



Centrum Wiskunde & Informatica

MAC1—Dynamical Systems and Numerical Analysis

Self-evaluation 2005-2010

Group leaders: Jason Frank (2007-2010)
Arjen Doelman (2005-2006)

Senior staff

Distinguished staff:

2 cluster leaders,
3 full professors, 1 CWI fellow, 2 royal
commendations, 1 director Lorentz Center

Five senior staff until end-2009:

- ▶ Nico Temme (–2005, ret.)
- ▶ Joke Blom (–2006, MAC3)
- ▶ Arjen Doelman (–2009, LC)
- ▶ Ben Sommeijer (–2009 +)
- ▶ Jan Verwer (–2011, ret.)
- ▶ Daan Crommelin (2006–)
- ▶ Jason Frank

As of 2011: two



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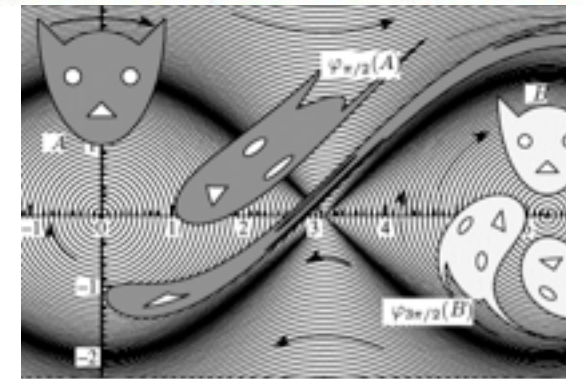
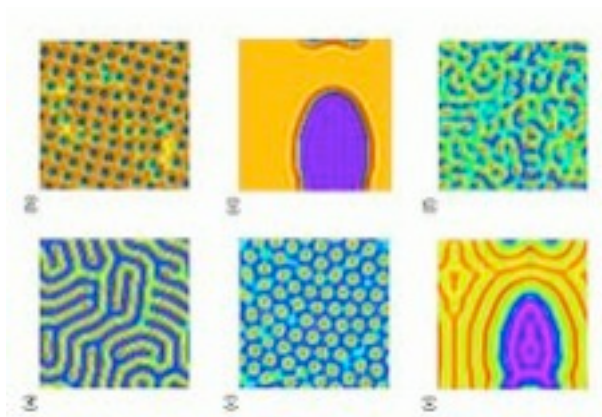
2011

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Evolution problems

- ▶ Period 2005-2010: Dynamical systems and numerical analysis (PDEs, pattern formation, geometric numerical integration), stochastics
- ▶ Long-term agenda: synthesis with stochastic differential equations, stochastic modeling of dynamical processes
- ▶ Applications in earth and life sciences
 - ▶ atmosphere and ocean
 - ▶ patterns in vegetation and sea bed
 - ▶ phytoplankton populations



Research activities 2005–2010

Research highlights:

- ▶ Numerical modeling of phytoplankton mixing (*Nature* '06)
- ▶ Rigorous theory, low-dimensional dynamics of coherent structures
- ▶ Implicit-explicit splitting methods for Maxwell equations
- ▶ Statistical bias in methods for long simulations of inviscid fluids
- ▶ Scale-independent Markov chain subgrid parameterization

Other highlights:

- ▶ Doelman: prominent roles in NDNS+, mathematics policy, Lorentz Center
- ▶ 15 PhD degrees, 71 journal publications (SIAM: MMS, SISC, SIADS; PNAS; J. Atmos. Sci.; JCP; J. Stat. Phys.; Nonlinearity; Phys. D)
- ▶ Stieltjes Prize for Van Heijster, knighthoods for Temme, Verwer
- ▶ Four international workshops, 72nd Euro. Study Group Math. Industry
- ▶ Professorship Frank in prestigious Chair at UvA; Editorial board SISC

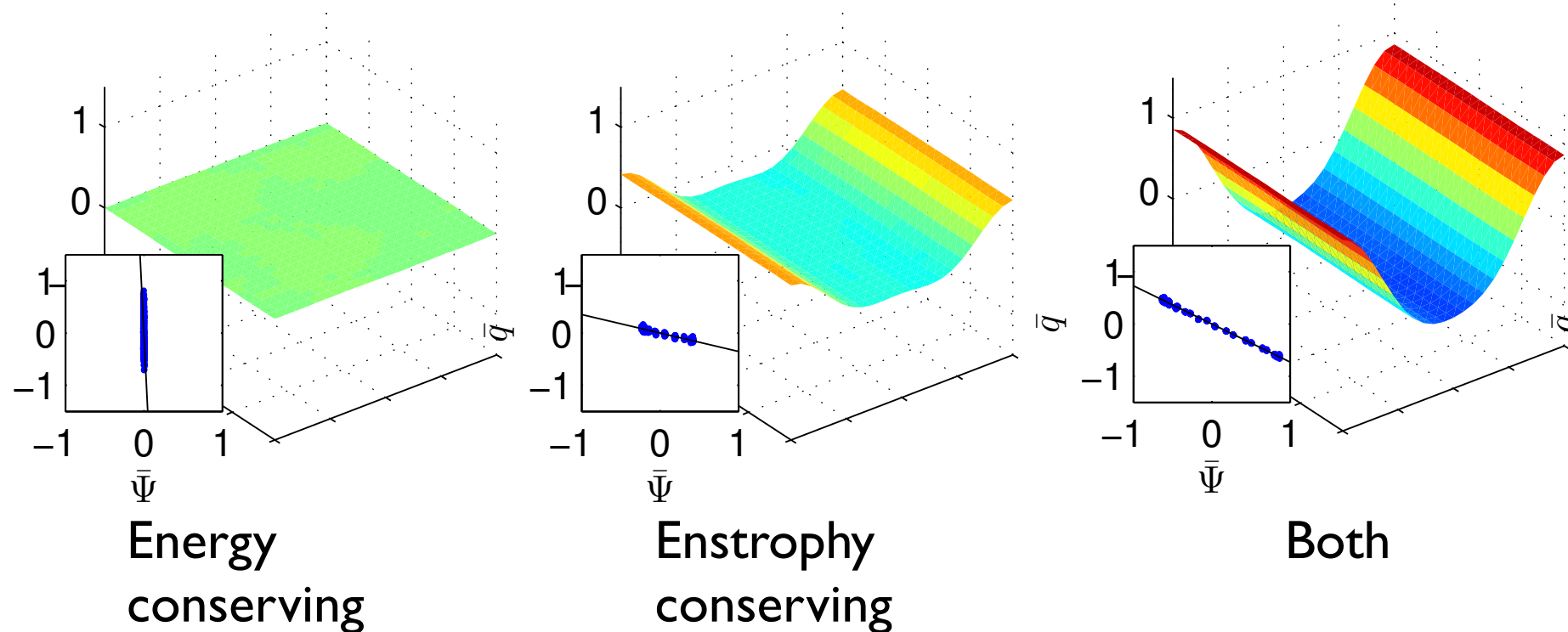
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Research activities 2005–2010

Rotating ideal fluids over topography: Mean stream function response

- Statistics depend on the discrete conservation properties
- Quantify and correct for numerical bias



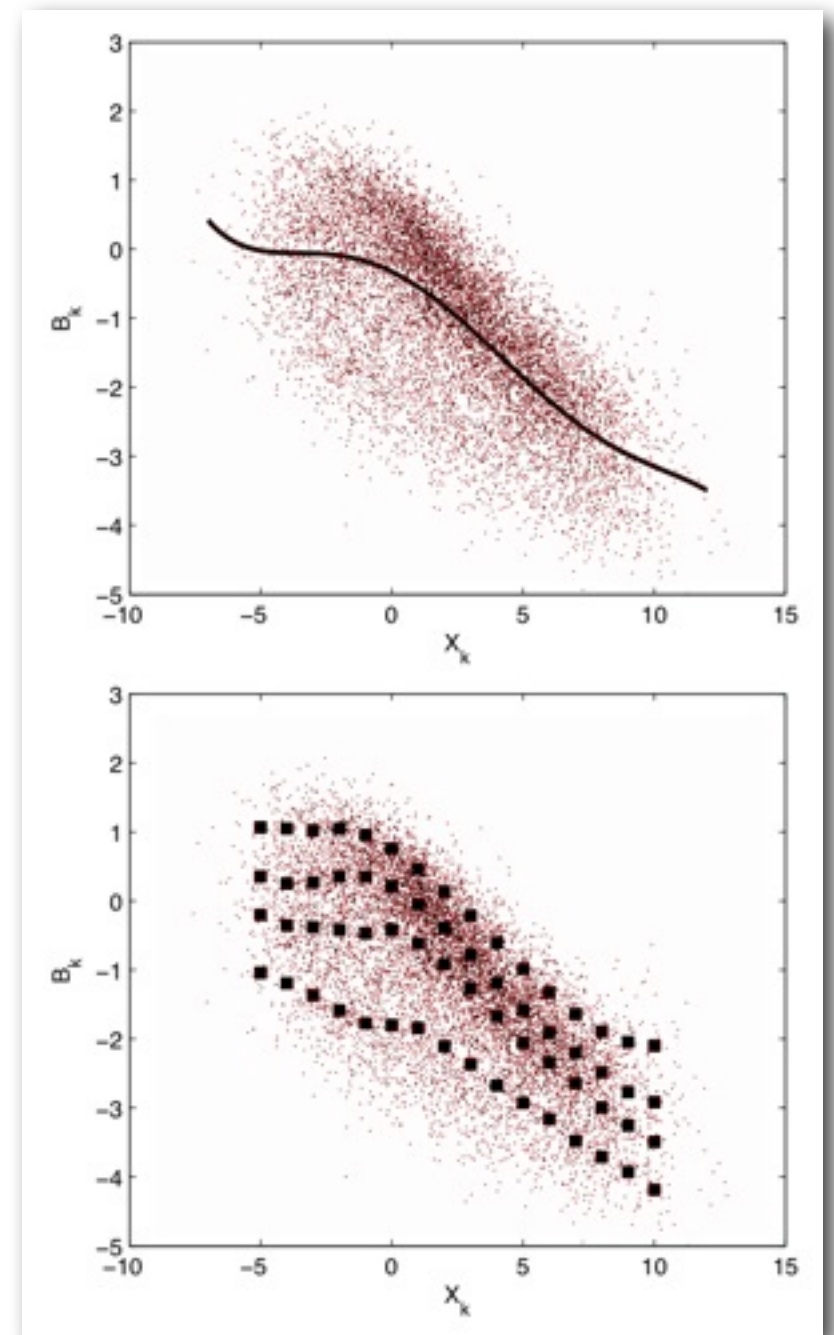
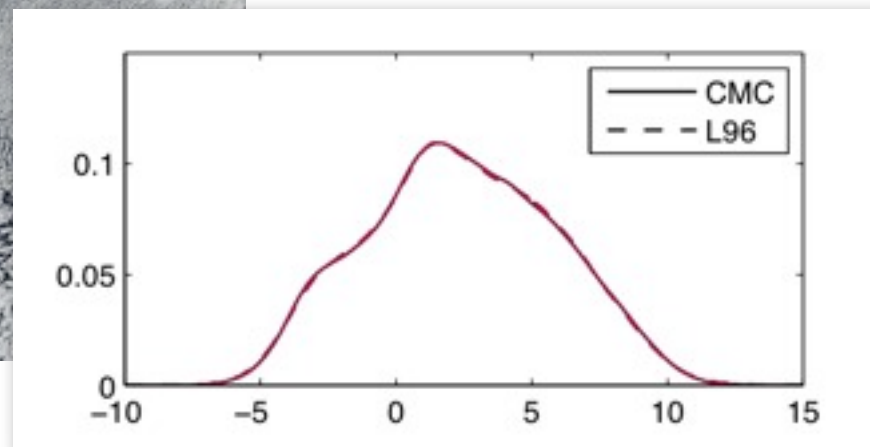
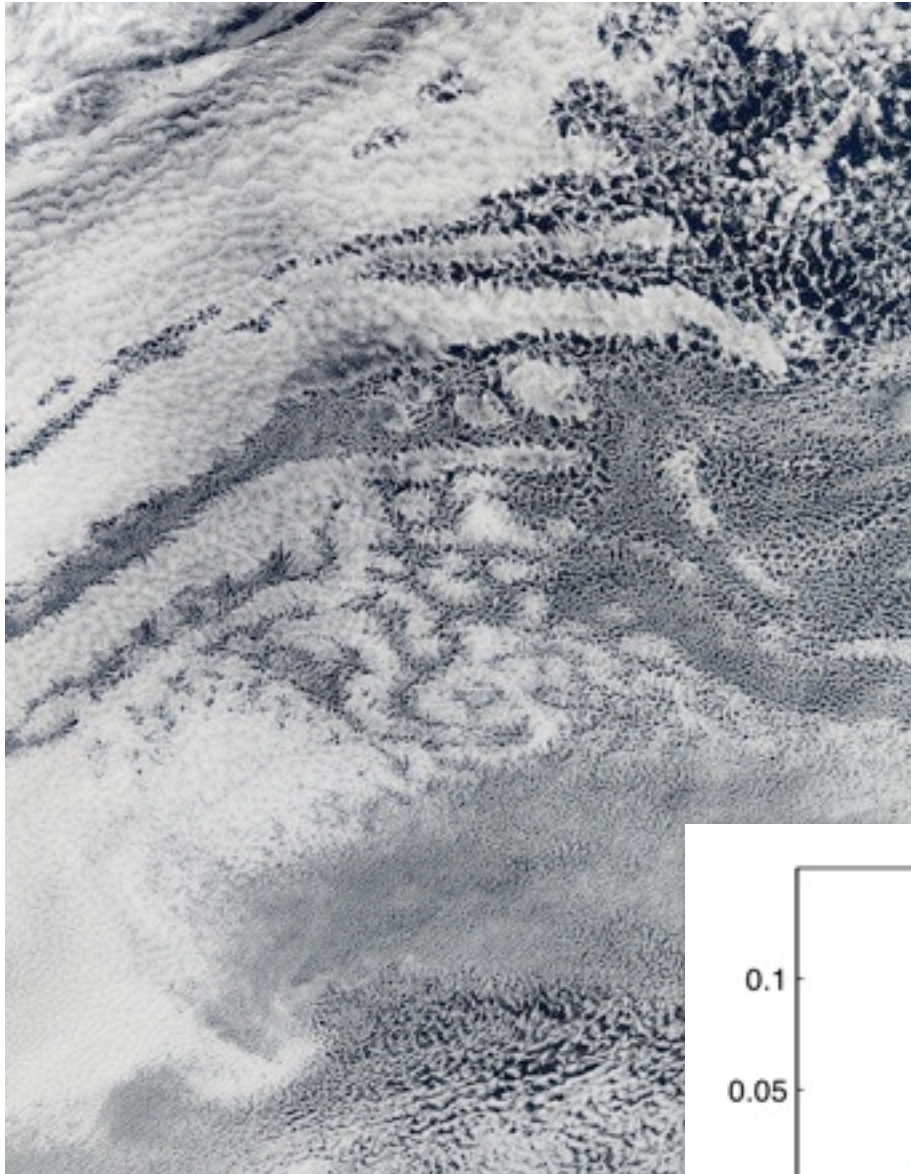
S. Dubinkina & J. Frank, *J. Comput. Phys.* (2007)

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Current Scientific Challenges

Cloud parameterization



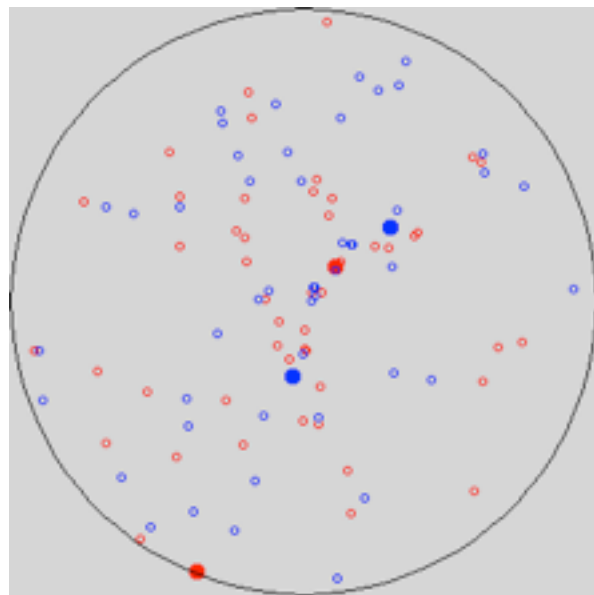
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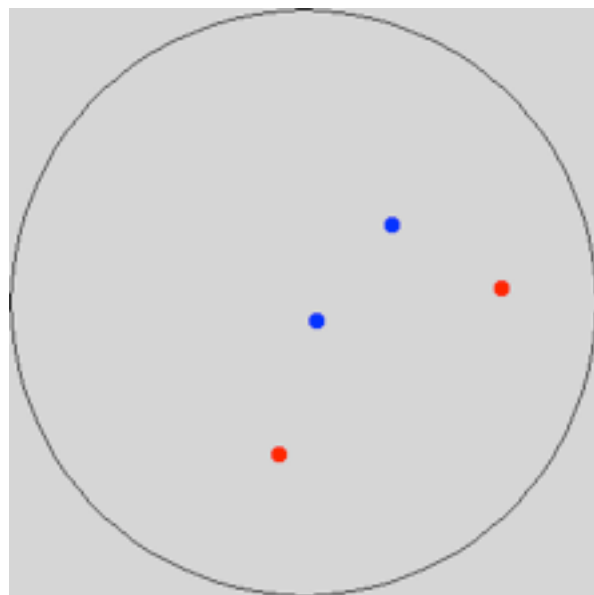
D. Crommelin & E. Vanden-Eijnden, *J. Atmos. Sci.* (2008)

Current Scientific Challenges

Statistically consistent reduced modelling: point vortices (2D hydrodynamics)

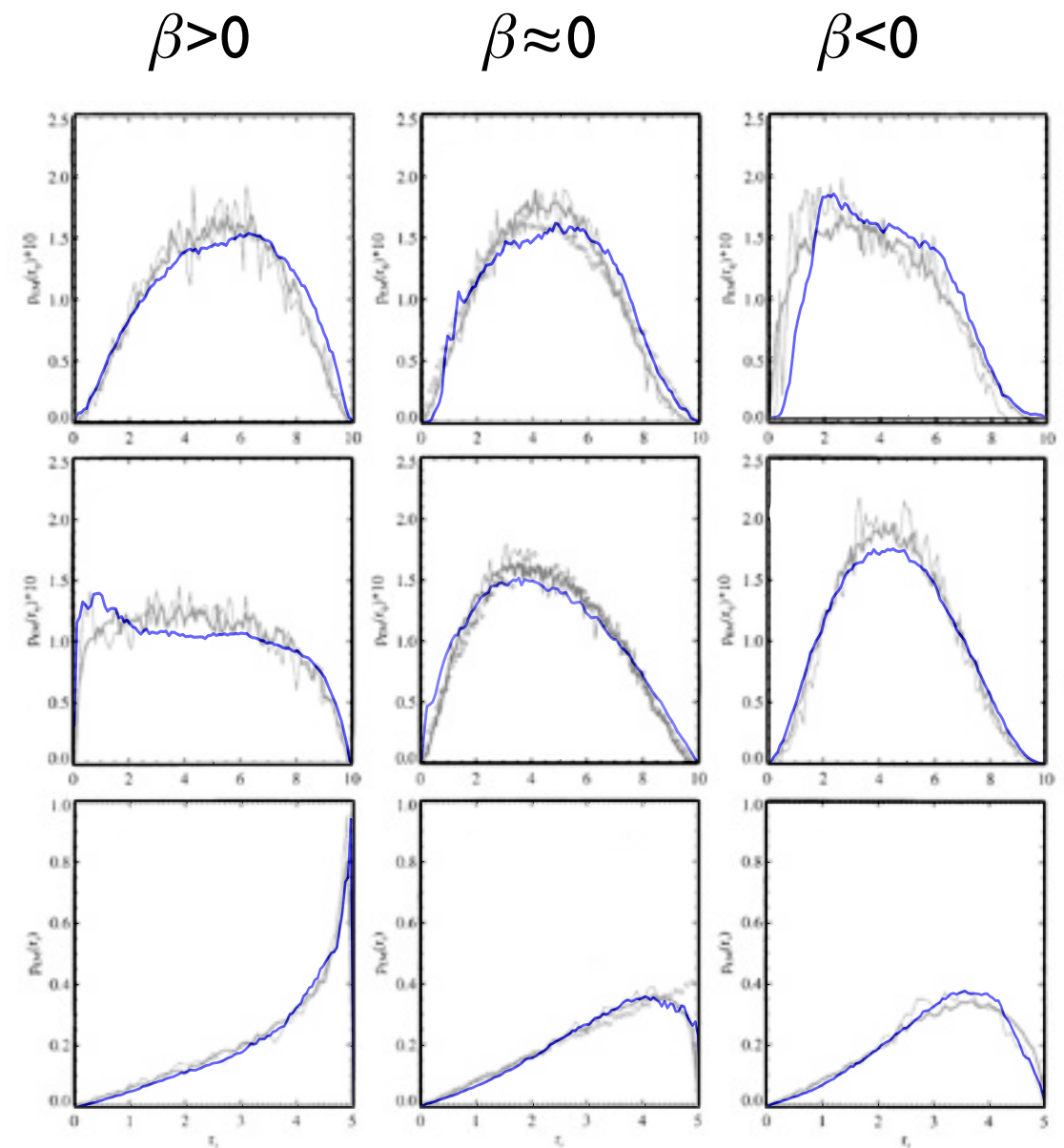


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$$|x_i - x_j|_{\pm\mp}$$

$$|x_i|$$



Strategy

- ▶ **S:** Young, ambitious, internationally oriented staff; active research areas with high societal relevance; strong record in competitive (NWO) funding; connections with other CWI groups
- ▶ **W:**
- ▶ **O:** Alignment with NWO & Government priorities; NDNS+
- ▶ **T:** To date, no industrial funding

Viability and Strategy:

- Rejuvenated MAC1 - *Computational & Stochastic Dynamics*
- Coherent research focus, threshold of stochastics and numerics
- Improving dynamics: group → *team*. Lively discussion/interaction
- Junior staff: 6 PhDs, 1 PD, 4 new projects; *guests*, sabbatical visitors
- Energy systems applications, potential industrial funding
- *Push for senior staff (2 → 3)*

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