VESPA:developing the Planetary Science Virtual Observatory

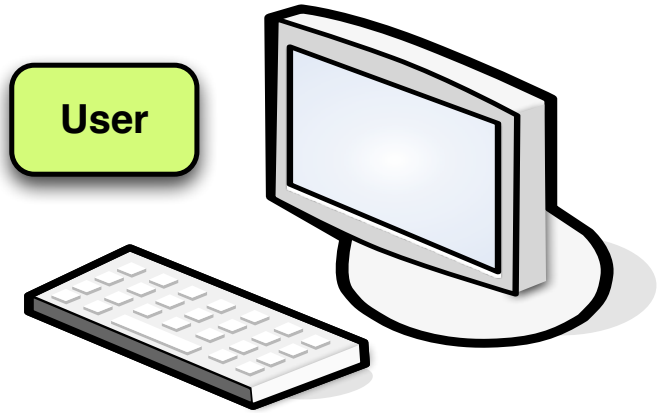
Stéphane Erard — OV-Paris / Observatoire de Paris
Baptiste Cecconi — OV-Paris / Observatoire de Paris
Pierre Le Sidaner — OV-Paris / Observatoire de Paris
Teresa Capria — INAF/ IAPS, Rome
Gérard Chanteur — LPP / CNRS / Ecole polytechnique

+ Many contributions from
Angelo Pio Rossi — Jacobs U., Bremen
Ann Carine Vandaele — IASB, Brussels
Nicolas André — IRAP, Toulouse
Vincent Génot — IRAP, Toulouse
Bernard Schmitt — IPAG, Grenoble
W. Thuillot — IMCCE / Obs Paris
& the VESPA / Europlanet H2020 partners

Congrès PNP 2014, Paris
3/10/2014

stephane.erard@obspm.fr

User's experience



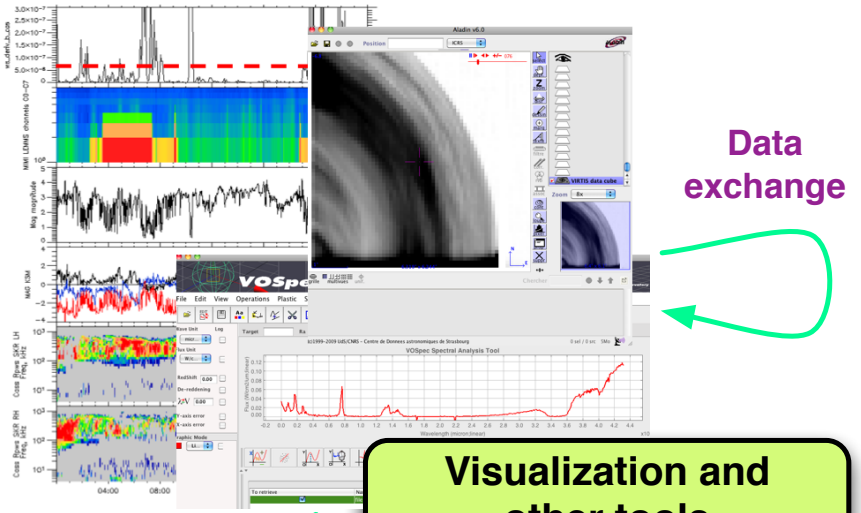
User

Queries

Answers

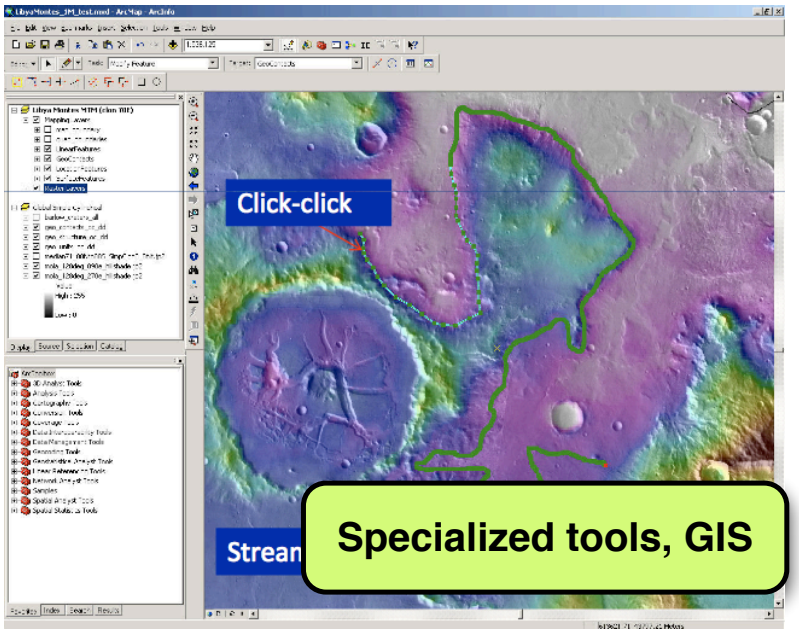
Catalogue / Registry

Data access



Data exchange

Visualization and other tools



Specialized tools, GIS

SSODnet

GhoSST KIDA

PSA

AMDA…

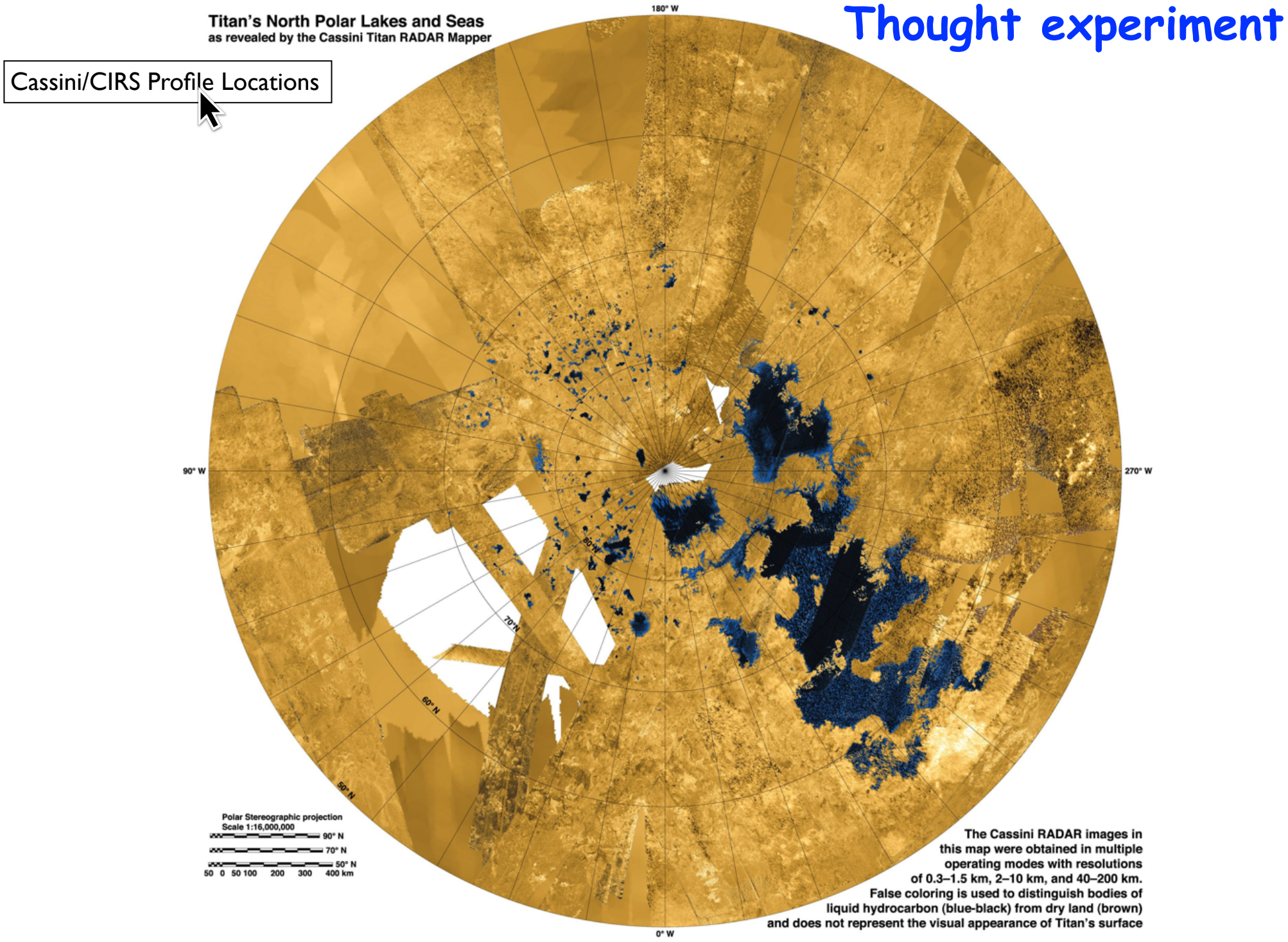
EPN

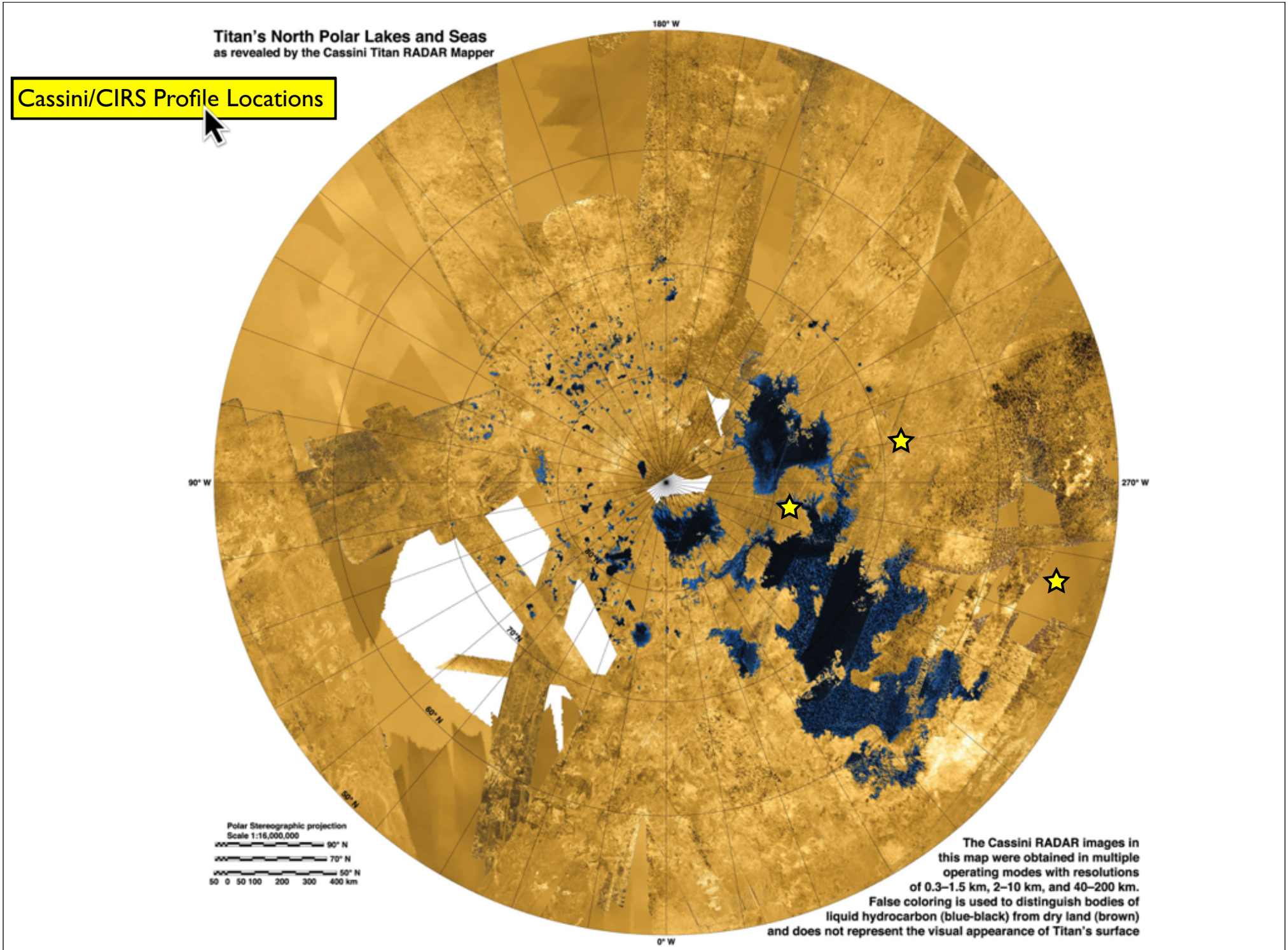
PDS

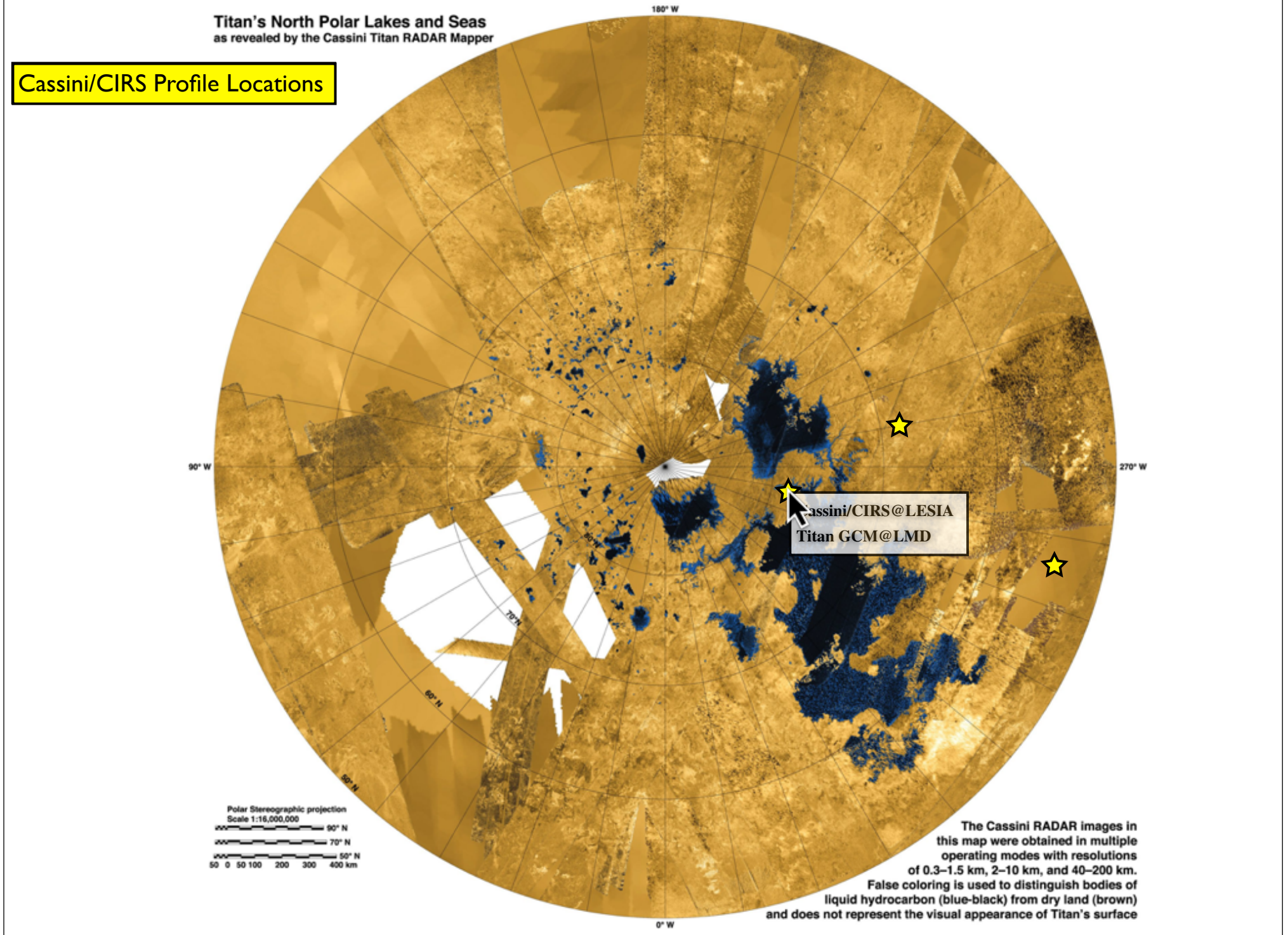
Data bases

Space agency archives

Thought experiment



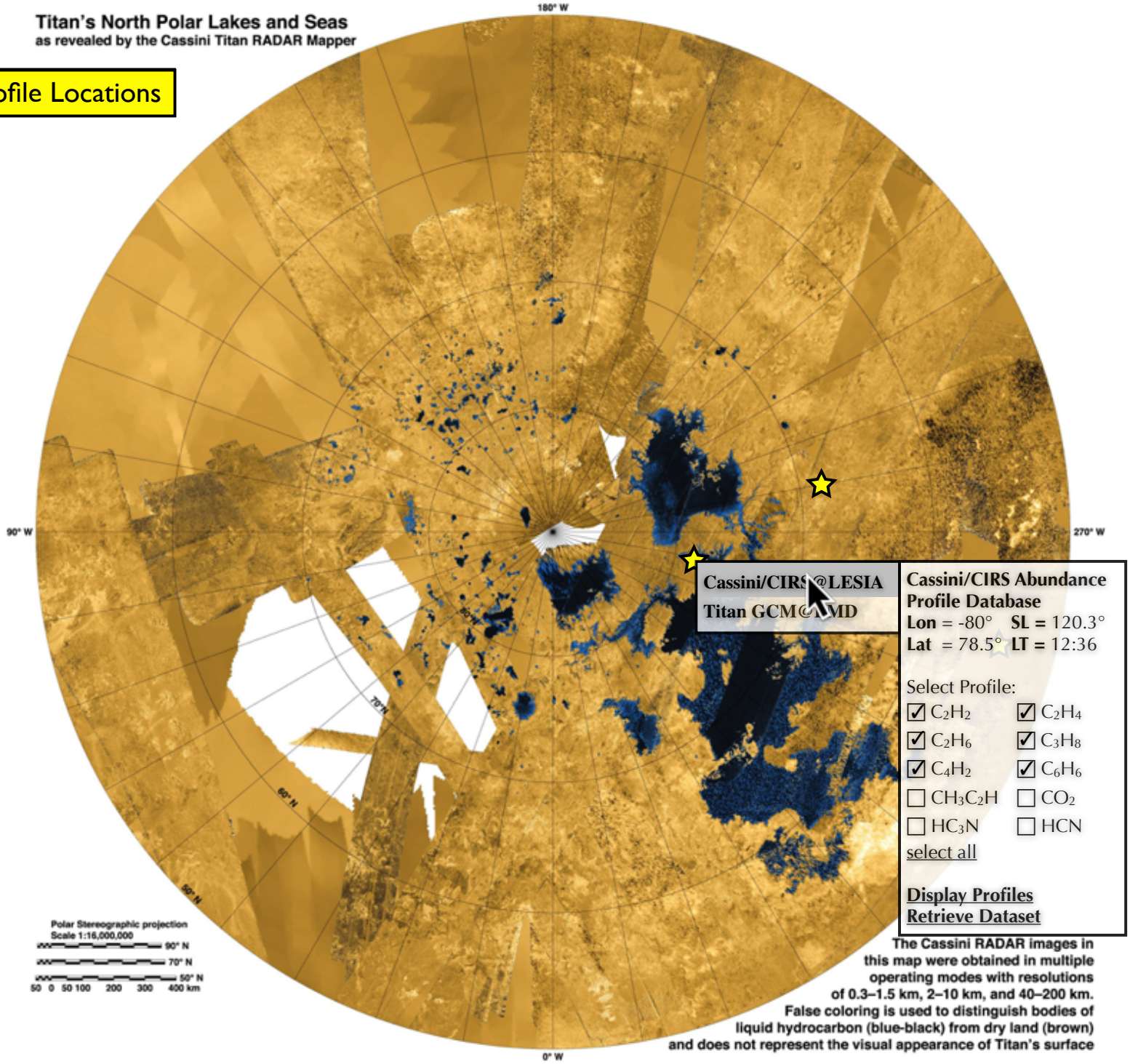

Titan's North Polar Lakes and Seas
as revealed by the Cassini Titan RADAR Mapper
Cassini/CIRS Profile Locations
180° W
90° W
270° W
0° W
80° N
70° N
60° N
50° N
Polar Stereographic projection
Scale 1:16,000,000
90° N
70° N
50° N
50 0 50 100 200 300 400 km
The Cassini RADAR images in this map were obtained in multiple operating modes with resolutions of 0.3–1.5 km, 2–10 km, and 40–200 km. False coloring is used to distinguish bodies of liquid hydrocarbon (blue-black) from dry land (brown) and does not represent the visual appearance of Titan's surface


Titan's North Polar Lakes and Seas
as revealed by the Cassini Titan RADAR Mapper
Cassini/CIRS Profile Locations
180° W
90° W
270° W
0° W
80° N
70° N
60° N
50° N
assini/CIRS@LESIA
Titan GCM@LMD
Polar Stereographic projection
Scale 1:16,000,000
90° N
70° N
50° N
50 0 50 100 200 300 400 km
The Cassini RADAR images in this map were obtained in multiple operating modes with resolutions of 0.3–1.5 km, 2–10 km, and 40–200 km. False coloring is used to distinguish bodies of liquid hydrocarbon (blue-black) from dry land (brown) and does not represent the visual appearance of Titan's surface

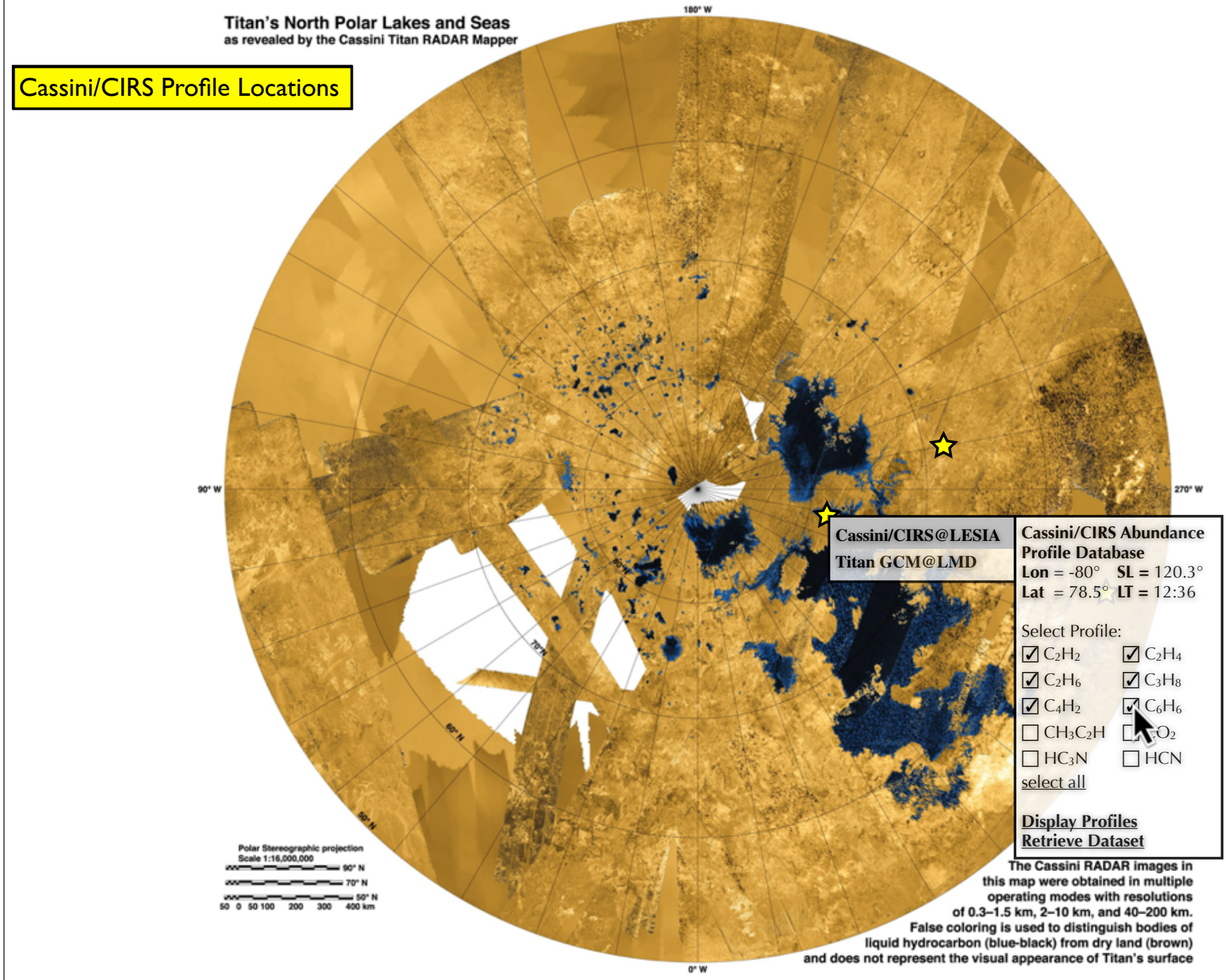
Titan's North Polar Lakes and Seas

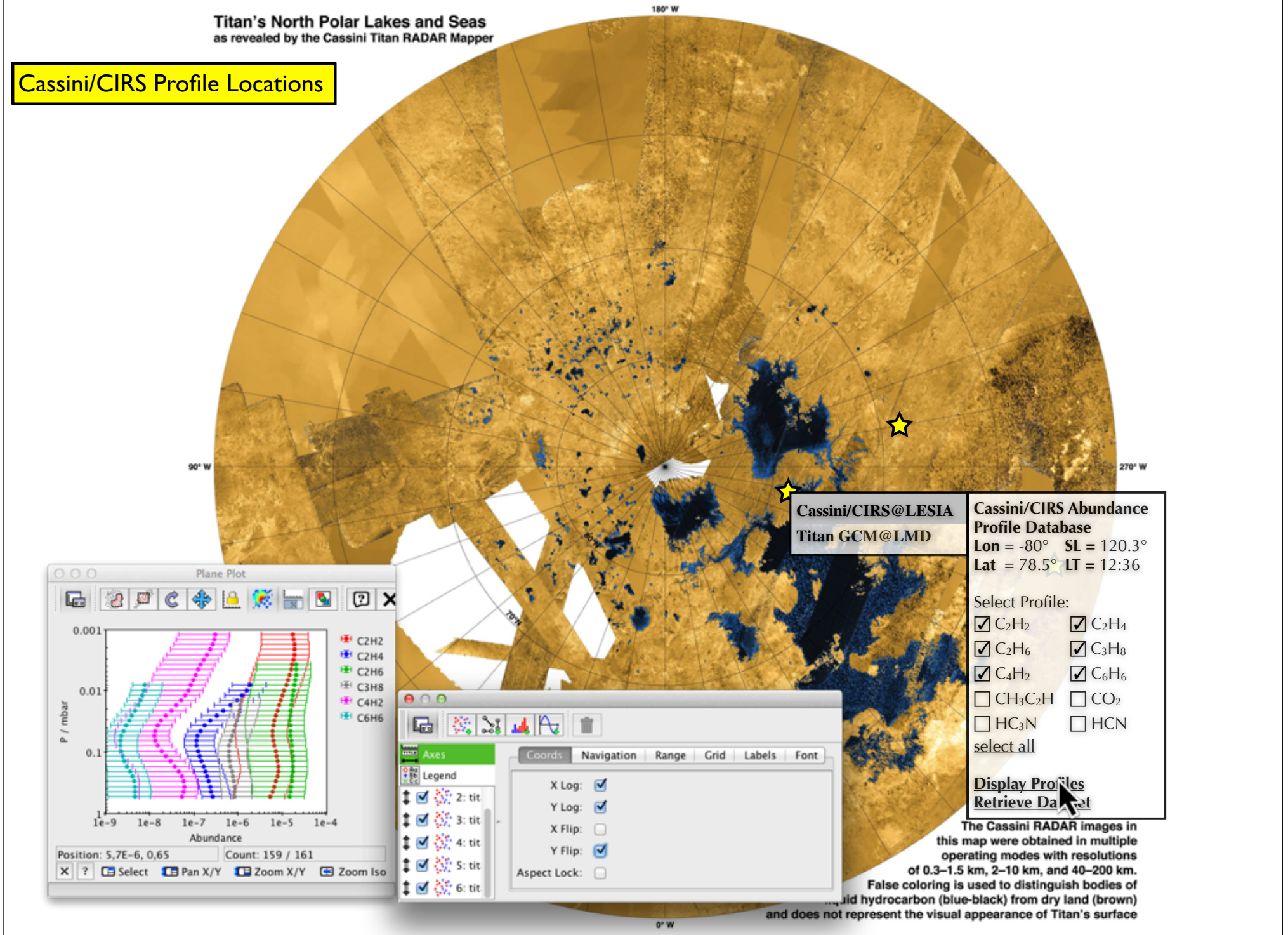
as revealed by the Cassini Titan RADAR Mapper

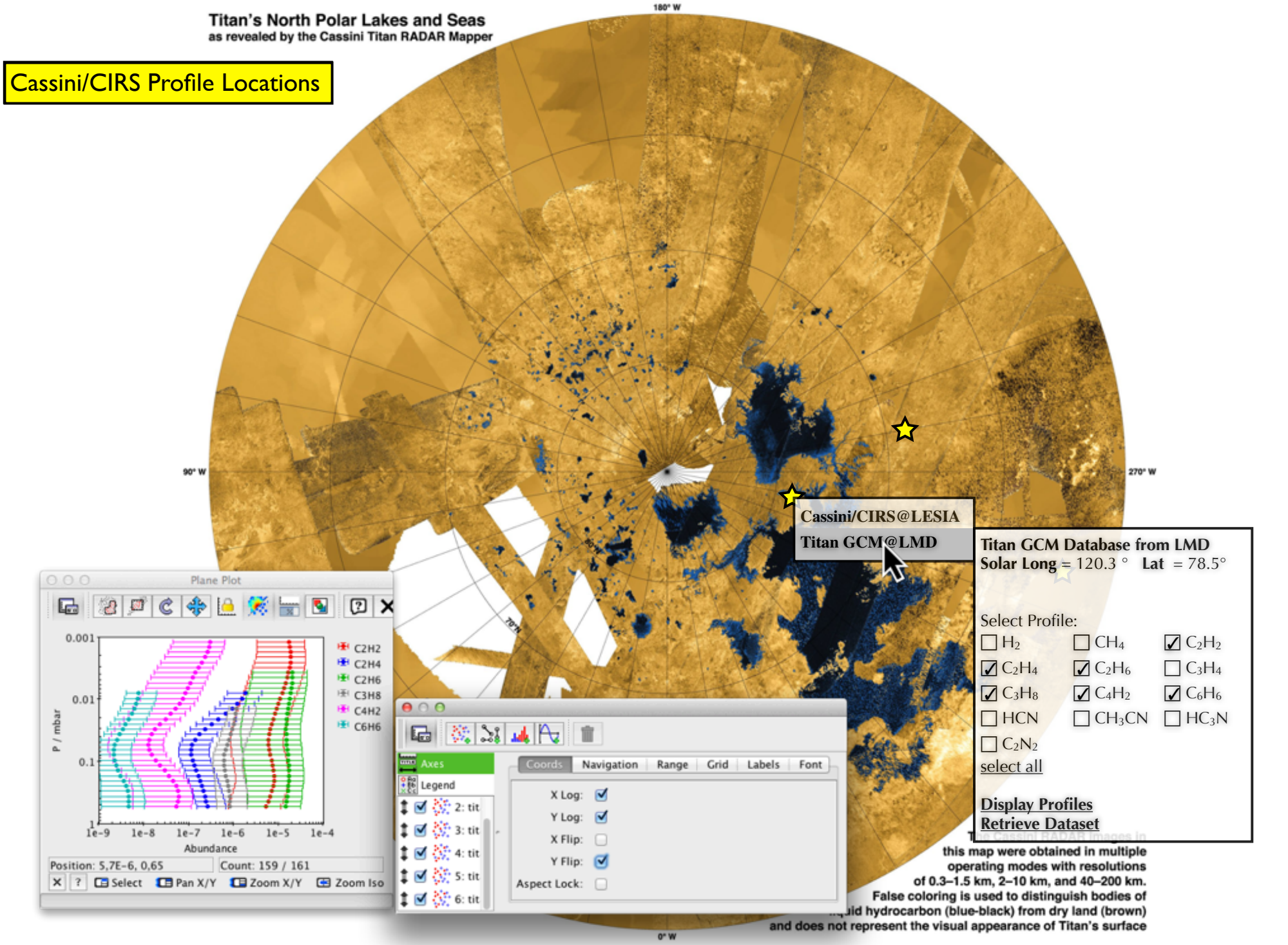
Cassini/CIRS Profile Locations

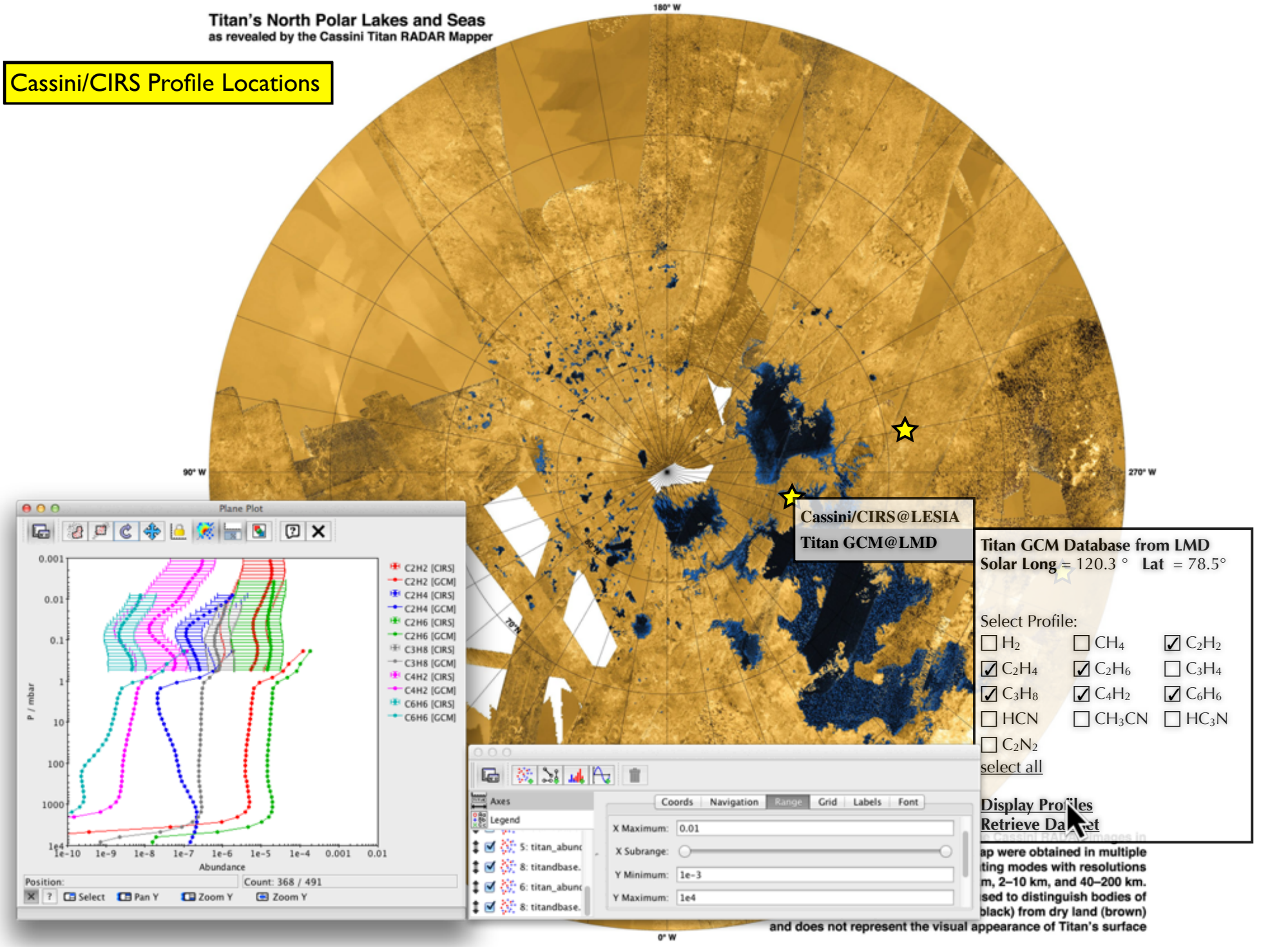


The Cassini RADAR images in this map were obtained in multiple operating modes with resolutions of 0.3–1.5 km, 2–10 km, and 40–200 km. False coloring is used to distinguish bodies of liquid hydrocarbon (blue-black) from dry land (brown) and does not represent the visual appearance of Titan's surface


Titan's North Polar Lakes and Seas
as revealed by the Cassini Titan RADAR Mapper
Cassini/CIRS Profile Locations
180° W
90° W
270° W
0° W
80° N
70° N
60° N
50° N
Cassini/CIRS@LESIA
Titan GCM@LMD
Cassini/CIRS Abundance Profile Database
Lon = -80° SL = 120.3°
Lat = 78.5° LT = 12:36
Select Profile:
C2H2
C2H4
C2H6
C3H8
C4H2
C6H6
CH3C2H
CO2
HC3N
HCN
select all
Display Profiles
Retrieve Dataset
Polar Stereographic projection
Scale 1:16,000,000
90° N
70° N
50° N
50 0 50 100 200 300 400 km
The Cassini RADAR images in this map were obtained in multiple operating modes with resolutions of 0.3–1.5 km, 2–10 km, and 40–200 km. False coloring is used to distinguish bodies of liquid hydrocarbon (blue-black) from dry land (brown) and does not represent the visual appearance of Titan's surface


Titan's North Polar Lakes and Seas
as revealed by the Cassini Titan RADAR Mapper
Cassini/CIRS Profile Locations
180° W
90° W
270° W
0° W
80°N
70°N
Cassini/CIRS@LESIA
Titan GCM@LMD
Cassini/CIRS Abundance Profile Database
Lon = -80° SL = 120.3°
Lat = 78.5° LT = 12:36
Select Profile:
C2H2
C2H4
C2H6
C3H8
C4H2
C6H6
CH3C2H
CO2
HC3N
HCN
select all
Display Profiles
Retrieve Dataset
Plane Plot
P / mbar
Abundance
Position: 5,7E-6, 0,65
Count: 159 / 161
Select
Pan X/Y
Zoom X/Y
Zoom Iso
Axes
Legend
Coords
Navigation
Range
Grid
Labels
Font
X Log:
Y Log:
X Flip:
Y Flip:
Aspect Lock:
The Cassini RADAR images in this map were obtained in multiple operating modes with resolutions of 0.3–1.5 km, 2–10 km, and 40–200 km.
False coloring is used to distinguish bodies of liquid hydrocarbon (blue-black) from dry land (brown) and does not represent the visual appearance of Titan's surface


Titan's North Polar Lakes and Seas
as revealed by the Cassini Titan RADAR Mapper
Cassini/CIRS Profile Locations
180° W
90° W
270° W
0° W
70°N
80°N
Cassini/CIRS@LESIA
Titan GCM@LMD
Titan GCM Database from LMD
Solar Long = 120.3 ° Lat = 78.5°
Select Profile:
H2
CH4
C2H2
C2H4
C2H6
C3H4
C3H8
C4H2
C6H6
HCN
CH3CN
HC3N
C2N2
select all
Display Profiles
Retrieve Dataset
Plane Plot
P / mbar
Abundance
C2H2
C2H4
C2H6
C3H8
C4H2
C6H6
Position: 5,7E-6, 0,65
Count: 159 / 161
Select
Pan X/Y
Zoom X/Y
Zoom Iso
Axes
Legend
Coords
Navigation
Range
Grid
Labels
Font
X Log:
Y Log:
X Flip:
Y Flip:
Aspect Lock:
2: tit
3: tit
4: tit
5: tit
6: tit
this map were obtained in multiple
operating modes with resolutions
of 0.3–1.5 km, 2–10 km, and 40–200 km.
False coloring is used to distinguish bodies of
and does not represent the visual appearance of Titan's surface


Titan's North Polar Lakes and Seas
as revealed by the Cassini Titan RADAR Mapper
Cassini/CIRS Profile Locations
180° W
90° W
270° W
0° W
80°N
70°N
Cassini/CIRS@LESIA
Titan GCM@LMD
Titan GCM Database from LMD
Solar Long = 120.3 ° Lat = 78.5°
Select Profile:
H2
CH4
C2H2
C2H4
C2H6
C3H4
C3H8
C4H2
C6H6
HCN
CH3CN
HC3N
C2N2
select all
Display Profiles
Retrieve Data Set
Plane Plot
P / mbar
Abundance
C2H2 [CIRS]
C2H2 [GCM]
C2H4 [CIRS]
C2H4 [GCM]
C2H6 [CIRS]
C2H6 [GCM]
C3H8 [CIRS]
C3H8 [GCM]
C4H2 [CIRS]
C4H2 [GCM]
C6H6 [CIRS]
C6H6 [GCM]
Position:
Count: 368 / 491
Select
Pan Y
Zoom Y
Zoom Y
Axes
Legend
Coords
Navigation
Range
Grid
Labels
Font
X Maximum: 0.01
X Subrange:
Y Minimum: 1e-3
Y Maximum: 1e4
5: titan_abunc
8: titandbase.
6: titan_abunc
8: titandbase.
ap were obtained in multiple
ting modes with resolutions
m, 2–10 km, and 40–200 km.
sed to distinguish bodies of
black) from dry land (brown)
and does not represent the visual appearance of Titan's surface

A history of the Planetary Science VO

Informal consortium in Astronomy

IVOA

2002++

Available and maintained for free!

Consortium of space agencies

IPDA

2007++

EU research pgr

Europlanet FP6

2006-2008

EU research infrastr.

Europlanet-RI FP7

2009-2012

IDIS

Consortium agreement (MoU)

Europlanet Consortium

2012++

Related EU prg

HELIO, VAMDC, IMPEx, etc

EU research infrastr.

Europlanet-RI H2020

2015? (under review)

VESPA

National level

SO5 in France, etc

Planetary Science VO — Objectives & status

Europlanet-RI FP7 - IDIS

Objectives:
- Make data search in archives easy
- Allow quick-look visualisation of data
- Allow external users to include their data easily
- Make it light and cheap!

Status:
- Infrastructure & demonstrator ready (12 services + interface)
- Uses IVOA standards & tools + IAU references
- Handles all Planetary Science, including exp. work and simus

Europlanet-RI H2020 - VESPA

Objectives:
- Increase accessible content (~50 new data services)
- Adapt existing tools to PS specificities
- Develop automated processing
- Users & providers training

Status:
- 25% of Europlanet proposal, 18 main partners in Europe
- Coordination @ OV-Paris

Mature activity from Europlanet-RI/IDIS

Built on astronomical VO developments

+ other European programs:

IMPEx, HELIO, VAMDC…

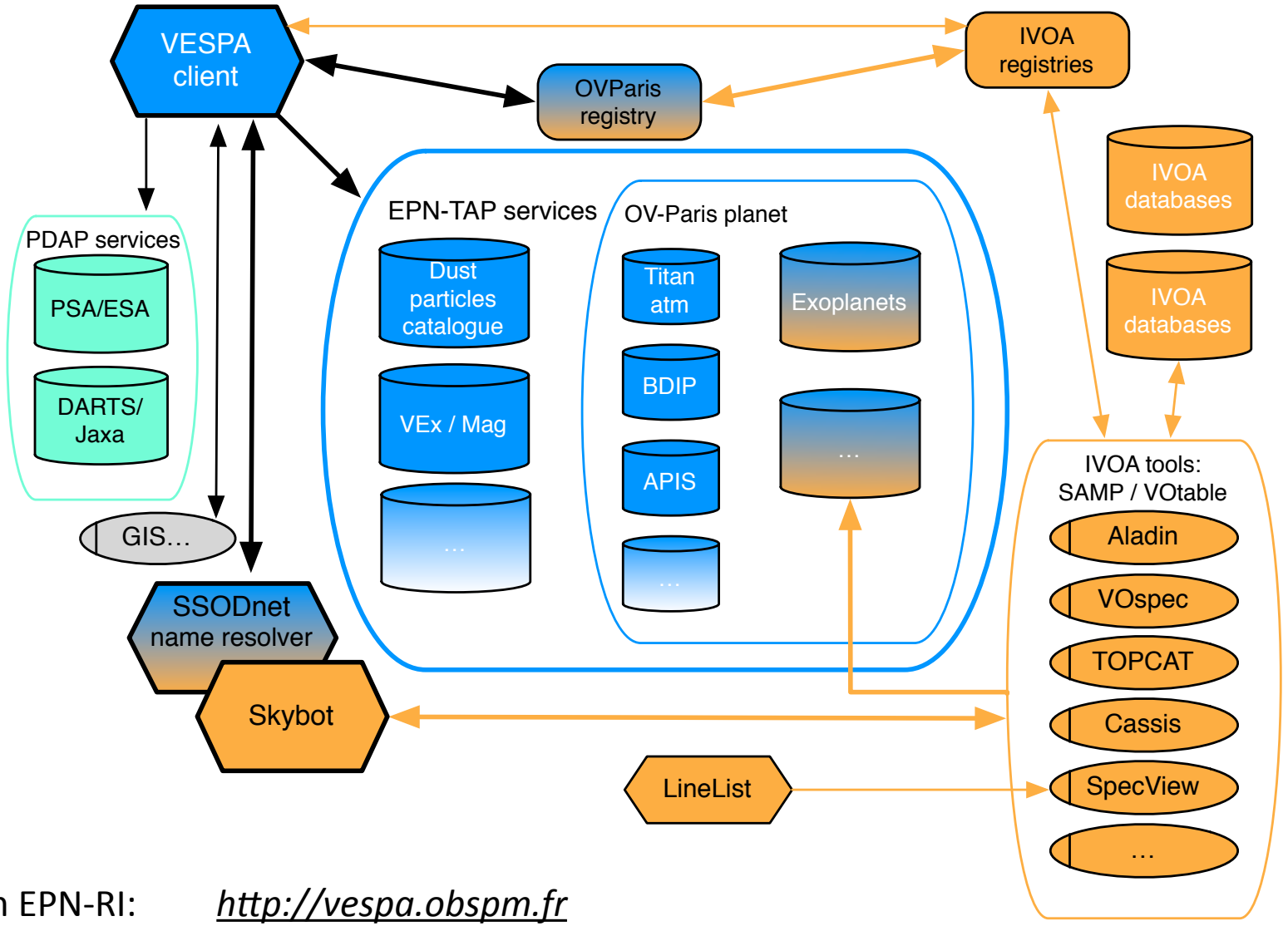
Available and maintained for free!

EPN-TAP

PDAP

IVOA

OGC



Existing prototype from EPN-RI: *http://vespa.obspm.fr*

VESPA access

- Global search interface for Planetary Science services
- Supports EPN-TAP + PDAP

http://vespa.obspm.fr

Query form: All VO

Target name

Resource type: granule

Dataset ID

Time selection: Data range is included in

Time min

Dataproduct type: image, spectrum, dynamic_spectrum

Query All VO | Reset

Query results for all resources

gran

EPN Resources

Auroral Planetary Imaging and Spectroscopy
Results : 341
DISPLAY RESULTS
▶ Description :
Credits: Creator

Base de Donn
Results : 0
DISPLAY VOTABLE
▶ Description :
Credits: Creator

Extrasolar Pla
Results : 0
DISPLAY VOTABLE
▶ Description :
Credits: Creator

Heliophysics F
Results : 0
DISPLAY VOTABLE
▶ Description :
Credits: Creator

Results in service apis

Full Text

Show 20 entries | Search: | Show / hide columns | Select all | Deselect all

dataproduct_type	target_name	time_min (d)	time_max (d)	access_url
image	Titan	2009-01-23T16:09:22	2009-01-23T16:19:22	jb9z01011_proc.f
image	Titan	2009-01-23T16:21:40	2009-01-23T16:38:20	jb9z01021_proc.f
image	Titan	2009-01-23T16:41:58	2009-01-23T16:51:58	jb9z01031_proc.f
image	Titan	2009-01-23T17:42:54	2009-01-23T17:52:54	jb9z01041_proc.f
image	Titan	2009-01-23T17:55:12	2009-01-23T18:11:52	jb9z01051_proc.f
image	Titan	2009-01-23T18:15:30	2009-01-23T18:25:30	jb9z01061_proc.f
image	Titan	2009-01-23T19:18:47	2009-01-23T19:28:47	jb9z01071_proc.f
image	Titan	2009-01-23T19:31:05	2009-01-23T19:47:45	jb9z01081_proc.f
image	Titan	2009-01-23T19:51:23	2009-01-23T20:01:23	jb9z01091_proc.f
image	Titan	2009-01-23T16:09:22	2009-01-23T16:12:42	jb9z01a1q_proc.f
image	Titan	2009-01-23T16:21:40	2009-01-23T16:25:00	jb9z01a4q_proc.f
image	Titan	2009-01-23T16:33:40	2009-01-23T16:37:00	jb9z01a7q_proc.f
image	Titan	2009-01-23T16:37:40	2009-01-23T16:41:00	jb9z01a8q_proc.f
image	Titan	2009-01-23T17:46:54	2009-01-23T17:50:14	jb9z01aeq_proc.f
image	Titan	2009-01-23T17:59:12	2009-01-23T18:02:32	jb9z01ahq_proc.f
image	Titan	2009-01-23T18:11:12	2009-01-23T18:14:32	jb9z01alq_proc.f

Plotting tools

- TOPCAT
- Aladin
- VOSpec
- SPLAT

Plotting tools

- TOPCAT
- Aladin
- VOSpec
- SPLAT

Example queries

- Saturn in March 2012

SELECTED DATA

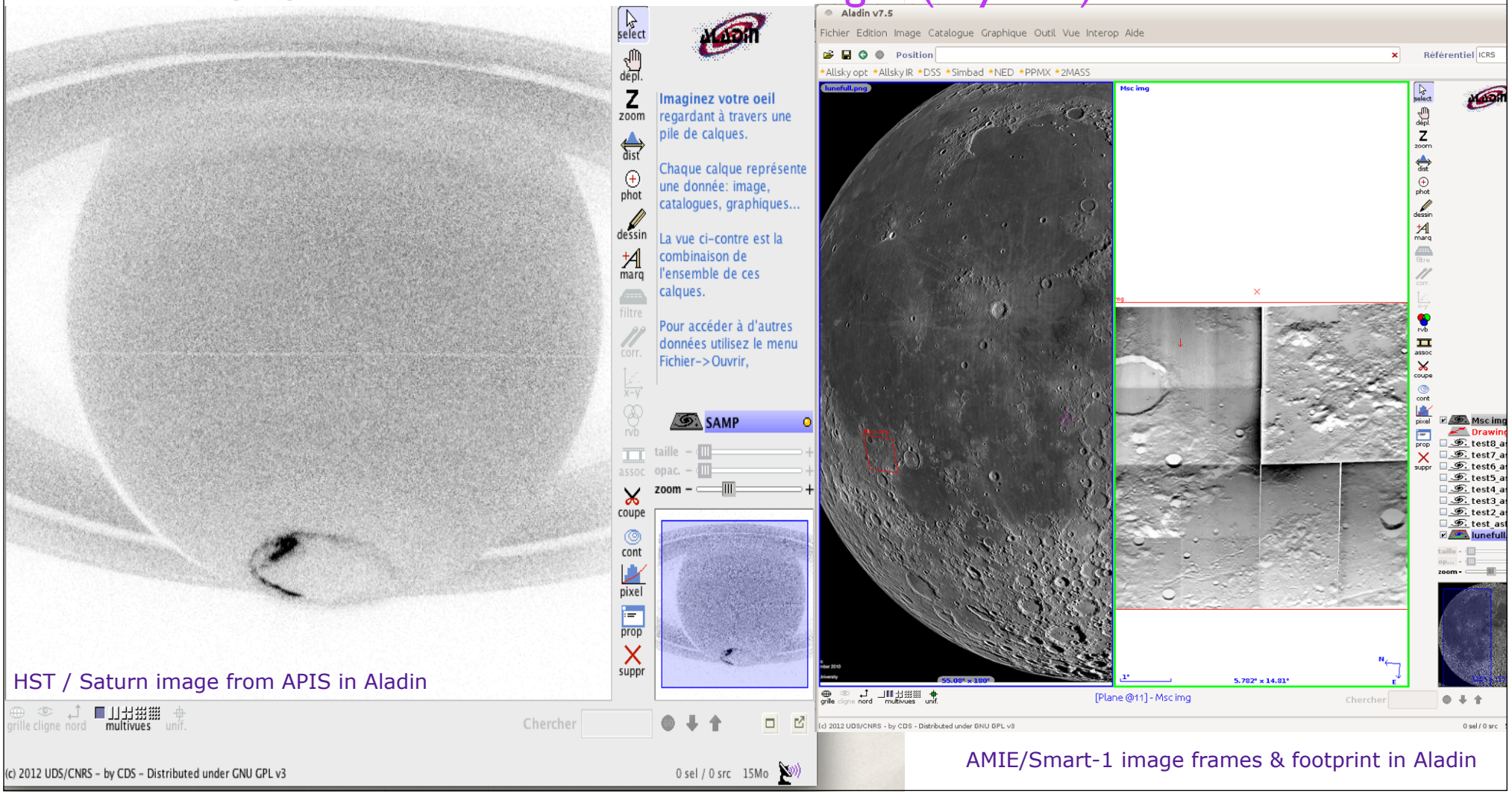
1 selected data
- 1 : image

PREVIEW

Visualization tools: adapt IVOA tools

Aladin:

- plots images/cubes
- handles sky/spheroid coordinates
- can build image mosaics
- can handle object catalogs
- Solar System bodies tracking on sky images (SkyBoT)



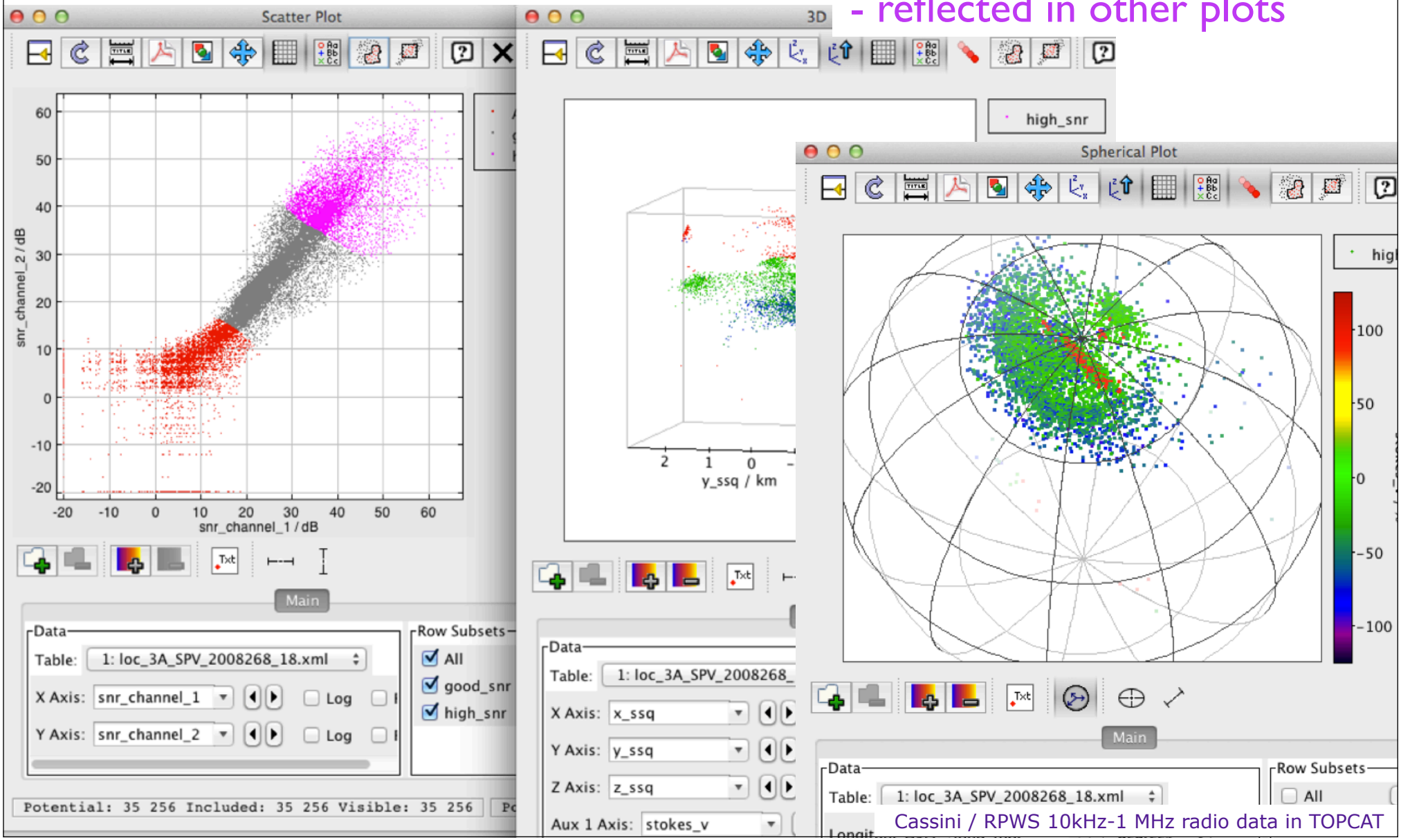
HST / Saturn image from APIS in Aladin

AMIE/Smart-1 image frames & footprint in Aladin

TOPCAT:

Allows data selection

- by formula or graphically
- reflected in other plots



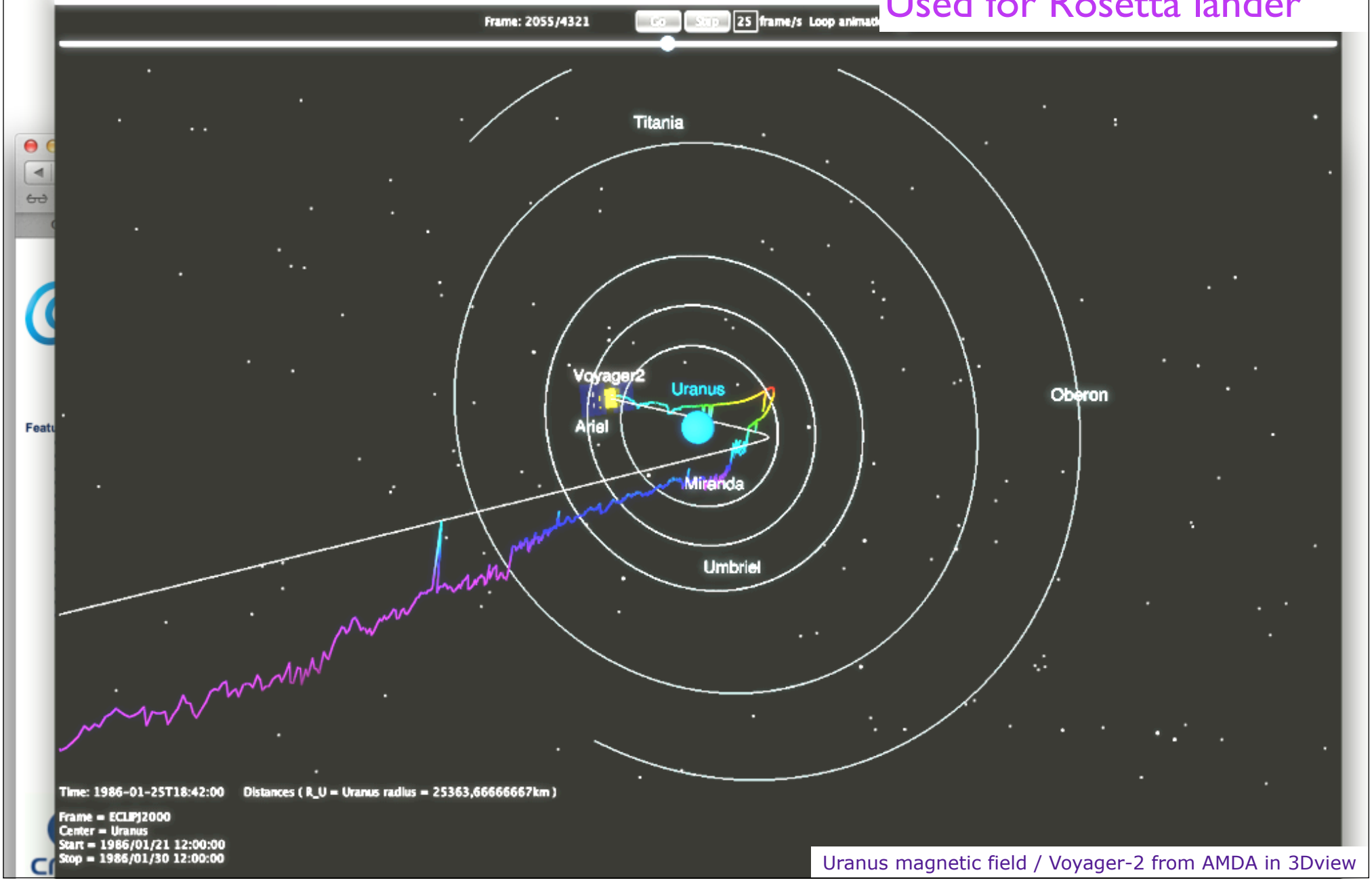
Cassini / RPWS 10kHz-1 MHz radio data in TOPCAT

Visualization tools:
adapt other existing tools

3Dview / CNES:

Spacecraft trajectories+data

Used for Rosetta lander

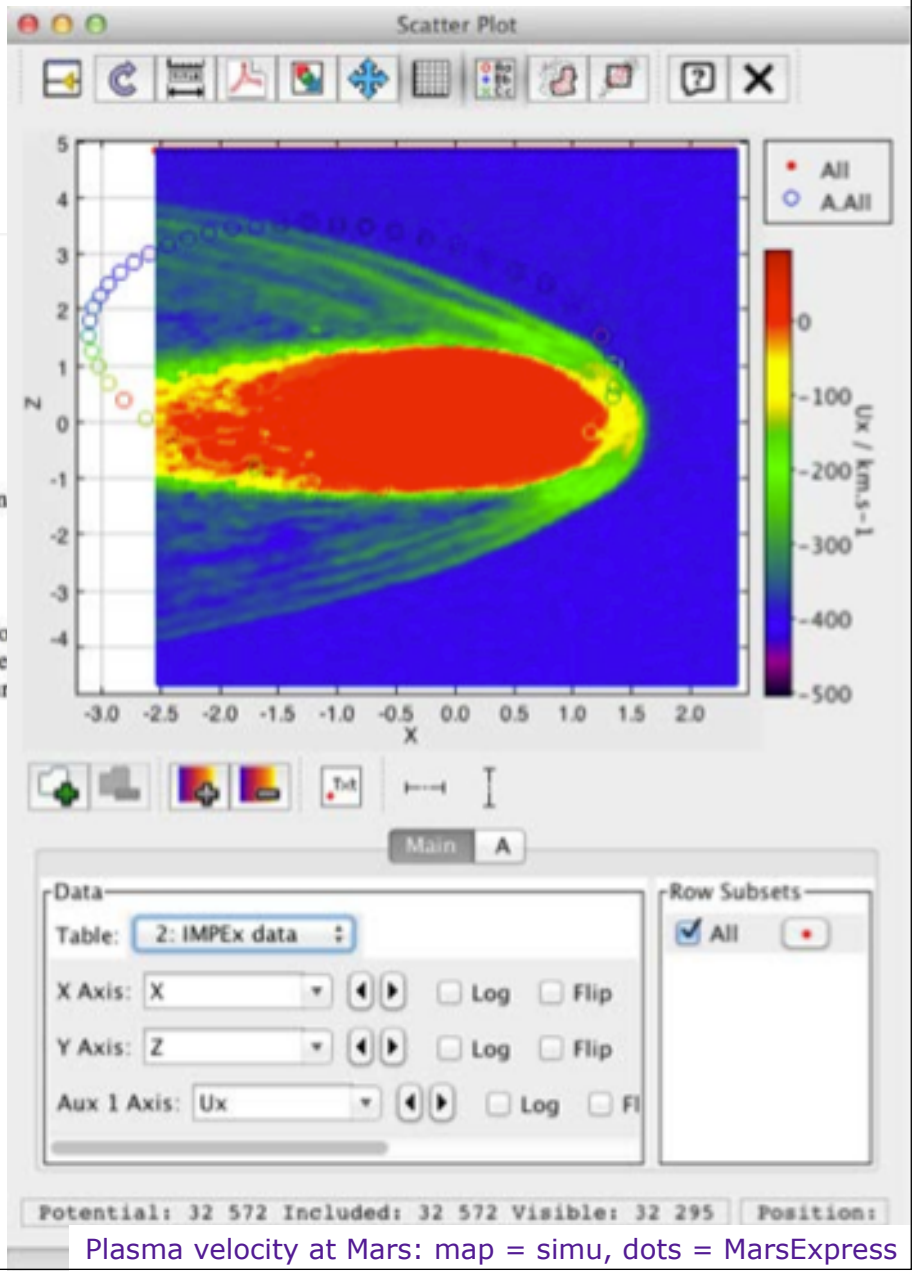


Uranus magnetic field / Voyager-2 from AMDA in 3Dview

Integrated services & tools:
connection to be optimized

AMDA / CDPP:
Observational archive

LatHyS / LATMOS:
Plasma simulations



Plasma velocity at Mars: map = simu, dots = MarsExpress

Integrated services & tools:
connection to be optimized

GhoSST / IPAG:
Spectroscopy / ices

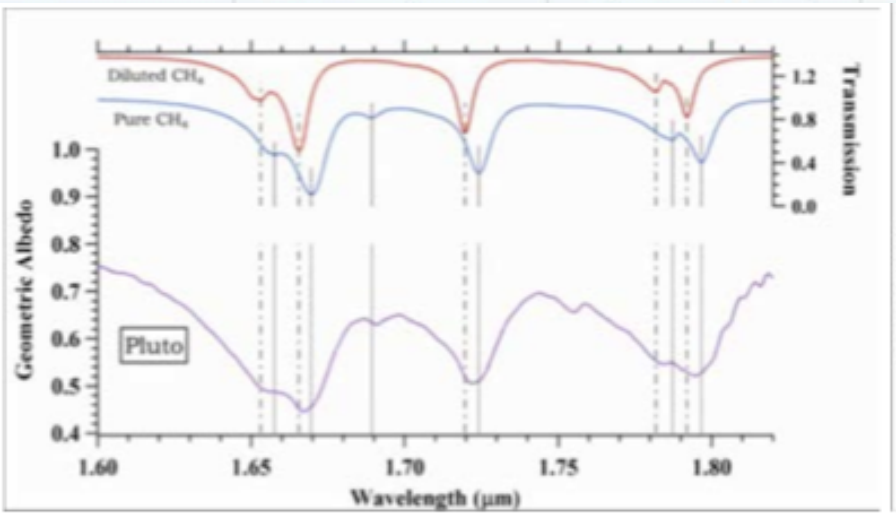
GhoSST

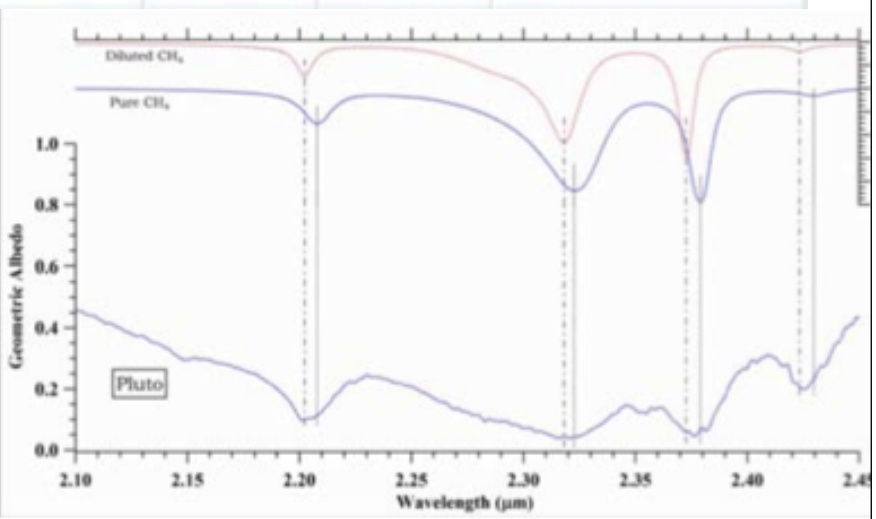
Spectrum

Request on CH_4 in NIR range

	ID	Type	Title	Sample	Spectral range min.	Spectral range max.	Sample temperature (K)	Species
	469	optical constants	NIR Optical constants spectrum of C	CH4 in beta-N2 crystalline	2000 cm-1	10000 cm-1	36.5	N2, CH4, CO2
	470	optical constants	NIR Optical constants spectrum of C	CH4 in beta-N2 crystalline	2000 cm-1	2235 cm-1	38	N2, CH4, CO2
	471	optical constants	NIR Optical constants spectrum of C	CH4 in beta-N2 crystalline	2000 cm-1	2235 cm-1	41	N2, CH4, CO2
	472	optical constants	NIR Optical constants spectrum of C	CH4 in beta-N2 crystalline	2000 cm-1	2235 cm-1	43	N2, CH4, CO2
	474	optical constants	NIR Optical constants spectrum of C	CH4 in alpha-N2 crystalline	2520 cm-1	2985 cm-1	35	N2, CH4, CO2
	506	absorption coefficient	Vis-NIR absorption coefficient spect	CH4 liquid	2380 cm-1	2970 cm-1	93	CH4, CO2
	518	absorption coefficient	Vis-NIR absorption coefficient spect	CH4 crystalline I	2000 cm-1	2986 cm-1	30	CH4, CO2
	519	absorption coefficient	Vis-NIR absorption coefficient spect	CH4 crystalline I	2000 cm-1	2983 cm-1	40	CH4, CO2
	520	absorption coefficient	Vis-NIR absorption coefficient spect	CH4 crystalline I	2475 cm-1	2979 cm-1	50	CH4, CO2
	521	absorption coefficient	Vis-NIR absorption coefficient spect	CH4 crystalline I	2000 cm-1	2976 cm-1	60	CH4, CO2
	522	absorption coefficient	Vis-NIR absorption coefficient spect	CH4 crystalline I	2000 cm-1	2973 cm-1	70	CH4, CO2
	523	absorption coefficient	Vis-NIR absorption coefficient spect	CH4 crystalline I	2000 cm-1	2971 cm-1	80	CH4, CO2
	524	absorption coefficient	Vis-NIR absorption coefficient spect	CH4 crystalline I	2000 cm-1	2968 cm-1	90	CH4, CO2
	526	absorption coefficient	Vis-NIR absorption coefficient spect	CH4 crystalline II	2000 cm-1	3002 cm-1	20	CH4, CO2
	572	transmission	MIR Transmission spectrum of 0.27	CH4 crystalline II - film 0.275µm	490 cm-1	6500 cm-1	15	CH4
	573	tr						
	574	tr						
	575	tr						
	576	tr						
	577	tr						

<< < Page 1 / 2 > >>





Fitting Pluto telescopic spectra

First data services

- EPN-TAP services:

  Public services at VO-Paris:

  - APIS: Aurorae images/spectra data base (HST)
  - BDIP: Historical planetary images in Meudon (ground-based)
  - Encyclopedia of Extra-Solar Planets (compilation of published data)
  - Atmospheric profiles of Titan (Cassini/CIRS)
  - IKS / Halley (Vega-1), M4ast (asteroid spectrosc.)
  - BaseCom (comets from Nançay), Jupiter radio observations (from Nançay)
  - Solar feature catalogues (from HELIO program)

  Projects at VO-Paris (from existing databases):

  TNO data compilation, VIRTIS/VEx & /Rosetta, mineral spectroscopy…

  Other services in development: Rome, Toulouse, Graz

- Other targeted data centres/services (with specific interfaces):

  AMDA (under test), ESO archive, GhoSST

- Space data centres accessible by VESPA (via **PDAP**):

  PSA and DARTS (ESA & JAXA archives, with minimal interface)

Europlanet-RI Horizon2020:

- Call for advanced communities (H2020-INFRAIA-2014-1-2015)
- Planetary Science is one out of 6 preselected communities
- Large budget (10 M€)
- British coordination (N. Mason, OU), deputy : Obs Paris (A. Coustenis)
- 32 partners in Europe
- Submitted September 2014, under review
- Expected kick-off mid 2015 — if selected

VO activities in Europlanet H2020:

- 2 Work Packages focusing on VO services in Europlanet H2020: **VESPA**

- 18 partners, including:

OV-Paris (Observatoire de Paris, IMCCE/LESIA), coordinator

IRAP, IPAG, LATMOS, GEOPS, CDS (CNRS)

IAPS/INAF Rome,

Jacobs Univ Bremen,

IWF Graz,

IASB Brussels,

UCL London,

IAP Prague,

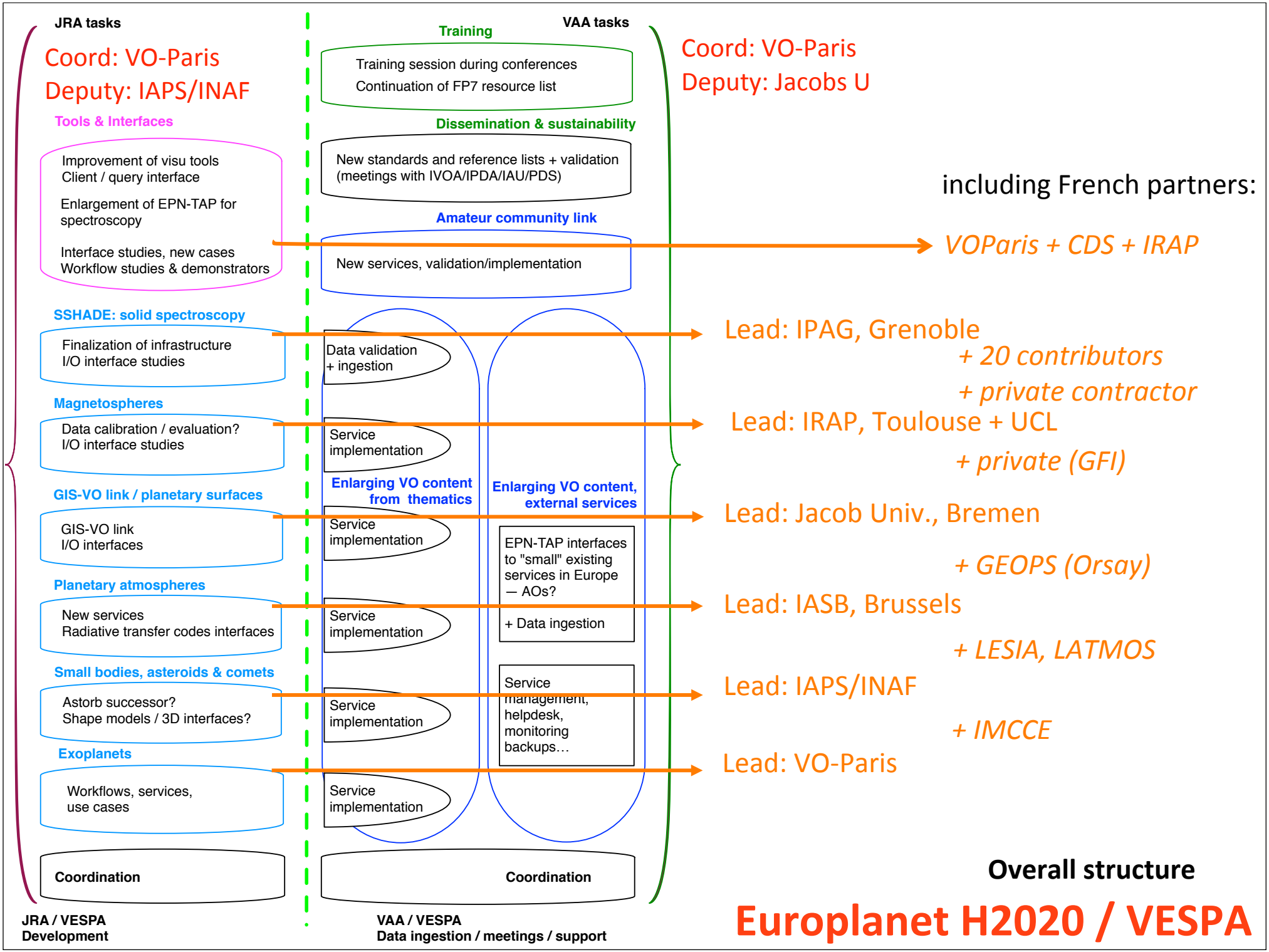
EHU Bilbao,

IGS Wroclaw,

Univ. Bern

Preliminary discussions on VO projects were held with potential French partners at national level, to reflect them at European level (support from PNP, ASOV, and CNES in 2014 is acknowledged)

Further support was requested to PNP for 2015 to bridge the gap between the two programs


JRA tasks
Coord: VO-Paris
Deputy: IAPS/INAF
Tools & Interfaces
Improvement of visu tools
Client / query interface
Enlargement of EPN-TAP for spectroscopy
Interface studies, new cases
Workflow studies & demonstrators
SSHADE: solid spectroscopy
Finalization of infrastructure
I/O interface studies
Magnetospheres
Data calibration / evaluation?
I/O interface studies
GIS-VO link / planetary surfaces
GIS-VO link
I/O interfaces
Planetary atmospheres
New services
Radiative transfer codes interfaces
Small bodies, asteroids & comets
Astorb successor?
Shape models / 3D interfaces?
Exoplanets
Workflows, services, use cases
Coordination
JRA / VESPA
Development
Training
Training session during conferences
Continuation of FP7 resource list
Dissemination & sustainability
New standards and reference lists + validation (meetings with IVOA/IPDA/IAU/PDS)
Amateur community link
New services, validation/implementation
Data validation + ingestion
Service implementation
Enlarging VO content from thematics
Service implementation
Service implementation
Service implementation
Service implementation
Enlarging VO content, external services
EPN-TAP interfaces to "small" existing services in Europe — AOs?
+ Data ingestion
Service management, helpdesk, monitoring backups…
Coordination
VAA / VESPA
Data ingestion / meetings / support
VAA tasks
Coord: VO-Paris
Deputy: Jacobs U
including French partners:
VOParis + CDS + IRAP
Lead: IPAG, Grenoble
+ 20 contributors
+ private contractor
Lead: IRAP, Toulouse + UCL
+ private (GFI)
Lead: Jacob Univ., Bremen
+ GEOPS (Orsay)
Lead: IASB, Brussels
+ LESIA, LATMOS
Lead: IAPS/INAF
+ IMCCE
Lead: VO-Paris
Overall structure
Europlanet H2020 / VESPA

Liens Europlanet / SO5

Utilisations typiques du VO:

Fouille d'archives:

- Les services doivent être VO *et* interopérables
- L'infrastructure Europlanet est un standard de fait en Europe, sans alternative ailleurs

Outils de traitement:

- Le std Europlanet est entièrement compatible IVOA et profite des outils maintenus par l'astronomie
- Ces outils seront adaptés dans le cadre H2020, avec les développeurs d'origine

Préparation d'observations télescopiques:

- Ephémérides (Miriad, interface VO): interfaçage à développer dans VESPA
- Outils de planification d'observations coordonnées (dans H2020)

Liens Europlanet / SO5

Structuration proposée des SO5:

Centres d'expertise + pôles thématiques + services de données / de calcul

Proposition PNP:

Plusieurs pôles "sous-thématiques" : petits corps, surfaces, atmosphères…

Point de vue Europlanet:

- Utiliser les développements communautaires européens
- Ne pas laisser diverger l'infrastructure généraliste via les "sous-thématiques"
- Préserver la possibilité d'études multithématiques
  (échanges surfaces / atmosphères, relations surfaces / vent solaire…)
- Lisser les interfaces externes (VAMDC, CDPP, astro…)

=> EPN-TAP doit être le standard pour les services de données SO5 en planéto

=> Besoin d'un pôle plus généraliste "Planétologie"