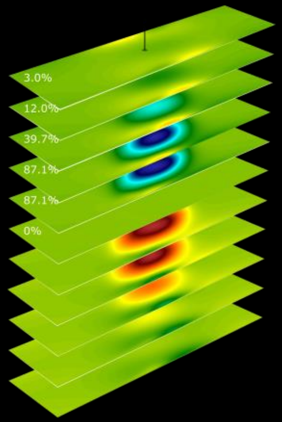
OBSERVATIONS



Experiments

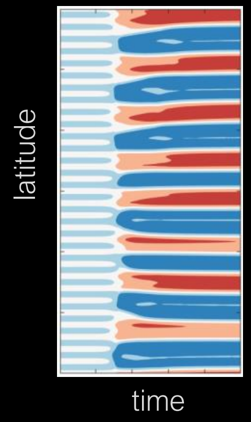
Lemasquerier+ 2021, 2023

Numerical models



Lemasquerier+ 2020

Theory



Lemasquerier (in prep.)

IDEALIZED MODELS

My research: approach/methods

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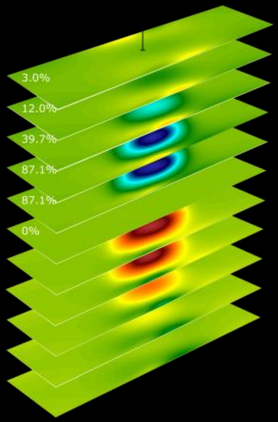
OBSERVATIONS

Experiments

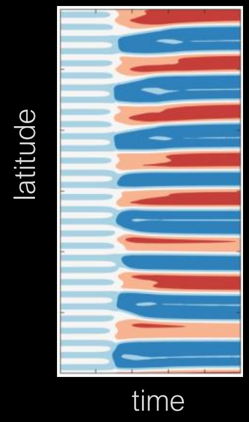
Lemasquerier+ 2021, 2023

Numerical models



Lemasquerier+ 2020

Theory

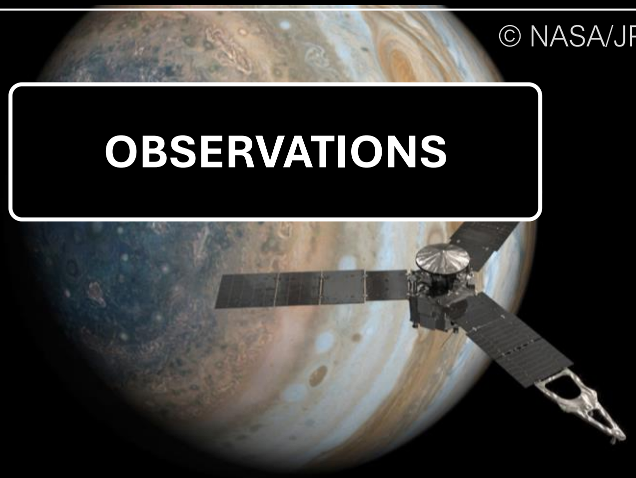


Lemasquerier (in prep.)

IDEALIZED MODELS

- ❖ Fundamentally improve our **understanding** of key physical processes (**generic results**)

My research: approach/methods



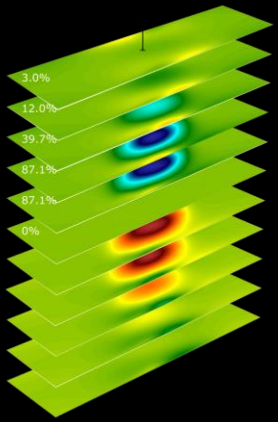
OBSERVATIONS

Inform the design of

Experiments

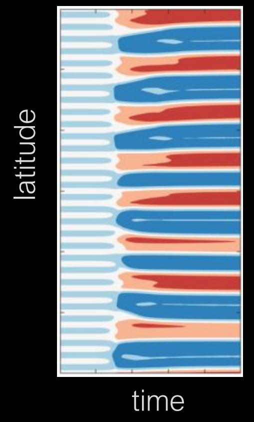
Lemasquerier+ 2021, 2023

Numerical models



Lemasquerier+ 2020

Theory



Lemasquerier (in prep.)

IDEALIZED MODELS

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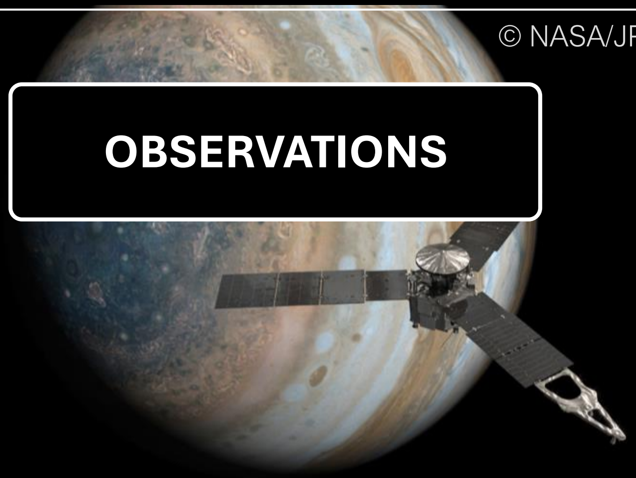
My research: approach/methods



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OBSERVATIONS

- Deduce properties **inaccessible to direct measurements**
- Evaluate deep flows **signatures in available observational data**

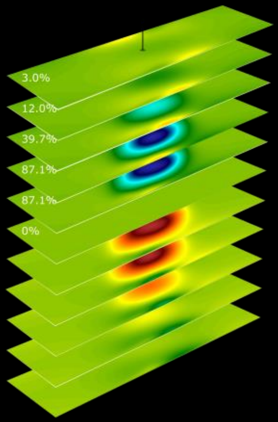
Inform the design of

Make predictions for

Experiments

Lemasquerier+ 2021, 2023

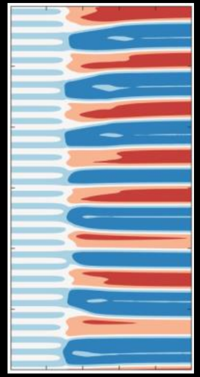
Numerical models



Lemasquerier+ 2020

Theory

latitude



time

Lemasquerier (in prep.)

IDEALIZED MODELS

- Fundamentally improve our **understanding** of key physical processes (**generic results**)

My research: approach/methods

Planetary science

- Deduce properties **inaccessible to direct measurements**
- Evaluate deep flows **signatures in available observational data**

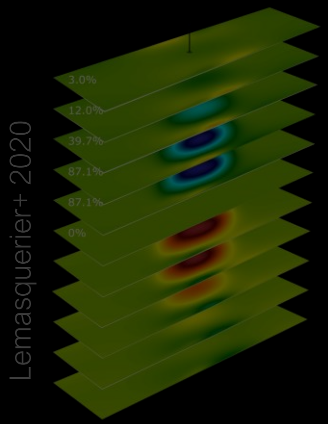
OBSERVATIONS

Inform the design of

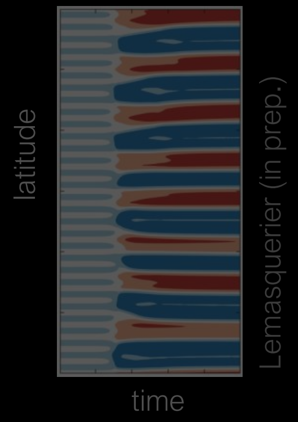
Make predictions for

Experiments

Numerical models



Theory



IDEALIZED MODELS

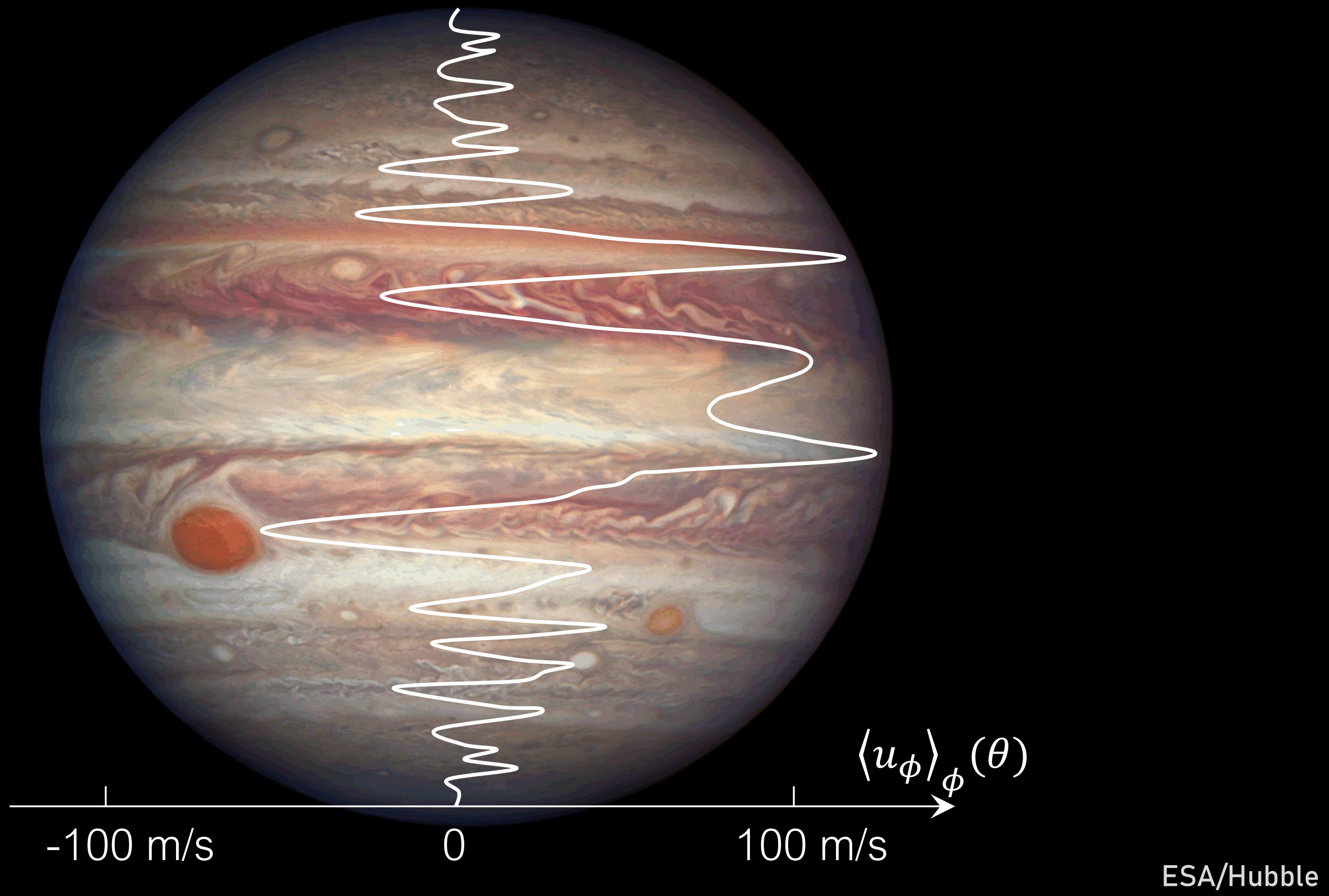
Fluids Dynamics and Mathematics

- Fundamentally improve our **understanding** of key physical processes (**generic results**)

1. First example: an experimental analog

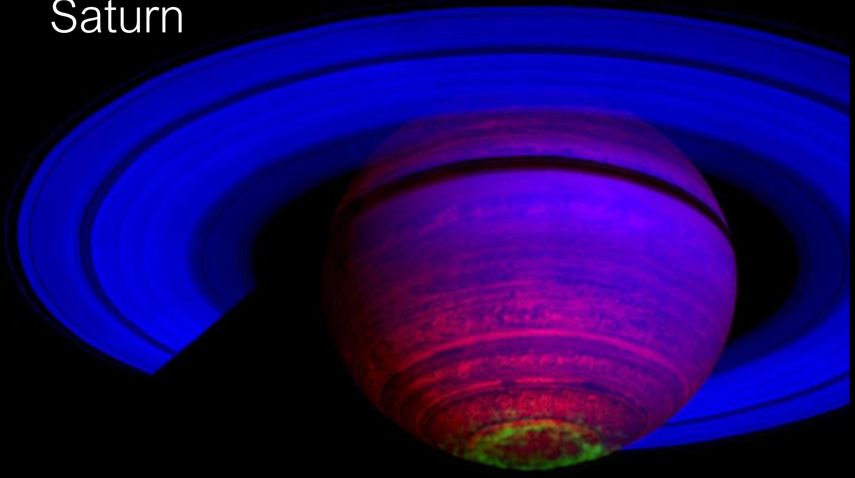
A laboratory model of zonal jets formation

with: Simon Cabanes, Benjamin Favier, Michael Le Bars, Jon Aurnou



Zonal jets in other systems

Saturn



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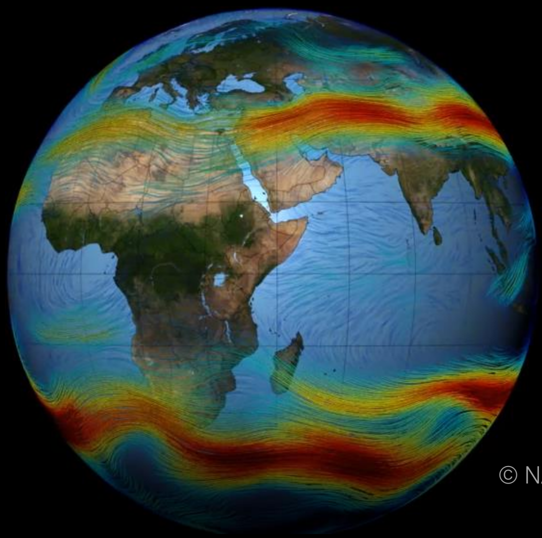
Terrestrial atmospheres



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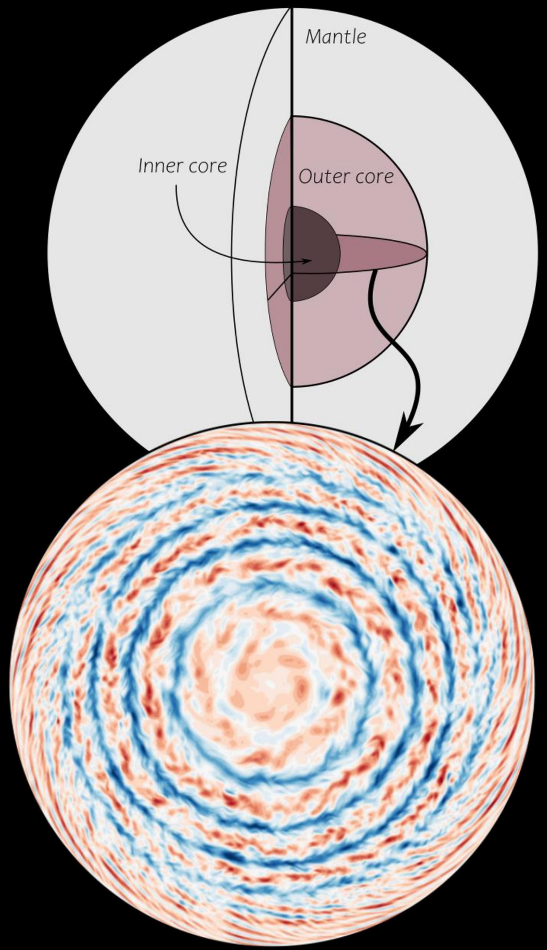
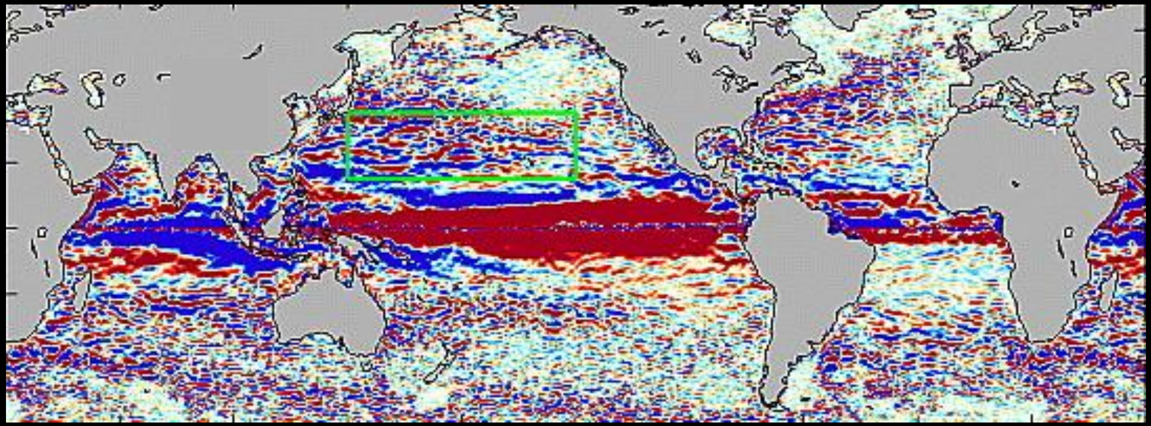
Liquid outer cores

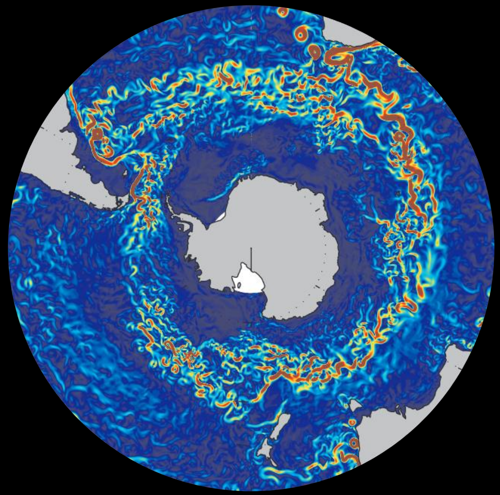


[Guervilly & Cardin, JGI 2017]

Earth's oceans



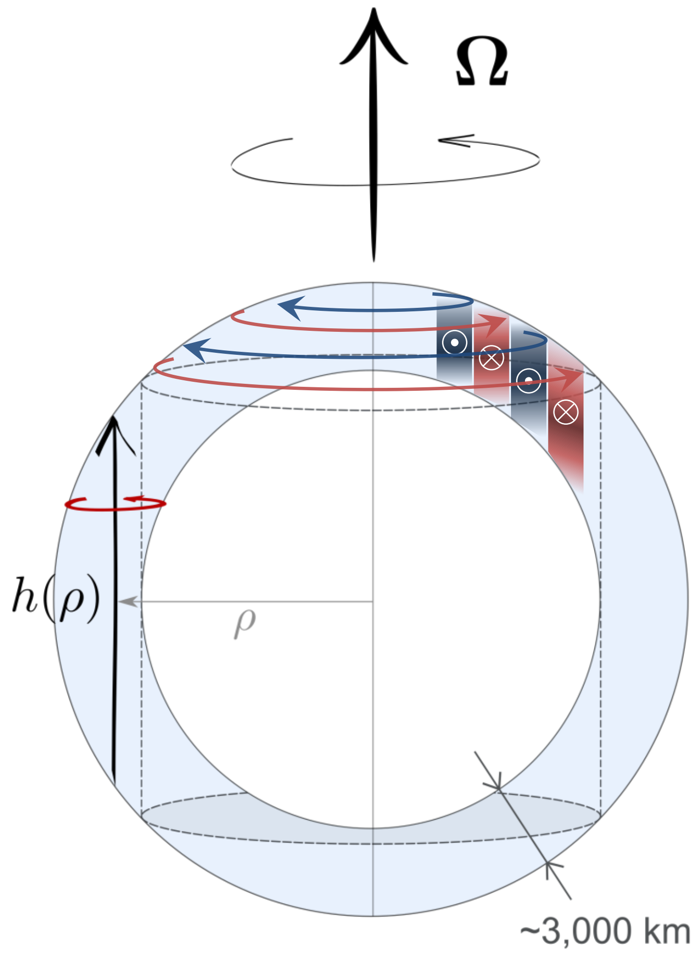
[Maximenko et al., GRL, 2005]



[Abernathey et al., JPO, 2010]

I. A laboratory model of zonal jets

1. Fundamental physical ingredients



1 Rotationally-constrained flow
(quasi-2D, inverse cascade of energy)

[Aubert at al., SpinLab, UCLA]

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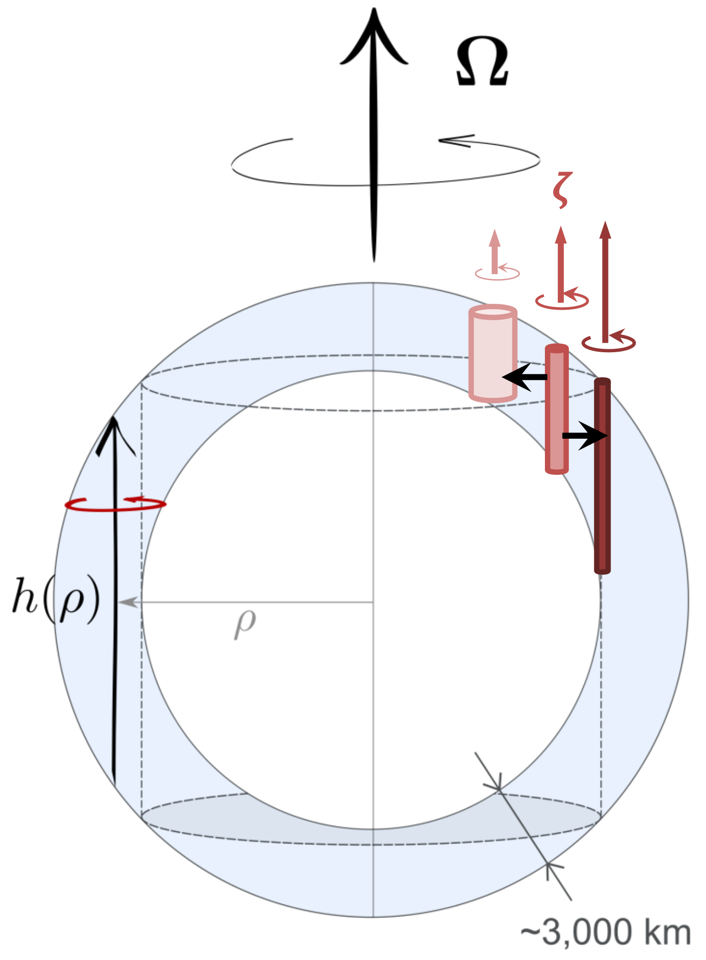
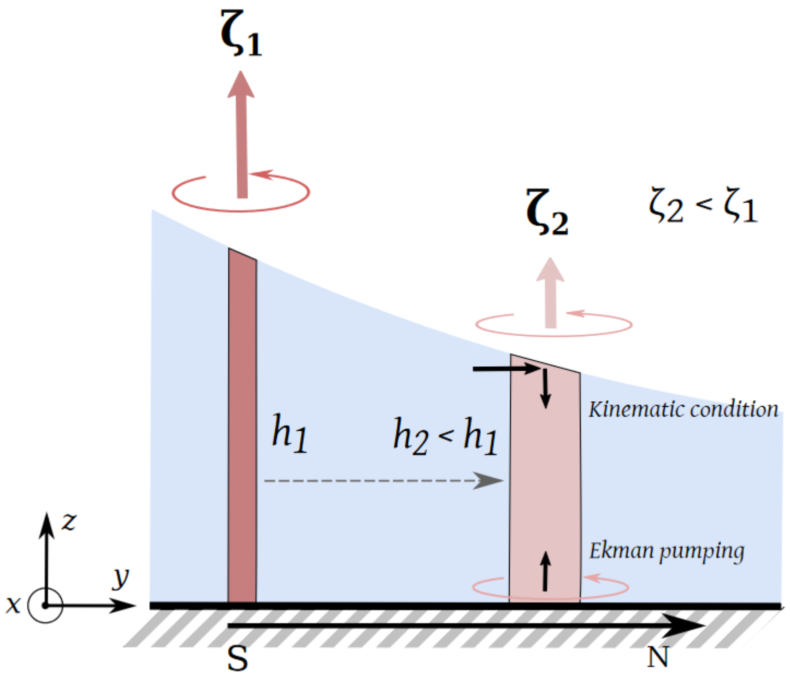


1 Rotationally-constrained flow
(quasi-2D, inverse cascade of energy)

2 Beta-effect
(topography variations)

$$\frac{D}{Dt}\frac{\zeta + 2\Omega}{h} = 0$$



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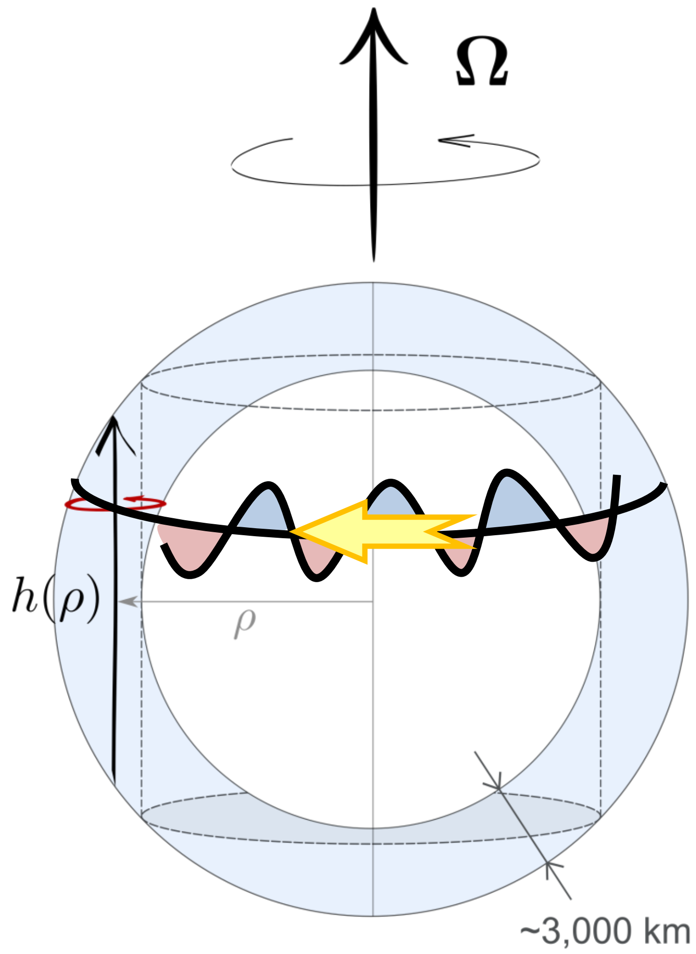

1 Rotationally-constrained flow
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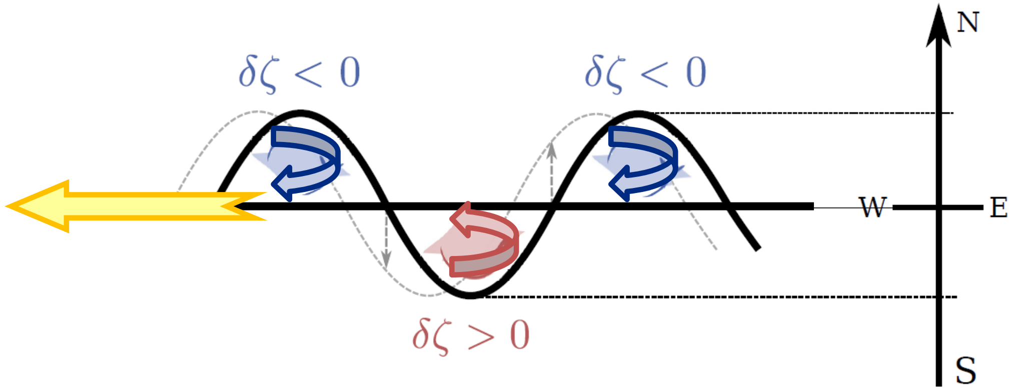
2 Beta-effect
(topography variations) → **Rossby waves**

$$\frac{D}{Dt}\frac{\zeta + 2\Omega}{h} = 0$$



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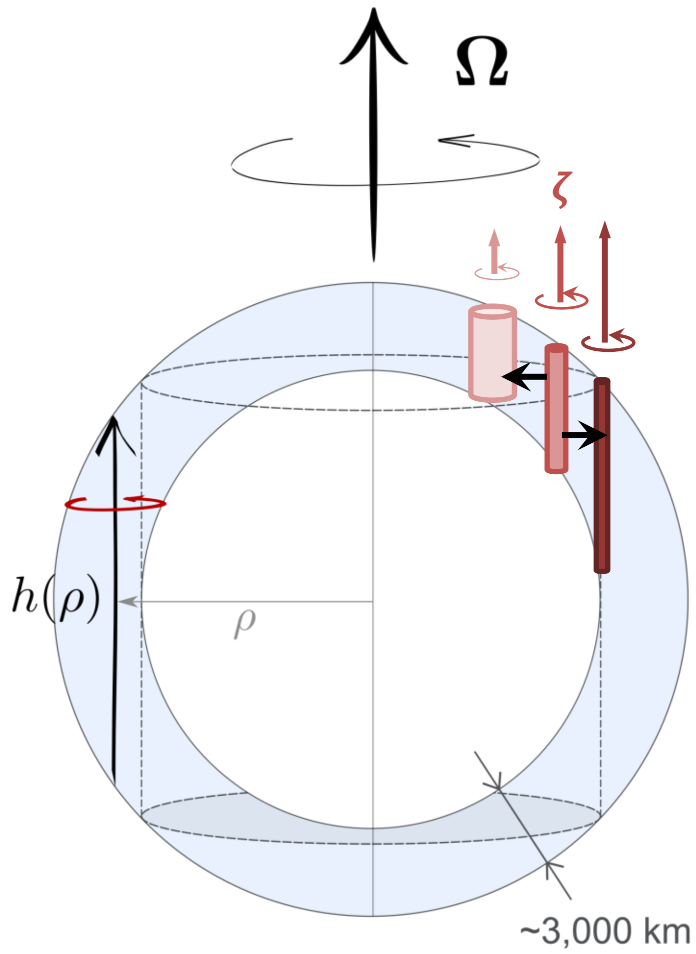

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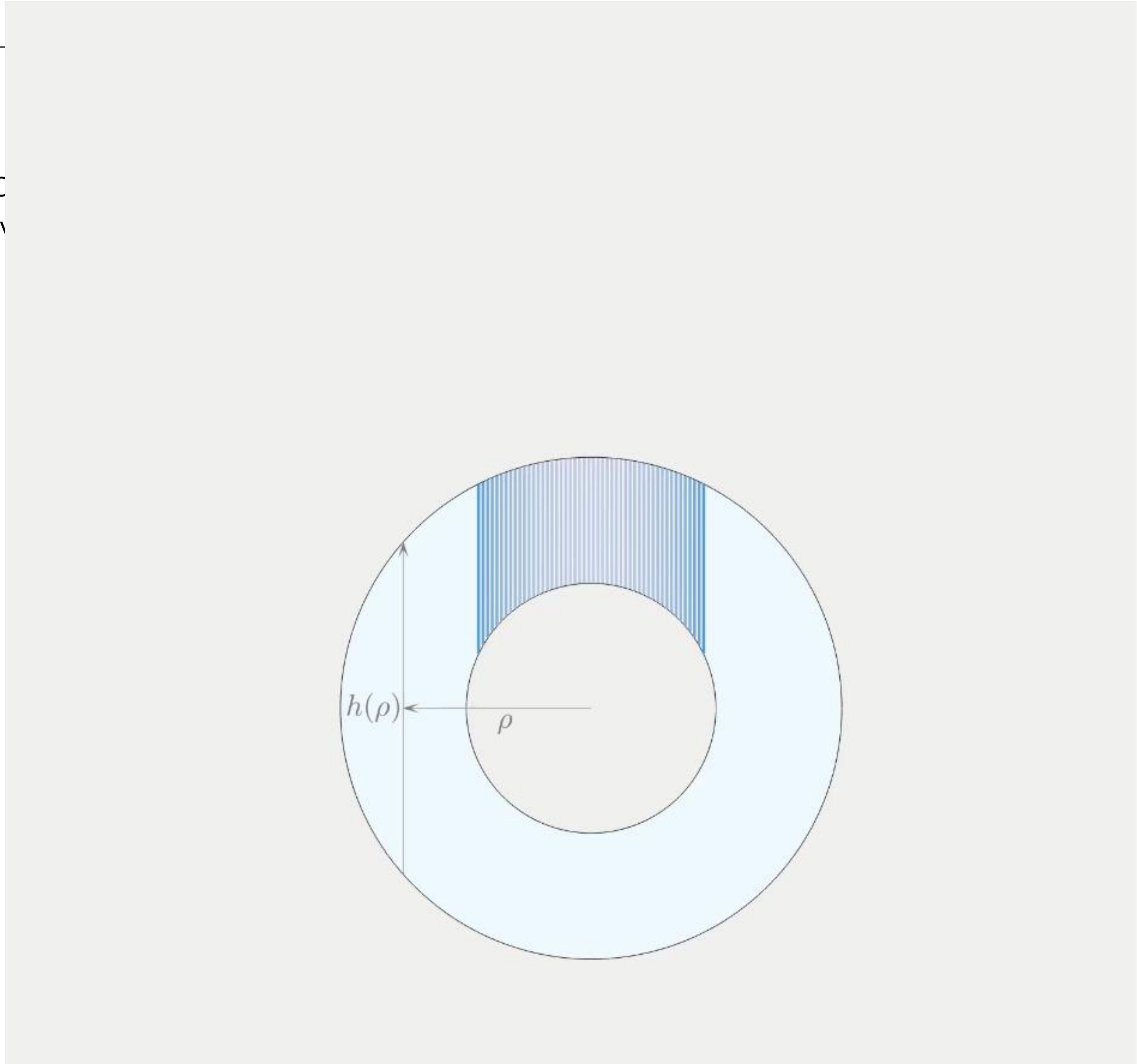
(quasi-2D, inv

2 Beta-effect
(topography



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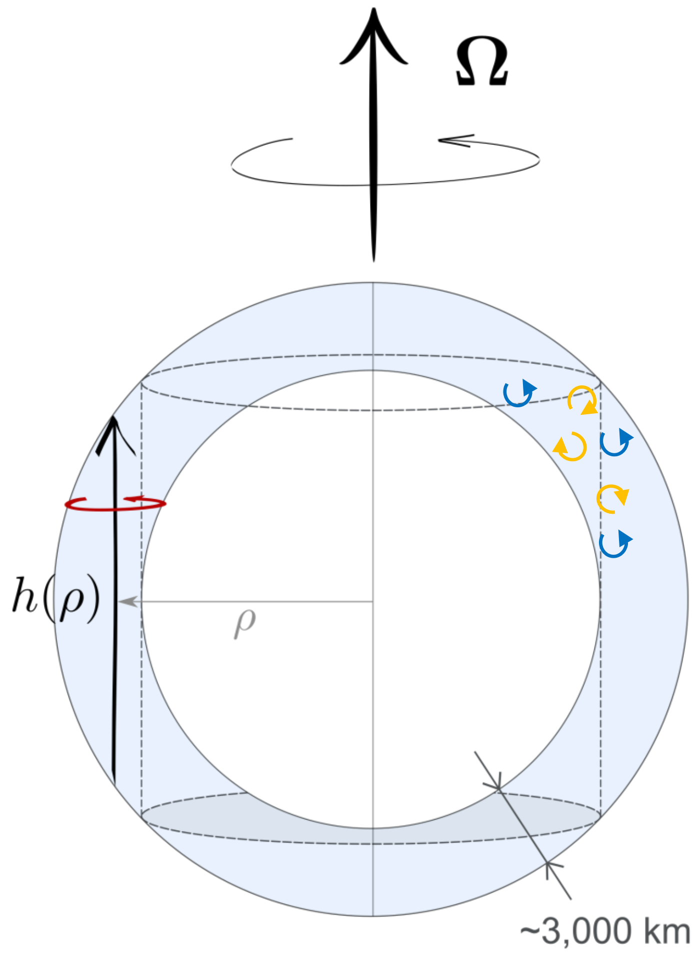


1 Rotationally-constrained flow
(quasi-2D, inverse cascade of energy)

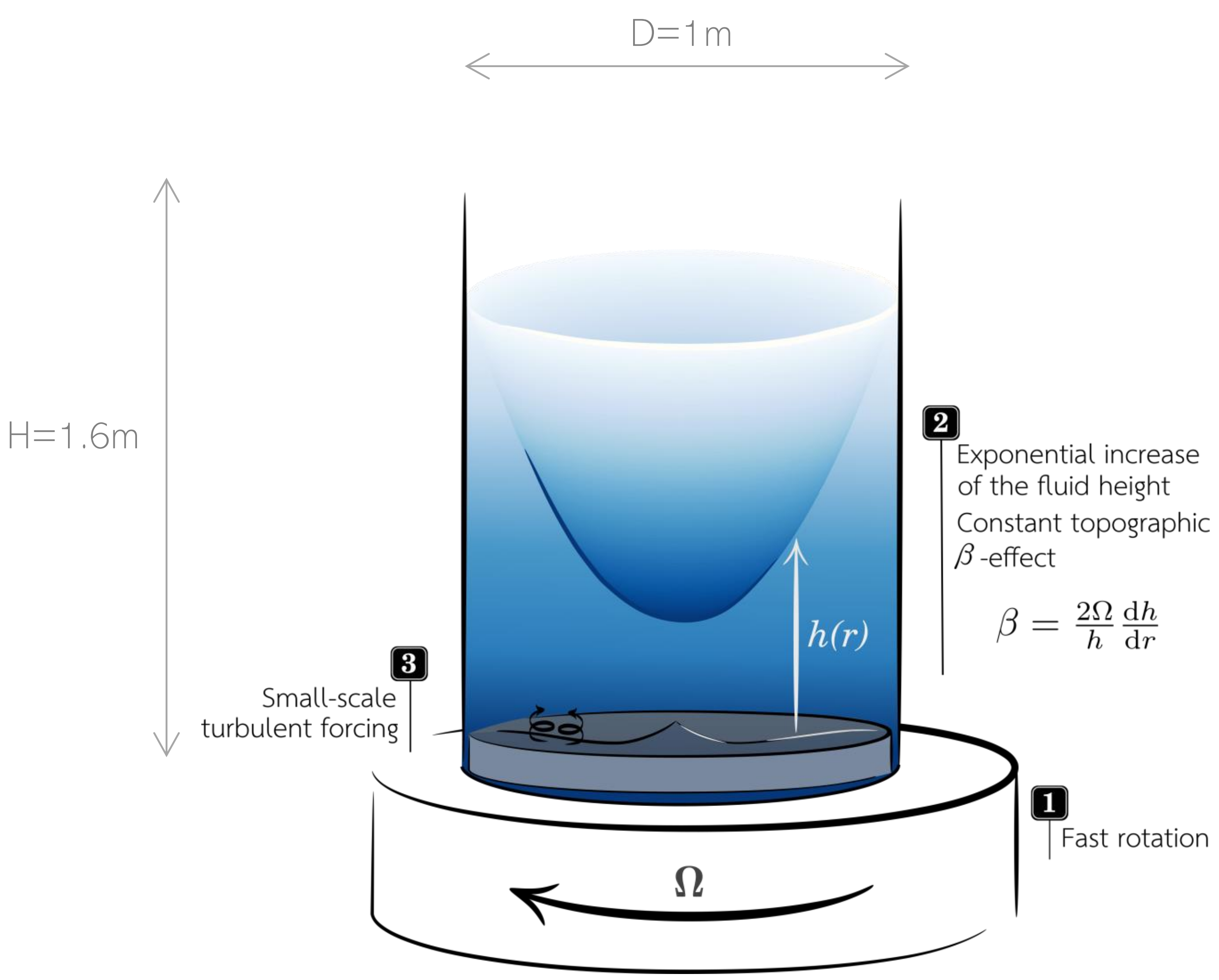
2 Beta-effect
(topography variations)

3 Forcing

- Moist convection
- Baroclinic instabilities
- Deep, small-scale thermal convection

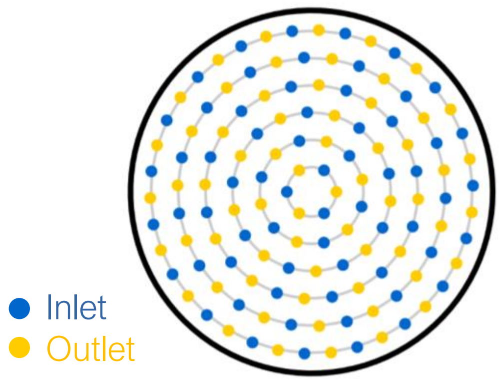
I. A laboratory model of zonal jets

3. Experimental setup



Dimensional parameters

- ✓ β = 50 $m^{-1}s^{-1}$
- ✓ H = 58 cm (~600L water)
- ✓ Ω = 75 RPM = 1.25 Hz
- ✓ U ~mm/s to cm/s

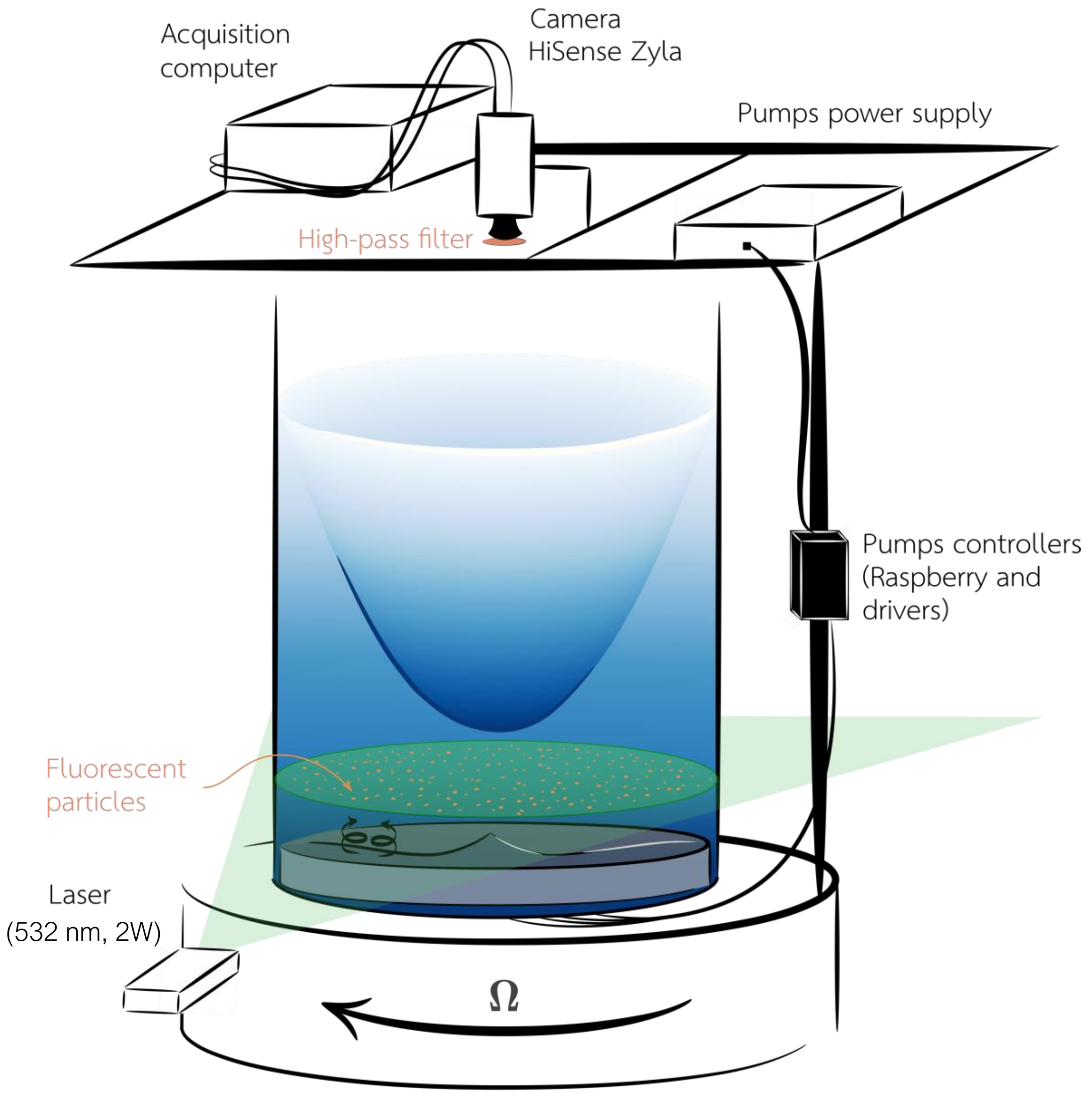


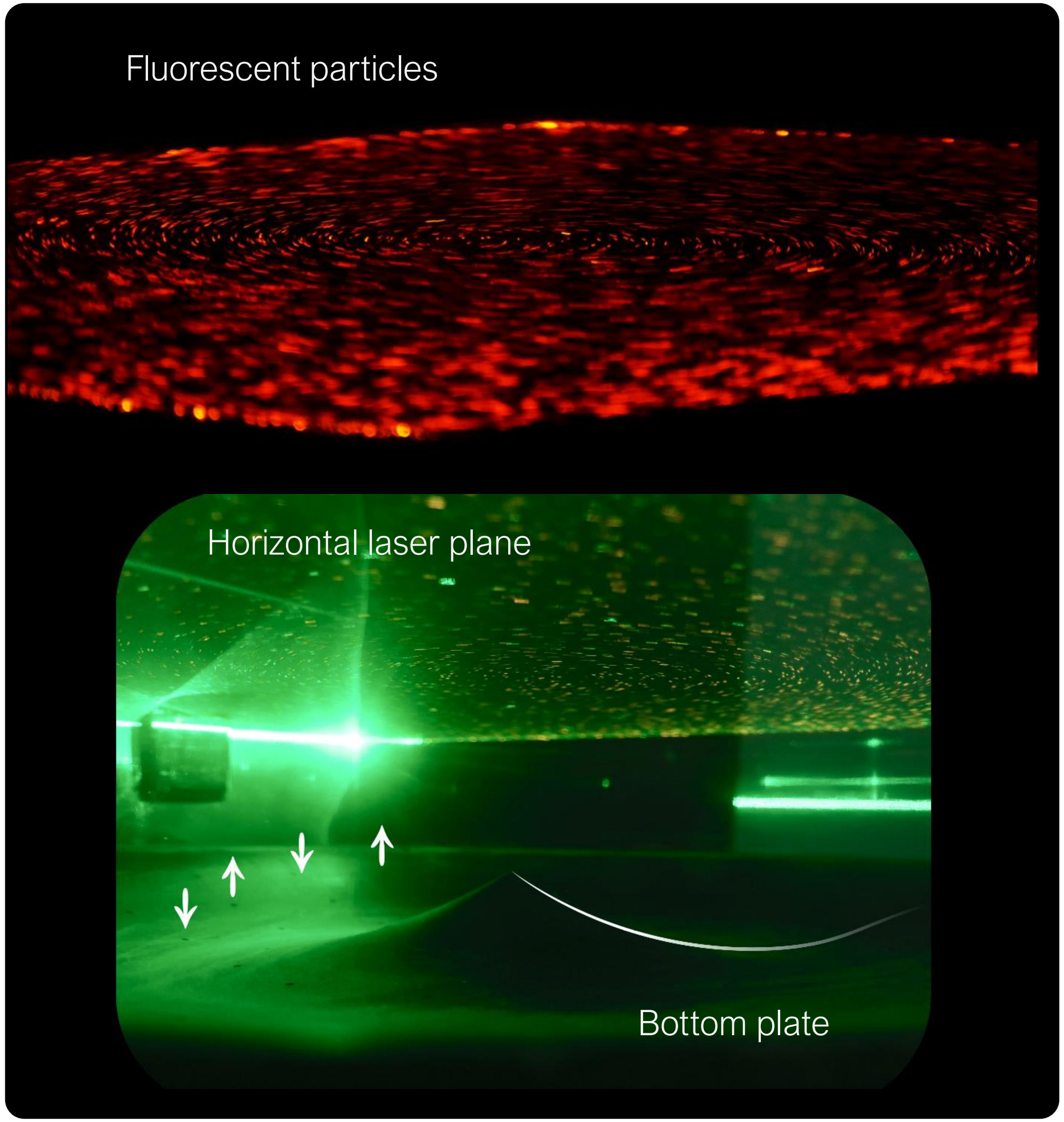
Forcing

- « Direct » (no instability)
- Zonal average = zero by construction
- 6 independent pumps
- Remote control

I. A laboratory model of zonal jets

3. Experimental setup





I. A laboratory model of zonal jets

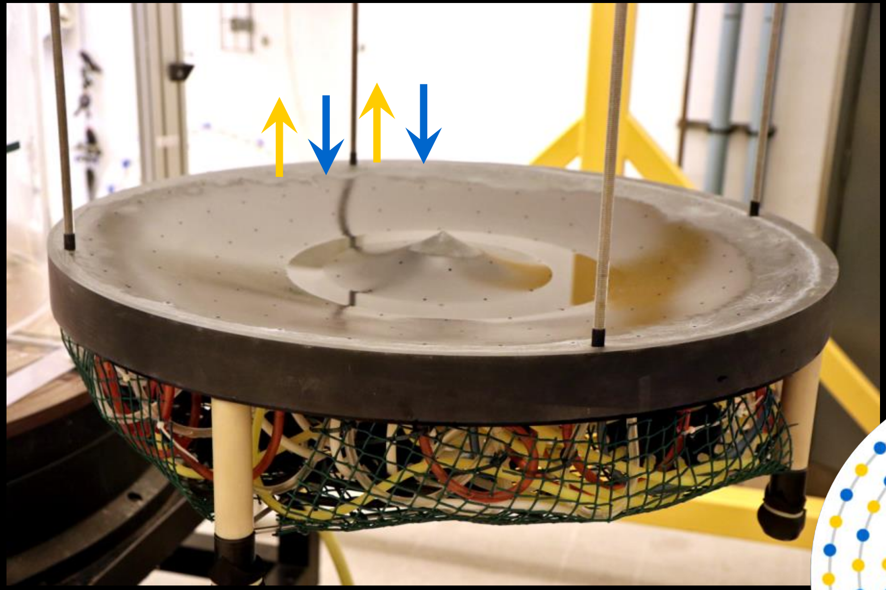
3. Experimental setup

The experiment at rest

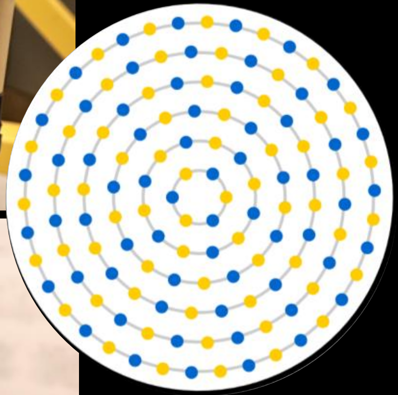
I. A laboratory model of zonal jets

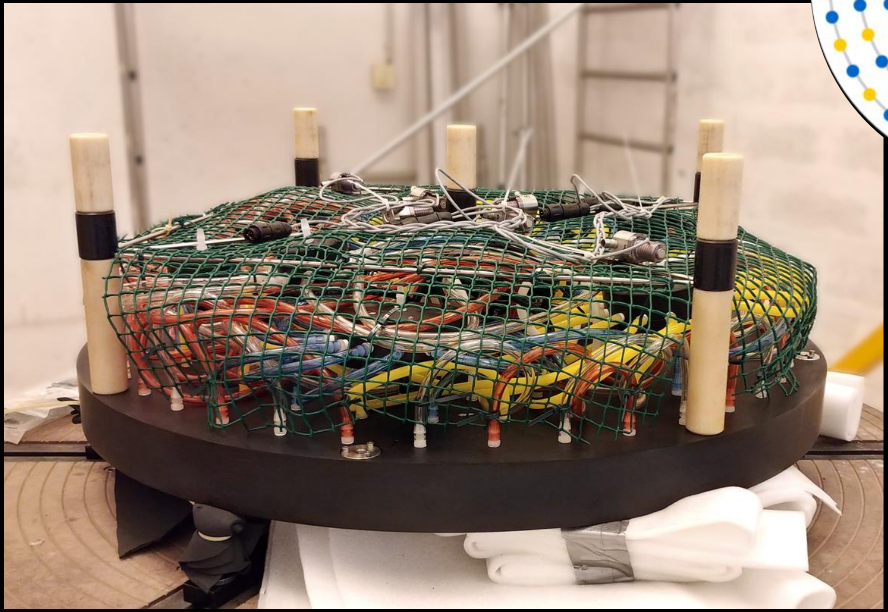
3. Experimental setup

The experiment at rest



128 inlets/outlets distributed on 6 rings



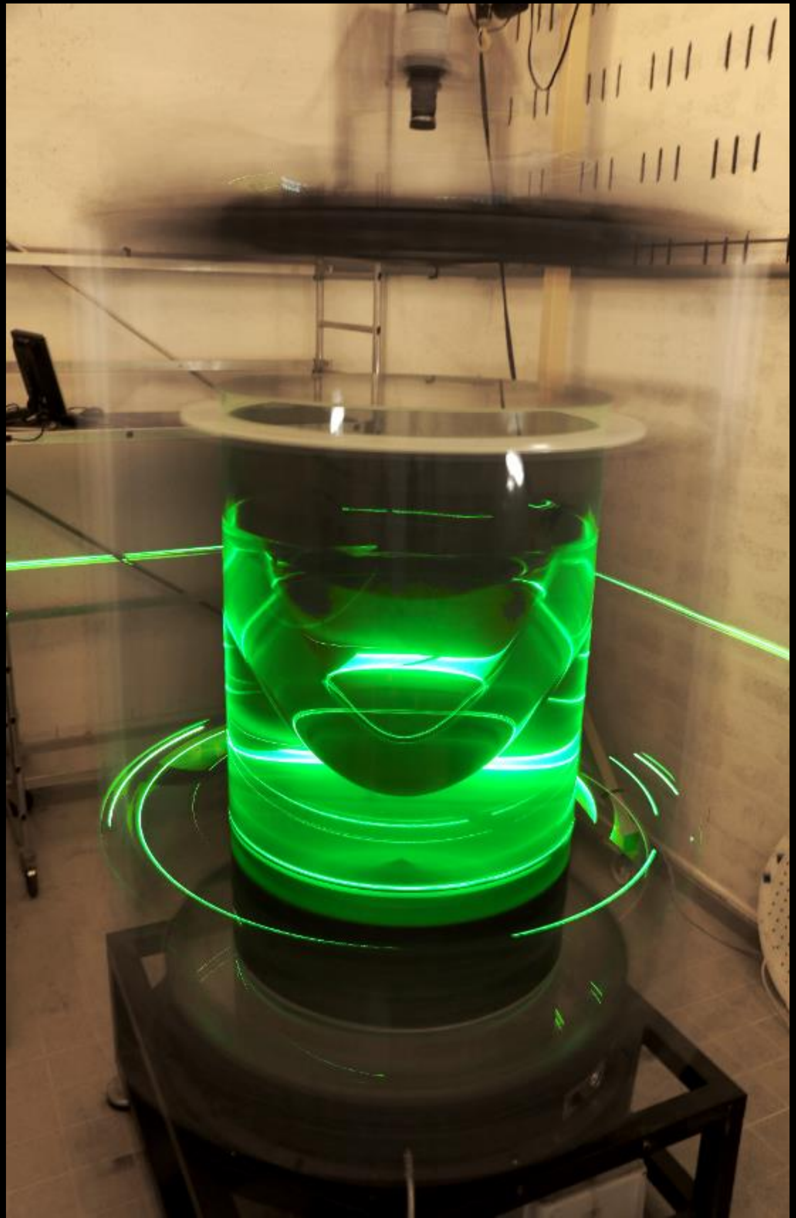


A mess of about 120 meters of hoses!

I. A laboratory model of zonal jets

3. Experimental setup

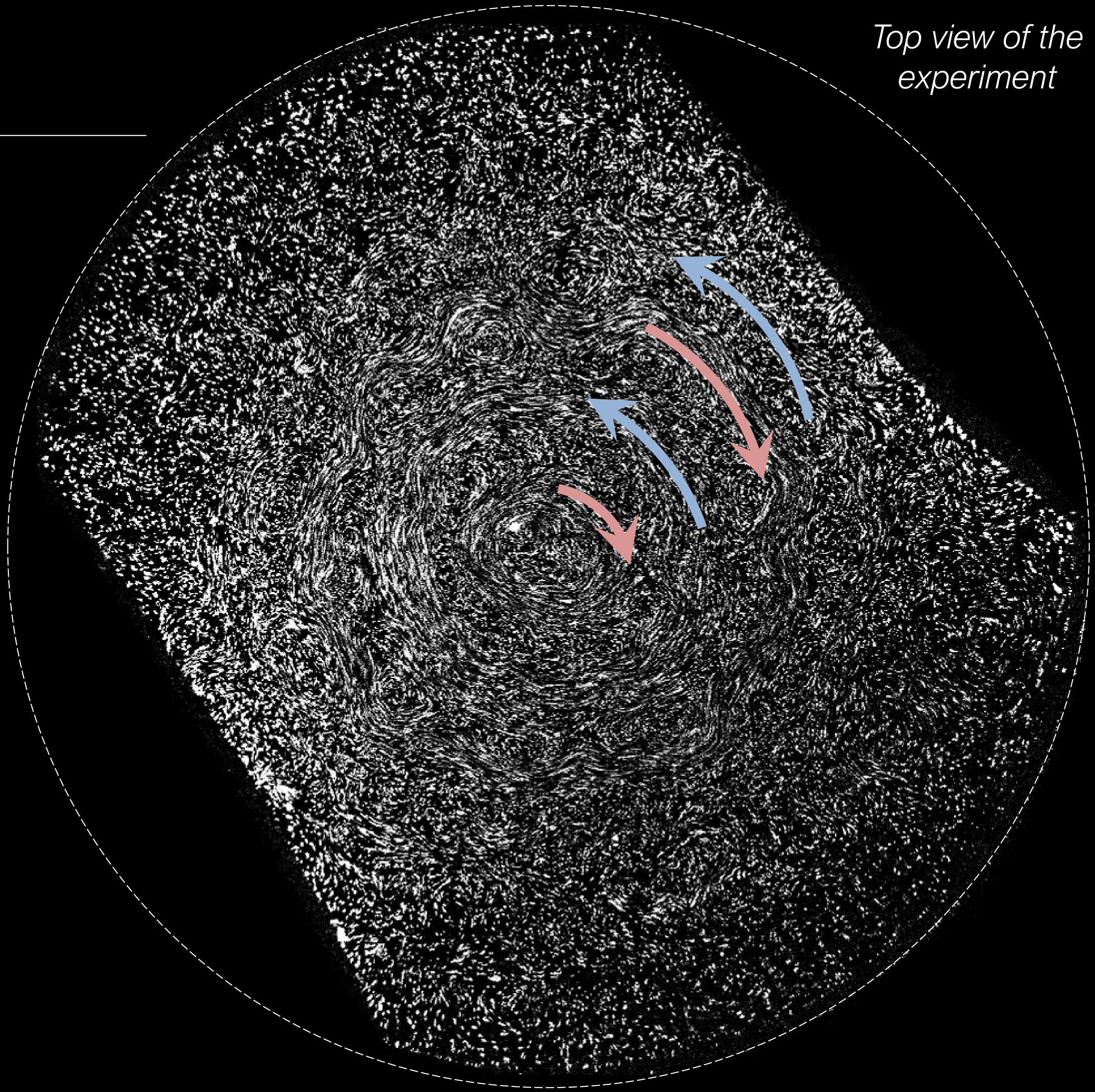
The experiment rotating at 75 RPM



I. A laboratory model of zonal jets

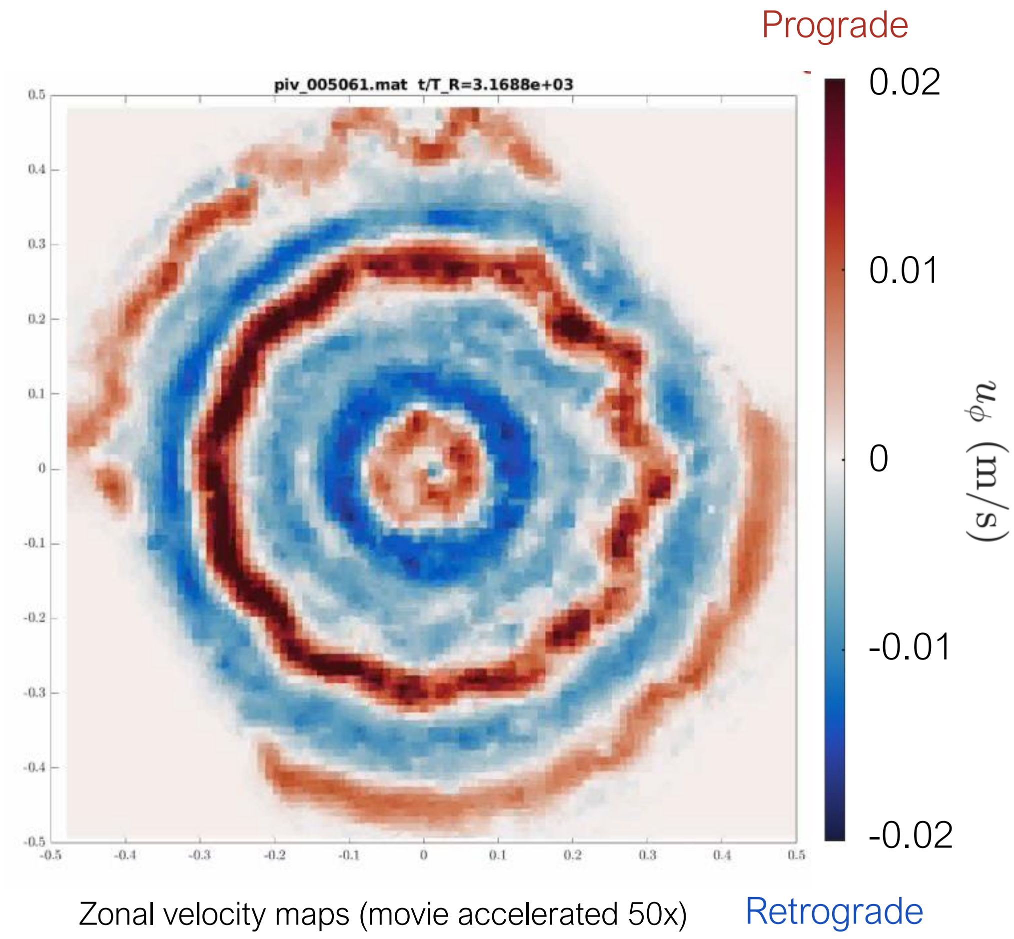
4. Experimental observations: two regimes

Fluorescent particles
moving on horizontal
laser sheet
→ Zonal jets!

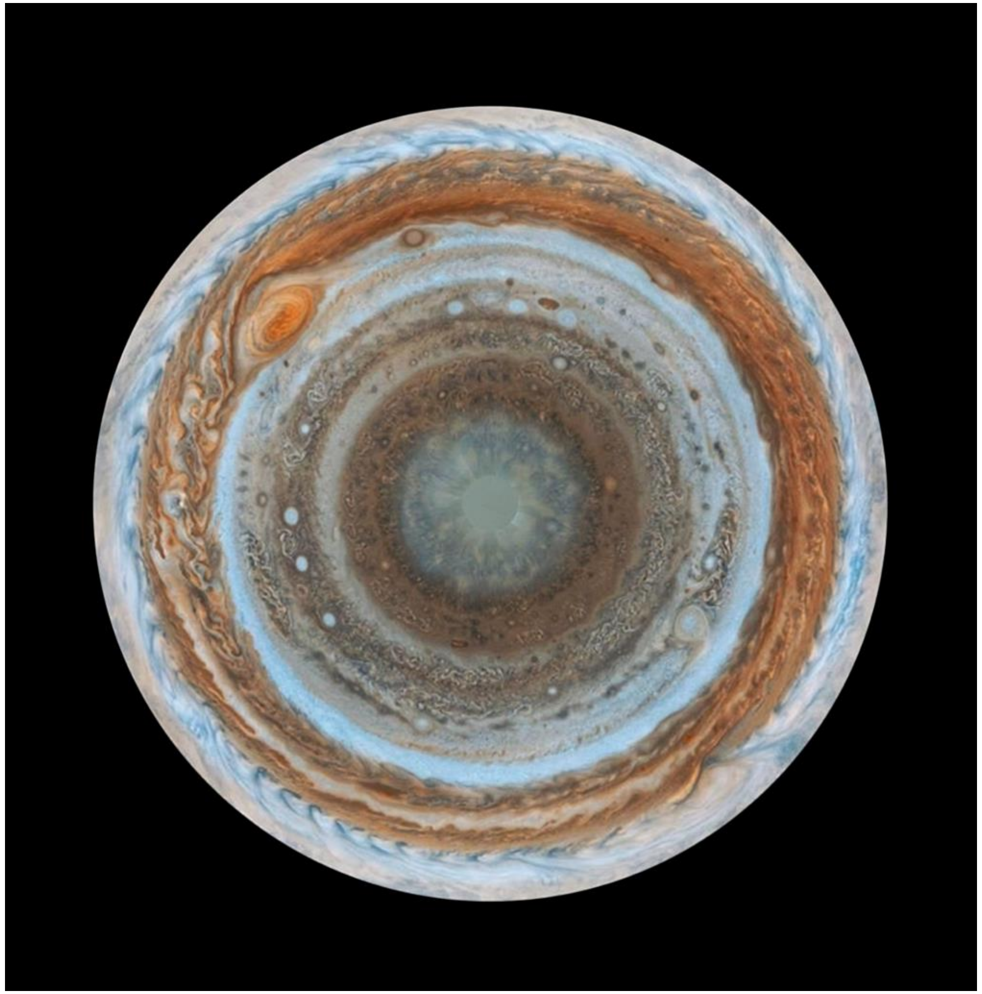


I. A laboratory model of zonal jets

4. Experimental observation: two regimes



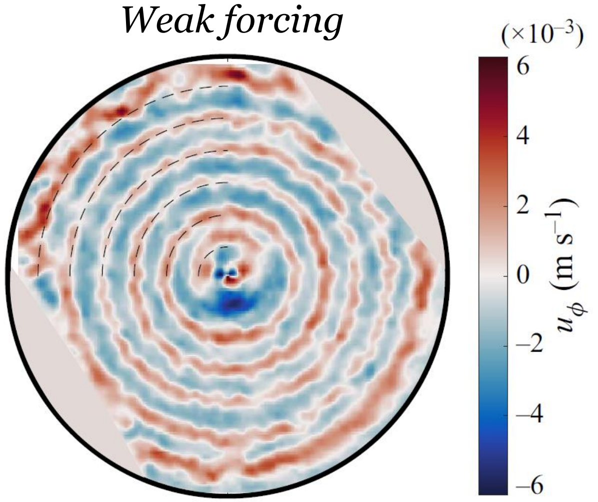
Zonal velocity maps (movie accelerated 50x)



I. A laboratory model of zonal jets

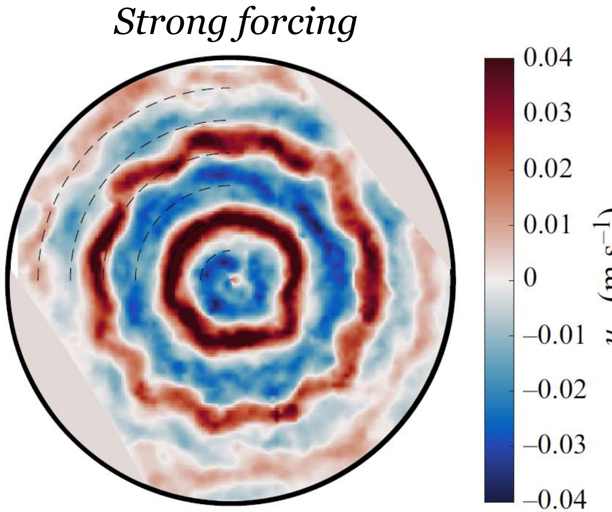
5. Theoretical model

Regime I
Local, eddy-driven jets
Sub-resonant



Quasi-geostrophic model of the transition (and bistability):
Rossby waves resonance due to the feedback of the zonal flow

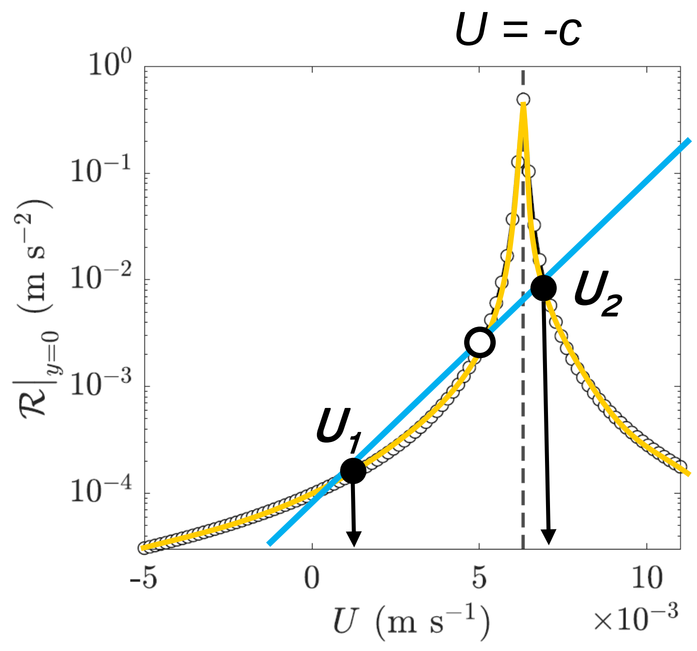
Regime II
Self-developed large-scale jets
Super-resonant



[Lemasquerier et al., PRF 2020 and JFM 2021]

I. A laboratory model of zonal jets

5. Theoretical model



Dissipation by linear friction representing Ekman pumping

Stationary solutions Us

Acceleration by Rossby waves

Forcing　Friction

$$\cancel{\frac{\partial U}{\partial t}} = \mathcal{R}(U) - \alpha U,$$

Quasi-geostrophic model of the transition (and bistability):
Rossby waves resonance due to the feedback of the zonal flow

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Local, eddy-driven jets
Sub-resonant

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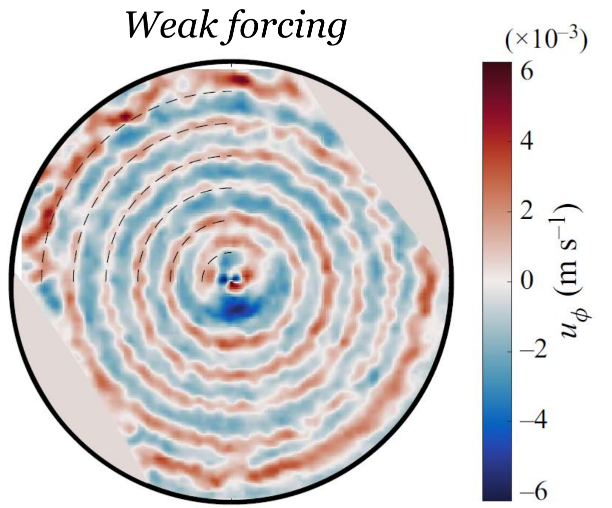
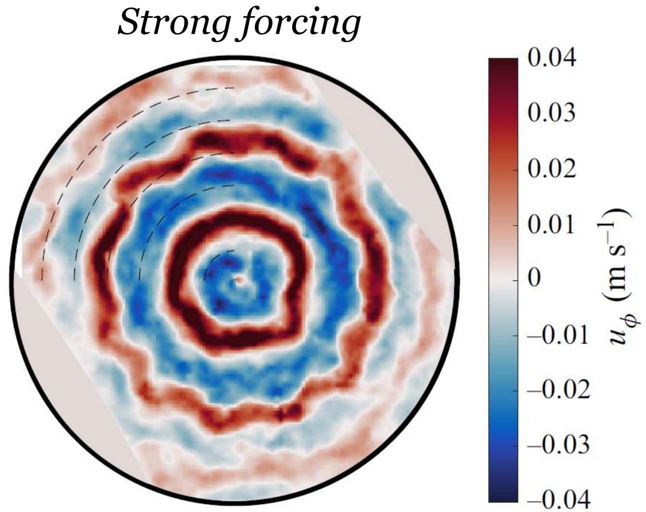
Self-developed large-scale jets
Super-resonant





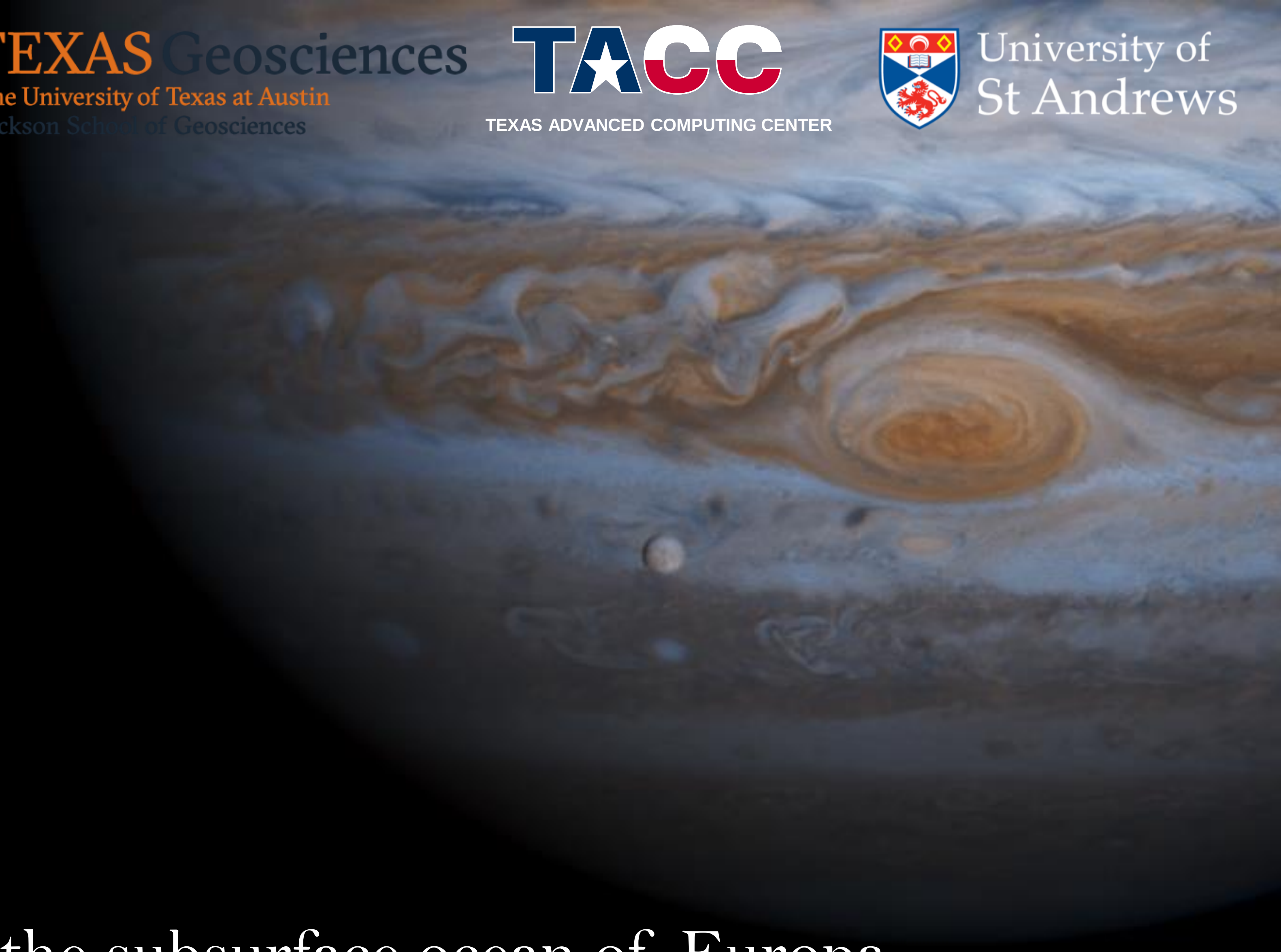
[Lemasquerier et al., PRF 2020 and JFM 2021]

2. Second example: a numerical model

INSTITUTE FOR GEOPHYSICS
TEXAS Geosciences
The University of Texas at Austin
Jackson School of Geosciences
TACC
TEXAS ADVANCED COMPUTING CENTER
University of St Andrews

Krista Soderlund
(UTIG)

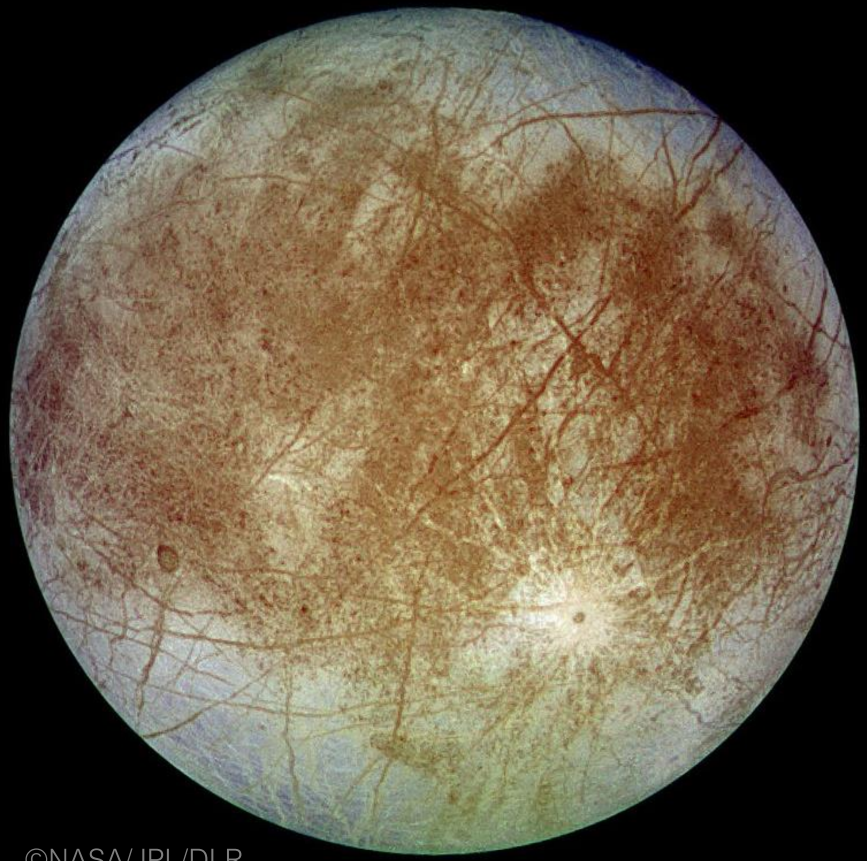
Carver Bierson
(ASU)

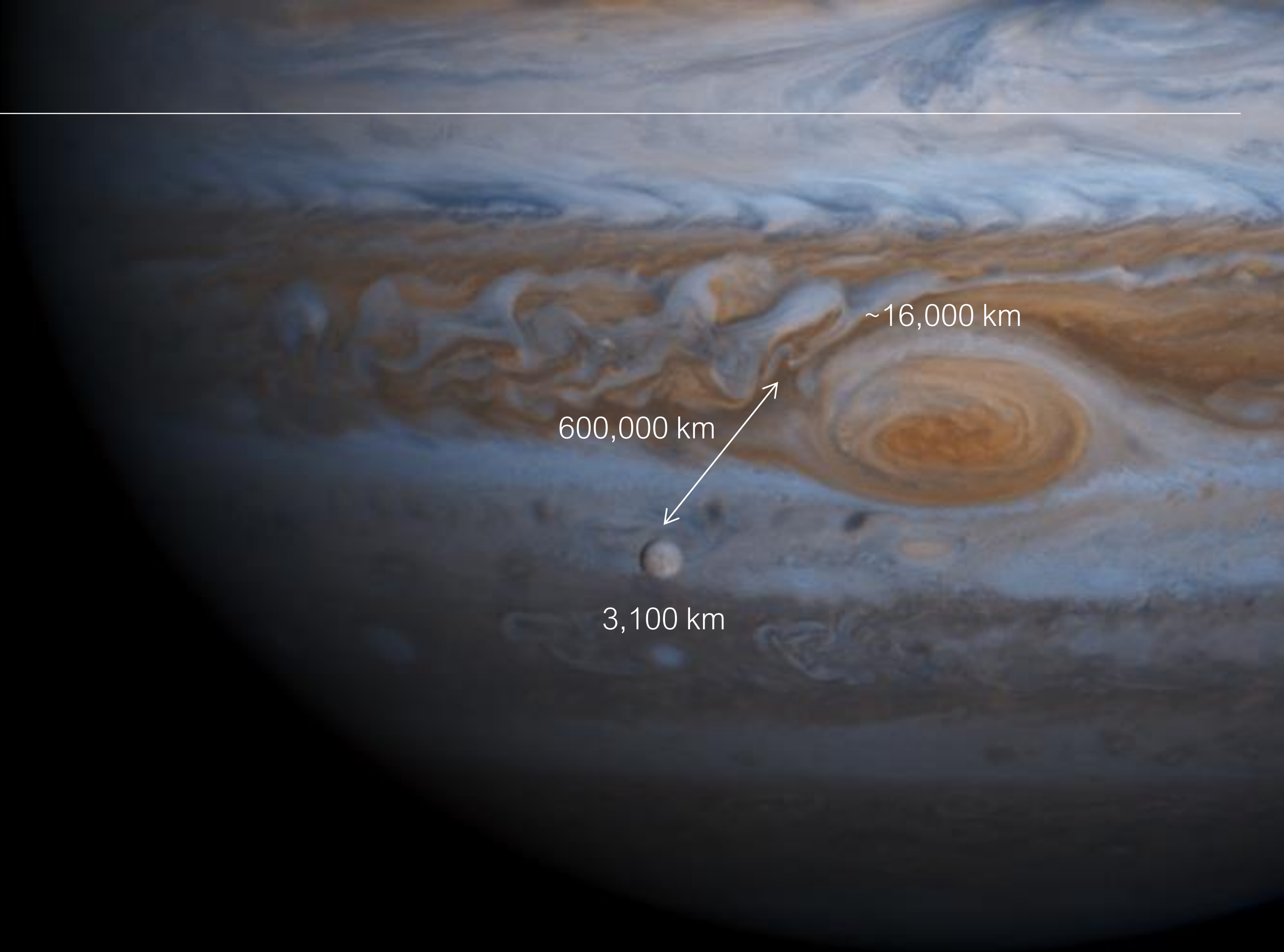


Circulation in the subsurface ocean of Europa

Daphné Lemasquerier, Carver Bierson, Krista Soderlund

Icy moons





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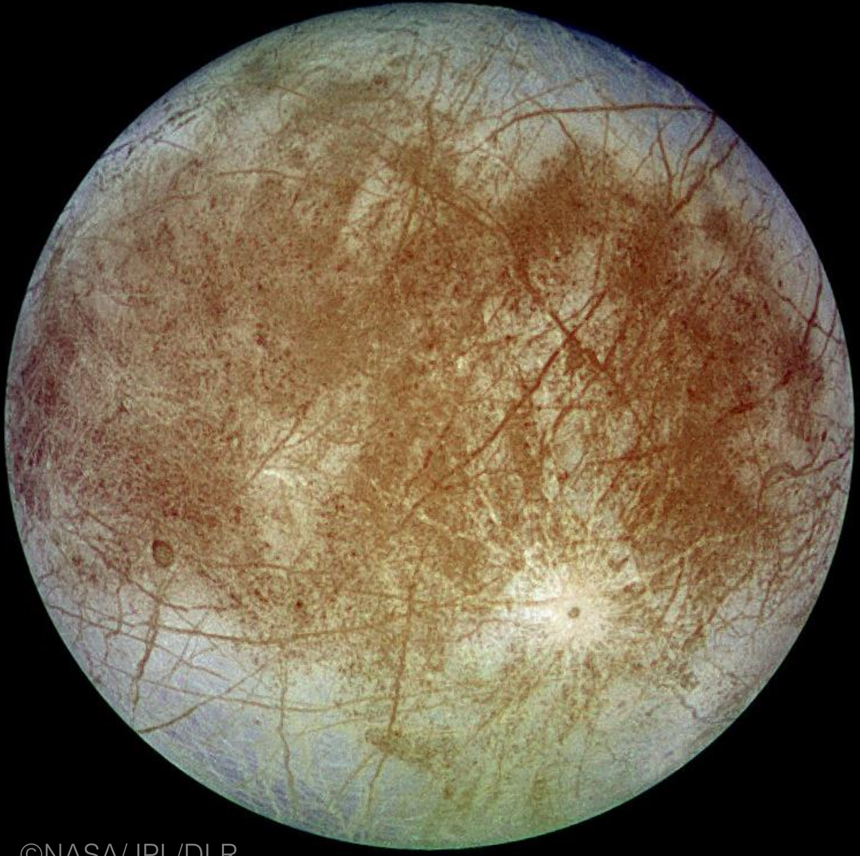
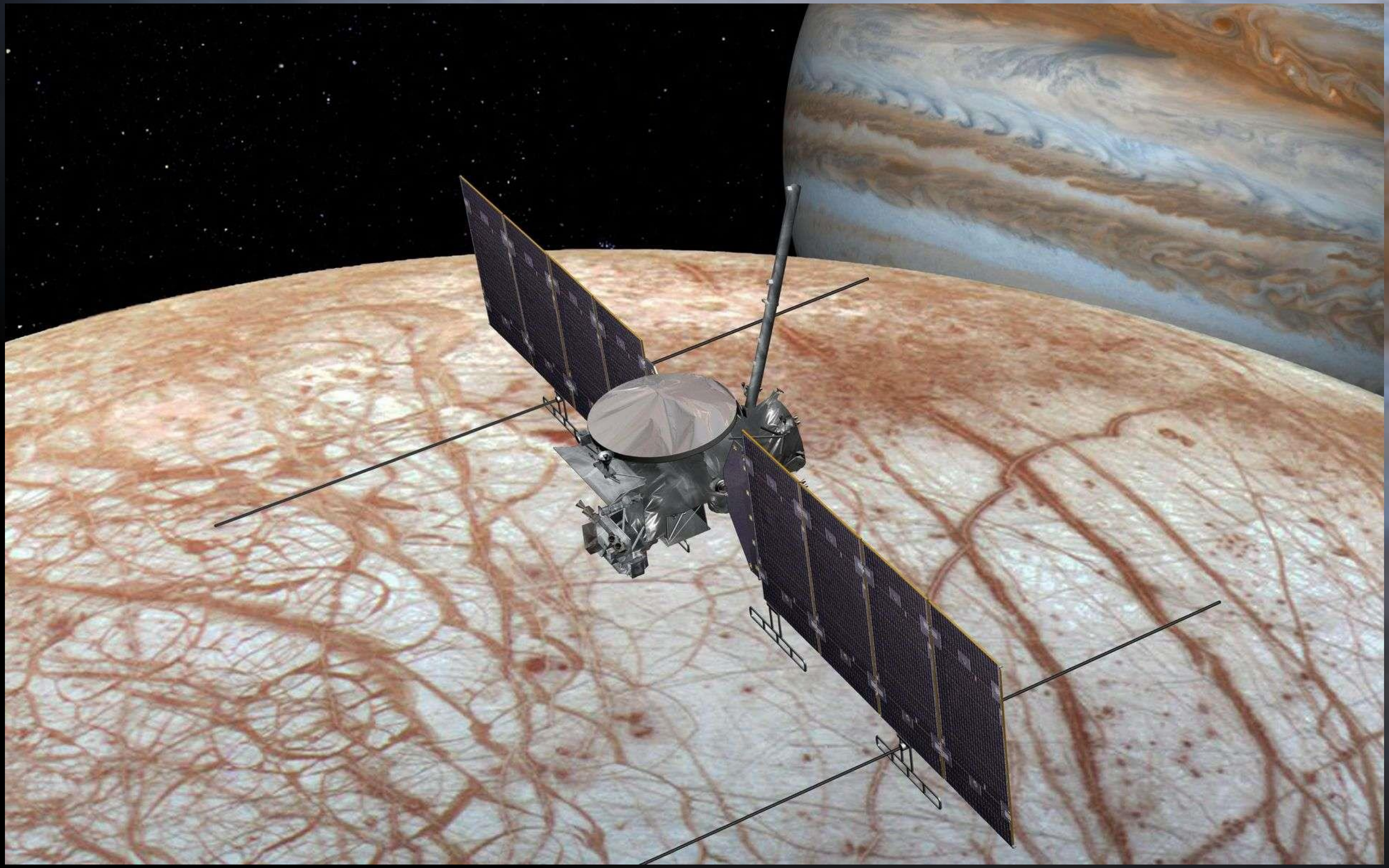
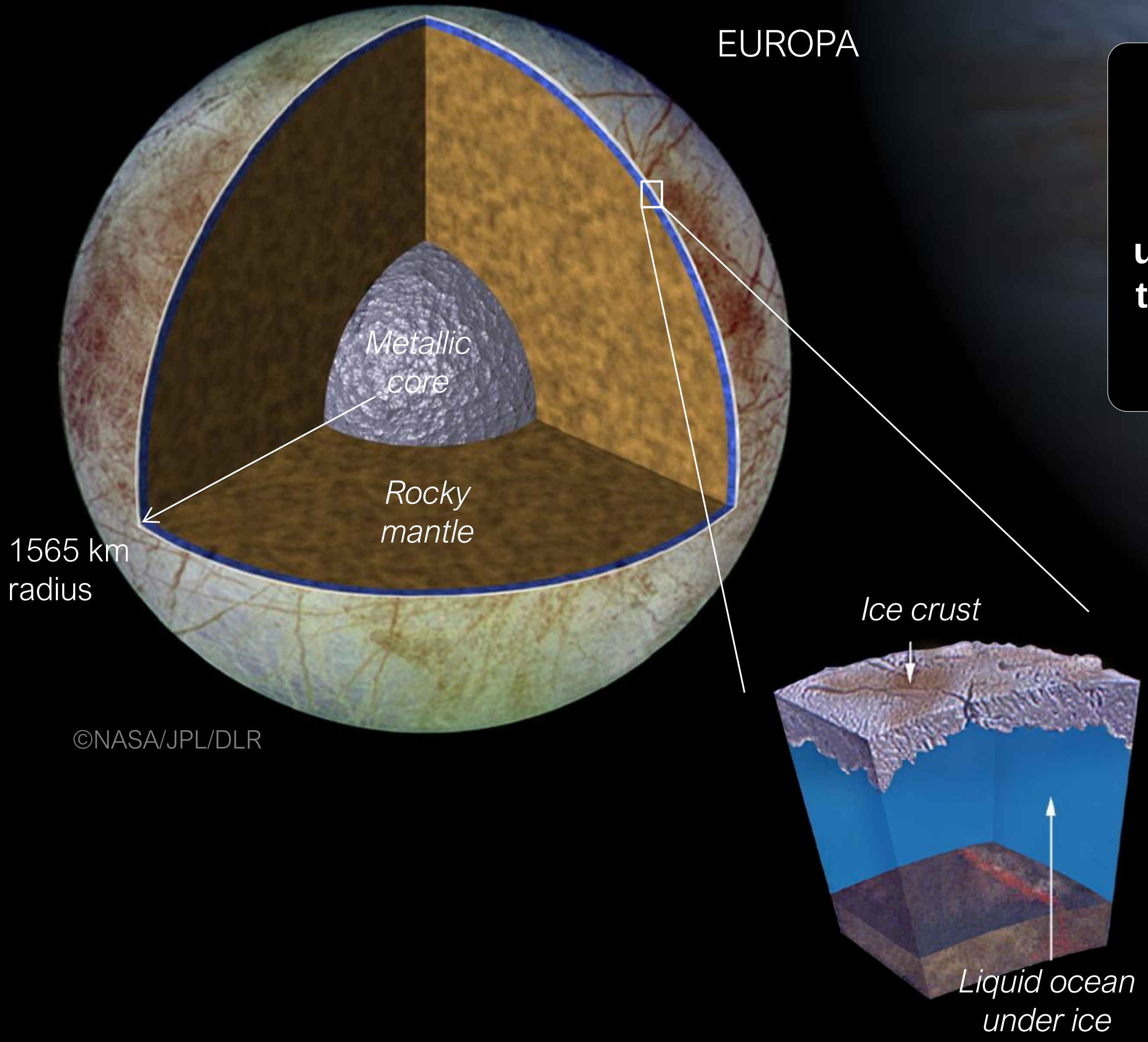


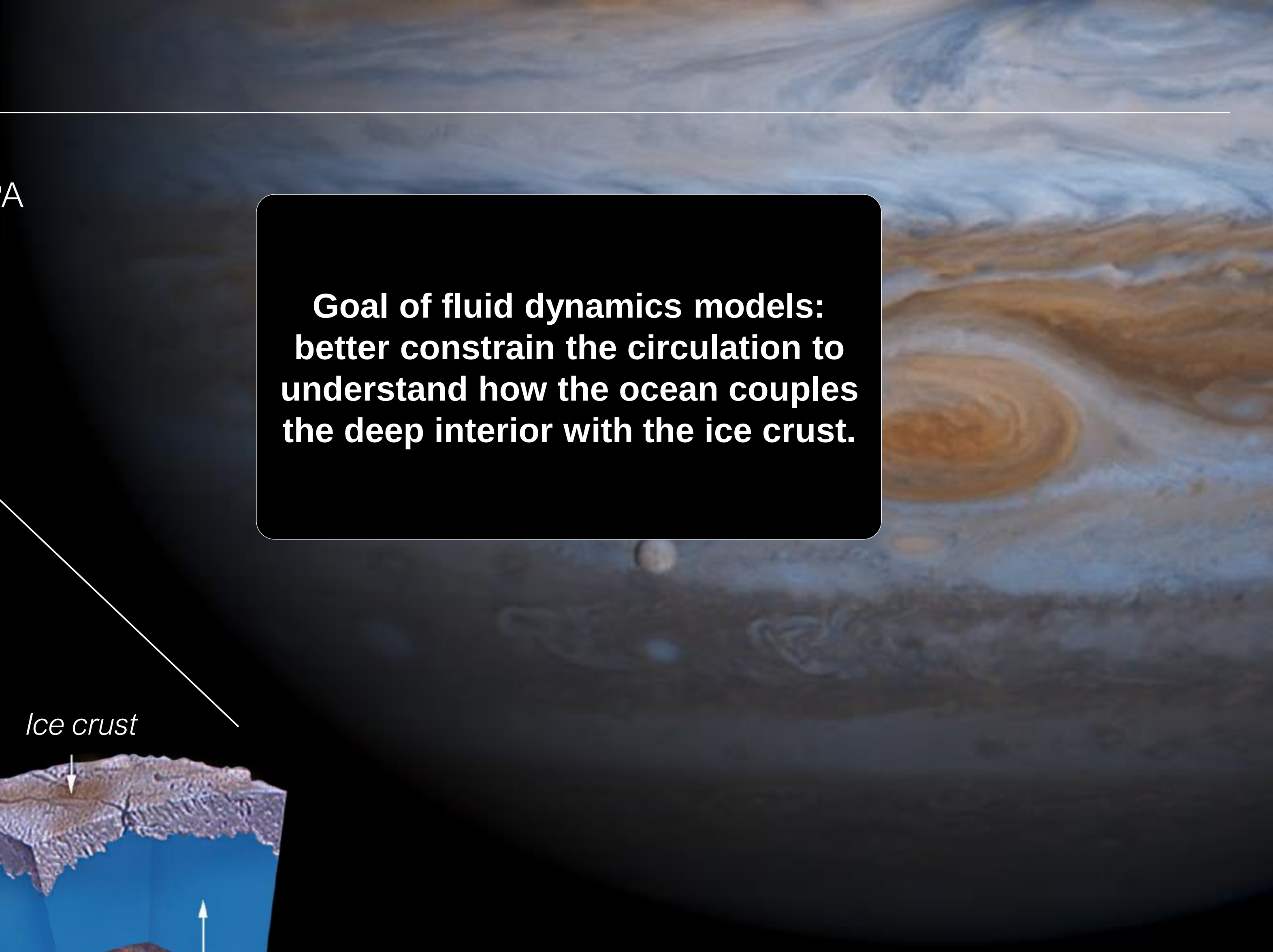


Europa Clipper (NASA)
launch: 2024
arrival: 2030

Icy moons



Goal of fluid dynamics models: better constrain the circulation to understand how the ocean couples the deep interior with the ice crust.



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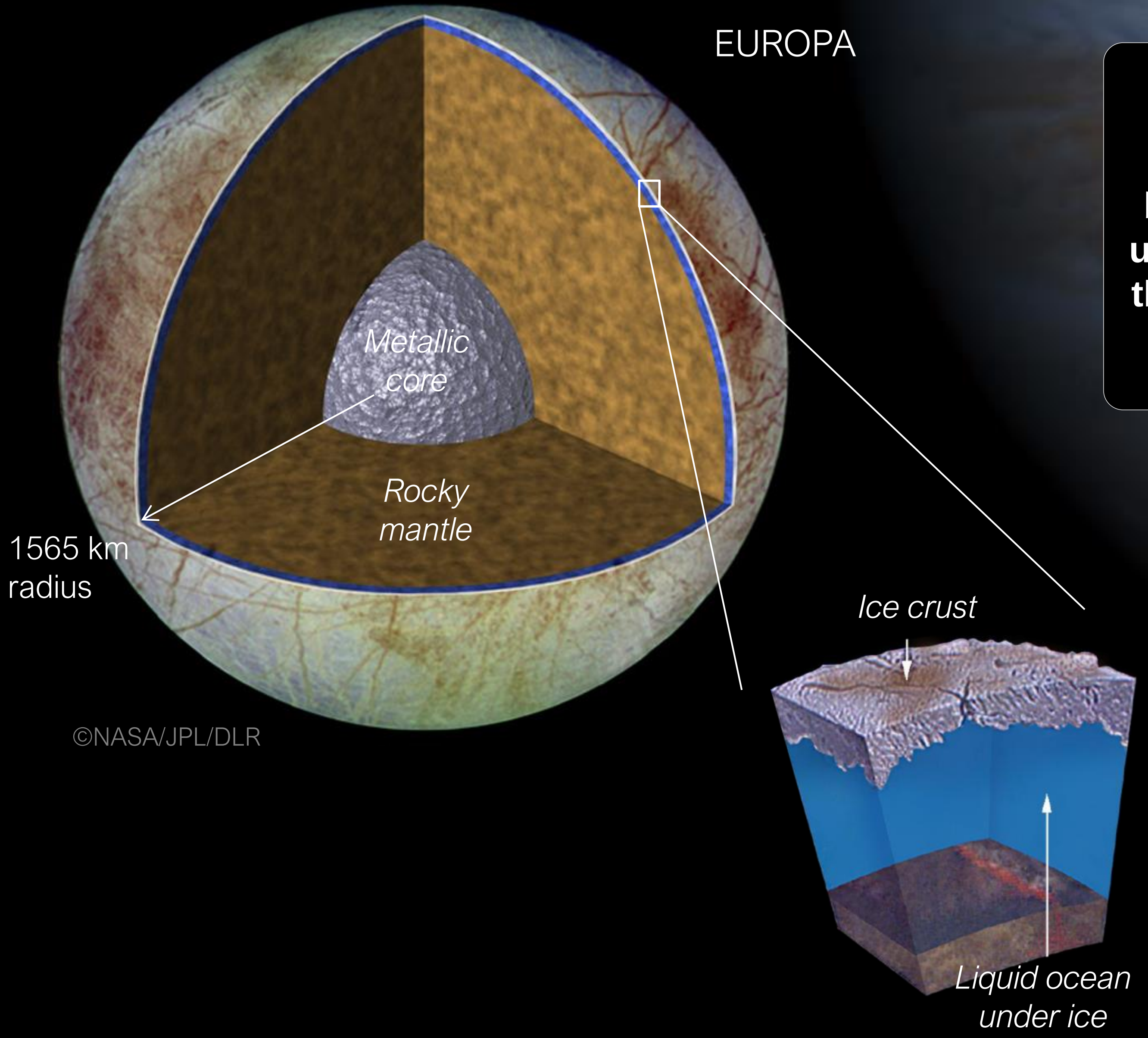

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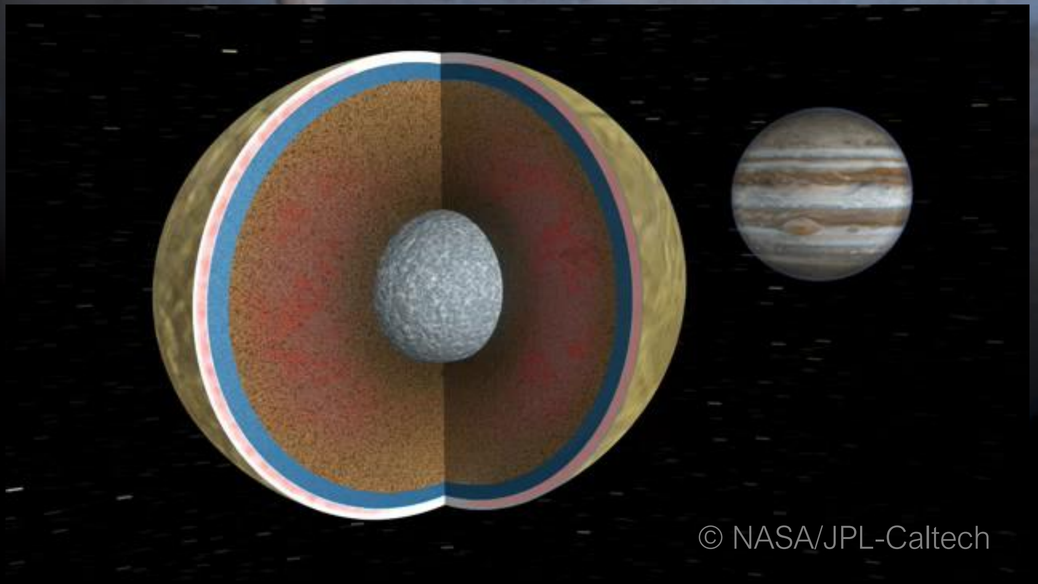

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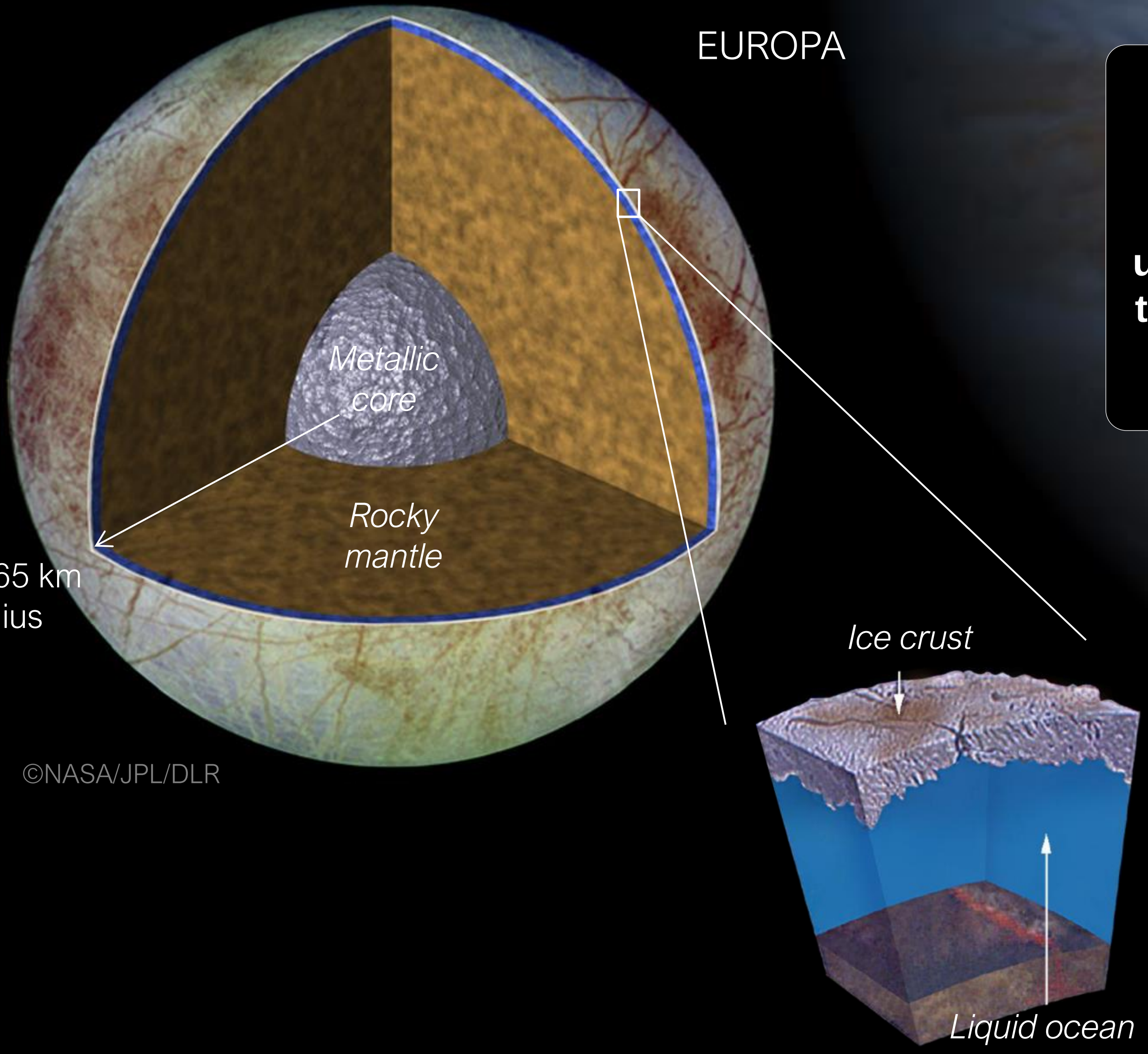

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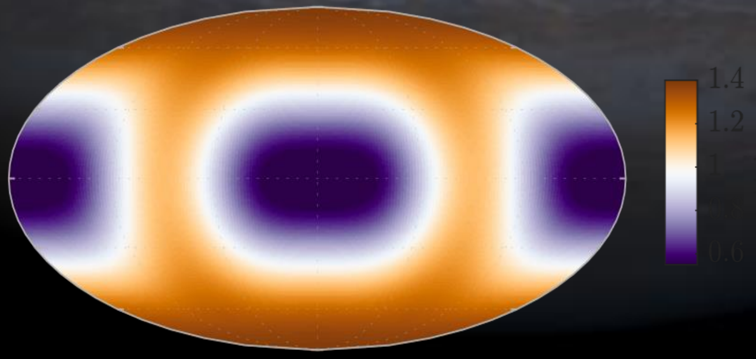
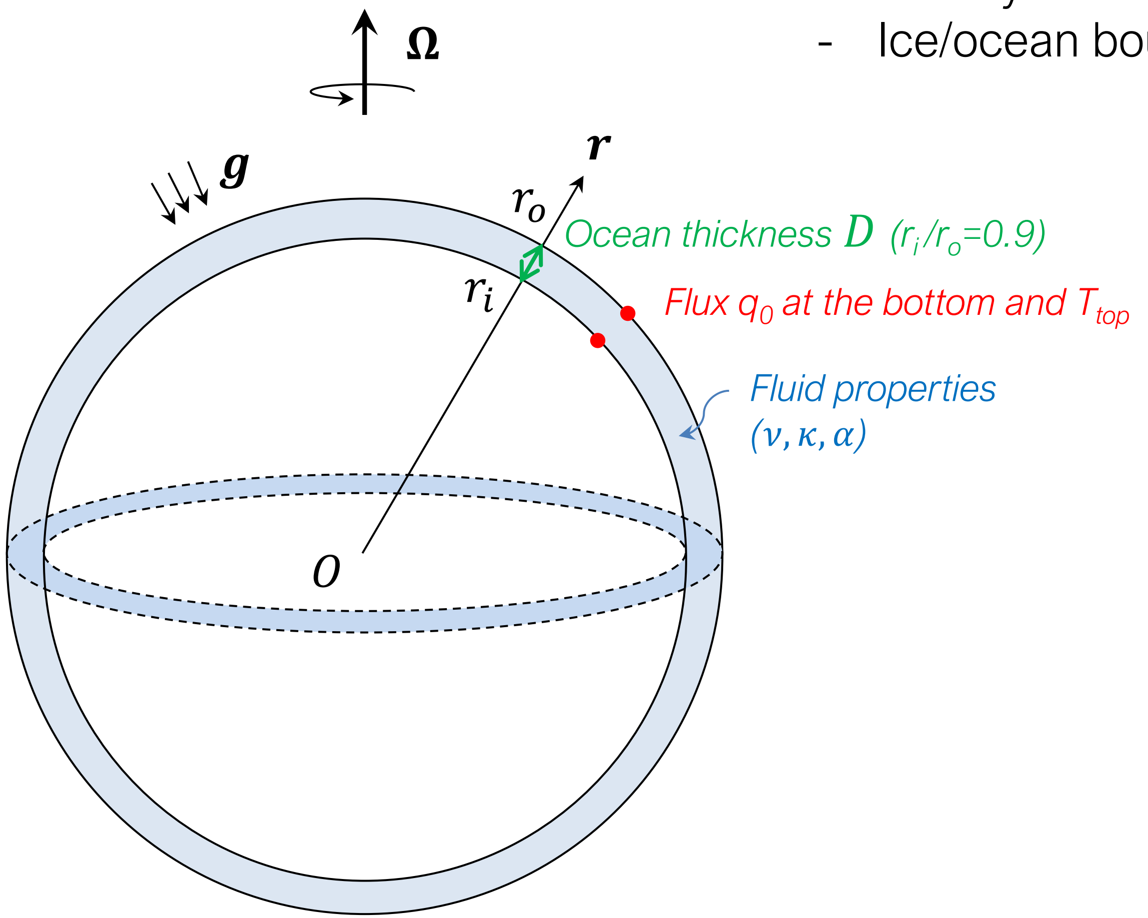
Tidal heating pattern



Global numerical model

Model: Rotating thermal convection in a spherical shell (open-source code **MagIC** [Wicht 2002, Gastine 2016])

Approximations/simplifications:
- Buoyancy-driven flow (no ocean tides, no libration)
- Salinity effect on buoyancy ignored
- Ice/ocean boundary = fixed T (no phase change)



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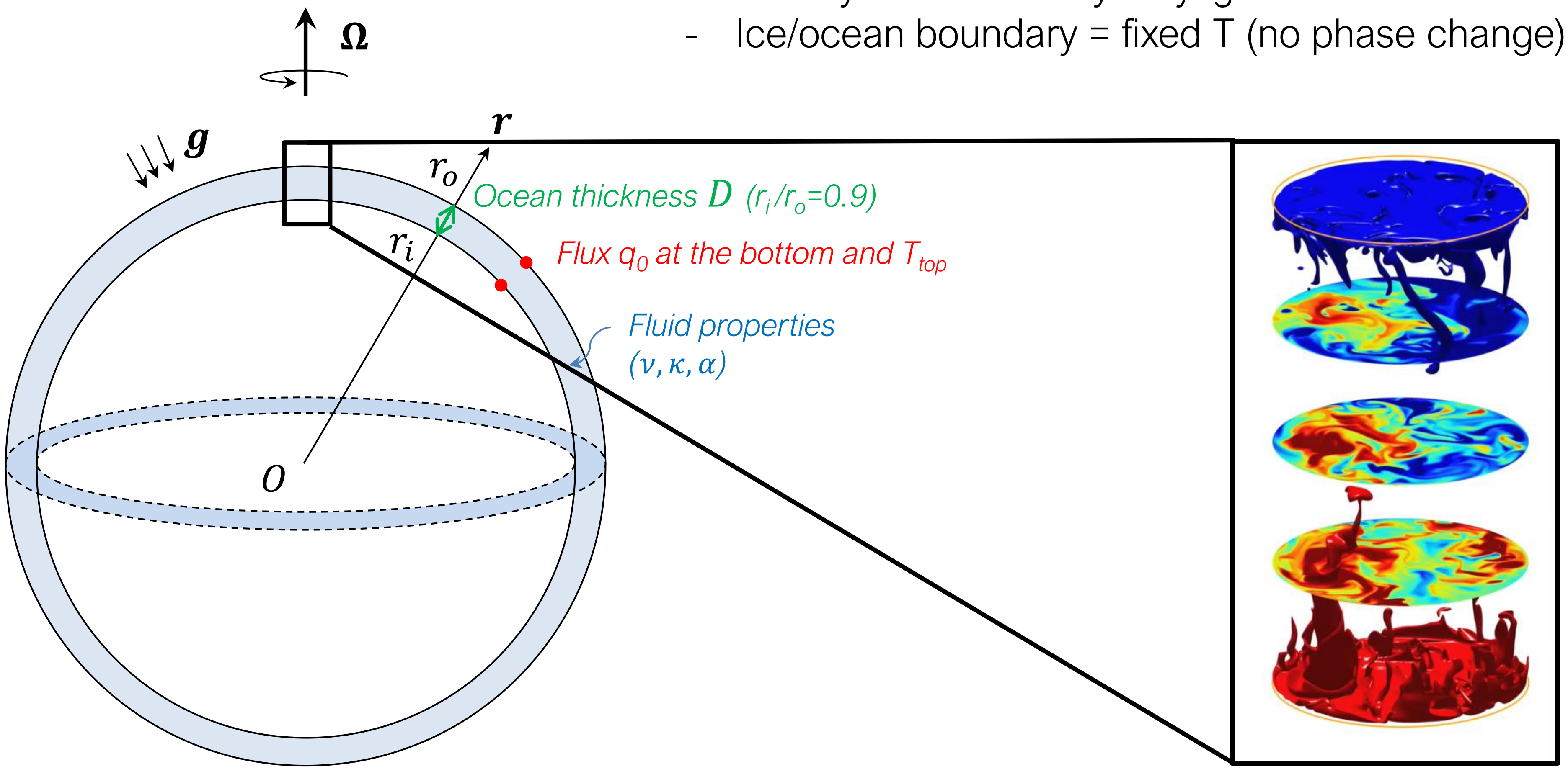

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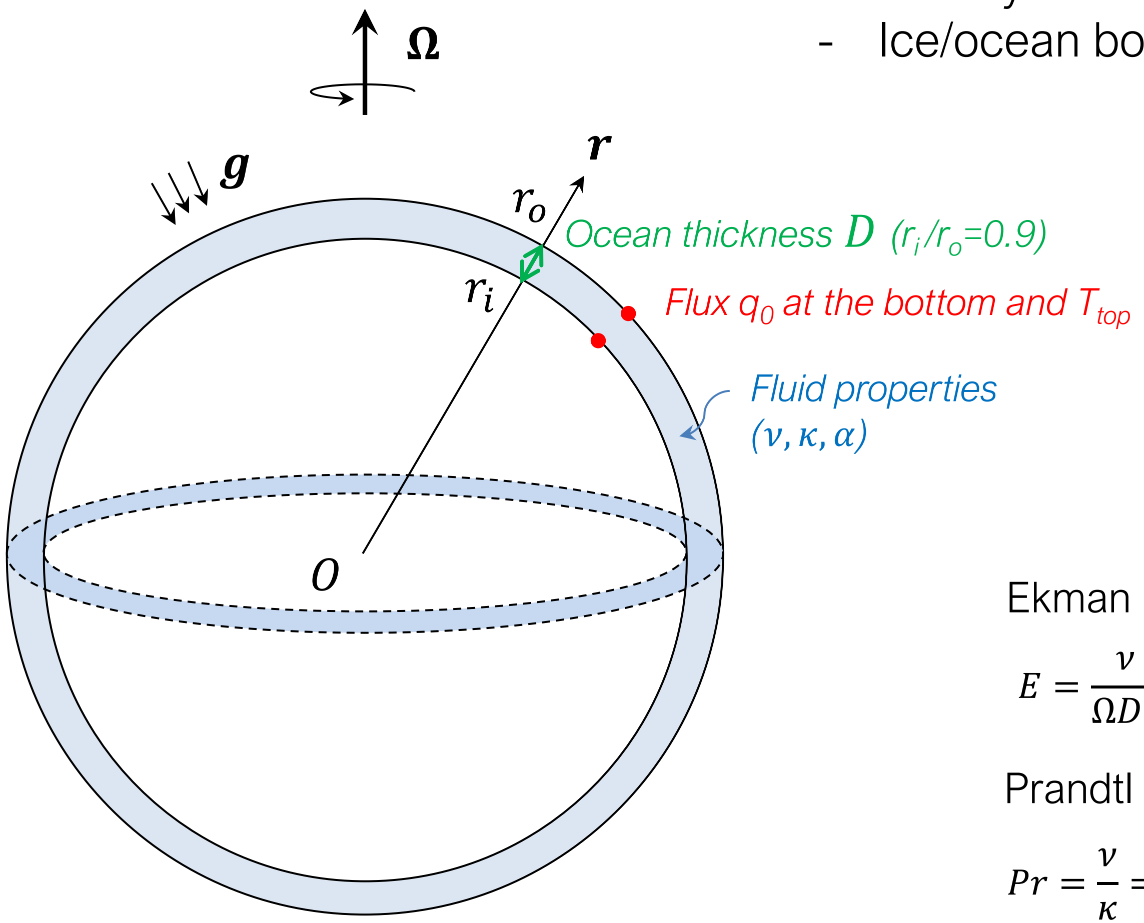

Governing equations

$$E\left(\frac{\partial \boldsymbol{u}}{\partial t} + \boldsymbol{u}\cdot\boldsymbol{\nabla}\boldsymbol{u}\right) = -\boldsymbol{\nabla}p - 2\boldsymbol{e}_z \times \boldsymbol{u} + \frac{Ra\ E}{Pr}\frac{r}{r_o}T\boldsymbol{e}_r + E\nabla^2\boldsymbol{u}$$

$$\frac{\partial T}{\partial t} + \boldsymbol{u}\cdot\boldsymbol{\nabla}T = \frac{1}{Pr}\nabla^2 T$$

$$\boldsymbol{\nabla}\cdot\boldsymbol{u} = 0$$

Ekman

$$E = \frac{\nu}{\Omega D^2} = \frac{\text{viscous effects}}{\text{rotation effects}}$$

Prandtl

$$Pr = \frac{\nu}{\kappa} = \frac{\text{viscous diffusion}}{\text{thermal diffusion}}$$

Rayleigh

$$Ra = \frac{\alpha g_0 q_0 D^4}{\nu k \kappa} = \frac{\text{buoyancy force}}{\text{diffusive effects}}$$

Relative amplitude of the bottom anomaly

$$q^* = \frac{\Delta q}{q_0}$$

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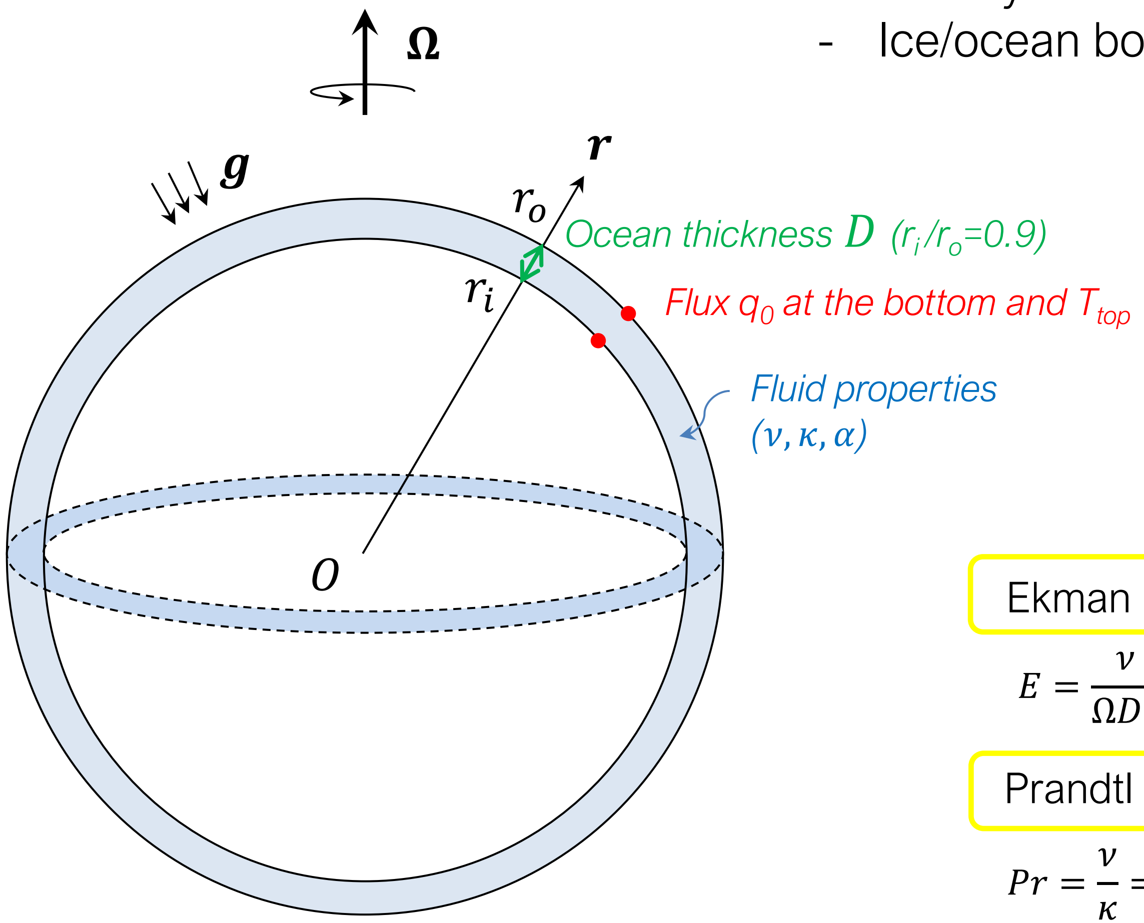

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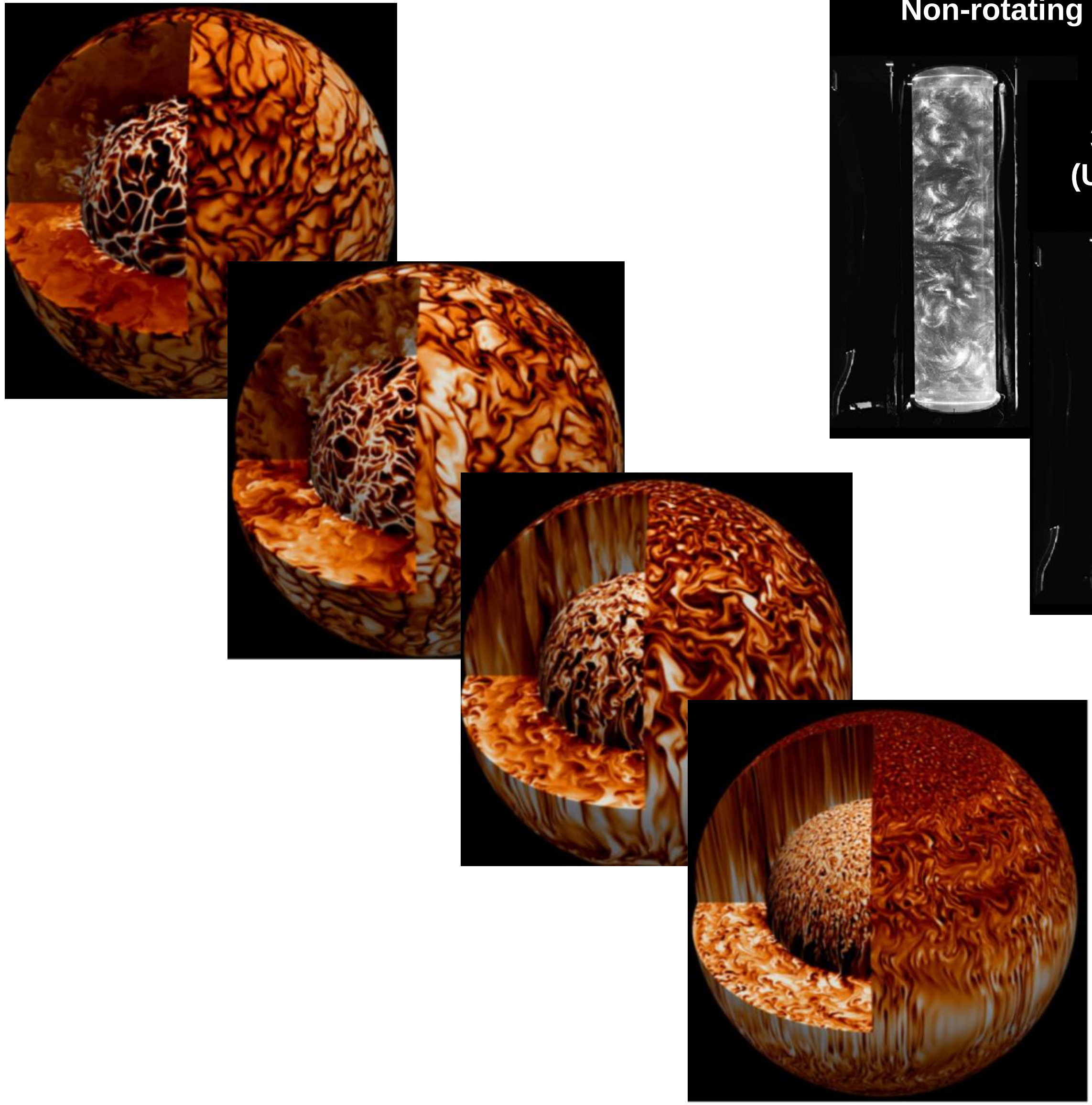
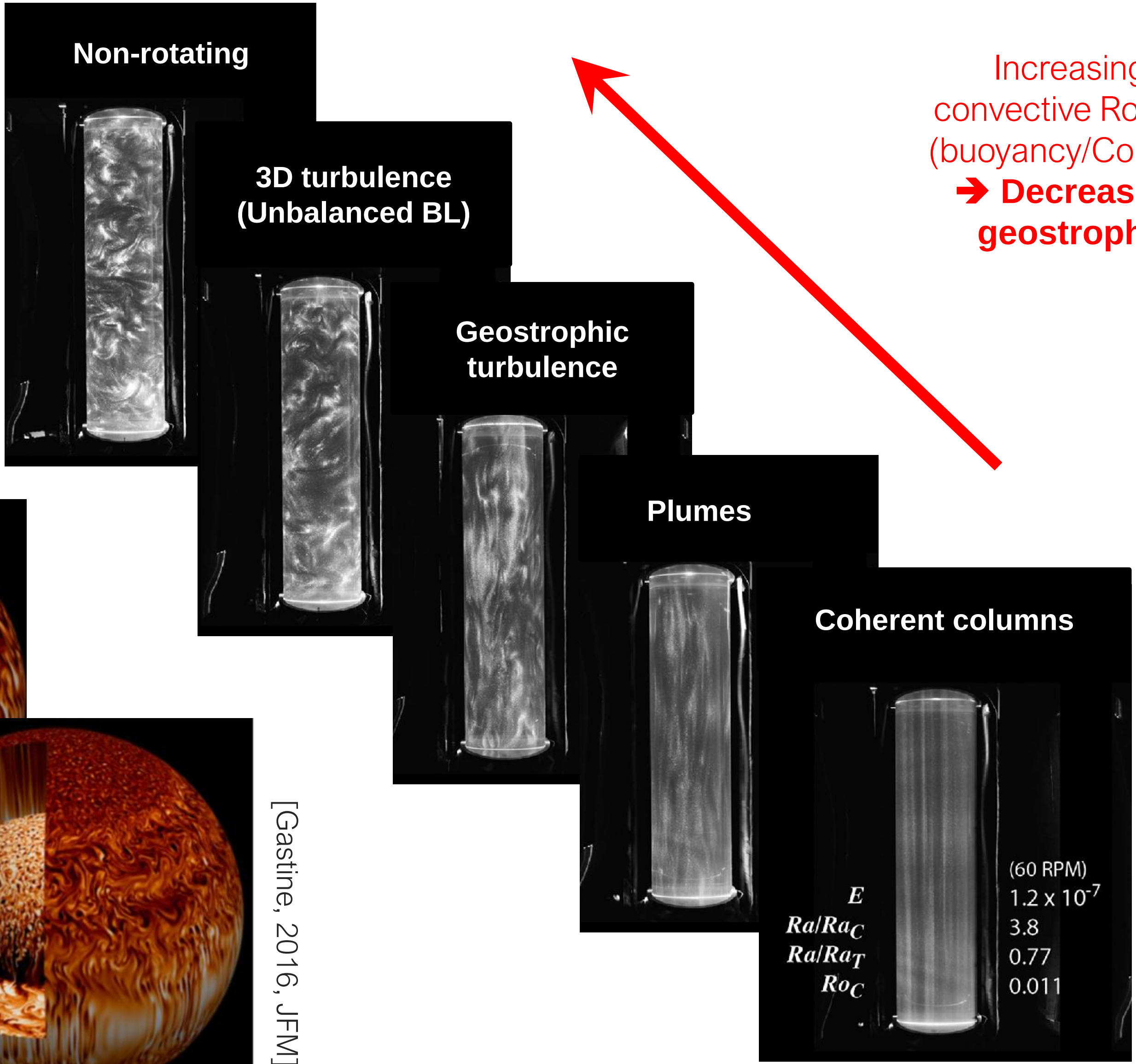
Parameters space and convective regimes

Supercriticality



[Gastine, 2016, JFM]



[Cheng+, GJI, 2015 GAFD, 2018]

Increasing convective Rossby (buoyancy/Coriolis)
➔ **Decreasing geostrophy**

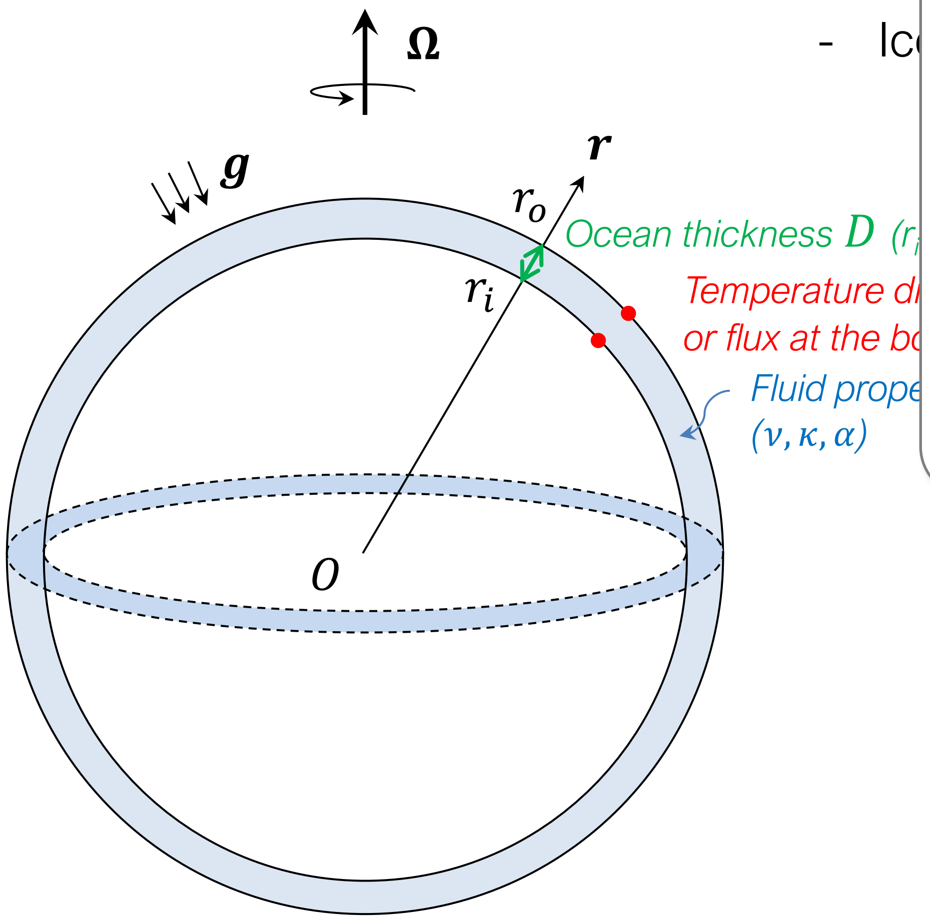
Increasing rotation // viscous forces

[Lemasquerier+ 2023, Cheng+, 2015; 2018; Gastine, 2016; Soderlund 2019; Kvorka and Cadek, 2022]

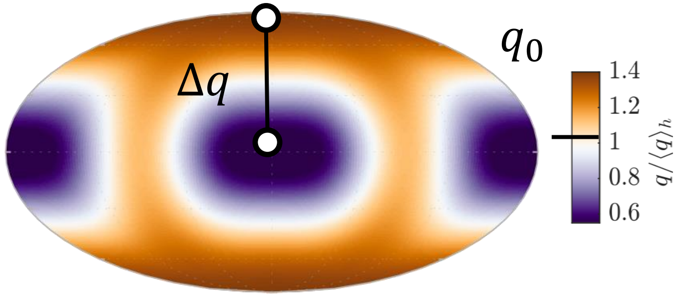
Global numerical model

Model: Rotating thermal convection in a sp

Approximations/simplifications:
- B
- Sa
- Ic



Relative amplitude of the bottom anomaly:



$$q^* = \frac{\Delta q}{q_0} \in [0,2]$$

Ekman

$$E = \frac{\nu}{\Omega D^2} = \frac{\text{viscous effects}}{\text{rotation effects}}$$

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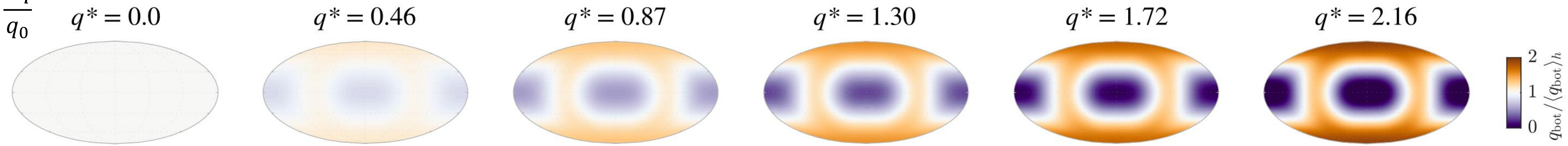
Results

Homogeneous forcing

Inhomogeneous forcing *following the tidal pattern (progressively larger bottom anomaly)*

$q^* = \frac{\Delta q}{q_0}$



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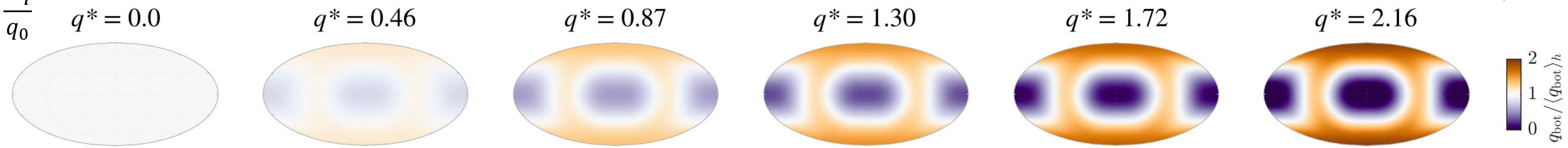
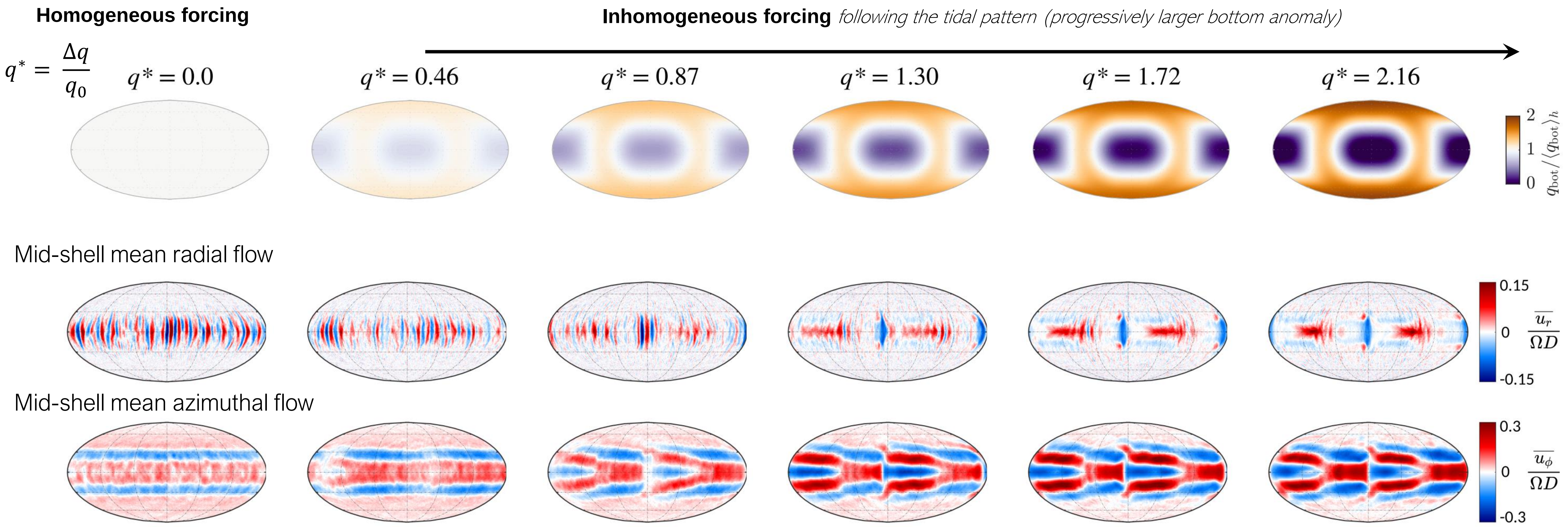


PURE RADIOGENIC HEATING (Homogeneous)

PURE TIDAL HEATING (Heterogeneous with q*~1)

Results: mean circulation



[Lemasquerier+ 2023]

Results: mean circulation

No slip

Homogeneous forcing

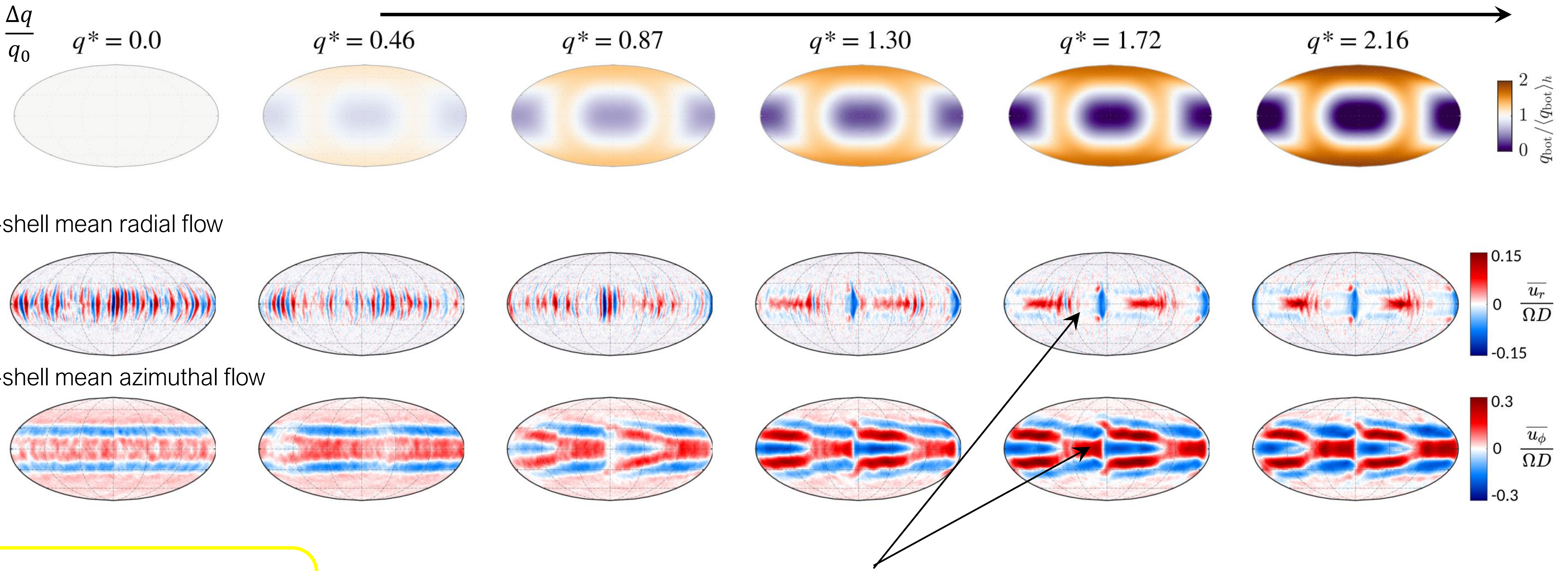
Inhomogeneous forcing *following the tidal pattern (progressively larger bottom anomaly)*

$q^* = \frac{\Delta q}{q_0}$

$q* = 0.0$ $q* = 0.46$ $q* = 0.87$ $q* = 1.30$ $q* = 1.72$ $q* = 2.16$

Mid-shell mean radial flow

Mid-shell mean azimuthal flow



“Thermal winds” solution

Localized downwellings, spead upwellings

Non-axisymmetric thermal winds

[Lemasquerier+ 2023]

Results: mean circulation

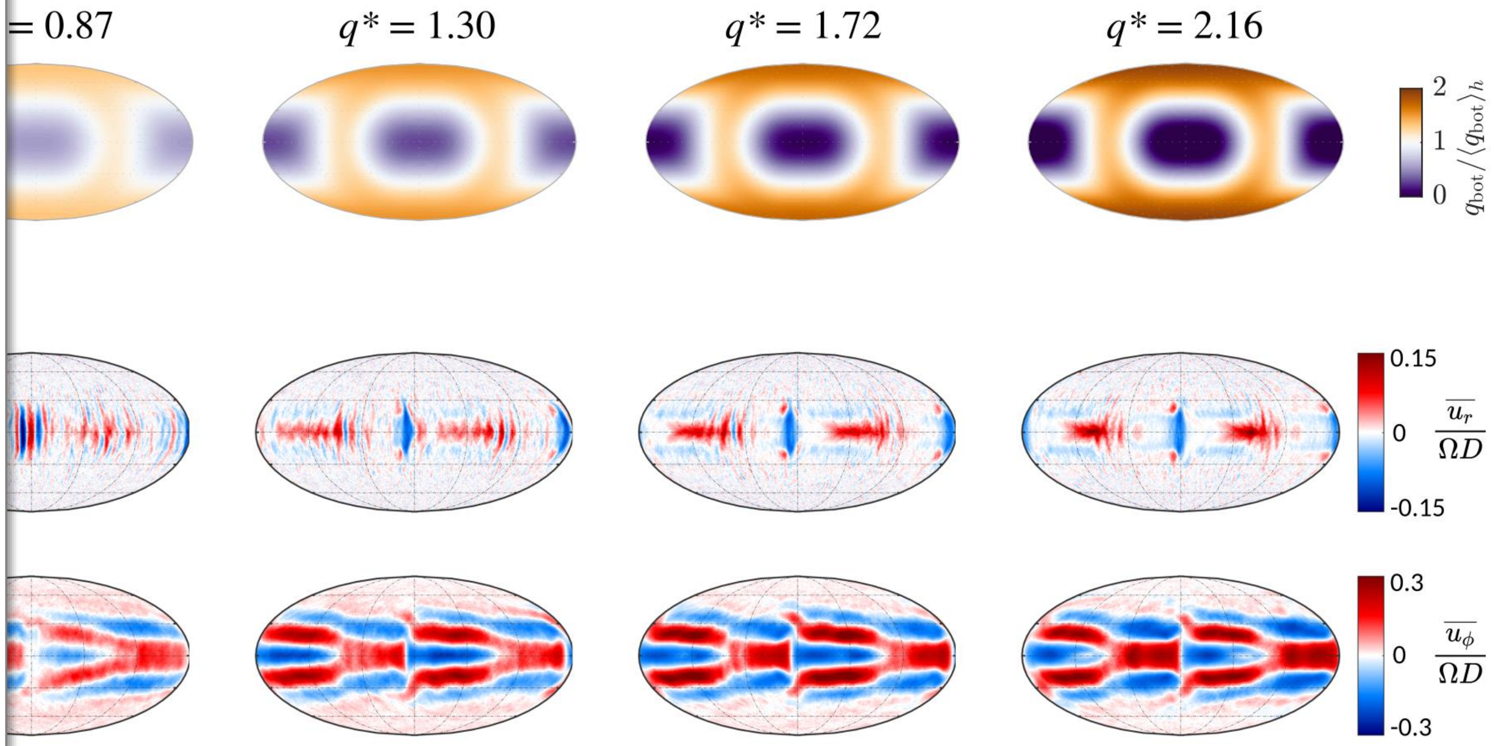
No slip

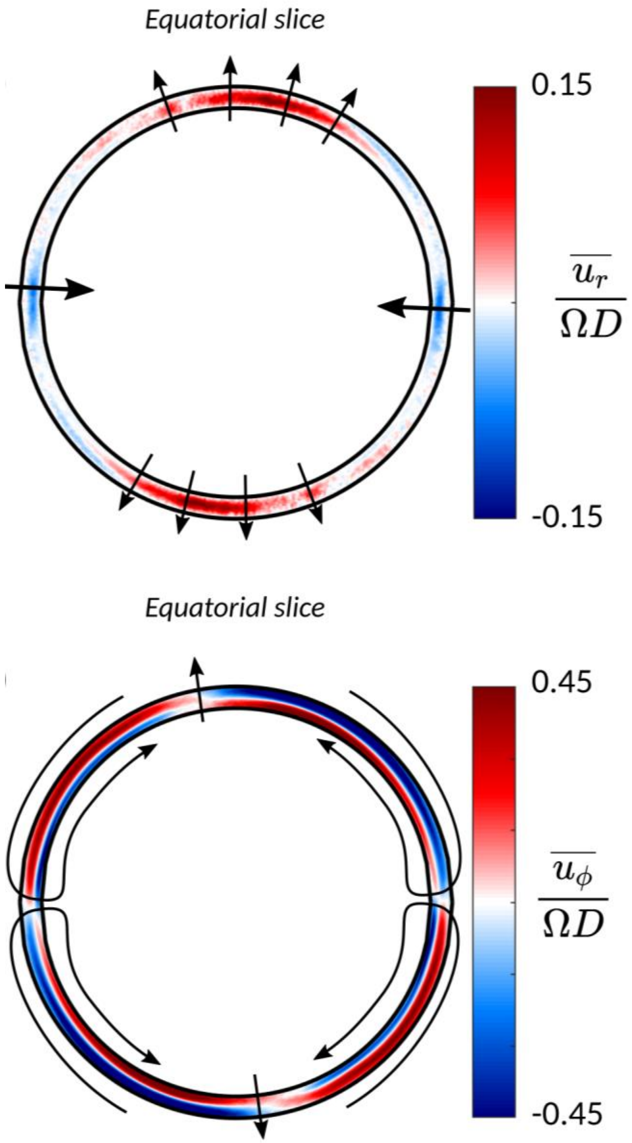
Homogeneo … **homogeneous forcing** *following the tidal pattern (progressively larger bottom anomaly)*

$q^* = \frac{\Delta q}{q_0}$

Mid-shell mea…

Mid-shell mea…





Thermal-wind balance
Buoyancy~Coriolis
(steady, no-inertia, inviscid)

$$u^g_{s,r} = -\frac{r_o^2 - s^2}{2r_o s^2}\frac{RaE}{Pr}\left\langle \frac{\partial T}{\partial \phi} \right\rangle_z$$

[Dietrich, PEPI 2016]

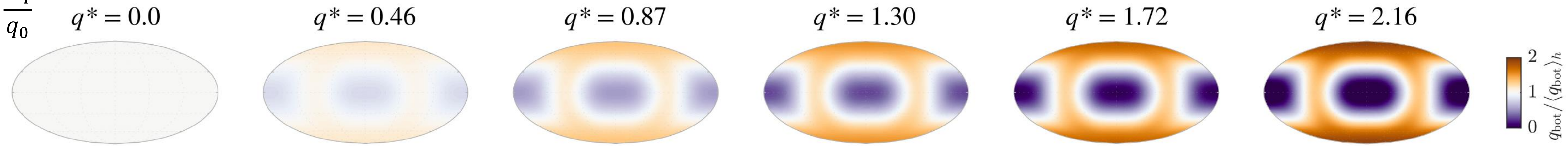
[Lemasquerier+ 2…

Results

Homogeneous forcing

Inhomogeneous forcing *following the tidal pattern (progressively larger bottom anomaly)*

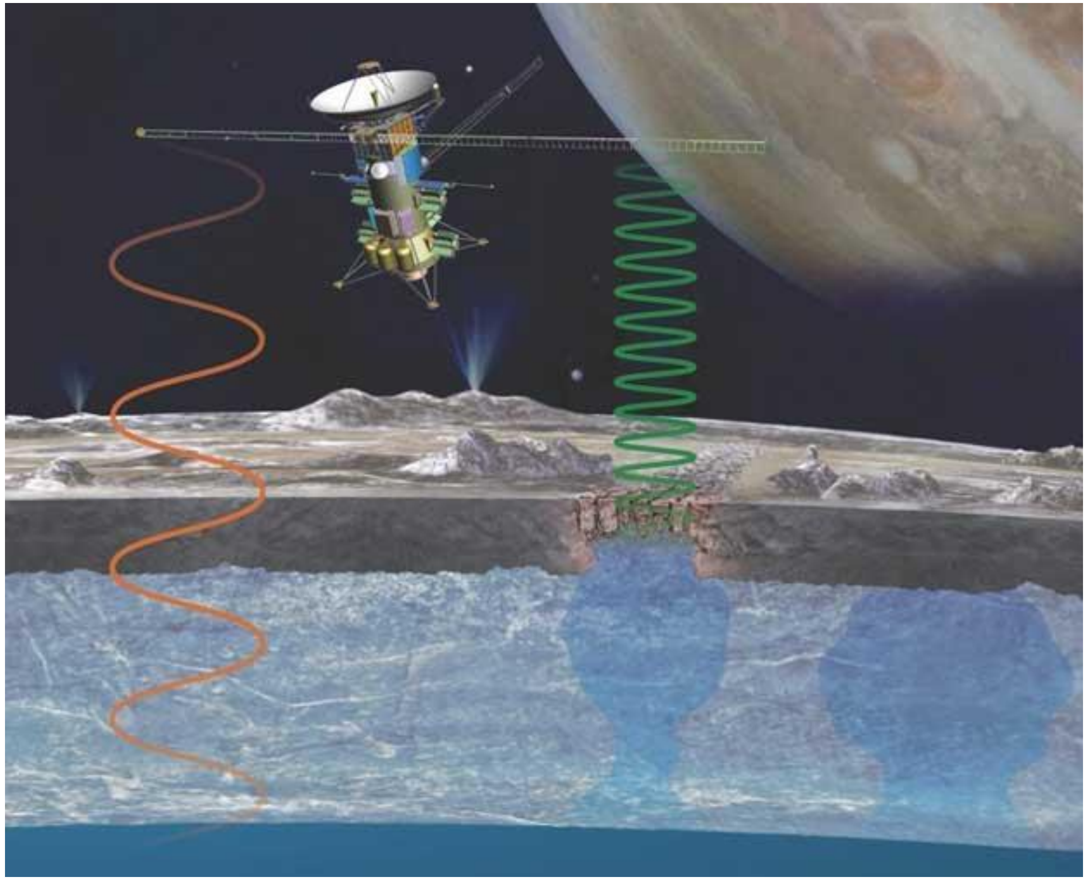
$$q^* = \frac{\Delta q}{q_0}$$



➔ How is the bottom heat flux anomaly transposed up the ice-ocean boundary in each solution?

Link with observations?

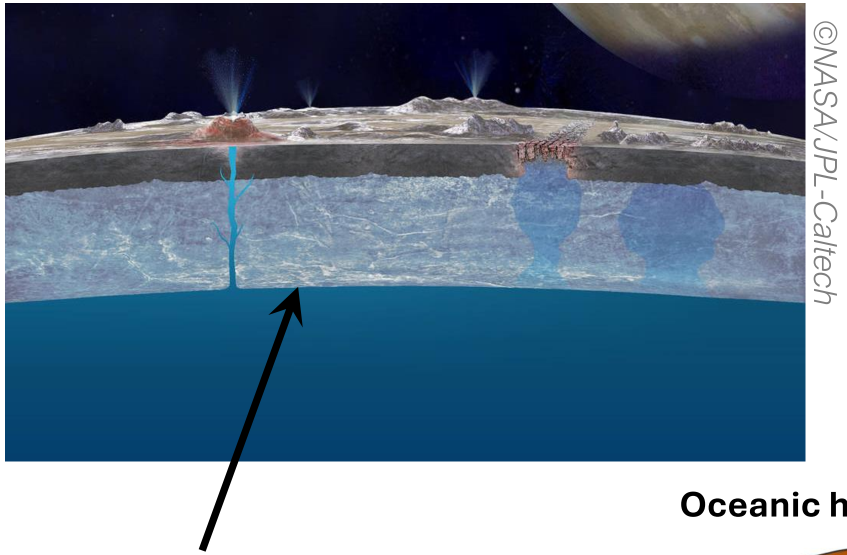
Radar for Europa Assessment and Sounding: Ocean to Near-surface (REASON)



- ❖ Ice thickness estimates for Titan and Enceladus
- ❖ Europa Clipper likely to provide such estimates for Europa (radar instrument)

➔ What we can do: **provide predictive ice thickness models**

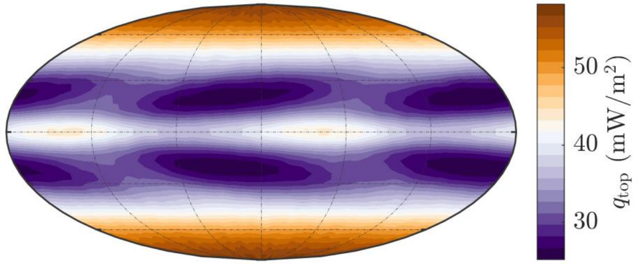
Implication for the ice crust



$T_b = T_m = 273$ K melting temperature

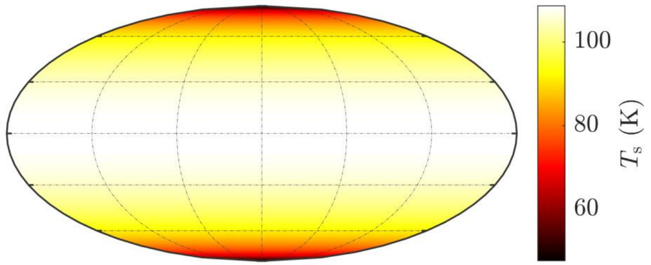
$-k\frac{dT}{dz} = q$ oceanic heat flux

Oceanic heat flux



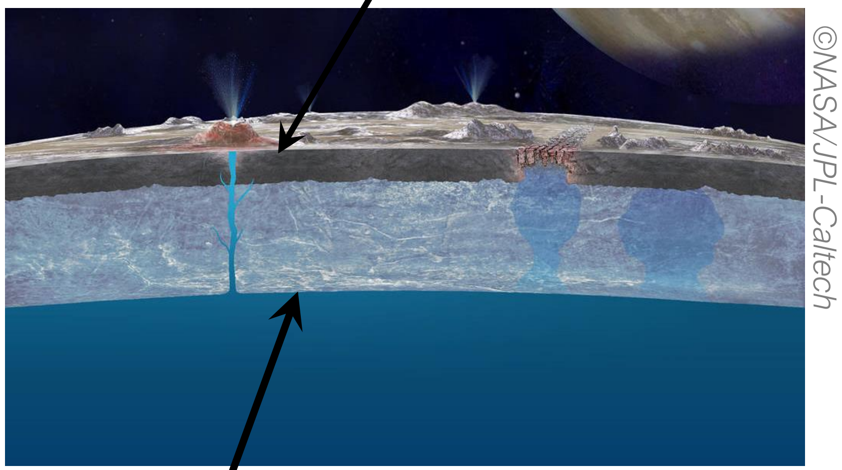
Implication for the ice crust

Surface temperature



[Ojakangas and Stevenson, 1989]

$T_s = T_s(\theta)$ radiative equilibrium



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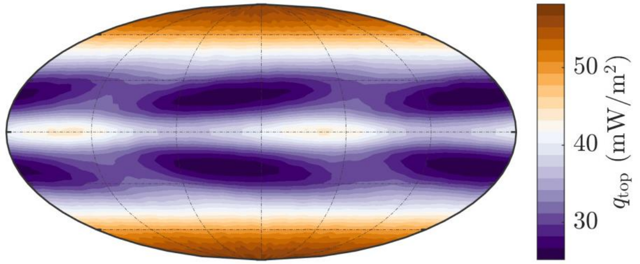


Implication for the ice crust

Internal ice tidal heating *h*

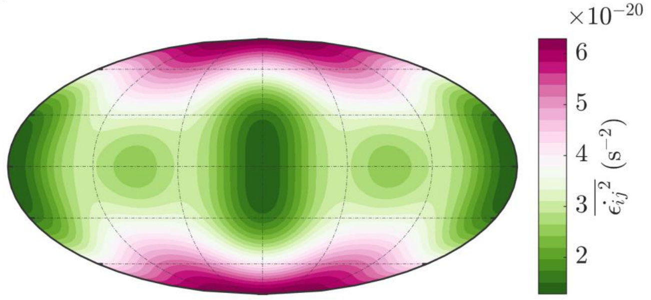
$$h(T) = \frac{2\mu\overline{\dot{\epsilon}_{ij}}^2}{\omega}\left[\frac{\omega\tau_m}{1+(\omega\tau_m)^2}\right]$$

$$\begin{cases} \tau_m(T) = \dfrac{\eta(T)}{\mu} & \textit{Maxwell time} \\ \eta(T) = \eta_b \exp(-\gamma(T - T_b)) & \end{cases}$$

Temperature-dependent viscosity

[Nimmo+ 2007]

Strain rate $\overline{\dot{\epsilon}_{ij}}^2$



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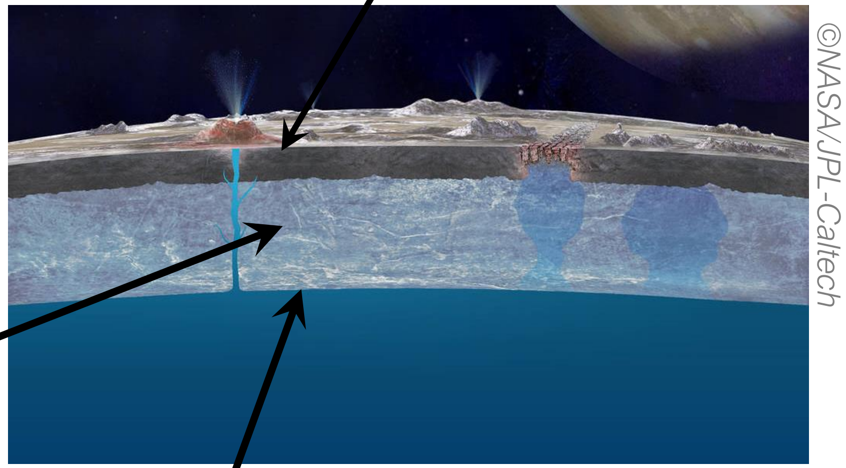

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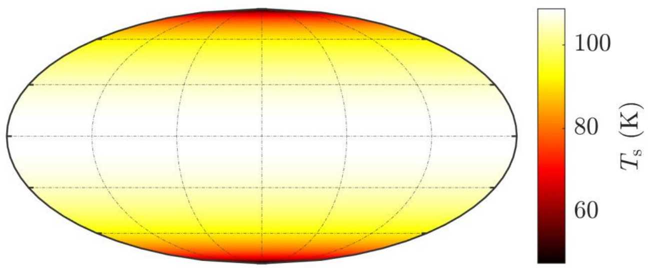
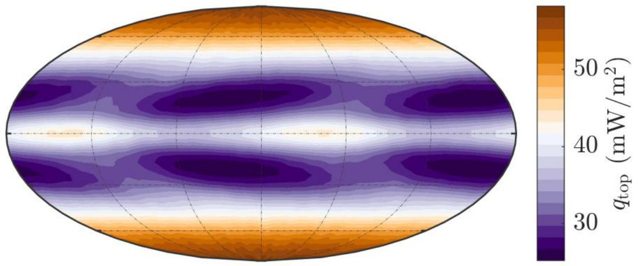
Surface temperature



[Ojakangas and Stevenson, 1989]

Oceanic heat flux



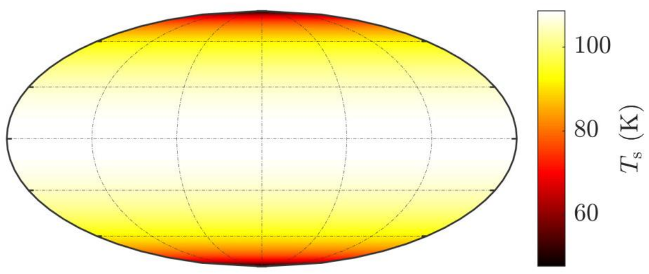
Implication for the ice crust

Solve one dimensional (steady) heat equation with internal tidal heating *h for each (θ, φ)* to find the ice thickness

$$-\frac{d}{dz}\left(k\frac{dT}{dz}\right) = h(T)$$

[Ojakangas and Stevenson, 1989]
[Nimmo et al., 2007]

Surface temperature



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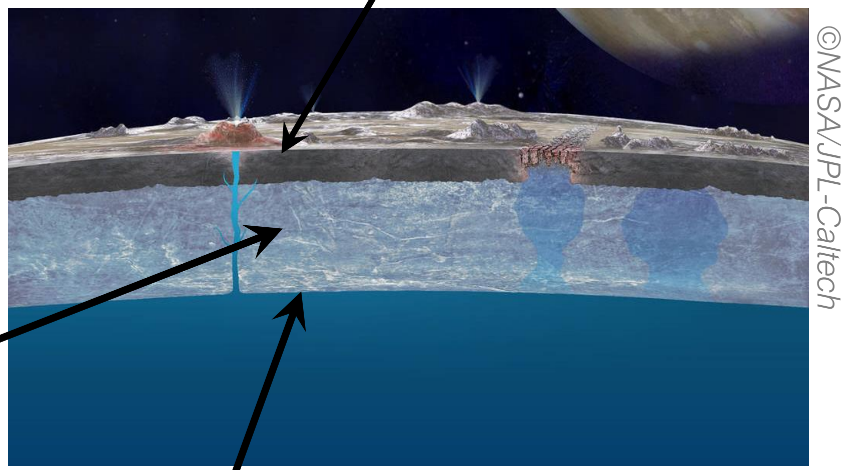

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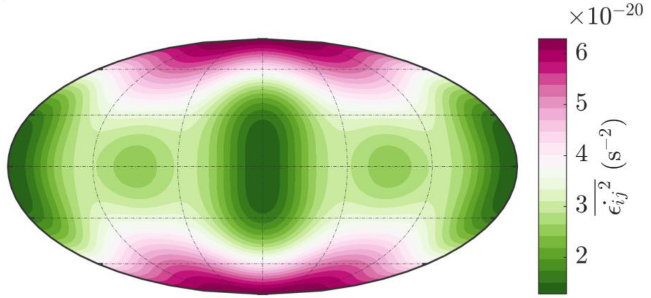

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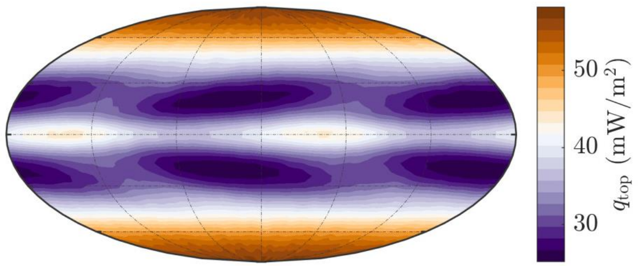
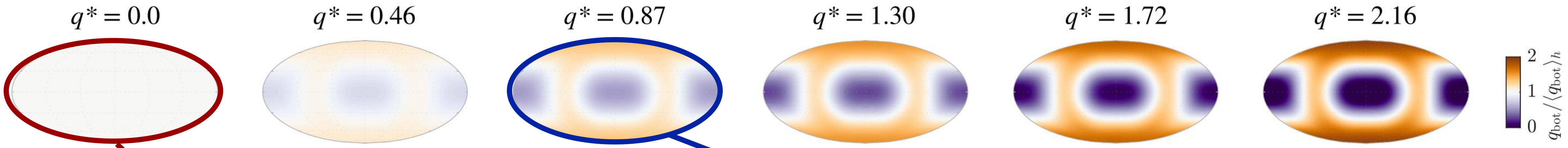


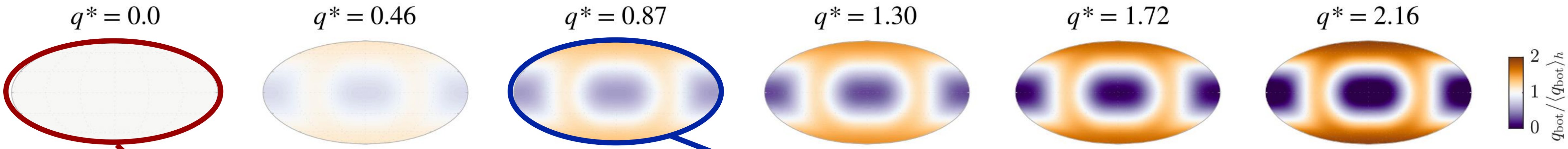
Implication for the ice crust



100% Radiogenic Heating

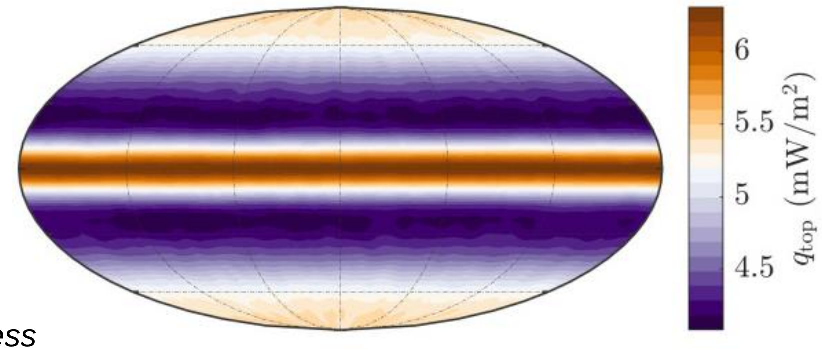
100% Tidal Heating

Implication for the ice crust

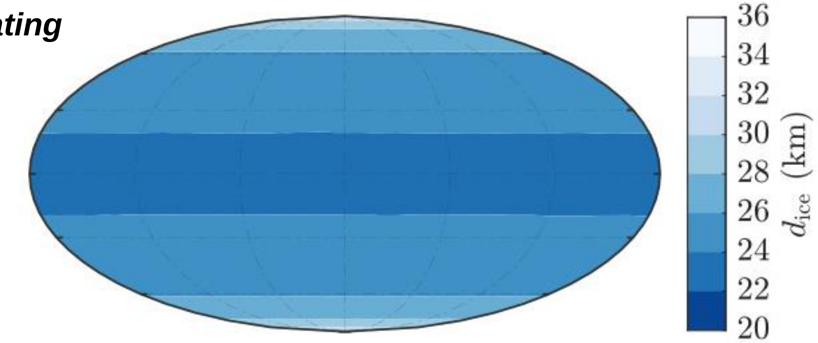


100% Radiogenic Heating

Top heat flux variations



Ice thickness variations ***(ocean heating only)***



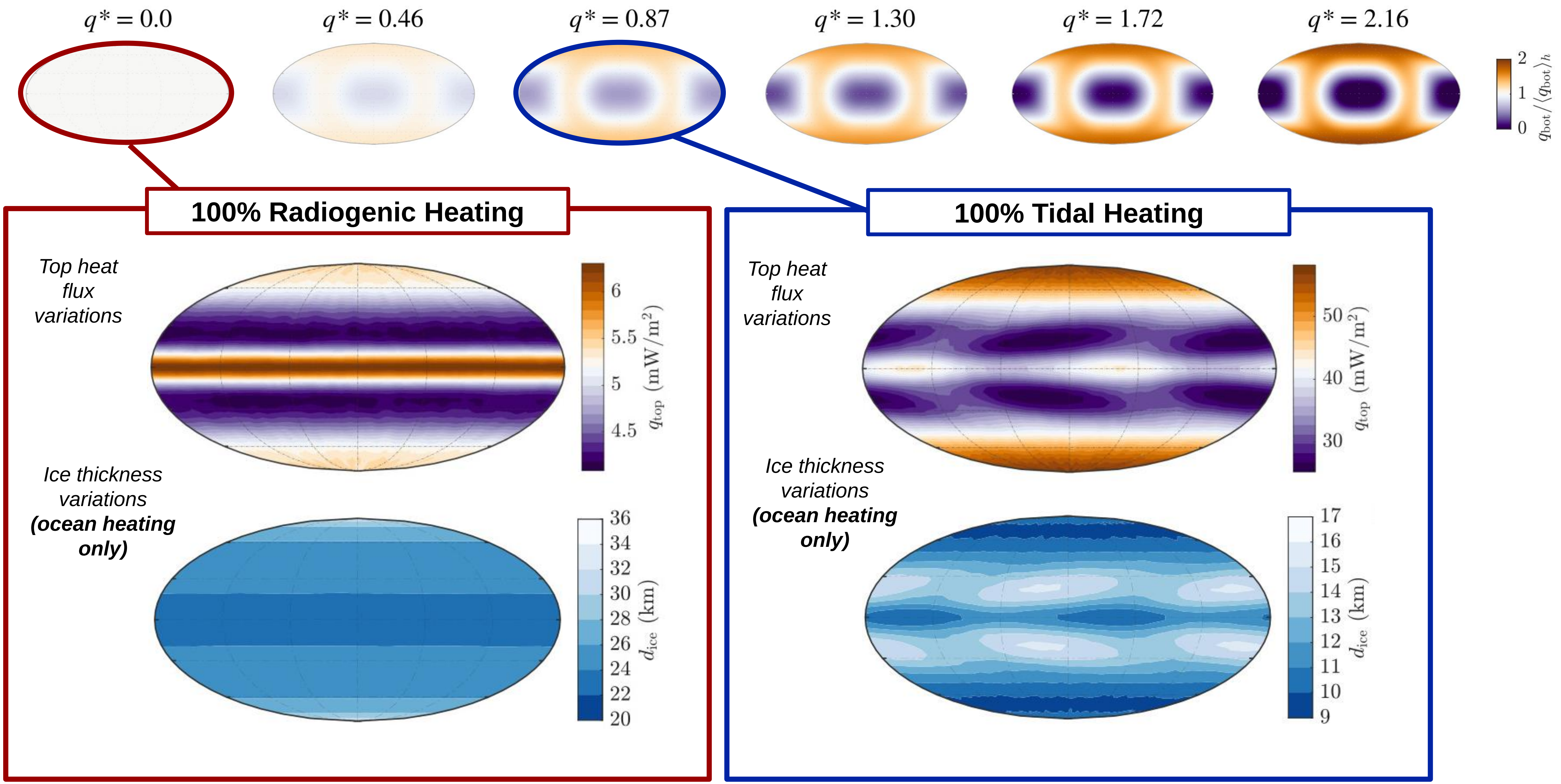
100% Tidal Heating

Top heat flux variations

Ice thickness variations ***(ocean heating only)***

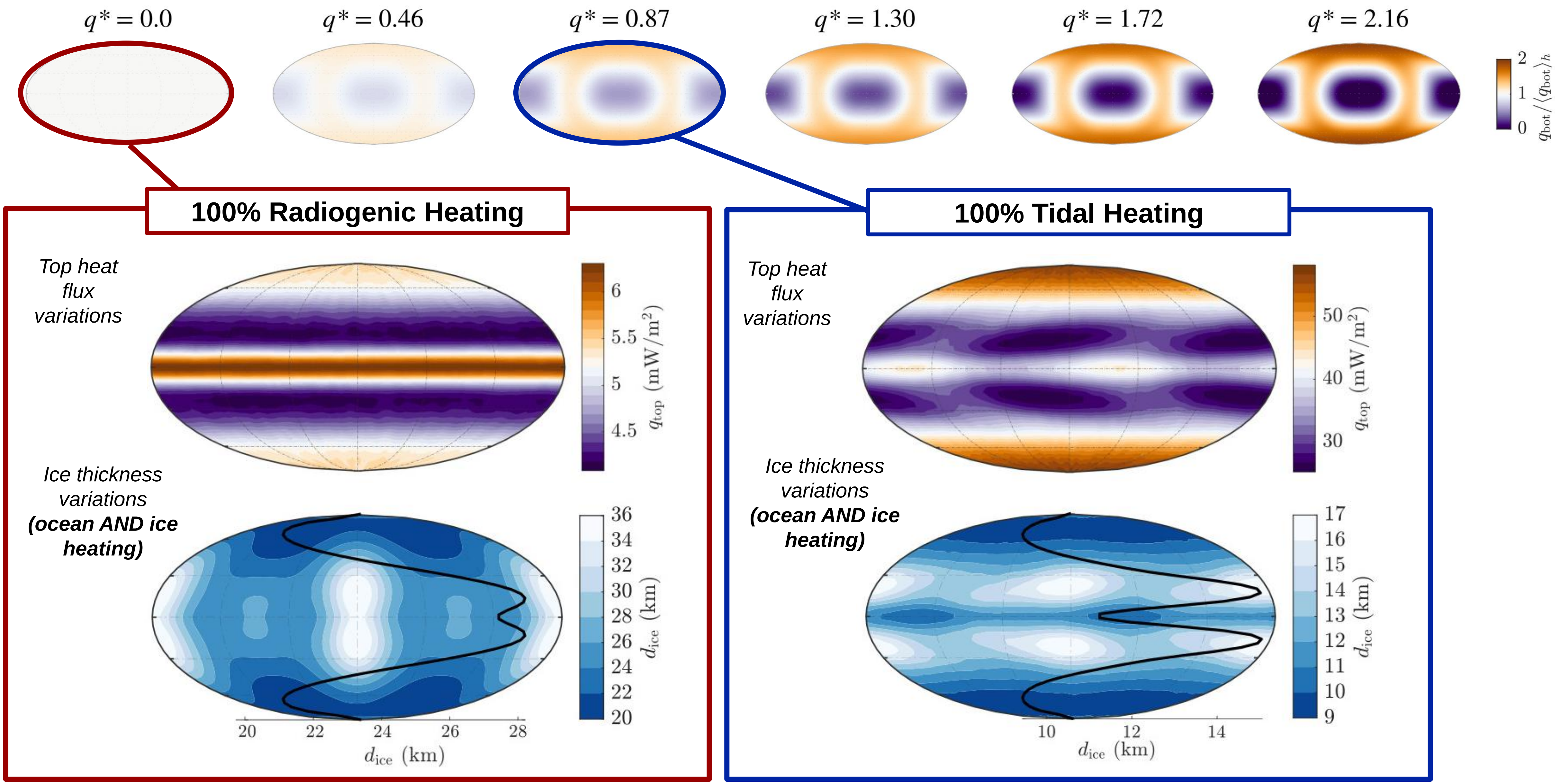
[Lemasquerier+ 2023]

Implication for the ice crust



[Lemasquerier+ 2023]

Implication for the ice crust



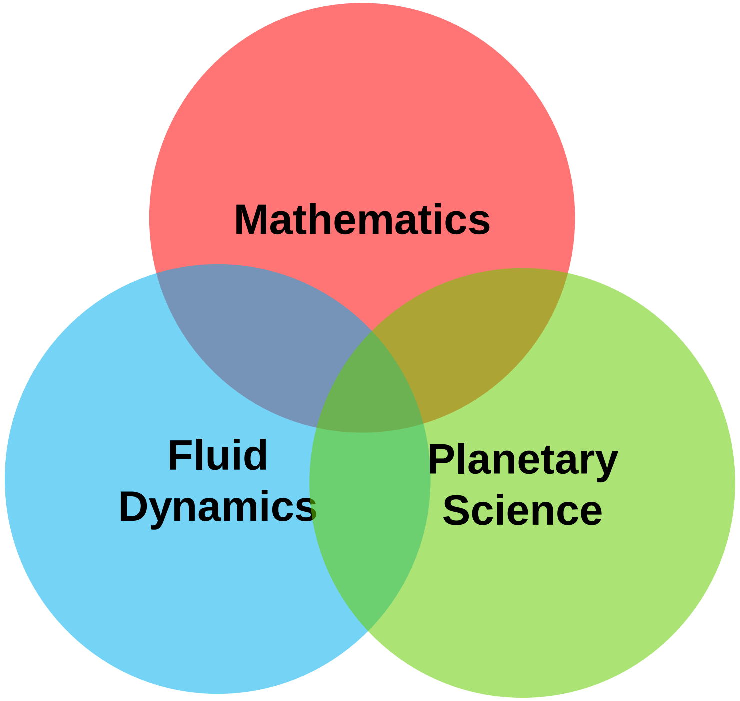
[Lemasquerier+ 2023]

The challenge of interdisciplinarity

Geophysical Fluid Dynamics
Planetary Fluid Dynamics
Astrophysical Fluid Dynamics

➔ **INTERDISCIPLINARY FIELDS**

University of St Andrews



Developing faithful/impactful models requires

1. To be an **independent learner**

2. To develop **collaborations**

3. To be **open-minded** and ready to learn from other disciplines (obstacles: assumed background knowledge, jargon, methods…)

4. To **combine approaches** (theoretical, numerical,experimental). Complex problems should be approached by multiple angles.

This is not taught at undergraduate level!

irphé Institut de Recherche sur les Phénomènes Hors Equilibre

INSTITUTE FOR GEOPHYSICS JACKSON SCHOOL OF GEOSCIENCES

Why Academia?

Why Academia?

A relevant question… at any career stage!

Should I pursue a doctorate? **→ Piscopia Initiative!**
Should I apply for postdoctoral or faculty positions?
Should I remain in academia, having obtained a permanent position?

1. **Get to know yourself! Think: What would make you happy going to work every day?**
   Are you self-driven?
   Do you like to work and meet with people?
   Do you like to present your work at conferences and in papers?
   Would you like to be a research-focused or teaching-focused academic?
   Would you like to work with a large or small group? At a large or small institution?

And also: do research/summer projects if you have the opportunity!

Why Academia?

2. Talk to people: ask PhD students, postdocs and academics what they do/like/dislike… get to know what the job entails. → Piscopia Initiative!

What I like:

. Curiosity-driven and creativity-driven job
. Learning every day
. Bridging gaps and making links between fields
. Flexibility ("own" boss!)
. Being part of an international community, working together to address complex challenges
. Opportunities for travels and collaborations
. Variety (teaching, supervision, research, admin…)
. Opportunities to mentor/supervise students and give them all I can to support them in their academic career

Why Academia?

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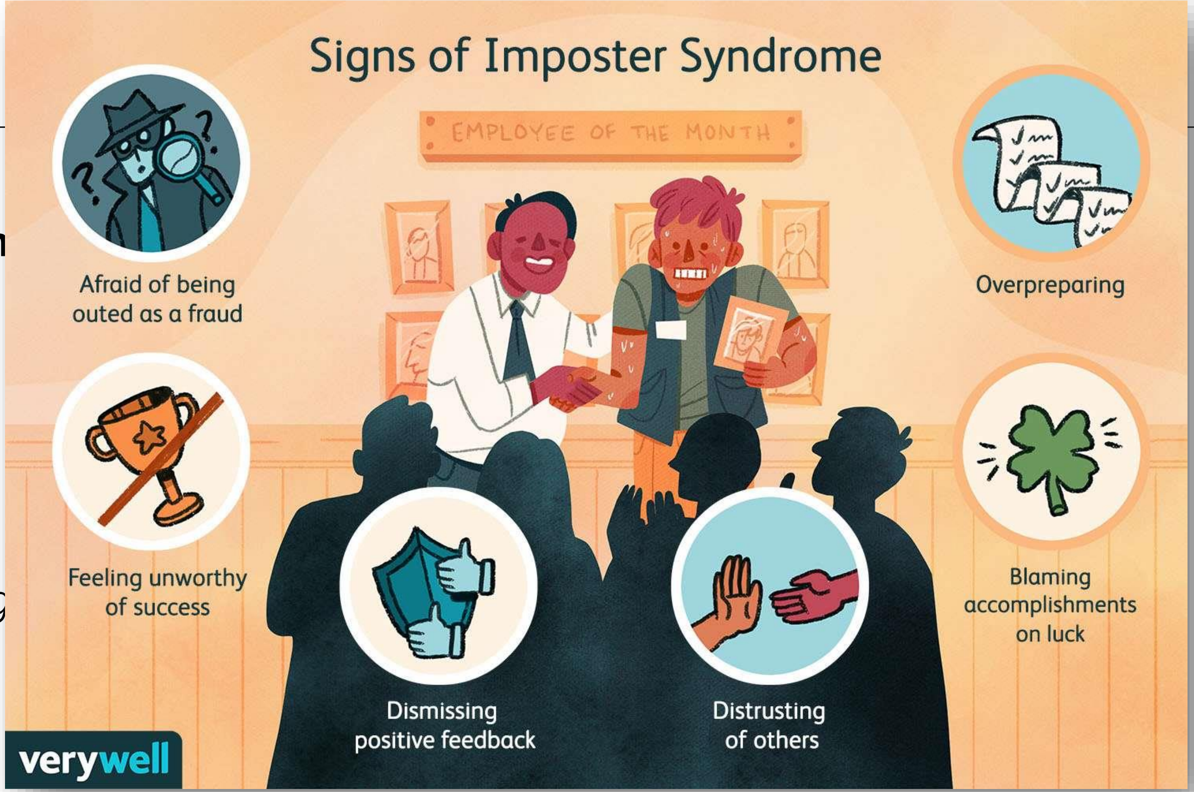


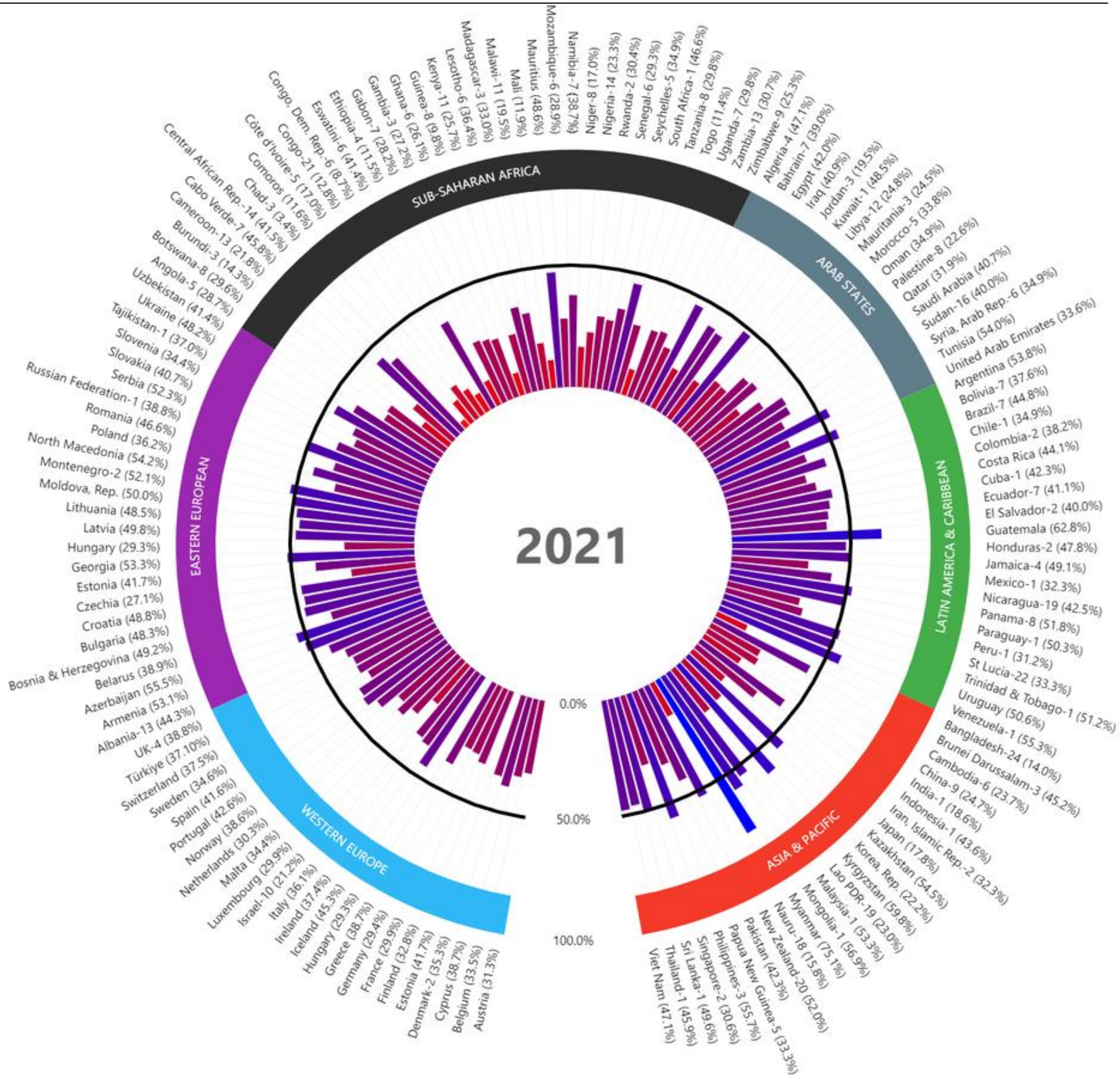
What I don't like / the challenges:

. *A career in academia is not easy (few permanent positions)*
. *As a result: it's competitive: importance of finding a supportive environment/mentors to help you*
. *The feeling of being judged by others (talks are stressful!) / the imposter syndrome*
. *Mobility if often required for postdocs, without much consideration for personal/family situations*
. *It's hard to balance teaching, research and admin*

Women In Science and Mathematics

The challenge: bridge the gender gap in science

- Only **31.7%** of researchers in R&D in 2021 in the world are **women** (UK:38.8%, France: 29.9%)



Source: UNESCO – The gender gap in science – Status and Trends – February 2024. https://unesdoc.unesco.org/ark:/48223/pf0000388805

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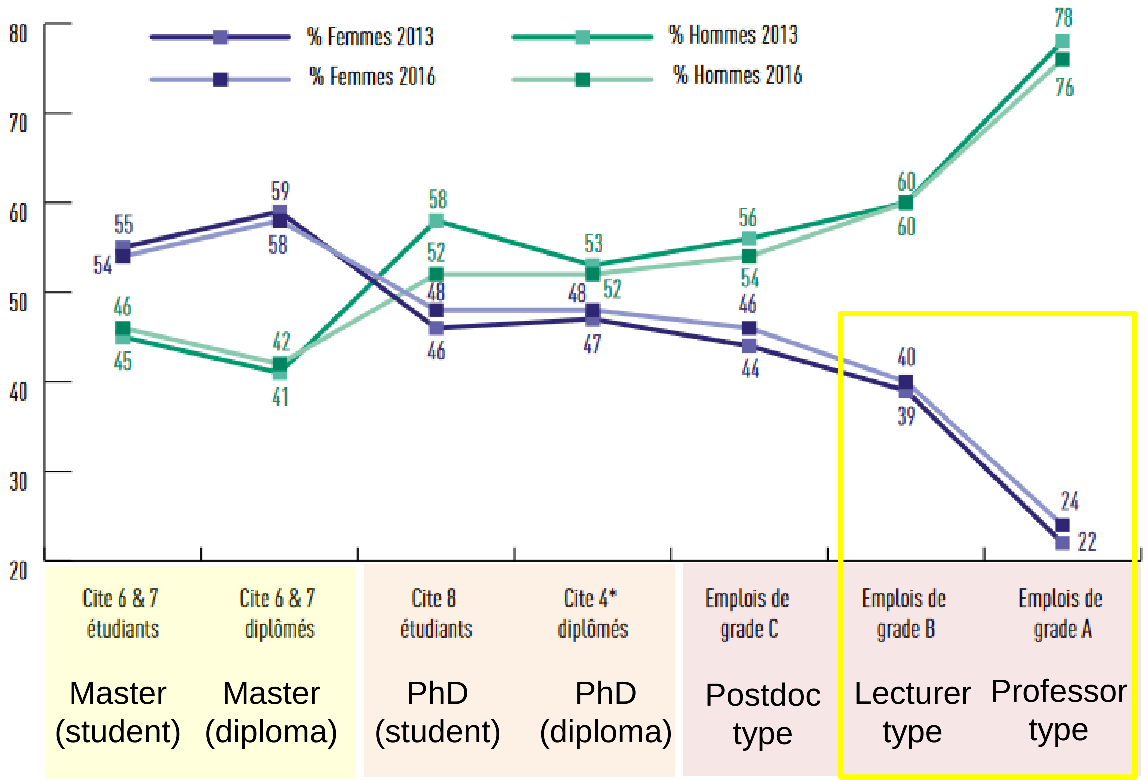
- A leaky pipeline effect: decreasing proportions at higher career stages

% for a typical academic career (all fields)



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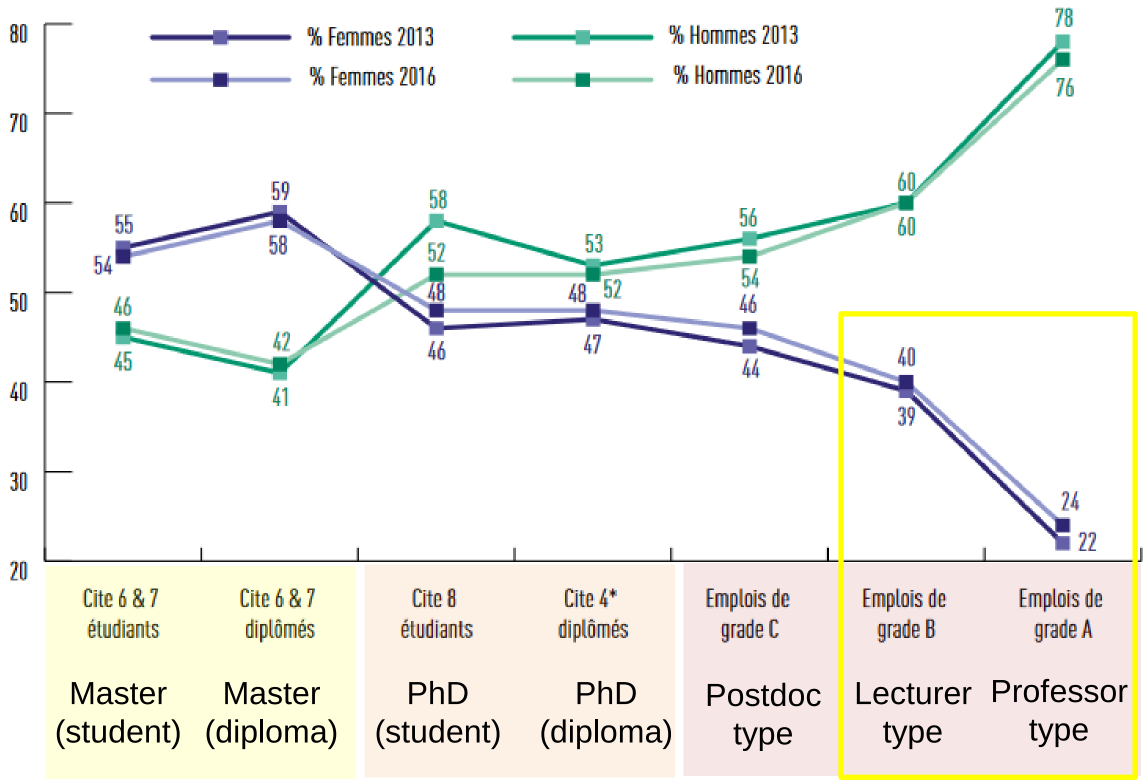
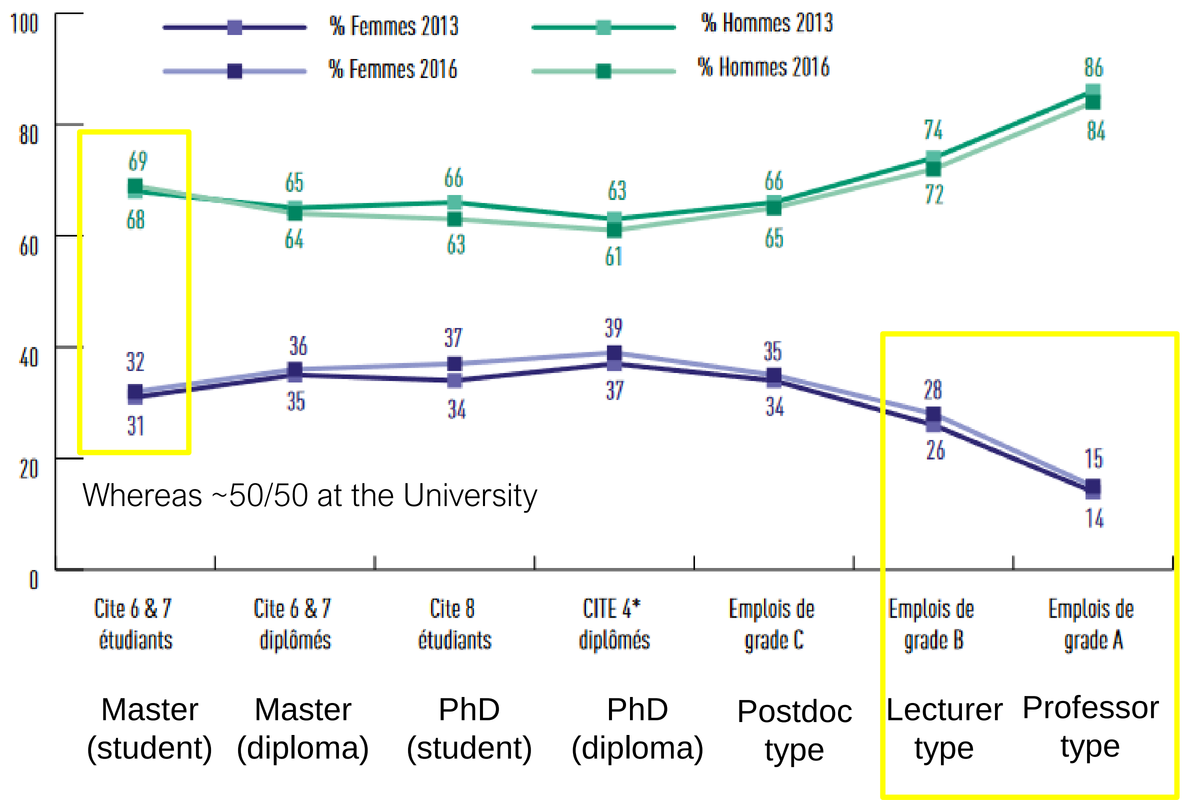
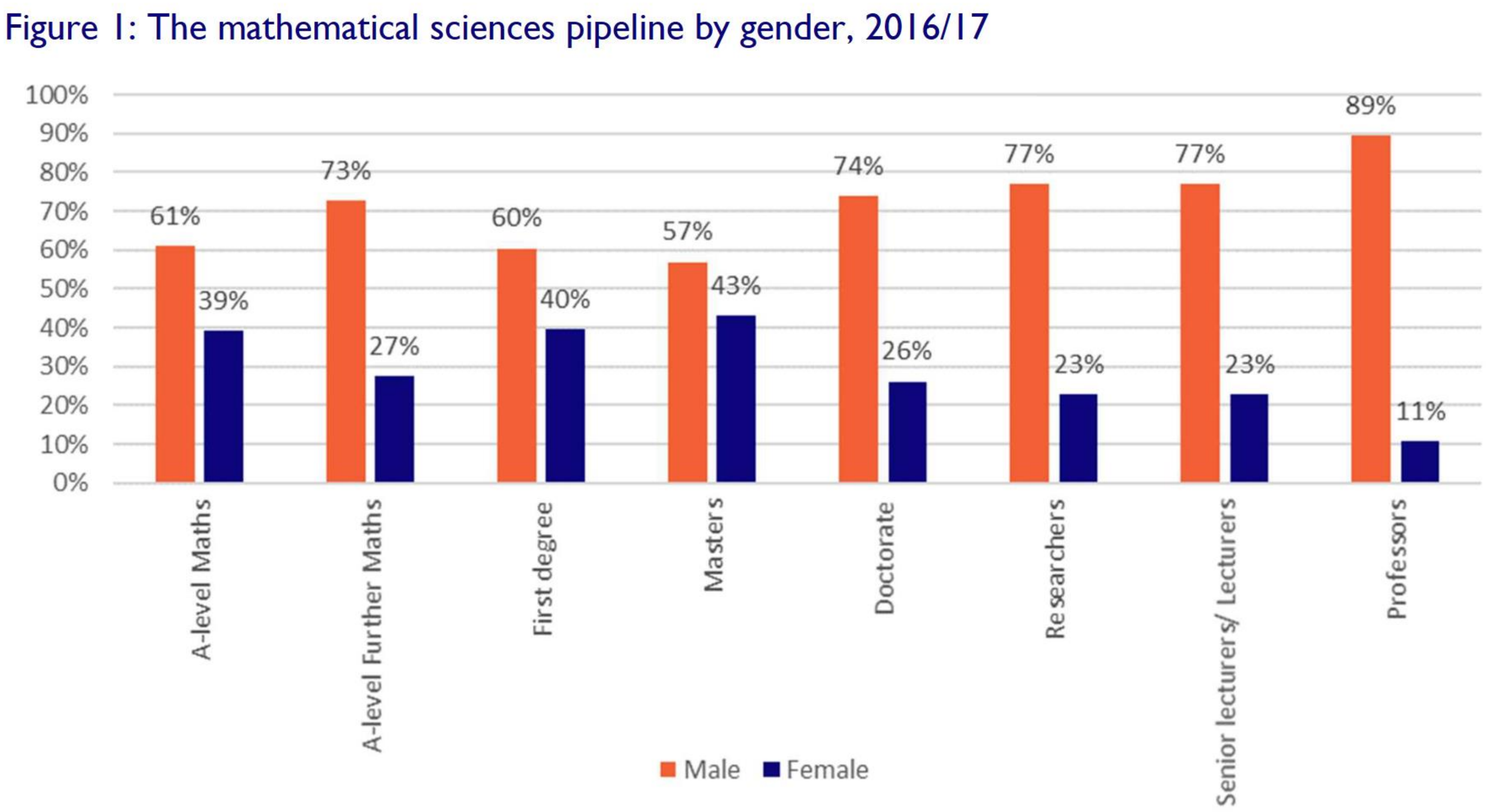


% for an academic career in science or engineering



Women In Science and Mathematics



- From 2011/12 to 2016/17:
  - increase from 7% to 11% women among UK mathematics professors
  - percent of women among MSc students in mathematics has increased from 37% to 43%

- Percentages of women at other stages of the pipeline have remained roughly constant over this period

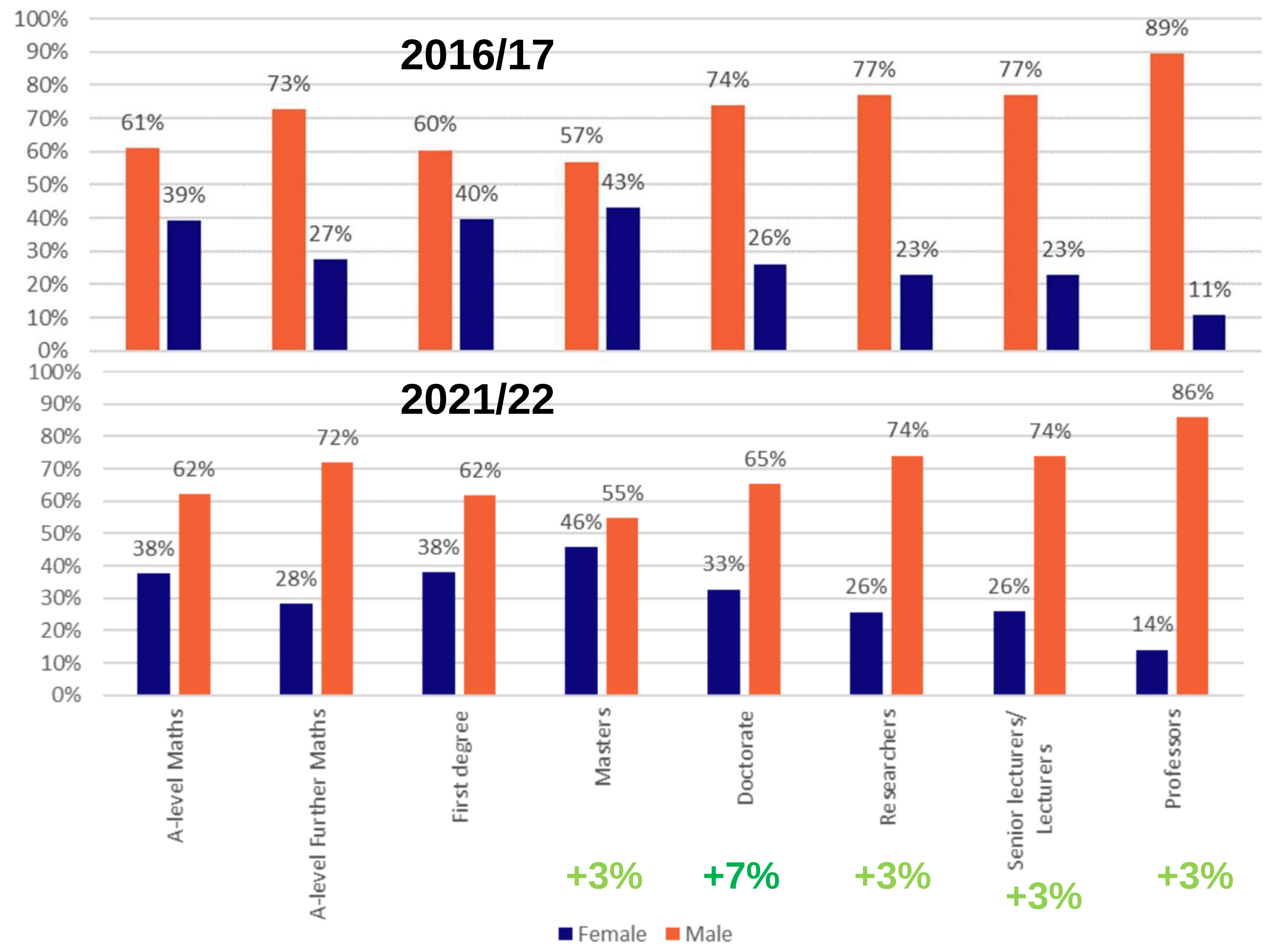
- The increase at MSc level is driven by international students and doesn't seem to result in larger per cents at higher levels

➔ Almost all departments report struggle in recruitment of women students and staff

Source: Benchmarking Survey -- **LMS Women in Mathematics Committee** and Good Practice Scheme Steering Group
https://www.lms.ac.uk/sites/default/files/inline-files/Benchmarking%20Report%20FINAL_0.pdf

Women In Science and Mathematics

Figure 1: The mathematical sciences pipeline by gender, 2016/17

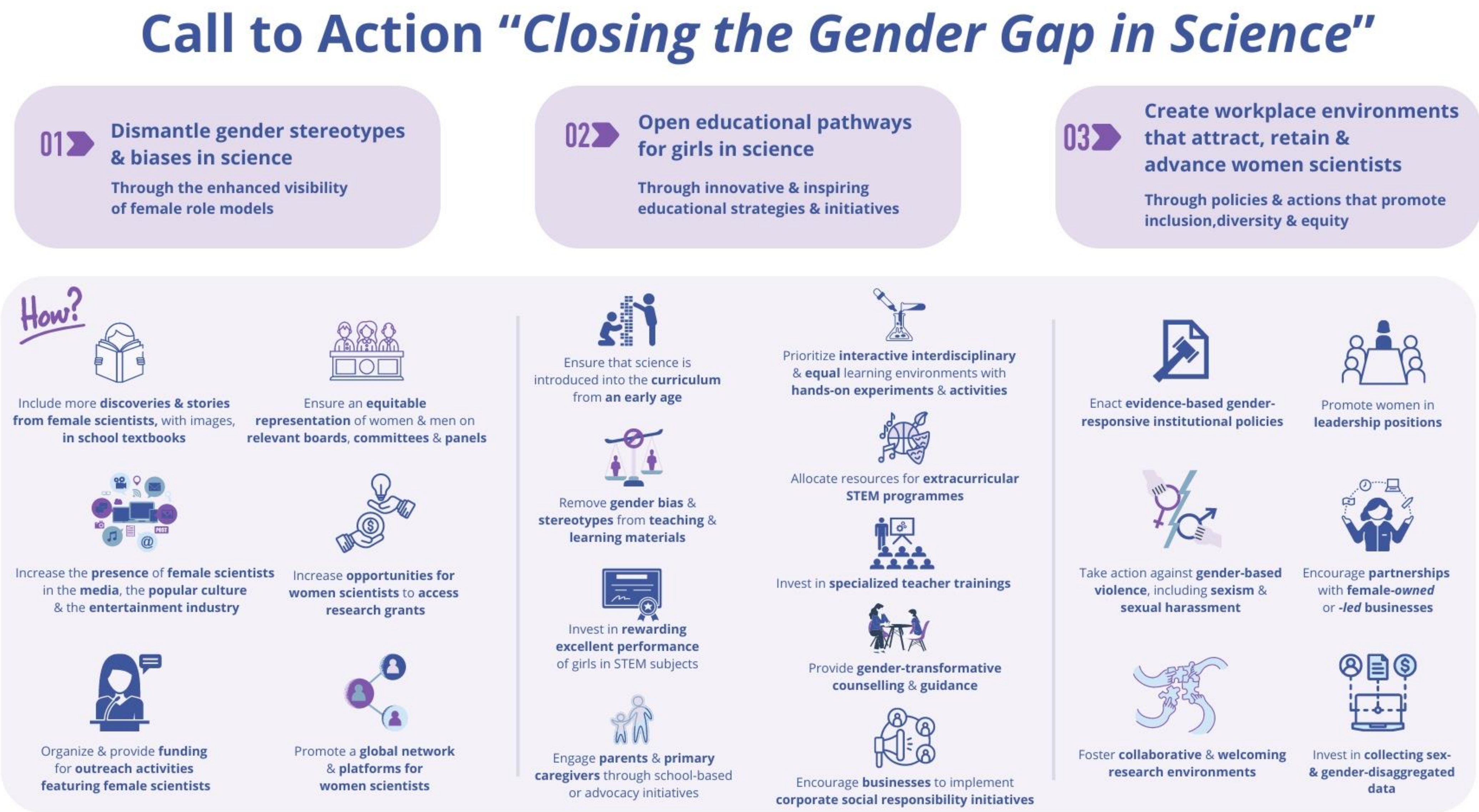


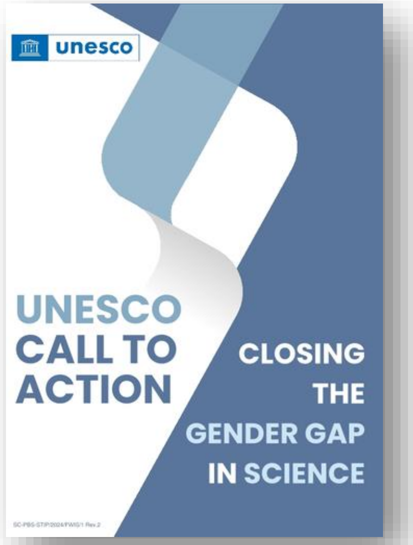
Source: Benchmarking Survey -- **LMS Women in Mathematics Committee** and Good Practice Scheme Steering Group 2023 update: https://www.lms.ac.uk/sites/default/files/inline-files/PN2113_LMS_Benchmarking_March2023_v0-4_3.pdf

But WHY?

- Low self-confidence
- Lack of role models
- Scientific culture in academia: competitive, few permanent positions, no guarantees…
- Difficulty of maintaining a career after having a family, especially in rapidly-changing subjects where it's hard to catch-up after a break.

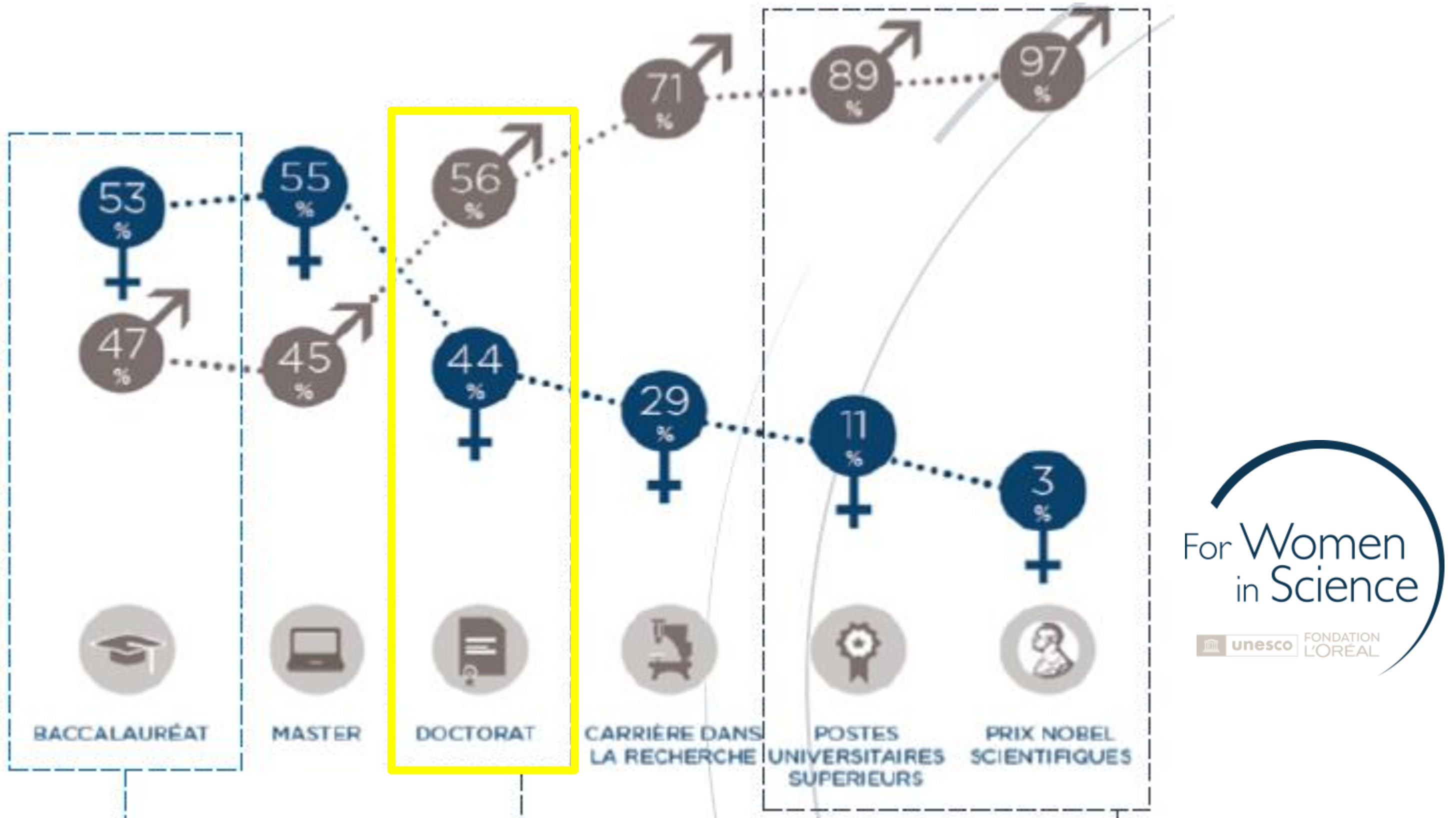
UNESCO Call to Action





https://www.unesco.org/en/science-technology-and-innovation/cta

« For Women In Science » program and awards, Fondation l'Oréal-UNESCO



For Girls In Science (schools)

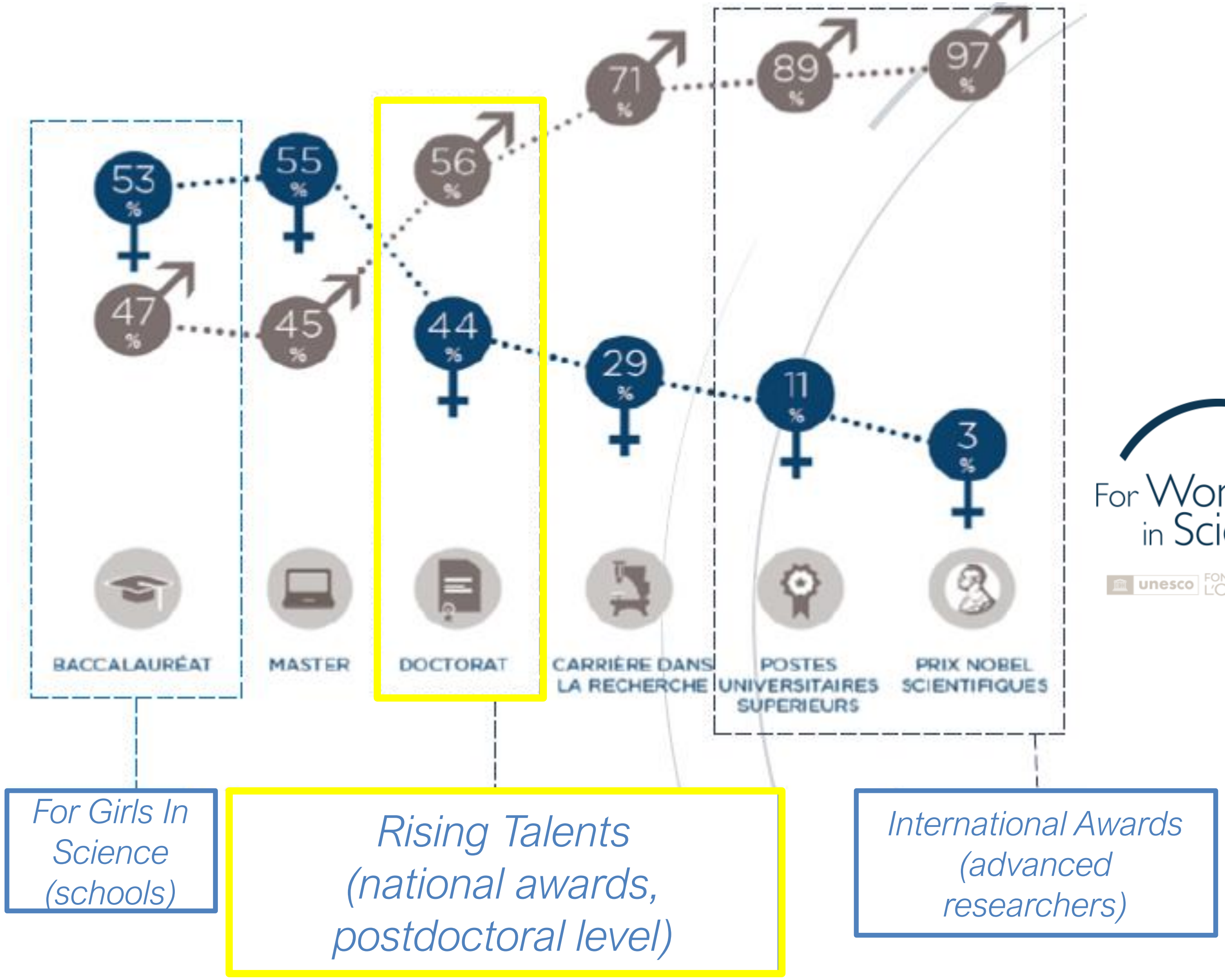
Rising Talents (national awards, postdoctoral level)

International Awards (advanced researchers)

https://www.forwomeninscience.com/authority/united-kingdom-and-ireland---national-programmes#auth-sub

« For Women In Science » program and awards, Fondation l'Oréal-UNESCO

- Awards from a partnership between L'Oréal-UNESCO UK & Ireland, the UK National Commission for UNESCO and the Irish National Commission for UNESCO, with the support of the Royal Society
- Under the umbrella of the L'Oréal-UNESCO For Women In Science Programme, which has promoted women in scientific research on a global scale since 1998.
- **Five Rising Talents Awards** per call
  – support a 12-month period of **postdoctoral research**
  – **£15,000** awards designed to provide flexible support; buying equipment, paying for childcare or funding travel costs to an overseas conference.
  – Goal: enable women scientists to pursue and **continue their research careers**



For Women in Science
unesco FONDATION L'ORÉAL

https://www.forwomeninscience.com/authority/united-kingdom-and-ireland---national-programmes#auth-sub

Some advice at your career stage

- Be aware of strong socio-cultural biases and steroreotypes in scientific disciplines and professions
→ *My role is to give you a better representation of academia, change the image of the scientist…: notice the diversity! Every academic has a different background and career path.*

- Cultivate your curiosity, try different things to identify what you really like and get to know what you dislike.

- Don't censor yourself, don't justify yourself; Don't ask yourself "am I good enough for" but "am I motivated/interested enough for/in".

- Find mentors and support from academics, teachers, family members...

- Follow your heart: take opportunities to work with people you find interesting/inspiring

A nice reference for PhDs in applied maths: Roberts, P.A. Advice to a Young Mathematical Biologist. *Bull Math Biol* **86**, 52 (2024). https://doi.org/10.1007/s11538-024-01269-1