

Nephelae

Network for studying Entrainment and
microPHysics of cLOUDs using Adaptive Exploration

3.5 years ANR founded project
01/2018 – 06/2021



Nephelae

Nymphs of clouds and rain



Structure of the project

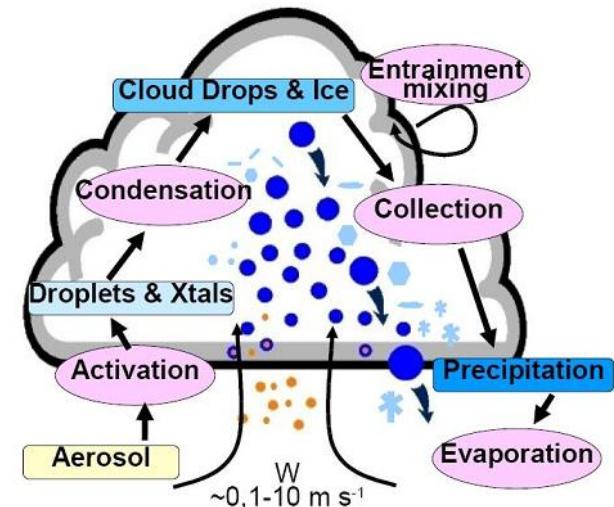
- Atmospheric science driven with focus on cloud microphysical processes
 - aims to develop a UAS fleet with decentralized cooperative sampling

Scope of the project

- Main target: follow the evolution of a cloud with multiple drones to study entrainment and the onset of precipitation



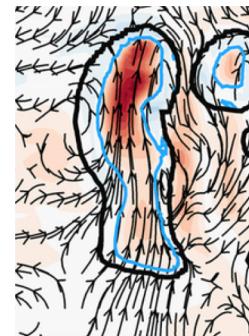
- identify dominant entrainment mechanism
- quantify timescale of cloud development and onset of precipitation
- assess impact of aerosol and surrounding cloud boundary conditions on entrainment and onset of precipitation.



→ Impacts the drone conception and the fleet control

Involved Partners

CNRM Centre National de Recherches Météorologiques
Experts in atmospheric sciences, fly drones



ENAC École Nationale de l'Aviation Civile
Experts in drones (cf Paparazzi autopilot)



LAAS Laboratory for Analysis and Architecture of Systems
Roboticians



Legacy: SkyScanner

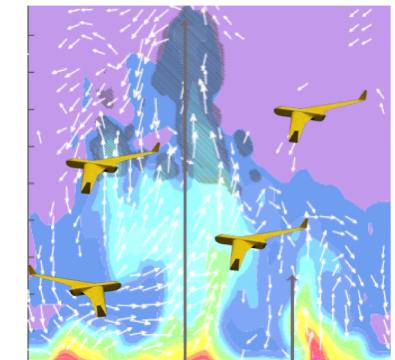
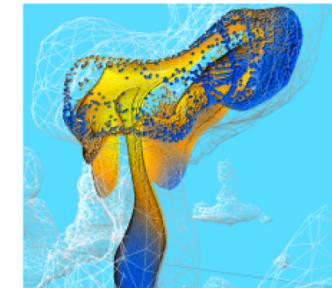
- “Deploying fleets of enduring drones to probe atmospheric phenomena”
STAE foundation project, 2015 / 2016

<https://www.laas.fr/projects/skyscanner/>

Legacy: SkyScanner

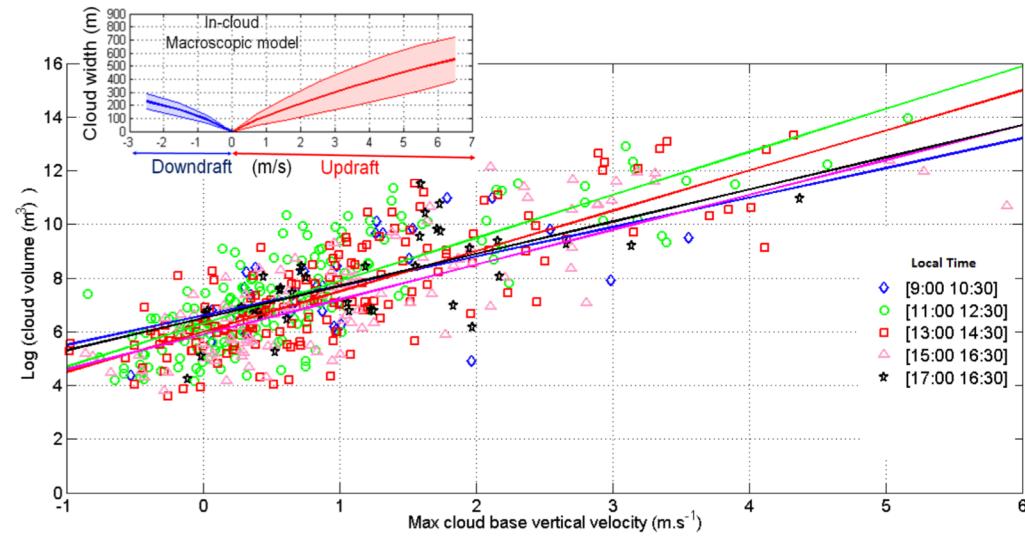
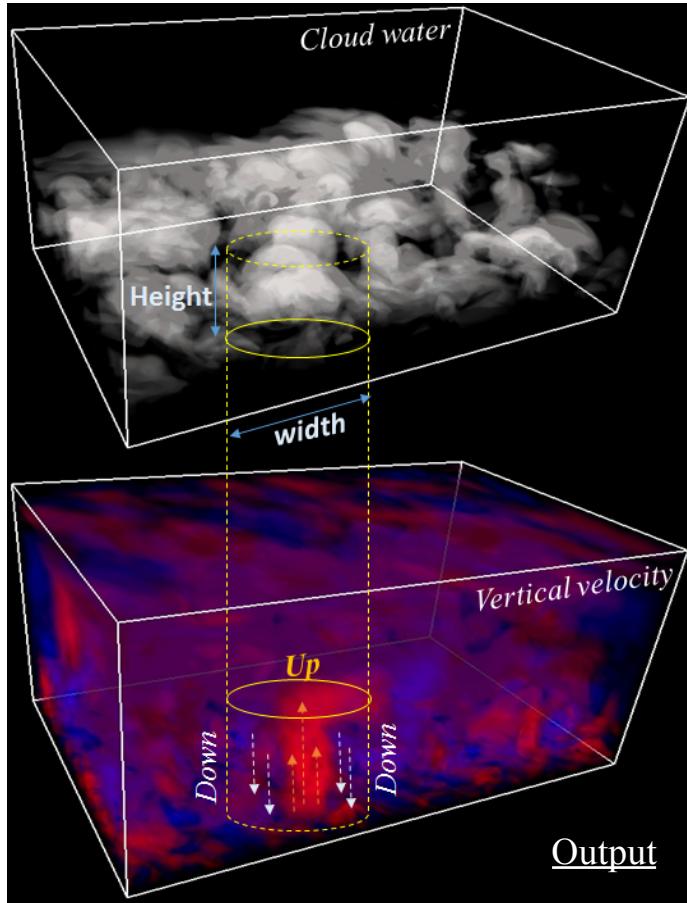
- “Deploying fleets of enduring drones to probe atmospheric phenomena”
STAE foundation project, 2015 / 2016
- Three research axes:

- Refine aerologic models of clouds
 - Conceive enduring micro-drones
 - Fleet control



SkyScanner achievements

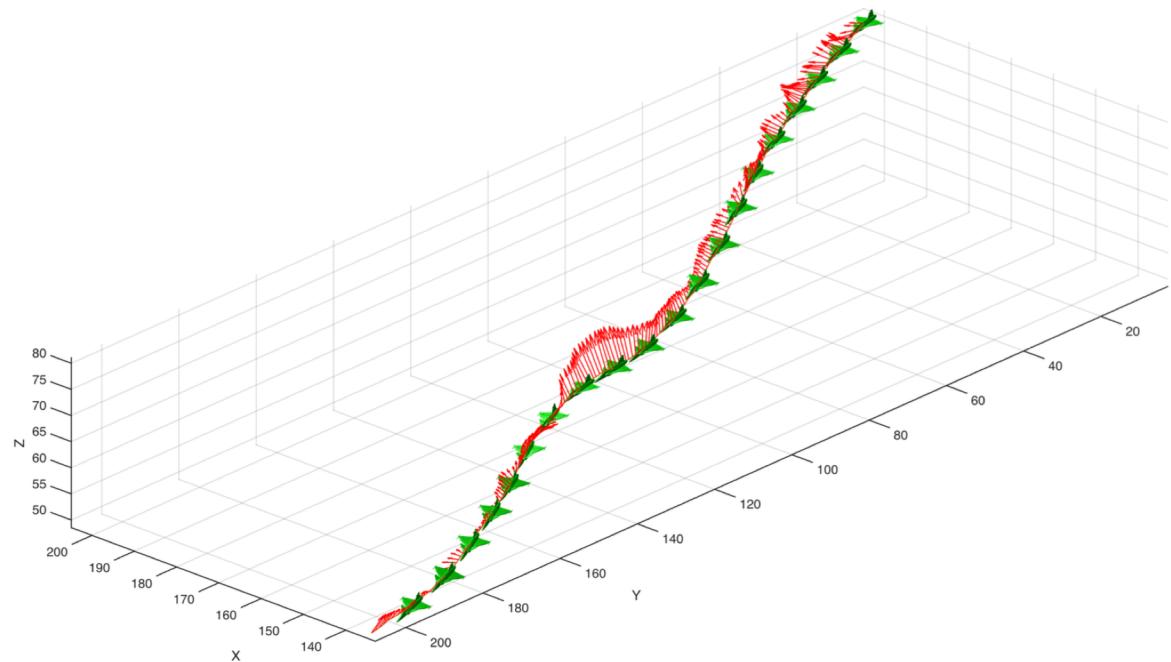
1. Cloud macroscopic models



SkyScanner achievements

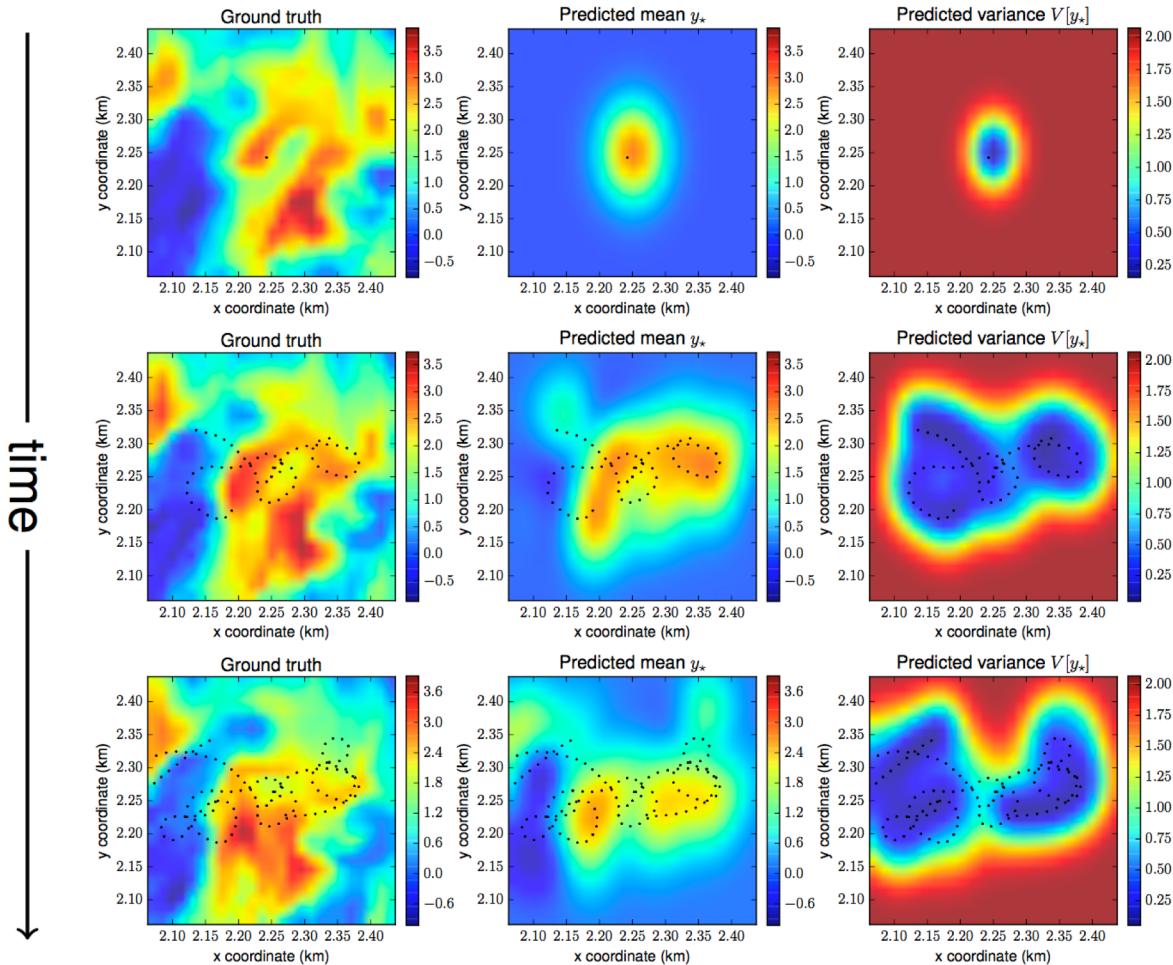
2. Wind estimation

Estimation of an updraft during a gliding phase



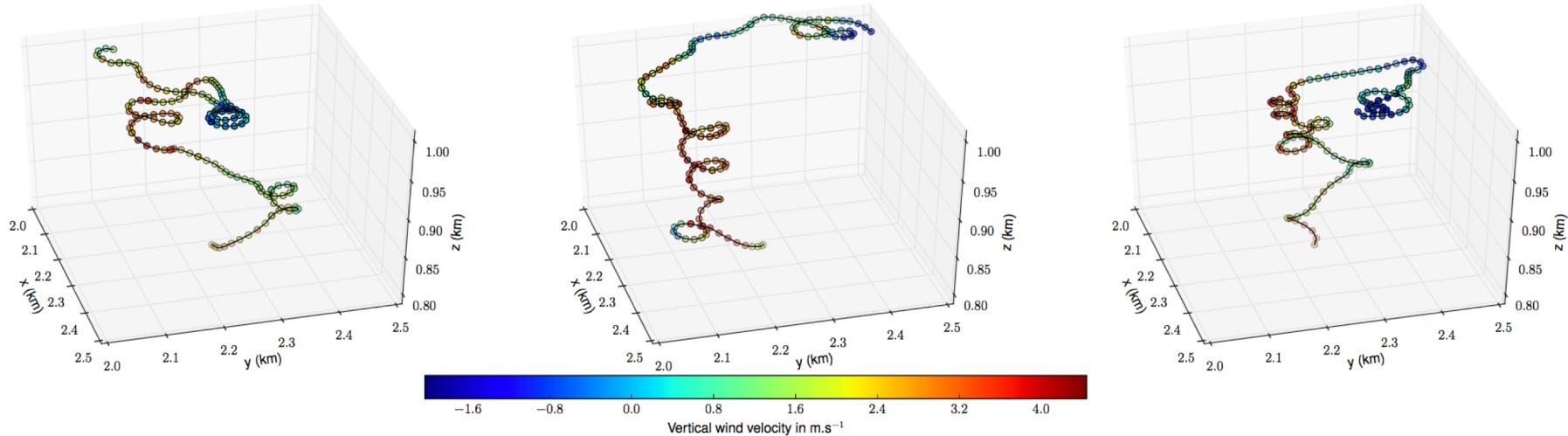
SkyScanner achievements

3. Cloud mapping



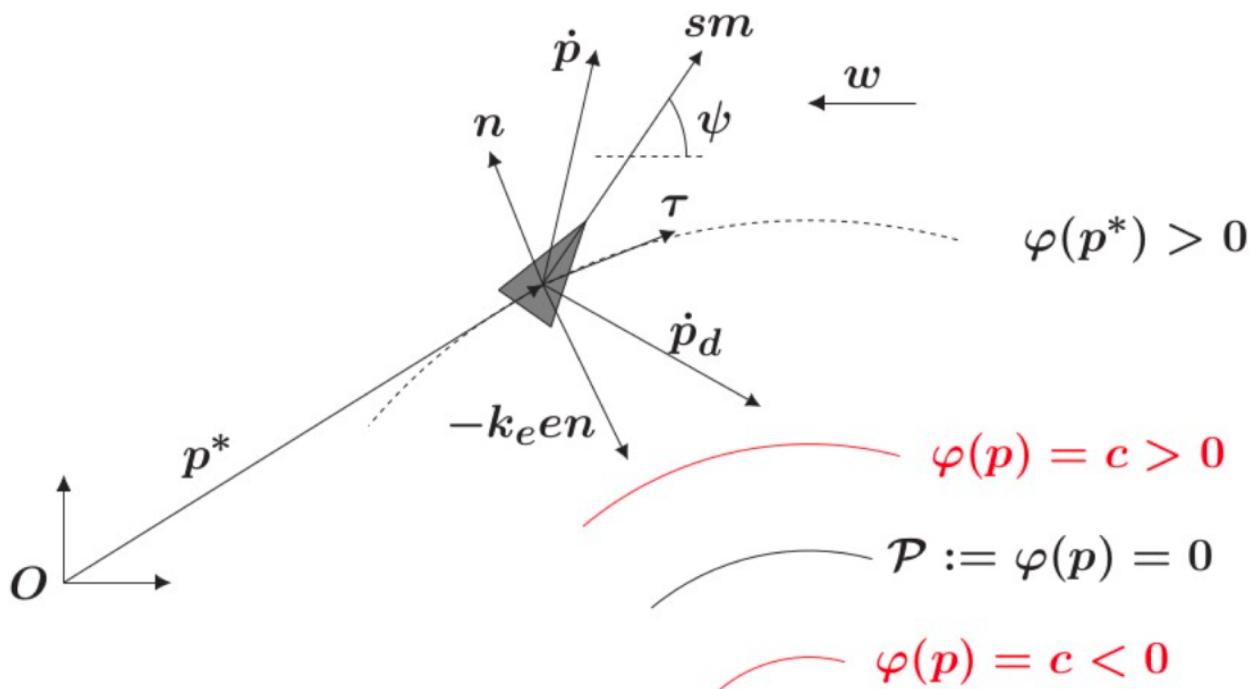
SkyScanner achievements

4. Planning observation strategies



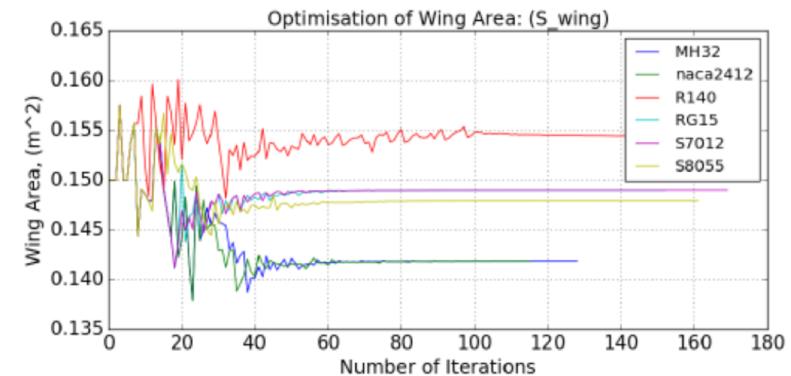
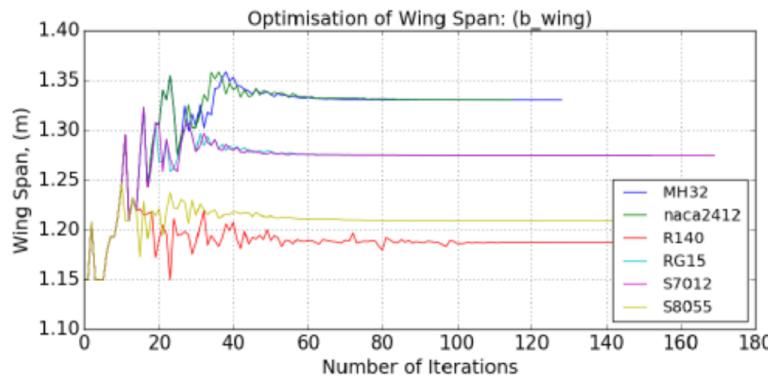
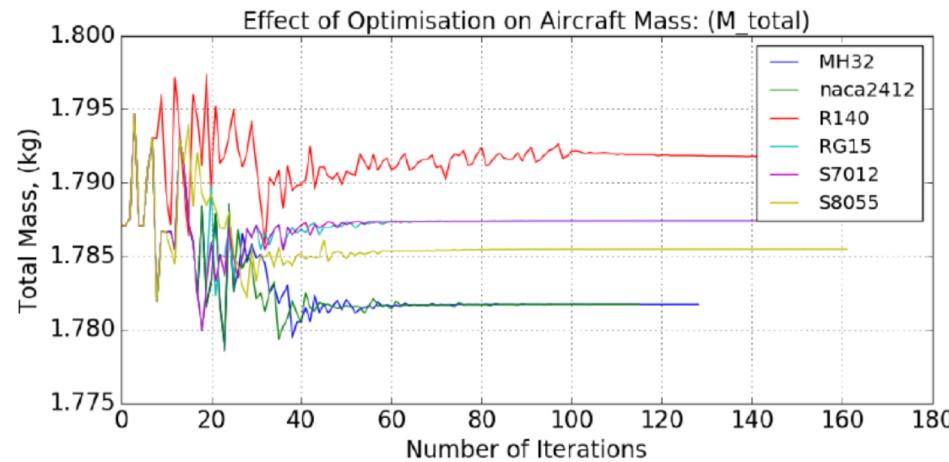
SkyScanner achievements

5. Guidance for formation flight



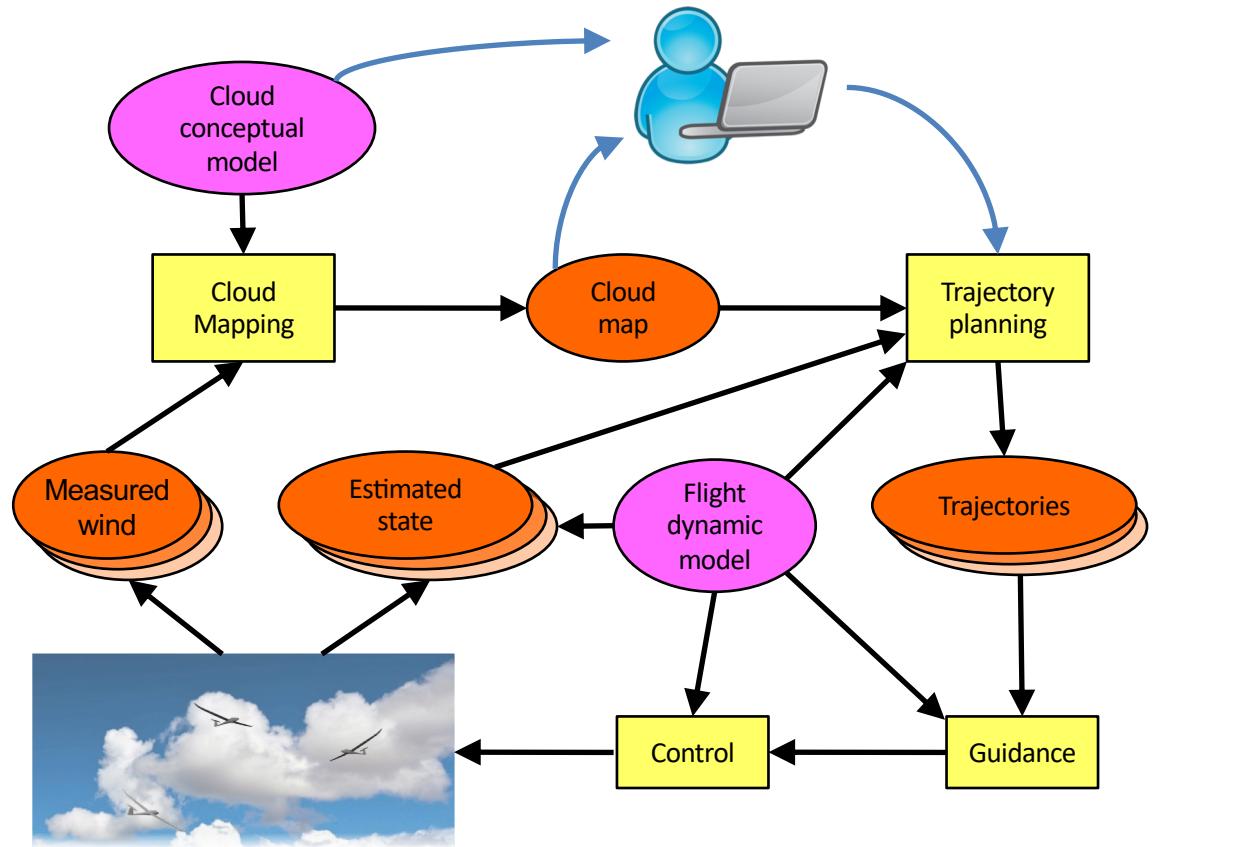
SkyScanner achievements

6. Optimal design methodology



SkyScanner achievements

6. Overall architecture and simulation



Optimized UAV conception

Overall simulation

Mode I

Proces S

Information

SkyScanner achievements

7. Other achievements

- All-sky photogrammetry techniques to georeference a cloud field
- Aircraft model parameters identification
- Robust finite time control
- ...

SkyScanner achievements

A thorough understanding of the
ins and outs of UAV cloud
mapping, shared by all partners

From SkyScanner to Nephelae

Turn prospective researches and developments into actual cloud mapping experiments

SkyScanner → Nephelae

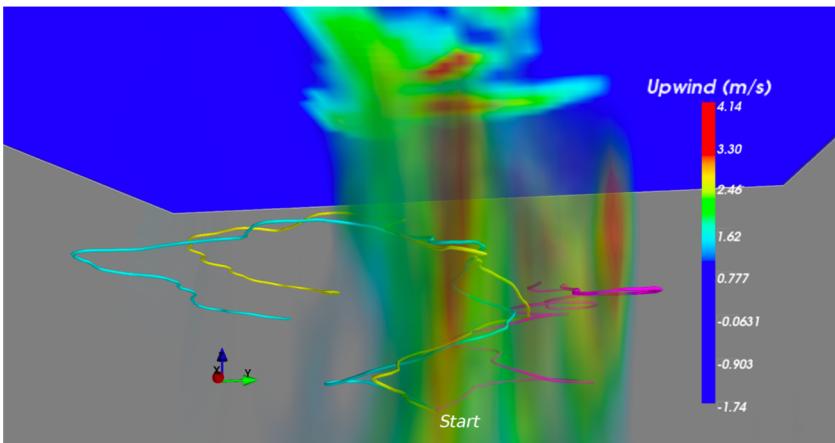
- Design methodology
- Aircraft model parameters identification
- Guidance for formation flight

SkyScanner → Nephelae

- Design methodology
 - Aircraft model parameters identification
 - Guidance for formation flight
- « Développement d'un drone dédié à l'exploration de nuages » (Aurélien Cabarbaye)

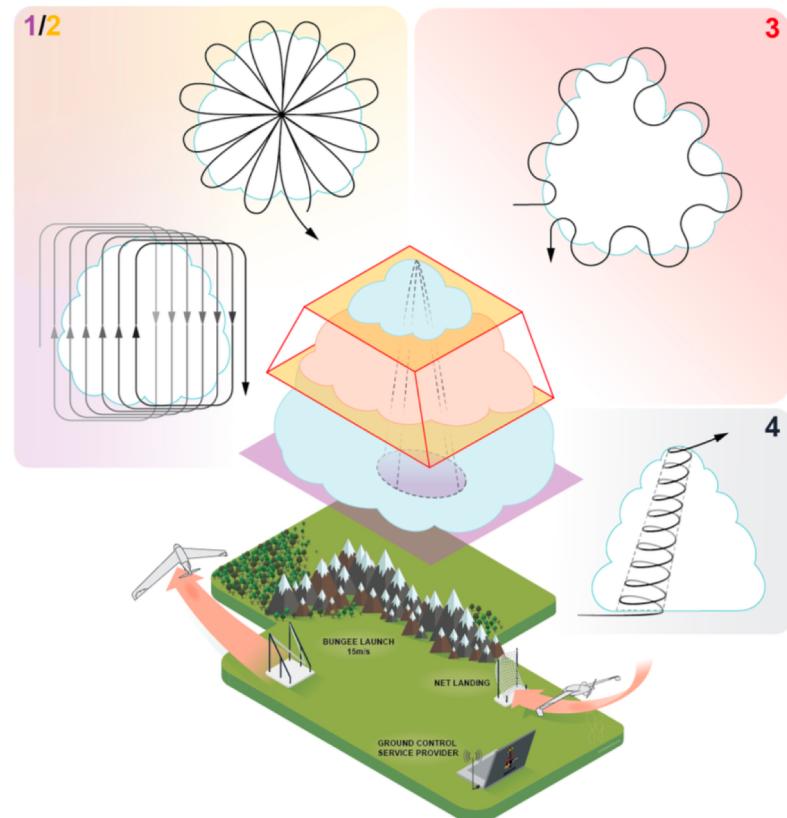
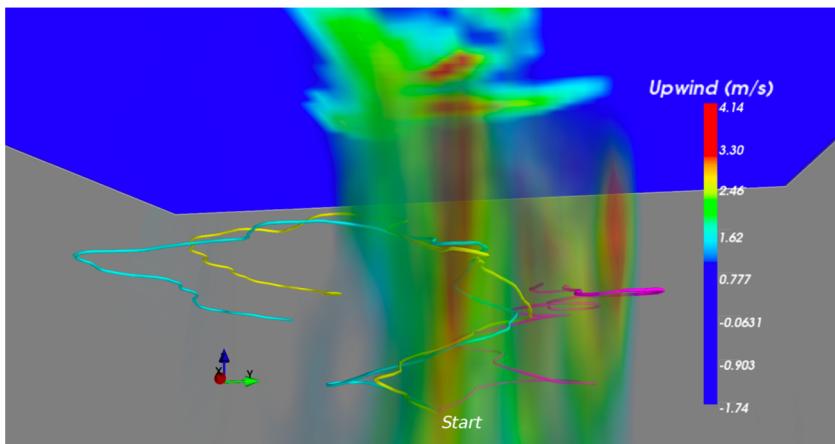
SkyScanner → Nephelae

- Cloud mapping
- Planning observation strategies



SkyScanner → Nephelae

- Cloud mapping
- Planning observation strategies

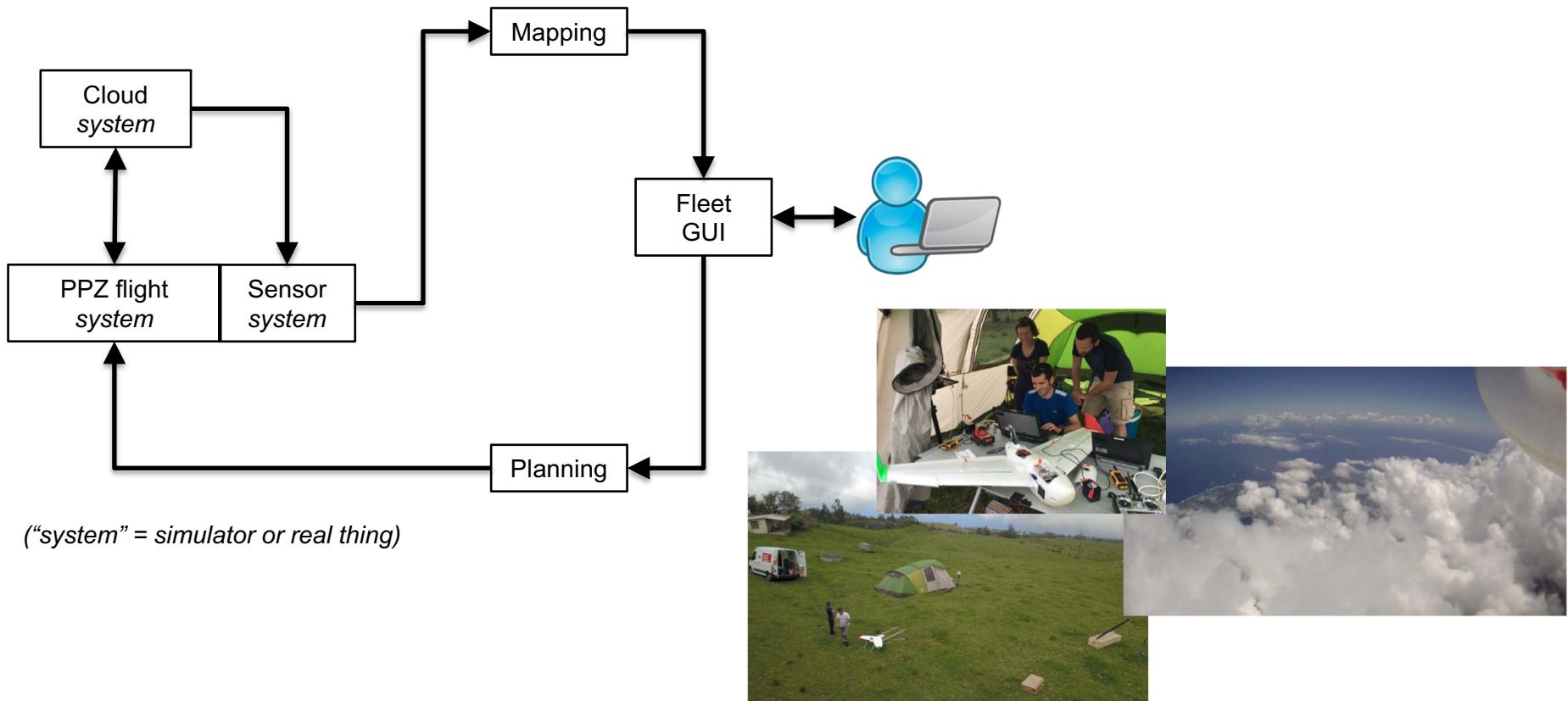


SkyScanner → Nephelae

- Overall architecture concept and simulations
 - Effective field deployments

SkyScanner → Nephelae

- Overall architecture concept and simulations
→ « Récentes campagnes de mesures atmosphériques par drones » (Greg Roberts)



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